

Ultrasonic Metal Welding – Quality Guidelines

Ultrasonic Wire Splicing

Correct Splicing:

- Place the smallest wires on top. The wires must be stacked vertically.
- The wires must not be positioned randomly.

Incorrect Splicing (No bent strands longer than 1.5 mm):

- No missing strands (indicative of retracted wires).
- No molten wire insulation.

Incorrect Splicing (Scorched or over-welded weld nugget must be released by supervisor):

- Only weld splices where all strands overlap are allowed.
- No unwelded strands. See "Broken strands guideline" below.

Incorrect Splicing (No wire insulation in the weld transition area):

- Looped strands shall be pushed to the wire – clarify with supervisor.
- Broken or cut strands: See "Broken strands guideline" below.

Ultrasonic Wire Termination

Correct Termination:

- Use terminals with a polished surface.
- Follow your internal guidelines on the weldability of the material because of aging and environmental factors.

Incorrect Termination (No upright single strands at the end of the weld brush that are longer than 2 mm):

- No noticeably projecting strands at the end of the weld brush.
- No collateral damage because of the terminal being welded.

Incorrect Termination (The weld nugget must not be shortened because of the wire placement under the horn):

- No damage to the wire insulation.
- No overlap of the insulation barrels.
- No folded back wires.
- No unwelded strands. See "Broken strands guideline" below.

Incorrect Termination (No wire insulation in the weld nugget):

- No deformation of the terminal.
- No weld nugget outside the terminal.
- Broken or cut strands: See "Broken strands guideline" below.

Correct Termination (An ideal weld):

- Place the smallest wires at the bottom. The strands must end between the two lines. If there are no lines, the strands must not disturb the function of the terminal connection.

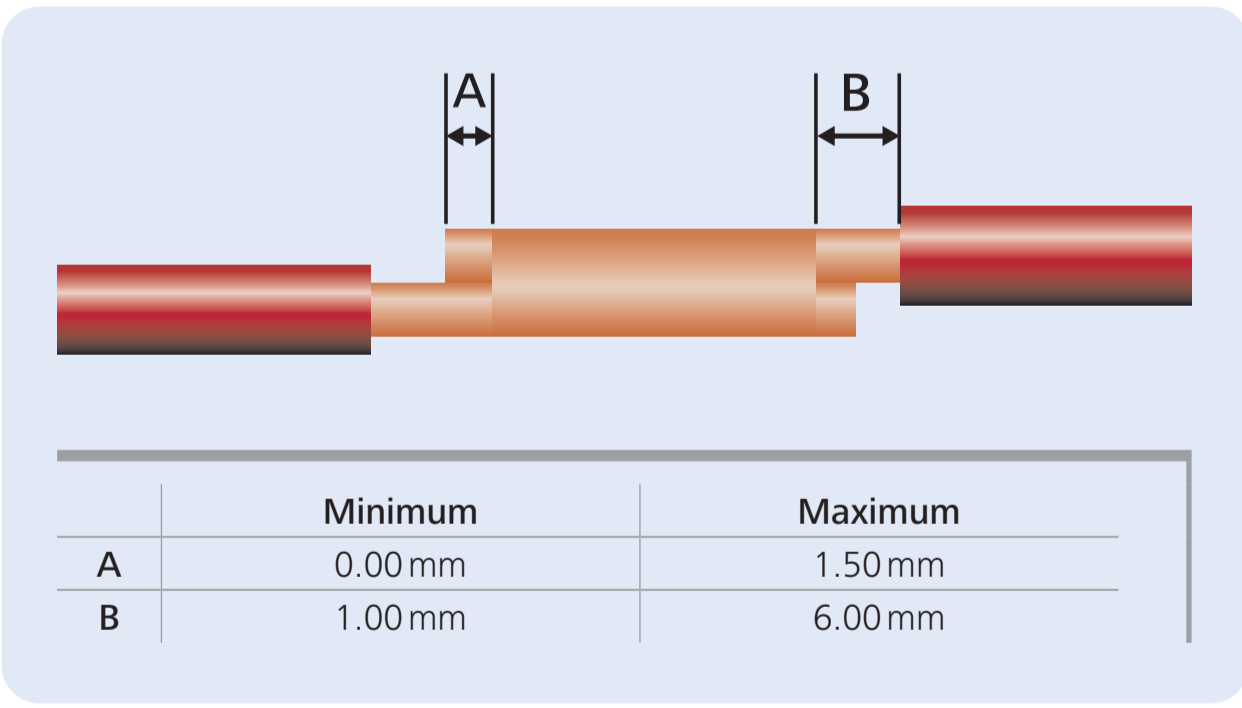
Incorrect Termination (No wire insulation in the weld):

- No insulated wire inside the insulation barrels.
- No broken wire insulation. No wires outside the insulation barrels.
- No overlap of the insulation barrels.
- No folded back wires.
- No unwelded strands. See "Broken strands guideline" below.

