TECHNICAL CLEANLINESS FOR ELECTRONIC COMPONENTS

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FORVIA

HELLA

TECHNICAL CLEANLINESS FOR ELCTRONICAL COMPONENTS

Overview

- Introduction
- Examples of recent cases at Hella
- Examples of recent cases at Aumovio
- Inspection methodologies
- Existing Norms and Guidelines
- Conclusions

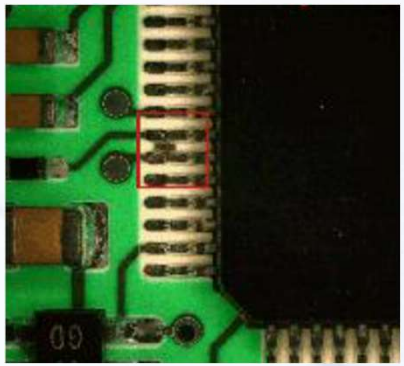
TECHNICAL CLEANLINESS FOR ELCTRONICAL COMPONENTS

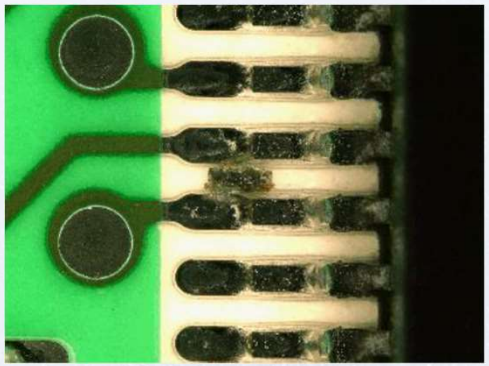
Introduction

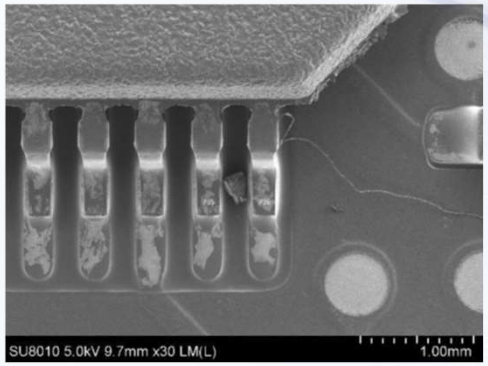
- Technical Cleanliness became important for mechanical systems in the automotive world around 2000
- Electronic Components originally were not in the focus
- Semiconductor companies sometimes stated, that Technical Cleanliness is not relevant to them as it was setup for mechanical systems
- They argue with their cleanroom policy (ISO 14644)
- As most particles are process generated and not airborne, this is not sufficient

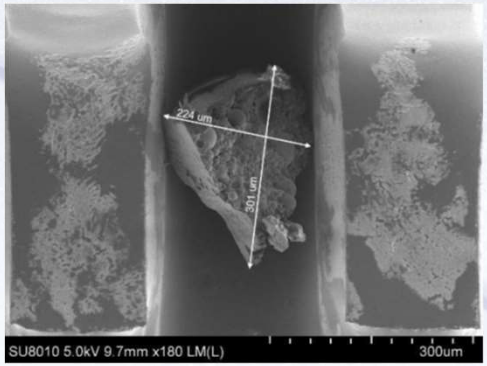
TECHNICAL CLEANLINESS FOR ELCTRONICAL COMPONENTS

Hella Case #1









- Plastic Protrusions from mold process
- Non metallic Particles
- Insufficient Cleaning of the Component after Molding

