INNOVATON IN DER PCB-TECHNOLOGIE

Waldkirch, 25.10.2017

Dirk Gennermann, Head of Product Marketing

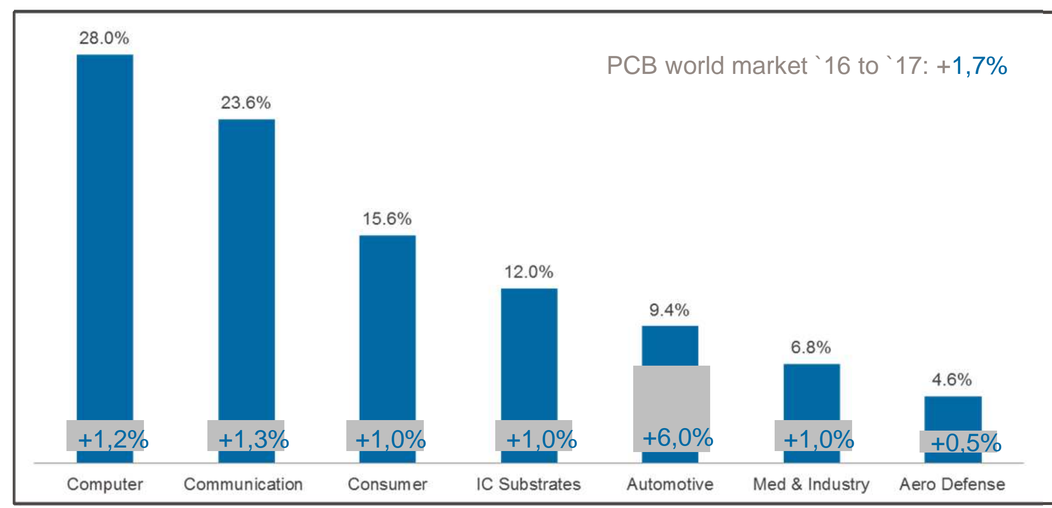
AGENDA

1. PCB Market overview
2. Schweizer @ a glance
3. Funding projects at Schweizer
4. Power PCB Trends
5. Power PCB Trends with Embedding

© Schweizer Electronic AG

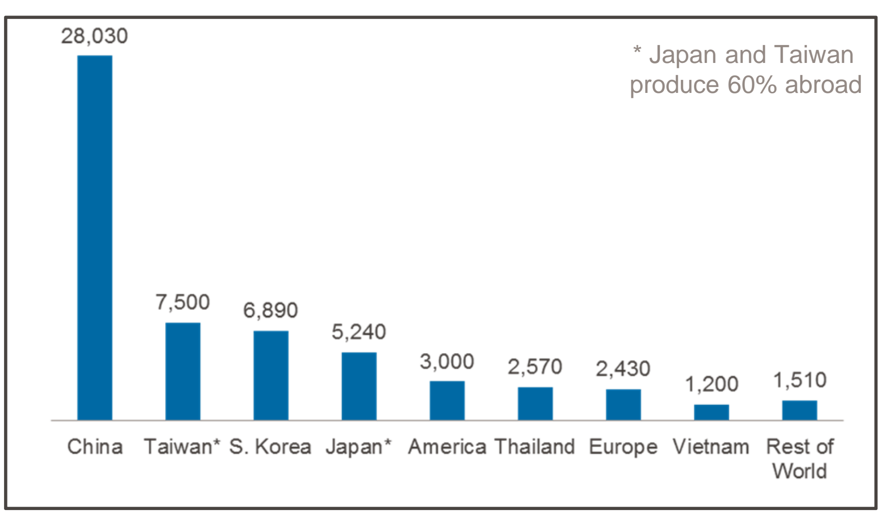
The PCB Market: 58.3 bn USD in 2016

PCB Market by Industries



Source NTI

World PCB Output in 2016 in mio. USD by country

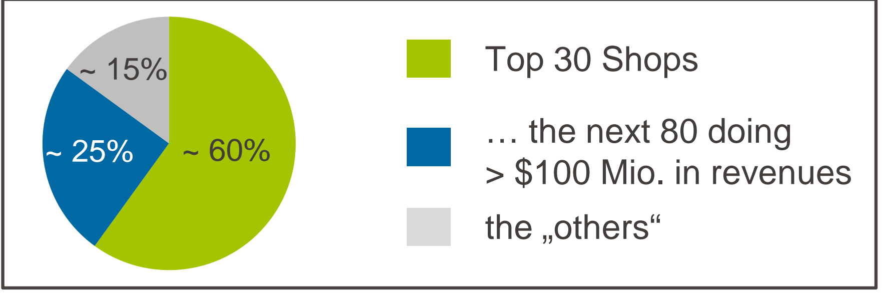


Source NTI

Different kinds of rigid PCB FABs

Lower Layer Count	Higher Layer Count	HDI	Super fine Pitch

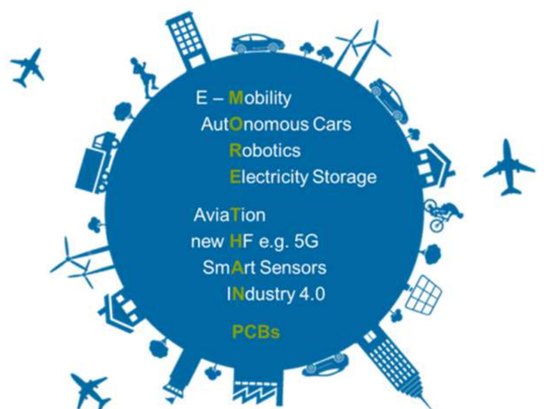
2,400 PCB Shops



Source NTI

SCHWEIZER @ A GLANCE

- 168 years successful company history
- 116.1 Mio. € revenue in 2016
- 5th growth year in a row
- Automotive 76%, Industrial 18%, Other 6%
- >780 employees
- Partners: WUS, Infineon, Meiko, Elekonta
- A leading supplier for Sensor and Power PCB solutions
- … with numerous substantial novel product concepts for tomorrows:



Schweizer and its global Partners

Chip Embedding

Reliable mass production

Technology development

HF PCBs / HiLo PCBs

WUS

Quick turnaround samples

AUTOMOTIVE INDUSTRY WILL BE DISRUPTED

Tony Seba, **Disruption Guru**

"The Automotive Industry will be disrupted on **battery cells, sensors and social networks.**"

IN 2030

ALL CARS

WILL BE

- **ELECTRIC**
- **AUTONOMOUS**
- **SHARED**

SCHWEIZER TODAY
SENSOR- & POWER PCB SOLUTIONS

	Sensor PCB Solutions		Power PCB Solutions		
	Autonomous Driving		**CO_2 Reduction**		
Application Examples	Radar Sensors Source: Bosch	Cameras Source: Continental	Optimisations of conv. Drivetrain Source: Continental	LED Headlamps Source: Daimler	Hybrid & E-Cars Drive – DC/DC –AC/DC Source: Infineon
PCB Solutions	77GHz Hybrid Source: Bosch	FR4 Flex Source: Continental	"Bond PCBs" Source: Continental	Power PCBs e.g.: IMS Board e.g.: Inlay Board	
Embedding Solutions	Due to further increasing performance- and miniaturisation needs, many applications will use Embedding Solutions in the Future µ² Pack® i² Board® p² Pack®				

FUNDING PROJECTS AT SCHWEIZER

STRENGTHEN OUR CORE COMPETENCIES

Project VoLiFa 2020

- Embedding of Power and Logic Semic.
- Highest Power Dissipation

Smart PVI-Box

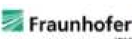
- High Temperature/ High Thermal Conductivity
- Embedding of Wide-Band-Gap Semiconductors

