模块 9

简介： SysTick 定时器

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教学目标：

学习 systick 定时器的基本原理
使用 systick 产生精确的延时
学习 如何用逻辑分析仪测量脉冲时间和周期
学习 如何用示波器测量振幅和周期
创建 采用 RC 电路的模拟低通滤波器（LPF）
使用 PWM 和 LPF 创建数模转换器（DAC）
设计、开发和测试
用 PWM 控制 LED 的亮度

需要预先学习的模块： 模块 5， 7 和 8

- 电压，电流，电阻，电容（模块 5）
- 微控制器 GPIO（模块 7）
- 开关和 LED 接口（模块 8）

推荐阅读材料：

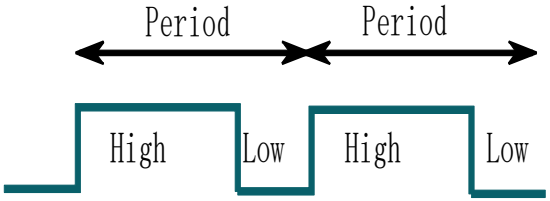
- Volume 1 Sections 4.4 and 8.7
  Embedded Systems: Introduction to the MSP432 Microcontroller ISBN: 978-1512185676, Jonathan Valvano, copyright (c) 2017

或

- Volume 2 Sections 2.6, and 6.3
  Embedded Systems: Real-Time Interfacing to the MSP432 Microcontroller, ISBN: 978-1514676585, Jonathan Valvano, copyright (c) 2017

时间是嵌入式系统的重要参数。 作为**输入（input）**，测量时间包括测量频率，周期和脉冲宽度。 例如，在 GPIO 模块中，我们看到线路传感器的光学反射率转换为电压与时间的响应，微控制器通过测量从逻辑高到逻辑低的响应时间，将传感器数据转换成数字形式。.

作为**输出（output）**，微控制器将创建影响其环境的信号。在模块 **8 开关和 LED（Switches and LED）** 中我们需要管理时间，以便使 LED 在 5Hz 振荡。在这个模块中，我们介绍了**脉冲宽度调制（pulse width modulation ）**(PWM)，这是一种利用时间向设备传递可调功率的方法。 利用 PWM，软件产生固定频率的数字输出。设 Period 为该数字波的固定周期，High 是信号为高电平的时间，Low 是信号为低电平的时间。通常，当信号高时，电源被施加到外部设备。软件调整高低时间，使得 Period = High + Low 是固定的。 在许多系统中，输出功率与**占空比（duty cycle）**（高/（高+低））成线性比例。



在与此模块相关的实验中，我们将使用 PWM 来调暗 LED 的亮度。通过将 PWM 输出传递到一个**模拟低通滤波器（analog low pass filter）**，只需一个电阻和一个电容，我们就可以创建一个数模转换器（**DAC**）。此时使用 RC 滤波器是解释电机如何响应 PWM 波的好方法。在未来的模块**（12.电机）（Motor）**中，我们的软件使用软件生成的 PWM 来控制电机的电源。PWM 产生是非常重要的嵌入式系统，我们将展示你在模块 **13.使用定时器的周期性中断（Periodic Interrupts using Timers）**中如何创建多个波形，将波形生成卸载到硬件中。在此方法中，软件仍然设置占空比和周期，但是定时器硬件完成生成数字方波的工作。

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