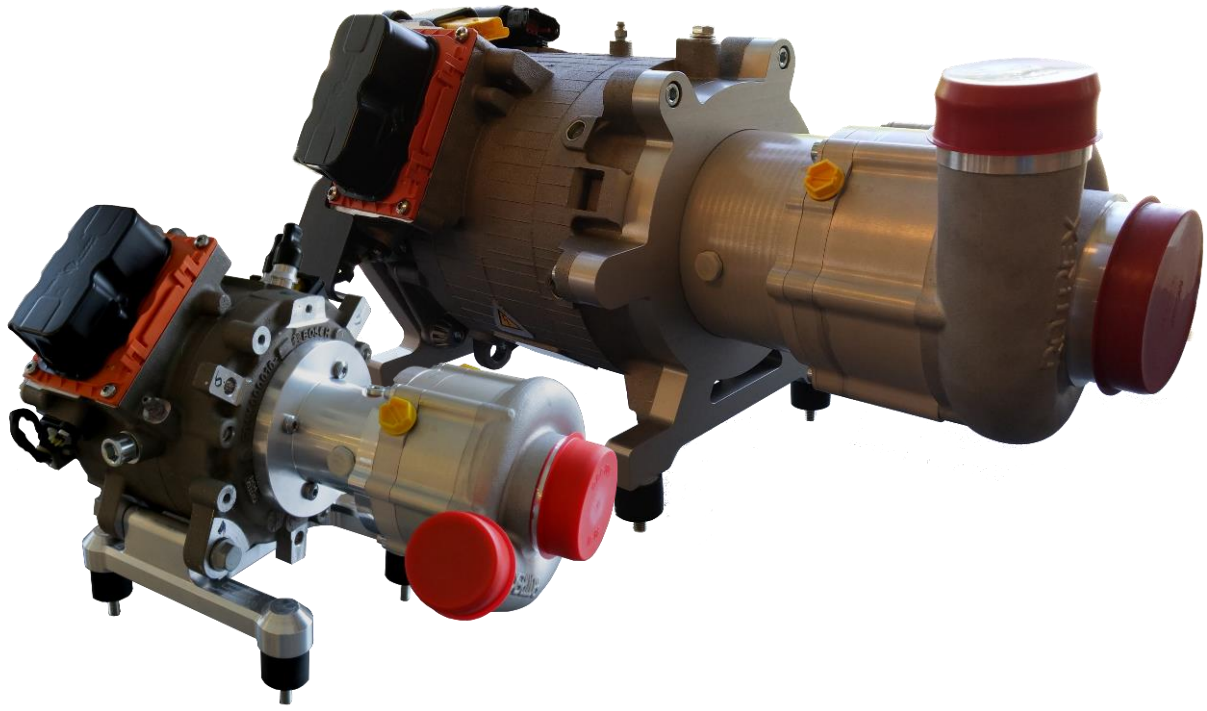
Rotrex™ E-charger

Technical Datasheet

Product:	EC-8/15/30/38
Version:	1.60
Page	1 of 7



General description of the E-charger compressor system

Due to recent successes with an electrification of the Rotrex Supercharger portfolio, Rotrex is now able to offer complete E-Charger compressor systems for various industrial, process engineering, educational, automotive, mobile and green energy applications. The E-Charger is equally well suited for permanently installed industrial applications, research and development on mobile solutions in laboratory environments, as well as mobile and automotive applications in the field.

Typical applications for the automotive/mobile system are: Air pumps for fuel cells (10kW - 1MW output), pre-boosters for downsized turbocharged engines, forced exhaust gas recirculation, particle filter regeneration systems etc.

