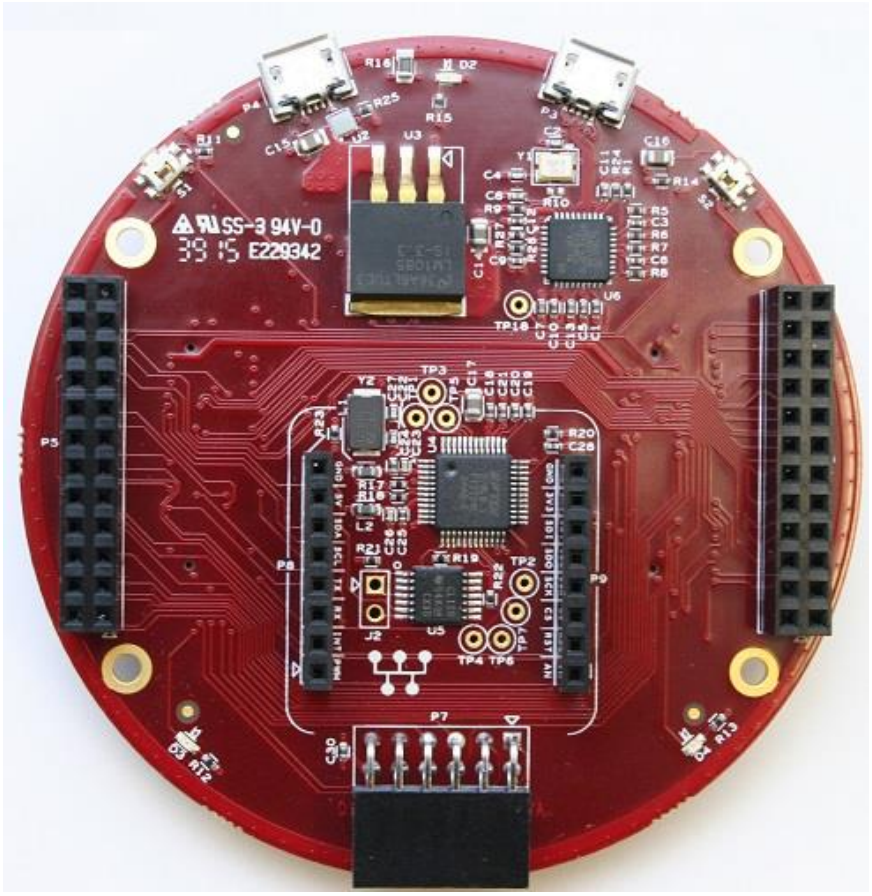
Discboards.org



DiscBoard Starter Kit (DBSK)

User's Guide

Revision 0.2

October 26th 2015

DiscBoards.org Overview

DiscBoards.org is a free and open community focused on Renesas Synergy based processors, software, and applications. Anyone can join and anyone can contribute hardware and software. Anyone can sell any boards they develop. No licenses are taken by Discboards.org. Everyone is encouraged to make their Hardware and Software Open Source.

There is a DiscBoards specification. The hardware is comprised of three modules.

- **Processor Module (PM)-** Specification will support all of the Synergy processors. All processors are interchangeable on any of the application modules. Some functions will be lost between the different processor based on reduced pin count to supported features.
- **Application Module (AM)**- This module supports application specific interfaces as required by the AM creator. The use of each pin on the PM is determined by the designer and their choice of hardware to be added.
- **Expansion Modules (AM**)- The AM can be used to further extend the AM. Not all AM will have the connectors and not all connectors need to be the same. EM capability is based on a specific AM design.

A full specification is in process and will be available for download on the Discboards.org website at a later date.

DBSK- DiscBoard StarterKit Overview

The DiscBoards.org Starter Kit (DBSK) is intended as an entry level start for those wanting to participate in the DiscBoards.org community. This allows the user to get experience with the Renesas development system. Nothing else is needed to allow the user to write programs, download them to the DBSK , set breakpoints and step through their program. By adding various expansion boards, with all sorts of different interfaces, the user is free to experiment with different application scenarios. The DBSK is made up of two boards, the Processor Module (PM) and the application Module (AM).

The DBSK is designed and supported by Embedded Product Design out of Richardson, TX.

Processor Module

The PM is equipped with a Synergy S7 part number R7F5A00Z03CFP. Future modules are planned with other processors on them. The features of the PM are listed below.

Feature	Specification
Processor	Synergy R7F5A00Z03CFP
Connectors	(3) Application Module connectors
LED	(1) Under Processor control
RTC Battery	Connector provided but not installed
Crystal	24MHz
External JTAG Header	10 pin
Boot mode strap	pin not installed

Application Module (AM)

The features of the AM are listed below.

Feature	Specification	Comments
USB 2.0 Interface	microUSB	Cable provided
Processor USB	Yes	
USB Power	Yes	
External Power	5V over micro USB cable	
AM Module Connector's	Yes (3)	
LEDs	1-Power, 2-User	
Buttons	1-Reset 1-User	
SWD Interface	Onboard	With disable jumper-not installed
PMOD Connector	12 pin	
Micro Bus Connector	Yes	
Expansion Connectors	Yes	

Expansion Options

There are three ways to expand the DBSK:

- Addition of Pmod™ expansion boards allows the user to experiment with numerous available interfaces.
- Addition of MikroBUS™ Adapters. There ae close to 200 different modules available.
- Create your own Pmod™ or MikroBUS™ or you can design your own custom module for use on the expansion headers on the Application Module.

Quick Start Guide

This section provides information on how to install the IDE Software drivers and get your board up and running. The board comes with installed software and when power is applied, it will run a flashing LED program.

Driver Installation

The driver installation takes a number of steps. Summarizing:

1) Install Renesas Synergy e2studio ISDE and SSP.
2) Install libusbK drivers
3) Install GNU ARM Eclipse OpenOCD

Install Renesas software

Renesas supplies e2studio Integrated Solution Development Environment (ISDE) and Synergy Software Package (SSP). ISDE is an Eclipse-based development environment on which the SSP builders and drivers are made available.

Follow Renesas-provided instructions to install e2studio ISDE and SSP.

Install DiscBoards Board Support Pack

The Renesas e2studio software expects supported boards to include a Board Support Pack (BSP) to tie SSP functionality to pins and peripherals on the board. EPD has generated a BSP template as a starting point for DiscBoards users, with nominal setting for the Starter Kit Click and PMod (4A Enhanced SPI) mode interfaces. Pin configurator changes may be needed depending on modules used.

To install the DiscBoards BSP:

1) Ensure Renesas e2studio is closed.
2) Download the DiscBoards BSP from github:
   DiscBoards.1.0.0.pack
3) Copy the DiscBoards "pack" file to the e2studio installation subdirectory:
   <e2studio install directory>\internal\projectgen\arm\Packs

E2studio should now show entries for the DiscBoards BSP.

Install GNU ARM Eclipse and OpenOCD

Open On-Chip Debugger (OpenOCD) is an open-source project initially-created as a diploma thesis, and has since been expanded-upon by the developer community. Users can compile from source or leverage community-provided binary images.

Embedded Product Design has extended OpenOCD to be able to both flash the Synergy processor (S7 currently-supported) and allow debugging from within the ISDE on Windows platforms.

Key links:

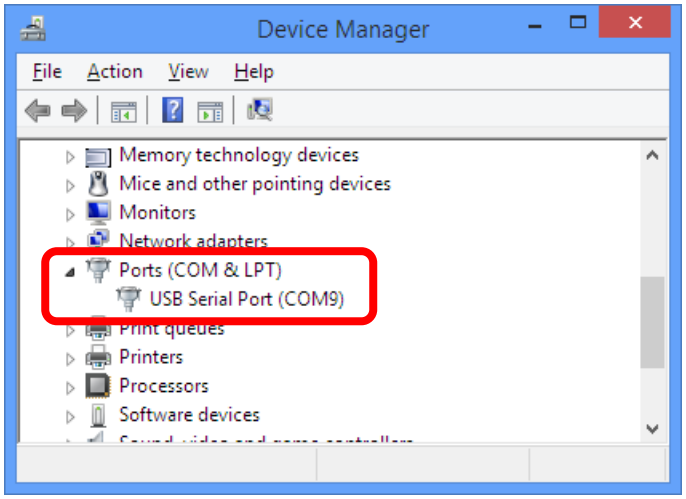
http://openocd.org/	Homepage for the OpenOCD project
http://gnuarmeclipse.github.io/	Open-source tools for ARM Development

OpenOCD communicates through the libusbk library rather than a WinUSB library, so standard Windows drivers are incompatible. To install libusbK drivers for use with Discboards:

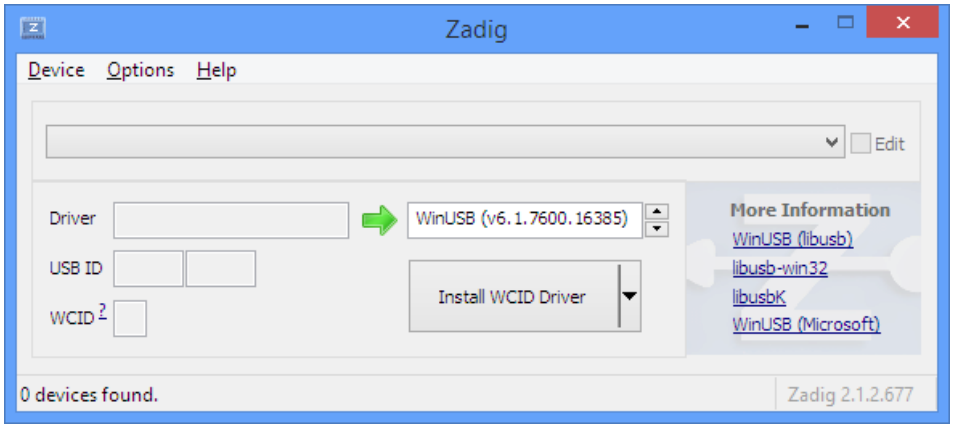
1) Install the Zadig windows application, an open-source program which allows easy driver installation. The program can be downloaded from:

   http://zadig.akeo.ie/

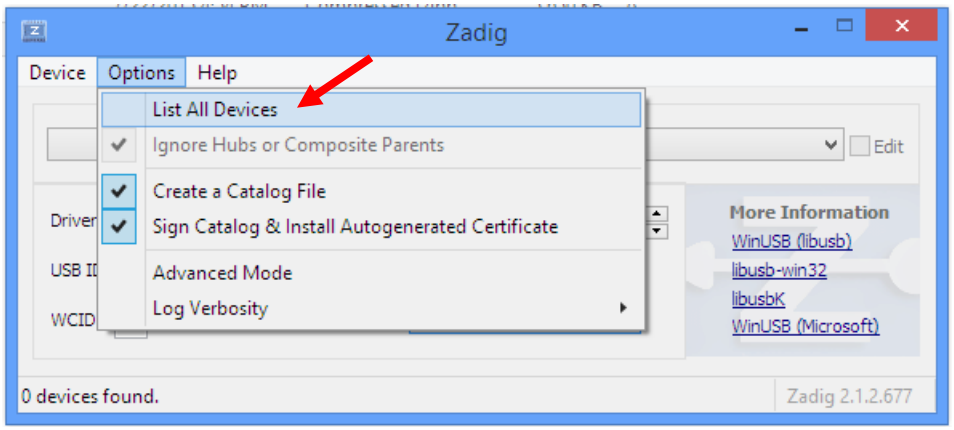
2) Connect the DiscBoard to your PC using a micro-USB cable to DiscBoard Application board connector P3 (USB + data). The computer will recognize the DiscBoard as a USB Serial Port similar to the Device Manager example below.



