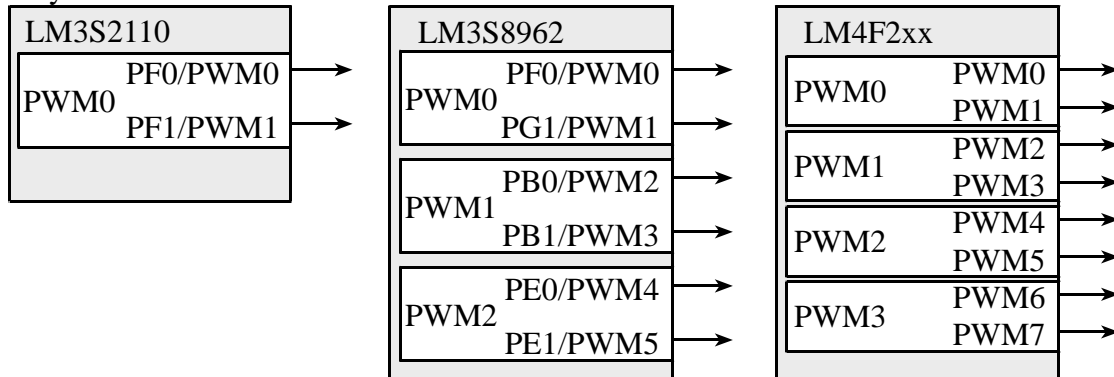


"My project's ready for grading, Dr. Big Nose...
Hey! ... I'm talking to you, squid brain!"

PWM-controller motor actuator

Only works on TM4C123 and not LM4F120



Show Lab6.sch

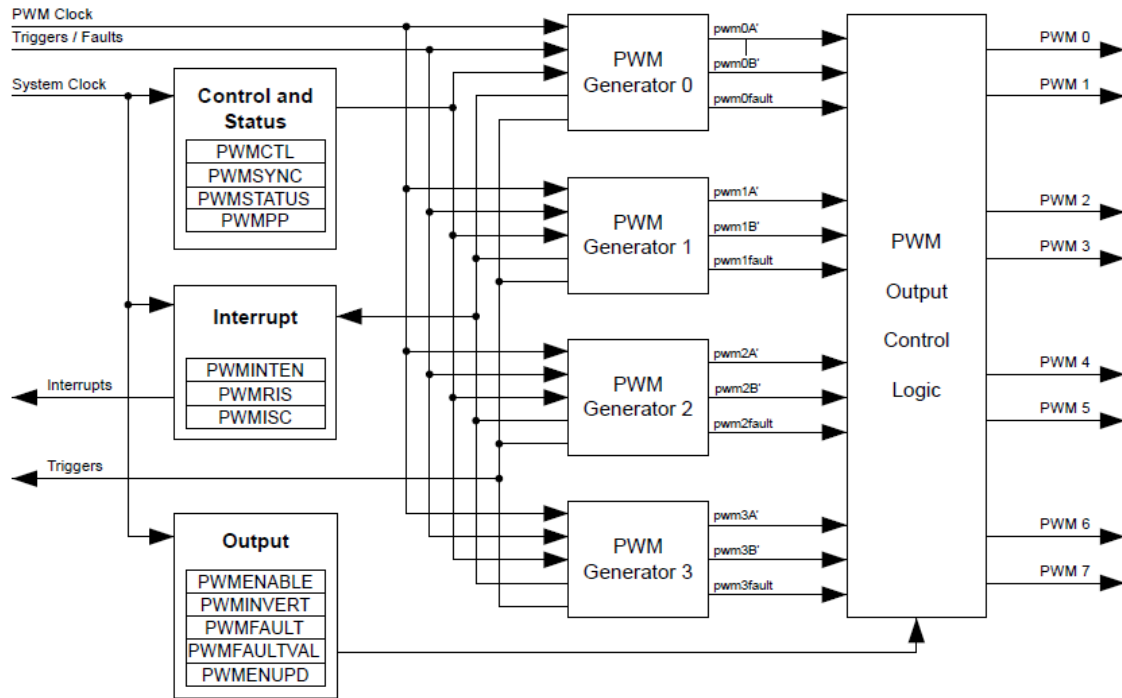
Power design kit

Protoboard
7805 regulator
Socket for L293

Connector for power from battery
Connector for power to Arm
eight diodes
two 4.7uF electrolytic capacitors
two motor connectors (0.156in header)

