Solar optimizers with CoolGaN™ transistors in a buck configuration: Firmware configuration guide

REF_OPTI_80V20A_GaN Reference Board

Scope and purpose

This user guide helps you get started with the REF_OPTI_80V20A_GaN CoolGaN™ reference design board for DC optimizer.

Intended audience

This user guide is intended for system application engineers who want to use the REF_OPTI_80V20A_GaN reference design board.

About this product group

Target applications

- Solar optimizers for residential and commercial photovoltaic systems
- Module-level power electronics (MLPE) such as DC power optimizers
- High-frequency DC-DC converters for distributed energy systems
- Smart energy storage interfaces requiring fast transient response
- Low-voltage conversion stages in renewable or hybrid power architectures Product family

Product family

This reference design highlights Infineon's CoolGaN™ 100 V power transistor family, which provides superior switching performance for compact, high-efficiency power conversion. CoolGaN™ devices offer low specific on-resistance, low output charge, and robust high-frequency operation, making them well-suited for high-density DC-DC converters.

The design also integrates complementary Infineon components that together form a complete system solution:

- CoolGaN™ 100 V Transistors – optimized for high-speed switching and minimal switching losses
- EiceDRIVER™ 1EDN71x6U gate driver family – designed for GaN compatibility with differential input and active Miller clamp
- PSOC™ PSC3 microcontroller family – providing MPPT control, sensing, and system management
- OPTIREG™ LDO TLS205B0EJV33 – low-noise, low-quiescent-current power regulation for the controller and sensing circuits

This family of Infineon components enables small-form-factor, high-efficiency solar optimizer designs with simplified integration and broad application scalability.

About this product group

Reference Board/Kit (Optional)

Product(s) embedded on a PCB with a focus on specific applications and defined use cases that may include software. PCB and auxiliary circuits are optimized for the requirements of the target application.

Note: Boards do not necessarily meet safety, EMI, quality standards (for example UL, CE) requirements.

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1 Introduction

The DC optimizer kit consists of a simple buck converter, which is used for solar and DC-DC converter applications.

1.1 Getting started

The DC optimizer board includes the following features:

- A simple buck converter that is operated in the following modes:
  - Open-loop mode
  - Outer current control mode
  - Outer voltage control or buck mode
  - Maximum power point tracking (MPPT) control mode
- The controller based on Infineon PSOC™ Control C3 MCU (PSC3M5FDS2LGQ1)
- Two general-purpose switches: one for user interaction or control, and the other to reset the microcontroller

1.2 Using out of the box example

The PSOC™ Control C3 MCU on the DC optimizer comes programmed with the code example: *PSOC™ Control MCU: Maximum Power Transfer Control Mode and One Eye GUI*. See the example's README.md file.

Do the following to use the code example:

1. Ensure sufficient input voltage is applied at the input terminals (see user guide)
2. Connect the external XMC™ Link to the X1 connector of the board and the other end to the USB port of a PC, connect as shown in Figure 1, for the UART direct TX to TX_PC and for the RX to RX_PC, no swap is needed
3. Verify that the power green LED D5 is glowing in the board
4. Turn on the controller. DO one of the following:
   - Press switch S2 on the board
   - From the One Eye GUI
5. Press the enable switch on the board to turn on the board. Press the switch again to turn off the board

Note: By default, the program runs in MPPT control mode.

