# 2024 Embedded Seminar

Seamlessly transition to the most comprehensive M0+ MCU portfolio available

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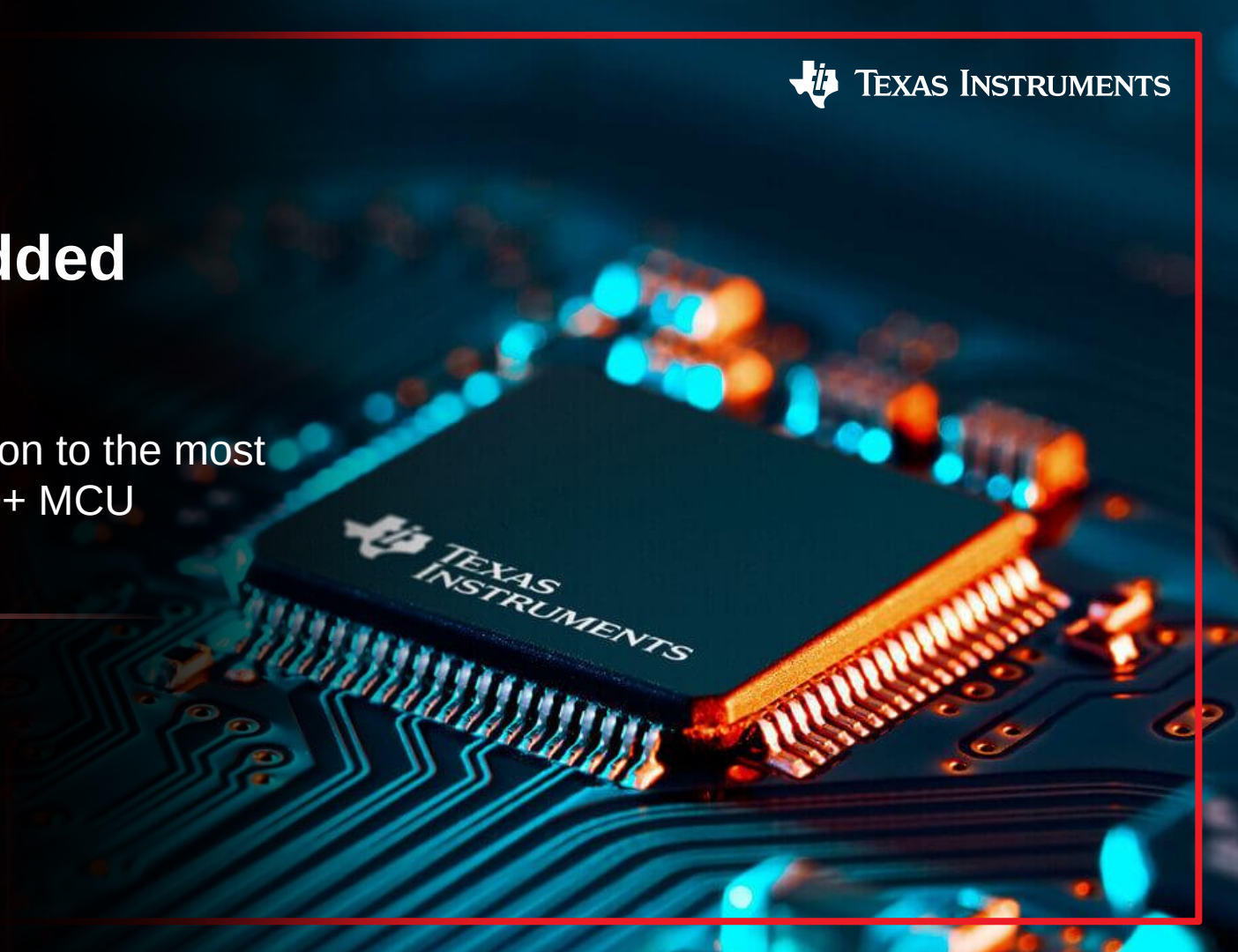


# Agenda

1. MSPM0 MCU portfolio overview
2. MSPM0 software & tools overview
3. Getting started with MSPM0 MCUs
4. MSPM0 MCU subsystems
5. Q & A

# MSPM0 MCU portfolio overview

**Reduce your system and development cost with MSPM0 MCUs**

**Leverage TI's internal manufacturing investments to simply your supply chain**

# MSPM0 MCUs | Reducing your system cost

**Cost-optimized**

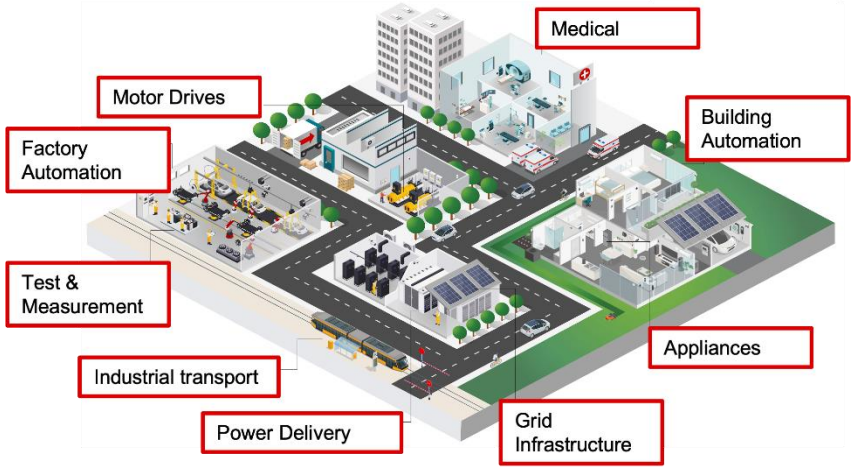
Best cost structure for microcontrollers with mix of digital, analog & memory

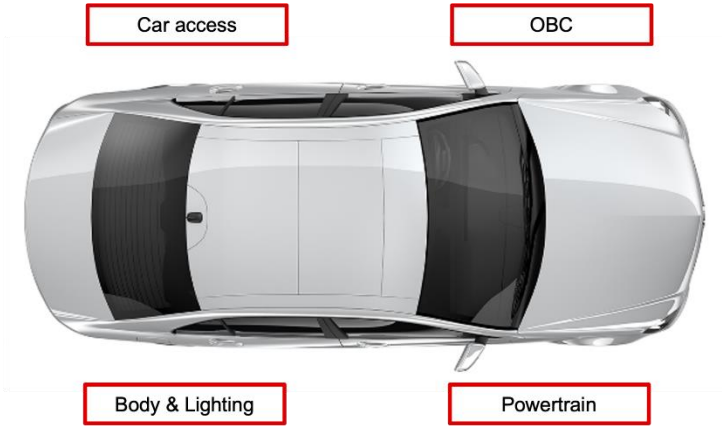
**Smallest packages**

Leverage the cost benefit of packages that are used by high volume analog

**Advanced analog integration**

Save components, board space and simplify supply chain with integrated advanced analog

