

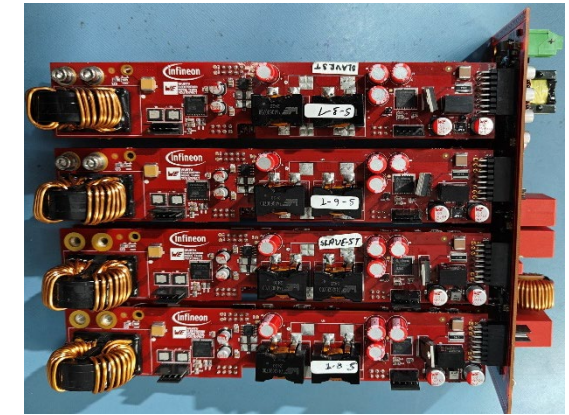
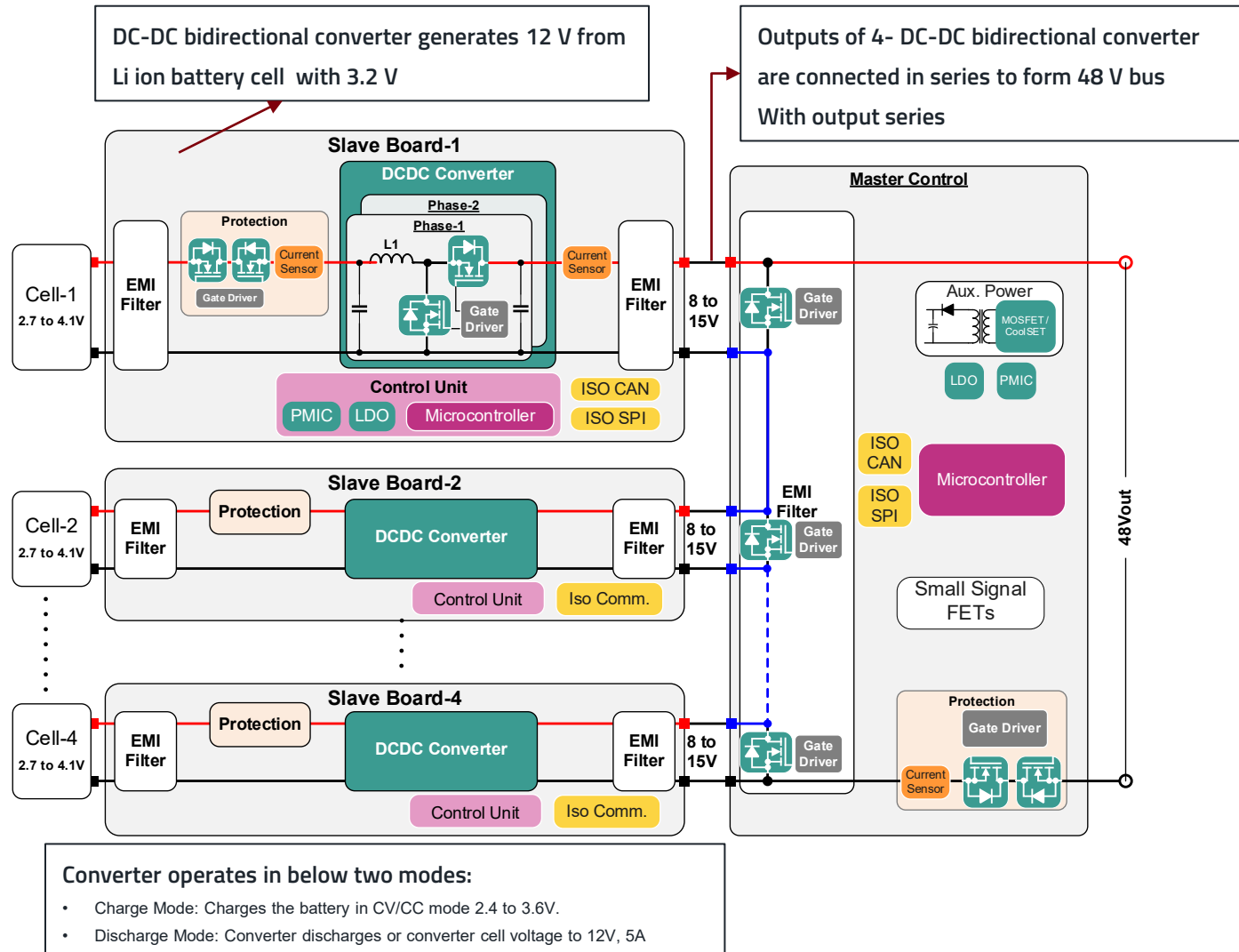


BATTERY MANAGEMENT USING MODULAR DC-DC CONVERTER

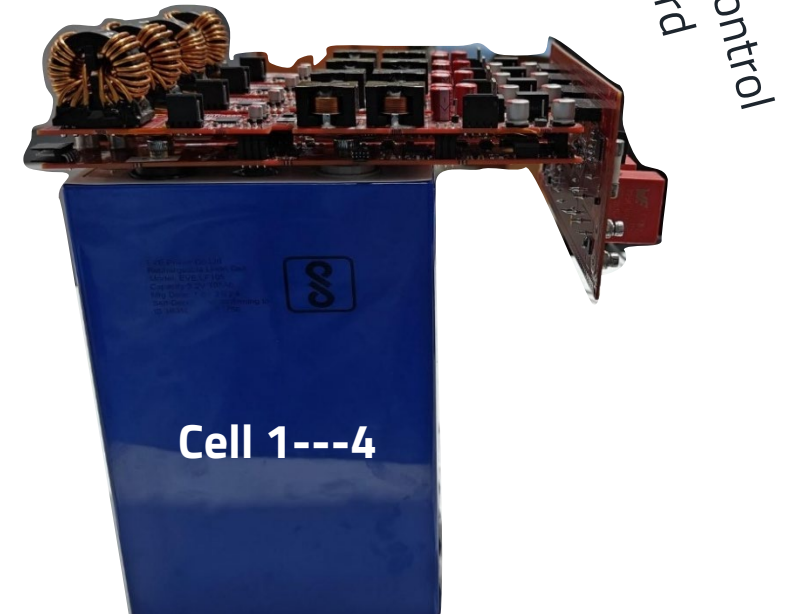
Isaac Aboelsaad *Product Definition Specialist (Würth Elektronik)*
Susheel Badha *System Applications Engineer (Infineon Technologies)*

WÜRTH ELEKTRONIK MORE THAN YOU EXPECT

OVER VIEW OF BATTERY MANAGEMENT USING MODULAR DCDC CONVERTER

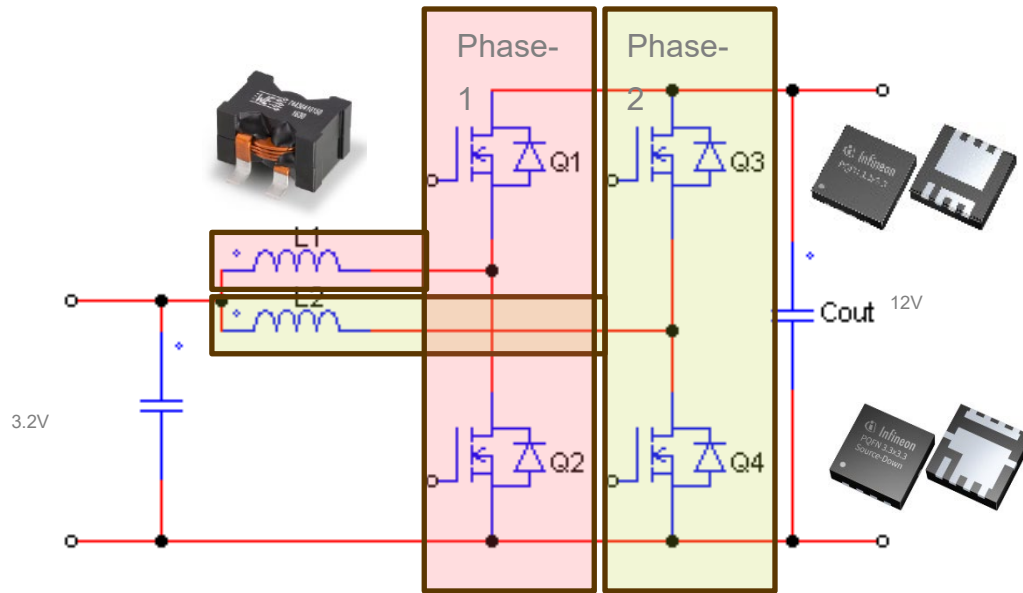


Slave Board 1---4



CONVERTER ON SLAVE BOARD

INTERLEAVED DCDC CONVERTER



Interleaved phase

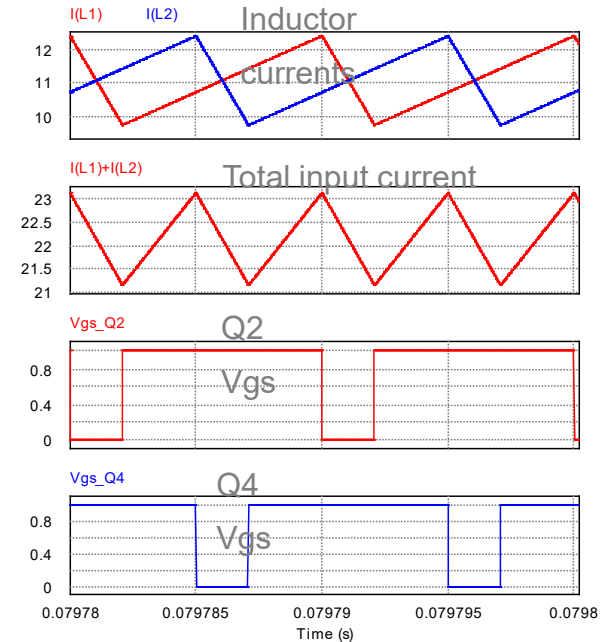
- Two Half bridges are operated in 180° phase shift
- Current ripple frequency $2x$ of PWM frequency resulting in low voltage ripple

