



Forest Electronic Developments



USB MultiChip

The FED USB multi-chip is a 20 pin through hole (DIP) or surface mounted (SSOP/SOIC) device which has a USB interface and which provides

PIC Programmer

and one of the following functions:

Parallel Read/Write Port with optional 16 bit address

Serial Interface

10 bit programmable I/O

I2C port

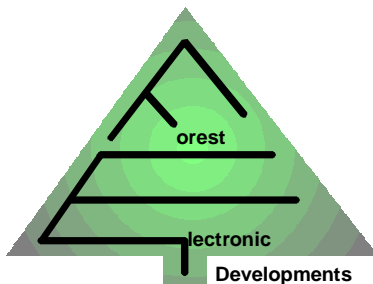
Forest Electronic Developments

12 Buldowne Walk

Sway

LYMINGTON

info@fored.co.uk



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INTRODUCTION

This manual describes the FED USB MultiChip (FUM), which can be used to add a USB port to a wide range of applications.

It has an optional PIC programmer function which can be used at the same time as any of the other functions of the chip. This can be used to allow software to be upgraded in the field through the USB port, and unlike bootloaders this will work with any of the devices in the PIC 12C/Fxxx, 16F/Cxxx and 18F/Cxxx families.

The chip can be set up to act as one of the following functions :

1. A USB to serial converter.
2. A USB to parallel Read/Write port with up to 16 bit addressable memory space (with external address latches if required).
3. A 10 bit I/O device which can be used to read switches or drive relays and LED's.
4. An I2C interface device.

USING THE FED USB MULTICHIP

The pinout of the FED USB MultiChip is shown below, many pins have different functions according to the mode in which the chip is to be used, however the two crystal pins, Vdd, Vss and the VUSB pin have the same function in all modes.

PINOUT

| <i>Pin</i> | <i>Programmer Mode</i> | <i>Serial Mode</i> | <i>Parallel Port Mode</i> | <i>I/O Mode</i> | <i>I2C mode</i> |
|------------|------------------------|--------------------|---------------------------|-----------------|-----------------|
| 1 | Vdd | Vdd | Vdd | Vdd | Vdd |
| 2 | Crystal 1 | Crystal 1 | Crystal 1 | Crystal 1 | Crystal 1 |
| 3 | Crystal 2 | Crystal 2 | Crystal 2 | Crystal 2 | Crystal 2 |
| 4 | Serial Mode Select | Programmer Select | Vss | Vss | Vss |
| 5 | PGC | | D 3 | IO 3 | |
| 6 | PGD | | D 2 | IO 2 | |
| 7 | Prog Vdd | | D 1 | IO 1 | |
| 8 | LED | | Write | IO 9 | |
| 9 | PGM (LVP) | | Read | IO 8 | |
| 10 | | Tx Data | D 7 | IO 7 | |
| 11 | | Select Serial | D 6 | IO 6 | |
| 12 | | Rx Data | D 5 | IO 5 | |
| 13 | | CTS (Input) * | D 4 | IO 4 | |
| 14 | | RTS | D 0 | IO 0 | |
| 15 | MCLRC | | ALEH | IOA | |
| 16 | HVC | | ALE | IOB | |
| 17 | VUSB | VUSB | VUSB | VUSB | VUSB |
| 18 | USB D- | USB D- | USB D- | USB D- | USB D- |
| 19 | USB D+ | USB D+ | USB D+ | USB D+ | USB D+ |
| 20 | Vss | Vss | Vss | Vss | Vss |

* 10K internal pullup

BASIC CIRCUIT

Figure 1 below shows the basic connections for the FED USB MultiChip. All applications have these minimum connections to the USB port and power supply. The crystal must be a 12MHz device. The chip should be decoupled close to the device with a 100nF capacitor.

As can be seen, apart from the FED USB MultiChip and the USB connector, there are only 5 components. The 1uF USB supply decoupling capacitor on pin 17 can be ceramic or electrolytic – in the latter case the positive

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end of the capacitor must connect to pin 17. The USB connector shown is for a large socket with 4 pins, miniature or sub-miniature connectors may also be used.

The circuit shows power supplied by the USB socket, but in practice an external 5V supply may be used. If the USB is to be used to supply the application then thought should be given to the overall power requirements. The minimum current supply from a USB port is 100mA, and a high power port 500mA.

