

# Academy for Beginners

— MSPM0 ecosystem training series

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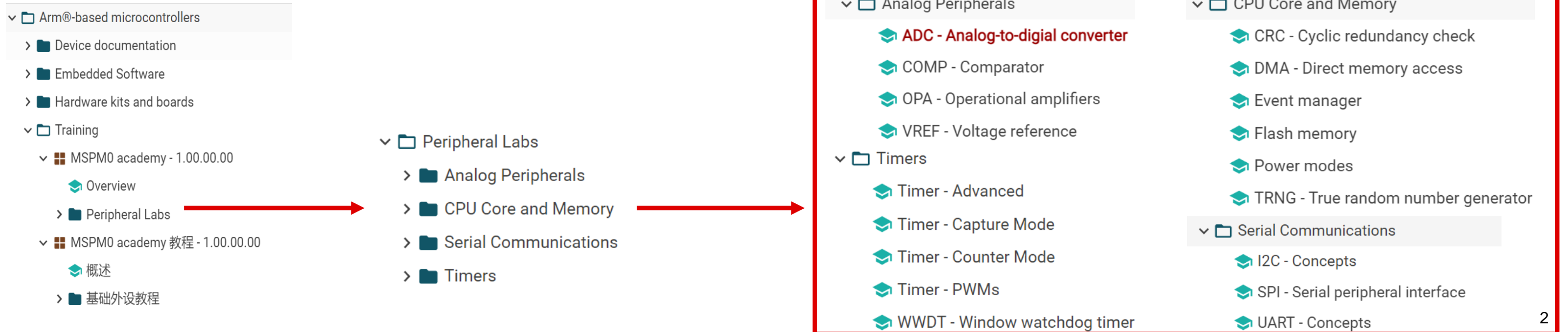
# Academy overview

## What is Academy?

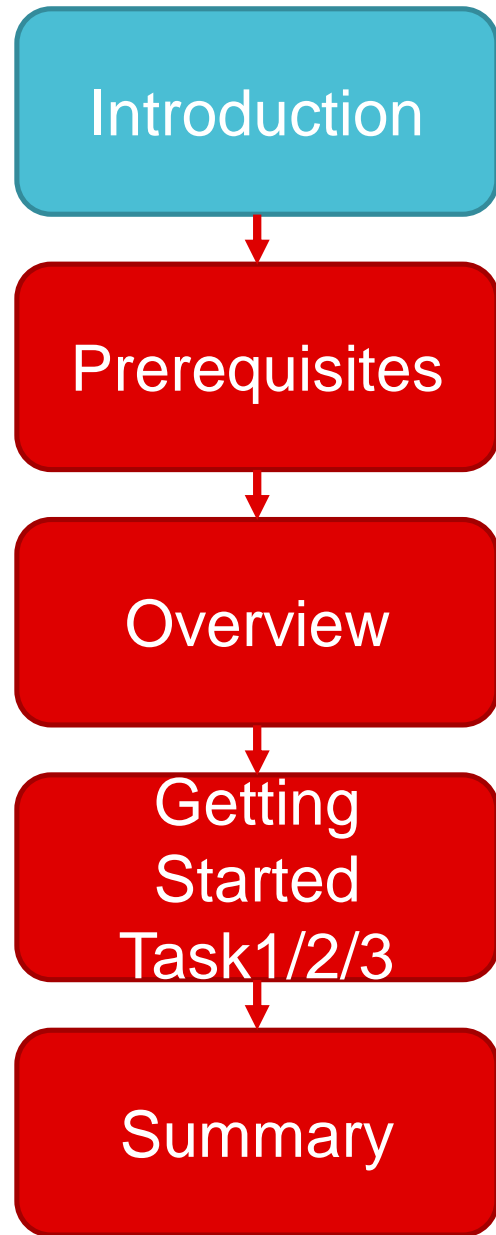
- MSPM0 Academy is a great starting point for all developers to learn about the MSPM0 MCU Platform which provides affordable solutions for all applications.
- MSPM0 Academy delivers easy-to-use training modules that span a wide range of topics and launchpads in the MSPM0 MCU portfolio.

