



I2C for PC

USB & RS232 TO I2C/SPI ADAPTOR & CONTROLLER

Features

- Uses **BL233B** I2C-Serial IC
- Both RS232 & USB interfaces
- 3 separate I2C busses
- 2x SPI bus
- 4x Dallas type 1-Wire bus
- Easy ASCII commands
- 5V and 3.3V On-board power
- Galvanic Isolation option
- High-Speed
- Power-On, Watchdog and other autonomous actions without working PC
- Auto-switching USB/RS232
- No DLL's, API's, Drivers needed.
- Cross-Platform: Linux, Windows, PDA's etc
- USB Bus Powered
- 45x80mm, in a box (not bare PCB)



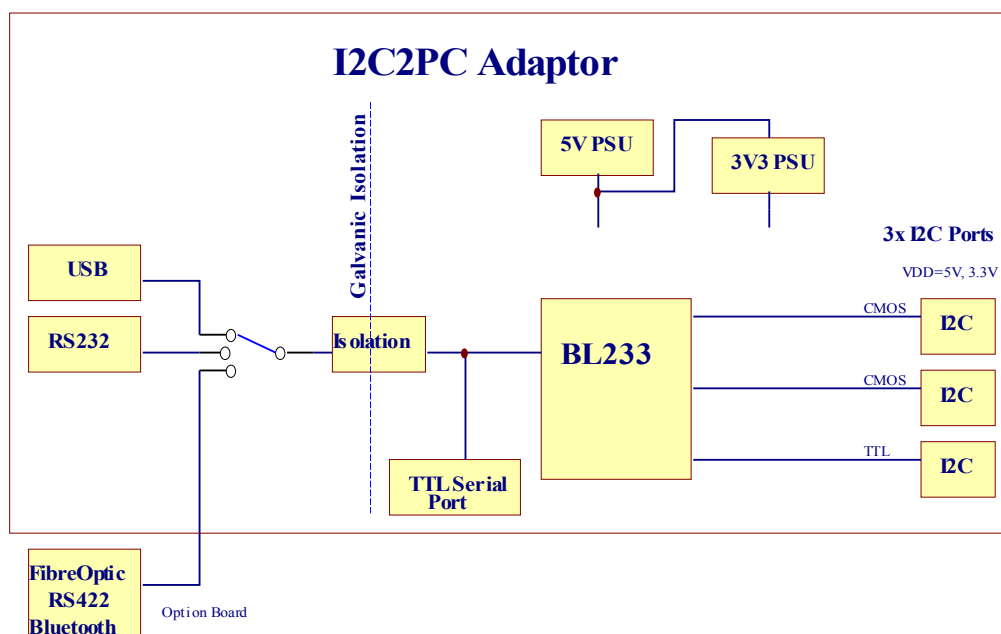
Applications

- ATE for I2C/SPI based equipment
- Evaluation of I2C and SPI chips
- Evaluation kits for I2C & SPI chips
- Rapid Prototyping & PnP design
- PC based instrumentation and control
- Reader for 1Wire serial numbers
- Galvanically Isolated I/O
- Cheap and Easy Data logging
- PC and Network Watchdogs
- PDA/Calculator Analog/Digital I/O
- Education
- RS232 parrallel I/O
- Camera chip control
- Fibre Optic and Laser Module

Programmable

EEProm stores commands and settings

- Power On Reset actions
- Interrupt actions
- Watchdog timeout actions
- Macro's
- Autonomous actions





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Description

With both USB and RS232 serial interfaces this is a truly universal I2C/SMBUS/SPI/1-Wire interface, for the widest possible range of computing hardware, with the simplest and most portable software format.

*I2C2PC is **not** an I2C slave or an I2C monitor. It is a **master** on the I2C/SPI bus only.*

Building an I2C based application needs nothing more than *your* I2C chip, everything else is included.

There is an internal 5V and 3.3V power supply to run the interface and your target hardware. Simple systems will run from the USB bus power.