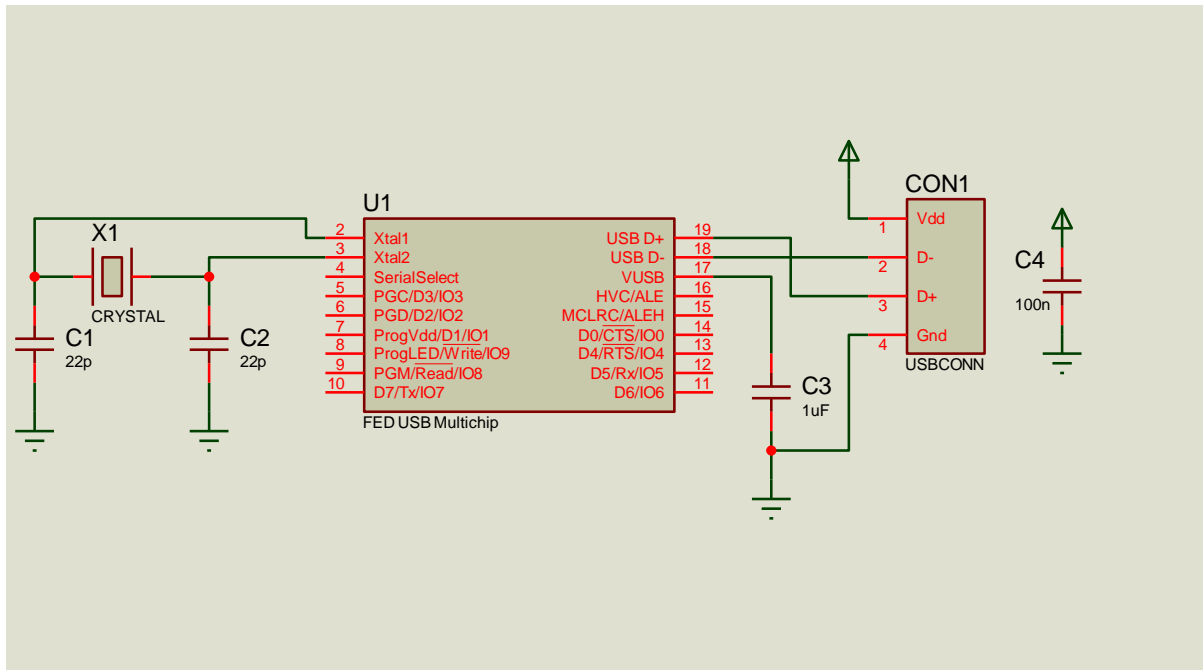


Figure 1 – Basic Connections to device

SELECTING THE USB MULTICHIP FUNCTION

The FED USB MultiChip installs as a serial port on the host computer regardless of which mode in which it is to be used. Pin 4 is used to select operation as either serial port mode or all other modes. For all other modes commands are sent to the chip through the USB port, this is further explained below.

INSTALLING THE DEVICE

There are two stages in the installation of the PIC Key. The first is for the installation of the drivers for the USB port, the second is for the programmer software if it is to be used. The drivers should be installed first and are necessary for use with the programmer and debugger.

The FED USB MultiChip installs as a virtual serial port. It uses a standard CDC serial driver which is provided on the CD or on our web site, both XP and Vista/Windows 7 drivers are supplied.

Insert the CD and when the opening menu comes up close the menu application. Plug the USB cable into the PC. The "Add New Hardware Wizard" will start, click Next and then select the option "Search for a new driver for my hardware (Recommended)". On the next screen select the CD-ROM option and then Windows will identify the appropriate driver for your version of Windows and install it.

The programmer will be installed as a spare COM Port.

PIC PROGRAMMER

The FED USB MultiChip can program PIC's in the 8 bit core ranges, the vast majority of the 12, 16 and 18 devices may be programmed.

The simplest programming interface is achieved where the device has a low voltage programming mode. These devices have one pin (eg. RB5) which may be dedicated either to general purpose I/O, or as programming control. The vast majority of PIC devices designed in the past 10 years or so have a low voltage programming mode. In this mode no external power supply other than 5V is required.

Where the device has no Low Voltage programming mode (in particular 8 pin devices typically do not have this mode), or when the LVP pin is required as a general purpose I/O in the application, then the Programmer can control an external supply to enter programming mode.

The PIC programmer can be used in parallel with all other modes offered by the FED USB MultiChip. This allows in circuit programming in the field though the USB port.

Figure 2 below shows the connections for a Low Voltage Programming device. The LED is optional and will light when the device is being programmed. PGC and PGD are connected to the PGC and PGD pins of the PIC device in use. Normally these pins are held in high impedance and only drive when programming is in use. The application circuit must take into account the use of these pins during programming. For example the PIC device can use the PGC and PGD pins as outputs or inputs in normal operation if they are coupled to the FED USB MultiChip by 1K resistors.

