

Page (/wiki/UART_Communication_Tutorial)Discussion (/mediawiki/index.php?title=Talk:UART_Communication_Tutorial&action=edit&redlink=1)

Nav Edit

UART (Universal Asynchronous Receiver Transmitter) or USART (Universal Synchronous Asynchronous Receiver Transmitter) are one of the basic interface which you will find in almost all the controllers available in the market till date. This interface provide a cost effective simple and reliable communication between one controller to another controller or between a controller and PC.

Table of Content

- UART Protocol
- RS-232 Basics
 - Voltage Levels
 - RS-232 Level Converters
- MAX232 Interfacing with Microcontrollers
- See Also
- Help & Queries

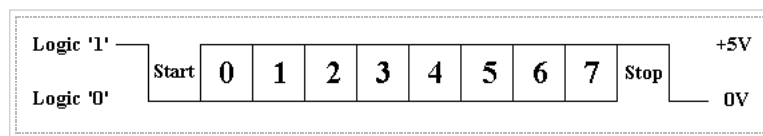
UART Protocol

UART is one of the simplest protocol available today. There are many devices available in market today that use UART for communication, like:

1. GPS Receiver
2. GSM Modem
3. RFID Reader
4. Camera Module (there is a serial camera available in market)

and so on...

UART supports data transmission from 5 bits to 9 bits, with parity option for data integrity checking and option for 1, 1.5 and 2 stop bits. UART can work on various speeds starting from 300bps upto 4Mbps. Most commonly used baudrates are 9800 and 115200. In simplicity an 8-bit UART protocol consists of a start bit, 8 data bits and one stop bit as shown in diagram below:



UART Protocol

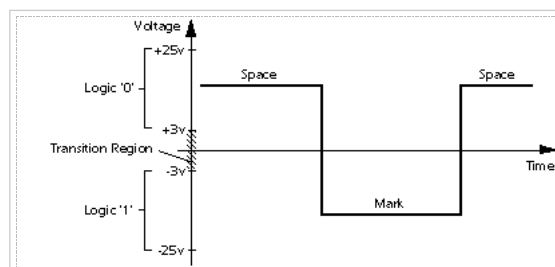
On physical layer UART can use many options from RS232, RS485, RS422 etc. As we are discussing only UART here so RS232 is the only basic physical communication layer used and discussed in this tutorial.

RS-232 Basics

RS-232 (Recommended Standard 232) is a standard for serial binary data signals connecting between a DTE (Data terminal equipment) and a DCE (Data Circuit-terminating Equipment).

Voltage Levels

The RS-232 standard defines the voltage levels that correspond to logical one and logical zero levels. Valid signals are plus or minus 3 to 25 volts. The range near zero volts is not a valid RS-232 level; logic one is defined as a negative voltage, the signal condition is called marking, and has the functional significance of OFF. Logic zero is positive, the signal condition is spacing, and has the function ON. So a Logic Zero represented as +3V to +25V and Logic One represented as -3V to -25V.



RS232 Voltage Levels

RS-232 Level Converters

Usually all the digital ICs works on TTL or CMOS voltage levels which cannot be used to communicate over RS-232 protocol. So a voltage or level converter is needed which can convert TTL to RS232 and RS232 to TTL voltage levels. The most commonly used RS-232 level converter is MAX232. This IC includes charge pump which can generate RS232 voltage levels (-10V and +10V) from 5V power supply. It also includes two receiver and two transmitters and is capable of full-duplex UART/USART communication.

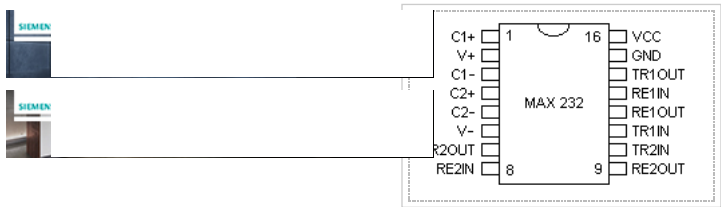


Fig A. - MAX232 Pin Description



Fig B. - MAX232 Typical Connection Circuit

MAX232 Interfacing with Microcontrollers

To communicate over UART or USART, we just need three basic signals which are namely, RXD (receive), TXD (transmit), GND (common ground). So to interface MAX232 with any microcontroller (AVR, ARM, 8051, PIC etc..) we just need the basic signals. A simple schematic diagram of connections between a microcontroller and MAX232 is shown below



MAX232 Connections with Microcontroller

See Also

- 8051 UART/Serial Communication Tutorial (/wiki/8051_UART/Serial_Communication_Tutorial)
- 8051 Software UART Tutorial (/wiki/8051_Software_UART_Tutorial)
- AVR UART/Serial Communication Tutorial (/wiki/AVR_UART/Serial_Communication_Tutorial)
- GPS Receiver Interfacing over UART Tutorial (/mediawiki/index.php?title=GPS_Receiver_Interfacing_over_UART_Tutorial&action=edit&redlink=1)
- GSM Modem Interfacing over UART Tutorial (/mediawiki/index.php?title=GSM_Modem_Interfacing_over_UART_Tutorial&action=edit&redlink=1)

Help & Queries

If you have any queries, doubts or feedback on this tutorial please share in our discussion forum (<http://www.8051projects.net/forum.html>).

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