Assignment Project Report

Final Project

Embedded Systems and Designs

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Declaration

This report has been prepared based on my work. Where other published and unpublished source materials have been used, these have been acknowledged.

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Abstract

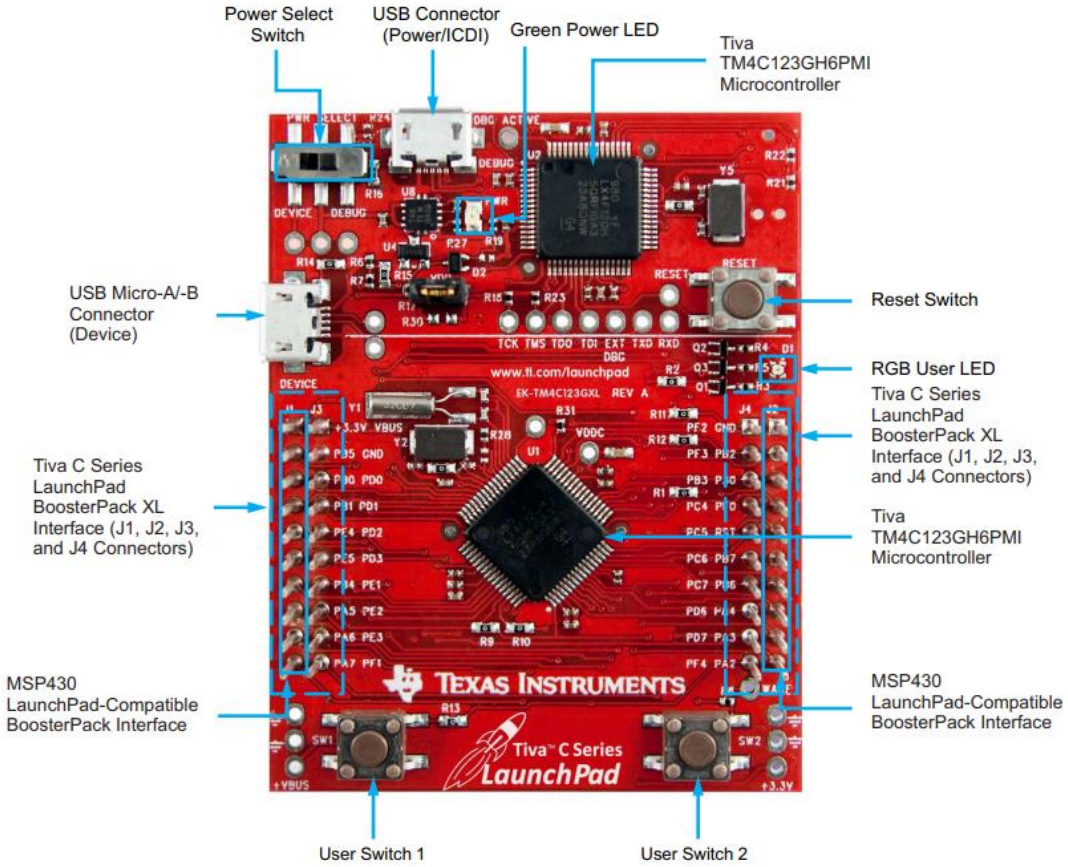
In this project we basically implemented to interface an HC-05 Bluetooth mode with TM4C123 Tiva C Launchpad. It uses serial communication to transmit and receive data serially over standard Bluetooth radio frequency. Thus, it uses UART module of TM4C123GH6PM microcontroller to interface HC-05 with Tiva C Launchpad. We use an android application to give input to microcontroller through Bluetooth module. For a particular input we get different RGB light combination as output.

