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Major e-drive component-related developments in 2023

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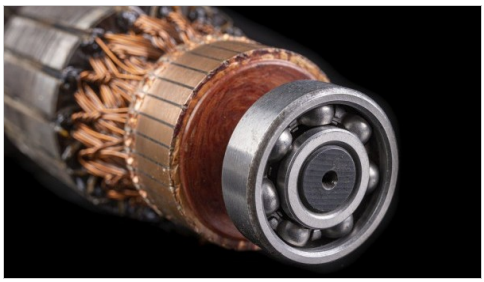
For the e-drive market, 2023 was marked with a high focus on SiC devices for EV advancement, vertical integration by original equipment manufacturers and collaboration between various industry players to drive competitiveness.



Source: Piotr Wytrazek via gettyimages

As 2023 draws to a close, we look at the main developments and market/technology trends during the year that shaped the e-drive components (such as e-motors, inverters) and the e-drive system integration market.

1. The increased focus on silicon carbide (SiC) devices as a way to increase EV range and enable ultra-fast charging.

An efficient inverter can increase the range and performance of an electric vehicle without significantly adding to the cost or weight of the vehicle. Owing to this improvement, automakers are increasingly moving toward wide band gap material, and SiC is one of them. SiC offers higher electric-field breakdown capability, better thermal conductivity, higher temperature operation capacity, and higher switching frequency owing to a wide electronic band gap resulting in lower switching and conduction losses compared with silicon insulated gate bipolar transistor (or Si IGBT).

Better thermal conductivity of SiC enables the inverter to dissipate heat much quicker and more efficiently. This allows the use of smaller, cost-effective cooling solutions. Furthermore, as the shift to 800V architecture is gaining traction among original equipment manufacturers, it further necessitates the use of wide band gap semiconductors such as SiC based inverters.

During the last 12 months, a series of SiC-based partnerships (mostly long-term supply agreements) took place wherein OEMs/tier 1 suppliers have partnered with SiC suppliers. The most common reason for the majority of these partnerships is to ensure a secure long-term and stable supply of SiC.

Major SiC-based announcements in 2023

Who	What
Magna – Onsemi	A long-term supply agreement (LTSA) in which Magna will integrate Onsemi's EliteSiC metal-oxide-semiconductor field-effect transistor (MOSFET) intelligent power solutions into its eDrive systems. Additionally, Magna announced the investment of roughly $40 million in the procurement of new SiC equipment at Onsemi's sites in New Hampshire, US and the Czech Republic. The investment ensures long-term SiC supply, thereby growing its production capacity and helping it to outpace competitors and advance its electrification strategy.
Renesas – Wolfspeed	The companies entered into a wafer supply agreement and Renesas made a $2 billion deposit to guarantee a 10-year supply commitment of 150 mm silicon carbide bare and epitaxial wafers from Wolfspeed.
Vitesco – ROHM	Vitesco entered into a supply agreement with ROHM to secure a long-term and stable supply of SiC. Vitesco's advanced inverters with integrated ROHM SiC chips will be adopted by two customers for

