

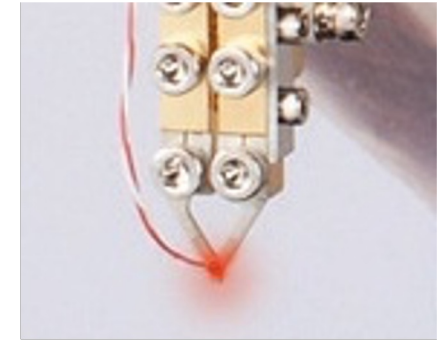
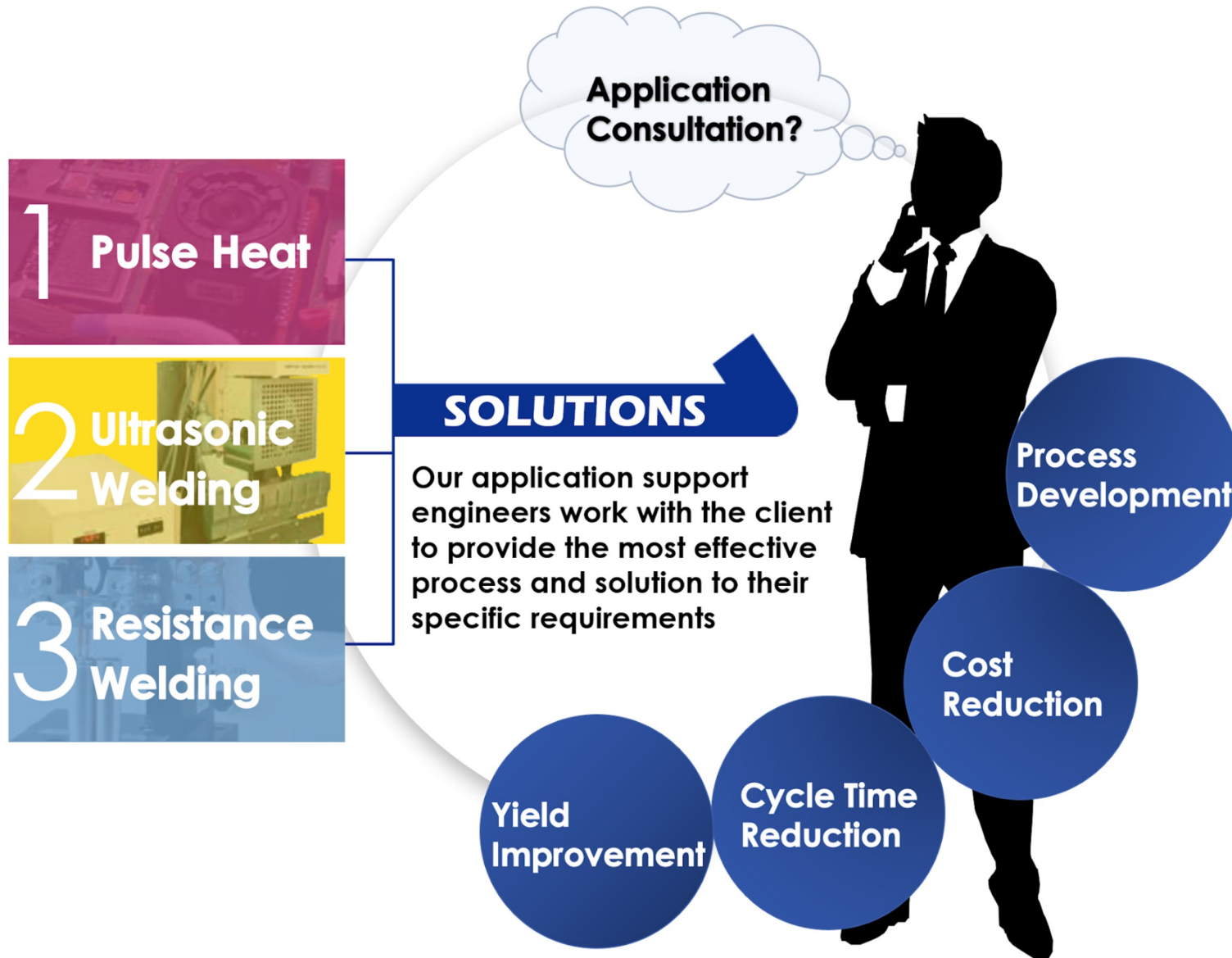
Micro-Joining Solutions



Presented By



Pulse Heat, Ultrasonic and Resistance Welding



Nippon Avionics (Avio) Welder Company History

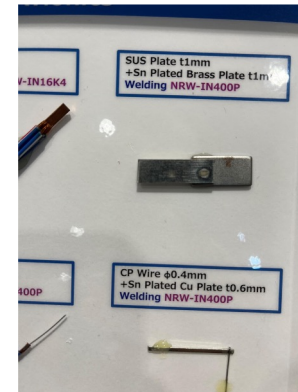
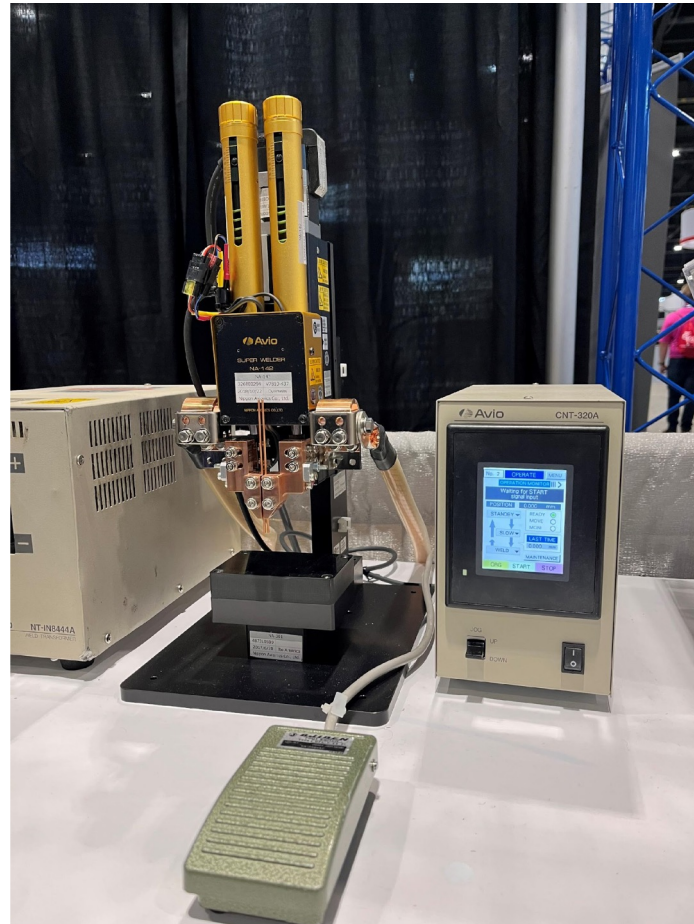
- 1960: Incorporated as a joint venture between NEC Corporation and Hughes Aircraft Company under the name “Nippon Aviotronics Co., Ltd.
- 1963: Started manufacturing welders
- 1980: Changed trade name to Nippon Avionics Co., Ltd.
- 1987: Started marketing of flex-rigid printed wiring board and started delivery of the subassemblies for patriot surface-to-air missile systems
- 1988: Listed on the 2nd section of Tokyo Stock Exchange
- 1993: Started marketing High-Frequency Hybrid IC for mobile objects communication
- 1996: Acquired ISO-9001 at Industrial Electronic Products Division
- 1998: Acquired ISO-9001 at Electronic Devices Division, ISO-14001 at Yokohama Plant, ISO-14002 at Yamanashi Avionics Co., Ltd
- 1999: Acquired ISO-9001 at Industrial Systems Division and ISO-14001 at Avionics Fukushima Co., Ltd
- 2010: Established Shin-Yokohama Plant
- 2020: Moved head office to the present location
- 2022: Building on a long history of working together in other business areas, Avio establishes a North American Sales Representation relationship with Easley Enterprises LLC

Resistance Welding

A joining method in which an object to be welded (work pieces) are sandwiched between electrodes, pressed appropriately then melted and welded by the “resistive heat” generated while electric current is passing through. As the total cost is low and the welding time is short compared to other joining methods, it is widely used in various applications.

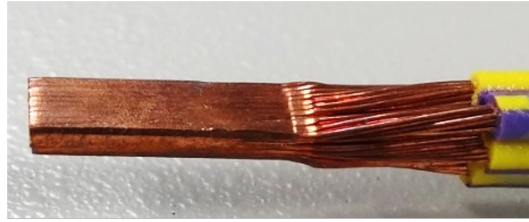
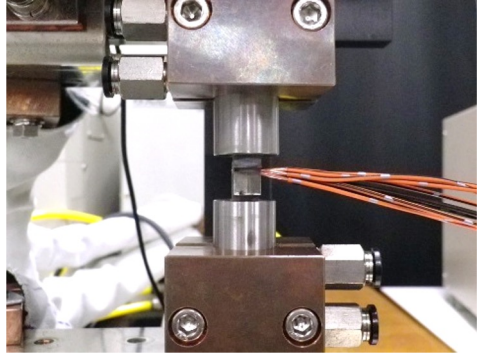
Welding Head & Welding Electrode

How to contact electrodes (how to apply welding current) is determined according to the shape and structure of the welding object. In addition, the shape and material of the electrodes and the value of pressure force are also important factors for the resistance welding.



- **Welding Power Supply controls the amount, time, and waveform of the electric current, welding voltage, and power**
- **Welding Transformer converts the current from the power supply into a larger current**
- **Welding Head controls the pressure to be applied**
- **Welding Electrode contacts the object to be welded to apply pressure and electric current**

Compacting – Resistance Welding



Compatible with 0.2~25SQ



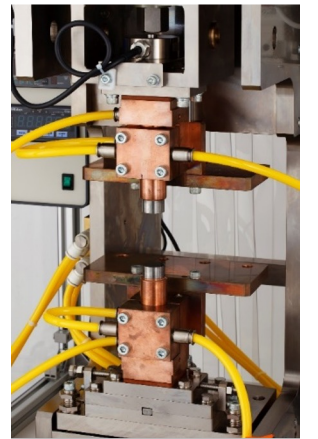
- NRW-IN400PA(8000A)
- NA-125(600N)



- NRW-IN16K4(16000A)
- NA-126(1800N)



- 10KN~15KN weld head
- Large capacity transformer (energized for long time)
- Control software
- Custom made electrode



Resistance Welding – Copper Alloy Tab Welding

Copper Alloying of Cylindrical Battery Tab Welds

Nickel

With the use of nickel in battery tabs there was the disadvantage of low conductivity and high cost

Copper Alloy

Battery tab material to replace nickel in recent years. As “tin-plated copper alloy” attracts attention

Large Capacity

With less loss in the battery tab For instantaneous high-current discharges

Rapid Charge

With faster charging speeds enables high-current quick charging

Inverter Type Welding Power Source NRW-IN400PA

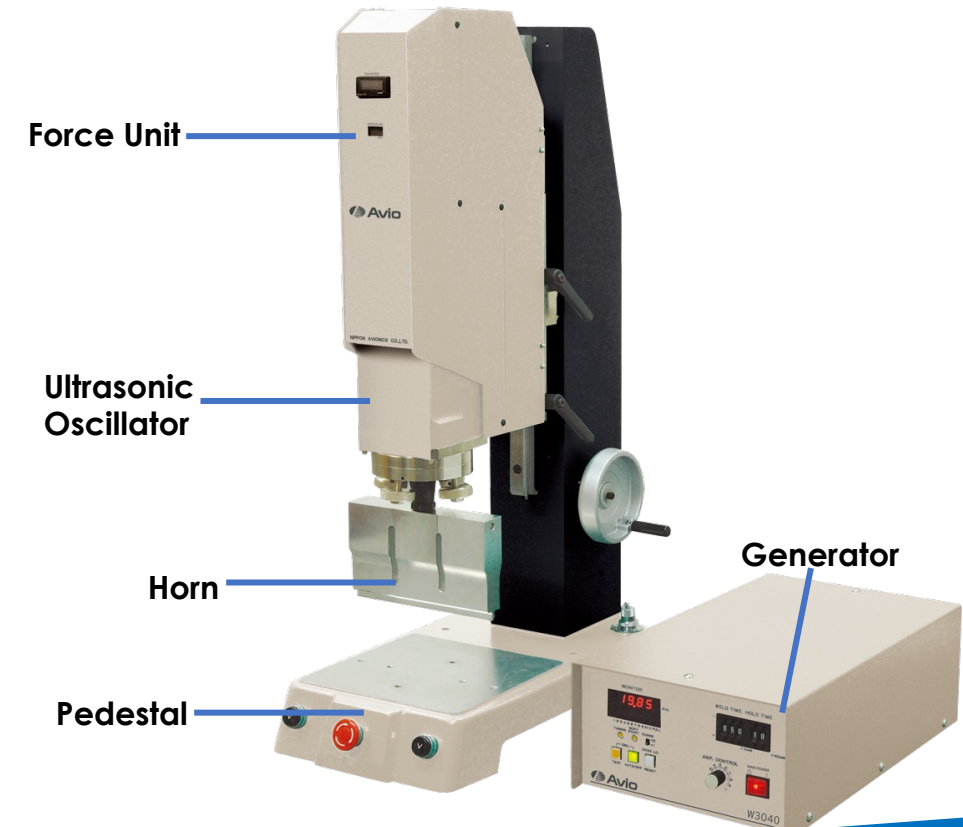
- **Max 5kHz Power Out Frequency**
 - High current value is output at high speed to ensure welding strength
- **Repeated Energization Possible**
 - Improvement of production tact
- **Remote Operation in the Program Box**
 - Easy to mount on automatic machines



Ultrasonic Plastic Welding

A joining method where ultrasonic vibration is transmitted while applying a force to plastic resin (thermoplastic resin) to melt the resin and join it. It is used in a wide range of fields such as automobiles, home appliances, daily necessities, and food packaging because the welding time is short and airtight welding can be easily achieved.

- **Ultrasonic Generator:** converts the commercial power line frequency 50/60Hz to the ultrasonic frequency to be used
- **Oscillator + Corn:** converts electrical frequencies to mechanical vibration frequencies and amplitudes
- **Horn:** resonates with the vibration of the oscillator, applies vibration and force to objects to be welded
- **Anvil:** positions and fixes the objects to be welded to prevent vibrational energy from escaping
- **Rib:** concentrates energy on the objects to be welded



Ultrasonic Metal Welding

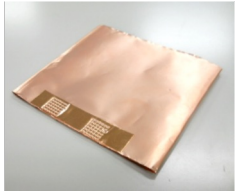
Ultrasonic vibrations are applied to metals to destroy and disperse the oxide film that exists at the bonding surface, causing the metals into intimate contact with each other through plastic deformation, which results in joining due to interatomic forces. This method is classified as solid-phase joining, which is different from fusion joining as typified by resistance welding in that the joining is done in the solid state and is less affected by the heat!

- ❑ **Since welding temperature is low, thermal effect is minimalized.**
 - Base material degradation is suppressed. Temperature rise in surrounding area is reduced
- ❑ **Welding of non-ferrous metals (copper, aluminum) is available.**
 - Thin plates, laminated foils, harnesses, bus bars, etc.
- ❑ **Welding of dissimilar metals is available**
 - Copper - Aluminum, Copper - Nickel ,etc.
- ❑ **Short welding time for excellent mass productivity**
 - Welding time: less than 1 second



Ultrasonic Welding From Small to Large

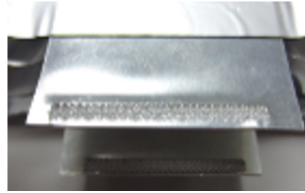
60 copper laminated foils



60 aluminum laminated foils



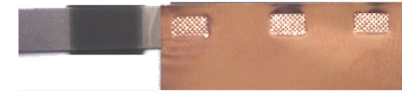
Aluminum tub 0.6mmt
Nickel-plated copper tub 0.4mmt



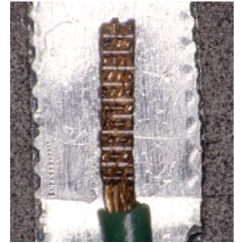
Aluminum stranded wire 20SQ
Nickel-plated copper terminal 1mmt



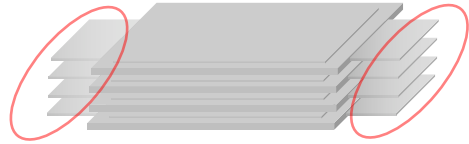
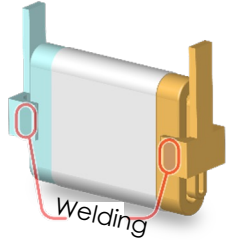
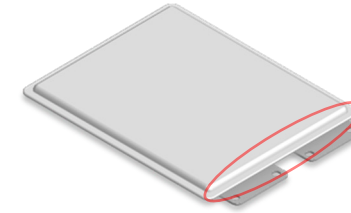
Copper foil 20µmt
Nickel tab lead 0.1mmt



Electric test wire
Aluminum tab



Copper busbar 1mmt to each other



Large Workpiece



Fine Workpiece

Supports large-capacity batteries
High-power model



Frequency 20 kHz
Powered 5000W/3500W
Pressurized 3700N

Accommodate a wide range of batteries
General-purpose model



Frequency 20 kHz
Powered 3500W
Pressurized 1600N

Compatible with small batteries
Motor drive
High-end model



Frequency 48 kHz
Powered 600W
Pressurized 350N

Compatible with small batteries
Space-saving installation
Inexpensive version of the model

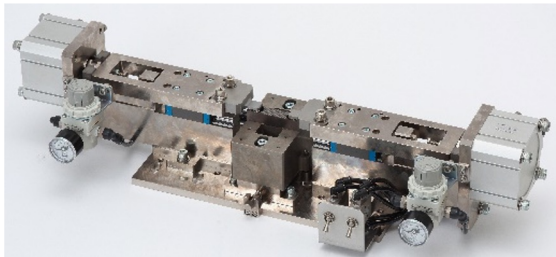


Frequency 48 kHz
Powered 600W
Pressurized 250N

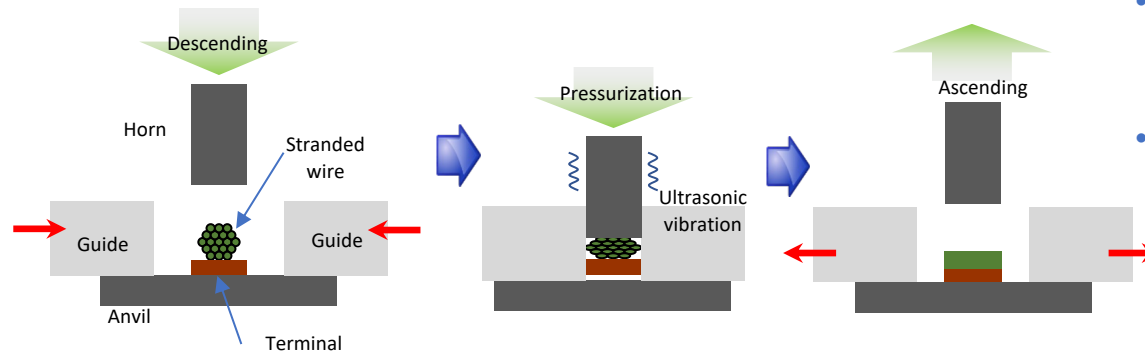
Compacting – Ultrasonic Welding

- Welding temp is low and thermal effect is suppressed
- Ideal for non-ferrous metal (Al, Cu) harnesses and foil welding
- Different metals can be bonded

Optional stranded wire connection guide unit



- Cylinder drive left/right guide open/close function
- Stranded compacting corresponds to both standard wires and terminal junctions



Ultrasonic Metal Welder SW-3500-20

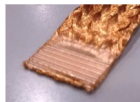
- Various oscillation control modes (time/energy/depth/height)
- High-resolution displacement control (1 μm resolution linear scale)
- Judgement of junction quality by monitoring function
- Control of production history through data output
- Simple operation and easy-to-see display (LCD touch panel)



1.25SQ



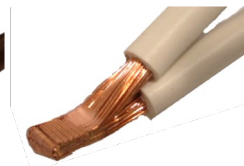
8SQ



9SQ



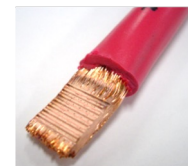
14SQ



16SQ



20SQ



22SQ

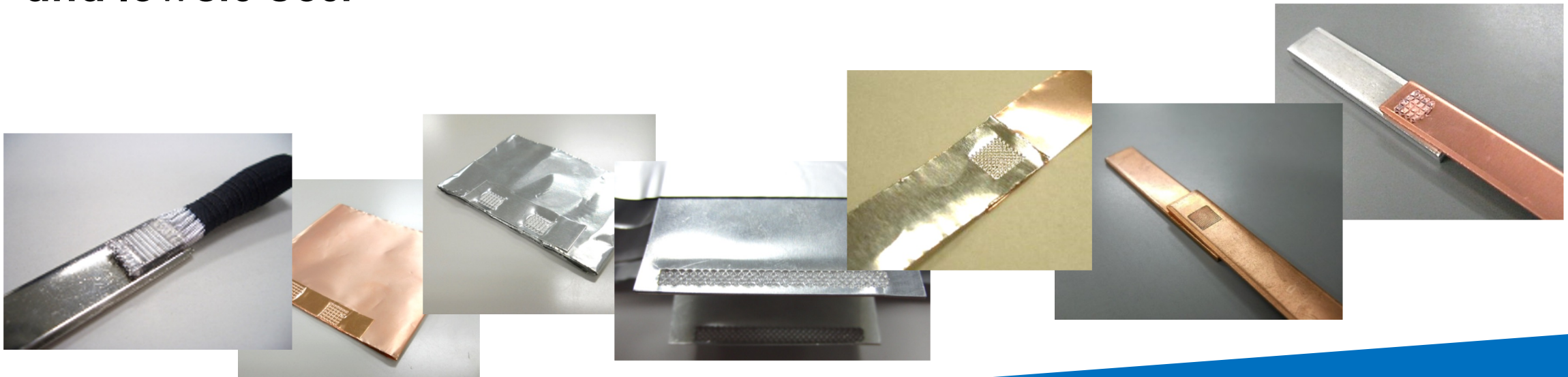


38SQ

← **Ultrasonic Bonding Samples**

Ultrasonic Metal Welder (Continued)

- Avios' unique spring pressure tracing mechanism and ultrasonic frequency tracking method allows high quality welding
- Bonding of dissimilar metals
- Low temperature bonding – no thermal damage to work
- Optimal solution for bonding of large diameter harness, multi-layered foil, such as Al and/or Cu
- Solder-free bonding! – helps production to be more environmentally friendly and lowers cost

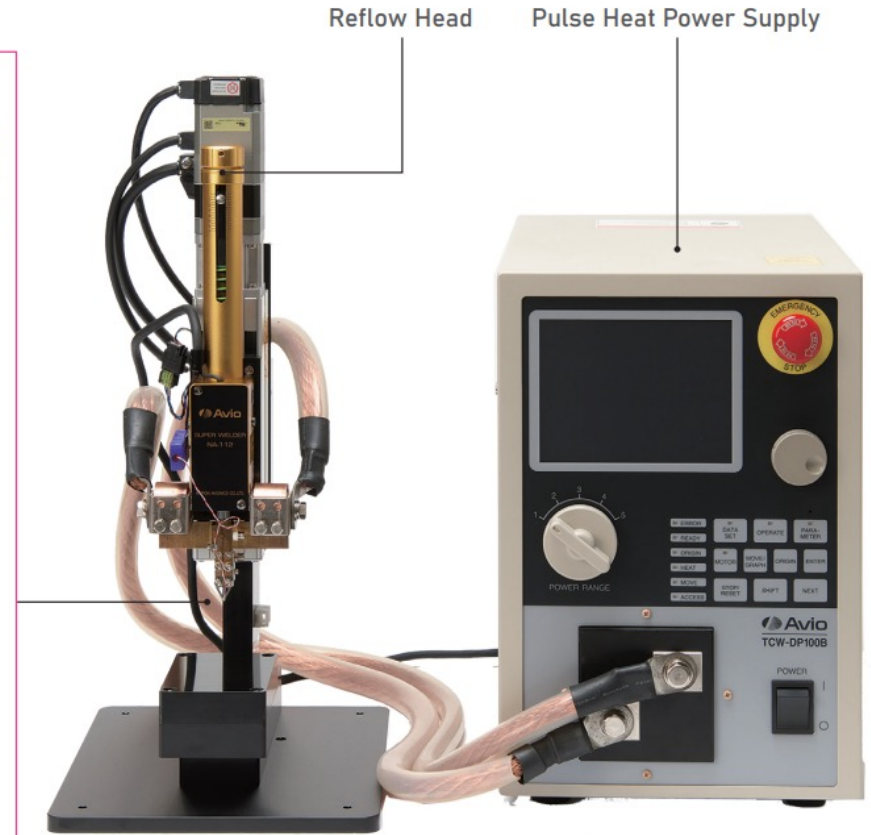
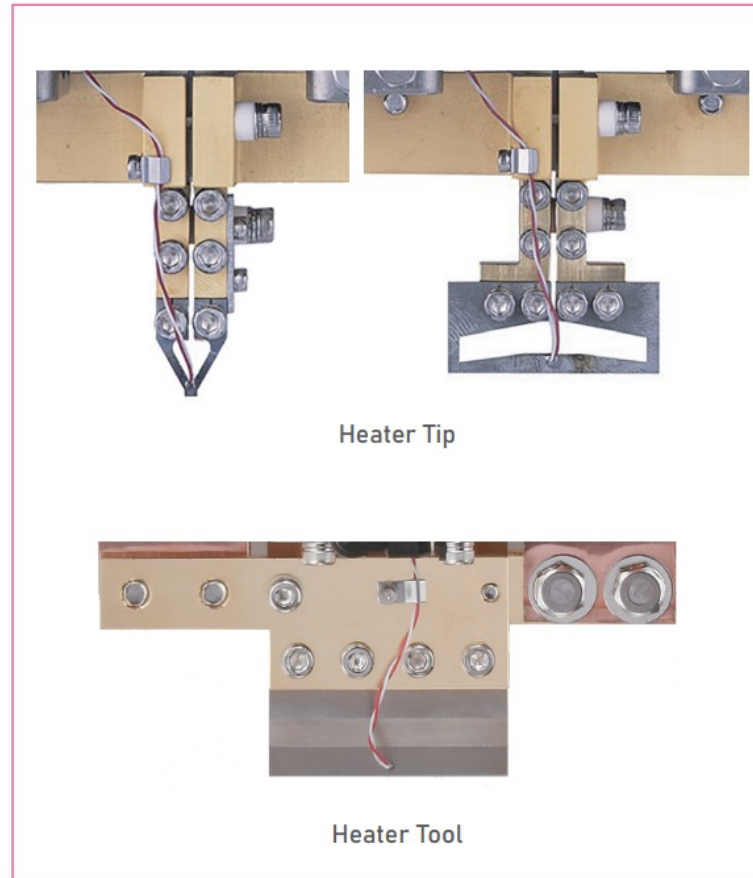


Pulse Heat

Process of utilizing resistance heat generated by passing an electric current through a metal heating body (heater tip/heater tool). Instantaneously performs soldering, thermocompression bonding, and plastic welding with heat and pressure

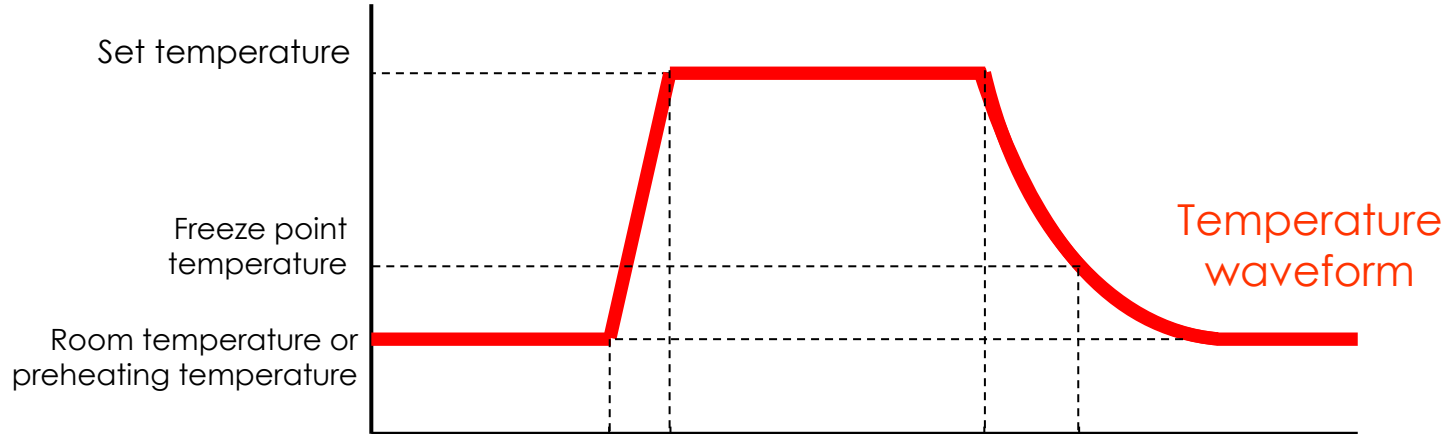
Basic Process Flow

- Press the heater tip/heater tool against the target work to pressurize
- Apply electric current to the heater tip/heater tool to raise the temperature from room temperature to preset temperature while pressurizing
- Hold pressure and heat for a set time
- When the set time is complete, welding stops.
- When the temperature reaches the preset cool temperature, the pressure is released
- The heater tip/heater tool returns to room temperature



Battery – Pulse Heat Caulking

Apply a large current to the metal tool (heater tip) and utilize Joule heat generation technology for resin caulking and soldering



Thermocouple is integrated with the heater tip and with feedback control follows the programmed temperature profile

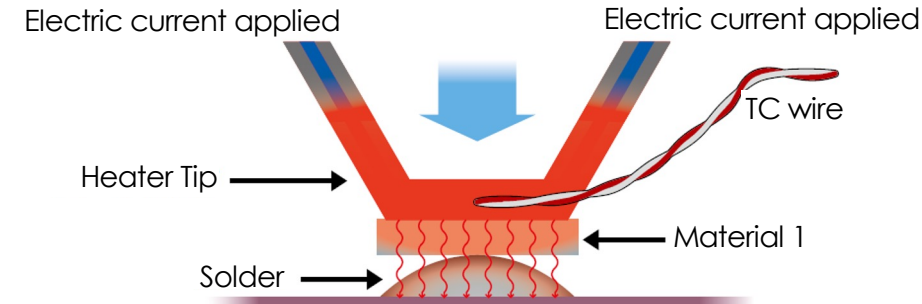
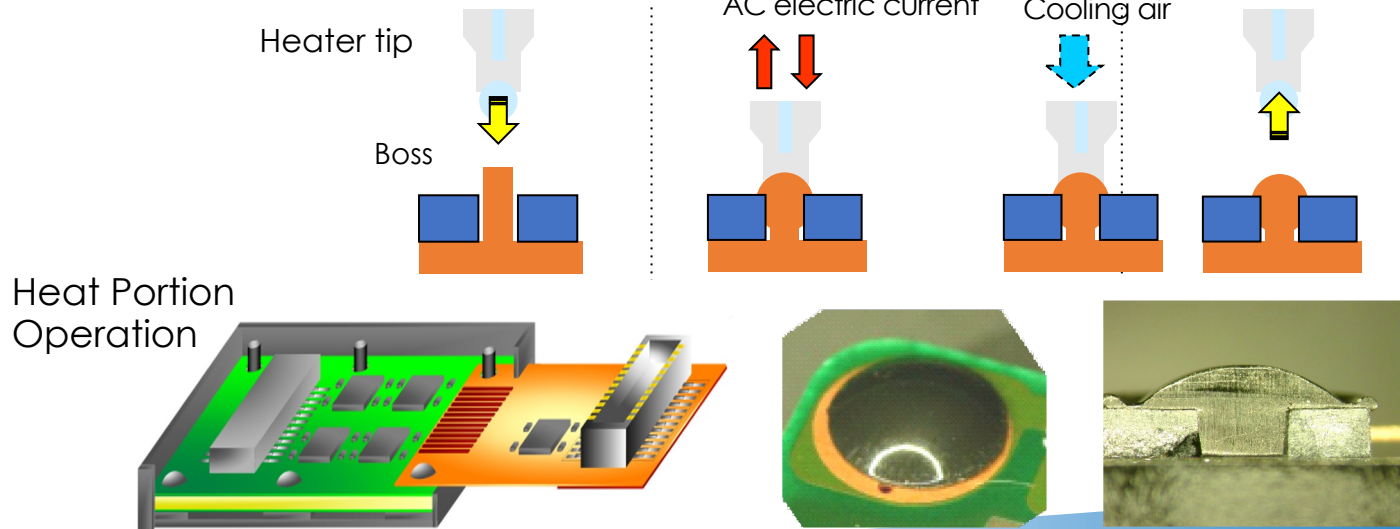


Fig. 1 Pressurization Head



Pulse Heat (Continued)

Features of Pulse Heat

Temperature control feeds back the heater tip/heater tool temperature and accurately reproduces the programmed temperature profile- eliminating operator variations

- The temperature rises quickly, reproducibility is good and programmed profiles are easily implemented
- Local heating minimizes the heat effect on the surrounding area
- Bond pressure is maintained through cool down, reducing bond failure
- Pulse heat power supply:
 - Supplies electric current to heater tip/heater tool
- Reflow head:
 - Applies pressure to hold the bond parts in place through the process
- Heater tip/heater tool:
 - Area where heat is generated due to resistance. Usually, the heater tip is small, and the heater tool is larger

See our Pulse Heat Unit Series Product Catalog for Much More!

Automotive

Motor Fusing, Terminal Welding

Resistance Welding



Sun Visor, Sunshade

Ultrasonic Welding Welding, Fusing, Cutting



Door Trim Insulator Welding, Boss Fusing

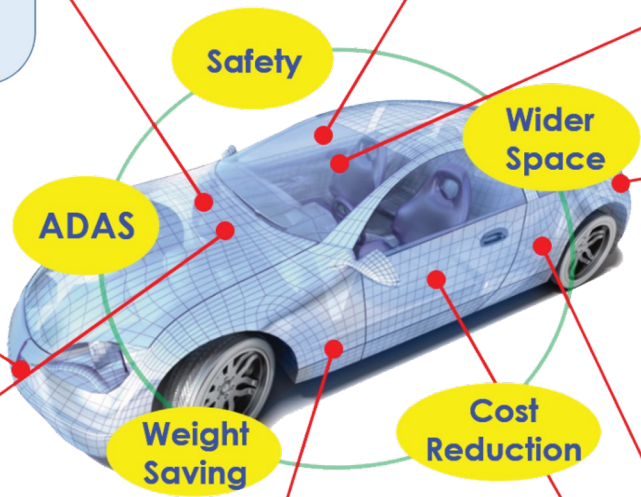

Pulse Heat

Ultrasonic Welding



Bumper, Emblem

Ultrasonic Welding Hole Drilling, Plastic Fusing



Lamp Nut/Bolt Insert

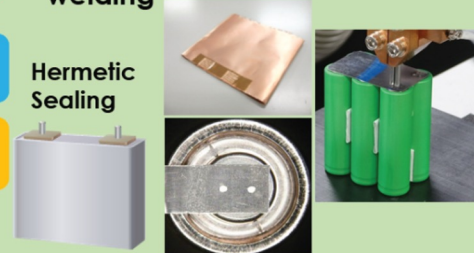
Ultrasonic Welding (High-Frequency Induction Heating)



