

Understanding and Connecting UART Devices

ECE 480: Design Team 4

Application Note

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Abstract:

Electronic devices are capable of sending important signals to other devices through certain types of wireless or wired transmission lines. These communicating signals help several electronic devices work together in forming a single, multipurpose system. Ensuring that these devices properly communicate with each other can often grow complicated due to incompatible transmission lines and data transfer rates. This note will briefly explain how to properly connect multiple devices together that use serial communication and ensure that the desired information is accurately transmitted and received between them.

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Key Words: Serial Port, RS-232, UART, Tera Term, Baud Rate, ASCII, MSP430

Introduction:

Establishing connections between computers and their peripheral devices such as keyboards, cameras, printers, and mice became the primary focus of many computer electronic device manufacturers in the early 1980s. When IBM introduced their first personal computer, they and other manufacturers quickly created devices that adhered to a new standard of serial data communication known as RS-232. This effort produced many compatible products that became known as Universal Asynchronous Receive and Transmit (UART) devices. Devices used for serial communication with interfaces such as USB, Ethernet, and FireWire all adhere to the RS-232 serial port standard. Pre-USB era RS-232 serial port devices come in several pin sizes ranging from 6 to 50 single different transmitting lines, with 6-pin and 9-pin RS-232 devices being most common.

Operation:

UART devices use receive (RXD) and transmit (TXD) connections to establish separate paths for sending and receiving data between multiple devices. Asynchronous communication uses a single transmitting channel to send one byte of data at a time at a specified rate, known as the baud rate which is measured in bits per second. Common baud rates include 4800, 9600, 19200 and 115200 bit/s. In addition to TXD and RXD connections, UART devices may also contain Clear to Send (CTS) and Request to Send (RTS) connections that send a “hand-shake” or confirmation signal to help control the data transmission between two connected devices in order to prevent data loss.



Figure 1: 6-Pin RS-232 Cable and Pin Assignment

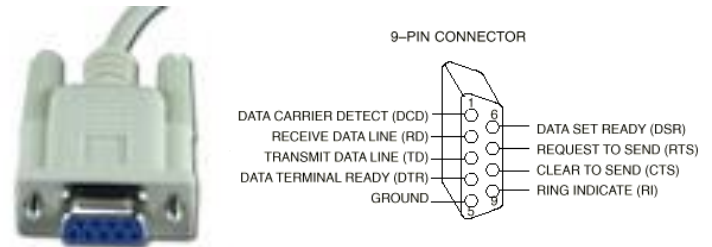


Figure 2: 9-Pin RS-232 Cable and Pin Assignment

When connecting two serial ports of different sizes, it is best to obtain an adapter that allows the two devices to properly communicate. If an adapter is not available, it is also possible to locate the most important pins on each connector cable, i.e. the RXD and TXD ports and connect them individually. These specific transmitting ports usually transmit data at a specified voltage, usually 3V, by sending electrical impulses that translate into single bytes. These electrical impulses are converted into 7-bit binary integers that are then translated into meaningful messages with the American Standard Code for Information Interchange (ASCII) language.

Viewing Output Information with Tera Term:

Before you connect any two devices together through serial port connections, you should make sure you know exactly what your devices are outputting. One way to ensure that a transmitting device is transmitting the desired information is by connecting the device to a computer and observing the information being sent from that device in real time. An ideal software program that can be used to display this information is Tera Term. Tera Term is a free terminal emulator software that can be downloaded online but is only compatible with Microsoft Windows operating systems. In order to use Tera Term you must first make sure that you have a device that is compatible with any available RS-232 connection port on your computer. Once you have the appropriate adapters and cables attached to your electronic device you should then proceed with connecting the device to the computer. Your computer may need to take a few minutes to download the driver software for the device you are using. Once this installation is complete, open up Tera Term and click the serial button selection and then select the appropriate COM port.

