QUALITY ASSURANCE FROM A-Z

› Supplier / Component Qualification
› Product Design
› Verification of Quality and Reliability performance

› Handling of incoming material
› Supplier Follow up
› Manufacturing

› Improvement work
› Traceability
› PCN – Product Change Notification
› Handling of customer claims

Product Development
Supply Chain
Supporting Activities
SUPPLIER / COMPONENT QUALIFICATION

PRODUCT DEVELOPMENT
QUALIFICATION

› Technical Performance
  - Design responsible evaluates if the component complies with our design requirement and specifications

› Total Cost evaluation considering the following parameters:
  - Result of Technical performance evaluation
  - Supplier performance (capability in quality, delivery & flexibility)
  - Storage (handling, capital cost etc.)
  - Purchase price
  - Available Capacity and flexibility for changing volume
QUALITY AND RELIABILITY PERFORMANCE

› Supplier and component qualification according to Ericsson quality specification (10563-2031)
› 100% component validation in application
› Additional qualification tests can be done on component level, e.g.
  - Voltage break down tests to investigate the limits of a component
  - Temperature stress test
PRODUCT DESIGN

PRODUCT DEVELOPMENT
PRODUCT PROJECT TIME

- Prototype run
- 50% of project time
  70% of work load
- Final Design Verification
- Test & Qualification
- UL safety approval
- Release
Ericsson Power Modules has been using the concept of **Product Life Cycle Management** (PLCM) since many years. This incorporates

- Design for Environment (DfE)
- Design for Reliability (DfR)
- Design for Manufacturing (DfM)
- Life Cycle analysis

All these aspects of the product design process are secured by a Quality Assurance plan where cross functional teams* evaluate the design from different aspects at predefined Tollgates in the development process.

All product development projects are based on the same quality assurance plan.

*) Electrical design, mechanical design, layout design, production, sourcing and product management
QUALITY ASSURANCE PLANS

› Secure product development quality regarding performance, price, time schedule and outgoing quality
› Clear product development process flow
› Documented activities to ensure product development quality and final product quality
› Quality assurance plans are under the authority of the unit Quality Manager
› QA-plan provided upon request
The purpose of the verification is to ensure that the products meet the necessary quality, performance and manufacturability requirements.

The product verification process includes documented test results, measurements or other reports to show the products compliance to:

- **Quality** requirements
- **Functionality** and **performance** requirements
- **Manufacturability** requirements
- This process is also used for product re-qualification and monitoring
QUALITY SPECIFICATION

Each product family has specified requirements for:
› Electrical performance
› Mechanical performance
› Visual appearance
› Environmental durability
› Operating reliability

EACH PRODUCT FAMILY MUST BE APPROVED ACCORDING TO QUALITY SPECIFICATION BEFORE RELEASE
PRODUCT VERIFICATION IN STEPS

› Design reviews throughout the project
› Designers verification
› Strife test
› Prototype and Final verification
› Worst case and stress analysis
› Risk analysis (FMEA)
› Qualification (Reliability and Environmental)
› Manufacturing pre-series and pilot series (evaluated by both design and manufacturing e.g. Cpk, yield, producibility)
› Reliability prediction
DESIGN RULES

› The purpose of design rules is to secure product robustness and reliability, and to ensure a cost efficient solution

› It is based on the collected experience from more than 30 years of design and manufacturing of high reliability board mounted power products

› Design rules are supported by:
  - De-rating for high reliability and robustness
  - Preferred components and supplier list
  - Printed board layout principles and design procedures
PRODUCT QUALIFICATION TESTING EQUIPMENT

In-house resources:
› Parameter measurement equipment
› Temperature cycling
› Damp heat (85°C / 85%RH)
› Sinusoidal vibration
› Random vibration
› Bump
› Shock
› Termination mechanical strength

› MSL testing
› Resistance to soldering heat
› Solderability
› Storage test
› Operational life time tests – Power cycling – max values
› Operation in cold / heat
› HALT/HAST – test chamber
VERIFICATION OF QUALITY AND RELIABILITY PERFORMANCE

PRODUCT DEVELOPMENT
Ericsson Power Modules Reliability Assurance team establishes qualification systems that guarantee the quality and reliability of our products, processes, and suppliers. This establishes a proactive presence early in the product development cycle and provides feedback regarding reliability performance of product families and processes for early design considerations.

Reliability calculations are made on all product series using Telcordia SR-332.
HANDLING OF INCOMING MATERIAL

SUPPLY CHAIN
INCOMING MATERIAL

The ambition is to only have suppliers that meet our requirements and secure quality direct at their own processes. We audit our suppliers and follow up of delivered material.

