USB UART Interface with galvanic isolation

1. Motivation

The main reason for this project was to build a little circuit to test one of the chinese PCB manufacturers. So I decided to turn a little idea which I had in mind for a longer time into reality, an idea that may become very useful in every day life (at least, if you are dealing with electronics :-)).

2. The USB UART Interface

The idea is to build an USB UART Interface which can be connected to a computer's USB port and provides a serial interface. You may choose between RS232 levels (for devices that have an RS232 with integrated level translators) and "TTL" levels with 5V or 3.3V (for example, for direct connection to a microcontroller). Besides RxD and TxD, also the control signals RTS and CTS are converted, so you can do for example simple switching tasks or control a RS485 interface and so on.

The trick with this interface is: it also is galvanically isolated*! Thus, you can avoid ground loops, you save your computer and you may communicate with circuits that work with high voltage or mains voltage. Isn't that great? *(* In the default configuration, a 1MOhm resistor is connected between USB ground and output ground. This should be taken into account if the interface is connected to high voltage levels.)*

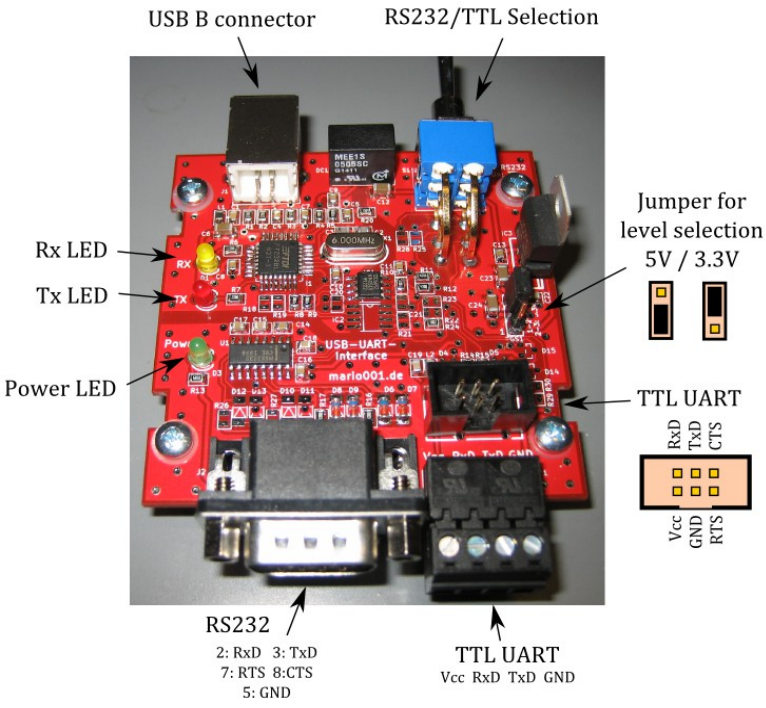
3. Operation and Connections

To connect the interface, use a standard USB cable with standard B type connector, the drivers should usually be detected automatically when using Windows 7. If not, the drivers may be manually downloaded here:

http://www.ftdichip.com/Drivers/VCP.htm

A virtual COM port will be provided which makes the interface accessible just like any other serial interface. The interface's power is supplied via the USB port, so no external power supply is necessary.

The image to the right shows the interface's connectors and their pinout. The RS232 signals are available at a Sub D9 male connector using the standard pinout, so that devices with a serial interface can be connected directly using a 1:1 serial cable.



The TTL level signals are available on a 4 pin screw terminal (without RTS, CTS) and a 6 pin pin header (all signals). Using the switch, you can choose between TTL levels (switch down) and RS232 levels (switch up). This selection is necessary, because else the RS232 level translator output could collide with a TTL signal supplied at the RxD input.

