QDC - Quiet DC Cooler

Air fluid cooler series with 24V DC brushless motor

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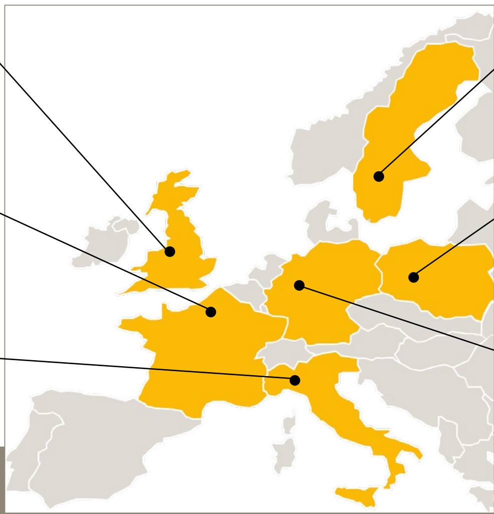

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Contents

If you are using an electronic version of this catalogue this icon will take you back to this CONTENTS page upon clicking.

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Are you interested in more information about Parker's product offering for electrified vehicles?
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Offer of Sale

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NEW

Introduction: QDC 24 VDC Series

The Parker QDC air fluid cooler series offers a unique cooling solution for the electrified, mobile market. Among the series' most outstanding features are:

- High power density: The QDC offers 2-3x higher power density than the LDC series.
- High efficiency. Integrated inverter controls the rotation speed with a standard PWM signal to reduce the power consumption to the minimum required RPM to dissipate the power out of the fluid.
- High noise reduction. The highly efficient design of the Parker heat exchanger turbulator together with the rotation speed control ensures quiet operation, suitable for operation even in noise emission reduced areas.
- This series can be fitted optionally with an IQAN controller, smart 24 VDC water-glycol pump, and a tank system. The maximum cooling capacity is 26 kW at 40°C, difference in temperature between ambient and cooler inlet, size 017
- The 24 VDC series features the same dimensions as the LDC series, yet offers improved matrixoptions. The brushless FAN drive comes with an integrated inverter for ideal efficiency.

Target Markets

- Truck cranes • Body builders • Mining machinery
- Forestry machines • Refuse trucks • Sweepers • Lawn mowers
- Mini- and Medium sized excavator • Surface drilling systems
- Hydrogen power fuel cell stack cooling

The Importance of Thermal Management

Electrification remains one of the primary trends in the global mobile machine market as vehicle makers push hard to introduce cleaner technologies that result in lower emissions. Manufacturers have come to realise the need for much lower emissions and environmental friendly technologies.

Construction vehicles, city buses, sweepers, refuse trucks and all other kinds of mobile machines have all been developed with hybrid electric powertrains and electro / electro-hydraulic work functions, as authorities look to reduce power-consumption and pollution by introducing more stringent environmental regulations. Also electrified vehicles offer new and different ways electric construction equipment can be used.

The ability to meet legal requirements for zero emissions, the ability to work outside of normal business hours due to their quiet operation, the ability to have a fast-charging option to work longer hours — these benefits of electrified vehicles open the doors of possibility for those looking to expand their business down the road.

On the other hand, vehicles with electro / electro-hydraulic work functions face different challenges than regular electric vehicles. To guarantee an efficient and consistent output, those components driving the work function require a thermal management solution which is able to adapt to the specific task and conditions.

Thermal management covers all cooling and heating tasks in an electrified mobile working machine or an electrified commercial vehicle. Almost all the technical conditions are changing in terms of the temperature ranges, heating/cooling power, the number of heating/cooling tasks and the fluids used. The variety of coolants ranges from water glycol to special electrically non-conductive fluids and demineralised water (DI-water), which is used in particular in the cooling of fuel cells.

When looking at some of the challenges these vehicles face, extreme heat conditions, created by narrow city streets, stand out.

Cities are urban heat islands, in addition there is low tolerance for sensory disturbances, especially from traffic or mobile machines.

With regard to temperature urban spaces are missing:

- **no natural convexion**
- **higher ambient temperature than in open spaces**
- **ground reflects temperature, tarmac adds as an additional heat storage**

This results in a loss of efficiency and operation-time. Parker's new thermal management solution provides an answer to this problem.

