EVAL_PMG1_S1_DRP Evaluation Kit user guide

About this document

Scope and purpose

The EVAL_PMG1_S1_DRP kit is an evaluation kit for USB Power Delivery dual role port (DRP) applications using the EZ-PD™ PMG1-S1 (Power Delivery Microcontroller Gen1) MCU. EZ-PD™ PMG1 is a family of high-voltage Power Delivery microcontrollers. These chips include the CPU core, Power Delivery controller, and configurable integrated analog and digital peripherals. The EZ-PD™ PMG1 MCU is targeted for any embedded system that powers from a high-voltage USB-C port and needs a microcontroller to control the actions and features of a product.

Intended audience

This document is intended for designers using the EVAL_PMG1_S1_DRP Evaluation Kit (EVK).

Reference Board/Kit

Product(s) embedded on a PCB, with focus on specific applications and defined use cases that can 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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Note: Please note the following warnings regarding the hazards associated with development systems.

Table 1 Safety precautions

	**Caution:** *The EVAL_PMG1_S1_DRP kit is intended for use as an evaluation platform for hardware or software in a laboratory environment. The board is an open-system design, which does not include a shielded enclosure. Due to this reason, the board may cause interference to other electrical or electronic devices in close proximity. In such cases, take adequate preventive measures. Also, do not use this board near any medical equipment or RF devices.*
	**Caution:** *Attaching additional wiring to EVAL_PMG1_S1_DRP kit or modifying the product operation from the factory default may affect its performance and cause interference with other apparatus in the immediate vicinity. If such interference is detected, suitable mitigating measures must be taken.*
	**Caution:** *The components and device surfaces of the EVAL_PMG1_S1_DRP kit may become hot during testing. Hence, necessary precautions are required while handling the board. Failure to comply may cause injury.*
	**Caution:** *EVAL_PMG1_S1_DRP kit 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 EVAL_PMG1_S1_DRP kit 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.*
	**Caution:** *Maximum current that can be consumed by an external load connected to the EVAL_PMG1_S1_DRP kit board cannot exceed 5A.*

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1 Introduction

The EVAL_PMG1_S1_DRP EVK is based on the EZ-PD™ PMG1-S1 MCU, which is part of the EZ-PD™ PMG1 USB-C Power Delivery (PD) MCU portfolio. This EVK is intended to be an evaluation vehicle for customers who want to use EZ-PD™ PMG1-S1 MCU in DRP applications.

A USB-C port configured as DRP can operate either as a power provider or power consumer or may alternate between these two states. Initially, when operating as a power provider, the port takes the data role of a DFP. When it operates as a sink, the port takes the data role of a UFP. However, the port's power role can be dynamically changed using the USB PD message (power role swap).

The EVAL_PMG1_S1_DRP EVK provides customers a complete single solution evaluation platform to quickly develop, test, and kick-start the DRP application designs using the EZ-PD™ PMG1-S1 MCU.

1.1 Key features

The EVAL_PMG1_S1_DRP EVK supports the following key features:

- Support for single-port USB PD 3.1 sink role, source role, or DRP role
- Dual-power operation: USB bus-powered and external power adapter (24 V ± 10%, 5A)
- Compatible with the example projects implemented in ModusToolbox™ software
- Onboard KitProg3 programming and debugging module
- 100 W (20 V/5A) DRP power handling capability
- Standard breadboard-compatible design
- Snap-away design to separate KitProg3 and EZ-PD™ PMG1 MCU board
- Onboard 5 V and 3. 3 V regulator
- Optional 10-pin standard SWD interface for MiniProg4 or third-party programmer/debugger module
- Firmware-controlled LED and user switch
- Debug I/O headers

1.2 Kit contents

- EVAL_PMG1_S1_DRP EVK
- Quick start guide

1.2.1 Hardware not included with the kit

The EVK requires the following items to perform the Kit operation:

- A USB Type-C power adapter that supplies power over the Type-C port
- USB-C cable for connecting the USB Type-C power adapter to the Type-C receptacle on the EVK
- A 24 V/5A DC power supply/adapter for source mode operation (Recommended adapter "CUI Inc. SDM120-24-UD-P5")
- USB Type-C load
- Multimeter and other measurement equipment
- CY4500 EZ-PD™ protocol analyzer

1.3 Getting started

For instruction to run a quick demonstration and observe the kit functionality, see the Kit operation section. Download the documents and the hardware design files for EVK from the kit webpage. The documents include a quick start guide, kit guide (this document), and release notes. The hardware design files include the schematics, bill of materials (BOM), and layout files.

For a summary of the different MCUs available in the EZ-PD™ PMG1 product line, visit the webpage.

The EZ-PD™ PMG1 MCU-based projects are developed using the ModusToolbox™ software development tool.

2 Board details

Figure 1 and Figure 2 show the front and back views of the board with critical components highlighted for the EVAL_PMG1_S1_DRP EVK, which are essential for kit functionality demonstration.

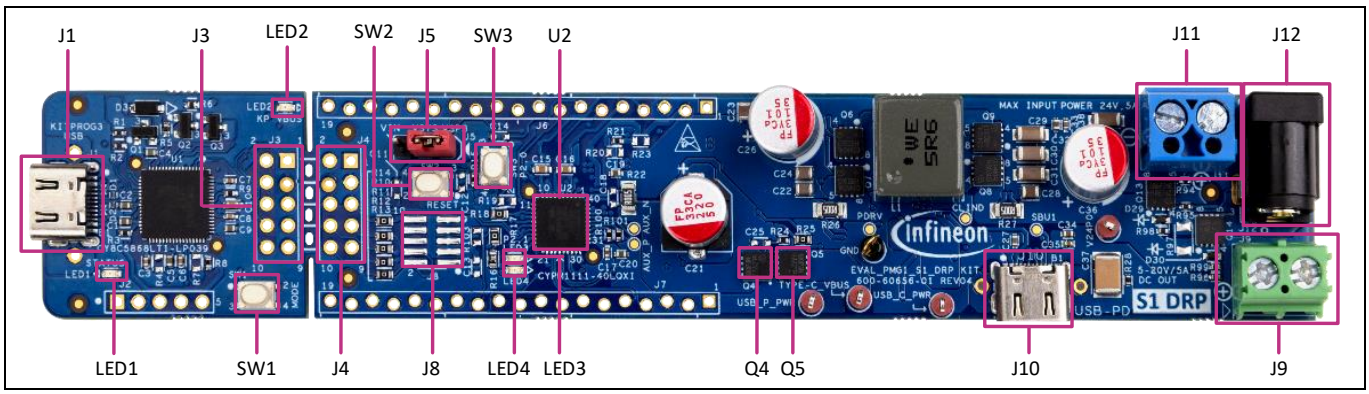


Figure 1 Front view of the board

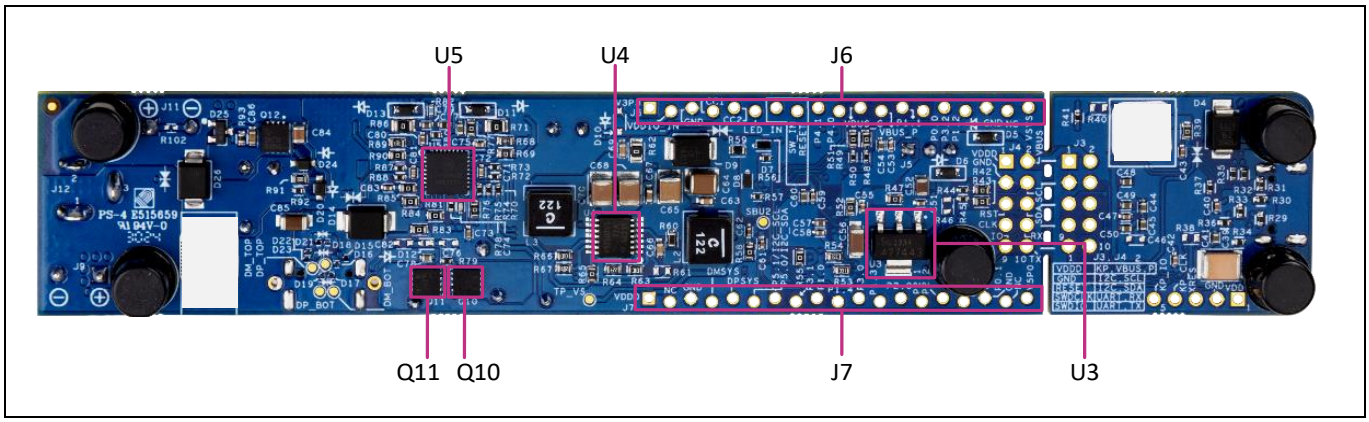


Figure 2 Back view of the board

The following tables list the major components of the EVK. A detailed BOM list is available in the design files on the kit webpage.

Table 2 Jumper settings

REFDES	Component	Default position	Description
J5	Power selection jumper	1-2 (V3P3)	3-pin header to select the EZ-PD™ PMG1-S1 MCU power source (see Power selection jumper)

Board details

Table 3 EVK components

REFDES	Component	Description
U2	EZ-PD™ PMG1-S1 MCU (CYPM1111-40LQXI)	EZ-PD™ PMG1-S1 single-port USB Type-C Power Delivery (PD) high-voltage MCU
Q4, Q5	Provider FETs (BSZ180P03NS3GATMA1)	MOSFET P-CH 30 V 40A TSDSON-8
Q10, Q11	Consumer FETs (BSZ180P03NS3GATMA1)	MOSFET P-CH 30 V 40A TSDSON-8
U5	Buck-boost converter (NCP81599MNTXG)	5 to 20 V DC-DC buck-boost regulator for USB PD source operation
U4	5 V buck converter (TLS4125D0EPV50XUMA1)	5 V buck regulator for system power
U3	3.3 V regulator (TLE42744GSV33HTMA1)	3.3 V low dropout linear voltage regulator for MCU and peripheral power

Table 4 EVK LEDs

REFDES	LED	Color	Description
LED1	KitProg3 status LED	Amber	This LED indicates the programming mode and status. The LED functions only when the KitProg3 USB Type-C port (J1) is connected to the PC. See the KitProg3 user guide for details.
LED2	KitProg3 power LED	Amber	This LED turns on when the kit is powered through the KitProg3 USB Type-C port (J1) and indicates that the PSoC™ 5LP MCU device is powered.
LED3	User LED	Green	This is a firmware-driven LED. The kit must be powered to use this LED.
LED4	Power LED	Green	Indicates that the PMG1-S1 MCU is powered. The LED is powered via VDDIO.

Table 5 EVK switches

REFDES	Switch	Description
SW1	KitProg3 mode switch	Mode switch required to enter the KitProg3 into bootloader mode. See the KitProg3 user guide for details.
SW2	Reset switch	This button is used to reset the EZ-PD™ PMG1-S1 MCU. It connects the EZ-PD™ PMG1-S1 MCU reset (XRES) pin to ground.
SW3	User switch	This button can be used to provide input to the EZ-PD™ PMG1 MCU. By default, this button pulls the pin to the ground.

Board details

Table 6 Connectors and terminal blocks

REFDES	Connector name	Description
J1	KitProg3 USB	Type-C connector to connect the KitProg3 with a PC for EVK programming and debugging
J3	KitProg3 debug header KitProg3 side	10-pin header for connections between KitProg3 and EZ-PD™ PMG1-S1 MCU
J4	KitProg3 debug header EZ-PD™ PMG1-S1 side	10-pin header for connections between KitProg3 and EZ-PD™ PMG1-S1 MCU
J6	I/O header 1	19-pin I/O header for observing and measuring various signals and connecting external modules for development if required
J7	I/O header 2	19-pin I/O header for observing and measuring various signals and connecting external modules for development if required
J8	EZ-PD™ PMG1-S1 SWD header	10-pin SWD header to program the EZ-PD™ PMG1-S1 MCU using MiniProg4 or third-party SWD debuggers/programmers
J9	2-pin output load terminal	2-pin header to connect DC load up to 5A in sink operation
J10	Type-C connector	Type-C receptacle connector for interfacing with Type-C/PD source/sink
J11	2-pin input DC terminal	2-pin header to connect 24 V/5A input power to the kit in source operation. WARNING: Max input should not exceed 24 V ± 10%.
J12	Barrel jack	Barrel jack connector to connect 24 V/5A input power to the kit in source operation. WARNING: Max input should not exceed 24 V ± 10%.

3 EVAL_PMG1_S1_DRP kit system design

This section details the complete system overview and description of the critical circuit blocks of the EVK board design. For more details, see the schematics of the “EVAL_PMG1_S1_DRP” kit board on the kit webpage.

