MOLEX MATERIAL SPECIFICATION – C52100 ALLOY METAL STRIPS

1.0 SCOPE

This specification covers the comprehensive technical requirements, applicable reference documents, and quality requirements for metal strips. The values listed for acceptance criteria are in SI units.

2.0 PURPOSE

The purpose of this specification is to comprehensively define the Molex requirements for the alloy's chemical composition, physical properties, mechanical properties, and reference other applicable documents related to quality requirements and dimensional tolerances.

This specification when constructed, referenced the requirements cited in the primary regional norms typically referenced for copper alloy strip manufacture in UNS C52100 alloy; ASTM B888M-13, EN 1654 (CuSn8), JIS H3110, JIS H3130 and various ultra-fine grain supplier citations.

3.0 REFERENCE DOCUMENTS

This primary specification focuses on the physics of C52100 alloy and related mechanical properties to ensure Molex product performance. Other Molex documents are necessary to verify material characteristics that support high quality and manufacturability of products.

These reference documents are crucial to the Molex process / product and therefore all requirements contained within them must be attested to and demonstrate their conformance, within the supplier's process certification:

ASTM B888M / ASTM B103 and the associated reference documents listed under Section 2.1 *ASTM Standards*
JIS H3130 and UFG supplier citations (< 4µ)
ASTM B820 is specifically mentioned as critical to Molex formability requirements
2090580043 Geometric Conditions and Tolerances for Metal Strips
2090580044 Metal Strip Surface conditions and Requirements

4.0 ORDER OF PRECEDENCE

This defines the priority order that should be followed when reviewing attributes and requirements of metal strip:

1. Molex Purchase Order
2. Packaging Specifications
3. Molex (Individual) Metal Strip Specification (i.e. Part Number Specification)
4. Molex Material Alloy Specification (**This document –** 2090580049– Molex Material Specification – C52100 Alloy Metal Strips)
5. Surface (2090580044) and Geometric (2090580043) Global Engineering Specifications

5.0 DEFINITIONS

Ultrafine grain (UFG) - is defined as a “ready-to-finish” (RTF) grain size of less than 0.004 mm (< 4µm).

6.0 TECHNICAL REQUIREMENTS

6.1 Chemical Composition

UNS #	Cu wt.%	Pb wt.%	Fe wt.%	P wt.%	Sn wt.%	Zn wt.%
C52100[2]	Remainder	≤ 0.02	≤ 0.10	0.03 – 0.35	7.0 – 9.0	≤ 0.20

2. Copper + Sum of Named Elements = 99.5% min.
Limits for unnamed elements may be established between Molex and the supplier to satisfy certain environmental or customer requirements.

6.2 Mechanical Properties (longitudinal direction)

Mechanical Properties Table C52100				
Designation	Tensile Strength (1)	Yield Strength (1)	Elongation %	RTF Grain size (2)
	(MPa)	0.2% offset (MPa)	in 50 mm	(mm)
061	385 - 450	≥ 160	≥ 60	N/A
H01	435 - 515	≥ 240	≥ 40	≤ 0.030
H02	475 - 580	≥ 290	≥ 25	≤ 0.010
HR02	475 - 580	≥ 260	≥ 27	≤ 0.010
H04	590 - 705	≥ 480	≥ 12	≤ 0.010
HR04	590 - 705	≥ 450	≥ 20	≤ 0.010
HR04 UFG	590 - 705	≥ 540	≥ 20	< 0.004
H06	685 - 785	≥ 610	≥ 10	≤ 0.010
HR06	685 - 785	≥ 580	≥ 11	≤ 0.010
HR06 UFG	685 - 785	≥ 650	≥ 15	< 0.004
H08	735 - 835	≥ 660	≥ 3	≤ 0.010
HR08	735 - 835	≥ 640	≥ 9	≤ 0.010
HR08 UFG	735 - 835	≥700	≥ 9	< 0.004
H10	770 - 885	≥ 700	≥ 2	≤ 0.010
HR10	770 - 885	≥ 690	≥ 5	≤ 0.010
HR10 UFG	770 - 885	≥ 775	≥ 5	< 0.004
HR12 UFG	835 - 1000	≥ 830	≥ 1	< 0.004

Notes:

(1) Tensile requirements are longitudinal values in uniaxial tension un accordance with ASTM E8M

(2) Ready to Finish (RTF) grain size is measured before final rolling for the H/HR tempers. The measurement of (RTF) grain size in the UFG tempers is typically verified by uniaxial tension values.

