

# 2 kW ZVS Phase Shift Full Bridge Demo Board

EVAL\_2KW\_ZVS\_FB\_CFD2

[Mente Rene](#)

[Di Domenico Francesco](#)

[Zechner Florian](#)



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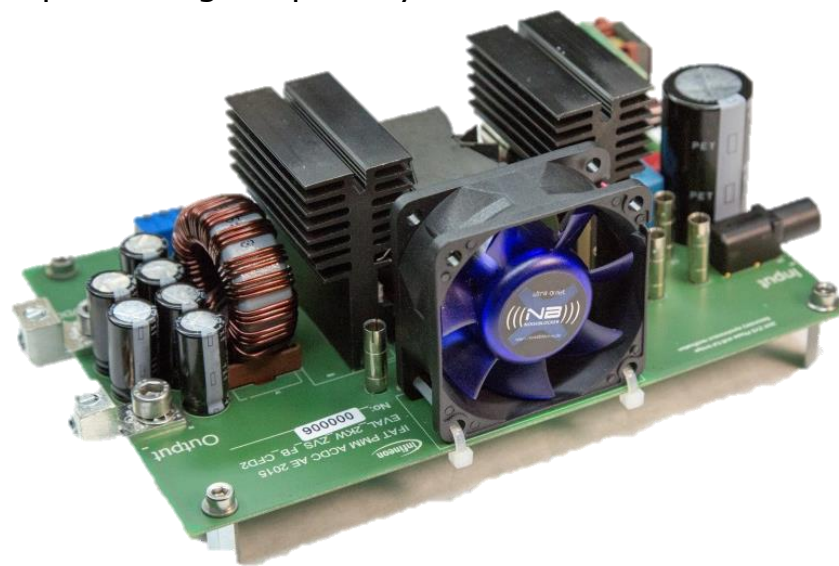
# General

## Description:

The "**EVAL\_2KW\_ZVS\_FB\_CFD2**" ZVS Phase Shift Full Bridge Evaluation Board (CoolMOS™ CFD2 [IPW65R080CFD](#)) represents the new developed ZVS DC-DC converter for Telecom Rectifiers with an output voltage from 45 V<sub>DC</sub> to 56 V<sub>DC</sub> and an output power of 2 kW. This converter works with an input voltage between 350 V<sub>DC</sub> and 420 V<sub>DC</sub> (typical 385 V<sub>DC</sub>) and a switching frequency of 100 kHz on the primary side. External resonant inductance and dead setting optimized for CoolMOS™ 650 V 80 mΩ CFD2 technology ([IPW65R080CFD](#)) Secondary synchronous rectification 200 V 12mΩ OptiMOS™ 5 200 V technology with fast body diode ([IPP110N20N3 G](#)) Infineon [2EDN7524F](#) dual channel 5 A, high-speed, low-side Gate Driver with high negative input voltage capability.

## Summary of Features:

- › Input Voltage: 350-420 V<sub>DC</sub>
- › Output Voltage: 45 up to 56 V<sub>DC</sub>
- › Output Power: up to 2 kW
- › Peak Efficiency: 96.6%\*



## The following variants are available:

- › 2 KW ZVS FB version with CoolMOS™ CFD2, [IPW65R080CFD](#) , **EVAL\_2KW\_ZVS\_FB\_CFD2**

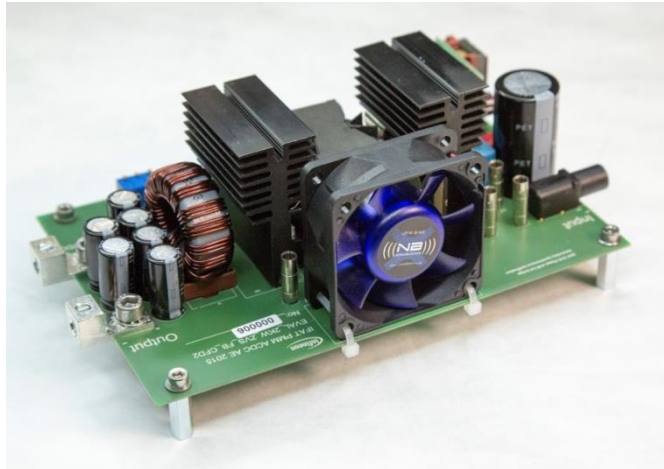
\*efficiency at golden sample

# Example of system understanding: Infineon demo solution for titanium HV DC-DC stage



Half bridge LLC with synchronous rectification in center tap configuration

$V_{in}$	300 V-420 V
$V_{out}$	45 V-56 V
$P_o$	2000 W
$f_{prim}$	100 kHz
$f_{sec}$	200 kHz



