

T.I.C.

TANTALUM-NIOBIUM INTERNATIONAL STUDY CENTER

PRESIDENT'S LETTER

Dear Members and Friends,

On behalf of the Executive Committee, I am pleased to report on the results of the April 22nd meeting in Brussels, at which we discussed the final arrangements set for the Thirty-eighth General Assembly in Xian from October 5th to 8th 1997. Our Secretary General, Mrs Judy Wickens, visited China in March and obtained first hand knowledge of the meeting venue and facilities in Xian. With the generous assistance provided by our hosts in China, namely Ningxia Non-ferrous Metals Smelter and the Non-ferrous Metals Society of China, I am confident that this meeting in Xian will be well taken care of. In addition, Ningxia Non-ferrous Metals Smelter has agreed to let all overseas visitors go to its plant on October 7th. Given the complexity of organizing this Xian meeting, I strongly recommend that our members submit their pre-registrations in a timely manner and only directly to T.I.C. I hope to see you all in Xian.

You will notice that our normal quarterly statistics have not been released. This is due to the non-reporting of one major contributor. The Committee had extensive discussions on this matter and a proposal was made to resolve this very important issue: we hope that this will be accomplished soon.

One piece of good news: our recent membership drive has resulted in three new applications to join T.I.C. These should give us a total of 53 members by the next General Assembly.

S.S. Yeap
President

T.I.C. IN CHINA

The 1997 meeting of the T.I.C. will take place in Xian, China, from October 5th to 8th. Formal sessions will be held at the Hyatt Regency Hotel, where delegates will also stay.

The registration desk will be open on Sunday October 5th, and there will be a welcome reception on Sunday evening. The Thirty-eighth General Assembly, for delegates of member companies, will be convened on Monday October 6th, and the rest of the day will be devoted to the presentation of technical papers. In the evening all delegates and guests will be invited to a special banquet, hosted by Ningxia Non-ferrous Metals Smelter and the Non-ferrous Metals Society of China.

Papers will focus on the tantalum and niobium industry in China, including raw materials, capacitors, hardmetals, hydrometallurgy, and the niobium industry; these papers will be prepared and presented by Chinese authors. The T.I.C. Technical Adviser will review the industry in general, and the programme will be completed by papers on other aspects of the industry in Asia. The sessions will be in English throughout.

On Tuesday October 7th a tour of the plant of Ningxia Non-ferrous Metals Smelter in Shizuishan City is being organised: a chartered aircraft will carry the group from Xian to Yinchuan, from the airport at Yinchuan buses will transport the participants to the factory. Our hosts will offer lunch to the travellers, and they are making every effort to provide a useful and informative tour of the facility.

Sightseeing tours for those accompanying the meeting participants will be arranged for Monday and Tuesday, and on Wednesday there will be an opportunity for the delegates who have taken the plant tour to make a visit to the museum of the Terra Cotta Warriors, the most remarkable monument of Xian. The splendid army of soldiers, with their weapons, horses and chariots, buried in the tomb of Emperor Qin Shi Huangdi more than 2000 years ago, was discovered by chance in 1974, and has been included in the Unesco World Heritage List.

Special arrangements are being made to help participants with their travel bookings within China. Pre-registrations and hotel reservations for the event are to be made only through the T.I.C.

The nominated delegates of T.I.C. member companies, and those who have already contacted the secretariat, have already (by the end of May) been sent invitations to pre-register for this conference. Anyone else interested should make themselves known as soon as possible, to the Secretary General, T.I.C., rue Washington 40, 1050 Brussels, Belgium; telephone +32.2.649.51.58, fax +32.2.649.64.47.

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IBM TANTALUM CAPACITOR USAGE

by Mr P.Y. Martin, IBM Component Procurement Council, given at the T.I.C. meeting in October 1996 (condensed)

IBM NETWORK COMPUTING

In this paper, IBM would like to provide an inside look at Network Centric Computing. It is part of an evolution from centralized mainframes to decentralized PCs to distributed client/servers. Client/servers will be the leading edge of the next phase. Network computing is a form of computing in which applications and data are placed in the network, allowing companies to be connected with their customers, suppliers and business partners. It will allow individuals at home, work, or school to share all forms of information on interconnected networks. It will allow businesses, governments and educational institutions to reach new markets, offer new services, and lower their costs. It is the convergence of two powerful forces: customer needs and advanced network technology.

