# Migration Guide from SAM E70/S70/V70/V71 to PIC32CZ CA70/MC70 Microcontroller Units (MCUs)



**AN5816** 

www.microchip.com Product Pages: PIC32CZ2051CA70064, PIC32CZ2051CA70100, PIC32CZ2051CA70144, PIC32CZ2051MC70064, PIC32CZ2051MC70100, PIC32CZ2051MC70144

### Introduction

The PIC32CZ CA70/MC70 family of microcontrollers are fully pin-to-pin compatible with the SAM E70/S70/V70/V71 family of microcontrollers. However, the PIC32CZ CA70/MC70 family of devices offers enhanced memory capabilities. The code developed for the SAM E70/S70/V70/V71 family is binary compatible with the PIC32CZ CA70/MC70 family.

**Note:** Although these device families are pin-compatible, the user needs to consider board/kit-specific differences. For example, the user switch and LED pin configurations are routed to different pins on the SAM E70 Xplained Ultra Evaluation Kit and the PIC32CZ CA70 Curiosity Ultra Development Kit.

For additional information on code compatibility, see FAQs section of this document.

Table 1. Product Lines in SAM E70/S70/V70/V71 Family of MCUs

Family	Core	Product Lines	Applications
SAM S7x	Arm® Cortex®-M7	SAM S70	Supports camera, cryptography, and Quad SPI (QSPI)
SAM E7x	Arm Cortex-M7	SAM E70	Supports camera, cryptography, and Quad SPI (QSPI) and connectivity
SAM V7x	Arm Cortex-M7	SAM V70, SAM V71	Media-Oriented Systems Transport (MOST*) technology, CAN FD, Ethernet Audio Video Bridging (AVB) connectivity and automotive

**Note:** The SAM V71 devices can be used for applications similar to the SAM E70 and automotive applications.

Table 2. Product Lines in PIC32CZ CA70/MC70 Family of MCUs

Family	Core	Product Lines	Applications
PIC32CZ CA70	Arm Cortex-M7	PIC32CZ CA70	Connectivity and automotive
PIC32CZ MC70	Arm Cortex-M7	PIC32CZ MC70	Motor Control

This document offers a comprehensive comparison of the various features across different product lines. This information assists users in determining whether the PIC32CZ CA70/MC70 family of MCUs can serve as an alternative to the SAM E70/S70/V70/V71 MCUs.

# **Table of Contents**

Inti	roduction	1
1.	Configuration Summary	3
2.	Cross Compatibility Across Product Lines	5
	Getting Started	
4.	FAQs	13
5.	References	14
6.	Revision History	15
	6.1. Revision A - February 2025	15
Mid	rochip Information	
	Trademarks	16
	Legal Notice	16
	Microchip Devices Code Protection Feature	16



# 1. Configuration Summary

Table 1-1. Core, Operating Conditions, and Memory Configuration Summary Comparison

Peripheral/Feature	SAM E70/S70/V70/V71	PIC32CZ CA70/MC70
Core	Arm Cortex-M7	Arm Cortex-M7
SRAM	Up to 384 KB	Up to 512 KB
Flash Memory	Up to 2 MB	Up to 2 MB
CPU Speed	Up to 300 MHz	Up to 300 MHz
Voltage Operating Conditions	Single supply voltage from 3.0V to 3.6V for Qualification AEC – Q100 Grade 2 Devices Single Supply voltage from 1.7V to 3.6V for Industrial Temperature Devices	Single supply voltage from 2.5V to 3.6V
Temperature Operating Conditions	-40°C to +105°C (For both Industrial and AEC - Q100 Grade 2)	-40°C to +105°C (AEC - Q100 Grade 2) -40°C to +85°C (Industrial)
Memory Protection Unit (MPU)	16 zones	16 zones
DSP Thumb*-2 compliant instruction set	Yes	Yes
L1 Cache	Yes	Yes
Tightly Coupled Memory (TCM)	Yes	Yes
External Bus Interface (EBI)	Yes (1)	Yes
Embedded Trace Module (ETM)	Yes	Yes
ROM	SAM-BA	IAP

#### Note:

1. In the SAME70/S70/V70/V71 family of MCUs, only ATSAMV71Q19, ATSAMV71Q20, ATSAMV71Q21 under the SAM V71 series; ATSAME70Q19, ATSAME70Q20, ATSAME70Q21 under the SAM E70 series; ATSAMV70Q19, ATSAMV70Q20 under the SAM V70 series; and ATSAMS70Q19, ATSAMS70Q21 under the SAM S70 series have EBI.

