



Magnetic tests on GaNs

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Meeting with Efficient Power Conversion (EPC), Thursday, 29 May 2014, at INFN Milan (Aula multifunzionale)



Summary



- Demo board description
- Experimental setup
- Experimental results
- Conclusions



Introduction

- We are interested in test GaN under Magnetic Field
- EPC9101 Rev 1.0 DEMOBOARD from EPC has been tested

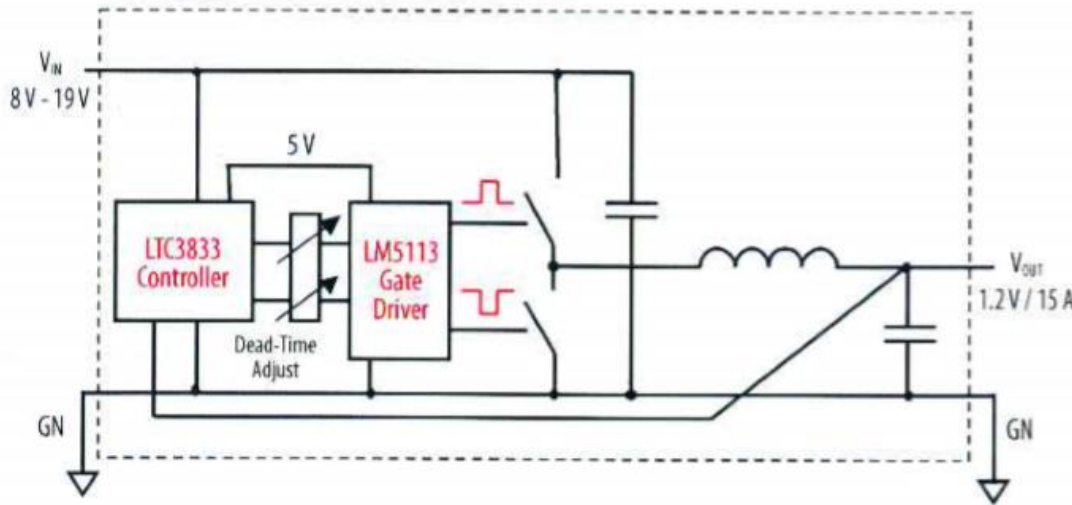
Description

The **EPC9101** demonstration board is a 1.2 V output, 1 MHz buck converter with an 20 A maximum output current and 8 V to 24 V input voltage range.

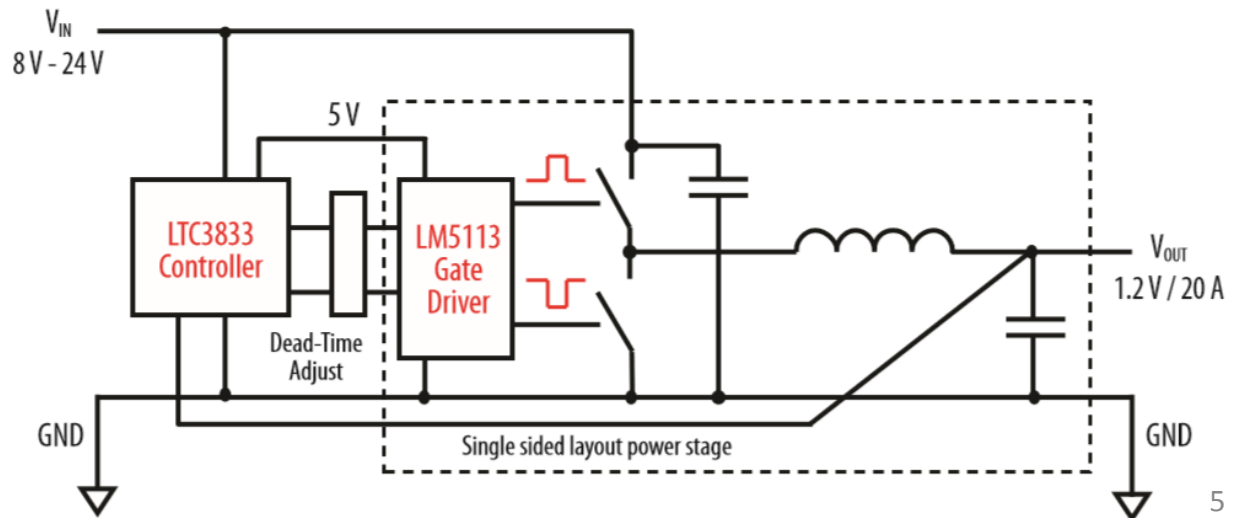
The demonstration board features the **EPC2014** and **EPC2015** enhancement mode (eGaN[®]) field effect transistors (FETs), as well as the first eGaN FET specific integrated circuit driver – the Texas Instruments **LM5113**.



