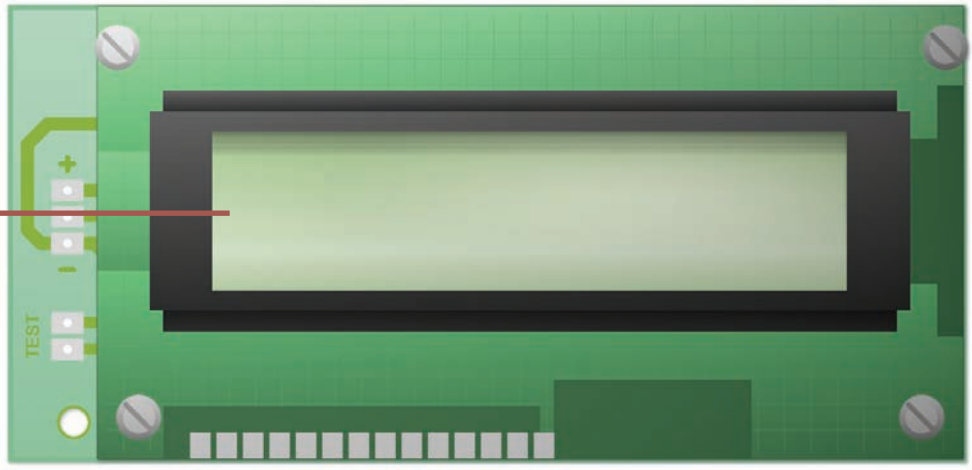
Introduction 1

Welcome to the GENIE Serial LCD module.

The GENIE Serial LCD module allows GENIE-based projects to display messages on a 16 character by 2 row liquid crystal display (LCD). This worksheet shows how to construct the LCD module and then explains how you can use it to connect to GENIE microcontrollers in order to output text and graphics.

Front (display) side

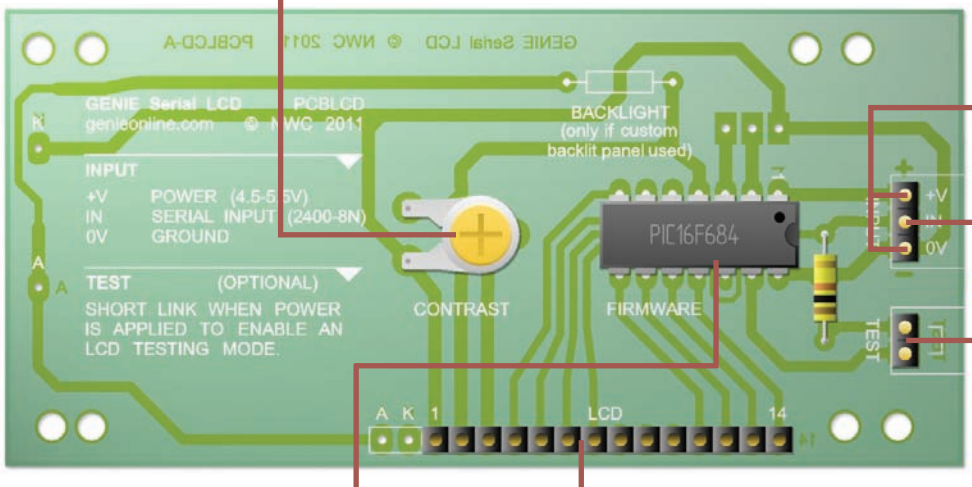


Liquid crystal display (16 characters by 2 rows)

Contrast dial: turn the dial to adjust the contrast of the display (see page 5)

Back (component) side

Power supply must be between 4.5 volts and 5.5 volts



Power connects here (red wire to '+V', black wire to '0V')

Serial signal from a GENIE microcontroller

Enables an LCD testing mode, see page 4 for details

Serial LCD control chip (this is not a GENIE chip)

Connection to LCD (on the other side of the board)

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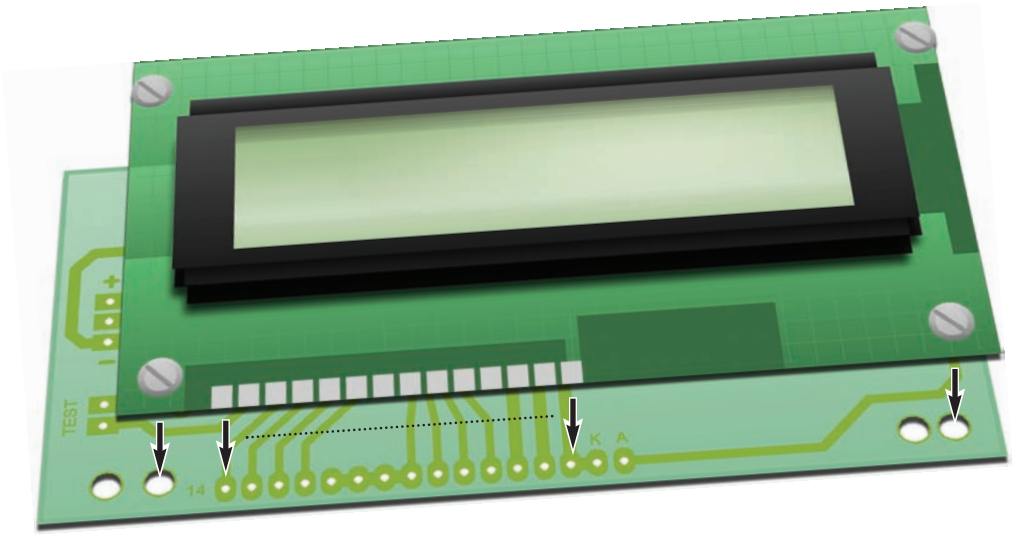
Making the LCD module 2

You can find out how to build the GENIE Serial LCD module by going through the steps below.

The liquid crystal display is normally mounted directly on to the back of the Serial LCD PCB, however more advanced users may wish to keep the display separate and connect it instead via a ribbon cable (not supplied). The instructions below and on page 3 are for direct mounting.



With direct mounting, the display is connected to the solder/track side of the PCB.

Ensure you have clean and tidy work area, access to a soldering iron, solder and the components for the Serial LCD module as listed on the right.

Switch on the soldering iron. It will only take a few minutes for the iron to reach its operating temperature. Once the soldering iron is hot, clean the soldering iron tip with a moist sponge.

Melt some solder at the chamfered end of the soldering iron tip. This is called 'tinning' and it will aid the flow of solder from the soldering iron to the copper track on the printed circuit board and component pins.

You should always remember to replace the soldering iron back into the stand after soldering and repeat cleaning the tip of the iron with the moist sponge before the start of each soldering operation.

These instructions are continued on page 3.

Components List

This is what you will need:

Component	Quantity
16 x 2 liquid crystal display	1
GENIE serial LCD PCB (PCBLCD)	1
GENIE serial firmware IC	1
14-pin dual-in-line (DIL) socket	1
10-way single-in-line (SIL) connector	2
4.8mm spacers	4
10k ohm potentiometer	1
10k ohm resistor *(brown, black, orange, gold)*	1

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Making the LCD module 3

With the soldering iron, solder and components ready, complete each of the following steps in order:

1 Take one of the 10-way SIL connectors and break it into lengths of 4 and 6.

2 With the 4-way connector and the remaining 10-way connector, push the black plastic to one end and insert both connectors into the holes marked 'LCD' (they should fit from the '1' to the '14' numbered on the PCB). The long connector pins need to be on the track side of the PCB. Solder the connectors in place, taking care not to bridge (join) the individual connector pins together.

3 Solder the 10k resistor, 14-pin dual-in-line (DIL) socket and 10k potentiometer in place; 'BACKLIGHT' is optional (see below).

4 Take the remaining 6-way SIL connector and break into lengths of 3, 2 and 1. Only the lengths of 3 and 2 are needed.

5 Solder the 3-way SIL connector to the connections marked 'INPUT', with the long pins on the component side of the board.

6 Solder the 2-way SIL connector to the connections marked 'TEST' in the same way.

7 Trim the resistor's legs. Do not trim any of the other componentlegs.

8 Carefully insert the spacers into the holes shown below on the solder/track side. The tight fitting is expected and is to stop the display from becoming loose once made.

9 Attach the LCD to the solder/track side of the PCB. The spacers should fit holes in the LCD and the 14 connection pins should also fit in a corresponding set of holes, typically numbered 1 to 14. Solder the 14 connection pins in place on the display-side of the LCD.