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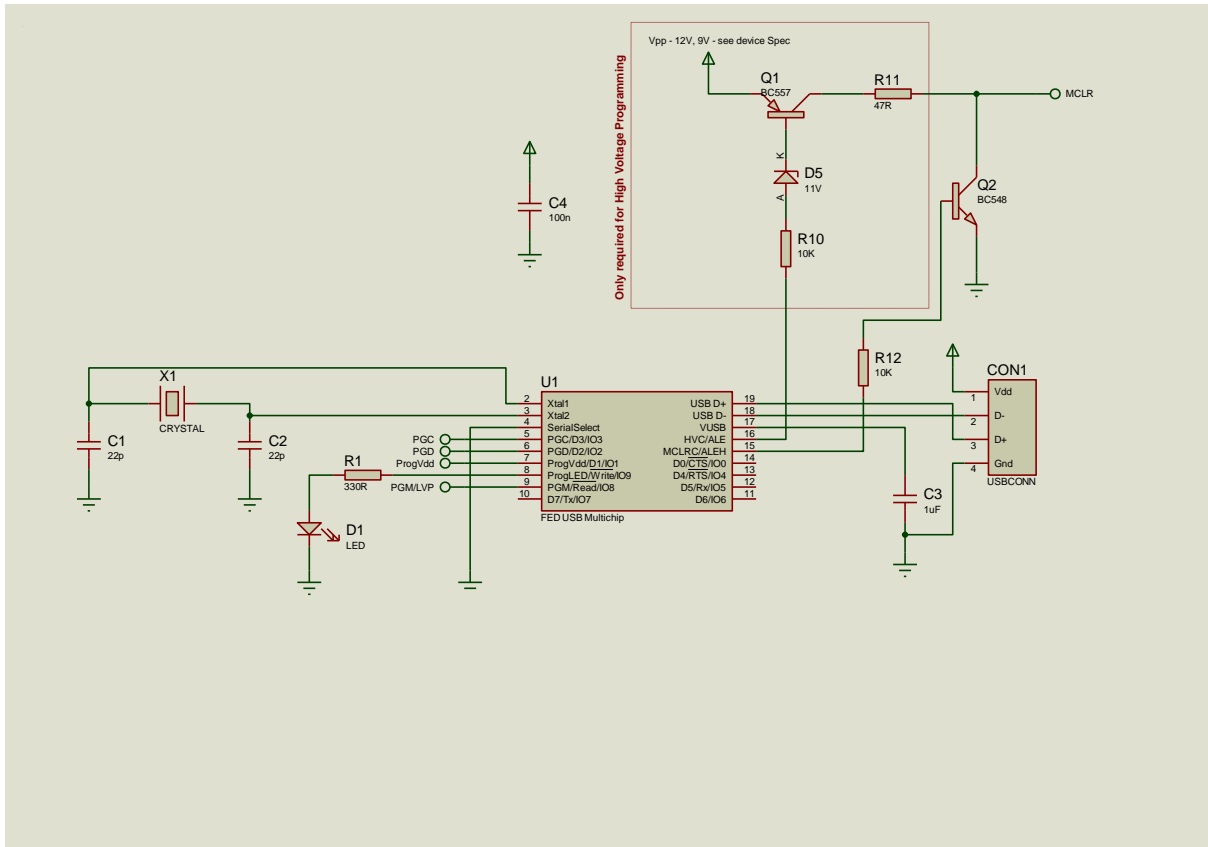


Figure 2 – Basic PIC Programmer

SERIAL PORT

The FED USB MultiChip can be used as a USB to serial port converter which supports hardware flow control if required through RTS/CTS signaling, and which supports bit rates up to 115K.

CONFIGURING THE FED USB MULTICHIP TO OPERATE AS A SERIAL PORT

The FED USB MultiChip may be configured to operate as a serial port on power up, to do this pin 4 is connected to Vcc by a 10K pull up resistor – if the chip is not be used as a PIC programmer then this may be connected directly to Vcc with no pull up. All bytes received from the USB are transmitted on the serial port connections.

Figure 3 below shows a typical circuit for the use of the serial port with no programmer, note that only 5 components are used in addition to the FED USB MultiChip itself.

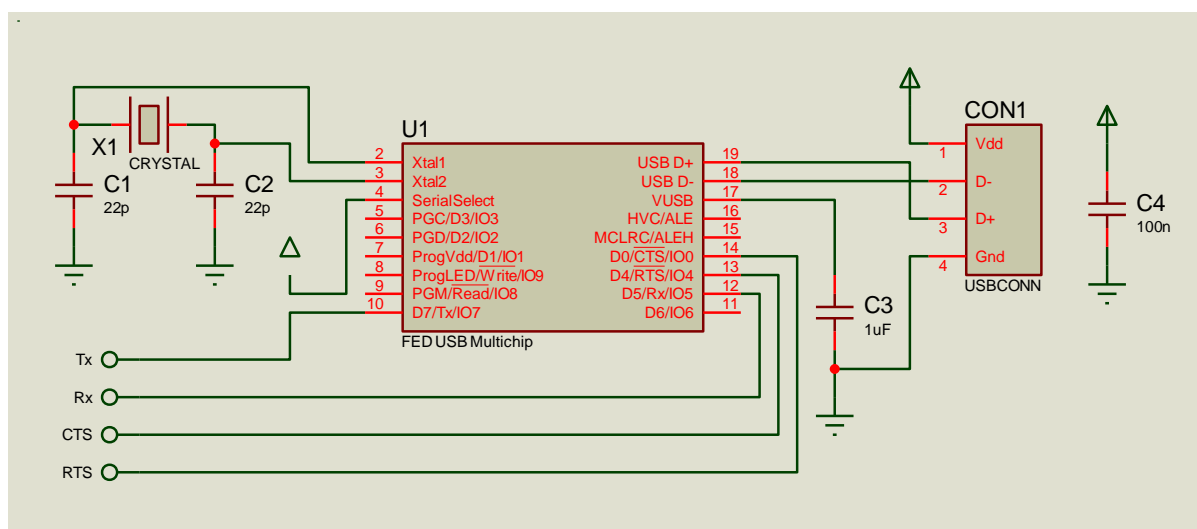


Figure 3 – Using the FED USB MultiChip as a USB to Serial Converter with no programmer

FLOW CONTROL

The RTS and CTS signals are the hardware flow control signals. Dependent on whether the FED USB MultiChip is wired as DTE or DCE will affect the meaning of these lines.

