Motor Control Application Kit

KITMOTORDC250W24VTOBO1

3-phase Motor Control Power Card

24V, 250W motor drive power card for XMC1000 and XMC4000

User Manual

About this document

Scope and purpose

This document describes in technical details the implementation and use of a 3-phase motor drive power card. The card has been designed to operate in various configurations and coditions, such input voltages and control algorithms.

The hardware is compatible with XMC DriveCards and DAVE™ configurations.

Attention: This board is intended for evaluation purposes only and is not intended to be an end product.

The design of this board originates from the need of a simple and plug-and-play motor drive power card to be used for XMC evaluation purposes in motor drive applications.

The layout of the board has been studied to offer a good starting reference to designers.

Intended audience

Design engineers approaching a low-voltage motor drive system either in H-Bridge or in 3-Phase full bridge configuration.

Table of Contents

1 Introduction 2

2 Block diagram 3

3 Hardware description 4

1 Introduction

This document describes the features and hardware details of the "3-phase motor control Power Card" which is designed to work with Infineon's DriveCards. DriveCards are microcontroller boards with isolated debug interface best suited for motor control applications. This power board works with DriveCards KIT_XMC1300_DC_V1 and KIT_XMC4400_DC_V1.

The "3-phase motor control Power Card" is designed to work under several supply voltage levels which are described in TABLEXX. A first buck converter produces the regulated 12V supply for the MOSFETs gate driving and a second buck converter generates the regulated 5V supply for the microcontroller and the analog signal conditioning.

The 3-phase bridge is composed by three Half-Bridges with SO8 gate driver IC and SSO8 power MOSFETs. Each leg provides a shunt resistor with amplifier for reconstruction of the phase current. A DC-link shunt is also provided. With the provided shunts configuration, the board provides flexibility to adopt many different control algorithms.

2 Block diagram

Figure 1 Shows a simplified block diagram of the hardware, which includes:

- 3-phase motor drive bridge, equipped with 6x BSC014N06N from OptiMOS™ 80V family, 1.4mOhm (max) power MOSFETs in SSO8 package
- Half-Bridge gate driver IC 2EDL05N06PF from EICEDriver™ COMPACT family in SO8 package with SOI technology
- SwitchedMode DC/DC buck converter IFX90121EL V50 for 5V supply
- SwitchedMode DC/DC buck converter for 12V supply
- Shunts to sense leg currents and DC-link current, with OpAmps for conditioning to XMC
- Resistor dividers to sense leg voltages and DC-link voltage, to XMC
- Additional general purpose Green-LED (EN, Enable port), 5V Green-LED and 12V Green-LED
- Additional general purpose trimmer to XMC

