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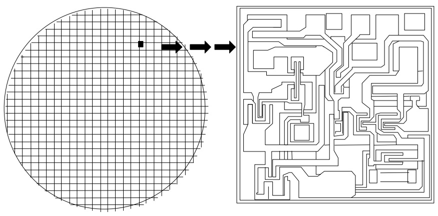
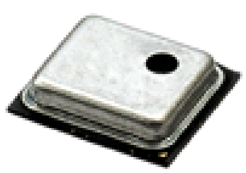
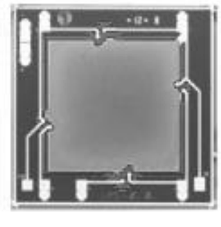


FAILURE MECHANISM BASED STRESS TEST QUALIFICATION FOR MICRO ELECTRO-MECHANICAL SYSTEM (MEMS) PRESSURE SENSOR DEVICES

Automotive Electronics Council
Component Technical Committee

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AEC-Q103-002 Failure Mechanism Based Stress Test Qualification for Micro Electro-Mechanical System (MEMS) Pressure Sensor Devices

Acknowledgment

Any document involving a complex technology brings together experience and skills from many sources. The Automotive Electronics Council would especially like to recognize the following significant contributors to the revision of this document:

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Automotive Electronics Council
Component Technical Committee

FAILURE MECHANISM BASED STRESS TEST QUALIFICATION FOR MICRO ELECTRO-MECHANICAL SYSTEM (MEMS) PRESSURE SENSOR DEVICES

1. SCOPE

This document contains a set of failure mechanism based stress tests specific to the Micro Electro-Mechanical System (MEMS) Pressure Sensor technologies listed in Section 1.1.1 below. This document shall be used in conjunction with AEC-Q100. The circuit elements of MEMS devices are susceptible to the same failure mechanisms as standard IC's, thus must meet the requirements defined in AEC-Q100. The MEMS portion of these devices, including circuit and package interactions, must meet the requirements defined herein.

The objective is to precipitate failures in an accelerated manner compared to use conditions, or to simulate extreme events to draw out design or intrinsic process deficiencies. This set of tests should not be used indiscriminately. Each qualification project should be examined for:

a. Any potential new and unique failure mechanisms
b. Any situation where these tests/conditions may induce failures that would not be seen in the application
c. Any extreme use condition and/or application that could adversely reduce the acceleration

Use of this document does not relieve the MEMS supplier of their responsibility to meet their own company's internal qualification program. In this document "user" is defined as all customers using a device qualified per this specification. User specific requirements will need to be considered in addition to these recommendations. The user is responsible to confirm and validate all qualification data that substantiates conformance to this document. Supplier usage of the device temperature grades as stated in this specification in their part information is strongly encouraged.

1.1 Purpose

The purpose of this specification is to determine that a MEMS pressure sensor device is capable of passing the specified stress tests and thus can be expected to give a certain level of quality/reliability in the application.

1.1.1 MEMS Pressure Sensor Technologies

The MEMS Pressure Sensor device technologies considered during the development of this document include**:**

- Polysilicon surface micro-machined
- Single crystal silicon Deep Reactive Ion Etching (DRIE)
- Bulk micro-machined
- Capping processes including:
    - Glass frit
    - Eutectic bonding
    - Fusion bonding
    - Anodic bonding

1.1.2 MEMS Pressure Sensor Types and Packaging

MEMS pressure sensor device types included in the scope of this document are as follows:

- A pressure sensing element integrated into a signal conditioning IC (“co-integrated”) mounted in an open cavity (gel covered or gel free) package
- A stacked die/side-by-side configuration where a pressure sensing element is mounted on/next to a signal conditioning IC in open cavity (gel covered or gel free) package
- A pressure sensing element mounted into a pre-mold cavity (gel covered or gel free) after overmolding of the signal conditioning IC
- A pressure sensing element mounted into a pre-mold cavity (gel covered or gel free) after package molding
- A pure pressure sensing element consisting of an unpackaged silicon micro-machined piezo-resistive pressure sensing element (i.e., bare die delivery)

MEMS pressure sensor packaging includes, but is not limited to, the following:

- Non-Hermetic Cavity Package
- Non-Hermetic Leadframe Cavity Package
- Overmolded Leadframe Package
- Overmolded Laminate Package

1.2 Reference Documents

The current revision of the referenced documents will be in effect at the date of agreement to the qualification plan. Subsequent qualification plans will automatically use updated revisions of these referenced documents.

1.2.1 Automotive

AEC-Q100	Failure Mechanism Based Stress Test Qualification for Integrated Circuits

1.2.2 Military

MIL-STD-202	Test Method Standard: Electronic and Electrical Component
MIL-STD-883	Test Method Standard: Microcircuits

1.2.3 Industrial

JEDEC JESD22	Reliability Test Methods for Packaged Devices
DIN 50018	Testing in a saturated atmosphere in the presence of sulfur dioxide
EN 60068-2-60	Environmental testing - Flowing mixed gas corrosion test
ISO 16750-5	Road vehicles - Environmental conditions and testing for electrical and electronic equipment – Part 5: Chemical loads

1.3 Definitions

1.3.1 AEC Q103-002 Qualification

Successful completion and documentation of the test results from requirements outlined in this document and AEC-Q100 document allows the supplier to claim that the part is “AEC-Q103-002 qualified”.

1.3.2 AEC Certification

Note that there are no "certifications" for AEC-Q103-002 qualification and there is no certification board run by AEC to qualify parts. Each supplier performs their qualification to AEC standards, considers customer requirements and submits the data to the customer to verify compliance to AEC-Q103-002.

1.3.3 Definition of MEMS Pressure Sensor Part Operating Temperature Grades:

The part operating temperature grades are defined in Table 1 of AEC-Q100. Additional temperature grades applicable to MEMS Pressure Sensor devices are defined in Table 1A below:

Table 1A: Additional MEMS Pressure Sensor Part Operating Temperature Grades

Grade	Ambient Operating Temperature Range
0A	-40°C to +165°C
0B	-40°C to +175°C

All automotive grades as defined in AEC-Q100 apply; the above grades are only needed if ambient operating temperature range exceeds AEC-Q100 grade zero requirements. For all biased tests from Table 2 of this document and Table 2 of AEC-Q100, the junction temperature of the MEMS pressure sensor device during stressing should be equal to or greater than the hot temperature for that grade.

If the minimum or maximum ambient temperature as specified in the supplier datasheet cannot be found in Table 1A of this document or Table 1 of AEC-Q100, then the next more challenging part operating temperature grade must be selected. Exceptions include the following:

- If the hot temperature of a chosen part operating temperature grade exceeds the allowed maximum temperature specified in the supplier datasheet, then testing should be limited to the maximum datasheet value. This applies only to biased tests from Table 2 of this document (e.g., PrHTOL, B_PPrTC) and biased tests from Table 2 of AEC-Q100 (e.g. , HTOL, ELFR, PTC). Actual tests and maximum ambient temperature used shall be per mutual agreement between user and supplier.
- Endpoint hot temperature for Pre- and Post-Stress Function/Parameter Verification testing should be limited to the maximum ambient operating temperature specified in the supplier datasheet.

1.3.4 Definition of MEMS Pressure Sensor Part Mechanical Grade:

The part mechanical grades for MEMS pressure sensors are defined in Table 1B below:

Table 1B: MEMS Pressure Sensor Part Mechanical Grades

Grade	Application Requirement
M1	Pressure Sensor – General
M2	Tire Pressure Monitoring System (TPMS) – Rim Mounted

2. GENERAL REQUIREMENTS

MEMS Pressure Sensor device qualification shall be compliant to AEC-Q100 with additional requirements as defined herein.

2.1 Precedence of Requirements

In the event of conflict in the requirements of this standard and those of any other documents, the following order of precedence applies:

a. The purchase order (or master purchase agreement terms and conditions)
b. The (mutually agreed) individual device specification
c. This document
d. AEC-Q100
e. The reference documents in Section 1.2 of this document
f. The supplier's datasheet

For the device to be considered a qualified part per this specification, the purchase order and/or the individual device specification cannot waive or detract from the requirements of this document.

2.5 Definition of Test Failure After Stressing

In addition to AEC-Q100 requirements, Test Group PS shall be used to disposition rejects from AEC-Q100 temperature cycling or accelerated moisture stresses that are not accelerated failure mechanisms.

3. QUALIFICATION AND REQUALIFICATION

3.1 Qualification of a New MEMS Pressure Sensor Device

Test Group PS provides guidance for the disposition of rejects specific to the MEMS element or MEMS to package interactions that occur due to the physical overstress inherent in accelerated temperature cycling and moisture tests at permanent or cycled pressure impact. This test group does not apply to the accelerated failure mechanisms for which the AEC-Q100 stress conditions are derived, such as corrosion, and the supplier must demonstrate that the circuit and package are free of these mechanisms.

