

Development of aerospace fuses

SCHURTER and ESA cooperation

Many years of intensive cooperation in research and development between SCHURTER and the European Space Agency (ESA) has led to the incorporation of new technologies and products for protecting electronic modules in aerospace applications.



Figure 1) Space Application (Source: ESA)

History

In 2004 SCHURTER was asked by the European Space, Research and Technology Center (ESTEC), a sub-organization of the European Space Agency (ESA), to participate in a development cooperation [1] to manufacture midget fuses for use in aerospace. During a four-year evaluation phase, first the requirements and potential solutions were developed, which culminated in a generic specification for the qualification, production and delivery of fuses [2]. The subsequent research and development cooperation [5] reached its high point in the MGA-S fuse being listed as an ESA-qualified product. SCHURTER documented the general requirements for an aerospace fuse in a White Paper [7]; the detailed specification [3] for the MGA-S [4] is noted in a data sheet. Since 2008 SCHURTER has produced MGA-S fuses according to the agreed upon product requirements [3]. Each individual aerospace fuse undergoes a screening test. At the same time, all measurement values are recorded and handed over in batch documentation along with the delivery to the customer. During requalification processes, that take place every two years, compliance of all technical production measures is checked by the ESA using clearly defined qualification criteria.

Further development of the technical approaches

Parallel to the series production of the MGA-S, a second phase of the cooperation between SCHURTER and the ESA was started in 2010, in which a solution for the protection of rated currents up to 15 A was to be developed. To this end, an evaluation phase began during

which potential variation of designs, particular the most risky as identified, were investigated. This second phase was an integral part of the cooperation and only approachable because of the positive experience from the first phase.

Parallel Circuit of MGA-S

Basically a higher rated current can be achieved through the parallel circuit of selected MGA-S fuses with the same cold resistance. Products [6] that have already been qualified can be used for this purpose. Electrical and thermal analyses of this approach were not only designed in a theoretical model at SCHURTER, but also measured in experimental set-ups. After extensive testing, however, this approach has some disadvantages. This is due to the increased space requirements for the parallel circuit fuses, as well as a negative impact on the Meantime Between Failure (MTBF).

Increase in the rated current using MGA-S technology

Based on a specification between SCHURTER and the ESA, the rated current range of 5 A to a 15 A, with a voltage of 125 VDC at a breaking capacity of 1000 A, was increased in a further experimental set-up. The mechanical dimensions had to be adjusted accordingly in order to absorb the energy during the high breaking test. With regard to the assembly, the ESA expected compatibility with existing solutions being used, meaning: the solder pads of the new solution had to fit the same connection geometries of the circuit board that had been defined already for the existing product.

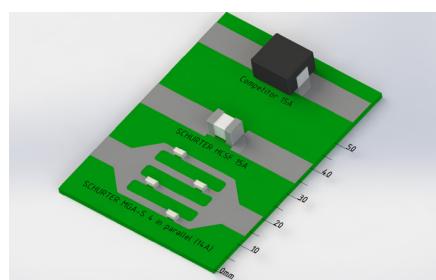


Figure 2) Size comparison of the new fuse with that of the existing product

This led to a solution using thin film technology, whereby a so-called sputter applies a metal layer of an exactly defined thickness in the micron range to a glass substrate material. Similar to the MGA-S, the device protecting the line is enclosed by a ceramic housing (Figure 2), which guarantees the stability necessary for the corresponding operational scenarios in the Too important to fail range.

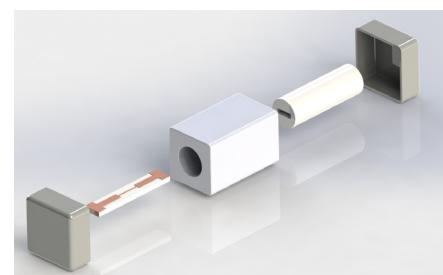


Figure 3) HCSF design study

As an alternative to the thin film technology, which uses the metal sputter process, the application of LIGA technology (stands for: lithography, electroplating, and molding process steps) on established substrate materials of the circuit board industry was also tested during the evaluation phase. The advantages and disadvantages during the evaluation focused on the reliability and long-term stability factors. For example, the carbon compounds generated during combustion were assessed as not sufficiently reliable because of their undefined conductance value.

Accordingly, various models to simulate the change in the cold resistance, the drop in voltage and the change in the temperature-dependent current/time characteristics were developed here for the different potential designs. These models were verified using manufactured and measured prototypes.