New opportunities for electric propulsion & work functions

Urban

Electric machines are impressively quiet, which makes them prime candidates for work in populated areas — especially on projects that require nighttime work or operation in residential areas. Digging or moving material outside a bedroom window , school zone or hospital room will be no problem at all. As more cities and states work on charging infrastructure for electric passenger vehicles, electric construction equipment can make a logical addition to their equipment fleets as well.

Indoor Demolition

Indoor construction jobs cause a unique set of problems for workers. Construction equipment needs to be compact enough to fit through tight spaces, yet powerful enough to complete the job. Ventilation also poses a problem as diesel-powered equipment emits exhaust fumes. Indoor projects can now benefit from the low noise and zero emission levels electric machines offer.

Where it used to take several laborers doing manual work or using smaller electric tools, now an electric compact excavator can dig or an electric loader can move material indoors without polluting enclosed spaces or causing major disruptions.

Agriculture

Because of electric machines' zero-emission factor, they are great for agricultural settings involving valuable livestock. Farmers don't want their livestock breathing in diesel emissions, but still need to get work done around them. With an electric wheel loader, farmers can keep barns or sheds closed for warmth while still moving loads of feed, for example. And they won't have to sacrifice power or reach, because these machines operate at the same level as their diesel counterparts.

Heavy Construction and Mining

With construction vehicles being powered by electric drives, there's an increased need to extend electric power also to heavy construction and mining vehicles in order to make charging more efficient and easy across the complete fleet. Emission reduction and, in the case of mining, the issue of ventilation are another driver for the electrification process.

High Dust Environments

A combustion engine can be dangerous in a high-dusting setting because of the possibility of sparking from the exhaust. In a lumber mill or sawmill, workers are keenly aware of safety issues like this. With an electric machine, productivity isn't sacrificed, and neither is safety.

Utility Vehicles

Combined motor, inverter and pump technology is quiet and efficient. As a result, vehicles can operate at extended times. For example, refuse trucks can collect household waste much earlier due to low noise emissions, and construction site vehicles may be allowed to operate at weekends.

YOUR EXPECTATION

- efficient
- power dense
- robust
- simple
- reduced noise level

OUR TECHNOLOGY

- 20-30% more efficient cooling matrix
- low noise fan and fan housing
- high performance fan drive with integrated inverter
- fan speed control from 1200 RPM to 4750 RPM
- air free fluid

YOUR VALUE

- 50-60% less space and power consumption
- silent operation
- compact design - low space claim

