Under all Conditions

Ideas, concepts and experiences with a benchmark of MOST components

After establishing the first hardware for MOST25, the release recommendations were introduced. This method was used to investigate and validate new products according to the requirements for automotive applications. In order to have a common basis for this work an application recommendation was written [1]. This specification describes all necessary test sequences and also the acceptance criteria for new products in the optical path of the MOST technology.

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(Bild: BMW)

This process was already developed before the concept of robustness validation [2] were released. Nevertheless, this approach also realizes some of the principles of robustness validation. Within the MOST community this approach is well proven, and mandatory not only for the German car manufacturers but for others as well.

After having some experience with different products also coming from different manufacturers, the concept of benchmarking was introduced. The goal of this method is to compare products with functionality with the best performance. The definition of best performance is based on the requirements for the automotive application. The challenge of this approach is that all relevant aspects are taken into account.

Principle of recommendation process

The recommendation process can be divided into several steps:

- Valid specification: based on the real operating conditions and common description of requirements.
- Assessment of project: review of project flow, technical implementation, planned verification steps, quality strategy and assessment of the manufacturing facility regarding new technologies used.
- Review of measured data: the measurements are mainly done by the manufacturer.
- Judgment-based on the results of the developed investigation tool.

This paper describes the method to review the data and make an objective judgment of the tested devices. For this goal the test sequences are separated into different sections:

- Characterization respectively electrical distribution: Measurement of all important parameters over the whole range of conditions. These are normally the operating temperatures, supply voltages, and for the receiver the specified optical input power range.
- Life time tests: Examples for this section are high temperature operating life (HTOL), temperature humidity bias (THB), and temperature cycling (TC).
- Characterization after life test: Same procedure as before, performed with only a few devices that were stressed by the complete required duration of life test.
- Short time tests: Examples for this section are mechanical shock (MS), solderability (SD), and physical dimension (PD).

In each section for each single test row some statistical values are calculated to describe the behaviour of each particular parameter. An example for this calculation is given in **figure 1**. The criteria in this calculation are the number of failures, capability index, the distance to the specification limits, and the distribution of the measurements.

For a complete description it is also necessary to consider the behaviour over the total set of different condi-

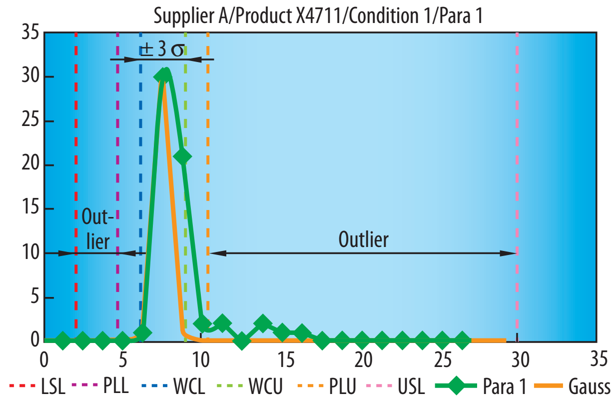

Figure 1. Criteria used for judgment of single row calculation.

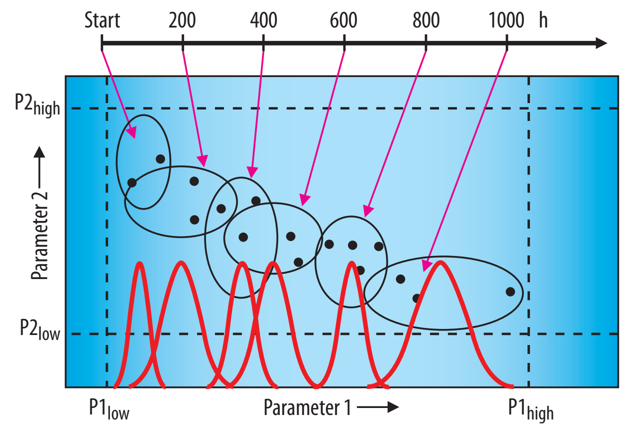

Figure 2. Principle of using the design index for judgment.

tions. This is true especially for the characterization and the life time test sequences. For this purpose the applicable automotive specification describes a method for calculating a design index, which is similar to the capability. **Figure 2** shows this approach for a test sequence that has several read-outs from start to 1000 hours. The statistical characteristics of the different distributions are the relevant criterion for this judgment. For this design index a minimum value of 1.0 is required. This is quite similar to the capability index where a minimum of 1.66 is required.

