

Wire-bonding tests on LTU foils

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New tests: Foil onto PCB

- Foils glued onto FR4 PCB to improve vacuum contact during bonding
- Some glue spilled onto the top surface of the foil
- Cleaned with PCB cleaner (cleaning + 2 rinse cycles + drying)
- Glue residue on top side successfully removed



Single layer foil



Multi layer foil



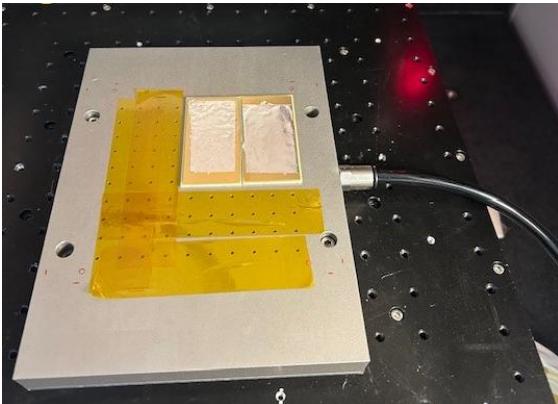
PCB cleaner



- Ran out of the wires used for the previous tests
 - CCC: Al-1%Si, 25 um diameter, EI % 1-4, TS 15-18g
- New Heraeus wire will now be used
 - Al Si-M, 25 um diameter, EL > 1%, BL 15-17 cN
 - Personal experience: this wire is not as good as the previous wire
- Foil on jig
 - Vacuum contact significantly improved
 - Foils were held firmly on the jig throughout testing



New wire



Foils on jig

Standard parameter

- Standard settings (full details in backup slides):

- Ultrasonic: 22%
- Bond force: 22 cN
- Deformation: 40%
- Overtravel: 25 μm

- 100 μm wire spacing, 1500 μm bond length \rightarrow $\sim 30^\circ$ pull angle
- Increased ultrasonic relative to bond force helped bonding
- See next slide for failure observations

Single Layer						
US%						
Mean		22	25	22	25	
CN	22	9.2				
	22		10.6			
	25			5.7		
	25				9.7	