Battery Foil lamination welding, Tab welding

Resistance Welding Hermetic Sealing

Ultrasonic Welding



Sensor, Device

Seam Welding

PKG Sealing

Pulse Heat

Soldering



Harness Wire Joining, Compacting

Resistance Welding

Ultrasonic Welding



Seat, Floor Mat

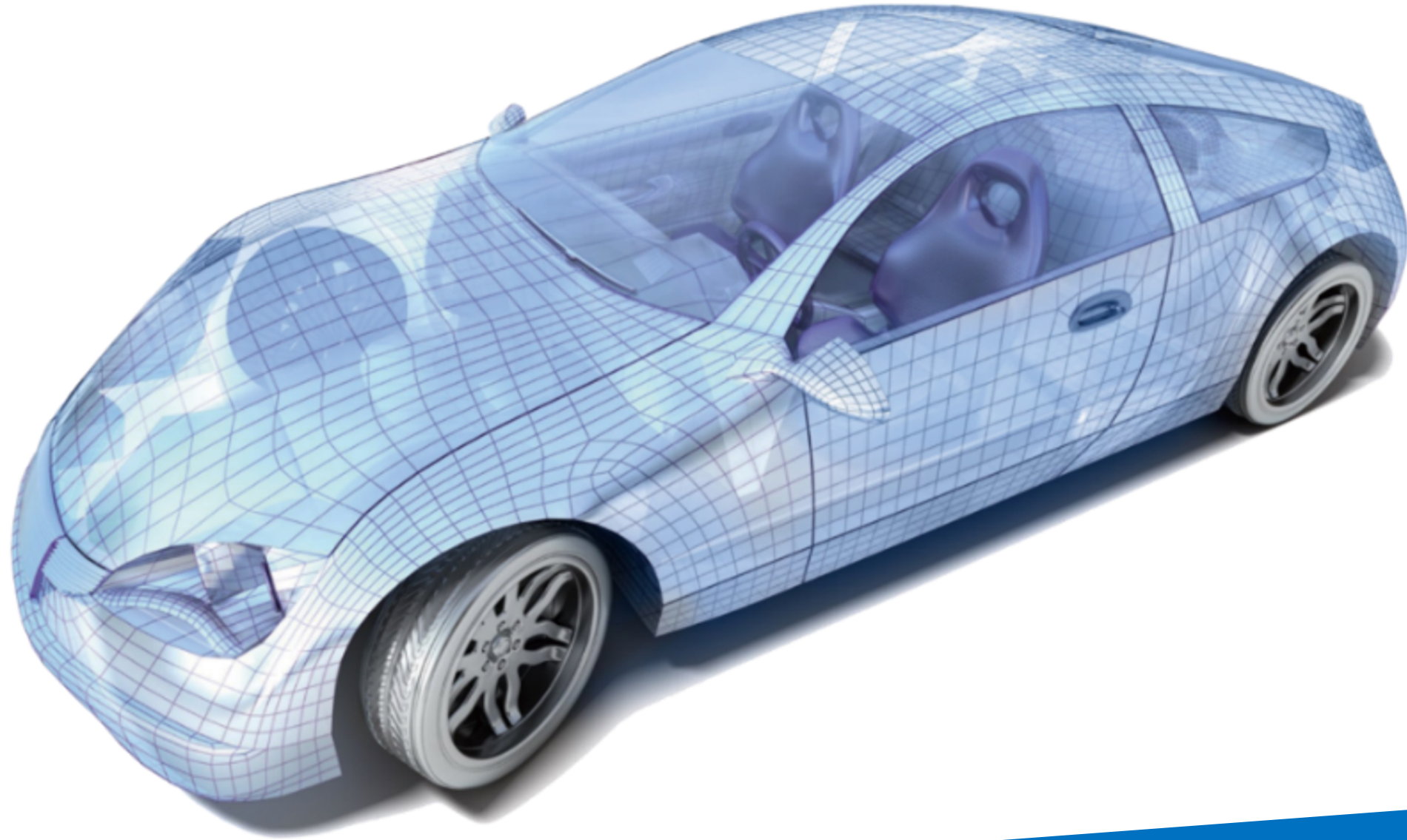
Ultrasonic Welder

Welding, Fusing, Cutting



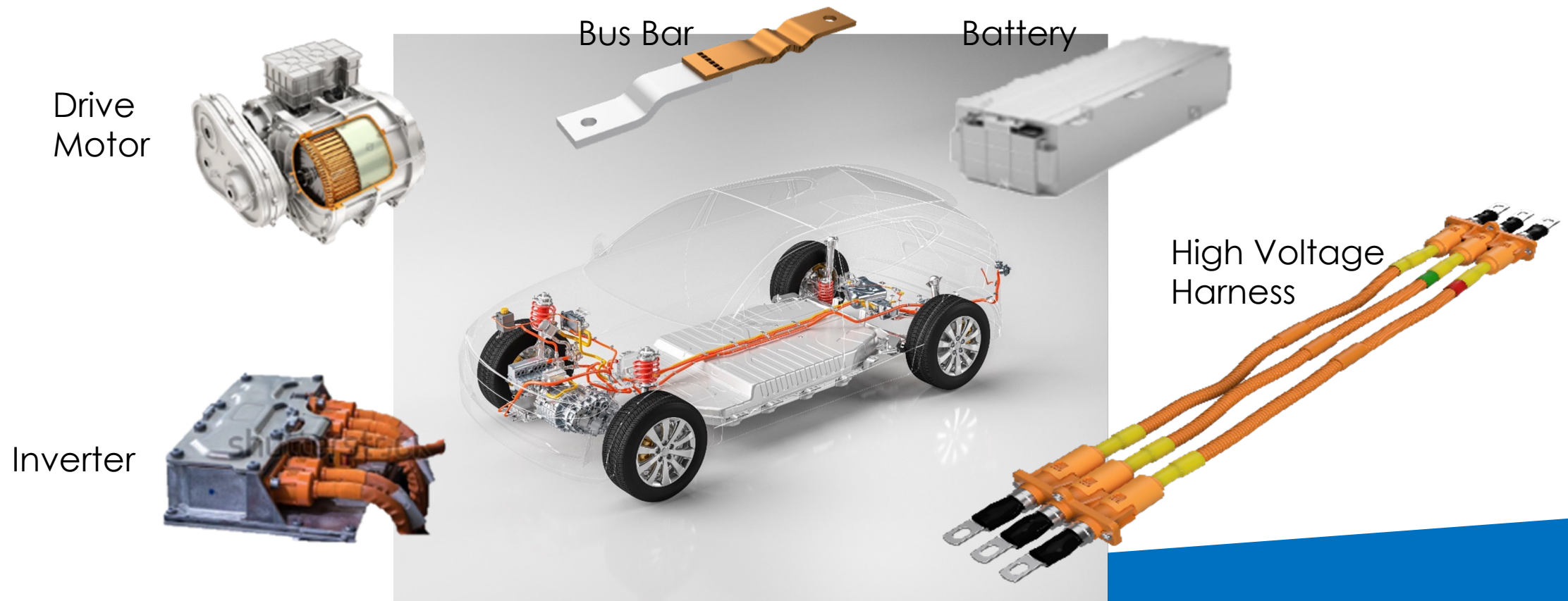
EV Junction Application

- **Harness**
- **Motor**
- **Batteries**
- **EV Relay**



Harness - Wiring

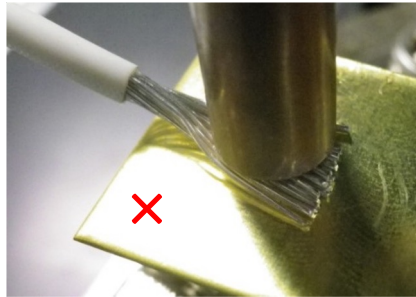
- High reliability strength and heat resistance is required for connections of high-voltage wiring harnesses connecting the motor to the battery and inverter
- Direct joining such as ultrasonic welding and resistance welding achieve high quality and high reliability



Harness - Compacting

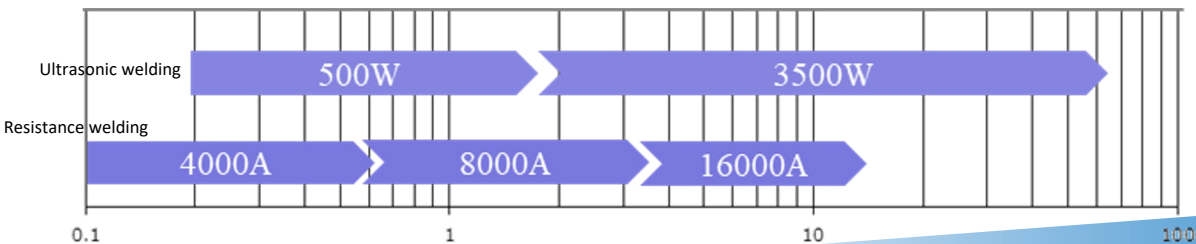
Variation of wire rods in twisted wire welding

