



# MPLAB Harmony Help Template

MPLAB Harmony Integrated Software Framework

# Touch Library Help

This document is a Help for Touch Library Solution on MCU devices.

## Introduction

This topic describes brief overview of Touch library and the associated contents.

### Description

MPLAB Harmony 3 is an extension of the MPLAB® ecosystem for creating embedded firmware solutions for Microchip 32-bit SAM and PIC microcontroller and microprocessor devices. It helps the user to select and configure software components for Microchip MCUs. The touch component includes a Touch Configurator to simplify the touch application development.

### Touch Library

Touch Library is a royalty-free software library for developing touch applications on 32-bit microcontrollers with Peripheral Touch Controller peripheral. Developers can use it to integrate touch-sensing capability into their applications. The library supports both self-capacitance and mutual-capacitance acquisition methods.

### Touch Configurator

Touch Configurator offers innovative, intuitive and a graphical configuration to help designing your touch application. The user can add sensors and configure QTouch parameters represented in graphical ways to create touch project.

### Data Visualizer

Data Visualizer is a PC software that provides a visual representation of touch debug data. It allows the user to plot touch signals in real time to help tuning the touch sensors. The touch library parameters are also displayed in the data visualizer software when the hardware kit is connected through edbg/medbg virtual com port.

### Related Documents

Refer to the following link for more information on how to create touch projects using the MPLAB Harmony 3.

<https://microchipdeveloper.com/touch:set-up-the-environment>

Refer to the following link for more details on how to open and execute touch example projects.

<http://microchipdeveloper.com/touch:open-and-execute-touch-example-projects>

Please refer the QTouch Modular Library Userguide available in the link below for further information.

<https://www.microchip.com/mymicrochip/filehandler.aspx?ddocname=en590454>

## Needed Configurations for Proper Operation

This topic describes brief overview of Clock configuration and the associated contents.

### Description

For Touch library to work properly, the user needs to manually configure clocks. The touch project performs touch measurement using the Peripheral Touch Controller (PTC). This touch project also uses the Timer and UART peripherals.

### Timer

Used to provide periodic interrupt on which touch measurement is initiated (touch measurement periodicity).

### UART

Used to send touch debug data to PC (Data Visualizer software) when debug data is enabled.

The PTC, Timer, and UART peripherals require clock. Depending on the device, these clocks can be the same or different from the CPU clock.

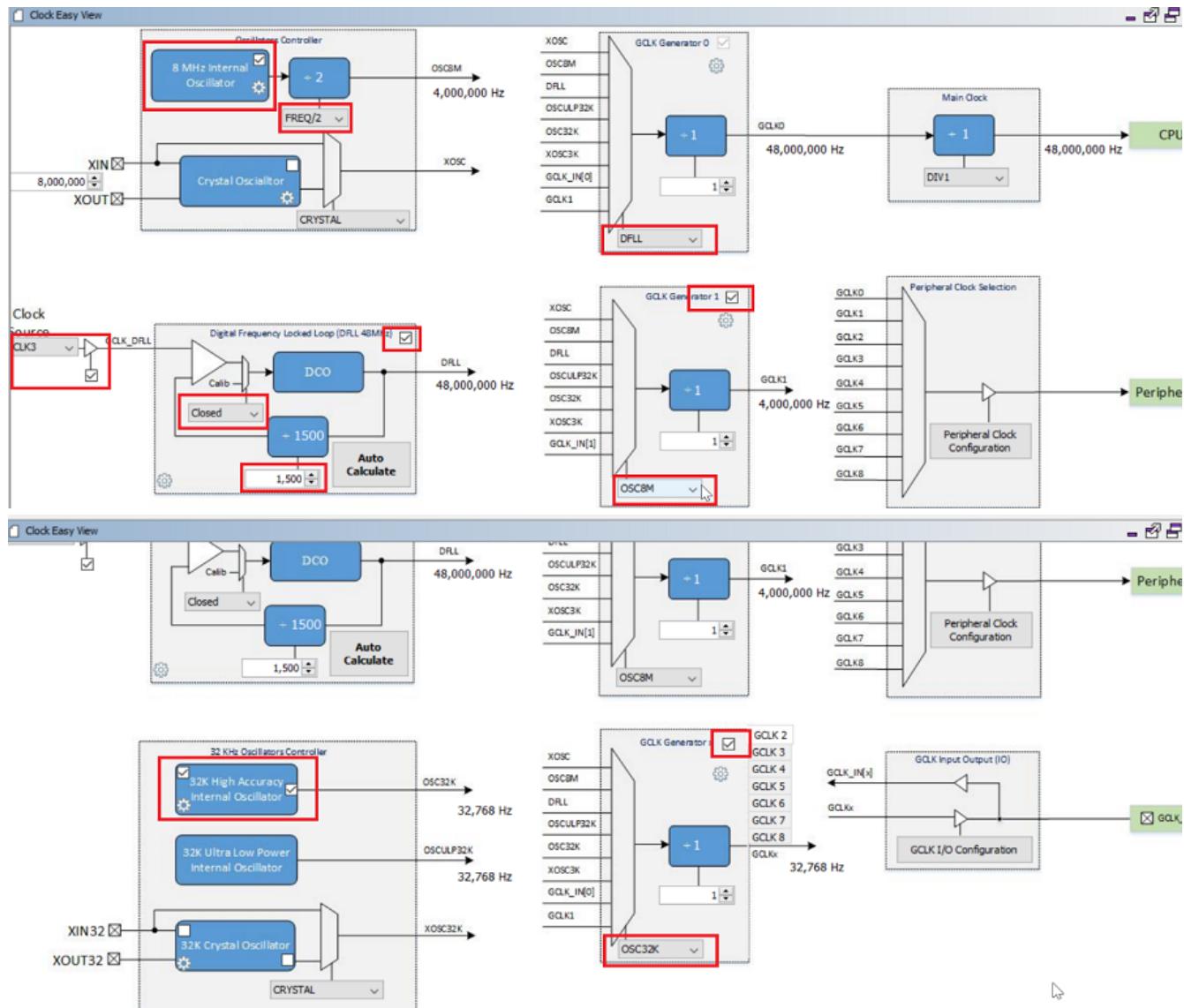
The recommended configurations for various set of devices is listed below.

