Migration from PIC12F to PIC16F15244 Microcontroller Family

Introduction

This document acts as a guide to assist users in converting the existing designs based on the PIC12F family of microcontrollers to the PIC16F15244 family.

This migration guide discusses I/O pin compatibility, device package compatibility, feature comparison, changes to electrical characteristics, differences in memory size and code compatibility between the PIC12F family and PIC16F15244 family of microcontrollers. Additionally, it highlights the PIC16F15244 family, functional changes to peripherals and feature enhancements.

This document is applicable to PIC12F and PIC16F15244 families. However, the content of this document focuses on PIC12F1572 microcontroller from the PIC12F family and the PIC16F15213 microcontroller from the PIC16F15244 family, which are equipped with 3.5 KB Flash, 256 bytes SRAM and are available in 8-pin packages.

The source code generated for the PIC12F family of microcontrollers is not fully compatible with the PIC16F15244 family and requires changes to the source code for migration. The migrated source code must be fully tested for the intended behavior of the target application. Sections 8. Register Mapping and 14. Firmware Migration from PIC12F1572 to PIC16F15213 explain the required changes to the source code while migrating.

The migration from the PIC12F family to the PIC16F15244 family provides enhanced features in the same compact footprint and flexibility while scaling up the microcontroller with more memory. The migration can fulfill higher product requirements, extra demands on memory size, or an increased number of I/Os and peripherals.

Microchip also offers a quick start guide and code examples to get started with the PIC16F15244 family.

For additional information regarding the PIC16F15244 microcontroller family, refer to the respective device data sheet.

Features

This document features the following content:

- Overview of feature comparison between PIC12F and PIC16F15244 microcontroller families
- Enhanced features of PIC16F15244 microcontroller family
- Firmware compatibility and migration from PIC12F1572 to PIC16F15213
- Microchip development tools ecosystem for the PIC16F15244 microcontroller family

Table of Contents

1. Relevant Devices

This section lists the relevant devices for this document. Figure 1-1 and Figure 1-2 show the PIC12F and PIC16F15244 product family devices with different pin counts and Flash memory size.

Figure 1-1. Overview of PIC12F Family

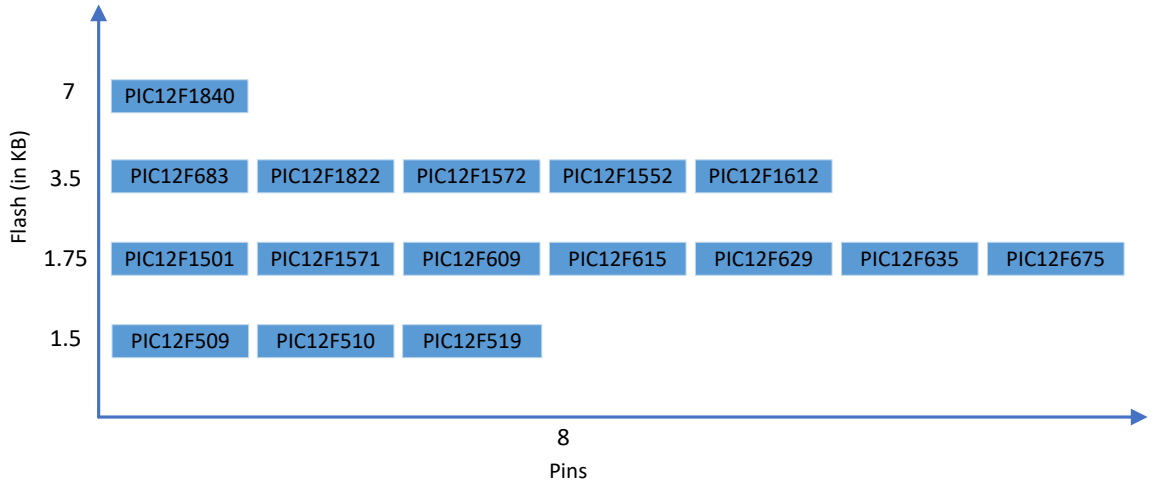
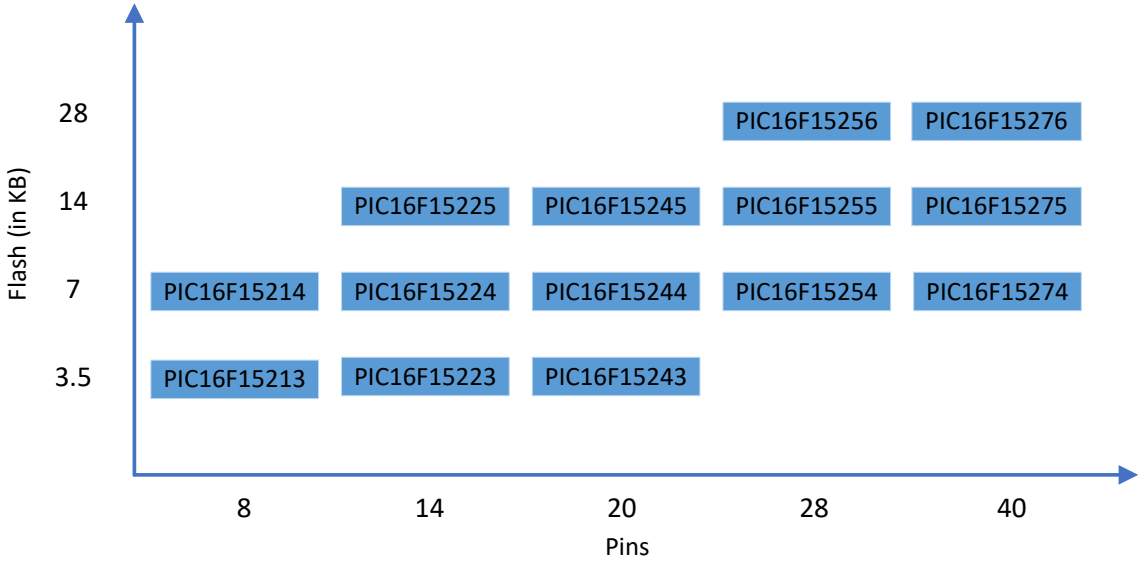


Figure 1-2. Overview of PIC16F15244 Family



2. General Migration Considerations

The general migration considerations are recommendations for users to migrate their applications from the PIC12F family to the PIC16F15244 family of microcontrollers. The following list summarizes the general considerations for a successful migration of an existing design based on the PIC12F family to the PIC16F15244 family.

- I/O pin compatibility
- Device package compatibility
- Peripheral features compatibility
- Peripheral registers compatibility
- Memory compatibility
- Electrical characteristics
- Development tools ecosystem availability

3. Device Package Compatibility

PIC16F15213/14 devices can act as a direct drop-in replacement for the 8-pin PIC12F family devices available in DFN and SOIC device packages. The existing designs based on PIC12F microcontrollers with DFN or SOIC device packages do not require any PCB layout changes when migrating to the PIC16F15244 family, whereas the existing designs using other device packages of the PIC12F family require PCB layout changes when migrating to the PIC16F15244 family.