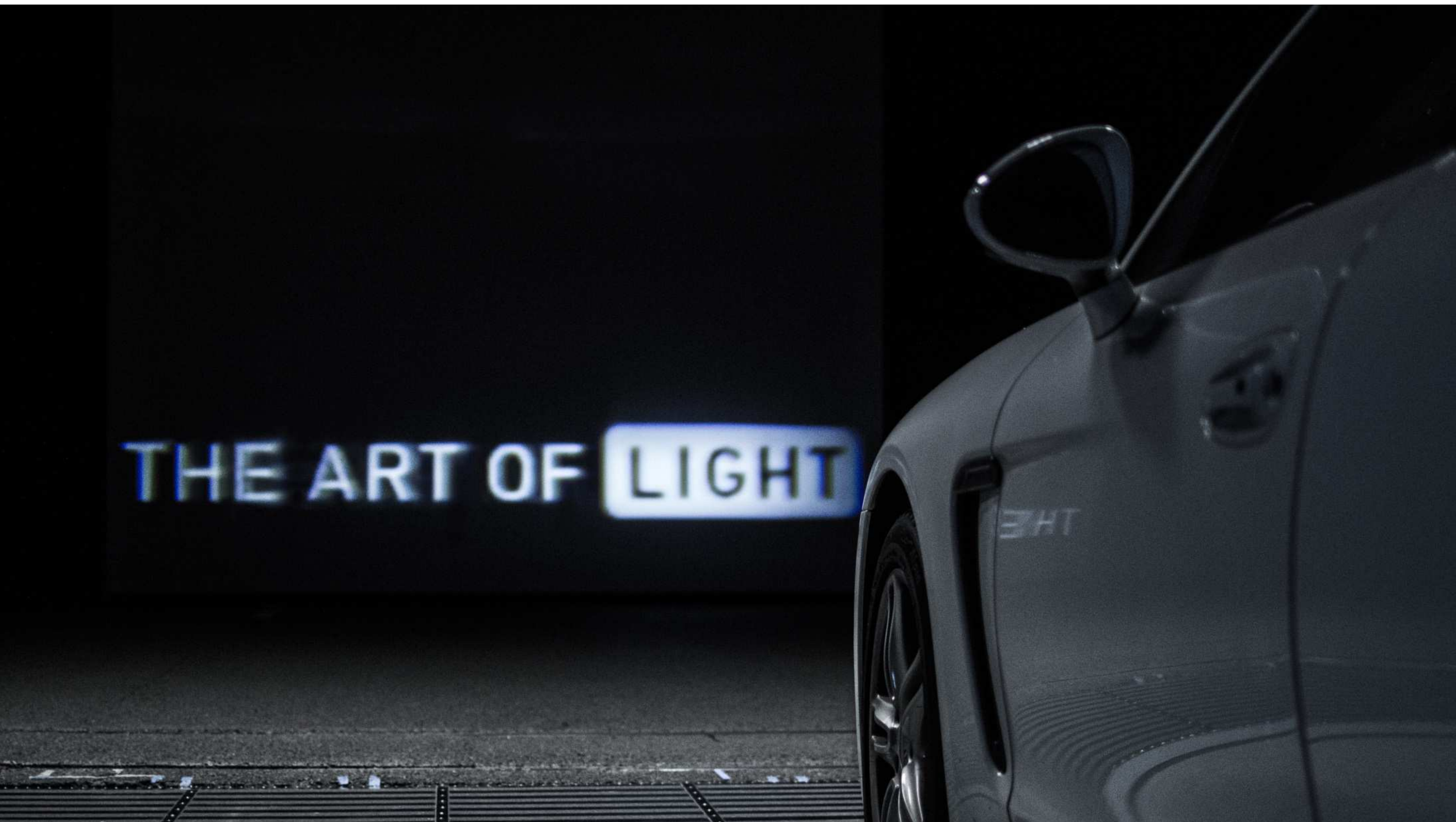
isola
PETERS

SIEMENS
DAIMLER

BMBF-Project KoRRund

- Embedding of Radar ICs
- Novel Radar Antenna Technologies




THE ART OF LIGHT

VoLiFa 2020 Head Lamp

Cornering light

Extra high beam

Daytime running light

LCD module

Forefield modules

Schweizer involvement

Liquid Crystal HD head lamp

Secondary Optics
Combination Of Both Lightpaths

LCD Unit
300 x 100 Pixel
Analyzer

Polarized Light (vertical)

Mirror
Deflection Of Light Beam

Polarized Light (horizontal)

Wire Grid Polarizer
Plane Of Polarisation Separation
WG Film Frame

Electronics LCD / LED

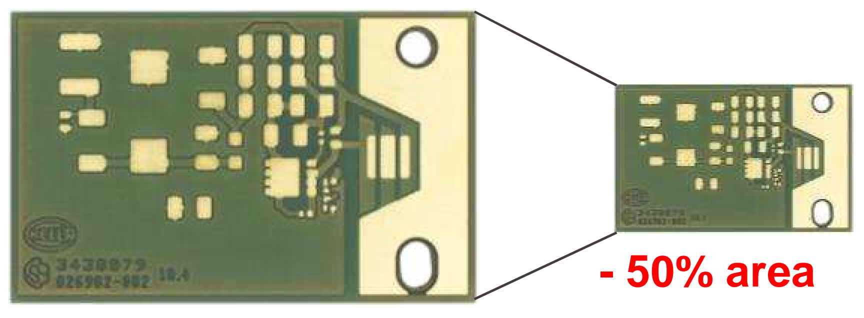
LED Matrix
With TIR Optics
(Non Polarized Light)

source: Hella

PCB FOR FOREFIELD MODULE

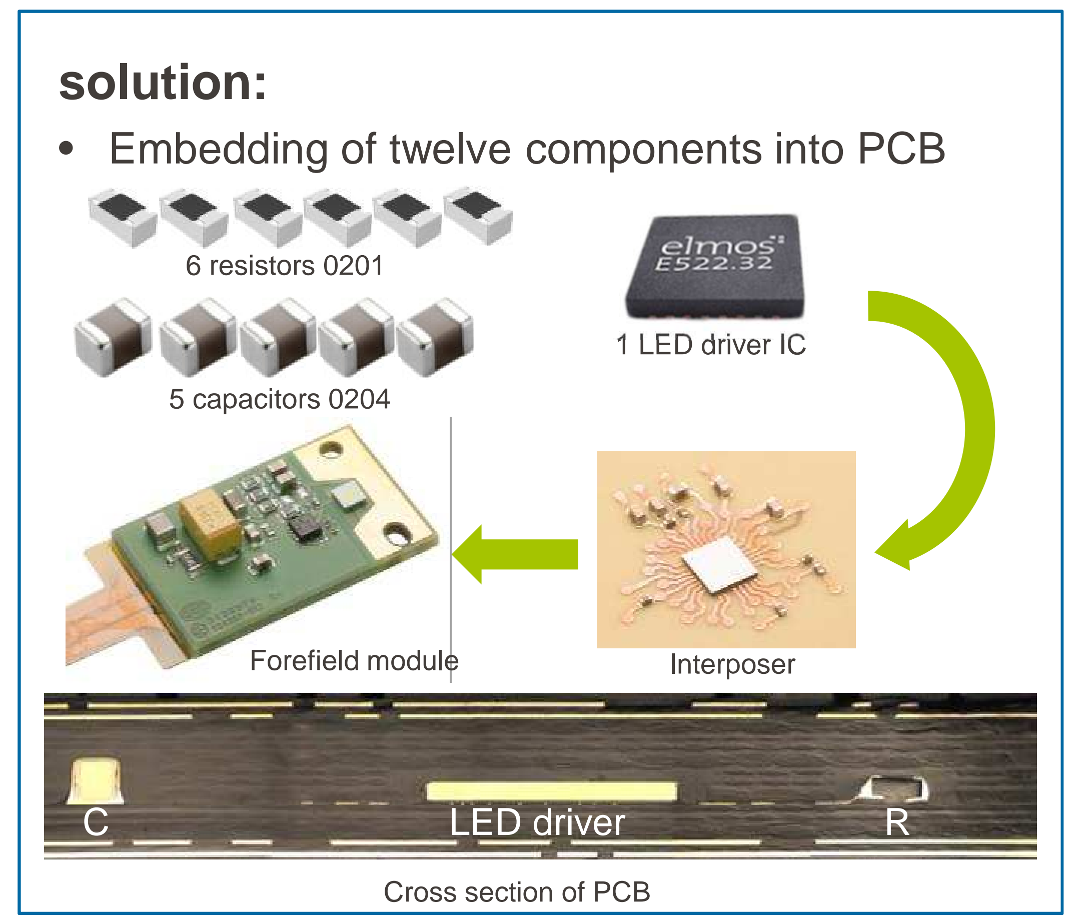
Innovation task:

- miniaturization
- More functions in less volume
- „More than Moore“



solution:

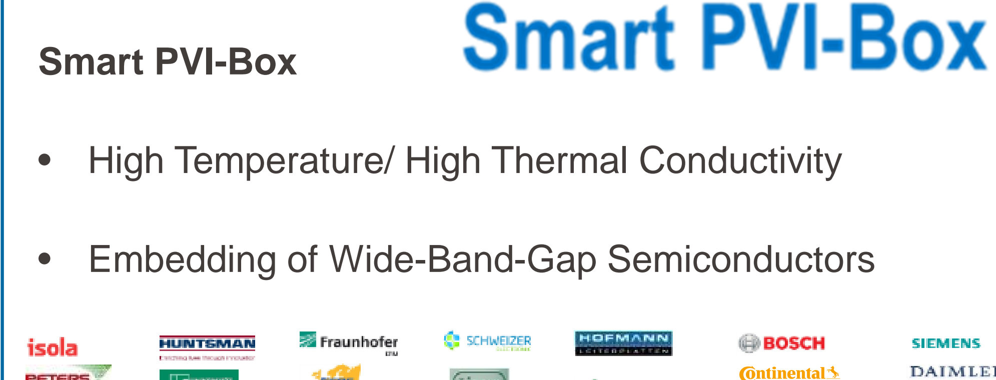
- Embedding of twelve components into PCB