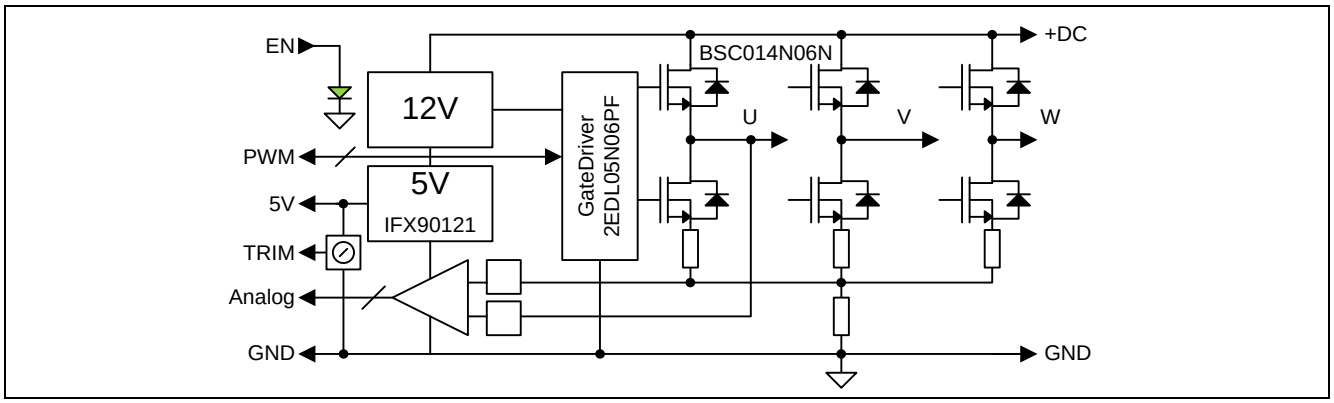


Figure 1 Simplified block diagram

3 Hardware description

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

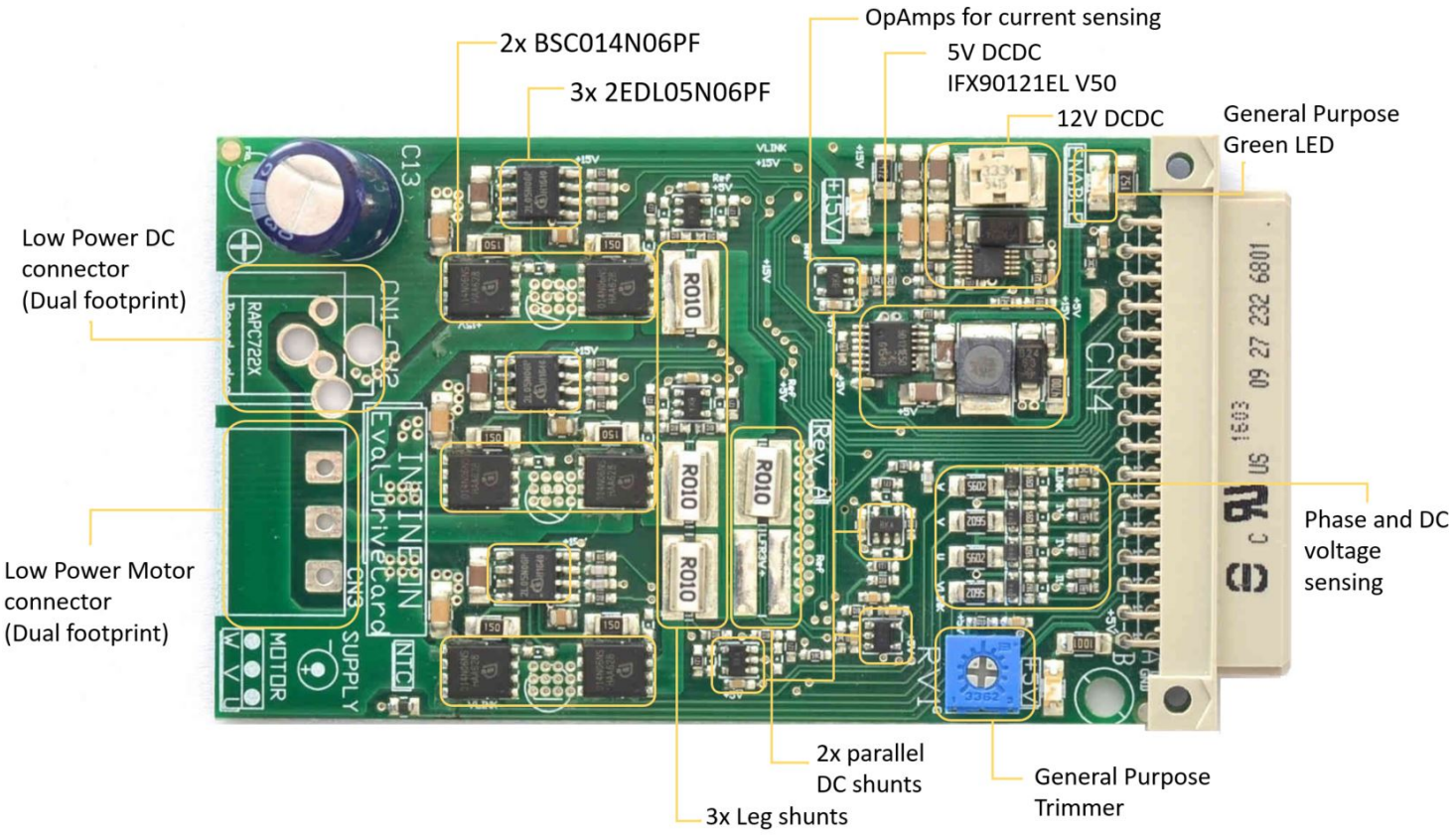


Figure 2 Hardware TOP overview

Table 1 Ratings

Description	Max	Typ	Notes
DC link input voltage	60V absolute max	24V	Hardware can run from 16V up to 42V operating
Output Power	TBD		No heatsink, still air, Ambient temperature, Test conditions TBD
Power mosfet ratings	60V BVDss abs max		**BSC014N06N** 1.4mOhm Rdson Max
SMPS IC rating	60V BVDss abs max		

3.1.1 Signal connector

The signal connector pin-out is listed below in Table 2. See also Figure 3 for reference.

Table 2 Signal connector pin-out

Row A (inner row)	Name	Notes	Row B (outer row)	Name	Notes
CN4-A16	GND	Ground	CN4-B16	VDD_5V	XMC supply
CN4-A15			CN4-B15		
CN4-A14	RVAR	Variable res	CN4-B14	TEMP	Temperature sense
CN4-A13			CN4-B13	DC_LINK_DIV_X	Voltage sense DC link
CN4-A12	I_U	Current sense U	CN4-B12	BEMF_U	Voltage sense phase U
CN4-A11	I_V	Current sense V	CN4-B11	BEMF_V	Voltage sense phase V
CN4-A10	I_W	Current sense W	CN4-B10	BEMF_W	Voltage sense phase W
CN4-A9	I_DC_LINK_AVG	Current sense DC link	CN4-B9	I_DC_LINK_0	
CN4-A8		NC	CN4-B8	U_L	Phase U low side command
CN4-A7		NC	CN4-B7	U_H	Phase U high side command
CN4-A6		NC	CN4-B6	V_L	Phase V low side command
CN4-A5		NC	CN4-B5	V_H	Phase V high side command
CN4-A4		NC	CN4-B4	W_L	Phase W low side command
CN4-A3		NC	CN4-B3	W_H	Phase W high side command
CN4-A2		NC	CN4-B2	/FO_0	Fault / NC
CN4-A1		NC	CN4-B1	/ENABLE_0	Driver enable

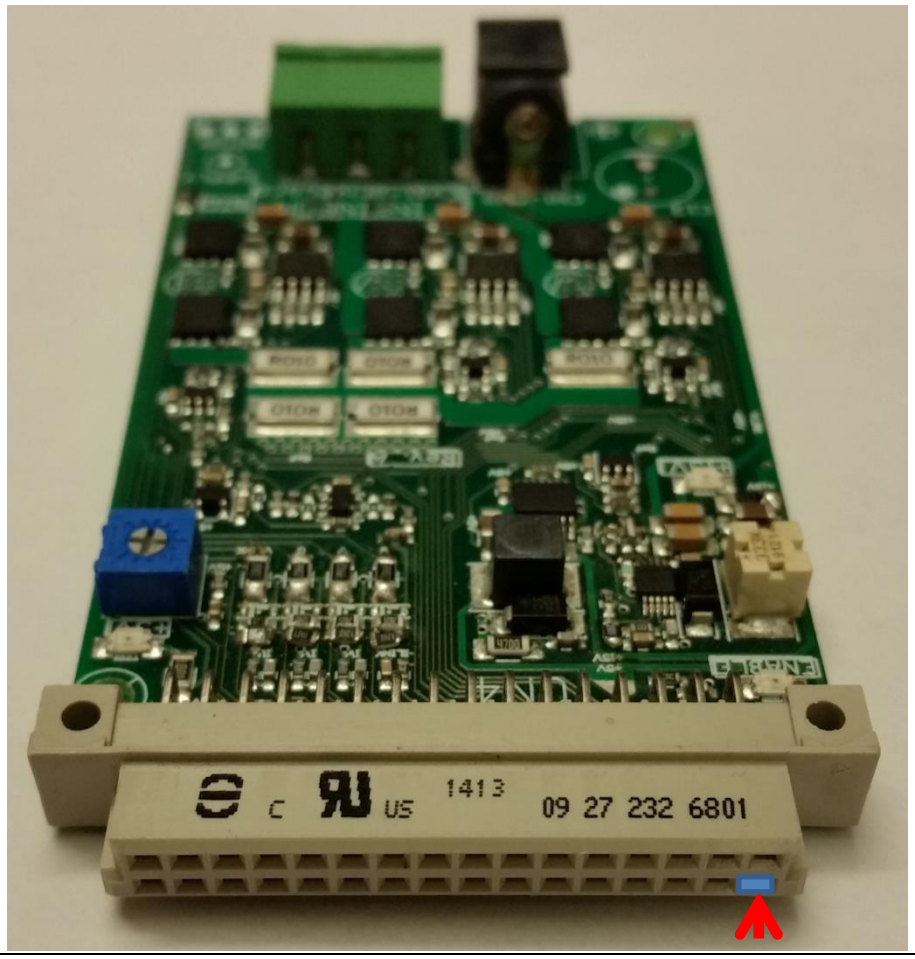


Figure 3 Signal DriveCard connector front view with pin-1/row A marked

3.1.2 Input Power and motor connectors

The board can be equipped with a standard low power RAPC 5A connector for demonstation purposes. Pinout is providing also standard 2-pin 5mm spacing drills for higher power Voltage connection.

