LCD Micro Serial/I²C Interface Module for R.G.B backlights

Technical Data

DS-LCDD5

Features

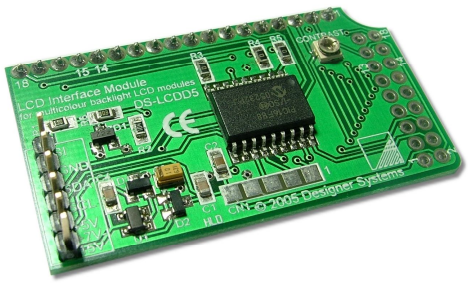
- **Supports new LCD panels with RGB backlights*.**
- **Micro size (53 x 29mm) to piggy-back on the LCD module and form a compact solution.**
- **Simple RS232 serial or I²C transfer of characters to the LCD from PC, BASIC Stamp, OOPic & other microcontroller modules.**
- **Serial/I²C selectable Backlight colour and brightness, No. of lines and serial baud rate (1200-9600bps).**
- **LCD contrast variable with on-board control.**
- **Low power operation from 5Volt regulated supply and/or 7-15V supply using on-board regulation.**
- **Supports 16x2, 20x2, 40x2 & 20x4 LCD modules.**
- **No learning curve to get characters on the LCD.**

Description

The DS-LCDD5 module provides a simple means of connecting any device capable of standard RS232 serial or I²C communication to a Liquid Crystal Display (LCD) module of 16 x 2, 20 x 2, 40 x 2 or 20 x 4 character/lines featuring a RGB backlight.

The DS-LCDD5 provides complete control of character placement, customisation and cursor movement to ensure that your application is up-and-running in a fraction of the time necessary to implement the standard LCD control protocol.

The DS-LCDD5 also features on-board supply regulation for both LCD supply and backlight, and also includes fully 'jumperless' setup of internal features over the serial/I²C link. These include 256 levels of RED, GREEN and BLUE (RGB) backlight colour, internal backlight colour pulsing with variable speed, serial baud rate (9600 baud default), number of display lines and I²C address.



The module simple piggy-backs on the LCD module to form a compact solution.
Controlled by a Microchip PIC FLASH microcontroller the module can be re-programmed from the standard LCD routines with client specific code to form any HID type application e.g. Serial terminal, door entry etc.

Applications

Simple HID applications within robotics, programming, user feedback, industrial control and monitoring.
Visual feedback in both amateur and professional applications.

INTERFACE MODULES

Selection Guide

Description	Part Number
LCD Interface Module with serial/I2C control and RGB backlight control	DS-LCDD5

* Please check with LCD panel provider to ensure compatibility.

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Power requirements

The DS-LCDD5 & LCD module requires either an external 5Volt regulated supply and/or a 7-15Volt un-regulated supply; both supplies can be connected simultaneously. The 7-15V supply can be derived from a mains adaptor or a battery pack. Current consumption is approx. 3.5mA excluding backlight, or from 3.5-30mA including backlight (colour/brightness dependant).
The six (6) pin header, see table below, is used to connect to either supply by connecting between 5V & GND and/or 7-15V & GND.
Note: Observe polarity to prevent damage!

LCD Contrast

The DS-LCDD5 has a 'CONTRAST' control which is provided to set the display contrast to the desired level.
Note: This control should not be continually adjusted as this may lead to malfunction.

LCD Connections

The DS-LCDD5 features two LCD connections to support both Single-In-Line (SIL) and Dual-In-Line (DIL) LCD modules. Both connections are easily soldered to the required LCD module using an 18 pin SIL pin header, 18 pin (9+9) DIL pin header or alternatively a flexible wire connection.
Note: Incorrect connection may damage the DS-LCDD or LCD module.

RS232 (serial) connection

The DS-LCDD5 supports RS232 serial communication and control. Connection to the module is through a six (6) pin header, pinned as follows:

Header pin	Connection Designation
1	SI (Serial input)
2	GND (Signal ground)
3	SDA (I2C data)
4	SCL (I2C clock)
5	+5V (Regulated Supply)
6	+7-15V (Unregulated supply)

There are two popular forms of RS232 interfacing, standard and inverted TTL, the latter not actually being defined under the RS232 specification but being popular with the microcontroller community as no interface IC is required.

