Update on MEMS Micro Qualification

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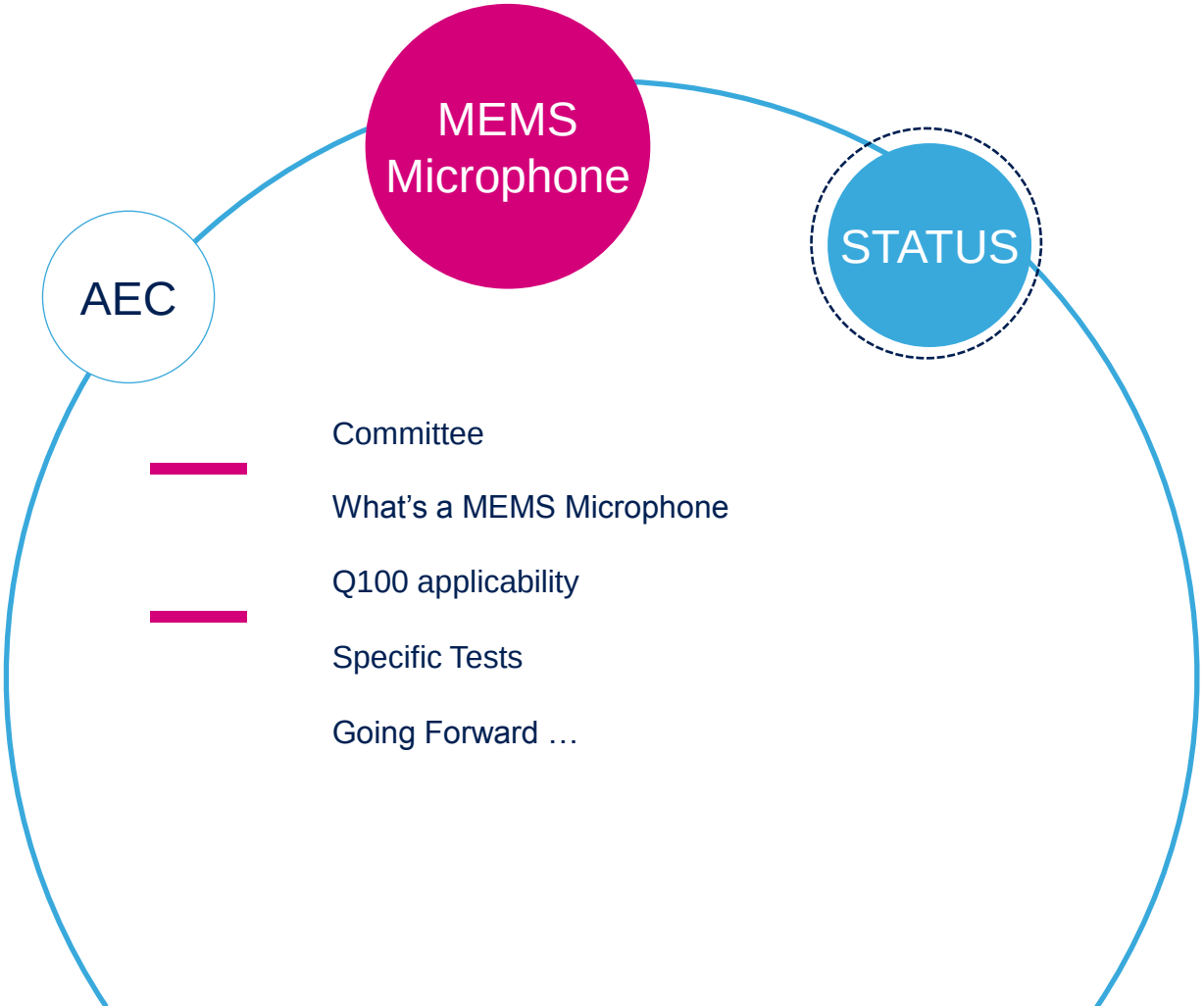
Agenda



- Committee
- What's a MEMS Microphone
- Q100 applicability
- Specific Tests
- Going Forward …