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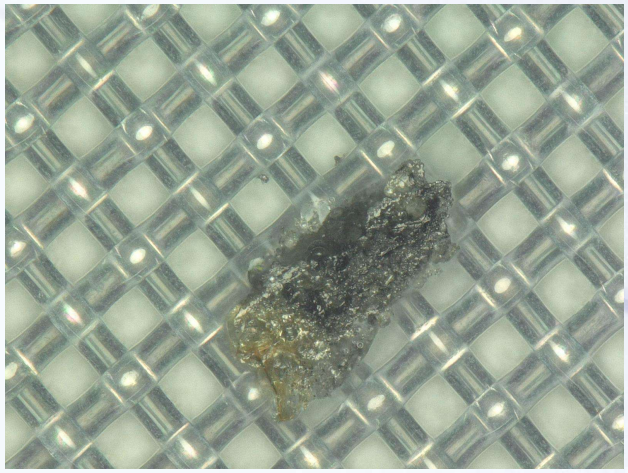
Hella Case #1

Evaluation at Hella acc VDA19.1
On virgin parts from reel



Length [µm]	Code	per Filter Membrane		per Part/Component		per 1000 cm²	
		Total[2]	Metallic	Total[2]	Metallic	Total[2]	Metallic
Summary:							
> 600	J-N	0	0	0.0	0.0	0.0	0.0
100...600	F-I	85	0	1.7	0.0	188.9	0.0
15...100	C-E	145	0	2.9	0.0	322.2	0.0
Detailed results:							
> 3000	N	0	0	0.0	0.0	0.0	0.0
2000...3000	M	0	0	0.0	0.0	0.0	0.0
1500...2000	L	0	0	0.0	0.0	0.0	0.0
1000...1500	K	0	0	0.0	0.0	0.0	0.0
600...1000	J	0	0	0.0	0.0	0.0	0.0
400...600	I	0	0	0.0	0.0	0.0	0.0
200...400	H	22	0	0.4	0.0	48.9	0.0
150...200	G	18	0	0.4	0.0	40.0	0.0
100...150	F	45	0	0.9	0.0	100.0	0.0
50...100	E	62	0	1.2	0.0	137.8	0.0
25...50	D	52	0	1.0	0.0	115.6	0.0
15...25	C	31	0	0.6	0.0	68.9	0.0
5...15	B	198	0	4.0	0.0	440.0	0.0

TECHNICAL CLEANLINESS FOR ELCTRONICAL COMPONENTS

Hella Case #1

Hella Concern: Non metallic Particles might affect solder connection

->Hella requirement : Maximum particle size < 200µm (HN40001)

Particle size [µm]	class	ZVEI example	Supplier measurement	Hella measurement	Hella requirement
600 ≤ x < 1000	J	0	0	0	0
400 ≤ x < 600	I	0	2	0	0
200 ≤ x < 400	H	32	24	48	0
150 ≤ x < 200	G	60	41	40	no limit
100 ≤ x < 150	F	160	110	100	no limit
50 ≤ x < 100	E	800	680	137	no limit

->Currently this is not achieved in the industry

->There is no real limit existing

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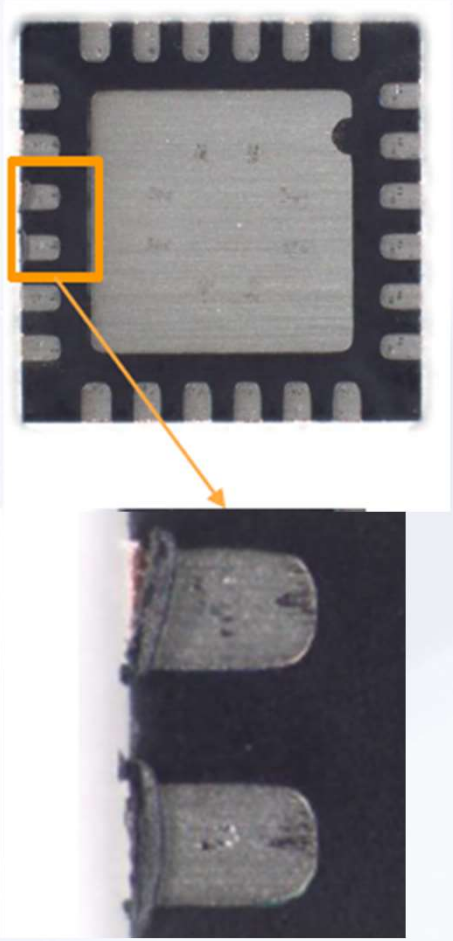
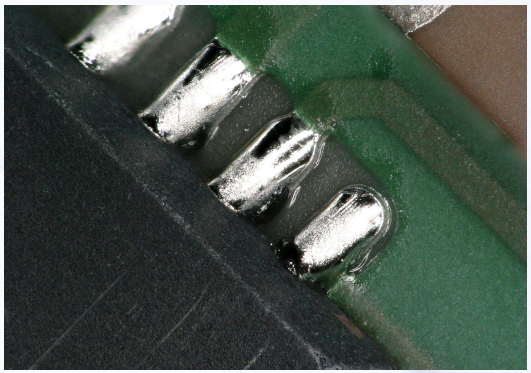
Hella Case #2