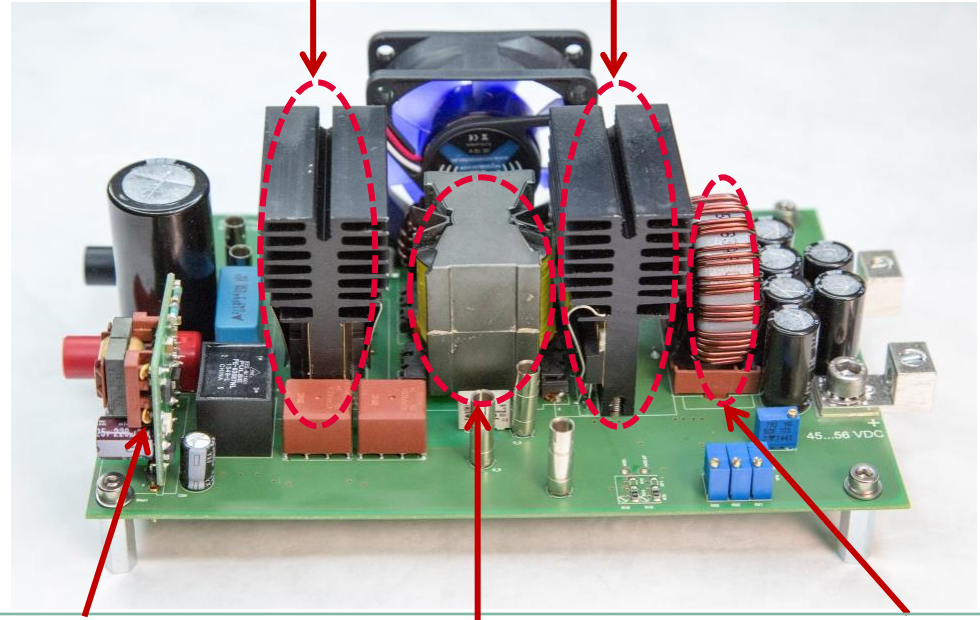
**FB HV MOSFETs**  
CoolMOS™ IPW65R080CFD2