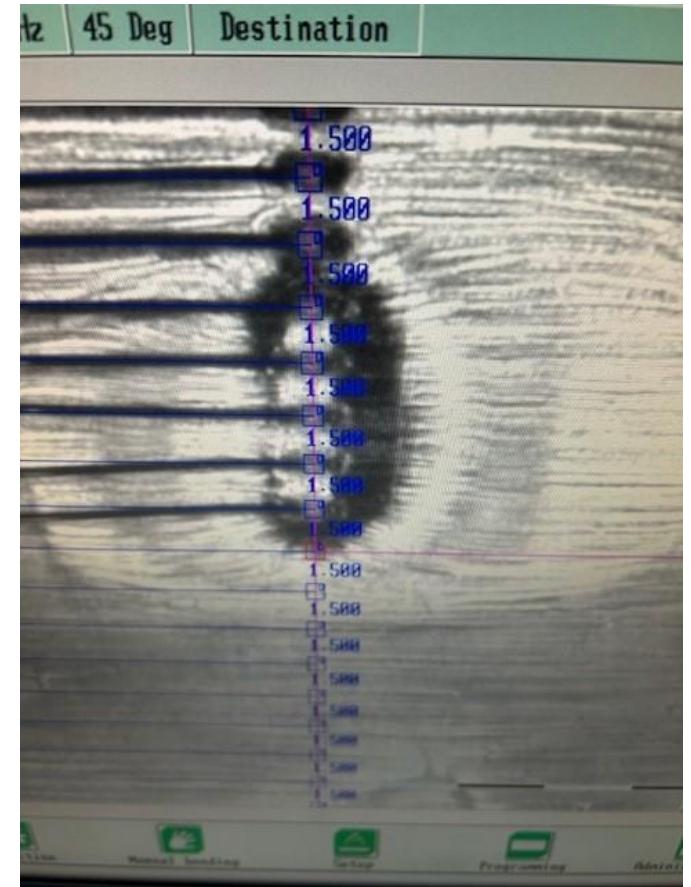
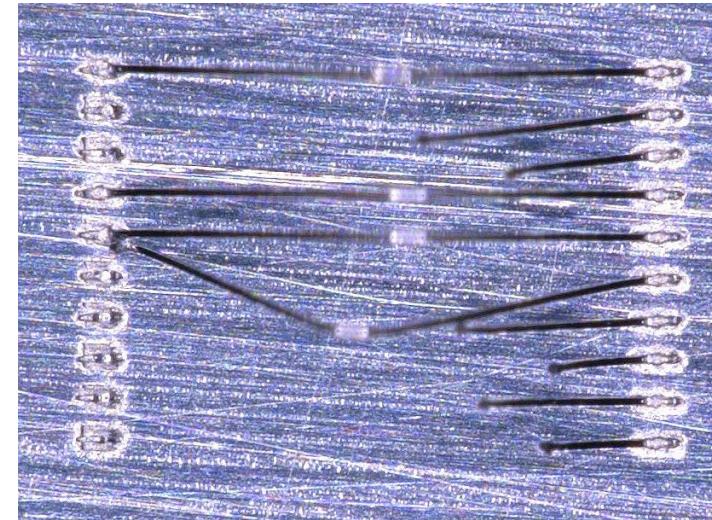
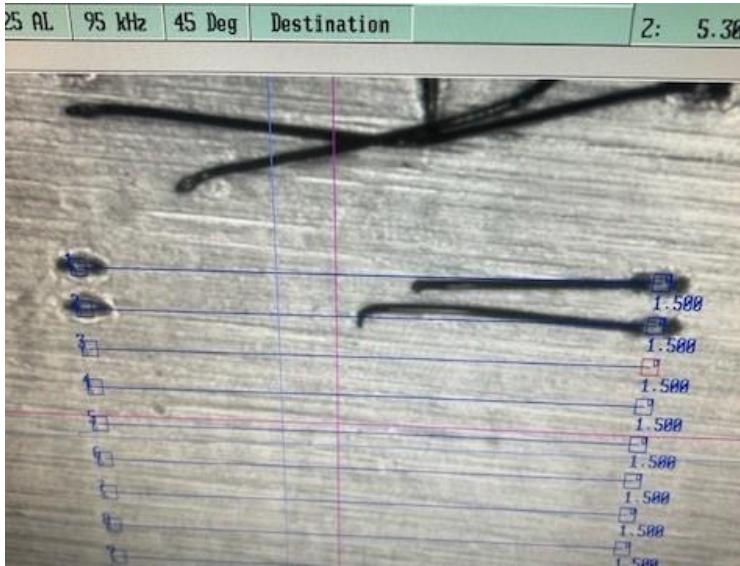
Single Layer						
US%						
Std Dev		22	25	22	25	
CN	22	1.73				
	22		0.68			
	25			2.92		
	25				1.26	

Multi Layer						
US%						
Mean		22	25	22	25	
CN	22	9.1				
	22		9.3			
	25			6		
	25					

Multi Layer						
US%						
Std Dev		22	25	22	25	
CN	22	1.51				
	22		2.04			
	25			2.26		
	25					

Failures

- Bond force or US <22 led to high failure rate → use parameters >22
- Failures also observed near black spots at source/destination
 - Likely due to insufficient glue support
 - Poor pull strengths in these regions
- Bonding was avoided in areas with uncleared glue residue



Repeat standard test



Single Layer						
US%						
Mean	22	25	22	25		
CN	22	7.33				
	22		10.11			
	25					
	25				9.32	

Multi Layer						
US%						
Mean	22	25	22	25		
CN	22	9.7				
	22		7.17			
	25					
	25					10.32

Repeated test

Single Layer						
US%						
Std Dev	22	25	22	25		
CN	22	2.12				
	22		1.31			
	25					
	25				1.42	

Multi Layer						
US%						
Std Dev	22	25	22	25		
CN	22	2.12				
	22		2.07			
	25					
	25					2

- Standard bonding test repeated on a different foil area
- Aimed to verify reproducibility of bond quality

Single Layer						
US%						
Mean	22	25	22	25		
CN	22	9.2				
	22		10.6			
	25		5.7			
	25			9.7		

Multi Layer						
US%						
Mean	22	25	22	25		
CN	22	9.1				
	22		9.3			
	25		6			
	25					

