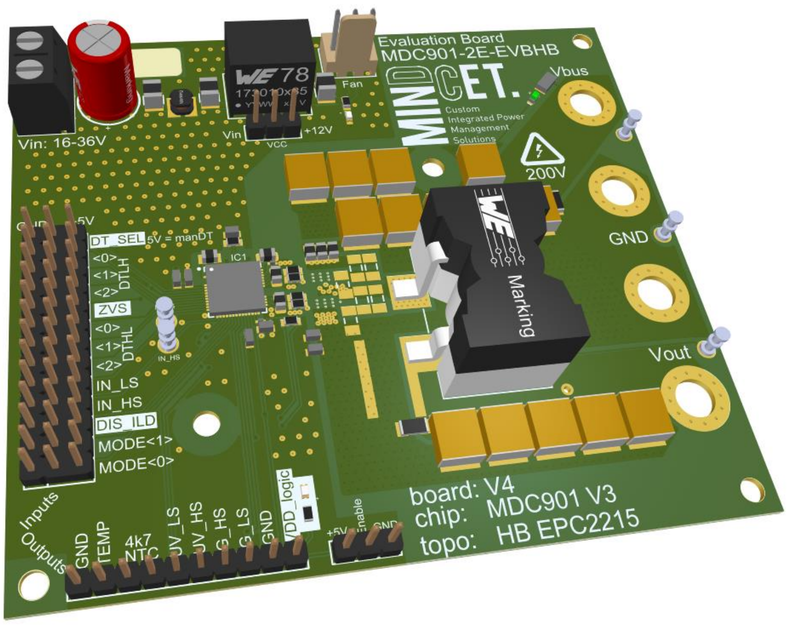
MDC901-2E-EVKHB
Technical Manual

MDC901 200V GaN Gate Driver Half-Bridge Evaluation Kit Utilizing EPC2215 GaN HEMTs

Integrated High-Side and Low-Side GaN Gate Driver (MDC901)



For the current version of this Technical Manual and accompanying product documentation, visit mindcet.com or scan the QR code.

**For safe and proper use,
follow these instructions.
Keep them for future reference.**

WARNING: ONLY qualified personnel* should handle this board!

WARNING: Electrical Shock Hazard - Hazardous high voltage may be present on the board during the test and even brief contact during operation may result in severe injury or death. Follow all locally approved safety procedures when working around high voltage.

Never leave the board operating unattended. After board is de-energized, only first touch the board once all capacitors are discharged.

CAUTION: PCB Surfaces may become hot during operation! Do not touch board during operation or for 10 minutes following proper power down of the board.

CAUTION: This product contains parts that are ESD sensitive. Follow proper ESD handling procedures when handling the evaluation board and do not apply excessive voltages to the power supplies, the bus voltages, signal inputs or outputs.

*Qualified personnel (skilled persons) is defined as an individual with relevant technical education, training, or experience to enable perceiving risks and avoiding hazards occurring during use of this product (Source: IEEE 82079-1 3.36)

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Introduction

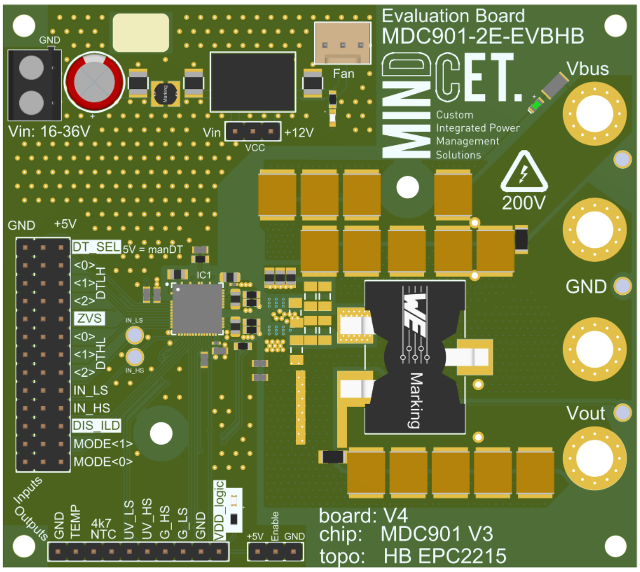


Figure 1: MDC901-2E-EVBHB 200V Half-bridge GaN evaluation board, top view

The MDC901-EVKHB evaluation kit is designed to allow the user to simply and flexibly evaluate the MDC901 200V GaN gate driver in a half bridge configuration. The evaluation board (EVB) utilizes Efficient Power Conversion (EPC) 200V enhancement mode HEMTs together with passive and active components from Würth Elektronik. The kit provides complete out-of-the-box testing capabilities for quick implementation. At a PCB size of 80x90mm², the evaluation board is compact and is accompanied with all required components to quickly begin testing.

This Technical Manual serves the primary purpose as the EVB handling & usage guide with accompanying information such as the EVB schematics and EVB measurement conditions and techniques.

Within the Technical Manual, the individual evaluation board (as shown in Figure 1), is referred to as the EVB where the full evaluation kit (displayed in Figure 2) is referred to as the EVK.

Evaluation Kit Contents

The MDC901-2E-EVKHB evaluation kit contains the necessary hardware for out-of-the-box testing:

Table 1: Contents of the EVK.

Quantity	Component Description
1	MDC901-2E-EVBHB Half-bridge evaluation board
1	Heatsink & fan assembly w/ thermal interface material preassembled on EVB (Alpha Heatsink type FSR30-15M32 & TIM TG-A1780 28*19*0.8mm)
1	Plexiglass protection cover (MDC-EVK-9PC8)
4	Electric power cable w/ crimped ring connector
4	Connector set (screws, washers, and nuts)
1	Coaxial BNC cable to PWM (BNC Plug to 0.64mm Square Pin Sockets Hirschmann 933844001)
4	M3 Spacer stud set (4mm and 2mm)
1	EVB Terms of Use manual
1	Reusable storage box

Figure 2: MDC901-2E-EVKHB evaluation kit displayed in the reusable box

External Equipment

Further equipment is needed for evaluating the EVB, specifically:

- Non-conductive, clean working surface
- High power, high voltage DC supply
- Low power, low voltage DC power supply
- PWM function generator (e.g. arbitrary waveform generator (AWG))
- Oscilloscope or DMM (recommended)
- Resistive or electronic load

Overview

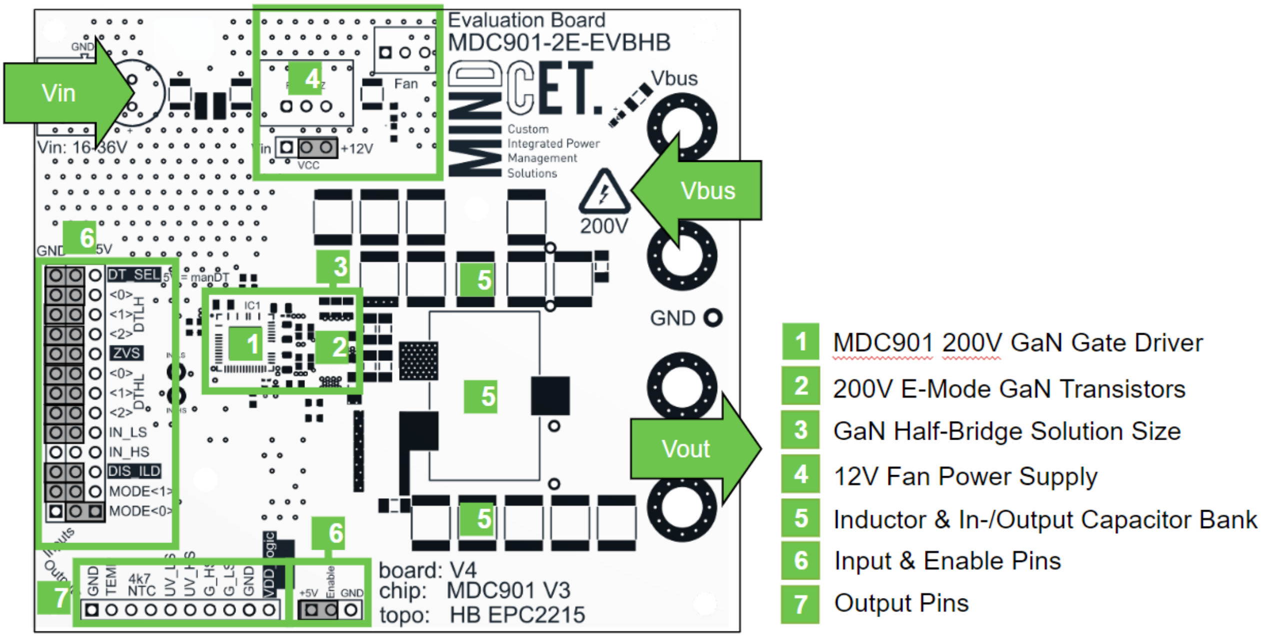


Figure 3: EVB layout description based, labeled by key aspects (gray boxes are the default jumper positions).