**SR MOSFETs**  
OptiMOS™ IPP110N20N3

**SR MOSFETs**  
IPW65R080CFD2

**SR MOSFETs**  
IPP110N20N3

**Non isolated LS Gate Drive**  
2EDN7524F

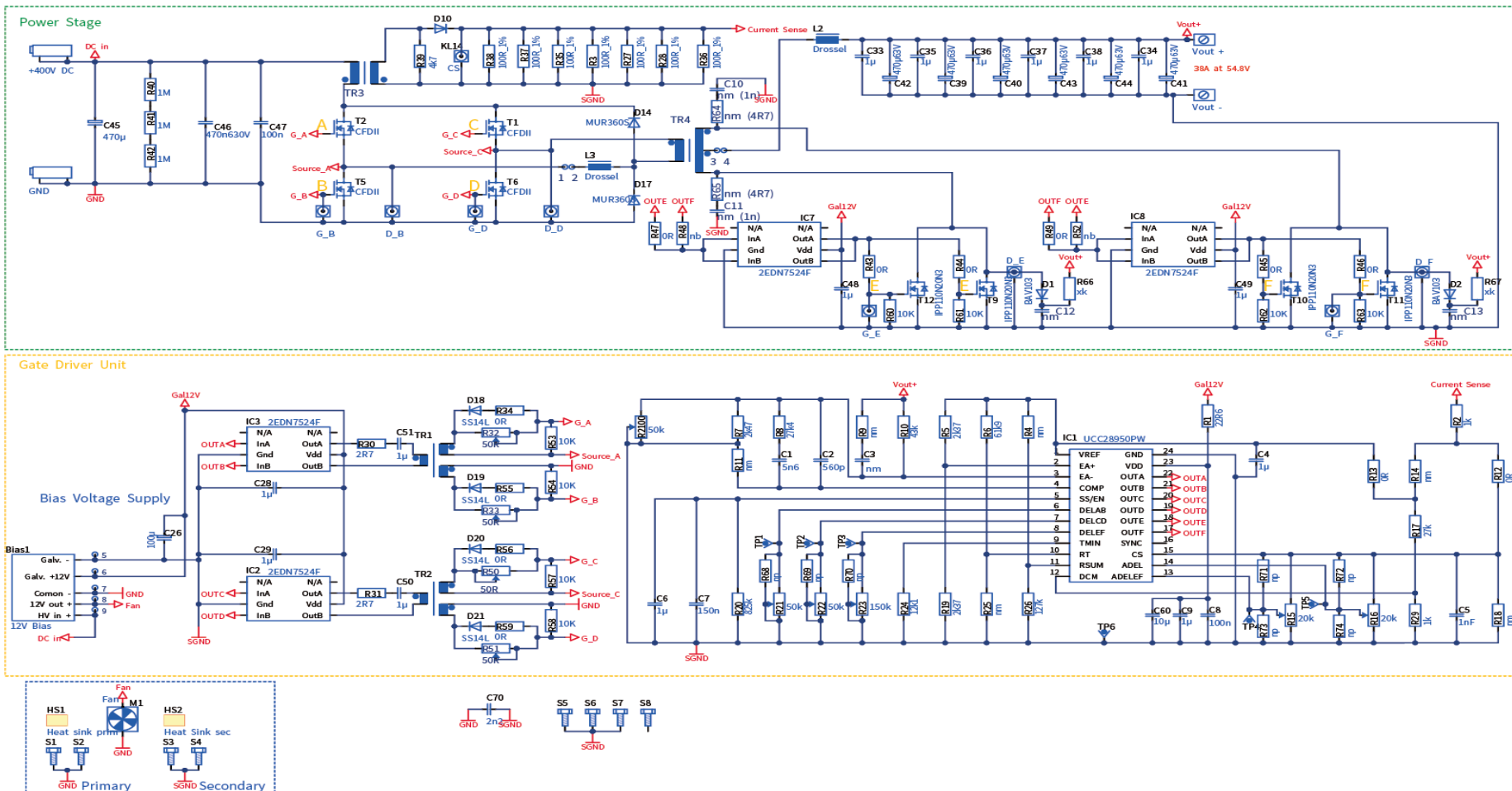


**Bias QR Flyback controller**  
ICE3RBR4765JZ

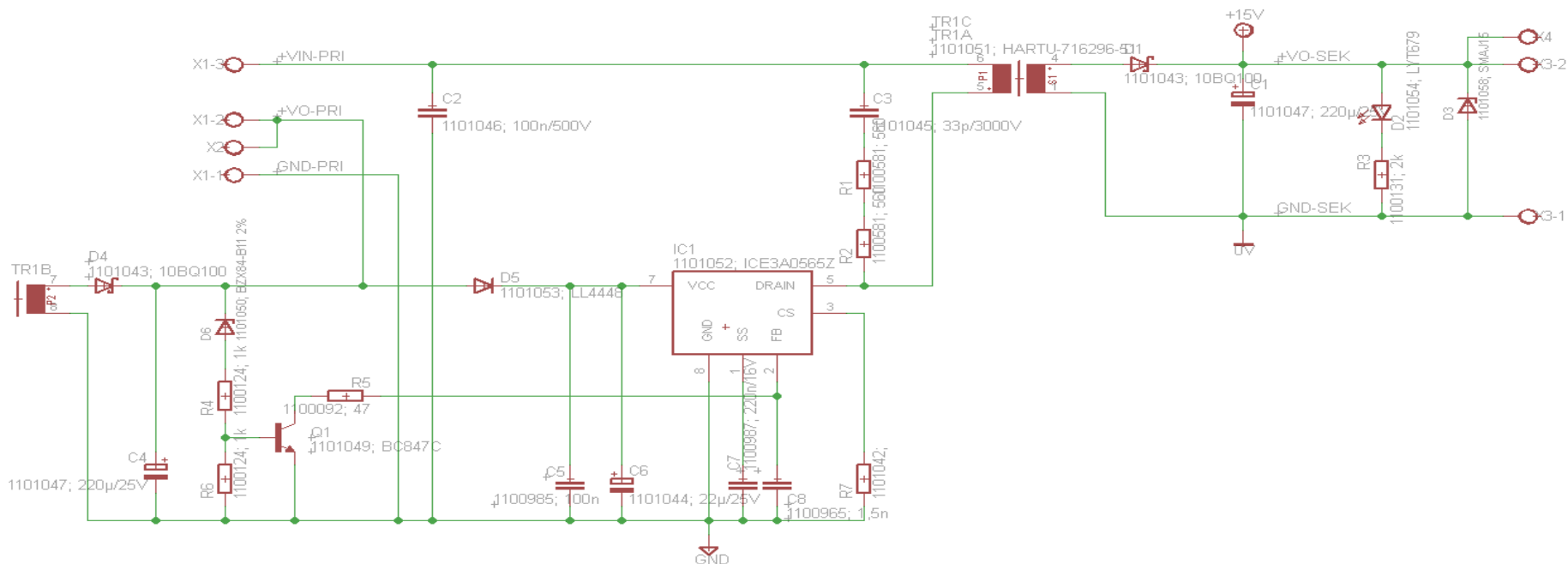
**Transformer**  
SP-PQ 40/40 ferrite core (center tapped)