Both signals are active high – that is when high the port may receive characters, or will transmit characters. RTS is an output showing the attached device that the FED USB MultiChip can accept characters, CTS is an input showing the FED USB MultiChip that the remote device is able to accept characters. Note that CTS is internally held high with an approximately 10K resistor, so when flow control is not in use it may be left unconnected.

USE WITH THE PROGRAMMER

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The FED USB MultiChip may be used as a PIC programmer as well as a serial port. Figure 4 below shows a typical circuit. As described above the PGC and PGD pins must be connected to the PGC and PGD pins on the PIC, the MCLR connection is connected to the PIC MCLR pin. For low voltage programming the PGM pin is connected to the PGM or LVP pin on the PIC. For high voltage programming the PGM pin may be disconnected, but Q1, D5 and R10 must be used together with an external supply of 9 to 13V – see the relevant PIC data sheet.

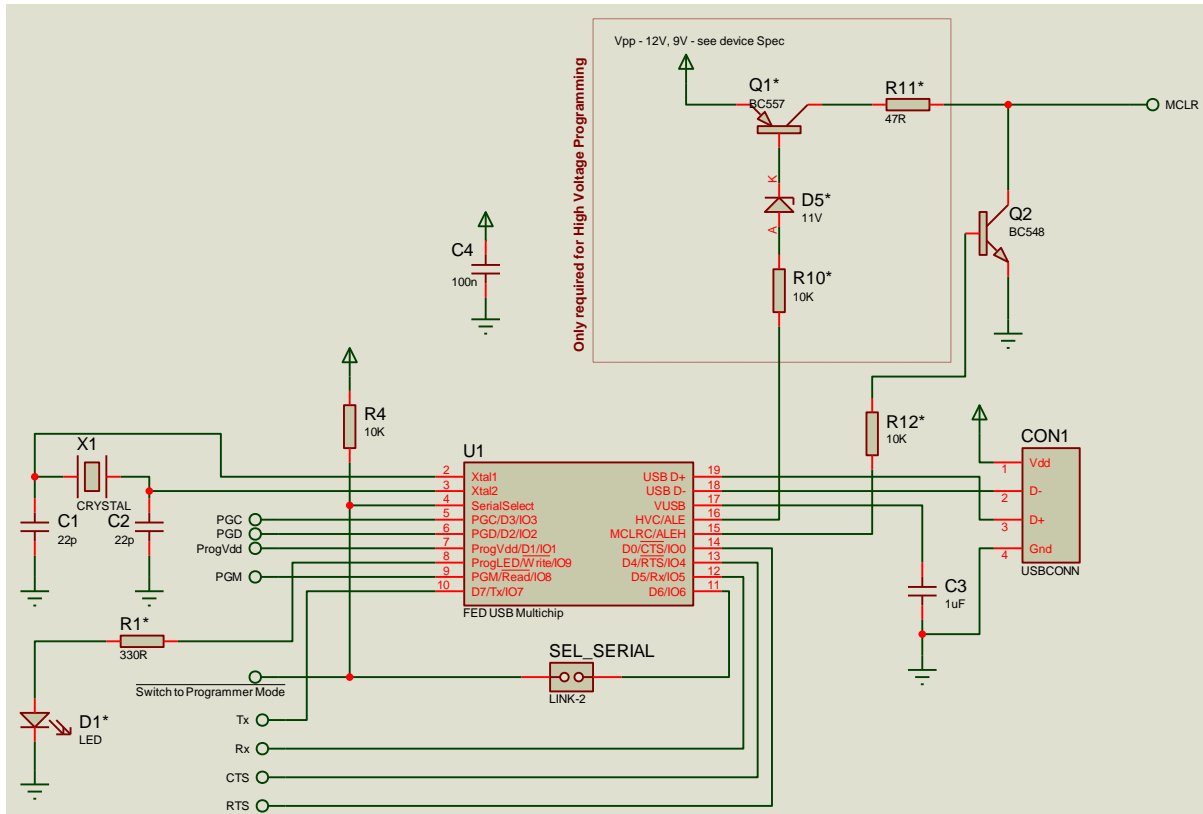


Figure 4 – Using the FED USB MultiChip as USB to serial converter with PIC Programmer

It is necessary to switch the FED USB MultiChip into PIC Programming mode to program the PIC. To do this pin 4 of the chip should be pulled low at power up, or during normal operation. This can be achieved with an external link, or by the application circuitry. It is the falling edge of the signal which switches the FED USB MultiChip into programmer mode.

