MOLEX MATERIAL SPECIFICATION – C51900 ALLOY METAL STRIPS

1. 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. PURPOSE

The purpose of this specification is 1) to comprehensively define the Molex requirements for the alloy's chemical composition, physical properties, mechanical properties, and 2) to reference other applicable documents related to quality requirements and dimensional tolerances.

This specification meets or exceeds the requirements cited in the primary regional norms typically referenced for copper alloy strip manufacture in UNS C51900 alloy; ASTM B103M, EN 1654 (CuSn6), and JIS H 3110 (C5191).

3. REFERENCE DOCUMENTS

This primary specification focuses on the physics of C51900 alloy and related mechanical properties to assure Molex product performance. 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 B103M and the associated reference documents listed under *2.1 ASTM Standards*
ASTM B820 is specifically mentioned as critical to Molex formability requirements
JIS H3110 and UFG supplier citations (< 4µm)
2090580043 Geometric Conditions and Tolerances for Metal Strips
2090580044 Metal Strip Surface conditions and Requirements

4. 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 –** 22090580062 – Molex Material Specification – C51900 Alloy Metal Strips)
5. Surface (2090580044) and Geometric (2090580043) Global Engineering Specifications

5. DEFINITIONS

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

6. TECHNICAL REQUIREMENTS

6.1 Chemical Composition

UNS #	Cu wt.%	Pb wt.%	Fe wt.%	P wt.%	Sn wt.%	Zn wt.%
C51900[1]	Remainder[2]	≤ 0.05	≤ 0.10	0.03 – 0.35	5.0 – 7.0	≤ 0.30

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

6.2 Mechanical Properties (longitudinal direction)

Mechanical Properties Table C51900				
Designation	**Tensile Strength (1)** (MPa)	**Yield Strength (1)** 0.2% offset (MPa)	**Elongation %** in 50 mm	**RTF Grain size (2)** (mm)
O61	≥ 315	N/A as per H3110	≥ 42	N/A
H01	390 - 510	≥ 360	≥ 35	≤ 0.030
H02	490 - 610	≥ 420	≥ 20	≤ 0.010
H03	500 – 590	≥ 460	≥ 8	≤ 0.010
H04	590 - 685	≥ 510	≥ 8	≤ 0.010
H04 UFG	550 - 650	≥ 500	≥ 16	< 0.004
H06	635 - 725	≥ 570	≥ 5	≤ 0.010
H06 UFG	635 – 725	≥ 570	≥ 8	< 0.004
H08	≥ 690	≥ 620	≥ 1	≤ 0.010
H08 UFG	670 - 780	≥ 660	≥ 7	< 0.004

Notes:
(1) Tensile requirements are longitudinal values in uniaxial tension in accordance with ASTM E8M.

(2) Ready to Finish (RTF) grain size is measured before final rolling for the H tempers.

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

6.3.1 The test standard shall be ASTM E 1004 (eddy current) or ASTM B 193 (resistivity).

	Conductivity @ 20℃ (%IACS)
O61	13% - 18%
H01	13% - 18%
H02	13% - 18%
H04	13% - 18%
H04 UFG	13% - 18%
H06	13% - 17%
H06 UFG	13% - 17%
H08	13% - 17%
H08 UFG	13% - 17%

Note: The acceptance is determined by the minimum value.

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, will be capable of achieving the inside bend radii as listed in the tables below without observable cracking on the outside bend radius (reference 5.4.1.) At a minimum, samples shall be tested in both directions, at 180º of bending, at the most representative thickness category for the metal strip purchase order.

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

H04

Thickness	90° GW	180° GW	90° BW	180° BW
	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	3.0 r/t
0.15-0.29 mm	0.5 r/t	2.0 r/t	1.0 r/t	3.0 r/t
≤0.149 mm	0.5 r/t	2.0 r/t	1.0 r/t	3.0 r/t

H04 UFG

Thickness	90° GW	180° GW	90° BW	180° BW
	10:1 w/t		10:1 w/t	
0.51-1.0 mm	-	-	-	-
0.3-0.5 mm	0.25 r/t	0.5 r/t	0.25 r/t	1.0 r/t
0.15-0.29 mm	0.25 r/t	0.5 r/t	0.25 r/t	1.0 r/t
≤0.149 mm	0.25 r/t	0.5 r/t	0.25 r/t	1.0 r/t

H06

Thickness	90° GW	180° GW	90° BW	180° BW
	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	3.5 r/t	4.0 r/t
0.15-0.29 mm	1.0 r/t	3.0 r/t	3.5 r/t	4.0 r/t
≤0.149 mm	1.0 r/t	3.0 r/t	3.5 r/t	4.0 r/t

H06 UFG

Thickness	90° GW	180° GW	90° BW	180° BW
	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	2.0 r/t
0.15-0.29 mm	0.5 r/t	1.0 r/t	1.0 r/t	2.0 r/t
≤0.149 mm	0.5 r/t	1.0 r/t	1.0 r/t	2.0 r/t

H08

Thickness	90° GW	180° GW	90° BW	180° BW
	10:1 w/t		10:1 w/t	
0.51-1.0 mm	-	-	-	-
0.3-0.5 mm	2.0 r/t	4.0 r/t	7.0 r/t	12.0 r/t
0.15-0.29 mm	2.0 r/t	4.0 r/t	7.0 r/t	12.0 r/t
≤0.149 mm	2.0 r/t	4.0 r/t	7.0 r/t	12.0 r/t

H08 UFG

Thickness	90° GW	180° GW	90° BW	180° BW
	10:1 w/t		10:1 w/t	
0.51-1.0 mm	-	-	-	-
0.3-0.5 mm	1.0 r/t	2.0 r/t	2.0 r/t	3.5 r/t
0.15-0.29 mm	1.0 r/t	2.0 r/t	2.0 r/t	3.5 r/t
≤0.149 mm	1.0 r/t	2.0 r/t	2.0 r/t	3.5 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 Thermal Stress Relaxation Resistance (Nominal expected performance as measured by the Ring Method in compliance with ASTM E328)

C51900 Alloy Thermal Stress Relaxation - Percent Retained @ 1000 Hours						
Temp ℃	50% $Rp_{0.2}$‖	80% $Rp_{0.2}$‖	100% $Rp_{0.2}$‖	50% $Rp_{0.2}$⊥	80% $Rp_{0.2}$⊥	100% $Rp_{0.2}$⊥
75	99%	99%	99%	99%	99%	99%
100	93%	93%	93%	93%	93%	93%
125	82%	82%	82%	82%	82%	82%
150	66%	66%	66%	66%	66%	66%

Note:
1. $Rp_{0.2}$ is equivalent to 0.2% offset Yield strength
2. This table represents the “Thermal Stress Relaxation” in the precipitation hardened state, common in most Molex applications. The values shown are intrinsic material characteristics primarily governed by alloy composition and are therefore independent of the applied stress level. What is not represented here is certain types of supplier processing such as, final cold rolling, stretch-bend-levelling, etc., that negatively influence the stress relaxation curve. Additional strong negative influences come from the types and intensities of part forming processes along with the strain component applied at the separable interface. Therefore, this thermal relaxation is only one component of the total relaxation that could be experienced in use.

7. 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)			

6.1 Requirements for "Annual Capability Assessment" of critical characteristics

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

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

6.1.3 Dimensional tolerances, requires a statistical assessment on an annual basis to verify capability. This assessment be on file and available to Molex when requested.

6.1.4 Stress relaxation resistance is to be verified for a temper and a process in the H04 to H08 designation range at 100% 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.

6.2 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.

6.3 Recent Change Summary

Initial Release.