

42-Volt Challenges: Arcs and Sparks

By Tim Moran, Special Correspondent

DETROIT – The auto industry was lucky the last time it boosted voltage in car electrical systems.

That was in the late 1950s, when the challenge of starting large, high-compression engines led engineers to push from existing 6-volt technology to the 14-volt charging system and 12-volt battery.

Unknowingly, the industry dodged a bullet in making the switch. Current flow below 15 volts is just under the threshold for persistent arc discharge. Sparking between electrical contacts occurs in a 14/12-volt system, but the arcing is unstable and is broken easily.

Boost the voltage to the emerging standard of 42 volts for charging (with a 36-volt battery), through, and what you get is an effect like a series of small welder's arcs.

The effect between connectors can generate temperatures above 1,832 degrees Fahrenheit. Connectors that vibrate loose can create the effect; so can a car owner accidentally disconnecting a live wire or a faulty switch.

The size of the connector doesn't matter. What matters are the space between charged surfaces and how the contacts pull apart.

Almost all switches experience a small bounce as they bring electrical contacts together, and the result is like a car constantly trying to strike its own match. It is one of the biggest challenges to the higher voltage car.

Flick of the switch

The advent of 42-volt power systems will prompt suppliers to redesign switches to prevent electrical arcing, which can:

- Generate temperatures up to 1,832 degrees Fahrenheit
- Melt metal or burn plastic
- Ignite fuel vapors

Need for new connectors?

"The auto industry is going to have to face up to this," said Thomas Keim, at the SAE World Congress last week. Keim is director of the Massachusetts Institute of Technology consortium, a global leader in setting 42-volt standards.

Keim said aviation has dealt with this kind of arcing for years, and only stringent, intensive maintenance has helped prevent electrical fires. Most vehicles don't receive that kind of maintenance, and mechanics agree that car wiring harness problems are notoriously difficult to repair.

It may take a new connector system in the car to handle electricity safely, at least on the high-power circuits that drive 42-volt features.

Researchers from the Fujikura Ltd. Automotive Products Division in Japan have posed a partial solution.

Fujikura's Koji Sakiyama said researchers installed permanent magnets in either side of a 42-volt plastic wiring harness connector. The magnets create a field that electrical arcs must go around, making them longer and easier to break off, within 40 to 80 milliseconds. Sakiyama urged development of a global standard for safe disconnects.

Challenge for switch makers

Switch makers, meanwhile, are facing many instrument panel challenges that change the way electricity flows.

At lower voltages, switches often carry the actual current used to drive devices in the car. Higher voltage switching will rely instead on indirect, low-voltage controls that may actuate remote power-handling solenoids, similar to that of a car's current ignition switch.

Suppliers also are reinventing the automotive fuse box, introducing smart fuses and computer-controlled switches to handle the loads imposed by 42 volts.

The simple replacement cartridge fuse likely will be a thing of the past for high-voltage electronics.