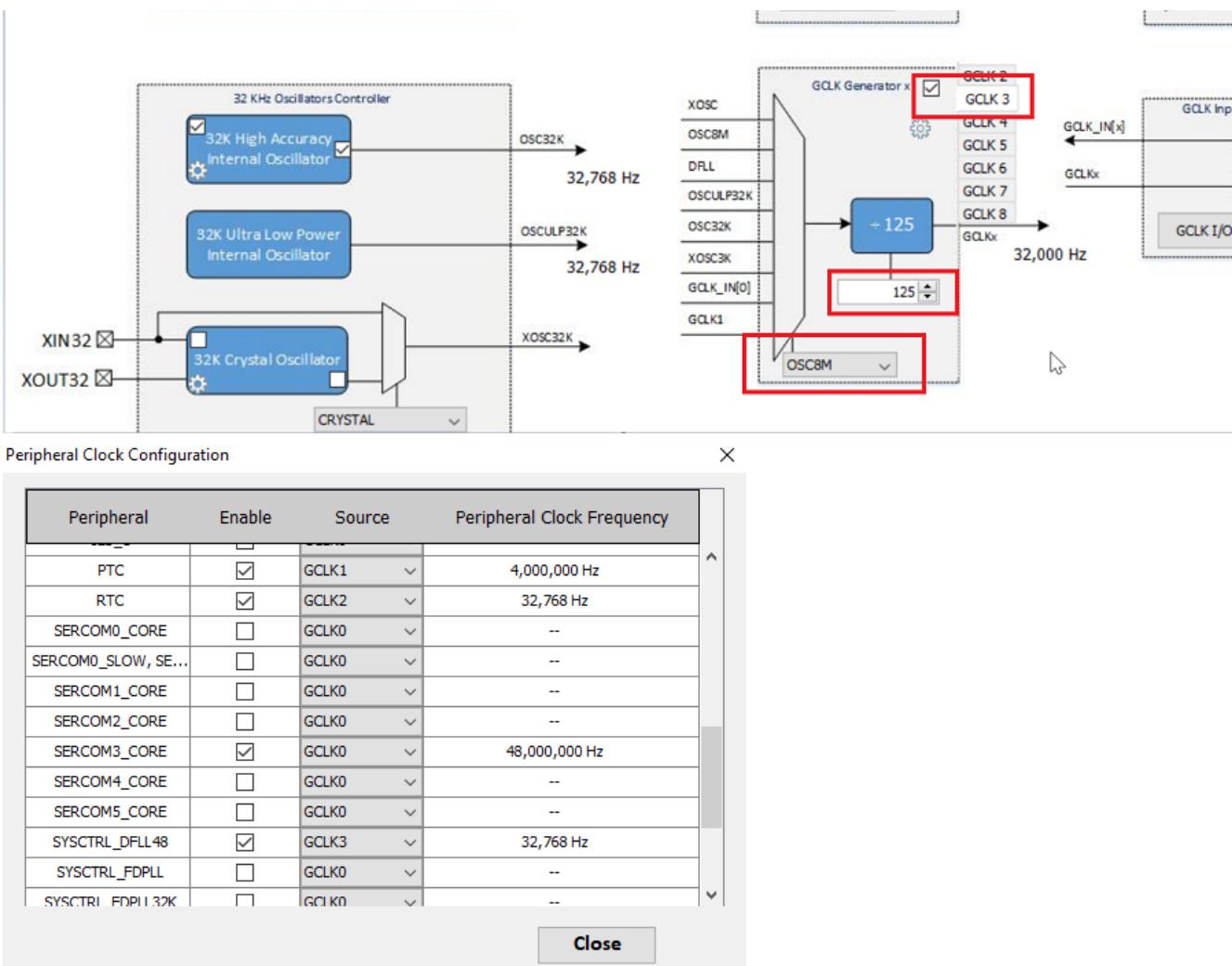
## Clock Configuration SAMD20

This topic describes brief overview of SAMD20 Clock configuration and the associated contents.

### Description

#### Clock Configuration for SAMD20 device:





## RTC Configuration:

RTC

- Hardware Settings
  - Generate Frequency Correction API
  - RTC Operation Mode 32-bit Counter with Single 32-bit Compare
- RTC MODE 0 Configuration
  - Enable Interrupts ?
  - RTC Prescaler DIV32
  - Compare Value 0x 1
  - Clear on compare Match
- RTC EVENTS configuration

## SERCOM Configuration:

Note: This configuration is for the Xplained Pro boards. You can choose the SERCOM as per the board design. Refer to Xplained Pro's user guide to know which SERCOM to use.

**SERCOM3**

- Select SERCOM Operation Mode** (Selected): USART with internal Clock
- Enable Interrupts ?
- Receive Enable
- Transmit Enable
- Enable Run in Standby
- Receive Pinout**: SERCOM PAD[3] is used for data reception
- Transmit Pinout**: SERCOM PAD[2] is used for data transmission
- Parity Mode: No Parity
- Character Size: 8 Bits
- Stop Bit Mode: One Stop Bit
- Baud Rate in Hz: 115,200

### Pin Configuration:

Pin Settings									
Pin Number	Pin ID	Custom Name	Function	Mode	Direction	Latch	Pull Up	Pull Down	
40	PB17		Available	Digital	High Impedance	Low	<input type="checkbox"/>	<input type="checkbox"/>	
41	PA20		Available	Digital	High Impedance	Low	<input type="checkbox"/>	<input type="checkbox"/>	
42	PA21		Available	Digital	High Impedance	Low	<input type="checkbox"/>	<input type="checkbox"/>	
43	PA22	LED_BUT_0	GPIO	Digital	In/Out	Low	<input type="checkbox"/>	<input type="checkbox"/>	
44	PA23	LED_BUT_1	GPIO	Digital	In/Out	Low	<input type="checkbox"/>	<input type="checkbox"/>	
45	PA24	SERCOM3_PAD2	SERCOM3_PAD2	Digital	High Impedance	n/a	<input type="checkbox"/>	<input type="checkbox"/>	
46	PA25	SERCOM3_PAD3	SERCOM3_PAD3	Digital	High Impedance	n/a	<input type="checkbox"/>	<input type="checkbox"/>	
47	GNDIO			Digital	High Impedance	Low	<input type="checkbox"/>	<input type="checkbox"/>	

### Manually configuring Wait States

The flash waits states needs to be configured based on the CPU clock frequency. This information is available in "NVM Characteristics" section of device data sheet. By default, the number of wait states is set to 0. To adjust the number of flash wait states, the following code should be altered manually within the Clock initialization routine.

Reference : Register description section 20.8.2 <http://ww1.microchip.com/downloads/en/DeviceDoc/60001504B.pdf>

**NVMCTRL**

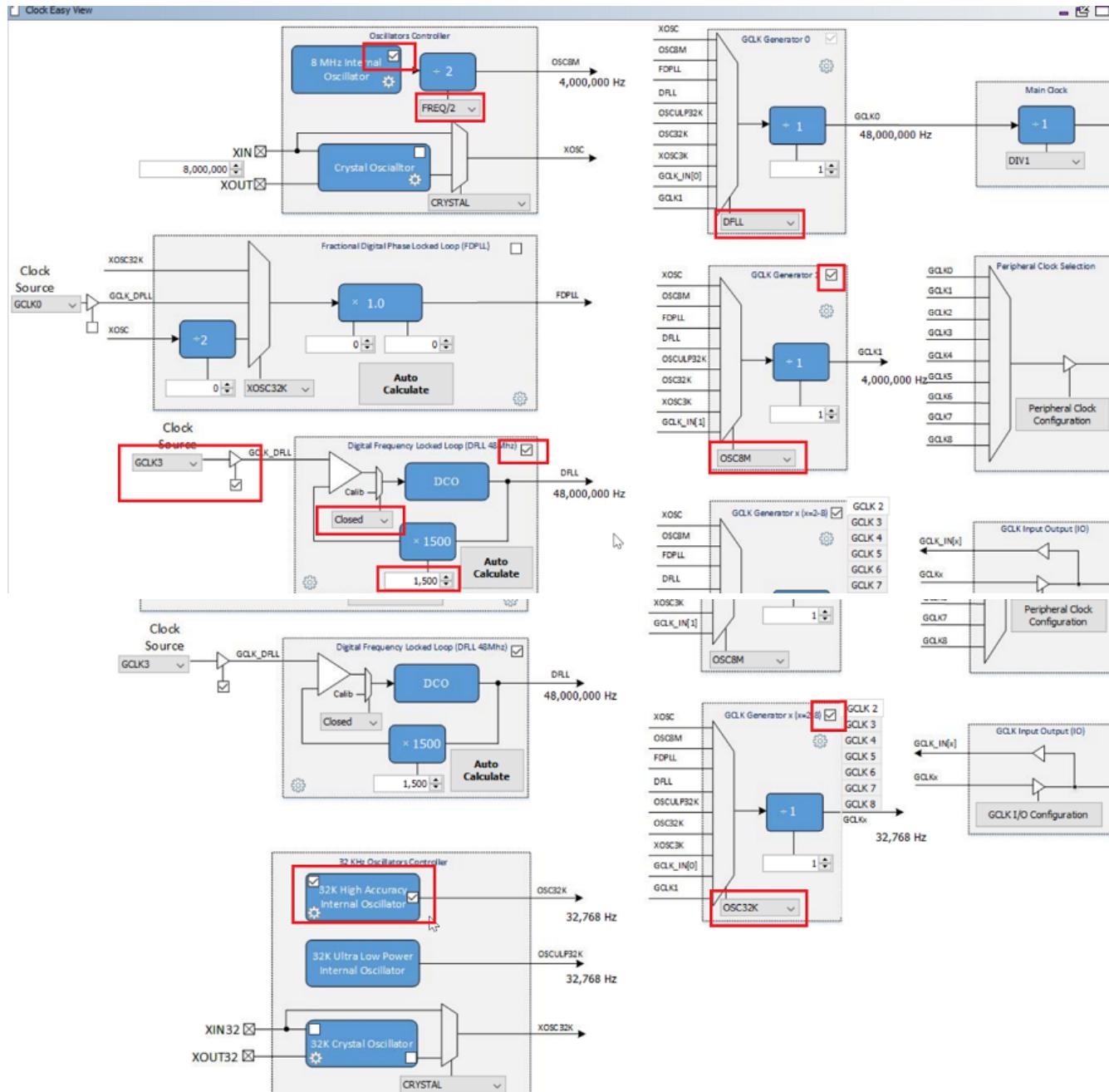
- NVMCTRL Read Mode**
- Wait States** (Selected): NO MISS PENALTY (Value: 4), WAKEUP ON ACCESS, MANUAL
- Power Reduction Mode During Sleep
- Write Policy
- Enable Instruction Cache?
- Enable Interrupt?