Refer to Table 3-1 and Table 3-2 for detailed information about the different devices of PIC12F and PIC16F15244 families and their device package types.

Table 3-1. PIC12F Family Device Package Details

Devices	8-Pin MSOP	8-Pin DFN	8-Pin UDFN	8-Pin SOIC	8-Pin PDIP	8-Pin DFN-S
PIC12F1571	X	X	X	X	X	
PIC12F1501	X	X	X	X	X	
PIC12F1572	X	X	X	X	X	
PIC12F508	X	X		X	X	
PIC12F509	X	X		X	X	
PIC12F519	X	X		X	X	
PIC12(L)F1552	X		X	X	X	
PIC12F510	X	X		X	X	
PIC12F609	X	X		X	X	
PIC12F1612		X		X	X	
PIC12F615	X	X		X	X	
PIC12F617	X	X		X	X	
PIC12(F)HV752		X		X	X	
PIC12F629		X		X	X	X
PIC12HV615				X		
PIC12F1822		X	X	X	X	
PIC12F1840		X	X	X	X	
PIC12F675		X		X	X	X
PIC12F635		X		X	X	X
PIC12F683		X		X	X	X

Table 3-2. PIC16F15244 Family Device Package Details

Devices	8-Pin SOIC	8-Pin DFN	14-Pin TSSOP	14-Pin SOIC	16-Pin VQFN	20-Pin PDIP	20-Pin SSOP	20-Pin VQFN	28-Pin SOIC	28-Pin SSOP	28-Pin VQFN	40-Pin PDIP	40-Pin VQFN	40-Pin TQFP
PIC16F15213	X	X												
PIC16F15214	X	X												
PIC16F15223			X	X	X									
PIC16F15224			X	X	X									
PIC16F15225			X	X	X									
PIC16F15243						X	X	X						
PIC16F15244						X	X	X						
PIC16F15245						X	X	X						
PIC16F15254									X	X	X			
PIC16F15255									X	X	X			
PIC16F15256									X	X	X			
PIC16F15274												X	X	X
PIC16F15275												X	X	X
PIC16F15276												X	X	X

4. Pin Compatibility

Pin compatibility is one of the major considerations for migrating designs from the PIC12F family to the PIC16F15244 family.

The 8-pin PIC12F family and PIC16F15244 family of microcontrollers available in DFN and SOIC packages are pin-to-pin compatible but some of the associated functions/features are different for each of these families. Refer to section 5. Feature Comparison Between PIC12F1572 and PIC16F15213 for more details about the feature differences between PIC12F1572 and PIC16F15244 families.

The PIC16F15213 microcontroller peripherals can use different I/O pins for their operations, so it is important to properly configure the relevant I/O pins for a peripheral through the Peripheral Pin Select (PPS) module.

Refer to the pin allocation table of the respective device data sheet for more details about the alternative functions of the microcontroller I/O pins.

5. Feature Comparison Between PIC12F1572 and PIC16F15213

The basic feature comparison between PIC12F1572 and PIC16F15213 microcontrollers is summarized in Table 5-1.

Table 5-1. Feature Comparison Between PIC12F1572 and PIC16F15213 Microcontrollers

Peripheral/Module	PIC12F1572	PIC16F15213
Operating Voltage (V)	1.8–5.5	1.8–5.5
System Clock (MHz)	Up to 32	Up to 32
Comparator	1	0
10-bit ADC Channels	4	5
5-bit DAC	1	0
Fixed Voltage Reference (FVR)	Yes	Yes
8-bit Timers	2	1
16-bit Timers	4	2
8-bit Timer with HLT	0	1
EUSART	1	1
MSSP(Notes 1,2)	0	1
WDT	Yes	Yes
CCP	0	2
PWM(Note 3)	3	1
Power-Saving Operating Mode	Yes	Yes

Notes:

1. PIC12LF1552, PIC12F1822, and PIC12F1840 microcontrollers are equipped with one instance of MSSP peripheral.
2. The PIC16F15244 family microcontroller MSSP peripheral can be configured either in I^2C mode or SPI mode.
3. The PIC12F1572 microcontroller PWM module offers 16-bit resolution. The PIC16F15213 microcontroller CCP module can be configured in 10-bit PWM mode.
4. The PIC12F1612 microcontroller is equipped with one instance of ZCD peripheral.
5. The PIC12F1501 microcontroller is equipped with two instances of CLC peripheral.

6. Enhanced Features of PIC16F15213 Microcontrollers

The PIC16F15213 microcontroller offers enhancements in the features of oscillator, ADC and memory modules. The enhanced features are described below.

6.1 Oscillator Module

The PIC16F15213 microcontroller oscillator module can accept input from multiple internal and external sources. In addition, the frequency of the High-Frequency Internal Oscillator (HFINTOSC) frequency may also be adjusted and fine-tuned by the user.

6.2 ADC Module

The PIC16F15244 family of microcontrollers supports up to 28 input channels for the Analog-to-Digital Converter (ADC) module. The PIC16F15213 microcontroller ADC module offers five external input channels and allows the conversion of an analog input signal into a 10-bit binary representation of the digital signal.

The total ADC conversion time can be minimized by correctly configuring the ADC clock and system clock settings. The PIC16F15213 ADC peripheral clock also can be derived from the ADCRC or the system clock, which can be set in the range of 1-32 MHz.

6.3 Memory Features

The PIC16F15213 microcontroller offers built-in program and data memory with multiple enhanced features, such as Memory Access Partition (MAP), Programmable Code Protection and Write Protection, Device Information Area (DIA), Device Configuration Information (DCI) and Direct, Indirect, and Relative Addressing modes support.

6.3.1 Memory Access Partition (MAP)

The PIC16F15213 microcontroller user Flash is partitioned into:

- Application Block
- Boot Block
- Storage Area Flash (SAF) Block

The user can allocate the memory usage by setting the $\overline{\text{BBEN}}$ bit, selecting the size of the partition defined by the BBSIZE bits and enabling the Storage Area Flash by setting the $\overline{\text{SAFEN}}$ bit.

6.3.2 Programmable Code Protection and Write Protection

The PIC16F15213 microcontroller offers write protection for programmable code and memory. All the memory blocks have corresponding write protection bits. If write-protected locations are set from the NVMCON registers, the memory cannot be changed and the WRERR bit of the NVMCON1 register is set.

6.3.3 Device Information Area (DIA)

The Device Information Area of Flash memory in the PIC16F15213 microcontroller is a dedicated region. These locations are read-only and cannot be erased or modified. The DIA contains the Microchip Unique Identifier words and the Fixed Voltage Reference (FVR) readings.

