

Lab 2 - RS-232 Serial Interface Waveform

Introduction

In this lab you will generate a waveform representing a serial data signal that encodes the characters of your name. You will test that your waveform is correct by feeding it into the PC's serial port and displaying the received data.

Software Installation

You will need to use three applications to complete this lab:

- LCC: a C compiler. You will use it to edit and compile a program that computes the samples values of a waveform corresponding to the RS-232 serial signal for the ASCII-encoded characters of your name.
- Audacity: an audio editing and playback application. You will use it to output the samples of the computed waveform through the PC's audio output port.
- TeraTerm: an application called a "terminal emulator". This application displays ASCII-encoded characters received by the PC's serial port. You will use it to verify that you've generated the correct waveform.

Check to see whether these applications are already installed. If not, install them from the course's share-out drive. Choose the default installation drives and folders for Audacity and TeraTerm. Choose the D: (work) drive to install LCC.

All three applications are free and may be installed on other computers.

Generate the RS-232 Waveform

Modify the Software

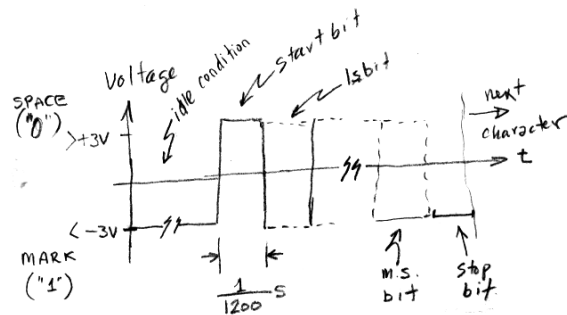
Download and modify the C program (lab2.c). To avoid losing your work when you log off, put your files in a directory on your network (H:) drive.

The supplied program may contain a number of errors. Check the following requirements and make the appropriate changes:

- the string to be output should consist of your name rather than "Hello world".
- the bits in a character should be output in order from least-significant to most-significant bit (lsb to msb).

- there should be 8 samples per bit period
- the output should be inverted (a higher value indicates a more negative output voltage) because you will be using an inverting amplifier between the output of your program and the RS-232 port.

A summary of the RS-232 waveform is given below:



Compile the Software

Run the lcc-win(64) application. Select File->Open to open your C source file. Use Compiler->Compile to compile your source. If there are any errors, fix them and re-compile the source. Use Compiler->Execute to run the software. The program will run in the 'lcc' subdirectory and save the waveform.txt file there.

Output the Waveform

Plug an audio cable into the audio output port (green) on the front of the PC.

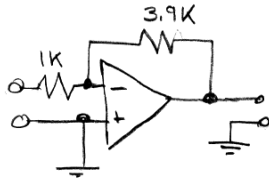
Run Audacity. Select File->Import->Raw Data and select the waveform.txt file from the lcc subdirectory of your working directory. Your data is in signed 8-bit format. Select a sample rate of 9600 Hz so you will get a data rate of 1200 bits per second. Select Transport->Loop Play to repeatedly output the waveform from the PC's audio output port. Set the volume slider to maximum.

Use the oscilloscope to check for a waveform of about ± 1.5 V on the connector at the end of the audio cable.

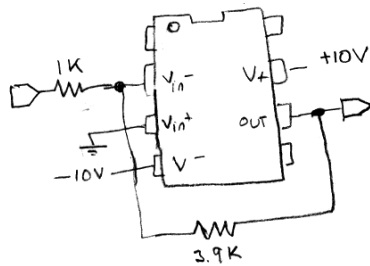
Build the Amplifier

Since RS-232 serial ports require voltages of at least ± 3 V, we need to build an amplifier to increase the voltage swing of the signal. Use a 741 op-amp in a

simple inverting amplifier configuration with a gain of -4. The schematic is:

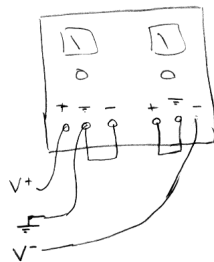


and the pin-out of the 741 and the connections for this circuit are:



Build the amplifier circuit on your prototyping board using the components supplied in the lab.

The lab supplies have floating outputs. In order to get positive and negative supplies you will need to connect one supply's positive terminal to ground and the other's negative terminal to ground:



Double-check your circuit. Check it again. Set the power supply voltages before connecting them to your circuit. Make sure the voltages are not being limited by the current limiting controls.

Use the connector supplied in the lab to connect the end of the audio cable to the amplifier input. Check the output of your amplifier for an appropriate waveform of the right level.

Connect the 9-pin serial cable connector from the PC to a BRK9MF "breakout box" to access the following RS-232 signals:

- terminal 1 of the terminal strip corresponds to pin 1 of the 9-pin connector and is the RS-232 signal ground

- terminal 2 of the terminal strip corresponds to pin 2 of the 9-pin connector and is the RS-232 receive data signal (PCs are wired as DTEs)

Connect terminal 1 to ground on the amplifier. Connect terminal 2 to the output of the amplifier.

Verify the Data

Run Teraterm. Select serial port input using COM1 when the program starts. Select Setup->Serial Port and set the baud rate for COM1 to 1200 bps.

If you've done everything correctly you should now see your name displayed repeatedly on the terminal. Show your result to the instructor to get credit for completing the lab.

If you don't get the expected results use the scope to check the bit period and voltage of the waveform. Check the Teraterm settings for the COM1 serial port. If these are correct, check to see that the waveform shown in Audacity corresponds to what you expected (check for the presence and polarity of start and stop bits, and verify that the bit order is correct).

Pre-Lab Assignment

Answer the following questions:

- What would you set as the PC's serial port baud rate if the audio waveform's sample rate was 38.4 kHz?
- What is the gain of the amplifier? If the input levels are ± 1.5 V, what levels would you expect at the output of your amplifier?

Download the sample C file (1ab2.c) and modify it according to the instructions given above.

Hand in the answers to the above questions and a printout of the modified C file *before the start of the lab*.

It is essential to complete the pre-lab before the lab because you will probably not have enough time to figure out how to modify the code *and* complete the procedure given above during the lab period.

Lab Report

Hand in: (1) a copy of your modified code with any additional changes you made in the lab and (2) a screen capture showing the Teraterm window with your name displayed (you can use the Windows Snipping Tool or PrtScr and paste into an editor).