

# XMC4000/XMC1000

32-bit Microcontroller Series for Industrial Applications

## XMC Digital Power Explorer Power Board User Manual

UG\_201511\_PL30\_001

Board User Manual

### Scope and purpose

This document describes the features and hardware details of XMC Digital Power Explorer, designed to provide an evaluation platform for digital control applications with Infineon XMC ARM® Cortex™ microcontrollers. This board is part of Infineon's Digital Power Control Application Kit.

### Applicable Products

- XMC4200 Microcontroller
- XMC1300 Microcontroller
- XMC Digital Power Explorer Kit
- DAVE™

### References (optional, may be shifted to Appendix)

Infineon: DAVE™, <http://www.infineon.com/DAVE>

Infineon: XMC Family, <http://www.infineon.com/XMC>

XMC Digital Power Explorer, [http://www.infineon.com/xmc\\_dp\\_exp](http://www.infineon.com/xmc_dp_exp)

Example codes for this board, [www.infineon.com/DAVE](http://www.infineon.com/DAVE)

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# 1 Overview

The XMC Digital Power Explorer is an evaluation board with the goal to help engineers in the learning and testing of digital power control applications. The board features a synchronous buck converter that can be controlled digitally with XMC microcontrollers. Synchronous buck converter is one of the most well known power topologies and many of the concepts of it can be ported to other power stages, what makes the synchronous buck converter a great platform for leaning and experimenting.

Different control cards can be plugged in to allow the user to select between different price/performance combinations available in XMC family of microcontrollers.

Both voltage control and peak current control with slope compensation can be implemented in this board. This board includes loads on board for easy test of step response. Frequency behaviour can be analyzed with the help of a network analyser. XMC Digital Power Explorer is ready for signal injection from network analyser equipment to study the frequency response of the buck stage.

This board is built with best in class Infineon Technologies components and with the collaboration of Biricha Digital and Würth Elektronik .

## 1.1 Key features

The XMC Digital Power Explorer power board is equipped with the following features:

- Synchronous buck converter capable of:
  - Synchronous and non-synchronous buck converter modes
  - Voltage and peak current control methods
  - 2 channel bucks with 1 XMC. Connecting a second XMC Digital Power Explorer in master-slave configuration (see section 2.3)
  - 3 on board loads for testing step response with option to connect external loads –i.e. electronic loads- for further advanced testing.
  - Bode diagram measurement ready - requires network analyzer
  - Dual channel serial communication including PMBus™ (I2C)communication
- Control card connector for plugging in:
  - Infineon XMC4200 Digital Power Control Card with XMC4200 (ARM® Cortex™-M4F-based) Microcontroller, 256 kByte on-chip Flash, LQFP64
  - Infineon XMC1300 Digital Power Control Card with XMC1300 (ARM® Cortex™-M0-based) Microcontroller, up to 200 kByte on-chip Flash, TSSOP38
- Single package high side and low side MOSFET
- Plenty of test points for learning all details of the buck converter
- General purpose switch for user interaction or control

## 1.2 Block diagram

Figure 1 shows the functional block diagram of the XMC Digital Power Explorer. For more information about the power supply domains please refer to chapter 0.

The buck converter board is comprised of the following building blocks:

### Overview

- 1 XMC Digital Power Control Card Connector compatible with XMC4200 and XMC1300 control cards. XMC Digital Power Explorer includes 2 PCB openings to the sides of the control card connector. This hinders wrong connection of the control card.
- Power adapter input jack to plug in 12 V DC adapter. Includes switch to interrupt the supply
- PMBus™ and UART communication options. Pull up resistors included on board for I2C communication support. Pulls up are supplied from XMC Digital Control Card Connector side
- 3 switchable loads (45%, 45%, 10%). Each is signaled with an LED→LED ON means load is active.
- Voltage measurements - ADC: Vout, Vin through resistive voltage dividers
- Current measurements - Comparators: inductor current through current transformer. Options for blanking (CCU) and slope compensation by HW components using provided jumper (SV5). For more details on current sensing consult section 2.5.
- 2PWM complementary signals – CCUx - to high and low side switches
- Master-Slave connectors for controlling a second XMC Digital Power Explorer with a single XMC Digital Power Control Card

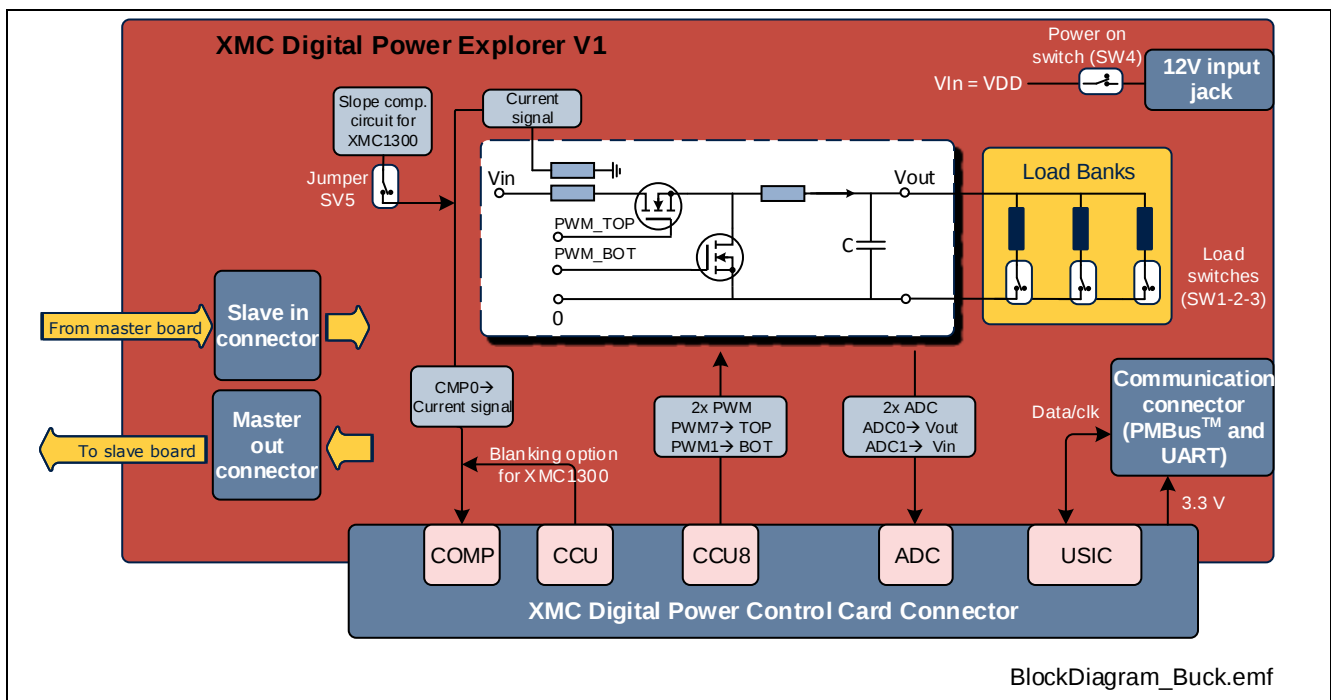


Figure 1 Block Diagram of XMC Digital Power Explorer

## 2 Hardware Description

The following sections give a detailed description of the hardware and how it can be used.