6.3.4 Device Configuration Information (DCI)

The Device Configuration Information (DCI) is a dedicated region in the memory that holds information about the device, which is useful for programming and bootloader applications.

The data stored in this region is read-only and cannot be modified/erased. Refer to the respective PIC16F15213/14/23/24/43/44 Full-Featured 8/14/20-Pin Microcontrollers device data sheet for more details on DCI and its table addresses.

Note: The enhanced features discussed in this section are applicable to the other relevant microcontrollers of the PIC16F15244 family.

7. Features and Peripherals Available in PIC16F15213

This section highlights the unique features and peripherals available in the PIC16F15213 microcontroller.

7.1 8-Bit Timer (TMR2)

The PIC16F15213 microcontroller offers one instance of an 8-bit timer peripheral with Hardware Limit Timer (HLT) functionality. In Hardware Limit Timer mode, the counter is reset by either high or low levels of an external signal; the timer can be started or stopped based on the external signal trigger. HLT can operate in Monostable or One-Shot mode. Switch debouncing in hardware is an example of the usage of HLT functionality.

7.2 Host Synchronous Serial Port (MSSP)

The PIC16F15213 microcontroller offers one MSSP module. The MSSP module is a serial interface used for communicating with other host/client modules or microcontroller devices. The MSSP module can operate in either Serial Peripheral Interface (SPI) mode or Inter-Integrated Circuit (I^2C) mode.

7.3 Peripheral Pin Select (PPS)

The PIC16F15213 microcontroller is equipped with a Peripheral Pin Select (PPS) module, which allows the user to remap the assignment of peripheral inputs and outputs to the device I/O pins. Only digital signals are included in the selections.

7.4 Capture/Compare/PWM (CCP)

The PIC16F15213 microcontroller offers two instances of Capture/Compare/PWM module. The CCP module allows the user to capture and control different events and to generate Pulse-Width Modulation (PWM) signals.

Note: The peripherals discussed in this section are applicable to the other microcontrollers of the PIC16F15244 family. For more details about these peripherals, refer to the respective device data sheet.

8. Register Mapping

The basic functionality of the common peripherals available in both PIC12F1572 and PIC16F15213 microcontrollers is the same, but several modifications have been done in registers and bit naming conventions between the PIC12F1572 and PIC16F15213 microcontrollers. The bit locations in the registers are also changed considerably.

This section highlights the peripheral register and bit name changes between the PIC12F1572 and PIC16F15213 microcontrollers.

8.1 ADC Registers

Table 8-1 shows the ADC peripheral registers and bit name mapping between the PIC12F1572 and PIC16F15213 microcontrollers.

Table 8-1. ADC Peripheral Register Mapping Between PIC12F1572 and PIC16F15213

PIC12F1572	PIC16F15213	Description
ADCON0bits.ADON	ADCON0bits.ON	ADC Enable bit name change
ADCON0bits.CHS	ADCON0bits.CHS	Analog Channel Select (CHS) bits: In PIC12F1572, bits 2 to 6 of ADCON0 register designated for CHS[4:0]. In PIC16F15213, bits 2 to 7 of ADCON0 register are assigned to CHS[5:0].
ADCON1bits.ADPREF	ADCON1bits.PREF	ADC Positive Voltage Reference Configuration bit name change
ADCON1bits.ADCS	ADCON1bits.CS	ADC Conversion Clock Select bit name change
ADCON1bits.ADFM	ADCON1bits.FM	ADC Result Format selection bit name change
ADCON2	ADACT	ADC Auto-Conversion Trigger Source Selection register name change
ADCON2bits.TRIGSEL	ADACTbits.ACT	Auto-Conversion Trigger Source selection register and bit name change. In PIC12F1572, bits 4 to 7 of ADCON2 register are assigned to TRIGSEL[3:0]. In PIC16F15213, bits 0 to 3 of ADACT register are assigned to ACT[3:0].

8.2 Timer0 Registers

Table 8-2. Timer0 Peripheral Register Mapping Between PIC12F1572 and PIC16F15213

PIC12F1572	PIC16F15213	Description
OPTION_REGbits.PS	T0CON1bits.CKPS	Prescaler Rate Select bit register and bit name change. In PIC12F1572, bits 0 to 2 of OPTION_REG register are assigned to PS [2:0]. In PIC16F15213, bits 0 to 3 of T0CON1 register are assigned to CKPS [3:0].
OPTION_REGbits.TMR0CS	T0CON1bits.CS	Clock Selection bit register, and bit name change. In PIC12F1572, bit 5 of OPTION_REG register is assigned to TMR0CS. In PIC16F15213, bits 5 to 7 of T0CON1 register are assigned to CS [2:0].
OPTION_REGbits.TMR0CS	T0CON0bits.EN	Enable Timer0 register name and bit name change
TMR0	TMR0H and TMR0L	Timer0 Period/Count Hold register name change (PIC16F15213 Timer0 has both 8-bit and 16-bit Timer modes)

8.3 Timer1 With Gate Control Registers

Table 8-3. Timer1 Peripheral Register Mapping Between PIC12F1572 and PIC16F15213

PIC12F1572	PIC16F15213	Description
T1CONbits.TMR1ON	T1CONbits.ON	Timer1 Enable bit name change
T1CONbits.nT1SYNC	T1CONbits.nSYNC	Timer1 Synchronization Control bit name and position change. In PIC12F1572, bit 2 of T1CON register designated for $\overline{\text{T1SYNC}}$. In PIC16F15213, bit 2 of T1CON register designated for $\overline{\text{SYNC}}$.
T1CONbits.T1CKPS	T1CONbits.CKPS	Timer1 Input Clock Prescaler select bits name change.

.....continued		
PIC12F1572	**PIC16F15213**	**Description**
T1CONbits.TMR1CS	T1CLKbits.CS	Timer1 Clock Source Selection bit register and bit name change. In PIC12F1572, bits 6 to 7 of T1CON register designated for TMR1CS[1:0]. In PIC16F15213, bits 0 to 4 of T1CLK register designated for CS[4:0].
T1GCONbits.T1GSS	T1GATEbits.GSS	Timer 1 Gate Source Selection bit register and bit names change. In PIC12F1572, bits 0 to 1 of T1GCON register designated for T1GSS[1:0]. In PIC16F15213, bits 0 to 4 of T1GATE register designated for GSS[4:0].
T1GCONbits.T1GVAL	T1GCONbits.GVAL	Timer1 Gate Value Status bit name change
T1GCONbits.T1GGO_nDONE	T1GCONbits.GGO_nDONE	Timer1 Gate Single-Pulse Acquisition Status bit name change
T1GCONbits.T1GSPM	T1GCONbits.GSPM	Timer1 Gate Single-Pulse Mode bit name change
T1GCONbits.T1GTM	T1GCONbits.GTM	Timer1 Gate Toggle Mode bit name change
T1GCONbits.T1GPOL	T1GCONbits.GPOL	Timer1 Gate Polarity bit name change
T1GCONbits.TMR1GE	T1GCONbits.GE	Timer1 Gate Enable bit name change

8.4 Timer2 Registers

Table 8-4. Timer 2 Peripheral Register Mapping Between PIC12F1572 and PIC16F15213

PIC12F1572	PIC16F15213	Description
T2CONbits.T2CKPS	T2CONbits.CKPS	Timer2 Clock Prescaler selection bits name change. In PIC12F1572, bits 0 to 1 of T2CON register are assigned to T2CKPS[1:0]. In PIC16F15213, bits 0 to 2 of T2CON register are assigned to CKPS[2:0].

