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1.0 Purpose/Scope/ Timing

This document outlines the quality requirements for the different stages of development of an electronics assembly produced for Aclara applications.

The scope of this document is to mandate the minimum requirements for all CMs manufacturing PCBAs for Aclara sites. Additional requirements can be defined by each Aclara site or business in the form of Aclara Engineering Technical Specifications or as notes on Aclara drawings. Product and process quality standards must at minimum meet per IPC 610 Class 2 and the requirements stated in this documentation, unless otherwise specified by site or drawing. The latest version applies, unless other specified. The content of this document covers Supplier Quality Requirements for both the Meter and AMI criteria. Please see the chart in section 5 on which sections are applicable to AMI, Meters and both.

1.1 Responsibility

As described in Procedure.

A. In general, copies of all required documents must be submitted by email to the SQE by the Contract Manufacturer (CM). All documents submitted to Aclara must be in English. Acceptable formats are Adobe PDF, Microsoft Excel or Microsoft Word.

B. It is the responsibility of the ACLARA Quality Department or Aclara appropriate function to document and notify the supplier of any approved deviations or changes or exceptions thru Engineering Change Notification process to the quality requirements document, and make referenced documents and procedures available for review.

C. It is the responsibility of the supplier to notify ACLARA Supplier quality or Quality Assurance and Operations of any needed exceptions to these requirements or changes in their processes or Quality Systems that are in conflict with the documented requirements. All exceptions agreed upon by ACLARA using Aclara provided system and the supplier and Aclara shall be documented and approved by the appropriate ACLARA and supplier representatives.

1.2 Compliance Date

The following timeline is expected from all organizations within scope:

A. Full compliance at the time of issuance of this document for all PCBAs quoted with *Supplier Quality Requirements* after April, 1st, 2013. Aclara site or business in the form of Aclara Engineering Technical Specification or as notes on Aclara drawings can apply requirements to PCBAs in production prior to April 1st, 2013.

B. Any system or specification conflicts to reference in this document, the following order of precedence must apply:

   1. Purchase Order
   2. PCBA assembly drawing package
   3. Latest Revision of this specification; 105X1009
   4. Documented reference in this specification

2.0 Procedure / Quality Record Requirements

2.1 Supplier Approval

2.1.1 Minimum Quality System Requirements

CM must maintain a documented quality system as specified and required in *Supplier Quality Requirements*. Other acceptable quality management systems for PCBA include ISO 9001, ISO 14001, and ISO 16949.

2.1.2 Supplier Approval

A. In case of a NPI program requiring an approval of a new vendor or on current projects requiring approval of an alternate CM, the following three surveys must be conducted by Aclara Sourcing and/or Aclara SQE to assess PCBA manufacturer capabilities:

B. Business Survey, Electronics Technical Audit (also known as Commodity Assessment or Technical Survey) and depending on manufacturing site location (i.e. Low Cost Country), a SRG (EHS) survey.

C. CM must achieve a score of 80% or greater on the Aclara Business survey and 80% or greater on the Aclara Electronics Technical Audit. In case of a score lower than 80% in any survey, CM must present an action item list with

corrective actions, implementation date and owner and a second survey must be scheduled by Aclara SQE in less than 180 days to validate corrective actions have been implemented and closed and survey score will be re-assessed.

D. An SRG/EHS audit will be required if CM Manufacturing Location is based in a region which requires an audit. CM must have no red flags on SRG/EHS audit to be approved as Aclara Supplier.

E. On NPI programs these surveys should be conducted by Aclara Sourcing and/or Supplier Quality personnel prior to awarding a contract.

F. Aclara SQE will define frequency of future audits and surveys on the Supplier Surveillance Plan for the specific Aclara manufacturing location or Commodity.

2.1.3 The Quality System Implementation

A. Shall contain documentation of critical systems (Reference ISO 9001 for the requirements):

1. Quality Manual
2. Management Responsibility
3. Internal audit
4. Component Supplier Control
5. Data Analysis
6. Purchasing Process Control
7. Process Control
8. Corrective / Preventive Action
9. Control of Non-Conforming Product
10. Control of Monitoring and Measurement Equipment
11. Documentation Control
12. Record Control
13. Resource Management
14. Design and development

2.1.4 Manufacturing System Requirements

A. The supplier shall designate a Quality Assurance representative to address quality issues and concerns from ACLARA.

B. The supplier shall supply required documentation in a format approved by ACLARA.

C. The supplier shall submit documentation and test reports as requested to ACLARA.

D. The supplier's shall have a system to address the following:

1. Quotation Process
2. Planning and Scheduling
3. Control of Design Specification and Definition
4. Design for Manufacturing (DFM)
5. Design for Test (DFT)
6. Design Process Flow
7. Design Change and Review
8. Design Verification and Validation
9. Final Approval

2.1.5 Material Control

A. The supplier shall preserve the conformity of product during internal process and delivery to the intended destination. This preservation shall include identification, handling, packaging, storage, maintaining shelf life, applicable environmental controls, and protection

2.2 Qualification of Sourced PCBA and HLA.

2.2.1 Control of Process

A. Conformal Coating

When Conformal Coating is required by Aclara:

1. When technically feasible, the preferred application method is automated spray or dispense machine, unless otherwise stated in Aclara drawing.
2. The preferred coating should be per masking drawing or BOM or if not specified in Aclara drawing, Dow Corning 3-1953 should be used.
3. PCBAs must be clean of any flux residue and meet Ionic Chromatography limitation level in Aclara Specification Table 1 in Section 2.4 B or as specified by Aclara Engineering per part drawing or per Aclara specific site board cleanliness specification before Conformal Coating process. If Ionic Chromatography limitation levels are higher than Table 1, then a cleaning step is recommended to meet cleanliness specification prior to conformal coating.
4. Other coatings can be proposed at the beginning of the NPI program. To be considered, alternate conformal coating materials recommended must meet the following conditions:
    a. Be UL or IPC 630 approved.
    b. Have a cost advantage to preferred coating.

B. Washing PCBA

When Aclara does not explicitly specify use of wash process or when there are no process limitations due to solder paste/flux combination, it is preferred that PCBA are built using a process that does not require washing the final assembly. However, if after a review of the process a wash step is required, it must meet the following requirements:

1. De-ionized water is mandatory, Tap water is not acceptable. De-ionized water resistivity level must be greater than ten mega ohms per centimeter (>10 Mohms/cm) after recharge or regeneration.
2. The equipment must be capable of continuously monitoring the wash water as well as waste water and have the capability to automatically turn off or trip alarm if cleanliness limits of the wash water or final waste water fall below four mega ohms per centimeter (>4 Mohms/cm). Any deviation shall need Aclara SQE approval.
3. If saponifier is needed to meet the cleanliness requirement in Section 7.11, Care must be taken to specify the correct saponifier by CM. The residues that are to be removed must be analyzed and understood in order to select the correct saponifier and the appropriate concentration.

4. The PCBA bill of materials (BOM) must be analyzed to ensure that components will not be damaged.
5. All PCBAs that have been Aqueous Washed are required to have Aclara approved dryer methodology or required to have a minimum baking time of 1 hour at 65C unless otherwise waived by Aclara Supplier Quality organization.

C. Electrostatic Discharge (ESD) Protection

1. CM shall strive to establish an ESD control program in accordance with ANSI/ESD S20.20.
2. An internal ESD audit schedule must be executed and corrective actions must be planned and closed in a timely manner in case of any finding.
3. ESD audits may be performed by certified ANSI/ESD S20.20 external agency, if internal audits are not performed.
4. Specific information on how to handle ESD sensitive devices is in JEDEC JESD625-A.
5. The use of gloves or finger cots is required to prevent contamination of parts and assemblies. Gloves and finger cots must be carefully chosen to maintain ESD protection. Handling with clean hands by board edges using full ESD protection is acceptable when approved by Aclara.
6. ESD protection must be worn by all persons on Aclara dedicated lines at CM site.
7. PCBAs must not be subjected to stress or strain beyond the limits specified in IPC-JEDEC-9704, Appendix A.

