

# 3.0 kW Dual LLC Evaluation Board

EVAL\_3kW\_2LLC\_C7

TO-220

TO-247

Di Domenico Francesco  
Zechner Florian



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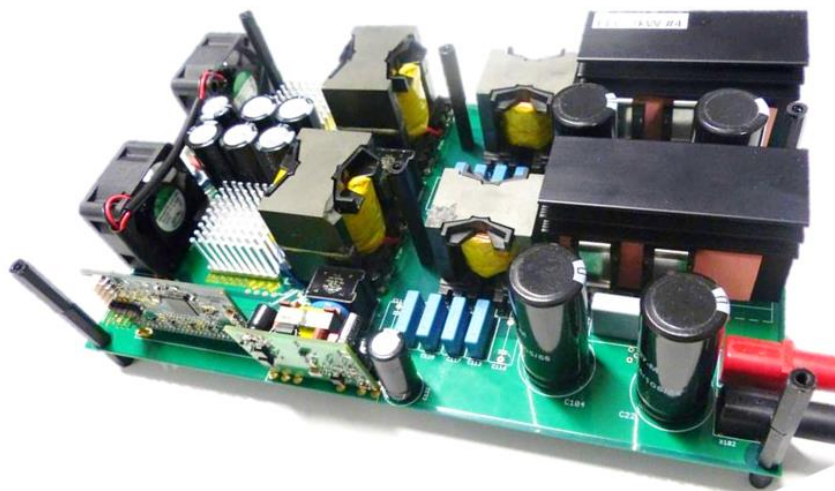
# General

## Description:

The "EVAL\_3kW\_2LLC\_C7" - evaluation board shows how to design a dual phase LLC system solution of a telecom/industrial SMPS with the target to meet **highest efficiency** requirements. On this purpose there has been applied latest CoolMOS™ technology [IPP60R040C7](#) 600 V Power MOSFET on the primary side and OptiMOS™ low voltage Power MOSFET in SuperSO8 [BSC093N15NS5](#) in the synchronous rectification secondary stage, in combination with QR CoolSET™ [ICE2QR2280Z](#), [1EDI60N12AF](#) [EiceDRIVER™](#) high voltage, high speed driver ICs for [MOSFETs](#), low side gate driver [2EDN7524R](#) and digital LLC controller [XMC4400](#)

## Summary of features:

- › Output voltage: 44 V<sub>DC</sub> – 58 V<sub>DC</sub>
- › Output current max: 55 A
- › Peak efficiency @ 50% load > 98.5%
- › Efficiency @ 10% load > 97%



## The following variants are available:

- › EVAL\_3kW\_2LLC\_C7 version with CoolMOS™ C7 **TO-220**, IPP60R040C7, EVAL\_3kW\_2LLC\_C7\_220
- › EVAL\_3kW\_2LLC\_C7 version with CoolMOS™ C7 **TO-247**, IPW60R040C7, EVAL\_3kW\_2LLC\_C7\_247

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

Half-bridge LLC with synchronous rectification in center tap configuration

$V_{in}$  350 V<sub>DC</sub> - 400 V<sub>DC</sub>

$V_{in\_nom}$  380 V<sub>DC</sub>

$V_{out}$  44 V<sub>DC</sub> - 58 V<sub>DC</sub>

$I_{out}$  55 A

$P_o$  3 kW

$C_r$  66 nF

$L_r$  12  $\mu$ H

$L_m$  62  $\mu$ H

## Primary HV MOSFETs CoolMOS™ IPP60R040C7

Reduced gate charge ( $Q_g$ )

