XDP™ XDP700-002 evaluation PCBA user guide

About this document

Scope and purpose

This document describes how to set up the XDP™ XDP700-002 Evaluation Board and configure the internal registers to evaluate the performance of the XDP700-002 hot-swap controller for negative rail.

Intended audience

This document is intended for test engineers who want to evaluate the performance of the XDP700-002 hot-swap controller.

Important notice

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Safety precautions

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

Table 1 Safety precautions

	**Warning**: *The evaluation or reference board contains DC bus capacitors which take time to discharge after removal of the main supply. Before working on the drive system, wait five minutes for capacitors to discharge to safe voltage levels. Failure to do so may result in personal injury or death.*
	**Caution:** *The heat sink and device surfaces of the evaluation or reference board may become hot during testing. Hence, necessary precautions are required while handling the board. Failure to comply may cause injury.*
	**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.*

Table of contents

1 Introduction

Infineon's XDP™ XDP7x0-002 family of devices (XDP700-002, XDP710-002) are highly integrated wide-input voltage system monitoring and inrush current protection devices. These are digitally configurable and use a power management bus (PMBus) communication interface to access their register map to configure their features.

The USB007A series dongle is a PC-USB COM port-to-PMBus bridge dongle that allows access to XDP700-002 registers from the software configurator.

This document describes how to set up the evaluation board and configure the internal registers to evaluate the performance of XDP700-002 in limiting the inrush current during startup by using regulation on the programmed FET safe operating area (SOA). This document also highlights the fault detection control.

2 Hardware and software requirements

The following hardware and software are required for the setup:

- XDP700-002 Evaluation Board
  - **Order code**: EVAL_XDP700
- XDP™ Designer USB dongle USB007 or higher
  - **Order code**: USB007A1
- XDP™ Designer GUI
  - Download from Infineon Development Center

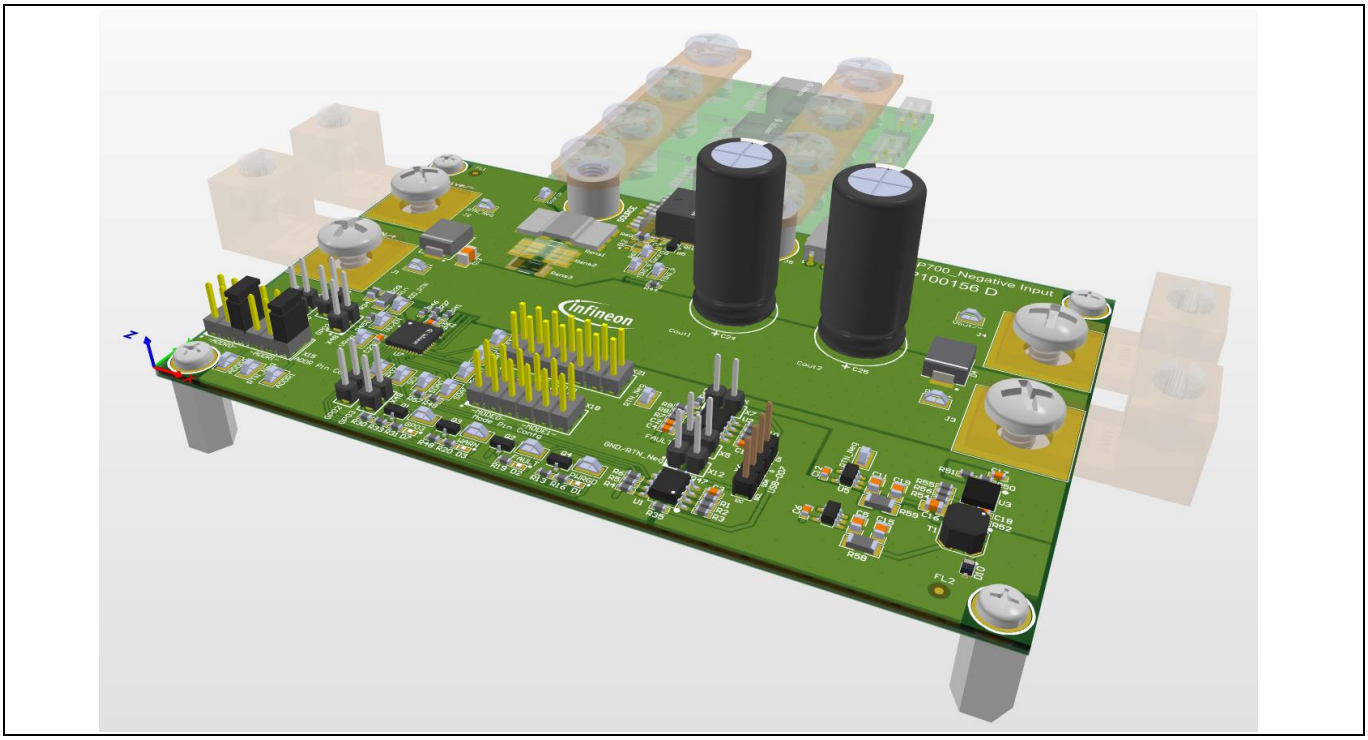

Figure 1 XDP700-002 Evaluation Board

Figure 2 USB007A1 dongle

Hardware and software requirements

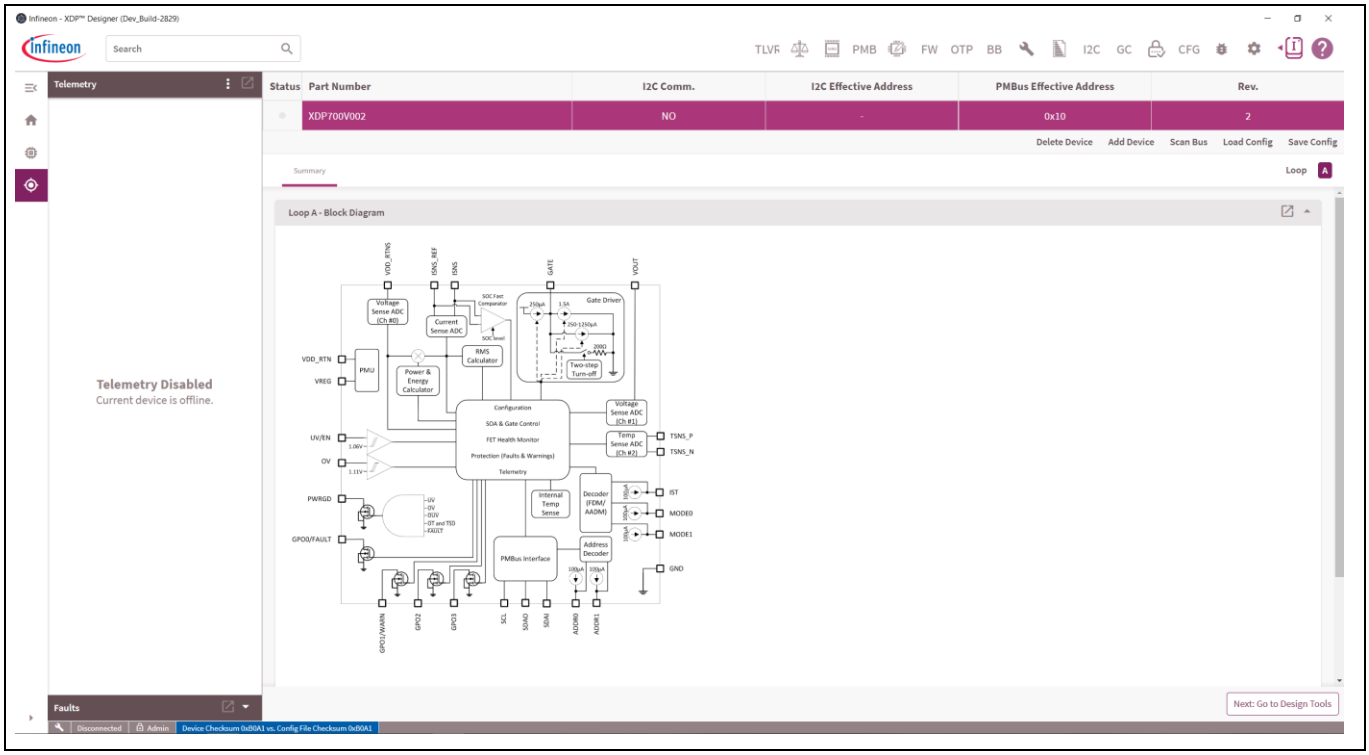

Figure 3 XDP™ Designer

3 XDP700-002 evaluation platform

The following sections describe the XDP700-002 Evaluation Board highlighting the electrical specifications, block diagram, schematics, layout, bill of materials (BOM), and different configuration settings that could be used on this evaluation board.

3.1 Electrical specifications

- Input and output voltage range: –12 V DC to –80 V DC
- Input current range: Up to 40 A

Note: The input current range depends on the number of paralleled MOSFET adapter boards. The MOSFET adapter boards can be removed and added to the evaluation board based on the required current level. The board can handle up to 75 A of current with three MOSFET adapter boards without the need of forced air cooling.

3.2 Block diagram

The XDP700-002 evaluation platform consists of the following:

- **XDP700-002 Evaluation Board**: Negative input hot-swap controller and eFuse circuitry designed to run a single-channel controller including its corresponding FET. Additionally, communication, control, and protection circuitry are included.
- **USB007A1 dongle**: Acts as the interface between the PC and XDP700-002. XDP™ Designer uses PMBus communication to send commands to XDP700-002. The USB007A1 dongle translates these commands from USB to PMBus, enabling XDP700-002.
- **XDP™ Designer**: Configuration and general control software tool for XDP700-002 PMBus communication.