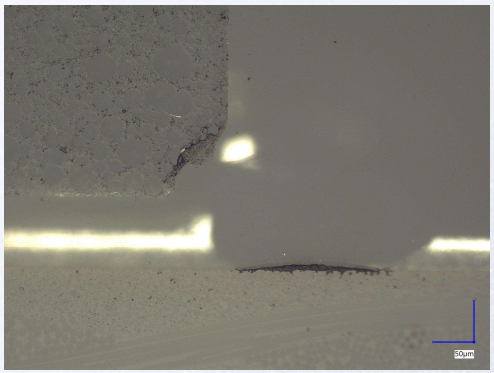
- Smaller Particles on the surface of QFN leads
- Caused by scratching of the component,
  when placing it into the tape
- Insufficient Tolerance between
  component and tape dimensions
- might cause soldering problems

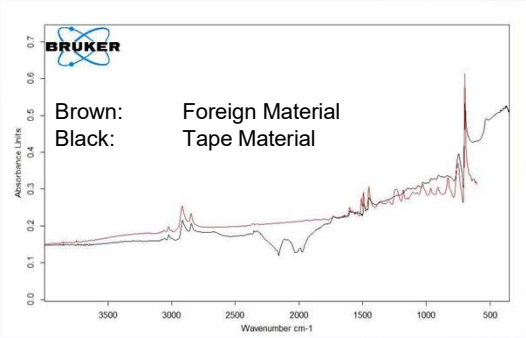


TECHNICAL CLEANLINESS FOR ELCTRONICAL COMPONENTS

Hella Case #3







- Black material on QFN Pins
- Origin : Flitters of Tape Material
- Rootcause :

Tolerance between tape width and linear track of testing machine did not match for all tape suppliers

- Usually this would not cause an issue, but… (see next page)

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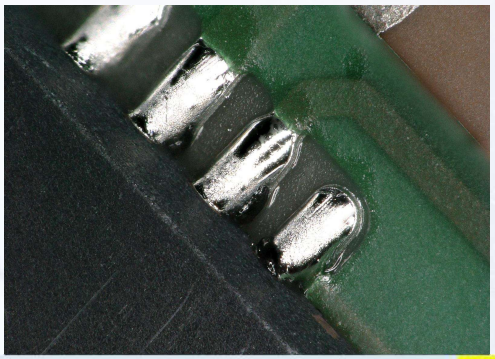
Hella Case #3



			MCHP Edits
ITAC-Fail value	Analyse-SUT	resistance betw. Pin 37 & 38	R as value
[mV]	[mV]	TP 155 - 154, Soll: ca. 8M	MIN=530
limits: -50 ~ 50			MAX=4720
228.37		811k	811
81.27	82,95	2,31M	2310
334.78		1,15M	1150
165.06	165,09	1,25M	1250
121.22	112,94	1,84M	1840
145.8		1,51M	1510
53.08		4,03M	4030
162.59	156,07	1,63M	1630
188.87	182,30	1,23M	1230
172.92		1,22M	1220
106.73		1,94M	1940
132.91	105,32	1,77M	1770
177.04	178,72	1,26M	1260