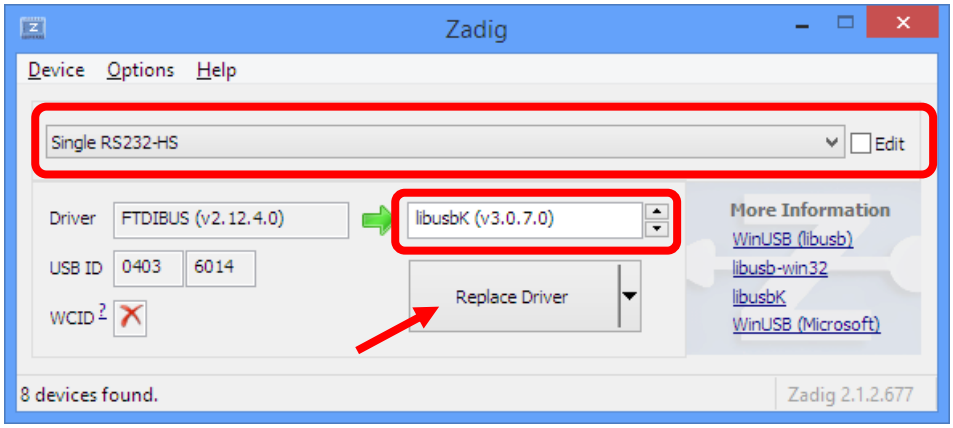
3) Open Zadig



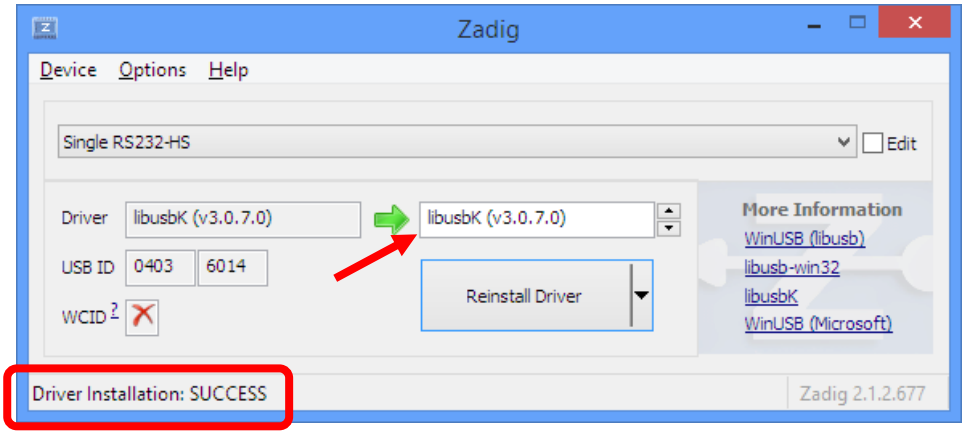
4) In Zadig, select Options→List All Devices.



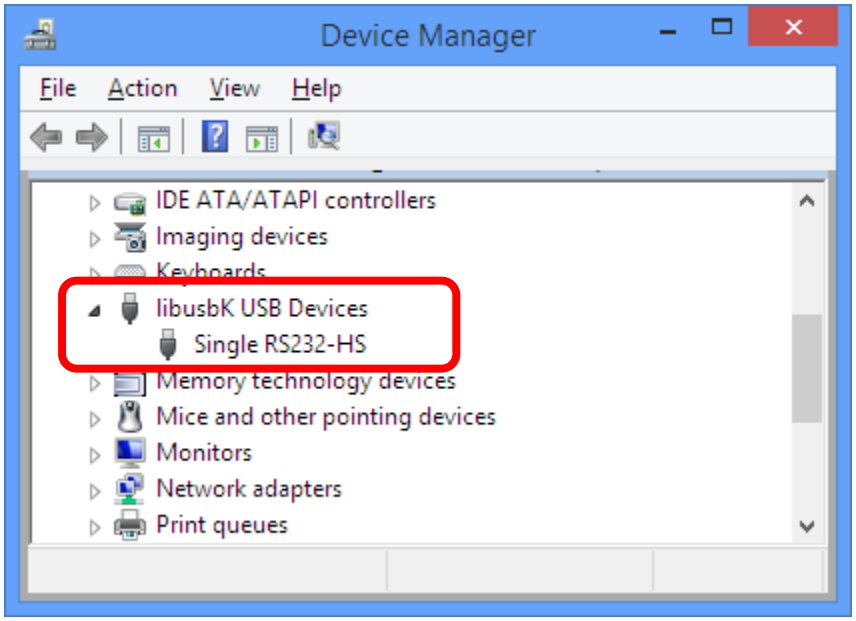
5) Open the Zadig drop-down menu and select the DiscBoard. The DiscBoard will show as "USB Serial Port" or "Single RS-232-HS". Be sure the proper USB serial port is selected.



6) Once the correct device is selected, choose the libusbK driver option, then click “Replace Driver”. On completion the Zadig screen should show as a libusbK driver with SUCCESS.



And the Windows Device Manager should show:



7) libusbK driver installation is now complete. Keep Zadig readily-available if required for future use.

To install OpenOCD for use with DiscBoards, use the DiscBoards-OpenOCD installer. This is different from the mainline OpenOCD.

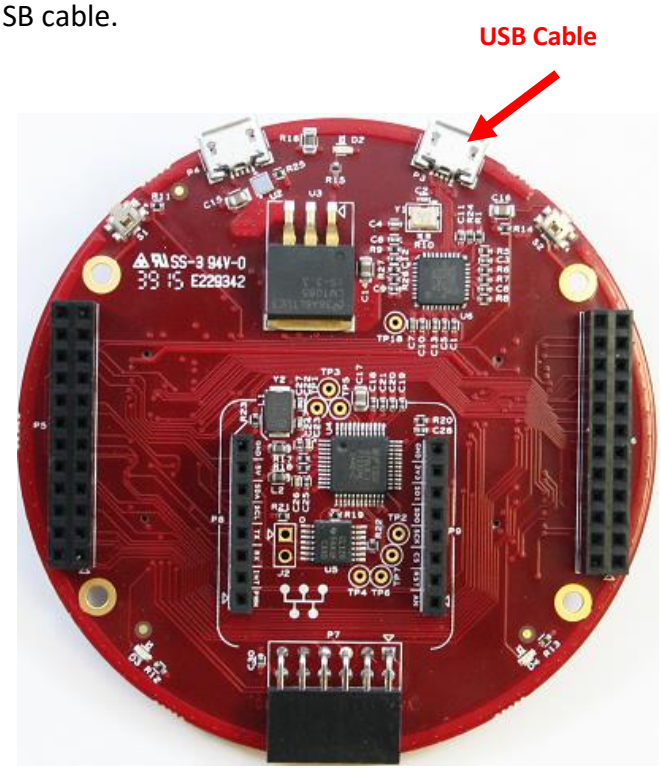
1) Download and run the GNU ARM Eclipse OpenOCD installer to load OpenOCD onto your computer with needed configurations. OpenOCD version 0.10.0-201510232034-dev for 64-bit and 32-bit Windows installations is available at:

gnuarmeclipse-openocd-win64-0.10.0-201510232034-dev-setup.exe

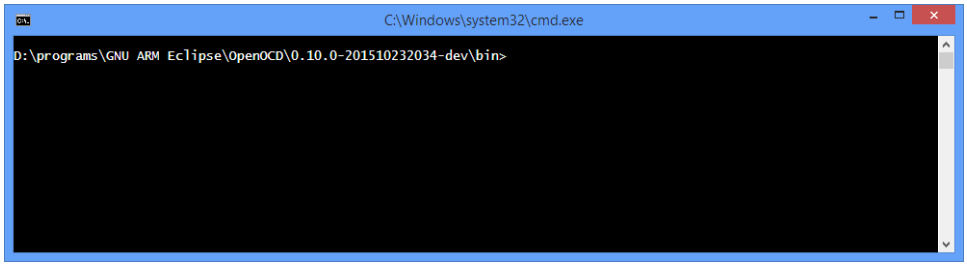
gnuarmeclipse-openocd-win32-0.10.0-201510232034-dev-setup.exe

DiscBoards-specific releases include all configuration files needed to run OpenOCD with DiscBoards and SSP, plus a Synergy-specific flash write driver for use over SWD.

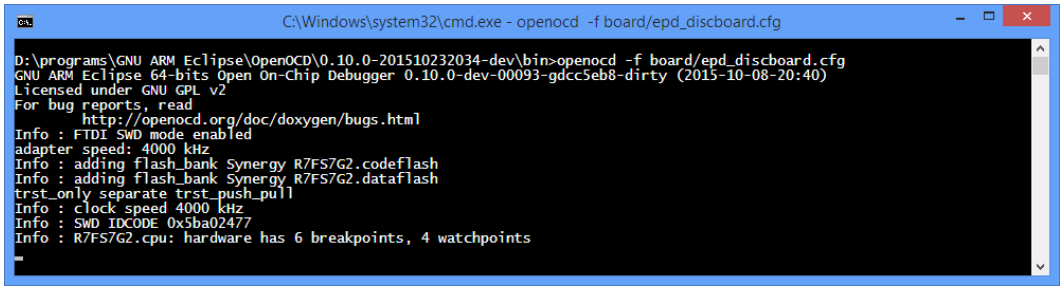
2) Test the OpenOCD executables.
    a. Attach your DBSK to the PC using the DBSK P3 connector and the supplied microUSB cable.



    b. Open a command prompt and navigate to your …/OpenOCD/.../bin directory.



c. Enter at the command prompt: “openocd –f /board/epd_discboard.cfg”, which should lead to the following output.



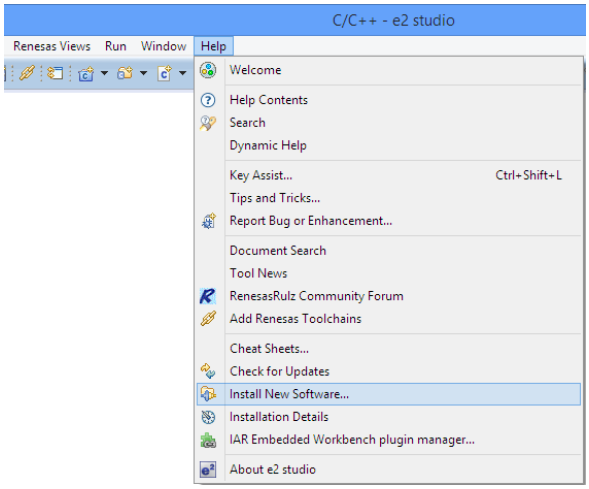
Failures mean a configuration problem that is often solved using Zadig.

d. Escape using <CTRL-C> and close the command. This is the last time the command line is needed during installation.

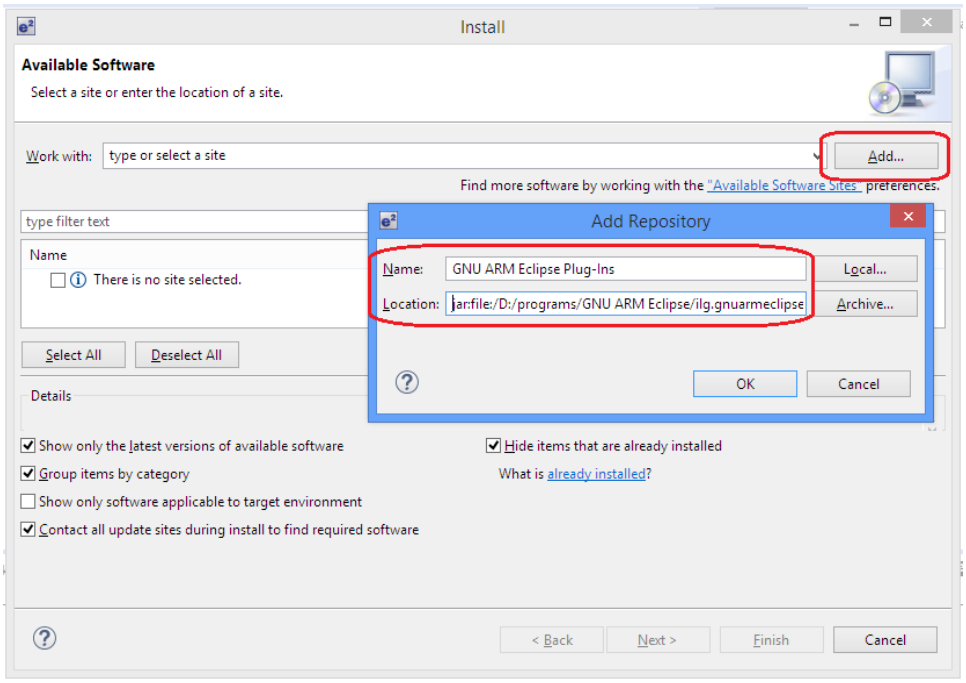
3) Download and install the OpenOCD debugging Eclipse plug-in. This is needed (along with the executable) for integration with the Eclipse-based e2studio environment.
   a. Open Renesas e2studio with Synergy.
   b. Copy the GNU ARM Eclipse Plug-ins repository to your PC. These can be downloaded from Github.

