



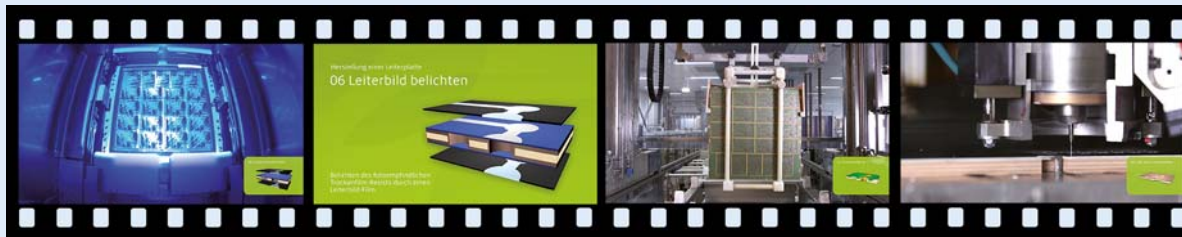
PCBs – PRODUCTS AND SOLUTIONS

SCHWEIZER ELECTRONIC – INNOVATIVE PCB SOLUTIONS FOR VARIOUS APPLICATIONS

Requirements related to electronic components for various applications are continuously increasing. Thus classical PCBs are evolving more and more from a pure component carrier towards a system solution. SCHWEIZER's strategy follows this approach by focusing on technological solutions which address today's trends towards mobility and energy efficiency. The following pages show an overview of SCHWEIZER's technology portfolio.



MANUFACTURING PROCESS OF A PCB



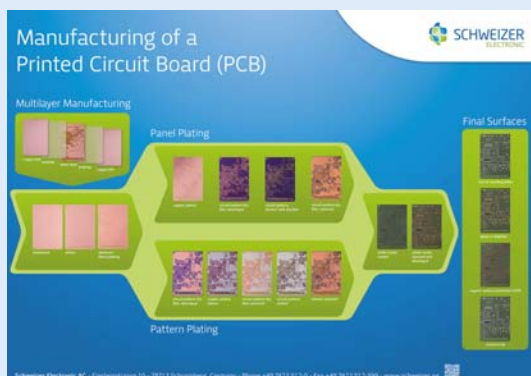
How does the production of printed circuit boards (PCBs) actually work?

Short and easy to understand, the new documentary presents the essential production stages of a standard PCB in the high-tech plant on SCHWEIZER's premises. This is an 'educational' video which explains the basis for all PCB innovations of our company. Just go to www.schweizer.ag/technologies/basicdata/making-of-a-pcb.html and convince yourself!

BASIC DATA

BASIC DATA	STANDARD	HIGH END
Min. Conductor Line/ Space [μm]	75	50
Min. Microvia (laser drilling) drill diameter [μm]	110	100
HDI Build Up (Copper filled Laser Vias)	up to 3-x-3	
Min. Mechanical drill diameter [μm]	200	150
Max. thickness PCB [mm]	2.4	3.8
Min. thickness PCB [μm]	500	400
Temp. Tg [C]	130 – 170	200 (HF 280)
Thermal conductivity base material [W/mK]	Data sheet supplier: 1.45 SCHWEIZER test method: 1.8	3.0 2.5
Solder mask	green, (white, black)	
Surface finish	<ul style="list-style-type: none"> • NiAu immersion. + galv. (fine and hard) • NiPdAu (ENEPAG) • OSP • Immersion Tin • HAL (SnPb and SnCuNi) • Immersion Silver (via Subcon) 	
Max. Size per PCB [mm]	575 x 583	
Certificates	<ul style="list-style-type: none"> • ISO 9001 • TS 16949 • ISO 14001 • ISO 50001 • EN 9100 	

Manufacturing process of a PCB as poster



www.schweizer.ag/en/technologies/basicdata.html



POWER ELECTRONICS

Solutions in power electronics play a key role in core topics of our times: They enable us to master the future challenges of electro mobility, energy creation and energy distribution.

