

SPECIFYING DIGITAL SWITCHING

FOR COMMERCIAL VEHICLES: 4 KEY CONSIDERATIONS

Over the last number of years, digital switching components have become the predominant design choice for the electrical systems of passenger vehicles. More recently the commercial vehicle sector of the transportation market has accelerated its migration to this technology. This white paper touches on issues surrounding digital switching components related to, among other subjects: pricing, manufacturing, haptics, purchasing costs, certifications and regulations, sales and marketing, and business performance.

Specifying Digital Switches for Commercial Vehicles: 4 Key Considerations

According to a research report by Mordor intelligence, the 2017 global automotive switch market was valued at USD 23.76 billion. The same report projects a CAGR of 8.59% for the forecast period of 2018-2023, with digital system switches expected to dominate the market. The latter statement is not breaking news to anyone. A major trend of recent years has been the automotive industry's transition from hardware to software-defined vehicles, during which time the amount of electronics and software per vehicle has increased substantially. This same trend has taken hold in the commercial vehicles sector, first as a trickle and now as a steady stream.

The electromechanical switch remains integral to the electrical design of on-road and off-road vehicles. However, the added features and functionality of digital switching, and other competitive advantages, make it a choice worth considering in any electrical design.

With these thoughts in mind, here are 4 key factors to consider when specifying digital switches for commercial vehicles:

1. Consider the ways digital switches can help lower vehicle manufacturing costs while adding value cross-functionally. – When you look at the price of the component itself and ignore related costs and other competitive issues, the cost of an electromechanical switch is decidedly lower than that of multiplex switching. Nevertheless, digital switching products can positively impact business operations in multiple ways. For example:

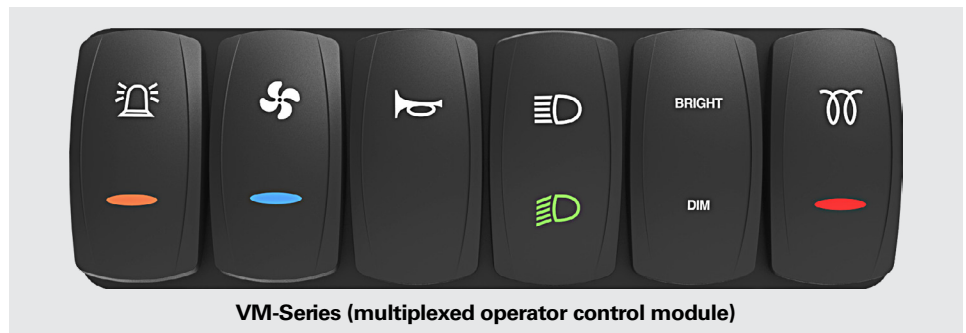
- **Purchasing** – Digital switching products can lower purchasing and stocking costs. Because digital switching simplifies manufacturability, purchasing managers can substantially reduce the number of SKUs they inventory and manage, thus gaining greater economies of scale. For instance, with multiplexing it's not inconceivable to go from forty variations of parts numbers down to four.

CASE IN POINT: Carling is working with a heavy-duty truck manufacturer that currently has about 300 different electromechanical component variants

within its cab. The manufacturer's goal is to replace this setup with one of three digital switching systems as selected by its customers, with actuators configured at the end. If all goes as planned, the manufacturer will see a sharp reduction in the number of components it purchases and stocks.

- **Manufacturing** – While it's true that electromechanical switches cost less, there are ancillary costs with these components that cannot be overlooked. In short, given that multiplexing results in significantly fewer components to assemble, wire, connect, etc., the opportunity clearly exists for meaningful savings. Consider transit buses, for instance. According to one transit bus manufacturer, prior to moving to multiplexed communication its electrical system accounted for as much as one-half of engineering time and 15% of vehicle assembly cost. [1] And GM reported that network communication helped it achieve a 70%+ reduction in the wiring needed in some of its light-duty vehicles. [2] Also, fewer components to assemble and connect means fewer chances for error.