Block Diagram of EPC9101 Demonstration Board

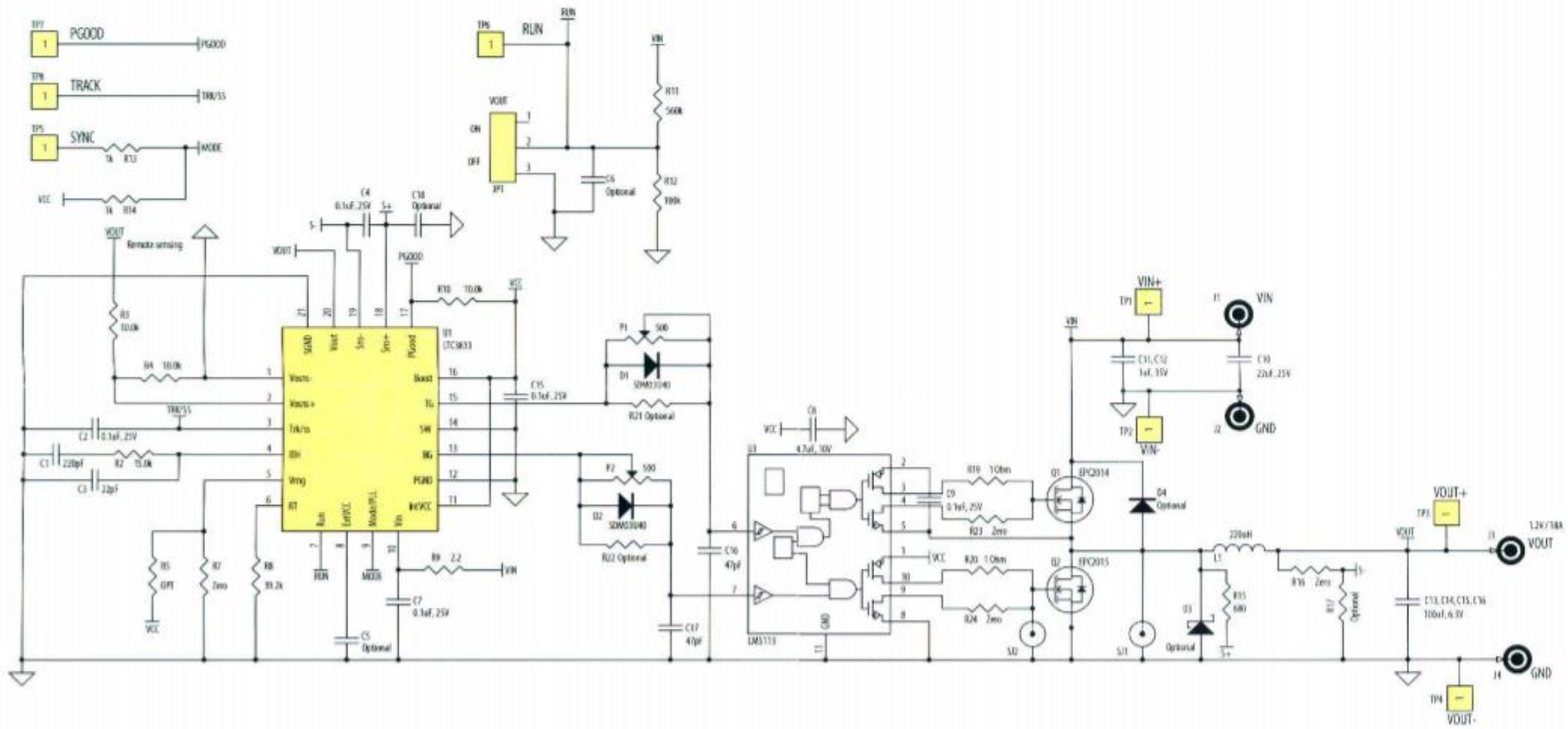


Rev 2.0



EPC9101

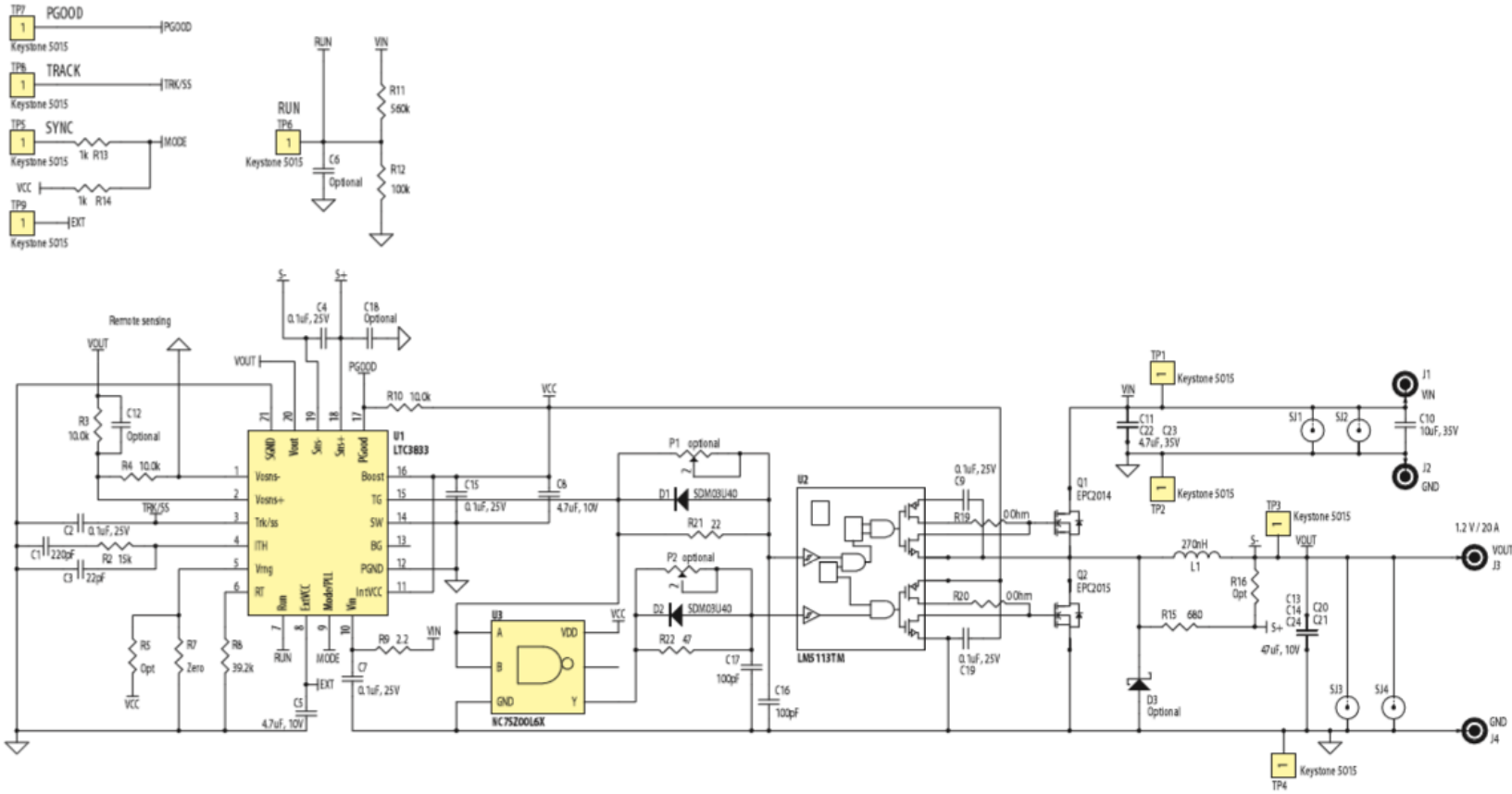
Schematic circuit – Rev. 1.0





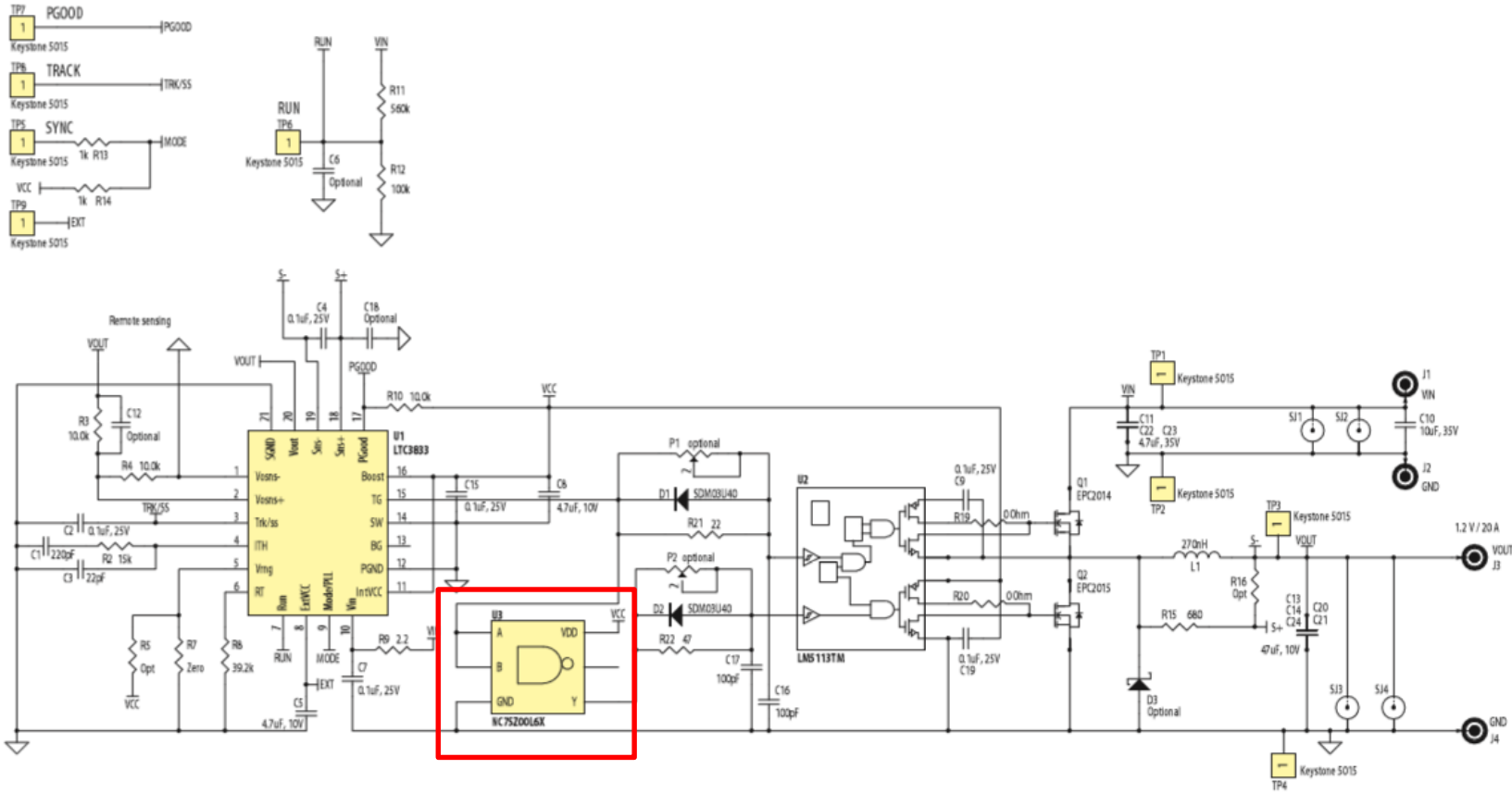
