

## Shogun Electric Match Connectors

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The most common point of attachment of an electric match to a fireworks aerial shell is via the shell leader, and most commonly the installation of the electric match is performed by a display company when preparing for a display. Because of the difficulty of performing that operation with the safety shroud left in place, too often the shrouds are removed prior to their installation. Unfortunately, while removing the safety shroud is allowed under a US-DOT exemption,<sup>[1]</sup> this greatly increases the likelihood of an accidental ignition.<sup>[2,3]</sup> Fortunately, now there is a simple and effective solution to the problem; the Shogun Electric Match Connector.<sup>[4]</sup>

The connector is a small piece of somewhat soft plastic that facilitates the attachment of electric matches to aerial shell leaders and is shown in cross section in Figure 1. Figures 2 and 3 are a drawing and photo of how the connectors are used. Once the connector has been installed, the electric match can then be quickly installed. This is accomplished by simply inserting the electric match into the connector and securing it in place using the leg wires around the built-in hooks for that purpose. As can be seen, the safety shroud of the electric match is left in place. In fact, the physical strength of the safety shroud is rein-

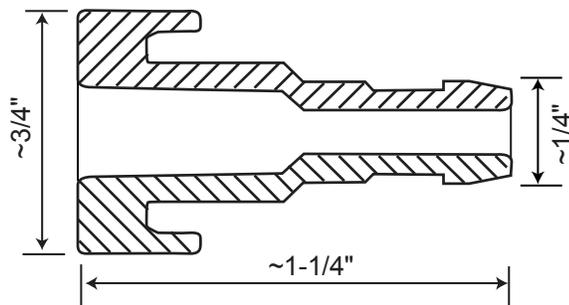


Figure 1. A cross-sectional drawing of the Shogun Electric Match Connector giving approximate overall dimensions.

forced by the body of the connector, thus affording the sensitive electric match tip a substantially increased level of protection. Since the actual installation of the electric match itself can be accomplished so quickly, that operation can be delayed until rather late in the process of preparing for a display. Also, in the event that the electric match needs to be removed, that task can be accomplished both simply and safely.

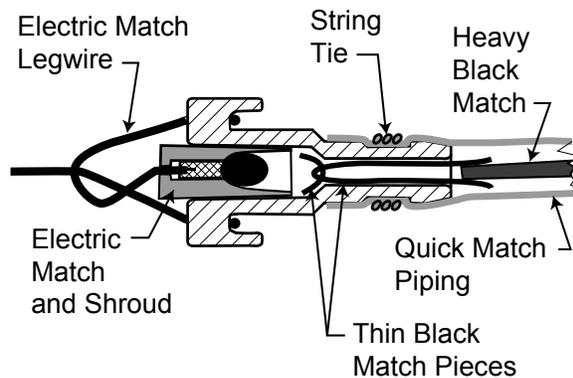


Figure 2. A cross-sectional drawing showing the operational configuration of the electric match connector.

While the connectors are apparently available for sale to display companies wishing to use them, reportedly<sup>[5]</sup> Shogun (USA) Pyrotechnics (offering Shogun, Vulcan and Haga brand display shells) started offering shells for the 2004 season with the connectors preinstalled. The aerial shells were to be supplied with the normal shell leader, thus allowing for their manual firing or chaining by a display company. In addition, the shells were to come with a short length of quick match fuse with the electric match connector already installed at the factory, thus facilitating electrical firing. As installed by the manufacturer of the aerial shells, the opening in the electric match end of the connector will have a small plastic plug inserted to close the opening (not shown in the above figures). To install the