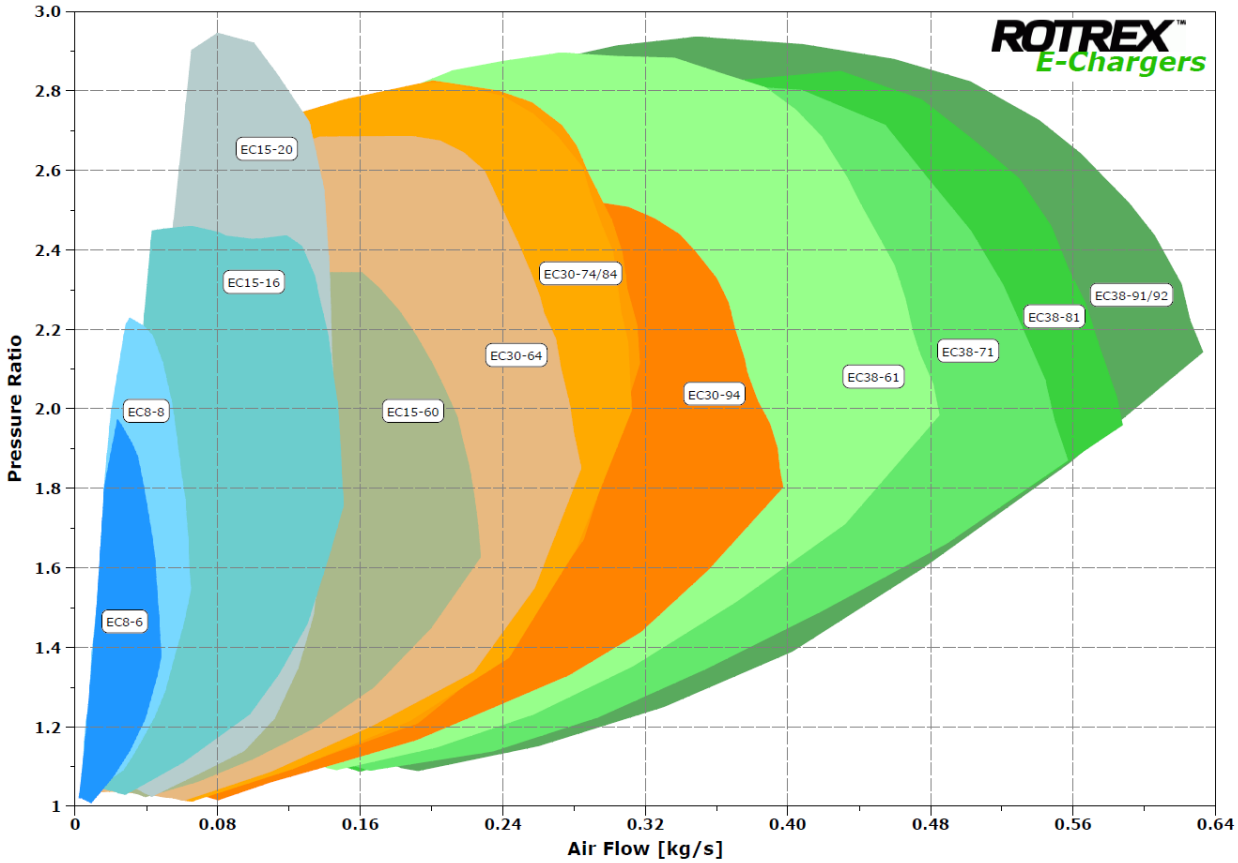
The E-charger prototype is available in two distinct physical packages, based on either the type "B-138" electric motor (approximately 20kW power output) and the type "B-180" electric motor (with approximately 60kW power output).

The Rotrex E-charger compressors are based on Rotrex traction drive technology, and comes in four different sizes . These are the C8, C15, C30 and C38. Each of these traction drive sizes are available with typically 2-4 different centrifugal compressor setups, known as sub-trims. With a total of four different traction drive sizes and no less than 12 different standard sub-trims, a sub-trim can be found to match nearly any aerodynamic operating point, resulting in the highest possible compressor efficiency for each application.

E-chargers based on the Type-B138 electric motor are available in the entire C8, C15, C30 and C38 range, while only the C30 and C38 variants are available with the Type-B180 electric motor. For applications requiring very high mass flow at low compression ratios, which cannot be obtained with the EC8 and EC15 E-chargers, a combination of Type B138 motors and oversized C30 and C38 compressors can be excellent solutions.

A compressor datasheet on each traction drive size, including compressor map for each sub-trim, is available for download at www.rotrex.com (under technology/technical data). Customized aerodynamic setups can also be developed.

The compressors themselves feature an integrated dual-action oil pump, that works as a dry sump scavenging pump in addition to being the oil supply pump. A small oil filter and oil canister is mounted externally by the system designer, along with an oil cooler. An oil radiator (cooled by fan air) or optionally a water-cooled oil cooler (liquid-liquid heat-exchanger) is required for keeping the oil temperature within the allowable range. Please read the technical handbook for important installation details!



(The Rotrex E-charger range now covers an immense span of air flows with the introduction of the EC30 and EC38)

The Rotrex C-type compressor has been developed and extensively tested with the special Rotrex traction fluid. To maintain performance and durability it is very important that the unit is run exclusively with the special Rotrex traction fluid. Full attention must be paid to ensure that the oil inlet temperature to the compressor is never exceeded (maximum 80°C oil in temperature).

The high-speed permanent magnet synchronous motors (PMSM) in the E-chargers are joined to the compressor head units through a high-speed direct drive coupling system. The result is a small, fully enclosed, compact and rugged E-charger unit, with an IP67 ingress protection classification and no exposed snagging or rotating mechanical parts to look out for. Mechanical vibrations are nearly absent due to the direct-drive connection, the lack of toothed gears and the extreme speeds of the centrifugal compressors. The E-charger is supplied with rubber shock dampeners to protect the E-charger from external shocks and vibrations.

Sevcon HVLP-20 automotive mobile inverter

Operating the E-Charger, Rotrex delivers a pre-set Sevcon (BorgWarner) Gen4 HVLP-20, IP67 automotive, mobile inverter.
Notable features from the HVLP-20 is a native, configurable, CAN J1939 communication interface.
200 – 800 VDC input voltage range. And best in class gravimetric and volumetric power densities.

The HVLP-20 is liquid cooled, similarly to the EK10AA E-Charger. Combined is the entire system completely sealed from dirt and contamination, enabling IP67 protection class.

This presently available HVLP-20 is capable of delivering 33 A output current (~22kW @ 700 VDC).

The Sevcon/BorgWarner Gen4 HVLP-20 inverter.

The RPCS 730 is a brand new state-of-the-art automotive rated mobile inverter (reproduced with permission)

The Parker AC30 inverter range for "industrial" applications

The compressor characteristics of the E-chargers make them quite applicable for a wide range of stationary applications in the industrial segment where 3-phase 400-480VAC is commonly available. As the E-chargers outperform all other compressor technologies in the low pressure segment, with respect to compressor efficiency and power density, the E-charger can be used in such diverse applications as green house spraying, granulate transport, cooling, drying, waste water treatment, fuel cell backup power, UPS systems etc.

The Parker AC30 inverter
(reproduced with permission)

System limitations and conditions

With E-Charger prototype systems being offered as research and development systems, a number of limitations and conditions are associated with the use of these systems.

The system developer is solely responsible for the proper electrical wiring of the components, including the fulfillment of all local and national electrical regulations and laws. Furthermore, both the motor and the inverter must be properly grounded to Protective Earth (PE) in stationary installations. Rotrex cannot take responsibility for the electrical characteristics of customer installations. All cables and cable accessories (between the E-charger and the inverter) are delivered along with the E-charger system, but some minor manual cable assembly work is required. Assembly guides are a part of the standard information and documentation package accompanying the E-charger.

The maximum power output of the E-charger is dependent on the combination of a number of factors such as compressor size, cooling water temperature, inverter input voltage, inverter current limit and motor winding temperature. Regardless of how the system developer runs the E-charger, the maximum motor winding temperature on both motor types is 130°C. Both inverter types are fitted with a trip system, that shuts down the E-charger in the event of excessive motor winding temperatures, preventing permanent system damage. A wide range of incidents can effectively be prevented with this safety system, as the common root cause is excessive winding temperatures.

The E-charger unit is fundamentally designed to keep all internal rotating parts contained in a worst-case scenario mechanical failure, but proper measures must be taken by the system developer to ensure that no human injury can occur in the unlikely event of a complete mechanical failure.

Any E-Charger system must be allowed a full 10 minutes de-energizing period after complete removal of power, before any mechanical work on the E-charger system can commence.

Deviation from the standard Rotrex oil circuit components can damage the E-charger.

Rotrex offers the E-Charger systems as laboratory type development kits for highly skilled and experienced personnel, requiring that the system developer is obliged to treat it as such. The Rotrex E-charger system and all subsystems are sold as a subsystem for integration into other products and are therefore not to be considered a finished product in themselves.

Rotrex is currently only offering limited warranty on the E-charger systems. This is a consequence of the E-charger being in continuous development, where customers are offered early access to the technology, in exchange for contributing in field trials of the system. The growing internal Rotrex database on E-charger extended endurance testing indicates a very rugged and dependable system, however it has not yet been released for production durability. In general, durability and life time depends heavily on the duty cycle of the application. Please contact Rotrex for more information on duty cycle considerations.

E-charger head units

Characteristic	EC-8 range	EC-15 range	EC-30 range	EC-38 range
Total drive ratio	1 : 12.52	1 : 12.67	1: 9.49	1 : 7.5
Unit weight (*)	≈ 16 kg		≈ 38 kg	
E-charger unit physical dimensions	350 x 250 x 280 mm		545 x 260 x 270 mm	
Motor type	Type-B138 (PMSM, sensorless)		Type-B180 (PMSM, sensorless)	
Maximum motor shaft speed	17500 RPM		12650 RPM	
Maximum impeller speed	220000 RPM	201500 RPM	120000 RPM	90000 RPM
Maximum air mass flow	0.065 kg/s	0.22 kg/s	0.39 kg/s	0.63 kg/s
Maximum pressure ratio	2.23	2.94	2.82	2.94
Maximum motor winding temp	130°C			
Motor winding temperature sensor	NTC			
Maximum cooling water temp (*)	105°C (corresponding de-rating required)			
Recommended cooling water temp	< 35°C (for true continuous maximum power)			
Maximum mechanical power (*)	>19 kW continuous (with proper cooling & >700VDC)		> 59 kW continuous (with proper cooling & >700VDC)	
Practical mechanical power (*)	≈ 15 kW continuous @ 3-phase 400VAC 50 Hz		≈ 45 kW continuous @ 3-phase 400VAC 50Hz	
Maximum continuous motor current(*)	≈ 32 A		≈ 100 A	
Enclosure rating, per design	IP67 minimum			
PMSM motor cooling method	Water/glycol 50-50% mix			
Min coolant flow rate (motor) (*)	6 l/min		8 l/min	
Compressor cooling method	Oil radiator requiring fan air or oil-water heat exchanger			
Max inlet oil temperature	+80°C (176°F)			
Rotational direction	Clockwise rotation, as seen from impeller side			