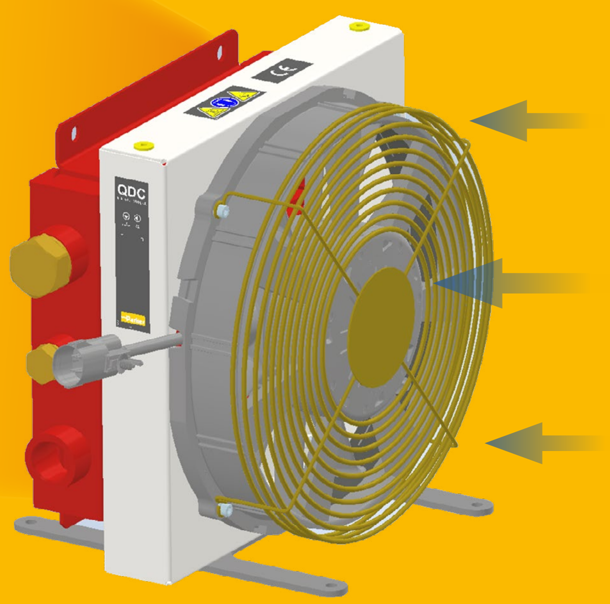
SUBSTITUTING HARDWARE WITH SOFTWARE

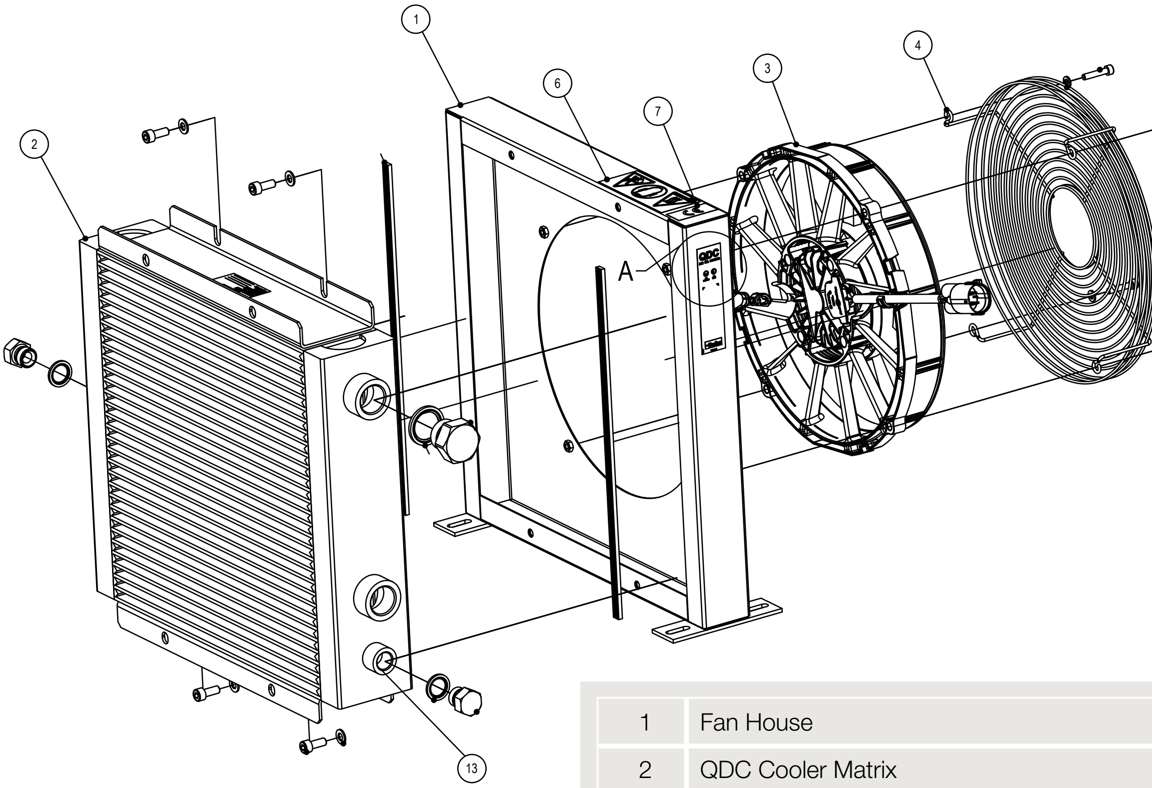
- **Increased working time and reduced battery cost**
- **Compliant with laws and noise pollution regulations**
- **Reduced engineering, installation and assembly cost**

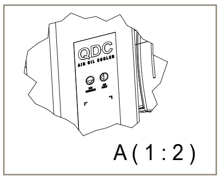
Parker PUSH Technology - How it works

Push technology allows the system to function under high ambient temperature and high fluid temperature.

- **Reduces the ambient temperature for the motor and the inverter in operation**
- **Increases the robustness and cleanness of the system**







1	Fan House	Steel
2	QDC Cooler Matrix	Aluminium
3	Push Fan , 24VDC Brushless Motor with integrated Inverter	Steel
4	Finger Guard Brushless Ø305 mm	Steel
6	Label Kit	Plastic
7	Label CE 50 x 24 mm	Plastic
13	Additional fluid port on both sides	

