Future Technology Devices International Ltd.

TTL-232R
USB to TTL Serial
Converter Cable

The **TTL-232R** is a USB to TTL serial converter cable incorporating FTDI's FT232RQ USB - Serial UART interface IC device, the latest device to be added to FTDI's range of USB UART interface Integrated Circuit Devices. It is designed to allow for a fast, simple way to connect devices with a TTL level serial interface to USB.

The FT232RQ chip used by the TTL-232R is housed within the USB 'A' connector. A 1.8 (6 foot) meter cable is terminated with a 6 way 0.1" pitch header socket which provides access to the transmit (Tx), receive (Rx), RTS#, and CTS#, as well as VCC (5V out) and GND.

The FT232R is a USB to serial UART interface with optional clock generator output, and the new FTDIChip-ID™ security dongle feature. In addition, asynchronous and synchronous bit bang interface modes are available. USB to serial interface designs using the FT232R have been further simplified by fully integrating the external EEPROM, clock circuit and USB resistors onto the device.

1. Features

1.1 Hardware Features

- TTL-232R Converter Cable provides a USB to TTL Serial header interface (6 way, 0.1" pitch).
- On board FT232RQ provides single chip USB to asynchronous serial data transfer interface.
- Entire USB protocol handled on the FT232RQ chip - No USB-specific firmware programming required.
- Connect directly to a microcontroller UART or I/O pins
- UART interface support for 7 or 8 data bits, 1 or 2 stop bits and odd / even / mark / space / no parity.
- Fully assisted hardware (RTS#/CTS#) or X-On / X-Off software handshaking.
- Data transfer rates from 300 baud to 3 Megabaud at TTL levels.
- 5V CMOS drive outputs and 5V safe TTL inputs makes the TTL-232R easy to interface to 5V MCU's.
- FTDI's royalty-free VCP allow for communication as a standard COM port and D2XX 'direct' drivers provide DLL application programming interface.
- In-built support for event characters and line break condition.
- Support for FT232R FTDIChip-ID™ feature.

- 256 byte receive buffer and 128 byte transmit buffer utilising buffer smoothing technology to allow for high data throughput.
- FIFO receive and transmit buffers for high data throughput.
- Adjustable receive buffer timeout.
- Integrated 1024 bit internal EEPROM for storing custom USB VID, PID, serial number and product description strings.
- Device supplied preprogrammed with unique USB serial number.
- Support for USB suspend and resume.
- Cable supply voltage comes from USB - no external supply required.
- 5V output allow devices to be powered from the USB port.
- 6 way 0.1" header connector (Tx, Rx, RTS#, CTS#, Vcc, and GND)
- Low USB bandwidth consumption.
- UHCI / OHCI / EHCI host controller compatible
- USB 2.0 Full Speed compatible.
- -40°C to +85°C operating temperature range.
- Connect to a PC via USB 'A' plug on 1.80 meter (6 foot) cable.
- A 3.3V TTL I/O version is also availalable (TTL-232R-3V3)
- Custom versions also available (subject to MOQ).

1.2 Driver Support

Royalty-Free VIRTUAL COM PORT (VCP) DRIVERS for...

- Windows 98, 98SE, ME, 2000, Server 2003, XP.
- Windows Vista / Longhorn*
- Windows XP 64-bit.
- Windows XP Embedded.
- Windows CE.NET 4.2 & 5.0
- MAC OS 8 / 9, OS-X
- Linux 2.4 and greater

Royalty-Free D2XX *Direct* Drivers (USB Drivers + DLL S/W Interface)

- Windows 98, 98SE, ME, 2000, Server 2003, XP.
- Windows Vista / Longhorn*
- Windows XP 64-bit.
- Windows XP Embedded.
- Windows CE.NET 4.2 & 5.0
- MAC OS OS-X*
- Linux 2.4 and greater

The drivers listed above are all available to download for free from the FTDI website. Various 3rd Party Drivers are also available for various other operating systems - see the FTDI website for details.

* Currently Under Development. Contact FTDI for availability.

1.3 Typical Applications

- USB to Serial TTL Level Converter
- Upgrading Legacy Peripherals to USB
- Interface Microcontroller UART or I/O to USB
- Interface FPGA / PLD to USB

- Replace MAX232 type level shifters allowing for direct connection of products to PC via USB
- USB Instrumentation PC interface
- USB Industrial Control
- USB Software / Hardware Encryption Dongles

2. Features and Enhancements of FT232R applicable to TTL-232R

2.1 FT232R Key Features

The TTL-232R uses FTDI's FT232RQ USB to serial IC device. This section summarises the key features and enhancements of the FT232RQ which apply to the TTL-232R USB to serial TTL converter cable. For further details, and a full features and enhancements description consult the FT232R datasheet, which is available from the FTDI website.