The model consists of Services, Applications, Platforms, Networks, and Products, all of which can be provided by IBM. These Products include hardware which employs the use of tantalum capacitors: this presentation describes the usage of tantalum capacitors in IBM.

1996 IBM CAPACITOR PURCHASES, TECHNOLOGIES

Ceramics account for the majority of the capacitors consumed by IBM. Tantalum capacitors account for approximately 40% of the capacitor dollars spent.

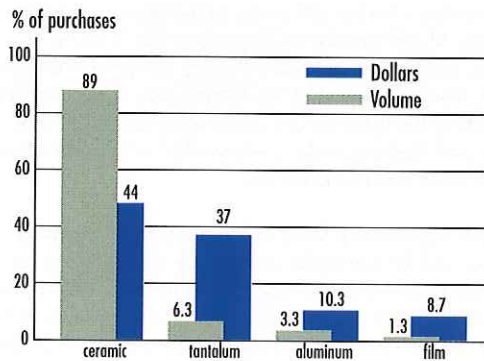


Figure 1 : 1996 IBM Capacitor Purchases, Technologies (\$ vs volume)

1996 TANTALUM USAGE PROFILE, SMT VERSUS PTH

SMT (Surface Mount Technology) tantalums are used extensively, but IBM still has requirements for PTH. Some large high end-products use PTH circuit boards. It is not cost effective to design PTH out at this point.

Volume is split 60/40 between non-fused and fused tantalum capacitors. Dollars spent are inversely proportional due to the higher cost of fused components. There is an effort under way to control the usage of fused capacitors. This will be described later. A fused tantalum SMT capacitor allows the capacitor to fail open when current levels reach the actuation point of the fusing element, thereby eliminating the short circuit failure mode identified with a non-fused tantalum SMT capacitor.

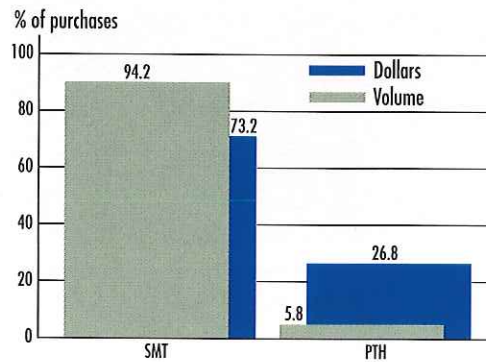


Figure 2 : 1996 Tantalum Usage Profile (fused versus non-fused)

1996 TANTALUM USAGE PROFILE, VOLTAGE RATINGS

Predominant voltage rating is 16 volts with 10V and 20V following. Voltage derating 2x to 3x is common. For example, a 16 volt capacitor is used in a 5V application.

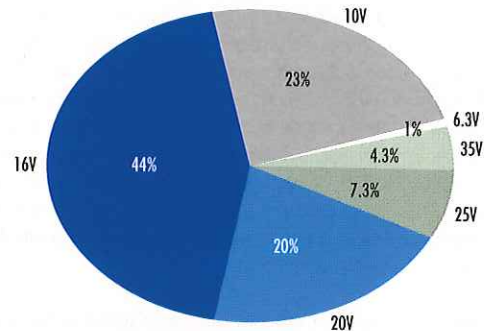


Figure 3 : 1996 Tantalum Usage Profile (voltage ratings)

1996 TANTALUM USAGE PROFILE, CASE SIZES

IBM uses a wide variety of the case sizes available to the industry. There has not yet been a need in IBM for case sizes smaller than A, space constraints have not reached those of a pager. Our predominant size is D case with A and C following.

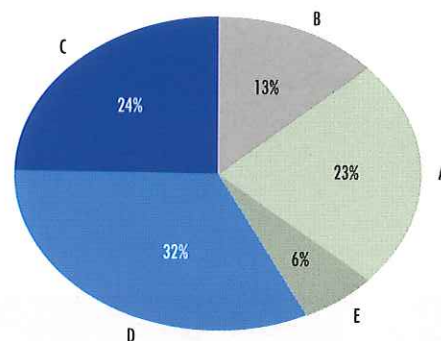


Figure 4 : 1996 Tantalum Usage Profile (case sizes)

IBM TANTALUM CAPACITOR APPLICATIONS

The predominant application is in a decoupling function. Tantalums are used throughout the IBM product lines.

