MOEMS Delta Qualification Methodology Phase 2
Final meeting

ESA ESTEC December 8th, 2006

December 2006

A. Bensoussan

ALCATEL ALENIA SPACE
An Alcatel/Finmeccanica company

LAM

MEMSCAP
The Power of a Small World

sercalo

Tecnologica
COMPONENTES ELECTRÓNICOS S.A.

imec

MOEMS Delta Qualification Methodology

Agenda

9:30 to 10:00 Introduction
10:00 to 10:45 Delta Qualification exercise: technical note TN5
10:45 to 11:30 MEMSCAP tests results
11:30 to 12:15 SERCALO tests results

Lunch

14:00 to 14:30 Synthesis of the program
14:30 to 15:00 Discussion and recommendations
15:00 to 15:20 Contractual business (Deliveries and invoices status)
15:20 to 16:00 Conclusions

Delta Qualification Exercise: Technical note TN5

MOEMS Delta Qualification Methodology

PHASE 2 : WP 4000 and WP 5000

Screening Test Group
100%

Test	Requirements	Conditions / Remarks
Pre-seal Burn-in (Optional)	100%	Mil-std-883 m1030 (96h/125°C if tuning required)
Internal visual (PRECAP)	100%	Manufacturer methods/Mil-std-883 m2017 – m2010 – m2032 (DPA/Failure Analysis/Constructional Analysis)
Sealing	100%	
Serialization	100%	
Electrical test Initial	100%	at 25°C (as per detail specification table2)
Burn-In	100%	Mil-std-883 m1015 (240 hrs at Tcase=125°C)
Final electrical test post burn-in	100%	a. Static tests (1) 25°C (subgroup 1, table I, 5005) (2) Maximum and minimum rated operating temperature (subgroups 2, 3, table I, 5005) b. Dynamic or functional tests 11/(1) 25°C (subgroup 4 or 7, table I method 5005) (2) Minimum and maximum rated operating temperature (subgroups 5 and 6, or 8 table I method 5005) c. Switching tests at 25°C (subgroup 9, table I, method 5005) d. Electrical / Optical characteristics at high and low temperature (m1012.1) (final before delivery)
IMEC: Alternative test for sealing integrity List	100%	X ray, Scaning Acoustic Macroscopy, Electrical test under vacuum (Q factor), Visual inspection
External visual	100%	Mil-std-883 m2009

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MOEMS Delta Qualification Methodology

PHASE 2 : WP 4000 and WP 5000

INITIALLY 25 DEVICES + 4 Bare dice

Thermo-Electrical Test Group 12 devices + CD		Environmental Test Group 6 devices + CD	Miscellaneous Test Group 6 devices + CD	
+ 1 Control Device for all Test Groups				
SG 1/ Thermo-integrity **4 devices + CD**	**SG 2 / Thermo-Electrical** **8 devices + CD**	**SG 3 / Mechanical & endurance** **4 devices + CD**	**SG 4 / Miscellaneous** **6 devices + CD**	
Temperature cycling (m1010.8) **cond. A (-55°C, + 85°C) 50Cy.** **cond. A (-55°C, +100°C) 50Cy.** **→100 cy. pass/fail** **cond. B (-55°C, +125°C)** **#Cy. Up to 50% lot fail**	**Electrical / Optical characteristics at room, high and low temperature (m1012.1)**	**Vibration Fatigue (m2007.3)**	**Radiation tests (m1019.6)**	
IMEC **Alternative test for Sealing integrity**	**Moisture resistance** **5 cy. -40°C to +75°C, RH 90% only controlled at 75°C**	**Mechanical shocks (m2002.4)**	**RGA (m1018.4)** **2 devices**	**Out gassing test** **4 devices**
	Thermal Shocks **5 cy., -55, +125°C** **(m 1011.9)**	**Endurance test at high Temp & Under Vacuum (m1033)**	**CONSTRUCTIONAL ANALYSIS** **2 devices + 4 Bare dice including Lead Integrity & Bending**	**Rapid depressurization (m1001)**
	3 Devices / **5 Devices**			
	ESD testing (m3015.7) / **Moisture resistance 10 cy. -40°C to +75°C, RH 90% only controlled at 75°C (m1004.7)**			
	IMEC Alternative test for Sealing integrity / **Thermal Shocks 5 cy., -55, +125°C (m 1011.9)**			
	~~IMEC Alternative test for Sealing integrity~~			

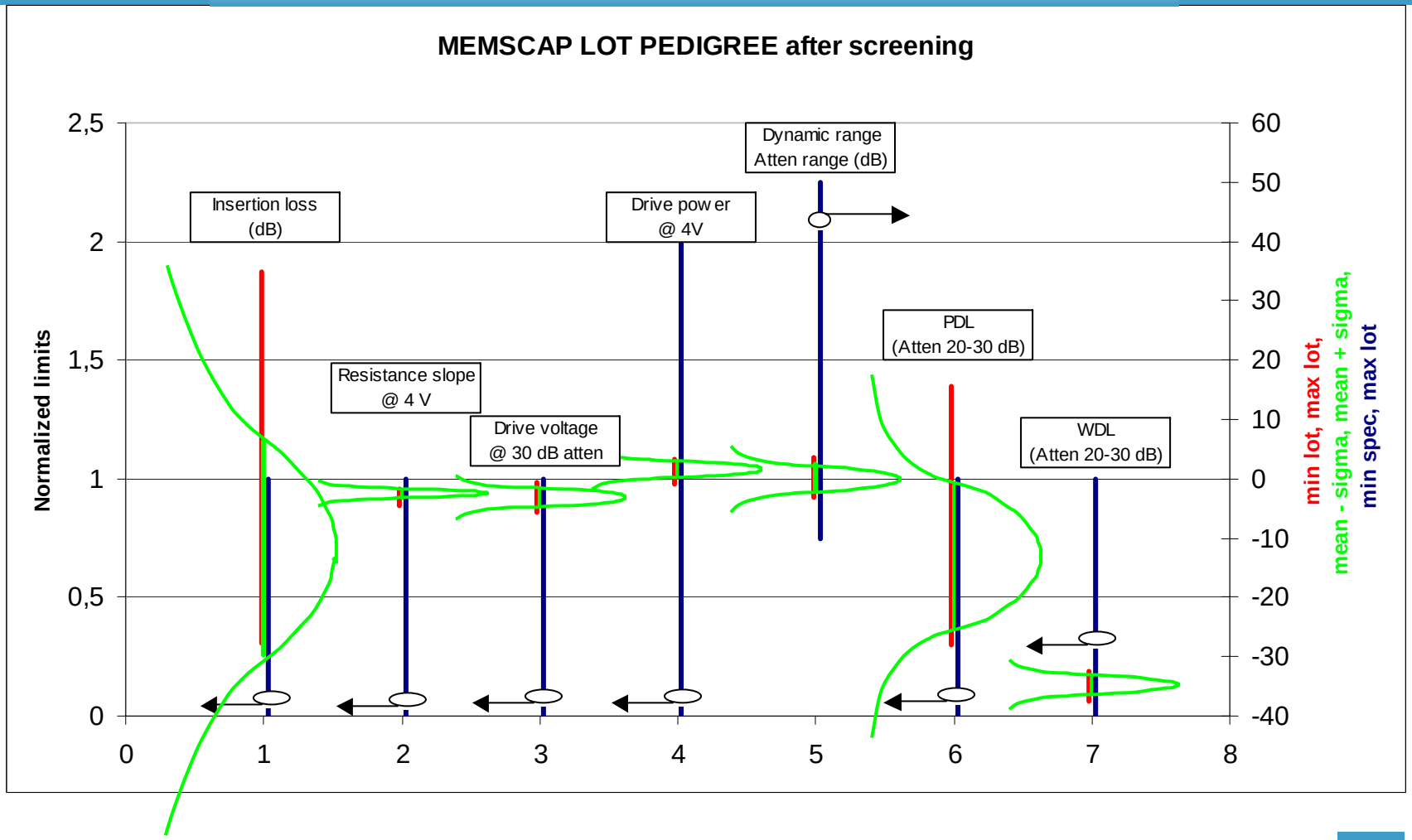
Do While:
lot failure rate
<=40%
or
5 loops

MOEMS Delta Qualification Methodology

MEMSCAP tests results

MOEMS Delta Qualification Methodology

MEMSCAP tests results



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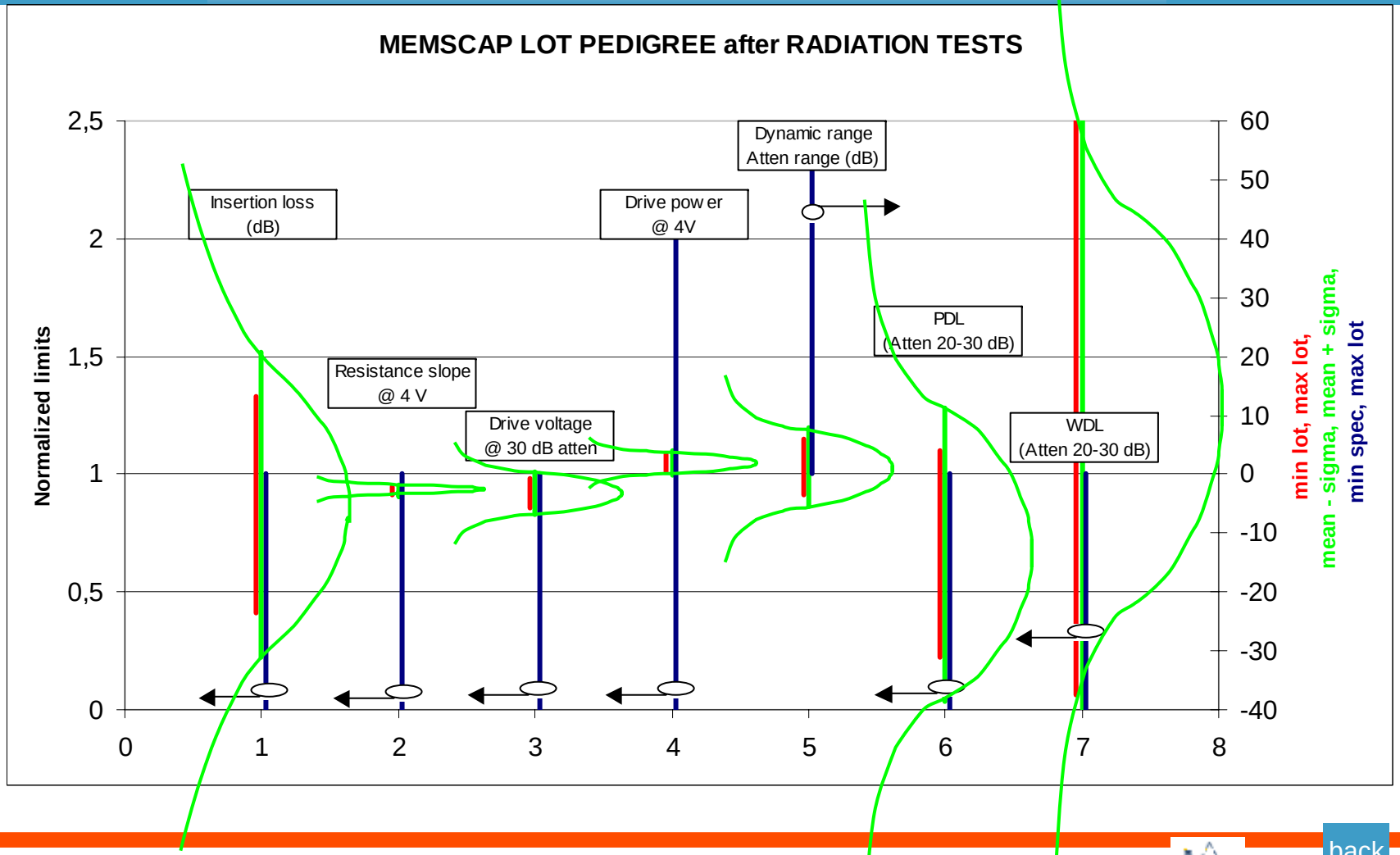
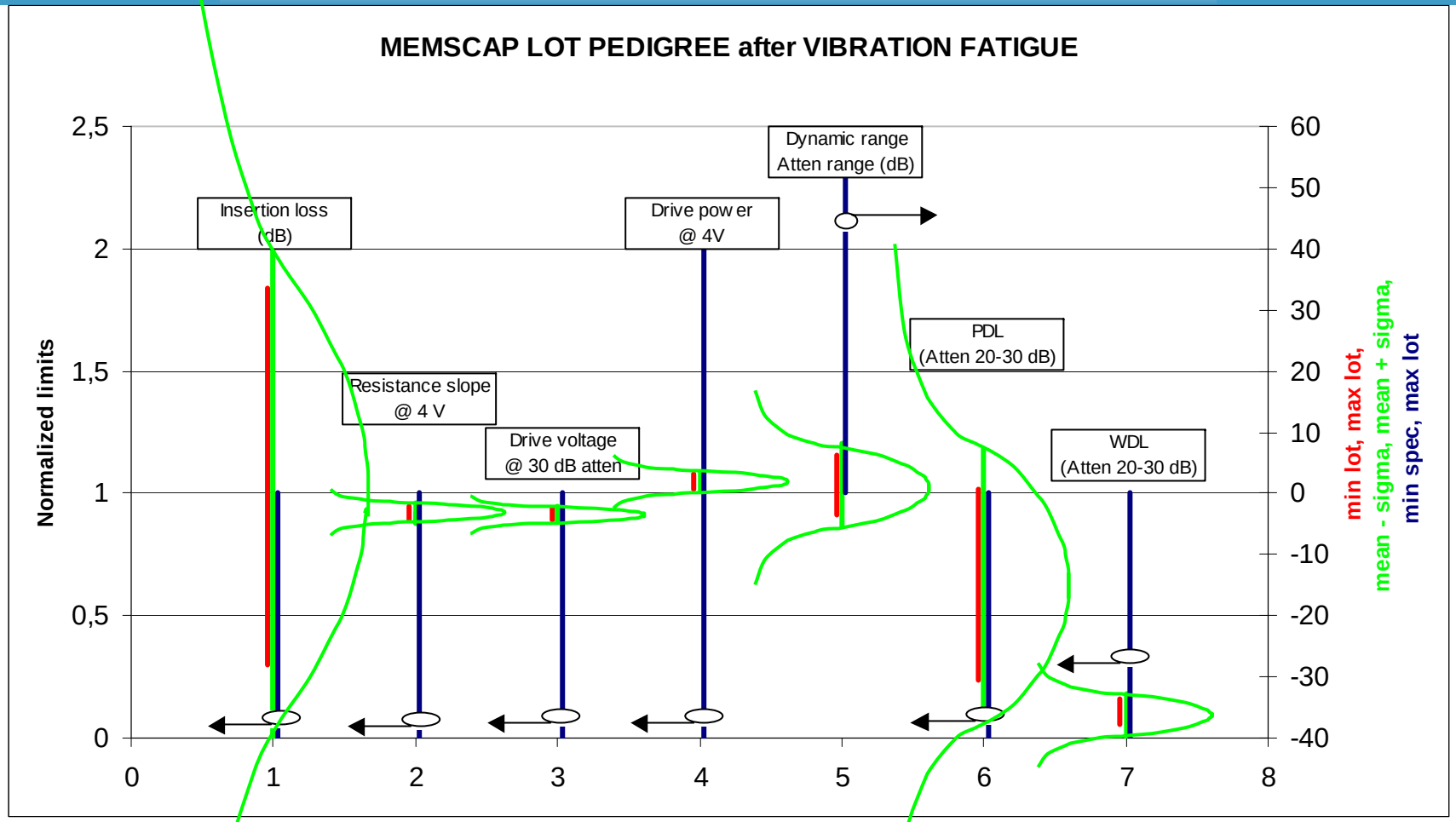
MEMSCAP tests results



