Never stop thinking

PMA71xx/PMA51xx

SmartLEWIS™ MCU

PMA Evaluation Kit

User Guide

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Wireless Control

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PMA Evaluation Kit

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1 Introduction

The PMA Evaluation Kit is an enhanced development tool for the SmartLEWIS™ MCU PMA-family and will support developing and debugging of Wireless Control Applications. The PMA RF Evaluation Board allows easy access to all pins for detailed measurements and supports the embedded LF receiver and ADC functionality of the SmartLEWIS™ MCU. Furthermore, the Evaluation Kit can be used as interface for programming external prototypes.

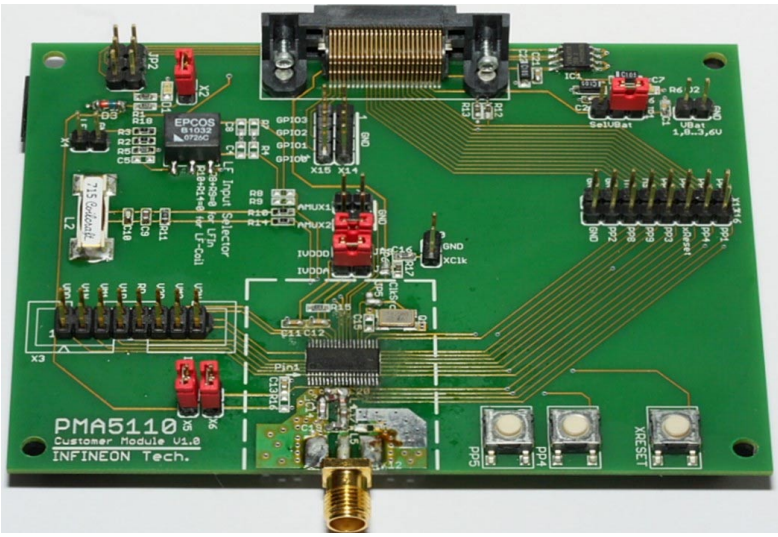


Figure 1 PMA RF Evaluation Board

1.1 Content of the PMA Evaluation Kit

- PMA RF Evaluation Board: an RF transmitter board assembled with PMA5110, optimized for required frequency band and output power
- 1/4 lambda antenna: reduced size with 50 Ohm SMA connector
- 2 additional PMA5110 samples
- SmartLEWIS™ MCU Product Brief
- Legal disclaimer sheet

*Note: The PMA RF Evaluation Board has been designed to be connected to the PC via the SmartLEWIS™ System Interface Board (SIB v2.0). Alternatively a PMA Starter Kit may be used as Interface to the PC, for details see **Chapter 1.3**. Both interface boards, SIB v2.0 or PMA Starter Kit, have to be ordered separately*

- *Order information*
  - *SmartLEWIS™ System Interface Board (SIB v2.0), SP000409156*
  - *PMAx110-315-5-USB-RF Kit, 315MHz, 5dBm, SP000409138*
  - *PMAx110-434-5-USB-RF Kit, 434MHz, 5dBm, SP000409140*
  - *PMAx110-868-10-USB-RF Kit, 868MHz, 10dBm, SP000426622*

1.2 Features of the PMA Evaluation Kit

- Equipped with the PMA5110 which is the most advanced type out of this product family
- Full access to all hardware features of the PMA IC
- Support of LF receiver (optional) and ADC
- Available for 315 MHz, 434 MHz, 868 or 915 MHz carrier frequency
- External 1/4 lambda antenna attached to SMA connector
- Fully integrated into KEIL™ C51 development suite (incl. software download to PMA-integrated Flash memory and debugging support)
- 5 different RF-matching network options are available:
  - 315 MHz, +5dBm, PMA5110-315-5 Board, SA000422368, SP000409122
  - 434 MHz, +5dBm, PMA5110-434-5 Board, SA000422420, SP000409126
  - 434 MHz, +10dBm, PMA5110-434-10 Board, SA000422422, SP000409128
  - 868 MHz, +10dBm, PMA5110-868-10 Board, SA000422426, SP000409132
  - 915 MHz, +10dBm, PMA5110-915-10 Board, SA0004224430, SP000409136

1.3 Connection to PC

To connect the PMA RF Evaluation Board to the PC and to program the PMA Flash, a separate interface board is required. The connection to the PC may be established by the SmartLEWIS™ System Interface Board (SIB v2.0) or alternatively by the PMA RF USB Stick, see **http:/www.infineon.com/pma_starterkit**. Both boards have to be ordered separately.

1.3.1 Connection to the PC using the SmartLEWIS™ System Interface Board

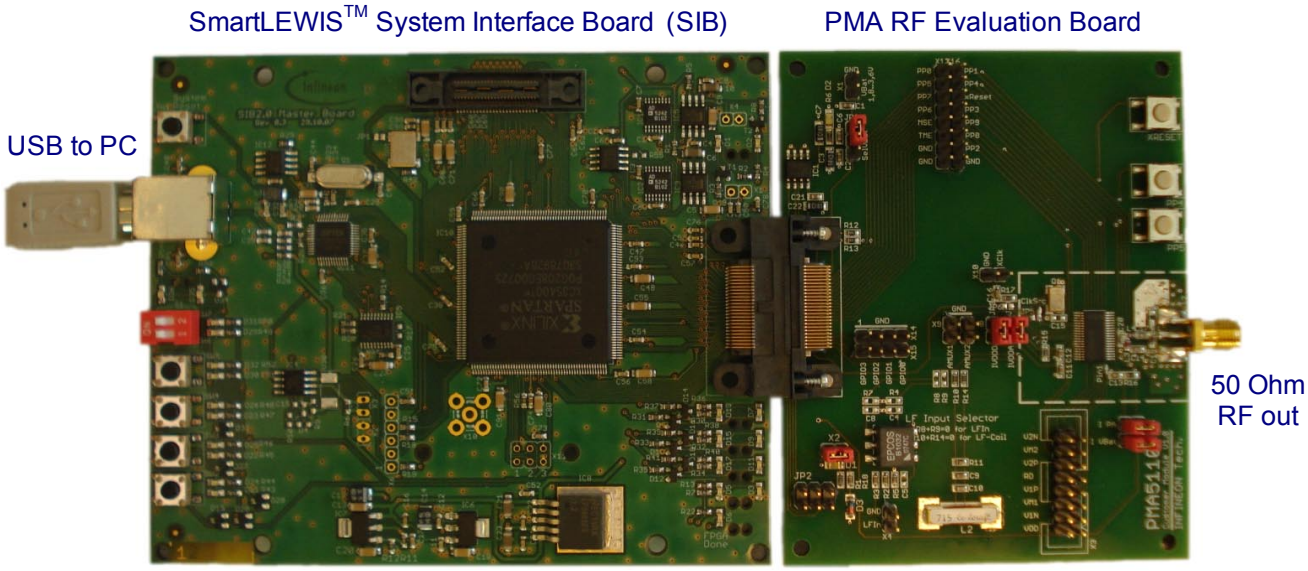


Figure 2 Connection of the PMA RF Evaluation Board to the PC via SIB v2.0 and USB

1.3.2 Connection to the PC using the PMA Starter Kit

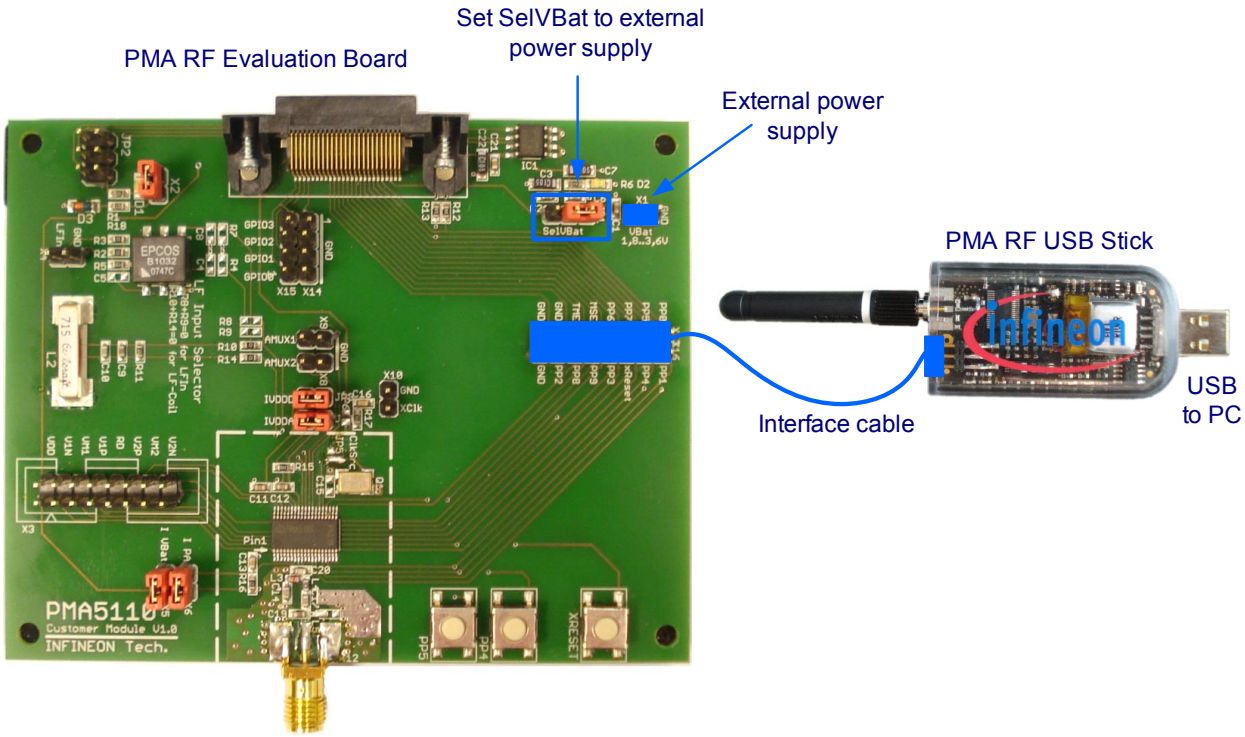


Figure 3 Connection to the PC via PMA RF USB Stick

Note: As the RF-part of the PMA RF USB Stick is not used for connecting the PMA RF Evaluation Board to the PC, any matching network option on the PMA RF USB Stick may be used independent from the matching network on the PMA RF Evaluation Board.