Voltage derating is a common practice. The amount of derating often depends on supplier recommendations, and on the application itself. Voltage derating is employed to improve the intrinsic reliability of the device. Tantalum capacitors also replace aluminum capacitors when this is dictated by the card manufacturing conditions. Tantalum capacitors are often more robust.

PC Products

Part count estimates

	Ceramic	Tantalum	Aluminum
Mobiles	300	30	10
Servers	300	125	30
Desktops	320	30	30

Common values

100 μ F	10V	D case
47 μ F	10V	D case
22 μ F	16V	D case
10 μ F	16V	B case
4.7 μ F	10V	A case

Aluminum radials used for bulk decoupling (cost)

Figure 5 : IBM Tantalum Capacitor Applications

Ceramics have by far the highest part count in typical PC products. This is due to cost, size and versatility (Fig. 5). Some of the extensively used CV (capacitor-voltage) values in our PCs are shown in the table. Aluminum radials are used extensively for bulk decoupling. They are PTH devices that are used instead of SMT tantalums. SMT tantalums would be the preferred choice, but are not cost effective at this point.

IBM TANTALUM CAPACITOR TRENDS, VOLUME - SMT

Volumes have been increasing over the past several years. This is due to advances in case size reduction, the increased need of SMT components and improvements in quality and reliability.

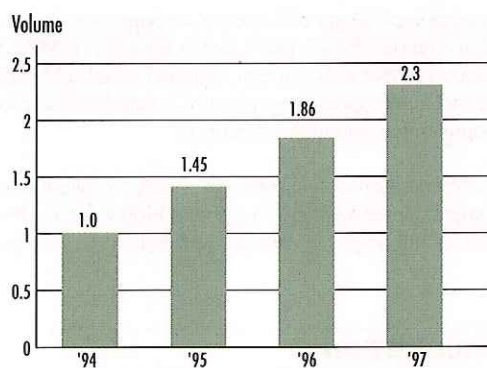


Figure 6 : IBM Tantalum Capacitor Trends (volume - SMT)

IBM TANTALUM CAPACITOR TRENDS, VOLUME - SMT FUSED VS. NON-FUSED

Overall tantalum volumes have increased, although the increase in the usage of fused capacitors has been kept relatively flat. This can be seen from the growing delta per year between fused and non-fused usage (Fig. 7). Although fused tantalums

are items found in supplier catalogues, IBM most probably consumes the bulk of this product. In an effort to increase supply flexibility and increase our usage of components that are generally available to the industry we are reviewing our needs for fused tantalums. This is an ongoing, case by case review of applications to determine the need for fused tantalums. Candidates which do not benefit from a fused tantalum are shown below. IBM must ensure that reliability and safety are not compromised by the migration (Fig. 8).

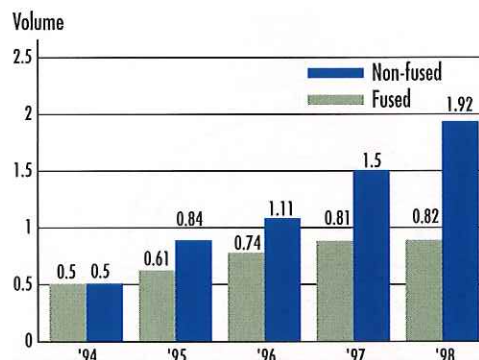


Figure 7 : IBM Tantalum Capacitor Trends (volume - SMT fused vs. non-fused)

WHY THE MIGRATION?

- Improved supply flexibility
- Improved cost competitiveness
- Increased usage of industry standard components

APPLICATIONS SELECTED

- Low voltage/low current
- High impedance circuits
- Actuation conditions not achievable
- Alternate circuit protection available
- No compromise on safety/reliability

Figure 8 : IBM Tantalum Capacitor Trends (fused to non-fused)

IBM TANTALUM CAPACITOR TRENDS, REQUIREMENTS

Demand for smaller case sizes is on the rise, however, IBM also maintains a strong need for the larger case sizes to cover our various product requirements.

