

XMC1000

32-bit Microcontroller Series for Industrial Applications

XMC1300 Digital Power Control Card User Manual

UG_201511_PL30_002

Board User Manual

Scope and purpose

This document describes the features and hardware details of XMC1300 Digital Power Control Card, designed to provide an evaluation platform for digital control applications with XMC ARM® Cortex™M0 based microcontroller. This board is part of Infineon's Digital Power Control Application Kit.

Applicable Products

- 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

Example codes for this board, www.infineon.com/DAVE

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1 Overview

The XMC1300 Digital Power Control Card is an evaluation board with the goal to help engineers in the learning and testing of digital power control applications. The board features a XMC1300 microcontroller base on ARM® Cortex™M0 core.

The tiny dimensions of the board allow using this evaluation card into designs with high requirements on power density. In particular the dimensions of XMC1300 Digital Power Control Card permit its usage in 1U rack power supply designs. The control card integrates an isolated on board debugger for ease of usage that can be removed once the code is finalized.

This board has been developed with the collaboration of Würth Elektronik whose passive components and mechanical components are used.

1.1 Key Features

The XMC1300 Digital Power Control Card is equipped with the following features

- Infineon XMC1300 (ARM® Cortex™-M0-based) Microcontroller, up to 200 kByte on-chip Flash, TSSOP38
- Connection to power board like Digital Power Explorer, via the power board connector
- USIC interface connector for connection of UART or PMBus™ (I2C)
- 4 LEDs
 - 1 Power indicating LED- “Power OK” from power board side
 - 1 User LEDs (P1.4)
 - 2 Debugger controller LEDs (DEBUG, COM)
- Isolated Debug options
 - On-Board Debugger (SEGGER J-Link LITE) via USB connector
 - ARM® Cortex™ 9 pin connector (1.27 mm pitch - double row) on non-isolated section. Isolation needs to be built between this connector and the computer side to avoid overvoltage in computer.
- Isolated Connectivity
 - UART channel of On-Board Debugger (SEGGER J-Link LITE) via USB connector
- Power supply of MCU domain
 - Via power board connector (12V). Converted to 3.3V with Infineon supply parts
- Power supply of isolated debug domain
 - Via Debug USB connector

1.2 Block Diagram

Figure 1 shows the functional block diagram of the XMC1300 Digital Power Control Card. For more information about the power supply domains please refer to chapter 2.1.

The control card is comprised of the following building blocks:

- 1 Power Board Connector
- 1 User LED connected to GPIOs (P1.4)
- 1 user test points (P1.4)
- USIC0 CH0 interface to power board (P1.0, P1.1)
- Isolated On-board Debugger via Debug USB connector (Micro-USB) with UART channel (USIC0, channel 0)
- Optional ARM® Cortex™-Debug interface connector

Overview

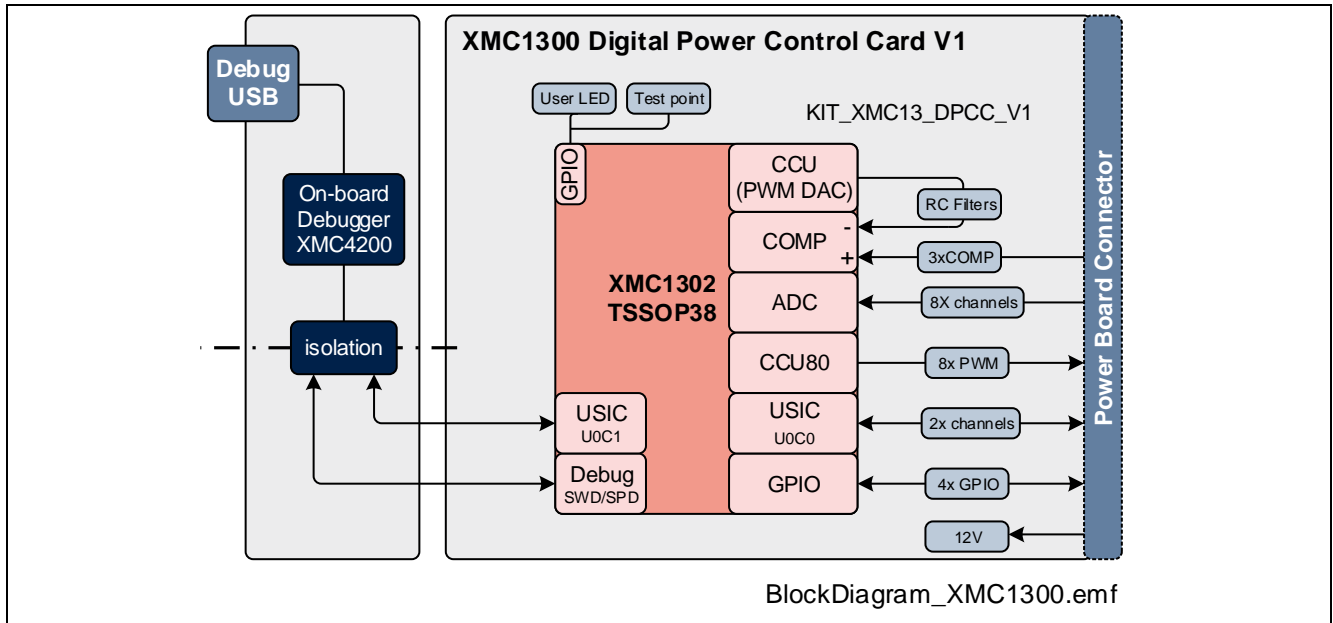


Figure 1 Block Diagram of XMC1300 Digital Power Control Card

2 Hardware Description

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

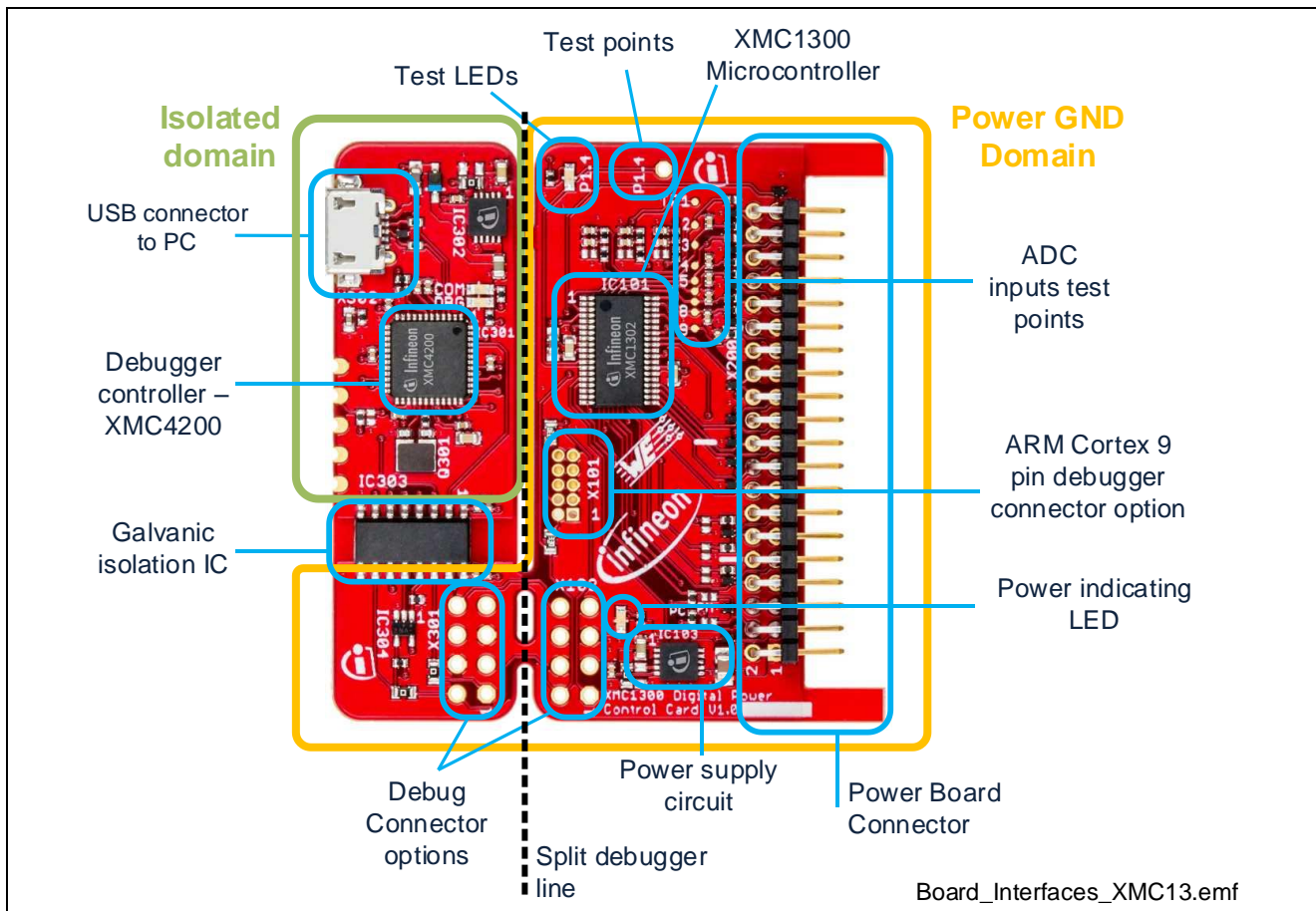


Figure 2 XMC1300 Digital Power Control Card hardware description

2.1 Power Supply

The XMC1300 Digital Power Control Cardboard is designed with two galvanically isolated supply domains. On the left side, there is the debug domain or isolated domain, which contains a XMC1300 MCU as on-board debug controller (OBD). The isolated domain is powered via the USB plug (5V)

The rest of the control card is called power GND supply domain. This part is supplied from the power board connector and the control card will step down the input voltage to the 3.3V that XMC1300 requires. This supply domain is usually powered from the power board connector. The typical current drawn by the drive card at the power GND domain is about 18 mA at 12 V input voltage.

To indicate the power status of the power GND domain, one indicating LED is provided on board (see Figure 2). The LED will be “ON” when the corresponding power rail is powered.