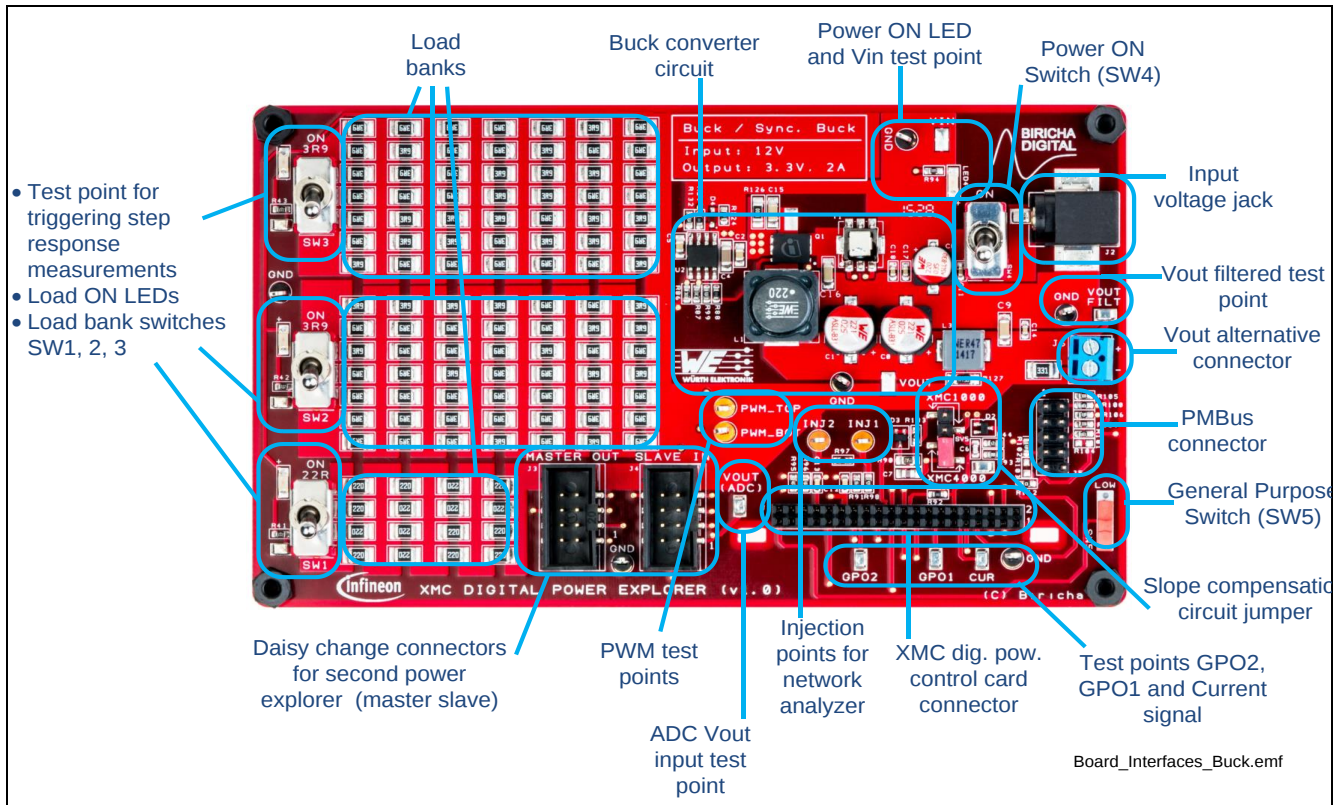


Figure 2 XMC Digital Power Explorer hardware description

### 2.1 Buck converter circuit description

XMC Digital Power Explorer buck converter is targeted for low voltage. Specification is shown in Table 1. The schematic view of the buck converter stage is shown in Figure 3. The target output voltage is 3.3V. Nevertheless, as a buck converter, any voltages from 0V to  $V_{in}$  are theoretically possible depending on the driving of the MOSFETs –duty cycle.

The inductor value ensures continuous conduction mode (CCM) of the buck converter as far as any of SW3 or SW2 load switches are in the “ON” position. In other words, DCM operation occurs only when SW1 load switch is activated assuming 200 kHz switching frequency.

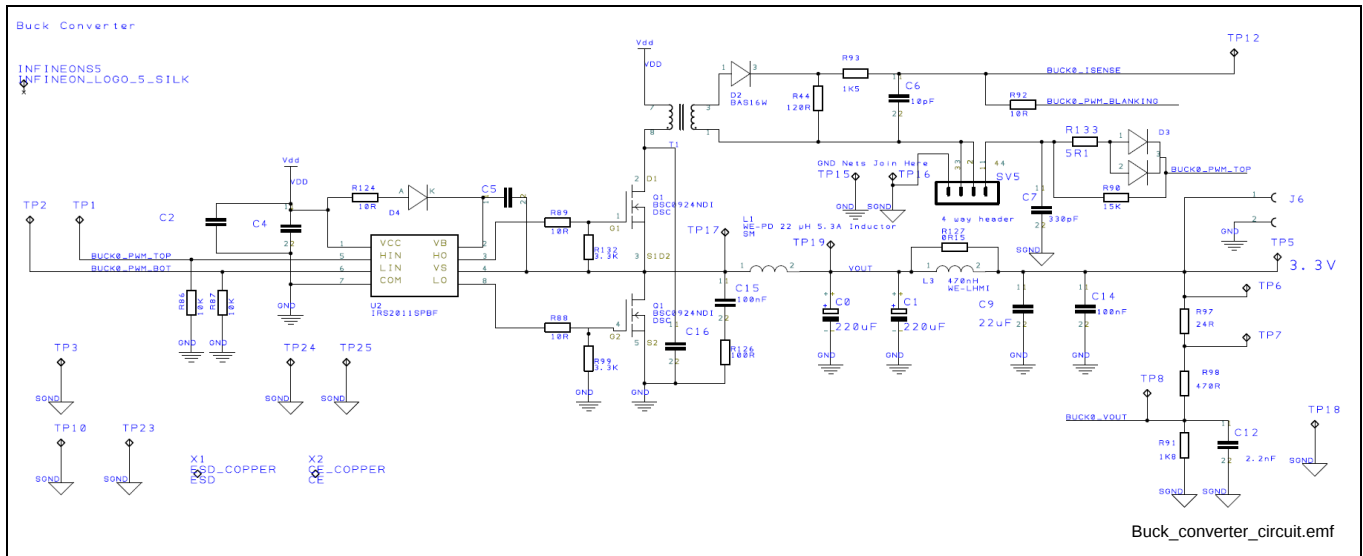
*Note: Depending on the buck converter configuration, for example target output voltage or load connected, the board might become hot. Read carefully the disclaimer.*

Table 1 Synchronous buck converter specification

| Specification          | Name          | Value                                                           |
|------------------------|---------------|-----------------------------------------------------------------|
| Input voltage          | $V_{in}$      | 12V DC                                                          |
| Output voltage         | $V_{out}$     | 3.3V DC (depending on SW)                                       |
| Maximum output current | $I_{out,max}$ | 2 A                                                             |
| On board load values   | -             | 3.9 $\Omega$ (SW3, SW2)→45% load<br>22 $\Omega$ (SW1)→ 10% load |

### Hardware Description

| Specification                   | Name     | Value                                 |
|---------------------------------|----------|---------------------------------------|
| Main inductor                   | L1       | 22uH                                  |
| Output capacitor                | C0    C1 | 200uF    200uF → 400uF                |
| Gate driver high and low side   | U2       | IRS2011SPBF (International Rectifier) |
| Dual MOSFET (high and low side) | Q1       | BSC0924NDI (Infineon Technologies)    |



## Hardware Description

| Specification                                 | Name              | Value Q1 (high side) | Value Q2 (low side) |
|-----------------------------------------------|-------------------|----------------------|---------------------|
| Resistance drain to source at $V_{GS} = 10V$  | $R_{DS(on), max}$ | 5m $\Omega$          | 3.7m $\Omega$       |
| Resistance drain to source at $V_{GS} = 4.5V$ | $R_{DS(on), max}$ | 7m $\Omega$          | 5.2m $\Omega$       |
| Max drain current                             | $I_D$             | 40A                  | 40A                 |

The voltage sensing in both input voltage and output voltage, is done with a resistor ladder (voltage divider). On the current side, a current transformer is utilized and provides information during the on time of the buck converter for peak current control mode. Sensing gains are summarized in Table 3. Those values are necessary for configuring the SW controlling the power stage.

More detailed information on current sensing can be found in section 2.5.

**Table 3 Analog sensing gains**

| Gain                 | Value    | Formula                                        |
|----------------------|----------|------------------------------------------------|
| Vout gain            | 0,78466  | $(R91) / (R91 + (R97 + R98))$                  |
| Vin gain             | 0,20930  | $R96 / (R96 + R95)$                            |
| Current sensing gain | 0.96 V/A | 1:125 (transformer ratio)<br>$R44 = 120\Omega$ |

## 2.2 Board power supply

The XMC Digital Power Explorer board is designed to be powered from a 12 V DC power supply supplying a current of 2A. The input jack is shown in Figure 2. Sw4 switch enables the supply of the board after plugging the power adapter. To indicate the status, one indicating LED –LED4– is provided on board (see Figure 2). The LED will be “ON” when the corresponding power rail is powered.