Component Name

1.TM4C123GH6PM (Tiva C Launchpad)

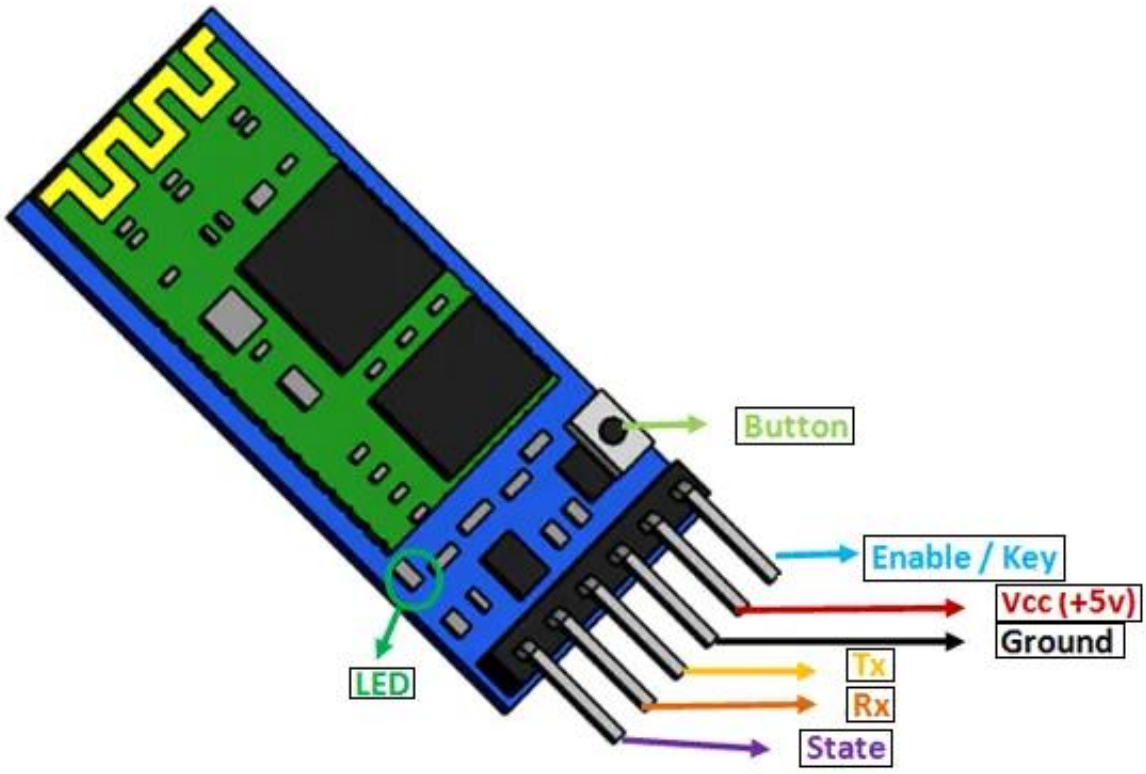
The TM4C123G Launchpad Evaluation Kit is a low-cost evaluation platform for Arm Cortex-M4F based microcontrollers. Featuring an 80-MHz Arm Cortex-M4F CPU, 256kB of flash, and 32kB of SRAM, the TM4C123GH6PM MCU provides integrated USB 2.0 support for USB Host/Device/OTG and two 12-bit ADC modules. The TM4C123GH6PM also includes a multitude of serial communication channels such as UART, SPI, I2C, and CAN. The design of the TM4C123G Launchpad highlights the TM4C123GH6PM USB 2.0 device interface and additional device features such as the hibernation and PWM modules.

Figure 1-1. Tiva C Series TM4C123G LaunchPad Evaluation Board



HC-05 Bluetooth Module

HC-05 is a two-way full-duplex Bluetooth to serial module. In other words, it uses UART serial communication to transmit and receive data packets through a classic Bluetooth standard. It communicates with other Bluetooth devices through serial communication. The default baud rate set for HC-05 is 9600. This module can be used to perform low-cost wireless communication between microcontrollers such as Arduino TM4C123, Pic Microcontroller, Raspberry Pi. The following figure shows the pinout diagram of the HC-05 Bluetooth module. Its output header contains six pins; namely Enable/Key, Vcc, GND, Tx, Rx, state.