Growth in usage of low ESR tantalums is expected. New developments in volumetric efficiency will be needed. SMT usage will increase over PTH. Reverse polarity will continue to be a concern to manufacturing sites. Reverse mounted components fail, causing damage to the card assembly. Tantalum must become cost competitive per CV with ceramic and aluminum technologies.

Reliability and quality of tantalums have improved dramatically over the years. There was, however, a painful learning curve for customers and suppliers. We are at a point where our major suppliers are shipping excellent quality levels. This attention to quality needs to be maintained. Attention to environment-friendly manufacturing processes and materials is also a key point.

TECHNOLOGY COMPETITION

Although there is potential for growth in the tantalum market, it is critical that the competition from ceramic and aluminum is respected. Both ceramics and aluminums have encroached on the tantalum market: ceramics are continually improving dielectrics, aluminums are improving ESR: both can offer cost advantages and they have the potential to take market share from tantalum.

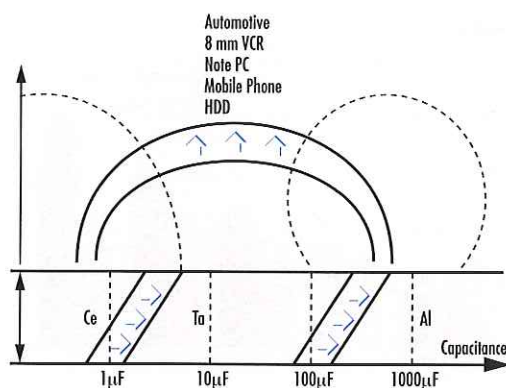


Figure 9 : Technology Competition

There are several factors which influence growth or shrinkage of the market. Supply instability or constraints result in double ordering by consumers, with the consequence that capacity is destabilized, causing a downward spiral effect. When pricing is erratic, an abnormal cost trend is created.

These factors send 'shock waves' to the community which uses the capacitors and forces the users to find alternative technology solutions. Those users are unlikely to return to tantalum once an alternative has been found.

IBM TANTALUM CAPACITOR USAGE: CONCLUSION

- Tantalum capacitors are used throughout the entire IBM product line. IBM Network Computing requires cost effective hardware.
- Volumes of usage of tantalum capacitors are projected to be on the rise. Again, this increase is contingent upon cost competitiveness and availability of supply.
- Cost will be a priority across all capacitor technologies.
- IBM's focus remains on Cost, Quality, Innovation, and Service.

NEW DESIGN OF TANTALUM CAPACITOR

New design of tantalum capacitor which allows small size down to 0603 with high volume efficiency

by Ian Salisbury, AVX, Paignton TQ4 7ER, England,
presented at the T.I.C. meeting in October 1996

ABSTRACT

This paper reports on how AVX has responded to the market needs for high capacitance in small body size by developing a surface mount type of tantalum capacitor which has high capacitance volumetric efficiency, with body size down to 0603 size.

INTRODUCTION

The demand for high component packing density on printed circuit boards in electronic equipment is driven by four factors:

- small equipment size, this is demonstrated by the mobile phone industry, personal computers, cameras, hearing aids and mobile office equipment;
- increased functionality, which requires an increase in electronic circuit packing density;
- smaller PCB and smaller equipment case size reduce manufacturing costs;
- higher circuit speeds which require short path lengths between components, to reduce inductance and resistance.

The capacitor industry is driven by customer demand, the change in surface mount in the 1980's required component manufacturers to replace wires with lead frames.

The tantalum capacitor industry responded by changing the packing and terminations configuration, the design within the component remained the same. However, in the late 1980's circuit technology demanded lower voltage working and higher capacitance: this required development of new tantalum powders with high surface area to increase the capacitance, and development of high purity powders and new dielectric formation methods to reduce electrical leakage currents.

The mechanical design of the tantalum capacitor element had remained unchanged for 25 years, but in the early 1990's it became apparent that only a major change in the build construction of the tantalum capacitor would give a significant improvement in capacitance volumetric efficiency.