      http://gnuarmeclipse.github.io/developer/releases/

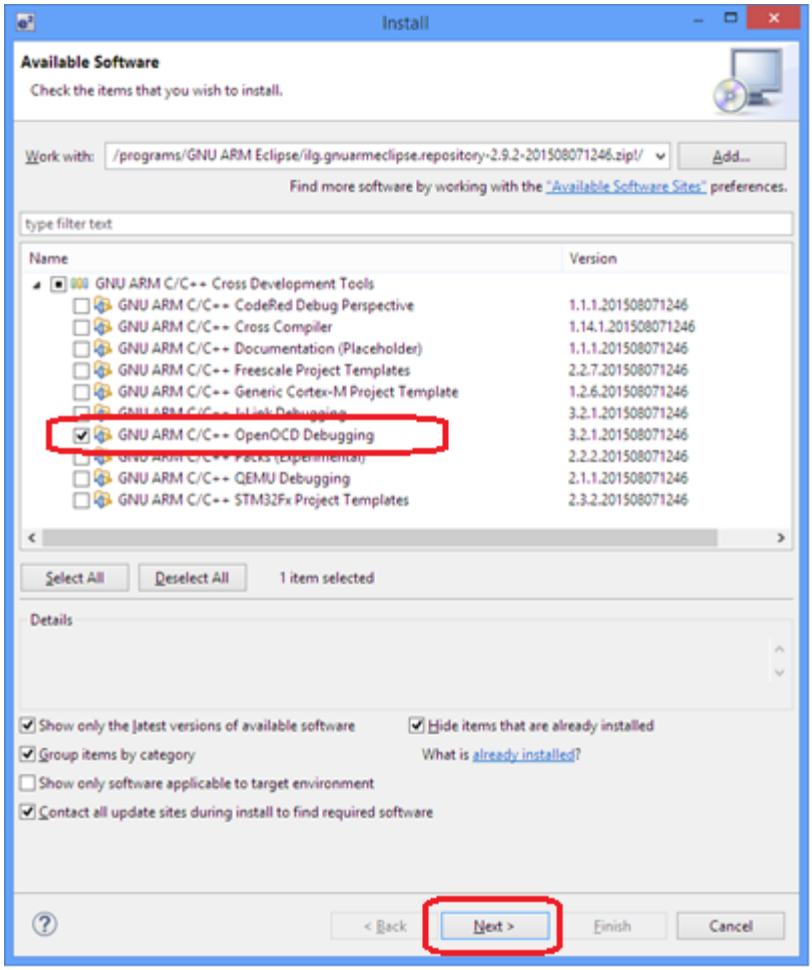
   c. From the menu select “Help→Install New Software”



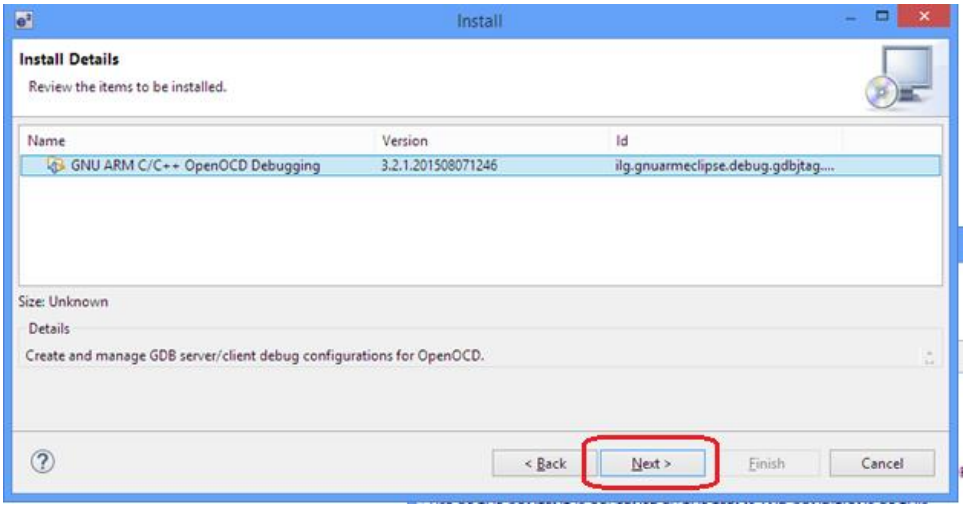
   d. Click “Add” from the Install dialog, then point to your PC’s copy of the GNU ARM Eclipse OpenOCD plug-ins.


Install
Available Software
Select a site or enter the location of a site.
Work with:
type or select a site
Add...
Find more software by working with the "Available Software Sites" preferences.
type filter text
Name
There is no site selected.
Select All
Deselect All
Details
Show only the latest versions of available software
Group items by category
Show only software applicable to target environment
Contact all update sites during install to find required software
Hide items that are already installed
What is already installed?
< Back
Next >
Finish
Cancel
Add Repository
Name:
GNU ARM Eclipse Plug-Ins
Location:
jar:file:/D:/programs/GNU ARM Eclipse/ilg.gnuarmeclipse
Local...
Archive...
OK
Cancel

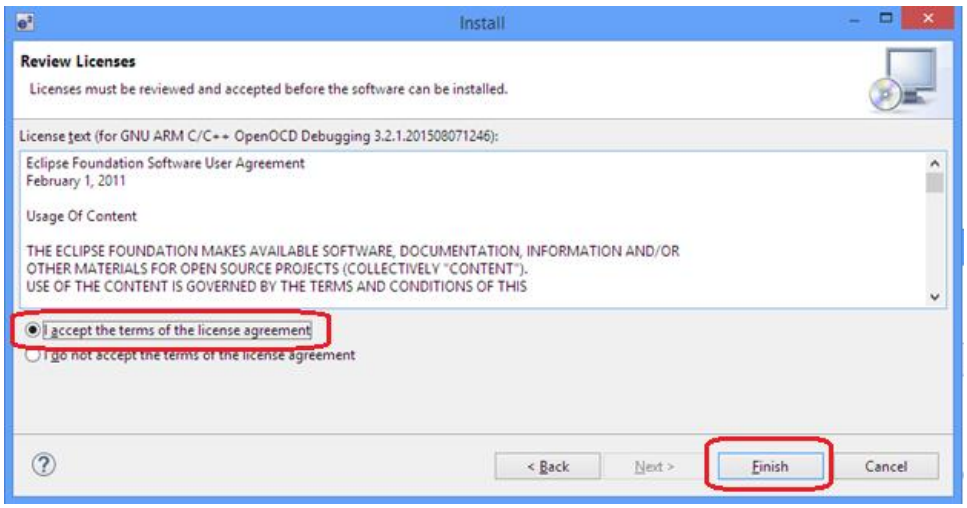
e. In the Install dialog select “GNU ARM C/C++ OpenOCD Debugging”, then “Next”.



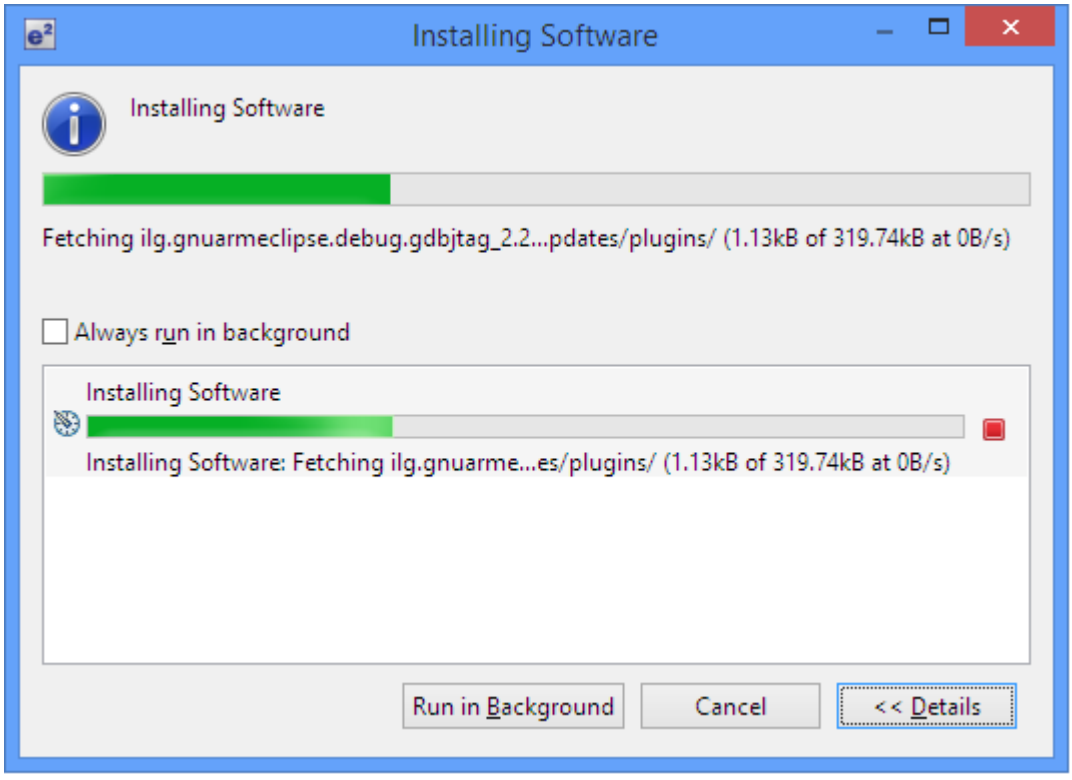
f. Click “Next” in the Install Details window



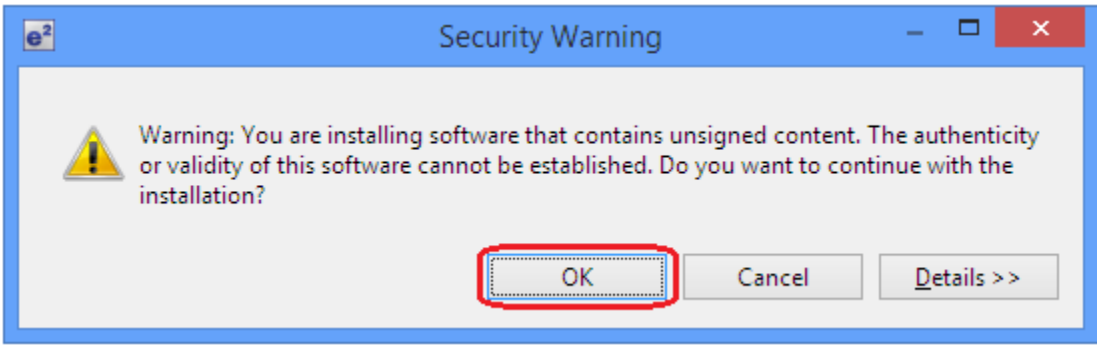
g. Then accept the license agreement and click “Finish”.



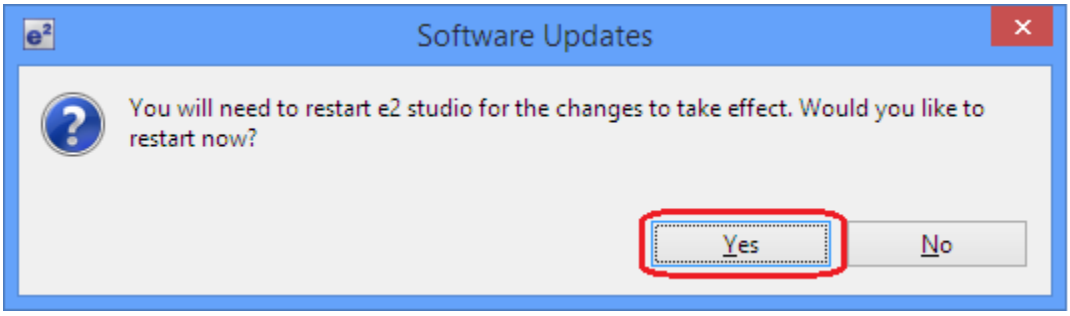
h. Eclipse plug-ins will install.



i. Click OK if you're comfortable with the unsigned content.

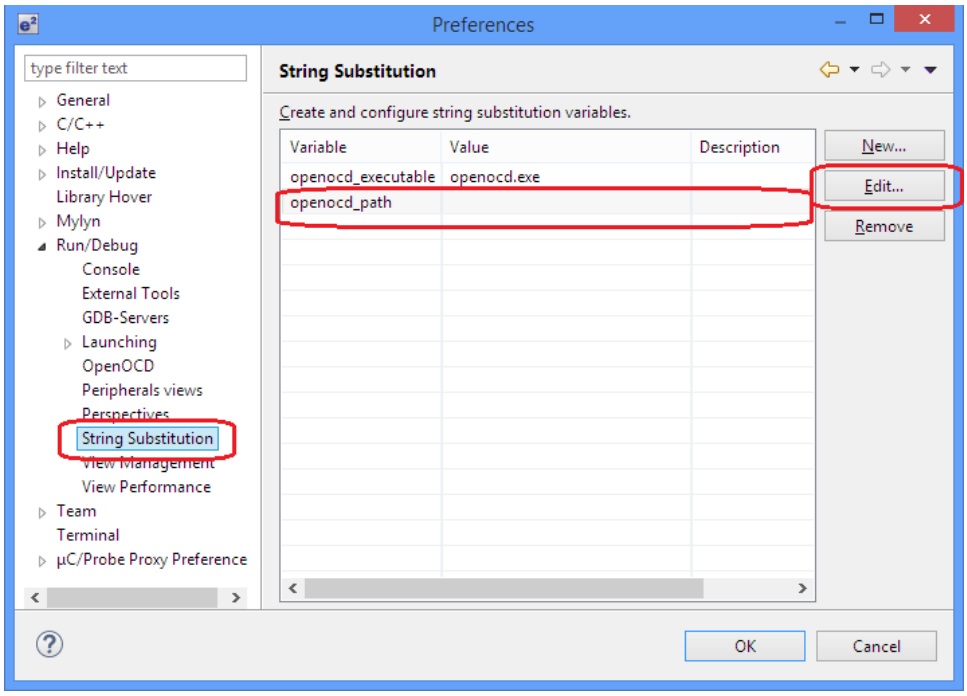


j. Restart e2studio to complete the GNU ARM Eclipse OpenOCD plug-ins installation.