The 12 V from VDD power rail are supplied to the XMC Digital Power Control Card. The control card internally converts that into 3.3 V to supply the MCU and other components in the control card. At the same time, the control card provides 3.3 V to XMC Digital Power Explorer board to supply the communication pin header (PMBus™ connector).

Additionally, the buck converter is designed to provide 3.3 V up to 2A to the Vout connector when the buck converter is running correctly.

Figure 5 shows details of the power supply concept of the control card. More detailed circuitry can be found in the section 3.1.

## Hardware Description

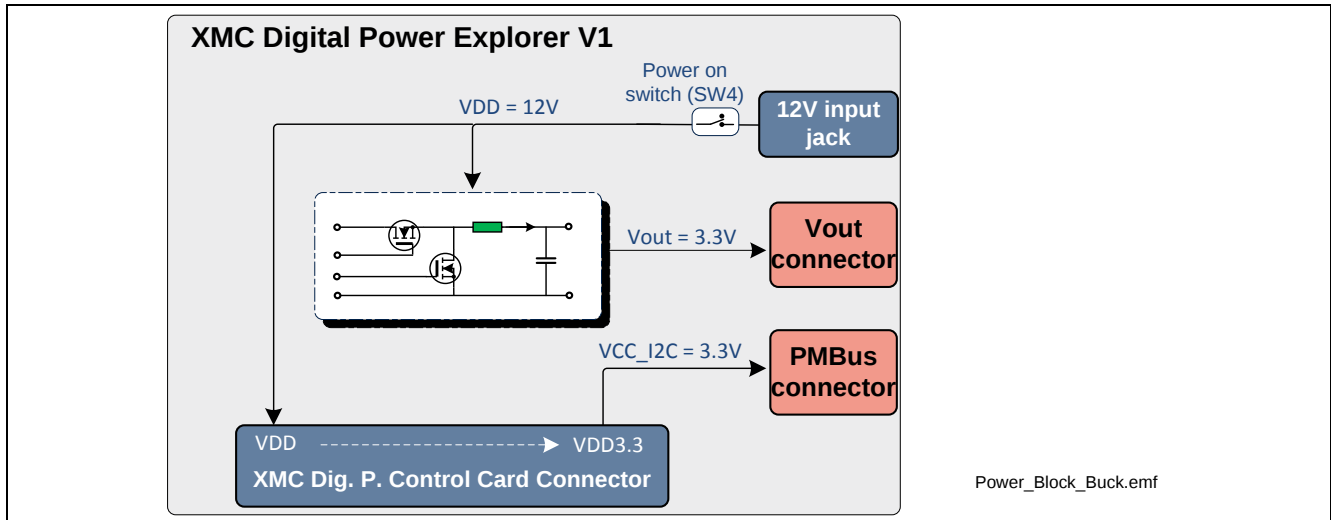


Figure 5 Block Diagram of Power Supply Concept

### 2.3 Master and slave configuration

XMC Digital Power Explorer can be chained to a second XMC Digital Power Explorer board to complete a master slave connection that can be controlled with a single XMC control card. To do that, connect “MASTER\_OUT” signals from the board where the XMC control card is plugged, into the “SLVE\_IN” connector of the slave board. This is shown in Figure 6.

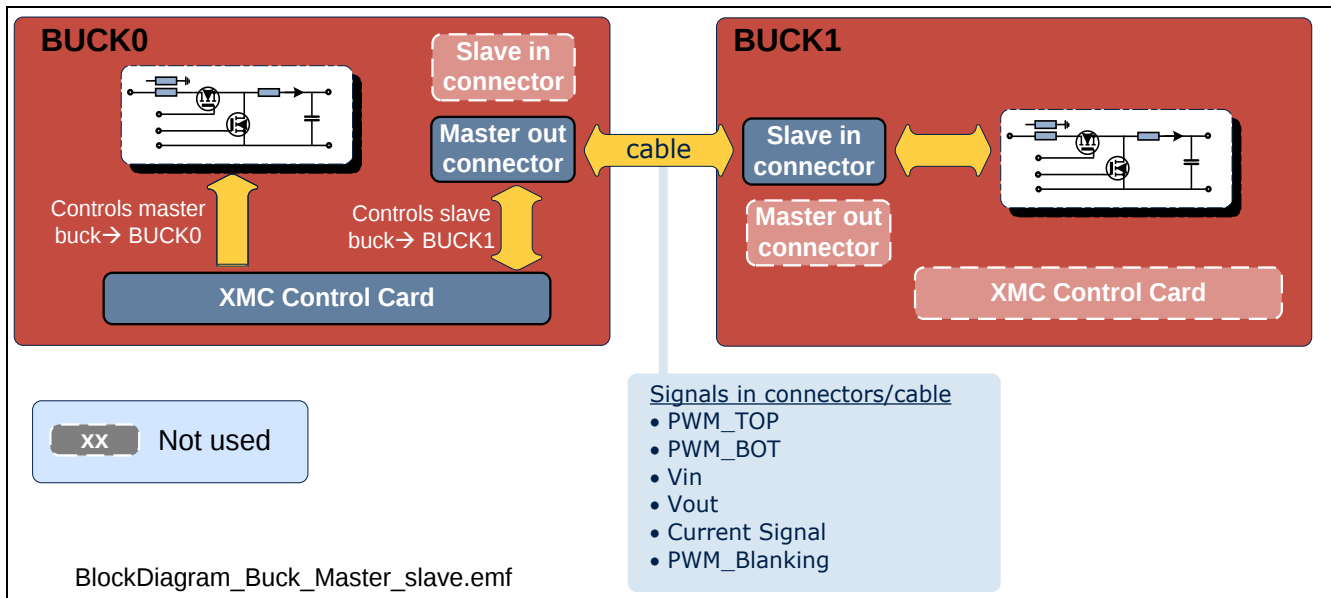


Figure 6 Diagram for a master slave connection. Control 2 Buck converters with a single XMC

In a master-slave configuration, both bucks can be controlled in voltage mode, peak current mode or a mixture of both. This is dependent only in the SW configuration of XMC in the control card side.

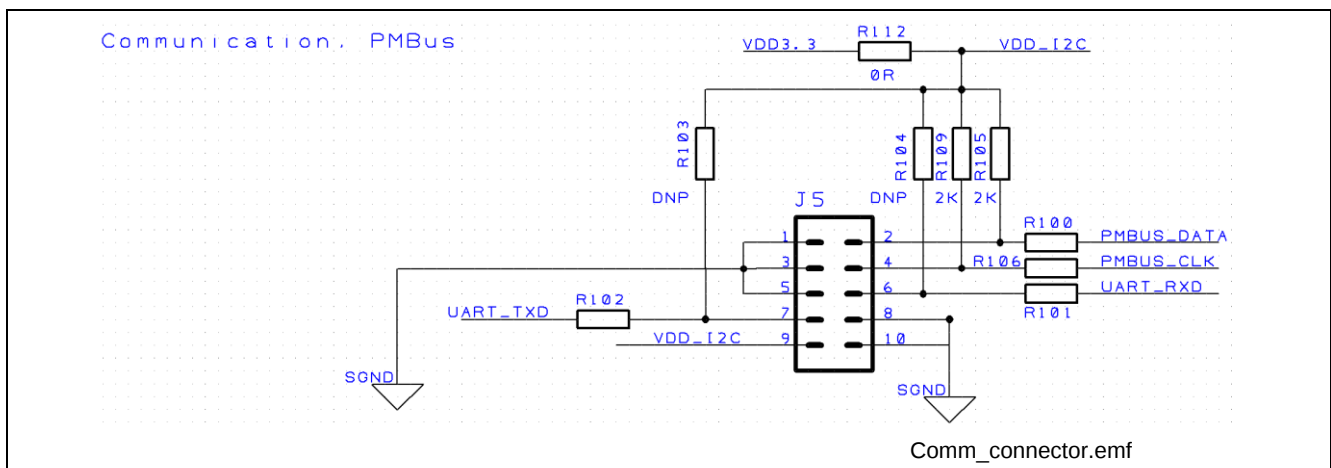
If communication is required –i.e. PMBus™– the connector in the master board must be used for that purpose, as there are no signals transferred from the slave board to the master for communication and the salved communication connector is not powered on.