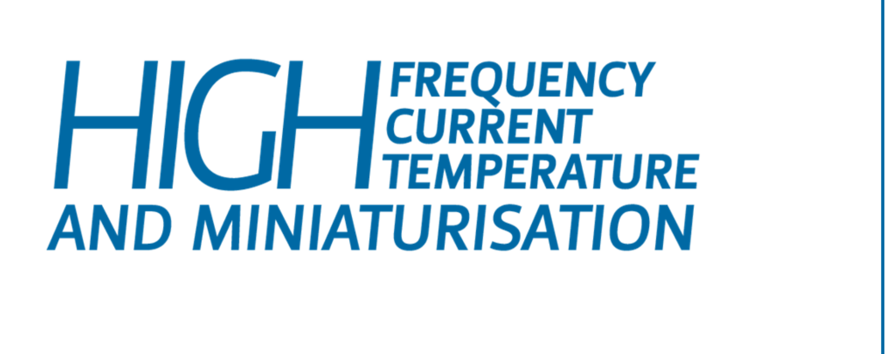


Cross section of PCB

Circulation and Publication subject to prior approval by Schweizer Electronic AG

STRENGTHEN OUR CORE COMPETENCIES





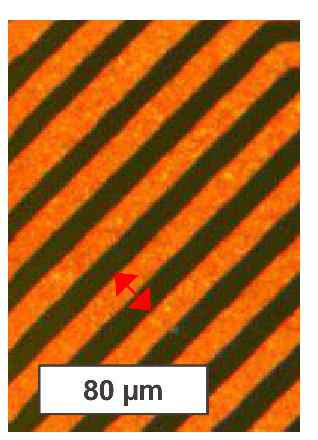
IN DEVELOPMENT: NEW RADAR TECHNOLOGY

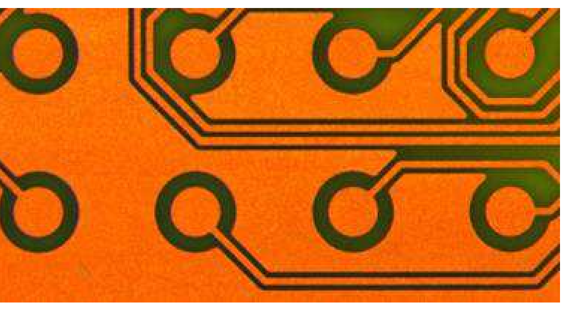
Impact on radar antennas

- Spec limit of traces today: undercut <20 µm
- New Technology: „no“ undercut (~2 µm)
- Sharp antenna edges

Benefits for Layout

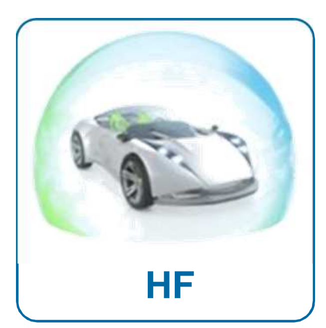
- 40 µm lines/spaces on HF side
- Via in pad without dimple

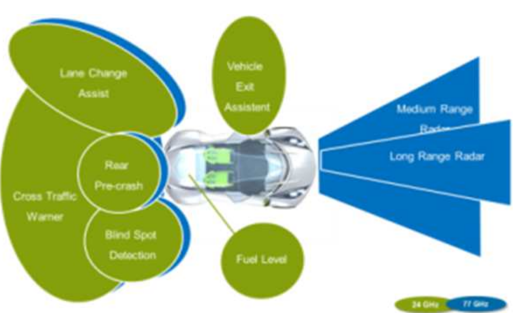




In development

EMBEDDING THE NEXT BIG TREND FOR HF

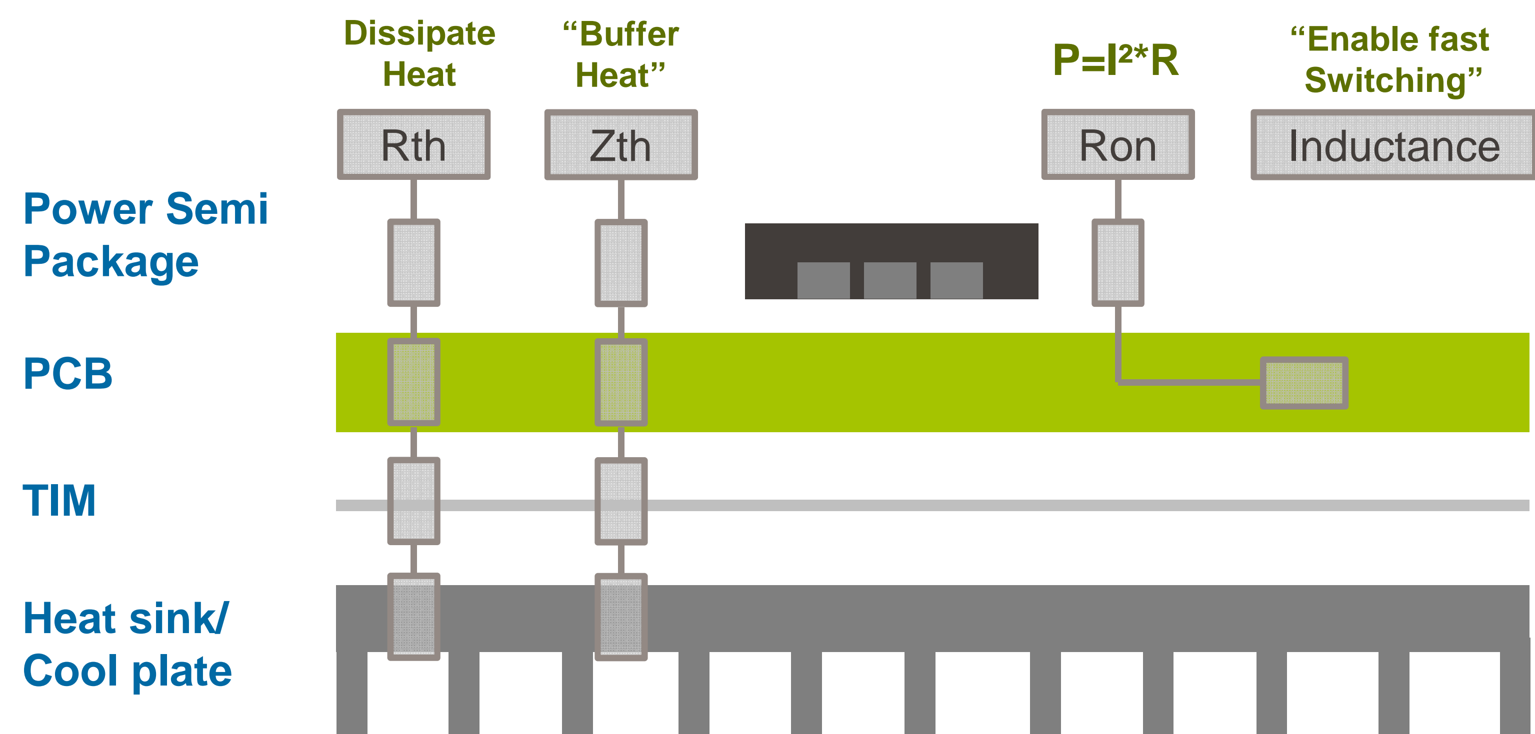




	Antenna HF	HF Embedding
Heat Dissipation	-	+
Shielding	-	+
Duty Cycle	-	+
Reliability	-	+
Form factor	-	+
Testability	+	-
PCB Cost	+	-