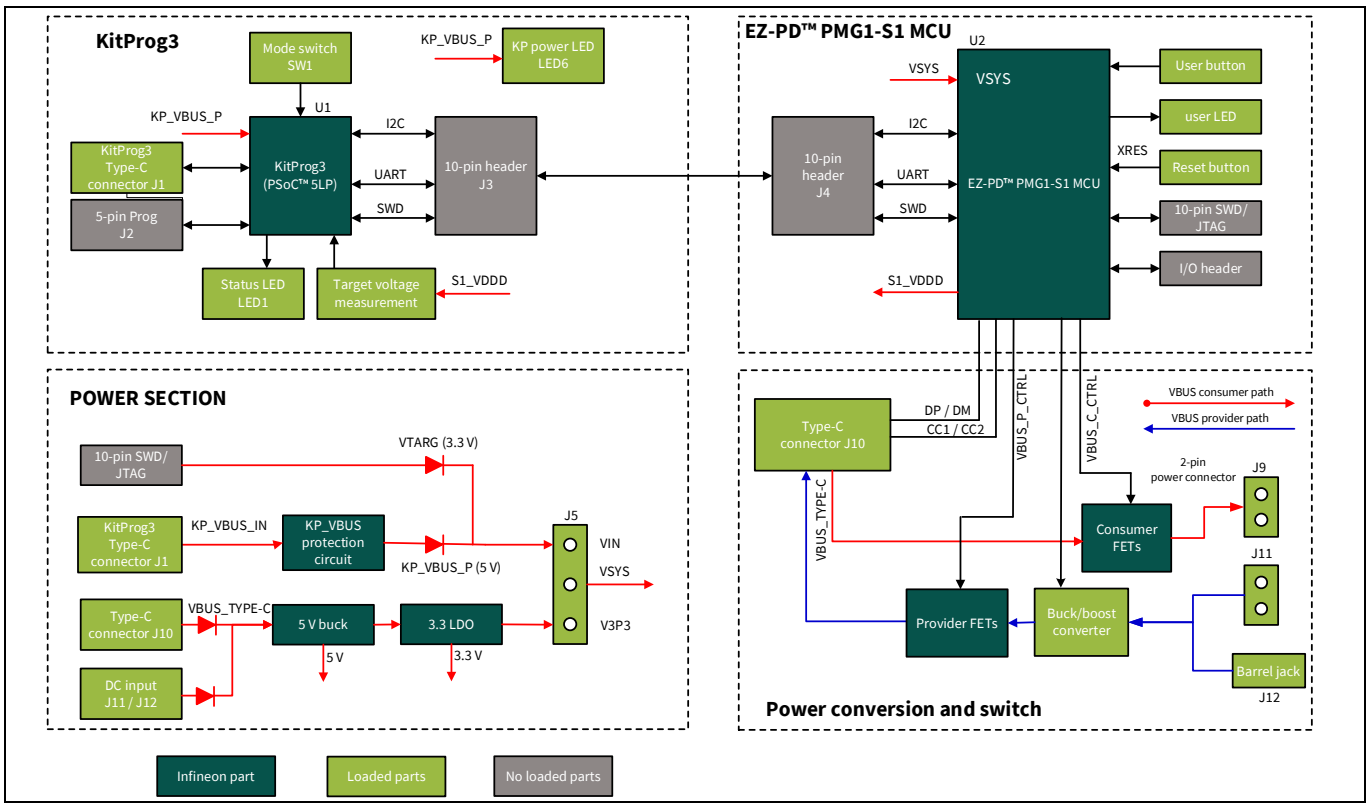


Figure 3 EVAL PMG1-S1 DRP kit block diagram

The EZ-PD™ PMG1-S1 MCU includes an Arm® Cortex® M0-MCU with the following features:

- 128 KB flash
- A complete Type-C USB PD transceiver with all termination resistors RP, RD, and dead battery RD
- Configurable serial blocks along with high-voltage protection circuits
- Overvoltage protection (OVP)
- Undervoltage protection (UVP)
- Overcurrent protection (OCP)
- Reverse current protection (RCP)
- VBUS to CC short-circuit protection (SCP).

3.1 System power supply design

The EVK consists of two step-down regulators to generate the 5 V and 3.3 V outputs to provide for VCONN, board peripherals, and EZ-PD™ PMG1-S1 MCU system power. The 5 V DC-DC converter generates 5 V from the DC input power supply when the EVK is in source mode. When the EVK is in sink mode, the regulator generates 5 V from the Type-C port that is sinking power. This regulator output also supplies the VCONN for the Type-C port.

The onboard 3.3 V LDO generates 3.3 V from the output of the 5 V regulator and is available as the power input for MCU. This 3.3 V regulated output is also available on an I/O header and can be used as a power rail for external components and modules. The onboard 3.3 V LDO can source a maximum current of 400 mA.

To power the USB Type-C VBUS in source mode, the EVK uses the NCP81599 buck-boost DC-DC converter as a variable output VBUS source. The voltage output of the regulator is controlled using the I2C interface from the EZ-PD™ PMG1-S1 MCU.

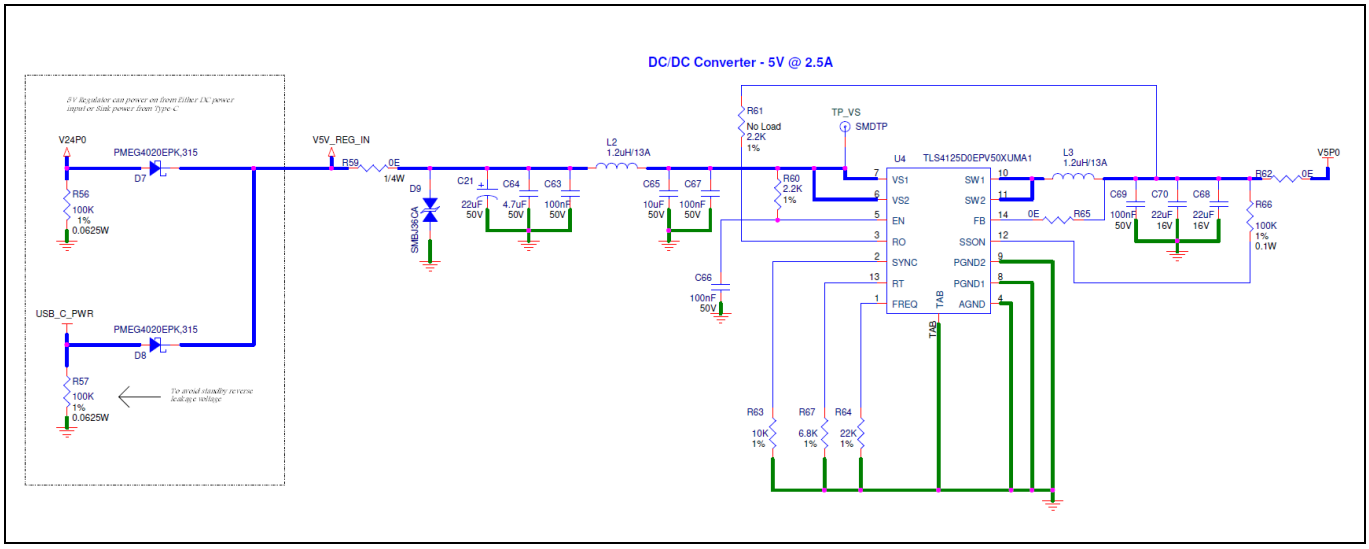


Figure 4 5 V regulator

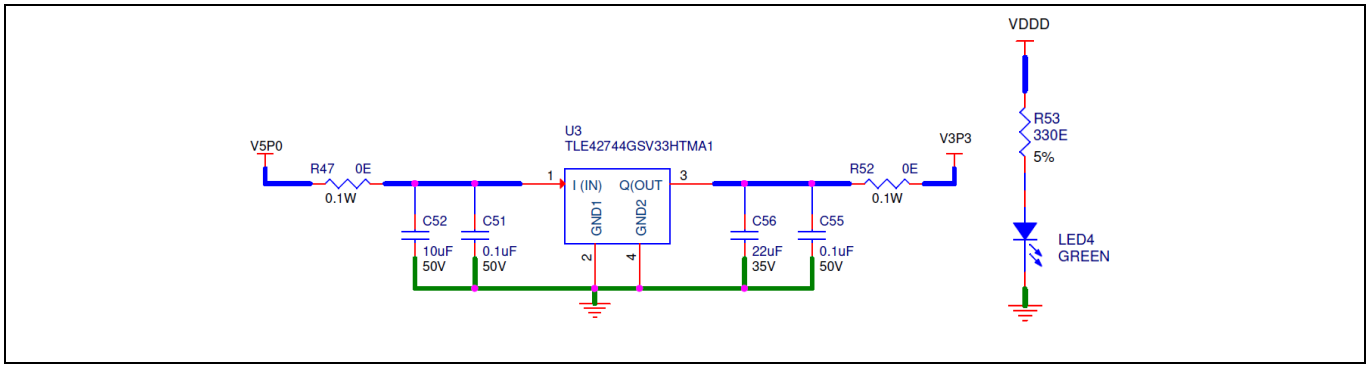


Figure 5 3.3 V LDO

3.1.1 Power selection jumper

The EZ-PD™ PMG1-S1 MCU on the EVK operates with two possible external supply voltages, VBUS or VSYS. The VDDIO supply powers the device I/Os. VDDD generates 3.3 V from an internal regulator, and this can be shorted to VDDIO. The VCCD is the output voltage from the core regulator and this pin is intended to connect only a decoupling capacitor. The VCCD pin cannot be used as a voltage source. The EZ-PD™ PMG1-S1 MCU has power supply inputs at the VCONN pin for providing power to EMCA cables through integrated VCONN FETs.

The onboard EZ-PD™ PMG1-S1 MCU supports two types of powering modes: programming and operational modes.

- **Programming mode**: For programming using the onboard KitProg3, the kit gets powered through the KitProg3 USB Type-C port (J1) or the SWD header (J8), whichever is available. When the programming mode setting is selected, power from the programming connector (J4 or J8) is connected to the VSYS pin of the EZ-PD™ PMG1 MCU.
- **Operation mode**: For normal operation, the prototyping kit gets powered through the 24 V power input at J11 and J12 in source mode operation or the Type-C adapter port in sink mode operation. The input power is fed to the 5 V regulator and 3.3 V LDO network to generate the system power, which powers the EZ-PD™ PMG1-S1 MCU.

The power selection jumper(J5) position decides the power input connected to the MCU and selects between the programming and operation power supply. The short pins 1–2 (V3P3) for operational mode and short 2–3 (VIN) for programming mode.

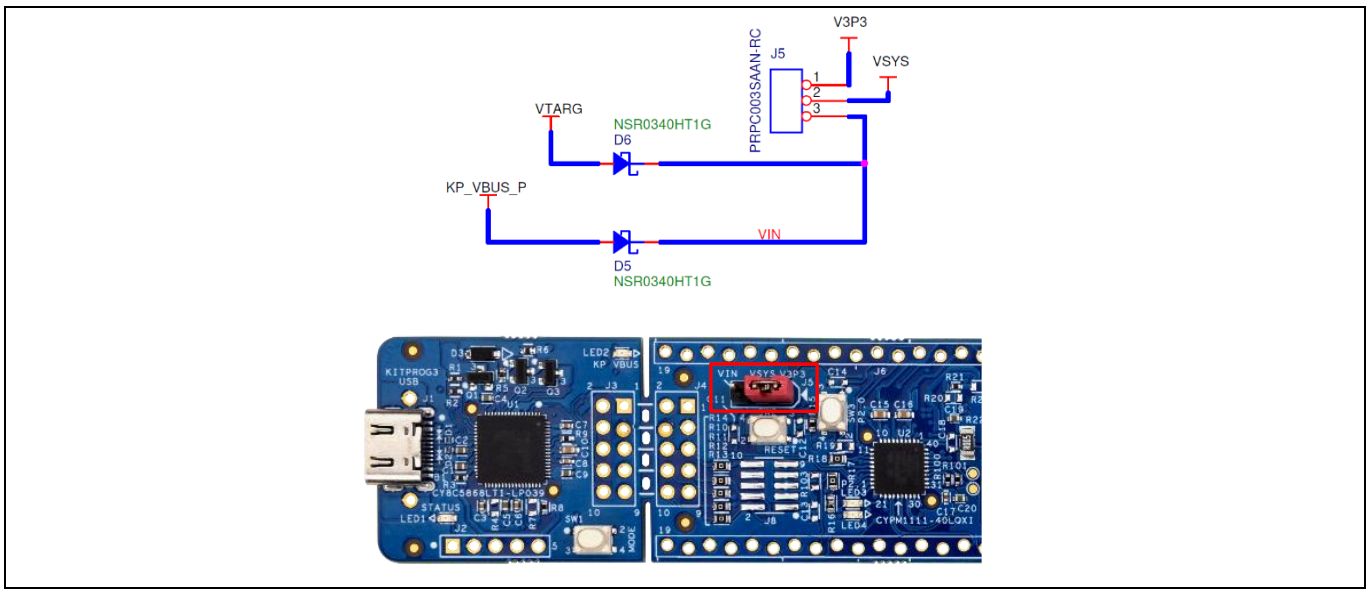


Figure 6 Power selection jumper

Note: The EZ-PD™ PMG1-S1 MCU can be powered via the VBUS pin also. So, in the sink mode of operation the prototyping kit can get power directly from Type-C_VBUS and can also function without the jumper connection.

3.2 Provider and consumer switch

The EZ-PD™ PMG1-S1 device consists of two I/Os with integrated PFET gate drivers: VBUS_P_CTRL and VBUS_C_CTRL. These drivers control the VBUS provider (sourcing of power) and consumer (sinking of power) path connecting the Type-C port to the power source and consumer.

While in the source mode, the power is supplied from the 24 V buck/boost regulator to the Type-C port (J10) using PFET Q4 and Q5. These PFETs are controlled via the VBUS_P_CTRL pin of the EZ-PD™ PMG1-S1 MCU.

In the provider path, a shunt resistance (R22) is connected in series to measure the current flowing to the Type-C port. This current measurement is used by the EZ-PD™ PMG1-S1 MCU to protect the OCP/SCP/RCP faults on the Type-C VBUS. EZ-PD™ PMG1-S1 also supports VBUS discharge and OVP/UVP features. This is done by monitoring the voltages on the VBUS pin of the EZ-PD™ PMG1-S1 MCU and providing a discharge path on it.

