



# QUALITY ASSURANCE MANUAL

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# **LATTICE SEMICONDUCTOR PRINCIPLES**

## **QUALITY POLICY**

Lattice is committed to Industry Leadership in the supply of high performance programmable logic components and software design tools. We strive for customer satisfaction through on-time delivery of innovative products with the highest levels of quality and reliability. Lattice drives continuous improvement within our organization and our suppliers to insure world class performance to our customers. We will always work to insure compliance of our quality systems with the requirements of our customers, ISO9001, and relevant industry regulations.

## **ENVIRONMENTAL POLICY**

Lattice is committed to conduct business in a manner consistent with the efficient use of resources and materials, and the preservation of the natural environment. We achieve reduced space, material and power consumption per electrical function with successive product generations. We minimize the use of hazardous materials, recycle where practical, and meet all applicable environmental laws and regulations. Our wafer fab and assembly contract partners are ISO14000 certified.

# QUALITY SYSTEM INTRODUCTION

This manual defines the Quality Program requirements of Lattice Semiconductor Corporation. It is based upon and complies with the following industry standards:

- ISO9001:2015 - Quality Management System Requirements.
- For automotive products - Technical Specification (IATF 16949) – Particular Quality Management System Requirements for the Application of ISO9001:2015 for Automotive Production and Relevant Service Part Organizations. There are no Lattice Quality system exclusions to IATF 16949 requirements for automotive product.

This manual serves as the primary document directing all quality provisions of the product delivery system. It also provides answers to the questions most frequently asked by our customers and can be used as an efficient, top down auditing tool of the Lattice quality system.

## Planning

Lattice utilizes a Strategic Long Range Plan (SLRP) planning process using linked teams that annually review to drive the major strategic corporate initiatives. Technologies, capabilities, operational infrastructure and business environment are included in the assessment. Key parties – Business Partners, suppliers, customers / users, competitors, substitutes, new-entrants and regulatory agencies – are considered in the business environment.

Technology building blocks and the relevant capabilities are key inputs into the roadmap and business plan. Linked cross functional teams are employed in the planning process. Strengths, weaknesses, opportunities and threats are addressed. The output of the SLRP process is reviewed with the Lattice Executive Leadership Team (ELT) and Board of Directors

An Annual Operating Plan (AOP) is derived based on the outputs from SLRP. This includes financial forecasts for the next year and department level resourcing and spending budgets. Progress to our AOP and continued performance monitoring to our SLRP is tracked in forums such as Business Operations (Biz Ops), Strategic Business Meeting (SBM), and Program Operations (Program Ops). These forums consist of Lattice ELT members and other key contributors who present regular updates on our performance to plan.

Lattice ELT use management by objectives (MBO) system to manage the company's yearly objectives across the company. This insures plans and commitments are executed.

## Management Review

This manual and the quality system it describes are reviewed annually by management to assure ongoing suitability and effectiveness. This annual review consists of two items:

1. A formal system review delivered to senior management by the Lattice Management Representative each year.
2. The Lattice Corporate Quality Audit Process is performed annually in calendar Q3 and reviewed by Lattice Management Representative and the Quality Improvement Team.

Additional periodic reviews are held among functional groups to measure progress to quality, operational, and development objectives. The description of these meetings follows below:

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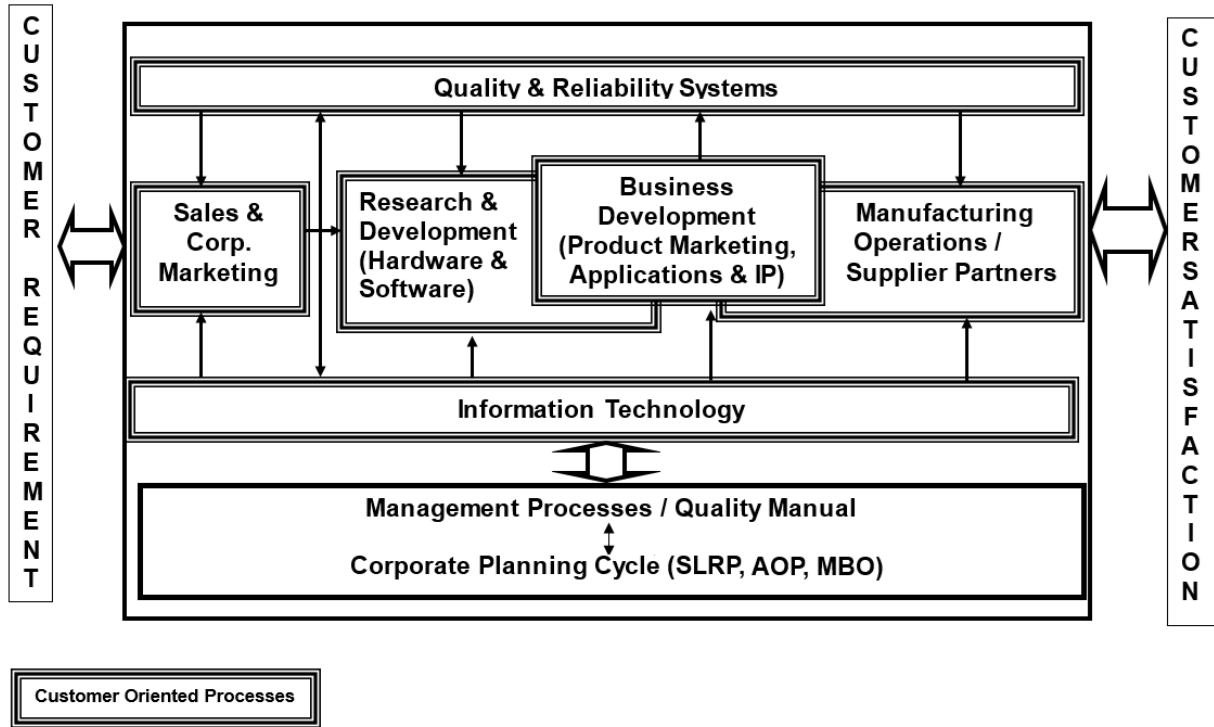
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1. Business Operations Review - periodic reviews with of Lattice Executive Leadership Team (ELT) members. These review covers the following topics:
  - Manufacturing and Delivery Metrics
  - Inventory trends
  - Critical customer issues
  - Significant Quality Issues Affecting Customers
  
2. Strategic Business Meeting (SBM) – regularly scheduled meeting to review the product roadmap and milestones leading up to the full development authorization. The SLRP and AOP plans drive regular updates to the roadmap that are then reviewed and ratified. The product owners work with their respective teams to prepare material and options for review in the SBM to authorize full-scale development. The typical SBM attendees include ELT members, as well as, key contributors depending upon the agenda.
  
3. New Products Review – periodic reviews of New Product Development Projects is conducted by engineering management. This review covers the following topics.
  - Silicon / Package Product Development Status
  - Software Product Development Status

Cross-functional teams meet on a periodic basis to address issues within different corporate systems. These teams include the following.

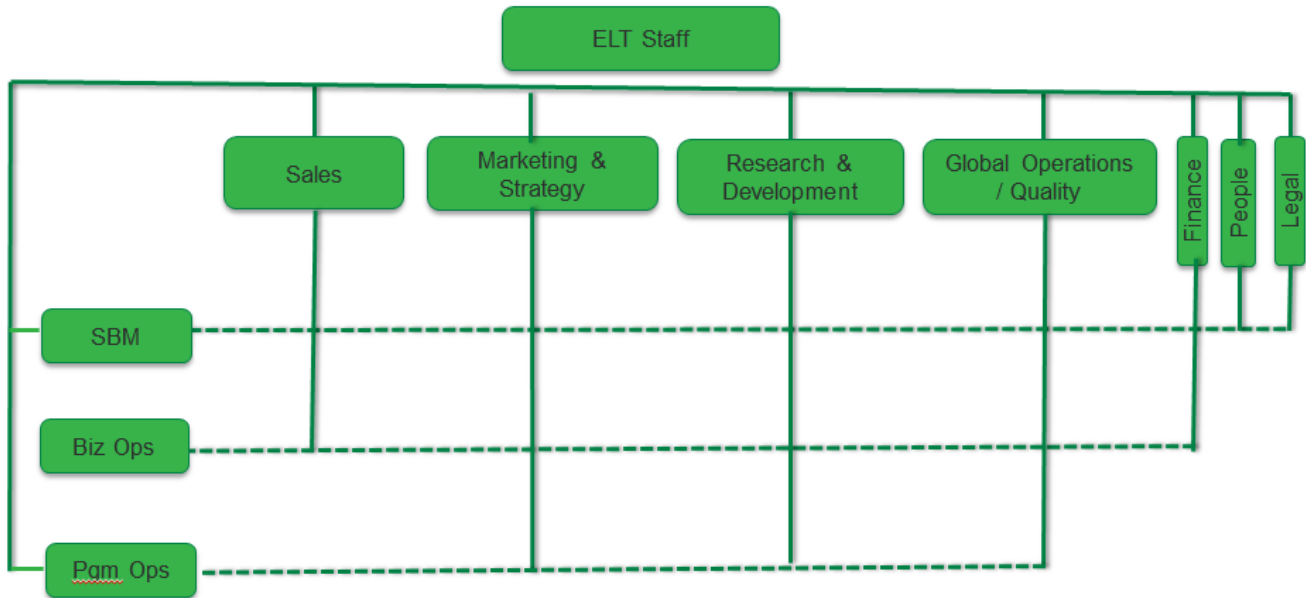
1. Customer Service Team – customer issues, customer complaints, and other customer-focused topics
2. Failure Analysis Reports (FAR) / Reliability Monitor Program (RMP) / Material Review Board (MRB) management team – review FAR, RMP and MRB performance and trends, recommend additional actions or escalations as needed.

