

# Z-FORCE™

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P O W E R T R A I N S

POWERTRAIN SOLUTIONS



## **THE 2013 MODEL YEAR Z-FORCE™ POWERTRAIN BY ZERO MOTORCYCLES**

The revolutionary 2013 Z-Force™ powertrain is a high power, high efficiency system designed and assembled by Zero Motorcycles in California. A modular design, the powertrain components can be used in a wide variety of applications where an electric power pack or complete powertrain offer advantages. Using robust systems originally designed to endure demanding motorcycle applications, the Z-Force™ powertrain offers a cost effective and rapid path to deploying industry-leading technology into a new concept, product or lineup.

### **Advantages of the Z-Force™ powertrain:**

- » Robust, modular and refined system
- » Produces little noise, no exhaust and minimal heat
- » Requires no gas or fluids
- » Requires no routine maintenance
- » Costs very little to operate
- » Offers an incredibly high power-to-weight ratio
- » Includes fully UN 38.3 certified batteries

### **Three main Z-Force™ powertrain kits:**

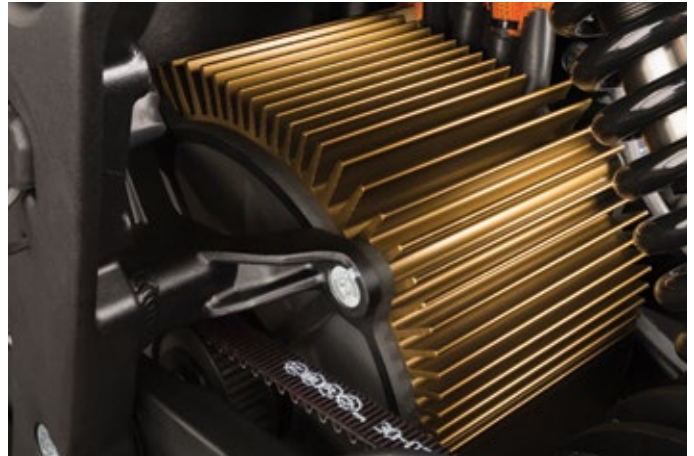
1. Battery pack kit
2. Motor/controller kit
3. Complete powertrain kit

## LEVERAGING ZERO MOTORCYCLES' STATE OF THE ART POWERTRAINS

The 2013 Z-Force™ powertrain is the culmination of years of research and design in creating a powertrain where minimizing size and weight are essential. Over the last several years, Zero Motorcycles has pushed the limits of technology to make the Z-Force™ powertrain one of the world's most compact, powerful and production ready systems. The Z-Force™ powertrains offered to you are the same powertrains used in the Zero Motorcycles 2013 electric motorcycle lineup.



» ZF8.5 Power Pack – as seen on the 2013 Zero DS



» Motor – as seen on the 2013 Zero S



» ZF5.7 Power Pack – as seen on the 2013 Zero XU



» DeltaQ Charger

## BATTERY PACK KIT

The Z-Force™ battery pack uses state of the art Li-Ion cell technology and an advanced battery management system to achieve longevity, reliability and a high power output. Capable of 2,500 full discharge cycles to 80% capacity, our battery pack is the solution to powering systems where consistency and quality are essential.

### Customers can now enjoy:

- » State of the art battery management system (BMS), Li-Ion NMC cell chemistry
- » Cells rated to 6.5C continuous discharge, 10C burst (15 sec), 1C charge
- » Elegant low-resistance and highly robust cell interconnect technology
- » Power pack rated to 2,500 full charge-discharge cycles to 80% of original capacity
- » Four available capacities: 2.8 kWh (ZF2.8)<sup>1</sup>, 5.7 kWh (ZF5.7)<sup>1</sup>, 8.5kWh (ZF8.5)<sup>2</sup> or 11.4 kWh (ZF11.4)<sup>2</sup> maximum capacity
- » ZF5.7 is a fully modular, patent-pending solution able to operate with one (2.8 kWh) or two (5.7 kWh) battery modules, even at different initial states of charge
- » Chargeable using a standard household electrical outlet
- » Scalable quick-charge options available to cut recharge times by as much as 75%
- » Available accessory to enable charging at CHAdeMO stations in under 1 hour (to 95%)