- > Reduced  $E_{off}$
- > High body diode ruggedness

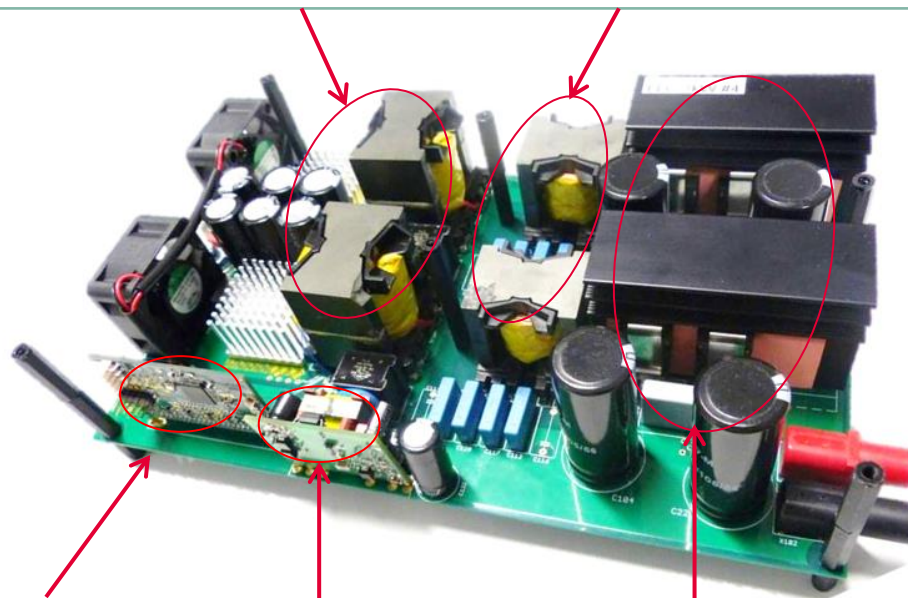
## SR MOSFETs OptiMOS™ BSC093N15NS5

New generation

- > Best FOM  $R_{DS(on)} \times Q_g$
- > Best FOM  $R_{DS(on)} \times Q_{oss}$

**Transformer**  
SP-PQ 40/40 core

**Resonant inductor**  
SP-PQ 35/35 core



**LLC controller**  
digital XMC4400

**Bias QR Flyback controller**  
ICE2QR2280Z

**HV MOSFETs**  
IPP60R040C7 TO-220  
IPP60R040C7 TO-247

# Digital control board

## Infineon`s solution to control the 3 kW dual phase LLC evaluation board

### Digital

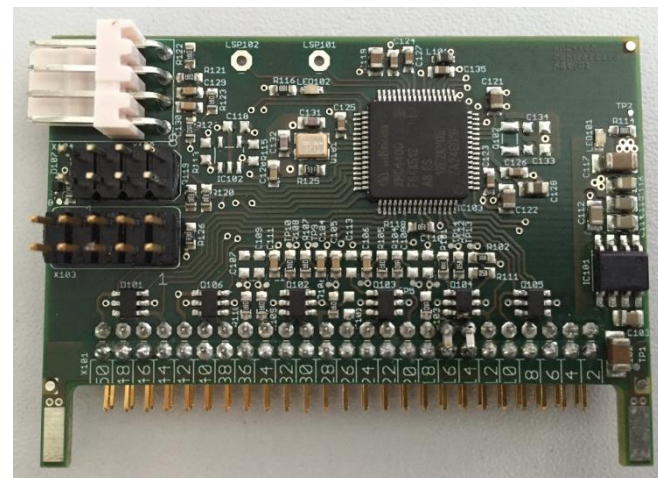
#### [XMC4400-F64K512 AB](#)

##### Summary of features:

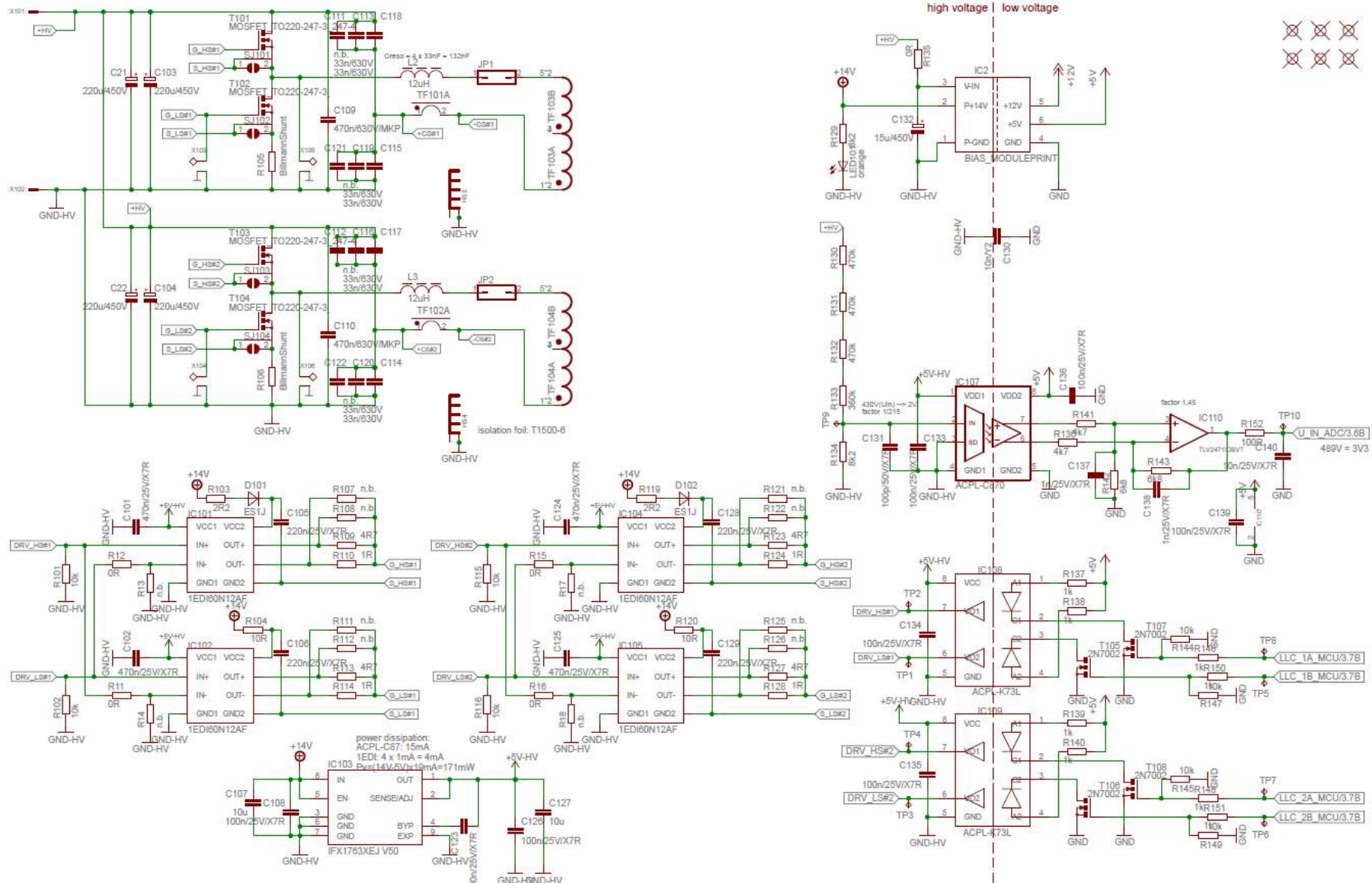
- > ARM® Cortex®-M4, 120 MHz, incl. single cycle DSP MAC and floating point unit (FPU)
- > 8-channel DMA + dedicated DMAs for USB and Ethernet
- > USB 2.0 full-speed on-the-go
- > CPU Frequency: 120 MHz
- > eFlash: 512 kB including hardware ECC
- > 80 kB SRAM
- > Package: PG-LQFP-64