# Key Customer Oriented Processes



The diagram above highlights the interaction of the key Lattice Semiconductor functions and processes within the Lattice Quality System.

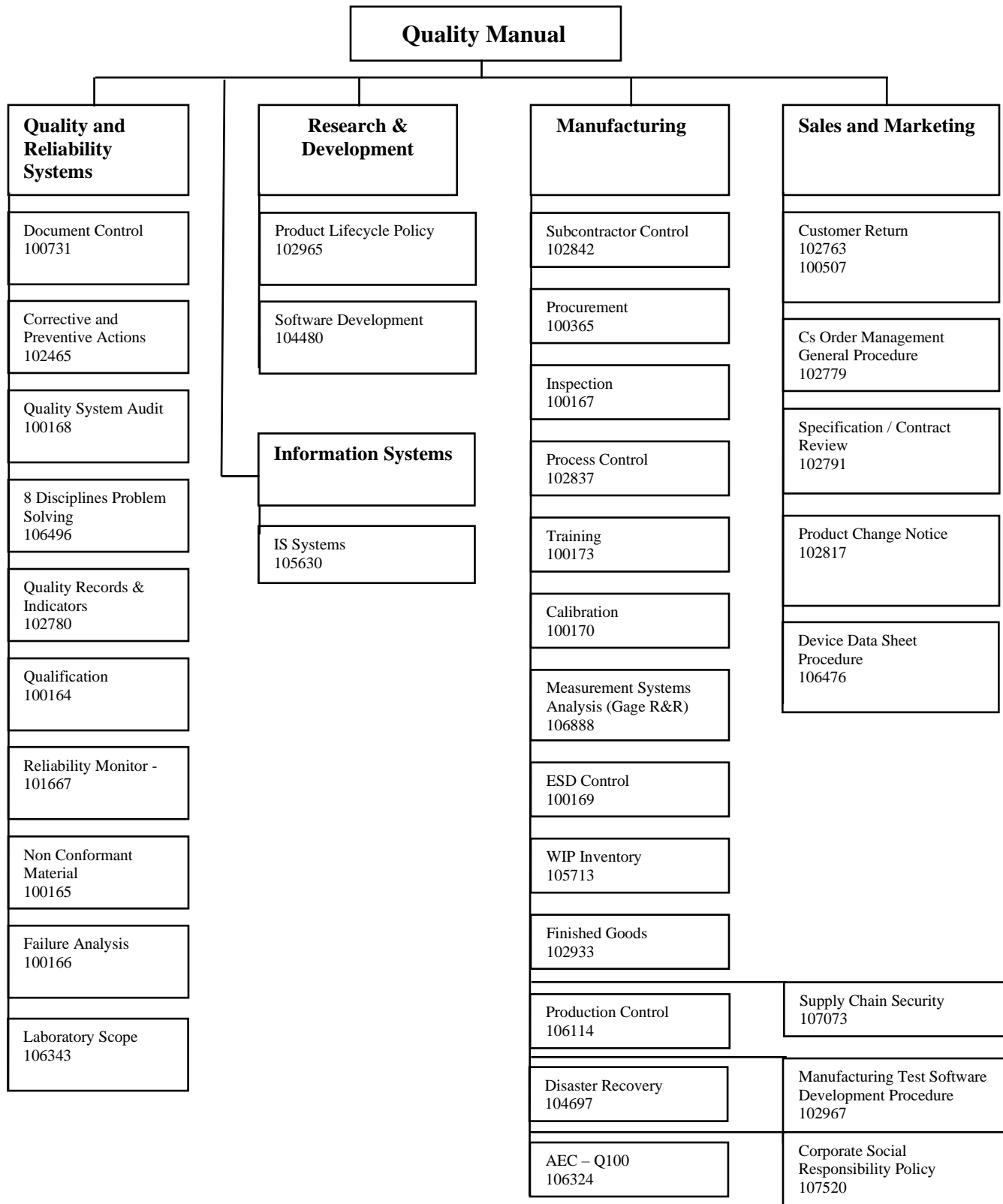
## Lattice Functional Organization Hierarchy of Linked Teams



