Keywords: SFN, attachment, IC package, 1-Wire, 1Wire, calibration, authentication, monitoring, accessory, consumable, electro-mechanical contact

Nov 26, 2007

APPLICATION NOTE 4132

Attachment Methods for the Electro-Mechanical SFN Package

Abstract: This application note discusses a Maxim packaging solution called SFN, which is designed for electro-mechanical contact solutions. The article discusses traditional packaging solutions for an electro-mechanical contact, and introduces the SFN alternative. The SFN mechanical specification is described. The article recommends ways to attach the SFN to an accessory or consumable, and then recommends contacts for the electro-mechanical interface. A reliability analysis of the package is provided.

Introduction

Adding electronic functionality to traditionally nonelectronic peripherals and consumables is becoming a common system requirement. Typical system-driven requirements include storage of calibration data or manufacturing information, or OEM authentication of the peripheral, accessory, or consumable. Besides selecting the proper memory and security functionality for these electronic requirements, one must add an electrical connection between the host system and peripheral.

This application note details Maxim's SFN packaging solution that is specially designed for electro-mechanical contact environments. The SFN mechanical specification will be discussed. The article will recommend solutions for attaching the SFN to an accessory or consumable, and then recommend contacts for the electro-mechanical interface. A reliability analysis of the SFN package follows.

Traditional Packaging Solutions

Conventional IC packages are designed for mounting on a printed circuit board. The board then connects the leads to contact pads that, in turn, provide connectivity to spring contacts in the host system. **Figure 1** shows examples of these circuit boards. In Example a) the chip is mounted on the backside of a dual-sided board. The pads in the center and to the right are IO; the left pad is GND. This redundant design is compatible with two different contact arrangements. In Example b) both chip and pads are located on the same side of a single-sided circuit board, an approach that reduces cost. In either case, the board size is approximately the same (1cm × 2cm). **Figure 2** shows the Example a) design mounted on an off-the-shelf printer cartridge.

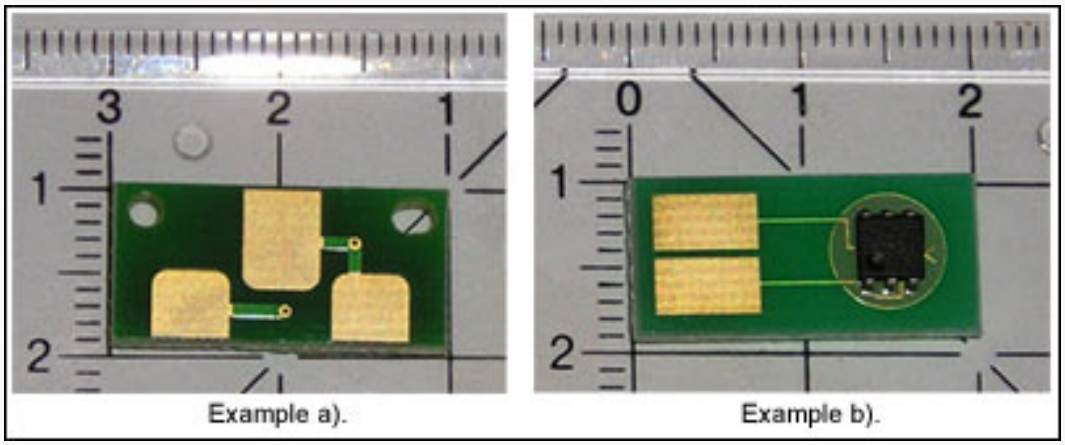


Figure 1. Design examples of circuit boards with contact pads. Scale is in centimeters.

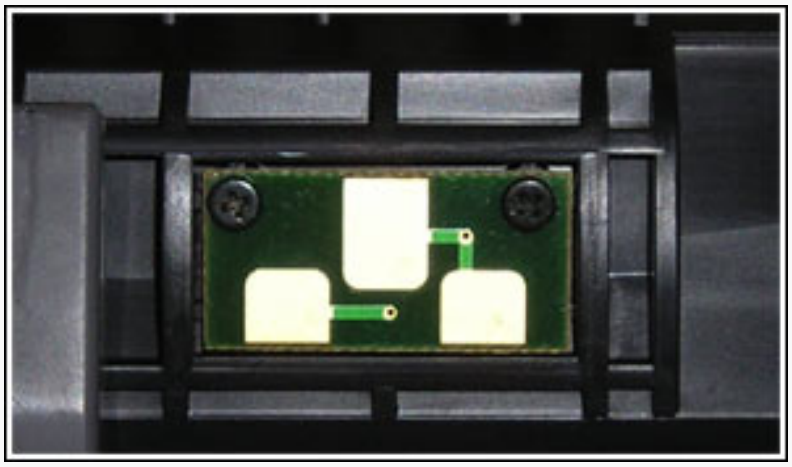


Figure 2. Photograph of Example a) on an end product.

The main disadvantages of the traditional solutions in Figure 1 are the fairly large size (for easy handling, screw attachment), an extra component (the circuit board), and the cost (the circuit board and mounting on the object). Although this connectivity approach performs properly, mounting the package on the circuit board is not the most cost-effective solution to the original challenge. However, an IC package that has contact pads (in contrast to leads) and is big enough for easy attachment directly to the peripheral would be an ideal solution.

The SFN Package

The name SFN stands for "Single (line of contacts), Flat, No leads" package. The SFN (**Figure 3**) combines the chip and contact pads in an enclosure that is compatible with the standard IC packaging process. The SFN mounts directly—no circuit board is needed—with snap-fit or adhesive into a recessed area of the peripheral. With its two contact pads, the SFN accommodates parasitically powered 1-Wire® devices only. For ESD reasons, to make contact first, and for polarity observation, the GND pad is larger than the IO pad.

In contrast to conventional IC packages, the SFN is designed for **contact applications only**. The package is not good for SMT soldering because the pads' large size creates the risk of delamination (pads separating from mold compound). Consequently, the SFN has not been qualified for soldering.

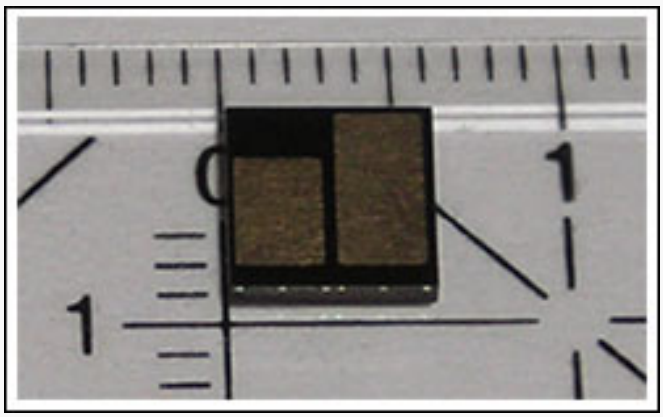


Figure 3. The small pad of the SFN package is IO and the large pad is GND. Scale is in centimeters.

The principal applications for the SFN package are identification and authentication of objects, and automatic calibration using data stored in the memory chip. The authentication ensures reliability and quality, which otherwise could be undermined by low-quality cloned products. Ideal applications for the SFN range from printer consumables and medical sensors to reagent bottles.

Package Characteristics

The SFN package's physical dimensions are 6mm × 6mm × 0.9mm with ±0.05mm tolerance. The lead frame is made of CDA194 copper alloy. The contact pads are 2.6mm wide with a spacing of 0.3mm; their length is 5.05mm for GND and 3.55mm for IO. The pads are plated with 1.02µm nickel, 0.02µm palladium, and a 0.005µm gold

finish. The mold compound is Sumitomo® G600 or G770 or a similar product. For additional mechanical data refer to the SFN package outline drawing. A 4mm × 4mm × 0.9mm version of the SFN package is also technically feasible. Please contact Maxim for details.

Given its purpose, the SFN is fairly large and, therefore, provides space for traditional IC markings (**Figure 4**). The contact pads are not visible in this view. Rather, they are drawn as dotted lines to indicate the orientation of the marking with respect to the pads. The marking consists of the part number on the first line, manufacturing date code with die revision on the second line, manufacturing lot code on the third line, and as an option, the country where the device was assembled on the fourth line. A plus sign (+) in the lower left corner indicates that the product is Pb-free.

