

General Quality Requirements

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1 General clauses – applicable to all ARS purchase orders directly related to product

1.1 General Requirements

- ARS will not accept mixed lots: all lots must be kept segregated and identified as stated.
- Certifications are required with each shipment and shall be traceable to applicable records.
- Test reports, when required, shall be traceable to applicable records.
- Changes to ARS purchase orders may only be made by the buyers.

1.1.1 Handling and Packaging

All products will be protected to prevent damage during handling, transit and storage. The supplier shall use the best standard packaging and preservation (wrapping, padding, capping, forming, etc) for **ALL** articles to prevent damage during shipment. Each package will be legibly marked with ARS's purchase order number. Printed Circuit Board (PCB) handling and storage must be in accordance with IPC-1601 guidelines.

1.2 Conformance to purchase order requirements

All materials supplied on ARS purchase orders must conform to all related drawings, specifications and revisions.

ARS will issue a Corrective Action Request (CAR) for non-conformances. This report must be completed and returned to ARS' QA department to preclude removal from ARS' approved vendor listing. All submittals must reference the CAR number and the applicable ARS Products purchase order number.

1.3 Certificate of Compliance (C of C)

Shipments made against an ARS Products purchase order must contain a Certificate of Compliance by the Supplier verifying that all applicable drawings, specifications, and purchase order requirements have been met. As a minimum, this C of C must contain:

- ARS purchase order number
- ARS part number, rev. level (if applicable) and quantity
- Suppliers identification and part number
- Manufacturers part number, if applicable
- Lot number or date code

Note: Lot numbers or date codes are used for traceability purposes. If not the manufacturer, supplier's records shall be traceable to the manufacturer.

1.4 Identification of materials

Identification of packaged materials is to include:

- ARS Purchase Order number
- Part Number and Qty

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- Lot numbers or Date codes which will ensure that materials, parts and assemblies can be associated with their records.

1.5 Counterfeit Parts

ARS Products is committed to the avoidance of counterfeit electrical parts in accordance with DFAR 252.246-7007. This DFAR clause is a flow-down requirement and is invoked by ARS on all purchase orders for electronic parts. Electronic parts are those as defined in DFAR 252.246-7007 paragraph (a).

In support of this requirement, ARS Products requires that purchases of electronic parts are made only from the manufacturer or the manufacturer's approved distributor. Suppliers of electronic parts to ARS Products are required to purchase materials only from the manufacturer or manufacturer's approved distributor and to maintain records providing traceability to the manufacturer for a minimum of 7 years.

Should a counterfeit product, or suspected counterfeit product, be found, ARS shall quarantine such material and report the finding to the supplier and to the appropriate authorities.

1.6 Conflict Minerals

In accordance with section 1502 of the Dodd-Frank Wall Street Reform and Consumer Protection Act, all conflict minerals (tantalum, tin, tungsten and gold or "T3G") used in products that are manufactured specifically for ARS Products must be sourced from non-conflict countries. This includes all PCB manufacturers and suppliers that provide plating services.

All suppliers that incorporate conflict minerals into materials that are to be delivered to ARS Products must maintain records substantiating the source of the minerals with identification of the original smelter. This information is to be reported to ARS Products annually at a minimum. The preferred reporting method is the Conflict Minerals Reporting Template (CMRT) that is available from the Conflict Free Sourcing Initiative's web site: www.conflictreesourcing.org. Supplier's format is acceptable providing the information required in the CMRT is included.

1.7 Records retention

Any quality records pertaining to ARS Products parts or processes must be maintained for no less than seven years, unless otherwise stated on the ARS purchase order. Traceability records shall be maintained for a minimum period of seven years by suppliers and their sub-tiers/suppliers, and made available to ARS Products and their representatives upon request.

Note: A lot or batch shall be defined as parts and/or material produced by one manufacturer in one unchanged process from the same certified raw material in accordance with the same drawing and/or specification revision.

1.8 Electrostatic Discharge (ESD) Control

The Supplier shall have an ESD control program in effect to protect ESD-sensitive product during manufacturing, inspection, testing, packaging and shipping. The program shall conform to MIL-STD-1686 or equivalent. ESD parts and assemblies must be labeled in accordance with MIL-STD-129 with ESD symbols.

1.9 Right of Entry

At times it may be necessary for ARS Products personnel and customers or their representatives to visit supplier facilities and/or their sub-tier suppliers for the purpose of verifying contract compliance and product conformity. Arrangements for such visits will be coordinated through the cognizant buyer.

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1.10 Flow-down of requirements

The supplier's quality system shall assure all relevant purchase order requirements are flowed down to their sub-tier suppliers. The supplier's sub-tier suppliers are responsible to comply with the same specifications and requirements specified on the ARS purchase order.

1.11 Traceability

All items provided against an ARS purchase order will be traceable to the Manufacturer. The supplier will impose these traceability requirements on sub-tier suppliers through flow down requirements.

Note: Identification of electrical, electronic and electro-mechanical parts (such as semiconductors, integrated circuits, relays, transformers, connectors, etc.) shall be traceable to manufacturer and manufacturer's lot date code. If due to physical size, the part cannot be identified, the manufacturer and lot date code is required to be on the packaging.

1.12 ARS proprietary documentation

ARS Products process drawings and techniques are the exclusive property of ARS and shall not be shared with others without ARS Products approval.

2 Quality requirements applicable to suppliers of custom machined and sheet metal parts

2.1 Compliance with ARS specifications

All products will be manufactured per the supplied ARS Products Drawing. Any applicable call-outs listed on the drawing will be completed as noted and will supersede this document.

2.2 Packaging of custom parts and sheet metal

Refer to section 1.1.1 *Handling and Packaging*

2.3 Finish Requirements

All suppliers shall follow the general finish requirements. The finish type will be listed on the part drawing or superseded by the purchase order. All contaminants from the plating process must be removed.

Any plated threads must remain functional. It is recommended that threads be masked for thread sizes of #4-40 and smaller for tin over copper plating.

Type YI - Aluminum alloy finish shall be: yellow/gold electrically-conductive chromate conversion per MIL-DTL-5541 Type II Class 3.

Type CI - Aluminum alloy finish shall be: RoHS compliant, clear electrically-conductive chromate conversion per MIL-DTL-5541 Type I Class 3.

Type ZY - Carbon steel alloy finish shall be: RoHS-compliant, electrically-conductive zinc yellow plating (Tri Valent) per ASTM-B633-07 Type VI.

Type SS - Stainless steel alloy finish shall be: RoHS-compliant, electrically-conductive passivated per ASTM A967-96.

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Type TC – Aluminum alloy finish shall be: RoHS-compliant, electrically-conductive electrodeposited tin 100-200 micro-in over 25-50 micro-in of copper. Finish: matte.

2.4 Powder Coating/Painting Acceptance

All suppliers shall follow the general powder coat requirements.

Unless otherwise specified or other methods are used:

- To avoid creating unpainted spots during the powder coating/painting process the panels shall be hung via a bracket(s) (ARS p/n 5210-0028; Keystone p/n 616) (ARS will provide the brackets and screws) A flat-head #4-40 x 3/16 screw is used to attach the bracket to the panel. A screw shall be inserted through a #6 countersink hole ($\varnothing 0.17$ thru, $\omega \varnothing 0.28 \times 100^\circ$) only, do not use any other holes! If there are no #6 countersink holes present this method is not permitted. A maximum of 2 holes per part could be used. The same holes must be used throughout the same lot. (See figure 1)



Figure 1

This addition to the process will create an unpainted circle(s) in the bottom of a countersunk hole of $\varnothing 0.22$ MAX which is acceptable. See figure 2 & 3



Figure 2

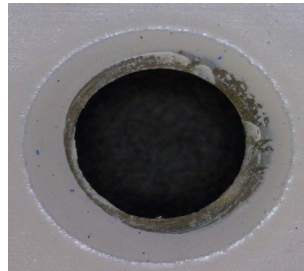


Figure 3

3 Quality requirements applicable to all PCB suppliers

The following quality requirements are applicable to all printed circuit boards ordered by ARS Products unless otherwise noted on the ARS purchase order.

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Seller is responsible to perform a review of data and/or artwork furnished by Buyer.

Data and/or artwork shall be verified for adequacy to assure that Seller is able to meet all requirements of the master drawing. Seller shall not make changes to or deviate from Buyer supplied PWB design without formal engineering changes incorporated into the contract by Buyer's Authorized Procurement Representative.

All coupons, cross-sections, Destructive Physical Analysis (DPA), when required, specimens, etc., must be traceable to the lot date code used for individual printed-wiring boards.

A copy of the Seller's test report analysis for micro-sections ("Group A" or Quality Conformance Testing per IPC-6012 Para. 4-3) must accompany the test coupons and micro-sections shipped to Buyer (A copy of the shop traveler must be provided along with certifications, when requested). Serial numbers and or Lot Date Codes, must be recorded on the Supplier's shipping documentation or pack sheet.

When DPA test boards are required per lot, Seller shall include the DPA test board(s) and micro section test specimens prior to the first shipment from the lot to delivery location specified by the Buyer's Authorized Procurement Representative.

Seller's electrical test certifications shall include contract number and changes, part number, procurement specification and a record of equipment used for testing along with the serial numbers, date code and/or traceability data and results for all items tested. Results shall record pass and/or failure characteristics, including shorted networks, isolation defects, or open networks.

Test certifications must include a description of the test procedure used for troubleshooting and/or manual testing. All testing, including re-testing from troubleshooting or manual testing, shall result in 100% successful completion of continuity and isolation testing requirements.

Printed Circuit Board (PCB) handling and storage must be in accordance with IPC-1601 guidelines.

3.1 Inspection requirements

Inspect per: IPC A 600, Class 2 (current rev.), and per additional ARS Products requirements listed below.

- Electrical Criteria:
 - 100% Electrical net testing.
 - Continuity Ohms: not greater than 5 Ohms – 250 volts
 - Isolation Meg Ohms: not less than 10 Mega Ohms
 - Excluding 400 Series Boards
- Solderability: per IPC-6012; test coupon to be supplied to ARS
- Board warp: 0.75%, per IPC-TM-650; 2.4.22 unless otherwise specified on drawing.
- Copper Peel Strength:
 - per IPC TM 650 2.4.8
 - (1.0 oz.) GENERIC MATERIALS AND FR4 6 lbs./in. minimum
 - Exotic dielectrics and specialty materials specified on drawing are per manufacturer's latest datasheet.

All printed circuit boards with more than 2 layers require the following:

- Stack up: Stack up per file – No Deviation
- Micro-section : per IPC-6012; test sample to be supplied to ARS along with validation of stack-up layers including copper layers
- Screening:

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- 100% Electrical net testing. (See above electrical criteria.)
- Temperature Cycling, 5 cycles of -25°C to +85°C, 0.5 hours minimum at each temperature, Ramp time not specified.
- 100% Electrical net testing (See above electrical criteria.)

3.2 Additional Markings

In addition to marking specified in the fabrication files, all printed circuit boards should have a lot-identifying date code clearly marked on the board.

3.3 Surface Finish and RoHS requirements

Acceptable RoHS-compatible finishes include Immersion Silver and Immersion Gold.

Unless otherwise noted on Fabrication notes or purchase order, surface finish must be according to the table below.

Part Number	Finish
1XX-13XX Except 150-1301 150-1302	HASL (Non-RoHS) RoHS RoHS
2XX-13XX	RoHS
3XX-13XX*	RoHS
4XX-13XX	HASL (Non-RoHS)
5XX-13XX	HASL (Non-RoHS)
6XX-13XX	HASL (Non-RoHS)
7XX-13XX	HASL (Non-RoHS)
8XX-13XX	HASL (Non-RoHS)
9XX-13XX	HASL (Non-RoHS)

- except 335-XXXX

3.3.1 Packaging of silver-immersion PCBs

Silver-immersion PCBs must be packaged, shipped and stored in a vacuum-sealed package with a backer board to prevent damage upon opening and have placed between each board a 3M anti-tarnish paper or equivalent to prevent scratching during shipping and handling. In addition to this special handling, also reference section 1.1.1 **Handling and Packaging**.

3.4 ARS Fabrication Standards

3.4.1 Fabrication Layer

All fabricated boards have an associated fabrication layer specifying the following:

- Overall board size and thickness.
- Stackup including dielectric materials and thicknesses, and copper weights.
- Drill chart. All holes are plated unless specified as non-plated holes.

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3.4.2 File Formats

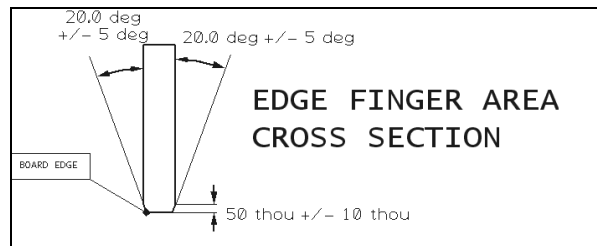
Data is in Absolute 2.3 format. Dimensions are in thousands of an inch.

Gerber files are RS-274-X.

Files are produced in one of 2 software packages, Pulsonix v7.5 or later or EasyPC v.13 or later.