POWER PCB TRENDS

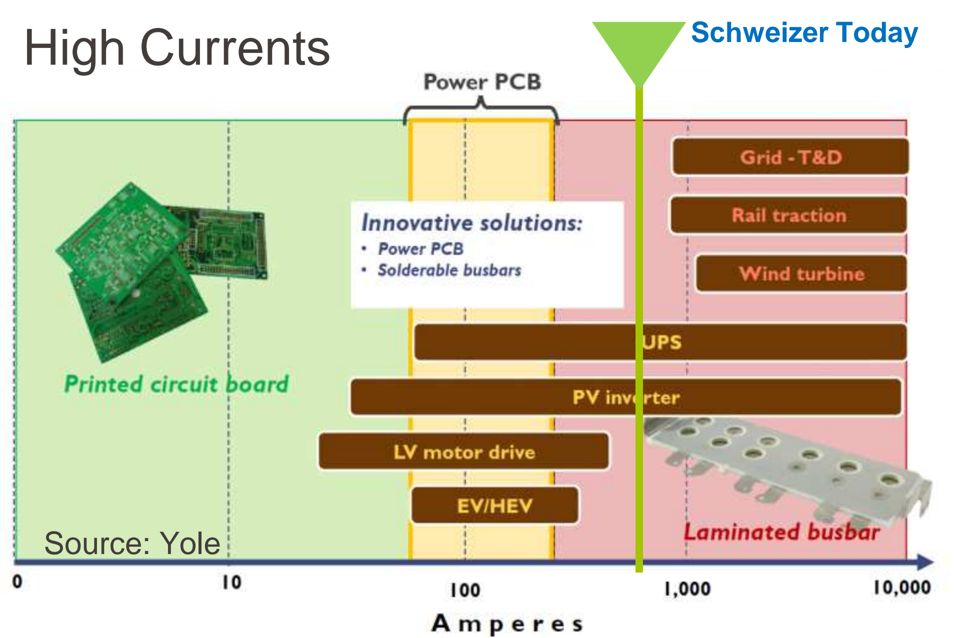
ELECTRICAL AND THERMAL PERFORMANCE OF A POWER DESIGN



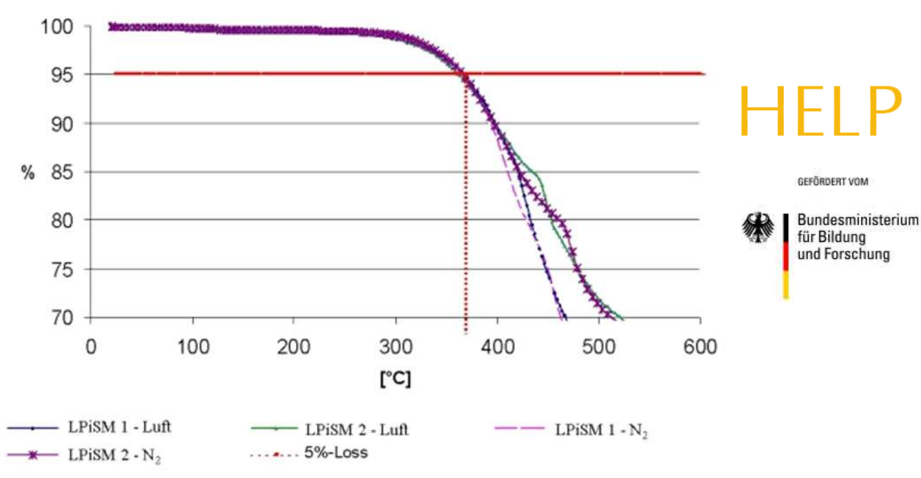
POTENTIAL POWER OPTIONS

POWER PCBS

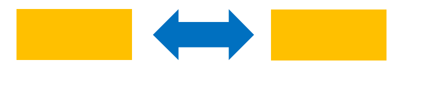
High Currents

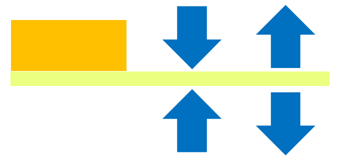


High Temperature

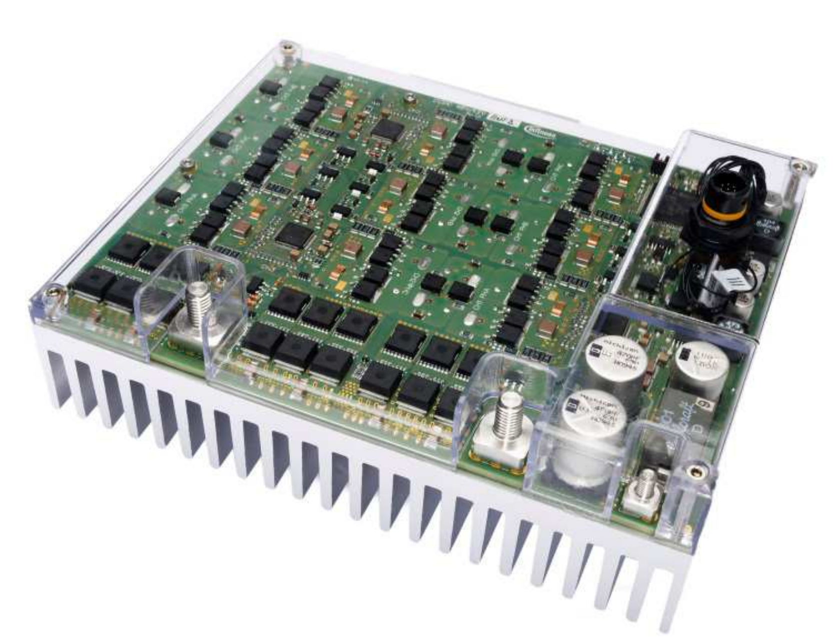


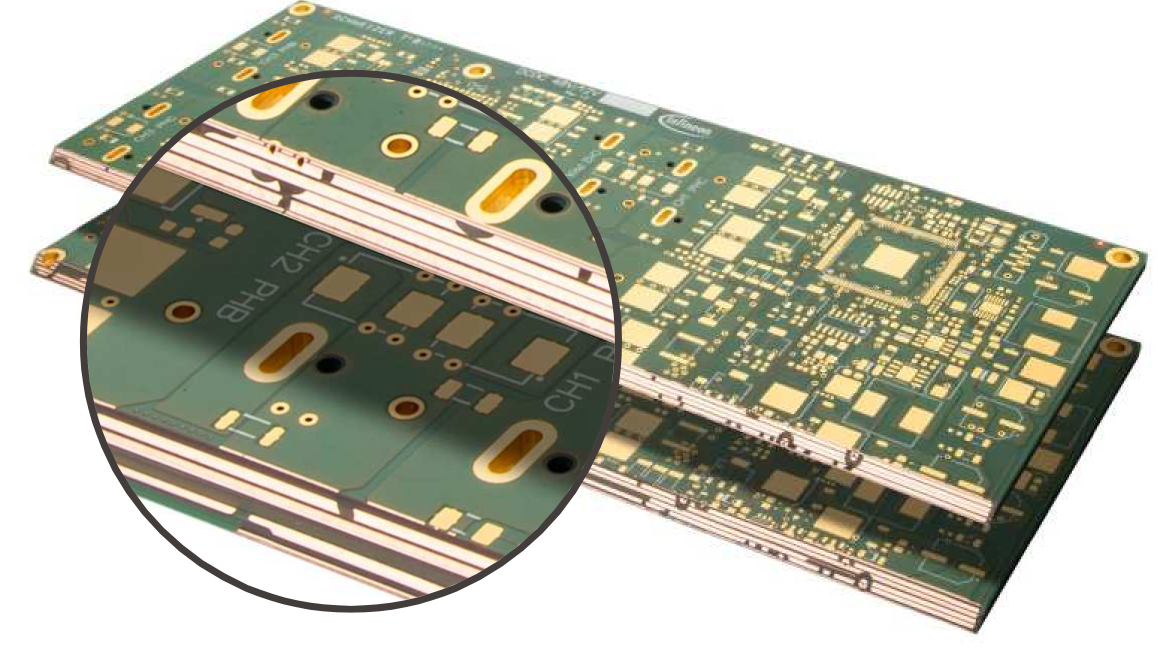
High Voltage





48/12V DC/DC DEMO





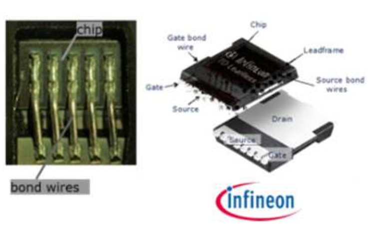
- in cooperation w/ infineon
- 4 x 400 µm Cu &
  4 x 70 µm Cu

- w/ Heavy Copper T² = 2,6 mm
- w/ Heavy Copper = 3,5 mm

ON-RESISTANCE LOSSES OF PCB MATTERS

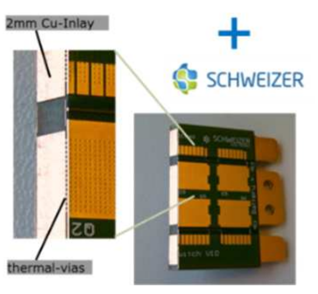
High current system approach, combining

- High current MOSFET technology **84µOhm @ 25°C**
- High current Inlay Board technology **29µOhm @ 25°C**



1. MOSFET losses $P=I^2*R$

P @ 300 A:
@ 25°C: = 7,6 W (75%)
@ 150°C: = 15,12W (79%)



2. PCB losses (2mm Inlay)

P @ 300 A:
@ 25°C: = 2,6 W (25%)
@ 150°C: = 4,05 W (21%)

Smart Battery Switch Demonstrator
TO-Leadless MOSFET & Inlay Board Technology

POWER PCB TRENDS WITH EMBEDDING

EMBEDDING – WHAT'S THAT?

	System in Package	System in PCB
Logik	e.g. µ² Pack® PLP Solutions	e.g. i² Board®
Power	e.g. p² Pack® DSV	e.g. p² Pack®

