



Partner for Reliability, Quality and Validation

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# **Benchmark of MOST Components – Idea, Concept and Experience**

**MOST Forum –  
International MOST Conference & Exhibition**

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# Content

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- Starting position
- Concept – Recommendation for Release
- Definitions
- Comparison of qualification approaches
- Algorithms
- Examples of results

# Starting position

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## Motivation

- New products / new technology
- Meeting quality and reliability targets
- Appraisal of new product

## Targets

- Proof of readiness for automotive market
- Identification of weak points
- Definition / calculation of guard bands
- Comparison to optimal performance

# Concept – Practical approach: Recommendation for Release (RecRel)

1. Assignment
2. Questionnaire
3. Assessment – principle and paper work (e.g. basis TS16949)
  - project
  - documentation
  - business processes (related to the project)
  - qualification procedure
  - measurement equipment
4. Production Assessment
  - production principle / facility
  - process quality
5. Review of data
  - measurement accuracy
  - characterization results
  - qualification results (required / for information)
  - early life failure rate
6. Recommendation for Release (if requirements fulfilled)

# Definition – scope of investigation

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- Life time evaluation
  - Based on mission profile
  - Calculation of test duration according established acceleration models
  - No failures allowed
  
  - **Required duration**
  
- End of life
  - Additional duration (to be added to required duration)
  - Failures allowed
  
  - **For information only**

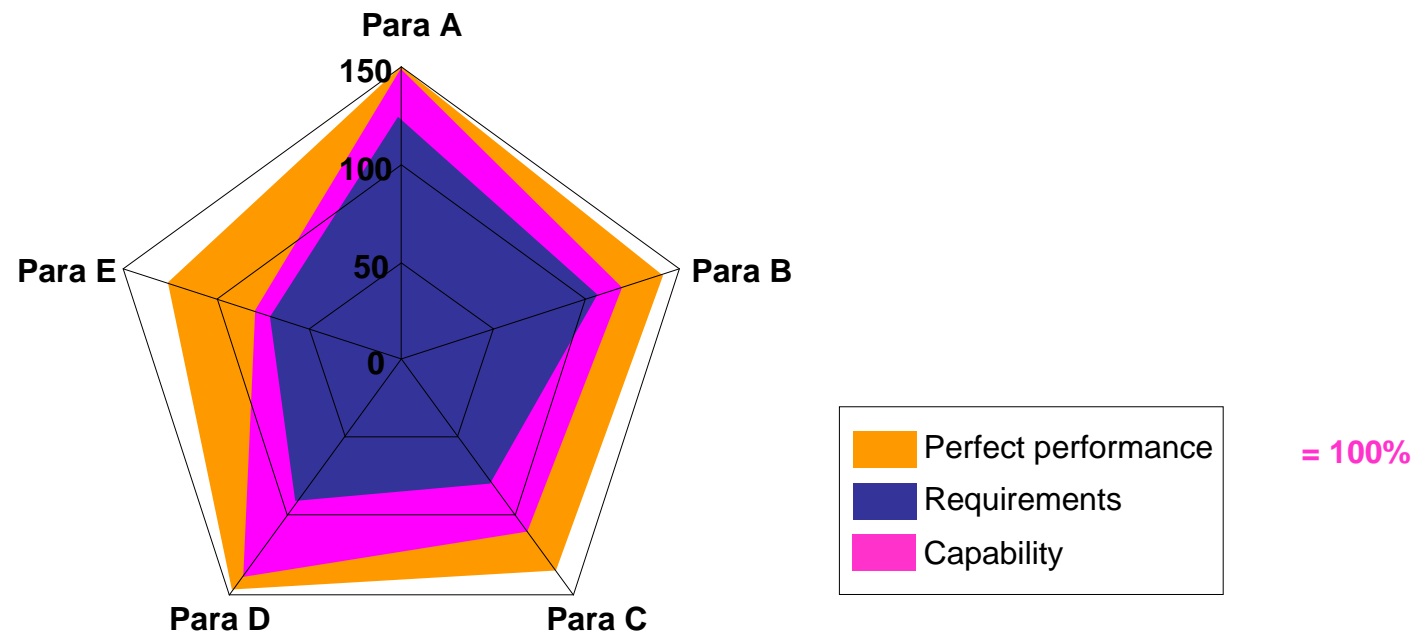
# Test sequences for investigation

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- Characterization
  - All conditions, all parameters
  
