ROTREX™

EK40 Technical Datasheet

40kW Fuel Cell Air Compressor

Rev 1.8

Clean oil-free, linear, and non-pulsing air supply (ISO 8573-1:2012 Class 0)

Class-leading efficiency and reliability

Automotive design – High resistance to shock/impacts

Immediate start-up and excellent start-stop properties

Ultra-compact modular design, lightweight, and flexible integration

Cost-effective solution

EK40C compressor

Motor power	40kW continuous / 60kW peak
Air flow range	0.05 – 0.45 kg/s
Pressure ratio range	1.2 – 2.9
Aerodynamic efficiency	Up to 78%

The EK series is our most compact electrical compressors. These units are fully integrated units with built-in motor, traction drive, lubrication, and coolant system.

GENERAL DESCRIPTION

The EK40 is the most powerful fuel cell air compressor on the market, designed specifically for heavy-duty applications and high-power fuel cell stacks. With its capacity, it can support fuel cell applications up to 400kW.

The Rotrex fuel cell compressors are based on our patented class-leading traction drive technology, perfected through decades. Over a decade of experience supplying reliable hardware to the fuel cell industry have led to the thorough development of the EK series fuel cell compressors. The result is a class leading air compressor, that offers unmatched reliability and efficiency.

The EK40 features a specially designed modular centrifugal compressor, developed for aerodynamic operation points matching many fuel cell applications ranging from 100kW – 400kW output. Resulting in a superior fuel cell compressor applicable for a wide variety of industries:

Forklifts • **Automotive** • **Busses** • **Stationary** • **Heavy-Duty** • **Railroad** • **Maritime** • **Aviation**

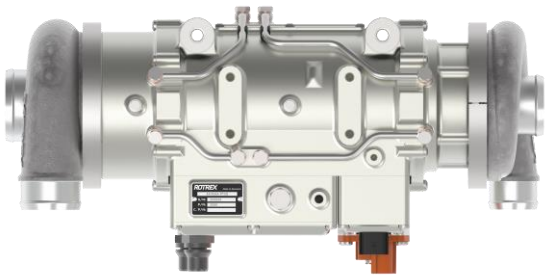
MADE IN DENMARK • PRODUCERET I DANMARK •

For more information go visit:
ROTREX-FUEL-CELL-COMPRESSOR.COM

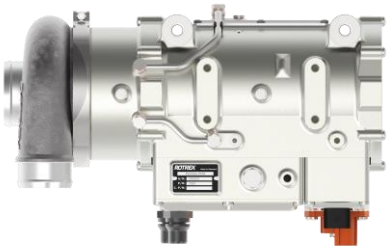
CONTACT@ROTREX.COM

System overview

A unique feature of the EK40 is the modular setup, allowing for different configurations to suit each project: single stage (EK40C) – dual stage (EK40CC) – turbine/expander (EK40CT)[1].



Turbine/Dual stage configuration



Single stage configuration

The unique design of the Rotrex fuel cell compressor is operating on a low-speed motor and the patented planetary traction drive. This enables the entire system to run on standard ball-bearings, instead of sensitive ultra-high-speed bearings.

More robust: using traction drive technology eliminates any sensitivity towards external shock/vibrations and air contaminants under use in even the most demanding environments.

More Efficient: Our traction drives typically run up to 98% efficiency and tested to 240.000 rpm of continuous operation.

More Scalable: Our fuel cell air compressors are fully scalable to match any fuel cell application. We can offer tailored solutions beyond 200 kW of continuous compressor power.

Mobile or industrial inverter

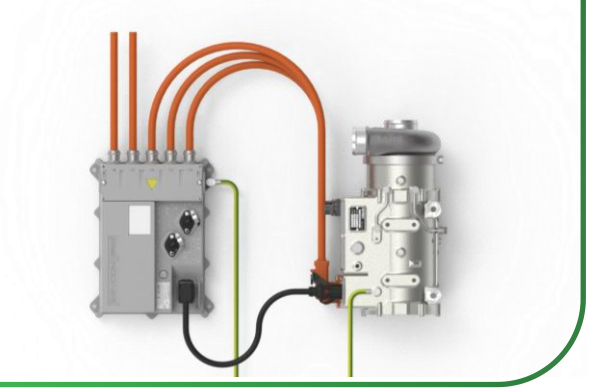
A motor controller, or inverter, is mandatory for operating the EK40 fuel cell compressor, Rotrex offers a range of pre-configured inverters:

Mobile inverters:

- ✓ Liquid cooled like the EK40.
- ✓ Compact, lightweight, and robust.
- ✓ IP6K9K with connectors mated.
- ✓ Capable of 200 A continuous output current.

Industrial inverters:

- ✓ AC grid powered.
- ✓ Display and buttons for easy control.
- ✓ Wide range of control add-on options.



[1] Turbo/Expander may require non-recurring engineering.