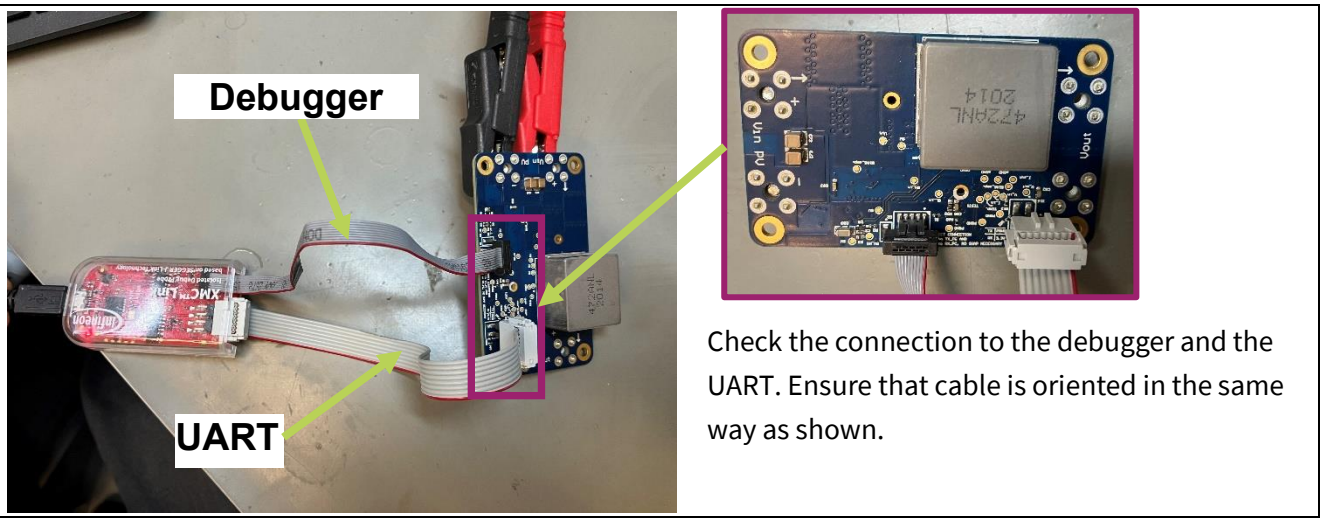


Figure 1 Connection to the board with XMC™ Link

1.3 Creating a project and program/debug using ModusToolbox™ software

The DC optimizer kit can be programmed and debugged using the external J-Link debugger, which supports the USB-UART bridge functionality. An XMC™ Link is used to implement the J-Link functionality.

1. Connect the board to the PC using the provided USB cable through the external XMC™ Link USB connector. Wait for the board to enumerate as a USB composite device if you are connecting it to your PC for the first time
2. Download and install J-Link software
3. In the Eclipse IDE for ModusToolbox™ software, import the desired code example (application) into a new workspace

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a) In the **Quick Panel**, click **New Application** from the Start section

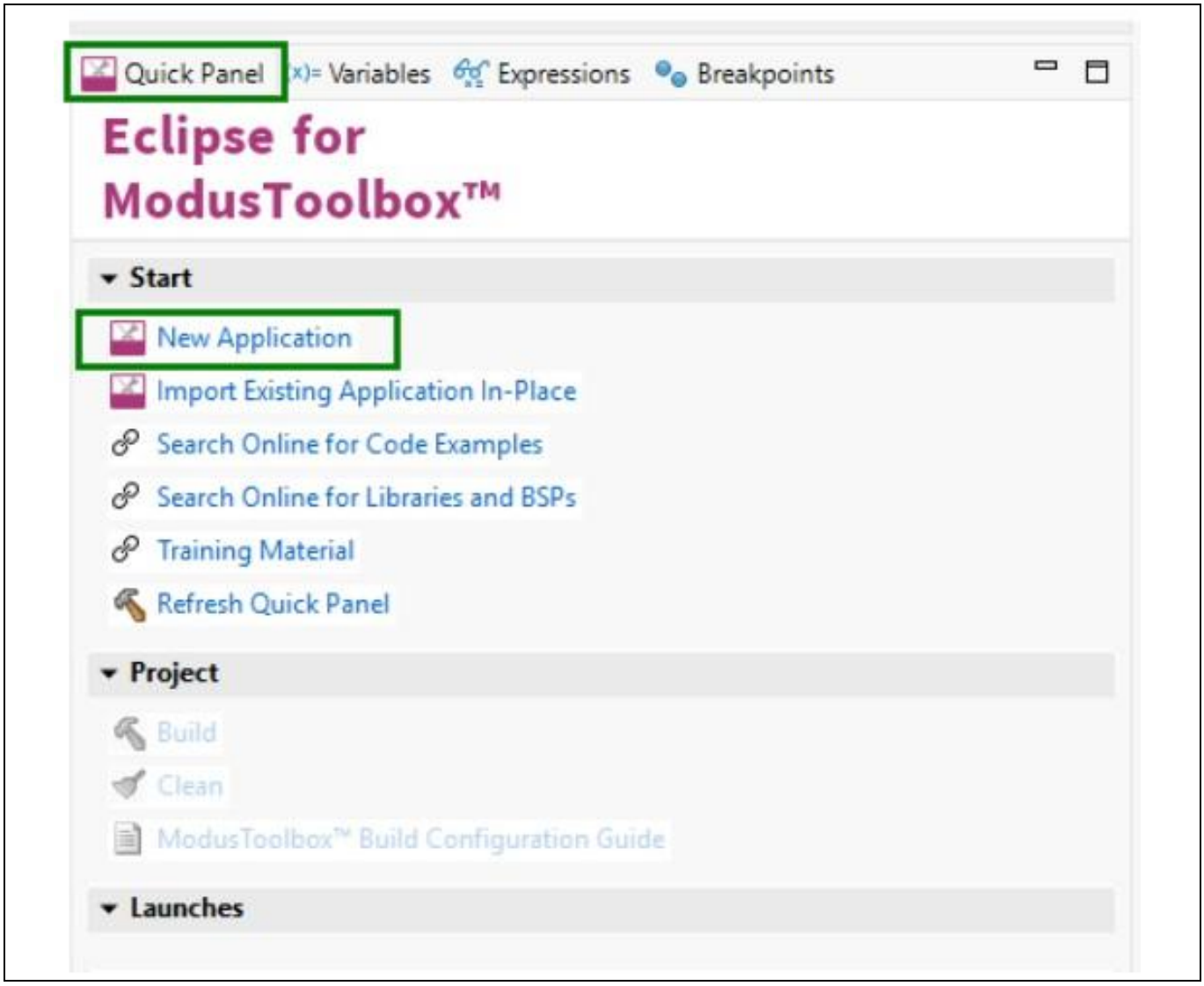


Figure 2 Create New Application

Introduction

b) Select the **REF_OPTI_80V20A_GaN** in the **Choose Board Support Package** window and click **Next**

