Living Automotive Excellence
On the way to Zero Defect products and services
Infineon established the Automotive Excellence Program in 2003

**Goals:**
- Sustainable quality improvement
- Zero Defect Culture

**Measurables:**
- Decrease of number of customer returns and quality spills
- Increase of customer satisfaction

**Improvement Examples:**
- Advanced Process Control
- Excellent Requirement Management

**Our target of ZD is your competitive advantage:**
- No quality events
- Defect-free product launches
- Low non-conformance costs
- Highest quality image in your market
- More business due to satisfied customers

Our quality is clearly seen as industry benchmark by almost all of our customers
Content

- Motivation for “Zero Defect”
- Infineon “Automotive Excellence Program”
- Our Zero Defect Culture
- First Time Right in Product Development (examples)
- Excellence in Front End Wafer Production (examples)
- Excellence in Backend Production (examples)
- Our Quality is industry benchmark
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Living Automotive Excellence

- to create a competitive advantage through excellent quality
- to exceed your quality expectations
Zero Defect products to guarantee the highest safety possible

1 ppm (1 defective part per million) is close to Zero Defect. Would 1 ppm not be enough?

To guarantee highest safety, we need Zero Defect.

*ECU: Electronic Control Unit
Customer Returns = FARs

failure cause of Airbag ECUs (0 km-/Field)
up to 90% caused by supplier of electronic components (Semiconductor)

In the automotive industry each failing device comes back to the supplier as a Customer Return or Failure Analysis Request.
Why invest in Zero Defect Supply Chain?

Example: Cost Explosion in case of a supplier quality event

- Failure analysis: $10,000€
- Failure analysis: $50,000€
- Cost of Scrap: $100,000€
- Cost of Overtime: $1,000,000€
- e.g. 1 day linedown
- Controlled shipping: $1,000,000€
- e.g. recall of 10,000 cars: $10,000,000€
Motivation: Why zero defect?

Reliability in cars: A question of life or death!
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Automotive Semiconductors
Commitment leads to success

Reliability through experience:
High quality products and services for the automotive industry for 40 years

Innovative product portfolio covering the complete control cycle:
From sensing over computing to actuating

System expertise with broad application competence:
Powertrain, Safety Management, Body & Convenience

Automotive Excellence:
Most comprehensive quality program in the industry

Market leader in automotive semiconductors:
No. 1 worldwide, No. 1 in Europe, No. 2 in USA,

(Source: Strategy Analytics)
Quality and safety of electronics demands a well-balanced co-operation of all involved parties.
Automotive Excellence Program Setup
Responsibility and Accountability in the Line Organization is key for a successful program

Sponsor
Dr. Reinhard Ploss
Jochen Hanebeck
Claus Geisler
Michael Seitz

Program Manager
Alexander Müller

Project Office: Dr. G. Mauckner (ATV)
Dr. C. Zeller (Production)

Steering Committee
Automotive Division Board and Operation Board

Business Lines

Standard Power
F. Schwertlein / L.A. Past

Cluster Zero Defect Initiatives
A. Heitzer

Powertrain Safety & ASICs
A. Doll / W. Glawischnig

Frontend
Dr. H.D. Loewe
Dr. M. Polzer

Body Power
T. Fitzek / K. Jauck

Assembly & Test Power
K.T. Ng
C.H. Yang

Microcontroller
P. Schäfer / R. Petter

Assembly & Test CMOS
W.T. Gan
Ch. Chan

Sense & Control
S. Hofschen / Dr. I. Trapp

Electric Drive Train
M. Muenzer / Dr. Eschbaumer

Support Functions

Power Technology Platform
T. Gutheit

Advanced Technology Management
A. Rahm

Supply Chain Management
S. Wollenberg
M. Stegherr

Sales & Marketing & Distri.
A. Müller

OEM Business Development
C. Preuschoff

Quality Management
A. Müller
C. Zeller/G. Mauckner/ E. Palmeda
Automotive Excellence has goals and measurables

**Goals**

- Sustainable quality improvements by running projects and continuous improvement actions
- Growing towards a Zero-Defect Culture