Unlike some competing products, it can sustain high baud rates, and has multiple I2C Busses

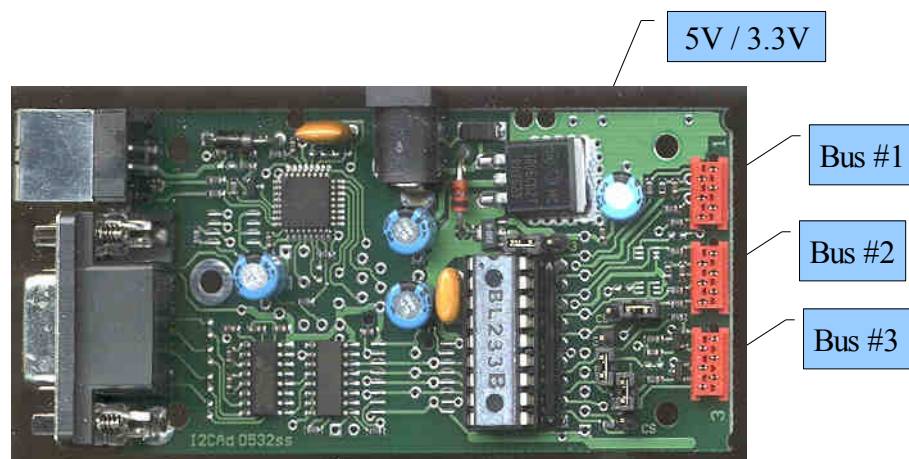
Compared to cruder solutions, it doesn't rely on bit-bashing PC software, ill defined I/O characteristics, or processor and OS dependent timing.

Power-On-Reset actions can be set in EEPROM so that systems are properly initialised when the PC is not present.

Watchdog actions can be programmed to automatically respond to PC failure.

Galvanic isolation can be installed where the I2C busses need to be isolated from the computer for noise, ground loop, or safety considerations.

An optional 3rd interface is available for Fibre Optic, Bluetooth, RS422 and similar interfaces.





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Figure 1 Adaptor with case removed

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1 Commands

Read the [BL233 B](#) PDF Datasheet for a full description of commands and operation.

There are application notes that clarify specific applications, and other information in the [PDF Library](#)

2 Software Interface

The I2C-2-PC appears as a serial port device when either the USB or RS232 are used. (Linux, Windows, Mac).

No special API's or DLL's are required to access it. Almost any programming language can be used including Labview. Our customers are using it with

- VB
- C, C++
- Labview
- Matlab
- Delphi
- Java
- Python
- Perl



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- PDA's
- Batch files

3 Installing and Testing Your New Adaptor

The I2C2PC is normally shipped set to **57,600 bd N81, RTS/CTS handshake**.

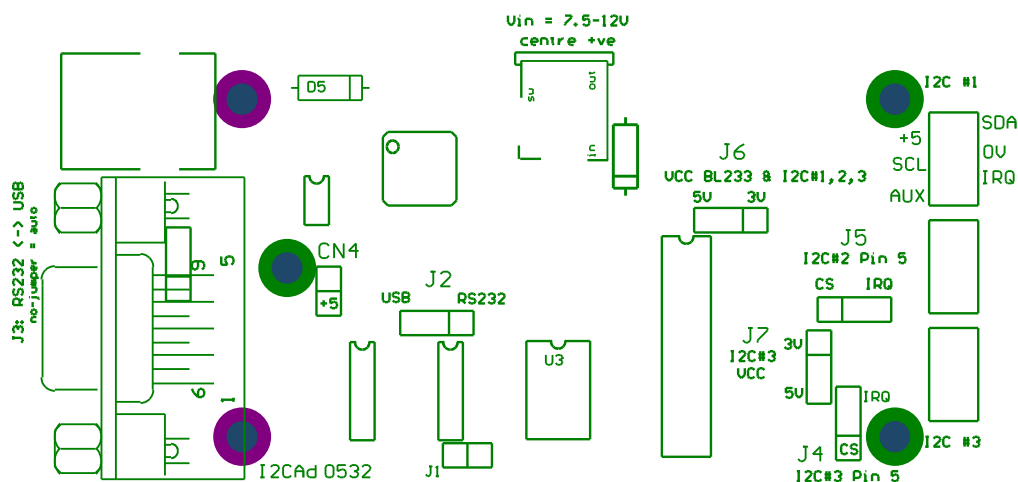
If you have Galvanic Isolation fitted, see sec 10.1 below.

The jumpers are set 5V, and IRQ on the I2C buses.