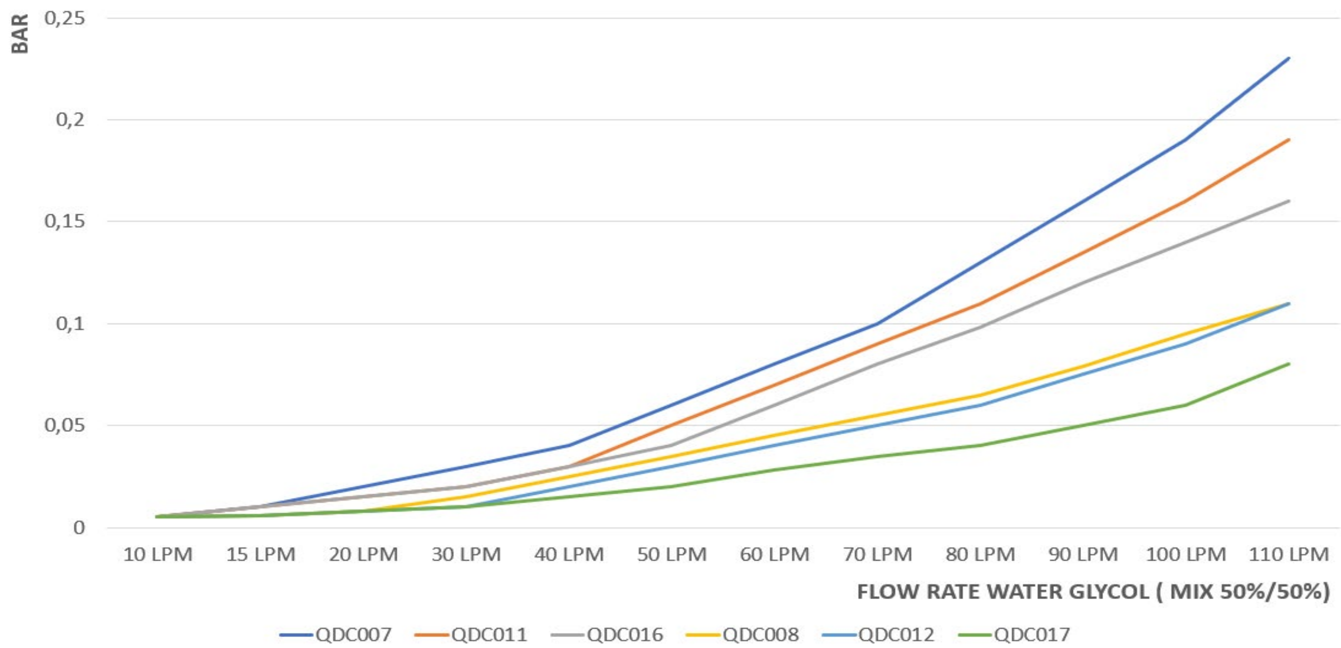
QDC 24 VDC performance overview

High Power 24VDC Brushless Fan Drive eMotor | Integrated Inverter | Push Fan Air Flow Technology
Option: RPM Control with IQAN
1-3 Cooling Circle in a Single Matrix on Request

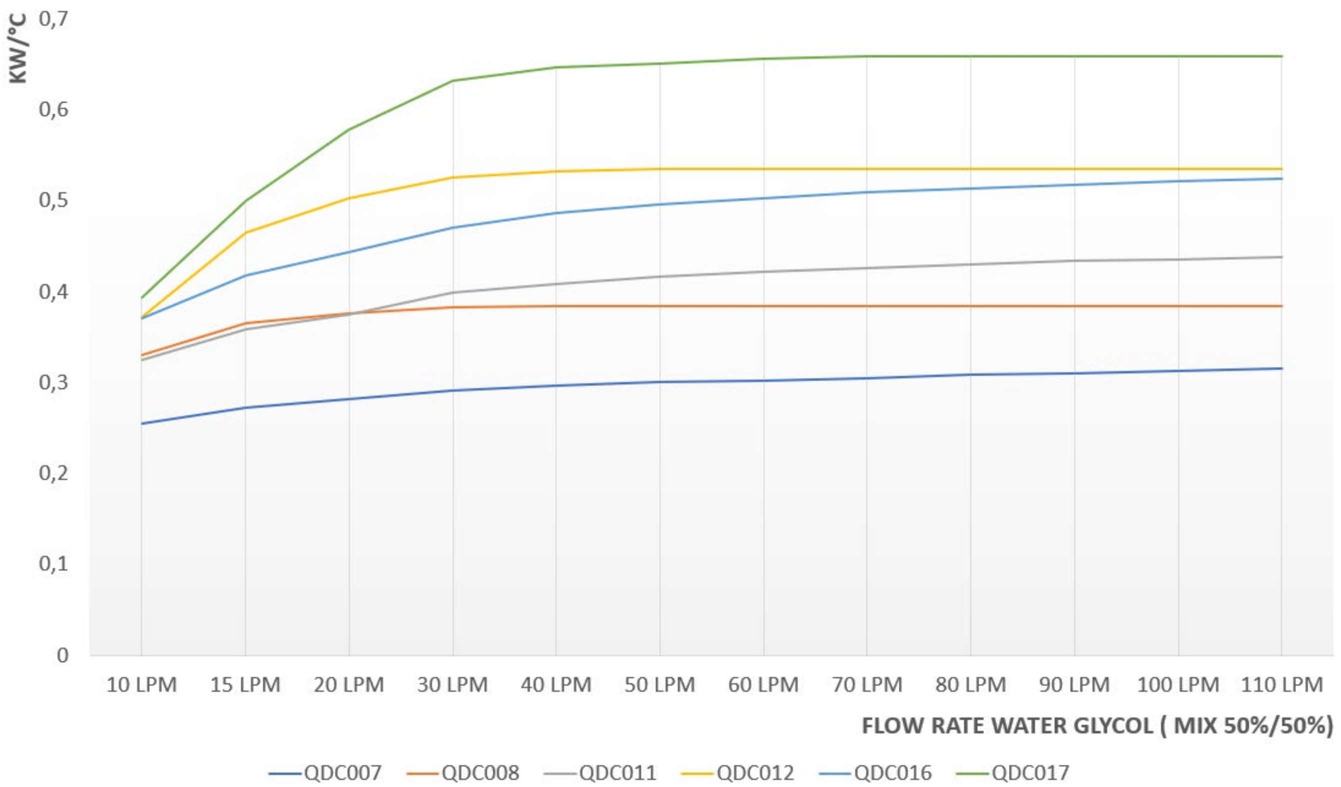
24 VDC High Power Single Matrix	@ Delta T 25°C*	@ Delta T 40°C*
QDC 007 Matrix 65 mm, Prt.no 5847007001	7.8 kW	15.6 kW
QDC 008 Matrix 95 mm, Prt.no 5847008001	9.6 kW	19.2 kW
QDC 011 Matrix 65 mm, Prt.no 5847011001	10.5 kW	21 kW
QDC 012 Matrix 95 mm, Prt.no 5847012001	13.4 kW	26.8 kW
QDC 016 Matrix 65 mm, Prt.no 5847016001	12.7 kW	24.4 kW
QDC 017 Matrix 95 mm, Prt.no 5847017001	16.4 kW	32.8 kW