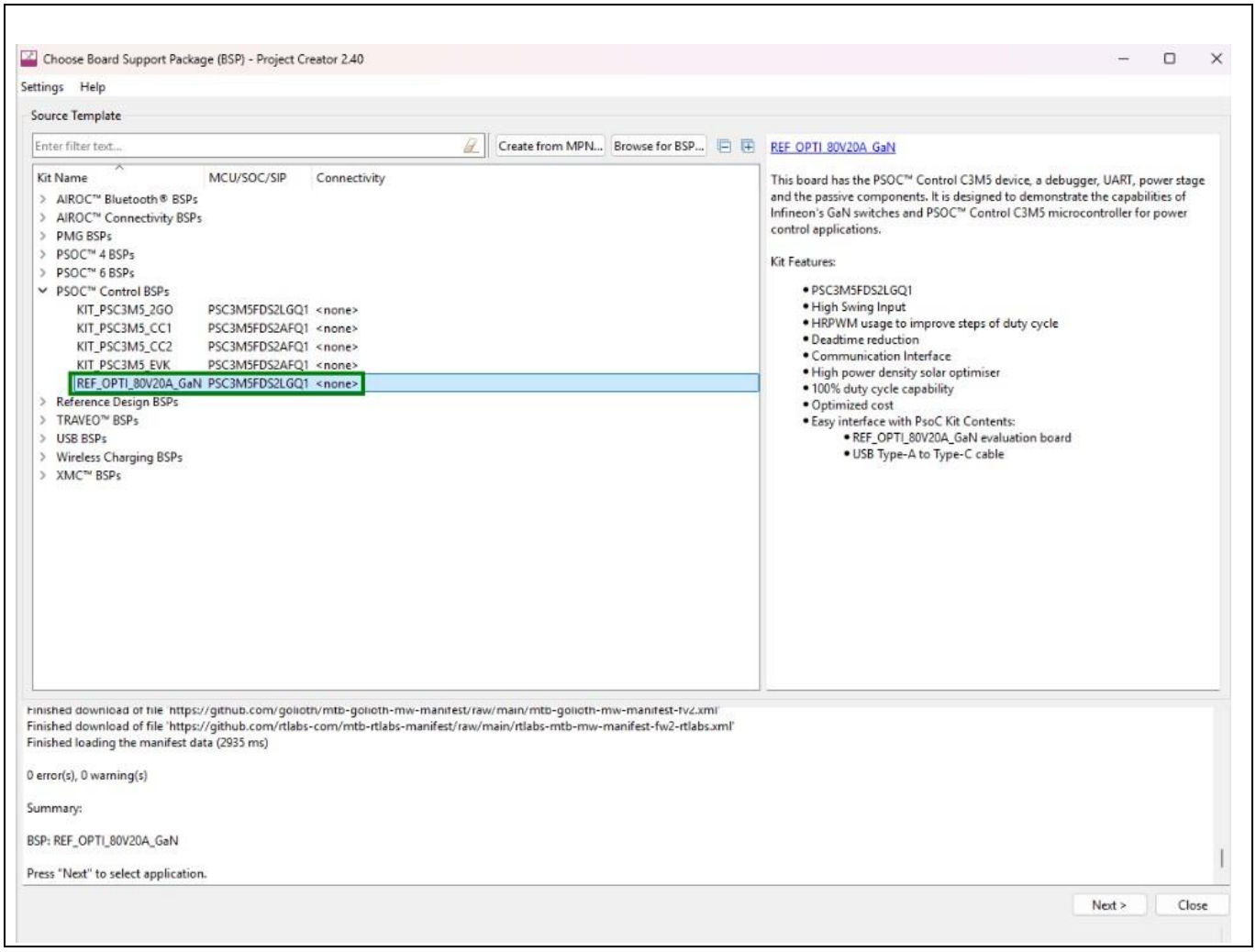


Figure 3 Choose board-specific package

c) Select the application in the **Select Application** window and click **Create**