Continuous conduction mode

- Used continuous conduction mode for optimized overall design by selecting ripple $\sim 30\%$

Asymmetric switch for top side and bottom side

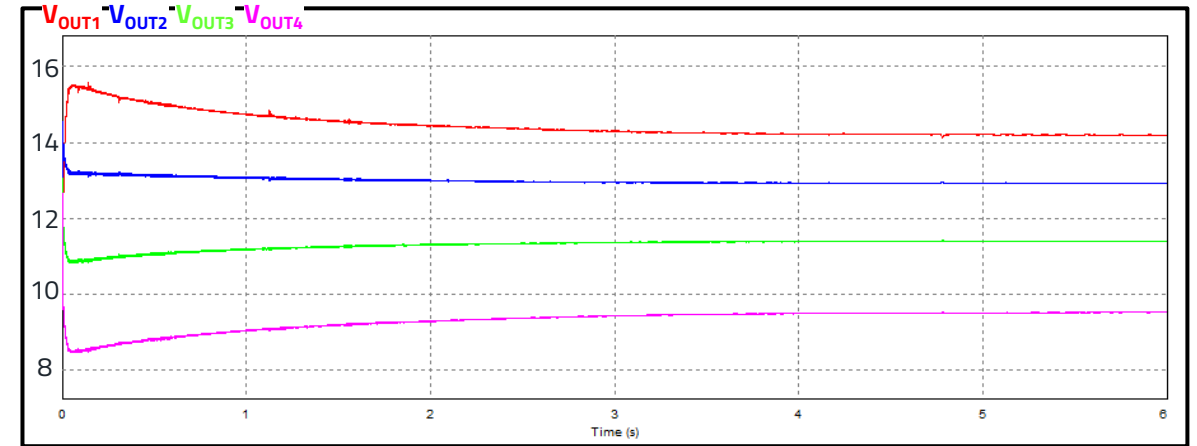
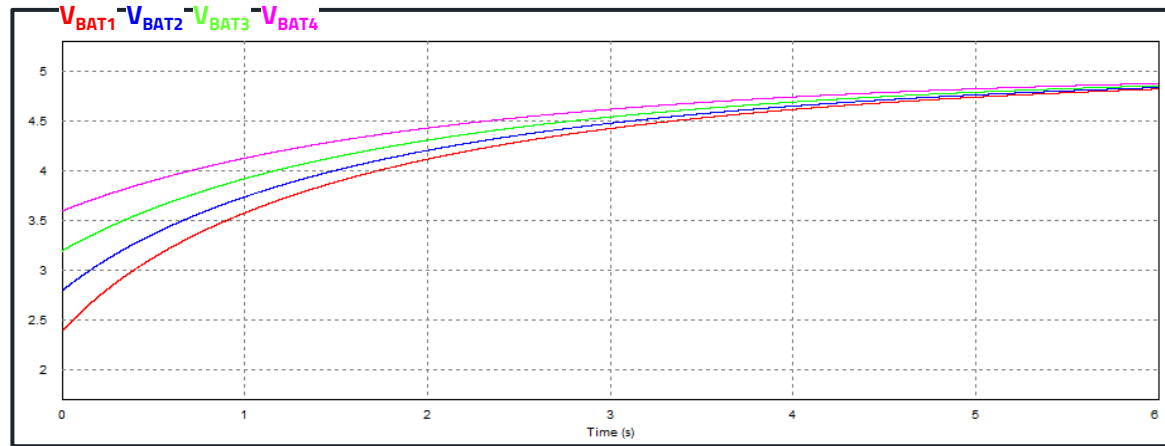
- Since voltage ratio is higher ($16V/2.6V$), expected duty is higher which results into higher current in bottom switch during boost operation



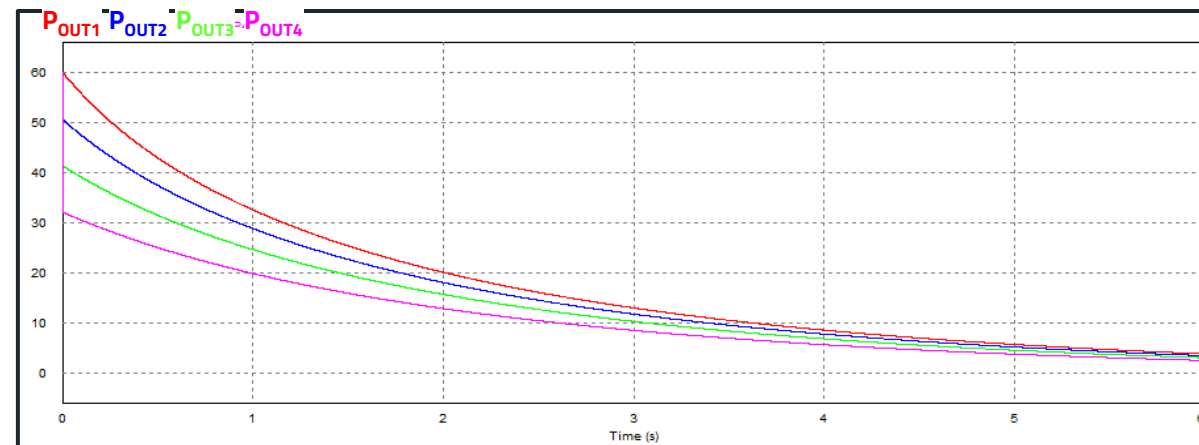
Total current with frequency $2x F_{PWM}$

