XDPP1100 quarter- and eighth- brick test fixture

About this document

Scope and purpose

This document describes the Infineon universal test fixture EVAL_QB_TEST_FIX_01 for digital controlled quarter-brick (QB) and eighth-brick (EB). The test fixture is the test platform of the QB and EB. The test fixture provides input and output connector terminals, input and output capacitor filters, input and output test points, an on/off toggle switch, a DC fan, I^2C and SWD communication ports, and three LEDs to indicate power good, fault and SMBALERT.

Intended audience

This user manual is aimed at XDP™ digital power quarter brick and eighth brick users.

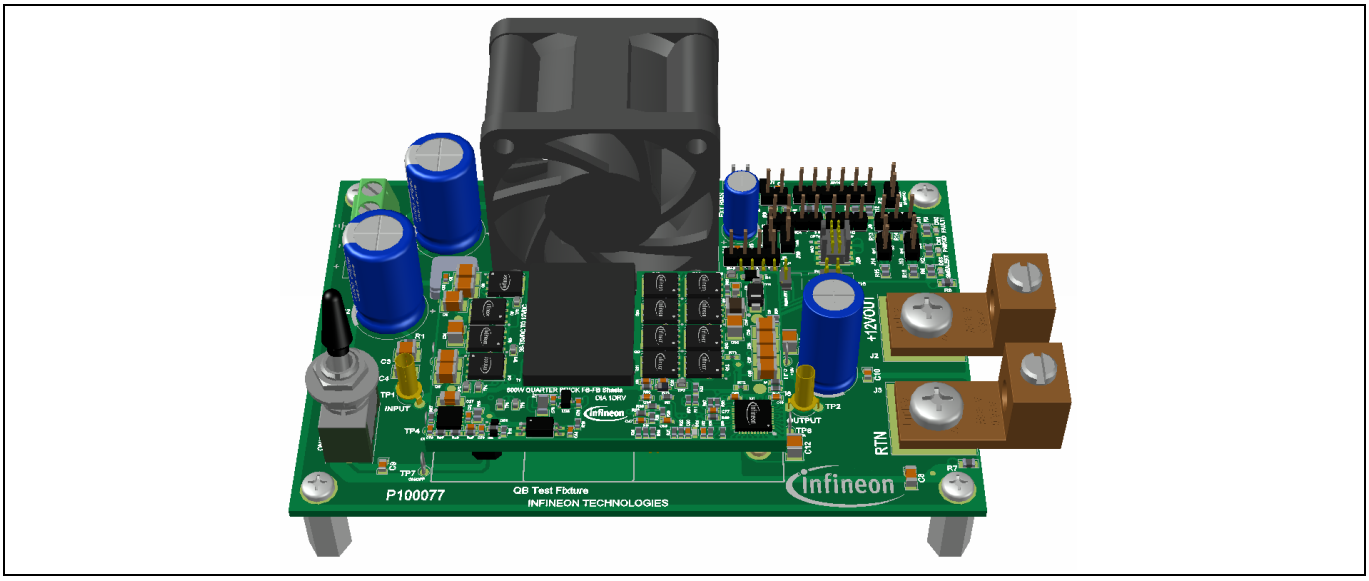


Figure 1 The XDPP100 QB test fixture with the REF_600W_FBFB_XDPP1100

Table of contents

Table of contents

1 Board information

The EVAL_QB_TEST_FIX_01 test fixture is the test platform of the XDPP1100 QB and EB. It provides power connection terminals, and communication and debugging ports, as well as a cooling fan. The input voltage of the board must be DC and should not be higher than 80 V. The output voltage should also be DC and not higher than 15 V. The maximum output current is 70 A.

When running the QB or EB, it is recommend to bias the DC fan for necessary airflow. The fan should be biased with external DC power supply (EXT BIAS), in the 5 V to 12 V range. The fan speed could be controlled by the bias voltage or by a PWM signal. The reference design REF_600W_FBFB_XDPP1100 supports fan speed control through connector J16. The digital controller XDPP1100 supports fan speed control through the PMBus command, which changes the fan speed per user-configured duty cycle. It also supports Current Mode (CM), which changes the fan speed per output current. The CM fan speed control can linearly increase fan speed with load current, and provide desired air-cooling at full load while keeping the fan quiet at light load to reduce noise pollution.

The board has an I^2C port for I^2C and PMBus communication. The external bias (EXT BIAS) is used to generate a 3.3 V DC voltage to pull up I^2C, PWRGD, FAULT1 and SMBALERT. It is recommended to always provide the bias voltage through J4 for the fan and the communication port. To communicate with the digital controller XDPP1100 located on the brick converter, a USB dongle USB007A or USB007B is recommended. The USB007A is a non-isolated dongle and the USB007B is an isolated dongle. The USB dongle does not come with the test fixture.

The switch SW1 at the primary side is the on/off switch to turn on the brick. The brick is enabled when SW1 is turned toward the edge of the board. This works with the XDPP1100 configured to enable polarity to “active low”. If EN “active high” is preferred, the user can change the configuration by writing PMBus command ON_OFF_CONFIG. Please note that in this case the SW1 turns on the converter when it turns to the direction of J1.

The board has a SWD debugger port (J20) for firmware (FW) debugging. The recommended debugger is Lauterbach LA-4532 (not included with the board).

Demo boards that work with the EVAL_QB_TEST_FIX_01 include the 600 W QB REF_600W_FBFB_XDPP1100, and 275 W EB REF_275W_HBCT_XDPP1100.