The evaluation board (EVB) is designed in a half bridge configuration to form a buck converter for step-down conversion. One MinDCet MDC901 GaN gate driver is present driving two Efficient Power Conversion 200V EPC2215 enhancement high mobility transistors (e-HEMT).

The EVB is separated into blocks for description purposes, as displayed in Figure 3.

1 MDC901 200V GaN Gate Driver

The MDC901 gate driver IC is a QFN56 7x7mm² package for precise driving of the GaN transistors.

For specifications and more information, refer to the most recent datasheet at https://www.mindcet.com/asic-products (or use the QR-code to the right).

2 200V E-Mode GaN Transistors (on the PCB backside)

Two Efficient Power Conversion EPC2215 enhancement mode GaN HEMTs, with a V_{DS} rating of 200V, are present on board as high and low side power switches in the half-bridge. The EPC2215 has a PCB footprint of 4.6 x 1.6 mm² and $R_{DS(ON)}$ of 8 mΩ. The GaN HEMTs leverage GaN's properties for high power densities with high voltage breakdown and high switching frequency. The HEMTs are mounted on the backside of the PCB and are top cooled.

For specifications and more information, refer to the most recent datasheet at EPC2215

3 GaN Half-Bridge Solution Size

The entire GaN half-bridge, including the (2) GaN HEMTs, (1) MDC901 gate driver, and required surrounding passives, has a highly compact footprint of less than 20x20mm².

4 12V Fan Power Supply

The FDSM MagI^{3}C Power Module (173011235) from Würth Elektronik provides a regulated 12V output, suppling the fan as well as the MDC901 itself.

Alternatively, the MDC901 can be directly powered by the input supply as long as the input voltage is below 30V. More information about the allowed input voltage can be found in the MDC901 datasheet. The input voltage can be selected with the three-pin VCC header.

For specifications and more information, refer to the most recent datasheet at

https://www.we-online.de/powermodules

5 Inductor & Input/output Capacitor Bank

For direct EVB evaluation purposes, a 4.2µH Würth Elektronik WE-HCF inductor (7443630420) and the fitting input/output capacitors were selected for a buck converter topology, designed for high current applications up to 24A output current.

6 Input Pins

The Inputs table describes the jumper position for the default IC state, which is for automatic dead time control.

Table 2: Input Pin Descriptions, function and default state

Pin Name	Default State	Function
ENABLE	+5V	General enable for gate driver functionality
MODE<1>	+5V	Operating mode selection state according to *Table 2*. EVB designed only for synchronous buck mode. **Maintain default state (+5V)**
MODE<0>	GND	Operating mode selection state according to *Table 2*. EVB designed only for synchronous buck mode. **Maintain default state (GND)**
Dis_ILD	GND	Digital input controlling HS and LS driver functions. **Maintain default state (GND)**
In_HS	PWM (0/5V)	Digital PWM input controlling HS and LS drivers.
In_LS	GND	Digital PWM input controlling HS and LS drivers. Function reflected in Table 6.
DTHL<2>	GND	Digital dead-time generation tuning input for feed forward turn-off delay. See *Manual Dead time* Selection.
DTHL<1>	GND	
DTHL<0>	GND	
ZVS	GND	Digital input for feed forward dead-time generation. Active high.
DTLH<2>	GND	Digital dead-time generation tuning input for feed forward turn-on delay. See *Manual Dead time* Selection.
DTLH<1>	GND	
DTLH<0>	GND	
DT_SEL	GND	Digital input for selection of closed loop or feedforward dead-time generation (automatic and manual dead time, respectively). Active high. See *Manual Dead time* Selection. CAUTION: Manual dead-time mode (open loop) must be monitored with an oscilloscope.

The default jumper positions are demonstrated in the EVK lid diagram with gray boxes and in Figure 3. For more information on the pin functions, refer to the MDC901 datasheet.

7 Output Pins

Table 3: Output pin description and function.

Pin #	Pin Name	Function
1	GND	GND connection, e.g. to measure TEMPOUT.
2	TEMPOUT	IC chip temperature (MDC901 internal sensor). Measure voltage and calculate temperature according to Section *"Temperature* Measurement*"*.
3	NTC_In	Board temperature. Measure resistance between NTC_In and NTC_Out to calculate temperature according to Section "Temperature Measurement".
4	NTC_Out	Board temperature at NTC, placed just below MDC901. See NTC_In.
5	UV_LS	Digital output, undervoltage on the LS supplies (both regulated and preregulated supply levels). Will give a low output in case of undervoltage condition.
6	UV_HS	Digital output, undervoltage on the HS supplies (both regulated and preregulated supply levels). Will give a low output in case of undervoltage condition.
7	G_HS	Digital signal, gate feedback of high-side driver.
8	G_LS	Digital signal, gate feedback of low-side driver.
9	GND	GND connection, e.g. to measure G_LS.
10	VDD_LOGIC	Digital 5V linear regulator. Can drive limited external resistive loads, but should not be loaded capacitively.

For more information on the pin functions, refer to the MDC901 datasheet.

Vin, Vbus and Vout

Vin is connected to the low voltage power supply and has an allowable input range of 16-36V. Vbus is connected to the high power, high voltage power supply and with an intended input range of 0-74.5V. Vout is the stepped down, outgoing power, connected to the (electronic) load with a voltage range of 0 to Vbus.

Additional EVB Features

Test pin probe points are installed for Vbus, Vout, and GND for waveform and efficiency measurements. For higher power loss situations, there is a 30x30mm² heat sink and fan assembly with thermal interface material applied, which can be fastened to the back of the PCB using the integrated spring pin system. Further information on operating conditions for safe handling of the EVB can be found in *EVB Operation Conditions*. Power Good indicators signal the presence of power for the 5V supply (from the MDC901), the 12V fan supply and Vbus. When the LED illuminates, voltage is present on the corresponding supply.

Board Block Diagram

The EVB layout has been simplified to a block diagram in to demonstrate the primary electrical connections on the board, centered around the functionality of the MDC901 GaN gate driver.

For the full MDC901-EVBHB schematics, please refer to the EVB Schematic section within the *Appendix*.

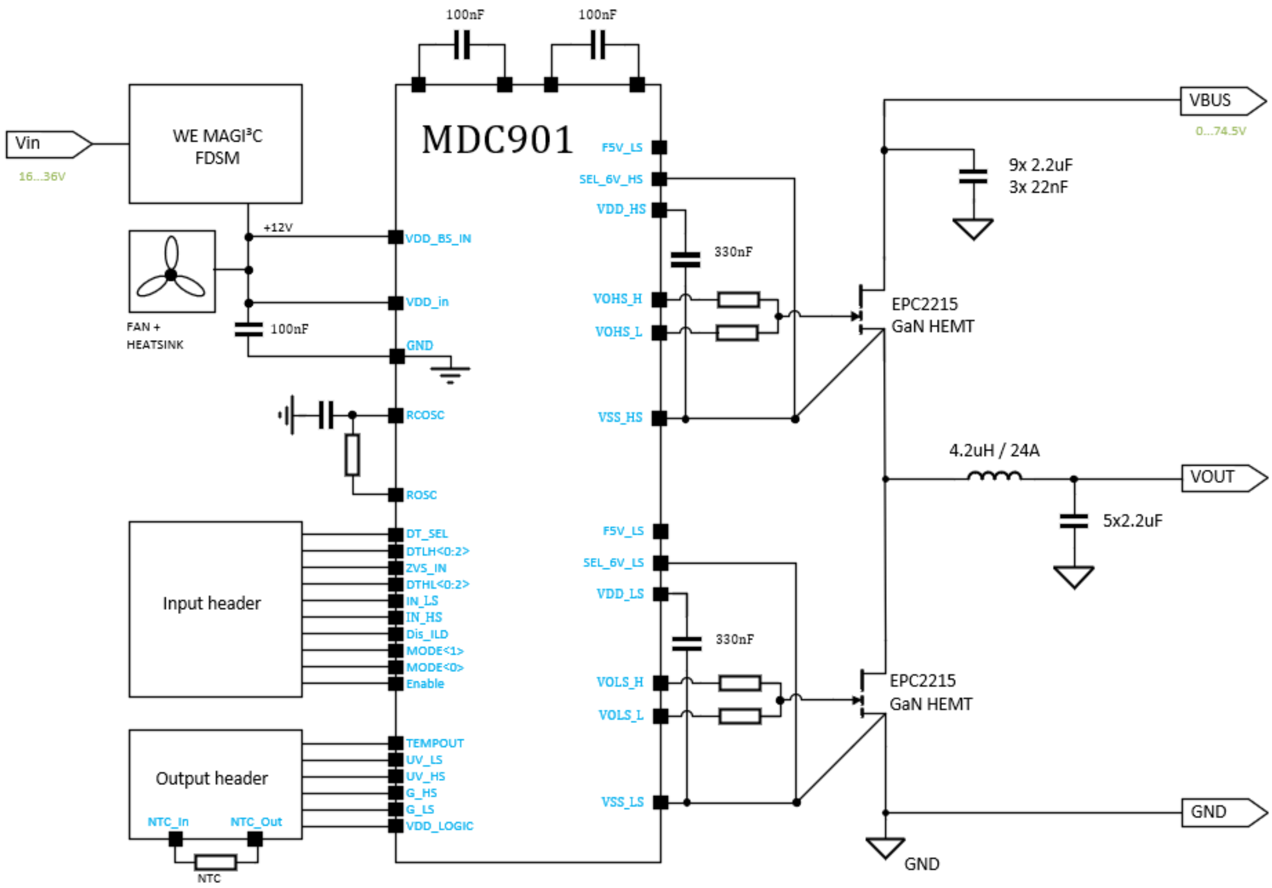


Figure 5: Block diagram of the MDC901-2E-EVKHB

EVB Operation Conditions

Operating conditions are conditions under which the EVB is functional and in a safe range. Adherence to the maximum values and the close monitoring of the conditions (e.g. Vbus, Ibus, Vout and Iout) is critical to prevent harm to the board or user.

Monitoring the board temperature and the total power loss Ploss is required for ensuring safe board operation.
Ploss is calculated according to the following equations:

Equation 1 $$Pin = Vbus \times Ibus\ [W]$$

Equation 2 $$Pout = Vout \times Iout\ [W]$$

Equation 3 $$Ploss = Pin - Pout\ [W]$$

Equation 4 $$Efficiency = \frac{Pout}{Pin} \times 100\%\ [\%]$$

The operation safety limit is a temperature rise of 25°C of Tboard over the ambient temperature Tambient. Tambient should be measured in a 30 cm vicinity at EVB level, away from air currents for a representative measurement.

Safe usage: the total power loss (Ploss) defines the safe operating conditions to prevent overheating and damage to EVB. The heatsink is always installed.

- **Ploss= 5W max with fan ON**
- **Ploss= 2W max with fan OFF**

These Ploss values are to be strictly adhered to, taking priority over the temperature rise measurement.

CAUTION: First confirm Ploss levels at lower operating conditions, then continue to higher power levels / switching frequencies

Table 4: EVB minimum and maximum operating parameters.

Parameter	Min.	Recommended	Max.	Unit	Notes
Vin	16		36*	V	
Vbus	0	-	74.5*	V	Absolute max of 200V including overshoot & ringing
Fsw (PWM)	0	300 to 700	1000	kHz	
Iout	0	-	15	A	
Board temperature	-	-	90	°C	Do not exceed 90°C on any component under operating conditions

*All voltage values are referenced respective to GND.

Dead Time Control Conditions

The MDC901 has different built-in dead time control options for optimizing device performance for high efficiency.

Automatic Dead time

The default jumper positions described in the Default State column of the *Input Pins* table provides the configuration for automatic dead time. This mode will monitor the gate voltages of the HS and LS switches, to guarantee a break-between operation of HS and LS GaN transistor. In this condition, the dead time is ensured, but cannot be controlled and is longer than what can be achieved in manual dead time mode.

Automatic dead time mode is consequently dynamic and ensures the dead time, even in changing loads and duty cycle conditions. However, the inherently longer dead time (compared to a manually selected dead time) typically leads to higher switching losses and resultantly lower efficiency.

Manual Dead time Selection

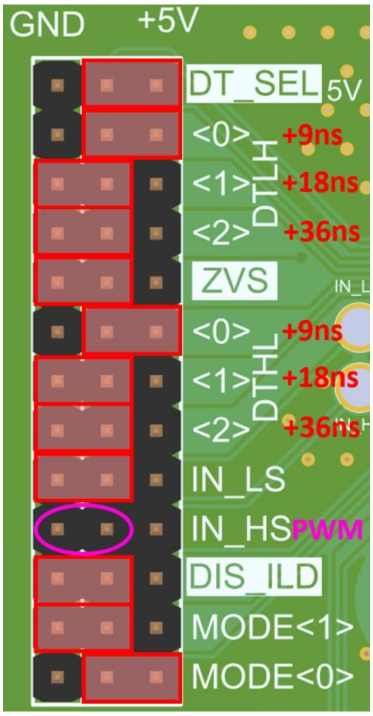
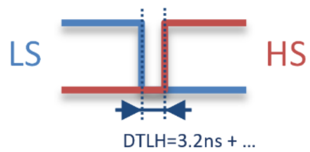


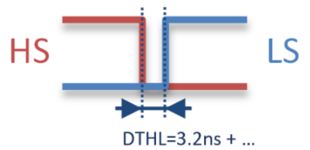
Figure 6: Jumper positions for synchronous buck mode with manual dead time of 12.2ns theoretically.

To operate the EVB in manual dead time mode, the input pin states jumpers must be placed for MODE<1> = GND and MODE<0> = 5V for synchronous buck mode, as well as the jumpers on dis_ILD = GND and DT_SEL = 5V to enable manual dead time selection.

DTLH is the dead time between the LS falling and HS rising.



DTHL is the reverse situation to DTLH from HS off to LS switching on.



The input pins jumper positions for DTLH<0:2> and DTHL<0:2> determine the respective total dead time according to the following equations:

Equation 5 *DTLH = 3.2ns + DTLH<0> + DTLH<1> + DTLH<2>*

Equation 6 *DTHL = 3.2ns + DTHL<0> + DTHL<1> + DTHL<2>*

Where Table 5 defines the amount of dead time for each input.

Figure 5 displays an example of the EVB configured for manual dead time in synchronous buck mode with 12.2ns DTLH/DTHL.

Table 5: Dead-time adjustment variable values.

Pin State	DTLH<0> / DTHL<0>	DTLH<1> / DTHL<1>	DTLH<2> / DTHL<2>
5V / open	9ns	18ns	36ns
GND	0ns	0ns	0ns

The listed DTLH/DTHL dead time adjustment values are theoretical and can differ to experimental results.

CAUTION: Dead time must be monitored by an oscilloscope in manual dead time mode to avoid high side/low side HEMT switch overlap

The MDC901-2E-EVBHB is specifically designed for synchronous buck mode
This is defined by Mode<1> = GND and Mode<0> = 5V.

The MDC901 IC offers four operating modes, described in Table 6.

Only use the EVB in the synchronous buck mode state.

Table 6: Truth table for mode selection

Mode selection	synch/async buck/boost	sync buck PWM=in_HS	sync boost PWM=in_LS	transparent in_LS & in_HS
MODE<1>	0	0	1	1
MODE<0>	0	1	0	1

For more information on the other operating modes, please refer to the MDC901 datasheet.