Lower Operating and Suspend Current - The device operating supply current has been further reduced to 15mA, and the suspend current has been reduced to around 70µA. This allows greater margin for peripheral devices incorporating the TTL-232R to meet the USB suspend current limit of 500µA.

Low USB Bandwidth Consumption - The operation of the USB interface to the FT232R IC, and thus the TTL-232R has been designed to use as little as possible of the total USB bandwidth available from the USB host controller.

High Output Drive Option - The UART interface I/O pins on the TTL-232R (RXD, TXD, RTS#, and CTS#) are configured to use the FT232R's high output drive option. This option makes the FT232R I.C.'s I/O pins drive out at three times the standard signal drive level thus allowing multiple devices to be driven, or devices that require a greater signal drive strength to be interfaced to the FT232R. This option is enabled in the internal EEPROM.

UART Pin Signal Inversion - The sense of each of the eight UART signals can be individually inverted by setting options in the internal EEPROM. Thus, CTS# (active low) can be changed to CTS (active high), or TXD can be changed to TXD#.

FTDIChip-ID™ - Each FT232R is assigned a unique number which is burnt into the device at manufacture. This ID number cannot be reprogrammed by product manufacturers or end-users. This allows the possibility of using FT232R based dongles for software licensing. Further to this, a renewable license scheme can be implemented based on the FTDIChip-ID™ number when encrypted with other information. This encrypted number can be stored in the user area of the FT232R internal EEPROM, and can be decrypted, then compared with the protected FTDIChip-ID™ to verify that a license is valid. Web based applications can be used to maintain product licensing this way. An application note describing this feature is available separately from the FTDI website.

Improved EMI Performance - The reduced operating current and improved on-chip VCC decoupling significantly improves the ease of PCB design requirements for the FT232R in order to meet FCC, CE and other EMI related specifications. The TTL-232R has passed FCC and CE testing.

Programmable Receive Buffer Timeout - The receive buffer timeout is used to flush remaining data from the receive buffer. This time defaults to 16ms, but is programmable over USB in 1ms increments from 1ms to 255ms, thus allowing the device to be optimised for protocols that require fast response times from short data packets.

Baud Rates - The TTL-232R supports all standard baud rates and non-standard baud rates from 300 Baud up to 3 Megabaud. Achievable non-standard baud rates are calculated as follows -

Baud Rate = 3000000 / (n + x)

where n can be any integer between 2 and 16,384 (= 2^{14}) and x can be a sub-integer of the value 0, 0.125, 0.25, 0.375, 0.5, 0.625, 0.75, or 0.875. When n = 1, x = 0, i.e. baud rate divisors with values between 1 and 2 are not possible.
This gives achievable baud rates in the range 183.1 baud to 3,000,000 baud. When a non-standard baud rate is required simply pass the required baud rate value to the driver as normal, and the FTDI driver will calculate the required divisor, and set the baud rate. See FTDI application note AN232B-05 for more details.

Extended Operating Temperature Range - The TTL-232R is capable of operating over an extended temperature range of -40º to +85º C thus allowing the device to be used in automotive and industrial applications.

Figure 1 - The TTL-232R USB to TTL Serial Converter Cable.

Figure 2 - Inside the USB 'A' connector on the TTL-232R.

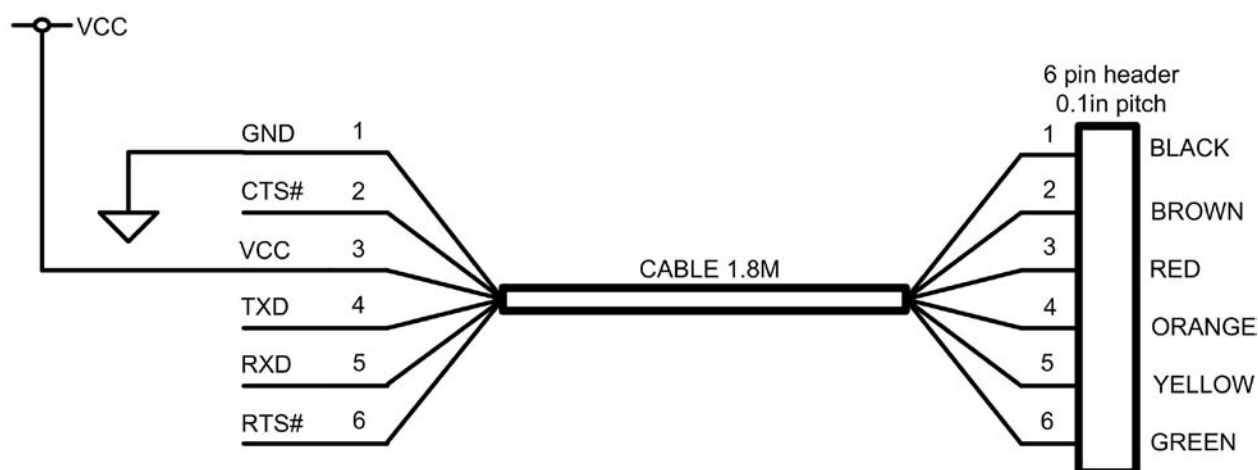# 3. TTL-232R Pin Out and Signal Descriptions