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PIC12F1572	**PIC16F15213**	**Description**
T2CONbits.TMR2ON	T2CONbits.ON	Timer2 On bit name change. In PIC12F1572, bit 2 of T2CON register is assigned to TMR2ON. In PIC16F15213, bit 7 of T2CON register is assigned to ON.
T2CONbits.T2OUTPS	T2CONbits.OUTPS	Timer2 Output Postscaler Selection bits name change. In PIC12F1572, bits 3 to 6 of T2CON register are assigned to T2OUTPS[3:0]. In PIC16F15213, bits 0 to 3 of T2CON register are assigned to OUTPS[3:0].

8.5 Enhanced Universal Synchronous Asynchronous Receiver Transmitter (EUSART) Registers

Table 8-5. EUSART Peripheral Register Mapping Between PIC12F1572 and PIC16F15213

PIC12F1572	PIC16F15213	Description
TXSTA	TX1STA	EUSART Transmit Status and Control register name change
RCSTA	RC1STA	EUSART Receive Status and Control register name change
BAUDCON	BAUD1CON	EUSART Baud Rate Control register name change
TXREG	TX1REG	EUSART Transmit Data register name change
RCREG	RC1REG	EUSART Receive Data register name change
SPBRGH	SP1BRGH	EUSART Baud Rate Generator Data Register High register name change
SPBRGL	SP1BRGL	EUSART Baud Rate Generator Data Register Low register name change

8.6 Pulse-Width Modulation (PWM) Registers

Table 8-6. PWM Peripheral Register Mapping Between PIC12F1572 and PIC16F15213

PIC12F1572	PIC16F15213	Description
PWM1CONbits.MODE	CCP1CONbits.MODE	PWM Control Bits register and bit name change. For PIC12F1572 the PWM1CONbits.MODE bits determine the PWM mode. For PIC16F15213 the CCP1CONbits.MODE bits determine whether to use CCP in Capture/ Compare or PWM mode.

8.7 Interrupt Registers

Table 8-7. Interrupt Module Register Mapping Between PIC12F1572 and PIC16F15213

PIC12F1572	PIC16F15213	Description
OPTION_REGbits.INTEDG	INTCONbits.INTEDG	External Interrupt Edge Selection register name and bit position change. In PIC12F1572, bit 6 of OPTION_REG register is assigned to INTEDG. In PIC16F15213, bit 0 of INTCON register is assigned to INTEDG.
INTCONbits.IOCIF	PIR0bits.IOCIF	Interrupt-On-Change Interrupt Flag bit register name and bit position change. In PIC12F1572, bit 0 of INTCON register is assigned to IOCIF. In PIC16F15213, bit 4 of PIR0 register is assigned to IOCIF.
INTCONbits.INTF	PIR0bits.INTF	External Interrupt Flag register name and bit position change. In PIC12F1572, bit 1 of INTCON register is assigned to INTF. In PIC16F15213, bit 0 of PIR0 register is assigned to INTF.
INTCONbits.TMR0IF	PIR0bits.TMR0IF	Timer0 Overflow Interrupt Flag register and bit position change. In PIC12F1572, bit 2 of INTCON register is assigned to TMR0IF. In PIC16F15213, bit 5 of PIR0 register is assigned to TMR0IF.

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PIC12F1572	PIC16F15213	Description
INTCONbits.IOCIE	PIE0bits.IOCIE	Interrupt-On-Change Enable bit register name and bit position change. In PIC12F1572, bit 3 of INTCON register is assigned to IOCIE. In PIC16F15213, bit 4 of PIE0 register is assigned to IOCIE.
INTCONbits.INTE	PIE0bits.INTE	INT External Interrupt Enable bit register name and bit position change. In PIC12F1572, bit 4 of INTCON register is assigned to INTE. In PIC16F15213, bit 0 of PIE0 register is assigned to INTE.
INTCONbits.TMR0IE	PIE0bits.TMR0IE	Timer0 Overflow Interrupt Enable bit register name change. In PIC12F1572, bit 5 of INTCON register is assigned to TMR0IE. In PIC16F15213, bit 5 of PIE0 register is assigned to TMR0IE.
PIE1bits.TMR1IE	PIE1bits.TMR1IE	Timer1 Overflow Interrupt Enable bit position change. In PIC12F1572, bit 0 of PIE1 register is assigned to TMR1IE. In PIC16F15213, bit 5 of PIE1 register is assigned to TMR1IE.
PIE1bits.TMR2IE	PIE1bits.TMR2IE	Timer2 Overflow Interrupt Enable bit position change. In PIC12F1572, bit 1 of PIE1 register is assigned to TMR2IE. In PIC16F15213, bit 6 of PIE1 register is assigned to TMR21E.
PIE1bits.TXIE	PIE1bits.TX1IE	USART Transmit Interrupt Enable bit name and position change. In PIC12F1572, bit 4 of PIE1 register is assigned to TXIE. In PIC16F15213, bit 3 of PIE1 register is assigned to TX1IE.

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PIC12F1572	PIC16F15213	Description
PIE1bits.RCIE	PIE1bits.RC1IE	USART Receive Interrupt Enable bit name and position change. In PIC12F1572, bit 5 of PIE1 register is assigned to RCIE. In PIC16F15213, bit 4 of PIE1 register is assigned to RC1IE.
PIE1bits.ADIE	PIE1bits.ADIE	ADC Interrupt Enable bit position change. In PIC12F1572, bit 6 of PIE1 register is assigned to ADIE. In PIC16F15213, bit 0 of PIE1 register is assigned to ADIE.
PIE1bits.TMR1GIE	PIE2bits.TMR1GIE	Timer1 Gate Interrupt Enable bit register name and bit position change. In PIC12F1572, bit 7 of PIE1 register is assigned to TMR1GIE. In PIC16F15213, bit 5 of PIE2 register is assigned to TMR1GIE.
PIR1bits.TMR1IF	PIR1bits.TMR1IF	Timer1 Overflow Interrupt Flag bit position change. In PIC12F1572, bit 0 of PIR1 register is assigned to TMR1IF. In PIC16F15213, bit 5 of PIR1 register is assigned to TMR1IF.
PIR1bits.TMR2IF	PIR1bits.TMR2IF	Timer2 Interrupt Flag bit position change. In PIC12F1572, bit 1 of PIR1 register is assigned to TMR2IF. In PIC16F15213, bit 6 of PIR1 register is assigned to TMR2IF.
PIR1bits.TXIF	PIR1bits.TX1IF	USART Receive Interrupt Flag bit name change. In PIC12F1572, bit 4 of PIR1 register is assigned to TXIF. In PIC16F15213, bit 3 of TX1IF register is assigned to TX1IF.
PIR1bits.RCIF	PIR1bits.RC1IF	USART Receive Interrupt Flag bit name change. In PIC12F1572, bit 5 of PIR1 register is assigned to RCIF. In PIC16F15213, bit 4 of PIR1 register is assigned to RC1IF.