Temperature Measurements

The gate driver IC temperature is calculated based on the measured voltage between output pin 2 and GND, according to:

Equation 7
$$Tchip = \frac{V-0.48}{0.0016} + 25\ [°C]$$

In addition to the on-chip temperature sensor of the MDC901 IC, the evaluation board offers a second temperature measurement point in the proximity of the MDC901 IC and GaN HEMTs. The board temperature sensor is an NTC thermistor placed close to the half-bridge, providing insight into the GaN half-bridge temperature.

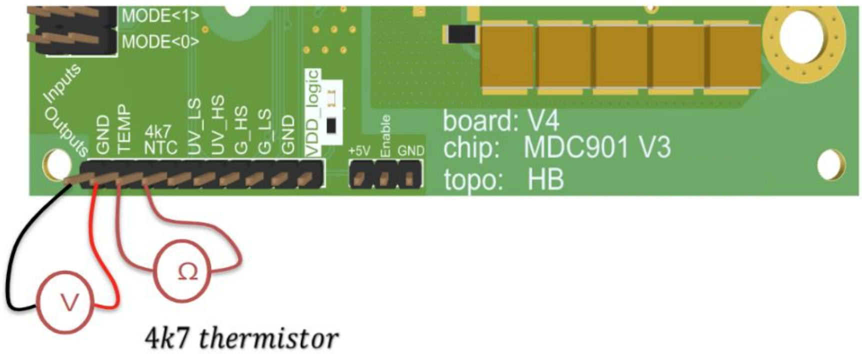


Figure 7: Board and internal IC temperature sensing measurement.

For the board temperature, measure the resistance (R) of the 4.7kΩ thermistor with a high impedance (>=10MΩ) digital multimeter between output pins 3 and 4 labeled 4k7 NTC.

The following equation converts the measured resistance value R to temperature:

Equation 8 $$Tboard = \frac{T_0\ \beta_{25/85}}{T_0\ ln\left(\frac{R}{R_0}\right)+\beta_{25/85}}\ [°C]$$ $R_0 = 4700\Omega$, $T_0 = 298.15K$, $\beta_{25/85} = 3830$

Inductor losses

The power inductor used in the MDC901-2E-EVBHB board is a Würth Elektronik type 7443630420, with an inductance of 4.2µH and rated current of 24A.

Depending on the operating conditions used on the EVB, the inductor will exhibit AC power losses, depending on DC and AC current conditions, which will also contribute to the overall dissipation on the board.

This inductor was characterized using the MADMIX system.
Figure 7 depicts the losses depending on the frequency and ripple current.

The ripple current will depend on the following equation (δ is the duty cycle).

Equation 9 $$I_{rip} = \frac{V_{bus}\delta(1-\delta)}{f_{sw}L}$$

Based on the ripple current and the graph in Figure 7, the AC losses can be determined.

The DC losses are Joule losses, defined by :

Equation 10 $$P_{dc} = R_{dc}.I_{dc}{}^2$$

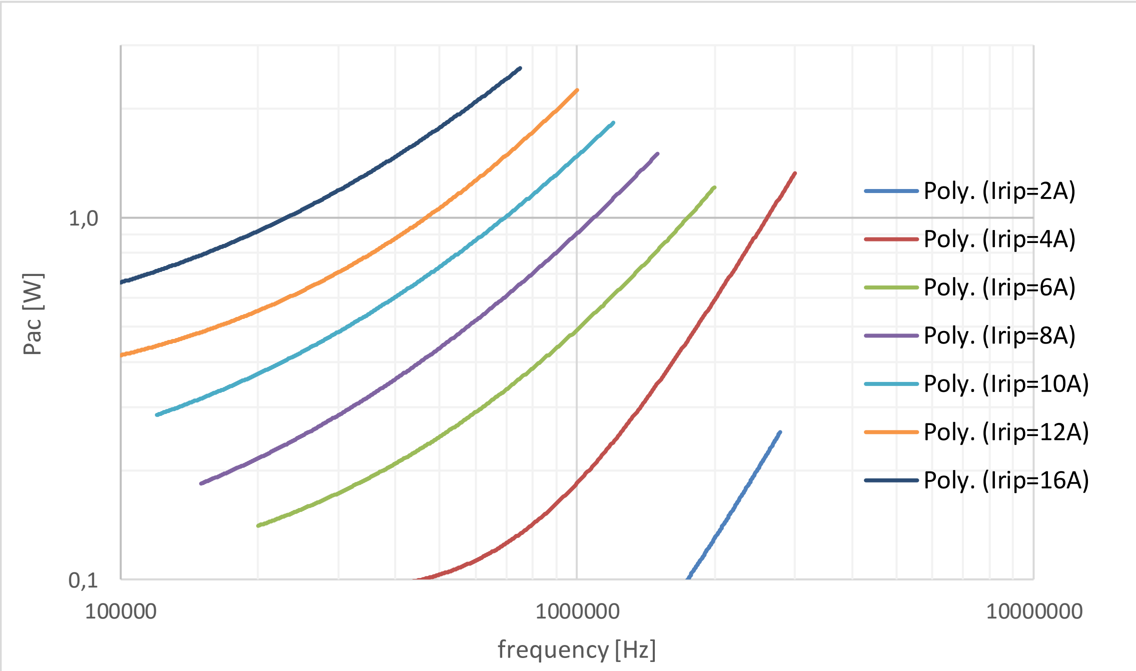


Figure 8: AC losses of the 4.2µH WE (7443630420) power inductor on the EVB

Figure 8 depicts the total inductor losses in a few typical applications, Vbus = 36V, 48V and 60V with Vout = 3.3V & 12V.

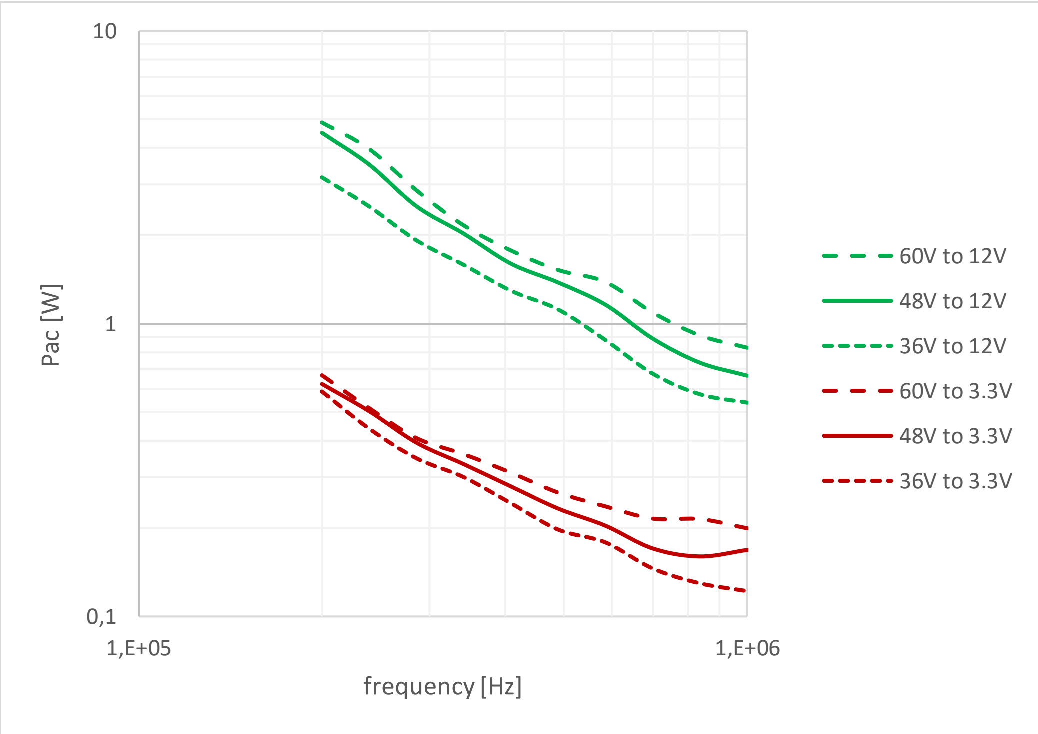


Figure 9: AC losses of the power inductor on the EVB in a few typical conversion ratio applications.