Figure 4 Jack Connector polarity

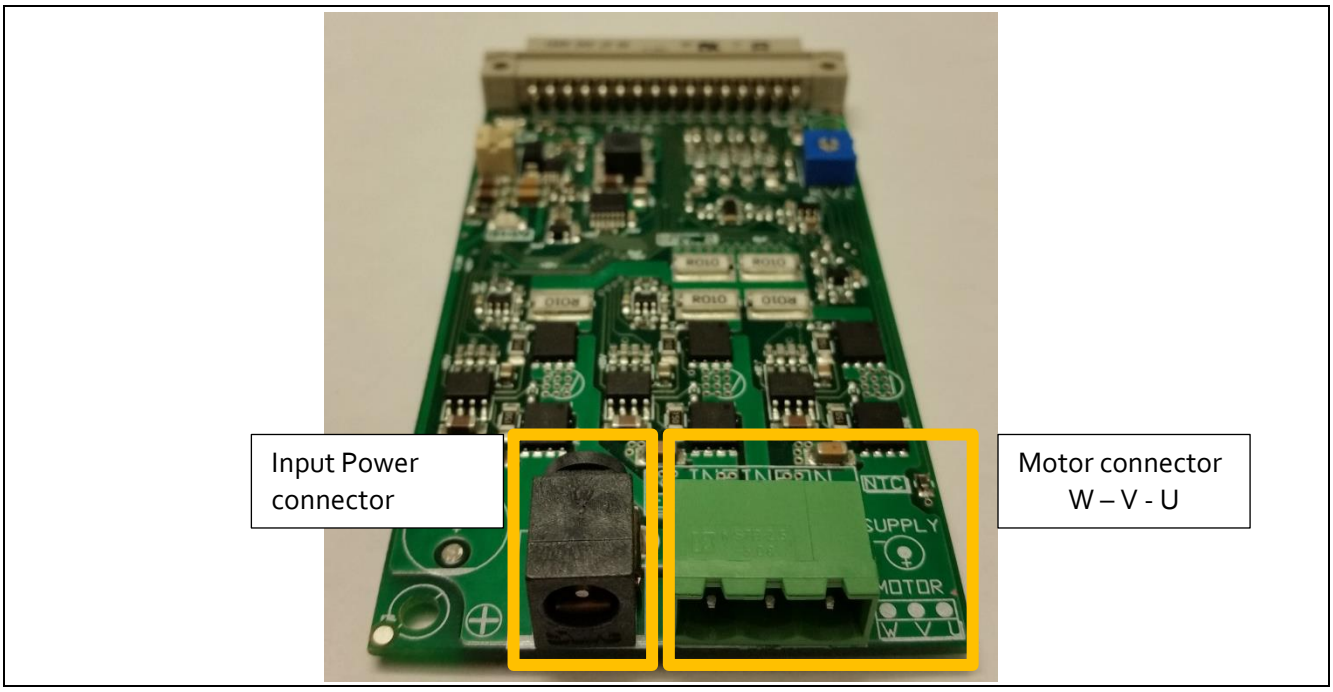


Figure 5 Power Drivecard connector view

Motor connections are available in the 3-pin power connector shown on the right side of Figure 5.

3.1.3 3-phase bridge

The 3-phase MOSFET bridge in Figure 6 shows MOSFETs, gate resistors and shunts.

The U3 comparator for overcurrent DC-link protection is also shown, providing a active-low FO (Fault) sigal to the microcontroller via XMC DriveCard signal connector.

Current trip is set by the resistor divider R20/R21 following Eq. 1.

$$V_{TH} = 2.5V \cdot \frac{R21}{R21 + R20} = 2.5V \cdot \frac{10K}{10K + 40K} = 0.5V \qquad \text{Eq. 1}$$

$$I_{TRIP} = \frac{V_{TH}}{R_{SHUNT}} = \frac{0.5V}{0.02\ Ohm} = 25A$$

A single-pole filter (represented by R19, C27) is added to trim noise immunity.

Values are R19=1KOhm, C27=1nF.

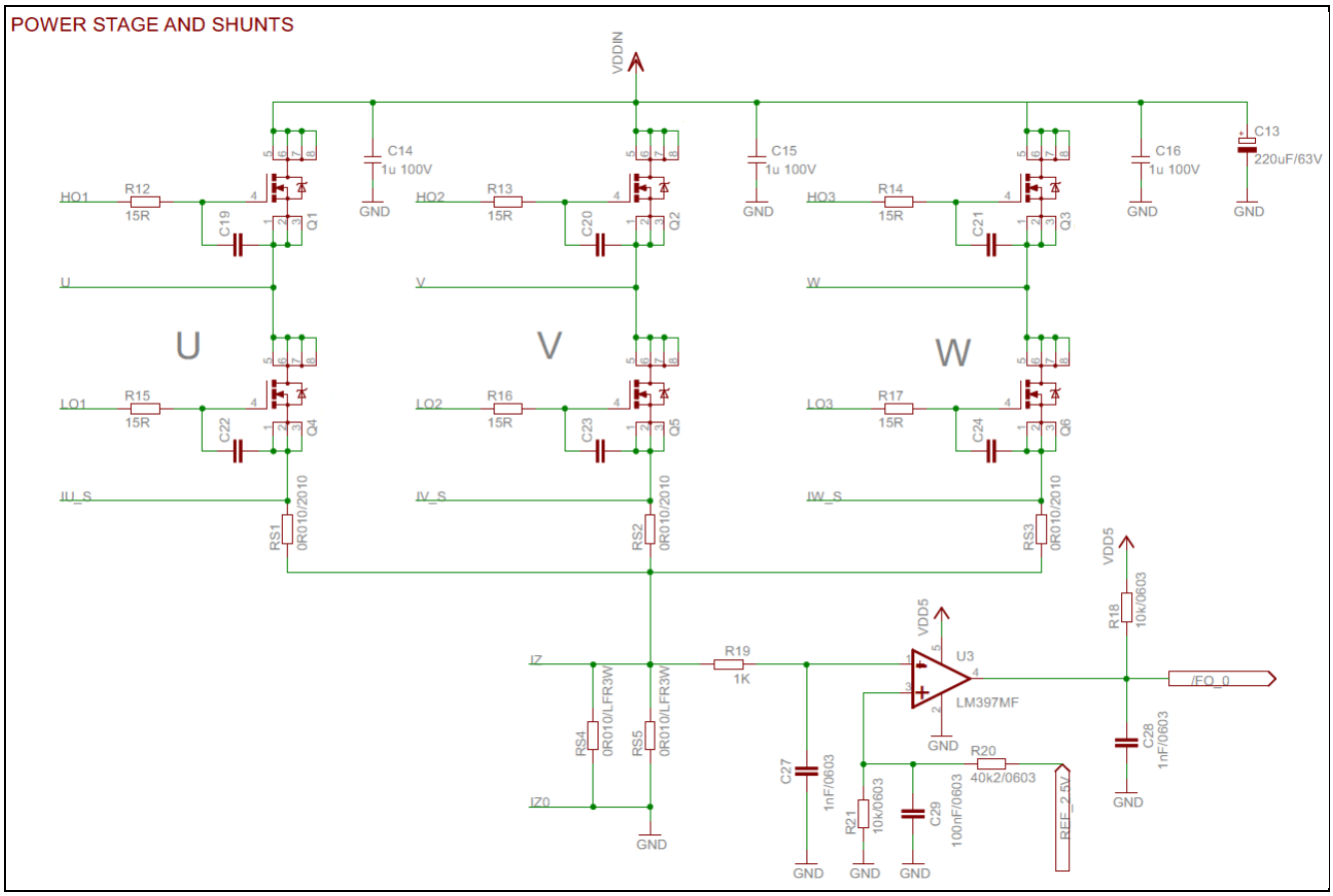


Figure 6 3-phase MOSFET bridge

Shunt voltages are fed into the DriveCard signal connector at I_U, I_V, I_W, I_DC_LINK_o pins as shown in Table 2.