Q4 phase shifted by 180°

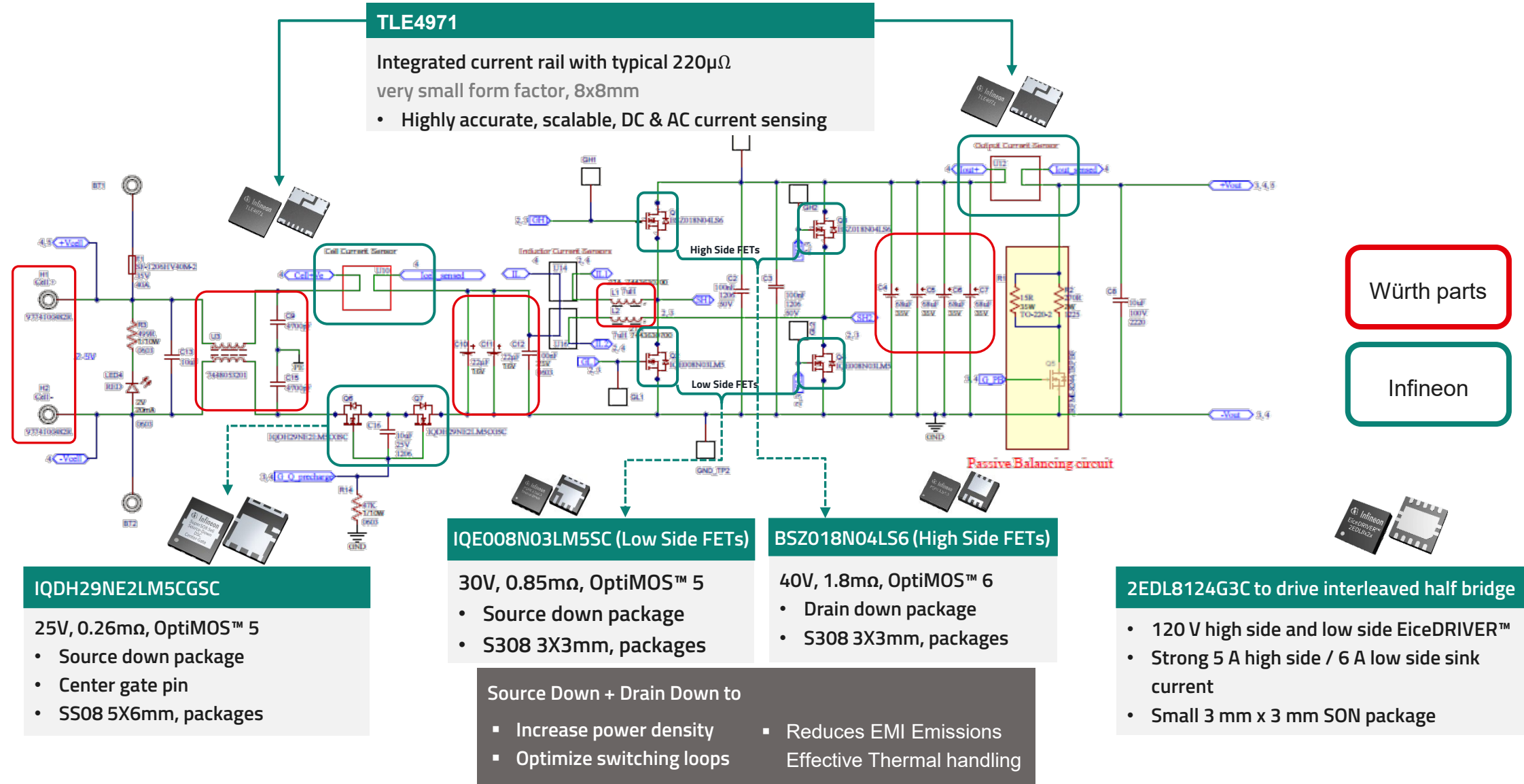
CELL BALANCING DURING CHARGING MODE



Parameter	Voc	SOC	Capacity
Unit	V	-	mAh
Voc1	2.4	0.10	10
Voc2	2.8	0.24	10
Voc3	3.2	0.38	10
Voc4	3.6	0.52	10
DC link voltage = 48V			

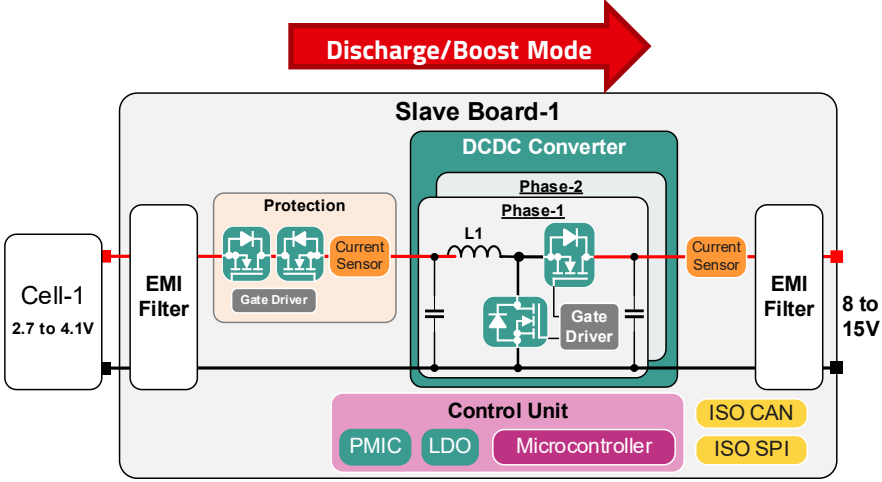
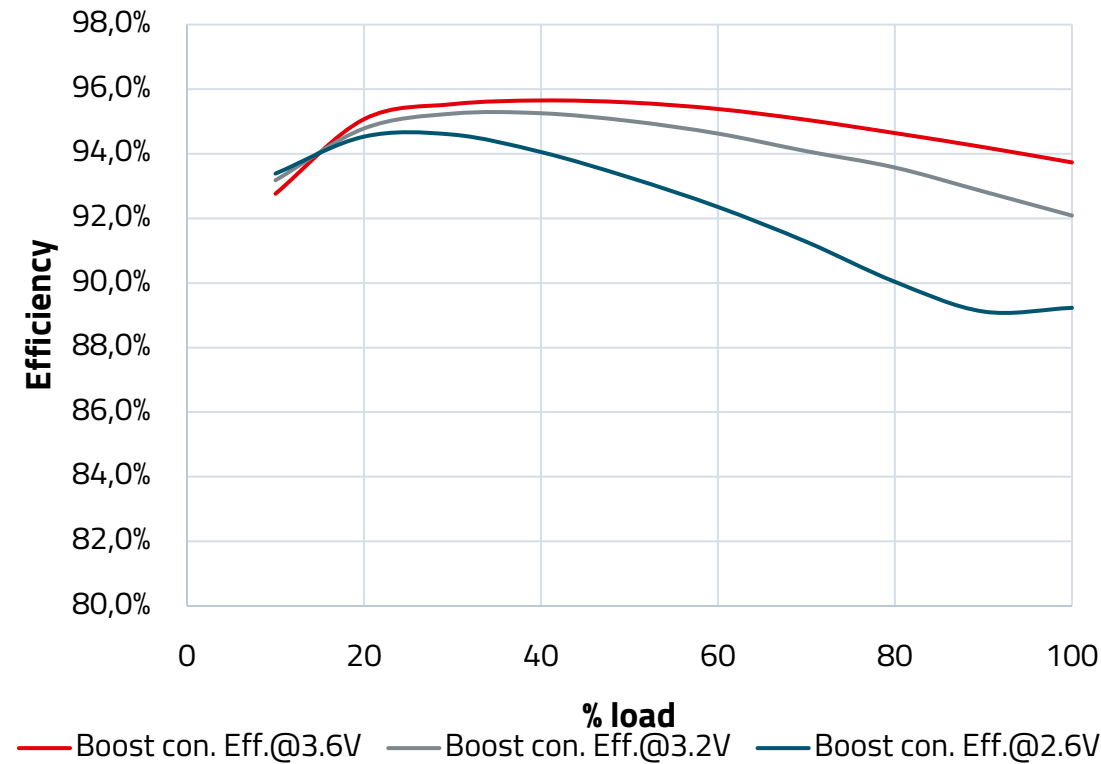


CRITICAL WÜRTH & INFINEON MAKE PARTS ON SLAVE BOARD



SLAVE BOARD EFFICIENCY IN DICHARGE MODE

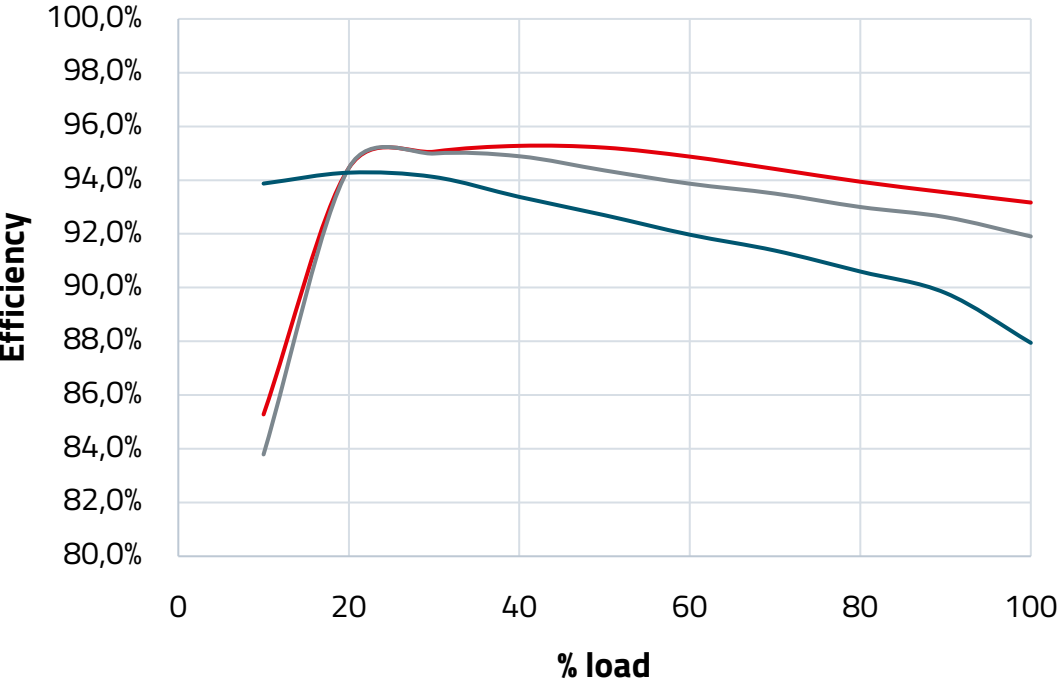
Efficiency in discharge (Boost mode)



