Introduction

The **EVAL-ADICUP360** is an Arduino-like platform based on the **ADUCM360** fully integrated, 3.9 kSPS, 24-bit data acquisition system that incorporates dual high performance, multichannel sigma-delta (Σ-Δ) analog-to-digital converters (ADCs), a 32-bit ARM Cortex™-M3 processor, and Flash/EE memory on a single chip. The platform has an Arduino-Due form factor and has two additional PMOD connectors. An Eclipse based development environment is provided for code development and debugging. The base platform is accompanied by a set of shields provided by Analog Devices but it can also work with 3rd party Aduino shields.

This guide is structured as follows:

- **Hardware** - Contains hardware-related information about the base board and the various shields
- **Quick Start Guides** - Provides all the necessary steps to get the software environment up and running
- **Reference Designs** - Contains detailed descriptions of the software reference designs available for the base board and the shields
- **Help and Support** - Provides info on where to get support on any questions you might have regarding the hardware or the software

Tool Chain Guides

This chapter provides all the necessary steps to get the software environment up and running.

It contains two main sections:

- **Tool Chain Download & Installation Guide** - Provides all the necessary instructions on how to download and install the customized software development environment for ADuCM360 based on Eclipse IDE.
- **Tool Chain Setup & User Guide** - Provides information about using the customized Eclipse IDE, in particular, the process of importing, building, debugging, and creating user applications for the ADuCM360 microcontroller.

- **Using EVAL-ADICUP360 with IAR and Keil IDEs** - Provides detailed information how to use the EVAL-ADICUP360 board with other IDEs than Eclipse, such as IAR Embedded Workbench and Keil µVision.

Tool Chain for EVAL-ADICUP360

This page provides all the necessary steps to get the customized Eclipse software environment up and running in either Windows or Linux.

The software development environment for EVAL-ADICUP360 is based on open source tools, and includes the following features and components:

- ADuCM360 customized Eclipse IDE for C/C+ + Developers
- GNU Tools for ARM Embedded Processors (GCC toolchain for ARM processors)
- GNU ARM Eclipse Plug-ins, Copyright © 2009 Liviu Ionescu, A family of Eclipse CDT extensions and tools for GNU ARM development (open source ARM debug and build tools)
- GNU ARM Eclipse Build Tools, Copyright © 2009 Liviu Ionescu (GNU make & busybox: sh, rm and echo)
- OpenOCD with support for ADuCM360 microcontroller (open source SWD)
- Mbed CMSIS-DAP/Serial drivers (for Windows)

The **Windows IDE** compared to **Linux IDE** is pretty much the same. So if the documentation mainly references the **Windows** version, things directly apply to the **Linux** version as well.

The **EVAL-ADICUP360 Toolchain** is based on **Eclipse IDE**, but because the MBED platform provides CMSIS-DAP interface to connect to the board, the EVAL-ADICUP360 can be used without problems together with **IAR Embedded Workbench IDE** or **Keil µVision IDE**.

Pre-Requisites and Requirements List

There are a few things that you will need for the tools and software to work properly.

- PC or laptop computer
- (2) Micro USB to USB cables

Both USB cables needs to have ALL data lines connected, can't use a charging only micro USB cable.

- Terminal Program to interface your PC with the EVAL-ADICUP360

    - Putty
    - Tera Term
    - Or other favorite Terminal program
- Detailed ADuCM360 User Guide

Windows Tool Chain Installer Instructions

Windows Tool Chain Installer is a tool that facilitates the installation of the entire tool chain. It's an single executable file which will either automatically download or install bundled packs of all of the necessary tool chain components. The following open source components are included in the tool chain installer:

- Customize ADuCM360 Eclipse IDE for C/C+ + Developers
- OpenOCD with ADuCM360 support
- GNU Tools for ARM Embedded Processors
- GNU Eclipse Build Tools for ARM Processors
- Mbed Windows serial port driver

DURING INSTALLATION ONLY CONNECT HARDWARE DEVICE WHEN YOUR ARE PROMPTED BY THE DRIVER INSTALLER. WAIT TO ENSURE THAT THE HARDWARE DRIVERS ARE COMPLETELY (AND SUCCESSFULLY) INSTALLED BEFORE MOVING FORWARD WITH THE SOFTWARE INSTALL

EVAL-ADICUP360 Tool Chain Installer for Windows

The executable installs the components to a default local directory structure which can be found below.

- ADuCM360 Eclipse IDE installs to **C:\Analog Devices\ADuCM360-IDE\Eclipse** (also creates links in the Start menu)
    - The customized ADuCM360 Eclipse IDE includes the required Eclipse plug-ins for ARM processor and for the debug tools.
- OpenOCD is saved in **C:\Analog Devices\ADuCM360-IDE\openocd\usr\bin**
- GNU ARM Processor Tools will be saved to **C:\Program Files (x86)\GNU Tools ARM Embedded\4.9 2014q4\arm-none-eabi**
- GNU ARM Eclipse Build Tools will be save to **C:\Program Files (x86)\GNU ARM Eclipse\Build_Tools**

Linux Tool Chain Installer Instructions

There are two methods to get **Linux Tool Chain Installer**:

- **Debian packages** for 32-bits and 64-bits
- **Tarball packages** for 32-bits and 64-bits

The preferred way is to use the **debian packages** (.deb). You may be asked if you want to install them while there are being downloaded. If not, you can use your file browser. The **debian package** is typically recognized and associated with your distribution package management system. In any case you can also install them from the command line using following command:

```
# sudo dpkg -i DEB_PACKAGE
```

The alternative way is to download the self-contained and relocateable **tarball packages** (.tar.gz). The only advantage is that unlike the **debian package** is installed system wide. You can extract the tarball anywhere including your *HOME* directory:

```
# tar xzf TAR_PACKAGE
```

The **tarball package** also includes some simple shell scripts that installs a symplic link to the **aducm360-ide** executable into */usr/local/bin* , copies the *udev* rules for the OpenOCD debugger, installs a application launcher with icon etc.

Depending on your system (32-bits or 64 bits) you should pick one of the available versions:

EVAL-ADICUP360 Tool Chain Installer for Linux 32-bit (debian package)
EVAL-ADICUP360 Tool Chain Installer for Linux 64-bit (debian package)
EVAL-ADICUP360 Tool Chain Installer for Linux 32-bit (tarball package)
EVAL-ADICUP360 Tool Chain Installer for Linux 64-bit (tarball package)

Tool Chain Setup User Guide

This page provides detailed information about using the ADuCM360 customized Eclipse IDE, in particular, the process of importing, building, debugging, and creating user applications for the ADuCM360 microcontroller.

This page will outline:

1. How to import existing projects into your workspace
2. How to build the .elf files, for programming the ADuCM360
3. How to configure the debug session for a particular user application
4. How to start a debug session
5. How to create a new project

Workspace and Projects

The workspace is a folder where Eclipse can access local copies of user application projects. When starting Eclipse, a prompt will ask you for a location of this folder. This is the location where all the ADuCM360 user applications will be stored.

Using the Tool Chain

The instructions below have been tested in Windows XP and Windows 7, on both 32-/64-bit machines.

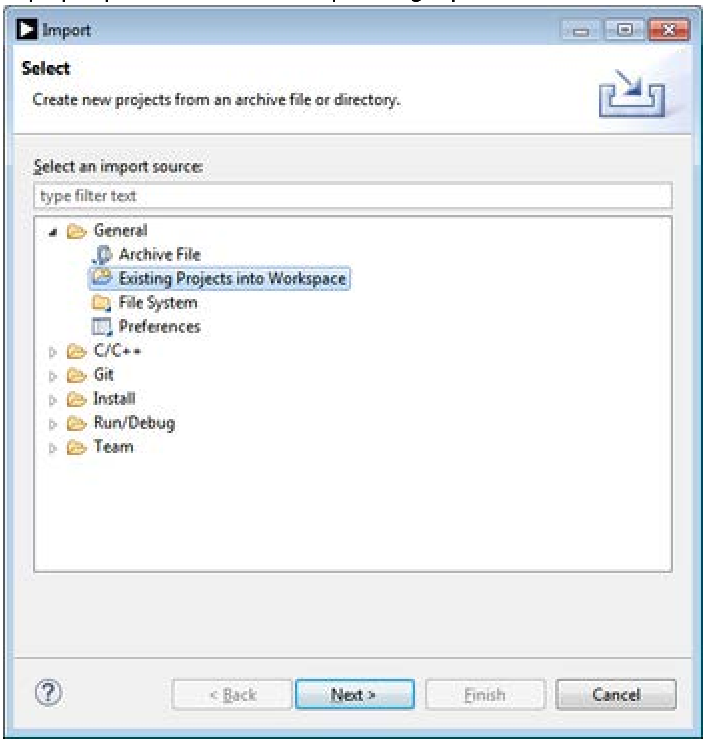
Importing a Project

There are 2 methods for importing existing programs:

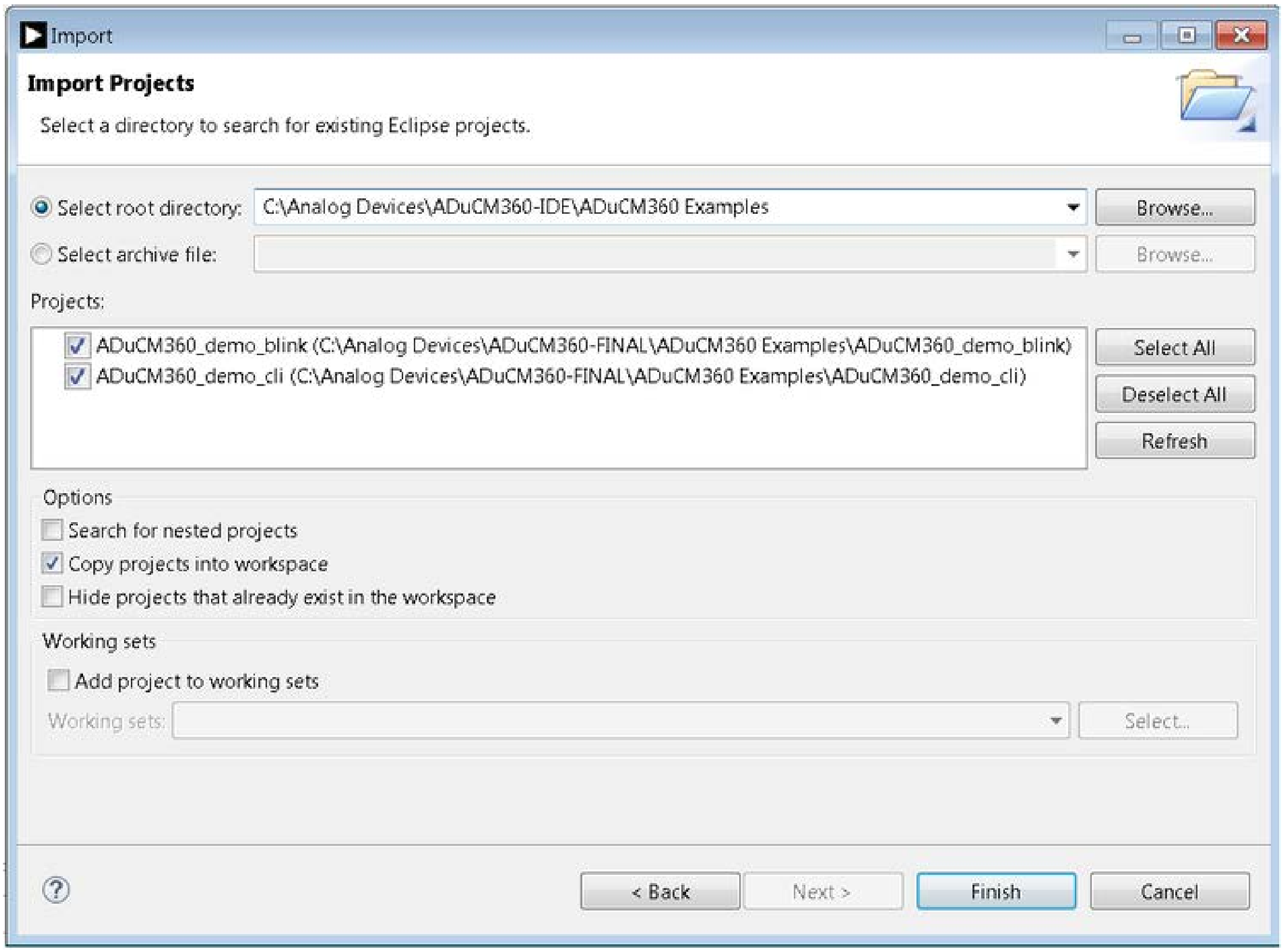
- Examples that come with the installer package.
- Examples which are in our GIT repository (most up to date content).

Only one method is needed to get started with the EVAL-ADICUP360.

How to Import Existing Projects within the Installer Package

1. From the menu located in the tool bar, select the *File → Import* option.
2. A window will pop-up with several importing options, select *General → Existing Projects into Workspace.* 

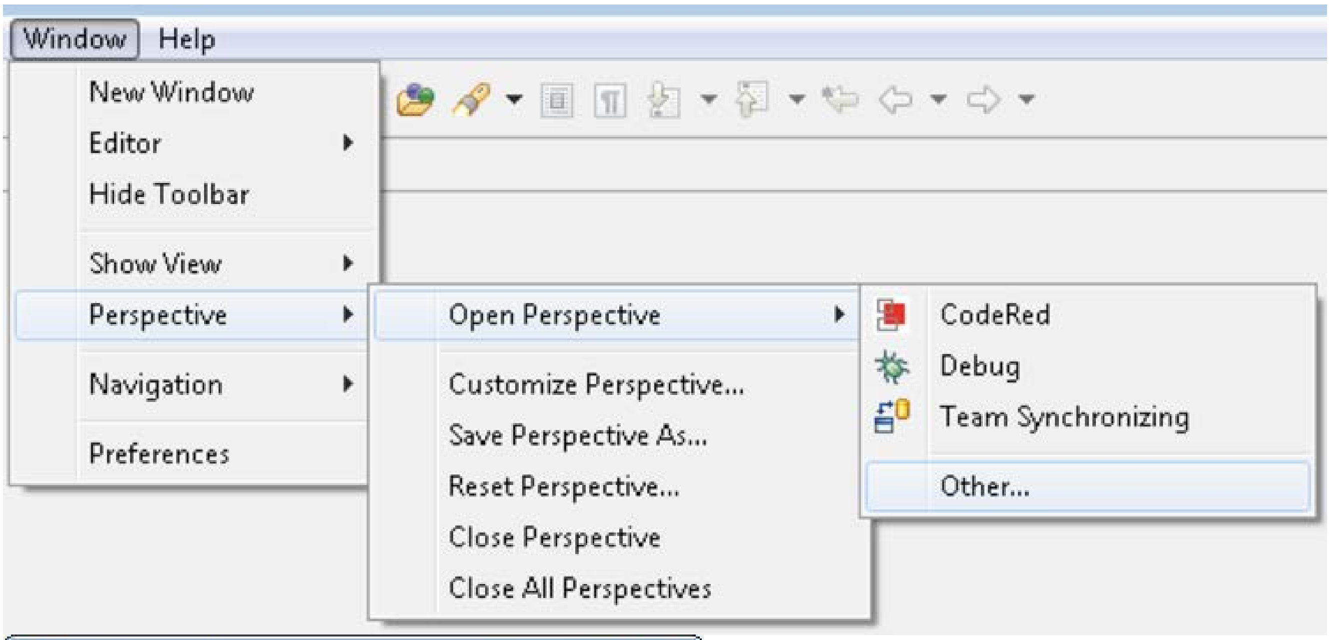
3. Select *Browse* in the dialog window and search for the local copy of where the ADuCM360-IDE examples are. If you used the default directory that can be found here: **C:\Analog Devices\ADuCM360-IDE\Examples**
4. Make sure that the check-box *Copy projects into workspace* is checked (this creates a local copy of the projects and preserves the original versions) and press *Finish* .

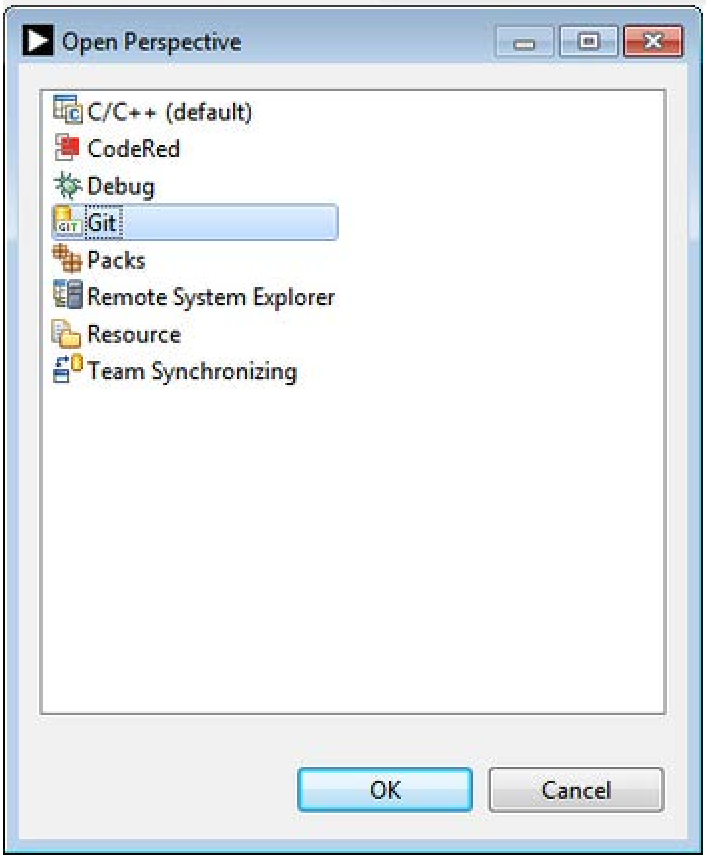


If you imported the example programs from the installer, you can skip ahead to “Building the .ELF/.HEX Files” section. The only time you will need to import from the GIT repository, is if you want to look for newly released/updated programs.

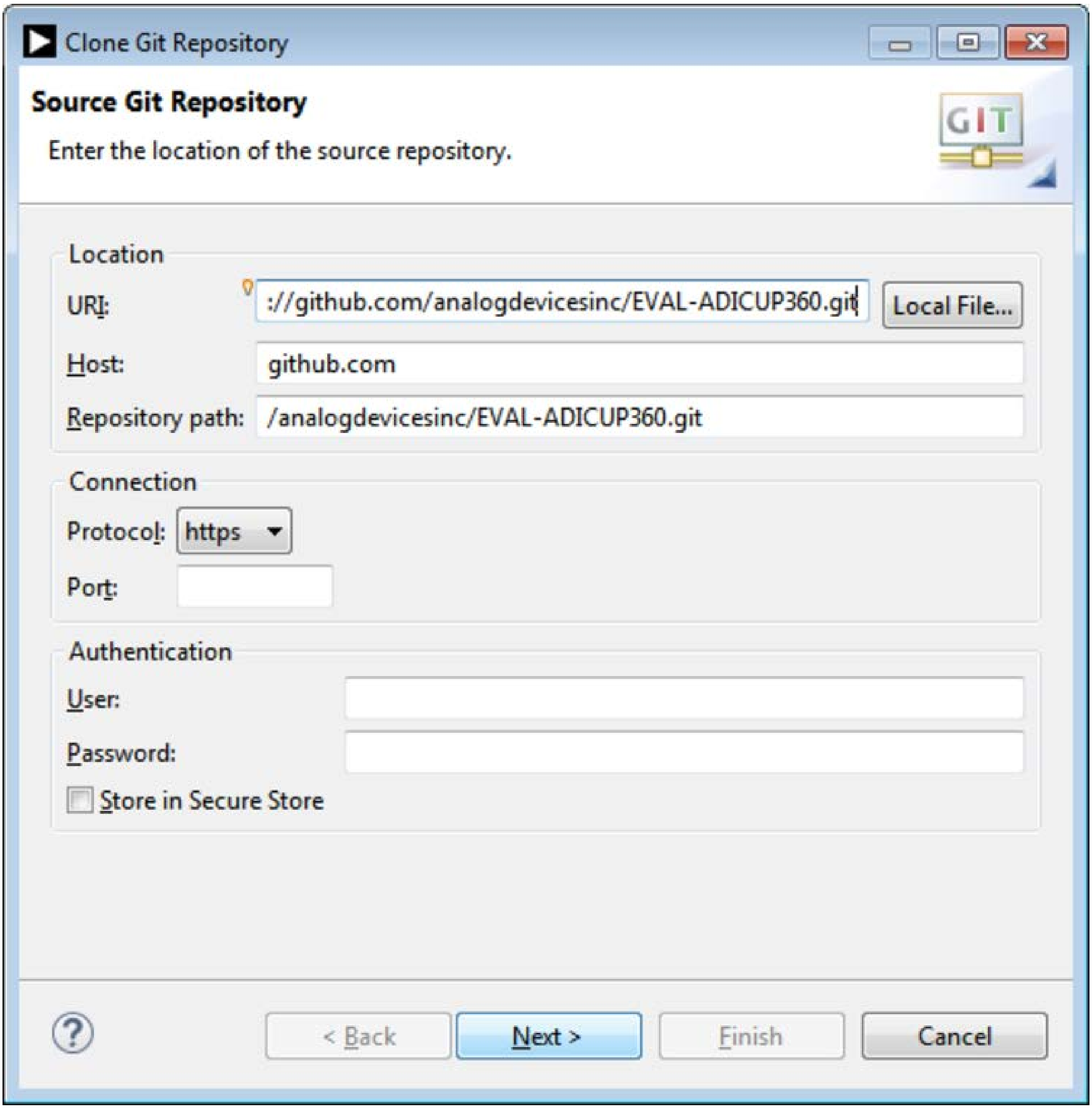
How to Import Existing Projects from the GIT Repository

1. Open the GIT perspective window by navigating the menu near the tool bar. *File → Perspective → Open Perspective → Other → GIT* and the press “OK”.

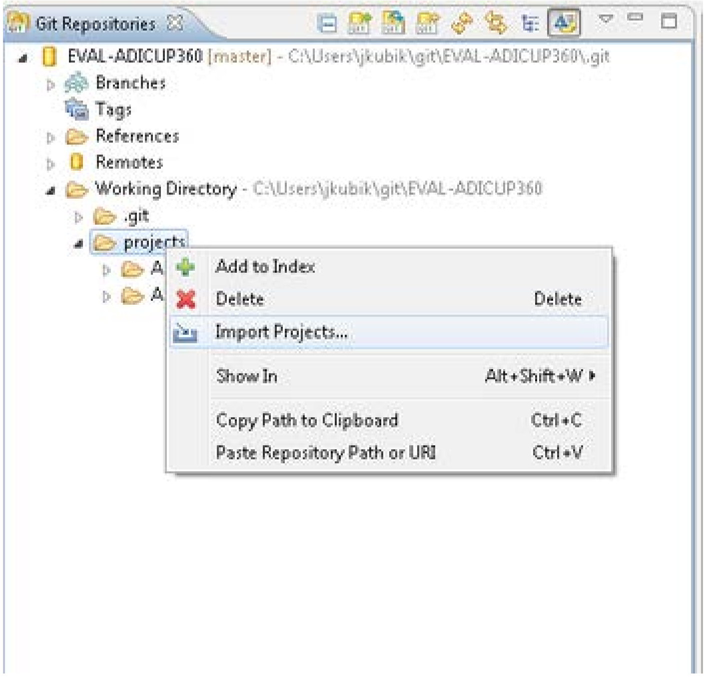




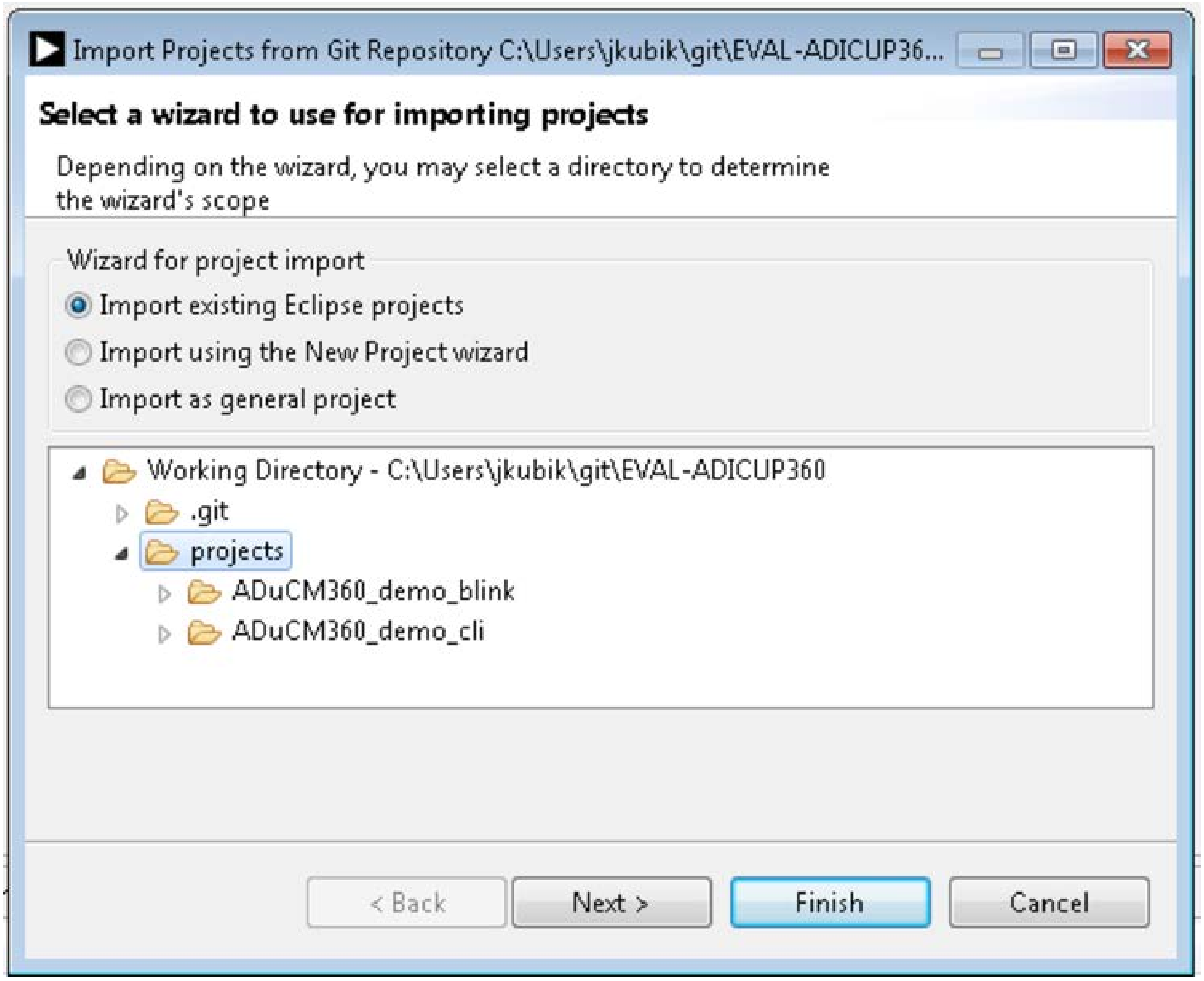
2. Clone the Git repository which contains all the latest code and projects associated with the ADuCM360. Populate the URI field with the following address.
    1. **URI:** - https://github.com/analogdevicesinc/EVAL-ADICUP360.git
    2. Click *Next* → *Next* → *Finish*

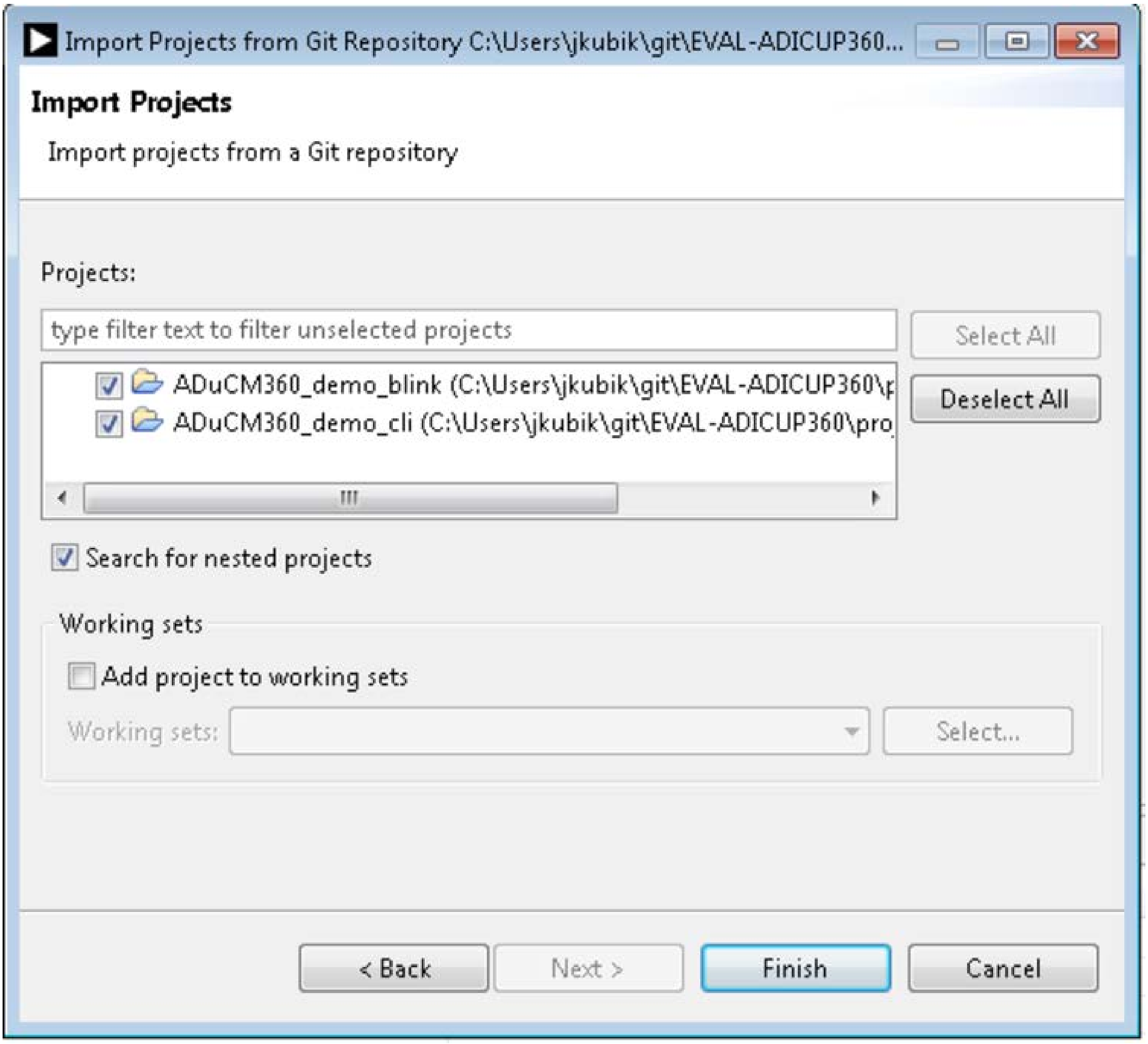


3. In the Git Repositories window, *Right Click* on *Projects* folder and select the *Import* option.



4. Select the radio button for *Import existing Eclipse projects* and click on the *projects* folder as the destination.





5. Click *Next* → *Finish*

Building the .ELF/.HEX Files

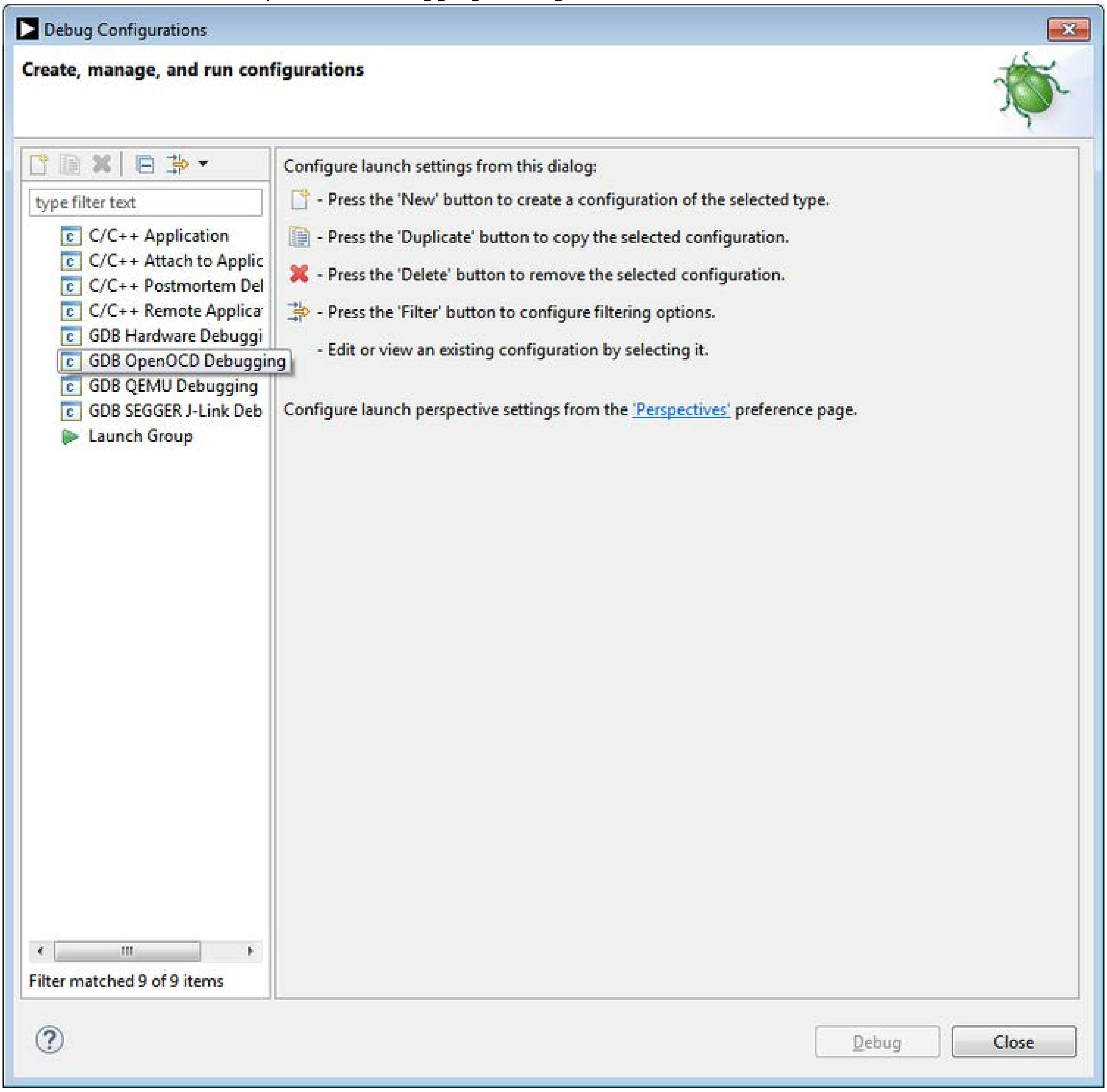
It's important to build your project before setting up the debug configuration. This will allow the debug configuration to automatically populate the appropriate fields.