EK40C - single stage compressor specifications

Parameter	EK40C-2429	EK40C-3425	EK40C-4521
Recommended Air Mass Flow Range	0.05 - 0.24 kg/s	0.07 – 0.34 kg/s	0.10 – 0.45 kg/s
Recommended Pressure Ratio Range	1.4 - 2.9	1.3 – 2.4	1.2 – 2.1
Aerodynamic Efficiency	Up to 75%	Up to 78%	Up to 77%
Physical Dimensions	450 x 220 x 250 mm		
Inlet Air Connection Diameter	76 mm (3”)		
Discharge Air Connection Diameter	63 mm (2.5”)		
Weight Incl. Fluid	≈ 32.8 kg (0,82 Kg / Kw)		
Port Angle	Fully adjustable, 360°		
Internal Drive Ratio	1:7.5		
Maximum Motor Shaft Speed	16,000 RPM	14,666 RPM[2]	13,333 RPM[2]
Maximum Impeller Speed	120,000 RPM	110,000 RPM[2]2 above	100,000 RPM[2]
Maximum Coolant Temp IN	50°C	50°C / 35°C [3]	50°C / 35°C[3]
Parameter	**Motor Data**		
Maximum Motor Shaft Speed	16,000 RPM		
Acceleration Rate (T_{90})	< 2 sec		
Motor Type	Permanent Magnet Synchronous Motor (PMSM)		
Motor Power	40kW continuous / 60kW peak		
Rated Motor Current	108A		
Maximum Motor Winding Temp.	130°C		
Cooling Medium	50/50 Glycol/Water mix		
Minimum Coolant Flow Rate	10 lpm		
Recommended Coolant Temp IN	35°C		
Maximum Allowable Coolant Pressure	2.0 Bar Gauge		
Parameter	**Regulatory compliance**		
Air Purity	ISO 8573-1:2012 Class 0 (certified)		
Ingress Protection	IP67 Enclosure Rating (by design)		

[2] Defined at SAE inlet conditions, consult with Rotrex if operating conditions are different.
[3] Maximum Coolant IN temperature for continuous operation at 40 kW

EK40CT – compressor + turbine specifications

Optional expander module for the modular EK40 is now available. Utilizing the fuel cell exhaust pressure and temperature to recuperate energy is a major gamechanger for the total **efficiency** of the fuel cell system.

The first Rotrex EK40 expander module (PE1) is designed to match the high PR of the EK40C-2429 compressor. The design is **scalable** and Rotrex can develop custom expander trims and adjust the impeller speed ratio between the compressor and expander for application specific exhaust composition, temperature, and pressure.

A benefit from the traction drive technology is the **robustness** of the highspeed shaft, building on top of Rotrex' s experience with steam compression, the design is built to last as long as the compressor.

Parameter	Compressor EK40CT-2429	Expander (PE1)
Recommended Air Mass Flow Range	0.05 - 0.24 kg/s	0,05-0,18 kg/s
Recommended Pressure Ratio Range	1.4 - 2.9	1,4-3
Aerodynamic Efficiency[4]	Up to 75%	Up to 75%
Physical Dimensions[5]	575 x 220 x 250 mm	
Power regeneration[6]	≈ 40% (up to 16kW)	
Inlet Air Connection Diameter	76 mm (3")	50.8 mm (2")
Discharge Air Connection Diameter	63 mm (2.5")	63.5 mm (2.5")
Weight Incl. Fluid[5]	≈ 37.7 kg	
Port Angle	Fully adjustable, 360°	
Internal Drive Ratio	1:7.5	1:9
Maximum Motor Shaft Speed	16,000 RPM	
Maximum Impeller Speed	120,000 RPM	144,000 RPM

[4] Aerodynamic efficiency depends on operation point.
[5] Includes EK40 motor, EK40C compressor stage and EK40T turbine stage.
[6] Power regeneration depends on exhaust composition and temperature. Hot, humid, and high-pressure exhaust will increase power regeneration potential and vice versa.