1.1 Specification

The specification of the QB test fixture is listed in **Table 1**.

Table 1 Specification

	Min.	Typ.	Max.	Unit
Input voltage range			80	V
Output voltage (at V_{IN} = 42 V to 72 V)			15	V
Output current			70	A
Recommended fan bias voltage	5	7.5	12	V

1.2 Schematic

Figure 2 shows the schematic of the test fixture.

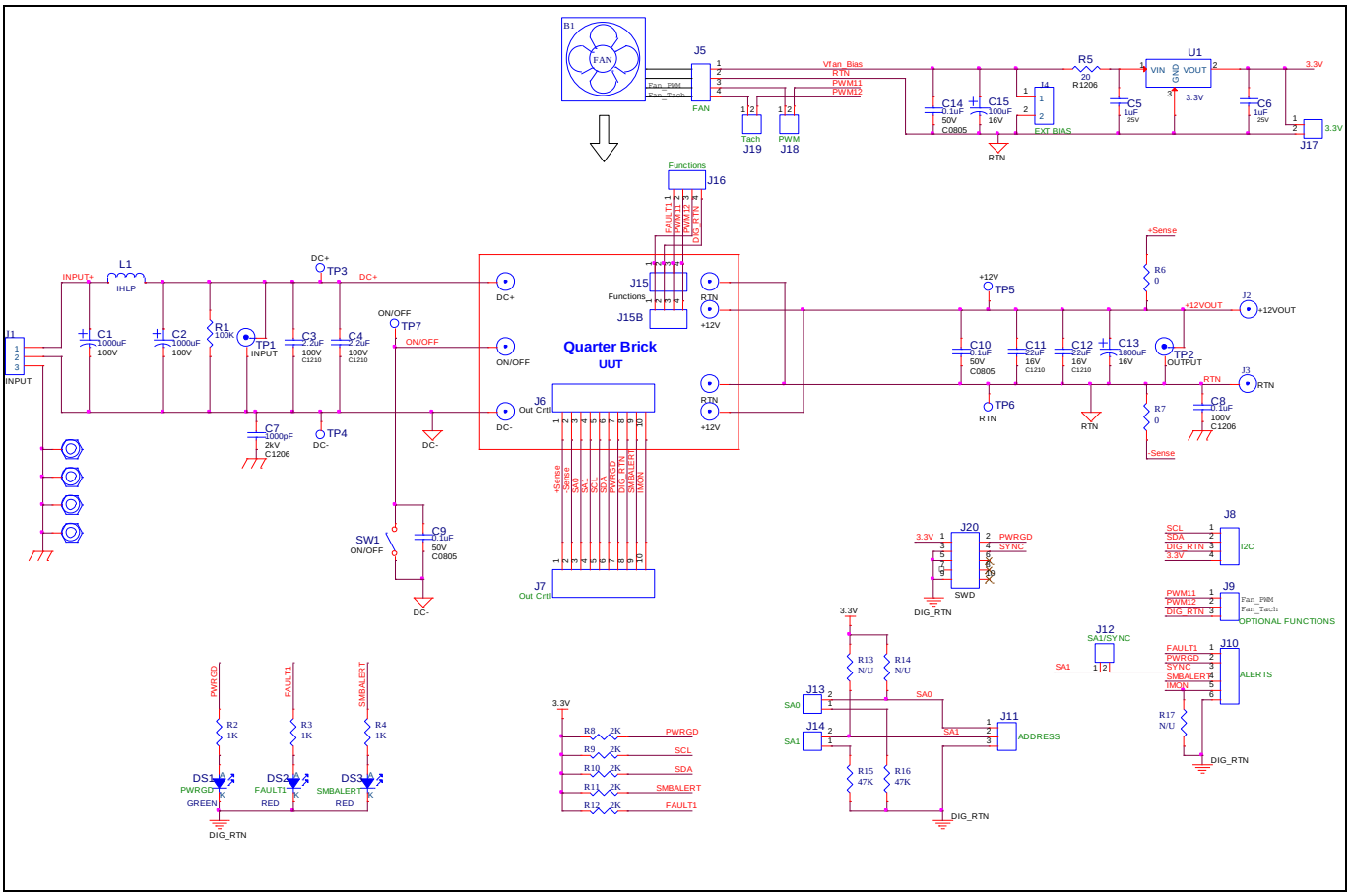


Figure 2 Test fixture schematic

1.3 Bill of Materials (BOM)

Table 2 BOM

Item	Qty.	Reference	Manufacturer	Part number
1	1	BRD1		P100077 B
2	1	B1	NMB	04028DA-12P-AA-F0
3	2	C1, C2	Nichicon	UPW2A101MHD
4	2	C3, C4	TDK	C3225X7R2A225K230
5	2	C5, C6	TDK	C1608X7R1E105K
6	1	C7	TDK	C4520JB3D102M130K
7	1	C8	TDK	C3216X7R2A104K160
8	3	C9, C10, C14	TDK	C2012X7R1H104M085
9	2	C11, C12	TDK	C3225X7R1C226K250
10	1	C13	United Chemi-Con	APSG160ELL182MJ20S
11	1	C15	Nichicon	UPW1C101MED1TD
12	1	DS1	Wurth	150060GS75000
13	2	DS2, DS3	Wurth	150060RS75000
14	1	J1	Phoenix	1729131
15	2	J2, J3	Panduit	CX70-14-CY