- Life time tests (examples)
  - High temperature operating life (HTOL)
  - Temperature humidity bias (THB)
  - Temperature cycling (TC)
  
- Characterization after life time tests (required duration)
  - Comparison before / after stress of life tests
  
- Short time tests (examples)
  - Mechanical shock (MS)
  - Solder ability (SD)

# Comparison of qualification approaches – Safety margin

- Distinguish capability of components in relation to the requirements
- Identification of weak parameter
- Calculation of safety margin (similar to Robustness validation)



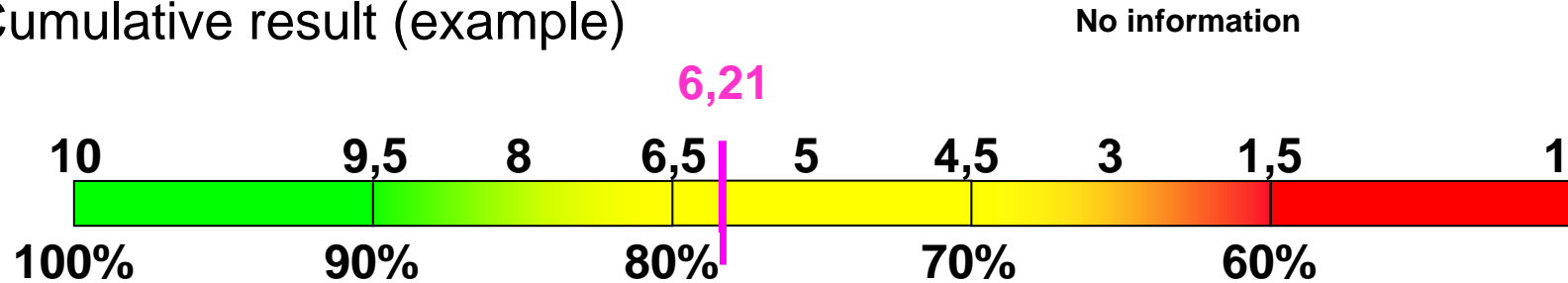
# Modified cumulated illustration

- Creating a short statement based on detail investigation
- adapted to established judgments  
e.g. classification in

## Judgment of steps

Not fulfilled – critical	1	C
Not fulfilled – recoverable	2	BC
Partly fulfilled	5	B
Partly fulfilled – positive tendency	7	AB
fulfilled	10	A