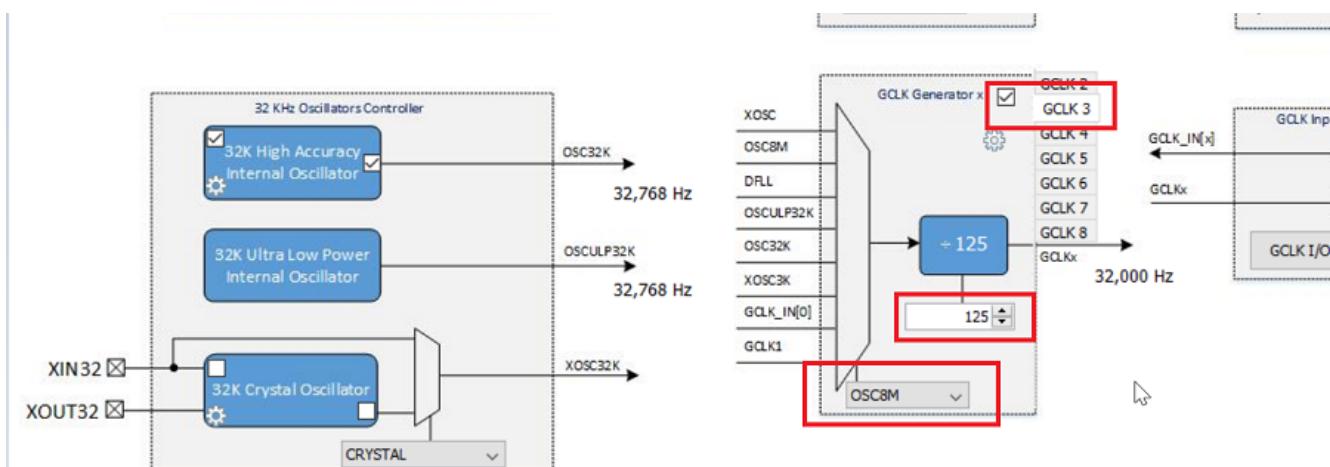
## Clock Configuration SAMD21

This topic describes brief overview of SAMD21 Clock configuration and the associated contents.

### Description

#### Clock Configuration for SAMD21 device:



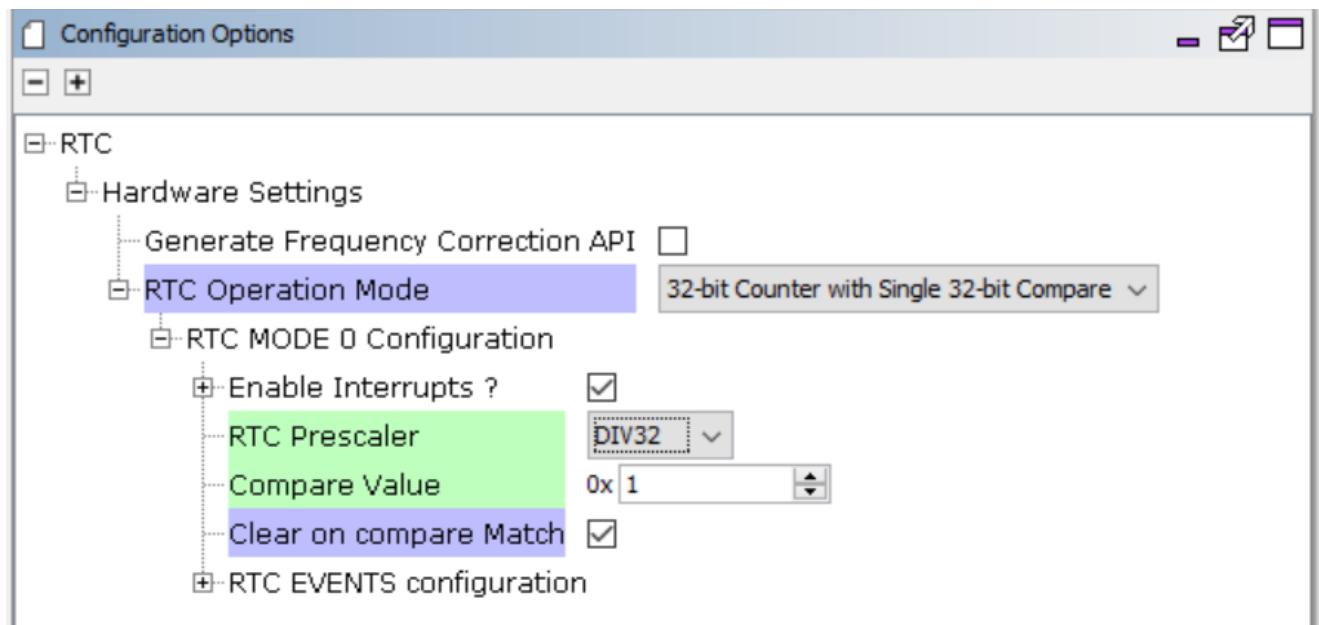


## Peripheral Clock Configuration

Peripheral	Enable	Source	Peripheral Clock Frequency
I2S_1	<input type="checkbox"/>	GCLK0	--
PTC	<input checked="" type="checkbox"/>	GCLK1	4,000,000 Hz
RTC	<input checked="" type="checkbox"/>	GCLK2	32,768 Hz
SERCOM0_CORE	<input type="checkbox"/>	GCLK0	--
SERCOM0_SLOW, SE...	<input type="checkbox"/>	GCLK0	--
SERCOM1_CORE	<input type="checkbox"/>	GCLK0	--
SERCOM2_CORE	<input type="checkbox"/>	GCLK0	--
SERCOM3_CORE	<input checked="" type="checkbox"/>	GCLK0	48,000,000 Hz
SERCOM4_CORE	<input type="checkbox"/>	GCLK0	--
SERCOM5_CORE	<input type="checkbox"/>	GCLK0	--
SYSCTRL_DFLL48	<input checked="" type="checkbox"/>	GCLK3	32,000 Hz
SYSCTRL_FDPLL	<input type="checkbox"/>	GCLK0	--