3.2 Criteria for Passing Requalification

All requalification failures shall be analyzed for root cause. Only when corrective and preventative actions are in place and proven effective, the MEMS pressure sensor device may then be considered AEC-Q103-002 qualified again.

4. QUALIFICATION TESTS

4.1 General Tests

In addition to well-known IC failure mechanisms, MEMS pressure sensor devices require specific qualification tests to verify performance of both the MEMS die and the packaging in an application environment taking into account mutual interactions, including environmental and functional loading. Unique qualification tests and/or test sequences are defined for MEMS pressure sensor devices by the presence of a pressure port and exposure of the pressure membrane to environmental influences. Stress tests have been defined on the basis of interactions of environmental and functional loads of MEMS pressure sensor devices (see Figure 1):.

a. Environmental loads include pressure, temperature, and humidity.

b. Functional loads include mechanical and chemical.

c. The set of loads and diverse interactions of their states (e.g., constant, cycled/pulsed, rapid change, shock) define the unique qualification tests and their sequences:
   - Pressure load states define the pressure life tests, pressure pulsed tests, and proof/burst tests:
     - Interaction between pressure, temperature, humidity, and chemical loads defines preconditioning before pressure tests and chemical tests.
     - Interaction between pressure, temperature, and humidity makes HAST and UHST more preferable tests than THB and AC.
   - Chemical load states define the chemical tests such as corrosive atmosphere, chemical resistance, salt immersion, etc.:
     - Interaction between temperature, humidity, chemical, and mechanical loads defines the internal visual inspection and wire bond pull testing performed post-chemical and post-mechanical tests.

The stress test requirement flow for qualification of a new MEMS pressure sensor device is shown in Figure 2. This specification defines the requirements for the qualification of MEMS pressure sensor devices. **It is to be used in conjunction with AEC-Q100, rather than in lieu of.** AEC-Q100 shall be used to qualify the active circuitry and basic package integrity of the MEMS pressure sensor device. Qualification tests and/or test sequences specific to MEMS pressure sensor devices are detailed in Figure 2 and Table 2A. Table 2B lists the AEC-Q100 tests updated to address MEMS pressure sensor device failure mechanisms.

Not all AEC-Q100 tests apply to all MEMS pressure sensor devices. For example, Constant Acceleration (CA, test #G3) as Pre-conditioning before Mechanical Shock (MS, test #G1) and Variable Frequency Vibration (VFV, test #G2) is only applicable to TPMS devices. The applicable tests for the particular device type are indicated in the “Note” column of Tables 2A and 2B. The “Additional Requirements” column of Tables 2A and 2B also serves to highlight test requirements that supersede those described in the referenced test method. Any unique qualification tests or conditions requested by the user and not specified in this document shall be negotiated between the supplier and user requesting the test. The Target Failure Mechanism column serves to provide guidance as to the rationale for the requirement.

4.2 Device Specific Tests

MEMS pressure sensor device specific tests shall be performed in accordance with Section 4.2 of AEC-Q100. In addition, the following tests must be performed on the specific MEMS pressure sensor device to be qualified in a given package. Generic data is not allowed for these tests. Device specific data, if it already exists, is acceptable.

1. Highly-Accelerated Temperature and Humidity Stress Test (Test #A2)
2. Pressure & High Temperature Operating Life Test (Test #PS1)
3. Biased Pulsed Pressure Temperature Cycling (Test #PS2)
4. Burst Pressure (Test #PS7)
5. Proof Pressure (Test #PS8)
6. Other Tests - A user may require other tests in lieu of generic data based on his experience with a particular supplier (e.g., Tests #G1-#G3 for TPMS depends on whether rim or tire mounted).