Board information

Item	Qty.	Reference	Manufacturer	Part number
16	1	J4	TE Connect	640456-2
17	2	J5, J8	Wurth	613 004 111 21
18	1	J6	Harwin	M22-6340542
19	1	J7	Harwin	M22-2580546
20	2	J9, J11	Wurth	613 003 111 21
21	1	J10	Wurth	613 006 111 21
22	6	J12, J13, J14, J17, J18, J19	Wurth	613 002 111 21
23	1	J15	Samtec	Not used
24	1	J15B	Samtec	CLP-102-02-G-D
25	1	J16	Samtec	TMM-102-03-L-D
26	1	J20	Samtec	FTSH-105-01-L-DV-K
27	1	L1	Vishay	IHLP-3232CZER1R0M1A
28	1	R1	Panasonic	ERJ-6ENF1003V
29	3	R2, R3, R4	Panasonic	ERJ-6ENF1001V
30	1	R5	Panasonic	ERJ-8GEYJ200V
31	2	R6, R7	Panasonic	ERJ-6GEY0R00V
32	5	R8, R9, R10, R11, R12	Panasonic	ERJ-6ENF2001V
33	3	R13, R14, R17	Panasonic	Not used
34	2	R15, R16	Panasonic	ERJ-6ENF4702
35	1	SW1	NKK	M2011SS1W03-BA
36	2	TP1, TP2	Cinch Connectivity	129-0701-202
37	5	TP3, TP4, TP5, TP6, TP7	Keystone	5020
38	1	U1	LT	LT1460KCS3-3.3#TRMPBF
39	3	1, 2, 3	Mil Max	0340-0-15-15-34-27-10-0
40	4	4, 5, 9, 10	Mil Max	9401-0-15-15-23-27-10-0
41	1	Fan	MinebeaMitsumi	04028DA-12R-AA-F0

2 Operation guide

2.1 Basic connection and power-up sequence

Figure 3 shows the connections of the input and output to test the QB REF_600W_FBFB_XDPP1100.

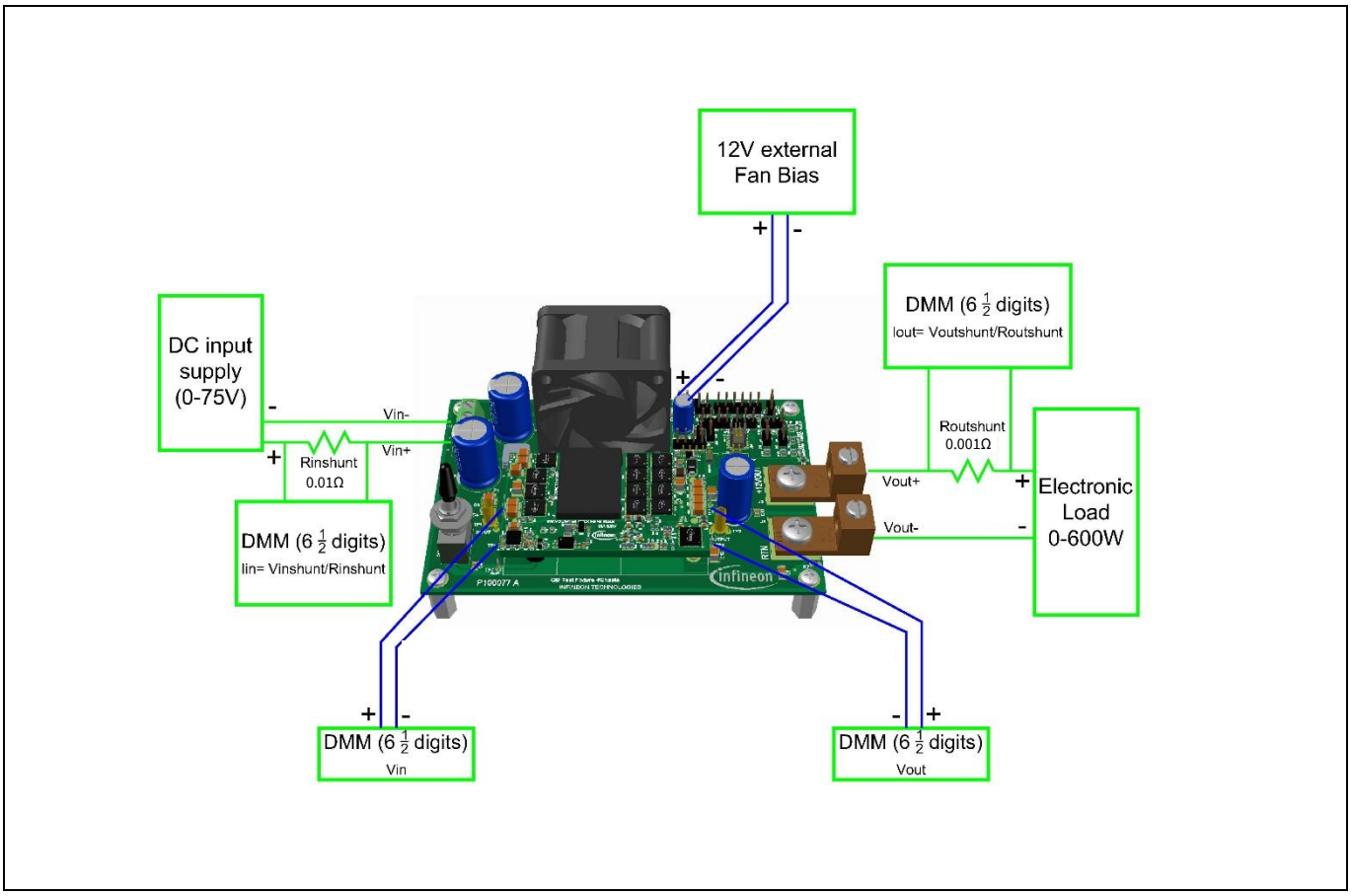


Figure 3 Test fixture board connections

Necessary connections to operate the board REF_600W_FBFB_XDPP1100:

- Connect the QB to the test fixture. Make sure the DC input, DC output and signal connector J6 have good contact.
- Connect input voltage to J1.
- Connect E-load to J2 and J3.
- Bias fan with 5~12 V DC power supply at J4 (EXT BIAS).
- Connect the XDPP1100 USB dongle (USB007 revA) to J8. Find the direction by identifying the ground pin G (black wire). The blue wire of USB007A is not used and can be left floating. To use the isolated dongle USB007B, the blue wire of the dongle has to be connected to the 3.3 V pin of J8.
- Make sure the switch SW1 is in the “off” position.
- Turn on the 48 V input power supply. Minimum 35 V voltage is required to enable the auxiliary power supply.
- When the auxiliary power supply is in operation, the 12 VS should have 10 V ±1 V voltage.
- This demo board comes with a default patch and configuration stored in non-volatile memory (OTP) and can be turned on once the operation command is asserted from the XDPP1100 GUI.

- In order to assert the operation command, open XDPP1100 GUI and click on “Auto populate”. The auto populate icon is in the top-left corner of the window. Once auto populated, the GUI reads the configuration from the device.
- Check if the PMBus commands are configured properly by reading the VOUT_COMMAND. It should read 12 V.
- Write “ON” to PMBus command 0x01 OPERATION, and turn SW1 to the “on” position (the sequence is not critical). The converter should regulate 12 V output for an input voltage range of 42 to 75 V.

2.2 Voltage measurement and probing

The test fixture offers several test points for the user to access the input and output. On the input side, TP1 is the tip and barrel test point for input voltage probing. TP3 (DC+) and TP4 (DC-) are the test points for input voltage measurement. On the secondary side, TP2 is the tip and barrel test point for output voltage probing. The TP5 (+12 V) and TP6 (RTN) are the test points for output voltage measurement.

The fan is connected to J5 to receive bias voltage and fan speed control. To use PWM duty-cycle control, short J18 and J19 to connect the PWM and tach signal to the QB REF_600W_FBFB_XDPP1100. More details on fan speed control can be found in section 2.3.

The connectors J7 and J10 provide access to the analog and digital signals. The connections are listed in **Table 3** and **Table 4**. The synchronize pin SYNC is a multi-connection pin. Depending on the brick board, it could be SYNC or XADDR2. The default connection is SYNC.

Table 3 J7 connector

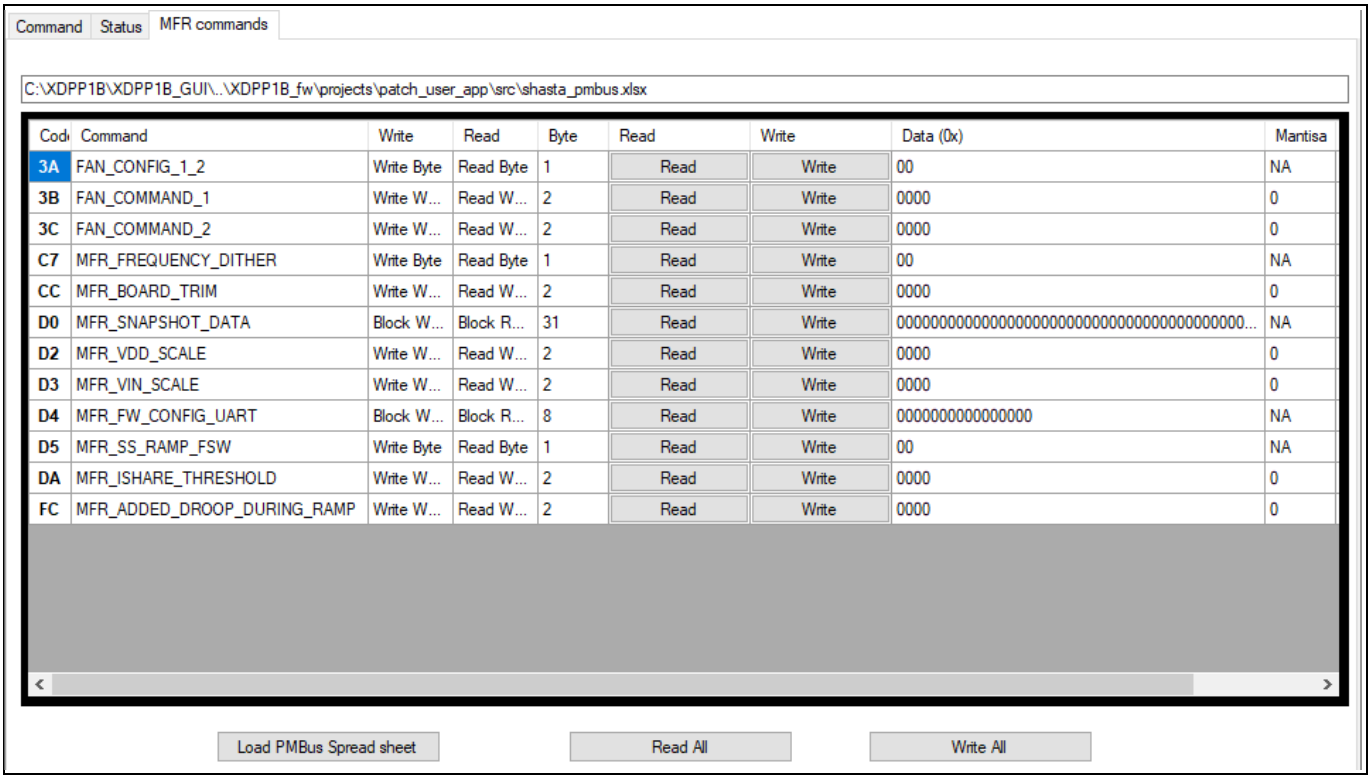
Pin number	Signal	Description
1	+Sense	Output positive remote sense
2	-Sense	Output negative remote sense
3	SA0	Address pin XADDR1
4	SA1	Address pin XADDR2 or SYNC
5	SCL	I^2C clock
6	SDA	I^2C data line
7	PWRGD	Power good
8	DIG_RTN	Digital ground
9	SMBALERT	SMBALERT
10	IMON	Active current sharing pin IMON