Board Handling Instructions & Quick Start

Before board operation, refer to the *EVB Operation Conditions* Section

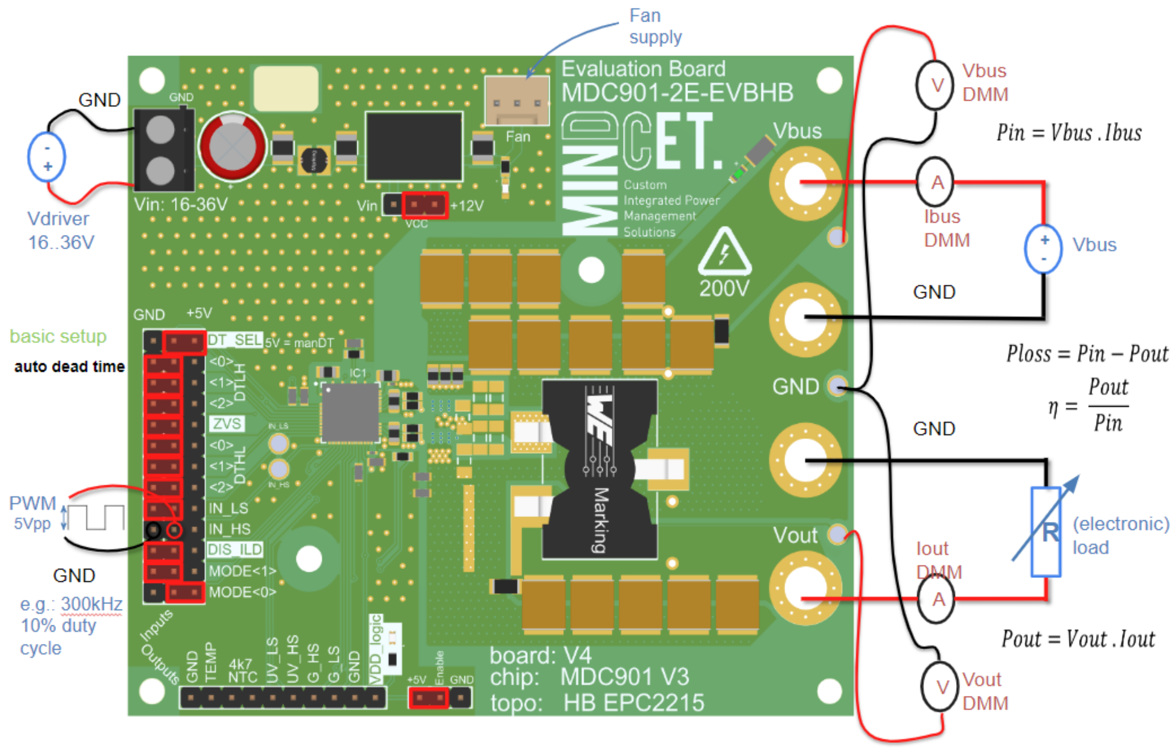


Figure 10: Standard EVB setup with external supply connections in automatic dead time mode.

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First Time EVB Preparation

1. Solder test points or equivalent on VBus, Vout, and GND for efficiency measurement (required data for monitoring the total power loss, Ploss)
2. Prepare the bare end of the power cables with the fitting connector type for the power supply connector (as necessary)
3. Mount the heatsink to the HEMTs on the backside of the board with the included hardware, so that the end of the bolt sits flush with the two nuts provided. This should provide good mounting pressure.
4. Plug fan connector into the fan socket on PCB front side (Figure 3, block 4) to power the fan.

Preparations: Electrical and Mechanical Setup

1. Setup a clean laboratory environment. EVB to be placed on a non-conductive surface to minimize the risk of an electric shock or fire.
2. Install the plastic spacer studs in each corner of the EVB (see Figure 11)
    a. 4 cm studs on the PCB bottom side
    b. 2 cm studs on the top side
3. Connect the power cables:
    a. Ring terminals to the PCB using the included bolt + washer + nut (according to Figure 11
    b. Free end to the power supply or load: Vbus to high voltage power supply, Vout to (electronic) load.
4. Connect the Vin supply cable
    a. Ferrule to the PCB terminal block Vin
    b. Banana connector to the power supply
5. Connect the coaxial cable
    a. BNC connector to AWG
    b. Female header to in_HS for BUCK mode (Input Pin 4)
6. Connect fan supply cable to "Fan supply" header, labeled accordingly in Figure 9.
7. Install the plexiglass cover on the spacer studs with the nylon M3 screws, as displayed in Figure 11.

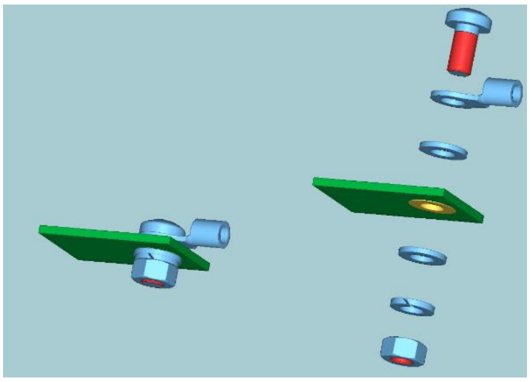


Figure 11: Power cables connector assembly.

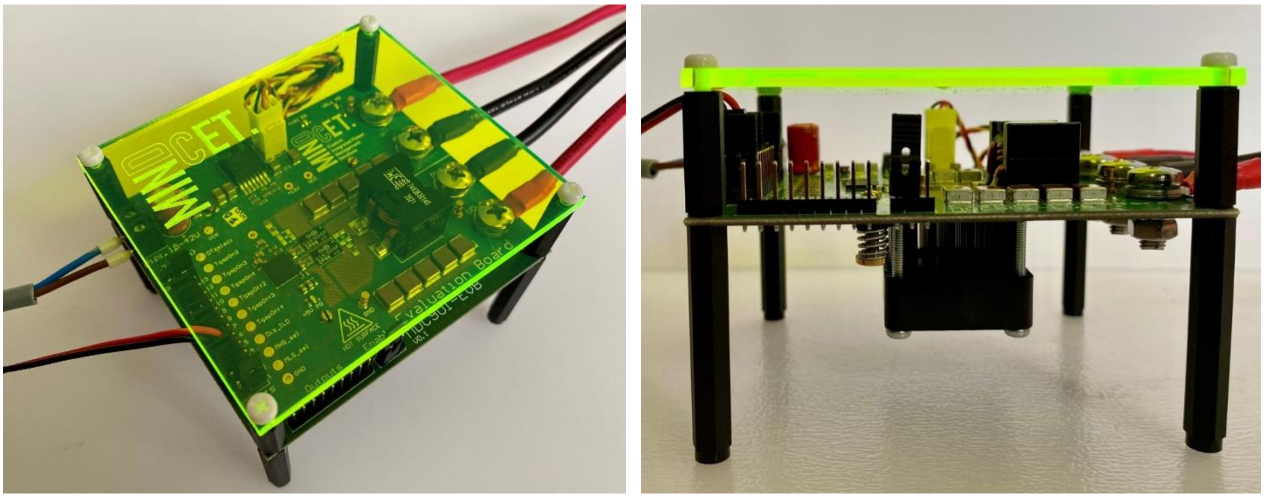


Figure 12: (left) Fully assembled EVB, ready for testing with a side view demonstrating the heat sink and plexiglass assembly (right).