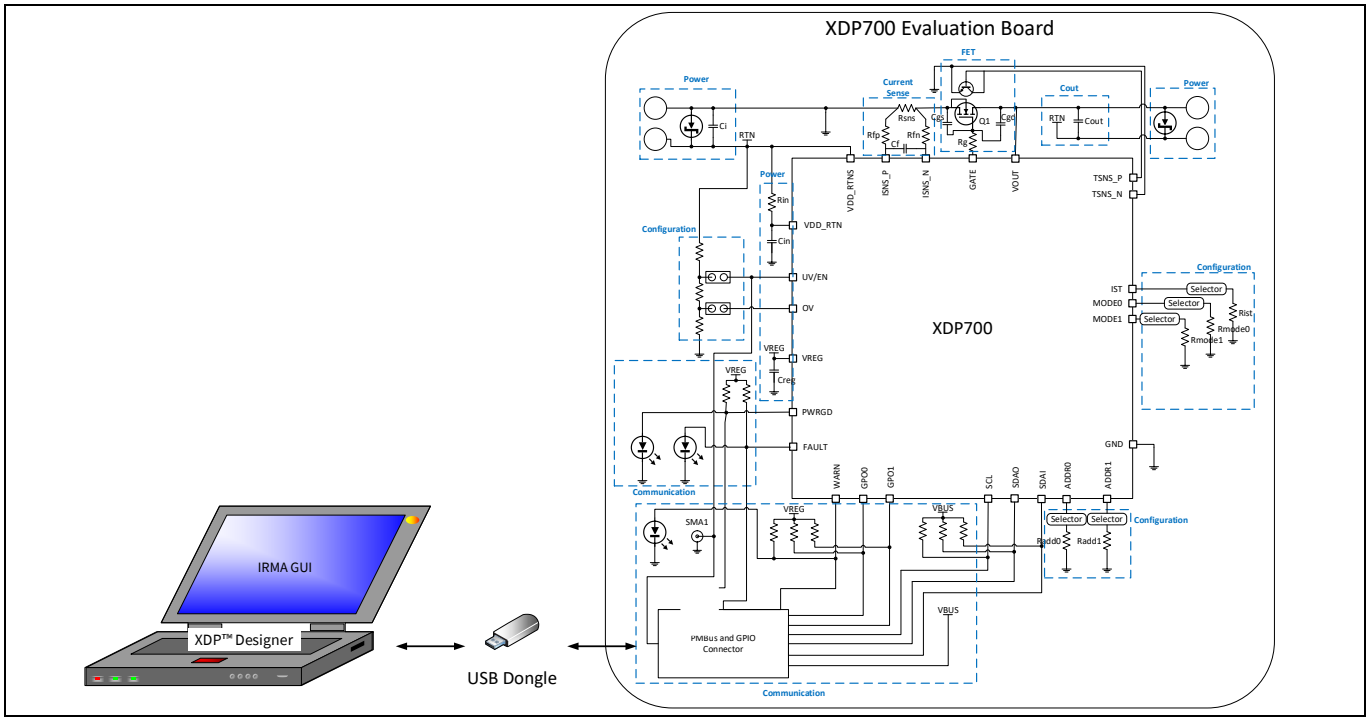

Figure 4 XDP700-002 evaluation platform

3.3 XDP700-002 Evaluation Board schematics

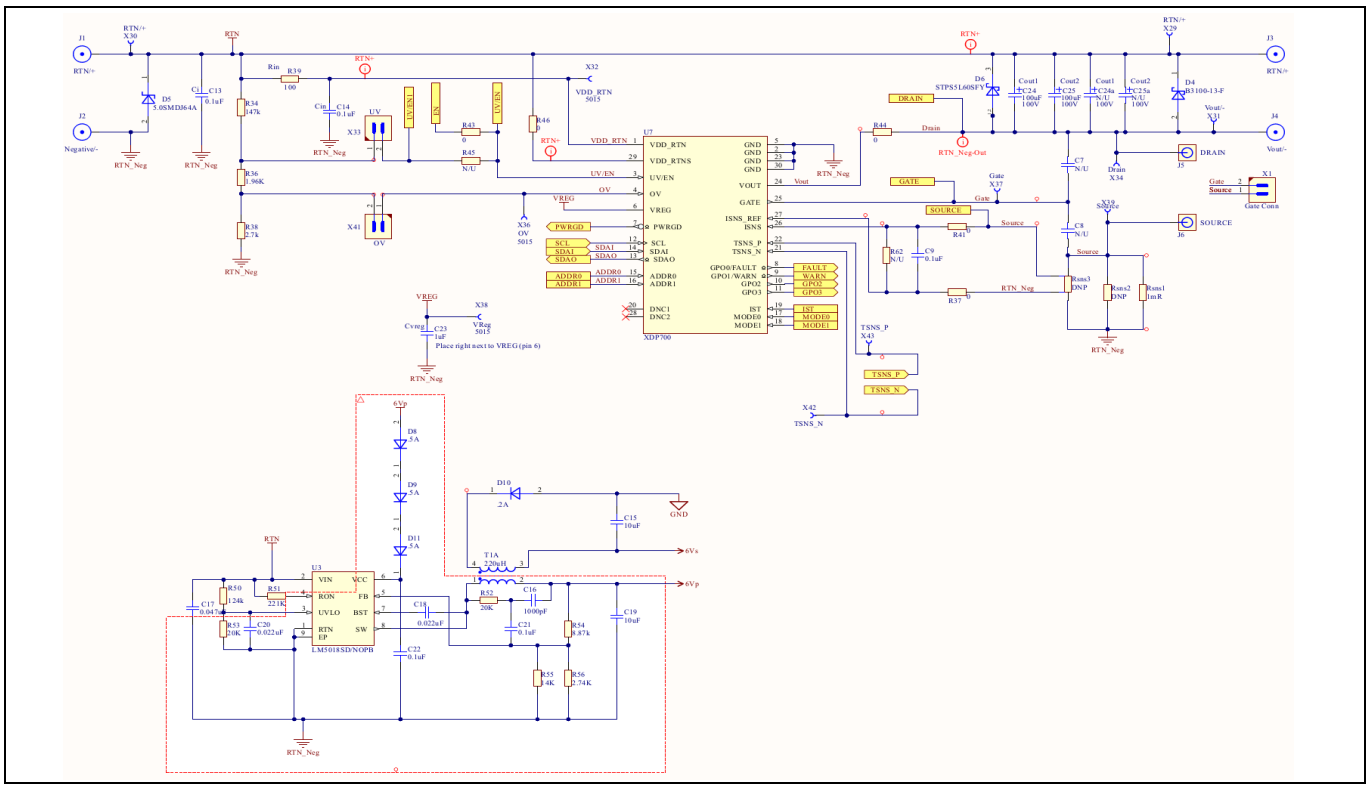

Figure 5 Main IC and bias

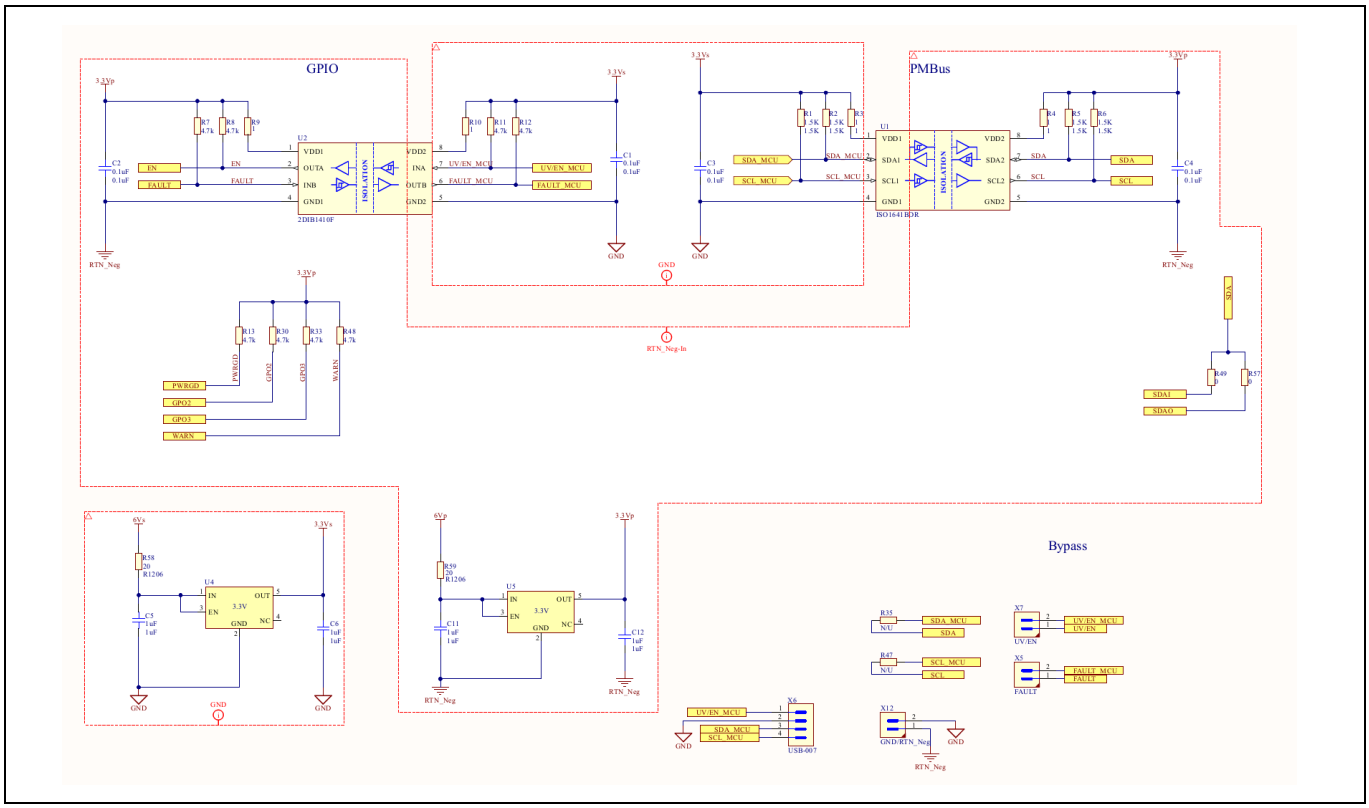

Figure 6 Communication and isolation

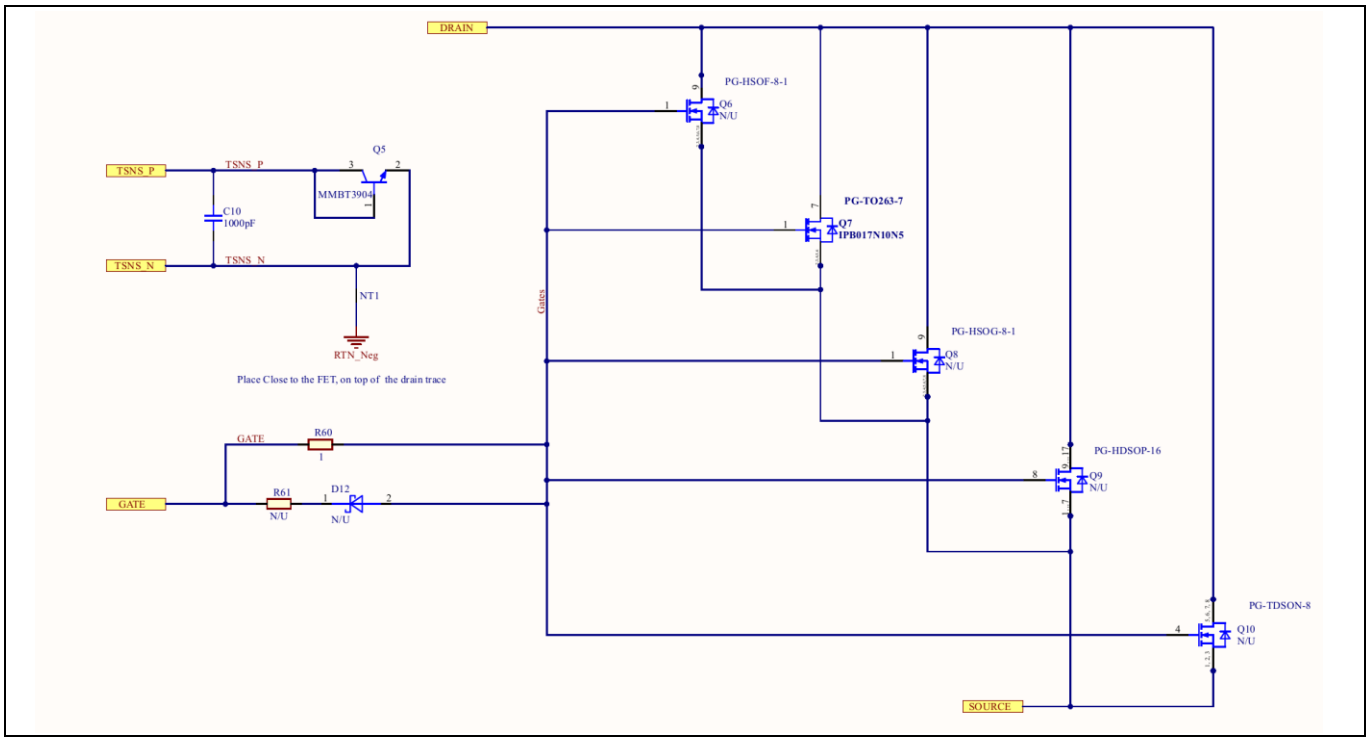

Figure 7 MOSFET

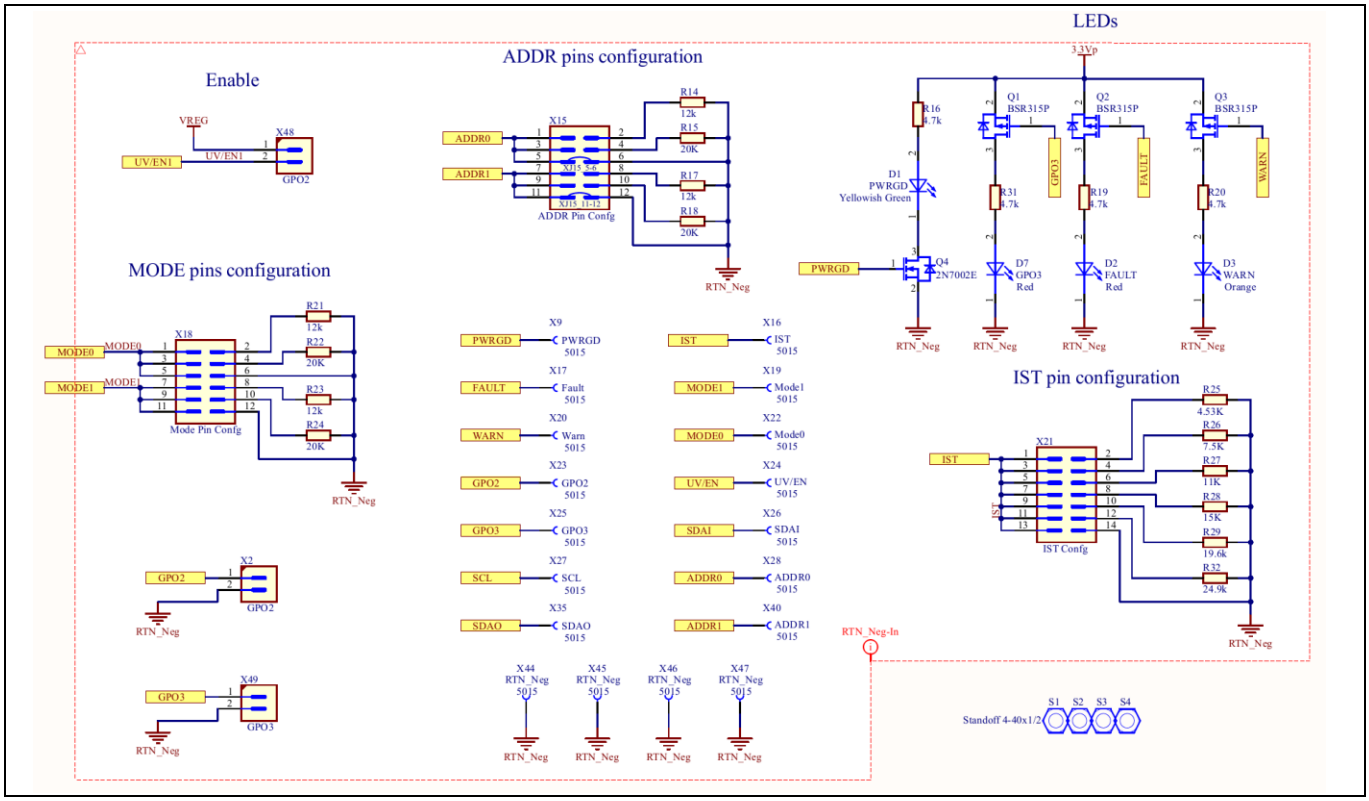

Figure 8 Configuration selection

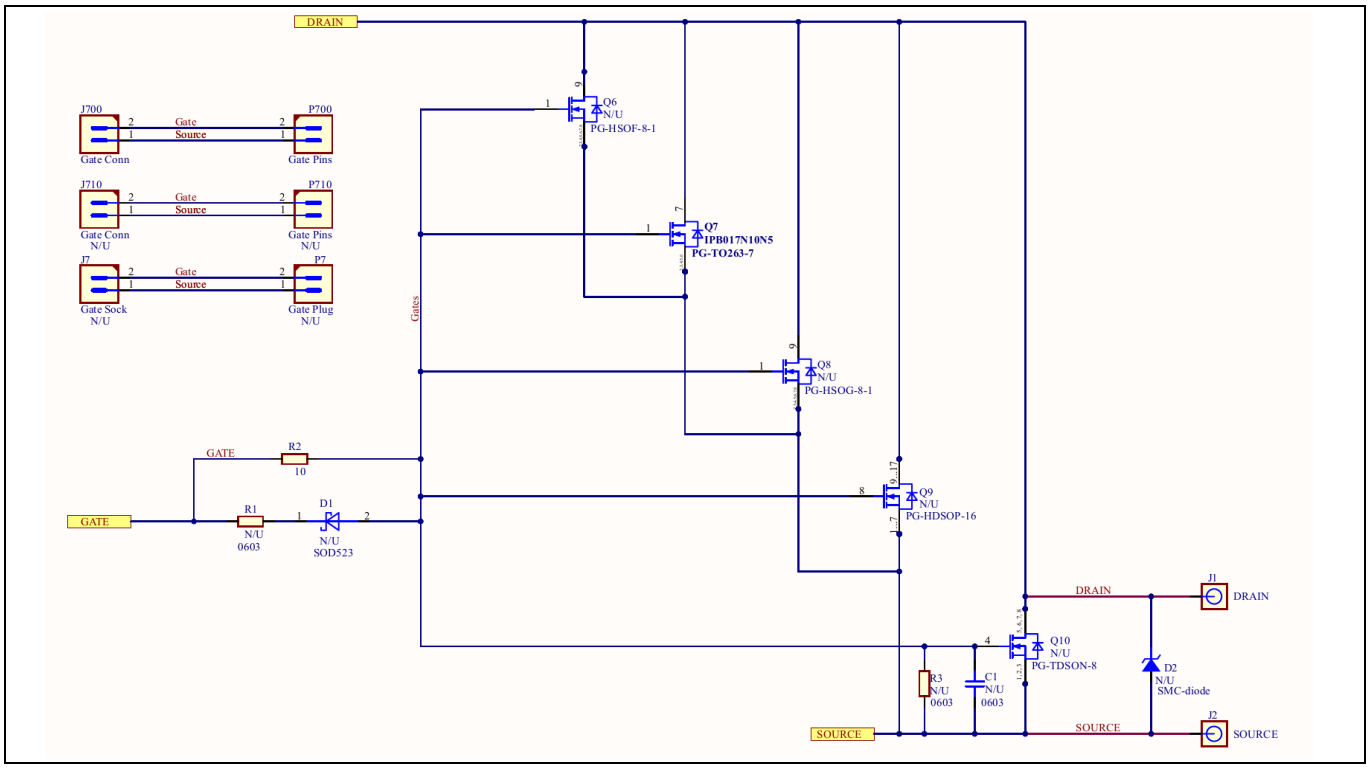

Figure 9 MOSFET PCBA

3.4 XDP700-002 Evaluation Board layout

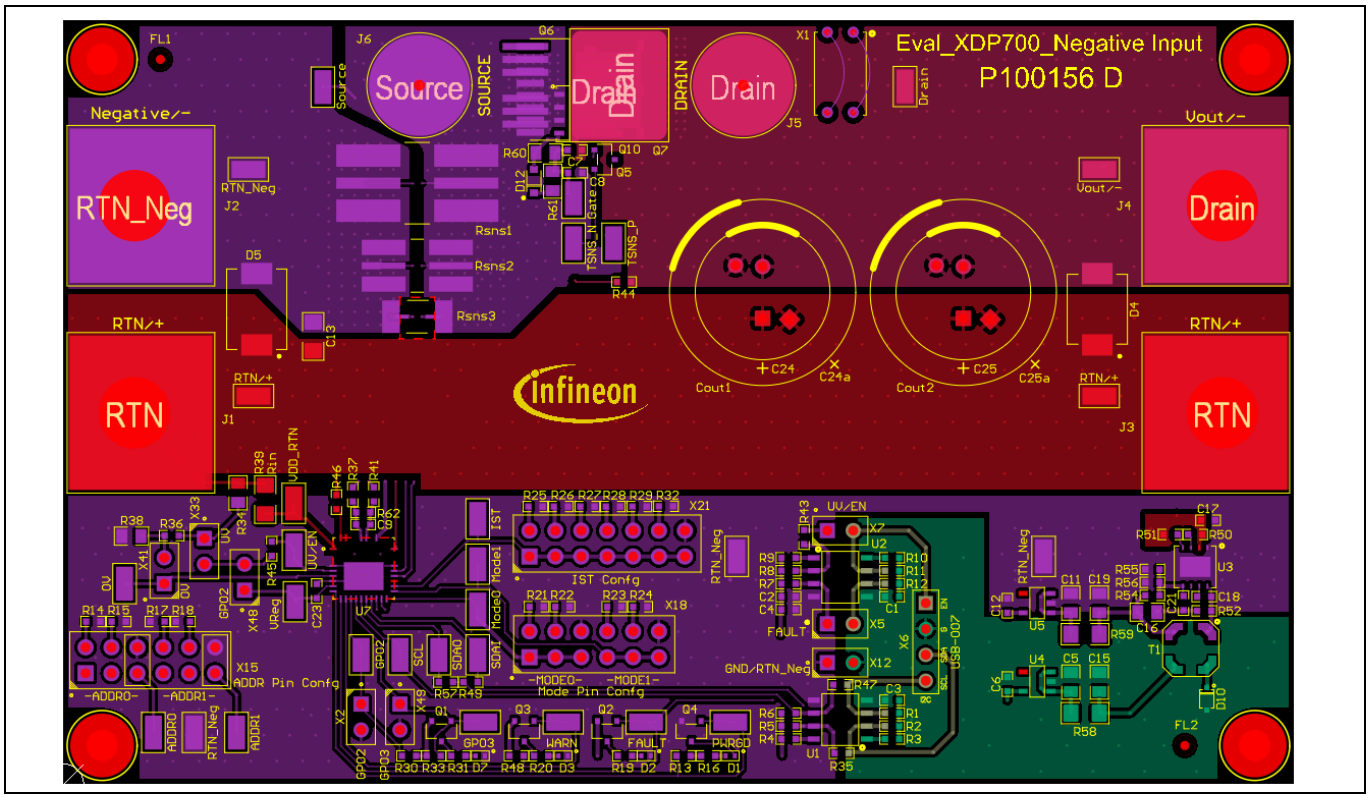

Figure 10 Top layer layout of main PCB

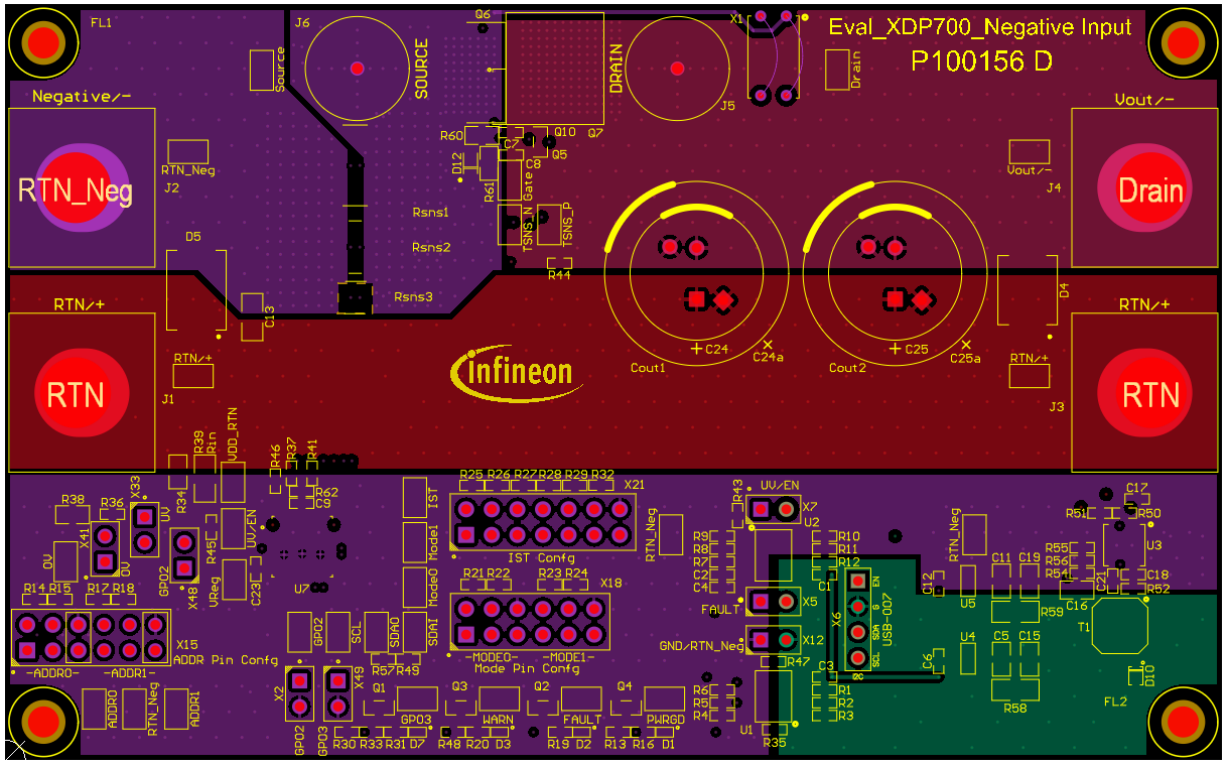

Figure 11 Mid 1 layer layout of main PCB

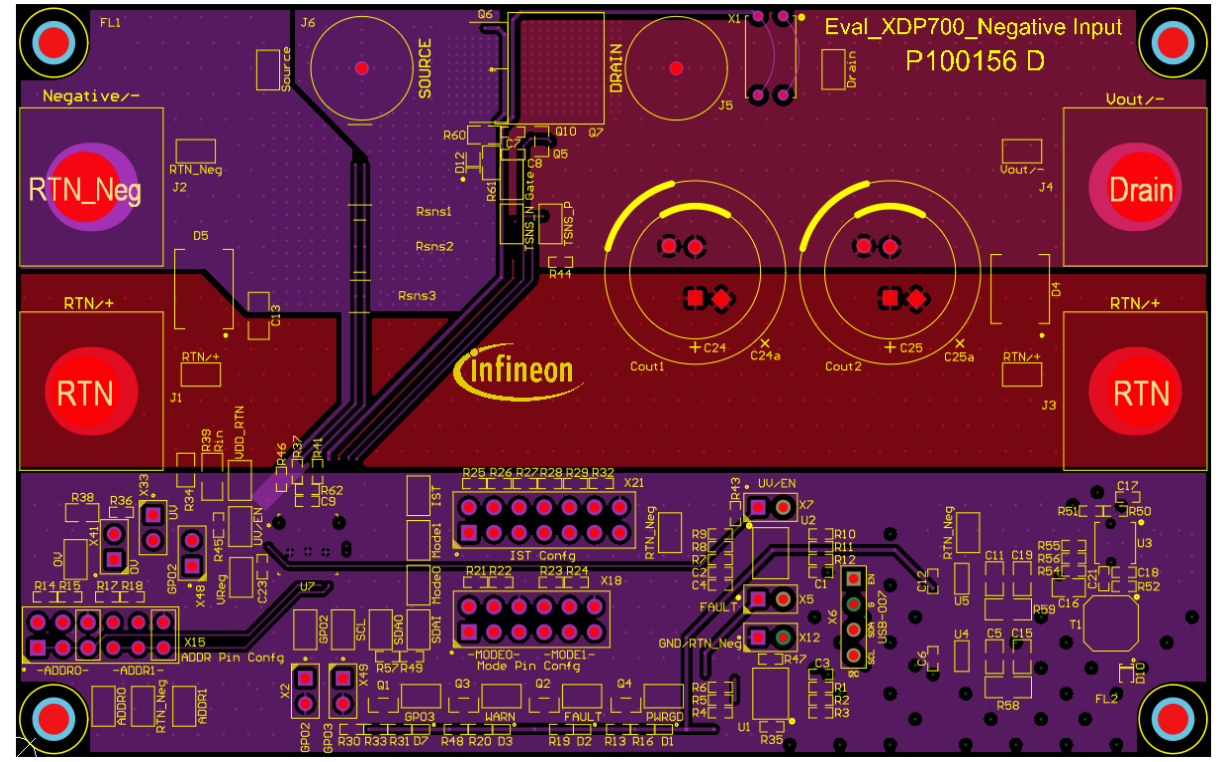

Figure 12 Mid 2 layer layout of main PCB

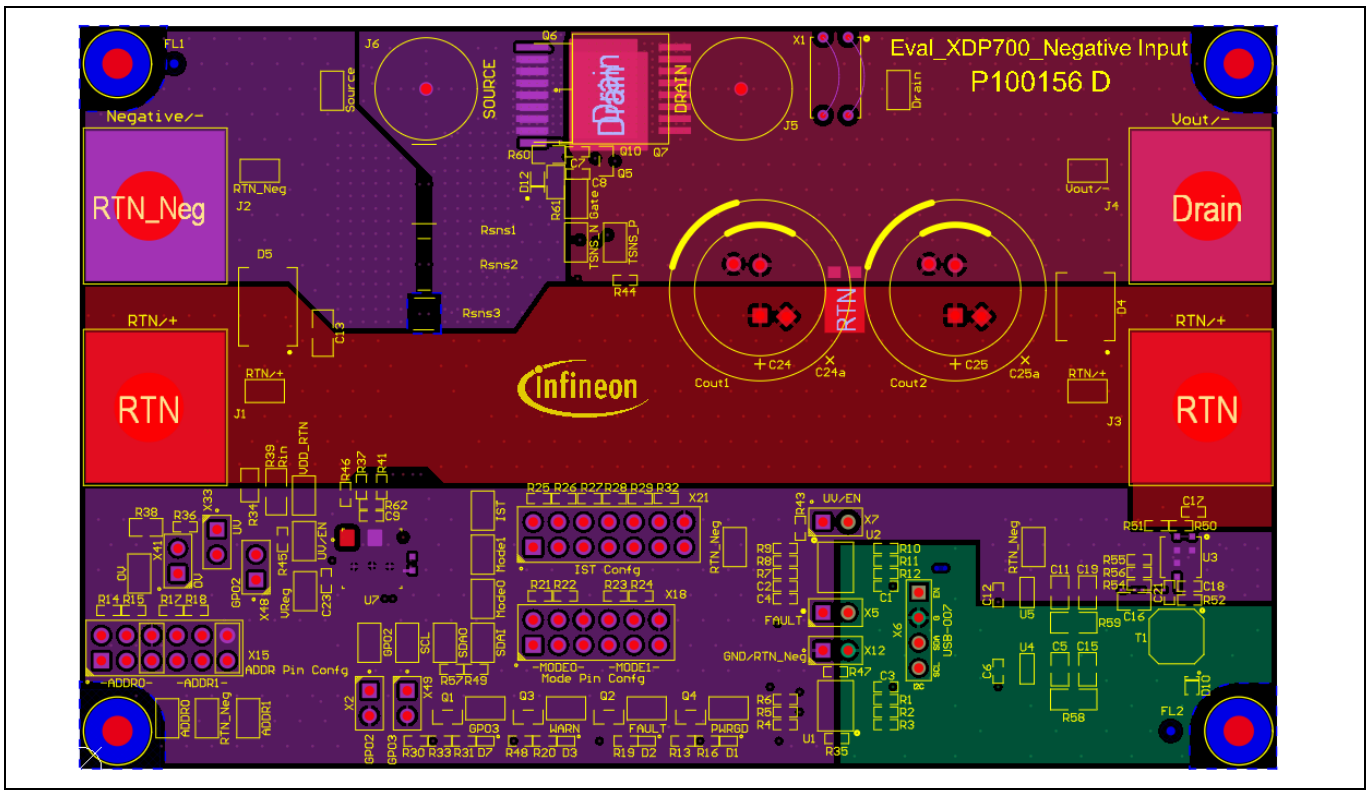

Figure 13 Bottom layer layout of main PCB

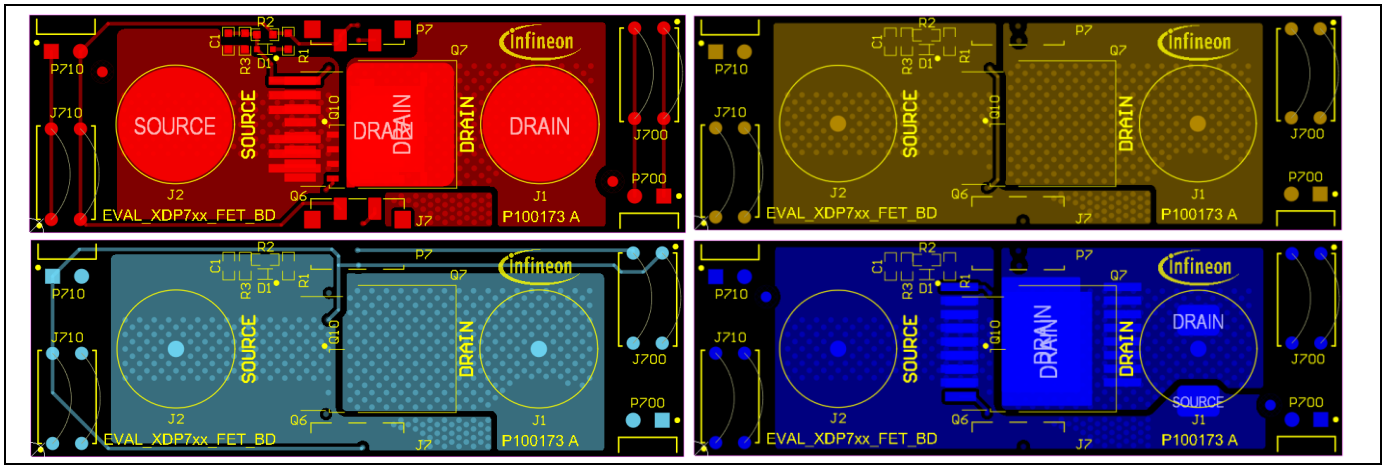

Figure 14 Top, Mid 1, Mid 2, and bottom layer layouts of MOSFET PCB

3.5 XDP700-002 Evaluation Board bill of materials

Table 2 Bill of materials (BOM) for the main PCBA

Item	Qty	Reference designator	Value	Footprint	Manufacturer	Part number
1	1	BRD1	PC Board (FAB)	–	–	P100156 D
2	7	C1, C2, C3, C4, C9, C21, C22	0.1 uF	C0603	AVX	06031C104K4Z2A
3	2	C5, C11	1 uF	C0805	TDK	C2012X7R1H105K125AB
4	3	C6, C12, C23	1 uF	C0603	TDK	C1608X7R1E105K080AB
5	1	C10	1000 pF	C0603	TDK	C1608C0G2A102J080AA
6	2	C13, C14	0.1 uF	C1206	TDK	C3216C0G2A104J160AE
7	2	C15, C19	10 uF	C0805	Samsung	CL21B106KOQNNNE
8	1	C16	1000 pF	C0805	TDK	C2012C0G2A102J060AA
9	1	C17	0.047 uF	C0603	TDK	C1608X7R1H473K080AA
10	2	C18, C20	0.022 uF	C0603	TDK	C1608X7R1H223K080AA
11	2	C24, C25	100 uF	Cap12p5x25mm	Panasonic	EEU-EE2C101
12	1	D1	Yellowish Green	LED-SMD-SMLP13BC8T	ROHM Semiconductors	SML-P11MTT86R
13	2	D2, D7	Red	LED-SMD-SMLP13BC8T	ROHM Semiconductors	SML-P11UTT86R
14	1	D3	Orange	LED-SMD-SMLP13BC8T	ROHM Semiconductors	SML-P11DTT86R
15	1	D4	B3100-13-F	DIOM7959X250N	Diodes Incorporated	B3100-13-F
16	1	D5	5.0SMDJ64A	DIOM7959X262N	Bourns	5.0SMDJ64A
17	1	D6	STPS5L60SFY	V10PL45-M3	STMicroelectronics	STPS5L60SFY
18	3	D8, D9,D11	.5A	SOD523	NXP	BAS516,135
19	1	D10	.2A	SOD323	On	BAS20HT1G
20	4	J1, J2, J3, J4	PEM NUT 8-32	Screw and nut for JACK1	Penn Eng	P-KF2-832-ET
21	2	J5,J6	7466105R	CON-MOSFET	Würth Elektronik	7466105R

XDP700-002 evaluation platform

Item	Qty	Reference designator	Value	Footprint	Manufacturer	Part number
22	3	Q1, Q2, Q3	BSR315P	SOT23	Infineon Technologies	BSR315P
23	1	Q4	2N7002E	sot23	On	2N7002ET1G
24	1	Q5	MMBT3904	Sot23	Nexperia	MMBT3904,215
25	1	Q7	IPB017N10N5	PG-TO263-7	Infineon Technologies	IPB017N10N5ATMA1
26	4	R1, R2, R5, R6	1.5K	R0603	Panasonic	ERJ-3EKF1501V
27	4	R3, R4, R9, R10	1	R0603	Panasonic	ERJ-3GEYJ1R0V
28	12	R7, R8, R11, R12, R13, R16, R19, R20, R30, R31, R33, R48	4.7k	R0603	Yageo	RC0603FR-074K7L
29	4	R14, R17, R21, R23	12k	R0603	Vishay	CRCW060312K0FKEAC
30	6	R15, R18, R22, R24, R52, R53	20K	R0603	Panasonic	ERJ-3EKF2002V
31	1	R25	4.53K	R0603	Panasonic	ERJ-3EKF4531V
32	1	R26	7.5K	R0603	Panasonic	ERJ-3EKF7501V
33	1	R27	11K	R0603	Panasonic	ERJ-3EKF1102V
34	1	R28	15K	R0603	Panasonic	ERJ-3EKF1502V
35	1	R29	19.6k	R0603	Vishay	CRCW060319K6FKEA
36	1	R32	24.9k	R0603	Vishay	CRCW060324K9FKEA
37	1	R34	147k	R0805	Vishay	CRCW0805147KFKEA
38	1	R36	1.96K	R0603	Panasonic	ERJ-3EKF1961V
39	7	R37, R41, R43, R44, R46, R49, R57	0	R0603	Panasonic	ERJ-3GEY0R00V
40	1	R38	2.7k	R0805	Vishay	CRCW08052K70FKEA
41	1	R39	100	R1206	Panasonic	ERJ-8ENF1000V
42	1	R50	124k	R0603	Vishay	CRCW0603124KFKEA
43	1	R51	221K	R0603	Panasonic	ERJ-3EKF2213V

XDP700-002 evaluation platform

Item	Qty	Reference designator	Value	Footprint	Manufacturer	Part number
44	1	R54	8.87k	R0603	Vishay	CRCW06038K87FKEA
45	1	R55	14k	R0603	Panasonic	ERJ-3EFK1402V
46	1	R56	2.74K	R0603	Panasonic	ERJ-3EKF2741V
47	2	R58, R59	20	R1206	Panasonic	ERJ-8GEYJ200V
48	1	R60	1	R0805	Panasonic	ERJ-6RQF1R0V
49	1	Rsns1	1mR	5930	Bourns	CSS2H-5930K-1L00F
50	1	Rsns2	1mR	3920	Bourns	Not Used
51	1	Rsns3	0.5uR	2512	Bourns	Not Used
52	1	T1	220uH	LPD5030V	Coilcraft	LPD5030V-224MRC
53	1	U1	ISO1641B	SO8	TI	ISO1641BDR
54	1	U2	2DIB1410F	SO8	Infineon	2DIB1410FXUMA1
55	1	U3	LM5018SD/NOPB	WSON-8	Texas Instruments	LM5018SD/NOPB
56	2	U4, U5	3.3 V	SOT23-5	STMicroelectronics	LDK320AM33R
57	1	U7	XDP700-002	IFX-PG-VQFN-29-1	Infineon Technologies	XDP700-002
58	1	X1	CON4-H	CON2_HZ_BCS-102-X-S-HE	Samtec	BCS-102-F-S-HE
59	8	X2, X5, X7, X12, X33, X41, X48, X49	CON2	CON-M-THT-M20-9770246_2	Harwin	M20-9770246