## Cumulative result (example)



No information

# Algorithms – Single test row

## Definition / Calculation

Lower specification limit LSL

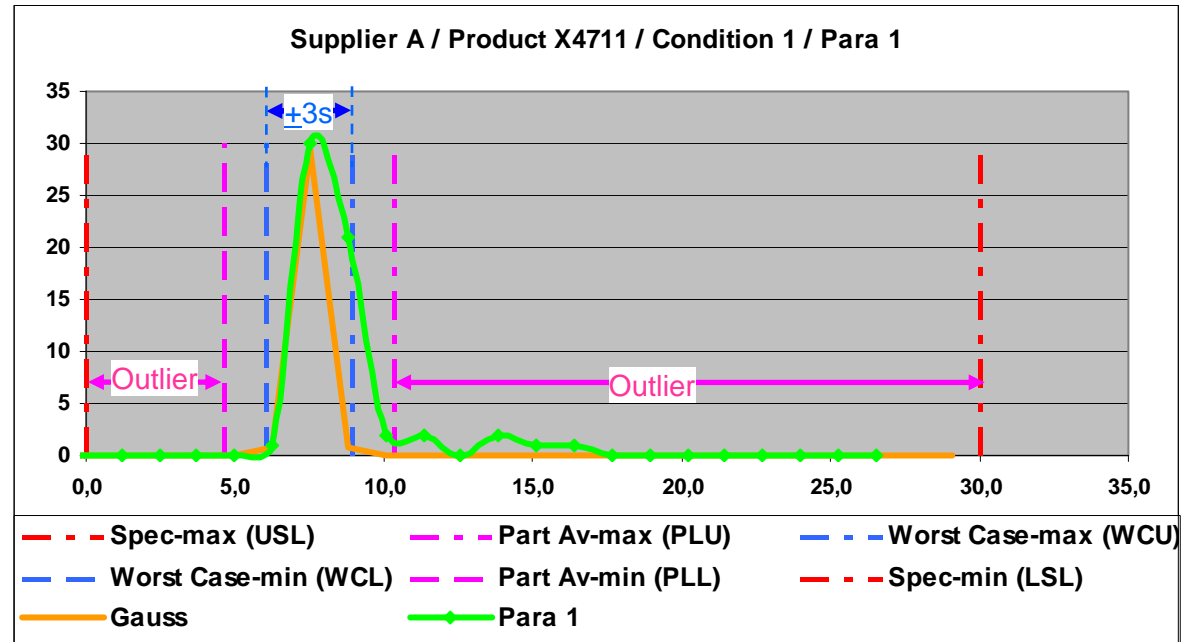
Upper specification limit USL

Mean value – robust  $x_{mr}$

Standard deviation – robust  $s_r$

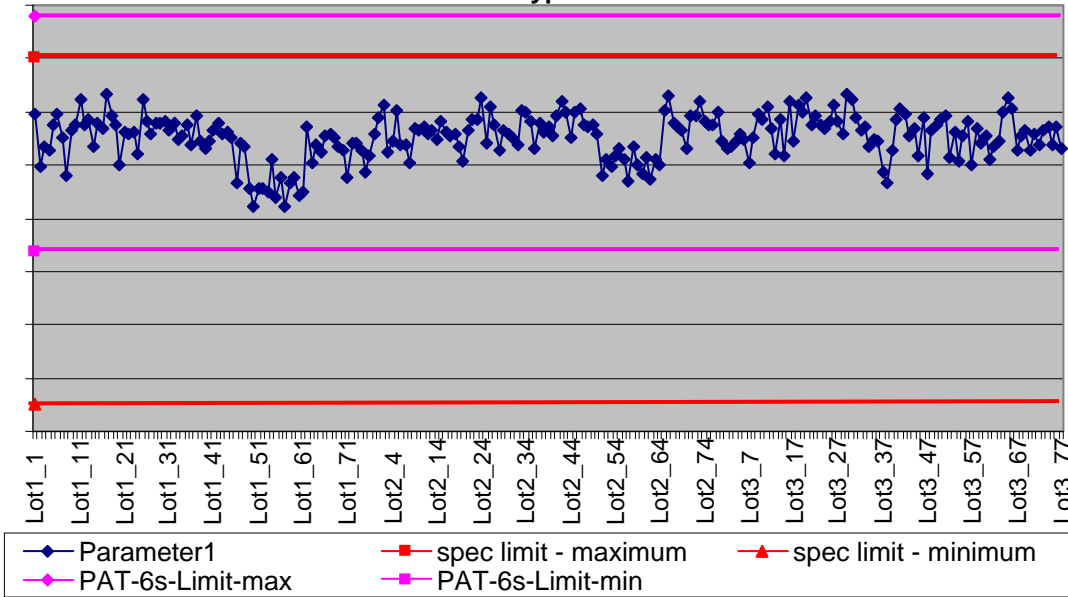
Part average limits  
 minimum PLL  
 maximum PLU