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PIC12F1572	PIC16F15213	Description
PIR1bits.ADIF	PIR1bits.ADIF	ADC Interrupt Flag bit position change. In PIC12F1572, bit 6 of PIR1 register is assigned to ADIF. In PIC16F15213, bit 0 of PIR1 register is assigned to ADIF.
PIR1bits.TMR1GIF	PIR2bits.TMR1GIF	Timer1 Gate Interrupt Flag bit register name and position change. In PIC12F1572, bit 7 of PIR1 register is assigned to TMR1GIF. In PIC16F15213, bit 5 of PIR1 register is assigned to TMR1GIF.

9. Memories

The PIC12F family of microcontrollers offers up to 7 KB of Flash memory, up to 256 bytes of SRAM, and 256 bytes of on-chip High-Endurance Flash (HEF) memory. The PIC16F15244 family of microcontrollers offers up to 28 KB of Flash memory and up to 2 KB of SRAM.

Table 9-1. PIC12F and PIC16F15244 Family of Microcontrollers On-Chip Memory

Memory	PIC12F	PIC16F15244
Flash	Up to 7 KB	Up to 28 KB
SRAM	Up to 256 bytes	Up to 2 KB
HEF	Up to 256 bytes	—

Table 9-2 highlights a comparison of memory sizes between PIC12F1572 and PIC16F15213 microcontrollers.

Table 9-2. PIC12F1572 and PIC16F15213 Microcontrollers On-Chip Memory

Device	Program Memory Size (Words)	SRAM (Bytes)	High Endurance Flash (HEF) (Bytes)
PIC12(L)F1572	2048	256	128
PIC16F15213	2048	256	None

10. Power-Saving Operating Modes

Both PIC12F1572 and PIC16F15213 microcontrollers support Low-Power Sleep mode for designs to save power consumption. The PIC12LF1572 microcontroller uses eXtreme Low-Power (XLP) technology in its design to meet the low-power design requirements. The PIC16F15213 microcontroller does not use XLP technology.

The PIC16F15213 microcontroller can wake up from Sleep through multiple events and interrupts.

Table 10-1. PIC12F1572 and PIC16F15213 Microcontrollers Power-Down Current (IPD) Details

Device Characteristics	Typ. Current (µA) @ 3.0V V_{DD}		Max. Current (µA) @ +85°C, 3.0V V_{DD}		Max. Current (µA) @ +125°C, 3.0V V_{DD}		Note
	PIC16F15213	PIC12F1572	PIC16F15213	PIC12F1572	PIC16F15213	PIC12F1572	WDT, BOR and FVR disabled, all peripherals inactive, Low-Power Sleep mode. In PIC12F1572, VREGPM = 1.
I_{PD} Base	0.4	0.3	2.5	3	12	3.8	

Refer to the *"Electrical Specifications"* section of the respective device data sheet for more details about the power consumption of the devices in different power-down configurations.

11. Electrical Characteristics

The PIC16F15213 microcontroller is produced in a different process than the PIC12F1572 microcontroller and the electrical characteristics will thus differ between these devices.

Table 11-1. Changes in Electrical Characteristics Between PIC12F1572 and PIC16F15213

Parameters		PIC16F15213			PIC12F1572		
		Conditions		Ratings	Conditions		Ratings
Maximum Current							
VSS pin		-40°C ≤ T_A ≤ +85°C		300 mA	-40°C ≤ T_A ≤ +85°C		250 mA
		85°C ≤ T_A ≤ +125°C		120 mA	-40°C ≤ T_A ≤ +125°C		85 mA
VDD pin		-40°C ≤ T_A ≤ +85°C		250 mA	-40°C ≤ TA ≤ +85°C		250 mA
		85°C ≤ T_A ≤ +125°C		85 mA	-40°C ≤ T_A ≤ +125°C		85 mA
I/O Sink and Source Current							
Sink by any standard I/O pin		—		25 mA	—		50 mA
Source by any standard I/O pin		—		25 mA	—		50 mA
Low Power Mode Current							
Sleep Current		@ 3V/25°C	WDT Enabled	500 nA	@ 3V/25°C	WDT Enabled	600 nA
			WDT Disabled	400 nA		WDT Disabled	300 nA
ADC Conversion Timing Specifications							
Characteristics	**Conditions**	**Min.**	**Typ.**	**Max.**	**Min.**	**Typ.**	**Max.**
ADC Clock Period (T_{ADC})	F_{OSC} Clock Source	0.5 µs	—	9.0 µs	1.0 µs	—	6.0 µs
Conversion Time (T_{CNV})	Set GO bit to conversion complete	—	11.0 T_{AD}	—	—	11.0 T_{AD}	—
Acquisition Time		—	2.0 µs	—	—	5.0 µs	—

Note: Refer to the latest revision of the respective device data sheet for more details on the electrical characteristics.

12. Development Tools and Software

Microchip offers a broad ecosystem of development tools for ease of application development. Designers can choose the desired hardware development boards, emulators, programmers, and debugger tools for application development using the PIC16F15244 family microcontroller.

12.1 Evaluation Boards

- PIC16F15244 Curiosity Nano Evaluation Kit (EV09Z19A)
- PIC16F15276 Curiosity Nano Evaluation Kit (EV35F40A)
- Curiosity Low Pin Count Nano Base for Click Boards™ (AC164162)

12.2 Programmers and Debuggers

- MPLAB® PICkit™ 4 In-Circuit Debugger (PG164140)
- MPLAB ICD 4 In-Circuit Debugger (DV164045)
- MPLAB Snap In-Circuit Debugger (PG164100)

12.3 Software Tools

The Microchip Software Development Ecosystem for the PIC16F15244 family consists of an Integrated Development Environment (IDE), Compilers and Code Configurator.

IDE

- MPLAB® X IDE

Compilers

- MPLAB XC8 Compiler

Code Configurator

- MPLAB Code Configurator (MCC)

For more detailed information about the available development ecosystem for the PIC16F15244 family of microcontrollers, refer to the PIC16F15244 Quick Start Guide.