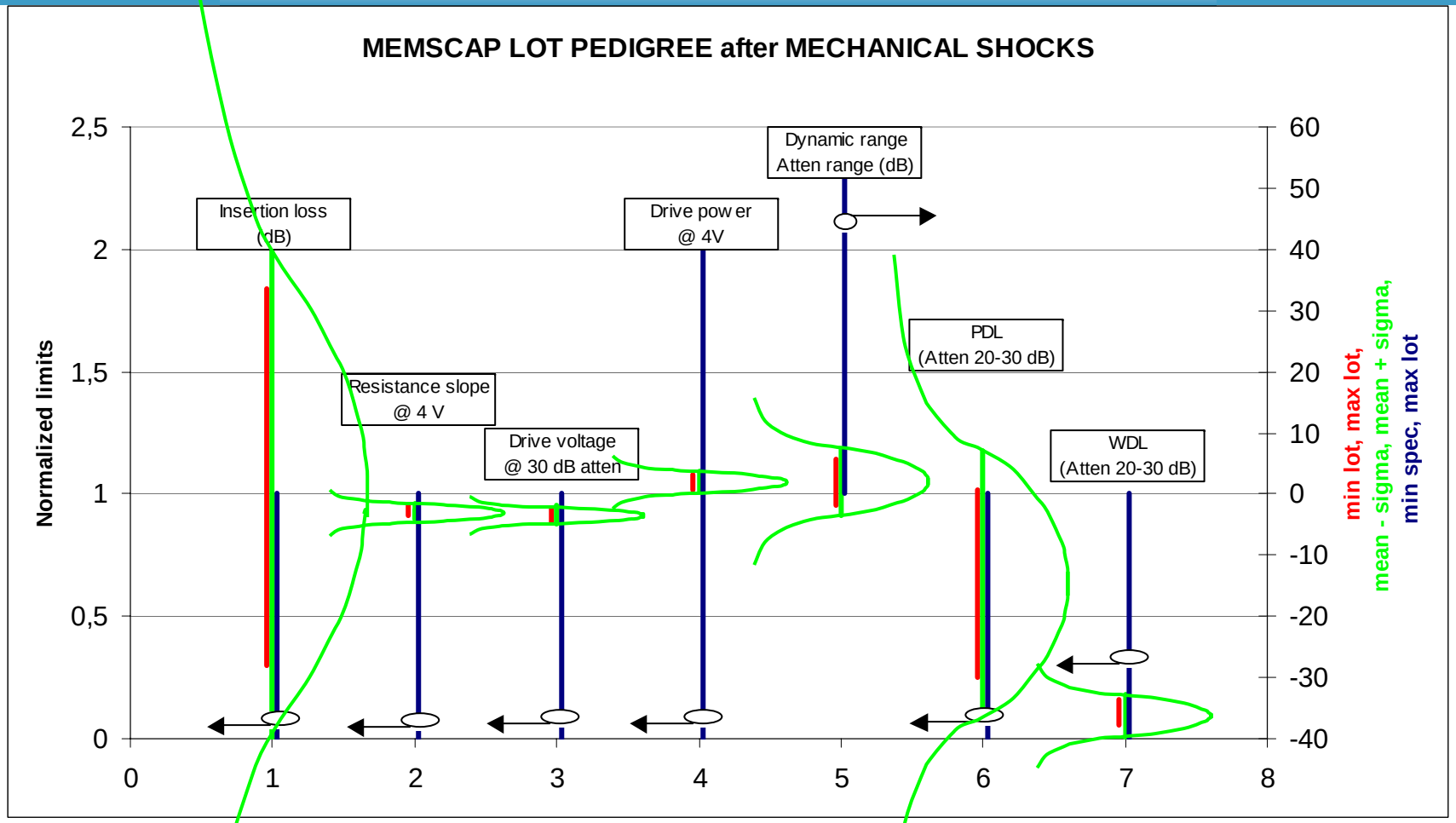
MOEMS Delta Qualification Methodology

MEMSCAP tests results



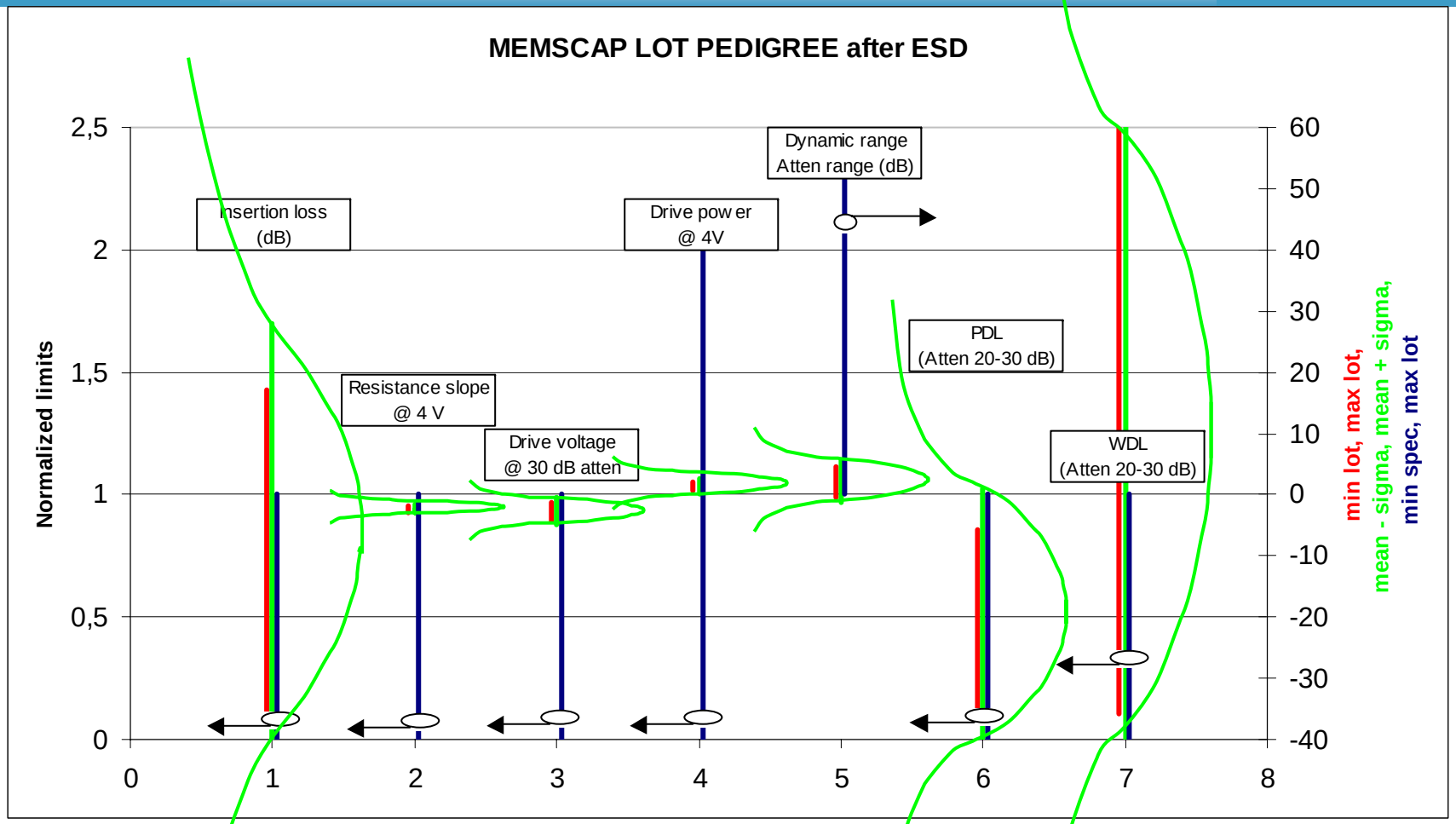
MOEMS Delta Qualification Methodology

MEMSCAP tests results



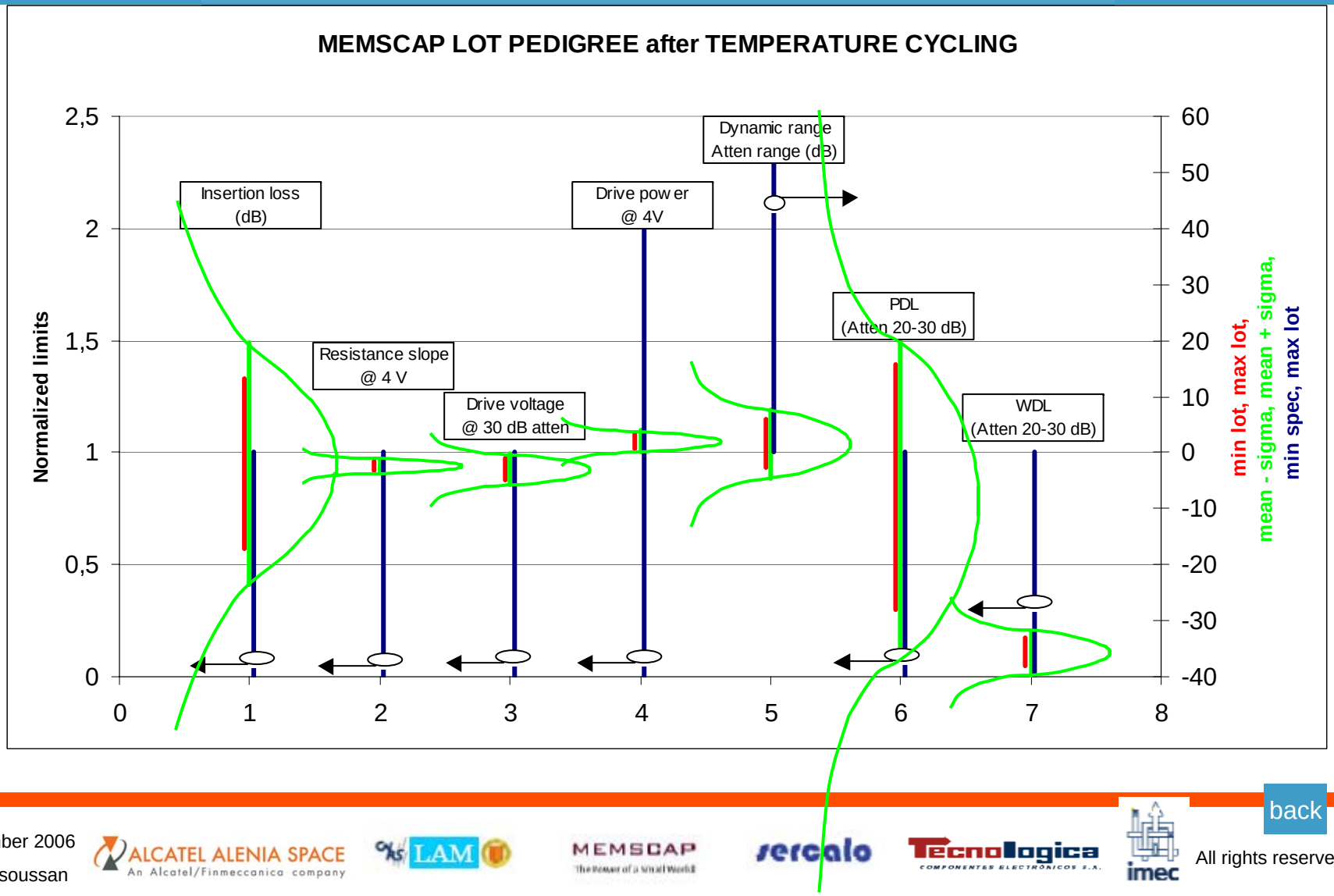
MOEMS Delta Qualification Methodology

MEMSCAP tests results



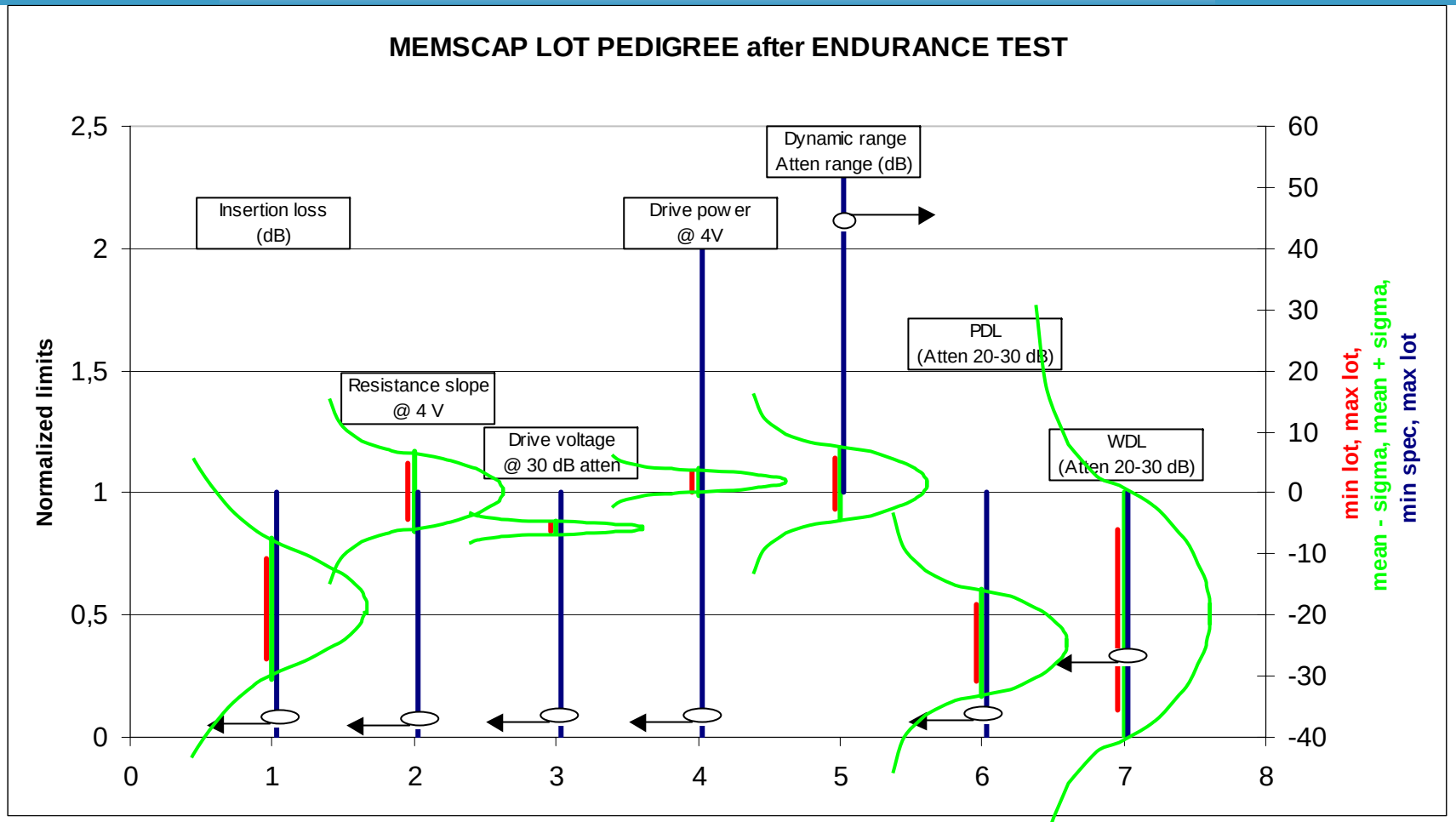
MOEMS Delta Qualification Methodology

MEMSCAP tests results



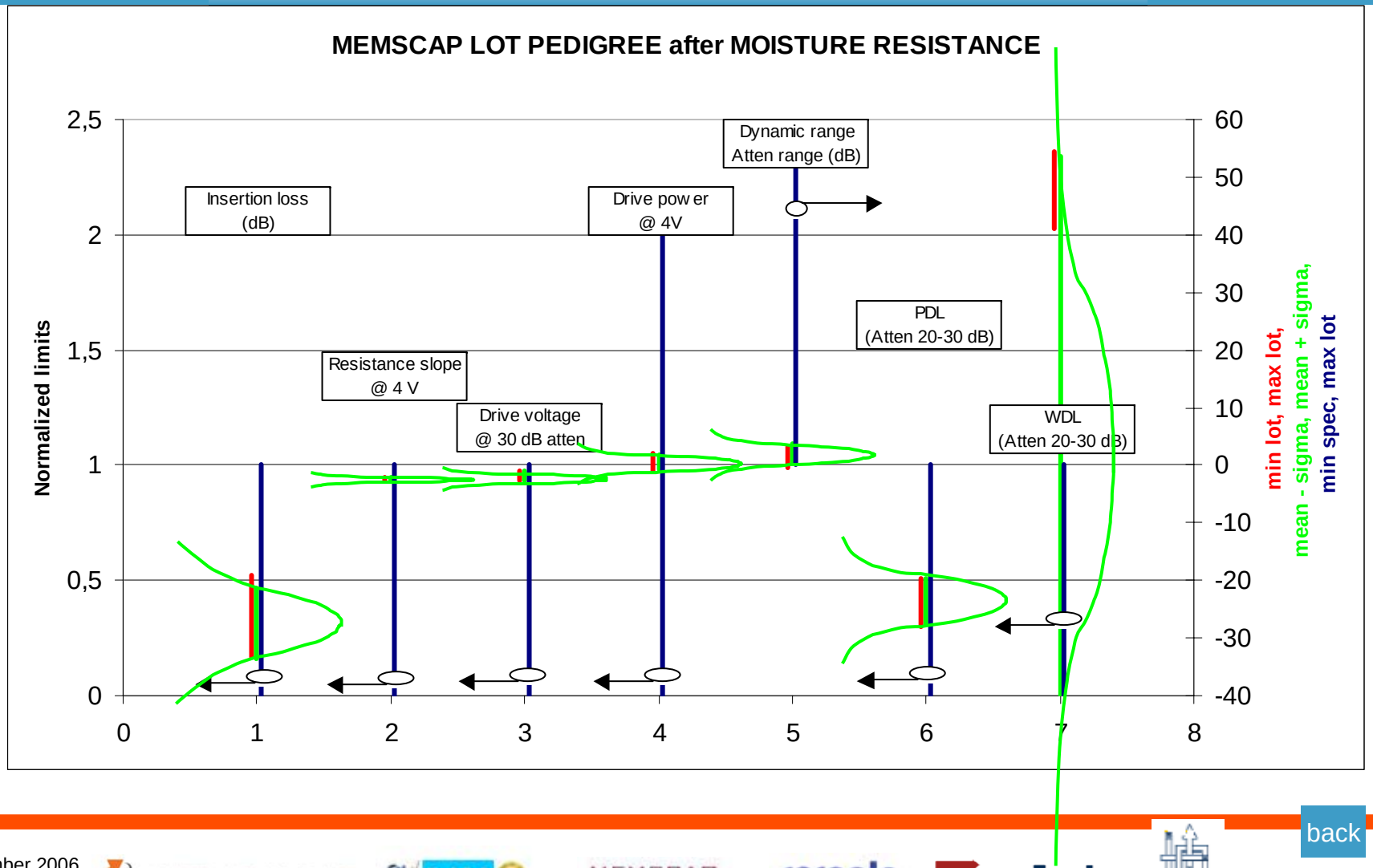
MOEMS Delta Qualification Methodology

MEMSCAP tests results



MOEMS Delta Qualification Methodology

MEMSCAP tests results



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MEMSCAP tests results

- **Insertion loss: easy to measure but large dispersion and not enough reproducible, out of spec for 30% of lot (not significant)**
- **Resistance slop @ 4V: easy to measure, very reproducible and sensitive parameter for reliability assessment (see endurance test)**
- **Drive voltage @ 30dB atten: easy to measure, very reproducible but seems not sensitive parameter for reliability assessment (see endurance test).**
- **Drive power @ 4 V: easy to measure, very stable and reproducible but not sensitive parameter for reliability assessment.**
- **Dynamic range (Atten range in dB):easy to measure, very stable and reproducible but not sensitive parameter for reliability assessment.**
- **PDL: difficult to measure, but may have large dispersion and not enough reproducible, not sensitive parameter for reliability assessment.**
- **WDL: Difficult to measure, not reproducible, not sensitive parameter for reliability assessment**
- **All parameters out of spec during low temperature measurements (spec definition to be re-considered).**

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MEMSCAP tests results

➢ Screening data

- **Screening process not fully completed and to be re-considered for a full space screening. Qualification data didn't reveal infant mortality behaviour.**
- **Insertion loss, PDL and WDL are parameters complicated to be characterized (reproducibility, large dispersion, precision not guaranteed. Measurement techniques to be demonstrated or even improved for reliability assessment.**

➢ Thermo-electrical group

➢ Environmental group

➢ Miscellaneous group

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SERCALO tests results

Synthesis of the program

ITT AO/1-4507/03/NL/CP

Negotiation meeting and Kick off

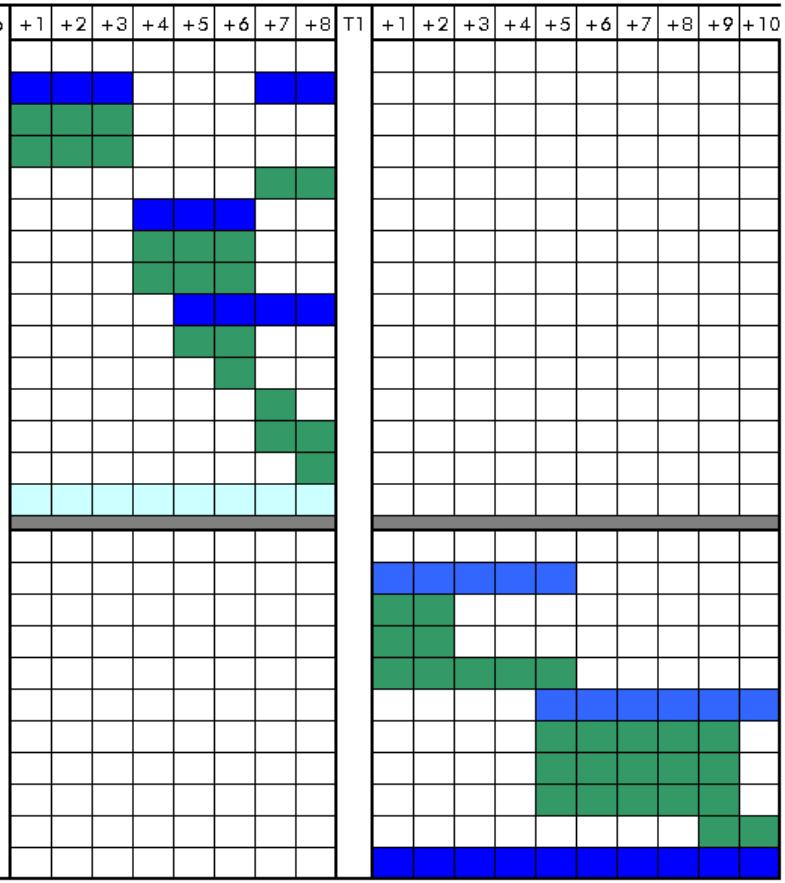
ESA ESTEC Noordwijk

December 16th and 17th, 2004

End date December 8th, 2006

MOEMS Delta Qualification Methodology

PHASE	WP references		WP Title
PHASE 1	WP 1000		MOEMS SURVEY
		WP 1100	MOEMS DATA COLLECTION
		WP 1200	MOEMS DATABASE CREATION
		WP 1300	MOEMS DATABASE UPDATE
	WP 2000		MOEMS SUITABILITY AND MATURITY
		WP 2100	MOEMS SUITABILITY FOR TELECOM
		WP 2200	MOEMS SUITABILITY FOR OBSERVATION AND SCIENCE
	WP 3000		PRELIMINARY SPACE QUALIFICATION METHODOLOGY
		WP 3100	MOEMS QUALIFICATION HERITAGE
		WP 3200	SPACE QUALIFICATION METHODOLOGY
		WP 3300	DRAFT TECHNICAL REQUIREMENTS
		WP 3400	QUALIFICATION TESTING AND COSTING
		WP 3500	MOEMS SELECTION
	WP 6000	WP 6100	PHASE 1 MANAGEMENT
PHASE 2	WP 4000		CONSOLIDATED SPACE QUALIFICATION METHODOLOGY
		WP 4100	CONSOLIDATED TECHNICAL REQUIREMENTS
		WP 4200	SPACE QUALIFICATION METHODOLOGY OF SELECTED MOEMS
		WP 4300	MOEMS TEST PLANS
	WP 5000		Δ SPACE QUALIFICATION TESTING
		WP 5100	MOEMS 1 TESTING AT SERCALO
		WP 5200	MOEMS 2 TESTING AT MEMSCAP
		WP 5300	MOEMS 2 TESTING AT IMEC
		WP 5400	Δ SPACE QUALIFICATION REPORTING
	WP 6000	WP 6200	PHASE 2 MANAGEMENT