AVX embarked on a total redesign concept to allow small tantalum capacitors to be manufactured in high volume, down to sizes of 0603, with high capacitance and high frequency performance.

DESIGN DISCUSSION

Present design/construction of the anode element is to press tantalum powder into a pellet, insert a wire into one end of the pellet and sinter at high temperature. The sinter operation welds the wire to the tantalum powder within the anode element.

The reason why this wire has remained a design feature for the last 25 years is that it is an integral part of the manufacturing process, it allows many anode elements to be attached to a support bar by the wire, thus allowing the anode element to be submerged into the electrolyte for dielectric formation, with the electrical energy applied through the support bar.

This process is repeated by dipping into manganese solution for the formation of the cathode, then subsequently dipping into the carbon and silver conductive resins, which form the cathode connections. To design this wire out would mean a total change in the manufacturing equipment.

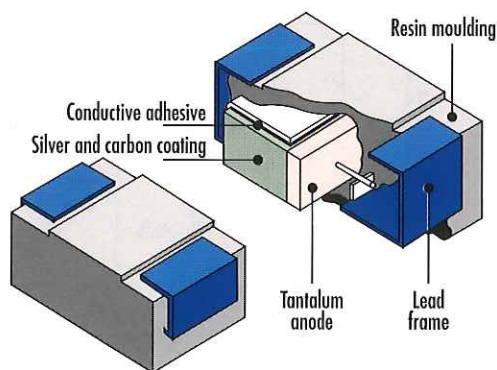


Figure 1 : Mechanical construction of a tantalum capacitor

It can be seen from Figure 1 that a large volume of the capacitor package is devoted to the wire connection and lead frame assembly: in the case of a 0805 size capacitor, 50% of the volume is taken up by the wire connection concept. Also the lead frame is an inductive loop which increases inductance.

The customer requirement is for the area of the PCB occupied by the component to be as small as possible, this requires a small footprint size, as well as a small component. The present design of, for example, a ceramic 0603 would have five metallised faces at each end, the international PCB footprint mounting pad would occupy a board area of the component of the next size up.

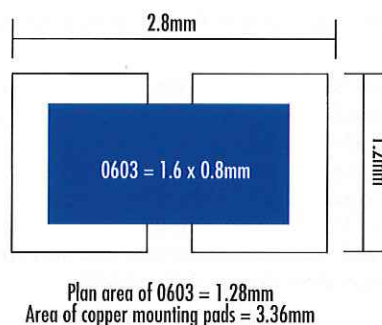


Figure 2 : Copper land area footprint for 0603 chip ceramic, based on IPC-SM-782 publication.
The pad area is 2.625 times the area of the 0603 device

If the dimensional body size tolerance is large, this means that the footprint also has to allow the increase in tolerance, which increases the footprint size, which therefore occupies a larger area of PCB.

The aim of the redesign was therefore to design a small body capacitor down to 0603 size, with a very tight tolerance on dimensions which only required a small area of PCB, and should be suitable for mounting by solder reflow.

CAPACITOR DESIGN

The first task was to look at the footprint size: the conventional ceramic capacitor has five faces on each end for solder attachment, this means that a footprint has to extend either side of the capacitor in both length and width.

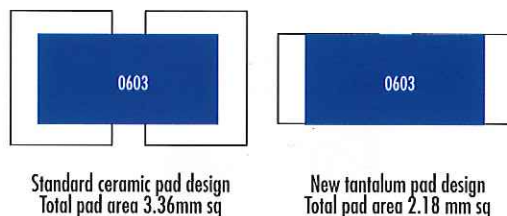


Figure 3 : Printed circuit board pad area comparison for a 0603 capacitor.
A saving of 35% PCB area

By designing the capacitor with only end face metallisation for soldering, the footprint could be significantly reduced in width (see Figure 3) to the size of the capacitor body, and, with no solder on the side faces, the body size can be increased without going outside the accepted category size.

Maintaining a very tight tolerance on the width allows maximum tantalum anode size to be fitted into the body size, giving an increase in capacitance volumetric efficiency.