1.3.2.1 Hardware Setup

To connect the PMA RF Evaluation Board with the PMA RF USB Stick, the GPIO-signals, available on connector X5 of the PMA RF USB Stick, have to be connected to the GPIO-pins of the PMA-IC on the PMA RF Evaluation Board (see **Table 1**).

Table 1 Signals to be connected for using the PMA RF USB Stick as PC interface

PMA RF USB Stick		PMA RF Evaluation Board		
Pin #	**Signal name**	**Signal name**	**Connector**	**Pin #**
1	PP2	PP0	X13	1
2	PP3	PP1	X16	8
3	PP4	xReset	X16	6 - on board test button
4	PP5	MSE	X13	5
5	VBAT	not connected		
6	GNDA	GND	X16	1
not connected		TME	X13	6 - connect to GND on board

*Note: **The power supply of the PMA RF Evaluation Board must be from an external source. Please make sure that the Jumper JP1 is in the right position for external supply, see Figure 4***

1.3.2.2 Software Setup

For setup of software tools, see **Chapter 4.1**, **Setup of KEIL™ C51 µVISION4 Tool Chain for PMA**

For installation of the PMA Starter Kit software, see “PMA Starter Kit User Guide”:

- Chapter 3.2, Download and install PMA Starter Kit Software
- Chapter 3.3, Setting up a Software Project in KEIL™ C51 µVISION4

2 Documentation Links

Latest version of all Data Sheets, Application Notes and other documents related to this product family may be downloaded from the Infineon Technologies home page, **http://www.infineon.com/PMA**.

Most important documents are Product Data Sheets and PMA Function Library Guide:

- PMA51xx Data Sheet
- PMA71xx Data Sheet
- PMA51xx Function Library Guide
- PMA71xx Function Library Guide (named PMA71xx ROM Library Guide in earlier versions)

General information about the development tools for the PMA product family is available at **http:/www.infineon.com/pma_tooling**.

All documentation and software for this PMA Evaluation Kit with the PMA RF Evaluation Board is available at **http:/www.infineon.com/pma_evalkit**.

3 PMA Evaluation Kit Hardware

The most important components of the PMA RF Evaluation Board are illustrated in **Figure 4**.

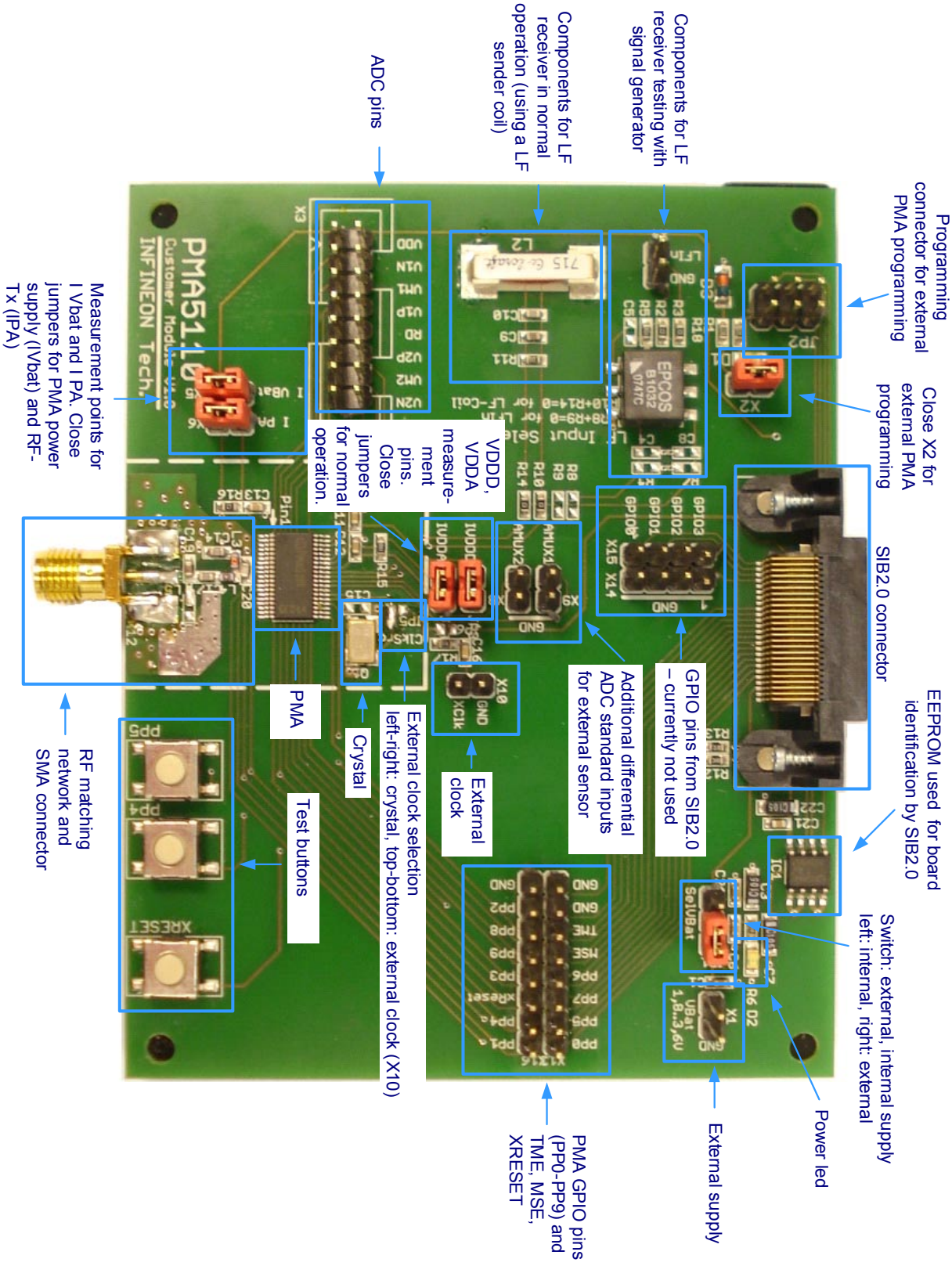


Figure 4 PMA RF Evaluation Board - important components

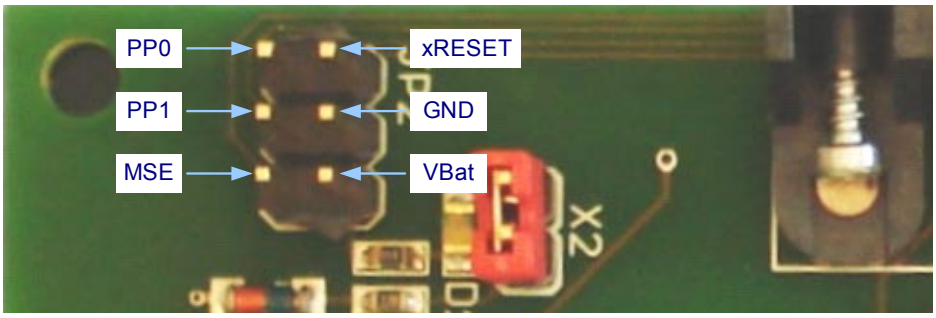


Figure 5 Pin description of programming connector JP2

JP2 can be used to program an external PMA IC. In this case the Flash Download Settings of KEIL™ µVISION4 have to be adapted: tick the "Use GPIO Connector" checkbox.

JP5 (soldered) is used to select the clock supply: on-board crystal or an external clock (see Figure 4). Please make sure that JP5 (near crystal) is set properly, if an external clock is supplied.

3.1 GPIO Assignment

For general purpose input-/output-lines (GPIO) see **Table 2**

Table 2 PMA Evaluation Board - GPIO assignment

PMA-IC	PMA Evaluation Board		
GPIO signal	connector	Pin #	on-board test button
PP0	X13	1	
PP1	X16	8	
PP2	X16	2	
PP3	X16	5	
PP4	X16	7	PP4
PP5	X13	2	PP5
PP6	X13	4	
PP7	X13	3	
PP8	X16	3	
PP9	X16	4	

3.2 ADC Pin Assignment

The ADC Pins are available on connector X3, see **Table 3**

Table 3 ADC Pins

ADC-Pin	VDD	V1N	VM1	V1P	RD	V2P	VM1	V2N
Connector X3 - Pin #	1	2	3	4	5	6	7	8

3.3 LF-receiver

For the LF-receiver 2 alternative paths are available:

- LF with signal generator:
  - resistors R8 and R9 have to be soldered, R10 and R14 must be left open. Signal generator to create LF-Pattern has to be connected to LF-Input (X4_1 and X4_2)
- LF with coil:
  - resistors R10 and R14 (0 Ohm) have to be soldered, R8 and R9 left open. In this case the LC-oscillator (L2, C9, C19, R11) can be used for creating a LF-signal, together with a LF-transmitter coil.

Table 4 LF components

Part	Value	Device
R2	0 Ohm	R_0603
R3	0 Ohm	R_0603
R4	100 Ohm	R_0603
R5	47 Ohm	R_0603
R7	100 Ohm	R_0603
R8	16 KOhm	R_0603
R9	16 KOhm	R_0603
C4	-	
C5	-	
C8	-	