The DS-LCDD5 supports both formats and can therefore be used with most microcontroller modules such as the OOpic-R and BASIC Stamp and any modern PC fitted with a serial port.

Connection examples:
To connect a PC fitted with a standard DB9 serial port pin 3 on the DB9 connector should connect to 'SI', pin 5 to 'GND' and pin 2 to 'SO'.
Additional connections may be required to allow serial communication to take place on the PC, these being wire links from 1 to 4 & 6 and 7 to 8 on the DB9 connector.

To connect a PC fitted with a standard DB25 serial port pin 2 on the DB25 connector should connect to 'SI', pin 7 to 'GND' and pin 3 to 'SO'.
Additional connections may be required to allow serial communication to take place on the PC, these being wire links from 20 to 6 & 8 and 4 to 5 on the DB25 connector.

A readymade PC cable fitted with a DB9 connector is available (P.n. DS-L232CAB3) that will also power the LCD module from the PC serial interface (with backlight disabled).

RS232 (serial) commands

Characters for display on the LCD module are sent to the DS-LCDD5 in the form of ASCII codes of value $32_{decimal}$ (20_{hex}) to $127_{decimal}$ ($7F_{hex}$). These characters are displayed as text on the LCD module at the current cursor position.
Text can be displayed very simply from a PC and many Microcontroller based controllers such as the OOPic (II), BS2, BASIC Stamp etc. by writing a serial out command with a string value.

Examples:
Savage Innovations OOPic-R:

```
RS232.Baud = cv9600              '9600 baud
RS232.Mode = 0                   'Async mode
RS232.Operate = cvTrue           'Enable
RS232.String = "Display Test"    'Send text
```

Parallax BASIC Stamp:

```
SEROUT 0, N9600, ("Display Test")  '9600 baud
```

The default serial requirements are:

9600 baud
8 Data bits
1 Stop Bit
No Parity
No handshaking (if configurable)

Tip: If character errors appear on the LCD display when sending from a fast PC then set Stop bits to 2.

LCDD5 control commands
To allow the setup of backlight colour/brightness, new serial baud rate etc. the module supports a control command format.
To place the DS-LCDD5 into control command mode $255_{decimal}$ (FF_{hex}) must be sent before the following instruction codes/values:

Command	Dec	Hex
Backlight - OFF	0	00
RED pulsing	1	01
GREEN pulsing	2	02
BLUE pulsing	3	03
BLUE/GREEN pulsing	4	04
RED/BLUE pulsing	5	05
RED/GREEN pulsing	6	06
RGB pulsing	7	07
Not implemented	8	08
Not implemented	9	09
Not implemented	10	0A
Not implemented	11	0B
Not implemented	12	0C
Not implemented	13	0D
Colour scan	14	0E
Backlight - ON	15	0F
BAUD rate - 1200baud	16	10
BAUD rate - 2400baud	17	11
BAUD rate - 4800baud	18	12
BAUD rate - 9600baud	19	13*
LCD 1 line display	32	20
LCD 2 line display	33	21*
RED backlight setup	48	30
GREEN backlight setup	64	40
BLUE backlight setup	80	50
Pulse speed setup	96	60

* Factory defaults

Serial baud rate and LCD lines are stored within non-volatile memory to ensure recall upon the next power-up.
The backlight defaults to 'OFF' on every power-up.
Values 0 to 15 control the operation of the RGB backlight to allow it to be turned ON ($15_{decimal}$), turned OFF ($0_{decimal}$) or set to a pulsing display.
The pulsing speed is controlled by sending a speed value of one (1) $_{decimal}$ (fastest) to $255_{decimal}$ (slowest) by writing the 'Pulse speed setup' value $96_{decimal}$ followed by the speed value itself.

Examples:
To turn ON the backlight, and set it to colour scan at slow speed, send decimal values:

255, 15, 255, 14, 255, 96, 255

Turn ON the backlight, and set it to BLUE pulsing at medium-fast speed, send decimal values:

255, 15, 255, 3, 255, 96, 64

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The DS-LCDD5 also allows the RGB backlight to be set to any colour in the RGB spectrum.