EPC9101

Schematic circuit – Rev. 2.0



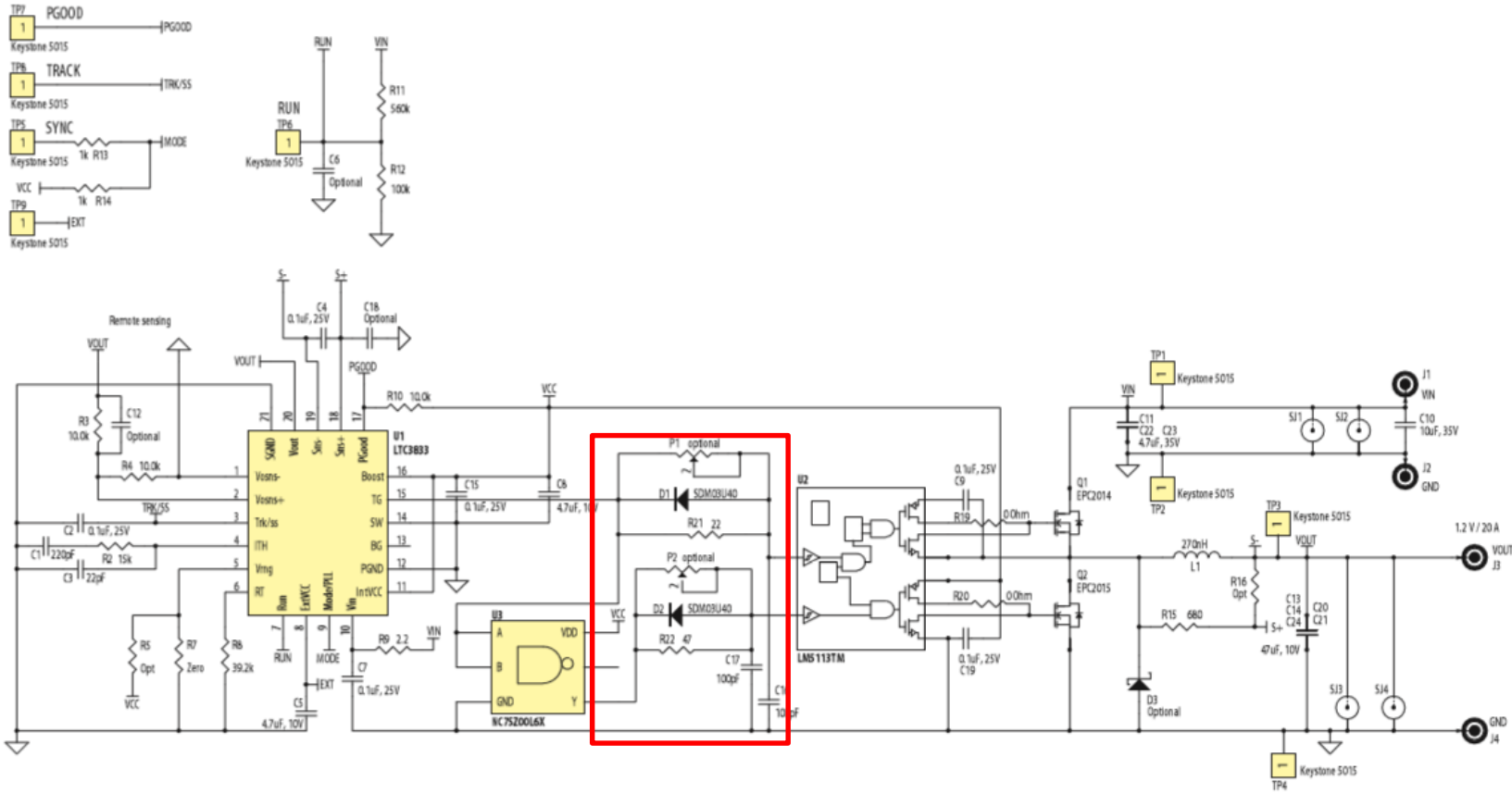
EPC9101

Schematic circuit – Rev. 2.0



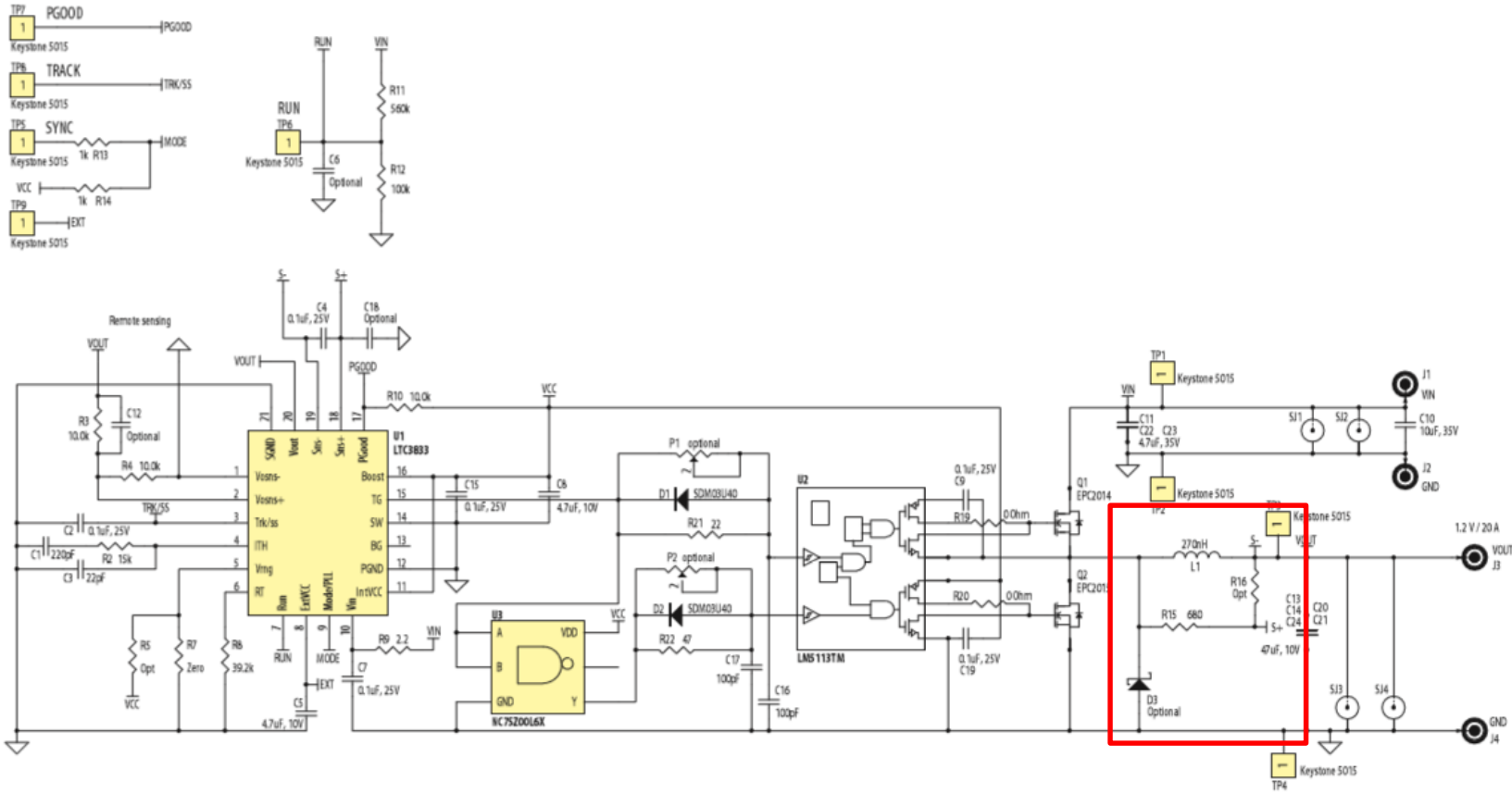
EPC9101

Schematic circuit – Rev. 2.0



EPC9101

Schematic circuit – Rev. 2.0



Performance Summary

($T_A = 25^\circ\text{C}$)

Rev 1.0

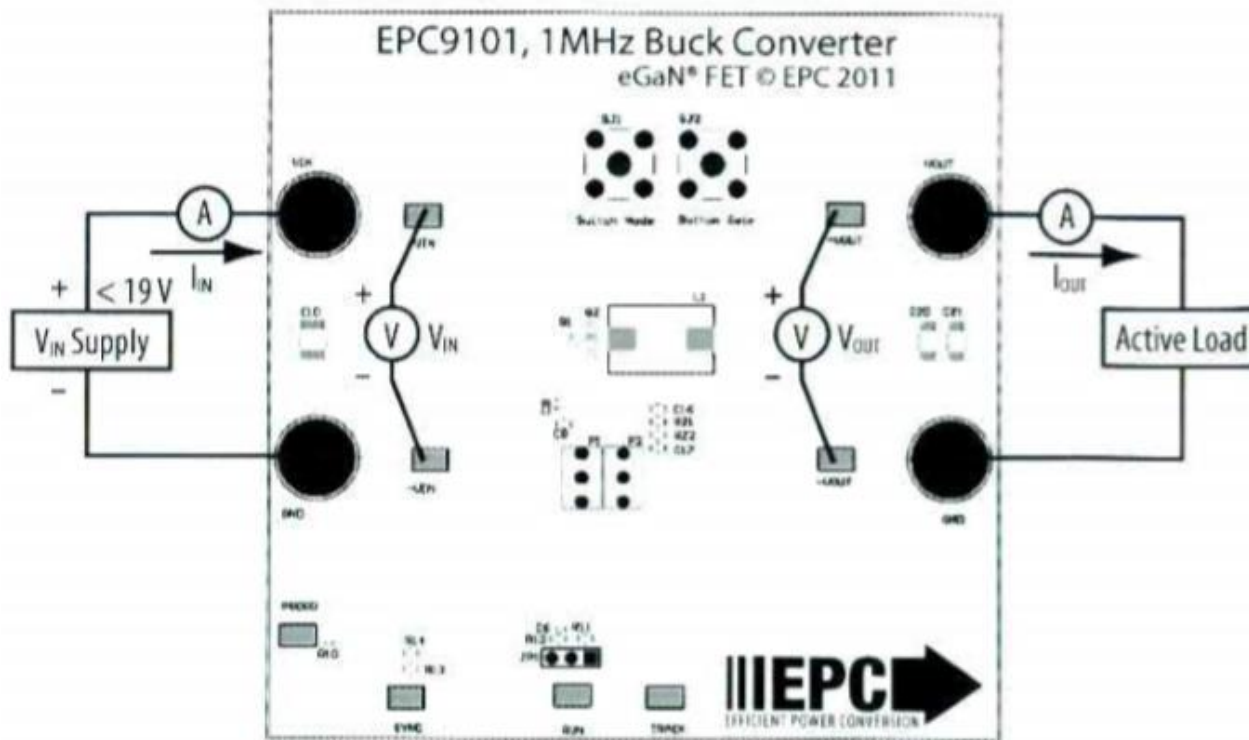
Table 1: Performance Summary ($T_A = 25^\circ\text{C}$)

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
V_{IN}	Bus Input Voltage Range		8		19	V
V_{OUT}	Switch Node Output Voltage			1.2		V
I_{OUT}	Switch Node Output Current				18*	A
f_{SW}	Switching frequency			1000		kHz
	Peak Efficiency	$12 V_{IN}, I_{OUT} = 9 \text{ A}$		88		%
	Full Load Efficiency	$12 V_{IN}, I_{OUT} = 18 \text{ A}$		85		%
	Full Load Efficiency	$19 V_{IN}, I_{OUT} = 17 \text{ A}$		84		%

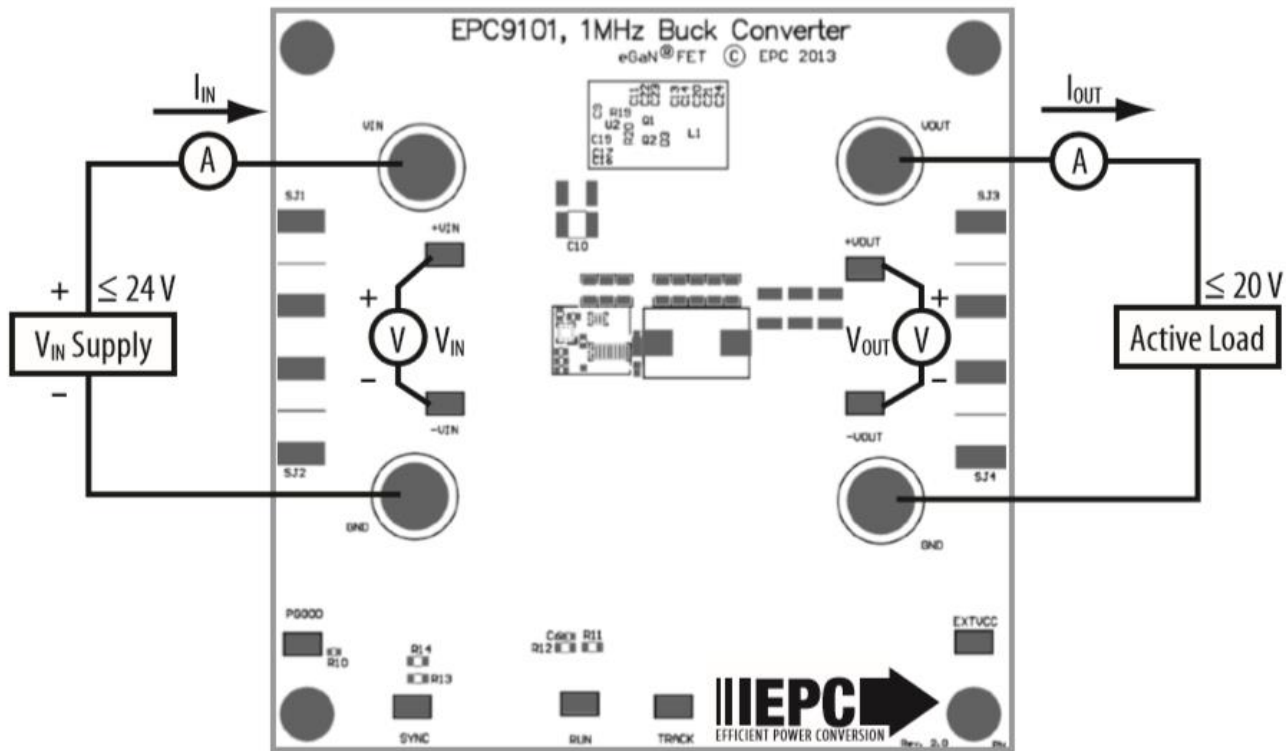
Rev 2.0

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
V_{IN}	Bus Input Voltage Range		8		24	V
V_{OUT}	Switch Node Output Voltage			1.2		V
I_{OUT}	Switch Node Output Current				20*	A
f_{SW}	Switching frequency			1000		kHz
	Peak Efficiency	$12 V_{IN} = 10 \text{ A } I_{OUT}$		89.5		%
	Full Load Efficiency	$12 V_{IN} = 20 \text{ A } I_{OUT}$		86.4		%
	Full Load Efficiency	$24 V_{IN} = 20 \text{ A } I_{OUT}$		83.3		%

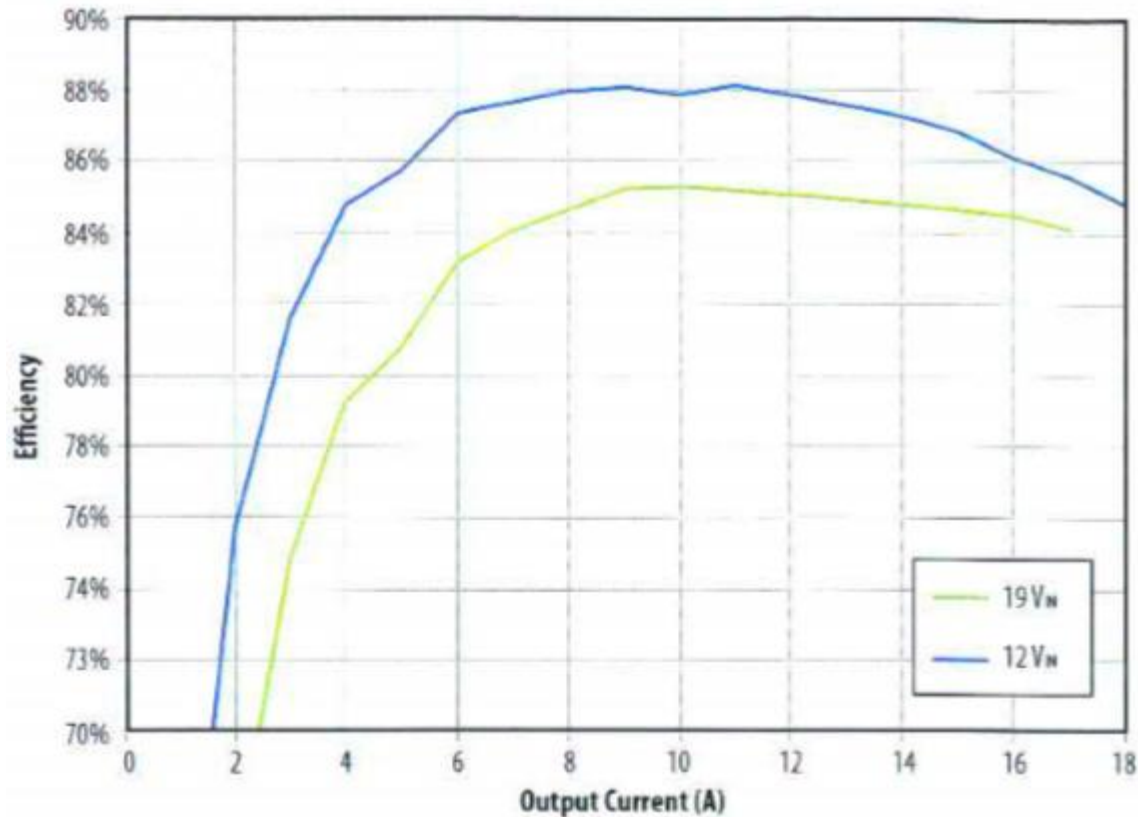
Measurement Setup (Rev 1.0)



Measurement Setup (Rev 2.0)



Typical efficiency curves (including controller and LDO losses)



Lasa

Tests carried out by:

Agostino Lanza
Stefano Latorre
Massimo Lazzaroni

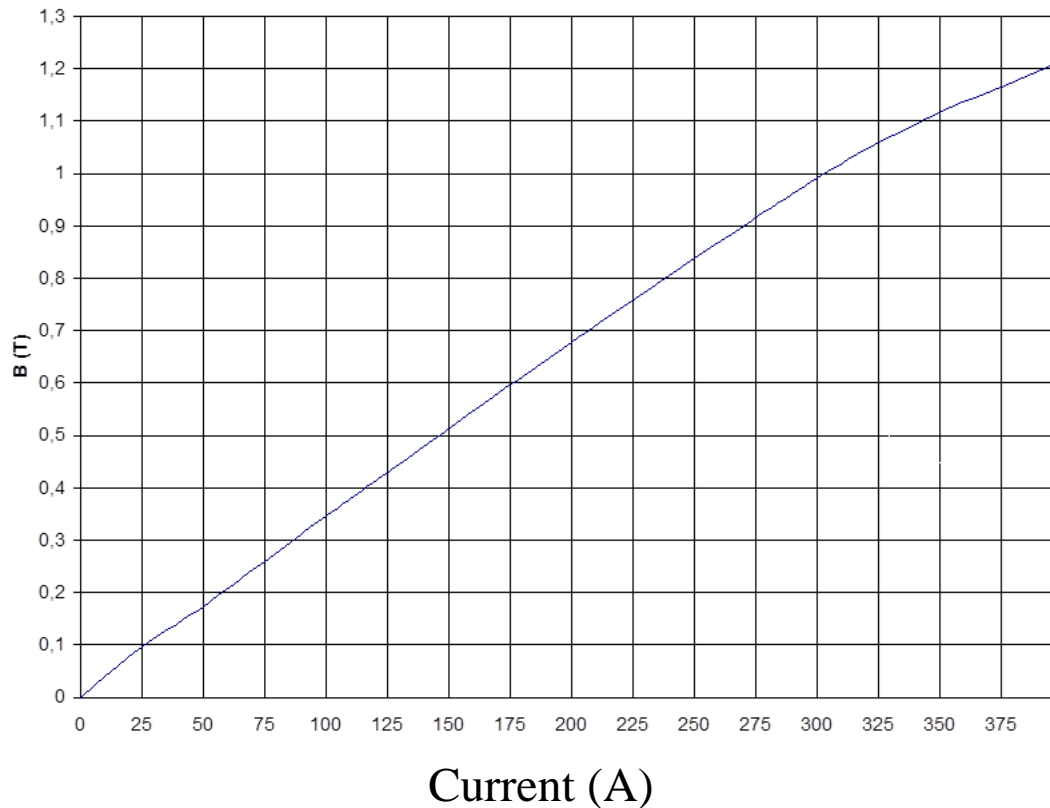


The test has been planned and realized at the LASA, which is a center for research and development in the fields of accelerators and superconductivity of the University of Milan and the Istituto Nazionale di Fisica Nucleare (INFN), devoted to the study and development of technologies for the design, the implementation and the test of particle accelerators.

Experimental Setup



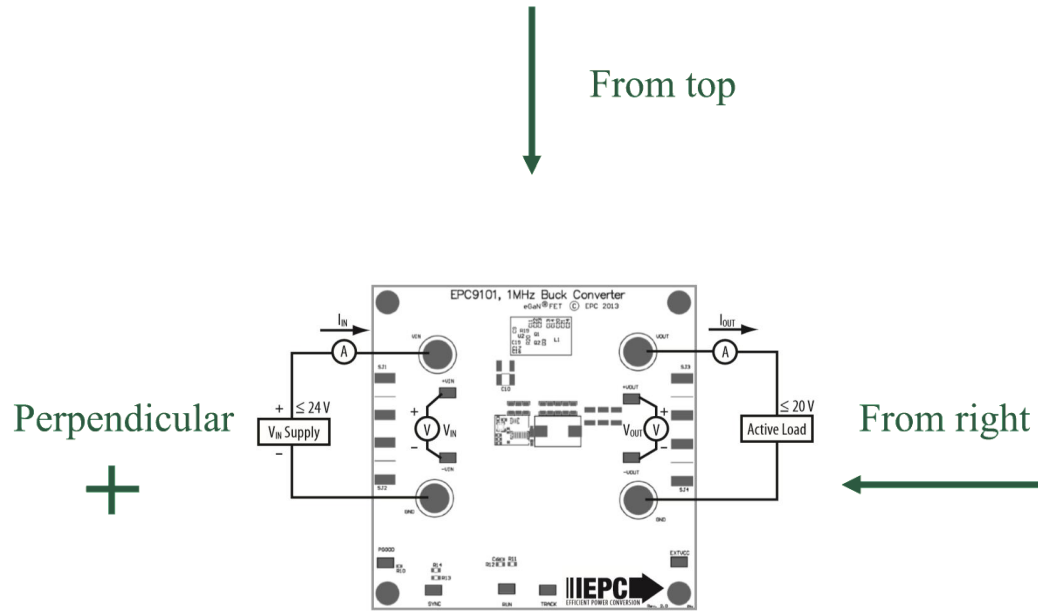
Specifications



The system used for B-Field generation presents a characteristic curve show in the figure where it is clear that it is possible to perform test up to 1 T of B-field.