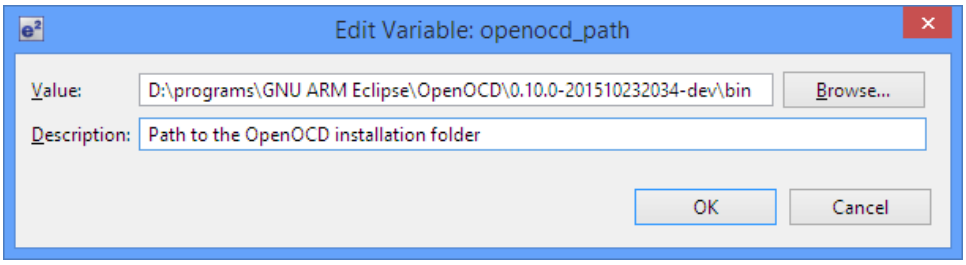


4) On e2studio restart, check the OpenOCD installation path.

a. From the menu select Windows→Preferences and select "Run/Debug→String Substitutions". Select the "openocd_path" variable and click "Edit".



b. Click “Browse… and navigate to the folder containing the executable. It is normally …\OpenOCD\<OpenOCD version>\bin. Click “OK”.



c. Click OK exit the Preferences dialog.

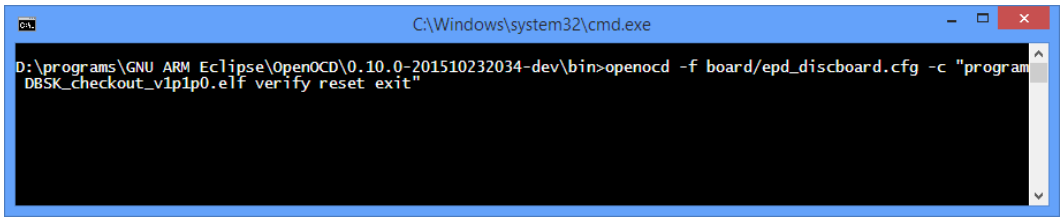
OpenOCD installation is now fully-complete, and you are ready to debug!

Restoring DBSK to “stock” configuration

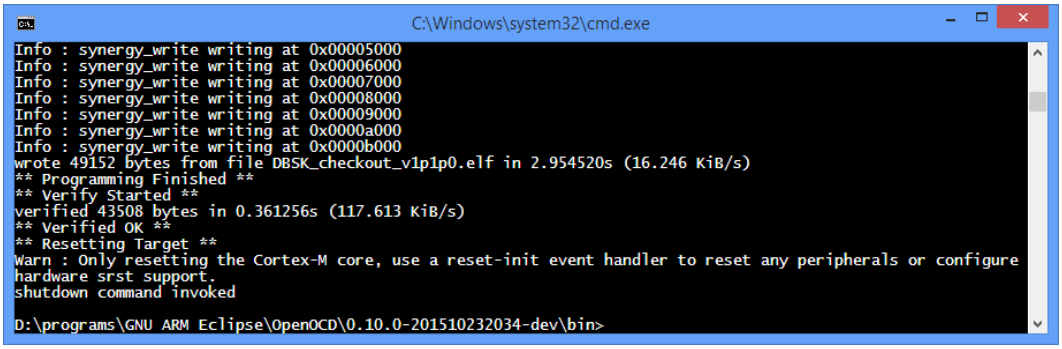
The DBSK board ships with an on-board application that blinks the LEDs. On power-up User LED D3 and D4 blink slowly, then transition to alternating double-blinks. When the operator presses the User Button the LEDs transition to blinking in sequence from User LED D3, to User LED D4, to the CPU board LED.

To return to this default behavior:

1) Reset the DBSK using the on-board Reset button.
2) Download the DBSK_default_rev1p1p0_elf.zip and unzip to the directory containing openocd.exe.
3) In a command prompt enter the following:
   openocd –f board/epd_discboard.cfg –c “program DBSK_checkout_rev1p01.elf verify reset exit”



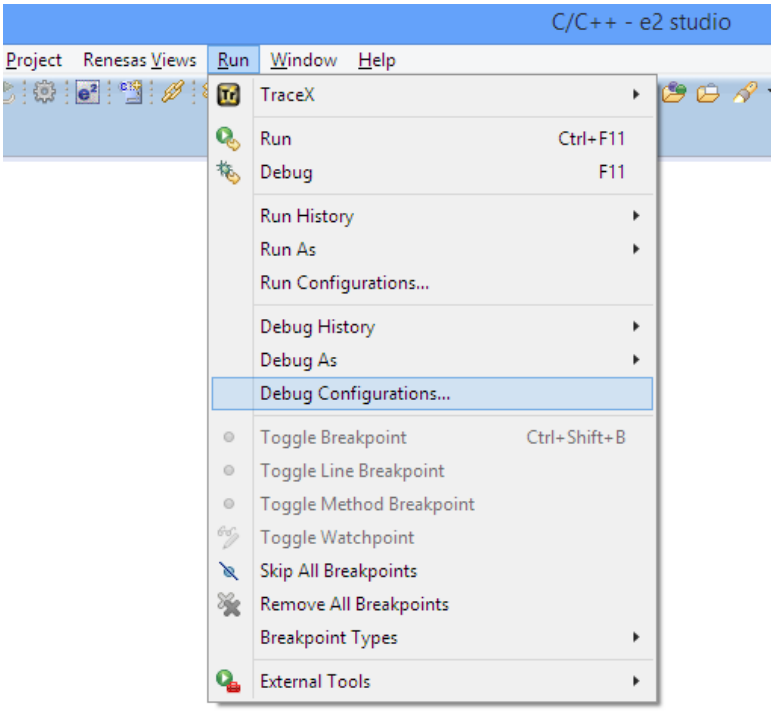
4) After downloading your command prompt should show “OK” and your DiscBoard LEDs blinking as they were out-of-the–box.



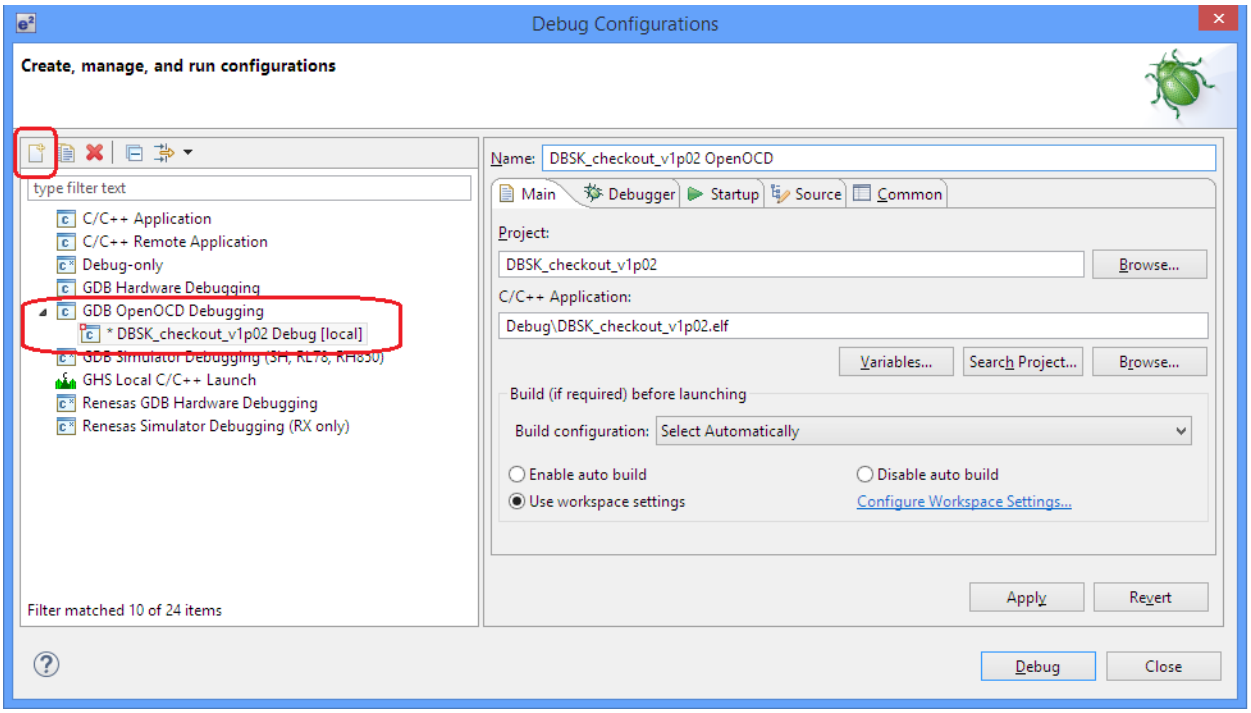
Debugging with OpenOCD

Debugging with OpenOCD in e2studio is similar to using JLink, except certain advanced features like tracing are not supported.

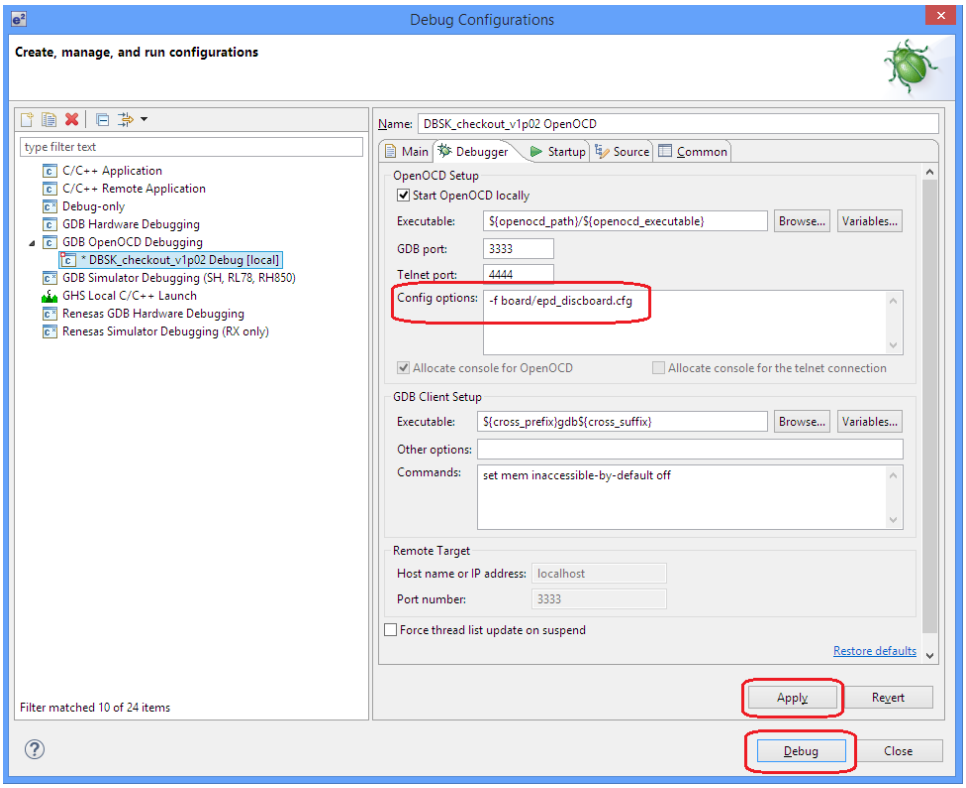
1) Within your Synergy project, from the menu bar select Run→Debug Configurations



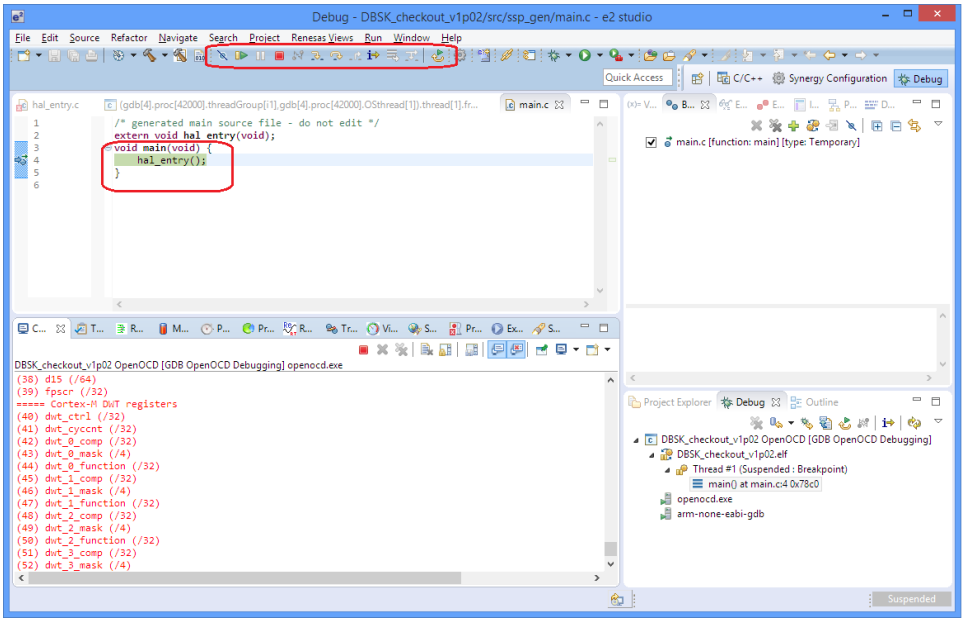
2) Click GDB OpenOCD Debugging, then select the “New” button. Check for a meaningful name and that the application .elf file is correct.