The FED USB MultiChip can assist this process automatically. When the device receives a special 5 byte sequence, in hex 21,19,11,62,AA,00 (in order) then pin 11 is pulled low. Now if pin 11 is connected to pin 4 (by use of the link shown as SEL_SERIAL in figure 4), then when the chip receives this sequence it will enter programming mode. The PC PIC Programmer application sends this sequence to the FED USB MultiChip when it is trying to detect it.

It is up to the user in designing the application to decide which method to use to enter the programmer application. If the link between pin 4 and 11 is made then the application and programming can be controlled entirely through the USB port – however the application must never send the special sequence as part of normal operation. If this method is not used then the application must be designed to pull pin 4 low when

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programming is required, or a link or push button used to manually pull pin 4 low (which may require physical access to the board).

PARALLEL PORT

In parallel port mode the FED USB MultiChip can be used as a simple 8 bit port with read/write control. The 8 bit port is set to drive or read as required. It can also be used with external address latches to address up to 16 lines – 64K.

The chip is configured as a serial port, and commands are sent to it from the PC as to any serial port.

PARALLEL PORT

Figure 5 below shows the use of the FED USB MultiChip as a simple parallel port with no programmer. The parallel port may be used for communication with another processor, or for driving one or more of the many common peripheral chips with 8 bit interfaces.

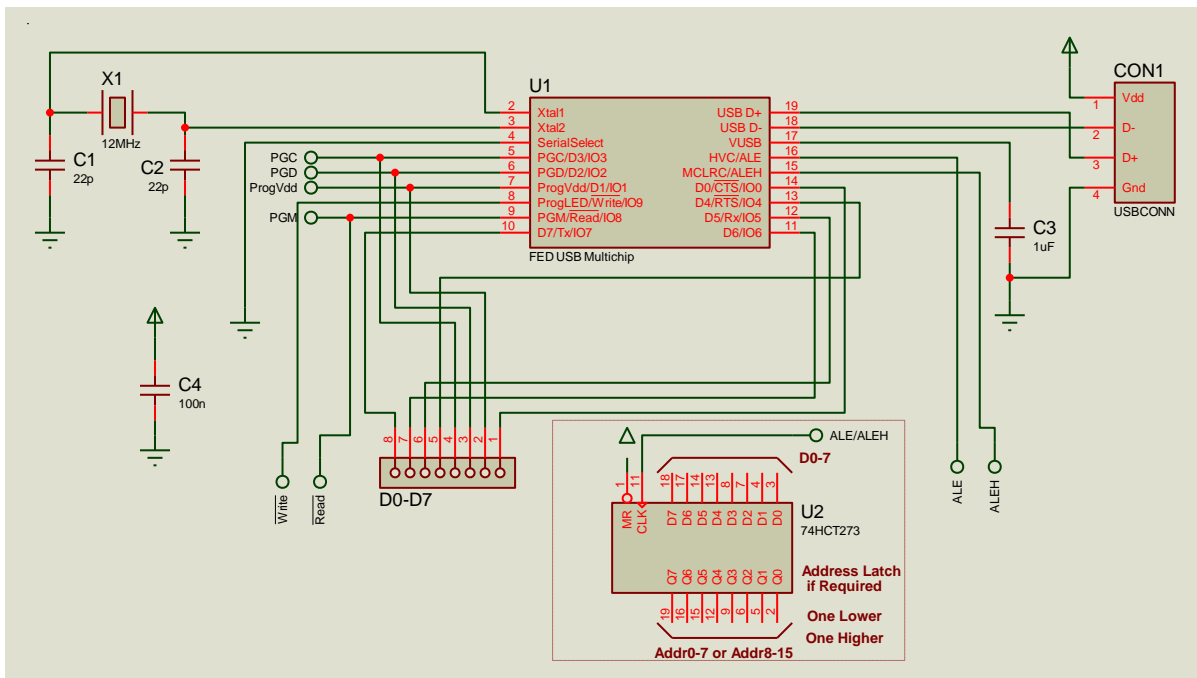


Figure 5 – Simple Parallel Port

There are 8 data bits. The read and write signals are active low. Read data is latched 80nS before the rising edge of the read pulse. Normally the data bus is an input, but the data bus is set to drive 80nS after the write signal falls, drives during the duration of the write low pulse and is released 80nS after the rising edge of the write signal. See fig 6 which shows the functional timing diagram.

The duration of the read and write signals is selectable as 1uS or 10uS.