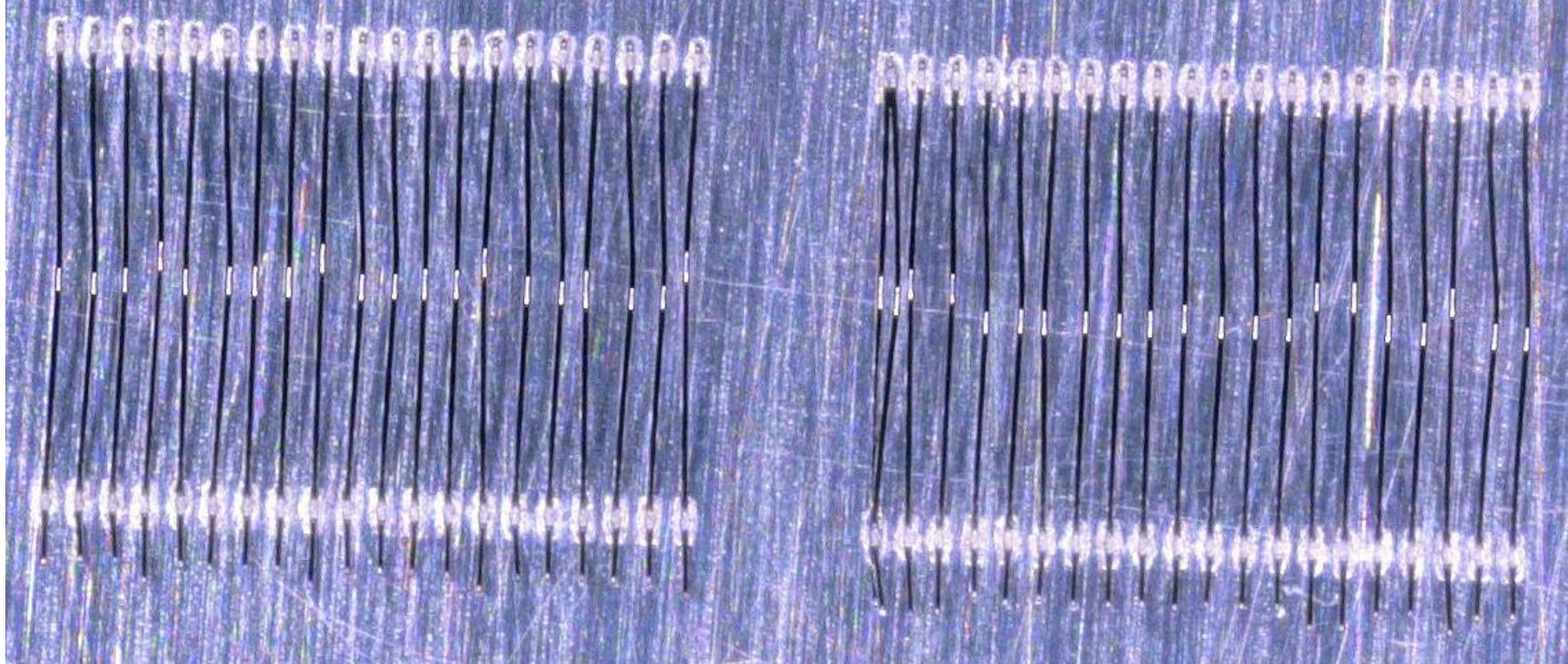
Single Layer						
US%						
Std Dev	22	25	22	25		
CN	22	1.73				
	22		0.68			
	25		2.92			
	25		1.26			

Multi Layer						
US%						
Std Dev	22	25	22	25		
CN	22	1.51				
	22		2.04			
	25		2.26			
	25					

Initial test

Longer tails

- Tail length was increased in later tests
- Result: **fewer failed wires, stronger and more consistent pull results**
- All tests after this point used longer tails



Pull test matrix



		Single Layer										Multi Layer										
		US % Ultrasonic										US % Ultrasonic										
Mean		22	22	25	25	28	28	30	30	32	32	22	22	25	25	28	28	30	30	32	32	
(CN) Bondforce	22		11.18									22		10.73								
	22			11.46								22			10.45							
	25				11.26							25				11.04						
	25					11.21						25					11.03					
	28						11.33					28						11.04				
	28							11.04				28							11.06			
	30								10.49			30								11.03		
	30									10.99		30									10.8	
	32										10.66	32										9.45
		Single Layer										Multi Layer										
		US % Ultrasonic										US % Ultrasonic										
Std Dev		22	22	25	25	28	28	30	30	32	32	22	22	25	25	28	28	30	30	32	32	
(CN) Bondforce	22		0.69									22		1.77								
	22			0.18								22			1.32							
	25				0.59							25				0.67						
	25					0.62						25					0.25					
	28						0.36					28						0.88				
	28							0.8				28							0.69			
	30								0.82			30								0.49		
	30									0.65		30									0.82	
	32										0.77	32										1.2

