ABSTRACT

Low ESR tantalum capacitor Evaluation and Qualification

Ref.No.: 400010504/10/NL/PA

Start Date: 4th November 2010
Completion Date: July 2013,

Contract Total Fixed Price: 99,000 EUR

Prime Contractor: AVX Czech Republic s.r.o.
Dvorakova 328, 563 01 Lanskroun, Czech Republic,
Bidding code: 58042

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Abstract prepared by: T.Zednicek
26th July 2013, reviewed 15th August 2013, 2nd revision 27th August 2013

1. TECHNICAL OBJECTIVES

The main technical objective is to develop a low ESR, High CV tantalum capacitor manufactured in European location for space application, mainly European space manufacturers.

There were limited specification options on tantalum capacitors for aerospace manufacturers based on European standardization. The limited choice of ESCC EQPL part numbers (ESCC 3012) running in relatively low volumes that increase manufacturing price and reduce interest from users towards the near future. There is also currently a limited range of CV for tantalum capacitors based on the 3012/001 TAJ-ESCC qualified range. European aerospace manufactures are today dependent on MIL (CWR or COTS+) based standardization offering the requested CV values and low ESR tantalum capacitors.

The latest low voltage, high power computing technologies require lower ESR tantalum capacitors that provide higher ripple current capability at smaller case sizes. Thus these low ESR capacitors may reduce component count and the total weight. Low ESR tantalum capacitor matrix will be created a based on the existing TAJ (ESCC-3012/001) capacitors, professional TRJ low ESR capacitors and TRM tantalum multianode very low ESR capacitors.

The development have been lead by AVX Czech Republic located in Lanskroun, Czech Republic as already manufacturing plant of ESCC qualified tantalum solid capacitors, type TAJ-ESA ESCC 3012/001 for long time.

2. IMPLEMENTATION STEPS

The project has been implemented into two working packages:

Evaluation of the technology (WP1) and **Qualification (WP2).**

The WP1 evaluation split in four sub WPs:

1] WP1100 ETP (Evaluation Test Plan) definition and proposal
existing ESA, MIL and other aerospace standards will be evaluated and ETP proposed based on the review and experience based on long term tantalum capacitor manufacturing

2] WP1200 manufacturing of the low ESR tantalum capacitor samples WP1200

3] evaluation testing WP1300
The evaluation testing will follow the ETP steps as defined in WP1100

4] results analysis WP1400
The failure analysis as per WP1300 will be reviewed and modifications to the ETP, PID or other documents will be considered

The WP2 qualification will follow in two steps:

1] manufacturing of improved test samples WP2100
Qualification samples of the low ESR tantalum capacitors will be manufactured in accordance to the PID and documentation created and agreed in WP1400

2] qualification testing WP2200
The qualification testing will be performed in accordance to the new ESCC specification as defined in WP1.

3. PROJECT OUTCOME

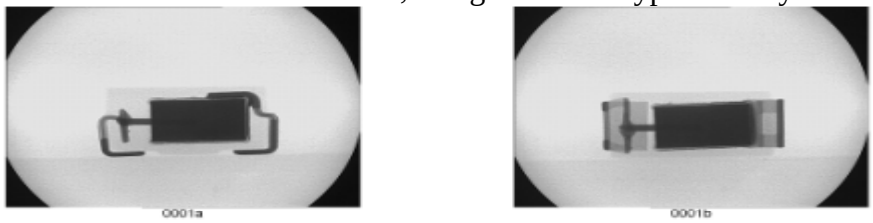
3.1 Design of capacitors

Tantalum industry has developed a design approach to achieve the lower ESR parameter. The ESR depending to design parameter, such as tantalum powder, and second electrode materials/configuration, such as silver, leadframe material etc.. Single anode technology is using modification of these parameter to reduce the ESR in comparison to the standard range. The other approach is to use more anode elements within one capacitor body to get higher surface area and thus lower ESR.

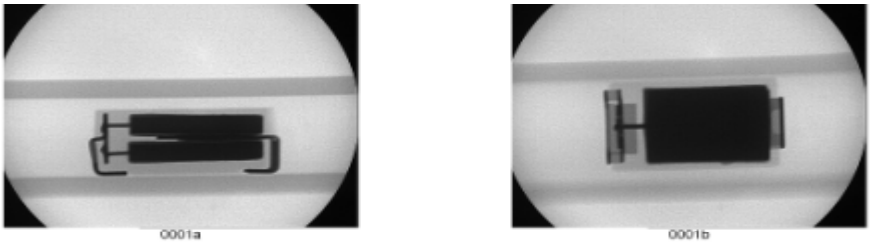
New ESCC Detailed Specification No. 3012/004 (Capacitors, leadess surface mounted, tantalum, solid electrolyte, low WSR based on type TES), PID 100 and PID 100/004 were prepared by AVX/CZ and as creating and approved by ESCC executive management.