##### Target applications:

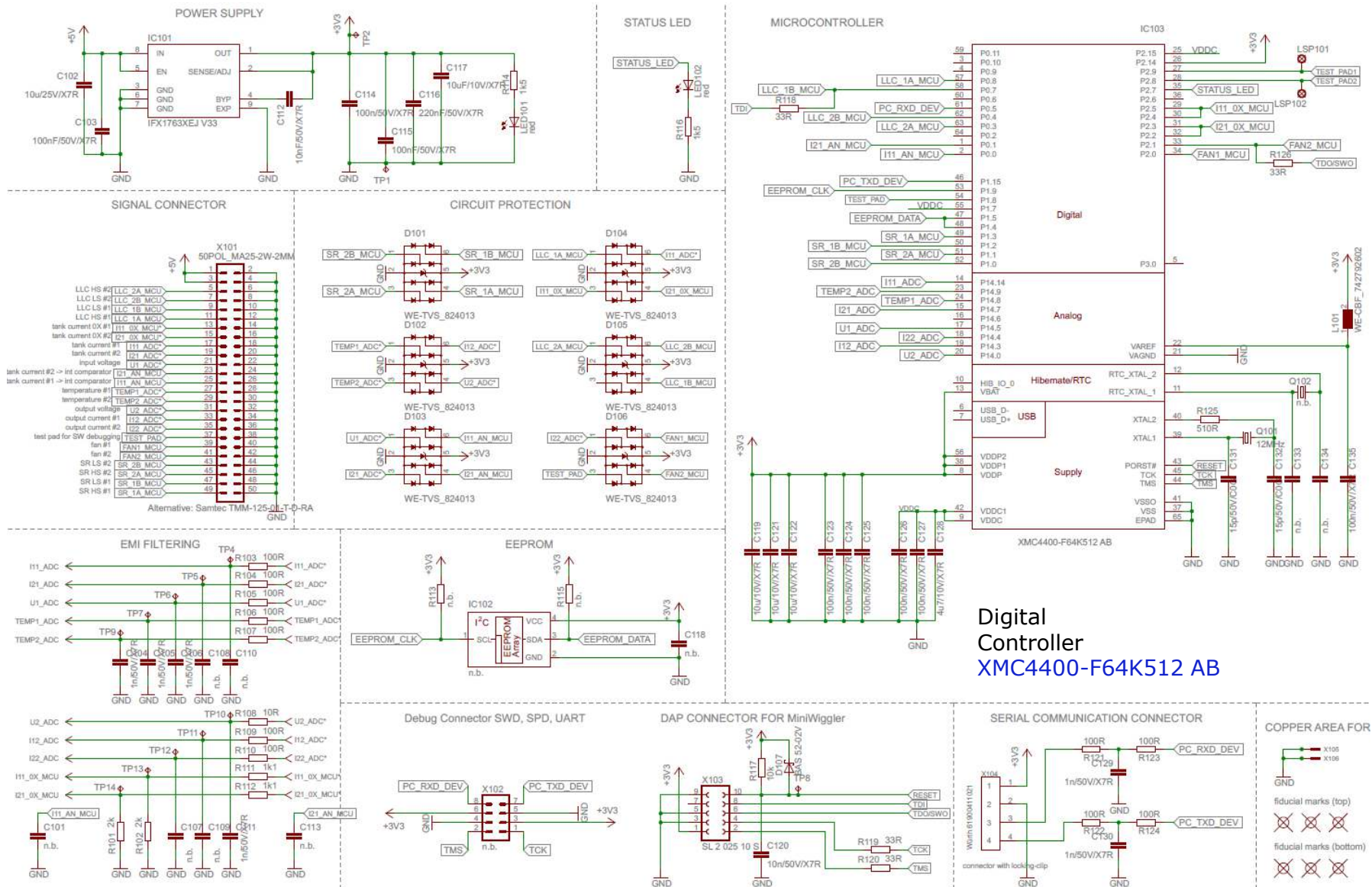
- > Motor control
- > Position detection
- > IO devices
- > HMI
- > Solar inverters
- > SMPS
- > Sense & control systems
- > PLC
- > UPS
- > Light networks