	their EV powertrains.
Vitesco – Onsemi	Vitesco has entered into a 10-year supply agreement valued at $1.9 billion for SiC products, a move designed to bolster its electrification technologies. In addition, Vitesco is investing $250 million in Onsemi for the procurement of new equipment. This equipment, intended for SiC boule growth, wafer production and epitaxy, will ensure Vitesco's access to SiC capacity. Onsemi will utilize this equipment to produce SiC wafers, thereby catering to Vitesco's growing SiC demand.
BorgWarner – Onsemi	The extension of the strategic collaboration for SiC, brings the agreement to over $1 billion in lifetime value. BorgWarner plans to integrate the Onsemi EliteSiC 1200V and 750V power devices into its VIPER power modules.
Foxconn – Infineon	The companies signed a Memorandum of Understanding (MoU) in May 2023, to focus on SiC development by leveraging Infineon's automotive SiC innovations and Foxconn's expertise in automotive systems. Both companies will collaborate on the implementation of SiC technology in automotive high-power applications such as traction inverters, onboard chargers and DC-DC converters.
ZEEKR – Onsemi	The companies announced a long-term supply agreement in which Onsemi will supply its EliteSiC (EliteSiC MOSFET, 1200V, M3E) power devices to increase the powertrain efficiency of ZEEKR's smart EVs. This agreement will also ensure ZEEKR has a stable supply of SiC.
BMW – Onsemi	Onsemi announced an LTSA with BMW to supply Onsemi's EliteSiC technology for BMW's electric drivetrains for the 400V DC Bus.
Volkswagen – Onsemi	The companies signed a strategic agreement in which Onsemi will supply modules and semiconductors that enable a complete EV traction inverter solution for Volkswagen's next-generation platform family.
ZF – STMicroelectronics	ZF has entered into an agreement with STMicroelectronics (ST), a global semiconductor player, to purchase SiC devices starting in 2025. The multiyear contract stipulates that ST will supply SiC devices in the double-digit millions, which will be integrated into ZF's new modular inverter architecture. This architecture is slated for series production in 2025.
ZF – Wolfspeed	ZF entered a partnership with Wolfspeed to establish a joint European research and development center for SiC power electronics in the Nuremberg Metropolitan Region.
Li Auto – STMicroelectronics	STMicroelectronics (ST) has signed a long-term supply agreement with Li Auto, a mainland Chinese EV manufacturer, to provide SiC MOSFET devices for Li Auto's high-voltage battery-electric vehicles (BEVs). The agreement stipulates that ST will provide Li Auto with SiC MOSFETs to support its strategy of offering premium smart EVs with superior performance and range.

Data compiled Dec. 27, 2023.
Sources: S&P Global Mobility.

2. Increased efforts to shift from permanent magnet e-motors to magnetless (free from rare earth elements) e-motors.

Permanent magnet motors are widely used in EVs because of their higher efficiency and high-power density. The permanent magnets used in e-motors contain neodymium and dysprosium, both of which have a geographically constrained supply chain and volatile price fluctuations. Therefore, in a bid to reduce dependency on rare earth elements (REEs) — the supply chain of which is fraught with multiple challenges — OEMs and tier 1 suppliers have increased efforts to develop magnet/REE free e-motors.

During its investor day in March 2023, Tesla announced that it will design and develop a permanent magnet motor free from REEs. Recently in September 2023, ZF announced that it has developed a compact and magnet free e-motor called in-rotor inductive-excited synchronous motor (I2SM), which transmits the energy for the magnetic field via an inductive exciter inside the rotor shaft. Japan-based Proterial has developed a magnet for e-motors that need only one-fifth of terbium compared with existing magnets. The company also has plans for mass production of this new magnet and expects the start of deliveries by 2027.

3. Efforts to establish and secure REE supply chain.

S&P Global Mobility forecasts that permanent magnet e-motors will comprise approximately 80% of total eAxle motors used in EVs by 2030. As the supply chain of REEs is fraught with numerous challenges such as geopolitical issues and overdependence on mainland China, automakers are entering into strategic agreements with REE suppliers to ensure a secure and long-term supply of REEs and REE magnets.

In July 2023, **Stellantis and NioCorp** executed a term sheet for a rare earth offtake term agreement. This ten-year agreement aims to bolster Stellantis' commitment to creating robust supply chains and achieving net-zero carbon emissions by 2038. Concurrently, it is designed to hasten NioCorp's journey toward the commercial production of magnetic rare earth oxides in the United States. Similarly, in January 2023, **General Motors (GM)** signed an agreement with **Vacuumschmelze** under which the latter will build a factory in North America to supply GM with REE magnets for EV e-motors for 10 years starting in 2025.