Process

Incoming material

Ship To Stock-material to warehouse - Qualification for STS is done according to Step-down-model

Incoming quality inspection is performed for new components or when a component problem occur. Sample based evaluation of selected parameters, both electrical and mechanical, according to AQL

All material checked regarding: Package, Quantity and Product

Receiving of material
The flammability rating for all construction parts meets the requirements for V-0 class material according to IEC 60695-11-10.

Incoming material data is stored in a database (SAP/R3) to keep track of status of all material.

If a problem is found, regardless of present level and where the problem is found, the sample size goes back to normal.
SUPPLIER FOLLOW UP

› Suppliers and supplied material are monitored in the following areas:
  - Quality
  - Delivery performance
  - Lead time
  - Service

› Supplier Quality Assurance Plan, SQAP, and audits are ongoing activities to improve performance of selected suppliers. SQAP is a method developed by Ericsson with the purpose to develop supplier performance

› Suppliers get feedback on a regular basis
MANUFACTURING

SUPPLY CHAIN
GENERAL

› Management system, MS
› Document system – Eridoc
› Business system, Product and logistic management – PRIM, ELIZA, SAP, RMA
› Production management system – Eristat
› Production Analysis – Statbase, Test Mgr
› Statistical Process Control – PM SPC
› Manufacturing system – Erimat, Eritrim, Eriburn/Analysis, EMpower
› Traceability system – Eristat/Pacman
› Corrective/Improvement action follow up system

SAME COMPUTERIZED SYSTEMS USED BY ERICSSON POWER MODULES FACILITIES ALL OVER THE WORLD
QUALITY ASSURANCE PLANS

› Quality assurance plans are used to secure outgoing quality
› Quality assurance plans are under the authority of the unit Quality manager
RELIABILITY STRESS SCREENING

› 100% RSS (Reliability Stress Screening) capability

› 100% failure analysis to find root cause and do corrective action

› 100% registration of time to failure
TYPICAL RSS DATA

› Duration: 3 h to 12 h
  – Method for reducing RSS time based on IPC-9592A
› Power cycling with load
› Temperature cycling by power cycling
› Max input voltage
› Temperature equal to absolute maximum rating of the product
PRODUCT QUALITY

› Front end of production, including assembly and soldering process, use Automatic Optic Inspection equipment (AOI):
  – DPMO: 50 ppm
› Back end, including all electrical testing and RSS:
  – First pass yield > 97%
› Field failures, reported by customers:
  – Below 100 ppm

WE KEEP TRACK OF THE YIELD THROUGHOUT THE PRODUCTION PROCESS
IMPROVEMENT WORK

› Proactive approach
  Identify a problem in an early stage using alarm triggers

› Statistical methods
  – Visualize potential problem areas and solve the problem before it happens (for example nozzle, head, feeder, material)

› Escalation process
  – Utilize SMS to escalate problem to the correct function automatically and immediately
ON-LINE FOLLOW UP OF STORED DATA

› Visual inspection (IPC-A-610-criteria) and electrical and mechanical failure analysis result stored in central data base accessible from all units within the company

› Product parameter values and SPC data from critical processes stored in local data base for follow up on all product parameters from electrical testing (statistical tools included in software, e.g. Cpk, distribution, etc.)

› Regularly meetings to follow the progress of the improvement work
Example:

Process Capability Analysis Parameter Level

Product: XXX
Order: 105035860
Week Code: YYWW
Process: Final Test
Parameter: Output voltage1 Nom Max

Process data:
- LSL = 5.13000
- USL = 5.17000
- Target = N/A
- Mean = 5.14969
- StDev = 0.00219

Capability:
- Cp = 3.0
- Cpk = 3.0
- Ca = -0.8
- Z = 9.0

ON PRODUCT LEVEL EACH PARAMETER IN ALL TEST EQUIPMENT CAN BE FOLLOWED ON LINE. TRENDS ARE FOLLOWED, BOTH FOR NEW DESIGNS AND IN NORMAL PRODUCTION
QUALITY ASSURANCE

SUPPORTING ACTIVITIES
BUSINESS CONTINUITY PLANNING

A security and risk management system is in place to take care of different security issues. Business Continuity Management includes Business Continuity Plans (BCP). The plan includes a number of identified possible scenarios with Business Interruption Analysis (BIA) and supply chain risk mapping.
We secure operational excellence by managing small and large improvements in a consistent, effective and uniform way, taking into consideration the two typical elements within an improvement or change process:

**Operational improvement** and **Behaviour change**

The first can be a process change and the second the implementation of that new process.
WAYS OF WORKING

› Everyone contribute to achieve operational excellence
› Active work with supplier improvements
› Design for manufacturing concept includes close co-operations between Ericsson Power Modules and customers from the first design to the final product
› Quality Assurance in the product development processes
› Quality Assurance in the production processes