LED Reference	Power Rail	Voltage
LED102	VDD3.3	3.3 V

Hardware Description

Figure 3 shows details of the power supply concept of the control card. More detailed circuitry can be found in section 3.1.

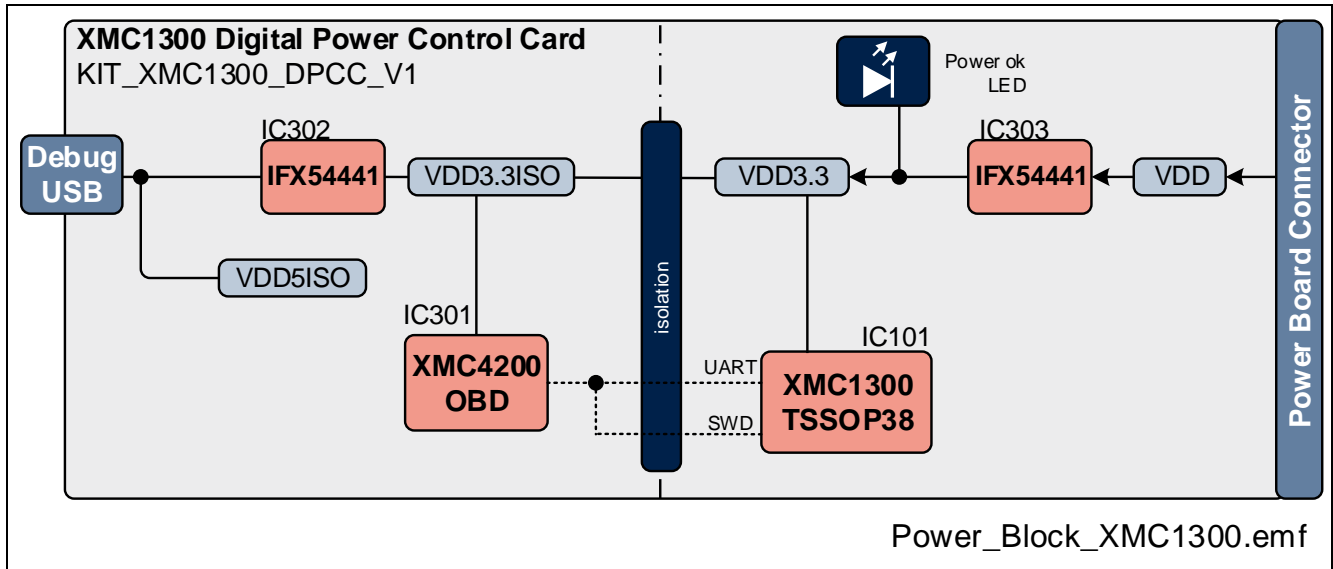


Figure 3 Installation of J-Link Serial Port Driver

2.2 Debug Interface

The XMC1300 Digital Power Control Card supports 2 different debug interfaces:

- Isolated On-Board Debugger (OBD). This is the default connection.

Connect to computer with an USB cable. The control card includes a debugger controller and isolation up to 1kV to protect the computer. This is the easiest way and is supported by DAVE™ and other debuggers

The On-Board Debugger [1] supports

- Serial Wire Debug (SWD)
- UART communication via a Virtual COM port
 - PC_RXD_DEV P1.2 USIC0CH0.DOUT0
 - PC_TXD_DEV P1.3 USIC0CH0.DX0A

[1] Attention: The firmware of the on-board debugger requires the latest J-Link driver (V5.00 or higher) and a Serial Port Driver (CDC driver) installed on your computer. Please check “Install J-Link Serial Port Driver” when installing the latest J-Link driver (see Figure 4)

Hardware Description

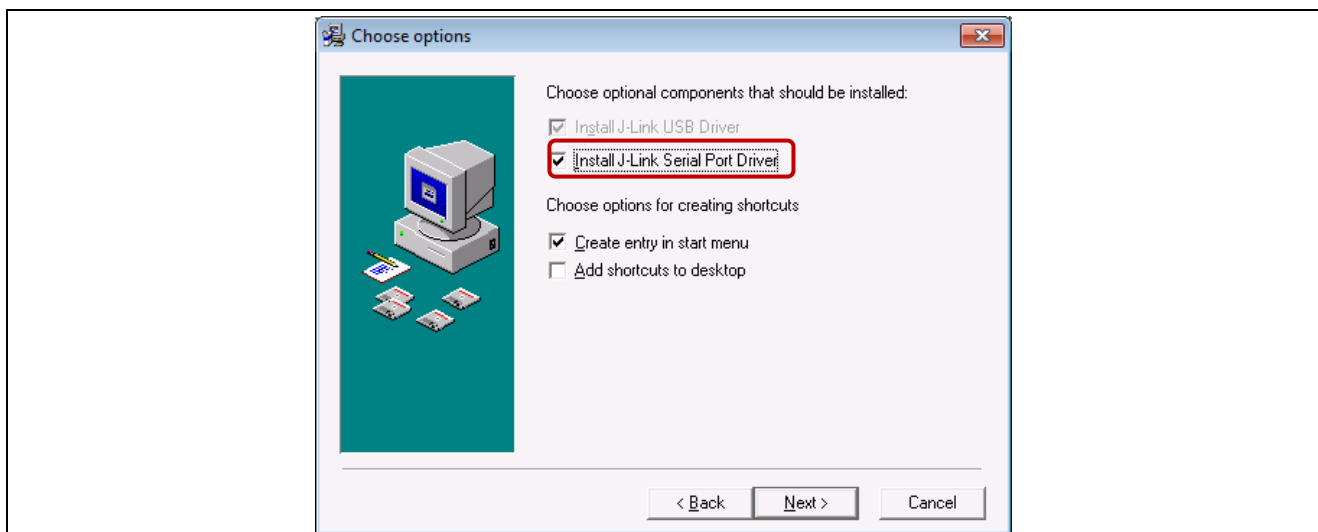


Figure 4 Installation of J-Link Serial Port Driver

The On-Board Debugger can be accessed through the USB connector.

The Debug LED (LED301), named as DBG in the board, shows the status during debugging. The LED named COM (LED302) signalizes the Virtual COM port communication with the computer.

- 9 pin ARM® Cortex™ connector and an external galvanically isolated debugger hardware or “box”. This option allows the user to utilize any ARM® Cortex™ debugger in the market. The user must make sure that the debugger box used provides galvanic isolation (typically 1kV) to avoid damage due to high voltages in the computer.

2.2.1 Debug Connector Options

XMC1300 Digital Power Control Card includes 3 connector options for debugging. The default configuration of the control card is prepared for OBD debug and therefore, none for the 3 connector options are assembled. If required, user has to mount the corresponding pin headers. The 3 connector options are:

- Two 8 pins connector: OBD Debug Connector (X301) and Debug Connector (X102)– 2.54 mm header pitch
- 9pin ARM® Cortex™ (X101)– 1.27mm header pitch

Connectors are described in Figure 5

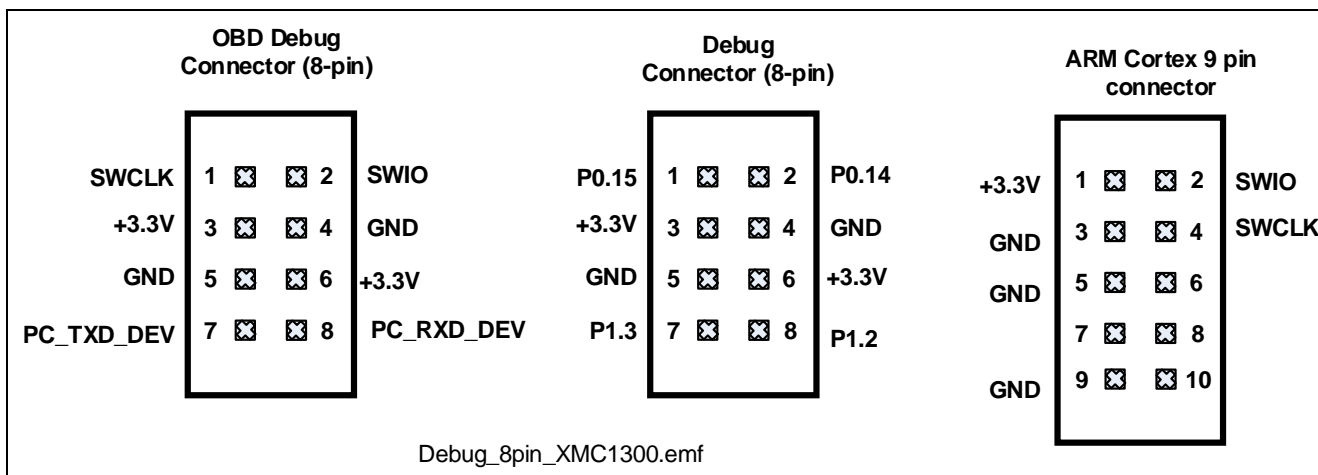


Figure 5 Pin assignment of Debug Connector (8-pin)

Hardware Description

2.2.2 Removing the On-Board Debugger

XMC1300 Digital Power Control Card can be broken off into 2 parts by breaking the PCB as shown in **Error! Reference source not found.** This will reduce the size of the main controller part so that it can fit into 1U standard sized rack systems once programmed. The control card can still be debugged in 2 different ways if debugger part is removed (see Figure 6):

1. connecting a ribbon cable to both 8 pin connectors (main controller part and debugger part) or,
2. using the 9 pin connector option with an external debugger box. If the board is not broken, this connection cannot work.

