A SIMPLE EMI FILTER SOLUTION
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For decades, if you wanted – or needed – to reduce harmful EMI, RFI or transient signals from an electronic device, filtered connections ranked among the most common methods. Traditional, filtered connections are both bulky and costly – but without a better alternative, manufacturers simply used the components available to them.

When filter inserts hit the market, it provided manufacturers with a legitimate alternative to traditional filtered connectors for the first time. The ease-of-use of such inserts made them particularly endearing to manufacturers and designers who had either recently failed EMI testing or those under pressure to find a solution quickly. These same benefits also make EMI filter inserts ideal for being specified into an application for manufacturing.

Some people remain skeptical – and for good reason. Until you dive deeper into the technology, it’s tough to understand how such a seemingly simple, tiny device could replace those large, traditional filtered connectors. For a better understanding, we’ll examine Quell’s EESeal - learning not just how filter inserts work, but why they’re so easy to use, how well they stand up against traditional filters, and what practical uses they offer product designers and manufacturers.
HOW IT WORKS
Quite simply, Quell’s EESeal is silicone rubber packaging technology. Inside, 0402 and 0603 chip components are placed directly into the silicone rubber. That silicone rubber then protects and suspends the components so that they can withstand harsh, rugged environments such as those seen in military and aerospace applications. The compressive forces of the silicone rubber help maintain connection while holding up under the extreme abuses that are common in such industries.

Quell designed the pinholes of the EESeal to be smaller than the pin itself, relying upon the compressive forces of the silicon. When the filter insert is placed over the pin of the connector, it stretches and then compresses down, holding the pins of the insert onto the pin of the connector, ensuring a tight connection. There is no chatter, under shock or vibration because of that tight connection.

If needed, the outer diameter of the insert can be oversized to provide strong compressive forces on the grounding of an edge contact as well.

All wires within the component are:
3 mill, copper annealed, gold plated wires not made from spring metal, making them more resilient. Filter inserts - EESeals in particular - are extremely resilient. As you can see in Figure 2, when a connection is made, the insert will take on the properties of the interfacial seal inside the connector. In doing so, it fills all the voids, nooks and crannies, maintaining the integrity of the interfacial seal.

For a better understanding of how the technology works, we’ll take a look at Figure 1, a cross section of a 38-999 connector. The blue portion that you see is an EESeal. Embedded in the silicone rubber is the 0402 and 0603 chip-device discussed earlier. Additionally, depending on the application, any of the following could also be included in the silicone rubber insert:

- Capacitor resisters
- Transient Voltage Suppressors (TVS)
- Multilayer Varistors (MLV)
- Other components

Dual contacts are soldered on one end of the device that protrude into the hole. There are dual contacts on the backend that simulate a ground bus or, a spider web of a ground plane that will ground the shell contact or the receptacle, depending on the contact types or the connector’s needs.

In Figure 3, you’ll notice that every device is discrete. The 0402 and 0603 type-devices are intentionally discrete, so every pin can be treated differently as needed in each...
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As an example, because of this design you can have pins with unique attributes, such as:

- Pins 1-4 = 47 nanofarads
- Pins 12-15 = 220 picofarads
- Remaining pins = open

Devices can also be designed in parallel or series, potentially allowing several chip devices to protect each pin.

USES
Filter inserts can help overcome many challenges by providing:

- EMI filtering
- RFI filtering
- Transient protection for indirect lightning
- Transient protection for ESD
- The ability to add pull up resistors
- The ability to add grounding
- Redistribution of power

Because of its resistance to the effects of extreme environments, the EESeal is often used in performance-critical electronic devices found in military and aerospace systems. That said, the versatility of filter inserts is enough to bridge almost any connection where EMI/RFI is problematic, such as medical equipment or transportation products.

INSTALLATION
The beauty of an EESeal, as opposed to a traditional filter, is the ease-of-use. No tools or soldering are required, and even a novice user shouldn’t face complications.

The device is inserted by hand into almost any connector in a matter of seconds. To ensure a mated connection, you’d follow two simple steps:

1. Place the filter insert over the pins of the connector
2. Use the mate to insert it at the bottom of the connector

Once the connection is made, the new circuitry is designed to work seamlessly with the originally manufactured device.

This easy installation and the elimination of product redesign is what makes the EESeal so popular for last-minute modifications - such as during compliance testing. Should a filter insert provide the requisite EMI filtering or transient suppression to achieve product certification, the EESeal then becomes a production solution for the life of the application.

If repeated baseline testing is required, extraction and reinsertion of the EESeal can be done in quickly while still in the lab.

PERFORMANCE

To see the EESeal in action, check out this short demonstration: [https://eeseal.com/instructional-videos/](https://eeseal.com/instructional-videos/)

To ensure optimum performance within harsh environments, rigorous testing is performed on filter inserts. Such tests include:

- Shock and vibration
- Salt spray
- Humidity
- Durability

As an example, the EESeal meets the minimum requirement of 500 mates/demates in a 38999 connector.

When speaking of EMI filtering performance, attenuation is the key metric. Utilizing the attenuation charts for various capacitances under a 50ohm load, such as those seen in Figure 4, the EESeal can mitigate frequencies from 10KHz to 40GHz. Chip capacitors range from 1pf up to 4.7uF. These C-filter devices give a peak attenuation of approximately 40 to 45 dB at the peak frequency.

The EESeal also provides transient protection, making it compatible with transient voltage suppressors and metal oxide varistor, depending on application.

Additionally, for lightning or ESD, any of the following could be included:

- Pull-up resistors
- Precision resistors
- Shorts

CUSTOMIZATION
Every EESeal filter insert is custom-designed: the only way to ensure it will meet your application’s specific re-
requirements. The EESeal can be customized to function:

- Pin to shell
- Pin to pin
- Component devices include:
  - capacitors
  - resistors
  - TVS’s
  - MOVs or MLV’s
- And most any other SMD compatible device

While filter inserts may vary in size and weight, the EESeal takes up no additional space - fitting right inside the connector. This affords a manufacturer the luxury of making zero late-stage product alterations and not delaying a launch date.

**CONCLUSION**

While filter inserts have been known as last-minute fixes for failed EMI tests, many designers have changed course. In fact, filter inserts are now finding their way into early design by some of the largest manufacturers in the world - providing EMI/RFI filtration and transient protection without sacrificing space. Available space within a system is often a concern as many electronic devices continue to shrink as newer, smaller technologies are created. Integrating the EMI filtering solution into the connector allows room for other components or even further shrinking of the system.

Quell’s EESeal, can match and even exceed the performance of a traditional filtered connector while providing significant, tangible space, weight, and cost-saving benefits.

You’ve read the stats and you understand the technology – now try an EESeal for yourself.