1. Starting on the C/C+ + perspective, select the project you want to debug in the *Projects Explorer* Window.
2. Right click on the project and select the *Build Project* option.
   - Could also go up to the tool bar and click on the *Hammer* icon .

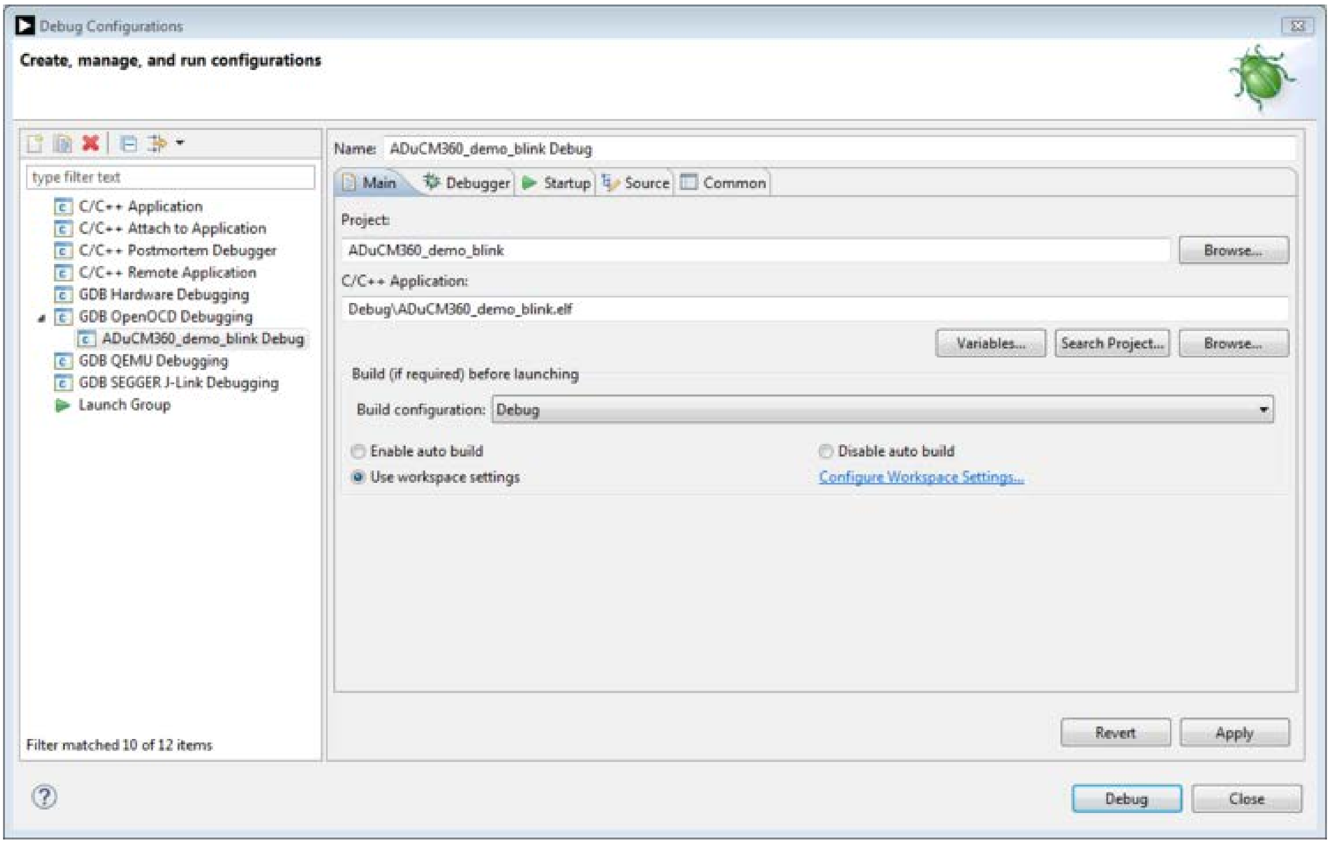
Setting up a Debug Configuration for the Project

A new debug configuration must be set up for EACH application you intend on developing/debugging. So you will have many different debug configurations, depending on the number of programs you create/debug.

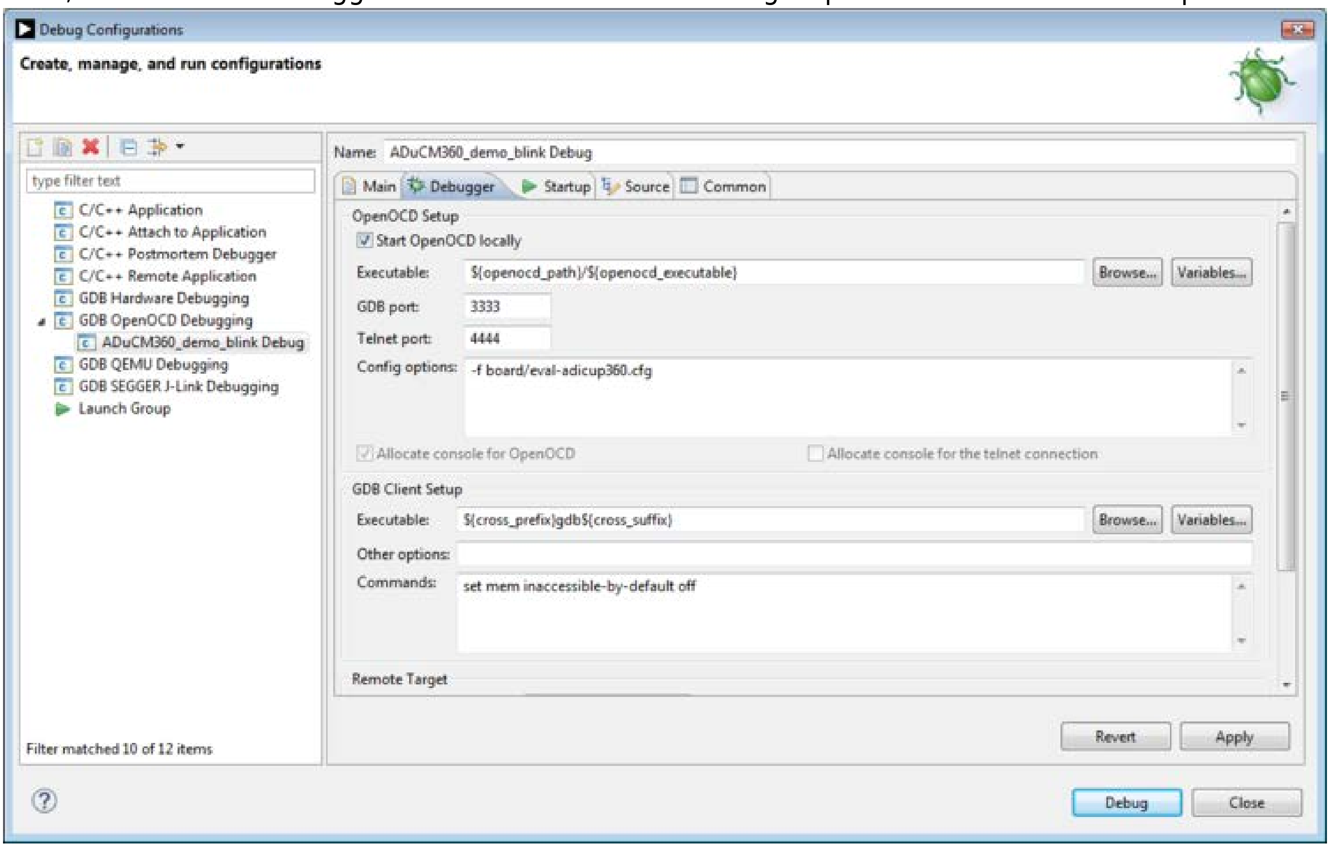
1. Go to the menu bar and follow this path, *Run → Debug Configurations...*
    - Alternatively, locate the small bug icon  in the tool bar and click the small downward facing arrow to the right, and select the *Debug Configurations...* option from the menu.
2. Double click the *GDB OpenOCD Debugging* configuration from window.



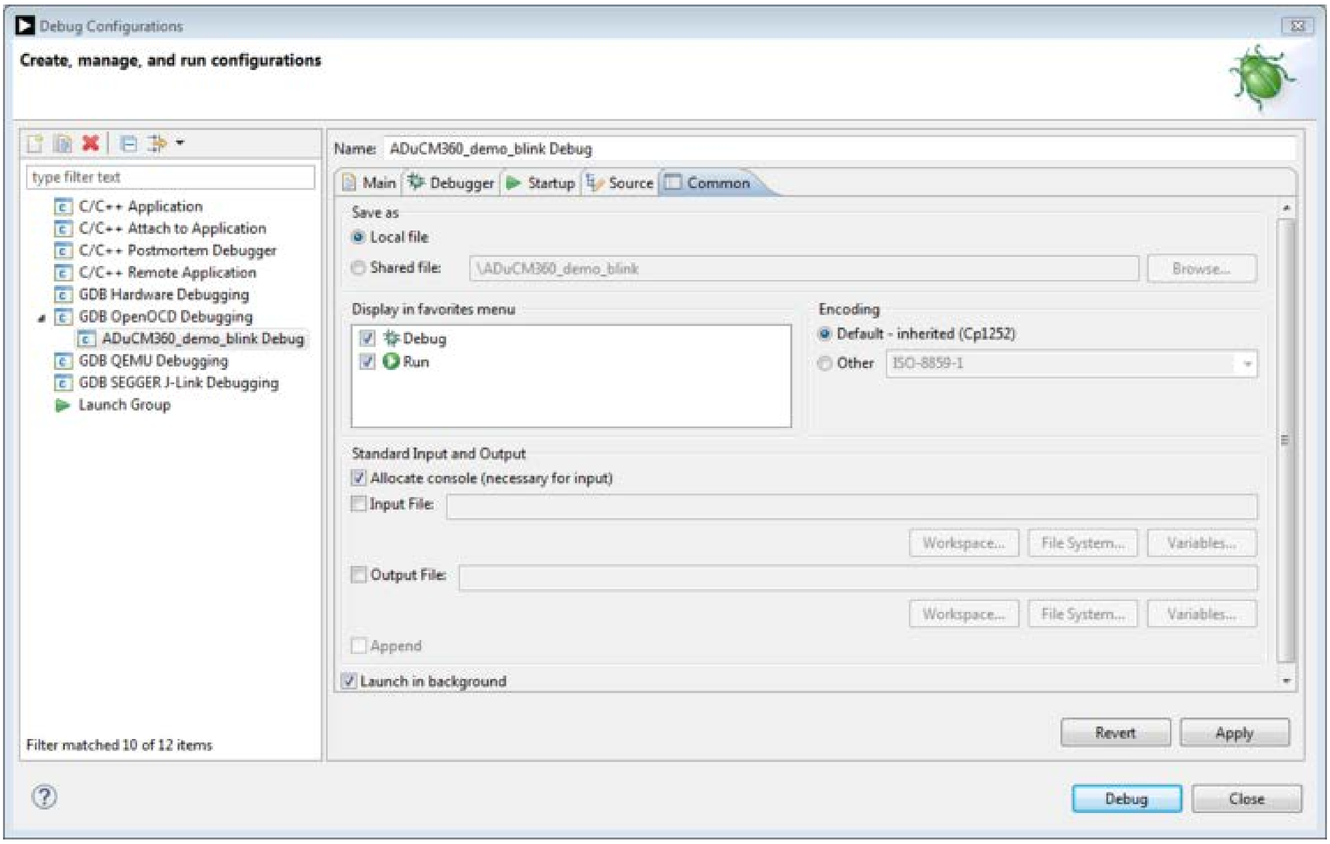
3. The necessary input fields should be populated, assuming that you built your project in the previous step. The following images should be used as a reference if some of the fields are blank.



4. Next, switch to the Debugger tab and ensure the following required GDB commands are present.

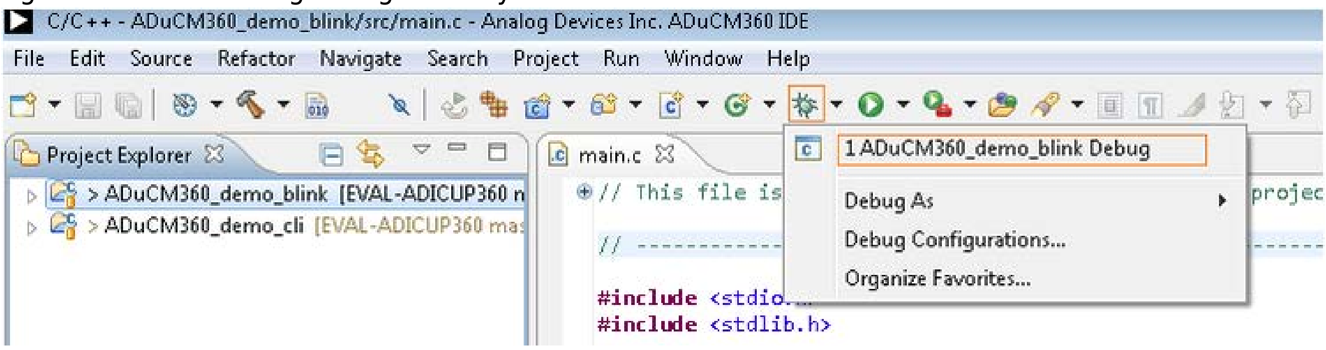


5. Finally, click the checkbox in the Common tab --> *Display in Favorites Menu* to make the created debug configuration appearing in the Debug Configurations section of the menu: Click “Apply”, then “Close”.

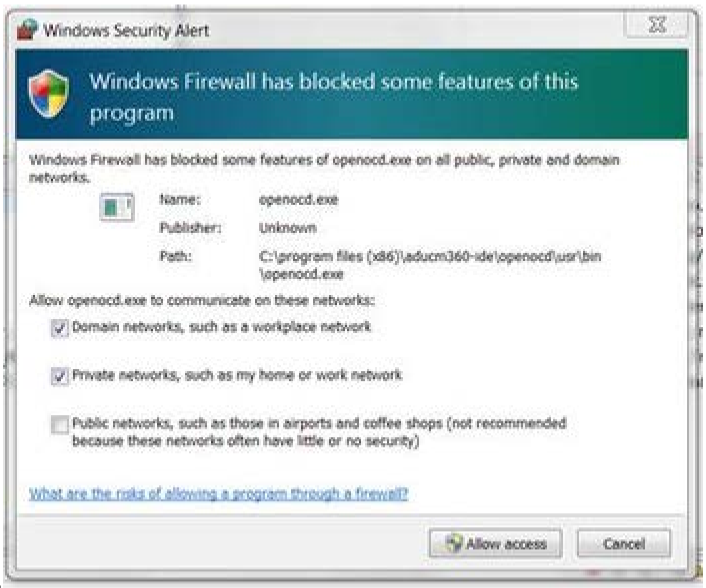


Debugging an Application

1. Make sure the EVAL-ADICUP360 board is connected to the computer via the **DEBUG USB** port. (The micro USB connector closest to the DC barrel jack)
2. Using the tool bar, navigate to the small Debug icon and click on the downward arrow to the right. Select the debug configuration you want to download to the ADuCM360.

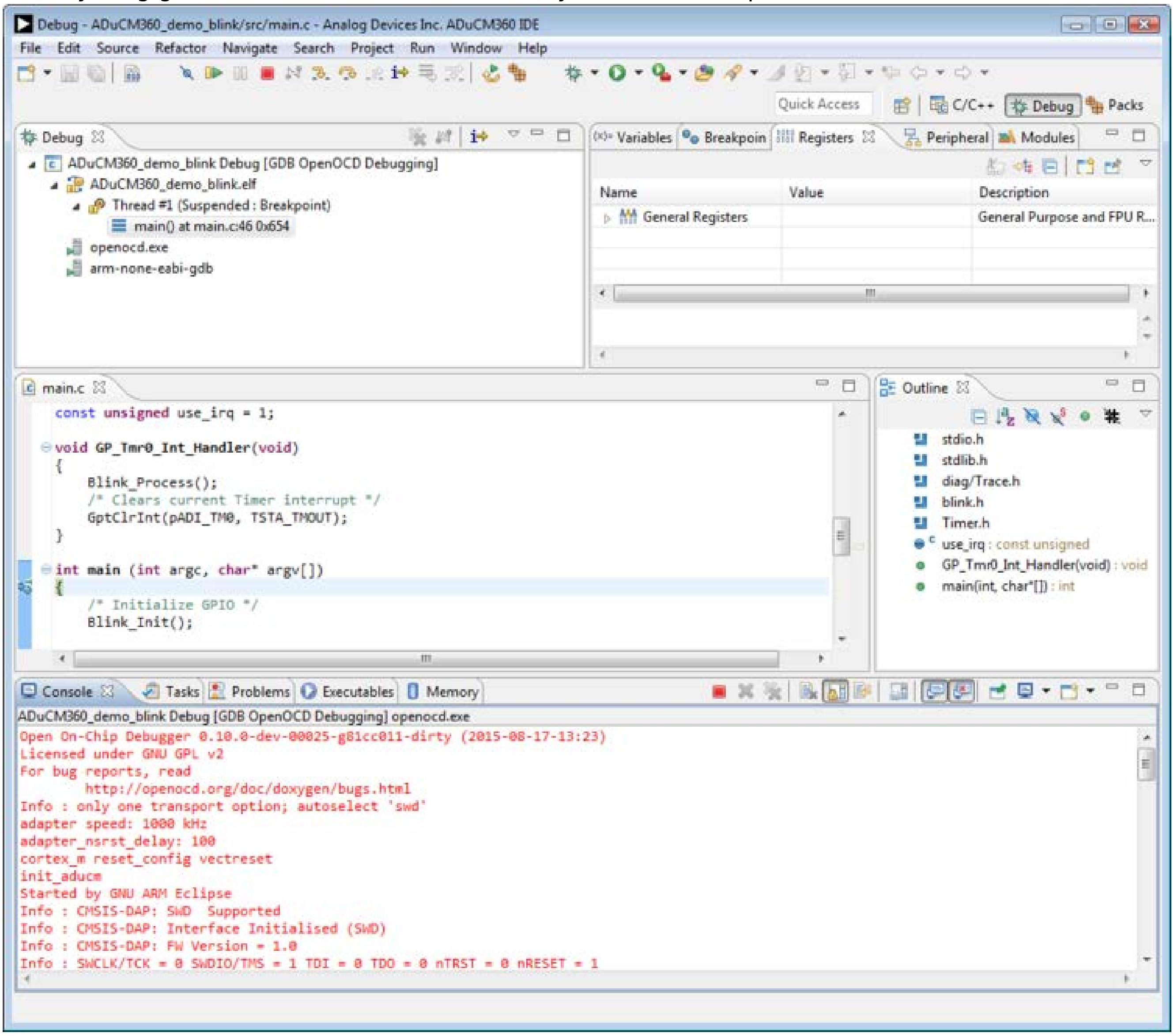


3. If this is the first time you have launched OpenOCD, a pop-up window will display asking for access.



Click on “*Allow Access*”.

4. If everything goes fine, in the Console window, you will see a report without errors.



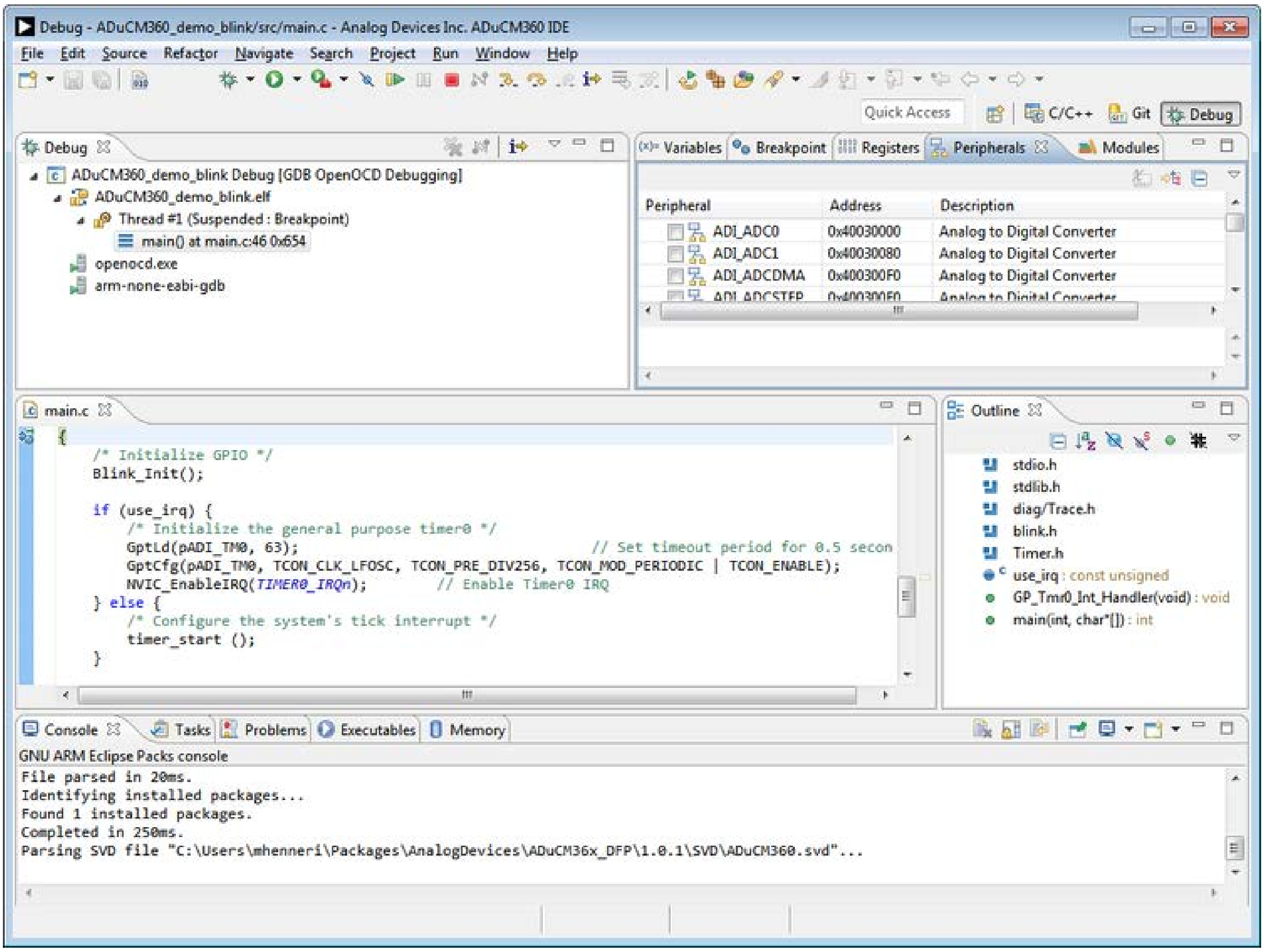
- As a reference, the full text should be similar to:Open On-Chip Debugger 0.10.0-dev-00025-g81cc011-dirty (2015-08-17-13:23)
  Licensed under GNU GPL v2

For bug reports, read
    http://openocd.org/doc/doxygen/bugs.html
Info : only one transport option; autoselect 'swd'
adapter speed: 5000 kHz
adapter_nsrst_delay: 100
cortex_m reset_config vectreset
init_aducm
Started by GNU ARM Eclipse
Info : CMSIS-DAP: SWD Supported
Info : CMSIS-DAP: Interface Initialised (SWD)
Info : CMSIS-DAP: FW Version = 1.0
Info : SWCLK/TCK = 0 SWDIO/TMS = 1 TDI = 0 TDO = 0 nTRST = 0 nRESET = 1
Info : CMSIS-DAP: Interface ready
Info : clock speed 5000 kHz
Info : SWD IDCODE 0x2ba01477
Info : aducm360.cpu: hardware has 6 breakpoints, 4 watchpoints
Info : accepting 'gdb' connection on tcp/3333

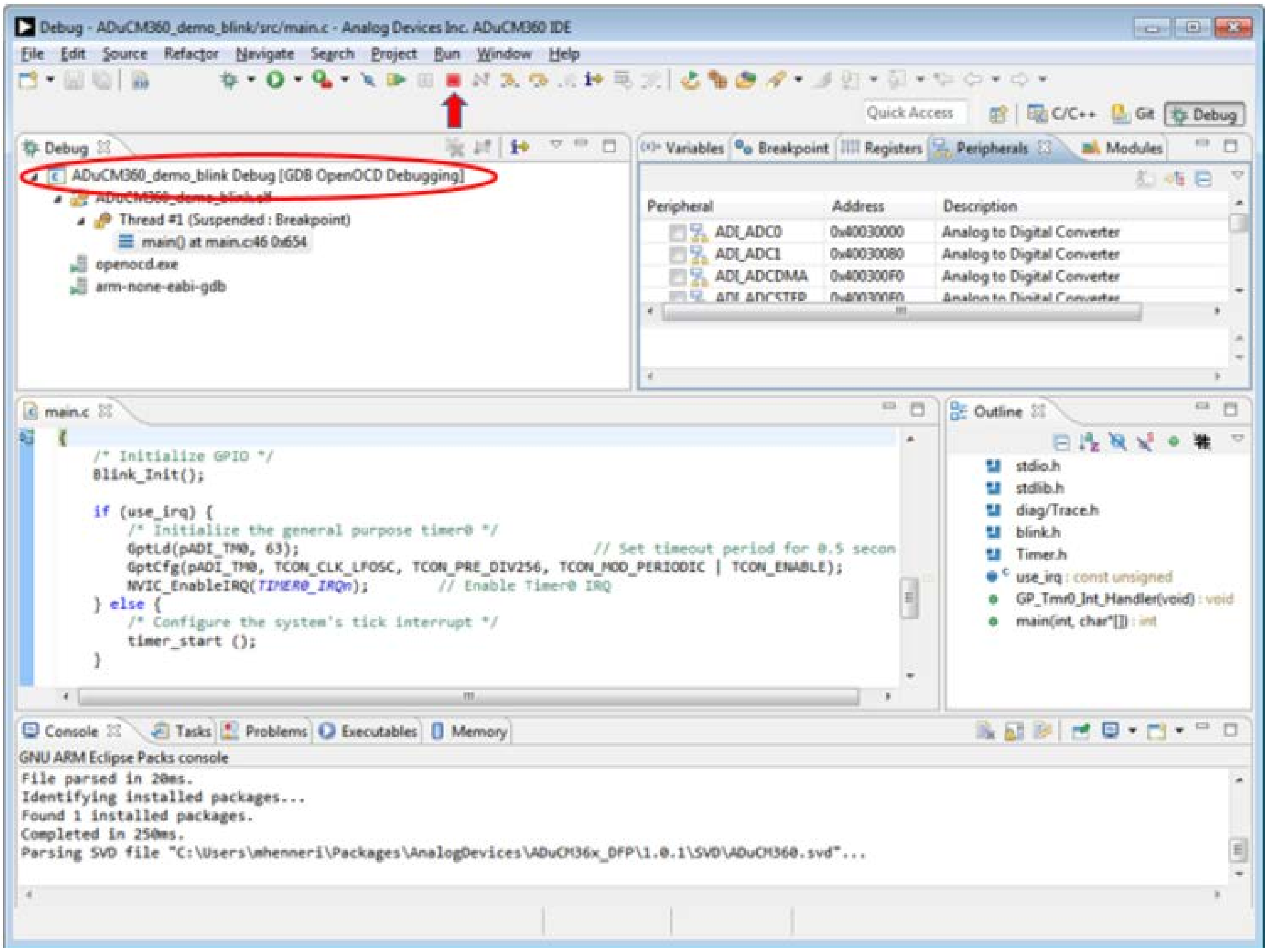
- The relevant EEPROM sectors of ADuCM360 are erased and the microcontroller is programmed. You can follow the progress in the Console window. As an approximate reference you will see something similar to:target state: halted
target halted due to debug-request, current mode: Thread
xPSR: 0x81000000 pc: 0x00000a94 msp: 0x20001fe0
semihosting is enabled
RESET: ADI halt after bootkernel
breakpoint set at 0x000001f5
Warn : Only resetting the Cortex-M core, use a reset-init event handler to reset any peripherals or configure hardware srst support.
target state: halted
target halted due to debug-request, current mode: Thread
xPSR: 0x01000000 pc: 0x000001f4 msp: 0x20002000, semihosting
flash 'aducm360' found at 0x00000000
Info : Padding image section 0 with 3 bytes
RESET: ADI halt after bootkernel
breakpoint set at 0x000001f5
Warn : Only resetting the Cortex-M core, use a reset-init event handler to reset any peripherals or configure hardware srst support.
target state: halted
target halted due to debug-request, current mode: Thread
xPSR: 0x01000000 pc: 0x000001f4 msp: 0x20002000, semihosting
RESET: ADI halt after bootkernel
breakpoint set at 0x000001f5
Warn : Only resetting the Cortex-M core, use a reset-init event handler to reset any peripherals or configure hardware srst support.
target state: halted
target halted due to debug-request, current mode: Thread
xPSR: 0x01000000 pc: 0x000001f4 msp: 0x20002000, semihosting
===== arm v7m registers
(0) r0 (/32): 0x40002800
(1) r1 (/32): 0x00000001

(2) r2 (/32): 0x00000064
(3) r3 (/32): 0x00000000
(4) r4 (/32): 0x00000000
(5) r5 (/32): 0x00000000
(6) r6 (/32): 0x00000000
(7) r7 (/32): 0x00000000
(8) r8 (/32): 0x00000000
(9) r9 (/32): 0x00000000
(10) r10 (/32): 0x00000000
(11) r11 (/32): 0x00000000
(12) r12 (/32): 0x00000000
(13) sp (/32): 0x20002000
(14) lr (/32): 0xFFFFFFFF
(15) pc (/32): 0x000001F4
(16) xPSR (/32): 0x01000000
(17) msp (/32): 0x20002000
(18) psp (/32): 0x6A850410
(19) primask (/1): 0x00
(20) basepri (/8): 0x00
(21) faultmask (/1): 0x00
(22) control (/2): 0x00
===== Cortex-M DWT registers
(23) dwt_ctrl (/32)
(24) dwt_cyccnt (/32)
(25) dwt_0_comp (/32)
(26) dwt_0_mask (/4)
(27) dwt_0_function (/32)
(28) dwt_1_comp (/32)
(29) dwt_1_mask (/4)
(30) dwt_1_function (/32)
(31) dwt_2_comp (/32)
(32) dwt_2_mask (/4)
(33) dwt_2_function (/32)
(34) dwt_3_comp (/32)
(35) dwt_3_mask (/4)
(36) dwt_3_function (/32)

5. The user application execution is then stopped automatically at the first breakpoint at the beginning of main() loop. From this point on, you can use the debug functions and features of the Eclipse environment. (Such as stepping through, breakpoints, register reads, variable values, etc.)



6. When finished, the debugger has to be stopped. Click on red Stop button up in the tool bar, then right click on the debug application in the "Debug" window, and select the *Terminate and Remove* option.



Creating a New Project

The customized Eclipse IDE that you installed for EVAL-ADICUP360 offer the possibility to create 2 types of projects: **Empty Project** and **Hello World Project**. Both **C** and **C++** formats.

