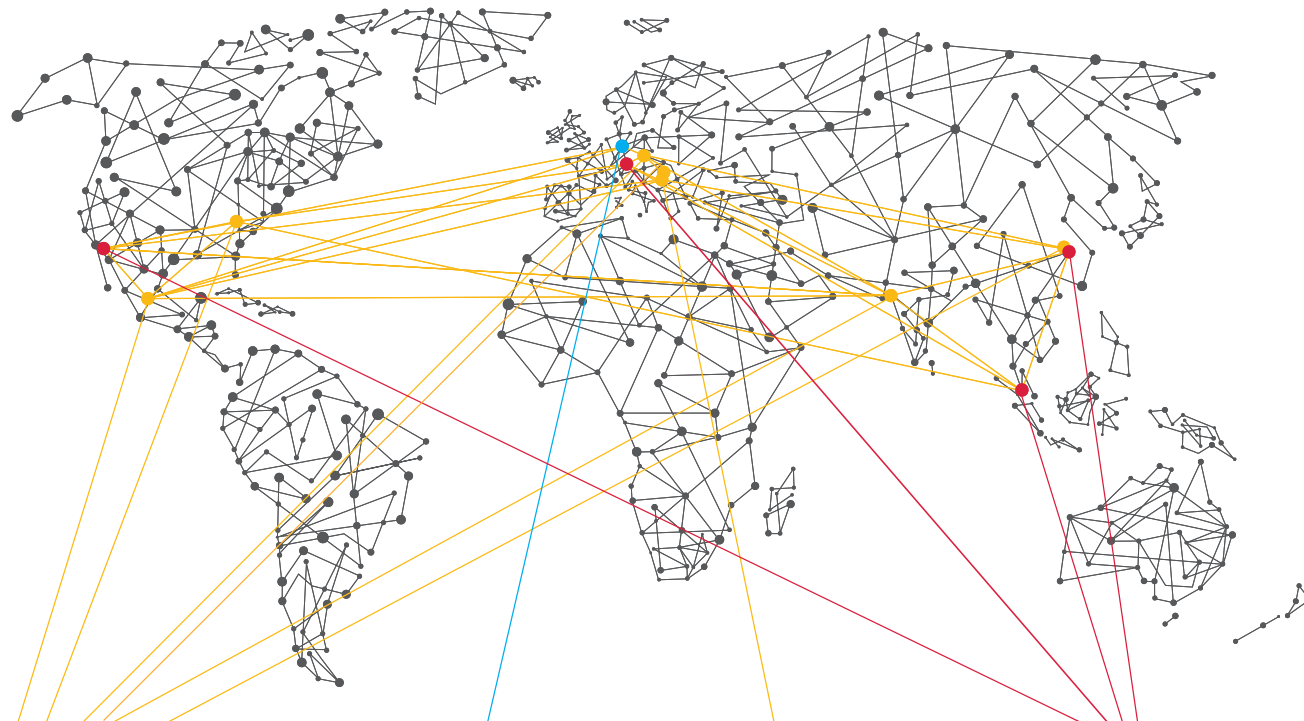


COMMON CONNECTION METHODS

WIREBONDING	<ul style="list-style-type: none"><li>• Friction welding process without fusion phase, at room temperature</li><li>• Numerous material combinations (also Al/Cu)</li><li>• Any connection geometries, because "endless" connectors in machine</li><li>• Any length, any direction, large height variations</li><li>• Cross-sections limited to wire or ribbons up to about 30 A</li></ul>	<ul style="list-style-type: none"><li>+ Fusion welding with laser</li><li>+ Unlimited geometry</li><li>+ Highest flexibility</li><li>+ Very high connection quality (= service life)</li><li>+ Excellent automation capability, perfect also for small quantities</li><li>- Sensitive to surface contamination</li><li>- Stable cell clamping required</li><li>- Cross sections limited</li></ul>
LASER WELDING	<ul style="list-style-type: none"><li>• Fusion welding with laser</li><li>• Numerous material combinations, as with other welding processes</li><li>• Connector geometries specified, typically stamped parts</li><li>• Cross sections of any size, therefore high currents possible</li></ul>	<ul style="list-style-type: none"><li>+ Very high connection quality (= service life)</li><li>+ Less sensitive to surface contamination</li><li>+ Mounting uncritical, because of low process forces</li><li>- Fixed geometry due to prefabricated connectors</li><li>- Difficult to automate (zero gap must be guaranteed)</li><li>- Not suitable for small quantities</li></ul>
LASERBONDING	<ul style="list-style-type: none"><li>• Fusion welding with laser</li><li>• Numerous material combinations, as with other welding processes</li><li>• Unlimited connector geometries, because "endless" connectors in machine</li><li>• Any length, any direction, height variations</li></ul>	<ul style="list-style-type: none"><li>+ Unlimited geometry</li><li>+ Very high connection quality (= service life)</li><li>+ Less sensitive to surface contamination</li><li>+ Mounting uncritical, because of low process forces</li></ul>
TAB-BONDING	<ul style="list-style-type: none"><li>• Fabric-locked connection by ultrasonic friction welding process without fusion phase, at room temperature</li><li>• Many material combinations (also Al/Cu)</li><li>• Connector shape specified as foil or punched part</li><li>• Cross-sections limited by ultrasonic power and coupling</li></ul>	<ul style="list-style-type: none"><li>+ Fast</li><li>+ Fixed geometry due to prefabricated connectors</li><li>+ Difficult to automate due to connector-placement</li><li>- Poorly suited for small quantities</li></ul>
LASER-TAB-BONDING	<ul style="list-style-type: none"><li>• Fusion welding with laser</li><li>• Numerous material combinations, as with other welding processes</li><li>• Connector geometries specified, typically stamped parts</li><li>• Cross-sections of practically any size, i.e. also high currents</li></ul>	<ul style="list-style-type: none"><li>+ Easy to automate; however, connectors must be positioned and pre-mounted beforehand</li><li>- Fixed geometry due to prefabricated connectors</li><li>- Difficult to automate</li><li>- Poorly suited for small quantities</li></ul>