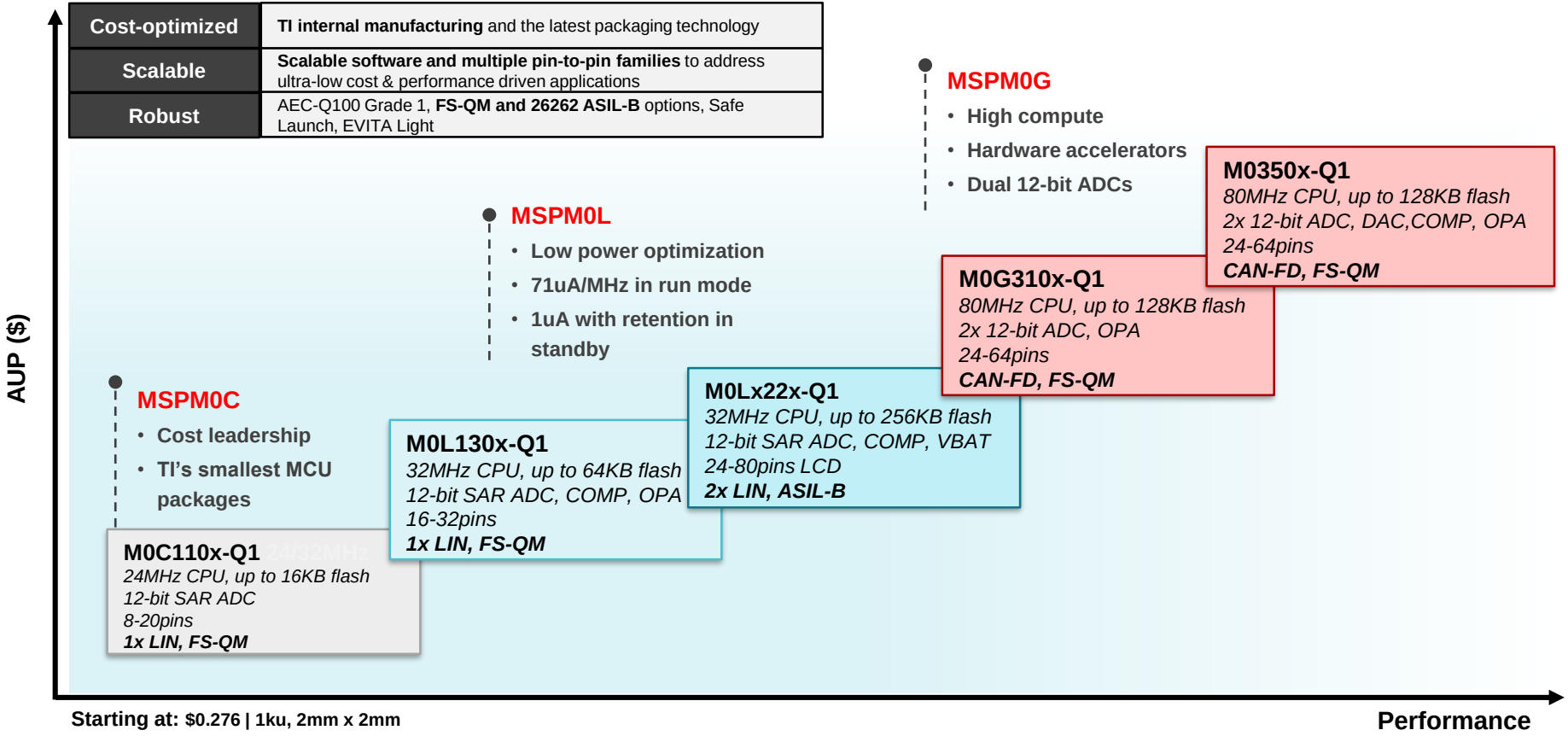



**Devices optimized for broad range of industrial and automotive applications**

# MSPM0 microcontrollers

| | |
|---|---|
| **Cost-optimized** | **TI internal manufacturing** and the latest packaging technology |
| **Scalable** | **Scalable software and multiple pin-to-pin families** to address ultra-low cost & performance driven applications |
| **Robust** | AEC-Q100 Grade 1, **FS-QM and 26262 ASIL-B** options, Safe Launch, EVITA Light |



# MSPM0 3.3V MCUs | Scalable portfolio

**M0G** *Best compute*

- 80MHz CPU
- CAN-FD options
- Fast 4Msps sim-sam ADCs
- Math accelerator

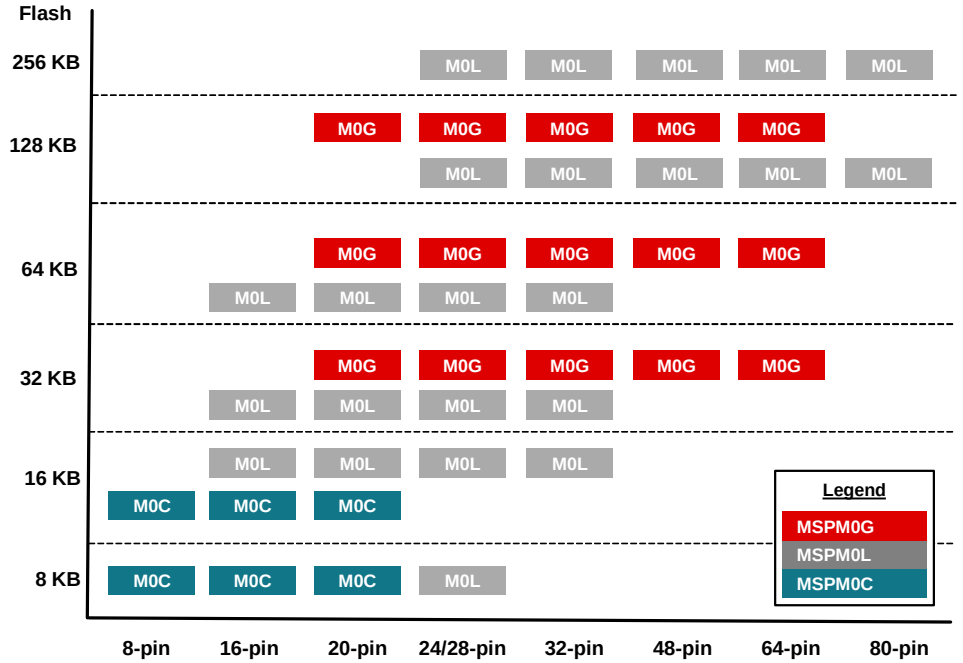
**M0L** *Lowest power*

- 32MHz CPU
- 71µA/MHz (CoreMark run)
- 6µA-max standby at 85 °C
- 1µA-typ standby at 25 °C

**M0C** *Lowest cost*

- 24/32MHz CPU
- Smallest QFN package (2x2)
- 0.5/0.65mm pitch packages
- Pin-compatible with industry

Unified software development kit & tools
Pin-to-pin compatible in 15+ packages



# MSPM0 software & tool overview

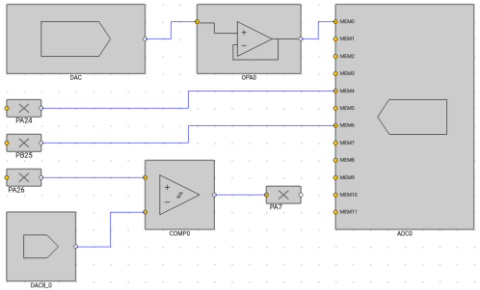
# Visual development: from design to configuration and tuning

**Get started in the TI Developer Zone** dev.ti.com

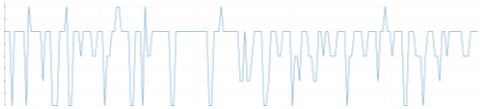
## Analog design

ti.com/tool/mspm0-analog-configurator

### Drag-and-drop ADCs, DACs, CMPs, amps



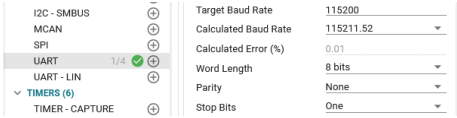
### View & log data converter outputs in real time