**Output Choke**  
SDR-37-0,012 Molypermalloy

# Main power board schematic



# Bias board schematic



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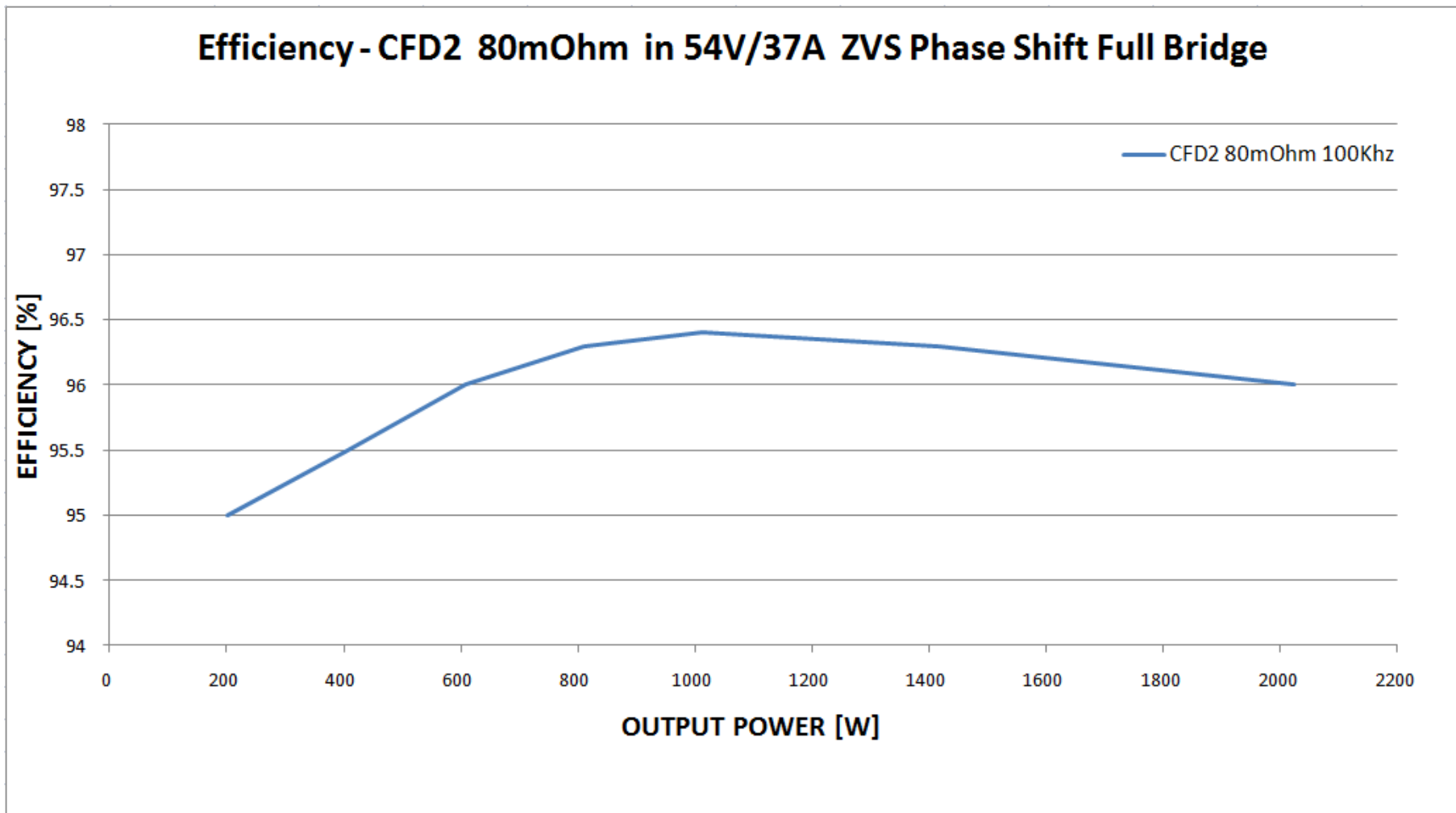
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# Automated efficiency measurement



\*average efficiency plot, expected tolerance in efficiency  $\pm 0,2\%$  over the mass production

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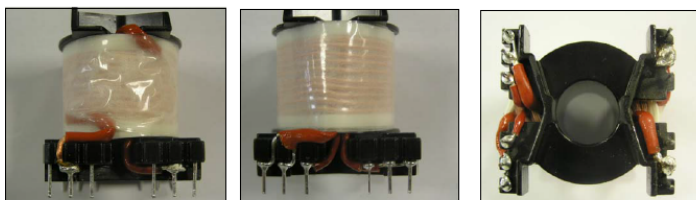
III Magnetics

# Main transformer

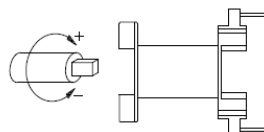
**KASCHKE-SP-PQ40/40 / I.C.E. 8065.0804.003**

