MAINSTREAM ENGINEERING CORPORATION

High Performance Motor Drives

Solutions Through Advanced Technology®
MAINSTREAM ENGINEERING

Mainstream's Approach

Mainstream Engineering Corporation uses the latest wide bandgap (both GaN and SiC) devices to develop high-efficiency, size- and weight-optimized motor drives for a wide range of demanding military and commercial applications. We specialize in medium- to high-speed motor drives (10 krpm to over 150 krpm) and low- to medium-power (1 kW to 500 kW) systems. Mainstream develops and produces components and systems specifically for the rugged military environment where size, weight, and power (SWaP) are critical. We rely on our extensive history of developing thermal control and energy conversion systems to provide fully integrated motor drives that have tremendous SWaP advantages when compared to commercial and legacy military systems. All of Mainstream's motor drives are designed to satisfy requirements of MIL-STD-461 and MIL-STD-810.

Hybrid Electric Turbocharger

Engine turbocharging provides many advantages in terms of improvement of fuel efficiency and

the potential for engine downsizing. However, current turbochargers are deficient in transient response,

effective operating range, and recovery of excess engine exhaust energy recovery. Mainstream is developing a hybrid electric turbocharger (HE-T/C) by incorporating an integrated motor alternator (IMA) into a turbocharger, making it capable of overcoming the downfalls of traditional turbochargers. The IMA device is used to reduce turbine spool-up time, leading to improved throttle response, and to expand its effective operating range, allowing it to operate at the most efficient point. This same IMA device will be used to harvest excess energy and generate electrical power that can be used for propulsive power or electrical accessories. These improvements will lead to better performance, increased fuel economy, and lower emissions in vehicles using HE-T/C technology.

Drive for Hybrid Electric Turbocharger

Motor drives designed for commercial and military vehicles typically require a separate cooling loop running at 65°C, as the existing 105°C vehicle cooling loop is too high to reliably operate the power electronics. This adds a significant burden on the vehicle integrator as the volume, weight, and power requirements of this additional coolant loop must be accounted for. Mainstream has developed an 18 kW continuous, 29 kW peak motor drive using SiC devices that is >98% efficient and can run from the existing 105°C coolant loop on vehicles. This motor drive was developed for HE-T/C applications but can be extended to higher power vehicle traction drives. Output power capability of the drive can be increased if running at lower coolant temperatures (<105°C).

HE-T/C Drive	
Power	18 kW cont./ 29 kW peak
Size	14" x 8.375" x 4.125"
Weight	16.9 lbs
Efficiency	>98%
Coolant Temperature	105°C

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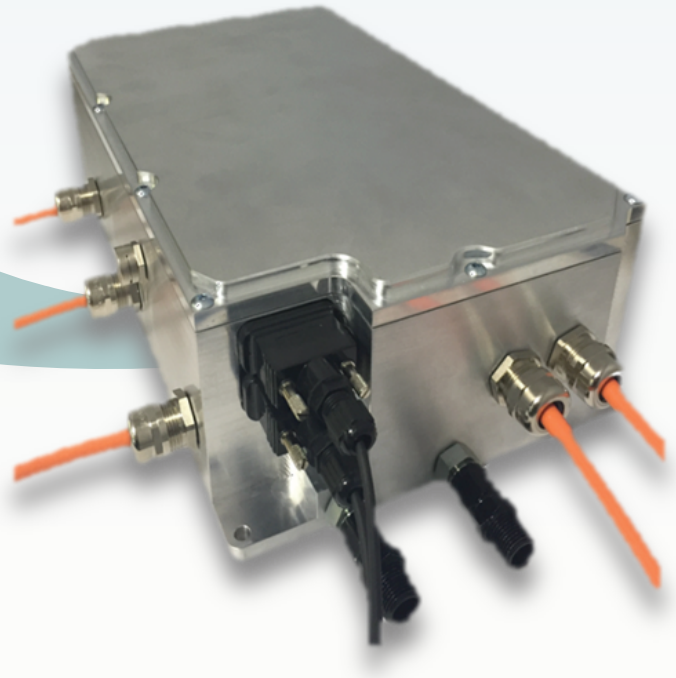
Drives for Vehicle Traction

The Department of Energy regularly releases volumetric and gravimetric energy density targets for vehicle traction drives. Building upon the success of our HE-T/C motor drive, we are developing a higher power and higher voltage motor drive for traction applications that uses the same SiC devices and can run with 105°C coolant. In 480 VAC applications, our motor drive can deliver 50 kW continuous power and 72 kW peak at 105°C coolant temperatures. At 70°C and 50°C coolant temperatures, the power delivery capability of the drive increases to 85 kW and 105 kW, respectively. Additional performance specifications of our drive in traction applications are shown below and highlight the ability to meet the DOE traction drive targets for 2020.

Traction Drive	
DOE 2020 Targets	13.4 kW/L, 14.1 kW/kg
Specific Power	13.9 kW/L, 14.3 kW/kg
Efficiency	>99%
Coolant Temp	105°C



Drives for Screw Compressor

We have developed a twin screw compressor that is 91% smaller and 87% lighter than commercial compressors. As part of the larger thermal management system, we are developing the motor drive that is required to drive our screw compressor. This drive uses the same SiC devices as our other motor drive products and is rated for 45 kW. Instead of using high-temperature engine coolant, this drive uses two-phase R-134a refrigerant to reduce the total thermal resistance seen by the SiC MOSFETs as well as to reduce the coolant temperature to 25 °C. With this reduced coolant temperature the power density of the VFD is increased to over 289 W/in3 (17.7 kW/L).

Direct Refrigerant Cooled SiC VFD	
Power Density	289 W/in^3 (17.7 kW/L)
Efficiency	>98%
Coolant Temp	25 °C
Coolant Type	2-Phase R-134a

Mainstream Engineering Corporation is a solutions-oriented research, development, and manufacturing business founded in 1986. Our engineering mission is to research and develop emerging technologies and to engineer these technologies into superior quality, military and private sector products that provide a technological advantage. Areas of expertise include thermal control, energy conversion, power electronics, turbomachinery, chemical technology, and materials science.

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