Examples:

To turn ON the backlight, and set it to the R.G.B value of 254 $_{decimal}$, 128 $_{decimal}$, 192 $_{decimal}$ (Pink), send decimal values:

255, 15, 255, 48, 254, 255, 64, 128, 255, 80, 192

To turn ON the backlight, and set it to the R.G.B value of 84 $_{decimal}$, 134 $_{decimal}$, 171 $_{decimal}$ (Blue grey), send decimal values:

255, 15, 255, 48, 84, 255, 64, 134, 255, 80, 171

Note: Ambient light conditions may cause differences in colour representation. Experimentation with colour values will deliver the best performance.

LCD control commands

To allow the control of cursor position, clear display and scroll etc. the LCD module also supports a command format. To place the DS-LCDD5 into command mode $254_{decimal}$ (FE_{hex}) must be sent before the following instruction codes:

Command	Dec	Hex
Home (abort scroll)	0	00
Clear display	1	01
Blank display (text not cleared)	8	08
Cursor OFF or restore after blanking	12	0C
Cursor ON & blinking	13	0D
Cursor ON & underline	14	0E
Move cursor left	16	10
Move cursor right	20	14
Scroll display left	24	18
Scroll display right	28	1C

The following examples for the OOPic (II), BS2 and BASIC Stamp issues a clear display command and then reverts back to waiting for text input:

Savage Innovations OOPic-R:

```
RS232.Baud = cv9600          '9600 baud
RS232.Mode = 0               'Async mode
RS232.Operate = cvTrue       'Enable
RS232.Value = 254            '
RS232.Value = 1              'Clear display
```

Parallax BASIC Stamp:

```
SEROUT 0, N9600, (254,1)     '9600 baud
```

A further two commands allow special characters to be defined and characters to be displayed at particular locations without having to re-write the whole display.

LCD addressing

Each character position on the LCD occupies a memory location with a specific address. These addresses allow one or more characters to be changed on the LCD without having to re-write the whole screen i.e. if you want to update just a temperature value on a display which reads 'Temperature = 25oC'.

To accomplish this the DD address of the character position is written after the command mode request e.g. to write the character 'A' to position 6 of line 1 on a 16 x 2 type display the following would be sent:

$254_{decimal}$, $134_{decimal}$, 'A'$_{ASCII}$

134 is calculated from the line start address 128, plus 6.

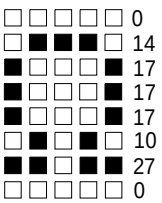
Note: All character based LCD modules use a 40-character per line RAM storage area. This means that if 20 characters were written to a 16-character display then only the first 16 characters would be displayed, with the missing 4 being stored in RAM but not displayed. A scroll-left of the display would then be necessary to view the additional characters.
It should also be noted that once the end of the current line is reached the display does not automatically wrap-around to the next line, a new line start address must be written.

Character Definition

The LCD contains a small amount of Character-Generator or CG RAM to allow the definition of special characters. Only 8 special characters are definable and displayed by writing a value of 0 to 7 into the display e.g. to display 'ohms Ω' the omega must be firstly defined as CG character 0 and be displayed by writing:

```
RS232.String = "ohms " + CHR$(0)
```

To define the omega character in CG RAM eight values are required to make up the character shape. These values consist of the binary representation, or bit map, of the character as follows:



After sending the command code $254_{decimal}$, the character address is then sent consisting of:
$64_{decimal}$ + ($8_{decimal}$ x CG character)

where CG character = character to define 0 to7
for CG 0 address would be $64_{decimal}$.

The above bit map values are then sent in the order shown to define the character. Therefore the above character would be defined by sending:

$254,64,0,14,17,17,17,10,27,0_{decimal}$

To then switch back to display RAM and print the character send $254_{decimal}$, DDRAM address i.e. 128 $_{decimal}$ (for start of line 1) and 0 $_{decimal}$ to display the character defined above.