## Hardware Description

### 2.4 PMBus™ and UART Interface

XMC Digital Power Explorer includes a connector for communicating the buck converter with an external interface. The connector is supplied with 3.3V from the XMC control card connector as can be seen in Figure 7. There are 2 communication options:

- PMBus™ through I2C interface. Pull up resistors are provided on board (R109, R105)
- General purpose serial communication. In case of I2C is required, it is possible to mount resistors R103 and R104 to provide the pull up functionality. Those resistors are not populated in the PCB (DNP)



**Figure 7 Communication connector schematic detail - (DNP = not populated component)**

The communication can be used to send commands to XMC Digital Power Explorer. For example it is possible to modify the Vout target value, or to read the status of the converter.

#### 2.4.1 Test points

Within XMC Digital Power Explorer card there are a total of 22 test points that are listed in Table 4. This will help the user to inspect different points of interest and learn how the buck converter behaves in detail.

**Table 4 Test points description**

| Test point name | Test point number                               | Description                                        | Type of test point |
|-----------------|-------------------------------------------------|----------------------------------------------------|--------------------|
| PWM_TOP         | TP1                                             | High side MOSFET PWM signal                        | Orange             |
| PWM_BOT         | TP2                                             | Low side MOSFET PWM signal                         | Orange             |
| INJ1/INJ2       | TP7/TP6                                         | Injection points for network analyzers             | Orange             |
| GND             | TP3, TP10, TP15, TP16<br>TP18, TP23, TP24, TP25 | 8 GND test points for oscilloscope probe grounding | Black/SMD          |
| VIN             | TP9                                             | Input voltage                                      | Not mounted SMD    |
| VOUT            | TP19                                            | Output voltage                                     | Not mounted SMD    |
| VOUT_FILT       | TP5                                             | Output voltage after additional filtering          | SMD                |
| VOUT (ADC)      | TP8                                             | Vout signal delivered to XMC ADC                   | SMD                |

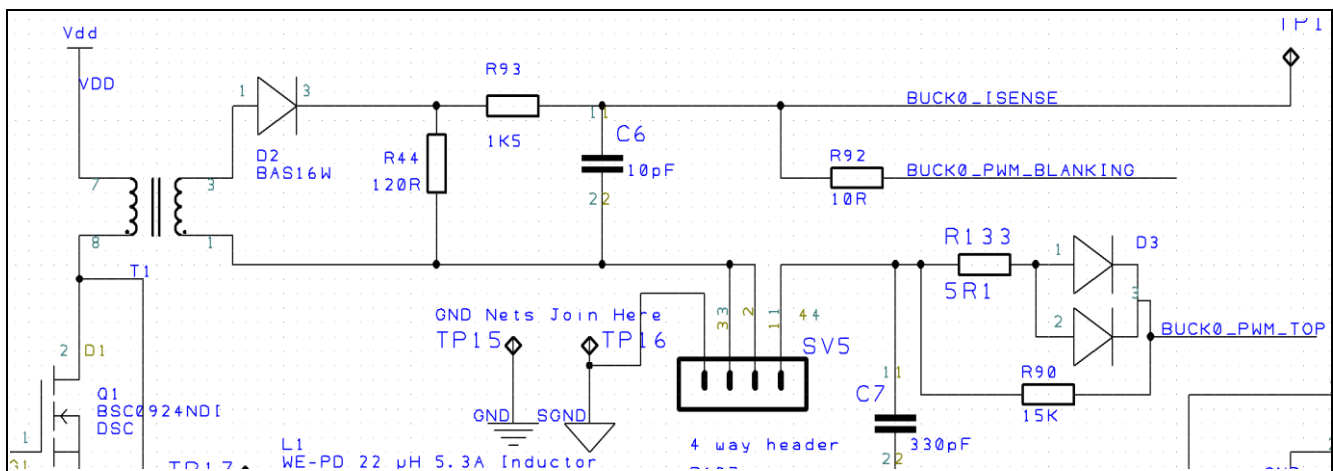
## Hardware Description

| Test point name | Test point number | Description                                                                                            | Type of test point                      |
|-----------------|-------------------|--------------------------------------------------------------------------------------------------------|-----------------------------------------|
| SW1-SW3         | TP20, TP21, TP22  | Used for triggering oscilloscope while testing step response of buck                                   | SMD                                     |
| Switching node  | TP17              | Node between both MOSFETs and buck inductor                                                            | Not mounted SMD (positioned next to Q1) |
| GPO1, GPO2      | TP13, TP14        | General purpose test points connected to general purpose pins of XMC for signalization (i.e. CPU load) | SMD                                     |
| CUR             | TP12              | Current signal out of current transformer (only during ON time) delivered to XMC comparator input      | SMD                                     |

Additionally to test points, XMC Digital Power Explorer power board includes a general purpose switch –SW5 connected to GP3 in connector (see Figure 2). This can be used by the user to signalize XMC, when to apply a specific action, for example, change the control scheme.

## 2.5 Current signal conditioning

The current of the buck converter is measured with a current transformer –T1- as shown in Figure 8, located between Vdd and the buck converter high side transistor. The current transformer has a turn ratio of 1:125. The secondary winding signal is half wave rectified –D2- and divided with a 120Ω resistor-R44. This results in a 120/125 gain which means that 1A in the buck converter translate into 0.96V in the MCU pin. Before the signal is delivered to the MCU, an RC filter (R93 and C6) is constructed to reduce high frequency spikes. The -3dB frequency of this filter is slightly above 10MHz. As a consequence, only the current during the PWM ON time is reflected in the signal BUCK0\_ISENSE. When Q1 transistor is in OFF state, the inductor current cannot be sensed in T1



**Figure 8 Current sensing circuit**

The current signal is then transferred to the XMC control card connector with the name BUCK0\_ISENSE. This can be connected to a comparator to detect the peak current of the buck converter. The current signal can as well be suppressed with the help of signal BUCK0\_PWM\_BLANKING. This signal must be connected to a

## Hardware Description

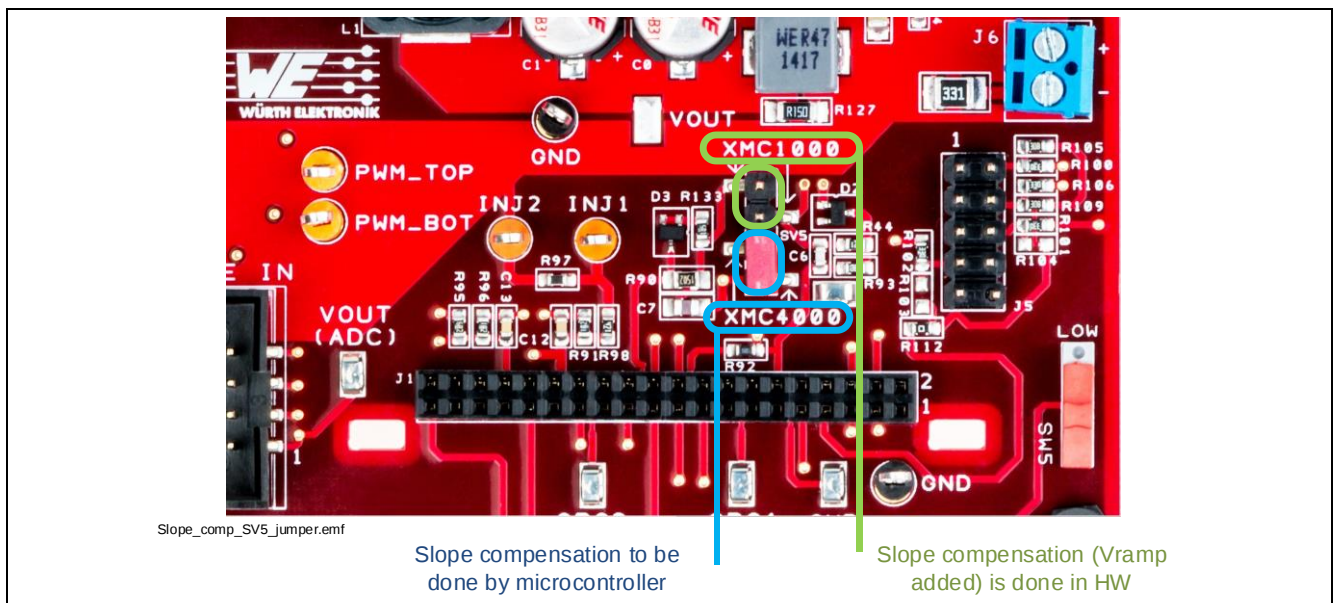
port pin in XMC configured as open drain. A resistor is in series to this signal to limit the current flowing into XMC port pin.