60	1	X6	CON4	CONN4PIN100	Würth Elektronik	61300411121
61	29	X9, X16, X17, X19, X20, X22, X23, X24, X25, X26, X27, X28, X29, X30, X31, X32, X34, X35, X36, X37, X38, X39, X40, X42, X43, X44, X45, X46, X47	TP SMD	CON-SMD-TP-5015	Keystone Electronics	5015
62	2	X15, X18	CON12	CON-M-THT-TSW-106-07-L-D	Samtec	TSW-106-07-L-D
63	1	X21	CON14	CON-M-THT-HTSW-107-07-L-D	Samtec	HTSW-107-07-L-D

Item	Qty	Reference designator	Value	Footprint	Manufacturer	Part number
64	4	S1a, S2a, S3a, S4a	Screw PHMS 4-40 x 1/4	–	Keystone	9900
65	4	S1, S2, S3, S4	Standoff 4-40x1/2	mtg_hole_125	Keystone	2203
66	2	C7, C8	N/U	C0603	TDK	Not used
67	2	C24a, C25a	N/U	CAP18X46mm	Nichicon	Not used
68	1	D12	N/U	DO-219AC	Vishay	Not used
69	1	Q6	N/U	PG-HSOF-8-1	Infineon Technologies	Not used
70	1	Q8	N/U	PG-HSOG-8-1	Infineon Technologies	Not used
71	1	Q9	N/U	PG-HDSOP-16	Infineon Technologies	Not used
72	1	Q10	N/U	PG-TDSON-8_1	Infineon Technologies	Not used
73	4	R35, R45, R47, R62	N/U	R0603	Yageo	Not used
74	1	R61	N/U	R0805	Panasonic	Not used

Table 3 BOM for MOSFET PCBA

Item	Qty	Reference designator	Value	Footprint	Manufacturer	Part number
1	1	BRD1	PC Board (FAB)	–	–	P100173 A
2	2	J1, J2	SO-SMD-M5-FEMALE	CON-MOSFET	Würth Elektronik	7466105R
3	1	J700	CON4-H	CON2_HZ_BCS-102-X-S-HE	Samtec	BCS-102-F-S-HE
4	1	P700	CON2	CON2_RA_TSW-102-08-F-S-RA	Samtec	TSW-102-08-F-S-RA
5	1	Q7	IPB017N10N5	PG-TO263-7	Infineon Technologies	IPB017N10N5ATMA1
6	1	R2	10	R0603	Panasonic	ERJ-3EKF10R0V
7	1	C1	N/U	C0603	TDK	Not used
8	1	D1	N/U	SOD523	On	Not used
9	1	D2	N/U	SMC-diode	Littelfuse	Not used
10	1	J7	N/U	CON2_SMD_AVX-20-9159	KYOCERA AVX	Not used
11	1	J710	N/U	CON2_HZ_BCS-102-X-S-HE	Samtec	Not used
12	1	P7	N/U	CON2_SMD_AVX-10-9159	KYOCERA AVX	Not used

Item	Qty	Reference designator	Value	Footprint	Manufacturer	Part number
13	1	P710	N/U	CON2_RA_TSW-102-08-F-S-RA	Samtec	Not used
14	1	Q6	N/U	PG-HSOF-8-1	Infineon Technologies	Not used
15	1	Q8	N/U	PG-HSOG-8-1	Infineon Technologies	Not used
16	1	Q9	N/U	PG-HDSOP-16	Infineon Technologies	Not used
17	1	Q10	N/U	PG-TDSON-8_1	Infineon Technologies	Not used
18	1	R1	N/U	R0603	Panasonic	Not used
19	1	R3	N/U	R0603	Panasonic	Not used

3.6 XDP700-002 Evaluation Board default settings

See the jumpers on the board as shown in Table 4.

Table 4 Jumper settings

Reference designator	Default configuration	Usage
X48	Open	**Shorted 1 to 2**: Connects UV/EN to VREG **Open**: UV/EN can be driven by dongle
X15	Between Pin 5 and 6 and in between Pins 11 and 12	ADDRx pins configuration to 0x10. Move the jumper to change the PMBus address.
X18	Open	MODEx pins configuration. Leave them open for fully digital mode (FDM)
X21	Open	IST pin configuration
X33	Open	**Shorted**: Connects UV/EN to voltage divider **Open**: UV/EN can be driven by Vreg or dongle
X6	Open	**Shorted**: Bypass isolation between UV/EN and UV/EN_MCU
X5	Open	**Shorted**: Bypass isolation between FAULT and FAULT_MCU
X12	Open	**Shorted**: Connects RTN_Neg and GND together and bypass isolation
X2	Open	**Shorted**: Connects GPO2 to GND (used to test CGDN application)
X49	Open	**Shorted**: Connects GPO3 to GND (used to test PMBUS Disable application)
X41	Open	**Shorted**: Connects OV to voltage divider **Open**: This header can be left open for DCM

Table 5 Resistors and capacitors

Reference designator	Default configuration	Notes
R44	Check depending on FET	–
C7, C8	DNF	C_{gd} and C_{gs} of FET
R37, R41	Check depending on sense resistor	Can be populated: 10 Ω
C9	Max 100 nF	R_{sns} filter
R62	DNF	Used to modify the gain of R_{sns} for accurate telemetry
C10	1 nF	Temperature sensor filter
R43	0 Ω	**Populate**: If EN is driven by dongle **DNF**: If EN is driven by header X48
R45	DNF	**Populate**: If EN is driven by header X48 **DNF**: If EN is driven by dongle
Rin	100 Ω	Or lower depending on test slew rate requirements

3.7 Current sensing resistor (R_{sns})

The following three footprints are provided to support different resistor sizes, with the default onboard resistor of 1 mΩ. These footprints are optimized for resistor packages:

- R_{sns1}: 5930, 5931
- R_{sns2}: 3920, 3921, 2818
- R_{sns3}: 2512

3.8 FET board

The XDP700-002 Evaluation Board comes with an option to parallel up to three FET boards to increase the current-carrying capability for testing heavy loads. This allows the board to drive multiple parallel N-channel MOSEFTs. Necessary heatsinking is provided via a copper bus bar; forced cooling is required if operating at currents greater than 50 A.

