



SUPPLIER QUALITY MANUAL

MACOM Technology Solutions Holdings, Inc. (NASDAQ: MTSI) (MACOM) is a leading supplier of high performance analog RF, microwave, and millimeter wave products that enable next-generation Internet and modern battlefield applications. Recognized for its broad catalog portfolio of technologies and products, MACOM serves diverse markets, including high speed optical, satellite, radar, wired & wireless networks, CATV, automotive, industrial, medical, and mobile devices. A pillar of the semiconductor industry, we thrive on more than 60 years of solving our customers' most complex problems, serving as a true partner for applications ranging from RF to Light.

TABLE OF CONTENTS

	6.2. PROCESS CAPABILITY	16
	6.3. INITIAL (FIRST-OFF) SAMPLE PARTS	17
	6.4. PROCESS CONTROLS	18
	6.5. CONTROL PLANS	19
	6.6. FAILURE MODE AND EFFECT ANALYSIS (FMEA)	19
	6.7. HANDLING AND STORAGE REQUIREMENTS	19
	6.8. PROCESSING MOISTURE SENSITIVE MATERIAL AND DEVICES	20
	6.9. PROCESSING ESD-SENSITIVE MATERIAL AND DEVICES	20
	6.10. REQUEST FOR DEVIATION	21
	6.11. PACKAGING AND LABELING	21
1. <u>QUALITY POLICY:</u>	5	
2. <u>PURPOSE AND SCOPE</u>	5	
3. <u>SOURCING</u>	6	
4. <u>SUPPLIER RESPONSIBILITIES</u>	8	
4.1. CONTINUOUS IMPROVEMENT	8	
4.2. SUPPLY CHAIN CODE OF CONDUCT	8	
4.3. CONFLICT MINERALS	8	
4.4. COUNTERFEIT PRODUCTS	9	
4.5. ENVIRONMENTAL PRODUCT COMPLIANCE	9	
5. <u>SUPPLIER REQUIREMENTS OVERVIEW</u>	10	
5.1. QUALITY MANAGEMENT SYSTEMS	10	
5.2. BUSINESS CONTINUITY	11	
5.3. SUB-TIER SUPPLIER CONTROL	11	
5.4. COMMUNICATION TO MACOM	12	
5.5. OBLIGATIONS FOR TIMELY AND PROPER NOTIFICATION OF CHANGE	12	
5.6. PURCHASING	15	
5.7. TRACEABILITY	15	
6. <u>PRODUCT REALIZATION</u>	16	
6.1. SPECIFICATION AND DOCUMENTATION REVIEW	16	
	7. <u>MEASUREMENT, ANALYSIS AND IMPROVEMENT</u>	23
	7.1. GENERAL	23
	7.2. CALIBRATION SYSTEM	23
	7.3. MEASUREMENT SYSTEMS ANALYSIS (MSA)	24
	7.4. MONITORING AND MEASUREMENT	25
	7.5. VERIFICATION OF QUALITY	26
	7.6. PRODUCT / MATERIAL NONCONFORMANCE	26
	7.7. CORRECTIVE AND PREVENTIVE ACTION (CAPA) SYSTEM	27
	7.8. MAVERICK LOT CONTROL	28
	7.9. QUALITY RECORDS	28
	8. <u>SUPPLIER PERFORMANCE MONITORING</u>	29
	<u>APPENDIX A: REFERENCE DOCUMENTS</u>	30
	<u>APPENDIX B: REVISION HISTORY</u>	33

GLOSSARY OF TERMS

Term	Definition
Agile	Agile is MACOM's Product Data Management system
APQP	Advanced Product Quality Planning
BCMS	Business Continuity Management System
BU	Business Unit
BOM	Bill of Materials
CAPA	Corrective and Preventive Action
CDA	Confidential Disclosure Agreement
CEM	Contract Equipment Manufacturer
C of A	Certificate of Analysis <i>A document provided by a supplier that reports and certifies the actual results of the tests performed on a shipment of products or materials</i>
C of C / COC	Certificate of Conformance <i>A certificate provided by a Supplier's Quality Assurance department to MACOM confirming that all material conforms to all applicable specifications.</i>
COPQ	Cost of Poor Quality
Cpk / Ppk	Process Capability Indices
DFMEA	Design Failure Mode & Effects Analysis
DPPM	Defective Parts Per Million
EDI	Electronic Data Interchange
EICC	Electronic Industry Citizenship Coalition
ESD	Electro-Static Discharge
FAI	First Article Inspection
FAR	First Article Report
FMEA	Failure Mode & Effects Analysis
GR&R	Gage Repeatability and Reproducibility
ICT	Information and Communication Technology
IMDS	International Material Data System
ISO	International Standard Organization
KPI	Key Performance Indicator
MACOM	MACOM Technology Solutions
MCA	Mutual Confidentiality Agreement
MDF	Material Declaration Form
MSA	Measurement System Analysis
MSL	Moisture Sensitivity Level
NDA	Non-Disclosure Agreement

Term	Definition
NCMR	Non-Conforming Material Report
NPI	New Product Introduction
OEM	Original Equipment Manufacturer
OCM	Original Component Manufacturer
PCB	Printed Circuit Board
PCN	Product / Process Change Notification
PFMEA	Process Failure Mode & Effects Analysis
PO	Purchase Order
PPAP	Production Part Approval Process
PPM	Parts Per Million
RFQ	Request for Quotation
RoHS	Restriction of Hazardous Substances
SCAR	Supplier Corrective Action Request
SCN	Supplier Change Notification
SCP	Subcontractor Change Proposal
SGS	Société Générale de Surveillance [<i>Certification company</i>]
Shall	Mandatory requirement
Should	Recommendation
SOW	Statement of Work
SPC	Statistical Process Control
SQE	Supplier Quality Engineer

Supplier Quality Manual

1. Quality Policy:

The goal of MACOM Technology Solutions is to continually deliver effective, high quality products and services that meet our customers' and internal operations' needs in terms of delivery, performance, safety and value. Process controls shall be implemented such that the tasks are performed properly the first time, so that products and services meet established, agreed-to requirements.

