Module 13
Introduction: Timers
Introduction: Timers

Educational Objectives:

UNDERSTAND Timers and their uses in embedded systems
INTERFACE The DC motors using hardware PWM
CREATE Multi-threaded software using multiple periodic interrupts
DESIGN Robot commands that move forward, turn left, turn right, and move backward

Prerequisites (Modules 9, 10, 12)
• Pulse width modulation (Module 9)
• Periodic interrupts using SysTick (Module 10)
• Mechanical and electrical interfaces of motors (Module 12)

Recommended reading materials for students:

This module, together with the last (Module 12), will develop the robot so it moves. Back in Module 9 you created software using pulse width modulation that dimmed an LED. You will now replace software-generated PWM with hardware-generated PWM. More specifically, you will configure the timer hardware on the MSP432 microcontroller. This will allow the system to adjust the power delivered to the DC motors on the robot with very little software overhead. Software will initialize the times, setting the PWM period and initial duty cycle. The hardware timers will automatically create the PWM outputs. Software needs to execute only when the system wishes to change the applied power or change the direction.

Back in Module 10, you created two threads: main program and SysTick ISR. In this module, you will use the hardware timers to create an additional periodic thread. Having multiple threads allows you to increase the complexity of the system in a modular way.

MSP432 microcontrollers have timers that are separate and distinct from SysTick. Input capture mode is used to make time measurements on input signals (Module 16), measuring the period from the tachometer (Lab 16). The MSP432 microcontroller has four General Purpose Timer Modules called Timer_A. Each timer has one 16-bit timer and seven associated capture/compare registers.

In this lab, you will use Timer A0 to create two PWM outputs for the motor interface, and you will use the Timer A1 to create an additional periodic interrupt that can be used by robot explorer. You will use Timers A2 and A3 later in Module 16 to interface the two tachometers.

Figure 1. (From Lab 6) After this lab you could create a robot explorer that finds its way out of a maze, using just the line sensors and bump sensors. Similarly, you could create a robot explorer that follows a line.
IMPORTANT NOTICE AND DISCLAIMER

TI provides technical and reliability data (including datasheets), design resources (including reference designs), application or other design advice, web tools, safety information, and other resources “as is” and with all faults, and disclaims all warranties, express and implied, including without limitation any implied warranties of merchantability, fitness for a particular purpose or non-infringement of third party intellectual property rights.

These resources are intended for skilled developers designing with TI products. You are solely responsible for (1) selecting the appropriate TI products for your application, (2) designing, validating and testing your application, and (3) ensuring your application meets applicable standards, and any other safety, security, or other requirements. These resources are subject to change without notice. TI grants you permission to use these resources only for development of an application that uses the TI products described in the resource. Other reproduction and display of these resources is prohibited. No license is granted to any other TI intellectual property right or to any third party intellectual property right. TI disclaims responsibility for, and you will fully indemnify TI and its representatives against, any claims, damages, costs, losses, and liabilities arising out of your use of these resources.

TI’s products are provided subject to TI’s Terms of Sale (www.ti.com/legal/termsofsale.html) or other applicable terms available either on ti.com or provided in conjunction with such TI products. TI’s provision of these resources does not expand or otherwise alter TI’s applicable warranties or warranty disclaimers for TI products.

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265
Copyright © 2019, Texas Instruments Incorporated