3.9 Different FET footprint options on the FET board

The FET footprint supports D^2PAK, TOLL, and TDSON packages in the following positions:

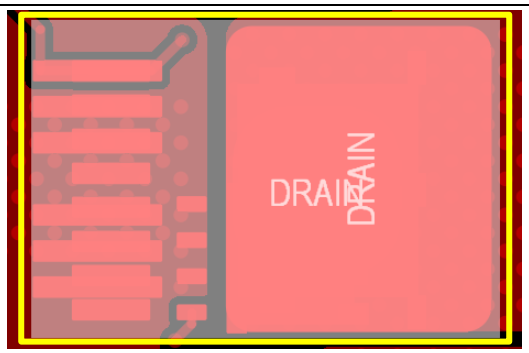

Figure 15 D2PAK7 position (top side)

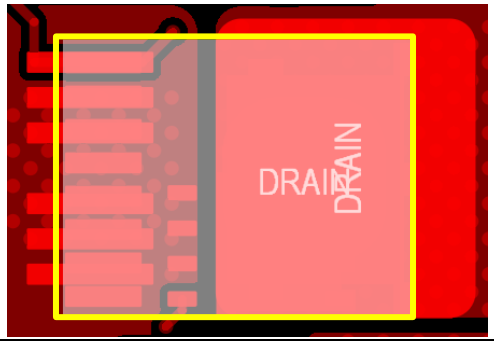

Figure 16 TOLL position (top side)

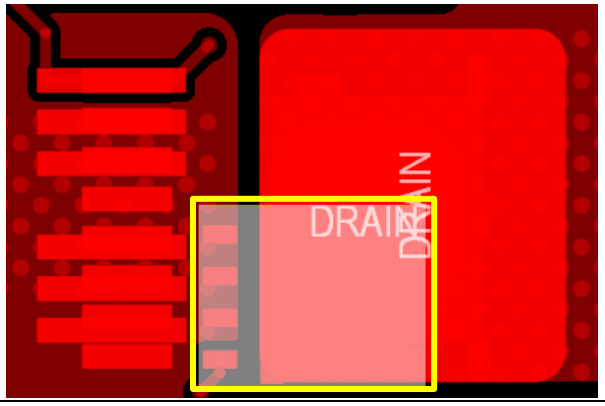

Figure 17 PG-TDSON-8-1 position (top side)

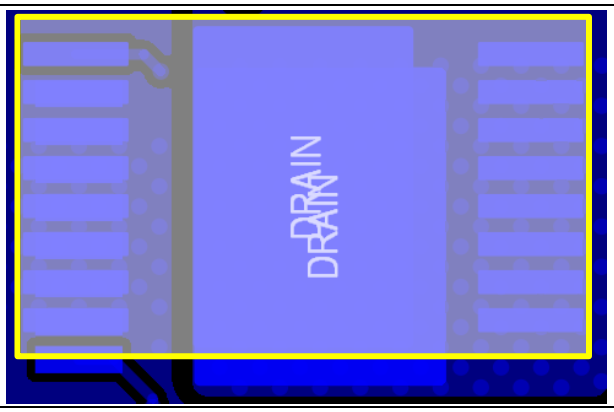

Figure 18 PG-HDSOP-16 position (bottom side)

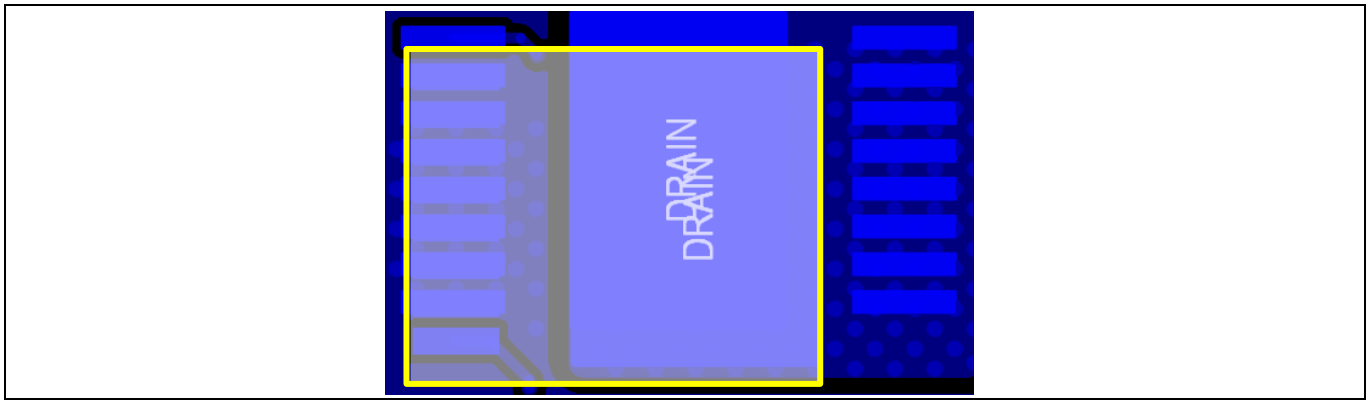

Figure 19 PG-HSOG-8-1 position (bottom side)

3.10 USB007A dongle schematics

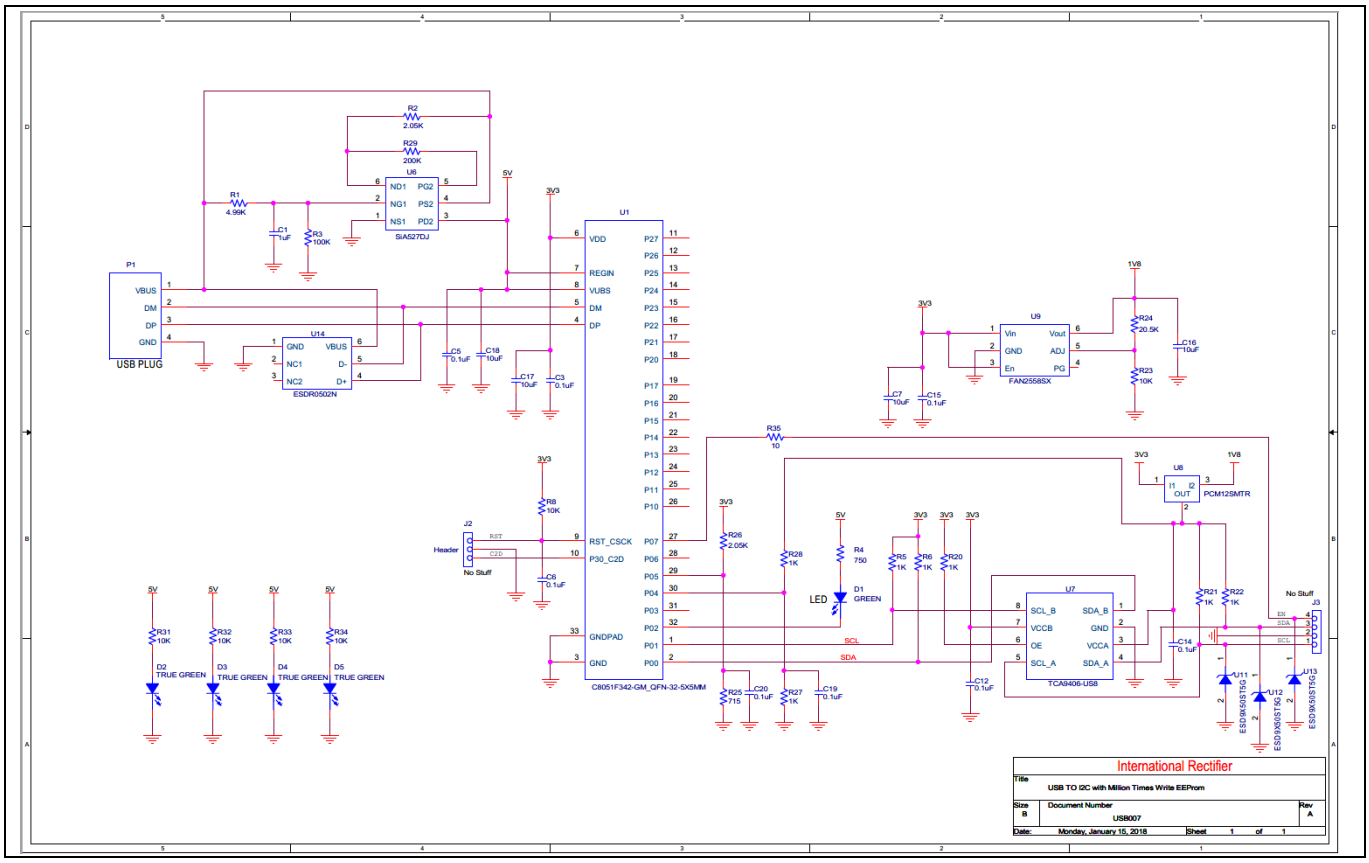

Figure 20 USB007A1 dongle schematic

4 Programming, setup, and turn-on instructions

Set up the system as follows:

1. Connect the USB007 dongle to the XDP700-002 Evaluation Board connector X6 as shown in Figure 21.
2. Connect the USB007 dongle to the PC USB port.
3. Ensure that the jumpers are connected properly.
4. Connect 48 V from RTN/+ (J1 connector) to Negative/- (J2) on the left of the board.

XDP700-002 powers up as soon as RTN/+ is equal to or greater than 9 V. At this point, communication and programming is possible, but the FET will be OFF. To turn ON the FET, a minimum of 14 V is required. After turn on, at least the following registers must be programmed to turn ON the device.

- FET select
- R_{sns}

The UV/EN signal (signal used to enable or disable the hot-swap controller) can be controlled in one of the following ways:

- Controlled by a dongle; it will hold the signal down until it is toggled manually inside the GUI as shown in Figure 40.
- Controlled by the UV/EN1 signal, which is controlled by the X48 header. It must be held LOW until the necessary registers are written.

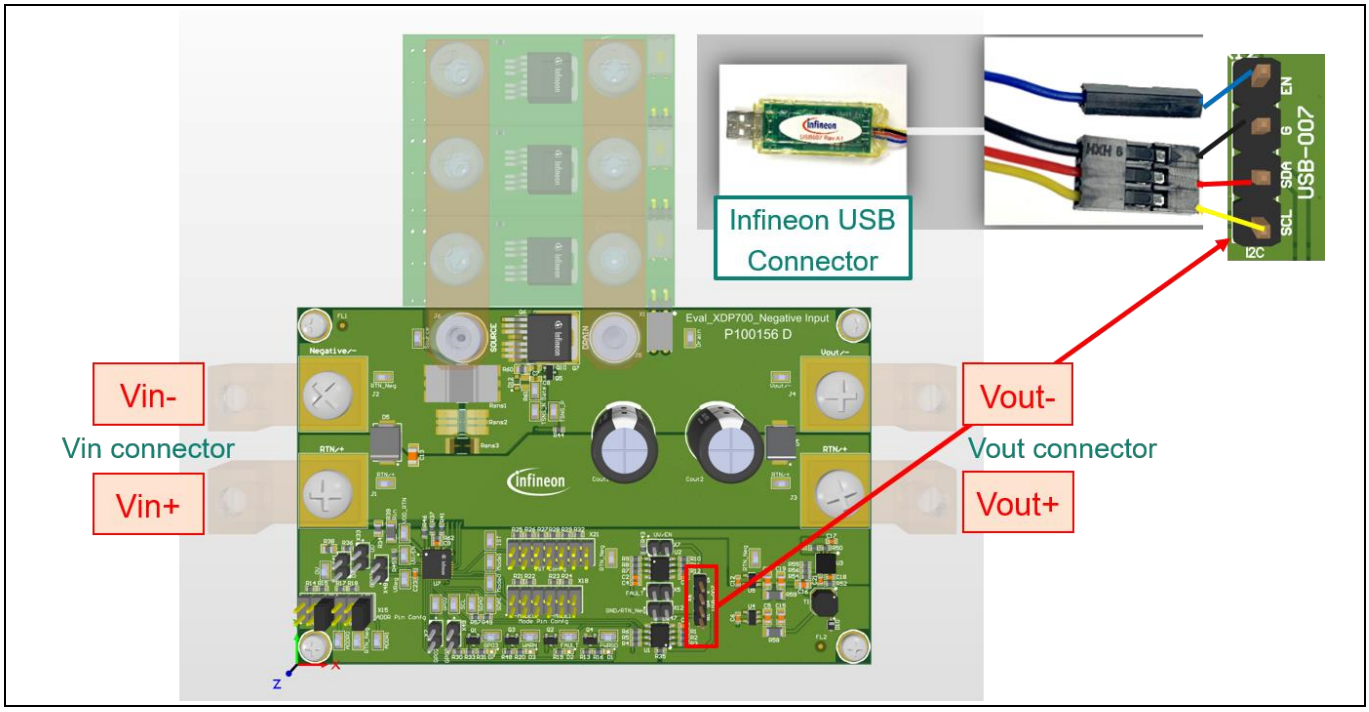

Figure 21 XDP700-002 Evaluation Board and dongle setup

4.1 XDP™ Designer communication setup

Install XDP™ Designer from the Infineon Development Center.

4.1.1 Dongle connection in XDP™ Designer

1. Open XDP™ Designer.
2. Wait for a few moments and check the bottom status bar for the dongle connection.
   When the dongle is detected, the highlighted area shown in Figure 22 turns green and displays **USB007**.
3. Ensure that the enable signal is LOW (EN L); if not, click on it to toggle to **EN L** from EN H.

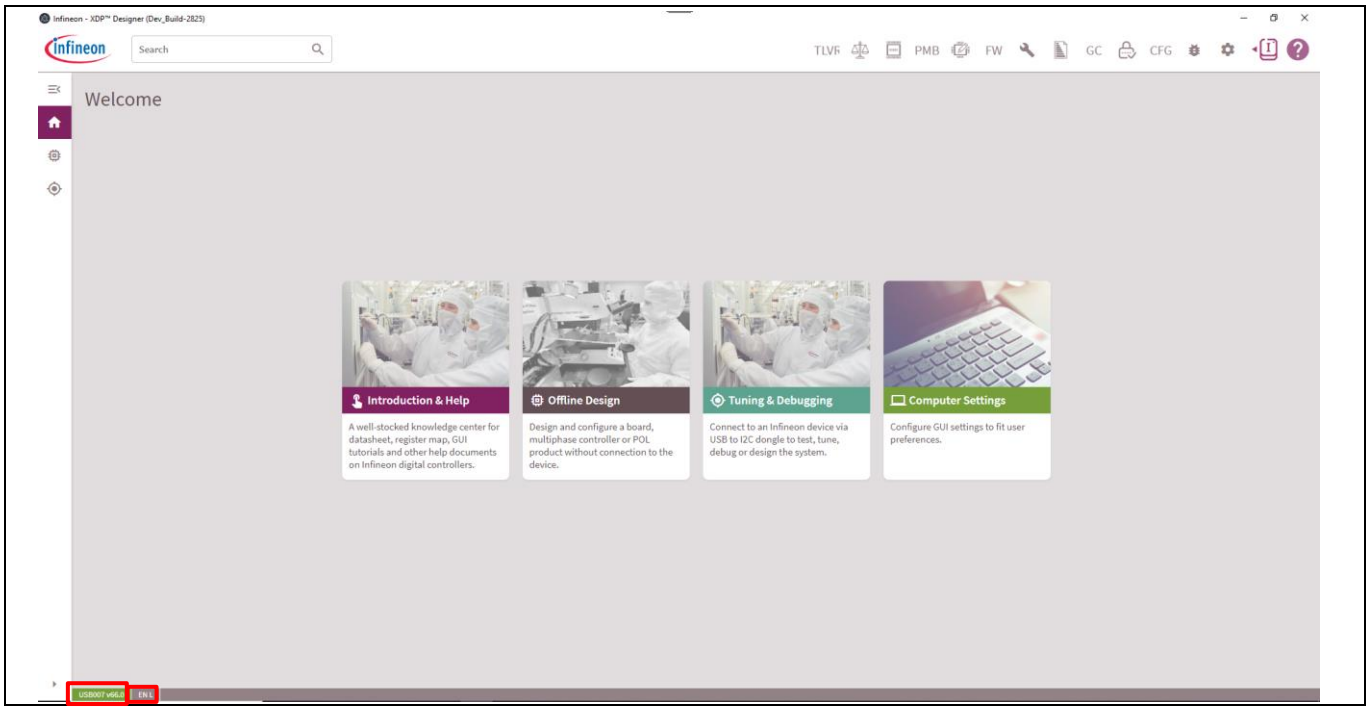

Figure 22 USB007A1 detection on XDP™ Designer

4.1.2 Detecting XDP700-002

1. Click the button highlighted in Figure 23 and then wait for a few seconds to detect the device. If the device is not detected on its own, click on **Scan For Devices**, as shown in Figure 24.