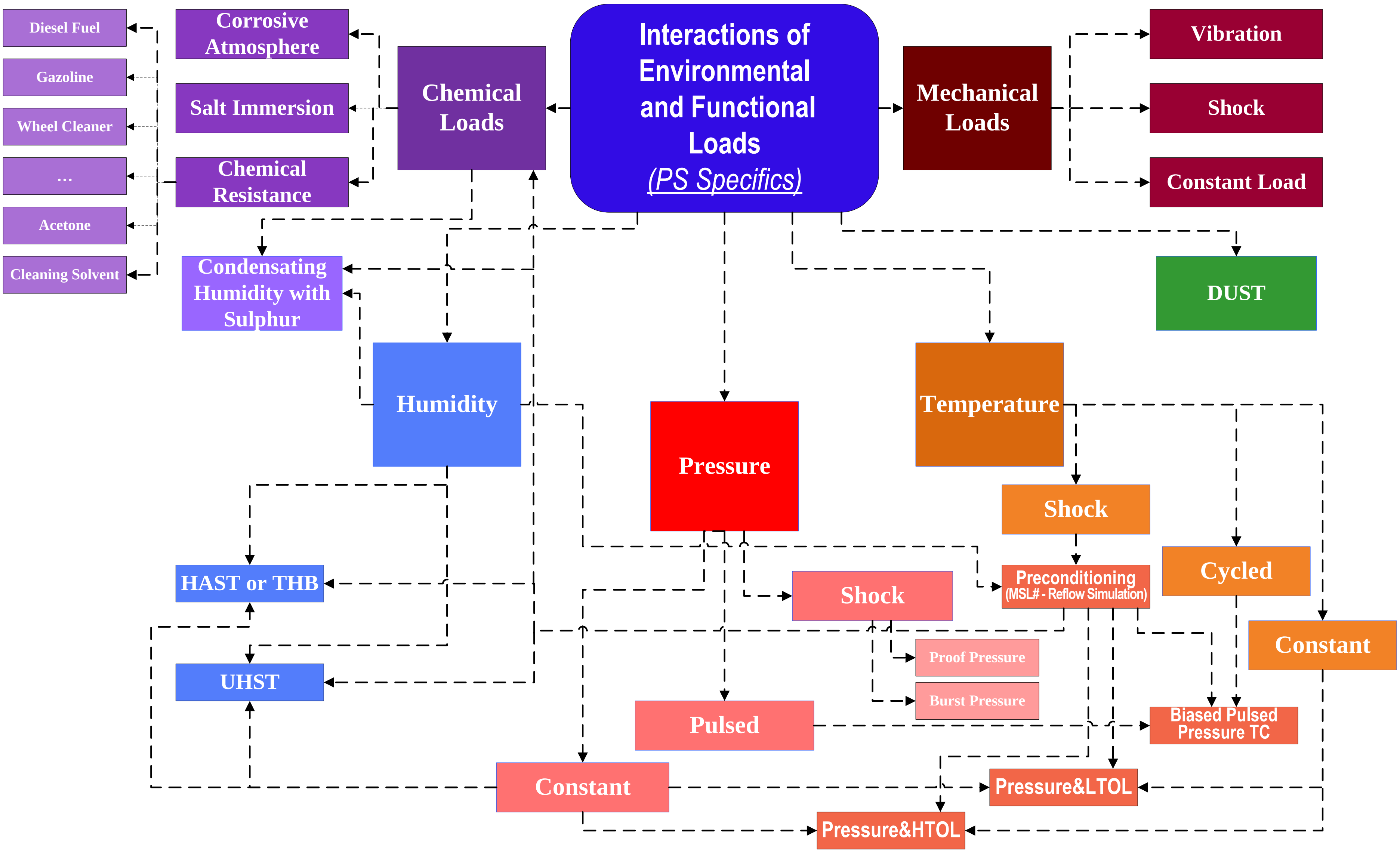

Figure 1: Basis of Determination of Qualification Tests

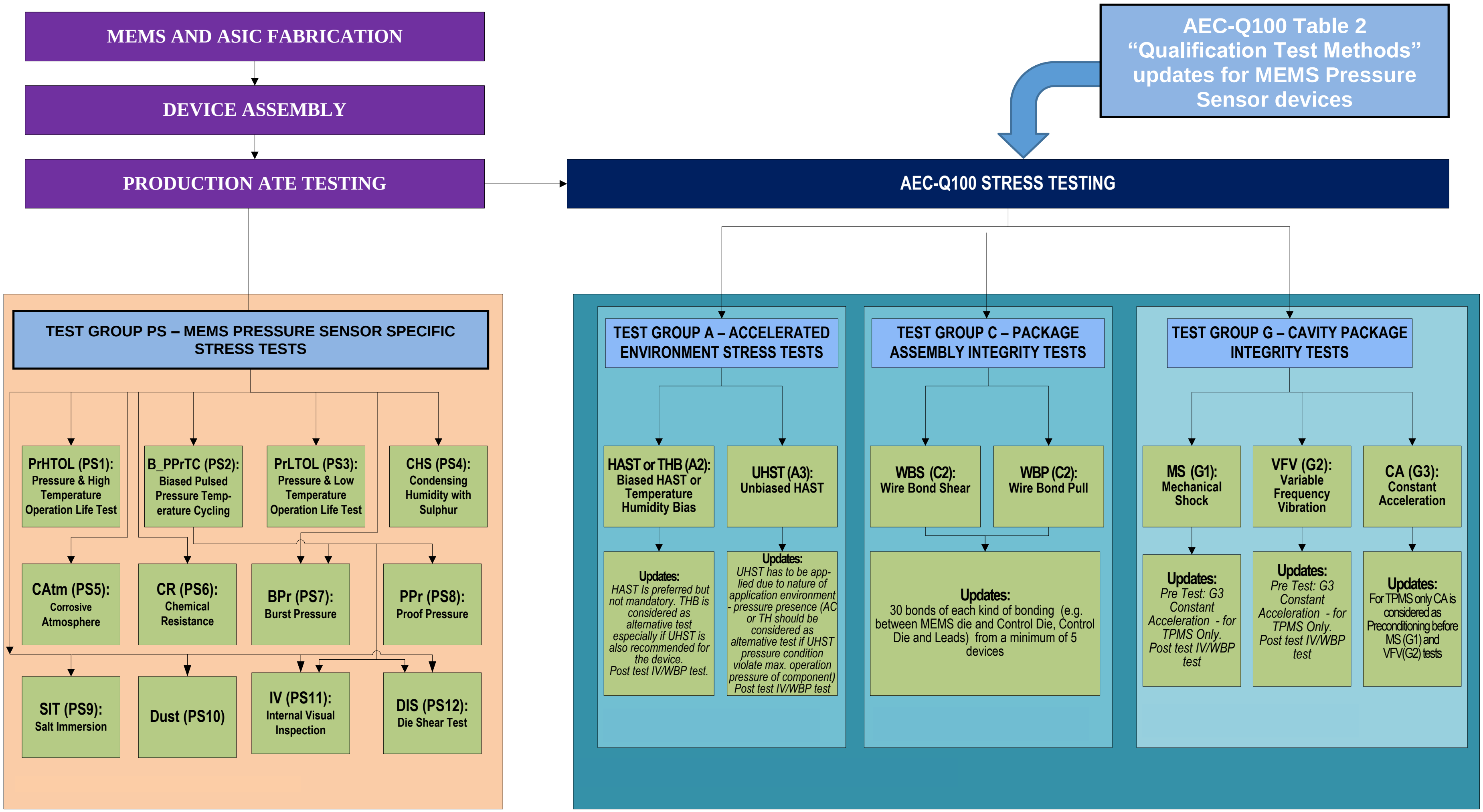

Figure 2: MEMS Pressure Sensor Device Qualification Test Flow

Table 2A: MEMS Pressure Sensor Specific Qualification Test Methods

Note: AEC-Q100 shall be used to qualify the active circuitry contained within the MEMS pressure sensor device, as well as package integrity for the active circuitry. The following tests are specific to MEMS pressure sensor technology and package integrity for the MEMS technology. **It is to be used in conjunction with AEC-Q100, rather than in lieu of.**

TEST GROUP PS – MEMS PRESSURE SENSOR SPECIFIC STRESS TESTS									
STRESS	**ABV**	**#**	**NOTES**	**SAMPLE SIZE (**) /LOT**	**NUMBER OF LOTS**	**ACCEPT CRITERIA**	**TEST METHOD**	**ADDITIONAL REQUIREMENTS**	**TARGETED MEMS FAILURE MECHANISM**
Pressure & High Temperature Operating Life Test	**PrHTOL**	PS1		77	3	0 Fails	Customer tailored plus JEDEC JESD22- A108	This test and its conditions is performed per agreement between user and supplier on a case-by-case basis. Pre-Test: Preconditioning (PC) per AEC-Q100 Test #A1. HTOL per AEC-Q100 Test #B1 requirements taking into account the added MEMS grades: **Grade 0A: +**165ºC Ta for 1000 hours **Grade 0B: +**175ºC Ta for 1000 hours Pressure condition: maximum operation pressure, $P_{max(op)}$, according to MEMS device pressure range **TEST before and after PrHTOL at room, cold, and hot temperature (in that order).** Continuous monitoring of pressure sensor output signal is recommended. **(**PrHTOL replaces AEC-Q100 Test #B1 HTOL)	Bulk die or diffusion defects, film stability and ionic contamination surface-charge spreading, mechanical creep, membrane fatigue, para-metric stability
Biased Pulsed Pressure Temperature Cycling	**B_PPrTC**	PS2		77	3	0 Fails	Customer tailored plus JEDEC JESD22- A104	This test and its conditions is performed per agreement between user and supplier on a case-by-case basis. Pre-Test: Preconditioning (PC) per AEC-Q100 Test #A1 TC per AEC-Q100 Test #A4 requirements taking into account the added MEMS grades~~.~~: **Grade 0A: -**55ºC to +165ºC for 2000 cycles or equivalent **Grade 0B: -**55ºC to +175ºC for 2000 cycles or equivalent Pressure cycling: fp=0.5 Hz in minimum operating pressure, $P_{min(op)}$, and maximum operating pressure, $P_{max(op)}$, pressure range (pressure rise and fall time should correspond to pressure mission profile from data sheet or to be adjusted according to application condition) Voltage condition: Vcc (max) at which dc and ac parameters are guaranteed **TEST before and after B_PPrTC at cold and hot temperature.** Continuous monitoring of pressure sensor output signal is required. Post-Test: IV (PS11) and WBP (C2) test for 5 devices; DIS (PS12) test for 5 parts; Burst Pressure Test (PS7) and Proof Pressure Test (PS8) for one lot. (B_PPrTC replaces AEC-Q100 Test #A4 TC if supplier can maintain appropriate transition time between hot and cold chamber)	Wire bond, wire, die bond, gel aeration, package failures, surface-charge spreading, volumetric gel changes, mechanical creep, membrane fatigue, parametric stability

Table 2A: MEMS Pressure Sensor Specific Qualification Test Methods (continued)

TEST GROUP PS – MEMS PRESSURE SENSOR SPECIFIC STRESS TESTS (CONTINUED)									
STRESS	**ABV**	**#**	**NOTES**	**SAMPLE SIZE (**)/ LOT**	**NUMBER OF LOTS**	**ACCEPT CRITERIA**	**TEST METHOD**	**ADDITIONAL REQUIREMENTS**	**TARGETED MEMS FAILURE MECHANISM**
Pressure & Low Temperature Operating Life Test	**PrLTOL**	PS3	G	77	1	0 Fails	MIL-STD-883 Method 1005.9	Pre-Test: Preconditioning (PC) per AEC-Q100 Test #A1 LTOL per MIL-STD-883 M1005.9 requirements. 1000 hours at minimum operating temperature, $T_{min(op)}$ Pressure condition: maximum operation pressure, $P_{max(op)}$, according to MEMS device pressure range **TEST before and after PrLTOL at room, hot, and cold temperature.** Continuous monitoring of pressure sensor output signal is required.	Bulk die defects or diffusion defects, mechanical creep, membrane fatigue, parametric stability
Condensing Humidity with Sulphur (can be also testing in a saturated atmosphere in the presence of sulphur dioxide)	**CHS**	PS4	G	45	1	0 Fails	DIN 50018	This test and its conditions is performed per agreement between user and supplier on a case-by-case basis. Pre-Test: Preconditioning (PC) per AEC-Q100 Test #A1 Bias Cycling condition: Vddmax, 1 hour ON, 1 hour OFF Test Cycle condition: 10 Cycles (1 cycle per 24hrs) according to DIN-50018 Sulphur condition: Concentration of SO2 at the beginning of each test cycle = 0.33 as percentage to volume **TEST before after CHS at room temperature.** Post-Test: IV (PS11) and WBP (C2) test for 5 devices. *** Note:** Certain applications may require modified test conditions.	Corrosion, wire bond, wire, contamination, volumetric gel changes, parametric stability
Corrosive Atmosphere	**CAtm**	PS5	G	10	1	0 Fails	EN 60068-2-60/ Method 4	This test and its conditions is performed per agreement between user and supplier on a case-by-case basis. Pre-Test: Preconditioning (PC) per AEC-Q100 Test #A1 Temperature condition: +25°C Humidity condition: 75% Flow Rate: $1m^3/h$ Gases: SO2 at 0.20ppm; H2S at 0.01ppm; NO2 at 0.20ppm; Cl2 at 0.01ppm Duration: 14 days **TEST before and after CAtm at room temperature.** Post-Test: IV (PS11) and WBP (C2) test for 5 devices. *** Note:** Certain applications may require modified test conditions.	Gel swelling, volumetric gel changes, corrosion, wire bond, wire, contamination parametric stability
Chemical Resistance (can be also solvent immersion)	**CR**	PS6	G	5 per chemical	1	0 Fails	Customer tailored plus ISO 16750-5	This test and its conditions is performed per agreement between user and supplier on a case-by-case basis. Pre-Test: Preconditioning (PC) per AEC-Q100 Test #A1 Subject samples to the required chemical agents (or solvents), durations, and temperatures per ISO 16750-5. **TEST before and after CR at room temperature.** Post-Test: IV (PS11) and WBP (C2) test for a minimum of 5 devices and a minimum of 1 part per chemical. *** Note:** Certain applications may require modified test conditions.	Gel swelling, volumetric gel changes, corrosion, wire bond, wire, contamination, parametric stability