## What you will learn from Academy([Academy link](#))?

- Key features and benefits of specific MSPM0 series
- System
- Memory
- Analog
- Communication protocol
- Watchdogs & timers
- Continually update



# Academy Structure



## Introduction

Welcome to the MSPM0 ADC academy. This lab demonstrates use of the MSPM0 integrated ADC and features several ADC conversion modes. Driver library code examples from MSPWare are used throughout the lab.

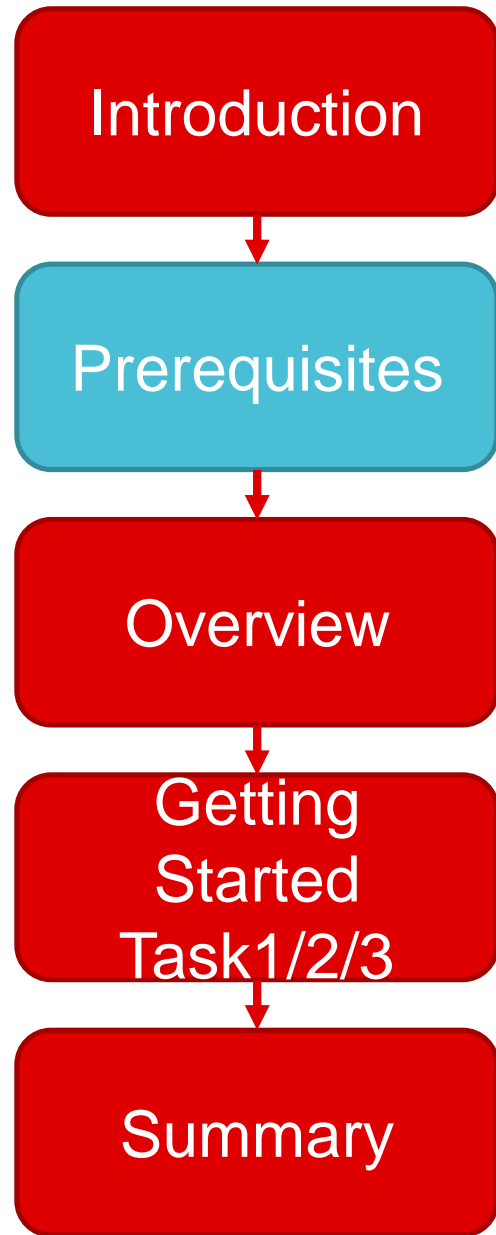
The lab consists of 3 main tasks described below:

- Sample the analog input voltage in Single-Channel Single-Conversion Mode, light the LED if the analog input voltage is > 1.25V.
- Sample two analog inputs in Single-Sequence-of-Channels Mode and store the conversion results into an array.
- Monitor the analog input voltage in ADC Window Comparator mode. Change the LED status according to different analog voltage ranges.

### MSPM0L1306

**Note:** This academy was originally written for the LP-MSPM0G3507 but it will also work with the [LP-MSPM0L1306 LaunchPad](#). There may be small differences in the MSPM0L1306 examples, such as pinouts and launchpad connections, but overall you should still be able to easily complete the included tasks.

# Academy Structure



## Prerequisites

### Hardware

The following hardware is required for this lab

- [LP-MSPM0G3507 LaunchPad](#)

### Software

The following software is required for this lab

- [Code Composer Studio \(CCS\)](#)
- [MSPM0 Code Examples](#)
- [MSPM0 SDK](#)

### Installing the software

#### NOTE:

The software examples used for this lab should be imported from within the TI Resource Explorer. This can be accessed from the web or locally in CCS by clicking View->Resource Explorer. Prior to Importing a Project, you first need to download the SDK in order to be able to import the examples to the CCS IDE. This may be done when CCS was installed or can be done later by clicking the "Download and Install" icon in the top right.

## Recommended Resources

The training videos provide an introduction to ADC parameter.