While in the sink mode, the power is supplied to the DC load terminal (J9) from the Type-C connector (J10) using PFET Q10 and Q11. These PFETs are controlled via the VBUS_C_CTRL pin of the EZ-PD™ PMG1-S1 MCU.

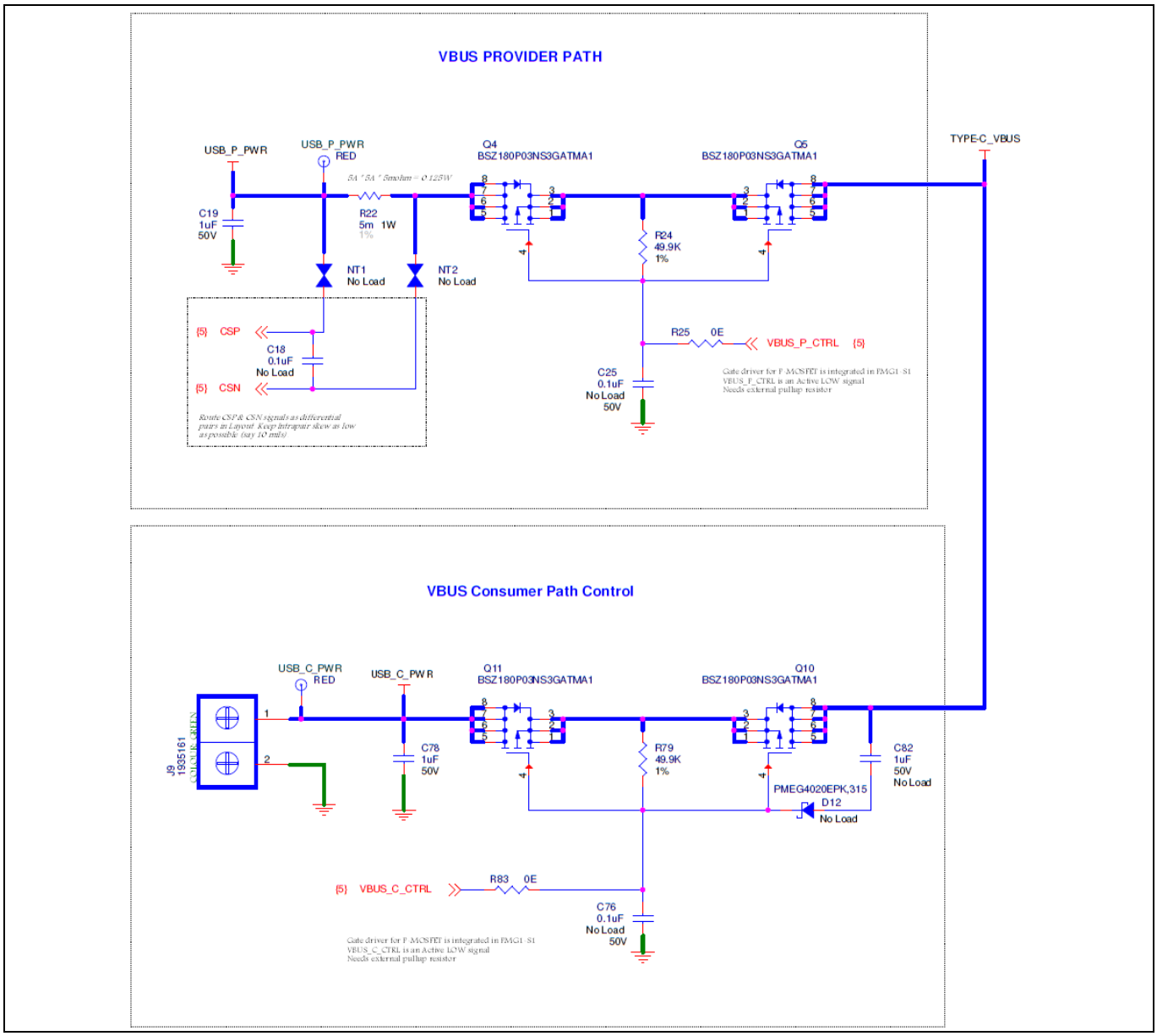


Figure 7 VBUS provider and consumer path

3.3 I/O headers

The EVAL_PMG1_S1_DRP kit has two I/O headers: J6 and J7, placed on either side of the board. These headers are standard breadboard compatible.

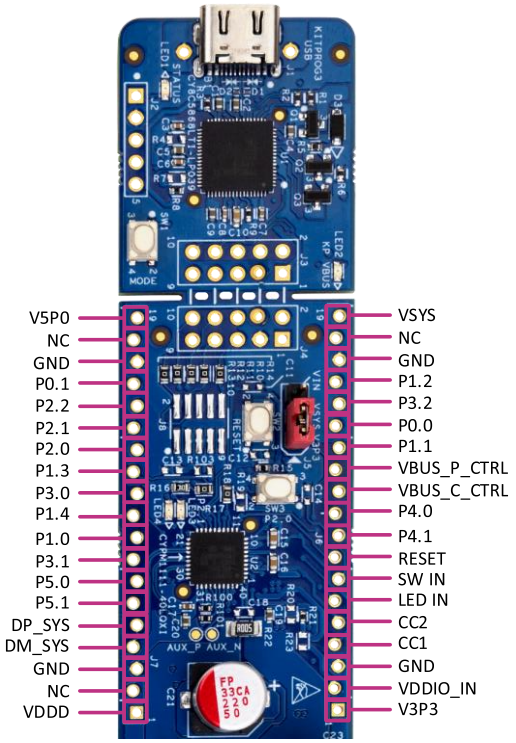


Figure 8 EVK I/O headers

Table 7 I/O header pinout at J6 pin

EVK pin J6	EVK pin name	EZ-PD™ PMG1-S1 MCU pin	Primary function	Secondary function	Connection details
1	V3P3	-	3.3 V regulator output	External 3.3 V regulator input to the board	-
2	VDDIO_IN	32	VDDIO alternate input	-	Connected through the non-populated resistor/diode
3	GND	-	-	-	Ground
4	CC1	9	CC1 signal	-	-
5	CC2	7	CC2 signal	-	-
6	LED_IN	14	User LED external input. By default, LED3 is driven by firmware. Use this pin to drive it externally.	P2.1 (GPIO)	Connected to LED3 and P2.1 pin through a 0-Ω resistor

EVK pin J6	EVK pin name	EZ-PD™ PMG1-S1 MCU pin	Primary function	Secondary function	Connection details
7	SW_IN	13	User switch output. SW2 is input to the EZ-PD™ PMG1 MCU device. This pin can be used to read the switch status externally.	P2.0 (GPIO)	Connected to SW2 and P2.0 pin through a 0-Ω resistor
8	PMG1S1_RESET_L	10	PMG1-S1 reset pin	-	-
9	P4_1/UART_RX	30	UART-RX	P4.1 (GPIO)	Connected to KitProg3 UART by default.
10	P4_0/UART_TX	29	UART-TX	P4.0 (GPIO)	
11	VBUS_C_CTRL	12	Consumer PFET load switch control signal	-	Connected to the load switch
12	VBUS_P_CTRL	11	Provider PFET load switch control signal	-	Connected to the provider switch
13	P1_1/REG_I2C_SDA	3	SCB1 I2C SDA	P1.1 (GPIO)	Connected to the buck-boost regulator I2C
14	P0_0/LSTX	38	P0.0 (GPIO)	-	-
15	P3_2	21	P3.2 (GPIO)	-	-
16	P1_2/REG_I2C_SCL	4	SCB1 I2C SCL	P1.2 (GPIO)	Connected to the buck-boost regulator I2C
17	GND	-	-	-	Ground
18	NC	-	-	-	-
19	VSYS	20	-	-	EZ-PD™ PMG1-S1 MCU VSYS

Table 8 I/O header pinout at J7 pin

EVK pin J7	EVK pin name	EZ-PD™ PMG1-S1 MCU pin	Primary function	Secondary function	Connection details
1	VDDD	31	–	–	–
2	NC	-	–	–	–
3	GND	-	–	–	–
4	DM_SYS	24	Connect to USB 2.0 DM from the host side	-	-
5	DP_SYS	23	Connect to USB 2.0 DP from the host side	-	-

EVK pin J7	EVK pin name	EZ-PD™ PMG1-S1 MCU pin	Primary function	Secondary function	Connection details
6	P5_1/I2C_SCL	17	SCB0 I2C SCL	P5.1 (GPIO)	Connected to KitProg3 for USB-to-I2C bridge
7	P5_0/I2C_SDA	16	SCB0 I2C SDA	P5.0 (GPIO)	Connected to KitProg3 for USB-to-I2C bridge
8	P3_1	20	P3.1 (GPIO)	-	-
9	P1_0/SWD_CLK	2	SWD clock	P1.0 (GPIO)	Connected to KitProg3
10	P1_4/SWD_IO	6	SWD data	P1.0 (GPIO)	Connected to KitProg3
11	P3_0	18	P3.0 (GPIO)	-	-
12	P1_3/REG_EN	5	Buck-boost regulator enabled	P1.3 (GPIO)	Connected to the buck-boost regulator
13	P2_0	13	User switch (SW2)	P2.0 (GPIO)	-
14	P2_1	14	User LED (LED4)	P2.1 (GPIO)	-
15	P2_2	15	P2.2 (GPIO)	-	-
16	P0_1/REG_INT/LSTX	39	Buck-boost regulator interrupt	P0.1 (GPIO)	Connected to the buck-boost regulator
17	GND	-	-	-	Ground
18	NC	-	-	-	-
19	V5P0	8	5 V regulator output	External 5-V input to the board	-

3.4 Programming and debugging

The EVAL_PMG1_S1_DRP EVK includes a PSoC™ 5LP-based KitProg3 module to enable programming and debugging of the kit without additional hardware/programmer module and interface the KitProg3 module through a USB programming connector (Type-C). The PCB design enables breaking apart the KitProg3 section of the board, if required. The portion of the board that contains the EZ-PD™ PMG1-S1 MCU can operate independently even after the KitProg3 section is detached.

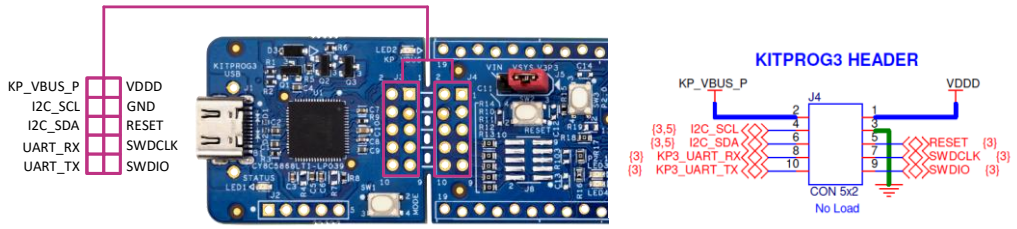


Figure 9 KitProg3 header

Table 9 KitProg3 header (J3 and J4) pinout

Pin#	Pin name	Description
1	VDDD	Target (EZ-PD™ PMG1-S1 MCU) internal regulator output
2	KP_VBUS_P	KitProg3 VBUS/programming VBUS
3	GND	Ground
4	I2C_SCL	I2C SCL signal between KitProg3 and EZ-PD™ PMG1-S1 MCU
5	RESET	Reset signal for programming EZ-PD™ PMG1-S1 MCU
6	I2C_SDA	I2C SDA signal
7	SWDCLK	SWD clock
8	UART_RX	UART RX
9	SWDIO	SWD data
10	UART_TX	UART TX

The EVK also has a 10-pin SWD/JTAG header (J8) for programming and debugging. The header is pin-compatible with all standard 10-pin SWD/JTAG interfaces and supports the Infineon MiniProg4 program and debug kit.

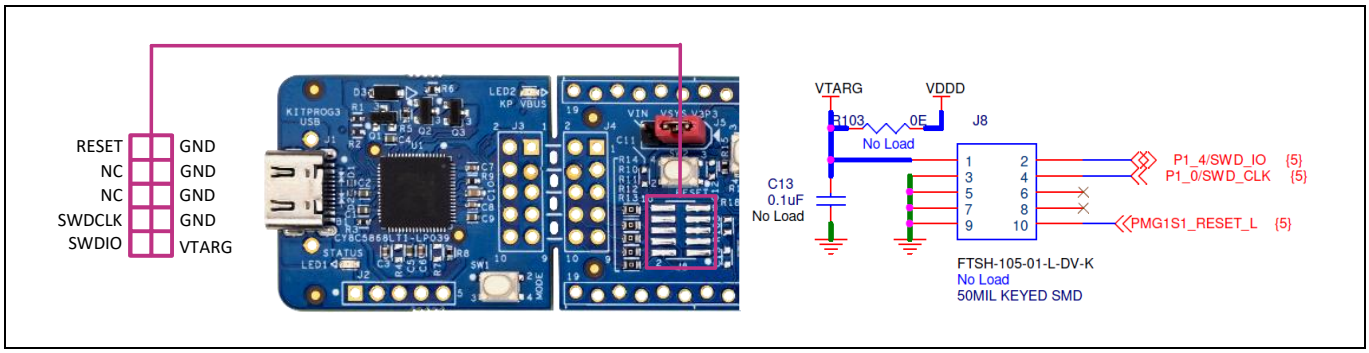


Figure 10 SWD/JTAG header

Table 10 SWD header (J8) pinout

Pin#	Pin name	Description
1	VTARG	Target (EZ-PD™ PMG1-S1 MCU) internal regulator output
2	SWDIO	SWD data
3	GND	Ground
4	SWDCLK	SWD clock
5	GND	Ground
6	-	-
7	GND	Ground
8	-	-
9	GND	Ground
10	RESET	Reset signal for programming EZ-PD™ PMG1-S1 MCU

3.5 User LED and switch

The EVK has one user LED and user switch connected to the EZ-PD™ PMG1-S1 MCU GPIOs. The user LED (green) is connected to the P2.1 and its functionality can be configured via the firmware. The GPIO needs to be driven LOW to turn on the user LED (LED3).