In order to reduce fuel consumption as well as CO₂ emissions and to increase safety and comfort, it is increasingly necessary to switch higher currents and to dissipate heat.

Amongst all PCB manufactures, SCHWEIZER offers the most comprehensive range of solutions to tackle these challenges. Already today, the automotive industry applies Schweizer PCBs which can operate up to 1,200 Ampere.

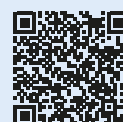
In the area of renewable energies, for example, the lifetime of an inverter is doubled if the average heat dissipation is lowered by 10 degrees Celsius.

The following technologies can easily be combined in order to achieve the best possible solution for every application.

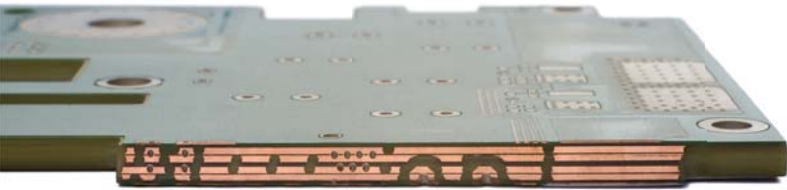
The Mountain Biker and Power Electronics

This sportsman deals with extremes: endurance, speed and performance on a continuously high level are demanded from him. Only with a lot of power in his lungs and in his legs will he enjoy reaching the summit. Transferred to our category Power Electronics, this means products and solutions in this field are subject to rising requirements. In many applications more and more currents need to be switched and more heat needs to be dissipated respectively.

Movie Power Electronics



HIGH CURRENTS



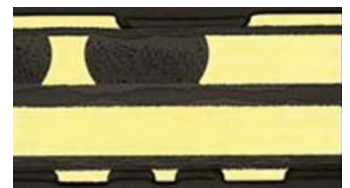
Heavy Copper Board

The Heavy Copper technology is regarded as the 'mother' of all power electronics PCBs. Based on standard components, this technology is used today in high volume production. Thickness in heavy copper usually ranges from 70 to 400 μm . By applying up to four inner layers with 400 μm of copper each, heavy copper technology facilitates an ampacity of several hundred Ampere.

SCHWEIZER's T^2 is a special heavy copper technology. Thanks to prefilled etched trenches, the number of prepregs is reduced and the isolation distance to the heavy copper material becomes smaller. This helps reducing the total thickness of the PCB significantly, thus reducing the thermal resistance by 50%.



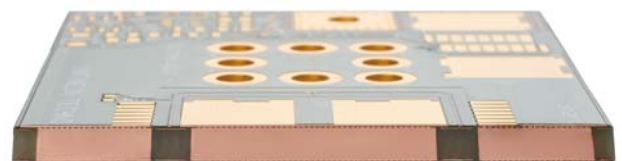
Conventional heavy copper PCB



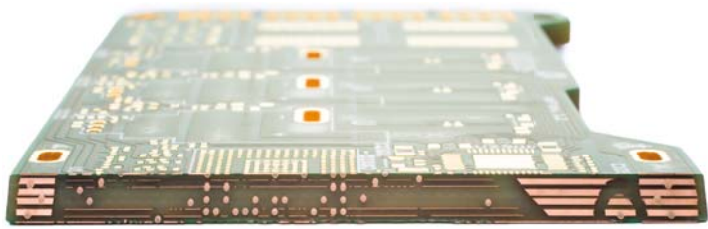
T^2 Technology

Inlay Board

When it comes to maximum heat dissipation and maximum ampacity, SCHWEIZER's Inlay Board is the technology of choice. By applying copper inlays with a thickness of up to 2 mm, areas on the PCB can be created which allow for current peaks of significantly more than 1,000 Ampere.



LOGIC AND POWER



Power Combi Board

Within the Combi Board heavy copper will only be applied in required areas in order to make the most efficient use of the expensive base material.