AVV. Wind.	CONDUTTORE Wire	Nr. SPIRE Nr. of turns	P. IN USCITA Pin output	SPIRE STRATO Turns per layer	Nr. STRATI Nr. of layers	TUBETTO Sleeve		NOTE Remarks
						Rif.	LENGTH mm.	
N1a	Litz 135xØ0.10 Rif.3	0 10	+ 5 *	10	1	8 8	30 30	ESEGUIRE 3 GIRI DI SPONDA RIF.14 AMBO I LATI. LASCIARE 120mm DI SPONDA LATO OPPOSTO PIN. BLOCCARE FINE CON BANDIERINA RIF.7 Perform 3 turns of tape ref.14 on each side. Leave 120mm of space on the opposite side of pin. Block with a piece of tape ref.7
ISOLAMENTO: 3 GIRI DI NASTRO POLIESTERE RIF. 9 E BLOCCARE CON BANDIERINA DI NASTRO RIF. 7 Insulation: 3 turns of polyester tape Ref. 9 And block with a piece of tape ref. 7								
N2	LAMINA-foil 0.40x0.24 RIF.4	0 4 8	+ 11/12 9/10 7/8	4 4 4	1 1	5 13 13 5	25 20 25	INTERCALARE TRA LE SPIRE POLIESTERE RIF.9 PASSAGGIO FILI COME IN FOTO Insert polyester tape ref.9 between the turns. See pictures for the crossing of wires
ISOLAMENTO: 3 GIRI DI NASTRO POLIESTERE RIF. 9 E BLOCCARE CON BANDIERINA DI NASTRO RIF. 7 Insulation: 3 turns of polyester tape Ref. 9 And block with a piece of tape ref. 7								
N1b	Litz 135xØ0.10 Rif.3	0 10	+ 2	10	1	8 8	30 30	ESEGUIRE 3 GIRI DI SPONDA RIF.14 AMBO I LATI. Perform 3 turns of tape ref.14 on each side.
ISOLAMENTO: 3 GIRI DI NASTRO ADESIVO POLIESTERE RIF. 6 Insulation: 3 turns of polyester adhesive tape Ref. 6								

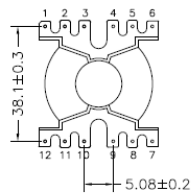
N.B.  
ESEGUIRE I GIRI DI NASTRO PRECISI. PASSAGGIO FILI COME IN FOTO  
Accurate turns of wires. See pictures for the crossing of wires



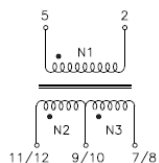
POSIZIONAMENTO ROCCHETTO  
Positioning of the coilformer



VISTA LATO PIN  
Bottom view



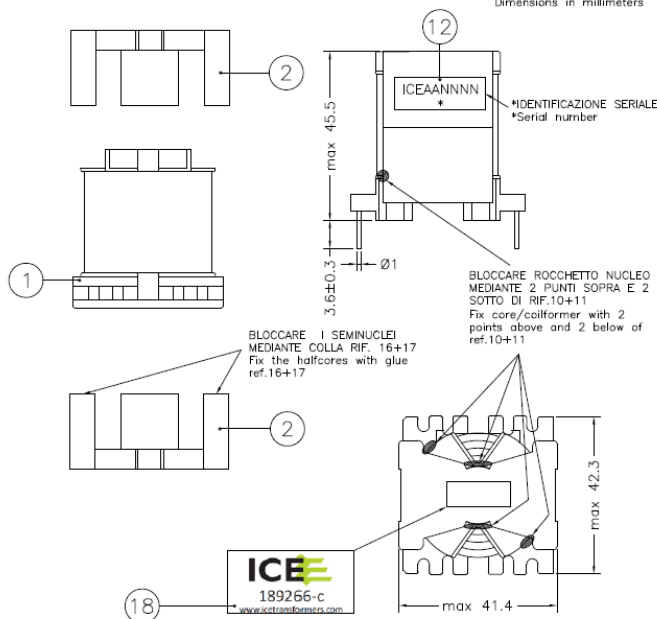
SCHEMA ELETTRICO  
Electrical diagram



## MONTAGGIO — Assembling

2011/65/UE (RoHS-2) Compliant

DIMENSIONI IN MILLIMETRI  
Dimensions in millimeters



## COLLAUDO ELETTRICO — Electrical checking

N°.	TIPO DI PROVA — Test	CONDIZIONI DI PROVA — Test Conditions	LIMITI — Limits
1	INDUTTANZA Inductance	5-2 @ 10 kHz - 100 mV	0.85 ± 1.15 mH
2	RAPPORTO SPIRE Turns ratio	TRA TUTTI GLI AVV. Between all windings @ 10kHz - 100mV	< 1 SPIRA Turn
3	INDUTTANZA DISPERSA Leakage inductance	5-2 @ 10 kHz - 100 mV - 11+12+9+10+7+8 c.c.	< 2.1 µH
4	RIGIDITÀ DIELETTRICA Dielectric strength	5+2/11+12+9+10+7+8 @ 3000 V - 50 Hz - 1 sec.	SUPERARE LA PROVA pass the test

I.C.E. TRANSFORMERS	Q1	15.01.16		EMISSIONE — Release	C. Ficcionni	D. Di Giorgio
	REV DATA APPR	RIF MOD.		DESCRIZIONE MODIFICA Description of modification	REDAZIONE Editing	VERIFICA E APPROVAZIONE Check and approval
	Mod. AQ 05.09	DOCUMENTO—Document	CODICE—Part Number	REV.—Revision	DATA EMISSIONE—Release date	PAG.—Page
		<b>P.F.</b>	<b>8065.0804.003</b>	<b>01</b>	15.01.16	1/1

# Resonant choke

[KASCHKE 170985-A / I.C.E 8024.6301.068](#)