Table 2A: MEMS Pressure Sensor Specific Qualification Test Methods (continued)

TEST GROUP PS – MEMS PRESSURE SENSOR SPECIFIC STRESS TESTS (CONTINUED)									
STRESS	**ABV**	**#**	**NOTES**	**SAMPLE SIZE (**)/ LOT**	**NUMBER OF LOTS**	**ACCEPT CRITERIA**	**TEST METHOD**	**ADDITIONAL REQUIREMENTS**	**TARGETED MEMS FAILURE MECHANISM**
Burst Pressure	**BPr**	PS7		15	3	0 Fails $5xP_{full\text{-}scale}$	Customer tailored	This test and its conditions is performed per agreement between user and supplier on a case-by-case basis. **Burst Pressure**: the maximum pressure that may be applied to the sensor without a catastrophic failure. Temperature condition: maximum operating temperature, $T_{max(op)}$ Pressure condition: $5 \times P_{full\text{-}scale} = 5 \times [P_{max(op)} - P_{min(op)}]$ Duration: 10 minutes, 1 time For Relative Pressure Sensors, apply pressure from back and front sides (i.e., perform Front-Side Burst Pressure Test and Back-Side Burst Pressure Test). Due to the destructive nature of the test, separate devices must be used for each test. Device shall be classified according to the maximum withstand pressure level. Devices should be stepped in pressure at $0.5 \times P_{full\text{-}scale}$ increments. Device levels $< 5 \times P_{full\text{-}scale}$ shall be documented in the supplier datasheet. **TEST before and after BPr at room temperature.** *** Note:** Certain applications may require modified test conditions.	Diaphragm fracture, adhesive or cohesive failure of die attach
Proof Pressure	**PPr**	PS8		15	3	0 Fails $3xP_{full\text{-}scale}$	Customer tailored	This test and its conditions is performed per agreement between user and supplier on a case-by-case basis. **Proof Pressure**: the maximum pressure that may be applied to the sensor without causing a change in performance with respect to the specifications (i.e., pressure that a sensor can routinely see without a permanent change in the output). Temperature condition: maximum operating temperature, $T_{max(op)}$ Pressure condition: $3 \times P_{full\text{-}scale} = 3 \times [P_{max(op)} - P_{min(op)}]$ Duration: 10 minutes, 10 times For Relative Pressure Sensors, apply pressure from back and front sides (i.e., perform Front-Side Proof Pressure Test and Back-Side Proof Pressure Test). Device shall be classified according to the maximum withstand pressure level. Devices should be stepped in pressure at $0.5 \times P_{full\text{-}scale}$ increments. Device levels $< 3 \times P_{full\text{-}scale}$ shall be documented in the supplier datasheet. **TEST before and after PPr at room temperature.** *** Note:** Certain applications may require modified test conditions.	

Table 2A: MEMS Pressure Sensor Specific Qualification Test Methods (continued)

TEST GROUP PS – MEMS PRESSURE SENSOR SPECIFIC STRESS TESTS (CONTINUED)									
STRESS	**ABV**	**#**	**NOTES**	**SAMPLE SIZE (**)/ LOT**	**NUMBER OF LOTS**	**ACCEPT CRITERIA**	**TEST METHOD**	**ADDITIONAL REQUIREMENTS**	**TARGETED MEMS FAILURE MECHANISM**
Salt Immersion Test	**SIT**	PS9	G	15	1	0 Fails	MIL-STD-883 Method 1002	Pre-Test: Preconditioning (PC) per AEC-Q100 Test #A1 Test conditions: 5 cycles of immersion between DI water at 65±3°C (60 min. dwell) and saturated salt water at 0±3°C (60 min. dwell) with 10 sec maximum transfer time. Immerse in DI water for 10 sec after the 5 cycles **TEST before and after SIT at room temperature.** Post-Test: IV (PS11) and WBP (C2) test for 5 devices. *** Note:** Certain applications may require modified test conditions.	Package failure, corrosion, contamination~~.~~
Dust	**DST**	PS10	G	15	1	0 Fails	MIL-STD-202G Method 110A	Test conditions according to mission profile (protection class, if any) **TEST before and after DST at room temperature.** *** Note:** Certain applications may require modified test conditions.	Dust contamination
Internal Visual Inspection	**IV**	PS11	G	5	3	0 Fails	MIL-STD-883 Method 2013	Internal Visual Inspection for virgin parts and post PS2, PS4, PS6, PS8, PS9, A2, A3, G1, and G2 tests.	
Die Shear Test	**DIS**	PS12	G	5	3	C_{PK} >1.67 or 0 Fails after **B_PPrTC** (PS2)	MIL-STD-883~~.~~ Method 2019	MEMS Pressure Sensor Die Shear Test conditions: DIS is not required for wafer bonding. It should be applied to the die of the pressure sensing element integrated with the interface chip, or in case of stacked die or side-by-side die design, applied to the pressure sensing element.	

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Table 2B: AEC-Q100 Qualification Test Methods Updated for MEMS Pressure Sensor Devices

(AEC-Q100 Table 2 tests updated to address MEMS pressure sensor device failure mechanisms)

STRESS	ABV	#	NOTES	SAMPLE SIZE (**)/LOT	NUMBER OF LOTS	ACCEPT CRITERIA	TEST METHOD	ADDITIONAL REQUIREMENTS	TARGETED MEMS FAILURE MECHANISM
UPDATED TEST GROUP A – ACCELERATED ENVIRONMENT STRESS TESTS									
Biased HAST or Temperature-Humidity-Bias	**HAST or THB**	A2		**77**	3	0 Fails	JEDEC JESD22-A110 or JESD22-A101	Pre-Test: Preconditioning (PC) per AEC-Q100 Test #A1 before HAST (130°C/85%RH for 96 hours, or 110°C/85%RH for 264 hours), or THB (85°C/85%RH for 1000 hours) **TEST before and after HAST (or THB) at room and hot temperature.** **HAST is preferred but not mandatory. THB is considered an alternate test, especially if UHST is also performed for the device.** Post-Test: IV (PS11) and WBP (C2) test for 5 devices.	Shift from ionic effect, moisture ingress, wire bond, package failure, gel swelling, parametric stability.
Unbiased HAST or Autoclave or Temperature-Humidity without Bias	**UHST or AC or TH**	A3	G	**77**	3	0 Fails	JEDEC JESD22-A118 or JESD22-A102 or JESD22-A110	Pre-Test: Preconditioning (PC) per AEC-Q100 Test #A1 before unbiased HAST (130°C/85%RH for 96 hours, or 110°C/85%RH for 264 hours) or the special conditions of AC (121°C/15psig for 96 hours) or TH (85°C/85%RH for 1000 hours). **TEST before and after UHST (or AC or TH) at room temperature.** **Unbiased HAST shall be applied for MEMS pressure sensor devices due to nature of the application environment (i.e., pressure presence). AC should be considered an alternate test if HAST pressure conditions violate the device maximum operation pressure. TH should be considered an alternate test for packages sensitive to high temperatures and pressure.** Post-Test: IV (PS11) and WBP (C2) test for 5 devices.	Wire bond, package failure, gel swelling, parametric stability.
UPDATED TEST GROUP C – PACKAGE ASSEMBLY INTEGRITY TESTS									
Wire Bond Shear	**WBS**	C1	G	30 bonds of each kind of bonding (e.g. between MEMS die and control die, control die and leads) from a minimum of 5 devices		C_{PK} >1.67	AEC Q100-001 AEC Q003	See additional requirements for test C1 and C2 in Table 2 of AEC-Q100. Perform WBS test for virgin devices. Perform WBP test for virgin devices and post PS2, PS4, PS6, PS8, PS9, A2, A3, G1, and G2 tests.	
Wire Bond Pull	**WBP**	C2	G			C_{PK} >1.67 or 0 fails after TC (test #A4)	MIL-STD-883 Method 2011 AEC Q003		