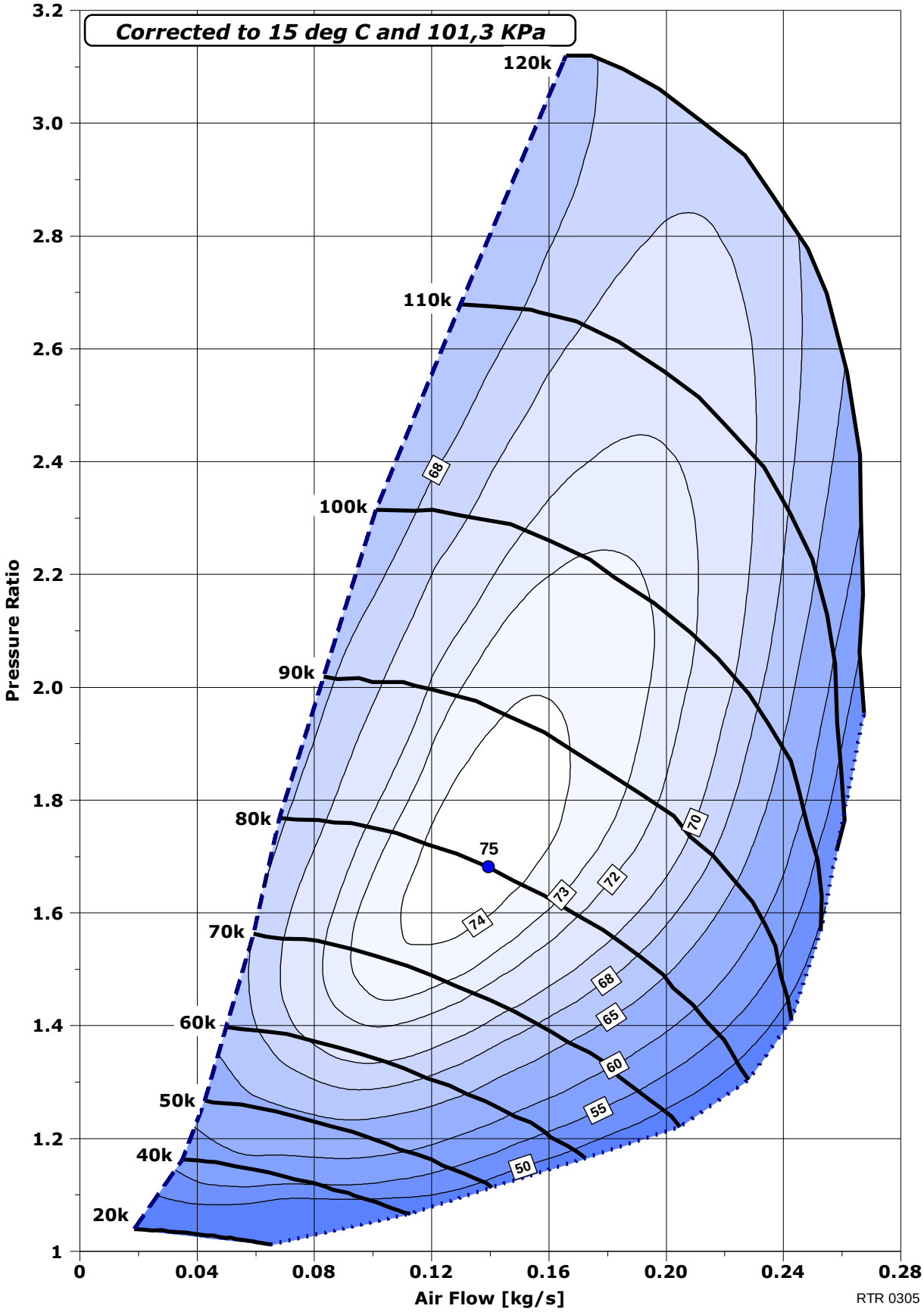
Pre-configured mobile inverters (Motor controller)

Parameter	Pre-set Sevcon Gen5 size 9	Pre-set Cascadia CM200DZ-SP
Physical Dimensions	394 x 285 x 81 mm (8,3L)	330 x 188 x 97 mm (3,9L)
Weight, Dry	≈ 6.8 kg	≈ 6.75 kg
Operating voltage range	120-420 VDC	100-840 VDC
Control Power Supply	12/24 VDC	
Output Current	200A continuous / 400A peak	
Commutation Method	Closed loop, UVW position feedback	Closed loop, sinusoidal position feedback
E-Charger Control Method	CAN J1939 (optional analog)	CAN2.0A (optional J1939 / analog)
Cooling Method	50/50 glycol/water mix	
Operating Coolant Temperature	-30°C to +50°C no current derating	-40°C to 80°C (derating 80-100°C)
Coolant Flow Rate	10 lpm	12 lpm
Max. Allowable Coolant Pressure	1.0 bar gauge	3.0 bar absolute
Motor Winding Overheat Shutdown	torque cutback at 125°C, shutdown at 130°C	
Vibration Tolerance	ISO 16750-3, 4.1.2.7 Test VII compliant, Class A	ISO 16750-3, 4.1.2.7 Test VII pending
Shock Tolerance	ISO 16750-3, 4.2.2 rigid Non-compliant	ISO 16750-3, 4.2.2.2 (50g) pending
Ingress protection	IP6K9K with connectors mated	

