SAE Aerospace
An SAE International Group

AEROSPACE MATERIAL SPECIFICATION

SAE AMS 2690 | REV. C

Issued 1968-05
Revised 1988-07
Noncurrent 2001-04
Reaf. Nonc. 2011-10

Superseding AMS 2690B

Parallel Gap Welding
Microelectronic Interconnections to Thin Film Substrates

NONCURRENT NOTICE

This specification has been declared “NONCURRENT” by the Aerospace Materials Division, SAE, as of April 2001. It is recommended, therefore, that this specification not be specified for new designs.

“NONCURRENT” refers to those materials which have previously been widely used and which may be required on some existing designs in the future. The Aerospace Materials Division, however, does not recommend these as standard materials for future use in new designs. Each of these “NONCURRENT” specifications is available from SAE.

TO PLACE A DOCUMENT ORDER: **Tel: 877-606-7323 (inside USA and Canada)**
Tel: +1 724-776-4970 (outside USA)
Fax: 724-776-0790
Email: CustomerService@sae.org
SAE WEB ADDRESS: **http://www.sae.org**

SAE values your input. To provide feedback on this Technical Report, please visit
http://www.sae.org/technical/standards/AMS2690C

THIS REVISION CONTAINS ONLY EDITORIAL CHANGES.

1. SCOPE:

1.1 Purpose:

This specification defines the equipment, procedures, and requirements for joining leads by parallel gap resistance welding.

1.2 Application:

For attaching leads by parallel gap resistance welding in the assembly of micro-electronic circuitry to thin film substrates.

2. APPLICABLE DOCUMENTS:

The following publications form a part of this specification to the extent specified herein. The latest issue of Aerospace Material Specifications shall apply. The applicable issue of other documents shall be as specified in AMS 2350.

2.1 SAE Publications:

Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096.

2.1.1 Aerospace Material Specifications:

AMS 2350 Standards and Test Methods

2.2 U.S. Government Publications:

Available from Commanding Officer, Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, PA 19120.

2.2.1 Military Standards:

MIL-STD-794 Parts and Equipment, Procedures for Packaging and Packing of

2.3 AWS Publications:

Available from American Welding Society, P.O. Box 351040, Miami, FL 33135.

2.3.1 AWS A3.0 Welding Terms and Definitions

3. TECHNICAL REQUIREMENTS:

3.1 Welding Machine:

The parallel gap welding machine shall have a controlled source of electrical power and a means of reliably controlling the power and the welding force.

3.2 Electrodes:

Electrodes shall be so designed as to provide a constant cross-section which shall extend not less than 0.010 inch (0.25 mm) above the tip after dressing. Newly installed electrodes shall be dressed to ensure proper alignment with the welding platen or stage. The gap between electrodes may be fixed or adjustable.

3.2.1 Electrodes showing evidence of pitting, excessive wear, warpage, or excessive degradation or contamination of insulating gaps shall not be used. Electrodes may be cleaned or redressed using fine grit emery paper or polishing stones. Redressed electrode surfaces shall be flat and equivalent in roughness to that obtained with a 3/0 or finer polishing paper. Electrodes shall be redressed in a direction parallel to the gap to prevent bridging or shorting of the gap.

3.3 Alignment Equipment:

Suitable micro-positioning equipment shall be used to accurately align and position leads for welding. Jigs, fixtures, or vacuum holding devices shall be used to minimize lateral movement of the lead relative to the substrate during the welding process.

3.4 Tensile Test Machine:

The machine and related equipment used to determine weld strengths shall operate at a pull rate of less than 5 inches (127 mm) per minute and be capable of measuring a load of 0 - 500 grams to an accuracy of ±2.0% of full scale rating. Scale graduations shall be 5 grams or smaller.

3.5 Equipment Maintenance:

All equipment shall receive maintenance as necessary to ensure that welding on any setting of the machine is reproducible within the requirements of this specification.