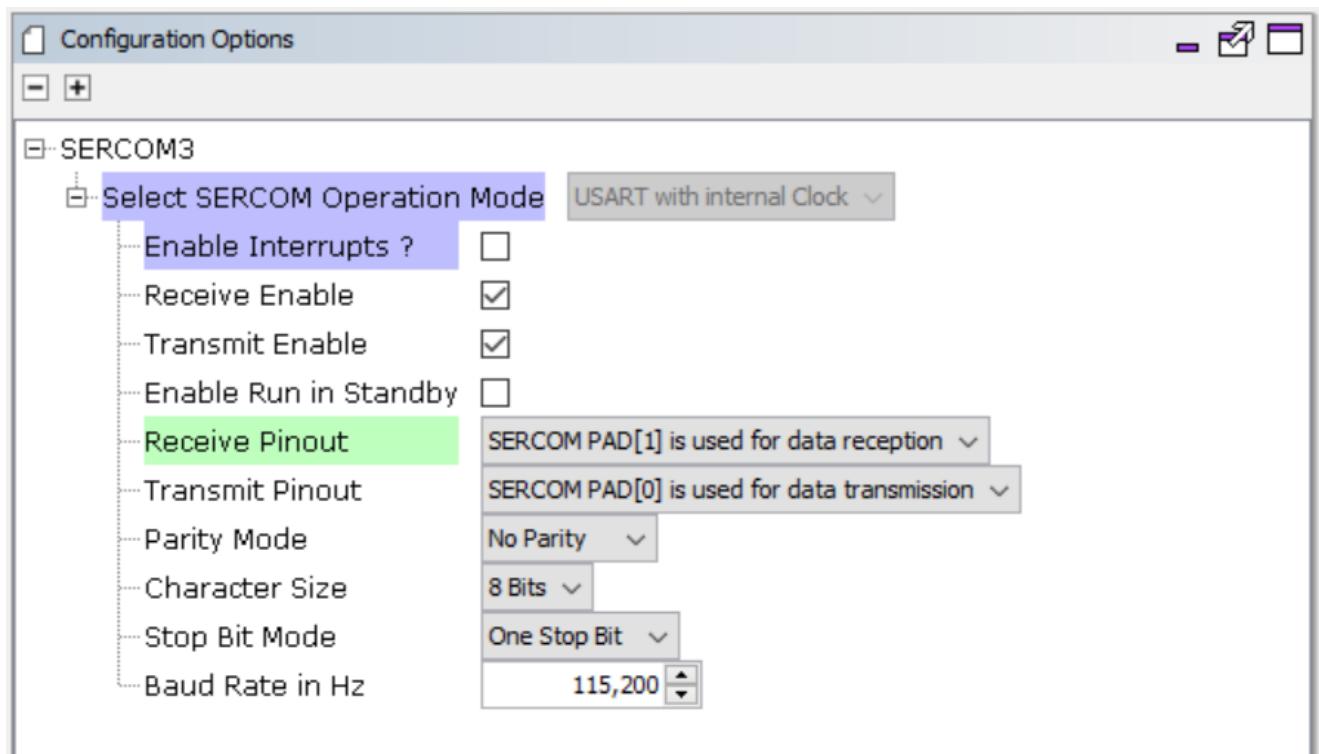
Close

## RTC Configuration:

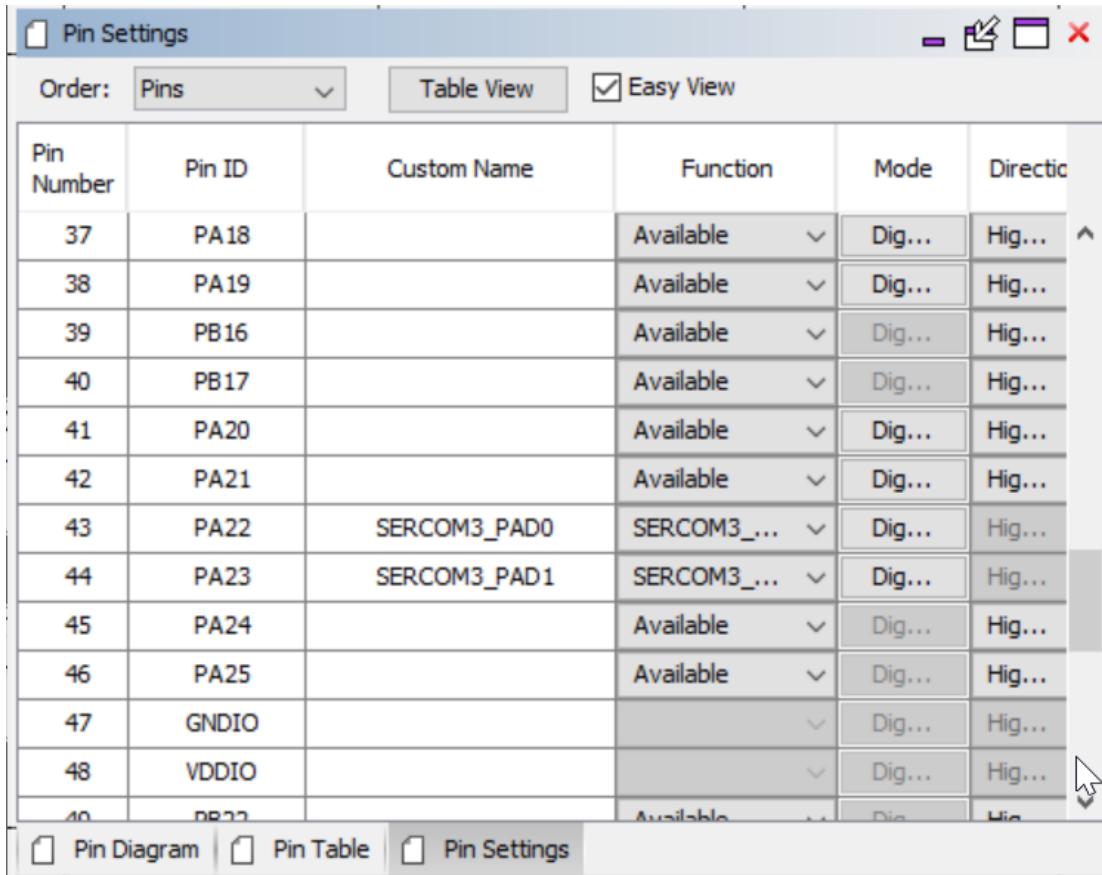


## SERCOM Configuration:

Note: This configuration is for the Xplained Pro boards. You can choose the SERCOM as per the board design.



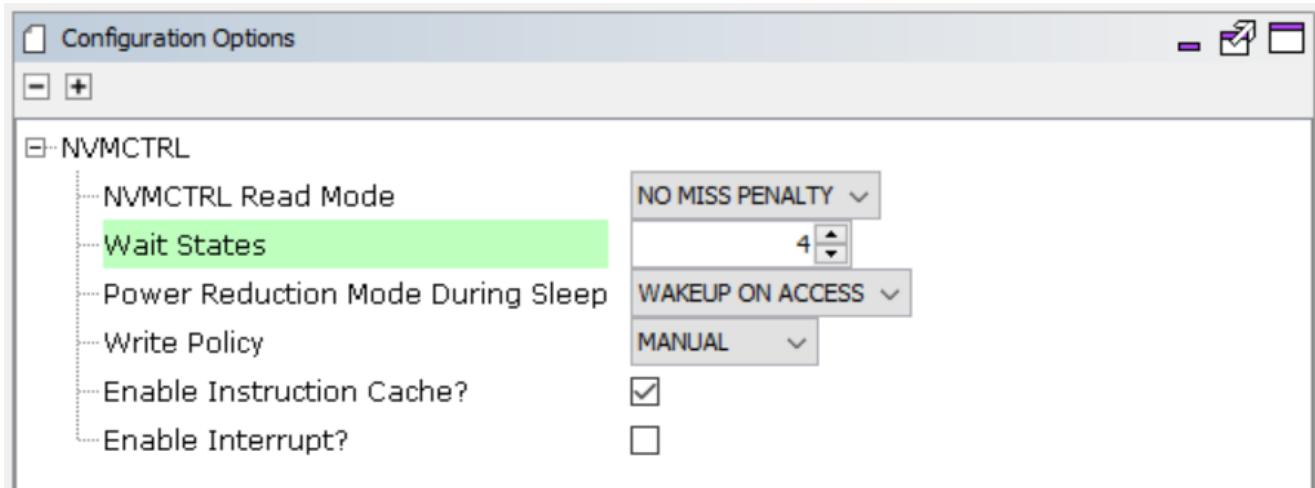
## Pin configuration:



The screenshot shows the Pin Settings dialog with the following configuration for pins PA18 through PA27:

Pin Number	Pin ID	Custom Name	Function	Mode	Direction
37	PA18		Available	Digital	High
38	PA19		Available	Digital	High
39	PB16		Available	Digital	High
40	PB17		Available	Digital	High
41	PA20		Available	Digital	High
42	PA21		Available	Digital	High
43	PA22	SERCOM3_PAD0	SERCOM3...	Digital	High
44	PA23	SERCOM3_PAD1	SERCOM3...	Digital	High
45	PA24		Available	Digital	High
46	PA25		Available	Digital	High
47	GNDIO			Digital	High
48	VDDIO			Digital	High
49	PE22		Available	Digital	High