(3) Temper 061 and H01 are derived from ASTM B888M-13

(4) Temper Designations; H04, H06, H08, and H10 are H3130 Tensile values, with fine (RTF) grain yield strength and elongation values

(5) Temper Designations; HR04, HR06, HR08 and HR10 are JIS H3130 properties.

(6) Temper Designations; HR04 UFG (ultrafine grain), HR06 UFG, HR08 UFG, HR10 UFG and HR12 UFG are derived from UFG supplier citations

6.3 Electrical Conductivity (SnP bronze conductivity is strongly influenced by chemical composition)

6.3.1 For annealed temper (“O” temper codes) the minimum requirement shall be 7 MS/m (12% IACS) @ 20ºC
6.3.2 For rolled tempers (“H”, “HR” temper codes) the minimum requirement shall be 5.8 MS/m (10% IACS) @ 20ºC
6.3.3 The test standard shall be ASTM E 1004 (eddy current) or ASTM B 193 (resistivity)

6.4 Bending properties

Bending of metal strip samples shall be in accordance with ASTM B820; Bend Test for Formability of Copper Alloy Spring Material. The requirement is that the supplier's material when tested at finished thickness and temper shall achieve the inside bend radii as listed in the table below without observable cracking on the outside bend radius (reference 5.4.1.)

If special forming requirements are necessary, those will be listed separately on the part number document.

H04		90° GW	180° GW	90° BW	180° BW
	Thickness	10:1 w/t		10:1 w/t	
	0.51-1.0 mm	-	-	-	-
	0.3-0.5 mm	0.5 r/t	2.0 r/t	1.5 r/t	3.5 r/t
	0.15-0.29 mm	0.5 r/t	2.0 r/t	1.5 r/t	3.5 r/t
	≤0.149 mm	0.5 r/t	1.5 r/t	1.0 r/t	3.0 r/t

HR04		90° GW	180° GW	90° BW	180° BW
	Thickness	10:1 w/t		10:1 w/t	
	0.51-1.0 mm	-	-	-	-
	0.3-0.5 mm	0.5 r/t	2.0 r/t	1.0 r/t	2.5 r/t
	0.15-0.29 mm	0.5 r/t	2.0 r/t	1.0 r/t	2.0 r/t
	≤0.149 mm	0.5 r/t	1.5 r/t	0.8 r/t	2.0 r/t

H06		90° GW	180° GW	90° BW	180° BW
	Thickness	10:1 w/t		10:1 w/t	
	0.51-1.0 mm	-	-	-	-
	0.3-0.5 mm	1.0 r/t	2.5 r/t	3.0 r/t	5.5 r/t
	0.15-0.29 mm	1.0 r/t	2.5 r/t	3.0 r/t	5.5 r/t
	≤0.149 mm	0.5 r/t	2.0 r/t	2.5 r/t	5.0 r/t

HR06		90° GW	180° GW	90° BW	180° BW
	Thickness	10:1 w/t		10:1 w/t	
	0.51-1.0 mm	-	-	-	-
	0.3-0.5 mm	1.0 r/t	2.5 r/t	2.5 r/t	4.0 r/t
	0.15-0.29 mm	1.0 r/t	2.5 r/t	2.5 r/t	4.0 r/t
	≤0.149 mm	0.5 r/t	2.0 r/t	2.0 r/t	3.0 r/t

H08		90° GW	180° GW	90° BW	180° BW
	Thickness	10:1 w/t		10:1 w/t	
	0.51-1.0 mm	-	-	-	-
	0.3-0.5 mm	2.0 r/t	3.0 r/t	7.0 r/t	-
	0.15-0.29 mm	2.0 r/t	3.0 r/t	7.0 r/t	-
	≤0.149 mm	1.5 r/t	2.5 r/t	6.5 r/t	-