During the active time of that port pin, the current signal will be forced to GND and therefore not detected in the comparator. This is an implementation of the blanking time that can avoid early switching of the comparator. However this is not always necessary as in most cases RC filter (R93-C6) effect is enough.

### 2.5.1 Jumper SV5 usage for slope compensation

XMC Digital Power Explorer includes a jumper to select between 2 different ways of generating slope compensation as shown in Figure 9:

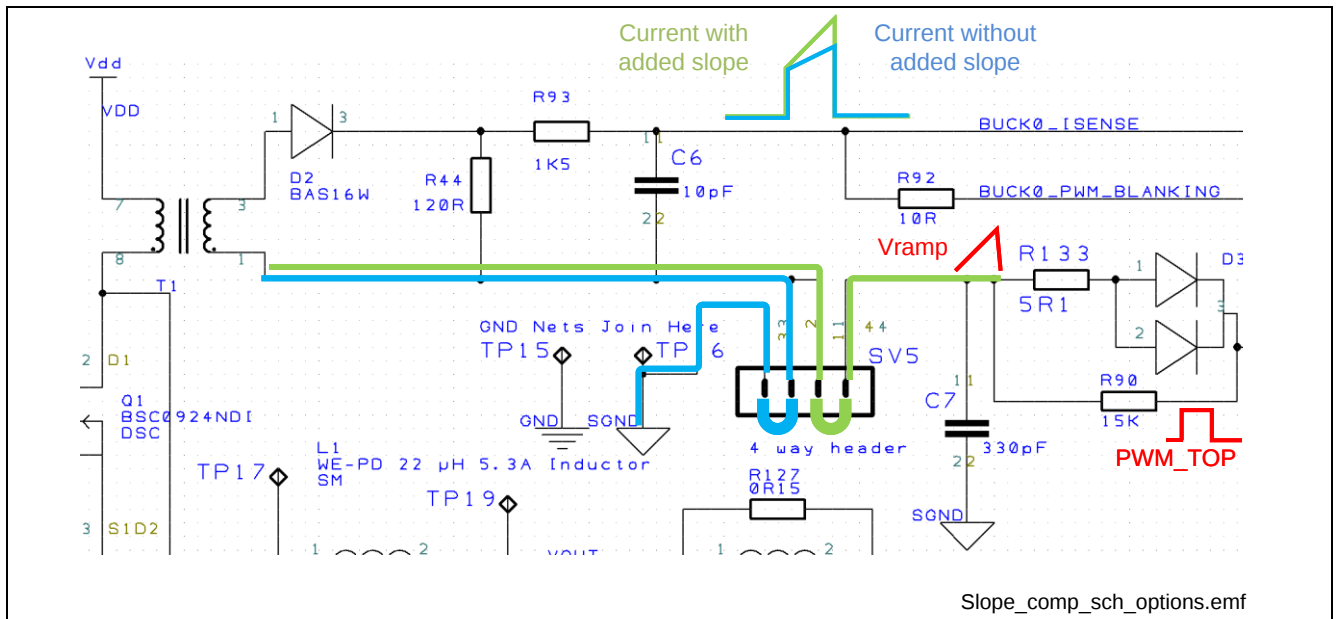
- **XMC4000 position:** in this case, GND is connected to pin 1 of the current transformer. This will permit XMC4200 (for example) to implement internally slope compensation. This is done by using Comparator and Slope Generation peripheral (CSG) in XMC4200 microcontroller. This module includes a Comparator and a DAC with automatic slope generation. Therefore there is no need to implement slope compensation in buck converter hardware.
- **XMC1000 position:** in this position, the generated voltage ramp on C7 connects to pin 1 of the current transformer. This will add that ramp voltage to the current signal with the effect that a slope is added. The slope increases while BUCK\_PWM\_TOP is active and decreases the rest of the time. This is useful for devices like XMC1300 where the comparators do not have an automatic slope generation that can be supplied to the comparator integrated in it.



**Figure 9 Slope compensation selection jumper (SV5)**

Figure 9 depicts a detail schematic view of the 2 different jumper positions and how the signals are routed to build an automatic slope generation. In the blue position-XMC4000-, the microcontroller must take care of the slope compensation, if necessary. This is labeled as XMC4000 because XMC4000 family includes the HRPWM module with its CSG – comparator and slope generation- submodule. This peripheral includes a DAC capable of automatically generate the necessary ramp to compensate the peak current signal

## Hardware Description



**Figure 10** Slope compensation option schematic detail. Depending on the jumper position, a ramp will be added or not to the current signal

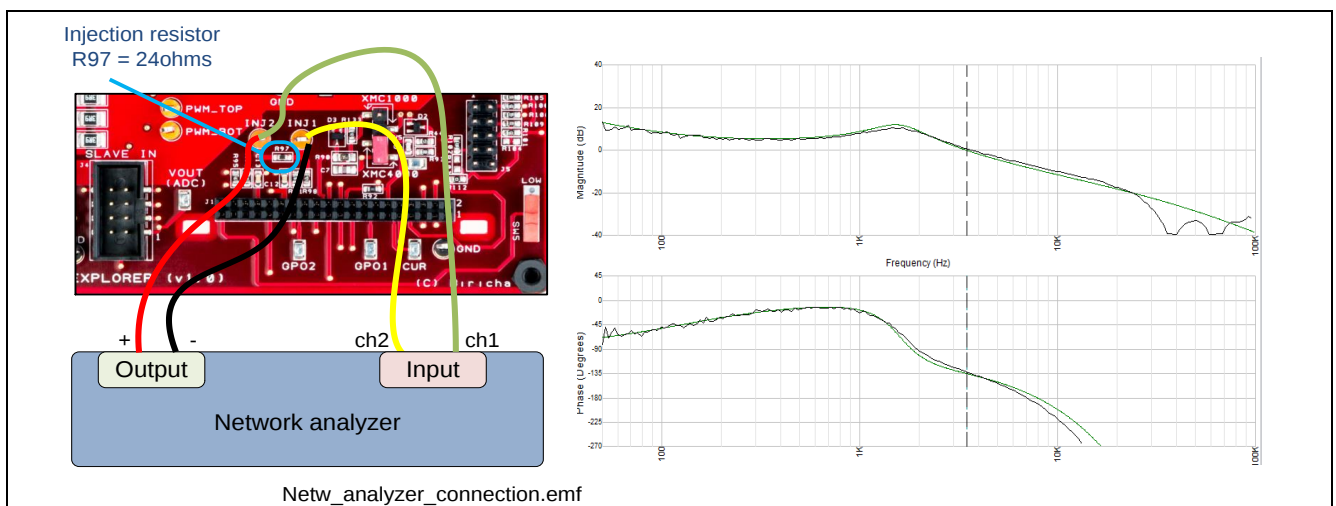
## 2.6 Connection to network analyzer

Typically, during the design of power supplies, a verification step is to analyze the frequency response of the system. In this way, it is possible to measure gain margin and phase margin and design for a robust control loop.

A network analyzer is responsible to inject a variable frequency signal into a small shunt in the circuit. At the same time, the network analyzer can measure transfer function for each given frequency of the input. In that way it is able to plot the bode diagram of that power supply.

XMC Digital Power Explorer is prepared to be used with network analyzer and includes test points (INJ1/2) as well as a shunt resistor –R97- with a resistance value of 24Ω to help measuring the bode diagram of the power stage.