* Temperature difference between ambient / inlet temperature cooler.

QDC 007 to QDC 017 - Pressure Drop



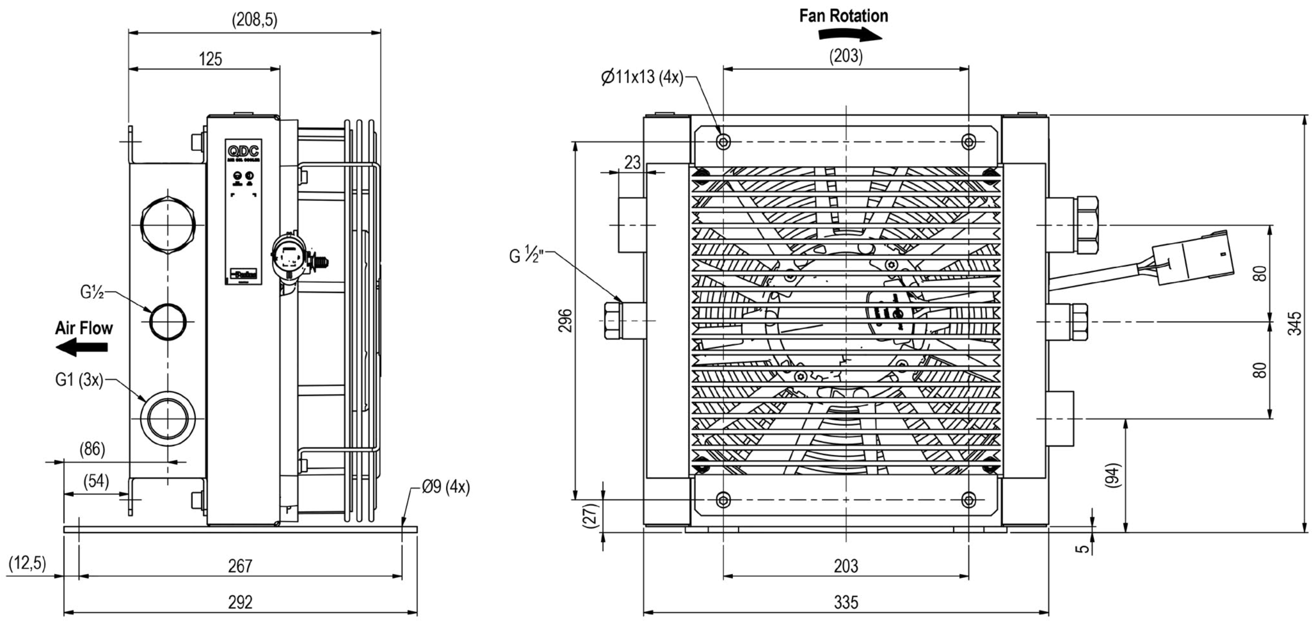
QDC 007 to QDC 017 - Cooling Capacity Water Glycol Mix 50% / 50%