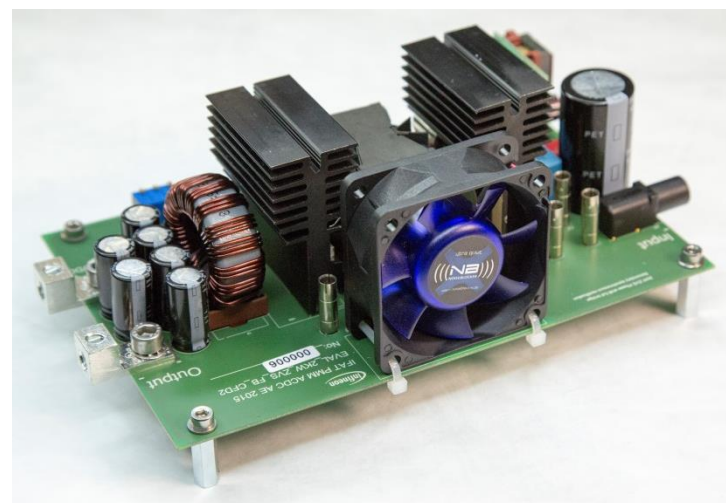
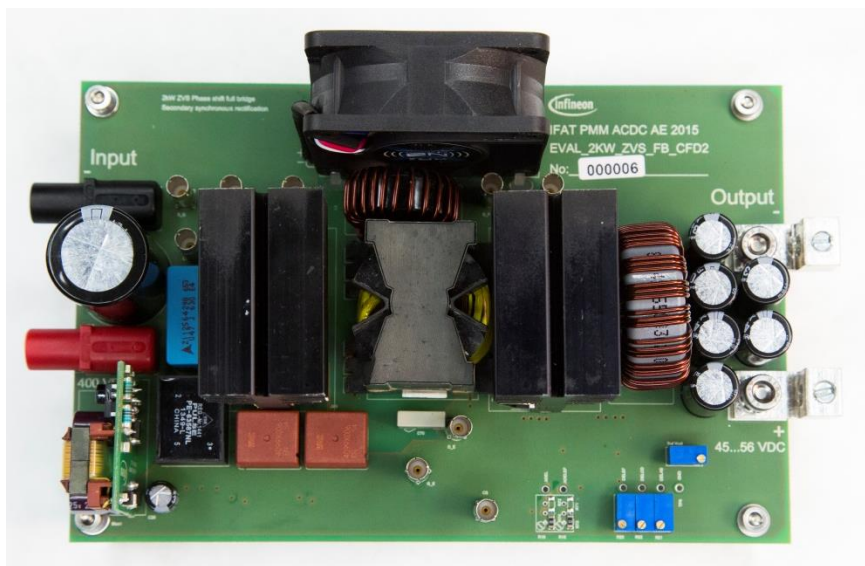
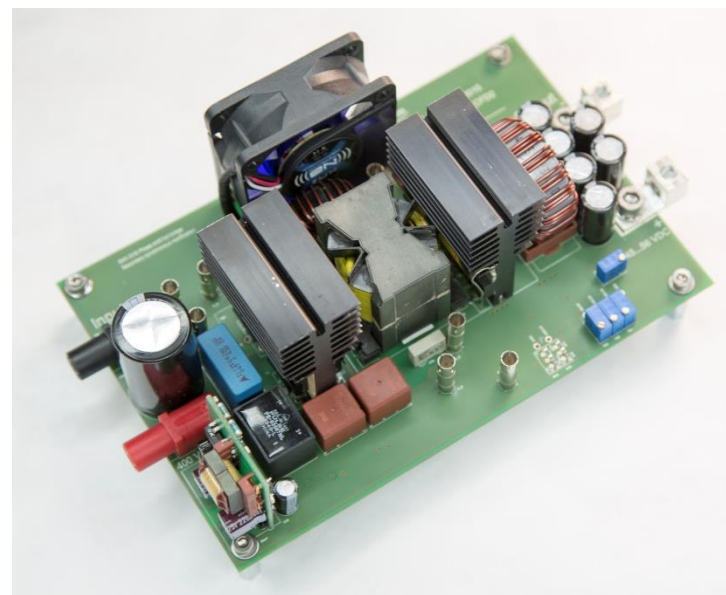
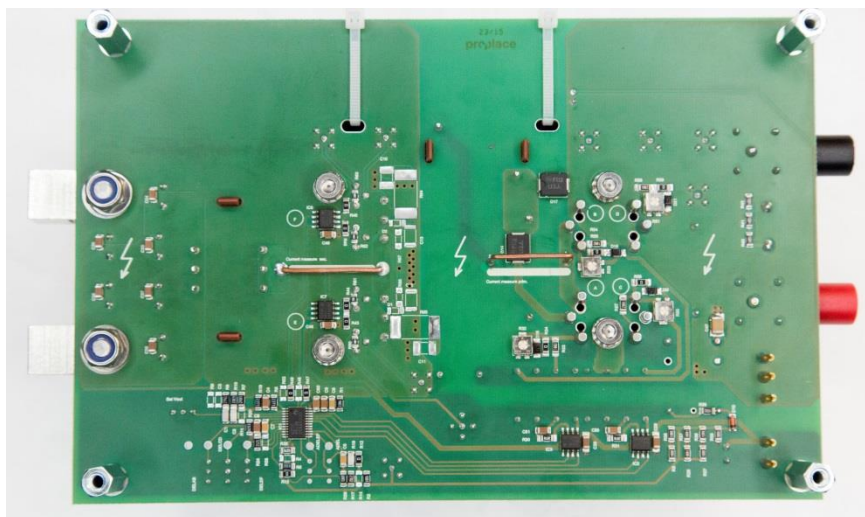
AVV. Wind.	CONDUTTORE Wire	Nr. SPIRE Nr. of turns	PIN DI USCITA Pin output	SPIRE STRATO Turns per layer	Nr. STRATI Nr. of layers	NOTE Remarks																														
N1	FILO RAME copper wire Ø 1.25 Rif.2	0 20	1 4	20	1																															
MONTAGGIO Assembling			SCHEMA ELETTRICO Electrical diagram																																	
<p>ESEGUIRE 2 GIRI DI NASTRO RIF.8 ATTORNO ALL'AVVOLTO Execute 2 turns of tape ref.8 around the inductor</p> <p>* IDENTIFICAZIONE SERIALE serial number</p> <p>max 32</p> <p>max 32</p> <p>5±0.5</p> <p>FISSARE L'AVVOLTO ALLA BASETTA MEDIANTE RIF.4+5 Fix the inductor to base with ref.4+5</p> <p>2011/65/UE (RoHS-2) Compliant</p> <p>DIMENSIONI IN MILLIMETRI Dimensions in millimeters</p>																																				
			<p>VISTA LATO PIN Pin view</p>																																	
COLLAUDO ELETTRICO – Electrical checking																																				
N°.	TIPO DI PROVA – Test	CONDIZIONI DI PROVA – Test Conditions			LIMITI – Limits																															
1	INDUTTANZA Inductance	1-4 @ 10 KHz 100 mV			24 ± 36 µH																															