Table 4 J10 connector

Pin number	Signal	Description
1	FAULT1	FAULT1
2	PWRGD	Power good
3	SYNC	SYNC
4	SMBALERT	SMBALERT
5	IMON	Active current sharing pin IMON
6	DIG_RTN	Digital ground

2.3 XDPP1100 fan speed control

The fan speed control function is implemented in the XDPP1100 FW patch. The fan configure and fan control commands can be found in the “MFR commands” tab in the XDPP1100 GUI.



Cod	Command	Write	Read	Byte	Read	Write	Data (0x)	Mantisa
3A	FAN_CONFIG_1_2	Write Byte	Read Byte	1	Read	Write	00	NA
3B	FAN_COMMAND_1	Write W...	Read W...	2	Read	Write	0000	0
3C	FAN_COMMAND_2	Write W...	Read W...	2	Read	Write	0000	0
C7	MFR_FREQUENCY_DITHER	Write Byte	Read Byte	1	Read	Write	00	NA
CC	MFR_BOARD_TRIM	Write W...	Read W...	2	Read	Write	0000	0
D0	MFR_SNAPSHOT_DATA	Block W...	Block R...	31	Read	Write	00000000000000000000000000000000000000000...	NA
D2	MFR_VDD_SCALE	Write W...	Read W...	2	Read	Write	0000	0
D3	MFR_VIN_SCALE	Write W...	Read W...	2	Read	Write	0000	0
D4	MFR_FW_CONFIG_UART	Block W...	Block R...	8	Read	Write	0000000000000000	NA
D5	MFR_SS_RAMP_FSW	Write Byte	Read Byte	1	Read	Write	00	NA
DA	MFR_ISHARE_THRESHOLD	Write W...	Read W...	2	Read	Write	0000	0
FC	MFR_ADDED_DROOP_DURING_RAMP	Write W...	Read W...	2	Read	Write	0000	0

Figure 4 Patched MFR commands table

2.3.1 PWM fan introduction

The four-wire PWM-controlled fan is used to reduce the overall system acoustics. When properly implemented, it will be significantly quieter than a similar three-wire fan.

To use the four-wire PWM fan NMB 04028DA-12R:

- Apply rated bias voltage to the fan.
- Apply PWM pulse to PWM control input (brown wire). The fan runs at the maximum speed if the PWM pin is left floating.
- Add a pull-up resistor to the tach pin (white wire). Tach is open-drain output for tachometer monitoring.

At higher PWM duty, the fan speed and tach output frequency are higher. For model NMB 04028DA-12R, two tach cycles represent one rotation of the motor.

