



## EE337 Microprocessors Laboratory

Wadhvani Electronics Laboratory  
Electrical Engineering IIT Bombay

Problem set: 8

Date: March 12, 2025

Refer to Prof. Dinesh Sharma's slides and notes on serial I/O to do this lab. The link is given here: [https://ee337.github.io/dks/serial\\_io.html](https://ee337.github.io/dks/serial_io.html).

1. [10 points] In this lab you will understand and use a program for communicating between Pt-51 and a computer using UART. This program will take inputs from the computer's keyboard that can be used in programs running on the kit, to perform appropriate operations.
  - i) To connect the kit to a computer, you will be using the USB-to-UART adapter Prolific PL2303 (Fig. 1) that was shipped along with the kit. The driver software for this adapter and the instructions for installing it can be found at the following link: [http://www.miklor.com/COM/UV\\_Drivers.php](http://www.miklor.com/COM/UV_Drivers.php)  
After installing the software, connect the PL2303 adapter to one of the USB ports of your PC.



Figure 1: USB to UART adapter.

- ii) Connect the Pt-51 kit to the USB-to-UART adapter using F-F wires as described next. In the Pt-51 kit, port pin P3.0 is the serial data input and P3.1 is the serial data output. Connect P3.0 of the kit to transmit data line (TxD) of the adapter. Connect P3.1 of the kit to receive data line (RxD) of the adapter. Connect the GND pin of the kit to GND pin of adapter.
  - iii) For recognizing keyboard inputs on the computer and transmitting to the kit, through the serial terminal, you need to use the **Realterm** software (or any equivalent software). This software will also be used to display the messages received from the Pt-51 kit on the PC. A screenshot of **Realterm** window is shown in Fig. 2.  
For Windows, download **Realterm** at: <https://realterm.i2cchip.com>  
For Linux, you can download **putty**.
  - iv) Configure **Realterm** (or equivalent tool) to use the appropriate COM port and baud rate. This can be done by clicking on **Serial Port/Port** tab and choosing appropriate

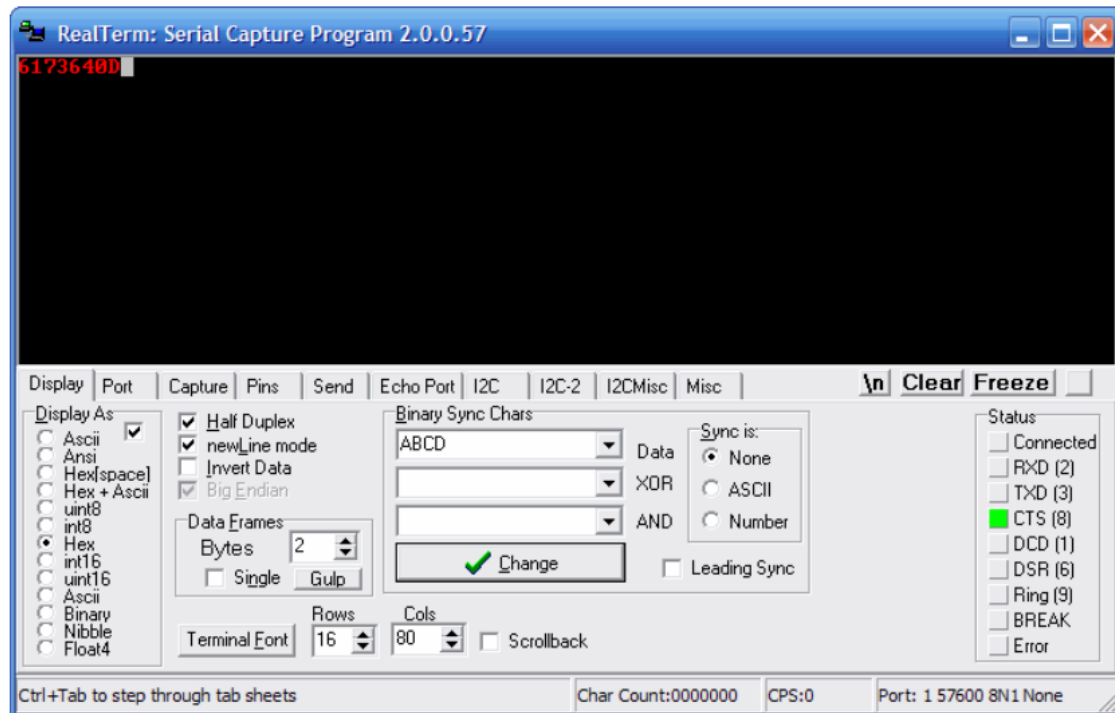


Figure 2: RealTerm: Serial/TCP Terminal

COM port as the port to which the USB-to-UART adapter is connected. Set the baud rate to 1200 (or that used in your program). Then click on **Open**.