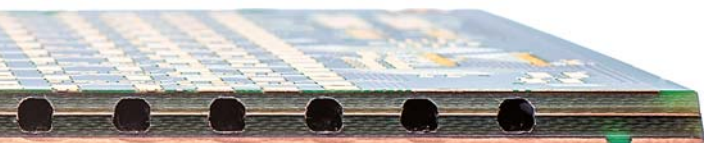
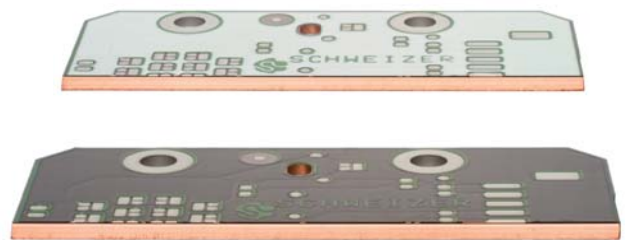
An inner layer is produced which combines heavy copper areas for high current applications as well as copper levels of standard thickness for a more refined signal conduct.

The Combi board thus combines logic and power electronics within one single PCB – and this with extremely good heat dissipation characteristics.

HEAT DISSIPATION

IMS Board

Insulated Metal Substrate – IMS. The particular material of the IMS Board facilitates high thermal conductivity and good electrical isolation at the same time. The board offers very good heat management, using a full space copper carrier plate as the metal backside for a quick and efficient temperature spread – without creating hotspots. Thanks to its low coefficient of thermal expansion, copper offers advantages when it comes to the reliability of the solder connection in particular for the mounting of high power LEDs.



Cool Board

Provided that none of the shown solutions for high power and passive cooling are sufficient, SCHWEIZER's Cool Board offers the possibility of active cooling in combination with our solutions for Power Electronics and Embedding.



EMBEDDING

Compact all-rounders for the smallest spaces: Systems for many of today's and tomorrow's applications are subject to an advancing process of miniaturisation and have to offer additional functionalities at the same time. One example are electric motors into which PCBs – together with the electronic system – are built. There are first applications where the surface of a PCB and the used semiconductors is nearly similar in size. Thus, the next and consistent step is the embedding of active and passive components into the PCB.

There are at least four good reasons for embedding:

1. Miniaturisation of the entire PCB
2. Improvement of the electric and thermal performance and thus a higher robustness
3. Active IP protection by integrating customer-specific ICs into the PCB
4. The opportunity to reduce system costs.

In order to address the different individual requirements in the best possible way, SCHWEIZER developed a modular system for products and embedding solutions.

The Swimmer and Embedding

A successful swimmer lies in the water in an optimal way and glides smoothly through this element. Similarly, embedded components need to lie in a PCB in an optimal way. Thus best performance can be realised in combination with high quality and utmost reliability.

Movies p² Pack® and i² Board®



i² Board®

The integrated interposer board for logic semiconductors with a horizontal current flow. This is a 'Motherboard Embedding Approach' with indirect pad contacting, e.g. for CMOS and BCDMOS of semiconductor technologies.

In this area the following challenges need to be mastered: manufacturers of PCBs intend to keep costs low for big production panels. Semiconductor manufacturers, however, map their technologies in increasingly smaller structure widths – due to cost pressure. Moore's Law states a bisection of the transistor size each 18 to 24 months. This renders the assembly of components on the PCB more and more difficult. The challenges of embedding are the Bond-Pads of the chips, sizes of which are 100 µm or smaller today.

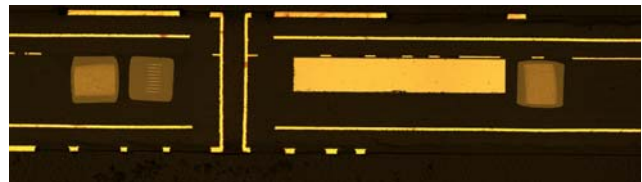
In embedding, there are basically two possibilities of contacting the bond pads:

- the direct approach via laser drilling and galvanic contacting onto the pads, however, with the disadvantage of lower yield and higher cost and
- the indirect way of contacting by using the SCHWEIZER i² Boards®.