Attention: when using external debuggers, make sure that the debugger box includes a galvanic isolation to the computer. If the control card is exposed to high voltages, this could produce damage to the computer

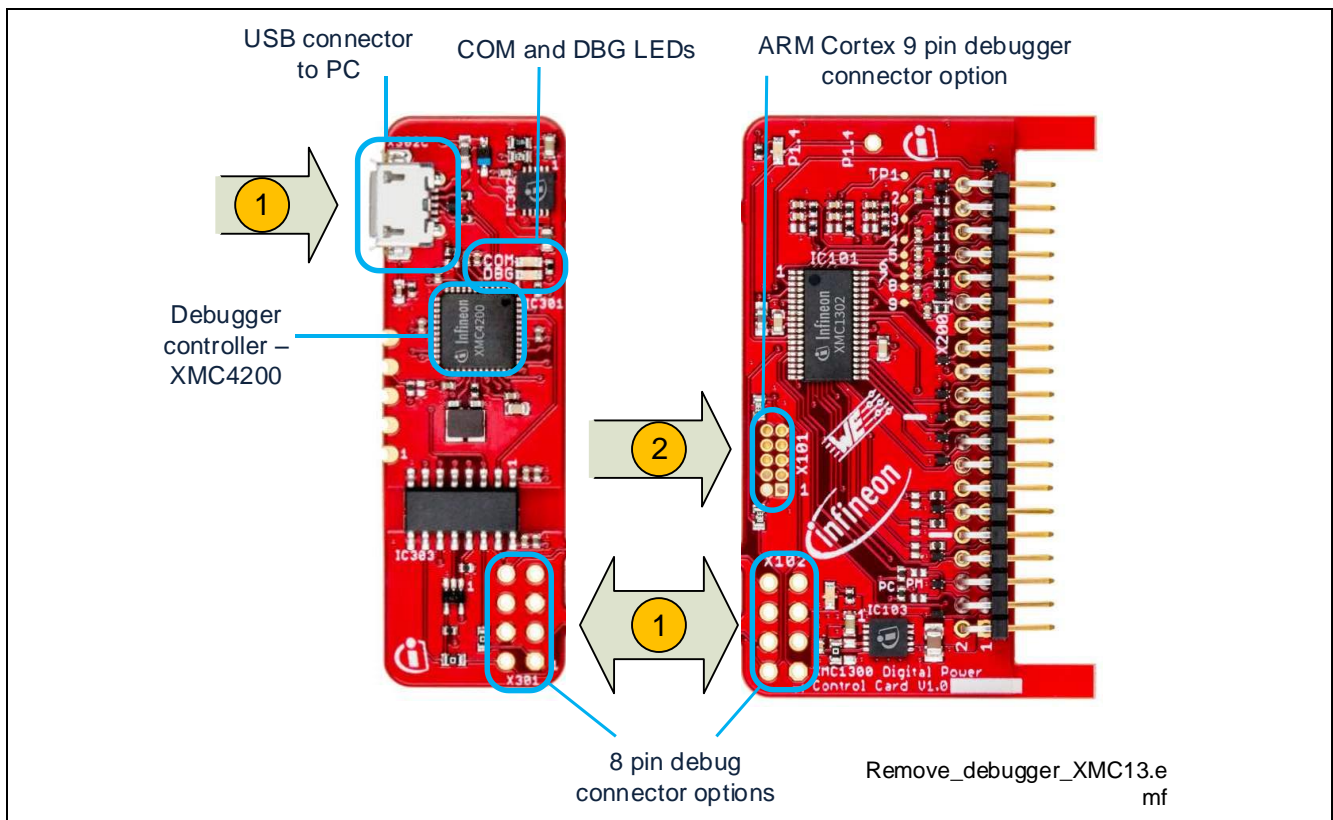


Figure 6 Debug options when removing debugger part of control card

2.3 User LEDs and test points

The XMC1300 Digital Power Control Card provides a two user LEDs (P1.4). Next to the LED there is a **test point (P1.4)** available in order to easily connect an oscilloscope's probe for controlled trigger signals. Both the LED and the test point are together due to the limited number of pins available.

Table 1 User LEDs

User LEDs	Connected to Port Pin
LED101	P1.4

Attention: The test point is referenced to power GND supply domain. Hence they may carry hazardous voltages.

Hardware Description

2.4 Power Board Connector

The XMC1300 Digital Power Control Card provides a power board connector with a set of signals that can be extensively used in power supply applications, from server power supplies to UPS or lighting power supplies. In summary, the signals available in the connector are:

- 8 PWM signals
- 8 ADC analog inputs
- 3 comparator inputs
- 2 serial channels
- 4 general purpose pins

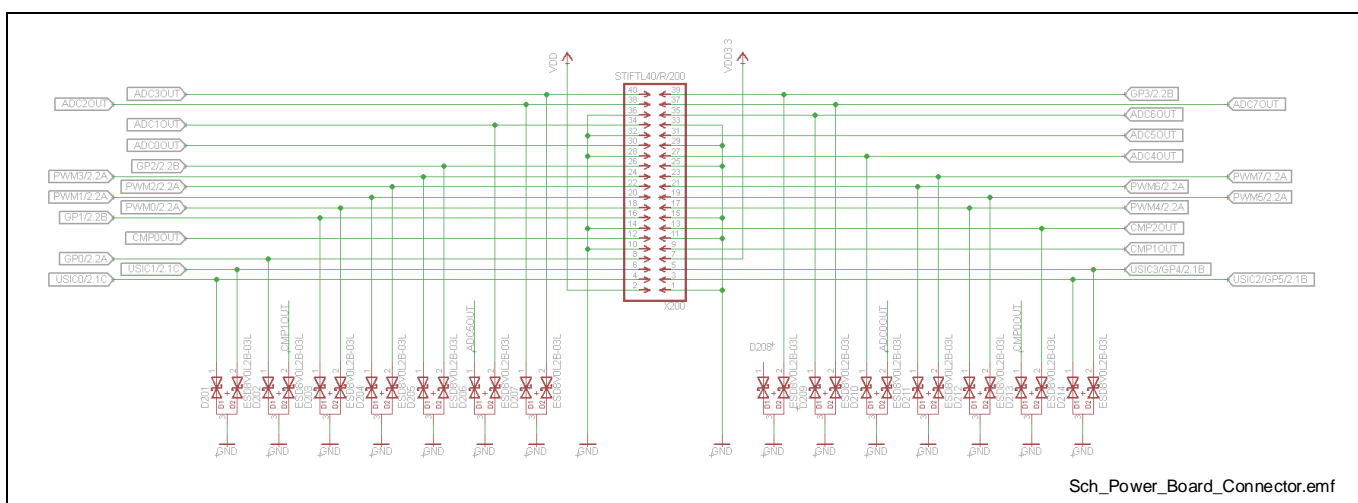


Figure 7 Control card power board connector schematic

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

As it can be seen in Figure 7, each signal entering XMC1300 Digital Power Control Card from the power board connector is additionally protected by an ESD protection from Infineon.

XMC1300 has internal ESD protection in each pin, however, given the general purpose characteristic of this control card, additional ESD protection is required to protect from very noisy power board environment that could eventually damage the control card or the microcontroller in it.

The pin out of the connector is detailed in Table 2.

Table 2 Power board connector pin out

Pin number	Signal Name	Port in XMC1300	Peripheral function	Note
1	GND			Digital GND
2	VDD			12V input from power board to control card
3	USIC2/GP5	P1.0	U0C0.DOUT0 or U0C0.DX0C	Can be used as serial port or user port pin
4	USIC0	Not connected (P1.3)	U0C1.SCLKOUT or U0C1.DX1A	The power board connector is per default disconnected to permit communication with Virtual COM port to computer (R113)
5	USIC3/GP4	P1.1	U1C1.DX0D	Can be used as serial port or user port

Hardware Description

Pin number	Signal Name	Port in XMC1300	Peripheral function	Note
				pin
6	USIC1	<i>Not connected (P1.2)</i>	<i>U0C1.DOU0 or U0C1.DX0B</i>	The power board connector is per default disconnected to permit communication with Virtual COM port to computer (R112)
7	VDD3.3			3.3 V output to power board
8	GP0	P0.8		User port pin
9	CMP1OUT	P2.7	ACMP1.INP or/and VADC.G1CH1	CMP1_INP - Through 0R resistor
10	GND			Digital GND
11	GND			Digital GND
12	CMP0OUT	P2.9	ACMP1.INP or/and VADC.G0CH2	CMP0_INP - Through 0R resistor
13	CMP2OUT	P2.1	ACMP2.INP or/and VADC.G0CH6	CMP2_INP - Through 0R resistor
14	GND			Digital GND
15	GND			Digital GND
16	GP1	P0.11		User port pin
17	PWM4	P0.1	CCU80.OUT01	
18	PWM0	P0.3	CCU80.OUT03	
19	PWM5	P0.4	CCU80.OUT13	
20	PWM1	P0.5	CCU80.OUT12	
21	PWM6	P0.6	CCU80.OUT11	
22	PWM2	P0.7	CCU80.OUT10	
23	PWM7	P0.0	CCU80.OUT00	
24	PWM3	P0.2	CCU80.OUT02	
25	GND			Analog GND (ADC)
26	GP2	P0.12		User port pin
27	ADC4OUT	P2.0	VADC.G0CH5	ADC4 – Trough RC filter
28	GND			Analog GND (ADC)
29	GND			Analog GND (ADC)
30	ADC0OUT	P2.3	VADC.G1CH5	ADC4 – Trough RC filter
31	ADC5OUT	P2.11	VADC.G0CH4 or ACMP.REF	ADC4 – Trough RC filter
32	GND			Analog GND (ADC)
33	GND			Analog GND (ADC)
34	ADC1OUT	P2.10	VADC.G0CH3 or VADC.G1CH2	ADC4 – Trough RC filter
35	ADC6OUT	P2.5	VADC.G1CH7	ADC4 – Trough RC filter
36	GND			Analog GND (ADC)
37	ADC7OUT	<i>Not connected (P2.6)</i>	<i>VADC.G0CH0</i>	CMP1_INN –Through 0R resistor. This pin is default connected to CMP1_INN
38	ADC2OUT	P2.4	VADC.G1CH6	ADC4 – Trough RC filter
39	GP3			User port pin
40	ADC3OUT	<i>Not connected (P2.2)</i>	<i>VADC.G0CH7</i>	CMP2_INN –Through 0R resistor. This pin is default connected to CMP2_INN

Hardware Description

Given the flexible pin out in XMC1300, the functions above can be modified with SW configurations. In Figure 8, the PWM options are depicted. The pin out is done to fully cover High Resolution PWM (HRPWM) outputs. However, combinations of CCU8 and HRPWM are possible.