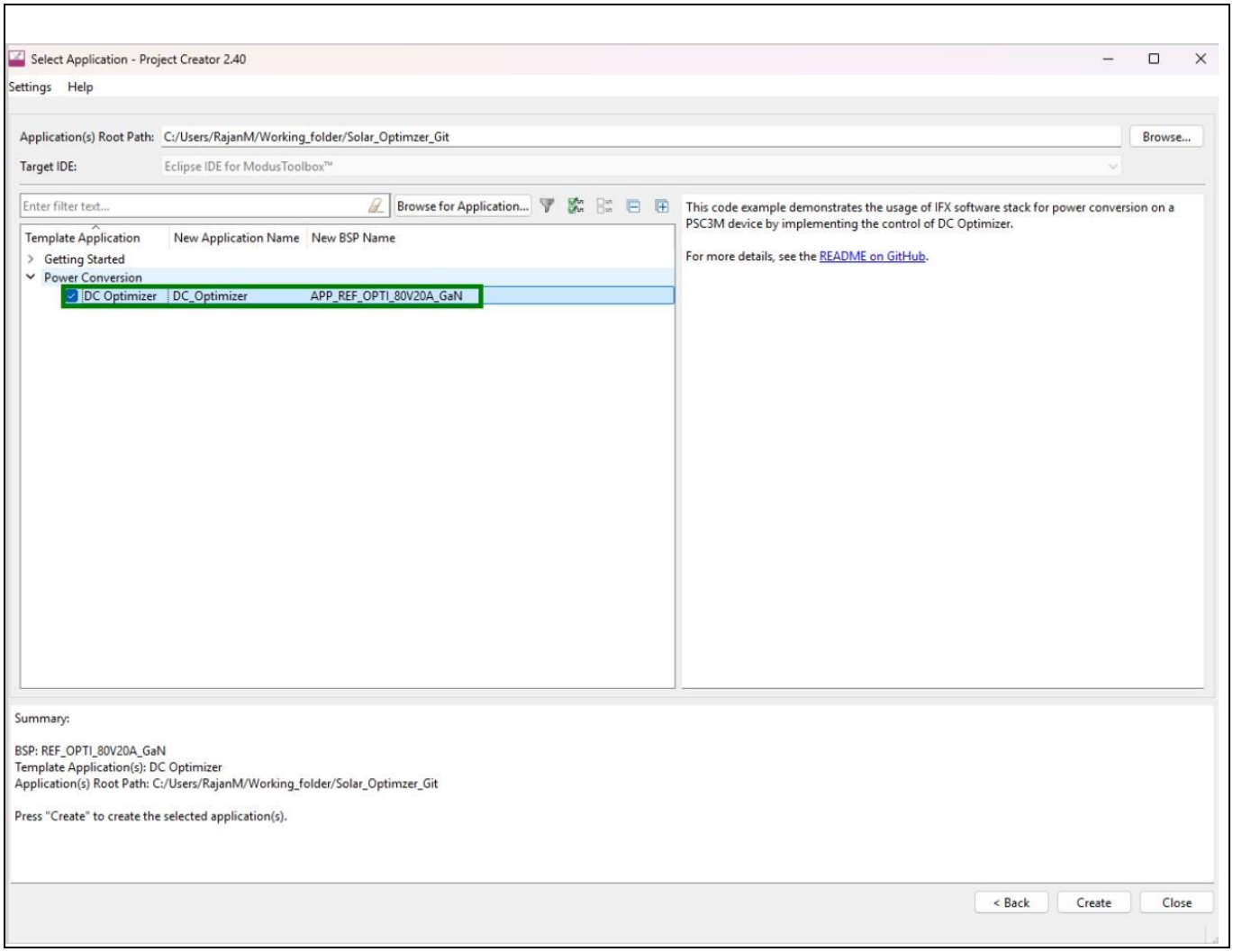


Figure 4 Select application

4. To build and program a PSOC™ Control C3M5 MCU application:

   a) In the **Project Explorer**, select <App_Name> project

   b) In the Quick Panel, click the <App_Name> Program (J-Link) configuration from the **Launches** section, as shown below:

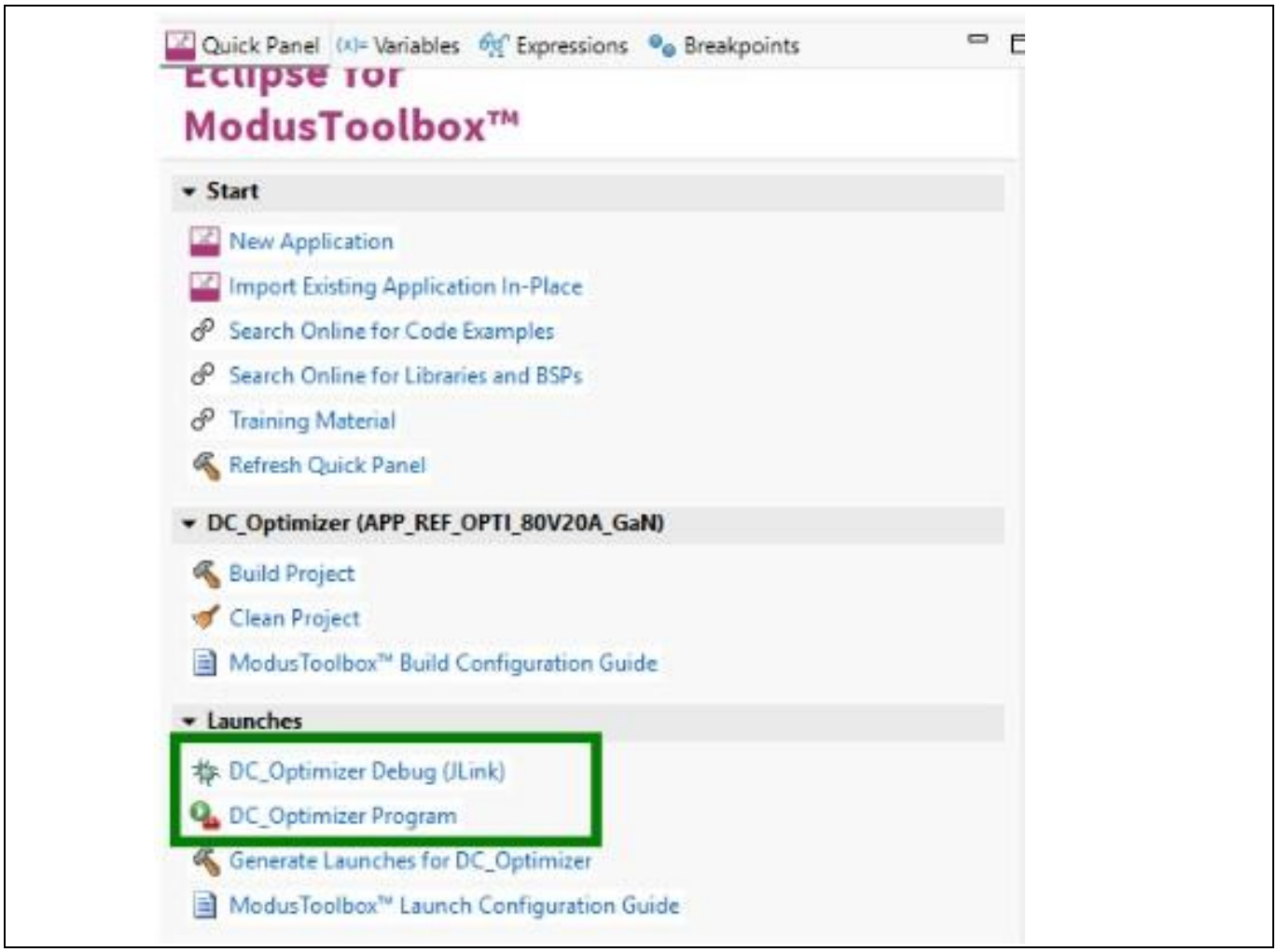


Figure 5 Programming in ModusToolbox™ software

1.4 Debug a PSOC™ Control C3M5 MCU application

1. In the **Project Explorer**, select the **project**
2. In the Quick Panel, click the **Debug** (J-Link) configuration from the Launches section. For more details, see the Program and debug section in the Eclipse IDE for ModusToolbox™ user guide
3. For using One Eye GUI, open Infineon GUI Designer
4. Select **File** > **Load Configuration** in One Eye GUI
5. In your workspace, navigate to the *DC_Optimizer*/*oneeye* folder, and select the **OneEye file**

Introduction

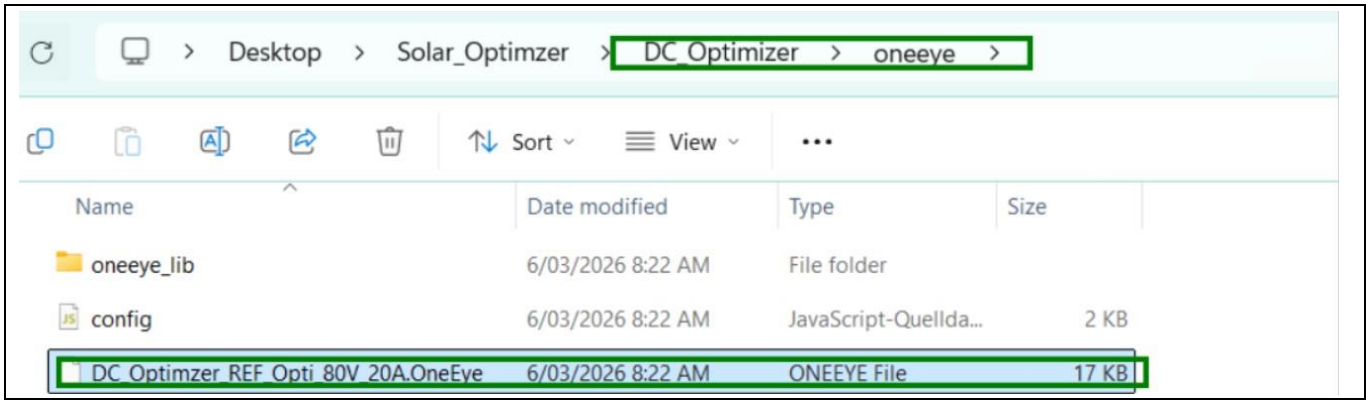


Figure 6 Load One Eye Configuration file

6. Click **Set Up Serial Device** and make the following settings, and then click **Connect**
   - Device: J-Link
   - Baud rate: 115200