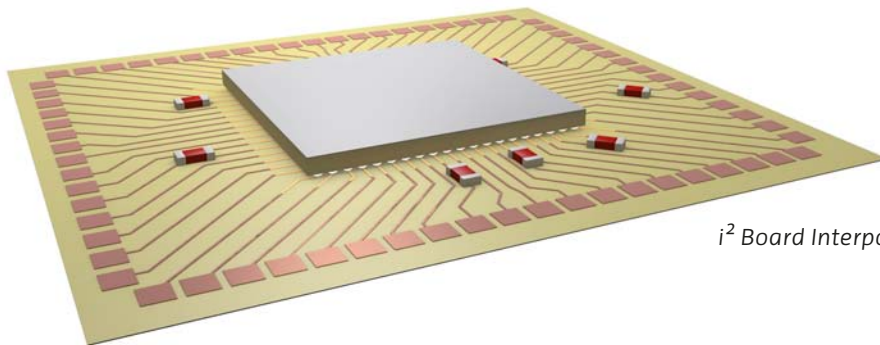
In this case, the pads are significantly enlarged by using a 'mini PCB' and thus safely contacted during lamination, enabling a high yield and continued favorable production in large scales.

Connecting the chip to the interposer is possible both conventionally as Face Up with bond wires as well as Face Down, e.g. with Stud Bumps. A Redistribution Layer (RDL), unpopular with most semiconductor manufacturers, is unnecessary which significantly increases the amount of the applications, even for smaller batch sizes.

The SCHWEIZER i² Board® allows for the integration of semiconductors as well as for passive components of an entire system.



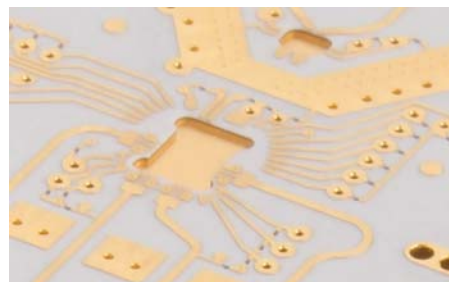
i² Board cross section with semiconductors and passive components



i² Board Interposer

Cavity Board

The Cavity Board offers the opportunity to realise deeper contact surfaces. Thus, a 'quasi' embedding of bare chips, so-called bare dies, is possible. This, for example, allows for shortest bondloops for high frequency applications. The 'rest' of the even PCB surface can be populated using the conventional way with SMD.



p² Pack® – The Power Embedding Solution

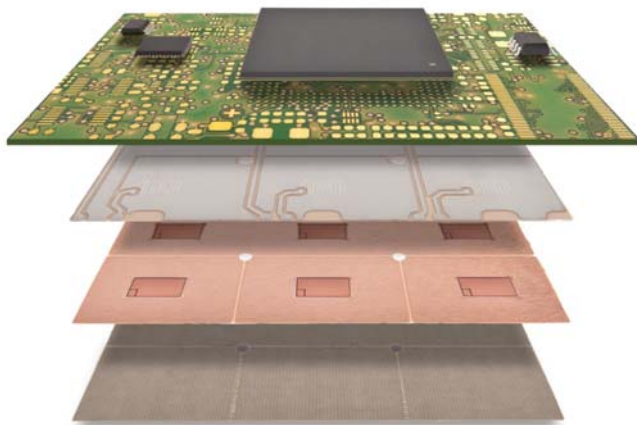
Conventional Power MOSFETs or significantly more expensive DCB substrates and modules, which are used today in power steering for example, have been until now the only solutions for highest demands regarding ampacity, electrical isolation requirements and thermal management.

In this context, the p² Pack® technology offers a new kind of technology for the manufacturing of power modules.

It consists of ultra-light, flat high power modules with a thickness of 1 to 1.4 mm, combined with embedding technology and PCB processes. Compared to conventionally built modules with ceramic substrates, this technology

enables a considerably improved switching behaviour, reduced power losses and optimised heat dissipation.

