# 9. Quality information

## 9.1 Quality management

### 9.1.1 TEMIC continuous improvement activities

- TEMIC conducts Quality training for ALL personnel, including production, development, marketing and sales departments.
- Zero defect mindset.
- Permanent Quality Improvement Process.
- Total Quality Management, TQM.
- TEMIC Quality Policy is established by the Management Board.
- Quality System Certified per ISO 9001 by July 12, 1993 (Commercial Quality System).
- Quality System formerly approved per AQAP-1 (Military Quality System).

### 9.1.2 TEMIC tools for continuous improvement

- TEMIC qualifies materials, processes and process changes.
- TEMIC uses Process FMEA (Failure Mode and Effects Analysis) for all processes. Process and machine capability, as well as Gage R&R (Repeatability & Reproducibility) are proven.
- TEMIC internal qualifications are in accordance with IEC 68–2 and MIL STD 883.
- TEMIC periodically requalifies device types (Short Term Monitoring, Long Term Monitoring).
- TEMIC uses SPC for significant production parameters. SPC is performed by trained operators.
- TEMIC Burn-In of selected device types is available.
- TEMIC 100% tests finished products.
- TEMIC lot release is via sampling. Sampling acceptance criterion is always c = 0.

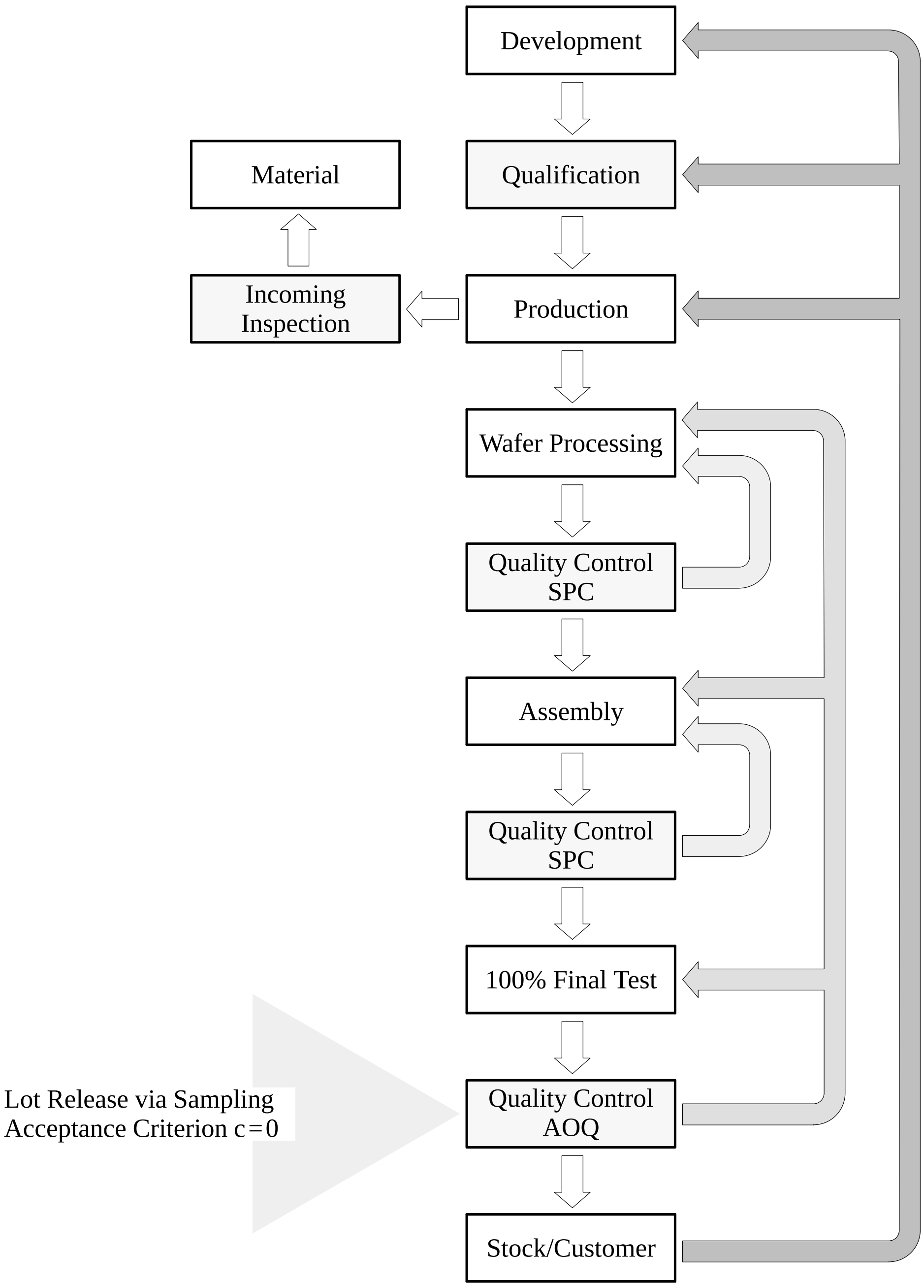
### 9.1.3 TEMIC quality policy

Our goal is to achieve total customer satisfaction
through everything we do.
Therefore, the quality of our products and services
is our number one priority.
Quality comes first!
All of us at TEMIC are part of
the process of continuous improvement.

Board of management:

| | | | | | |
|---|---|---|---|---|---|
| **H.P. Eberhardt** | **R.J. Kulle** | **M. Desbard** | **R. Pudelko** | **G.Bolenz** | **P.W. Weber** |
| **Chairman** | **Siliconix** | **MHS** | **Dialog** | **Controller** | **Sales& Marketing** |

## 9.2 General quality flow chart diagram



SPC : **S**tatistical **P**rocess **C**ontrol
AOQ : **A**verage **O**utgoing **Q**uality

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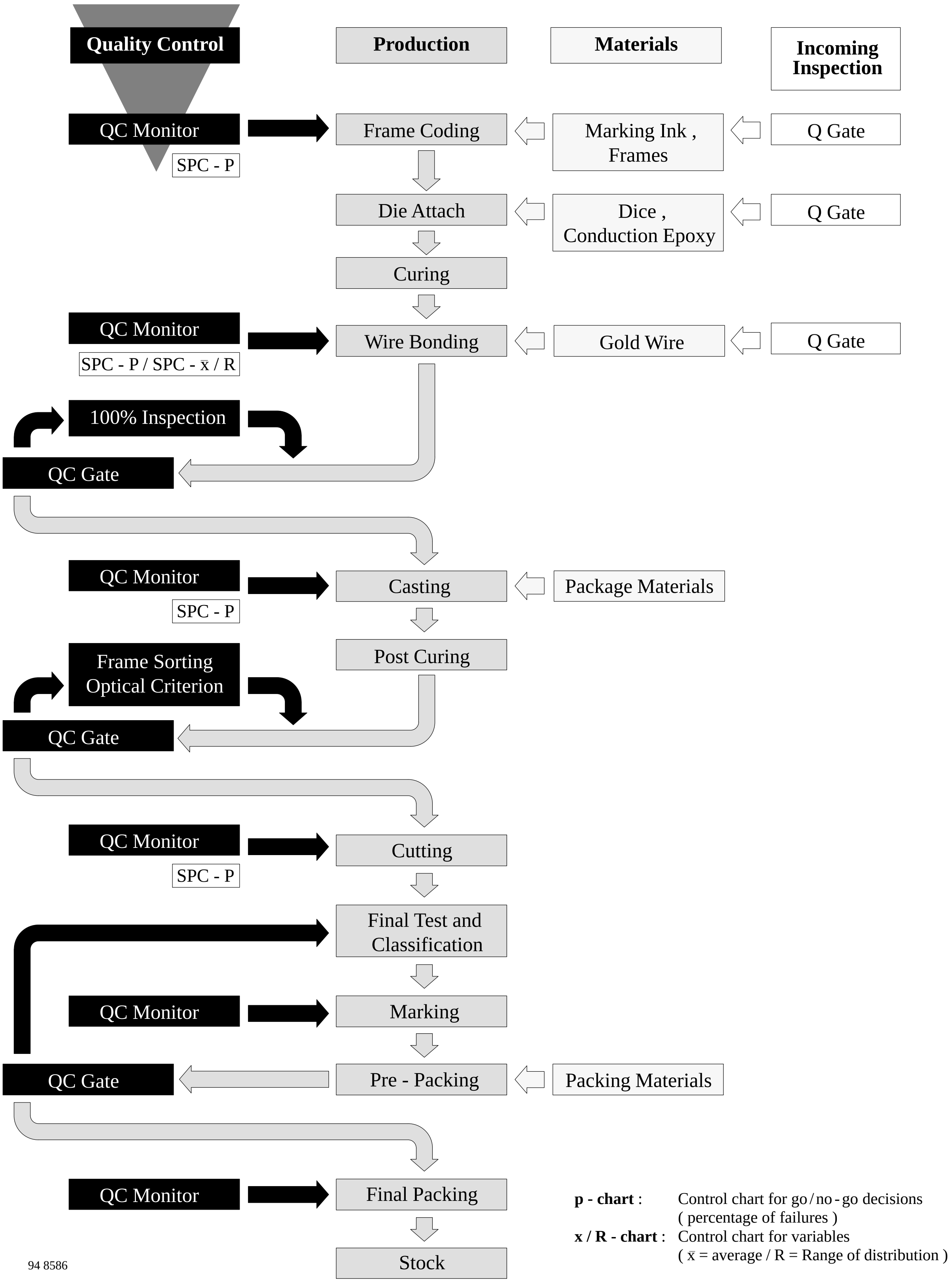
## 9.2.2 Production flow chart diagram



