

The I2C and serial display driver provides easy operation of a standard 20 x 4 or 16 x 2 LCD Text display. It requires only a 5v power supply and the two data connections for either mode, freeing up pins on your processor.

Many useful text formatting functions are provided and also the ability to put together custom characters into memory which can be called off as required.

There is a 100 byte FIFO buffer to ensure a minimum of delay in writing to the display.

The LCD05 controller is our new generation LCD display driver and adds additional features to our previous LCD03 driver while being fully compatible in both software and pin-out.

### Device Highlights

- Adjustable backlight and contrast with software commands
- 100 byte FIFO buffer
- Start-up screen can be personalised
- 20x4 or 16x2 screens can be used
- Keypad automatically scanned
- Array of useful commands
- Custom character generation
- 5 useable addresses for I2C

### Current consumption (typical)

Display	Backlight off	Backlight on
20 x 4 green	5 mA	135 mA
16 x 2 green	5 mA	80 mA
20 x 4 blue	5 mA	55 mA
16 x 2 blue	5 mA	40 mA

### Serial/I2C Mode selection

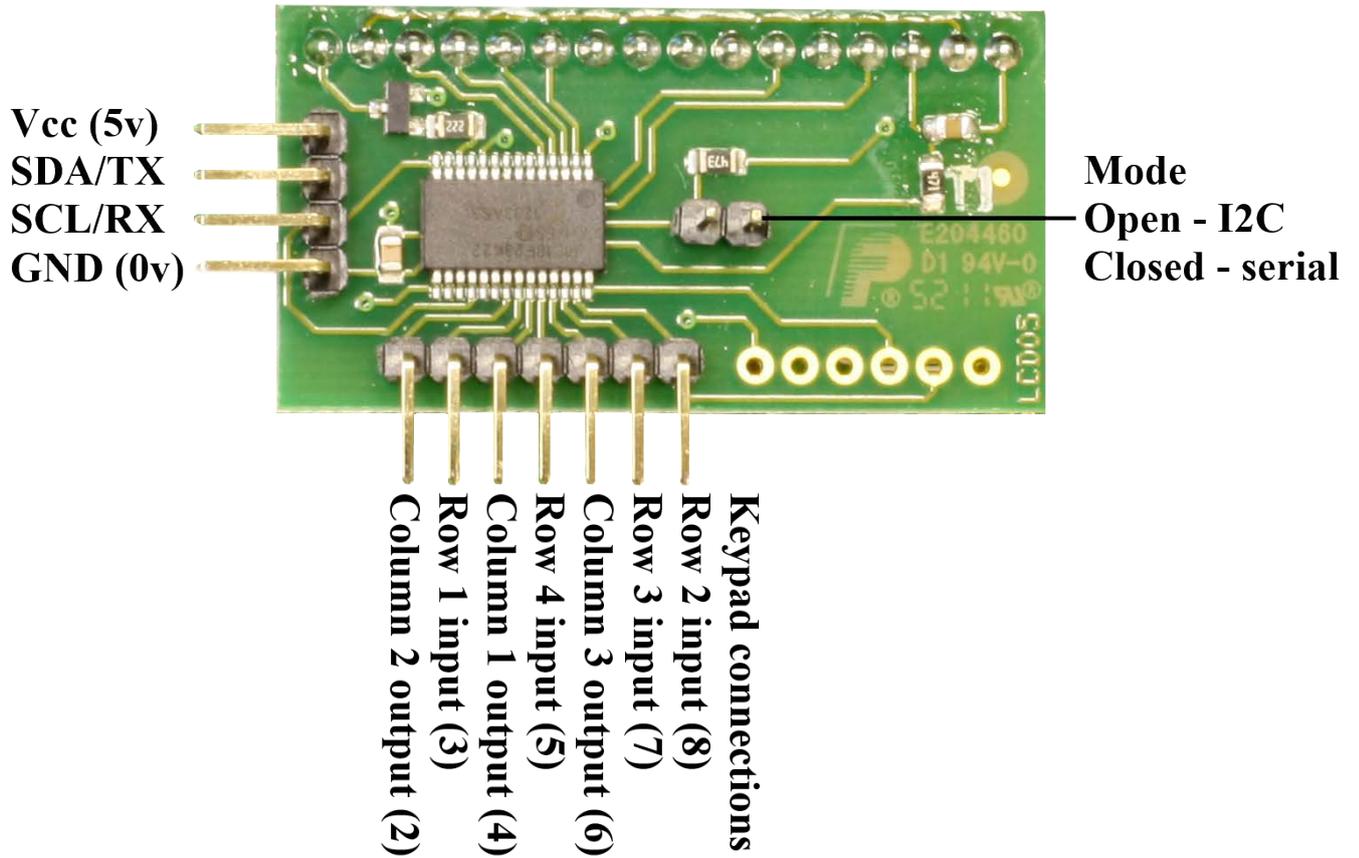
A single jumper link is used to select Serial or I2C mode. When the jumper is present (factory default) the module is in serial mode. When the jumper is removed the module is in I2C mode. The mode jumper is only checked as part of the power-up sequence, so make sure the display is off before changing modes. If you change the link position while the module is powered, nothing will change until next time you switch on.