Signal amplifiers are set as follows for emitter-shunt sensing (refer to Figure 7, I_U, I_V, I_W signals):

$$Gain_I_U = \frac{I_U}{Imotor} = 12 \cdot R_{s1} = \frac{[V]}{[A]}$$

$$Offset_I_U = VREF_2.5V = 2.5V$$

Eq. 2

While for Bus-shunt sensing (refer to Figure 8, I_DC_LINK_o signal):

$$Gain = \frac{I_U}{Imotor} = 12 \cdot R_{s4}//R_{s4} = \frac{[V]}{[A]}$$

$$Offset = VREF_2.5V = 2.5V$$

Eq. 3

I_DC_LINL_AVG, averaged version of the I_DC_LINK_o, is available as well at connector.

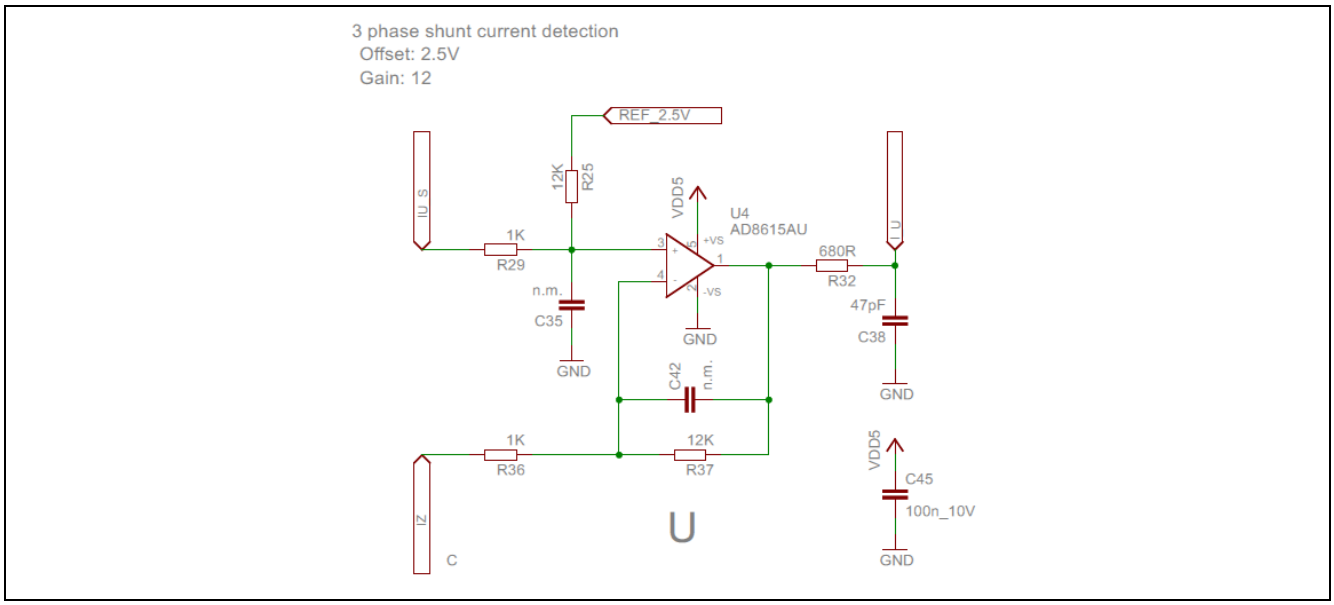


Figure 7 Emitter-shunt current amplifier (U phase shown)

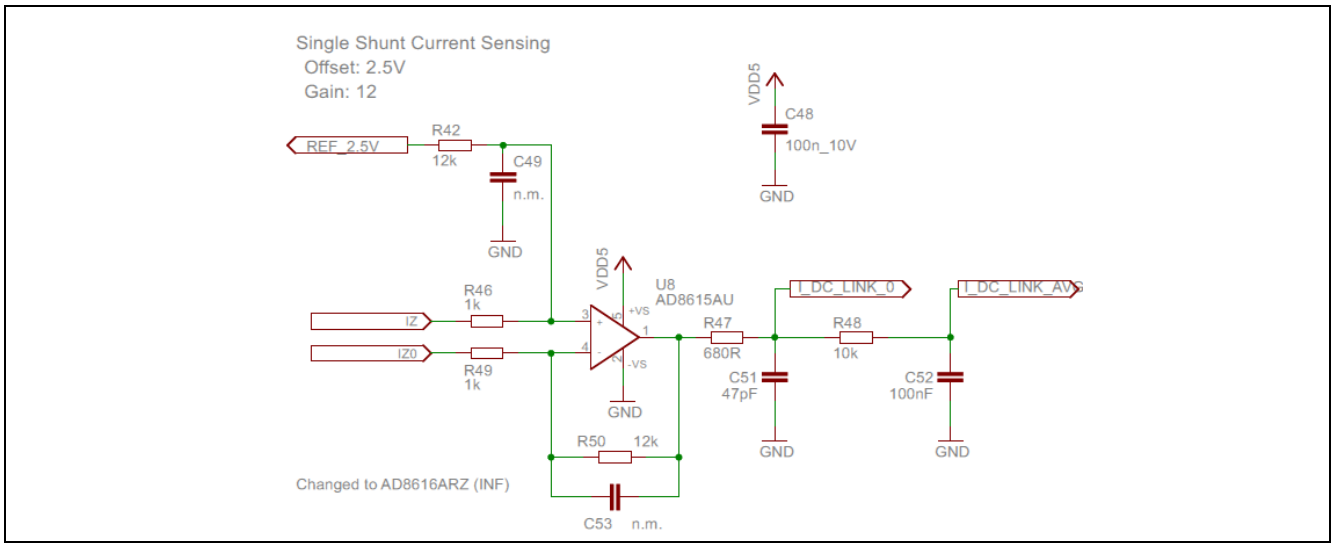


Figure 8 DC Bus current sensing

3.1.4 DC bus Voltage sensing

DCbus (DC_LINK) voltage is available at DC_LINK_DIV_X, CN4-B13 connector pin.

Voltage at pin is clamped to 5V1.