With the kit connected to the computer using the USB-to-UART adapter, you will next write code to recognize key presses, perform an operation on the kit, and display messages sent by the kit on the computer.

Use `main.c` as starting (template) code. This uses `serial.c` and `lcd.h` for initialisation of UART and LCD, respectively. These files are part of the zip file shared with you.

The flow of the program is given below.

1. Complete the function `uart_init()` in `serial.c` to configure the serial port for UART communication. Use timer T1 and a baud rate of 1200 bps.
2. The given `main.c` has code for transmitting a set of strings and to capture a key press on the PC. Compile the project, dump the hex file on to Pt-51 and run the program. Launch the **Realterm** window on your PC and you can see that the following is displayed on the window.

```
*****
*****8051 Tests*****
*****
Press 1 to test the LCD
Press 2 to test the LED
```

3. Now, Pt-51 should be respond to the key presses on the PC's keyboard. With **Realterm** window in focus (active window), any key press on PC's keyboard will be captured by it and transferred to Pt-51.

- When 1 is pressed, it will be detected by Pt-51 and you will see a message “LCD Ok” on the LCD screen and “LCD tested” display on the **Realterm** window. This happens because of the function `lcd_test` in `main.c`.
- When 2 is pressed, it should be detected by pt-51 and should glow all four LEDs and display “LED tested” on the **Realterm** window. For this to happen, you will have to update the function `led_test` in `main.c`
- When any other key is pressed, you will see the message “Incorrect key pressed” displayed on the **Realterm** window.

2. [10 points] The resources available in Wadhwani Electronics Lab (WEL) are listed in Table 1.

Index	Resource	Quantity (MAX)
1	Digital Storage Oscilloscope	5
2	Arbitrary Function Generator	5
3	Digital Multi-Meter	8
4	Digital Power Supply	6

Table 1: Resources available in Wadhwani Electronics Lab (WEL)

These resources can be borrowed by students. Store this table database in your C-program. You can either use arrays (recommended) or just individual variables.

You need to read input from keyboard on RealTerm and send it to the Pt-51 kit using USB to UART converter. You need to take care of the following cases three states of operation.

### 1. Initial state

- Upon resetting the Pt-51 kit, the program should enter the Initial state and display the maximum resource available on RealTerm.  
**Resources available: DSO-5 AFG-5 DMM-8 DPS-6.**
- Whenever it is in the Initial state, two tasks are to be done:
  - i The current availability of resources must be displayed on RealTerm (number of current available resources after issuing need to be displayed).  
**Resources available: DSO-x AFG-x DMM-x DPS-x.**
  - ii Then RealTerm must show the following message.  
**Press I for Issue and R for Return**
- Based on the key pressed, one of the other two states must be entered. If a different key is entered, the program should remain in Initial state

### 2. Issue state

- This state is for issuing items. It is entered when the user types the character "I" through UART. When this happens, details must be asked from the user.
- Display the following message- **Enter Resource to be borrowed:** and read character from UART. The index of the resource (refer Table 1.) to be borrowed must be entered.
- Then display the following message- **Enter Quantity:** and read character from UART. The quantity of resources to be borrowed must be entered.
- Once the inputs are read, display **Requested resource allocated!** and decrement the count of the corresponding resource from the database.
- If the requested resource is not available (i.e all are borrowed), then display- **Requested resource not available...**

### 3. Return state

- This state is for returning items. It is entered when the user types the character "R" through UART. When this happens, details must be asked from the user.
- Display the following message- **Enter Resource to be returned:** and read character from UART. The index of the resource (refer Table 1.) to be returned must be entered.
- If the returned resource is already maximum (i.e it was not borrowed in the first place), then display- **You can't return what you don't have...** and exit the state. Else follow the next steps.

- Then display the following message- **Enter Quantity:** and read character from UART. The quantity of resources to be returned must be entered.
- Once the inputs are read, display **Returned resource received!** and increment the count of the corresponding resource from the database.
- If the sum of the returned resource count and existing resource count goes beyond maximum (i.e it is not possible to return that many resources), then display- **Returned resource out of bounds...** After the functions of Issue state or Return state, the execution must return to Initial state. To convert character to integer, you can subtract 48 from the character received.

## TA Checkpoints

1. Verify that the student can configure UART for the required baud rate.
2. Verify that the student can demonstrate the UART setup to measure communicate between PC (RealTerm) and Pt-51.
3. Verify that the student has implemented the ATM application with proper working of all 3 states of operation.