RESISTANCE WELDING	<ul style="list-style-type: none"><li>• Gap welding by current transfer</li><li>• Non Fusion welding process on prefabricated nickel sheet connector with contact studs</li></ul>	<ul style="list-style-type: none"><li>+ Simple procedure, inexpensive for manual operation</li><li>- Prefabricated connector required</li><li>- No copper connectors possible</li><li>- Connection quality comparatively low</li><li>- Very high energy input</li><li>- Automation difficult because of connector placement</li></ul>
SOLDERING	<ul style="list-style-type: none"><li>• Substance-to-substance connection through solder metal between battery and connector</li><li>• Material combinations limited by solderability</li></ul>	<ul style="list-style-type: none"><li>+ Very simple procedure</li><li>+ Cost-effective equipment for manual operation</li><li>- Service life</li><li>- Costs</li><li>- Poor automation capability</li></ul>
SCREW CONNECTION	<ul style="list-style-type: none"><li>• Force-locked contacting with bolts on the battery cell and connector structures</li></ul>	<ul style="list-style-type: none"><li>+ Any connector cross-sections possible</li><li>- No continuous bulk connection, therefore risk of corrosion and shortening of service life</li></ul>
CLAMPING CONNECTION / SPRING CONTACT	<ul style="list-style-type: none"><li>• Force-locking contact by contact spring</li></ul>	<ul style="list-style-type: none"><li>+ Very flexible for replacing individual cells (repairable)</li><li>- No continuous bulk connection, therefore risk of corrosion</li><li>- Spring material may be expensive</li></ul>

POWERFUL SYNERGIES AS „MEMBER OF STRAMA GROUP“

Together with our parent company, Strama-MPS, we integrate our wirebonders into complete assembly lines with other joining, assembling and testing stations. Our customers profit from the combination of our bonding and automotive expertise, „One-stop-shopping“, and the interface free quality of the complete package.



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HUNGARY, Budapest  
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PRODUCT-BROCHURE



Battery Bonding

For the production of battery packs, F & K DELVOTEC always offers the perfect solution for the highest quality products with our ultrasonic bonding and ultrasonic laserbonding processes.

Battery packs for electric vehicles have various cell types and formats that have to be interconnected. They differ not only in the geometry, but also in the current ratings for the interconnections. In addition, there are connections to the BMS (Battery Management System) which require further separate bonding solutions.

More than 40 years of experience in wire bonding ensures our mastery of the technology, even for the most challenging of materials. For the entire evolution from product development to series production, F & K DELVOTEC offers tailor-made support at every stage: from process development, sample bonding, bonding for prototypes, small series manufacture through to process support during series production. Our automation is made to measure; Industry 4.0 naturally.



NOT JUST MACHINES.  
BUT BONDING SOLUTIONS.

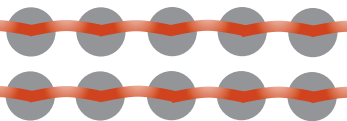




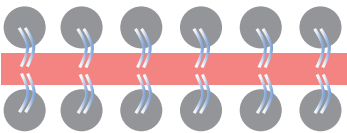
# BATTERY CELL TYPES

Different connector solutions are selected depending upon the battery cell types and required current capacities.

## CYLINDRICAL CELLS



- Direct connection from cell to cell**
- With wire, ribbons or flat connectors
  - Limitation by current carrying capacity of the wire or ribbon
  - Currents up to approx. 20 A per wire: ultrasonic bonding
  - Higher currents possible due with multiple wires
  - Connections also possible on the cell edge for negative pole
  - Higher currents through ribbons with laserbonding



- Connection from cell to busbar**
- By single wires or ribbons (US bonded)
  - Current limited by wire thickness, multiple wires possible
  - Conductor mask or busbar must be suitably manufactured
  - Connections also possible on the cell edge for negative pole

## PRISMATIC CELLS

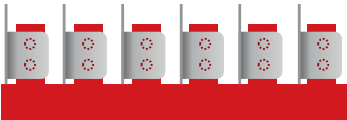


- Direct connection from cell to cell**
- Connection by tab with laserbonding, limited by ribbon cross-section (up to approx. 300 A)
  - Or by a directly welded busbar, limited then by cross-section



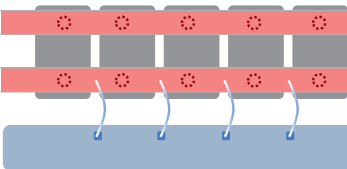
- Connection to busbar with ribbon**
- Currents up to about 300 A per cell
  - Current limited by ribbon cross-section

## POUCH CELLS



- Connections from Cell Tabs to busbar**
- Remove by laser-TAB-bonding for higher currents
  - Remove by US bonding for taps to the BMS

## OTHER BMS CONNECTIONS



- Connection of cells to BMS tabs**
- Contacts to the battery management system via US wire bonds, even over large height differences
  - Connections directly via ultrasonic bonding wire, flex PCB and ultrasonic TAB process are possible

# ULTRASONIC BONDING

## WHEN ULTRASONIC?

- Suitable for lower currents
- Ultrasonic bonding for wires up to 20 A or ribbons, preferably with aluminium or copper

## ADVANTAGES

- Very flexible, any length and any direction
- Insensitive to height variations between cells
- Problem-free bonding over height variations
- Lowest energy input in cell
- Favorable cost of ownership and high productivity
- In-head pulltester for highest quality requirements



# LASERBONDER / LASER-TAB-BONDER

## WHEN LASERBONDING?

- Suitable for higher currents
- Laserbonding for ribbons over 60 A, aluminium or copper
- Laser-TAB-bonding for any cross sections

## ADVANTAGES

- Very flexible, any length and any direction
- Insensitive to height variations between cells
- Zero gap is easy to ensure
- Zero bonding force possible
- Problem-free bonding over height variations
- Ribbon dimensions up to 10 x 0.5 mm
- Low-spatter process through oscillation welding
- Simple component holder without clamping



## BONDERS WITH OPTIMIZED WORKING AREAS ARE AVAILABLE FOR DIFFERENT BATTERY PACK FORMATS

### BONDER M17L

- Working area 350 x 652 mm
- Wire thickness up to 500 µm
- Can be automated, in-line capable



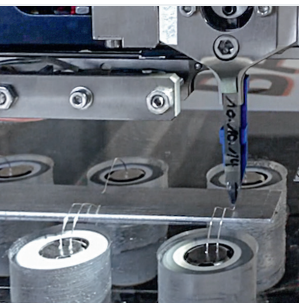
### BONDER M17XL

- Largest working area worldwide: 1,133 x 702 mm
- Height clearance up to 500 mm
- Wire thickness up to 500 µm
- Can be automated, in-line capable



### LASERBONDER M17LSB

- Working area 350 x 652 mm
- Ribbon width 2 to 10 mm
- Can be automated, in-line capable
- Fiber lasers up to 1 kW power
- Laser wavelength 1,060 nm
- Galvanometer scanner



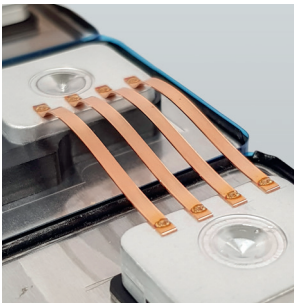
Wire bonds on 18650 battery cells

### Automated material transport

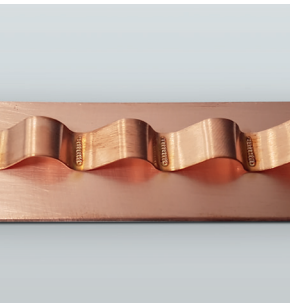
- Numerous customized automation solutions for battery packs of virtually any size, up to 70 kg mass
- Manual bonding stations for small batch sizes and frequent product changes
- Semi-automatic and fully automatic solutions with automatic positioning and clamping. Manual operation or automatic loading and unloading outside the machine
- Single-track or double-track transport systems
- Transport systems with throughput or in/out transport on the same side
- Isolated solutions or integration into fully automated production chains
- All solutions from a single source: designed and manufactured by us
- Alternative automation solutions can be retrofitted



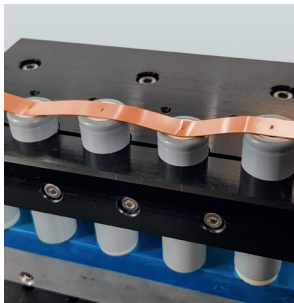
Prismatic cells connected by



Prismatic cells connected by



Copper ribbon with large



TAB bonds compensate for