Extension of the method to benchmark approach

The calculated values of the investigation are set in relation to the specification limits. Together with the automotive requirements, perfect performance is defined and set to 100 percent. With this definition it is possible to describe the real performance of the product as a percentage.

For better understanding of the benchmark the values from each single calculation were merged together to come to one single value for the judgment. This procedure is similar to the guideline for auditing of quality systems at automotive suppliers [5]. In this approach a classification from A to C was defined to characterize the performance of the product:

- Classification A: >90 % (status: green)
- Classification AB: 80 … 90 % (status: green; improvement possible)
- Classification B: 70 … 80 % (status: yellow; improvement highly recommended)
- Classification BC: 60 … 70 % (status: yellow; improvement required)
- Classification C: <60 % (status: red)

The total counts of measurements are mentioned as additional information to increase the confidence of the judgment.

Results and examples

In the investigation process the information is transferred to the customer first in concrete values. In addition to this, the information is given in a diagram to make the behaviour more clear. For example, to see the outliers of one single test row, see **figure 3**.

An example of the behaviour of the design index for one parameter regarding all conditions during characterization is given in **figure 4**. Most of the conditions fulfil the requirement. Only at two supply voltage conditions at low temperature are the limits exceeded.

After the required duration of each life test sequence it is necessary to take

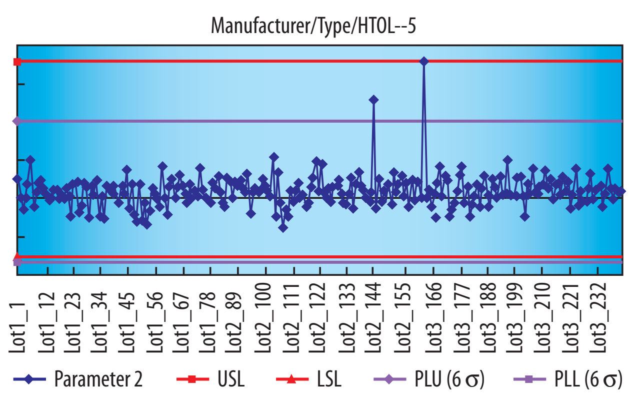

Figure 3. Outliers for one set of conditions for the test sequence high temperature operating life (HTOL).

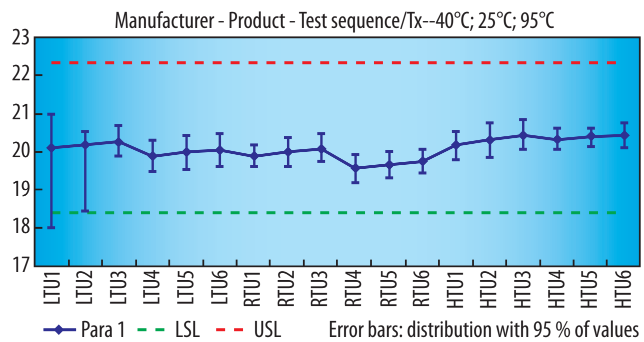

Figure 4. Behaviour of design index for one test sequence, two supply voltages and three temperatures (low: –40 °C; room: +25 °C; high: +95 °C).