- Download, Install **Realterm** from: <http://www.i2cchip.com/realterm>
Documentation is at <http://realterm.sourceforge.net/>
- Use the “Realterm I2C” shortcut to start up Realterm. This will automatically configure the port settings to hardware handshake RTS/CTS.
- Ensure the Port Select jumper is in AUTO position (ie not fitted). The port will default to RS232 when the USB is not connected.
- Connect a DB9 serial extender (m-f) cable (not a cross over cable) to the RS232.
- Apply 9V Centre positive 2.1mm power supply.
- When you apply power you should see a default startup message like “HI I2C v1.18”. Note you probably won't see this when using USB power, as the message is normally sent before the USB bus has enumerated.
- Type “?”. The I2C2PC should reply with 2 hex bytes of the status byte eg “18”
- If you are going to use the USB, install the FTDI driver software for Windows.
<http://www.ftdichip.com/Drivers/VCP.htm>

4 Jumpers

The back of the PCB has silkscreen of the jumpers with their functions labeled.



5 RS232-USB Selection

See also “USB“ sec 12 below and “Should I use USB or RS232?“ sec 12.1 below

Selector J3 ¹at edge of board under USB/DB9 connectors:

- Jumper toward DB9: Always RS232
- Jumper toward USB connector: Always USB
- No Jumper: Autoselect USB when bus enumerates, RS232 otherwise.

<i>J1</i>	<i>J2,J3</i>	<i>Mode</i>
none	none	Autoselect USB/RS232 Selects USB when it is enumerated

¹ Boards before May 2003 are:

Jumper toward DB9: Always USB

Jumper toward USB connector: Autoselect USB when enumerated, RS232 otherwise.

No Jumper: Always RS232



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<i>J1</i>	<i>J2,J3</i>	<i>Mode</i>
none	USB	USB only
none	RS232	RS232 only
fitted	none	invalid
fitted	USB	AUX Only
fitted	RS232	invalid

Duplicate jumper holes J2 are inside the case, so a jumper can be fitted internally when you don't want to use the ones at the edge, or you don't want users to be able to change jumper. (and J3 can be removed)

5.1 Aux Interface CN9

CN9 is a third serial interface that can be manually selected instead of RS232 and USB. It is selected by installing link J1, and the setting J2 to USB.

***** WARNING: While it uses a 6 pin micromatch it is completely incompatible with the I2C bus. Do not plug into the wrong socket *****

You can use it to add a 3rd interface, eg Bluetooth or Fibre or RS422 or TTL
It can be directly connected to the logic level² pins of a UART or microprocessor serial pins. For example you can connect it direct to the serial pins of a Linksys WRT54G Linux router. It is directly compatible with 3V and 5V devices.

5.2 Bluetooth on Aux

See [I2C2PC Bluetooth.pdf](#) for more details.

The BlueSMiRF extended module from www.sparkfun.com can be directly connected to CN9. Set the module to 57600bd using its AT command set, and you are ready to go.

#	<i>I2C2PC CN9</i>	#	<i>Sparkfun Blue SmiRF Extended</i>
1	VCC (+5)	2	PWR
2	CTS (out)	1	CTS-I
3	RXD (out)	5	RX-I
4	TXD (in)	4	TX-O

²You cannot connect CN9 directly to RS232. RS232 is inverted and has high voltage levels



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#	<i>I2C2PC CN9</i>	#	<i>Sparkfun Blue SmiRF Extended</i>
5	RTS (in)	6	RTS-O
6	GND	3	GND

6 I2C Bus Connector

The I2C Bus connector used is a *MICRO-MATCH* by AMP. Either 4 or 6 way can be used. 6 Way I2C Connectors and Cables are available from I2CCHIP, as well as from Farnell.

I2CCHIP can supply bulk connectors (boxes of 250) if required as well as cables, and small quantities of connectors.

#	4 Way	6 Way	
1	SDA	SDA	
2	VDD	VDD	
3	VSS	VSS	
4	SCL	SCL	
5		INT / CS	Interrupt input (active low) <i>or</i> Chip select for SPI (jumper select)
6		VAUX	Aux supply. Not connected

The reason for the power lines being between the I2C wires is to stop the edges of SDA and SCL coupling together. This follows the Philips pattern set out in section 17.3 of The I2C Bus Specification.

- If the length of the bus lines exceeds 10 cm
- This arrangement will have similar capacitive loading on SDA and SCL. Where you don't use pins 5 & 6, it can be better to just use 4 wires.