Detail specification of the high current fuse for aerospace applications

The evaluation of the tested approaches carried out jointly with the ESA has shown that the technical solution for the MGA-S also corresponds to that of the future high current fuse for aerospace applications, in short:

HCSF (High Current Space Fuse) [9]. As a result – proceeding from the general specification for fuses [2] – the new detailed specification for the HCSF fuse [8] was developed, and so its qualification also initiated.

SCHURTER aims now to have the HCSF fuse qualified according to the ESA/ESCC 2015 listing requirements, and then proceed to series production with the recently developed product, same as its successor MGA-S.



Figure 4) Cold resistance measurement of HCSF fuses

Safer solutions for higher rated currents

Currently, the aerospace fuses are being used to protect redundant systems against short-circuits in satellites, or they can be used individually to switch off and allow backup systems to take over function. Also, communication systems are specifically switched on and off, for example to send data packets at a specific time. Each of these switching actions typically cause high pulse loads when connected, which have to be handled by the fuses, without tripping and without affecting their long-term disconnect behavior. Because of the high performance requirements, two to four MGA-S fuses are needed in parallel at present. However, this is inconvenient because of the spatial constraints; furthermore, long-term reliability is reduced because of the many placed components. Therefore, the ESA is interested in a solution with only a single component.

A concentration of the line cross-section in one location offers a more stable behaviour than would be the case with the MGA-S distributed to 2 to 4 locations. Furthermore, it has been shown that other solutions offer suitable options for higher rated currents, which are not only used within one circuit, but also can protect complete power bus systems. Therefore, a pin-compatible product is preferable compared to a parallel switching of

MGA-S. With the MGA-S solutions for circuit protection, and the new HCSF solution, systems comprised of several modules can also be protected. For example, redundantly designed communication systems can be protected completely with SCHURTER fuses.

Conclusion: a qualified supplier of high-tech solutions

The cooperation between the ESA and SCHURTER has created two outstanding products with the MGA-S and the HCSF. As a result, to date SCHURTER has been the sole European supplier of qualified fuses by the ESA [10]. Accordingly, SCHURTER has provided an impressive demonstration of the necessary technologies during both development and production. We are proud of the products that have been qualified by ESA and are ready to provide competent solutions to similar circuit protection challenges identified in the area of aerospace, and other applications requiring specialized circuit protection.

We are also using our broad-based expertise and the current aerospace technologies for our customers in the industrial sector, for example, when carrying out other specialized qualification processes. We welcome the opportunity to find the optimal made-by-SCHURTER solution together with you.



"The professional cooperation with SCHURTER not only produced a pioneering specification for the qualification of fuses for aerospace – it was furthermore a real pleasure. Besides the exceptional technological competence, the staff involved created a very congenial working atmosphere." - Denis Lacombe (ESTEC/ESA)

Offering

SCHURTER offers following two fuse families for Space applications:

- MGA-S [4], Qualified in 2008 [3] for a current range from 0.14 to 3.5 A @125 VDC
- HCSF [9], Qualified in 2015 [8] for a current range from 5 to 15 A @125 VDC

References

- [1] Cooperation Agreement
- [2] ESCC Generic Specification No. 4008
- [3] ESCC Detail Specification No. 4008/001
- [4] MGA-S Data Sheet
- [5] MGA-S History of Success
- [6] Qualified manufacturer according to ESCC specifications
- [7] White Paper, Fuse for the Aerospace Industry
- [8] ESCC Detail Specification No. 4008/002
- [9] HCSF Data Sheet
- [10] Certificate of Qualification



Headquarters in Lucerne

Company

SCHURTER continues to be a progressive innovator and manufacturer of electronic and electrical components worldwide. Our products ensure safe and clean supply of power, while making equipment easy to use. We offer a broad range of standard products including circuit protection, connectors, EMC products, switches and input systems, as well as electronic manufacturing services. Moreover, SCHURTER is ready to work with our customers to meet their application specific requirements, not covered in our standard range. You can rely on SCHURTER's global network of companies and partners to guarantee a high level of local service and product delivery.

Headquarters

Division Components
SCHURTER Group

SCHURTER AG
Werkhofstrasse 8-12
PO Box
6002 Lucerne
Switzerland
schurter.com

Contact

Asia-Pacific
T +65 6291 2111
info@schurter.com.sg

Europe (Headquarters)
T +41 41 369 31 11
contact@schurter.ch

USA
T +1 707 636 3000
info@schurterinc.com