Smaller A,B, and C case capacitors are using single anode with optimised low ESR performance, larger D and E case sizes are using multianode design with more anode elements moulded in one capacitor body. The D case multianode is designed with two anodes in “mirror” configuration and the E case size three anodes in vertical configuration in order to optimise low ESR and high reliability requirements.

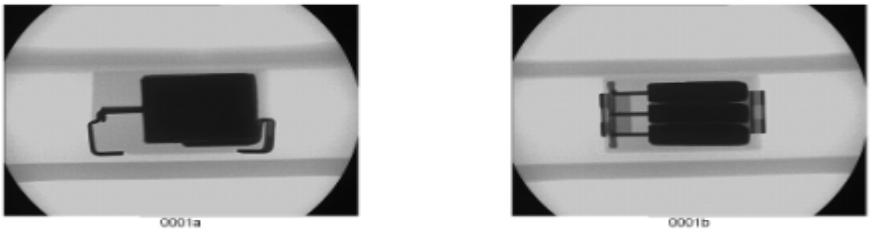
301200401B226KJ0900– A22/6,3 single anode – typical X-ray view



301200404B226KV0100 – D22/35 “mirror” multianode typical X-ray view



301200405B227KB0035 – E220/12– multianode typical X-Ray view



3.2 EVALUATION TESTING

The first step of this project was to evaluate the low ESR capacitors with single anode and multianodes. The matrix of the low ESR capacitors was proposed for Evaluation testing. Evaluation test plan was defined on the basic of established standards. The main objective was to compare available standards for tantalum capacitors over the aerospace and military sector.

Compared standards:

ESCC Basic Specification No.2263000, Issue 2
ESCC Generic Specification No. 3012, Issue 1
ESCC Detail Specification No.3012/001, Issue 2
MIL-PRF-55365G, Amendement 2
EEE-INST-002: Instructions for EEE Parts Selection. Screening, Qualification, and Derating, Addendum 1, 2008
SRC9000 – Internal AVX Procedure
ECSS-Q-ST-70-08 – Space product assurance – Manual soldering of high-reliability electrical connections, March 2009

Codes for Evaluation testing have been defined based on these rules:
- all case sizes - A, B, C, D, E
- all construction types (single anodes, standard multianode and mirror multianode)
- all rated voltages – 6, 10, 16, 20, 25, 35, 50 (V)
- all tantalum powder types

The matrix (TES) of the low ESR tantalum capacitors was proposed based on the European space manufactures requirements for aerospace, MIL standard parts and the technology readiness to meet the aerospace level. The initial TES matrix subjected for evaluation ESCC testing has been discussed continuously with European Aerospace suppliers. Based on this discussion 12V voltage range and E case size, 220 μF, 12V was added to the matrix. See below the TES matrix prepared for ESCC 3012/004 specification.

During the Evaluation testing it was confirmed that the codes with exception of E10/50 (originally proposed) would meet ESCC 3012/004 specification nevertheless there were identified some differences between the codes. Based on results of evaluation testing were made some design and process modifications to improve the codes with lowest margin to the specification. The results of these modifications were verified with additional testing and were proved as efficient As result the whole range of product was revised to apply the identified improvements to other codes. The E10/50 was removed from the product range due to exception results across more provided tests. On other hand we included to the matrix E220/12 based on customer requirements for this code and feasibility study made by AVX.

Capacitance		Rated Voltage							
Cap uF	Code	6 V	10 V	12V	16 V	20 V	25 V	35 V	50 V
1	105						**A-3000**		**B-2000**
3,3	335					**A-2500**		**B-1000**	**C-1000**
4,7	475				**A-2000**		**B-1000**	**C-0600**	**D -0200**
10	106		**A-1800**			**B-1000**	**C - 0600**	**D-0120**	
22	226	**A-0900**			**B-0600**	**C-0400**		**D-0100**	
33	336		**B-0650**			**C-0300**	**D-0065**	**E-0065**	
47	476	**B-0500**			**C-0350**	**D - 0055**	**E - 0065**		
100	107		**C-0200**		**D-0055**	**E-0045**			
150	157	**C-0300**	**D-0045**		**E-0040**				
220	227		**D-0035**	**E-0035**					
330	337	**D-0035**	**E-0035**						
470	477	**E-0030**							

Fig.1. TES – ESCC 3012/004 range of low ESR tantalum capacitors
Note: The letter indicate case size, numbers indicate Equivalent Series Resistance (ESR) in mΩ

3.3. QUALIFICATION TESTING

Qualification testing of the component has been done in accordance with the requirements of:

- Generic Specification ESCC 3012
- Detail Specification ESCC 3012 / 004
- ESCC Basic specification No.20100

ESCC Part type	Code	Design
301200401B226KJ0900	**A/22/6,3**	Single anode
301200402B476KJ0500	**B/47/6,3**	Single anode
301200404B157MA0045	**D/150/10**	Multianode, mirror
301200405B227KB0035	**E/220/12**	Multianode
301200402B226KC0600	**B/22/16**	Single anode
301200405B107KD0045	**E/100/20**	Multianode
301200404B226MV0100	**D/22/35**	Multianode, mirror
301200405B336KV0065	**E33/35**	Multianode
301200403B335KT1000	**C3,3/50**	Single anode
301200404B475KT0200	**D4,7/50**	Multianode, mirror

The qualification samples were manufactured in accordance to the relevant PID documents.