- The utilized instrumentation and equipment have been turned in advance in order to exclude the presence of significant thermal drift.
- All the necessary steps for zeroing the instrument used in the measurement of the magnetic field has been applied.

Magnetic field directions



Test conditions

I input (A)		0,452
V input (V)		12,000
P input (W)		5,424
V output (V)		1,199
Load (Ω)		0,3
I output (A)		3,885
P output (W)		4,658
Efficiency		85,8 %

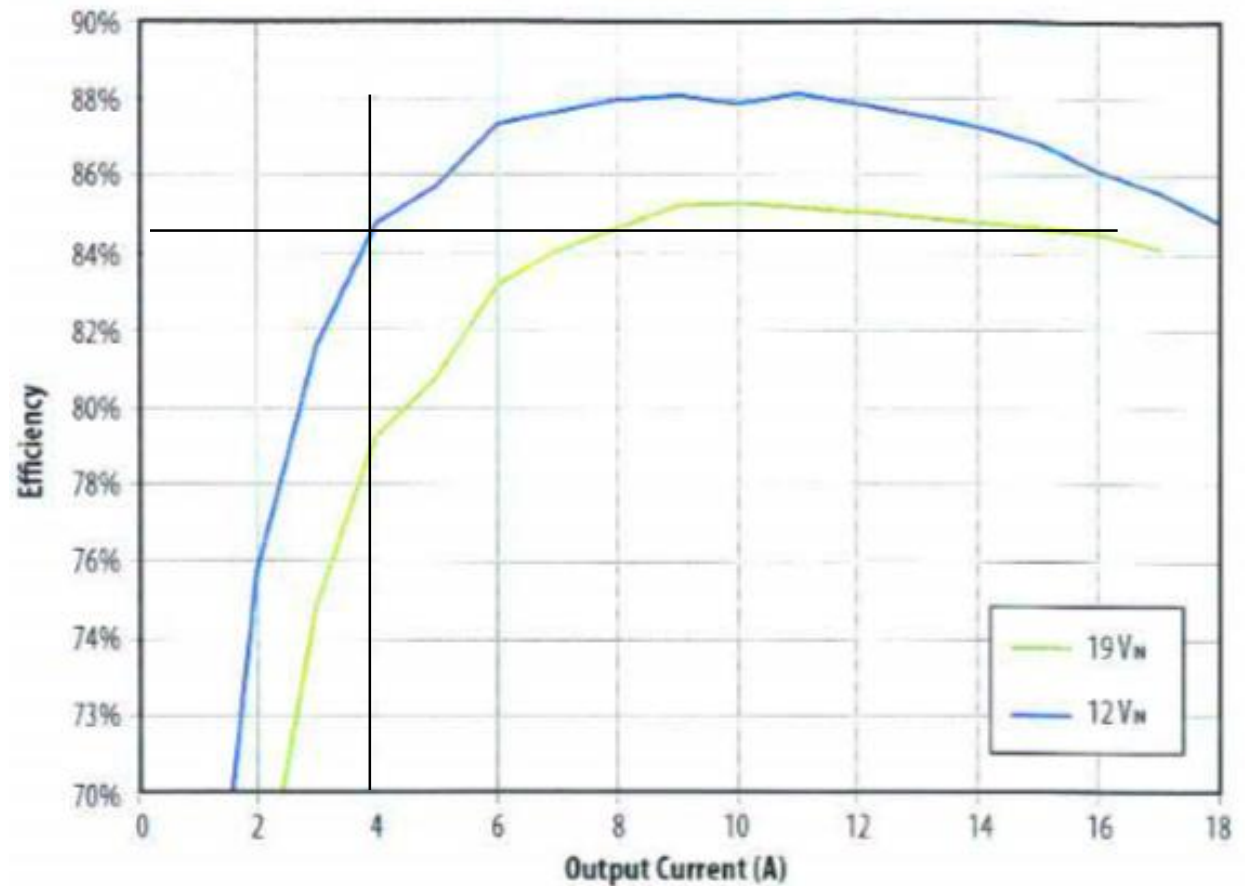
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Set point

Efficiency experimentally evaluated = 85.8 %

(uncertainty of the measuring instrument has not been considered)