Figure 11 shows how to set up the connection of XMC Digital Power Explorer to a network analyzer. Red and black signal represents the injected voltage with variable frequency, whereas the yellow and purple lines represent the measurement paths for the analyzers to capture the amplitude of the transfer function.



## Hardware Description

Figure 11 Network analyzer connection diagram

## 2.7 XMC Digital Power Control Card Connector

The XMC Digital Power Explorer includes a control card connector compatible with XMC4200 Digital Power Control Card and with XMC1300 Digital Power Control Card. This connector provides to and receives from the control card, relevant signals for the control, supply or communication of the buck converter. The signals available in the connector are:

- 2 pairs of complementary PWM signals: buck0 (master) and buck1 (slave).
- 4 ADC analog inputs: Vout and Vin for both buck0 and buck1.
- 2 comparator inputs: peak current detection for both buck0 and buck1.
- 2 serial channels
- 4 general purpose pins

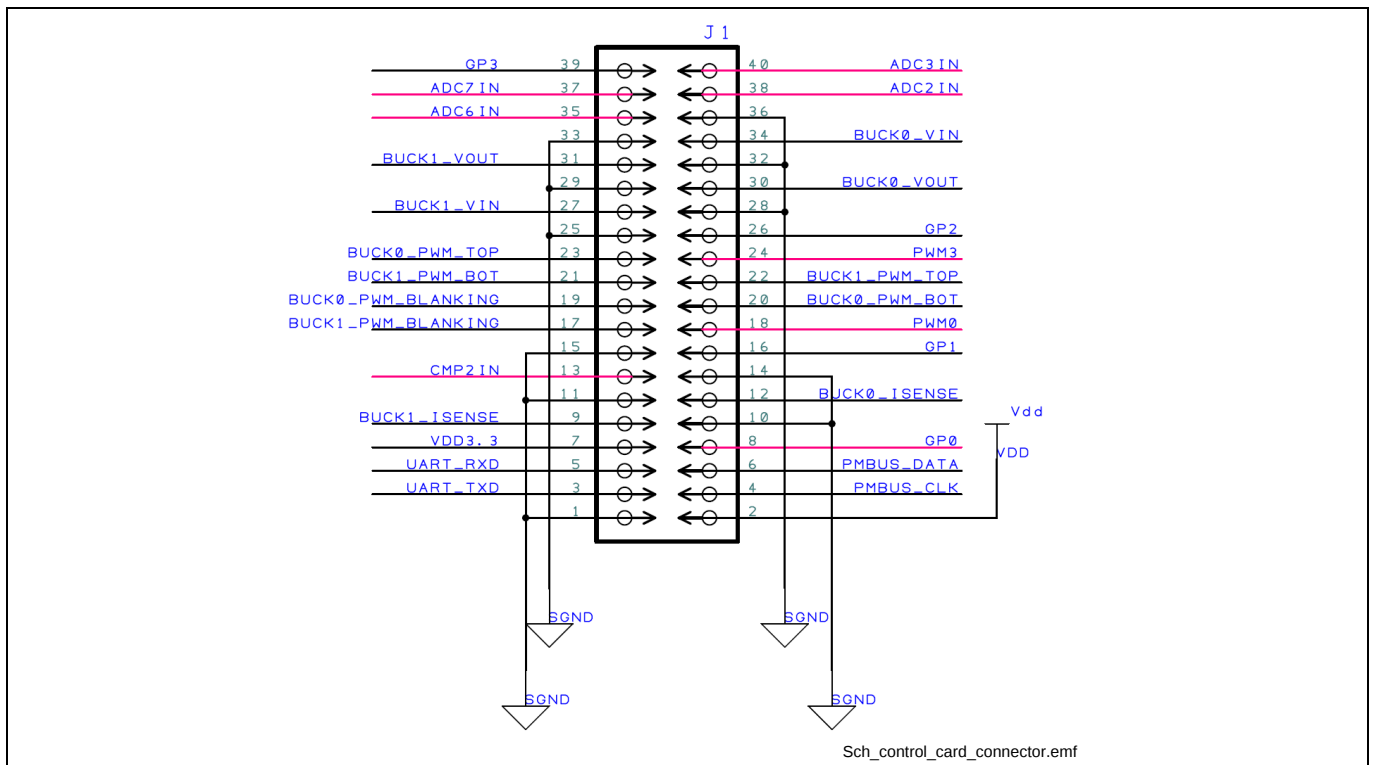


Figure 12 Control card power connector schematic

**Attention:** The power board connector is also providing the power supply for the power GND supply domain. Hence it may carry hazardous voltages.

The pin out of the connector is described in detail in Table 5.

Table 5 Power board connector pin out

| Pin number | Signal Name | Control card port | Note                                        |
|------------|-------------|-------------------|---------------------------------------------|
| 1          | SGND        | -                 | Digital GND                                 |
| 2          | VDD         | VDD               | 12V supply to the control card              |
| 3          | UART_TXD    | USIC2/GP5         | Can be used as serial port or user port pin |
| 4          | PMBUS_CLK   | USIC0             | PMBus clock signal (I2C)                    |
| 5          | UART_RXD    | USIC3/GP4         | Can be used as serial port or user port     |