- ❓ Welding strength is not stable because contact conditions vary
- ❓ Bulk wire may cause short circuit

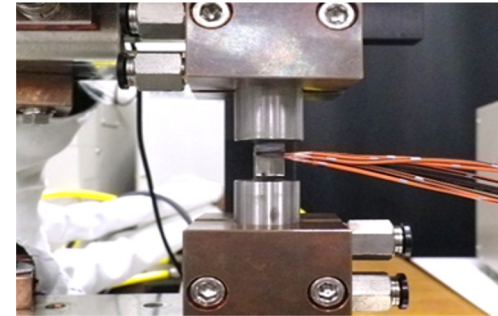


Resistance welding

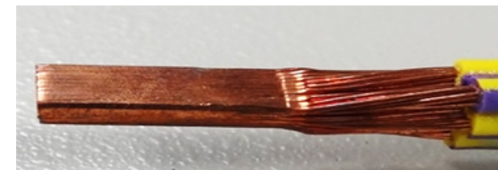
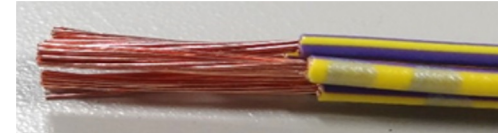
- Ultrasonic Welding: sonic phase bonding, less heat
- Resistance Welding: melt bonding, low line breakage, compatible with small and large diameters



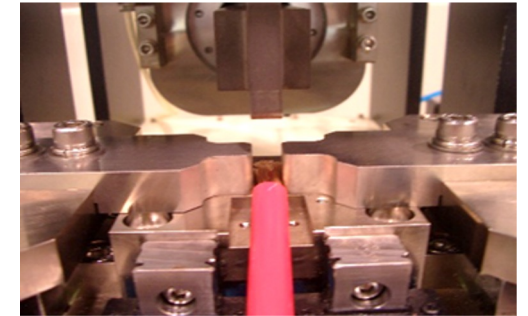
Resistance Welding



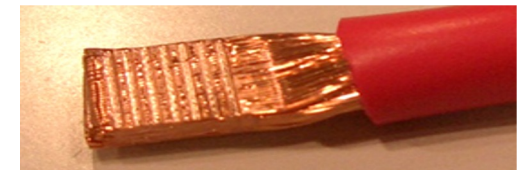
AWG20 *5 pcs.



Ultrasonic Welding



AWG4



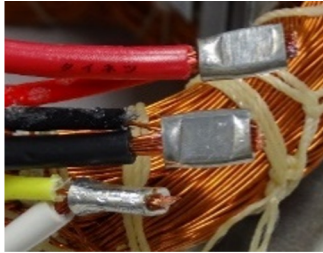
<Reference: Cable Standard: Wire Diameter>

SQ(JIS)	0.2	2	8	14	22	38	60	100
AWG(UL)	24	14	8	6	4	1	1/0	4/0
Sectional area (mm ²)	0.205	2.08	8.37	13.3	21.15	42.41	53.49	107.2

Motor

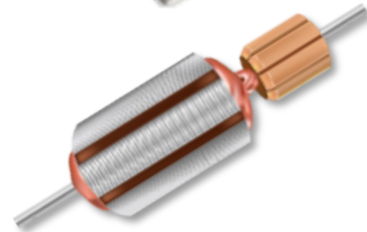
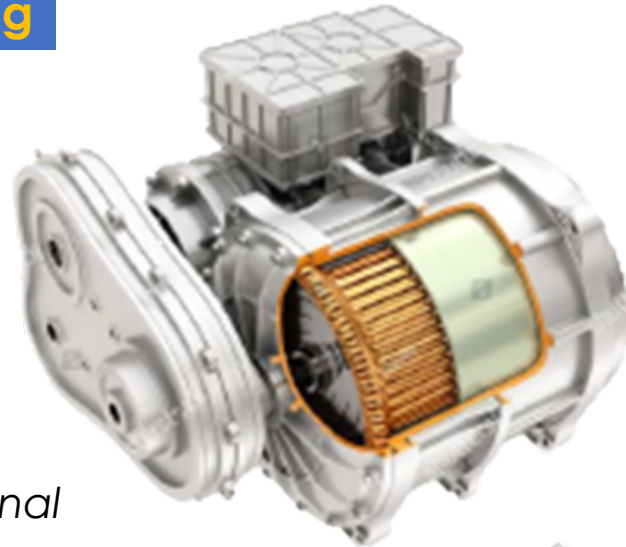
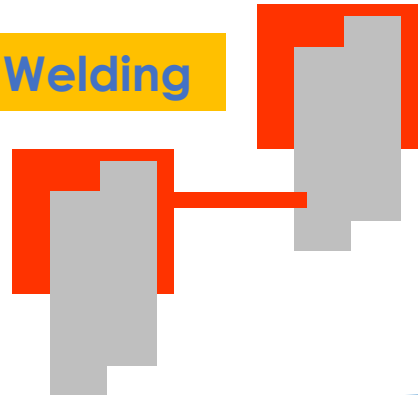
Magnet wire x UVW terminal

Resistance Welding



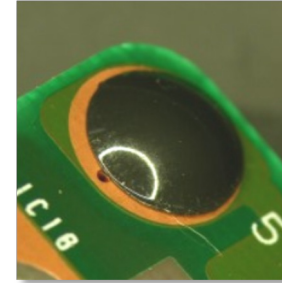
Aluminum flat wire x UVW terminal

Ultrasonic Welding



Bracket Processing
For small motors

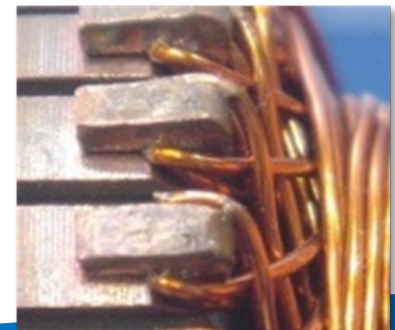
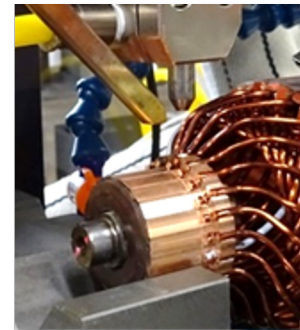
Thermal Caulking



Rotor Assembly

Magnet wire x terminal

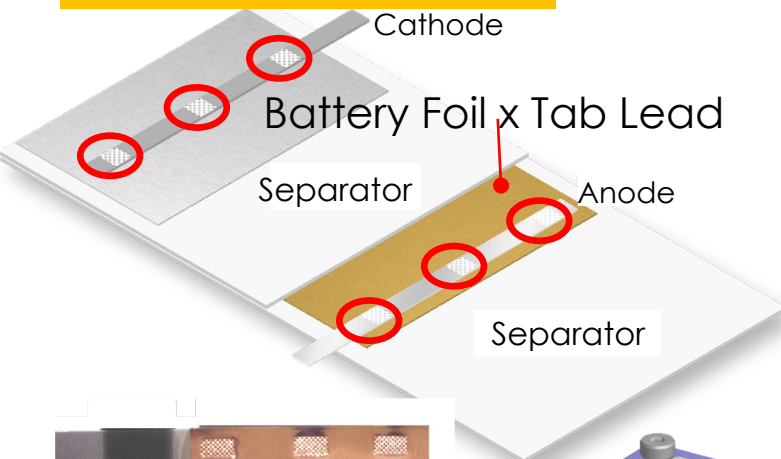
Resistance Welding



Batteries – 18650 – Inch Can Batteries

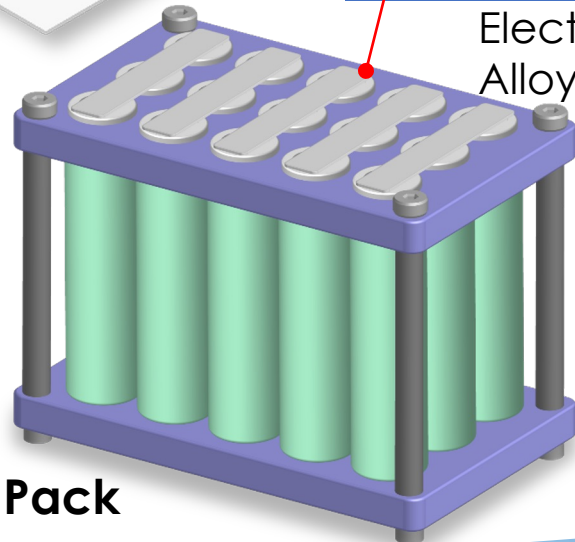
Manufacturing Process and Joints of Type 18650 Can Batteries