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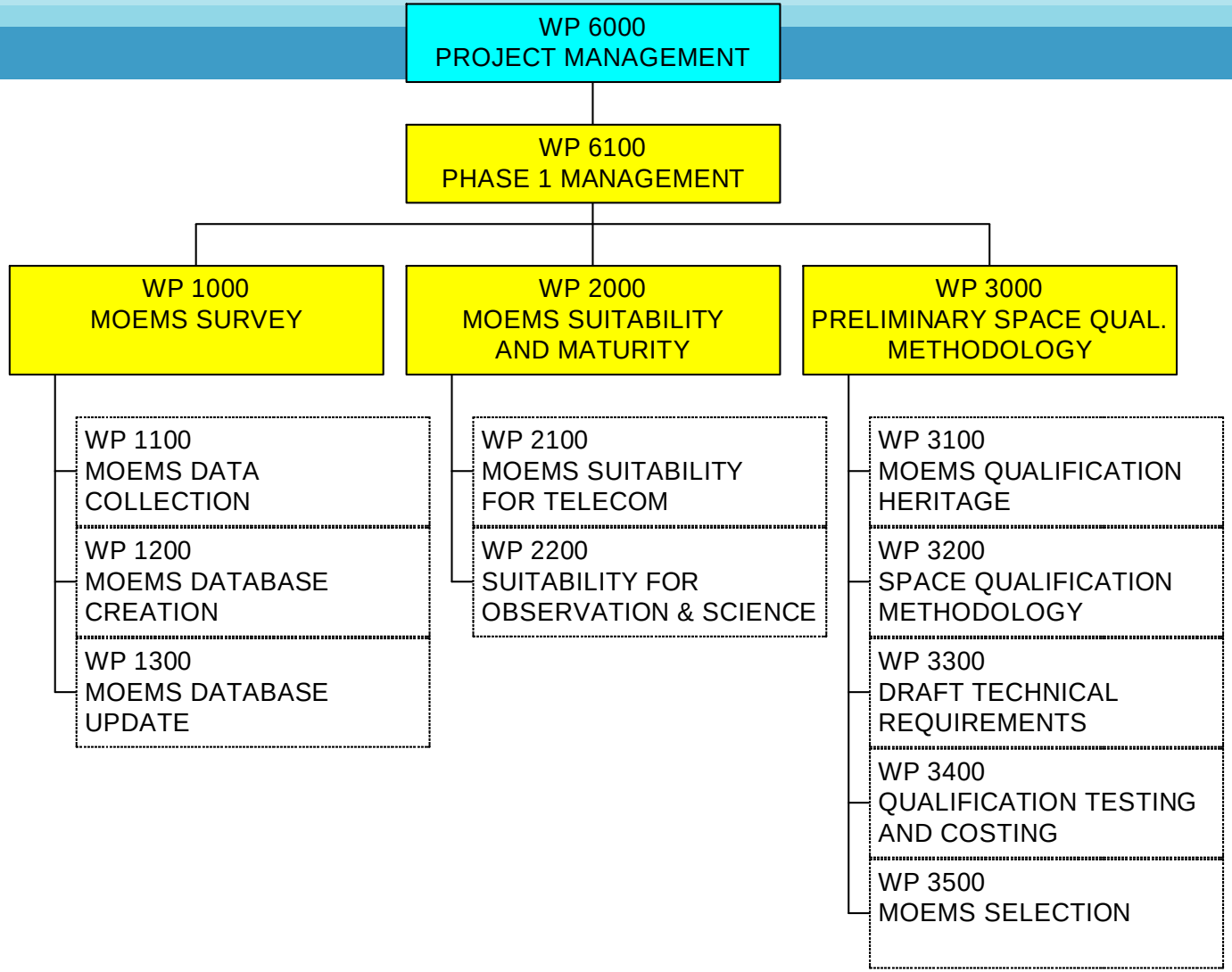
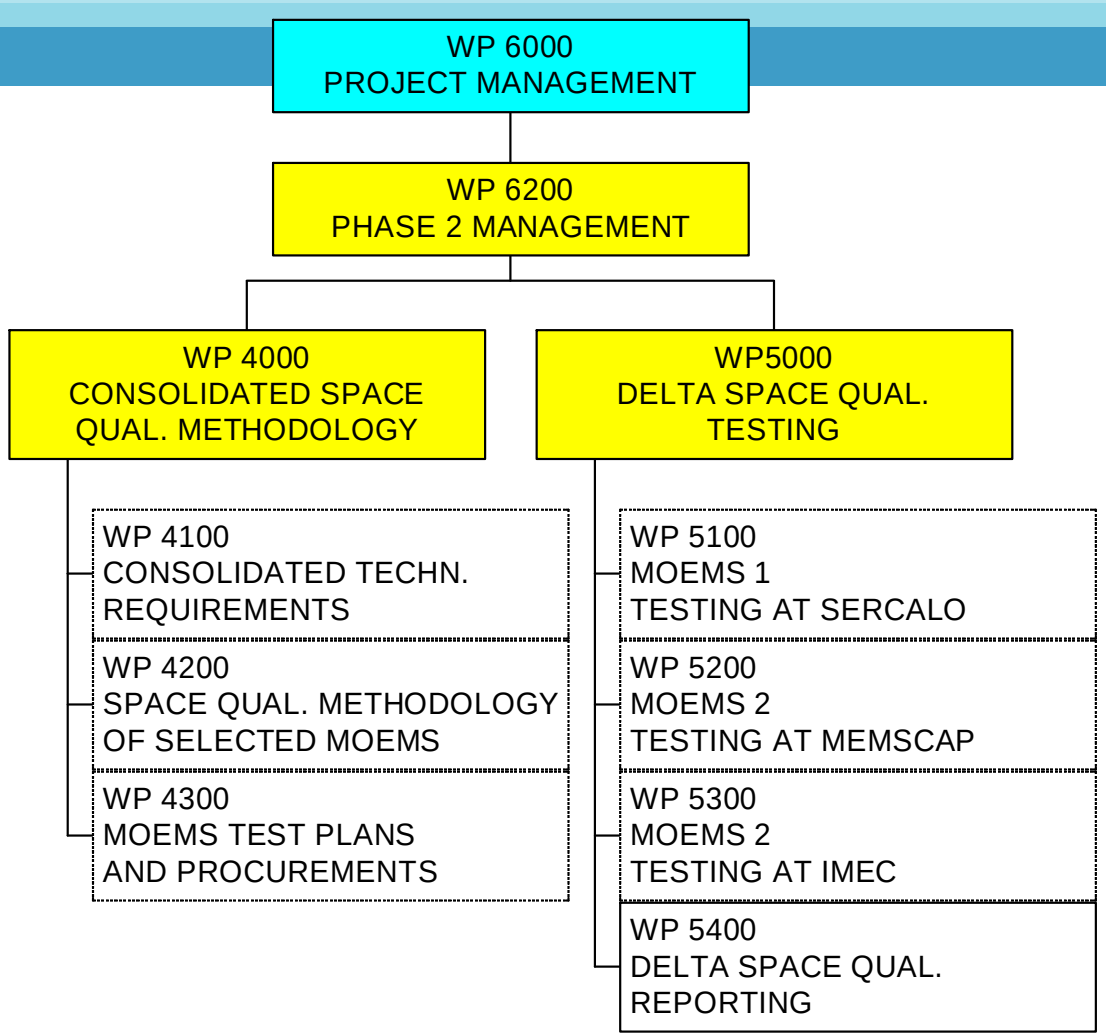
MOEMS Delta Qualification Methodology



MOEMS Delta Qualification Methodology



MOEMS Delta Qualification Methodology

PHASE 2 : WP 4000 and WP 5000

TITLE	MILESTONE	DATE	MAJOR CONTENT
PHASE 1			
TN1: "Survey of MOEMS"	Completion of WP 1100	To + 3	Manufacturer documents, data sheets, general process flows.
MOEMS Database definition	Completion of WP 1200	To + 3	Data base description and tool draft.
MOEMS DATABASE TOOL	Completion of WP 1300	To + 8	Database tool up-dated.
TN2: "MOEMS Suitability for Space Applications and Technology Maturity Level"	Completion of WP 2xxx	To + 6	MOEMS candidate for Space Qualification; TML status for each MOEMS.
TN3 : "Space Qualification Definition, Effort for Delta Qualification, MOEMS selection"	Completion of WP 3xxx	To+ 8	MOEMS selection; Detail specification for MOEMS procurement; Qualification test method review (TELCORDIA, MIL); Space Qualification methodology; Generic test plan for MOEMS Δ qualification and definition of Test plans for the two selected MOEMS; Phase 1 final report.
PHASE 2			
TN3 up-dating TN4: "Refinement of Delta Qualification Definition, Procurement Preparation"	Completion of WP 4xxx	T1 + 5	MOEMS procurement test plan; Precap inspection and CSI report; Space Qualification Methodology for 2 MOEMS types;
TN5 : "Δ Space Qualification Testing and Reporting"	Completion of WP 5xxx	T1 + 10	Qualification Test results on 2 MOEMS; Recommendations for future use of MOEMS in Space.

MOEMS Delta Qualification Methodology

Delta qualification phase 1:

WP 1000 : MOEMS market survey (Technical note 1)
WP 2000 : MOEMS SUITABILITY AND MATURITY (Technical note 2)
WP 3000 : Preliminary SPACE QUALIFICATION Methodology (Technical note 3)

MOEMS Delta Qualification Methodology

WP1000 : MOEMS market survey (Technical note 1

Objectives:

→ Survey of MOEMS being developed in Europe and commercially available in and outside Europe.

→ Preparation of a Technical Note reporting the findings of the survey.

→ Development of a database collecting the results of the survey.

Activities:

→ literature survey, market survey, web search, etc. The survey is independent from application (or expected application) of the micro-system, i.e. it shall include: bio-MOEMS, automotive, telecom, instrumentation, space (including ground segment) applications and shall address:

- MOEMS being developed or ready for use today in European Research Centres, Universities or other small processing facilities
- MOEMS already commercially available off the shelf in Europe but also outside Europe
- Data base format definition

Data base construction

- More than 95 companies contacted
- Identify companies which are real market players, which have theirs own MOEMS products
- 19 companies proposed commercial MOEMS products
- 55% of the database are filled
  - 65 datasheets downloaded
  - 53 publications
- to contact the interesting firms to have further information (12/19 answers)
- Data base completed

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WP2000 : MOEMS SUITABILITY AND MATURITY (Technical note 2)

Test methods table comparison (ESA/MIL/TELCORDIA) and discussion

Goal is to identify tests method applicable to MOEMS and discuss about their advantages, drawbacks, implementation ability, effectiveness, availability, …

IDENTIFICATION				PACKAGING	
MANUFACTURER	**COUNTRY**	**PRODUCT TYPES** (product manufacturer reference)	**TECHNOLOGY** (process name or type of technology)	**REFERENCE** (yes, no, if yes, package reference)	**DIMENSIONS Lxlxh** (package reference)
Active				no	5,4 dia - 16,6 L

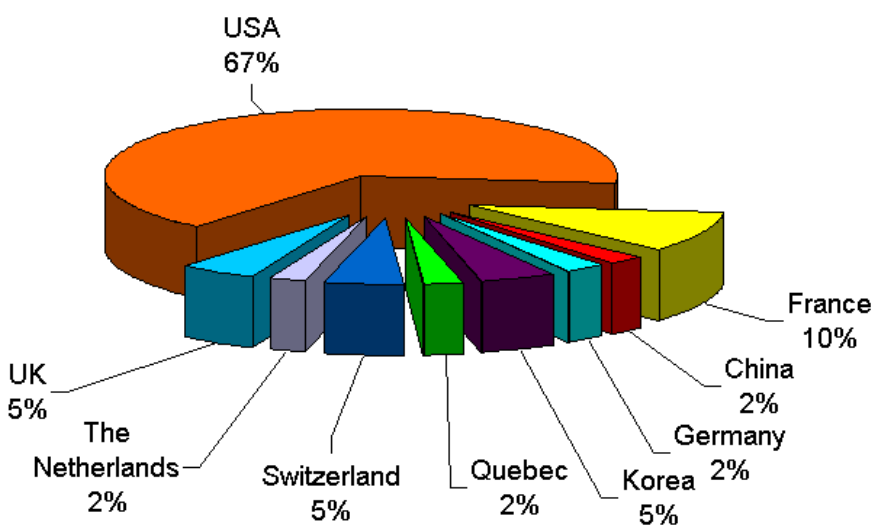
MARKETING				
APPLICATION (telecom, space&defense,	**FAMILY** (sensors, attenuator, cross connects, data transmitters, optical	**MARKET SURVEY** (R&D,	**MATURITY** (use	**AVAILABILITY** (specific product Not Available (NA), standard Off the

MAIN PERFORMANCES							
INSERTION LOS	**ISOLATION**	**RESPONSE SPEED**	**CONSUMPTION** (total	**POWER SUPPLY** (V	**TEMPERATURE RANGE** (max and min	**WAVELENGTH**	**OTHER**
< 0,7							

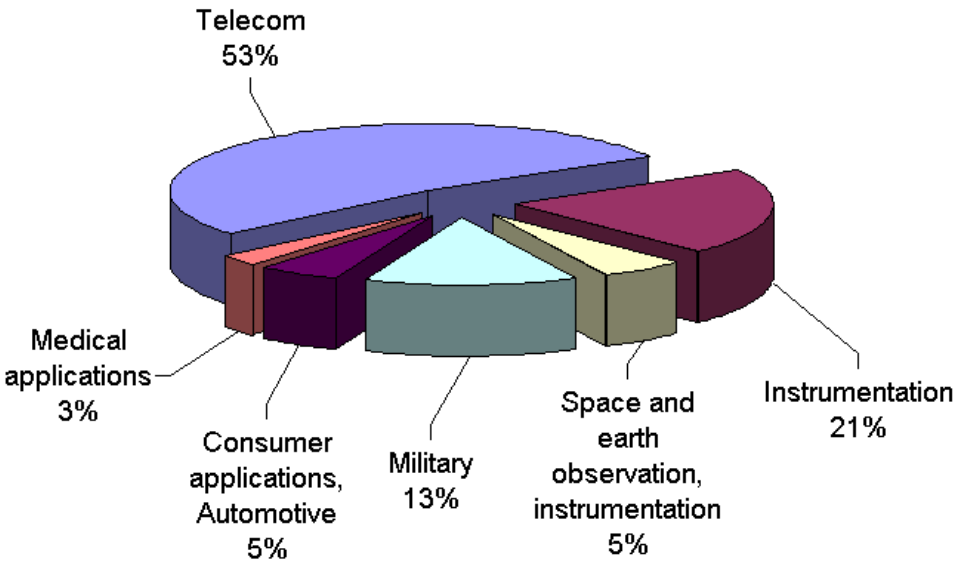
QUALITY		OTHER	
QUALIFICATION STATUS (Telcordia, other)	**QUALITY LEVEL** (commercial, military, ground, space, other)	**WEB SITE**	**DOCUMENT REFERENCE AND BIBLIOGRAPHY**

MOEMS market trends

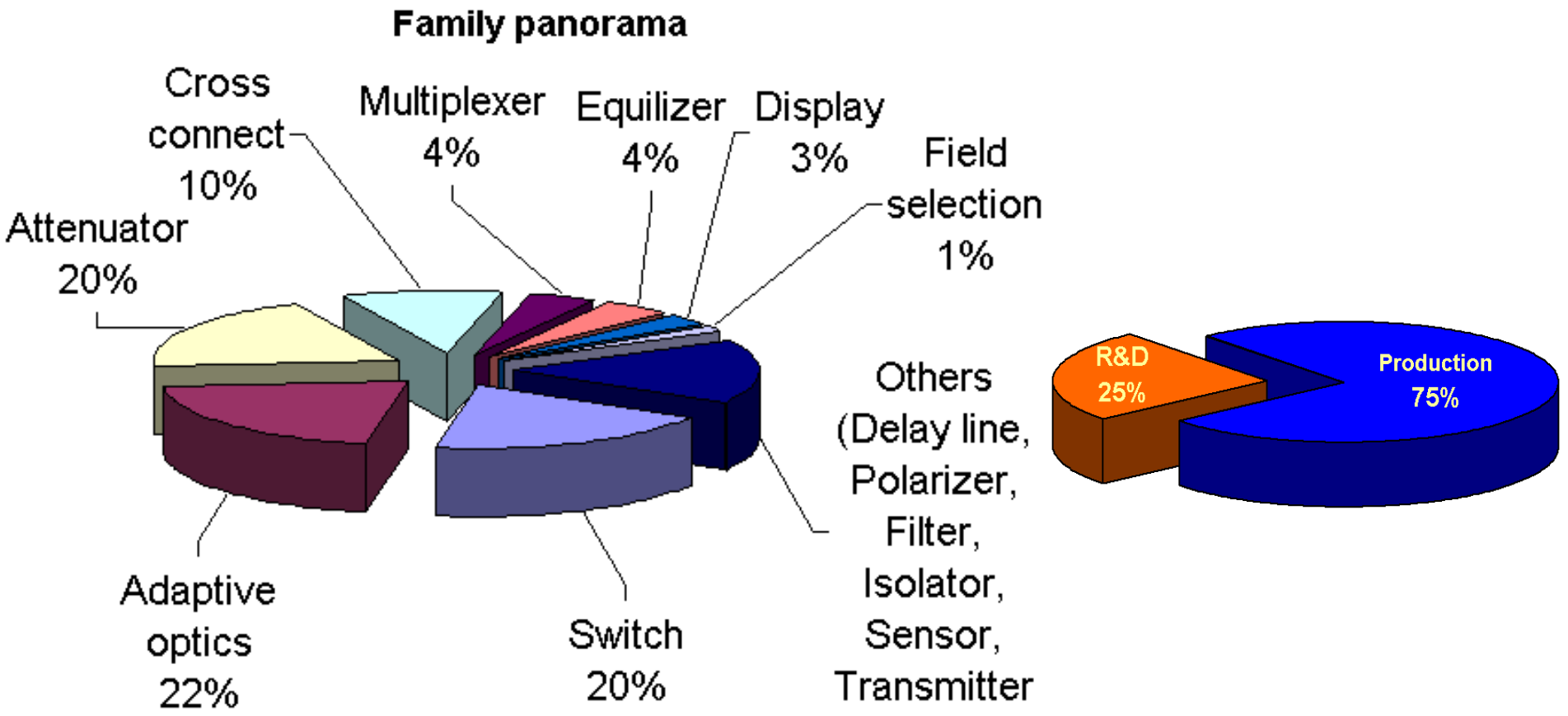
MOEMS Market players (2005)



Application panorama



MOEMS market trends



WP3000 : Preliminary SPACE QUALIFICATION Methodology (Technical note 3)

DEFINITION OF GENERIC FLOW-CHART, SCREENING & QUALIFICATION FLOW

Final meeting Phase 1 in line with the schedule and Phase 1 closed with TN3 final issue taking into account ESA comments as per AI's listed in these MoM.

Start KO Phase 2 ATP OK. Official KO by January 16th 2006.

MEMSCAP devices ready for week 10 of 2006.
SERCALO devices ready for week 5 of 2006.

CONSOLIDATION OF GENERIC FLOW-CHART, SCREENING & QUALIFICATION FLOW

WP 4000 : CONSOLIDATED SPACE QUALIFICATION METHODOLOGY
WP 5000 : Δ SPACE QUALIFICATION TESTING

Test exercise conducted on 2 MOEMS manufacturers (SERCALO and MEMSCAP).

25 samples tested 10 bare dice (see part one of this presentation and annexes)

3 test group sequences including Electro-Mechanical, Environmental and Miscelaneous tests group (Radiation, CA, Outgassing, …)

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MOEMS Delta Qualification Methodology

GENERIC FLOW RECOMMENDED

INITIALLY 24 DEVICES + 4 Bare dice

Thermo-Mechanical Test Group 12 devices + CD	Environmental Test Group 6 devices + CD	Miscellaneous Test Group 6 devices + CD
+ 1 Control Device for all Test Groups		
Thermo-integrity 4 devices + CD	Performance Characterization 8 devices + CD	Electro-mechanical group 6 devices + CD
Thermal Shocks 10 cy., -55, +125°C (m 1011.9)	Electrical / Optical characteristics at room, high and low temperature (m1012.1)	Vibration Fatigue (m2005.2)	CONSTRUCTIONAL ANALYSIS 2 devices + 4 Bare dice including Lead Integrity & Bending test
Temperature cycling (m1010.8) 50 cy. pass/fail cond. B (-55°C, +125°C)	Radiation tests (m1019.6)	Mechanical shocks (m2002.4)	RGA (m1018.4)
Moisture resistance 20 cy. -40°C to +75°C, RH 90% only controlled at 75°C (m1004.7)		Endurance test at high Temp & Under Vacuum (?) (m1033)	ESD testing (m3015.7)
IMEC Alternative test for Sealing integrity			

MOEMS Delta Qualification Methodology

Discussion and recommendations

MOEMS Delta Qualification Methodology

MAIN LESSONS LEARNED (1/4):

MOEMS devices are TLM3 to TLM 4 maturity for Space application.
TELCORDIA standard is not enough to cover Space requirements and Delta Qualification program added or more stringent conditions:
Radiation tests,
ESD, RGA, Outgassing and rapid depressurization
Thermal shocks and moisture resistance (test in series and loop proposed),
Mechanical chocks, Vibration variable frequency and endurance lifetest under vacuum,
Thermal cycling (-55, +125°C) and alternative test method for hermeticity.