D. Thermal Processes

1. Each CM's production line and/or revised combination of solder and cleaning process must be qualified. Any change in type or modification of soldering or cleaning equipment (reflow oven, wave solder, wash, hand solder, rework, etc.) or change in materials used in these processes must require re-qualification. Because the thermal profile, amount of flux, and wash efficiency, (if washed) vary, material manufacturer's test data is not acceptable.
2. Profiles should be established for each Aclara PCBA to insure the flux is properly activated, components are not thermally stressed, and proper solder joint formation is achieved. The appropriate number of thermocouples or temperature labels must be applied to the top and bottom of the PCBA to insure these requirements are met. Infrared sensors could also be used.
3. Where multiple reflow ovens or wave solder machines are used in a work cell, an individual profile must be qualified on each machine.

4. Changes to the PCBA design, the reflow oven, wave solder machine or processes, must require the Supplier to review the profile to insure the requirements as stated are met.
5. Profiles must be archived for at a minimum of three (3) years and available for Aclara review upon request. Any deviation shall require Aclara Supplier Quality approval. The data record must define all applicable machine parameters and serial numbers, thermocouple locations, PCBA part number and revision, date, and the person performing the profile.
6. All soldering materials (solder paste, wire, bars, and fluxes) must be compatible with other materials used.

E. Lot Traceability

1. CM must have systems supporting lot traceability which includes SMT component lot traceability, as well as electrical testing, rework and packaging processes traceability. Each PCBA must be serialized at the start of the assembly process with a unique number label (i.e. labeled, inkjet marked or laser etched) to help trace the assembly through the entire manufacturing process. Specific requirements on identification of serial numbers must be provided by each Aclara business or site. At minimal each serial number must include a code indicating the manufacturer name and location and a date code indicating the serialization date.
2. Each serial number must have the following information associated with it:
    a. Date and time of serialization
    b. Manufacturer part number and date code of each component, including PCB, on the PCBA
    c. Each MAC address allocated to the unit (when applicable)
    d. Date and time of each successful product quality conformance test
3. Records of each serial number and the associated information must be kept for at least three years.
4. In case a top level assembly (parent) is directly sold to Aclara and is conformed of two or more sub-assemblies (children), information must be available to allow traceability to the sub-assemblies serial numbers.
5. In case of a CM or sub-tier supplier quality issue, CM must be able to provide the following information in less than 24 hours:
    a. Shipments and Invoices # affected (shipping tracking numbers).
    b. Specific Pallets affected within affected shipments. (if applicable)
    c. Specific Boxes where suspect material was shipped.
    d. Specific Range of Serial Numbers of PCBAs affected based on specific date codes or lot numbers of suspect components.
    e. Test historical data (at minimum ICT and FCT) of Serial Numbers affected.

F. Component Material Handling and Purchasing

1. Per *Contract Manufacturer Counterfeit Part Avoidance Requirements*, all components must be sourced directly from OEM or OEM Authorized Distributors. Buying from individual brokers (Spot Buy) is not allowed and a Supplier Deviation request must be submitted to Aclara for approval in case components are urgently needed and there is no other feasible option to obtain parts from authorized channels.
2. Material shelf life must follow active and passive component shelf life Specification (when specifically defined by Aclara Engineering or defined in the Aclara drawing) or component datasheet, whichever is less.
3. Passive and Active Components over two (2) years old and less than five (5) years old must be tested for solderability per IPC/EIA/JEDEC J-STD-002 prior to use. Any use of parts older than 5 years requires the written approval of Aclara.
4. Material storage conditions (recommended: Ambient temperature of 23 C +/-5C at 35% + 15%/- 15% relative humidity) must be properly controlled; incoming material must be stored/sealed in the manufacturer original package; resealed reels and open package material must follow the material floor life and moisture sensitivity level guidelines defined by J-STD-033. Any deviation shall require Aclara Quality or Supplier Quality approval.
5. For Last-Time-Buy (LTB) material requiring long term storage, the LTB material must be stored in proper condition (i.e. vacuum sealed moisture barrier bag) to limit the impact of material reliability and solderability.
6. In case shelf life of material has been exceeded or improper storage conditions, material must be tested for solderability according to Wetting Balance or Reflow simulation J-STD-002 test procedures and components with MSL >2 must be handled according to J-STD-033. In addition, Reliability tests (i.e. Temperature cycling, Autoclave, etc.) might be required depending on the application and Aclara specific requirements for the project in question.
7. A written and approved deviation from Aclara via proper system driven Supplier Deviation Request thru Aclara provided site should be used in order to process:
    a. LTB material exceeding its shelf life.

b. Sub-tier supplier ECN/EOL notifications

c. Spot Buys

d. Use of components or bare PCBs exceeding material shelf life.

G. Rework and Repair Process

1. Rework process must be fully compatible to guidelines on IPC 7711/7721 Rework, Repair and Modification of Electronic Assemblies.
2. Rework area must have clearly marked areas for storing any WIP which is classified as non-conforming material. Material flow must be controlled to prevent any mixing of good and suspected/rejected parts.
3. Full traceability is mandatory in rework area. CM must be able to trace any serial number that has been reworked, identify failure mode and have rework action stored in database as well as time and date when board was released from rework area.
4. Rework equipment must follow calibration schedule.
5. Operators in rework / touch-up areas must have specialized training on IPC 7711/7721 or compatible standard and must be evaluated before working in mass production. Annual internal recertification program must be conducted.
6. Except for BGA, QFN and hidden solder joints, every reworked solder joint or touch-up operation must be inspected using magnification aid (i.e. Microscope) according to J-STD-001. Rework of BGA or QFN and similar packages with hidden solder joints must be inspected with X-ray equipment and Electrical test (i.e.: ICT or FCT) prior to release to next manufacturing step.
7. A supervisor or second operator must re-inspect every reworked PCBA.
8. PFMEA must include all rework and touch-ups operations in the product assembly line.

2.2.2 Process Specific Requirement

A. <u>Solder wave:</u>

1. Configuration of the measurement process
2. Pallet configuration

3. Location of temperature sensor
4. Certificate of calibration of temperature sensor used for Profile board
5. Acquisition data system
6. Temperature Profile of following Key Characteristic's:
7. Preheat ramp rate top & bottom PCB & comp (°C/sec)
8. Preheat temperature top & bottom – PCB (°C)
9. Solder contact dwell time (sec)
10. Bottom side component temperature delta (preheat to solder immersion) (C°)
11. Velocity of Carrier
12. Solder bar configuration (composition)
13. Wave configuration (lambda/chip)
14. Identification of the profile board
15. Storage conditions of the profile board
16. X ray inspection (if applicable)
17. Solder Wave Machine Reference Number
18. Maintenance plan
19. Solder Bath Analysis Reporting (minimum of monthly per machine)

B. Reflow oven:

1. Configuration of the measurement process
2. Frame configuration
3. Location of temperature sensor
4. Certificate of calibration of temperature sensor
5. Acquisition data system
6. Temperature Profile of following Key Characteristic's:
7. Maximum Temperature (°C)
8. TAL (sec)
9. Temperature Ramp rates (°C/sec)

10. Liquidous temperature (°C)
11. Velocity of Carrier
12. Solder paste configuration (composition, thickness)
13. Identification of the profile board
14. Storage conditions of the profile board
15. X ray inspection (if applicable)
16. Oven Reference Machine Number
17. Maintenance plan

C. Hand solder:

1. The solder must be minimum qualified according to supplier training plan based on IPC-A-610 standard.
2. Solders dedicated to rework operations must be qualified according to IPC-7711/21.