It is the personal responsibility of every employee to ensure quality, customer satisfaction, continual improvement, maintenance of our quality management system and compliance with customer and regulatory requirements.

2. Purpose and Scope

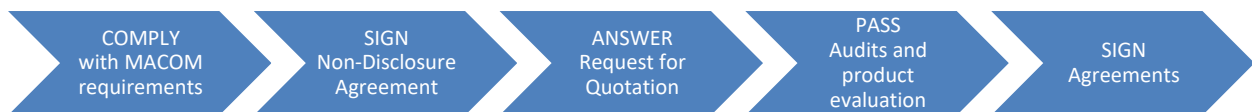
The purpose of this Supplier Quality Manual is to clearly communicate MACOM's Quality expectations to all new and existing external Suppliers, including raw material, component, Original Equipment Manufacturers (OEM), Contract Manufacturers of Finished Devices, and Service Suppliers associated with Product. These Quality Requirements shall apply to the development and manufacture of all Products supplied to MACOM. Suppliers are critical to MACOM's success in delivering high-quality product to our customers at the right time, therefore it is important for us to set expectations, identify gaps and track progress of gap resolution. MACOM works to build long-term relationships with those Suppliers who have achieved, or who are committed to achieving, these requirements.

MACOM Technology Solutions reserves the right to make changes to this document and requirements referenced herein. Hard copies of this document may not be updated. The latest version of this document is available on the Quality section of the MACOM Technology Solutions web site at <http://www.macom.com/about/sustainability-quality--reliabil>. Suppliers are responsible for ensuring that they are using the current version of this document.

3. Sourcing

The awarding of business to a supplier is one of the most important decisions made by MACOM Purchasing. It impacts the ability of our brand and our ability to deliver to our customers, remain competitive and to deliver future developments through projects and technological innovation. The MACOM Global Sourcing Process ensures the contribution and coordination of all decisions for all MACOM locations. It's the first step in building a strong and long lasting relationship between MACOM and our key suppliers.

The overview of the process is as shown here:



The supplier has an active role to play in this process:

- During the RFQ (Request For Quotation) process, the supplier is responsible for conducting a detailed specification review.
- In the audit performed by MACOM.
- In the demonstration of the achievement of MACOM requirements.
- In the implementation of action plans to reach the required performance level.

3.1. COMPLY with MACOM requirements

- 3.1.1. Have the products or technology required by MACOM.
- 3.1.2. Meet the quality requirements outlined in this document.

3.2. SIGN Non-Disclosure Agreement

- 3.2.1. The supplier understands and agrees to hold in strict confidence all confidential information derived from MACOM. As a Supplier to MACOM you may be asked to sign a Confidential Disclosure Agreement (CDA), Non-Disclosure Agreement (NDA), or Mutual Confidentiality Agreement (MCA) depending on the level of technology or information disclosed during the course of business. It is our policy to utilize a MACOM standard form that has been created for this purpose. When requested by an authorized representative of MACOM, the supplier shall return all documents provided by MACOM.

3.3. **ANSWER Request for Quotation (RFQ)**

3.3.1. Requests for quotation shall be provided by the MACOM buyer/authorized purchasing personnel. Suppliers are required to respond to RFQ's within the allocated time, and to quote based on a technical review of the information provided.

Any clarification or additional detail required should be requested from the MACOM Sourcing and Quality teams prior to providing the final written quotation. Full compliance with the RFQ requirements and product specifications is expected.

Any requests for exceptions or deviations to the specifications or RFQ requirements shall be clearly documented and communicated to MACOM, and shall not be assumed or deemed to be acceptable without clear written confirmation of acceptance from MACOM.

3.4. **Supplier Audit:**

3.4.1. As part of the evaluation process MACOM may request the supplier to complete a Self-Audit using MACOM's audit questionnaire, QAF-391. Depending on the product or service being provided, MACOM may follow up with an on-site audit by MACOM personnel and sample parts will be subjected to an evaluation process as appropriate for the product in question.

3.5. **SIGN Agreements:**

3.5.1. Where applicable, suppliers may be required to sign specific agreements such as Purchasing Agreements, Statement of Work (SOW), Service Level Agreements, Foundry/Manufacturing Service Agreements, etc.

4. Supplier Responsibilities

4.1. Continuous Improvement

MACOM strives for reliability and quality in all of our products, and we recognize that this cannot be achieved without the support of a strong supply base. To that end, MACOM strives to achieve a world-class supply chain utilizing Lean methodologies.

MACOM expects our suppliers to be committed to continual process improvement by emphasizing reduction of part to part variation and the elimination of all waste.

4.2. Supply Chain Code of Conduct

MACOM is committed to conducting our business activities in an ethical and responsible manner, contributing to economic development, while working to integrate social and environmental concerns into our business operations and stakeholder engagements. We also expect our suppliers to conduct their activities in an ethical and responsible manner, in conformance with, or exceeding, all applicable environmental laws and regulations of the jurisdictions in which the supplier does business.

Suppliers are directed to the Supply Chain Code of Conduct in the Corporate Social Responsibility section of the MACOM Technology Solutions web site at <http://www.macom.com/about/sustainability-quality--reliabil>, which incorporates the text of the Electronic Industry Citizenship Coalition's Code of Conduct, and is supplemented with additional requirements described therein.

