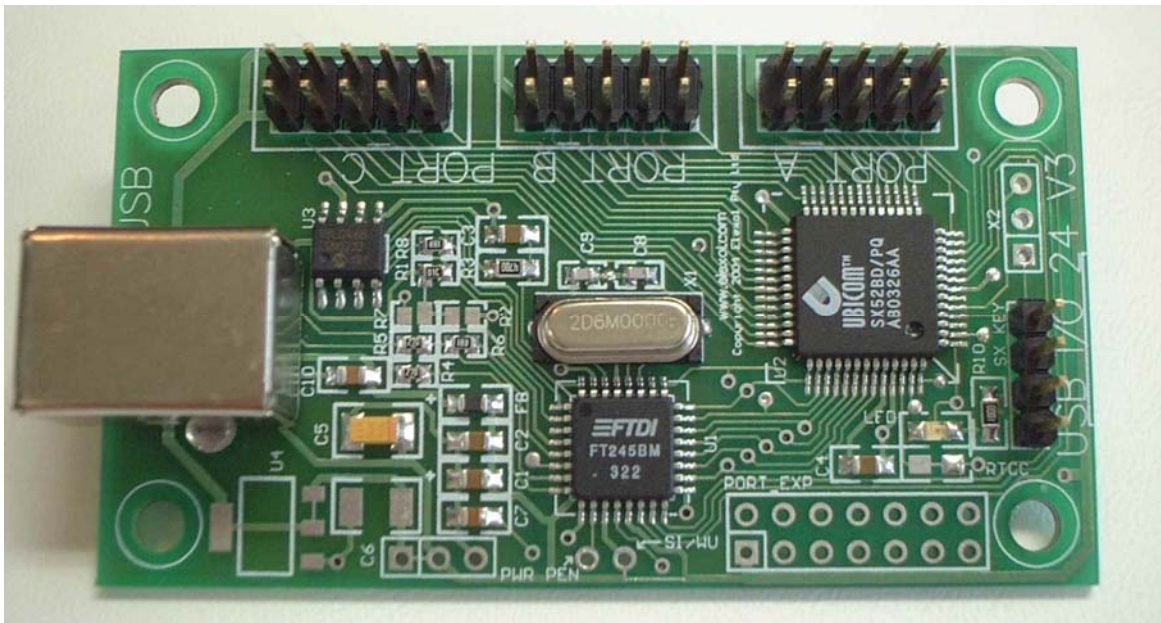


USBIO24 VERSION 3 Digital I/O Module

The USBIO24 VERSION 3 is the third generation of a low-cost integrated module for the input and/or output of digital signals from a computer system by connection to the USB port. The module pin out and firmware are 100% compatible with the first and second version of the USB I/O24 modules.

The module features 24 5V level signal lines individually programmable as input or output as well as capabilities for further expansion via the expansion port. As the module connects to the USB port, multiple modules can be connected to a single PC by the use of a USB hub or hubs. Each module features a serial number and the PC can identify each module uniquely allowing for multiple modules to be connected for a single application. The outputs of the module are able to source or sink up to 30mA per I/O, up to a maximum 50mA per port, to allow for direct connection to a variety of devices.

The USB I/O 24 Version 3 Module



MODULE FEATURES

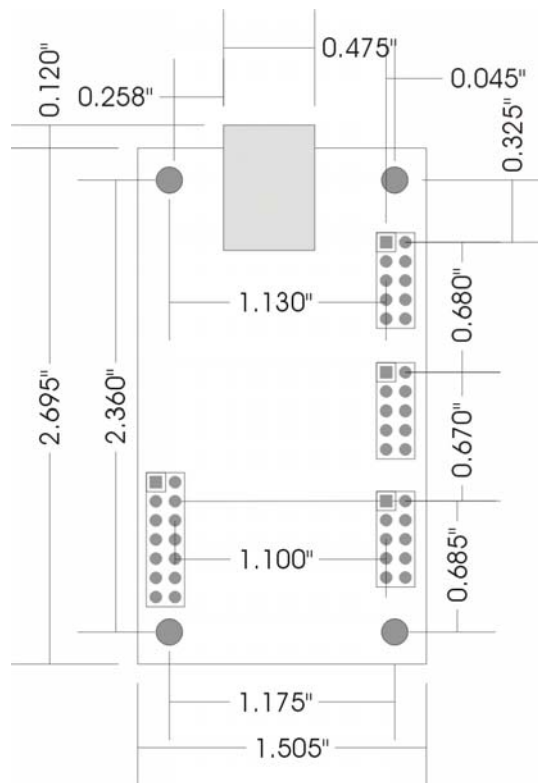
- 24 independently programmable Input / Output Pins Grouped into 3 ports.
- Single module High-Speed Digital Input / Output solution.
- Up to 128 modules can be connected to a single PC with capabilities of further expansion.
- Integrated Type-B USB Connector.
- On-board unique serial number in EEPROM and custom programmable FLASH microcontroller.
- Both USB Enumeration information and Microcontroller can be re-programmed to suit customer needs.
- Module powered by the USB from the PC or by an external power supply.