**Measurables**

- Decrease of number of customer returns (FARs) and quality spills
- Increase of customer satisfaction (feedback & ratings)
Our Zero Defect Policy

• Zero Defect is a strategic mindset

• Zero Defect is . . .
  - embedded in our business processes,
  - driven by our people, and
  - stimulated by personal senior management leadership

• Zero Defect mindset means ...
  - No compromise on quality
  - No deviations from our commitments
  - Fast reaction on deviations
  - Excellence in Problem Solving – no reoccurrences

We bring Zero Defect to Reality. Be part of it.
Project Management @ Automotive Excellence

- **Dedicated project structure** with representatives...
  - of all business lines, logistics, technology development and sales of the Automotive Division
  - of all production units

- Almost 6 years, more than **200 Sub-Projects** from all areas with an active participation of more than **1000 Employees**

- **Methodology:**
  - a systematic structuring of the projects according to the „4P – approach“ into the 4 pillars „**Products, Production, Processes, People**“ guarantees an holistic approach
  - Consequent project management for our activities
  - Review Meetings on working and management level
  - Program KPI Reviews
Automotive Excellence Program
Embracing all sites and lines worldwide

**Enablers**
- To establish and staff a dedicated AEX organization
- Consequent Project Management
- Regular Zero Defect review at sites / segments
- Quality Spill reviews

**Relevant Production Sites**
- Frontend (FE): Regensburg, Villach, Kulim, Dresden
- Backend (BE): Regensburg, Singapore, Batam, Malacca, Wuxi, Warstein

**Relevant Automotive Business Lines**
- Microcontroller
- Powertrain Safety & Asics
- Sense & Control
- Electric Drive Train
- Standard Power
- Body Power
Examples of automotive quality measures implemented along the semiconductor value chain

- Requirement Management
- FMEA and Risk Management
- Enhanced Simulation & Characterization
- Advanced Process Control, no rework
- Intelligent Outlier Screening (SBA, PAT, ..)
- Forward & Backward Traceability

Customer and Supplier → Specification → Product Development

Qualification Technology (FE, BE) → Product

Frontend → Backend → Electrical Test → Logistics

Automotive Excellence

Design for Quality, Design for Reliability, Design for Manufacturability, Design for Test

Design for Testability, Test coverage

FMEA, Risk & Deviation Management

Zero Defect Culture

Success is enabled by cross functional approach
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Our Way to a Zero Defect Culture
Your satisfaction has utmost importance

Full Management Commitment

Zero Defect Event Day

5S/Fuguai Program

Error Proofing

Zero Defect Training

Zero Defect Poster Campaign

Internal Audit

Quality Bonus

Zero Defect Culture
Zero Defect Culture - Change of mind set is the key enabler to achieve our goals

Who is able to contribute to success will be proud of it

Source: IFX, AEP Consultant
Dear Colleagues,

We warmly invite you to our AIM Quality Day under the motto 'Get into Dialog' on **Tuesday, April 15, 2008, starting at 4 p.m.**

Together we’ll be celebrating five years Automotive Excellence Program. The afternoon will be centered on dialog with you. The various facets of 'Zero Defect – Zero Deviation from Requirements' will be explored in panel discussions, followed by in-depth debate in small rounds.

We’ll be welcoming **Ernst Schmidt, Head Semiconductor Platforms & Technology Electronics BMW Group** in Munich as our guest. His talk will give insight into requirements management in the automotive industry and its significance for semiconductor manufacturers.
Zero Defect as Key for our Future Mindset

**Target:**
Highest awareness of all employees on quality and customers expectations

**Actions:**
- Employee's training
- Target group oriented information given by managers
- Poster advertising
- Article in employees magazine
- Zero Defect exhibitions
Zero Defect Exhibitions at OPP FE

Regensburg and Villach
Abnormality Management System
We work to remove abnormality before it turns into defect

What is abnormality?

**Abnormality = Fuguai**

- **Not at standard condition**
- **Different from the normal state**
- **Any Difference in Sound, Color, feeling of Touch, Smell, Speed**

Prevent future occurrence of abnormality

Eliminate root cause

Analyze and Identify root cause

Identify focus areas

Process? Equipment? Productivity?