Table 1-2. Analog Peripherals Summary

Peripheral/Feature	SAM E70/S70/V70/V71	PIC32CZ CA70/MC70
12-bit Analog-to-Digital Converter (ADC) Channels	Up to 24	Up to 24
Analog Comparators (AC)	1	1
Digital-to-Analog Converter (DAC) Channels	Up to 2	Up to 2
Analog Front-End Controller (AFEC)	Yes	Yes

**Table 1-3.** Digital and Timing Peripherals Summary

Peripheral/Feature	SAM E70/S70/V70/V71	PIC32CZ CA70/MC70
Direct Memory Access (DMA) Channels	24	24
Timers/Counters (TC)	Yes	Yes
Real-Time Counter (RTC)	Yes	Yes
Watchdog Timer (WDT)	Yes	Yes
Reinforced Safety Watchdog Timer (RSWDT)	Yes	Yes
Real-Time Timer (RTT)	Yes	Yes
Pulse-Width Modulation (PWM)	Yes	Yes



Table 1-4. Security Subsystem Summary

Peripheral/Feature	SAM E70/S70/V70/V71	PIC32CZ CA70/MC70
Advanced Encryption Standard (AES)	Yes	Yes
Secure Hash Algorithm (SHA)	Yes	Yes
Error Correction Codes (ECC)	Yes	Yes
True Random Number Generator (TRNG)	Yes	Yes
Tamper Detection (TD)	Yes	Yes
Integrity Check Monitor (ICM)	Yes	Yes

Table 1-5. Communication Peripherals Summary

Peripheral/Feature	SAM E70/S70/V70/V71	PIC32CZ CA70/MC70
Universal Synchronous and Asynchronous Receiver and Transmitter/Universal Asynchronous Receiver and Transmitter (USART/UART) (1)	3/5	3/5
Two Wire Interface High Speed (TWIHS)	3	3
Quad Serial Peripheral Interface (QSPI)	Yes	Yes
Serial Peripheral Interface (SPI)	2	2
Synchronous Serial and Controller (SSC)	Yes	Yes
Image Sensor Interface (ISI)	Yes	Yes
Inter-IC Sound Controller (I2SC)	2	2
High-Speed Multimedia Card Interface (HSMCI)	Yes	Yes
I/O pins	Up to 114	Up to 114
USB	Yes	Yes

#### Note:

1. The number of USART/UART instances may vary across different variants, refer to the *Configuration Summary*section of the Data Sheets for detailed information on specific variants.



# 2. Cross Compatibility Across Product Lines

Table 2-1. Comparison Between Peripherals Available on SAM E70/S70/V70/V71 and PIC32CZ CA70/MC70

	Series			770/ V71 and FIC32C2 CA70/ W	
Peripheral	SAM E70/S70/V70/V71	PIC32CZ	Comments	Functionality	Alternate Peripheral on the other family
PIO	Yes	Yes	Available and fully compatible with both device families	The PIO (Parallel Input/ Output) refers to a set of features that manage general-purpose input/output (GPIO) pins for interfacing with external devices. The PIO system provides flexible control over the microcontroller's I/O pins, allowing them to be configured as inputs, outputs, or even used for alternate functions, such as communication interfaces or peripherals.	NA
TWIHS	Yes	Yes	Available and fully compatible with both device families	Inter-Integrated Circuit (I <sup>2</sup> C) compatible communication interface.	NA
AFEC	Yes	Yes	Available and fully compatible with both device families	Advanced ADC peripheral with extended features.	NA
GMAC	Yes	Yes	GMAC is fully compatible with both device families	The Ethernet Media Access Controller (GMAC) module implements a 10/100 Mbps Ethernet MAC, compatible with the IEEE® 802.3 standard. The GMAC can operate in either half or full duplex mode at all supported speeds.	NA
MLB	Yes	Yes	MLB is fully compatible with both device families	The Media Local Bus (MLB) is a three-wire interface that maps all the Media Oriented Systems Transport (MOST) Network data types (transport methods) into a single low-cost, scalable, and standardized hardware interface between a MLB Controller and at least one other MLB Device.	NA

 Table 2-1. Comparison Between Peripherals Available on SAM E70/S70/V70/V71 and PIC32CZ CA70/MC70 (continued)