I²C connection

The DS-LCDD5 also supports I²C serial communication and control. Connection to the module is through the six (6) pin header, pinned as follows:

Header pin	Connection Designation
1	SI (Serial input)
2	GND (Signal ground)
3	SDA (I2C data)
4	SCL (I2C clock)
5	+5V (Regulated Supply)
6	+7-15V (Unregulated supply)

The I²C interface is bi-directional and is configured as a slave device which allows a master controller such as the OOPic to write to the LCD display or control the backlight.
To connect the DS-LCDD5 to the I²C master the SDA, SCL & GND lines must be connected and the master checked to ensure that bus pull-up resistors are present.

I²C commands

The DS-LCDD5 has a device address of $0010100D_{binary}$, 28_{hex}, $40_{decimal}$ (by default), the 'D' bit determining if a read or a write to the DS-LCDD5 is to be performed. If the 'D' bit is set '1' then a register read is performed or if clear '0' a register write.

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To write text to the LCD a device write must be undertaken by the OOPic / I^2C Master which consists of a Start condition, device ID ('D' bit cleared), Register address set to zero (0), one or more characters to be displayed and a stop condition (see Figure 1.0 for I^2C write protocol). The characters to be displayed are actually written into the same internal register 'R0' before being sent to the display.
The following shows the process which sets the register address to R0 and writes two characters:

	N_7	N_6	N_5	N_4	N_3	N_2	N_1	N_0
DS-LCDD5 I2C address								
1.	0	0	1	0	1	0	0	0
DS-LCDD5 Register address								
2.	0	0	0	0	0	0	0	0
Character to write to display								
R0	D	D	D	D	D	D	D	D

D..D = Character to write 32 –$127_{decimal}$

Character to write to display								
R0	D	D	D	D	D	D	D	D

D..D = Character to write 32 –$127_{decimal}$

Example.

To write 'Hello' to the display:

Byte 1 - 00101000_{binary}, 28_{hex}
Byte 2 - 00000000_{binary}, 00_{hex}
Byte 3 - 'H'$_{ASCII}$
Byte 4 - 'e'$_{ASCII}$
Byte 5 - 'l'$_{ASCII}$
Byte 6 - 'l'$_{ASCII}$
Byte 7 - 'o'$_{ASCII}$

The following code can be used on the OOPic (II) to write 'Hello' to the display:

```
Dim LCD As New oi2c

Sub Main ()
'Set the LCDD2 I2C address shifted right by 1 bit
LCD.Node = &h14         'Device address
LCD.Width = cv8bit      'Control Info is 1-byte
LCD.Mode = cv10bit      'I2C mode is 10-Bit
LCD.NoInc = cvTrue      'No increment
LCD.Location = 0        'Point to register R0
LCD = &h48              'Write 'H'
LCD = &h65              'Write 'e'
LCD = &h6C              'Write 'l'
LCD = &h6C              'Write 'l'
LCD = &h6F              'Write 'o'
End Sub
```

LCD control commands

To allow the control of cursor position, clear display, scroll & character definition etc. the LCD module also supports a command register (R1) which can be written with the following instruction codes:

Command	Dec	Hex
Home (abort scroll)	0	00
Clear display	1	01
Blank display (text not cleared)	8	08
Cursor OFF or restore after blanking	12	0C
Cursor ON & blinking	13	0D
Cursor ON & underline	14	0E
Move cursor left	16	10
Move cursor right	20	14
Scroll display left	24	18
Scroll display right	28	1C

The following shows the process which sets the register address to R1 and writes a command:

	N_7	N_6	N_5	N_4	N_3	N_2	N_1	N_0
DS-LCDD2 I2C address								
1.	0	0	1	0	1	0	0	0
DS-LCDD2 Register address								
2.	0	0	0	0	0	0	0	1
Command to send to LCD module								
R1	D	D	D	D	D	D	D	D

D..D = Command code

etc.

Example.

To clear the display:

Byte 1 - 00101000_{binary}, 28_{hex}
Byte 2 - 00000001_{binary}, 01_{hex}
Byte 3 - $1_{decimal}$

A further two commands allow special characters to be defined and characters to be displayed at particular locations without having to re-write the whole display.