Due to the fact that the p² Pack is really flat, such modules can be further embedded into printed circuit boards, enabling a combination with logic switching without using additional connecting elements. Such a 'Smart p² Pack' construction is open to the bottom side of the PCB and can be easily applied to a heat sink, enabling to manufacture the entire system in a much less complex and cost-intensive way.



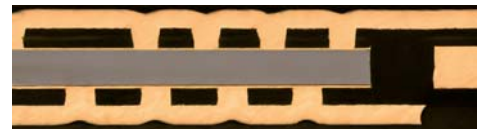
Smart p² Pack layup



Smart p² Pack (Performance & Logic) cross section



p² Pack (Performance) cross section



p² Pack DSV cross section – contacting option with Double Sided Vias

μ² Pack®

The module approach System in Package (SIP) is an embedding alternative to the classic 'motherboard embedding'. In this case, modules with different functionalities are being built onto a base board which allows for a modularisation according to cutomers' requirements.

The μ² Pack® is perfectly suitable for the implementation of such modules. By applying μ² Pack® technology, very thin modules with several components and a very fine pitch can be realised.



μ² Pack cross section – microcontroller with 232 I/Os, 80μm pitch, 65μm Pads

SYSTEM COST REDUCTION

A PCB is a relatively cheap component which, however, has a high relevance for the application. This requires balancing between cost on the one hand and quality and reliability on the other hand. A challenge that SCHWEIZER is meeting with.

By being involved in customers' planning and layout process at an early stage, SCHWEIZER can achieve an optimum manufacturing panel size. Thus, producing standard products at favourable rates is possible. In addition, SCHWEIZER is improving efficiency through

- investment in modern production facilities
- ongoing productivity improvement
- process optimisation after the first series orders.

SCHWEIZER offers a variety of smart solutions. They contribute to reducing the overall system cost and thus also the cost of the entire system. An illustrative example is the FR4 Flex board which allows for three-dimensional printed circuit boards by depth milling of the bending areas making it adaptable to difficult installation conditions and saving cost for connectors and cables.

Further product examples for system cost reduction are:

- the high frequency (HF) Board, applying the cost intensive HF materials only there, where they are really required,
- the ENEPAG Board, which can be used to replace the cost intensive LTCC ceramics,
- the Combi Board for a smart combination of different PCB technologies.

The Runner and System Cost Reduction

Running is regarded as the most efficient form of sport and has the big advantage that it can be done nearly everywhere at any time with little preparation. We are pursuing a similar approach with our category System Cost Reduction. Our aspiration is to understand complete solutions and systems and to contribute to rendering a complete, efficient and affordable system supported by a PCB.

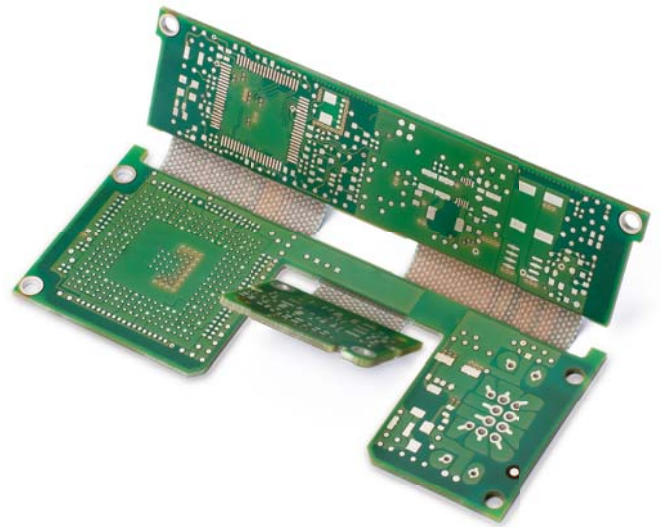
Movie System Cost Reduction:
All in one PCB



For complex installation situations: FR4 Flex Board

In many cases, miniaturisation is a must. With the FR4 Flex Board SCHWEIZER offers a mature solution to realise three-dimensional printed circuit boards with a bending radius of up to 180°. This solution leads to significant cost advantages in comparison with the so-called StarrFlex PCBs, using Polyimid (PI) in the bending radius.