The next step was to redesign the tantalum anode assembly, removing the wire connection from the anode, also removing the lead frame.

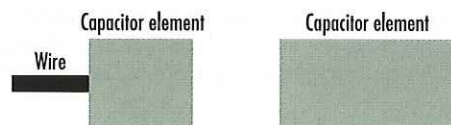


Figure 4 : Capacitor element design change:
replacing the wire with an end plate
increases the volume of the anode

Figure 4 shows the concept of increasing anode size by removing the wire and lead frame. The wire is replaced with a tantalum plate bonded to the total end face of the enlarged capacitor element. In the case of the 0805 capacitor this increased the anode size by a factor of two, with the additional increase in width this increased the total anode size.

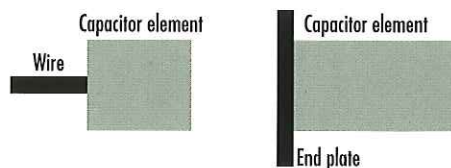


Figure 5 : Capacitor element design change:
replacing the wire with an end plate
increases the volume of the anode

The next step was to add the cathode termination plate: this is bonded to the end face of the silver coated anode assembly, the bonding material had to be electrically conductive, as well as mechanically stress absorbent. This is necessary to compensate for the difference in temperature coefficient of expansion between the tantalum anode and the PCB, during the solder mounting of the capacitor to the PCB, and for operational life.

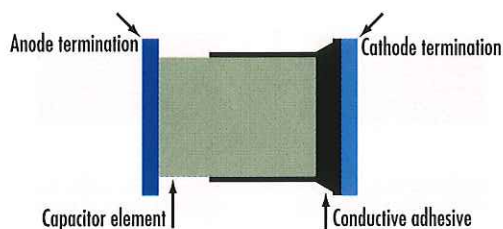


Figure 6 : Capacitor element cathode termination

The capacitor element had to have protection against solder and flux, so a thin resin encapsulation coat which incorporated a polarity band was added.

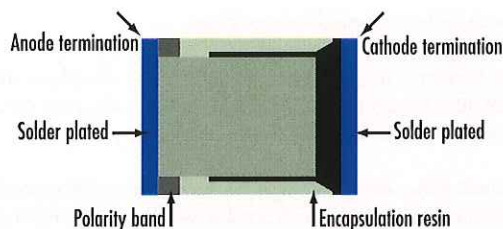


Figure 7 : Encapsulated chip tantalum capacitor

Comparison of the old and new construction methods shows that the anode volume has increased considerably. This construction also allows capacitors to be manufactured down to 0603 size.

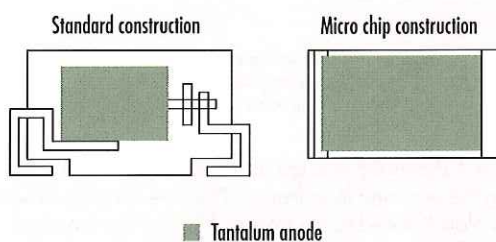


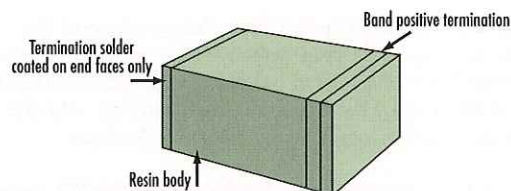
Figure 8 : Tantalum capacitor: micro chip physical construction compared to standard

CAPACITOR PERFORMANCE INFORMATION

Typical range of the new style micro chip tantalum capacitors:

Capacitance μF	Rated voltage d.c.			
	3V	4V	6.3V	10V
0.47				0603
0.68				0603
1.0			0603	
1.5		0603		
2.2	0603			
3.3				0805
4.7				0805
6.8			0805	
10		0805		
15	0805			
22				

Table 1 : Micro chip tantalum capacitor
Capacitance range/rated voltage



Size of footprint	Dimensions in mm		
	Length	Width	Height
0805	2.00 \pm 0.15	1.35 \pm 0.1	1.35 \pm 0.1
0603	1.6 \pm 0.10	0.85 \pm 0.10	0.85 \pm 0.10

Table 2 : Size outline for the tantalum micro chip capacitor

The physical size has tight tolerance which is inherent in the capacitor manufacturing process. Each capacitor, after encapsulation and solder terminating, is accurately profiled to size using precision cutting techniques; this ensures very close tolerances on the finished capacitor and perfect coplanar alignment of the end terminations. The very symmetrical outline which is eminently suitable for pick and place equipment, and the improved mounting pad design allow close packing densities.

