Application Note AN-103 InnoSwitch-Pro Family



PIC Library Overview and Guide

Introduction

The application of InnoSwitch-Pro Family PIC Library is discussed in this document. This library can be used with both the InnoSwitch3-Pro and InnoSwitch4-Pro family of devices. This code was designed to be highly portable with different microcontroller platforms. The use of C++ language will make it easy for users to understand and modify the code according to their needs. This guide will allow the user to get sufficient knowledge on how to operate the devices with a use of a widely used microcontroller such as PICs.

InnoSwitch4-Pro

InnoSwitch4-Pro devices are ideal for AC/DC power supply applications where fine (10 mV, 50 mA) output voltage and current adjustment are

necessary. Typical implementations comprise a system microprocessor or dedicated microcontroller with an I^2C port that is used to configure, control and supervise the operation of the power sub-system. The uVCC pin provides a bias supply for the microprocessor in stand-alone implementations such as USB PD adapters and chargers.

The command and telemetry registers on InnoSwitch4-Pro are updated compared to InnoSwitch3-Pro. These features add flexibility and improve fault response. An example of these changes is with the Constant Current register resolution which is increased from 128LSB to 192 LSB and therefore provides better control on the output current.



Figure 1. InnoSwitch4-Pro Schematic



Figure 2. PIC16F18325 16-Pin UQFN Diagram

This demo runs on a 65W Reference Design Board (DER-961) with a PIC device as the microcontroller. The PIC microcontroller used in this design is the 16-pin UQFN packaged PIC16F18325. J1 is configured as the programming header based on the PICkit 4 Pin-out (Figure 5). Header

pins J2, J4, and J6 are shorted to bridge the I²C and uVcc lines of the InnoSwitch4-Pro to the PIC microcontroller. By removing the short on J2, J4, and J6 pins, an external I²C interface header can be used to bypass the I²C signals of the PIC microcontroller to the InnoSwitch4-Pro.



Figure 3. DER 961 Front



Figure 4. DER 961 Back

Number	Label				
1	1 AC Input Terminals				
2	TP3, TP4				
3	PICkit4 Programming Header	J1			
4	MCU Push Buttons	SW1, SW2			
5	uVcc and I ² C Isolation Headers	J2, J4, J6			
6	MCU GPIO Headers	J5			
7	External I ² C Interface Header	J3			
Table 1. DER 961 Part Description					





Figure 5. PICkit Programming Header Pin Mapping



Code Library

The InnoSwitch4-Pro Family library consists of both InnoSwitch3-Pro and InnoSwitch4-Pro drivers and examples. The combined library makes it easy to switch from one InnoSwitch-Pro device to another. Click on the link below to go to the Power Integration's website and download the InnoSwitch3-Pro/InnoSwitch4-Pro PIC Library.

https://www.power.com/design-support/downloads/innoswitch4-pro-code-library-and-api-microchip-pic16f18325

Software Settings

MPLAB IDE is the software used to develop the InnoSwitch3-Pro/InnoSwitch4-Pro PIC library for its ease of use. The IDE has a variety of tools specifically designed for PIC microcontrollers and embedded systems. The setting below ensure that the PIC library will not encounter any compatibility issues while compiling and uploading.

MPLAB X v5.50

- MPLAB Code Configurator v5.0.3
- PIC16F1xxxx_DFP v1.8.149
- XC8 v2.32 Compiler

Installing MPLAB IDE

Download the XC8 installer from the Microchip website below. The XC8 installer can be found under the MPLAB X IDE Archives. https://www.microchip.com/en-us/tools-resources/archives/mplab-ecosystem

MPLAB X IDE Archives		
		1 5 6 7 8 9
Windows® (x86/x64)	macOS® (10.X)	\$ Linux® (32/64 bit)
MPLAB X V5.50	MPLAB X v5.50	MPLAB X v5.50
		1 5 6 7 8 9

In the MPLAB X IDE. Go to Tools > Plugins Download and search for the MPLAB Code Configurator under the Available Plugins tab and click install.