## NVMCTRL Configuration:



The screenshot shows the Configuration Options dialog with the following NVMCTRL settings:

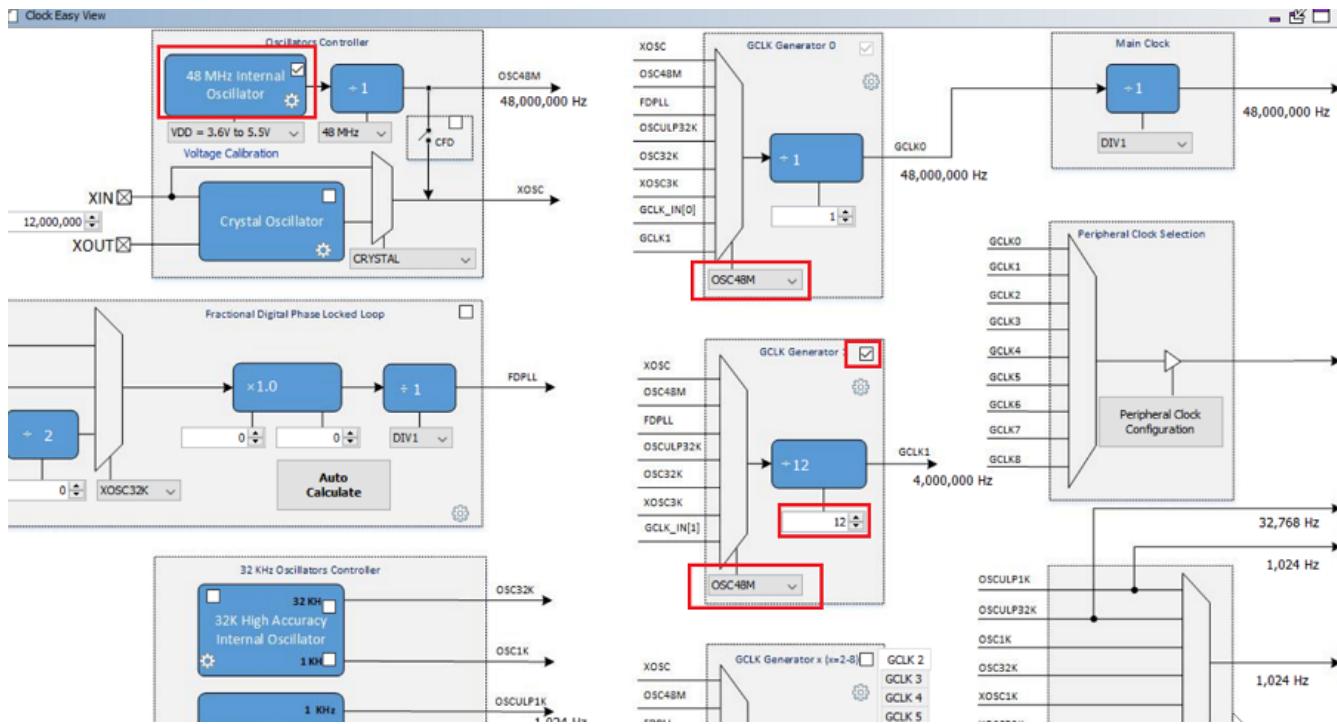
- NVMCTRL Read Mode:**
  - Wait States: 4 (highlighted in green)
  - Power Reduction Mode During Sleep
  - Write Policy
  - Enable Instruction Cache? (checked)
  - Enable Interrupt? (unchecked)

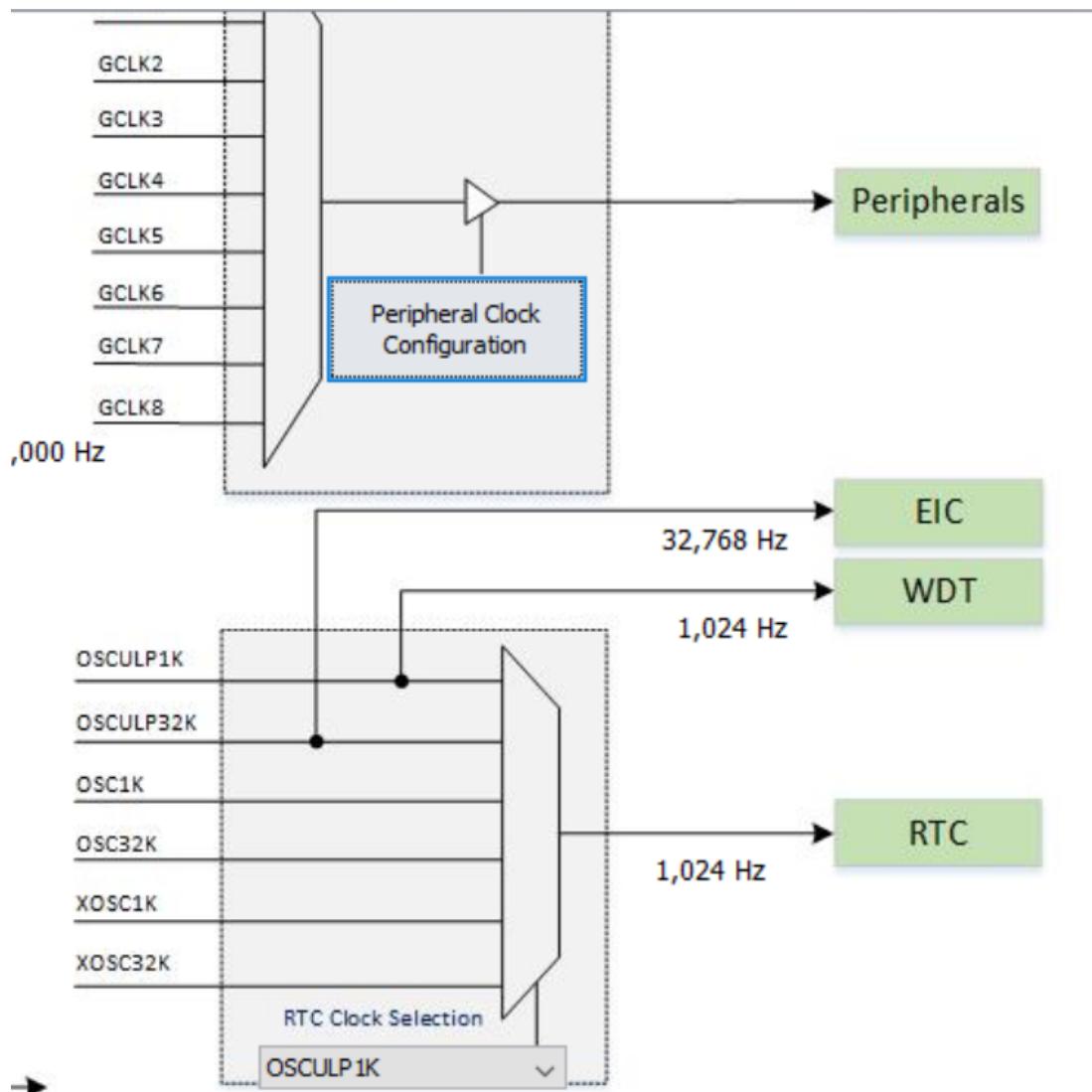
## Clock\_Configuration\_SAMC20\_SAMC21

This topic describes brief overview of SAMC20, SAMC21 Clock configuration and the associated contents.