The idea of these templates is to have at the end a functional ADuCM360 project which can be run on the target. The basic system configuration is the same for both:

- startup code

- memory map and linker script

- system clock configuration

- disabling watchdog

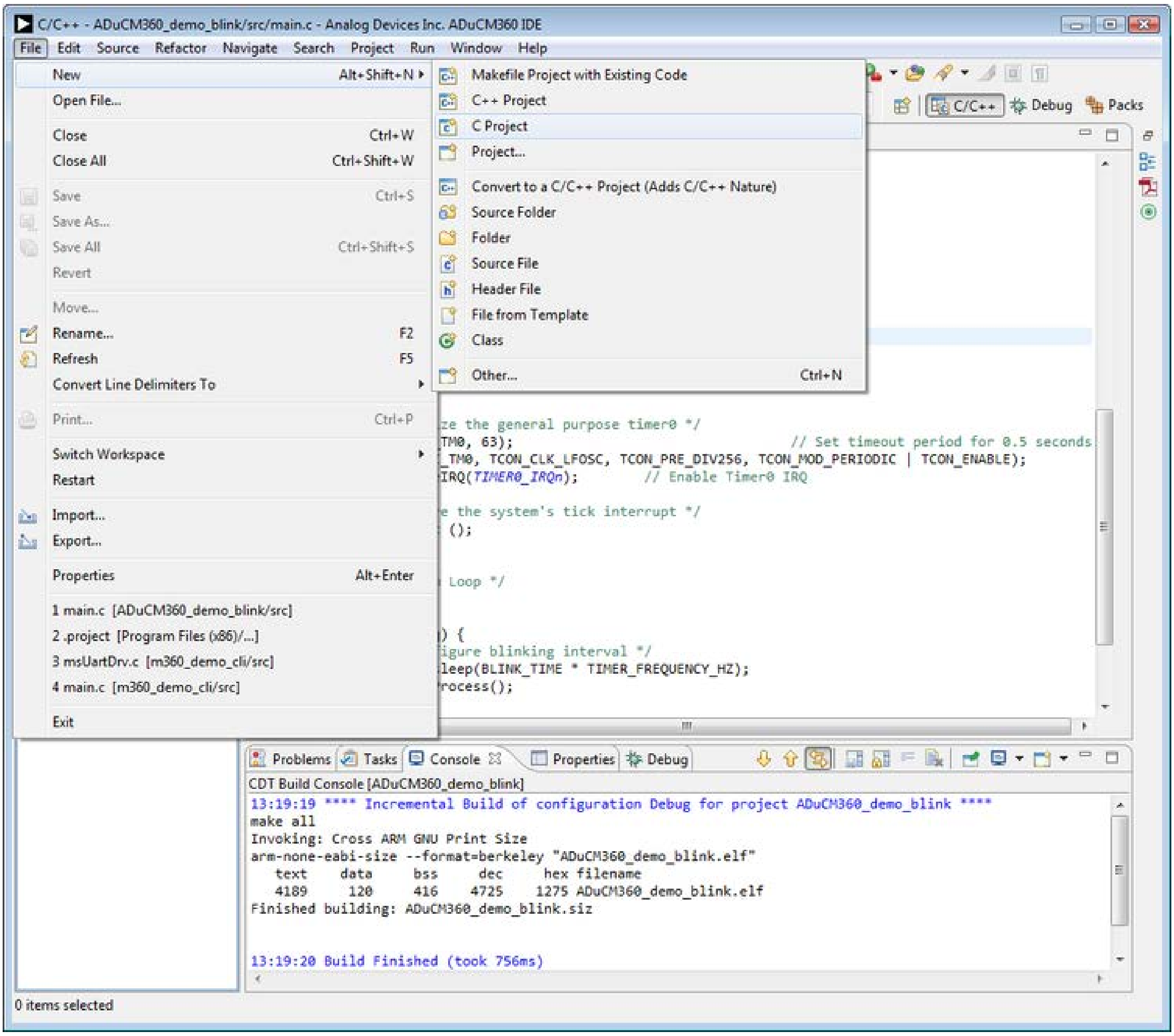
- enabling clocks for all peripherals

- low drivers libraries for ADuCM360 microcontroller

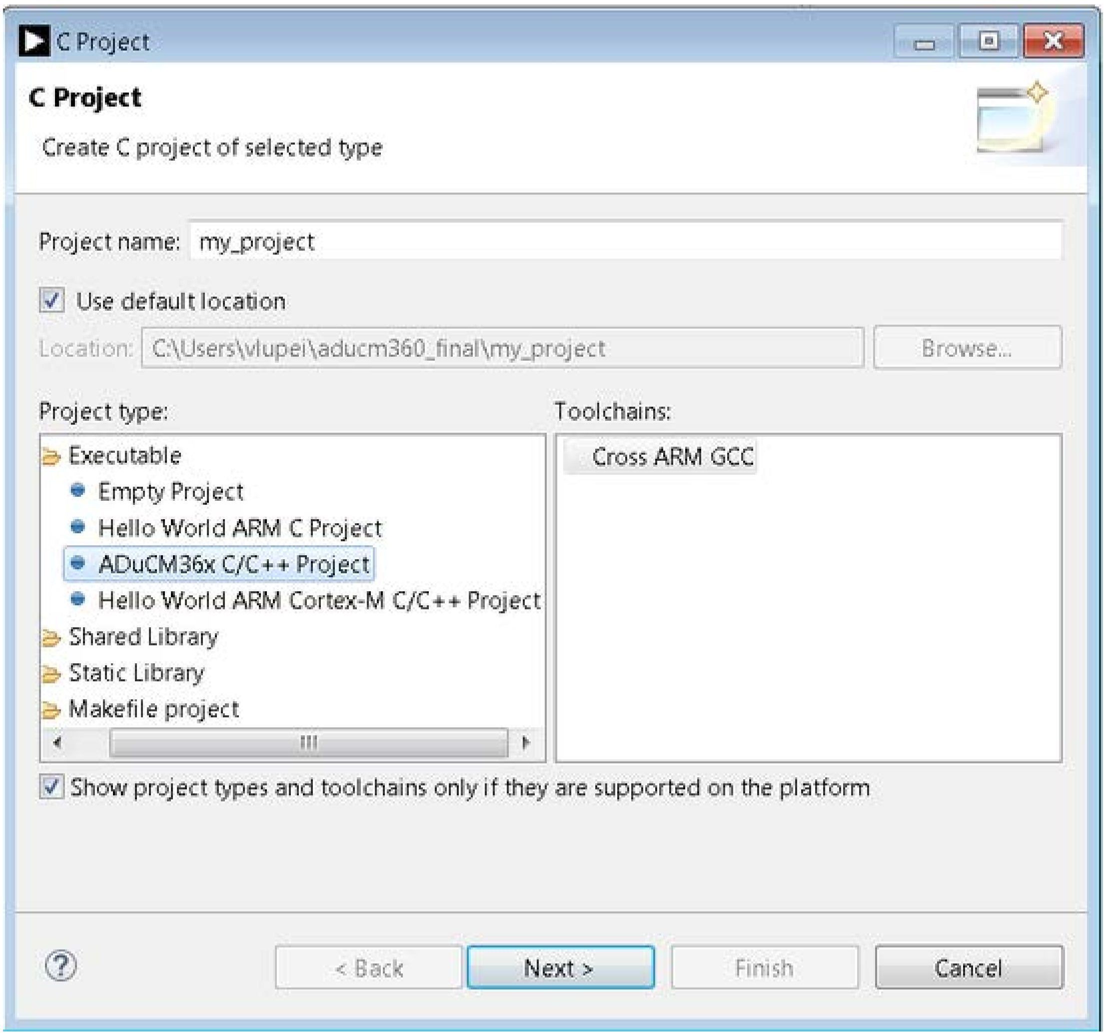
The differences are regarding the complexity of the main() function: the **Empty** template provide an empty main() function, being in this way a good choose when you want to start your ADuCM360 project from the scratch; the **Hello World** template is for more complex projects. It provide 1 sec time base and different possibilities to display an output message to the user.

See below how to create the C projects for EVAL-ADICUP360 board. The same steps being available for C++ projects as well.

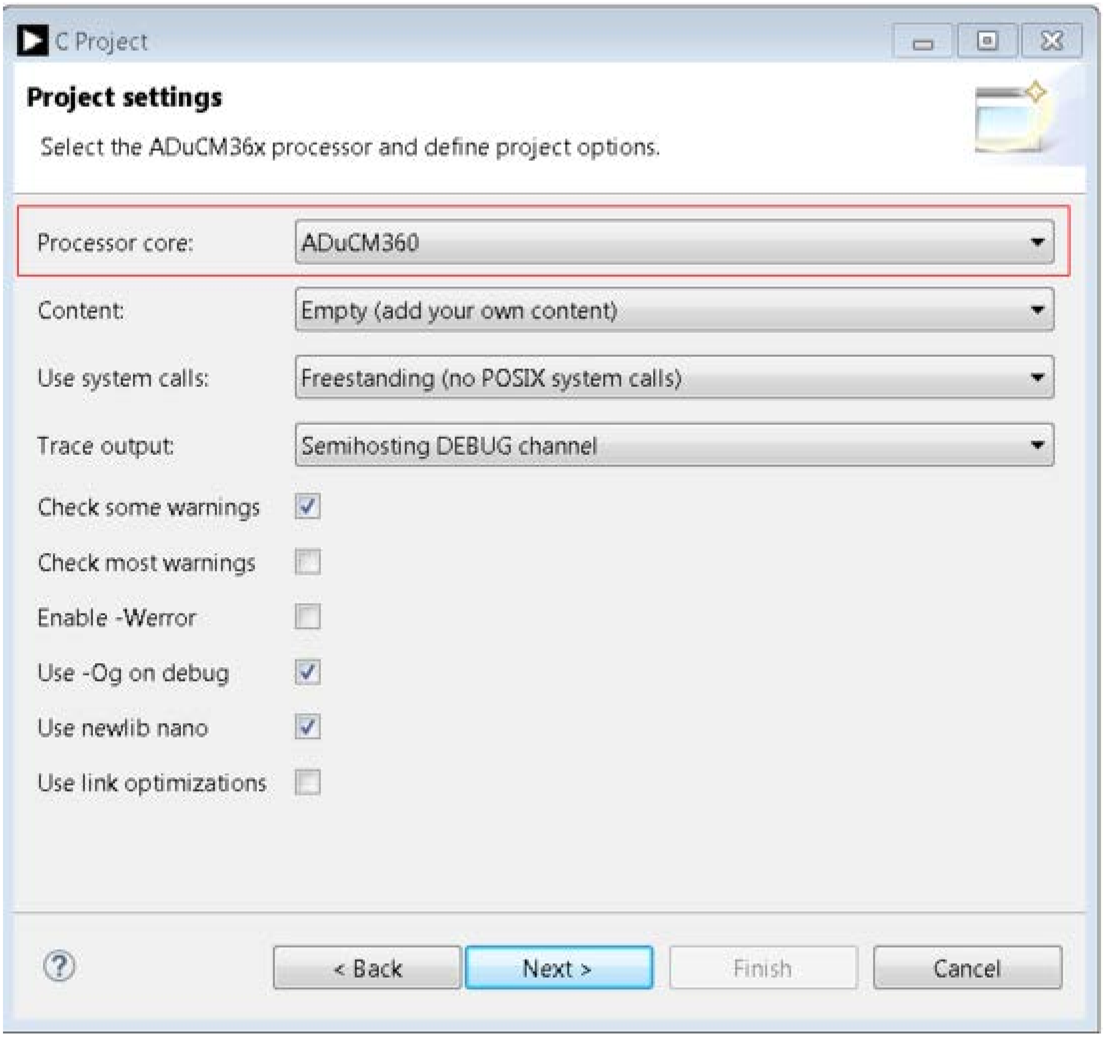
1. To create a new project, go to the menu bar and find *File → New → C Project.*



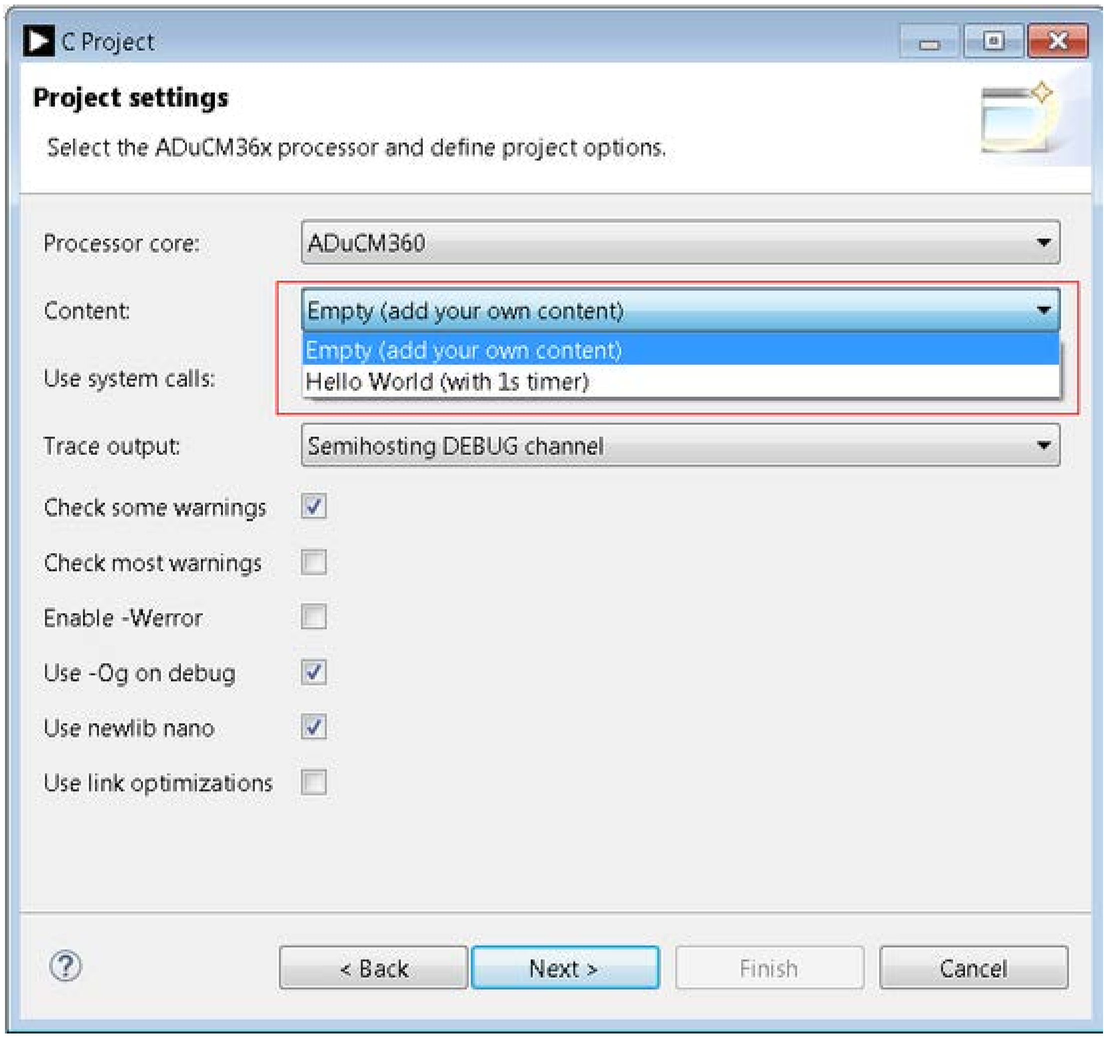
2. Provide a name for your project, and then choose Project Type: *Executable → ADuCM36x C/C+ + Project* , with the Toolchains: *Cross ARM GCC*. Press *Next.*



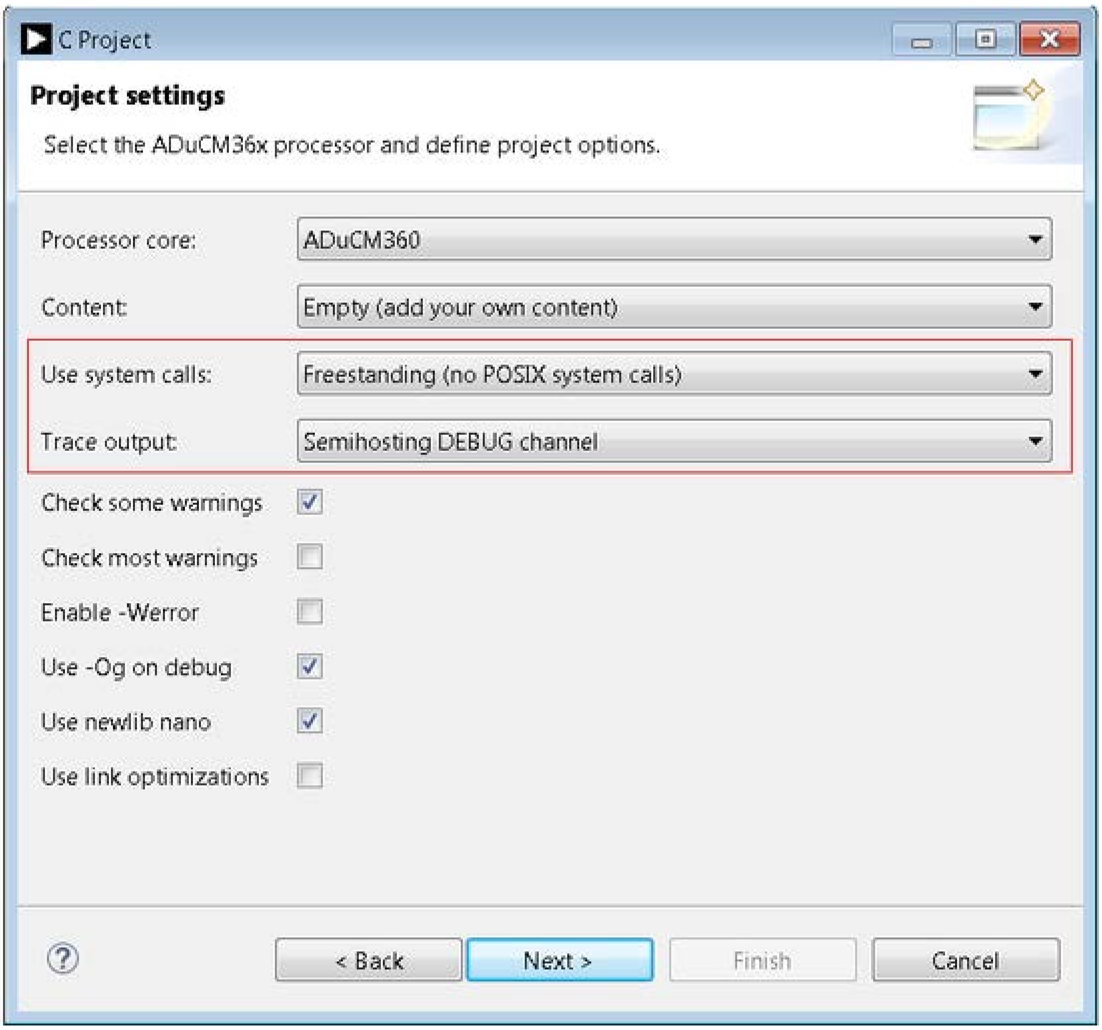
3. Choose as Processor core: *ADuCM360*.



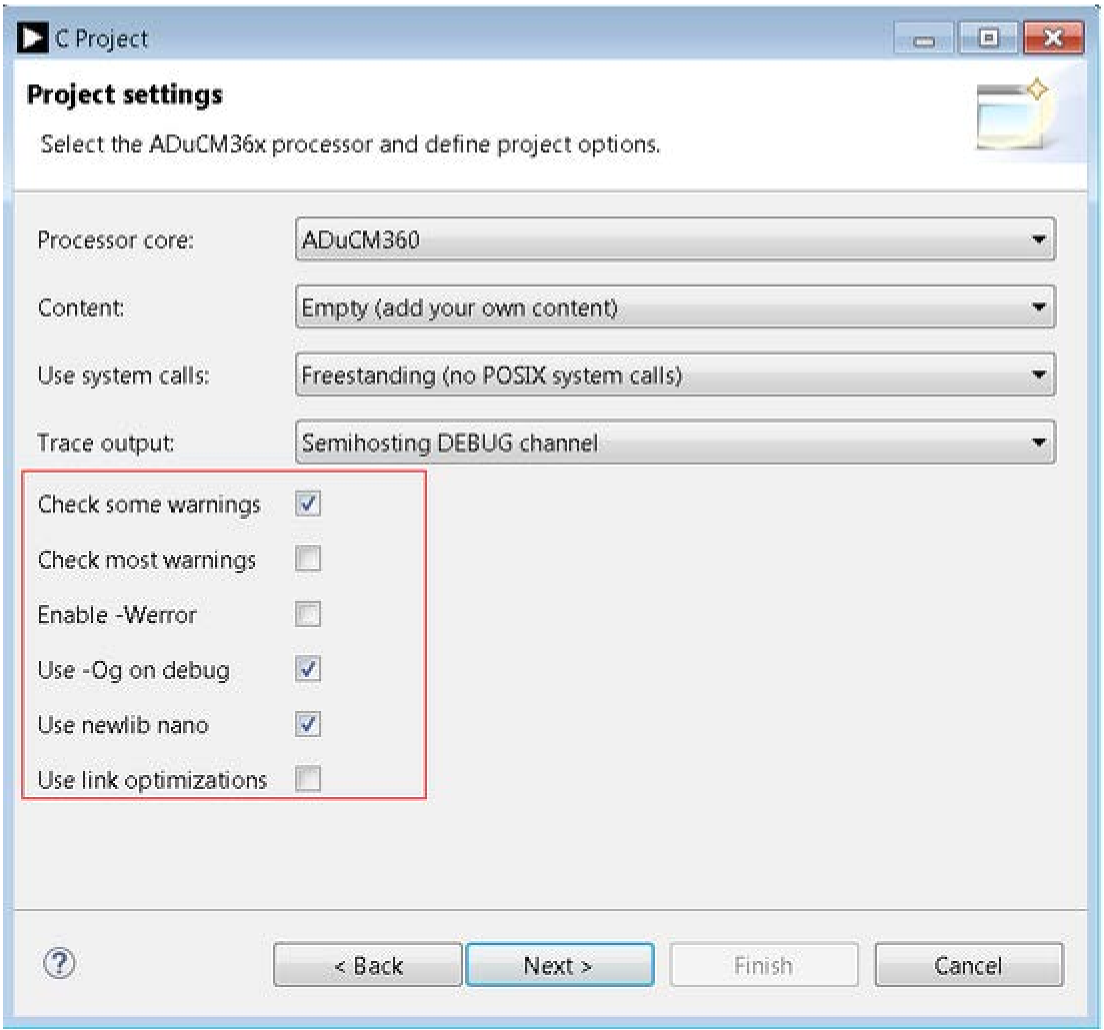
4. Select which type of project do you want: Content: *Empty (add your own content)* or *Hello World (with 1s timer).*



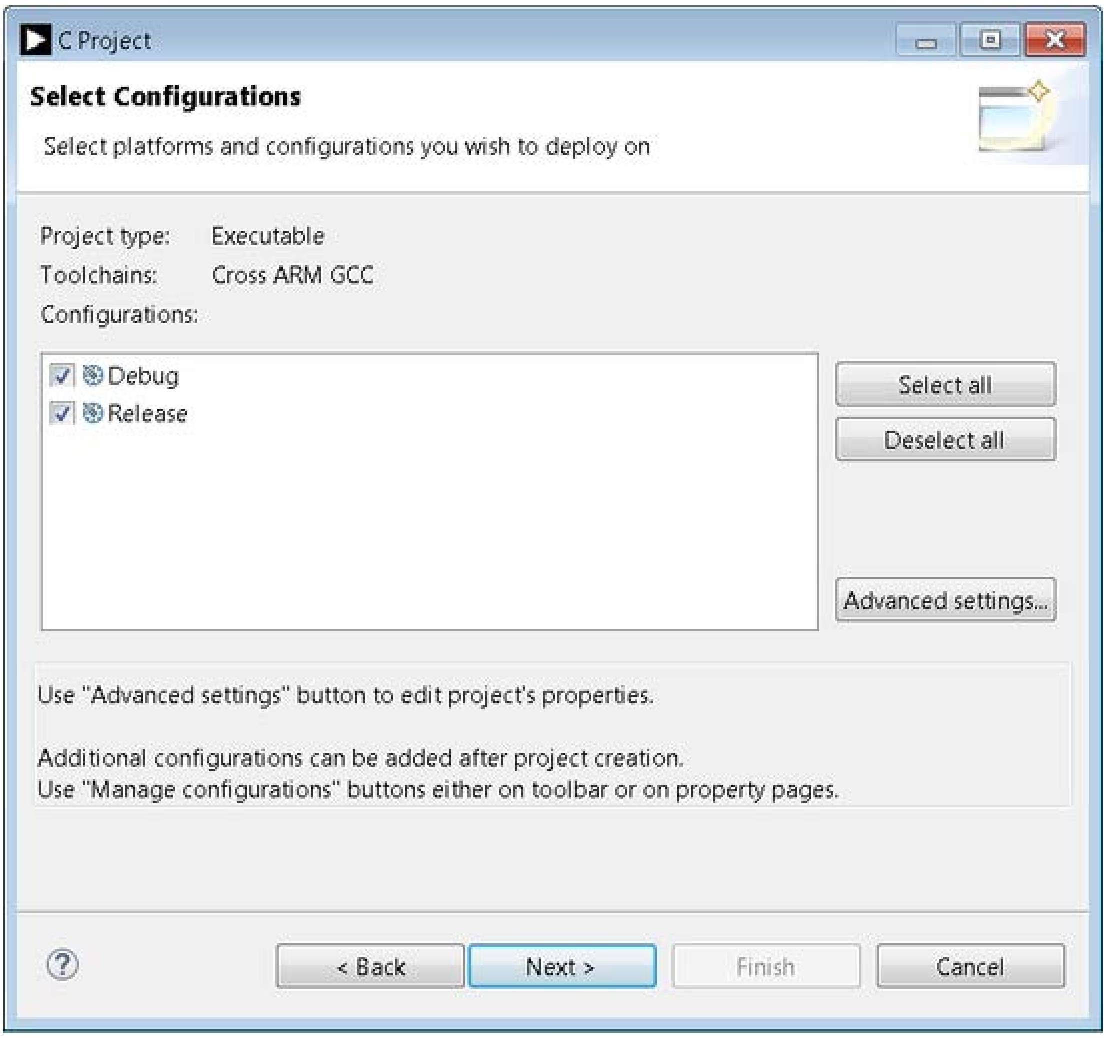
5. The Use system calls and Trace output options are available for **Hello World** template only.



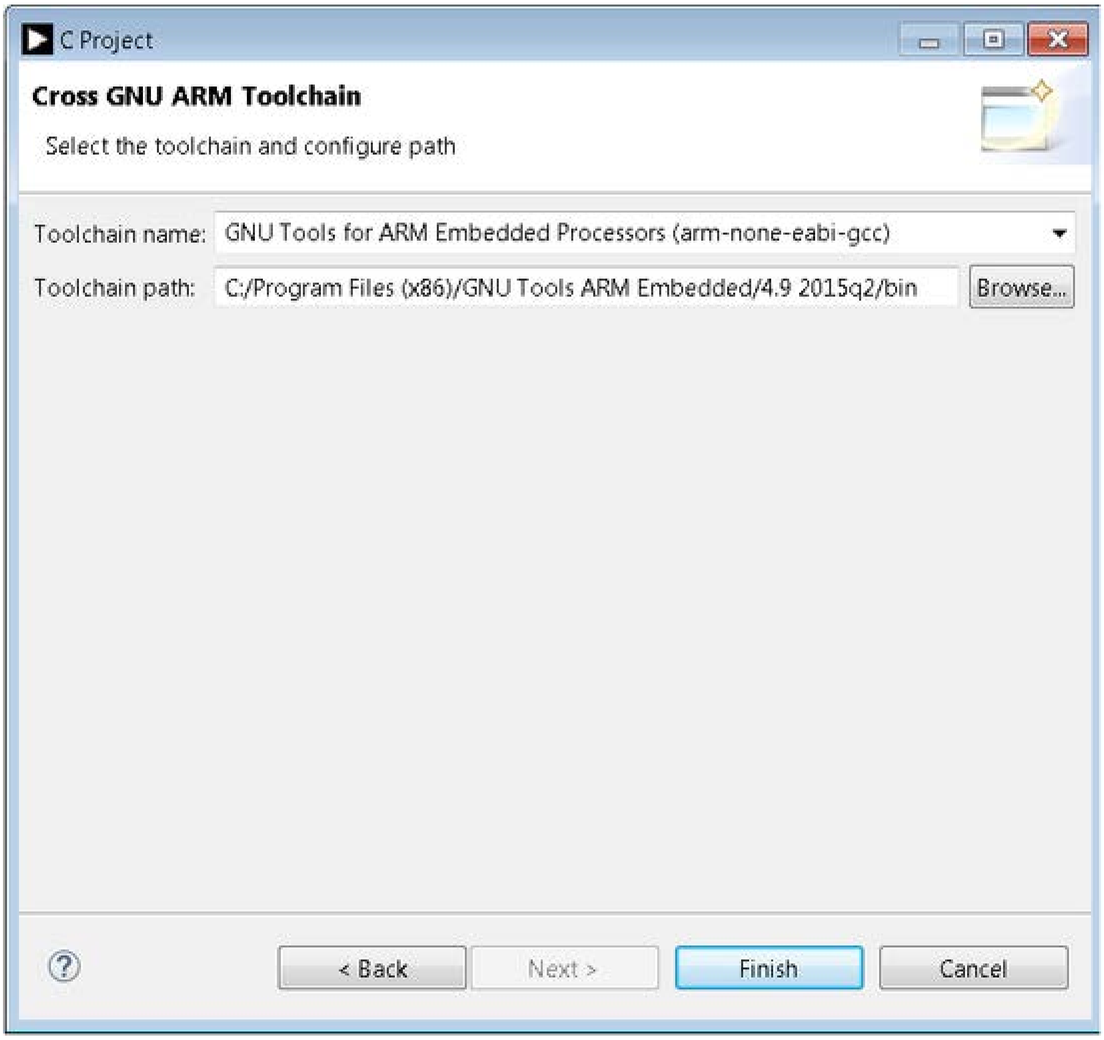
6. You can select various settings for your project (which can be changed later, in the project settings, or as different pre-processor definitions).



7. Select both the configuration check boxes you want to deploy on.



8. On the next page select the compiler toolchain. It should will automatically selected, just check or enter the right path to it.



9. Finally, press *Finish* and the project will be created and you can begin programming.

Options available for "Hello World" template only

Use system calls available options are (see GNU ARM Eclipse support page):

- Freestanding - a typical embedded configuration, that does not use the POSIX system calls (open, close, read, write, etc).
- POSIX (retargetting) - a more elaborate embedded configuration where the application makes use of these calls, but redirects the file descriptors to local devices or files, by providing custom implementations for the system calls (like _open, _close, _read, _write etc). This configuration allows to port POSIX programs easier.

Semihosting - a special testing configuration, that bridges all system calls to the host operating system where the GDB server runs. This configurations is particularly interesting for running test programs that can leave the test results in a file stored on the host, for automated integration in a test suite.

Trace output available options are:

- None (no trace output) - a basic configuration that doesn't use trace output messages.
- ARM ITM (via SWO) - a specific configuration that help to print information via SWO pin when using J-Link.
- Semihosting STDOUT stream - a more complex configuration that configure stdout to use a physical serial connection as UART or any other peripherals that offer the possibility to output messages.
- Semihosting DEBUG channel - a debug specific configuration which enable semihosting in DEBUG mode and offer the possibility to use resources from the development platform n the embedded target via debugger. This can help the user to send trace stream to debugger console (like trace_printf, trace_puts etc).