4.3. Conflict Minerals

MACOM is committed to responsible sourcing and to compliance with the requirements of Section 1502 of the Dodd-Frank Wall Street Reform and Consumer Protection Act, 2010. Conflict minerals are defined as Tin, Tungsten, Tantalum and Gold.

Suppliers are directed to our Conflict Minerals Policy Statement in the Corporate Social Responsibility section on MACOM Technology Solutions website at <http://www.macom.com/about/sustainability-quality--reliabil>

We require all relevant suppliers to submit conflict minerals data, including smelter information, using the standardized Conflict Free Reporting Template (CMRT). We also

request that relevant suppliers ensure all smelters in their supply chain engage with the CFSI or other relevant bodies, such as the London Bullion Market Association, the Responsible Jewellery Council or the Tungsten Industry – Conflict Minerals Council.

Enquiries related to Conflict Minerals should be directed to conflictminerals@macom.com

4.4. Counterfeit Products

To protect our customers and provide quality products, MACOM only procures its components directly from OEM's or through an authorized agent/broker or distributor. All suppliers providing turnkey assembly services to MACOM are required to implement the same approach when purchasing components. Any independent distributor/broker shall provide full acquisition traceability to the Original Equipment Manufacturer (OEM)/Original Component Manufacturer (OCM).

Again, suppliers are directed to MACOM's Supplier Declaration on Sustainability (ref. section 4.2) for additional details on requirements related to Counterfeit Products.

4.5. Environmental Product Compliance

MACOM's goal is to avoid the use of substances in its products, which could harm the environment or human health. We are committed to adhering to all relevant legal requirements, international treaties and conventions, along with specific market requirements.

We expect our suppliers to conduct operations in conformance with, or exceeding, all applicable laws and regulations of the jurisdictions in which the supplier does business, along with other relevant international regulations.

Suppliers are directed to Supplier Compliance Requirements in the Environmental Product Compliance section on MACOM Technology Solutions website at <http://www.macom.com/about/sustainability-quality--reliabil>

The list below includes some of the relevant legislation, but compliance is not limited to these. Additional information may be required, such as independent test reports or MSDS sheets for relevant products.

- EU: Restriction of Hazardous Substances (RoHS) Directive 2011/65/EU
- EU: Registration, Evaluation, Authorization and Restriction of Chemicals (REACH) EC 1907/2006,
- EU: EC 1005/2009 on Substances that deplete the ozone layer
- EU: Regulation No. 842/2006 on certain Fluorinated Greenhouse Gases
- EU: Persistent Organic Pollutants (EC/850/2004)
- EU: 2009/425/EC, Restrictions on marketing and use of organostannic compounds

Enquiries related to Environmental Product Compliance should be sent to

product_compliance@macom.com



A copy of MACOM's full Environmental Health and Safety Policy is available on the Sustainability, Quality & Reliability section of the MACOM website

<http://www.macom.com/about/sustainability-quality--reliabil>

5. Supplier Requirements Overview

5.1. Quality Management Systems

Suppliers are encouraged to earn relevant third party registration to ISO 9001, TL 9000, ISO/TS 16949, SAE AS 9100, BS EN 9100, or equivalent national standards as appropriate.

Supplier expectations are as follows;

Supplier Type	Supplier Category	Expectation
Raw Material and Component Suppliers	Both New and Existing	Already certified, or working towards ISO 9001:2015 certification
OEM and Contract Manufacturing of Finished Devices	Both New and Existing	ISO 9001:2015 certified ISO 14001:2015 certified
OEM and Contract Manufacturing of Finished Devices - Automotive	Both New and Existing	ISO 9001:2015 & ISO/TS 16949 certified

Suppliers are responsible for ensuring that Products or services meet established MACOM specifications and Quality Requirements. Audits, approvals or verification by MACOM of the Supplier's facility, quality system, process controls, acceptance activities, etc., does not absolve the Supplier of the responsibility to provide acceptable Product, nor will it preclude the subsequent rejection of unacceptable Product.

5.2. **Business Continuity**

As a responsible manufacturer we expect our Suppliers to complete a formal business Continuity/Disaster Recovery Plan to ensure no interruption in supply to our end customers is encountered.

It is recommended that business recovery plans should be developed and maintained based on ISO 22301, "Societal security - Business continuity management systems – Requirements" which is an international standard for Business Continuity Management System (BCMS). ISO 22301 specifies requirements to plan, establish, implement, operate, monitor, review, maintain and continually improve a documented management system to prepare for, respond to and recover from disruptive events when they arise. ISO 22301 is supported by ISO 22313, "Societal security -- Business continuity management systems – Guidance" which provides pragmatic advice concerning business continuity management.

ISO/IEC 27031, "Information security - Security techniques — Guidelines for information and communication technology [ICT] readiness for business continuity" offers guidance on the ICT aspects of business continuity management.

5.3. **Sub-Tier Supplier Control**

The Supplier must maintain qualifications for raw material suppliers and for subcontractors and the products purchased through them. It is the Suppliers' responsibility to ensure and control the quality of all components and raw materials that are purchased to manufacture components and parts for MACOM.

Suppliers will manage sub-tier suppliers with controls commensurate with those MACOM applies to direct suppliers. Suppliers are responsible to ensure that product(s) manufactured utilize only authentic, conforming and specified material requirements as stipulated in the BOM.

The supplier is not to subcontract any work related to any given purchase order without notification and written permission from MACOM purchasing.

The supplier shall not place any MACOM tooling with subcontractors without notification and written permission from MACOM purchasing.