D. Pick & Place

1. Standard PCBA as tool description
2. Standard Program
3. Pick & Place Reference Machine Number
4. Maintenance plan

E. Coating:

1. Environment conditions (housing, temperature, humidity, compressed air)
2. ESD compliance
3. Cleaning Procedure and Material
4. Curing Process
5. Masking procedure
6. Varnish preparation (composition of components)
7. Varnish application with records of Key Characteristics
8. Adherence test (per manufacturing requirement)
9. Thickness measurement

F. Bow & Twist Dimensional Inspection

1. Through-hole component only PCBA: Bow and Twist must not exceed 1.5% (0.015 inch per inch) as measured on the diagonal. Measured per IPC-TM-650, Method 2.4.22.
2. SMT or Mixed Technology PCBA: Bow and Twist must not exceed 0.75% (0.0075 inch per inch) as measured on the diagonal. Measured per IPC-TM-650, Method 2.4.22.
3. Dimensional inspection according to mechanical drawing is required.

G. Solder Paste Print Inspection

1. CM must have process controls to measure solder paste area and volume applied on PCB solder pads. Techniques available, but not limited to, are:
   a. Automatic 2D or 3D inspection on solder printing machine.
   b. Off-line solder paste height measurement with specialized equipment.
   c. In-line Automatic Optical Inspection for solder paste printing (recommended for fine pitch components, QFN and BGAs pads).

H. Solder Joint and Component Placement Inspection

1. Aclara recommends use of Automatic Optical Inspection (AOI) equipment after reflow to inspect quality of solder joints, component polarity and placement.
2. Aclara recommends use of Automatic Visual Inspection (AVI) equipment after wave to inspect quality of solder joints, component polarity and placement.
3. In case of BGAs, QFN or other package type where solder joint is hidden below component body, X-ray inspection is required. Automatic X-ray Inspection is recommended for high volume projects or very critical parts where QFNs or BGAs are present. An individual ball must not have overall void area of 30% and total component's voids must be less than 10% of covered surface area.
4. The need of above equipment is based on Coverage Report analysis using the PCOLA-SOQ method.

2.2.3 First Piece Part Qualification (or Process Qualification for AMI products)

A. Prior to Purchase Order for First Piece Samples, (First Article) Aclara SQE or Aclara Buyer will inform CM of First Piece Qualification Requirements, sample quantity and due dates. Prior to shipping Pre-Production parts, a First Piece Qualification Report (or AMI Process Qualification checklist) must be electronically submitted via email to Aclara SQE for analysis and consideration of approval. At minimum, FPQ Reports require 5 samples and the following requirements to be completed:

1. Measurement of all dimensions specified on the Aclara released drawings (i.e. Gerber files, bare PCB drawing, Assembly drawing, etc.).
2. Verification that all components match the vendor and part number listed on the Aclara master or approved Bill of Material /Approved Vendor List (BOM/AVL).
3. Verification that all drawing notes are in compliance
4. Verification of the correct software revision with checksum if applicable.
5. When requested by Aclara SQE, a Capability study with Gage Repeatability Reproducibility (GRR) study on Critical to Quality (CTQ) parameters as specified on the drawings.
6. Process yield at all major manufacturing steps with Pareto of defects and applicable corrective actions.
7. Complete and up to date manufacturing process plan (MPP)
8. Complete and up to date product quality plan (PQP).
9. Complete and up to date process Failure Mode Effects Analysis (PFMEA)
10. Ionic Chromatography test results that meet the IC limits.
11. Packaging Plan that been approved by the Aclara receiving site.
12. Inspection procedures must be in accordance with IPC-A-610, Class 2 or as specified by Aclara site.
13. Any changes affecting the form, fit, function, or manufacturing process and procedures must require new first piece reports and samples to be submitted.

B. New Production Introduction or major product/process changes may require joint participation of Aclara representatives during qualification activities.

C. Proposed changes to a previously qualified process or product shall be submitted to Aclara Quality Assurance for evaluation to determine the need for, and extent of, an additional Process Qualification.

D. Deviations from the requirements of the approved process require a submittal of a deviation form to obtain approval from ACLARA.

E. Process approval may be rescinded at any time by written notification from ACLARA as a result of (but not limited to) design errors, audit results, or lack of control as demonstrated by process DPM levels or customer returned product.

F. Upon successful demonstration that the process/product meets Aclara requirements, a Manufacturing Release (MR) or Qualification Signoff will be issued to the CM by Aclara.

G. *Refer to Aclara Supplier Quality Requirements* for additional Qualification requirements.

H. *CM is responsible to provide access and to support Agency Approvals (UL, CE, etc.*) certifications at a certified agency lab in case they are required by Aclara Energy drawing.

I. When requested by Aclara or specified in drawing, CM must present convincing evidence (MSDS, Chemical Composition Tables or equivalent) that the CM's Process non-AVL and MRO Materials is complying with EU ROHS and/or REACH regulations. When a part requires having ROHS and/or REACH certification, a written approval from Aclara must be granted to the CM before starting any kind of production of sellable parts.

J. The CM must complete and submit IPC Form IPC 1752-2, Class 1 or 5, or equivalent statement and provide a Reach Supplier Declaration Letter on their company letter head for all non-AVL and MRO Material that include but not limited to:

    1. Solder Paste
    2. Solder Bar
    3. Solder Wire
    4. Flux
    5. Adhesive/Tape
    6. Conformal Coating

K. For Printed Circuits Fabricated Assemblies, Aclara may require a C of C for either first article, for each production lot or both. In that case, the required information shall be reflected in the C of C is as follows:

1. Customer Name
2. Customer Part Number
3. Supplier Part Number
4. Lot Number / Identification
5. Lot Quantity
6. Ship Date
7. Customer Drawing Number/Identification with revision
8. Customer Fabrication File Name
9. Signature of fabricator's quality representative and date of certification.

The certificate of compliance must state that for the printed circuit (if applicable per Aclara specification):

1. All finished boards have been 100% electrically tested and pass testing.
2. All finished boards meet the 94V-0 flammability rating.

3. The Laminate material(s) used are in compliance with IPC-4101.
4. Identify the laminate part number and manufacturer.
5. Identify the solder mask part number and manufacturer.
6. The printed circuits meet RoHS Directive requirements.
7. The printed circuits meet all other specified requirements as defined by Aclara.

Accompanying the certificate of compliance:

1. Visual Inspection Report, to include:
   a. Laminate material
   b. Laminate finished thickness
   c. Copper foil weight and finished thickness
   d. Plating thickness where applicable (ENIG gold and nickel plating, Immersion Ag, etc.) – not applicable for HASL or OSP finishes
   e. Minimum and maximum line width
   f. Minimum line spacing
   g. Minimum annular ring
2. Mechanical Dimension Report, to include
   a. Board outer dimensions

b. Finished thickness
c. Warp / twist
d. V-cut
e. Hole diameters
f. Panel Dimensions
g. Tooling hole locations
h. Hole wall plating thickness
i. Mask registration
j. Silkscreen / markings registration

3. Electrical Test Report, to include
a. Open/Short electrical testing
b. Controlled impedance lines, as specified
c. Dielectric Constant measurement of finished board
4. Physical Test Report, to include
a. Ionic contamination requirement and measured levels
b. Solderability test
c. Thermal stress test
d. Solder mask adhesion test
e. Chemical resistance test

Additionally, it is also required for first article to have a micro sectioned sample of the PC board, clearly showing the layer stack-up and a cross-section of a plated-through component hole or via to demonstrate hole plating integrity/thickness.

2.2.4 Subtier Suppliers Requirement

A. Printed Circuit Boards (Bare Boards/PCB):

1. Only Aclara approved PCB suppliers may be used for circuit board assemblies.
2. Other PCB suppliers can be proposed at the beginning of the project. To be considered, alternate PCB suppliers must meet the following conditions:
3. Become an approved and qualified PCB supplier for Aclara.
4. May have a cost advantage to other qualified vendors listed on AVL.