$$\mathrm{RPM} = 60 \times \frac{FTACH}{2}$$

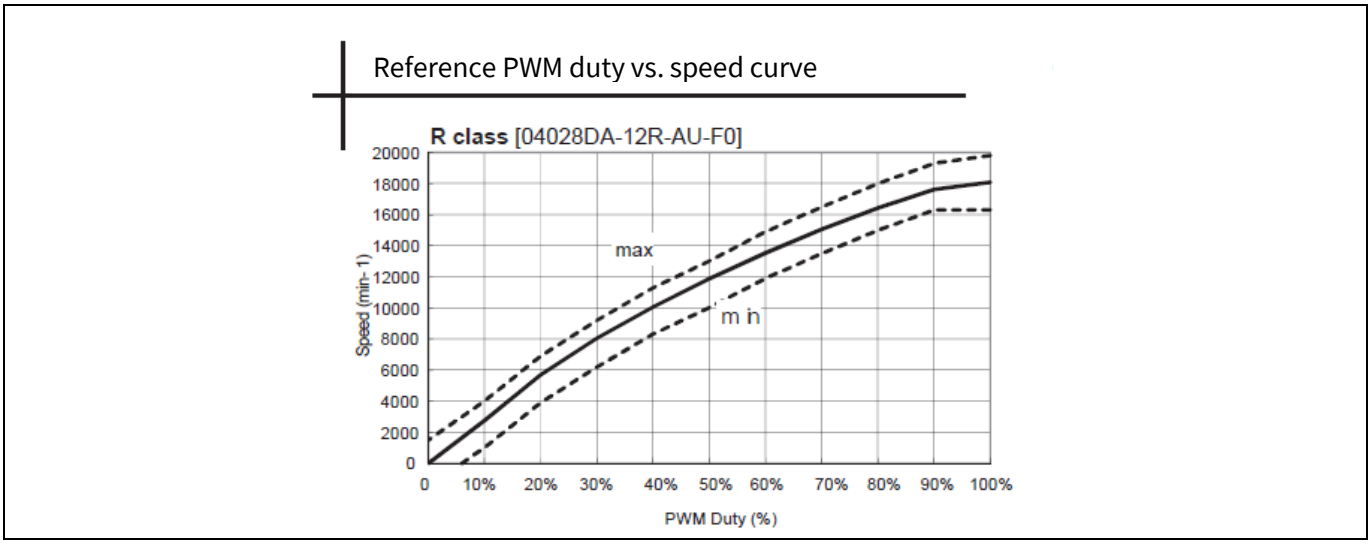


Figure 5 PWM duty vs. speed (NMB 04028DA-12R)

2.3.2 Fan configuration

The XDPP1100 multi-purpose pin for fan speed control is shown in **Table 5**.

Table 5 XDPP1100 GPIO mapping table for fan speed control

Name	Function 4
MP_FAULT1	O:FAN2_PWM
MP_FAULT2	I:FAN2_TACH
MP_IMON	I:FAN1_TACH
MP_SYNC	O:FAN1_PWM
PWM11	O:FAN1_PWM
PWM12	I:FAN1_TACH
PWM7	O:FAN2_PWM
PWM8	I:FAN2_TACH

It is possible to configure any of the GPIO pins in Table 5 for fan speed control. The REF_600W_FBFB_XDPP1100 demo board uses PWM7 and PWM8 for fan speed control. To enable fan control, configure the registers per Table 6, configuring PMBus command per Table 7.

Table 6 Fan control register configuration

Register name	Value	Meaning
pwm7_func	4	Set PWM7 pin to be Fan 2 PWM output
pwm7_ppen	1	Set PWM7 pin to CMOS output
pwm8_func	4	Set PWM8 pin to be Fan 2 tach output
fan2_frequency	0	Fan speed 25 kHz

Table 7 Fan control PMBus configuration

PMBus command	Value	Meaning
FAN_CONFIG_1_2	0x09	Enable Fan 2, duty-cycle control, two pulses per revolution

PMBus command	Value	Meaning
FAN_COMMAND_1	0x0000	Set Fan 1 duty cycle to 0
FAN_COMMAND_2	0xC833	Set Fan 2 duty cycle to 40 percent

With the above settings, fan speed will be changed per the PWM duty cycle set by FAN_COMMAND_2. More details of the fan commands are explained below.

FAN_CONFIG_1_2 is used to configure up to two fans.

Table 8 FAN_CONFIG data byte format

Bit(s)	Value	Meaning
7	1	A fan is installed in position 1
	0	No fan is installed in position 1
6	1	Fan 1 is commanded in RPM
	0	Fan 1 is commanded in duty cycle
5:4	00b to 11b	Fan 1 tachometer pulses per revolution
3	1	A fan is installed in position 2
	0	No fan is installed in position 2
2	1	Fan 2 is commanded in RPM
	0	Fan 2 is commanded in duty cycle
1:0	00b to 11b	Fan 2 tachometer pulses per revolution

Bit 5:4 and 1:0 of the command tells the PMBus device the number of tachometer pulses per revolution. This information is needed for commanding and reporting fan speed in RPM. Two bits are provided for each fan. These settings do not have to be the same for Fan 1 and Fan 2. The binary values of these bits map to pulses per revolution as follows:

• 00b = one pulse per revolution,

• 01b = two pulses per revolution,

• 10b = three pulses per revolution, and

• 11b = four pulses per revolution.

For example:

- To set a fan at position 2, with duty-cycle control, tachometer two pulses per revolution, write 0x09 to command FAN_CONFIG_1_2.

The XDPP1100 only supports duty-cycle mode; please set proper FAN_CONFIG_1_2.

The FAN_COMMAND_1, FAN_COMMAND_2 commands are used to adjust the operation of up to two fans contained in the system. This command has two data bytes.

To set the PWM duty cycle, use the “Linear Format Calculator” provided in the XDPP100 GUI to calculate FAN_COMMAND value (**Figure 6**). For example, to set 40 percent duty cycle, write 0.4 Decimal Value in the Linear 11 Calculator, then set the exponent by clicking the up/down arrow in the Exponent section, until the Exact Value approaches target 0.4, then click the green arrow that points to the hex value. It will give the result C8 33, which defines duty cycle as 0.3984375. Write C8 33 to FAN_COMMAND_2, setting the fan PWM duty cycle to 0.4.