Distribution within  $\pm 3s$  (incl. Margin  $x_{mr}$ )  
 minimum WCL  
 maximum WCU



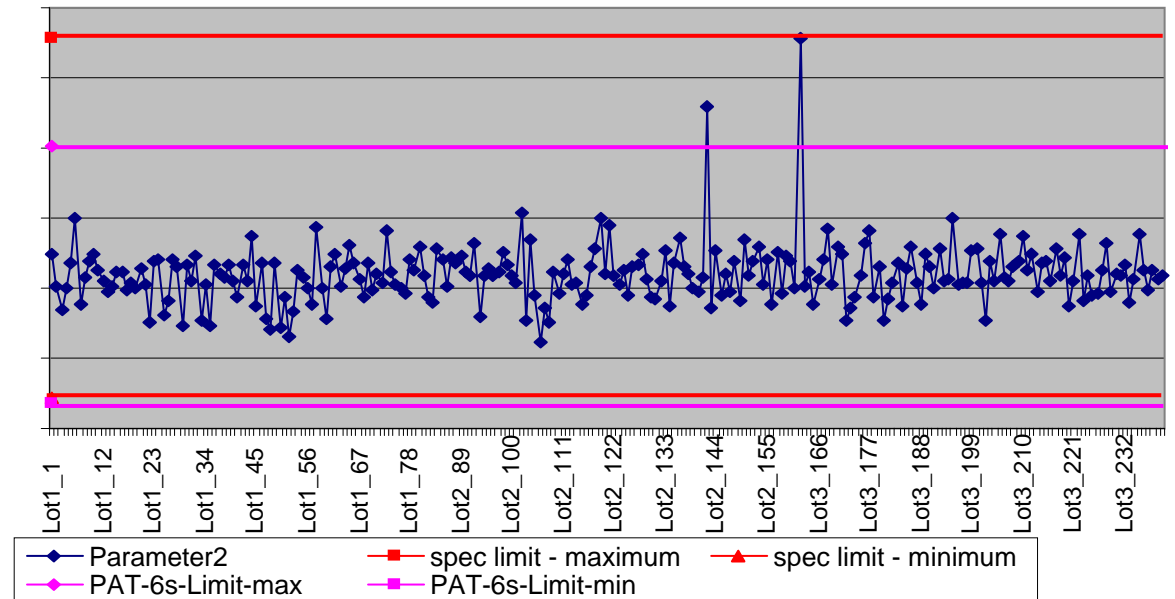
# Example of results – Single test row

Manufacturer / Type / HTOL-2



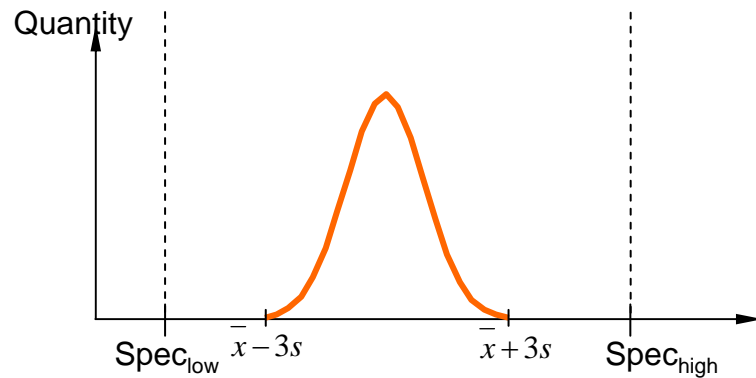
Manufacturer / Type / HTOL--5

Outlier



# Algorithms – Test sequence – Design Index

## Capability Index

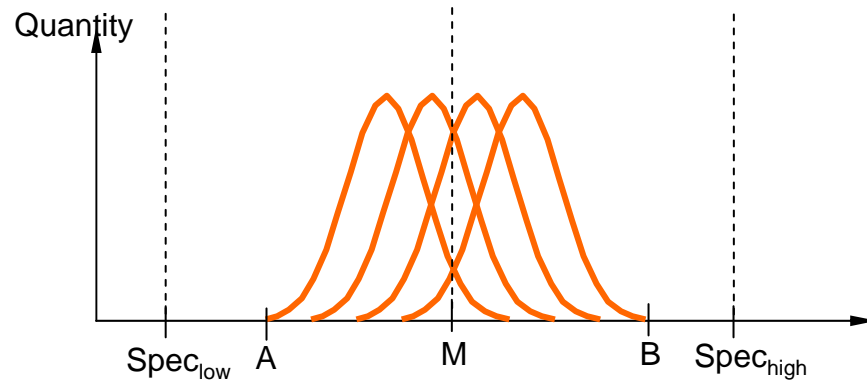


Presumption: upper limit is closer

$$C_{pk} = \left( \frac{USL - \bar{x}}{3s} \right) > 1,66$$

- $C_{pk}$  Capability Index