Here, the application had a sensor input,
Where a high resistance (8MOhms)
was needed between to adjacent pins

Tape material has a lower resistance
than standard isolating plastics
due to ESD requirements

This can result in parallel resistors
of several 100kOhm,
which caused electrical failures

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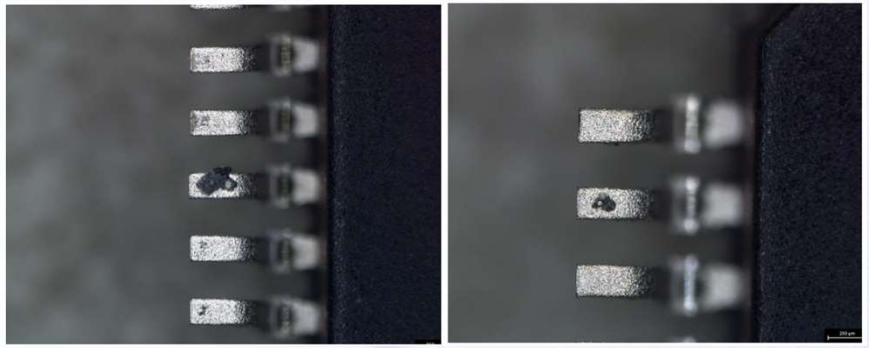
Aumovio Case #4



Escape: The particles were not detected in the lead scan at the supplier due to insufficient contrast. Tightening limits resulted in high over rejection rate.

Foreign material under lead detected by SMT camera before soldering the IC on the PCB board. Increased scrap in test.

Based on detected elements (Si, Fe, others) the supplier identified the Trim & Form process as the most probably source.

Mold debris accumulated at the Trim & Form as the established cleaning frequency was insufficient.

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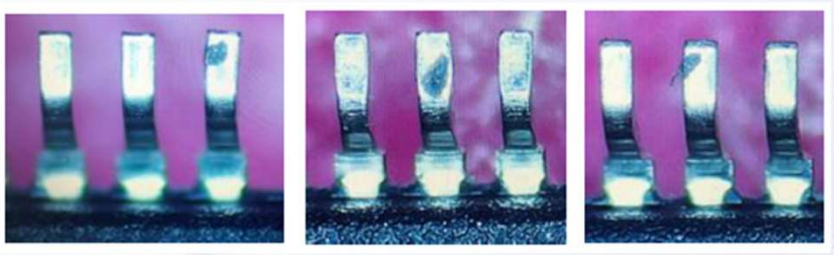
Aumovio Case #5



Escape: Bottom inspection not active at the supplier as this was rated as “not feasible” and showed a high over rejection rate. Top side inspection also not very sensitive due to non-optimum lightning condition.

Foreign material contamination observed in device inspection prior to SMT assembly. Same defects observed in multiple units from different material batches.

Worn out tooling in Trim & Form identified as root cause, resulting in accumulation of debris.

Missing PM item resulted in non-detection and replacement of the worn out part of the Trim & Form tool.