Embedding – requires a new business model & supply chain

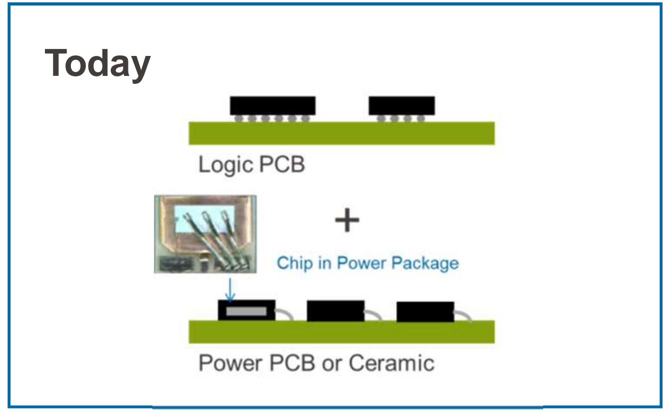
POWER ON DEMAND WITH SMART p² PACK® IN PARTNERSHIP WITH INFINEON

#1 in Power Semiconductors

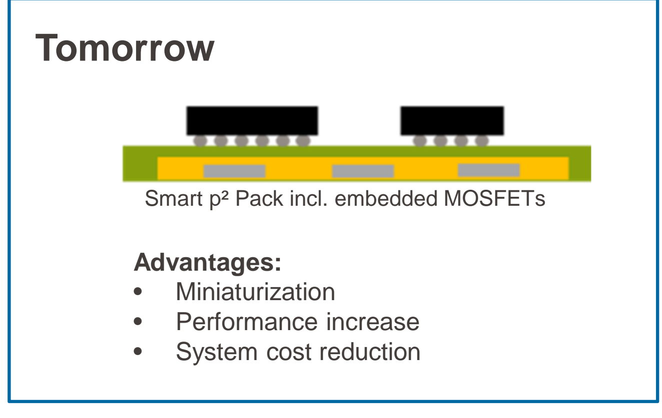
Leading Supplier of Power PCBs

… join forces to establish a new Semiconductor & PCB solution

Today

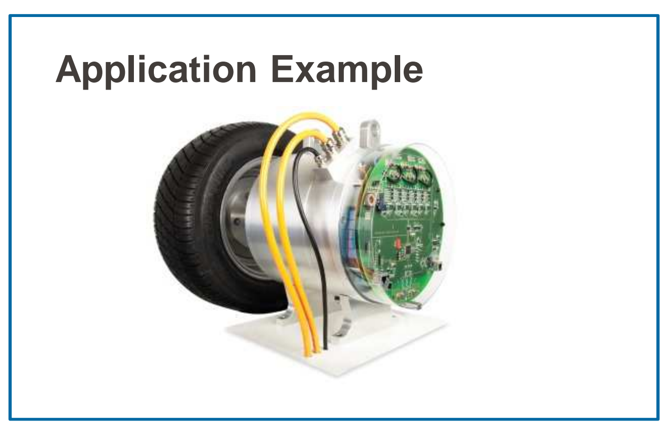


Tomorrow



Advantages:
- Miniaturization
- Performance increase
- System cost reduction

Application Example



SMART p² PACK GOAL

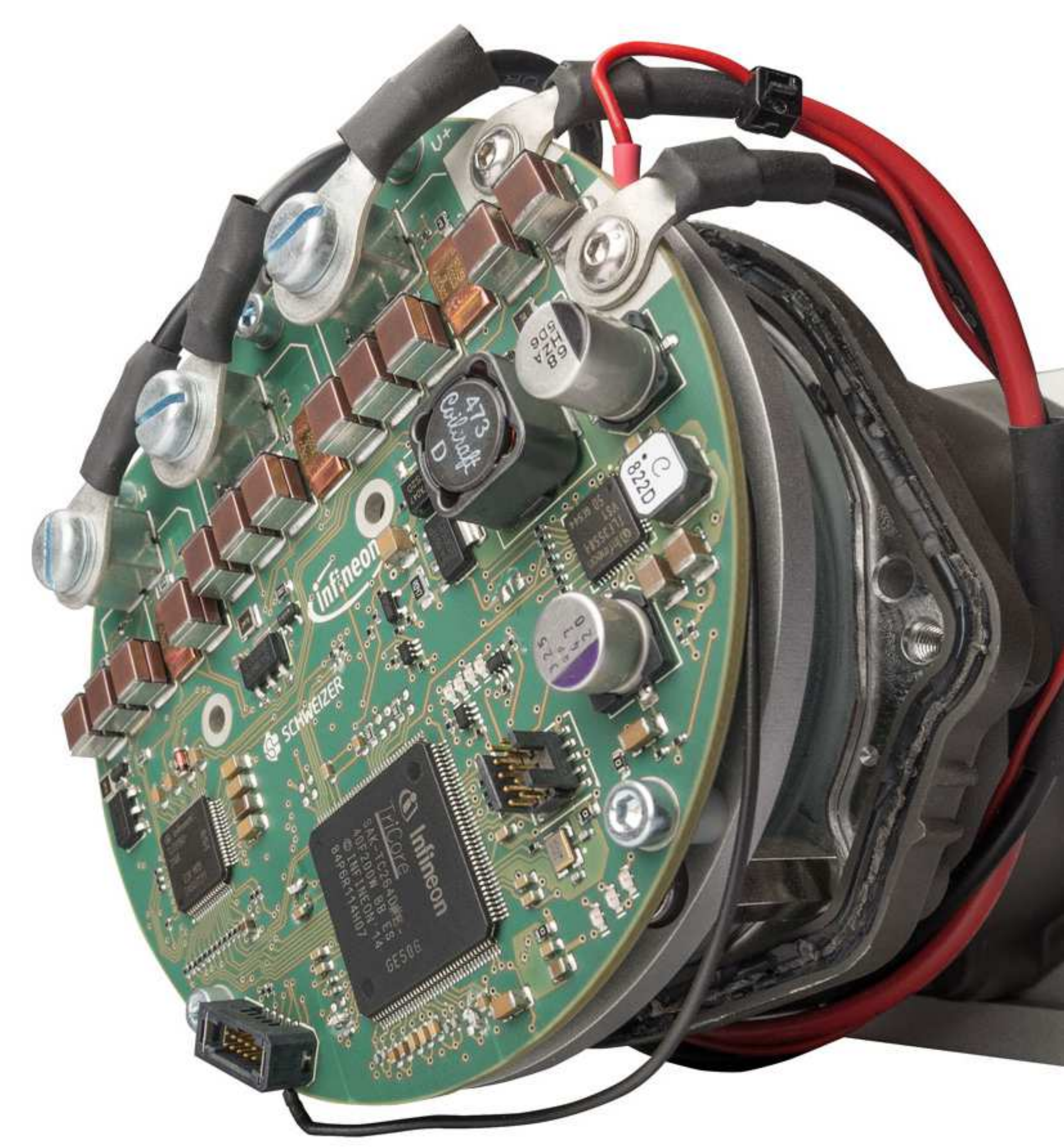
p² Pack® offers

either **~30%* less power dissipation**

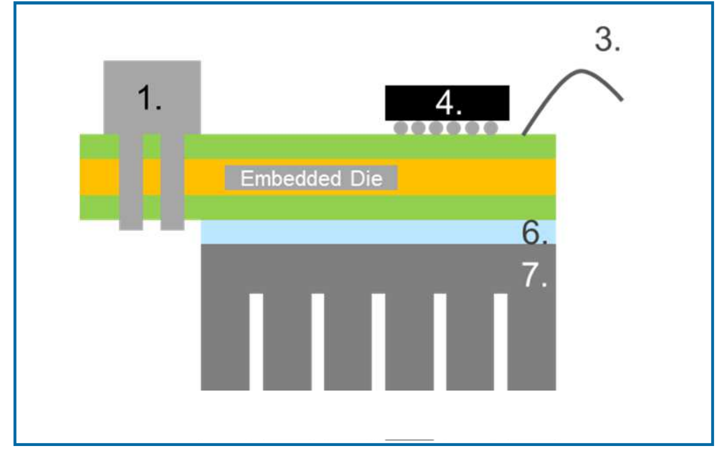
or **~50%* higher performance**

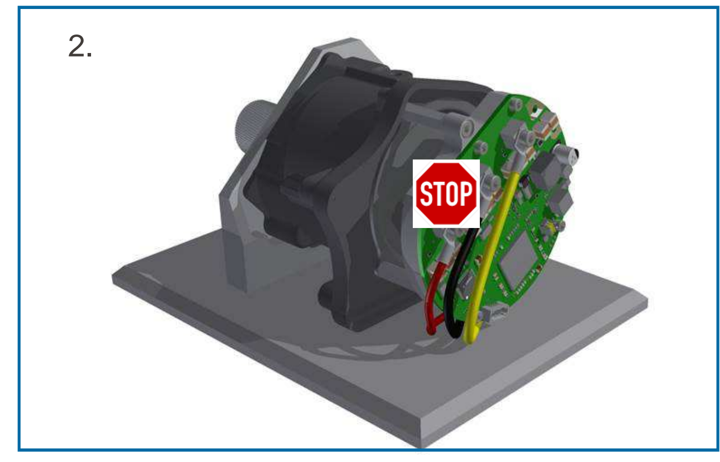
compared to a conventional packaged MOSFET (w/ same Die Size) on PCB solution.