# Main power board schematic



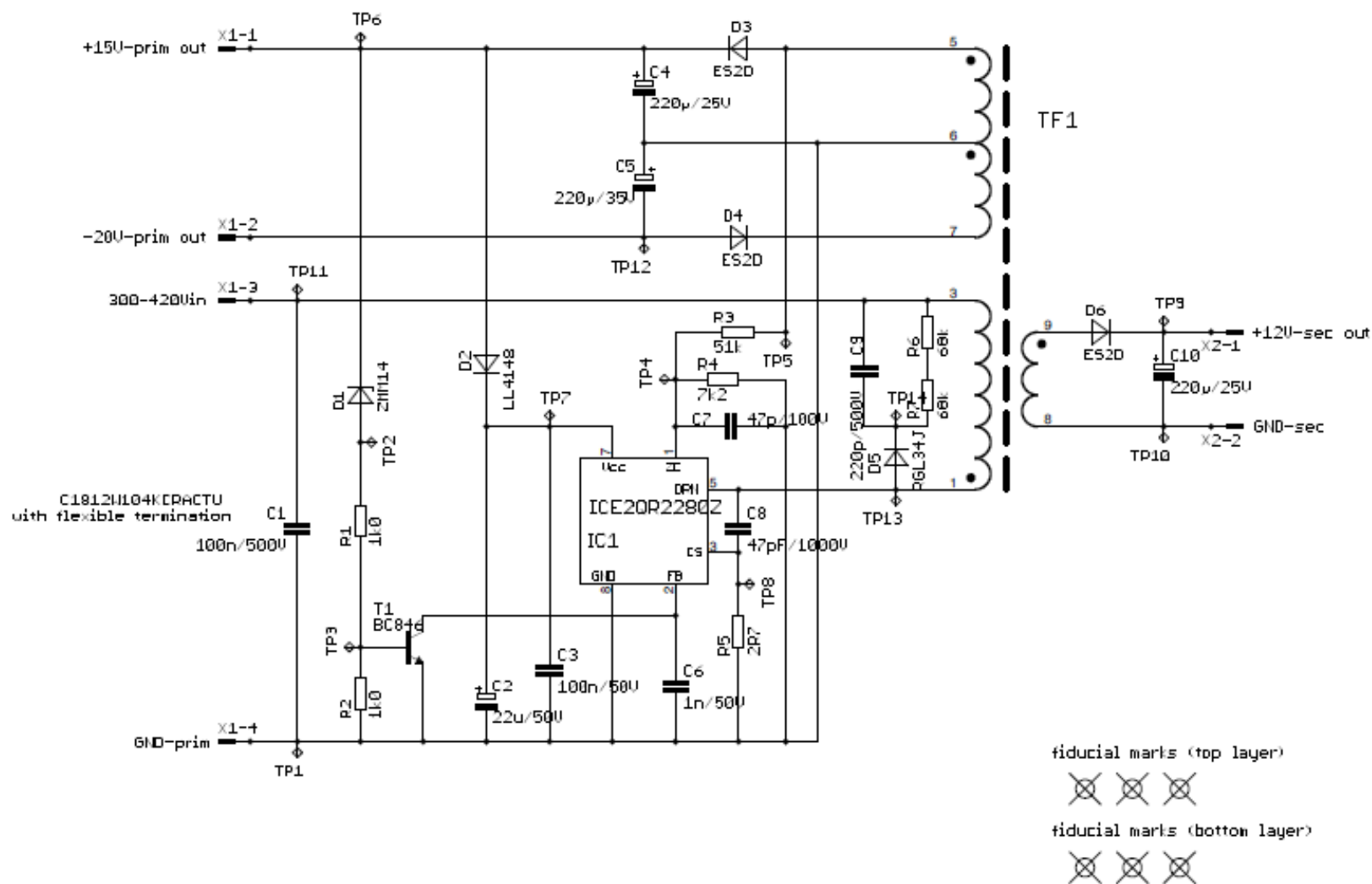
# Digital control board schematic



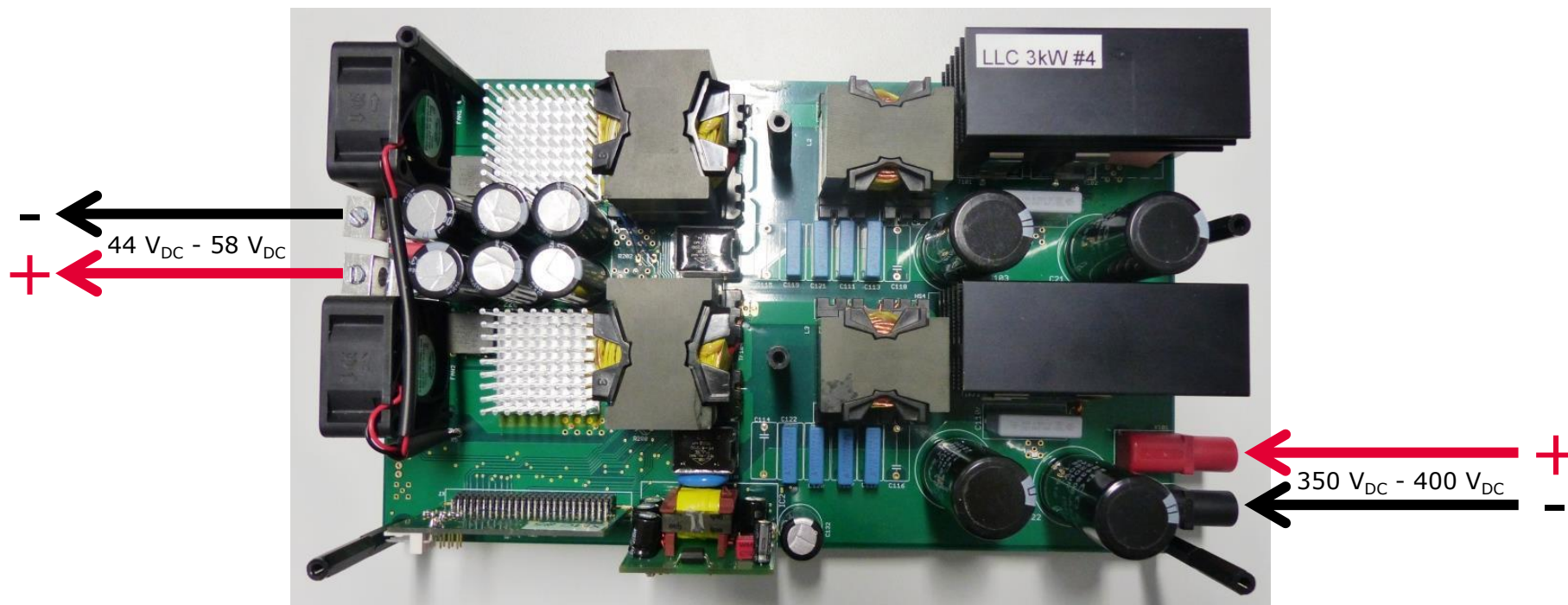
Digital Controller  
XMC4400-F64K512 AB



# Bias board schematic



# Connection instruction