MOEMS Delta Qualification Methodology

MAIN LESSONS LEARNED (2/4):

TEST CONDUCTED AT VIARIOUS FACILITIES INCLUDING : SERCALO, MEMSCAP, IMEC, ALCATEL ALENIA SPACE.

OPTO-ELECTRICAL TESTS AT NOMINAL ROOM TEMPERATURE ARE VERY CRITICAL AND NEEDS TO BE CAREFULLY IMPLEMENTED: some opto-electrical parameters are sensitive to fiber bent and require to attach fibers to the test equipment set (to avoid mechanical vibration) in an air controlled room environment (Temperature and humidity).

MEASUREMENT REPRODUCIBILITY IS TOUGH TO ACHIEVE AND NEEDS SAFE (ESD)AND QUIET DEDICATED TEST ROOM.

MOEMS Delta Qualification Methodology

MAIN LESSONS LEARNED (3/4):

RADIATION TESTS NEED TO BE PERFORMED WITH A CARE TEST JIG DESIGN IN ORDER TO AVOID EMC OR OSCILLATION OR GROUND PROBLEMS.

ESD TEST ARE DIFFICULT TO IMPLEMENT AS SOME DEVICES ARE WITH (AND OTHER WITHOUT) ELECTRONIC PARTS INSIDE THE MODULE. REPRODUCIBILITY CONCERN TOO.

ENVIRONMENTAL ENDURANCE TEST UNDER VACUUM PERFORMED SUCCESSFULLY. LESSON LEARNED TO ACHIEVE GOOD MEASUREMENT REPRODUCIBILITY AND IDENTIFY CRITICAL PARAMETERS FOR RELIABILITY ASSESSMENT.

MAIN LESSONS LEARNED (4/4):

ENDURANCE UNDER VACUUM HAVE SHOWN 1 FAILURE ON A NON-HERMETIC PACKAGE AND ALLOW TO IDENTIFY A TREND IN THE DRIFT PARAMETERS. INTERESTING TO BE INVESTIGATED LATER.

PDL AND WDL ARE PARAMETERS NOT RECOMMENDED TO BE USED FOR QUALITY AND RELIABILITY VERIFICATION: TO MUCH SENSITIVE (MEASUREMENT DISPERSION) FOR ENVIRONMENT TEST CONDITIONS OR NEED TO DEFINE THE TEST SET UP WITH EXTREM CARE.

GENERIC QUALIFICATION FLOW CHART ADAPTED TO EACH MANUFACTURER ARE APPLICABLE AND PROPOSED TO BE GENERALIZED ON THE GLOBAL METHODOLOGY.

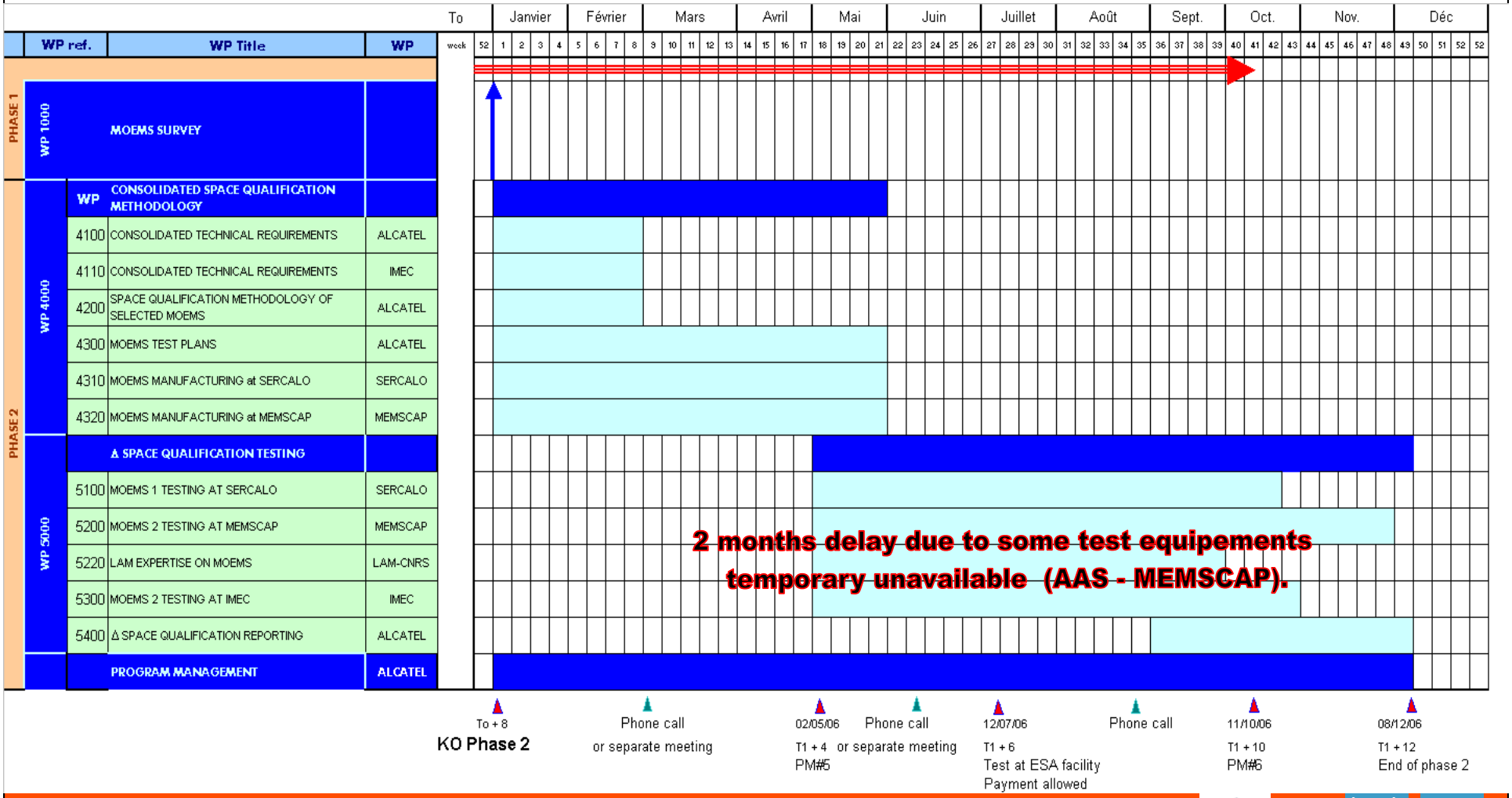
MOEMS Delta Qualification Methodology

Contractual business
(Deliveries and invoices status)

MOEMS Delta Qualification Methodology

Planning

	WP ref.	WP Title	WP
PHASE 1	WP 1000	MOEMS SURVEY	
PHASE 2	WP 4000	WP CONSOLIDATED SPACE QUALIFICATION METHODOLOGY	
	4100	CONSOLIDATED TECHNICAL REQUIREMENTS	ALCATEL
	4110	CONSOLIDATED TECHNICAL REQUIREMENTS	IMEC
	4200	SPACE QUALIFICATION METHODOLOGY OF SELECTED MOEMS	ALCATEL
	4300	MOEMS TEST PLANS	ALCATEL
	4310	MOEMS MANUFACTURING at SERCALO	SERCALO
	4320	MOEMS MANUFACTURING at MEMSCAP	MEMSCAP
	WP 5000	Δ SPACE QUALIFICATION TESTING	
	5100	MOEMS 1 TESTING AT SERCALO	SERCALO
	5200	MOEMS 2 TESTING AT MEMSCAP	MEMSCAP
	5220	LAM EXPERTISE ON MOEMS	LAM-CNRS
	5300	MOEMS 2 TESTING AT IMEC	IMEC
	5400	Δ SPACE QUALIFICATION REPORTING	ALCATEL
		PROGRAM MANAGEMENT	ALCATEL



MOEMS Delta Qualification Methodology

Conclusions

MOEMS Delta Qualification Methodology

MOEMS Delta Qualification Methodology study program implemented within 2 years.

Thanks to a large contribution in the frame of a consortium including:
Two MOEMS manufacturers in Europe (SERCALO in Switzerland and MEMSCAP in France)
Two Laboratories (IMEC in Belgium and LAM CNRS in France)
Partial contribution of TECNOLOGICA
One Space industry user : Alcatel Alenia Space in France.

MOEMS Delta Qualification Methodology

Several benefits and know-how achieved.
Good European collaboration and fruitful contributions.
Space Qualification methodology drawn and tested with important and major lessons learned.

MOEMS in space will require maturity at multiple levels:

- **Products designed, industrialized and manufactured for space harsh environment,**
- **Equipment designed for new breaking architectures demonstrating the benefits of MOEMS instead of standard products (cost and technical benefits to be demonstrated)**
- **User manufacturing and testing in mature environments (learning curve to be initiated and maintained) : role of Agencies to promote these new technologies and help to built a new age of techniques (opto and nanosystems)**

Annexes

The Screening TEST GROUP

MOEMS Delta Qualification Methodology

Screening Test Group 100%			
Test		**Requirements**	**Conditions / Remarks**
Pre-seal Burn-in (Optional)		100%	Mil-std-883 m1030 (96h/125°C If tuning required)
Internal visual (PRECAP)		100%	Mil-std-883 m2017 – m2010 – m2032
Sealing		100%	
Serialization		100%	
Electrical test Initial		100%	at 25°C (as per detail specification table2)
Burn-In		100%	Mil-std-883 m1015 (240 hrs at Tcase=125°C)
Final electrical test post burn-in		100%	a. Static tests (1) 25°C (subgroup 1, table I, 5005) (2) Maximum and minimum rated operating temperature (subgroups 2, 3, table I, 5005) b. Dynamic or functional tests 11/(1) 25°C (subgroup 4 or 7, table I method 5005) (2) Minimum and maximum rated operat
IMEC: Alternative test for sealing integrity List		100%	X ray, Scaning Acoustic Macroscopy, Electrical test under vacuum (Q factor), Visual inspection
External visual		100%	Mil-std-883 m2009

MOEMS Delta Qualification Methodology

SERCALO		Spec	Screnning				Control Device
			Mean	σ	Min	Max	1861
Insertion Loss	OFF (dB)	< 1	0,36	0,08	0,25	0,59	**0,37**
	ON (dB)	<1	0,38	0,10	0,19	0,55	**0,28**
Cross Talk	OFF (dB)	> 45	61,62	2,37	56,50	68,80	**62,40**
	ON (dB)	> 45	73,20	8,01	62,70	89,80	**80,65**
Curent	OFF (mA)	< 1	0,20	0,03	0,15	0,28	**0,19**
	ON (mA)	< 2	0,77	0,16	0,49	1,19	**0,63**
Switching Speed	OFF (ms)	< 15	4,23	1,11	2,67	6,87	**4,85**
	ON (ms)	< 20	2,35	0,50	1,73	4,01	**2,16**

MOEMS Delta Qualification Methodology

MEMSCAP		Spec	Screening				Control Device
			Mean	σ	Min	Max	LK86 6997
Insertion Loss (dB)		< 1	0,71	0,45	0,31	1,87	**0,47**
Dynamic Range	Attenuation Range (dB)	> 40	50,41	2,08	46,76	53,64	**51,83**
	Corresponding voltage (V)	NA	0,09	0,22	0,00	0,75	**0,06**
	Attenuation Slope (dB/V)	NA	-29,23	1,31	-31,33	-27,25	**-30,88**
WDL	Attenuation 0-10 dB	< 0,1	0,15	0,03	0,20	0,08	**0,07**
	Attenuation 10-20 dB	< 0,5	0,15	0,04	0,03	0,24	**0,09**
	Attenuation 20-30 dB	< 1	0,13	0,03	0,06	0,19	**0,06**
PDL	Attenuation 0-10 dB	< 0,1	0,28	0,17	0,10	0,90	**0,18**
	Attenuation 10-20 dB	< 0,2	0,46	0,23	0,16	1,21	**0,29**
	Attenuation 20-30 dB	< 0,3	0,67	0,30	0,30	1,39	**0,39**
Resistance Slope	Attenuation 30 dB	< 15	11,98	0,39	11,26	12,65	**11,74**
	4v Voltage	< 20	18,67	0,29	17,78	19,14	**17,87**
Drive Voltage	Attenuation 10 dB	< 3	2,84	0,07	2,70	2,96	**2,87**
	Attenuation 20 dB	< 2,7	2,50	0,07	2,36	2,60	**2,50**
	Attenuation 30 dB	< 2,3	2,12	0,08	1,97	2,26	**2,15**
Drive Power @ 4 V		NA	125,32	3,29	116,90	129,57	**129,68**

MOEMS Delta Qualification Methodology

INITIALLY 25 DEVICES + 4 Bare dice

Thermo-Electrical Test Group 12 devices + CD	Environmental Test Group 6 devices + CD	Miscellaneous Test Group 6 devices + CD
+ 1 Control Device for all Test Groups		

SG 1/ Thermo-integrity 4 devices + CD	SG 2 / Thermo-Electrical 8 devices + CD	SG 3 / Mechanical & endurance 4 devices + CD	SG 4 / Miscellaneous 6 devices + CD	
Temperature cycling (m1010.8) cond. A (-55°C, + 85°C) 50Cy. cond. A (-55°C, +100°C) 50Cy. →100 cy. pass/fail cond. B (-55°C, +125°C) #Cy. Up to 50% lot fail	Electrical / Optical characteristics at room, high and low temperature (m1012.1)	Vibration Fatigue (m2007.3)	Radiation tests (m1019.6)	
IMEC Alternative test for Sealing integrity	~~Moisture resistance 5 cy. -40°C to +75°C, RH 90% only controlled at 75°C~~	Mechanical shocks (m2002.4)	RGA (m1018.4) 2 devices	Out gassing test 4 devices
	Thermal Shocks 5 cy., -55, +125°C (m 1011.9)	Endurance test at high Temp & Under Vacuum (m1033)	CONSTRUCTIONAL ANALYSIS 2 devices + 4 Bare dice including Lead Integrity & Bending	Rapid depressurization (m1001)
	3 Devices / 5 Devices			
	ESD testing (m3015.7) / Moisture resistance 10 cy. -40°C to +75°C, RH 90% only controlled at 75°C (m1004.7)			
	IMEC Alternative test for Sealing integrity / ~~Thermal Shocks 5 cy., -55, +125°C (m 1011.9)~~			

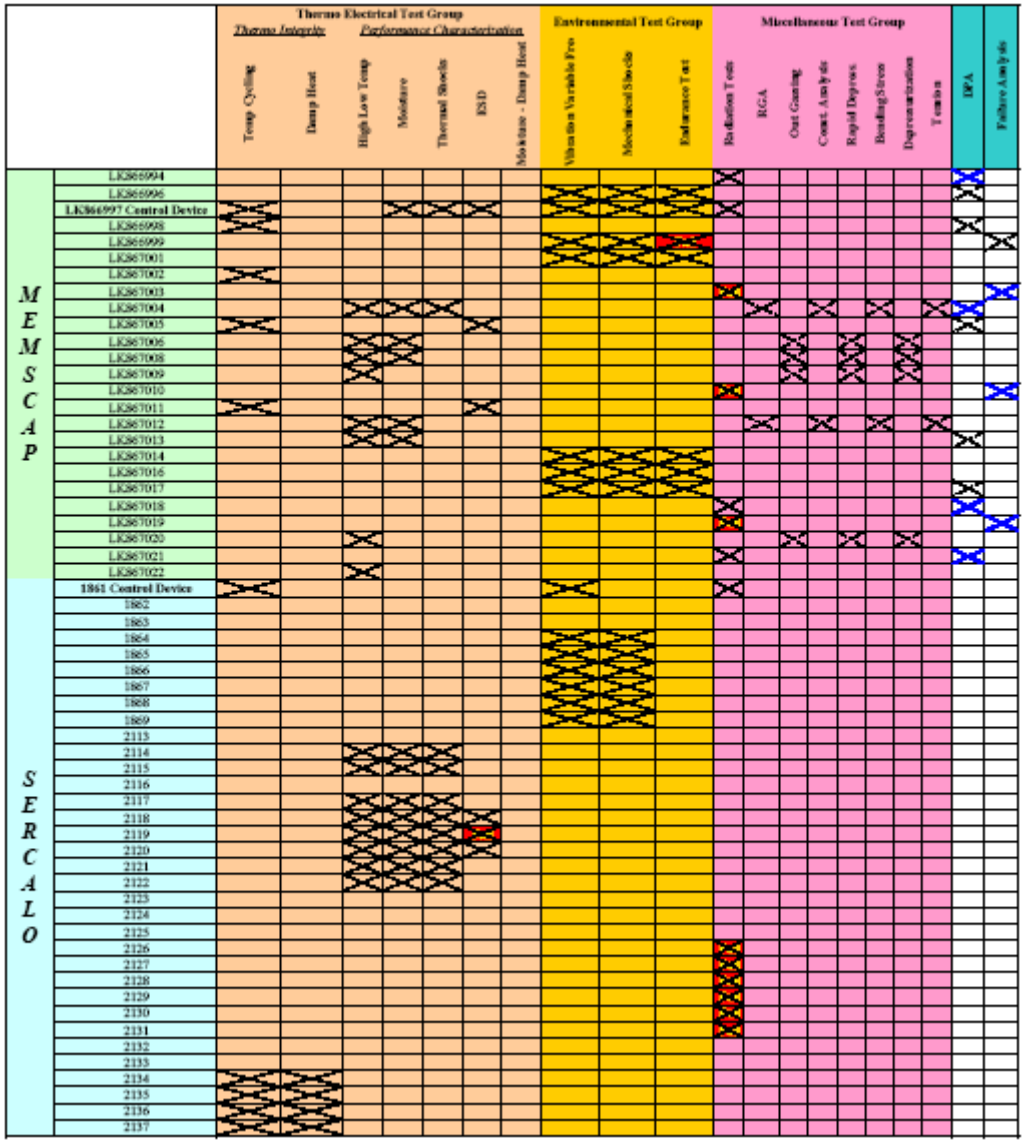
15 cy

Do While:
lot failure rate
<=40%
or
5 loops

MEMSCAP

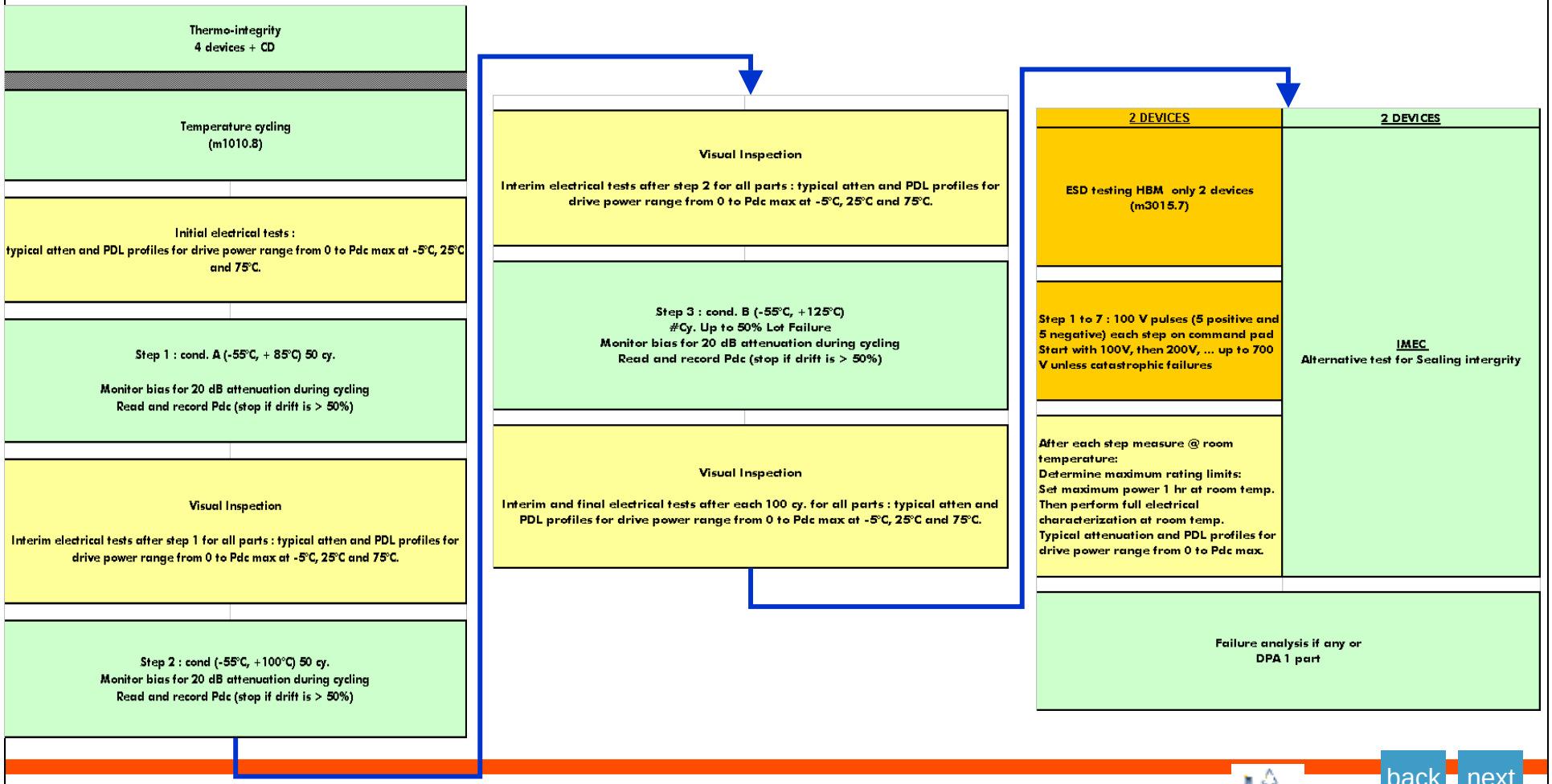
MOEMS Delta Qualification Methodology

Devices Inventory



MOEMS Delta Qualification Methodology

Thermo-electrical test group on MEMSCAP devices (1/2)



MOEMS Delta Qualification Methodology

Thermo-electrical test group on MEMSCAP devices (2 / 2)

Do While: lot failure rate<=40% or 5 loops

MOEMS Delta Qualification Methodology

Environmental test group on MEMSCAP devices

Vibration Fatigue
(m 2005.2)
(MEMSCAP only sine)

Typical attenuation and PDL profiles for drive power range from 0 to Pdc max at room temperature.