Incorrect Termination (Only consistent anvil imprints at the bottom of the terminal allowed):

- Do not use wires with cut strands.
- Broken or cut strands: See "Broken strands guideline" below.

WELD QUALITY GUIDELINE



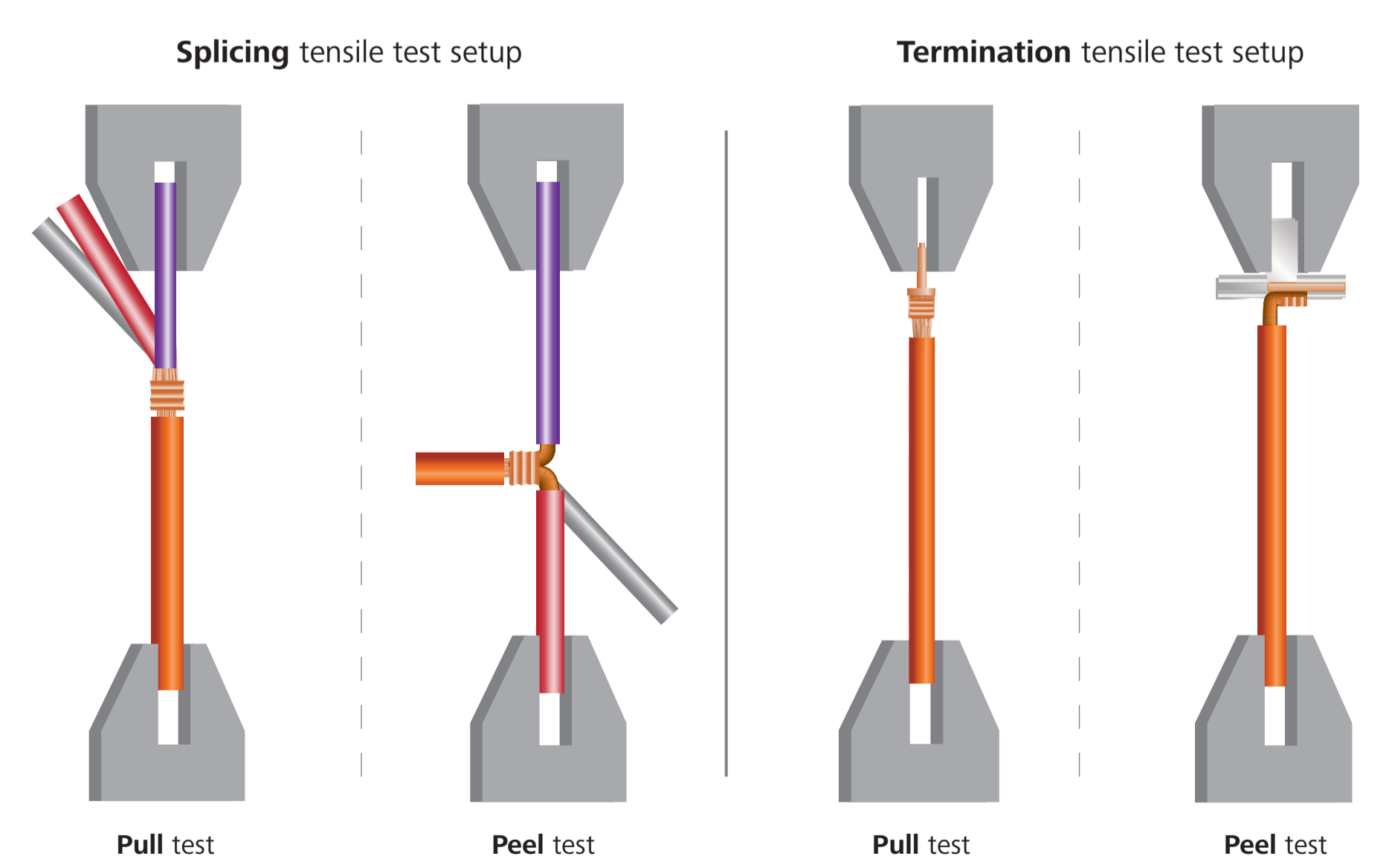
BROKEN STRANDS GUIDELINE

Maximum allowed broken or missing strands for splicing & termination in production.