Table 2B: AEC-Q100 Qualification Test Methods Updated for MEMS Pressure Sensor Devices (continued)

(AEC-Q100 Table 2 tests updated to address MEMS pressure sensor device failure mechanisms)

UPDATED TEST GROUP G – CAVITY PACKAGE INTEGRITY TESTS									
STRESS	**ABV**	**#**	**NOTES**	**SAMPLE SIZE (**)/LOT**	**NUMBER OF LOTS**	**ACCEPT CRITERIA**	**TEST METHOD**	**ADDITIONAL REQUIREMENTS**	**TARGETED MEMS FAILURE MECHANISM**
Mechanical Shock	**MS**	G1	G	39	3	0 Fails	JEDEC JESD22-B110	Grade M1: • Test conditions: 5 pulses in both directions of each axis, 0.3 ms duration, 6000 g peak acceleration Grade M2: • Pre-Test: Constant Acceleration (CA) per Test #G3 below • Test conditions: 10 pulses in both directions of each axis, 0.3 ms duration, 6000 g peak acceleration Alternate Test condition: according to mission profile (mechanical conditions defined by mounting location) **TEST before and after MS at room temperature.** Post-Test: IV (PS11) and WBP (C2) test for 5 devices.	Diaphragm fracture, package failure, die and wire bonds.
Variable Frequency Vibration	**VFV**	G2	G	39	3	0 Fails	JEDEC JESD22-B103	Grade M1: • Test conditions: Per AEC-Q100 (50 g, 20Hz to 2kHz), stress shall be applied to each of three mutually perpendicular axes in plus and minus directions Grade M2: • Pre-Test: Constant Acceleration (CA) per Test #G3 below • Test conditions: Per AEC-Q100 (50 g, 10Hz to 2kHz in 1 hour), stress shall be applied to each of three mutually perpendicular axes in plus and minus directions Alternate Test condition: according to mission profile (mechanical conditions defined by mounting location) **TEST before and after VFV at room temperature.** Post-Test: IV (PS11) and WBP (C2) test for 5 devices.	
Constant Acceleration	**CA**	G3	G	39 (78 for TPMS only)	3	0 Fails	MIL-STD-883 Method 2001	Grade M1: • Test conditions: Per AEC-Q100 (2000 g for 1 min), stress shall be applied to each of three mutually perpendicular axes in plus and minus directions Grade M2: • Test conditions: Per AEC-Q100 (2500 g for 1 hour), stress shall be applied to each of three mutually perpendicular axes in plus and minus directions Alternate Test condition: according to mission profile (mechanical conditions defined by mounting location) **TEST before and after CA at room temperature.**	

Legend for Tables 2A and 2B

Notes:

- ****** Sample size per life tests at bare die delivery. In case of bare die delivery (e.g., piezo-resistive pressure sensing element), test samples must be mounted on a "test substrate" or in ceramic packaging. Optional recommendation is joint qualification where user sub processes are implemented with reduced sample sizes per agreement between user and supplier.

- **G** Generic data allowed. See AEC-Q100, Section 2.3 and Appendix 1 of this document.

- **#** Reference Number for the particular test.

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Table 3: Process Change Qualification Guidelines for the Selection of Tests for MEMS Pressure Sensor Devices

A2 Temperature Humidity Bias / HAST
A3 Autoclave / Unbiased HAST
A4 Temperature Cycling
A5 Power Temperature Cycling
A6 High Temperature Storage Life
B1 High Temperature Operating Life
B2 Early Life Failure Rate
B3 NVM Endurance, Data Retention
C1 Wire Bond Shear
C2 Wire Bond Pull
C3 Solderability
C4 Physical Dimensions
C5 Solder Ball Shear
C6 Lead Integrity
C7 Bump Shear
C8 Die Pull / Peeling
C9 Lid Pull
D1 Electromigration
D2 Time Dependent Dielectric Breakdown
D3 Hot Carrier Injection
D4 Negative Bias Temperature Instability
D5 Stress Migration
E2 Human Body Model ESD
E3 Charged Device Model ESD
E4 Latch-up
E5 Electrical Distribution
E7 Characterization
E9 Electromagnetic Compatibility
E10 Short Circuit Characterization
E11 Soft Error Rate
E12 Pb-Free
G1-G4 Mechanical Series
G5 Package Drop
G6 Lid Torque
G7 Die Shear
G8 Internal Water Vapor
PS1 Pressure & High Temperature Operating Life
PS2 Biased Pulsed Pressure Temperature Cycling
PS3 Pressure & Low Temperature Operating Life
PS4 Condensing Humidity with Sulphur
PS5 Corrosive Atmosphere
PS6 Chemical Resistance
PS7 Burst Pressure
PS8 Proof Pressure
PS9 Salt Immersion
PS10 Dust
PS11 Internal Visual Inspection
PS12 Die Shear

Note: A letter or "●" indicates that performance of that stress test should be **considered** for the appropriate process change. Reason for not performing a considered test should be given in the qualification plan or results.

Table 2 Test #	A2	A3	A4	A5	A6	B1	B2	B3	C1	C2	C3	C4	C5	C6	C7	C8	C9	D1	D2	D3	D4	D5	E2	E3	E4	E5	E7	E9	E10	E11	E12	G1-G4	G5	G6	G7	G8	PS1	PS2	PS3	PS4	PS5	PS6	PS7	PS8	PS9	PS10	PS11	PS12
Test Abbreviation	THB	AC	TC	PTC	HTSL	HTOL	ELFR	EDR	WBS	WBP	SD	PD	SBS	LI	BST	DPT	LPT	EM	TDDB	HCI	NBTI	SM	HBM	CDM	LU	ED	CHAR	EMC	SC	SER	LF	MECH	DROP	LT	DS	IWV	PrHTOL	B_PPrTC	PrLTOL	CHS	CAtm	CR	BPr	PPr	SIT	DST	IV	DIS
DESIGN																																																
Active Element Design		●	●	M		●	●	DJ										D	D	D	D	D	●	●	●	●	●	●	●	●			F				●	●										
Circuit Rerouting			A	M																			●	●	●	●	●	●	●																			
Wafer Dimension/Thickness (including Pressure Sensor Membrane)			E	M		●	●		E	E											●		E	E	E	●						S					●	E	E				E	E			●	●
MEMS (Pressure Sensing Element) Design Change	●																										●					●					●	●					●	●				
WAFER FAB																																																
Lithography	●		●	M		●	G		●	●											●					●											●	●										
Die Shrink	●	●		M		●	●	DJ										●	●	●	●	●	●	●	●	●	●	●	●	●							●											
Diffusion/Doping				M		●	G														●		●	●	●	●	●										●											
Polysilicon			●	M		●		DJ													●		●	●	●	●	●										●	●										
Metallization/Via/Contacts	●	●	●	M		●			●	●								●				●				●	●		●								●	●										
Passivation/Oxide/Interlevel Dielectric	K	K	●	M		●	GN	DJ	K	●									●	●	●	●	●	●	●	●	●										●	●		K	K	K			K	K	K	
Backside Operation			●	M		●																	M	M	●		●					H			H		●	●										
FAB Site Transfer	●	●	●	M		●	●	J	●	●								●	●	●	●	●	●	●	●	●						H			H		●	●	●	●	●	●	●	●	●	●	●	●
MEMS (Pressure Sensing Element) Specific Process	●																									●						●					●	●					●	●				
WAFER BUMPING																																																
Redistribution Layer	●	●	●	M	●										●	●	●									●												●										
Under Bump Metal	●	●	●	M	●										●	●	●									●												●										
Bump Material	●	●	●	M	●										●	●	●									●												●										
Bump Site Transfer	●	●	●	M	●										●	●	●									●												●										
ASSEMBLY																																																
Die Overcoat/ Underfill	●	●	●	M	●	●																								●						H	●	●	●	●	●	●	●	●	●	●	●	●
Leadframe Plating	●	●	●	M	●					C	●			●																	L				H					●	●	●						●
Bump Material/Metal System	●	●	●	M	●	●						●	●																	●	L						●	●		●	●	●						
Leadframe Material		●	●	M	●					●	●	●		●															●		L	H			H			●		●	●	●						●
Leadframe Dimension		●	●	M							●	●		●															●		L	H						●		●	●	●						●
Wire Bonding	S	●	●	Q	●				●	●																M			●			H						●		●	●	●			●			●
Die Scribe/Separate	●	●	●	M																																		●										●
Die Preparation/Clean	●	●		M		●			●	●																									H			●										●
Package Marking											B																																					
Die Attach	●	●	●	M		●																				●			●		L	H			H	H	●	●		●	●	●	●	●				●
Molding Compound	●	●	●	M	●	●	●				●	●		●																●	L						●	●			●	●						●
Molding Process	●	●	●	M	●	●					●	●		●																	L						●	●			●	●						●
Hermetic Sealing		H	H		H							H		H																		H		H		H												
New Package	●	●	●	M	●	●	●		●	●	●	●	T	●									●	●		●			●		L	H			H	H	●	●	●	●	●	●	●	●	●	●	●	●
Substrate/Interposer	●	●	●	M	●	●			●	●			T																		L	H			H	H	●	●										
Assembly Site Transfer	●	●	●	M		●	●		●	●	●	●	T	●												●					L	H			H	H	●	●	●	●	●	●	●	●	●	●	●	●