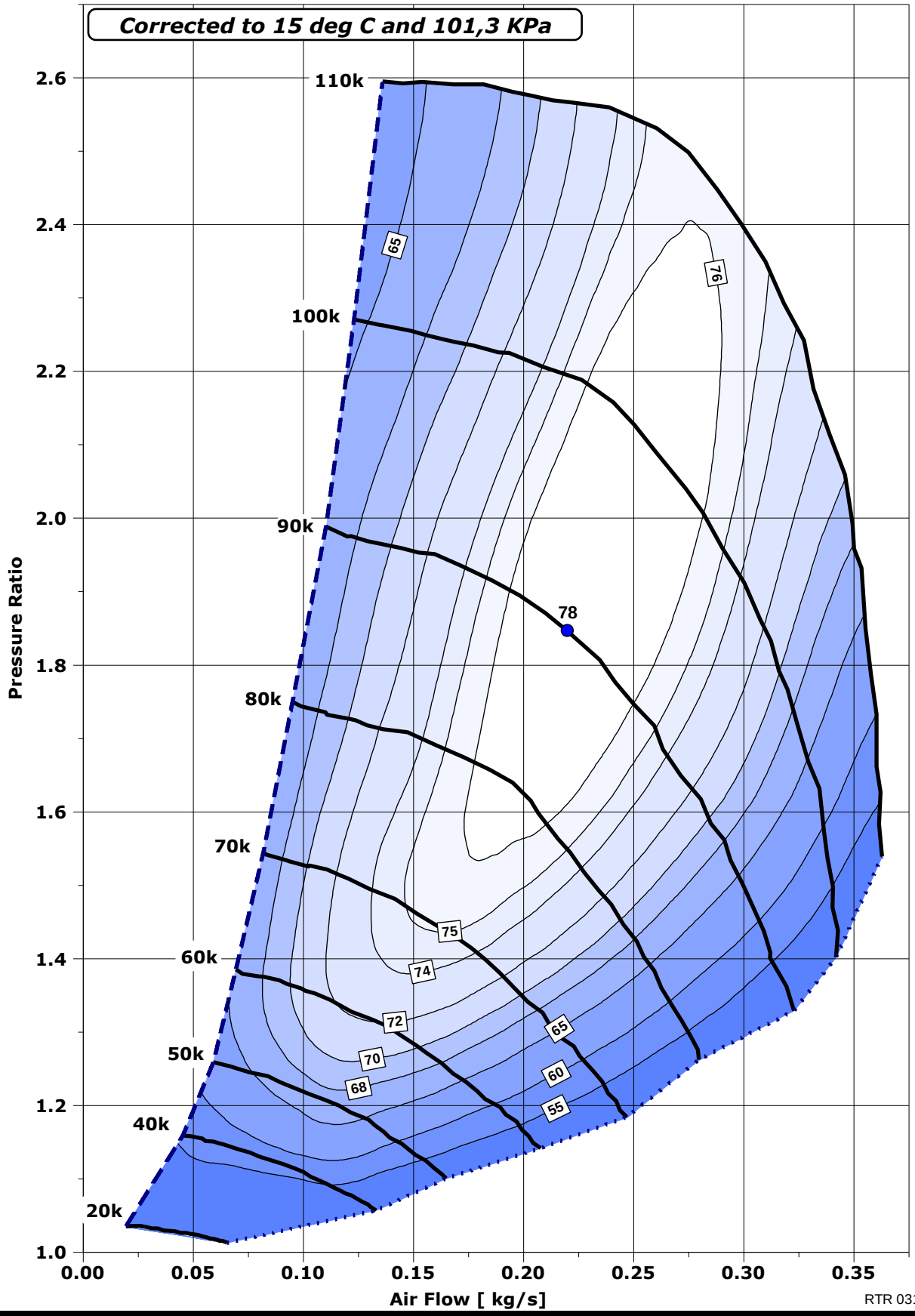
3D model of the mobile inverters is available as STEP upon request.

Conversion Toolbox
$^{0}C = \frac{5}{9} \times (^{0}F-32)$ OR $^{0}F = \frac{9}{5} \times {}^{0}C + 32$
$CFM = \frac{kg}{s} \times 1731.8$ $\frac{kg}{s} = \frac{CFM}{1731.8}$ @15^{0}C and 0.1013 MPa
$\frac{kg}{s} = 0.0075 \frac{lb}{min}$ $\frac{lb}{min} = \frac{\frac{Kg}{s}}{0.0075}$
Pressure Ratio $= \frac{P_{out}}{P_{in}}$