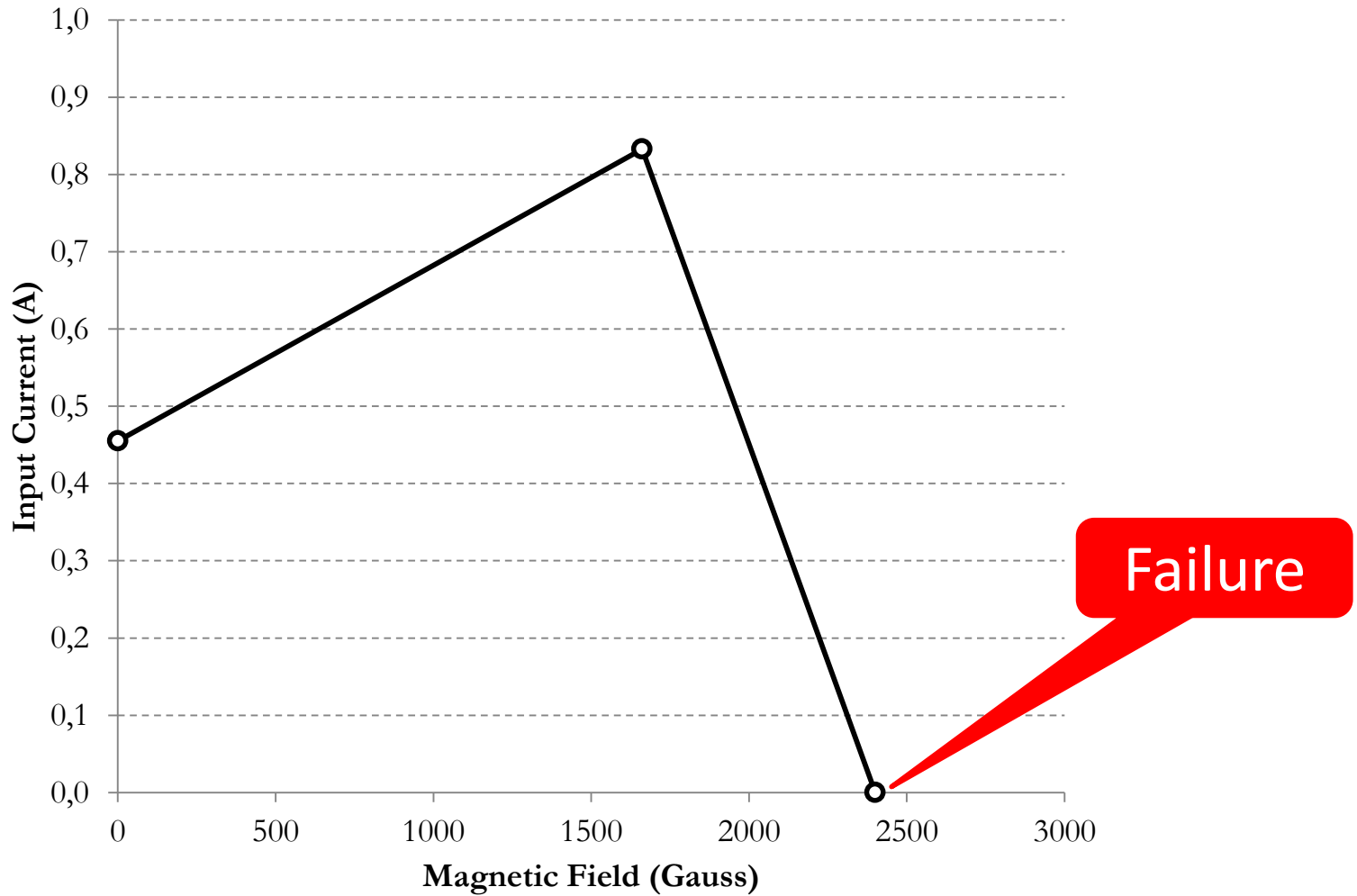


Experimental results (Perpendicular)

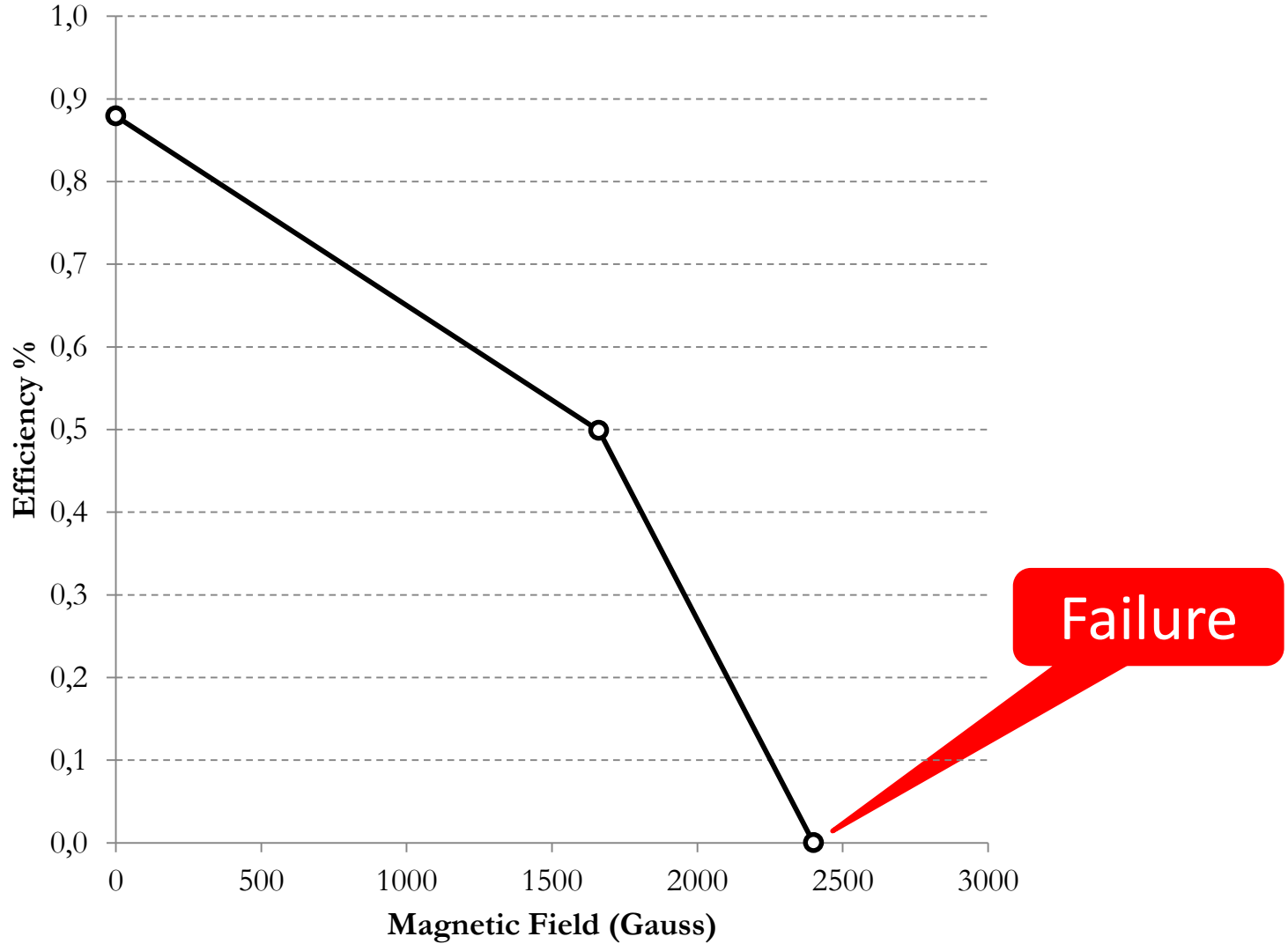


Id	MF(Gauss)	Vin (V)	I input (A)	V output (V)	Ripple (V pp)	Efficiency [0 - 1]
1	0	12,000	0,452	1,199	0,06	0,858
2	1661,5	12,000	0,833	1,223	0,3	0,499
3	2400	12,000	failure			
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						

Input Current



Efficiency



Conclusions

- A failure of the demo-board under test has been detected at about 0.24 T.
- During operation in magnetic field a substantial increase of the ripple (up to values not eligible) has been measured.
- Failure mode has not been investigated.
- Demo board with different type of GaN EPC2015 (*i.e.* EPC9107) can be also tested.



Thank you

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