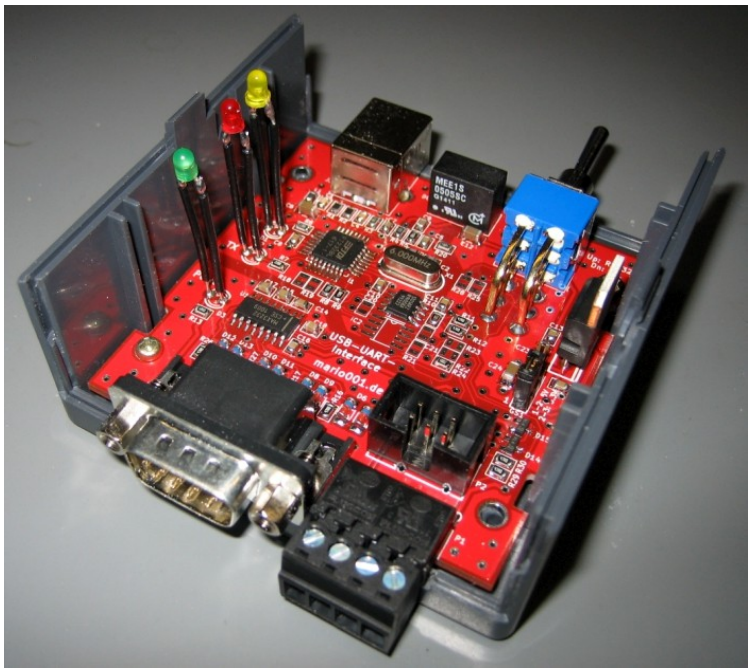
A jumper is used to select the TTL level (5V or 3.3V). This voltage is also available at the screw terminal and the pin header (Vcc), so you may directly supply circuits with low power consumption from the interface.

4. Circuit description

Page 1 of the KiCAD schematic diagram only contains the schematic sheet overview.

Page 2 shows the FT232BL (manufacturer: FTDI), which is the heart of the interface. It forms the USB UART bridge and provides a complete serial interface. The chip is wired according to the datasheet in the USB powered configuration. On the UART side (pins 18 to 25), the serial signals are available at 5V levels.

Below the 1W DC/DC converter (type MEE1S0505SC) is shown, which provides the galvanic isolation for the supply voltage and generates +5V for the interface part, that is, the iCoupler and the MAX3232 ("secondary side"). A linear regulator (LF33CV) generates +3.3V. The LED D3 serves as optical control and as basic load for the DC/DC converter.



On page 3 of the schematic, the part of the circuit providing the galvanic isolation, the level translation for the RS232 and the output circuitry can be found. The galvanic isolation of the data lines is done using two "iCoupler" devices from Analog Devices. These chips have a little transformer inside that submits the data to the other side. The ADUM1201 derivative provides one forward and one return channel, so that RxD and TxD can be translated using one single chip. The chip works with a supply voltage ranging from 2.7V to 5.5V (either side), so that they can also be used as level translators (if 3.3V supply is chosen). The output level for the TTL interface can be chosen using jumper GS1.

At the upper right, the RS232 interface chip can be seen, a MAX3232 that can be supplied with either 5V or 3.3V. It translates RxD, TxD, RTS and CTS to RS232 levels and connects to the Sub D connector. The resistors and zener diodes serve as ESD and overvoltage protection. Because R1OUT and R2OUT are outputs, their signals are fed into the switch, so that when used with TTL levels they do not collide with the TTL signals. If the interface is to be used as RS232 interface only, you may omit the switch and populate R25 and R28 with 0 ohm resistors to have a fixed RS232 configuration.

Finally, the two output connectors for the TTL signals can be seen on the lower right of the schematic, a 6 pin pin header and a 4 pin pluggable screw terminal. This signals are also protected from ESD and over voltages via resistors and schottky diodes. The supply output is buffered with a ferrite bead and a capacitor.

5. Build your own

The project files for the interface can be downloaded on my website, www.mario001.de. The ZIP file contains schematic diagram, assembly drawing, two BOMs (one for the completely populated interface, and another "light" version that only provides RxD and TxD), the complete KiCAD design files and gerber files for the PCB.

The interface can be used as is or it can be mounted to a case; the PCB is designed to fit into a Bopla U75 housing (Farnell #4456129). To fit it into the housing, you have to make the openings for the switch, the USB connector, the Sub D connector and the screw terminal. The LED connection wires can be extended with some wires so that they look through holes in the upper side of the housing.

Here are some more pictures of the interface in the housing: