Focus on EMS Activities with Q&A manual

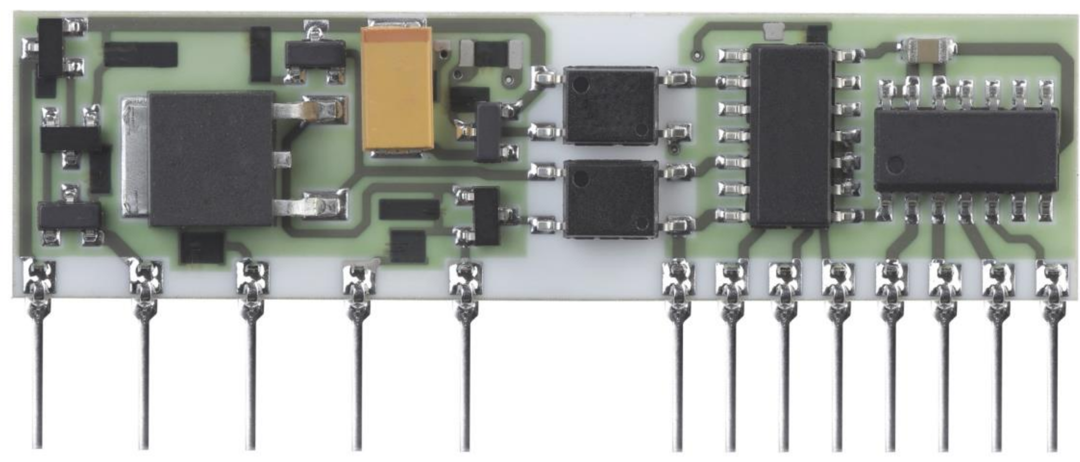
Electronic Manufacturing Services (Hybrid Circuits – Power Modules)

September 2022

DIVISION ——— ELECTRONIC MANUFACTURING

Metallux is a **reliable, flexible** *and* **responsive Electronic Manufacturing Services** *partner for the* **development** *and* **production** *of* **electronic devices***.*

We Engineer, Prototype, Assemble, and Produce over 4.5 Mio Electronic Products yearly in Contract Manufacturing.



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DIVISION —— ELECTRONIC MANUFACTURING

- Thick Film Technology
- IPC Compliant
- Substrates — *Al_2O_3 Ceramic, AIN, Stainless Steel, Sapphire, FR4, Flex*
- Multi-layered And Hybrid Circuits
- Die Attach
- Ball And Wedge Bonding
- Chip-on-board
- Surface Mount Technology
- Encapsulation
- Assembly
- Fully Customizable Production

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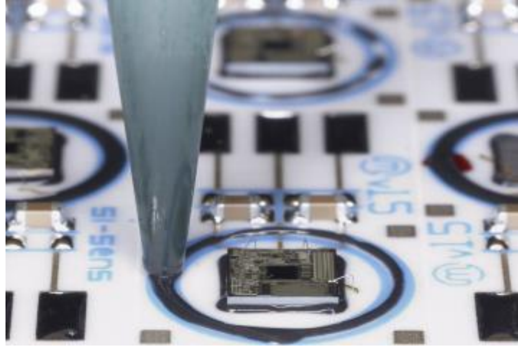
CUSTOMIZATION & CAPABILITIES



We offer the technology to produce your project in ***contract manufacturing***

Metallux has a long experience in ***EMS Electronic Manufacturing Services.***

Our ***know-how*** *is a guarantee for* ***maximum reliability in the most demanding environmental conditions.***

- *Electronic assembly and manufacturing*
- *Hi-Rel Hybrid Circuits*
- *Multilayers Hybrid Circuits with integrated components*
- *Automated and Manual screen-printing lines*
- *Laser trimming*
- *SMD, Chip-On-Board and reflow line*
- *Active and Passive SMT, from 0402 to BGA and µBGA*
- *Chip&Wire: Die attach, Wedge and Ball Bonding*
- *Encapsulation and coating on all kind of substrates*
- *Finishing and Injection with coatings, epoxy, silicone, resins*
- *Automated inspection and testing*
- *Climatic chambers for calibration*
- *X-ray and AOI testing*
- *EMC compliance testing*
- *End-of-life and testing equipment for quality assurance*
- *Production, Assembly and Packaging in DNA-Free environm*

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CUSTOMIZATION & CAPABILITIES

SolidWorks
- Animation/rendering
- Mechanical construction: Plastic injection molding, sheet metal, aluminum die-casting/extrusion molding, composite materials
- Housing and device construction
- Miniaturization
- Assembly drawings/instructions