» ZF2.8 Power Pack

» DeltaQ charger



### FACT SHEET

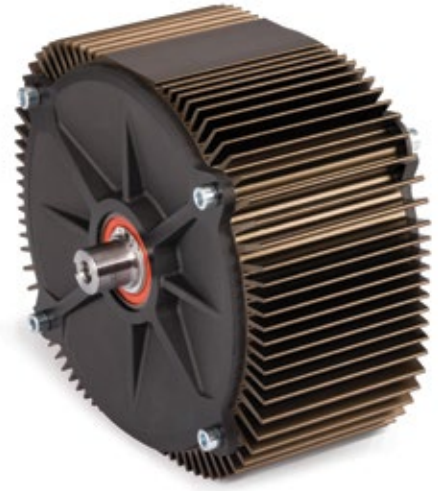
	ZF2.8	ZF5.7	ZF8.5	ZF11.4
<b>POWER PACK</b>				
Estimated pack life to 80%	2,500 full charge-discharge cycles	2,500 full charge-discharge cycles	2,500 full charge-discharge cycles	2,500 full charge-discharge cycles
Maximum voltage	116.2 V	116.2 V	116.2 V	116.2 V
Nominal voltage	102.2 V	102.2 V	102.2 V	102.2 V
Nominal capacity	24.5 Ah	49 Ah	73.5 Ah	98 Ah
Nominal energy capacity	2.5 kWh	5.0 kWh	7.5 kWh	10 kWh
Max energy capacity	2.8 kWh	5.7 kWh	8.5 kWh	11.4 kWh
Pack max continuous discharge	150 A	300 A	300 A	300 A
Pack max burst discharge, 15 sec	240 A	480 A	500 A	500 A
Pack max continuous charge	25 A	50 A	2 x 25 A	2 x 25 A
Dimensions (LxWxH)	248x200x188 mm	2X 248x200x188 mm	378x252x430.5 mm	378x252x430.5 mm
Weight	19 kg / 42 lb	38 kg / 84 lb	62 kg / 137 lb	77 kg / 170 lb
Pack Vol. Energy Density, Nom	253 Wh/l	253 Wh/l	181 Wh/l	242 Wh/l
Pack Grav. EnergyDensity, Nom	132 Wh/kg / 60 Wh/lb	132 Wh/kg / 60 Wh/lb	121 Wh/kg / 55 Wh/lb	130 Wh/kg / 59 Wh/lb
<b>CHARGER</b>				
Power	1.0 kW	1.0 kW	1.0 kW	1.0 kW
Input	Standard 110 V or 220 V	Standard 110 V or 220 V	Standard 110 V or 220 V	Standard 110 V or 220 V
Pack recharge time (hours)	2.7 h (2.2 h to 95%)	4.9 h (4.4 h to 95%)	7.1 h (6.6 h to 95%)	9.3 h (8.8 h to 95%)
Accessory: max # of chargers	2	4	4	4
Dimensions (LxWxH)	278x246x109 mm	278x246x109 mm	278x246x109 mm	278x246x109 mm
Weight	9.5 lb	9.5 lb	9.5 lb	9.5 lb
<b>Additional components</b> Low-power pigtail, high-power pigtail, documentation				
Retail price <sup>3</sup>	\$2,995	\$5,495	\$7,495	\$9,195

## MOTOR/CONTROLLER KIT

The Z-Force™ motors are Zero Motorcycles' compact and efficient brushless motors. Completely air cooled, they are designed to provide years of performance and utility without the need for regular maintenance. When decelerating the motor/controller combination is designed to recapture energy. If coupled with the Z-Force™ battery pack, this regenerative power can be used to partially recharge the battery.

### Unique features of this motor kit are:

- » Z-Force™ brushless permanent magnet electric motor capable of delivering instant torque from 0 rpm while omitting the need of routine maintenance
- » Motor/controller combination allowing regenerative deceleration capable of incrementally recharging Z-Force™ battery pack
- » Three available configurations: ZF75-5 with Sevcon size 2 controller (27hp), ZF75-5 with Sevcon size 4 controller (44hp) and ZF75-7 with Sevcon size 4 controller (54hp)