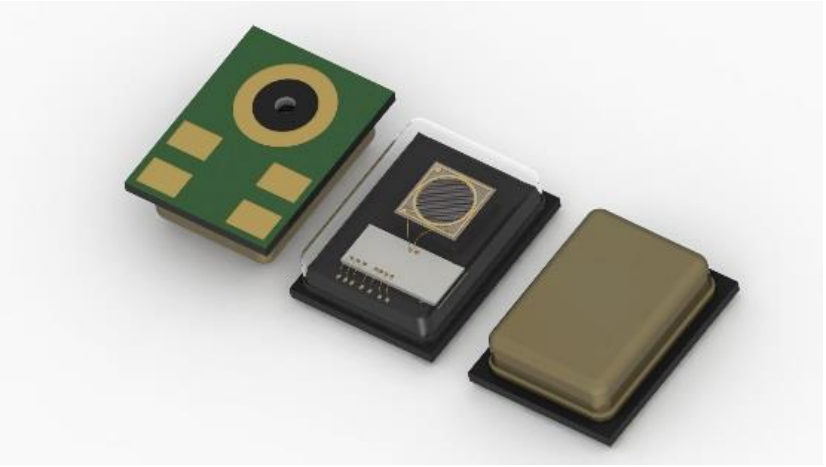
Committee

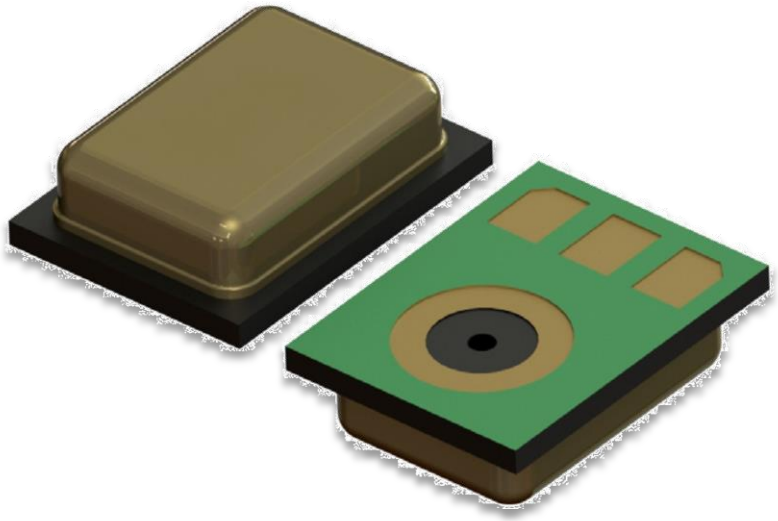
- MEMS Microphone is being used by Automotive.
  - Each application meets customer specific requirements
  - Because not 100% applicable Q100 is not used as a reference today
  - Automotive customers would appreciate a Q100 like std.
  - Our intention is to develop a common qualification plan

- Members – Wide Variety
  - Bose – Mark Sears and Carla Maroun
  - Harman – Christoph Frank and Steve Sibrel
  - John Deere – Robert Kinyanjui
  - STMicro – Davide Lombardo and Luca Gubellini
  - Cirrus – XinMiao Zhao and Peter Abramowitz
  - AMS – Christoph Lercher and Ahmed Abdelrazek
  - TI – Larry Ting and Mike Douglass
  - NXP – Bobby Mays and Adeline Feybesse
  - Indium – Andy Mackie

- Kick off Meeting on September 29 2016
  - Twelve Meetings to get here.

MEMS Microphone





Made up of:
ASIC + Membrane

Microphones Automotive applications

- The use of microphones in vehicles was mainly driven by the introduction of hands-free applications

- Currently main applications for MEMS microphones are:
  - Hands-free call → 2-8 mics
    - Phone calls and Voice commands
  - E-call → 1 mic only
    - Automatic call to be initiated after a car crash
    - eCall will be mandatory in all new cars sold within EU after April 2018
  - Noise cancellation → 4 mics
    - Allowing a noiseless cabin by cancelling road, engine, tires, vibration noises
  - ICC (In Car Communication) → 4 mics (1x seat)
    - Avoid the attenuation of the speech signal recording the speaker's speech through microphones and play it back over loudspeakers located closer to the listening passengers

Why Digital MEMS Microphones

- Electret Condenser Microphones (ECMs) are temperature sensitive and thus less stable, harder to achieve consistent performance for automotive applications over temperature, and especially over time
  - A stable SMD microphone is the alternative
- Frequency response and corner frequency have much smaller tolerances compared to ECMs. The same applies to the phase response of the microphone.
- MEMS microphone footprint is around 10x smaller than ECM allowing optimized Mic array solutions
- Due to the low mass of the diaphragm and the mass of the air in its vicinity, the MEMS microphone is far less sensitive to vibrations/mechanical shocks than a conventional ECM

AEC-Q100

Applicable Tests

Test Group	Purpose	Test Methods										
A	ACCELERATED ENVIRONMENT STRESS TEST	PC	THB	TH	TC	HTS	LTS					
B	ACCELERATED LIFETIME SIMULATION TESTS	HTOL	ELFR									
C	PACKAGE ASSEMBLY INTEGRITY TESTS	WBS	WBP	SD	PD							
E	ELECTRICAL VERIFICATION TESTS	TEST	HBM	CDM	LU	CHAR	EMC	ED	LF			
F	DEFECT SCREENING TESTS	PAT	SBA									
G	CAVITY PACKAGE INTEGRITY TESTS	MS	VFV	DROP	DS							