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Peripheral	SAM PIC32CZ CA70/MC70		Comments	Functionality	Alternate Peripheral on the other family
CAN	Yes	Yes	Available and fully compatible with both device families	The Controller Area Network (CAN) performs communication according to ISO 11898-1:2015 and to Bosch CAN-FD specification. Additional transceiver hardware is required for connection to the physical layer.	NA
USB High- Speed Interface (USBHS)	Yes	Yes	Available and fully compatible with both device families	Communication interface.	NA
QSPI	Yes	Yes	Available and fully compatible with both device families	Communication interface.	NA
SPI	Yes	Yes	The peripheral is the same in both device families	Communication interface.	NA
ЕВІ	Yes	Yes	The peripheral is the same in both device families	The EBI allows the microcontroller to communicate with external devices, such as external memory (e.g., SRAM, Flash), peripherals, or other external systems in a controlled and efficient manner.	NA
FFPI	Yes	Yes	Available and fully compatible with both device families	The Fast Flash Programming Interface (FFPI) provides parallel high-volume programming using a standard gang programmer. The parallel interface is fully handshake and the device is considered to be a standard EEPROM.	NA

lable 2-1. Com	parison Between	Peripherais Availa	bie on SAIVI E/C	/5/0/٧/0/٧/1	and PIC32CZ CA	A/U/IVIC/U (conti	nuea)

14516 2 21 6611	1	ries		and PIC32CZ CA70/MC70 (conti	lacay
Peripheral	SAM E70/S70/V70/V71	PIC32CZ	Comments	Functionality	Alternate Peripheral on the other family
AC/ACC	Yes	Yes	Available and fully compatible with both device families	The AC consists of two individual comparators. Each comparator (COMP) compares the voltage levels on two inputs and provides a digital output based on this comparison. Each comparator may be configured to generate interrupt requests and/or peripheral events upon several different combinations of input change.	NA
EEFC	Yes	Yes	Available and fully compatible with both device families	The Enhanced Embedded Flash Controller (EEFC) provides the interface of the Flash block with the 32-bit internal bus.	NA
PWM	Yes	Yes	Available and fully compatible with both device families	This peripheral produces output pulses on 4 channels independently according to parameters defined per channel.	NA
UART	Yes	Yes	Available and fully compatible with both device families	Communication interface.	NA
тс	Yes	Yes	Available and fully compatible with both device families	The TC is a versatile peripheral found in many microcontrollers, including both device families, that is used for generating time delays.	NA
DACC/DAC	Yes	Yes	Available and fully compatible with both device families	The DAC is a peripheral that converts digital data (usually binary) into a continuous analog signal.	NA
SWD/JTAG Boundary Scan	Yes	Yes	Both device families share this same peripheral	Used to debug and test interfaces in microcontrollers and embedded systems. Both interfaces provide a mechanism for programming, debugging, and testing embedded systems.	NA



 Table 2-1. Comparison Between Peripherals Available on SAM E70/S70/V70/V71 and PIC32CZ CA70/MC70 (continued)

	Series  Series						
Peripheral	SAM E70/S70/V70/V71	PIC32CZ CA70/MC70	Comments	Functionality	Alternate Peripheral on the other family		
HSMCI	Yes	Yes	Available and fully compatible with both device families	Supports the embedded MultiMedia Card (eMMC) specification, the SD memory card specification, and the SDIO specification. It is compliant with the SD Host Controller standard specifications.	NA		
SSC	Yes	Yes	Available and fully compatible with both the device families	The Synchronous Serial Controller (SSC) provides a synchronous communication link with external devices. It supports many serial synchronous communication protocols generally used in audio and telecommunications applications, such as I²S, Short Frame Sync, Long Frame Sync, etc.	NA		
WDT	Yes	Yes	Both device families have this peripheral	The primary purpose of the WDT is to monitor the operation of the system. It does this by constantly tracking the execution of a program or application. If the system does not reset or 'feed' the watchdog timer within a specified period, it assumes the system has encountered a problem, such as an unresponsive or frozen application, and initiates a recovery mechanism.	NA		
RTC	Yes	Yes	Both device families have this peripheral	The RTC is designed to operate independently of the main microcontroller and often uses a separate low-power clock source, such as a crystal oscillator or an external 32.768 kHz crystal. This ensures that the RTC can continue running while the microcontroller itself is in low-power or sleep mode.	NA		



Table 2-1. Comp	parison Between Peripherals Available on	SAM E70/S70/V70/	V71 and PIC32CZ CA70/	MC70 (continu	(bəu