Insertion loss distribution data.

Random: White Noise excitation
Condition A: 20g
4 test in each directions (X,Y,Z)
4 minutes each test

Visual Inspection

Final electrical tests after Vibration fatigue for all parts : typical atten and PDL profiles for drive power range from 0 to Pdc max at -5°C, 25°C and 75°C.

Mechanical shocks
(m2002.4)

1500g in 0,5ms
Half-sine acceleration with distrortion<20%

Visual Inspection

Final electrical tests after Mechanical shocks for all parts : typical atten and PDL profiles for drive power range from 0 to Pdc max at -5°C, 25°C and 75°C.

Endurance test at high Temp & under vacuum
(m1033)
If the package is leaky, then it is relevant to perform this test.

at 2 10-5 Bar, 85°C, 1000hrs

step 1 : @168hrs
Visual Inspection

Final electrical tests after step 1 for all parts : typical atten and PDL profiles for drive power range from 0 to Pdc max at -5°C, 25°C and 75°C.

step 2 : @336hrs
Visual Inspection

Final electrical tests after ste 2 for all parts : typical atten and PDL profiles for drive power range from 0 to Pdc max at -5°C, 25°C and 75°C.

step 3 : @720hrs
Visual Inspection

Final electrical tests step 3 for all parts : typical atten and PDL profiles for drive power range from 0 to Pdc max at -5°C, 25°C and 75°C.

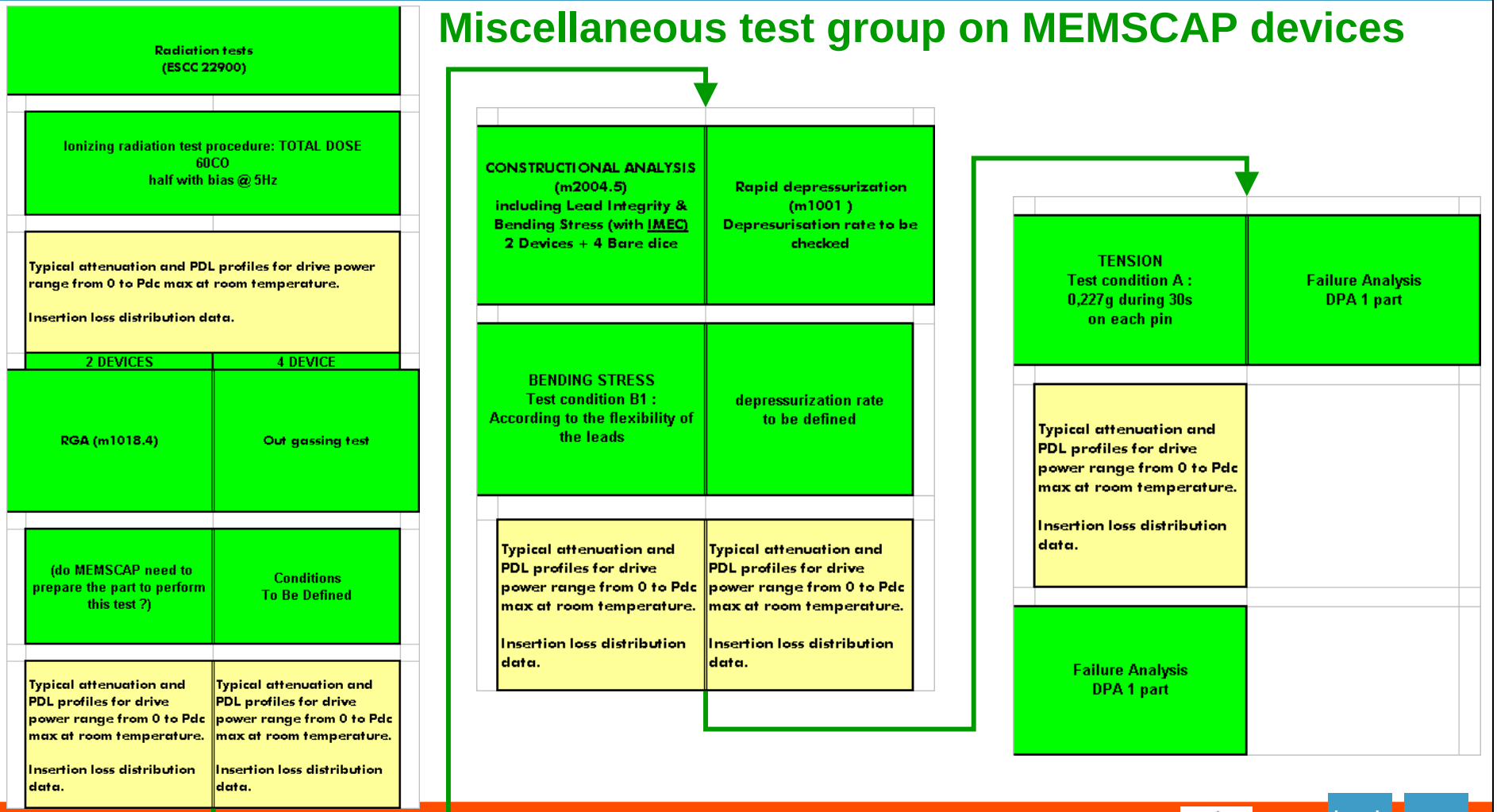
step 4 : 100hrs
Visual Inspection

Final electrical tests after final step for all parts : typical atten and PDL profiles for drive power range from 0 to Pdc max at -5°C, 25°C and 75°C.

Failure Analysis
DPA 1 part

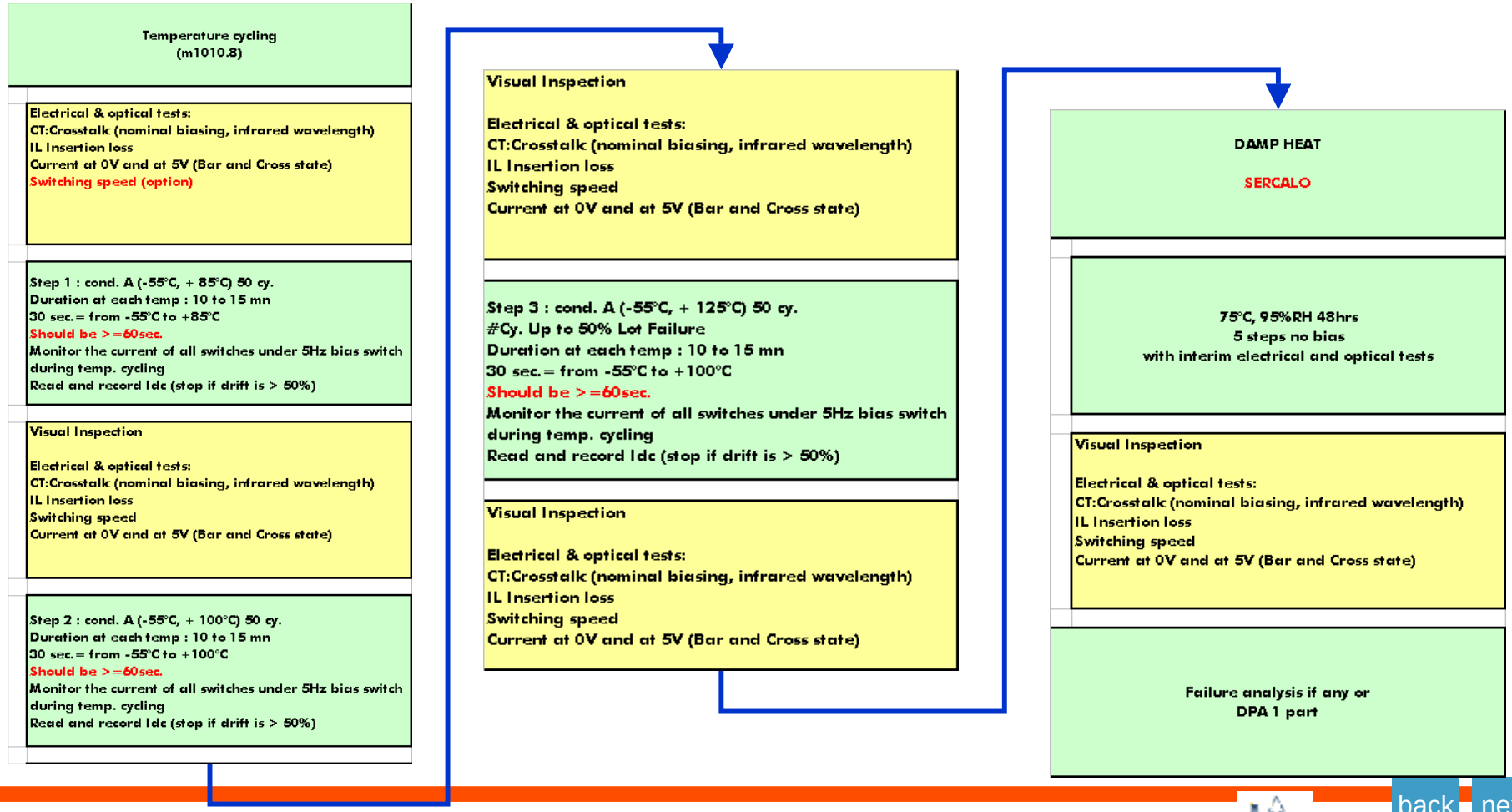
MOEMS Delta Qualification Methodology

Miscellaneous test group on MEMSCAP devices



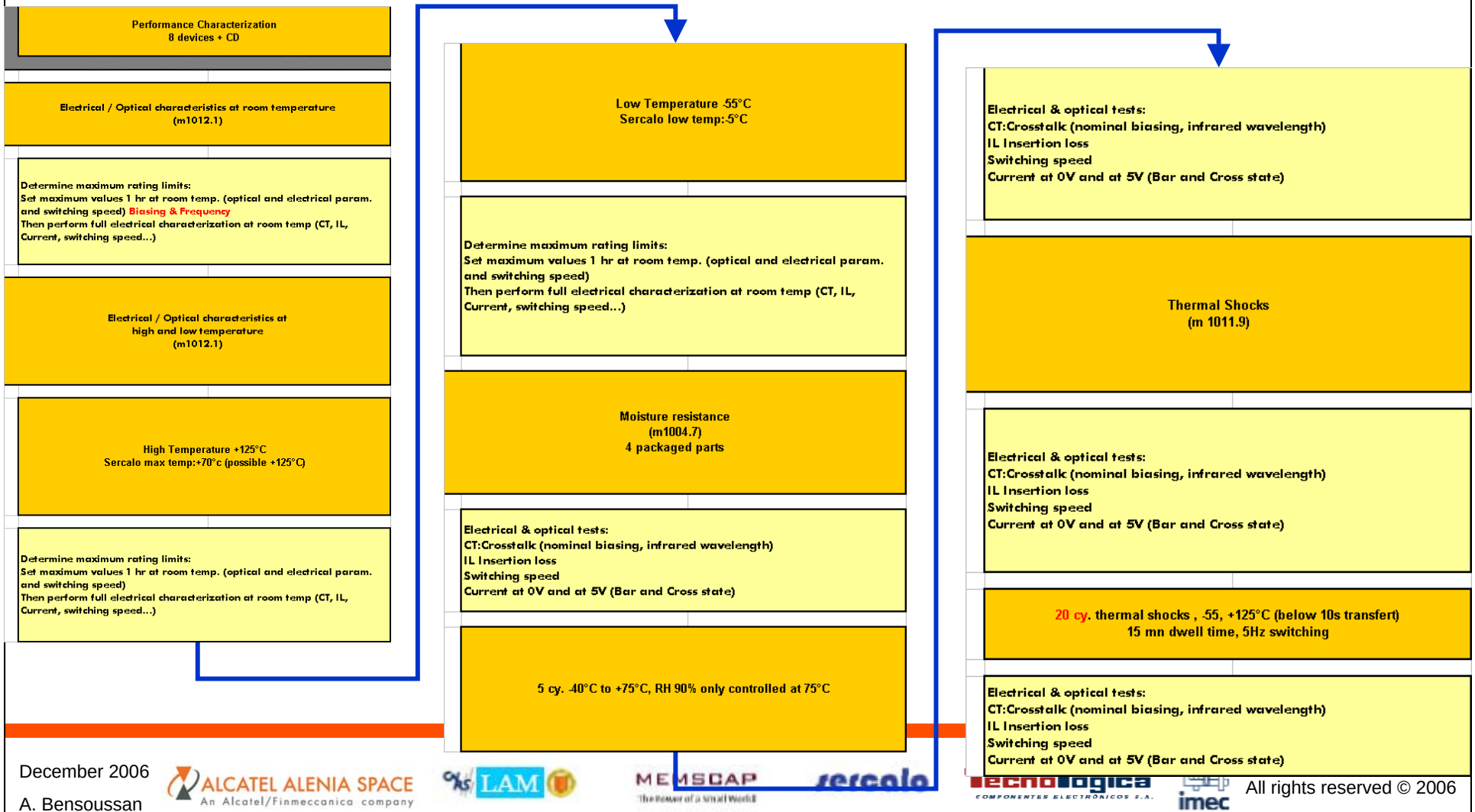
MOEMS Delta Qualification Methodology

Thermo-electrical test group on SERCALO devices (1/3)



MOEMS Delta Qualification Methodology

Thermo-electrical test group on SERCALO devices (2 / 3)



MOEMS Delta Qualification Methodology

Thermo-electrical test group on SERCALO devices (3 / 3)

3 DEVICES	5 DEVICES
ESD testing HBM only 2 devices (m3015.7) F. Moncassin à l'ESA	Moisture resistance (m1004.7)
Step 1 to 7 : 100 V pulses (5 positive and 5 negative) each step on command pad Start with 100V, then 200V, ... up to 700 V unless catastrophic failures	Electrical & optical tests: CT:Crosstalk (nominal biasing, infrared wavelength) IL Insertion loss Current at 0V and at 5V (Bar and Cross state)
Electrical & optical tests: CT:Crosstalk (nominal biasing, infrared wavelength) IL Insertion loss Switching speed Current at 0V and at 5V (Bar and Cross state)	10 cy. -40°C to +75°C, RH 90% only controlled at 75°C
Failure analysis if any or DPA 1 part	Visual Inspection Electrical & optical tests: CT:Crosstalk (nominal biasing, infrared wavelength) IL Insertion loss Current at 0V and at 5V (Bar and Cross state)

internal document at SERCALO:

Step 1 : SERCALO to perform visual inspection with their own procedure
Step 2: SERCALO to idenbtify differences between the MIL or ESA standards and their procedure ; then to make recommendations to a new MEMS visual inpection document.

OPTION:
biasing the switch with a DC voltage

Do While:
lot failure rate<=40%
or
5 loops

DAMP HEAT on 3 devices

75°C, 95%RH 48hrs
5 steps no bias
with interim electrical and optical tests

Visual Inspection

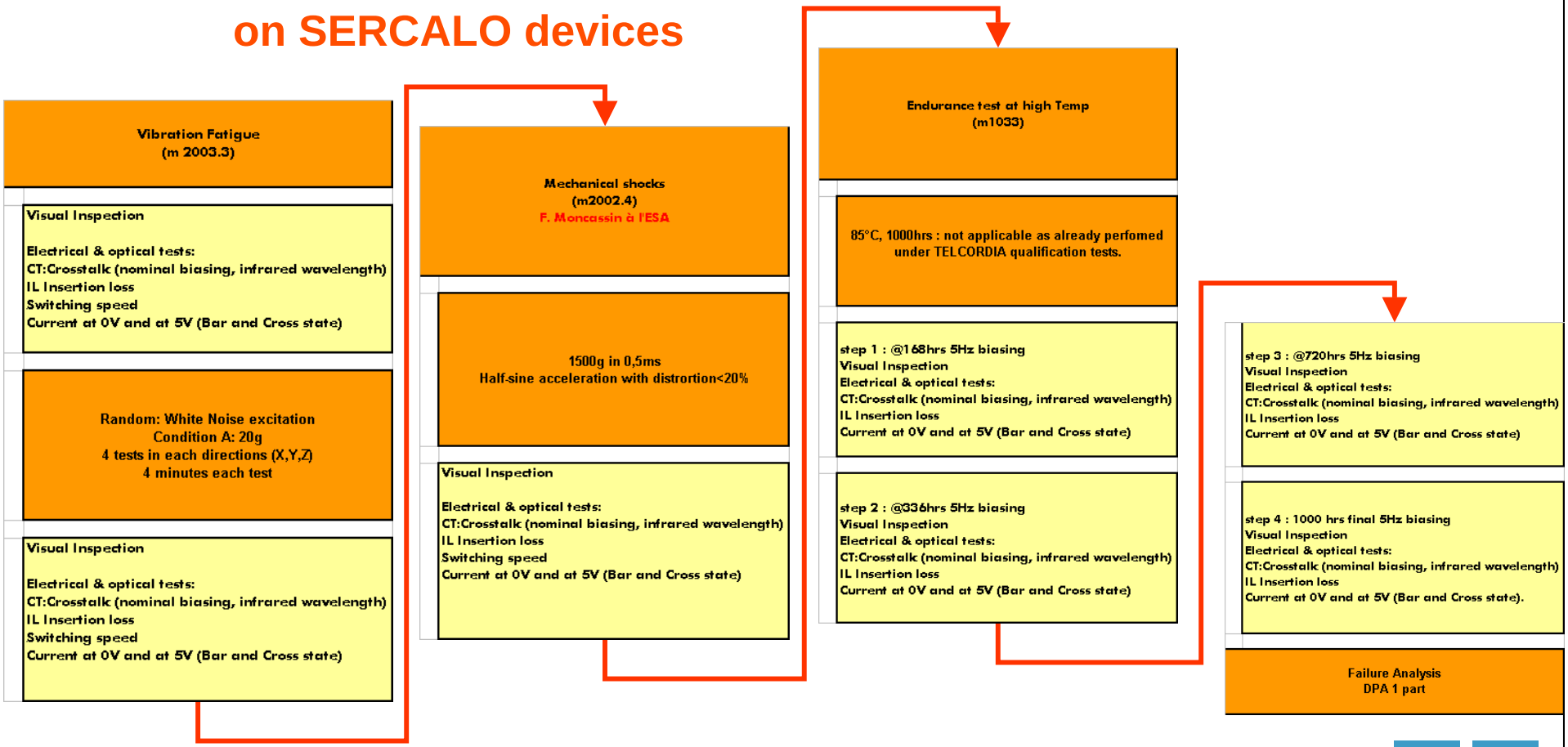
Electrical & optical tests:
CT:Crosstalk (nominal biasing, infrared wavelength)
IL Insertion loss
Switching speed
Current at 0V and at 5V (Bar and Cross state)