- $\bar{x}$  Mean value
- $USL$  upper specification limit
- $s$  Standard deviation

## Design Index



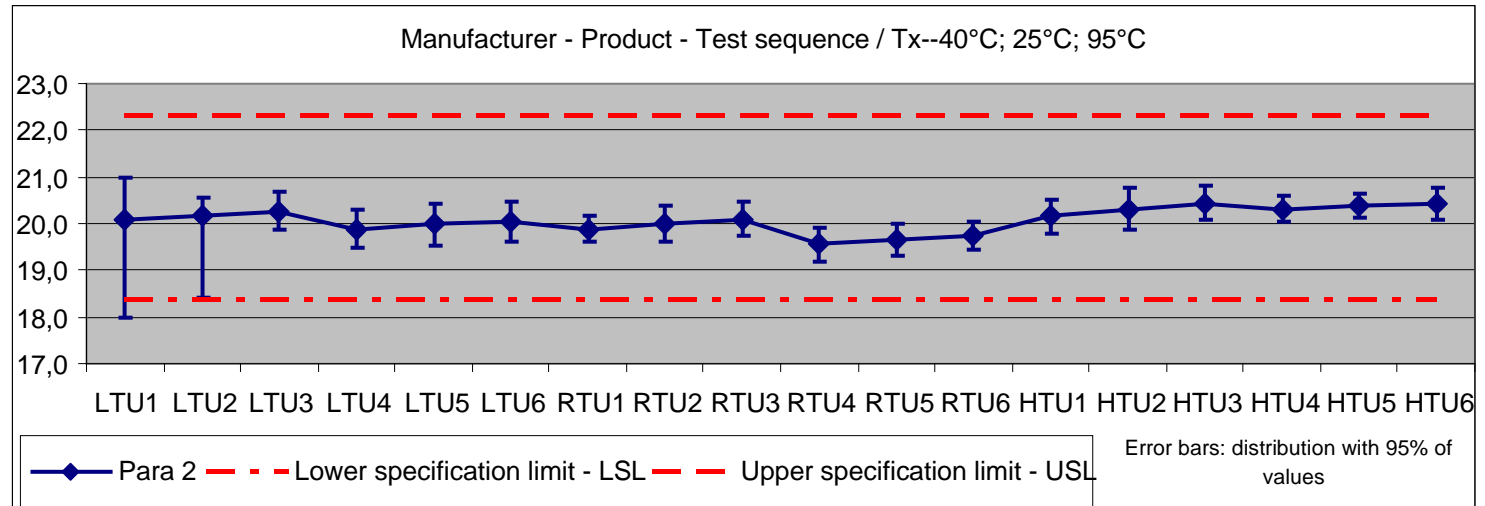
Presumption: upper limit is closer

$$DI = \left( \frac{USL - M}{B - M} \right) > 1$$

- $DI$  Design Index
- $\bar{x}_i$  Mean value single test row
- $M$  Mean value over all tests
- $USL$  upper specification limit
- $\bar{x}_{iCL}$  Conficende level of  $\bar{x}_i$
- $M = \frac{1}{2}(A + B)$
- $A = \min(\bar{x}_i - x_{iCL} - 3s)$
- $B = \max(\bar{x}_i + x_{iCL} + 3s)$