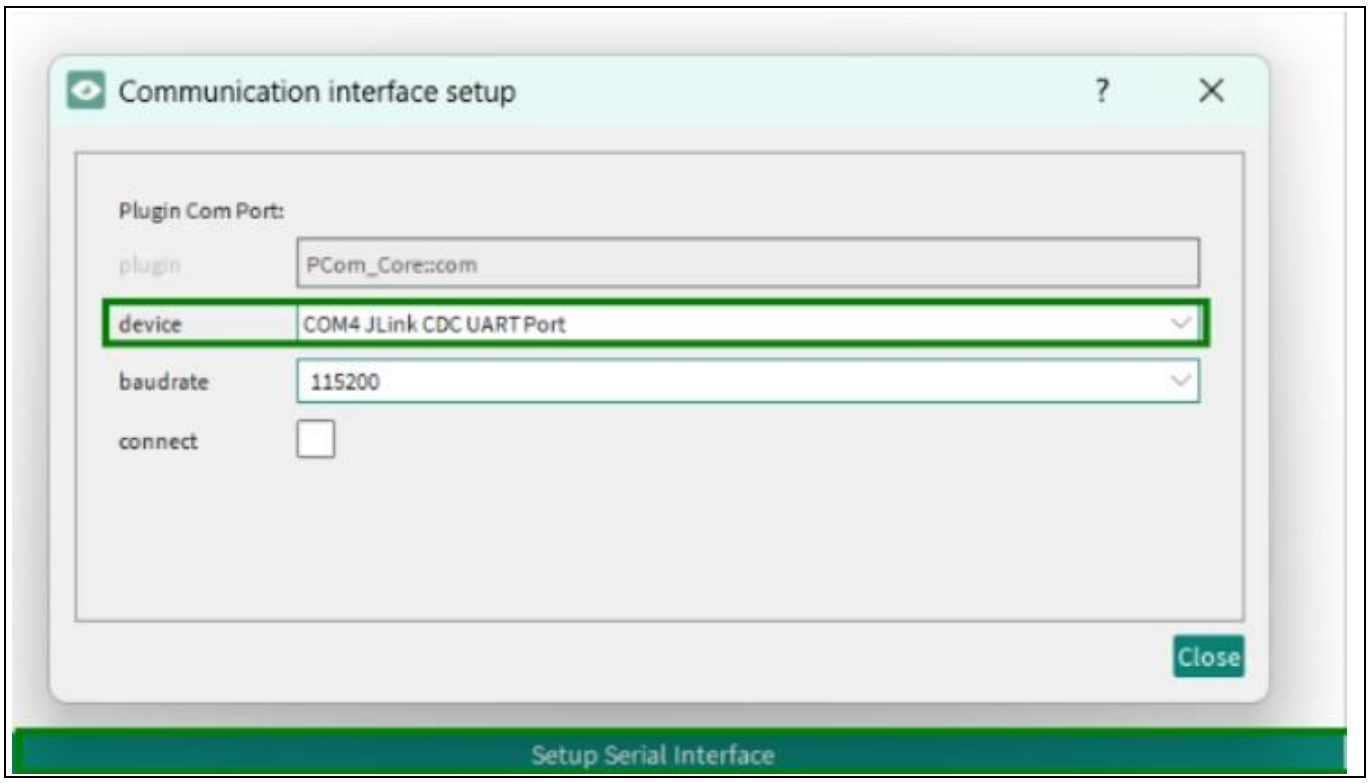


Figure 7 Set up the J-Link connection

If the connection is established successfully, the One Eye GUI shows the default settings as follows.
If the device is not detected, check the cable connection . Then, open the Device Manager on the PC and verify whether the device appears under COM port detection.

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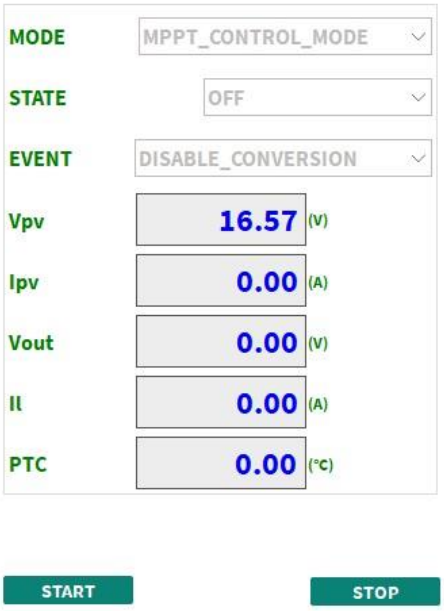


Figure 8 Default configuration in One Eye GUI

2 Software configurations in DC Optimizer

The DC Optimizer firmware platform provides a robust and scalable reference design for developers seeking to implement high-performance DC-DC power conversion in different working modes.

The DC optimizer application headers and source file are in the *dco* folder as shown below.

You can modify the *dco_cfg.h* file to match the design requirements and control techniques. A state machine template is provided to implement the state machine for DC optimizer. Based on the macros defined in the *dco_cfg.h* the precompile steps select the necessary functions for the selected mode of operation. You can modify different working modes from the firmware.