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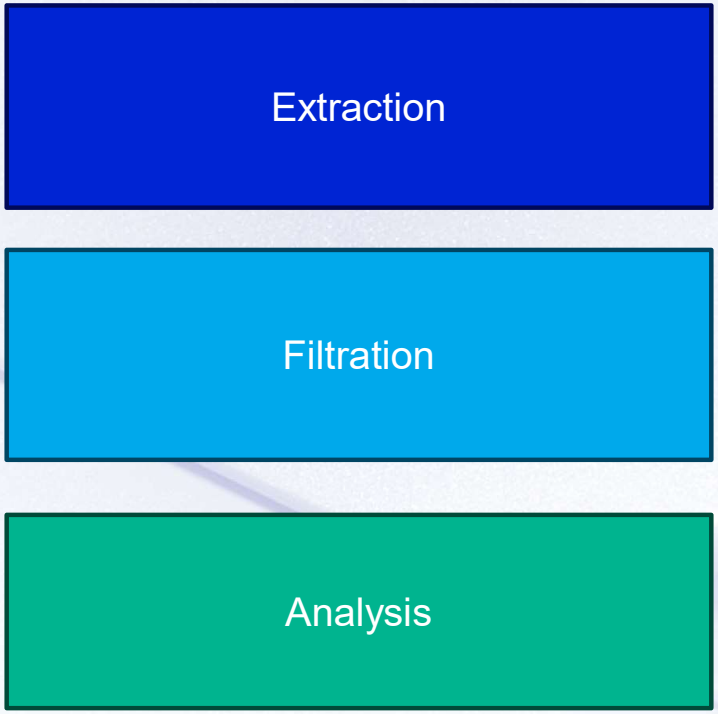
Inspection methodologies



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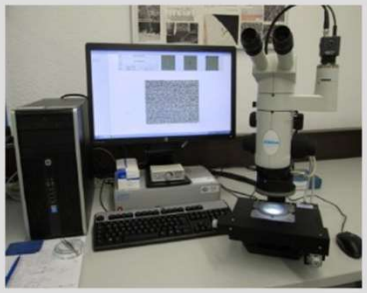
Inspection methodologies @Forvia

Standard Particle Monitoring

(VDA 19 based)
Established in every GE production plant

Rinsing Cabinet



Particle Counting Microscope

Particle Filter Conditioning

Advanced Particle Monitoring

Lippstadt

SEM / EDX

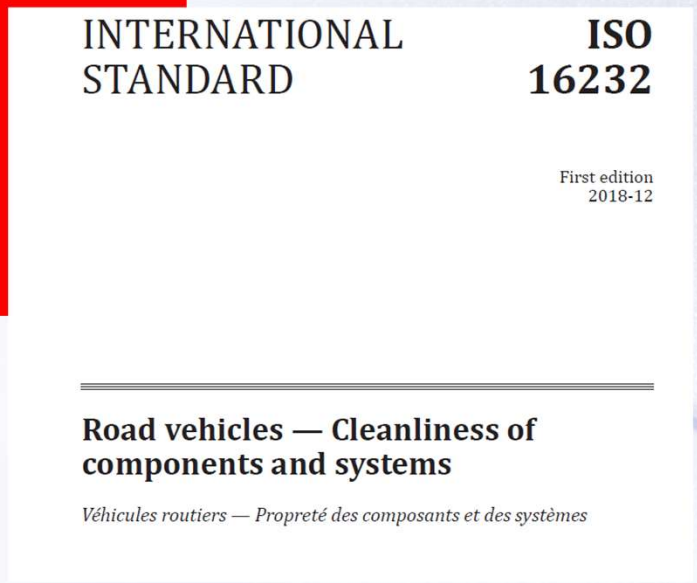
- IR spectroscope
- CT
- High precision scales
- XRF (Fischerscope)

Additional rinsing cabinets

High Resolution Microscopes

TECHNICAL CLEANLINESS FOR ELCTRONICAL COMPONENTS

Norms and Guidelines



- VDA 19.1 first established in 2004
- International Version established as ISO 16232 in 2018