Module Standard Firmware & Software

- Virtual COM Port driver allows access as a regular serial port.
- Optional DLL based driver available.
- Easy to program using popular development languages C, Basic, Delphi, VB, etc.
- Simple command set for easy control of ports and data transfer.

Module Layout and Physical Dimensions

Shown in the diagram below is the module layout along with the physical dimensions of the unit.

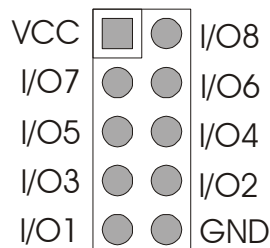


Module Connections

The USB I/O 24 module has 6 user connections and 1 programming connection.

I/O Port Connector Pin out

Shown in the diagram below is the I/O port Connector for each of the Ports on the module.
USB END



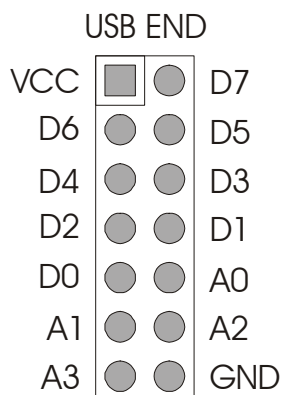
USB I/O 24 I/O Connector (PORT A, B, C)

Listed in Table 1 below are the connections for the I/O port connector. Ports A,B and C have identical connections.

| PIN # | SIGNAL | TYPE | DESCRIPTION |
|-------|--------|------|--|
| 1 | VCC | PWR | +3.3V to +5V depends on powering SX52 option – May be used to supply your circuitry Note A maximum of 50mA can be drawn when powered through USB |
| 2 | I/O8 | I/O | Programmable I/O pin with bit value of 128 |
| 3 | I/O7 | I/O | Programmable I/O pin with bit value of 64 |
| 4 | I/O6 | I/O | Programmable I/O pin with bit value of 32 |
| 5 | I/O5 | I/O | Programmable I/O pin with bit value of 16 |
| 6 | I/O4 | I/O | Programmable I/O pin with bit value of 8 |
| 7 | I/O3 | I/O | Programmable I/O pin with bit value of 4 |
| 8 | I/O2 | I/O | Programmable I/O pin with bit value of 2 |
| 9 | I/O1 | I/O | Programmable I/O pin with bit value of 1 |
| 10 | GND | PWR | Ground signal USB BUS and all I/O |

Port Expansion Connector Pin out

Shown in the diagram below is the I/O port Connector for each of the Ports on the module.

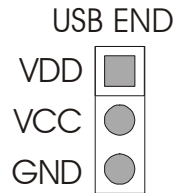


USB I/O 24 Port Expansion Connector (PORT EXP)

| PIN # | SIGNAL | TYPE | DESCRIPTION |
|-------|--------|------|--|
| 1 | VCC | PWR | +3.3V to +5V depends on powering SX52 option – May be used to supply your circuitry Note A maximum of 50mA can be drawn when powered through USB |
| 2 | D7 | I/O | Data pin on FTD chip / I/O pin with bit value of 128 |
| 3 | D6 | I/O | Data pin on FTD chip / I/O pin with bit value of 64 |
| 4 | D5 | I/O | Data pin on FTD chip / I/O pin with bit value of 32 |
| 5 | D4 | I/O | Data pin on FTD chip / I/O pin with bit value of 16 |
| 6 | D3 | I/O | Data pin on FTD chip / I/O pin with bit value of 8 |
| 7 | D2 | I/O | Data pin on FTD chip / I/O pin with bit value of 4 |
| 8 | D1 | I/O | Data pin on FTD chip / I/O pin with bit value of 2 |
| 9 | D0 | I/O | Data pin on FTD chip / I/O pin with bit value of 1 |
| 10 | A0 | I/O | RA4 on SX52 |
| 11 | A1 | I/O | RA5 on SX52 |
| 12 | A2 | I/O | RA6 on SX52 (currently used for LED Function) |
| 13 | A3 | I/O | RA7 on SX52 |
| 14 | GND | PWR | Ground signal USB BUS and all I/O |

