KIT_PSC3M5_2GO PSOC™ Control C3M5 compact kit guide

About this document

Scope and purpose

This document provides a comprehensive understanding of the KIT_PSC3M5_2GO PSOC™ Control C3M5 Compact Kit, which includes kit operation, an out-of-the-box (OOB) example and its operation, and the hardware details of the board.

Intended audience

This document is intended for all embedded developers using the KIT_PSC3M5_2GO PSOC™ Control C3M5 Compact Kit.

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Safety precautions

Note: *Please note the following warnings regarding the hazards associated with development systems.*

Table 1 **Safety precautions**

	**Caution:** *The evaluation or reference board contains parts and assemblies sensitive to electrostatic discharge (ESD). Electrostatic control precautions are required when installing, testing, servicing or repairing the assembly. Component damage may result if ESD control procedures are not followed. If you are not familiar with electrostatic control procedures, refer to the applicable ESD protection handbooks and guidelines.*
	**Caution:** *The evaluation or reference board is shipped with packing materials that need to be removed prior to installation. Failure to remove all packing materials that are unnecessary for system installation may result in overheating or abnormal operating conditions.*

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1 Introduction

The KIT_PSC3M5_2GO PSOC™ Control C3M5 Compact Kit is designed with the PSOC™ C3M5 series MCU to run an on-the-go motor application using USB pluggable hardware and with Infineon's PSOC™ C3 family of devices. The board contains a USB interface, a DC-DC converter, a PSOC™ controller, an XMC4200 on-board debugger, an integrated power module (IPM), and a 3-phase BLDC motor with single shunt FOC support. This board is intended to be used under no-load conditions and only for the purpose of evaluating compact kit motor control software and tools. The PSOC™ Control C3M5 is a high-performance and low-power 32-bit single-core Arm® Cortex® M33-based MCU with a digital signal processor (DSP), floating-point unit (FPU), and state-of-the-art security features.

This device has the following features:

- High-performance programmable analog subsystem (HPPASS)
- 12-bit, 12-Msps SAR ADC with parallel idle sampling of up to 16 analog channels
- Five comparators with <10 ns built-in 10-bit DAC and slope generator
  - Real-time control peripherals
    - Coordinate rotation digital computer (CORDIC)
    - 16 x 16-bit and 4 x 32-bit timer/counter pulse-width modulator (TCPWM) supporting <80 ps
  - High-resolution pulse-width modulator (HRPWM)
  - Enhanced routing flexibility with a combinatorial trigger multiplexing unit
  - Communication interfaces: six SCBs and two CAN FDs (one supporting 8 Mbps)
  - 256 KB read-while-write flash with ECC support
    - Low-power operation: Sleep, Deep Sleep (three modes) below 10 µA, and hibernate below 1 µA
    - Up to 50 GPIOs with programmable drive modes, strengths, and slew rates; up to 28 pins of support
  - Smart I/O programmable logic and up to 16 dedicated analog pins
  - Security: PSA L2 certified; configurable flash partitioning and protection
  - Safety: Class B and SIL 2 compliant safety test libraries are available
  - Power supply range: 1.7 V to 3.6 V
  - Ambient temperature range: -40°C to 105°C
  - Packages: VQFN-48, E-LQFP-48, VQFN-64, E-LQFP-64, and E-LQFP-80
  -
    - PSC3P5xD and PSC3M5xD devices are based on the Arm® Cortex®-M33, running up to 180 MHz with DSP and FPU capability. In addition to the CPU subsystem, the devices contain advanced real-time control peripherals, such as a high-performance programmable analog subsystem, comparators, advanced timers with high-resolution capability, up to six SCBs, and two CAN FDs for communication
    - The devices support one active and five low-power modes for managing and reducing power consumption, depending on application requirements

Additionally, the board has the following features:

- Onboard programmer/debugger (XMC4200)
- Type-A USB connector for the USB device interface
- Two user LEDs, one potentiometer, and two push buttons

The board supports an operating voltage of 3.3 V for the MCU and 15 V for the IPM device.

ModusToolbox™ software is used to develop and debug the PSC3M5 projects. ModusToolbox™ is a set of tools that enable you to integrate these devices into your existing development methodology.

1.1 Kit contents

The KIT_PSC3M5_2GO PSOC™ Control C3M5 Compact Kit comprises the following components:

- PSOC™ Control C3M5 Compact Kit
- Screwdriver for potentiometer tuning

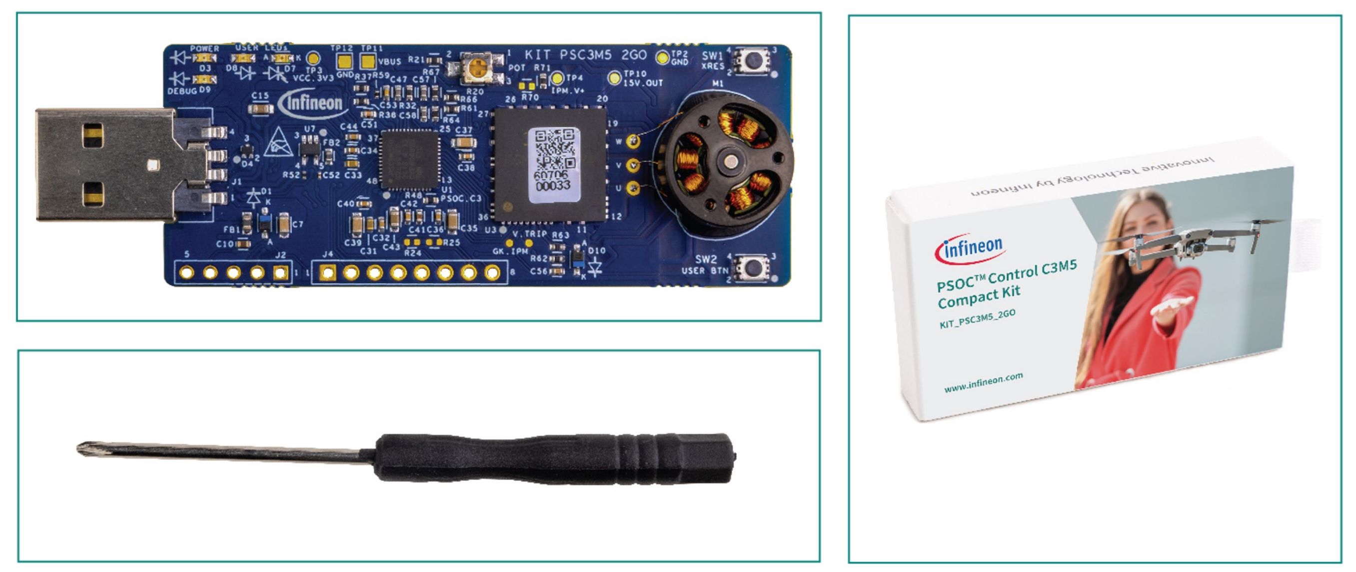

Figure 1 **Kit content**

1.2 Getting Started

This guide helps you get acquainted with the evaluation kit.

- The Kit operation section describes the major features and functionalities, such as programming, debugging, and USB-UART bridges, of the PSOC™ Control C3M5 Compact Kit
- The Hardware section provides a detailed hardware description, design information, and rework details
- The PSOC™ Control C3M5 Compact Kit enables the user with two operating modes; user can either run the motor in standalone mode or can connect to ModusToolbox™ Motor Suite software to control the motor operations
- Application development using the PSOC™ Control C3M5 Compact Kit is supported in ModusToolbox™
- ModusToolbox™ is a free development ecosystem that includes the Eclipse IDE for ModusToolbox™ PSOC™ Control C3M5 MCU. Using ModusToolbox™, you can enable and configure device resources, middleware libraries, write C/assembly source codes, and program or debug the device. For more information, see the ModusToolbox™ software installation guide
- Code examples are available for evaluating the PSOC™ Control C3M5 Compact Kit. These examples help you become familiar with the PSOC™ Control C3M5 MCU and create your own designs. These examples can be accessed through the ModusToolbox™ Project Creator tool. Additionally, see Infineon code examples for ModusToolbox™ software to access these examples
- In addition to the standalone operation of the kit, ModusToolbox™ Motor Control Suite helps the user to connect with a graphical user interface to run a motor control application. Using ModusToolbox™ Motor Control Suit, the user can control the motor operations and able to see and configure motor parameters in real time using a graphical interface
- For more information on the installation and operation of the ModusToolbox™ Motor Control Suite, refer to the kit operation section or the quick start guide for the kit available on the kit webpage

1.3 Board details

The PSOC™ Control C3M5 Compact Kit has the following features:

- USB-A connector for input power and system communication
- XMC4200 based programmer and debugger
- PSOC™ Control C3 device
- Onboard BLDC motor
- Infineon's Intelligent Power Module (IPM) with three-phase inverter integrated
- User switch and reset switch
- Potentiometer control
- User LEDs
- Power LED
- Debug LED

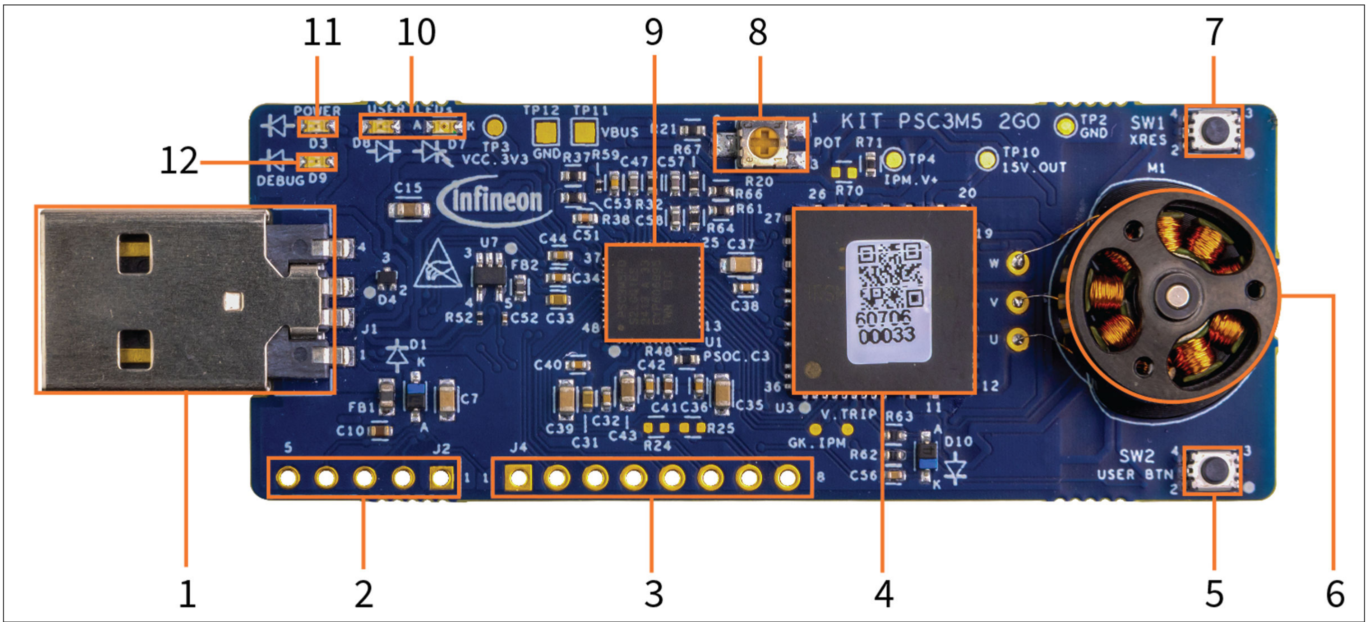

Figure 2 KIT_PSC3M5_2GO board details

Table 2 Peripheral details

Sl No.	KIT_PSC3M5_2GO blocks
1	USB-A connector (J1)
2	XMC4200 SWD programming header (J2)
3	GPIO header option(J4)
4	Intelligent Power Module (IPM) three-phase (IRSM836-044MA - U3)
5	User button (SW2)
6	BLDC motor (M1)
7	Reset button (SW1)
8	Potentiometer-POT (R20)
9	PSOC™ Control C3 device (PSC3M5FDS2LGQ1 - U1)

(table continues...)

Table 2 (continued) Peripheral details

Sl No.	KIT_PSC3M5_2GO blocks
10	User LEDs (D7, D8)
11	Power LED (D3)
12	Debug LED (D9)

Table 3 KIT_PSC3M5_2GO pinout details

Port pin	Primary onboard function	Connection details
P0.0	EN_IPM	Enable signal for the IPM Module.
P1.2	SWDCLK	SWD clock signal.
P1.3	SWDIO	SWD IO signal.
P2.0	GK_IPM	Gate kill signal from IPM.
P2.1	TDO	TDO is connected to the 10-pin SWD header interface. JTAG support is not available on this board.
P2.2	Not connected	
P2.3	Not connected	
P4.0	PWMWL	PWM low side input to IPM.
P4.1	PWMVL	PWM low side input to IPM.
P4.2	PWMUL	PWM low side input to IPM.
P4.3	PWMWH	PWM high side input to IPM.
P4.4	PWMVH	PWM high side input to IPM.
P4.5	PWMUH	PWM high side input to IPM.
P4.6	USER_SW	User switch input.
P4.7	Not connected	
P6.0	Not connected	
P6.1	Not connected	
P6.2	Not connected	
P6.3	Not connected	
P7.0	USER_LED1	User LED output. A RED LED (D7) is connected to this pin with the anode being connected to the VCC_3V3 supply.
P7.1	Not connected	
P7.2	Not connected	
P8.0	GPIO	P8.0 is connected to the J4 header. This pin supports slave select in SPI mode of operation.

(table continues...)

Table 3 (continued) KIT_PSC3M5_2GO pinout details

Port pin	Primary onboard function	Connection details
P8.1	GPIO	P8.1 is connected to the J4 header. This pin supports MOSI in SPI mode of operation. P8.1 can be utilized as a UART RX. P8.1 can be used as an I2C clock signal by populating the R24 resistor (4.7K) for pull-up.
P8.2	GPIO	P8.2 is connected to the J4 header. This pin supports MISO in SPI mode of operation. P8.2 can be utilized as a UART TX P8.2 can be used as an I2C data signal by populating the R25 resistor (4.7K) for pull-up.
P8.3	GPIO	P8.3 is connected to the J4 header. This pin supports SPI_CLK in SPI mode of operation.
P9.0	USER_LED2	P9.0 is connected to user LED—D8 (green)
P9.2	PSC3_UART_RX	RX from PSC3M5. TX from J-Link debugger is connected to P9.2.
P9.3	PSC3_UART_TX	TX from PSC3M5. RX from J-Link debugger is connected to P9.3.
AN_A0	IDC_LINK_PSEUDO_P	Current sense input from IPM. Motor phase current (single shunt) is sensed from AN_A0, providing feedback to the PSC3M5 device.
AN_A1	IDC_LINK_PSEUDO_N	Current sense input from IPM. Motor phase current (single shunt) is sensed from AN_A1, providing feedback to the PSC3M5 device.
AN_A2	IDC_LINK_OPAMP	Low-side single shunt current is fed to an external op-amp for gain amplification. The op-amp output is connected to PSOC™ C3 MCU device.
AN_A3	TEMP	AN_A3 is connected to the thermistor to monitor the temperature from the PSC3M5 device.
AN_A4	VDC_LINK	AN_A4 is connected to the voltage divider network to sense and monitor VDDA voltage on the hardware and to the PSC3M5 device analog supply.
AN_A5	Not connected	
AN_B1	Not connected	
AN_B2	AN_B2	AN_B2 is connected to the GPIO header for external evaluation purpose.
AN_B3	AN_B3	AN_B3 is connected to the GPIO header for external evaluation purpose.
AN_B4	M_SPEED_POT	AN_B4 is connected to the on-board potentiometer input to control the motor speed manually.
XRES	XRES_L_MCU	Active low reset signal to PSC3M5 device. The reset switch is used to manually reset the MCU.