B. The PCB must comply with IPC-A-600 Class 2. The Qualification of PCB must comply with following requirements:
    1. Base Material Certificate
    2. 100% inspection report including:
    3. Boards edges
    4. Holes and plated through holes
    5. Printed contacts
    6. Thickness of metallic coating
    7. Holes diameters
    8. Bow & Twist
    9. Peel Strength
    10. Electrical Test (Continuity, Insulation)
    11. Solder mask characteristics
    12. Process Flow chart
    13. Control Plan
    14. PFMEA if required from the dedicated check-list
    15. Solderability test as per IPC-J-STD-002
    16. Ionic Chromatography test according to Section 2.2.11b

C. Process Consumables:
    1. MSDS are required for all process materials including:
        a. Solder material, flux, adhesives, conformal coating.
        b. Other chemicals used in the manufacturing process.
        c. Flame retardants - detailed chemical composition is required for all components using Flame retardants.

D. Materials and services purchased for use in or on ACLARA final products, including Pilot Runs or Prototypes shall be procured from approved sources.

E. Sources of materials and services which have not been previously approved or used by ACLARA shall be approved by ACLARA prior to use and be subject to supplier

qualification requirements. Suppliers shall submit requests for addition of sources to ACLARA Operations with applicable supporting documentation.

F. The supplier shall be responsible for control of component suppliers, including quality of purchased components, supplies, assemblies, and services unless managed by ACLARA or specifically highlighted by ACLARA as a critical component with ACLARA defined requirements.

G. If receipt of purchased supplies or services may impact scheduled manufacture, delivery, or unit cost of ACLARA products, the appropriate ACLARA Operations personnel shall be promptly notified.

H. Receiving inspection

1. The supplier shall develop specified purchase requirements based on ACLARA drawing requirements, IPC requirements and the vendor component information.
2. The supplier shall establish and implement the inspection or other activities necessary for ensuring that purchased product conforms to specified purchase requirements.
3. The supplier shall use an established industry standard for the creation of inspection sampling plans, and identify the standard used. The preferred sampling standard for designated critical parts is one that is AQL based, such as ANSI/ASQ Z1.4, with an assumed AQL of 0.65 Level II.
4. The supplier shall develop specific inspection processes or plans for critical parts or assemblies as designated by ACLARA Quality Assurance. The supplier shall submit these inspection processes or plans to ACLARA Quality Assurance for approval. ACLARA Quality Assurance shall supply the required inspection criteria based on part type. The supplier shall, upon request, produce the inspection plans and results for review/audit to determine adequacy with ACLARA Quality Assurance.
5. The supplier shall maintain receiving inspection information for each part, including applicable drawings, history log, applicable instructions, and nonconformance reporting.

2.2.5 Manufacturing Process Plan (MPP)

A. In addition to requirements for MPP by *Supplier Quality Requirements* , MPP must contain the following information:

1. Include detailed description of equipment including make and model.
2. Describe equipment layout and factory arrangement. Include description of manufacturing and inspection steps. Include high level documentation number for each process step.
3. CM is required to provide latest IPC form IPC-1720 for submission in the First Piece Qualification.

B. The supplier shall plan the production to ensure that it is carried out under controlled conditions and in accordance with agreed upon production and shipping schedules.

C. The supplier shall have a documented processes and maintain records for validating equipment and processes when:

1. Starting up ACLARA products
2. Making any changes to previously approved products

D. Process documentation (including work instructions) shall be completed and submitted to Aclara to support Product/Process qualification before the start of pilot production.

E. The supplier shall identify and develop all necessary tools, fixtures, and software required for production.

2.2.6 Product Quality Plan (PQP)

A. In addition to requirements for PQP by *Supplier Quality Requirements*, MPP must contain the following information:

1. The following processes must be controlled using Statistical Process Control :
   a. Solder Paste Height and Volume (Continuous variable)
   b. Deionized Water Washing (Continuous variable)
   c. PCBA Process Cleanliness (Discrete variable)

B. Adequate controls shall be implemented for tools and fixtures regardless of ownership.

C. The supplier shall establish processes to ensure that monitoring and measurement equipment and applicable software used to determine acceptability per established design and quality requirements shall be:

1. Calibrated or verified at specified intervals against measurement standards traceable to international standards, national measurement standards, or documented verification method.
2. Identified so calibration status can be determined

D. The supplier shall use Statistical Process Control (SPC) where appropriate on critical process parameters. The supplier shall determine process capability prior to starting SPC. A minimum CPK of 1.33 shall be achieved unless otherwise authorized by Aclara QA or Supplier Quality.

E. Unless otherwise approved by ACLARA, the supplier shall perform 100% test of all manufactured/integrated assemblies at various test stations to ensure conformance to drawing and specification requirements. Evidence of such tests shall be on file and available for review by ACLARA Supplier Quality or Quality Assurance.

F. ACLARA Quality Assurance will work with the supplier to set production yield targets

G. Personnel performing work affecting product quality shall be competent on the basis of appropriate education, training, skills, experience, and applicable industry standards.

2.2.7 Characteristic Accountability and Verification (CAV)

A. When requested by Aclara, a Gage R&R study using ANOVA method is required for critical operations (i.e. visual inspection, test, dimensional checks, etc.).

B. When requested by Aclara, Capability studies are required to be performed for each Critical to Quality (CTQ) specifications.

C. Critical Internal process (CTP) parameters can also be considered as CTQ on SPC system when requested by Aclara SQE.

D. The minimum sample size for computing the capability (Cpk) must consist of 30 parts made up of 6 logical subgroups of 5 consecutively made parts each. Subgroups are selected in a way as to maximize the exposure to varying conditions.

E. Workmanship standards

1. ACLARA product shall be manufactured according to applicable industry workmanship standards as specified in ACLARA engineering drawings, specifications, and procedures.
2. All cable and wire harnesses shall meet the requirements of IPC/WHMA-A-620 unless otherwise specified by the product drawing requirements.

F. Special Technical requirements for AMI products

1. Unless otherwise noted on an Engineering Drawing or Statement of Work, the supplier shall meet the requirements of Aclara drawing 300010046 “Printed Wiring Board Notes”.
2. The Aclara drawing 300010047 “Printed Circuit Board Assembly Notes/Requirements” will supersede existing drawing notes.

2.2.8 Process Failure Mode and Effects Analysis (FMEA)

A. CM must conduct and present a process FMEA. All high-risk FMEA items must be addressed in the Product Quality Plan.

B. There must exist, an internal best practice document and communication process that is utilized in the PFMEA development. The process must include documentation and data which explains how the PFMEA numbers/rankings were developed. In case CM needs some guidance on how to develop PFMEA rankings, please contact Aclara SQE or use as reference the following Table of PFMEA Rankings for Electronics (PCBA) manufacturing.

C. This process must be reviewed periodically for effectiveness and must include continuous improvement and lessons learned.

D. All PFMEA concerns must have descriptions of current controls and recommended actions.

E. The PFMEA is a living document and must be traceable to process changes. These documents must contain the special Product/Process characteristics agreed to and identified by the Qualification Team.

F. The Process FMEA must reflect the entire manufacturing process from receiving through shipping.

G. The CM must ensure all failure modes observed during pre-production runs are captured on the PFMEA.

H. The CM must ensure failure occurrence and the detection ability of these failures, observed during pre-production runs correlate with the occurrence and detection numbers documented on the FMEA. CM may use their current RPN chart or Aclara Proposed RPN chart in Chart 1, for PFMEA Scoring.