<b><u>Responsibility &amp; Authority</u></b>	<b><u>Department / Function</u></b>
Corporate & Customer Quality	Management Representative
Quality Assurance	SPC Authority
Manufacturing Ops	ESD Authority
Business Ops Marketing	Automotive Customer Representative



# LATTICE QUALITY SYSTEMS STRUCTURE



Corporate HR Policies are managed by the Lattice Semiconductor Human Resource Department.  
 Corporate Finance Policies are managed by the Lattice Semiconductor Finance Department.  
 Corporate Environmental Policies are managed by the Lattice Semiconductor Corporate Social Responsibility Officer

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# QUALITY SYSTEM POLICY

## **Introduction**

The quality system provides the necessary infrastructure within the operational functions of the company to assure that products conform to specified requirements. The Quality Assurance department is responsible for monitoring and demonstrating effective operation of the entire quality system.

## **Training**

We are committed to ensuring all our employees receive sufficient training in order to fulfill their positions effectively, efficiently, and up to the standards of quality and safety necessary. Specific technical or skill training needs required for successful completion of an employee's individual job function are identified by the manager and/or division. Courses in the area of management, leadership, and professional development are developed in partnership between Human Resources, business groups, and as needed external 3rd party vendors. These training needs are evaluated on a regular basis during the normal course of business.

## **Document Control**

Written procedures, instructions and specifications required to support the entire quality system are maintained and controlled. All required documentation is verified current and available at the point of use. A master list of all controlled documents with current revision is maintained. Initial release as well as subsequent revisions are properly reviewed and approved before implementation.

## **Internal Audit**

Internal corporate audits of the entire quality and delivery system are performed by trained auditors independent of the function being audited per written procedures and to a predefined schedule. The corporate audits compare ISO 9001 and IATF 16949 requirements to actual method and written procedure as well as assess the adequacy and relevance of the written procedure. The results of these audits are documented. Discrepancies require corrective actions to be initiated and subsequently verified as to deployment and effectiveness. A report containing the corporate audit results and corrective actions is presented to Management.

## **Nonconforming Material**

Material found to be nonconforming to the specified requirements is identified, segregated, analyzed and dispositioned per documented procedures. Records are maintained denoting the nature of the discrepancy as well as the final disposition. All dispositions as a minimum involve the

applicable engineering section and QA. Where applicable, the root cause of the discrepancy will be identified and a corrective action implemented using the CAR form.

### **Failure Analysis**

Failure modes discovered during qualification testing, inspections, customer returns or in-process screening are processed through Lattice's failure analysis group to determine the cause or relevance of the failure. Verified failure modes are documented and corrective action initiated as required to eliminate the root cause.

### **Structured Problem Solving**

Teams composed of members from different disciplines use a facts based root cause problem solving process to identify, analyze, correct and eliminate recurrence of high-risk high cost quality problems. Team members are selected based on their skills, experience, and authority proportionate with the problem to be solved. Selected problem investigation reports are summarized using an Eight Discipline (8D) format.

### **Corrective Action**

All operational functions utilize a documented corrective action system coordinated, recorded and monitored by Quality Assurance. The system is designed to provide for proactive problem identification and resolution in a timely manner. Inputs include vendor, internal and customer related problems. Emphasis is placed on effective elimination of the root cause to prevent recurrence of the problem.

Management is responsible for ensuring that employees have sufficiently defined responsibilities, authority and organizational freedom to identify potential quality related problems as well as initiate and implement solutions.

### **Preventive Action**

Preventive actions may be initiated and closed within the Corrective Action System in the same manner as Corrective Actions. In addition, in some areas of the quality management system, key learnings from previous projects and risk assessments for new projects are being done as part of project management. Risk assessments and continuous improvement are also embedded in the self-audit/ internal audit process of Lattice.

Quality improvement teams provides a forum where any employee can suggest improvements in the quality and effectiveness of Lattice manufacturing and quality systems.

Cross Functional Teams meet regularly to drive improvements in key areas. These teams include quality improvement and R&D Functional Operations. Senior management reviews the progress and plans for all of these teams.

### **Quality Records and Indicators**

Each functional department identifies, collects, indexes, files, stores, maintains and checks accuracy of its own quality records and indices. Quality Assurance maintains a master list of data and monitors progress toward achieving stated quality goals.