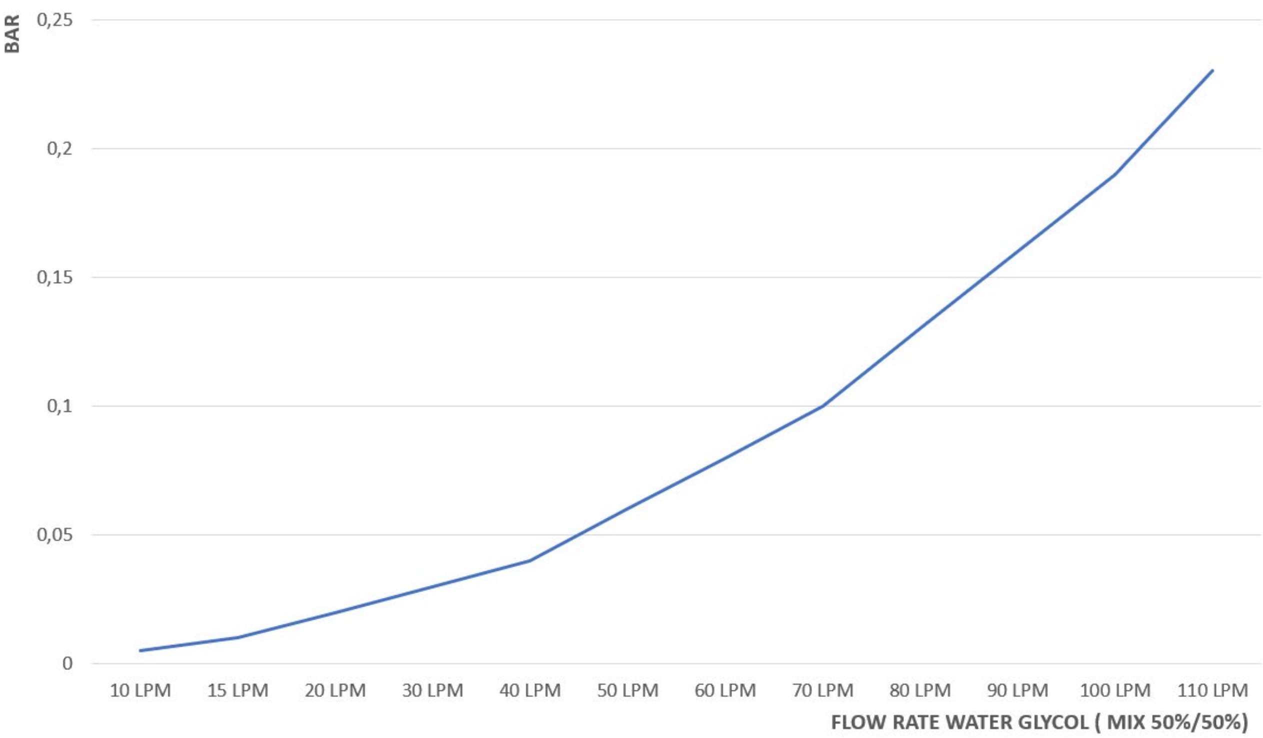
QDC 007

Type	P/N	Total Dimension	Weight kg	LpA dB(A)1 m
QDC 007	5847007001	345 x 335 x 208.5 mm	9	50 - 86*