Assign Device to the Project using Packs

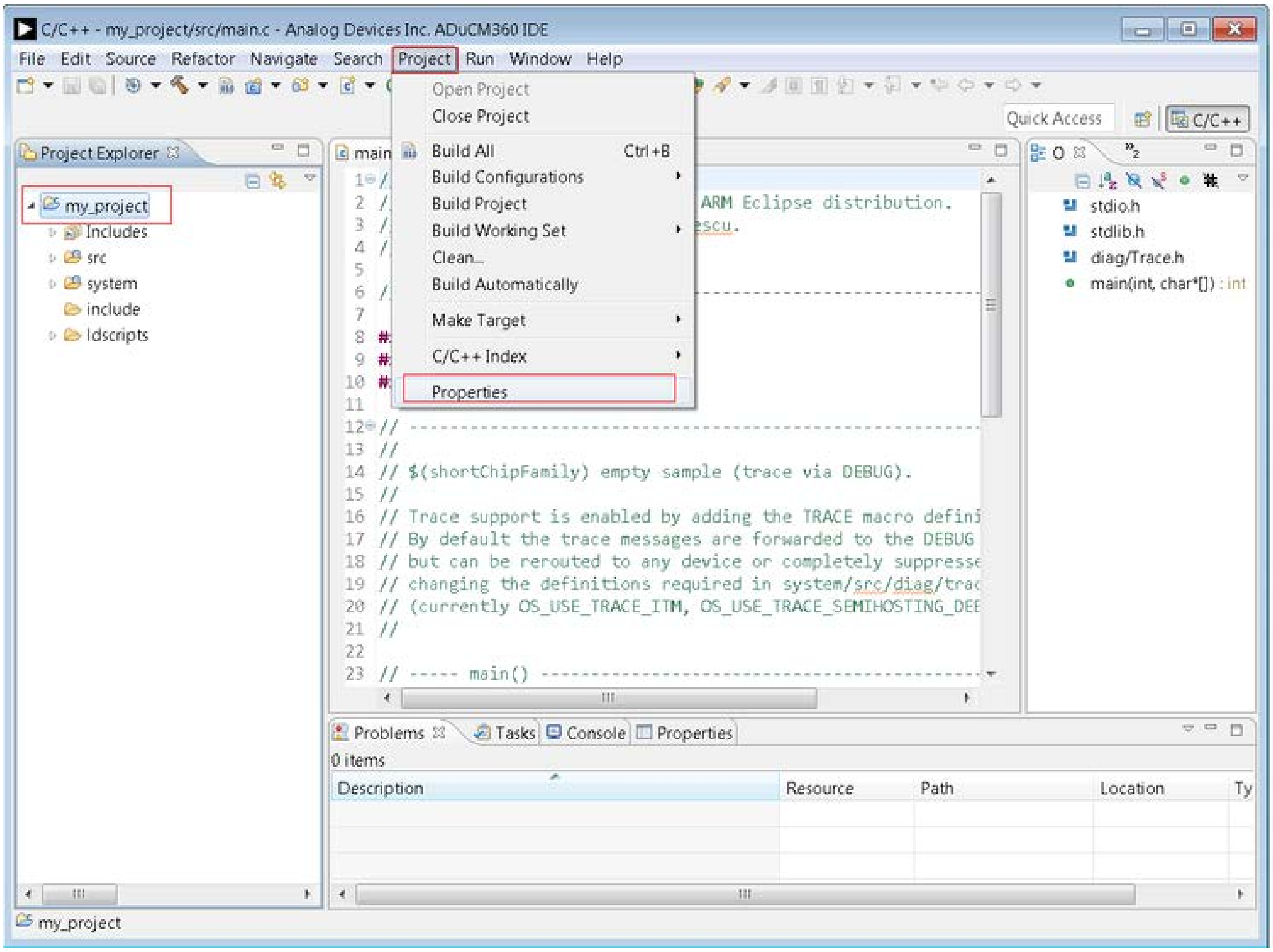
This step will allow you to access the ADuCM360 registers in debugger mode. In order to see the device list it is required to have Packs plug-ins installed. This is already done by the installer, however you do need to update the Packs list, and then install a particular family of devices.

1. To update your Packs library, go to the menu and Choose **Window**→ *Perspective* → *Open Perspective* → *Other*
2. Click on “Packs”. Once open, find the Packs window, and click on the Update arrow in the upper-righthand corner.
3. After updating has completed, find the folder for **Analog Devices** and navigate down to the latest version of **ADuCM36x** and right click and hit *Install*.

To assign device to your project:

- Select your project in the **Project explorer** view

- Go to **Project** tab from Eclipse menu and select *Properties*

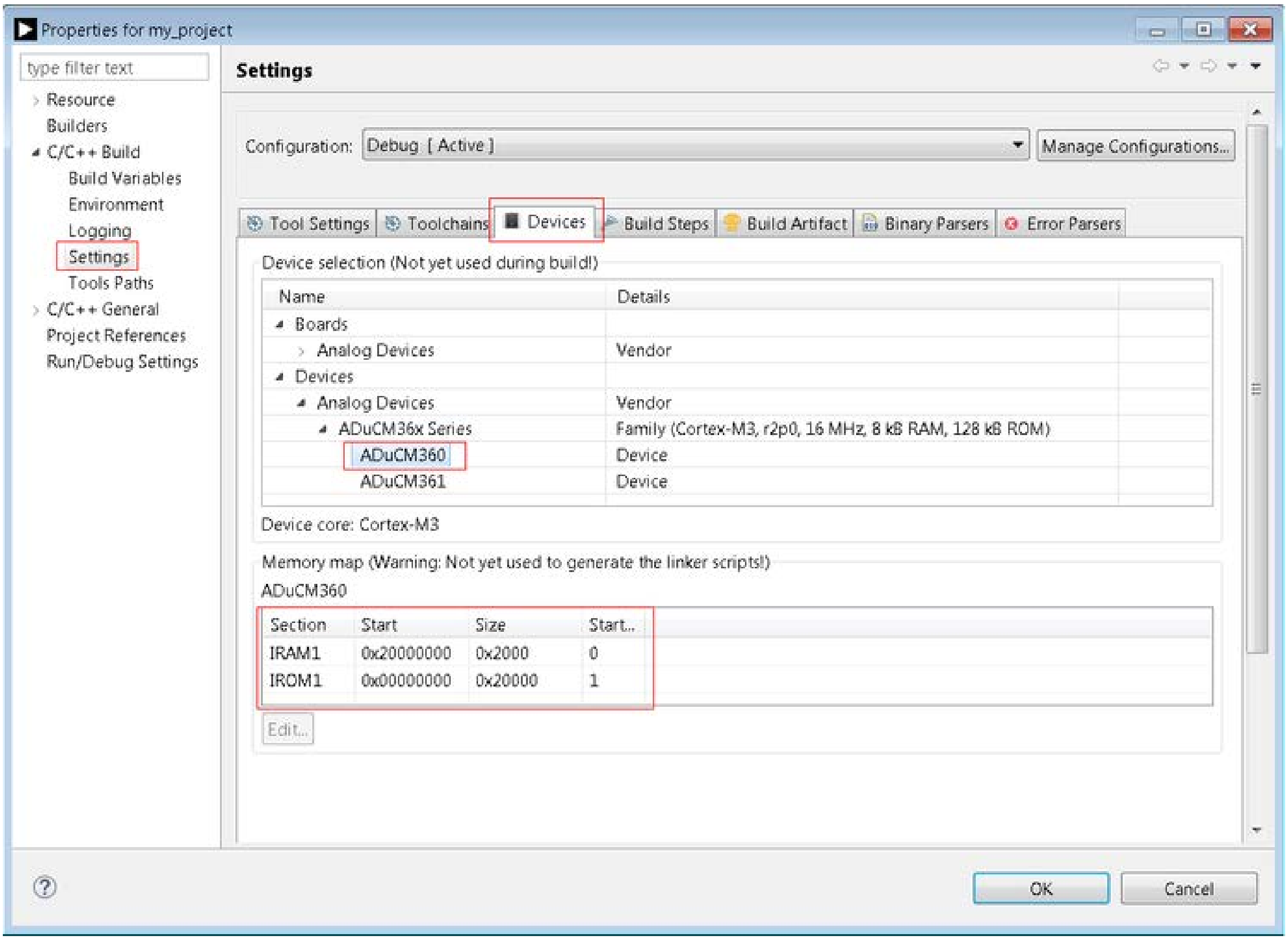


- Go to **C/C+ + Build**→ *Settings*

- Select the desired configuration

- Click on **Device** tab and expand the *Analog Devices* node

- Select **ADuCM360** as a device and press **OK**



Properties for my_project
type filter text
Resource
Builders
C/C++ Build
Build Variables
Environment
Logging
Settings
Tools Paths
C/C++ General
Project References
Run/Debug Settings
Settings
Configuration: Debug [Active]
Manage Configurations...
Tool Settings
Toolchains
Devices
Build Steps
Build Artifact
Binary Parsers
Error Parsers
Device selection (Not yet used during build!)
Name
Details
Boards
Analog Devices
Vendor
Devices
Analog Devices
Vendor
ADuCM36x Series
Family (Cortex-M3, r2p0, 16 MHz, 8 kB RAM, 128 kB ROM)
ADuCM360
Device
ADuCM361
Device
Device core: Cortex-M3
Memory map (Warning: Not yet used to generate the linker scripts!)
ADuCM360
Section
Start
Size
Start...
IRAM1
0x20000000
0x2000
0
IROM1
0x00000000
0x20000
1
Edit...
OK
Cancel

Hardware

This chapter contains hardware-related information about the base board and the various shields. Each sub-section contains a general description of the board, detailed description of the connectors, jumpers, and buttons (if any). It also provides links to the Schematics, Bill of materials, design projects, and Technical documentation. It also gives internal links to the provided example demo software projects.

The following boards are currently available:

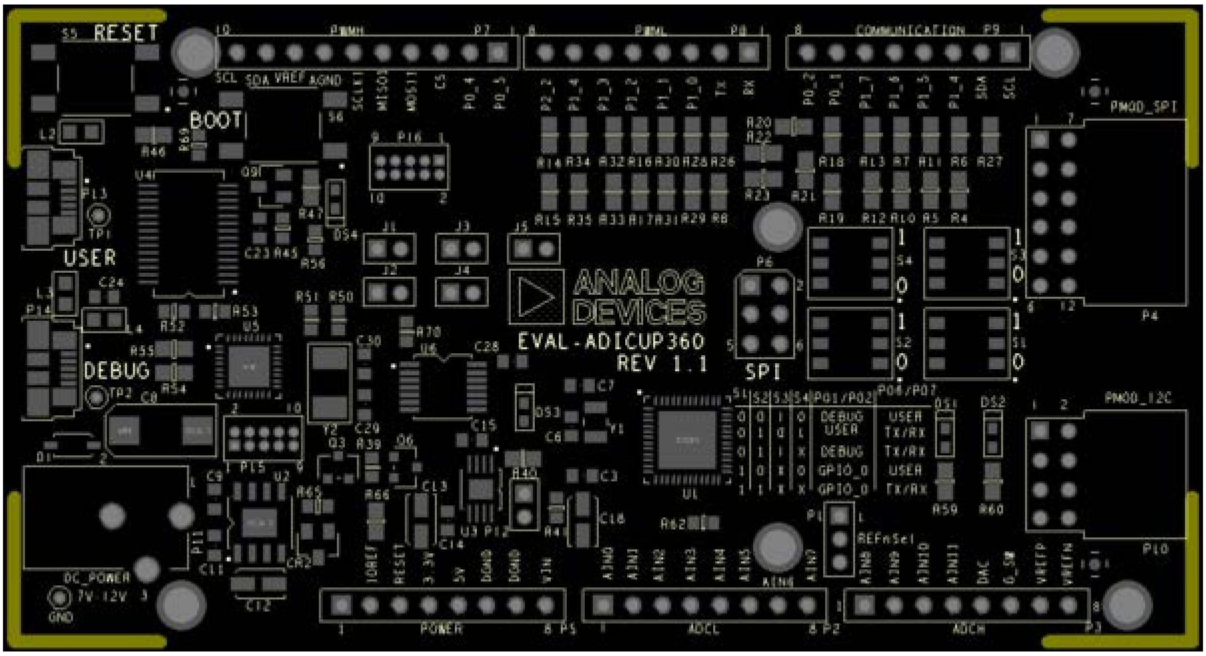
- **EVAL-ADICUP360 Base Board**
- **EVAL-CN0216-ARDZ Shield**
- **EVAL-CN0357-ARDZ Shield**

EVAL-ADICUP360 Base Board

The **EVAL-ADICUP360 base board** consists of two basic blocks:

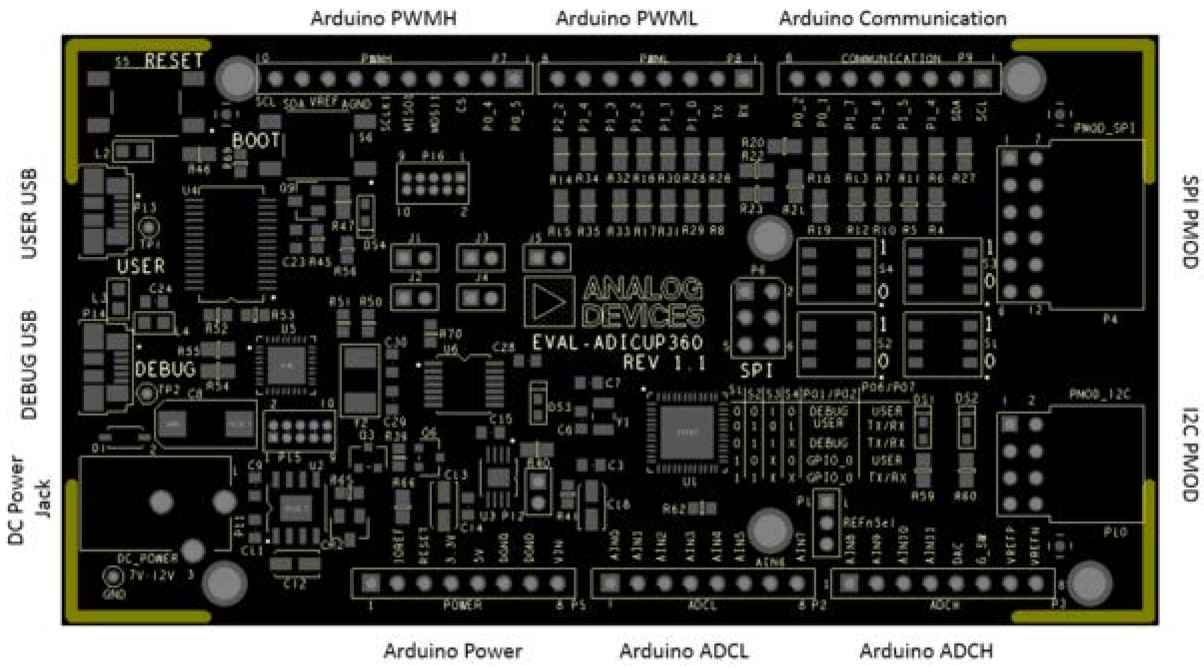
- A fully integrated, 3.9 kSPS, 24-bit data acquisition system that incorporates dual high performance, multichannel sigma-delta (Σ-Δ) analog-to-digital converters (ADCs), a 32-bit ARM Cortex™-M3 processor, and Flash/EE memory, realized on a single chip **ADuCM360 microcontroller**.
- An on-board SWD interface, based on the OpenSDA platform, which is implemented with the **Freescale's K20DX128 microcontroller**. This block allows using a free Software Development Toolchain to program and debug the ADuCM360 microcontroller part.

This page describes the hardware connectors, the jumpers and switches configuration options, the USB connectors, and links to download the schematics and the layout.



Connectors

The following connectors are populated on the base board:



- DC Power Jack: Core positive, accepts +7V to +12V DC supply voltage;
- DEBUG USB: Used for flash programming and debug interface;
- USER USB: Provides a Virtual serial port connection to ADuCM360 microcontroller;
- PMOD_SPI: 12-pin SPI PMOD connector;
- PMOD_I2C: 8-pin I2C PMOD connector;
- Six Arduino connectors described in the table below.

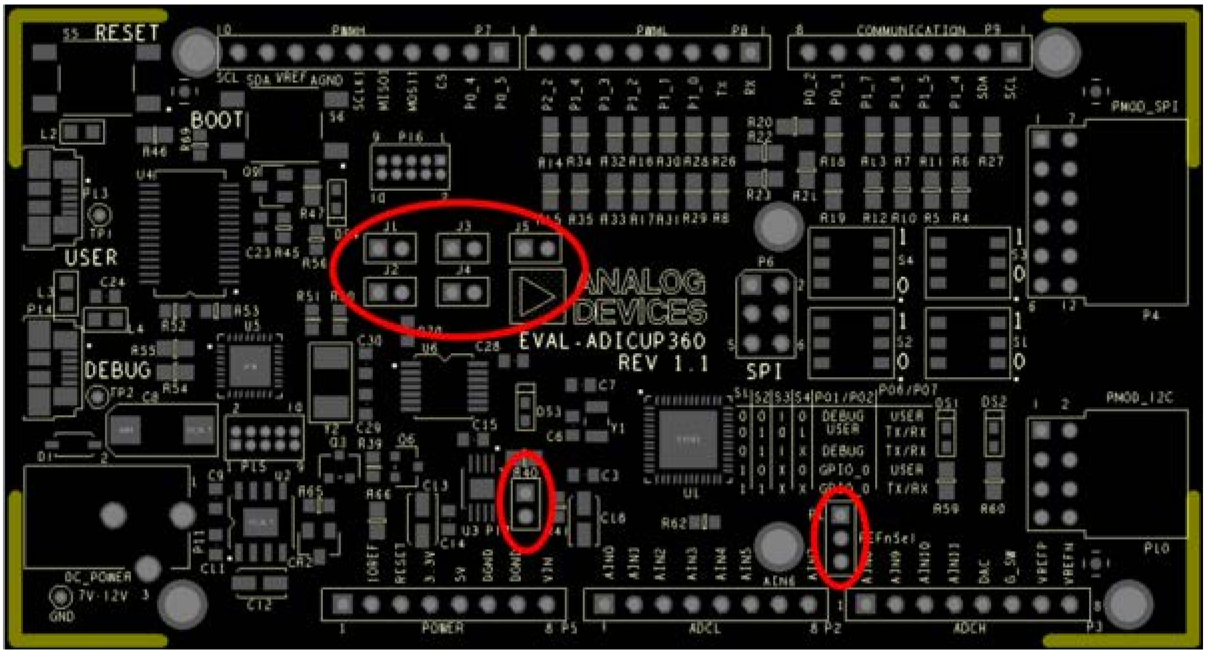
Connector	Pin No.	Pin Name	ADuCM360 pin or other function	Arduino Due Pin Name
PWMH	10	SCL	P2.0/SCL/UARTCLK	SCL1
	9	SDA	P2.1/SDA/UARTDCD	SDA1
	8	AREF	VREF+	AREF
	7	GND	AGND (Analog ground)	GND
	6	SCK	P0.1/SCLK1/SCL/SIN	PWM13
	5	MISO	P0.0/MISO1	PWM12
	4	MOSI	P0.2/MOSI1/SDA/SOUT	PWM11
	3	SS	P0.3/IRQ0/CS1	PWM10
	2	P0.4	P0.4/RTS/ECLKO	PWM9
	1	P0.5	P0.5/CTS/IRQ1	PWM8

Connector	Pin No.	Pin Name	ADuCM360 pin or other function	Arduino Due Pin Name
PWML	8	PWM5	P2.2/BM	PWM7
	7	PWM4	P1.4/PWM2/MISO0	PWM6
	6	PWM3	P1.3/PWM1/DSR	PWM
	5	PWM2	P1.2/PWM0/RI	PWM4
	4	PWM1	P1.1/IRQ4/PWMTRIP/DTR	PWM3
	3	PWM0	P1.0/IRQ3/PWMSYNC/EXTCLK	PWM2
	2	TX	P0.7/POR/SOUT	TX0
	1	RX	P0.6/IRQ2/SIN	RX0
COMMUNICATION	8	P0.2	P0.2/MOSI1/SDA/SOUT	TX3
	7	P0.1	P0.1/SCLK1/SCL/SIN	RX3
	6	P1.7	P1.7/IRQ7/PWM5/CS0	TX2
	5	P1.6	P1.6/IRQ6/PWM4/MOSI0	RX2
	4	P1.5	P1.5/IRQ4/PWM3/SCLK0	TX1
	3	P1.4	P1.4/PWM2/MISO0	RX1
	2	SDA	P2.1/SDA/UARTDCD	SDA
	1	SCL	P2.0/SCL/UARTCLK	SCL
ADCH	1	A8	AIN8/EXTREF2IN-	A8
	2	A9	AIN9/DACBUFF+	A9
	3	A10	AIN10	A10
	4	A11	AIN11/VBIAS1	A11
	5	DAC	DAC	DAC0
	6	G_SW	GND_SW	DAC1
	7	VREF+	VREF+	CANRX
	8	VREF-	VREF-	CANTX
ADCL	1	A0	AIN0	A0
	2	A1	AIN1	A1
	3	A2	AIN2	A2
	4	A3	AIN3	A3
	5	A4	AIN4/IEXC	A4
	6	A5	AIN5/IEXC	A5
	7	A6	AIN5/IEXC	A6
	8	A7	AIN7/VBIAS0/IEXC/EXTREF2IN+	A7
POWER	1	NC	- not connected -	NOT USED
	2	IOREF	DVdd (+3.3V)	IOREF
	3	RESET	RESET	RESET
	4	3.3V	DVdd (+3.3V)	3V3
	5	5V	+5V	5V
	6	GND	DGND (Digital Ground)	GND
	7	GND	DGND (Digital Ground)	GND
	8	Vin	The input line of the +5V linear voltage regulator	VIN

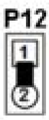
Connector	Pin No.	Pin Name	ADuCM360 pin or other function	Arduino Due Pin Name
SPI	1	MISO	P0.0	MISO
	2	+5	+5	+5
	3	SCLK	P0.1	SCLK
	4	MOSI	P0.2	MOSI
	5	RESET	RESET	RESET
	6	GND	DGND	GND
SPI_PMOD	1	CS	P1.7	CHIP SELECT
	2	MOSI	P1.6	MOSI
	3	MISO	P1.4	MISO
	4	SCLK	P1.5	SCLK
	5	GND	DGND	GND
	6	VDD	DVDD	VDD
	7	INT	P1.0	INT
	8	RESET	P1.1	RESET
	9	GPIO	P1.2	GPIO
	10	GPIO	P2.2	GPIO
	11	GND	DGND	GND
	12	VDD	DVDD	VDD
I2C_PMOD	1	SCL	P2.0	SCL
	2	SCL	P2.0	SCL
	3	SDA	P2.1	SDA
	4	SDA	P2.1	SDA
	5	GND	DGND	GND
	6	GND	DGND	GND
	7	VDD	DVDD	VDD
	8	VDD	DVDD	VDD

Jumper Configuration

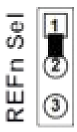
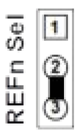
There are **3 jumpers groups** on the EVAL-ADICUP360 base board:



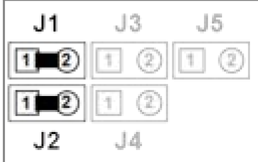
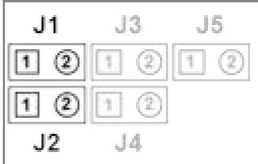
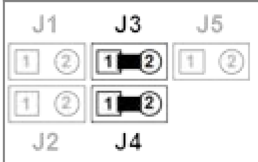
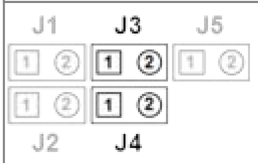
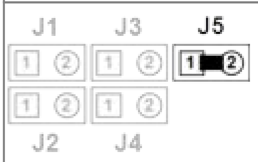
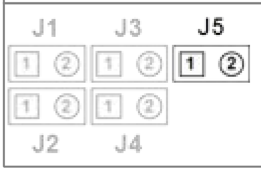
Jumper P12

Configuration	Function
	ADuCM360 **is powered** from the linear voltage regulator on the baseboard
	ADuCM360 **is not powered** from the baseboard and may be powered from the application shield

Jumper REFnSel

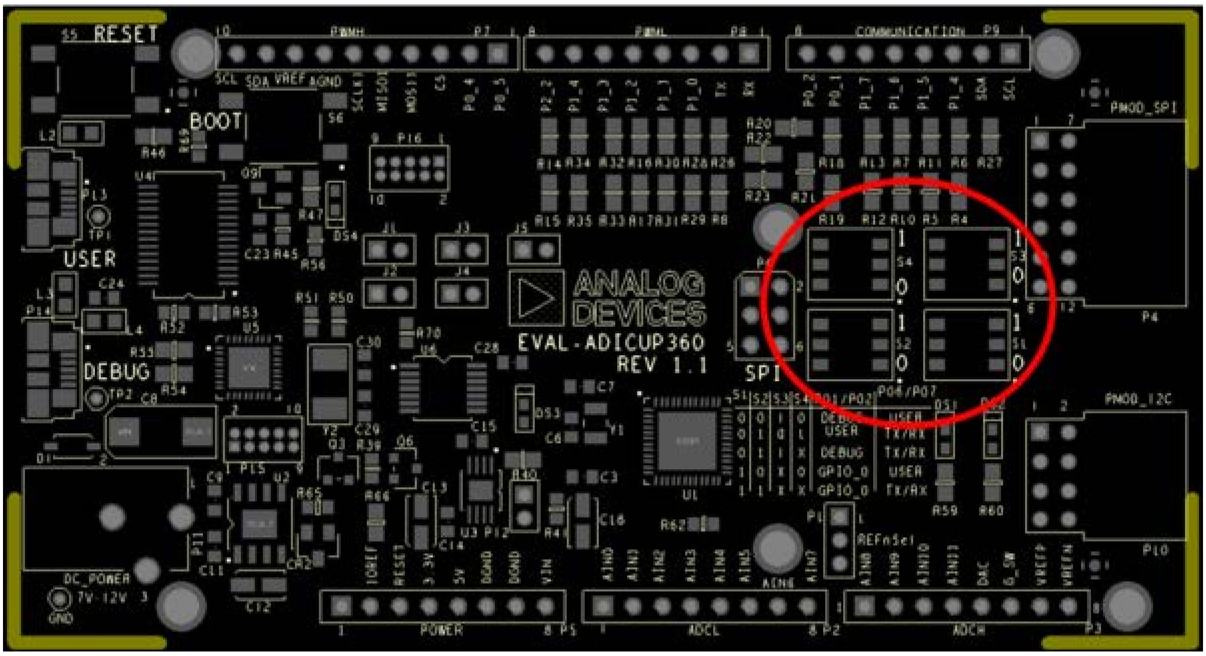
Configuration	Function
	ADuCM360 VREF- pin connected to Analog GND
	ADuCM360 VREF- pin connected to the ADCH connector, pin 8

Jumpers J1, J2, J3, J4, J5

Configuration	Function
	ADuCM360's UART pins **are connected** to the Virtual serial port of the Debug adapter
	ADuCM360's UART pins **are not connected** to the Virtual serial port of the Debug adapter
	ADuCM360's SWD lines **are connected** to the Debug adapter. ADuCM360 can be programmed
	ADuCM360's SWD lines **are not connected** to the Debug adapter. ADuCM360 cannot be programmed
	ADuCM360's RESET line **is connected** to the Debug adapter. The button **B1** can be used to invoke the Debug adapter's Bootloader.
	ADuCM360's RESET line **is not connected** to the Debug adapter. The button **B1** is just an ADuCM360 reset button.

USB/Connector Multiplexer

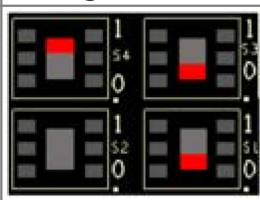
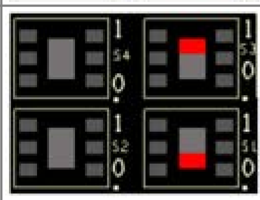
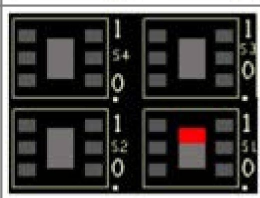
There are **4 switches** on the EVAL-ADICUP360 base board, which are used to multiplex pairs of pins **(P0.1/P0.2, and P0.6/P0.7)** to various different connectors on the board. Depending on how the pins are configured you may route them to the **USB ports**, use them for **SPI communication** or for **UART communication**.

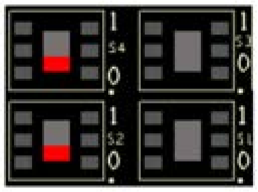
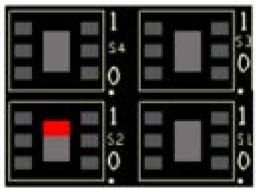


Switches S1, S2, S3, S4

The **S1, S2, S3, S4 switches** are used to route the P0.1/SCLK1/SCL/SIN, P0.2/MOSI1/SDA/SOUT, P0.6/IRQ2/SIN and P0.7/POR/SOUT pins when they have been assigned a UART function to either the **Arduino I/O** and the **PMOD** connectors or to the Virtual Serial ports implemented via the **USER USB** or the **DEBUG USB** connectors. Each pin can be routed separately, but the routing is usually done for the pairs TxD/RxD.

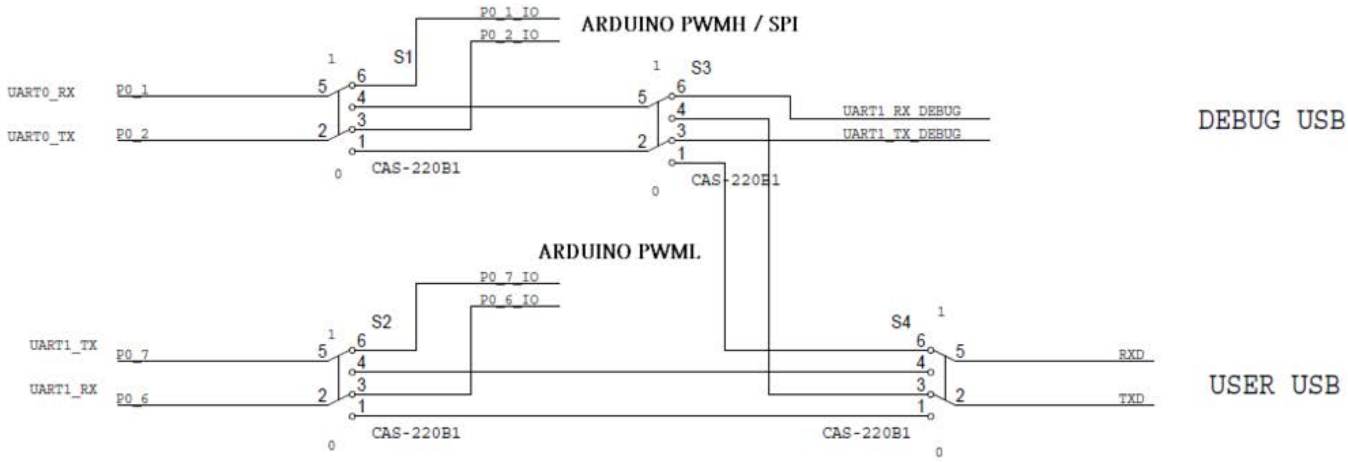
Most commonly used configurations are given in the table below. For any other more 'exotic' configuration, consult with the Schematics and the Layout of the board.

ADuCM360's pair of pins	Required connection	Configuration
P0.1/SCLK1/SCL/SIN P0.2/MOSI1/SDA/SOUT	to the User USB (FT232RL)	
	to the Debug USB (mbed's Serial Port)	
	to the Arduino PWMH (pin 6, pin 3) and the SPI header (pin 1, pin 3)	

ADuCM360's pair of pins	Required connection	Configuration
P0.6/IRQ2/SIN P0.7/POR/SOUT	to the User USB (FT232RL)	
	to the Arduino PWML (pin 1, pin 2)	

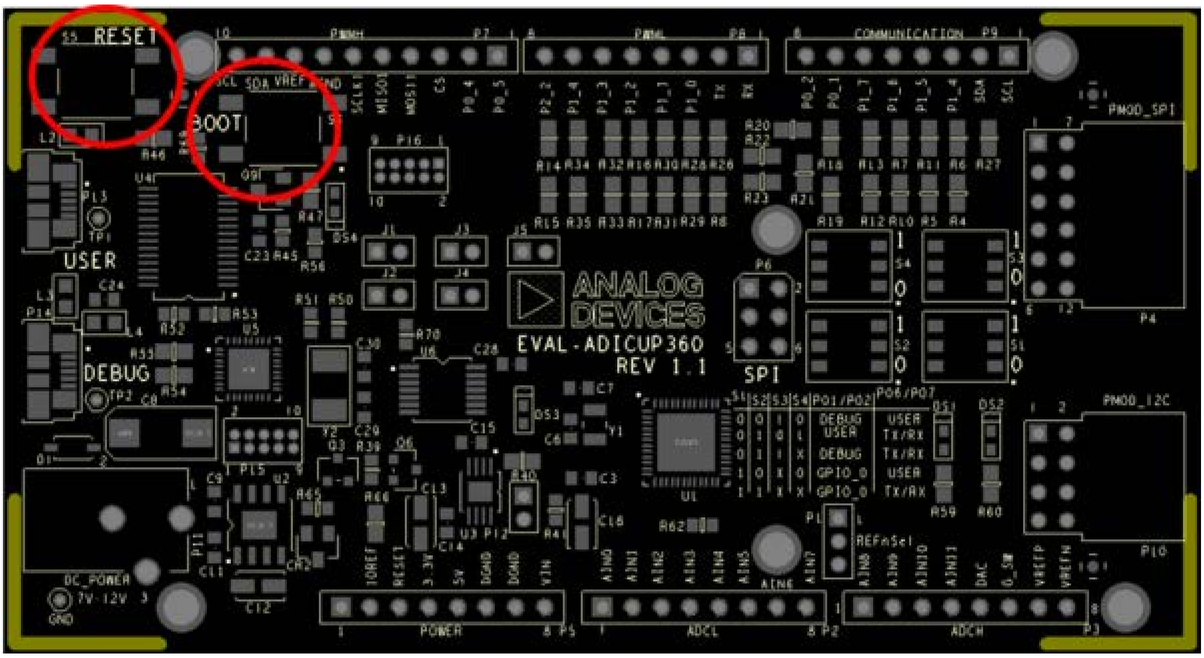
Switch Schematic

Here is the schematic of the switching network, the switches allow to route the P0.1/P0.2 and P0.6/P0.7 signals to multiple connector depending how you want to configure the pins. Above are the common configurations, but for complete details please reference the diagram.



