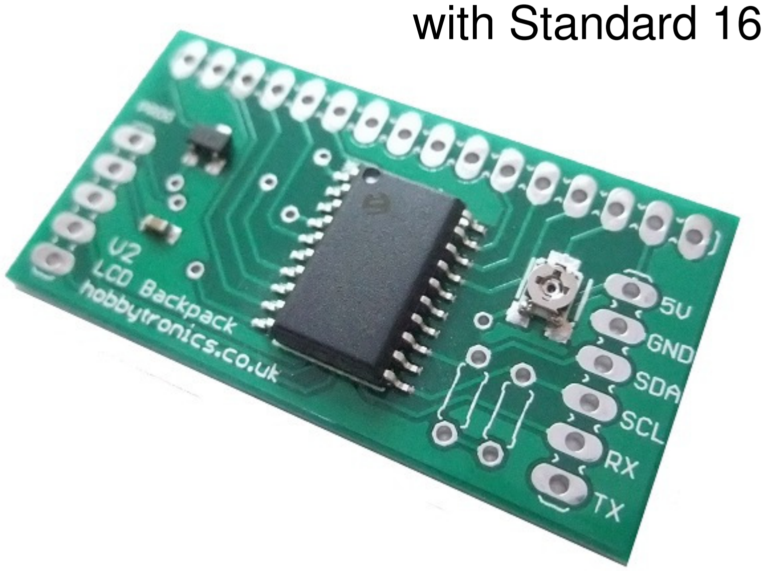
LCD I^{2}C/Serial RX Backpack

Data Sheet

LCD to I2C/Serial RX Backpack

I2C or Serial RX communication
with Standard 16 Pin LCD modules

Version 2.03
Sep 2013



Contents

Introduction

The Hobbytronics LCD Backpack is a useful little board that can be soldered onto the back of LCD's that use the standard Hitachi HD44780 compatible interface. This allows the LCD (and backlight if fitted) to be controlled directly from a microcontroller using either the I2C interface or via a serial RX connection at baud rates from 2400 up to 115200.

This has a number of advantages

- Reduces the minimum number of connections needed from 12 (for an LCD with backlight) to only 3 or 4 thus saving many input/output pins on the microcontroller
- Control an LCD using virtually any microcontroller either through the I2C interface or via a serial RX connection (either in hardware or software)
- Simplifies wiring
- Digital control of LCD backlight brightness from off (0) to fully on (250) and any level in between
- LCD Contrast adjustment potentiometer fitted to backpack
- Allows the connection of multiple LCD displays to one microcontroller without additional pins.

The backpack uses a 160 byte command buffer to alleviate any need for delays in your code. Send commands and data in a stream and the backpack will process then in order.

Note: Digital LCD backlight control is suitable for common Anode LCD backlights. I.e. Anode (+) is pin 15, Cathode is pin 16. If used on an LCD that is common cathode – DO NOT use the backlight functionality.

Voltage Levels

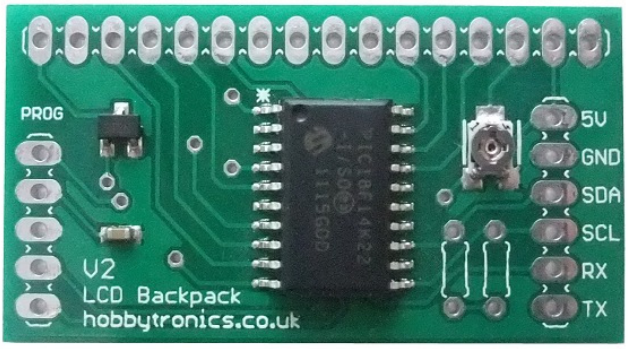
The LCD Backpack requires a 5V supply. This is primarily because the LCD itself runs at 5V. This means that communication using I2C will be at 5V levels. To connect to a 3.3V microcontroller using the I2C interface you will need to use a voltage logic level shifter.

This does not apply to the Serial connection however. Because only the RX in pin of the backpack is used, this can be connected directly to the TX of a system running at 3.3V without any level shifting. This makes it ideally suited to connecting directly to a Raspberry Pi for instance.