Check	for Newest				Search:	
nstall	Name	Category	Source		MDI AR® Code Configurator	Ī
	MPLAB Touch	MPLAB Data Visu	- 6	^		
П	Machine Learning Plugin	MPLAB Data Visu	-		An Community Contributed Physic	ï
Π	Arduino Import Plugin	MPLAB IDE	-		We community contributed Plugin	
	MPLAB® Code Configurator	MPLAB IDE	ŤŤ		Version: 5.0.3	
	ELFViewer	MPLAB IDE (Opti	<u>-</u>		Author: Microchip Technology Inc	
	Power Monitor	MPLAB Plugin	ŵŵ		Date: 10/11/21	
	ECAN Bit Rate Calculator	MPLAB Plugin	<u>-</u>		Source: Microchip Plugins	
	MPLAB® Harmony 3 Launcher	MPLAB Plugin	କ୍ଷିକ		Homepage: http://www.microchip.com/mcc	
	PCLint	MPLAB Plugin	କିଳି			
	DMCI	MPLAB Plugin	କ୍ଷିକ		Plugin Description	
	Halt Notifier (Trial)	MPLAB Plugin	ଲିକି		The MDI AR® Code Configurator (MCC) experiates complete events understand C	
	Remote USB Debugging (Trial Ver	MPLAB Plugin	କ୍ଷିକ		I ne MPLAB(8) Code Configurator (MCC) generates seamless easy to understand C code that's inserted into your project. It enables, configures and utilizes a rich set of	
	Plugin Update Services	MPLAB Plugin	କିକି		peripherals across a select list of devices. It's integrated into MPLAB X (IDE) to	
	USB Tool Connection Diagnostics	MPLAB Plugin	6		provide a very powerful and extremely easy to use development platform.	
	Doxygen Integrator	MPLAB Plugin	କିଳି			
	App Launcher	MPLAB Plugin	- - - - - - - - - - -		System requirements	
	MemoryStarterkit	MPLAB Plugin	କ୍ଷିକ୍		MPLAB X: v5.50	
	Code Profiling (Trial Version)	MPLAB Plugin	<u>ŵ</u> ŵ			
	dsPICWorks	MPLAB Plugin	<u> <u> </u></u>			
	MPLAB® Harmony Configurator	MPLAB Plugin	<u></u>		Visit the MCC website for user's guides and release notes containing the lists of	
	SEGGER JLink Probe	MPLAB Plugin	W	~	supported devices.	



Installing the PIC16F1xxxx_DFP v1.8.149(Device Family Pack)

Go to Tools > Packs. Search for PIC16F1xxxx_DFP in the Packs window and click on the install button for v1.8.149.

MPLAB Pack Manager adds and removes	device :	support for MPLAB X IDE		Last	3049 devices suppor 50 checked for updates 2	ted by 96 installed packs 6 pack updates available 8 new packs available 1022-02-17T10:31:43.519
Check for Updates Install or Uninstall Packs 👻			Show Packs Com	patible with MPLAB X IDE	- Search	Show
Device Family Packs (63) Tool Packs (1)						
4 more pack releases	^	Device Name	Family	Core	Datasheet	Product Page
▼ PIC16F1xxx_DFP New	d.	ATA5505	ATautomotive	AVR8	Datasheet	Product Page
1.11.176 Added PIC16F18025, PIC16F18025, PIC Update 110.174 Added PIC16F18025 PIC16F18025 A PI		ATA5700M322	ATautomotive	AVR8	Datasheet	Product Page
1.10.174 - Added PIC for 18073, PIC for 18034, Pl Uninstal		ATA5702M322	ATautomotive	AVR8	Datasheet	Product Page
1.9.163 Updated REAL ICE trace macros. Instal		ATA5781	ATautomotive	AVR8	Datasheet	Product Page
✓ 1.8.149 - Added PORTH to views in MPLAB X for ap Instal	$\boldsymbol{<}$	782	ATautomotive	AVR8	Datasheet	Product Page
1.6.143 - Added PIC16F15256, PIC16F1527[4]5[6] par Instal 15 133 - Added debug excitet for PIC16F15274 Lind		ATA5783	ATautomotive	AVR8	Datasheet	Product Page
1.3.135 - Added debug scripts for Pictor 13244, Opd 1.4.119 - Added PIC16F152nn devices. Instal		ATA5787	ATautomotive	AVR8	Datasheet	Product Page
1.3.117 - Updated access mask of CRCCON1. Remov Instal		ATA5831	ATautomotive	AVR8	Datasheet	Product Page
1.2.99 - Updated device descriptor files. Instal		ATA5922	ATautomotive	A1/P9	Datasheet	Product Page
1.1.82 - Updated tool scripts for PIC16LF18456, PIC1 Instal 1.0.71 Added CelDeteZare for PIC16E/LE189/Educ		A1A3652	Allautomotive	AVRO	Datasheet	Product Page
1.0.71 - Added CalDataZone for PIC10r/LF188X5 dev 10.62 - Initial release Instal		ATA5833	ATautomotive	AVR8	Datasheet	Product Page
► PIC16Exxx DEP New	4	ATA5835	ATautomotive	AVR8	Datasheet	Product Page
► PIC18Cxxx_DFP New	1	ATA8210	ATautomotive	AVR8	Datasheet	Product Page
► PIC18F-J_DFP New	1	ATA8215	ATautomotive	AVR8	Datasheet	Product Page
► PIC18F-K_DFP New	1	ATA8510	ATautomotive	AVR8	Datasheet	Product Page
► PIC18F-Q_DFP New	1	ATA8515	ATautomotive	AVR8	Datacheet	Product Page