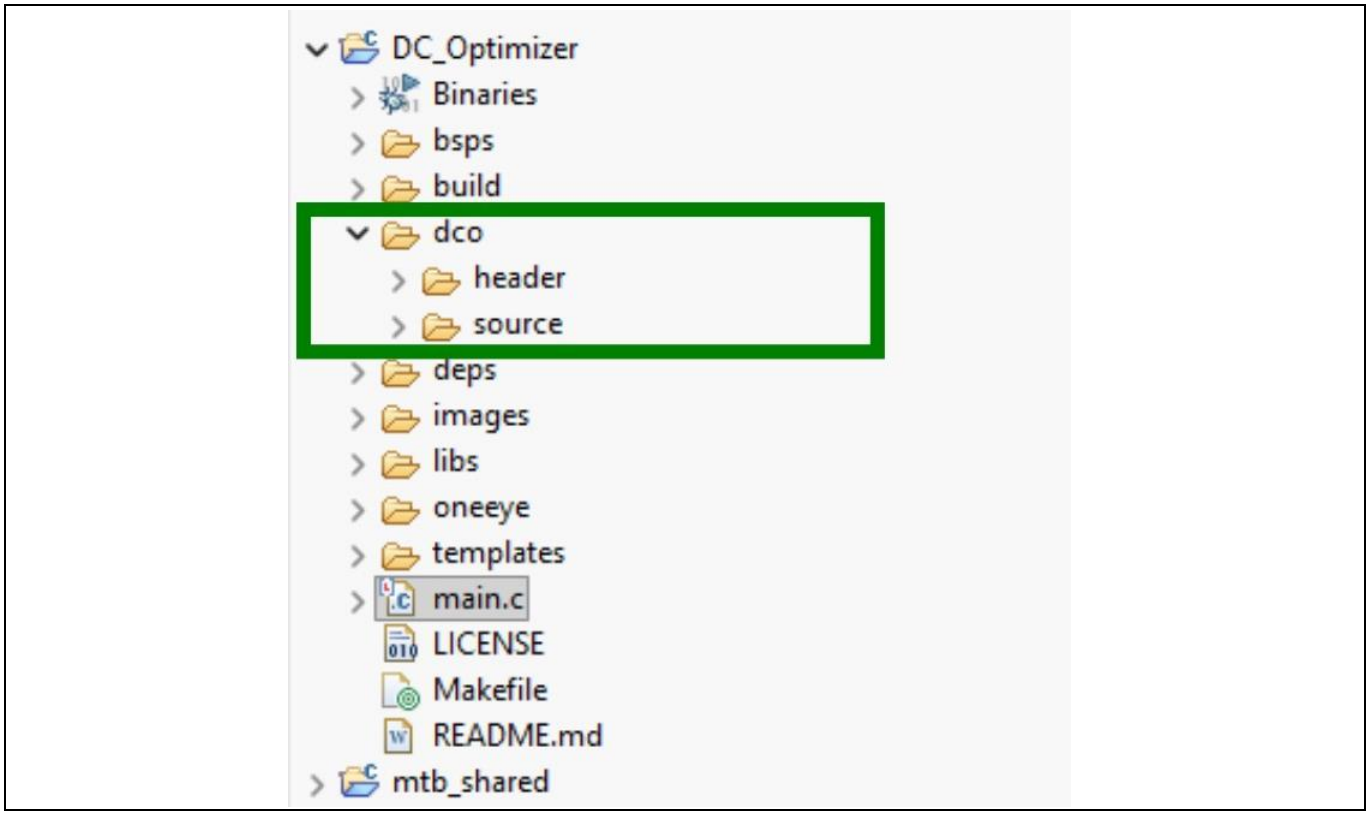


Figure 9 DCO -DC Optimizer Files

- To work in open-loop mode, edit *dco/dco_cfg.h* and make the `DCO_MODE_SELECTION` as `DCO_MODE_OPEN_LOOP` as follows:

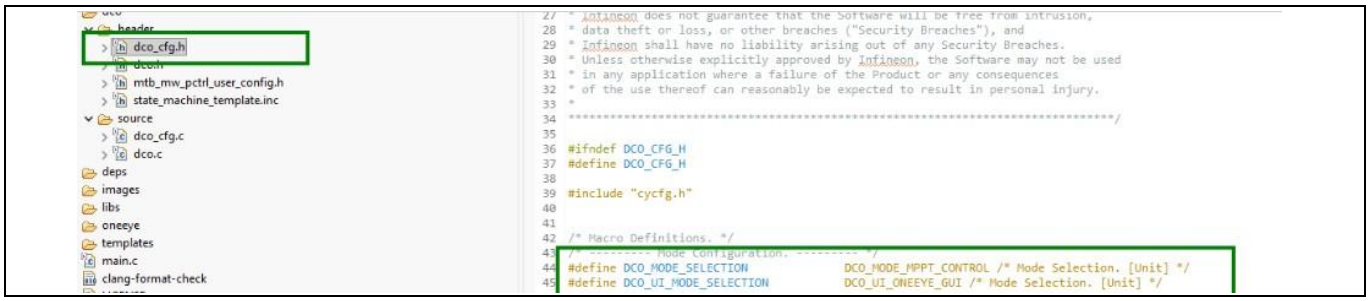


Figure 10 DC Optimizer Configuration file

a) Other possible modes are defined in *dco.h* as follows:

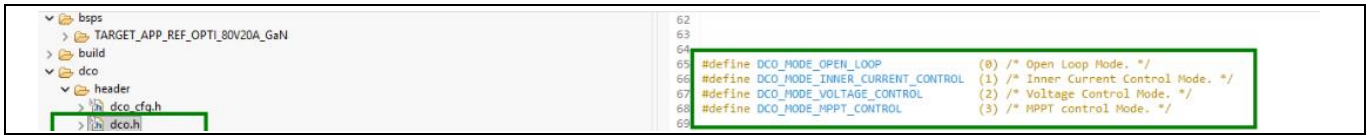


Figure 11 Mode selection in DC optimizer

- Configure parameters for different modes such as the following:
  - `DCO_MODE_INNER_CURRENT_CONTROL`: Choose the reference current for this mode using the `DCO_IL_REF_A macro`
  - `DCO_MODE_VOLTAGE_CONTROL`: Choose the output voltage references provided by the `DCO_VOUT_REF_V macro`
  - `DCO_UI_MODE_SELECTION`: Choose the user interface mode as serial terminal or OneEye GUI application
  - `DCO_IL_OCP_HW_THRESHOLD_A and DCO_IPV_OCP_HW_THRESHOLD_A`: Define the threshold values of output and input currents, above which the CSG kills the PWM

```
#define DCO_IL_OCP_HW_THRESHOLD_A       (float32_t)(30.0) /* Il Over-Current Protection threshold.
                                                             [A] */

#define DCO_IPV_OCP_HW_THRESHOLD_A      (float32_t)(30.0) /* Ipv Over-Current Protection threshold.
                                                             [A] */
```

Figure 12 Overcurrent threshold settings

  - Modify the temperature, voltage counter, and MPPT scheduler time using the following macros:

```
#define DCO_SCHEDULER_PERIOD            (uint32_t)(1000) /* Main Scheduler period. 1ms [us] */
#define DCO_VPV_BROWN_IN_DELAY          (uint32_t)(200000) /* Vpv minimum brown-in period. 200ms
                                                              [us] */
#define DCO_VPV_BROWN_OUT_DELAY         (uint32_t)(200000) /* Vpv minimum brown-out period. 200ms
                                                              [us] */
#define DCO_PTC_OVER_TEMP_DELAY         (uint32_t)(500000) /* Delay for over temperature error. 500
                                                              ms [us] */
#define DCO_MPPT_DELAY                  (uint32_t)(30000) /* Delay for over temperature error.
                                                              2s[us] */
```

Figure 13 Counter settings for different parameters

2.1 Analog sensing gains

The firmware also provides different sensor gains which can be modified for a different hardware configuration. An ADC reference voltage of 3.3 V and a 12-bit ADC is used for analog-to-digital conversion.

```
#define DCO_IL_ADC_CONVERSION_FACTOR    (float32_t)(0.009827571) /* Amphere to Digital-data
                                                                    conversion factor for Il. [Unit]
                                                                  */

#define DCO_IPV_ADC_CONVERSION_FACTOR   (float32_t)(0.009827571) /* Amphere to Digital-data
                                                                    conversion factor for Ipv.
                                                                    [Unit] */

#define DCO_VOUT_ADC_CONVERSION_FACTOR  (float32_t)(0.02138103) /* Voltage to Digital-data
                                                                   conversion factor for Vout.
                                                                    [Unit] */

#define DCO_VPV_ADC_CONVERSION_FACTOR   (float32_t)(0.02138103) /* Voltage to Digital-Counts
                                                                    conversion factor for Vin.
                                                                   [Unit]  */

#define DCO_TEMP_ADC_CONVERSION_FACTOR  (float32_t)(0.000805861) /* Voltage to Digital-Counts
                                                                    conversion factor for Vin.
                                                                     [Unit] */
```

Figure 14 Analog Sensing Gains

The following tables list the formulas used for calculating the gains shown in *dco_cfg.h*:

Table 1 Parameter description for analog channels

Parameter	Value	Gain	Description
DCO_IL_ADC_CONVERSION_FACTOR	0.082 V/A	RL3||RL4	(3.3)/(0.082*4095)= 0.009827571
DCO_IPV_ADC_CONVERSION_FACTOR	0.082 V/A	RL1||RL2	(3.3)/(0.082*4095)= 0.009827571
DCO_VOUT_ADC_CONVERSION_FACTOR	0.0376904	R27/(R24+R27)	(3.3)/(0.0376904*4095)= 0.02138103
DCO_VPV_ADC_CONVERSION_FACTOR	0.0376904	R30/(R25+R30)	(3.3)/(0.0376904*4095)= 0.02138103
DCO_TEMP_ADC_CONVERSION_FACTOR	1.0	–	(3.3)/(4095)= 0.000805861

Revision history

Document revision	Date	Description of changes
V 1.0	2026-03-31	Initial release

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Email: erratum@infineon.com

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