PWR Connector Pinout

Shown in the diagram below is the I/O port Connector for each of the Ports on the module.



USB I/O 24 Port Expansion Connector (PORT EXP)

| PIN # | SIGNAL | TYPE | DESCRIPTION |
|-------|--------|------|---|
| 1 | VDD | PWR | +3.3V to +5V depends on powering SX52 option – May be used to supply your circuitry Note A maximum of 50mA can be drawn when powered through USB |
| 2 | VCC | PWR | +4.35 to 5V VCC supply to FT245BM when in self-powered mode. Note: In USB powered mode this pin is linked to pin 1 ** NO External power needs to be applied when in Bus powered mode** |
| 3 | GND | PWR | Ground signal USB BUS and all I/O |

Communication Protocol

Listed in the tables below is the communication protocols used to operate the module. The commands that are sent to the unit is in ASCII format and all data that is sent is in Binary format.

Standard Firmware

| COMMAND | DATA | FUNCTION |
|---------|--------------------------------|------------------------------------|
| '?' | Responds 'USB I/O 24' | Identify Device |
| 'A' | 1 Byte Port Data | Write to Port A |
| 'B' | 1 Byte Port Data | Write to Port B |
| 'C' | 1 Byte Port Data | Write to Port C |
| 'a' | Responds with 1 Byte Port Data | Read from Port A |
| 'b' | Responds with 1 Byte Port Data | Read from Port B |
| 'c' | Responds with 1 Byte Port Data | Read from Port C |
| '!A' | 1 Byte Port I/O Data | Write to Port A Direction Register |
| '!B' | 1 Byte Port I/O Data | Write to Port B Direction Register |
| '!C' | 1 Byte Port I/O Data | Write to Port C Direction Register |

The commands in the above table are in ASCII format. All Data is sent in Binary format.

Additional VERSION 3 Firmware

- Transmits on Pin Change without Software Polling (Mode 2)
- Enables setting of the pin pull up feature on SX52
- Enables setting of inputs as CMOS Level or TTL Level or Schmitt Trigger Inputs
- Single I/O pin commands
- SPI interface (available on all ports.)
- Temperature interface to a DS18B20 (available on all I/O pins)

| COMMAND | DATA | FUNCTION |
|---------|--|--|
| '?' | Responds 'USB I/O 24' | Identify Device |
| 'A' | 1 Byte Port Data | Write to Port A |
| 'B' | 1 Byte Port Data | Write to Port B |
| 'C' | 1 Byte Port Data | Write to Port C |
| 'a' | Responds with 1 Byte Port Data | Read from Port A |
| 'b' | Responds with 1 Byte Port Data | Read from Port B |
| 'c' | Responds with 1 Byte Port Data | Read from Port C |
| '!A' | 1 Byte Port I/O Data | Write to Port A Direction Register |
| '!B' | 1 Byte Port I/O Data | Write to Port B Direction Register |
| '!C' | 1 Byte Port I/O Data | Write to Port C Direction Register |
| 'H' | 1 Byte specifying which I/O pin (0-23) | Set specific I/O Pin High |
| 'L' | 1 Byte specifying which I/O pin (0-23) | Set specific I/O Pin Low |
| '#' | Follow with Port write and binary data | Port Pull up feature for SX52 |
| '@' | Follow with Port write and binary data | Set inputs to CMOS/ TTL level |
| '\$' | Follow with Port write and binary data | Set Port Schmitt trigger enables |
| '2' | | Sets unit to Mode 2 (Enables transmit on pin change) |
| '1' | | Sets unit to Mode 1 (Exits Mode 2) |

The commands in the above table are in ASCII format. All Data is sent in Binary format.