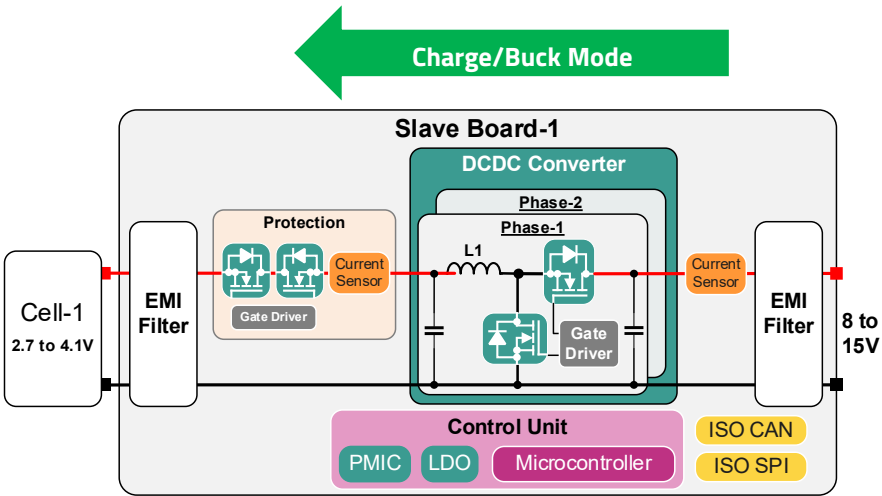
Sr. No	Parameter	Value (Discharge mode)
1	Power	60 W
2	Input voltage range	2.6 V to 3.6 V
3	Output voltage range	8.5 V to 15 V
4	Input under voltage protection	2.6 V
5	Input overvoltage protection	3.65 V

SLAVE BOARD EFFICIENCY IN DICHARGE MODE

Efficiency in charging/Buck mode



— Efficiency@3.6V(Chg)
— Efficiency@3.2V (Chg)
— Efficiency@2.6V (Chg)



Sr. No	Parameter	Value (Discharge mode)
1	Power	60 W
2	Input voltage range	8.5 V to 15 V
3	Output voltage range	2.6 V to 3.6 V

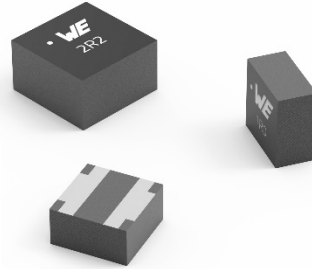
PARTS FROM WÜRTH (SLAVE BOARD)



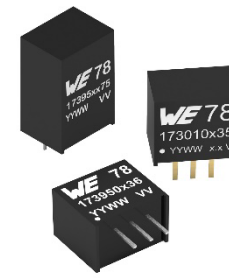
WE-HCF
High Current Inductor



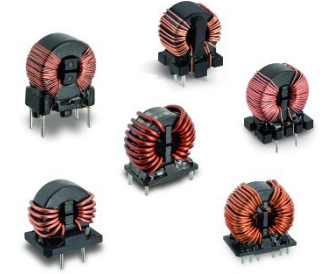
WCAP-CSSA
Interference Suppression
X1/Y2



WE-MXGI
Power Inductor



MagI³C-FDSM
Fixed Step Down Regulator
Module



WE-CMBNC
Common Mode Power Line
Choke Nanocrystalline



WE-CBF
EMI Suppression
Ferrite Bead



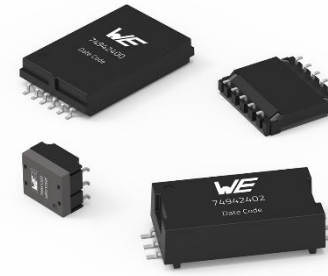
WCAP-PSHP
Aluminum Polymer Capacitors



WA-SMSI
Steel Spacer



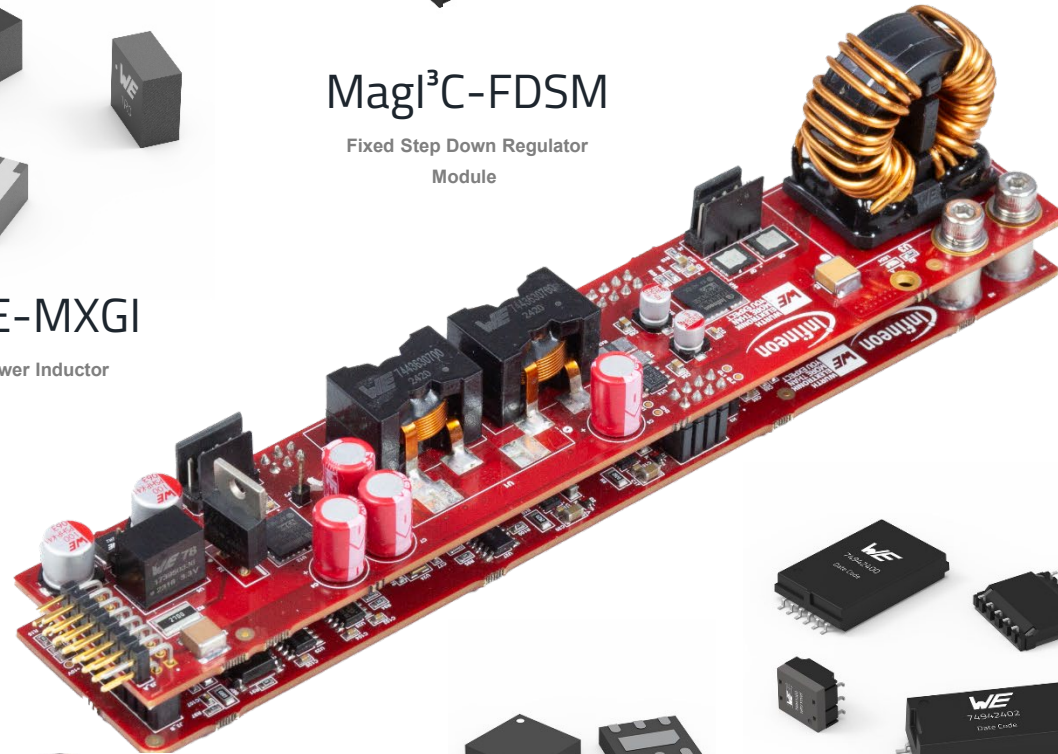
WSEN-TIDS
Silicon based digital temperature sensor



WE-BMS
Transformer for
Battery Management
Systems

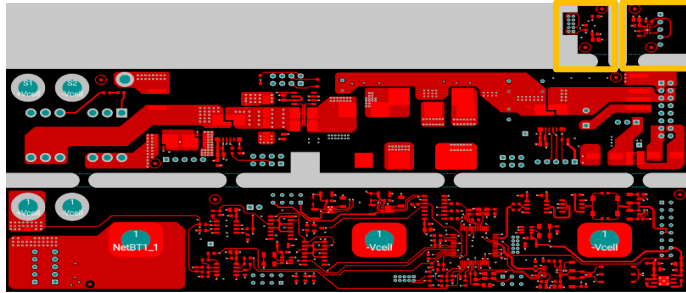


WE-SL3
Common Mode Line
Filter

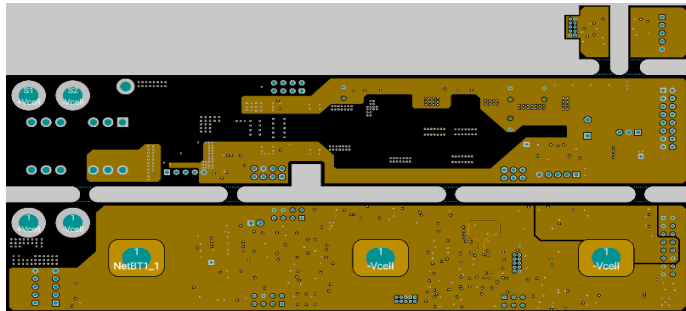


LAYOUT – SLAVE BOARD

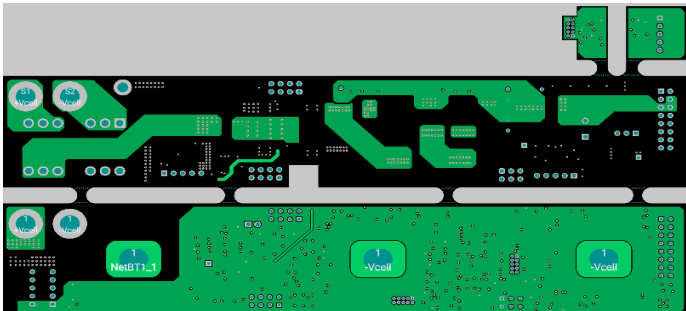
L1
(top)