| | |
|---|---|
| **p - chart :** | Control chart for go / no - go decisions<br>( percentage of failures ) |
| **x / R - chart :** | Control chart for variables<br>( $\bar{x}$ = average / R = Range of distribution ) |

## 9.3 Qualification and monitoring

Waferprocess, package and device (type) are qualified before production is started. A Qualification Specification exists for each product. Tests for qualification are based on INTERNATIONAL STANDARD IEC 68. These qualification procedures are similar to MIL and CECC procedures.

### 9.3.1 Qualification procedure

The qualification procedure is in detail described in the latest edition of the QSA 3000, an internal document of TEMIC TELEFUNKEN Semiconductors.

### 9.3.2 Quality indicators

AOQ: Average Outgoing Quality is calculated from results of lot release as ppm (parts per million) figures in accordance with JEDEC STANDARD No 16.

Unit: ppm

AQL: TEMIC TELEFUNKEN lot release uses a sampling size n = 200 with an acceptance criterion c = 0. This correlates to an AQL (Average Quality Level) better or equal to 0.065 % in accordance with standard IEC 410.

Unit: %

EFR: Early Failure Rate (EFR) is calculated in ppm at accelerated electrical life stress condition from Short Term Monitoring and correlates to cumulative failures within first year in the field.

Unit: ppm

LFR: Long Term Failure Rate (LFR) is calculated in FIT at ambient temperature, generally $T_{amb}$ = +55°C

Unit: FIT

FIT: Failure In Time (FIT) is calculated from electrical life tests performed at maximum junction temperature for 1000 h or 2000 h.
TEMIC generally uses a calculation with an activation energy E = 0.6 eV and a 60 % confidence level for FIT values at ambient temperature $T_{amb}$ = +55°C. Calculation is based on ARRHENIUS Model and Chi$^2$ Distribution.
For specific failure modes calculation must use the related activation energy. (See chapter 9.4 and 9.5 using an activation energy of $E_a$ = 0.8 eV for failure mode degradation.)

Unit: $10^{-9}$/h

## 9.4 Failure rates: FIT

Failure rates and MTTF (mean time to failures) values can be calculated from test results.

$$Observed\ failure\ rate\ \lambda = \frac{Number\ of\ failures}{test\ duration \times number\ of\ components\ in\ hours}$$

The failure rate $\lambda_{60\%}$ means that with a probability of 60% the failure rate λ in the field will be below $\lambda_{60\%}$.

$\lambda_{60\%}$ = 300 FIT thus means that the failure rate of the device will, with a probability of 60%, not be greater than $300*10^{-9}$/h at a given junction temperature.

In many cases, the reliability of components is documented in the form of MTTF values. MTTF is the mean operating lifetime.

If the failure rate λ is constant, there is a simple relationship

$$MTTF = 1/\lambda.$$

In the lifetime tests, test conditions are selected such that the maximum permissible junction temperature exists in the test object. The junction temperature, which is determined by internal heating and the ambient temperature, has a dominant effect on the reliability of a component. The effects of temperature on the component failure rate are shown in figure 9.4. 0.8 eV is a typical failure activation energy $E_a$ for optical transmitters. Under normal operating conditions, the junction temperatures are considerably lower than $T_{jmax}$ which means that the failure rate is also considerably reduced.

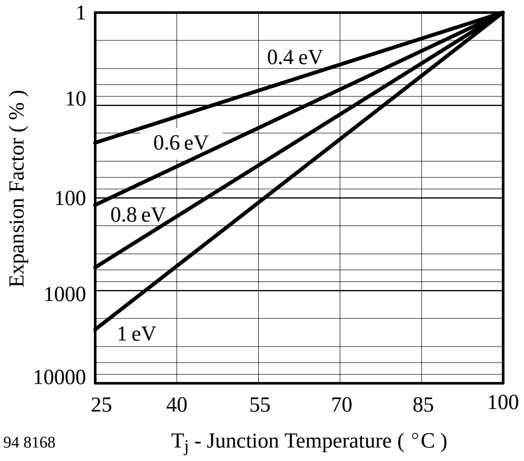


Figure 9.4 Expansion factor for degradation

**Example**

In an electrical lifetime test at $T_j$ = 100°C, a failure rate of $\lambda_{60\%} = 1 \cdot 10^{-7}$ 1/h was determined for an IRED.