Resistor divider is set to:

R45=5.6k; R43=56k

$$\text{DC_LINK_DIV_X} = DCbus \cdot \frac{R45}{R45 + R43} \qquad \text{Eq. 4}$$

$$\text{@24V Bus voltage: DC_LINK_DIV_X} = 24V \cdot \frac{5.6kOhm}{5.6kOhm + 56kOhm} = 2.18V$$

$$\text{@42V Bus voltage: DC_LINK_DIV_X} = 42V \cdot \frac{5.6kOhm}{5.6kOhm + 56kOhm} = 3.81V$$

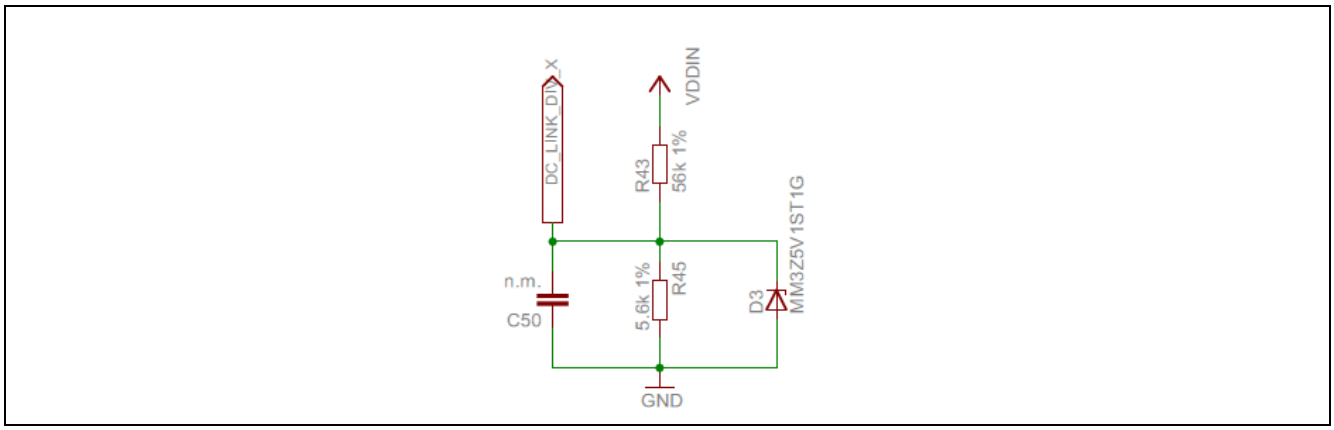


Figure 9 DC bus sensing divider

3.1.5 Phase voltage sensing

Phase voltage sensing is available at BEMF_U, BEMF_V, BEMF_W pins of the signal connector as mentioned in Table 2.

$$\mathrm{BEMF_U} = \mathrm{U} \cdot \frac{R54}{R54 + R51} \qquad \text{Eq. 5}$$

Phase voltage sensing is available for sensorless BLDC scalar control using 6-step modulation scheme as well as for various other scopes.

Pin voltage is clamped by a 5.1V Zener to protect the uC pin.

Consider that the Zener diode might have considerable capacitive behavior and it might be needed to remove them from the board.

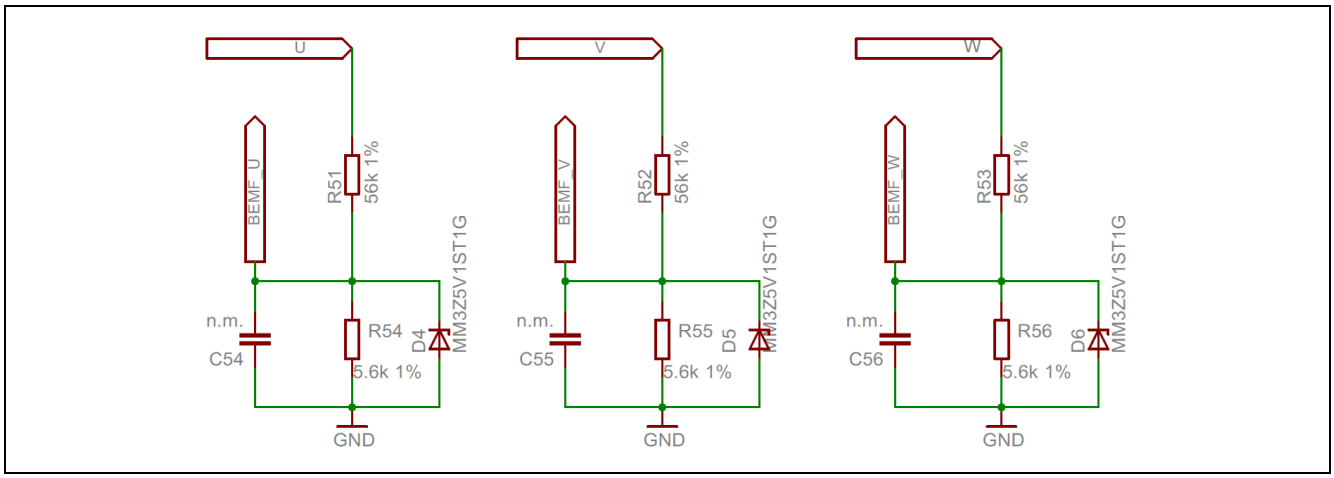


Figure 10 Phase voltage sensing divider

3.1.6 DC/DC converters

The present board embeds two step-down converters.

The first one brings BCbus voltage down to 12V and it is shown in Figure 11.

The second one brings the supply to the uC and analog circuits from 12V to 5V (Figure 12).

