

ENGINEERING PRACTICE STUDY

TITLE: HIGH TEMPERATURE SOLDERS IN LEADED CERAMIC CAPACITORS

19 AUGUST 2008

PROJECT NUMBER 5910-2008-018

FINAL REPORT

Study conducted by John A. Bonitatibus
Electronics Engineer
Electronics Component Team
DSCC-VAT

Prepared by:

//Signed//

John A. Bonitatibus
Electronics Engineer
Electronics Components Team

Approved by:

//Signed//

Michael A. Radecki
Chief
Electronics Components Team

OBJECTIVE

This engineering practice study was conducted to determine if lead (Pb)-free solders are being used in the manufacture of military leaded ceramic capacitors, and if so, what actions should be taken.

BACKGROUND

Military specifications for leaded ceramic capacitors include:

MIL-PRF-20
MIL-PRF-39014

MIL-PRF-81
MIL-PRF-49467

MIL-PRF-123
MIL-PRF-49470

MIL-C-11015

The military specifications listed above include a prohibition on the use of pure tin both internally and externally. DSCC's approved current wording for prohibiting the use of pure tin is as follows:

3.X Pure tin. The use of pure tin, as an underplate or final finish, is prohibited both internally and externally. Tin content of capacitor components and solder shall not exceed 97 percent by mass. Tin shall be alloyed with a minimum of 3 percent lead, by mass (see 6.X).

(Note: Of the specifications listed above, only [MIL-PRF-123](#) and [MIL-PRF-81](#) contain DSCC's **current** pure tin prohibition in its entirety. However, the remaining specifications will be updated with the above language in future specification actions.)

This prohibition statement has evolved slowly over time from a simple pure tin prohibition on the lead finish to language which includes undercoating, internal components, hardware, and finally solder.

The proper design of many components, including leaded ceramic capacitors, requires the use of high temperature solders at specific locations. In fact, [MIL-PRF-123](#) has a stated requirement for the use of high temperature solder for lead attachment. High temperature solders available include those that have a high lead content and some that are lead-free, such as tin silver (SnAg). The designs of these capacitors and the solder used have been in place for many years, perhaps decades; longer than the initial introduction of the pure tin prohibition and certainly longer than the inclusion of "solder" into this prohibition.

A conflict exists between DSCC's current pure tin prohibition and the use of lead-free high temperature solders. The pure tin prohibition requires that tin be alloyed with a minimum of 3 percent lead. In effect, this prohibits the use of a SnAg high temperature solder. This conflict was brought to DSCC's attention with the DPA failure of some [MIL-PRF-39003](#) capacitors. The SnAg high temperature solder used did not meet the tin-lead alloy requirement.

The QPL suppliers to the above specifications were surveyed regarding the high temperature solder used in their QPL product.

RESULTS

The survey of the QPL leaded ceramic capacitor manufacturers revealed that at least one manufacturer is using a lead-free high temperature solder. This manufacturer stated that they have had no known failures with regard to the high temperature solder used.

RECOMMENDATION

It is not DSCC's intent to place restrictions on proven designs of QPL product using SnAg high temperature solder. In order to accommodate SnAg high temperature solder, language needs to be incorporated into the specifications to allow its use with the approval of the qualifying activity. The language should include the requirement that the tin content of the high temperature solder not exceed 97 percent.