Figure 4. Top marking for the SFN package. This is topside view and contacts are not visible.

SFN-packaged parts are available on tape and reel only. **Figure 5** shows the orientation of the parts on tape. The tape is 16mm wide and has a 12mm cavity pitch (also known as "component pitch" or "tape pitch"). One 13-inch diameter reel holds 2500 devices.

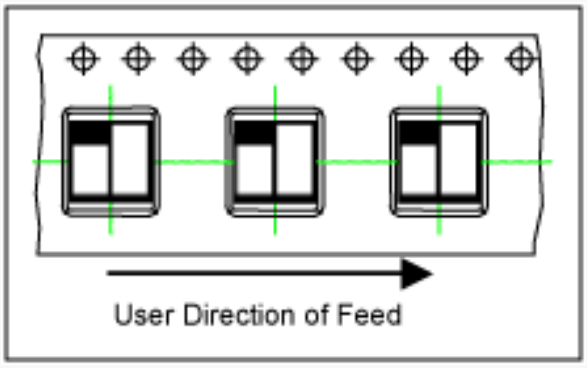


Figure 5. The SFN orientation on tape. Leads face up in the orientation shown in the drawing.

Attachment Methods

To keep the contact pads accessible, the SFN must be attached to a peripheral with its topside towards the object. Consequently, when attached, the topside marking is no longer visible. The two best ways to attach the SFN to an object are: 1) mechanical clip, and 2) adhesive tape. Although suitable liquid adhesives do exist, they are inconvenient to use and, therefore, are not discussed here.

The preferred choice for attachment is a clip, as shown in **Figure 6**. It is obvious that the clip's cavity must be large enough the hold the SFN package. The exact dimensions of the flexible hook, which secures the SFN in its place, depend on the material of the clip. **Figure 7** shows a similar clip integrated into the design of the peripheral object to be authenticated.

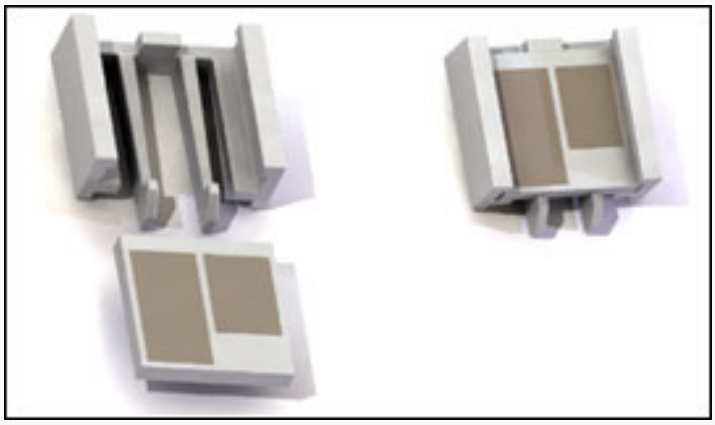


Figure 6. Retaining clip for a SFN package, shown before and after the SFN is inserted.

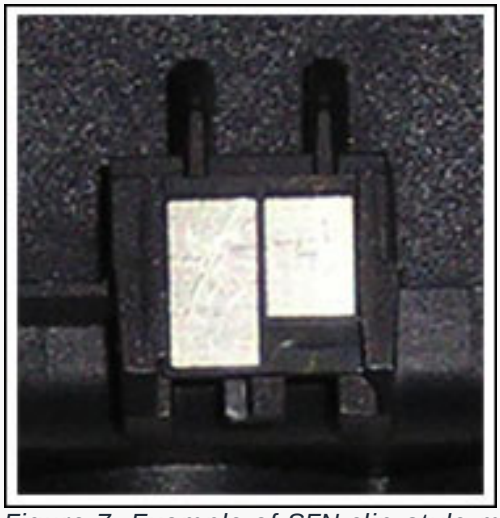


Figure 7. Example of SFN clip-style mounting on end product.

A feasible alternative to a clip is double-sided adhesive tape. There are several adhesives that should adhere well to the mold compound used for the SFN package. The 3M® Company manufactures a large variety of pressure-sensitive adhesives designed to operate in a wide variety of environments.