### FIFO

Because the I2C communications operate faster than the display can accept data, all commands and text you send to the display are placed in the FIFO (First In, First Out) buffer. This data is sent to the display as fast as it will accept it. The FIFO is 100 bytes in length and the number of free bytes can be returned in either mode. When sending lots of text to the display, you should check the number of free bytes so you don't overflow the buffer. If the buffer does overflow, the excess bytes are ignored. The FIFO buffer exists in Serial mode too, but at 9600 the display is fast enough and you are unlikely to need to check it.

Connections

LCD03



Keypad



Easy connection  
for a 3 x 4 keypad  
Just wire pins 2-8  
to corresponding  
numbers in  
brackets above

## I2C operation

The I2C display is at an address of 0XC6. The SCL and SDA lines should have pull-up resistors on on the bus. You only require 1 pair of resistors for the whole I2C bus, not specifically for the LCD05. They are normally on the master controller and you may already have them. Anything between 1k8 and 10k should work.

## I2C registers

The LCD05 has four registers, three being read only information registers. Register 0 is a dual purpose register, when written it is the command register where all of the instructions from the commands section should be sent, when read it returns the number of free bytes in the FIFO buffer.

Register	Read	Write
0	Number of free bytes in FIFO buffer	Command register
1	Keypad state Low byte	x
2	Keypad state High byte	x
3	Version	x

## I2C commands

Decimal	Command	Description
0	null (ignored)	Ignored as a no operation
1	Cursor home	Sets the cursor to the home position (top left)
2	Set cursor (1-80/32)	Set cursor using the next byte, where 1 is the top left and 80/32 is the bottom right
3	set cursor (row, column)	Sets cursor using two bytes, where first byte is the row and the second byte is the column
4	Hide cursor	Stops the position cursor from appearing on the display
5	Show underline cursor	Changes the cursor to the underline type
6	Show blinking cursor	Changes the cursor to the blinking type
8	Backspace	Deletes the preceding character from the current position on the display
9	Horizontal tab (by tab set)	Moves the cursor position to next tab point set by command 18 (default tab space 4)
10	Smart line feed	Moves the cursor down one line to the position beneath in the same column
11	Vertical tab	Moves the cursor up one line to the position above in the same column
12	Clear screen	Clears the screen and sets cursor to the home position
13	Carriage return	Moves the cursor to the start of the next line
17	Clear column	Clears the contents of the current column and moves cursor right by one column
18	Tab set	Sets the required tab size, the following byte can be a size of between 1 and 10
19	Backlight on	Turns the backlight of the LCD05 on
20	Backlight off (default)	Turns the backlight of the LCD05 off
21	Disable start-up message	Disables the display of setup information at power up
22	Enable start-up message	Enables the display of setup information at power up
23	Save as start-up screen	Saves current screen and displays it on power up
24	Set display type	Sets which display is connected to the LCD05 (see changing display type below)
25	Change address	First byte of sequence to change LCD05 address (see changing address below)
27	Custom char generator	Allows 8 custom chars to be built. See custom char generator section
28	Double keypad scan rate	Increases the frequency of the keypad scan to 20hz
29	Normal keypad scan rate	Returns to the default keypad scan frequency of 10hz
30	Contrast set	Byte following this command will be contrast level (0-255)
31	Brightness set	Byte following this command will be brightness level (0-255)
32-255	ASCII chars	Writes ASCII chars straight to the display

## Changing address

The LCD05 software contains the facility to easily change the modules address on the I2C bus system in the range of 0xC6 - 0xCE ( even numbers only ). This is achieved by sending the following sequence: 0x19,0xA0,0xAA,0xA5 then 0xC6, 0xC8,0xCA,0xCC or 0xCE ( new address to map LCD05 at )

Current address is displayed every time the module is first powered as a default, this may be changed to no display or custom display by user command.

## Serial operation

The Serial mode operates over a link with a baud rate of 9600 bps (no parity, 2 stop bits) and 5v signals, Do NOT connect RS232 directly to the module - you will destroy it. Use a MAX232 or equivalent to convert the RS232 levels to 5v. Operation is with the same command set as the I2C mode with an additional set of commands to request data to be sent i.e. the software version.