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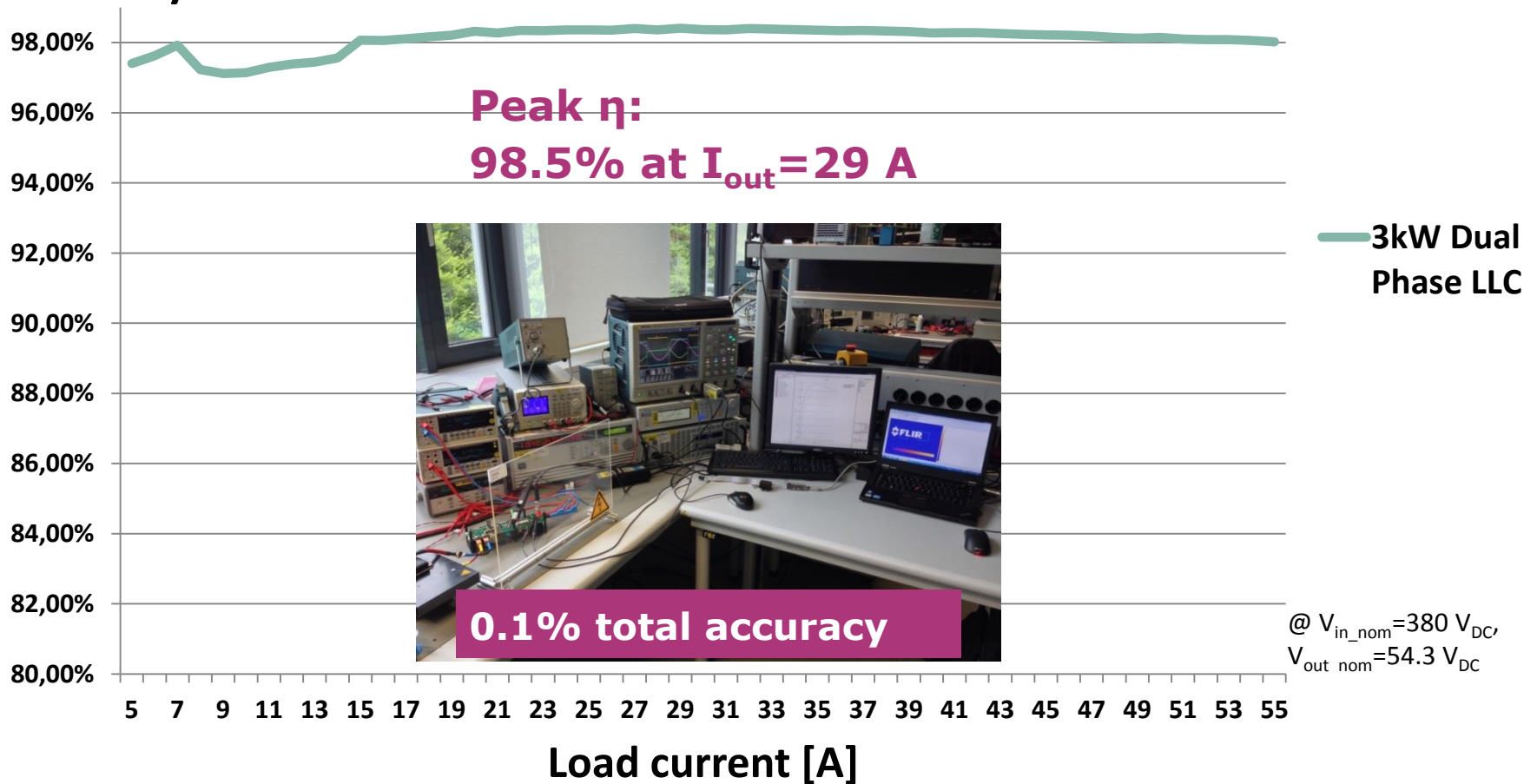
Design concept

# Efficiency plot measured with IPP60R040C7/ IPW60R040C7

## 3 kW Dual Phase LLC efficiency

(without Bias & fans absorption)