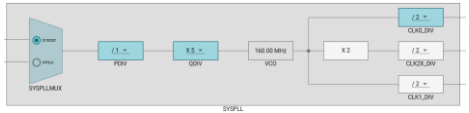
## System configuration

ti.com/tool/sysconfig

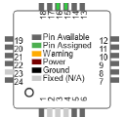
### Select and set up peripherals

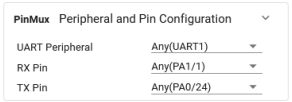



### Configure & optimize clock system



### Solve pin multiplexing challenges

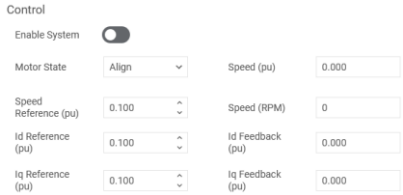


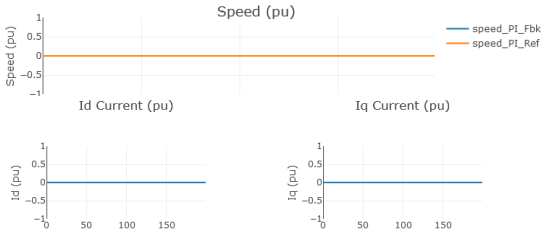

## Application tuning

ti.com/tirex

### Tune motor control loops

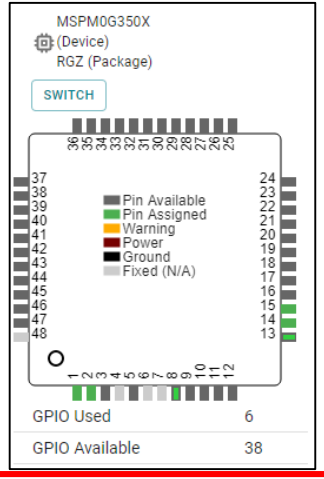


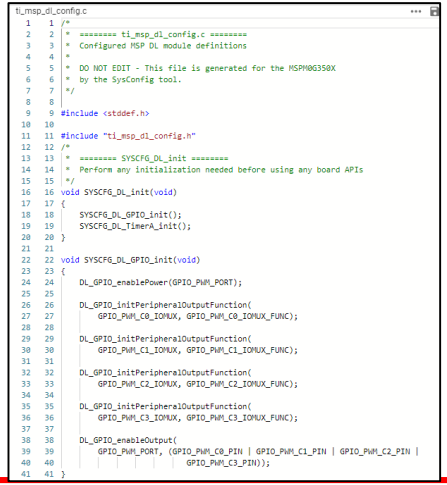

### View & log motor & sensor parameters



# SysConfig | Intuitive GUI-based configuration

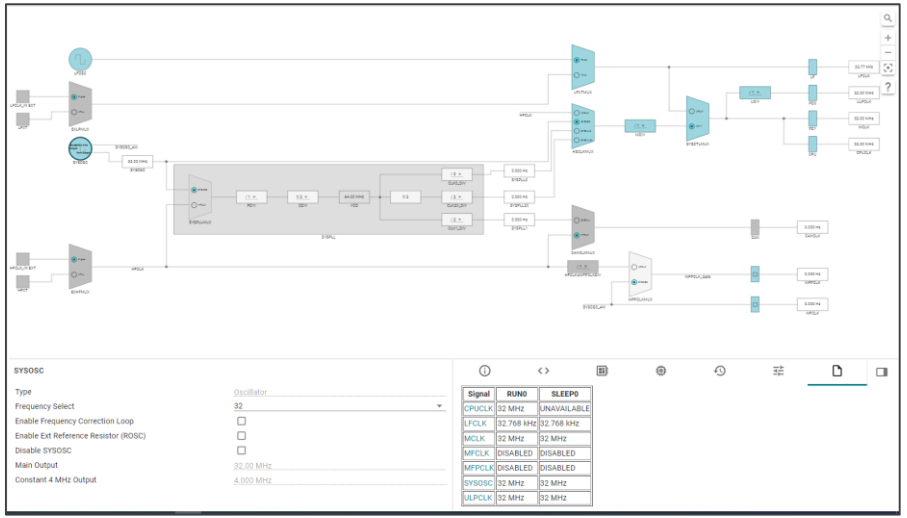
- Graphical utilities to configure pins, peripherals, subsystems, and other components
- Generates C code files for SDK examples or custom software
- Real-time conflict management ensures creating a valid configuration
- Real-time code preview
- Board and device-level views to show pin and peripheral configurations
- Planned library support for:
  - DriverLib
  - TI Drivers
- Tool support:
  - Standalone Desktop and Cloud application
  - Integrated in CCS, IAR and Keil IDEs

# SysConfig | Clock tree tool

- Intuitively manage all system clocks. Currently available in SysConfig now
- Includes all on-chip muxes and clocks that automatically will propagate to peripherals
- Generate clocking code quickly and graphically
- Validation and error checking for best practices
- See all available clocks and values for different low power modes




MSPM0G Clock Tree

# HW & SW Tools: shorten time to market

**Get started in the TI Developer Zone** dev.ti.com

## Hardware & partners

**Low-cost Launchpad with on-board debug**

**Ecosystem of third-party tools partners**

IAR SYSTEMS · KEIL Tools by ARM · SEGGER www.segger.com · FreeRTOS · Elprotronic Inc.

## Software & applications

**Subsystem examples for common use-cases**

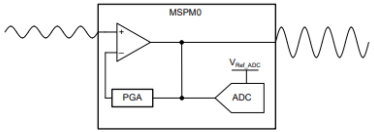



Figure 1. Subsystem Functional Block Diagram

**Broad selection of middleware**

| | | | |
|---|---|---|---|
| Motor control | Automotive | Grid | Math Libraries |
| Security | Building Automation | Medical | Factory Automation |

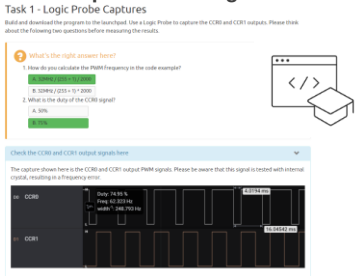
**Hundreds of code examples**

```
int main(void)
{
    SYSCFG_DL_init();

    NVIC_EnableIRQ(ADC12_0_INST_INT_IRQN);
    gCheckADC = false;

    while (1) {
        DL_ADC12_startConversion(ADC12_0_INST);
```

## Educational resources

**Learn MCU concepts with Precision Labs**


**Hands-on self-paced training with Academies**



# Embedded software available today

**MSPM0SDK: Optimized, robust, and flexible embedded software**

**Operating Systems**

**RTOS**
- FreeRTOS
- Zephyr

**Schedulers**
- Light task scheduler

**Libraries and Subsystems**

**Data**
- EEPROM emulation

**Safety**
- IEC 60730

**Security**
- Secure boot

**Logic**
- Power sequencing
- Digital muxing

**Communication**
- LIN library
- CAN library
- SMBus
- PMBus
- DALI
- OneWire
- SENT
- UART to I2C bridge

**Sensing**
- Battery management
- Smoke detection
- Electricity metering
- Occupancy detect
- Pulse oximeter
- Blood pressure
- Temperature
- Analog to serial

**Control**
- Brushed DC
- Stepper
- Sensored trap
- Sensorless FOC

**Processing**
- IQ-MATH
- FIR/IIR filters
- CMSIS-DSP

**Device Support**

**Hardware Abstraction**
- TI Drivers (high level abstraction)
- DriverLib (low level abstraction)

**Device Boot Features**
- Boot loaders (UART, I2C, SPI, CAN)
- Flexible debug security modes

**Comprehensive Examples**

**Peripheral driver example projects**
Digestible driver examples to demonstrate basic functionality

**Subsystem example projects**
Connect modules together to implement simple functions

**Library example projects**
Demos for using the libraries provided in the software development kit

**RTOS example projects**
Demos for using drivers in the context of a real-time operating system

**Third Party Support**

**Automotive software**
Solutions for LIN and CAN protocol stacks

**Emulation and production**
Programming tools from Elprotronic, Segger, Lauderbach and more

**Overview:** Arm® Cortex ®-M0+ MCUs design & development | TI.com
**Middleware one-pagers:** https://texasinstruments.seismic.com/Link/Content/DCJ9TW88bM3jR8QBjGBb4mWXPf3B
**TI.com:** MSPM0-SDK Software development kit (SDK) | TI.com
**GitHub:** GitHub - TexasInstruments/mspm0-sdk: Git version of Texas Instrument's MSPM0 SDK

**Choose your favorite delivery format**
- Windows, macOS, and Linux support
- Make a clone of MSPM0-SDK from GitHub
- Core contents are BSD 3-clause licensed

**Develop with TI Code Composer Studio**
- Theia (VS-code) based environment
- Eclipse-based environment
- TI Arm compiler with functional safety