13. Firmware Compatibility

The firmware generated for the PIC12F1572 microcontroller is not directly compatible with the PIC16F15213 microcontroller. The user must perform a few changes to the source code to build the code successfully for the PIC16F15213 microcontroller.

Refer to section 14. Firmware Migration from PIC12F1572 to PIC16F15213 for detailed guidelines to migrate PIC12F1572 microcontroller firmware to the PIC16F15213 microcontroller.

14. Firmware Migration from PIC12F1572 to PIC16F15213

This section explains details on the necessary configuration changes that need to be performed to successfully migrate PIC12F1572 source code to the PIC16F15213 microcontroller. The existing PIC12F1572 microcontroller-based code example is used for explaining this process. The example consists of toggling the LED when a timer overflow interrupt occurs, which is implemented using an I/O line and a timer peripheral.

The code project for the PIC12F1572 is available through GitHub:

Blink LED with Timer and Interrupt using PIC12F1572
Click to browse repositories

The code can be downloaded as a .zip file or can be cloned as a Git repository.

When completed, the migrated code project will be functionally identical to the code in this GitHub project:

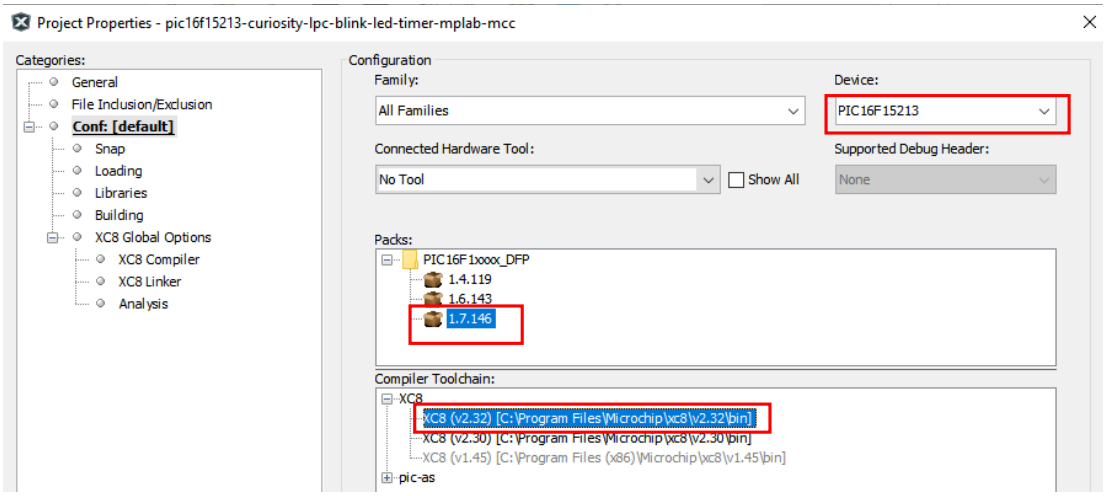
Blink LED with Timer and Interrupt using PIC16F15213
Click to browse repositories

To successfully migrate the project to PIC16F15213 microcontroller, follow the steps listed below.

1. Modify the following device parameters of the PIC12F1572 project from the Configuration section of the Project Properties window, as shown in Figure 14-1.
   - Device
   - Packs
   - Compiler Toolchain

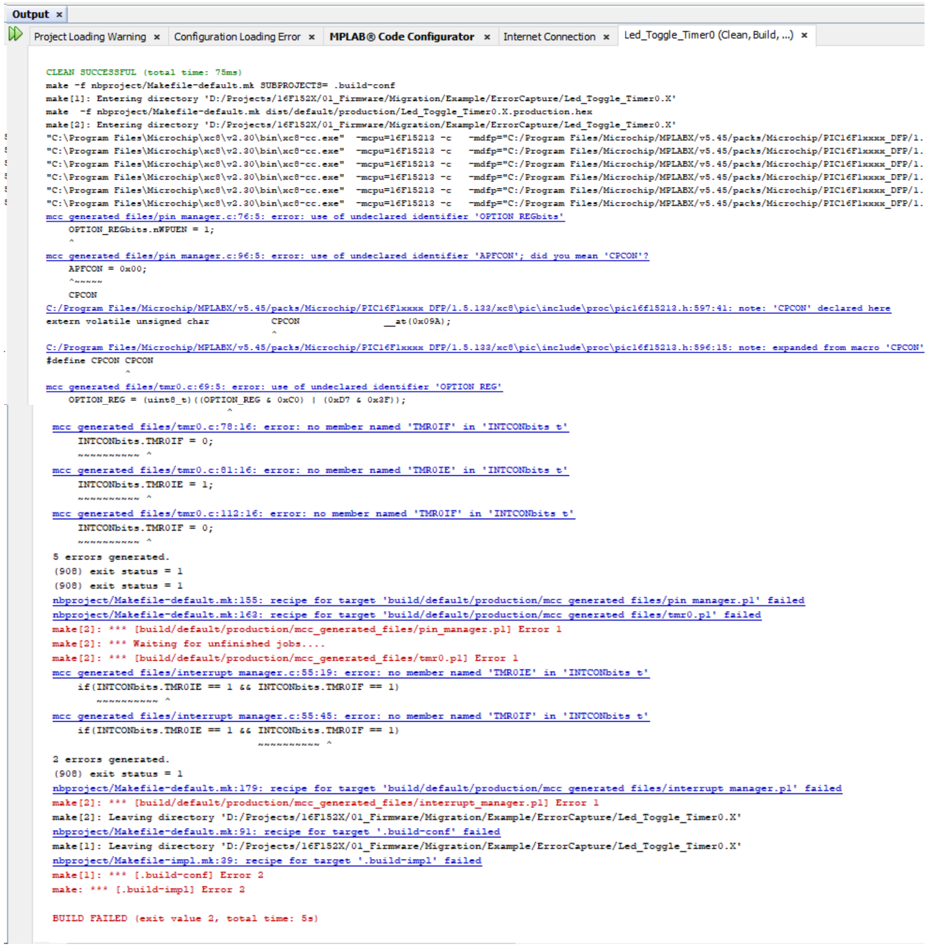
   Note: To open the Project Properties window, navigate to **MPLAB X IDE → File → Project Properties** .