<table border="1"> <thead> <tr> <th>REV</th> <th>DATA APPR</th> <th>RIF. MOD.</th> <th>DESCRIZIONE MODIFICA</th> <th>REDAZIONE</th> <th>VERIFICA E APPROVAZIONE</th> </tr> <tr> <th>Rev</th> <th>Appr. Date</th> <th>Ref. Mod.</th> <th>Description of modification</th> <th>Editing</th> <th>Check and approval</th> </tr> </thead> <tbody> <tr> <td>01</td> <td>15.01.16</td> <td></td> <td>EMISSIONE – Release</td> <td>C. Picciari</td> <td>D. Di Giorgio</td> </tr> </tbody> </table> <p>DESCRIZIONE—Description <b>Resonant choke (170985-A)</b></p> <table border="1"> <thead> <tr> <th>Mod.</th> <th>DOCUMENTO—Document</th> <th>CODICE—Part Number</th> <th>REV.—Revision</th> <th>DATA EMISSIONE—Release date</th> <th>PAG.—Page</th> </tr> </thead> <tbody> <tr> <td>AQ 05.09</td> <td><b>P.F.</b></td> <td><b>8024.6301.068</b></td> <td><b>01</b></td> <td>15.01.16</td> <td>1/1</td> </tr> </tbody> </table>							REV	DATA APPR	RIF. MOD.	DESCRIZIONE MODIFICA	REDAZIONE	VERIFICA E APPROVAZIONE	Rev	Appr. Date	Ref. Mod.	Description of modification	Editing	Check and approval	01	15.01.16		EMISSIONE – Release	C. Picciari	D. Di Giorgio	Mod.	DOCUMENTO—Document	CODICE—Part Number	REV.—Revision	DATA EMISSIONE—Release date	PAG.—Page	AQ 05.09	<b>P.F.</b>	<b>8024.6301.068</b>	<b>01</b>	15.01.16	1/1
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AQ 05.09	<b>P.F.</b>	<b>8024.6301.068</b>	<b>01</b>	15.01.16	1/1																															