- Best results (mean and standard deviation) achieved with settings between 25–30
- Foil bondability improved significantly under these conditions

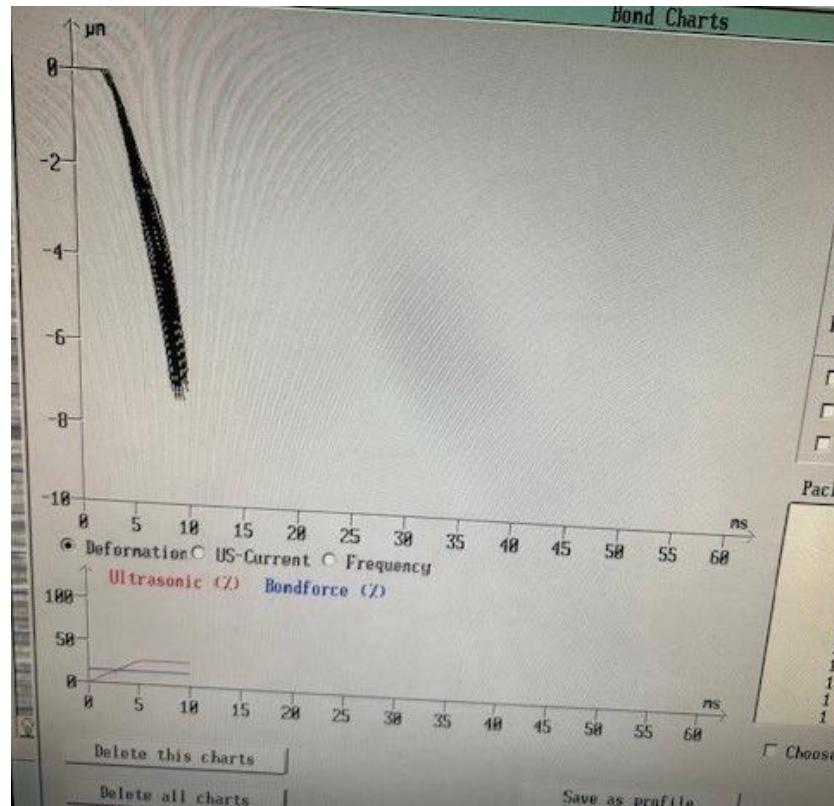
30% and 50% deformations



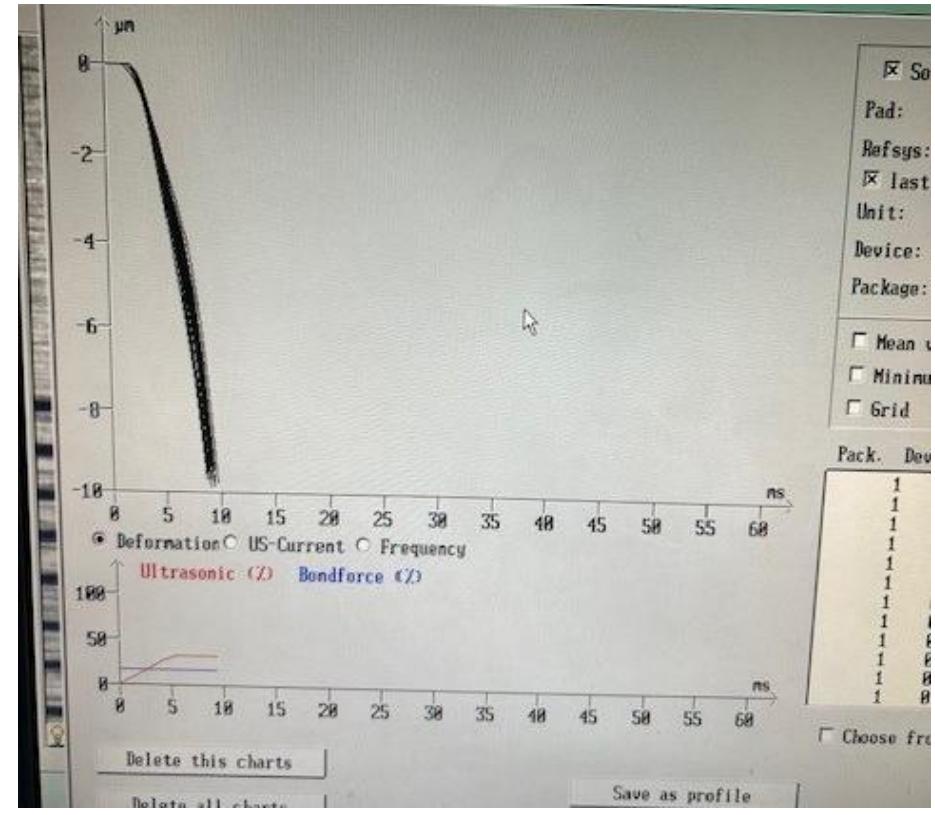
		Single Layer						Multi Layer			
		US%						US%			
Mean		25	28	28	30	Mean		25	28	28	30
CN	25	10.98				CN	25	10.44			
	25		11.39				25		11.12		
	28			10.71			28			10.33	
	28				11.21		28				11.03
30% deformation											
		Single Layer						Multi Layer			
		US%						US%			
Std Dev		25	28	28	30	Std Dev		25	28	28	30
CN	25	0.94				CN	25	1.34			
	25		0.26				25		0.79		
	28			0.79			28			0.91	
	28				0.87		28				0.57
50% deformation											
		Single Layer						Multi Layer			
		US%						US%			
Mean		25	28	28	30	Mean		25	28	28	30
CN	25	11.14				CN	25	11.39			
	25		11.24				25		11.42		
	28			10.77			28			11.07	
	28				10.58		28				11.05
50% deformation											
		Single Layer						Multi Layer			
		US%						US%			
Std Dev		25	28	28	30	Std Dev		25	28	28	30
CN	25	0.76				CN	25	0.4			
	25		0.86				25		0.28		
	28			1.01			28			0.66	
	28				1.04		28				0.63