Motor details

Table 4 Motor performance requirements

No.	Item	Requirement	Note
1	Rated voltage (V)	6.5	
2	No-load current (A/6.5 V)	≤0.1	Final inspection item, current tester
3	No-load speed (RPM/6.5 V)	20850±5%	Final inspection item, speed tester
4	Motor internal resistance (Ω) (Environmental temperature: 25℃)	12±1	Final inspection item, DC low resistance selector
5	Whole machine weight (g)	≤5.5	Final inspection item, electronic balance (sampling)
6	Machine insulation/leakage current	DC 200 V(3 s)/3 mA	Final inspection item, high voltage tester
7	Machine balance (mg)	≤5	Production inspection item, dynamic balance (sampling)
8	Operating environment temperature (℃)	-10℃-65℃	
9	Storage temperature (℃)	-10℃-50℃	
10	Storage humidity (%)	≤85	

Table 5 Motor shape, installation structure

No.	Item	Requirement	Note
1	Slot number	9N8P	
2	Whole machine outline (mm)	≤1.0	Final inspection item, ruler
3	Whole machine height (mm)	8.8±0.1	Final inspection item, ruler (sampling)
4	End play (mm)	≤0.05	Production inspection item, thousandth inspection (sampling)
5	Radial play (mm)	≤0.05	Production inspection item, thousandth inspection (sampling)
6	Motor height (mm)	7.9±0.1	Final inspection item, ruler (sampling)
7	Whole machine outer diameter (mm)	13.6±0.1	Final inspection item, ruler (sampling)
8	Installation hole position (mm)	5.84*11.68*3-M1.2	Final inspection item, ruler (sampling)
9	Wire/wire sequence	Painted wire, same color	Final inspection item, visual inspection
10	Line length (mm)	8~9 mm	Final inspection item, ruler (sampling)

1.4 Technical support

For assistance or product related queries, contact Infineon Support or post your queries on the Infineon Developer Community platform.

1.5 Abbreviations and definitions

Table 6

Abbreviation	Definition
USB	Universal serial bus
PSOC	Programmable system on chip
CPU	Central processing unit
FOC	Field-oriented control
MCU	Micro controller unit
ADC	Analog-to-digital converter
BLDC	Brush-less direct current
SWD	Serial wire debug
JTAG	Joint test action group
PCB	Printed circuit board
PWM	Pulse width modulation
PMSM	Permanent magnet synchronous motor
GPIO	General purpose input/output
I2C	Inter-integrated circuit
UART	Universal asynchronous receiver transmitter
SPI	Serial peripheral interface
CORDIC	Coordinate rotation digital computer
IPM	Intelligent power module
Op-amp	Operational amplifier

2 Kit operation

2.1 Out-of-box: Standalone operation

The kit is pre-programmed with the out-of-box (OOB) firmware, which is configured to operate the included motor in sensorless field-oriented control (FOC) single-shunt mode.

1. Connect the PSOC™ Control C3M5 Compact Kit to a 5 V USB-A power adapter or computer USB socket. The green power LED (D3) and green debug LED (D9) will turn on

   The onboard motor starts spinning in the clockwise direction (from the motor's front side). The motor speed is controlled by the potentiometer (R20)
2. Rotate the potentiometer to adjust the motor speed

   During sensorless close-loop operation, motor stops if the set speed is too low due to brake boot mode of motor state machine
3. To restart the motor, set the speed to '0' and then increase it again using the potentiometer
4. The user button (SW2) changes the motor's direction. In the closed loop, when SW2 is pressed, the motor speed ramps down to '0' and stops. Set the potentiometer (R20) speed to '0' and then increase the speed to restart the motor in the reverse direction. In case of open loop (when motor speed is too low <20%), it automatically spins in reverse direction upon switch press
5. The green user LED (D8) shows the motor's direction:
   - Off - Clockwise direction
   - On - Counter-clockwise direction

***Note**: The motor speed is determined by the potentiometer setting. If the potentiometer is set to '0' (fully turned counterclockwise), the motor will not run.*

***Note**: Due to inherent variations in motor mechanical tolerances, some level of noise is expected from the board while the motor is spinning. The noise level may vary between boards. From a measurement perspective, the actual noise remains below 63 dB for all boards.*

2.2 OOB: GUI-based operation

1. Download and install ModusToolbox™ Motor Suite Setup for Windows from the Infineon Developer Center or use the link ModusToolbox™ Motor Suite (minimum required version: 2.4.1)
2. Connect the compact kit to the PC via USB-A connector and then open the ModusToolbox™ Motor Suite GUI

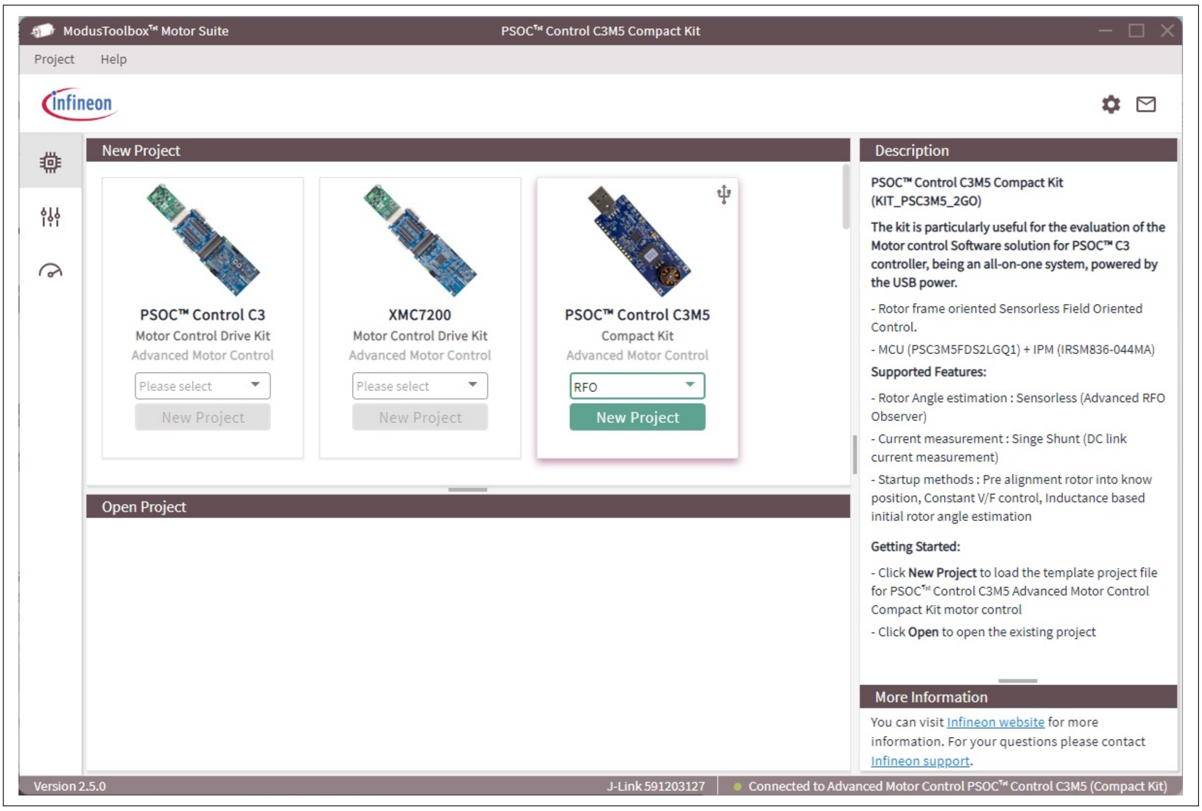

Figure 3 **GUI: Open new project**

3. Go to **PSOC™ Control C3M5 Compact Kit**, select **RFO**, and click **New Project** to open the configurator view

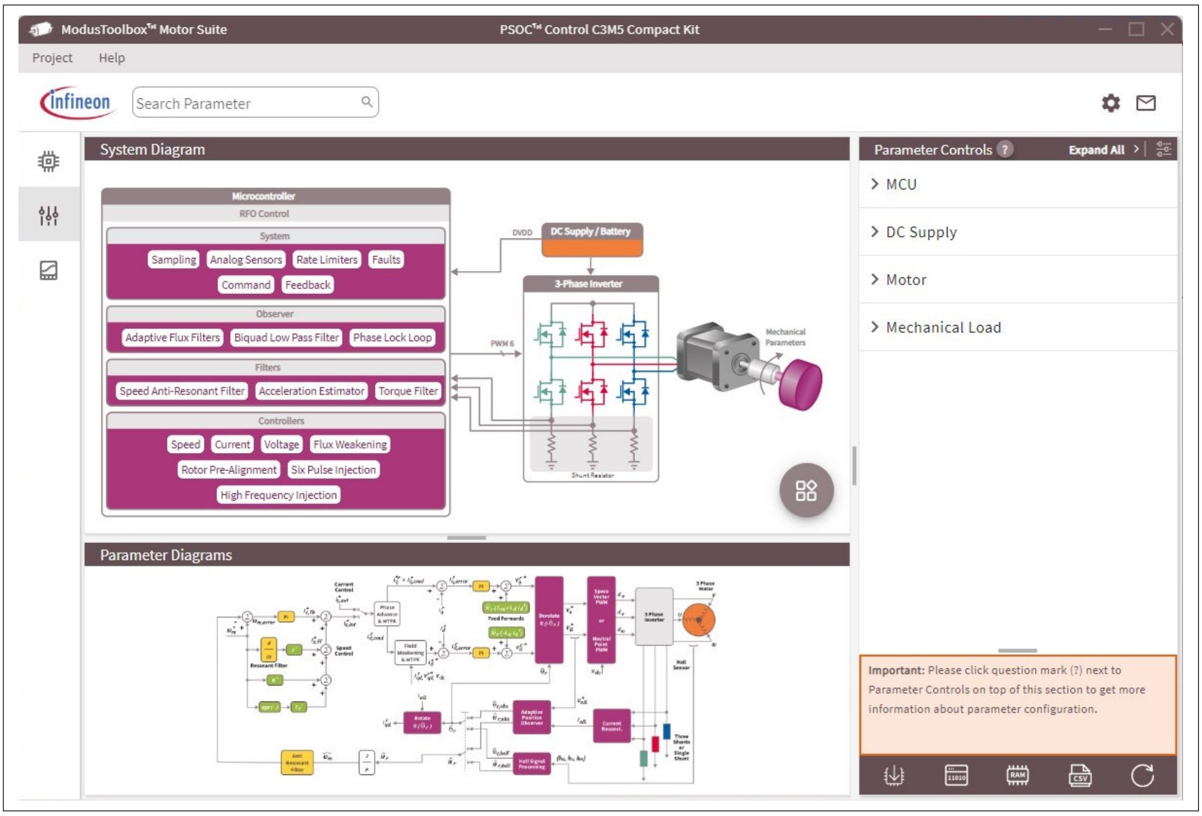

Figure 4 **GUI: Configurator view**

A green dot at the bottom right of the GUI windows indicates a successful connection to the kit. The configurator view provides the option to configure the static parameters

4. Click **Flash Firmware** on the lower right side and then click on the **Default** option to reprogram the default firmware into the controller
5. Click the **Test Bench** button to switch to the Test Bench view

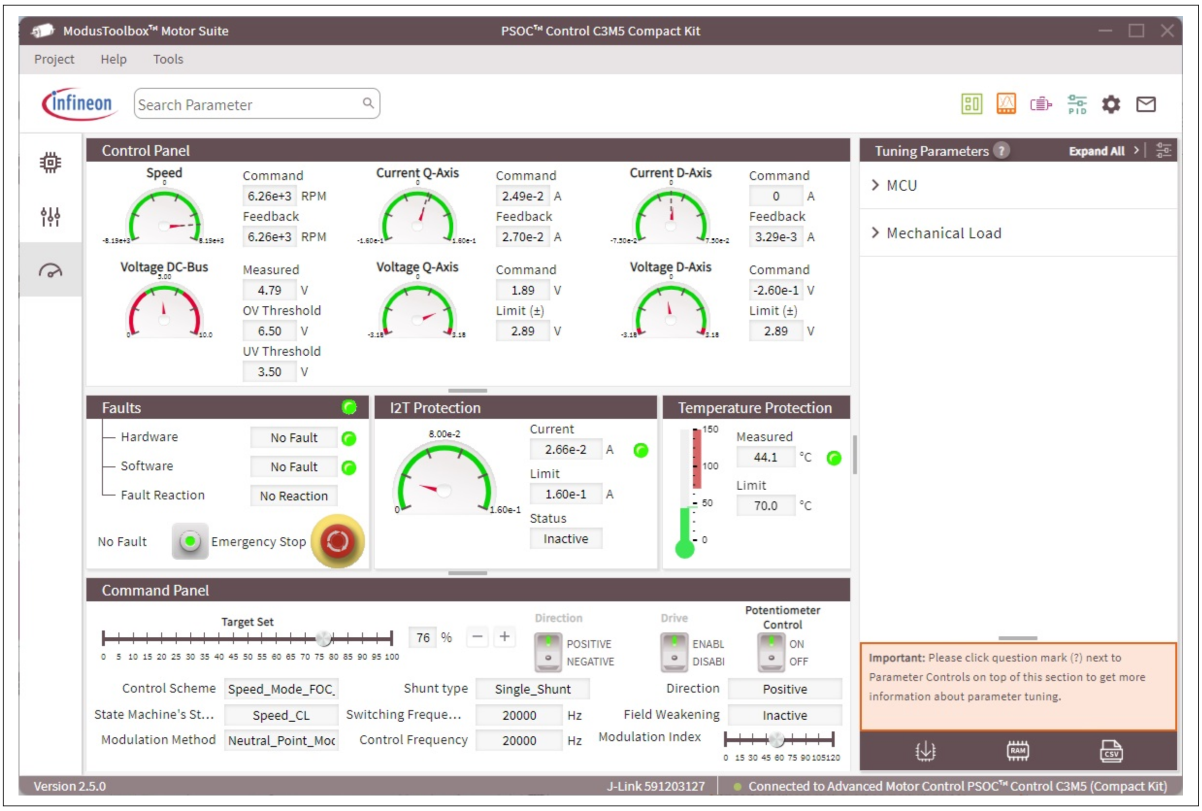

Figure 5 GUI: Test Bench view

6. In the **Command Panel**, the drive switch is used to enable/disable the drive
7. If the **Potentiometer Control** switch is on, then the potentiometer (R20) on the kit controls the motor speed
8. To set the motor speed using the **Target Set** slider in the **Command Panel**, turn the **Potentiometer Control** switch in the GUI

   ***Note**: Emergency stop under the **Faults** tab is used to stop/restart the motor and clear the faults*

9. The **Control Panel** and **Command Panel** sections display parameters such as voltage applied, currents flowing, DC bus voltage, faults, control scheme, state of the state machine, and the motor direction
10. To view current waveforms or other parameters, launch the **Oscilloscope** by clicking the icon in the top right corner of the Motor Suite GUI. For further details, refer to the user manual in the top corner inside the Oscilloscope window

    ***Note**: During the installation process, if prompted to install the J-Link driver, select "Yes" if it is not already installed on the test PC.*

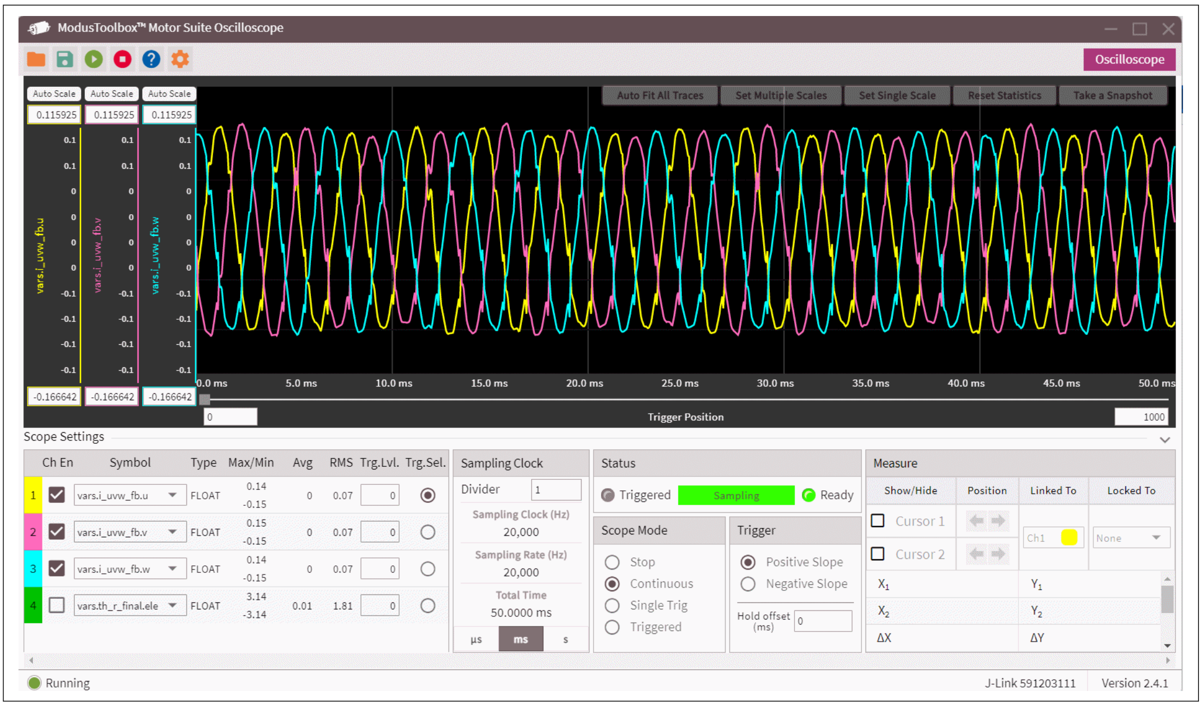

Figure 6 **Oscilloscope view**

Oscilloscope view can be used to visualize any global variable in the project. It allows up to 4 variables to be monitored simultaneously. Figure 6 shows the three motor phase currents reconstructed from single shunt DC link current measurements.