Apart from partnerships, OEMs are also investing in startups that deal with recycling of REEs or developing REE-free permanent magnets. In November 2023, both GM (through its investment arm GM Ventures) and Stellantis (through its investment arm Stellantis Ventures) participated in the funding round of Niron Magnetics that develops Clean Earth Magnets based on iron nitride that function without rare earths or other critical materials used in modern EVs. In April 2023, BMW i Ventures announced an investment in Cyclic Materials, a circular supply chain firm focused on recycling REEs, based in Canada.

Additionally, various countries are also developing regulations and policies to help establish a local and secure REE supply in a bid to reduce overdependency on mainland China for REEs.

4. Increased investments by OEMs for in-house production of e-drive components and system integration

Many OEMs are increasingly leaning toward in-house production for e-motors and system integration, as evidenced by their investments in new plants and expansion of existing production lines. This shift can be attributed to several factors, including the desire to gain a competitive edge, expedite product development and reduce costs. According to S&P Global Mobility forecasts, in-

house production is the preferred strategy for e-motors and system integration, while inverters are typically outsourced. In 2023, OEMs made significant investments in the establishment and expansion of facilities for in-house production of e-motors and e-drive components.

- **GM:** In February 2023, GM announced its investment in its powertrain plant (which currently manufactures ICEs and transmissions for various GM car and pickup models) in Ontario to produce 400,0000 units of e-drives per annum. It also announced its plans to manufacture new Ultium electric drive units at its St. Catharines Propulsion Plant in Ontario, Canada. The plant is projected to produce over 400,000 e-drive units annually.
- **Stellantis:** In February 2023, Stellantis announced a $155 million investment in three Kokomo, Indiana, plants to produce new electric drive modules (EDMs). The EDMs built in the Kokomo plant will be integrated into vehicles designed on the STLA Large and STLA Frame platforms.

5. Automotive suppliers are capitalizing on the growth in EVs through strategic investments (for increased production) and mergers and acquisitions (M&As).

The swift transition to electrification is facilitating a multitude of market opportunities that OEMs and suppliers are eager to tap into. Many suppliers are investing in the construction or expansion of production facilities for the production of e-drive components and meet rising demand. Meanwhile, others are leveraging M&As to secure a strong market position, enhance their expertise and expand their product portfolio.

Some of the notable M&As of 2023 are as follows.

- **Schaeffler – Vitesco**: Recently, in November 2023, following Schaeffler's voluntary tender offer to acquire Vitesco, Schaeffler and Vitesco signed a business combination agreement. This agreement will help Schaeffler to emerge as a strong supplier in the overall e-drive market with an extensive product portfolio offering e-motors and inverters. According to Schaeffler, Vitesco's offerings will be bundled into the former's E-mobility division with the aim of becoming an e-mobility market leader.
- **Infineon – GaN System:** In October 2023, Infineon completed the acquisition of GaN System to accelerate its gallium nitride (GaN) roadmap and expand its product portfolio. With the acquisition, Infineon now has 450 GaN experts and over 350 GaN patent families, expanding the company's leadership position in power semiconductors and significantly shortening time to market.

Examples of investments by suppliers in new plants/expansion include:

In July 2023, BorgWarner announced an investment in Mexico that includes a new manufacturing plant focusing on power electronics components and e-motors. ZF also announced that it will open a new e-mobility plant in Shenyang, China to produce advanced products such as eAxle drives. The first phase of the project will be launched in March 2025. Other suppliers such as Dana, Nidec, AISIN, Vitesco and Bosch have also announced significant investments for the production of e-drive components.

Conclusion

At the close of 2023, the e-drive market was marked by a focus on SiC devices for EV advancement and a shift to magnetless e-motors for sustainability. Future innovation will likely center on optimizing SiC technology and exploring alternative materials. Vertical integration by OEMs is set to

continue, ensuring a streamlined production process. Collaborative efforts between automotive suppliers and cross-industry partnerships will drive competitiveness. The path forward involves sustained technological refinement, a commitment to sustainability and collective endeavors to address challenges such as motor technology advancements and infrastructure development. The e-drive market is not just adapting, but actively shaping the future of electric mobility.

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