Specifications

- Suitable for 5V common Anode LCD's with Hitachi HD44780 compatible interface
- I2C address defaults to 58 (0x3A) but can be set to any valid I2C address in the range 1 - 127
- Digital control of LCD backlight brightness with 250 brightness levels.
- LCD contrast set by trimmer potentiometer.
- Space for I2C pullup resistors (if needed)
- Bootloader installed for easy software updates
- Serial connection at 2400, 4800, 9600, 14400, 19200, 28800, 57600, 115200
- 160 byte command buffer
- **I2C Communication at 5V levels**
- **Serial RX communication at 5V or 3.3V levels**

Pinout



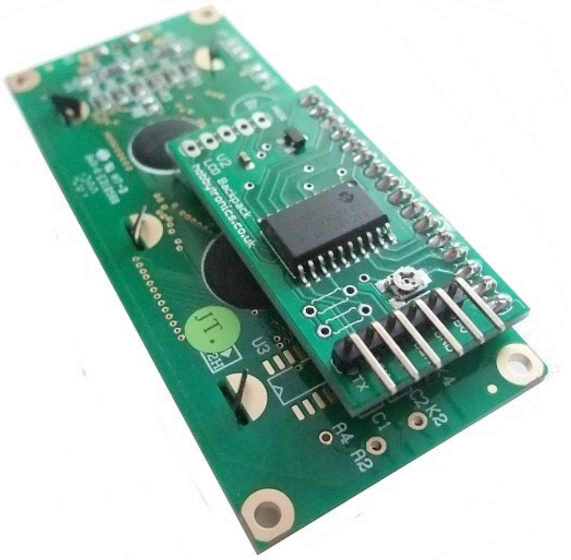
For I2C connection use

5V
GND
SDA
SCL

For Serial RX Connection use

5V
GND
RX connected to microcontroller's TX
TX does NOT need to be connected. The TX pin is only used for software updates

Fitting the backpack to an LCD



The six pin (straight or right-angle) header pins should be soldered on first

Then the backpack should be soldered to the back of the LCD using the 16 row header pins supplied with the backpack.
Alternatively, a combination 16 pin male headers and a 16 pin female socket can be used.

Ensure you leave sufficient room underneath the backpack so as no pins touch any of the metal tabs that are quite often found on the back of LCD's

Command Interface

The backpack can be used by any microcontroller with an I2C or serial RX/TX interface by sending a command code followed by one or more bytes of data. The command codes are as follows

Command Code	Description	Data 1	Data 2
1	Print a string	Character 1	Character 2 etc…
2	Set Cursor Position	Line number	Column Number
3	Clear line. Afterwards, places cursor at beginning of the line ready for write	Line number	
4	Clear Display		
5	Set LCD Type	Num Lines	Num Columns
6	Send a HD44780 command to the LCD	HD44780 command	
7	Backlight Brightness	Brightness value (0-250)	
10	Write single character	Ascii Character code	
32	Change I2C Address **Note**: I2C address change command can only be sent using the serial connection	1 - 127	
33	Set Baud Rate	0 - 2400 1 - 4800 2 - 9600 3 - 14400 4 - 19200 5 - 28800 6 - 57600 7 - 115200	
64	Create a character	Character storage position (0-7)	Send 8 bytes defining character

Commands are the same whether you are using I2C or serial RX connection, with one difference. With the Serial Connection we need to send an end of command character (0xFF) otherwise the backpack doesn't know the command is complete. With I2C this is not required. This is easier to see in the example programs at the end of the document.

I2C Slave Address Configuration

The default address is 58 (hex 0x3A) and no change is necessary if this address is to be used.
To change the I2C address, send the command 32 followed by a number between 1 and 127 (hex 0x01 to 0x7F)
After changing the I2C address, the backpack needs to be powered off and back on again.

NOTE: The I2C address can only be changed using the serial connection. We have implemented this security feature due to the possibility of changing the I2C address if erroneous data or commands are received.

Serial RX Baud Rate Configuration

To set the Baud rate, send the command 33 followed by a number between 0 and 7 (hex 0x00 to 0x07) based on the following table.

0 - 2400
1 - 4800
2 - 9600
3 - 14400
4 - 19200
5 - 28800
6 - 57600
7 – 115200

After changing the Baud Rate, the backpack needs to be powered off and back on again.

Reset Configuration to Defaults

If you have set the I2C address or baud rate and you can't remember what they are, you can reset then to the defaults of

- I2C Address 58 (0x3A)
- Baud Rate 9600

Do this by connecting the TX pin to GND then briefly applying power.