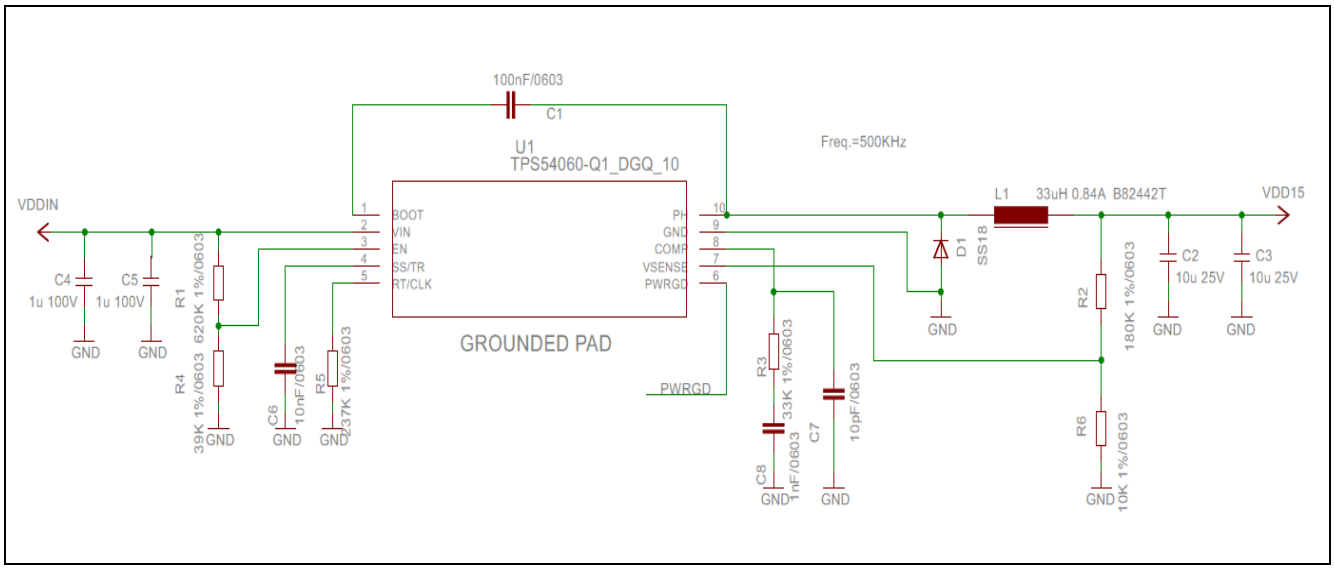


Figure 11 Step-down converter from DCbus to 12V

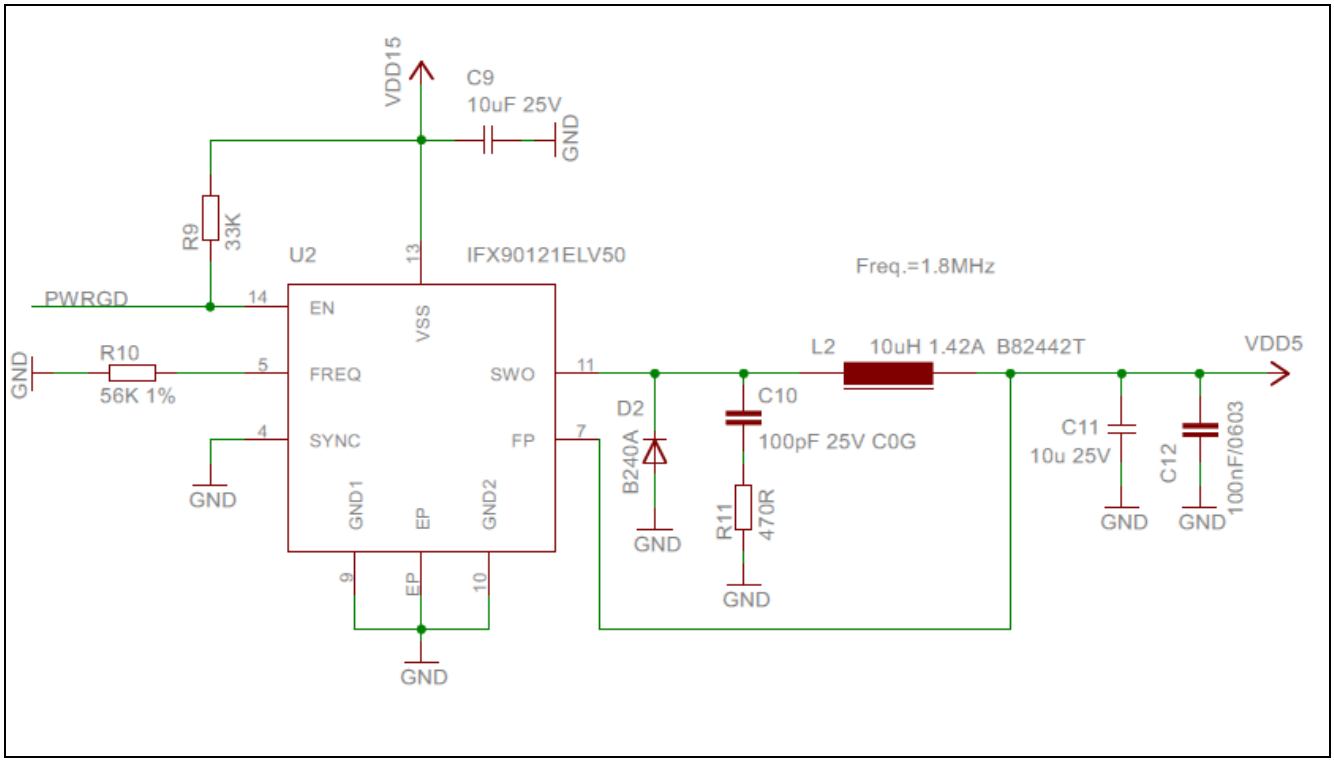


Figure 12 Step-down converter from 12V to 5V

3.1.7 Miscellaneous

Two GREEN ligh LEDs indicate presence of 12V and 5V supply. They both must be turned on when board is operative.

One LED connected to /ENABLE_o pin of the signal connector is available as general purpose indicator for the uController. See Figure 13.

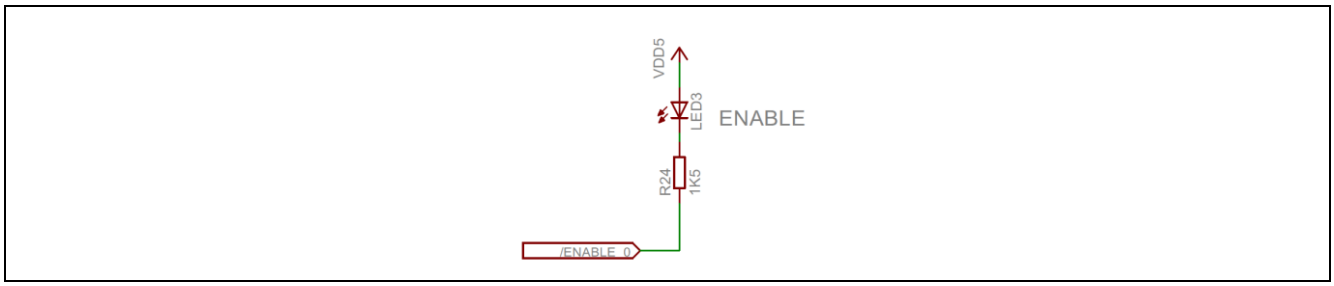
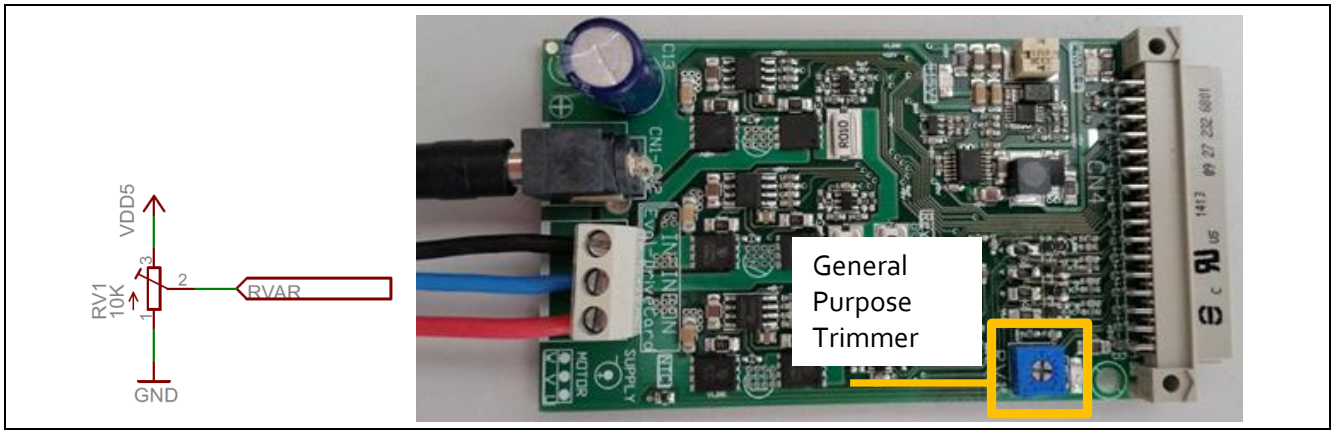


Figure 13 ENABLE general purpose LED

A general purpose MANUAL Trimmer is also available on the board, connected to RVAR (see Table 2).
RV1 is a 10KOhm trimmer, which ranges from 0V to VREF=5V.