HR08		90° GW	180° GW	90° BW	180° BW
	Thickness	10:1 w/t		10:1 w/t	
	0.51-1.0 mm	-	-	-	-
	0.3-0.5 mm	2.0 r/t	3.0 r/t	4.0 r/t	6.0 r/t
	0.15-0.29 mm	2.0 r/t	3.0 r/t	4.0 r/t	6.0 r/t
	≤0.149 mm	1.5 r/t	2.5 r/t	3.5 r/t	5.0 r/t

H10		90° GW	180° GW	90° BW	180° BW
	Thickness	10:1 w/t		10:1 w/t	
	0.51-1.0 mm	-	-	-	-
	0.3-0.5 mm	2.5 r/t	4.0 r/t	7.5 r/t	-
	0.15-0.29 mm	2.5 r/t	4.0 r/t	7.5 r/t	-
	≤0.149 mm	2.0 r/t	3.5 r/t	7.0 r/t	-

HR10		90° GW	180° GW	90° BW	180° BW
	Thickness	10:1 w/t		10:1 w/t	
	0.51-1.0 mm	-	-	-	-
	0.3-0.5 mm	2.5 r/t	4.0 r/t	6.0 r/t	7.5 r/t
	0.15-0.29 mm	2.5 r/t	4.0 r/t	6.0 r/t	7.5 r/t
	≤0.149 mm	2.0 r/t	3.5 r/t	5.5 r/t	7.0 r/t

HR04 UFG		90° GW	180° GW	90° BW	180° BW
	Thickness	10:1 w/t		10:1 w/t	
	0.51-1.0 mm	-	-	-	-
	0.3-0.5 mm	0.5 r/t	0.5 r/t	0.5 r/t	2.0 r/t
	0.15-0.29 mm	0.5 r/t	0.5 r/t	0.5 r/t	2.0 r/t
	≤0.149 mm	0.5 r/t	0.5 r/t	0.5 r/t	1.5 r/t

HR06 UFG		90° GW	180° GW	90° BW	180° BW
	Thickness	10:1 w/t		10:1 w/t	
	0.51-1.0 mm	-	-	-	-
	0.3-0.5 mm	0.5 r/t	1.0 r/t	1.0 r/t	2.5 r/t
	0.15-0.29 mm	0.5 r/t	1.0 r/t	1.0 r/t	2.5 r/t
	≤0.149 mm	0.5 r/t	0.5 r/t	0.5 r/t	2.0 r/t

HR08 UFG		90° GW	180° GW	90° BW	180° BW
	Thickness	10:1 w/t		10:1 w/t	
	0.51-1.0 mm	-	-	-	-
	0.3-0.5 mm	0.5 r/t	2.0 r/t	2.0 r/t	3.5 r/t
	0.15-0.29 mm	0.5 r/t	2.0 r/t	2.0 r/t	3.0 r/t
	≤0.149 mm	0.5 r/t	1.5 r/t	1.5 r/t	2.5 r/t

HR10 UFG		90° GW	180° GW	90° BW	180° BW
	Thickness	10:1 w/t		10:1 w/t	
	0.51-1.0 mm	-	-	-	-
	0.3-0.5 mm	1.0 r/t	3.0 r/t	4.0 r/t	6.0 r/t
	0.15-0.29 mm	1.0 r/t	3.0 r/t	4.0 r/t	6.0 r/t
	≤0.149 mm	1.0 r/t	2.5 r/t	3.5 r/t	5.0 r/t

HR12 UFG		90° GW	180° GW	90° BW	180° BW
	Thickness	10:1 w/t		10:1 w/t	
	0.51-1.0 mm	-	-	-	-
	0.3-0.5 mm	-	-	6.0 r/t	-
	0.15-0.29 mm	-	-	6.0 r/t	-
	≤0.149 mm	-	-	5.5 r/t	-

Notes:
(1) W/t = width to thickness ratio (defining bending width). r/t = inside bend radius to thickness ratio
(2) It is the expectation that tempers lower than H04 will possess bend formability that is as good (or better) than the values listed for the H04 temper.