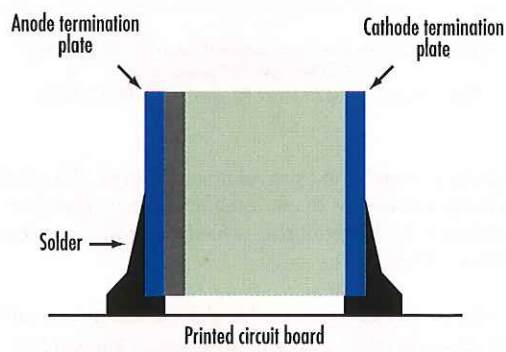


Figure 9 : Capacitor element cathode termination

The positive and negative terminations are thin metal plates, as this capacitor design only uses the end faces for soldering, the use of a solder plated metal plate ensures very high adhesion strengths between the PCB and the capacitor termination. Had

conductive resin or conductive glass frit materials been used, dimensional tolerance would have been much larger and adhesion strengths more difficult on an end face connection.

Comparison of ceramic capacitor technology (Y5V) and present tantalum capacitor technology shows that the new design of micro chip tantalum capacitor has an improved capacitance/volumetric efficiency, as well as retaining improved stability with temperature and applied voltage.

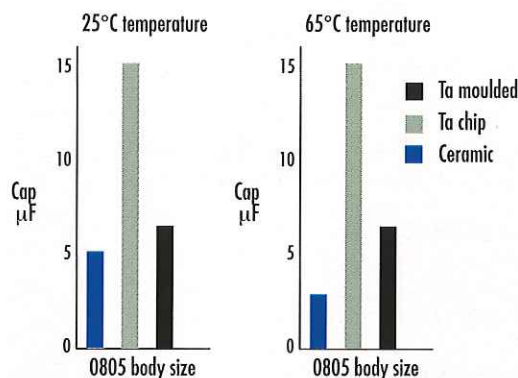


Figure 10 : 0805 micro chip tantalum capacitor: capacitance range against ceramic for 3 volt rating

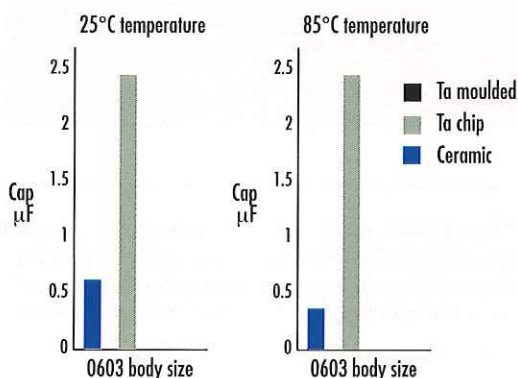


Figure 11 : 0603 micro chip tantalum capacitor: capacitance range against ceramic for 3 volt rating d.c.

Figures 12 and 13 show a comparison of capacitance stability against temperature and applied voltage.