Pull Up

The Pull Up configuration applies to those lines that are set as inputs, writing a 0 to the corresponding bit applies a pull up resistor to the line so that if it is not driven low it will be pulled to a known high state, this is very useful if sensing contact closures or open collector outputs

Threshold

The threshold function sets the threshold at which a line reads as high or low. When the corresponding bit is set as 1 then the threshold is set at 1.4V and any voltage above this reads as a high level. When the corresponding threshold bit is set to 0 the threshold is set at 2.5V and any voltage above this reads as a high level.

Schmitt

Schmitt trigger inputs means that the input line is compared to 2 voltages, 0.75V and 4.25V. When the line's voltage drops below 0.75V it will read as a low until the line's voltage rises above 4.25V at which time the line will read as a high. When the line's voltage is in between 0.75V and 4.25V, the value will remain stable at its previous level. To enable the Schmitt trigger on any input a 0 must be written to the corresponding bit

Mode 2 Functional Changes

All reads have a port designator ('a', 'b' or 'c') before the data.

All auto sends have a port designator ('a', 'b' or 'c') before the data.

All writes to the port that change the port will results in a port data auto send.

SPI Interface

Send / Receive SPI Byte on PORT A

| COMMAND | DATA | REPLY | FUNCTION |
|---------|--------------------------------|------------------------------------|-----------------------------------|
| 'S' | 1 Byte of data sent on SPI Bus | 1 Byte of data received on SPI Bus | Send / Receive SPI Byte on PORT A |

Send / Receive SPI Byte on PORT B

| COMMAND | DATA | REPLY | FUNCTION |
|---------|--------------------------------|------------------------------------|-----------------------------------|
| 'T' | 1 Byte of data sent on SPI Bus | 1 Byte of data received on SPI Bus | Send / Receive SPI Byte on PORT B |

Send / Receive SPI Byte on PORT C

| COMMAND | DATA | REPLY | FUNCTION |
|---------|--------------------------------|------------------------------------|-----------------------------------|
| 'U' | 1 Byte of data sent on SPI Bus | 1 Byte of data received on SPI Bus | Send / Receive SPI Byte on PORT C |

Notes on SPI

Bit 1 is always Clock and must be set as an output from the SPI to function

Bit 2 is always Serial Data Out (MOSI) and must be set as an output from the SPI to function

Bit 3 is always Serial Data In (MISO) and must be set as an input from the SPI to function

All other port pins act as normal

Setting the port pin as high or low will set the clock as normally high or low before the SPI transaction begins.

Any of the other pins can be used as SS or CE when SPI is used.

NOTE: This interface will not work with the 50MHz upgrade.

Temperature Sensor Interface using DS18B20

Convert Start

| COMMAND | DATA | REPLY | FUNCTION |
|---------|-------------------------------------|--------------------------|------------------|
| 'J' | 1 Byte specifying which pin 0 to 23 | 1 Byte Status of Command | Start Conversion |

Read Temperature

| COMMAND | DATA | REPLY | FUNCTION |
|---------|-------------------------------------|--|------------------|
| 'K' | 1 Byte specifying which pin 0 to 23 | 3 Bytes Byte 1 – Status (see below) Byte 2 – MSB of Temperature Byte 3 – LSB of Temperature | Read Temperature |

Notes on the DS18B20

Status Bytes

- G Command execute normally
- C A CRC error occurred while reading the data
- N No sensor found
- E Bad pin number (only pins 0 to 23 are valid)
- S Bus Shorted (or pull up resistor missing)

The DS18B20 requires a resistor between 1K and 4.7K between the data line and the +5V rail. A DS18S20 may also be used if the higher resolution of the DS18B20 is not required.

NOTE: This interface will not work with the 50MHz upgrade.

LED Function

The LED function on the USB I/O 24 V3 is to provide a visual indication of when there is data being read by the SX52. This function is standard with all USB I/O 24 V3 but can be removed by reprogramming the SX52 with different firmware and/or removing the 0805 LED.

Reprogramming and Customising the firmware

In order to reprogram the original or any customized firmware into the USB I/O 24 you will require a SX Key programmer. These programmers are available from Parallax. For further information on these programmers visit http://www.parallax.com/sx/programming_kits.asp

The firmware for the USB I/O 24 is available on request. Please contact support@elexol.com

50MHz Upgrades

Upgrades are available to run the SX52 at 50MHz clock speed instead of using the internal 4MHz clock.