Strands of cable	Broken or missing allowed
1 to 7	0
8 to 19	1
20 to 37	2
38 or more	max 5 % of total strands in splice

TENSILE TEST METHODS & VALUES

SPLICING		
Copper Wire		
Wire Size [mm ²]	Pull Force [N]	Peel Force [N]
0.13	50	7
0.35	55	10
0.5	80	15
0.75	120	23
1	160	32
1.5	200	40
2	225	45
2.5	250	50
3	350	70
4	370	75
5	400	80
6	425	85
8	500	100
10	750	150
12	1000	185
14	1025	200
16	1050	210
18	1100	215
20	1200	235
25	1350	265
30	1500	290
35	1700	335
40	1850	365
50	2200	440



Tensile test setup
Pull the smallest wire and hold the opposing individual wire/the terminal. For termination tensile tests use a specific fixture to hold the terminal. For multi-wire termination tensile test, it is preferred to pull and peel both the largest and smallest wire, from different samples. Termination peel test may also be carried out in 180 degree. The measured tensile value shall exceed the listed value per table.

Mechanical strength test capability study
Short term: $C_{pk} \geq 1.67$ based on minimum of 50 samples
Process: $C_{pk} \geq 1.67$ based on minimum of 125 samples
Long term: $C_{pk} \geq 1.33$ based on minimum of 125 samples out of minimum 25 subgroups with minimum 3 samples each
Typical values are shown. Other values may be used depending on project requirements.

TERMINATION						
Copper Wire				Aluminum Wire		
Wire Size [mm ²]	Pull Force [N]	Peel Force [N]	Weld Width Range [mm]	Pull Force [N]	Peel Force [N]	Weld Width Range [mm]
0.22	50	10	0.5-1.0	-	-	-
0.35	55	11	0.5-1.0	-	-	-
0.50	85	17	0.5-1.0	50	10	-
0.75	120	24	0.5-1.0	85	17	-
1	170	34	1.0-1.2	120	24	-
1.5	225	45	1.2-1.8	150	30	-
2	250	50	1.8-2.5	180	36	-
2.5	275	55	1.8-2.5	200	40	-
3	350	70	3.0-3.6	240	48	-
4	375	75	3-5	260	52	-
5	400	80	3-5	280	56	-
6	435	-	4-6	300	-	4-6
8	500	-	4-6	350	-	4-6
10	800	-	6-8	400	-	6-8
12	1000	-	6-8	450	-	6-8
14	1025	-	6-8	500	-	6-8
16	1050	-	8-10	550	-	8-10
18	1100	-	8-10	600	-	8-10
20	1200	-	8-10	650	-	8-10
25	1350	-	10-12	850	-	10-12
30	1500	-	10-12	1000	-	10-12
35	1700	-	11-13	1200	-	12-14
40	1850	-	11-13	1400	-	12-14
50	2200	-	13-16	1650	-	14-17
60	2200	-	13-16	1800	-	17-19
70	2400	-	16-20	1880	-	17-21
85	2700	-	18-22	2000	-	18-22
95	3000	-	18-22	2050	-	19-25
110	3200	-	18-24	2150	-	19-25
120	3400	-	20-28	2200	-	22-30
150	3600	-	28-36	2350	-	30-38

WIRE SPECIFICATIONS

SAE AWG					ISO METRIC					
SAE AWG size	Min. Cross-Section Area [mm ²]	Strand count			ISO Metric size	Min. Cross-Section Area [mm ²]	ISO 6722-1 Strand count		ISO 19642-1 Strand count	
		Type A	Type B	Type C			Structure A	Structure B	Structure C	Standard
26	0.127	7	19		0.13	0.127	7	19	7	19
24	0.205	7	19	41	0.22	0.203	7	19	7	30
22	0.345	7	19	37	0.35	0.317	7	12	19	7
20	0.543	7	19	41	0.5	0.465	7/19	16	26	19
18	0.779	19		41	0.75	0.698	19	24	38	19
					1	0.932	19	32	54	19
16	1.18	19		41	1.25	1.16	19	16	50	19
					1.5	1.36	19	30	76	19
14	1.88	19		105	2	1.83	19	28	105	19
					2.5	2.27	37	50	140	37
12	2.96	19	65	105	3	2.80	37	44	160	44
					4	3.68	37	56	224	56
10	4.73	19	105		5	4.38	37	65	250	70
					6	5.49	37	84	320	84
8	7.50	19	133		8	7.24	98	50	240	116
					10	9.47	63	80	320	144
6	12.4	37	133	280	12	11.3	154	96	380	174
					16	14.9	105	126	512	228
4	18.9	61	133	440	20	18.1	247	152	610	276
					25	23.2	154	196	790	355
					30	26.6	361	224	900	408
					35	32.7	551	276	1070	501
					40	36.5	494	308	1200	558
					50	47.8	798	396	1600	717
					60	55.8	741	296	1200	838
					70	67.9	1140	360	1427	1019
00	63.4	1254	1408		95	89.7	836	475	1936	1347
000	80.4		1760		0000	104		1112		

The above shown strand counts are common industry stranding. Other stranding configurations may be used depending on manufacturer.