	AMP www.amp.com	Farnell www.farnell.com	RS	
6 way male-on-wire	7-215083-6	149-068		
6 pin female-on-board	7-215079-6	148-519		
4 pin male-on-wire	7-215083-4	149-032		
4 pin female-on-board	7-215079-4	148-507		



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7 CS and Interrupt Pins

Jumpers J4,5 are provided to select the function of pin 5 of the I2C connector between IRQ (input), and CS/1Wire (i/o). This is for BUS# 2, 3 only. Bus#1 is always connected to IRQ.

If you are using the adaptor for SPI, you will need to change the jumper position to CS to make it an output.

Note that the IRQ pin is common to all buses it is connected to. So changing its level at one bus, will affect all of them.

8 Bus Drive and Pullups

The bus is fitted with **1k5** pullup resistors in a SIL resistor pack.

If you want to reduce or increase the current, replace the resistor pack. We recommend cutting it out with fine side cutters, removing the individual pins through the top of the board, and desoldering the holes.

Note that although Bus#3 may be pulled up to 5V, it has a diode clamp that keeps the voltage down to VDD on that bus.

The BL233 can drive much higher currents if required, 15-20mA @5V VCC. There is a 47 ohm protection resistor in series with the outputs that will need to be reduced of course.

You will need a buffer at the other end of the bus if you do this.

9 Power Supply

External power is 9-12V DC, (2.1mm centre positive).

An on board 7805 regulator is fitted to provide 5V. An HT7333 regulator provides 3.3V at up to 250mA.

If you have a Galvanic Isolated adaptor, see 10.2 below

- USB Bus Powered USB Data: ~50mA for I2C devices
- USB Bus Powered RS232 Data: ~50mA for I2C devices
- External Power, RS232
- External Power USB



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9.1 USB Bus Powered

The USB bus can deliver up to 500mA³. When operating from USB, the supply voltage is normally about 4.7V. The 3.3V regulator will operate correctly from the USB supply.

Even if you are using the RS232 port, you can use a USB cable for power. Just fit the RS232 jumper to force the adaptor to ignore the usb port.

9.2 I2C Bus Power Selection 5V / 3.3V

I2C Bus #1,2 are connected to the BL233B's VDD supply. J6 selects between 5V and 3.3V for the BL233B's VDD.

I2C Bus#3 has a separate VDD jumper J7. Using J7 you can operate I2C Bus#3 from either 5V or 3.3V, while Bus#1,2 are operating from 5V.

If you leave J7 off completely, then you can power Bus#3 from another the I2C cable. Bus#3 has TTL levels and an in-built diode bus clamp, that keeps clamps the voltage on SDA and SCL to the Bus#3 VDD. This means that you can operate Bus#3 VDD from 2-5V

The I2C Bus VDD is connected to the interfaces VDD (5V).

To isolate an I2C Bus#1 or 2's VDD from the adaptors VDD, remove the associated 0603 link by the connector. (FB10,11)

9.3 Local AND USB Power

Boards manufactured after April 2003⁴ should work happily with both external and USB power.

If you do not want the USB bus to try and power your equipment, remove D5 (by USB connector). Normally you would do this when building the I2C-2-PC into a standalone equipment that has its own 5V supply.

If you are making test systems, be aware that a short circuit, high voltages etc, that may accidentally be applied to the VDD of the I2C bus, will be connected through the USB cable to the powersupply of your computer. This can reset your computer or worse. For these applications, the Galvanic Isolated option is available.

³Devices that draw > 100mA from the bus should have switched load, and in theory you should change links on the FT232, so the adaptor tells the PC that it is a high current device. See FT232BM datasheet for more detail if this matters to you.

⁴With boards manufactured before May 2003:

There are some traps to watch when using a local power source, and the USB adaptor. The USB chip will not see a power on reset when the USB Bus is connected, and local power is already applied, and may not enumerate correctly. See FTDI documentation for more reset details.

10 Options

10.1 Galvanic Isolation

Before using a new Galvanic Isolated unit anywhere safety-critical, you should use a multimeter to verify that the input and output side of the adaptor are actually isolated. This is good practice.

Adaptors can be ordered with Galvanic Isolation. Isolated versions have:

- Printing is marked Isolated, or Purple stripe on the metal of DB9 connector
- Isolator is fitted to pcb.