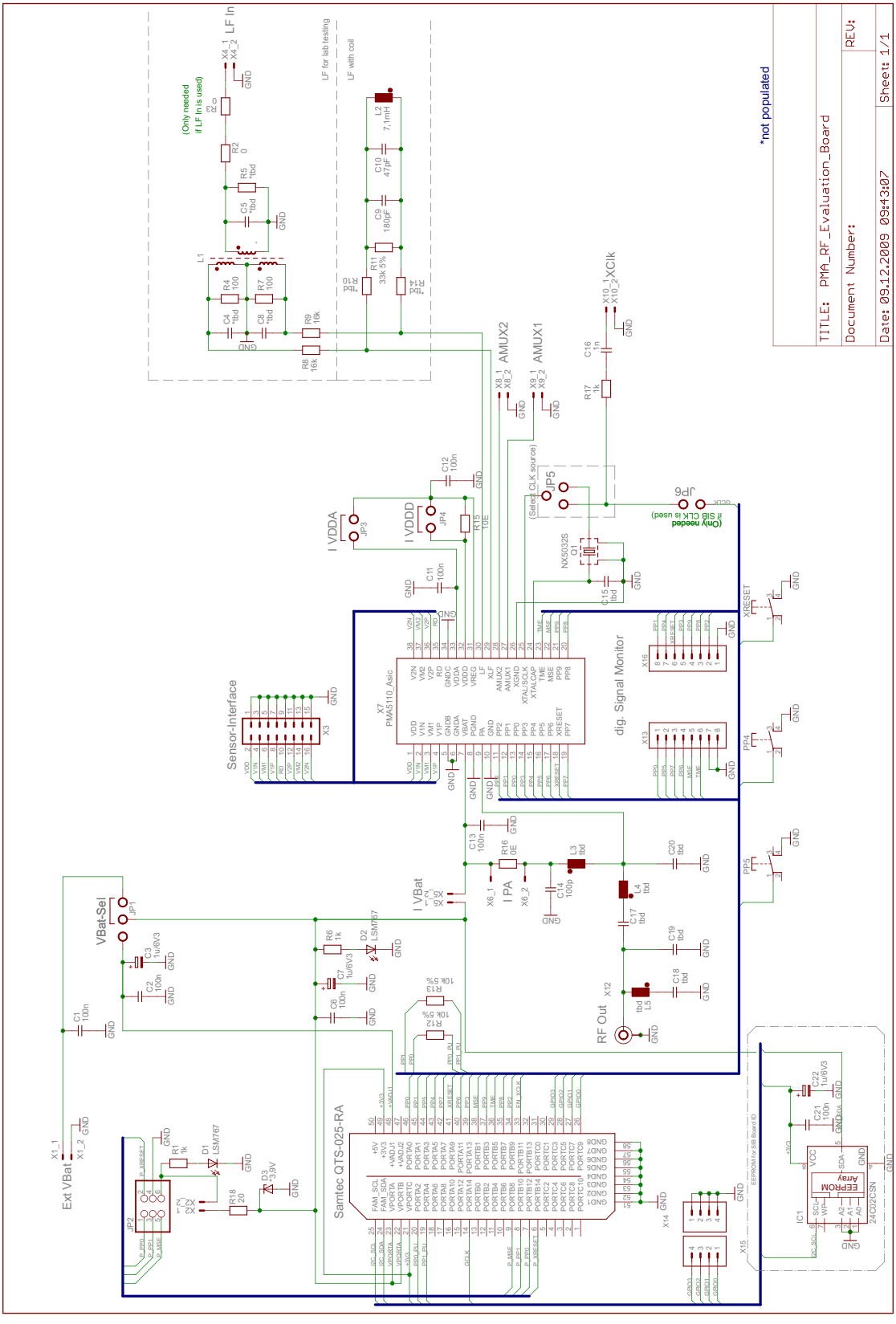


Figure 6 Schematic of PMA RF Evaluation Board

4 Setup of Software Development Tools

This chapter will guide you step-by-step through the installation of the tool environment. This process consists of the following steps which will be explained in full detail below:

- Setup of KEIL™ C51 µVISION4 Tool Chain for PMA
- Download and install Infineon's PMA Evaluation Kit software
- Setting up a new project in the KEIL™ development suite
- Debugger usage

4.1 Setup of KEIL™ C51 µVISION4 Tool Chain for PMA

KEIL™ µVISION4 is an integrated development environment and a state-of-the-art software development suite. It includes an editor, linker, compiler and a flash tool. The SmartLEWIS™ MCU family is perfectly integrated into this environment. The ANSI C optimized compiler supports all PMA51xx/PMA71xx devices.

Before you can setup the KEIL™ development environment for PMA you have to download the free evaluation software at **https:/www.keil.com/c51/demo/eval/c51.htm**. This demo version of the KEIL™ development environment is code-size limited (maximum 2 kbyte code) and comes up with other restrictions. For details please refer to the online documentation from KEIL™. The evaluation software can be used as starting point to develop PMA applications. The full flash memory size of the PMA IC may be utilized with a full version from KEIL™.

Download the C51 Evaluation Software and follow the instructions for installation.

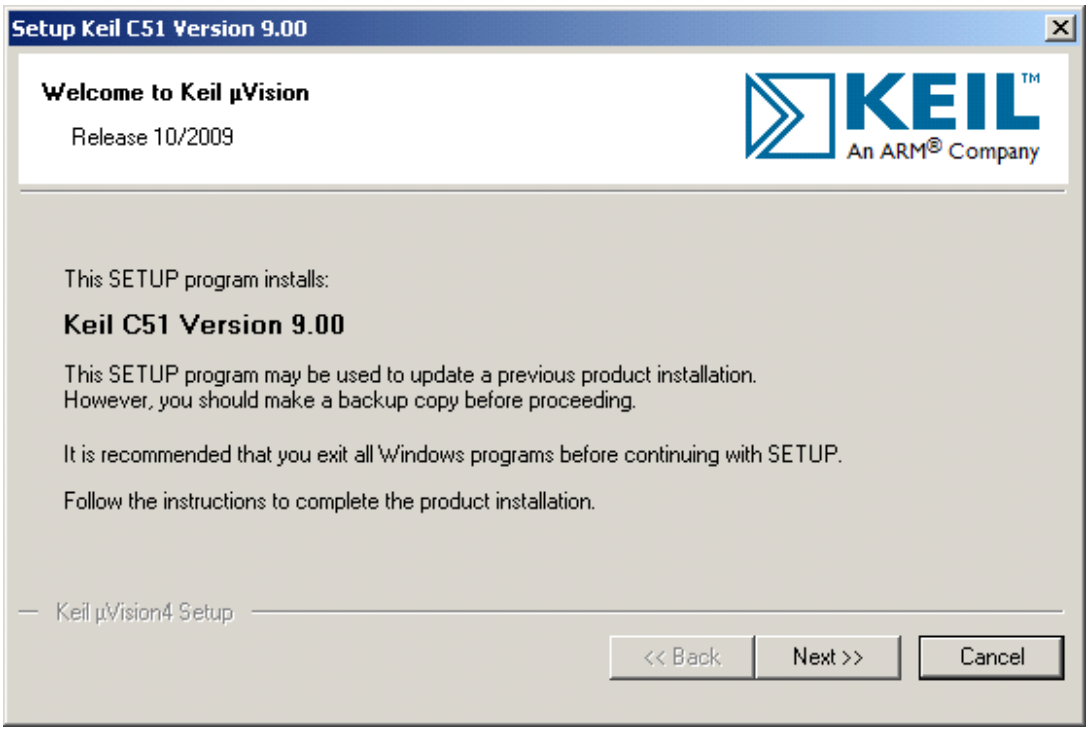


Figure 7 Setup KEIL™ C51

Note: It is assumed that the default installation folder C:\Keil is used. If any other installation folder is selected during KEIL™ installation process please replace C:\Keil with your custom installation folder throughout the installation process.

4.2 Download and install PMA Evaluation Kit Software

For the integration of the PMA71xx/PMA51xx devices into KEIL™ µVISION4 and the installation of software examples please download and install Infineon's PMA Evaluation Kit software:

- Go to **http://www.infineon.com/pma_evalkit** and download the PMA Evaluation Kit software (PMA_EVALUATION_KIT_SW_Vx.y.zip).

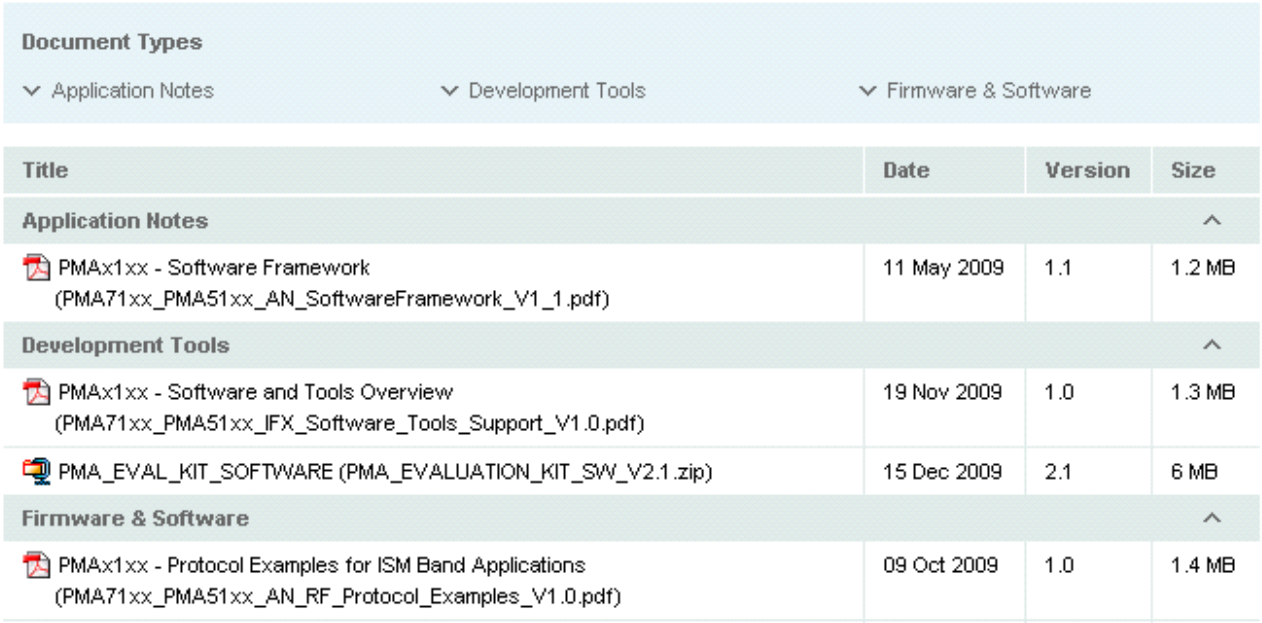


Figure 8 Download Development Tools

- Extract the PMA Evaluation Kit SW ZIP-archive to a temporary directory on your PC.