- Bond foot width estimation
 - 30% → ~32.5 μm
 - 40% → ~35 μm
 - 50% → ~37.5 μm
- 30% deformation
 - Appears comparable to best-case pull matrix results
- 50% deformation
 - Mean pull force similar to 30%, but improved standard deviation for multilayer foil

Deformations



30% deformation



50% deformation

- Deformation charts for 30% and 50% cases (US 30%, BF 30 cN)
- All wires reached maximum deformation within 10 ms → good bondability

15 μm overtravel

		US%						
Mean		25	25	28	28	30	30	32
CN	22	11.21						
	25		10.89					
	25			11.34				
	28				10.79			
	28					11.06		
	30						11.3	
	30							11.25

Single Layer

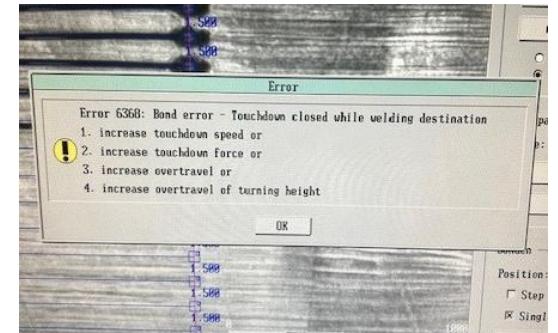
		US%						
Std Dev		25	25	28	28	30	30	32
CN	22	0.47						
	25		0.88					
	25			0.39				
	28				0.94			
	28					0.82		
	30						0.65	
	30							0.38

		US%						
Mean		25	25	28	28	30	30	32
CN	22	11.48						
	25		10.96					
	25			11.34				
	28				11.09			
	28					11.09		
	30						10.82	
	30							11.06

Multi Layer

		US%						
Std Dev		25	25	28	28	30	30	32
CN	22	0.44						
	25		1.09					
	25			0.65				
	28				0.43			
	28					0.64		
	30						0.76	
	30							0.66