5.4. **Communication to MACOM**

MACOM has established primary interfaces (e.g. Sourcing, Quality, Planning, Applications Engineering, etc.) for ensuring that all supplier requests for information are satisfied, in addition to electronic systems to enable suppliers to obtain product information.

Suppliers must identify and implement a communication plan with MACOM regarding product information, contracts, order handling, feedback and complaints. Suppliers will provide prompt notification to MACOM of any Supplier Product recalls or field actions.

All suppliers of production parts, assemblies, components and production materials to MACOM plants should have capabilities for the exchange of purchasing documents via electronic methods.

5.5. **Obligations for Timely and Proper Notification of Change**

5.5.1. **Changes By MACOM**

Product specifications are subject to revision by MACOM. Any such specification changes shall be notified by MACOM to the relevant supplier for the product affected by the change. Supplier shall implement the revision as specified by MACOM, and confirm the implementation to MACOM by the requested date.

5.5.2. **Changes by Supplier**

The continuous improvement philosophy encourages process improvements. However, changes or deviations considered by Supplier must be submitted in writing to MACOM for review and approval **prior** to making any changes. It is important to be aware that any technical change may have a significant influence on MACOM product performance.

A process change is defined as any significant change to the manufacturing process, equipment modifications or replacements, changes to process parameters, and the purchasing of materials from new sources that could adversely affect form, fit, function or reliability of the purchased material that has

been accepted/approved by MACOM and/or our customer.

MACOM must ensure that its customers receive product that is consistent with drawings, product specifications, and inherent performance requirements. To facilitate this requirement for consistency, MACOM requires that the supplier provides prior written notice of the changes proposed.

Supplier's change notification procedure and process shall be generally in line with EIA/JESD46 (Guidelines for User Notification of Product Process Changes by Semiconductor Suppliers), and the actual notification documentation shall meet the minimum contents as outlined therein.

Supplier shall notify MACOM a minimum of 90 days before implementation of the proposed change per JESD46. For material or process phase-out / End-of-Life situations, supplier shall provide 6 months notification to place orders and 12 months for shipments per JESD48.

Suppliers shall not implement changes to automotive components until the changes have been qualified and, PPAP submitted to MACOM or MACOM directed sub-tier supplier. All notifications of proposed changes must be sent via email or via SCP process.

The responsible buyer/authorized purchasing and quality personnel will work with the supplier to review the proposed change and the qualification information required, as the requirements vary for the different MACOM business units. The change shall **not** be implemented prior to written approval from MACOM.

5.5.3. Supplier Access to Agile

MACOM uses Oracle's Agile Product Lifecycle Management software/database to manage updates to all controlled specifications.

Selected suppliers will be setup to directly access the product related information for the parts they are providing to MACOM, and will use Agile to:

- View / Access all documentation for product build/manufacture.
- Review and action Supplier Change Notifications (SCNs).

– Make proposals to MACOM for changes they think MACOM needs to make or for changes the supplier wants to make, via Subcontractor Change Proposals(SCPs).

IMPORTANT NOTE: For suppliers with Agile access accounts, any other source of documentation is considered uncontrolled.

Supplier access is via the following link:

<https://agile.macom.com/Agile/default/login-cms.jsp>

Login credentials and Agile training will be provided by MACOM when the supplier is being setup on the system.

Refer to MACOM procedure QP-248 for additional details.

5.5.4. SCN Overview

The purpose of the Supplier Change Notifications (SCN) process on Agile is as follows;

- Automatically notify suppliers of a change.
Supplier will receive automatic email notification to their Agile email address on closure of a Change Order in MACOM.
- Track the supplier change on Agile.
- Have a priority level for the change.
 - 1 – High (Supplier completes SCN within 5 working days)
 - 2 – Low (Supplier completes SCN within 10 working days)
- Provides a Closed-Loop system.
Supplier must complete a check list to confirm they have carried out the requirements to incorporate the changes and close the SCN.

5.5.5 SCP Overview

The purpose of Subcontractor Change proposals (SCP) on Agile is as follows;

- Process on Agile for Suppliers and subcontractors to propose a change to MACOM for a product or process which they are supplying to MACOM.
- The supplier should connect the change to the relevant assemblies/parts in Agile and assign the relevant MACOM owner to review the change.
- If the change proposal is approved and accepted then the supplier will receive notification via Agile.
- If the change proposal requires a change within MACOMs system, then an Agile change order will be created and linked to the affected part(s), and the supplier will receive an SCN notification.

5.6. Purchasing

Supplier shall establish and maintain controls on the purchase of components used in the manufacture of Product to ensure conformance to specified requirements, including visual inspection of packaging, labeling, or shipping containers, and dimensional inspection or analytical testing.

Supplier shall maintain documentation that clearly describes the quality requirements for components, and shall require component sources to notify Supplier of any proposed changes in the manufacturing of the components prior to making any change. MACOM shall participate in the review and approval of component source changes.

In the event that, with MACOM's knowledge and approval, Supplier subcontracts a portion of the manufacture and/or inspection of components to sub-tier suppliers, the requirements defined in this document shall be passed on to those Suppliers through purchase order requirements. Supplier shall remain responsible for all acts or omissions of the sub-tier supplier with whom it contracts.

5.7. Traceability

Supplier shall be responsible for setting up and maintaining controlled documentation of product traceability during all stages of receipt, production, and distribution. Traceability and quality records will be maintained throughout the life of the Product.

Traceability requirements include, but are not limited to, the following:

- Minimum Traceability – All Products and components are traced by lot/batch, automotive products must be traceability to individual serial number.
- Process Information – Traced to the sub-assembly. At a minimum, this includes the operator, date performed, shift, manufacturing instructions used, use of validated equipment and identification of equipment used, Bill of Material (BOM)/design revision and configuration, resolution of any discrepancies, and record of any rework performed.
- Raw Materials – Traced to original material manufacturing lot/batch at a minimum.