3.1 TTL-232R Pin Out

Figure 3 - TTL-232R 6 Way Header Pin Out

3.2 Serial TTL Signal Descriptions

Table 1 - Serial TTL Signals

Header pin No.	Name	Type	Colour	Description
1	GND	GND	Black	Device groud supply pin.
2	CTS#	Input	Brown	Clear to Send Control input / Handshake signal.
3	VCC	Output	Red	+5V Output
4	TXD	Output	Orange	Transmit Asynchronous Data output.
5	RXD	Input	Yellow	Receive Asynchronous Data input.
6	RTS#	Output	Green	Request To Send Control Output / Handshake signal.

4. TTL-232R Parameters

Table 2 - TTL-232R I/O Operating Parameters

Parameter	Description	Min	Typ	Max	Units	Conditions
VCC	Output Power Voltage	4.25	5.0	5.25	V	Dependant on the USB port that the TTL-232R is connected to
Io	Output Power Current	-	-	50	mA	
T	Operating Temperature Range	-40	-	+85	ºC	

Table 3 - TTL-232R I/O Pin Characteristics

Parameter	Description	Min	Typ	Max	Units	Conditions
Voh	Output Voltage High	3.2	4.1	4.9	V	I source = 6mA
Vol	Output Voltage Low	0.3	0.4	0.6	V	I sink = 6mA
Vin	Input Switching Threshold	1.3	1.6	1.9	V	**
VHys	Input Switching Hysteresis	50	55	60	mV	**

Both the FT232RQ I.C. device used and the entire TTL-232R are fully compliant with European Union directive 2002/95/EC.