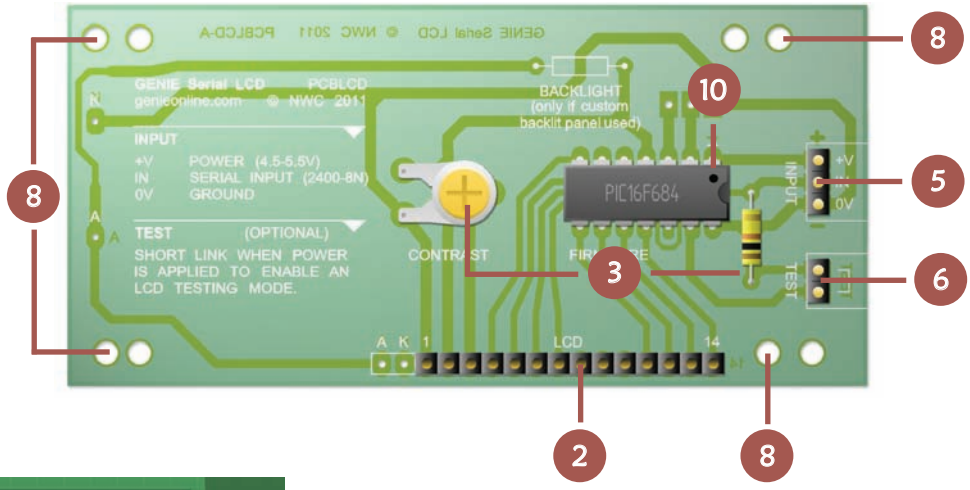
10 Insert the firmware IC into the 14-pin socket on the PCB. Take note of the orientation of the chip. The dot next to pin 1 needs to be next to the '1' indicated on the board.

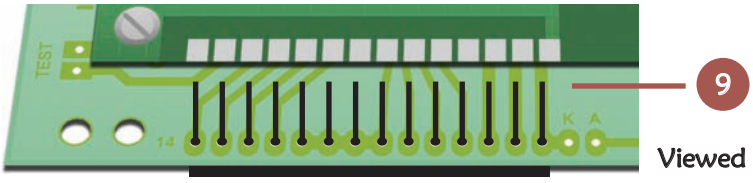
11 Test your LCD as shown on page 4.

The 'BACKLIGHT' is where you would fit a current-limiting resistor if you have a custom backlit LCD along with the 'A' and 'K' connections, which are for the backlight power supply.

The LCD that is supplied with the GENIE Serial LCD module does not include a backlight and therefore neither this resistor nor the 'A' and 'K' connections are needed.

Viewed from component side





Viewed from display/track/solder side

You can use the unused holes for mounting the module within a larger project.

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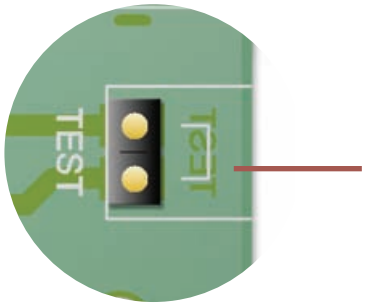
Testing the LCD module 4

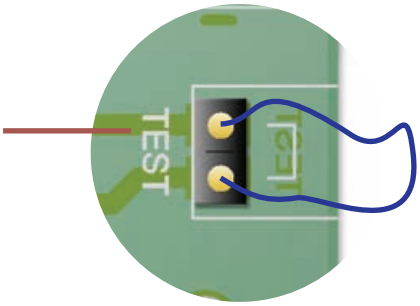


Once you have constructed the serial LCD module, you can make use of a special, built-in testing mode to ensure that the display is working correctly.

On the edge of the component side of the board you will find two connections marked 'TEST' (see the picture on the left).

Under normal use, these two 'TEST' pins should be left unconnected.

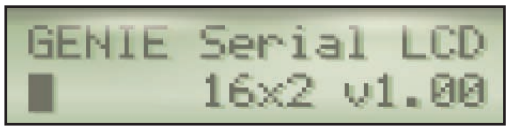
If, however, you connect a wire between these pins (this is also known as 'shorting' the pins) when power is applied to the LCD module, the module will enter its own testing mode. This mode described below.



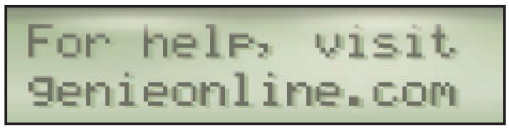
Power supply must be between 4.5 volts and 5.5 volts.

Once in testing mode, the display will show a series of messages to test different aspects of the LCD.

You can disconnect the wire from the 'TEST' pins at this point since testing will continue until power is removed. If you cannot see any of the test messages, try adjusting the 'CONTRAST' dial (see page 5).



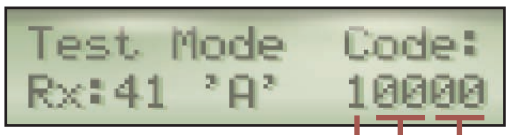
The first message to appear will be a title along with the version number of the Serial LCD firmware being used.



Next, a help message is displayed. You can access more information and support for building GENIE-based projects at our website: **genieonline.com**.

Following the help message, the Serial LCD module will display each character in turn.

There are 256 characters supported by the display, and these are shown in 16 groups of 16 characters. The range of each group is shown in hexadecimal (see the table on page 11).