System packs location: C:\Program Files\Microchip\MPLABX\v5.50\packs - User packs location: C:\Users\VALLO\.mchp_packs - Remote packs repository: https://packs.download.microchip.com/

Installing XC8 v2.32 Compiler

Download the XC8 installer from the Microchip website below. The XC8 installer can be found under the Language Tool Archives.

<u>v2.32 (WIN) (2/18/2021)</u>
v2.32 (OSX) (2/18/2021)
v2.32 (Linux) (2/18/2021)
v2.35 (WIN) (1/4/2022)
v2.35 (OSX) (1/4/2022)



Driver and Source Files

Open the InnoSwitch4-Pro Library in the MPLAB IDE. Download and extract the InnoSwitch4-Pro PIC Library from the link below.

https://www.power.com/

Projects × Files	Services	
🖃 🔚 🔐 InnoSwitch 4-Pro	_PIC1618325	
🕀 💼 Header Files	3	
🗄 👉 Important Fi	iles	
🗄 💼 Linker Files		
🖨 👍 Source Files	i -	
🖭 main.c		
🕀 💼 MCC Ger	nerated Files	
🗄 👘 Source_	c	
🕀 💼 Libraries		
🗄 📠 Loadables		

The driver files serve as the core of the InnoSwitch4-Pro library. The files handle timings, communication, and InnoSwitch4-Pro registers. InnoSwitch3-Pro drivers are also included in the library. However, they are disabled by default.

▼	Source_C
	▼ app
	► app.c
	► buttons.c
	► led.c
	▼ device
	▼ inno3Pro
	► inno3Pro.c
	▼ inno4Pro
	► inno4Pro.c
	▼ innoProBase
	▶ innoProBase.c
	▼ hal
	▶ hal_i2c.c
	► hal_timer.c
	main_examples
	 InnoSwitch3-Pro
	► InnoSwitch4-Pro

App – Handles application routines specifically for functions related to PIC GPIO.

Device - Handles command sequences, timings, register settings, threshold calculations, parity implementations, telemetry, and etc. related to InnoSwitch4-Pro registers.

Hal – Also known as the hardware abstraction laver. Files under this section manages the I²C packet format based on InnoSwitch4-Pro datasheet. In addition, they control the hardware timings and clock signals of the PIC microcontroller.

NOTE: The files inno3Pro.h, inno3Pro_Config.h, and inno3Pro.c is excluded from the compilation by default.

Examples

The example implementations can be found in *Source Files > Source C* > main_examples. These files contain implementations for different use cases of the InnoSwitch4-Pro register. The examples serve as a guide or template for the user on different functions such as initializing the InnoSwitch4-Pro device and changing the output voltage.

Source_C

- app ►
- device
- hal
- main examples
 - InnoSwitch3-Pro ▼
 - Inno3Pro Basic.c
 - Inno3Pro Basic Volt Amps OV UV.c
 - Inno3Pro_PDOs.c
 - Inno3Pro_Ramp.c
 - Inno3Pro_Random_Volt_Timer.c
 - Inno3Pro SineWave.c

InnoSwitch4-Pro

- Inno4Pro_Basic.c
- Inno4Pro_Basic_Volt_Amps_OV_UV.c
- Inno4Pro_PDOs.c
- Inno4Pro_Ramp.c
- Inno4Pro_Random_Volt_Timer.c
- Inno4Pro SineWave.c

The files under the main examples folder are excluded from the configuration by default. The compiler will ignore the files excluded from the current configuration. In order to use an example file, the user must exclude the main.c file and include the example file, in this case, Inno4Pro_Basic.c. This is done through a right click on the file and selecting Exclude/Include files(s) from current configuration.