Buttons

The EVAL-ADICUP360 base board provides two buttons **RESET** and **BOOT**.

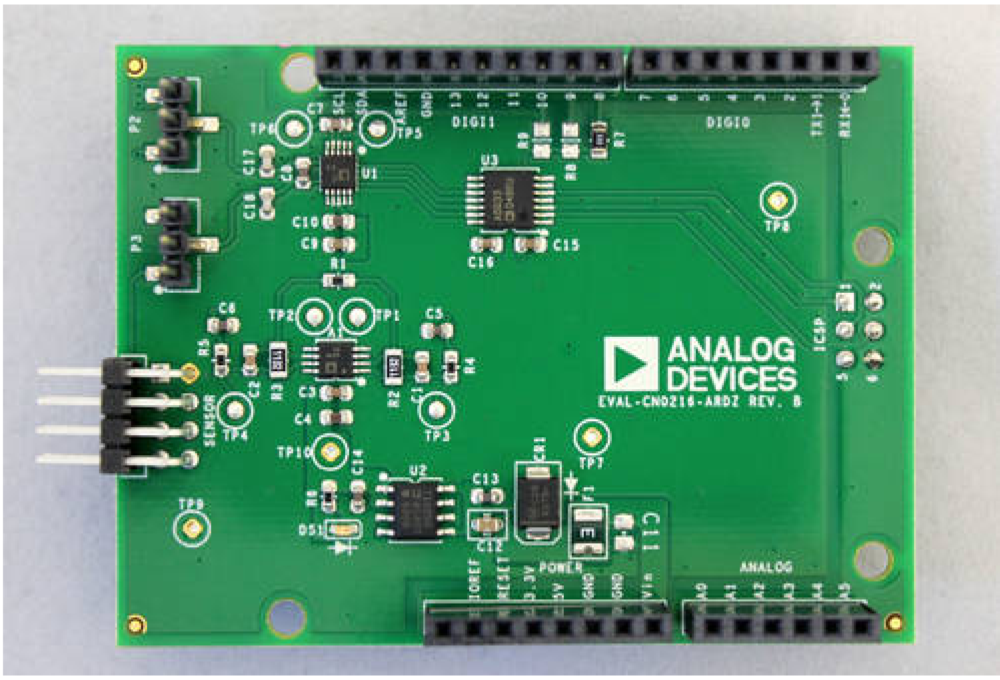


Button	Function
RESET	Provides a hardware RESET to ADuCM360 microcontroller. If the RESET line is connected to the Debug adapter, this button can be used to invoke the Debug adapter's Bootloader, see section Jumper Configuration.
BOOT	When BOOT is held down during the reset and after, the ADuCM360 microcontroller enters UART download mode via P0.1 and P0.2. In this case, the user can download program via DEBUG USB or USER USB, depending on the jumpers settings, see section Jumper Configuration. BOOT button should be held press while a reset from the button is performed.

EVAL-CN0216-ARDZ Shield

CN-0216 is a precision weigh scale signal conditioning system. It uses the AD7791, a low power buffered 24-bit sigma-delta ADC along with dual external ADA4528-2 zero-drift amplifiers. This solution allows for high dc gain with a single supply.

Ultralow noise, low offset voltage, and low drift amplifiers are used at the front end for amplification of the low-level signal from the load cell. The circuit yields 15.3 bit noise-free code resolution for a load cell with a full-scale output of 10 mV.

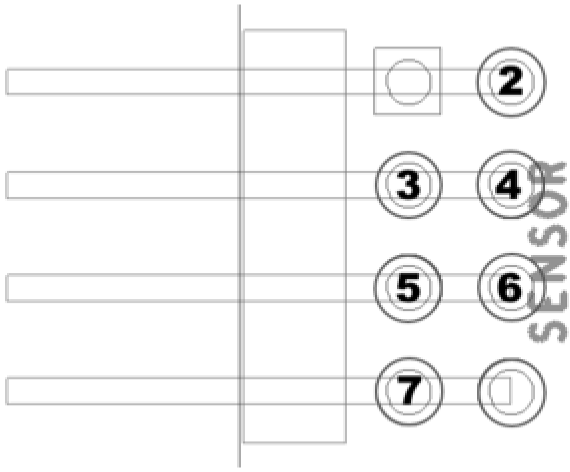


This circuit allows great flexibility in designing a custom low-level signal conditioning front end that gives the user the ability to easily optimize the overall transfer function of the combined sensor-amplifier-converter circuit. The AD7791 maintains good performance over the complete output data range, from 9.5 Hz to 120 Hz, which allows it to be used in weigh scale applications that operate at various low speeds.

Connectors and Jumper Configurations

PICTURE OF THE BOARD FILE with JUMPERS AND CONNECTORS HIGHLIGHTED

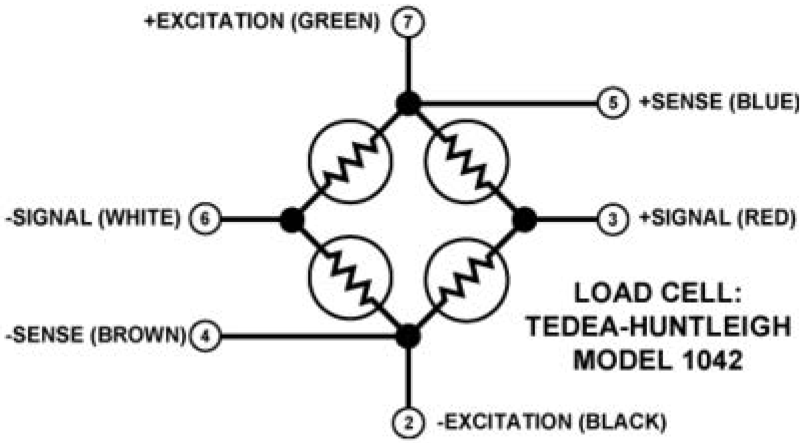
Sensor Connector



Pin Number	Pin Function
Pin 1	Not Used
Pin 2	- Excitation
Pin 3	+ Signal
Pin 4	- Sense
Pin 5	+ Sense
Pin 6	- Signal
Pin 7	+ Excitation
Pin 8	Not Used

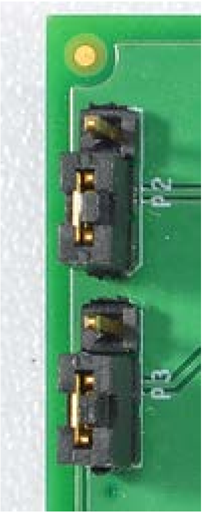
Bridge Configuration

NOTE - Any 4 or 6 wire load cells can be used with the **EVAL-CN0216-ARDZ**.
The Tedeah Huntleigh Model 1042 load cell was used during testing.



Position “0” (shown below) is used for 6-wire resistive bridges

- P2 - Connects REFIN+ to Sensor +Sense pin
- P3 - Connects REFIN- to Sensor -Sense pin



Position “1” is used for 4-wire resistive bridges

- P2 - Connects REFIN+ to 5V supply
- P3 - Connects REFIN- to GND

EVAL-CN0357-ARDZ Shield

CN0357 single-supply, low noise, portable gas detector circuit using an electrochemical sensor. The Alphasense CO-AX carbon monoxide sensor is used in this example. Electrochemical sensors offer several advantages for instruments that detect or measure the concentration of many toxic gases. Most sensors are gas specific and have usable resolutions under one part per million (ppm) of gas concentration.

The circuit shown in below uses the ADA4528-2, dual auto zero amplifier, which has a maximum offset voltage of 2.5 µV at room temperature and an industry leading 5.6 µV/√Hz of voltage noise density. In addition, the AD5270-20 programmable rheostat is used rather than a fixed transimpedance resistor, allowing for rapid prototyping of different gas sensor systems, without changing the bill of materials. The ADR3412 precision, low noise, micropower reference establishes the 1.2 V common-mode, pseudo ground reference voltage with 0.1% accuracy and 8 ppm/°C drift. For applications where measuring fractions of ppm gas concentration is important, using the ADA4528-2 and the ADR3412 makes the circuit performance suitable for interfacing with a 16-bit ADC, such as the AD7790.

Connectors and Jumper Configurations

PICTURE OF THE BOARD FILE with JUMPERS AND CONNECTORS HIGHLIGHTED

Sensor Footprint

NOTE - Three electrode electrochemical toxic gas sensors can be used with the **EVAL-CN0357-ARDZ** The footprint can accommodate 3 different sizes of sensors.
The Alphasense CO-AX electrochemical gas sensor was used during testing and programming.

Recommended PCB Sockets(for Alphasense Sensors)

- A Series Sensors - Mill-Max 0364-0-15-15-13-27-10-0
- B Series Sensors - Mill-Max 0294-0-15-15-06-27-10-0
- D Series Sensors - Mill-Max 0667-0-15-15-30-27-10-0

- The sensor may be connected to the M1 footprint using the appropriate pin sockets

Jumper P1 Settings

- “0” position - Sensor output connected to ADC(defualt)
- “1” position - Sensor output connected to A1 pin of ANALOG header, for connection to external ADCs

Reference Designs

This chapter contains various reference designs available for the base board and the various shields. Each sub-section describes the demo program, how to setup the hardware, how to obtain the source code, and finally, how to import the project in the Eclipse workspace and to run it.

The following reference designs are currently available:

- **Blinking LEDs Demo** - Shows the basic steps of creating a new project for the EVAL-ADICUP360 base board, running and debugging the software.
- **Command Line Interpreter Demo** - A Command Line Interpreter (CLI) demo project for the EVAL-ADICUP360 base board.
- **Accelerometer Demo** - Illustrates the functionality of the ADXL362 3-axes accelerometer. It works with the EVAL-ADXL362-ARDZ Shield.
- **Weigh Scale Demo** - Weigh Scale measurement example for 4-/6-wire bridge sensors. It works with the EVAL-CN0216-ARDZ Shield.
- **pH Measurement Demo** - pH Measurement System with Temperature Compensation that works with the EVAL-CN0326-PMDZ Pmod.
- **Data Acquisition for Input Current Demo** - Handles data of the acquisition system for 4-20 mA inputs current that works with the EVAL-CN0336-PMDZ Pmod.
- **RTD Temperature Measurement Demo** - RTD temperature measurement example that works with the EVAL-CN0337-PMDZ Pmod.
- **Carbon Dioxide Gas Detection Demo** - Non Dispursive Infrared Gas Detection that works with the EVAL-CN0338-ARDZ Shield.
- **Toxic Gas(CO) Detection Demo** - Measuring toxic gases using electrochemical sensors that work with the EVAL-CN0357-ARDZ Shield.

Blinking LEDs demo

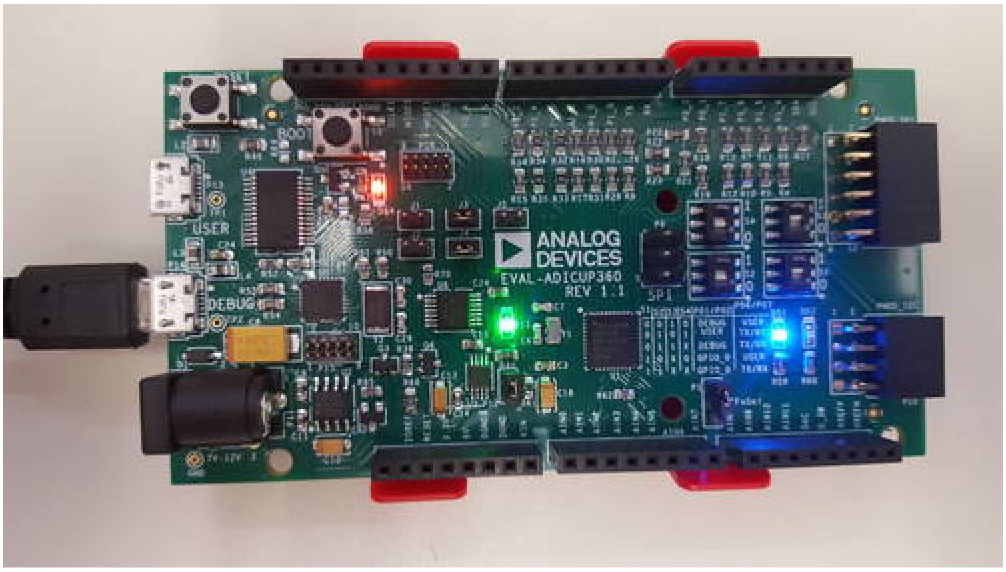
The **ADuCM360_demo_blink** is the simplest possible demo project for the EVAL-ADICUP360, created using the GNU ARM Eclipse Plug-ins in Eclipse environment.

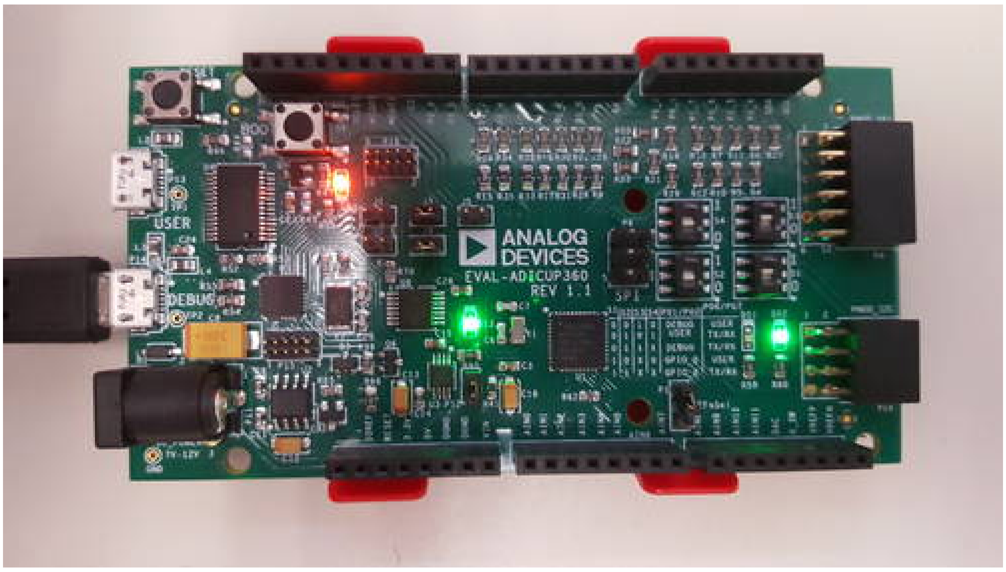
General description

The project includes basic initialization - stopping the watchdog, configuring the system clock, disabling the clocks for all peripherals and setting two digital outputs for driving the two LEDs on the board: LED2 and LED3. The automatically generated code by the GNU ARM Eclipse Plug-ins provide a system tick interrupt at 1ms intervals and a simple delay function.

This project uses the low level drivers available for ADuCM360 microcontroller. It provide the possibility to choose the LEDs blinking method: use the delay function or use timer interrupt service.

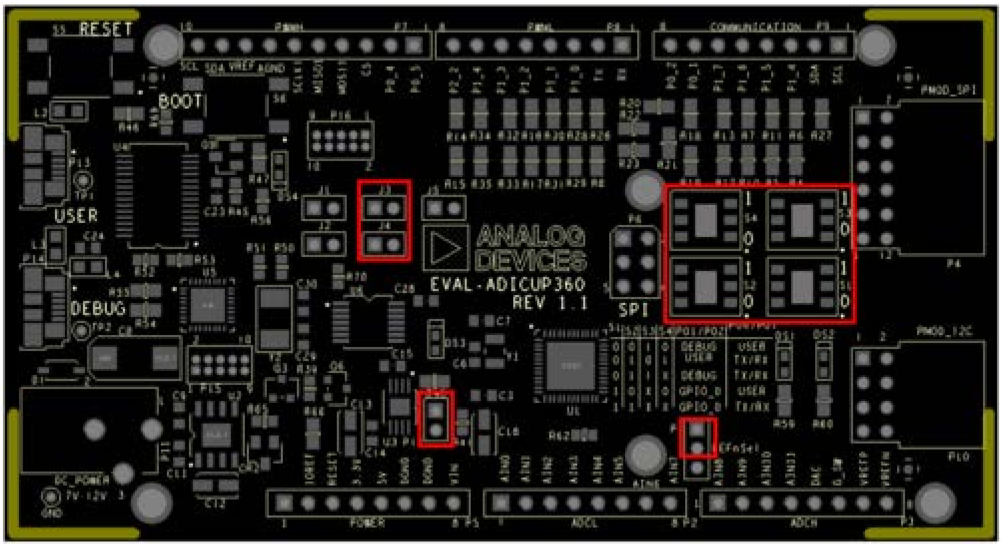
When the project is compiled and run, the two LEDs flash alternatively in predefined intervals (1 second for delay function method and 0.5 seconds for timer interrupt method).





Setting up the hardware

- To program the EVAL-ADICUP360, set the jumpers as shown in the next figure. The important jumpers are highlighted in red.



- Connect the PC to the EVAL-ADICUP360 via DEBUG USB
- Load the program and run it.

Obtaining the source code

We recommend not opening the project directly, but rather import it into Eclipse and make a local copy in your Eclipse workspace.

To learn how to import the **ADuCM360_demo_blink** project from the projects examples in the Git repository, please click on How to import existing projects from the GIT Repository.

The source code and include files for the **ADuCM360_demo_blink** can be found in projects examples which comes with installer package, or the latest version of the project can be found on Github:

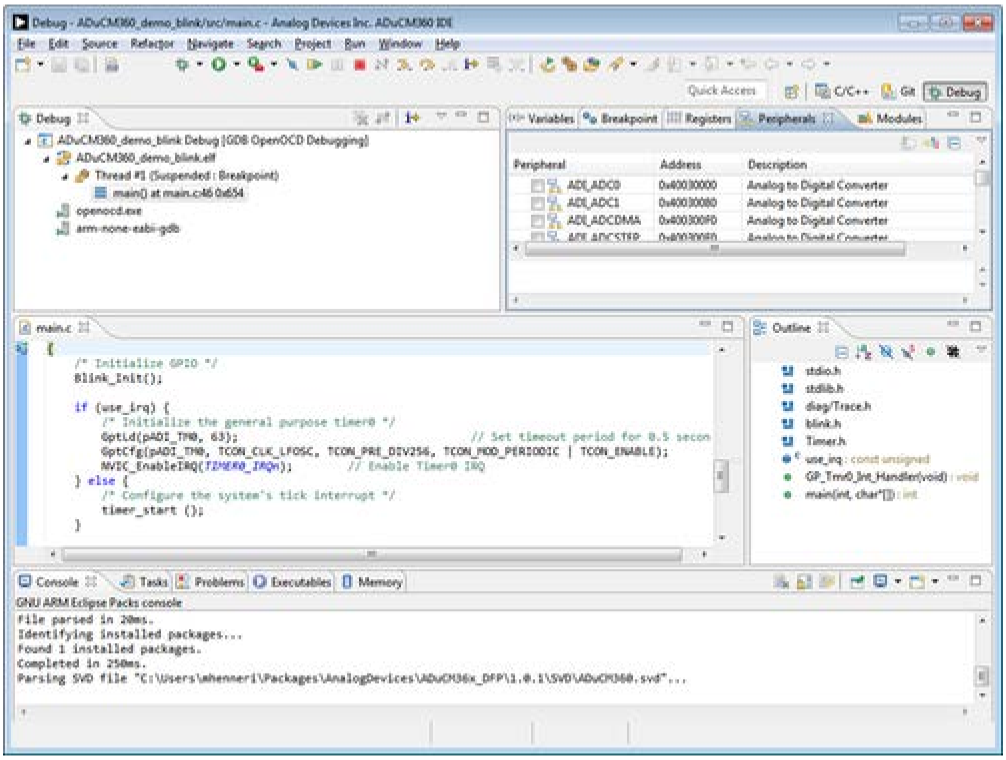
ADuCM360_demo_blink at Github

Importing the ADuCM360_demo_blink project

The necessary instructions on how to import **ADuCM360_demo_blink** project in your workspace can be found in the section, Import a project into workspace.

Debugging the ADuCM360_demo_blink project

- A debug configuration must be set up for this project in order to have the possibility to program and to debug it. To do this, follow the instructions from Setting up a Debug Configuration.
- Make sure the target board is connected to the computer (via **DEBUG USB**) and using the tool bar, navigate to the small Debug icon  and select the debugging session you created. The application will programmed and the program execution will stop at the beginning of the main() function.

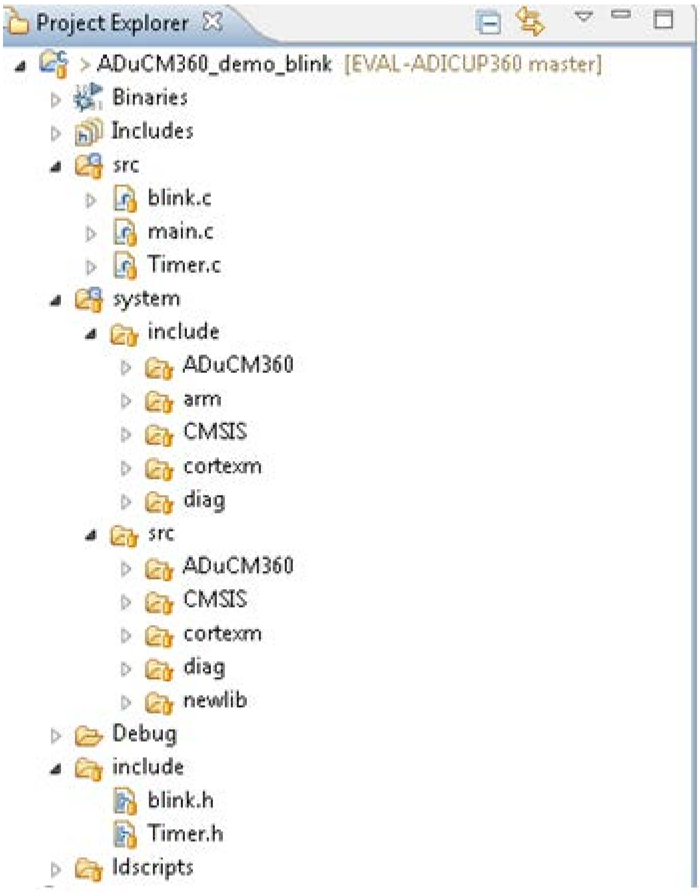


- Use step-by-step execution or directly run the program.

After completion of the steps above the program will remain written into the system flash and it will run by default every time the board is powered up.

Project structure

The **ADuCM360_demo_blink** project use basic ARM Cortex-M C/C++ Project structure:



In the **src** and **include** folders you will find the source and header files related to blink application. You can modify as you wanted those files.

Here you can configure:

- **LEDs blinking method**: in order to use LEDs blinking in a Timer 0 interrupt routine you need to set *use_irq* parameter to *1* (*main.c*). When *use_irq = 0* then you use only a delay function for LEDs blinking.
- **Time for blinking delay**: *BLINK_TIME* (*blink.h*).

The **system** folder contains system related files (try not to change these files):

- **ADuCM360** – contains low levels drivers for ADuCM360 microcontroller.
- **CMSIS** – contains files related to ADuCM360 platform, such as: *ADuCM360.h* (registers definitions), *system_ADuCM360.c/h* (system clock), *vectors_ADuCM360.c* (interrupt vector table).
- **cortexm** – contains files for system management (start-up, reset, exception handler).

Command Line Interpreter Demo

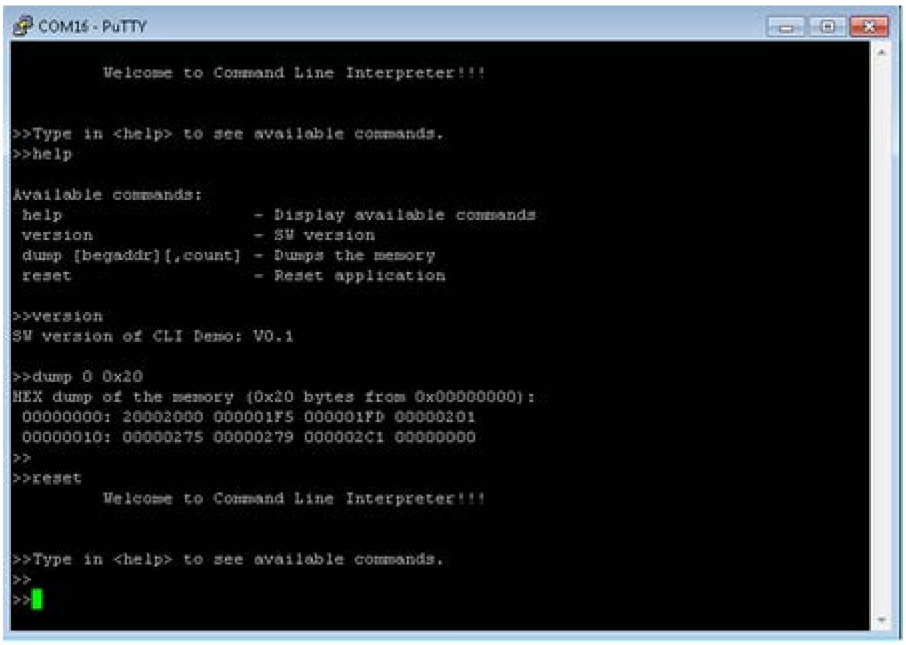
The **ADuCM360_demo_cli** is a Command Line Interpreter (CLI) demo project for the EVAL-ADICUP360 base board, created using the GNU ARM Eclipse Plug-ins in Eclipse environment.

General description

The purpose of this project is to help you to get used with UART peripheral of **ADuCM360** microcontroller. The source code example can serve as a template for a resident command line interpreter, complementing any other user application functionality. Interrupt-based receiving of text commands from the UART is implemented. As soon as a command is entered, an execution request flag is raised to signal the main loop. The commands are recognised and may be executed immediately or later depending on the priority of the current tasks.

You can use any Terminal session you want, such as **Putty** or **Serial Terminal with Eclipse Kepler** (incorporated in Eclipse environment).

A serial connection of a PC to the EVAL-ADICUP360 board using the user USB connector is required to test and use the CLI application (**EVAL-ADICUP360 board** incorporates an FTDI USB-to-serial converter). Any terminal application run on a PC at 9600-8-N-1 without flow control can be used to 'talk' to the **EVAL-ADICUP360 board**. After connecting and sending CR (by pressing Enter), the command prompt '»' and a welcome message should appear.

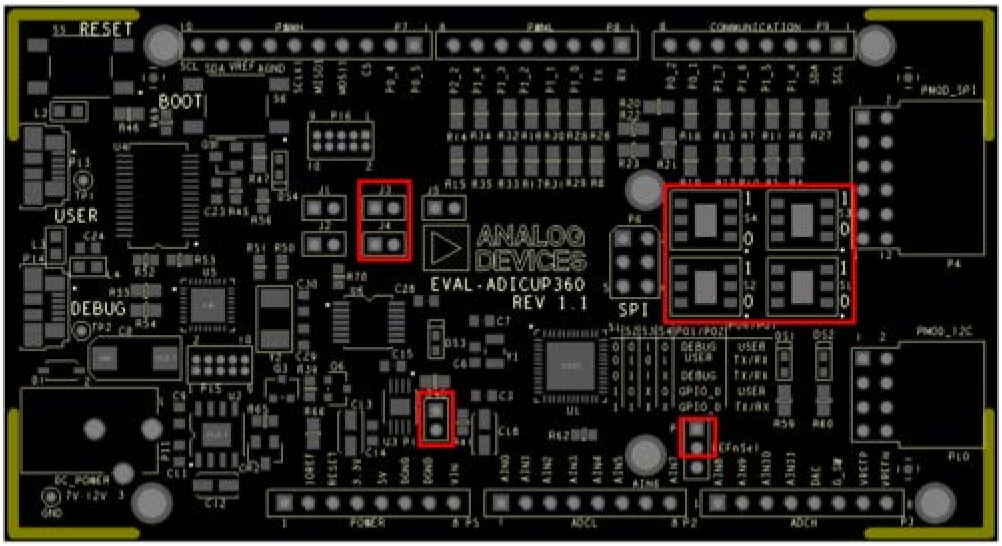


Available commands

Command	Description
help	Display available commands
version	Display SW version of CLI project
dump [begaddr] [count]	Display up to 0x40 consecutive byte-size locations from any address of the ADuCM360 memory space. One should be careful not to request locations which are not decoded because the hardware_fault exception code will block the board.
reset	Perform a HW reset which also initialize the application

Setting up the hardware

In order to program the EVAL-ADICUP360 you need to use the **DEBUG USB**. The jumper set up is shown in the next figure. The important jumpers are highlighted in red.

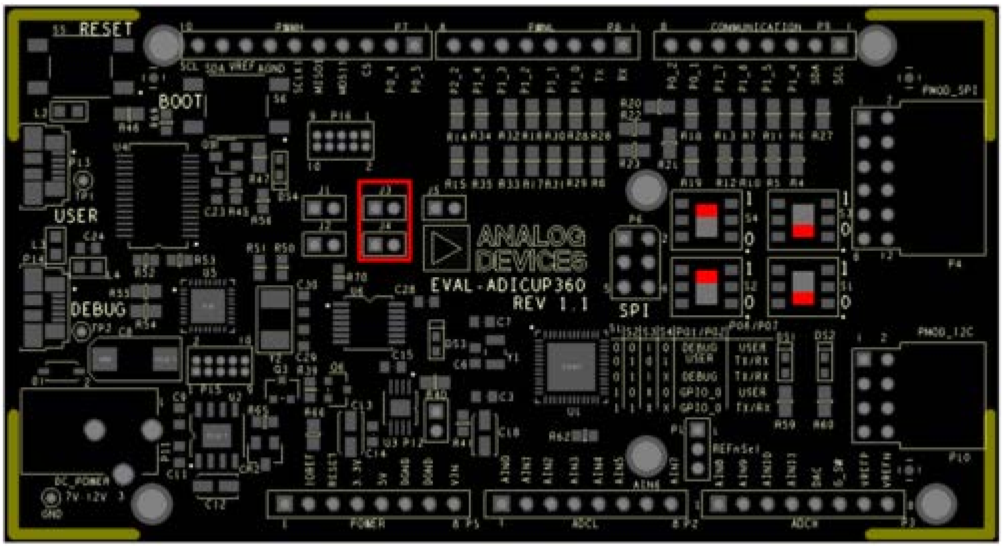


The ADuCM360_cli_demo can connect to the serial port of a PC through two different USB ports on the board:

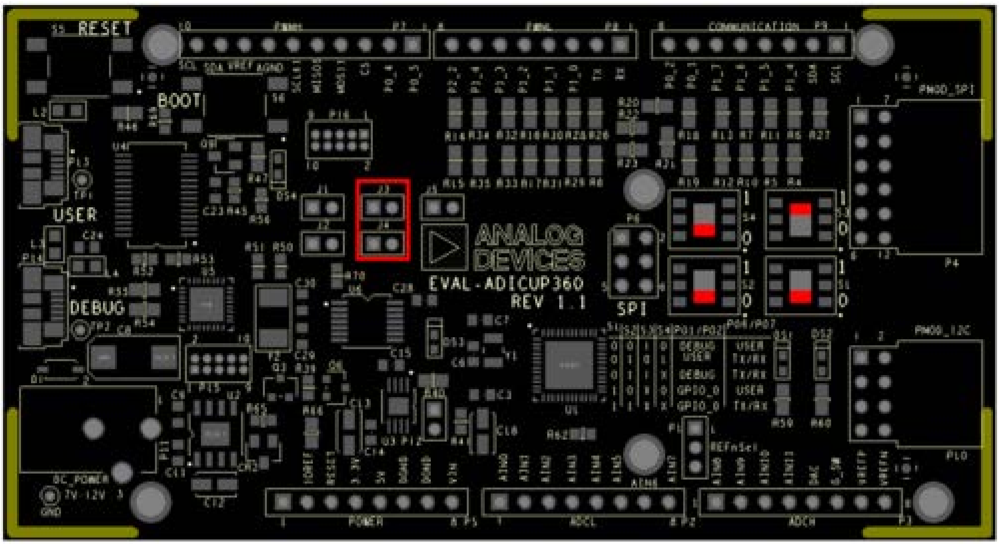
- **USER USB** (using P0.1, P0.2 or P0.6, P0.7 of the ADuCM360)
- **DEBUG USB** (only P0.1, P0.2 of the ADuCM360)

A bank of jumpers provided near the PMOD ports of the EVAL-ADICUP360, makes this easy to configure. The jumpers required for particular configurations are provided in the images below. Ensure that the pins you select in the hardware configuration, also match what is in your software pin definition.(*UART_PINS*)

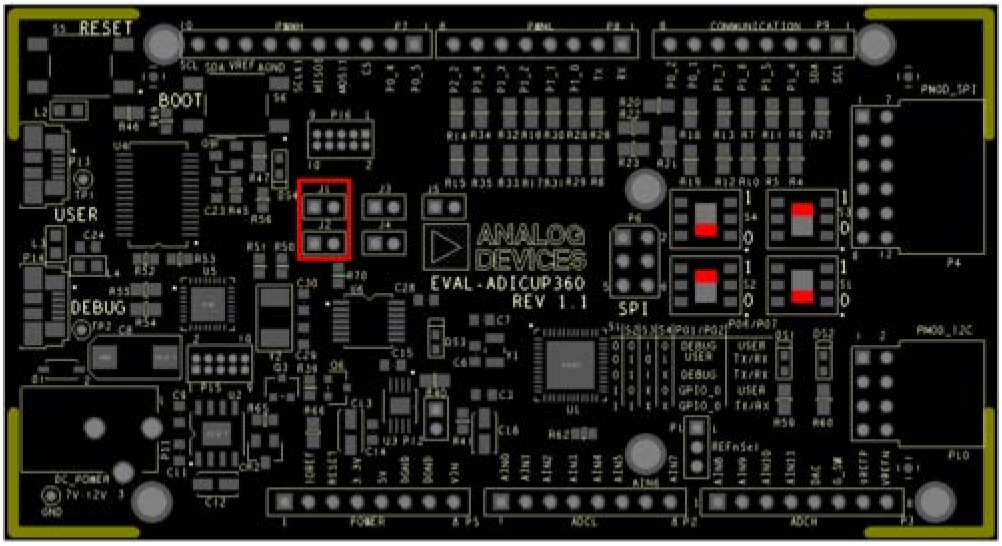
Using UART via USER USB (P0.1, P0.2)



Using UART via USER USB (P0.6, P0.7)



Using UART via DEBUG USB (P0.1, P0.2)



If using UART in **USER USB** configuration, you first need to program the board using **DEBUG USB**

If using UART in **DEBUG USB** configuration you first need to program the board using **DEBUG USB** and after the program runs on target, you need to change jumper (J1 and J2) positions

Obtaining the source code

We recommend not opening the project directly, but rather import it into Eclipse and make a local copy in your Eclipse workspace.