### Description

## Clock Configuration for SAMC20, SAMC21 device:





## Peripheral Clock Configuration



Peripheral	Enable	Source	Peripheral Clock Frequency
OSCCTRL_FDPLL32K	<input type="checkbox"/>	GCLK0	--
PTC	<input checked="" type="checkbox"/>	GCLK1	4,000,000 Hz
SDADC	<input type="checkbox"/>	GCLK0	--
SERCOM0_CORE	<input type="checkbox"/>	GCLK0	--
SERCOM0_SLOW, SE...	<input type="checkbox"/>	GCLK0	--
SERCOM1_CORE	<input type="checkbox"/>	GCLK0	--
SERCOM2_CORE	<input type="checkbox"/>	GCLK0	--
SERCOM3_CORE	<input type="checkbox"/>	GCLK0	--
SERCOM4_CORE	<input checked="" type="checkbox"/>	GCLK0	48,000,000 Hz
SERCOM5_CORE	<input type="checkbox"/>	GCLK0	--
SERCOM5_SLOW	<input type="checkbox"/>	GCLK0	--
TC0, TC1	<input type="checkbox"/>	GCLK0	--

## SERCOM Configuration:

Note: This configuration is for the Xplained Pro boards. You can choose the SERCOM as per the board design.

The screenshot shows the configuration options for SERCOM4. Under "Select SERCOM Operation Mode", the dropdown is set to "USART with internal Clock". The "Receive Pinout" and "Transmit Pinout" fields are highlighted in green, indicating they are being configured. The "Receive Pinout" dropdown shows "SERCOM PAD[3] is used for data reception" and the "Transmit Pinout" dropdown shows "SERCOM PAD[2] is used for data transmission". Other settings include "Enable Interrupts ?" (unchecked), "Receive Enable" (checked), "Transmit Enable" (checked), "Enable Run in Standby" (unchecked), "Parity Mode" (set to "No Parity"), "Character Size" (set to "8 Bits"), "Stop Bit Mode" (set to "One Stop Bit"), and "Baud Rate in Hz" (set to "115,200").

## Pin configuration:

Pin Settings

Order: Pins Table View  Easy View

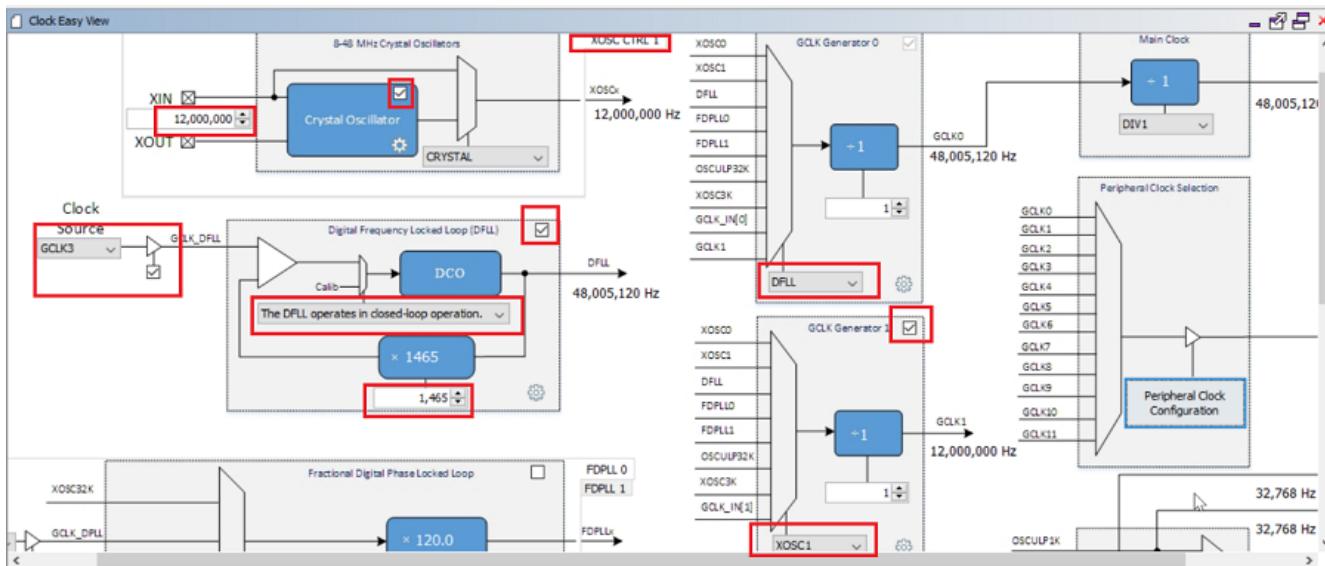
Pin Number	Pin ID	Custom Name	Function	Mode	Direction
19	PA10		Available	Dig...	Hig...
20	PA11		Available	Dig...	Hig...
21	VDDIO			Dig...	Hig...
22	GNDIO			Dig...	Hig...
23	PB10	SERCOM4_PAD2	SERCOM4_...	Dig...	Hig...
24	PB11	SERCOM4_PAD3	SERCOM4_...	Dig...	Hig...
25	PB12	LED_SLIDER2	GPIO	Dig...	Out
26	PB13	LED_SLIDER3	GPIO	Dig...	Out
27	PB14		Available	Dig...	Hig...
28	PB15		Available	Dig...	Hig...
29	PA12		Available	Dig...	Hig...
30	PA13		Available	Dig...	Hig...
31	PA14		Available	Dig...	Hig...

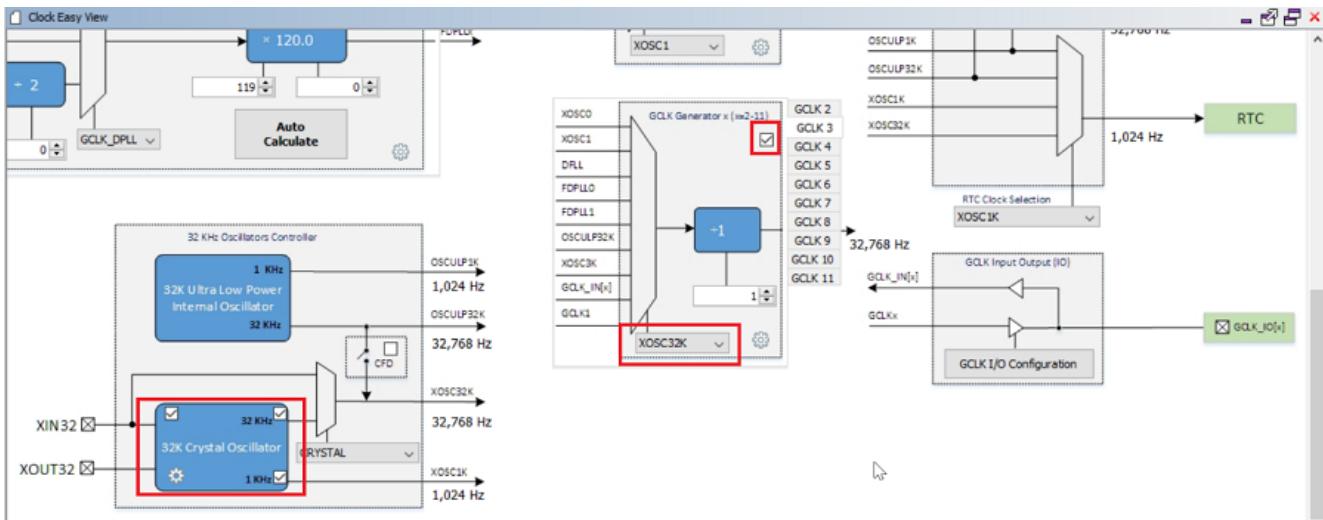
## Clock Configuration\_SAME54\_SAME53\_SAME51\_SAMD51

This topic describes brief overview of SAME54, SAME53, SAME51 and SAMD51 Clock configuration and the associated contents.

### Description

#### Clock Configuration for SAME54, SAME53, SAME51, SAMD51 devices:





Main clock can be sourced from FDPLL also.