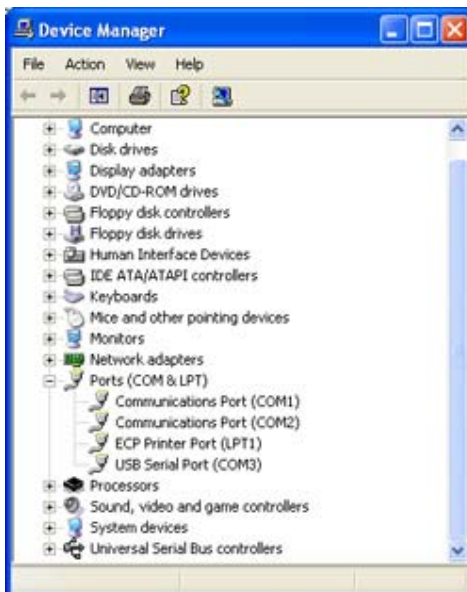
Accessory Boards

Accessory boards are available for this product. Please check the Elexol website for further information.

Driver Installation

Your first choice when using the USBIO24 VERSION 3 is whether you want to use the Virtual COM Port driver or the Direct DLL driver.

For programming simplicity the best driver is the Virtual COM Port and when installed the USBIO24 VERSION 3 will appear in the System Properties / Device Manager as an USB Serial Port (COMn) as follows.



The COM port number will vary depending on the number of existing COM ports on your computer and the number of USBIO24 VERSION 3s or USBMODs connected to your system.

To install the Virtual Com Port drivers, download the driver from our website or the ftdichip.com website and unzip the files to a local directory. Then connect the USBIO24 VERSION 3 and windows will automatically ask for the driver, select to specify a location and browse to the directory where you have unzipped the files. (Use of the Non Plug & Play driver for the USBIO24 VERSION 3 is recommended to avoid a delay on connecting the USBIO24 VERSION 3)

Once the Virtual COM Port is installed it can be programmed exactly as a regular serial COM port using the MSComm control from within VB or API calls from C or other languages. Set the COM port to the same number as appears in the Device Manager, the baud rate, stop bits, parity etc are not used as the device always runs at full speed.

The Direct DLL driver is installed in a similar manner but using the alternative download from the website.

Programming the Direct DLL driver is by call to the DLL Library functions. Please download the Direct DLL programmers guide from the FTDI website.

NOTE: Only one driver for the device can be installed at any one time.

Programmers Reference Documentation

Programming the USBIO24 VERSION 3 from Visual Basic using the Virtual COM Port.

To operate the USBIO24 VERSION 3 from within Visual Basic it's best to use the Microsoft MSComm control to access the COM port. To input data from the USBIO24 VERSION 3 you must use the port in binary mode and receiving the data is a bit convoluted.

Opening the Port

As the USBIO24 VERSION 3 unit uses binary data transfer we must use the port in binary mode.

If the port number is incorrect or the USBIO24 VERSION 3 module is not connected then VB will generate an error.

```
MSComm1.CommPort = 3 ' Set this number as shown in the Device Manager  
MSComm1.InputMode = comInputModeBinary ' Set Binary Input Mode  
MSComm1.PortOpen = True ' Open the Port
```

Setting the pins as Inputs or Outputs

Setting the Ports as Input or Output you must determine the value for the pins you want set as inputs.

To set pins I/O1, I/O2 and I/O3 as inputs and the remaining pins as outputs you simply add the bit values of the input pins $1 + 2 + 4 = 7$ and thus the value to be placed in the IOValx variable in the following example code is 7.

```
' Set I/O1, I/O2 & I/O3 of port A to inputs and the rest as outputs.
```

```
IOValA = 7 ' First 3 inputs all the rest as outputs  
IOValB = 0 ' All outputs  
IOValC = 0 ' All outputs  
MSComm1.Output = "!A" + Chr$(IOValA) ' Write to Port A Direction Register  
MSComm1.Output = "!B" + Chr$(IOValB) ' Write to Port B Direction Register  
MSComm1.Output = "!C" + Chr$(IOValC) ' Write to Port C Direction Register
```

Writing to the Ports

To write to the Output Pins simple repeat the Above without the ! character.