If, however, this component is operated at $T_j$ = 55°C, the failure rate is reduced by the factor 40 (expansion factor from figure 9.4).

At this working point, a $\lambda = 2.5 \cdot 10^{-9}$ 1/h has to be expected, corresponding to a failure rate of 0.00025% per 1000 operating hours or 2 to 3 FIT.

This example clearly shows how operating temperatures can considerably reduce expected failure rates.

## 9.5 Degradation of IREDs

The diagrams in figure 9.5 and figure 9.6 are based on electrical life tests, calculated with $E_a$ = 0.8 eV at $T_j$ = 25°C.

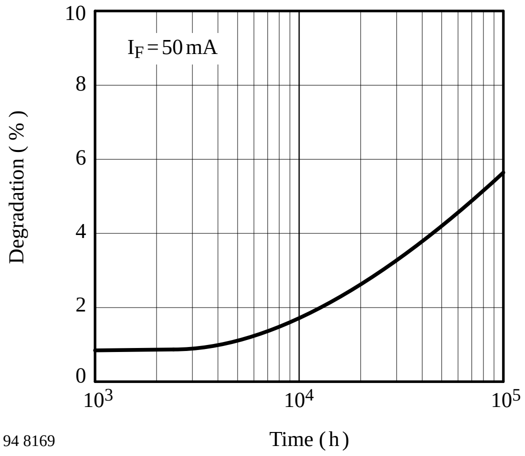


Figure 9.5 Average degradation of TSUS 5.

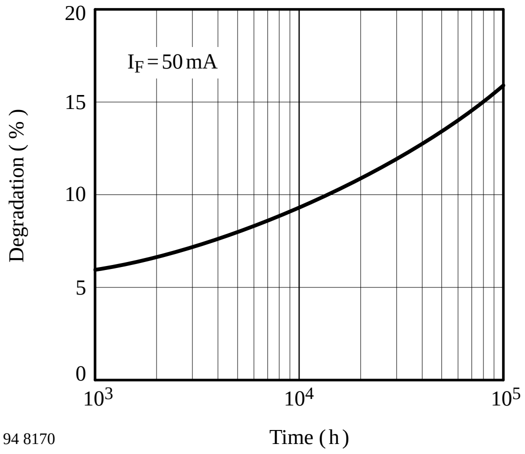


Figure 9.6 Average degradation of TSHA 5.

## 9.6 Safety

### 9.6.1 Reliability and safety

All semiconductor devices have the potential of failing or degrading in ways that could impair the proper operation of safety systems. Well-known circuit techniques are available to protect against and minimize the effects of such occurrences. Examples of these techniques include redundant design, self-checking systems and other fail-safe techniques. Fault analysis of systems relating to safety is recommended. Environmental factors should be analyzed in all circuit designs, particularly in safety-related applications.

If the system analysis indicates the need for the highest degree of reliability in the component used, it is recommended that TEMIC TELEFUNKEN microelectronic be contacted for a customized reliability program.

### 9.6.2 Toxicity

Although gallium arsenide and gallium aluminium arsenide are both arsenic compounds, under normal use conditions they should be considered relatively benign. Both materials are listed by the 1980 NIOH ”Toxicology of Materials” with $LD_{50}$ values (Lethal Dosis, probability 50%) comparable to common table salt.

Accidental electrical or mechanical damage to the devices containing these IRED chips should not affect the toxic hazard, so the units can be applied, handled, etc. as any other semiconductor device. Although the chips are small, chemically stable and protected by the device package, conditions that could break these crystalline compounds down into elements or other compounds should be avoided.

### 9.6.3 Safety aspects of IR radiation

Light and IR emitting diodes are included into the scope of the laser safety standards IEC 825 or EN 60825.

In the safety standard IEC 825–1 obviously the effects of extended sources are not or not correctly considered. The German standardization committee has proposed an amendment for the correction of the evident misinterpretations in June 1994.

The user of IR-transmission should be aware of the possible risks of retinal damage. Because of the errors inside the standard (editions of the year 1993) users should contact their national standardization committees for getting the newest edition of the standard or, when not yet available, a statement for rating the potential of risk. The typical remote control and IrDA applications will not to be classified as a harmful application following the above mentioned German proposal.