A Only for peripheral routing
B For symbol rework, new cure time, temp
C If bond to leadfinger
D Design rule change
E Thickness only
F MEMS element only
G Only from non-100% burned-in parts
H Hermetic only
J EPROM or E^2PROM
K Passivation only
L For Pb-free devices only
M For devices requiring PTC
N Passivation and gate oxide
Q Wire diameter decrease
S MEMS Pressure Sensors
T For Solder Ball SMD only

Appendix 1: Definition of a MEMS Pressure Sensor Product Qualification Family

MEMS Pressure Sensor product qualification family shall be compliant to Appendix 1 of AEC-Q100 with additional requirements specific to MEMS Pressure Sensor devices as defined below:

A1.1 Product

i. Specified MEMS Operating Pressure Range
j. Specified MEMS Operating Mechanical Condition (e.g., general Pressure Sensor, rim or tire mounted TPMS)
k. Specified MEMS Operating Environmental Condition (e.g., details of expected harsh operating environment)

A1.2 Fab Process

b. **Wafer Fab Process**
- MEMS structure and material
- MEMS silicon cap bonding process and bonding materials
- MEMS internal atmosphere composition

A1.3 Assembly Process – Plastic, Ceramic, or Flip-Chip BGA

b. **Assembly Process**
- MEMS sensor overcoat (e.g., silicone gel)

A1.4 Qualification/Requalification Lot Requirements

Table A1.1: MEMS Part Qualification/Requalification Lot Requirements
(see AEC-Q100 with additional requirements as shown below)

Part Information	Lot Requirements for Qualification
New MEMS design and no applicable generic data.	Lot and sample size requirements AEC-Q100 Table 2 and Tables 2A/2B of this specification.
Generic data available for the MEMS design, but in a different package.	Only MEMS device specific tests as defined in Section 4.2 are required. Lot and sample size requirements per AEC-Q100 Table 2~~,~~ and Tables 2A/2B of this specification for the required tests.
Same MEMS design and package, but new circuit or IC (with similar geometry).	Review Table 3 (both AEC-Q100 and this specification) to determine which tests from AEC-Q100 Table 2 and Tables 2A/2B of this specification should be considered.
MEMS design change, MEMS fabrication process change, or package change.	Review Table 3 (both AEC-Q100 and this specification) to determine which tests from AEC-Q100 Table 2 and Tables 2A/2B of this specification should be considered.

Appendix 2: Q103-002 Certification of Design, Construction and Qualification

Supplier Name: **Date:**

The following information is required to identify a device that has met the requirements of AEC-Q103-002. Submission of the required data in the format shown below is optional. **All entries must be completed; if a particular item does not apply, enter "Not Applicable".** This template can be downloaded from the AEC website at http://www.aecouncil.com.

This template is available as a stand-alone document.

Item Name	Supplier Response
1. User's Part Number:	
2. Supplier's Part Number/Data Sheet:	
3. Device Description:	
4.1. Control Wafer/Die Fab Location & Process ID: a. Facility name/plant #: b. Street address: c. Country:	
4.2. MEMS Wafer/Die Fab Location & Process ID: a. Facility name/plant #: b. Street address: c. Country:	
4.3. Cap Wafer/Die Fab Location & Process ID: a. Facility name/plant #: b. Street address: c. Country:	
4.4. Cap Wafer to MEMS Wafer Bonding Location & Process ID: a. Facility name/plant #: b. Street address: c. Country:	
5.1. Control Wafer Probe Location: a. Facility name/plant #: b. Street address: c. Country:	
5.2. MEMS Wafer Probe Location: a. Facility name/plant #: b. Street address: c. Country:	
5.3. Bonded Wafer Probe Location: a. Facility name/plant #: b. Street address: c. Country:	
6. Assembly Location & Process ID: a. Facility name/plant #: b. Street address: c. Country:	
7. Final Quality Control A (Test) Location: a. Facility name/plant #: b. Street address: c. Country:	

8.1. Control Wafer/Die: a. Wafer size: b. Die family: c. Die mask set revision & name: d. Die photo:	See attached ☐ Not available ☐		
8.2. MEMS Wafer/Die: a. Wafer size: b. Die family: c. Die mask set revision & name: d. Die photo:	See attached ☐ Not available ☐		
9.1. Control Wafer/Die Technology Description: a. Wafer/Die process technology: b. Die channel length: c. Die gate length: d. Die supplier process ID (Mask #): e. Number of transistors or gates: f. Number of mask steps:			
9.2. MEMS Wafer/Die Technology Description: a. Wafer/Die process technology: b. Sensor length x width x depth: c. Sensor anti-stiction coating: d. Die supplier process ID (Mask #): e. Number of sensor detection elements (comb/fingers cells, pressure-sensing cells, thermos cells…): f. Number of mask steps:			
9.3. Cap to MEMS Wafer Bonding Technology Description: a. Bonding process technology: b. MEMS cavity gas atmosphere after bonding: c. MEMS cavity pressure range after bonding:			
10.1. Die Dimensions: a. Die width: b. Die length: c. Die thickness (finished): d. Membrane Thickness:	Control Die	MEMS Die	Cap Die
10.2. Capped MEMS Thickness: a. After bonding: b. Bonded wafer thinning process description: c. Finished Capped MEMS die thickness:	Capped MEMS Wafer		
11. Die Metallization: a. Die metallization material(s): b. Number of layers: c. Thickness (per layer): d. % of alloys (if present):	Control Die	MEMS Die	Cap Die
12. Die Passivation: a. Number of passivation layers: b. Die passivation material(s): c. Thickness(es) & tolerances: d. MEMS Anti-stiction Coating:	Control Die	MEMS Die	Cap Die
13.1. Die Overcoat Material (e.g., Polyimide) or Capped MEMS Die (e.g., Gel):	Control Die	MEMS Die	

14. Die Cross-Section Photo/Drawing:	Control Die See attached ☐ Not available ☐	MEMS Die See attached ☐ Not available ☐	Cap Die See attached ☐ Not available ☐
15. Die Prep Backside: a. Die prep method: b. Die metallization: c. Thickness(es) & tolerances:	Control Die	MEMS Die	Cap Die
16. Die Separation Method: a. Kerf width (μm): b. Kerf depth (if not 100% saw): c. Saw method:	Control Die Single☐ Dual☐	MEMS Die Single☐ Dual☐	Bonded MEMS Die Single☐ Dual☐
17. Die Attach: a. Die attach material ID: b. Die attach method: c. Die placement diagram:	Control Die See attached ☐ Not available ☐	MEMS Die See attached ☐ Not available ☐	
18. Package: a. Type of package (e.g., plastic, ceramic, unpackaged): b. Ball/lead count: c. JEDEC designation (e.g., MS029, MS034, etc.): d. Lead (Pb) free (< 0.1% homogenous material): e. Package outline drawing:	Yes ☐ No ☐ See attached ☐ Not available ☐		
19.1. Mold Compound: a. Mold compound supplier & ID: b. Mold compound type: c. Flammability rating: d. Fire Retardant type/composition: e. Tg (glass transition temperature)(°C): f. CTE (above & below Tg)(ppm/°C):	UL 94 V1 ☐ UL 94 V0 ☐ CTE1 (above Tg) = _____ CTE2 (below Tg) = _____		
19.2. Package Material Used Before or After Mold Over MEMS or Capped MEMS Die: a. Material type and ID: b. Minimum material coverage: c. Maximum material coverage:	Supplier for items b and c shall supply MEMS material coverage drawing with dimensions. See attached ☐ Not available ☐ See attached ☐ Not available ☐		
20.1. Die to Leadframe Wire Bond: a. Wire bond material: b. Wire bond diameter (mils): c. Type of wire bond at die: d. Type of wire bond at leadframe: e. Wire bonding diagram:	See attached ☐ Not available ☐		
20.2. Die to Die Wire Bond: a. Wire bond material: b. Wire bond diameter (mils): c. Type of wire bond at Control die: d. Type of wire bond at MEMS die: e. Wire bonding diagram:	See attached ☐ Not available ☐		