NTC thermistor is available as well, with the temperature dependence shown inFigure 14:

$$R = R_0 \cdot e^{B\cdot\left(\frac{1}{T}-\frac{1}{T_0}\right)} = \frac{R54}{R54 + R51} \qquad \text{Eq. 6}$$

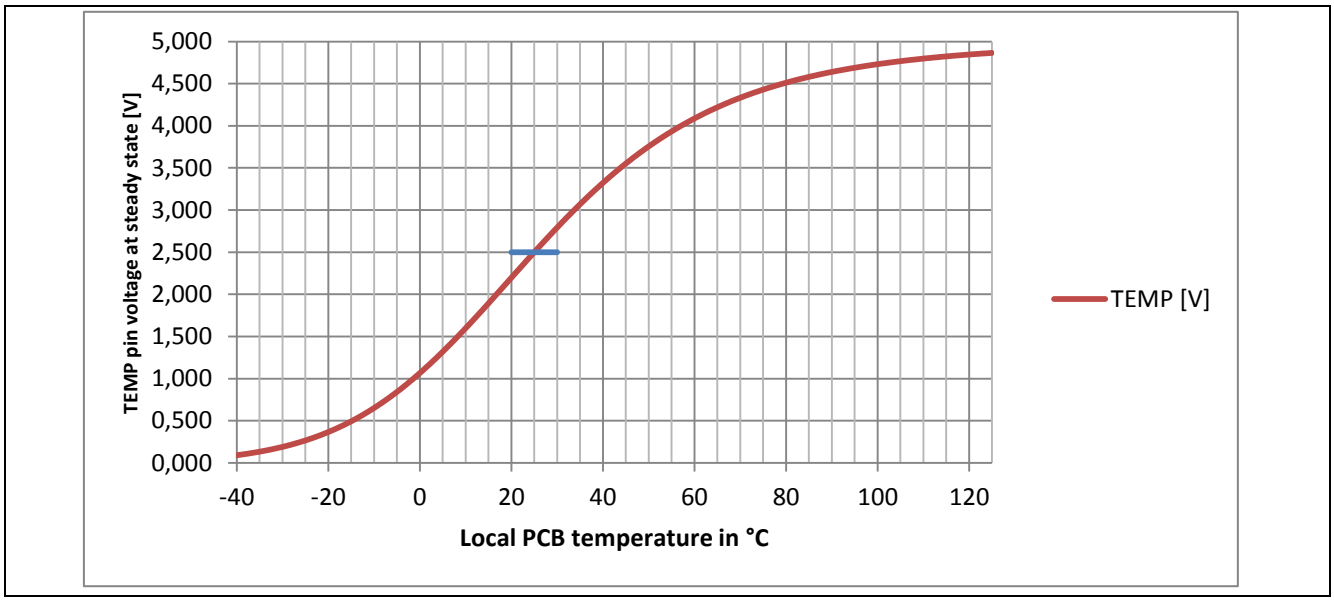


Figure 14 TEMP pin voltage as a function of local PCB temperature

NTC thermistor is located as shown in Figure 15

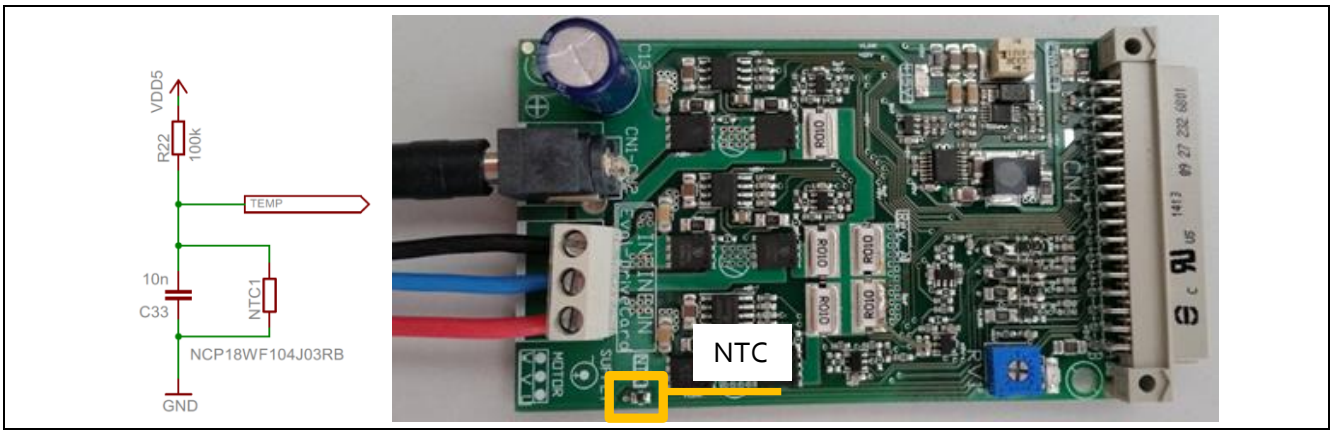


Figure 15 Position of the NTC thermistor

Therimistor capability to sense real mosfet temperature is very limited. It can be used just to have a superficial indication of local PCB temperature.

3.1.8 PWM signals

This board uses as gate driver IC the Compact series EiceDriver™ 2EDL05N06PF. For detailed specification, please visit www.infineon.com/EiceDriver and look for Isolated Gate Driver ICs.

The main characteristics of the Gate Driver IC follow:

- Technology: Rugged SOI (Silicon on Isolator) technology, allows negative voltage spikes at VB pin
- Outoput: +360/-700mA gate drive output current capability
- Protection: Interlocking function with minimum deadtime insertion (typ 75ns)
- UVLO: Mosfet tailored Under Voltage Lock Out (rising 9.1V, falling 8.3V typ), suitable for 12V driving voltage
- Bootstrap: Low Ohminc Integrated bootstrap diode

In order to drive correctly the mosfet stage, please follow the suggested parameter choice:

Table 3 Motor Control configuration

Parameter	Value	Units
Deadtime	>500	ns
Switch delay time	400	ns
Polarity	Active high all PWMs	
Amplifier gain	12	V/V
DCLink Voltage divider ratio	0.909 or 9.09%	
Enable pin is DEACTIVATED	Active high → Led ON	

[1] A Reference. See the code examples at **www.infineon.com**

Trademarks of Infineon Technologies AG

AURIX™, C166™, CanPAK™, CIPOS™, CIPURSE™, CoolGaN™, CoolMOS™, CoolSET™, CoolSiC™, CORECONTROL™, CROSSAVE™, DAVE™, DI-POL™, DrBLADE™, EasyPIM™, EconoBRIDGE™, EconoDUAL™, EconoPACK™, EconoPIM™, EiceDRIVER™, eupec™, FCOS™, HITFET™, HybridPACK™, ISOFACE™, IsoPACK™, i-Wafer™, MIPAQ™, ModSTACK™, my-d™, NovalithIC™, OmniTune™, OPTIGA™, OptiMOS™, ORIGA™, POWERCODE™, PRIMARION™, PrimePACK™, PrimeSTACK™, PROFET™, PRO-SIL™, RASIC™, REAL3™, ReverSave™, SatRIC™, SIEGET™, SIPMOS™, SmartLEWIS™, SOLID FLASH™, SPOC™, TEMPFET™, thinQ!™, TRENCHSTOP™, TriCore™.