To learn how to import the **ADuCM360_demo_cli** project form the projects examples in the Git repository, please click on How to import existing projects from the GIT Repository.

The source code and include files of the **ADuCM360_demo_cli** can be found in the projects examples which comes with the installer package, or the latest version of the project can be found on Github:

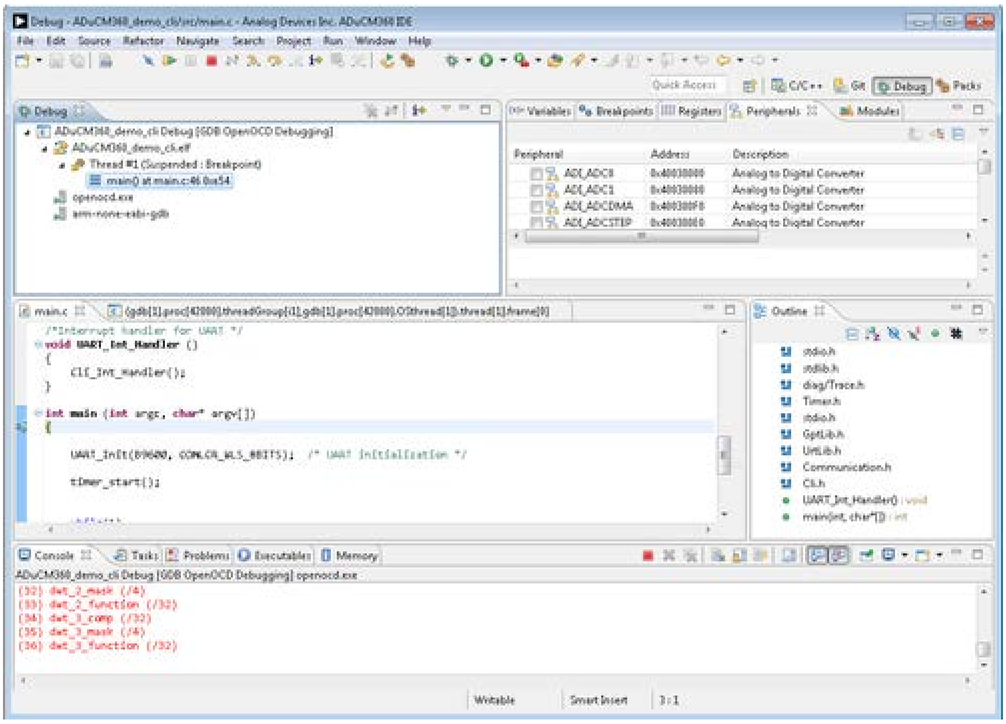
ADuCM360_demo_cli at Github

Importing the ADuCM360_demo_cli project

The necessary instructions on how to import **ADuCM360_demo_cli** project in your workspace can be found in the section, Import a project into workspace.

Debugging the ADuCM360_demo_cli project

- A debug configuration must be set up for this project in order to have the possibility to program and to debug the **ADuCM360_demo_cli** project. To do this, follow the instructions from Setting up a Debug Configuration Page.
- Make sure the target board is connected to the computer (via **DEBUG USB**) and using the tool bar, navigate to the small Debug icon  and select the debugging session you created. The application will programmed and the program execution will stop at the beginning of the main() function.

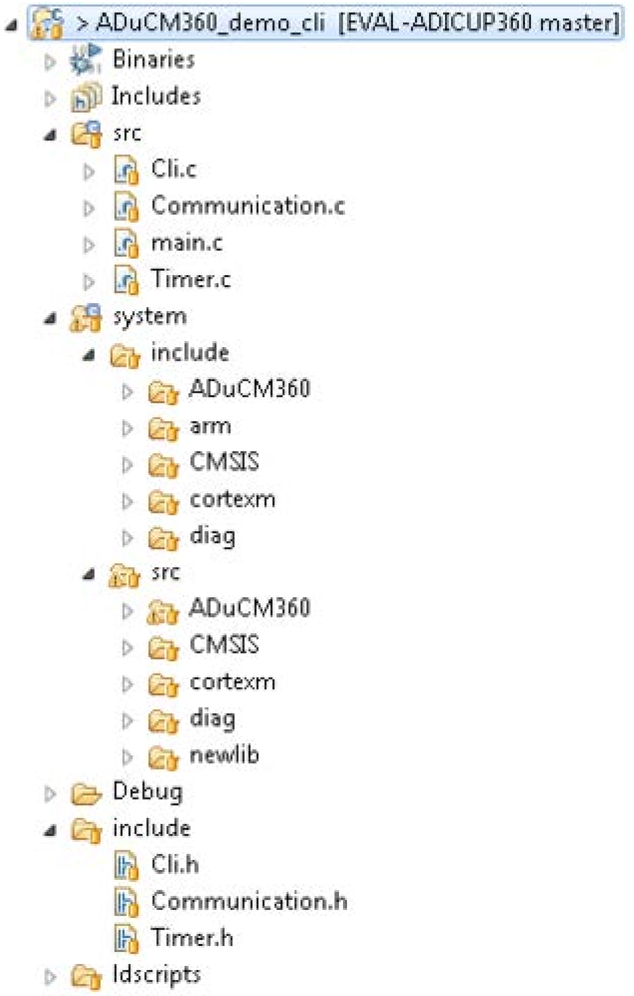


- Use step-by-step execution or directly run the program.

After completion of the steps above the program will remain written into the system flash and it will run by default every time the board is powered up.

Project structure

The **ADuCM360_demo_cli** project use basic ARM Cortex-M C/C++ Project structure:



This project contains: initialization part - disabling watchdog, setting system clock, enabling clock for peripheral; UART interrupt service; port configuration for UART use; UART read/write management; command line interpreter application.

In the **src** and **include** folders you will find the source and header files related to CLI application. You can modify as you wanted those files. The *Communication.c/h* files contain UART specific data, meanwhile the *cli.c/h* files contain the command interpreter data.

Here you can configure:

- **UART pin configuration** - *UART_PINS* paramater - use for P0.1, P0.2 connection - UART_PINS_12 or use for P0.6, P0.7 connection - UART_PINS_67 (*Communication.h*).
- **UART mode**- *UART_MODE* paramater - interrupt or polling mode (*Communication.h*).
- **UART baud rate** - available baud rates for serial port can be changed at initialization part (*main*).
- **UART data bits** - 5 to 8 bits can be changed at initialization part (*main*).

The **system** folder contains system related files (try not to change these files):

- **ADuCM360** – contains low levels drivers for ADuCM360 microcontroller.
- **CMSIS** – contains files related to ADuCM360 platform, such as: *ADuCM360.h* (registers definitions), *system_ADuCM360.c/h* (system clock), *vectors_ADuCM360.c* (interrupt vector table).
- **cortexm** – contains files for system management (start-up, reset, exception handler).

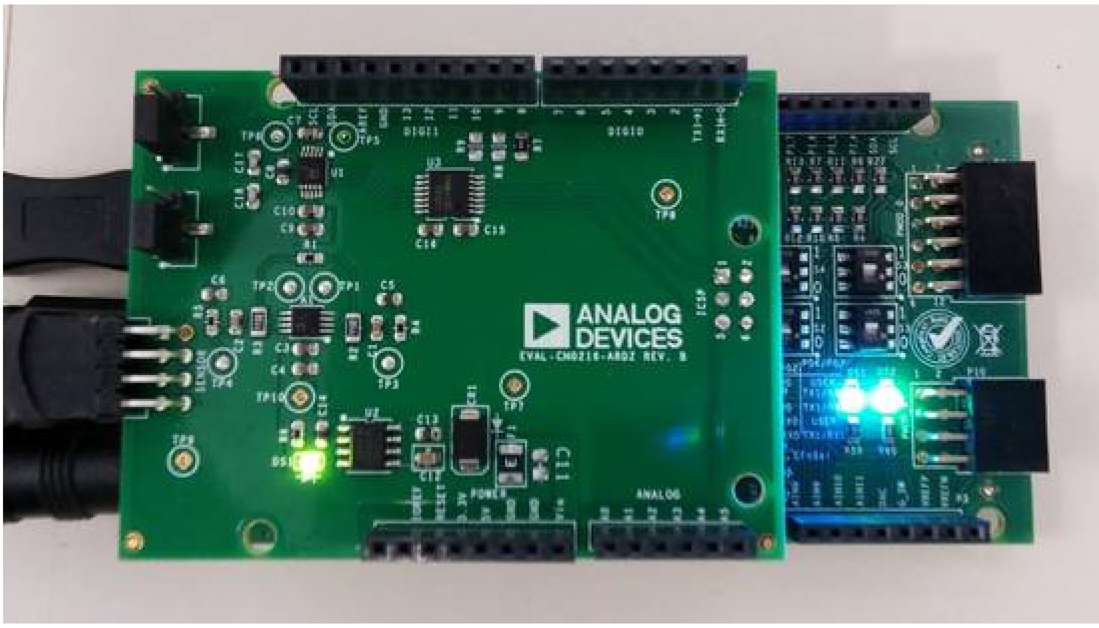
Weigh Scale Measurement Demo

The **ADuCM360_demo_cn0216** is a weigh scale measurement demo project for the EVAL-ADICUP360 base board with additional EVAL-CN0216-ARDZ shield, created using the GNU ARM Eclipse Plug-ins in Eclipse environment.

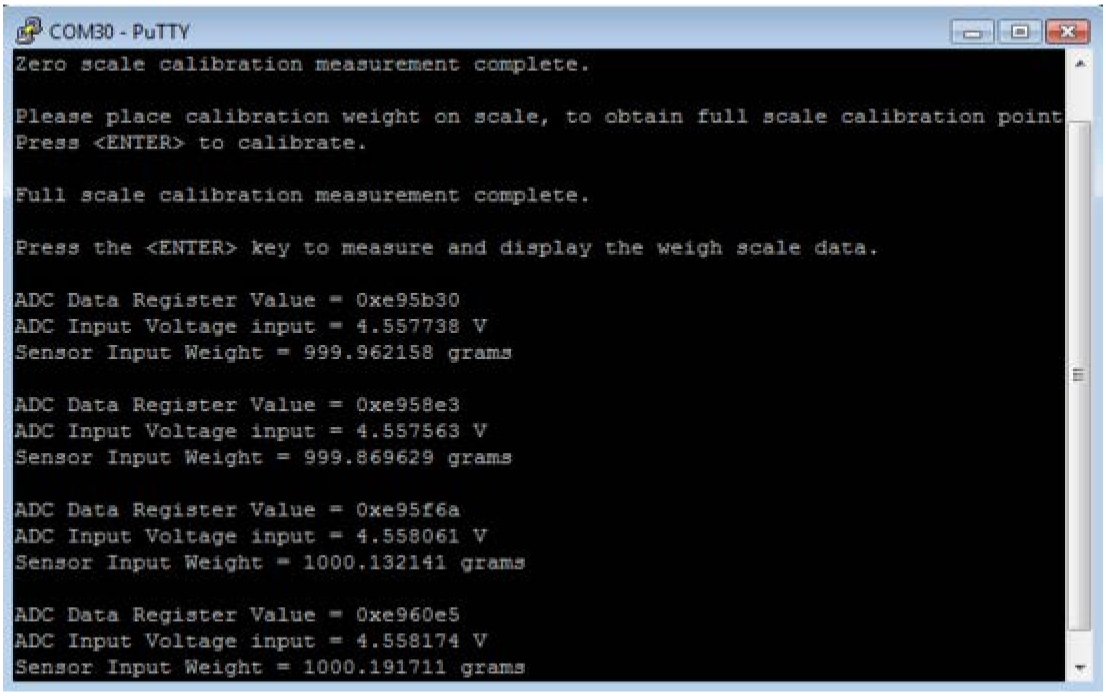
General description

This project is a good example for how to use EVAL-ADICUP360 board in different combinations with various shield boards. It expand the list of possible applications that can be done with the base board.

The **ADuCM360_demo_cn0216** project uses the EVAL-CN0216-ARDZ shield which is a precision weigh scale system using a **24-bits** sigma-delta converter, and auto-zero amplifiers providing high gain for the bridge sensor input



The CN0216 circuit translates the resistance changes on the bridge into very small voltages. The bridge is excited by a regulated 5V and that determines the full scale range of the bridge output. Those values are passed through very low noise, auto zero amplifiers to remove as many error sources as possible before being gained up to levels that will be compatible with the ADC. The 24-bit ADC value is received via SPI interface of the EVAL-ADICUP360 board.



The **ADuCM360_demo_cn0216** application processes ADC output value and make all necessary conversions in order to provide the weight results. A UART interface (9600 baud rate and 8-bits data length) is used to send the results to terminal window: ADC Data Register **codes**, ADC Input Voltage **volts**, and Sensor Input Weight **grams** are the outputs provided in the terminal window.

At the start of the project, a calibration of the upper and lower input range of the weigh scale is taken to remove both offset and gain errors in the circuit, providing the most accurate weigh scale measurements possible. Make sure you open up the serial terminal to your PC in order to do the calibration. Once the program is running, it will ask you to make the zero scale calibration, you **MUST** press <ENTER> to begin the zero scale calibration(takes about 5 seconds). Once that calibration has taken place, the serial terminal will prompt you to add the calibration weight to the scale and then press <ENTER> to make the full scale calibration(again takes about 5 seconds). Those measurements are averaged over 100 samples and then stored into memory as the upper and lower calibration coefficients.

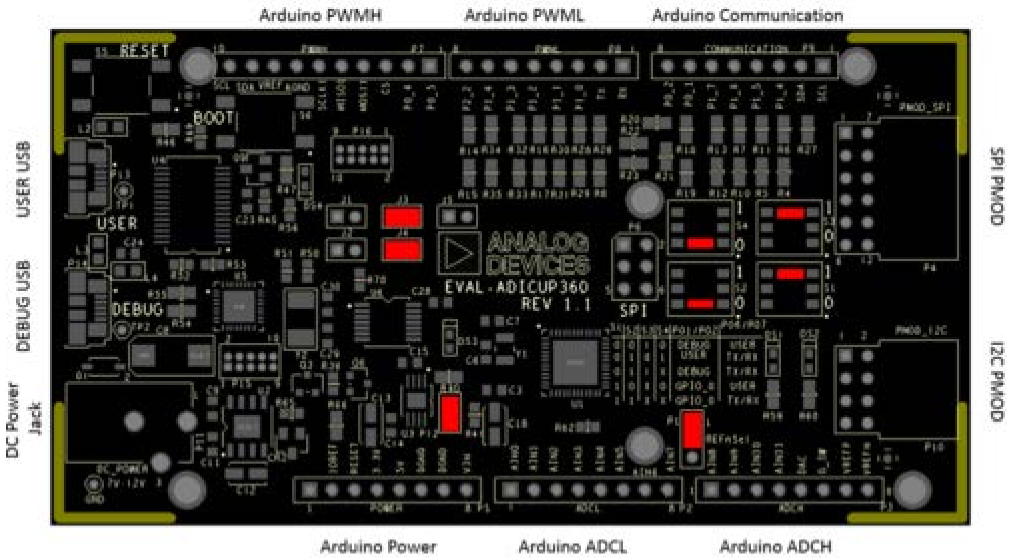
Once calibration is complete, measurements of the output values (weights and conversion information) are displayed every time you press <ENTER> key from the keyboard. Measurements should be between the lower and upper calibration limit can be made at the beginning of the program.

Setting up the hardware

Connect the **EVAL-CN0216-ARDZ** to the Arduino connectors **P4, P5, P6, P7, P8** of the **EVAL-ADICUP360** board.

Extremely important to plug in an acceptable power supply to the barrel jack **P11** to supply power for the **EVAL-CN0216-ARDZ**. The boards will not work if you try only to power it from the DEBUG_USB or the USER_USB.

In order to program the base board you need to use the **DEBUG USB**, and you will need to use the **USER USB** to communicate with the serial terminal program. The important jumpers and switches configurations are highlighted in red.



The ADuCM360_demo_cn0216 uses **UART** connection via **P0.6/P0.7** and **SPI1** channel of the ADuCM360 to communicate with EVAL-CN0216-ARDZ shield.

Obtaining the source code

We recommend not opening the project directly, but rather import it into Eclipse and make a local copy in your Eclipse workspace.

The source code and include files of the **ADuCM360_demo_cn0216** can be found on Github:

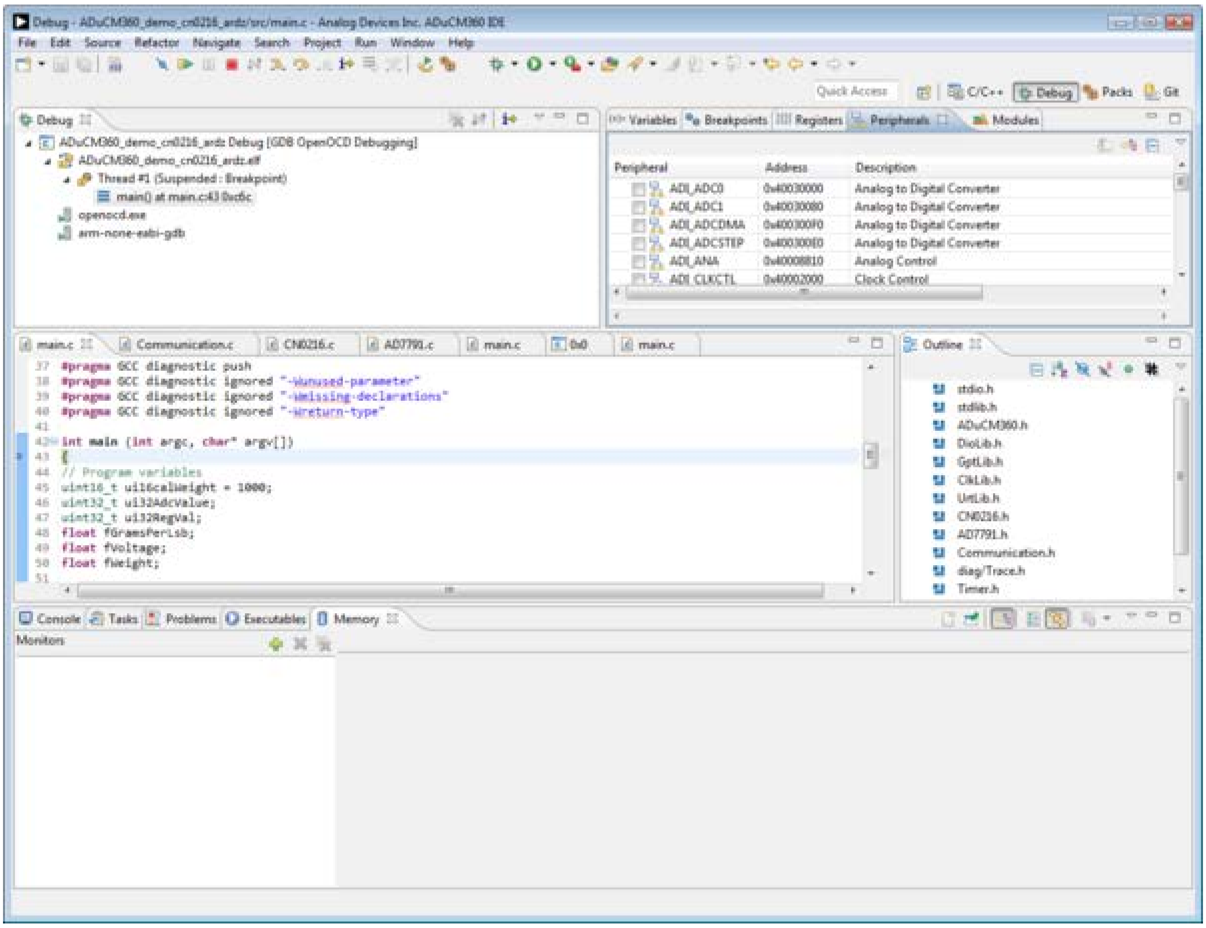
AduCM360_demo_cn0216 at Github

Importing the ADuCM360_demo_cn0216 project

The necessary instructions on how to import the **ADuCM360_demo_cn0216** project form the projects examples in the Git repository, can be found in How to import existing projects from the GIT Repository page.

Debugging the ADuCM360_demo_cn0216 project

- A debug configuration must be set up for this project in order to have the possibility to program and to debug the **ADuCM360_demo_cn0216** project. To do this, follow the instructions from Setting up a Debug Configuration Page.
- Make sure the target board is connected to the computer (via **DEBUG USB**) and using the tool bar, navigate to the small Debug icon  and select the debugging session you created. The application will programmed and the program execution will stop at the beginning of the main() function.



- Use step-by-step execution or directly run the program.

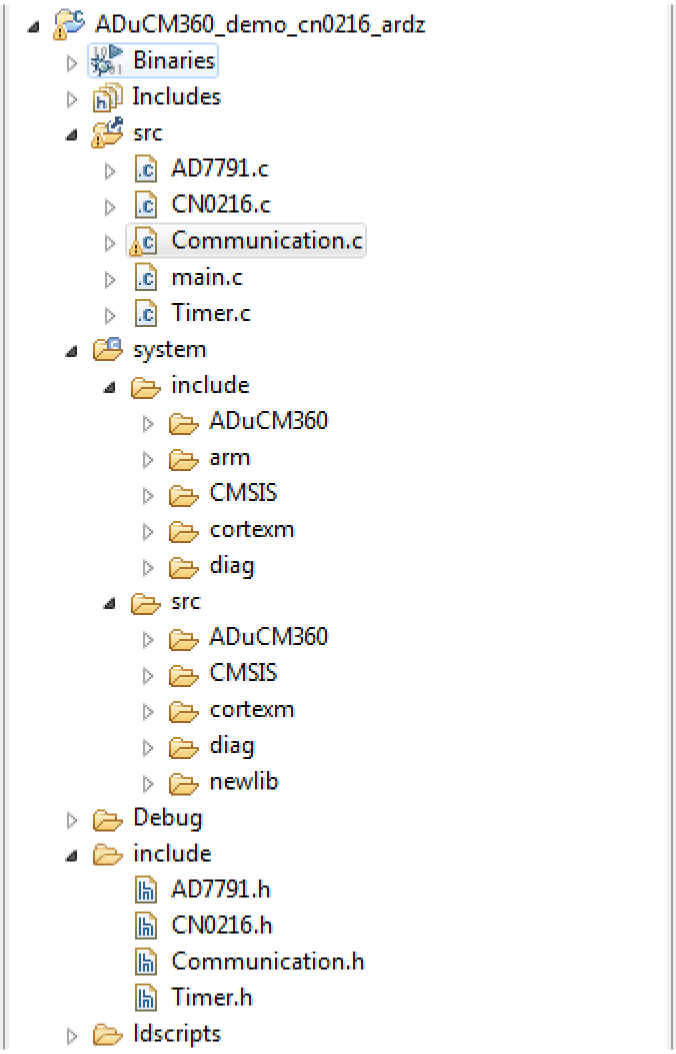
After completion of the steps above the program will remain written into the system flash and it will run by default every time the board is powered up.

Project structure

The **ADuCM360_demo_cn0216** project use ADuCM36x C/C++ Project structure.

This project contains: system initialization part - disabling watchdog, setting system clock, enabling clock for peripherals; port configuration for SPI1, UART via P0.6/P0.7; SPI, UART read/write functions; AD7791 control and weight conversions.

In the **src** and **include** folders you will find the source and header files related to CN0216 software application. The *Communication.c/h* files contain SPI and UART specific data, meanwhile the *AD7791.c/h* files contain the ADC control data and the *CN0216.c/h* files contain the calibration and measurements management.



In the appropriate header files you can **configure** next **parameters**:

- **Converter reference voltage** - VREF - reference voltage (V) for AD7791 converter (*AD7791.h*).

```
    #define VREF              5
```

- **Full scale calibration weight** - CAL_WEIGHT - this parameter can be set to the numeric value of the full scale calibration weight you are using. (in grams) (*CN0216.h*).

```
    #define CAL_WEIGHT     1000
```

The **system** folder contains system related files (try not to change these files):

- **ADuCM360** – contains low levels drivers for ADuCM360 microcontroller.
- **CMSIS** – contains files related to ADuCM360 platform, such as: *ADuCM360.h* (registers definitions), *system_ADuCM360.c/h* (system clock), *vectors_ADuCM360.c* (interrupt vector table).
- **cortexm** – contains files for system management (start-up, reset, exception handler).

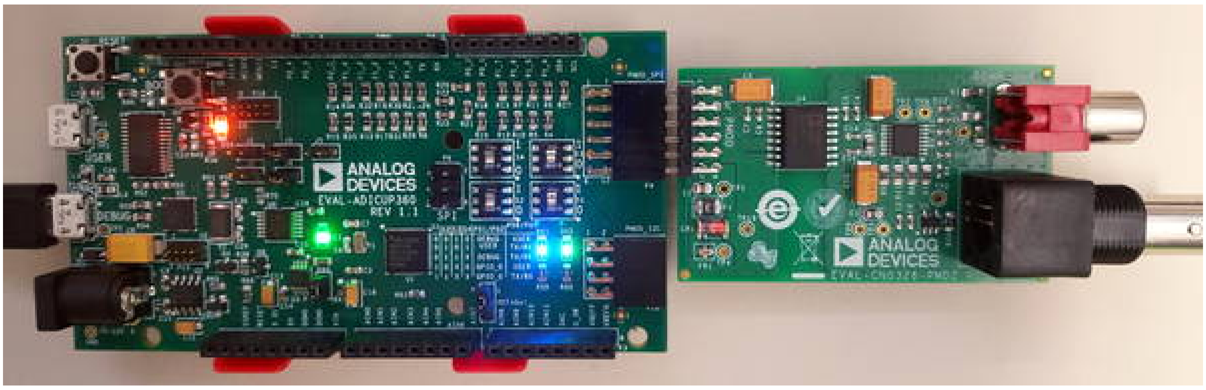
pH Monitor with Temperature Compensation Demo

The **ADuCM360_demo_cn0326** is a pH monitor with automatic temperature compensation demo project, for the EVAL-ADICUP360 base board with additional EVAL-CN0326-PMDZ pmod, created using the GNU ARM Eclipse Plug-ins in Eclipse environment.

General description

This project is a good example for how to use EVAL-ADICUP360 board in different combinations with pmod boards. It expand the list of possible applications that can be done with the base board.

The **ADuCM360_demo_cn0326** project uses the EVAL-CN0326-PMDZ pmod which is a pH sensor signal conditioner and digitizer with automatic temperature compensation.



The CN0326 circuit provides a complete solution for pH sensors with internal resistance between **1 MΩ** and several **GΩ**. It consist of **pH probe** buffer, **Pt1000 RTD** for temperature compensation and **24-bits ADC** with 3 differential analog inputs.

The pH probe consists of a glass measuring electrode and a reference electrode, which is analogous to a battery. When the probe is place in a solution, the measuring electrode generates a voltage depending on the hydrogen activity of the solution, which is compared to the potential of the reference electrode. As the solution becomes more **acidic** (pH < 7) the potential of the glass electrode becomes more positive (**+mV**) in comparison to the reference electrode; and as the solution becomes more **alkaline** (pH > 7) the potential of the glass electrode becomes more negative (**−mV**) in comparison to the reference electrode.

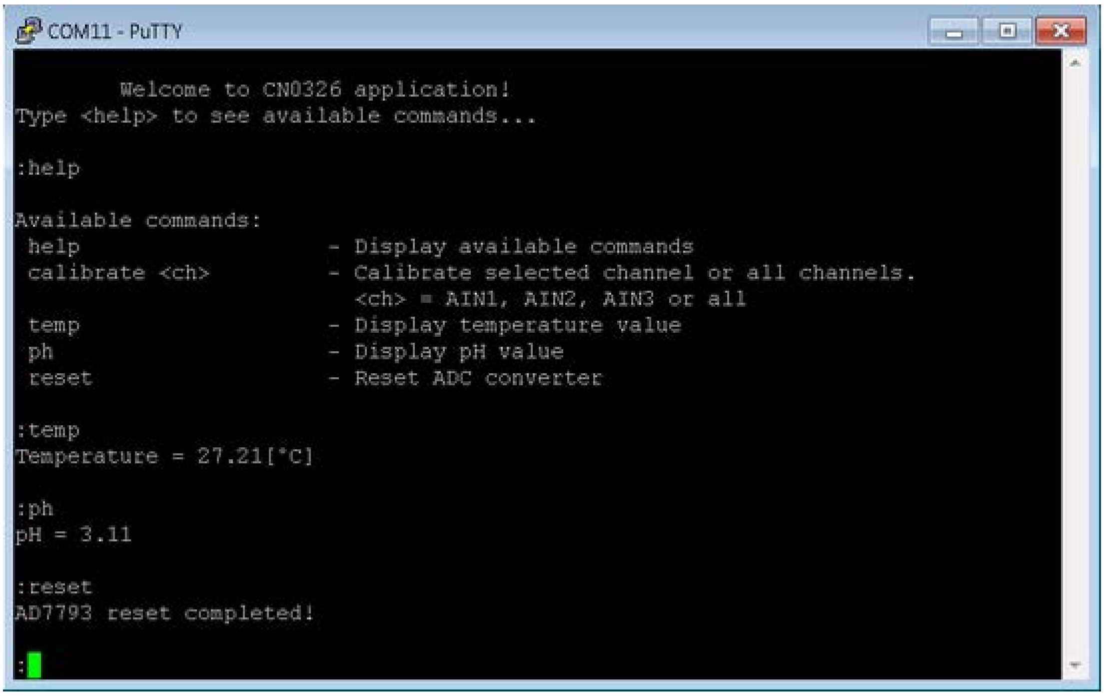
The change in temperature of the solution changes the activity of its hydrogen ions. When the solution is heated, the hydrogen ions move faster which result in an increase in potential difference across the two electrodes. In addition, when the solution is cooled, the hydrogen activity decreases causing a decrease in the potential difference. Electrodes are designed ideally to produce a zero volt (**0 V**) potential when placed in a buffer solution with a pH of 7 (**neutral** pH).

The **EVAL-CN0326-PMDZ** comes with an evaluation software which can help you to test and to calibrate your pmod before you use it.

Please visit CN0326 Software User Guide page to find out how to get and how to use the **CN0326 evaluation software**.

The potential changes are outputted as ADC 24-bits value which is received via SPI interface of the EVAL-ADICUP360 board. The ADC analog differential channels are:

- **AIN1(+)/AIN1(-)** - pH probe (voltage full range: ±414 mV at 25°C to ±490 mV at 80°C)
- **AIN2(+)/AIN2(-)** - Pt1000 RTD (voltage full range: 210 mV to 290 mV with 210 µA excitation current)
- **AIN3(+)/AIN3(-)** - Bias current (used to minimized tne voltage errors)



The **ADuCM360_demo_cn0326** application purchase ADC outputs from input channels, calculates voltage, temperature and pH values. You can choose to use internal excitation current of the ADC (IOUT2) or calculate bias current of the circuit (see *USE_IOUT2* parameter).

A UART interface (9600 baud rate and 8-bits data length) is used, as a command line interpreter, to send the results to terminal window: **temperature** and **ph** values. Beside this two the interpreter process other three commands: **help**, **calibrate** channel/channels and ADC **reset**.

To start the command line interpreter you need to press ENTER key (CR) from the keyboard and after that just type in <help> to see available commands. The output data are send via UART using semihosting mechanism.