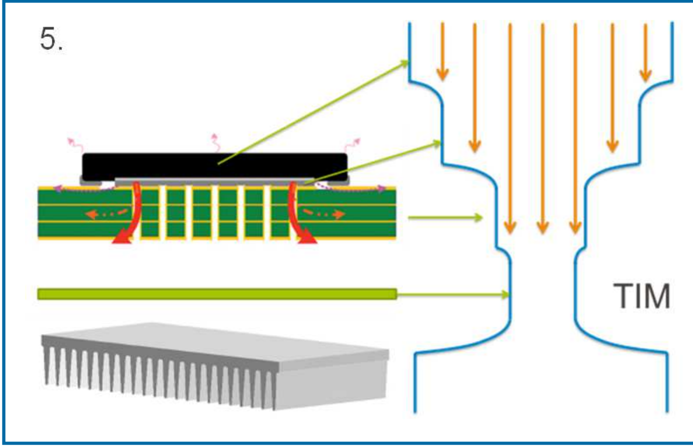
* Engineering estimate: exact % may vary depending on the specific application

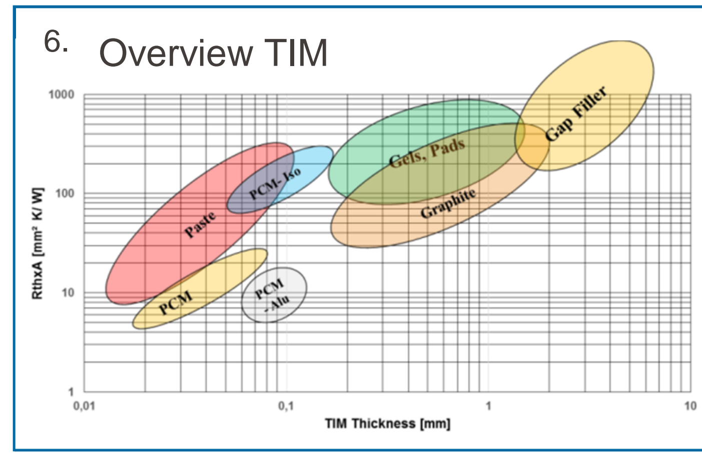


EMBEDDING REQUIRES NEW SYSTEM CONSIDERATIONS









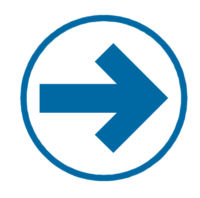
1. How to bring high currents "ON and OFF the PCB"?
2. How to connect Motor and Inverter?
3. How to connect the Logic- and the Power PCB?
4. Component Placement?
5. Optimize the heat flow
6. Performance TIM (and other new BAMA for High Tg and Voltage), Thickness, Isolation?
7. Water-, Air – no Cooling?

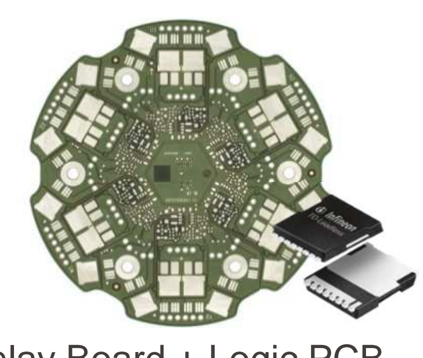
p^2 PACK DEMONSTRATORS

BSG Demonstrator in cooperation w/ Continental and Infineon

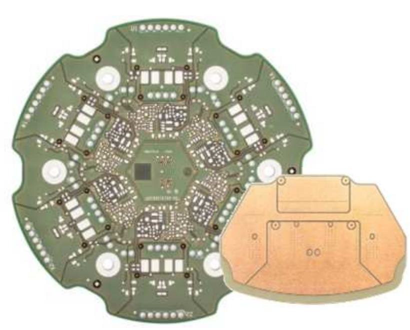
Source: Conti

Solution Today





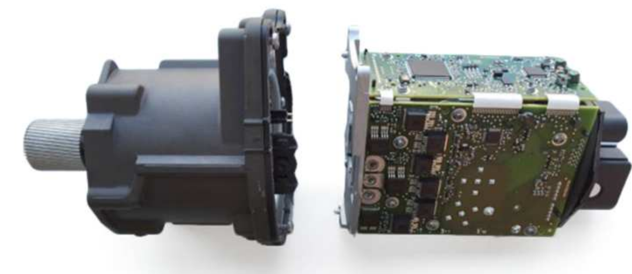
Inlay Board + Logic PCB



Smart p^2 Pack

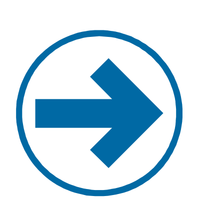
p^2 Pack with embedded MOSFETs

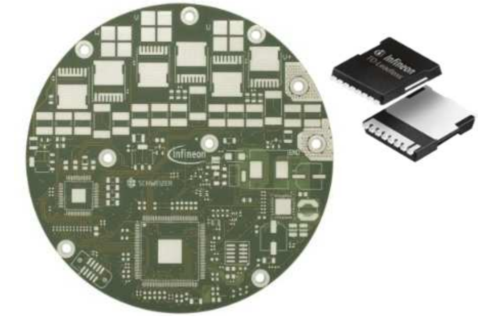
Auxiliary Drive Demonstrator in cooperation w/ Infineon



Source: VW

Solution Today



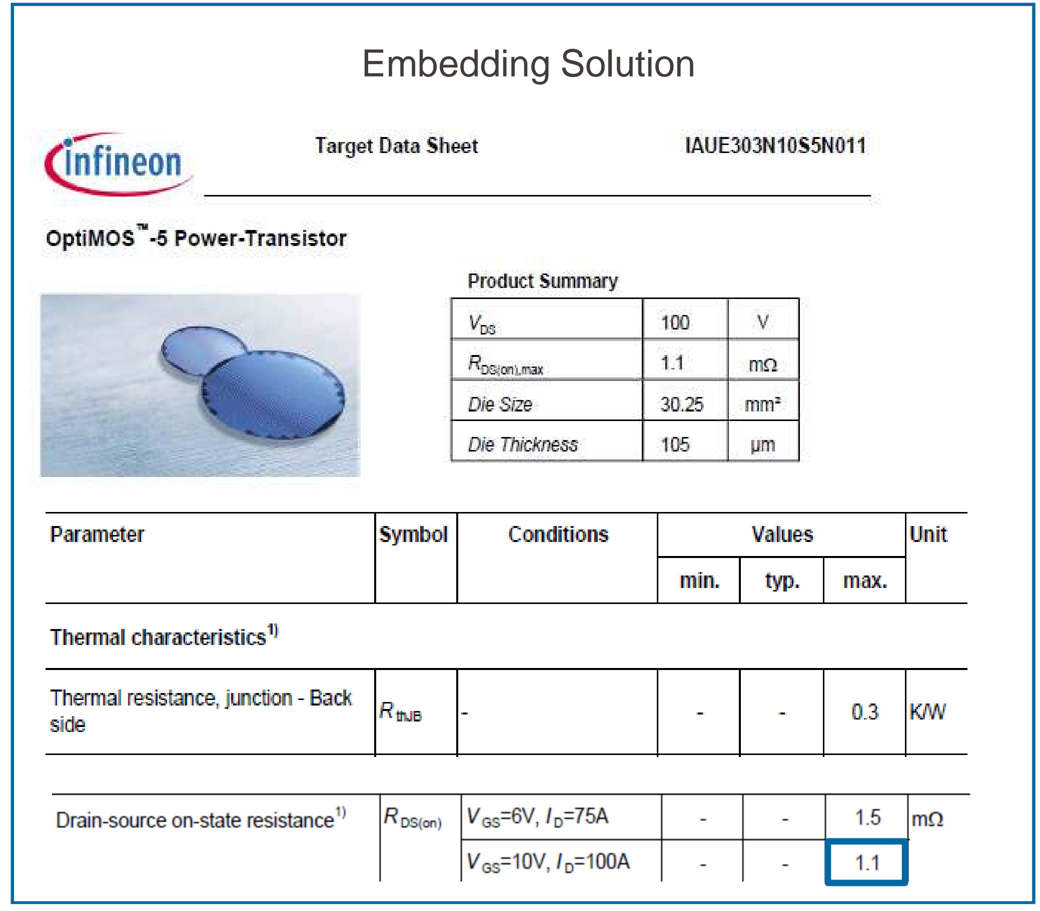


Heay Copper Solution

Smart p^2 Pack

p^2 Pack with embedded MOSFETs

COMPARISON OF “TOLL PACKAGE” W/ p² PACK DATASHEET LEVEL



Embedding Solution

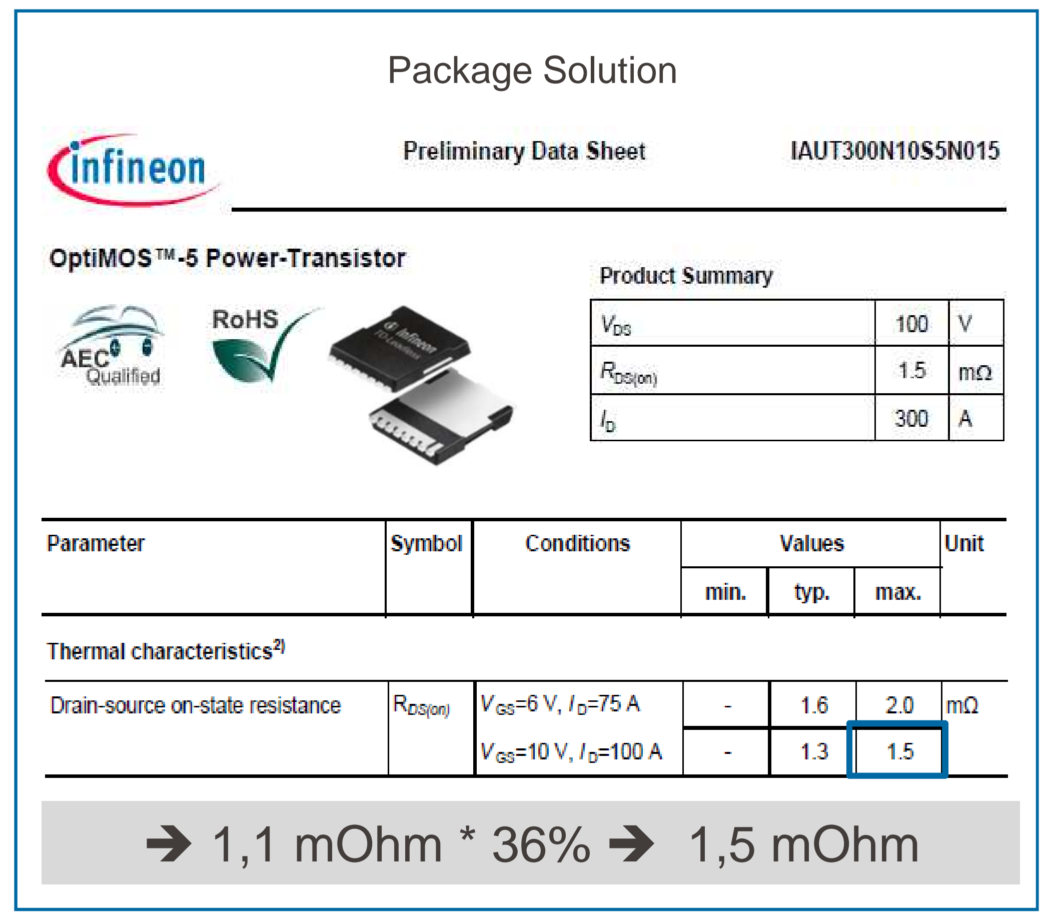
infineon | Target Data Sheet | IAUE303N10S5N011