FR4 Flex gets by without special materials such as jumpers, cables or plugs. Instead, SCHWEIZER uses the standard PCB FR4 and deep routing of the bending area to adapt the PCB to difficult installation situations. This means installation costs are kept low. Thanks to the completely flat PCB, the mounting can be easily soldered.



FR4 Flex Board in cooperation with Continental

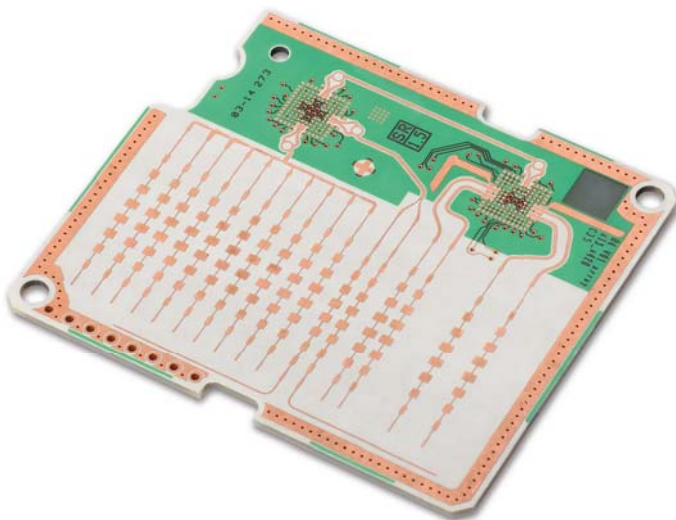
HF (High Frequency) Board for maximum performance in radar control

Radar technology has become omnipresent and vehicle safety engineering cannot be imagined without it anymore. It fulfils an enormously important part in safety engineering for vehicles. Also as distance radar for the automatic emergency stop and as blind spot assistant this safety engineering has become indispensable for 'Autonomous Driving'. The active intervention into the vehicle actuator engineering places severe demands on the electronics and on the PCB being used.

The basis for a flawless recognition of a dangerous situation is the PCB technology on which the radar beam is being generated and captured as a reflecting imaginary picture. The HF PCB unites sender and receiver within one component.

Special basic material such as PTFE with ceramic and glass ceramic is used, which is perfectly attuned. An important part is the manufacturing of components such as filters, resonators and the entire aerial geometry in the form of structure on the HF PCB. A highly specialised and continuous manufacturing process enables a production within tightest tolerances which is the basic requirement for the realisation in frequency areas of more than 77 GHz.

In close coordination with our customers, we develop special solutions which reduce the cost of systems.



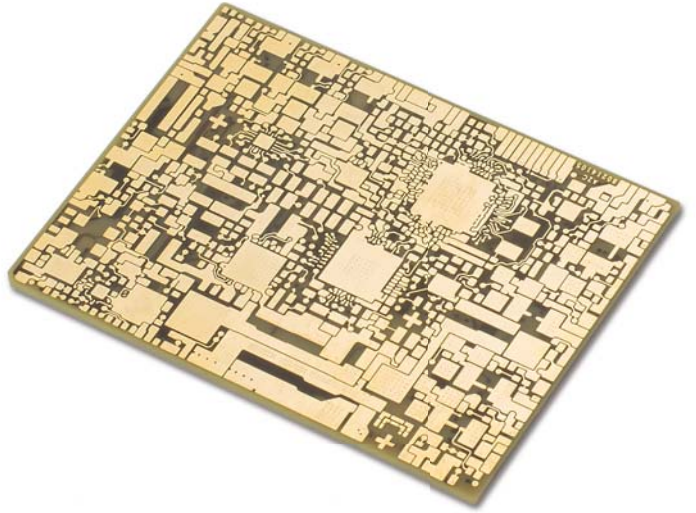
HF Board in cooperation with Bosch

ENEPAG Board

A growing number of automotive and industrial applications require an ENEPAG (**E**lectroless **N**ickel - **E**lectroless **P**alladium - **A**utocatalytic **G**old) surface finish. The unique features of an ENEPAG surface finish makes it an ideal partner for gold wire bonds in applications like e.g. modern automatic transmission systems or LED applications.