The project uses below formula to determine output **ADC code** for an input voltage on either channel:

$$Code = 2^{N-1}\left(\frac{AIN \times GAIN}{V_{REF}} + 1\right)$$

AIN - analog input voltage
GAIN - gain value in the in-amp setting
N - ADC resolution (24)

The **temperature** value is calculated using RTD resistance value and it varies from 0°C (1000 Ω) to 100°C (1385 Ω):

$$T = \frac{R_{rtd} - R_{\min}}{\alpha \cdot R_{\min}}$$

Rrtd - RTD resistance at T°C
Rmin - RTD resistance at 0°C
α - temperature coefficient (0.00385 Ω/Ω/°C)

To calculate **pH** value is used Nernst equation:

$$E = a - \frac{2.303\, R\,(T + 273.1)}{nF} \times (pH - pH_{ISO})$$

E - voltage of the hydrogen electrode with unknown activity
α - zero point tolerance (±30 mV)
T - ambient temperature in °C
n - valence, number of charges on ion (1 at 25 °C)
F - Faraday constant (96485 coulombs/mol)
R - Avogadro's number (8314 mV-coulombs /°K mol)
pHiso - reference hydrogen ion concentration (7)

Semihosting with ARM

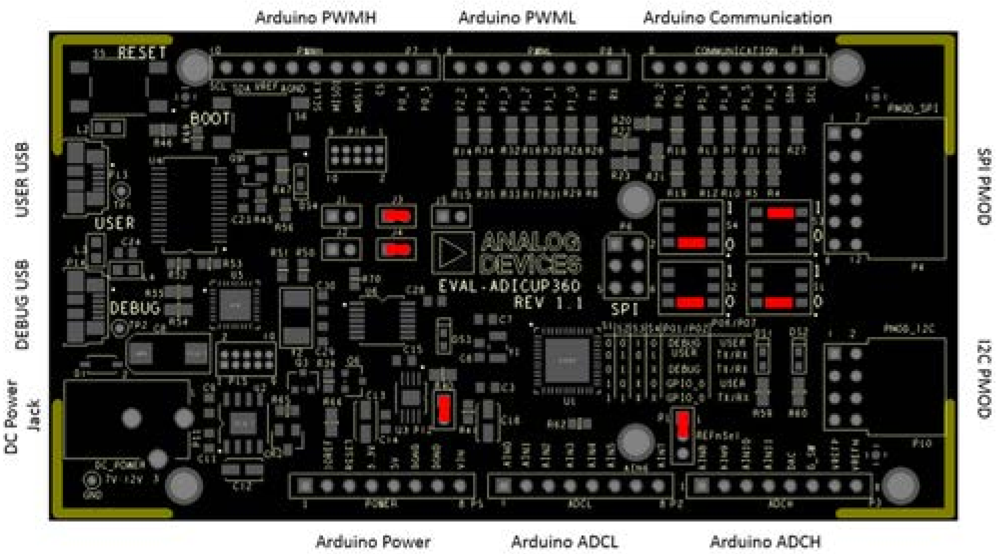
Semihosting is a mechanism that connect the target firmware's standard IO (printf, scanf/fgets, open, write, read, close, etc) to your host PC via JTAG or SWD. It’s easy to configure it with open source tooling - the **newlib** C standard library and **OpenOCD JTAG** implementation.

You can automatic enable semihosting and configure it by using the project ADuCM36x C/C+ + Project template, which offer you the ability to select how do you want to use semihosting.

This example present the possibility to use semihosting to output messages with **printf()** by using a physical serial connection as UART. It uses the **newlib** GNU ARM library which actually links the UART physical port to standard C functions. You need only to overwrite **_write()** function, which is marked as *weak* function in the GNU ARM library, with your own function that write characters to UART (the same for **_read()** function when you want to use **scanf()** in your code).

Setting up the hardware

Connect the **EVAL-CN0326-PMD** to the **SPI_PMOD** connector of the **EVAL-ADICUP360** board. In order to program the base board you need to use the **DEBUG USB**. After you program the board you can switch to **USER USB** and you are set to use the application. The important jumpers and switches configuration are highlighted in red.



The ADuCM360_cn0326_demo use **UART** connection via **P0.6/P0.7** and **SPI0** channel of the ADuCM360 to communicate with CN0326 board.

Obtaining the source code

We recommend not opening the project directly, but rather import it into Eclipse and make a local copy in your Eclipse workspace.

The source code and include files of the **ADuCM360_demo_cn0326** can be found on Github:

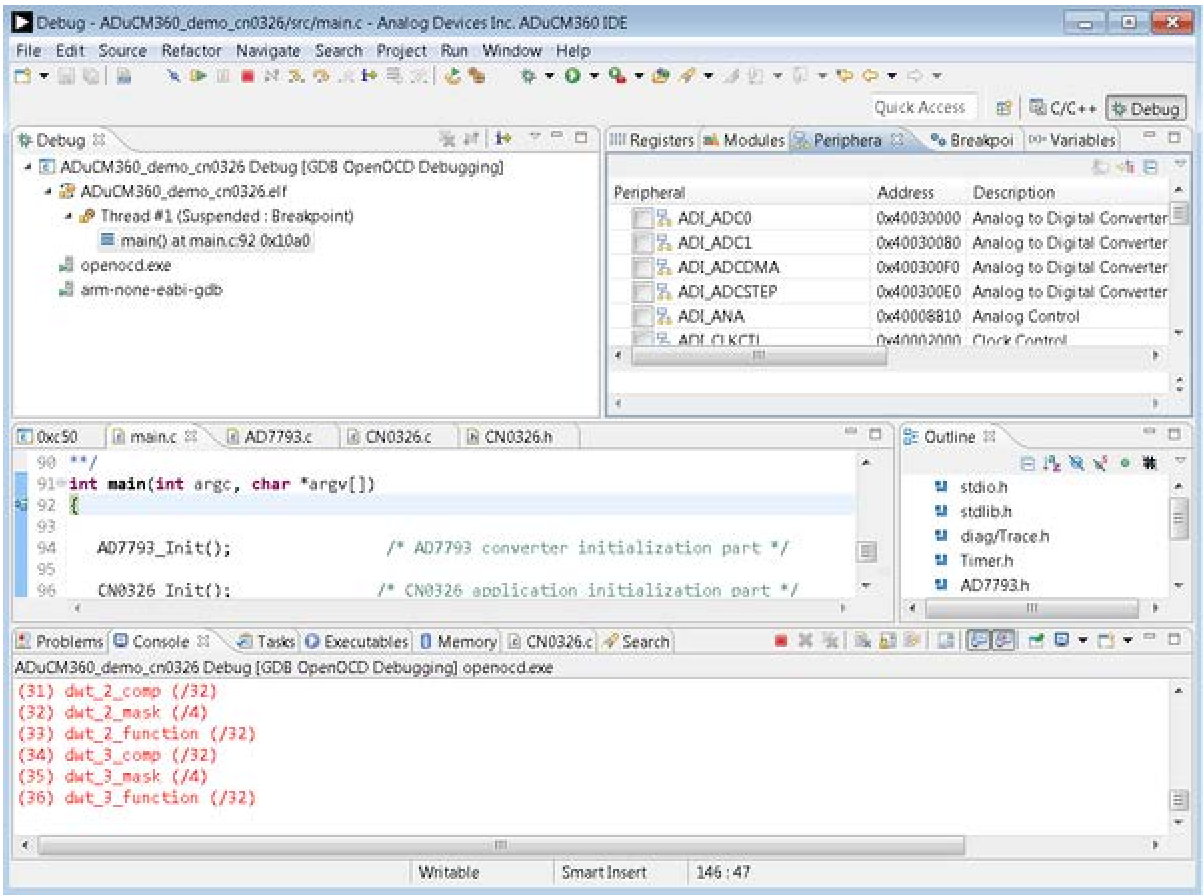
AduCM360_demo_cn0326 at Github

Importing the ADuCM360_demo_cn0326 project

The necessary instructions on how to import the **ADuCM360_demo_cn0326** project form the projects examples in the Git repository, can be found in How to import existing projects from the GIT Repository page.

Debugging the ADuCM360_demo_cn0326 project

- A debug configuration must be set up for this project in order to have the possibility to program and to debug the **ADuCM360_demo_cn0326** project. To do this, follow the instructions from Setting up a Debug Configuration Page.
- Make sure the target board is connected to the computer (via **DEBUG USB**) and using the tool bar, navigate to the small Debug icon and select the debugging session you created. The application will programmed and the program execution will stop at the beginning of the main() function.



- Use step-by-step execution or directly run the program.

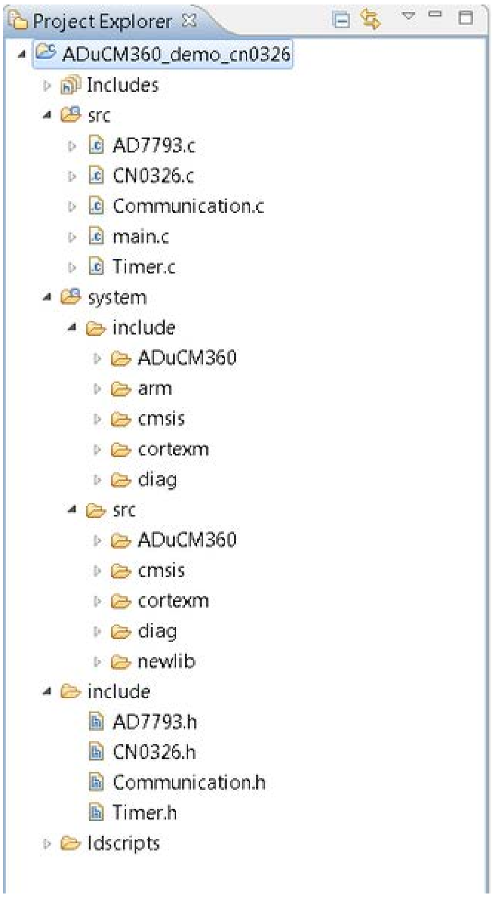
After completion of the steps above the program will remain written into the system flash and it will run by default every time the board is powered up.

Project structure

The **ADuCM360_demo_cn0326** project use ADuCM36x C/C++ Project structure.

This project contains: system initialization part - disabling watchdog, setting system clock, enabling clock for peripherals; port configuration for SPI0, UART via P0.6/P0.7; SPI, UART read/write functions; AD7793 control, voltage conversion, command interpreter, temperature and pH calculations.

In the **src** and **include** folders you will find the source and header files related to CN0326 software application. The *Communication.c/h* files contain SPI and UART specific data, meanwhile the *AD7793.c/h* files contain the ADC control data and the *CN0326.c/h* files contain the pH monitor application data.



In the appropriate header files you can **configure** next **parameters**:

- **ADC gain** - AD7793_GAIN - POWER_DOWN set gain value for AD7793 converter (*AD7793.h*).

```
#define AD7793_GAIN                    AD7793_GAIN_1
```

- **Excitation current** - USE_IOUT2 - select if you want to use bias current from the AIN3 channel: YES or you want to use internal excitation current, 210 µA: NO(*CN0326.h*).

```
#define  USE_IOUT2         NO
```

- **Zero point tolerance** - TOLERANCE - tolerance used in Nernst equation (*CN0326.h*).

```
 #define  TOLERANCE            0
```

The **system** folder contains system related files (try not to change these files):

- **ADuCM360** – contains low levels drivers for ADuCM360 microcontroller.
- **CMSIS** – contains files related to ADuCM360 platform, such as: *ADuCM360.h* (registers definitions), *system_ADuCM360.c/h* (system clock), *vectors_ADuCM360.c* (interrupt vector table).
- **cortexm** – contains files for system management (start-up, reset, exception handler).

Data Acquisition for Input Current Demo

The **ADuCM360_demo_cn0336** is a data acquisition demo project for 4-20 mA inputs, for the EVAL-ADICUP360 base board with additional EVAL-CN0336-PMDZ pmod, created using the GNU ARM Eclipse Plug-ins in Eclipse environment.

General description

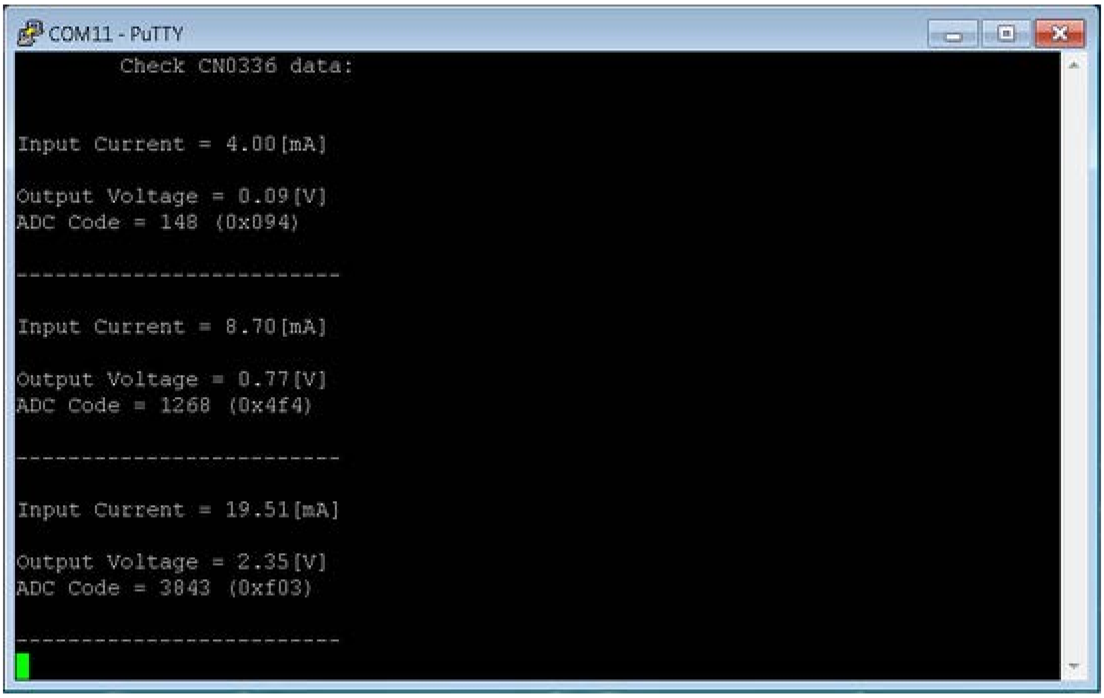
This project is a good example for how to use EVAL-ADICUP360 board in different combinations with pmod boards. It expand the list of possible applications that can be done with the base board.

The **ADuCM360_demo_cn0336** project uses the EVAL-CN0336-PMDZ pmod which is a completely isolated **12-bits**, **300 kSPS** data acquisition system (with only three active devices) that processes **4 mA** to **20 mA** input signals.

The CN0336 circuit consists of an input current-to-voltage converter, a level shifting circuit, an ADC stage and an output isolation stage. The **4 mA** to **20 mA** input signal is converted into **voltage** levels compatible with the input range of the ADC (**0 V** - **2.5 V**). The 12-bits ADC value is received via SPI interface of the EVAL-ADICUP360 board.

The **EVAL-CN0336-PMDZ** comes with an evaluation software which can help you to test and to calibrate your pmod before you use it.

Please visit CN0336 Software User Guide page to find out how to get and how to use the **CN0336 evaluation software**.



The **ADuCM360_demo_cn0336** application processes ADC outputs and provide current and voltage values. You can decide how often the ADC measurements take place (see *SCAN_TIME* parameter).

A UART interface (115200 baud rate and 8-bits data length) is used to send the results to terminal window: **input current** value, **voltage** calculation and **ADC code**. If the input value is out of range you get an error message which means that you need to check your settings.

To start displaying data acquisition results on a terminal (putty in this case) you need to press ENTER key (CR) from the keyboard and after that the data are updated every time the input values are changed. The output data are send via UART using semihosting mechanism.

The project offers two method to calculate the input current, giving you the possibility to get more accurate results (see CN0336 circuit note). You can use **transfer function** of the circuit which calculate input current based on voltage changed value and circuit gain:

```
I = Imin + (Vout - Voffset)/Gain
```

Or you can use the **two-point calibration** method which used the ADC output values for 2 different measurements: first at Imin = 4 mA (ADC1) and second at Imax = 20 mA (ADC2):

```
Ix = Imin + [(Imax - Imin)/(ADC2 - ADC1)]*(ADCx - ADC1)
```

Semihosting with ARM

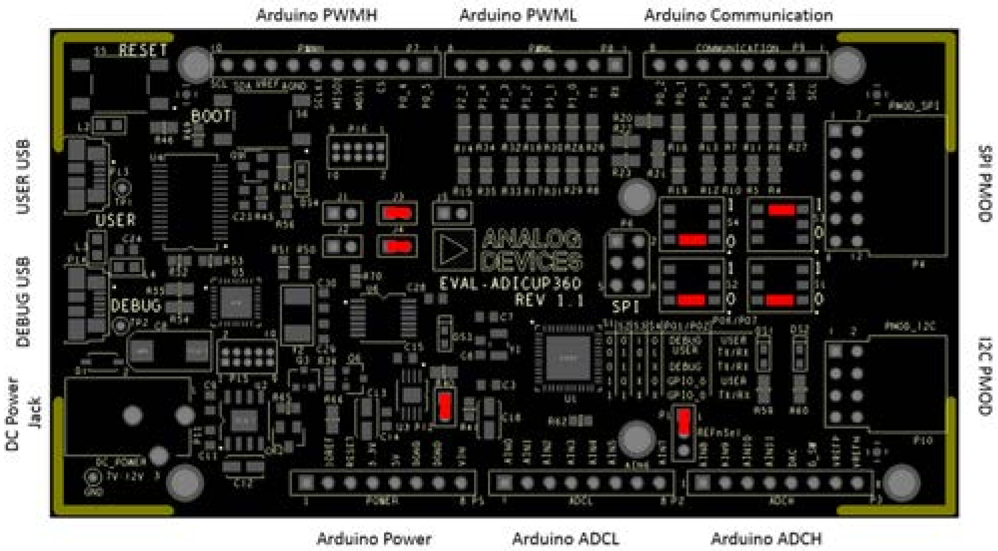
Semihosting is a mechanism that connect the target firmware's standard IO (printf, scanf/fgets, open, write, read, close, etc) to your host PC via JTAG or SWD. It’s easy to configure it with open source tooling - the **newlib** C standard library and **OpenOCD JTAG** implementation.

You can automatic enable semihosting and configure it by using the project ADuCM36x C/C+ + Project template, which offer you the ability to select how do you want to use semihosting.

This example present the possibility to use semihosting to output messages with **printf()** by using a physical serial connection as UART. It uses the **newlib** GNU ARM library which actually links the UART physical port to standard C functions. You need only to overwrite **_write()** function, which is marked as *weak* function in the GNU ARM library, with your own function that write characters to UART (the same for **_read()** function when you want to use **scanf()** in your code).

Setting up the hardware

Connect the **EVAL-CN0336-PMD** to the **SPI_PMOD** connector of the **EVAL-ADICUP360** board. In order to program the base board you need to use the **DEBUG USB**. After you program the board you can switch to **USER USB** and you are set to use the application. The important jumpers and switches configuration are highlighted in red.



The ADuCM360_cn0336_demo use **UART** connection via **P0.6/P0.7** and **SPI0** channel of the ADuCM360 to communicate with CN0336 board.

Obtaining the source code

We recommend not opening the project directly, but rather import it into Eclipse and make a local copy in your Eclipse workspace.

The source code and include files of the **ADuCM360_demo_cn0336** can be found on Github:

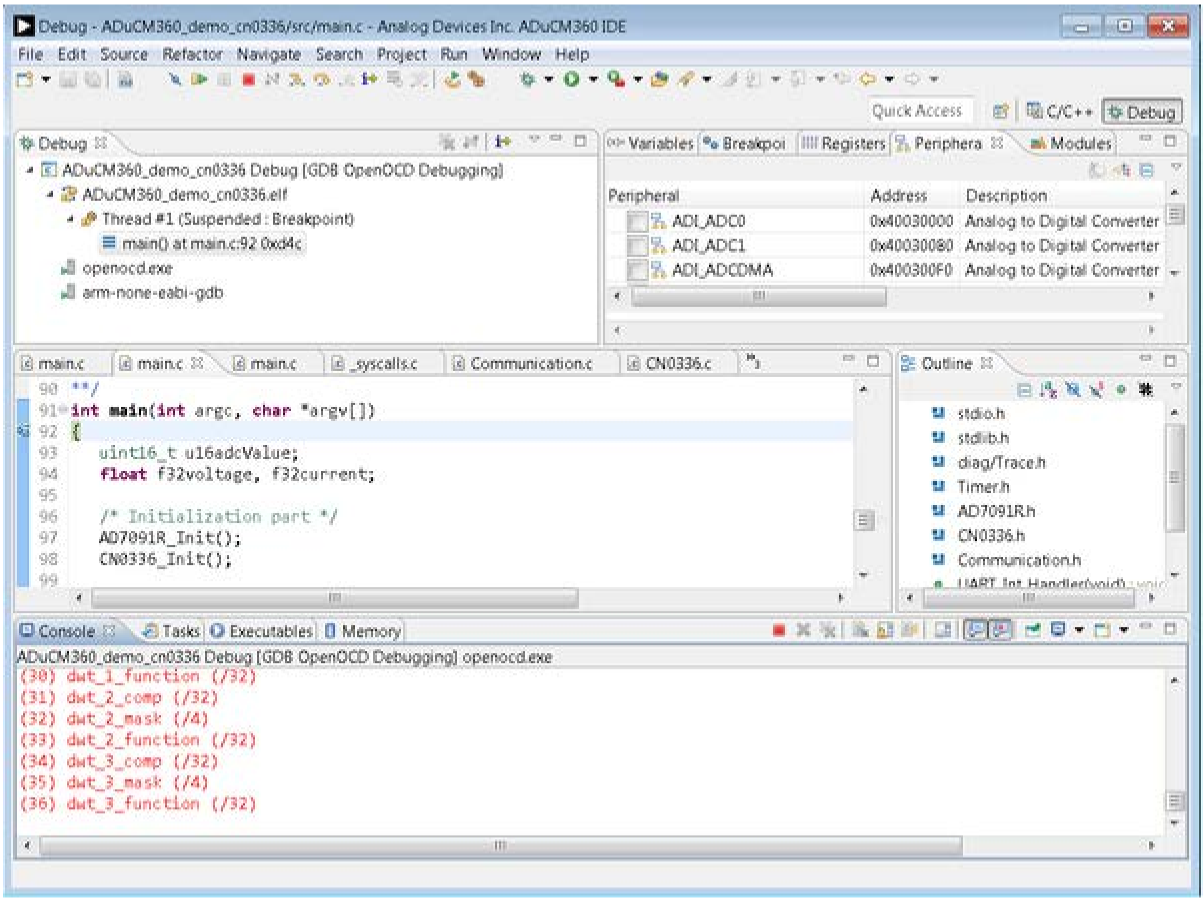
AduCM360_demo_cn0336 at Github

Importing the ADuCM360_demo_cn0336 project

The necessary instructions on how to import the **ADuCM360_demo_cn0336** project form the projects examples in the Git repository, can be found in How to import existing projects from the GIT Repository page.

Debugging the ADuCM360_demo_cn0336 project

- A debug configuration must be set up for this project in order to have the possibility to program and to debug the **ADuCM360_demo_cn0336** project. To do this, follow the instructions from Setting up a Debug Configuration Page.
- Make sure the target board is connected to the computer (via **DEBUG USB**) and using the tool bar, navigate to the small Debug icon  and select the debugging session you created. The application will programmed and the program execution will stop at the beginning of the main() function.



- Use step-by-step execution or directly run the program.

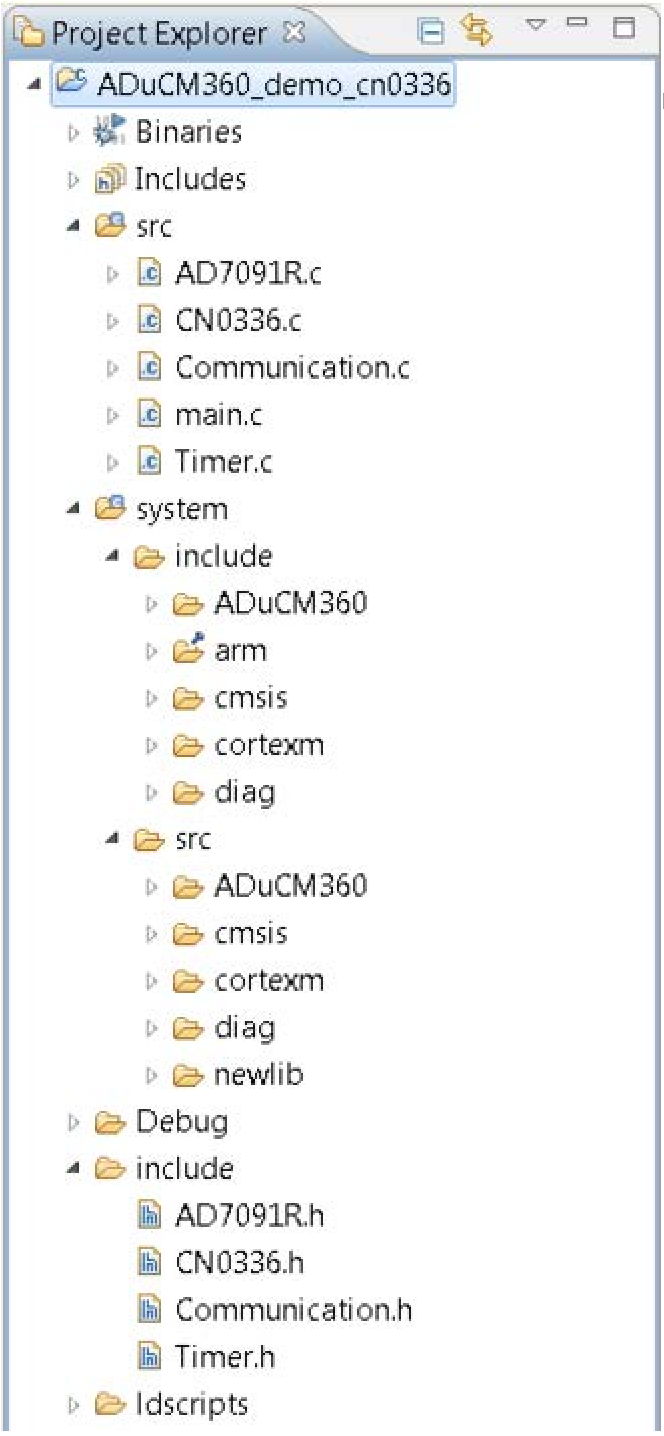
After completion of the steps above the program will remain written into the system flash and it will run by default every time the board is powered up.

Project structure

The **ADuCM360_demo_cn0336** project use ADuCM36x C/C++ Project structure.

This project contains: system initialization part - disabling watchdog, setting system clock, enabling clock for peripherals; port configuration for SPI0, UART via P0.6/P0.7; SPI, UART read/write functions; AD7091R control and current-voltage conversion.

In the **src** and **include** folders you will find the source and header files related to CN0336 software application. The *Communication.c/h* files contain SPI and UART specific data, meanwhile the *AD7091R.c/h* files contain the ADC control data and the *CN0336.c/h* files contain the data acquisition parts.



In the appropriate header files you can **configure** next **parameters**:

- **Converter operation mode** - AD7091R_OPERATION_MODE - POWER_DOWN to select power-down AD7091R mode of operation or NORMAL for normal mode (*AD7091R.h*).

```
#define AD7091R_OPERATION_MODE      POWER_DOWN
```

- **Converter scan time** - SCAN_TIME - how often (msec) to read conversion results (*AD7091R.h*).

```
#define SCAN_TIME            500
```

- **Converter reference voltage** - VREF - reference voltage (V) for AD7091R converter (*AD7091R.h*).

```
 #define VREF                2.5
```

- **Current calculation formula** - CALC_FORMULA - this parameter can be set as TRANSFER_FUNCTION or TWO_POINT_CALIBRATION (*CN0336.h*).

```
    #define CALC_FORMULA     TWO_POINT_CALIBRATION
```

- **Data acquisition parameters** - all needed parameters for data calculations (*CN0336.h*).

```
    #define  IMIN           4             /* Imin [mA] */
    #define  IMAX           20            /* Imax [mA] */
    #define  ADC_MIN        147           /* ADC min for IMIN */
    #define  ADC_MAX        3960          /* ADC max for IMAX */
```

The **system** folder contains system related files (try not to change these files):

- **ADuCM360** – contains low levels drivers for ADuCM360 microcontroller.
- **CMSIS** – contains files related to ADuCM360 platform, such as: *ADuCM360.h* (registers definitions), *system_ADuCM360.c/h* (system clock), *vectors_ADuCM360.c* (interrupt vector table).
- **cortexm** – contains files for system management (start-up, reset, exception handler).

Test procedure

The **ADuCM360_demo_cn0336** project was tested using the base HW configuration (EVAL-ADICUP360 board together with EVAL-CN0336-PMDZ pmod) and by using additional EVAL-CN0179-PMDZ pmod which was choose because it can generate the input current between required range **4mA** - **20 mA**.

In order to generate input current with **CN0179 circuit** is necessary just to use ADI available evaluation software for this pmod (CN-0179 Software User Guide).

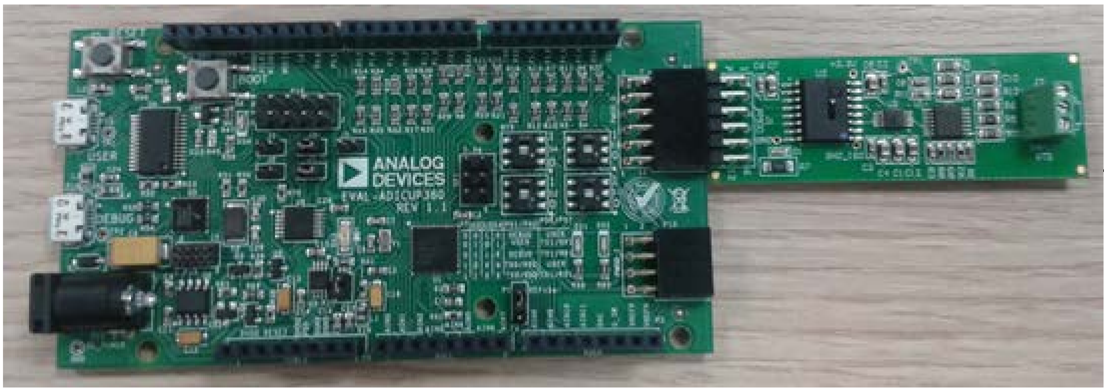
RTD Temperature Measurement Demo

The **ADuCM360_demo_cn0337** is a RTD temperature measurement demo project for the EVAL-ADICUP360 base board with additional EVAL-CN0337-PMDZ pmod, created using the GNU ARM Eclipse Plug-ins in Eclipse environment.

General description

This project is a good example for how to use EVAL-ADICUP360 board in different combinations with pmod boards. It expand the list of possible applications that can be done with the base board.

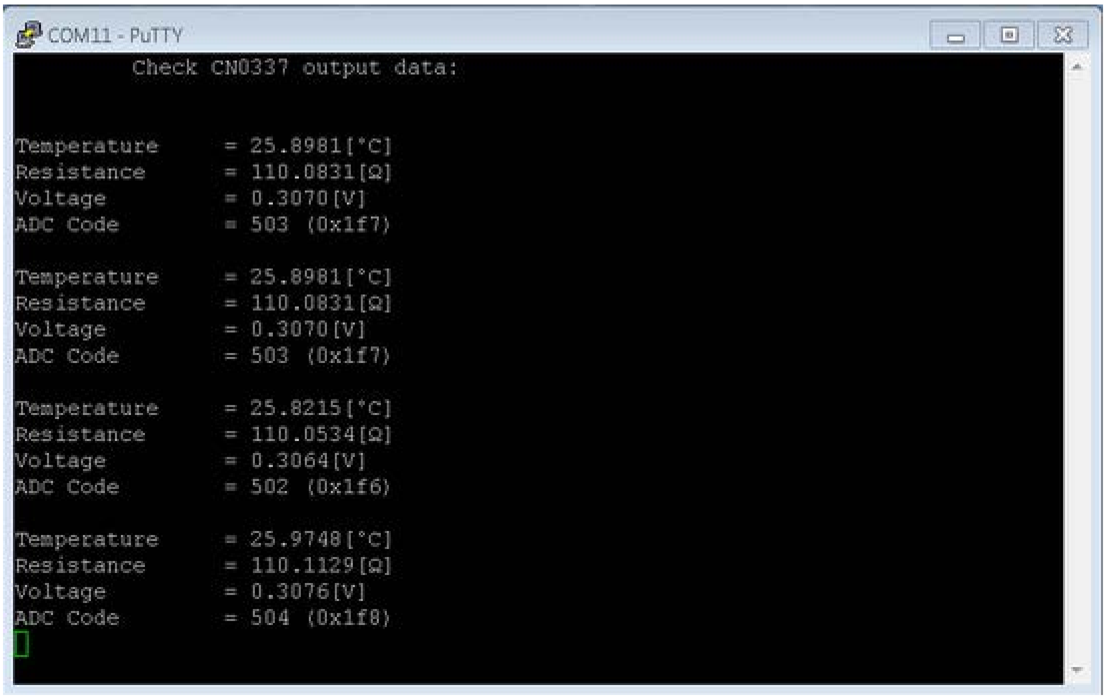
The **ADuCM360_demo_cn0337** project uses the EVAL-CN0337-PMDZ pmod which is a completely isolated **12-bits**, **300 kSPS RTD** temperature measuring system (with only three active devices) that processes the output of a **Pt100 RTD** and includes an innovative circuit for lead-wire compensation using a standard **3-wire** connection.