Human factor? Poor design? Incoming Material? Handling Procedures?

Examples of Fuguai ........

- Wafer Colour Variation
- Water on the floor
- Grounding Wire Not Secured
- Tower Light Faulty
Sustainable problem solving: No Reoccurrence

- We follow the 8D (8 disciplines) systematics
- We focus on 7.D: Permanent corrective actions and standardization
- Systematic rollout of solutions to all relevant fabs and sites
- Longterm follow-up of preventive actions within Automotive Excellence Program

1D: Team
2D: Problem verification
3D: Containment action
4D: Root cause analysis
5D: Corrective action and verification
6D: Implementation of corrective action
7D: Prevention
8D: Congratulate Team
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Excellent requirement management to ensure perfect fit for customer’s application

An excellent data sheet is required to develop an excellent product that fits your application.
Motivation for Data Sheet Excellence
Example of critical wording: Short Circuit Protection

General Description

- N channel vertical power MOSFET with charge pump, ground referenced CMOS compatible input and diagnostic feedback, monolithically integrated in Smart SIPMOS® technology.
- Fully protected by embedded protection functions

„Fully protected“ : What does it mean ?

Customer Impression: „Indestructible“

But:

- Protection functions are not meant for repetitive operation
- Depending on conditions any device can be damaged
Improved Version

• Detailed description of Short Circuit protection feature
• Description of the Influence of inductance and resistance
• Showing the limits of the feature
Tasks

- Review existing Data Sheets
- Create a guideline for writing Data Sheets
- Update the AP Data Sheet Template
- Define a release process for Data Sheets
- Roll-Out of guideline and release process

The Data Sheet Excellence Team is:
- Tobias Otter (AIM AP M AE)
- Günter Schwarzberger (AIM AP M AE)
- Andreas Kiep (AIM AP M AE)
- Jürgen Kositza (AIM AP M AE)
- Gunther Krall (IFNA AI)
Data Sheet Guideline
A guideline how to write a data sheet

- Absolute Maximum Ratings
- ESD Definition
- Thermal Resistance
- Operation Range
- Short Circuit
- Functional Description
- Electrical Characteristics
- Application Diagram
- Legal terms
Only products with proof of design quality

Customer Requirements

Data Sheet

Generic verification, validation plan

Experiments

Your advantage: Each of your requirements is reliably fulfilled

Stringent flow from requirements to simulation and lab measurement

Spec compliance due to full traceability and completeness of requirements

Reuse for simulation and lab verification

Automation in simulation/lab characterization and documentation
Our products are robust in automotive environment

Infineon OptiMOS™

No delamination even after 260° C preconditioning and 1000TC with robust package
(TC = Temperature cycles)

Package chip

100% adhesion

Delamination

4 different competitors

Total delamination already after 260° C preconditioning (red areas)

Your advantage: High reliability in the field
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### Examples of Automotive Excellence Projects

- No rework
- Advanced Process Control wafer fab
- Advanced Process Control assembly
- Via testchip and redundant vias
- R2D2: Reliability Related Defect Density
- Intelligent outlier screening
Due to our ‘No rework’ principle we deliver first-time-right products

No Rework in Front End and Back End Production

A Zero Defect principle

Our engineers focus on process stabilization

Wafer flow in production interrupted due to process instabilities and rework

Smooth and stable production flow without interruption

Your advantage: You receive first-time right products
Excellence in Production

- Examples of Automotive Excellence Projects
  - No rework
  - Advanced Process Control wafer fab
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  - Intelligent outlier screening
With Advanced Process Control we realize deviations before they affect the product.