3.4.3 Edge Fingers

When edge fingers are specified on the fabrication notes, hard gold plating is to be used and the following chamfers are to be made. Also, all PCB suppliers shall use a non-residue Kapton ESD tape, or an equivalent method, to protect gold finger contacts from any amount of contamination during the PCB manufacturing process.



3.4.4 Drill Holes

Drill-hole sizes specified on fabrication notes are finished dimensions. Excluding drill position tolerance, minimum annular ring due to vendor drill size selection shall be 0.005". (i.e. The maximum nominal drill size used on a 0.015" pad would be 0.005").

Drill size tolerance is ± 0.003 ". Drill-hole position tolerance is ± 0.003 " unless otherwise stated.

3.4.5 Stackups

Board layer stackups are to be specified on every fabrication drawing. Dimensions are specified in finished thicknesses, unless proprietary material has been specified. Layer order is never to be modified from the fabrication drawing contained in the Gerber files without specific instruction from ARS Products Engineering.

3.4.6 Copper Thicknesses

When copper thicknesses are specified in ounces/in², thicknesses are to be as follows: 0.5oz = 0.7mil, 1.0oz = 1.4mil, and so forth.

3.4.7 Silkscreen

Yellow or white color if not specified in drawing. Vendor to use an epoxy-based, non-conductive ink. Supplier to clip silkscreen from all solderable surfaces.

3.4.8 Solder mask

LPI Green solder mask is preferred unless otherwise specified in fabrication layer.

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Via solder mask plug and solder mask overprint: all vias containing solder mask covered 100% on both sides, 0.015" or smaller finished hole diameter, with a minimum of 8 mil clearance to the closest exposed feature in the CAD files shall be filled with an approved solder mask and over-coated with solder mask. Final protrusion height of solder mask plug above vias shall not exceed 3.5 mil. Trim solder mask off of overlapping component pad.

Vias in the CAD files that do not meet the above criteria have no requirement of solder plugging or mask overprint.

Non-conductive via fill is also an acceptable alternative to via plugging.

3.4.9 Inside Cutouts

Inside corners with an unspecified radius in Gerber files are to have a maximum radius of 0.040". Specified radiuses whether smaller or larger than 0.040" must have radius tolerance $\pm 10\%$.

3.4.10 Gerber Modification

Gerber files or data are not to be modified in any manner without direction from an ARS Products representative.

3.4.11 Registration

Board registration must be no more than 0.003" in X or Y direction, from one layer to any other one layer.

3.4.12 Annular Ring

Please refer to Drill Holes section 3.4.4 for vendor drill requirements related to annular rings. Annular Ring Minimum shall be in accordance with IPC-6012 Class 2.

3.4.13 Board Dimension

Dimension features and specifications are specified for reference. Gerber should be used for board fabrication

3.4.14 Overall Board Thickness

Board size tolerance is $\pm 10\%$.

3.4.15 Dielectric Thicknesses

Dielectrics must have a $\pm 10\%$ thickness tolerance. Dielectric thicknesses requiring tolerances less than 10% will be specified on the fabrication drawings.

Dielectrics with thicknesses specified as TBD or unspecified can be determined by fabrication vendor to meet the rest of board requirements, specifications, and tolerances.

3.4.16 Cleanliness

All PCBs delivered to ARS Products must be clean in accordance with IPC-5703 (Cleanliness Guidelines for Printed Board Fabricators).

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3.4.17 Deviations from this Document

Correspondence from an ARS Products representative can override this document and the board fabrication drawing.

4 Quality requirements applicable to all contract PCB assemblers

4.1 Workmanship Requirements

Workmanship shall be in accordance with IPC-J-STD-001, Class 2 (current rev.), unless otherwise specified by purchase order.

4.2 Inspection Requirements

All assembled PCBs shall be inspected in accordance with IPC-A-610, Class 2 (current rev.), unless otherwise specified by purchase order.

4.3 Shipping and Handling

Populated PCBs are to be placed in an ESD bag by themselves. Paper, extra parts or FOD should not be placed in the bag. If there are parts or paper that needs to stay with the board, it should be attached to the outside of the ESD bag using ESD tape or equivalent. Paper clips and staples **SHALL NOT BE USED**. In addition to this special handling, also reference section 1.1.1 **Handling and Packaging**.

5 Requirements applicable to suppliers of special processes

All special processes will be performed in accordance with the supplied ARS Products drawing(s) and any additional requirements specified in the purchase order.

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