**Develop with fully supported 3P environments**
- IAR Embedded Workbench for ARM
- Arm Keil uVision environment

# Getting started with MSPM0 MCUs

# MSPM0 MCU ecosystem

**Code source:**

SDK

MSPM0-SDK

**IDE:**

CCS

ARM KEIL Microcontroller Tools

IAR SYSTEMS

**Debugger:**

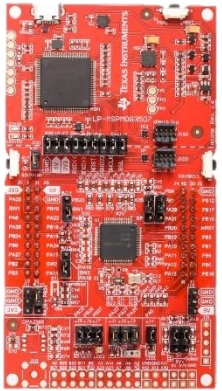
XDS110

SEGGER www.segger.com

J-LINK

**MSPM0 MCU:**

**Development board:**



LaunchPad

**Code generator:**

SysConfig

**PC programming tool:**

UniFlash

**Programmer:**

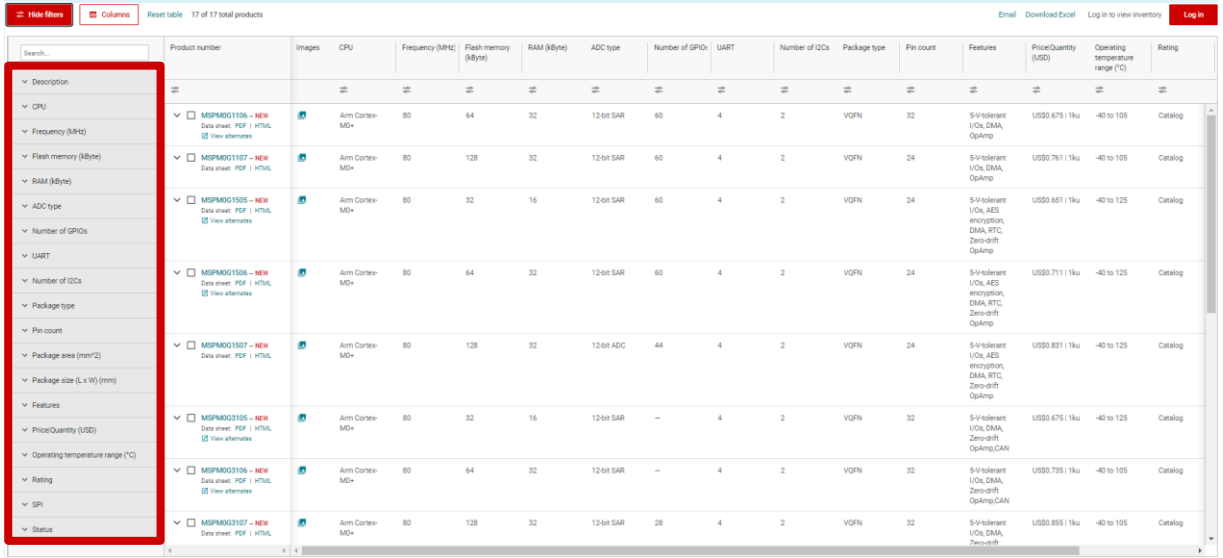
MSP-GANG

# MSPM0 MCU migration & development flowchart

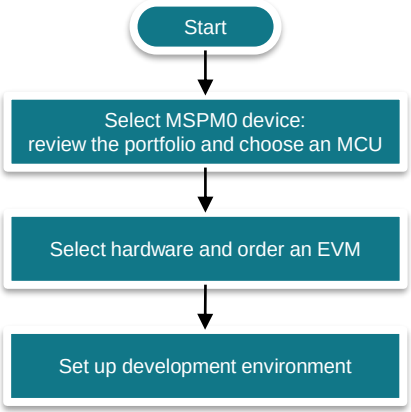
Start

Select MSPM0 device:
review the portfolio and choose an MCU

**MSPM0 MCU online selection tool:**

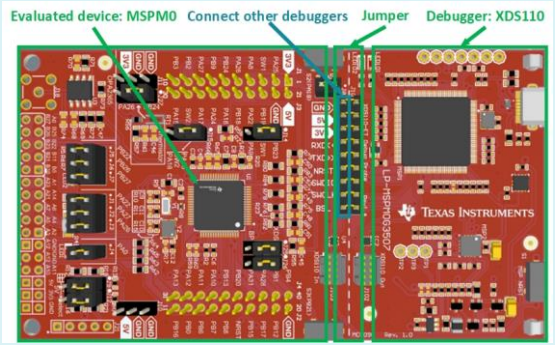


# MSPM0 MCU migration & development flowchart




**Low-cost evaluation board LaunchPad™:**

- LP-MSPM0L1306
- LP-MSPM0G3507




**Development environment:**

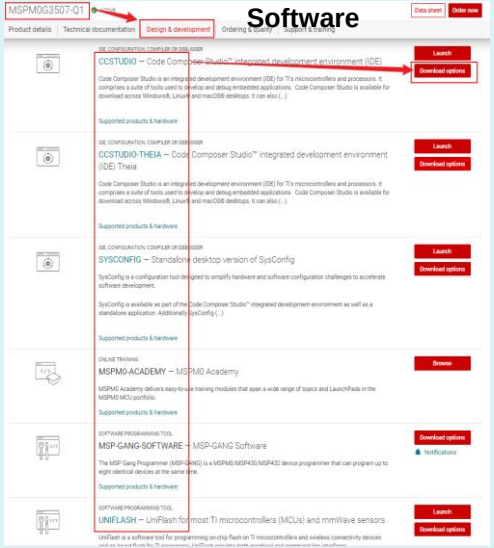
**Code Composer Studio™:**

- **TI own free IDE**

ARMKEIL Microcontroller Tools

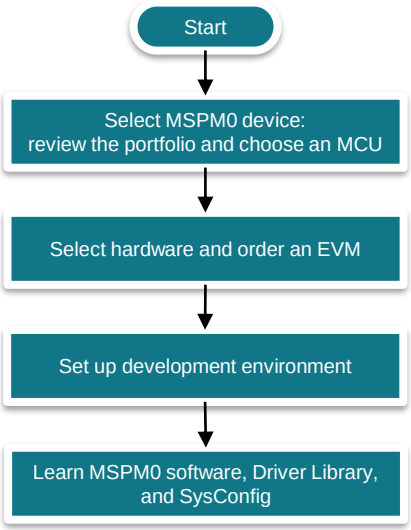
IAR SYSTEMS

**Software**

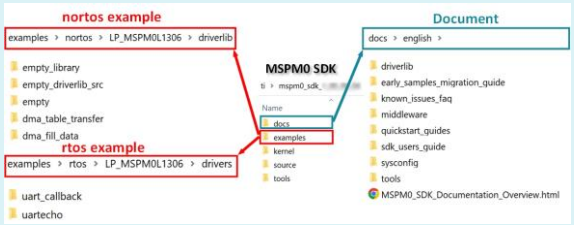


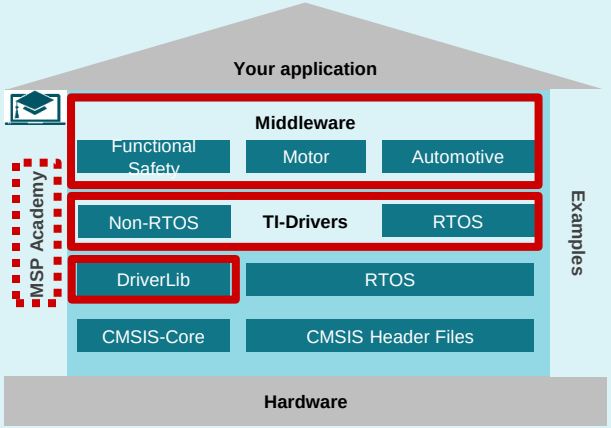

**SDK**

# MSPM0 MCU migration & development flowchart



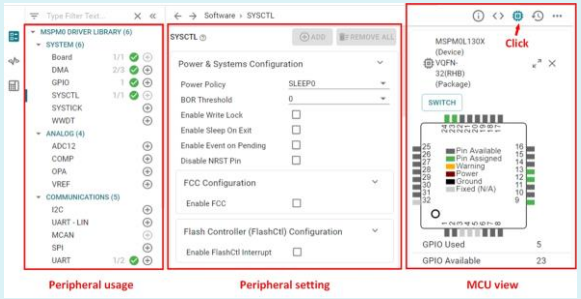

## MSPM0 SDK (Software Development Kit):



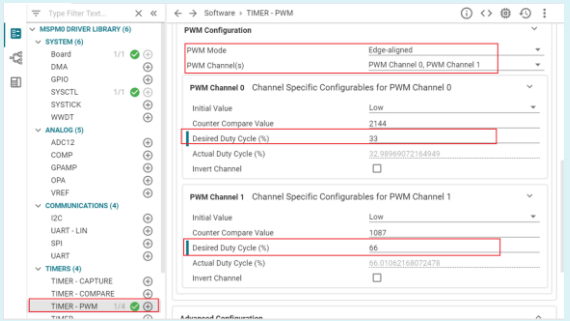




## SysConfig:

- **TI own free intuitive graphical configuration tool**




**Sysconfig overview**




**PWM configuration**

# MSPM0 MCU migration & development flowchart

Start

Select MSPM0 device:
review the portfolio and choose an MCU

Select hardware and order an EVM

Set up development environment

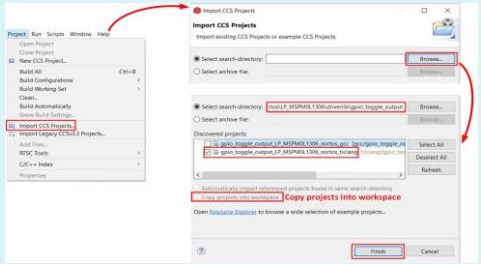
Learn MSPM0 software, Driver Library and SysConfig