***Caution**: Do not touch the power cables and maintain distance to the EVB during operation to maintain the proper tabletop position of the board, as demonstrated in Figure 12.*

8. Setup the external equipment
    a. Power supply **Vbus at 0V**
    b. Power supply Vin at a voltage between 16V and 36V (24V recommended)
    c. Initialize electronic load at 0A or connect fixed load
    d. PWM generator (e.g. arbitrary waveform generator (AWG)) square wave with peak-to-peak Vpp= 5V (0V to 5V, high impedance)

Essential Rules for Operation

- Prepare your measurements by checking the graphs and calculating the expected values (see section *EVB Operation Conditions*).
- Never leave the setup unattended
- Never disable the external PWM while Vbus is high (can lead to shorting event of the half bridge)
- **Immediately switch off Vbus when safety limits are exceeded**
- Measuring the temperature of the chip and board is a highly recommended safety feature
- Altering duty cycle during operation is NOT RECOMMENDED due to possible spikes or delays (e.g. when software controlled) that can lead to a short circuit event of the HS/LS HEMTs
- The Vbus input voltage should not exceed 75V

Powering Up: General-Sequence

1. Check if the desired setpoint is within the limits of temperature, current and voltage, most importantly for the expected power loss. See *EVB Operation Conditions*.
    a. Heatsink installed + FAN ON (forced cooling) → ***Ploss*= 5W max**
    b. Heatsink installed + FAN OFF (natural convection) → ***Ploss*= 2W max**
2. Ensure all preparations (previous section) were properly completed.
3. Verify the LED status
    a. PG 5V: ON
    b. PG 12V: ON
    c. PG Vbus: **OFF**
4. Setup the desired jumper combinations (refer to *Dead Time Control Conditions*)
    a. Dead-time: automatic or manual. In case of the latter, configure the dead-time settings appropriately and verify non-overlap with an oscilloscope.
    b. Switching mode: buck
    c. Enable pin to 5V
5. Set the PWM signal to the desired frequency and duty cycle. (if not regulated in closed loop)
6. Increase Vbus while monitoring Vout. (only continue when the output is as expected)
7. Increase the output load current while monitoring Vout.
8. Lower Vbus and Iout back to zero when finished

Power Down & Disconnect Procedure

1. Slowly power down Vbus voltage back to zero and turn off
2. Shut down the PWM function generator
3. Wait at least 2 minutes (with fan on) or 5 minutes (without fan assembly installed) after operation for EVB to fully de-energize and cool down
4. Shut down low voltage power supply
5. Disconnect coaxial cable
6. Disconnect the power cables from high voltage supply (with supply off)
7. Disconnect the input supply (Vin) from low voltage power supply (supply is off)
8. Disconnect cables from EVB as desired (EVB can fit into storage container with cables still attached)

Measurement Example: Buck Mode with Auto Dead time

1. Ensure all preparations (previous section) were properly completed.
2. Fan is connected and running
3. Verify the LED status
   a. PG 5V: ON
   b. PG 12V: ON
   c. PG Vbus: **OFF**
4. Setup jumpers in the default position, as described in Table 1 and shown in Figure 3
   a. Auto dead time: DT_SEL = GND
   b. Buck mode: MODE<0> = 5V
      MODE<1> = GND
5. Set the PWM frequency to 300kHz and duty cycle to 25%
6. Increase the voltage of Vbus to 48V
7. Verify whether the output voltage is 12V (Note, the expected voltage will be <12V due to losses)
8. Increase the load current up to 5A and measure Vbus, Ibus, Vout and Iout
   a. An efficiency of approximately > 95% is to be expected (Equation 5 to 8)
9. Power down Vbus to 0V and the load current Iout to 0A

Measurement Example: Buck Mode with Manual Dead time (12.2ns theoretical)

1. Setup jumpers like in Figure 9
   a. Manual dead time: DT_SEL = 5V
   b. Buck mode: MODE<0> = 5V
      MODE<1> = GND
   c. Dead-time setting: DTHL<0>& DTLH<0> = 5V
      DTHL<1:2> & DTLH<1:2> = GND
2. Fan connect
3. Set the PWM frequency to 300kHz and duty cycle to 25%
4. Increase the voltage of Vbus to 48V
5. Verify whether the output voltage is 12V (Note, the expected voltage will be <12V due to losses)
6. Increase the load current up to 5A and measure Vbus, Ibus, Vout and Iout
   a. An efficiency of > 96% (calculated based “Efficiency Calculation”) is to be expected
7. Power down Vbus to 0V and the load current Iout to 0A

Helpful Information

- The converter exemplifies the best performance in the 100kHz to 1MHz switching frequency range
- 0% or 100% duty cycle are non-switching situations of conversion
- Perform tests first without the heat sink/fan assembly as heat sink removal may damage the thermal adhesive
- Automatic dead-time is conservative and results in a higher power loss compared to a well-tuned manual dead time
- Manual dead time requires user verification by oscilloscope measurements
- Powering down Vbus with an active load current may de-energize quicker as the capacitors are drained

Performance Evaluation

EVB performance was evaluated in a step-down conversion of 48 to 12 V and 3.3V (respectively), sweeping over a switching frequency range from 200 to 400 kHz and an output current (Iout) from 0.5 A to 12.5 A, with the heatsink attached and fan turned on. A manual dead time of (theoretical) 12.2ns was used.

Efficiency

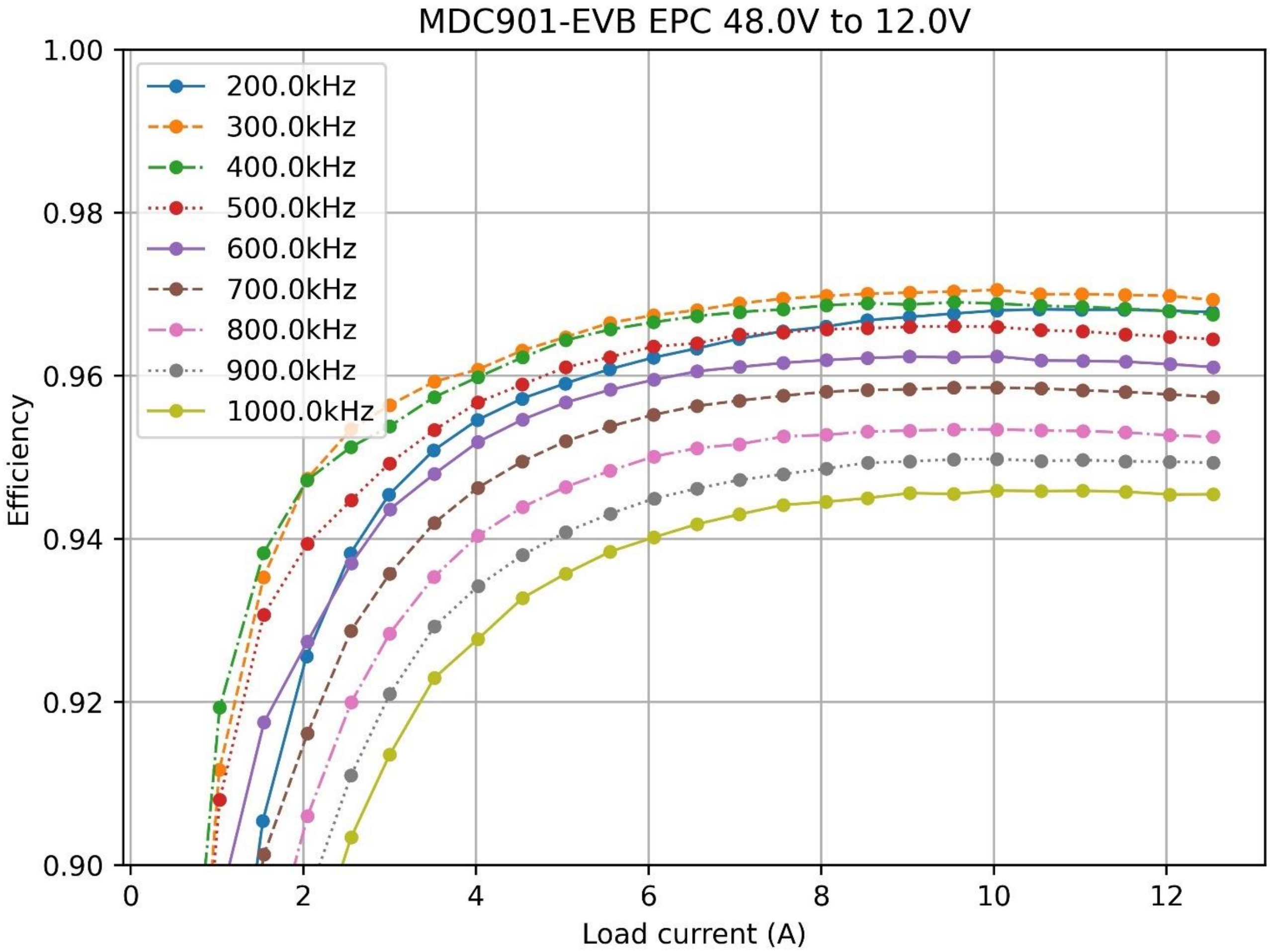


Figure 13: EVB efficiency plots of 48V to 12V conversion at varying switching frequencies up to 12.5A output current.