### **Reliability**

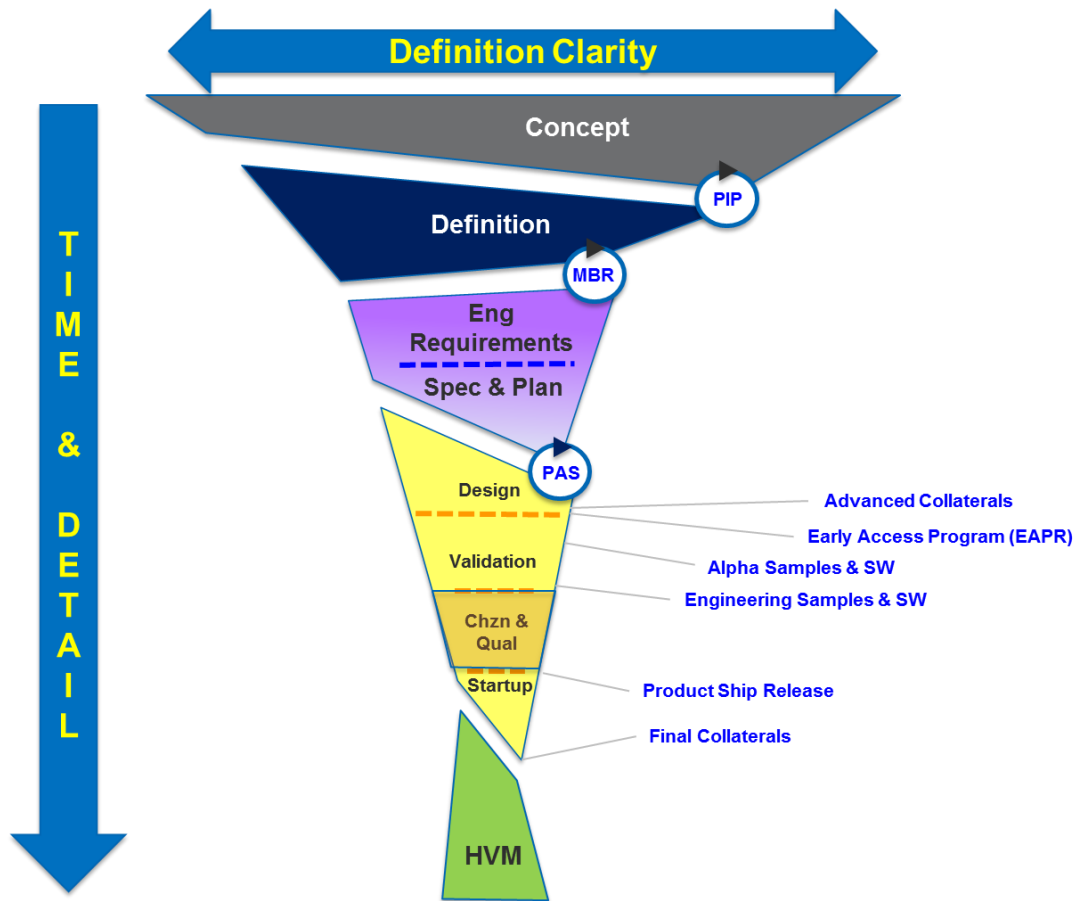
All new products, processes and suppliers must pass predetermined evaluations before receiving initial qualification release. Major product changes also require evaluation before release into the standard manufacturing flow. To assure continuing conformance of all products to reliability goals, an ongoing monitor program is maintained.

# PRODUCT LIFECYCLE POLICY

## Introduction

The Research & Development department through the Program Management Office (PMO) is chartered with the responsibility for the development of all new Product Platforms. In this context, a platform comprises any one or more of the following: Silicon Components, Software Design Tools, Application-specific IPs (intellectual property), Reference Designs, Demonstration Boards, Evaluation Boards and other related collateral that, collectively, provide a solution for an end-customer market. The Product Development process is a multi-disciplinary milestone driven process that is divided into multiple phases. Each Product Development phase defines the development process steps, inputs and outputs, milestone requirements, and verifications necessary to continue on to the next phase of development. The amount of effort for each phase is situational, dependent on the amount of work and resolution of the technical risks needed to fulfill the phase requirements.

The Lattice Product Lifecycle process is depicted in the diagram below.



### **Product Introduction Proposal (PIP)**

Product marketing develops the business strategy, market requirements, and the preliminary business case for new product platforms. During this early concept phase, product marketing defines a new product opportunity with identification of potential customers, their needs, market size and prioritized business objectives. The concept phase is successfully completed when the PIP is presented to and approved by the Executive Leadership Team (ELT). Only new product platform concepts that meet the minimum business case requirements move to the Definition Phase where the product concept is fully developed in preparation for the Market and Business Review.