Two groups of adhesive products should be considered: 1) double-coated foam tapes, and 2) double-coated tapes. A third product group, adhesives for electronics, includes products that are either electrically conductive, require heat or solvent activation, or were developed explicitly for purposes unlike SFN attachment. As electrical conductivity is not needed for the SFN applications and as heat or solvent activation requires additional steps, adhesive products in this third product group can be disregarded.

To navigate through the 3M website, go to www.3m.com and search on "adhesive transfer and double coated tapes." Follow the headlines Double Coated Foam Tapes or Double Coated Tapes to find the products in each category. From the double-coated foam tapes, choose a product that is compatible with the material of the object to which the SFN will be attached. The adhesive foam tapes are available in thickness from 0.8mm to 6.4mm and for maximum temperatures of +49°C, +70°C, +104°C, and +152°C. Products in the double-coated tapes section are much thinner, ranging from 0.03mm to 0.26mm; most are suitable for operating temperatures of +70°C and higher. **Note**: rubber-based tapes should not be considered because of their limited temperature range (for both indoor and room temperatures).

Choosing the Contacts

To access the data in the peripheral object that holds the SFN package, the host system needs a pair of suitable electrical contacts. These contacts are found under the category of "Battery connectors" from the Suyin Corporation. **Figures 8** through **10** show Suyin products that have been successfully evaluated with the SFN. For simplicity, these connectors are referred to as Contact A, B, and C in this document. The manufacturer's part numbers and original product descriptions are listed below each figure.

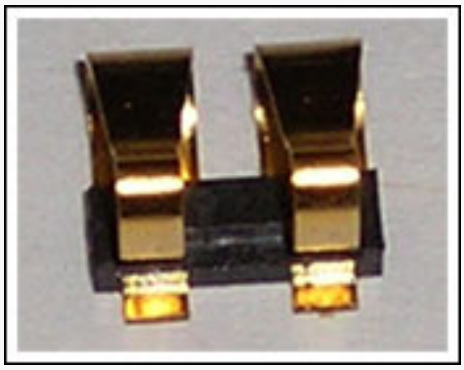


Figure 8. Contact A, Suyin 060191MA Series. Part number as shown: 060191MA002__02ZR (_ = place holder for plating specification). Description: 3.90mm Pitch Battery Connector Male SMD Type (Insert Molding Type).

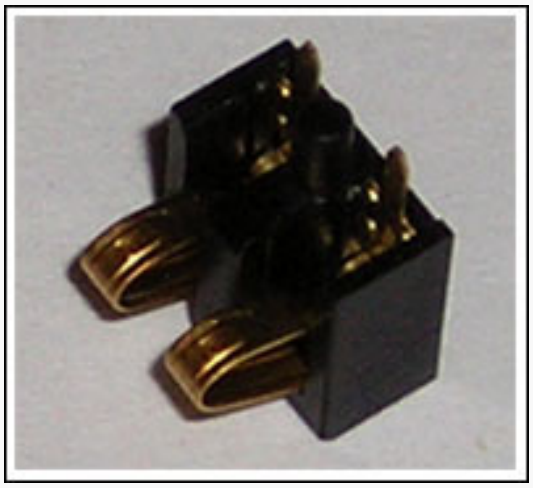


Figure 9. Contact B, Suyin 060121MR Series. Part number as shown: 060121MR002G_00ZU (_ = place holder for plating specification). Description: 3.60mm Pitch 2 Pin Battery Connector Spring DIP Type. ***Note****: The product is pictured "upside down," i.e., the pins and the center-post are designed for through-mounting on a circuit board.*

Figure 10. Contact C, Suyin 425122MA Series. Part number as shown: 425122MA002G_00Z_ (_ = place holders for plating specification and tube or reel). Description: 4.25mm Pitch 2 Pin Battery Connector SMT Type.

The Contact D through-mounted, custom spring design in **Figure 11** was also successfully tested with the SFN. The design drawing is found in the Appendix.

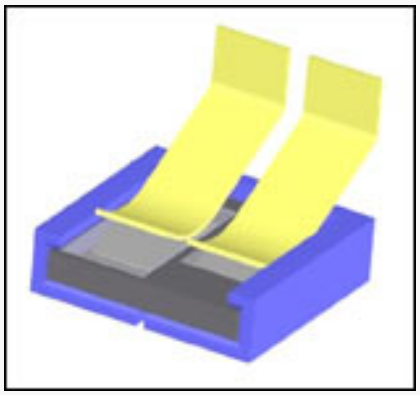


Figure 11. Contact D, a custom design.