2.3 Creating project and programming/debugging using ModusToolbox™

The PSOC™ Control C3M5 Compact Kit can be programmed and debugged using the onboard J-Link debugger. This onboard programmer/debugger supports USB-UART bridge functionality. An XMC4200 device is used to implement the J-Link functionality. See UM08001: J-Link/J-Trace Getting started document in J-Link downloads for more details.

The following steps briefly introduce project creation, programming, and debugging using ModusToolbox™. For detailed instructions, see the Eclipse IDE for ModusToolbox™ user guide.

1. Connect the KIT_PSC3M5_2GO Compact Kit to the PC via USB-A connector, as shown in Figure 7. It enumerates as a USB composite device if you are connecting it to your PC for the first time

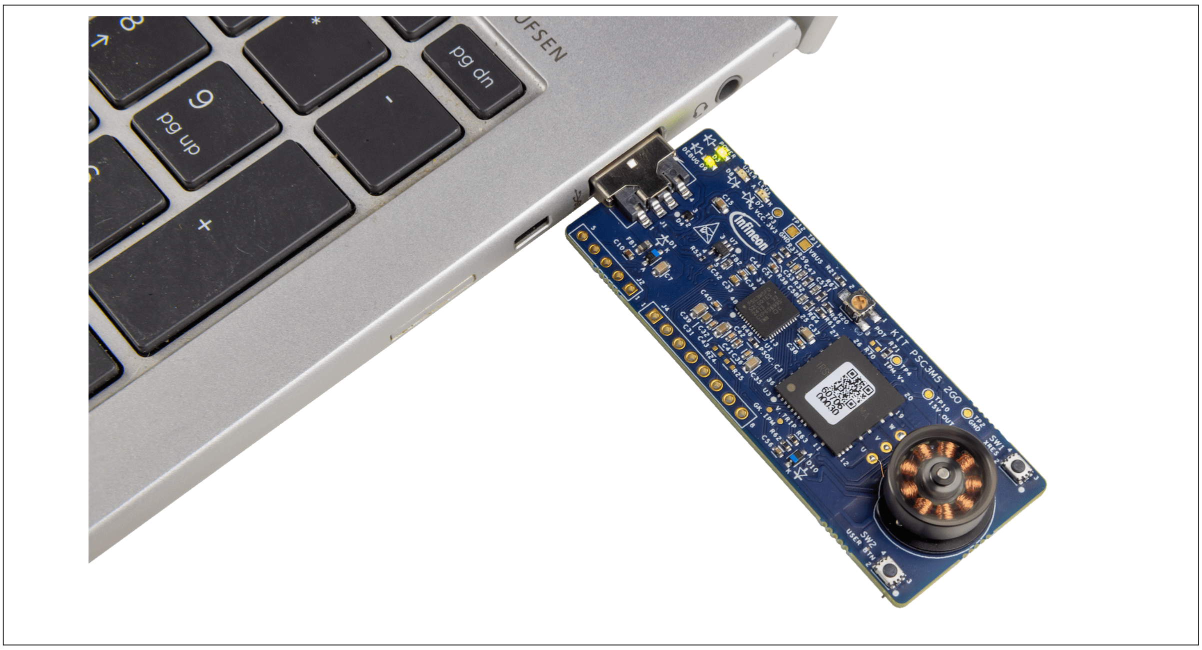

Figure 7 Connect compact kit to PC via USB-A connector

2. The debugger on this kit features the J-Link LITE with UART. The debug LED (green) is always ON if the USB is connected
3. In the Eclipse IDE for ModusToolbox™, import the desired code example (application) into a new workspace
   a. Click **New Application** on the **Quick Panel** tab

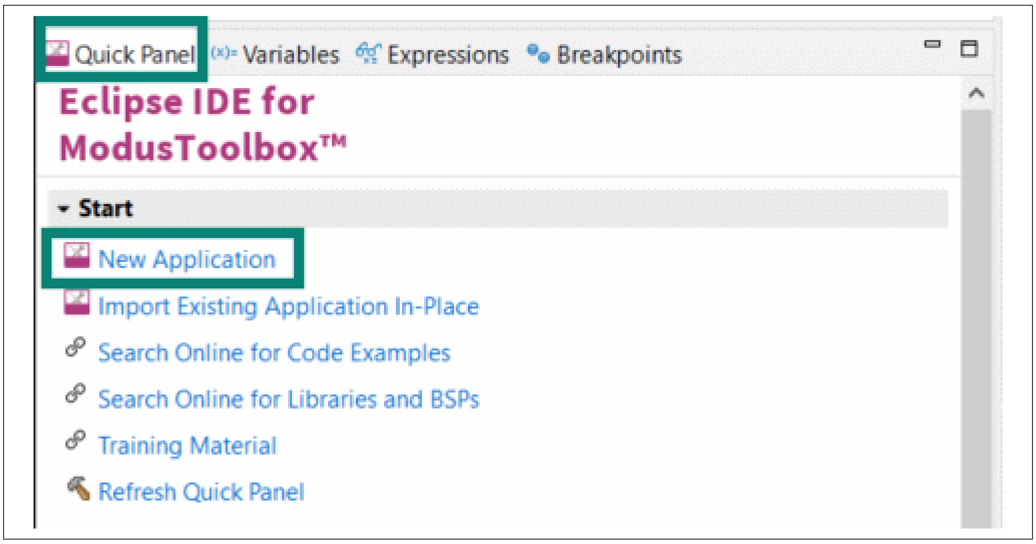

Figure 8 Create new application

   b. Select **BSP -KIT_PSC3M5_2GO** in the **Choose Board Support Package** window and click **Next**

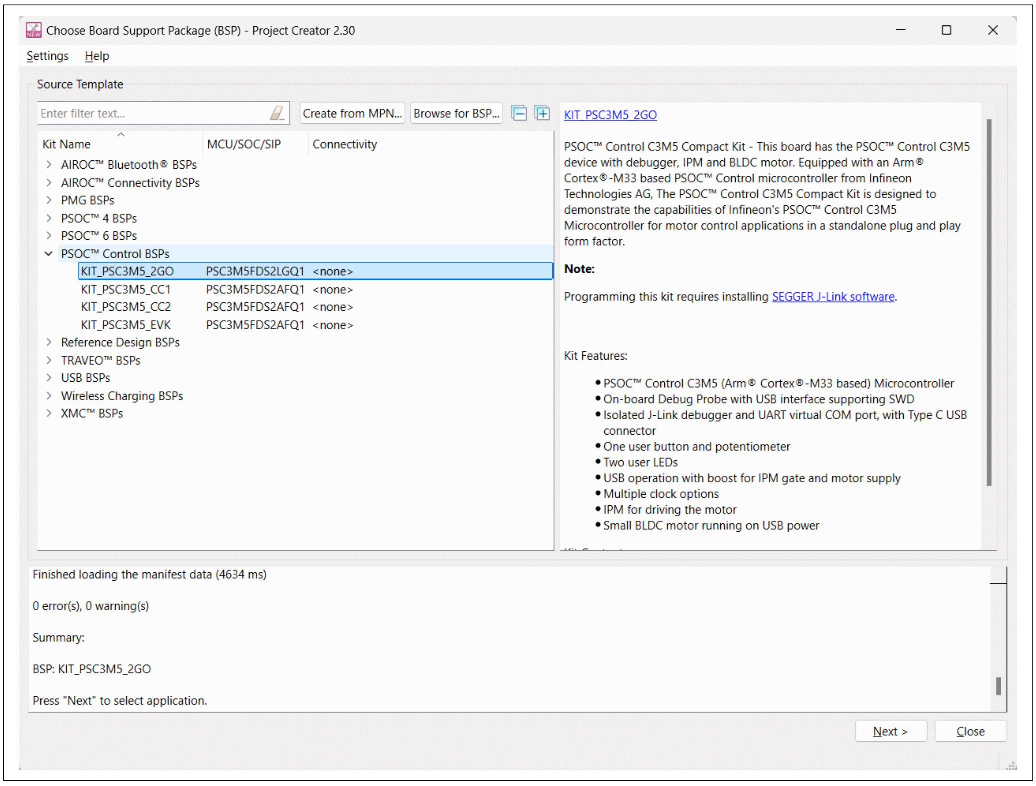

Figure 9 Choose Board Support Package

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

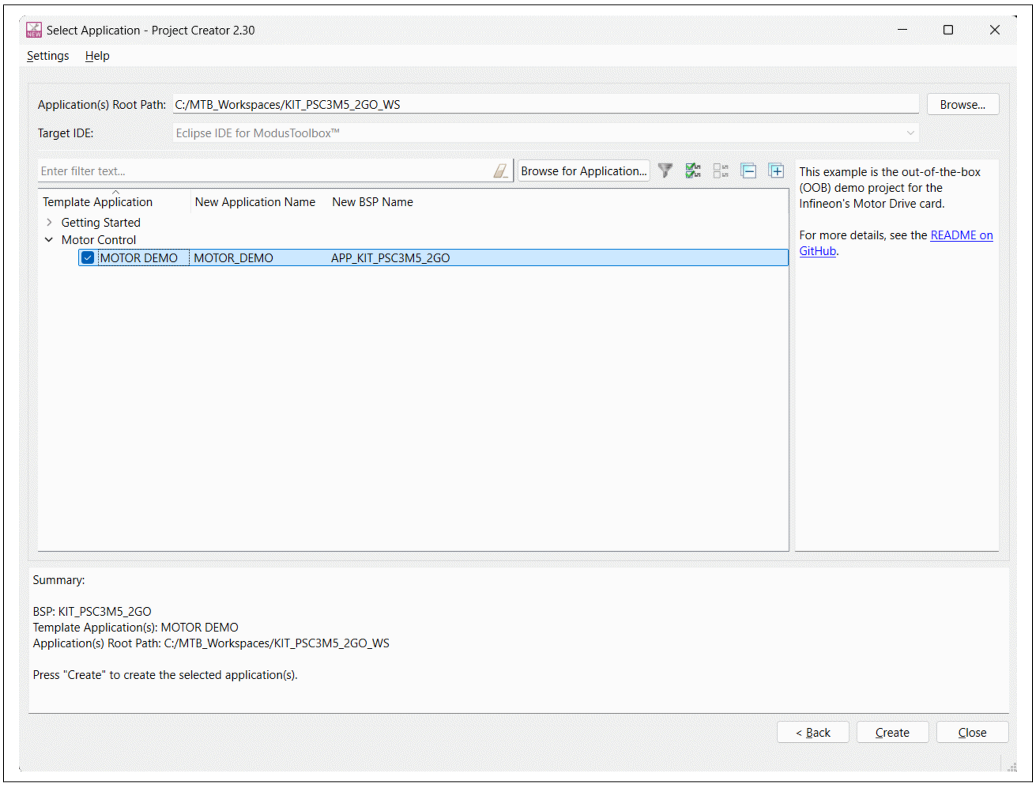

Figure 10 Select application

4. To build and program a PSOC™ Control C3M5 MCU application, follow these steps:
   a. In the **Project Explorer** tab, select **<App_Name>** project
   b. In the **Quick Panel** tab, scroll to the **Launches** section and click the **<App_Name> Program** (J-Link) configuration

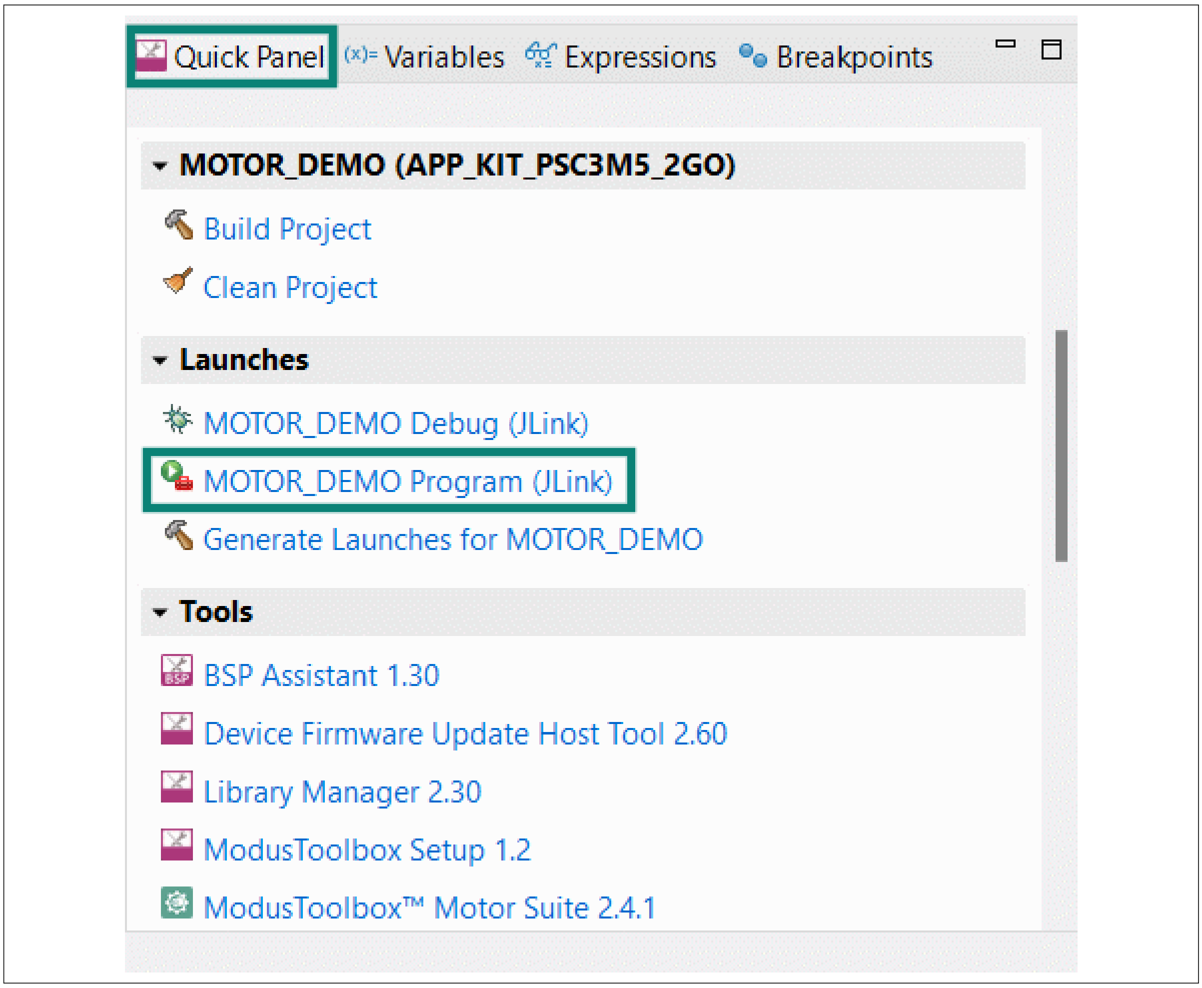

Figure 11 Programming in ModusToolbox™

5. ModusToolbox™ has an integrated debugger. To debug a PSOC™ Control C3M5 MCU application, follow these steps:
   a. In the **Project Explorer** tab, select **<App_Name>** project
   b. In the **Quick Panel** tab, scroll to the **Launches** section and click the **<App_Name> Debug** (J-Link) configuration