The ENEPAG surface can be applied for nearly all PCB layups and is suitable for both aluminum and gold wire bond processes. It can also be combined with soldering processes. ENEPAG ensures robust gold and aluminum bond wire connections to the PCB and reduces system costs since LTCCs (Low Temperature Cofired Ceramic) can be replaced by it.

Furthermore, its thicker gold layers of up to ~80 nm ensure a better bondability compared to ENEPIG, where the gold layer thickness is limited to ~10 to 20 nm.

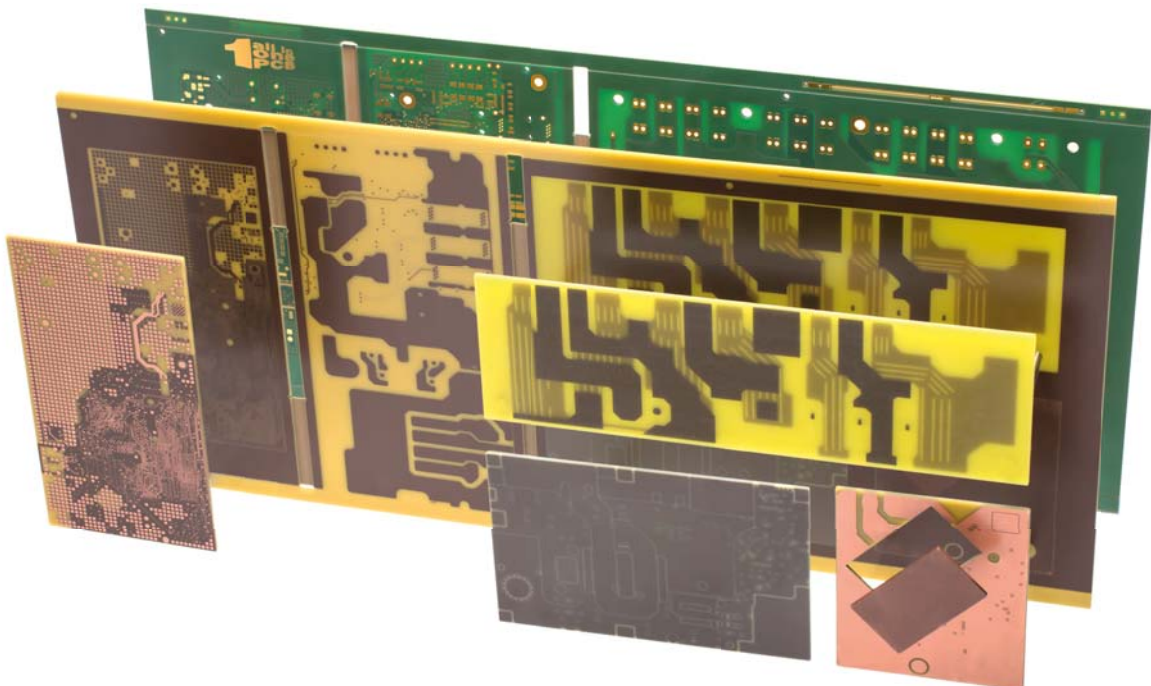


ENEPAG Board in cooperation with Continental

Flexibility in combining: The Combi Board

The Combi Board is an important milestone of a PCB on its way from a pure system carrier to a system solution. Overall, the Combi Board allows to offer the functionality of several PCBs within one single board, without connectors and cables. In many cases, this approach leads to a possible

system cost reduction as well as to improved quality and reliability. Based on the Combi Board idea the 'All in One inverter demonstrator' has been created, which illustrates the almost unlimited options of today's PCB technology.