Arduino I2C Library

We have created a free I2C Arduino Library for the LCD Backpack to make it even easier to use with the I2C protocol.
The library can be easily modified for use with other programming languages

The following commands are available in the library

clear	Clear the screen
write	Write a single character to the LCD
createChar	Create a user defined character
clearLine	Clear a complete line
backLight	Send a backlight brightness command
setType	Set the type of display (number of rows, columns)
setCursor	Set cursor position
print	Print a string
command	Send an HD44780 command to the LCD. I.e. Turn cursor on/off

To install the library

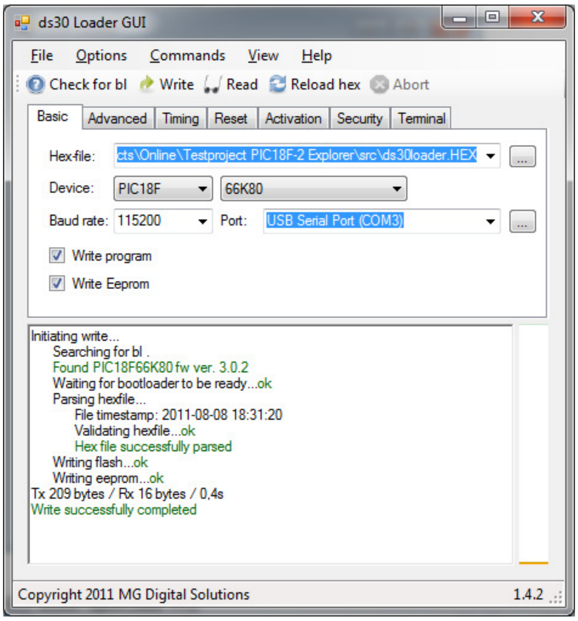
- Download the HTI2CLCD.zip file from the product page on our website
- open the HTI2CLCD.zip file
- drag and drop the HTI2CLCD directory into your Arduino Libraries folder

Software Updates

The LCD Backpack uses a bootloader which enables the software to be upgraded without needing a special programmer. A suitable serial connection to a PC is required
Note: This is NOT an RS232 connection – do not connect to a PC serial port

Downloading software to the board is easy because it has a bootloader already installed. You can download software using the free ds30Loader.

You can download the ds30Loader application from http://mrmackey.no-ip.org/elektronik/ds30loader/


ds30 Loader GUI
File Options Commands View Help
Check for bl Write Read Reload hex Abort
Basic Advanced Timing Reset Activation Security Terminal
...
...
Copyright 2011 MG Digital Solutions
1.4.2

Hex-file: cts\Online\Testproject PIC18F-2 Explorer\src\ds30loader.HEX
Device: PIC18F 66K80
Baud rate: 115200 Port: USB Serial Port (COM3)
☑ Write program
☑ Write Eeprom

```
Initiating write...
    Searching for bl .
    Found PIC18F66K80 fw ver. 3.0.2
    Waiting for bootloader to be ready...ok
    Parsing hexfile...
        File timestamp: 2011-08-08 18:31:20
        Validating hexfile...ok
        Hex file successfully parsed
    Writing flash...ok
    Writing eeprom...ok
Tx 209 bytes / Rx 16 bytes / 0,4s
Write successfully completed
```

Run the ds30loader application and...

- Select the hex file to upload (our latest software version for the Backpack)
- Set the device to be PIC18F and 14K22
- Set Baud rate to 115200
- Set Port to your serial port connection

In order to make the bootloader active we need to reset the board – Use a small loop of wire to connect the reset pin to earth. The reset pin is the top one on the 5-way header at the left of the board, just below the text "PROG". Connect this to the centre (0V) pin on the same connector.
Once you have this setup, click on the **Write** button just below the Commands menu, then immediately remove the wire. The software will attempt to connect to the bootloader and upload the firmware.

Example Programs

We have some example programs written using

Arduino using I2C
Arduino using software serial
Hi-Tech C compiler
Python on Raspberry Pi

These examples should be easily ported to other languages.
The Arduino examples are shown below. Please refer to our website at www.hobbytronics.co.uk for other examples and library functions.