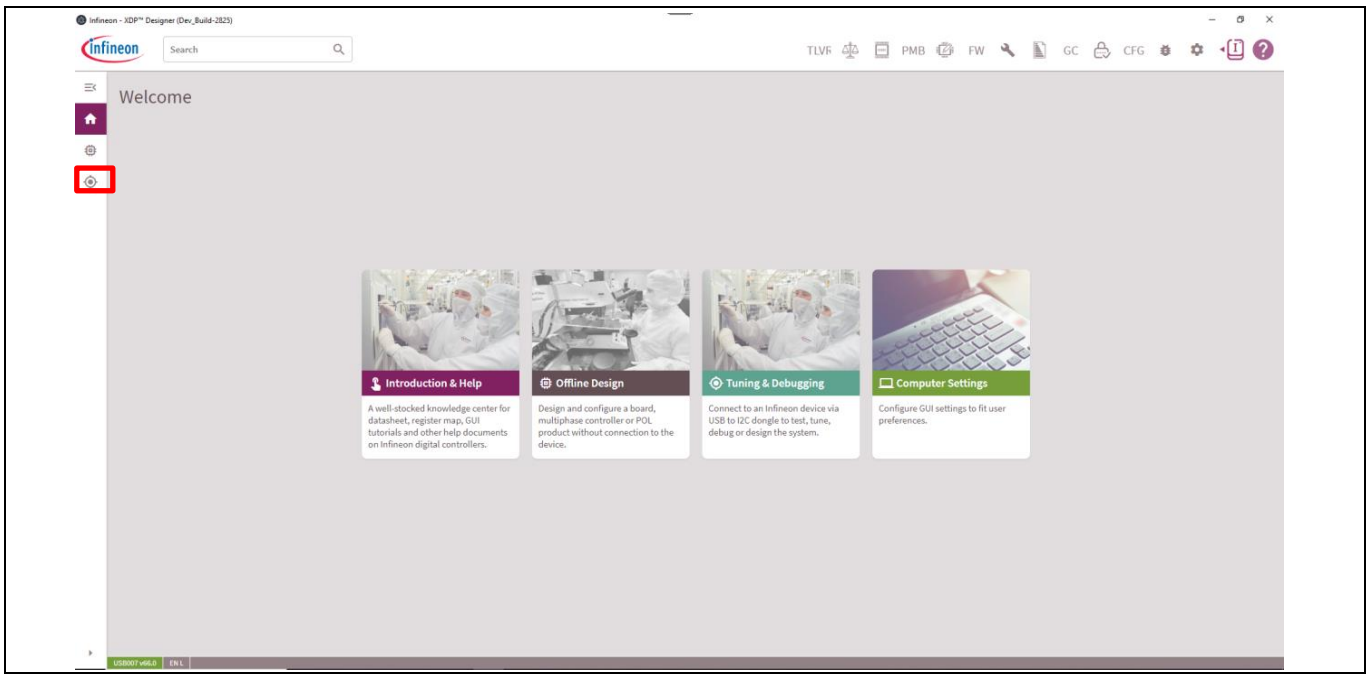

Figure 23 XDP700-002 detection

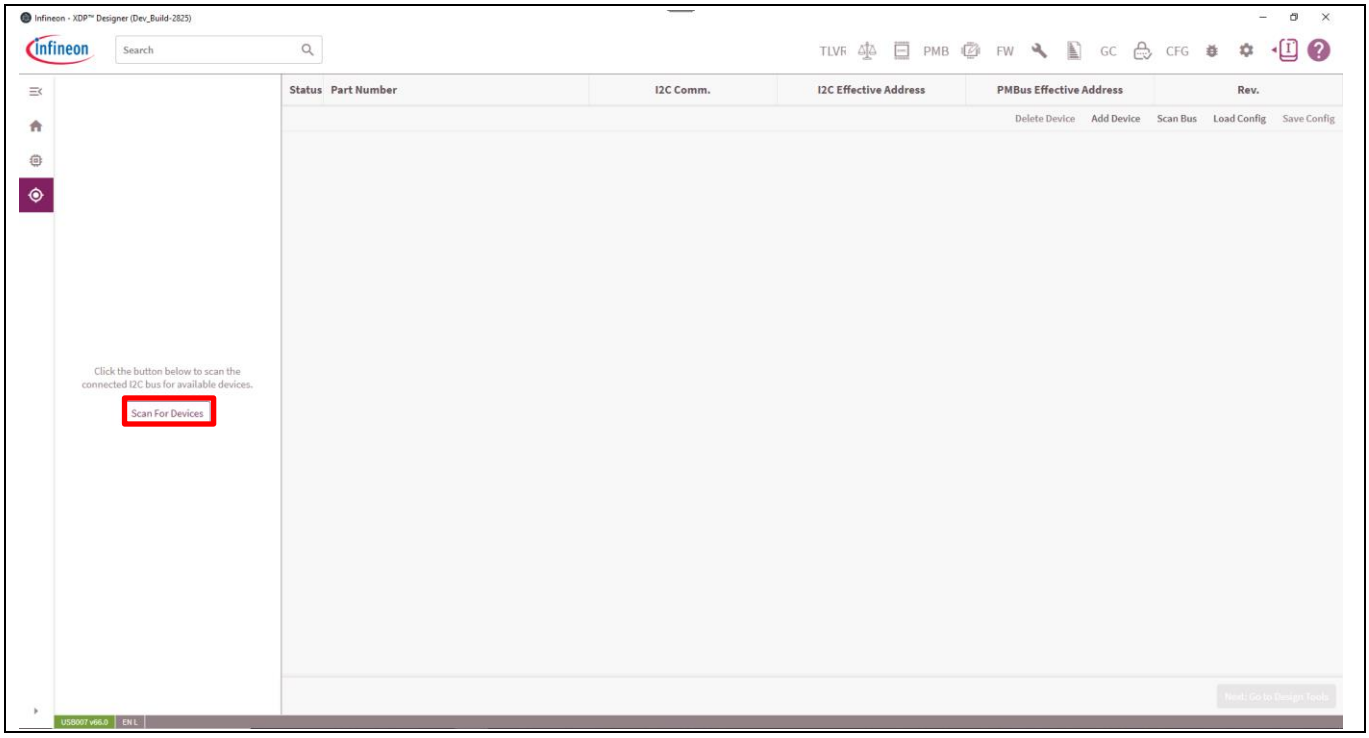

Figure 24 Scan For Devices to find XDP700-002

XDP700V002 is detected, with **Telemetry** displayed on the left as shown in Figure 25.

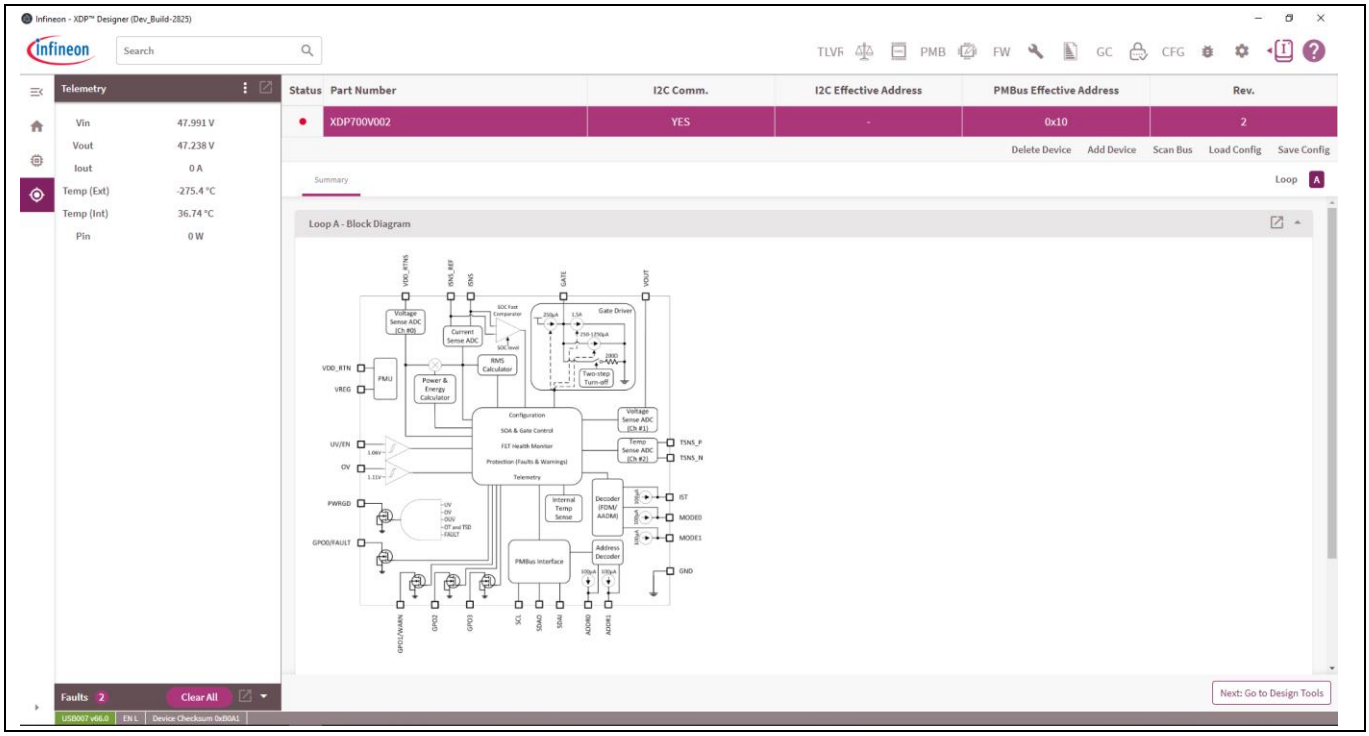

Figure 25 Live telemetry of the connected XDP700-002

2. Click the **PMB** button to view PMBus registers and their stored values. See Figure 26.

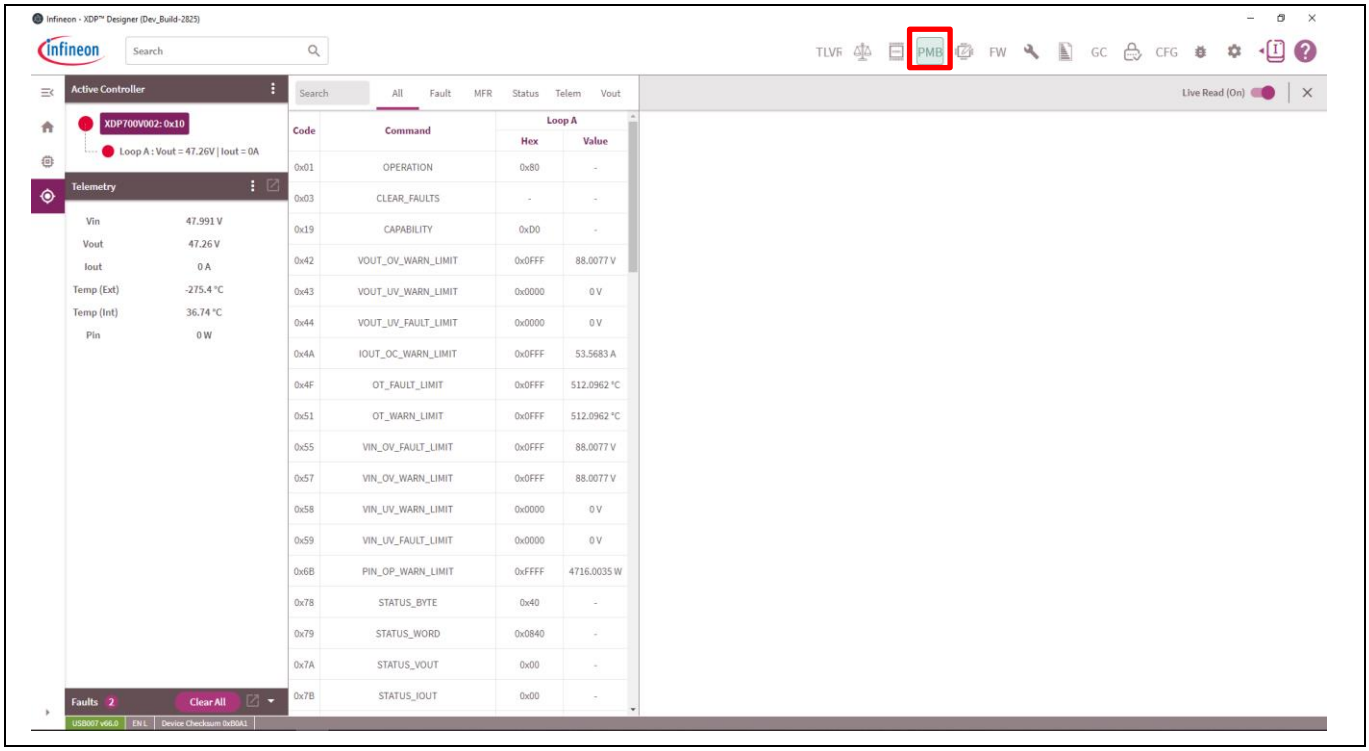

Figure 26 XDP™ Designer displaying PMBus registers of connected XDP700-002

4.1.3 Reading and writing registers

1. To edit a register individually, click on the corresponding PMBus register.
2. Make the necessary changes, and then click **Write**. See Figure 27.

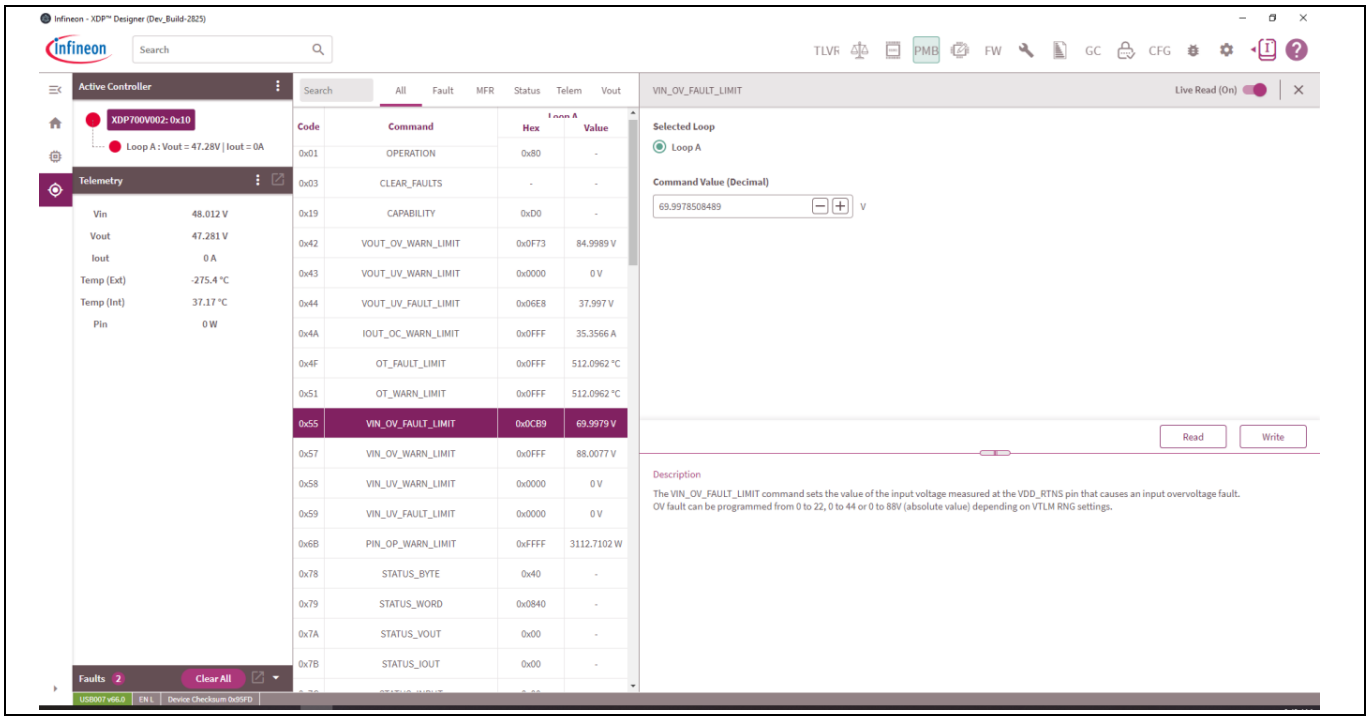

Figure 27 Editing VIN_OV_FAULT_LIMIT

Most of the registers are updated automatically.

3. To read the latest register values, click **Read**. See Figure 28.

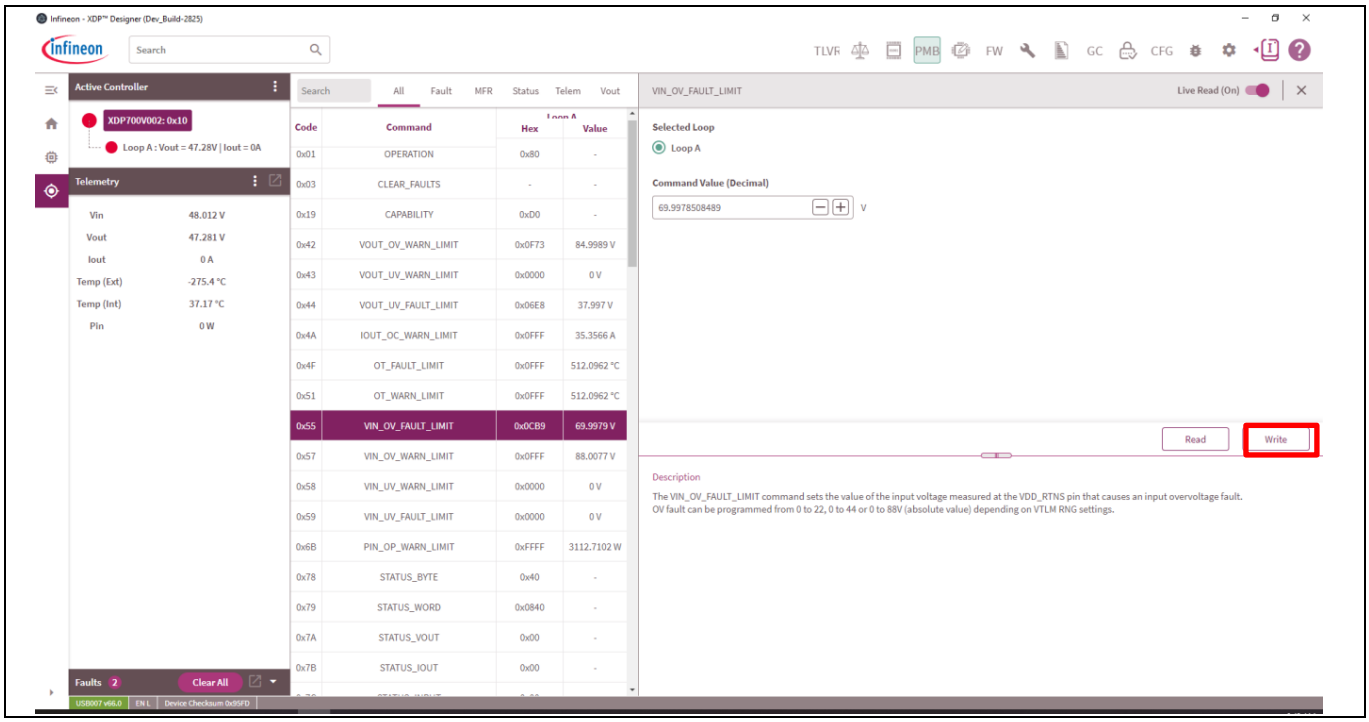

Figure 28 Reading VIN_OV_FAULT_LIMIT

4.1.4 Programming the FET

Note: This section is applicable only if fully digital mode (FDM) is used. If using analog-assisted digital mode (AADM), the FET will be pre-programmed. These modes are discussed in detail in Section 4.2. You can skip this step in that case.

If FDM is used, the FET must be programmed in the FET_SELECT bits of the MODE register (0xD1) according to the one populated on the board. The board has the **IPB017N10N5** FET populated.