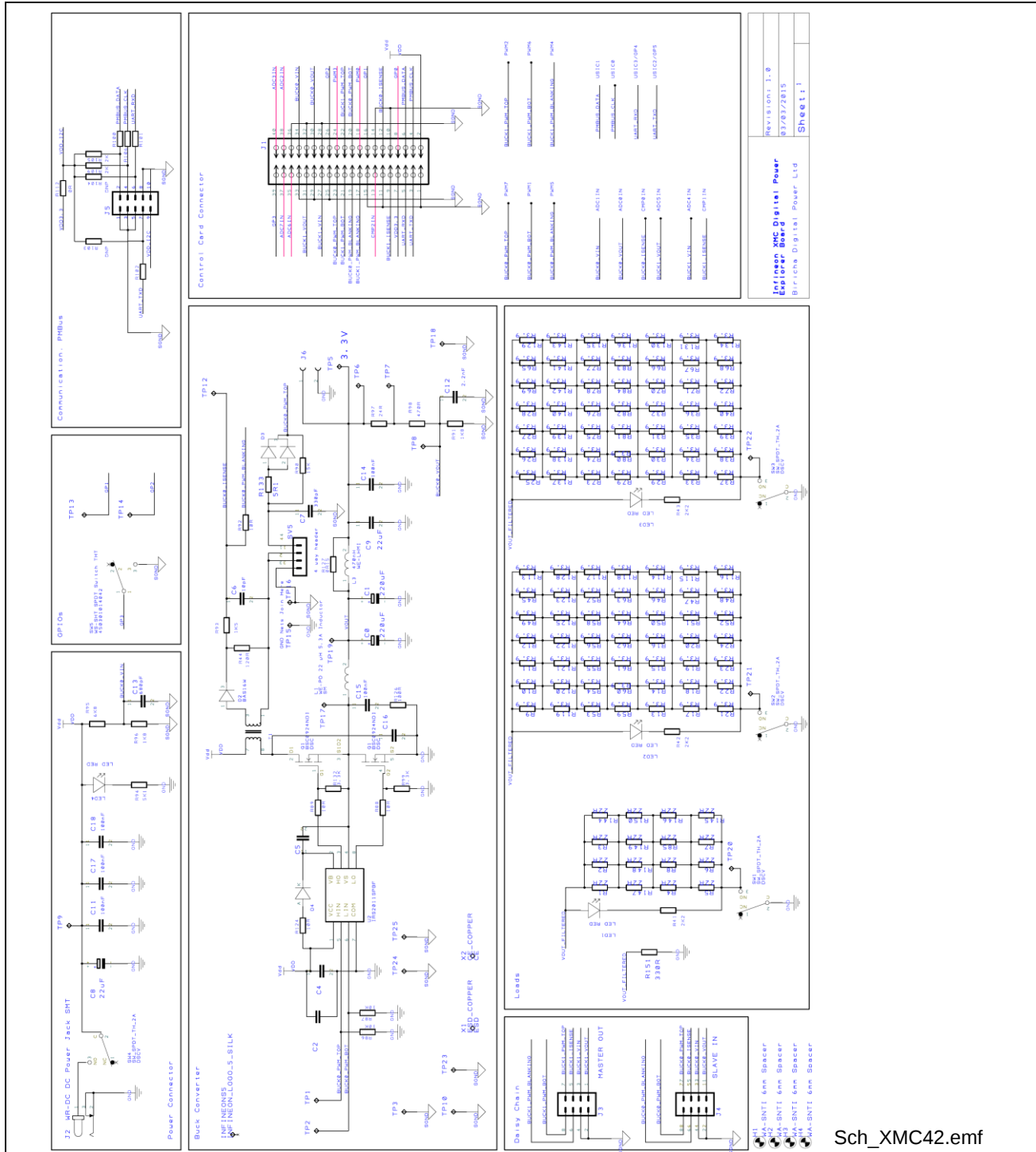
**Hardware Description**

| Pin number | Signal Name        | Control card port | Note                                         |
|------------|--------------------|-------------------|----------------------------------------------|
|            |                    |                   | pin                                          |
| 6          | PMBUS_DATA         | USIC1             | PMBus data signal (I2C)                      |
| 7          | VDD3.3             | VDD3.3            | 3.3 V output to power board                  |
| 8          | GP0                | GP0               | User port pin                                |
| 9          | BUCK1_ISENSE       | CMP1IN            | Current signal from slave buck               |
| 10         | SGND               | GND               |                                              |
| 11         | SGND               | GND               |                                              |
| 12         | BUCK0_ISENSE       | CMP0IN            | Current signal of master buck                |
| 13         | -                  | CMP2IN            |                                              |
| 14         | SGND               | GND               |                                              |
| 15         | SGND               | GND               |                                              |
| 16         | GP1                | GP1               | User port pin                                |
| 17         | BUCK1_PWM_BLANKING | PWM4              | Leading edge blanking option for slave buck  |
| 18         | -                  | PWM0              |                                              |
| 19         | BUCK0_PWM_BLANKING | PWM5              | Leading edge blanking option for master buck |
| 20         | BUCK0_PWM0_BOT     | PWM1              | Low side PWM (master buck)                   |
| 21         | BUCK1_PWM0_BOT     | PWM6              | Low side PWM (slave buck)                    |
| 22         | BUCK1_PWM0_TOP     | PWM2              | High side PWM (slave buck)                   |
| 23         | BUCK0_PWM0_TOP     | PWM7              | High side PWM (master buck)                  |
| 24         | -                  | PWM3              |                                              |
| 25         | SGND               | GND               |                                              |
| 26         | GP2                | GP2               | User port pin                                |
| 27         | BUCK1_VIN          | ADC4OUT           | Slave buck input voltage value               |
| 28         | SGND               | GND               |                                              |
| 29         | SGND               | GND               |                                              |
| 30         | BUCK0_VOUT         | ADC0OUT           | Master buck output voltage value             |
| 31         | BUCK1_VOUT         | ADC5OUT           | Slave buck output voltage value              |
| 32         | SGND               | GND               |                                              |
| 33         | SGND               | GND               |                                              |
| 34         | BUCK0_VIN          | ADC1OUT           | Master buck input voltage value              |
| 35         | -                  | ADC6OUT           |                                              |
| 36         | SGND               | GND               |                                              |
| 37         | -                  | ADC7OUT           |                                              |
| 38         | -                  | ADC2OUT           |                                              |
| 39         | GP3                | GP3               | User port pin                                |
| 40         | -                  | ADC3OUT           |                                              |

## 3 Production Data

### 3.1 Schematics

This chapter contains the schematics of XMC Digital Power Explorer  
The board has been designed with Design Spark (RS Online). The full PCB design data of this board can also be downloaded from [www.infineon.com/xmc-dev](http://www.infineon.com/xmc-dev).



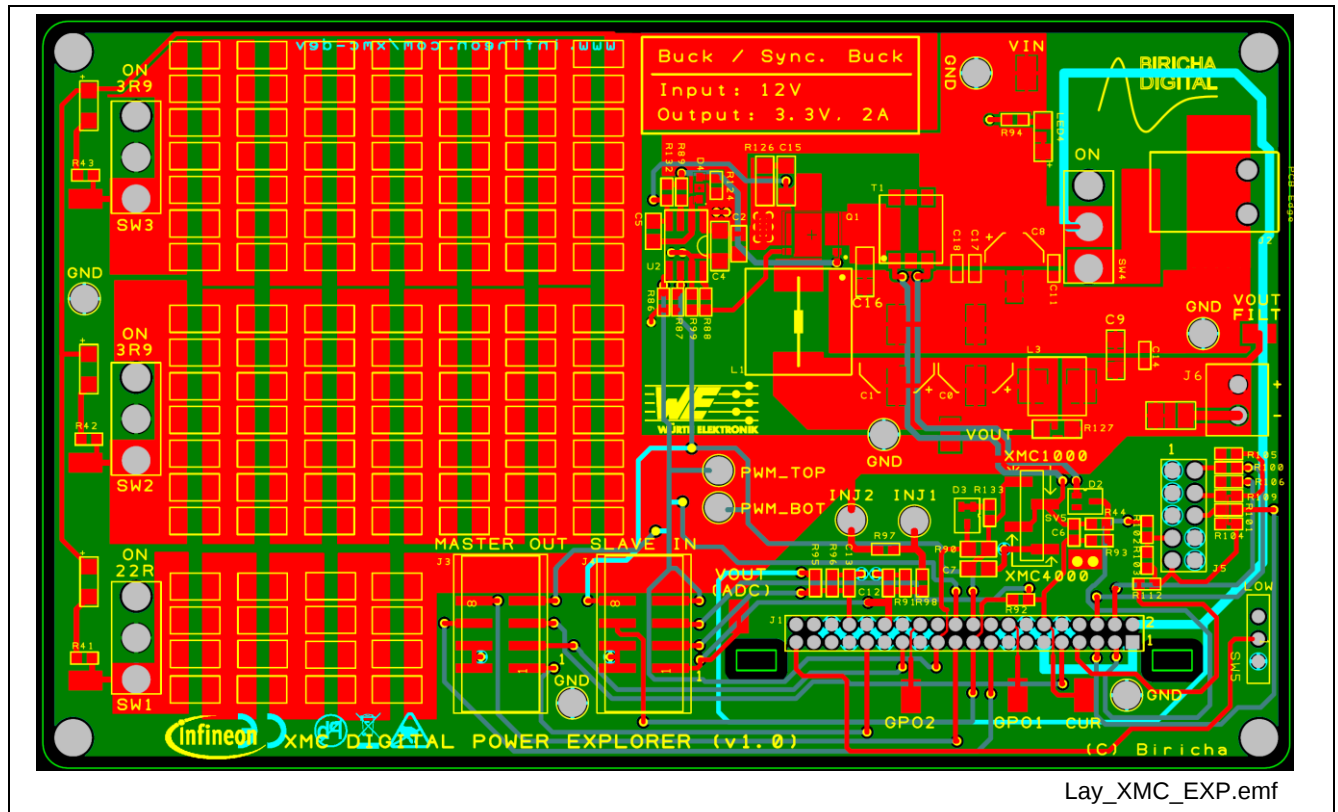
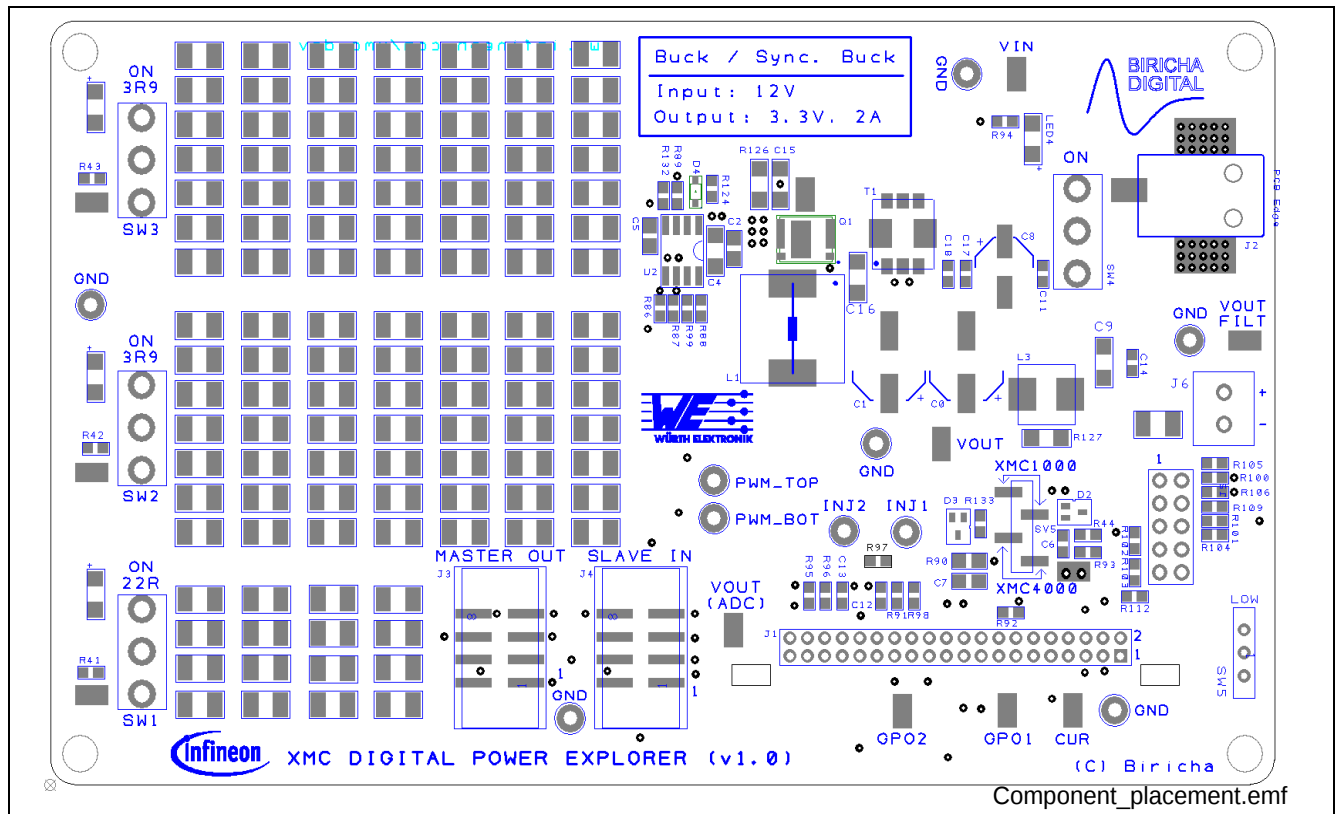