(*) Asterisk marked parameters are interpolated and not guaranteed

AC30 industrial type inverter (motor controller)

Characteristic	AC30 for EC8/15	AC30 for EC30	AC30 for EC38
Unit weight incl. motor leads (*)	≈ 11 kg	≈ 44 kg	≈ 90 kg
Drive physical dimensions	350 x 250 x 150 mm	670 x 260 x 316 mm	800 x 330 x 374 mm
Estimated efficiency	0.97	0.98	0.98
Electrical supply (AC)	3-phase 400VAC to 480VAC (+/- 10%) 45-65Hz		
Electrical supply (DC)	470 - 800 VDC directly on DC bus (requires external pre-charge circuit and fusing)		
Overvoltage category	Category III		
Commutation method	Sensorless space vector control		
E-charger control method	Closed loop speed control		
Cooling method	Forced convection air cooling with internal fans		
Enclosure rating	IP20		
Maximum continuous output current (including de-rating for high speed*)	≈ 30 A	TBD	TBD
Practical continuous output power at 400VAC/560VDC(*)	≈ 15kW	TBD	TBD
Motor winding overheat shutdown	Integrated NTC thermistor based shutdown control as standard		
Default control method	Analog, LAN (build-in application webpage)		
Optional expansion control methods	PROFIBUS DP-V1, DeviceNet, CANopen, PROFINET I/O, Ethernet IP, RS485, Modbus RTU, BACnet MSTP, BACnet/IP, CC-Link, ControlNet, EtherCat, Ethernet, analog voltage or current		

(*) Asterisk marked parameters are interpolated and not guaranteed

Conversion Toolbox
$°C = \frac{5}{9} \times (°F - 32)$ OR $°F = \frac{9}{5} \times °C + 32$
$CFM = \frac{kg}{s} \times 1731.8$ $\frac{kg}{s} = \frac{CFM}{1731.8}$ @15°C and 0.1013MPa
$\frac{kg}{s} = 0.0075 \cdot lb/min$ $lb/min = \frac{kg/s}{0.0075}$

Sevcon HVLP-20 mobile inverter (motor controller)

Characteristic	HVLP-20, Liquid cooled
Physical dimensions	255 x 223 x 88 mm
Weight, dry	≈ 2.3 kg
Electrical supply (high power bus)	200-800 VDC
Aux supply (control board)	12/24 VDC
Output current	33 A continuous. 53 A_{peak}, 60 sec
Commutation method	Closed loop, UVW absolute position feedback
E-Charger control method	CAN J1939 speed request control
Cooling method	50/50 glycol/water mix
Operating coolant temperature	Coolant temperature: -25°C to +65°C no current derating
Minimum coolant flow rate (*)	6 l/min
Maxi. allowable coolant pressure	1.0 bar gauge
Motor winding overheat shutdown	Integrated thermistor-based shutdown control as standard
Vibration tolerance	3 g, 5 Hz to 500 Hz
Shock tolerance	40 g peak, 6 ms, 1000 bumps in each direction repetition rate 1 to 3 Hz.
Enclosure rating	IP6K9K with connectors mated

(*) Asterisk marked parameters are interpolated and not guaranteed

3D model of the HVLP-20 mobile inverter is available in STEP and IGES upon request.

Conversion Toolbox
$°\mathrm{C} = \frac{5}{9} \times (°\mathrm{F} - 32)$ OR $°F = \frac{9}{5} \times °C + 32$
$\mathrm{CFM} = \frac{\mathrm{kg}}{\mathrm{s}} \times 1731.8$ $\frac{\mathrm{kg}}{\mathrm{s}} = \frac{\mathrm{CFM}}{1731.8}$ @15°C and 0.1013MPa
$\frac{\mathrm{kg}}{\mathrm{s}} = 0.0075 \cdot \mathrm{lb/min}$ $\mathrm{lb/min} = \frac{\mathrm{kg/s}}{0.0075}$