For 48V to 12V conversion (regulated 12V output via duty cycle adjustment), a stable efficiency exceeding 96% for switching frequencies of 200 to 400kHz was observed over the entire 5A to 12.5A output current range. Specifically, a peak efficiency of >97% was seen around 10 A current output.

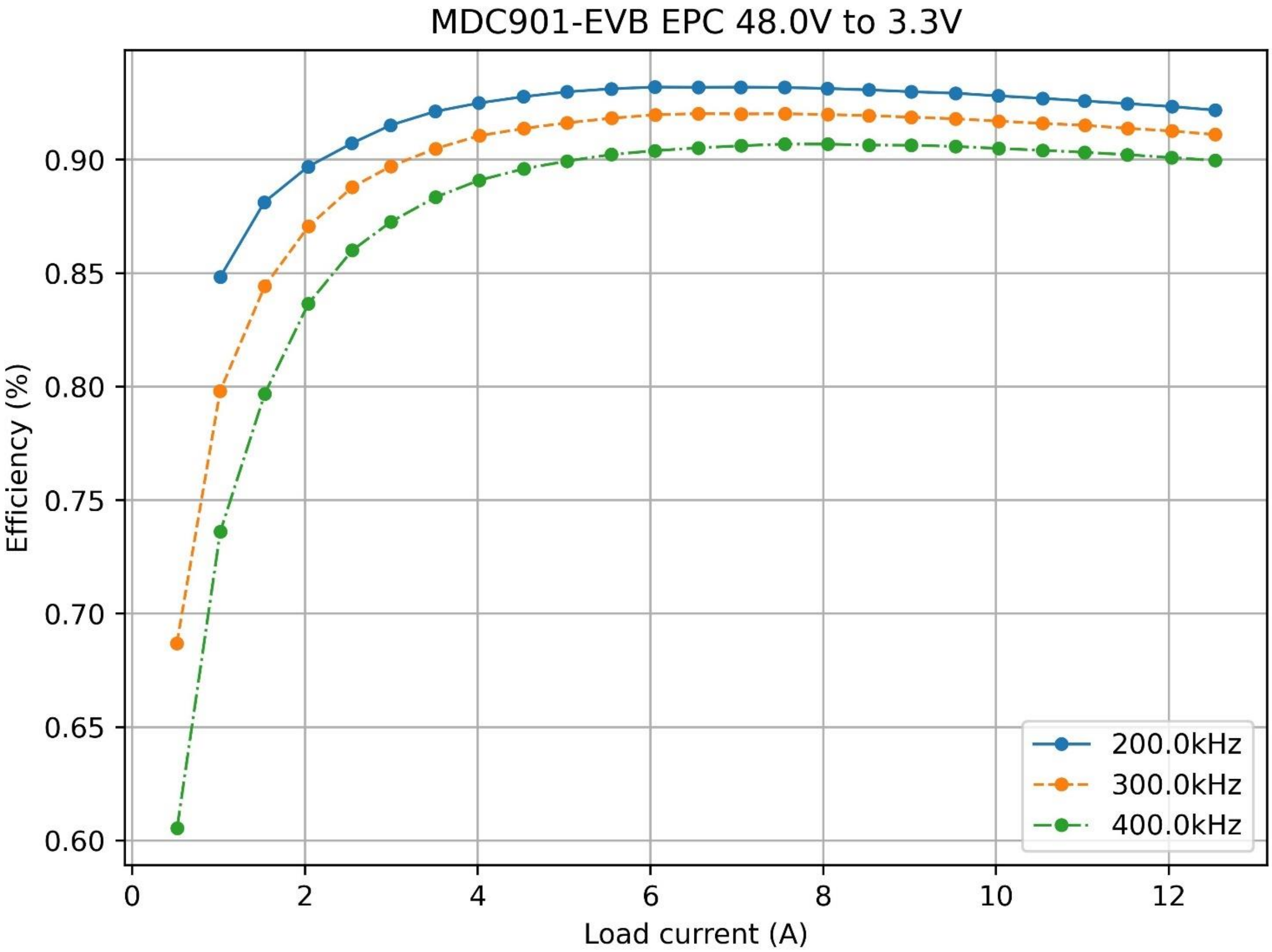


Figure 14: EVB efficiency plots of 48V to 3.3V conversion at varying switching frequencies up to 12.5A output current.

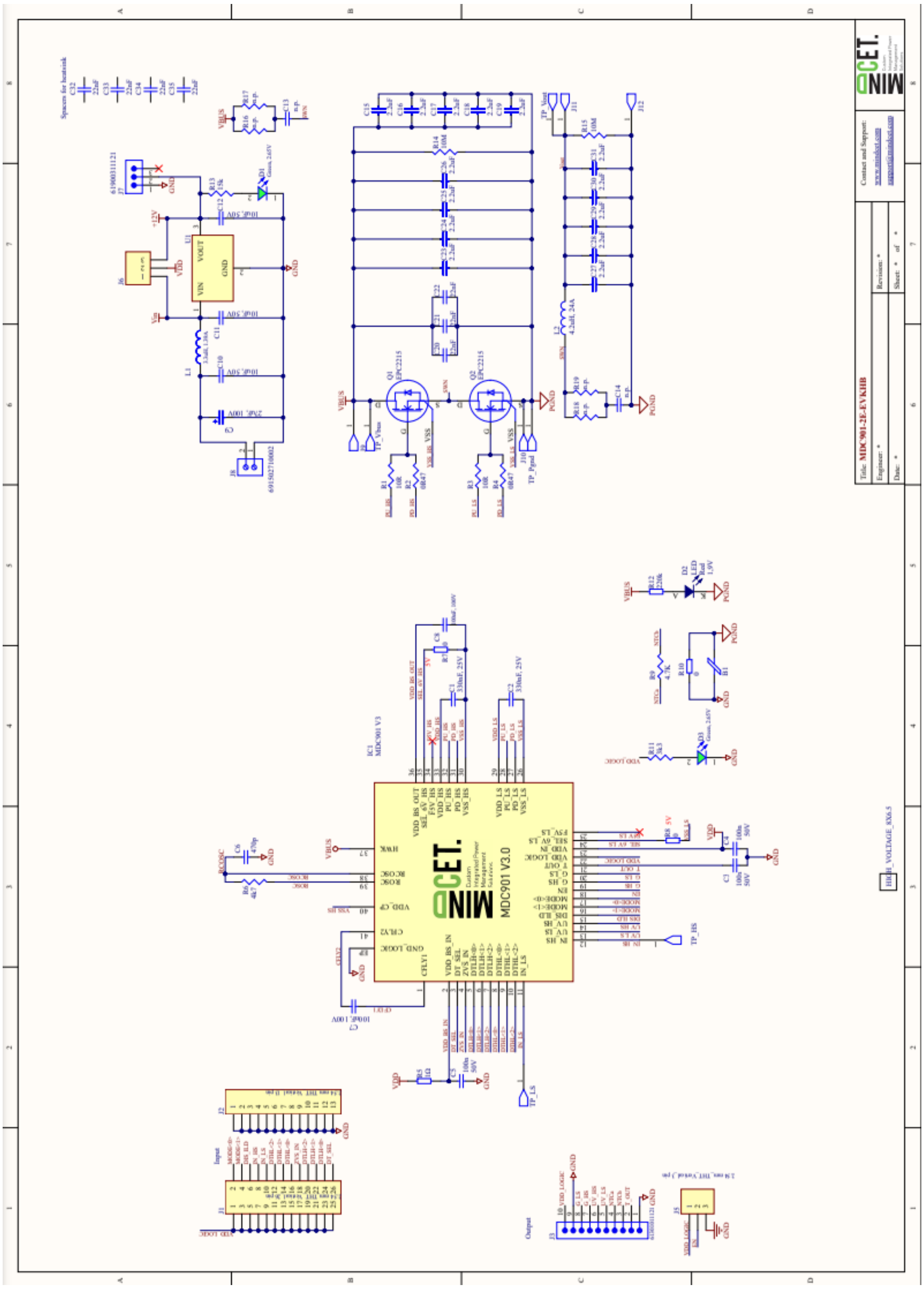
For 48V to 3.3V, a dependence of switching frequency on efficiency can be observed. Above 5A current output, approximately 1% in efficiency drop per 100kHz is observed. For the highest efficiency results of the 200kHz sweep, a maximum efficiency of 93% occurred at 6A.