TECHNOLOGY DEMONSTRATORS ILLUSTRATE NEW POSSIBILITIES WITH INNOVATIVE PCBS

POWER COMBI BOARD



48V Motor Drive

In cooperation with Infineon

INLAY BOARD



Smart Battery Switch

In cooperation with Infineon

HEAVY COPPER T²



48/12V DC/DC

In cooperation with Infineon

SMART p² PACK



40kW E-Drive

In cooperation with ETH Zürich

SCHWEIZER's PARTNER NETWORK:

OPTIMISED PRODUCTION SET UP FOR SMALL-, MEDIUM- AND HIGH VOLUME SERIES



Our partner for chip embedding

Infineon Technologies AG is a global technology leader, in particular in power semiconductors. Its semiconductor and system solutions address three central challenges to modern society: energy efficiency, mobility and security. In future, Infineon and SCHWEIZER intend to generate synergies from their semiconductor and printed circuit board know-how and to jointly tap the market for chip embedding.

Infineon is listed on the Frankfurt Stock Exchange (ticker symbol: IFX) and in the USA on the over-the-counter market OTCQX International Premier (ticker symbol: IFNNY).

Further information is available at www.infineon.com



SCHWEIZER
ELECTRONIC



MEIKO ELECTRONICS CO., LTD.

Our partner for reliable mass volumes and technology

Meiko Electronics Co., Ltd., Ayase/Japan, the core company of the Meiko Group established in 1975, designs, manufactures and sells printed circuit boards (PCBs). The company offers a wide range of PCBs (double-sided/multi-layer through-hole, HDI, flexible, flex-rigid, large electric current, heat releasing, embedded). The Meiko Group is headquartered in Ayase City in Japan, and it operates four PCB manufacturing sites in Japan, two sites in China and one site in Vietnam.

MEIKO is publicly listed at the Frankfurt and Tokyo Stock Exchanges, Ticker ISIN JP3915350007.

Further information is available at www.meiko-elec.com





Our partner for HF products in the automotive and industry segments

The family-owned company WUS Printed Circuit (Kunshan) Co., Ltd. was founded in Taiwan in 1971 and looks back on 44 years of experience in manufacturing printed circuit boards.

WUS produces high layer count PCBs for telecommunication and network equipment, automotive electronics, industrial automation controls and aviation electronics. Following its product differentiation strategy, WUS focusses on providing value to its customers through technology, quality and service and is today one of the leading brands in the printed circuit board industry.

WUS Printed Circuit Co., Ltd. is listed at the Shenzhen Stock Exchange, stock code SZ002463.



Further information is available at www.wuscn.com

Schweizer Electronic AG stands for state-of-the-art technology and consultancy competence. SCHWEIZER's premium printed circuit boards and innovative solutions and services address key challenges in the areas of Power Electronics, Embedding and System Cost Reduction. Its products are distinguished for their superior quality and their energy-saving and environmentally-friendly features.

Together with its partners the company offers cost- and production-optimised solutions for small, medium and large series. The company was founded in 1849, is managed by family members and listed at the Stuttgart and Frankfurt Stock Exchanges (ticker symbol "SCE", "ISIN DE 000515623").

Further information is available at www.schweizer.ag



Our partner for superfast prototypes and technology prototypes

Founded in 1973, Elekonta Marek GmbH & Co. KG, headquartered in Gerlingen, Baden Württemberg, has been one of the leading German PCB manufacturers in the field of prototypes and express delivery for more than four decades. Specialised in innovative and high technology products, ELEKONTA has considered itself since its early beginnings as a development partner for the electronics industry and expands this approach by readiness for innovations, a good sense of proportion and an uncompromising quality standard.

Further information is available at www.elekonta.de

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