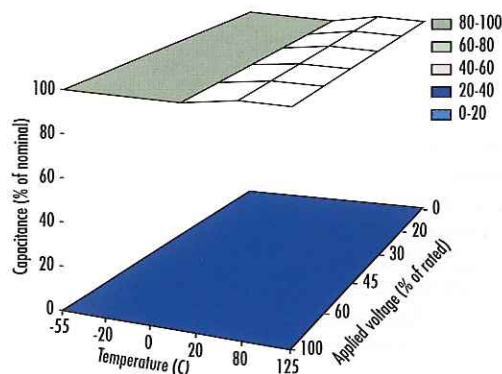


Figure 12 : Tantalum stability

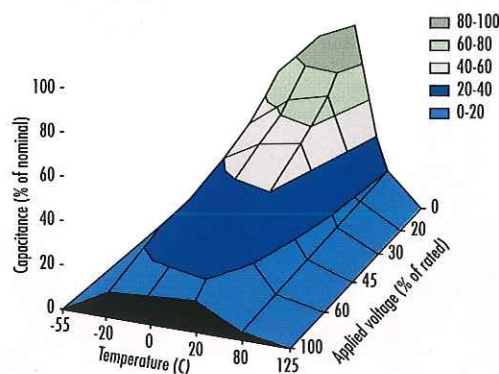


Figure 13 : Ceramic stability

CONCLUSIONS

The new design uses the same tantalum technology as the conventional tantalum capacitor, therefore it exhibits the same excellent reliability and temperature stability as the standard products.

Ceramic capacitors using Y5V dielectric can reduce capacitance by 80% when 100% of rated voltage is applied. Tantalum is not sensitive to working voltage, and therefore has excellent stability in circuit applications where voltage changes occur.

Ceramic capacitors using Y5V dielectric can reduce in capacitance by 50% when heated to 85°C. Tantalum increases in capacitance by 5% when heated to 85°C, has excellent stability against temperature change.

Small capacitor size down to 0603 in tantalum technology can now be realised, with high capacitance volumetric efficiency.

Due to the construction design, high frequency performance is assured, by virtue of low inductance design.

By using only end termination soldering, the capacitor uses a much smaller PCB area.

SYMPOSIUM PROCEEDINGS

The proceedings of the International Symposium held in Goslar in September 1995 are available from the T.I.C. \$150 including postage and packing.

LUNCHEON



Mr. Yeap Soon Sit, President of T.I.C., invited during a recent stay in New York City four past presidents of T.I.C. who live in the New York area to a private luncheon. From left H. Hutton, J.C. Abeles, Yeap S.S., G.J. Korinek and H. Becker-Fluegel. Judging from the smiling faces, the luncheon was a great success.

MEMBER COMPANY NEWS

Metallurg

Metallurg, Inc. successfully completes its operational and financial restructuring

Metallurg, Inc., a member of T.I.C., announced in April that it had successfully completed its operational and financial reorganization and that both it and the company's principal U.S. subsidiary Shieldalloy Metallurgical Corporation (SMC) have emerged from the court protection they sought in September 1993 under Chapter 11 of the U.S. Bankruptcy Code.

On the company's Board of Directors, incumbent members Michael Standen and Alan Ewart, of London and Scandinavian Metallurgical, have been joined by representatives of three of the company's major investors: Peter Langerman, of Franklin Mutual Series Fund, Inc., Jon Bauer, of Contrarian Capital Management LLC, and Herbert Self, of SBC Capital Markets, Inc.

Founded in 1911, Metallurg employs approximately 1700 people worldwide, including about 300 in the United States.

Siemens Matsushita

Siemens Matsushita has announced that it is expanding its manufacturing capacity for tantalum chip capacitors by building a new factory in Evora, Portugal. The foundation stone has been laid, and production should be established by the end of 1998 : a volume of 740 million capacitors annually is planned, while full scale production of tantalum chip capacitors continues in Heidenheim.

Lydenburg Exploration

Modification of address :
Suite 210, Postnet Parktown,
X30500, Houghton, 2041, South Africa.

Metallurg

Change of address :
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6 East 43rd Street, 12th Fl.,
New York, NY 10017, U.S.A.
Telephone : +1 212 835 0200
Telex : +23 420358
Fax : +1 212 687 9623

Mr David Henderson has taken the place of
Mr Robin Brumwell as the nominated delegate.

King Metallurgical

Modification of address :
69 Jiefang Road (E),
Changsha, Hunan, China

H.C. Starck (Thailand)

Dr Jürgen Bonjer, President, is now the nominated
delegate in place of Mr Yoot Eamsa-Ard.

Gwalia

Please note these modified contact numbers for
Gwalia Consolidated:
Telephone : +61 8 9263 5555
Fax (marketing) : +61 8 9481 5133
Fax (general) : +61 8 9481 1271

Mr Chuck Hanna, retired V.P. of Kennametal Inc., passed away in March 1997. Mr Hanna was well known in the cemented carbide industry and represented Kennametal Inc. as a voting delegate in T.I.C. for a number of years.

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