# Example of results – Test sequence – Design index

Design index



Manufacturer / Type / Test-Sequence		Para1	Para2	Para3	Para4	Para5	Para6	Para7	Para8	Para9	Par10	Par11	Par12	Par13	Par14	Par15	Par16
lower specification limit	LSL	LSL1	LSL2	LSL3	LSL4	LSL5	LSL6	LSL7	LSL8	LSL9	LSL10	LSL11	LSL12	LSL13	LSL14	LSL15	LSL16
upper specification limit	USL	USL1	USL2	USL3	USL4	USL5	USL6	USL7	USL8	USL9	USL10	USL11	USL12	USL13	USL14	USL15	USL16
critical design index	$D_{krit}$	3,08	0,92	2,33	26,74	2,25	0,82	2,73	1,73	1,68	19,10	4,02	14,58	1,01	1,67	3,71	2,13

↑  
Specification not fulfilled

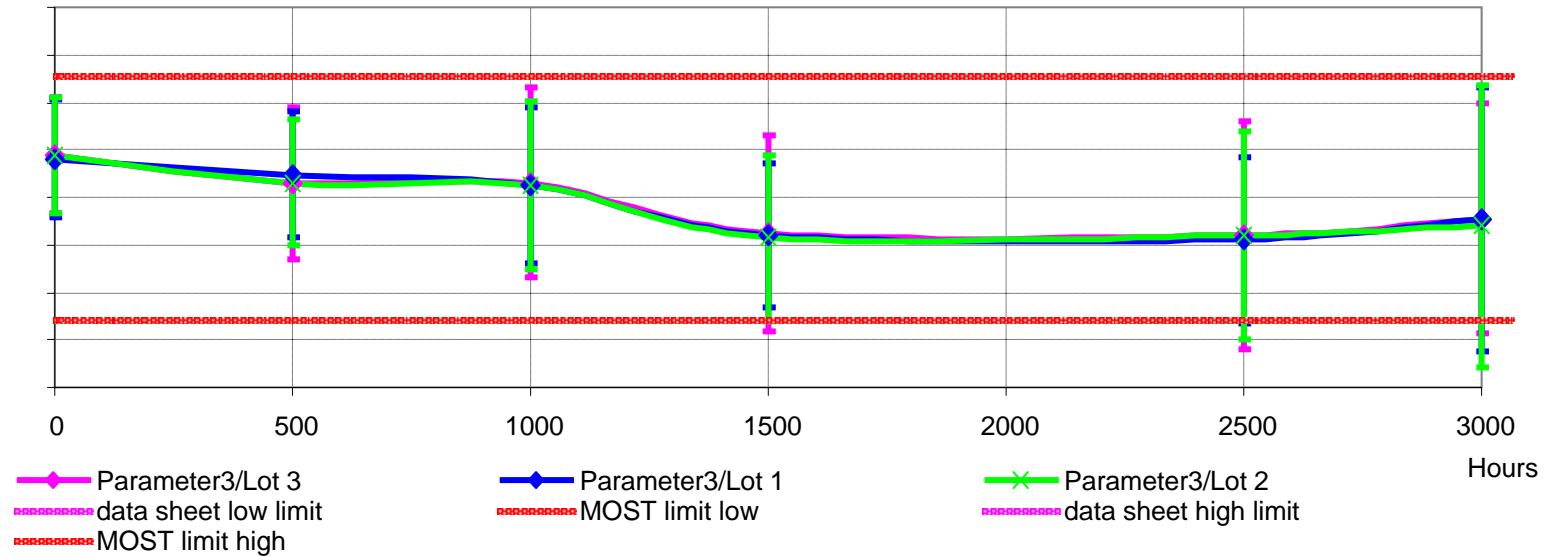
↑  
Most sensitive parameter (within specification)