1. Select the **IPB017N10N5** FET.
2. Modify the FET_SELECT bit to 0xB, and then click **Write**. See Figure 29.

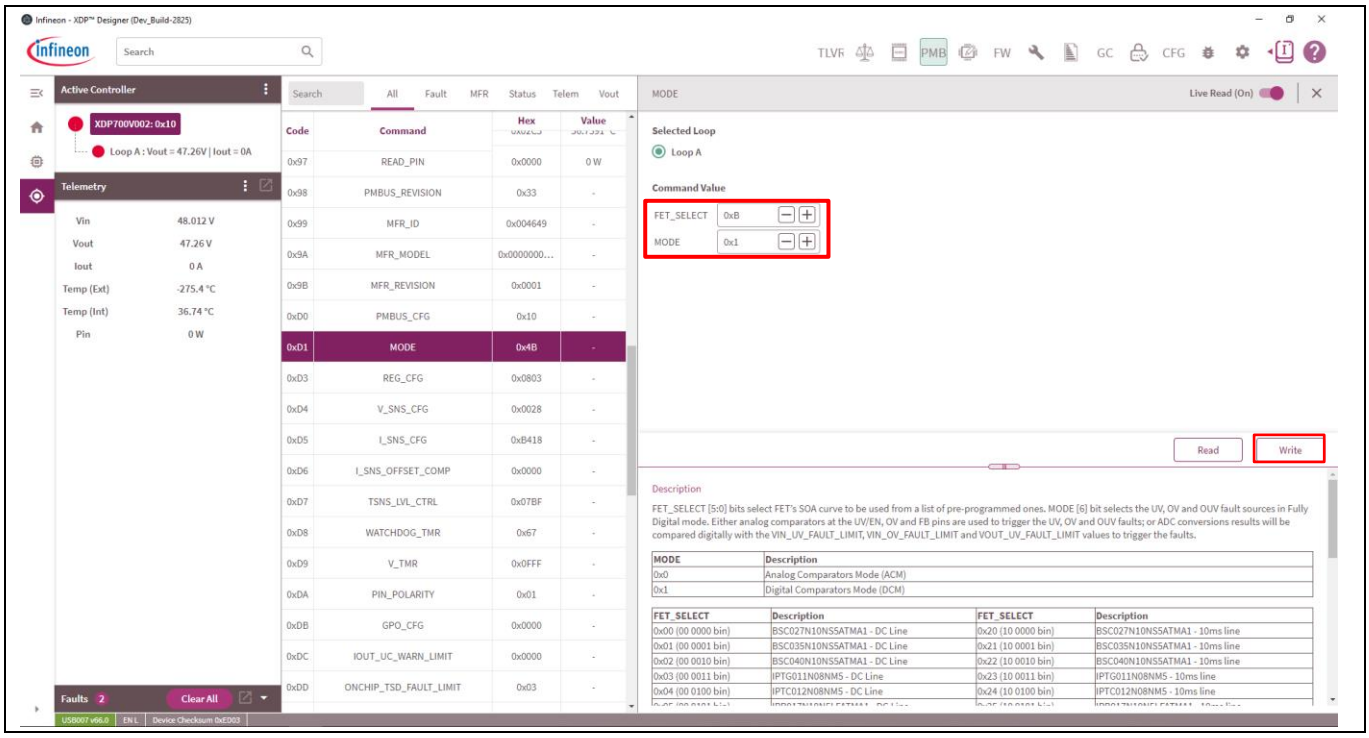

Figure 29 FET selection in FDM

4.1.5 Programming R_{sns}

The sense resistor value must be programmed in the R_{sns} bits of the REG_CFG register according to the one populated on the board. The board has R_{sns} of **1 mΩ** populated.

1. Select the 1 mΩ resistor.
2. Modify the R_{sns} bit to 0xD, and then click **Write**. See Figure 30.

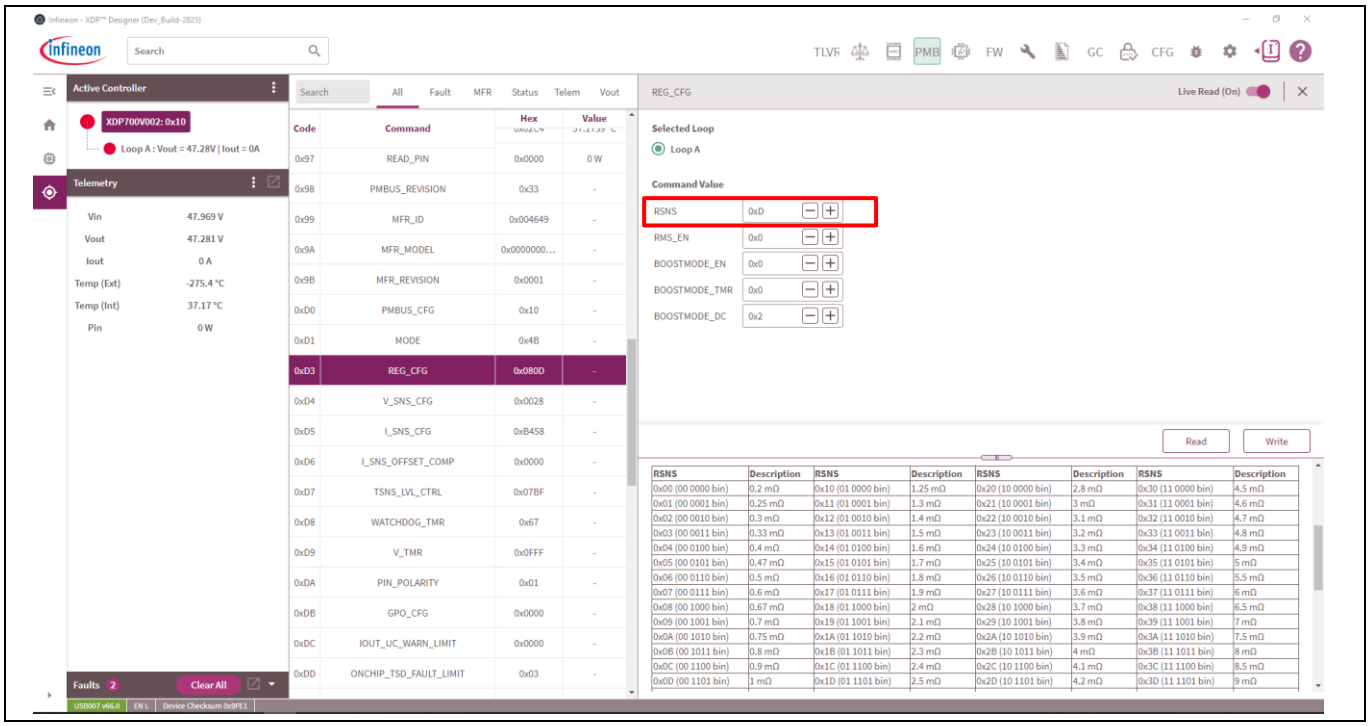

Figure 30 R_{sns} selection

4.1.6 Selecting the watchdog timer

Set the watchdog timer higher than the turn-on time to ensure that the watchdog timer does not expire before the turn-on. At the same time, ensure that the watchdog timer is not set much longer than the turn-on time to prevent damage to the FET in the event of a short-circuit during turn-on. The watchdog timer is modified to 200 ms, as shown in Figure 31.

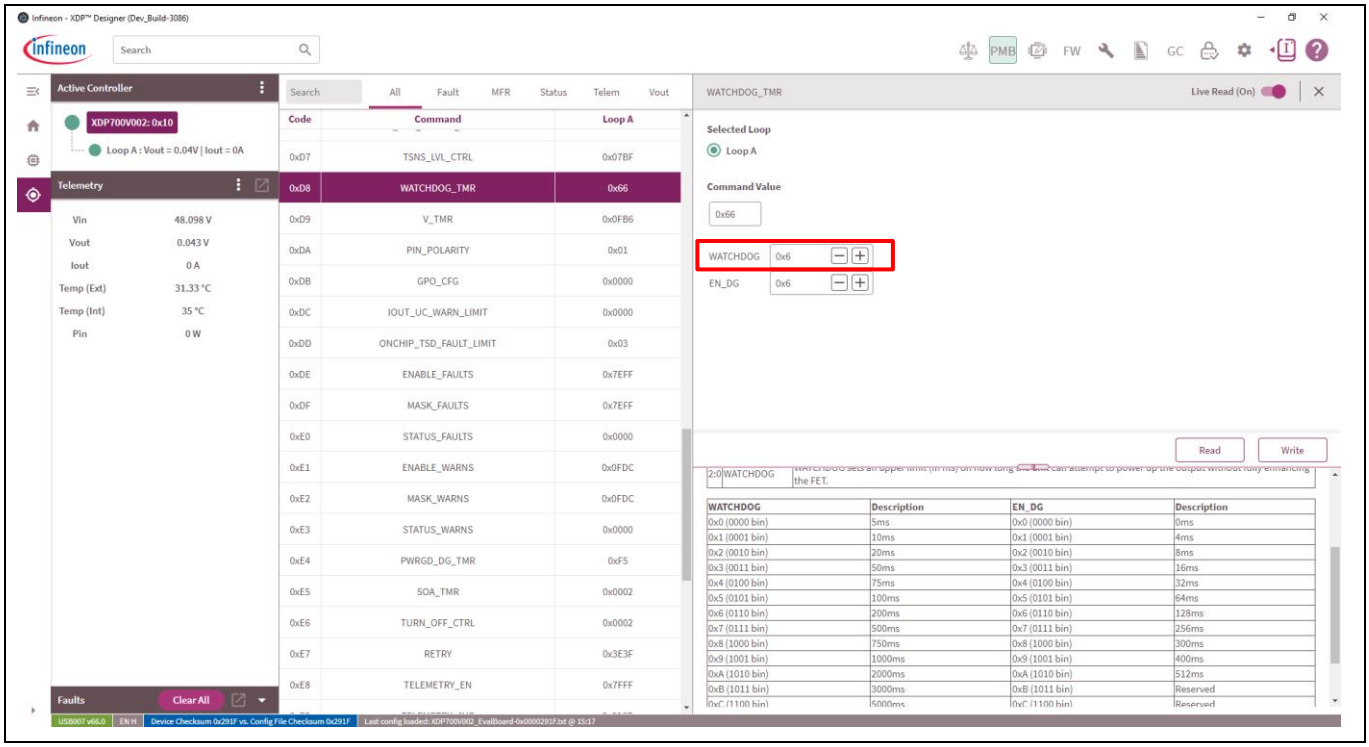

Figure 31 Watchdog timer selection

4.1.7 Programming the current sense range (CS_RNG) and start-up current limit (IST)

Note: If using AADM, skip this step because the resistor on the IST pin selects the start-up current limit and current sense range.

In FDM, program the desired current sense range and start-up current limit in the I_SNS_CFG register (0xD5), as shown in Figure 32.

Note: Do not set the current sense range as 100 mV with 1 mΩ sense resistor. The SOA regulation loop does not work when (current sense range (mV)/ R (mohm)) > 83.33 A.

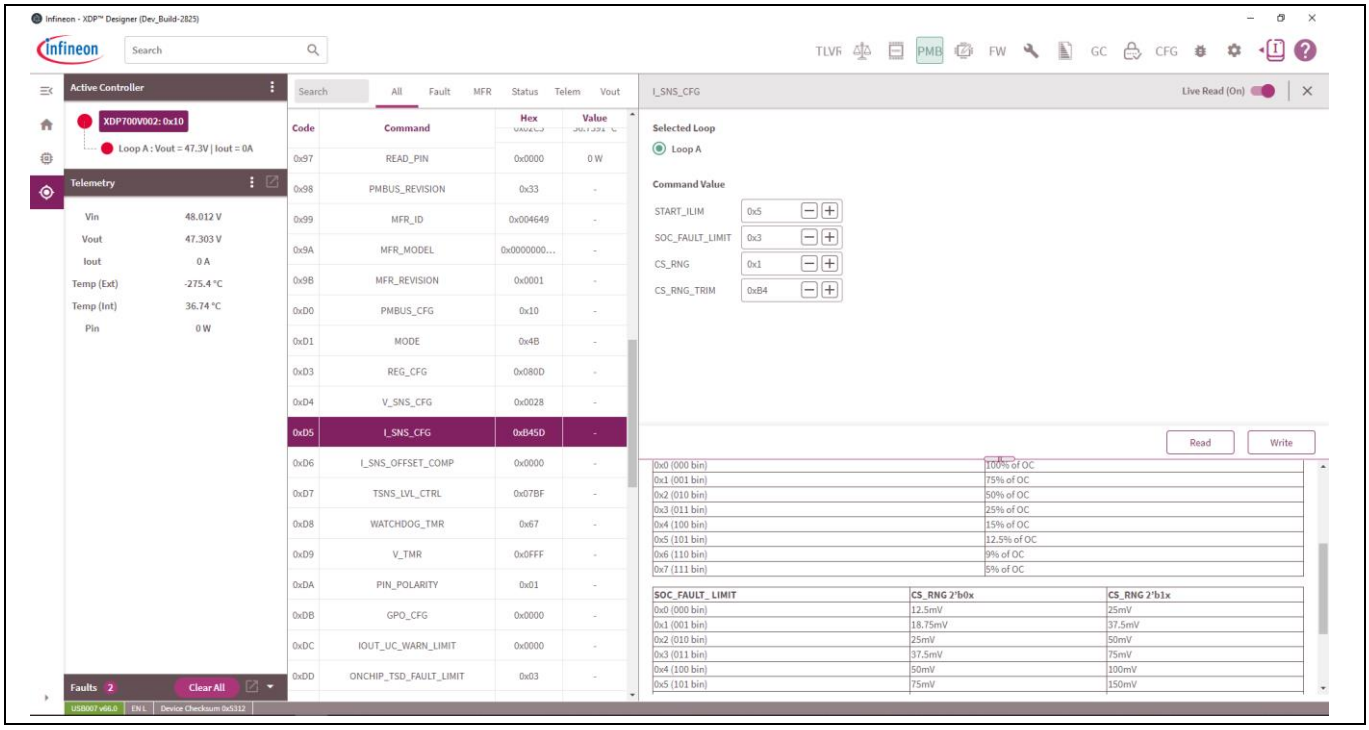

Figure 32 Current sense range and start-up current limit setting

4.1.8 Programming VIN_UV_FAULT_LIMIT

If using AADM or ACM, skip this step because the input undervoltage (UV) fault limit is set by external resistors on the UV pin.

If using DCM, program the desired UV fault limit in the VIN_UV_FAULT_LIMIT register (0x59). If the UV fault is not used, the register can be programmed to 0 V, or the fault can be disabled.

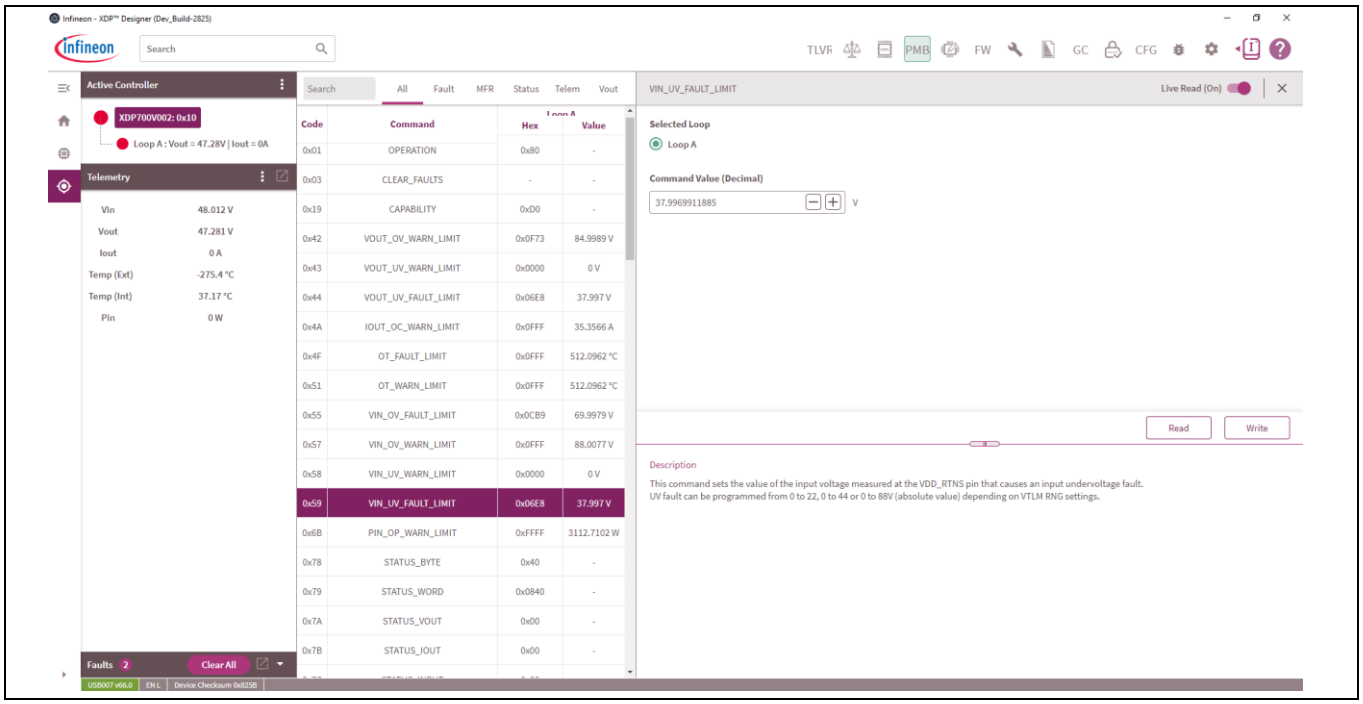

Figure 33 Program VIN_UV_FAULT_LIMIT

4.1.9 Programming VIN_OV_FAULT_LIMIT

Note: If using AADM or ACM, skip this step because the input overvoltage (OV) fault limit is set by external resistors on the OV pin.

If using DCM, program the desired OV fault limit in the VIN_OV_FAULT_LIMIT register (0x55). If the OV fault is not used, the register can be programmed to 88 V, or the fault can be disabled.

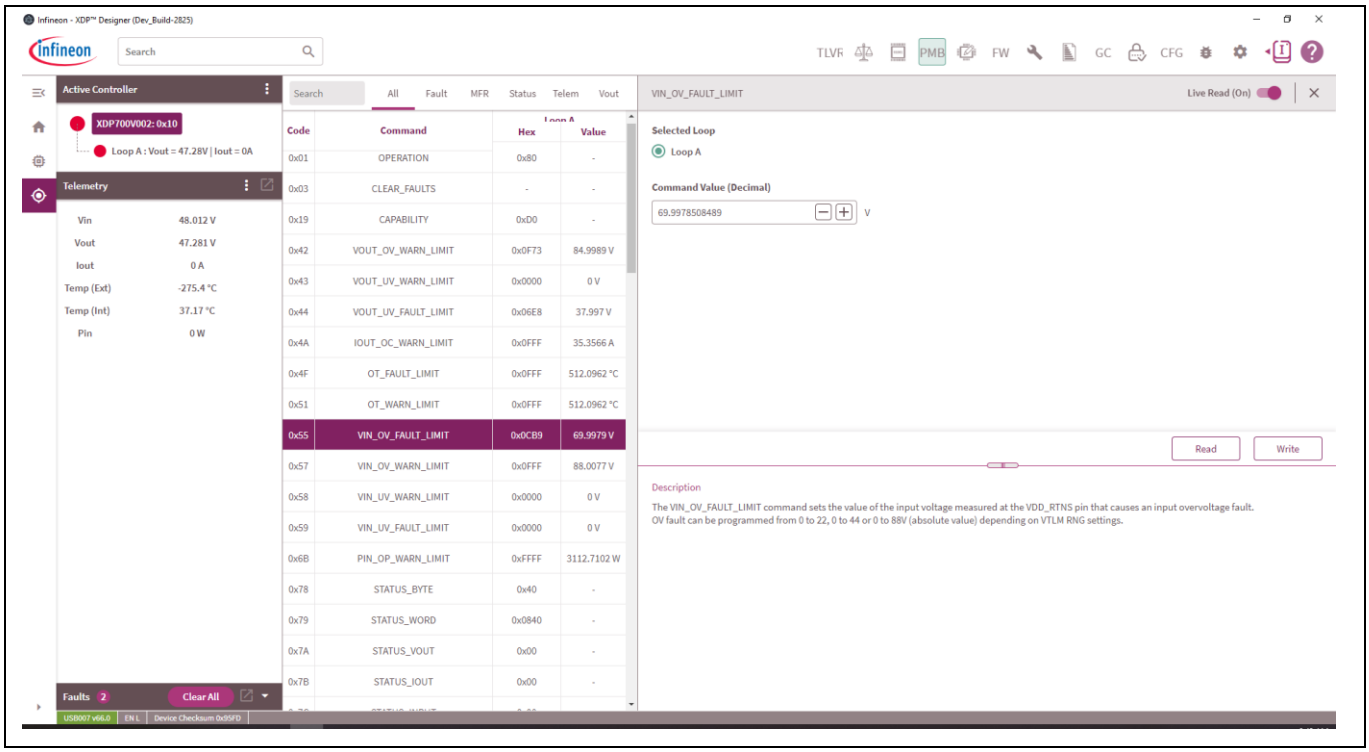

Figure 34 Program VIN_OV_FAULT_LIMIT

4.1.10 Programming VOUT_UV_FAULT_LIMIT

To program the desired UV fault limit, set the VOUT_UV_FAULT_LIMIT register (0x44). If the UV fault is not used, the fault can be disabled.