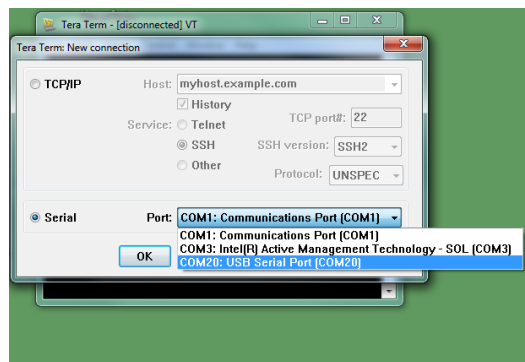


Figure 3: Tera Term “New connection” Screen

Once your device is connected to the Tera Term terminal, you should then select the “Setup” tab and click on “Serial port...”. Once you access the setup information, make sure that you choose the correct selections, paying careful attention to the Baud rate.

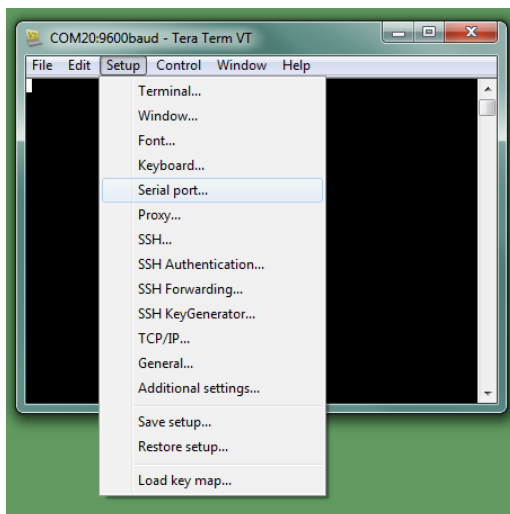


Figure 4: Tera Term “Setup” Tab

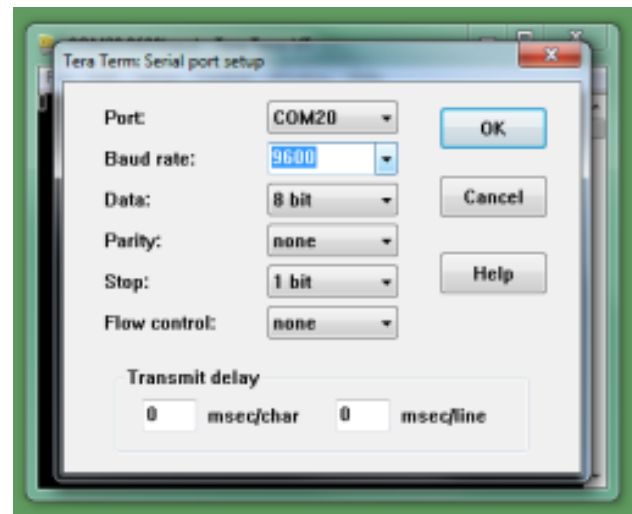


Figure 5: Tera Term “Serial port setup” Menu

After the correct setup information is entered, you should be able to observe your device's output messages in ASCII characters in the Tera Term terminal window. If the output messages are not what is expected, make sure that you are operating at the correct baud rate of your device and that all connection ports are completely connected. If your device is outputting the correct information, make sure that you save the information from your terminal session so that you can associate the specific operations of your electronic device with the corresponding ASCII message that the device sends during those particular operations.

Connecting Multiple UART Devices:

In order to connect two different electronic devices with UART connections you can take one of two approaches. You can either attach the devices with a single cable that encompasses all TXD, RXD, CTS, RTS and other pins or you can attach individual jumper wires to each of these significant individual pins and connect them between the two devices. For this example we will explore how to attach a development board from Asante Solutions using its 6 pin RS-232 port to RC Systems' V Stamp digital speech chip. When attaching the RXD and TXD ports of the two devices, make sure that the TXD of one of the devices goes to the RXD of the other and vice-versa.