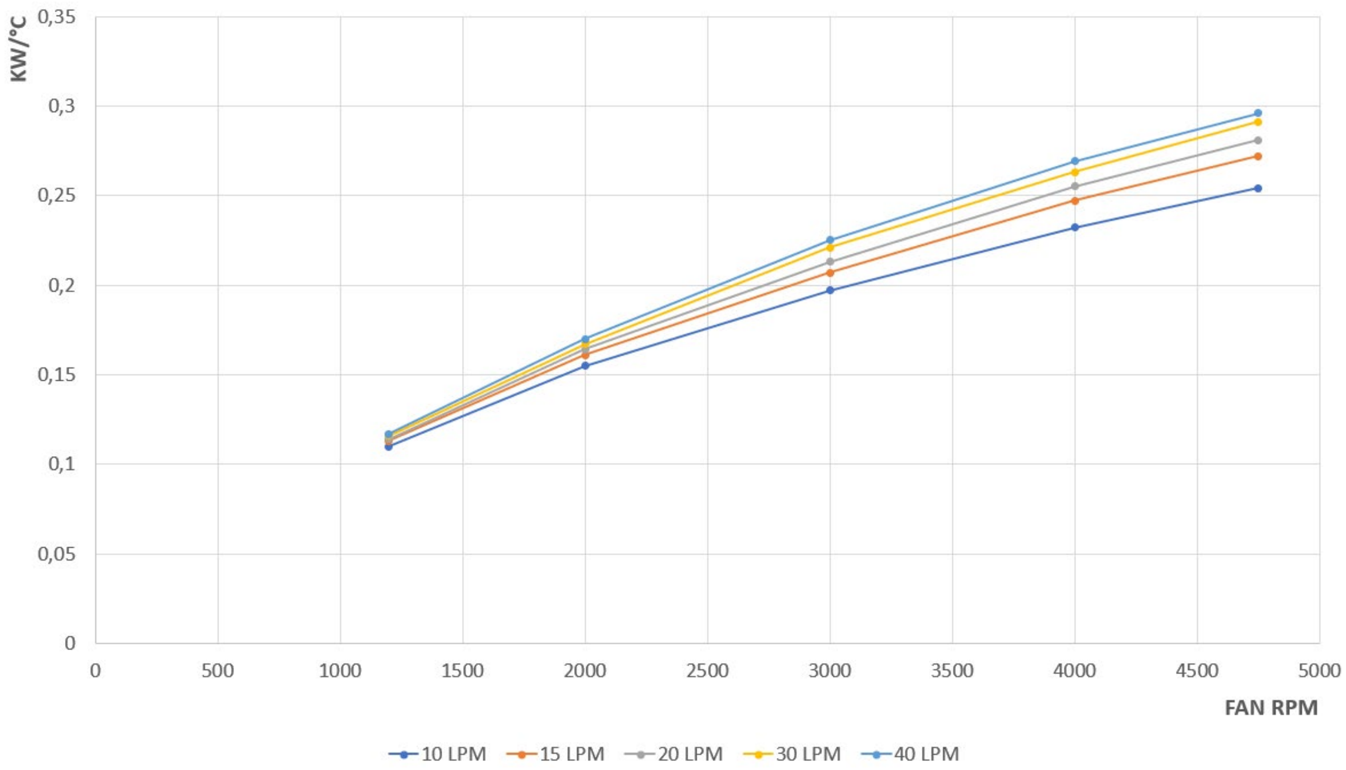
* = max. speed 4750 RPM / Noise level tolerance ± 3 dB(A)