5. TTL-232R Circuit Schematic

Figure 4 shows the TTL-232R circuit schematic. Note that there is an option internal to the cable design which allows for the TTL I/O pins supply voltage to be changed to 3.3V instead of 5V, thus making the TTL-232R suitable for interfacing with 3.3V logic (part number TTL-232R-3V3). Customised versions of these cables are also available. Contact FTDI sales if you are interested in any of these options.
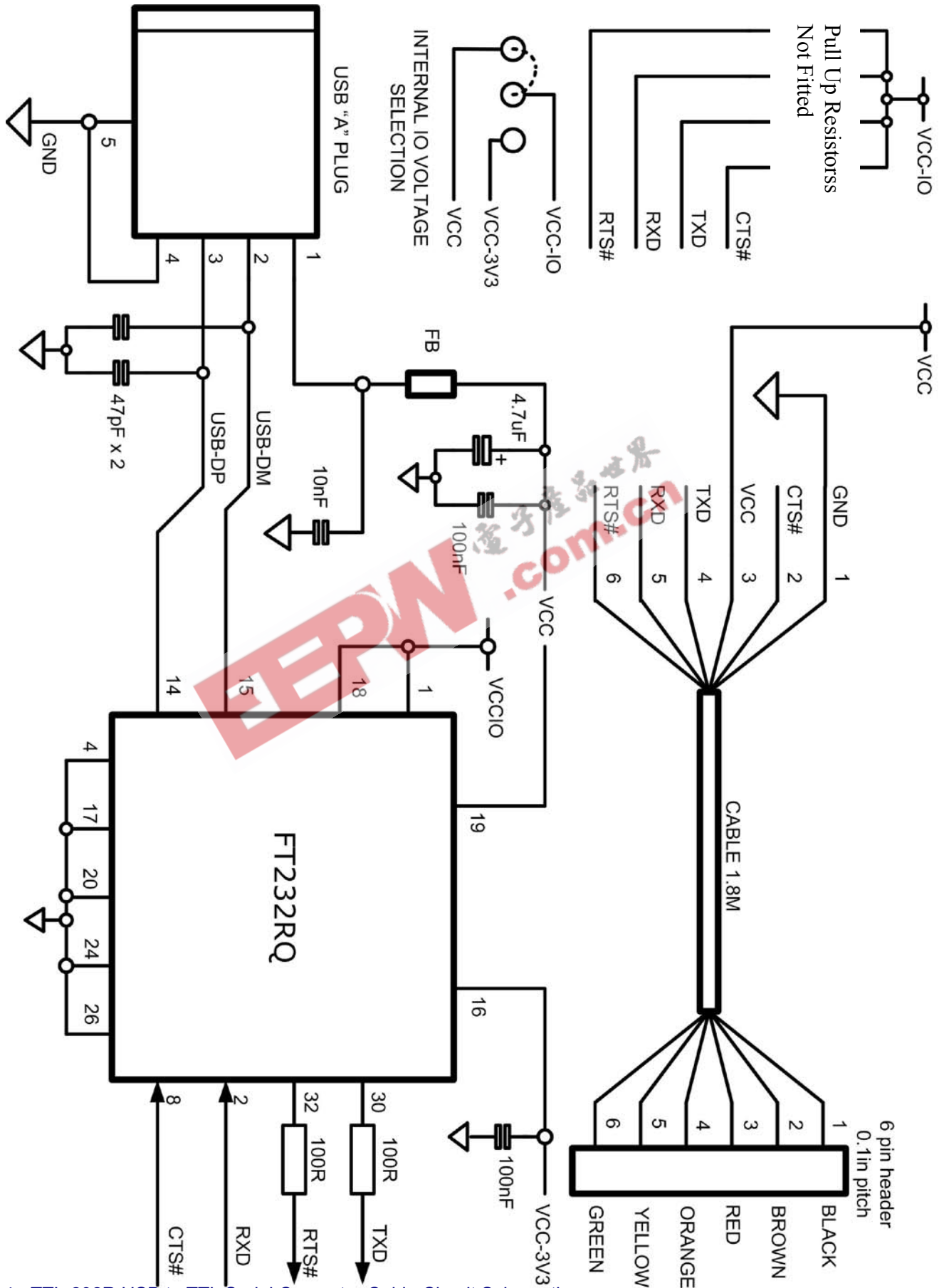

Figure 4 - TTL-232R USB to TTL Serial Converter Cable Circuit Schematic

6. Internal EEPROM Configuration

Following a power-on reset or a USB reset the FT232R will scan its internal EEPROM and read the USB configuration descriptors stored there. The default values programmed into the internal EEPROM in the FT232RQ used in the TTL-232R are shown in Table 2.

Table 4 - Default Internal EEPROM Configuration

Parameter	Value	Notes
USB Vendor ID (VID)	0403h	FTDI default VID (hex)
USB Product ID (PID)	6001h	FTDI default PID (hex)
Serial Number Enabled?	Yes	
Serial Number	*See Note*	A unique serial number is generated and programmed into the EEPROM during final test of the TTL-232R module.
Pull Down I/O Pins in USB Suspend	Disabled	Enabling this option will make the device pull down on the UART interface lines when the power is shut off (PWREN# is high)
Manufacturer Name	FTDI	
Manufacturer ID	FT	
Product Description	TTL232R	
Max Bus Power Current	90mA	
Power Source	Bus Powered	
Device Type	FT232R	
USB Version	0200	Returns USB 2.0 device descriptor to the host. Note: The device is be a USB 2.0 Full Speed device (12Mb/s) as opposed to a USB 2.0 High Speed device (480Mb/s).
Remote Wake up	Disabled	RI# pin is not available, so this option has been disabled.
High Current I/Os	Enabled	Enables the high drive level on the UART and CBUS I/O pins
Load VCP Driver	Enabled	Makes the device load the VCP driver interface for the device.
Invert TXD	Disabled	Signal on this pin becomes TXD# if enabled.
Invert RXD	Disabled	Signal on this pin becomes RXD# if enabled.
Invert RTS#	Disabled	Signal on this pin becomes RTS if enabled.
Invert CTS#	Disabled	Signal on this pin becomes CTS if enabled.

The internal EEPROM in the FT232R can be reprogrammed over USB using the utility program MPROG. MPROG can be downloaded from the FTDI website. Version 2.8a or later is required for the FT232R chip. Users who do not have their own USB Vendor ID but who would like to use a unique Product ID in their design can apply to FTDI for a free block of unique PIDs. Contact FTDI support for this service.

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