21. Leadframe (if applicable): a. Paddle/flag material: b. Paddle/flag width (mils): c. Paddle/flag length (mils): d. Paddle/flag plating composition: e. Paddle/flag plating thickness (μinch): f. Leadframe material: g. Leadframe bonding plating composition: h. Leadframe bonding plating thickness (μinch): i. External lead plating composition: j. External lead plating thickness (μinch):	Control Die	MEMS Die
22. Substrate (if applicable): a. Substrate material (e.g., FR5, BT, etc.): b. Substrate thickness (mm): c. Number of substrate metal layers: d. Plating composition of ball solderable surface: e. Panel singulation method: f. Solder ball composition: g. Solder ball diameter (mils):		
23. Unpackaged Die (if not packaged): a. Under Bump Metallurgy (UBM) composition: b. Thickness of UBM metal: c. Bump composition: d. Bump size:		
24. Header Material (if applicable):		
25. Thermal Resistance: a. θ_{JA} °C/W (approx): b. θ_{JC} °C/W (approx): c. Special thermal dissipation construction techniques:		
26. Test circuits, bias levels, & operational conditions imposed during the supplier's life and environmental tests:	See attached ☐ Not available ☐	
27. Fault Grade Coverage (%)	_____ % Not digital circuitry ☐	
28. Maximum Process Exposure Conditions: a. MSL @ rated SnPb temperature: b. MSL @ rated Pb-free temperature: c. Maximum dwell time @ maximum process temperature:	** Note: Temperatures are as measured on the center of the plastic package body top surface.* _____ at _____ °C (SnPb) _____ at _____ °C (Pb-free) _____	

Attachments:		Requirements:
Die Photo	☐	1. A separate Certification of Design, Construction & Qualification must be submitted for each P/N, wafer fab, and assembly location.
Package Outline Drawing	☐	
Die Cross-Section Photo/Drawing	☐	2. Design, Construction & Qualification shall be signed by the responsible individual at the supplier who can verify the above information is accurate and complete. Type name and sign below.
Wire Bonding Diagram	☐	
Die Placement Diagram	☐	
MEMS material coverage drawing with dimensions	☐	
Test Circuits, Bias Levels, & Conditions	☐	

Completed by: Date:	Certified by: Date:
Typed or Printed: Signature: Title:	

Appendix 4: Minimum Requirements for MEMS Pressure Sensor Qualification Plans and Results

The following information is required as a minimum to identify a device that has met the requirements of AEC-Q103-002 (see Appendix Templates 4A and 4B). Submission of data in this format is optional. However, if these templates are not used, the supplier must ensure that each item on the template is adequately addressed. The templates can be downloaded from the AEC website at http://www.aecouncil.com.

A4.1 Plans

1. Part Identification: Customer P/N and supplier P/N.
2. Site or sites at which life testing will be conducted.
3. List of tests to be performed (e.g., JEDEC method, Q100 and Q103-002 method, MIL-STD method) along with conditions. Include specific temperature(s), humidity, and bias to be used.
4. Sample size and number of lots required.
5. Time intervals for end-points (e.g., after PC, 0 hour, 500 hour, 1000 hour).
6. Targeted start and finish dates for all tests and end-points.
7. Supplier name and contact.
8. Submission date.
9. Material and functional details and test results of devices to be used as generic data for qualification. Include rationale for use of generic data.

A4.2 Results

All of above plus:

1. Date codes and lot codes of parts tested.
2. Process identification.
3. Fab and assembly locations.
4. Mask number or designation.
5. Number of failures and number of devices tested for each test.
6. Failure analyses for all failures and corrective action reports to be submitted with results.

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Component Technical Committee

Appendix Template 4A: AEC-Q103-002 Qualification Test Plan

Q103-002 QUALIFICATION TEST PLAN

USER COMPANY:		DATE:	
USER P/N:		TRACKING NUMBER:	
USER SPEC #:		USER COMPONENT ENGINEER:	
SUPPLIER COMPANY:		SUPPLIER MANUFACTURING SITES:	
SUPPLIER P/N:		PPAP SUBMISSION DATE:	
SUPPLIER FAMILY TYPE:		REASON FOR QUALIFICATION:	

STRESS TEST	ABV	TEST#	TEST METHOD	Test Conditions/S.S. per Lot/# Lots (identify temp, RH, & bias)	REQUIREMENTS S.S	REQUIREMENTS # LOTS	RESULTS Fails/S.S./# lots
Preconditioning	PC	A1	J-STD-020	Peak Reflow Temp. = Preconditioning used =	Min. MSL = 3		MSL =
Temperature Humidity Bias or HAST	THB / HAST	A2	JESD22-A101/A110		77	3	
Autoclave or Unbiased HAST	AC / UHST	A3	JESD22-A102/A118		77	3	
Temperature Cycle	TC	A4	JESD22-A104		77	3	
Power Temperature Cycling	PTC	A5	JESD22-A105		45	1	
High Temperature Storage Life	HTSL	A6	JESD22-A103		45	1	
High Temperature Operating Life	HTOL	B1	JESD22-A108		77	3	
Early Life Failure Rate	ELFR	B2	AEC Q100-008		800	3	
NVM Endurance, Data Retention, & Operational Life	EDR	B3	AEC Q100-005		77	3	
Wire Bond Shear	WBS	C1	AEC Q100-001		5	1	
Wire Bond Pull Strength	WBP	C2	MIL-STD-883 - 2011		5	1	
Solderability	SD	C3	JESD22-B102 J-STD-002D	8 hr steam aging prior to testing	15	1	
Physical Dimensions	PD	C4	JESD22-B100/B108		10	3	
Solder Ball Shear	SBS	C5	AEC Q100-010		10	3	
Lead Integrity	LI	C6	JESD22-B105		5	1	
Electromigration	EM	D1					
Time Dependent Dielectric Breakdown	TDDB	D2					
Hot Carrier Injection	HCI	D3					
Negative Bias Temperature Instability	NBTI	D4					
Stress Migration	SM	D5					
Pre- and Post-Stress Electrical Test	TEST	E1	Test to spec		All		
ESD - Human Body Model	HBM	E2	AEC Q100-002		See Test Method		
ESD - Charged Device Model	CDM	E3	AEC Q100-011		See Test Method		
Latch-Up	LU	E4	AEC Q100-004		6	1	
Electrical Distributions	ED	E5	AEC Q100-009		30	3	
Fault Grading	FG	E6	AEC-Q100-007				
Characterization	CHAR	E7	AEC Q003				
Electromagnetic Compatibility	EMC	E9	SAE J1752/3		1	1	
Short Circuit Characterization	SC	E10	AEC Q100-012		10	3	
Soft Error Rate	SER	E11	JESD89-1, -2, -3		3	1	
Lead Free	LF	E12	Q005		See Test Method		
Process Average Test	PAT	F1	AEC Q001				
Statistical Bin/Yield Analysis	SBA	F2	AEC Q002				
Mechanical Shock	MS	G1	JESD22-B110		39	3	
Variable Frequency Vibration	VFV	G2	JESD22-B103		39	3	
Constant Acceleration	CA	G3	MIL-STD-883 - 2001		39/78	3	
Gross/Fine Leak	GFL	G4	MIL-STD-883 - 1014		15	1	
Package Drop	DROP	G5			5	1	
Lid Torque	LT	G6	MIL-STD-883 - 2024		5	1	
Die Shear Strength	DS	G7	MIL-STD-883 - 2019		5	1	

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Appendix Template 4A: AEC-Q103-002 Qualification Test Plan (continued)

STRESS TEST	ABV	TEST#	TEST METHOD	Test Conditions/S.S. per Lot/# Lots (identify temp, RH, & bias)	REQUIREMENTS		RESULTS Fails/S.S./# lots
					S.S	# LOTS	
Pressure & High Temperature Operating Life Test	PrHTOL	PS1	JESD22- A108		77	3	
Biased Pulsed Pressure Temperature Cycling	B_PPrTC	PS2	JESD22- A104		77	3	
Pressure & Low Temperature Operating Life Test	PrLTOL	PS3	MIL-STD-883 - 1005		77	1	
Testing in a saturated atmosphere in the presence of sulfur dioxide	CHS	PS4	DIN 50018		45	1	
Corrosive Atmosphere	CAtm	PS5	EN 60068-2-60 / Method 4		10	1	
Chemical Resistance	CR	PS6	ISO 16750-5		Var (5xChemical)	1	
Burst Pressure	BPr	PS7			15	3	
Proof Pressure	PPr	PS8			15	3	
Salt Immersion Test	SIT	PS9	MIL-STD-883 - 1002		15	1	
Dust	DST	PS10	MIL-STD-202G - 110A		15	1	
Internal Visual Inspection	IV	PS11	MIL-STD-883 - 2013		5	3	
Die Shear Test	DIS	PS12	MIL-STD-883 - 2019		5	3	
Supplier:				Approved by: (User Engineer)			