The user switch (SW3) is a tactile push-button switch on the EVK whose functionality can be configured via the firmware. When the switch is pressed, the GPIO (P2.0) connected to the button is pulled down to the ground.

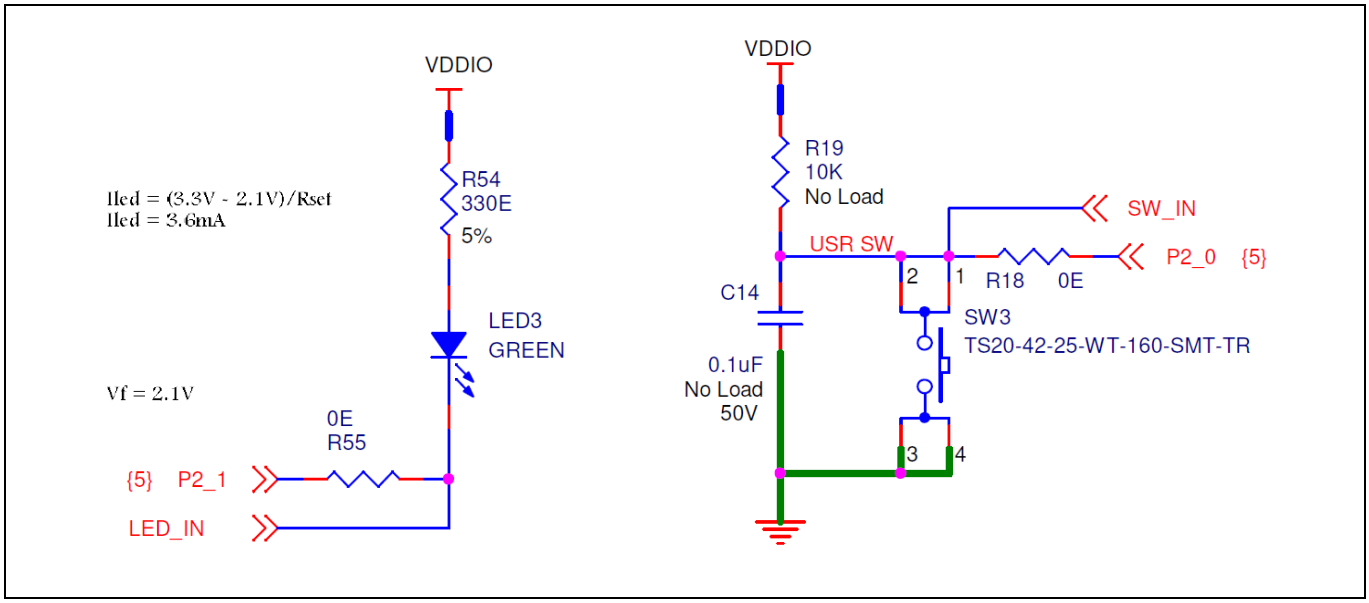


Figure 11 User LED and switch

3.6 Reset button

The EVK kit has a reset button (SW2) to reset the device manually. When the reset button is pressed, the XRES pin on the EZ-PD™ PMG1-S1 MCU is pulled down to the ground and resets the device.

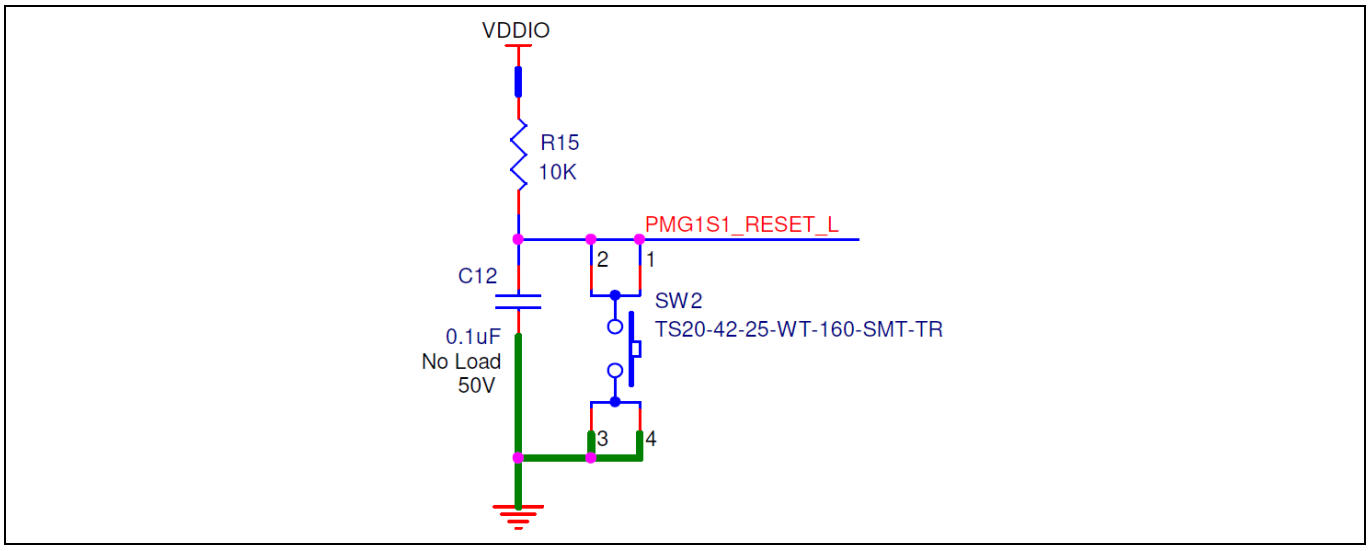


Figure 12 Reset button

4 Kit operation

This section explains the operation, programming, and debugging modes of the kit. It also describes the procedure for programming and debugging the application firmware on the kit.

The EVK is designed to work as a USB PD DRP. By default, this kit is loaded with the firmware associated with the USB PD DRP code example, supported in ModusToolbox™.

4.1 USB PD sink operation

The EVK supports up to a maximum contract of 20 V and 5A (100 W) in the sink mode. The kit automatically switches to sink mode as soon as a Type-C adapter is connected to the USB PD Type-C port (J10) of the kit.

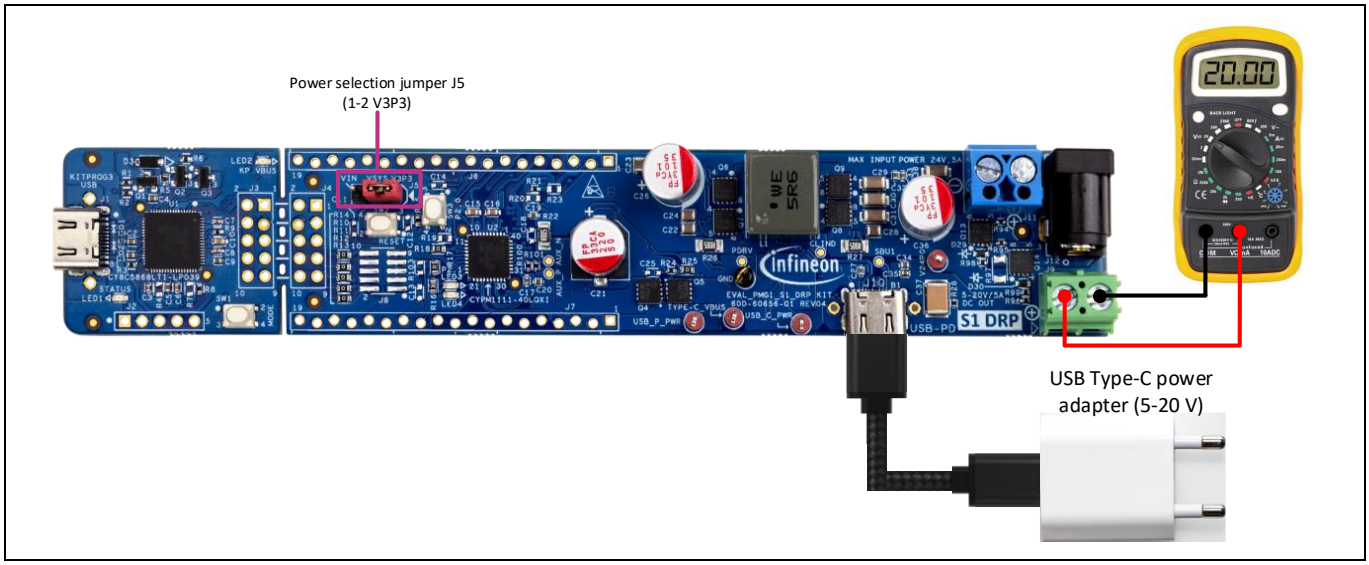


Figure 13 Test setup in sink mode

Follow these steps to operate the EVK in the USB PD sink mode:

1. Put the kit in operational mode by placing a jumper shunt on the power selection jumper (J5) at positions 1-2 to select the USB-C power adapter as the power source for the EVK (see Table 2).
2. Connect the USB PD sink port (J10) of the board to the USB-C power adapter using the USB Type-C cable.
3. Confirm that the power LED (LED4) glows green and the user LED (LED3) blinks green slowly (1 Hz).
4. Measure the DC_OUT voltage by connecting a multimeter to the terminal block (J9). Confirm that the DC_OUT voltage value is within the 4.75 V–21.00 V range. The actual value is determined by the maximum voltage, which the USB-C power adapter can supply.
5. Remove the multimeter and connect an external load to the terminal block (J9).

Attention: The maximum current that can be consumed by an external load is limited to 5A by the USB PD specification. If the load exceeds 5A, the USB-C power adapter may trigger overcurrent protection (OCP) and cut off the power supply to the kit. This behavior is dependent on the implementation of the USB-C power adapter.

4.2 USB PD source operation

The EVK is designed to work as a USB PD DRP and the firmware associated with the USB PD DRP code example supported in the ModusToolbox™ software is downloaded in the factory on the kit. The EVK supports up to a maximum contract of 20 V and 5A (100 W) in the source mode. The kit switches to source mode if the kit is powered via an external power supply at J11 or J12 and a Type-C load is connected to the USB PD Type-C port (J10) of the kit. The kit offers the PDOs of 5 V, 9 V, 15 V, and 20 V. The connected Type-C load should be compatible with one of these PDOs to test the Source operation successfully.

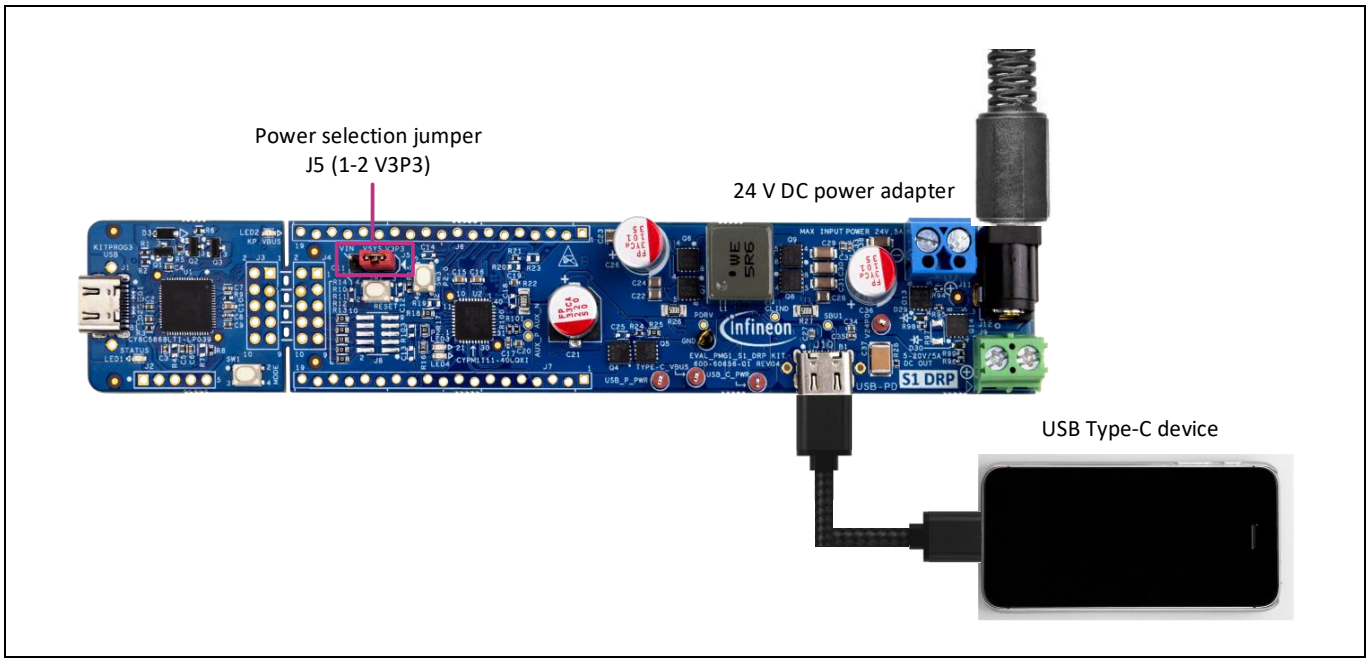


Figure 14 Test setup in source mode

Follow these steps to operate the EVK in the USB PD source mode:

1. Put the kit in operational mode by placing a jumper shunt on the power selection jumper (J5) at positions 1-2 to select the USB-C power adapter as the power source for the EVK (see Table 2).
2. Power up the kit using a 24 V power adapter (J12) or using an external 24 V DC power supply (J11).
3. Confirm that the power LED (LED4) glows continuously.
4. Connect a Type-C USB PD sink load at the USB PD Type-C port (J10) of the EVK.
5. Confirm that the user LED (LED3) glows green continuously.
6. Check that the Type-C load is drawing the power (for example, if the load is a mobile device, it will start charging).
7. The user LED (LED3) will blink rapidly (10 Hz) if any fault is detected on the Type-C VBUS.