- Inspired by positive results from James @ Birmingham: reduced overtravel to 15 μm
- Good bonding results achieved: strong mean force, low std deviation
- But: touchdown errors appeared at US or BF >30%



Wire comparison

- Used
 - CCC: Al-1%Si, 25 μm , EI % 1-4, TS 15-18g
- Currently using
 - Heraeus: AlSi-M, 25 μm , EL > 1%, BL 15-17 cN
- **Planned (Not provided by Accelonix)**
 - Tanaka TABN Type aluminium wire (Al-1%Si with nickel doping, 25 μm)
- **Alternative (Accelonix in stock)**
 - Heraeus H74-41 (around £400): Aluminum Wire 25 μm , 100m, AlSi-S, EL 1,0-4,0%, BL 14-16g, 2x1" spool

Summary

- Parameter optimisation led to stronger bonds and fewer failures
- Bonding on gold PCB and longer tails significantly improved foil stability
- Single-layer foils outperformed multilayer ones — likely due to their stiffer mechanical response, allowing more consistent bonding
- Detailed test results can be found here: <https://cernbox.cern.ch/s/jCSqHk7Fm7xzpqr>
- Next step
 - Repeat tests with vacuum + diffuser setup (Birmingham method)
 - Comparative tests with other type of wires
- Two gold PCBs can be sent to Birmingham for comparative testing if needed

Backup

Standard bonding parameters

Touchdown:	-11334	µm	-11331	µm
Starting height:	1000	µm	200	µm
Touchdown area:	200	µm	200	µm
Lower tolerance:	200	µm	200	µm
Touchdown velocity:	2500	µm/s	2500	µm/s
Touchdown force:	22.00	cN	22.00	cN
Tail offset:	8	µm		
Bonding				
<input type="checkbox"/> Shape angle:	90.00	°	<input type="checkbox"/> 90.00	°
<input type="checkbox"/> Overtravel:	25	µm	<input type="checkbox"/> 25	µm
<input type="checkbox"/> Pad Locator			<input type="checkbox"/> Parameters	
<input type="checkbox"/> Delay:	10	ns	<input type="checkbox"/> 10	ns
<input type="checkbox"/> Turning height:			<input type="checkbox"/> 8	µm
<input type="checkbox"/> TH Overtravel:			<input type="checkbox"/> 8	µm
Loop				
<input type="checkbox"/> Loop			<input type="checkbox"/> Leave angle:	45.00
<input type="checkbox"/> Parameters			<input type="checkbox"/> Intermediate height:	200
<input type="checkbox"/> Parameters			<input type="checkbox"/> Intermediate radius:	200
<input type="checkbox"/> Parameters			<input type="checkbox"/> Reverse distance:	0
<input type="checkbox"/> Parameters			<input type="checkbox"/> Vertical distance:	0
<input type="checkbox"/> Parameters			<input type="checkbox"/> Loop angle:	45.00
<input type="checkbox"/> Parameters			<input checked="" type="checkbox"/> Loop shape source:	05.0
<input type="checkbox"/> Parameters			<input type="checkbox"/> Close clamp	
<input type="checkbox"/> Parameters			<input type="checkbox"/> Loop height source	
<input type="checkbox"/> Parameters			<input type="checkbox"/> Loop height destin.	
<input type="checkbox"/> Parameters			<input type="checkbox"/> Apex height	
<input type="checkbox"/> Parameters			<input type="checkbox"/> Wire length	
<input type="checkbox"/> Parameters			<input type="checkbox"/> Loop height:	400
<input type="checkbox"/> Parameters			<input type="checkbox"/> Height correction:	0.0
<input type="checkbox"/> Parameters			<input type="checkbox"/> Loop shape dest:	05.0
<input type="checkbox"/> Parameters			<input type="checkbox"/> Clamp remains open	
<input type="checkbox"/> Parameters			<input type="checkbox"/> Intermediate height:	
<input type="checkbox"/> Parameters			<input type="checkbox"/> Vertical	
<input type="checkbox"/> Parameters			<input checked="" type="checkbox"/> Direct	
<input type="checkbox"/> Parameters			<input type="checkbox"/> Arc	
<input type="checkbox"/> Parameters			<input type="checkbox"/> Horizontal distance:	0
<input type="checkbox"/> Parameters			<input type="checkbox"/> Welding	
<input type="checkbox"/> Parameters			<input type="checkbox"/> OK	
<input type="checkbox"/> Parameters			<input type="checkbox"/> Text Export	
<input type="checkbox"/> Parameters			<input type="checkbox"/> Cancel	
<input type="checkbox"/> Parameters			<input type="checkbox"/> S/	
Welding				
<input type="checkbox"/> Process control:	<input checked="" type="radio"/> Const. ultrasonic		<input type="checkbox"/> Process control:	<input checked="" type="radio"/> Const. ultrasonic
<input type="checkbox"/> Min. welding time:	0.0	ns	<input type="checkbox"/> Min. welding time:	0.0
<input type="checkbox"/> Stop after deformation:	40.0	ns	<input type="checkbox"/> Stop after deformation:	40.0
<input type="checkbox"/> Max. welding time:	50	ns	<input type="checkbox"/> Max. welding time:	50
<input type="checkbox"/> No. of intervals:	1		<input type="checkbox"/> No. of intervals:	1
<input type="checkbox"/> Interval:	1		<input type="checkbox"/> Interval:	1
<input type="checkbox"/> Ultrasonic:	22.00	ns	<input type="checkbox"/> Ultrasonic:	22.00
<input type="checkbox"/> Bondforce:	22.00	cN	<input type="checkbox"/> Bondforce:	22.00
<input type="checkbox"/> Duration:	50.0	ns	<input type="checkbox"/> Duration:	50.0
<input type="checkbox"/> Ramp:	5.0	ns	<input type="checkbox"/> Ramp:	5.0
<input type="checkbox"/> Interval:			<input type="checkbox"/> Interval:	
<input type="checkbox"/> Ultrasonic:			<input type="checkbox"/> Ultrasonic:	
<input type="checkbox"/> Bondforce:			<input type="checkbox"/> Bondforce:	
<input type="checkbox"/> Duration:			<input type="checkbox"/> Duration:	
<input type="checkbox"/> Ramp:			<input type="checkbox"/> Ramp:	
<input type="checkbox"/> Quality check			<input type="checkbox"/> Quality check	
<input type="checkbox"/> Tear off			<input type="checkbox"/> Tear off	