- **Sales & Marketing** – In a CAN bus system there's no need for a huge



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array of hard-wired components and circuit boards as the functionality they enabled is now software-driven. The resulting weight reduction – the dash weight of a heavy-duty truck can often be reduced by half when eliminating large, heavy wiring harnesses – improves fuel efficiency and strengthens a manufacturer’s selling proposition.

- **Serviceability** – As a software-driven product, digital switching modules come equipped with built-in diagnostics. This enables the quick and easy identification and repair of myriad issues that can help lower the total cost of vehicle ownership. In summary, multiplexing products can benefit a manufacturer’s business operations in multiple ways across multiple departments. Given this fact, when making a case for digital switching, today’s design engineer should be prepared to engage with, if not the entire company, multiple departments within it.

2. Consider the human/machine interface and operating environment.

– One reason digital switches appeal to design engineers is because they are stylish. Indeed, a trendy, modern style and unique look can help differentiate a vehicle and enhance perceived value. The key to design success though is to ensure that the new style in no way compromises the substance of the operator’s interaction with the vehicle. Therefore it’s important to thoroughly think through the environment in which the vehicle operator currently interacts with switches compared to the anticipated digital experience.

For example -

- How significantly will the changeover affect this interaction?
A little or a lot?
- Will retraining be required?
How much?
- Have all safety-related issues been fully considered?

Simply put, while style is important, substance is more important.



CKP-Series (SAE J1939 CAN customizable keypad)

CASE IN POINT: A few years ago product designers for some metro bus manufacturers sought a more pleasing aesthetic by specifying membrane keypads. However, these keypads presented a fundamentally different experience than what bus operators were accustomed to as there was no positive haptic feedback. What’s more, because the drivers had to take their eyes off the road to confirm they were pressing the right spot on the keypad it made for unsafe driving. Understandably, there was a massive backlash from drivers. All the consequence of not fully considering one of the most important elements in product design: the human/machine interface. (This element has since undergone a redesign.)

3. Consider the certifications, regulations, and standards the hardware and software must meet or comply with.

– Any reputable supplier will readily provide up-to-date documentation from standards organizations such as ASTM, SAE, UL/CSA and, in Europe, e-Mark – as well as proof of RoHS compliance. In addition, because digital switches are a software-driven product the supplier will have the accreditation, expertise, and experience to meet all software-related standards and requirements. These include ASPICE levels, SAE J1939 CAN and the ISO-26262 safety standard. (The standards and certifications

highlighted herein apply mainly to over-the-road vehicles, less so to agriculture, construction, mining, and recreational vehicles markets.)

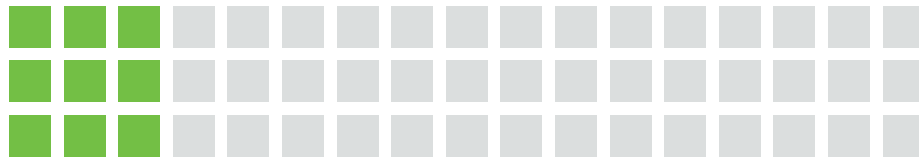
Large, multi-national manufacturers already selling into a global marketplace will have a firm handle on the certifications, regulations, and standards that need to be met. In fact, they will usually provide suppliers with their internal Technical Standards & Requirements document detailing all specifications for hardware and software. On the other hand, for small and mid-size companies looking to transition to digital switches, knowledgeable guidance from a trusted supplier-partner can be invaluable. Simply stated, the right supplier-partner can help the design engineer quickly sort through all variables to select the most cost-effective product for his or her application and market(s).