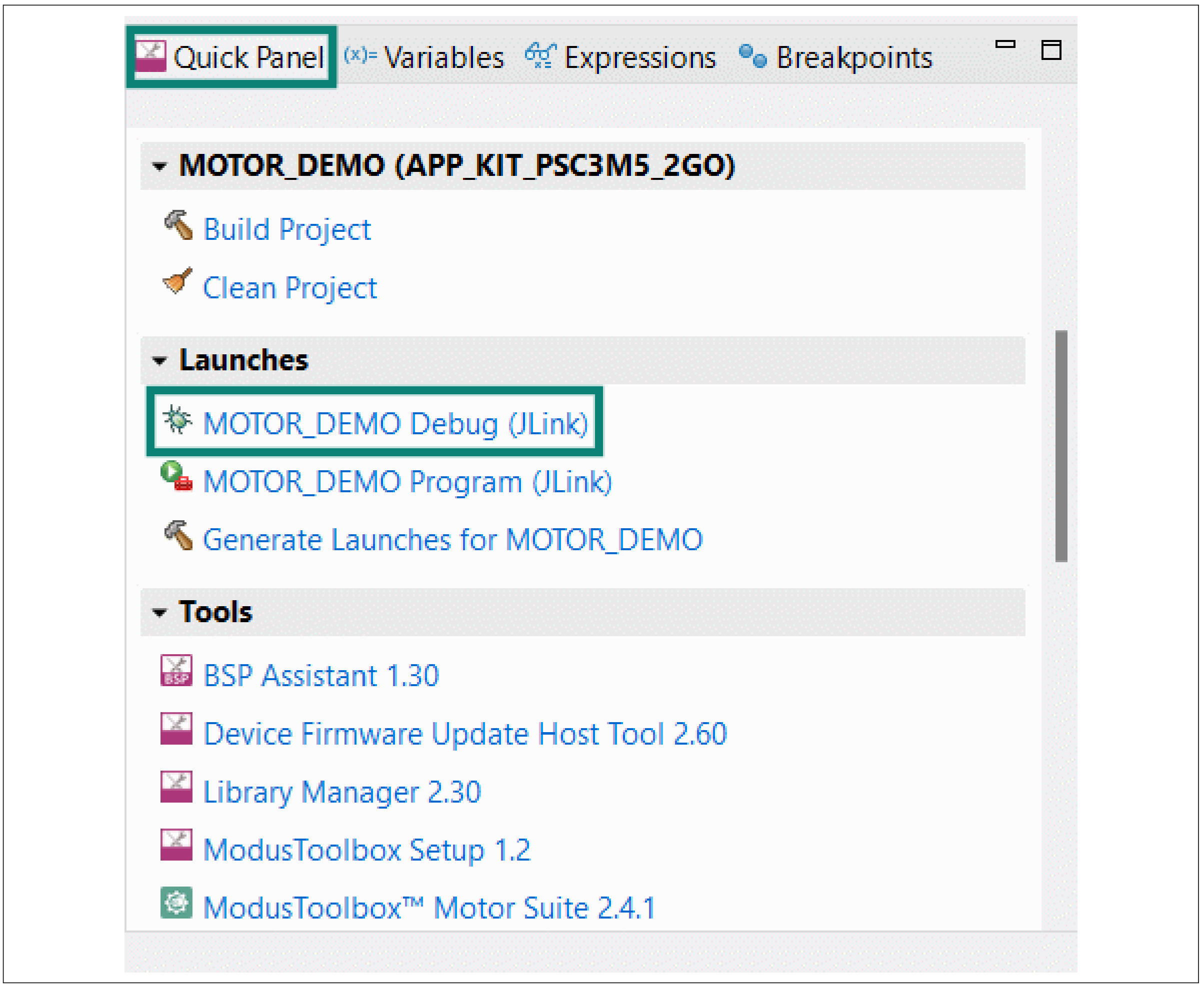

Figure 12 Debugging in ModusToolbox™

For a detailed explanation on how to debug using ModusToolbox™, see the 'Program and debug' section in the Eclipse IDE for ModusToolbox™ user guide.

3 Hardware

The hardware section provides details about the design document and how every block in the hardware is designed.

This section details each schematic block in the design. The user may have to rework the hardware in a few of the cases where provisions are given but components on the board are not populated by default.

Rework instructions are given in this section, and for any component manufacturer part number, refer to the kit PCBA bill of materials on the kit webpage.

3.1 Schematics

The PSOC™ Control C3M5 Compact Kit is built around the PSC3M5 MCU. The following section describes the block diagram of the PSC3 device and peripherals on the board. For more information on device features, see the device datasheet.

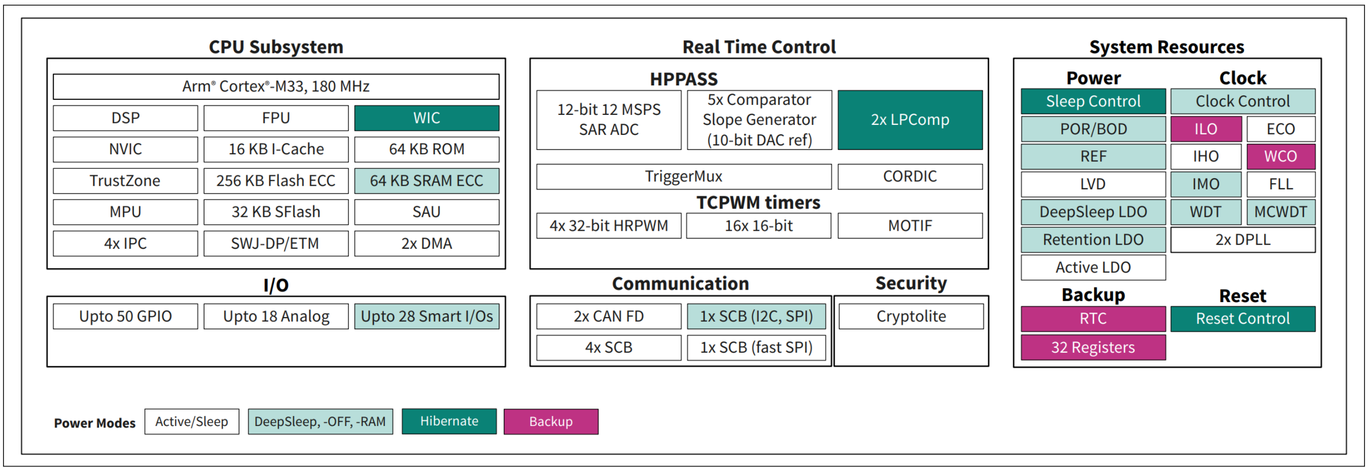

Figure 13 **PSOC™ Control C3M5 device block diagram**

KIT_PSC3M5_2GO block diagram

Figure 14 shows the power supply connections, peripheral interface, and motor connections on the kit.

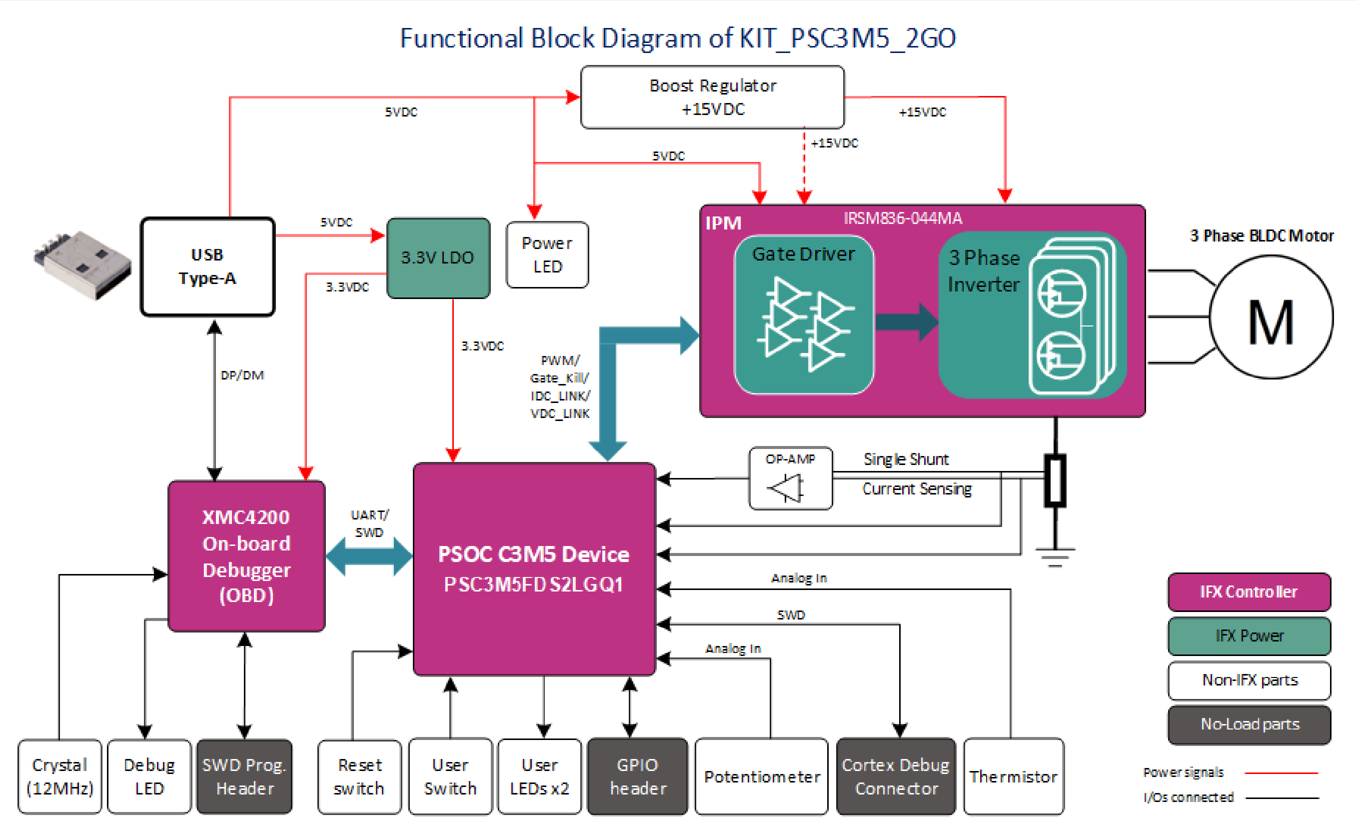

Figure 14 **Functional block diagram**

KIT_PSC3M5_2GO image

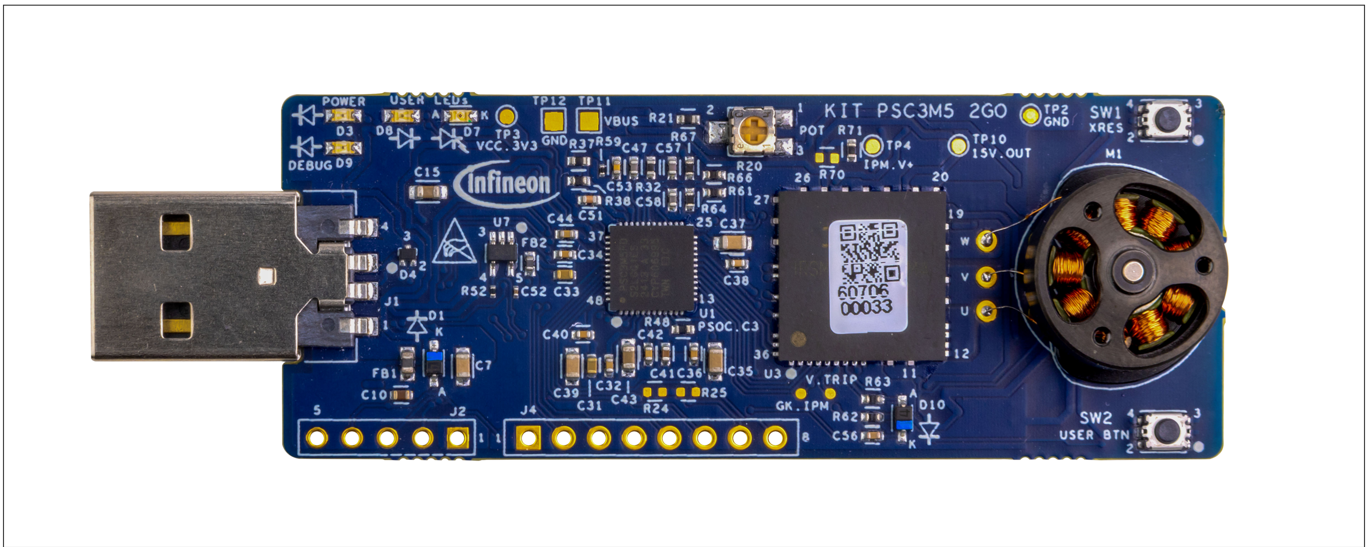

Figure 15 **KIT_PSCM5_2GO board top view**

3.2 Hardware functional description

The PSOC™ Control C3M5 Compact Kit is designed as a plug-and-play device to demonstrate motor spinning applications. The kit is supported in ModusToolbox™ for comprehensive development purposes. With an intuitive graphical user interface, users can effortlessly adjust motor speed and direction in real-time, utilizing PWM control within the application. This user-friendly interface simplifies the development process, allowing designers to focus on creating innovative motor control solutions.

3.2.1 PSOC™ C3M5 MCU (PSC3M5FDS2LGQ1)

PSC3M5FDS2LGQ1 is a PSOC™ C3 family of devices with industrial power and motor applications. The PSC3P5xD and PSC3M5xD devices are based on the Arm® Cortex®-M33 running up to 180 MHz with DSP and FPU capability. In addition to the CPU subsystem, the devices contain advanced real-time control peripherals, such as a high-performance programmable analog subsystem, comparators, advanced timers with high-resolution capability, up to six SCBs, and two CAN FDs for communication. The devices support one active and five low-power modes for managing and reducing power consumption, depending on application requirements.

