GEOMETRIC CONDITIONS AND TOLERANCES FOR METAL STRIPS

1. SCOPE:

This appendix covers 100% of the individual metal strip specifications in the Molex portfolio, except where superseded by requirements outlined in the Molex Alloy specification or the Individual Metals Strip specification (see 1.0 Order of Precedence).

2. PURPOSE:

This appendix defines the tolerances requirements for metal strips. Tolerances not stated on the individual metal strip specification or in the applicable general material specification shall be found in this appendix.

3. 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 (i.e. 2090580050– Molex Material Specification – C70250 Alloy Metal Strips)
5. Surface (2090580044) and Geometric (2090580043) Global Specifications

4. REFERENCES:

Information was utilized from the following documents in the creation of this specification:

- Molex (Individual) Metal Strip Specifications
- ASTM, Copper and Copper alloys, V02.01 (Plate Sheet and Strip)
- EN 1654; Copper and Copper alloys – Strip for springs and connectors
- JIS, Wrought Copper
- 2090580045 – Metal Strip Packaging Standard (Global)
- 2194612589 – Molex Lincoln Metal Trip Packaging Standard (Local)
- 2010170002 – Molex Maumelle Metal Trip Packaging Standard (Local)

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5. CATEGORY TIERS AND REQUIREMENTS:

5.1. Definitions

The geometric tolerances for metal strip which Molex requires in its global specifications must be competitive within terminal design, feasible to achieve for the supply base, and enforceable without inhibiting traditional process schemes or reporting practices. Thus, Molex has categorized all industry-typical geometric categories into three distinct tiers. These represent importance to Molex design and production, and account for the current state of test methods and precision and bias statements for their respective tests. A geometric tolerance with high importance but low test precision may qualify as *Tier 2* as the value of actual variable data is less meaningful than that of a test with a well-defined precision and bias statement.

The reporting method for these geometric tolerances is outlined in the packaging specification of the receiving Molex facility:

- 2090580045 – Metal Strip Packaging Standard (Global)
- 2194612589 – Molex Lincoln Metal Trip Packaging Standard (Local)
- 2010170002 – Molex Maumelle Metal Trip Packaging Standard (Local)

5.1.1. Tier 1: Actual Variables Data

Tier 1 is reserved for geometric tolerances with high importance to Molex and established or common testing practices within the industry. These attributes require *actual variables data*, or *real quantitative values* reported for all material delivered to Molex.

5.1.2. Tier 2: Attribute Data

Geometric categories designated under Tier 2 are still critical to Molex production and design but recognized by Molex as requirements which may not be as developed or precise as those captured under Tier 1. These must be reported with a “pass” to the defined acceptance criteria, but the passing value achieved is not required.

5.1.3. Tier 3: Definitions (As Required per Higher Precedence Documentation, 3.0 Order of Precedence)

All other traditional industry geometric categories recognized by Molex, and their acceptability criteria, are defined as Tier 3. These exist within this global specification as a definition but become required when called out in a document of higher precedence (**Section 3.0**).

5.2. Assignment

- Tier 1: Thickness, Width
- Tier 2: Burr (Edge), Camber, Coil Set, Die Exit Twist
- Tier 3: Crossbow, Waviness

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6. GEOMETRIC TOLERANCES:

6.1. Tier 1: Actual Variables Data

6.1.1. Thickness and Width

The thickness and width shall conform to the tolerances given below, unless otherwise specified on the individual metal strip specification or the applicable Molex Alloy specification. Thickness tolerances listed are for the “bare” material only. When pre-plating is required, the plated strip thickness tolerance becomes the “bare” material tolerance plus the plating tolerance cited on the specification document.

Thickness (mm)	Tolerance (mm)
< 0.08	± 0.003
0.08 to 0.119	± 0.004
0.120 to 0.350	± 0.005
0.351 to 0.508	± 0.007
0.509 to 0.711	± 0.008
0.712 to 1.016	± 0.010
≥ 1.017	± 0.015

Width (mm)	Tolerance (mm)
≤ 37.10	± 0.05
> 37.10	± 0.08

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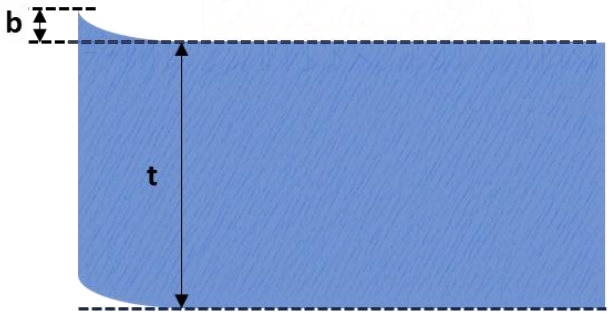
6.2. Tier 2: Attribute Data

6.2.1. Burr (Edge)

Edge burr is an extended or turned-over edge on the strip resulting from shearing, punching, machining or grinding. This condition most commonly occurs during the slitting operation to establish the width characteristic. The edge burr shall conform to the tolerances given in the following table, or the superseding special requirements listed directly on the Molex Alloy specification (if applicable) or the individual metal strip specification (if applicable).