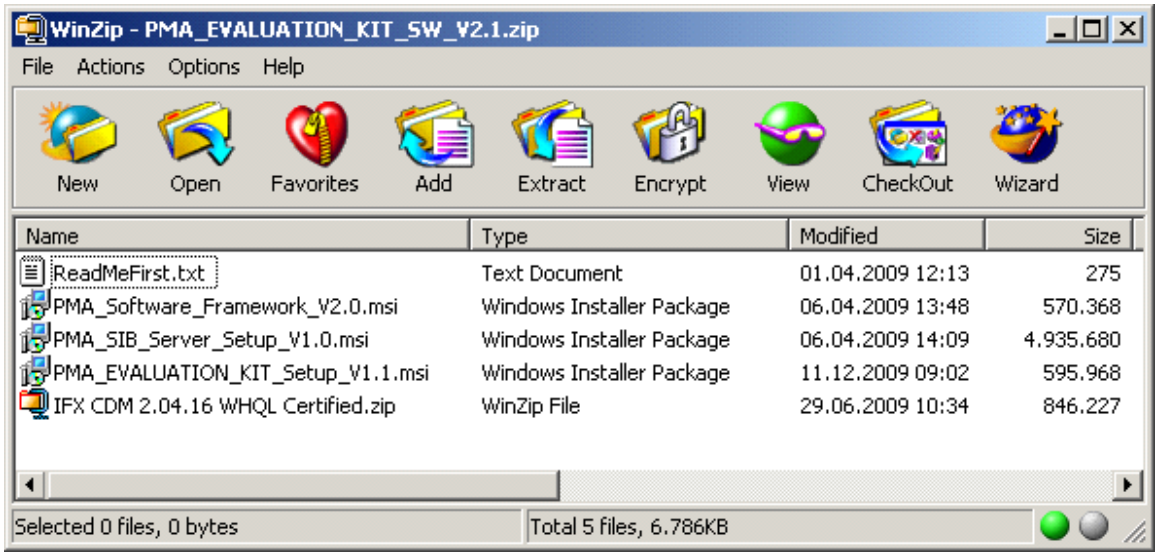


Figure 9 PMA Evaluation Kit SW ZIP archive

- Start PMA_EVALUATION_KIT_Setup_Vx.y.msi, to integrate the PMA product family into the KEIL™ C51 µVISION4 Tool Chain. Follow the installation instructions.

Note: KEIL™ C51 µVISION4 Tool Chain must be installed BEFORE this step!

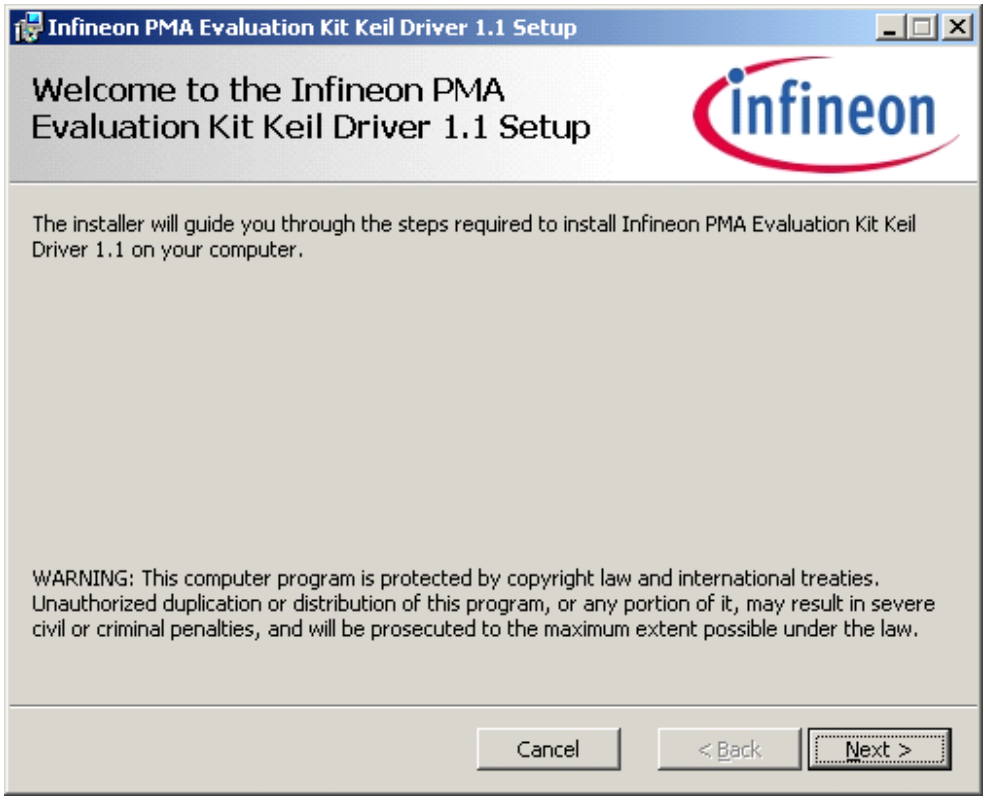


Figure 10 Setup PMA Evaluation Kit KEIL™ Driver

- Start PMA_SIB_Server_Setup_Vx.y.msi, to install the software interface between the KEIL™ environment and the System Interface Board (SIB) and follow the installation instructions.

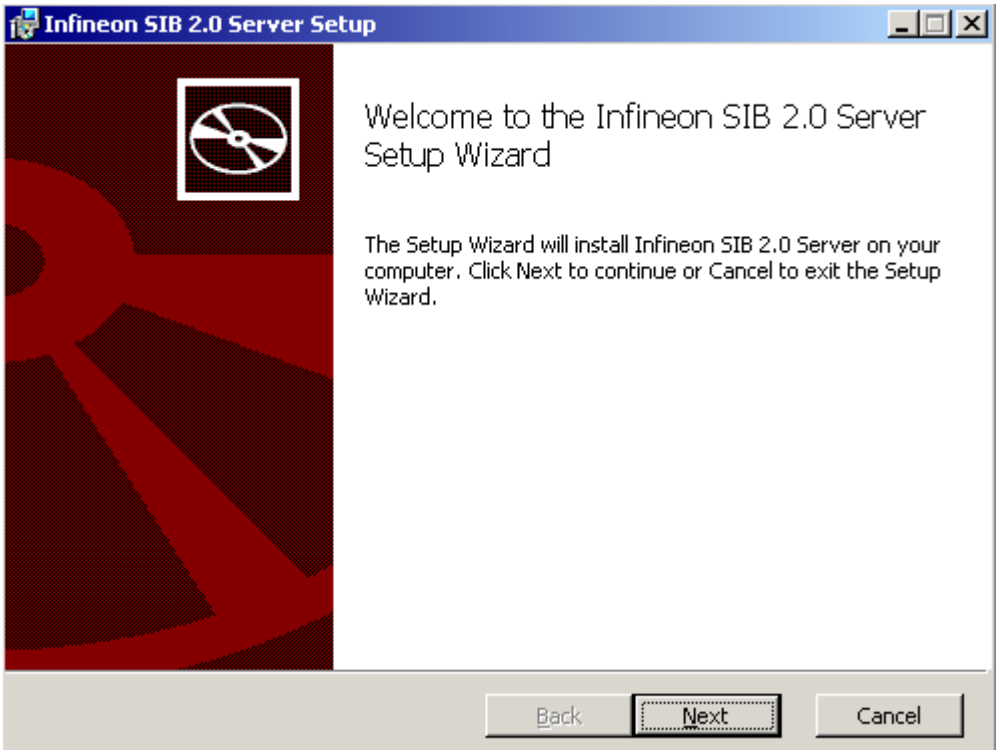


Figure 11 Setup of SIB Server

- Start PMA_Software_Framework_Vx.y.msi, to install the PMA Software Framework with typical coding examples.

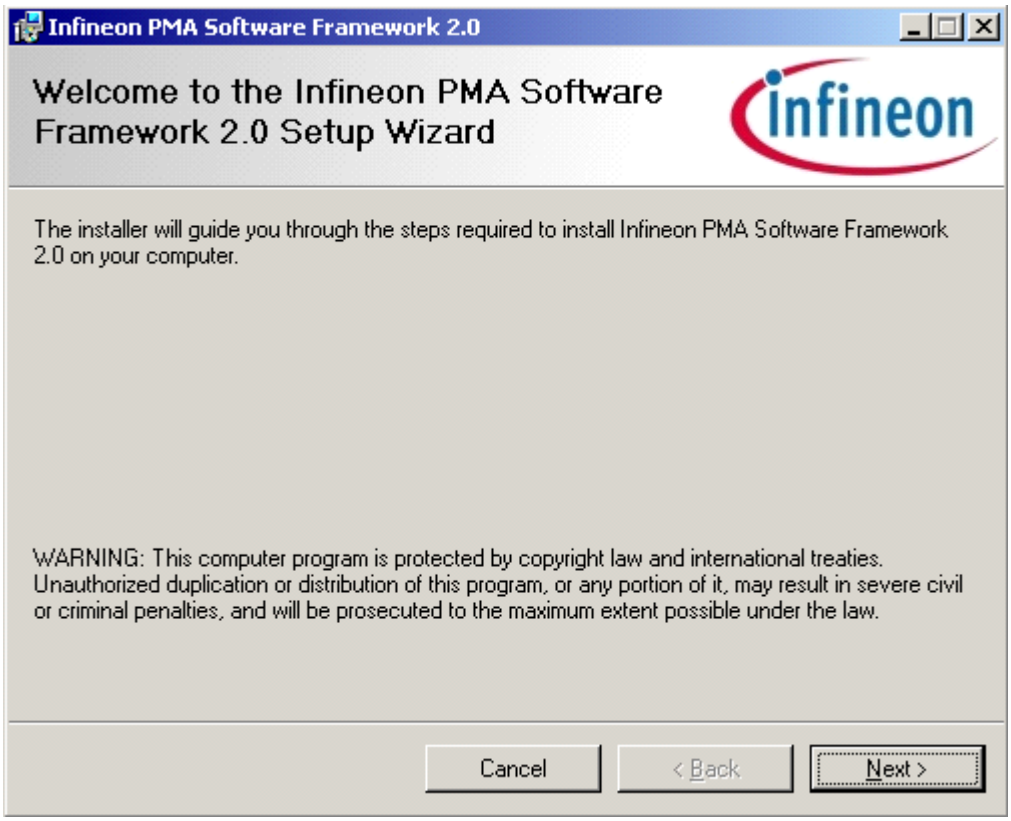


Figure 12 Setup PMA Software Framework

Note: The SIB Server requires the Microsoft.Net Framework 1.1 to be installed on your System. If it is not installed you will get an error message during installation. The .Net Framework 1.1 can be obtained from Microsoft www pages **http:/www.microsoft.com/downloads/details.aspx?FamilyID=262D25E3-F589-4842-8157-034D1E7CF3A3&displaylang=en**

4.3 Setting up a Software Project in KEIL™ µVISION4

You can work directly with the example projects (e.g. the PMA Software Framework) or you can setup your own software project for PMA71xx/PMA51xx in KEIL™ µVISION4:

- Start KEIL™ µVISION4.
- Create a new project in KEIL™ µVISION4.