EK40C-2429 compressor map



EK40C-3425 compressor map



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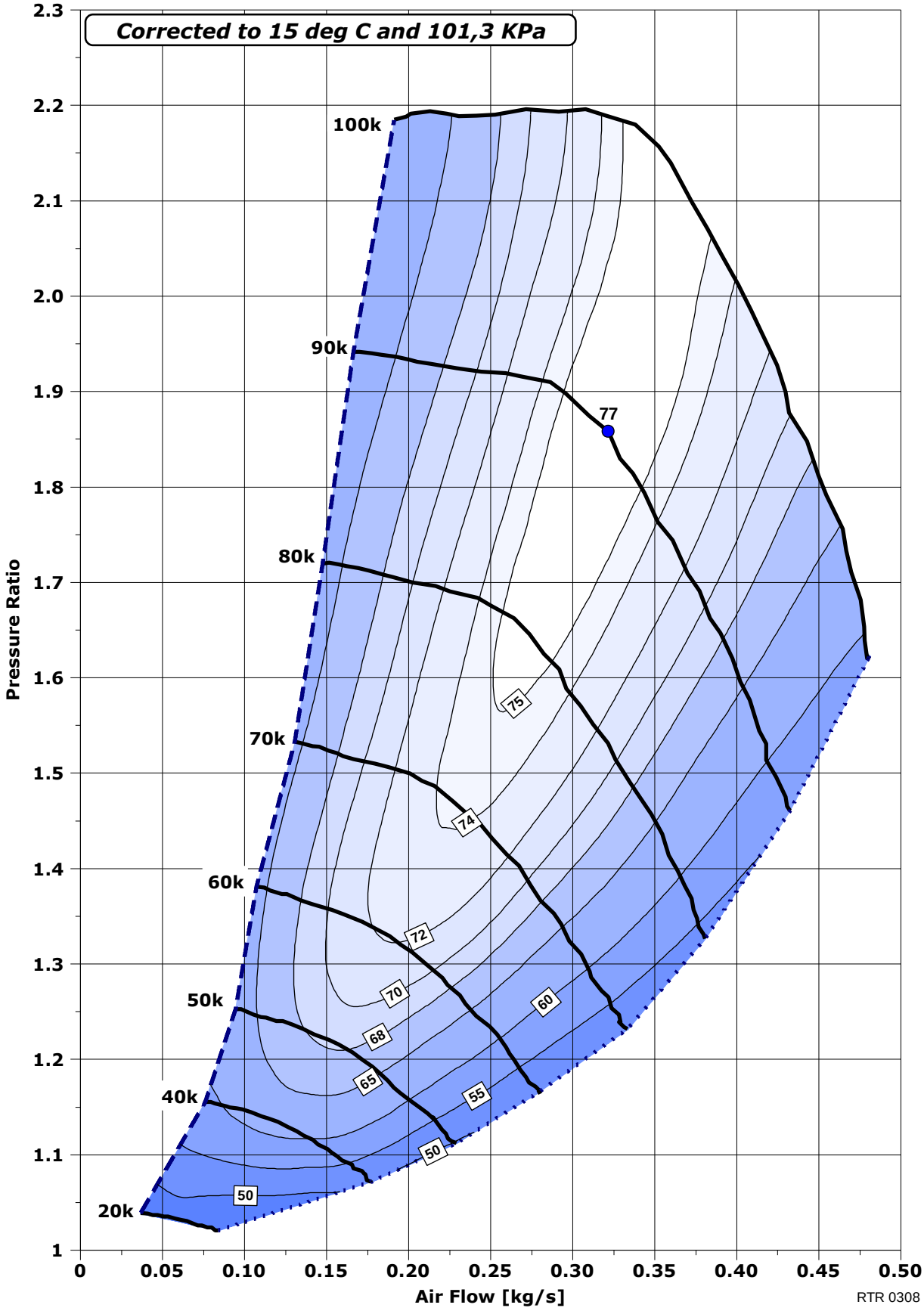
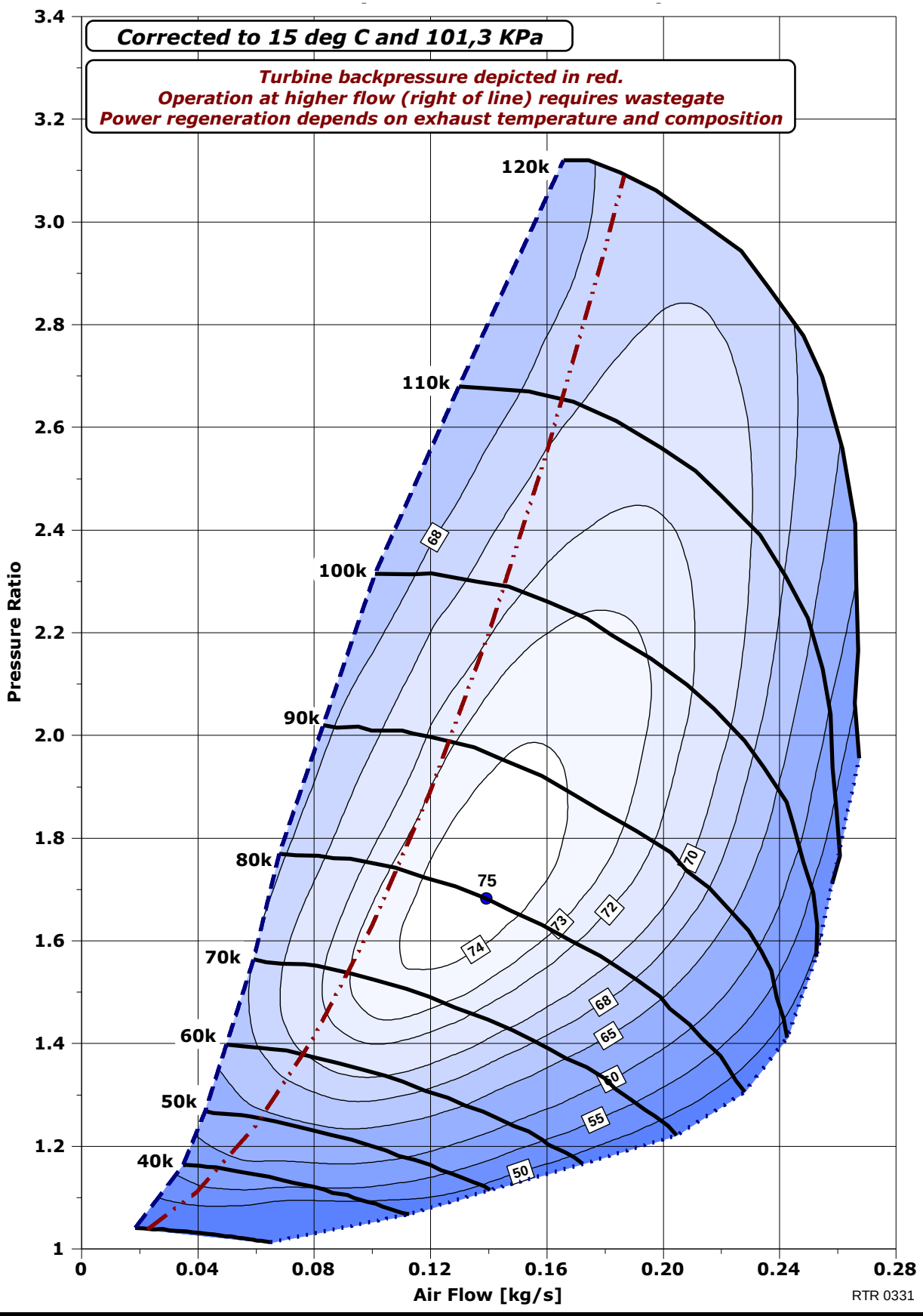
EK40C-4521 compressor map