# Example of results – Test sequence – Customized



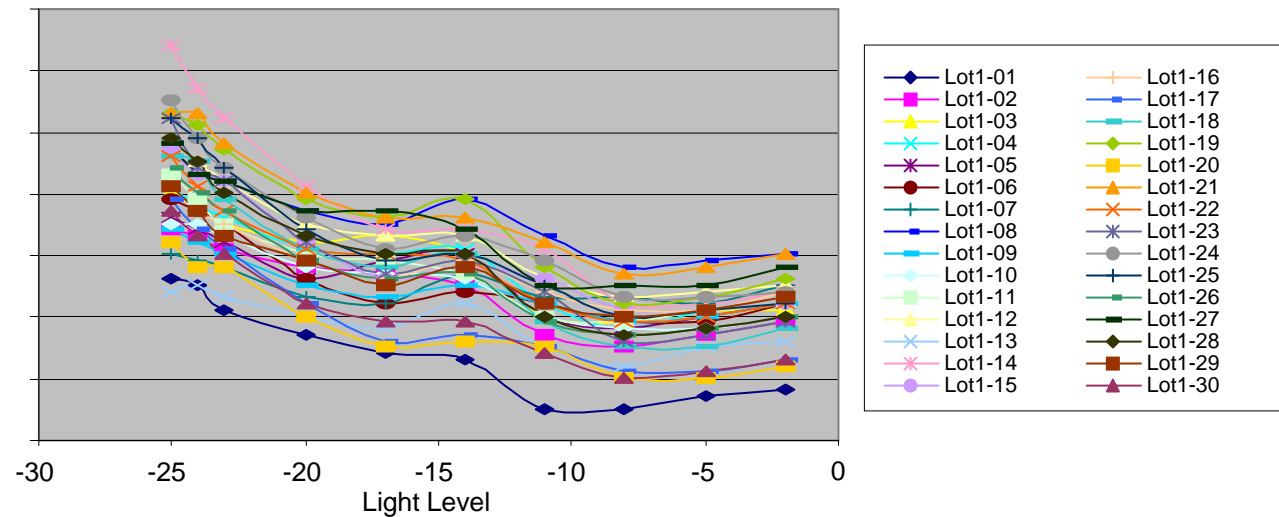
Manufacturer / Type / High Temperature Operating Life