Chapter 1: Introduction

1.1 RCGCGPIO

The RCGCGPIO register provides software the capability to enable and disable GPIO modules in Run mode. When enabled, a module is provided a clock and accesses to module registers are allowed. When disabled, the clock is disabled to save power and accesses to module registers generate a bus fault.

General-Purpose Input/Output Run Mode Clock Gating Control (RCGCGPIO)

Base 0x400F.E000
Offset 0x608
Type RW, reset 0x0000.0000

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
reserved															
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
reserved										R5	R4	R3	R2	R1	R0
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RW	RW	RW	RW	RW	RW
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

1.2 UART

Table 14-1. UART Signals (64LQFP)

Pin Name	Pin Number	Pin Mux / Pin Assignment	Pin Type	Buffer Type[a]	Description
U0Rx	17	PA0 (1)	I	TTL	UART module 0 receive.
U0Tx	18	PA1 (1)	O	TTL	UART module 0 transmit.
U1CTS	15 29	PC5 (8) PF1 (1)	I	TTL	UART module 1 Clear To Send modem flow control input signal.
U1RTS	16 28	PC4 (8) PF0 (1)	O	TTL	UART module 1 Request to Send modem flow control output line.
U1Rx	16 45	PC4 (2) PB0 (1)	I	TTL	UART module 1 receive.
U1Tx	15 46	PC5 (2) PB1 (1)	O	TTL	UART module 1 transmit.
U2Rx	53	PD6 (1)	I	TTL	UART module 2 receive.
U2Tx	10	PD7 (1)	O	TTL	UART module 2 transmit.
U3Rx	14	PC6 (1)	I	TTL	UART module 3 receive.
U3Tx	13	PC7 (1)	O	TTL	UART module 3 transmit.
U4Rx	16	PC4 (1)	I	TTL	UART module 4 receive.
U4Tx	15	PC5 (1)	O	TTL	UART module 4 transmit.
U5Rx	59	PE4 (1)	I	TTL	UART module 5 receive.
U5Tx	60	PE5 (1)	O	TTL	UART module 5 transmit.
U6Rx	43	PD4 (1)	I	TTL	UART module 6 receive.
U6Tx	44	PD5 (1)	O	TTL	UART module 6 transmit.
U7Rx	9	PE0 (1)	I	TTL	UART module 7 receive.
U7Tx	8	PE1 (1)	O	TTL	UART module 7 transmit.

a. The TTL designation indicates the pin has TTL-compatible voltage levels.

In this project we have used UART5 communication.(Transmit->PE5 and Reciever->PE4.

1.3 Ports Used

- GPIO Port A (AHB): 0x4005.8000
- GPIO Port B (APB): 0x4000.5000
- GPIO Port B (AHB): 0x4005.9000
- GPIO Port C (APB): 0x4000.6000
- GPIO Port C (AHB): 0x4005.A000
- GPIO Port D (APB): 0x4000.7000
- GPIO Port D (AHB): 0x4005.B000
- GPIO Port E (APB): 0x4002.4000
- GPIO Port E (AHB): 0x4005.C000
- GPIO Port F (APB): 0x4002.5000
- GPIO Port F (AHB): 0x4005.D000

We have used Port E for UART5 for serial communication with bluetooth and Port F with LED of Tiva C microcontroller.