LCD addressing

Each character position on the LCD occupies a memory location with a specific address. These addresses allow one or more characters to be changed on the LCD without having to re-write the whole screen i.e. if you want to update just a temperature value on a display which reads 'Temperature = 25oC'.

To accomplish this the DD address of the character position is written to register 'R1' and then the character to register 'R0'.

Example:

To write the character 'A' to position 6 of line 1 on a 16 x 2 type display:

Byte 1 - 00101000_{binary}, 28_{hex}
Byte 2 - 00000001_{binary}, 01_{hex}
Byte 3 - $134_{decimal}$, 86_{hex}

Byte 1 - 00101000_{binary}, 28_{hex}
Byte 2 - 00000000_{binary}, 00_{hex}
Byte 3 - 'A'$_{ASCII}$

134 is calculated from the line start address 128, plus 6.

Note: All character based LCD modules use a 40-character per line RAM storage area. This means that if 20 characters were written to a 16-character display then only the first 16 characters would be displayed, with the missing 4 being stored in RAM but not displayed. A scroll-left of the display would then be necessary to view the additional characters.
It should also be noted that once the end of the current line is reached the display does not automatically wrap-around to the next line, a new line start address must be written.

Character Definition

The LCD contains a small amount of Character-Generator or CG RAM to allow the definition of special characters. Only 8 special characters are definable and displayed by writing a value of 0 to 7 into the display e.g. to display 'ohms Ω' the omega must be firstly defined as CG character 0 and be displayed by writing:

Byte 1 - 00101000_{binary}, 28_{hex}
Byte 2 - 00000000_{binary}, 00_{hex}
Byte 3 - 'o'$_{ASCII}$
Byte 4 - 'h'$_{ASCII}$
Byte 5 - 'm'$_{ASCII}$
Byte 6 - 's'$_{ASCII}$
Byte 7 - ' '$_{ASCII}$
Byte 8 - $0_{decimal}$, 00_{hex}

To define the omega character in CG RAM eight values are required to make up the character shape. These values consist of the binary representation, or bit map, of the character as follows:

□□□□□ 0
□■■■□ 14
■□□□■ 17
■□□□■ 17
■□□□■ 17
□■□■□ 10
■■□■■ 27
□□□□□ 0

Firstly the character address is written to register 'R1' consisting:

$64_{decimal}$ + ($8_{decimal}$ x CG character)

where CG character = character to define 0 to7
for CG 0 address would be $64_{decimal}$.

The above bit map values are then written to register 'R0' in the order shown to define the character.

Example:

To define the character omega:

Byte 1 - 00101000_{binary}, 28_{hex}

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Byte 2 - 00000001_{binary}, 01_{hex}
Byte 3 - $64_{decimal}$, 40_{hex}

Byte 1 - 00101000_{binary}, 28_{hex}
Byte 2 - 00000000_{binary}, 00_{hex}
Byte 3 - $0_{decimal}$
Byte 4 - $14_{decimal}$
Byte 5 - $17_{decimal}$
Byte 6 - $17_{decimal}$
Byte 7 - $17_{decimal}$
Byte 8 - $10_{decimal}$
Byte 9 - $27_{decimal}$
Byte 10 - $0_{decimal}$

To then display the omega character at the beginning of line one:

Byte 1 - 00101000_{binary}, 28_{hex}
Byte 2 - 00000001_{binary}, 01_{hex}
Byte 3 - $128_{decimal}$, 80_{hex}

Byte 1 - 00101000_{binary}, 28_{hex}
Byte 2 - 00000000_{binary}, 00_{hex}
Byte 3 - $0_{decimal}$, 00_{hex}

LCDD5 control commands

To allow the setup of backlight colour/brightness, new serial baud rate etc. the module supports a control command register (R2) which can be written with the following instruction codes/values:

Command	Dec	Hex
Backlight - OFF	0	00
RED pulsing	1	01
GREEN pulsing	2	02
BLUE pulsing	3	03
BLUE/GREEN pulsing	4	04
RED/BLUE pulsing	5	05
RED/GREEN pulsing	6	06
RGB pulsing	7	07
Not implemented	8	08
Not implemented	9	09
Not implemented	10	0A
Not implemented	11	0B
Not implemented	12	0C
Not implemented	13	0D
Colour scan	14	0E
Backlight - ON	15	0F
BAUD rate - 1200baud	16	10
BAUD rate - 2400baud	17	11
BAUD rate - 4800baud	18	12
BAUD rate - 9600baud	19	13*
LCD 1 line display	32	20
LCD 2 line display	33	21*

* Factory defaults

Serial baud rate and LCD lines are stored within non-volatile memory to ensure recall upon the next power-up.
The backlight defaults to 'OFF' on every power-up.

Values 0 to 15 control the operation of the RGB backlight to allow it to be turned ON ($15_{decimal}$), turned OFF ($0_{decimal}$) or set to a pulsing display.

The following shows the process which sets the register address to R2 and writes a command:

	N_7	N_6	N_5	N_4	N_3	N_2	N_1	N_0
DS-LCDD5 I2C address								
1.	0	0	1	0	1	0	0	0
DS-LCDD5 Register address								
2.	0	0	0	0	0	0	1	0
Control command to send to DS-LCDD5								
R2	D	D	D	D	D	D	D	D

D..D = Control command code

There are also a further four (4) registers (R3-R6) as follows:

R3	RED backlight setup
R4	GREEN backlight setup
R5	BLUE backlight setup
R6	Pulse speed setup

Each can be accessed in the same manner as register R2 above and allow the backlight colour and colour pulsing speed to be set.

Examples:
To turn ON the backlight:

Byte 1 - 00101000_{binary}, 28_{hex}
Byte 2 - 00000010_{binary}, 02_{hex}
Byte 3 - $15_{decimal}$, $0f_{hex}$

To set the backlight to the R.G.B value of $254_{decimal}$, $128_{decimal}$, $192_{decimal}$ (Pink) requires three transactions:

Byte 1 - 00101000_{binary}, 28_{hex}
Byte 2 - 00000011_{binary}, 03_{hex}
Byte 3 - $254_{decimal}$, FE_{hex}

Byte 1 - 00101000_{binary}, 28_{hex}
Byte 2 - 00000100_{binary}, 04_{hex}
Byte 3 - $128_{decimal}$, 80_{hex}

Byte 1 - 00101000_{binary}, 28_{hex}
Byte 2 - 00000101_{binary}, 05_{hex}
Byte 3 - $192_{decimal}$, $C0_{hex}$

To set the backlight to BLUE pulsing at medium-fast speed requires two transactions:

Byte 1 - 00101000_{binary}, 28_{hex}
Byte 2 – 00000010_{binary}, 02_{hex}
Byte 3 - $3_{decimal}$, 03_{hex}

Byte 1 - 00101000_{binary}, 28_{hex}
Byte 2 - 00000110_{binary}, 06_{hex}
Byte 3 - $192_{decimal}$, $C0_{hex}$

Finally, there are also registers R7 & R8 which allow the default I^2C address 00101000_{binary}, 28_{hex} to be changed to any required.
The new address must be written into R7 first and then R8 to take effect. The following example shows an address change from 28_{hex} to $2C_{hex}$:

Byte 1 - 00101000_{binary}, 28_{hex}
Byte 2 – 00000111_{binary}, 07_{hex}
Byte 3 - 00101100_{binary}, $2C_{hex}$

Byte 1 - 00101000_{binary}, 28_{hex}
Byte 2 – 00001000_{binary}, 08_{hex}
Byte 3 - 00101100_{binary}, $2C_{hex}$

Note: This procedure should be used with extreme caution, as the new address is effective immediately register R8 is written and may render the DS-LCDD5 un-usable if the new address collides with another on the I^2C bus or is forgotten.
The DS-LCDD5 stores the address in non-volatile memory and recalls this on power application.

Testing

The DS-LCDD5 can be tested for operation by shorting the 'SI' input to '+5V' and applying power.
The Part Number and firmware version are displayed on the LCD until power is removed, e.g.:

DS-LCDD5 (c)2005
Version 1.00

Note: Ensure that no other serial connection is made to prevent damage to external serial equipment such as the PC.