The important distinguishing parameters of the four contact designs (Figures 8 through 11) are summarized in **Table 1**. For reliable operation (i.e., contact cleaning), it is necessary that some wiping occurs between the SFN and the contacts when the peripheral is inserted into the host system. Contacts A, C, and D require the object to slide towards the spring. Only Contact B is designed for the object to push against the contact so the spring in the contact yields and performs the wiping action.

Table 1. Comparison of Contact Examples

	Contact A 060191MA Series	Contact B 060121MR Series	Contact C 425122MA Series	Contact D Custom Design
Design Objective	Object slides against the spring and wipes; high force	Object pushes against the spring; spring yields and wipes; high force	Object slides against the spring and wipes; high stroke	Object slides against the spring and wipes; low stroke
Footprint on PCB	6mm × 6.7mm	4.5mm × 6.75mm	6.2mm × 7mm	2.3mm × 6.2mm
Height	4.65mm	6.5mm	6.8mm	2.1mm
Mounting Type	SMD	Through-mount	SMT	Through-mount
Stroke	0.9mm (max)	0.6mm (2mm, abs max)	1.2mm (max)	0.2mm
Spring Durability	10k cycles	10k cycles	3k cycles	1k cycles
Force per Contact	500g at 0.9mm stroke	250g to 300g at 0.3mm (= half) stroke	150g to 260g at 1.2mm stroke	90g to 115g at 0.2mm stroke
Force per Contact at 0.2mm Stroke	111g	167g to 200g	25g to 43g	90g to 115g
PCB Thickness	1.2mm	1.2mm	0.8mm	0.8mm

The dimensions used in the Suyin's documents are inconsistent. For convenience, the dimensions were all converted to metric. The SI unit of force is N (Newton); many mechanical product data sheets still use the outdated unit of "gramme-force gf." The conversion is: 1000gf = 1kp (Kilopond) = 9.80665N.

Reliability Testing

Two series of qualification tests were performed on the SFN package. Test parameters are listed in **Table 2**.

Table 2. SFN Test Parameters from Two Tests

a)	• Operating life (+125°C, 5.5V, 1000 hours) • Mechanical verification (X-ray, dimensions, marking, lead integrity) • Storage life (+150°C, unbiased, 1000 hours) • Temperature cycle (-55°C to +125°C, 1000 cycles) • Temperature humidity bias (+85°C, 85% R.H., 5.5V, 1000 hours) • Unbiased moisture resistance (85°C, 85% R.H., 1000 hours)
b)	• Mechanical life (shock test 200g, 30 cycles) followed by temperature cycle (-55°C to +125°C, 1000 cycles) • Mechanical life (vibration 10g, 5Hz to 2kHz in X Y Z axes, 30 hours), followed by temperature humidity bias (+85°C, 85% R.H., 5.5V, 1000 hours).

In both tests all SFN devices passed without failure. For more details refer to the respective reports (see **Appendix**). As a result, **the SFN package meets the same reliability requirements as conventional IC packages**. The SFN is qualified for the industrial temperature range from -40°C to +85°C. In a separate test, the SFN package passed 1000 contact cycles with the custom-design Contact D.