Non – Applicable Q100 Tests

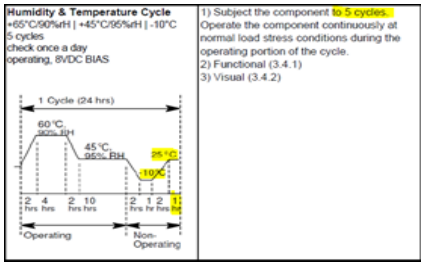
TEST Group		AEC-Q100 microphone	Rationale
A	THB or HAST	THB selected	Since microphone in a cavity package with hole, there is no need to have extra acceleration of humidity penetration and the stress activates the same failure mechanisms as the THB test.
A	AC or UHST or TH	TH selected	Since microphone in a cavity package with hole there is no need to have extra acceleration of humidity penatration
A	PTC	n/a	MEMS microphone are low power devices (<<1W) (< 1 mA @ 3V)
B	EDR	n/a	Depends on the supplier design related to memory
C	SBS	n/a	to our knowledge, MEMS microphone does not use packages with solder ball
C	LI	n/a	not required for surface mount device, but only to through hole devices
D	EM	n/a	this test is to qualify new technologies not products, N/A for MEMS microphones which are based on proven technology
	TDDB	n/a	
	HCI	n/a	
	NBTI	n/a	
	SM	n/a	
E	FG	n/a	to our knowledge, MEMS microphone does not use extensive digital blocks
E	SC	n/a	MEMS microphone is not a smart power devices
E	SER	n/a	in our knowledge MEMS microphone does not embed SRAM or DRAM
G	CA	n/a	package ceramic hermetic only, in ST experience MS and DROP are enough to cover all package and MEMS related potential failure mode, while CA is not representive of any further potential failure mode
G	GFL	n/a	package ceramic cavity only
G	LT	n/a	package ceramic cavity only, we can discuss
G	IWV	n/a	package ceramic cavity only

OEM/Tier1 Tests

Rain test	**ISO 20653:2006 - Table7 Code2**	
Chemical resistance	**Exposition to different car care products, liquids (coffee, coke) etc.**	
Performance while vibrating	**Characterization test per application (small sample size): measure voltage coming off of microphone and compare to reference**	Application Level. Test will be defined between supplier and customer on a case by case basis.

MEMS Micro Specific Tests

Temperature/Humidity, Bias Damp Heat Cyclic with frost		Test will be implemented in addition to the THB. ST is running a simulation starting 3/29 to see the impact of condensation on samples. Concern here is Frost and Condensation impact.
Slamming the door/airbag explosion.	**closing the door very hard.**	This test is NOT needed as described here. However, we need to see if other tests exists. Check with the other MEMS specs groups.
Salt Mist	**5% salt water spray at +35°C for 24h**	Per EN 60068-2-52, two hours spray of 5% NaCl salt mist spray at 35°C, then be left at 40°C and 95% RH for 7 days, non-operational. Requirement is visual inspection and no corrosion shall be on any of the metal parts



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MEMS Micro Specific Tests

Dust / particle contamination	**Arizona Dust A2 for 5 hours, according IP5KX compliance**	**Status? Harman can NOT do it test is done without operation, then powered after the test parameters are compared before and after**
EMI (Audible)		Q100 covered radiation part. If there are more requirements then we can cover by characterization. Test needs to be split to be done both at module level and component level.
ESD characterization to failure		Max pressure test: need the details, Davide will send.

MEMS Micro Specific Tests

Low Temperature Bias	**2/16 LTOL at -40 and -55 storage test. This is specific for MEMS with a risk for stickssion.**	biased or unbiased? Concern is sticksion. ST has never seen this as issue, Harman ran the same tests without issues as well. Recommendation is to go with unbiased only.
Low Temperature, Storage	**2/16 this is a new test specific so we will use it at -40C for 1000h.**	OK use -40C for 1K hrs.
Endurance Life Test, powered		Test will be done for 96 hours with continuous sound pressure of 130dB, Davide to provide test details.
Variable Frequency		Mech Shock test use 10Kg with 0.1msec (instead of 1.5 Kg), plus Package drop test as is in Q100. Do we have concurrence of members?

Going Forward

- Committee is open to new members
  - Open to anyone who likes to contribute or attend
- Tackle the rest of the open concerns …
  - Finish the experiments running, close the loop on the open points.
  - Conduct a review with other MEMS products qualification committees
- Ballot
  - Targeting June 2017