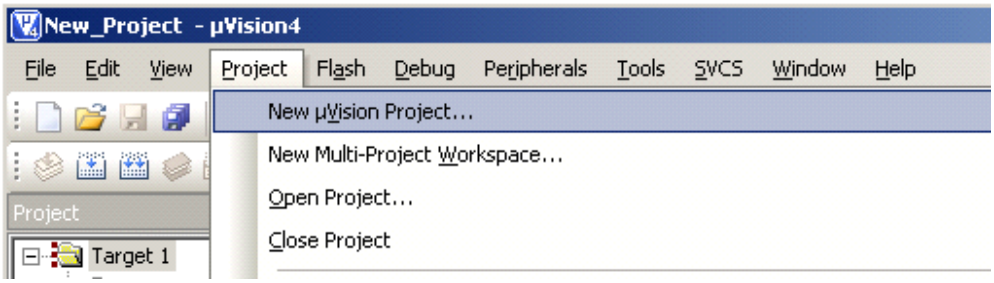


Figure 13 New µVISION4 Project

- Select your CPU type. After installation of the PMA Evaluation Kit software you should be able to select the Infineon PMA Device List.

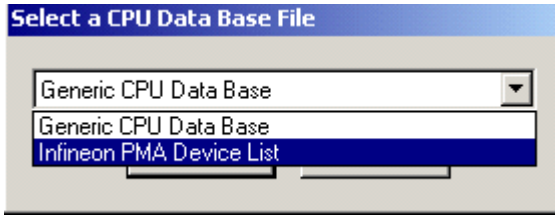


Figure 14 Select Infineon PMA Device List

- Select the PMA derivative of your choice (PMA7110 and PMA5110 provide the full feature set).

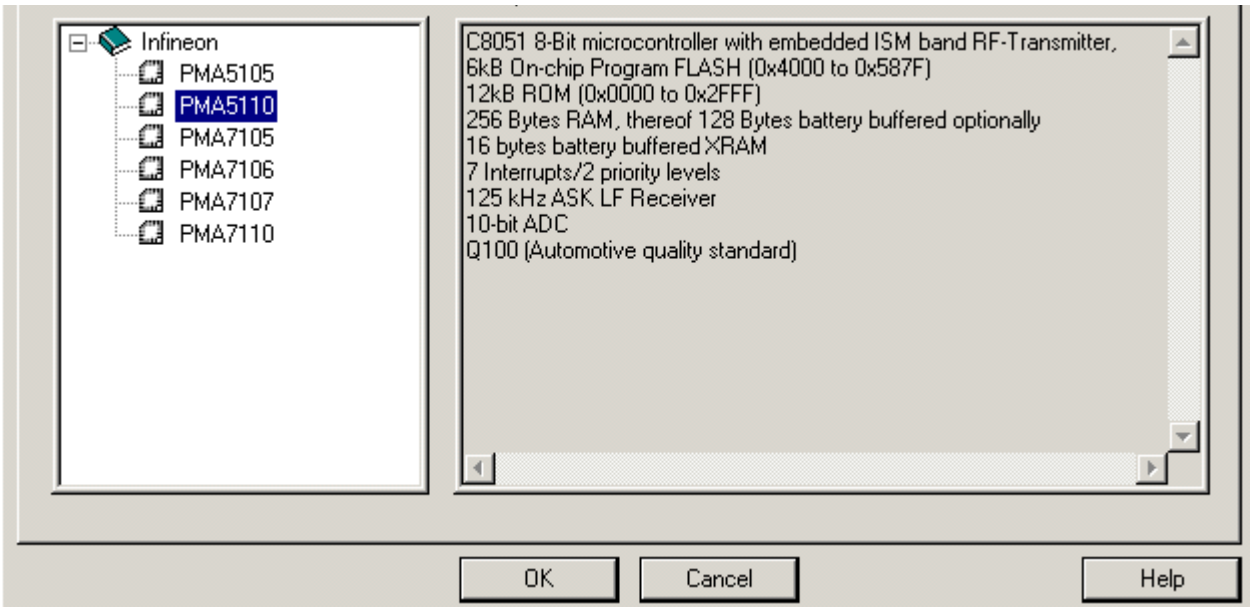


Figure 15 Select PMA derivative

- Configure your initial software project settings. Right click on your project to add “Add Group”, “Add Files to New Group” and manage:
  – Source files (.c / .a51)
  – Header files (.h)
  – File groups

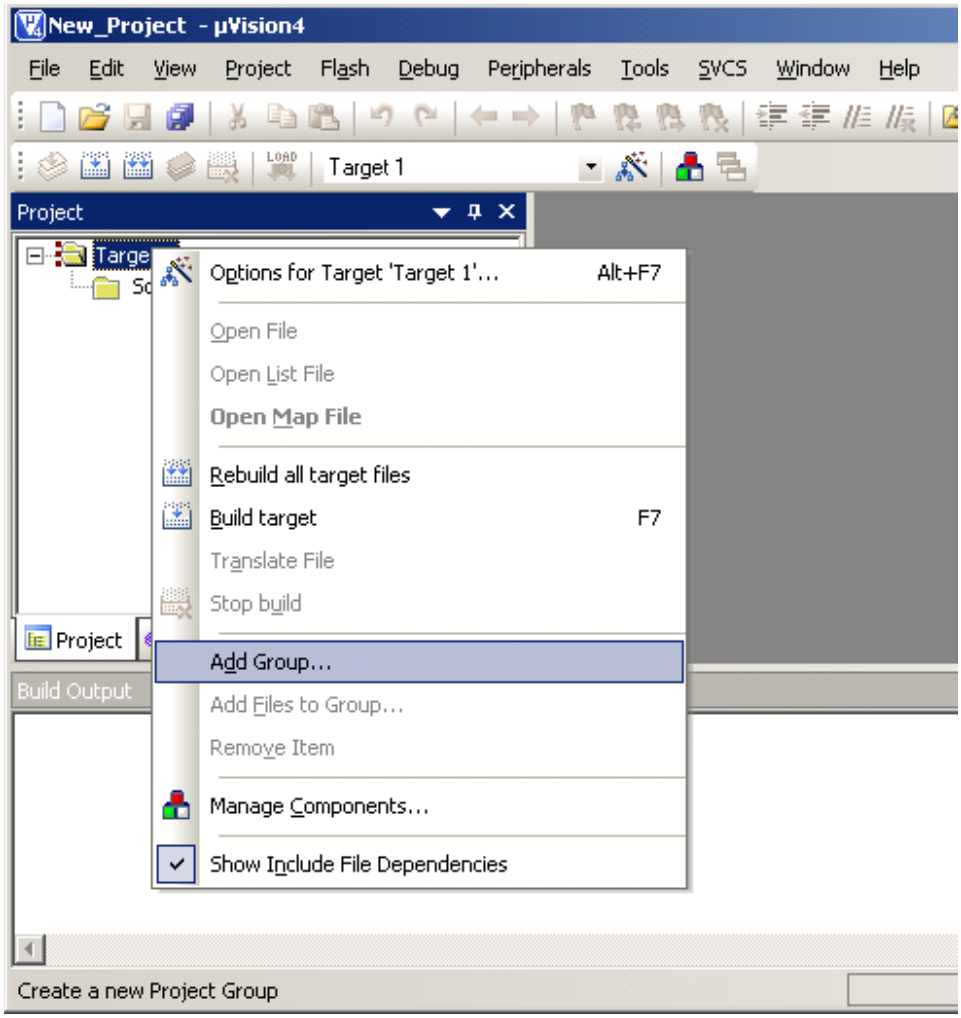


Figure 16 Add Group

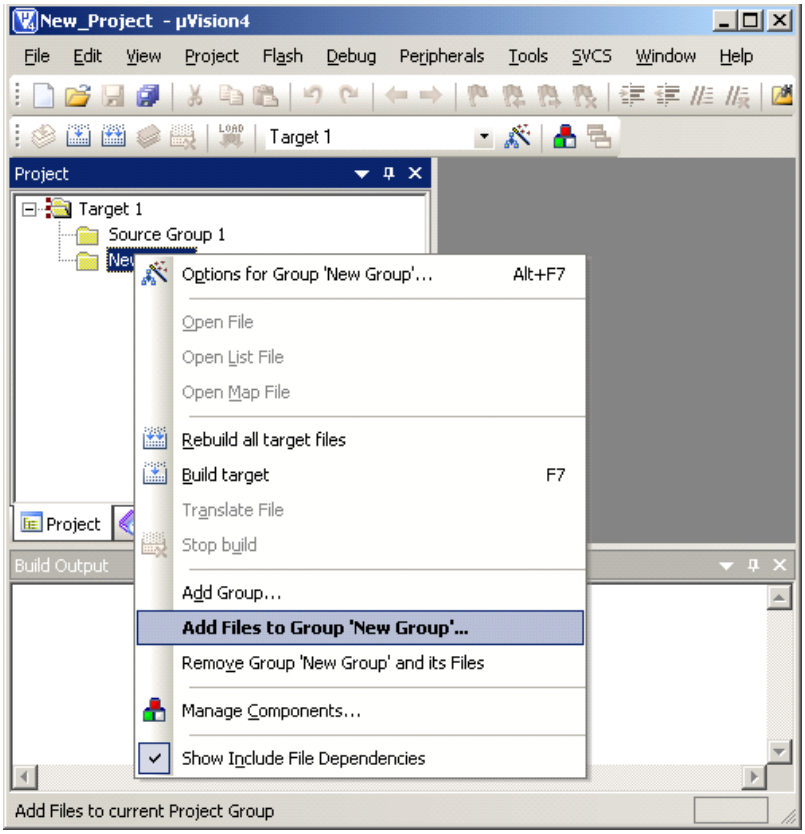


Figure 17 Add Files to New Group

- Typically, following files being part of the PMA Software Framework must be added to a PMA software project:
  - STARTUP_PMA71xx_PMA51xx.A51
  - Reg_PMA71xx_PMA51xx.h
  - PMA71xx_PMA51xx_Library.h
  - PMA71xx_PMA51xx_Library.LIB