These records will be made available to MACOM upon request, and a traceability review may form part of a MACOM surveillance audit.

6. Product Realization

6.1. Specification and Documentation Review

Prior to acceptance of the purchase order, the supplier shall review all engineering drawings and specifications to ascertain that they are to the engineering revision level specified on the purchase order. The supplier shall notify the appropriate buyer/authorized purchasing personnel of any errors or omissions. MACOM will either correct the error or arrange for a temporary deviation until correction can be made.

The supplier shall not implement changes to any MACOM document without prior approval having been issued in writing by the MACOM buyer/authorized purchasing personnel.

The supplier review shall also determine compliance to special labeling and packaging requirements, delivery requirements and supplier's own specifications and quality manual.

The supplier will establish a process to ensure the timely review, distribution and implementation of authorized drawing and document changes.

6.2. Process Capability

MACOM recommends that a Statistical Process Control Plan (SPC) be implemented, and that appropriate SPC data for special part and process characteristics will be kept on file by the supplier as required.

All critical characteristics should be controlled with SPC and variable gauging as applicable. The capabilities must be identified in the control plan and subsequently followed. This data may be required with each shipment at the discretion of the receiving facility. Special characteristics will be defined in MACOM specifications when applicable. For these characteristics, the minimum expected capability level is ≥ 1.33 Cpk (Automotive suppliers are required to achieve a minimum process Cpk of 1.67).

6.3. Initial (first-off) sample parts

6.3.1. When providing initial sample parts to MACOM, the supplier may be requested to provide a First Article Report (FAR) detailing inspection and measurement results and the results of all testing conducted on the parts to confirm compliance to specifications or a PPAP submission as applicable.

Supplier is responsible for notifying MACOM Purchasing when first article samples and inspection data are available. MACOM will make arrangements with the supplier to review the first article data and samples, and conduct additional evaluation and testing as required.

6.3.2. Supplier FAR's should include all applicable of the following items and any other relevant information for the product being sampled:

- Material Declaration & Certificate of Conformance
- SGS REPORT (or equivalent)
- Conflict Minerals Report (CMRT)
- DIMENSIONAL ANALYSIS REPORT
- CROSS SECTION (PCBs) (Via-hole Integrity, Solder Mask & Stack-up Thickness)
- PLATING ANALYSIS REPORT (Composition and Thickness)
- MATERIAL CERTIFICATE
- ELECTRICAL CHARACTERISATION DATA
- MANUFACTURERS RELIABILITY DATA

6.3.3. Supplier shall not start full production until formal approval of the initial samples is received from MACOM, or until MACOM provides a written instruction to commence production.

6.3.4. MACOM first article approval does not relieve the supplier of the responsibility of assuring that subsequent production is in accordance with documented requirements.

6.3.5. A PPAP documentation package at submission level 3 unless otherwise specified must be supplied with all automotive products. Suppliers are directed to the AIAG Production Part Approval Process Latest Edition.

6.4. Process Controls

- 6.4.1.** Supplier is responsible for the quality of any process that affects the configuration, assembly, heat treatment, plating, and/or metallurgical properties of MACOM consigned or stocked material.
- 6.4.2.** Supplier is responsible for adopting the necessary techniques and controls during all phases of manufacturing to ensure that the quality of the product being produced is both known and controlled. These controls should include, but are not limited to:
- Approved and documented production processes, instructions, and methods that define and control the manner of production.
 - Monitoring and control of process parameters and component and device characteristics during production.
 - Compliance with specified reference standards or codes.
 - Approval of processes and process equipment.
 - Criteria for workmanship, which shall be expressed in documented standards or by means of identified and approved representative samples.
- 6.4.3.** Supplier will monitor and control the manufacturing process using industry standard tools such as: in-process inspection; control plans; and Statistical Process Control.
- 6.4.4. Error-Proofing**
Supplier should use error-proofing devices and techniques as a form of process control, especially for repetitive functions, difficult tasks prone to mistakes, or where the cost of error is high.
- 6.4.5. Preventive Maintenance**
Supplier should identify key process equipment and provide resources for machine/equipment maintenance activities and develop an effective planned total preventive maintenance system.

6.5. Control Plans

Processes used for the manufacture of any finished products shall be validated and require a control plan. A Control Plan is a documented description of the systems for controlling part and process quality by addressing their key characteristics and engineering requirements. Suppliers are directed to the AIAG Advanced Product Quality Planning and Control Plan (APQP) manual for additional information and guidelines. Control Plan templates are available from MACOM upon request.

6.6. Failure Mode and Effect Analysis (FMEA)

It is strongly recommended that the supplier develop a Process or Product FMEA and use those results to determine the appropriate test and inspection points as well as appropriate control methods.

Additional information can be found in the AIAG FMEA manual.

FMEA templates are available from MACOM upon request.

6.7. Handling and Storage Requirements

- 6.7.1. The supplier is responsible for the proper handling and storage of all raw material, components, and tooling supplied or consigned from MACOM. Any special handling, packaging, and storage requirements requested by MACOM will be documented on the purchase order or on the product specifications.
- 6.7.2. Prior to processing, the supplier is responsible for the inspection of MACOM supplied material and verification of the correct quantity. If MACOM supplies nonconforming material to the supplier, the supplier shall be responsible for notifying the respective MACOM buyer/authorized purchasing personnel of the receipt of nonconforming material. MACOM buyer/authorized purchasing personnel shall provide specific instructions regarding the disposition or use of supplied nonconforming material.
- 6.7.3. For materials with a limited or specified shelf life, supplier shall implement a robust system for material control which should be monitored, evaluated, and continuously improved to assure reliability and accountability for all items maintained under the program.

