

Pinsky Tin Whisker Risk Algorithm- CALCE_release version 2.0

Introduction

The Pinsky Tin Whisker Risk Algorithm was developed by David Pinsky while he worked at Raytheon Missiles and Defense. The algorithm is implemented in a Microsoft Excel Spreadsheet and is used to calculate a risk index for tin whisker induced failure for a component. The spreadsheet has three tabs: Instructions (depicted in Figure 1), Metric (depicted in Figure 2), and English (depicted in Figure 3). Calculations are conducted in either the Metric or English tabs by updating the parameters in the yellow filled cells found under column J. The calculated risk index is displayed in the maroon filled cell (N18 for the Metric tab and N20 for the English Tab).

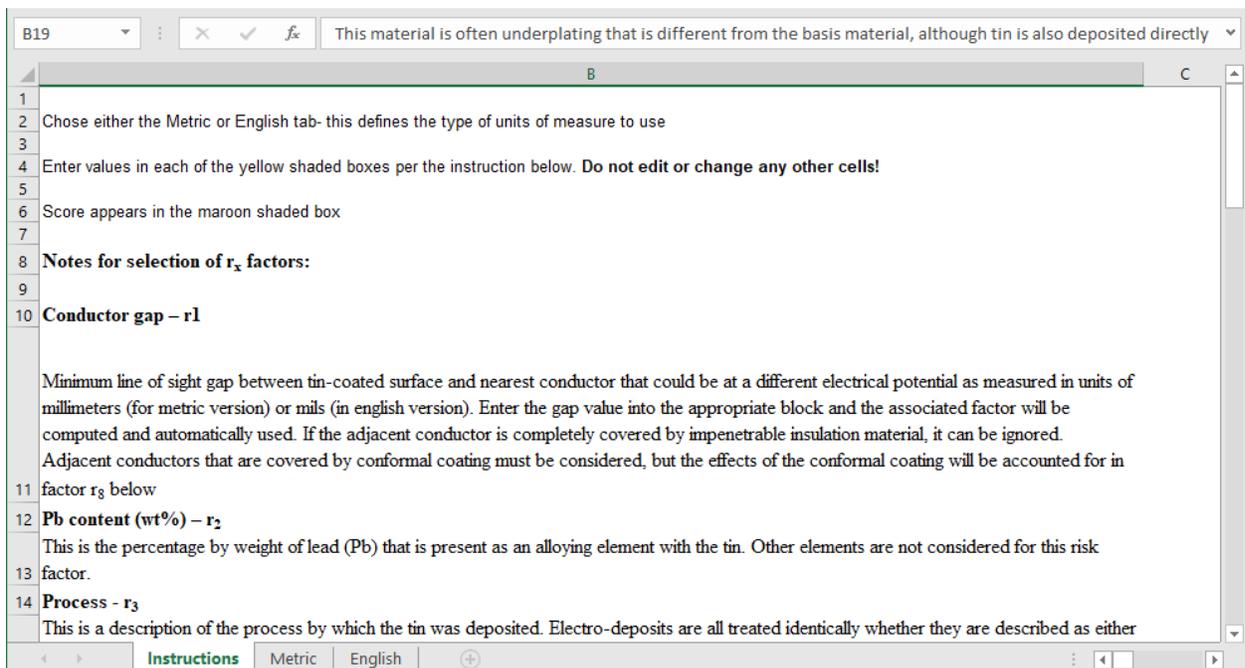


Figure 1 Instructions Tab

Risk Factor	C	D	E	F	G	H	I	J	M	N	O	P
Conductor gap (mm)	0.50							0.4000	Conductor gap in mm			
Pb content (wt%)	<0.2	0.2-1	1.0-2.0	2.0-3.0	>3.0			1.0000				
Process	electroplate		Immersion		Hot dip			1.0000				
Tin thickness (microns)	<125	125-6.5	6.5-10	10-25	>25			1.0000				
Material directly beneath tin	brass/bronze/BeCu	copper	ferrous	nickel		other		0.2000	R(total)=	0.00562644		
Substrate controlling CTE	ceramic	low expansion alloy	Cu or Al	ferrous	other			1.0000	output	-2.48796208		
Plating heated after deposition	no		annealed		fused			1.0000				
Conformal coat	none	urethane > 1mil	silicone > 1mil	parlylene	acrylic	Other		0.5000				
directly on tin surface - r(8a)	1	0.15	0.25	0.10	0.45	15		0.0500				
on adjacent conductors - r(8b)	1	0.05	0.05	0.01	0.05	0.5						
Use of Mechanical HWD		fasteners compressed onto surface			none			1.0000				
Where was assembly performed	Clean Room	Special clean area	Typical Factory	Field assembly				0.2000				
exposed shortening wires with in enclosure	many	some	few	almost none	none			1.0000				
Airflow within assembly	Forced air		Dynamic Use		none			0.5000				
Size of component	Large mechanical item	small mechanical item	wire or coonact	Multi-lead electronic (two-lead electronic)				0.0000				