Status (bit 0 set=waiting, bit 1 set=overflow)

Bytes waiting in the buffer

Total received bytes count

Once all of the characters have been displayed, the module will enter a permanent (until power is removed) input testing mode. In this mode, the values of any data bytes sent to its serial input pin will be displayed.

You can use this mode to see if your data is being received.

'Rx' shows the data value in hexadecimal and is followed by the actual character. 'Code' is a hexadecimal number that describes the state of the module's serial input buffer.

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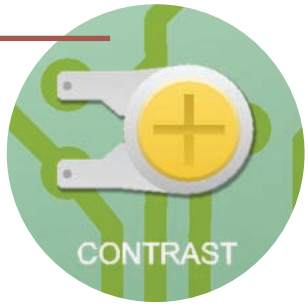
Adjusting the contrast 5

Contrast determines how light or dark text appears on the display.

To adjust the contrast, turn the 'CONTRAST' dial located on the component side of the Serial LCD module.

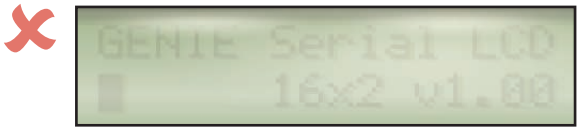


Note that the contrast of the display will vary depending on the power supply voltage. As the power supply falls, so will the contrast; you can use the 'CONTRAST' dial to adjust for this fall.

Setting the correct contrast level

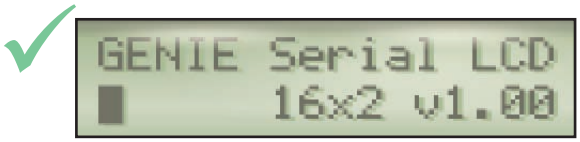
You can only adjust the contrast when there is text on the display. One quick way to make text appear on the display is to use the testing mode described on page 4.

Adjust the dial until the text is clearly readable. Use the pictures below as a guide.



With the contrast dial set too low, the text will appear faded (or even not appear at all).

Set too high, the contrast dial will make even the blank parts of the display appear dark.



When the contrast dial is set correctly, the text on the display will be clear and easily visible.

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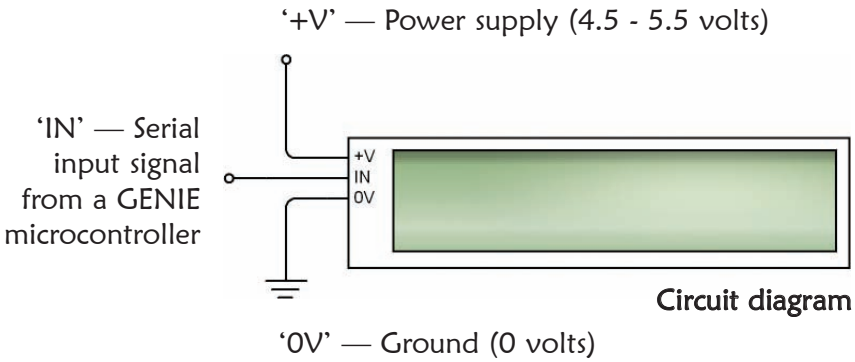
Connecting to GENIE 6

With the Serial LCD module built and tested, it needs to be connected to a GENIE microcontroller. It is the GENIE that will provide, through its program, the intelligence to decide on what should be displayed.

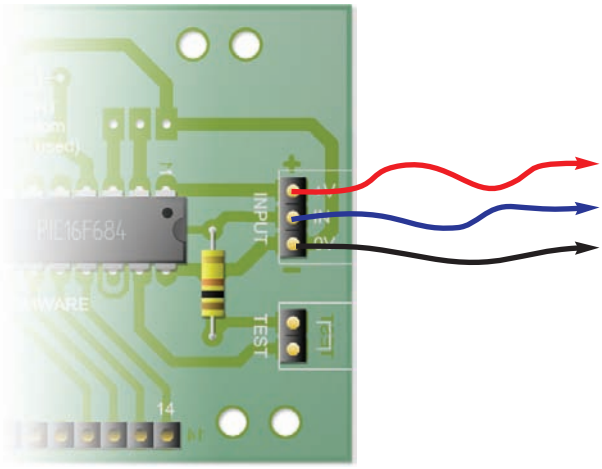
Connect the Serial LCD module as shown here.

On the right is the circuit diagram and below is the real-life module.



Circuit diagram

Real-life module



'+V' — Power supply (4.5 - 5.5 volts)
'IN' — Serial input signal from a GENIE microcontroller
'0V' — Ground (0 volts)

The 'TEST' pins must be left unconnected unless you are following the testing steps shown on page 4.