   Figure 14-1. Modifying Project Properties Through Configuration Window



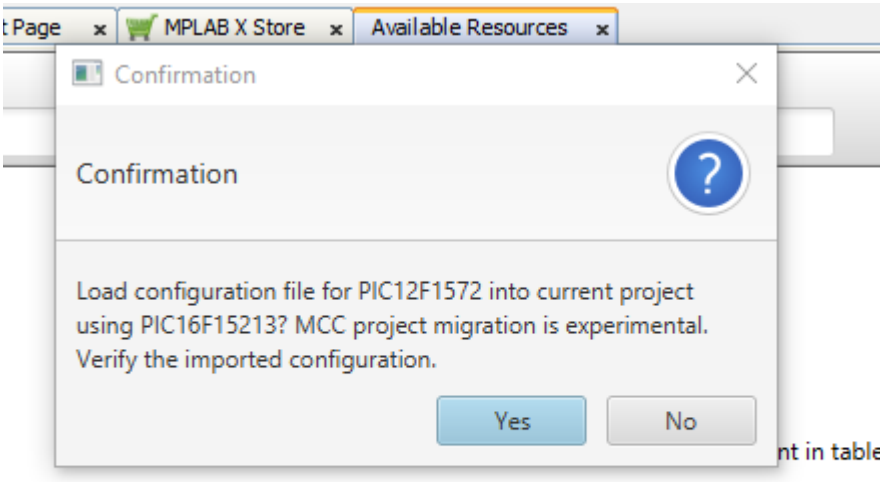
2. Rebuild the migrated project.

Figure 14-2. PIC16F15213 Project Build Errors and Warnings Listed on Output Window



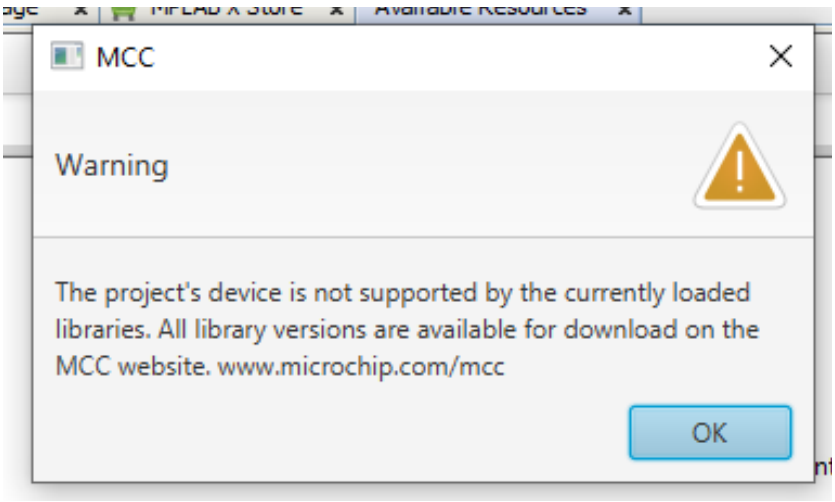
3. Open the MCC tool for configuring the drivers.
Note: The MCC tool may ask for the confirmation to load the MCC configuration file of the PIC12F1572 microcontroller project into the current project based on the PIC16F15213 microcontroller. Click **Yes**, as shown in Figure 14-3.

Figure 14-3. Loading MCC Configuration File of PIC12F1572 Project into the Migrated PIC16F15213 Project



4. A warning message may pop up after the confirmation to load the configuration file, as shown in Figure 14-4.

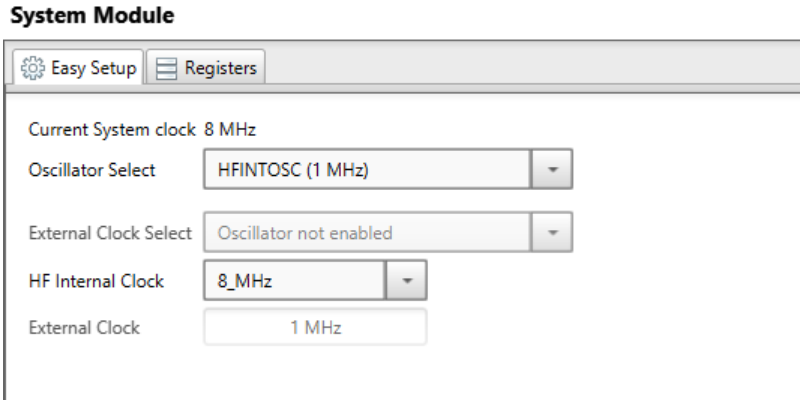
Figure 14-4. Warning Message Due to Unavailability of MCC Library Support for Target Microcontroller



Note: The MCC tool may pop up a warning message on the library support availability if the installed version of the MCC library for the 8-bit PIC® microcontrollers does not support PIC16F15213.

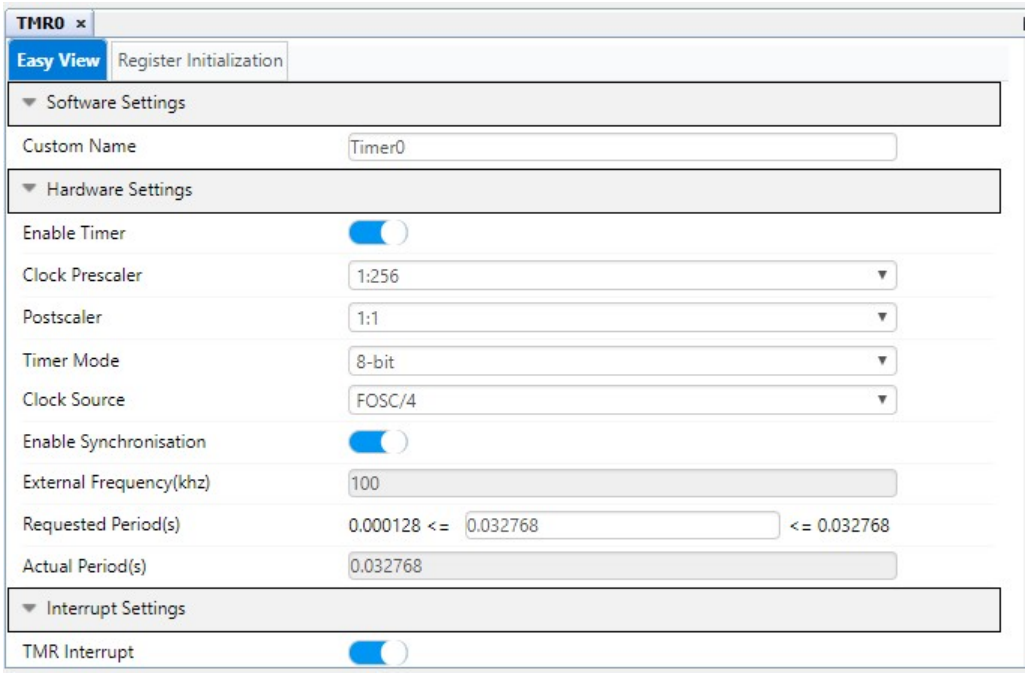
5. Configure the System Module drivers per the PIC12F1572 project configuration, using MCC System Module configuration window, as shown in Figure 14-5.