6.8. Processing Moisture Sensitive Material and Devices

Where applicable, suppliers providing packaged finished goods to MACOM or shipping directly to MACOM's customers shall have procedures and processes in place to correctly handle moisture sensitive products.

MACOM's standard policy is to ship semiconductor products with an assembly date code of 5 years or less. The packaging used for finished goods must provide sufficient protection to meet the 5 year shelf life requirement.

Suppliers should refer to MACOM procedure MFG-1075 and IPC/JEDEC J-STD-033 for detailed guidelines and requirements.

6.9. Processing ESD-Sensitive Material and Devices

Where applicable, supplier shall have an ESD control program, with defined procedures to support implementation of the standard.

The latest revision of ANSI/ESD S20.20 and IEC 61340-5-1 are the recommended standards for the implementation of an ESD Control Program.

The basic components of an ESD control program are as follows;

- All ESD-sensitive materials and devices shall be clearly identified before processing.
- ESD Protected Areas shall be clearly identified within the facility.
- All employees that handle unprotected ESD-sensitive products shall have successfully completed the supplier's ESD training program.
- All employees shall be grounded when handling unprotected ESD sensitive devices.
- Transport of ESD sensitive products between controlled areas shall only be done in conductive or static dissipative containers or on conductive or static dissipative trolleys.
- All ESD control elements must be periodically verified per a defined compliance verification plan.
- Non-essential insulators must be removed from the ESD work station within the ESD Protected Area.

6.10. Request for Deviation

- 6.10.1. Supplier is responsible for meeting all the requirements of the purchase order, drawings, and MACOM specifications or industry standards and Specifications (e.g., EIA, ISO, ASTM, etc.) when specified or applicable. Material that does not conform to these requirements shall not be shipped to MACOM, its customers or other suppliers without prior written approval having been given in the form of an approved deviation request for known nonconformance.
- 6.10.2. Request for deviation from requirements shall be brought to the attention of the MACOM buyer/authorized purchasing or Quality personnel. Approval or disapproval of supplier deviation requests will be documented and communicated to the supplier.
- 6.10.3. Each request for deviation shall include a statement of corrective action, person responsible for the corrective action, and estimated date of implementation of corrective action to prevent recurrence of the nonconformance.
- 6.10.4. Supplier shall identify, store, and ship approved deviated nonconforming material in such a manner as to keep it separate from conforming material. Where applicable, the deviation number shall be noted on the packing slip, and when requested, on all shipping containers.

6.11. Packaging and Labeling

- 6.11.1. Packaging shall conform to all packaging and labeling requirements documented on the purchase order, product drawings, or material specifications. When not specified, packaging and labeling are the responsibilities of the supplier and shall be adequate to prevent damage or deterioration during shipment. EIA/JEP 130, Guidelines for Packaging and labeling of Integrated Circuits in Unit Container Packing (Tubes, Trays, and Tape and Reel), is the recommended reference standard for applicable product types.

6.11.2. All shipments shall be labeled as a minimum with:

- A.** Purchase order number
- B.** MACOM part number
- C.** Product/material revision level.
- D.** Quantity
- E.** Country of Origin

6.11.3. All CEMs, subcontractors and IC Packaging Suppliers involved in the supply of assembled products to MACOM shall meet the label requirements as defined in MACOM procedure, MFG-1079.

6.11.4. One copy of a C of A or C of C shall be submitted by the supplier and included with the shipment.

The C of C and/or C of A shall certify and provide evidence (as appropriate) that the material meets all specified requirements.

7. Measurement, Analysis and Improvement

7.1. General

Measurement, analysis, and improvement are the processes of planning, defining, and using performance metrics for products delivered to MACOM. These performance metrics determine the current level of performance, drive continuous improvement activities, and monitor performance levels. Statistical tools should be applied to measure the performance metrics on processes and products, and are also recommended to measure supply chain performance. Supplier must define, plan, and implement measurements where processes affect the quality of products or services that MACOM receives.

7.2. Calibration System

Supplier shall implement systems to satisfy the following requirements:

7.2.1. Gages, measuring devices, and testing equipment used to determine the acceptability of materials and tooling used in production shall be controlled and calibrated in accordance with the current revision of ISO 10012 or equivalent national standard.

NOTE: Provision for special measurement and test equipment, unique to a specific purchase order or product, shall be negotiated at time of order placement or product qualification, and responsibility for calibration and maintenance of such special equipment shall also be agreed at that time.

7.2.2. Ensure that measuring equipment be identified to enable the calibration status to be determined.

7.2.3. Ensure that measuring equipment is safeguarded from adjustments that would invalidate the measurement result.

7.2.4. Ensure that measuring equipment is protected from damage and deterioration during handling, maintenance and storage.

7.2.5. Have documented procedures in place that provides for prompt MACOM notification, in writing of any event such as the identification of defective calibration equipment that casts doubt on the validity of results.

7.3. Measurement Systems Analysis (MSA)

Measurement Systems Analysis (MSA) is recommended in determining whether measurement or test equipment has sufficient accuracy, precision, or resolution to adequately provide information about process performance, or the effects of inherent or applied variation of the process under development.

One tool recommended is Gage Repeatability and Reproducibility (Gage R&R or GR&R). Gage R&R using variables data is preferred, although attribute MSA is possible. If performing MSA using attribute measurement (simple pass/fail values), the results of this analysis are limited by the measured item's values compared with specification requirements. Select test parts which are marginally acceptable and marginally rejectable to criteria to provide meaningful results from this type of analysis.