1.4 User Switches and RGB User LED

Table 2-2. User Switches and RGB LED Signals

GPIO Pin	Pin Function	USB Device
PF4	GPIO	SW1
PF0	GPIO	SW2
PF1	GPIO	RGB LED (Red)
PF2	GPIO	RGB LED (Blue)
PF3	GPIO	RGD LED (Green)

1.5 Source Code

```
#include "TM4C123GH6PM.h"
#include <stdint.h>
#include <stdlib.h>

void Delay(unsigned long counter); // Delay Function
void HC05_init(void); // UART module 5 is used to initialize HC05
bluetooth module
char Bluetooth_Read(void); //Data is read from PE4
void Bluetooth_Write(unsigned char data); // Data transmitted to PE5
void Bluetooth_Write_String(char *str); // String Data transmitted to PE5

int main(void)
{

    HC05_init();

    SYSCTL->RCGCGPIO = 0x20;    //Enabling clock to Port F
    GPIOF->DIR = 0x0E;          //PF1, PF2, PF3 are used as digital pins
    GPIOF->DEN = 0x0E;          // Pins are digitally enabled
    Delay(10);

    while(1)
    {
        char c = Bluetooth_Read();          //Char input from bluetooth
function

        if( c == 'A'){
            GPIOF->DATA = 0x02;             //PF1 is connected to Red LED
            Bluetooth_Write_String("RED LED ON\n");
        }
        else if( c == 'B'){
            GPIOF->DATA = 0x04;             //PF2 is connected to Blue LED
            Bluetooth_Write_String("BLUE LED ON\n");
        }
        else if( c == 'C'){
            GPIOF->DATA = 0x08;             //PF3 is connected to Green LED
            Bluetooth_Write_String("GREEN LED ON\n");
        }
        else {
            GPIOF->DATA = 0x00;             //Turns LEDs off as no input to
any pin of Port F
            Bluetooth_Write_String("LEDs OFF\n");
        }
    }
}

void HC05_init(void)
{
    SYSCTL->RCGCUART |= 0x20;  // enable clock to UART5 /Uart 5 is
attached to PE4 and PE5, Pg No. 895 from datasheet/
    SYSCTL->RCGCGPIO |= 0x10;  // enable clock to PORT E
    Delay(1);
    /* UART5 initialization */
    UART5->CTL = 0;         /* UART5 module disbable //*Steps from
```

```
Datasheet Pg. No. 903/
    UART5->IBRD = 104;       /* for 9600 baud rate, integer = 104 */
    UART5->FBRD = 11;        /* for 9600 baud rate, fractional = 11*/
    UART5->CC = 0;           /select system clock/
    UART5->LCRH = 0x60;
    UART5->CTL = 0x301;      /* Enable UART5 module, Rx and Tx */

    /* UART5 TX5 and RX5 use PE4 and PE5. Configure them digital and
enable alternate function */
    GPIOE->DEN = 0x30;       /* set PE4 and PE5 as digital */
    GPIOE->AFSEL = 0x30;     /* Alternate function for PE4 and PE5 */
    GPIOE->AMSEL = 0;     // Analog Functions are turned off
    GPIOE->PCTL = 0x00110000;     /* configure PE4 and PE5 for UART */
}
char Bluetooth_Read(void)
{
    char data;
    while((UART5->FR & 0x10) != 0); // Waits for the input char
    data = UART5->DR ;
    return (unsigned char) data;
}

void Bluetooth_Write(unsigned char data)
{
    while((UART5->FR & 0x20) != 0); //Waits for the output to be printed
    UART5->DR = data;
}

void Bluetooth_Write_String(char *str)
{
  while(*str)
        {
                Bluetooth_Write(*(str++)); // This function is using the
above function to print a string char by char
        }
}

void Delay(unsigned long counter)
{
        unsigned long i = 0;
        while(i < counter) i++;
}
```

References

[1] Tiva C Launchpad Datasheet (Texas Instrument)

[2] Tiva C Launchpad Datasheet Evaluation Board (Texas Instrument)

[3] https://youtube.com/playlist?list=PL3ZmPhf-_xiWxQ8nnbAcRo2CNSHxXxxVW

[4] https://create.arduino.cc/projecthub/electropeak/getting-started-with-hc-05-bluetooth-module-arduino-e0ca81