Port application software

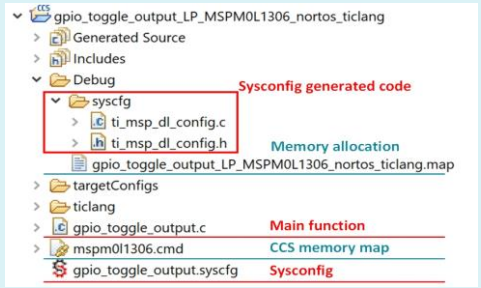
Debug and verify software

Finish!

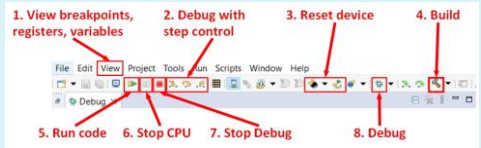
**Port and debug application software:**




Import Project




Project Structure




CCS Debug Menu

**Program:**

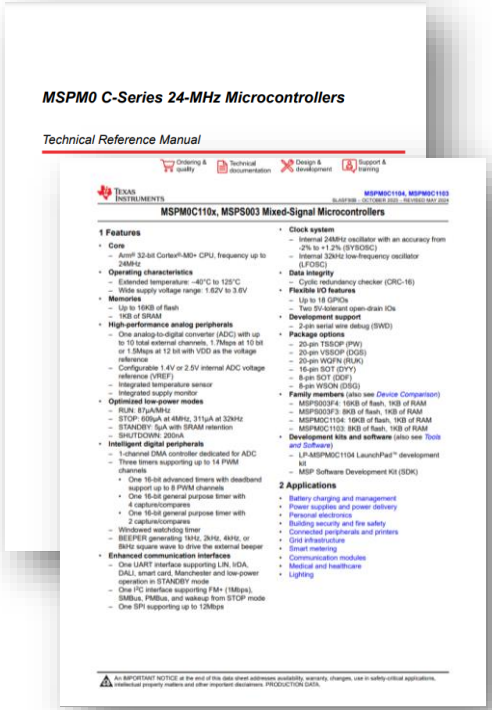
J-LINK


XDS110 JTAG Debug Probe


MSP-GANG Programmer for Mass Production

UniFlash Software On-chip Flash Programming Tool

# Migration resources from your system to MSPM0




[Datasheet](#) & [TRM](#)

Launchpad & devices

**MSPM0 training and development resources:**

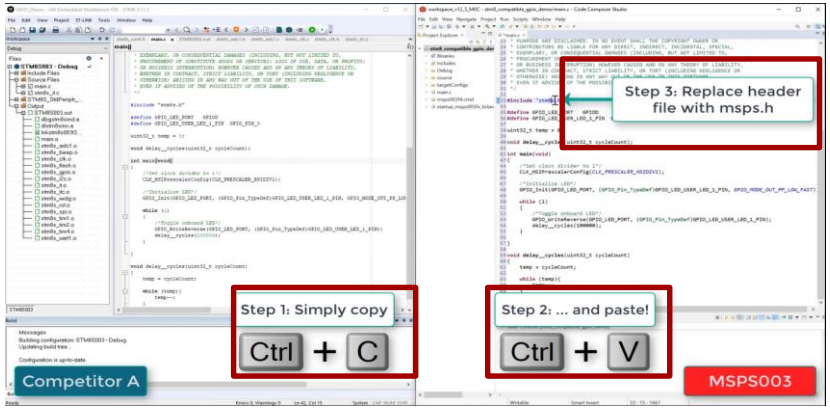
- MSPM0 MCUs Quick Reference Guide
- MSPM0-SDK — MSPM0 Software Development Kit (SDK)
- MSPM0 Academy — Self-pace training module

**Migration guides:**

- Migration Guide From *Competitor A* to Arm-Based MSPM0
- ……

**Migration tool:**

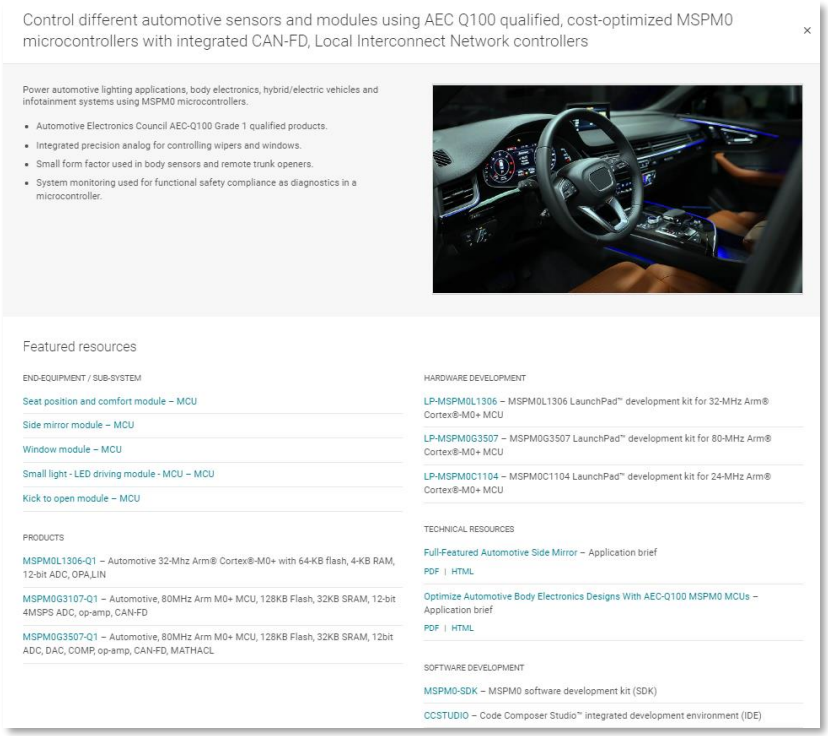
- Simplified code migration tool




Video resources

# Getting started

## Arm Cortex-M0+ MCUs | TI.com



Control different automotive sensors and modules using AEC Q100 qualified, cost-optimized MSPM0 microcontrollers with integrated CAN-FD, Local Interconnect Network controllers

Power automotive lighting applications, body electronics, hybrid/electric vehicles and infotainment systems using MSPM0 microcontrollers.

- Automotive Electronics Council AEC-Q100 Grade 1 qualified products.
- Integrated precision analog for controlling wipers and windows.
- Small form factor used in body sensors and remote trunk openers.
- System monitoring used for functional safety compliance as diagnostics in a microcontroller.