- [DC DC Specifications – INL, DNL, Cin, Leakage, Vref](#)
- [AC & DC Specifications – Offset Error, Gain Error, CMRR, PSRR, SNR, and THD](#)

# Academy Structure

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## Overview

In this lab you will be using one launchpad and input an analog voltage signal into the launchpad header pins which have ADC input function. You will see the ADC conversion results in the ADC result registers and you will also see the LED status change according to the input analog voltages.

## Getting Started

### Hardware Setup:

- [LP-MSPM0G3507 MSPM0 LaunchPad](#)

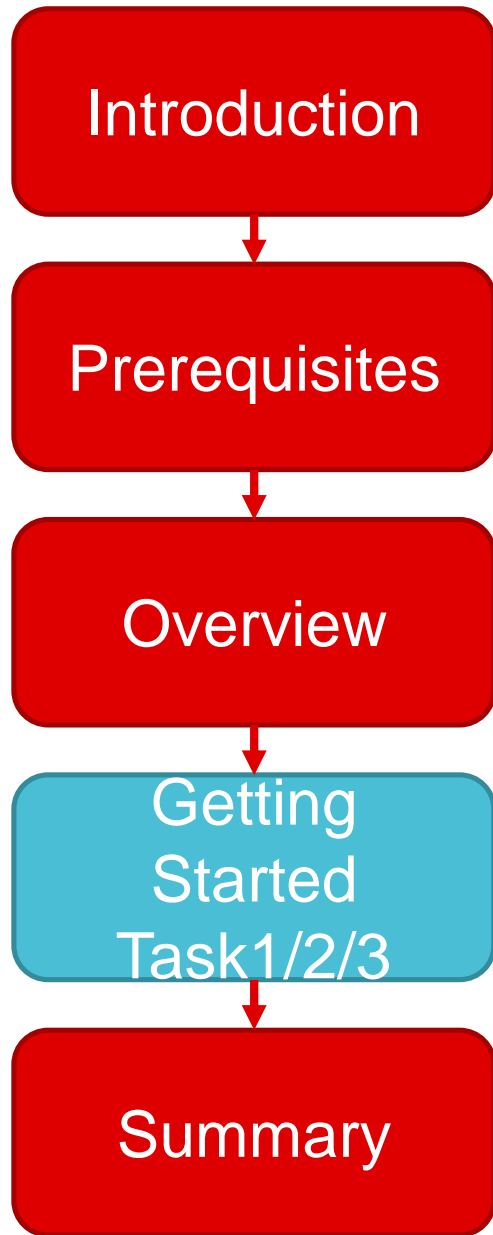
To configure the MSPM0 LaunchPad for ADC conversion test:

1. Connect the USB cable to the launchpad for power supply, programming and debug
2. Apply an analog signal less than 3.6v on pin A0 which is the maximum operation voltage.
3. Apply an analog signals less than 3.6v on pin A1.

Launchpad Input and Output diagram:



# Academy Structure



## Task 1 – Sample an Analog Input Voltage in Single-Channel Single-Conversion Mode

### Task 1 Example Overview

This task samples the analog input voltage, turns on the LED if the analog input voltage is greater than 1.25V and turns off the LED if the input voltage is less than 1.25V. The purpose is to demonstrate how to use ADC Single-Channel Single-Conversion Mode to convert analog input to digital data.

In this task there is no code to modify. So build and program the mspm0 launchpad with the code example .

1. Import the `adc12_single_conversion_vref_internal` example [adc12\\_single\\_conversion\\_vref\\_internal](#) into CCS from TI Resource Explorer later or [MSPM0 SDK](#).
  - o [MSPM0 SDK](#)
  - o Click import in the upper right hand corner
2. Build the code and program it to the launchpad.

### Task 1 Code Overview

Let us break down the MSPM0 example code into three parts:

1. Initialization
2. Main loop
3. ADC subroutine

### Task 1 Initialization:

In this code example, the following modules are used: clock system (for CPU and ADC), GPIO, ADC module and voltage reference. These modules need to be configured before the main loop code execution. They are configured in `SYSCFG_DL_init()`, and the code can be found in `ti_msp_dl_config.c`.

- Since the code example is using the default clock frequency after power-on, there is no code for clock system configuration.