3.6 Procedure:

Welds shall be made in accordance with the following; terms used are defined in AWS A3.0:

3.6.1 Qualification and Certification: Before any welding is performed in accordance with this specification, welding machines and operators shall be qualified and certified in accordance with the following:

3.6.1.1 Welding Machine: The welding equipment shall be qualified as a system including power supply, welding head, and electrodes. Each system shall be qualified for certification by satisfying specified calibration and proof-testing requirements.

3.6.1.1.1 Calibration: Pulse amplitude, pulse duration, number of pulses, and pulse rise and fall times shall be measured. Measurements shall be made at not less than six predetermined power settings, selected to verify all operator-controlled parameters of the equipment at three levels of operation (low, medium, and high power). Measurements shall be taken using a standard load shunt in place of the electrodes or against the electrodes using a specified pressure.

3.6.1.1.2 Electrode Force: A calibration curve, setting vs actual electrode force in pounds (N), shall be determined for each welding head or settings may be made using an external force gage. Repeatability of force setting shall be maintained within ±0.1 pound (0.5 N).

3.6.1.1.3 Proof Testing: Weld-test specimens shall be prepared in accordance with the following:

3.6.1.1.3.1 Prepare specimens of the following combinations:

10 specimens of 0.003 x 0.010 inch (0.08 x 0.25 mm) pure gold ribbon welded to a thin-film substrate.

10 specimens of 0.004 inch (0.10 mm) diameter pure gold wire welded to thin-film substrate.

3.6.1.1.3.2 The thin film selected shall show prior evidence of being suitable for microwelding (3.6.6.1). Actual thin film materials or specially designed test patterns may be used. Welds shall be made using the applicable welding schedule.

3.6.1.1.3.3 All weld strengths shall exceed the minimum value specified in the welding schedule in order to qualify the machine.

3.6.1.1.4 Certification: Welding machines that have been qualified shall be certified by the cognizant quality assurance organization.

3.6.1.1.5 Maintenance of Certification: Qualification and certification of a welding machine shall be repeated at intervals of not more than six months, whenever evidence indicates out-of-control production welding, or when major maintenance on the equipment is performed.

3.6.1.2 Operator Qualification: Welding operators shall satisfactorily complete a training program to ensure adequate familiarization with handling procedures for microminiature components, circuits, and modules, the operation of the welding equipment, and weld requirements as specified herein. Operators, in addition to the training program, shall demonstrate ability to produce satisfactory welds by completing requirements in 3.6.1.1.3.

3.6.1.2.1 Records and Requalification: In order to ensure the use in production of qualified personnel only, records shall be maintained to indicate successful completion of a training program. As found necessary because of absence, new equipment, components, and design, or to upgrade the level of operators, retraining and requalification shall be provided.

3.6.2 Welding Schedules: A welding schedule shall be established using not less than 50 weld pull tests for each combination of material and size to be joined. Once a satisfactory schedule is established, that schedule shall be used for making all welds except that minor adjustments of ±10% of the weld energy, approved in accordance with 3.6.2.2, are permitted to compensate for minor variations in the materials being welded.

3.6.2.1 Weld Schedules: Welding schedules shall be recorded on forms acceptable to purchaser. Recorded information shall include not less than the following:

Welding equipment - make and model
Electrode tip - size and material
Electrode force setting
Lead material identification and mechanical strength
Thin-film identification (See 3.6.6.1)
Substrate material
Weld schedule power supply settings
Visual characteristics and minimum weld strength requirements

3.6.2.2 Weld Schedule Modification: Slight variations in power supply settings for established weld schedules are permissible within limits to accommodate slight variations in thin-film characteristics. Setting deviation limits shall be established on the applicable welding schedule and shall in no instance exceed ±10% of the prescribed setting for any single parameter. At least five tensile tests in accordance with 3.7.1 shall be required for approving the modification of a given setting. Such modifications require the approval of authorized personnel. Approval of schedule modifications constitutes approval for substrates of a given lot only. Where variations greater than 10% are required, new weld schedules shall be developed.

3.6.3 Routing of Leads: In routing component leads and interconnecting leads, service loops shall be used to minimize stresses.