## Serial commands

Decimal	Command	Description
0	null (ignored)	Ignored as a no operation
1	Cursor home	Sets the cursor to the home position (top left)
2	Set cursor (1-80/32)	Set cursor using the next byte, where 1 is the top left and 80/32 is the bottom right
3	set cursor (row, column)	Sets cursor using two bytes, where first byte is the row and the second byte is the column
4	Hide cursor	Stops the position cursor from appearing on the display
5	Show underline cursor	Changes the cursor to the underline type
6	Show blinking cursor	Changes the cursor to the blinking type
8	Backspace	Deletes the preceding character from the current position on the display
9	Horizontal tab (by tab set)	Moves the cursor position to next tab point set by command 18 (default tab space 4)
10	Smart line feed	Moves the cursor down one line to the position beneath in the same column
11	Vertical tab	Moves the cursor up one line to the position above in the same column
12	Clear screen	Clears the screen and sets cursor to the home position
13	Carriage return	Moves the cursor to the start of the next line
14	FIFO status	Returns the FIFO status, the number of free bytes up to 100
15	Software version	Returns a single byte module version
16	Keypad status	Returns keypad input status, two bytes low byte first (see keypad input section)
17	Clear column	Clears the contents of the current column and moves cursor right by one column
18	Tab set	Sets the required tab size, the following byte can be a size of between 1 and 10
19	Backlight on	Turns the backlight of the LCD05 on
20	Backlight off (default)	Turns the backlight of the LCD05 off
21	Disable start-up message	Disables the display of setup information at power up
22	Enable start-up message	Enables the display of setup information at power up
23	Save as start-up screen	Saves current screen and displays it on power up
24	Set display type	Sets which display is connected to the LCD05 (see changing display type below)
25	Change address	First byte of sequence to change LCD05 address (see changing address below)
27	Custom char generator	Allows 8 custom chars to be built. See custom char generator section
28	Double keypad scan rate	Increases the frequency of the keypad scan to 20hz
29	Normal keypad scan rate	Returns to the default keypad scan frequency of 10hz
30	Contrast set	Byte following this command will be contrast level (0-255)
31	Brightness set	Byte following this command will be brightness level (0-255)
32-255	ASCII chars	Writes ASCII chars straight to the display

### Contrast and brightness set

Contrast and brightness may be adjusted using software commands to vary the level between 0 and 255. Following a power cycle the LCD05 will automatically revert to a predetermined level for the display that is attached.

### Changing display type

Because there are four variations of the LCD display that the LCD05 connects to a software command can be used to switch between them. Firstly a command of 24 must be issued, this is then followed by the display type attached:

LCD style	Byte
20 x 4 Green	3
20 x 4 Blue	4
16 x 2 Green	5
16 x 2 Blue	6

### Custom char generator

Custom characters can be generated by sending an 8 byte map. The first thing that must be done is to send a command of 27 to indicate that you intend to make a custom char. Next you have to specify the position in ram of one of the 8 available chars you intend to build, the 8 chars are mapped at positions 128-135. Then the pattern should be sent as below.

How to calculate an 8 byte character pattern:

8 bytes are sent with the high bit masked on, the next two are ignored (x) and the final 5 bits show the line pattern.

	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Sent byte
Byte 0						1xx00000 (128)
Byte 1			■			1xx00100 (132)
Byte 2		■	■	■		1xx01110 (142)
Byte 3	■		■		■	1xx10101 (149)
Byte 4			■			1xx00100 (132)
Byte 5			■			1xx00100 (132)
Byte 6			■			1xx00100 (132)
Byte 7						1xx00000 (128)

So to build the above arrow into location 128 you would send this sequence to the command register:

27 (char generate command), 128 (location to be filled), 128, 132, 142, 149, 132, 132, 132, 128

Now the char is built into a memory location it can be called at any time as long as the module remains powered by simply sending the address between 128 and 135.

### Keypad input

An added feature of the module is the ability to connect a 3 x 4 Keypad, the module will automatically scan the status of the keys at regular intervals. The result is then provided in two bytes for easy use, shown by the diagram below. Each bit represents the row and column of each button on the keypad. The second row is the keypad characters when using our keypad.