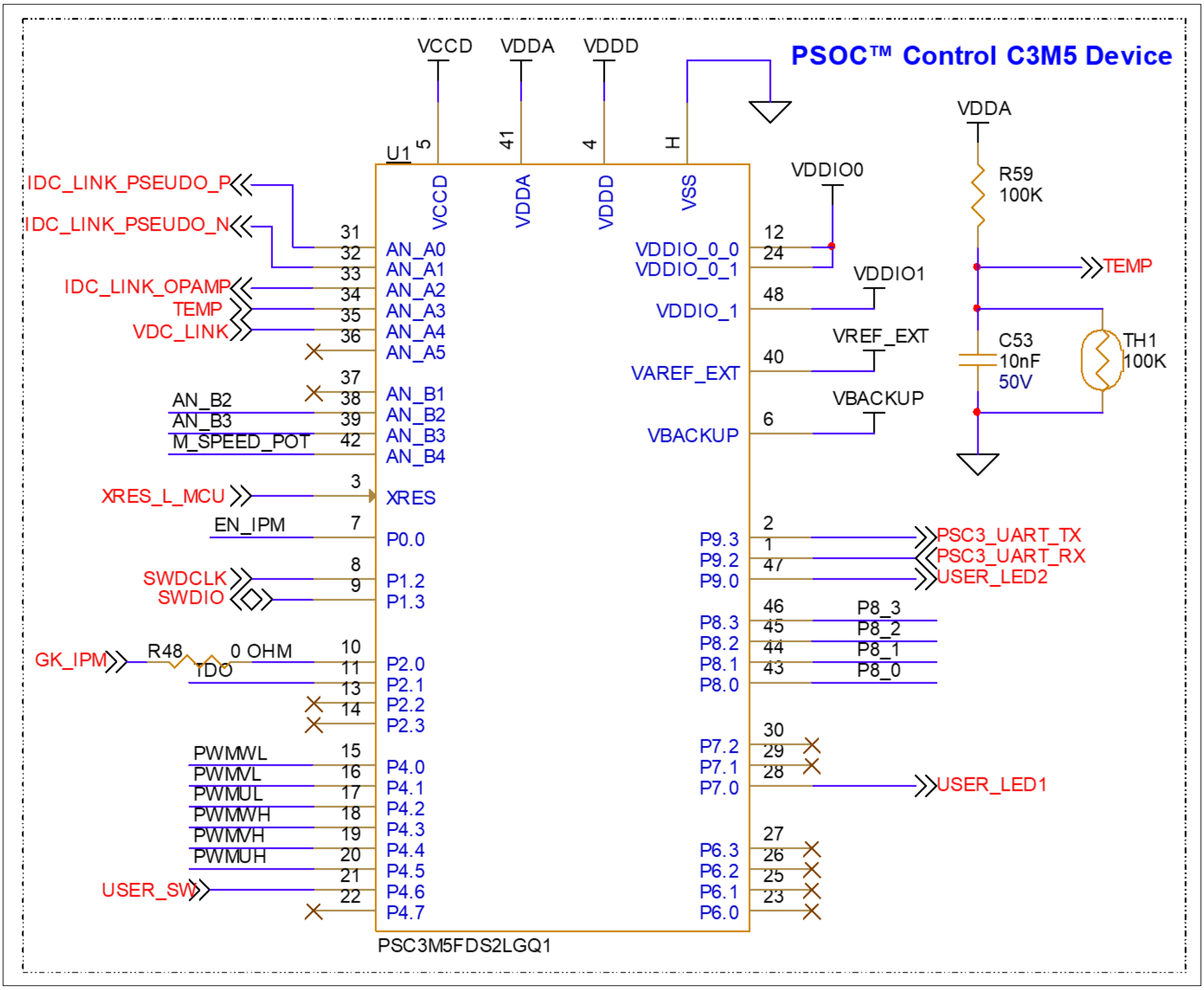

Figure 16 PSOC™ Control C3M5 device design

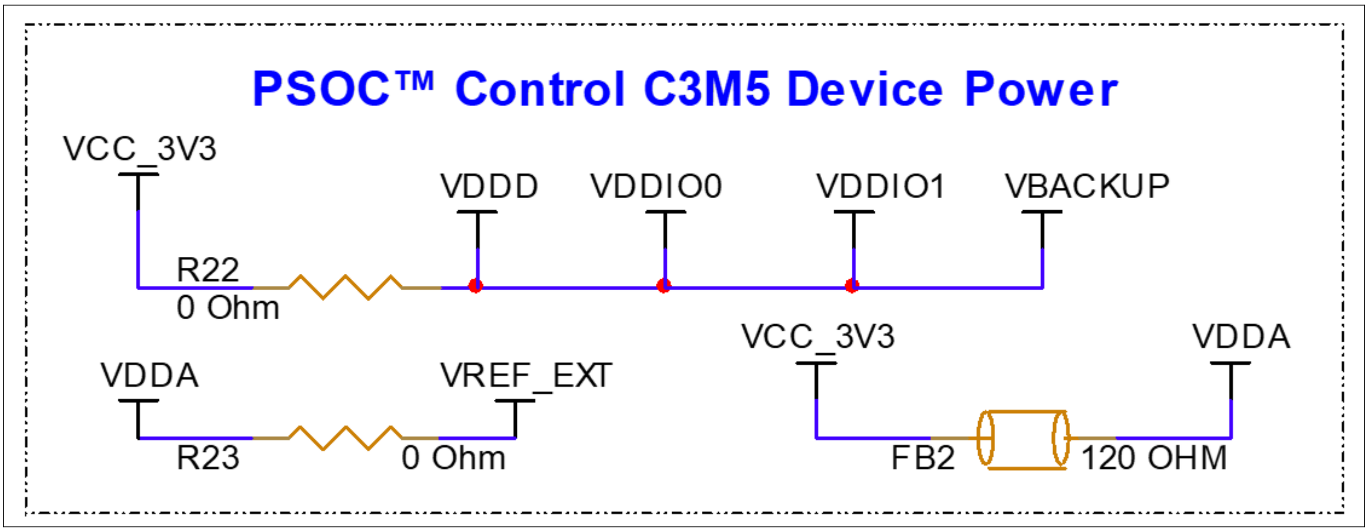

Figure 17 PSOC™ Control C3M5 device power

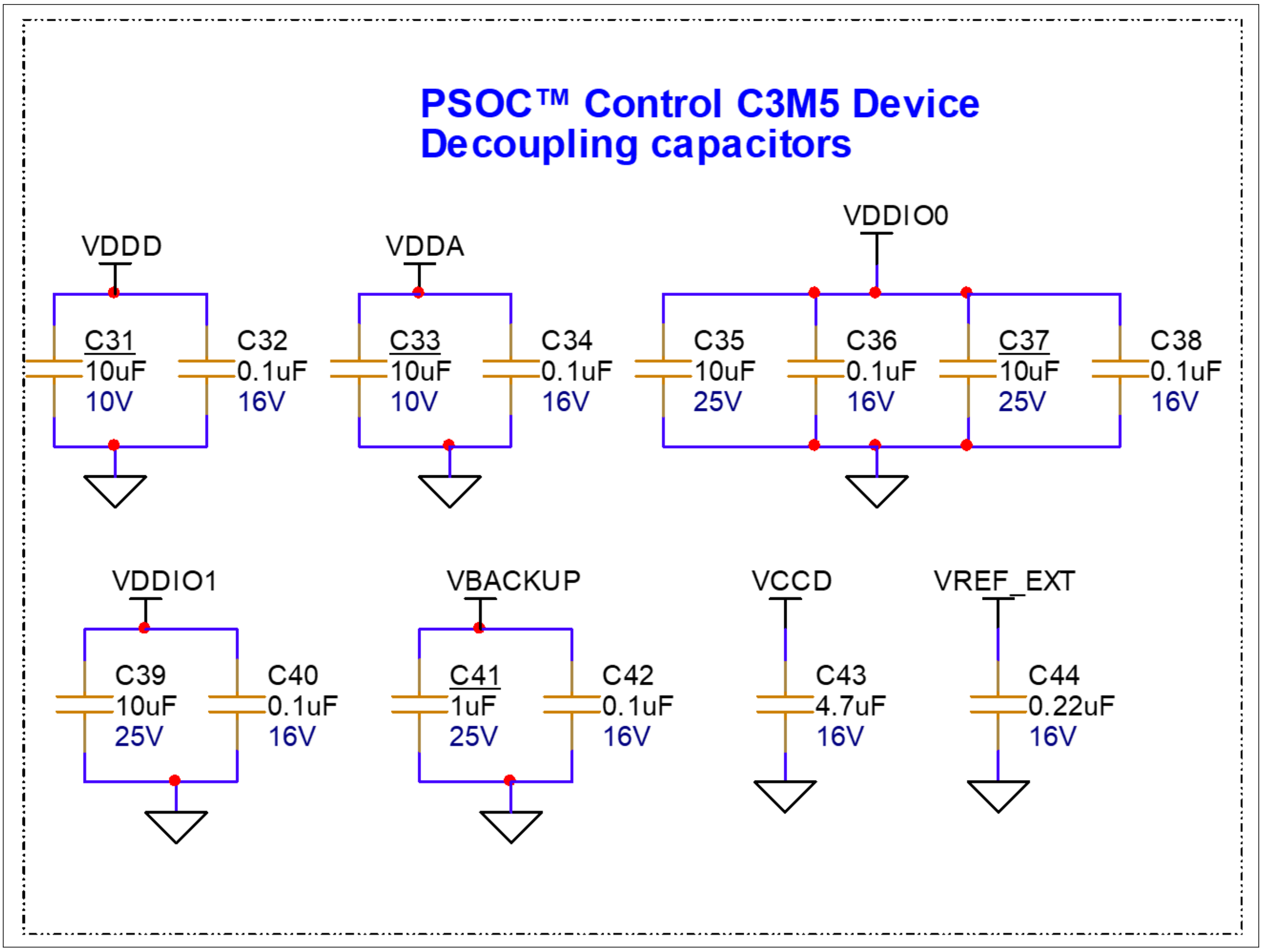

Figure 18 PSOC™ Control C3M5 device decoupling capacitors

3.2.2 XMC4200 based on-board programmer/debugger

XMC4200 is a member of the XMC4000 family, which incorporates a bridge between the USB interface and the PSOC™ Control C3M5 device. XMC4200 is a J-Link programmer and debugger on the board. The USB-SWD and USB-UART interfaces help the user to interact with the hardware by establishing communication between the target device and the test systems while programming and debugging. XMC4200 is preloaded with application-specific firmware to support SWD and UART communications on the kit.

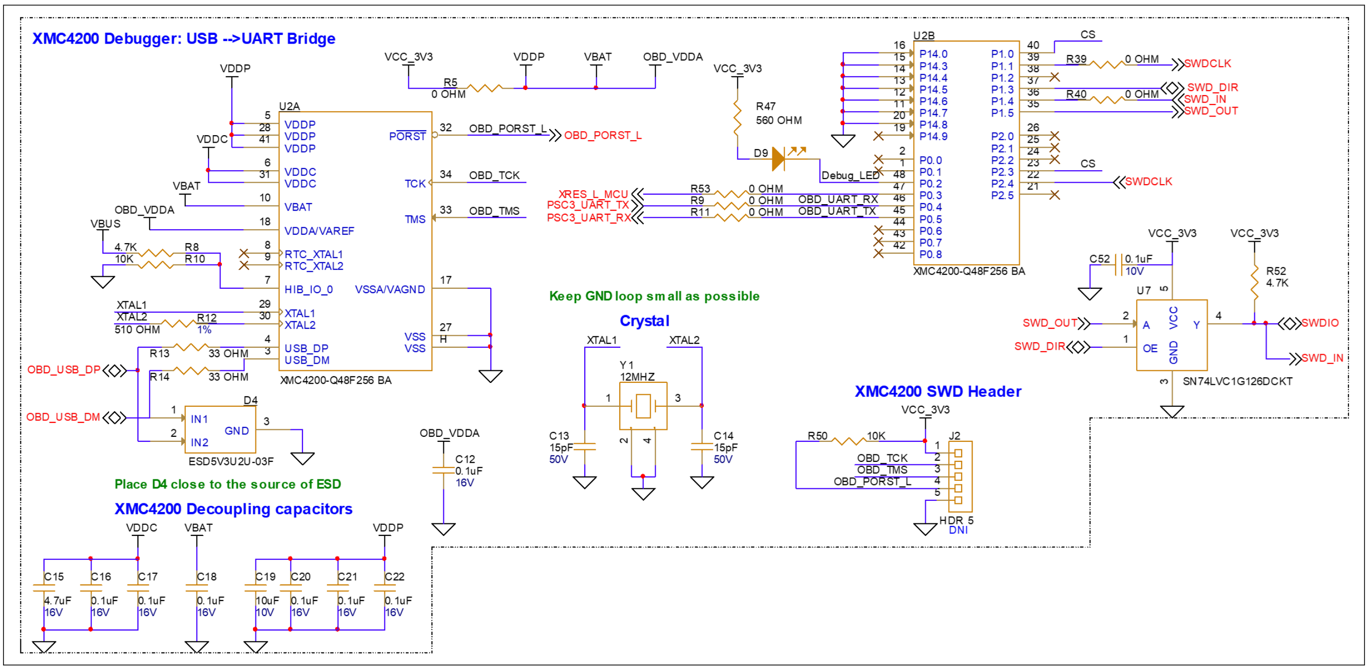

Figure 19 XMC4200 on-board debugger

3.2.3 Serial interconnection between XMC4200 and PSOC™ C3M5 MCU

The XMC4200 device works as a USB-UART bridge on the board, providing UART communication between the target MCU and the test PC.

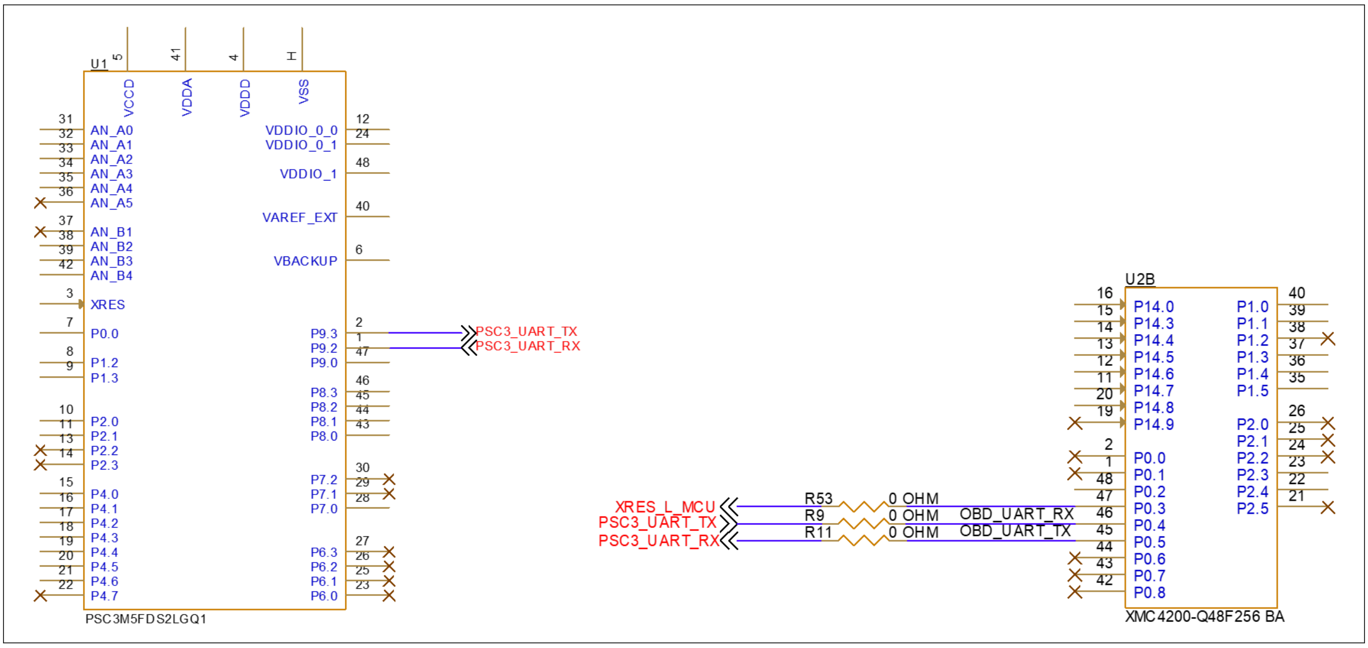

Figure 20 UART interface between XMC4200 and PSC3M5 device

3.2.4 Power supply system

External power through USB is the source of power on the kit. There are two fixed power rails running on the board.

A fixed 3.3 V will be generated from a linear voltage regulator, which uses VBUS (USB-5 V) as input and generates a 3.3 V output for PSOC™ Control C3 device, XMC4200 debugger, and other peripherals.

A boost regulator is used on the kit to generate 15 V output from a 5 V USB input. The IPM module inverter circuitry requires 15 V input to operate.

3.2.4.1 Voltage regulators and reverse voltage protection

The linear regulator TLS208D1EJV33XUMA1 from Infineon is designed to generate a fixed 3.3 V output from VBUS. This LDO has internal protection for overcurrent (>800 mA), short circuit protection, and an overtemperature protection feature.

An adjustable boost switching regulator MIC2250-1YD5-TR is used on the kit, generating the 15 V output required for IPM inverter circuitry. The regulator must have a built-in soft start to avoid any inrush and prevent output voltage overshoot.

TVS diodes are included at the output of both USB and the boost regulator circuit to prevent any kind of damage to the input/source supply from reverse supply of voltage.