7.3.1. General Requirements

The Supplier shall develop or obtain gages to control their processes and to inspect the parts, whenever possible.

Gages used to inspect parts should be variable gages, when possible and feasible, which have been designed to inspect the functionality of the part. If variable gages are not available, then attribute gages ("go" or "no go") are acceptable for use.

For those characteristics specified by MACOM, the Supplier must perform a Gage R&R Study using procedures described in Measurement Systems Analysis published by AIAG (Automotive Industry Action Group) or equivalent.

At a minimum, for all special characteristics, a Gage R&R (variable or attribute) is required, unless directed otherwise by MACOM.

If the Supplier has a number of duplicate custom gages, a gage correlation study should also be completed.

7.3.2. Gage R&R Studies

For the recommended requirements for Gage R&R studies and the guidelines for acceptance of Gage R&R (% R&R), the supplier is again referred to Measurement Systems Analysis published by AIAG.

7.3.3. Gage Correlation Studies

When it is deemed a Gage Correlation Study is necessary, the Supplier will identify, measure, and record a specified number of production parts. If requested, the Supplier may send the parts to MACOM for measurement, or coordinate with a third party based upon the sourcing strategy and relationship for production of the part in qualification. If the Supplier has a number of like gages, an internal gage correlation study should also be completed and provided to MACOM upon request. If an acceptable correlation value is not demonstrated, an acceptable rationale must be documented and approved by MACOM.

7.4. Monitoring and Measurement

7.4.1. Incoming Acceptance

Supplier shall have procedures for acceptance of incoming product, including inspection, testing, and verification as conforming to MACOM specifications. Supplier will document acceptance or rejection of incoming product.

7.4.2. In-Process Acceptance

Supplier shall have in-process acceptance procedures to ensure that in-process Product is controlled until the required inspection and tests or other verification activities have been completed, or necessary approvals are received.

7.4.3. Final Acceptance

Supplier shall have procedures for finished Product acceptance to ensure that each production unit, lot, or batch of finished Product meets MACOM's acceptance criteria. Finished Product shall be adequately controlled until released.

7.5. Verification of Quality

- 7.5.1. MACOM and its customers reserve the right to perform any testing or inspection that may be necessary to determine that the purchase order requirements have been met, including verification at the supplier's location if required. The supplier may be required to submit test or inspection data corresponding to the lot(s) being tested or inspected for comparison or correlation purposes.
- 7.5.2. The supplier shall permit access by representatives of MACOM, MACOM's customers, and applicable regulatory agencies to the supplier's premises (and the premises of Supplier's subcontractors and supplier(s)) for the purpose of evaluating Supplier's facilities, processes, goods, quality system and records.
- 7.5.3. Product accepted at receiving inspection may be found to be nonconforming during the manufacturing process. The supplier is liable for such product regardless of when a nonconformance is found.

7.6. Product / Material Nonconformance

- 7.6.1. Supplier shall notify the respective MACOM buyer/authorized purchasing and quality personnel if nonconforming material has been shipped to MACOM. The MACOM buyer/authorized purchasing and quality personnel shall coordinate the containment and disposition of suspect nonconforming material.
- 7.6.2. If a supplier responsible nonconformance is found at MACOM, its customer, or an agent of MACOM, upon communication of the details of the nonconformance the supplier is responsible for determining the necessary actions to establish an effective containment plan. The supplier is responsible for immediately initiating containment of any suspect product within their facility or in the supply pipeline. This shall include the present lot, or any lots currently being inventoried. The supplier shall also notify the MACOM buyer/authorized purchasing personnel of any suspect material that is in transit.
- 7.6.3. MACOM generally communicates any such non-conformance requiring a corrective action by formally issuing a SCAR to the supplier. A unique case

identifier in the form of a SCAR Number will be assigned, and should be included on all communication related to the issue.

Further details outlining MACOM's expectations relating to the SCAR response are outlined in the following section of this document.

In other cases, MACOM may use a Non-Conforming Material Report (NCMR) for issue notification and material disposition.

7.7. Corrective and Preventive Action (CAPA) System

7.7.1. Supplier will establish and maintain procedures for implementing a CAPA system in substantial compliance with the industry standards and Quality Management System requirements.

7.7.2. When requested, supplier will supply an 8D corrective action plan that provides the details of how the nonconformity will be resolved. MACOM expects supplier to investigate the root cause(s) and to promptly respond to the MACOM buyer/authorized purchasing or Quality personnel.

Unless otherwise specified by the business unit, as per JESD671, MACOM expects;

- Acknowledgement of receipt of issue notification and confirmation of the immediate containment actions to be taken within 1 day.
- Interim containment plan in place and reported within 5 Days (3 days for urgent issues)
- Root cause analysis identified and results communicated within 15 days (5 days for urgent issues)
- Formal 8D report with corrective action plan defined within 23 Days (9 days for urgent issues)
- Corrective and preventive action plan implemented and verified within maximum of 90 days.

7.7.3. The details of the investigation, corrective action plan, verification of the effectiveness of the corrective action and preventive actions shall be documented.

Should the corrective action be ineffective, untimely, or performance not be restored, MACOM may exercise all rights available under contracts or purchase orders.

7.8. **Maverick Lot Control**

- 7.8.1. Maverick Product or Outliers to the normal population can result in one or more populations of material having an actual or potential problem that may go undetected until its use in the final application.
- 7.8.2. It is recommended that Suppliers have a Maverick lot control program which meets minimum requirement as per JEDEC standard JESD50.