Chart 1: Aclara Default RPN Scale recommendation

RATING	DEGREE OF SEVERITY	LIKELIHOOD OF OCCURRENCE		ABILITY TO DETECT	
1	Customer will not notice the adverse effect or it is insignificant. (No Impact on Form, Fit, or Function)	Likelihood of occurrence is remote	1 PPM	Sure that the potential failure will be found or prevented before reaching the next customer. (Defect is Obvious and can be kept from affecting the customer.)	100%
3	Customer will experience annoyance due to the slight degradation of performance. (Customer will need to conduct Rework or Sorting.)	Low failure rate without supporting documentation	100 PPM	Low likelihood that the potential failure will reach the next customer undetected. (Automated inspection built into process, such as a machine-based vision system. Or, process control monitoring is established.)	95%
5	Customer is made uncomfortable or their productivity is reduced by the continued degradation of the effect. (Customer will need to scrap parts or be subject to warranty costs)	Relatively moderate failure rate with supporting documentation	200 PPM	Moderate likelihood that the potential failure will reach the next customer. (Manual inspection built into process. This includes human-based visual inspections.)	85%
7	High degree of customer dissatisfaction due to component failure without complete loss of function. Productivity impacted by high scrap or rework levels.	Relatively high failure rate with supporting documentation	500 PPM	Poor likelihood that the potential failure will be detected or prevented before reaching the next customer. (Audit and/or Sampling Plan established.)	70%
10	Customer endangered due to the adverse effect on safe system performance without warning before failure or violation of governmental regulations	Assured of failure based on warranty data or significant DV testing	1,000 PPM	Absolute certainty that the current controls will not detect the potential failure. (Not Detectable)	< 50 %

2.2.9 Detailed Drawing, Manufacturing, and Producability Review

A. In addition to requirements by *Supplier Quality Requirements* , Review must contain the following information:

1. The CM should present a complete Design for Manufacturing (DFM) report for PCBA and PCB Layout. Specific design guidelines required in order for designs to be built in the CM factory. Specify any limitations such as PCB trace line width, maximum PCB sizes, component sizes the equipment can handle.
2. The CM should present a complete Design for Testability (DFT) report, include Test and evaluation capabilities (i.e. number of test chambers, capacity, and temperature/humidity capabilities, availability of electrical testers/fixtures like ICT and/or Flying Probe and/or FCT, etc.).

2.2.10 Packaging and Preservation Requirements

A. In addition to requirements by *Supplier Quality Requirements* , the following requirements apply:

1. A package sample must be delivered to the receiving site for approval prior to Pilot build.
2. Packaging must adequately protect parts and satisfactorily meet Ship Test requirements per Fed Ex test as defined in Cycle II, Schedule C (FedEx).
3. Packages should have dividers inside to separate individual PCBAs
4. Individual PCBAs must be stored in an ESD-safe package. ESD-safe packages (i.e. Dissipative Metallized Shielding Bags/Conductive Cardboard) must have a surface resistivity value of less than 1x10^11 ohms @100 volts or per Aclara Engineering Site Specification. When qualifying Anti-static Shielding bags type III, these must be tested according to MIL-B-81705C standard.
5. When Pallets (set of boxes) are requested, palletizer plastic must cover 100% of the area of the pallet to avoid water damage to packages and PCBAs.
6. Individual package weight maximum is 35 pounds or as per Aclara site requirements.
7. Packages are to be palletized (Aclara preferred method) and shipped on pallets made from materials approved by the materials manager of the Aclara receiving site.
8. Refer to Marking Packaging Preservation and Shipping Requirements latest revision or specific Aclara site-specific Packaging Requirements.

9. Each package must at a minimum be labeled as specified by *Supplier Quality Requirements*
10. In cases where Import/Export control requires a form of product identification to indicate a difference between new product and product returned for warranty/rework, extra characters may be added following the Aclara part number on the shipping documents and labels to indicate the returned status.

2.2.11 Ionic Chromatography

A. This section is mainly dedicated to NPI but when there is any cleanliness issue is raised then this may be applicable to ongoing production at once to recalibrate the process. Cost coverage (NRE) of this shall be discussed with Aclara's appropriate resource during NPI.

B. Incoming PCB and CM processed board cleanliness levels must be proven to meet the specifications of Ionic Chromatography limitation in Aclara Specification Table 1 in Section 2.4 or as specified by Aclara Engineering per part drawing or per Aclara specific site board cleanliness specification.

C. Ionic Chromatography test must be performed at an Aclara approved laboratory site per IPC-TM-650 2.3.28. Refer to Section 2.4 for limitation level and defined test results analysis.

1. Five (5) Bare Boards directly from PCB supplier.
2. Five (5) Processed PCBs from PCBA CM, run through all soldering processes and after wash process if applicable without conformal coating.
3. Whole bag extraction for Ionic Chromatography test procedure is defined per IPC-TM-650 2.3.28.
4. Localized extraction at six (6) locations or less, as agreed upon by Aclara SQE, for Ionic Chromatography can be performed using the C3 tester equipment as per Foresite C3 operation manual to secure test solution. Test solution will be process per Ionic Chromatography test procedure as defined per IPC-TM-650 2.3.28.
5. Ionic Chromatography limitation levels are defined and test results analysis is define in section 2.4.

2.2.12 Qualification Sign-Off or Manufacturing Release process for AMI

A. In addition to requirements *Supplier Quality Requirements,* Aclara qualification team must have Electronic Quality Review signed off and released approval.

2.3 Supplier Performance Management (Meter)

2.3.1 Process Capability Checks

A. In addition to requirements by *Supplier Quality Requirements* , the following requirements apply:

B. For those CTQs identified on the drawings, data must be saved to provide in accordance with the sampling plan defined by Aclara SQE.

C. Internal Process CTQs (i.e. solder paste volume) at CM production line must be monitored with control charts and those can be audited and requested by Aclara at any given time for Engineering or Quality reviews. Control Charts must be reviewed by Process or Quality Engineer every shift and corrective actions should be taken and documented.

D. Confirmed defects shall be recorded for each unit of PCBA. Each Defect Record shall include the following information, and shall be kept for at least 5 years:

1. Manufacturing location
2. Manufacturing line
3. Aclara product identifier
4. Aclara product revision code
5. Unit serial number
6. Defect category according to IPC-9261 or equivalent
7. Defect description
8. Component reference designator (CRD) for component, placement, and termination defects
9. Aclara component part number for component, placement, and termination defects
10. Defect quantity for termination defects
11. CM to provide a Product Defect Report and Process Yield Report shall be provided on a minimal quarterly basis of critical process steps;
12. Paste Printing
13. Placement
14. Reflow

15. AOI (if applicable).
16. X-ray (if applicable)
17. Manual Insertion
18. Wave solder
19. Selective soldering
20. In-circuit Test X
21. Functional Test

2.3.2 Cost of Failure (COF) and Recovery

A. In addition to *Supplier Quality Requirements* , the following requirements are to be applied:

1. CM shall be required to strive a rolling three month quality level of less than 1000 defective parts per million (PPM) at each Aclara production site.
2. PPM is defined as CM responsible PCBA rejected from Aclara production lines divided by PCBA used on Aclara production line used in same time period multiplied by one million.

$$PPM = \frac{\#\ of\ CM\ responsible\ for\ rejected\ PCBA}{\#\ of\ PCBA\ used\ on\ Aclara\ producrtion\ Line} \ X\ 1{,}000{,}000$$

3. Aclara SQE to provide PPM level to CM periodically, with a maximum timeframe of quarterly per year.
4. CM has the first six months of a new PCBA production intent volume to established PPM baseline and plan of actions to strive to reduce rolling three month PPM to 1000 PPM within the first year of production intent volume.
5. CM is responsible for additional screens on internal production line to reduce identify defects caused by CM at Aclara production line until corrective actions are implemented.

6. For defects that CM suspects to be related to Aclara production processes or designs, CM must submit RFI in Aclara driven system with detail of defect and impact on PPM in total and percentage defect per month for Aclara SQE to review. If approved by Aclara SQE, the Aclara SQE will initiate an audit finding into Gensuite or Aclara site approved audit tracker for Root Cause and Corrective Action tracking. Aclara SQE is responsible for updating CM's PPM data to reflect defects that are only attributable to CM.
7. If CM does not show plan of actions, effective implementation of actions on CM production line and at a minimum 20% improvement year over year on PPM value, Aclara can take effective actions against CM as stated in the Aclara Supplier Agreement with CM.
8. CM internal quality targets at critical process steps listed below must support the 1000 PPM Aclara target. Internal quality targets must be reviewed at a maximum every 3 months to demonstrate continuous improvement.
    a. Paste Printing
    b. Placement
    c. Reflow
    d. AOI (if applicable).
    e. X-ray (if applicable)
    f. Manual Insertion
    g. Wave solder
    h. Selective soldering
    i. In-circuit Test
    j. Functional Test
9. CM has the first six months of a new PCBA production intent volume to established First Pass Yield baseline of 95% for each critical process step and plan of actions to improve First Pass Yield within the first year of production intent volume to 97%.
10. Each year, the CM and Aclara SQE will review first pass yield data and established first pass yield goal for each process for each of the Aclara Production site.

2.3.3 Root Cause Analysis (RCA)/Corrective Action and Preventative Action (CAPA)

In addition to Supplier Quality Requirements, the following requirements apply:

A. The CM is required to have a well implemented Return Material Authorization (RMA) system in order to approve and track rejected material returns from Aclara. CM is responsible for shipping and analysis (laboratory) expenses for all rejects being returned for failure analysis on confirmed rejects. The CM must provide the return procedure for Aclara to follow to ensure tracking of all failures. It is important that this procedure works quickly and smoothly.

B. The CM is required to have a defined and working failure analysis and corrective action system. Failures identified at Aclara manufacturing facilities will be returned to the CM for analysis and corrective action. Each failure returned to CM or agreed to have repaired must be tracked, analyzed, and have a corrective action implemented before closing the report.

C. Failure analysis laboratory must have adequate equipment to perform:

    1. Autopsy Analysis Level 1: To confirm that the suspect PCBA is defective.
    2. Autopsy Analysis Level 2: To confirm which component or process is causing the assembly to be defective.

D. In case of sub-tier supplier quality issue, CM must send defective components to sub-tier supplier or 3rd party external laboratory if failure rate is above one percent (1%) of total failure returned in RMA shipment for:

    1. Autopsy Analysis Level 3: To confirm root cause of component malfunction.

E. Internal Audits

    1. The supplier shall conduct internal process and product audits at planned intervals to determine if the quality system conforms to planned arrangements and is effectively implemented and maintained. Completed audit reports shall be available upon ACLARA request.

2.3.4 Production Reliability Audit Testing (PRAT)

A. Production Reliability Audits (PRAT) Testing Specification requirements must be followed in cases where Aclara requests per the drawing. Test methods and detailed specifications of PRAT testing will be provided by Aclara Engineering team in charge of the project.

2.3.5 Production Cleanliness Audit Testing

Bare PCB Ionic or C3 Test cleanliness report is required on each PCB shipment lot to CM and results archived by CM for minimum three years.

Daily cleanliness audit testing is required using Ionic Chromatography, Static ROSE (i.e.: Omegameter or Ionograph), or C3 Testing, at minimum every four hours or once per production build if less than eight hours.

Quarterly Ionic Chromatography testing is required by the PCBA CM at the Aclara approved laboratory site. In cases where there are multiple part families, alternate samples from varying part families each quarter, so that all part families are tested at a minimum annually with an equal number of samples each quarter. Part Families are defined as having the same Aclara PCB part number. If CM is currently Ionic Chromatography testing or C3 testing for daily cleanliness monitoring on a part family, quarterly auditing monitoring is not necessary.

This must be documented in the Product Quality Plan for the production of

A. PCBA family and approved by Aclara SQE during qualification.
B. One (1) Processed PCB per part family from PCBA CM, run through each soldering processes and after wash process if applicable without conformal coating
C. Whole bag extraction for Ionic Chromatography test procedure is defined per IPC-TM-650 2.3.28.
D. Localized extraction at three (3) locations or less, for Ionic Chromatography can be performed using the C3 tester equipment as per Foresite C3 operation manual to secure test solution. Test solution will be process per Ionic Chromatography test procedure as defined per IPC-TM-650 2.3.28.
E. The static ROSE method is fully described in IPC-TM-650 2.3.25 and 2.3.25.1.
F. C3 test procedure is defined per Foresite operation manual at three (3) locations or less, as agreed upon by Aclara SQE.
G. Ionic Chromatography, Static Rose, and C3 limitation level are defined and test results analysis is define in section 2.4.

2.3a Supplier Performance Management (AMI)

2.3a.1 Process

A. Quality Reviews shall be held to review issues and actions including the following:
    1. New products
    2. Manufacturing issues
    3. Design changes
    4. Test and inspection failures / results
    5. Documentation issues
    6. Corrective actions
B. Suppliers shall submit or make available monthly summary information measured in DPM (defects per million) or process yield per each product family for the following areas as applicable:
    1. SMT / Wave Solder
    2. ICT (in circuit testing)
    3. FCT (functional circuit testing)
    4. Burn In Testing, when applicable to product
    5. Out of box inspection (or “dock audit”)
C. Suppliers shall submit or make available an Action Plan based on a Pareto analysis of defects and test failures recorded during process inspection.
D. Suppliers may be subject to on-site visits by ACLARA Quality with the following review agenda (as applicable):
    1. Review of latest supplier DPM/Yield summary report
    2. Review / verification of open corrective actions
    3. Review of data and actions / improvements related to critical process areas
    4. Out of box inspection (or “dock audit”)
E. Supplier shall submit all data in a format method as stipulated by ACLARA QA.

2.3a.2 Documentation / Software Control

A. ACLARA assumes responsibility for assuring the correct revision level of drawings, test software revision and version, and specifications are available for the procured product.

B. The documentation control activities at the supplier and ACLARA shall coordinate to ensure proper communication and implementation of all documentation transmissions and changes to established ACLARA and supplier procedures.

C. Note: Access to Aclara's electronic documentation system will allow the suppliers to maintain their internal systems in sync with Aclara.

D. The supplier shall be responsible for assuring availability and application of the required drawings, test software revision or version, and specifications within the manufacturing process.

E. The supplier shall maintain records of all inspections and test results, and calibration records for a period of not less than 2 years.

F. Records shall indicate the nature and number of observations, the number and type of deficiencies found, the quantities approved and rejected, and the nature of the corrective action taken.

G. The supplier shall contact ACLARA for disposition of records in the event of business relationship termination.

2.3a.3 Non-Conforming Product Control

A. *The supplier shall segregate all non-conforming material (components and assemblies) from normal product and production flow and clearly identify its status.*

B. *The supplier's MRB authority is authorized to issue dispositions of:*

1. *Rework to ACLARA engineering requirements*
2. *Return to previous operation for reprocessing*
3. *Scrap, unless material is owned by ACLARA*
4. *Return to a component supplier*

Note: Documentation of the dispositions is required and shall be available for ACLARA review.