The following example code sets the I/O8 pin on port B to high and the remaining pins as low.

```
IOValB = 128 ' I/O8 high, all the rest low  
MSComm1.Output = "A" + Chr$(IOValB)
```

Reading from the Ports

To Read the Input Pins is a bit more complicated as we must request the data from the module, wait for it to arrive and then retrieve the data from the port. The following example reads the value from port A.

```
MSComm1.Output = "a" ' Request data from port A
```

```
T = Timer ' Use the Timer to allow the program to continue if there is an error
  While Timer < T + 0.4 And MSComm1.InBufferCount < 1
  Wend
If MSComm1.InBufferCount <> 1 Then
  Call MsgBox("Read Timeout", vbInformation, "USBIO24 VERSION 3 Error")
  Exit Sub
End If
Dim TempBuffer As Variant
Dim ByteBuffer() As Byte
TempBuffer = MSComm1.Input
ByteBuffer = TempBuffer
PortAVal = ByteBuffer(0)
```

Hardware Configurations outlined on the schematic for the USB I/O 24

The USB I/O 24 V3 has a number of different hardware configurations that can be implemented. Each of the configurations are listed below:

Bus Powered (FTDI Chip)

The bus powered mode draws power from the USB Bus. This option is the current configuration that is used when the USB I/O 24 is sent out.

Self Powered (FTDI Chip)

The self-powered mode of operation draws power from its own external Power supply and doesn't draw any current from the USB Bus.

Note: The FTDI chip can only be bus powered or self powered

Powering SX 52 Options

There are a number of different ways that the UBICOM SX52 micro controller can be powered. These various options are shown below.

Note: When the SX52 is powered from the USB this also means that the USB Bus will also power the FTDI FT245BM.

USB 5V

The SX52 draws it power from the USB Bus.

USB 3.3V

The SX52 draws it power from the USB Bus, but a 3.3V regulator regulates the voltage provided by the USB. Note: This 3.3V regulator is not currently placed on the board and is only provided as a separate option.

