LAB REPORT– EXPERIMENT 8

Serial Communication & ADC / DAC Implementation in ViARM 2378 Development Board (through C - Interface)

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1. Serial Communication:

1.1 Introduction:

Serial Communication is a form of data transfer in which data is transferred between two entities, namely the sender (which transmits the data) and the receiver (which receives the data transmitted), 1 bit at a time. This makes the communication between the two devices more secure than in the case of parallel communication, where all data (i.e. bits) are transmitted at the same time. The sender and receiver ”agree” on a common data transfer rate, called the baud rate. Serial communication is done through many interfaces like RS-232, I2C, SPI etc.

In this experiment, we have used the RS-232 interface to connect the computer and the LPC2378 processor on the ViARM Development Kit. The baud rate was set to 19200, which is the default baud rate for the processor.

1.2 Code:

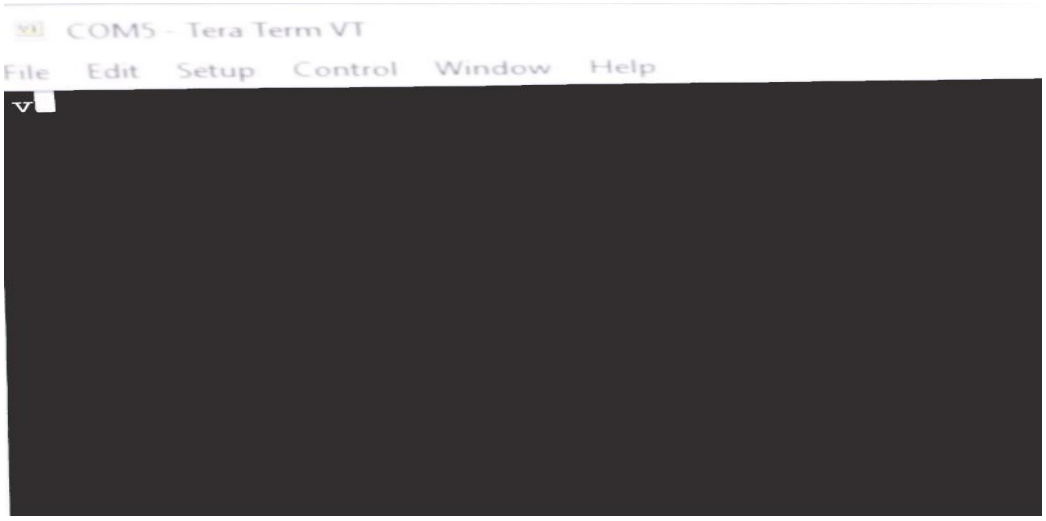
Write a program (in C) to display the ASCII code in LEDs, corresponding to the key pressed in the key board of the PC interfaced to ViARM-2378. Use the RS232 serial cable interfaced to the Vi Microsystem's ViARM 2378 development board

```
#include "LPC23xx.h"

/*Routine to set processor and peripheral clock */


void TargetResetInit(void)
{
   // 72 MHz Frequency
   if((PLLSTAT&0x02000000)>0)
   {
      /* If the PLL is already running */
      PLLCON&=~0x02; /* Disconnect the PLL */
      PLLFEED=0xAA; /* PLL register update sequence, 0xAA, 0x55 */
      PLLFEED=0x55;
   }
   PLLCON&=~0x01; /* Disable the PLL */
   PLLFEED=0xAA; /* PLL register update sequence, 0xAA, 0x55 */
   PLLFEED=0x55;
   SCS&=~0x10; /* OSCRANGE=0, Main OSC is between 1 and 20 Mhz */
   SCS|=0x20; /* OSCEN=1, Enable the main oscillator */
   while((SCS&0x40)==0);
   CLKSRCSEL=0x01; /* Select main OSC, 12MHz, as the PLL clock source */
   PLLCFG=(24<<0)|(1<<16); /* Configure the PLL multiplier and divider */
   PLLFEED=0xAA; /* PLL register update sequence, 0xAA, 0x55 */
   PLLFEED=0x55;
```