Arduino I2C Example

Here is an Arduino Sketch which uses the I2C Library. It creates 2 special characters, displays some text and sets the backlight.

```
/*
  I2CLCD
  Example Arduino sketch to communicate with HobbyTronics I2CLCD backpack
  The I2CLCD backpack turns a standard HD44780 LCD display into an I2C addressable
  Device which will free up many pins for use elsewhere.

  Requires the Hobbytronics HTI2CLCD library

  Copyright (c) 2011 www.hobbytronics.co.uk

  This example code is in the public domain.
*/

#include <Wire.h>
#include <HTI2CLCD.h>        // Include the Library

HTI2CLCD lcd;                // Create an instance of the HTI2CLCD

const int  lcd_address=58;   // I2C Address of LCD backpack
unsigned long counter=0;
int       bl=0;              // Backlight power value
unsigned long currentTime;
unsigned long bloopTime;
unsigned long cloopTime;
byte updown=0;

// We can create up to 8 of our own characters to display
// Here we define 2 characters to be uploaded
byte ht_logo[8] = {
  B10100,
  B10100,
  B11111,
  B10110,
  B10110,
  B00010,
  B00010,
};
byte smiley[8] = {
  B00000,
  B10001,
  B00000,
  B00000,
  B10001,
  B01110,
  B00000,
};

void setup()
{
    delay(800);                             // Give LCD time to configure itself
    Wire.begin();                           // join i2c bus
    lcd.setType(lcd_address,4,20);          // Define rows and columns for LCD

    lcd.createChar(lcd_address,0, ht_logo);  // Upload ht_logo as character 0
    lcd.createChar(lcd_address,1, smiley);   // Upload smiley as character 1
    lcd.clear(lcd_address);                   // Clear LCD
    lcd.backLight(lcd_address,10);            // Set backlight to dim

    // Display String
    lcd.write(lcd_address,0);                 // Display our ht_logo character
    lcd.print(lcd_address," HobbyTronics ");
    lcd.write(lcd_address,1);                 // Display our smiley character

    currentTime = millis();
    cloopTime = currentTime;
    bloopTime = currentTime;
}

void loop()
{
    currentTime = millis();

    if(currentTime >= (cloopTime + 1000)){
      // Create String with Text and Number
      lcd.setCursor(lcd_address,2,1);
      char ascii[32];
      sprintf(ascii,"Counter: %0.7d",counter);
      lcd.print(lcd_address,ascii);

      counter++;
      cloopTime = currentTime;  // Updates cloopTime
    }

    if(currentTime >= (bloopTime + 30)){
      // Lets increase the brightness until we hit 150, then we reduce back to 0 again
      if(updown==0) bl++;
      else bl--;
      if(bl==150) updown=1;
      if(bl==0) updown=0;
      lcd.backLight(lcd_address,bl);

      bloopTime = currentTime;  // Updates bloopTime
    }

}
```

Arduino Serial RX Example

Here is an Arduino Sketch which shows most of the features of the LCD backpack using the Serial Interface. Note the sending of the 0xFF character to terminate each command.

```
/*
  Hobbytronics LCD Backpack RX Demo

  We use Software Serial so the program upload doesn't interfere with the LCD

  This example code is in the public domain.
 */

#include <SoftwareSerial.h>

SoftwareSerial mySerial(2, 3); // RX, TX

unsigned long currentTime;
unsigned long cloopTime;
unsigned long counter=0;
unsigned char pdelay=1;

// We can create up to 8 of our own characters to display
// Here we define 2 characters to be uploaded
byte ht_logo[8] = {
  B10100,
  B10100,
  B11111,
  B10110,
  B10110,
  B00010,
  B00010,
};
byte smiley[8] = {
  B00000,
  B10001,
  B00000,
  B00000,
  B10001,
  B01110,
  B00000,
};

void setup() {
  mySerial.begin(9600);

  // Need to give LCD and backpack time to initialise
  delay(800);

  // Set display 20x4
  mySerial.write(5);
  mySerial.write(4);
  mySerial.write(20);
  mySerial.write(0xFF);

  // Create HT character in position 0 (0 - 7)
  mySerial.write(64);
  mySerial.write((byte) 0);
  for (int i=0; i<8; i++) {
    mySerial.write((byte) ht_logo[i]);
  }
  mySerial.write(0xFF);

  // Create Smiley character in position 1 (0 - 7)
  mySerial.write(64);
  mySerial.write((byte) 1);
  for (int i=0; i<8; i++) {
    mySerial.write((byte) smiley[i]);
  }
  mySerial.write(0xFF);

  // Clear Display
  mySerial.write(4);
  mySerial.write(0xFF);

  // Set backlight on bright
  mySerial.write(7);
  mySerial.write(250);
  mySerial.write(0xFF);

  // Print single character - HT Character
  mySerial.write(10);
  mySerial.write((byte) 0);
  mySerial.write(0xFF);

  // Print Hello
  mySerial.write(1);
  mySerial.print(" Hello ");
  mySerial.write(0xFF);

  // Print single character - Smiley Character
  mySerial.write(10);
  mySerial.write((byte) 1);
  mySerial.write(0xFF);

  // Move to line 2 column 1
  mySerial.write(2);
  mySerial.write(2);
  mySerial.write(1);
  mySerial.write(0xFF);

  // Print Hobbytronics
  mySerial.write(1);
  mySerial.print("Hobbytronics");
  mySerial.write(0xFF);

  currentTime = millis();
  cloopTime = currentTime;
}

void loop() {

   currentTime = millis();

   if(currentTime >= (cloopTime + 1000)){

      // Move to line 1 column 10
      mySerial.write(2);
      mySerial.write(1);
      mySerial.write(10);
      mySerial.write(0xFF);
      // Create right justified counter text
      char ascii[32];
      sprintf(ascii,"%7.0d",counter);

      mySerial.write(1);
      mySerial.print(ascii);
      mySerial.write(0xFF);

      counter++;
      cloopTime = currentTime;  // Updates cloopTime
   }
}
```