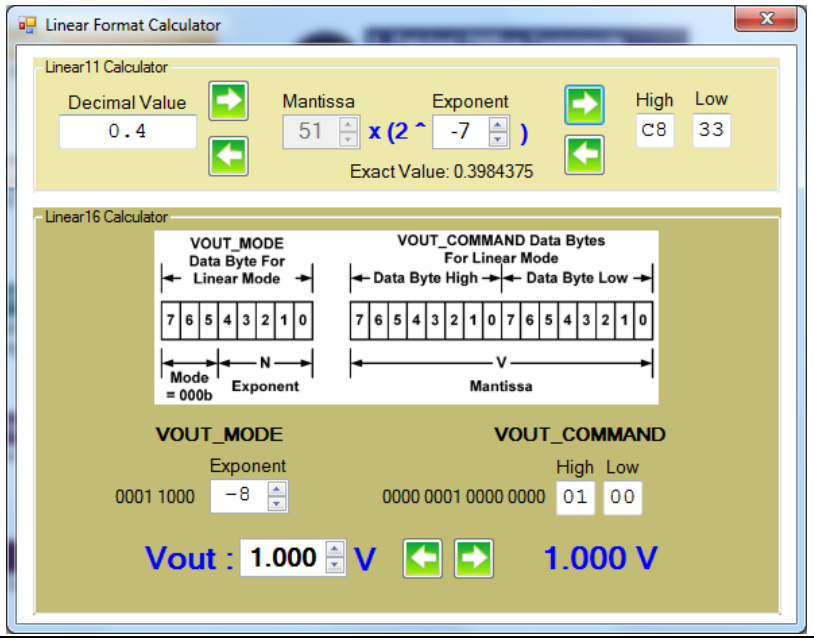


Figure 6 Linear Format Calculator

All the fan control registers are listed in **Table 9**.

Table 9 Fan control registers

Register name	Value (example)	Description
en_fan1	1	Fan 1 is enabled. Automatic set by FW per FAN_CONFIG_1_2 command. 0x90 enables Fan 1
fan1_duty_min		Set Fan 1 minimum duty cycle when operating in CM. LSB = 1/256
fan1_freq	00	Fan 1 switching frequency set to 25 kHz
fan1_imax		Fan 1 maximum current reference when operating in CM (U8.0, LSB = 1 A). When the output current exceeds I_{MAX} the output duty cycle will be 100 percent
fan1_imin		Fan 1 minimum current reference when operating in CM (U8.0, LSB = 1 A). When the output current is less than fan1_imin the output duty cycle will be zero
fan1_iout_sel		Fan 1 I_{OUT} source when operating in CM. 0: loop 0 I_{OUT} 1: loop 1 I_{OUT}
fan1_mode		0: duty-cycle mode, Fan 1 speed is set by FAN1_COMMAND 1: CM, Fan 1 speed is calculated based on output current
fan1_tach_ppr	1	Tachometer pulses per revolution. Automatic set by FW per FAN_CONFIG_1_2 command. 0x90 set fan1_tach_ppr to 1, means two pulses per revolution
en_fan2	1	Fan 2 is enabled. Automatic set by FW per FAN_CONFIG_1_2 command. 0x09 enables Fan 2. 0x99 enables both Fan 1 and Fan 2
fan2_duty_min		Set Fan 2 minimum duty cycle when operating in CM
fan2_freq	00	Fan 2 switching frequency set to 25 kHz

Register name	Value (example)	Description
fan2_imax		Fan 2 maximum current reference when operating in CM (U8.0, LSB = 1 A). When the output current exceeds I_{MAX} the output duty cycle will be 100 percent
fan2_imin		Fan 2 minimum current reference when operating in CM (U8.0, LSB = 1 A). When the output current is less than fan1_imin the output duty cycle will be zero
fan2_iout_sel		Fan2 I_{OUT} source when operating in CM. 0: loop 0 I_{OUT} 1: loop 1 I_{OUT}
fan2_mode		0: duty-cycle mode, Fan 2 speed is set by FAN2_COMMAND 1: CM, Fan 2 speed is calculated based on output current
fan2_tach_ppr	1	Tachometer pulses per revolution. Automatic set by FW per FAN_CONFIG_1_2 command. 0x09 set fan2_tach_ppr to 1, means two pulses per revolution

2.3.3 Fan control with CM

When fan2_mode is set to 1, the XDPP1100 controls Fan 2 speed per output current.

Table 10 Fan control registers set to CM

Register name	Value	Meaning
en_fan2	1	Fan 2 is enabled. Automatic set by FW per FAN_CONFIG_1_2 command. 0x09 enables Fan 2
fan2_duty_min	52	Set fan minimum duty cycle when operating in CM. To set minimum duty to 20 percent, write 52. fan1_duty = 0.2/0.003906 = 52
fan2_freq	00	Fan switching frequency set to 25 kHz
fan2_imax	25	Fan maximum current reference when operating in CM (U8.0, LSB = 1 A). When the output current exceeds 25 A the output duty cycle will be 100 percent
fan2_imin	2	Fan minimum current reference when operating in CM (U8.0, LSB = 1 A). When the output current is less than 2 A the output duty cycle will be zero
fan2_iout_sel	0	Fan I_{OUT} source is loop 0 I_{OUT} when operating in CM
fan2_mode	1	1: CM, fan speed is calculated based on output current
fan2_tach_ppr	1	Tachometer pulses per revolution. Automatic set by FW per FAN_CONFIG_1_2 command. 0x09 set fan2_tach_ppr to 1, means two pulses per revolution

Table 11 shows test results of fan2_imax set to 25 A, fan2_imin = 2 A, fan2_duty_min = 0 (0 percent minimum duty cycle).

Table 11 Fan speed vs. I_{OUT}

I_{OUT} (A)	Expect fan PWM duty	FAN2_PWM_O	READ_FAN_SPEED2 (RPM)	READ_FAN_EXP
0	0 percent	0	0	3
6	24 percent	24.0 percent	6208	3
10.25	41 percent	40.97 percent	9440	4

I_{OUT} (A)	Expect fan PWM duty	FAN2_PWM_O	READ_FAN_SPEED2 (RPM)	READ_FAN_EXP
15.69	62.76 percent	62 percent	12816	4
20	82.52 percent	82 percent	15712	5
24.88	99.52 percent	98.92 percent	17632	5
26.88	100 percent	100 percent	17632	5

Read_fan_exp is configured by PMBus 0xC6 FW_CONFIG_TELEMETRY. Please select proper read_fan_exp to display the READ_FAN_SPEED properly.