Cross-section view of the strip
b = Edge Burr
t = strip thickness

Thickness (mm)	Burr tol. * (mm)
≤ 0.099	0.005
0.100 to 0.199	0.008
0.200 to 0.399	0.01
0.400 to 0.599	0.015
≥ 0.600	0.018

*For annealed tempers, values shown are increased by 25%

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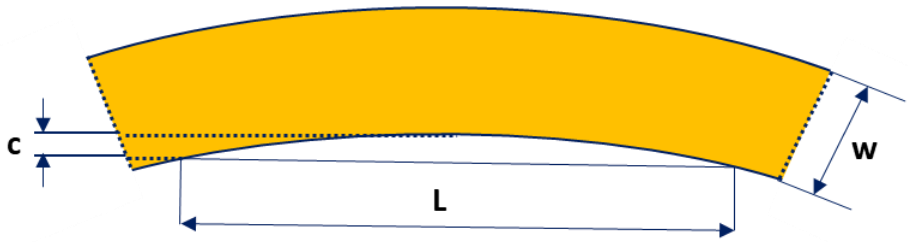
6.2.2. Camber (Strip Edgewise Curvature “c”)

The straightness of the longitudinal edge shall be based on a measuring length of 1 meter.



L = measuring length
w = strip width
EDGEWISE CURVATURE (CAMBER) “c”

Allowable Camber (mm) per 1 Meter Length	Width (mm)				
Thickness (mm)	5 - < 10	10 - < 15	15 - < 30	30 - < 50	≥ 50
≤ 0.100	3	2	1	1	1
> 0.100 - ≤ 0.300	4	2	1	1	1
> 0.300 - ≤0 .600	5	3	1.5	1	1
> 0.600	6	4	2	1.5	1

Reversing direction of camber (a positive, C+, and negative, C-, curvature) along a sample length, L, is unacceptable.

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6.2.3. Coil Set "a"

The coil set is measured as the deflection **"a"** from the vertical of a continuous 300 mm long sample section of strip. The test shall be carried out in the manner described in the figure below. The deflection shall not exceed the values given in the table below. This requirement shall be applicable to both layer wound coil and traverse wound spool dimensions as listed in 2090580045. Coil set must be all in one direction, reversing coil set is not allowable. Reversing coil set is defined as coil set repeating in positive and negative values down the strip's length. Samples measured should not be within 1 meter of a weld area.

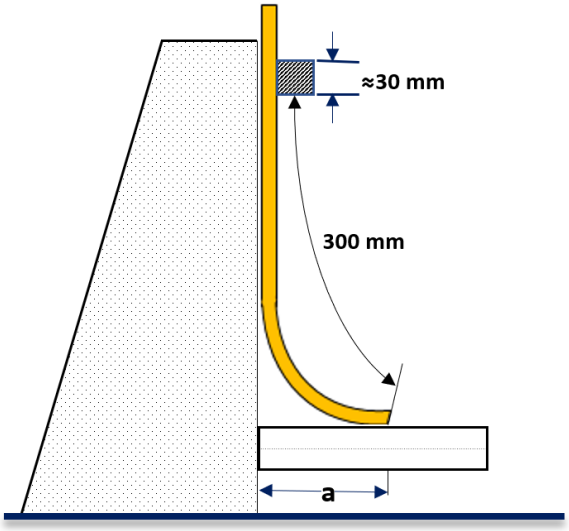

Figure: Coil set as measured by deflection "a"

Width (mm)		Maximum Coil Set (mm/300mm) for Thickness (mm)				
Over	Up to	≤ 0.08	> 0.08 - 0.15	> 0.15 - 0.3	> 0.3 - 0.5	> 0.5 - 0.8
5	8	100	120	150	300	300
8	10	80	100	120	250	250
10	15	40	50	80	90	100
15	20	35	40	60	65	80
20	25	30	35	50	55	65
25	30	25	30	45	50	55
30	35	25	30	40	45	50
35	60	20	25	35	40	45
60	100	15	20	25	30	35

Note: This coil set table is not applicable to "soft" temper. Any tolerance must be agreed with supplier before P.O.