Test	# Conditions	# Devices	# Parameters	Values	Result
Characterization	18	90	24	19,800	65.70 % (BC)
Characterization after life: HTOL, THB, TS	3	30	24	2,160	80.04 % (AB)
Short time qualification tests	4	42.50	20	3,400	75.63 % (B)
Temperature humidity bias (THB), 85 °C, 85 % rel. hum.	4	231	40	36,960	91.34 % (A)
High temperature storage life (HTOL), 95 °C	8	231	40	73,920	95.23 % (A)
Low temperature operating life (LTOL), –40/+105 °C	4	231	40	36,960	85.37 % (AB)
Temperature cycling (TC), –40/+105 °C	4	231	40	36,960	86.30 % (AB)
Humidity temperature cycling (HTC), -10/+64 °C, 95 % rel. hum.	3	25	40	3,120	73.21 % (B)
Overall result	-.-	-.-	-.-	**213,280**	**82.71 % (AB)**

Example for benchmark

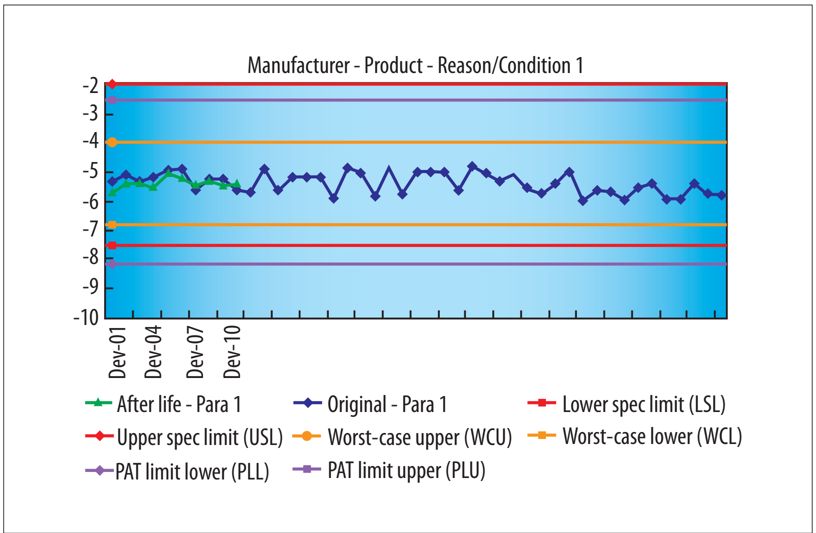

Figure 5. Characterization after life in comparison to the original measurements mainly fulfilling the requirements with some minor deviation regarding the limits for the outliers.

a few devices and measure the parameter for the characterization again. The criterion in this case is the comparison to the original characterization measurement. It is clear that these are not the same devices but these devices should have a similar distribution. Therefore the general behaviour should be similar and within the distribution of the original characterization. An example for demonstrating the behaviour is given in **figure 5**.

The example of the total result is showing acceptable performance (**table**). Some of the tests are very good (A). Others should perform better. This is mainly true for the characterization which is marked BC. The reason for this low value is that some of the measured parameters are outside the limits of the specification. A solution for this could be to increase the specification range. If this is not possible because the limits are fixed by the MOST specification, a small design change could increase the performance in this case. *sj*

Literature

[1] Automotive Application Recommendation for optical MOST Components – Through Hole Mount (THM), June 2009.
[2] Handbook for Robustness Validation of Automotive Electrical/Electronic Modules. ZVEI/SAE, April 2008.
[3] Failure Mechanism based Stress Test Qualification for Integrated Circuits, Rev. G. Automotive Electronics Council (AEC-Q-100), May 2007.
[4] Guideline for Characterization of Integrated Circuits. Automotive Electronics Council (AEC-Q-003), July 2001.
[5] Quality management in automotive industry – Process Audit. VDA Volume 6, Part 3, 1998.

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Relnetyx:

First test house for MOST150

Relnetyx is the first „MOST150 Compliance Test House“ certified to perform MOST150 oPhy compliance testing. Relnetyx is already a certified testing facility for MOST25 and now offers full and limited optical physical layer tests for MOST25 and MOST150. The accreditation was carried out by DAkkS according to ISO/IEC17025 specification and recognized by the MOST Cooperation.

Relnetyx also provides MOST compliance testing on core and profile level through a network of partner companies. Beyond compliance testing and tool development, Relnetyx offers an assessment process to verify the quality and reliability of MOST components according to the document Automotive Application Recommendation for SMD and THM MOST components. *sj*