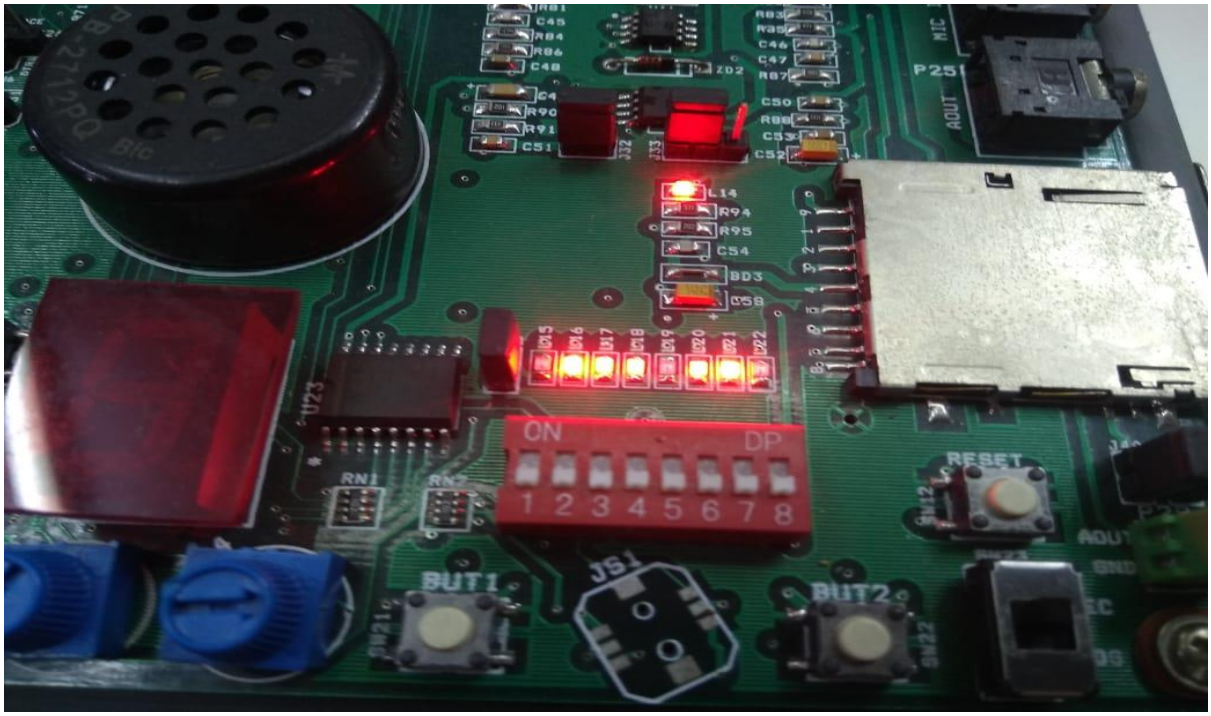
```
   PLLCON|=0x01; /* Enable the PLL */
   PLLFEED=0xAA; /* PLL register update sequence, 0xAA, 0x55 */
   PLLFEED=0x55;
   CCLKCFG=3; /* Configure the ARM Core Processor clock divider */
   USBCLKCFG=5; /* Configure the USB clock divider */
   while((PLLSTAT&0x04000000)==0);
   PCLKSEL0=0xAAAAAAAA; /* Set peripheral clocks to be half of main clock */
   PCLKSEL1=0x22AAA8AA;
   PLLCON|=0x02; /* Connect the PLL. The PLL is now the active clock source */
   PLLFEED=0xAA; /* PLL register update sequence, 0xAA, 0x55 */
   PLLFEED=0x55;
   while((PLLSTAT&0x02000000)==0);
   PCLKSEL0=0x55555555;        /* PCLK is the same as CCLK */
   PCLKSEL1=0x55555555;
}



/*Serial Reception Routine */



int serial_rx(void)
{
   while(!(U0LSR&0x01));
   return(U0RBR);
}


/* Serial Transmission Routine */


void serial_tx(int ch)
{
   while((U0LSR&0x20)==0x00);
   U0THR=ch;
}


/*Serial Transmission Routine for a string of characters */


void string_tx(char* a)
{
   while(*a!='\0')
   {
      while((U0LSR&0X20)!=0X20);
      U0THR=*a;
      a++;
   }
}
```

```
/*Main Routine */


int  main()
{

   unsigned int Fdiv;
   char value;
   TargetResetInit();
   FIO3DIR=0xFF; // Setting the LEDs on the board as output


   /* UART1 Initialization */


   PINSEL0=0x00000050;
   U0LCR=0x83; // 8 bits, no Parity, 1 Stop bit
   Fdiv=(72000000/16)/19200 ;  // Baud rate
   U0DLM=Fdiv / 256;
   U0DLL=Fdiv % 256;
   U0LCR=0x03; // DLAB=0
   while(1)
   {
      value=serial_rx(); // Receiving value from the computer, i.e., key press
      FIO3PIN=value;  // Displaying the value on the LEDs as output
      serial_tx(value);  // Transmitting the value received by the processor back to computer to verify
if correct data was received by it.
   }
   return 0;
}
```

1.3 Output:



Transmitted Key Press



Output on LEDs

- The transmitted key is v, whose ASCII value is 118. The binary value of 118 is 01110110, which is shown in the LEDs.