Featured resources

END-EQUIPMENT / SUB-SYSTEM

Seat position and comfort module – MCU

Side mirror module – MCU

Window module – MCU

Small light - LED driving module - MCU – MCU

Kick to open module – MCU

PRODUCTS

MSPM0L1306-Q1 – Automotive 32-Mhz Arm® Cortex®-M0+ with 64-KB flash, 4-KB RAM, 12-bit ADC, OPA,LIN

MSPM0G3107-Q1 – Automotive, 80MHz Arm M0+ MCU, 128KB Flash, 32KB SRAM, 12-bit 4MSPS ADC, op-amp, CAN-FD

MSPM0G3507-Q1 – Automotive, 80MHz Arm M0+ MCU, 128KB Flash, 32KB SRAM, 12bit ADC, DAC, COMP, op-amp, CAN-FD, MATHACL

HARDWARE DEVELOPMENT

LP-MSPM0L1306 – MSPM0L1306 LaunchPad™ development kit for 32-MHz Arm® Cortex®-M0+ MCU

LP-MSPM0G3507 – MSPM0G3507 LaunchPad™ development kit for 80-MHz Arm® Cortex®-M0+ MCU

LP-MSPM0C1104 – MSPM0C1104 LaunchPad™ development kit for 24-MHz Arm® Cortex®-M0+ MCU

TECHNICAL RESOURCES

Full-Featured Automotive Side Mirror – Application brief

PDF | HTML

Optimize Automotive Body Electronics Designs With AEC-Q100 MSPM0 MCUs – Application brief

PDF | HTML

SOFTWARE DEVELOPMENT

MSPM0-SDK – MSPM0 software development kit (SDK)

CCSTUDIO – Code Composer Studio™ integrated development environment (IDE)

### MSPM0 SDK

https://www.ti.com/tool/MSPM0-SDK

### MSPM0C Launchpad

https://www.ti.com/tool/LP-MSPM0C1104

### MSPM0L Launchpads

https://www.ti.com/tool/LP-MSPM0L1306
https://www.ti.com/tool/LP-MSPM0L2228

### MSPM0G Launchpad

https://www.ti.com/tool/LP-MSPM0G3507

# MSPM0 MCU subsystems

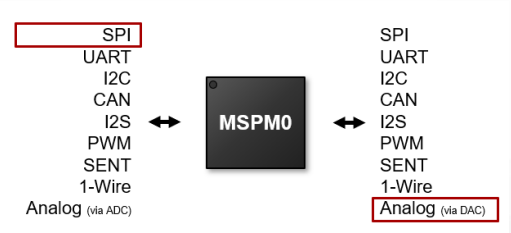
# What/where is a subsystem

## Subsystem is

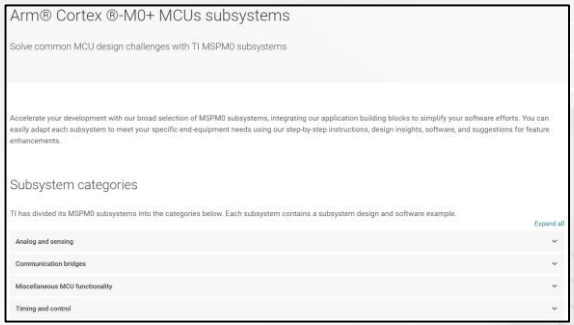
- **MSPM0 can adding value to the product**
- **Solve common MCU design challenges**

MSPM0 Subsystem = Specific functionality that MSPM0 can provide, such as:

ADC sampling with ping-pong buffer
Ping-pong buffer with I2C, SPI, UART
Sensor aggregator
MSPM0 as a logic expander




## Landing page

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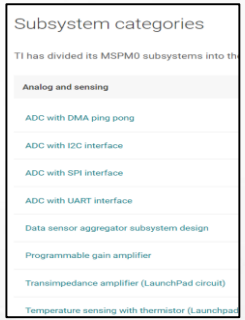
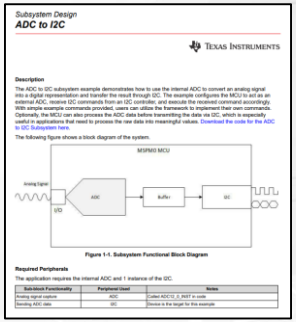
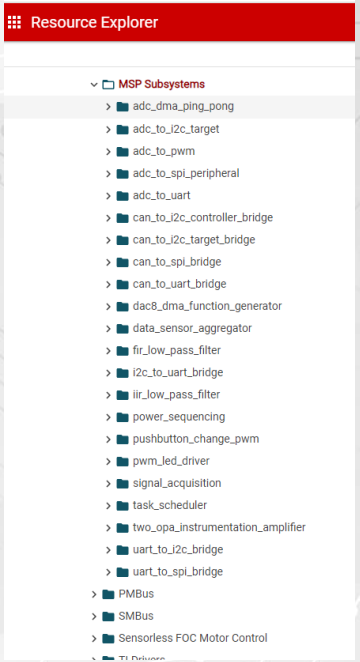



**2. Application brief**




## SDK



# MSPM0 MCU subsystems

## Subsystem use case

- Analog and Sensing
- Communication bridges
- Timing and control
- Miscellaneous MCU functionality

## Why MSPM0

- Accelerate software development
- Provide high-performance peripherals
- Simplify system design
- Have greater flexibility

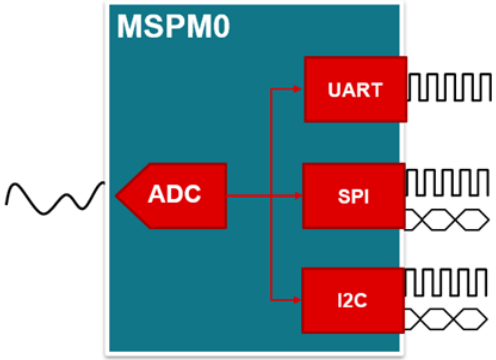



Figure 1: Low-cost ADC to UART,SPI, I2C

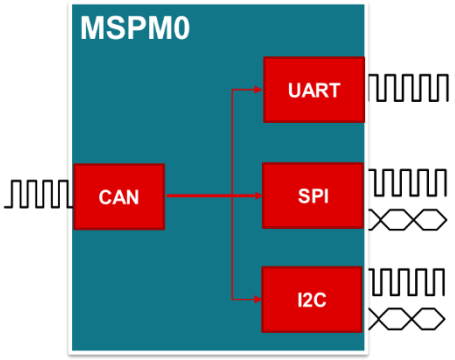
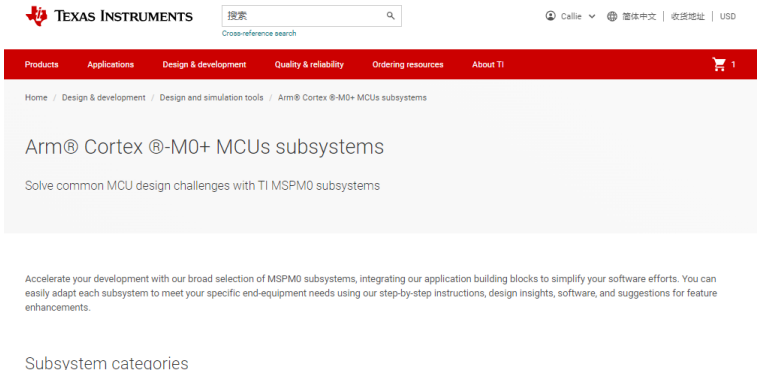



Figure 2: CAN to UART,SPI, I2C Bridge

**MSPM0 MCU subsystems on TI.com!**

Arm® Cortex ®-M0+ MCUs subsystems | TI.com



# MSPM0 MCU subsystem frequently asked questions

| Questions | | Subsystem Link |
|---|---|---|
| Many GPIOs in the system? | Need IO expander? | I2C IO Expander |
| | Need GPIO matrix? | Diode Connected Matrix |
| | Need IO MUX | IOs to UART<br>Emulating a Digital MUX |
| Is there ADC in the system? | Need digital ADC? | Low cost ADC to SPI, I2C, UART |
| | Need ADC to PWM? | Low cost analog to PWM |
| | Need precision temperature monitoring? | Thermistor Temperature Sensing |
| | Need power moniter? | Power sequencer and voltage supervisor |
| Is there OPA in the system? | Need dynamic OPA? | Dynamic Programmable Gain Amplifier |
| | Need photodiode detect? | Transimpedance Amplifier |
| | Need reject the common-mode voltage? | Two OPA Instrumentation Amplifier |
| DAC? | Need low cost DAC? | PWM DAC |
| Interface bridge in the system? | Need CAN bridge?<br>( SPI<>I2C, UART<>I2C, UART<>SPI…) | CAN to I2C Bridge<br>CAN to UART Bridge<br>CAN to SPI Bridge |
| Other functions | Need start up sequence/Logic IC? | System startup / configuration controller |
| | Need LED driver? | LED Drivers with PWM |
| | Need digital filter? | Digital FIR Filter<br>Digital IIR Filter |
| | Need multi-tasks? | RTC Scheduler |
| | Need EEPROM? | EEPROM emulation typeA<br>EEPROM emulation typeB |