Table 2-1. Comparison Between Peripherals Available on SAM E70/S70/V71 and PIC32CZ CA70/MC70 (continued)							
	Series						
Peripheral	SAM E70/S70/V70/V71	PIC32CZ CA70/MC70	Comments	Functionality	Alternate Peripheral on the other family		
XDMAC	Yes	Yes	Available and fully compatible on both the device families	The DMAC (Direct Memory Access Controller) is a peripheral in microcontroller that facilitates efficient, high-speed data transfer between memory and peripherals (or between two memory locations) without requiring the CPU to be involved in the process. This offloads the CPU from managing data transfer tasks, allowing it to focus on other processing tasks and improving overall system performance.	NA		
ISI	Yes	Yes	Available and fully compatible with both device families	The ISI connects a CMOS-type image sensor to the processor and provides image capture in various formats. The ISI performs data conversion, if necessary, before the storage in memory through DMA.	NA		
RSWDT	Yes	Yes	Available and fully compatible with both device families	The RSWDT works in parallel with the WDT to reinforce safe watchdog operations.	NA		

Table 2-1. Comparison Between Peripherals Available on SAM E70/S70/V70/V71 and PIC32CZ CA70/MC70 (continued) Series Alternate **Peripheral Peripheral** SAM PIC32CZ **Functionality** on the Comments E70/S70/V70/V71 CA70/MC70 other family The Inter-IC Sound Controller (I2SC) provides a 5-wire, bidirectional, synchronous, digital audio link to external audio devices: DI, DO, WS, CK, and MAIN\_CLK pins. The I2SC is compliant with Available and the Inter-IC Sound (I2S) bus fully compatible specification. Yes NA Controller with both device The I2SC consists of a families receiver, a transmitter and a common clock generator that can be enabled separately to provide Host, Client or Controller modes with receiver and/or transmitter active.

#### Notes:

- 1. Refer to the *Power Supply and Startup Considerations* section in the Data Sheets for additional information.
- 2. The 100-pin and 144-pin variants of the SAM E70/S70/V70/V71 and the PIC32CZ CA70/MC70 are fully pin compatible.
- 3. The ROM section has separate features on both the device families. The SAM E70/S70/V70/V71 family of devices has SAM-BA Boot® Program, which integrates an array of programs permitting download and/or upload into the different memories of the product and the PIC32CZ CA70/MC70 family of devices has IAP feature which is a function located in ROM that any software application can call. When called, this function sends the desired Flash command to the EEFC and waits for the Flash to be ready (looping while the FRDY bit is not set in the MC\_FSR register). For additional information regarding these features, refer to the Data Sheets.
- 4. Refer to *Block Diagram* section in the Data Sheets for more information.

# 3. Getting Started

The following resources are available to get started with the PIC32CZ CA70/MC70 MCU family, MPLAB® Harmony v3 framework, MPLAB Code Configurator (MCC), MPLAB Code Configurator Content Manager (CM), and MPLAB X IDE.

#### · Microchip Developer Help:

 Access the Microchip Developer Help website, which provides documentation, tutorials, and examples specific to the PIC32CZ CA70/MC70 family of devices.

#### · Community and Support:

- Utilize *Microchip forums* for any issues during the migration process. Microchip's community is very active and provides substantial support for migrating from other families.

#### • Example Projects:

 Review example projects from MPLAB Harmony and MPLAB X IDE example collections for the PIC32CZ CA70/MC70 family of devices.

#### **Reference Demos:**

- Getting Started Application using Harmony v3 Drivers on SAM E70 Xplained Ultra Evaluation Kit
- Getting Started Application using Harmony v3 Drivers and FreeRTOS on SAM E70 Xplained Ultra Evaluation Kit
- Getting Started Application on SAM E70 Xplained Ultra Evaluation Kit
- PIC32CZ CA70 Applications

**Note:** The above list provides the reference demonstrations for the SAM E70/S70/V70/V71 devices. Because the PIC32CZ CA70/MC70 family is pin-to-pin compatible with the SAM E70/S70/V70/V71 family of MCUs, the reference demos on the SAM E70/S70/V70/V71 can be used as a starting point. Also, note that the same demonstration can be easily ported to the PIC32CZ CA70 as explained in the point 2 of the FAQs section.