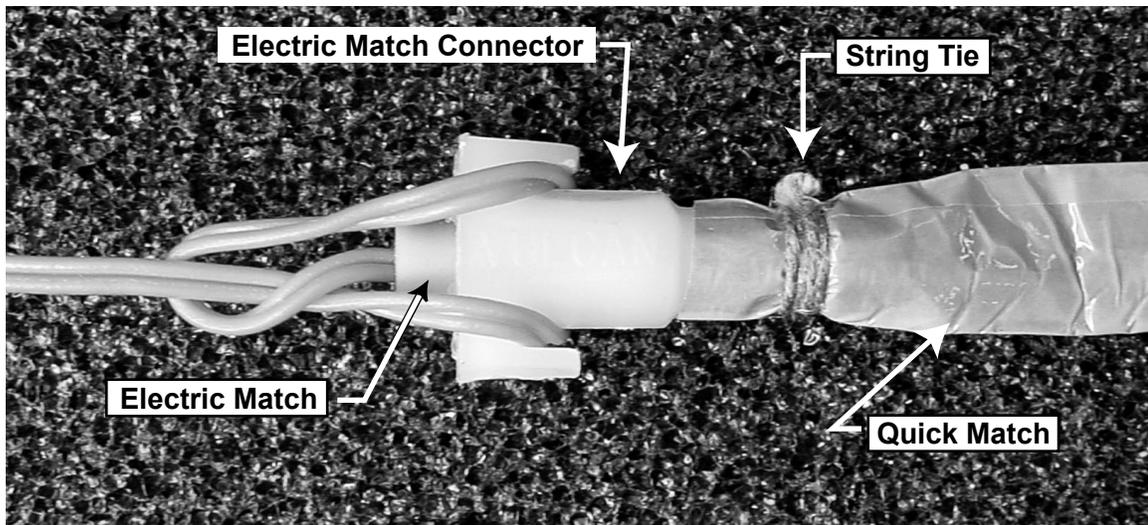


Figure 3. A photograph of the operational configuration of the electric match connector.

electric match, the user needs to first remove that protective plug.

Initially it had been anticipated that some sensitiveness testing would be performed using the electric match connectors. However, after examining the nature of the connectors and reviewing the test results of electric matches with their safety shrouds left in place,<sup>[2]</sup> further sensitiveness testing seemed pointless. Given the yielding nature of the plastic, the connector can only act to further reduce the already low impact sensitiveness of shrouded electric matches. Given the added protection afforded by the connector, it can only act to further reduce the already low friction sensitiveness of shrouded electric matches. Use of the connector will in no way affect the sensitiveness of the electric match to thermal ignition. However, because of the high temperatures needed to cause the ignition of electric matches, compared to temperatures at which humans can survive, this was not found to be a likely source of accidental ignition.

Use of the electric match connector will do nothing to affect the sensitiveness of electric matches to electrostatic discharges (ESDs) through the bridgewire, but this is already relatively low.<sup>[2]</sup> The type of ESD events that are most problematic for electric matches are those ESD events occurring from the bridgewire and passing through the electric match composition. This second type of ESD sensitiveness is only possible when there is a conductive path for the

discharge leading away from the tip of the electric match. In earlier testing, it was found that black powder compositions were only capable of providing the necessary conduction path if the grains of powder were coated with graphite, such as is sometimes done with granulated lift powders. For the low electrical conductivity of black match, the only material potentially in contact with the electric match tip inside a connector, it was found that the static voltage level anticipated under the likely conditions of use was not sufficient to cause the ignition of an electric match due to a discharge from the bridgewire through the electric match composition.

The pieces of thin black match, shown inside the connector in Figure 2, should serve well to insure the rapid and reliable ignition of the short length shell leader attached to the shell's lift charge. Given the labor costs in China, the use of pieces of thin black match would seem to be a prudent expenditure. However, in the thought that some users of the connectors installed in the US might be tempted to forego the use of pieces of thin black match, some testing was undertaken. Figure 4 is a photograph of the jet of fire produced by the firing of a Daveyfire A/N 28 BR match installed into the end of a bare Shogun electric match connector, without the use of the thin strands of black match. The main body of the jet of fire extended approximately 5 inches (125 mm) from the end of the connector and sparks ranged to about 15 inches (380 mm). This

result suggests that coupling a connector directly to a reasonably good grade of quick match under reasonably good conditions should provide a reasonably high level of ignition reliability.

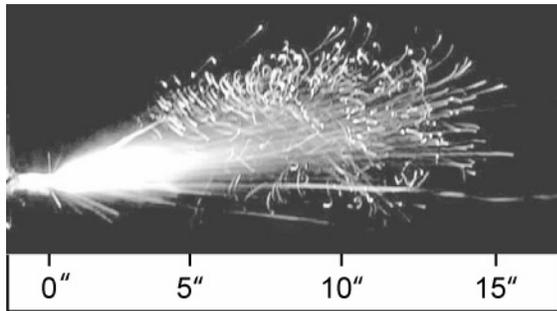


Figure 4. A photograph of the firing of a Davey-fire A/N 28 BR electric match from a bare electric match connector, without the use of the thin strands of black match.

The authors are grateful to John Werner for providing a number of the Shogun Electric Match connectors for evaluation and testing.

## References

- 1) US Department of Transportation, DOT-E 11685.
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- 3) K. L. & B. J. Kosanke, "DOT Exemption for Display Fireworks with Electric Matches Attached," *Fireworks Business*, No. 221, 2002; also in *Selected Pyrotechnic Publications of K. L. and B. J. Kosanke, Part 6 (2001 and 2002)*, Journal of Pyrotechnics, 2005.
- 4) Shogun (USA) Pyrotechnics, Ltd., US Technical Correspondent, John Werner, 410-287-4849, jawerner@dol.net.
- 5) Personal communication, John Werner, Shogun (USA) Pyrotechnics, Ltd.