### **Market and Business Review (MBR)**

Over the course of the definition phase, product marketing works with the product architecture to further define the product requirements and determine if the new product platform concept is technically and financially feasible. The product architect and design engineering review system architecture requirements, design assumptions, and system use cases and identify any gaps to the market requirements. From this analysis, the product marketing updates (as required) the business objectives, priorities, customer requirements, market risk assessment and financial business plan. The market (MRD) and system requirements (SRD) are finalized. The updated market and business plan along with the requirements gap analysis is presented to the Executive Leadership Team for review and approval. If the marketing and business review is approved, the product initiative proceeds to the Engineering Requirements and Spec & Plan Phase in preparation for the Product Authorization Submittal (PAS).

### **Product Authorization Submittal (PAS)**

After the marketing and business review has been approved, the product architect develops the product requirements document (PRD) reviewing it with product marketing insuring consistency between the MRD and PRD. As the PRD development progresses the product architect works with a cross functional team typically comprised of design, technology, and manufacturing engineers to develop the architecture requirements document (ARD). If, after finalizing the PRD and MRD, there are any material changes in the estimated budget that would affect the business case, a review meeting is held with the ELT.

As the engineering requirements are being finalized, the Program Manager leads the cross-functional development team in the development of a comprehensive project plan. The product development team complete their technical specifications and provide schedule, development costs, and product cost input to the program manager. The Program Manager integrates the individual plans, updated product development costs, product costs, and risk assessment to present and review with the ELT as part of the Product Authorization Submittal (PAS) milestone. Approval of the PAS

defines the development plan of record (POR) and allows the product development team to move to the Design Phase.

### **Advanced Collaterals (AC)**

During the design phase, early technical data is documented and published in Advanced Collaterals (AC) documentation for customer engagement. The collaterals typically include advanced datasheet, based upon simulated data, software programming information, and reference design schematics. Customer presentations are developed to assist the sales and marketing teams to educate customers on the new product.

### **Early Access Program Release (EAPR)**

The culmination of the design phase (for a silicon product) is release of the silicon design to be fabricated (tape out) along with the early release of the design software. The early release of the design software allow customers to begin design in activities ahead of receiving the first silicon product. The release of design software tools is denoted as the Early Access Program Release (EAPR) milestone and generally signifies the end of the Design Phase.

### **Alpha Sample Release (ASR)**

Upon receipt of first silicon samples, the product development team begins the Validation Phase where the product (including silicon, software, IP cores, and usage models) is validated to the product target specifications. Basic functionality is checked during the early part of validation. If the basic functionality of the product meets the defined release criteria, alpha samples are released (ASR) to a limited number of customers for early design in activities.

### **Engineering Sample Release (ESR)**

As the product validation continues, additional validation data is captured and checked against the product requirements. If the product meets agreed upon release criteria, engineering samples may be released (ESR) to customers. Updates are made to the advanced collateral product documentation based upon the validation results for typical conditions. The Engineering Sample Release (ESR) generally signifies the conclusion of the Validation Phase of development.

### **Product Ship Release (PSR)**

Characterization of the product proceeds after validation of product under typical conditions has been completed. The characterization testing may include variation of parameters such as process, voltage, temperature and frequency to check the product against the requirements and complete the datasheet parameters. The product is qualified by executing the reliability qualification test plan that stresses the product and checks for early life failure and potential reliability issues. Product Ship Release (PSR) occurs at the end of the Characterization and Qualification phase, providing the

product passes the tests and known errata are documented and approved. A review of remaining activities to close out the final collaterals is done and a plan is put in place to insure closure. The final collaterals typically include final software, soft IP, reference design and other sales enablement collaterals.

#### **Final Collaterals (FC)**

During the startup phase the final product collaterals are issued based upon the finalization of the product characterization and qualification, including final update to the customer software (as required).

#### **High Volume Manufacturing**

A cross-functional team directed by Manufacturing Operations manages the new product platform manufacturing ramp. The Manufacturing Ramp phase activities include building high volume, low cost production flows yielding high quality product.

Customer Software, Customer IP, Reference Designs, and Applications Kits are maintained and continually improved for quality and cost reduction activities.

#### **Product Maintenance and Cost Reductions**

Manufacturing Operations manages the product platform manufacturing in high volume manufacturing (HVM). The Manufacturing Maintenance phase activities include utilizing statistical control tools to maintain high quality product manufacturing through continuous improvement (CI) on quality, service and cost reductions.