Trend

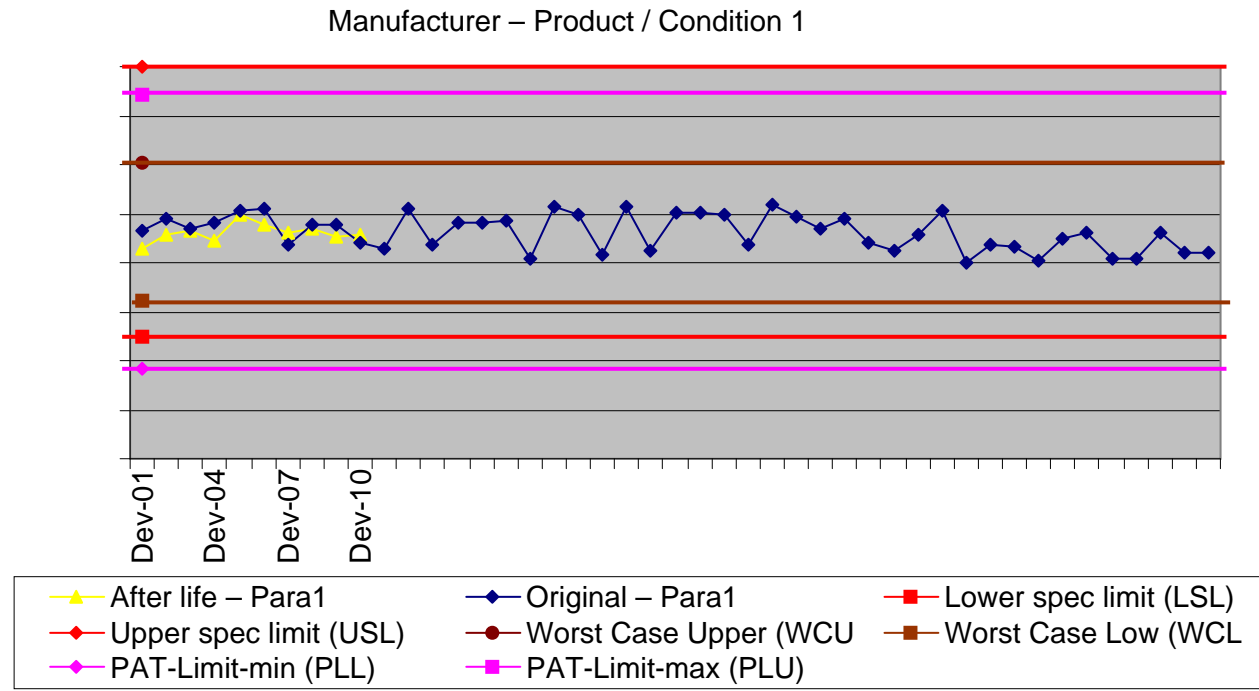


Parameter 4 / -40°C

Rx: Variation input  
light level



# Example of results – Test sequence – Characterization after life testing



## Comparison

original characterization (without stress)

blue line

characterization after stress

yellow line

# Example of results – Complete

Test	Type	Quantity of				Result	
		Devices	Conditions	Parameters	Measurements		
<b>Characterization including measurement after life: HTOL, THB, TS</b>	Comp1	--	--	--	<b>17.280</b>	<b>AB</b>	<b>86,6%</b>
Characterization	Comp1	90	12	12	12.960	A	97,0%
Characterization after Life	Comp1	30	12	12	4.320	AB	87,8%
<b>Short time</b>	Comp1	<b>138</b>	<b>2</b>	<b>15</b>	<b>4.140</b>	<b>AB</b>	<b>85,2%</b>
<b>Life time</b>	Comp1	--	--	--	<b>51.975</b>	<b>AB</b>	<b>86,6%</b>
Temperature humidity bias (THB) (85°C; 85% rel.hum)	Comp1	231	5	15	17.325	A	90,6%
High temperature operating Life (HTOL) (+95°C; 5,25V)	Comp1	231	6	15	20.790	AB	82,8%
Temperature shock (TS) (-40°C / +105°C)	Comp1	231	4	15	13.860	AB	86,4%
<b>Overall result</b>	Comp1	--	--	--	<b>73.395</b>	<b>AB</b>	<b>86,1%</b>

Test	Type	Quantity of				Result	
		Devices	Conditions	Parameters	Measurements		
<b>Characterization including measurement after life: HTOL, THB, TS</b>	Comp2	--	--	--	<b>190.080</b>	<b>A</b>	<b>96,1%</b>
Characterization	Comp2	90	144	11	142.560	A	97,6%
Characterization after Life	Comp2	30	144	11	47.520	A	96,7%
<b>Short time</b>	Comp2	<b>138</b>	<b>2</b>	<b>14</b>	<b>3.864</b>	<b>A</b>	<b>93,5%</b>
<b>Life time</b>	Comp2	--	--	--	<b>48.510</b>	<b>A</b>	<b>94,9%</b>
Temperature humidity bias (THB) (85°C; 85% rel.hum)	Comp2	231	5	14	16.170	A	93,5%
High temperature operating Life (HTOL) (+95°C; 5,25V)	Comp2	231	6	14	19.404	A	93,3%
Temperature shock (TS) (-40°C / +105°C)	Comp2	231	4	14	12.936	A	95,9%
<b>Overall result</b>	Comp2	--	--	--	<b>242.454</b>	<b>A</b>	<b>94,8%</b>

# Kontakt Daten

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