Figure 2 Metric Tab

Risk Factor	C	D	E	F	G	H	I	J	M	N	O	P
Conductor gap (mm)	1.02							40.0000	conductor gap in mls			
Pb content (wt%)	<0.2	0.2-1	1.0-2.0	2.0-3.0	>3.0			1.0000				
Process	electroplate		Immersion		Hot dip			1.0000				
Tin thickness (micro-inches)	<50	50-250	250-500	500-1000	>1000			1.0000				
Material directly beneath tin	brass/bronze/BeCu	copper	ferrous	nickel		other		0.7000	R(total)=	0.002622907		
Substrate controlling CTE	ceramic	low expansion alloy	Cu or Al	ferrous	other			0.3000	output	-2.58121718		
Plating heated after deposition	no		annealed		fused			1.0000				
Conformal coat	none	urethane > 1mil	silicone > 1 mil	parlylene	acrylic	Other		0.1500				
directly on tin surface - r(8a)	1	0.15	0.25	0.10	0.45	15		0.0500				
on adjacent conductors - r(8b)	1	0.05	0.05	0.01	0.05	0.5						
Use of Mechanical HWD		fasteners compressed onto surface			none			0.1000				
Where was assembly performed	Clean Room	Special clean area	Typical Factory	Field assembly				0.2000				

Figure 3 English Tab

Instructions

Enter values in each of the yellow shaded boxes (column J) per the instruction below. **Do not edit or change any other cells!**

Score appears in the maroon shaded box (N18 Metric tab, N20 English tab)

Notes for selection of r_x factors:

Conductor gap – r_1

Minimum line of sight gap between tin-coated surface and nearest conductor that could be at a different electrical potential as measured in units of millimeters (for metric version) or mils (in english version). Enter the gap value into the appropriate block and the associated factor will be computed and automatically used. If the adjacent conductor is completely covered by impenetrable insulation material, it can be ignored. Adjacent conductors that are covered by conformal coating must be considered, but the effects of the conformal coating will be accounted for in factor r_8 below

Pb content (wt%) – r_2

This is the percentage by weight of lead (Pb) that is present as an alloying element with the tin. Other elements are not considered for this risk factor.

Process - r_3

This is a description of the process by which the tin was deposited. Electro-deposits are all treated identically whether they are described as either “bright” or “matte”. Immersion tin is deposited by an electroless plating process. Hot dip involves submerging of the part into a bath of molten tin. If the deposition process is unknown, assume “electro-deposit”, as this is the worst-case for whiskering propensity. For hot dip Pb-free solder material use “hot dip”.

Tin thickness - r_4

This is based upon the thickness of the deposit in microns (for metric version) or microinches (for english version). If a range of thickness is present or may be present, choose the highest possible risk factor. For example, if a plating is known to range between 100 and 300 microinches in thickness, r_2 should be set to 1.0, rather than to 0.7.

Material directly beneath the tin- r_5

This material is often underplating that is different from the basis material, although tin is also deposited directly onto some basis materials. If the material is a copper alloy termed “brass” or “bronze”, or contains less than 95% copper by wt, use the “Brass or bronze” factor. If the material is a low copper alloy not termed “brass” or “bronze” use the “copper” factor. Low expansion Fe-Ni or Fe-Ni-Co alloys such as alloy 42 or Kovar should be given the risk factor of “ferrous”. The “nickel” factor should be used with a nickel underplate or with any low alloy nickel. **The nickel value can only be used with an underplate under the following conditions: the component is a ceramic chip-style passive device, or the component in question is a connector pin where the connector specification calls for corrosion resistance and durability testing, or the user has performed direct analysis of the component and is verified the quality of the nickel deposit.**

Substrate controlling the CTE – r_6

This may be the basis metal of the component in question, but often is not. Some judgement will be necessary to determine which material in a complex stack-up will dominate the CTE that is imposed onto the tin deposit. The term “low expansion alloy” is used to describe metals such as Alloy 42 or Kovar that have been formulated to exhibit a low CTE that is compatible with ceramic and glass. All other alloys where the majority constituent is Fe should be classed under “ferrous”.

Plating reheated – r₇

This factor relates to thermal treatments the tin was subjected to after deposition. If the deposit was fully melted and re-solidified, use the “fused” factor. (Note: solder re-flow operations will not necessarily fuse a pure tin deposit. Use the “fused” rating only if full melting of the plating is known to have occurred.) Some manufacturers utilize a special annealing process as a means to mitigate tin whisker risk. If the deposit is known to have been subjected to a treatment whose express purpose is such mitigation, and they test their plating in accordance with JESD 201, use the “annealed” rating. Normal solder reflow processing should not be considered as “annealing” unless there is specific data to support such a classification.