3) In the “Debugger” tab Config Options” enter the line “-f board/epd_discboard.cfg”, then click “Apply” and “Debug”.



4) Code will be downloading to the Discboard at this point, with information showing on the e2studio Console window. The line hal_entry() will be highlighted green if debugging is successfully started.



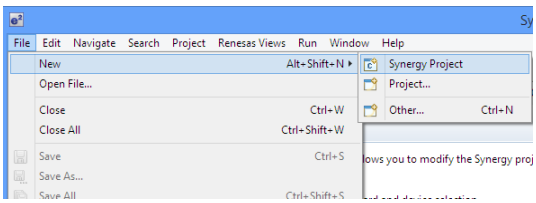
From this point, the Eclipse Resume, Terminate, stepping, Expression, and Variables controls should work as normal.

If there are any issues, Terminate  the debug session, reset the DBSK using the on-board Reset button, and restart the debug session using the “Debug”  button.

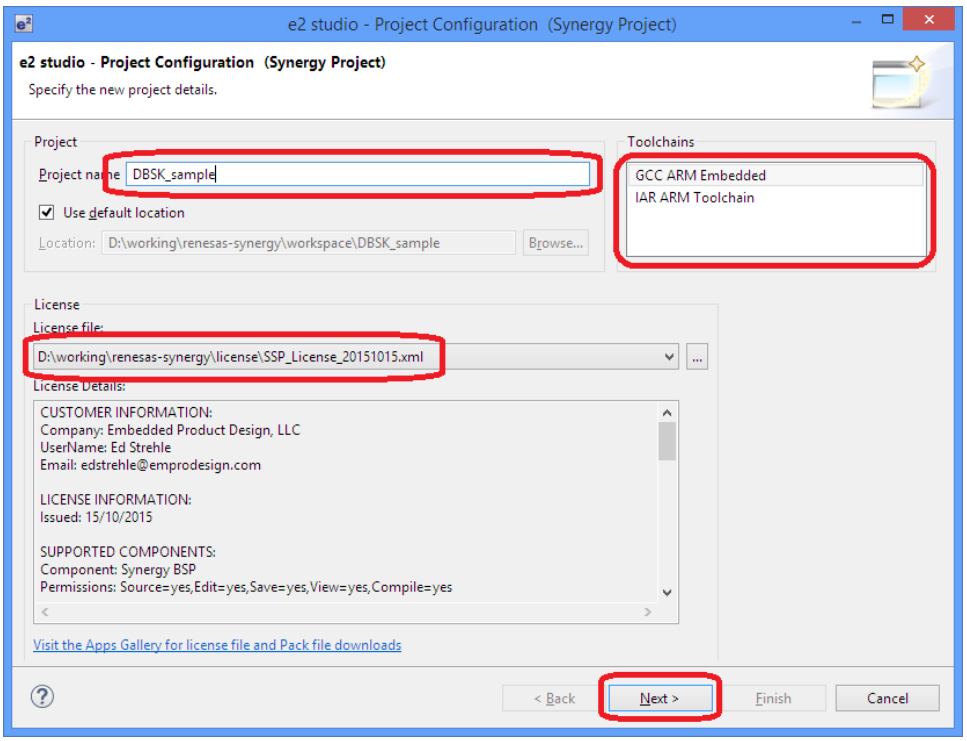
Creating your first DiscBoards project

The following will assist in creating your first project using the DiscBoards BSP.

1) Open e2studio
2) From the menu select “File→New→Synergy Project”



3) After a short progress dialog a dialog similar to the following will appear:



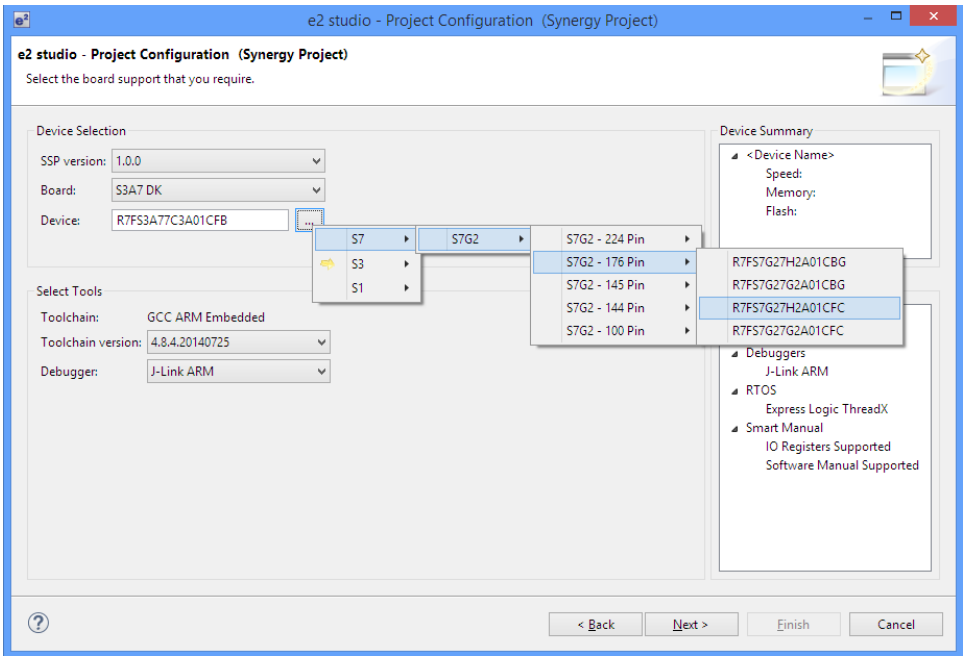
Enter a meaningfull project name and select your compiler toolchain.

Be sure point to the license file you received from Renesas. Unless you were provided a production license your file is likely in:

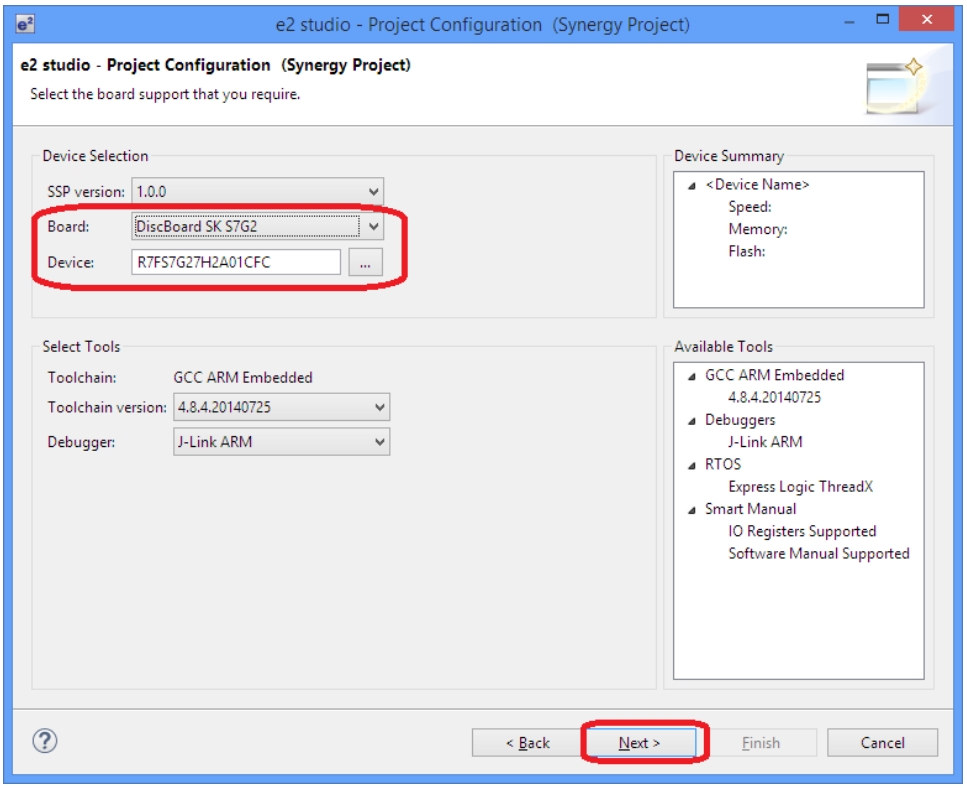
<e2studio install directory>\internal\projectgen\arm\Licenses

Once these are complete click “Next”.

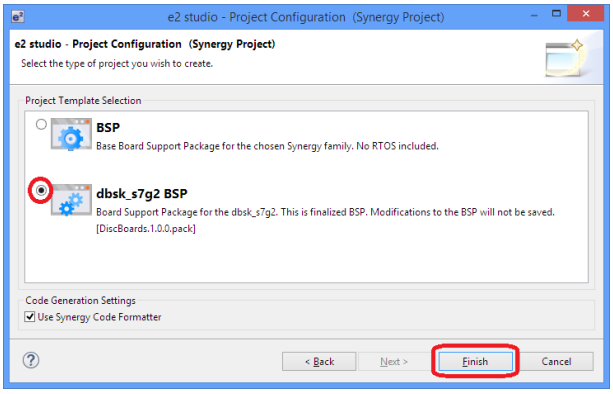
4) The next step is to select your board and BSP. Under “Device” select “R7FS7G27H2A01CFC”, as the 176-pin QFP device is used on DiscBoard Processor board.



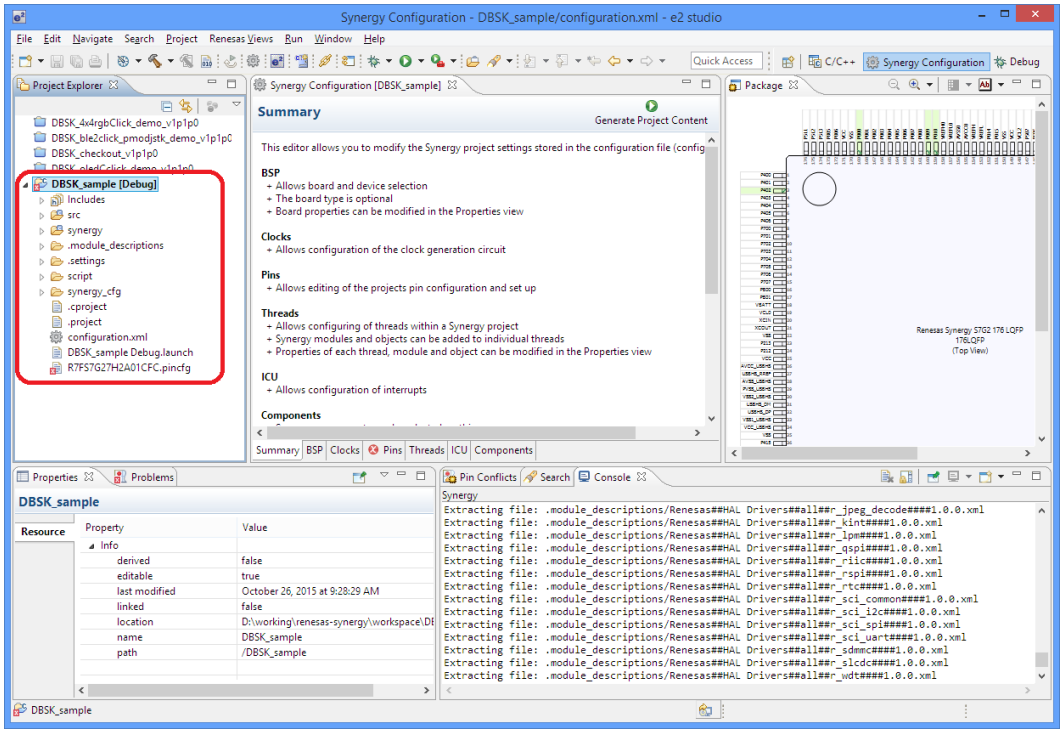
5) After selecting device select the board “DiscBoard SK S7G2”. Confirm the dialog matches the board and device information shown below, then click “Next”.