TM4C123

8 PWM pins



$$\text{duty cycle} = \frac{\text{High}}{\text{High} + \text{Low}}$$

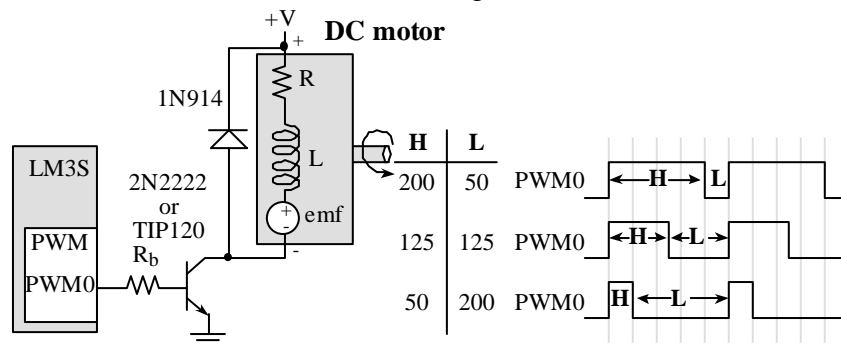


Figure 8.13. DC motor interface.

use PWM channel

Choose PWM outputs

Runs at 16-bit precision

Fix the period (10 times faster than time constant of the motor)

Prescale determines resolution

high+low sets the precision

Choose the high+low as large as possible (prescale as low as possible)

Example

2 ms period, bus clock = 80 MHz

Prescale divide by 2 so clocks at 40 MHz 25ns,

high+low= 50000

Precision is 50000 alternatives or 16 bits

Duty cycle range is 0 to 100%

Duty cycle resolution is 100%/50000= 0.002%

This is TM4C123 code

1) Change to new clock registers

2) Activate two PWM outputs

3) Make two output functions, or one function with two duty cycles

```
// period 16-bit number of PWM clock cycles in one period (3<=period)
// duty number of PWM clock cycles output is high (2<=duty<=period-1)
// PWM clock rate = processor clock rate/SYSCTL_RCC_PWMMDIV
//                    = BusClock/2 (in this example)
void PWM0_Init(unsigned short period, unsigned short duty){
    volatile unsigned long delay;
    SYSCTL_RCGC0_R |= SYSCTL_RCGC0_PWM; // 1)activate PWM
    SYSCTL_RCGC2_R |= SYSCTL_RCGC2_GPIOF; // 2)activate port F
    delay = SYSCTL_RCGC2_R; // allow time to finish activating
    GPIO_PORTF_AFSEL_R |= 0x01; // enable alt funct on PF0
    SYSCTL_RCC_R |= SYSCTL_RCC_USEPWMDIV; // 3) use PWM divider
    SYSCTL_RCC_R &= ~SYSCTL_RCC_PWMMDIV_M; // clear PWM divider field
    SYSCTL_RCC_R += SYSCTL_RCC_PWMMDIV_2; // configure for /2 divider
    PWM_0_CTL_R = 0; // 4) re-loading mode
    PWM_0_GENA_R = (PWM_X_GENA_ACTCMPAD_ONE|PWM_X_GENA_ACTLOAD_ZERO);
    PWM_0_LOAD_R = period - 1; // 5) cycles needed to count to 0
    PWM_0_CMPA_R = duty - 1; // 6) count value when output rises
    PWM_0_CTL_R |= PWM_X_CTL_ENABLE; // 7) start PWM0
    PWM_ENABLE_R |= PWM_ENABLE_PWM0EN; // enable PWM0
}
void PWM0_Duty(unsigned short duty){
    PWM_0_CMPA_R = duty - 1; // 6) count value when output rises
}
}
```

Program 8.4. Implementation of a 16-bit PWM output (PWM_XXX.zip).