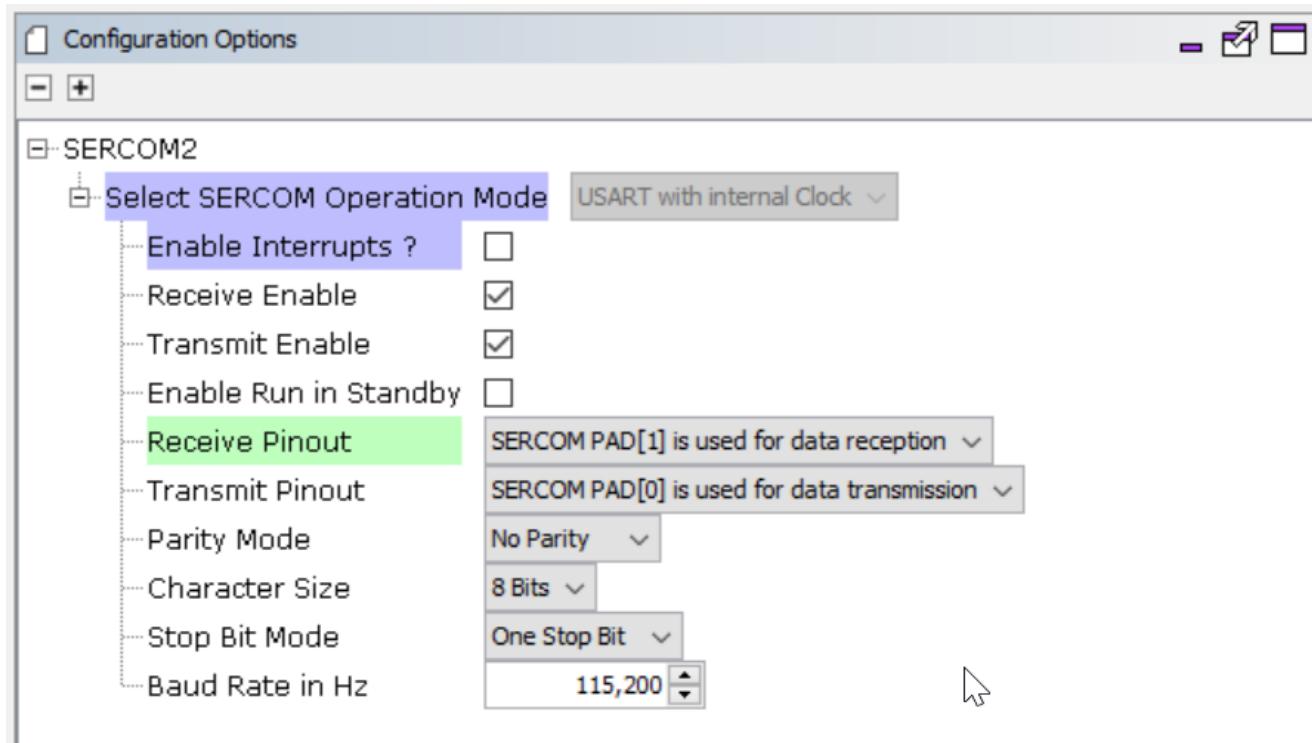
#### Peripheral Clock Configuration

Peripheral	Enable	Source	Peripheral Clock Frequency
AC	<input type="checkbox"/>	GCLK1	--
ADC0	<input checked="" type="checkbox"/>	GCLK1	12,000,000 Hz
ADC1	<input type="checkbox"/>	GCLK1	--
CAN0	<input type="checkbox"/>	GCLK1	--
CAN1	<input type="checkbox"/>	GCLK1	--
CCL	<input type="checkbox"/>	GCLK1	--
DAC	<input type="checkbox"/>	GCLK1	--
EIC	<input type="checkbox"/>	GCLK1	--
EVSYS_0	<input type="checkbox"/>	GCLK1	--
EVSYS_1	<input type="checkbox"/>	GCLK1	--
EVSYS_10	<input type="checkbox"/>	GCLK1	--
EVSYS_11	<input type="checkbox"/>	GCLK1	--

**Close**

#### SERCOM Configuration:

Note: This configuration is for the Xplained Pro boards. You can choose the SERCOM as per the board design.



### Pin Configuration:

Pin Settings					
Order: Pins		Table View	Easy View		
Pin Number	Pin ID	Custom Name	Function	Mode	Direction
94	PA24		Available	Dig...	Hig...
95	PA25		Available	Dig...	Hig...
96	GND			Dig...	Hig...
97	VDDIO			Dig...	Hig...
98	PB22		Available	Dig...	Hig...
99	PB23		Available	Dig...	Hig...
100	PB24	SERCOM2_PAD1	SERCOM2_...	Dig...	In/...
101	PB25	SERCOM2_PAD0	SERCOM2_...	Dig...	Hig...
102	PB26	LED_SLIDER7	GPIO	Dig...	Out
103	PB27	LED_SLIDER5	GPIO	Dig...	Out
104	PB28	LED_SLIDER4	GPIO	Dig...	Out
105	PB29	LED_SLIDER6	GPIO	Dig...	Out
106	CND			Dig...	Hig...

**NVMCTRL Configuration:**

The screenshot shows a configuration dialog titled "Configuration Options". The "NVMCTRL" section is expanded, displaying the following options:

- Enable Automatic Read-Wait-State for Flash
- Power Reduction Mode During Sleep
- Wait States
- Disable NVM Line Cache for AHBO
- Disable NVM Line Cache for AHB1
- Enable Interrupt

At the bottom left of the configuration window, there is a button labeled "+ SmartEEPROM Configurations".

# Touch Driver Applications

This section provides help for the Touch applications available in MPLAB Harmony 3.

## qt1\_selfcap\_xpro\_board

SelfCap Example with QT1 Extension board

### Description

This example demonstrates the basic touch application where the touch sensors are measured and the touch status is indicated using LED on the QT1 extension board. The touch library parameters are also displayed in the data visualizer software when the hardware kit is connected through edbg/medbg virtual com port.

## Building The Application

This section provides information on how to build an application using the MPLAB X IDE.

### Description

The parent folder for all the MPLAB X projects for this application is given below:

Application Path	\touch\apps\qt1_selfcap_xpro_board\firmware
------------------	---

To build the application, refer the following table and open the appropriate project file in the MPLAB X IDE.

Project Name	Description
sam_c21_xpro.X	SAM C21 Xplained Pro Evaluation Kit
sam_d20_xpro.X	SAMD20 Xplainedpro kit
sam_d21_xpro.X	SAMD21 Xplainedpro kit

## MPLAB Harmony Configurations

This section provides information on the MHC configurations.

### Description

Refer to the MHC project graph for the components used and the respective configuration options.

## Hardware Setup

This section describes how to configure the supported hardware.

### Description

1. Project **sam\_c21\_xpro.X**.
  - **Hardware Used**
    - SAMC21 Xplained Pro Evaluation kit
    - QT1 Xplained Pro Extension kit
  - **Hardware Setup**
    - Connect QT1 Xplained Pro to SAM C21 Xplained Pro Kit
    - Connect the Debug USB port on the board to the computer using a micro USB cable
2. Project **sam\_d20\_xpro.X**.
  - **Hardware Used**
    - SAMD20 Xplained Pro Evaluation kit

- QT1 Xplained Pro Extension kit
- **Hardware Setup**
  - Connect QT1 Xplained Pro to SAM D20 Xplained Pro Kit
  - Connect the Debug USB port on the board to the computer using a micro USB cable

### 3. Project sam\_d21\_xpro.X

- **Hardware Used**
  - SAMD21 Xplained Pro Evaluation kit
  - QT1 Xplained Pro Extension kit
- **Hardware Setup**
  - Connect QT1 Xplained Pro to SAM D21 Xplained Pro Kit
  - Connect the Debug USB port on the board to the computer using a micro USB cable

## Running The Application

This section provides information on how to run an application using the MPLAB X IDE.

### Description

1. Build and Program the application using the MPLAB X IDE.
2. The Button LEDs turns ON when touch made on the respective buttons
3. Open Atmel Data Visualizer software and set the config path to folder that contains th datastreamer scripts
  - **Scripts Folder:** `\touch\apps\qt1_selfcap_xpro_board\firmware\src\config\sam_xxx_xpro\touch\datastreamer`
4. Open serial port connection and connect to the target. Verify the connection is made successfully and the buttons touch status are displayed on the dashboard.
  - For more information, see the [microchip developer page](#).



## qt1\_mutualcap\_xpro\_board

MutualCap Example with QT1 Extension board.