Serial input connection

Wire the 'IN' pin on the Serial LCD module to a GENIE output. See page 7 for our recommendations.

This input pin needs to receive serial data sent at 2400 bits per second, with 8 bits per character, no parity and at CMOS logic levels; sometimes referred to as 2400-8N format. Note that if you are using GENIE's LCD command (described on pages 8 and 9), the serial format will be handled automatically.

Because the serial input requires a voltage that is at CMOS logic levels, you should not connect this pin to the output from a transistor or any other type of driver; instead always take the signal directly from one of GENIE's output pins.

Power and ground connections

The '+V' (power) and '0V' (ground) connections must also be wired up. You may be able to share these with the power from the GENIE board if it is at a suitable voltage (4.5 - 5.5 volts).

Remember to check the contrast (see page 5) after changing the power supply, since the power supply voltage can affect the clarity of any text shown on the display.

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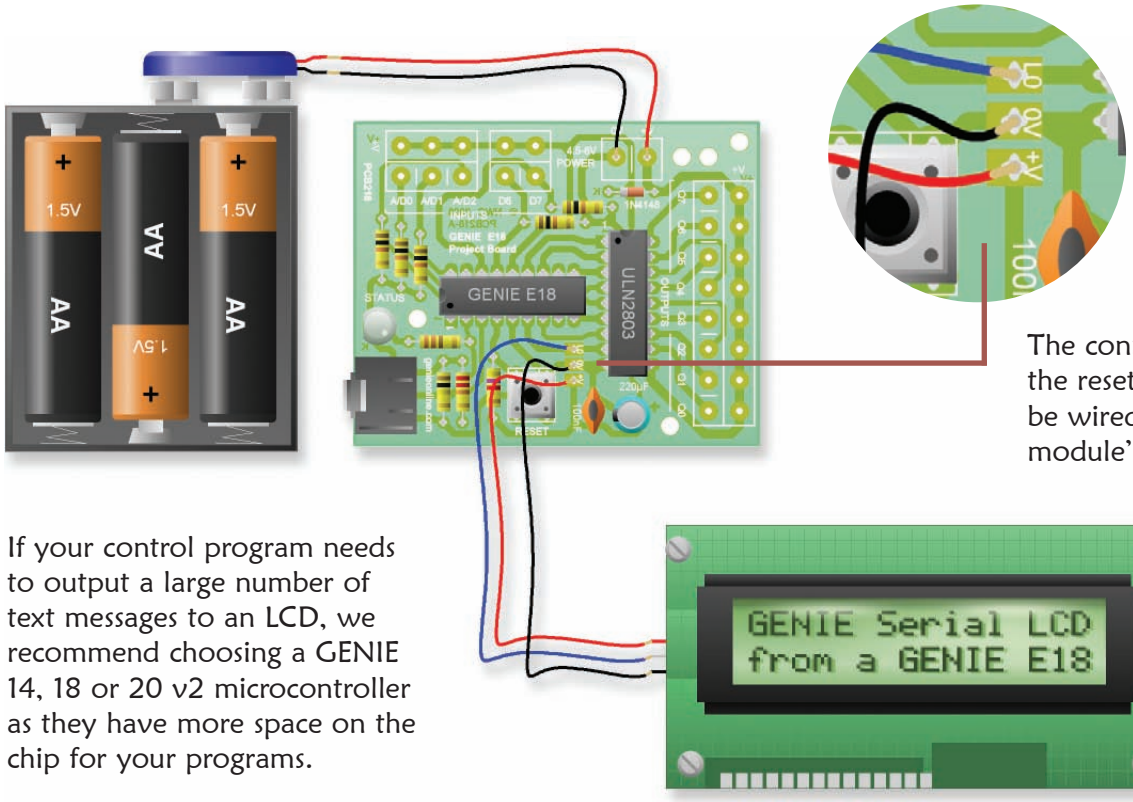
Connecting to GENIE 7

Some of the standard GENIE boards provide connections ideal for linking to an LCD. The following table lists the recommend ways of connecting each GENIE microcontroller to the Serial LCD module:

GENIE microcontroller	Recommended board and output signal
GENIE 08 or C08	Use the GENIE 08 Project Board (PCB208) and select output 'G2' for the serial signal. 'G4' cannot be chosen because of the transistor.
GENIE 14 or C14	Use the GENIE 14 Project Board (PCB214) and choose between outputs 'Q1' and 'Q2' for the serial signal. Alternatively, you can use the LCD output 'Q3' on the GENIE Audio Board (PCB-A14).
GENIE 18 or E18	Use the GENIE 18 Project Board (PCB218) and select the 'L0' output next to the reset switch. You can see this in the picture below.
GENIE 20 or C20	Use the GENIE 20 Project Board (PCB220) and choose between outputs 'L0' and 'L1' for the serial signal. You must use the logic ('L') outputs next to the GENIE chip rather than the ULN2803 driver ('Q') outputs.
GENIE E28	Use the GENIE 28 Project Board (PCB228) and choose any of the logic ('L') outputs situated next to the GENIE chip.