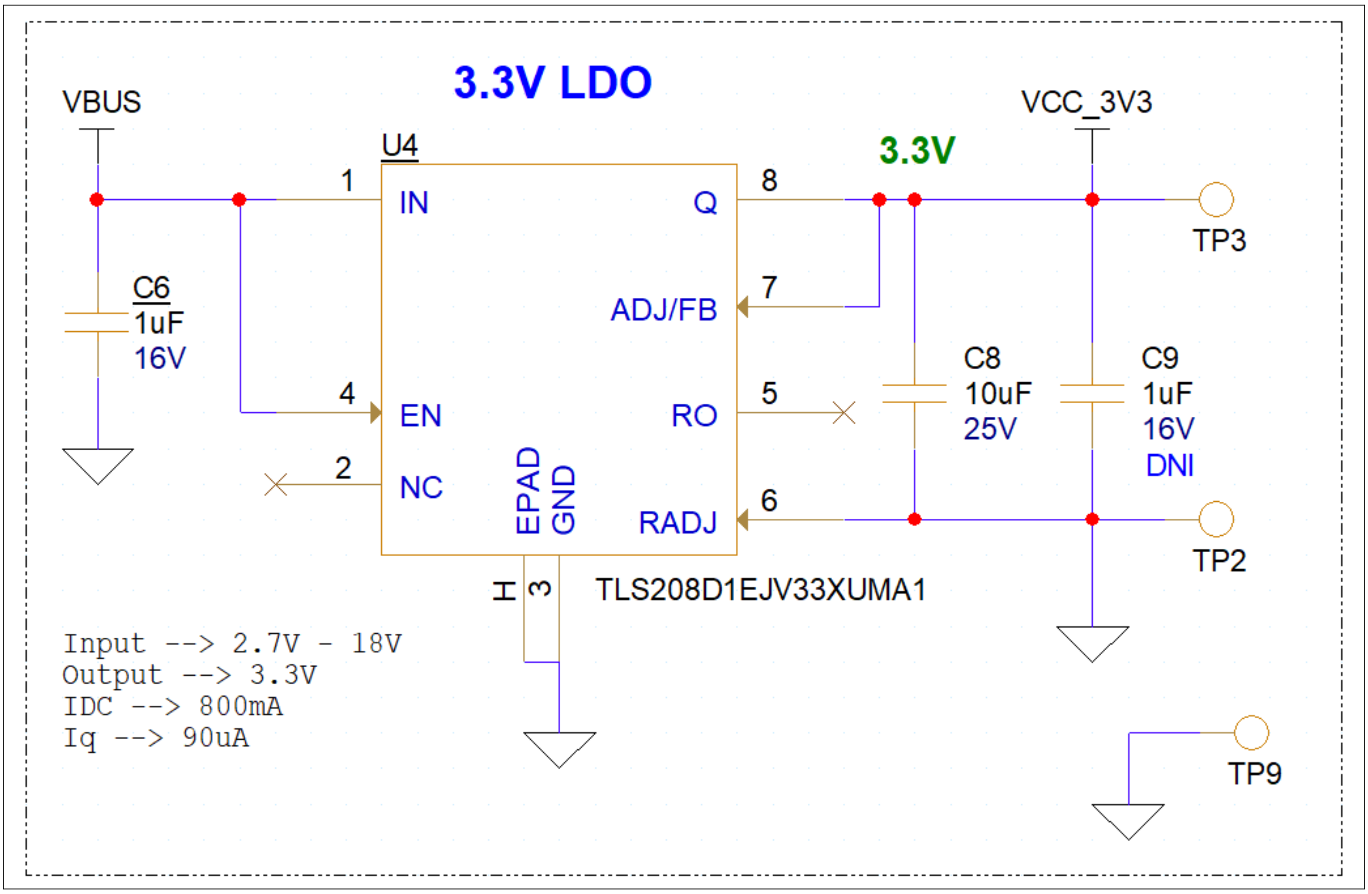

Figure 21 **3.3V LDO**

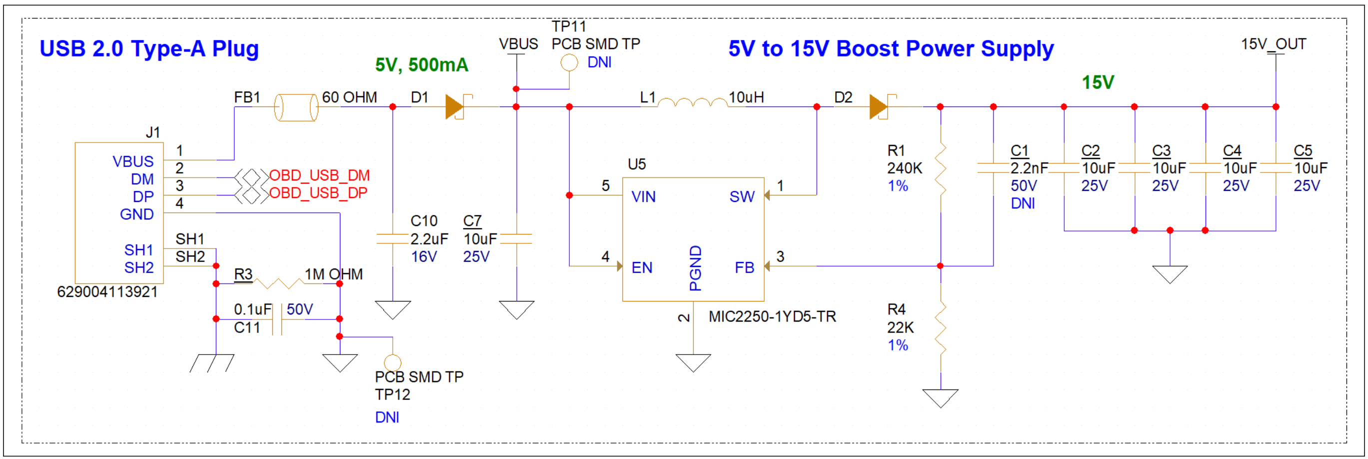

Figure 22 VBUS supply and 15V boost regulator

3.2.5 I/O headers

A GPIO header on the kit allows the user to use interfaces such as UART, I2C, or SPI from external boards or sensors.

Provision is given to populate an 8-pin header from which the user will be able to communicate from the PSOC™ Control C3M5 device to any externally connected device or sensor interface. The default configuration does not populate connector J4, so the user needs to populate it themselves. For connector details, refer to the PCBA BOM for the kit available on the kit webpage.

The connector J4 has a provision to communicate with external devices or sensors using the I2C, UART, or SPI interface. Table 7 provides the pin assignment for the specific communication interface. In case of using I2C communication, while there are no pull-up options available in the external interface connected, the user needs to have pull-up resistors (R24 and R25) populated on the board.

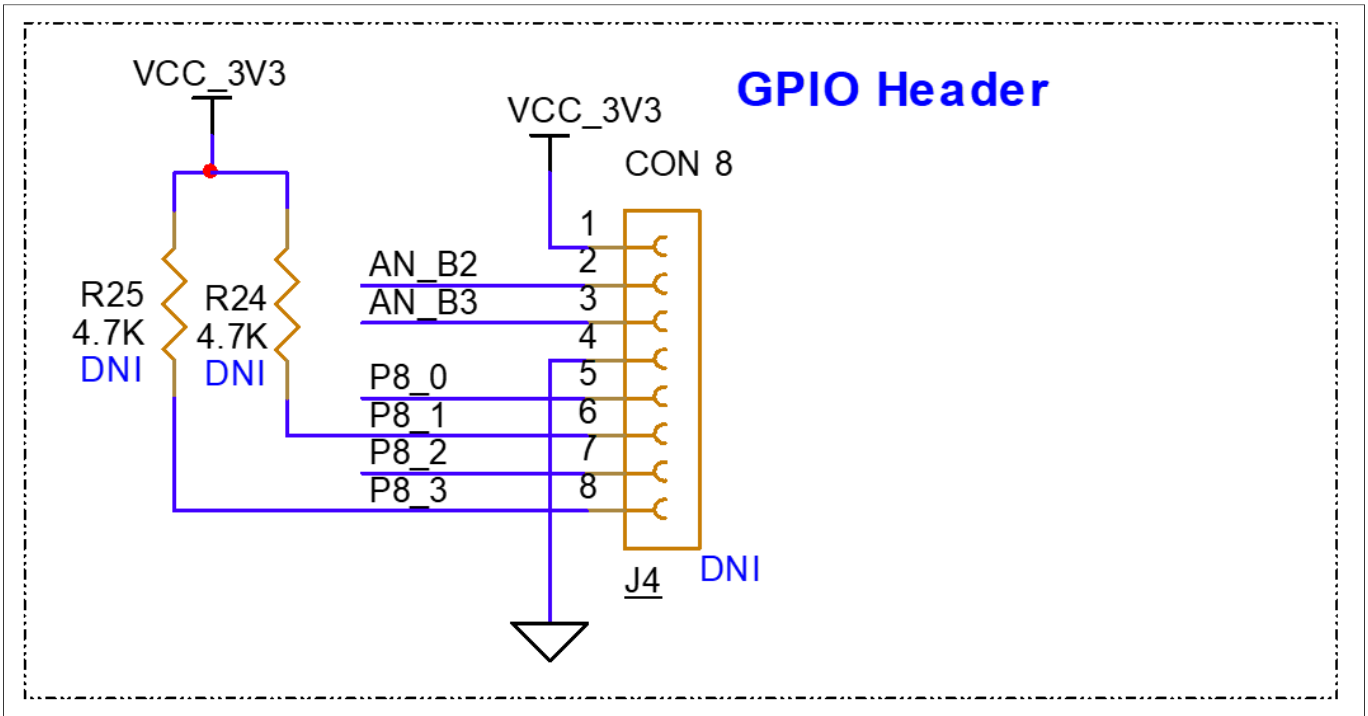

Figure 23 GPIO header

Table 7 Pin assignment details

Pin	I2C	UART	SPI
P8.0			CS
P8.1	SCL	RX	MOSI
P8.2			MISO
P8.3	SDA	TX	CLK

3.2.6 IPM motor driver module operation

Intelligent Power Module IRSM83044 device is used on the board as an integrated power module for motor control applications. IPM is integrated with inverter circuitry and the gate drivers for motor control applications.

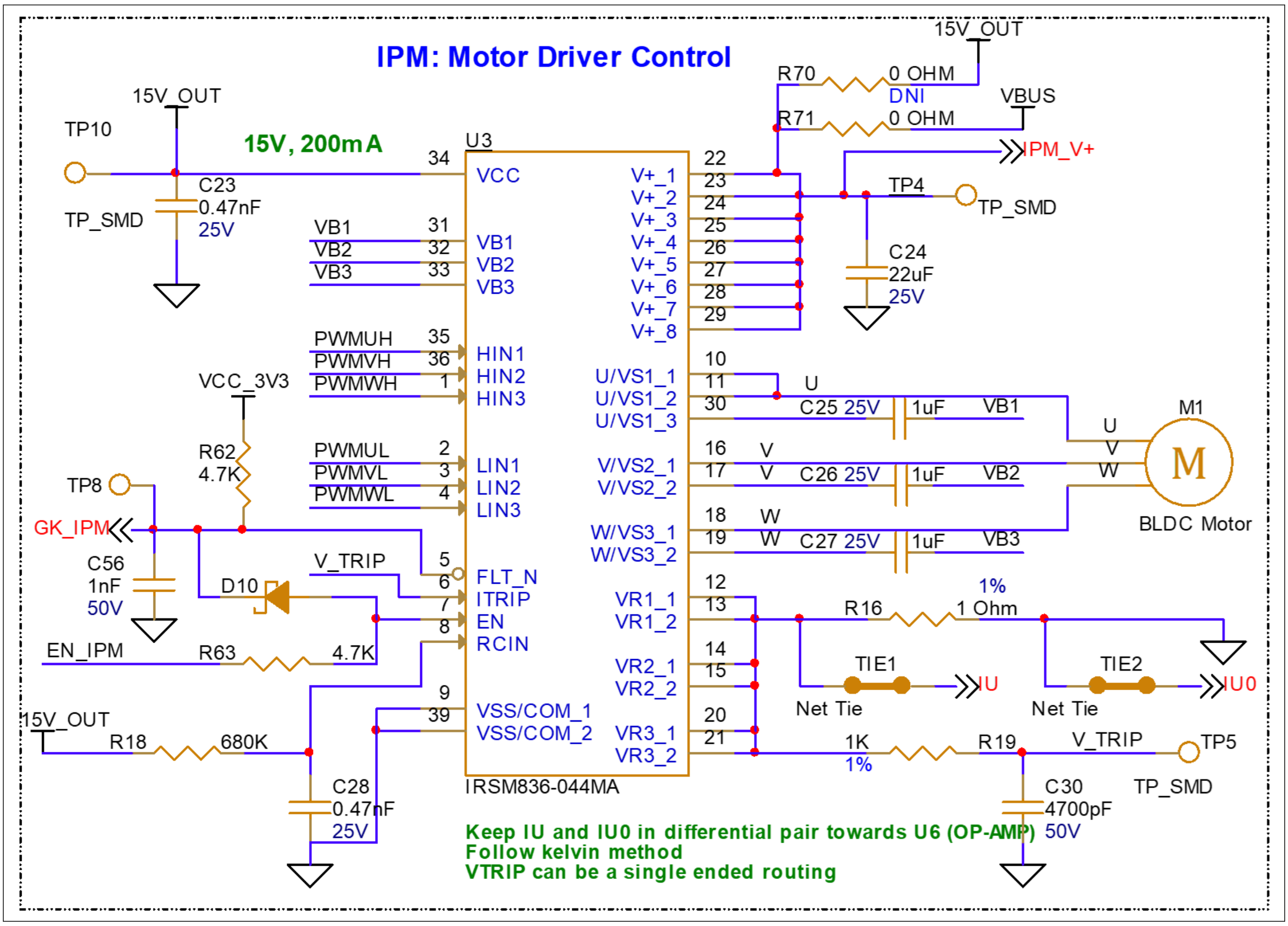

Figure 24 Intelligent Power Module (IPM)

3.2.7 Potentiometer

A potentiometer is used for speed control applications. The PSOC™ C3 device will be used to control the speed of the motor based on potentiometer input in standalone application. Speed control can also be controlled from the ModusToolbox™ Motor Suite application.

***Note**: Do not overstress the potentiometer while adjusting the motor speed. Over force applied on rotary control of potentiometer may cause permanent damage to the component.*

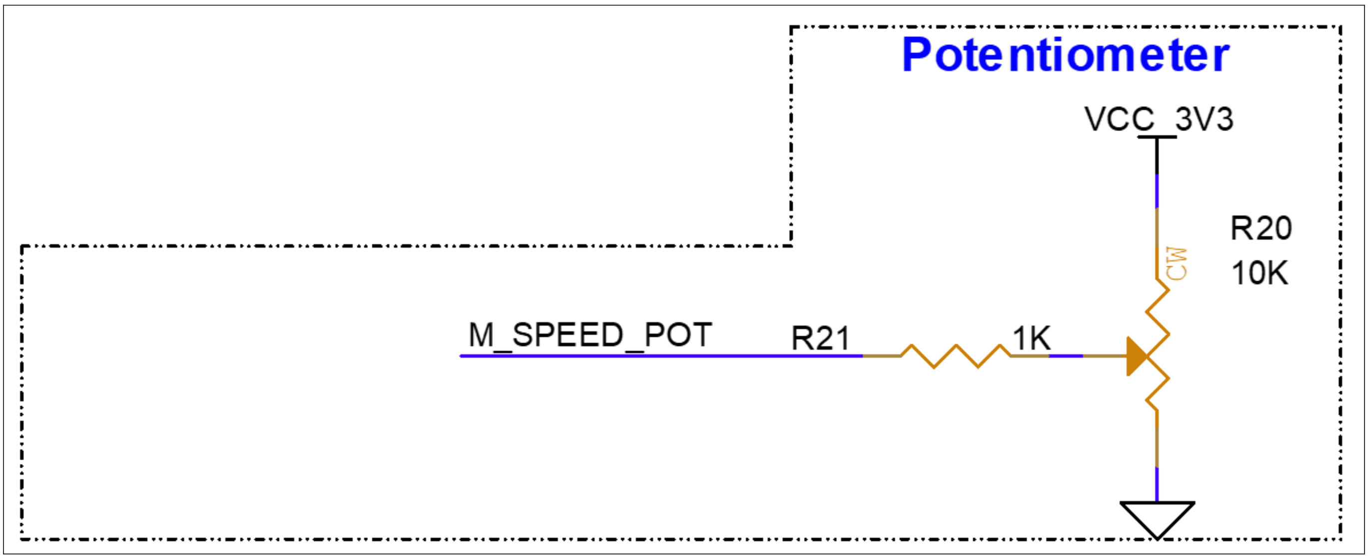

Figure 25 Potentiometer

3.2.8 LEDs

Power LED

The Power LED will glow once the board is powered using USB. LED is connected to the VBUS supply of the USB input.

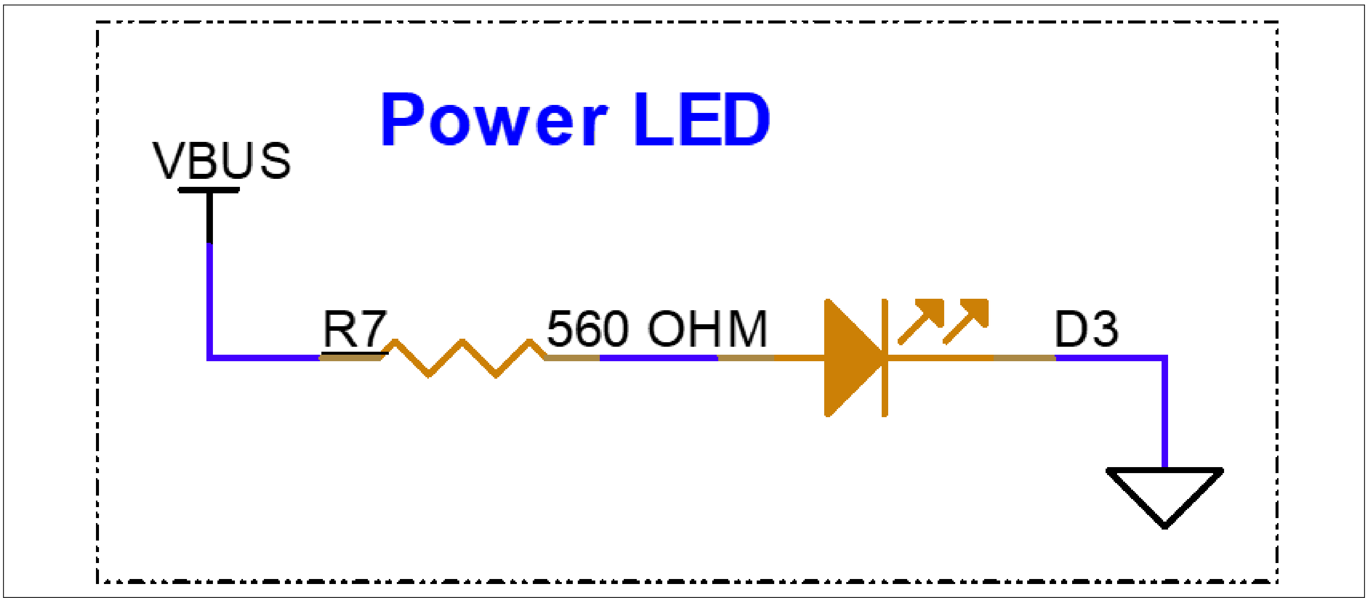

Figure 26 Power LED

Debug LED

An LED connected to the XMC4200 to denote debug status: whenever the user undergoes debug mode and transmits or receives any data from the USB bridge using SWD, LED D9 will show the status by blinking based on live communication.