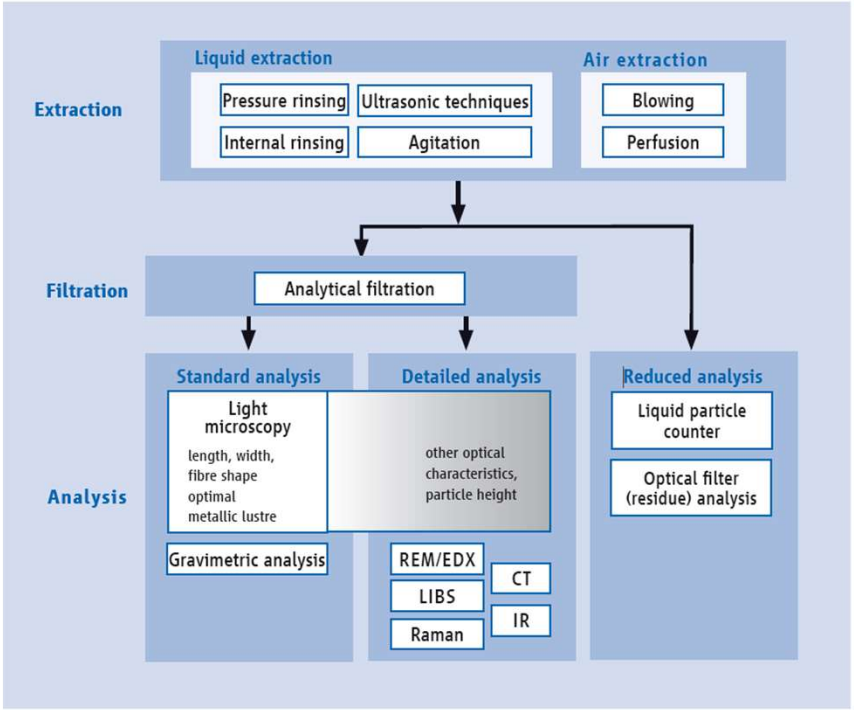
TECHNICAL CLEANLINESS FOR ELCTRONICAL COMPONENTS

Norms and Guidelines

IEC16232 and VDA19.1

- Detailed description of measurement setups
- Extraction methods
  - Liquid
  - Air
- Filtration Methods
- Analysis methods

Fig. 1: Test method as per VDA 19 Part 1



TECHNICAL CLEANLINESS FOR ELCTRONICAL COMPONENTS

Norms and Guidelines

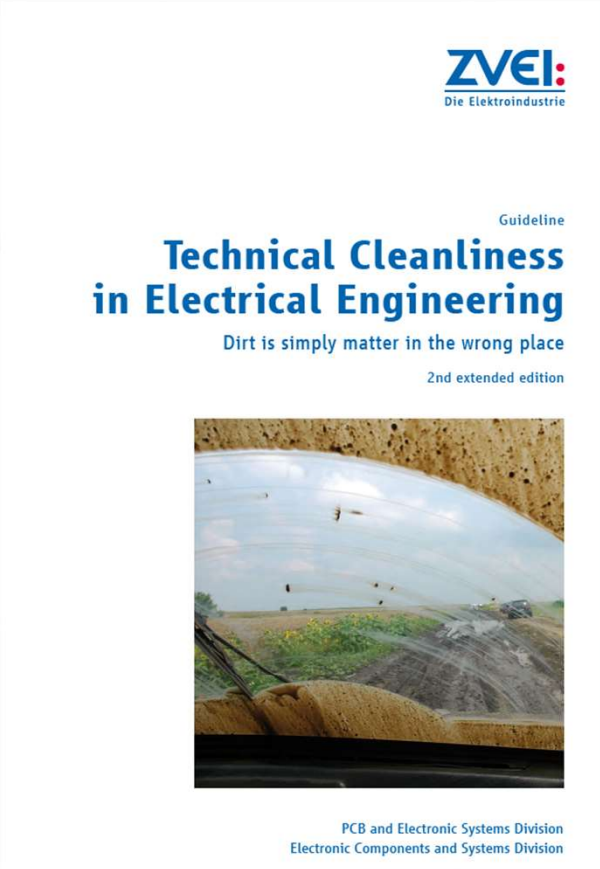
IEC16232 and VDA19.1

- Qualification tests and blank value
- Cleanliness Specifications
  - Metallic / Non metallic / Fibres
- Examples
  - Air tank
  - Piston Rings
  - Plastic housings
  - Cast cylinders
  - Crankshaft