Attention: Power the kit using a compatible power adapter only. The voltage output of the power adapter/DC supply connected at J12/J11 should be 24 V ± 10%.

Attention: The components and device surfaces of the EVAL_PMG1_S1_DRP kit may become hot if higher power is being sourced from the USB PD Type-C port of the EVK. Hence, necessary precautions are required while handling the board. Failure to comply may cause injury.

5 Application development on EVK using ModusToolbox™ and ModusToolbox™ programmer

The EZ-PD™ PMG1 MCU-based projects are developed using the ModusToolbox™ software development tool. ModusToolbox™ software is a set of multiplatform development tools and a comprehensive suite of GitHub-hosted firmware libraries.

For more details on ModusToolbox™ software, see the documentation on the ModusToolbox™ software environment home page.

The prototyping kit can be programmed and debugged through any of the following interfaces:

- KitProg3 USB Type-C port
- 10-pin SWD header
- I/O header pins

The kit supports programming and debugging via the KitProg3 interface by default.

5.1 Programming through the KitProg3 interface

5.1.1 Using ModusToolbox™ software

KitProg3 is a PSoC™ 5LP MCU-based onboard programming and debugging solution integrated with the EZ-PD™ PMG1 MCU prototyping kits. The kit is programmed and debugged without using any separate programming and debug module. Connect the kit to the PC using the programming connecter as shown in Figure 15.

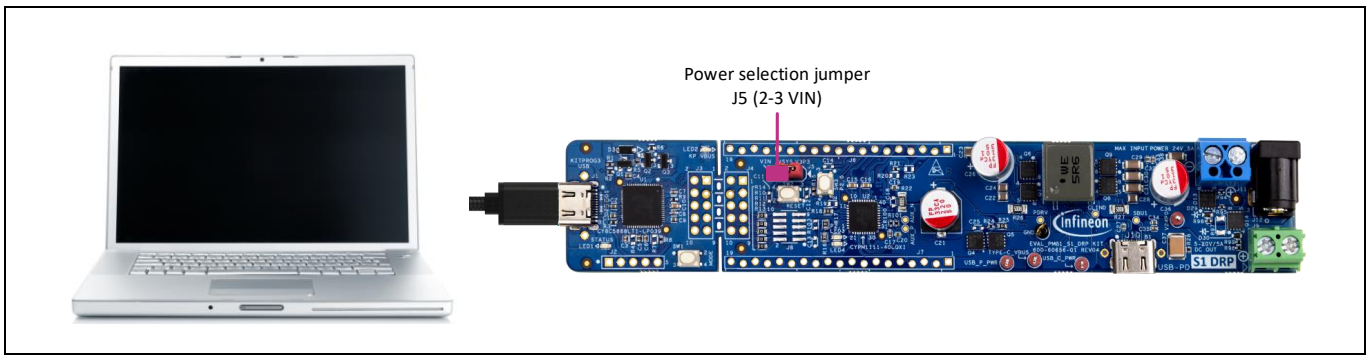


Figure 15 Programming through the KitProg3 interface

Do the following to program the prototyping kit using the KitProg3 interface from the ModusToolbox™ software:

1. Open the Eclipse IDE for ModusToolbox™ software and select the PMG1 project on the host PC. For details, see the Eclipse IDE for ModusToolbox™ software user guide.
2. Connect the power section jumper (J5) to position 2-3 (VIN).
3. Connect the kit to the host PC through the KitProg3 USB Type-C port (J1).
4. Ensure that LED1 and LED2 glow amber.

   LED2 (KitProg3 Power LED) indicates that the KitProg3 module and target MCU are powered. LED1 (status LED) indicates the programming mode and status and is ON when KitProg3 is powered.

5. In the project explorer, select the intended project, which needs to be programmed, as the current active project as shown in Figure 16.

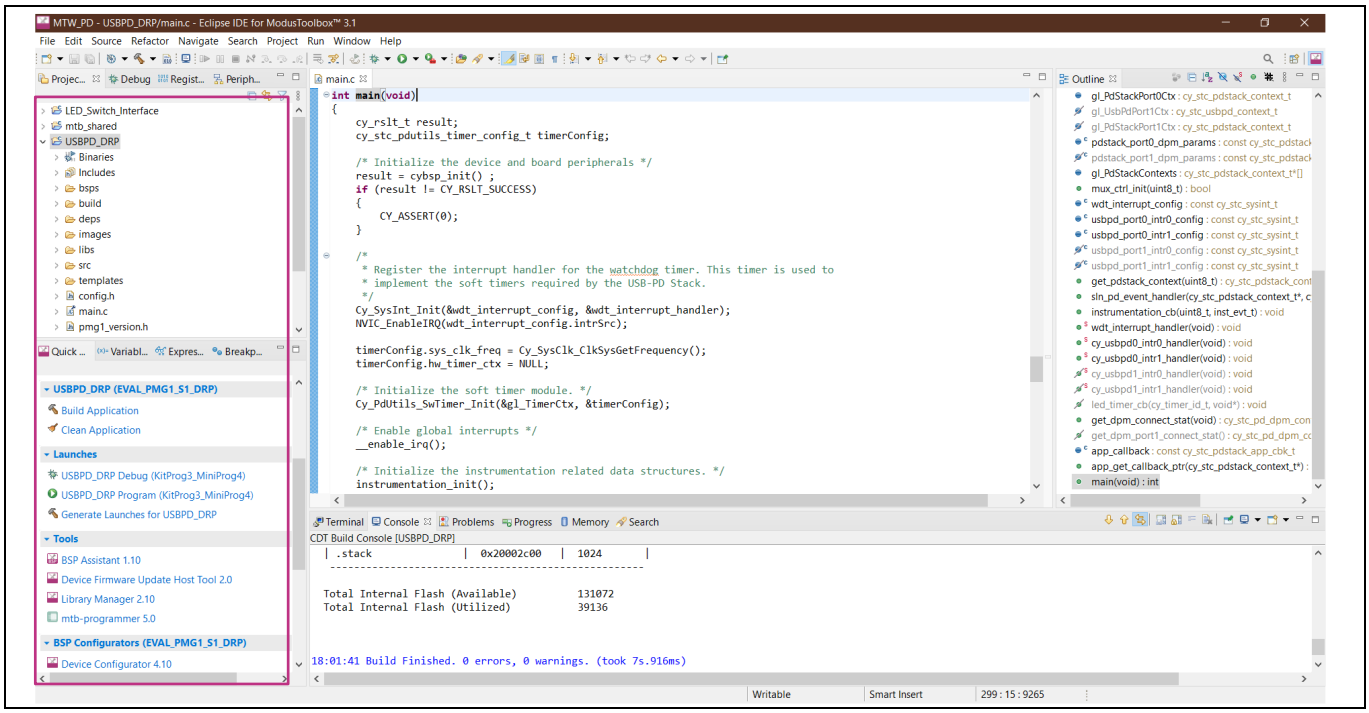


Figure 16 Eclipse IDE for ModusToolbox™ software

6. On the **Quick Panel**, click **<Application name> Program (KitProg3_MiniProg4)** from the **Launches** section.

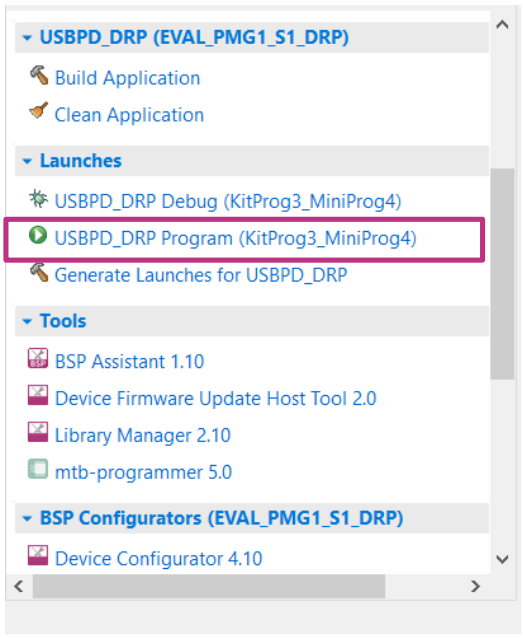


Figure 17 Quick panel and programming options

7. The **Console** tab displays the progress of the build/program. You can check the **Problems** tab for any errors and warnings. The success message is displayed on the Console tab if the programming is successfully complete.

5.1.2 Using ModusToolbox™ programmer (MTBP)

ModusToolbox™ programmer (MTBP) is a standalone, cross-platform, and flash programmer tool. Mtb-programmer provides a GUI to program, erase, verify, and read the flash of the target MCU. MTBP supports the HEX, SREC, ELF, and BIN programming file formats. Do the following to program the prototyping kit using the KitProg3 interface from the MTBP.

1. Connect the power section jumper (J5) to position 2–3 (VIN).
2. Connect the kit to the host PC through the KitProg3 connector. See Figure 15 for the setup.
3. Launch MTBP.
4. From the **Probe/kits** drop-down list, select the connected prototyping kit. Based on the selection, the **Platform** displays the PMG1 and the **Log** panel displays the selected device/kit/probe name.

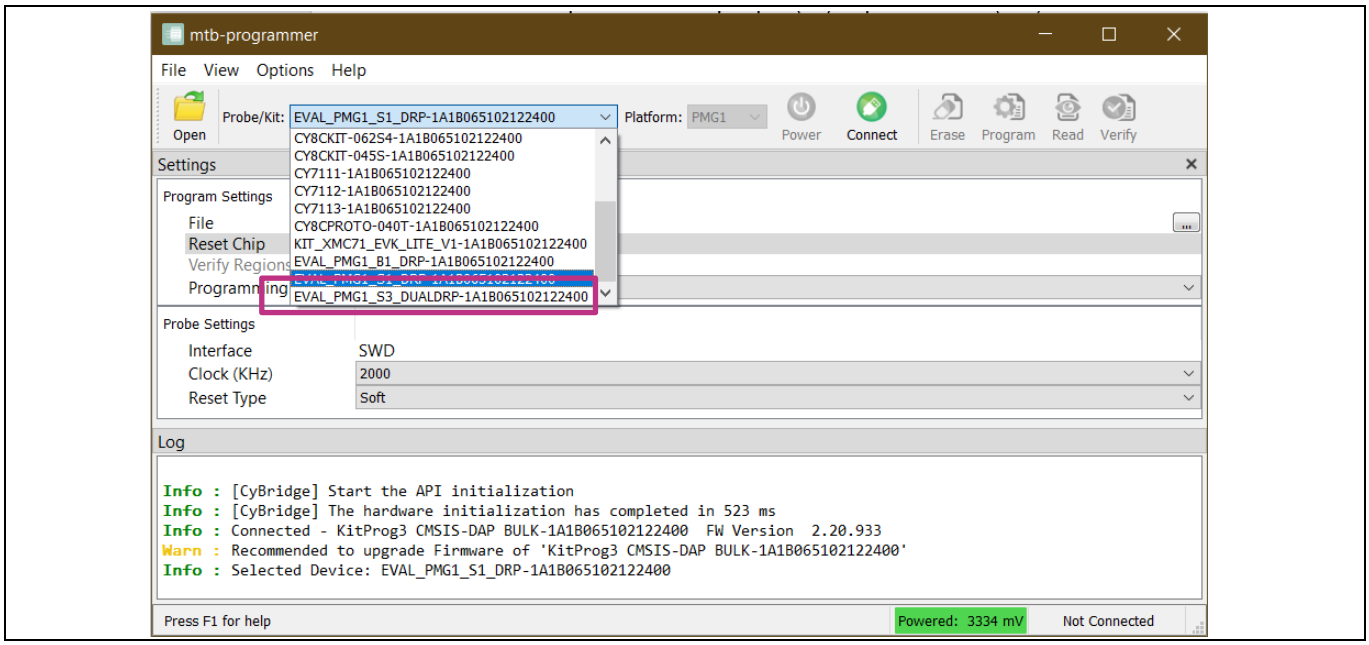


Figure 18 Selecting the probe/kits

5. Click **Open** to load the programming file. In the **Open programming file** dialog, browse to the location of the HEX, SREC, ELF, or BIN file to be loaded. Select the file and click **Open**.