#### **Technical Briefs:**

- How to Setup MPLAB Harmony v3 Software Development Framework (DS90003232)
- Create a new MPLAB Harmony v3 project using MCC
- How to Build an Application by Adding a New PLIB, Driver, or Middleware to an Existing MPLAB Harmony v3 Project (DS90003253)
- Video How to Set up the Tools Required to Get Started with MPLAB® Harmony v3 and MCC

### Migration Guides to Help Users Get Started with MPLAB Harmony v3 Framework:

MPLAB Harmony v3 Project Migration (DS00004495)

#### **Application Notes:**

32-bit Microcontroller Collateral and Solutions Reference Guide (DS70005534)

#### **Training Modules:**

MPLAB® Harmony v3 Software Framework

#### **GitHub Repositories:**

- https://github.com/Microchip-MPLAB-Harmony/reference\_apps
- https://github.com/Microchip-MPLAB-Harmony/quick\_docs
- github.com/Microchip-MPLAB-Harmony/csp\_apps\_pic32cz\_ca70
- github.com/Microchip-MPLAB-Harmony/core\_apps\_pic32cz\_ca70
- github.com/Microchip-MPLAB-Harmony/net\_apps\_pic32cz\_ca70



• github.com/Microchip-MPLAB-Harmony/gfx\_apps\_pic32cz\_ca70\_mc70

### **MPLAB Discover References:**

- PIC32CZ CA70
- PIC32CZ MC70



## 4. FAQs

1. Is the existing code on the SAM E70/S70/V70/V71 devices directly usable on the PIC32CZ CA70/MC70 devices?

**Answer:** Yes, the code is binary compatible for flashing on PIC32CZ CA70/MC70 MCUs.

2. Can code developed for the SAM E70/S70/V70/V71 be easily compiled for the PIC32CZ CA70/ MC70? If not, what adjustments are needed?

**Answer:** While the code can be compiled for the PIC32CZ CA70/MC70, some modifications may be required. The primary concern is board-level differences. For instance, the pin assignments for user switches and LEDs differ between the SAM E70 Xplained Ultra Evaluation Kit and the PIC32CZ CA70 Curiosity Ultra Development Kit.

3. Is there a guide for migrating projects from the SAM E70/S70/V70/V71 MCUs to the PIC32CZ CA70/MC70 MCUs?

**Answer:** Yes, this document provides specific compatibility details between the two families. Refer to this document for detailed instructions on transitioning the application.

- a. The following Migration Steps provide guidance on how to port and migrate an existing application developed on the SAM E70/S70/V70/V71 device family to the PIC32CZ CA70/MC70 device family.
- b. The following Migration Steps specifically discuss migrating a Getting Started application developed on the *ATSAME70Q21B* MCU to the *PIC32CZ2051CA70* MCU.
- c. The following software and hardware tools are used:
  - MPLAB X IDE v6.20 and above
  - MPLAB Code Configurator Plug-in v5.5.1 and above
  - MPLAB XC32 Compiler v4.45 and above
  - MPLAB Harmony v3 repository: csp v3.20.0 and above
  - SAM E70 Xplained Ultra Evaluation Kit
  - PIC32CZ CA70 Curiosity Ultra Development Kit

#### **Migration Steps:**

- 1. Follow the steps mentioned in the *Training Module*: Getting Started with MPLAB® Harmony v3 Peripheral Libraries on SAM E70/S70/V70/V71 MCUs.
- 2. In the Step 2.5 for creating a new project, instead of the ATSAME70Q21B part number, enter the part number *PIC32CZ2051CA70144*.
- 3. After creating a new project using the PIC32CZ2051CA70144 as the part number, follow the instructions given in the *Training Module* to configure the peripherals and to generate the code.
- 4. On the SAM E70 Xplained Ultra Evaluation Kit, the user switch and user LED are configured on the PA11 and PA5 pins, respectively. On the PIC32CZ CA70 Curiosity Ultra Evaluation Kit, the user LED0 and user Button0 are configured on the PD23 and PA01 pins, respectively (refer to *Button and LED* section in the PIC32CZ CA70 Curiosity Ultra User's Guide (*DS70005572*) for more information). The user is required to implement this configuration change as mentioned in Step 3 of the *Training Module*.
- 5. From the **Plugins** drop-down item list, select **Pin Configuration**.

Figure 4-1. MCC Pin Configuration Window



6. Ensure that the PIC32CZ CA70 pin configurations for the user switch and user LED are set to **Available**.



# 5. References

- The following documents are available for download from the Microchip web site (www.microchip.com):
  - PIC32CZ CA70/MC70 Family Data Sheet (*DS60001825*)
  - SAM E70/S70/V70/V71 Family Data Sheet (*DS60001527*)
  - PIC32CZ CA70 Curiosity Ultra User's Guide (DS70005572)
- PIC32CZ CA70 Curiosity Ultra Development Board



# 6. Revision History

# 6.1 Revision A - February 2025

This is the initial release of this document.



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