-> Focus on mechanical components

TECHNICAL CLEANLINESS FOR ELCTRONICAL COMPONENTS

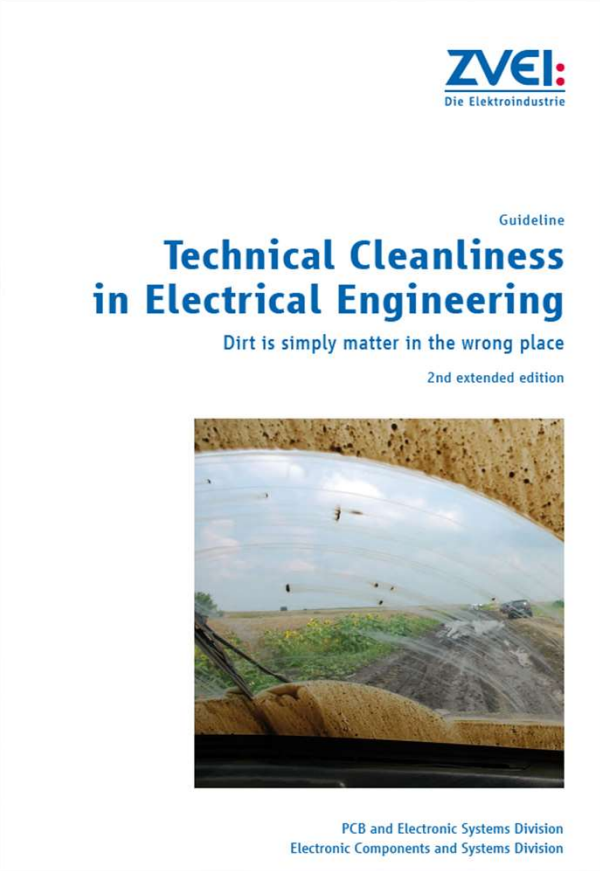
Norms and Guidelines



- 2018
- Dedicated to Electronics
- Pressure Rinsing
- Metallic / Non metallic / Fibres
- Particle Sources
- Metallic Components vs Shorts
- No limits
- Empirical data for Component classes (that may serve as reference)

TECHNICAL CLEANLINESS FOR ELCTRONICAL COMPONENTS

Norms and Guidelines



4.2.2.6 Semiconductors

Table 15: Empirical data from semiconductors

Empirical particle data from **semiconductors** per 1000 cm² surface, based on particle class			
Particle size [µm]	Size classes	All particles	Metallic particles[1)]
50 ≤ x < 100	E	8000	100
100 ≤ x < 150	F	1600	20
150 ≤ x < 200	G	600	0.00
200 ≤ x < 400	H	320	0.00
400 ≤ x < 600	I	0.00	0.00
600 ≤ x < 1000	J	0.00	0.00
1000 ≤ x < 1500	K	0.00	0.00
1500 ≤ x < 2000	L	0.00	0.00
2000 ≤ x < 3000	M	0.00	0.00
3000 ≤ x	N	0.00	0.00

TECHNICAL CLEANLINESS FOR ELCTRONICAL COMPONENTS

Conclusions

- Hella / Aumovio experienced significant issues with technical cleanliness of supplier electronic components in the last years
- Applicable and established industry standard exist that allow to define cleanliness criteria and specify methods for quantitative evolutions
- Particles adhering to components can cause solderability issues, test rejects and potential latent defects
- Supplier do not specify any cleanliness level of the shipped material
- It needs to be questioned on whether tape material flitters can be handled correctly with the definition of metallic/non metallic
- There is no limits defined in the norms

TECHNICAL CLEANLINESS FOR ELCTRONICAL COMPONENTS

Conclusions

Tier 1 expectation:

- Semiconductor suppliers should monitor their particle count
- Semiconductor suppliers should assure
  a defined level of cleanliness