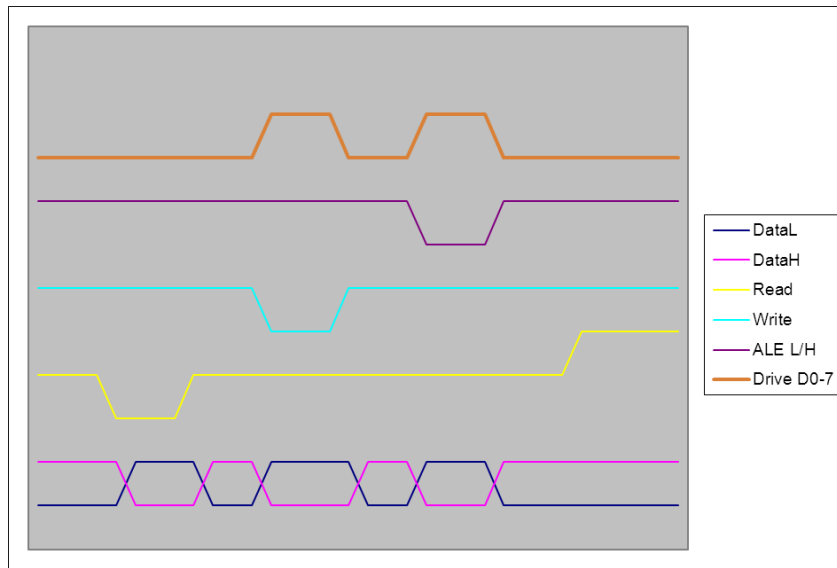


Figure 6 – Parallel port functional timing

To address up to 64K of peripheral space then external address latches may be used – such as the 74HCT273. 8 or 16 bits of address space is available. These are also shown on figure x. The ALEL or ALE H signals drive the lower and upper 8 bits of address space respectively. The address is set by the commands sent over the serial interface as shown below.

USING THE PARALLEL PORT WITH THE PIC PROGRAMMER

Figure 7 below shows a typical circuit. As described above the PGC and PGD pins must be connected to the PGC and PGD pins on the PIC, the MCLR connection is connected to the PIC MCLR pin. For low voltage programming the PGM pin is connected to the PGM or LVP pin on the PIC. For high voltage programming the PGM pin may be disconnected, but Q1, D5 and R10 must be used together with an external supply of 9 to 13V – see the relevant PIC data sheet.

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It is not necessary to use this link which may be left permanently connected if :

- The address latches are not used (and the commands to set them up are not used).

OR

- Only the lower address latch is used and low voltage programming is used.

The logic family 273 device works fine as an 8 bit address latch and the ALE and ALEH lines may be connected directly to the device.

Note that the PIC Programmer LED is shared with the Write signal. This means that in parallel port mode the LED will be permanently active and will flash when the programmer is in use. It may be left unconnected normally as it is not required.

The full set of commands is shown in the section below.

PARALLEL PORT COMMANDS

To use the parallel port a number of commands are available which are sent over the emulated serial link to the FED USB MultiChip. On entry into parallel port mode the address latches will be unknown and must be set using the !A command if required. The pulse length is set to 1uS.

To enter parallel port mode the command string !P (in hex 0x21,0x50) is sent, this must always be sent to set the FED USB MultiChip into parallel port mode, it can be sent at anytime.

| Command string | Hex | Parameters | Return Value | Meaning |
|----------------|----------------------------------|--|--------------|---|
| | 0x21,0x19,0x11 0x62,0xAA,0x00 | | | Exit parallel port mode and enter PIC Programmer mode |
| !z | 0x21,0x7A | | | Exit parallel port mode and enter PIC Programmer mode |
| !P | 0x21, 0x50 | | 0x4B | Enter parallel mode, or remain in parallel mode. Return character K to confirm |
| | | | | |
| !Ah | 0x21,0x41,l,h | l – Lower 8 bits of address h – Upper 8 bits of address | | Set the address latches to the supplied address |
| !Bl | 0x21,0x42,l | L – Lower 8 bits of address | | Set the lower 8 bit address latch to the supplied address |
| !Cx | 0x21,0x43,x | x – Configuration | | Set configuration. x has the following meaning : Bit 0 – Pulse 0=1uS, 1=10uS |
| !R | 0x21,0x52 | | 0xvv | Return 8 bit value read from bus |
| !S | 0x21,0x53 | | 0xvv | Return 8 bit value from bus and increment the address latches by one |
| !Tn | 0x21,0x54,n | n – 8 bit count | v0,v1...vn | Read up to 255 values from the bus, increments the address latches by one after each value |
| !Wv | 0x21,0x57,v | v – 8 bit data value | | Write 8 bit value v to bus |
| !Xv | 0x21,0x58,v | v – 8 bit data value | | Write 8 bit value v to bus and increment the address latches by one |
| !Yn[p0,p1...] | 0x21,0x59,p0,p1... | n – 8 bit count p0..pn – 8 bit values | | Write sequence of up to 255 values to the bus incrementing the address latches by one every time. |

For example to set the address to 0x1234 then the command sequence 0x21,0x41,0x34,0x12 would be sent.

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There is a five second timeout on commands – if the command is not completed with one second then the FED USB MultiChip returns to searching for the next command and will not complete the previous command. Invalid characters are ignored.

I/O PORT

In I/O port mode the FED USB MultiChip can be used as an I/O driver with up to 12 individually programmable I/O lines. Each line may be set to input, or output and the output drive set to 0 or 1. The chip is configured as a serial port, and commands are sent to it from the PC as to any serial port.

IO PORT

Figure 8 below shows the use of the FED USB MultiChip as a simple parallel port with no programmer. Each IO line from 0 to 9 and A,B may be set high or low output, or set to an input.