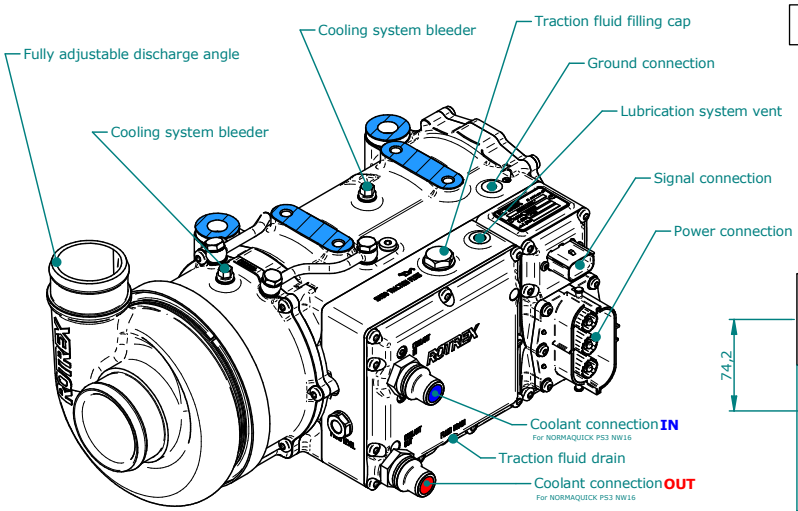
EK40CT-2429 compressor/turbine map

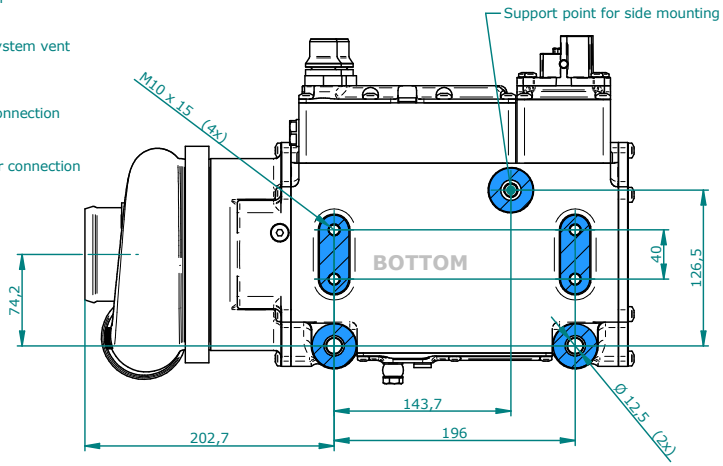


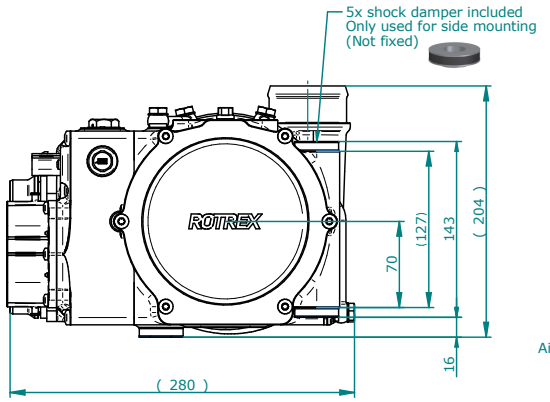
EK40C dimensions

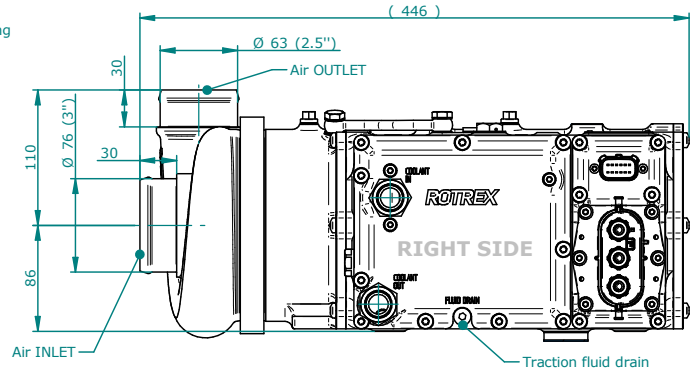
3D model of the EK40C is available as STEP file upon request.

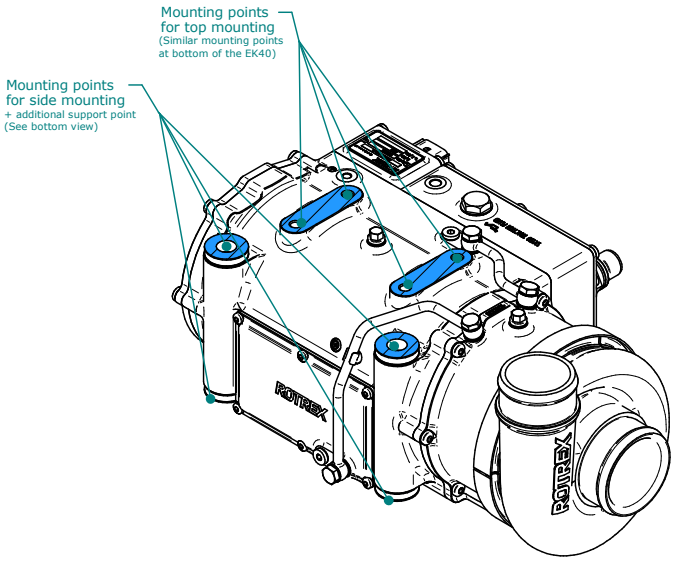
All dimensions in mm unless otherwise specified.