**APC Advanced Process Control:**
Real-time monitoring of key process parameter

- Equipment control: temperature, etching rate, deposition rate, contamination.....
- Process control: metal thickness, resist line width, metal line width, optical inspection

**SPC Statistical Process Control:**
Control Limits and Process Capability cpk
**Equipment Integration + Fault Detection & Classification**

### Tool Integration Milestones

<table>
<thead>
<tr>
<th>Stage</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>Specification agreed &amp; Characterization done</td>
</tr>
<tr>
<td>T2</td>
<td>Tested in Simulation</td>
</tr>
<tr>
<td>T3</td>
<td>Tested with Equipment</td>
</tr>
<tr>
<td>T4</td>
<td>User Acceptance</td>
</tr>
<tr>
<td>T5</td>
<td>FDC tested and accepted</td>
</tr>
<tr>
<td>T6</td>
<td>Rollout to all tool instances</td>
</tr>
<tr>
<td>T7</td>
<td>Stability run</td>
</tr>
<tr>
<td>T8</td>
<td>Final acceptance</td>
</tr>
</tbody>
</table>

In principle available from T5  
Operatively available from T8

### Fault Detection and Classification

<table>
<thead>
<tr>
<th>FDC Stage</th>
<th>Status</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>NO USAGE</td>
<td>PDA is not ready.</td>
</tr>
<tr>
<td>1</td>
<td>PDA AVAILABLE</td>
<td>PDA is ready and accepted based on specification.</td>
</tr>
<tr>
<td>2</td>
<td>KN SETUP</td>
<td>Simple Keynumbers are set in Config</td>
</tr>
<tr>
<td>3</td>
<td>MONITORING</td>
<td>Keynumbers are build in Config; Systematic usage of APC trend. (includes LFA)</td>
</tr>
<tr>
<td>4</td>
<td>OOCAP</td>
<td>Systematic usage of APC Trend. Limits are set, reaction on violations during office hours. (EQ FMEA required)</td>
</tr>
<tr>
<td>5</td>
<td>MESSENGER</td>
<td>Same as &quot;4&quot; additional MESSENGER is switched on.</td>
</tr>
<tr>
<td>6</td>
<td>AUTO STOP</td>
<td>Same as &quot;5&quot; additional LH, INL and/or Tool Stop is switched on.</td>
</tr>
<tr>
<td>7</td>
<td>CONTINUOUS IMPROVE MENT</td>
<td>Constant usage of FDC for continuous improvement, e.g. Cpk, yield, scrap. Automatic stop reactions are set on 100% of FMEA requested Keynumbers.</td>
</tr>
</tbody>
</table>

**Definitions**

- **Equipment Integration**
- **Fault Detection and Classification**
- **PDA** = Process Data Acquisition

**Living FDC**

PDA = Process Data Acquisition
APC Road Map and Status Sept. 2008
RBG + VIH

**RBG**
- Overall FDC stage slightly above target

**VIH**
- FDC stage on target
- CR due to EI reasons (e.g. EI of ASM) and parameter availability from tool (e.g. RCD Litho)

Quelle: K. Forster
Achievement:
Weekly APC Violation Review Meeting

Pareto Analysis:
Key numbers with most violations

detailed analysis of single violations

<table>
<thead>
<tr>
<th>EQUIPMENT</th>
<th>BATCHID</th>
<th>LIMITID</th>
<th>FEATURENAME</th>
<th>MSG_ACTIVE</th>
<th>INHIBIT_ACTIVE</th>
<th>HOLDLOT_ACTIVE</th>
<th>TOOLSTOP_ACTIVE</th>
<th>DATUM</th>
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<tbody>
<tr>
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<td>2866566</td>
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<td>1</td>
<td>0</td>
<td>0</td>
<td>21.01.2008</td>
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</tbody>
</table>

Detailed analysis and reporting:
Top 3 work centers per Area => key numbers with according equipment/recipe, defined action, status and due date
weekly limit violation review meeting with key user / UPS running since March 2008
Result of APC:
Continuous increase of process stability

<table>
<thead>
<tr>
<th>Cpk fulfillment [%]</th>
<th>Kulim</th>
<th>Regensburg</th>
<th>Villach</th>
<th>Perlach</th>
</tr>
</thead>
<tbody>
<tr>
<td>50%</td>
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<td>55%</td>
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<td>95%</td>
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<tr>
<td>100%</td>
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</tr>
</tbody>
</table>

- *Target for green process steps < 100% as continuously new processes are implemented*
## Excellence in Production

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  - Intelligent outlier screening
APC (advanced Process Control) means we act on process deviations online, preventing deviations of the product.
We invent innovative methods to detect deviations in the assembly fabs

Together with the tool vendors we develop sensors to measure tool parameters that are critical for the result of the process step.