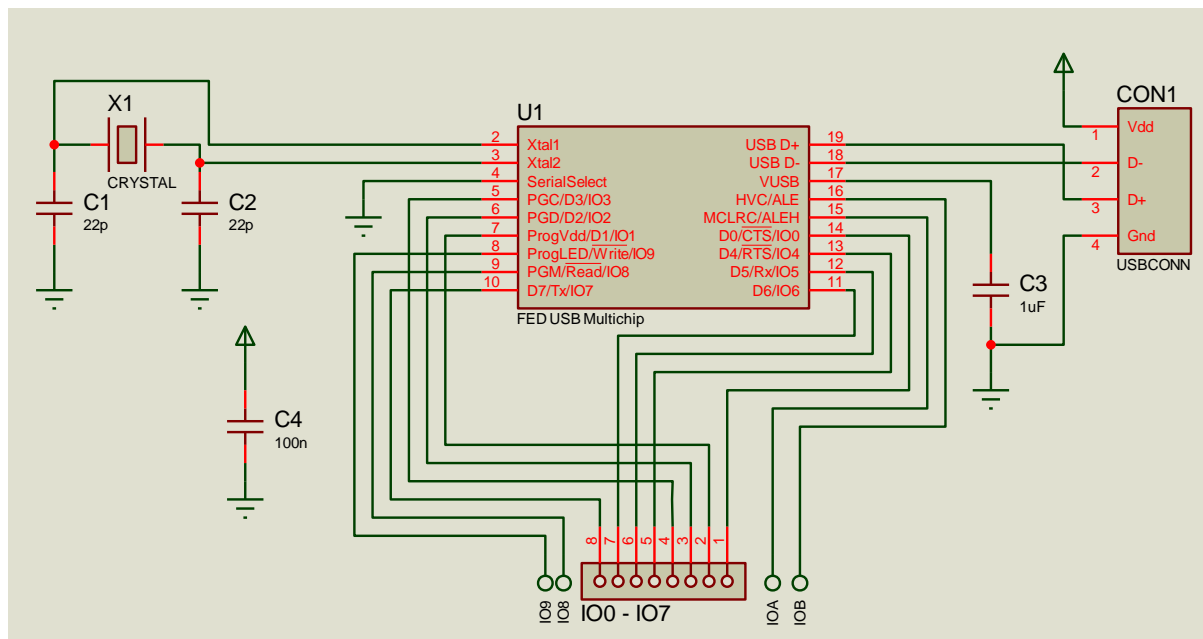


Figure 8 – Use of FED USB MultiChip as a 12 channel USB to I/O device

USING THE I/O PORT WITH THE PIC PROGRAMMER

When the programmer is used with the I/O port only 10 bits are available and bits IOA and IOB are not available and should not be addressed.

Figure 9 below shows a typical circuit. As described above the PGC and PGD pins must be connected to the PGC and PGD pins on the PIC, the MCLR connection is connected to the PIC MCLR pin. For low voltage programming the PGM pin is connected to the PGM or LVP pin on the PIC. For high voltage programming the PGM pin may be disconnected, but Q1, D5 and R10 must be used together with an external supply of 9 to 13V – see the relevant PIC data sheet.

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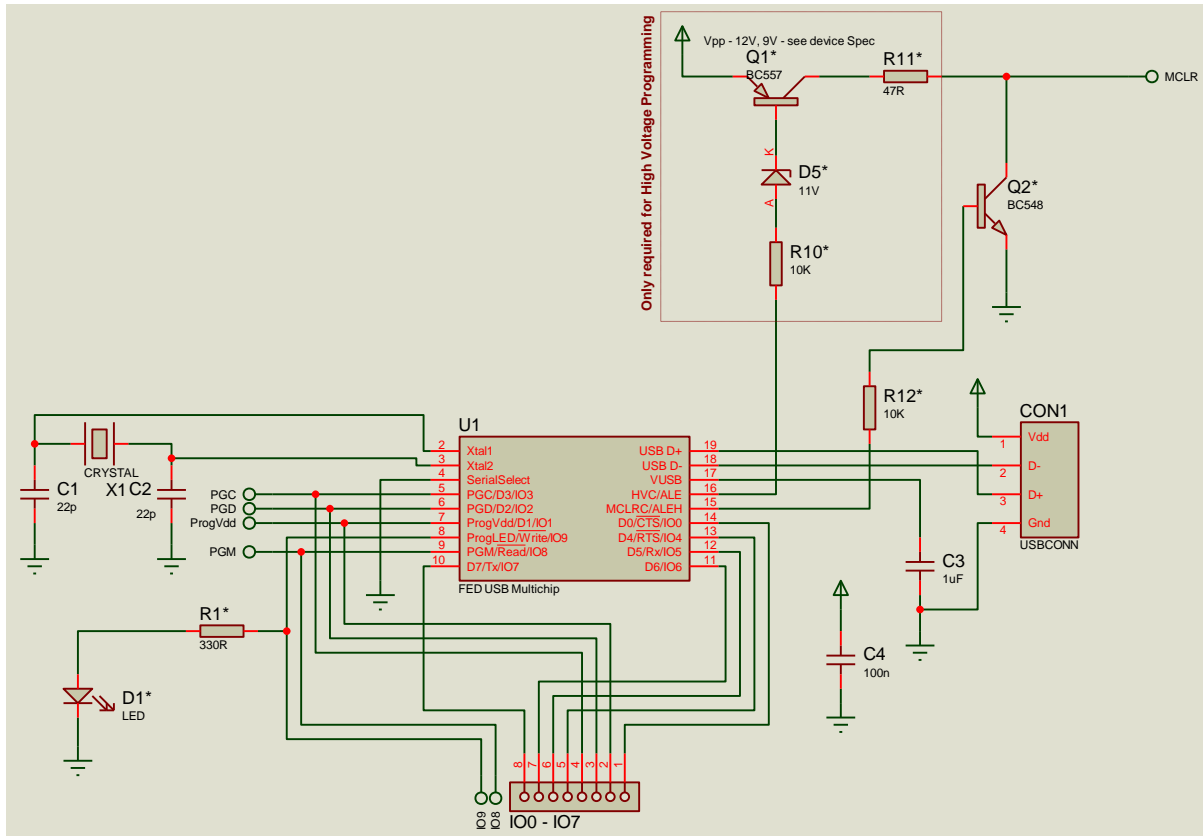