6) Select the “dbsk_s7g2 BSP”, then click “Finish”.



7) Following some activity including multiple progress bars your e2studio Project Explorer screen should show entries similar to the following:



You are now ready to write code using the DiscBoards BSP.

Items to note:

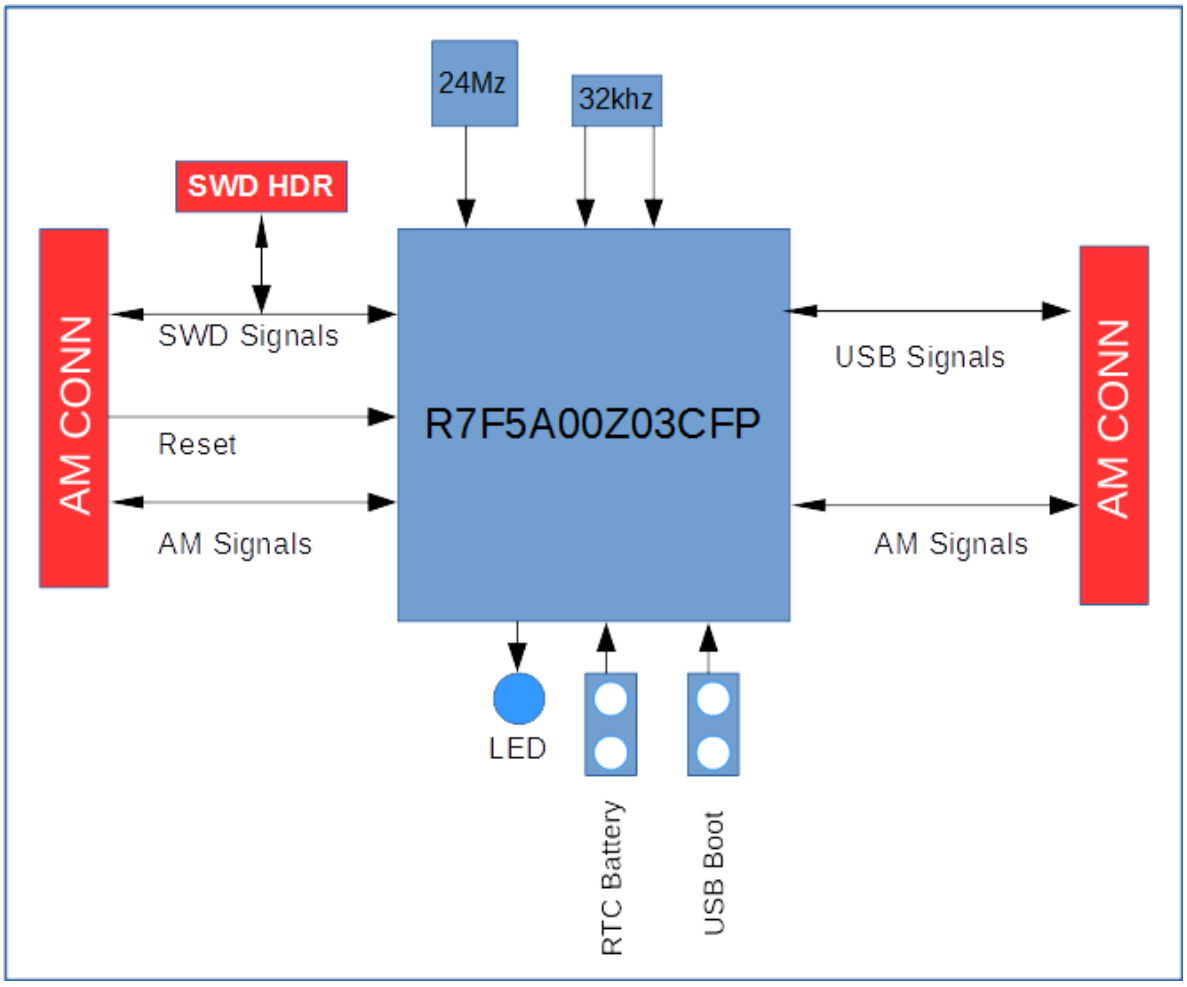
- DiscBoards Starter Kit uses Serial Wire Debug (SWD); not JTAG. If using a purchased debugger pod like JLink, be sure to setup for SWD.
- DiscBoards BSP includes nominal pin configurator settings for the Click bus SPI, I2C, UART, PWM, GPIO, and interrupt pins. PMod pins are similarly setup for mode 4A Enhanced SPI. Usage by module may differ slightly. Check the SSP Pin Configurator against your module’s usage for compatibility.

Processor Module (PM) Design Description

This section will describe the design of the Processor Module used in the DiscBoards Starter Kit.

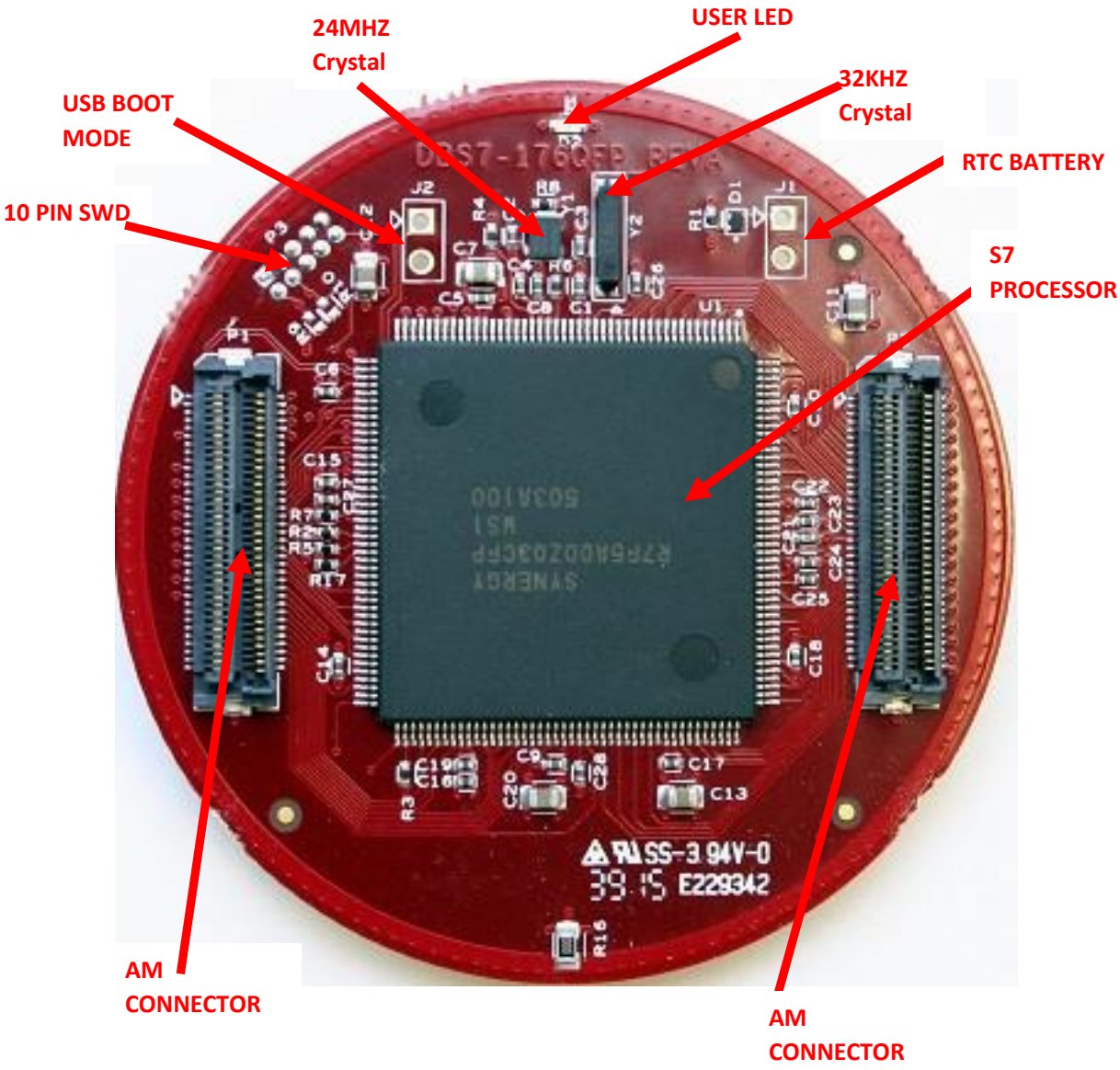
Processor Module Block Diagram

The following figure is the block diagram of the PM.

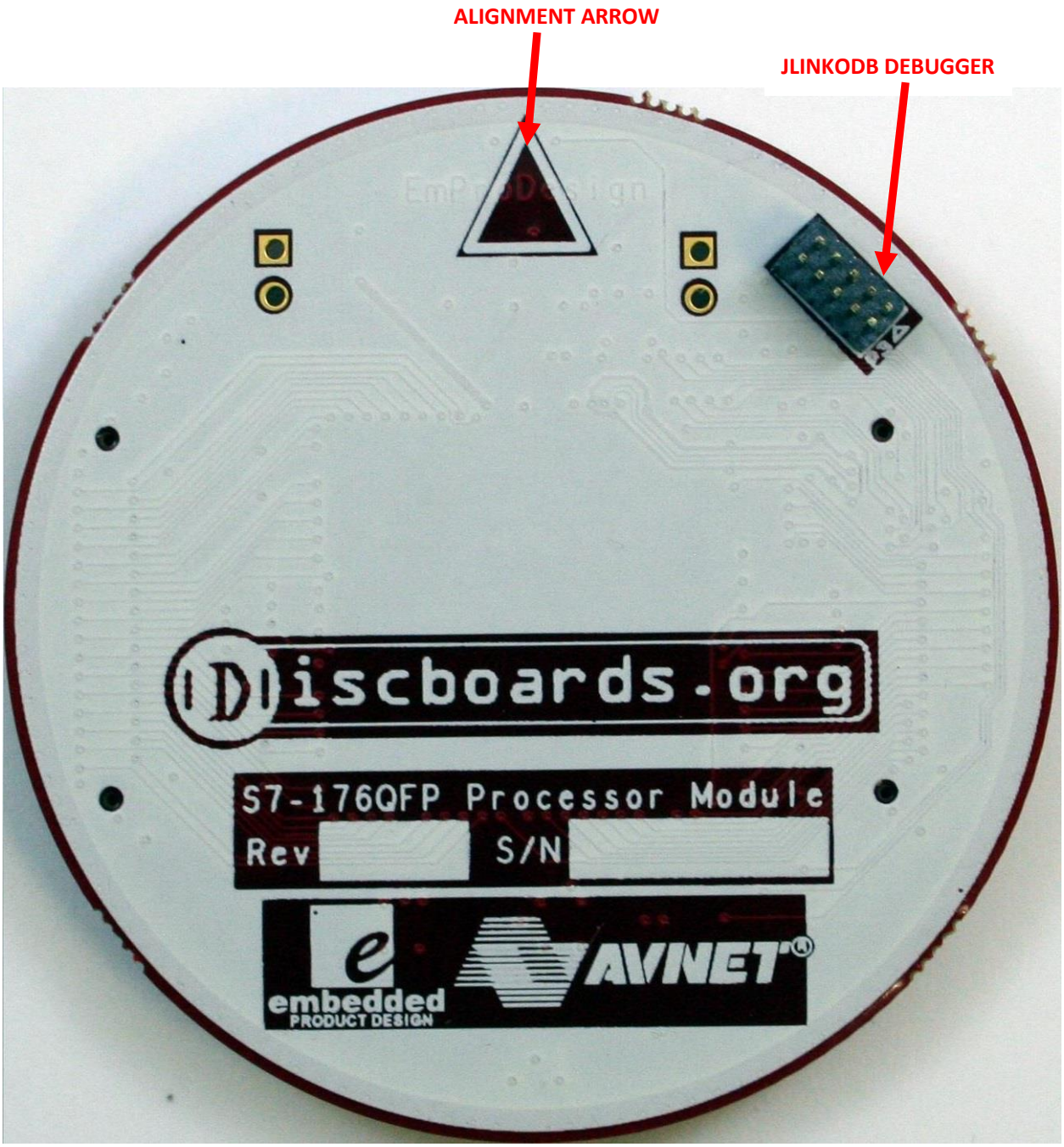


Processor Module Component Locations

The figure below shows the top side locations of the components on the PM.