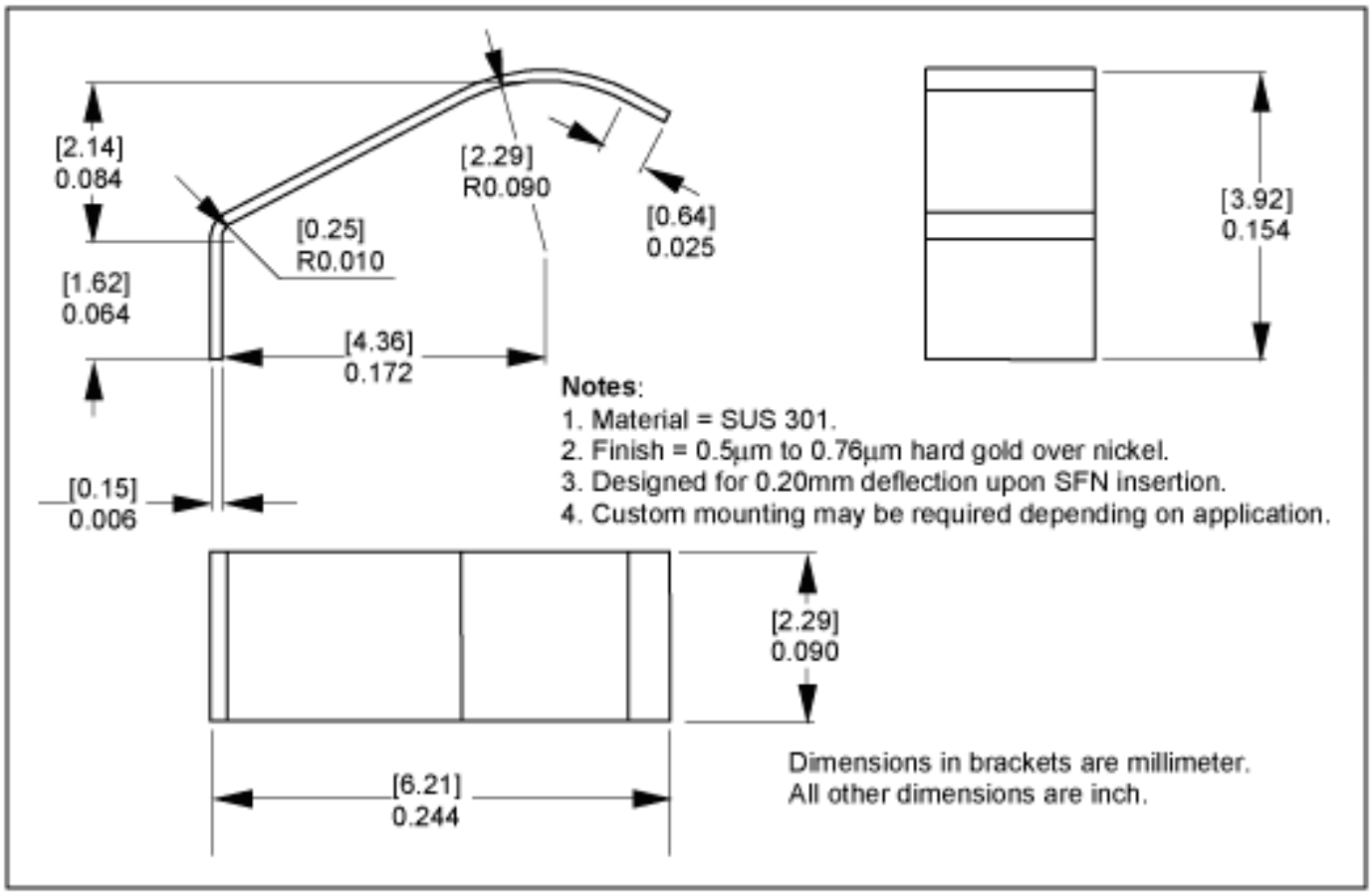
An autoclave test was not performed because, per JESD47E January 2007, it is no longer recommended as a qualification test for organic substrate packages. A biased or unbiased Highly Accelerated Stress Test (HAST) of 96 hours at +130°C and 85% R.H. is now the preferred test for galvanic and direct chemical corrosion for organic substrates. For parts that passed the 1000 hour test at +85°C and 85% R.H., the HAST is usually not required.

Summary

The SFN package is a cost-effective alternative to mounting a module with chip onto the peripheral object to be identified. SFN attachment options are clip-style retainers integrated into the nonelectric object and double-sided adhesive tape. Inexpensive mobile battery connectors provide the electrical connection between the host system and SFN. The reliability of the SFN package matches that of conventional IC packages.

Appendix

1. Qualification Test Report a): Request the UTL_2SFN_LF.pdf through the support center
2. Qualification Test Report b): www.maxim-ic.com/reliability/product/DSQ3301_CONTACTOR.pdf
3. Contact D design drawing



Application note 4132: www.maxim-ic.com/an4132

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