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Appendix Template 4B: AEC-Q103-002 Generic Data

Objective:		***Package:***		***Qual Plan Ref #:***	
Device:		***Fab/Assy/Test:***		***Date Prepared:***	
Cust PN:		***Device Engr:***		***Prepared by:***	
Maskset:		***Product Engr:***		***Date Approved:***	
Die Size:		***Component Engr:***		***Approved by:***	

Test #	ABV	Q100 Test Conditions	End-Point Requirements	Sample Size/Lot	# of Lots	Total # Units	Part to be Qualified	Differences from Q100/Q103	Generic Family part A	Differences from Q100/Q103	Generic Family part B	Differences from Q100/Q103
A1	PC	J-STD-020	TEST = ROOM	All surface mount parts prior to A2, A3, A4, A5								
A2	THB / HAST	JESD22-A101/A110	TEST = ROOM and HOT	77	3	231						
A3	AC / UHST	JESD22-A102/A118	TEST = ROOM	77	3	231						
A4	TC	JESD22-A104	TEST = HOT	77	3	231						
A5	PTC	JESD22-A105	TEST = ROOM and HOT	45	1	45						
A6	HTSL	JESD22-A103	TEST = ROOM and HOT	45	1	45						
B1	HTOL	JESD22-A108	TEST = ROOM, COLD, and HOT	77	3	231						
B2	ELFR	AEC Q100-008	TEST = ROOM and HOT	800	3	2400						
B3	EDR	AEC Q100-005	TEST = ROOM and HOT	77	3	231						
C1	WBS	AEC Q100-001	Cpk>1.5 and in SPC	An appropriate time period for each bonder to be used								
C2	WBP	MIL-STD-883 – 2011										
C3	SD	JESD22-B102 J-STD-002D	>95% solder coverage	15	1	15						
C4	PD	JESD22-B100/B108	Cpk > 1.5 per JESD95	10	3	30						
C5	SBS	AEC Q100-010	Two 220°C reflow cycles before SBS									
C6	LI	JESD22-B105	No lead breakage or finish cracks	10 leads from each of 5	1	5						
D1	EM											
D2	TDDB											
D3	HCI											
D4	NBTI											
D5	SM											
E1	TEST		All parametric and functional tests	All units	-	All						
E2	HBM	AEC Q100-002	TEST = ROOM and HOT		1	Var.						
E3	CDM	AEC Q100-011	TEST = ROOM and HOT		1	Var.						
E4	LU	AEC Q100-004	TEST = ROOM and HOT	6	1	6						
E5	ED	AEC Q100-009	TEST = ROOM, HOT, and COLD	30	3	90						
E6	FG	AEC Q100-007										
E7	CHAR	AEC Q003										
E9	EMC	SAE J1752/3		1	1	1						
E10	SC	AEC Q100-012		10	3	30						
E11	SER	JESD89-1, -2, -3		3	1	3						
E12	LF	Q005										
F1	PAT	AEC Q001		All units	-	All						
F2	SBA	AEC Q002		All units	-	All						
G1	MS	JESD22-B110	TEST = ROOM	39	3	117						
G2	VFV	JESD22-B103	TEST = ROOM	39	3	117						
G3	CA	MIL-STD-883 – 2001	TEST = ROOM	39	3	117						
G4	GFL	MIL-STD-883 – 1014		15	1	15						
G5	DROP		TEST = ROOM	5	1	5						
G6	LT	MIL-STD-883 – 2024		5	1	5						
G7	DS	MIL-STD-883 – 2019		5	1	5						
G8	IWV	MIL-STD-883 - 1018		5	1	3						

Appendix Template 4B: AEC-Q103-002 Generic Data (continued)

Test #	ABV	Q100 Test Conditions	End-Point Requirements	Sample Size/Lot	# of Lots	Total # Units	Part to be Qualified	Differences from Q100/Q103	Generic Family part A	Differences from Q100/Q103	Generic Family part B	Differences from Q100/Q103
PS1	PrHTOL	JESD22- A108	TEST = ROOM, COLD, and HOT	77	3	231						
PS2	B_PPrTC	JESD22- A104	TEST = COLD and HOT	77	3	231						
PS3	PrLTOL	MIL-STD-883 - 1005	TEST = ROOM, HOT and COLD	77	1	77						
PS4	CHS	DIN 50018	TEST = ROOM	45	1	45						
PS5	CAtm	EN 60068-2-60 / Method 4	TEST = ROOM	10	1	10						
PS6	CR	ISO 16750-5	TEST = ROOM	Var (5/Chemical)	1	Var (5/Chemical						
PS7	BPr		TEST = ROOM	15	3	45						
PS8	PPr		TEST = ROOM	15	3	45						
PS9	SIT	MIL-STD-883 - 1002	TEST = ROOM	15	1	15						
PS10	DST	MIL-STD-202G - 110A	TEST = ROOM	15	1	15						
PS11	IV	MIL-STD-883 - 2013		5	3	15						
PS12	DIS	MIL-STD-883 - 2019		5	3	15						

Part Attributes	Part to be Qualified	Generic Family Part A	Generic Family Part B
User Part Number			
Supplier Part Number			
A1.1 Product			
Product Functionality (e.g., Op-Amp, Regulator, Microprocessor, Logic – HC/TTL)			
Operating Supply Voltage Range(s)			
Specified MEMS Operating Temperature Range			
Specified MEMS Operating Frequency Range			
Specified MEMS Operating Pressure Range			
Specified MEMS Operating Mechanical Condition (e.g., general Pressure Sensor, rim or tire mounted TPMS)			
Specified MEMS Operating Environmental Condition (e.g., details of expected harsh operating environment)			
[1] Analog Design Library Cells (e.g., active circuit elements, passive circuit elements)			
[1] Digital Design Library Cells (e.g., circuit blocks, IO modules, ESD cells)			
Memory IP (e.g., cell structure, building block)			
Memory Type(s) & Size(s)			
Design Rules for Active Circuits under Pads			
Other Functional Characteristics (as defined by supplier)			

Appendix Template 4B: AEC-Q103-002 Generic Data (continued)

Part Attributes	Part to be Qualified	Generic Family Part A	Generic Family Part B
A1.2 Fab Process			
Wafer Fab Technology (e.g., CMOS, NMOS, Bipolar)			
Circuit Element Feature Size (e.g., layout design rules, die shrinks, contacts, gates, isolations)			
Substrate (e.g., orientation, doping, epi, wafer size)			
Maximum Number of Masks (supplier must show justification for waiving this requirement)			
Lithographic Process (e.g., contact vs. projection, E-beam vs. X-ray, photoresist polarity)			
Doping Process (e.g., diffusion vs. ion implantation)			
Gate Structure, Material & Process (e.g., polysilicon, metal, salicide, wet vs. dry etch)			
Polysilicon Material, Thickness Range, & Number of Levels			
Oxidation Process & Thickness Range (e.g., gate & field oxides)			
Interlevel Dielectric Material & Thickness Range			
Metallization Material, Thickness Range, & Maximum Number of Levels			
Passivation Process (e.g., passivation oxide opening), Material, & Thickness Range			
Die Backside Preparation Process & Metallization			
Wafer Fabrication Site			
MEMS Structure and Material			
MEMS Silicon Cap Bonding Process and Bonding Materials~~.~~			
MEMS Internal Atmosphere Composition			
A1.3 Assembly Process – Plastic or Ceramic			
Assembly Site			
Package Type (e.g., DIP, SOIC, QFP, PGA, PBGA)			
Range of Paddle/Flag Size (maximum & minimum dimensions) Qualified for the Die Size/Aspect Ratio Under Consideration			
Worst Case Package (e.g., package warpage due to CTE mismatch)			
Substrate Base Material (e.g., PBGA)			
Leadframe Base Material			
Die Header / Thermal Pad Material			
Leadframe Plating Material & Process (internal & external to the package)			
Die Attach Material			

Appendix Template 4B: AEC-Q103-002 Generic Data (continued)

Part Attributes	Part to be Qualified	Generic Family Part A	Generic Family Part B
Wire Bond Material & Diameter			
Wire Bond Method, Presence of Downbonds, & Process			
Plastic Mold Compound Material, Organic Substrate Material, or Ceramic Package Material			
Plastic Mold Compound Supplier/ID			
Solder Ball Metallization System (if applicable)			
Heatsink Type, Material, & Dimensions			
Die Preparation/Singulation			
MEMS sensor Overcoat: Material or Process (e.g., silicone gel)			

Note 1: Design Library cells need to follow guidelines for temperature ranges, voltage ranges, speed, performance, and power dissipation as defined in Appendix 1 of this document.

Revision History

Rev #	Date of change	Brief summary listing affected sections
-	March 1, 2019	Initial Release