Efficiency



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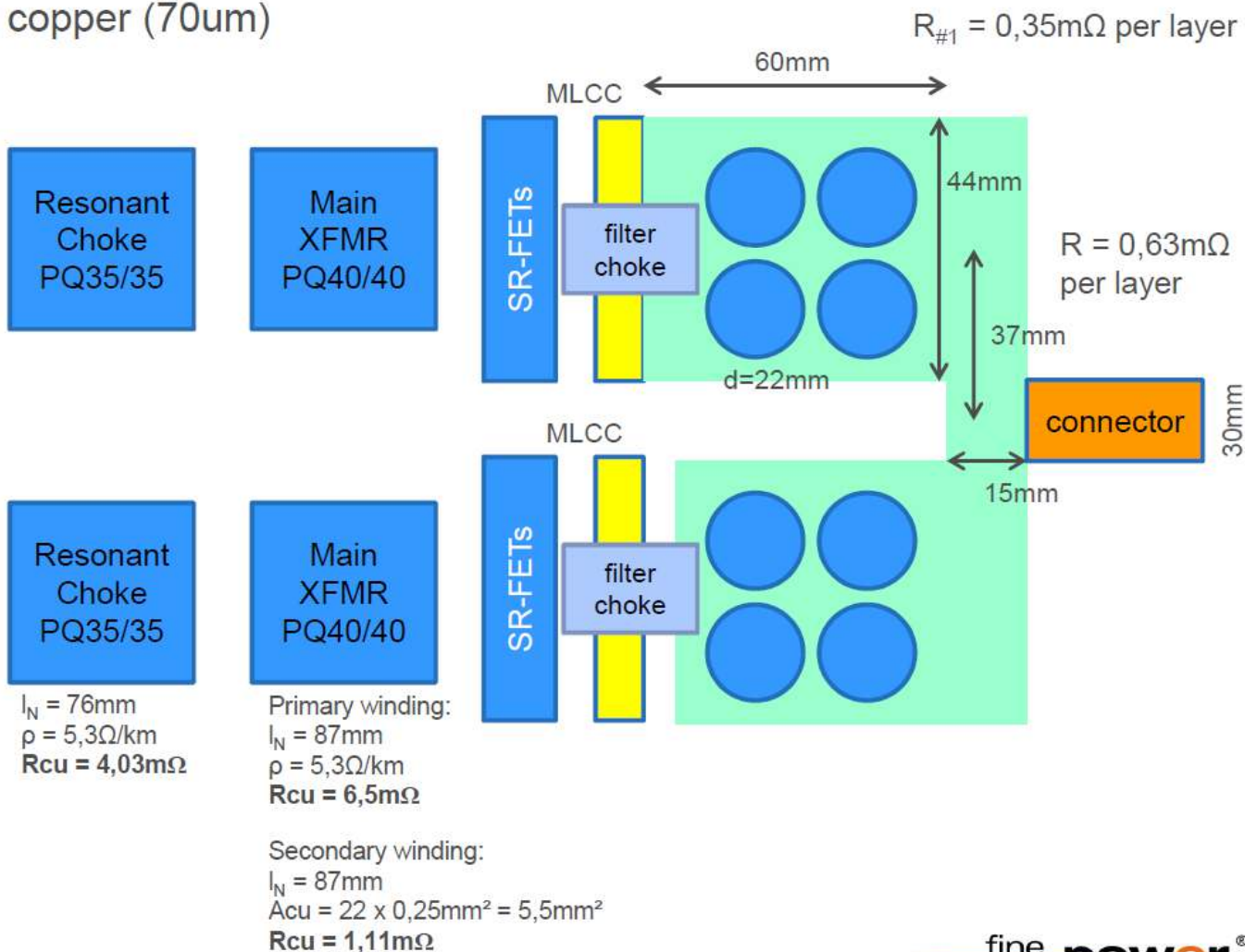
Design concept