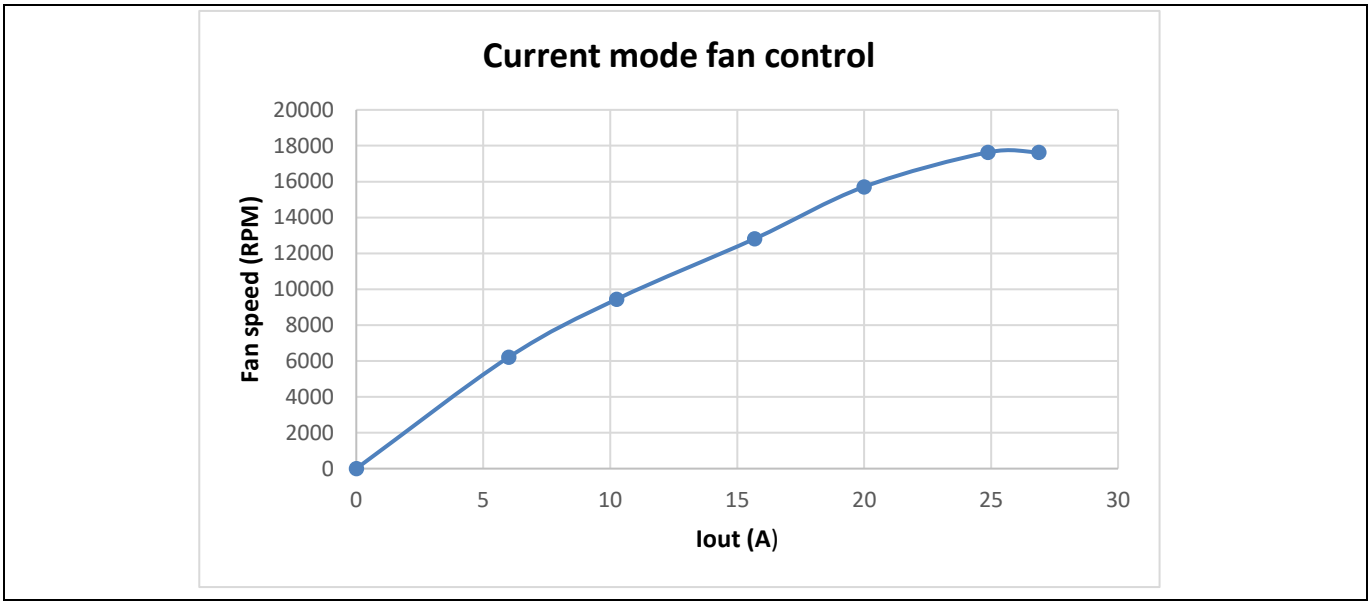


Figure 7 Fan speed vs. load current in CM control

References

[1] Infineon Technologies AG: *XDPP1100 Datasheet* (V 2.1); 2021-07-28; **XDPP1100 Datasheet**

[2] Infineon Technologies AG: *XDPP1100 GUI installation guide*, Application Note (V 1.0); 2021-02-05; **XDPP1100 GUI installation guide**

[3] Infineon Technologies AG: *Configure XDPP1100 with GUI*

[4] Infineon Technologies AG: 600 W FB-FB quarter brick using the XDPP1100 digital controller, REF_600W_FBFB_XDPP1100 Application Note (V 1.1); 2020-10-28; **600 W FB-FB quarter brick using the XDPP1100 digital controller**

Revision history

Document version	Date of release	Description of changes
V 1.0	2022-03-29	First release

Trademarks
All referenced product or service names and trademarks are the property of their respective owners.

Edition 2022-03-29

Published by

Infineon Technologies AG

81726 München, Germany

Do you have a question about this document?

Email: erratum@infineon.com

Document reference

UM_2001_PL88_2002_224640

IMPORTANT NOTICE

The information given in this document shall in no event be regarded as a guarantee of conditions or characteristics (“Beschaffenheitsgarantie”) .

With respect to any examples, hints or any typical values stated herein and/or any information regarding the application of the product, Infineon Technologies hereby disclaims any and all warranties and liabilities of any kind, including without limitation warranties of non-infringement of intellectual property rights of any third party.

In addition, any information given in this document is subject to customer’s compliance with its obligations stated in this document and any applicable legal requirements, norms and standards concerning customer’s products and any use of the product of Infineon Technologies in customer’s applications.

The data contained in this document is exclusively intended for technically trained staff. It is the responsibility of customer’s technical departments to evaluate the suitability of the product for the intended application and the completeness of the product information given in this document with respect to such application.

For further information on the product, technology, delivery terms and conditions and prices please contact your nearest Infineon Technologies office (**www.infineon.com**).

WARNINGS

Due to technical requirements products may contain dangerous substances. For information on the types in question please contact your nearest Infineon Technologies office.

Except as otherwise explicitly approved by Infineon Technologies in a written document signed by authorized representatives of Infineon Technologies, Infineon Technologies’ products may not be used in any applications where a failure of the product or any consequences of the use thereof can reasonably be expected to result in personal injury.