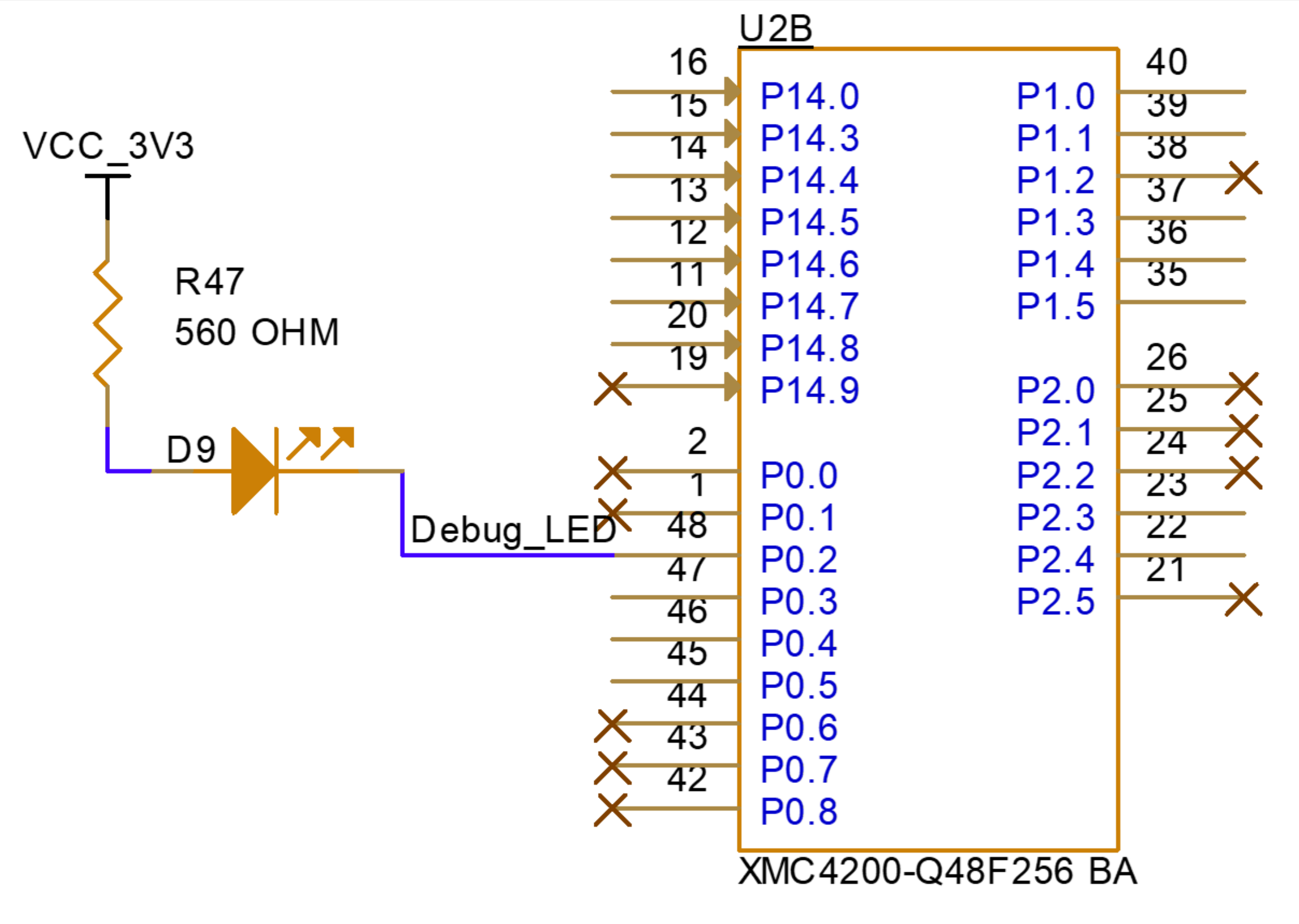

Figure 27 **Debug LED**

User LEDs

The compact kit will have two user LEDs connected to free IOs. The user can utilize these LEDs for any indication purpose based on the user-specific application.

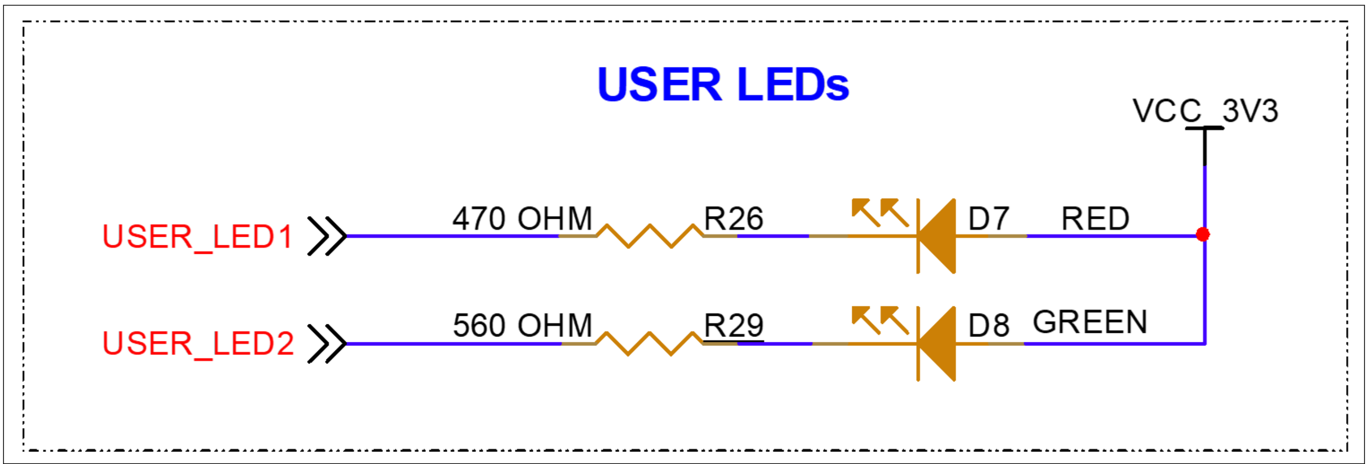

Figure 28 **User LEDs**

3.2.9 Reset and user buttons

User button

The user button (SW2) is provided for user application purpose. P4.6 from the PSOC™ C3 device is connected to SW2. Default program loaded on the kit shall use SW2 for direction control of the motor while operating in standalone mode. Upon pressing SW2 motor changes its direction from clockwise to counter clock wise direction and vise versa. A LED indication is provided for per-programmed application which denotes direction of the motor based on SW2 control.

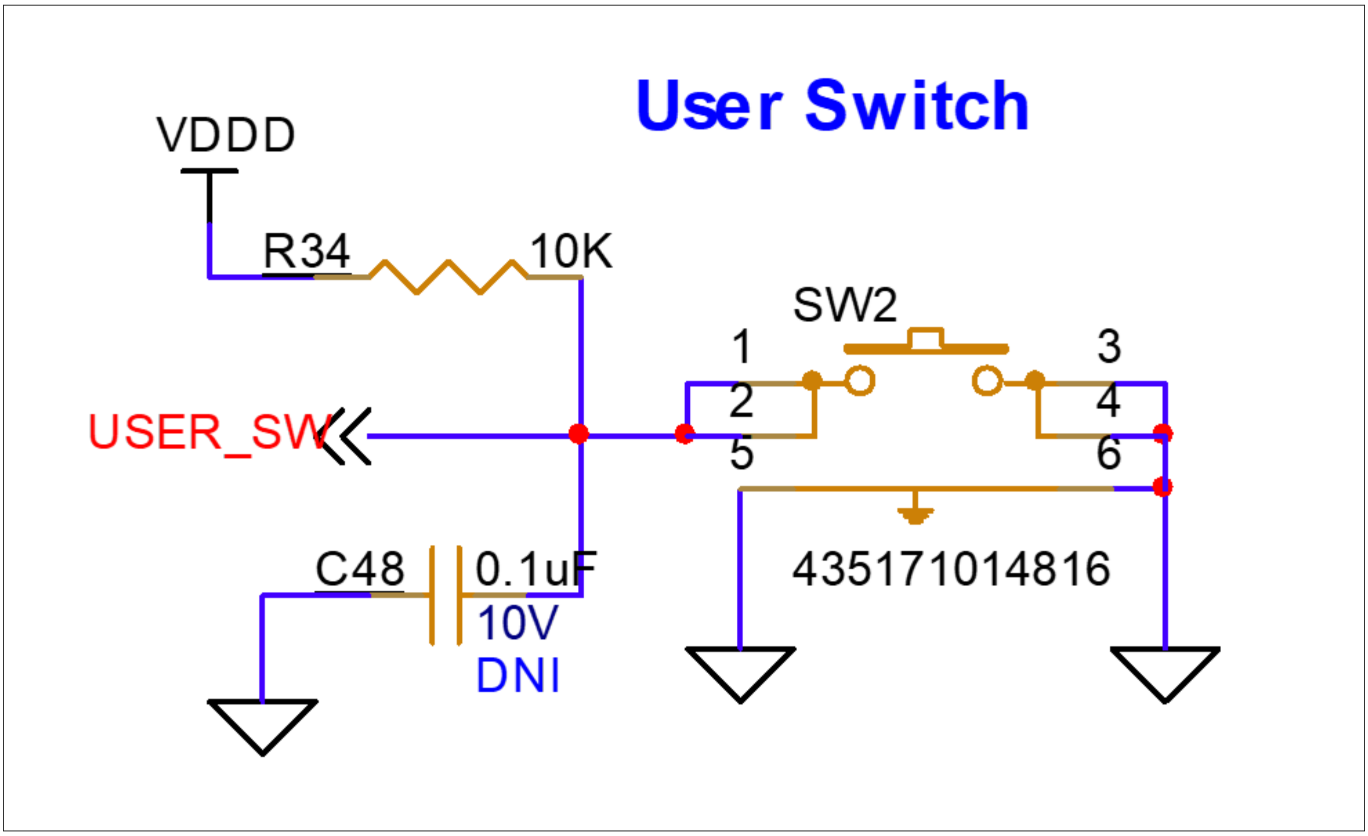

Figure 29 **User switch**

Reset switch

A hardware reset can be obtained from the reset switch. The PSOC™ C3 MCU must reset upon pressing this switch. Motor Suit application would break the connectivity from the board upon pressing SW1. Motor shall still continue to run in standalone mode. User required to reconnect the hardware to operate from motor suit GUI application.

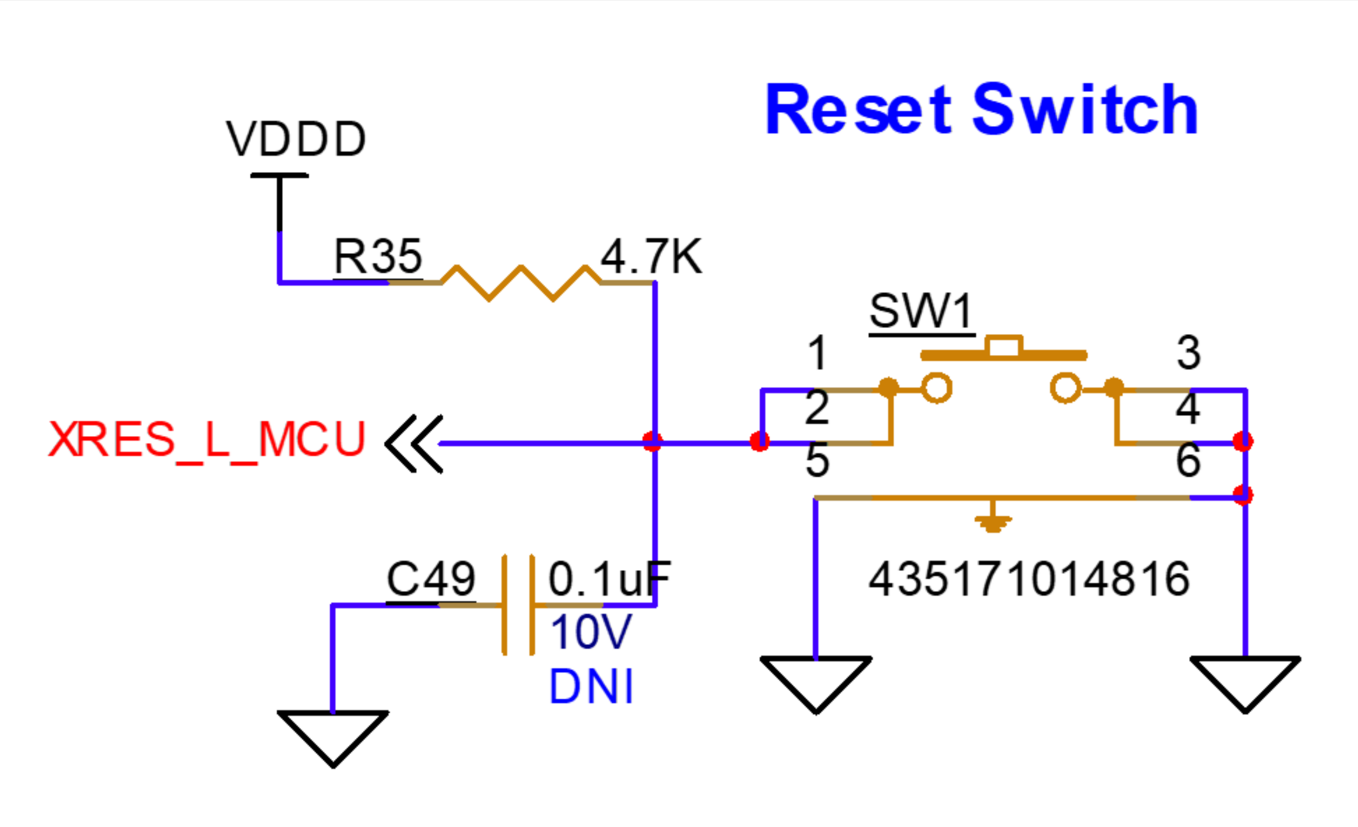

Figure 30 Reset switch

3.2.10 OP_AMP for single shunt FOC

Single Shunt FOC Operation

Motor control application on this kit is based on a low-side single shunt current sensing method. A 1 Ω shunt resistor is connected on the LOW side FET of the IPM module. All three phases are tied to a single shunt resistor, and it operates in single shunt FOC mode. As a current sensing operation, an external op-amp is used to get appropriate gain on the PSOC™ Control C3 device. The output of the op-amp (IDC_LINK) is given to the PSOC™ Control C3 device ADC for further processing and motor control applications.