# Design concept

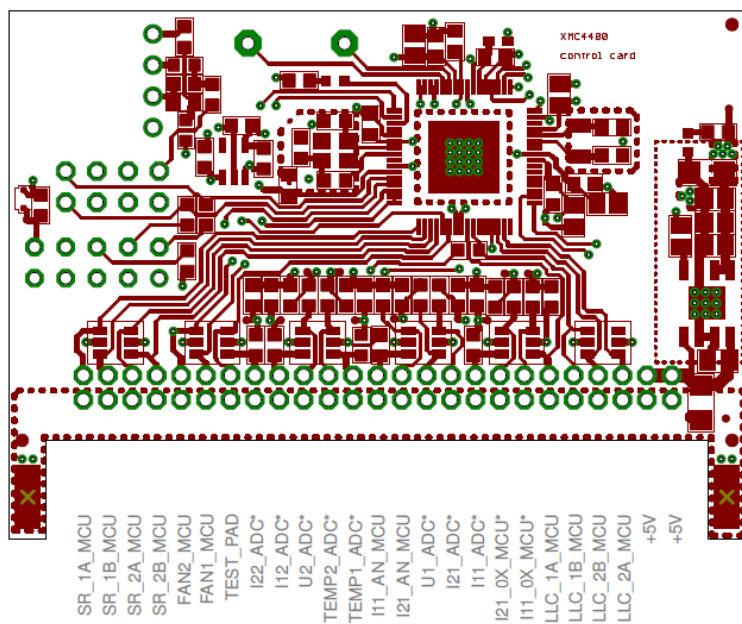


# Basic components positioning in the PCB

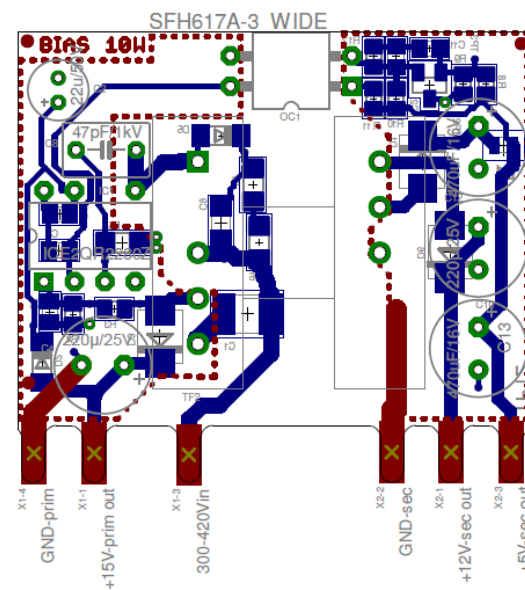
4 layer PCB, 2oz copper (70um)