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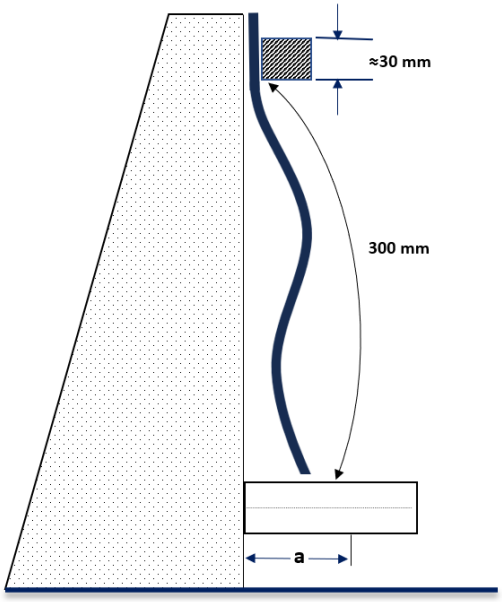
Reversing Coilset:



a = Reverse Coil Set

6.2.4. Die Exit Twist

The angular twist component of the sample strips is measured (ref. Appendix A at end of document) and must adhere to the requirements of the table shown.

Molex Specified Category	Angular Twist 0.06 to 0.50mm thickness	Angular Twist 0.51 to 1.00mm thickness
Category 1	No Requirement	No Requirement
Category 2	25° Maximum	50° Maximum
Category 3	10° Maximum	As defined by Molex
*Category 4	5° Maximum	As defined by Molex

* Denotes "Stress Free" Material (Bare Condition Only)

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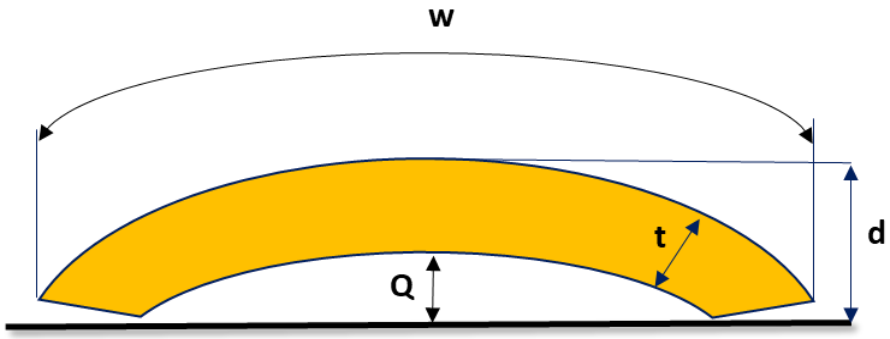
6.3. Tier 3: Definitions (As Required per Higher Precedence Documentation, 3.0 Order of Precedence)

6.3.1. Cross Bow (Transverse, "Q")

For rolled tempers of H03 and higher, transverse cross bow Q (see figure below) including edge burr, shall not exceed the values listed in the table below.

Allowable Crossbow (mm)	Width (mm)				
Thickness (mm)	≤ 20	> 20 - 40	> 40 - 60	> 60 - 80	> 80 - 100
≤ 0.3	0.05	0.08	0.10	0.15	0.20
> 0.3 - 0.5	0.08	0.10	0.15	0.20	0.25
> 0.5 - 0.7	0.10	0.15	0.20	0.25	0.30
> 0.7 - 1.0	0.15	0.20	0.25	0.30	0.35

Table: Transverse cross bow
(leveled prior to slitting, H03 temper and up)



w= strip width
t = strip thickness
d = Max. distance between surface and strip
TRAVERSE CROSSBOW Q = d – t

Figure: Cross Bow (Transverse, "Q")

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6.3.2. Waviness “v”

The waviness **“v”** (see figure below) is a departure from flatness that can occur at the strip’s edge or be confined within the strip’s width (buckle). Both are measured similarly; with the equation shown in the figure below. The waviness tolerance is found in the table below.

Thickness (mm)	Width <50mm	Width ≥50mm
< 0.20mm	0.10%	1.00%
0.20 - < 0.50mm	0.07%	0.70%
0.50 - 1.00mm	0.05%	0.50%

Table: Maximum Waviness “v”, represented as a percentage:

$$v = 100 \times \left(\frac{h - t}{L} \right)$$

Example: a strip 0.20 mm X 26 mm X Coil, with L = 300 mm, v = 0.21 mm, then h = 0.41 mm. This would produce a waviness value “v” = 0.07%.