OptiMOS™-5 Power-Transistor

Product Summary

V_{DS}	100	V
$R_{DS(on),max}$	1.1	mΩ
Die Size	30.25	mm²
Die Thickness	105	µm

Parameter	Symbol	Conditions	Values min.	Values typ.	Values max.	Unit
Thermal characteristics[1]						
Thermal resistance, junction - Back side	R_{thJB}	-	-	-	0.3	K/W
Drain-source on-state resistance[1]	$R_{DS(on)}$	V_{GS}=6V, I_D=75A	-	-	1.5	mΩ
		V_{GS}=10V, I_D=100A	-	-	1.1	



Package Solution

infineon | Preliminary Data Sheet | IAUT300N10S5N015

OptiMOS™-5 Power-Transistor

Product Summary

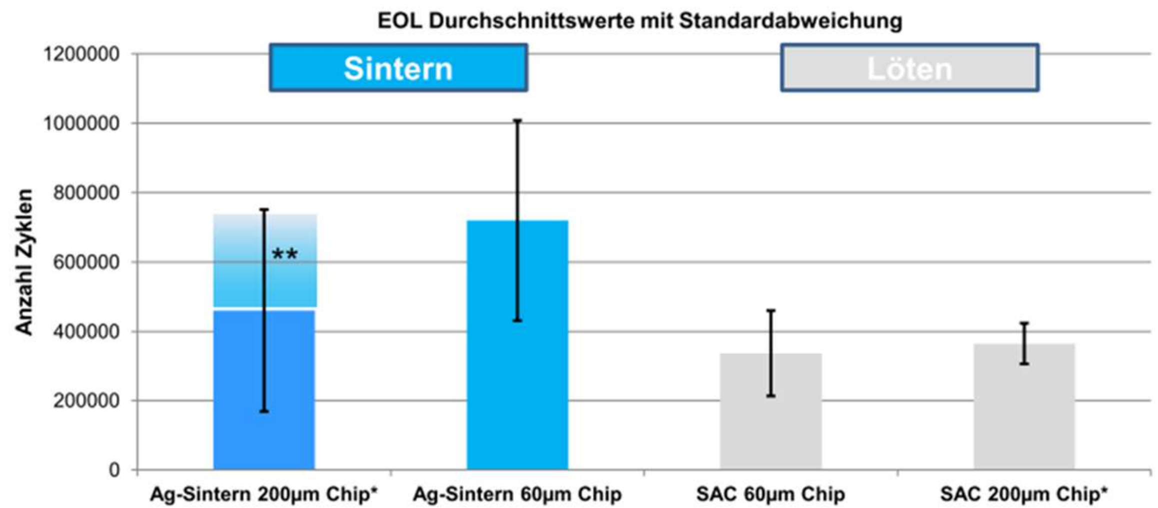
V_{DS}	100	V
$R_{DS(on)}$	1.5	mΩ
I_D	300	A

Parameter	Symbol	Conditions	Values min.	Values typ.	Values max.	Unit
Thermal characteristics[2]						
Drain-source on-state resistance	$R_{DS(on)}$	V_{GS}=6 V, I_D=75 A	-	1.6	2.0	mΩ
		V_{GS}=10 V, I_D=100 A	-	1.3	1.5	

➔ 1,1 mOhm * 36% ➔ 1,5 mOhm

CHIP EMBEDDING OFFERS POTENTIAL TO FURTHER IMPROVE RELIABILITY

Powercycling p² Pack

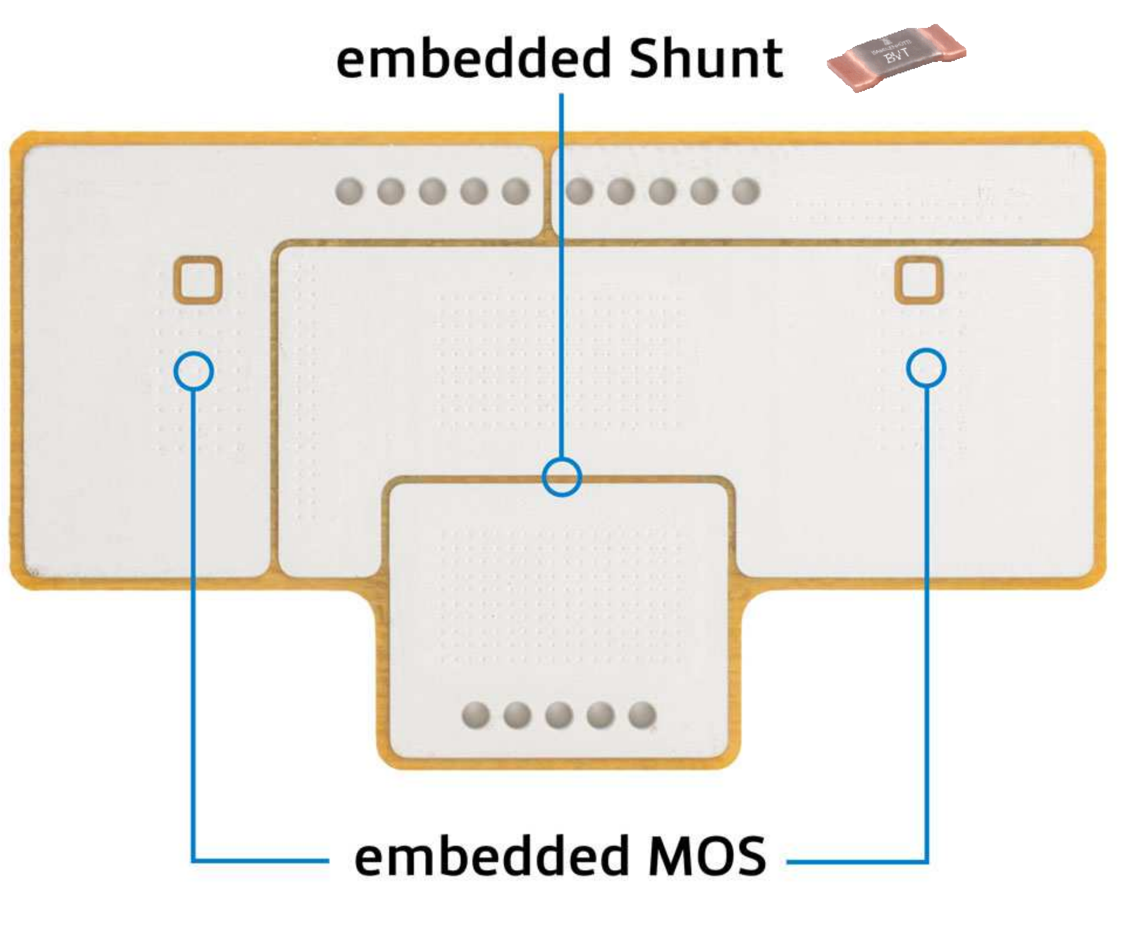


*Zyklisierung mit 80K Hub gestartet, dann auf 120K gesteigert. Umrechnung 80K->120K mit angenommenen Coffin-Manson-Koeffizient=3
** 4/5 der gesinterten 200µm Chip Muster haben bei Testabbruch EOL nicht erreicht. Schattierter Bereich symbolisiert qualitativ höheres Lebensdauerpotential.