You can see below how to wire-up a GENIE 18 microcontroller to the Serial LCD module.



The connections are near to the reset switch. 'L0' should be wired to the Serial LCD module's 'IN' pin.

If your control program needs to output a large number of text messages to an LCD, we recommend choosing a GENIE 14, 18 or 20 v2 microcontroller as they have more space on the chip for your programs.

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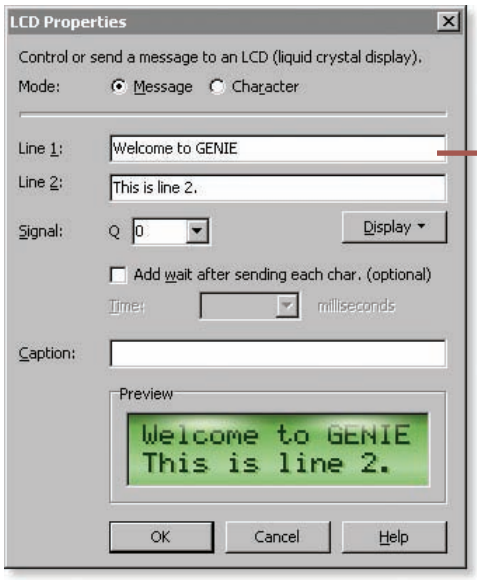
Displaying text messages 8

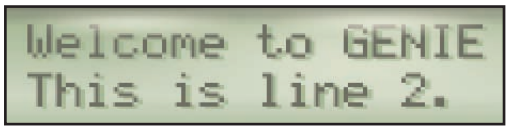
The **LCD** flowchart command allows you to output messages on the liquid crystal display.

In the command, select the **Message** option and then type your text into the **Line 1** and **Line 2** boxes. You can have up to 16 characters appear on each line.



The **Signal** box needs to be the number of the output signal to which the Serial LCD module has been connected.

Once run, the message will then appear on the display:



The other settings in the window are optional.

You can, for example, use the **Add wait after sending each char.** option (along with a suitable time, such as 100 milliseconds) so that the text appears more slowly, one character at a time.

Clicking on the **Display** button brings up a menu that shows a range of special codes for displaying values such as variables and analogue sensor readings.

These special display codes are all enclosed in square brackets, '[' and ']'.

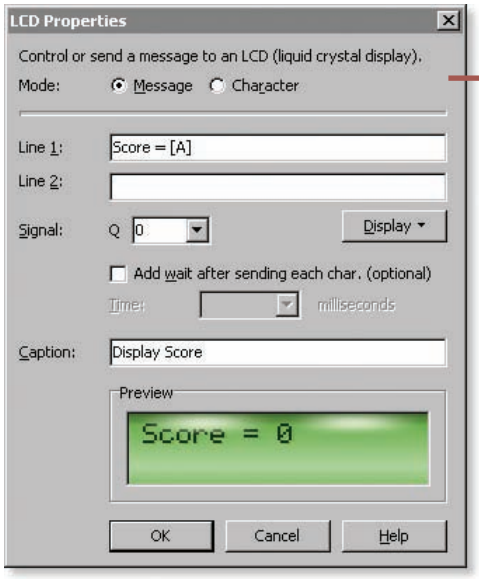
To display the value of a variable, for example, you can include the code '[A]' in one of the **Line** boxes, as shown here.

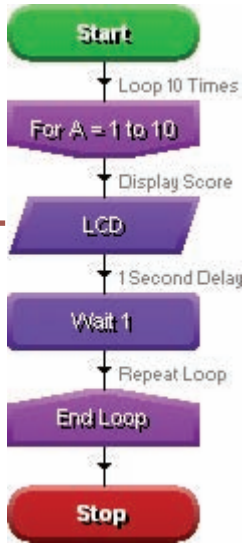
The variable will be displayed in decimal, so if variable A contained the value 100, the command on the right would output 'Score = 100'.

The flowchart on the far right uses the variable A in a loop, displaying each score value from 1 to 10 in turn.

A **Wait** is included so that the display doesn't change too fast to read.

You can learn more about using these display codes on pages 9 and 10.





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Creating and displaying graphics 9

In addition to displaying text and numbers, the Serial LCD module allows you to create and display up to eight custom graphics. Each graphic is made up of 8 rows and 5 columns of dots.