Figure 9 – Use of FED USB MultiChip as an I/O chip and PIC Programmer

It is necessary to switch the FED USB MultiChip into PIC Programming mode. To do this the command sequence !z (in hex 0x21,0x7A) may be used. Also a special 6 byte sequence , in hex 21,19,11,62,AA,00 can be used. The PC PIC Programmer application sends this sequence to the FED USB MultiChip when it is trying to detect it.

When used as a programmer the associated circuitry needs to be designed bearing in mind that IO lines IO1, IO2, IO3 and IO8 are driven by the programmer when in programming mode, and that IO2 will be driven by the PIC device which is being programmed during programming. This implies that these lines must either not be used, or may be used to read devices which are decoupled by a resistor, or drive devices such as LED's which don't matter if they are driven in programming mode. The LED D1 and resistor are optional and may be used to show programmer status when programming, bearing in mind that they will be driven by the I/O port.

The full set of commands is shown in the section below.

IO PORT COMMANDS

To use the IO port a number of commands are available which are sent over the emulated serial link to the FED USB MultiChip.

To enter IO port mode the command string !Q (in hex 0x21,0x51) is sent, this must always be sent to set the FED USB MultiChip into IO port mode, it can be sent at any time.

| Command string | Hex | Parameters | Return Value | Meaning |
|----------------|----------------------------------|---|--------------|---|
| | 0x21,0x19,0x11 0x62,0xAA,0x00 | | | Exit IO port mode and enter PIC Programmer mode |
| !z | 0x21,0x7A | | | Exit IO port mode and enter PIC Programmer mode |
| !Q | 0x21, 0x51 | | 0x4B | Enter IO mode, or remain in IO mode. Return character K to confirm |
| !Dnc | 0x21,0x44,n,c | n – ASCII character 0 to 9 or A,B (in hex 0x30 to 0x39, or 0x41, 0x42) c – ASCII 0 or 1 (0x30 or 0x31) | | Set bit 0 to 9 or A,B to an output and drive that output to level 0 or 1. Leave as an output. |
| !En | 0x21,0x42,l | n – ASCII character 0 to 9 or A,B (in hex 0x30 to 0x39, or 0x41, 0x42) | c | Set bit 0 to 9, or A,B to an input and return the value of that input as ASCII 0, or 1. Leave as an output. |

For example

- To set bit 2 to an output and drive that output to a logic 1, then the command sequence 0x21,0x44,0x32,0x31 would be sent.
- To set bit A to an input and read it then the command sequence 0x21,0x45,0x41 would be used, the command return '0' or '1' (hex 0x30 or 0x31) would be returned to read the input logic level.

There is a five second timeout on commands – if the command is not completed with one second then the FED USB MultiChip returns to searching for the next command and will not complete the previous command. Invalid characters are ignored.

I2C PORT COMMANDS

Version 1.0 of the FED USB MultiChip does not support I2C, this will added by Q1 2012.

SPECIAL COMMANDS

The following special commands are defined, but should not generally be used

| Command string | Hex | Parameters | Return Value | Meaning |
|----------------|-----------------------|------------------------|--------------|--|
| !0abcde | 0x21,0x30,aa,bb,cc,dd | abcd – 32 bit hex code | | Set the serial number of the FED USB MultiChip used in attached PC such as Windows to recognize that device. |
| !1 | 0x21,0x31 | | nnnnn | Return the serial number of the chip in ASCII decimal form |

ELECTRICAL SPECIFICATIONS

The FED USB Multi-Chip is based on the PIC18F14K50 device. The electrical specifications are therefore shown by the data sheet for that device.

It may be downloaded here :

<http://tinyurl.com/18F14K50>