- » High-efficiency, radial flux, permanent magnet, brushless motor

- » Sevcon Gen4, size 2, 3-phase controller



### FACT SHEET

		ZF75-5 SIZE 2	ZF75-5 SIZE 4	ZF75-7 SIZE 4
<b>MOTOR</b>				
Type		High efficiency, radial flux permanent magnet, brushless motor	High efficiency, radial flux permanent magnet, brushless motor	High efficiency, radial flux permanent magnet, brushless motor
Cooling		Passively air-cooled	Passively air-cooled	Passively air-cooled
Peak power		27 hp @ 3500 rpm	44 hp @ 3700 rpm	54 hp @ 4300 rpm
Peak torque (up to 3500 rpm)		42 ft-lb	70 ft-lb	68 ft-lb
Dimensions (diameter x L)		269x124 mm	269x124 mm	269x144 mm
Shaft diameter and length		1inx23.4 mm	1inx23.4 mm	1inx23.4 mm
Weight		30 lb	30 lb	39 lb
<b>CONTROLLER</b>				
Type		Sevcon Gen4, size 2 3-phase	Sevcon Gen4, size 4 3-phase	Sevcon Gen4, size 4 3-phase
Maximum output		250 A	420 A	420 A
Operating voltage		85-116.4 VDC	85-116.4 VDC	85-116.4 VDC
Dimensions (LxWxH)		187x151x69 mm	227x168x79 mm	227x168x79 mm
Weight		2.9 lb	5.9 lb	5.9 lb
<b>Additional components</b>		Signal pigtail, controller pigtail, high-power leads (w/motor), documentation		
<b>Retail price<sup>3</sup></b>		<b>\$1,595</b>	<b>\$1,795</b>	<b>\$1,995</b>



» ZF8.5 Power Pack



» DeltaQ charger



» Sevcon Gen4, size 4,  
3-phase controller



» High-efficiency, radial flux,  
permanent magnet, brushless motor

## COMPLETE POWERTRAIN KIT

Zero Motorcycles also offers the complete Z-Force™ powertrain kit as a turn-key solution that can be easily integrated into a wide range of applications.

### Customers can now enjoy:

- » State of the art battery management system and Li-Ion cell chemistry
- » Elegant low resistance and highly robust cell interconnect technology
- » Power pack rated to 2,500 full charge-discharge cycles before hitting 80% capacity
- » Four available capacities: 2.8 kWh (ZF2.8)<sup>1</sup>, 5.7 kWh (ZF5.7)<sup>1</sup>, 8.5kWh (ZF8.5)<sup>2</sup> or 11.4 kWh (ZF11.4)<sup>2</sup> maximum capacity
- » ZF5.7 is a fully modular, patent-pending solution able to operate with either one (2.8 kWh) or two (5.7 kWh) battery modules, even at different initial states of charge
- » Chargeable using a standard household electrical outlet
- » Scalable quick-charge options available to cut recharge times by as much as 75%
- » Available accessory to enable charging at CHAdeMO stations in under 1 hour (to 95%)
- » Z-Force™ brushless permanent magnet electric motor capable of delivering instant torque from 0 rpm while omitting the need of routine maintenance
- » Motor/controller combination allowing regenerative deceleration capable of incrementally recharging Z-Force™ battery pack
- » Integrated mode switch allows for two different controller setting configurations with respect to max rpm, max torque, and re-gen rate

## The complete powertrain kit exists in five different configurations:

- 1) ZF2.8 battery pack + ZF75-5 motor and Sevcon size 2 controller – **Retail price<sup>3</sup> \$5,195**
- 2) ZF5.7 battery pack + ZF75-5 motor and Sevcon size 4 controller – **Retail price<sup>3</sup> \$7,795**
- 3) ZF5.7 battery pack + ZF75-7 motor and Sevcon size 4 controller – **Retail price<sup>3</sup> \$7,995**
- 4) ZF8.5 battery pack + ZF75-7 motor and Sevcon size 4 controller – **Retail price<sup>3</sup> \$9,995**
- 5) ZF11.4 battery pack + ZF75-7 motor and Sevcon size 4 controller – **Retail price<sup>3</sup> \$11,695**

*See sections above for the detailed specifications of the battery packs, motors and controllers.*

## Each powertrain kit includes the following components:

- » Battery pack
- » Motor
- » Controller
- » System control module
- » External contactors (ZF2.8 and ZF5.7 kits only)
- » Low-current control harness
- » High-current power harness
- » Low-current control harness pigtail kit: motor signal, controller, throttle
- » Basic dash
- » Kill switch
- » Mode switch

In addition to the above basic components in the complete powertrain kits, following components can be ordered as needed: throttle, DC-DC converter, key switch, kickstand switch, lighting harness, LH switch unit, service kit.

## Notes:

1. The modular battery packs kits, ZF2.8 and ZF5.7, have an internal solid-state switch and a number of safety interlocks to ensure that the battery does not assert power in an unsafe manner. Integration of the battery into your system will be required including CAN Bus interface, digital safety signals, and pre-charge circuits. Without this integration the battery will not enable power to its outputs
2. The monolith battery pack kits, ZF8.5 and ZF11.4, have an internal contactor and a number of safety interlocks to ensure that the battery does not assert power in an unsafe manner. Integration of the battery into your system will be required including CAN Bus interface, digital safety signals, and pre-charge circuits. Without this integration the battery will not enable power to its outputs
3. Prices are retail prices per unit. Discount prices for volume purchase available upon request.





**ZERO MOTORCYCLES**

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