Failure analysis if any or
DPA 1 part

MOEMS Delta Qualification Methodology

Environmental test group

on SERCALO devices



MOEMS Delta Qualification Methodology

Miscellaneous test group on SERCALO devices

Radiation tests
(ESCC 22900)

Ionizing radiation test procedure: TOTAL DOSE
60CO
2 parts without bias
2 parts with DC bias
2 parts with switching bias (5 Hz)

Visual Inspection

Electrical & optical tests:
CT:Crosstalk (nominal biasing, infrared wavelength)
IL Insertion loss
Switching speed
Current at 0V and at 5V (Bar and Cross state)

2 DEVICES	4 DEVICES
CONSTRUCTIONAL ANALYSIS (m2004.5) including Lead Integrity & Bending Stress 2 Devices + 4 Bare dice	Out gassing test
BENDING STRESS Test condition B1 : According to the flexibility of the leads	Conditions To Be Defined
Electrical & optical tests: CT:Crosstalk (nominal biasing, infrared wavelength) IL Insertion loss Current at 0V and at 5V (Bar and Cross state)	Electrical & optical tests: CT:Crosstalk (nominal biasing, infrared wavelength) IL Insertion loss Current at 0V and at 5V (Bar and Cross state)

TENSION Test condition A : 0,227g during 30s on each pin	Rapid depressurization (m1001) Depresurisation rate to be checked
Electrical & optical tests: CT:Crosstalk (nominal biasing, infrared wavelength) IL Insertion loss Current at 0V and at 5V (Bar and Cross state)	depressurization rate to be defined
X ray Open the package 1 part Visual ?	Electrical & optical tests: CT:Crosstalk (nominal biasing, infrared wavelength) IL Insertion loss Current at 0V and at 5V (Bar and Cross state)
	Failure Analysis DPA 1 part

Tests conducted on Sercalo Devices

Thermo Mechanical Tests Group

Thermo Integrity

• Temperature Cycling

Part Number	Conditions	Step 1	Step 2	Step 3
		Switching test	Switching test	Switching test
1861 (CD)	Control device	Pass	Pass	Pass
2134	Biased 5 Hz	Pass	Pass	Pass
2135	DC Biased	Pass	Pass	Pass
2136	Not biased	Pass	Pass	Pass
2137	Not biased	Pass	Pass	Pass

MIL-STD-883G, method 1010.8, condition A

Dwell time 10 min, transition time 1 min

Step1 : -55°C to +85°C, 50 cycles, 22min/cycle
Step2 : -55°C to +105°C, 50 cycles, 22min/cycle
Step3 : -55°C to +115°C, 50 cycles, 22min/cycle

SERCALO		Spec	Thermal Cycling						Control Device
			Step 1		Step 2		Step 3		
			Mean	σ	Mean	σ	Mean	σ	**1861**
Insertion Loss	OFF (dB)	< 1	0,22	0,05	0,16	0,12	0,31	0,06	**0,37**
	ON (dB)	<1	0,27	0,08	0,17	0,11	0,31	0,06	**0,28**
Cross Talk	OFF (dB)	> 45	59,49	1,13	57,50	2,91	61,98	2,79	**62,40**
	ON (dB)	> 45	56,04	0,31	55,76	0,29	57,45	4,23	**80,65**
Curent	OFF (mA)	< 1	0,21	0,00	0,21	0,00	0,21	0,00	**0,19**
	ON (mA)	< 2	0,77	0,02	0,76	0,02	0,77	0,01	**0,63**
Switching Speed	T on (ms)	< 15	3,99	0,36	4,32	0,82	3,38	0,30	**4,85**
	T off (ms)	< 20	2,15	0,05	2,18	0,07	1,96	0,08	**2,16**

Thermo Mechanical Tests Group

Thermo Integrity

• Damp Heat

Damp Heat

+75°C, 95% humidity during 48 hours

5 cycles

Part Number	Conditions	Cycle 3	Cycle 4	Cycle 5
		Switching test	Switching test	Switching test
2134	Not biased	Pass	Pass	Fail *
2135	Not biased	Pass	Pass	Pass
2136	Not biased	Pass	Pass	Pass
2137	Not biased	Pass	Pass	Pass

Comments :

* Device 2134 no switching after test. Mechanical failure on PCB. Electronic problem and no MEMS

SERCALO		Spec	Damp Heat Cycle 3 Mean	Damp Heat Cycle 3 σ	Damp Heat Cycle 4 Mean	Damp Heat Cycle 4 σ	Damp Heat Cycle 5 Mean	Damp Heat Cycle 5 σ	Control Device 1861
Insertion Loss	OFF (dB)	< 1	0,55	0,1	0,19	0,1	0,4	0,06	**0,37**
	ON (dB)	<1	0,56	0,2	0,31	0,1	3,99	7,38	**0,28**
Cross Talk	OFF (dB)	> 45	57,2	4,1	57,7	1,8	43,6	28,1	**62,4**
	ON (dB)	> 45	72,4	9,5	69,3	3,2	71,7	5,72	**80,65**
Current	OFF (mA)	< 1	0,2	0	0,2	0	0,19	0,04	**0,19**
	ON (mA)	< 2	0,78	0,1	0,79	0,1	0,75	0,23	**0,63**
Switching Speed	T on (ms)	< 15							**4,85**
	T off (ms)	< 20							**2,16**
Devices hors spec.		2134 (electronic broken)							

back next

Thermo Mechanical Tests Group

Thermo Electrical

Electrical Charact. High Low Temp

MIL-STD-883G, method 1012.1

Step 1 : +25 °C room ambient during 1 hour
Step 2 : +85 °C oven during 1 hour
Step 3 : - 5 °C oven during 1 hour all devices except 2122

Device 2122 :
- 55 °C oven during 1 hour
- 60 °C oven during 1 hour

Part Number	Conditions	Temp Ambient	High Temp	Low Temp
		Switching test	Switching test	Switching test
2114	Not biased	Pass	Pass	Pass
2115	Not biased	Pass	Pass	Pass
2117	Not biased	Pass	Pass	Pass
2118	Not biased	Pass	Pass	Pass
2119	Not biased	Pass	Pass	Pass
2120	Not biased	Pass	Pass	Pass
2121	Not biased	Pass	Pass	Pass
2122	Not biased	Pass	Pass	Pass

SERCALO		Spec	Low High Temp						Control Device
			Temp		High Temp		Low Temp		
			Mean	σ	Mean	σ	Mean	σ	1861
Insertion Loss	OFF (dB)	< 1	0,39	0,1	0,52	0,2	0,57	0,27	**0,37**
	ON (dB)	<1	0,37	0,1	0,48	0,2	0,66	0,3	**0,28**
Cross Talk	OFF (dB)	> 45	64,2	3,2	59,5	3,3	58,47	5,13	**62,4**
	ON (dB)	> 45	55,9	0,3	56,2	0,1	53,99	5,51	**80,65**
Current	OFF (mA)	< 1	0,18	0	0,19	0	0,18	0,02	**0,19**
	ON (mA)	< 2	0,63	0,2	0,7	0,2	0,62	0,15	**0,63**
Switching Speed	T on (ms)	< 15	4,15	1,2	1,99	0,5	135,9	106,2	**4,85**
	T off (ms)	< 20	2,44	0,7	0,9	0,3	357,3	282,4	**2,16**
Devices hors spec.		All devices at low temperature							

back next

Thermo Mechanical Tests Group

Thermo Electrical

Moisture Resistance

MIL-STD-883G, method 1004.7
Temperature : - 40 °C to 70 °C
Humidity : 90%
Dwell : 5 hours
5 cycles
(24 hours standby room ambient after end)

Part Number	Conditions	Characterization
2114	Not biased	Pass
2115	Not biased	Pass
2117	Not biased	Pass
2118	Not biased	Pass
2119	Not biased	Pass
2120	Not biased	Pass
2121	Not biased	Pass
2122	Not biased	Pass

SERCALO		Spec	Moisture Resistance Mean	σ	Min	Max	Control Device 1861
Insertion Loss	OFF (dB)	< 1	0,43	0,1	0,33	0,64	**0,37**
	ON (dB)	<1	0,45	0,1	0,29	0,64	**0,28**
Cross Talk	OFF (dB)	> 45	63,6	1,8	60,8	66	**62,4**
	ON (dB)	> 45	55,6	0,1	55,4	55,8	**80,65**
Current	OFF (mA)	< 1	0,18	0	0,15	0,23	**0,19**
	ON (mA)	< 2	0,63	0,2	0,45	0,9	**0,63**
Switching Speed	T on (ms)	< 15	3,89	1,1	2,73	5,63	**4,85**
	T off (ms)	< 20	2,28	0,7	1,53	3,47	**2,16**

Thermo Mechanical Tests Group

Thermo Electrical

• Thermal shocks

MIL-STD-883G, method 1011.9

- 55 °C to +125 °C
20 cycles
Dwell : 15 mn
Transfert time : 10 s

Part Number	Conditions	Characterization
2114	Biased 5 Hz	Pass
2115	Biased 5 Hz	Pass
2117	Biased 5 Hz	Pass
2118	Biased 5 Hz	Pass
2119	Biased 5 Hz	Pass
2120	Biased 5 Hz	Pass *
2121	Biased 5 Hz	Pass
2122	Biased 5 Hz	Pass *

Comments :

* 2120 and 2122 devices have been damages by operator – wrong manipulation. No possible to measure optical performance anymore.

SERCALO		Spec	Thermal Shocks Mean	σ	Min	Max	Control Device 1861
Insertion Loss	OFF (dB)	< 1	0,43	0,1	0,37	0,52	**0,37**
	ON (dB)	<1	0,5	0,1	0,33	0,64	**0,28**
Cross Talk	OFF (dB)	> 45	60,3	2,5	58,3	64,5	**62,4**
	ON (dB)	> 45	55,4	0,1	55,3	55,5	**80,65**
Current	OFF (mA)	< 1	0,18	0	0,15	0,23	**0,19**
	ON (mA)	< 2	0,64	0,2	0,46	0,91	**0,63**
Switching Speed	T on (ms)	< 15	4,6	1,4	3,15	7,05	**4,85**
	T off (ms)	< 20	2,3	0,6	1,57	3,5	**2,16**

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Thermo Mechanical Tests Group

Thermo Electrical

- ESD

MIL-STD-883G, method 3015.7

Step 1 to 7 : 5 positives pulses and 5 negatives pulses from 100 tu 700 volts.

SERCALO		Spec	ESD Tests Mean	σ	Min	Max	Control Device 1861
Insertion Loss	OFF (dB)	< 1	0,32	0	0,29	0,34	**0,37**
	ON (dB)	<1	0,29	0	0,28	0,3	**0,28**
Cross Talk	OFF (dB)	> 45	63,1	0,3	62,9	63,3	**62,4**
	ON (dB)	> 45	54,4	0,5	54,1	54,7	**80,65**
Current	OFF (mA)	< 1	0,2	0	0,18	0,23	**0,19**
	ON (mA)	< 2	0,77	0,2	0,65	0,9	**0,63**
Switching Speed	T on (ms)	< 15	3,7	0,4	3,41	3,99	**4,85**
	T off (ms)	< 20	2,14	0,4	1,89	2,38	**2,16**
Devices hors spec.			2119 manipulation error				

Part Number	Conditions	Characterization
2118	Not biased	Pass
2119	Not biased	Fail
2120	Not biased	Pass

Comments :

* 2119 device has been damage by operator – wrong manipulation. No possible to measure optical performance anymore. Input fiber is broken.

Thermo Mechanical Tests Group

Thermo Electrical

Moisture Resistance

MIL-STD-883G, method 1004.7
Temperature : - 40 °C to 70 °C
Humidity : 90%
Dwell : 5 hours
5 cycles
(24 hours standby room ambient after end)

Part Number	Conditions	Characterization
2114	Not biased	Pass
2115	Not biased	Pass
2117	Not biased	Pass
2123	Not biased	Pass
2124	Not biased	Pass

SERCALO		Spec	Moisture Resistance								Control Device
			02/08/2006		24/11/2006		31/10/2006		23/10/2006		
			Mean	σ	Mean	σ	Mean	σ	Mean	σ	1861
Insertion Loss	OFF (dB)	<1	0,30	0,10	0,29	0,06	0,41	0,15	0,37	0,17	**0,37**
	ON (dB)	<1	0,40	0,10	0,38	0,11	0,43	0,13	0,23	0,14	**0,28**
Cross Talk	OFF (dB)	>45	62,80	2,26	63,80	2,51	61,50	1,47	62,60	2,97	**62,40**
	ON (dB)	>45	54,90	0,08	72,70	2,15	73,70	3,01	74,20	3,27	**80,65**
Curent	OFF (mA)	<1	0,19	0,03	0,10	0,03	0,19	0,03	0,19	0,03	**0,19**
	ON (mA)	<2	0,68	0,16	0,29	0,07	0,72	0,17	0,73	0,18	**0,63**
Switching Speed	T on (ms)	<15	4,30	1,40	4,37	1,43	3,66	1,36	3,26	1,16	**4,85**
	T off (ms)	<20	2,60	0,90	2,59	0,79	3,35	1,00	3,22	1,17	**2,16**
Devices hors spec.											

back next

Thermo Mechanical Tests Group

Thermo Integrity

• Damp Heat

Damp Heat

+75°C, 95% humidity during 48 hours

5 cycles

Part Number	Conditions	Cycle 3	Cycle 4	Cycle 5
		Switching test	Switching test	Switching test
2114	Not biased	Pass	Pass	Pass
2115	Not biased	Pass	Pass	Pass
2117	Not biased	Pass	Pass	Pass
2123	Not biased	Pass	Pass	Pass
2124	Not biased	Pass	Pass	Pass

SERCALO		Spec	Damp Heat #2						Control Device
			Cycle #3		Cycle #4		Cycle #5		
			Mean	σ	Mean	σ	Mean	σ	**1861**
Insertion Loss	OFF (dB)	<1	0,34	0,09	0,35	0,08	0,36	0,15	**0,37**
	ON (dB)	<1	0,49	0,04	0,59	0,21	0,46	0,06	**0,28**
Cross Talk	OFF (dB)	>45	62,96	3,11	61,16	2,34	62,81	2,54	**62,40**
	ON (dB)	>45	69,84	2,25	71,60	0,85	72,60	4,14	**80,65**
Curent	OFF (mA)	<1	0,18	0,02	0,18	0,02	0,18	0,02	**0,19**
	ON (mA)	<2	0,68	0,14	0,69	0,15	0,73	0,16	**0,63**
Switching Speed	T on (ms)	<15							**4,85**
	T off (ms)	<20							**2,16**
Devices hors spec.									

back next

Environmental Tests Group

Vibrations Variable Frequency

Mil-STD-883G, method 2005.2

20g Random noise
X – Y – Z axis direction
15 mn each

Part Number	Conditions
1861	Control Device
1864	Biased 1 Hz
1865	Biased 1 Hz
1866	Biased 1 Hz
1867	Biased 1 Hz
1868	Biased 1 Hz
1869	Biased 1 Hz

Comments :

To be careful with optical fiber during these types of test, because we can break fibers.
We must fix firmly optical fiber on tool.

Environmental Tests Group

Mechanical Shocks

Mil-STD-883G, method 2002.4

1500g in 0.5 ms
Half sine acceleration

SERCALO		Spec	Mechanical Shocks Mean	σ	Min	Max	Control Device 1861
Insertion Loss	OFF (dB)	< 1	0,32	0,1	0,26	0,39	**0,37**
	ON (dB)	<1	0,37	0,1	0,18	0,56	**0,28**
Cross Talk	OFF (dB)	> 45	63,6	3,2	59,6	68,1	**62,4**
	ON (dB)	> 45	57	3,7	55,4	64,5	**80,65**
Current	OFF (mA)	< 1	0,18	0	0,17	0,21	**0,19**
	ON (mA)	< 2	0,63	0,1	0,53	0,74	**0,63**
Switching Speed	T on (ms)	< 15	4,5	0,9	3,73	5,9	**4,85**
	T off (ms)	< 20	2,1	0,4	1,72	2,63	**2,16**

Part Number	Conditions	Characterization
1864	Not biased	Pass
1865	Not biased	Pass
1866	Not biased	Pass
1867	Not biased	Pass
1868	Not biased	Pass
1869	Not biased	Pass

Comments :

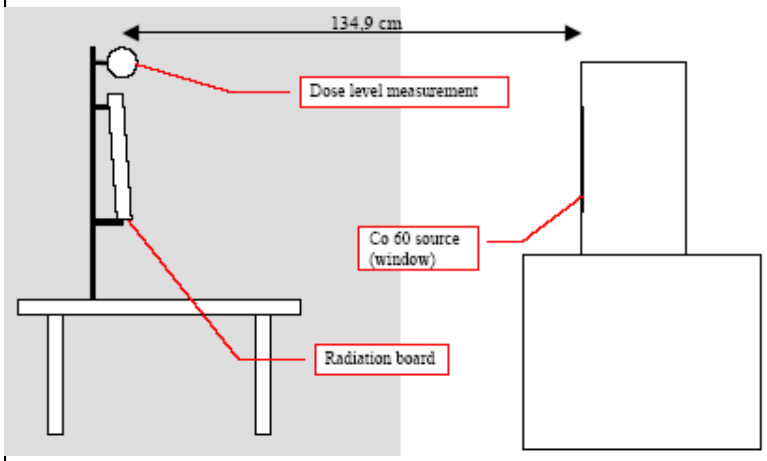
To be careful with optical fiber during these types of test, because we can break fibers.
We must fix firmly optical fiber on tool.