Ultrasonic Welding



Resistance Welding

Electrode x Copper Alloy Tab



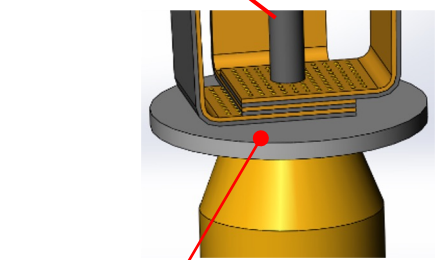
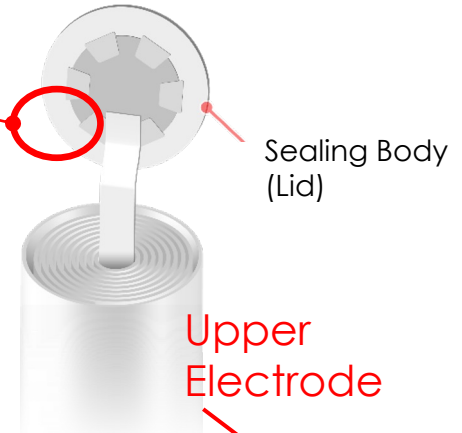
Ultrasonic Welding

Top Cap x Tab Lead



Welding

Sealing Body (Lid)



Resistance Welding

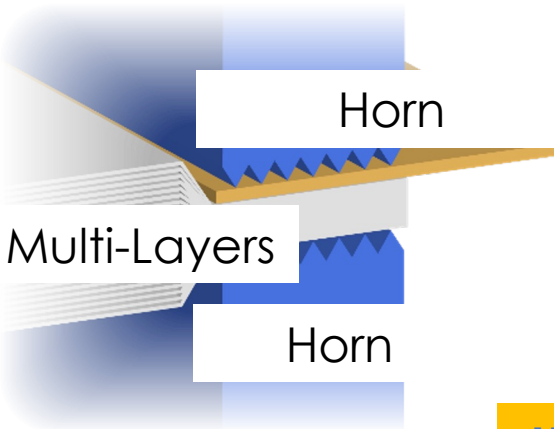
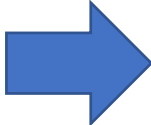
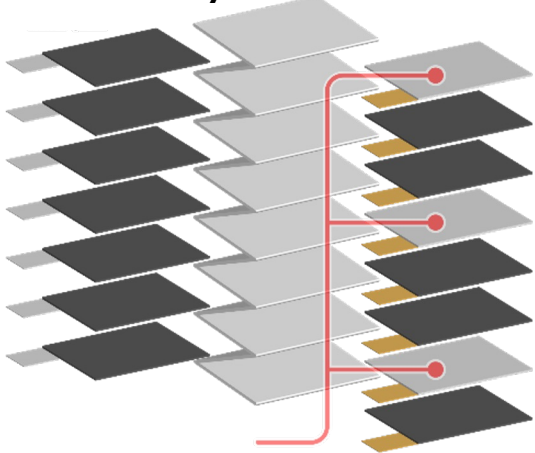
Can Bottom x Tab Lead



Laminated Batteries

Manufacturing Process and Joints of Laminated Can Batteries

Battery Foil x Tab Lead



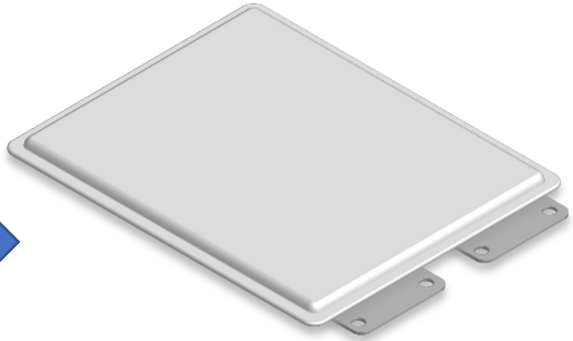
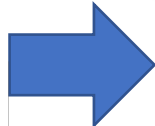
Horn

Multi-Layers

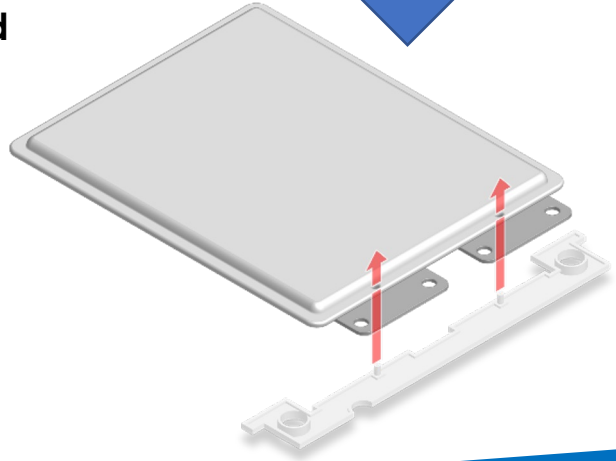
Horn



Ultrasonic Welding

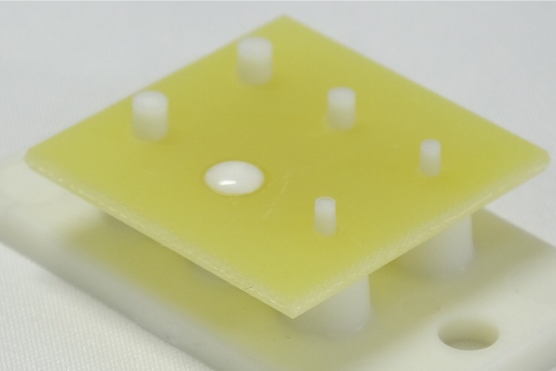
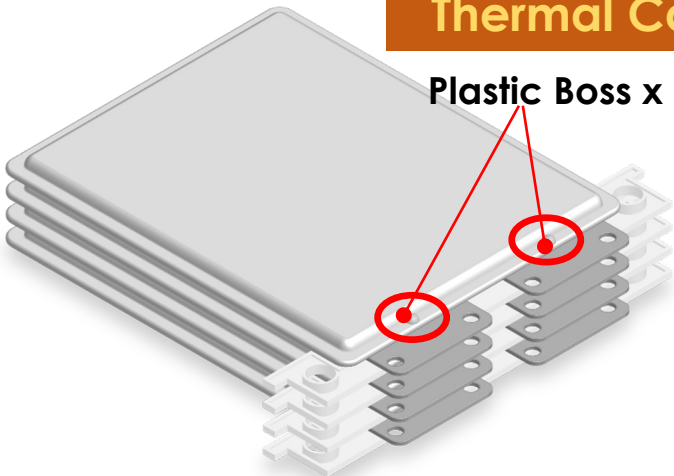


Laminated Battery Foil x Tab Lead



Thermal Caulking

Plastic Boss x Laminated Bag



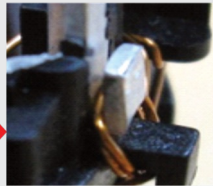
New Product NRW-IN400PA Resistance Welder

Challenge

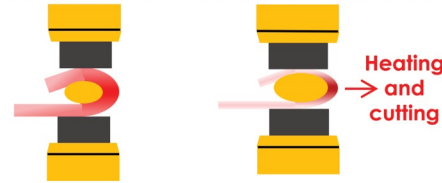
When wires are thick and terminals are thin, heat generation is unbalanced, and terminals may fuse



fusing of Cu terminal and magnet wire



① Good Heat Balance ② Heat Imbalance



Highly Reliable Welding and Ease to Use



Precise Heat Input Control Provides Better Joining

Solution

Proper Heat Balance Creates Stable Fusing

Uniquely programmable up to 127 steps (*) of welding time and output prevents melting of terminals by setting the optimum heat value.

<Pulsation Function: Image of Welding>



- ☐ Selectable Frequency (2k, 4k, 5kHz)
 - Current ripple is reduced by optimization
- ☐ 127 Step (slope, weld, cool) Arbitral Setting
 - Multi-Step Welding Ideal for Fusing and Resistance Heating
- ☐ Remote Control by Program Box
 - Easy Facility Designing
 - Easy Condition Change
- ☐ Support Worldwide Operations
 - AC200V ~ 480V, 3-Phase
 - Easy Facility Designing

NRW-IN400PA Specifications & Features

1. Multi Power Support(200~480V)



2. Program Box Structure



3. Free Style Profile

max.
127 Step

Industry's first!

4. Selectable Inverter Frequency

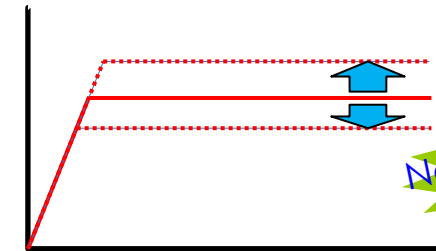
Industry's first

5000Hz
4000Hz
2000Hz

Inverter Welding Controller NRW-IN400PA



5. Target compensation of welding condition



New feature!