Storage Conditions

The EVB is best stored in the original packaging under room temperature with dry conditions. After testing and proper de-energizing/cool-down time, the EVB can be placed in the large compartment of the foam insert (the EVB spacer studs align with the holes in the foam to better secure the EVB during storage and transportation). Normal ESD handling precautions, including for storage, apply.

Appendix

EVB Schematic



Bill of Materials

Available upon request, please contact support@mindcet.com

PCB Design / Gerber Files

For assistance in accelerating the design-in phase, the EVB layout files are available upon request. For the most recent version, please contact support@mindcet.com

Cautions and Warnings

The following conditions apply to all goods within the product series of MinDCet NV

General:
All recommendations according to the general technical usage and specifications of this guide have to be complied with.

The usage and operation of the product within ambient conditions which probably alloy or harm the component surface has to be avoided.

The responsibility for the applicability of customer specific products and use in a particular customer design is always within the authority of the customer. All technical specifications for standard products do also apply for customer specific products.

Residual washing varnish agent that is used during the production to clean the application might change the characteristics of the body, pins or termination. The washing varnish agent could have a negative effect on the long-term function of the product.
Direct mechanical impact to the product shall be prevented as the material of the body, pins or termination could flake or in the worst case it could break. As these devices are sensitive to electrostatic discharge customer shall follow proper IC Handling Procedures.

Customer acknowledges and agrees that it is solely responsible for compliance with all legal, regulatory and safety-related requirements concerning its products, and any use of MinDCet NV components in its applications, notwithstanding any applications-related information or support that may be provided by MinDCet NV. Customer represents and agrees that it has all the necessary expertise to create and implement safeguards which anticipate dangerous consequences of failures, monitor failures and their consequences lessen the likelihood of failures that might cause harm and take appropriate remedial actions. Customer will fully indemnify MinDCet NV and its representatives against any damages arising out of the use of any MinDCet NV components in safety-critical applications.

Product specific:
Follow all instructions mentioned in the MDC901 datasheet and this technical manual, especially:
- All products are supposed to be used before the end of the period of 12 months based on the product date-code.
- Violation of the technical product specifications such as exceeding the absolute maximum ratings will void the warranty. It is also recommended to return the body to the original packaging (ESD bag) and reseal the package.
- ESD prevention methods need to be followed for manual handling and processing by machinery.

Important Notice

The Technical Manual is based on our knowledge and experience of typical requirements concerning these areas. It serves as general guidance and should not be construed as a commitment for the suitability for customer applications by MinDCet NV (hereafter referred to as MDC). The information in the Application Note is subject to change without notice. This document and parts thereof must not be reproduced or copied without written permission, and contents thereof must not be imparted to a third party nor be used for any unauthorized purpose. MinDCet NV and are not liable for application assistance of any kind. Customers may use MDC's assistance and product recommendations for their applications and design. The responsibility for the applicability and use of MDC Products in a particular customer design is always solely within the authority of the customer. Due to this fact it is up to the customer to evaluate and investigate, where appropriate, and decide whether the device with the specific product characteristics described in the product specification is valid and suitable for the respective customer application or not. The technical specifications are stated in the current datasheet of the products. Therefore the customers shall use the datasheets and are cautioned to verify that datasheets are current. The current data sheets can be downloaded at www.mindcet.com. Customers shall strictly observe any product-specific notes, cautions and warnings. MDC reserves the right to make corrections, modifications, enhancements, improvements, and other changes to its products and services. MDC DOES NOT WARRANT OR REPRESENT THAT ANY LICENSE, EITHER EXPRESS OR IMPLIED, IS GRANTED UNDER ANY PATENT RIGHT, COPYRIGHT, MASK WORK RIGHT, OR OTHER INTELLECTUAL PROPERTY RIGHT RELATING TO ANY COMBINATION, MACHINE, OR PROCESS IN WHICH MDC PRODUCTS OR SERVICES ARE USED. INFORMATION PUBLISHED BY MDC REGARDING THIRD-PARTY PRODUCTS OR SERVICES DOES NOT CONSTITUTE A LICENSE FROM MDC TO USE SUCH PRODUCTS OR SERVICES OR A WARRANTY OR ENDORSEMENT THEREOF. MDC products are not authorized for use in safety-critical applications, or where a failure of the product is reasonably expected to cause severe personal injury or death. Moreover, MDC products are neither designed nor intended for use in areas such as military, aerospace, aviation, nuclear control, submarine, transportation (automotive control, train control, ship control), transportation signal, disaster prevention, medical, public information network etc. Customers shall inform MDC about the intent of such usage before design-in stage. In certain customer applications requiring a very high level of safety and in which the malfunction or failure of an electronic component could endanger human life or health, customers must ensure that they have all necessary expertise in the safety and regulatory ramifications of their applications. Customers acknowledge and agree that they are solely responsible for all legal, regulatory and safety-related requirements concerning their products and any use of MDC products in such safety-critical applications, notwithstanding any applications-related information or support that may be provided by MDC. CUSTOMERS SHALL INDEMNIFY MDC AGAINST ANY DAMAGES ARISING OUT OF THE USE OF MDC PRODUCTS IN SUCH SAFETY-CRITICAL APPLICATIONS.

The following conditions apply to all goods within the product range of MinDCet NV:

1. General Customer Responsibility

Some goods within the product range of MinDCet NV contain statements regarding general suitability for certain application areas. These statements about suitability are based on our knowledge and experience of typical requirements concerning the areas, serve as general guidance and cannot be estimated as binding statements about the suitability for a customer application. The responsibility for the applicability and use in a particular customer design is always solely within the authority of the customer. Due to this fact it is up to the customer to evaluate, where appropriate to investigate and decide whether the device with the specific product characteristics described in the product specification is valid and suitable for the respective customer application or not. Accordingly, the customer is cautioned to verify that the datasheet is current before placing orders.

2. Customer Responsibility related to Specific, in particular Safety-Relevant Applications

It has to be clearly pointed out that the possibility of a malfunction of electronic components or failure before the end of the usual lifetime cannot be completely eliminated in the current state of the art, even if the products are operated within the range of the specifications. In certain customer applications requiring a very high level of safety and especially in customer applications in which the malfunction or failure of an electronic component could endanger human life or health it must be ensured by most advanced technological aid of suitable design of the customer application that no injury or damage is caused to third parties in the event of malfunction or failure of an electronic component.

3. Best Care and Attention
Any product-specific notes, warnings and cautions must be strictly observed.

4. Customer Support for Product Specifications
Some products within the product range may contain substances which are subject to restrictions in certain jurisdictions in order to serve specific technical requirements. Necessary information is available on request. In this case the field sales engineer or the internal sales person in charge should be contacted who will be happy to support in this matter.

5. Product R&D
Due to constant product improvement product specifications may change from time to time. As a standard reporting procedure of the Product Change Notification (PCN) according to the JEDEC-Standard we inform about minor and major changes. In case of further queries regarding the PCN, the field sales engineer or the internal sales person in charge should be contacted. The basic responsibility of the customer as per Section 1 and 2 remains unaffected.

6. Product Life Cycle
Due to technical progress and economical evaluation we also reserve the right to discontinue production and delivery of products. As a standard reporting procedure of the Product Termination Notification (PTN) according to the JEDEC-Standard we will inform at an early stage about inevitable product discontinuance. According to this we cannot guarantee that all products within our product range will always be available. Therefore it needs to be verified with the field sales engineer or the internal sales person in charge about the current product availability expectancy before or when the product for application design-in disposal is considered. The approach named above does not apply in the case of individual agreements deviating from the foregoing for customer-specific products.

7. Property Rights
All the rights for contractual products produced by MinDCet NV on the basis of ideas, development contracts as well as models or templates that are subject to copyright, patent or commercial protection supplied to the customer will remain with MinDCet NV. MinDCet NV does not warrant or represent that any license, either expressed or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right relating to any combination, application, or process in which MinDCet NV components or services are used.

8. General Terms and Conditions
Unless otherwise agreed in individual contracts, all orders are subject to the current version of the "General Terms and Conditions of MinDCet NV", last version available at www.mindcet.com.

Contact Information

For product questions and technical assistance, please contact support@mindcet.com

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