Figure 14-5. MCC System Module Configuration Window



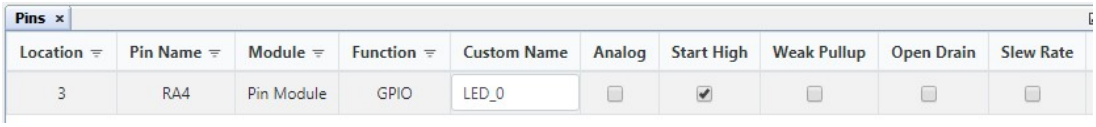
6. Configure the Timer0 drivers per the PIC12F1572 project configuration using MCC Timer0 configuration window, as shown in Figure 14-6.

Figure 14-6. MCC Timer0 Configuration Window



7. Configure the pin module per the PIC12F1572 project configuration using the MCC Pin Module configuration window, as shown in Figure 14-7.

Figure 14-7. MCC Pin Module Configuration Window



The microcontroller registers configured in this example are mapped to the PIC16F15213 microcontroller register name and bit position. The following list shows the required changes to the peripheral registers.

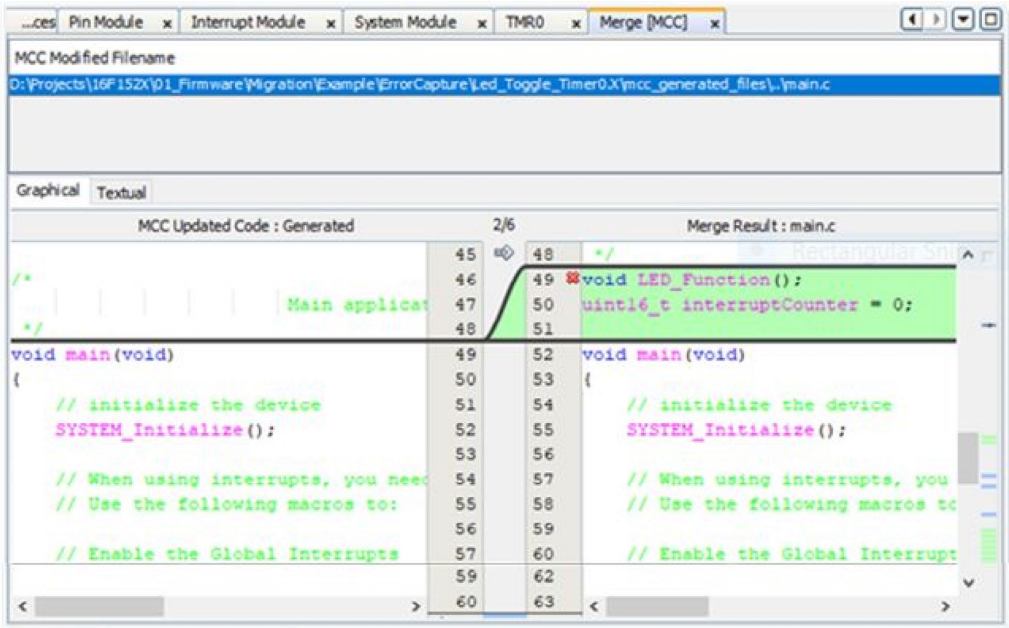
- OPTION_REG
  The PIC12F1572 microcontroller OPTION_REG register configuration needs to be applied in the PIC16F15213 microcontroller-based project using the T0CON and INTCON registers.
- APFCON
  The PIC12F1572 microcontroller APFCON register configuration needs to be applied in the PIC16F15213 microcontroller-based project using the PPS registers.
- INTCONbits.TMR0IF
  The PIC12F1572 microcontroller INTCON register Timer0 Interrupt Flag bit configuration needs to be applied in the PIC16F15213 microcontroller-based project using PIR0 register.
- INTCONbits.TMR0IE
  The PIC12F1572 microcontroller INTCON register Timer0 Interrupt Enable bit configuration needs to be applied in the PIC16F15213 microcontroller-based project using the PIE0 register.

Refer to section 8. Register Mapping for more details regarding the register name and bit position changes.

Note: Configure the available resources, such as peripheral drivers, interrupt modules, pin module, system module and libraries if there is a need to use an alternative or new peripheral/module.

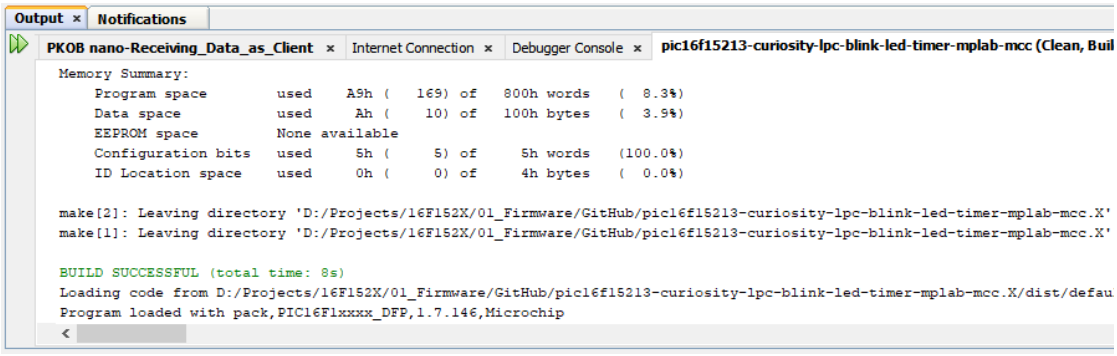
8. Generate the drivers for the PIC16F15213 microcontroller peripherals per the configuration by clicking the **Generate** button at the top of Project Resources, in the top left corner.
9. After the driver generation is completed, MCC may bring up a merge window for some files. The user can merge or ignore the suggestion as required by the application. Closing the merge window will decline any pending changes. Figure 14-8 shows the MCC merge window.

Figure 14-8. MCC Driver Firmware Merge Window



10. Figure 14-9 shows the result on the output window of MPLAB X IDE after the project is successfully compiled.

Figure 14-9. Project Build Result on Output Window of MPLAB® X IDE



Note: The migration of the 8-pin PIC12F family microcontroller source code to a PIC16F15244 family with higher pin count requires I/O pin remapping and PCB re-design as per the application functionalities.

15. References

- PIC16F15244 Quick Start Guide (web site). Microchip Technology, Inc., 2021.
- PIC16F152XX Family Product Brief
- PIC16F15213/14/23/24/43/44 Full-Featured 8/14/20-Pin Microcontrollers Data Sheet (DS40002195). Microchip Technology, Inc., 2020.
- Microchip PIC® and AVR® GitHub code examples. Microchip Technology, Inc.
- MPLAB® X IDE User's Guide (DS50002027). Microchip Technology, Inc., 2015.

16. Revision History

Doc Rev.	Date	Comments
A	08/2021	Initial document release.

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