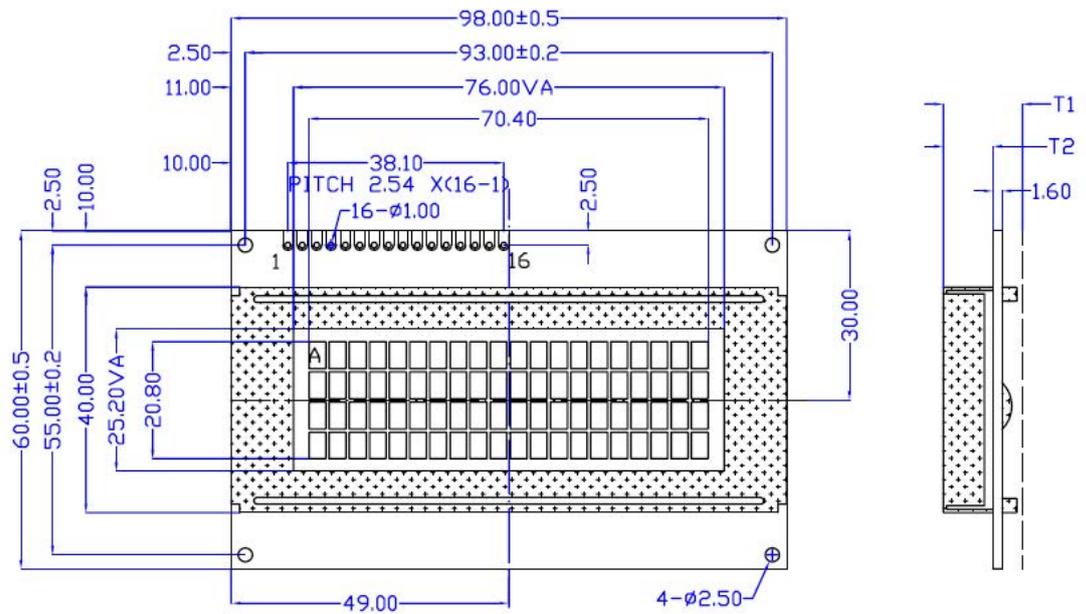
High byte								Low byte							
0	0	0	0	4/3	4/2	4/1	3/3	3/2	3/1	2/3	2/2	2/1	1/3	1/2	1/1
				#	0	*	9	8	7	6	5	4	3	2	1

Any key press will result in the corresponding bit in the byte being driven high. In I2C mode these bytes are available for reading from registers one and two.

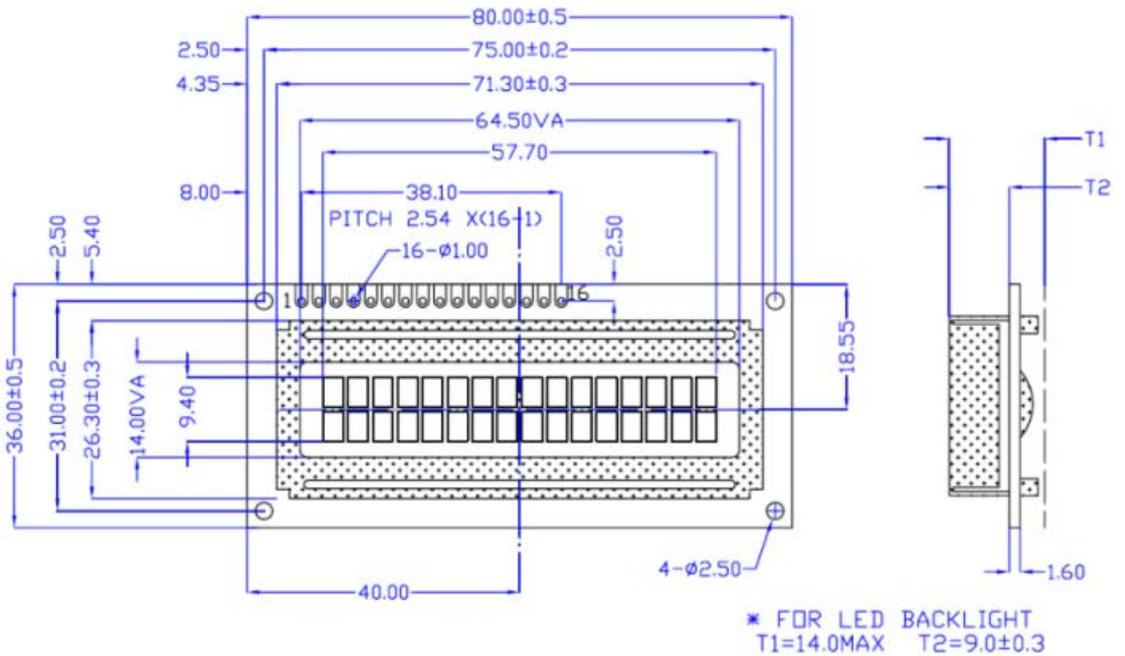
In serial mode, just send 16 to the LCD05 and it will reply with the two bytes as above with the low byte first.

Dimension data

20 x 4 LCD



16 x 2 LCD



Keypad