Test engineering
- Development of test concepts (AOI/X-ray/functional and electrical tests)
- Design and programming of test systems
- Integration of test systems into the production environment
- Quality data management with traceability throughout the product

SMT production
- Fully automatic in-line screen printing and pick&place machines
- Fine pitch assembly up to 0.3 mm pitch (in series production)
- µBGA up to 0.35 mm pitch
- Chip from 01005 (0.4 × 0.2 mm)
- Flexprint assembly
- Individual soldering profiles in reflow oven
- Pcbs depaneling

Optical inspection
- Inline-AOI systems
- X-ray

Project management
- Project planning/control
- Design-to-cost
- Life cycle management
- Feasibility studies and concepts
- Change management
- Risk management

Expertise and services
- Engineering expertise
- HW/SW development
- PCB design
- Mechanical engineering
- Project management

Rework
- SMD rework stations

WORK FLOW

Coating
- Inline spray coating
- Encapsulation with various types of resins, PU, silicone, etc.
- Hot encapsulation

Traceability
- Individual assembly barcode (label)
- At board and production order level
- Components Lots
- Work and test procedures
- Test results and verification

Testing
- Development of product-specific test concepts
- In-circuit, flying probe and functional tests
- Development and setup of product-specific test systems

Assembly of systems
- Clean room assembly
- Functional testing
- Configuration management

Chip&Wire
- Bonding with various types of adhesives, UV, epoxy, etc.
- Wedge and ball bonding
- Encapsulation with various types of glob top

SUBSTRATE

	Min		Max	
Dimensions	X-Y:	50.8 x 50.8 mm	X-Y:	130 x 190 mm
	Thickness:	0.65 mm	Thickness:	1.65 mm
Standard Type	DBC (Direct bond copper), Al_2O_3 (alumina) with Cu layers			
Alternative substrates	IMS (Insulated Metal Substrate), AIN (Aluminum Nitride), HPS (Al_2O_3 + ZrO_2), Si_3N_4 (Silicon Nitride), all with Ag or Cu layers			
DCB Structure	Double Cu layers on both substrates sides, Cu from 0.2 mm to 0.5 mm			

Thermal Conductivity and Coefficient of linear Thermal Expansion	Material	Thermal Conductivity	CTE
	Al_2O_3	24 W/mK @20°C	6.8 ppm/K @25-300°C
	Cu	355 W/mK @20°C	18 ppm/K @25
	IMS	Up to 10 W/mK @20°C	10-20 ppm/K @25
	AIN	170 W/mK @20°C	4.7 ppm/K @25-300°C
	HPS	26 W/mK @20°C	7.1 ppm/K @25-300°C
	Si_3N_4	90 W/mK @20°C	2.5 ppm/K @25-300°C

Substrates Finishing	Electroless Ni, Ni-Au, Ag

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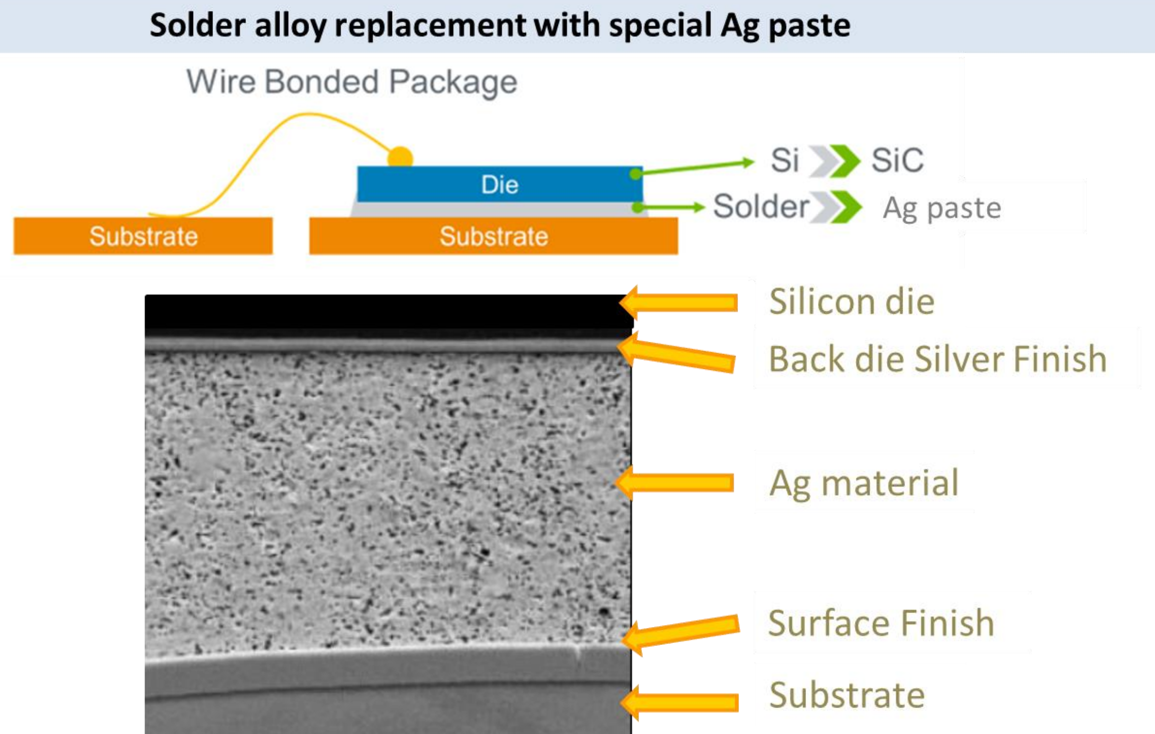
ASSEMBLY PROCESS