Figure 14 Layout top view of XMC Digital Power Explorer

### 3.2 Component Placement

In Figure 15 the placement of components is shown in a layout view of the top layer of XMC Digital Power Explorer



**Figure 15** Layout top level view of XMC Digital Power Explorer

### 3.3 Bill Material (BOM)

This board has been done in collaboration with Würth Elektronik. In Figure 16, the different components from Infineon and Würth Elektronik are highlighted. In Table 6 a complete bill of material is given.

### Table 6 Bill of Material List

| No. | Device / Description   | Quantity | Position                                               |
|-----|------------------------|----------|--------------------------------------------------------|
| 1   | SW_SPDT_TH_2A          | 1        | SW1, SW2, SW3, SW4                                     |
| 2   | Test Pin SM            | 9        | TP5, TP8, TP12, TP13, TP14, TP16, TP20, TP21, TP22     |
| 3   | BAS16W                 | 1        | D2                                                     |
| 4   | BAT54-05W              | 1        | D3                                                     |
| 5   | BAS30                  | 1        | D4                                                     |
| 6   | BSC0924NDI             | 1        | Q1                                                     |
| 7   | IRS2011SPBF            | 1        | U2                                                     |
| 8   | TP_THT_Orange          | 4        | TP1, TP2, TP6, TP7                                     |
| 9   | TP_THT_Black           | 6        | TP3, TP10, TP18, TP23,TP24, TP25                       |
| 10  | C-2.2uF-1206-50V       | 1        | C4                                                     |
| 11  | SMD Resistor 22R 1210  | 16       | R1-R8, R144-R150, R85                                  |
| 12  | SMD Resistor 3R9 1210  | 98       | R9-R40, R45-R84, R113-R123, R125, R128-R131, R134-R143 |
| 13  | SMD Resistor 33R 0603  | 4        | R100-R102, R106                                        |
| 14  | SMD Resistor 2K 0603   | 2        | R105, R109                                             |
| 15  | SMD Resistor 0R 0603   | 1        | R112                                                   |
| 16  | SMD Resistor 10R 0603  | 4        | R124, R88, R89, R92                                    |
| 17  | SMD Resistor 100R 1206 | 1        | R126                                                   |
| 18  | SMD Resistor 0R15 1206 | 1        | R127                                                   |
| 19  | SMD Resistor 3K3 0603  | 2        | R132, R99                                              |

**Production Data**

|    |                                   |   |                    |
|----|-----------------------------------|---|--------------------|
| 20 | SMD Resistor 5R1 0603             | 1 | R133               |
| 21 | SMD Resistor 330R 1210            | 1 | R151               |
| 22 | SMD Resistor 2K2 0603             | 3 | R41, R42, R43      |
| 23 | SMD Resistor 120R 0603            | 1 | R44                |
| 24 | SMD Resistor 10K 0603             | 2 | R86, R87           |
| 25 | SMD Resistor 15K 0805             | 1 | R90                |
| 26 | SMD Resistor 1K8 0603             | 2 | R91, R96           |
| 27 | SMD Resistor 1K5 0603             | 1 | R93                |
| 28 | SMD Resistor 5K1 0603             | 1 | R94                |
| 29 | SMD Resistor 6K8 0603             | 1 | R95                |
| 30 | SMD Resistor 24R 0603             | 1 | R97                |
| 31 | SMD Resistor 470R 0603            | 1 | R98                |
| 32 | C-WE-220uF-SMD-25V                | 2 | C0, C1             |
| 33 | C-WE-100nF-0603-50V               | 4 | C11, C14, C17, C18 |
| 34 | C-WE-2.2nF-0603-50V               | 1 | C12                |
| 35 | C-WE-680pF-0603-16V               | 1 | C13                |
| 36 | C-WE-100nF-1206-50V               | 2 | C15, C16           |
| 37 | C-WE-100nF-0805-50V               | 2 | C2, C5             |
| 38 | C-WE-10pF-0603-50V                | 1 | C6                 |
| 39 | C-WE-330pF-0805-50V               | 1 | C7                 |
| 40 | C-WE-22uF-SMD-35V                 | 1 | C8                 |
| 41 | C-WE-22uF-1206-10V                | 1 | C9                 |
| 42 | WA-SNTI 6mm Spacer                | 4 | H1-H4              |
| 43 | WR-PHD 40 way Header              | 1 | J1                 |
| 44 | WR-DC DC Power Jack<br>5.5/2.5    | 1 | J2                 |
| 45 | WR-BHD 8 way SMT Box<br>Header    | 2 | J3, J4             |
| 46 | WR-PHD 10 way Header THT          | 1 | J5                 |
| 47 | WR-TBL 2 Way Terminal<br>Block    | 1 | J6                 |
| 48 | WE-PD 22 $\mu$ H 5.3A Inductor    | 1 | L1                 |
| 49 | WE-LHMI 0.47 $\mu$ H 11.5A<br>SMD | 1 | L3                 |
| 50 | LED-WE-RED-1206                   | 4 | LED1-LED4          |
| 51 | WR-PHD 4 way Header               | 1 | SV5                |
| 52 | WS-SHT SPDT Switch THT            | 1 | SW5                |
| 53 | WE-CST 1:125 Current Sense        | 1 | T1                 |

## **4 Revision History**

**Current Version is V1.0, 2015-10**

| <b>Page or Reference</b> | <b>Description of change</b> |
|--------------------------|------------------------------|
| V1.0, 2015-10            |                              |
|                          | Public version               |

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Email: [erratum@infineon.com](mailto:erratum@infineon.com)

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