Several topologies in power supplies can be controlled with that pin out including LLC with synchronous rectification, multi-phase buck/boost converters, PFC stages and much more.

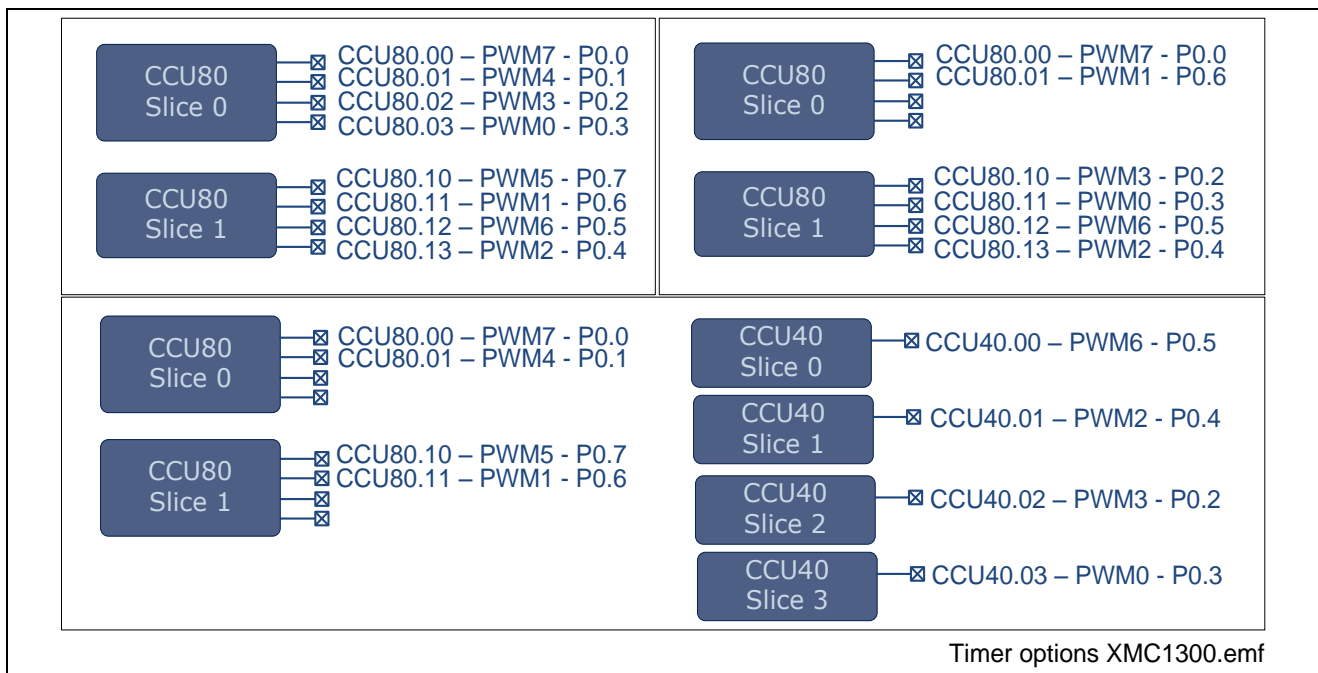


Figure 8 PWM output options with CCU8 and CCU4

2.5 Comparator reference generation

XMC1300 includes 3 analog comparators that can be used for protections such as overcurrent or overvoltage, but as well for valley detection or peak current control in sophisticated power conversion systems.

Those comparators need a reference generation that is created from a PWM signal together with an on board RC filter. The configuration for all 3 comparators and their reference generation is depicted into Figure 9.

The RC filter used is a second order that provides better dynamic response and fewer ripple. The filter can be configured by the user by exchanging the components of it to fit the specific requirements of the application, for example, for a reference that needs to vary quickly, a smaller capacitor network is necessary, however increasing output voltage ripple.

Hardware Description

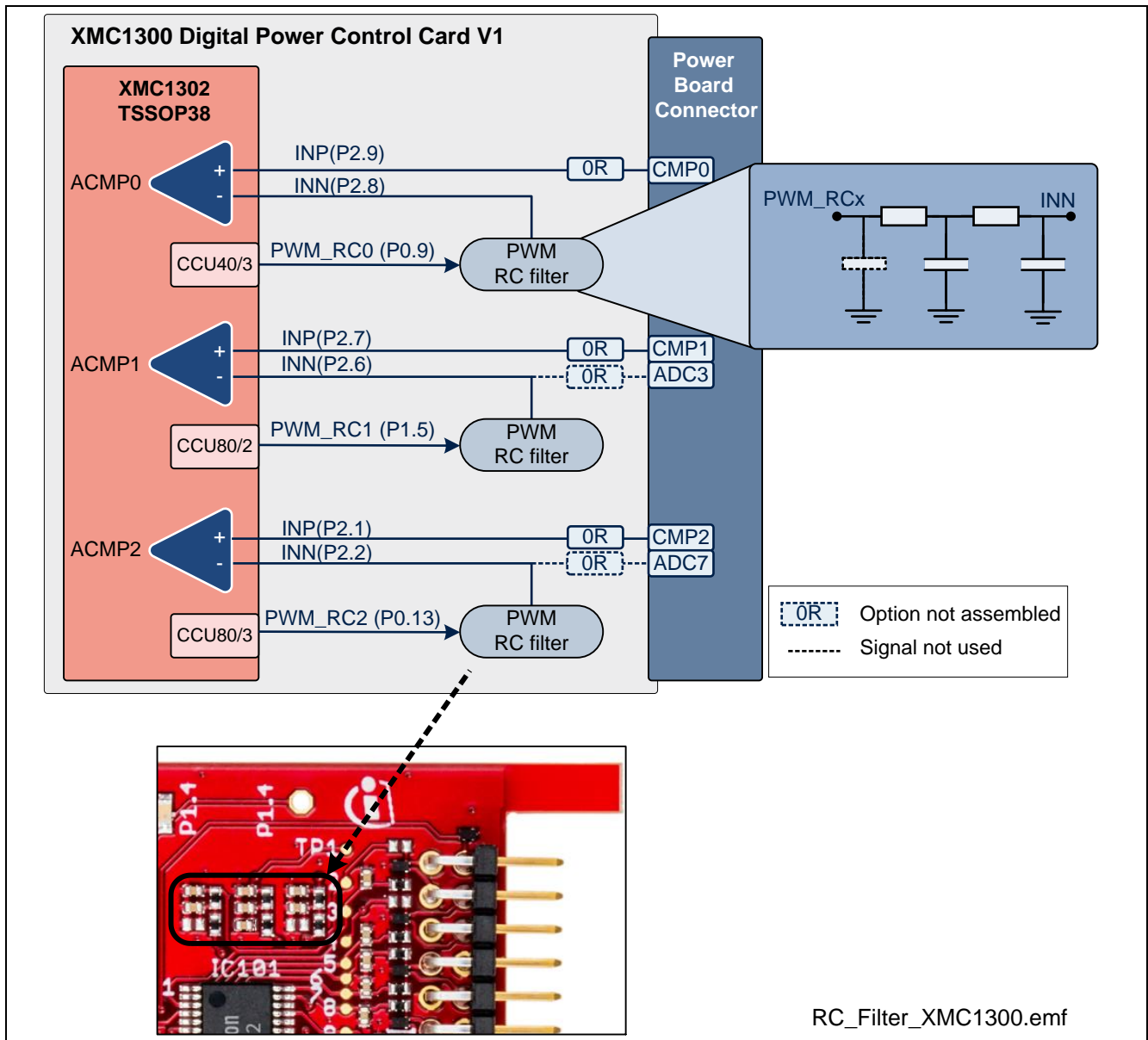


Figure 9 Comparator reference generation

XMC1300 Digital Power Control Card provides flexibility to implement different use cases. In Figure 10, two important use cases are demonstrated.

- Use case 1: more than 6 ADC channels are needed. In XMC1300, comparator inputs and ADC inputs can be shared if required. In such case, the comparator reference and the comparator input signal can be measured simultaneously with the ADC with up to 12 bits resolution.
- Use case 2: the accuracy of a RC filter generated reference is limited even when using second order filter. In some cases, a very accurate reference for the comparator might be critical for the system. In such case, a reference signal can be connected from the power board side by assembling the corresponding OR resistor and removing the RC filter connection to INN.