Table 1.0

LCD Display addresses

16 characters x 2 lines:

	0	1	2	3	4	5	6	.....	15	.....	39
Line 1 DD Address	128	129	130	131	132	133	134	.....	143	.....	167 Hidden
Line 2	64	65	66	67	68	69	70	.....	79	.....	103
DD Address	192	193	194	195	196	197	198	.....	207	.....	231 Hidden

20 characters x 2 lines:

	0	1	2	3	4	5	6	.....	19	.....	39
Line 1 DD Address	128	129	130	131	132	133	134	.....	147	.....	167 Hidden
Line 2	64	65	66	67	68	69	70	.....	83	.....	103
DD Address	192	193	194	195	196	197	198	.....	211	.....	231 Hidden

40 characters x 2 lines:

	0	1	2	3	4	5	6	.....	39
Line 1 DD Address	128	129	130	131	132	133	134	.....	167
Line 2	64	65	66	67	68	69	70	.....	103
DD Address	192	193	194	195	196	197	198	.....	231

20 characters x 4 lines:

	0	1	2	3	4	5	6	.....	19
Line 1 DD Address	128	129	130	131	132	133	134	.....	147
Line 2	64	65	66	67	68	69	70	.....	83
DD Address	192	193	194	195	196	197	198	.....	211
Line 3	20	21	22	23	24	25	26	.....	39
DD Address	148	149	150	151	152	153	154	.....	167
Line 4	84	85	86	87	88	89	90	.....	103
DD Address	212	213	214	215	216	217	218	.....	231

Note : RED boxed values denote line start addresses

Electrical Characteristics (T_A = 25°C Typical)

Parameter	Minimum	Maximum	Units	Notes
Supply Voltage (5V)	4.5	5.5	V	
Supply Voltage (7-15V)	7	15	V	
Supply Current	3	3.5	mA	1
RS232 TX data output level	0	VCC-0.8	V	
RS232 RX data input level	-15	+15	V	
I2C Bus Speed	-	400	kHz	
I2C Input Voltage	-0.3	VCC	V	

Absolute Maximum Ratings

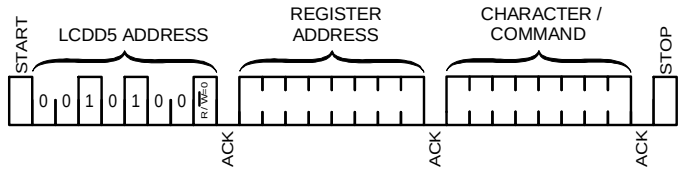
Parameter	Minimum	Maximum	Units
Supply Voltage (5V)	-0.5	+6	V
Supply Voltage (7-15V)	-0.5	16V	V

Environmental

Parameter	Minimum	Maximum	Units
Operating Temperature	-5	70	**°C**
Storage Temperature	-10	80	**°C**
Humidity	0	80	**%**
Immunity & emissions	EMC compliance to 89/336/EEC		

Notes:
1.Value given does not include backlight current.

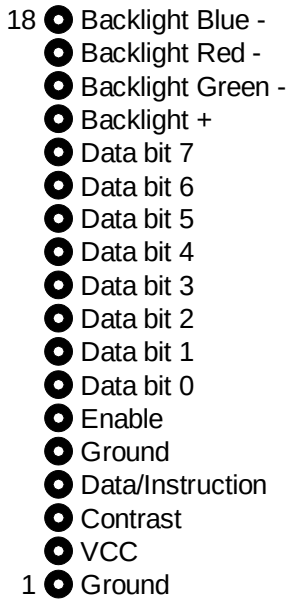
Figure 1.0 (I^2C write protocol)

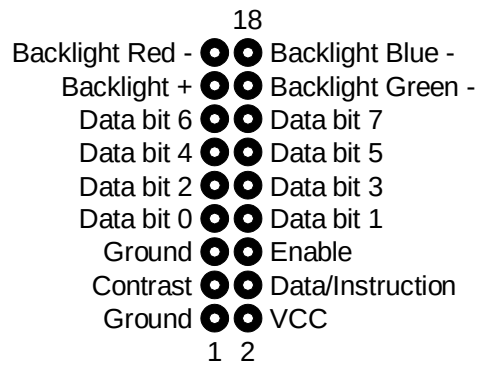


Multiple bytes may be written before the 'STOP' condition. Characters are written to the LCD display at the current cursor position. Each character transfer is acknowledged 'ACK' by the LCDD5 until the 'STOP' condition.