Figure 10.1.: Isolated



Figure 10.2.: Isolated



Figure 10.3.: Normal

You should use the Galvanic Isolated version if:

- I2C side can be inadvertently short-circuited and you are using USB
- Faults at the I2C could possibly connect high voltages to any pins of the adaptor (including the ground pin)
- You don't want to ground your I2C bus to the PC chassis
- Measurements are sensitive and you need to decouple from the PC's noise, and ground currents, and earth loops.
- This is a valuable and important industrial system that should be designed to be robust.
- You need to run the I2C bus floating or above ground potential

The Analog Devices ADUM1402A⁵ is used for isolation in V3 adaptors For more information see the datasheet. Creepage distance is ~2.5mm.

10.2 Galvanic Power

When isolation is fitted, ***you have to power the PC side separately from the I2C side.*** Normally USB power is used for the PC side, and an external 9V supply for the I2C side.

⁵The [NVE IL716-3](#) magnetic isolator is used for galvanic isolation on V2 units

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If you want to use the RS232 interface, you can still use the USB connector to provide power. Just fit the "RS232" jumper to force the interface to use RS232. (with no jumper the interface autoselects USB when the USB is connected to a computer, but not when a USB power-only cable is used)

10.3 External 5V to PC Side

If you are not using USB power, fit 2 pin connector CN4 and protection zener D1 (BZX85C5V6 or BZX85C6V2).

The PC side requires 4-5V, 30mA.

See the wires in Figure 5 below

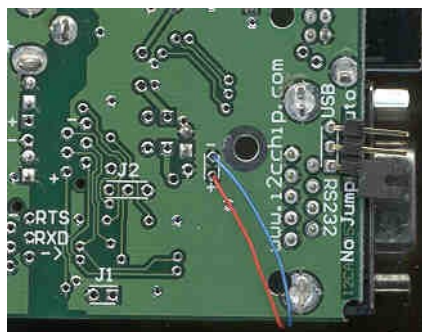


Figure 10.4:

10.4 Defeating Isolation

If you don't need the isolation you can simply join VCC and GND with wires as shown in Figure 10.5 below. ie CN2-1 to CN9-1 and CN2-6 to CN9-6.

Beware of forgetting that the isolation is gone!

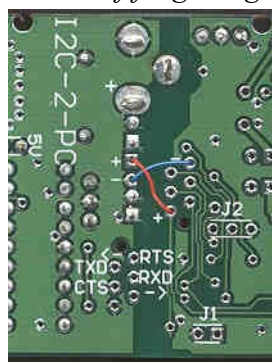


Figure 10.5:



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10.4.1 Fitting a DC-DC Convertor

If you want to power one side of the isolation barrier from the other, you can fit a 5V-5V DC-DC convertor module. Connect it in place of the wires of Figure 10.5 above

You can power either side from the other. Suitable convertors are available from Farnell, RS, Digikey etc.

10.4.2 Fitting Isolator Yourself

If you need isolation, either mill, or chisel the bridging tracks from the isolator footprint and fit the IC.

If you use RS232, and an isolator you will need to power the RS232 section. Fit CN4, and protection diode D1 (BZX85C5V6 or C6V2)

10.4.3 USB Power only Cable

You can use a USB Power-only cable to power the PC side, when using RS232. This is just a USB cable with only the 2 power wires fitted. Just cut the end off a Usb cable. Normally the power wires are red and blue, and thicker than the data wires.

10.5 Daughter Board Connector

I2C2PC can be used as a daughter/mother board that plugs onto another board, instead of using cables from the I2C Bus. A 12 pin SIL connector CN10 can be fitted on either side of the PCB. See the ***Mechanical drawing*** for details of the position and mounting holes. DXF and Protel PCB files are available.

10.6 82B715 Bus Extender

Obsolete this has been removed from V3 boards

10.7 USB Leds and Power Led

USB-RX (led1) and USB-TX (led2) leds can be fitted if you want. Use 5V built-in resistor type leds (or use 3mm leds + 330 ohm resistors). These LEDs flash briefly when data is sent or received through the USB bus. They are useful for debugging purposes. Led3 is a power LED.

10.8 USB EEPROM

USB info can be set in the 93C46B EEPROM. FTDI utilities allow you to set this. This will let you enumerate the device as something other than a generic usb/serial adaptor, as well as setting special information such as current consumption.