Projects ×	Files	Services		
🖃 🥅 InnoS	witch4-Pro_	PIC1618325		
њ 💼 н	eader Files			
🖶 🚰 In	nportant Fil	es		
👘 💼 Lii	nker Files			
🖻 📠 So	ource Files			
	main.c	•		1
	MCC G	Open		
	Source	Cut	Ctrl+X	
中山	ing app	Conv	Ctrl+C	
- -	- 🛱 hal	Dacto	Ctrl+V	
	- Can ma	Paste	Cult V	
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Application Note





Application Note

Example 1 – Inno4Pro_Basic.c

Inno4Pro_Basic.c file implements the essential commands to run the InnoSwich4-Pro IC. The adapter will output 5V 3.1A while using this code. There are five commands in this file to note:

Inno4Pro_Initialization();	Function for initializing the InnoSwitch4-Pro device	
Inno4Pro_Write_VI();	Function for setting the output voltage and current	
Inno4Pro_Write_Volt_Peak();	Sets the knee voltage (V_{KP})	
Inno4Pro_Vbus_Switch_Control();	Controls the BUS switch	



Figure 8. Inno4Pro_Basic.c Output Voltage Waveform

//MPLAB Code Configurator Header File #include "///mcc_generated_files/mcc.h"					
<pre>//Step 1 : Add the Header Files #include "//.src/hal/hal_i2c.h" #include "//.src/hal/hal_timer.h"</pre>					
<pre>#include "//src/inno4Pro/inno4Pro_Config.h" #include "//src/inno4Pro/inno4Pro.h"</pre>					
void main(void) {					
<pre>// Initialize the device - PIC16F18325 SYSTEM_Initialize(); INTERRUPT_GlobalInterruptEnable(); INTERRUPT_PeripheralInterruptEnable();</pre>					
<pre>//Step 2 : Write Initial Commands to InnoSwitch4-Pro Inno4Pro_Initialization();</pre>					
<pre>//Step 3 : Call the Functions on the Main Loop while (1)</pre>					
// Main Loop Variable Initialization float fVolts = 5; //Initialize Voltage at 5V float fAmps = 3.1; //Initialize Constant Current at 3.1A float fCableDropComp = 300; //Initialize Cable Drop Compensation to 300mv float fVoltPeak = 24; //Initialize Knee Voltage at 24V float fVbusEn = 1; //Initialize Vbus Enable to at ON					
<pre>//Library Call in the Mainloop Inno4Pro_PD_Write_VI (fVolts , fAmps); //Set Voltage and current Inno4Pro_Write_Cable_Drop_Comp (fCableDropComp); //Set Cable Drop Compensation Inno4Pro_Write_Volt_Peak (fVoltPeak); //Set Constant Output Power Knee Voltage Inno4Pro_Vbus_Switch_Control (fVbusEn); //Set Vbus Enable</pre>					
}					



Application Note

Example 2 – Inno4Pro_PDOs.c

This file cycles through the multiple output voltages. This mimics the USBPD standard PDO's for 60W adapters.

Inno/Pro Initialization():	Function for initializing the	
	InnoSwitch4-Pro device	
The ADar Miller MICh	Function for setting the output	
Inno4Pro_Write_VI();	voltage and current	
Inno4Pro_Write_Volt_Peak();	Sets the knee voltage (V_{KP})	
Inno4Pro_Vbus_Switch_Control();	Controls the BUS switch	
dock HasTimeElancedMs()	Returns 1 when a certain amount of	
clock_has hilleelapseums();	time in milliseconds has elapsed	
	Returns the current time in	
Clock_GetTimeStapsMs();	milliseconds	
	Another implementation of	
Inno4Pro_PD_Write_VI();	Inno4Pro_Write_VI() specifically for	
	USBPD applications	





Figure 9. Inno4Pro_PDOs.c Output Voltage Waveform



Programming

Connect the PICkit 4 to the programming header of the PiC device. The picture below shows the correct connection of the PIC IC pins to the PICkit 4 programmer.



Note: When programming the PIC device without the microcontroller voltage supply. Check the **Power target circuit from PICkit4** option in the PICkit4 properties. Change the voltage level to 3.6 to 3.7 V to power up the PIC microcontroller. Uncheck the **Power target circuit from PICkit4** when programming a PIC device that is powered up.

Project Properties - InnoSwitch4-Pro_PIC1618	325	×
Project Properties - InnoSwitch4-Pro_PIC1618 Categories: General File Indusion/Exclusion Gonf: [default] PICkit 4 Loading Libraries Building (bad language toolchain) 	225 Options for PICkit 4 Option categories: Power Power target circuit from PICkit 4 Voltage Level	Reset
	Option Description If you select an option its description will appear here.	
Manage Configurations	C	K Cancel Apply Unlock Help



Open the project properties from the project dashboard located beneath the projects window. Select PICkit 4 as the Connected Hardware Tool, 1.8.149 under the Packs pane, and XC8 v2.32 under the Compiler Toolchain. Make sure that the proper PIC device is selected which in this case is PIC16F18325.