7.9. **Quality Records**

Supplier is responsible for maintaining the following records for each production part number manufactured or provided, as applicable:

- 7.9.1. Inspection records
 - First article inspection results
 - Incoming inspection
 - Set up inspection records
 - In process inspection records
 - Final inspection records
- 7.9.2. Certificates of analysis (if applicable)
- 7.9.3. Certificates of compliance
- 7.9.4. Laboratory analysis test results
- 7.9.5. SPC data (if applicable)
- 7.9.6. Purchase orders
- 7.9.7. Change orders
- 7.9.8. Approved deviations
- 7.9.9. Calibration records
- 7.9.10. Nonconforming material records
- 7.9.11. Corrective action responses
- 7.9.12. Shipping records
- 7.9.13. PPAP (if applicable)
- 7.9.14. Environmental record
- 7.9.15. IMDS registration number (if applicable)
- 7.9.16. Production record
- 7.9.17. Tool maintenance/repairing record

These records shall be maintained for the time period specified by the business unit purchasing department.

8. Supplier Performance Monitoring

8.1. Selected suppliers will be included in MACOM's Supplier Scorecard program.

A Scorecard will generally be issued on a quarterly basis, and will track items such as SCAR activity, SCN implementation, On-time Delivery performance and general Quality and Service Level.

8.2. Implications for Poor Performance Levels:

Based on poor performance results, MACOM may at its discretion initiate any or all of the following actions:

- 8.2.1. Initiate a SCAR to the supplier as a mechanism to drive a formal improvement plan.
- 8.2.2. Request the supplier's Management representative(s) to attend a review meeting at a location designated by MACOM to present Root Cause analysis for the below standard performance and to outline an Improvement Plan to achieve the required level.
- 8.2.3. A MACOM team may visit the Supplier to conduct a Business Review or Quality Audit as deemed appropriate.
- 8.2.4. MACOM may adjust business share to the supplier pending improved performance levels.
- 8.2.5. Where appropriate and feasible, MACOM will provide assistance to the Supplier to achieve the improvements required for a mutually beneficial outcome.

APPENDIX A: Reference Documents

The following documents and forms constitute a part of this specification to the extent specified herein. Unless otherwise specified, the latest edition of the document applies.

Document Number	Document Title
ISO 9001	Quality Management Systems Requirements
ISO 14001	Environmental management systems – Requirements with guidance for use
ISO 10012	Measurement management systems – Requirements for measurement processes and measuring equipment
ISO/IEC 17025	General Requirements for the Competence Of Testing and Calibration Laboratories
ISO/IATF 16949	Quality Management Systems – Particular Requirements for the Application of ISO 9001 for Automotive Production and Relevant Service Part Organizations
ISO 22301	Societal security - Business continuity management systems – Requirements
ISO 22313	Societal security - Business continuity management systems – Guidance
ISO/IEC 27031	Information security - Security techniques — Guidelines for information and communication technology [ICT] readiness for business continuity
AIAG Reference Manuals	Advanced Product Quality and Control Plan Manual (APQP) Failure Mode and Effects Analysis Manual (FMEA) Statistical Process Control Manual (SPC) Measurement System Analysis (MSA) Production Part Approval Process Manual (PPAP)
TL 9000	Quality System Requirements for Telecommunications Industry
BS EN 9100	Aerospace Series - Quality Management Systems
SAE AS 9100	Quality Management Systems - Requirements For Aviation, Space And Defense Organizations
EIA/JESD46	Guidelines for User Notification of Product Process Changes by Semiconductor Suppliers
EIA/JESD48	Product Discontinuance
EIA/JEP 130	Guidelines for Packaging and labeling of Integrated Circuits in Unit Container Packing (Tubes, Trays, and Tape and Reel)
ANSI/ESD S20.20	Protection of Electrical and Electronic Parts, Assemblies and Equipment (Excluding Electrically Initiated Explosive Devices)
IEC 61340-5-1	Protection of electronic devices from electrostatic phenomena – General Requirements
IPC/JEDEC J-STD-033	Handling, Packing, Shipping and Use of Moisture/Reflow Sensitive Surface Mount Devices
JESD50	Special Requirements For Maverick Product Elimination And Outlier Management

Document Number	Document Title
JESD671	Component Quality Problem Analysis And Corrective Action Requirements
FRM-4221	MACOM's Material Declaration Form (MDF)
MFG-1075	MACOM's IC MSL Bake and Packaging Procedure
MFG-1079	MACOM's Sub-Contractor – Standard Label Format Procedure
QAF-391	MACOM Audit Form
QP-248	Supplier Change Management Processes
QP-245	MACOM Procedure: Sub-Contractor FAR Process
QAP-5116	MACOM Form: First Article Report template for MACOM's CEMs
QAP-5119	Counterfeit Parts Risk Mitigation Procedure
ECP-PUR-0017	Supplier Management Program

CONFIRMATION:

We hereby confirm that we have received and we understand the Supplier Quality Manual.

We agree to strive to meet these customer requirements and guidelines, in all our facilities working with MACOM products.

Supplier Name:	
Supplier Address:	
Submitted By (Name):	
Function / Job Title:	
Telephone Number:	
Email Address:	
Signature:	
Date (dd-mmm-yyyy):	

APPENDIX B: Revision History

Revision	Description of Change	Release Date
-	Initial Release	10-Sep-2014
A	Clarify Automotive specific requirements	04/27/15
B	Adding 2 sections to Supplier Responsibilities. Conflict Minerals & Environmental Product Compliance	Feb 2016
C	Updated company name from M/A-COM to MACOM, CO-021342	06/28/2016
D	Updated section 6.9 to reflect the recommended use of the latest revisions of ANSI/ED S20.20 and IEC 61340-5-1.	10/22/2019
E	Updated multiple items to reflect the current practice and requirement.	04/16/2021