# MSPM0Gx50/Gx10x Family overview

***Powerful 80 MHz G-series MCUs up to 128kB flash and 64 pins***

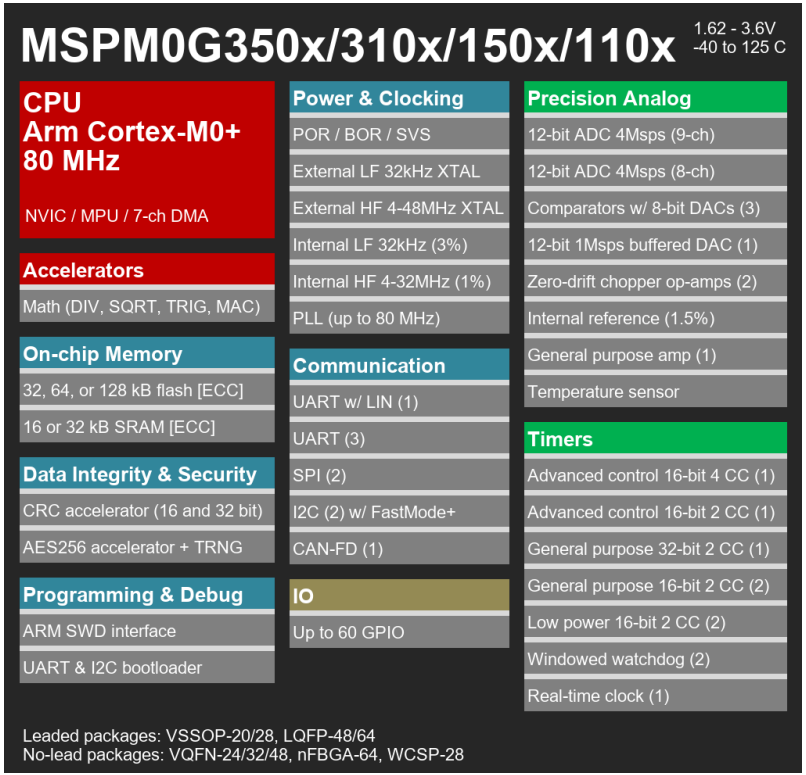
In production

## Key features and benefits

- Cost optimized **80MHz** Arm Cortex-M0+ CPU (96µA/MHz), with **math accelerator**
- Flexible communications: **CAN-FD** controller, 4 UARTs (1 w/ LIN), 2 SPI, 2 I2C
- Two **simultaneous sampling** 12-bit, **4-Msps** ADCs (with **11.2 ENOB**, averaging to **14-bit / 250ksps**, window comparator, and FIFO), 17 total external channels for industry-leading precision in energy monitoring and real-time control applications
- 3x high-speed **(32ns)** / low-power (**1µA**) comparators with 8-bit reference DACs for 1-shunt to 3-shunt monitoring in control applications or low power monitoring of multiple signals
- 12-bit 1Msps **DAC** with output buffer for waveform generation or biasing
- Advanced control timers with complementary outputs, dead-band, cycle-by-cycle limiting, quadrature/hall sensing, and synchronization for real-time control applications
- ECC-protected flash with SRAM parity and dual WWDT for robust operation

## Reduce your system cost and size

- Two zero-drift **chopper stabilized** 6MHz op-amps with 32x PGA & near-zero $V_{os}$ enable **removal of discrete amplifiers** on the PCB, or **buffering of 8-bit DAC voltages**
- **1.2% accurate** 4/32MHz on-chip oscillator from -40 to 85 ºC enables **crystal-less UART**
- Two 5V-tolerant open drain IO for **simplifying interfacing** to mixed-voltage systems
- Nine package options (4 leaded, 3 no-lead, 1 BGA/1 WCSP) for **optimizing size and cost**
- Industry's **smallest 0.5mm pitch leaded packages** with CAN-FD for smaller PCB designs




| Variants: | | | | |
|---|---|---|---|---|
| MSPM0G350x | 32-128 kB flash | 16-32 kB SRAM | 28-64 pins | ADC, CMP, DAC, OPA, AES/TRNG, MATHACL, CAN-FD |
| MSPM0G310x | 32-128 kB flash | 16-32 kB SRAM | 20-64 pins | ADC, AES/TRNG, CAN-FD |
| MSPM0G150x | 32-128 kB flash | 16-32 kB SRAM | 28-64 pins | ADC, CMP, DAC, OPA, AES/TRNG, MATHACL |
| MSPM0G110x | 32-128 kB flash | 16-32 kB SRAM | 28-64 pins | ADC |

# MSPM0Lx22x Family overview

***32 MHz L-series MCUs up to 256kB flash, 80 pins, VBAT, LCD***

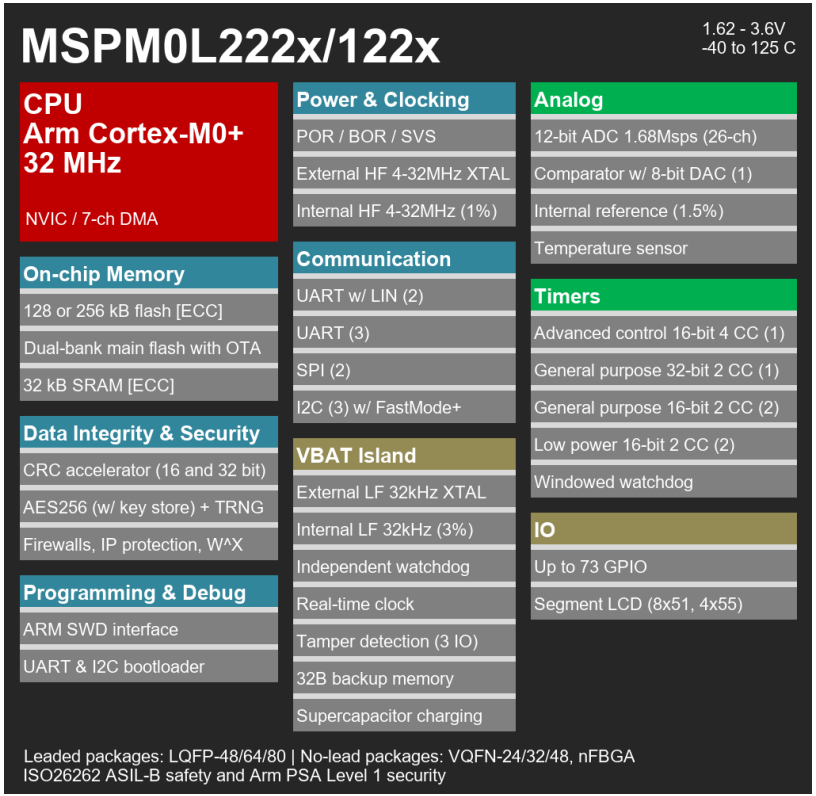
**Sampling now**

## Key features and benefits

- **Cost optimized** 32MHz Arm Cortex-M0+ CPU with flexible 7-ch DMA controller
- Low power **8x51 / 4x55** segmented LCD controller with charge pump & flexible biasing/muxing
- Robust backup **power island** with independent RTC, WDT, 32-byte memory, tamper IO
- Excellent high temperature standby current (**1.7µA** at 25 ºC/TYP, **7µA** at 85 ºC/MAX)
- **Dual-bank** main flash with W^X bank address swap for in-system firmware updates (with ECC)
- **Security enablers** for IoT (PSA-L1), including secure startup firewalls and IP protection
- Powerful AES 128/256 accelerator with GCM/CCM, local key store, and TRNG
- 12-bit, **1.68-Msps**, 26-ch ADC with **11.2 ENOB**, averaging, window comparator, FIFO
- ISO26262 **ASIL-B** functional safety, ASPICE-L3 ROM
- High-speed **(32ns)** / low-power (**1.5µA**) comparator with 8-bit reference DAC
- 5 UARTs (2 w/ LIN) all supporting standby mode (32kHz or edge wake), 2 SPI, 3 I2C
- Fully independent watchdog

## Reduce your system cost and size

- Support for supercapacitor operation with supercapacitor charging
- **1.2% accurate** 4/32MHz on-chip oscillator from -40 to 85 ºC enables **crystal-less UART**
- Wide VDD range of **1.62-3.6V** supporting 1.8V and 3.3V supplies with ±10% tolerance
- 0.5mm and 0.4mm pitch options (for 80-pin LQFP)