• General • File Indusion/Exclusion • O Enf. [default] • O Enf. [default] • O Enf. [default] • O Enf. [default] • O Loading • Ubraries • Building • XC8 Global Options • O XC8 Compiler • O XC8 Compiler • O Analysis Panage Configurations Manage Configurations Panage Configurations Panage Configurations	egories:	Configuration	
Image Configurations All Families Image Configurations All Families All Families Image Configurations All Families All Families PIClifF18325 PIClifF18325 PIClifF18325 All Families All Families <	• General	Family:	Device:
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 Loading Libraries Building XC8 Global Options XC8 Compiler XC8 Linker Analysis Packs: Packs: I.1.7.146 I.1.9.163 Compiler Toolchain: VC8 VC8 Compiler Toolchain: VC8 VC8 VC8 I.1.0.174 Compiler Toolchain: VC8 VC8 VC8 I.1.0.174 Compiler Toolchain: VC8 VC8 V.C8 I.1.0.174 Compiler Toolchain: VC8 VC8 V.C8 V.2.32 (C:\Program Files\Microdhip\xc8\V2.32\bin\) I.1.0.174 Compiler Toolchain: V.C8 V.C8 V.C8 V.2.32 (C:\Program Files\Microdhip\xc8\V2.32\bin\) I.1.0.174	• PICkit 4	Connected Hardware Tool:	Supported Debug Header:
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Building Image Configurations Building Image Configurations Packs: Packs: Image Configurations Packs: Image Configurations Packs: Image Configurations Packs: Image Configurations	····		None
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Compiler Toolchain: □-XC8 □-XC8 □-yC8 (v2.32) [C:\Program Files\Microchip\xc8\v2.32\bin] ⊕-pic-as			
Manage Configurations		Compiler Toolchain:	
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Figure 9. Project Property Settings for InnoSwitch4-Pro Library

Clean and build the project before uploading the library into the PIC microcontroller to check for errors in the configuration.



Figure 9. Clean and Build Project



Revision	Notes	Date
А	Initial release.	01/20/23

For the latest updates, visit our website: www.power.com

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Power Integrations Worldwide Sales Support Locations

World Headquarters 5245 Hellyer Avenue

San Jose, CA 95138, USA Main: +1-408-414-9200 Customer Service: Worldwide: +1-65-635-64480 Americas: +1-408-414-9621 e-mail: usasales@power.com China (Shanghai) Rm 2410, Charity Plaza, No. 88 North Caoxi Road Shanghai, PRC 200030 Phone: +86-21-6354-6323 e-mail: chinasales@power.com China (Shenzhen) 17/F, Hivac Building, No. 2, Keji Nan 8th Road, Nanshan District, Shenzhen, China, 518057 Phone: +86-755-8672-8689 e-mail: chinasales@power.com

Germany (AC-DC/LED Sales) Einsteinring 24 85609 Dornach/Aschheim Germany Tel: +49-89-5527-39100 e-mail: eurosales@power.com

Germany (Gate Driver Sales) HellwegForum 1 59469 Ense Germany Tel: +49-2938-64-39990 e-mail: igbt-driver.sales@power.com India #1, 14th Main Road Vasanthanagar Bangalore-560052 India Phone: +91-80-4113-8020 e-mail: indiasales@power.com

Italv

Via Milanese 20, 3rd. Fl. 20099 Sesto San Giovanni (MI) Italy Phone: +39-024-550-8701 e-mail: eurosales@power.com Japan Yusen Shin-Yokohama 1-chome Bldg. 1-7-9, Shin-Yokohama, Kohoku-ku Yokohama-shi, Kanagawa 222-0033 Japan Phone: +81-45-471-1021 e-mail: japansales@power.com Korea RM 602, 6FL Korea City Air Terminal B/D, 159-6 Samsung-Dong, Kangnam-Gu, Seoul, 135-728, Korea Phone: +82-2-2016-6610 e-mail: koreasales@power.com

Singapore

51 Newton Road #19-01/05 Goldhill Plaza Singapore, 308900 Phone: +65-6358-2160 e-mail: singaporesales@power.com Taiwan 5F, No. 318, Nei Hu Rd., Sec. 1 Nei Hu Dist. Taipei 11493, Taiwan R.O.C. Phone: +886-2-2659-4570 e-mail: taiwansales@power.com UK Building 5, Suite 21 The Westbrook Centre Milton Road Cambridge CB4 1YG Phone: +44 (0) 7823-557484 e-mail: eurosales@power.com