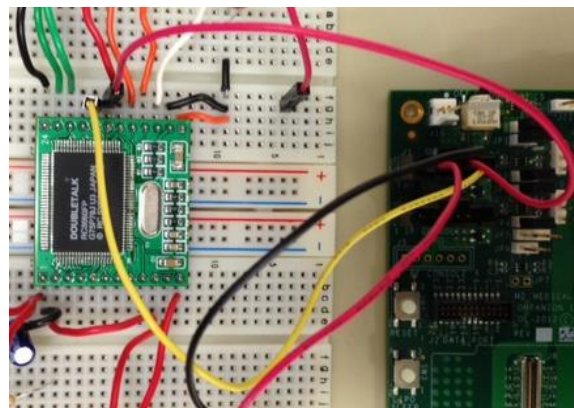


Figure 6: TXD and RXD Connections between Development Board and V Stamp

If you are having difficulty with these devices responding to the other you may need to switch the transmitting cables and have the RXD of one device connect to the RXD of the other and the same should be done with TXD. In addition to making sure that each of these cables are connected, make sure that each electronic device receives the proper voltage to power them. Also, make sure that the transmitting voltage ratings are the same for both devices so that you do not damage any components. Once both devices are properly connected and powered, the receiving device should be performing its intended function such as displaying information on an LED screen or speaking received text with a text to speech processor once it receives a signal from the transmitting device.

If information needs to be translated or filtered from a transmitting device before it is received from a receiving device, a microcontroller may be used to act as a translating medium between any two UART devices. For this example we will see how a Texas Instruments MSP430 Launchpad can be used as a computing device between two UART devices. In order to use the Launchpad in between the devices, you must simply connect the TXD jumper cable to the declared receiving UART port of the Launchpad and then connect the TXD cable of the Launchpad to the RXD port of the receiving device.

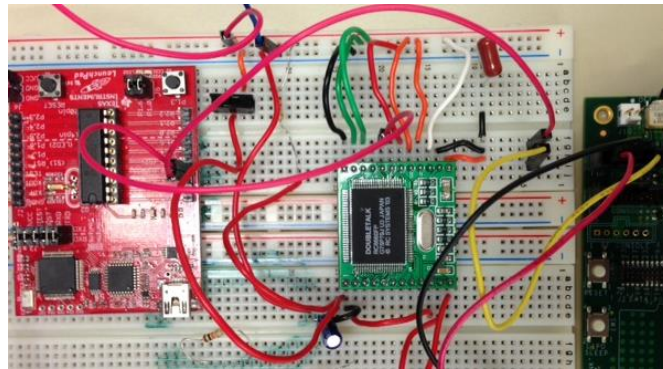


Figure 7: TXD and RXD Connections between Development Board, MSP430 and V Stamp

You can use Texas Instruments' Code Composer Studio Software to specify which ports should be used as TXD and RXD and also what functions are to be performed with incoming and outgoing data bytes.

```
1 /*
2  * change_uart.c
3  *
4  * Created on: Nov 10, 2014
5  * Author: garre119
6  */
7
8 #include<msp430g2553.h>
9 #define TXLED BIT0
10 #define RXLED BIT6
11 #define TXD BIT2
12 #define RXD BIT1
13
14 const char string[] = { "Hello World\r\n" };
15 unsigned int i; //Counter
16
17 int main(void){
18     WDTCTL = WDTPW + WDTHOLD; // Stop WDT
19     DCOCTL = 0; // Select lowest DCOx and MODx settings<
20     BCSCTL1 = CALBC1_16MHZ; // Set DCO
21     DCOCTL = CALDCO_16MHZ;
22     P2DIR = 0xFF; // All P2.x outputs<
23     P2OUT &= 0x00; // All P2.x reset
24     P1SEL |= RXD + TXD ; // P1.1 = RXD, P1.2=TXD
25     P1SEL2 |= RXD + TXD ; // P1.1 = RXD, P1.2=TXD
26     P1DIR |= RXLED + TXLED;|
27     P1OUT &= 0x00;
28 //ME1 |= UTXE0 + URXE0;
29 //UCTL0 |= CHAR;
30 //UTCT1A |= CCF1A.
```

Figure 8: Code Composer Studio code displaying how to initialize data ports for UART RXD and TXD

Conclusion:

Serial port connections come in a wide variety of types of connection ports but generally all possess the same essential communicating pins of TXD, RXD, CTS, and RTS. Ensuring that serial devices are properly connected is an extremely important component of any electronic system that includes multiple individual electronic devices. Serial port connections provide reliable communication between devices that work in close proximity. It is essential to understand the different parameters that affect how UART devices communicate and the proper steps to maximize data transfer efficiency in such systems.

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