Default graphics

Eight custom graphics are pre-programmed into the Serial LCD module. These are shown on the right.

You can show these graphics on the display by using the '[...]' codes indicated. So for example to display the person icon, use code '[8]'.

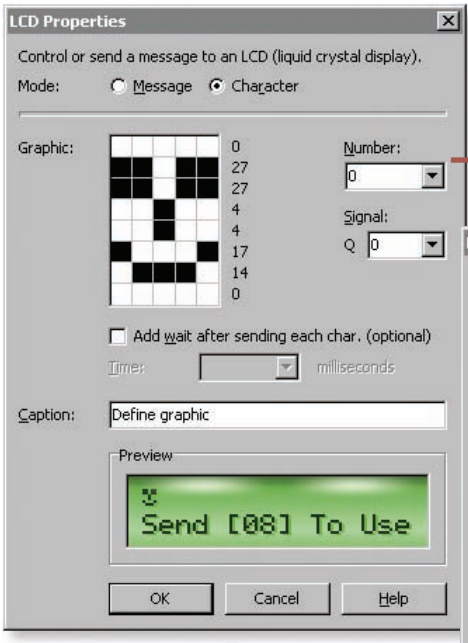
[8] [9] [10] [11] [12] [13] [14] [15]

The default graphics are (from left to right): person, locked padlock, unlocked padlock, musical note, loudspeaker, play, pause and stop.

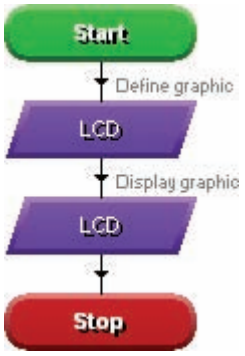
Custom graphics

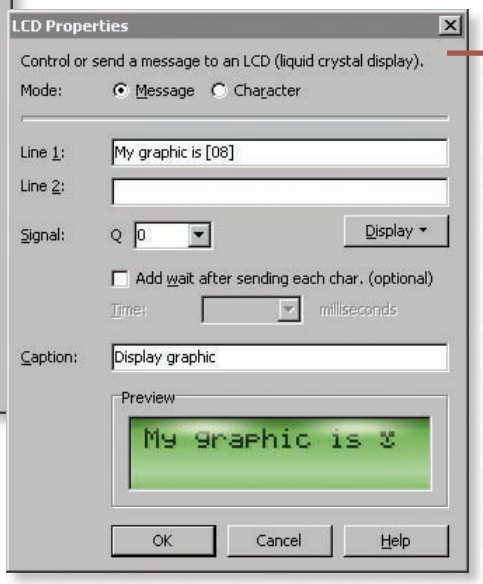
In addition to using the built-in graphics, you can also define your own graphic characters. This can be done by using the **LCD** command and selecting the **Character** option.

For example, the flowchart below will display the message shown on the right, incorporating a 'smiling face' graphic:



Click on the graphic to set or clear the individual dots.





Signal should be the output to which the Serial LCD module is connected.

Select the graphic to be changed in the **Number** box. It should be between 0 and 7.

The **Character** option will only define the graphic, not show it on the display. To show a custom graphic, add a second **LCD** command after the first, but this time using the **Message** option.

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Advanced display control 10

For more advanced users, or those using the BASIC programming language, direct control over the Serial LCD module is available through a range of special display codes:

LCD display code	Description
[home]	Restore display and move back to top-left.
[line 1..2]	Move to start of specified line.
[move *X Y*]	Move cursor to a given position (0 0 is home).
[left]	Move cursor one place to the left.
[right]	Move cursor one place to the right.
[scroll 0..2]	Scroll entire display left (1), right (2) or cancel (0).
[clear]	Clear contents of display.
[blank]	Hide (but do not clear) display.
[restore]	Restore a blanked display.
[cursor 0..2]	Set cursor display as a block (1), line (2) or hidden (0).
[char *index data0 data1 ... data7*]	Define a custom graphic character.
[pause *value*]	Include a millisecond delay during the output.
[*number*]	Output the given character code. *Number* should be replaced by the code of the required character (see page 11).
[*variable*]	Display the contents of a variable in decimal.
[bin *variable*] or [hex *variable*]	Display the contents of a variable in binary or hexadecimal (only available on the GENIE ELITE microcontrollers).
[*#variable*]	Display the character given by the value in the variable.

To access these display codes using flowcharts, use the **Message** option in the **LCD** command then click on the **Display** button and untick the **Clear Screen** option. Once done, type the code in the **Line 1** box.

