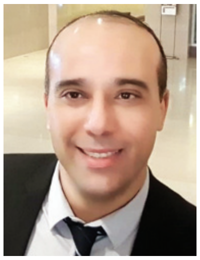
AMINE DHIA



A guide to using EPIC/MEPIC igniters in pyrotechnic applications

Introduction

The markets for pyrotechnic applications such as detonators and initiators require ever-higher levels of performance, reliability, and safety. These days, the bridge wire (BW) is the leading technology in a wide range of industries, including mining (rock fragmentation), automotive (airbags and seatbelt pre-tensioners), demolition (tunneling and building), military (missile destruction), and special effects (fireworks and movies). Although BW technology provides good performance to cost ratio it requires specific detonator/initiator designs in which the header and the wire always have to be adapted to one another. In order to offer design and process alternatives, Vishay has developed surface-mount (SMD) solutions which performance is not dependent on the header: the EPIC and MEPIC Ignitors series. Furthermore, these SMD solutions enable manufacturers to build a productive assembly process based on standard state of the art equipment (pick and place from reel packaging, reflow soldering, and post cleaning).

Pyrotechnic applications requirements

The generic concept is to apply an energetic (pyrotechnic) material in close contact with the heating zone of the EPIC/MEPIC, called the active area. Upon different electrical solicitations (from capacitive discharge or direct current pulse), the energy provided to the EPIC/MEPIC will be either fully thermally transferred to this primer pyrotechnic material or sufficiently dissipated through the substrate.

EPIC and MEPIC manufacturing and technologies

The SMD components EPIC and MEPIC are manufactured according to 2 different technologies as follows.

- EPIC – Case size 0603

  Materials: Alumina substrate – Tantalum Nitride resistive layer (Fig.1)
- MEPIC – Case size 0805

  Materials: Epoxy based FR4 substrate– NiCr resistive layer on adhesive (Fig.2)

Mr. Amine Dhia, Senior Manager Product Marketing, Thin Film & Igniters, Vishay Sfernice Division, France.

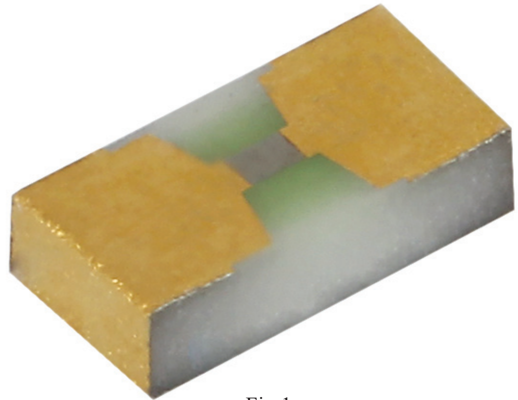


Fig.1

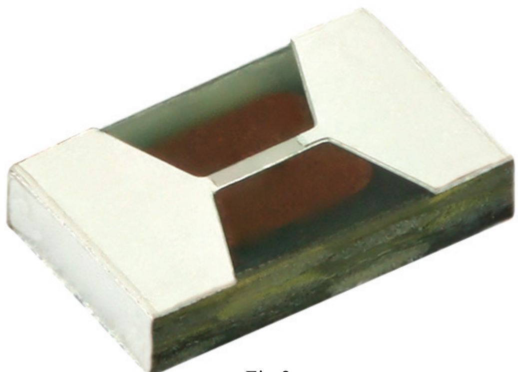


Fig.2

For both EPIC and MEPIC technologies the active area will be designed according to customer requirements and Vishay's knowhow, in order to provide the appropriate "Volume" of the active area.

Reflow soldering assembly

EPIC and MEPIC being SMD products, they are more often reflow soldered on flat PCBs using standard reflow processes for assembly. In addition to providing a good electrical contact, the assembly must take extreme care in insuring that the active areas of EPIC and MEPIC resistors remain clean from flux residues from solder paste to provide intimate contact with the pyrotechnic material. In combination with the use of standard land patterns, the EPIC and MEPIC series have specific constructions and architecture that will strongly minimize the presence of flux at the active area and optimize heat transfer process. Nevertheless, post cleaning must be performed in good conditions in order to not generate any pollution that could be redeposited on the active area.

As the resistance value is fully dependent on the active area dimensions being part of the global package size (0603 for EPIC and 0805 for MEPIC), the PCB will not need any design adjustment and so, the standard land patterns will be used whatever the EPIC or MEPIC intended ignition performances.

Pyrotechnic materials

The pyrotechnic materials are chosen by the customer.

In this document we will only speak about the primary pyrotechnic material (primer), which is in direct contact with the active area of EPIC/MEPIC resistors and, initiates the explosion. The heat provided by EPIC/MEPIC devices, when submitted to an electrical solicitation, will provide a sufficient temperature rise to make the primer explode. Following this first-stage explosion, a secondary-stage explosion will be initiated by the heat generated from the first and, will create the final explosion (inducing shock wave for detonators or gas generation for airbags).

The customer process for the primer pyrotechnic material can be in a lacquer form (applied by dispensing or by dipping) for the so-called “wet process” or, in a powder form to be compressed on the active area for the so-called “dry process”.

The major characteristic of a primer pyrotechnic material is its auto-ignition temperature. The most commonly used family of primers are listed in Table 1.

TABLE 1

Primer code	Primer name	Ignition temperature
PETN	Pentaerythritol tetranitrate	≈190°C
KDNBF	Potassium dinitrobenzofuroxane	≈210°C
$BKNO_3$	Boron potassium nitrate	≈210°C
ZPP	Zirconium potassium perchlorate	≈400°C

Despite the chemical nature of the primer, it is important to consider the particles’ size to enable intimate contact with the active area. For very sensitive applications with small active areas, it is strongly recommended to consider nanometer particle sizes instead of micrometer. In addition, for the purpose of performance reproducibility, the primer must be prepared in a manner to obtain a very homogeneous mixture without air bubbles inside.

Conclusion

Advantages of using EPIC and MEPIC technologies compared to the bridge wire (BW)

Using EPIC and MEPIC resistors offers several advantages compared to BW, mainly in the deployment of

standard SMD methods for both the design and the manufacturing of detonators and initiators.

The PCB, or so-called header, will be designed with a common SMD footprint (0603 or 0805 case size) and, the assembly process will be based on pick and place from tape and reel packaging, followed by a standard reflow soldering process. By using such standard processes, the achievement of high throughput is possible. Moreover, SMD technology allows designers to avoid using the costly polished headers that are mandatory for BW technology.

To meet specific performance requirements, Vishay is able to customize the active area of the EPIC and MEPIC without affecting their case size, and hence without affecting the initial footprint on the PCB or header, which will provide a common base for various applications. From a design and development point of view, it is also important to consider that despite the interface with the pyrotechnic material, the use of EPIC and MEPIC devices will avoid any reliability issues from electric soldering during assembly and, will also enable a downsizing level where only the reflow soldering can be applied.

Finally, the highly monitored manufacturing process for both EPIC and MEPIC resistors, combined with the strong automated optical inspection (AOI), will provide high reproducibility and reliability, which remains a key issue in insuring safety in field applications.

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