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AG PASTE FEATURES

Comparison of materials properties between solder alloy and special Ag materials

Die attach Material properties	Lead-free solder paste $Sn_{96.5}Ag_{3.5}$	High-Lead solder $Pb_{92.5}Sn_{5}Ag_{2.5}$	Special Ag material
Max. operating temperature (°C)	220	296	> 380
Thermal Conductivity (W/m•K)	55	25	> 150
Electrical resistivity (mΩ•cm)	0.012	0.0196	≤ 0.008
CTE (ppm/K)	25	29	≈ 20
Young modulus (GPa)	30	23.5	≈ 50
Residue free	No	No	Yes

Compatible substrates surfaces Finishing
Ag
Au
Cu
Pd

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DIE AND WIRE BONDING CAPABILITIES

Die Bonding	
Type of connection	**Ag**
Features	**No voids, No flux residuals**
Thermal Conductivity	**≥ 150 W m/K**

Wire Bonding				
Type of connection	**Al, Cu, Al-Cu (Al cladded Cu) wires. Al or Cu ribbon**			
Wire Diameter (Aluminum)	**Min**	**Max**	**Max Current, (125 µm)**	**Max Current (500 µm)**
	125 µm	**500 µm**	5A	40A
Ribbon (Al & Cu)	**Min**	**Max**	**Max Current (0.1x2mm)**	**Max Current (0.5x2mm)**
Ribbon Thickness	**0.1 mm**	**0.3 mm**	35A (Cu)	130A (Cu)
Ribbon Width	**0.75 mm**	**2 mm**	20A (Al)	80A (Al)

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ENCAPSULATION AND PACKAGING CAPABILITIES

Encapsulation	
Type of Encapsulation	**Glob Top, Potting**
Materials	**Silicone, Silicone Gel, Epoxy, Polyurethane resins**

Packaging	
Customization	**Yes**
Type of Package	**Insert molding and over molding**
Plastic Material	**PA66+30FV, PBT, PPS, PPO etc.**

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QUESTION

What experience does Metallux have with power hybrids?

ANSWER

Metallux has long-term knowledge about Chip&Wire process to interconnect bare chips to several types of different substrates by wedge and ball bonding. In the last two years, some Metallux technicians attended several courses and got relevant information to learn recent developments about the same processes related to the attachment and the interconnection of power dies.

Note:
We have experience in low-power hybrids in the past and now we want to pursue the next step of "high power hybrids":

- Max current: > 10 Amp
- Max power: above 500 W
- Max Voltage: 10 kV and more

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QUESTION

What technologies and processes does Metallux have for the production of power hybrids or what investments do they need to make to produce them?

ANSWER

Long years of experience in screen printing on ceramic (alumina) and metal (steel) substrates, soldering, wire bonding
Standard "hybrid technology" (Al_2O_3, thick film technology, Die-bonding [organic attachment], wire bonding [wire diameter up to 500 µm], more? See thick film technology on alternative substrates as AlN, sintering Ag.

We have evaluated all the missing processes to pursue the "high power hybrids project", we have already programmed the proper investments and we believe we could be ready to produce power modules samples in 8-10 months.
The same equipment can be used also for producing several tens of thousands of power devices.