### Description

This example demonstrates the basic touch application where the touch sensors are measured and the touch status is indicated using LED on the QT1 extention board. The touch library parameters are also displayed in the data visualizer software when the hardware kit is connected through edbg/medbg vritual com port.

## Building The Application

This section provides information on how to build an application using the MPLAB X IDE.

### Description

The parent folder for all the MPLAB X projects for this application is given below:

Application Path	\touch\apps\qt1_mutualcap_xpro_board\firmware
------------------	---

To build the application, refer the following table and open the appropriate project file in the MPLAB X IDE.

Project Name	Description
sam_c21_xpro.X	SAM C21 Xplained Pro Evaluation Kit
sam_d20_xpro.X	SAMD20 Xplainedpro kit
sam_d21_xpro.X	SAMD21 Xplainedpro kit
sam_e54_xpro.X	SAM E54 Xplained Pro Evaluation Kit

## MPLAB Harmony Configurations

This section provides information on the MHC configurations.

### Description

Refer to the MHC project graph for the component used and the respective configuration options.

## Hardware Setup

This section describes how to configure the supported hardware.

### Description

#### 1. Project sam\_c21\_xpro.X.

- **Hardware Used**
  - SAMC21 Xplained Pro Evaluation kit
  - QT1 Xplained Pro Extension kit
- **Hardware Setup**
  - Connect QT1 Xplained Pro to SAM C21 Xplained Pro Kit
  - Connect the Debug USB port on the board to the computer using a micro USB cable

#### 2. Project sam\_d20\_xpro.X.

- **Hardware Used**
  - SAMD20 Xplained Pro Evaluation kit
  - QT1 Xplained Pro Extension kit
- **Hardware Setup**
  - Connect QT1 Xplained Pro to SAM D20 Xplained Pro Kit
  - Connect the Debug USB port on the board to the computer using a micro USB cable

#### 3. Project sam\_d21\_xpro.X

- **Hardware Used**
  - SAMD21 Xplained Pro Evaluation kit
  - QT1 Xplained Pro Extension kit
- **Hardware Setup**
  - Connect QT1 Xplained Pro to SAM D21 Xplained Pro Kit

- Connect the Debug USB port on the board to the computer using a micro USB cable

#### 4. Project sam\_e54\_xpro.X

- **Hardware Used**
  - SAME54 Xplained Pro Evaluation kit
  - QT1 Xplained Pro Extension kit
- **Hardware Setup**
  - Connect QT1 Xplained Pro to SAM E54 Xplained Pro Kit
  - Connect the Debug USB port on the board to the computer using a micro USB cable

## Running The Application

This section provides information on how to run an application using the MPLAB X IDE.

### Description

1. Build and Program the application using the MPLAB X IDE.
2. The Button LEDs turns ON when touch made on the respective buttons
3. Open Atmel Data Visualizer software and set the config path to folder that contains th datastreamer scripts
  - **Scripts Folder:** [touch\apps\qt1\\_mutualcap\\_xpro\\_board\firmware\src\config\sam\\_xxx\\_xpro\touch\datastreamer](#)
4. Open serial port connection and connect to the target. Verify the connection is made successfully and the buttons touch status are displayed on the dashboard.
- For more information, see the [microchip developer page](#).



## on\_board\_sensor

SelfCap Example with the on-board sensor present in the Xplained Pro board.

### Description

This example demonstrates the basic touch application where the touch sensors are measured and the touch status is indicated using LED on the Xpro board. The touch library parameters are also displayed in the data visualizer software when the hardware kit is connected through edbg/medbg virtual com port.

## Building The Application

This section provides information on how to build an application using the MPLAB X IDE.

### Description

The parent folder for all the MPLAB X projects for this application is given below:

Application Path	\touch\apps\on-board_sensor\firmware
------------------	--------------------------------------

To build the application, refer the following table and open the appropriate project file in the MPLAB X IDE.

Project Name	Description
sam_e54_xpro.X	SAME54 Xplainedpro kit

## MPLAB Harmony Configurations

This section provides information on the MHC configurations.

### Description

Refer to the MHC project graph for the component used and the respective configuration options.

## Hardware Setup

This section describes how to configure the supported hardware.

### Description

#### 1. Project sam\_e54\_xpro.X.

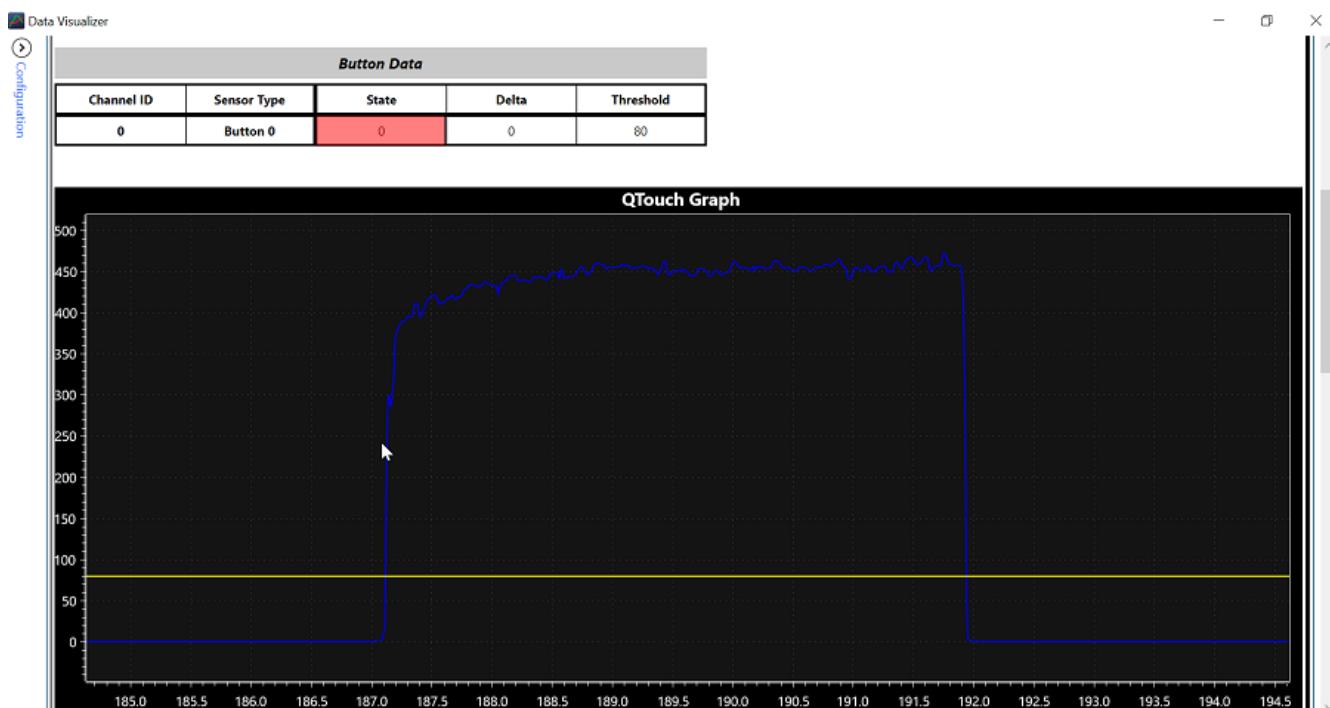
- **Hardware Used**
  - SAME54 Xplained Pro Evaluation kit
- **Hardware Setup**
  - Connect the Debug USB port on the SAM E54 Xplained Pro Kit board to the computer using a micro USB cable

## Running The Application

This section provides information on how to run an application using the MPLAB X IDE.

### Description

1. Build and Program the application using the MPLAB X IDE.
2. The LED on the XPro turns ON when touch is made on the respective on-board button
3. Open Atmel Data Visualizer software and set the config path to folder that contains th datastreamer scripts
  - **Scripts Folder:** \touch\apps\on-board\_sensor\firmware\src\config\sam\_e54\_xpro\touch\datastreamer
4. Open serial port connection and connect to the target. Verify the connection is made successfully and the buttons touch status are displayed on the dashboard.
  - For more information, see the [microchip developer page](#).



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