The CN0337 circuit translates the **RTD** input **resistance** range (**100 Ω** - **212.05 Ω** for a **0°C** - **300°C** temperature) into **voltage** levels compatible with the input range of the ADC (**0 V** - **2.5 V**). The 12-bits ADC value is received via SPI interface of the EVAL-ADICUP360 board.

The **EVAL-CN0337-PMDZ** comes with an evaluation software which can help you to test and to calibrate your pmod before you use it with an RTD sensor.

Please visit CN0337 Software User Guide page to find out how to get and how to use the **CN0337 evaluation software**.



The **ADuCM360_demo_cn0337** application processes ADC output value and make all necessary conversions in order to provide RTD measure results. A UART interface (9600 baud rate and 8-bits data length) is used to send the results to terminal window: RTD **temperature** and **resistance** values, **voltage** calculation and **ADC code**. If the resistance and temperature values are out of range you get an error message which means that you need to check your settings.

The output values are displayed when you press ENTER key (CR) from the keyboard. Also you can decide how often the measurements take place (see *SCAN_TIME* parameter).

The project offers two method to calculate the RTD resistance, giving you the possibility to get more accurate RTD measurement results (see CN0337 circuit note).

You can use **transfer function** of the circuit which calculate RTD resistance based on voltage changed value and circuit gain:

```
Rrtd = (Vout - Voffset)/Gain
```

Or you can use the **two-point calibration** method which used the ADC output values for 2 different measurements: first using Rmin = 100 Ω (ADC1) precision resistor and second with Rmax = 212.05 Ω (ADC2) resistor.

```
Rrtd = Rmin + [(Rmax - Rmin)/(ADC2 - ADC1)]*(ADCrtd - ADC1)
```

Because the transfer function of the RTD (resistance vs. temperature) is nonlinear is needed a software linearization to eliminate the nonlinearity error of the RTD Pt100 sensor. This project used so called **Piecewise Linear Approximation** method.

Piecewise Linear Approximation Method

This method characterized by taking linear approximation one step further, one can conceptualize any number of linear segments strung together to better approximate the nonlinear RTD transfer function. Generating this series of linear segments so that each segment's endpoints meet those of neighboring segments results in what can be viewed as a number of points connected by straight lines.

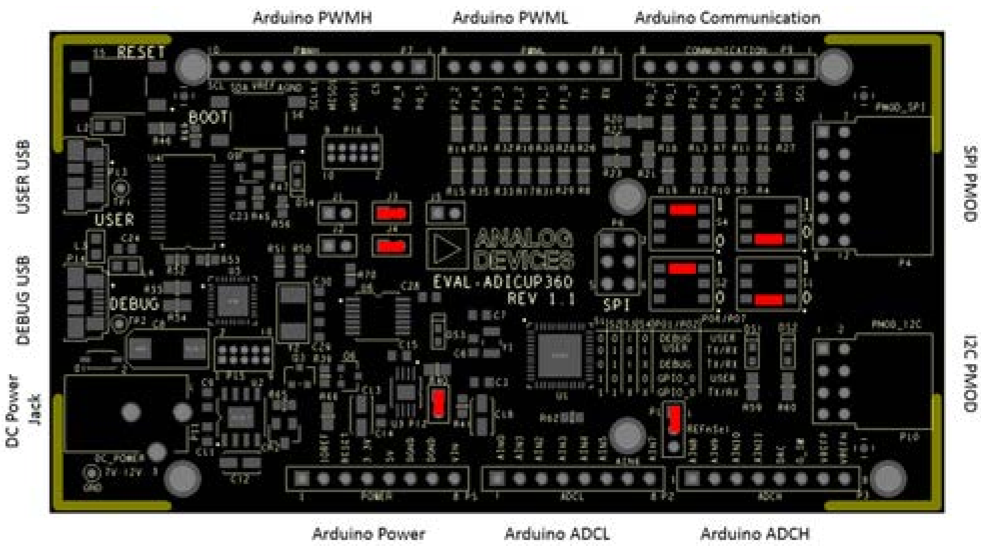
These coefficients is calculated once to best match the RTD's nonlinear transfer function and then stored permanently in a look-up table (see *C_rtd[]* table). From this table of coefficients, the software can perform simple linear interpolation to determine temperature based on measured RTD resistance.

The look-up table can have how many coefficients you needed depending how accurate you want to be. For this project the RTD resistance range is separated into 100 linearization segments.

This method is also used in the AN-709 application note which provide also an RTD coefficient generator tool that you also can use.

Setting up the hardware

Connect the **EVAL-CN0337-PMD** to the **SPI_PMOD** connector of the **EVAL-ADICUP360** board. In order to program the base board you need to use the **DEBUG USB**. After you program the board you can switch to **USER USB** and you are set to use the application. The important jumpers and switches configuration are highlighted in red.



The ADuCM360_cn0337_demo use **UART** connection via **P0.1/P0.2** and **SPI0** channel of the

ADuCM360 to communicate with CN0337 board.

Obtaining the source code

We recommend not opening the project directly, but rather import it into Eclipse and make a local copy in your Eclipse workspace.

The source code and include files of the **ADuCM360_demo_cn0337** can be found on Github:

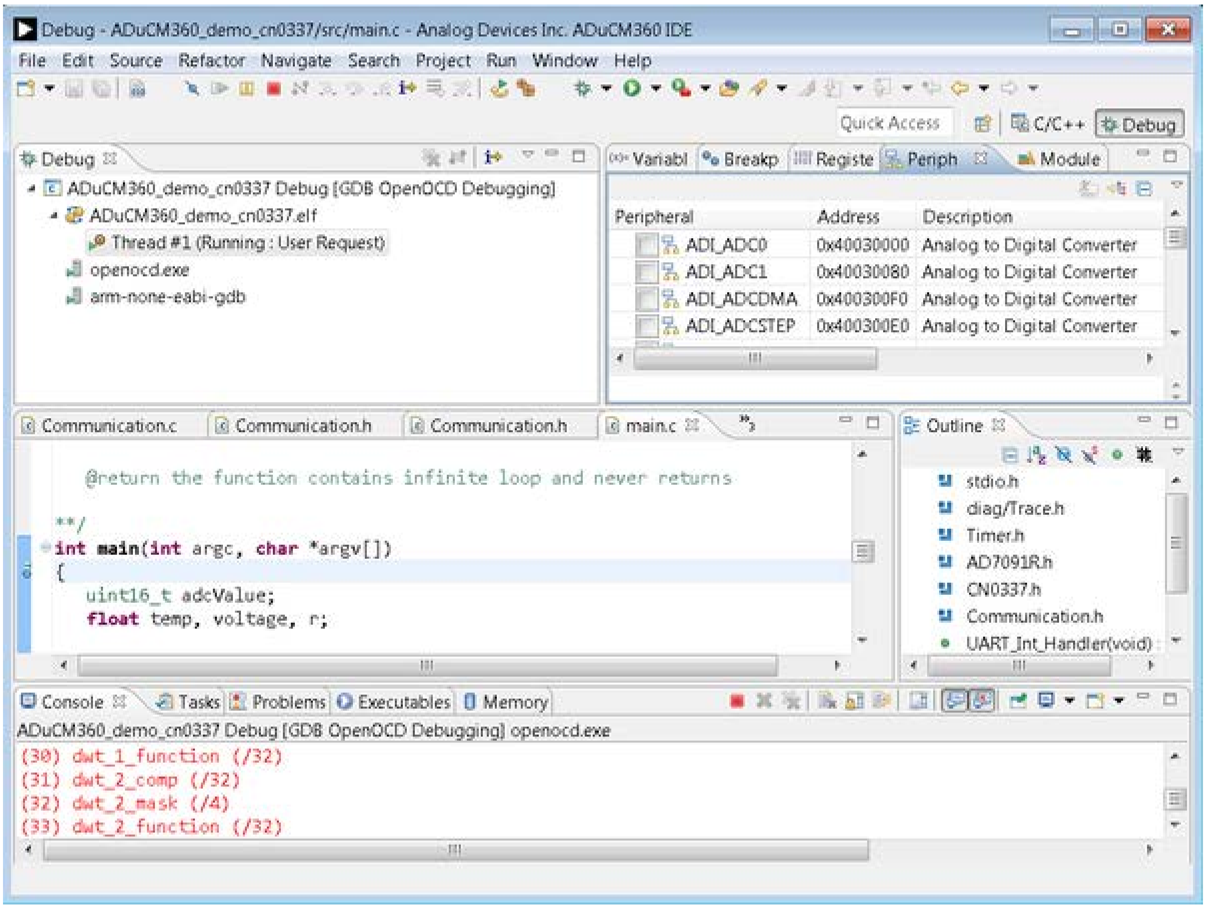
AduCM360_demo_cn0337 at Github

Importing the ADuCM360_demo_cn0337 project

The necessary instructions on how to import the **ADuCM360_demo_cn0337** project form the projects examples in the Git repository, can be found in How to import existing projects from the GIT Repository page.

Debugging the ADuCM360_demo_cn0337 project

- A debug configuration must be set up for this project in order to have the possibility to program and to debug the **ADuCM360_demo_cn0337** project. To do this, follow the instructions from Setting up a Debug Configuration Page.
- Make sure the target board is connected to the computer (via **DEBUG USB**) and using the tool bar, navigate to the small Debug icon  and select the debugging session you created. The application will programmed and the program execution will stop at the beginning of the main() function.



- Use step-by-step execution or directly run the program.

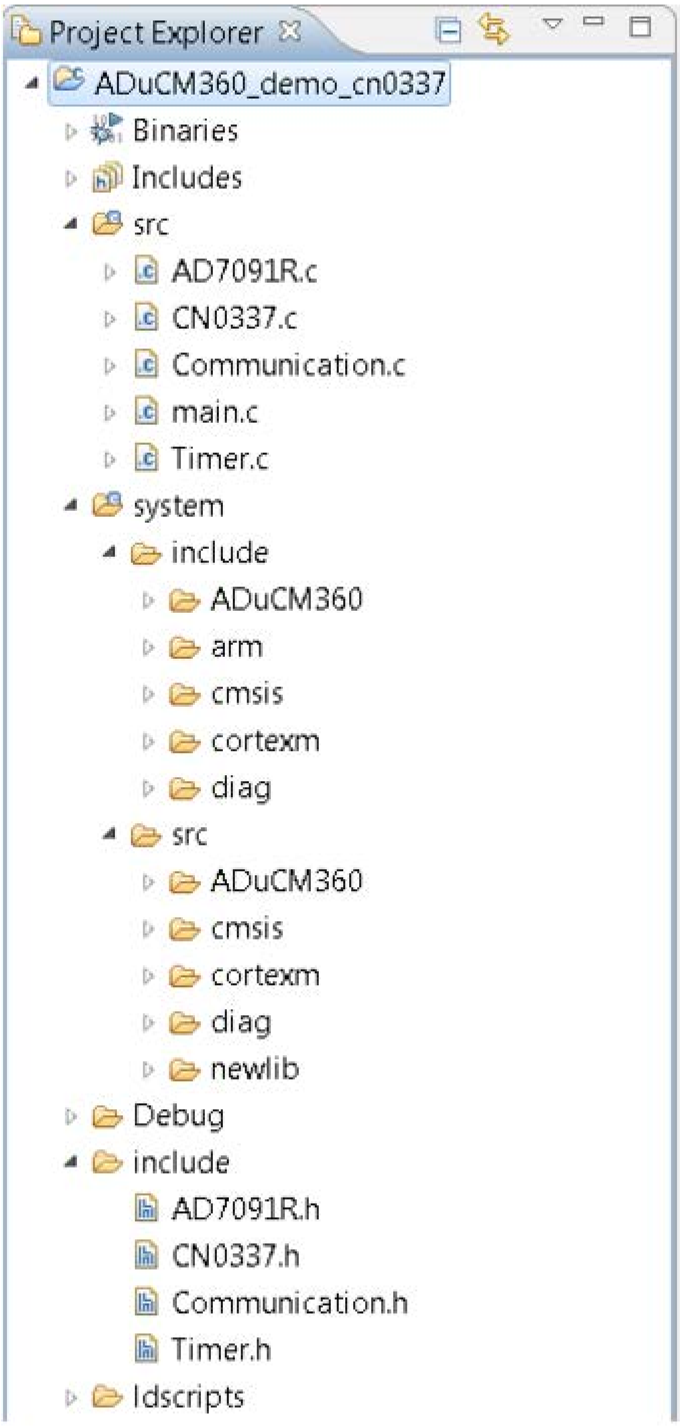
After completion of the steps above the program will remain written into the system flash and it will run by default every time the board is powered up.

Project structure

The **ADuCM360_demo_cn0337** project use ADuCM36x C/C++ Project structure.

This project contains: system initialization part - disabling watchdog, setting system clock, enabling clock for peripherals; port configuration for SPI0, UART via P0.1/P0.2; SPI, UART read/write functions; AD7091R control and RTD conversions.

In the **src** and **include** folders you will find the source and header files related to CN0337 software application. The *Communication.c/h* files contain SPI and UART specific data, meanwhile the *AD7091R.c/h* files contain the ADC control data and the *CN0337.c/h* files contain the RTD measurements management.



In the appropriate header files you can **configure** next **parameters**:

- **Converter operation mode** - AD7091R_OPERATION_MODE - POWER_DOWN to select power-down AD7091R mode of operation or NORMAL for normal mode (*AD7091R.h*).

```
#define AD7091R_OPERATION_MODE       POWER_DOWN
```

- **Converter scan time** - SCAN_TIME - how often (msec) to read conversion results (*AD7091R.h*).

```
#define SCAN_TIME             500
```

- **Converter reference voltage** - VREF - reference voltage (V) for AD7091R converter (*AD7091R.h*).

```
 #define VREF                 2.5
```

- **RTD resistance calculation method** - RTD_FORMULA - this parameter can be set as TRANSFER_FUNCTION or TWO_POINT_CALIBRATION (*CN0337.h*).

```
    #define RTD_FORMULA     TRANSFER_FUNCTION
```

- **RTD parameters** - all needed parameters for RTD calculations (*CN0337.h*).

```
    #define  TMIN          (0)             /* Tmin [˚C] */
    #define  TMAX          (300)           /* Tmax [˚C] */
    #define  RMIN          (100)           /* Resistance [Ohms] at Tmin */
    #define  RMAX          (212.052)       /* Resistance [Ohms] at Tmax  */
    #define  NSEG          100             /* Nr. of sections in look-up
table */
    #define  RSEG          1.12052         /* Resistance of each segment */
    #define  ADC_MIN       152             /* ADC min for RMIN */
    #define  ADC_MAX       4095            /* ADC max for RMAX */
```

The **system** folder contains system related files (try not to change these files):

- **ADuCM360** – contains low levels drivers for ADuCM360 microcontroller.
- **CMSIS** – contains files related to ADuCM360 platform, such as: *ADuCM360.h* (registers definitions), *system_ADuCM360.c/h* (system clock), *vectors_ADuCM360.c* (interrupt vector table).
- **cortexm** – contains files for system management (start-up, reset, exception handler).

Test procedure

The **ADuCM360_demo_cn0337** project was tested using the base HW configuration (EVAL-ADICUP360 board together with EVAL-CN0337-PMDZ pmod) and by connecting the 3-wire **PT100 CZUJNIK** temperature sensor.

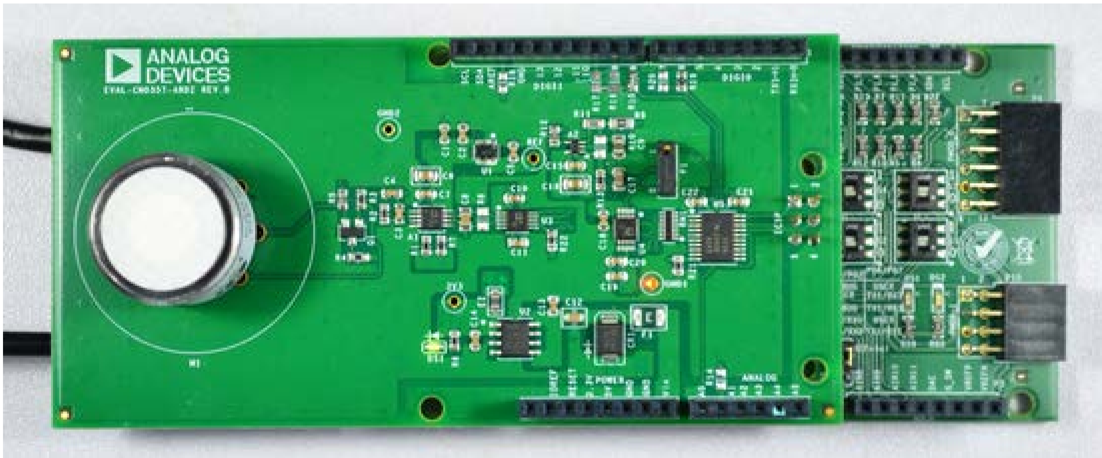
Toxic Gas (CO) Measurement Demo

The **ADuCM360_demo_cn0357** is a toxic gas(CO) detector demo project for the EVAL-ADICUP360 base board with additional EVAL-CN0357-ARDZ shield, created using the GNU ARM Eclipse Plug-ins in Eclipse environment.

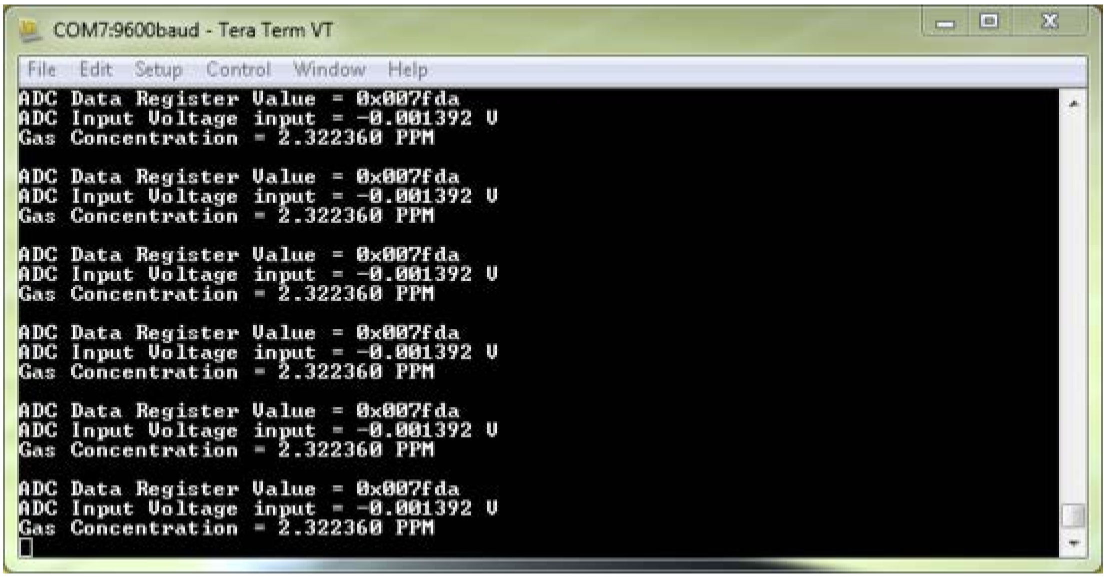
General description

This project is a good example for how to use EVAL-ADICUP360 board in different combinations with various shield boards. It expand the list of possible applications that can be done with the base board.

The **ADuCM360_demo_cn0357** project uses the EVAL-CN0357-ARDZ shield which is a single-supply, low noise, portable gas detector circuit using an electrochemical sensor.



The EVAL-CN0357-ARDZ shield circuit provides a potentiostatic circuit for biasing the electrochemical sensor, along with a programmable TIA and 16-bit Sigma-Delta ADC. The TIA converts the small currents passing in the sensor to a voltage that can be read by the ADC. The 16-bit ADC value is received via SPI interface of the EVAL-ADICUP360 board, where the gas concentration is computed.



The **ADuCM360_demo_cn0357** application configures the necessary components, processes ADC output value and make all necessary conversions in order to provide the gas concentration. A UART interface (9600 baud rate and 8-bits data length) is used to send the results to terminal window: ADC Data Register **codes**, ADC Input Voltage **volts**, and Gas Concentration **Parts Per Million(PPM)** are the outputs provided in the terminal window.

At the start of the project, the software computes the necessary parameters and configure the digital rheostat(AD5270) of the TIA. The required parameters are the sensor sensitivity and sensor range. These can be modified by changing the values of the constants **SENSOR_SENSITIVITY** and **SENSOR_RANGE** found in the **CN0357.h** header file of the project. See the “*Project Structure*” section for more details.

Once configuration is complete, the software remains in a loop and continuously reads data from the ADC. Data can be read from a terminal by pressing the **<Enter>** key on the computer's keyboard.

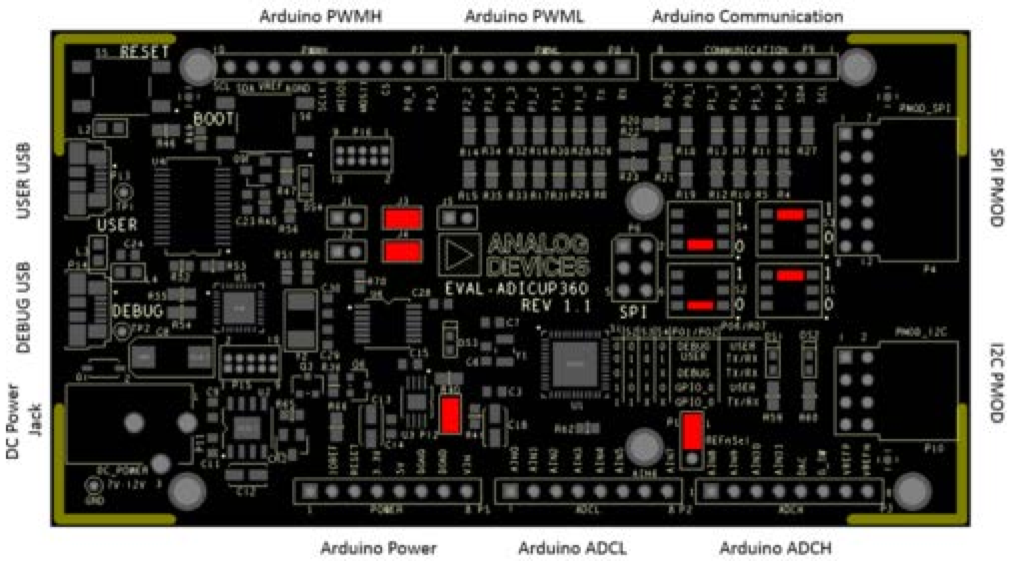
Setting up the hardware

Connect the **EVAL-CN0357-ARDZ** to the Arduino connectors **P4, P5, P6, P7, P8** of the **EVAL-ADICUP360** board.

Extremely important to plug in an acceptable power supply to the barrel jack **P11** to supply power for the **EVAL-CN0357-ARDZ**. The boards will not work if you try only to power it from the DEBUG_USB or the USER_USB.

In order to program the base board you need to use the **DEBUG USB**, and you will need to use the

USER USB to communicate with the serial terminal program. The important jumpers and switches configurations are highlighted in red.



The ADuCM360_demo_cn0357 uses **UART** connection via **P0.6/P0.7** and **SPI1** channel of the ADuCM360 to communicate with EVAL-CN0357-ARDZ board.

Obtaining the source code

We recommend not opening the project directly, but rather import it into Eclipse and make a local copy in your Eclipse workspace.

The source code and include files of the **ADuCM360_demo_cn0357** can be found on Github:

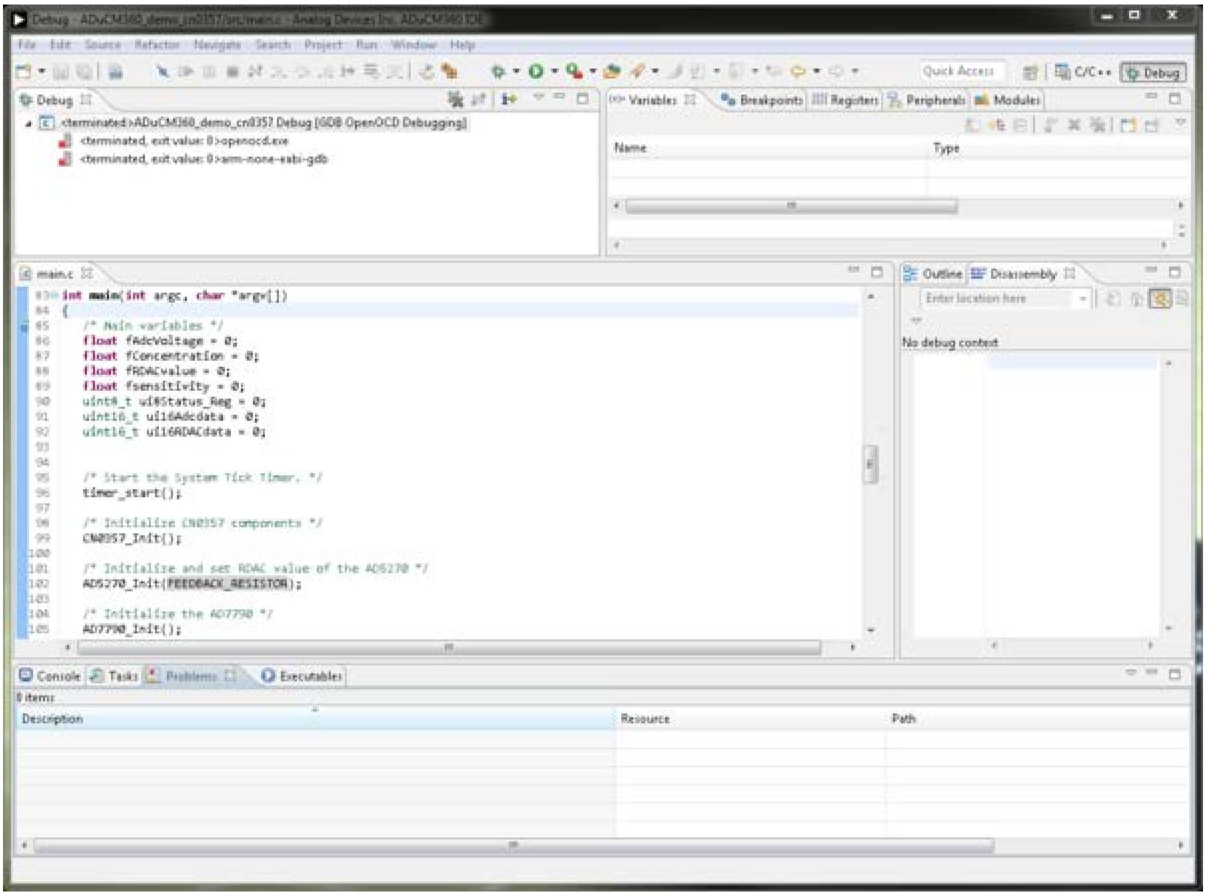
ADuCM360_demo_cn0357 at Github

Importing the ADuCM360_demo_cn0357 project

The necessary instructions on how to import the **ADuCM360_demo_cn0357** project form the projects examples in the Git repository, can be found in How to import existing projects from the GIT Repository page.

Debugging the ADuCM360_demo_cn0357 project

- A debug configuration must be set up for this project in order to have the possibility to program and to debug the **ADuCM360_demo_cn0357** project. To do this, follow the instructions from Setting up a Debug Configuration Page.
- Make sure the target board is connected to the computer (via **DEBUG USB**) and using the tool bar, navigate to the small Debug icon and select the debugging session you created. The application will programmed and the program execution will stop at the beginning of the main() function.



- Use step-by-step execution or directly run the program.

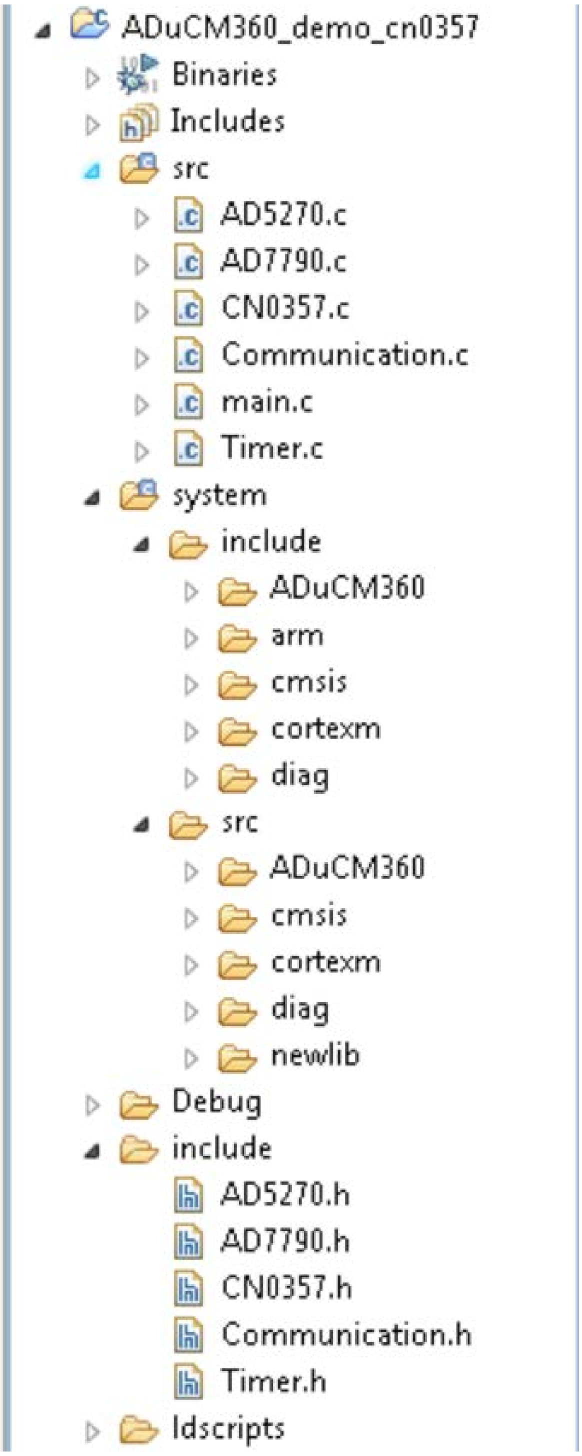
After completion of the steps above the program will remain written into the system flash and it will run by default every time the board is powered up.

Project structure

The **ADuCM360_demo_cn0357** project use ADuCM36x C/C++ Project structure.

This project contains: system initialization part - disabling watchdog, setting system clock, enabling clock for peripherals; port configuration for SPI1, UART via P0.6/P0.7; SPI, UART read/write functions, AD7790 control, AD5270 control and gas concentration computation.

In the **src** and **include** folders you will find the source and header files related to CN0357 software application. The *Communication.c/h* files contain SPI and UART specific data, the *AD7790.c/h* files contain the ADC control, the *AD5270.c/h* files contain the rheostat control and the *CN0357.c/h* files contain configurations and computations specific to the gas detector application.



In the appropriate header files you can **configure** next **parameters**:

- **Sensor Range** - SENSOR_RANGE - maximum value of the gas conentration (ppm) that can be detected by the electrochemical gas sensor being used (*CN0357.h*).

```
    #define SENSOR_RANGE     2000
```

- **Sensor Sensitivity** - SENSOR_SENSITIVITY - sensitivity (nA/ppm) of the electrochemical sensor being used (*CN0357.h*).

```
    #define SENSOR_SENSITIVITY  65
```

The **system** folder contains system related files (try not to change these files):

- **ADuCM360** – contains low levels drivers for ADuCM360 microcontroller.
- **CMSIS** – contains files related to ADuCM360 platform, such as: *ADuCM360.h* (registers definitions), *system_ADuCM360.c/h* (system clock), *vectors_ADuCM360.c* (interrupt vector table).
- **cortexm** – contains files for system management (start-up, reset, exception handler).

Help and Support

This page wants to help you when you have a specific issue which required a different approach or when the wiki information are not enough.

ADuCM360 questions

If you have any questions regarding the **base platform** or any of the **shields/pmods** or are experiencing any problems while using the boards or while following any of the user guides feel free to ask us a question. Questions can be asked on our EngineerZone support community.

When asking a question please take the time to give a detailed description of your problem. If you are experiencing a problem please state the steps you have executed, the result you expected you would get and the result you actually got. By doing so you enable us to provide you precise and detailed answers in a timely manner.

Before asking questions please take the time to check if somebody else already asked the same question and already got an answer.

IDE questions

If you need additional information about **Eclipse IDE** which is part of the EVAL-ADICUP360 Tool Chain you can visit GNU ARM Eclipse page.

ADICUP360 Compliance Results

Introduction

Regulatory compliance means conforming to a rule, such as a specification, policy, standard or law. Most products that ships into a country need to pass a variety of tests and regulations specific to that country.

Due to the increasing number of regulations, organizations are increasingly adopting the use of consolidated sets of compliance controls. This means once you normally get one, you can have them all.

Reports

The ADICUP360 passes all requirements of the CE tests.

- ADICUP360 EMC emissions and immunity test report

What are all these logos?

- CE Mark : a mandatory conformity marking for certain products sold within the European Economic Area (EEA).
- Electrical and Electronic Equipment Waste Directive : a European Community directive 2002/96/EC on waste electrical and electronic equipment (WEEE).
- Federal Communications Commission : is an independent agency of the United States government, this logo means we pass part 15, class B.