C. *The supplier shall identify all reworked assemblies by:*

1. *Providing sufficient traceability of the reworked assembly to all rework and testing records through an electronic data collection system.*

D. *The supplier's MRB authority for ACLARA product may be rescinded at any time by written notification from ACLARA Quality Assurance.*

E. *The supplier shall have documented procedures for the handling, control, and reporting of customer returned product.*

F. *Rework and analysis data for returned product shall be submitted directly to ACLARA Quality Assurance and Service and Repair. ACLARA will determine the extent and the format of the information required.*

G. *Finished product which contains any nonconformance to the purchase order, drawings, specifications, or applicable documents must be reviewed by ACLARA for disposition.*

H. *Previous disposition shall not be considered as a precedent for continued delivery of nonconforming material, and each occurrence shall be considered on an individual basis.*

I. *Disposition of scrap material owned by ACLARA shall be coordinated through the ACLARA Supply Chain Account Manager and Supplier Quality Engineer.*

2.3a.4 Supplier request for deviations

A. *Any deviations from established ACLARA requirements shall be requested through the ACLARA Quality Assurance*

2.3a.5 Continual Improvement and Statistics

A. *The supplier shall continually improve the effectiveness of the quality system through established policy, objectives, audits, data analysis, corrective and preventive actions, and management review.*

B. *The supplier shall determine applicable statistical methods to facilitate continual improvement, identification and prediction of failures, and development of improvement action plans.*

2.3a.6 Corrective action requests to supplier

A. *The supplier shall submit an initial response to any ACLARA issued corrective action request by the due date indicated on the corrective action form. Extensions to this due date must be requested through ACLARA Quality Assurance*

1. *The supplier shall submit updates and verification data for corrective actions as it is requested by ACLARA.*
2. *For AMI products, Aclara may submit a Notice of Escape (NOE) to request corrective actions on minor issues*.

2.4 Cleanliness

2.4.1 Purpose

A. This section outlines Aclara Printed Circuit Board Assembly (PCBA) Cleanliness testing requirements, PCB/PCBA sample testing to be conducted, the data collection procedure, the method of analysis, definition of specification limits of each ion of concern and direction on action to take when levels are exceeded. In the event of conflict between the requirements of this document and the referenced applicable documents listed below, this document governs and takes precedence. This test is required when starting a new assembly line, switching to a new printed circuit board supplier, changing a PCB supplier process or materials, or moving to a new

contract manufacturer. The test should be performed quarterly to ensure the CM has maintained the quality of work.

B. Ionic Chromatography measures the amount of ionic contamination that is present on the surface of the printed circuit board. Ionic contamination concerns Aclara due to the relationship between high contamination levels and failure of the printed circuit board due to electromigration. This document defines the data collection procedure, the recommend method of analysis, the specification limits of each ion of concern and finally the direction on what action to take when ionic levels exceed the specified limits.

2.4.2 Approved laboratories

Foresite
1982 S. Elizabeth St.
Kokomo IN 46902
(765) 457-8095
FAX (765) 457-9033
www.Residues.com

* Any lab recommendation by CM shall require Aclara Supplier Quality approval.

2.4.3 Test Results Analysis

A. Analysis of the Ionic Chromatography report as conducted by the Qualification team and/or CM. In case the average ionic values of individual ion of tested boards exceed the max limit for a given region or whole board of the PCBA, and/or any individual ionic value exceed 1.5x the max limit of a particular ion, and/or the WOA values exceed the limits in the below table (table 1):

1. If qualifying a new PCB Manufacturer or a new PCBA Contact Manufacturer or a process/material change at current CM, then the qualification is rejected. Status is rejected until corrective action is implemented and proven effective through subsequent testing.
2. If during audit testing of current product, then the production lots of printed circuit boards associated with the failed board must be placed into non-conforming material. Two additional boards must be selected from affected lot and tested. If both boards pass, lot is released. If another failure is observed, CM must follow Supplier Deviation process for Aclara disposition.

B. Analysis of the C3 report as conducted by the Qualification team and/or CM. In case the individual reading is above 250uA @ 120 seconds:

1. If taken during qualifying a new PCB Manufacturer or a new PCBA Contact Manufacturer or a process/material change at current CM, then the C3 sample is recommend to be sent for Ionic Chromatography testing to understand potential cause of test result. C3 testing during qualification is only recommended for the development of processes at CM.
2. If during audit testing of current product, then the production lots of printed circuit boards associated with the failed board must be placed into non-conforming material. Two additional boards must be selected from affected lot and tested. If both boards pass, lot is released. If another failure is observed, CM must follow Supplier Deviation process for Aclara disposition and C3 sample is to be sent for Ionic Chromatography testing to understand potential cause of test results.

2.4.4 Specification Limits

A. C3 Specification Limits: Localized extraction will be performed using the C3 tester equipment as per Foresite C3 operation manual. C3 current leakage must not exceed the normal standard reliability of 120 seconds at 250uA of leakage current.

Table 1: Ionic Chromatography Specification Limits

Contaminants		**PCB (µg/in²)**	**PCBA with No Wash (µg/in²)**	**PCBA with Wash (µg/in²)**
Sodium	Na^+	<3	<3	<3
Potassium	K^+	<3	<3	<3
Calcium	Ca^{+2}	<1	<1	<1
Magnesium	Mg^{+2}	<0.5	<1	<1
Ammonium	NH_4^+	<2	<2.5	<2.5
Acetate	$CH_3CO O^-$	<2.5	<3	<3
Formate	HCOO-	<2.5	<3	<3
Bromide	Br^-	<3	<6	<6
Chloride	Cl^-	<2.5	<3.5	<3.5
Fluoride	F^-	<0.5	<1	<1

Table 2: Static Rose

Nitrate	NO_3^-	<2	<3	<3
Nitrite	NO_2^-	<2	<3	<3
Lithium	Li	<0.5	<1	<1
Sulfates	SO_4^{-2}	<3	<3	<3
Citrate		<0.5	<2	<2
Phosphate	PO_4^{-3}	<2	<3	<3
WOA	WOA - SMT	N/A	25	25
	WOA-WAVE	N/A	150	25

(Omegameter) levels must not exceed the following levels:

Contaminants		**Bare Board (µg/in²)**	**Processed Board (µg/in²)**
Sodium Chloride	NaCl	<5	<5

3.0 Definitions, Acronyms and References

To improve the clarity of the requirements stated in this document, selected words, phrases and acronyms are defined below.

ALT	Accelerated Life Test
AVL	Approved Vendor List
BOM	Bill of Materials
CM	Contract Manufacturer
DFM	Design for Manufacturing
DFX	Design Manufacturing and Testability Excellence
DPM	Defects Per Million
EAU	Estimated Annual Usage
EQ	Electronics Quality
ESD	Electrostatic Discharge
FPQ	First Piece Qualification
HLA	High Level Assembly
MRB	Material Review Board (a formal review to evaluate and issue disposition for non-conforming material)
MPP	Manufacturing Process Plan
NCA	Non-Conformance Assessment
OEM	Original Equipment Manufacturer
PCB	Printed Circuit Board
PCBA	Printed Circuit Board Assembly
PFMEA	Process Failure Mode Effects Actions
PQP	Product Quality Plan
PRAT	Product Reliability Audit Testing
QMS	Quality Management System
RCA	Root Cause Analysis
RCE	Remote Communications Equipment
RPN	Risk Priority Number

SCE	Substation Communications Equipment
SPQ	Supplier Process Quality System
SQE	Supplier Quality Engineer
SRG	Supplier Responsibility Guidelines
TRS	Technical, Regulatory, and Standards

Audit – Independent review and examination of records and activities to assess the adequacy of system controls, to ensure compliance with established policies and operational procedures, and to identify deficiencies in controls, policies or procedures for corrective and preventive action.

Audit Criteria – Set of policies, procedures, work instruction or requirement used as a reference.

Audit Finding – Result of the evaluation of the collected audit evidence against audit criteria. Audit findings can indicate either conformance or nonconformance with audit criteria or opportunities for improvement.

Containment – Actions taken to minimize the Aclara and customer risk associated with a nonconformance. Containment actions apply to product, process or material in which the nonconformance was detected as well as similar products or product families in which the nonconformance may occur.

Continuous Improvement – Recurring activity to increase the ability to fulfill requirements. The process of establishing objectives and finding opportunities for improvement is a continuous process.

Correction – Actions to repair rework or replace the detected nonconformance, defect or other non-desirable situation.

Corrective Action – Action taken to eliminate the cause(s) of an existing nonconformance, defect or other non-desirable situation to prevent recurrence.

Pareto Analysis – A method used to analyze the frequency of defects or failures to classify their relative importance.

Procedure – Documented statement of QMS process requirements. Unlike a Work Instruction, a procedure does not state how the process must be performed.