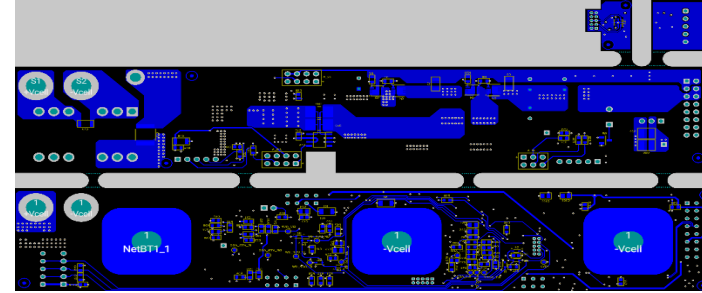
L2
GND



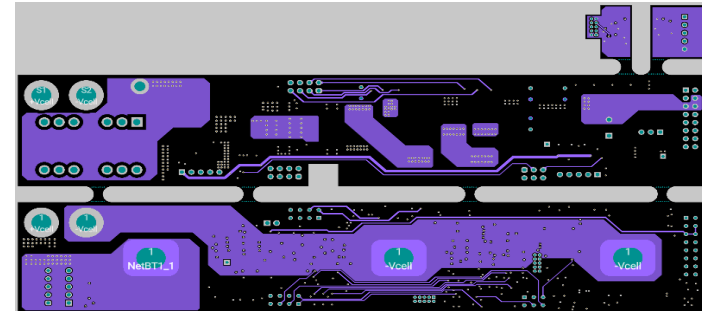
L3
PWR



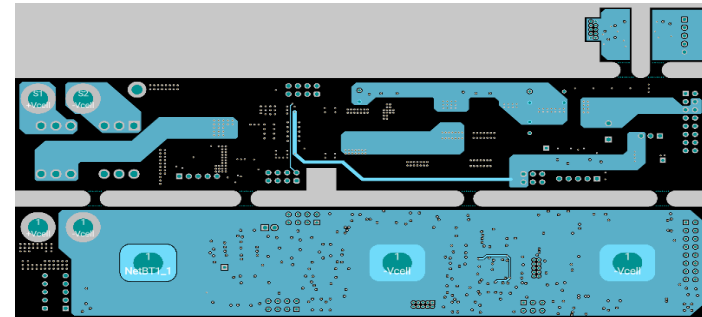
L6
(Bottom)



L5
SIG



L4
VCC



CRITICAL WÜRTH & INFINEON MAKE PARTS ON MASTER BOARD

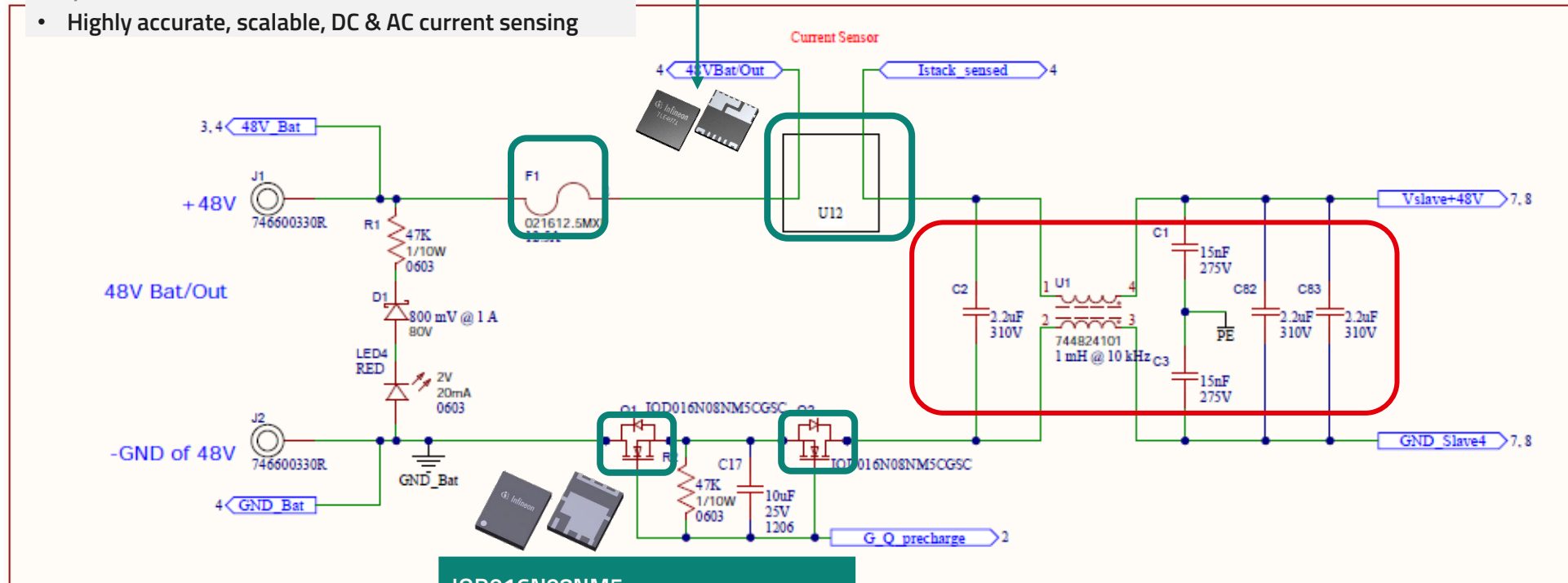
Würth parts

Infineon
parts

TLE4971

Integrated current rail with typical $220\mu\Omega$
very small form factor, 8x8mm

- Highly accurate, scalable, DC & AC current sensing



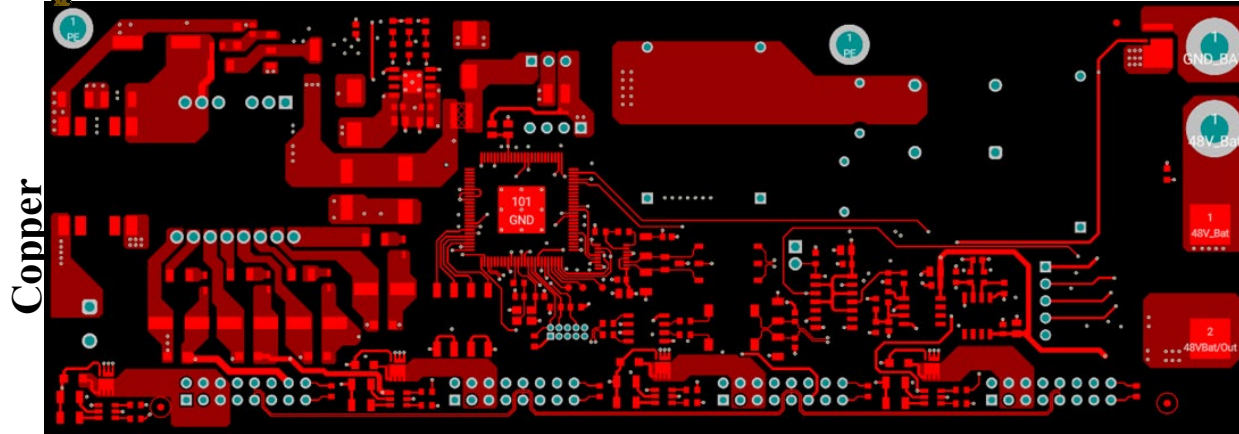
IQD016N08NM5

25V, 0.26mΩ, OptiMOS™ 5

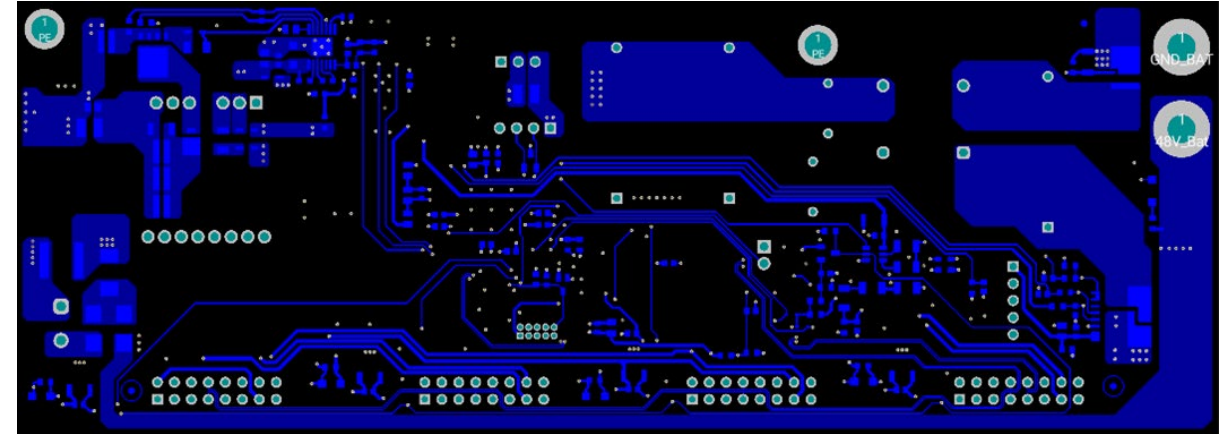
- Source down package
- SS08 5X6mm, packages