Default CPU clock is `MCLK = SYSOSC ~32MHz`. Default `LFCLK = LFOSC ~32kHz`. `ADCCLK` is set to `SYSOSC` by ADC module initialization.

- GPIO initialization is to configure the package pins to the assigned functionalities: GPIO output.
- Configure the voltage reference for ADC module.

In this code example, the internal reference 2.5V is selected as the ADC conversion voltage reference. Please note, the internal reference is configurable and can be programmed based on user preference (1.4V or 2.5V).

```
SYSCONFIG_WEAK void SYSCFG_DL_init(void)
{
    SYSCFG_DL_initPower();
    SYSCFG_DL_GPIO_init();
    /* Module-Specific Initializations*/
    SYSCFG_DL_SYSTCL_init();
    SYSCFG_DL_ADC12_0_init();
    SYSCFG_DL_VREF_init();
}

SYSCONFIG_WEAK void SYSCFG_DL_initPower(void)
{
    DL_GPIO_reset(GPIOA);
    DL_GPIO_reset(GPIOB);
    DL_ADC12_reset(ADC12_0_INST);
    DL_VREF_reset(VREF);

    DL_GPIO_enablePower(GPIOA);
    DL_GPIO_enablePower(GPIOB);
    DL_ADC12_enablePower(ADC12_0_INST);
    DL_VREF_enablePower(VREF);
    delay_cycles(POWER_STARTUP_DELAY);
}

SYSCONFIG_WEAK void SYSCFG_DL_GPIO_init(void)
{
    DL_GPIO_initDigitalOutput(GPIO_LEDS_USER_LED_1_IOMUX);

    DL_GPIO_clearPins(GPIO_LEDS_PORT, GPIO_LEDS_USER_LED_1_PIN);
    DL_GPIO_enableOutput(GPIO_LEDS_PORT, GPIO_LEDS_USER_LED_1_PIN);
}

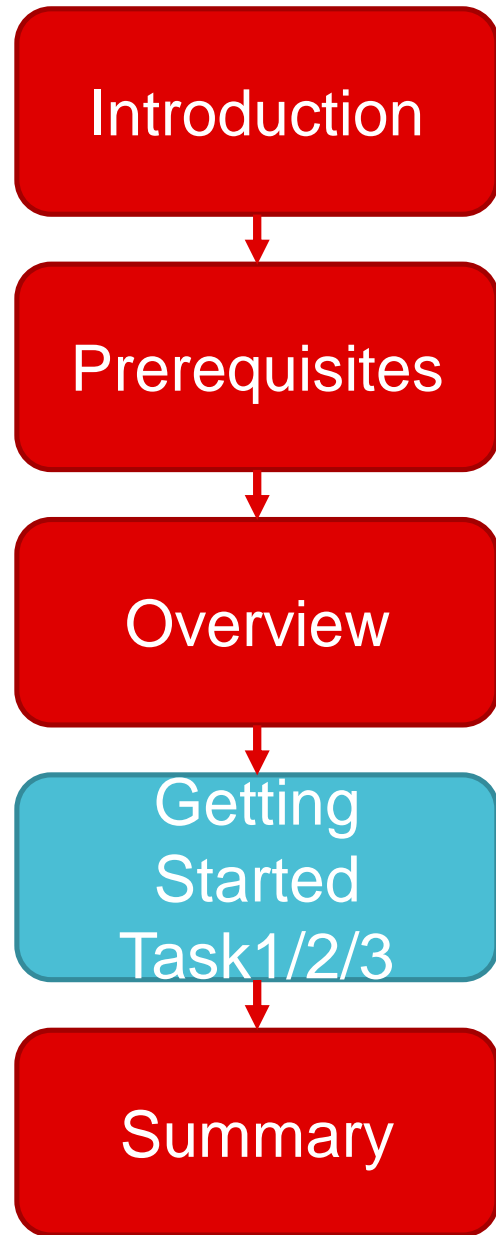
static const DL_VREF_ClockConfig gVREFClockConfig = {
    .clockSel = DL_VREF_CLOCK_BUSCLK,
    .divideRatio = DL_VREF_CLOCK_DIVIDE_1,
};

static const DL_VREF_Config gVREFConfig = {
    .vrefEnable = DL_VREF_ENABLE_ENABLE,
    .bufConfig = DL_VREF_BUFCONFIG_OUTPUT_2_5V,
    .shModeEnable = DL_VREF_SHMODE_DISABLE,
    .holdCycleCount = DL_VREF_HOLD_MIN,
    .shCycleCount = DL_VREF_SH_MIN,
};

SYSCONFIG_WEAK void SYSCFG_DL_VREF_init(void) {
    DL_VREF_setClockConfig(VREF,
        (DL_VREF_ClockConfig *) &gVREFClockConfig);
    DL_VREF_configReference(VREF,
        (DL_VREF_Config *) &gVREFConfig);
}
```