The product marketing groups maintain Customer IP, and Applications Kits and continue work on cost reduction activities. Applications maintains and improves Reference Designs. Customer Software is maintained by customer software engineering while working on continuous improvements.

#### **Product Platform End of Life/Obsolescence Phase**

Manufacturing Operations, Solutions Group and Sales manage product platform end of life activities. The Product Platform End of Life phase activities include appropriate customer notifications and management of product to meet customers' needs while completing the product obsolescence phase.



# SOFTWARE PRODUCTS DEVELOPMENT POLICY

## **Introduction**

Development of Customer Software to support a new product platform introduction is described in the Research and Development Policy. Additional Customer Software is developed to support customer and Lattice marketing activities. It is the policy of the Lattice Customer Software and Customer Application Development Groups to maintain a standard process for development of customer software products. This process is designed to ensure software products of the highest quality are brought to market quickly, and maintained over their lifetime.

The Customer Software Development Process Guide defines the standard process used for software product development. It defines the Software Development Milestones used in the Lattice software development lifecycle. This process is followed for new product releases as well as maintenance releases on existing product offerings. This process is designed to provide Software Engineering with the tools to measure and continuously improve performance.

## **Market Requirement Document (MRD)**

The Marketing Group, working with Software Engineering, defines the customer requirements for software product direction and the expected functionality for specific product releases. These requirements are clearly defined in the Marketing Requirements Document (MRD) prior to software development, and appropriate revision control is maintained during the development cycle.

## **Engineering Requirement Document (ERD)**

The Software Engineering Requirement Document (ERD) is in response to the MRD based on technology, resource and schedule requirements. All points in the MRD are addressed. Items may be included, deferred, or rejected. All issues are discussed and agreed to before signoff. Once signoff is complete no new changes will be included without a signed Engineering Change Notice (ECN).

## SOFTWARE PRODUCTS DEVELOPMENT POLICY (CONTINUED)

### **Software Design Specification**

The Customer Software Development Group generates a detailed Software Design Specification that includes a breakdown on all major SW modules and their interfaces. This document defines the software product to be developed. The document is complete to the functional level of the final software product

### **Unified Test Plan**

All customer software releases have a defined test plan to ensure the software functions according to the specification. During development, a QA test plan is defined to test all elements of the software, and the integration of the elements into the final product. The test plan ensures the final product meets all requirements of the ERD and Software Specification.

### **QA System Test**

Final Customer Software Product validation is completed at the QA System Test. Every software release is tested to ensure full system testing of end-to-end design flows with real-world customer designs meeting the specified criteria. This testing includes system performance, competitive benchmark, feature acceptance as well as Out-of-the Box Acceptance Testing, and Fit-for-Use / Ease-of-Use testing.

### **Release to Manufacturing**

A version of the software is generated after completion of all QA System Tests.

# MANUFACTURING POLICY

## Introduction

Each manufacturing function at Lattice operates to documented procedures with the objective of eliminating variance to specification requirements as well as defects and waste. Use of the following quality systems provides the means to execute to this objective. Constant auditing and improving of each system is an integral part of the philosophy.

## Subcontractor Control

Manufacturing subcontractors are considered a key party to overall quality management system of Lattice. Because of this, all subcontracted manufacturing operations are performed by sources exhibiting a quality program commensurate to that of Lattice. Incoming inspection is performed as a means for feedback and continuous improvement of subcontractor performance so as to control quality at the source. Communications and in-line data are continuously exchanged to allow real time monitoring of manufacturing operations. Quarterly reviews are held with all key assembly and test subcontractors to review quantified scorecards including a quality assessment.

## Procurement

Materials and services affecting the quality or reliability of end product are purchased from capable qualified sources. Each purchase order specifies the applicable controlling requirements for all such critical materials or services. Qualification of these suppliers is based upon one or more of the following: quality system reviews, facility audits, product qualification testing, correlation studies, or demonstrated ability. A qualified supplier list will be maintained by Quality Assurance and used by Purchasing to control procurement of critical items.

We are committed to a comprehensive corporate social responsibility (CSR) program that aligns with our values and contributes to our success as a responsible corporate citizen. We draw upon internationally recognized standards to advance social and environmental responsibility throughout our supply chain.

## **MANUFACTURING POLICY (continued)**

### **In-Process Inspection**

In-process inspection by our subcontractors are performed per documented quality sampling plans to identify and segregate all nonconforming products. The in-process inspections are defined in the manufacturing flows that are created for each product and are recorded on the respective log sheets, SPC systems (when applicable), and computer-aided manufacturing systems of each qualified subcontractor.