1.4 Video:

https://drive.google.com/file/d/1ZGrD3ACg9tpDXeqksO7oXCHOj2ty_fkw/view?usp=share_link

2 Analog-to-Digital Converter(ADC):

2.1 Code:

Given a real-time (analog) signal from a sensor, convert it into a digital signal (Implement an ADC). Decrease the step size? Do you see any change in the bits used to represent the whole range? What is the quantization error?

```
#include "LPC23xx.h"

/*Routine to set processor and peripheral clock */


void TargetResetInit(void)
{
   // 72 Mhz Frequency
   if ((PLLSTAT&0x02000000)>0)
   {
```

```
    /* If the PLL is already running */
    PLLCON&=~0x02; /* Disconnect the PLL */
    PLLFEED=0xAA; /* PLL register update sequence, 0xAA, 0x55 */
    PLLFEED=0x55;
  }
  PLLCON&=~0x01; /* Disable the PLL */
  PLLFEED=0xAA; /* PLL register update sequence, 0xAA, 0x55 */
  PLLFEED=0x55;
  SCS&=~0x10; /* OSCRANGE=0, Main OSC is between 1 and 20 Mhz */
  SCS|=0x20; /* OSCEN=1, Enable the main oscillator */
  while((SCS&0x40)==0);
  CLKSRCSEL=0x01; /* Select main OSC, 12MHz, as the PLL clock source */
  PLLCFG=(24<<0)|(1<<16); /* Configure the PLL multiplier and divider */
  PLLFEED=0xAA; /* PLL register update sequence, 0xAA, 0x55 */
  PLLFEED=0x55;
  PLLCON|=0x01; /* Enable the PLL */
  PLLFEED=0xAA; /* PLL register update sequence, 0xAA, 0x55 */
  PLLFEED=0x55;
  CCLKCFG=3; /* Configure the ARM Core Processor clock divider */
  USBCLKCFG=5; /* Configure the USB clock divider */
  while((PLLSTAT&0x04000000)==0);
  PCLKSEL0=0xAAAAAAAA; /* Set peripheral clocks to be half of main clock */
  PCLKSEL1=0x22AAA8AA;
  PLLCON|=0x02; /* Connect the PLL. The PLL is now the active clock source */
  PLLFEED=0xAA; /* PLL register update sequence, 0xAA, 0x55 */
  PLLFEED=0x55;
  while((PLLSTAT&0x02000000)==0);
  PCLKSEL0=0x55555555;      /* PCLK is the same as CCLK */
  PCLKSEL1=0x55555555;
}

/* Serial Transmission Routine */

void serial_tx(int ch)
{
  while ((U0LSR&0x20)!=0x20);
  U0THR=ch;
}

/*Hex to ASCII Routine */

int atoh(int ch)
{
  if(ch<=0x09)
    ch=ch+0x30;
  else
    ch=ch+0x37;
  return(ch);
}

/*Main Routine*/
```

```
int main()
{
   unsigned int Fdiv,value,i,j;
   TargetResetInit();

   PCONP|=0X00001000; // switch ADC from disable state to enable state
   PINSEL0=0x00000050; // Pinselection for UART TX and RX lines
   PINSEL1=0X01554000; // Pinselection for ADC0.0
   /****************** UART Initialization ********************************/
   U0LCR=0x83; // 8 bits, no Parity, 1 Stop bit
   Fdiv=(72000000/16)/19200 ; // Baud rate
   U0DLM=Fdiv/256;
   U0DLL=Fdiv%256;
   U0LCR=0x03; // DLAB=0
   AD0CR=0X01210F01; // ADC initialization
   while(1)
   {
      while((AD0DR0&0X80000000)!=0X80000000){}; // Wait here until ADC make conversion
complete
      /****** To get converted value and display it on the serial port ******/
      value=(AD0DR0>>6)& 0x3ff ;    //ADC value
      serial_tx('\t');
      serial_tx(atoh((value&0x300)>>8));
      serial_tx(atoh((value&0xf0)>>4));
      serial_tx(atoh(value&0x0f));
      serial_tx(0x0d);
      serial_tx(0x0a);
      for(i=0;i<=0xFF;i++)
         for(j=0;j<=0xFF;j++);
   }
   return 0;
}
```

2..2 Inferences:

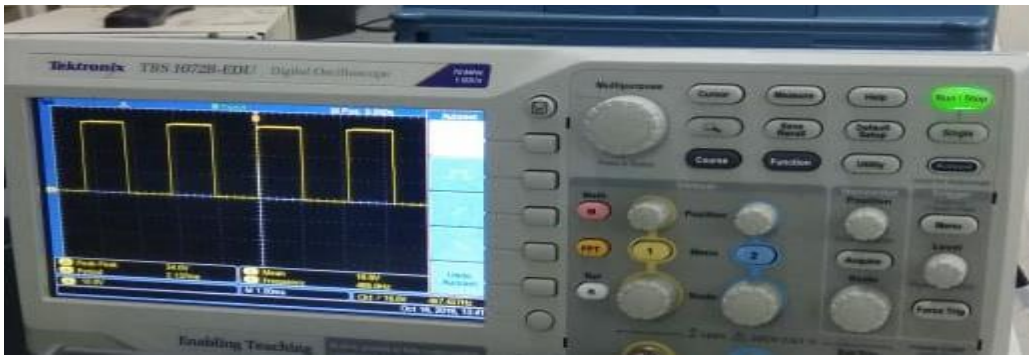
- On increasing the step size, we observe that the change in the analog value required to reflect a change in the digital value becomes larger.
- On decreasing the number of bits to be used in the digital value, the maximum digital value becomes lesser. This is expected as we are reducing the range of the digital values.

2.3 video: https://drive.google.com/file/d/1Z62fDrLlXIZDqI8l2m-7hgsxny68OkN1/view?usp=share_link

3 Digital-to-Analog Converter(DAC):

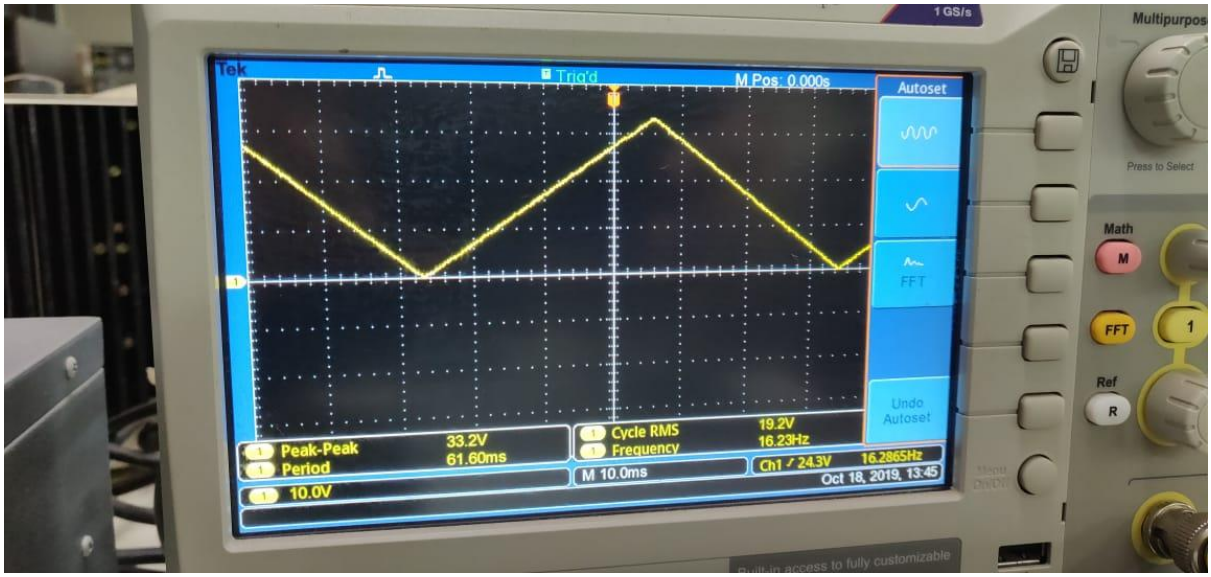
3.1 Codes and Oscilloscope Outputs:

3.1.1 Square Wave:




```
#include "LPC23xx.h"

void dLAY(int n)
{
   int i,j;
   for(i=0;i<n;i++)
      for(j=0;j<0x0F;j++);
}

int main (void)
{
   PCLKSEL0=0x00C00000;
   PINMODE1=0x00300000;
   PINSEL1=0x00200000;
   int value;
   int i=0;

   while(1)
   {
      //Square Wave
      value=1023;
      DACR=(value<<6);
      dLAY(100);
      value=0;
      DACR=(value<<6);
      dLAY(100);
   }
   return 0;
}
```