The signal in CMP2 will be compared to a high accuracy reference

Hardware Description

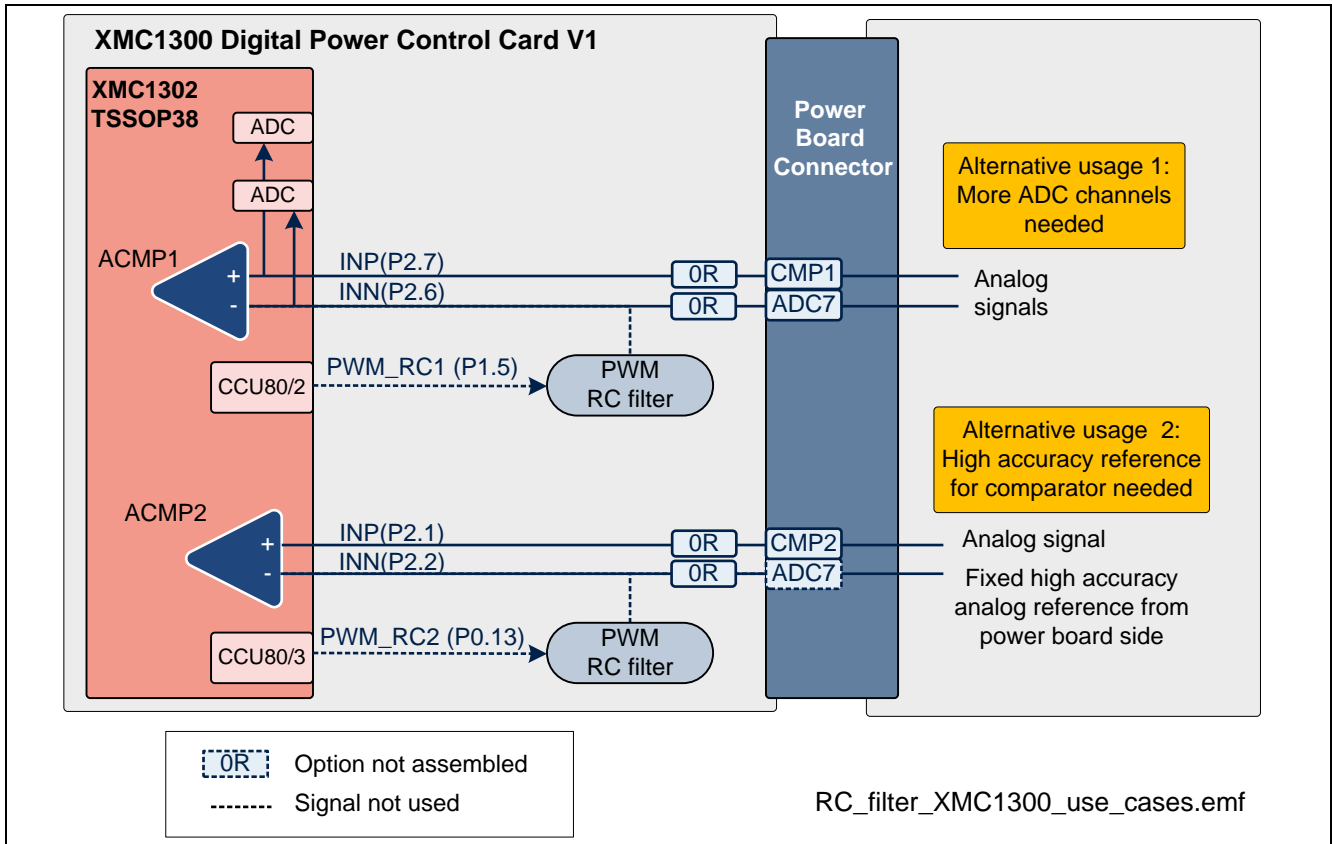


Figure 10 Possible comparator use cases

2.6 Analog Comparator input filter option

Comparator input signals entering the control card from the power board connector, can be additionally filtered with an RC filter option. As can be seen in Figure 11, there is a not assembled 0402 option component. This is typically a capacitor. That filter can be used to reject high frequency noise in the comparator input signal.

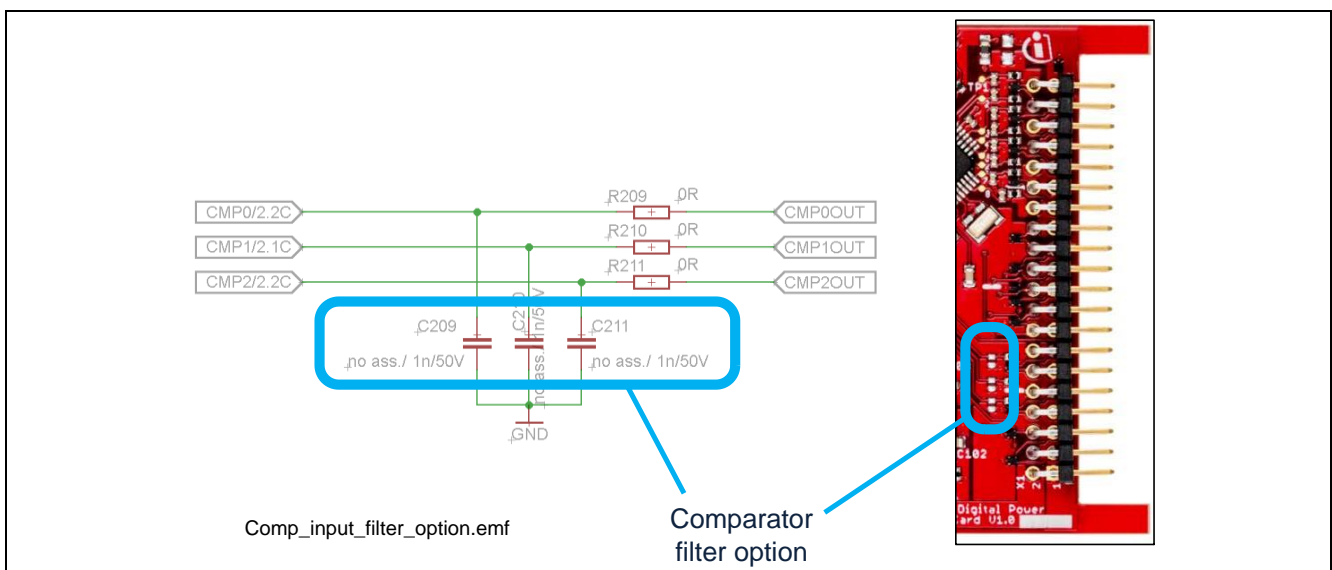


Figure 11 Comparator input filter option- default not assembled

Hardware Description

2.7 Analog to Digital Converter (ADC) input filter

All ADC inputs in the control card are filtered with a high frequency cross-over frequency RC filter, as shown in Figure 12. This will help to remove undesired high frequency noise from the input signals, and therefore, will improve the measurement performance of the microcontroller

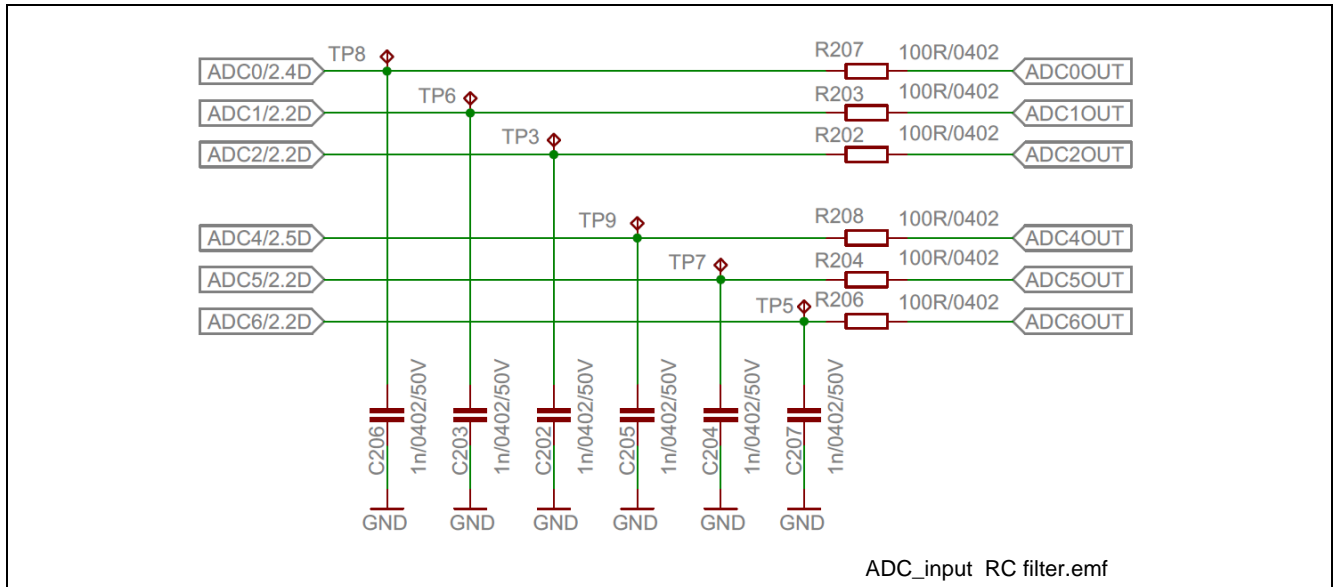


Figure 12 ADC input RC filter schematic

2.8 Communication channel options

XMC1300 Digital Power Control Card provides different communication paths to the power board side or to the computer side through the OBD explained in section.

XMC1300 includes 2 independent serial channels that can be configured to work with different protocols like I2C, UART or SPI. In order to support 2 channels into the power board with in many cases is necessary, and at the same time to allow communication with the computer, XMC1300 Digital Power Control Card has been prepared with or resistors to easily switch channels.

In Figure 13 the set up in XMC1300 Digital Power Control Card can be seen in detailed. The default configuration is:

- USIC0C0: UART through the OBD to the computer
 - P1.3 → PC_TXD_DEV
 - P1.2 → PC_RXD_DEV
- USIC0C1: general purpose serial channel to power board. For example for PMBus™ (pull ups must be provided in the power board side)
 - P1.0 → USIC2
 - P1.1 → USIC3

Optionally, by removing assembled resistors R114 and R115 (labeled as PC in Figure 13 and in silkscreen of the board), and mounting R112 and R113 (labeled as PM), 2 general purpose channels are routed to the power board, providing following configuration:

- USIC0C0: general purpose serial channel to power board. For example for PMBus™ (pull ups must be provided in the power board side)
 - P1.3 → USIC0
 - P1.2 → USIC1

Hardware Description

- USIC0C1: general purpose serial channel to power board. For example for PMBus™ (pull ups must be provided in the power board side)
 - P1.0 → USIC2
 - P1.1 → USIC3