Other Trademarks

Advance Design System™ (ADS) of Agilent Technologies, AMBA™, ARM™, MULTI-ICE™, KEIL™, PRIMECELL™, REALVIEW™, THUMB™, µVision™ of ARM Limited, UK. ANSI™ of American National Standards Institute. AUTOSAR™ of AUTOSAR development partnership. Bluetooth™ of Bluetooth SIG Inc. CAT-iq™ of DECT Forum. COLOSSUS™, FirstGPS™ of Trimble Navigation Ltd. EMV™ of EMVCo, LLC (Visa Holdings Inc.). EPCOS™ of Epcos AG. FLEXGO™ of Microsoft Corporation. HYPERTERMINAL™ of Hilgraeve Incorporated. MCS™ of Intel Corp. IEC™ of Commission Electrotechnique Internationale. IrDA™ of Infrared Data Association Corporation. ISO™ of INTERNATIONAL ORGANIZATION FOR STANDARDIZATION. MATLAB™ of MathWorks, Inc. MAXIM™ of Maxim Integrated Products, Inc. MICROTEC™, NUCLEUS™ of Mentor Graphics Corporation. MIPI™ of MIPI Alliance, Inc. MIPS™ of MIPS Technologies, Inc., USA. muRata™ of MURATA MANUFACTURING CO., MICROWAVE OFFICE™ (MWO) of Applied Wave Research Inc., OmniVision™ of OmniVision Technologies, Inc. Openwave™ of Openwave Systems Inc. RED HAT™ of Red Hat, Inc. RFMD™ of RF Micro Devices, Inc. SIRIUS™ of Sirius Satellite Radio Inc. SOLARIS™ of Sun Microsystems, Inc. SPANSION™ of Spansion LLC Ltd. Symbian™ of Symbian Software Limited. TAIYO YUDEN™ of Taiyo Yuden Co. TEAKLITE™ of CEVA, Inc. TEKTRONIX™ of Tektronix Inc. TOKO™ of TOKO KABUSHIKI KAISHA TA. UNIX™ of X/Open Company Limited. VERILOG™, PALLADIUM™ of Cadence Design Systems, Inc. VLYNQ™ of Texas Instruments Incorporated. VXWORKS™, WIND RIVER™ of WIND RIVER SYSTEMS, INC. ZETEX™ of Diodes Zetex Limited.

Last Trademarks Update 2019-03-20

www.infineon.com

Ed ition <2019-03-20>

Published by

Infineon Technologies AG

81726 Munich, Germany

© 2019 Infineon Technologies AG. All Rights Reserved.

Do you have a question about any aspect of this document?

https://www.infineon.com/cms/en/about-infineon/company/contacts/

Legal Disclaimer

THE INFORMATION GIVEN IN THIS APPLICATION NOTE (INCLUDING BUT NOT LIMITED TO CONTENTS OF REFERENCED WEBSITES) IS GIVEN AS A HINT FOR THE IMPLEMENTATION OF THE INFINEON TECHNOLOGIES COMPONENT ONLY AND SHALL NOT BE REGARDED AS ANY DESCRIPTION OR WARRANTY OF A CERTAIN FUNCTIONALITY, CONDITION OR QUALITY OF THE INFINEON TECHNOLOGIES COMPONENT. THE RECIPIENT OF THIS APPLICATION NOTE MUST VERIFY ANY FUNCTION DESCRIBED HEREIN IN THE REAL APPLICATION. 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) WITH RESPECT TO ANY AND ALL INFORMATION GIVEN IN THIS APPLICATION NOTE.

Information

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

Warnings

Due to technical requirements, components may contain dangerous substances. For information on the types in question, please contact the nearest Infineon Technologies Office. Infineon Technologies components may be used in life-support devices or systems only with the express written approval of Infineon Technologies, if a failure of such components can reasonably be expected to cause the failure of that life-support device or system or to affect the safety or effectiveness of that device or system. Life support devices or systems are intended to be implanted in the human body or to support and/or maintain and sustain and/or protect human life. If they fail, it is reasonable to assume that the health of the user or other persons may be endangered.

OCEAN CHIPS
Океан Электроники
Поставка электронных компонентов

Компания «Океан Электроники» предлагает заключение долгосрочных отношений при поставках импортных электронных компонентов на взаимовыгодных условиях!

Наши преимущества:

- Поставка оригинальных импортных электронных компонентов напрямую с производств Америки, Европы и Азии, а так же с крупнейших складов мира;
- Широкая линейка поставок активных и пассивных импортных электронных компонентов (более 30 млн. наименований);
- Поставка сложных, дефицитных, либо снятых с производства позиций;
- Оперативные сроки поставки под заказ (от 5 рабочих дней);
- Экспресс доставка в любую точку России;
- Помощь Конструкторского Отдела и консультации квалифицированных инженеров;
- Техническая поддержка проекта, помощь в подборе аналогов, поставка прототипов;
- Поставка электронных компонентов под контролем ВП;
- Система менеджмента качества сертифицирована по Международному стандарту ISO 9001;
- При необходимости вся продукция военного и аэрокосмического назначения проходит испытания и сертификацию в лаборатории (по согласованию с заказчиком);
- Поставка специализированных компонентов военного и аэрокосмического уровня качества (Xilinx, Altera, Analog Devices, Intersil, Interpoint, Microsemi, Actel, Aeroflex, Peregrine, VPT, Syfer, Eurofarad, Texas Instruments, MS Kennedy, Miteq, Cobham, E2V, MA-COM, Hittite, Mini-Circuits, General Dynamics и др.);

Компания «Океан Электроники» является официальным дистрибьютором и эксклюзивным представителем в России одного из крупнейших производителей разъемов военного и аэрокосмического назначения «**JONHON**», а так же официальным дистрибьютором и эксклюзивным представителем в России производителя высокотехнологичных и надежных решений для передачи СВЧ сигналов «**FORSTAR**».

AVIC JONHON

«JONHON» (основан в 1970 г.)

Разъемы специального, военного и аэрокосмического назначения:

(Применяются в военной, авиационной, аэрокосмической, морской, железнодорожной, горно- и нефтедобывающей отраслях промышленности)

«FORSTAR» (основан в 1998 г.)

ВЧ соединители, коаксиальные кабели, кабельные сборки и микроволновые компоненты:

(Применяются в телекоммуникациях гражданского и специального назначения, в средствах связи, РЛС, а так же военной, авиационной и аэрокосмической отраслях промышленности).

FORSTAR®

Телефон: 8 (812) 309-75-97 (многоканальный)
Факс: 8 (812) 320-03-32
Электронная почта: ocean@oceanchips.ru
Web: http://oceanchips.ru/
Адрес: 198099, г. Санкт-Петербург, ул. Калинина, д. 2, корп. 4, лит. А