ALWAYS DELIVER FULLY FUNCTIONAL PRODUCTS
MANAGEMENT INVOLVEMENT

Management involvement in the improvement work is a guarantee for efficiency of the process

Everyone needs to be aware of the quality aspects and how they are integrated in our daily work and

Line Managers Responsibilities

› Communicating and implementing Ericsson Group Management System
› Meeting business objectives through effective use of established processes
› Ensuring that business and process measurements are implemented to sustain the organization’s process capabilities
SHARED RESPONSIBILITY

› Process owners
  - The process owners are responsible for providing the line organization with appropriate processes. This includes defining and documenting the process, its measurements and controls, as well as necessary support systems, training methods and tools. It also includes managing process improvements on the basis on performance measurements

› Project managers
  - The project managers are responsible for achieving the project objectives by managing schedule, budget, resources and quality in projects as defined in the assignment specification approved by the line organization

› Employees
  - The employees are responsible for using relevant parts of the management system, taking responsibility for the quality of their work, highlighting problem areas and supporting improvement activities
SIX SIGMA

› Training in using Six Sigma tools
  – Black Belts – Yellow Belts
› Focus on value added processes
› Control of variation
› Mental approach concerning the whole company
  – do the right thing right first time

We use Six Sigma methodology to make improvement work efficient, both internally and in the supplier improvement work.
We use different improvement tools in different stages in the improvement work.
SIPOC – Model is used when analyzing a process. Interfaces and internal customers need to be identified, for clear responsibilities.
FAILURE ANALYSIS

› Analysis of all failures coming from development, from production and customer complaints to identify the root cause
› Feedback for actions to concerned department or supplier
› Containment actions to prevent failing products to reach customers
› Close cooperation between involved functions, such as sales, design, production and sourcing
› 8D method used in both ends; customers and suppliers
TRACEABILITY

Incoming material
- Bar code identification of each item
- Part No
- Batch No
- Vendor
- Date code

Assembly
- Barcode information connected to production batch number

Electrical Test
- Transfer batch number and Test data into Database

Marking
- Marking of batch number

Delivery to Stock/Customer
- Enter batch number of products when shipping.
- Customer order number in database.

EACH PRODUCTION BATCH HAVE DETAILED INFORMATION
PRODUCT CHANGE NOTIFICATION (PCN)

Ericsson Power Modules has a documented **PCN** process according to JESD 46-C standard that includes the criteria used to classify the changes in major or minor change.

**PCR** (Product Change Request) initiates the change regarding Product and Process. The PCR is an investigation about the pre-requisitions for the change.

If the change adds value to the business the PCR will result in a PCN.
PRODUCT CHANGE NOTIFICATION
PCN ROUTINE – MAJOR CHANGES

PCR  14 days  PCN  30 days  PCN  60 days

Customer notification

Requested feedback. OK or not OK (no feedback is taken as OK)

Revision change
PRODUCT CHANGE NOTIFICATION
PCN ROUTINE – MINOR CHANGES

PCR  14 days  PCN  30 days  Customer notification  Revision change
### Handling of Customers Complaints

**Process**

<table>
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<tr>
<th>RMA</th>
<th>Goal: Within 1 work days</th>
<th>Goal: Within 15 work days</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Customer complaint</strong></td>
<td>Review and register RMA request</td>
<td>Improvement work</td>
</tr>
</tbody>
</table>

- Dedicated failure analysis group for fast response to customers
- Full product revision history on component level in database
- Customer claim database for full traceability on customer and product level
- Customer claim management in accordance with JESD671-A (RMA - Return Material Authorisation)

**AN IMPORTANT PART OF THE QUALITY IMPROVEMENT WORK IS TO LEARN FROM CUSTOMER COMPLAINTS TO FURTHER IMPROVE PRODUCT QUALITY**
## RMA PROCESS

<table>
<thead>
<tr>
<th>Step</th>
<th>Urgent</th>
<th>Standard</th>
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<tbody>
<tr>
<td>Problem verification</td>
<td>2 days</td>
<td>4 days</td>
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<tr>
<td>Containment</td>
<td>3 days</td>
<td>7 days</td>
</tr>
<tr>
<td>Root cause analysis</td>
<td>7 days</td>
<td>16 days</td>
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<tr>
<td>CA Plan</td>
<td>9 days</td>
<td>23 days</td>
</tr>
<tr>
<td>Action implemented and verified</td>
<td>ASAP</td>
<td>ASAP</td>
</tr>
</tbody>
</table>

*Notice: The times are cumulative*

FAILURES ANALYSIS AND CORRECTIVE ACTIONS PROCEDURES IS IN ACCORDANCE WITH JEDEC STANDARD JESD671-A