TI-RSLK MAX

Texas Instruments Robotics System Learning Kit

Texas Instruments

Module 16

Introduction: Tachometer

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Educational Objectives:

UNDERSTAND Timers measuring period
INTERFACE the tachometer
CREATE A low-level software driver to implement input capture
DESIGN A system that can measure wheel rotational speed

Prerequisites (Modules 10, 12, 13)
- Periodic interrupts using SysTick (Module 10)
- Mechanical and electrical interfaces of motors (Module 12)
- Timer_A periodic interrupts (Module 13)

Recommended reading materials for students:
- Chapter 16, **Embedded Systems: Introduction to Robotics,** Jonathan W. Valvano, ISBN: 9781074544300, copyright © 2019

We will combine this module, together with Modules 12, 13, and 17, to create a closed-loop control system. With a control system, we can independently set the rotational speed of each motor. The control system measures speed and uses feedback to adjust the PWM duty cycle of each motor to achieve the desired speed. With a control system the robot can move in a straight line, run at a desired speed, travel a prescribed distance, or turn a prescribed angle.

A tachometer is a sensor with digital outputs that relate to rotational speed. The Romi Shaft encoder has two outputs, and each output pulses 360 times per rotation, see Figure 1. If we measure the **Period** (in sec) of one of the tachometer signals, we can calculate the motor **Speed** in rpm as

Speed = 360*60/**Period**

We use input capture mode to make time measurements on input signals. 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.
Similar to the ADC measurements in Module 15, we are concerned with range, resolution, precision, noise, and accuracy. **Range** is defined as the smallest and largest period that can be measured. **Resolution** is defined as the smallest difference in periods that can be reliability measured. **Precision** is defined as the number of distinct periods that can be measured. Resolution and precision are usually limited by noise, rather than the theoretical parameter of the number of bits in the timer. One simple measure of **noise** is to fixed the input at a constant period, and then observe the variability in the measurements. **Accuracy** is defined as the difference between truth and measured. Truth is often difficult to know and can be subject to the same errors as the measurement system you are trying to develop.

In this lab, you will use Timer A3 to create two input capture measurements for the tachometer interfaces. There will be an interrupt on each rising edge, and the timer will measure the periods of the two inputs.

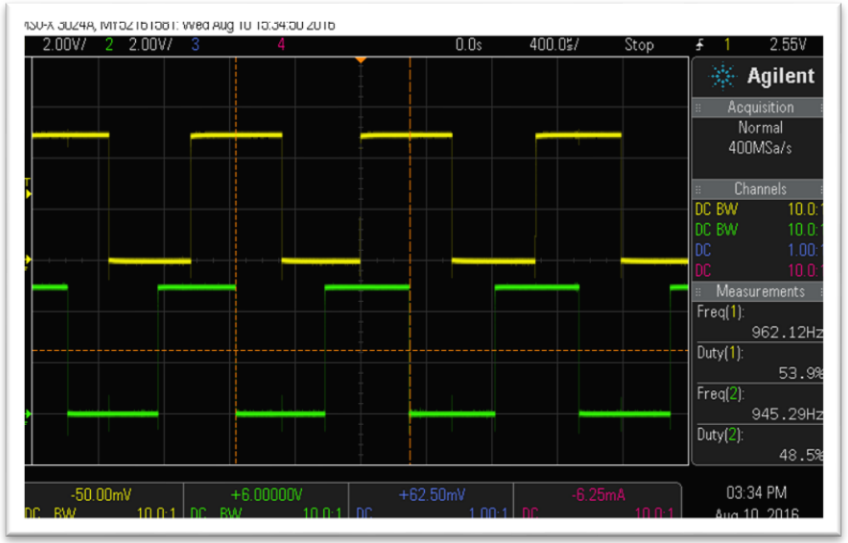

*Figure 1. Scope trace of the two outputs of the tachometer, period*360 is the time for one revolution. (From https://www.pololu.com/product/3542/)*

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