4. Consider the ways digital switching can enhance vehicle marketability and help boost profitability.

– Multiplexing is the future and the future is now as the functionality and features of the passenger car dashboard steadily find their way into the cabs of commercial vehicles. As with many 21st-century business trends, this one is driven by the new economics and capabilities afforded by innovative technology. Chief among these new capabilities are increased levels of customization and flexibility in design:

1 Owen C. Duffy, Gus Wright (2016) Fundamentals of Medium/Heavy Duty Commercial Vehicle Systems, Jones & Bartlett Learning, 5 Wall Street, Burlington, MA 01803 (<http://bit.ly/2TxnZqL>)

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• **Customization** – With multiplexing, manufacturers now have the ability to customize the “brains” of their vehicles to much the same extent as the body. This has resulted in numerous new add-on features (and upsell opportunities) that can enhance vehicle comfort, productivity, and safety. A few safety-related examples include:

- Headlights that automatically switch on upon wiper activation per road safety regulations.
- Automatic dimming of interior bus lighting that minimizes windshield glare.
- Power door lock activation above 5 mph (8 kph).

Digital switching offers varying degrees of customization depending on the customer’s wants, needs, and budget. For example, the manufacturer can specify a standard digital switch at one price point and for an incremental price increase offer the option to customize the rocker. At the other end of the spectrum if the customer wants a completely customized dashboard that’s an option as well; the possibilities are virtually limitless.

• **Flexibility in design** – Digital switching enables manufacturers to easily integrate new options into their vehicles. This is a particular benefit for many smaller to mid-size companies whose key competitive strength is maximum design flexibility. Take, for example, switch placement. With some digital switches, the intelligence is in the switch itself so switch placement can be anywhere the customer wants. If, for instance, the customer wants the door lock switch on the door instead of the center console, no problem. The switch can be removed, relocated and reprogrammed. Indeed, by making design customizable, scalable and expandable multiplexing gives the manufacturer and its customers the ultimate in design flexibility. In summary, while electromechanical switches still play a major role in commercial vehicle electrical

design, digital switches offer advantages that can make them the more suitable choice for many applications. Without a doubt, multiplexing is the future of commercial vehicle electrical design that’s fast becoming the present. The market for global automotive digital switching systems, valued at roughly USD 9.8 billion in 2017 is expected to grow to USD 16.8 billion by 2023. For now, at the least, it’s fair to say that a point has been reached when commercial vehicle transportation engineers should carefully weigh the pros and cons of both switch types when designing in a switching system.

Why Choose Carling Technologies, Part of Littelfuse, as Your Switch Supplier

1. More than a century of business experience and an unwavering focus on switches and controls.– Founded in Hartford, CT in 1920 by Arthur Carling, the company began operations as Carling Tool and Machine Company. Since the 1940s the company has focused on the development and precision-manufacturing of switches and controls and has been awarded more than sixty patents for switch designs.

The company’s steadfast focus has helped Carling components become a preferred choice among manufacturers of on-road and off-road vehicles. And it has positioned Carling as a top 3 global supplier of dashboard switches.

Carling switches are, in fact, among the most recognizable switches in the industry because of their unmatched quality and aesthetics. And thanks to the dedication of its employees over the years, Carling has grown to become a respected industry leader with a worldwide presence.

Acquired by Littelfuse in 2021, Carling continues to broaden its global impact by leveraging the complementary engineering capabilities, application expertise, and product portfolios of Littelfuse to provide greater value to its diverse and growing OEM and distributor customer base.

2. Long-term supplier-partner relationships with the world’s preeminent commercial vehicle manufacturers.

– One sound criterion for judging a company is by the quality of the relationships it builds and the longevity of those relationships. In the case of Carling, a track record of innovation and engineering excellence has helped it earn the business of the world’s largest truck, bus, construction, and agriculture OEMs. Equally important is the fact that the majority of these relationships are more than 20 years old.