Some customers have reported that Windows XP does not correctly handle multiple adaptors on the same USB, and that this may be fitted, and a unique serial number set.



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11 Example Applications

See the <http://www.i2cchip.com> for more examples.

There are application notes that clarify specific applications, and other information in the [PDF Library](#)

11.1 8 Bit I/O Port

Use a Philips PCF8574 or Onsemi JLC1562. See <http://www.i2cchip.com/pcf8574.html> for i/o boards and keyboards.



Figure 11.1

11.2 Simple Data logger with no PC Software

Use a Philips PCF8591 4 channel 8 bit A-D chip.

Store this macro in the EEPROM at location 0. It will run automatically at power on, sending 4 channels of A-D data in hex, followed by LF

S90 04 R04 T0A L0200 >00

[Start][address 0x90 (8591)][Control register=0x04][Read 4 channels of A-D] [Type LF (linefeed)][delay 512 ms][goto start]

Capture the data to file with Realterm.

Plot it with Excel, Matlab etc.

11.3 Simple RS232 I/O Port

The I2C-2-PC can be used directly as an 8 bit I/O port with a 1 bit IRQ input. No I2C or SPI chips are needed at all. This is ideal for connecting relays, lights and switches to a PC.

O OF

[write 0x0F direct to pins]

Q

[read pins]

?

[read IRQ input]

11.4 RS232 to LCD Module adaptor

A single PCF8574 can drive a standard LCD module. This circuit is available built up.



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11.5 Huge RS232 Parallel Port

To get a large number of cheap and easy output pins with good drive capability, use the SPI output, and 74HC4094 shift registers. Eg a 32 bit output with 4x 4094's.

SDA4 is used as STB for the 4094's

G3 Y01020408 OFFFD OFFFC

[select bus3][send 4 bytes to 4094's][pulse STB pin to latch data] nb **O** not zero

11.6 Reading a DS2401 1 Wire serial number

To read a DS2401 serial number

GC S ? W33 R04

[Select 1 wire bus#1 (bus #C)][Start(reset)][Get status to check presence][ReadRom Command][Read 4 bytes of rom data]

Since Start can be followed immediately by write data, a shorter version is:

GC S 33 R04

[Select 1 wire bus#1][Start][ReadRom command][read 4 bytes]

12 USB

USB requires the Virtual Comport drivers for Windows. For other operating systems see <http://www.ftdichip.com/FTDriver.htm>

USB introduces latency that may affect your software design. See <http://www.ftdichip.com/knowledgebase/AppNotes/005/knowledgebase.htm>

This latency affects *all* USB devices. To avoid it you should structure your software to decouple the commands you send from the data coming back. ie you send as many commands as possible to the BL233, then you process the data as it returns. If you send a command, then wait for each response, performance can be very poor.

Just because USB runs at 12Mbps does not mean it really works fast. RS232 may perform better in practice. This is why we provide *both* interfaces.

The USB configuration in EEPROM can be changed so that it enumerates as a special device rather than a virtual comm port. FTDI utilities can be provided to do this. FTDI provides D2XX DLL Drivers are to directly access the USB interface.

<http://www.ftdichip.com/FTD2XXDriver.htm>

We recommend using the Virtual Comm Port approach, as you retain the flexibility to use RS232 with no software changes.



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12.1 Should I use USB or RS232?

If you are making test systems or otherwise require reliability and performance, we recommend that you try and use a real serial port, rather than USB. Reliability does not depend on drivers, and on other USB devices being connected and disconnected from the computer. The Comport number will not move around. Latency is reduced, and more reliable.

13 FAQ

The BL233 datasheet is the place to find answers to all your software questions!

Can I use SMBUS chips

Yes. SMBUS chip will usually operate directly.

Can I mix 5V and 3V IC's?

Yes. Bus# 3 has TTL Levels. You can have bus 1&2 at 5V and bus 3 at 3.3V

My adaptor doesn't work. I have Galvanic Isolation.

You have to power the PC side **and** the I2C side separately. See Isolation section 10.2

Will your product continue to be available.

Yes it is a successful product with a growing market.

USB is really slow?

Latency is an issue. See USB section 12

The data is gobbledygook.

First use Realterm to test the adaptor. Make sure the baud rate is correct (57600 is default) and that you are using RTS/CTS handshaking. Once you have used Realterm to send commands successfully and found out what the returned data is, you are ready to start writing your software.