Miscellanous Tests Group

Radiations (1/2)

12.7 rads per mn
Cobalt 60 Source
Uniform irradiation area (46.6 x 46.6 cm) @ 134.9 cm

Step 1 : 0 to 14.478 Krads
Step 2 : 14,478 Krads to 34.290 Krads
Step 3 : 34.290 Krads to 101.346 Krads



SERCALO		Spec	Radiation Tests: Step 1 : Mean	Step 1 : σ	Step 2 : Mean	Step 2 : σ	Step 3 : Mean	Step 3 : σ	24 Hrs Mean	24 Hrs σ	Control Device 1861
Insertion Loss	OFF (dB)	< 1	0,28	0,06	0,07	0,1	0,48	0,3	0,37	0,3	**0,37**
	ON (dB)	<1	0,41	0,14	28,3	30,4	68,4	6,5	55,9	0,3	**0,28**
Cross Talk	OFF (dB)	> 45	61,1	2,27	96,9	83,2	0,48	0,3	67	103	**62,4**
	ON (dB)	> 45	55,6	0,27	56	0,37	68	6,2	55,9	0,4	**80,65**
Current	OFF (mA)	< 1	0,66	0,51	0,72	0,55	5,12	3,9	4,9	3,8	**0,19**
	ON (mA)	< 2	1,33	0,8	0,86	0,18	3,83	2,8	3,64	2,7	**0,63**
Switching Speed	T on (ms)	< 15	4,4	0,87	3,43	0,64	Fail	Fail	Fail	Fail	**4,85**
	T off (ms)	< 20	2,47	0,25	2,12	0,21	Fail	Fail	Fail	Fail	**2,16**
Devices hors spec.			All devices								

SERCALO		Spec	Radiation Tests: 48 Hrs after Mean	48 Hrs after σ	72 Hrs after Mean	72 Hrs after σ	76 Hrs Mean	76 Hrs σ	94 Hrs Mean	94 Hrs σ	Control Device 1861
Insertion Loss	OFF (dB)	< 1	0,27	0,23	0,5	0,12	0,43	0,2	0,31	0	**0,37**
	ON (dB)	<1	55,8	0,32	56	0,22	55,8	0,4	55,8	0,3	**0,28**
Cross Talk	OFF (dB)	> 45	66,9	-	0,5	0,12	0,43	0,2	0,31	0	**62,4**
	ON (dB)	> 45	55,8	0,32	56	0,21	55,8	0,4	55,8	0,3	**80,65**
Current	OFF (mA)	< 1	4,7	3,68	4,51	3,57	4,49	3,6	4,35	3,5	**0,19**
	ON (mA)	< 2	3,45	2,54	3,27	2,41	3,26	2,4	3,12	2,3	**0,63**
Switching Speed	T on (ms)	< 15	Fail	Fail	Fail	Fail	Fail	Fail	Fail	Fail	**4,85**
	T off (ms)	< 20	Fail	Fail	Fail	Fail	Fail	Fail	Fail	Fail	**2,16**
Devices hors spec.			All devices								

back next

Miscellanous Tests Group

Radiations (2/2)

Part Number	Conditions	Step 1	Step 2	Step 3	24 Hrs after Step 3
		Switching test	Switching test	Switching test	Switching test
1861	Control Device	Pass			
2126	Biased 5 Hz	Pass	Pass	Fail	Fail
2127	Biased 5 Hz	Pass	Fail	Fail	Fail
2128	DC biased	Pass	Fail	Fail	Fail
2129	DC biased	Pass	Fail	Fail	Fail
2130	Not biased	Pass	Pass	Fail	Fail
2131	Not biased	Pass	Pass	Fail	Fail

Part Number	Conditions	48 Hrs after Step 3	72 Hrs after Step 3	76 Hrs after Step 3	94 Hrs after Step 3
		Switching test	Switching test	Switching test	Switching test
1861	Control Device				Pass
2126	Biased 5 Hz	Fail	Fail	Fail	Fail
2127	Biased 5 Hz	Fail	Fail	Fail	Fail
2128	DC biased	Fail	Fail	Fail	Fail
2129	DC biased	Fail	Fail	Fail	Fail
2130	Not biased	Fail	Fail	Fail	Fail
2131	Not biased	Fail	Fail	Fail	Fail

Comments :

Step 1 : All devices passed
Step 3 : All devices are not working and not recover

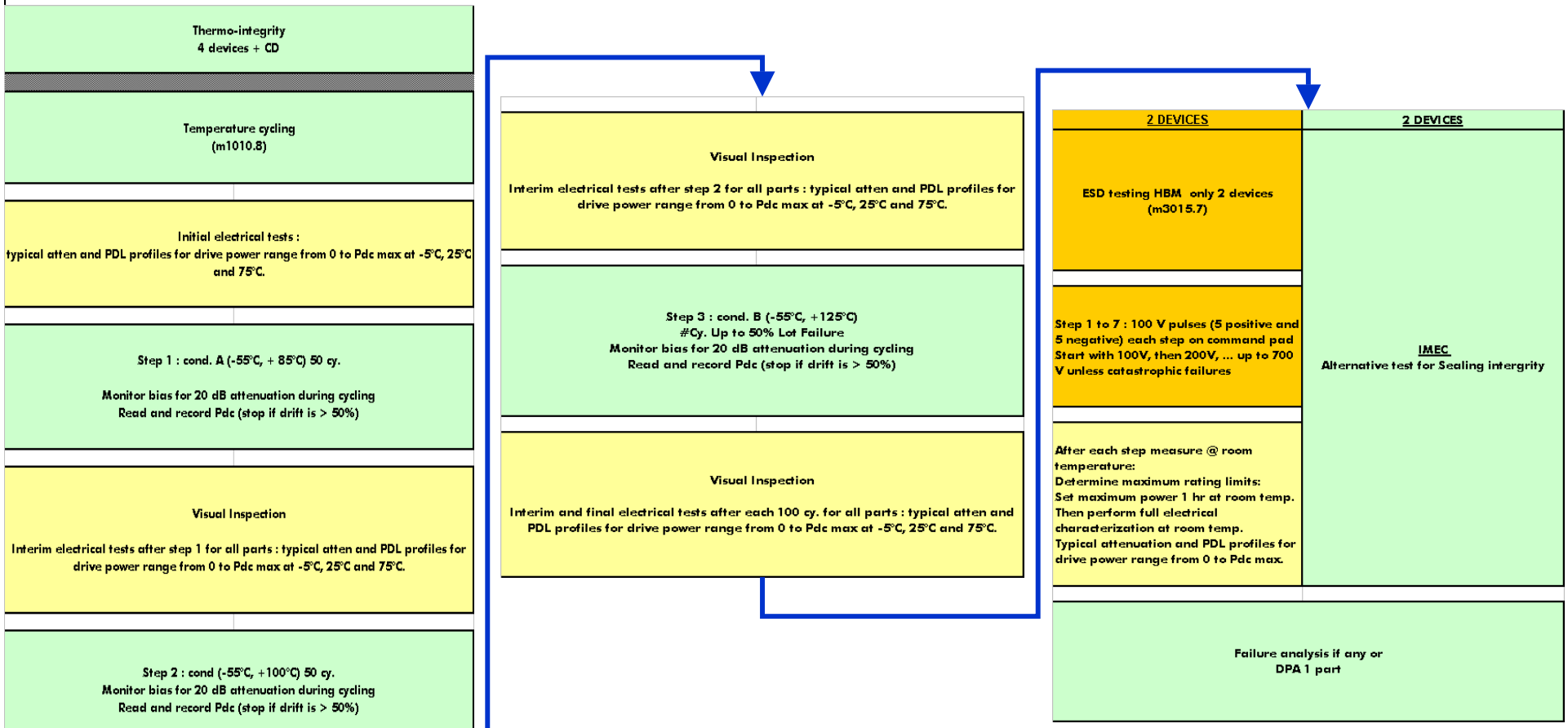
This is an electronic failure. Moems still work after step up DC DC converter replacement.
Switch recover.

MOEMS Delta Qualification Methodology

Tests conducted on MEMSCAP devices (AAS/IMEC/MEMSCAP)

MOEMS Delta Qualification Methodology

Thermo-electrical test group on MEMSCAP devices



Thermo Mechanical Tests Group

Thermo Integrity

Temperature Cycling

Mil-STD-883m 1010.8, Thermal Cycling

1) Step 1: 50 Cycles, from -55°C to 85°C,
Dwell Time>10 minutes, Ramp Time=60 seconds.
2) Step 2: 50 Cycles, from -55°C to 100°C,
Dwell Time>10 minutes, Ramp Time=60 seconds.
3) Step 3 : Condition B: 50 Cycles and up to 50% failure rate,
from -55°C to 125°C, Dwell Time>10 minutes, Ramp Time=60 seconds.

MEMSCAP		Spec	Temperature Cycling						Control Device
			Step 1		Step 2		Step 3		
			Mean	σ	Mean	σ	Mean	σ	LK86 6997
Insertion Loss (dB)		< 1	0,53	0,09	0,54	0,11	0,51	0,07	**0,47**
Dynamic Range	Att Range (dB)	> 40	52,27	2,77	52,15	2,54	52,32	2,34	**51,83**
	Correspond volt (V)	NA	0,01	0,00	0,02	0,03	0,00	0,00	**0,06**
	Att Slope (dB/V)	NA	-29,79	0,83	-29,51	0,62	-29,51	0,72	**-30,88**
WDL	Att 0-10 dB	< 0,1	0,07	0,00	0,07	0,01	0,07	0,01	**0,07**
	Att 10-20 dB	< 0,5	0,07	0,00	0,06	0,01	0,06	0,01	**0,09**
	Att 20-30 dB	< 1	0,06	0,01	0,06	0,01	0,06	0,01	**0,06**
PDL	Att 0-10 dB	< 0,1	0,10	0,02	0,10	0,04	0,11	0,05	**0,18**
	Att 10-20 dB	< 0,2	0,22	0,09	0,25	0,06	0,26	0,11	**0,29**
	Att 20-30 dB	< 0,3	0,39	0,14	0,35	0,06	0,38	0,10	**0,39**
Resistance Slope	Att 30 dB	< 15	11,94	0,44	11,96	0,47	12,04	0,57	**11,74**
	4v Voltage	< 20	18,49	0,35	18,51	0,30	18,67	0,44	**17,87**
Drive Voltage	Att 10 dB	< 3	2,86	0,07	2,86	0,07	2,84	0,09	**2,87**
	Att 20 dB	< 2,7	2,50	0,07	2,48	0,07	2,48	0,08	**2,50**
	Att 30 dB	< 2,3	2,14	0,09	2,14	0,09	2,14	0,10	**2,15**
Drive Power @ 4 V		NA	128,15	3,27	127,56	3,25	126,94	4,03	**129,68**
Samples hors specification		6998 - 7005							

Part Number	Conditions	Step 1 50 Cycles (-55 to +85° C)	Step 2 50 Cycles (-55 to +100° C)	Step 3 50 Cycles (-55° to +110° C)
		Switching test	Switching test	Switching test
LK867997	Control device	Pass	Pass	Pass
LK866998	DC 2,5 V (20 dB Atten)	Pass	Pass	Pass
LK867002	DC 2,5 V (20 dB Atten)	Pass	Pass	Pass
LK867005	No-Bias	Pass	Pass	Pass
LK867011	No-Bias	Pass	Pass	Pass

Thermo Mechanical Tests Group

Thermo Electrical

• Electrical Charact. High Low Temp

MIL-STD-883G, method 1012.1

Step 1 : +25 °C room ambient during 1 hour
Step 2 : +125 °C oven during 1 hour
Step 3 : - 55 °C oven during 1 hour except

MEMSCAP		Spec	High & Low Temperature				Control Device
			+ 125 °C		- 55°C		
			Mean	σ	Mean	σ	LK86 6997
Insertion Loss (dB)		< 1	0,44	0,17	0,58	0,19	**0,47**
Dynamic Range	Att Range (dB)	> 40	57,19	1,82	48,44	1,18	**51,83**
	Correspond volt (V)	NA	0,03	0,04	0,02	0,04	**0,06**
	Att Slope (dB/V)	NA	-30,94	1,16	-27,77	1,36	**-30,88**
WDL	Att 0-10 dB	< 0,1	0,26	0,02	0,29	0,02	**0,07**
	Att 10-20 dB	< 0,5	0,27	0,01	0,30	0,04	**0,09**
	Att 20-30 dB	< 1	0,27	0,01	0,30	0,06	**0,06**
PDL	Att 0-10 dB	< 0,1	0,14	0,14	1,26	0,13	**0,18**
	Att 10-20 dB	< 0,2	0,25	0,13	1,41	0,18	**0,29**
	Att 20-30 dB	< 0,3	0,37	0,13	0,91	0,18	**0,39**
Resistance Slope	Att 30 dB	< 15	12,34	0,40	12,34	0,39	**11,74**
	4v Voltage	< 20	18,36	0,10	19,10	0,15	**17,87**
Drive Voltage	Att 10 dB	< 3	2,94	0,05	2,97	0,07	**2,87**
	Att 20 dB	< 2,7	2,60	0,06	2,60	0,07	**2,50**
	Att 30 dB	< 2,3	2,26	0,05	2,21	0,08	**2,15**
Drive Power @ 4 V		NA	107,97	2,80	139,34	3,82	**129,68**
Samples hors specificatio		All samples at low temperature					

Comments :

All devises no switching at low temperature.
No possible to transmit optical information in these conditions.
All devises recover if you increase the temperature (> -10°C).

Part Number	Ambient T°	High T°	Low T°
LK867004	Pass	Pass	Fail
LK867006	Pass	Pass	Fail
LK867008	Pass	Pass	Fail
LK867009	Pass	Pass	Fail
LK867012	Pass	Pass	Fail
LK867013	Pass	Pass	Fail
LK867020	Pass	Pass	Fail
LK867022	Pass	Pass	Fail

Thermo Mechanical Tests Group

Thermo Electrical

Moisture Resistance & Thermal Shocks

MIL-STD-883G, method 1004.7
Temperature : - 40 °C to 70 °C
Humidity : 90%
Dwell : 5 hours
15 cycles
(24 hours standby room ambient after end)

Part Number	Moisture Resistance Switching test
LK866997 (CD)	Pass
LK867004	Pass
LK867006	Pass
LK867012	Pass
LK867013	Pass

MEMSCAP		Spec	Moisture Resistance Mean	σ	Min	Max	Control Device LK86 6997
Insertion Loss (dB)		<1	0,31	0,15	0,166	0,52	**0,66**
Dynamic Range	Attenuation Range (dB)	>40	52,14	1,66	49,676	53,3	**52,79**
	Corresponding voltage (V)	NA	0,00	0,00	0	0	**0,01**
	Attenuation Slope (dB/V)	NA	-28,99	1,31	-30,409	-27,584	**-30,86**
WDL	Attenuation 0-10 dB	<0,1	2,16	0,14	2,007	2,302	**0,88**
	Attenuation 10-20 dB	<0,5	2,17	0,16	1,995	2,331	**0,88**
	Attenuation 20-30 dB	<1	2,19	0,15	2,026	2,362	**0,90**
PDL	Attenuation 0-10 dB	<0,1	0,08	0,03	0,0454	0,1094	**0,18**
	Attenuation 10-20 dB	<0,2	0,20	0,07	0,142	0,27	**0,29**
	Attenuation 20-30 dB	<0,3	0,41	0,10	0,298	0,509	**0,40**
Resistance Slope	Attenuation 30 dB	<15	12,29	0,37	11,784	12,637	**11,85**
	4v Voltage	<20	18,83	0,15	18,616	18,961	**17,89**
Drive Voltage	Attenuation 10 dB	<3	2,93	0,05	2,866	2,994	**2,87**
	Attenuation 20 dB	<2,7	2,57	0,04	2,523	2,61	**2,51**
	Attenuation 30 dB	<2,3	2,20	0,05	2,144	2,246	**2,17**
Drive Power @ 4 V		NA	121,65	3,52	117,39	125,82	**129,19**
Samples hors specification							

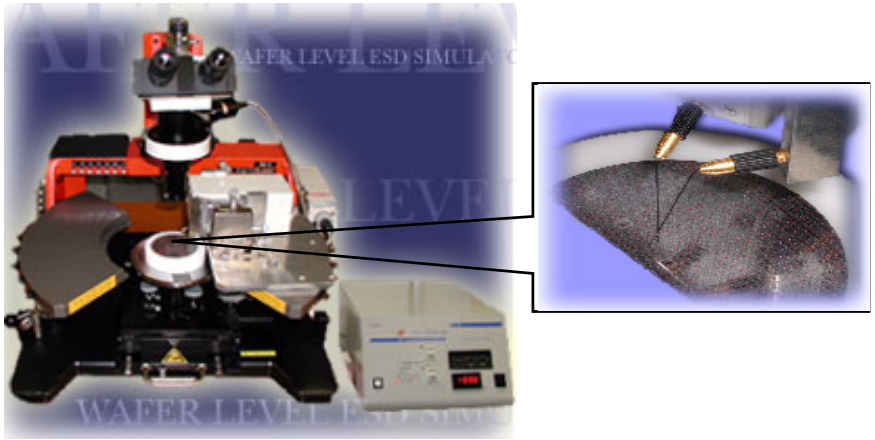
Thermo Mechanical Tests Group

Thermo Electrical

ESD (1/2)

MIL-STD-883G, method 3015.7

Step 1 to 7 : 5 positives pulses and 5 negatives pulses from 100 tu 700 volts.



MEMSCAP		Spec	ESD Test								Control Device
			100 V		200 V		300 V		400 V		
			Mean	σ	Mean	σ	Mean	σ	Mean	σ	LK86 6997
Insertion Loss (dB)		< 1	0,48	0,05	1,33	0,14	0,71	0,85	0,37	0,18	**0,47**
Dynamic Range	Att Range (dB)	> 40	51,63	2,90	52,25	3,37	51,93	3,30	51,66	2,93	**51,83**
	Correspond volt (V)	NA	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	**0,06**
	Att Slope (dB/V)	NA	-29,27	0,59	-29,37	0,68	-29,27	0,74	-28,52	1,72	**-30,88**
WDL	Att 0-10 dB	< 0,1	2,99	0,17	1,70	0,10	2,39	1,28	2,93	0,81	**0,07**
	Att 10-20 dB	< 0,5	2,99	0,19	1,71	0,08	2,36	1,23	2,94	0,83	**0,09**
	Att 20-30 dB	< 1	2,98	0,18	1,71	0,09	2,39	1,26	2,93	0,81	**0,06**
PDL	Att 0-10 dB	< 0,1	0,09	0,09	0,21	0,17	0,07	0,00	0,08	0,02	**0,18**
	Att 10-20 dB	< 0,2	0,22	0,08	0,12	0,04	0,17	0,10	0,12	0,08	**0,29**
	Att 20-30 dB	< 0,3	0,30	0,00	0,20	0,16	0,29	0,02	0,29	0,05	**0,39**
Resistance Slope	Att 30 dB	< 15	12,34	0,33	12,30	0,36	12,30	0,42	12,15	0,53	**11,74**
	4v Voltage	< 20	18,80	0,17	18,80	0,19	18,80	0,19	18,87	0,23	**17,87**
Drive Voltage	Att 10 dB	< 3	2,91	0,02	2,91	0,03	2,90	0,03	2,88	0,06	**2,87**
	Att 20 dB	< 2,7	2,55	0,08	2,52	0,40	2,58	0,04	2,50	0,06	**2,50**
	Att 30 dB	< 2,3	2,17	0,07	2,18	0,08	2,17	0,09	2,14	0,13	**2,15**
Drive Power @ 4 V		NA	123,88	3,21	123,92	3,06	123,89	3,00	122,88	1,86	**129,68**
Samples hors specification											

Thermo Mechanical Tests Group

Thermo Electrical

- ESD (2/2)

Comments :

To be difficult to apply the ESD voltage on MEMSCAP components with this equipment. No possible to secure the connections during the test.

MEMSCAP		Spec	ESD Test (2/2) 500 V Mean	500 V σ	600 V Mean	600 V σ	700 V Mean	700 V σ	Control Device LK86 6997
Insertion Loss (dB)		< 1	0,58	0,20	0,63	0,15	0,62	0,20	**0,47**
Dynamic Range	Att Range (dB)	> 40	51,01	1,93	51,64	2,92	51,88	3,09	**51,83**
	Correspond volt (V)	NA	0,00	0,00	0,00	0,00	0,00	0,00	**0,06**
	Att Slope (dB/V)	NA	-29,26	0,75	-29,18	0,71	-29,23	0,75	**-30,88**
WDL	Att 0-10 dB	< 0,1	0,80	0,98	0,66	0,18	0,56	0,04	**0,07**
	Att 10-20 dB	< 0,5	0,79	0,99	0,68	0,17	0,56	0,02	**0,09**
	Att 20-30 dB	< 1	0,81	0,99	0,68	0,17	0,57	0,02	**0,06**
PDL	Att 0-10 dB	< 0,1	0,09	0,01	0,07	0,02	0,08	0,01	**0,18**
	Att 10-20 dB	< 0,2	0,22	0,04	0,19	0,07	0,20	0,06	**0,29**
	Att 20-30 dB	< 0,3	0,28	0,01	0,27	0,02	0,26	0,01	**0,39**
Resistance Slope	Att 30 dB	< 15	12,28	0,42	12,30	0,34	12,24	0,38	**11,74**
	4v Voltage	< 20	18,82	0,32	18,89	0,23	18,94	0,29	**17,87**
Drive Voltage	Att 10 dB	< 3	2,90	0,03	2,90	0,02	2,90	0,03	**2,87**
	Att 20 dB	< 2,7	2,54	0,00	2,57	0,03	2,57	0,04	**2,50**
	Att 30 dB	< 2,3	2,16	0,10	2,16	0,08	2,16	0,09	**2,15**
Drive Power @ 4 V		NA	123,67	3,09	123,74	3,14	123,87	3,07	**129,68**
Samples hors specification									

Part Number	Burn-in	100V	200V	300V	400V	500V	600V	700V
	Switching test							
LK866997	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
LK867005	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
LK867011	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass

MOEMS Delta Qualification Methodology

Environmental test group on MEMSCAP devices

Vibration Fatigue
(m 2005.2)
(MEMSCAP only sine)

Typical attenuation and PDL profiles for drive power range from 0 to Pdc max at room temperature.

Insertion loss distribution data.

Random: White Noise excitation
Condition A: 20g
4 test in each directions (X,Y,Z)
4 minutes each test

Visual Inspection

Final electrical tests after Vibration fatigue for all parts : typical atten and PDL profiles for drive power range from 0 to Pdc max at -5°C, 25°C and 75°C.

Mechanical shocks
(m2002.4)

1500g in 0,5ms
Half-sine acceleration with distrortion<20%

Visual Inspection

Final electrical tests after Mechanical shocks for all parts : typical atten and PDL profiles for drive power range from 0 to Pdc max at -5°C, 25°C and 75°C.