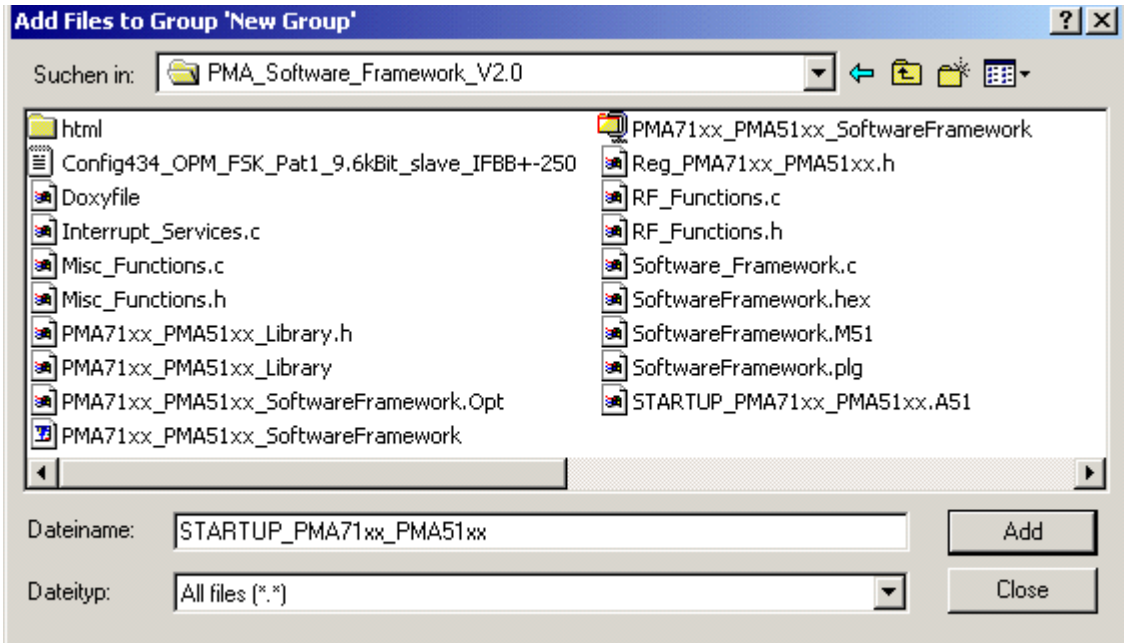


Figure 18 PMA_Software_Framework_V2.0 Files

- Adjust the settings for your project. Right click on your project and click **Options for Target.**

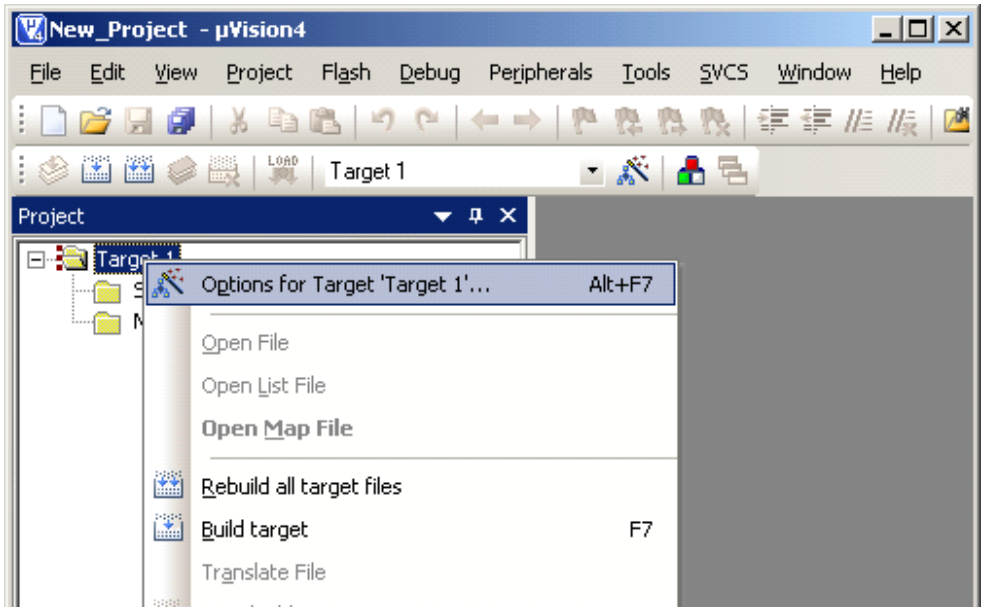


Figure 19 Options for Target

- Go to the Target dialogue. Make sure that the On-chip ROM (Flash memory) is used for code development.

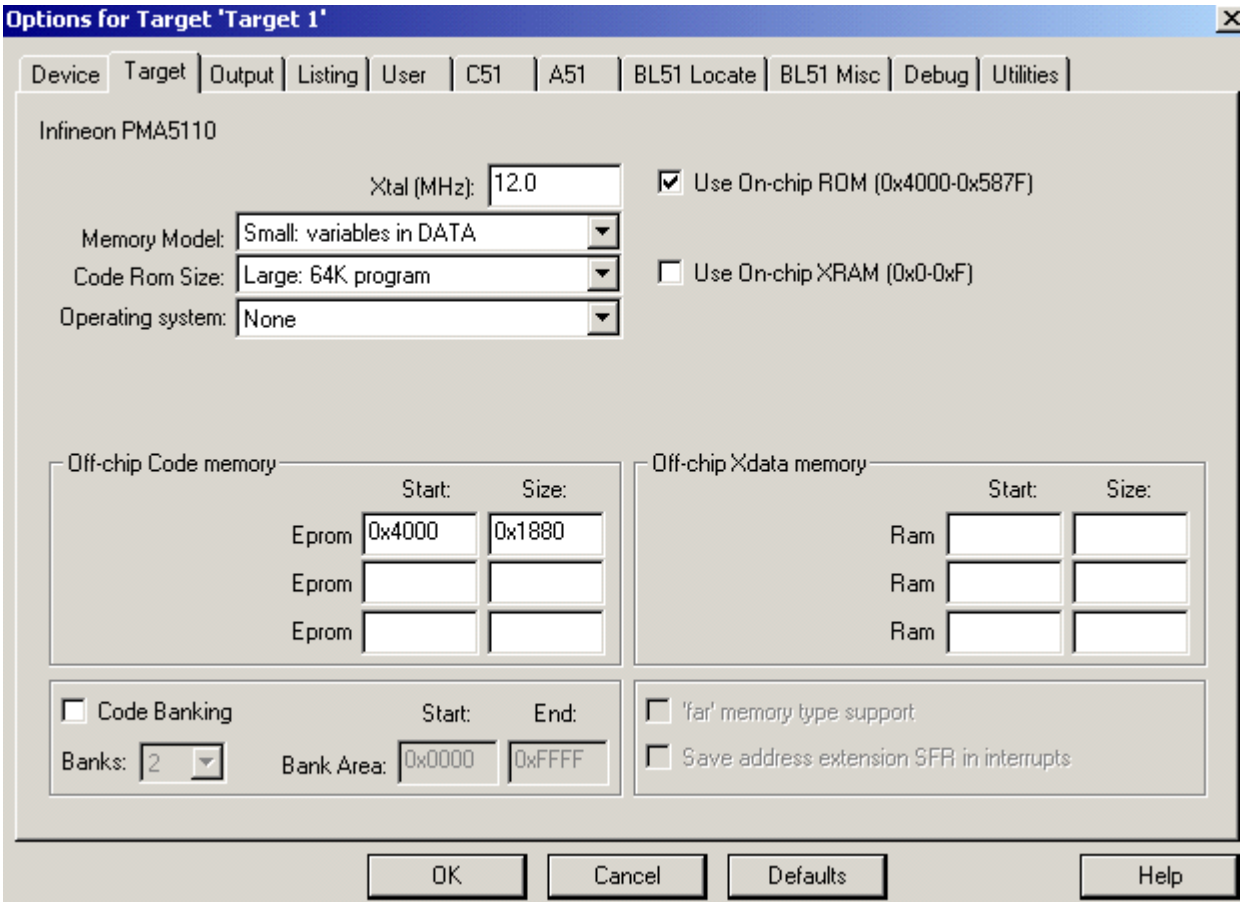


Figure 20 Target dialogue

- Go to the Output dialogue. Select to create a hex file and assign a name to it.

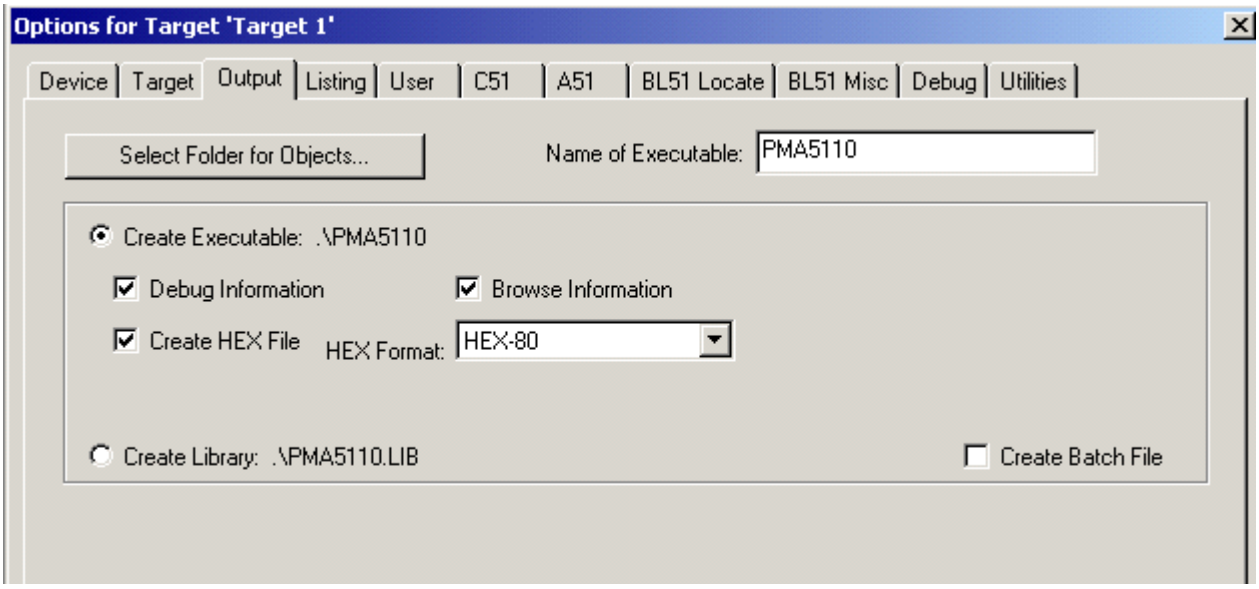


Figure 21 Output dialogue

- Go to the Debug dialogue. From the drop down menu select Infineon PMA Eval Kit Driver.