Realterm doesn't do XXXX

You can try the latest development version of Realterm at
<http://www.i2cchip.com/realterm>

Does it work with Labview?

Yes. Labview has good serial support

Does it work with Linux / Solaris / Mac



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Yes. No special drivers are required. You will probably find it easier to use the rs232 interface.

How do I interface to a PDA?

- Most PDA's have TTL level serial connections available. The BL233 will directly interface to this through the AUX header on the pcb.
- RS232 adaptor cables are available for some PDA's. You will probably need a null modem plug/cable to connect them together
- You can use an IRDA receiver connected to the AUX header. The IR port is a comm port to the PDA software
- Use a bluetooth module connected to the AUX header. These give up to 100m range.
- RS232 Compact Flash card. If your PDA has a CF slot you can get an RS232 card for it.

My PDA has a USB cable. How do I use it?

Except for the latest devices, most PDA's are a USB slaves, and cannot control other USB slaves. (ie you can't)

If your PDA can plug direct into a USB->RS232 adaptor then it has a good chance of working.

How do I interface to a Wireless Router.

Most routers such as the Linksys RTA54G have a logic level serial port. This can be connected directly to the AUX port. You may need to put 4k7 resistors in series for level shifting.

Some routers (eg ASUS) have a USB port, and may have be able to work with the USB-Serial interface.

14 Factory Test Procedure

This is the factory test procedure:

14.1 Visual Inspection

Inspect paying close attention to all leaded solder joints.

14.2 DC Supply current and Power supply

Set PSU to 0V.

Connect to DC socket.

Increase supply voltage *slowly* to 8V, whilst measuring the 5V line across D2, and watching for excessive current (>50mA)

Check supply voltage on BL233B is between 4.75 and 5.25V



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Change jumper J6 to 3V position, check voltage is 3.2-3.4V

14.3 RS232

Install RS232 jumper

Connect RS232 cable and set terminal program to nominal baud rate (normally 57600)

Connect power to adaptor

Terminal should display "HI I2CAD V118" or similar. Note that once the EEPROM has been changed this may no longer be true.

Type "?". Board will reply with 2 chars eg 18

Remove jumper (auto-select).

Type "?" again and check still works

14.4 USB

(Note that FTDI USB/serial adaptor drivers may need to be installed first time)

Remove RS232.

Plug in USB.

Type "?" and check response.

In case of problems check the USB RX and USB TX LED positions with an oscilloscope. These pulse low when chars are received or sent. Note that you won't see the "HI I2CAD V118" power on message through the USB port as the USB connection is not enumerated yet, when the BL232 starts.

14.5 I2C Bus 1

Connect the test PCF8574 board to I2C Bus1.

Type "S42F0P"

Half the leds will come on

14.6 I2C Bus 2

Connect the test PCF8574 board to I2C Bus1.

Type "G2" to change to I2C Bus 2

Type "S42F0P"

Half the leds will come on

14.7 INT Pin

Put jumpers J4,5 in INT position

Send ?. Reply is "18"

Hold down a button on 8574 board.

Send ?. Reply is "08"

Check for 3 busses



I2C for PC

USB & RS232 TO I2C/SPI ADAPTOR & CONTROLLER

15 RoHS & Lead Free

I2C2PC supplied after April 2003 use >90% lead-free solder

I2C2PC RoHS/Lead Free are being supplied to EU from April 2006, and globally from October 2007.

(BL233_B supplied after October 2005 are RoHS/Lead Free)

16 Ordering Information

17 OEM Versions

It is available as a bare board in OEM packs.

See Mechanical PCB and DXF files for mounting hole positions.

Special builds are also available for volume orders.

- RS232 only
- USB only
- Waterproof metal box
- other voltages

17.1 RS232/USB to TTL Interface

We supply this board for use as a built up serial interface to customers TTL level devices. Contact us for pricing.

CN2 connects to your device and can power it.

Pin#	Direction	Function
1		V+
2	From PC	TTL RTS
3	From PC	TTL TXD
4	To PC	TTL RXD
5	To PC	TTL CTS
6		0V

18 Co-operation

We offer all customers a link page on our web site, where others can find out about *your* products. We encourage you to use this.

19 Schematics and Drawings

See PDF's included in the I2C_All_Docs.zip

Mechanical drawings and DXF files of mounting holes etc are included.