LCD connections:

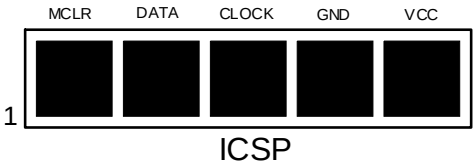
The DS-LCDD5 features two types of LCD connector, SIL (Single In Line) and DIL (Dual In Line), these being pinned as follows:





Programmable features:

The DS-LCDD5 module features a Microchip FLASH based PIC® microcontroller that can be re-programmed with a suitable lead (P.n. DS-ICSP18) which plugs directly into the ICD2® development programmer and mates with five square pads on the PCB:



This allows the customer (or Designer Systems) to write his or her own application code to produce Display based systems without the need to design additional hardware.
Applications could include Security entry systems, Robotic programming systems, Diagnostic display and programming in industrial control systems etc.

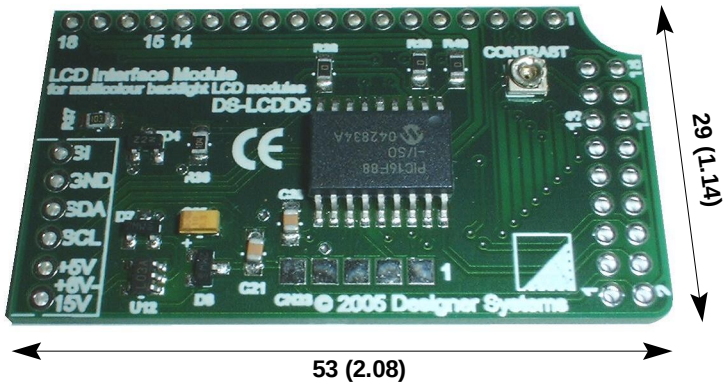
The following table lists the IO pin structure for the DS-LCDD5 to allow custom applications to be developed:

IO Description	IO Port / Line	IO Direction
LCD data bus input 0 / RS232 serial input	Port B / RB0	IO
LCD data bus input 1	Port A / RA7	Output
LCD data bus input 2	Port B / RB2	Output
LCD data bus input 3	Port A / RA6	Output
LCD data bus input 4	Port A / RA4	Output
LCD data bus input 5	Port B / RB5	Output
LCD data bus input 6	Port B / RB6	Output
LCD data bus input 7	Port B / RB7	Output
LCD enable line (H=Enabled)	Port A / RA0	Output
LCD register select (L=Instruction, H= Data)	Port A / RA1	Output
I2C SDA	Port B / RB1	IO
I2C SCL	Port B / RB4	IO
Blue backlight	Port A / RA2	Output
Red backlight	Port A / RA3	Output
Green backlight	Port B / RB3	Output

The above IO lines may also be re-assigned in program code to allow the DS-LCDD to be used in other applications that do not require an LCD panel.

Mechanical Specifications – Units millimetres (inches)

Design subject to change without notice.



Declaration of Conformity

Apparatus name / model number DS-LCDD5
Conformity via Generic Standard EN50081-1
Generic Standard EN50082-1
Conformity criteria For use only within commercial, residential and light industrial applications
We certify that the apparatus identified above conforms to the requirements of Council Directive 89/336/EEC & 73/23/EEC
Signed. **Date** 1/4/05

Having made this declaration the CE mark is affixed to this product, its packaging, manual or warranty.

Manufacturer Designer Systems, 15 Andrew Place, Truro, Cornwall TR1 3HZ, United Kingdom
Description of apparatus LCD panel interface peripheral

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3 Clerewater Place,
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