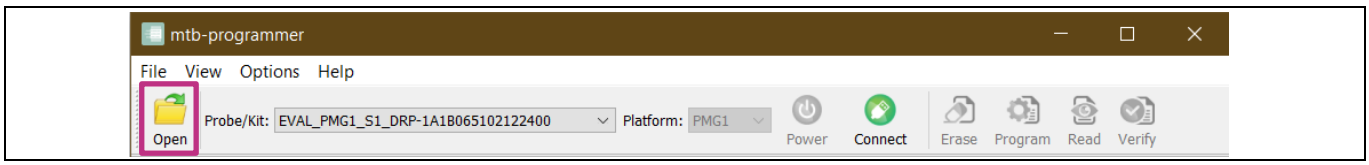


Figure 19 Loading the programming file

6. Click **Connect**. CYP connects to the target board and displays the **Erase**, **Program**, **Read**, and **Verify** options.

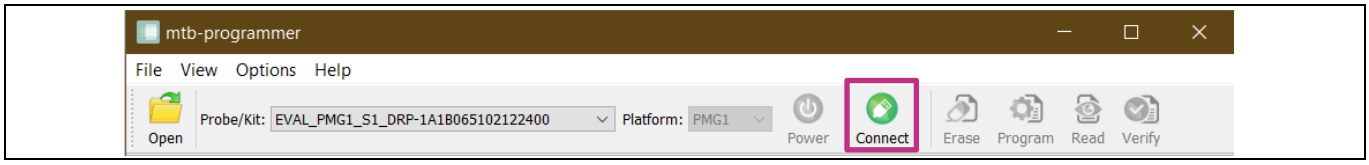


Figure 20 Establishing a connection with MCU

7. Click **Program** to initiate the firmware update. The message "**Device programmed successfully**" appears on the bottom left after the programming is complete as shown in Figure 21.

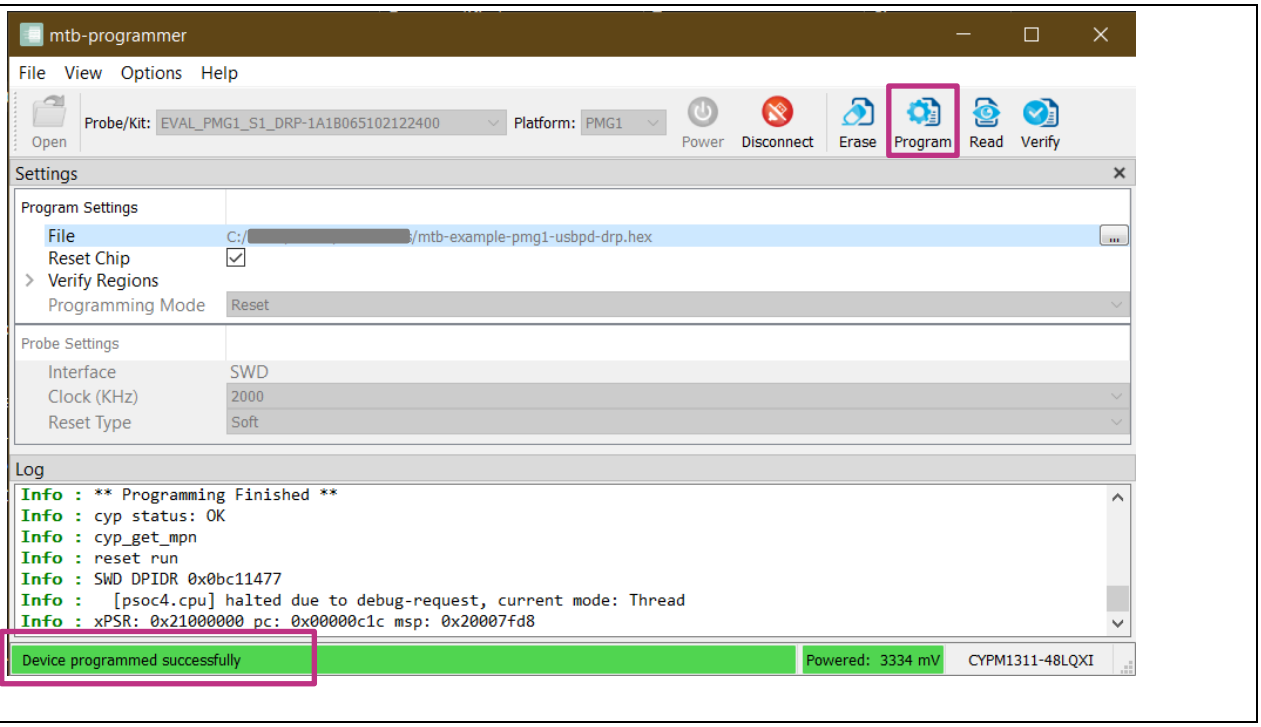


Figure 21 Programming through ModusToolbox™ programmer

5.2 Debug mode using KitProg3 interface using ModusToolbox™

The kit needs to be configured for operational mode for the debug mode using a power selection jumper (J5).

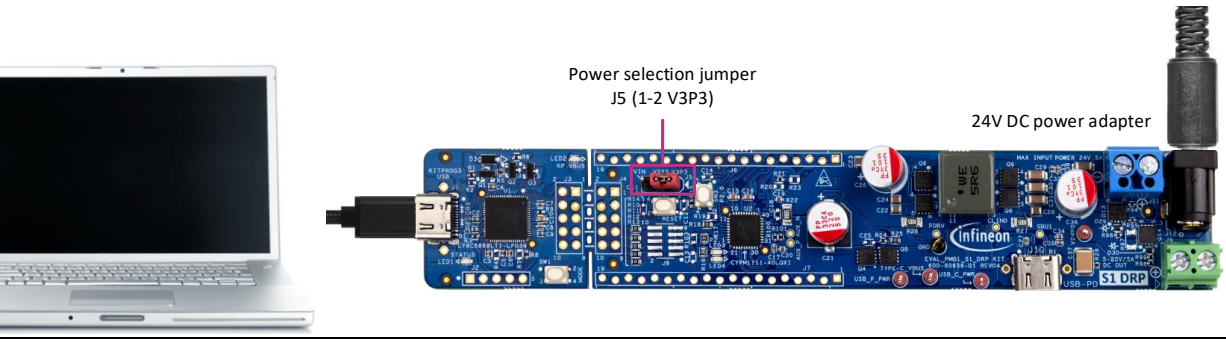


Figure 22 Debugging through KitProg3

Follow these steps to enter the debug mode from the KitProg3 interface from Eclipse IDE for ModusToolbox™ software.

1. Open the Eclipse IDE for ModusToolbox™ software and select the PMG1 project on the host PC. For more details, see the Eclipse IDE for ModusToolbox™ software user guide.
2. Place the jumper shunt on pins 1–2 of the power section jumper (J5) to configure the kit in operational mode.
3. Connect the external power to the kit using a power adapter (J12) or DC power supply (J11).

4. Connect the kit to the host PC through the programming KitProg3 USB Type-C port. Ensure that the LED1 and LED2 glow amber.
5. On the **Quick Panel**, click **<Application name> Debug (KitProg3_MiniProg4)** from the **Launches** section.
6. The IDE will switch to debugging mode and will halt at the first line of the `main()` function. This indicates that the application is ready for debugging.

5.3 Programming and debugging using J-Link debug probes

The EZ-PD™ PMG1 family of MCUs is supported by Segger J-Link software. Download and install the latest version (V7.92 or above) of J-Link software from the J-Link/J-Trace download page.

The EVAL_PMG1_S1_DRP kit supports programming and debugging using the Segger J-Link in-circuit debugger through a 10-pin SWD connector (J8).

The J-Link debugger probe has a 19-pin (2.54 mm) connector to interface with target boards. For interfacing Link Debugger probes to the EVAL_PMG1_S1_DRP kit through the onboard 10-pin SWD connector, use a 9-pin Cortex®-M Adapter from Segger.



Figure 23 9-Pin Cortex®-M adapter

The J-Link debugger measures the target MCU's voltage through the VTARG pin to detect and establish the connection. The reverse voltage protection diode (D6) between the VTARG pin (of J8) and VSYS (J5.3) prevents the measurement of the target MCU voltage on the VTARG pin. Do the following changes in hardware before using J-Link.

1. Solder the standard Mini-SWD 0.05-inch-pitch connector. FTSH-105-01-L-DV-K-P-TR from Samtech is the recommended connector.
2. Populate the 0-Ω series resistor 'R103' between VTARG (J8.1) and VDDD (MCU).

Do the following to program or debug the EVAl_PMG1-S1_DRP kit using J-Link probe from ModusToolbox™ software:

1. Open the Eclipse IDE for ModusToolbox™ software and select the PMG1 project on the host PC. For more details, see the Eclipse IDE for ModusToolbox™ software user guide.
2. Place the jumper shunt on pins 1–2 of the power section jumper (J5) to configure the kit in operational mode.
3. Connect the USB PD sink port (J10) to the USB PD source to activate the onboard LDO, load switch, and user LED. Ensure that LED4 (power LED) glows green.
4. Connect the J-Link debugger to EVK through the 10-pin SWD connector and use a 9-pin Cortex®-M adapter.

Do the following on the Quick panel:

- Click **<Application name> Program (J-Link)** from the Launches section to program the MCU.
- Click **<Application name> Debug (J-Link)** from the Launches section to launch the application debug. The IDE switches to debugging mode and alts at the first line of the `main()` function. This indicates that the application is ready for debugging.

6 Troubleshooting

Table 11 lists the common problems and troubleshooting methods that may be encountered during operation in the Kit operation section.

Table 11 Common troubleshooting methods

S. No.	Issue	Possible cause	Possible solution(s)
1	The EVK USB PD Type-C port does not enter PD contract	The power selection jumper may not be set to the correct setting	Set the power selection jumper to operational mode (1-2)
2	Unsuccessful programming of the EVK using KitProg3	The power selection jumper may not be set to the correct setting	Set the power selection jumper to programming mode (2-3)
3	The PD port is only making a 5 V contract.	The Type-C device connected to the port only supports 5 V contract and/or does not support USB PD 3.1 protocol.	Connect a Type-C device that supports the USB PD 3.1 protocol
4	When the EVK is in sink mode, the PD port is not entering a PD contract of 100 W.	The Type-C adapter connected to the port does not support 100-W power. Type-C EMCA cable does not support 20 V or 5A	Connect a Type-C adapter that supports the required power range (up to 100 W). Connect a Type-C EMCA cable that supports the required power range (up to 20 V and 5A)
5	When the EVK is in source mode, the PD port is not able to provide 100 W	The DC power adapter/supply connected to the kit does not support 100-W power. The Type-C EMCA cable does not support 20 V or 5A	Connect a power adapter that supports require power range (24 V, 5A) Connect a Type-C EMCA cable that supports the required power range (up to 20 V and 5A)

7 Appendices

7.1 Appendix A

7.1.1 KitProg3

An onboard PSoC™ 5LP MCU (CY8C5868LTI-LP039)-based KitProg3 module is used to program and debug the EZ-PD™ PMG1 MCU.

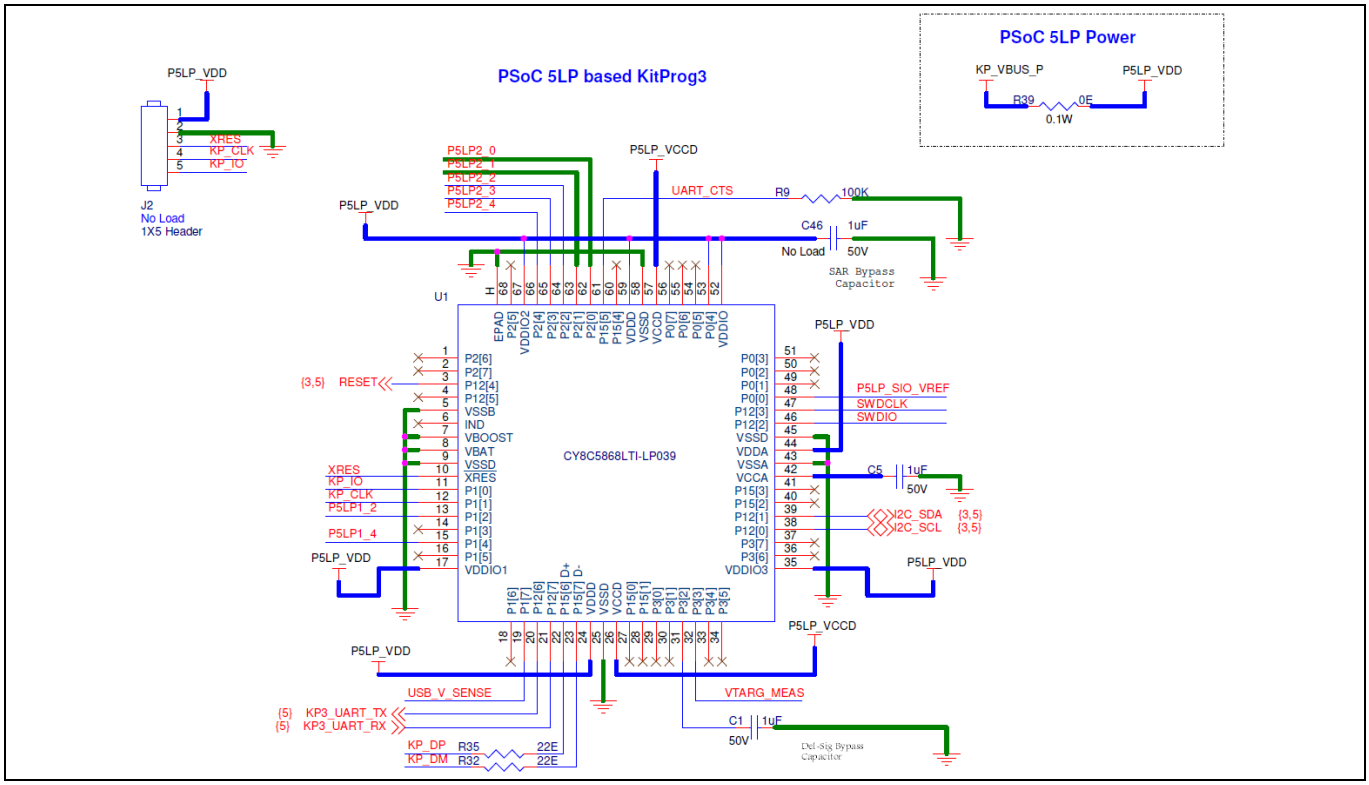


Figure 24 PSoC™ 5LP MCU-based KitProg3

The PSoC™ 5LP MCU device interfaces with a PC through a Type-C USB connector (J1) and functions as a bridge between the PC and EZ-PD™ PMG1 MCU devices over SWD, I2C, and UART interfaces. The KitProg3 module gets power through the J1 port; receives and transmits the data between the host PC through D+/D- signals. The programming/debugging module can access the EZ-PD™ PMG1 MCU device in programming or debugging mode via the SWD header. In addition to being an onboard programmer, the KitProg3 functions as an interface for the USB-I2C and USB-to-UART bridges.