Raspberry Pi Python Serial RX Example

Raspberry Pi Python script which uses the serial port at the default 9600 baud
Uses the python-serial library. If you don't have this installed use

```
sudo apt-get install python-serial
```

Code Comments

serialport.write(chr(5)+chr(2)+chr(16)+chr(0xFF))	Set to 16x2
serialport.write(chr(4)+chr(0xFF))	Clear LCD
serialport.write(chr(7)+chr(250)+chr(0xFF))	Backlight to max
serialport.write(chr(1)+"Welcome to"+chr(0xFF))	Print "Welcome to"
serialport.write(chr(2)+chr(2)+chr(1)+chr(0xFF))	Move to line 2, column 1
serialport.write(chr(1)+"Hobbytronics"+chr(0xFF))	Print "Hobbytronics"

Then in the loop we have

```
while 1 :
        serialport.write(chr(2)+chr(1)+chr(13)+chr(0xFF))   Move to line 1 column 13
        serialport.write(chr(1)+str(count)+chr(0xFF))       Print variable 'count'
        time.sleep(1)                                        Wait for 1 second
        count = count + 1                                    Increment 'count' variable
```

Source Code listing

```
#
# Hobbytronics LCD Backpack - example code
#
import serial
import time
serialport = serial.Serial("/dev/ttyAMA0", 9600, timeout=5)
time.sleep(1)
serialport.write(chr(5)+chr(2)+chr(16)+chr(0xFF))
serialport.write(chr(4)+chr(0xFF))
serialport.write(chr(7)+chr(250)+chr(0xFF))
serialport.write(chr(2)+chr(1)+chr(1)+chr(0xFF))
serialport.write(chr(1)+"Welcome to"+chr(0xFF))
serialport.write(chr(2)+chr(2)+chr(1)+chr(0xFF))
serialport.write(chr(1)+"Hobbytronics"+chr(0xFF))
count = 0
while 1 :
        serialport.write(chr(2)+chr(1)+chr(13)+chr(0xFF))
        serialport.write(chr(1)+str(count)+chr(0xFF))
        time.sleep(1)
        count = count + 1
serialport.close()
```

Raspberry Pi – I2C example using i2cset

We tested it out using a 20x4 LCD display and the following commands.

```
// Turn Backlight on (value 0xF0)
i2cset -y 0 0x3A 0x07 0xf0
// Set display type to 20x4
i2cset -y 0 0x3A 0x05 0x04 0x14 i
// Print Hello
i2cset -y 0 0x3A 0x01 0x48 0x65 0x6C 0x6C 0x6F i
// Move to line 2 position 1
i2cset -y 0 0x3A 0x02 0x02 0x01 i
// Print Hello again
i2cset -y 0 0x3A 0x01 0x48 0x65 0x6C 0x6C 0x6F i
```