Note: If enabled, VOUT_UV_FAULT should not be set to 0 V because hot swap will turn off after turning on, detecting it as a VOUT_UV fault.

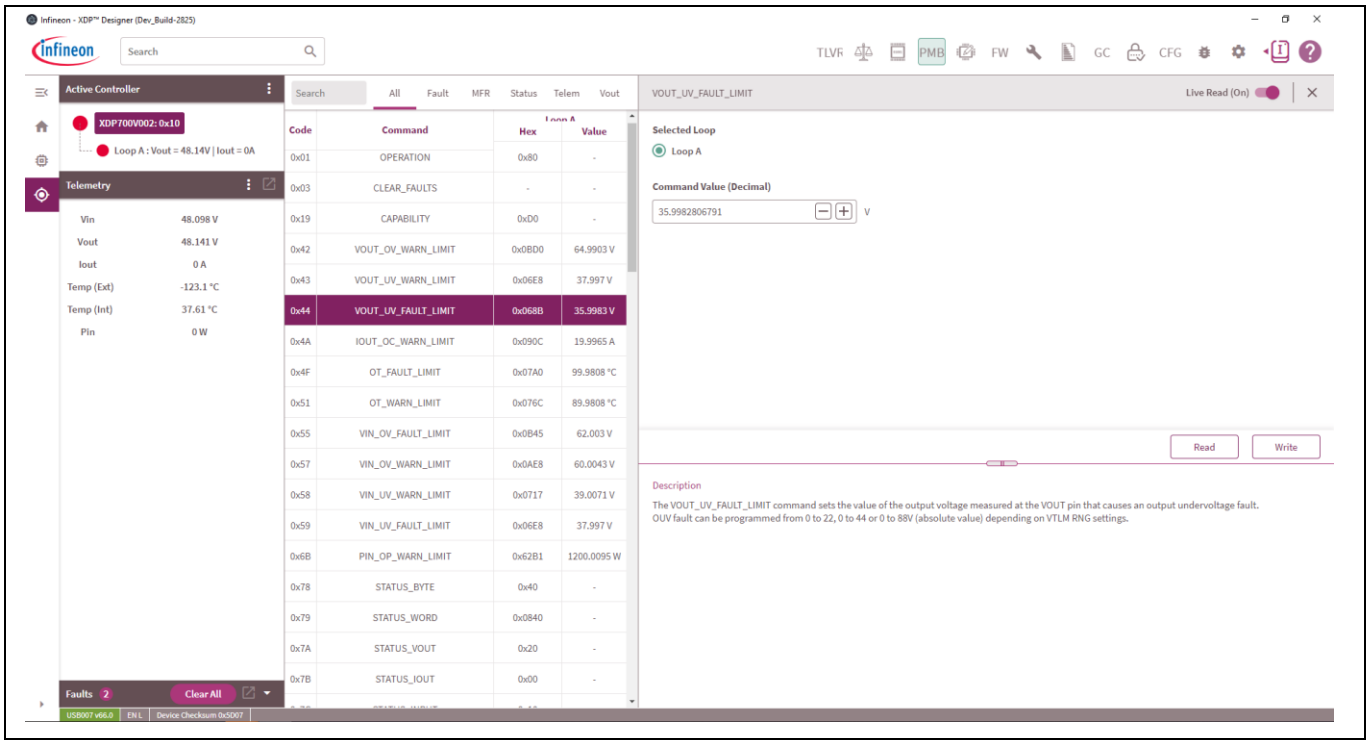

Figure 35 Program VOUT_UV_FAULT_LIMIT

4.2 Programming XDP700-002 in different modes

XDP700-002 can be operated in two different modes: FDM and AADM. FDM has two selections: DCM and ACM. AADM or FDM can be selected based on the resistor connected on the Mode 0 and Mode 1 pins on the evaluation board. Based on the mode selected, you need to configure different PMBus registers.

4.2.1 Fully Digital Mode (FDM)

FDM lets you select the FET, start-up current limit, and current sense range via PMBus registers. In digital comparator mode (DCM), the fault sensing on input and output voltages is done via digital comparators and is based on the telemetry of the device. This approach reduces the analog circuitry required while in analog comparator mode (ACM). This method uses external voltage dividers on the UV and OV pins. The voltage on the divider is compared with the internal threshold to detect faults. Voltage warnings are set internally via PMBus. You need to program the following registers through PMBus in FDM for both DCM and ACM:

- FET_SELECT: See Section 4.1.4
- R_{sns}: See Section 4.1.5
- Watchdog (optional): See Section 4.1.6
- Current sense range (CS_RNG) and start-up current limit (IST): See Section 4.1.7

- Enable telemetry
- Enable warnings (if needed)
- Setting warnings (if needed)

4.2.1.1 Digital Comparator Mode (DCM)

If the device is programmed using DCM, select DCM in the register 0xD1 and modify bit '7' to '1'. You need to modify the following register to detect the necessary faults if the corresponding fault bits are enabled in the PMBus register (0xDE).

- VOUT_UV_FAULT_LIMIT (0x44): See Section 4.1.10
- VIN_OV_FAULT_LIMIT (0x55): See Section 4.1.9
- VIN_UV_FAULT_LIMIT (0x59): See Section 4.1.8

To turn ON the FET, toggle the enable signal to **HIGH** (EN H) on the GUI, as shown in Figure 36.

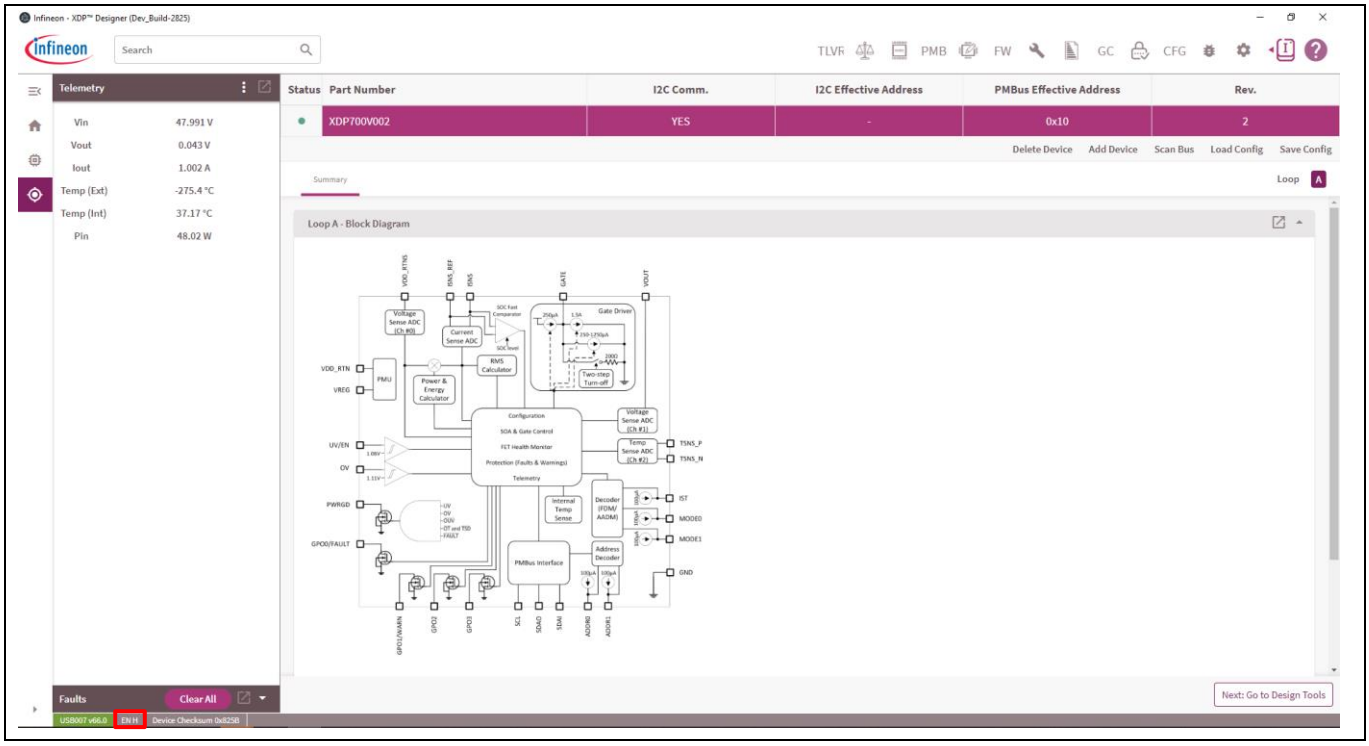

Figure 36 Enabling FET by toggling enable signal high

4.2.1.2 Analog Comparator Mode (ACM)

If the device is programmed using ACM, select the ACM in the 0xD1 register, and modify bit '7' to '0'. In this mode, all the voltage faults are sensed using external resistors. Therefore, you need to place the following jumpers on the evaluation board to detect faults if the corresponding fault bits are enabled in the PMBus register (0xDE):

- **VIN_OV_FAULT_LIMIT (OV pin)**: Jumper is required on connector X41; the input OV fault limit can be set by modifying R34, R36, and R38.
- **VIN_UV_FAULT_LIMIT (UV pin)**: Jumper is required on connector X33. If UV_FAULT is disabled, ensure that the UV pin gets the necessary enable signal voltage to turn ON the FET.

4.2.2 Analog Assisted Digital Mode (AADM)

AADM lets you select the FET, start-up current (IST) limit, and current sense range (CS_RNG) via external resistors connected on pins Mode 0, Mode 1, and IST. For the evaluation board, the settings are done as shown in Table 6.

Table 6 AADM selection resistors

Connector	Jumper position (resistor)	Function
X18 (mode pins)	Between 3 and 4 (Mode 0: Open)	Selects the FET IPB017N10N5ATMA1
	Between 9 and 10 (Mode 1: 20 kΩ (2.0 V))	
X21 (IST pins)	Between 5 and 6 recommended (IST: 11 kΩ (1.1 V))	25 mV current sense range is selected and IST as 12.5 percent of overcurrent (OC) level is selected.

Place the following jumpers on the evaluation board to detect faults if the corresponding fault bits are enabled in the PMBus register (0xDE):

- **VIN_OV_FAULT_LIMIT (OV pin)**: Jumper is required on connector X41; the input OV fault limit can be set by modifying R34, R36 and R38.
- **VIN_UV_FAULT_LIMIT (UV pin)**: Jumper is required on connector X33. If UV_FAULT is disabled, ensure that the UV pin gets the necessary enable signal voltage to turn on the FET.

Modify the necessary PMBus registers for proper operation:

- R_{sns}: See Section 4.1.5
- Watchdog: See Section 4.1.6
- Enable telemetry
- Enable warnings (if needed)
- Setting warnings (if needed)

5 Loading the configuration file

You can load the configuration file into the device, which eliminates the need to manually modify the required registers. The configuration file can be loaded into the device as follows:

1. Click **Load Config**, as shown in Figure 37.
2. Click **Browse** and select the *.txt* file, as shown in Figure 38.
3. Click **Load** to load the configuration onto the device, as shown in Figure 39.

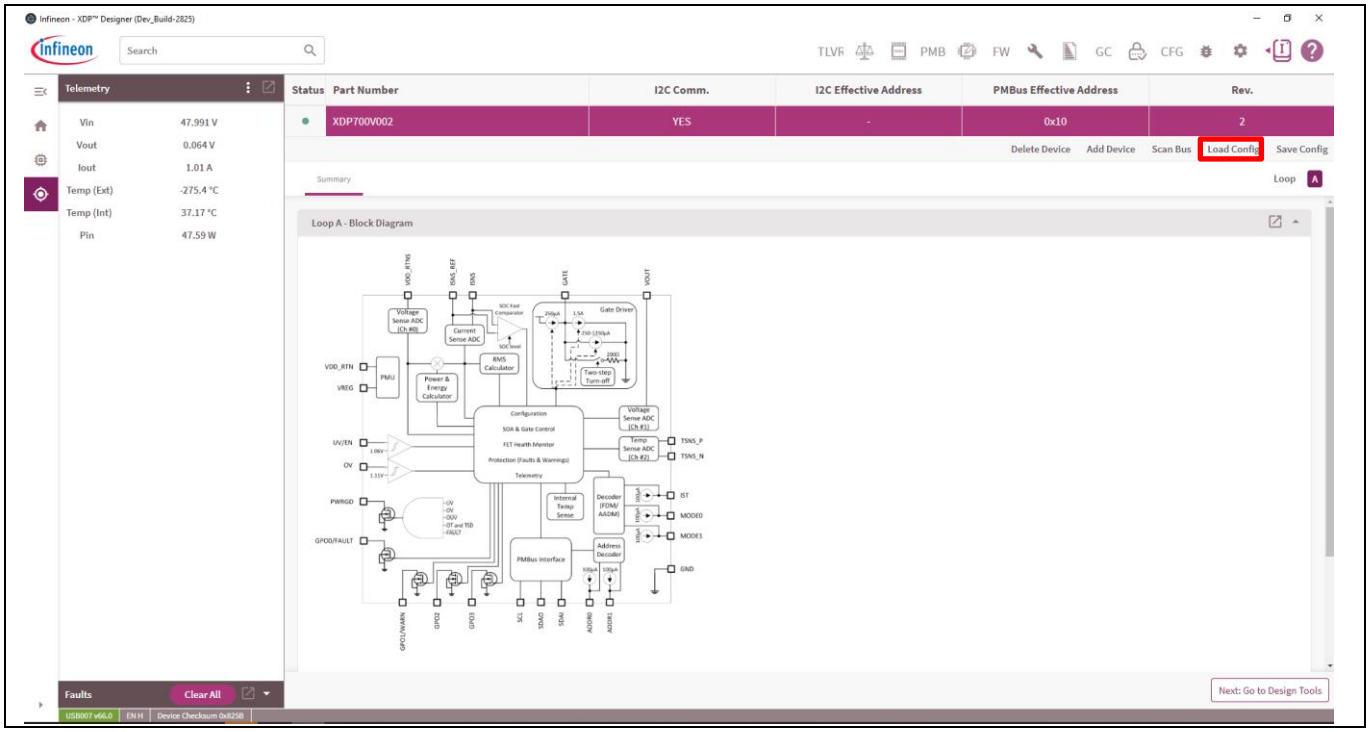

Figure 37 Select Load Config option

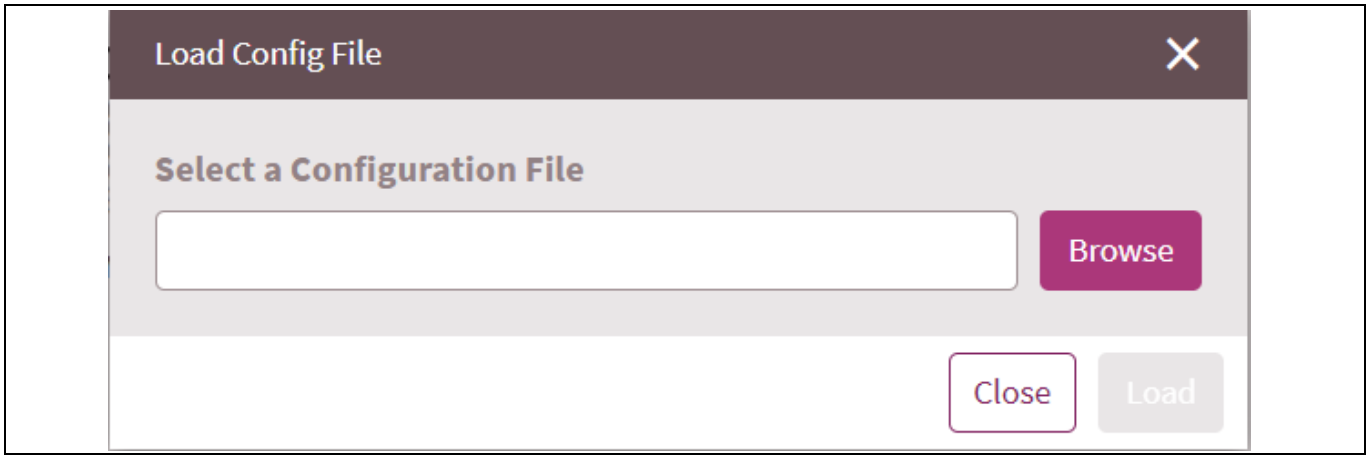

Figure 38 Browse to select the necessary configuration file

Loading the configuration file

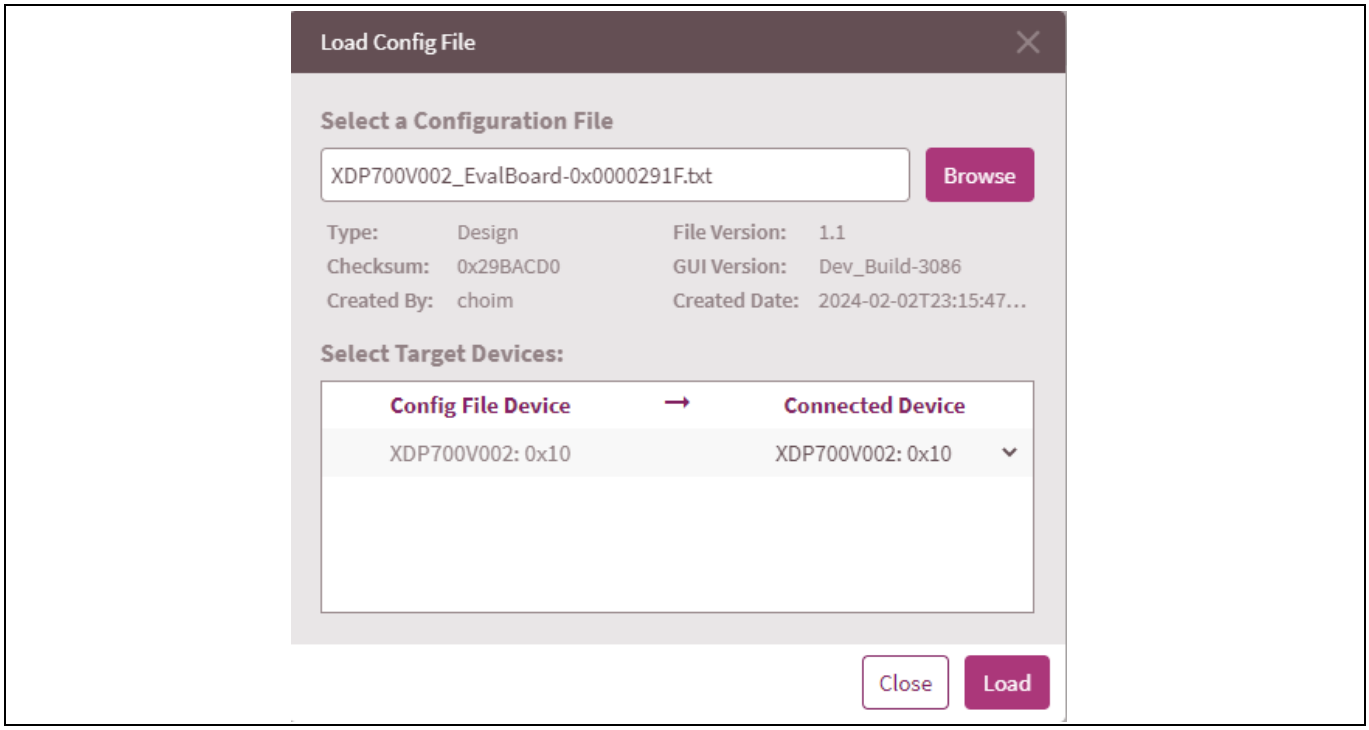

Figure 39 Load to load the selected configuration file

An example configuration file in .txt format is available in the XDP700-002 Evaluation Board page [2] as *XDP700V002_EvalBoard-0x0000291F.txt*. This configuration file is compatible with the evaluation board in the default configuration.