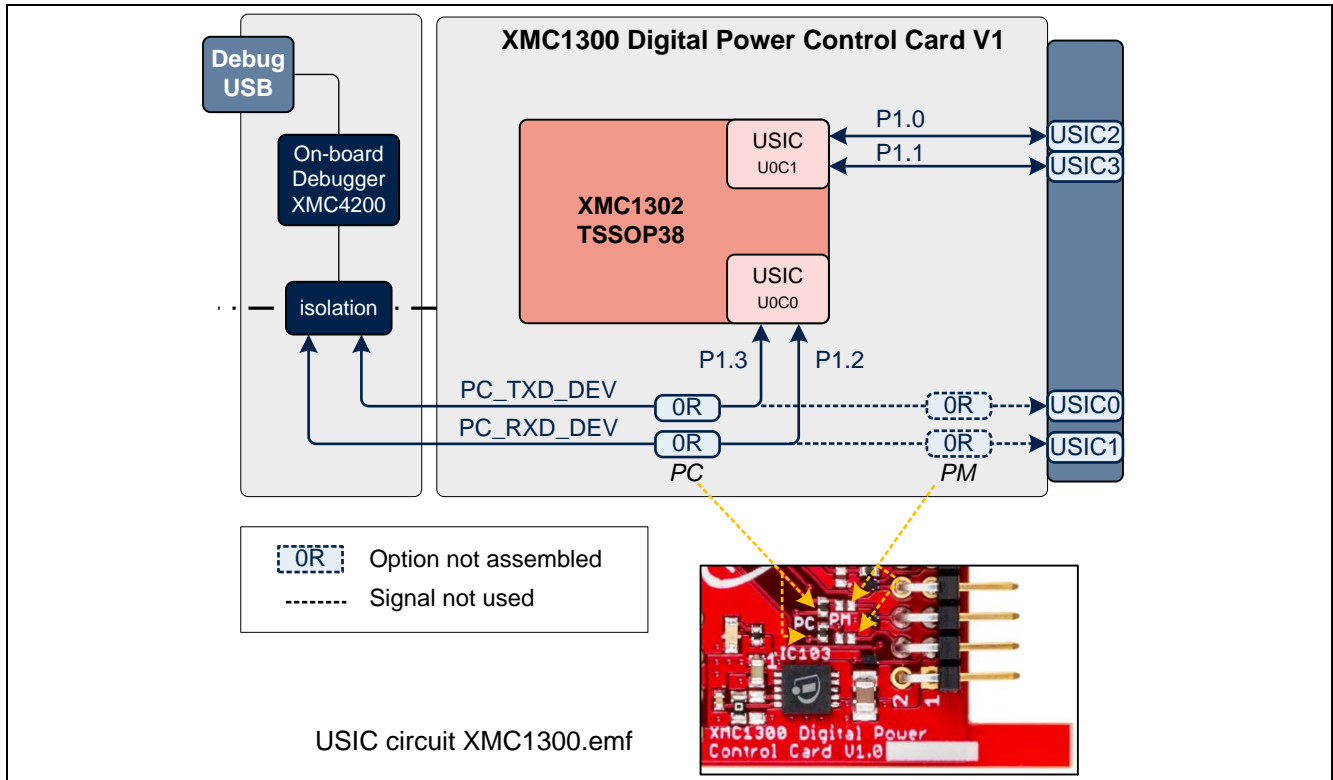


Figure 13 Serial communication interfaces possible in XMC1300 Digital Power Control Card

3 Production Data

3.1 Schematics

This chapter contains the schematics for XMC1300 Digital Power Control Card
 The board has been designed with Eagle. The full PCB design data of this board can also be downloaded from www.infineon.com/xmc-dev.