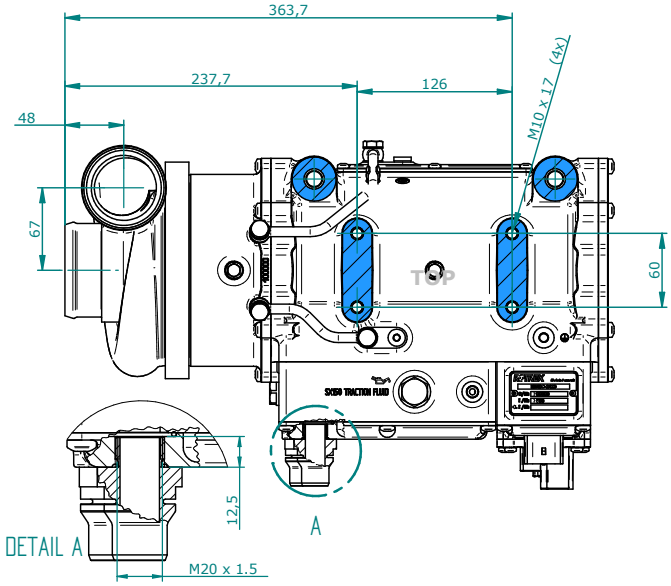










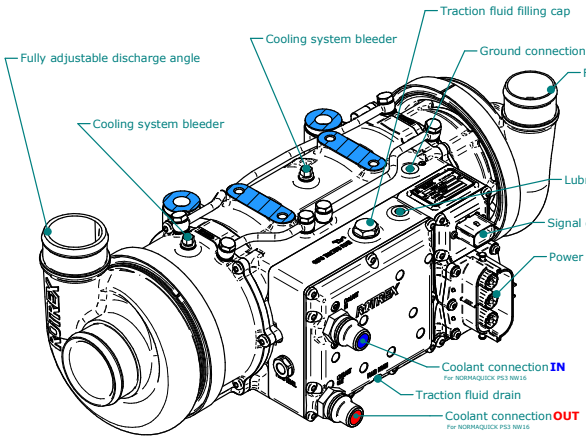


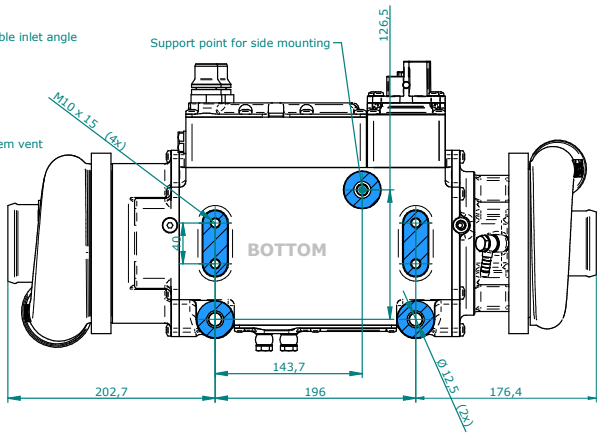
EK40 allows various mounting options; Bottom mounted, top mounted or side mounted
The different mounting points can be seen as highlighted

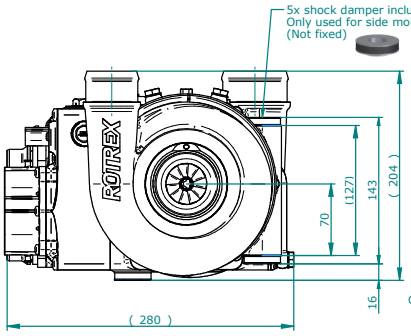
EK40CT dimensions

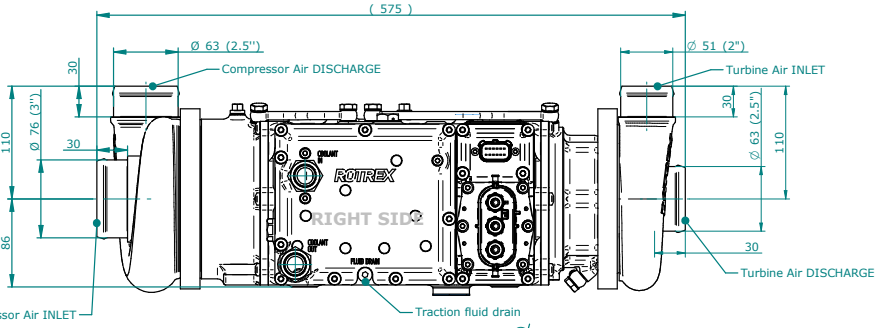
3D model of the EK40CT is available as STEP file upon request.

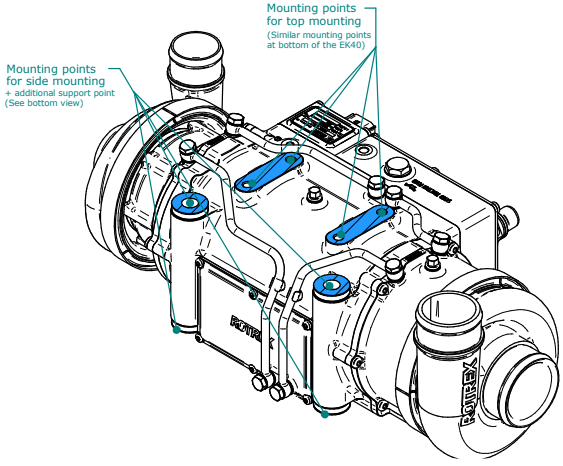
All dimensions in mm unless otherwise specified.

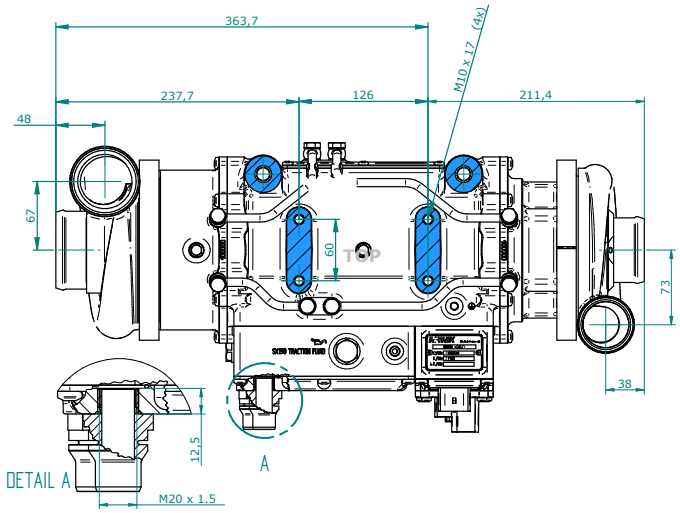












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