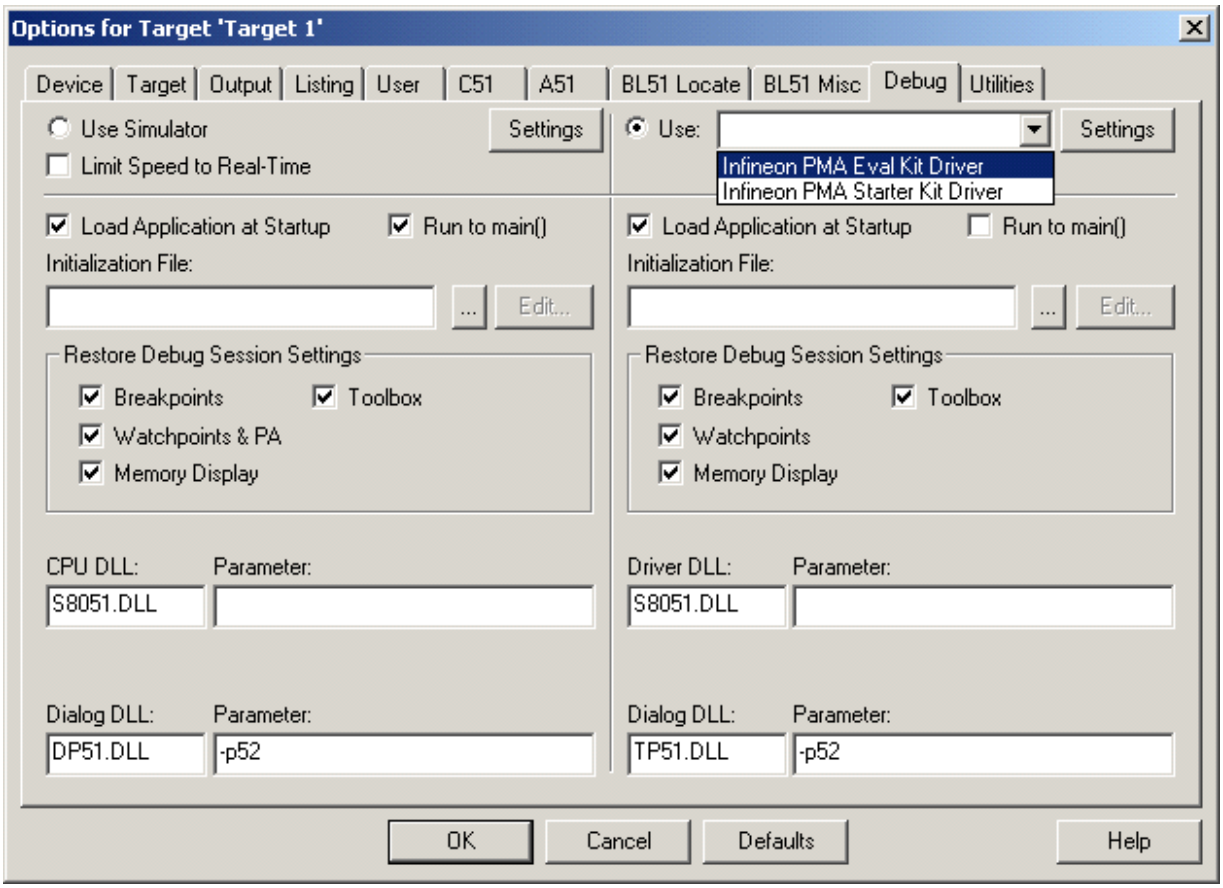


Figure 22 Debug dialogue

- Connect the PMA RF Evaluation Board to the PC via the System Interface Board (SIB) or alternatively via the PMA RF USB Stick, see **Figure 2** and **Figure 3**.

Note: If requested by the New Hardware Found Wizard (Windows), the required drivers are available in the zip-archive "IFX CDM 2.04.16 WHQL Certified.zip" which is included in the PMA Evaluation Kit software download package.

- Click on "Settings", in the Debug dialogue, then your SIB and the connected PMA Evaluation Board should be detected.

Note: If it is the first time after connecting your board this may take a few seconds as the USB interface gets initialized

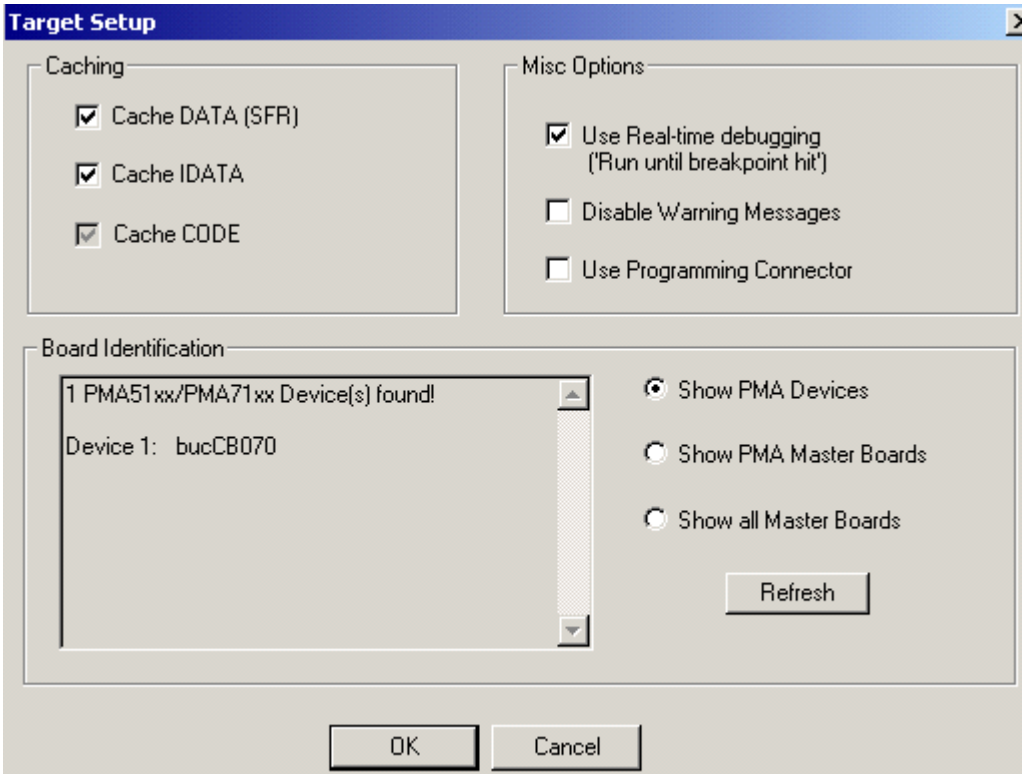


Figure 23 Debug dialogue, Settings, Target Setup

- Go to the Utilities dialogue. From the drop down menu select Infineon PMA Eval Kit Driver.

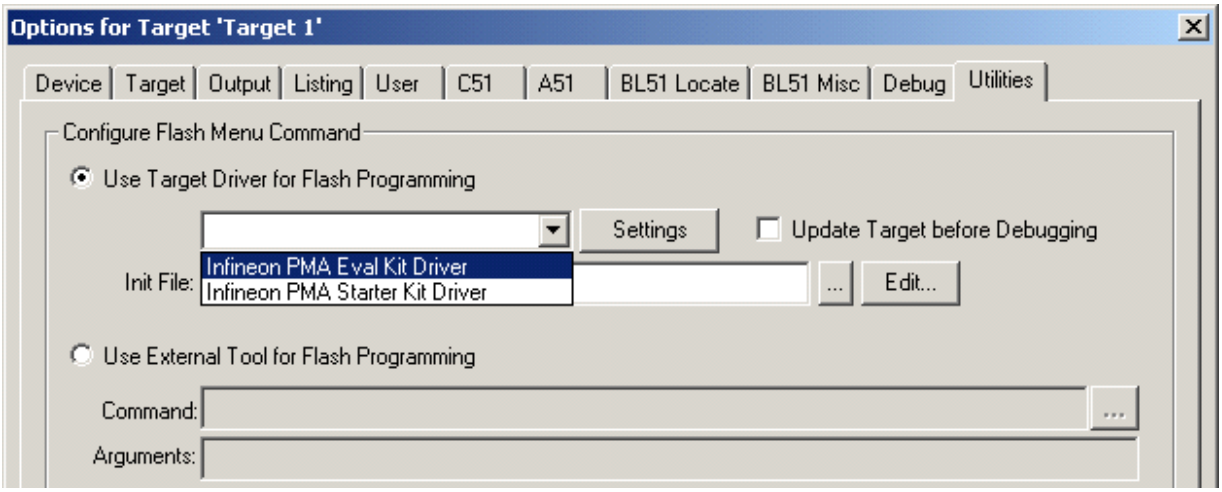


Figure 24 Select Infineon PMA Eval Kit Driver

- Click on “Settings”. Tick options: ’Erase Flash’, ’Program Flash’, ’Verify Flash’, ’Run after Download’ (before downloading, default setting).

Note: If you select the SET Lock option you cannot re-enter Programming- or Debug Mode again.