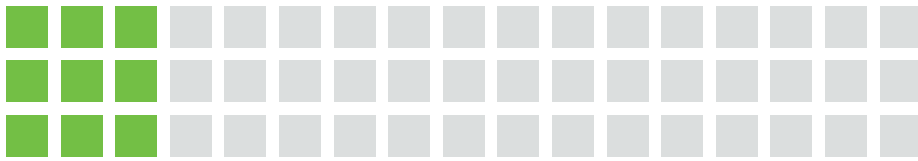
3. History of technical excellence and innovation extending to the present.

– As a trusted, long-standing, supplier-partner to global leaders in one of the world’s most competitive industries, Carling is continuously challenged to innovate. To engineer products that exceed existing performance levels, products that help cut costs, that deliver greater value, that make its customers’ vehicles more competitive.

Over the years and into the present-day Carling has met and continues to meet the challenge of innovation. For example, the company developed the industry’s first waterproofed/sealed switch and the first with removable rockers and removable actuators. Carling also engineered the first 8-terminal switch and the first switch with LED lighting.

The Carling innovation strategy is to listen to customers and identify and track industry trends and mandates and invest wisely and accordingly. For example, Carling’s investment in electronic design and software development dates back 20 years. This

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seed capital yielded a line of electronic switch, monitoring and control products. Which in turn led to opportunities to develop custom multiplex switch products for major customers. Carling continues to invest in innovation and to partner with customers; its customization capabilities are, indeed, a company strong suit.

4. Comprehensive global industry certifications that meet or comply with all major standards and regs for hardware and software. – Carling maintains up-to-date manufacturing and software-related certifications from all major global standards organizations. These include ASTM, IATF, SAE, UL/CSA, e-Mark, ISO 9001, ISO 14001, ISO-26262, SAE J1939 CAN and the like. In addition, the company meets compliance requirements for REACH and RoHS and follows industry-recognized APQP design and development standards and adheres to the Global Code of Conduct.

Whether it's a start-up launching a niche product aimed solely at the U.S. market or a global manufacturing giant targeting the world...customers can count on Carling to help them select the best-suited, most cost-competitive components for the job.

5. Extensive customization capabilities. – As a long-time strategic supplier to leading commercial vehicle manufacturers, Carling has substantial experience developing customized

products. And in adding custom touches to standard components. In both cases the result is the same: the customer differentiates and enhances its vehicles and its brand, while often gaining upsell opportunities that can boost business results. In one instance it's adding a customer-branded cover and rocker to a standard switch. In another, it's working hand-in-hand with the customer to develop a full-blown, fully-customized dash panel. In every instance, the takeaway is this: Carling offers a full suite of products and customization capabilities to serve any need and fit any budget.

6. Worldwide presence. – Carling supports and services customers in every corner of the globe. It delivers this support and service through strategically located worldwide manufacturing operations and a complementary suite of distribution, sales, and R&D facilities and offices. From technology-aided execution of cross-continent R&D projects to the boots-on-the-ground operation of a certified distributor... Carling has the presence and the people to take you from concept to production anywhere in the world.

Thank you for downloading and reading this white paper. For nearly a century we've been dedicated to serving the needs of our customers.

During this time we're proud to have earned the trust and confidence of many of the world's largest commercial vehicle manufacturers. We are honored and privileged as well to have merited the business of many small and mid-size manufacturers. In every instance, of course, it began with a contact, an inquiry, a conversation. If you have a need, a challenge, a problem in search of a solution, or any situation with which our people and our products may be of assistance, we welcome the opportunity to serve you.

About Littelfuse – Founded in 1927, Littelfuse is a diversified industrial technology manufacturing company empowering a sustainable, connected, and safer world. Across more than 20 countries, and with approximately 18,000 global associates, e partner with customers to design and deliver innovative, reliable solutions.

Why Choose Littelfuse – Complementing our wide portfolio of circuit protection products is a global network of design and technical support expertise. We offer decades of design experience to help you address application challenges and achieve regulatory compliance.

Corporate Headquarters
8755 West Higgins Road, Suite 500
Chicago, Illinois 60631

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