Process – Set of interrelated activities which transform inputs into outputs.

Product – The result of a process. Whenever the term "product" occurs, it can also mean "service", or any deliverable associated with fulfillment of a contract.

Quality Management System – Management system to direct and control an organization with regard to quality.

Record – Document stating achieved results or providing evidence of performed activities.

Requirement – Need or expectation that is stated, generally implied or obligatory.

Root Cause – A cause of an incident, which, if it had not occurred, would have prevented the incident.

Traceability – The ability to determine the history, location, application, processing conditions and/or composition of a product by means of documented recorded identification.

Through this document the term Contract Manufacturer (CM) and the term Supplier are used indistinctively and are considered of equivalent meaning.

References:

The most recent revision of the referenced documents applies:

Test Methods	
IPC-TM-650	Test Methods Manual
Printed Circuit Board	
IPC-A-600	Acceptability of Printed Circuit Board
Acceptance	
IPC-A-610	Acceptability of Electronic Assemblies
Assembly	
J-STD-001	Requirements for Soldered Electrical and Electronic Assemblies
IPC-7912	Calculation of DPMO and Manufacturing Indices for Printed Wiring Assemblies
IPC-9261	In-Process DPMO and Estimated Yield for PWAs
Solderability	
J-STD-002	Solderability Testes for Components Leads, Terminations, Lugs, Terminals and Wires
J-STD-003	Solderability Tests for Printed Boards
Assembly Support	
J-STD-609	Marking and Labeling of Components, PCBs and PCBAs to Identify Lead (Pb) Pb-Free and Other Attributes and Devices
IPC-7711/7721	Rework, Repair and Modification of Electronic Assemblies
Flux/Solder	
J-STD-004	Requirements for Soldering Fluxes
J-STD-005	Requirements for Soldering Pastes
J-STD-006	Requirements for Electronic Grad Solder Alloys and Fluxed and Non-Fluxed Solid Solders for Electronic Soldering Applications
Adhesives	

IPC-SM-817	General Requirements for Dielectric Surface Mounting Adhesives
IPC-CA-821	General Requirements for Thermally Conductive Adhesives
Conformal Coating	
IPC-CC-830	Qualification and Performance of Electronic Insulating Compound for Printed Board Assemblies
Components	
J-STD-020	Moisture/Reflow Sensitivity Classification of Plastic Surface Mount Devices
J-STD-033	Packaging and Handling of Moisture Sensitive Non-hermetic Solid State Surface Mount Devices
Regulatory	
IPC-1751	Generic Requirements for Declaration Process Management
IPC-1752	Material Declaration Management
Handling	
JS625-A	Requirements for Handling ESDs Devices
ANSI/ESD S20.20	Electrostatic Discharge Control Program Standard
Qualification	
	Supplier Quality Requirements
	Marking, Packaging, Preservation, and Shipping Requirements
	Contract Manufacturer Counterfeit Part Avoidance Requirements

Applicable Aclara AMI Documents:

A. Corrective Action Procedure
B. Deviation Procedure
C. Process Qualification Procedure
D. First Article Inspection Procedure
E. Supplier Assessment and Control Procedure
F. Manufacturing Release Procedure
G. IPC/WHMA-A-620 Requirements and acceptability for Cable and Wire Harness assemblies
H. First Article Request form
I. Process Qualification Checklist
J. Notice of Escape form

4.0 Chart and Checklist

The following table indicates applicable sections to Aclara's AMI and Meters sectors

ESQR Sections	Title	Meters only	AMI only	Both
1.0	**Purpose/Scope/Timing**			X
1.1	Responsibility			X
1.2 A	Compliance	X		
1.2 B	Compliance			X
2.0	**Procedure/Quality Record requirements**			
2.1	**Supplier Approval**			
2.1.1	Min Quality System Requirements			X
2.1.2 A,B,C	Supplier surveys	X		
2.1.3 A	Quality System elements			X
2.1.4 A,B,C,D	Mfg System Requirements			X
2.1.5 A	Material Control			X
2.2	**Qualification of Sourced PCBA and HLA**			
2.2.1	Control of Process			
2.2.1 A	Conformal coating	X		
2.2.1 B	Washing PCBA			X
2.2.1 C	ESD protection			X
2.2.1 D	Thermal processes			X
2.2.1 E	Lot Traceability			X
2.2.1 F	Component Matl handling and purchasing			X
2.2.1 G	Rework and repair process			X
2.2.2	Process specific requirements			X
2.2.3	First piece Part Qualification			
2.2.3 A	qualification report submittal	X		

2.2.3 B	Aclara joint participation			X
2.2.3 C	proposed changes			X
2.2.3 D	deviations			X
2.2.3 E	rescinding approval			X
2.2.3 F	mfg release signoff			X
2.2.3 G	additional requirements			X
2.2.3 H	agency approvals			X
2.2.3 I	rohs/reach regs			X
2.2.3 J	IPC form	X		
2.2.3 K	C of C requirements		X	
2.2.4	Subtier Suppliers requirement			X
2.2.5	Mfg Process Plan			
2.2.5 A	information	X		
2.2.5 B	controlled conditions			X
2.2.5 C	documented processes			X
2.2.5 D	documentation submittal			X
2.2.5 E	tools			X
2.2.6	Product Quality Plan			
2.2.6 A	SPC	X		
2.2.6 B	controls			X
2.2.6 C	measurement equip			X
2.2.6 D	SPC			X
2.2.6 E	testing			X
2.2.6 F	yields			X

2.2.6 G	training			X
2.2.7	Characteristic Accountability & Verification			
2.2.7 A	gage R&R			X
2.2.7 B	capability study			X
2.2.7 C	SPC			X
2.2.7 D	Cpk samples			X
2.2.7 E	workmanship stds			X
2.2.7 F	AMI tech requirements		X	
2.2.8	PFMEA			X
Chart 1	RPN scale			X
2.2.9	Dwg, Mfg, Producability Review			X
2.2.10	Packaging and Preservation			X
2.2.11	Ionic Chromatography	X		
2.2.12	Qualification signoff, MR process		X	
2.3	**Supplier Performant Mgt (Meters)**	X		
2.3a	**Supplier Performance Mgt (AMI)**		X	
2.4	**Cleanliness**	X		
3.0	**Definitions, etc**			
	Acronyms			X
	Definitions			X
	Reference documents	X		
	AMI documents		X	
4.0	**Document revisions and approvals**			X

5.0 Document Revisions

Rev.	Section Modified and Revision Description	Date	Author
8.0	Re-issue in EM QMS format. Simplified. Replaces ESQR 105X1007 REV 7.	11/2/2015	C Danner, T Holder
1.0	Replaces 105X1009 REV 8. Removed GE EM references and updated with Aclara	6/20/2016	M Wright
1.0a	Clerical corrections	6/20/2016	M Wright
2.0	Additions to reflect Aclara AMI QMS procedures and references	6/29/2016	K Ravichandran, R Telker, M Wright
2.1	Added applicable Aclara AMI document references	6/30/2015	R Telker/mkw
3.0	Formatting and clarifications in PCBA baking & drying and conformal coating material usage	7/1/2015	K Ravichandran
4.0	Renamed document for ISO procedure	8/3/2016	J Galida/mkw
5.0	CM's feedback and chart addition	10/13/2016	K Ravichandran
6.0	Revision addition to the table	11/07/2017	K Ravichandran
7.0	Moved Doc Revisions to Section 5.0. Removed reference to DMS from Doc Revisions. Ran spell checker. Added doc approval signature area at the bottom of the final page.	13MAR2018	J Galida
8.0	Added Fusion document reference number and eliminated signature line and revision table, as signatures are now digital and revision and ISO relevance information is now captured in Fusion Item Details. Upload of existing QMS documents into Fusion is for closure of CARs 190029, 180040, and 180043.	04FEB20	B Fulton