The USB-serial pins of the PSoC™ 5LP MCU are hard-wired to the I2C pins of the EZ-PD™ PMG1 MCU and these pins are also available on the KitProg3 headers (J3 and J4). By default, the USB-to-UART bridge functionality is enabled by connecting the UART lines between KitProg3 and the EZ-PD™ PMG1 MCU.

7.1.1.1 Mode switch

The KitProg3 mode switch in the EZ-PD™ PMG1 MCU family kit enables the KitProg3 module to enter the bootloader mode. The bootloader mode is required to update the KitProg3 firmware on the PSoC™ 5LP MCU when the existing firmware corrupts, or a newer version is available.

7.1.1.2 KitProg3 power and status LEDs

The KitProg3 power LED (amber) turns on when the KitProg3 module supplies the power to the target MCU. The LED is always on in a fault-free condition when the kit is powered through the programming connector.

The status LED (amber) indicates the KitProg3 programming mode and the programming status. See the KitProg3 user guide for details.

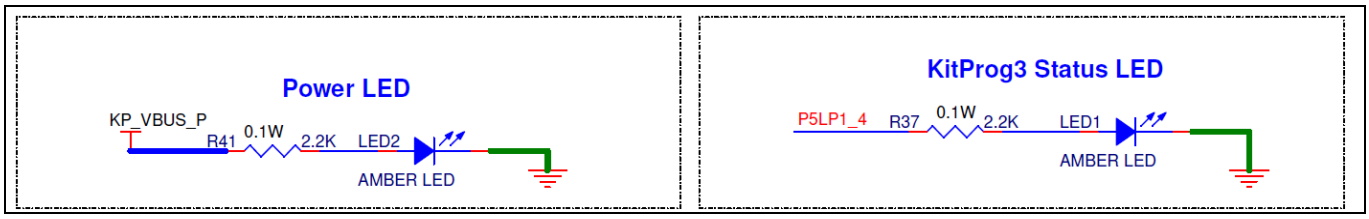


Figure 25 KitProg3 power and status LED

7.1.1.3 KitProg3 overvoltage protection circuit

A MOSFET and a Zener diode-based protection circuit is implemented to protect the KitProg3 (PSoC™ 5LP MCU) from damage due to overvoltage and reverse voltage fault on the programming Port (J1). The maximum rating for the PSoC™ 5LP MCU device is 5.8 V; the circuit shuts down the power supply if the voltage exceeds 5.8 V.

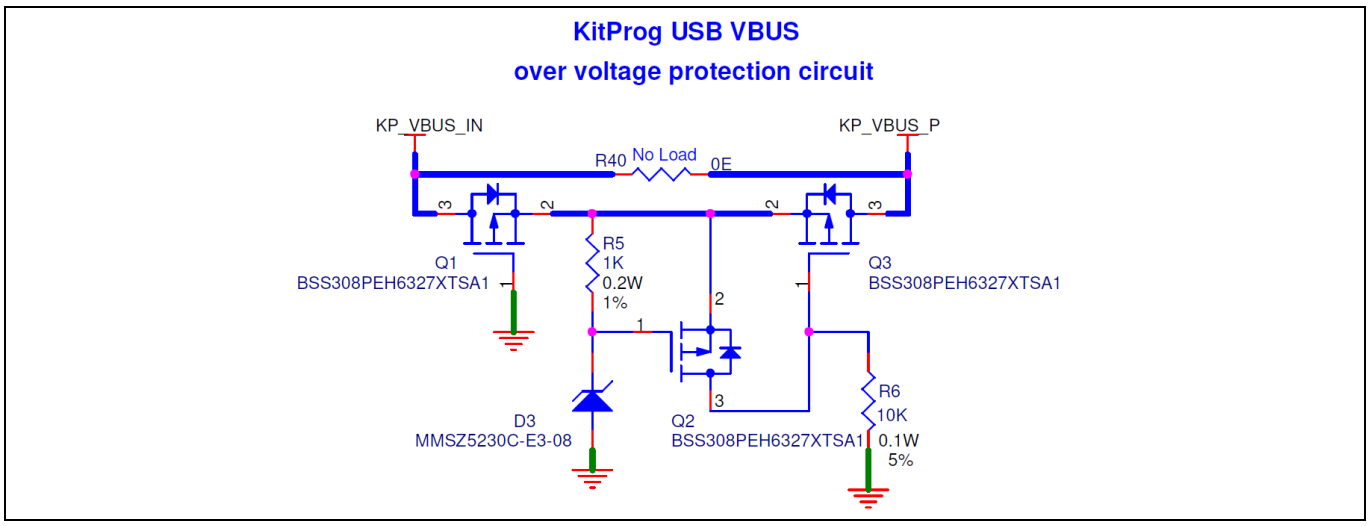


Figure 26 KitProg3 power and status LED

7.1.1.4 Target voltage measurement

The KitProg3 module is required to monitor the voltage at which the target MCU is working. The measured target voltage is used as the reference to configure the logic level for communication between the KitProg3 and the EZ-PD™ PMG1 MCU device.