The figure below is the bottom side locations of the components on the PM. Only P3 is mounted from the back side of the board.



Processor

The Processor Module uses the 176 pin QFP package of the S7 processor. The part number is R7F5A00Z03CFP.

LED

The LED is controlled by the processor by toggling GPIO pin P109. A low signal turns on the LED.

Optional RTC Header

J1 Is not populated but it can be used to apply a backup battery for the internal real Time Clock. Pin1 is the positive lead for the battery. Future plans include a battery board for the system that can be used to connect to J1.

USB Boot

When shorted, J2 places the processor in the USB boot mod, where the code is loaded over the USB port into the processor.

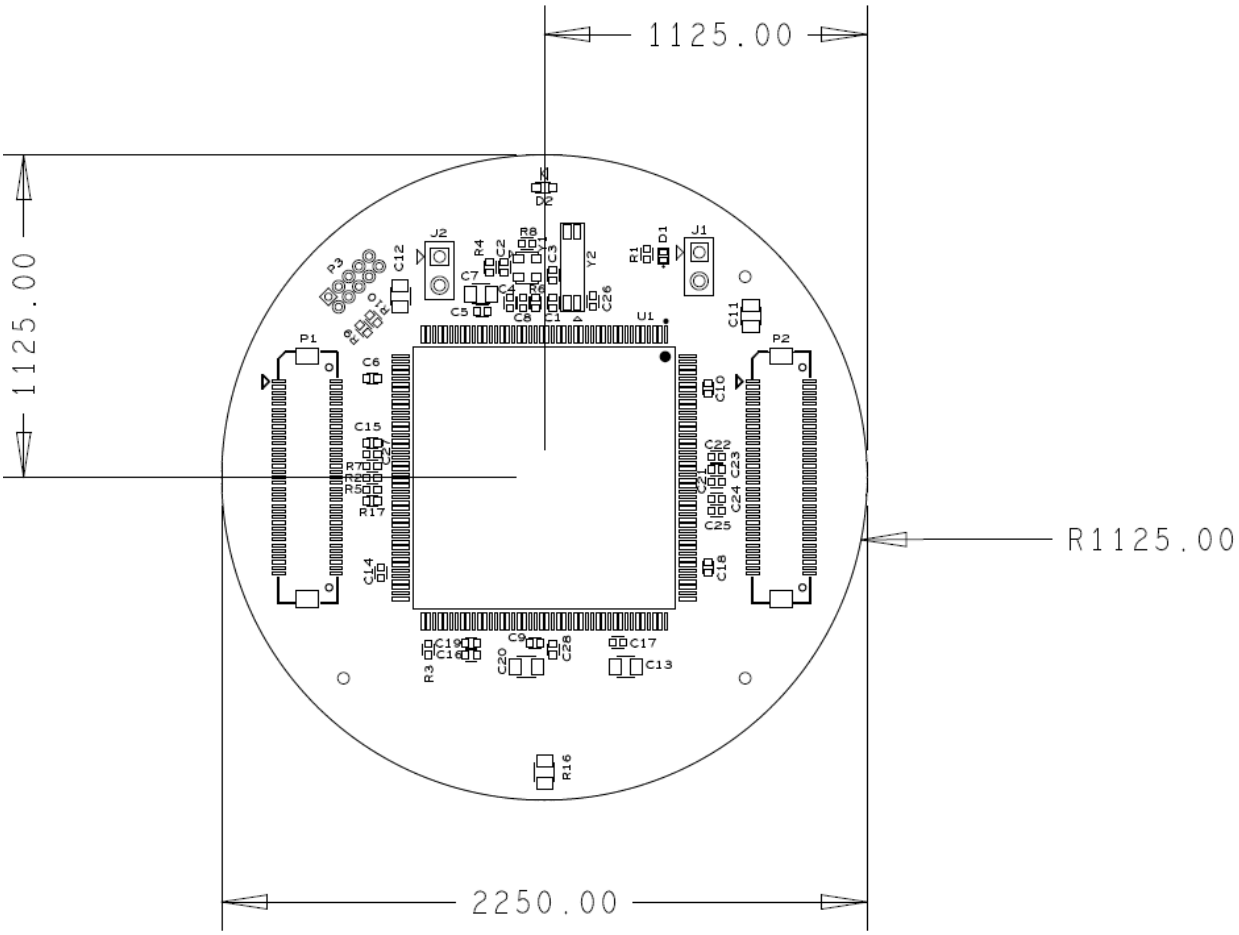
NOTE: CURRENTLY THIS FEATURE IS NOT SUPPORTED BY RENESAS.

SWD Header

P1 is mounted from the bottom side of the board and is used to connect a SWD debugger to the board. A jumper on the AM needs to be installed to disable the OCD onboard debugger on the AM board before this can be used.

PM Board Dimensions

Following are the dimensions of the Processor module.

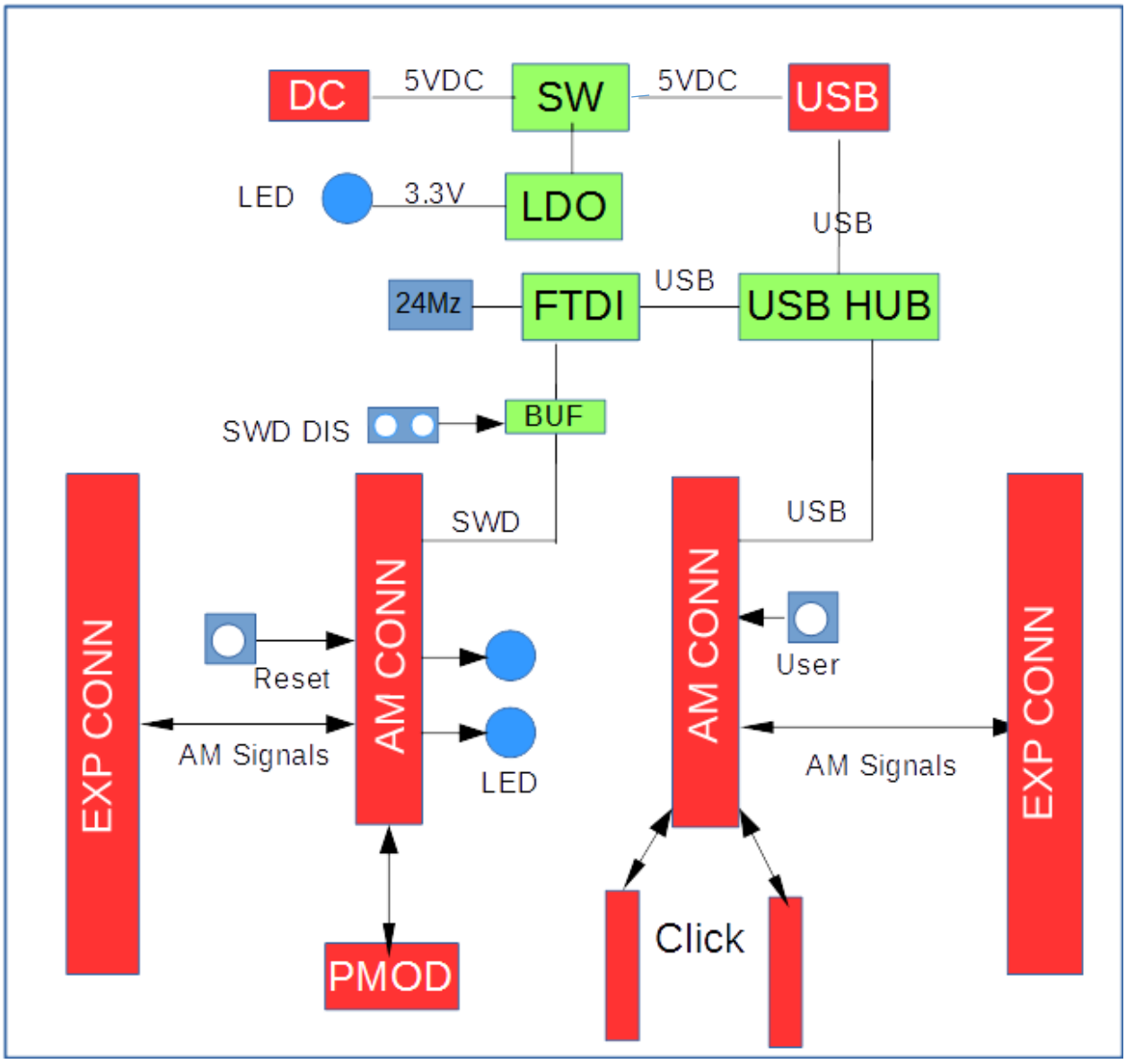


Application Module (AM) Design Description

This section describes the Application module used on the Starter Kit.

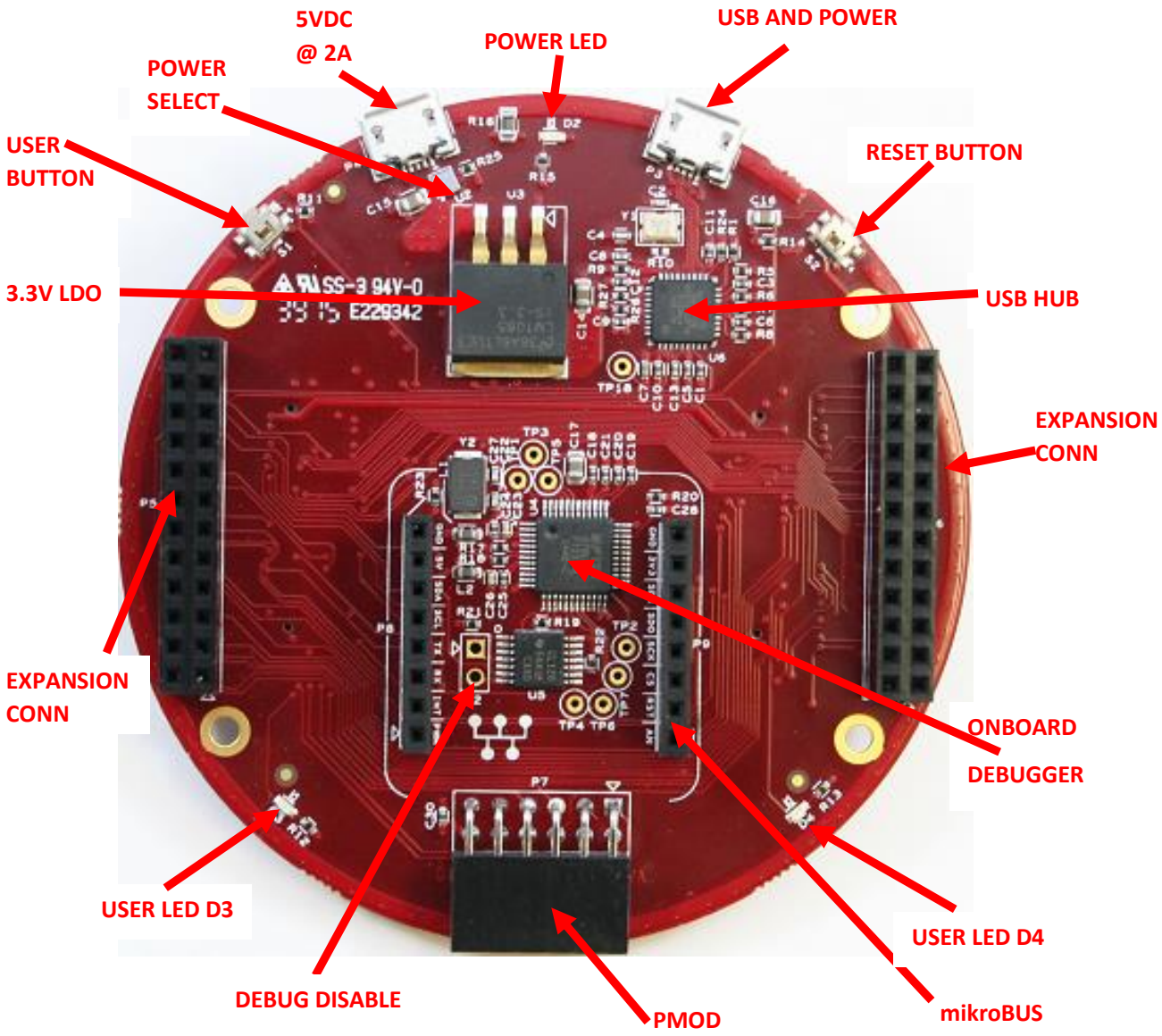
Application Module Block Diagram

The figure below is the block diagram of the AM.