6 Hands-on

Ensure the following:

- Proper input voltage (48 V) is available on the input of the evaluation board.
- The example configuration is loaded onto the device.
- The device is not yet enabled.

6.1 Turn ON FET test

The FET is turned ON by toggling the enable signal to HIGH (EN H) as shown in Figure 40.

Note: Ensure that the load is not ON when enabling the FET because it could cause the watchdog timer fault; in such a case, the FET will not turn ON.

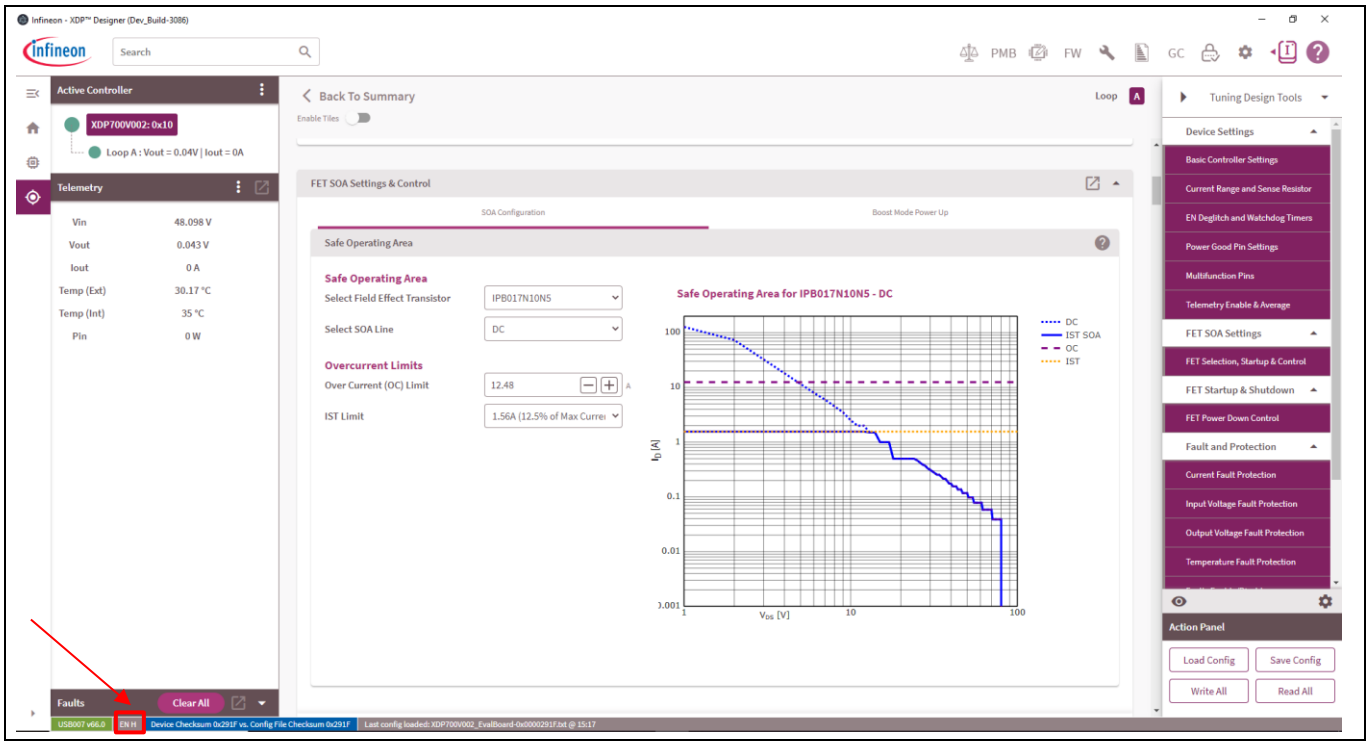

Figure 40 Enabling FET by toggling enable signal to high

Figure 41 shows the turn-on waveforms. Note that the start-up current follows the programmed SOA of the FET as shown in Figure 41 closely, and ensures that the FET SOA is not violated during turn-on operation, thereby providing a safe and fast turn-on. Additionally, the maximum startup current observed is 1.626 A at an IST setting of 12.5%. Figure 42 highlights the regulation current at various VDS levels based on the SOA of IPB017N10N5.

Hands-on

Figure 41 Startup current waveform at 48 V input

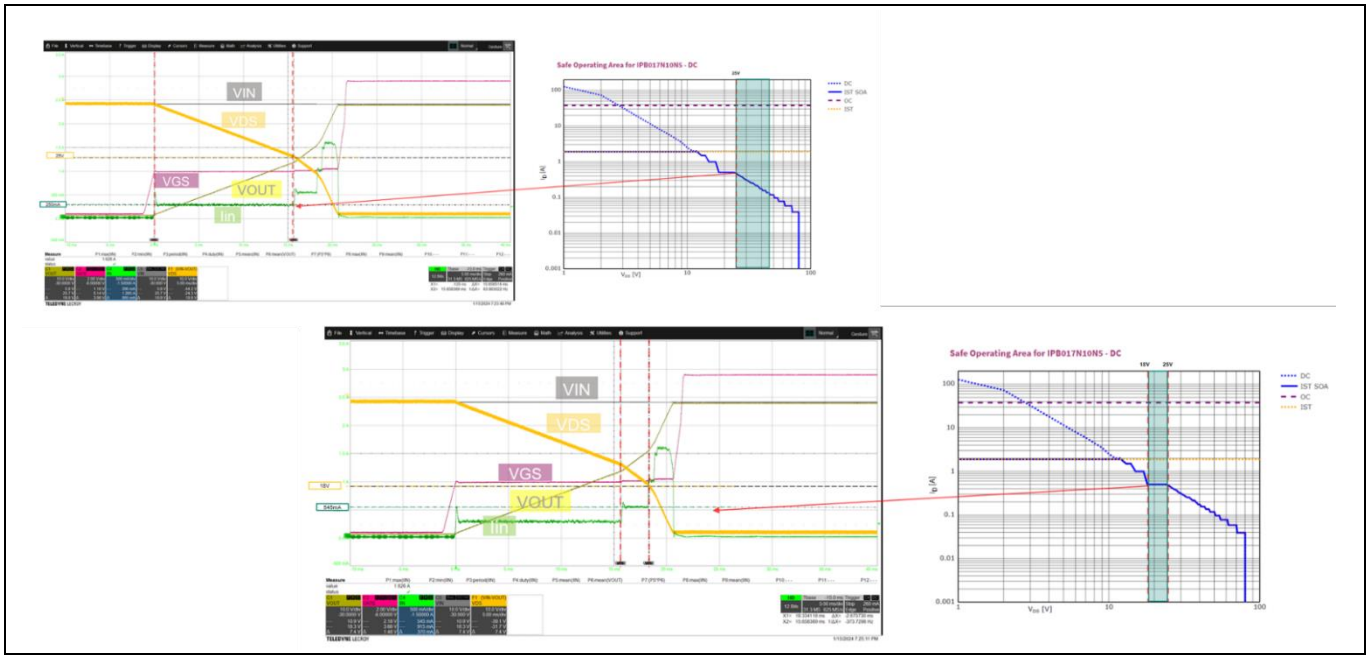

Figure 42 Startup current regulation at various VDS levels

6.2 Boost mode test

For FETs with weaker SOA, with current capability of less than 0.25 A at higher voltages, it is recommended to turn ON the FET in boost mode. In the following example, boost mode is enabled, and the parameters are set as follows:

- Type of boost mode: Automatic boost mode
- SOA line: 1 ms
- Duty cycle: 20%

If the SOA is below 0.5 A, boost mode is activated; the controller sends gate pulses allowing the drain current for only 1 ms with its limit restricted to 8x the programmed SOA level. When the regulation current reaches 0.5 A, boost mode turns off, and the FET is regulated with regular SOA. Figure 43 shows the startup behavior with automatic boost mode and at V_{DS} = 25 V where I_{SOA} = 0.5 A, the controller resumes with regular current regulation.

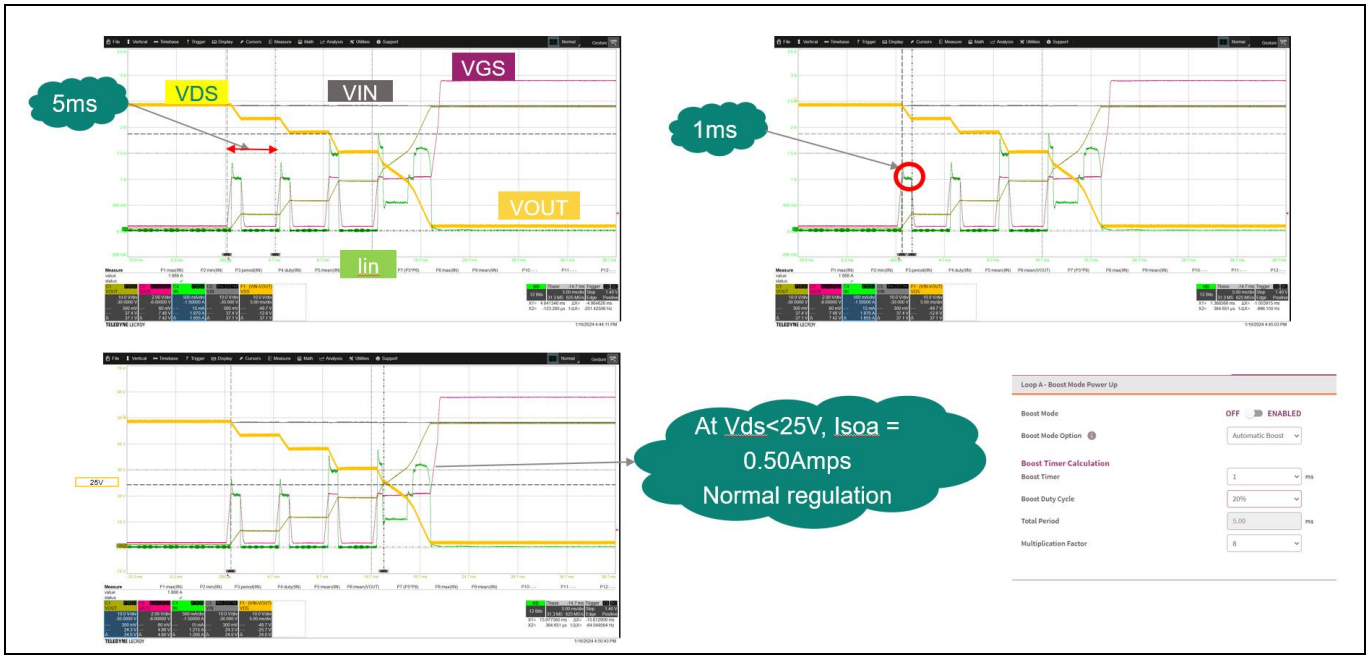

Figure 43 Automatic boost mode operation

Attention: ***Set the duty cycle according to C_{gs} to provide sufficient time for the gate to discharge to avoid double pulses and violation of SOA on 1 ms line.***

6.3 Turn-ON in output short test

The output of the evaluation board is shorted together, and the watchdog timer is reduced down to 200 ms from 500 ms. Hot swap is enabled by toggling the enable signal to **HIGH** (EN H). Figure 44 shows that the current has been regulated down to the minimum level of 0.25 A; after the watchdog timer expires, the gate is turned OFF and a watchdog timer fault is issued.

Figure 44 Turn on in output short

7 Programming SOA, OTP, and MTP

Do the following to program the required settings in internal commands or OTP at power-up. See the XDP700-002 datasheet [1] for details.

1. Apply a voltage at the VDD_RTN and VDD_RTNS pins:
   - At least 9 V to program commands (evaluation board bias is activated at 9 V)
   - At least 20 V to program OTP or MTP
2. Keep the UV/EN pin at chip GND potential.
3. Wait for the device to enter STANDBY state. Communication via PMBus is possible now.
4. Program the commands, OTP, or MTP.

Note: To ensure successful programming, keep the internal temperature of the device below 125°C at all times.

7.1 Program OTP or MTP sections

1. Program the commands in volatile memory as required.
2. Click the button highlighted in red as shown in Figure 45.

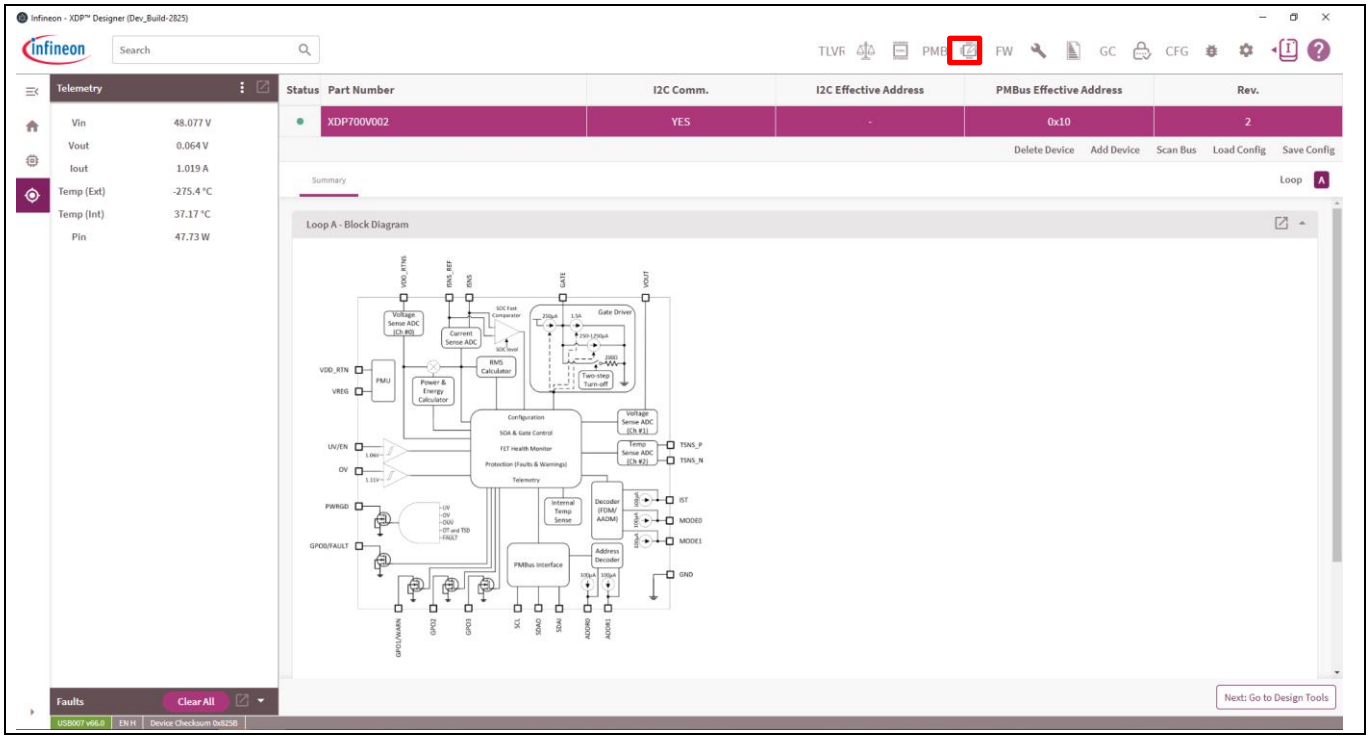

Figure 45 Programming tab

3. Set the program from **Registers**, select the memory section that needs to be programmed, and click **Program to OTP**, as shown in Figure 46.

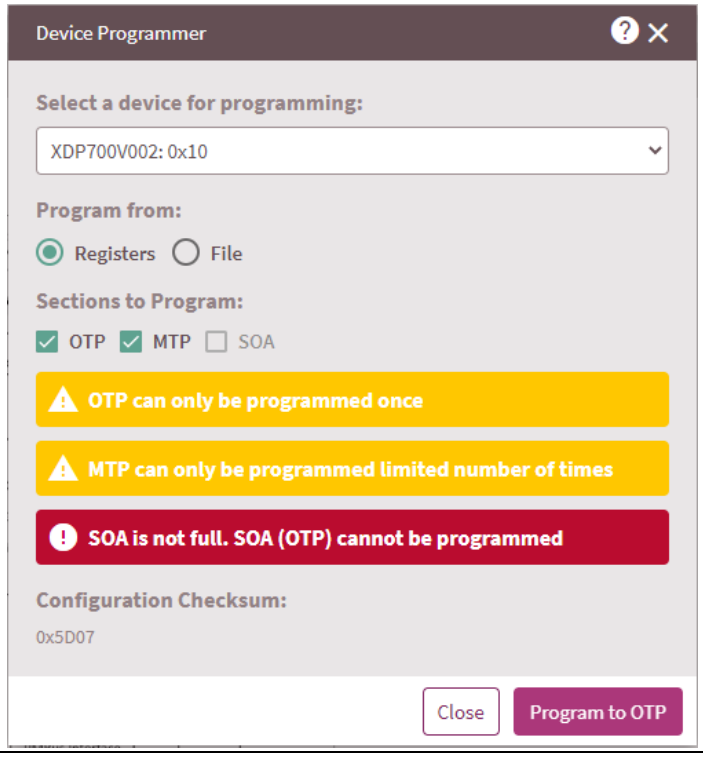

Figure 46 OTP and MTP programming

The command configuration will be automatically copied to the selected memory section.

References

[1] Infineon Technologies AG: *XDP700-002 hot-swap controller datasheet*; Available online

[2] Infineon Technologies AG: *XDP700-002 Evaluation Board webpage*; Available online

Revision history

Document revision	Date	Description of changes
V 1.0	2024-04-12	Initial release

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