3.6.4 Handling Methods: Part movement during welding shall be minimized and use shall be made of alignment equipment (See 3.3). Protective covering, such as finger cots, shall be worn by the operator to prevent surface contamination of thin films and delicate lead materials. Hand tools, tweezers, vacuum pick-up, etc used to handle interconnect leads, component leads, and thin films shall be so designed, used, and maintained as to minimize scratching or marring of thin film networks and lead materials.

3.6.4.1 Holding of Add-On Components: Components to be connected directly to a thin film may be located and held in place in preparation for welding of the leads to the thin-film deposit by bonding the component body to the thin-film substrate with adhesive, as specified on the drawing.

3.6.5 Assembling Functional Electronic Block (FEB) Packages: Thin film substrates, integrated circuit flatpacks, and other micro-electronic components which are included in FEB circuits shall be fixed to minimize movement during the subsequent welding of leads and interconnecting materials. All surfaces of thin film substrates to be welded shall be maintained parallel to the electrode faces.

3.6.5.1 External Leads: External FEB leads shall provide a minimum ribbon length of 0.035 inch (0.89 mm) internal to the package for the connection of interconnecting leads or component leads within the package. This length of ribbon lead shall be clean and free of sealing glass, frit, and other contaminants which would impair the welding of specified leads.

3.6.6 Process Controls: In order to ensure that the welding process will remain under control, the following conditions shall be complied with:

3.6.6.1 Thin Film Identification: Thin film deposits, to which lead materials are to be welded, shall be fully identified to permit proper assignment of applicable welding schedules. Identification shall include film and substrate material, substrate size, and film thickness (determined by actual measurement, electrical resistance, or other suitable method). The following procedure shall be used:

3.6.6.1.1 At least one thin film substrate to serve as a control sample shall accompany each lot of thin film substrates submitted for welding of component leads or interconnecting lead material. The control sample shall have been deposited and processed identically with all substrates of a lot so as to be representative of the lot. Lot numbering or other means of identification shall be maintained to ensure proper identification.

3.6.6.1.2 The control sample shall be an actual film network. Film networks which do not meet electrical requirements of the circuit may be used as control samples provided conductor pads and welding target areas are in all respects representative of the thin film lot.

3.6.6.1.3 Welding characteristics of a thin film deposit lot shall be determined by making welds of the specified material combination on each of the prescribed conductor pads or target areas of the network on the control sample using the applicable welding schedules.

3.6.6.1.4 Welds made to the control sample shall fulfill all acceptance requirements specified herein. In addition, welds shall be pulled to failure, manually or mechanically, at approximately 45 degrees as specified in 3.7.1. Tested welds shall meet one or both of the following requirements:

3.6.6.1.4.1 Where weld separation occurs, positive evidence of welding shall be found in the thin film. Evidence of welding is indicated by peeling of the film under the weld or traces of lead material on the thin film after removal of the lead. Gross crazing and pull out of the substrate under the weld or weld separation with little or no load applied to the lead material is not acceptable.

3.6.6.1.4.2 Failure of the lead near or away from the weld impression. The lead shall show evidence of necking or deformation at the point of failure.

3.6.6.1.5 Each lot of thin film substrates may be used for welding only after control sample welds are completed and accepted.

3.6.6.1.6 When the assigned control sample substrate fails to meet the requirements, a second substrate from the same lot shall be subjected to qualifying welding procedures. The second test shall be performed on a duplicate weld station by a different operator, or on the initially used station only after authorized personnel have checked weld schedule settings and condition of the weld station. Failure of the second substrate to meet welding requirements shall be cause for rejection of the entire thin film lot for purposes of welding component leads or interconnection leads for assembling micro-electronic devices in accordance with this specification.

3.6.7 Examination: A 100% examination of the electronic circuit for conformance to the requirements of this specification shall be accomplished at the latest assembly stage possible. Use shall be made of a binocular microscope, at 30X magnification, to determine acceptance of welded leads in accordance with the following:

3.6.7.1 Weld: The interconnection shall show evidence of welding. Open weld joints or absence of electrode impressions on the lead material are not acceptable. Slight discolorations of the thin film surfaces are acceptable.