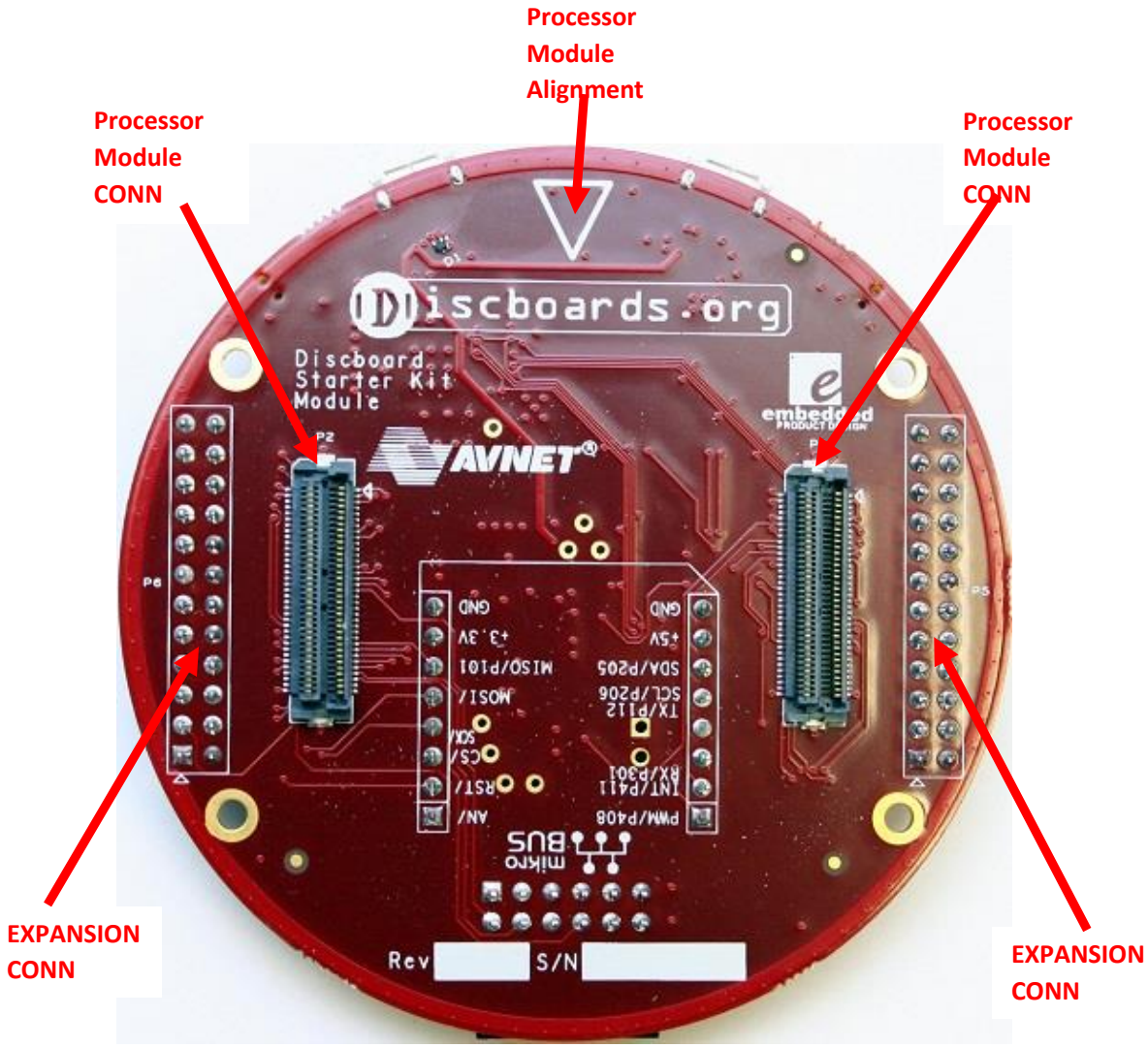


Application Module Component Locations

Following are the component locations on the front side of the Application Modules.



Following are the component locations on the back side of the Application Module.



Power

Power can be supplied from two sources:

- From a laptop or PC over the microUSB port. This is limited to 500mA over a USB 2.0 port
- From a 5V 2A power supply with a microUSB connector plugged into the power port. This provides additional power for those applications that need it.

The board will automatically switch to the 5V power supply when it is plugged into the board. U2 is responsible for making the switch. When on 5V DC power, the USB port is still operational.

USB Port

The USB port is a USB2.0 compliant interface used to connect to a PC or laptop. It is used to connect to the IDE for software development.

The HUB connects the USB port to one of two onboard USB ports. One port for the S7 processor and one port for the SWD debugger.

SWD Interface

The SWD debugger is Open OCD compatible and runs on a FT232H USB to serial interface. The interface can be disconnected from the processor by placing a jumper in J2. This allows the 10 pin connector on the PM to be used for debugging.

LEDs

There are three LEDs on the board.

- D2 is the power LED. It is on whenever power is applied to the board.
- D3 is controlled by the software and is connected to P201.
- D4 is controlled by the software and is connected to P402.

All LEDs are active low.

Buttons

There are two buttons on the board.

- S1 can be read by the processor and is connected to port P111. The signal from the switch is normally high and goes low when the button is pressed.
- S2 connects to the reset line and when pressed, the processor is reset.

Expansion Connector

Here are two Expansion Connectors on the Application module, P5 and P6. These connectors can be used to add additional functions to the boards that are of a custom nature. The signals on these pins are dictated by the Processor Module. All the signals listed below are on the Starter Kit. While other PMs can be used, all of these signals may not be present.

SIGNAL	P5		SIGNAL
5V	**1**	**2**	GND
P001	**2**	**4**	P002
P003	**3**	**6**	P004
P005	**5**	**8**	P006
P007	**7**	**10**	P104
P105	**11**	**12**	P107
P106	**13**	**14**	P207
P113	**15**	**16**	P303
P302	**17**	**18**	P415
P600	**19**	**21**	P601
PB00	**21**	**23**	PB01
3.3V	**23**	**24**	GND

SIGNAL	P6		SIGNAL
5V	**1**	**2**	DCIN
P008	**2**	**4**	P010
P014	**3**	**6**	P111
P204	**5**	**8**	P203
P403	**7**	**10**	P313
P405	**11**	**12**	P404
P410	**13**	**14**	P409
P413	**15**	**16**	P412
P302	**17**	**18**	P414
P500	**19**	**21**	P501
P502	**21**	**23**	P507
3.3V	**23**	**24**	DCIN

Most of the signals are self-explanatory as they from the processor. The DCIN pins are connected to the microUSB connector that is dedicated for the 5V 2A DC input. This allows the expansion connectors to be used as an alternate DC input source for such things as a battery or a voltage supply higher than 5V.

Each if these connectors are 2.54mm spaced from pin to pin and row to row.

Pmod Expansion Connector

Connector P7 is a 12 pin connector that is Digilent Pmod™ Compatible and supports the Interface Type 2A (expanded SPI) as specified in the Pmod Specification. By adding the various modules, the system can easily be expanded with different peripherals. The table below is the assignments for the Pmod connector.

SIGNAL	PIN	**P7**		PIN	SIGNAL
SS	P307	**1**	**7**	P009	INT
MOSI	P305	**2**	**8**	P603	RESET
MISO	P304	**3**	**9**	P604	I/O
SCK	P306	**4**	**10**	P605	I/O
GND	GND	**5**	**11**	GND	GND
VCC	3.3V	**6**	**12**	3.3V	VCC

- SS……Slave Select. Active low to enable the Pmod board
- MOSI….Master Out Slave In. Data from the processor to the Pmod board
- MISO…..Master In Slave Out. Data from Pmod board to the processor.
- SCK….Serial clock. Processor provides the clock to shift the data
- INT….Interrupt signal from the Pmod board to the processor
- RESET - Reset signal for processor to the Pmod board.
- I/O…..GPIO pins from the processor.

Only 3.3V Pmod boards can be supported.

MikroBUS™ Add On Board Connectors

The MikroBUS specification is for a series of boards that can be used to add functionality when connected to a MikroBUS connector. The connector supports:

- Analog
- I2C
- SPI
- UART

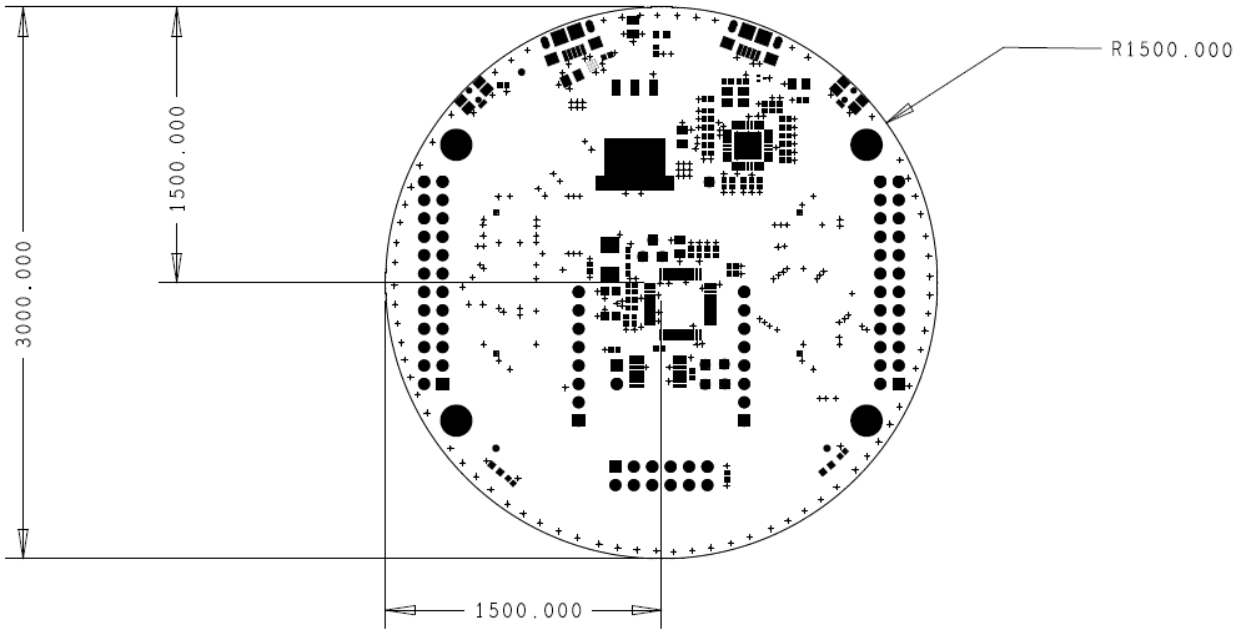
The AM provides for a single set of connectors for adding these boards. The table below is the pinout of the connector.

PIN	SIGNAL	**P8**	**P9**	SIGNAL	PIN
P408	PWM	**1**	**1**	ANA	P000
P411	INT	**2**	**2**	RESETn	P010
P301	RX	**3**	**3**	CSS	P103
P112	TX	**4**	**4**	SCK	P102
P206	SCL	**5**	**5**	MISO	P100
P205	SDA	**6**	**6**	MOSI	P101
	5VDC	**7**	**7**	3.3VDC	
	GND	**8**	**8**	GND	

Only 3.3V boards are supported.

- PWM…….Pulse Width Modulation
- INT……Processor Interrupt
- RX……UART RX
- TX……UART TX
- SCL……I^2C Clock
- SDA……I^2C Data
- ANA…….Analog
- RESETn….Reset line
- CSS…….SPI Chip Select
- MISO……..Processor input and board output
- MOSI……..Board input and processor output

Board Dimensions



Support

A DiscBoards.org supported Support Wiki is provided to document the different boards. This Wiki is open to everyone that creates boards that are sold to the community and documented on the WIki. This Wiki can only be modified by those people. The Wiki can be found at www.discboards.org/support . For access to the Wiki, contact admin@discboards.org .

Document Change History

Rev	Changes	Date	By
0.1	Initial release	October 6th, 2015	GC
0.2	Updates including changes for SSP 1.0.0. 1) Added DiscBoards BSP install instructions 2) Simplified OpenOCD install instructions 3) Added new project with DiscBoards custom board support pack.	October 26th, 2015	GC