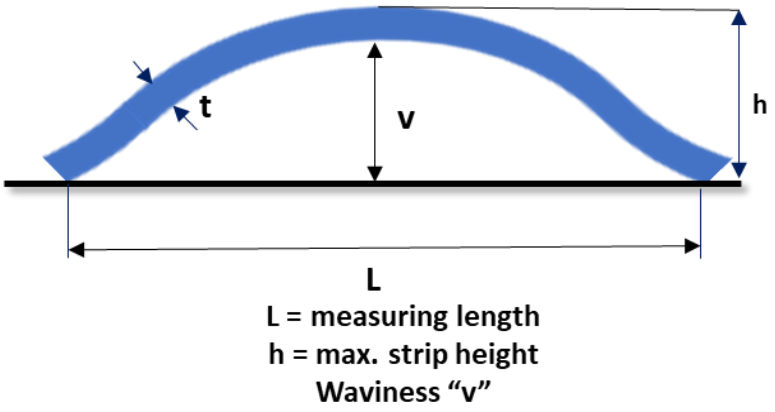

Figure: Strip waviness “v”

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7. SUMMARY OF CHANGES

Document ID# Change from **ES-40000-5005** → **2090580043**.

Split from larger 2090580044 (ES-40000-5007) engineering specification.

Established *Three Tier* system and assigned existing geometric categories accordingly.

Added *6.2.4 Die Exit Twist* and *Appendix A: Die Exit Twist Procedure*.

Inclusion of lighter gauge category (0.1mm and below) to Tolerance Requirements:

1. Gauge
2. Camber
3. Burr
4. Coilset

Converted all remaining Imperial to Metric Units.

Changes to *3.0 Order of Precedence*:

- Addition of *Packaging Specifications*
- Reclassification of “Global Specifications” item #5.

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Appendix A: Die Exit Twist Procedure

1.0 SCOPE

The scope of this descriptive test method is for metal strips with slit edges and is to be used on metal strips of width greater than 5.0mm.

2.0 PURPOSE

The purpose of this appendix is to describe sampling, test methods and evaluation procedures for determining the ability of the metal strip to be processed in the stamping die and subsequently meet the established acceptance criteria as set forth by Molex.

3.0 REFERENCE DOCUMENTS

Individual Metal Strip Specifications

4.0 DEFINITIONS

2.1 COUPON STRIP

A 200mm X 2.5mm section of metal sheared from sample.

2.2 SLITTING STRESSES

The stored mechanical energy imparted to the metal strip's edge during the slitting process.

2.3 INITIAL SETUP QUALIFICATION

Slitter setup qualification includes the Die Exit Twist (DET) test with compliance to the acceptance criteria prior to the production run.

5.0 REQUIREMENTS

5.1 EQUIPMENT

Precision Shear: Di-ACRO Type Houdaille Industries, Inc., or equivalent low angle shear
Precision Angle Indicator – accuracy to +/-1°

5.2 MATERIALS

A 200mm long section of slit strip from each element of the head in use.

5.3 MATERIAL PREPARATION

A 200mm X 2.50mm coupon strip of metal sheared from sample.

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5.3.1 APPLY MARKINGS TO STRIPS (AS SHOWN IN FIGURE 1)

While still attached to the slitter, number each sample sequentially starting from the drive side, starting with 1, then 2, etc.
Pointing always in the same direction (to indicate a fixed orientation), mark an arrowhead on each strip next to the sequential number.
Cut samples of each strip approximately 280mm long.
At the shear, set trim gauge to 2.5mm +/-.13mm.
Initial setup: The tests shall be conducted at the beginning of an initial setup.
Produce coupons.
Cut sample to a length of 200mm +/- 2.0mm.
Place an identifying mark across the width of the sample to orientate the strips later.
Shear 1 cut lengthwise from each edge of the sample material

Figure 1: Example Coupon Markings

5.4 MEASUREMENT

5.4.1 ANGULAR TWIST

On a flat surface (shear bed) hold down one end of each coupon and measure the twist angle with the precision angle indicator on the opposite end.

5.5 ACCEPTANCE

5.5.1 ANGULAR TWIST

Unless specified otherwise on the individual metal strip specifications, the default acceptance criterion is category 1.

Molex Specified Category	Angular Twist 0.06 to 0.50mm thickness	Angular Twist 0.51 to 1.00mm thickness
Category 1	No Requirement	No Requirement
Category 2	25° Maximum	50° Maximum
Category 3	10° Maximum	As defined by Molex
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