Endurance test at high Temp & under vacuum
(m1033)
If the package is leaky, then it is relevant to perform this test.

at 2 10-5 Bar, 85°C, 1000hrs

step 1 : @168hrs
Visual Inspection

Final electrical tests after step 1 for all parts : typical atten and PDL profiles for drive power range from 0 to Pdc max at -5°C, 25°C and 75°C.

step 2 : @336hrs
Visual Inspection

Final electrical tests after ste 2 for all parts : typical atten and PDL profiles for drive power range from 0 to Pdc max at -5°C, 25°C and 75°C.

step 3 : @720hrs
Visual Inspection

Final electrical tests step 3 for all parts : typical atten and PDL profiles for drive power range from 0 to Pdc max at -5°C, 25°C and 75°C.

step 4 : 100hrs
Visual Inspection

Final electrical tests after final step for all parts : typical atten and PDL profiles for drive power range from 0 to Pdc max at -5°C, 25°C and 75°C.

Failure Analysis
DPA 1 part

Environmental Tests Group

Vibrations Variable Frequency

Mil-STD-883G, method 2005.2

20g Random noise
X – Y – Z axis direction
15 mn each

Comments :

To be careful with optical fiber during these types of test, because we can break fibers. We must fix firmly optical fiber on tool.

MEMSCAP		Spec	Vibration fatigue				Control Device
			Mean	σ	Min	Max	LK86 6997
Insertion Loss (dB)		<1	1,07	1,09	0,3	1,84	**0,47**
Dynamic Range	Attenuation Range (dB)	>40	51,44	6,83	46,61	56,274	**52,79**
	Corresponding voltage (V)	NA	0,28	0,39	0	0,55	**0,05**
	Attenuation Slope (dB/V)	NA	-29,59	2,47	-31,33	-27,84	**-30,90**
WDL	Attenuation 0-10 dB	<0,1	0,11	0,05	0,073	0,15	**0,11**
	Attenuation 10-20 dB	<0,5	0,14	0,13	0,054	0,232	**0,12**
	Attenuation 20-30 dB	<1	0,11	0,07	0,055	0,159	**0,10**
PDL	Attenuation 0-10 dB	<0,1	0,19	0,19	0,058	0,33	**0,25**
	Attenuation 10-20 dB	<0,2	0,33	0,29	0,126	0,54	**0,38**
	Attenuation 20-30 dB	<0,3	0,63	0,55	0,24	1,02	**0,46**
Resistance Slope	Attenuation 30 dB	<15	11,88	0,54	11,5	12,26	**11,86**
	4v Voltage	<20	18,39	0,86	17,78	19	**17,84**
Drive Voltage	Attenuation 10 dB	<3	2,84	0,07	2,79	2,89	**2,87**
	Attenuation 20 dB	<2,7	2,47	0,05	2,43	2,5	**2,49**
	Attenuation 30 dB	<2,3	2,11	0,08	2,05	2,16	**2,16**
Drive Power @ 4 V		NA	125,86	4,90	122,39	129,32	**129,86**
Samples hors specification			7001				

Part Number	Burn-in	Vibration Fatigue
	Switching test	Switching test
LK866997 (CD)	Pass	Pass
LK866996	Pass	Pass
LK866999	Pass	Pass
LK867001	Pass	Pass
LK867014	Pass	Pass
LK867016	Pass	Pass
LK867017	Pass	Pass

Environmental Tests Group

Mechanical Shocks

Mil-STD-883G, method 2002.4

1500g in 0.5 ms
Half sine acceleration

Part Number	Burn-in Switching test	Mechanical Shock Switching test
LK866997 (CD)	Pass	Pass
LK866996	Pass	Pass
LK866999	Pass	Pass
LK867001	Pass	Pass
LK867014	Pass	Pass
LK867016	Pass	Pass
LK867017	Pass	Pass

Comments :

To be careful with optical fiber during these types of test, because we can break fibers.
We must fix firmly optical fiber on tool.

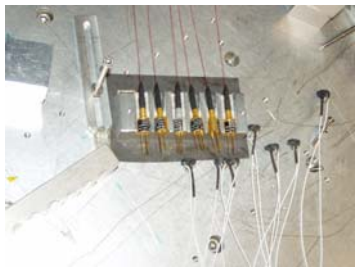
MEMS CAP		Spec	Mechanical Shocks Mean	σ	Min	Max	Control Device LK86 6997
Insertion Loss (dB)		<1	1,07	1,09	0,3	1,84	**0,67**
Dynamic Range	Attenuation Range (dB)	>40	51,90	5,44	48,05	55,75	**50,72**
	Corresponding voltage (V)	NA	0,28	0,39	0	0,55	**0,00**
	Attenuation Slope (dB/V)	NA	-29,48	2,62	-31,33	-27,63	**-27,99**
WDL	Attenuation 0-10 dB	<0,1	0,11	0,07	0,066	0,16	**0,10**
	Attenuation 10-20 dB	<0,5	0,15	0,12	0,06	0,232	**0,11**
	Attenuation 20-30 dB	<1	0,11	0,07	0,053	0,159	**0,10**
PDL	Attenuation 0-10 dB	<0,1	0,19	0,21	0,04	0,33	**0,19**
	Attenuation 10-20 dB	<0,2	0,34	0,30	0,122	0,55	**0,42**
	Attenuation 20-30 dB	<0,3	0,64	0,54	0,25	1,02	**0,66**
Resistance Slope	Attenuation 30 dB	<15	11,84	0,59	11,42	12,26	**11,45**
	4v Voltage	<20	18,64	0,64	18,19	19,09	**18,23**
Drive Voltage	Attenuation 10 dB	<3	2,83	0,07	2,78	2,88	**2,81**
	Attenuation 20 dB	<2,7	2,47	0,05	2,43	2,5	**2,43**
	Attenuation 30 dB	<2,3	2,11	0,09	2,04	2,17	**2,06**
Drive Power @ 4 V		NA	126,06	5,18	122,39	129,72	**129,24**
Samples hors specification			7001				

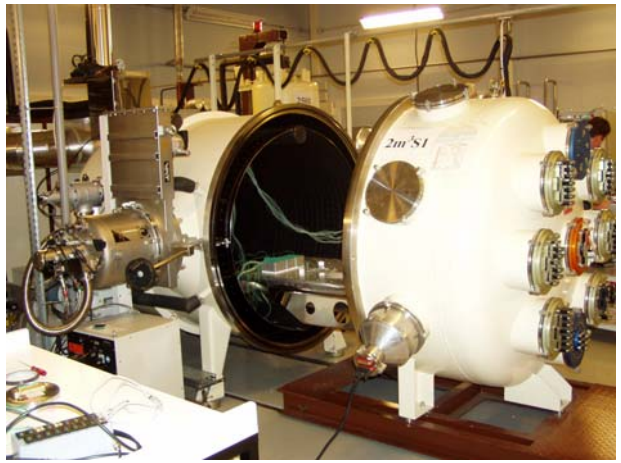
Environmental Tests Group

Endurance Test at High Temp (1/2)

MIL-STD-883 m 3015.7, ESD HBM
Vaccum 2x10-5 bar, high ambiance 125 °C.

Step 1 : 125 °C during 19 hrs
Step 2 : 125 °C during 75 hrs
Step 3 : 125 °C during 239 hrs
Step 4 : 125 °C during 489 hrs
Step 4 : 125 °C during 1000 hrs





MEMSCAP		Spec	Endurance Test										Control Device
			T0 + 19h		T0 + 75h		T0 + 239h		T0 + 486h		T0 + 1000h		
			Mean	σ	Mean	σ	Mean	σ	Mean	σ	Mean	σ	LK86 6997
Insertion Loss (dB)		< 1	0,53	0,10	0,51	0,10	0,50	0,12	0,53	0,12	0,50	0,11	**0,47**
Dynamic Range	Att Range (dB)	> 40	52,74	2,34	52,62	2,30	51,62	2,35	51,79	2,33	50,86	2,58	**51,83**
	Correspond volt (V)	NA	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	**0,06**
	Att Slope (dB/V)	NA	-30,13	1,84	-29,81	1,76	-29,19	2,13	-30,28	-2,47	-29,15	3,14	**-30,88**
WDL	Att 0-10 dB	< 0,1	0,72	0,06	0,65	0,04	0,73	0,02	0,57	0,07	0,36	0,07	**0,07**
	Att 10-20 dB	< 0,5	0,71	0,07	0,65	0,05	0,72	0,02	0,57	0,07	0,37	0,08	**0,09**
	Att 20-30 dB	< 1	0,72	0,01	0,63	0,04	0,71	0,02	0,56	0,07	0,36	0,09	**0,06**
PDL	Att 0-10 dB	< 0,1	0,09	0,03	0,08	0,03	0,09	0,04	0,11	0,02	0,31	0,50	**0,18**
	Att 10-20 dB	< 0,2	0,22	0,06	0,20	0,05	0,21	0,07	0,21	0,05	0,20	0,04	**0,29**
	Att 20-30 dB	< 0,3	0,40	0,09	0,37	0,10	0,40	0,07	0,35	0,08	0,35	0,04	**0,39**
Resistance Slope	Att 30 dB	< 15	12,08	0,30	12,05	0,29	12,02	0,50	12,01	0,60	11,82	0,91	**11,74**
	4v Voltage	< 20	19,27	0,70	19,23	0,76	20,09	1,50	20,18	1,58	19,92	1,72	**17,87**
Drive Voltage	Att 10 dB	< 3	2,80	0,06	2,81	0,06	2,74	0,07	2,75	0,09	3,05	0,78	**2,87**
	Att 20 dB	< 2,7	2,46	0,06	2,47	0,07	2,42	0,06	2,41	0,07	3,63	3,04	**2,50**
	Att 30 dB	< 2,3	2,10	0,08	2,09	0,06	2,05	0,07	2,03	0,07	4,18	5,32	**2,15**
Drive Power @ 4 V		NA	125,69	2,45	125,42	2,39	124,02	2,74	123,72	3,10	124,34	3,77	**129,68**
Samples hors specification		6996 - 6999											

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Environmental Tests Group

Endurance Test at High Temp (2/2)

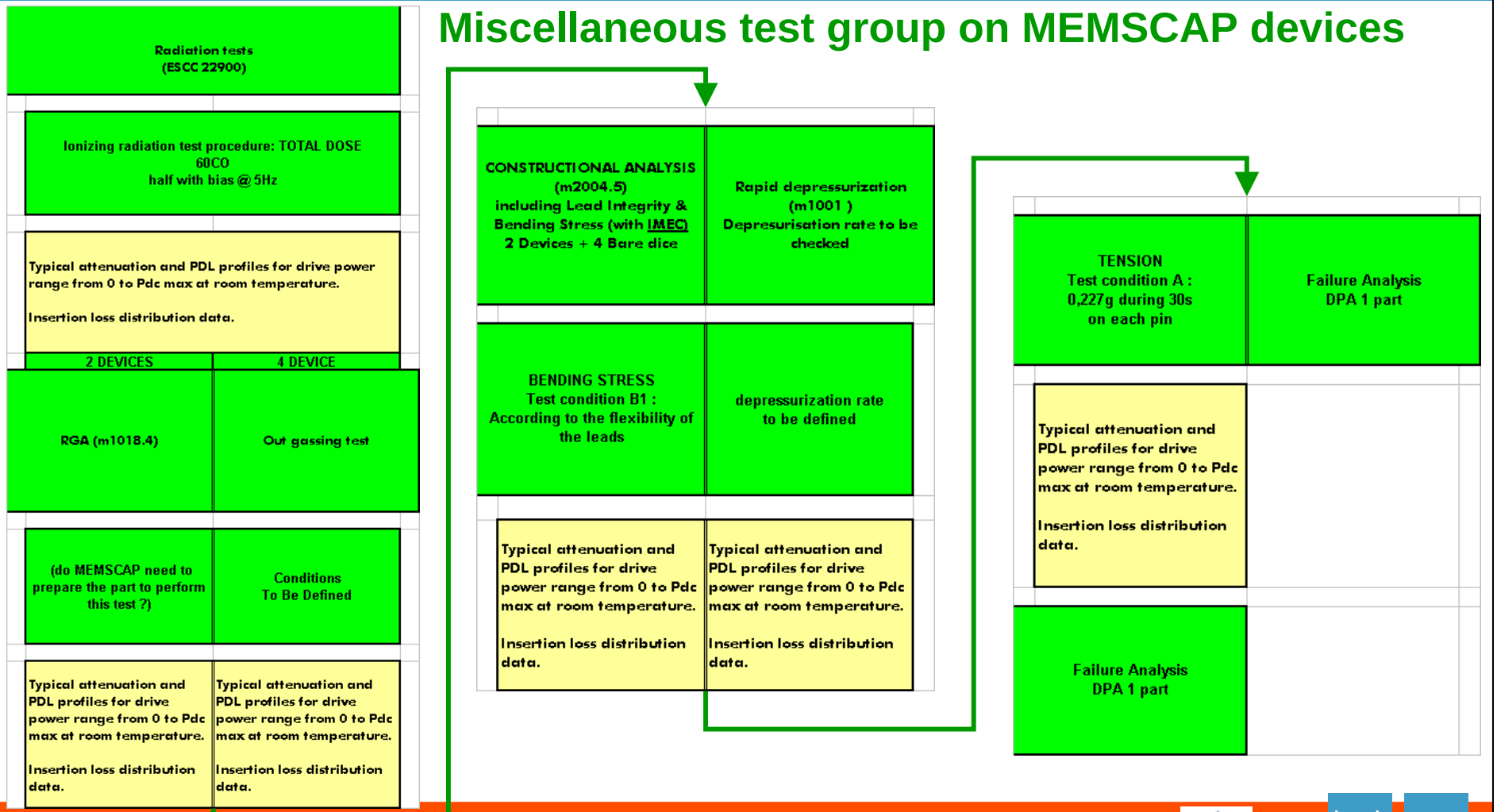
Comments :

- To be careful with optical fiber during these types of test, because we can break fibers.
- We must fix firmly optical fiber on thermal plate. We need a tool to perform the test.
-

Part Number	Conditions	Step 1 T0 + 19 hres	Step 2 T0 + 75 hres	Step 3 T0 + 239 hres	Step 4 T0 + 486 hres	Step 5 T0 + 1000 hres
		Switching test				
LK86 6996	Control device	Pass	Pass	Pass	Pass	Pass
LK86 6997 (CD)	DC 4,5 V	Pass	Pass	Pass	Pass	Pass
LK86 6999	DC 4,5 V	Pass	Pass	Pass	Pass	Fail
LK86 7001	DC 4,5 V	Pass	Pass	Pass	Pass	Pass
LK86 7014	DC 4,5 V	Pass	Pass	Pass	Pass	Pass
LK86 7016	DC 4,5 V	Pass	Pass	Pass	Pass	Pass
LK86 7017	DC 4,5 V	Pass	Pass	Pass	Pass	Pass

MOEMS Delta Qualification Methodology

Miscellaneous test group on MEMSCAP devices



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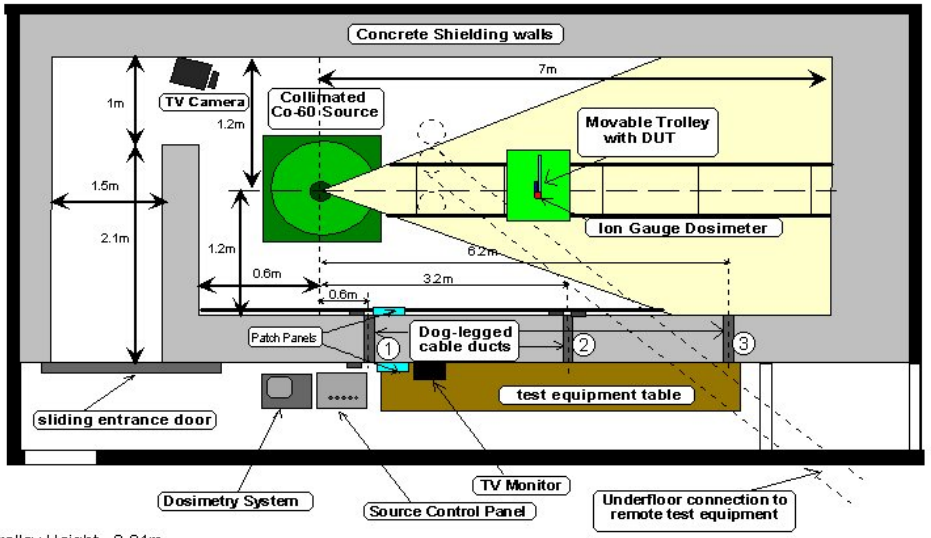
Miscellanous Tests Group

Radiations (1/2)

ESA / ESCC N°22900, Total dose steady-state irradiation test method, method 1019.6

Step 1: from 0 to (10-15) Krad
Interim Electrical and Optical characterization
Step 2: from (10-15) Krad to (40-50) Krad
Interim Electrical and Optical characterization
Step 3: from (40-50) Krad to (100) Krad
Final Electrical and Optical characterization
Final Electrical and Optical characterization

Part Number	Conditions	Switching test
LK866997 (CD)	Control device	Pass
LK866994 (No-Bias)	No-Bias	Pass
LK867003 (5Hz)	5Hz	Fail
LK867010 (5Hz)	5Hz	Fail
LK867018 (No-Bias)	No-Bias	Pass
LK867019 (5Hz)	5Hz	Fail
LK867021 (No-Bias)	No-Bias	Pass



Trolley Height =0.94m
Beam Height = 1m
Room Height = 2.4m

Estec 2000 Ci Co-60 Facility

Miscellanous Tests Group

Radiations (2/2)

Comments :

- 3 devices detected fail after test
- Failure analysis needed

MEMSCAP		Spec	Radiation Test										Control Device
			14,5 Krad		33,91 Krad		100,82 Krad		Rad after 24h		Rad after 1w		
			Mean	σ	Mean	σ	Mean	σ	Mean	σ	Mean	σ	x6997
Insertion Loss (dB)		< 1	0,48	0,06	0,90	0,39	0,75	0,11	0,93	0,14	0,77	0,11	**0,47**
Dynamic Range	Att Range (dB)	> 40	49,58	1,80	51,50	1,72	51,29	1,15	52,23	3,21	50,77	1,03	**51,83**
	Correspond volt (V)	NA	0,00	0,00	0,01	0,02	0,00	0,00	0,07	0,07	0,00	0,00	**0,06**
	Att Slope (dB/V)	NA	-28,36	0,87	-28,35	0,91	-28,83	0,83	-28,18	0,75	-28,21	0,81	**-30,88**
WDL	Att 0-10 dB	< 0,1	0,15	0,02	0,05	0,00	0,06	0,01	0,05	0,00	0,07	0,01	**0,07**
	Att 10-20 dB	< 0,5	0,15	0,02	0,12	0,09	0,05	0,01	0,05	0,00	0,06	0,01	**0,09**
	Att 20-30 dB	< 1	0,14	0,02	0,07	0,01	0,06	0,01	0,06	0,01	0,06	0,01	**0,06**
PDL	Att 0-10 dB	< 0,1	0,24	0,10	0,31	0,40	0,09	0,01	0,07	0,01	0,09	0,00	**0,18**
	Att 10-20 dB	< 0,2	0,44	0,21	0,39	0,41	0,16	0,04	0,13	0,05	0,18	0,02	**0,29**
	Att 20-30 dB	< 0,3	0,68	0,32	0,56	0,36	0,34	0,05	0,33	0,05	0,33	0,03	**0,39**
Resistance Slope	Att 30 dB	< 15	11,79	0,45	11,81	0,17	11,76	0,09	11,74	0,08	11,77	0,14	**11,74**
	4v Voltage	< 20	18,70	0,24	18,68	0,29	18,65	0,29	18,72	0,33	18,67	0,28	**17,87**
Drive Voltage	Att 10 dB	< 3	2,79	0,09	2,79	0,01	2,80	0,04	2,80	0,03	2,81	0,03	**2,87**
	Att 20 dB	< 2,7	2,43	0,08	2,44	0,03	2,43	0,03	2,43	0,03	2,44	0,03	**2,50**
	Att 30 dB	< 2,3	2,06	0,11	2,08	0,01	2,06	0,02	2,06	0,02	2,07	0,02	**2,15**
Drive Power @ 4 V		NA	126,12	2,90	127,47	2,84	127,73	2,62	127,86	2,86	127,99	2,60	**129,68**
Samples hors specification			7003 - 7010 - 7019										