With BASIC, the display code can be added to the **lcd** command's output string, for example:

```
rem display a message on an LCD connected to output Q0
lcd 0, "[clear]Welcome to GENIE[line 2]This is line 2."

rem define a custom "smiling face" graphic
lcd 0, "[char 0 0 27 27 4 4 17 14 0]"

rem display a custom graphic
lcd 0, "[8]"

rem output the value of variable C (100) in decimal
C = 100
lcd 0, "Score = [C]"

rem output character determined by the contents of variable C (65 = "A")
C = 65
lcd 0, "[#C]"
```

Tip! To display '[' or ']', use codes '[91]' and '[93]' instead.

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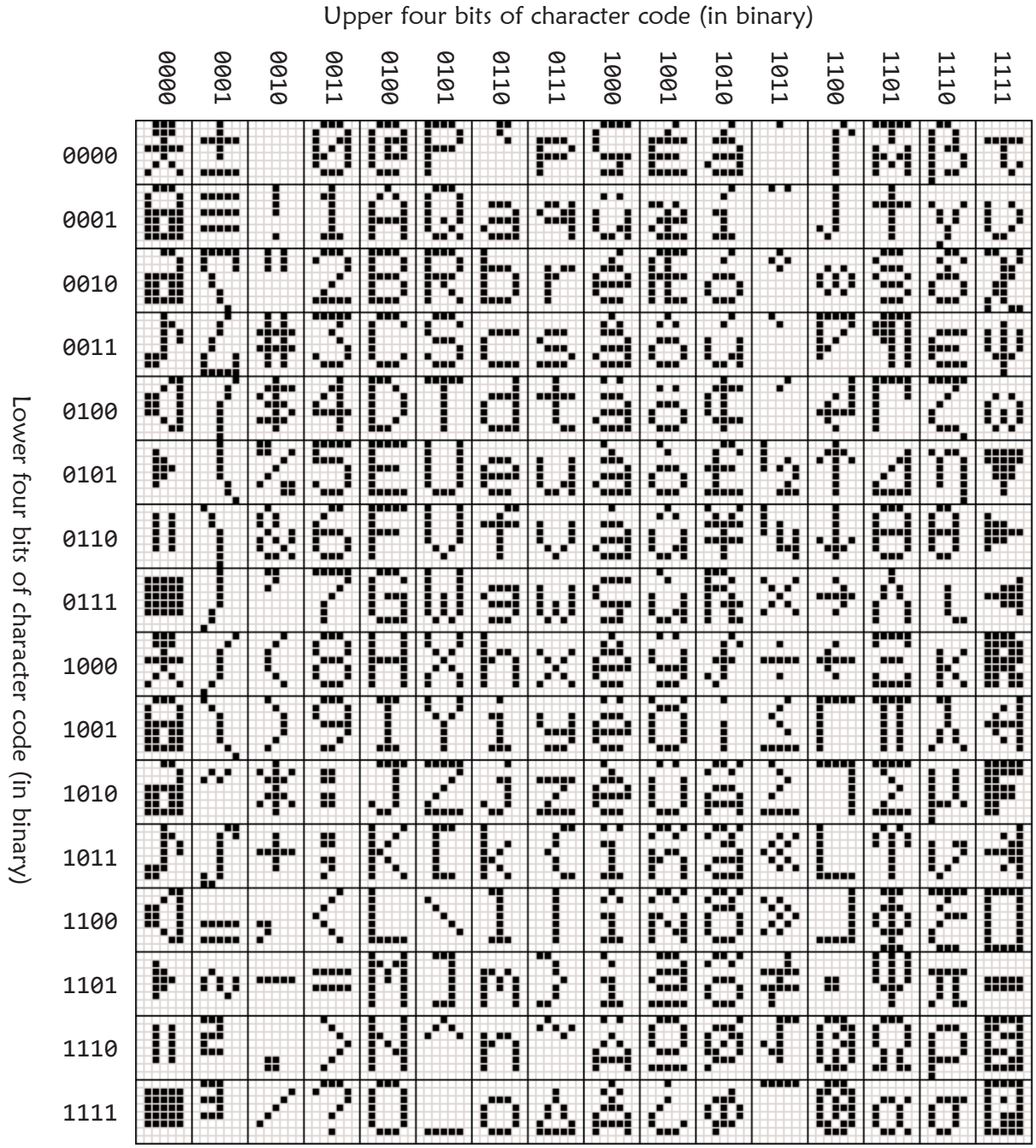
LCD character set 11

The table below shows the codes for each character supported by the LCD module†. Each code is made up of four upper bits (at the top) combined with four lower bits (on the left) to make an 8-bit code.

Codes 254 and 255 cannot be used as they are required for supporting the display codes on page 10.



† Character codes 0 to 7 are the same as codes 8 to 15. Codes 16 to 31 and above 127 are manufacturer-specific and can change.

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