### **Process Control**

All manufacturing processes are documented and utilize suitable equipment in an appropriate environment. Processes directly affecting quality or reliability are proven capable and controlled through continuous monitoring of process or product characteristics during the production operation.

Statistical Process Control (SPC) techniques and tools will be utilized for key parameters. The Assembly Engineering, Foundry Engineering and Manufacturing Product Engineering Manager positions are the Lattice authority to define the key parameters and coordinate the implementation of the appropriate control mechanism throughout the Lattice manufacturing flow and with their respective qualified subcontractors.

### **Calibration**

All equipment involved in determining product conformance to specifications through inspection, measurement or testing is of the required accuracy. Equipment is calibrated and maintained on a defined interval against a nationally recognized standard and exhibit a suitable indicator showing calibration status as well as safeguards to disallow unauthorized adjustments.

### **Measurement System Analysis (Gage R&R)**

Key equipment involved in determining product conformance to specifications meets or exceeds the required precision. Lattice Semiconductor uses Gage R & R methods to assure conformity and achieve improvement of internal and external manufacturing operations.

## **MANUFACTURING POLICY (continued)**

### **Material Handling**

Documented methods and means for handling all subassemblies and finished product are adequate to prevent damage or deterioration. Personnel to be involved in the handling of hazardous materials must complete HAZCOM training prior to performing such tasks.

Electronic components are sensitive to Electro-Static-Discharge (ESD). The authority and responsibility for defining and implementing industry recognized ESD standards is the cross-site Lab Council in conjunction with Quality Assurance.

### **Inventory Control**

Production Control is responsible for the initiation, scheduling, and tracking of all work-in-process (WIP). All WIP is uniquely identified on a computer tracking system as well as at the physical batch level as to lot number, location and status. Only product successfully completing all screening and QA requirements can be moved to the next step. Traceability on each batch is maintained throughout the manufacturing flow back to the raw material used and facility processing the material.

### **Finished Goods**

The packing and shipping methodology ensures finished product is protected from all detrimental effects including electrostatic discharge and mechanical damage from final inspection to the customer site. Designated storerooms incorporate methods such that unauthorized receipt and dispatch is not allowed.

# SALES AND MARKETING POLICY

## **Introduction**

Lattice maintains a system to review and respond to all customer requirements in a timely fashion. The following elements are key to assuring customer requests are satisfied. The automotive customer representative is the Marketing Manager position.

## **Specification Review**

Lattice Customer Requirements department is responsible for receiving and circulating all customer specifications, questionnaires, purchase contracts and agreements for technical review. Contract activity is managed by the Contract Review Board. Any questions or required deviations are documented, approved and resolved prior to the acceptance of a contract. A documented system is maintained for converting all non-standard customer requirements into operating instructions.

## **Customer Order Entry**

Lattice Customer Service is responsible for receiving and entering orders from sales offices and field representatives and assuring on-time shipment of the proper products.

## **Customer Account Management**

Lattice field sales is responsible for key customer account interface for sales support, issue resolution, and customer feedback.

## **Return Material Request**

Lattice Customer Service is responsible for processing all requests for returned material. A database is maintained to allow compilation of the quantity and type of quality related returns enabling analysis and corrective action to be initiated.

## SALES AND MARKETING POLICY (continued)

### Product Change Notice

A documented system is maintained by Quality with Marketing which serves to notify applicable customers of any change to a released product that affects form, fit, function or reliability levels. Unless otherwise agreed to, notice will be given 90 days prior to shipping the changed product for commercial and industrial products.

# INFORMATION TECHNOLOGY POLICY

## **Introduction**

The Information Technology department is responsible for the support of our business software and systems, the implementation and support of Lattice's worldwide networks and the company's infrastructure. The Information Technology systems provide uninterrupted service for all systems and networks and supports and enhances new business practices and processes by the modification of existing systems or the implementation of new systems.

Information Technology is also responsible for ensuring that Lattice systems are secure as required by customers and regulators. IT conducts periodic security assessments to ensure the IT perimeter and systems are secure.

## **Information Technology Operations**

The Information Technology Operations group designs, implements and supports Lattice's worldwide data network and voice systems, the servers which support Lattice's business systems, the worldwide computer network, and standards definition and license tracking for PC desktops

## **Information Technology Applications**

The Information Technology Applications group implements, modifies, and supports Lattice's current business systems and selects, modifies, and supports new business systems

## **Information Technology Tools & Technology**

The Information Technology Systems Tools & Technology group designs, implements, and supports the various databases used by Lattice's business systems, business system related tools such as job schedulers, reporting tools and end user query tools, and the company portal.