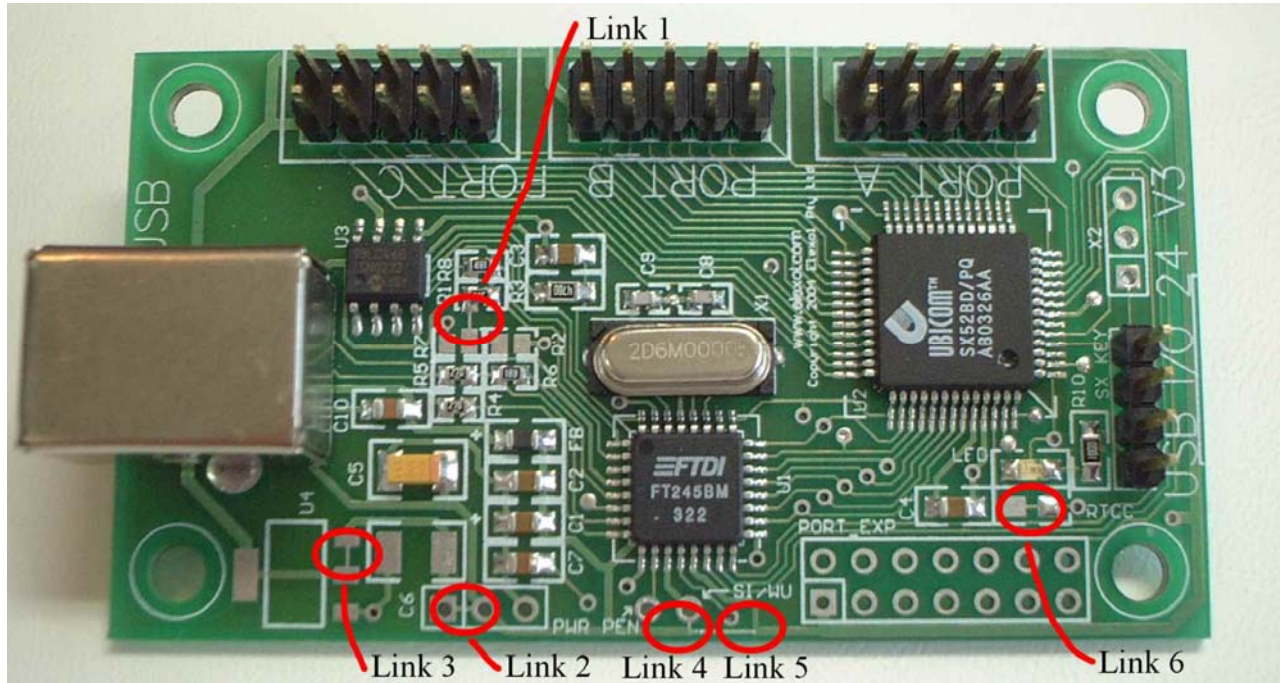
External 5V

The SX52 draws it power from its own external power supply

External 3.3V

The SX52 draws it power from its own external power supply, but the voltage provided by the power supply can be either set to the desired 3.3V or regulated by a 3.3V regulator. Note: This 3.3V regulator is not currently placed on the board and is only provided as a separate option.

Location of Links on USB I/O 24 PCB for various configuration setups



Link 1 = remove link to use FTDI chip in Self Powered mode. Also remove components C10 and FB. Place components R2, R6, R7. Apply an external power supply (5V MAX) to pin 2 of PWR Connector.

Link 2 = remove if the SX52 and the ports are to be powered by and external Power Supply. Apply an external power supply (5V MAX) to pin 1 of PWR Connector once the link has been removed.

Link 3 = used for to provide a direct connection to the External Power supply for the SX52 and ports. Remove link if placing the 3.3V Regulator

Link 4 =Links SIWU to VCC and VCCIO. Note: This pin when not being used is tied to VCCIO

Link 5 =Link between VCC FTDI and VCCIO. This link must be removed if the interface voltages between the FTDI and SX52 are different (3V3 to 5V interface) or the SX is being powered by an external supply (not pushing external power into the USB bus).

Link 6 = Connected to the RTCC pin on the SX52.

Absolute Maximum Ratings

Subjecting the device to conditions outside these rating will invalidate the product warranty and may cause irreparable damage the device.

| | |
|--|----------|
| Maximum Voltage on Any Pin (referenced to GND) | 5.1 V DC |
| Minimum Voltage on Any Pin (referenced to GND) | -0.1V DC |
| Supply current when USB enumerating | 55mA |
| Supply current when running with no load on I/O pins | 32mA |
| Total Current to or from Any Single I/O Pin | 30mA |
| Total Current to or from Any PORT (8 Single I/O make a PORT) | 50mA |
| Total Current in or out of all the module's I/O pins | 200mA |

Further Reading and Examples

More information and examples for the USBIO24 VERSION 3 can be found on our websites at www.elexol.com

Updated drivers and further information about the USB interface chip can be found at the FTDI website www.ftdichip.com

Information about the SX52 micro controller can be found on the UBICOM website at www.ubicom.com

Document Revision History

USB I/O 24 Version 3 Datasheet V1.1– Initial document created 29th September 2004

USB I/O 24 Version 3 Datasheet V1.2– Updated 8th June 2005

- **Description for Pull up, Threshold and Schmitt added**

Technical Support and Further Information

For any questions relating to the USBIO24 VERSION 3 please contact us by Email, Fax or Phone.

Email: support@elexol.com

Ph: +61 755 743988

Fax: +61 755 743833

Elexol Pty Ltd
Level 2
Commerce Centre
146 Bundall Road, Bundall
Queensland 4217
Australia

Elexol Pty Ltd
PO Box 5972
GCMC
Queensland 9726
Australia

Product Use Limitations, Warranty and Quality Statement.

The USBIO24 VERSION 3 should not be used in any situation where it's failure or failure of the PC or software controlling it could cause human injury or severe damage to equipment. This device is not designed for or intended to be used in any life critical application.

The USBIO24 VERSION 3 is warranted to be free from manufacture defects for a period of 12 months from the date purchase.

Subjecting the device to conditions beyond the Absolute Maximum Ratings listed above will invalidate this warranty.

The USBIO24 VERSION 3 is a static sensitive device, anti static procedures should be used in the handling of this device.

All USBIO24 VERSION 3 units are extensively tested at time of manufacture to be free of defects.

Elexol is committed to providing products of the highest quality. Should you experience any product quality issues with this product please contact our quality assurance manager at the above address.

Disclaimer.

This product and its documentation are provided as-is and no warranty is made or implied as to their suitability for any particular purpose.

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