LAYOUT – MASTER BOARD

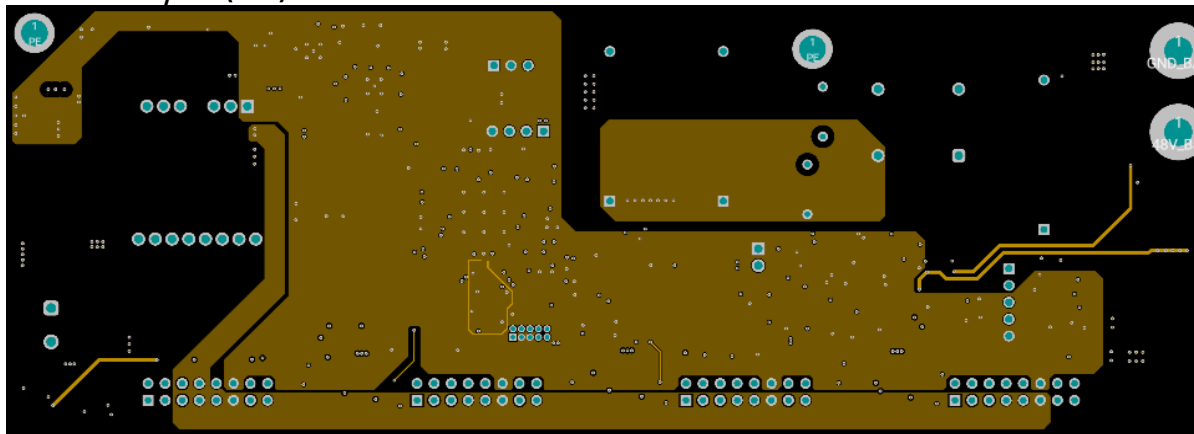
Top layer (L1)



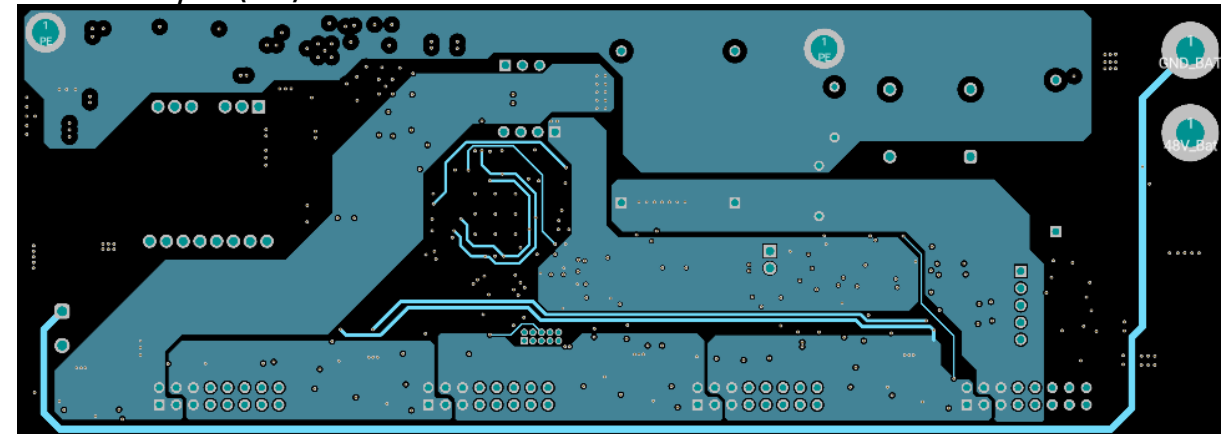
Bottom layer (L4)



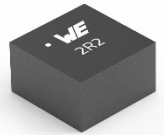
Inner layer (L2) GND



Inner layer (L3) PWR



PARTS FROM WÜRTH (MASTER BOARD)



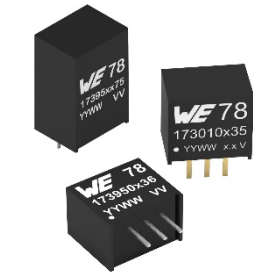
WE-MXGI

Power Inductor



WE-CBF

EMI Suppression
Ferrite Bead



MagI³C-FDSM

Fixed Step Down Regulator
Module



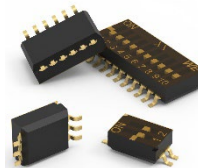
WE-SL3

Common Mode Line
Filter



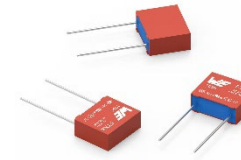
WS-DISV

Small Compact SMT Flat Actuator with Top Tape



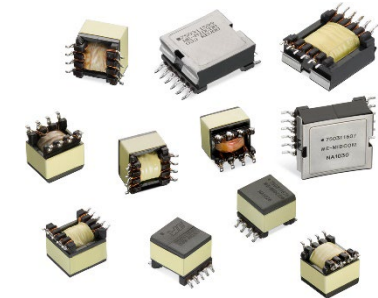
WCAP-FTXX

X2 - Film Capacitors



WE-CMB

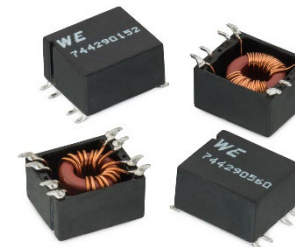
Common Mode Power Line
Choke



Flyback
Transformer

WCAP-PSHP

Aluminum Polymer Capacitors

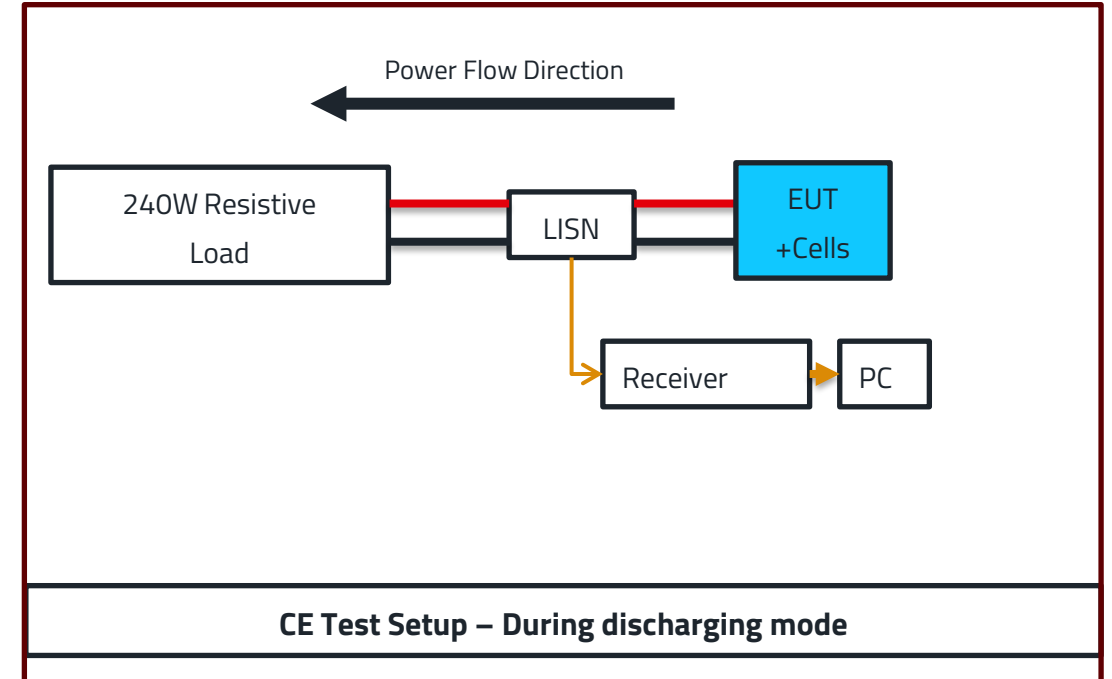
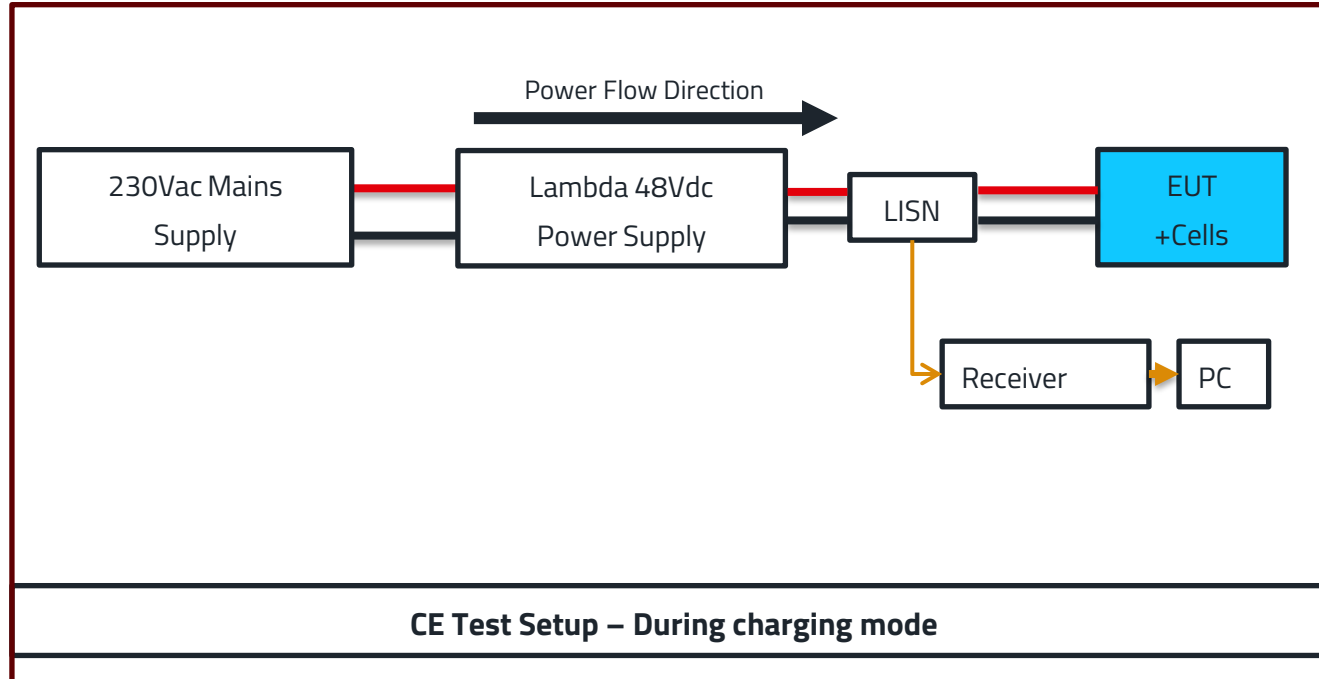