**Wafer Sawing:**
- Spindle speed
- Cutting speed
- Cutting force

**Wire Bond:**
- Bond Force
- Bond Power
- Temperature

**Moulding:**
- Speed
- Position
- Temperature
- Transfer Pressure

**Trim & Form:**
- Acoustic signals
Excellence in Production

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With via testchip and via doubling for µCs we came close to Zero Defects for via-related fails.

On a typical C11 chip there may be more than 10 million vias.

With our innovative via testchip and via doubling we reach a defect level for via related fails that is close to zero!
What is via – doubling?

Automatic routine doubles vias, wherever possible.
R2D2 Test Chip – Overview

- 8 inch wafer
- 68 chips
- 12 wspw

- 4 blocks with 34 arrays (40% of area)
- other structures

- 512x512 vias per array
- Each via is addressable

Overall: About 3.2 billion contacts/vias

Concept
- Measuring
- Analysis ⇒ Yield Improvement
- Stressing
- Measuring
- Analysis ⇒ Reliability Improvement

- contact holes (CA)
- all Via levels (till VQ) connecting thin wires
- all Via levels connecting fat wires
- stacked Vias
- misaligned Vias
- design rule variations
- short Via chains
### Excellence in Production

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R2D2: Reliability Related Defect Density
Focus not only on yield -, but on reliability related defects

An essential contributor to ppm reduction is the continuous reduction of defects with impact on reliability

The continuous downward trend of ppm rates is the result of numerous activities:

Detection of single defects

Pareto analysis

Root cause finding

Root cause elimination

One after the other...
Result of R2D2:
Continuous reduction of ppm rate
### Excellence in Production

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Highest outgoing product quality by intelligent outlier screening

Intelligent PAT* Screening

under SBA** control

with Pattern Recognition

*PAT: Part Average Testing; **SBA: Statistical Bin Analysis
Implementation of PAT in automotive wafer fabs

High Volume, Automotive (12,42,58)

Implementation level all: 88 %
Implementation level suitable: 100 %
Motivation for “Zero Defect”

Infineon “Automotive Excellence Program”

Our Zero Defect Culture

First Time Right in Product Development (examples)

Excellence in Front End Wafer Production (examples)

Excellence in Backend Production (examples)

Our Quality is industry benchmark
Automotive Product Quality (0km + Field)

0.95 ppm

-76%

0.23 ppm

Production Year
Our customers appreciate our results


„Honor Quality Award Toyota Hirose“ received in 2010 for zero defect quality for last four years. Infineon is the First non-Japanese company that received this honour in this highest level category.

“Automotive Supplier of the Year 2009“ and “Supplier Performance Award“ for the Year 2008

German “TOPIT Award” for the year 2008 for the Automotive Excellence Program

“Hitachi Quality Award” for the year 2006 for achieving customer satisfaction

“Bosch Supplier Award” for the years 2005 and 2006
Automotive Excellence is the differentiator for your business success

- Excellent Requirement Management
- Intelligent Outlier Screening
- Zero Defect culture
- Product Robustness
- No Rework
Infineon’s Automotive Excellence Program is your competitive advantage

Our Quality is clearly seen as industry benchmark by almost all of our automotive customers.

Our target of Zero Defect means for you:
- no quality events
- defect-free product launches
- automotive product quality of 0 defect parts per million
- low non-conformance costs
- highest quality image in your market
- more business due to satisfied customers.
and finally ...
Please visit our Automotive Excellence Webside

Homepage Hyperlink:

Living Automotive Excellence – no compromise when it comes to quality - Infineon Technologies

E-Learning Hyperlink (Flash Player):

Infineon Technologies – Living Automotive Excellence
"If there's a way to do something better, I'll find it."

Thomas Edison (1847-1931)