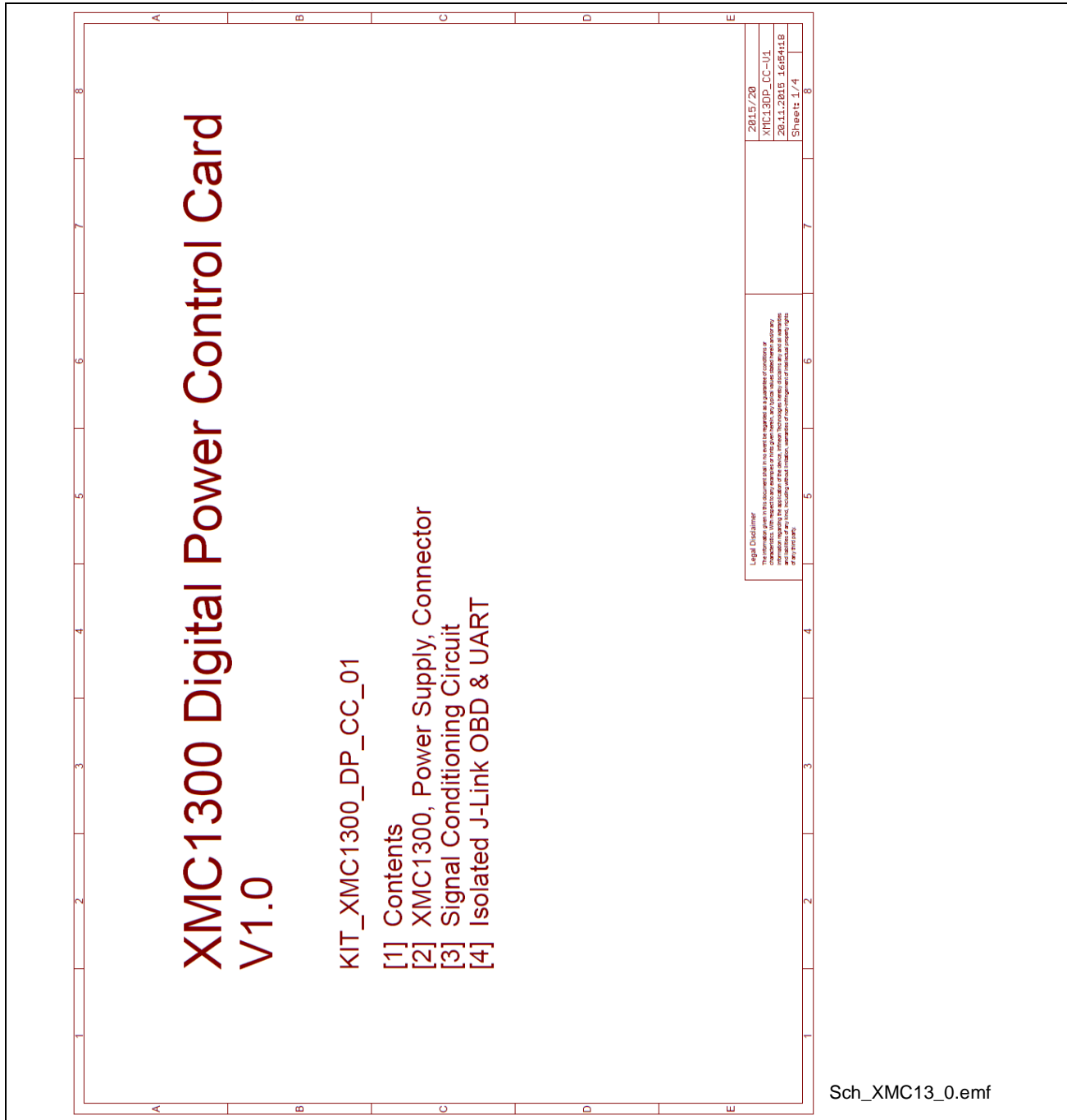


Figure 14 Schematic page 0: cover

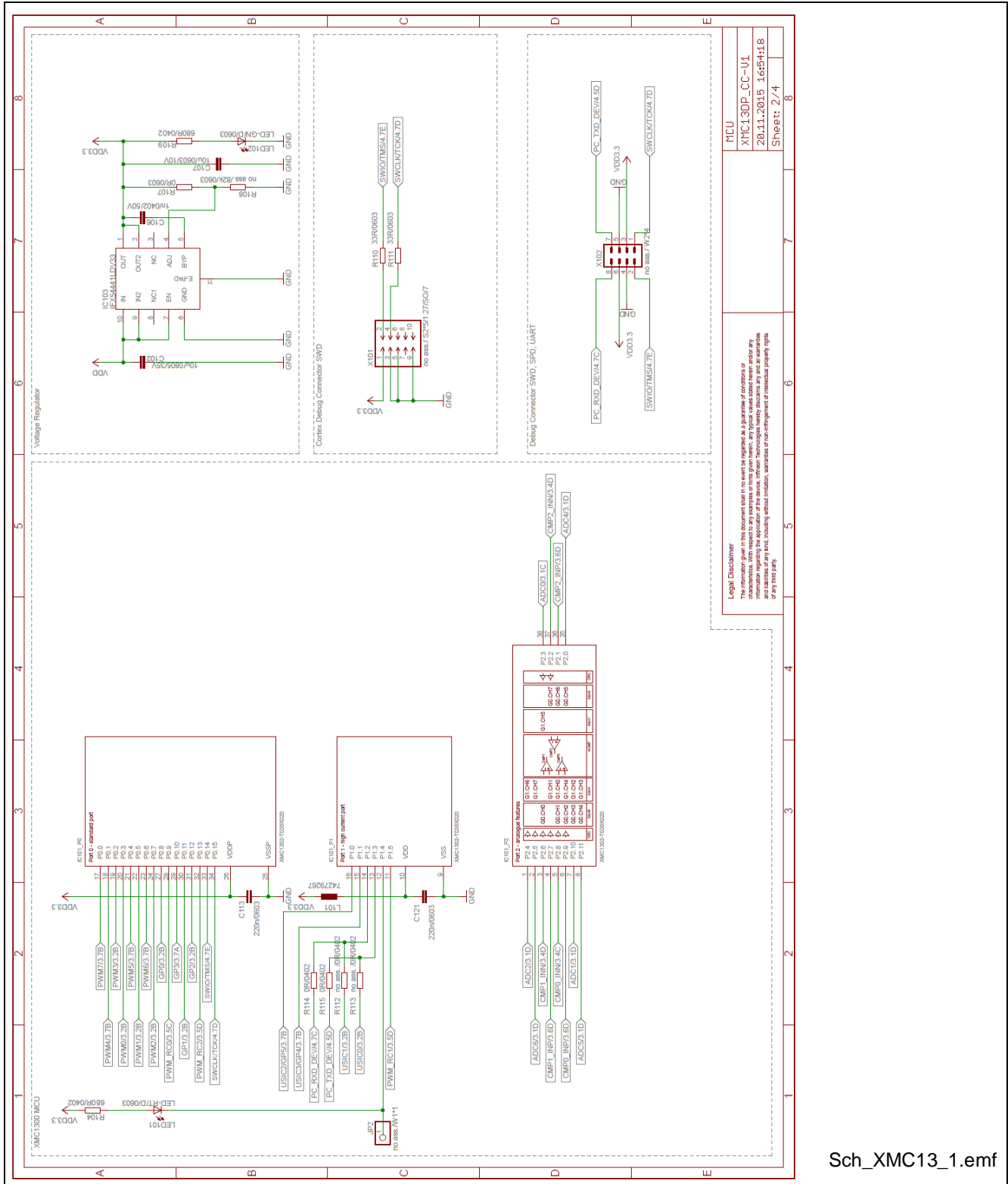


Figure 15 Schematic page1: MCU

Sch_XMC13_1.emf

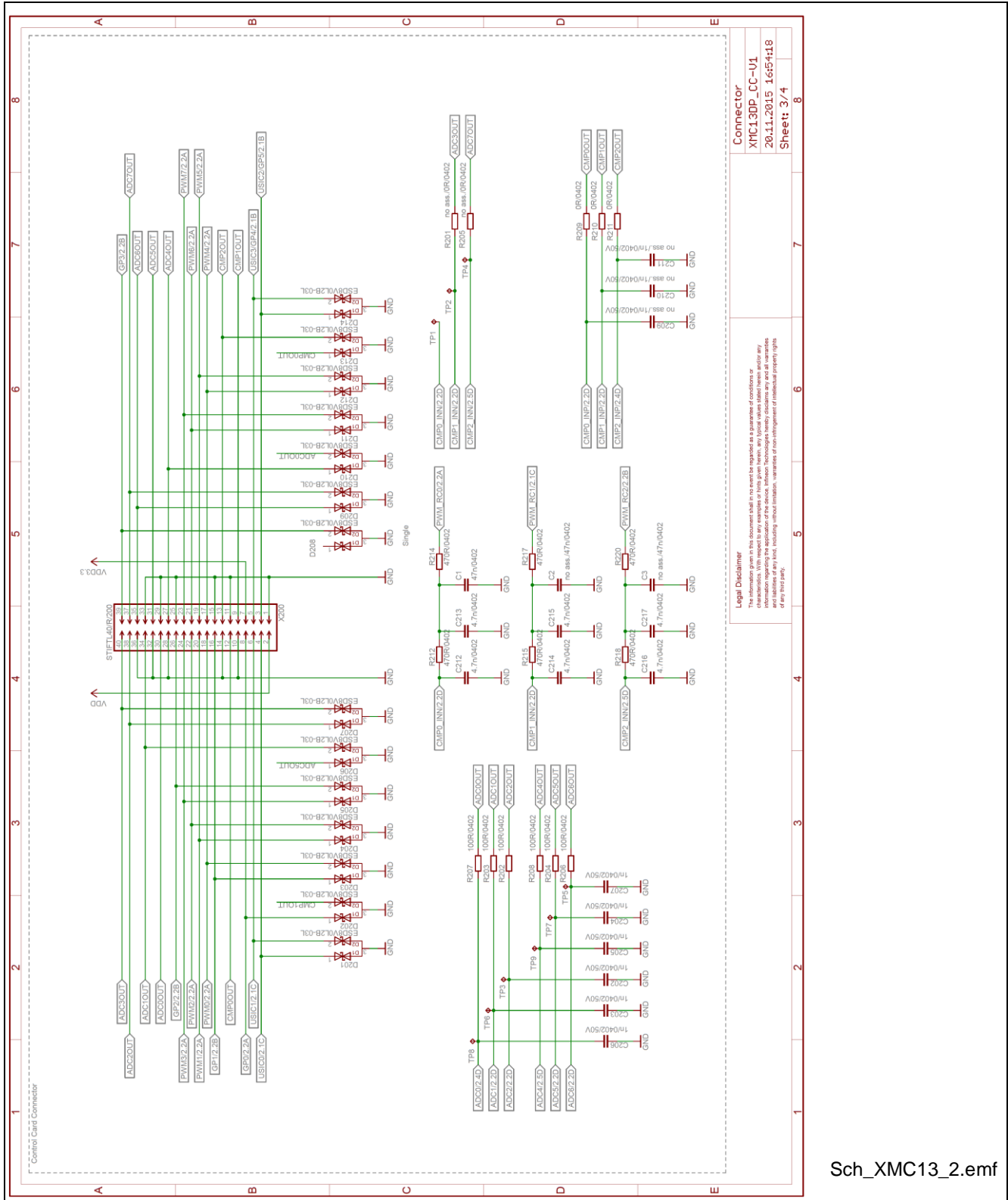


Figure 16 Schematic page 2: connector

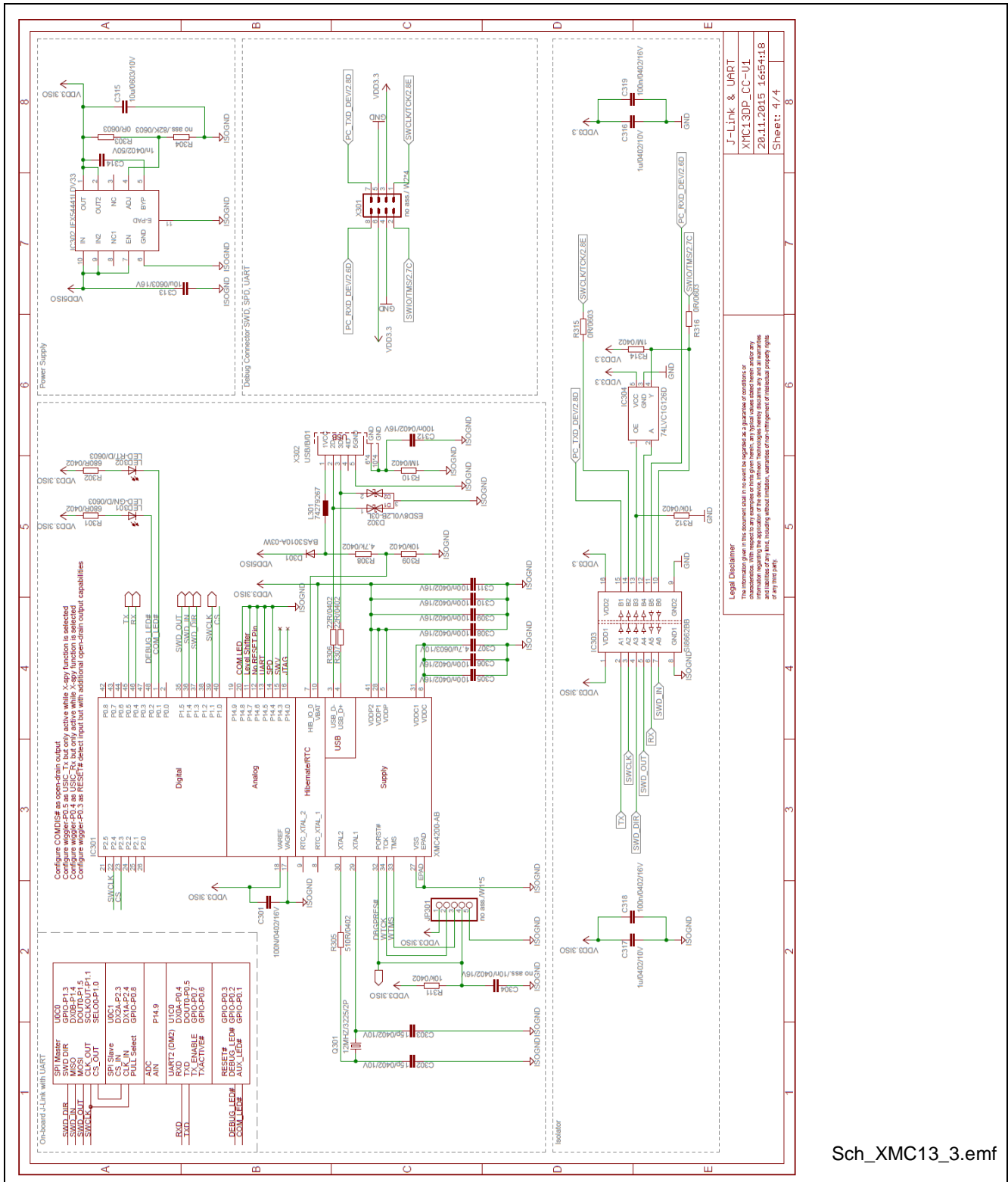


Figure 17 Schematic page 3: JLink &UART

Sch_XMC13_3.emf

3.2 Component Placement

In Figure 18 the placement of some components is shown in a layout snapshot of the top layer of XMC1300 Digital Power Control Card