# Academy Structure



## Task 1 Code Execution

Connect the PC to the LaunchPad using the Micro USB cable. In CCS, build the example code and program the launchpad. Input the analog voltage signal (may be from an adjustable voltage regulator) on the header pin A0. (Please note the external voltage should be applied on A0 after the MCU DVCC power-on.)

After the launchpad reset, the code will execute. You can see the LED is turned on if the voltage on A0 is greater or equal to 1.25V and turn off when the voltage on A0 is less than 1.25V.

Adjust the voltage on pin A0 to see the LED turn on or off.



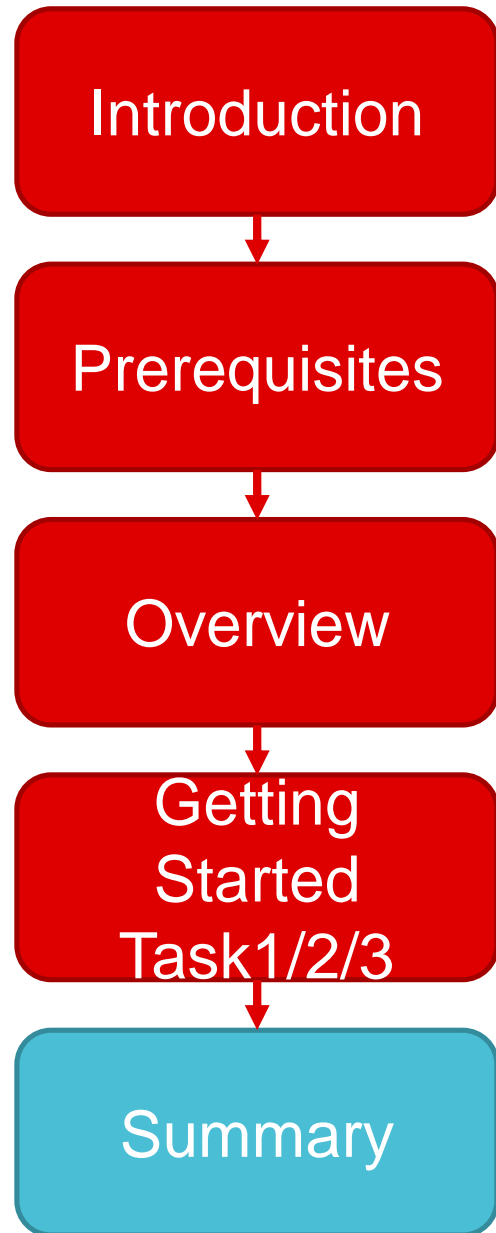
What description is correct for MSPM0?

Configurable ADC reference source: only two options including VDD and the external reference (V<sub>REF</sub>)

Software-selectable on-chip reference voltage of 1.4V or 2.5V

200-kSPS conversion rate at a resolution of 12 bits

# Academy Structure



## Summary

At the end of this lab, you should now be able to:

- Understand the MSPM0 ADC conversion modes, Vref configuration and ADC window comparator operation
- Understand the ADC sample-and-hold time calculation
- Understand the ADC low power modes operation
- Use different ADC trigger source for different application use cases



# To find more MSPM0 training series, please visit:

- [Ti.com.cn](http://ti.com.cn)
- [WeChat \(德州仪器公众号\)](#)
- [Bilibili](#)
- [21IC](#)