# Two daughter boards



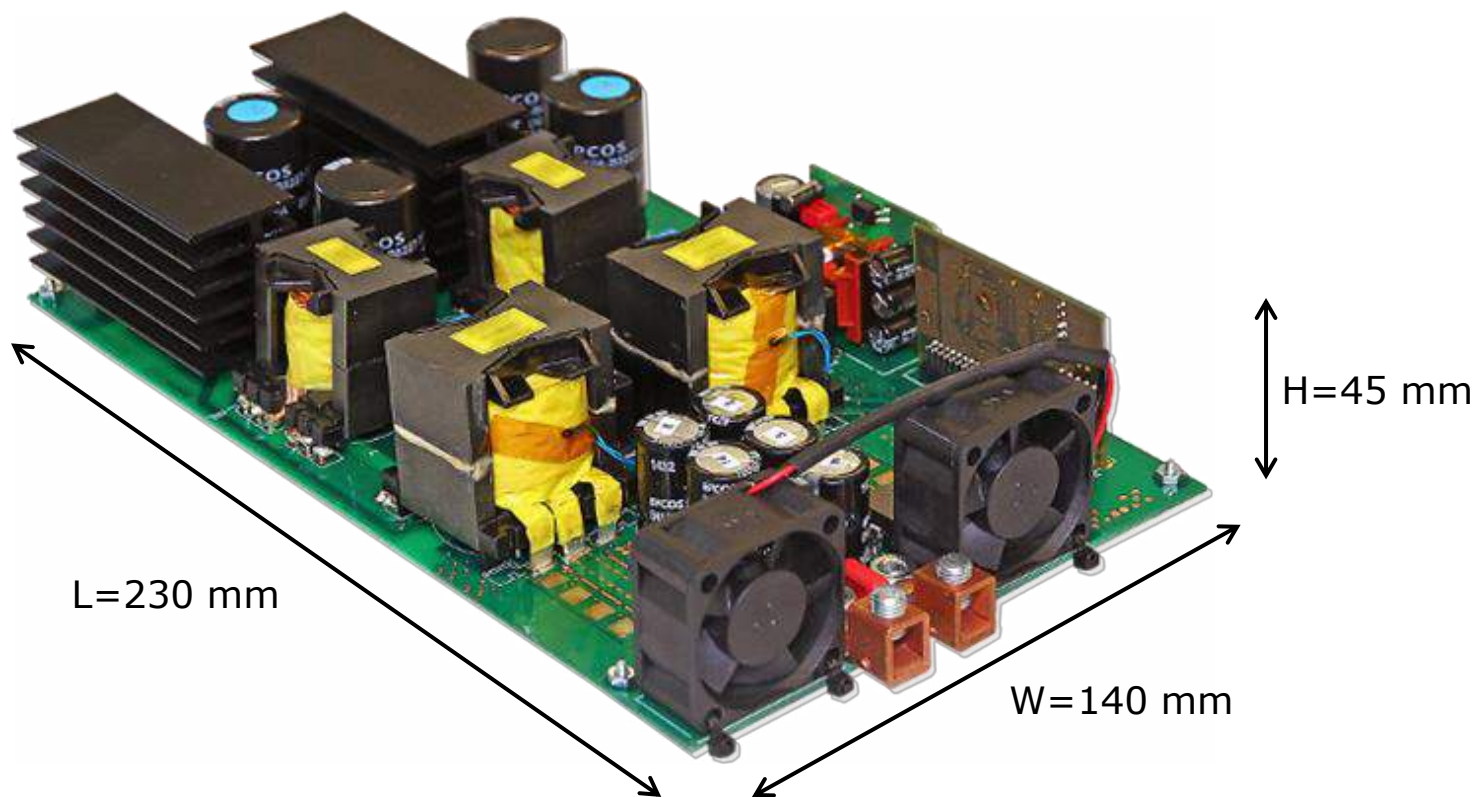
**Microcontroller board**



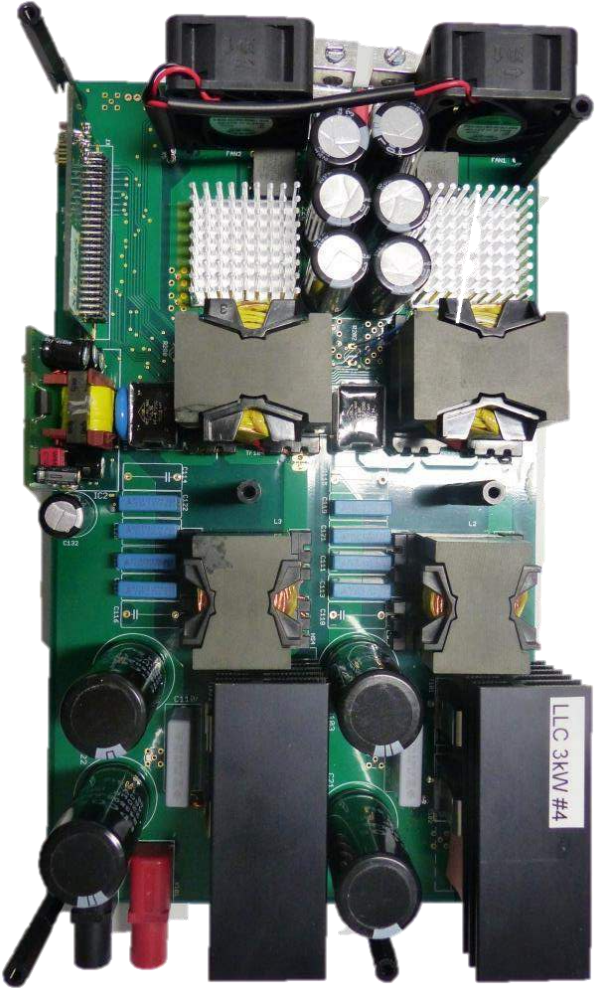
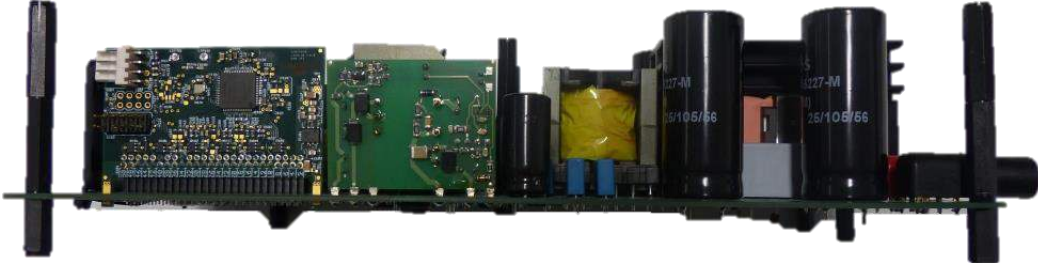
**Auxiliary converter board**



# Final shape and overall dimensions



# Evaluation board EVAL\_3kW\_2LLC\_C7



# Support slides

## 3 KW Dual LLC evaluation board

### Evaluation board page

- > Technical Description
- > Datasheets
- > Parameters
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Overview

Parameters

Diagrams

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Support

### EVAL\_3KW\_2LLC\_C7\_47

Description:

The 3kW Dual Phase LLC demo board is an example of a complete Infineon solution for the HV DC-DC stage of telecom rectifiers and industrial SMPS, meeting the highest efficiency and reliability standard levels. The combination of state-of-the-art 600V CoolMOS™ C7 in TO-247 and OptiMOS™ 5 in SuperSO8 power device technologies with optimized driving and control techniques using Infineon components allows to achieve this result.

Summary of features:

- Dual Phase LLC topology with full digital control (including current sharing and phase shedding)
- Prevention of MOSFET body diode hard commutation and LLC capacitive mode operation
- Graphical User Interface (GUI) for parameters setting and monitoring

Benefit:

- Peak efficiency >98.4%
- Flat efficiency plot from 10% to 100% load
- Flexible design adjustment and fine tuning through the GUI

Target Applications:

- Telecom rectifiers
- Industrial SMPS
- High power battery chargers

Solution Finder

MOSFET	IGBT	Diode	MCU	Other
<input type="checkbox"/> ESD Protection	<input type="checkbox"/> Sim Models			
<input type="checkbox"/> Bipolar Transistor	<input type="checkbox"/> Eval Boards			
<input type="checkbox"/> Zener Diodes	<input type="checkbox"/> Infineon Tools			
<input type="checkbox"/> Smart Switch	<input type="checkbox"/> IP Design Tools			
<input type="checkbox"/> Transceivers				

Reset Find

> [EVAL\\_3kW\\_2LLC\\_C7](#)

### Product family pages

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- > Application Notes
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- > Videos
- > Simulation Models

Infineon

Products Applications Tools About Infineon Careers

600V CoolMOS™ C7

A stepping stone to GaN in hard- and soft-switching topologies

Customer benefits

Key features

- Reduced switching loss parameters such as  $E_{sw}$ , resulting in higher switching frequency
- 50%  $E_{sw}$  reduction compared to older CoolMOS™ CP technology and lower to

Key benefits

- Boosting the switching frequency will reduce the size and cost of magnetic components (e.g. 50 Hz)
- Increased efficiency in hard-switching topologies such as PFC and TFC

Go to product selection table

Power Management Selection Guide 2018

Download

Free Request Evaluation Board

Technical Information

Reliability Data

MOSFET Finder

- > [IPP60R040C7](#)
- > [BSC093N15NS5](#)
- > [XMC4400-F64K512 AB](#)
- > [2EDN7524R](#)
- > [ICE2QR2280Z](#)
- > [1EDI60N12AF](#)
- > [IFX1763XEJ V50](#)
- > [IFX1763XEJ V33](#)



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