6.4.1 Acceptance Criteria for Bending

Bending Observations	Acceptance Criteria	Rank
	"Accepted", smooth, no orange peel, no cracks	1
	"Accepted", small orange peel, no cracks	2
	"Accepted", heavy orange peel, no cracks	3
	"Rejected", heavy orange peel, shallow cracks	4
	"Rejected", heavy orange peel, deep cracks	5

6.5 Stress Relaxation Resistance (in accordance with ASTM E 328)*

C52100 Alloy (10µ grain) Stress Relaxation in Percent Retained @ 1000 Hours						
Temp °C	50% $R_{p0.2}$∥	80% $R_{p0.2}$∥	100% $R_{p0.2}$∥	50% $R_{p0.2}$⊢	80% $R_{p0.2}$⊢	100% $R_{p0.2}$⊢
75	97%	96%	75%	96%	95%	74%
100	93%	92%	71%	92%	91%	70%
125	82%	81%	59%	77%	76%	54%
150	55%	54%	32%	54%	53%	31%

C52100 Alloy (< 4µ grain) Stress Relaxation in Percent Retained @ 1000 Hours						
Temp °C	50% $R_{p0.2}$∥	80% $R_{p0.2}$∥	100% $R_{p0.2}$∥	50% $R_{p0.2}$⊢	80% $R_{p0.2}$⊢	100% $R_{p0.2}$⊢
75	97%	96%	75%	96%	95%	74%
100	90%	89%	68%	89%	88%	67%
125	70%	69%	58%	69%	68%	46%
150	47%	46%	25%	46%	45%	24%

*Annual test data certification required

7.0 CERTIFICATION REQUIREMENTS

Certification at P.O. Level	Supplied Data at P.O. Level	Annual Capability Statement	Engineering Data by Request
Chemical Compostion (data)		Chemical Capability	
Tensile (data)		Tensile Capability	Transverse properties
Yield (data)		Yield Capability	Spring Bending Limit
Elongation (data)			
Grain size (data)			
			Elastic Modulus (data)
Thickness (data)		Thickness Capability	
Width (data)		Width Capability	
Camber (pass/fail)			
Surface Roughness (data)			
		Stress Relaxation Verification	
Burr (pass/fail)			
Bend Formability (pass/fail)			ASTM B820 Appendix narrow beam reporting table, or other
Electrical Conductivity (data)			
			Other Physical Properties
Reference Documents (pass/fail)			

7.1 Requirements for "Annual Capability Assessment" of critical characteristics

7.1.1. Chemical composition requires a statistical assessment on an annual basis to verify capability. This assessment be on file and available to Molex when requested.

7.1.2 Mechanical properties require a statistical assessment on an annual basis to verify capability. This assessment be on file and available to Molex when requested.

7.1.3 Dimensional tolerances, requires a statistical assessment on an annual basis to verify capability. This assessment be on file and available to Molex when requested. Stress relaxation resistance is to be verified for a temper and a process in the H04 to H08 designation range at 80% of yield strength for 1000 hours at 75ºC and 125ºC. The supplier shall select an active Molex item to fulfill this requirement. It is acceptable to utilize Larson Miller Parameters to facilitate this annual verification audit.

7.2 Engineering Data

Acceptance of this material specification and the requirements include the supplier's commitment to provide other engineering data when requested. These types of data may include transverse properties, spring bending limits or other physical properties of this material.

7.3 Recent Change Summary

Document ID# Change from **400005024-ES** → **2090580049**.

Updated **Section 3: Reference Documents** to reflect new **2090580043** and **2090580044** titles and content.

Removed **ES-40000-5006: Mechanical Tool-Wear Test Standard** from **Section 3: Reference Documents** due to obsolescence.

Added **Section 4: Order of Precedence**.

Removal of what was previous **Section 6: Dimensional Requirements**

- All current Geometric and Dimensional Requirements are contained in **2090580043: GEOMETRIC CONDITIONS AND TOLERANCES FOR METAL STRIPS**. Including:
  - Strip Thickness
  - Strip Width
  - Burr
  - Camber
- All current Surface Condition Requirements are contained in **2090580044: METAL STRIP SURFACE CONDITIONS AND REQUIREMENTS**. Including:
  - Surface Roughness