3.6.7.1.1 Deformation: Deformation of lead material caused by the electrode impression shall be limited as follows (See Fig. 1):

3.6.7.1.1.1 Ribbon: Ribbon width plus deformation of the ribbon lead at the electrode impression shall not exceed 1.5 times the undisturbed ribbon width.

3.6.7.1.1.2 Wire: Wire diameter plus deformation of the wire lead at the electrode impression shall not exceed 2.0 times the undisturbed wire diameter.

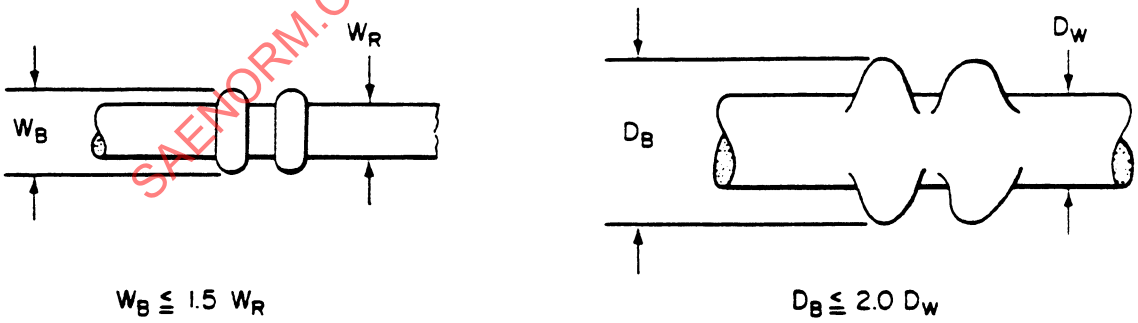

FIGURE 1 - Ribbon and Wire Deformation

3.6.7.1.2 Electrode Impression: Electrode impression on the lead shall extend over at least 80% of the width of a ribbon lead and over 50% of the circumference of a round lead.

3.7 Properties:

Welds shall conform to the following requirements:

3.7.1 Tensile Tests: Test specimens shall be fixtured in a suitable tensile machine (See 3.4) to permit axial loading of the lead wire at an angle of 45 degrees ± 5 to the thin film surface or other surface to which leads are welded (See Fig. 2). Breaking loads shall be measured to the nearest 5 grams.

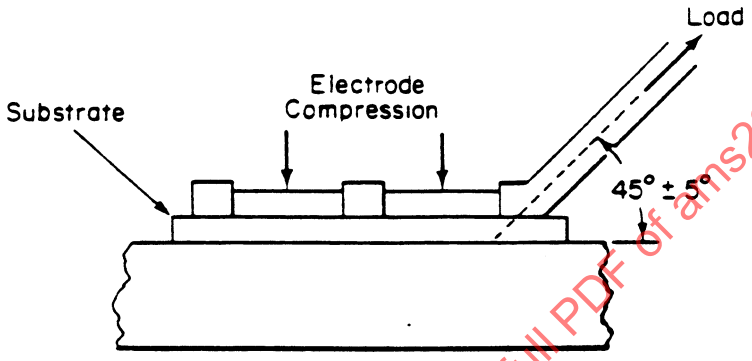

FIGURE 2 - Specimen Test Position

3.7.1.1 Where lead size or general configuration of the weld does not permit use of a tensile machine, manual test methods may be used. The thin film substrate shall be adequately anchored, the lead carefully grasped with tweezers, and manually pulled to failure. Qualitative and visual evaluations shall be made as specified in 3.6.6.1.4.

3.7.2 Process Control Tests: Five test specimens shall be prepared and tested in accordance with the procedure of 3.7.1 using the applicable welding schedule for the material combination specified, as follows:

3.7.2.1 Frequency: Process control tests shall be conducted at least once every 4 hours of operation. Thin film test welds specified in 3.6.6.1 may serve as process control tests.

3.7.2.2 Test Material: Material combinations for the process control tests shall be representative of those used during the operation period being monitored.

3.7.2.3 Test Results: The tensile strength of the welds, determined by procedures of 3.7.1, shall be equal to or greater than the minimum value specified in the applicable welding schedule.