7.2 Appendix B

7.2.1 EVAL_PMG1_S1_DRP schematics

Appendices

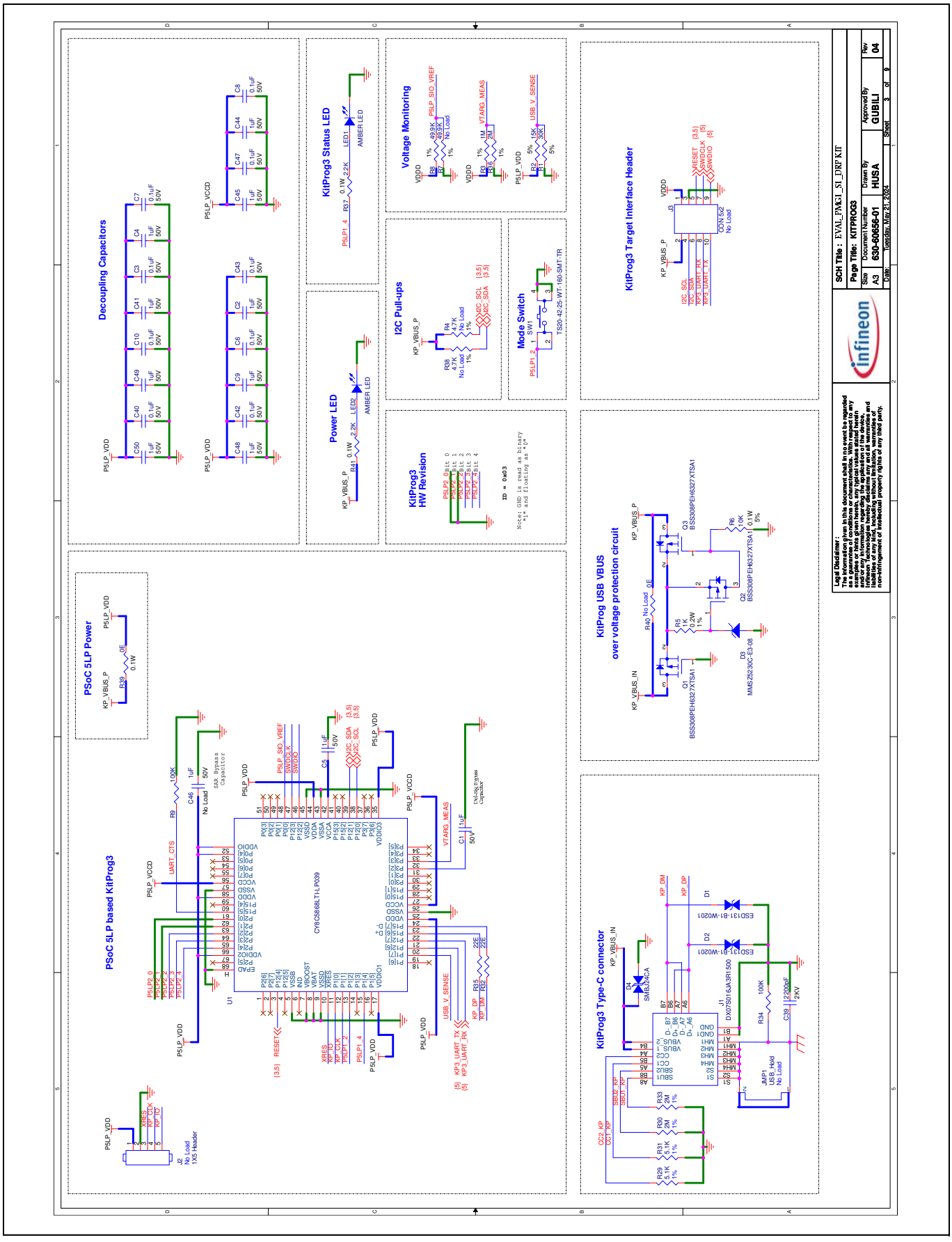


Figure 27 KitProg3 schematics

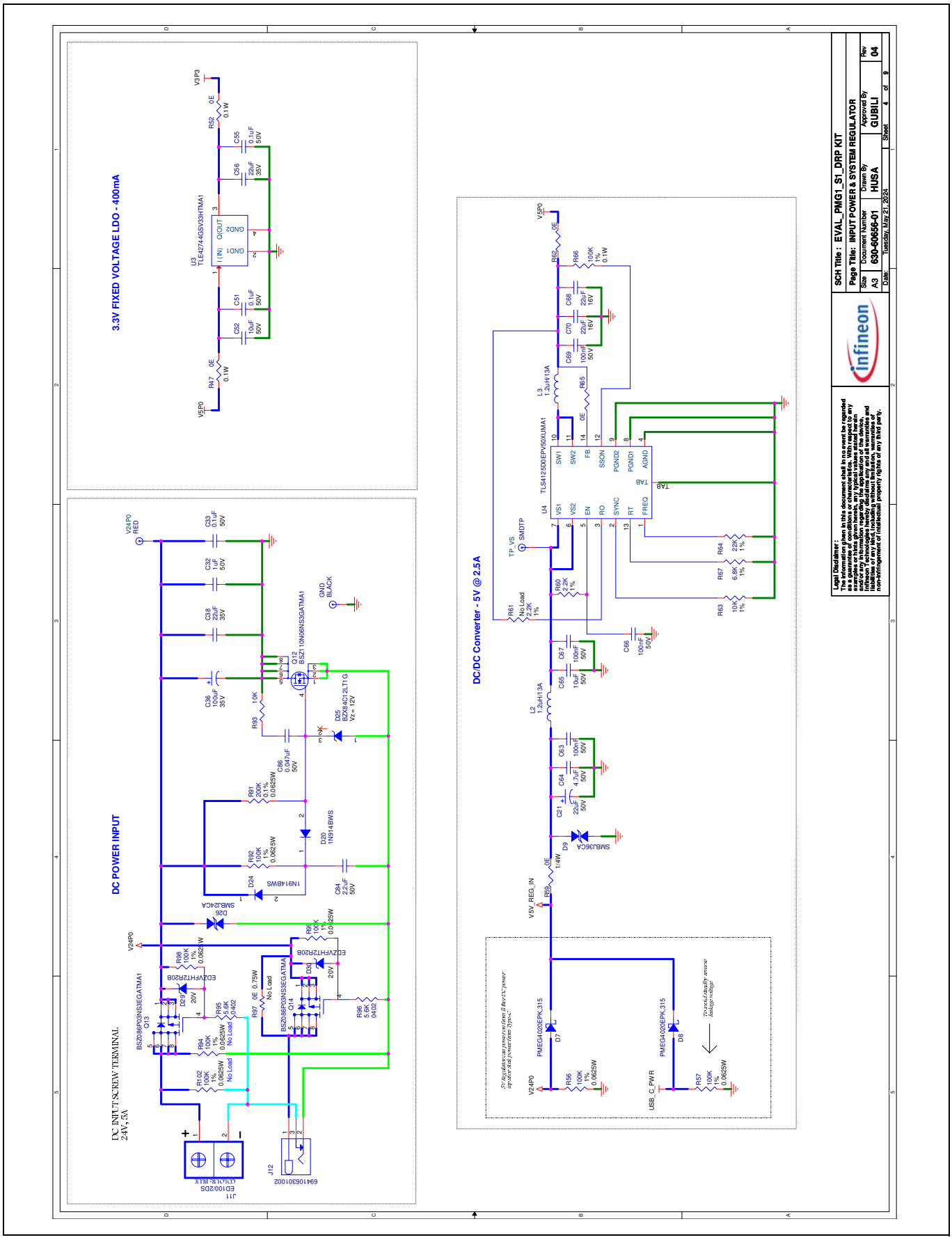


Figure 28 DC input power and system regulator schematics

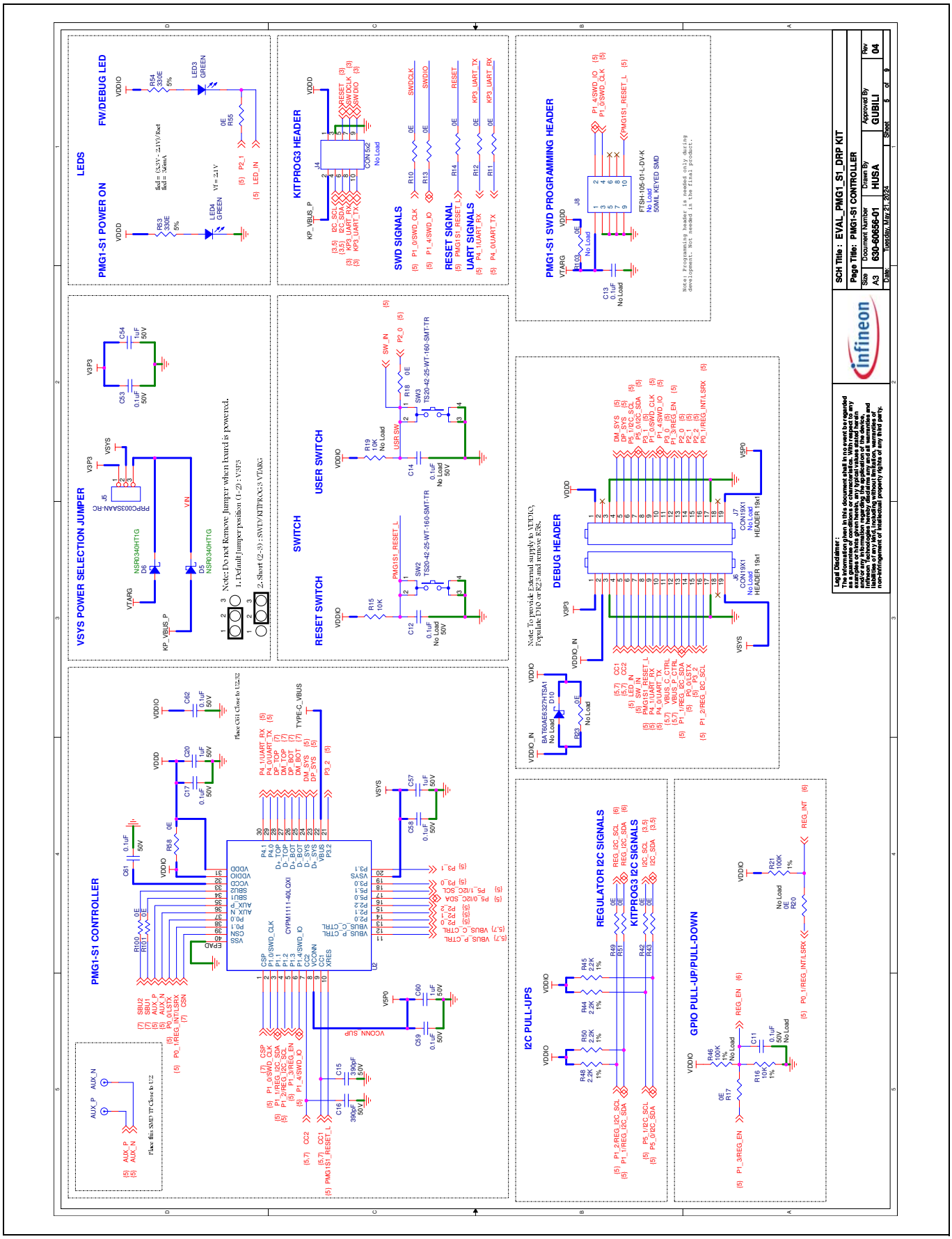


Figure 29 PMG1 S1 MCU schematics

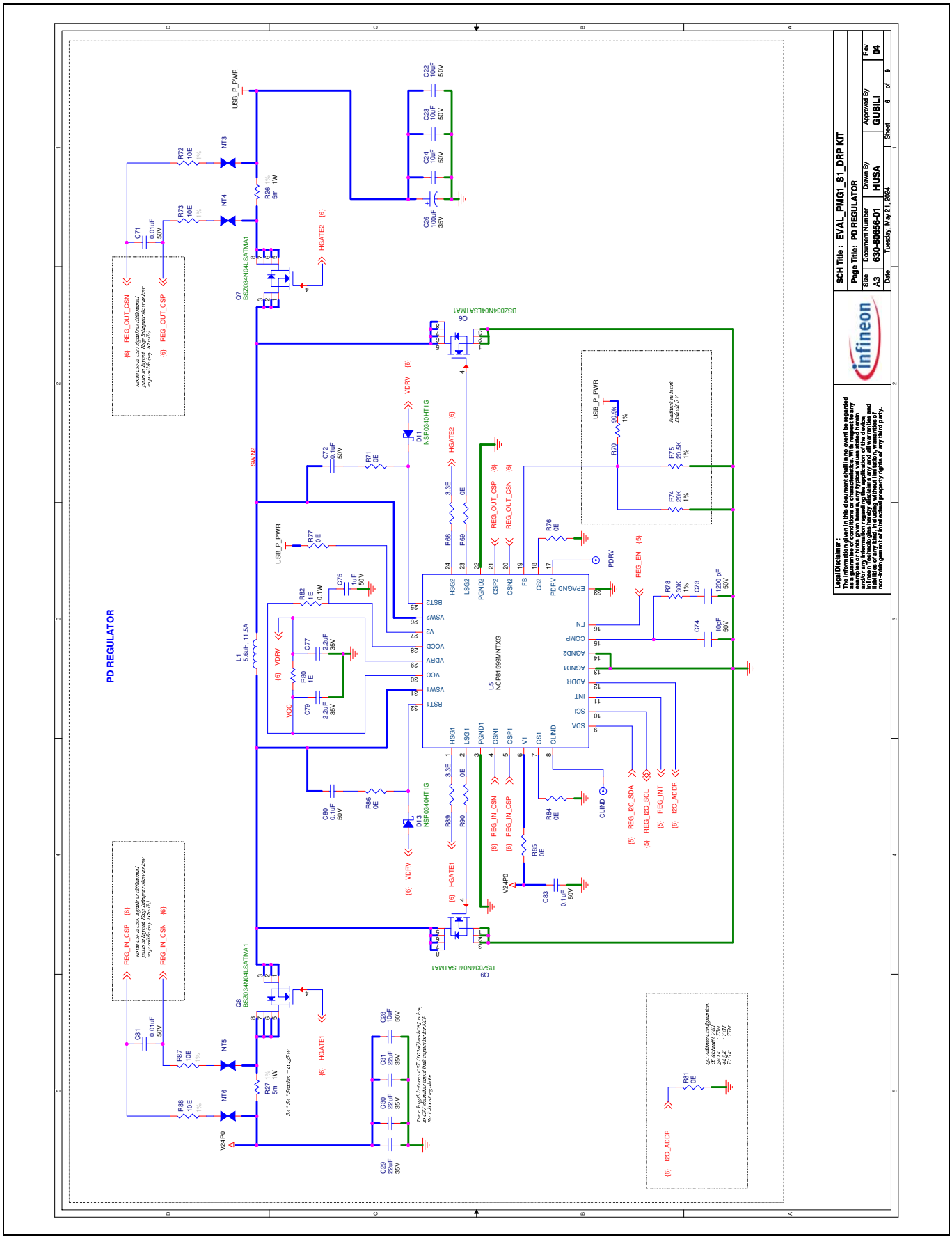


Figure 30 USB PD source regulator schematics

Appendices

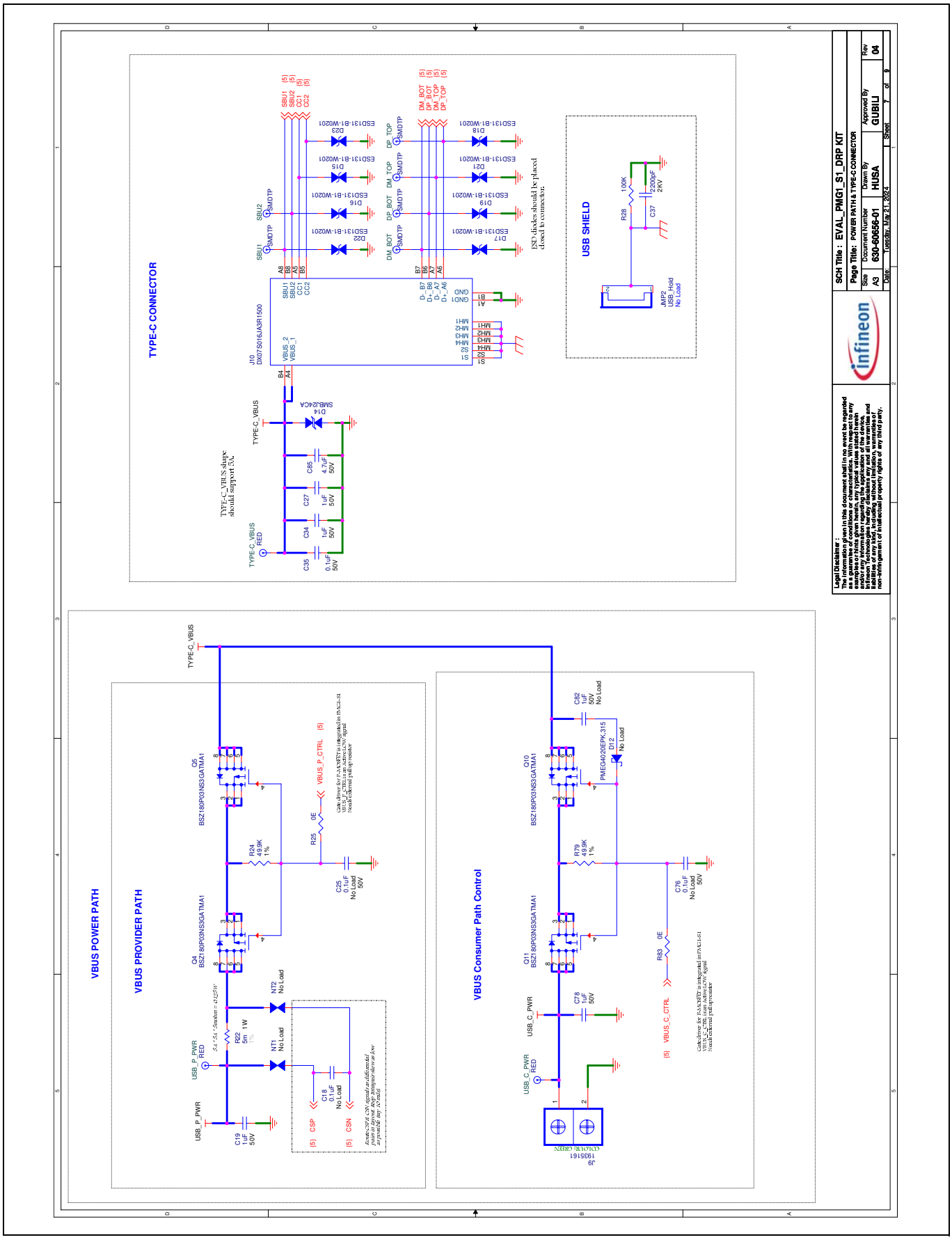


Figure 31 USB PD provider and consumer switch schematics

Glossary

AFC
adaptive fast charging

BC
Battery Charging

DFP
Downstream Facing Port

DNP
Do Not Populate

DRP
Dual Role Power

EMCA
Electronically Marked Cable Assembly

ESD
electrostatic discharge

EVK
Evaluation Kit

FET
Field-Effect Transistor

GPIO
general-purpose input/ output

IC
integrated circuit

LED
light-emitting diode

NA
not applicable

Glossary

OVP
overvoltage protection

PA
power adapter

PD
Power Delivery

PDO
Power Data Object

PFET
P-channel Field Effect Transistor

PSoC™
programmable system-on-chip

SoC
system-on-chip

UFP
Upstream Facing Port

USB
Universal Serial Bus

USB PD
Universal Serial Bus Power Delivery

UVP
undervoltage protection

Revision history

Document revision	Date	Description of changes
**	2023-08-11	Initial release
*A	2024-03-12	Updated kit images with Rev02 of kit. Added warnings in section 4. Added schematics in EVAL_PMG1_S1_DRP schematics.
*B	2024-06-19	Updated kit images with Rev03 of kit. Updated schematics screenshots with Rev03 of kit.
*C	2024-09-11	Updated kit images with Rev04 of kit. Updated schematics screenshots with Rev04 of kit.

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