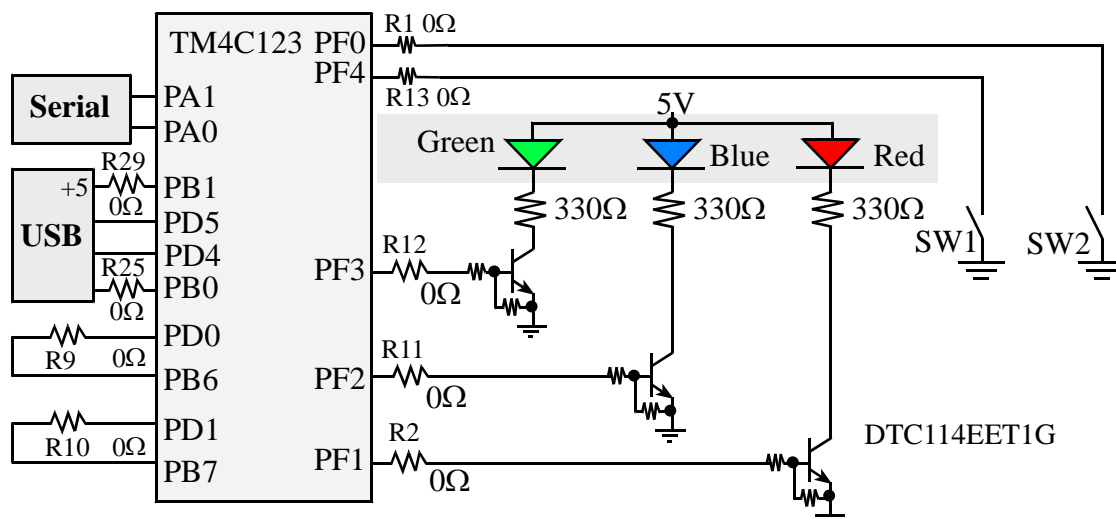


Figure 1.16. Switch and LED interfaces on the Tina® TM4C123 LaunchPad Evaluation Board. The zero ohm resistors can be removed so the corresponding pin can be used for its regular purpose.

Notice R9 and R10

IO	Ain	0	1	2	3	4	5	6	7	8	9	14
PA0		Port	U0Rx							CAN1Rx		
PA1		Port	U0Tx							CAN1Tx		
PA2		Port		SSI0Clk								
PA3		Port		SSI0Fss								
PA4		Port		SSI0Rx								
PA5		Port		SSI0Tx								
PA6		Port			I ₂ C1SCL		M1PWM2					
PA7		Port			I ₂ C1SDA		M1PWM3					
PB0	USB0ID	Port	U1Rx						T2CCP0			
PB1	USB0VBUS	Port	U1Tx						T2CCP1			
PB2		Port			I ₂ C0SCL				T3CCP0			
PB3		Port			I ₂ C0SDA				T3CCP1			
PB4	Ain10	Port		SSI2Clk		M0PWM2			T1CCP0	CAN0Rx		
PB5	Ain11	Port		SSI2Fss		M0PWM3			T1CCP1	CAN0Tx		
PB6		Port		SSI2Rx		M0PWM0			T0CCP0			
PB7		Port		SSI2Tx		M0PWM1			T0CCP1			
PC4	C1-	Port	U4Rx	U1Rx		M0PWM6		IDX1	WT0CCP0	U1RTS		
PC5	C1+	Port	U4Tx	U1Tx		M0PWM7		PhA1	WT0CCP1	U1CTS		
PC6	C0+	Port	U3Rx					PhB1	WT1CCP0	USB0open		
PC7	C0-	Port	U3Tx						WT1CCP1	USB0pflt		
PD0	Ain7	Port	SSI3Clk	SSI1Clk	I ₂ C3SCL	M0PWM6	M1PWM0		WT2CCP0			
PD1	Ain6	Port	SSI3Fss	SSI1Fss	I ₂ C3SDA	M0PWM7	M1PWM1		WT2CCP1			
PD2	Ain5	Port	SSI3Rx	SSI1Rx		M0Fault0			WT3CCP0	USB0open		
PD3	Ain4	Port	SSI3Tx	SSI1Tx				IDX0	WT3CCP1	USB0pflt		
PD4	USB0DM	Port	U6Rx						WT4CCP0			
PD5	USB0DP	Port	U6Tx						WT4CCP1			
PD6		Port	U2Rx			M0Fault0		PhA0	WT5CCP0			
PD7		Port	U2Tx					PhB0	WT5CCP1	NMI		
PE0	Ain3	Port	U7Rx									
PE1	Ain2	Port	U7Tx									
PE2	Ain1	Port										
PE3	Ain0	Port										
PE4	Ain9	Port	U5Rx		I ₂ C2SCL	M0PWM4	M1PWM2			CAN0Rx		
PE5	Ain8	Port	U5Tx		I ₂ C2SDA	M0PWM5	M1PWM3			CAN0Tx		
PF0		Port	U1RTS	SSI1Rx	CAN0Rx		M1PWM4	PhA0	T0CCP0	NMI	C0o	
PF1		Port	U1CTS	SSI1Tx			M1PWM5	PhB0	T0CCP1		C1o	TRD1
PF2		Port		SSI1Clk		M0Fault0	M1PWM6		T1CCP0			TRD0
PF3		Port		SSI1Fss	CAN0Tx		M1PWM7		T1CCP1			TRCLK
PF4		Port					M1Fault0	IDX0	T2CCP0	USB0open		

Table 1.7. PMCx bits in the GPIOPCTL register on the LM4F/TM4C specify alternate functions. **PB1**, **PB0**, **PD4** and **PD5** are hardwired to the USB device. **PA0** and **PA1** are hardwired to the serial port. PWM is not available on LM4F120.