**Variants:**

| | | | | |
|---|---|---|---|---|
| MSPM0L222x | 128-256 kB flash | 32 kB SRAM | 48-80 pins | ADC, CMP, LCD, VBAT |
| MSPM0L122x | 128-256 kB flash | 32 kB SRAM | 24-80 pins | ADC, CMP, VBAT |

# MSPM0L13xx/110x Family overview

In production

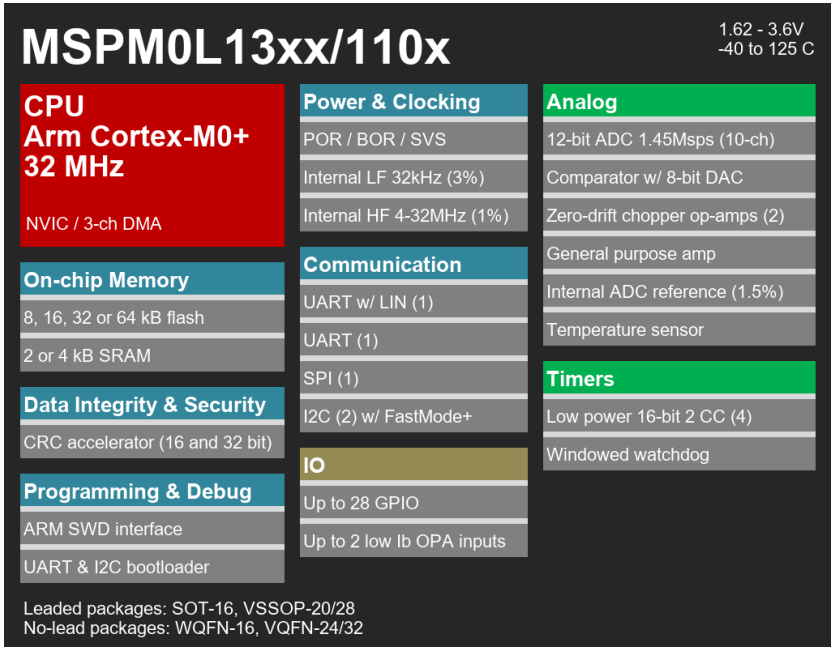
***Easy to use 32 MHz L-series MCUs up to 64kB flash and 32 pins***

## Key features and benefits

- **Cost optimized** 32MHz Arm Cortex-M0+ CPU (71µA/MHz), flexible 3-ch DMA controller
- Excellent high temperature standby current (**1µA** at 25 ºC/TYP, **6µA** at 85 ºC/MAX)
- Up to **8 PWM outputs** via 4 general purpose timers, operational in standby mode
- Protocol support for **LIN**, IrDA, DALI, Manchester, smart card, SMBus, PMBus, FM+
- 12-bit, **1.68-Msps**, 10-ch ADC with **11.2 ENOB**, averaging, window comparator, FIFO
- High-speed **(32ns)** / low-power (**1µA**) comparator with 8-bit reference DAC

## Reduce your system cost and size

- Two zero-drift **chopper stabilized** 6MHz op-amps with 32x PGA & near-zero $V_{os}$ enable **removal of discrete amplifiers** on the PCB, or **buffering of 8-bit DAC voltage**
  - Available **low $I_b$** (<10pA) to support transimpedance amplifier configurations
- **1.2% accurate** 4/32MHz on-chip oscillator from -40 to 85 ºC enables **crystal-less UART**
- 3% accurate 32kHz on-chip LF oscillator enables **accurate wake-up timing**
- Two 5V-tolerant open drain IO for **simplifying interfacing** to mixed-voltage systems
- Wide VDD range of **1.62-3.6V** supporting 1.8V and 3.3V supplies with ±10% tolerance
- Six package options (3 leaded, 3 no-lead) for **optimizing size, cost, and pin count**
  - Industry's **smallest 0.5mm pitch leaded packages** for smaller PCB designs






| Variants: | | | | |
|---|---|---|---|---|
| MSPM0L130x | 8-64 kB flash | 2-4 kB SRAM | 16-32 pins | ADC, CMP, 2x op-amps |
| MSPM0L134x | 8-64 kB flash | 2-4 kB SRAM | 20-28 pins | ADC, CMP, 2x TIA op-amps |
| MSPM0L110x | 32-64 kB flash | 4 kB SRAM | 16-32 pins | ADC |

# MSPM0C1103/4 Family Overview

In production

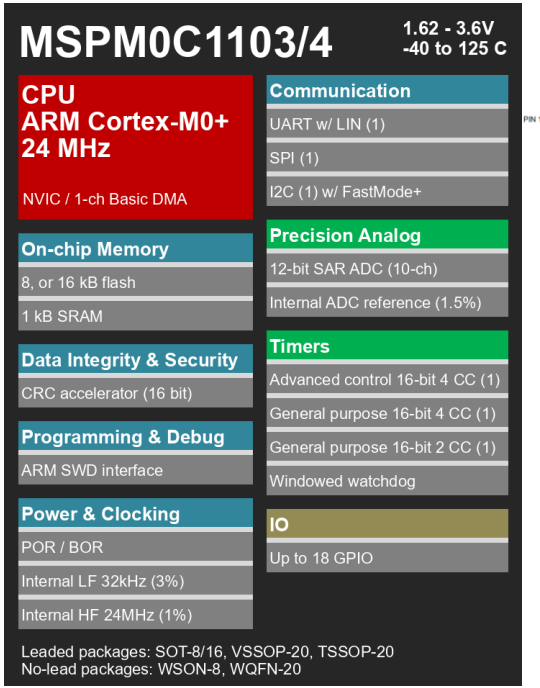
***8-bit replacement 24 MHz C-series MCUs up to 16kB flash and 20 pins***

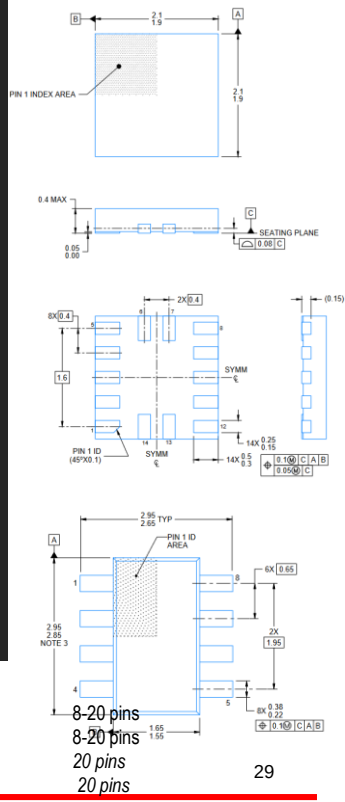
## Key features and benefits

- Industry's **lowest cost** ARM Cortex-M0+ MCU featuring in-system programmable flash, delivering a standard MCU development experience OTP prices
- Choose from 6 of the industry's **smallest**, easiest to assemble MCU packages
  - Smallest no-lead 8-pin (WSON) with **2.0 x 2.0 mm total size** & 0.5mm pitch
  - Smallest leaded 8-pin (SOT) with **2.8 x 2.9 mm total size** & 0.65mm pitch
- Three **flexible timers** (1 advanced with **complementary outputs and dead-band**, 1 general purpose, and 1 interval) for PWM generation, capture/trigger, and wakeup
- 12-bit **866Ksps** or 10-bit **1Msps**, 10-ch ADC and **internal voltage reference** for signal, supply, and temperature monitoring
- **1-ch DMA** controller for boosting ADC throughput
- Up **to 125C temperature grade** for industrial and automotive applications
- Up to **6 IO** in 8-pin packages and 18 GPIO in 20-pin packages

## Get a cost reduction faster

- **Avoid hardware changes** with MSPM0's TSSOP-20 package, which is drop-in pin compatible with STM8S003 TSSOP-20 footprint
- Port existing code easily according to the migration guide from STM8 to MSPM0C




**Variants:**

| | | | |
|---|---|---|---|
| MSPM0C1103 | 8 kB flash | 1 kB SRAM | 8-20 pins |
| MSPM0C1104 | 16 kB flash | 1 kB SRAM | 8-20 pins |
| *MSPS003F3* | *8 kB flash* | *1 kB SRAM* | *20 pins* |
| *MSPS003F4* | *16 kB flash* | *1 kB SRAM* | *20 pins* |

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