# Output choke

[KASCHKE 170986-B / I.C.E 8024.3601.075](#)

AVV. Wind.	CONDUTTORE Wire	Nr. SPIRE Nr. of turns	RIF. REF.	PIN DI USCITA Pin output	SPIRE STRATO Turns per layer	Nr. STRATI Nr. of layers	NOTE Remarks
N1	TRIFILARE 3xcopper wire Ø 1,25 Rif.2	0 14	+	1/2/3 4/5/6	14	1	
MONTAGGIO Assembling				SCHEMA ELETTRICO Electrical diagram			
<p>ESEGUIRE 2 GIRI DI NASTRO RIF.8 ATTORNO ALL'AVVOLTO Execute 2 turns of tape ref.8 around the inductor</p> <p>* IDENTIFICAZIONE SERIALE serial number</p> <p>max 45</p> <p>max 45</p> <p>5 ± 0.5</p> <p>ICE 170986-b</p> <p>8</p> <p>7</p> <p>FISSARE L'AVVOLTO ALLA BASETTA MEDIANTE RIF.4+5 Fix the inductor to base with ref.4+5</p>							
<p>VISTA LATO PIN Pin view</p>							
2011/65/UE (RoHS-2) Compliant				DIMENSIONI IN MILLIMETRI Dimensions in millimeters			
COLLAUDO ELETTRICO – Electrical checking							
N°.	TIPO DI PROVA – Test	CONDIZIONI DI PROVA – Test Conditions		LIMITI – Limits			
1	INDUTTANZA Inductance	1+2+3/4+5+6 @ 10 KHz 100 mV		12.8 ± 19.2 µH			
I.C.E.	01	15.01.16		EMISSIONE – Release	C. Piccioni	D. Di Giorgio	
	REV	DATA APPR	RIF. MOD.	DESCRIZIONE MODIFICA	REDAZIONE	VERIFICA E APPROVAZIONE	
	Rev	Appr. Date	Ref. Mod.	Description of modification	EdiSng	Check and approval	
TRANSFORMERS	DESCRIZIONE—Description Output choke (170986-b)						
Mod.	DOCUMENTO—Document	CODICE—Part Number	REV.—Revision	DATA EMISSIONE—Release date	PAG.—Page		
AQ 05.09	P.F.	8024.3601.075	01	15.01.16	1/1		

# Final release in ISAR



# Support slides

## ZVS phase shift full bridge evaluation board



### Evaluation Board Page

- > Technical Description
- > Datasheets
- > Parameters
- > Related material
- > Videos

**EVAL\_2KW\_ZVS\_FB\_CFD2**

The 2kW Phase Shift Full Bridge Evaluation Board (CoolMOS™ CFD2) IPW65R080CFD2 represents the new developed ZVS DC-DC converter for Fusion facilities with an output voltage from 40V<sub>dc</sub> to 160V<sub>dc</sub> and an output power of 2kW. This converter works with an input voltage between 300V<sub>ac</sub> and 650V<sub>ac</sub> typical 50Hz and a switching frequency of 20kHz on the primary side.

- Extended component selection and fast setting supported by CoolMOS™ 650V R<sub>DS(on)</sub> CFD2 technology (IPW65R080CFD2)
- Secondary inductance modification 200V
- 12mΩ CoolMOS™ 2.00V technology with fast body diode [CoolMOS™](#)
- Infineon 650V R<sub>DS(on)</sub> dual channel SiC high speed, low state losses device with high negative input voltage capability

**Download Application Note**

**Summary of Features:**

- Input Voltage: 300-650V<sub>ac</sub>
- Output Voltage: 40 up to 160V<sub>dc</sub>
- Output Power: up to 2kW
- Peak Efficiency: 96.6%

**Benefit:**

- Full ZVS achieved even in the loading of the bridge starting from 20% load onwards
- Optimized primary and secondary data sheet

**Target Applications:**

- Fusion Reactors/SAPS
- Industrial High Power UPS
- High Power Battery Chargers

### ■ [EVAL\\_2KW\\_ZVS\\_FB\\_CFD2](#)

### Product Family Pages

- > Product Brief
- > Application Notes
- > Selection Guides
- > Datasheets and Portfolio
- > Videos
- > Simulation Models

**650V CoolMOS™ CFD2**

Market Leading 650V CoolMOS™ Technology with Integrated Fast Body Diode

650V CoolMOS™ CFD2 is a second generation of market leading high voltage CoolMOS™ IPW65R080CFD2 with ultra-precision gate driver, the implementation of an integrated body diode with minimal energy efficiency. The ultra-precision gate driver and fast body diode offer you the most robust and reliable solution in operation with any application.

The product portfolio provides a benefit of fast switching, suspension IPW65R080CFD2 offering high light load efficiency, extended gate driver, the implementation of an integrated body diode with minimal energy efficiency. The ultra-precision gate driver and fast body diode offer you the most robust and reliable solution in operation with any application.

**Product Portfolio 650V CoolMOS™ CFD2**

Click on product type to have more detailed information and order

Part Number	TO-247-3	TO-247-3 Power	TO-247-3 Power	TO-247-3 Power	TO-247-3 Power
650	IPW65R080CFD2				
650	IPW65R080CFD2	IPW65R080CFD2	IPW65R080CFD2	IPW65R080CFD2	IPW65R080CFD2
650	IPW65R080CFD2	IPW65R080CFD2	IPW65R080CFD2	IPW65R080CFD2	IPW65R080CFD2
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- [IPW65R080CFD](#)
- [IPP110N20N3 G](#)
- [2EDN7524F](#)
- [ICE3RBR4765JZ](#)





Part of your life. Part of tomorrow.