Results of qualification: All tested part numbers pass the qualification in accordance to the ESCC specifications.

4.0. CONCLUSION

TES series have been qualified to meet requirements of ESCC 3012/004 detail specification. The matrix is significant improvement of maximum capacitance and lower ESR compare to the existing ESCC 3012/001 on solid tantalum chip capacitors.

Appendix 1 – Application for ESCC qualification approval

	APPLICATION FOR ESCC QUALIFICATION APPROVAL	Page 5
ESCC	Component Title: Capacitors, leadless surface mounted, tantalum, solid electrolyte, low equivalent series resistance based on type TES	Appl. No.
	Executive Member: ESTEC Date: 23rd August 2013	

1 Components (including series and families) submitted for Qual. App.

ESA/ESCC COMP. NO.	VARIANTS	RANGE OF COMPONENTS	BASED ON	TEST VEHICLE / S	COMPONENT SIMILAR
3012/004	01 – A case size	1-470µF, 6,3-50V	TES	301200401B226KJ0900	And all parts define in ESCC 3012/004 issue 1 +DCR 810
	02 – B case size			301200402B476KJ0500	
	03 – C case size			301200404B157MA0045	
	04- D case size			301200405B227KB0035	
	05 – E case size			301200402B226KC0600	
				301200405B107KD0045	
				301200404B226MV0100	
				301200405B336KV0065	
				301200403B335KT1000	
				301200404B475KT0200	

2 AVX Czech Republic s.r.o.

3 Location of Manufacturing Plant

Tantalum Division
Dvorakova 328
Lanskroun, Czech Republic

4 ESCC Specification used for Qualification

Generic: ESCC 3012 issue 2

Detail/s: ESCC3012/004 issue 1 +DCR 810

5 Qualification Report Reference and date:

Project 400010504/10/NL/PA

Date: 23rd August 2013

6 **PID** used for manufacturing Qualification Lot

Ref No: PID 100 issue1 (march 2011) + PID 100/004 issue 2 (December 2012)

Issue:

Date:

7 **PID** changes since start of qualification

None ☑

~~Minor *~~ ☐ *Provide detail.

~~Major *~~ ☐

8 Current **PID** Verified by Click here to enter text.

Ref No: PID 100 issue1 (march 2011) + PID 100/004 issue 2 (December 2012)

Issue:

Date:

9 Current Manufacturing facilities surveyed by: L.Bonora

(Name of Executive Responsible) (Date)7-8 April 2009

Ref.QCS/LB/090401 dated 2009-04-29

Satisfactory: Yes ☑ ~~No~~ ☐ Explain

10 Quality and Reliability Data

Evaluation testing performed Yes ☑ ~~No~~ ☐

Failure analysis, DPA, NCCS available Yes ☐ ~~No~~ ☑

Report Ref. No.:	Evaluation test report – project 400010504/10/NL/PA Additional test report - project 400010504/10/NL/PA CA 00623 - done by laboratory at ESTEC / February 2012 Results of DPA – September 2012	Date: May 2013	1.
Equivalent Data: Certification:			Ref. Nos. and purpose:

	APPLICATION FOR ESCC QUALIFICATION APPROVAL	Page 2
	Component title: Capacitors, leadless surface mounted, tantalum, solid electrolyte, low equivalent series resistance based on type TES	Appl. No.
	Executive Member: ESTEC Date: 23rd August 2013	

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The undersigned hereby certifies on behalf of the ESCC Executive, that the above information is correct; that the appropriate documentation has been evaluated; that full compliance to all ESCC requirements is evidence except as stated in box 13; that the reports and data are available at the ESCC Executive and therefore applies for ESCC qualification status to be given to the component(s) listed herein.

Date:

((Signature of the Executive Coordinator)

12

Continuation of Boxes above: 9/ ESA manufacturing line visits were done in May 2011 and in March 2013

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13

Non compliance to ESCC requirements:

No.:	Specification	Paragraph	Non compliance

14

Additional tasks required to achieve full compliance for ESCC qualification or rationale for acceptability of noncompliance:

Click here to enter text.

15

Executive Manager Disposition

Application Approval: Yes ☐ No ☐

Action / Remarks:

Click here to enter text.

Date: Click here to enter a date.

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Signature, ESA Representative

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