6. Multi-Transformer



7. Monitoring Function

NRW#10 運転モード				
	1st	2nd	3rd	4th >
Voltage[V]	209.0	208.0	0.0	0.0
wTime[ms]	25.0	35.0	0.0	0.0
Pulse[W[%]	10.0	10.0	0.0	0.0
Vave[V]	0.071	0.070	0.000	0.000
Iave[A]	300	300	0	0
Wave[W]	25	24	0	0
Rave[m2]	0.20	0.18	0.00	0.00
Vpeak[V]	0.128	0.126	0.000	0.000
Ipeak[A]	325	320	0	0
Wpeak[W]	33	33	0	0
Rpeak[m2]	0.55	0.50	0.00	0.00
Vlimit	OK,OK	OK,OK	--	--
Ilimit	OK,OK	OK,OK	--	--
Wlimit	OK,OK	OK,OK	--	--
Rlimit	OK,OK	OK,OK	--	--
Pulse Width	OK,OK	OK,OK	--	--

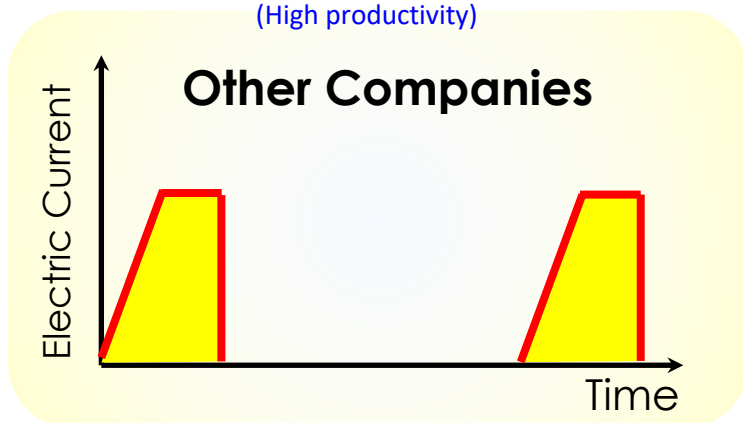
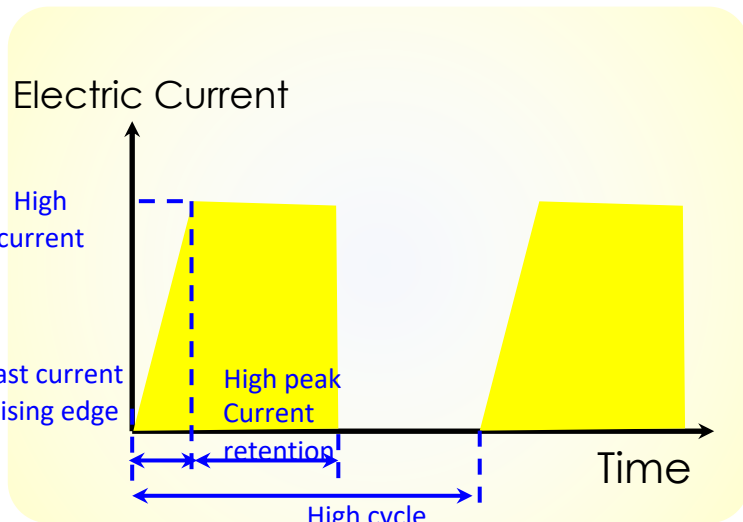
Program #11
Weld Result: MONITOR OK
Output: NONE
Count1: 75
Count2: 75
Status: OPERATE
MODE: EMG 00000, CAU 0000, WELD 0000
I/O確認

8. Transformer-switcher for Multiple Welding



Resistance Welding: NRW-IN400PA

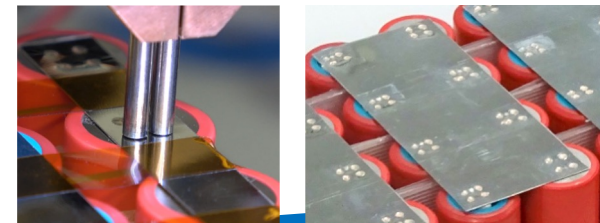
Current carrying performance with high-speed current rise and peak current retention



- High-speed current rise in the copper alloy tab- a difficult material to weld
- Welding quality (ensuring calorific value) and high peak current retention (diffusion progress)
- **Important factor for stabilization**
- With Avio welding power source the energization performance is designed for copper alloy tab welding
- Stable production process is maintained



No slitting for copper alloy tab thickness 0.15 mm or less
Technical know-how that enables welding without projection
Simple tab shape design
Reduction of engineering cost of tab design



Feedback Shift Function for NRW-IN400PA

Feedback Shift Function

It monitors physical quantities (voltage value, current value, power value, and current-integral time square) inside the power supply when welding, and transitions to the next phase when the values reach the set values.

It is Effective When Condition of Workspace or Current Flow is Unstable



Realization of Constant Welding Result

- Suppresses spatter, expulsion and surface flash
- Suppresses variation of welding strength

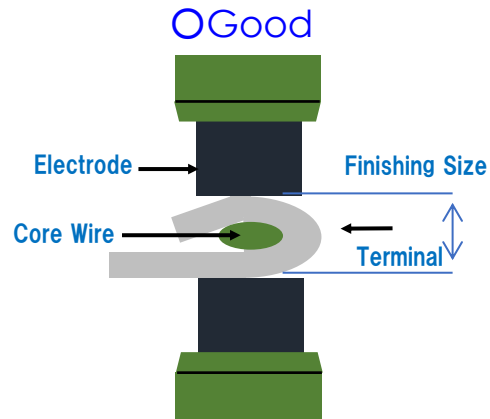
Inverter Type Welding Power Supply NRW-IN400PA

Fusing – Stabilization by Changing Parameters

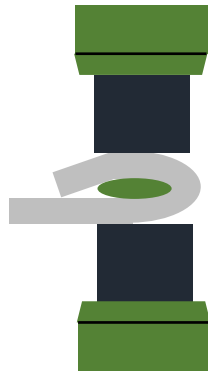
Challenge



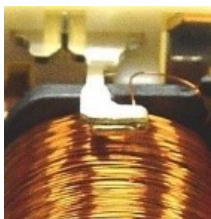
- Displacement control is difficult in short-time fusing.
- When fusing is performed at the same current value and welding time, displacement increases due to effects of electrode temperature rise, electrode deterioration, and workpiece temperature rise.



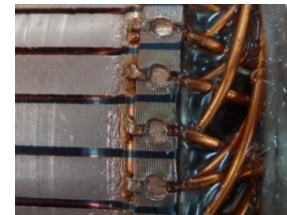
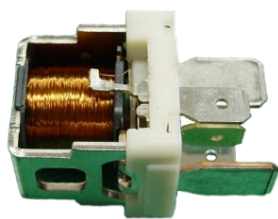
✗ Over-Crushing



✗ Insufficient-Crushing



Hook Type Direct Method

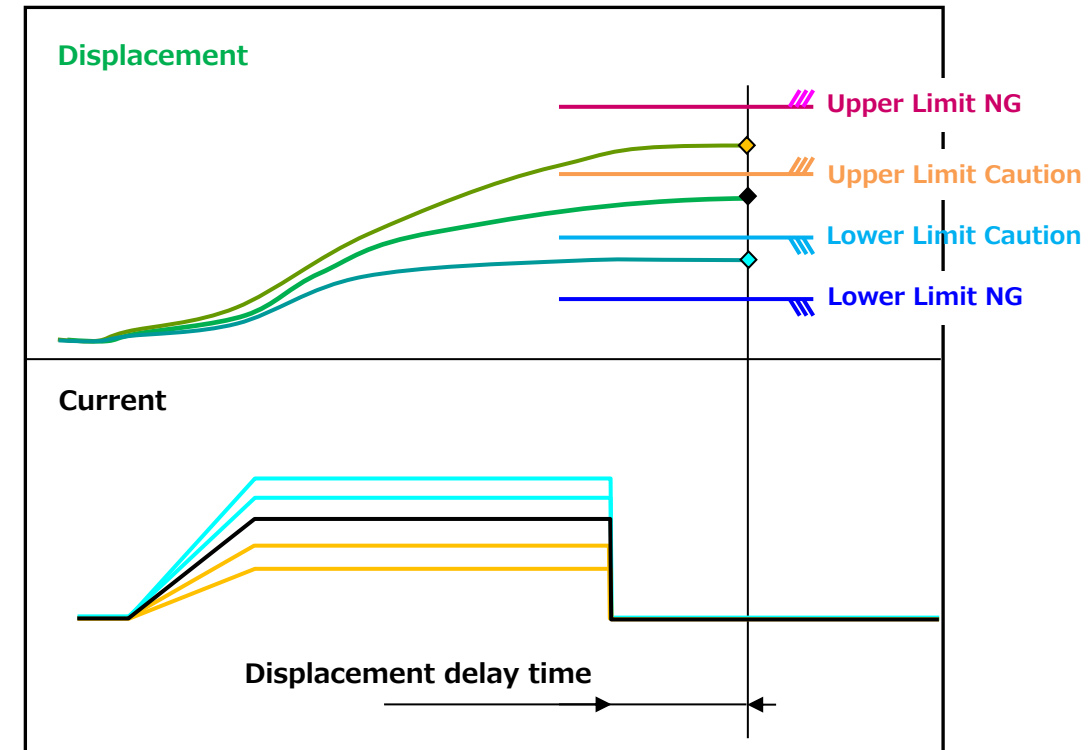


Slit Type Indirect Method

Solution



By sending displacement data to the PLC side and switching the welding parameter, the finished dimensions can be stabilized.



Thank you