Conformal Coat – r_{8a} and r_{8b}

Factor r_{8a} refers to organic coating applied directly over the tin deposit. And r_{8b} factor refers to organic coating applied directly over the adjacent conductors. If a coating is known to be urethane in excess of 1 mil thick, or silicone in excess of 1 mil thick, use the appropriate ratings. If Parylene is used, apply the rating (no minimum thickness). If a different coating type is used, or if a urethane or silicone coating of less than 1 mil is used, apply the “other” rating. If no coating at all is use, apply the “none” rating (not the “other” rating). In most cases, the same coating will be present on the tin and on the adjacent conductors. However, in those instances where one of the relevant surfaces have been masked prior to conformal coat, the coating state will be different.

Use of Mechanical HWD – r₉

This factor is used to rate the amount of mechanical force that is applied to the surface of the deposit. If any mechanical component is in contact with the tin surface such that compression of the tin could occur, use the “fasteners” rating. Use the “fasteners” rating when tin-plated surfaces are mechanically mated into sockets or connectors. Components soldered onto the surface do not count for this risk factor. If no such components bear on the tin surface, use the “none” rating. (Note: the factor for “none” is not zero because some mechanical damage is assumed to always be present on the surface due to normal handling, etc.)

Where was assembly performed? – r₁₀

This factor is used to assess the overall vulnerability of the system to dysfunction as a result of the presence of small pieces of conductive contaminants. The concept behind this risk factor is that a device that is assembled in a clean room is likely to be very susceptible to contamination-related failure (or the expense of clean room operations would not be justified). Conversely, an assembly that is made under field conditions is likely to be fairly immune to conductive contamination (or it would never function). Another way to view is to consider how the addition of a few loose whiskers affects the total amount of conductive contamination present. For a clean-room built assembly, this would be a significant increase, while the same number of whiskers could represent a negligible increase for a system that is assembled in the field.

If the assembly that contains the tin-coated part is assembled in a clean room of any rating, use the “clean-room” factor. If the assembly occurs in a special “cleaner” area that has no specific rating (like a closed room with laminar-flow benches) use the “special clean area” rating. If the assembly occurs in a normal factory environment (indoor, temperature-humidity controlled, workers in ESD smocks, etc.) use the “typical factory” rating. If the assembly is performed in an uncontrolled location (outdoor, open hangar, garage, etc.) use the “field assembly” rating.

Shorting opportunities within an enclosure – r₁₁

The purpose of this factor is to help determine the risk of failure due to a loose whisker causing a “secondary” short. To determine the proper setting one must consider which electronics loose whiskers could possibly reach. In general, all electronics with a path through the air from the tin plated surface should be considered. For example, if the tin surface is within a sealed box, only those conductors within the box would be at risk for secondary shorting.

One very common configuration for an electronics cabinet is assumed to be a series of circuit card assemblies mated into a backplane, or other form of interconnection. An estimation of the number of sites available for secondary shorting is determined by the degree to which the circuit cards and backplane are protected by conformal coat. For the purposes of this factor, conformal coat of all types and thickness are equivalent. If all exposed conductors are coated, apply the “none” value. If no coatings are used, apply the “many” value. Often, some but not all, conductive surfaces will be coated. In this case select “almost none”, “few” or “some” values. Use the “almost none” value if all but a handful of conductors are coated, “few” value if a clear majority conductors are known to be coated, otherwise apply the “some” value.

If the enclosure under consideration does not consist of circuit cards, an estimation of the number of vulnerable sites must be performed. If there are no exposed conductors with a gap of <1/2in. use the value corresponding with “none”. If there are a small number of vulnerable sites, use the value corresponding with “almost none”. If there are many vulnerable sites, use the value corresponding with “many”.

Air flow within assembly – r₁₂

The purpose of this factor is to rate the risk that whiskers which break off can migrate to regions of the assembly at a distance from their site of growth. If air is forced over the tin-coated component by use of fans, etc. then use the “forced air” setting. If the assembly is used in a dynamic environment such as flight or ground vehicles, or large stationary machines with many moving parts, use the “dynamic environment” setting (unless the higher “forced air” setting applies). If cooling is achieved by passive means only and the application is in a fairly static environment, select the “none” setting.

Size of the component - r₁₃

The purpose of this factor is to account for the increased risk of increased area of tin plating, particularly with regard to the creation of tin whiskers as potential foreign objects within an enclosure. Choose one of the four settings that most closely matches the component under evaluation.

Large mechanical item- does not fit in the palm of your hand

Small mechanical item- fits in the palm of your hand. use this setting also for electronic parts that are packaged in a tin-plated can

wire/contact- Use this setting for pieces of wire, terminal lugs, turrets, and contact pins.

Multi-leaded electronic part- has three or more I/O's

Small parts- devices with only two I/O's