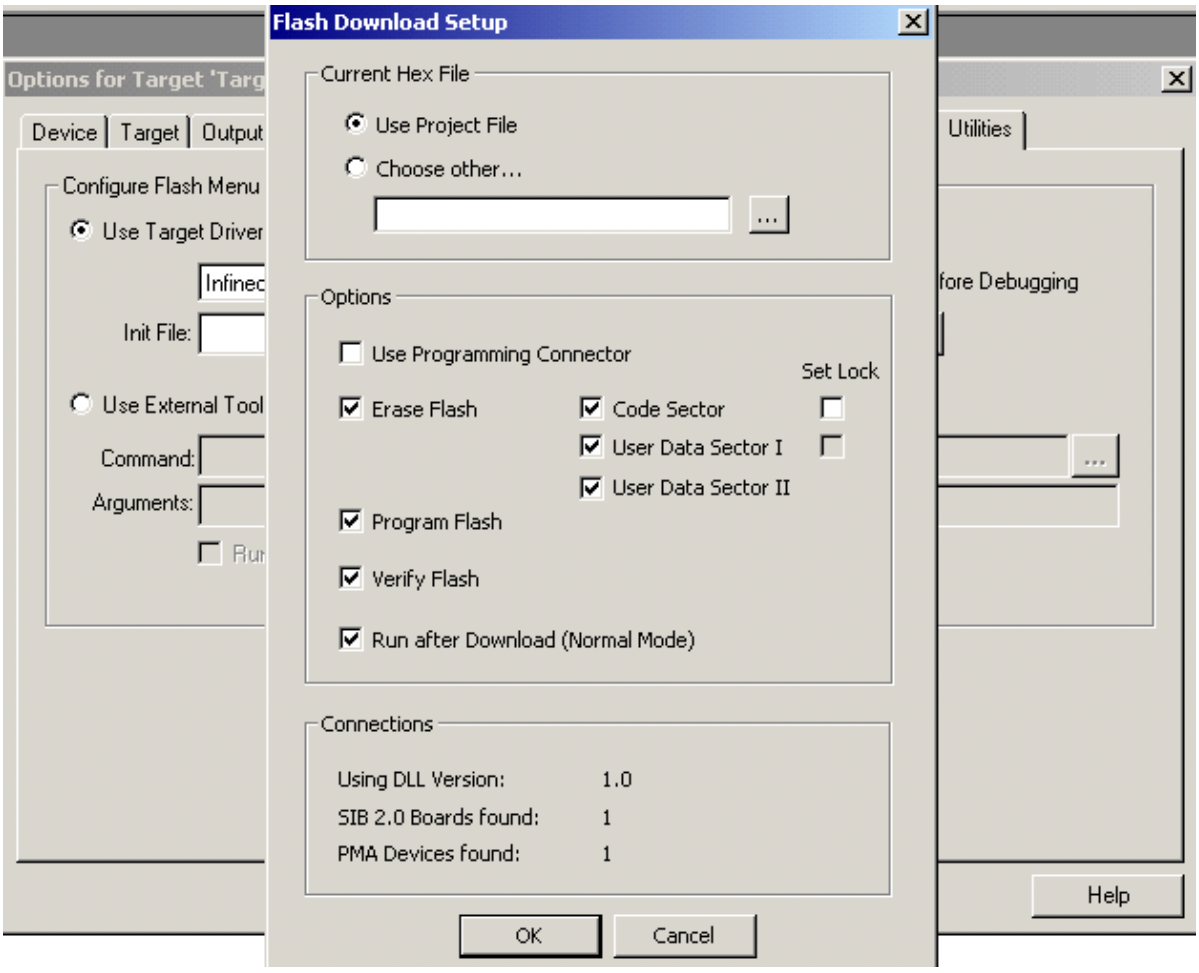


Figure 25 Flash Download Setup

4.4 Use the PMA on-chip Debugger

The KEIL™ C51 µVISION4 Tool Chain provides a powerful debugger which is directly accessing the PMA hardware. Following features are available:

- Multi- or single step execution
- Run until cursor line
- Step over
- Up to 25 breakpoints
- Run interruptible (Run/Stop)
- Real-time Run (“Run until Breakpoint”)
  - Not interruptible
  - One breakpoint
- Memory r/w access possible (SFR, IData)

Following restrictions apply when using PMA on-chip Debugger:

4.4.1 Hardware Breakpoints: Real Time debugging

The on-chip debug handler on the PMA71xx/PMA51xx is based on two hardware breakpoints. As a consequence the debugger functions *Run (F5), Step Over (F10), Run to Cursor line (Strg+F10)* are internally a rapid sequence of *Step (F11).* This single stepping will not execute the instructions in the same execution time as in *Normal Mode.*

RF transmission or bus transfer will show a slower baud rate, timers keep running on full speed whilst code execution is delayed. This may cause the system to be incompatible to *Normal Mode* environment.

Full-speed debugging can be achieved by setting the *Use Real-time debugging* flag. Be aware that if none of the hardware breakpoints is hit, the communication to the target is lost.

4.4.2 Hardware Breakpoints: Debugging of interrupt functions

The two hardware breakpoints are provided to help debug program execution. It is not possible to display interrupt handling during debugging using the functions *Run (F5), Step Over (F10), Run to Cursor line (Strg+F10).*

In this way it is possible to debug the code not in real-time whilst time-critical functions are handled in interrupt service routines in real-time between the (rapid) single steps. Be aware that interrupt service routines may alter SFRs and variables.

When an interrupt service routine shall be debugged, a breakpoint has to be set into the interrupt service routine and the option *Use Real-time debugging* has to be selected. Once the interrupt service routine is active (Breakpoint hit) single stepping can be continued

4.4.3 Debugging of Clear-on-Read SFRs

The debugger fetches SFRs for displaying in the Watch window. SFRs that contain Clear-on-Read flags will be displayed correctly in the Watch window of the Debugger, nevertheless the fetch for the Watch window clears the flag contents and will cause the instructions to be executed invalid.

4.4.4 Debugging of functions out of the PMA Function Library

Debugging of the PMA Function Library is blocked. It is not possible to step through the lines of code that are stored in the ROM. The debugger automatically steps through the PMA Function Library without interaction to the the Debugger. After the return instruction in the ROM the debugging can be continued. It is possible to execute functions out of the PMA Function Library in real-time debugging mode by *Use Real-time debugging* and *Run to Breakpoint.*

5 Pre-installed PMA Test software

Upon shipment of the PMA Evaluation Kit there is a test software stored in the PMA Flash memory. This program code will be executed automatically after power-on.

Main features of the Test software are:

- RF continuous wave output
- ADC test: Measurement of voltage applied to AMUX1
- LF carrier detect wake-up
- PMA IC revision identification

The different test modes may be selected by setting a jumper on the related position of connectors X13 and X16 and by pressing buttons PP4 and PP5:

Table 5 Pre-installed PMA Test software

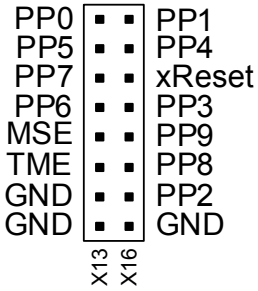
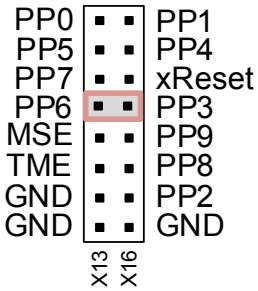
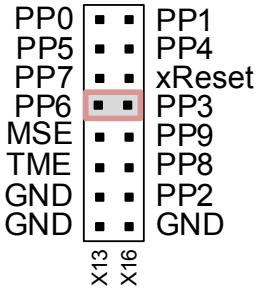
Test selection	Test content and response
	**IDLE:** If there is no jumper at X13 and X16 and if buttons PP4 and PP5 are not pressed, PP8 and PP9 are toggling at a frequency of approx. 20Hz.
	**RF 315MHz, +5dBm:** RF continuous wave output at 315MHz. PP8 and PP9 will output 0V.
 + Press button PP4 (PP4 to GND)	**RF 434MHz, +5dBm:** RF continuous wave output at 434MHz. PP8 will output V_{Bat}. PP9 will output 0V.

Table 5 Pre-installed PMA Test software

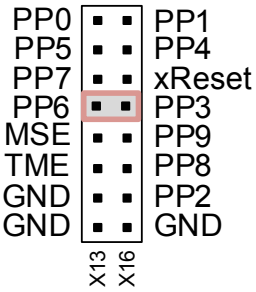
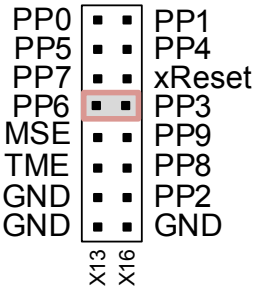
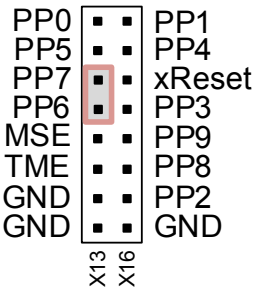
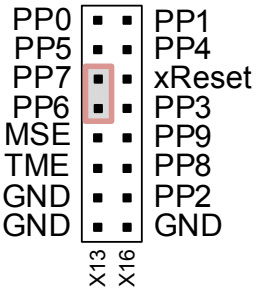
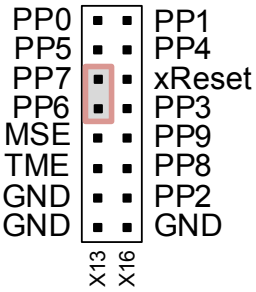
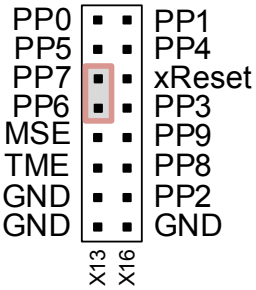
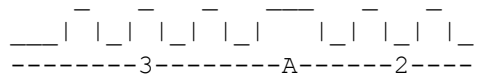
Test selection	Test content and response
 + Press button PP5 (PP5 to GND)	**RF 434MHz, +10dBm:** RF continuous wave output at 434MHz. PP8 will output 0V. PP9 will output V_{Bat}.
 + Press button PP4 (PP4 to GND) + Press button PP5 (PP5 to GND)	**RF 868MHz, +10dBm:** RF continuous wave output at 868MHz. PP8 will output V_{Bat}. PP9 will output V_{Bat}.
	**RF 915MHz, +10dBm:** RF continuous wave output at 915MHz. PP8 and PP9 will output 0V.
 + Press button PP4 (PP4 to GND)	**ADC:** Apply 2,0V at AMUX1 and connect AMUX2 to GND. Measured value in range (1,9V to 2,1V): PP8 will output V_{Bat} Measured value out of range: PP8 will output 0V.

Table 5 Pre-installed PMA Test software

Test selection	Test content and response
 + Press button PP5 (PP5 to GND)	**LF-receiver carrier detect wake-up:** Apply LF-carrier at LFIn (X4). LF-carrier detected: PP8 is toggling with every carrier detect wake-up (approx. every 1,6 ms). LF-carrier not detected: PP8 will output 0V
 + Press button PP4 (PP4 to GND) + Press button PP5 (PP5 to GND)	**Firmware revision:** Software (ROM) Revision number is put out to PP8. Upper nibble of MSB is not put out! Short pulse (1ms) counting: 1=one, 2=two, …. Long pulse (4ms) counting: A=one, B=two, …. Short pulse (1ms) counting: 1=one, 2=two, …. e.g.: 13A2.. 

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