WE-UCF

Common Mode Line
Filter

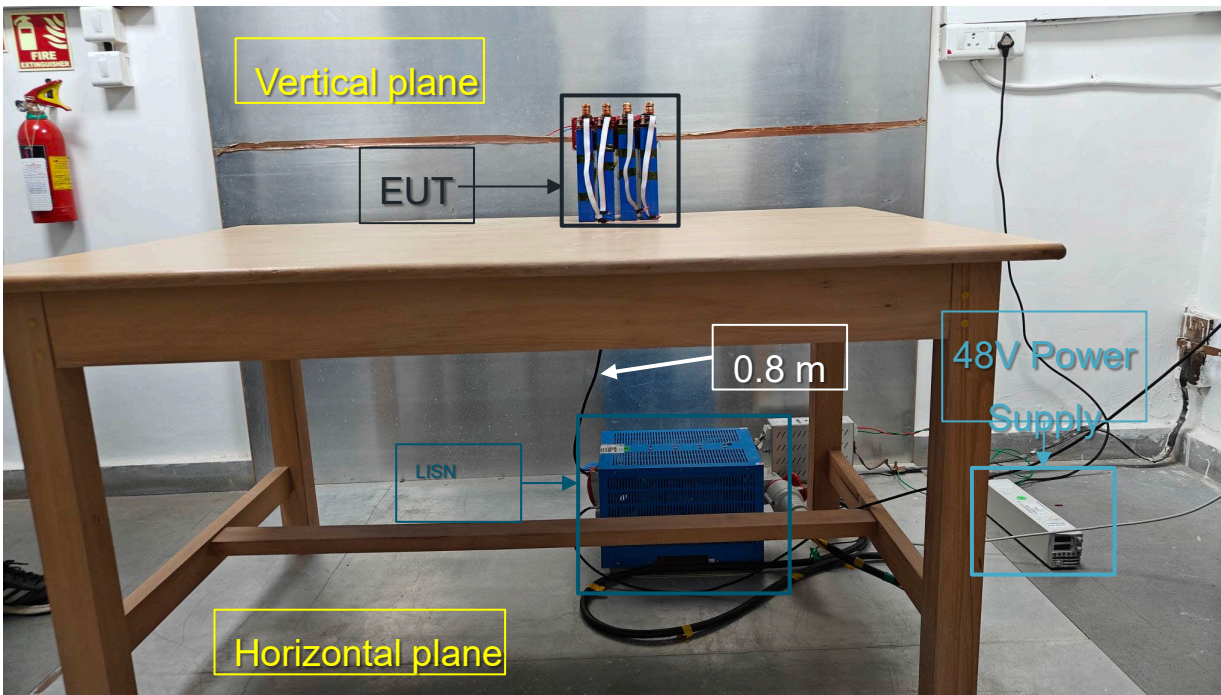
TEST SETUP BLOCK DIAGRAM

CISPR 22 Class A

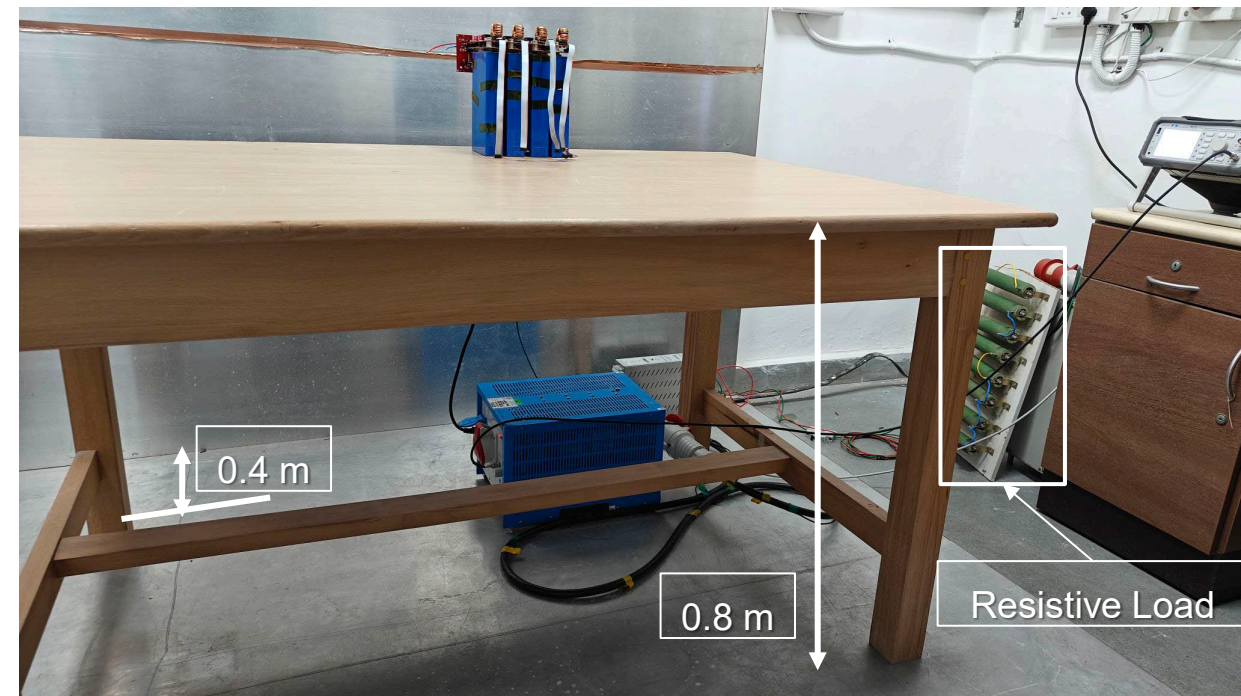


CE TEST SETUP

Charging Mode

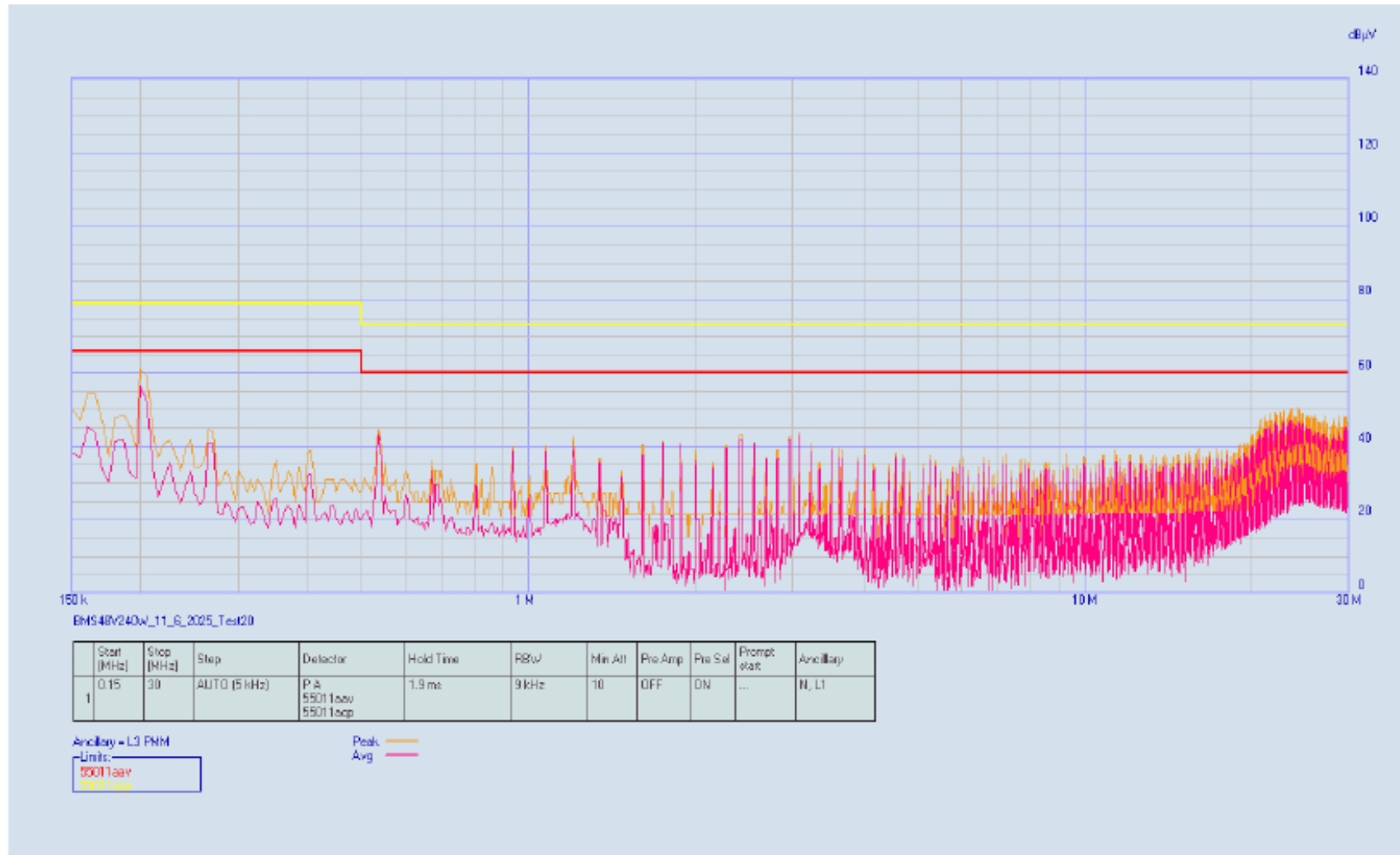


Discharging Mode



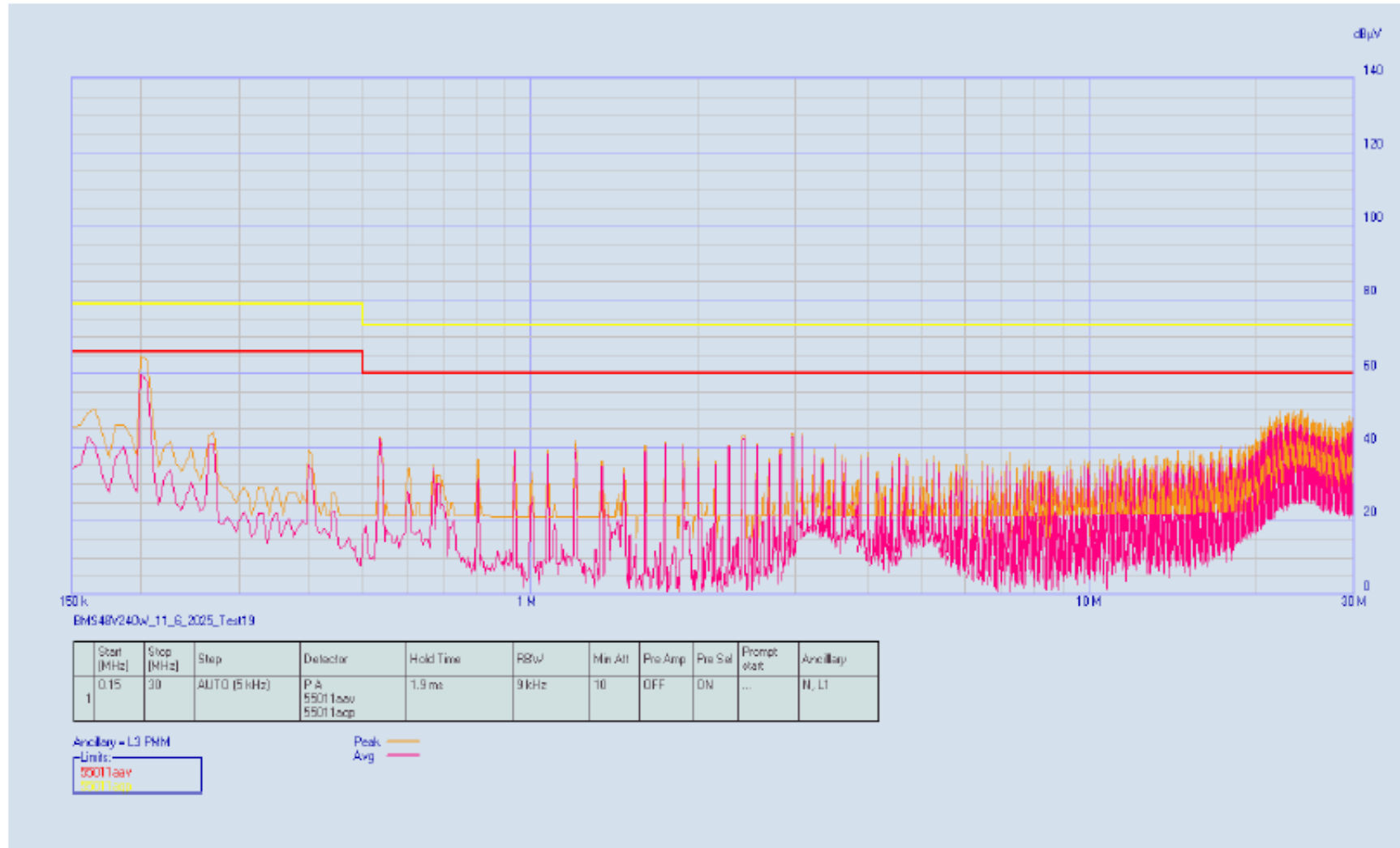
RESULT – CHARGING MODE

Vout= 48V, Iout= 4.45A



RESULT – DISCHARGING MODE

Vout= 48V, Iout= 4.45A

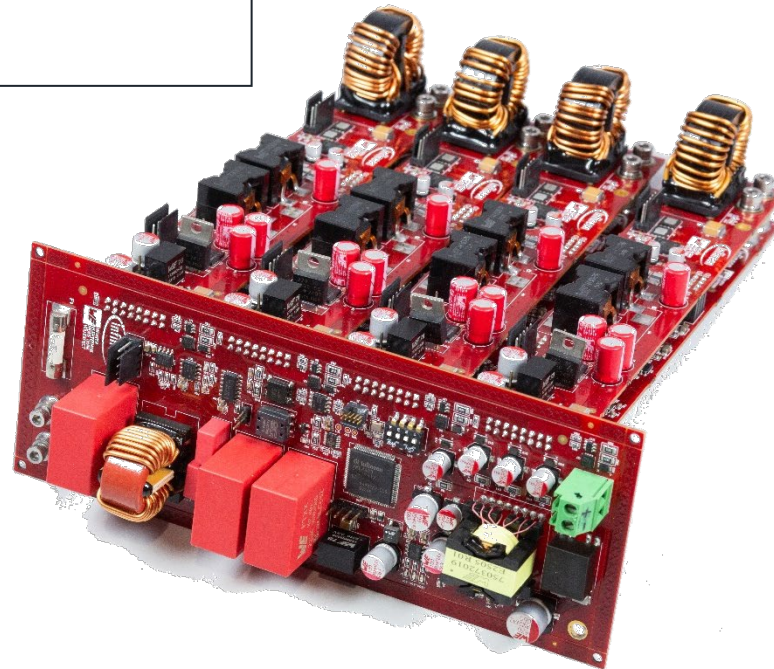


Features

- Active cell balancing without BMS
- Modular and scalable solution
- High output voltage using less number of cells
- Reduce stress on power semiconductor
- Improved Efficiency: 95%
- Improved Reliability

Benefits

- Reduced voltage stress on MOSFETs
- Lower harmonic distortion
- Inherent redundancy
- Flexible Control
- Controls and Distributes the stress on cells
- Extendable to Transformer less DCAC Converter





WÜRTH ELEKTRONIK MORE THAN YOU EXPECT