- Chip: MOSFET, 60V
- LP-Material: Panasonic R14-T
- Testbedingungen: 120K Temperaturhub, 2s/2s Pulslänge
- EOL-Kriterien: el. Ausfall; Temperaturdrift >30K; R_{th} +20%

Silbergesinterte p² Pack Muster erreichten gegenüber den gelöteten Varianten eine deutlich höhere Beständigkeit beim Powercycling

p² PACK HALF BRIDGE W/ EMBEDDED SHUNT



- Embedded Shunt: 0,05 to 0,1 mOhm.
- 0 - 300 A
- 0,5 - 30 mV
- Thermal Dissipation 4,5 - 9 W
- Temperature rise 3 - 5 K
- Contact resistance < 1%(Microvias) of nominal resistance value

p² PACK INDUSTRIALIZATION ROADMAP

Applications

Motivation

High Currents
-
Fast Switching
-
Form factor

Low Voltage Applications

M

DC/DC

48V DC/DC
POWER CONVERTER

High Voltage Applications

incl. “wide band gap” Semis

AC/DC

AC/DC
POWER CONVERTER

Time

POWER ON DEMAND – POTENTIAL SMART p² PACK APPLICATIONS

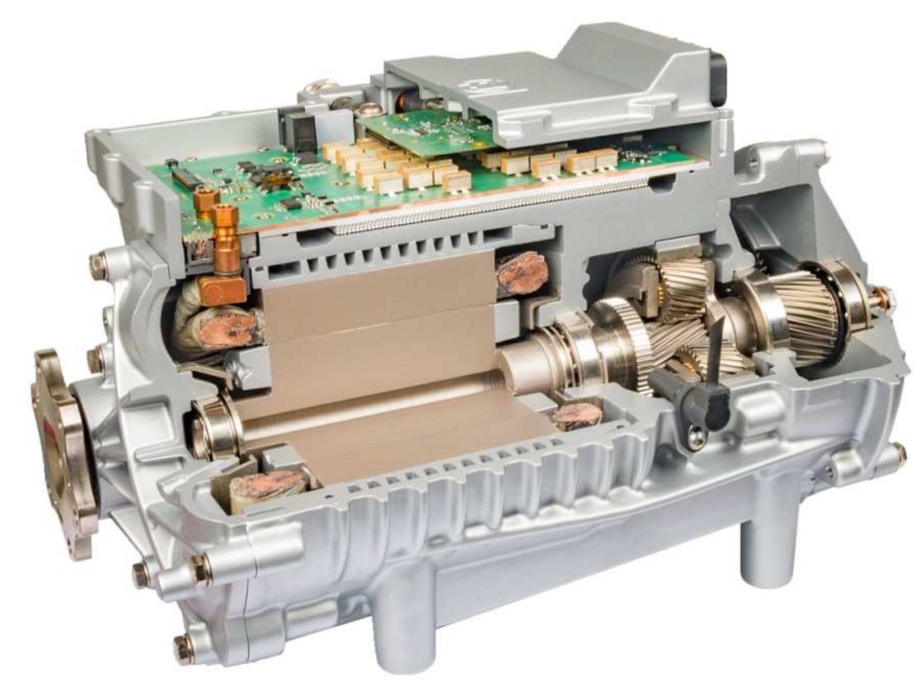
	Electrification ~ 500W – 5kW	Downsizing ~ 3kW – 50kW	Hybrid & E-Drive ~ >50kW
HV			Hybrid (+ DC/DC); E-Car (+ AC/DC)
48V	Active Roll Stabilize (Source: Silver Atena); Climate Compressor	48/12V DC/DC; Crankshaft Starter Generator	Mild Hybrid
12V (+ Optional 2nd 14V)	Gearbox; Power Steering; E-Pumps + Fans + Heaters	E-Compressor; Belt Driven Starter Generator	

SPHIN(X) 100 KW DEMO

Highly integrated electric axle drive for passenger cars

Joint research project (01.01.2013 – 31.12.2016)

- ZF Friedrichshafen AG (project coordination)
- Daimler AG
- Infineon Technologies AG
- TLK Thermo GmbH
- Institut für Thermodynamik / Technische Universität Braunschweig



Power-PCB by Schweizer; inverter in p² Pack technology

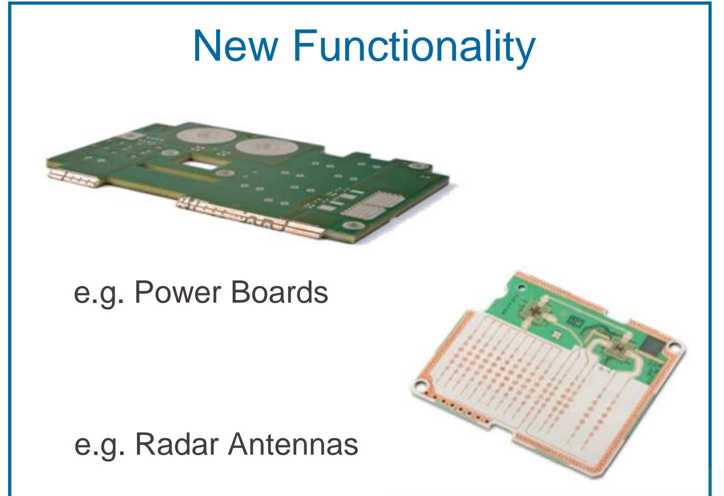
Compact, highly integrated, scalable inverter

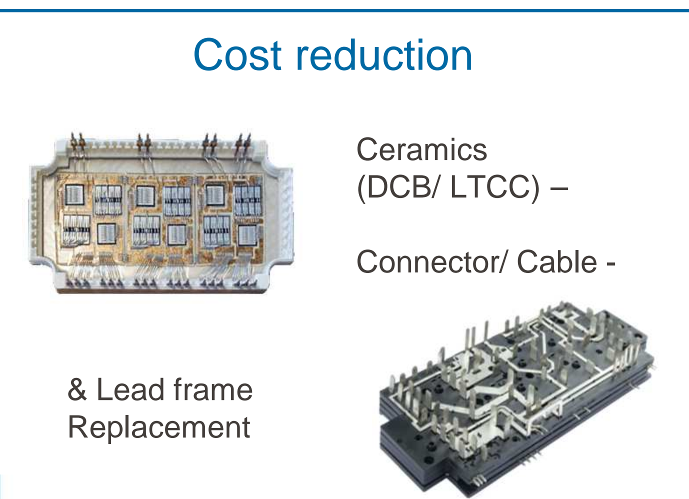
- U_{nenn} = 300 VDC
- I_{max} = 450 A_{rms}
- P_{max} = 100 kW

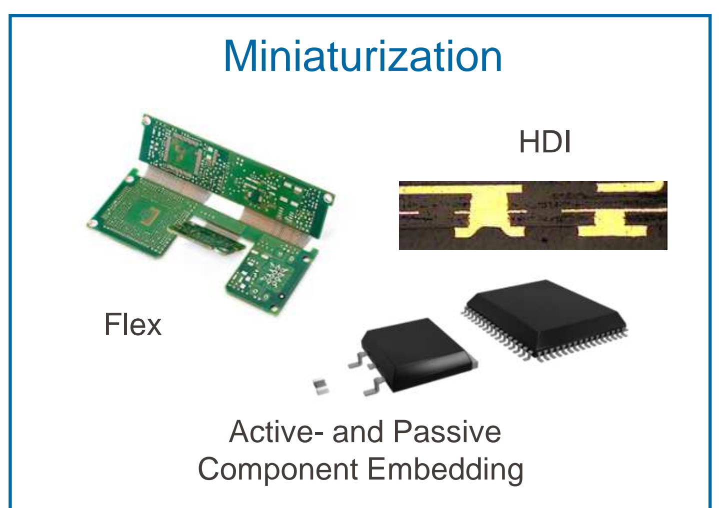
APPLICATION FIT

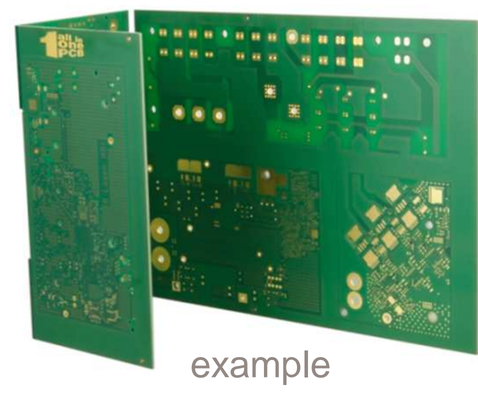
Major Applications	Block Diagram	Schematic View	Heavy Copper	Inlay	Cu IMS	p² Pack
LED				X	X	
Switch				X		
Motor Drive			X	X	X	X
DC/DC, AC/DC	H-Bridge DC/DC		X	X	X	X

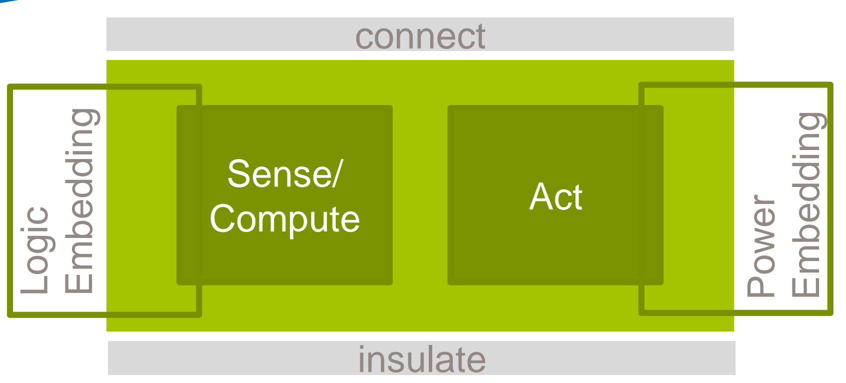
MORE THAN PCBS











SCHWEIZER

more
than PCBs