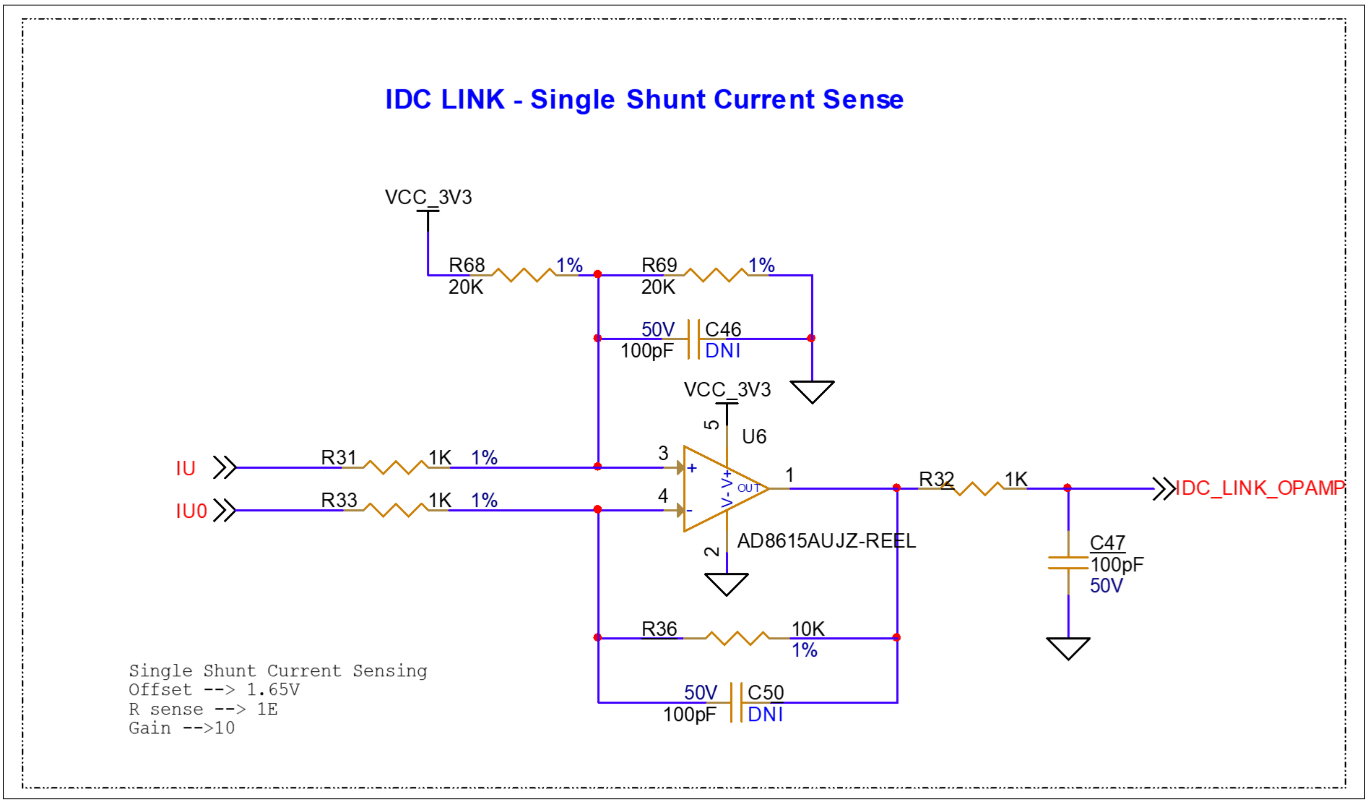

Figure 31 Single Shunt FOC using external op-amp

Pseudo differential mode

Apart from the external op-amp, provision is given on the board for the pseudo differential mode of operation, which will isolate the op-amp circuitry. The shunt measurement is directly given to the two different ports of the PSOC™ control C3 device. Two ADC signals must be processed further for internal gain control and current sensing applications for motor control operation.

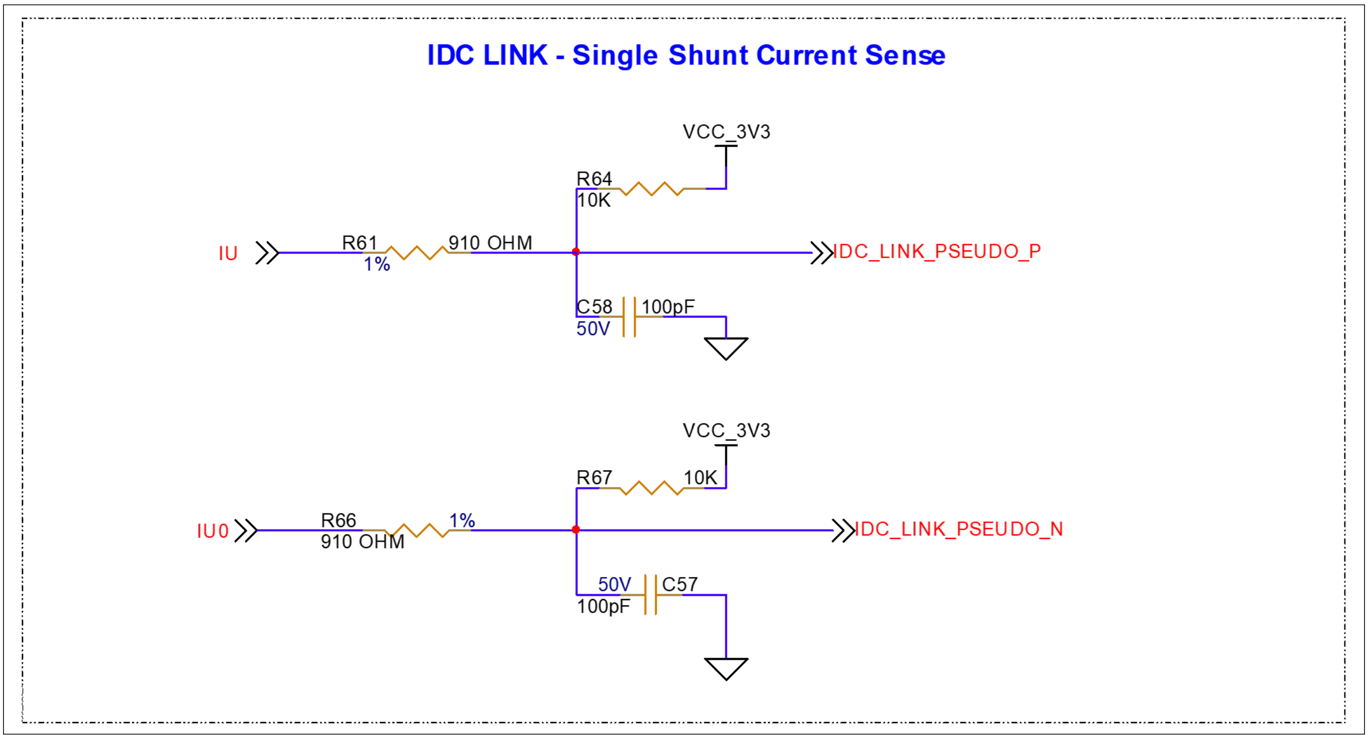

Figure 32 Single shunt FOC using pseudo differential method

3.2.11 Crystal oscillators

A 12 MHz crystal is used as an external clock source for the XMC4200 on-board debugger. The XTAL1 and XTAL2 pins of the XMC4200 are connected to the external crystal operation.

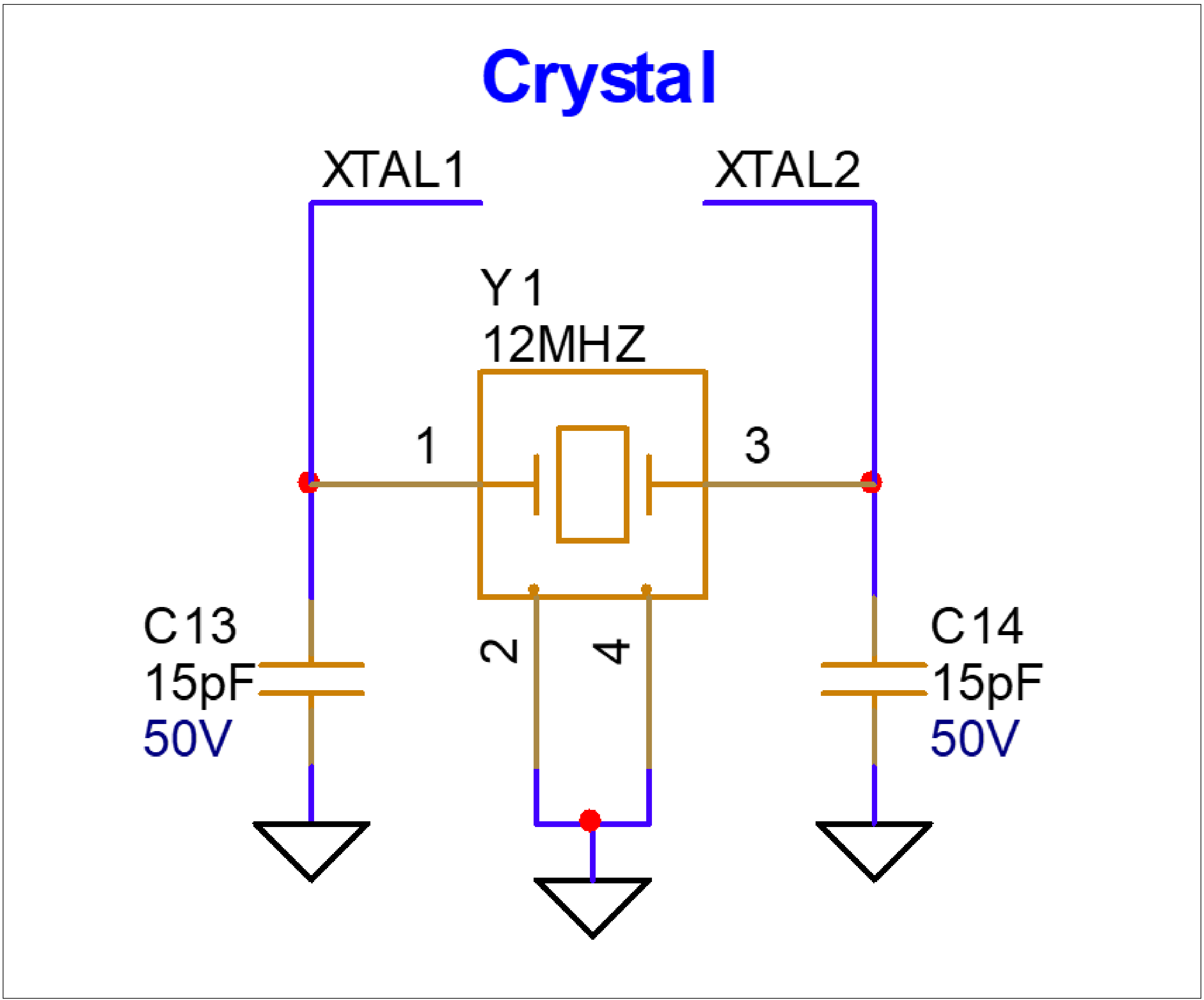

Figure 33 **Crystal for XMC4200 on-board debugger**

3.2.12 PSOC™ C3M5 MCU 10-pin SWD header (Cortex® debug header)

Provision for a 10-pin Cortex® standard debug connector is given on the board (only a footprint). External debuggers such as Segger J-Link can be connected to the header for debug and programming purposes. Only the SWD interface is enabled on the board. The JTAG function is not supported on the board.

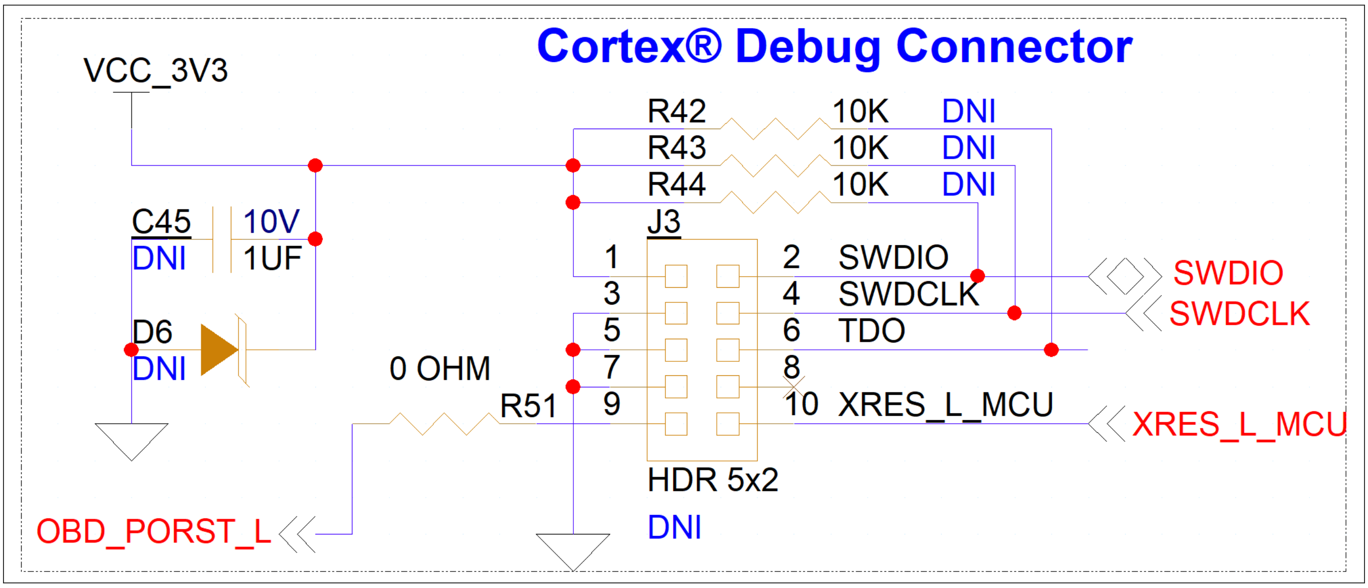

Figure 34 **Cortex® debug connector**

3.3 PSOC™ C3M5 Board rework

The PSOC™ Control C3M5 Compact Kit has the majority of the components assembled on the board for a specific functionality. In a few cases where the component is not loaded on the board (only the footprint is available), the user needs to have particular rework done on the board based on the requirement. Based on the reference designator defined in the schematic design, the user can populate the required component on the board. For manufacturer details of the component, refer to the PCBA bill of material available for the kit on the webpage.

3.3.1 Rework on 10-pin SWD connector

10-pin Cortex® debug connector rework

To connect external debuggers to the board, KIT_PSC3M5_2GO need to be assembled with 10-pin connector (J3) suitable with the footprint provisioned.

Preferred part: FTSH-105-01-L-DV-K

User is expected to assemble discrete components to enable the hardware, such as resistors R42, R43, and R44 also input bypass capacitor C45 and diode D6 to avoid damage from voltage surges causing from external emulators.

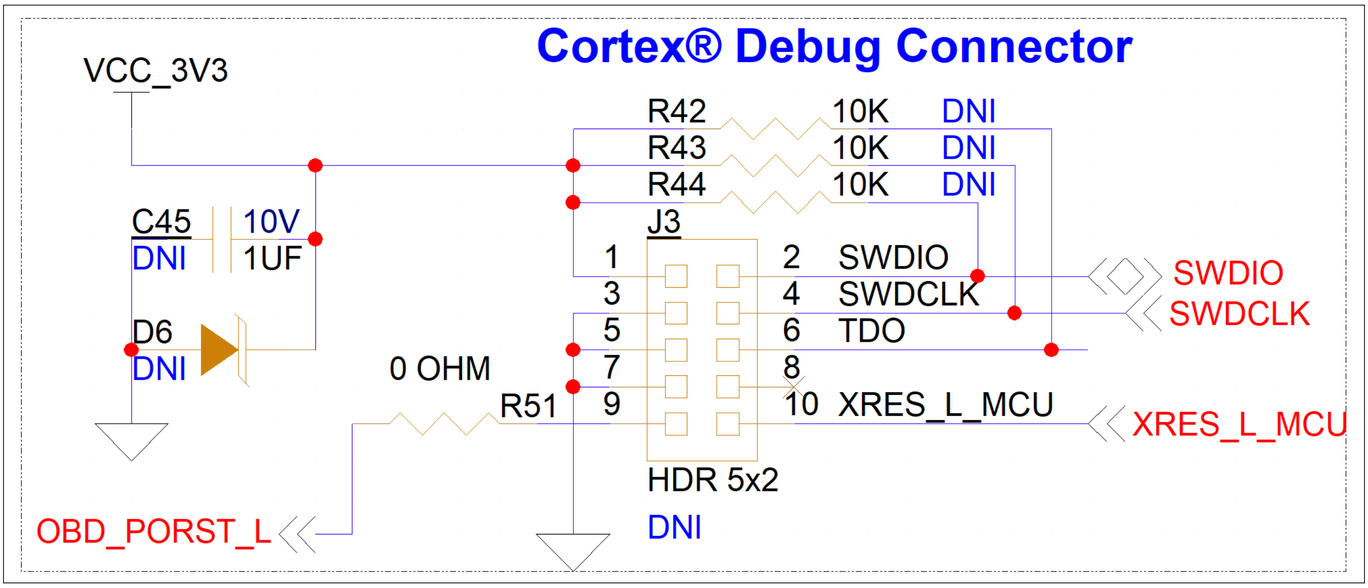

Figure 35 **Rework details for Cortex® debug connector**

3.4 Bill of Materials

Refer to the Printed Circuit Board Assembly Bill of Materials (PCBA BOM) file available on the kit webpage

Revision history

Document revision	Date of release	Description of changes
**	2025-04-28	Initial release
*A	2025-07-25	Updated Board details Updated Out-of-box: Standalone operation

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Edition 2025-07-25

Published by

Infineon Technologies AG

81726 Munich, Germany

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Document reference
IFX-vil1715239524416