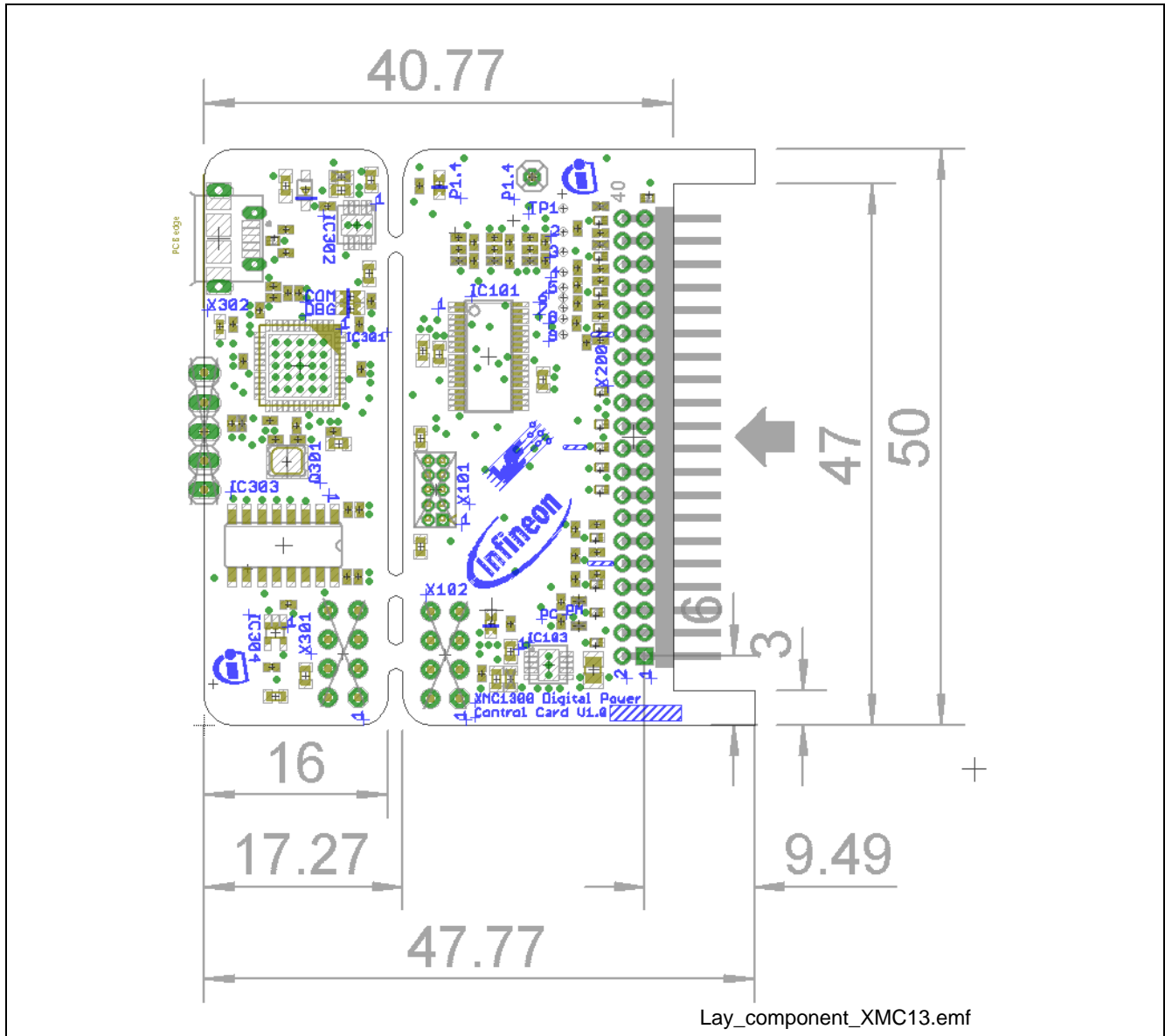


Figure 18 Layout and component placement top view of XMC1300 Digital Power Control Card

3.3 Bill Material (BOM)

This board has been done in collaboration with Würth Elektronik. In Figure 19, the different components in the board are shown. In table 4 a complete bill of material is given.

Production Data

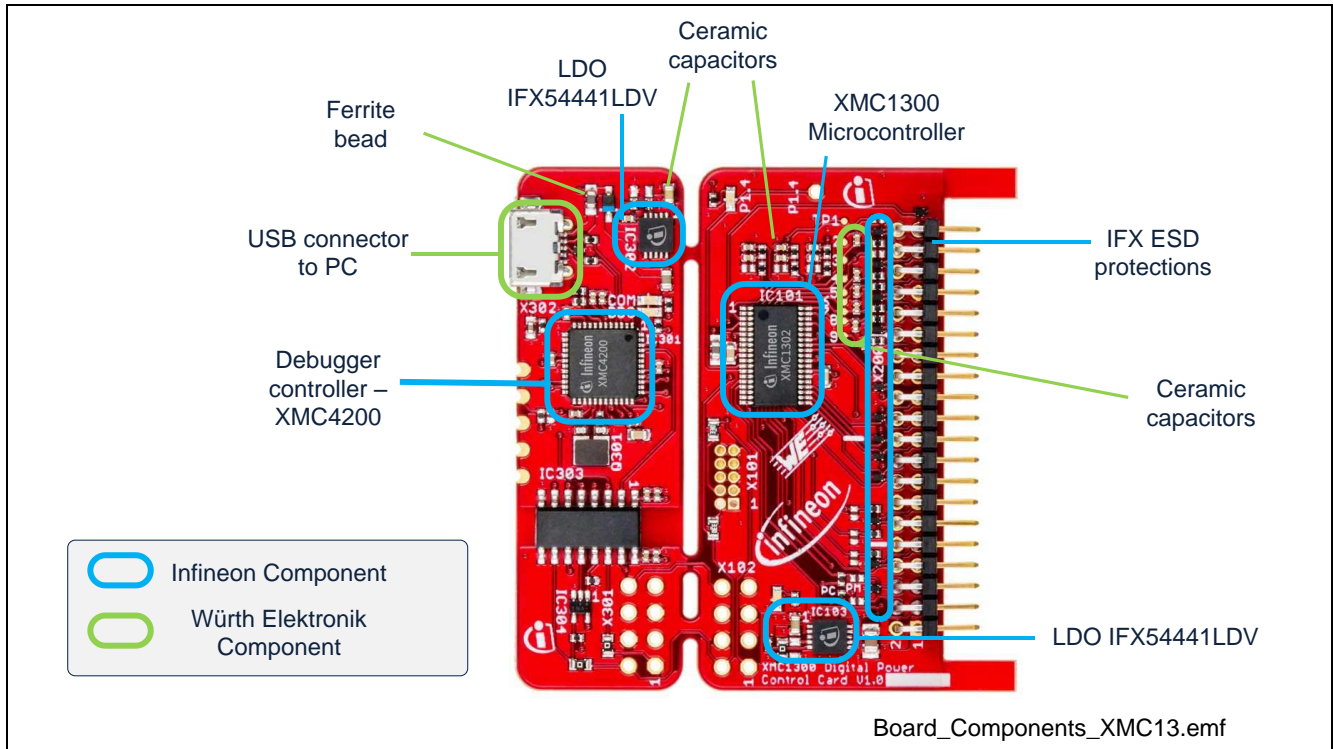


Figure 19 Components from Infineon and Würth Elektronik

Table 3 Bill of Material List

No.	Device / Description	Quantity	Position
1	SN74LVC1G126DCKR SC70 SN74LVC1G126DCKR	1	IC304
2	ESD8V0L2B-03L Protect. Diode bi-dir ESD8V0L2B-03L IFX	15	D201, D202, D203, D204, D205, D206, D207, D208, D209, D210, D211, D212, D213, D214, D302
3	XMC4200 QFN-48 AB-Step XMC4200-Q48K256 AB-step IFX	1	IC301
4	CPU XMC1302-T038X0200 AB Infineon	1	IC101
5	Si8662BB-B-IS1 Hex Isolator 4xIn / 2xOut 150MBit NB SOIC-16 SiLabs	1	IC303
6	SMD-LED SMD rt 0603 diffus 110mcd LSQ976-Z	2	LED101, LED302
7	SMD-LED SMD gn 0603 diffus 10mcd LGQ971-Z	1	LED102, LED301
8	LDO IFX54441LDV33 Infineon TSON10 300mA 1,8-20Vin	2	IC103, IC302
9	SMD-Quarz 12MHz 3.2x2.5mm 2Pad NX3225GB 12MHZ SMD 2Pad	1	Q301
10	SMD Resistor 0R 1% 0603	4	R107, R303, R315, R316
11	SMD Resistor 33R 1% 0603	2	R110, R111
12	SMD Resistor 680R 1% 0402	4	R104, R109, R301, R302
13	SMD Resistor 10K 1% 0402 TK100	3	R309, R3011, R312
14	SMD Resistor 0R 0402	5	R114, R115, R209, R210, R211
15	SMD Resistor 100R 1% 0402	6	R202, R203, R204, R206, R207, R208

Production Data

16	SMD Resistor 1% 470R 0402	6	R212, R214, R215, R217, R218, R220
17	SMD Resistor 4K7 1% 0402	1	R308
18	SMD Resistor 1M 1% 0402	2	R310, R314
19	SMD Resistor 22R 1% 0402	2	R306, R307
20	SMD Resistor 510R 0402 1%	1	R305
21	SMD Capacitor 220nF 16V X7R 0603 10% Würth 885012206048	2	C113, C121
22	SMD Capacitor 4n7 X7R 0402 16V 10% Würth 885012205029	6	C212, C213, C214, C215, C216, C217
23	SMD-Capacitor 47nF 10% X7R 0402 16V Würth	1	C1
24	SMD-Capacitor 10uF 10V 0603 10%	2	C107, C315
25	SMD Capacitor 15pF 10V 5% NP0 0402 Würth 885012005008	2	C302, C303
26	SMD-Capacitor 1nF 10% X7R 0402 50V Würth 885012205061	9	C106, C202, C203, C203, C204, C205, C206, C207, C314
27	SMD Capacitor 100n X7R 0402 16V 10% Würth 885012205037	10	C301, C305, C306, C308, C309, C310, C311, C312, C318, C319
28	SMD Capacitor 1uF X5R 0402 10V 20% Würth 885012105012	3	C316, C317, C307
29	SMD Capacitor 10uF 0805 35V X5R	1	C102
30	SMD-Capacitor 10uF 16V 0603 X5R	1	C313
31	Ferrite Bead 0603 60R 500mA Würth 74279267	2	L101, L301
32	Schottky Diode SOD323 low Vf BAS3010A-03W IFX 30V 1A	1	D301
33	USB-connector Micro USB 2.0 Type AB - Horizontal Würth 629105150921	1	X302
34	Pin header 2-rows 20-poles low profil 4mm	1	X200
Not mounted components			
35	SMD Resistor 0R 0402	2	R112, R113
36	Pin header 1 row 1 pole	1	JP2
37	SMD Resistor 82K 1% 0603	2	R108, R304
38	SMD Resistor 0R 0402	2	R201, R205
39	SMD-Capacitor 47nF 10% X7R 0402 16V Würth	1	C2, C3
40	SMD Capacitor 10n 5% X7R 0402 16V C0402C103J4R Kemet	1	C304
41	Pin header 1 row 5 poles	1	JP301
42	Pin header, 1,27, 2*5 pol SMD Pin7 ASP-166471-01 Samtec Pin7 weg	1	X101
43	Wrap-Leiste 2-reihig je 4-polig	1	X102, X301
44	SMD-Capacitor 1nF 10% X7R 0402 50V Würth 885012205061	3	C209, C210, C211

Revision History

4 Revision History

Current Version is V1.0, 2015-10

Page or Reference	Description of change
V1.0, 2015-10	
	Public version

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