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QUESTION

Did Metallux produce products or prototypes of power hybrids?

ANSWER

We have experience in low power hybrids in the past and now we want to pursue the next step of "high power hybrids"

Note:
We have done this in the past and we do have the expertise and the know-how on this matter.

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QUESTION

What materials are used for bonding wires for power circuits?

ANSWER

See the table below:

Type of connection	Al, Cu, Al-Cu (Al cladded Cu) wires. Al or Cu ribbon		
Wire Diameter	**Min**	**Max**	
	125 µm	**500 µm**	
Ribbon	**Min**	**Max**	
Ribbon Thickness	**75 µm**	**300 µm**	
Ribbon width	**0.75 mm**	**2 mm**	

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QUESTION

What currents can we manage on the bonding wires used on power hybrids?

ANSWER

Wires: Au: 1,2 mA/µm^2 Al 0,3 mA/µm^2
Ribbon: xxxxx (to be collected)
From a few Amps to several hundred Amps

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QUESTION

What substrates can be used for power circuits?

ANSWER

Primarily AlN
See the table below:

Standard Type	DBC (Direct bond copper), Al_2O_3 (alumina) with Cu layers
Alternative substrates	AlN (Aluminum Nitride), HPS (Al_2O_3 + ZrO_2), Si_3N_4 (Silicon Nitride), all with Ag or Cu layers
DCB Structure	Double Cu layers on both substrates sides, Cu from 0.2 mm to 0.5 mm

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QUESTION

What are the operating conditions of a power circuit (temperature, humidity, ...)?

ANSWER

Depending on the application, generally speaking, a power module can withstand high temperatures (-40°C +150°C) and high humidity (85%)

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QUESTION

What is the useful life we guarantee for a power circuit and what are the reliability tests we plan to apply?

ANSWER

"useful life" has no general answer, because it depends on specific projects and its requirements. Well packed, into a climatic chamber, maybe it can last 100 years!
Thermal cycles, thermal shocks, high-temperature storage are the main useful tests, the temperature range is strictly depending on the specific application of the power module.
The key point is how the temperature is treated (the lower the better for life duration).
It is important to have info on the thermal resistivity of each circuit.
We normally define a validation test list in agreement with the customer.

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QUESTION

Which testing capabilities for mechanical (shock, vibration, etc.), environmental (temperature, humidity, salt spray, etc.) and electrical (EMC, etc) are available at Metallux?

ANSWER

Actual state: Thermal cycles, thermal shocks, high-temperature storage, dump heat (heat and humidity), and vibration tests are all available in Metallux/Eltekgroup. Some test equipment for automotive applications is available at Eltek Group, otherwise available at external service suppliers.

Target state: Mechanical test (vibration and shock) only for automotive;

>> external service supplier

Environmental test (temperature, humidity);

>> recommended in-house capabilities

EMC

>> for pre-tests simple equipment in-house is recommended;

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QUESTION

What are the capabilities for defect analysis (SEM, x-ray, etc.) are available at Metallux?

ANSWER

We have the capability to perform SEM and X-Ray analysis internally in the Group.

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QUESTION

What kind of information does Metallux need from the customer to provide samples?

ANSWER

Basically, the standard information as application, technical specifications, environmental situation, commercial (price target, quantities, time schedule,...), specific technology required or can it be defined by MLX, the reason of the inquiry if there is an existing supplier, possible "stumbling blocks" BOM (included the type of ASIC/electronic components), schematics, dimensions, operating temperature range, operating voltage and current, power dissipation needed

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QUESTION

What is the minimum / maximum quantity of modules Metallux is able / willing to produce?

ANSWER

No limitations
From hundred to tens of thousands of power modules per year
(it is only a question of the price).

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QUESTION

What are typical set-up costs depending on substrate size, and the number of layers?

ANSWER

There is no ***typical*** *cost. Very much depends on the requirements. Have to be defined after getting the customer's requirements.*

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QUESTION

What influences the cost of the module?

ANSWER

Total volumes, component costs, substrate size, bonding technology, test requirements, packaging (eventual).
Requirements concerning performance, quantity, and tests.

Components cost, substrate cost, and total volumes are the main elements that influence the cost. The process relatively affects the cost to a lesser degree

Note:
We, as Eltek Group, can also do the packaging (e.g. special plastic housing, etc...) of these modules – mold design and construction and molding activities. We can be the supplier for the whole assembly.

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SWISS TECHNOLOGY

END – EMS Q&A MANUAL

More info/documentation available on our recently wholly renovated website www.metallux.ch

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