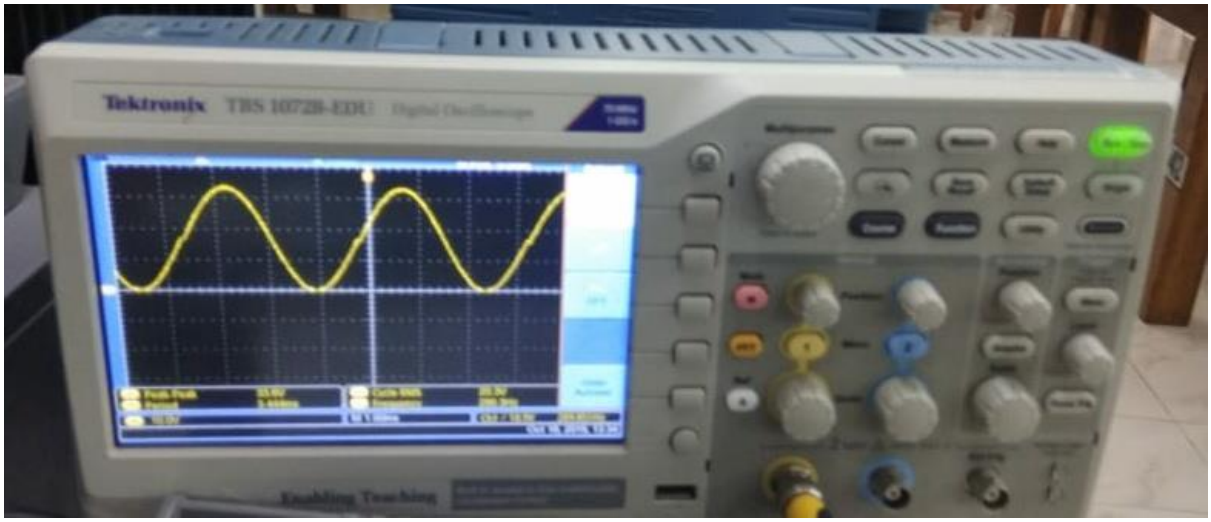
3.1.2 Triangular Wave:




```
#include "LPC23xx.h"

void dLAY(int n)
{
   int i,j;
   for(i=0;i<n;i++)
      for(j=0;j<0x0F;j++);
}

int main (void)
{
   PCLKSEL0=0x00C00000;
   PINMODE1=0x00300000;
   PINSEL1=0x00200000;
   int value;
   int i=0;
   while(1)
   {
      //Triangular Wave
      value=0;
      while(value!=1023)
      {
         DACR=((1<<16)|(value<<6));
         value++;
      }
```

```
        while (value!= 0)
        {
           DACR=((1<<16)|(value<<6));
           value--;
        }
    }
    return 0;
}
```

3.1.3 Sine Wave:




```
#include "LPC23xx.h"

void dLAY(int n)
{
    int i,j;
    for(i=0;i<n;i++)
        for(j=0;j<0x0F;j++);
}

int main (void)
{
    PCLKSEL0=0x00C00000;
    PINMODE1=0x00300000;
    PINSEL1=0x00200000;
    int value;
    int i=0;

    //  Lookup Table for sine values
    int sin_wave[101]={0x200,0x220,0x240,0x25f,0x27f,
    0x29e,0x2bc,0x2d9,0x2f6,0x312,0x32c,0x346,0x35e,0x374,
    0x38a,0x39d,0x3af,0x3c0,0x3ce,0x3db,0x3e6,0x3ef,0x3f6,
    0x3fb,0x3fe,0x3ff,0x3fe,0x3fb,0x3f6,0x3ef,0x3e6,0x3db,
    0x3ce,0x3c0,0x3af,0x39d,0x38a,0x374,0x35e,0x346,0x32c,
    0x312,0x2f6,0x2d9,0x2bc,0x29e,0x27f,0x25f,0x240,0x220,
    0x200,0x1df,0x1bf,0x1a0,0x180,0x161,0x143,0x126,0x109,
```

```
  0xed,0xd3,0xb9,0xa1,0x8b,0x75,0x62,0x50,0x3f,0x31,0x24,
  0x19,0x10,0x9,0x4,0x1,0x0,0x1,0x4,0x9,0x10,0x19,0x24,
  0x31,0x3f,0x50,0x62,0x75,0x8b,0xa1,0xb9,0xd3,0xed,0x109,
  0x126,0x143,0x161,0x180,0x1a0,0x1bf,0x1df,0x200};

  while(1)
  {
    //Sine Wave
    i=0;
    while(i<101)
    {
      value=sin_wave[i];
      DACR=(value<<6);
      dLAY(100);
      i++;
    }
  }
  return 0;
}
```