Loop		
<input type="checkbox"/> Loop	<input type="checkbox"/> Leave angle:	45.00
<input type="checkbox"/> Parameters	<input type="checkbox"/> Intermediate height:	200
<input type="checkbox"/> Parameters	<input type="checkbox"/> Intermediate radius:	200
<input type="checkbox"/> Parameters	<input type="checkbox"/> Reverse distance:	0
<input type="checkbox"/> Parameters	<input type="checkbox"/> Vertical distance:	0
<input type="checkbox"/> Parameters	<input type="checkbox"/> Loop angle:	45.00
<input type="checkbox"/> Parameters	<input checked="" type="checkbox"/> Loop shape source:	05.0
<input type="checkbox"/> Parameters	<input type="checkbox"/> Close clamp	
<input type="checkbox"/> Parameters	<input type="checkbox"/> Loop height source	
<input type="checkbox"/> Parameters	<input type="checkbox"/> Loop height destin.	
<input type="checkbox"/> Parameters	<input type="checkbox"/> Apex height	
<input type="checkbox"/> Parameters	<input type="checkbox"/> Wire length	
<input type="checkbox"/> Parameters	<input type="checkbox"/> Loop height:	400
<input type="checkbox"/> Parameters	<input type="checkbox"/> Height correction:	0.0
<input type="checkbox"/> Parameters	<input type="checkbox"/> Loop shape dest:	05.0
<input type="checkbox"/> Parameters	<input type="checkbox"/> Clamp remains open	
<input type="checkbox"/> Parameters	<input type="checkbox"/> Intermediate height:	
<input type="checkbox"/> Parameters	<input type="checkbox"/> Vertical	
<input type="checkbox"/> Parameters	<input checked="" type="checkbox"/> Direct	
<input type="checkbox"/> Parameters	<input type="checkbox"/> Arc	
<input type="checkbox"/> Parameters	<input type="checkbox"/> Horizontal distance:	0
<input type="checkbox"/> Parameters	<input type="checkbox"/> Welding	
<input type="checkbox"/> OK		
<input type="checkbox"/> Text Export		
<input type="checkbox"/> Cancel		
<input type="checkbox"/> S/		