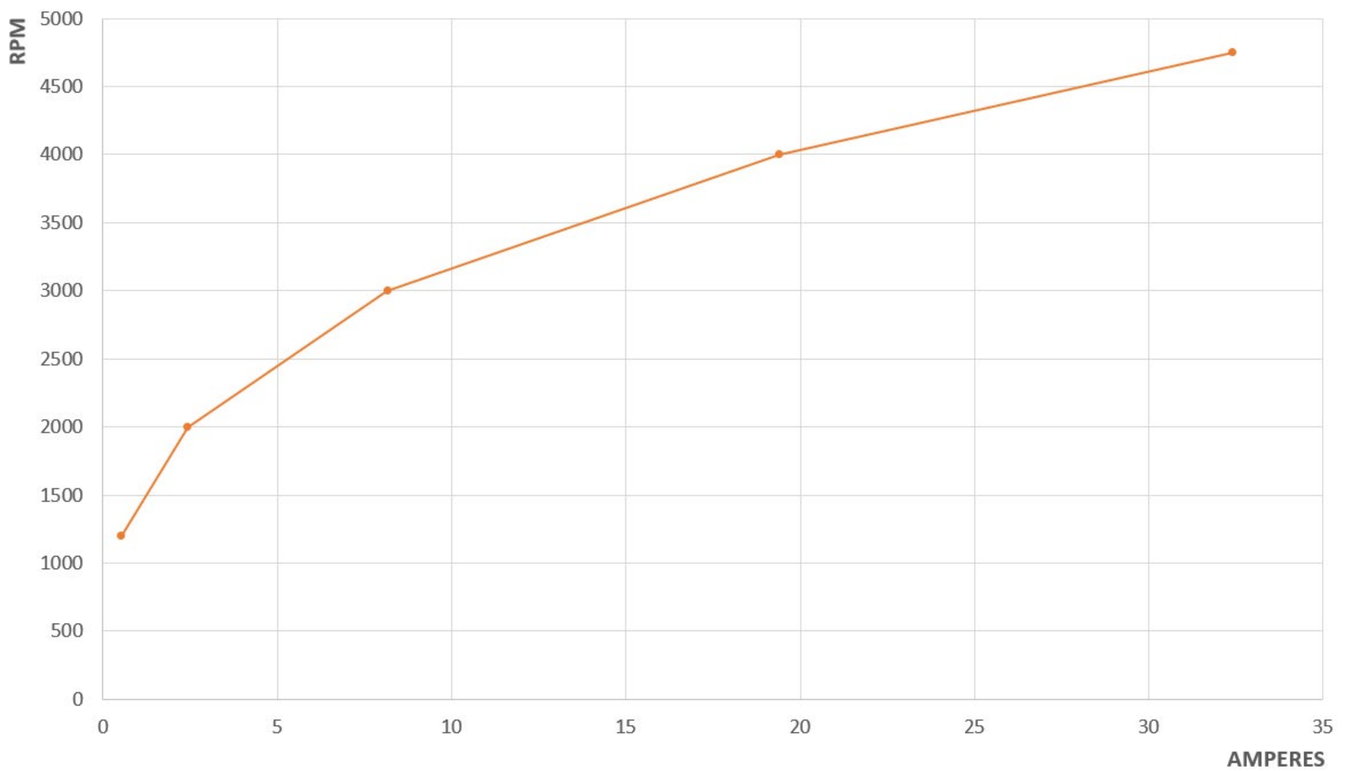
QDC 007 - Pressure Drop



QDC 007 - Cooling Capacity Water Glycol Mix 50% / 50%



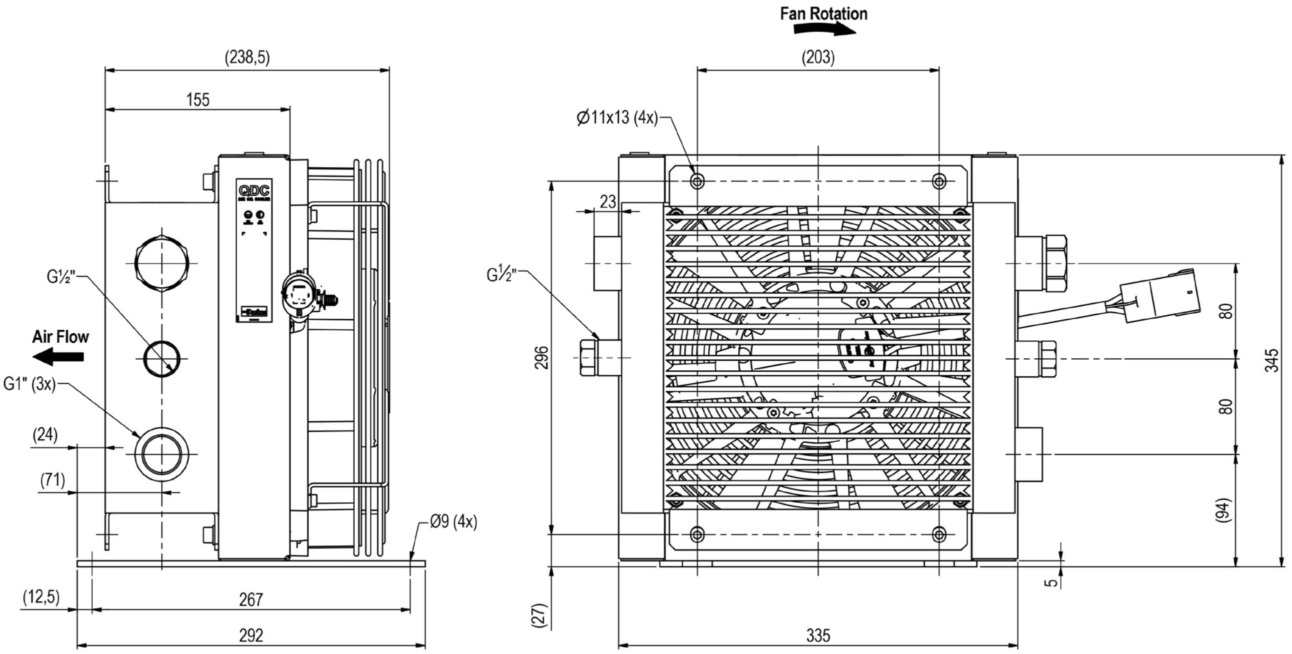
QDC 007 - A/RPM



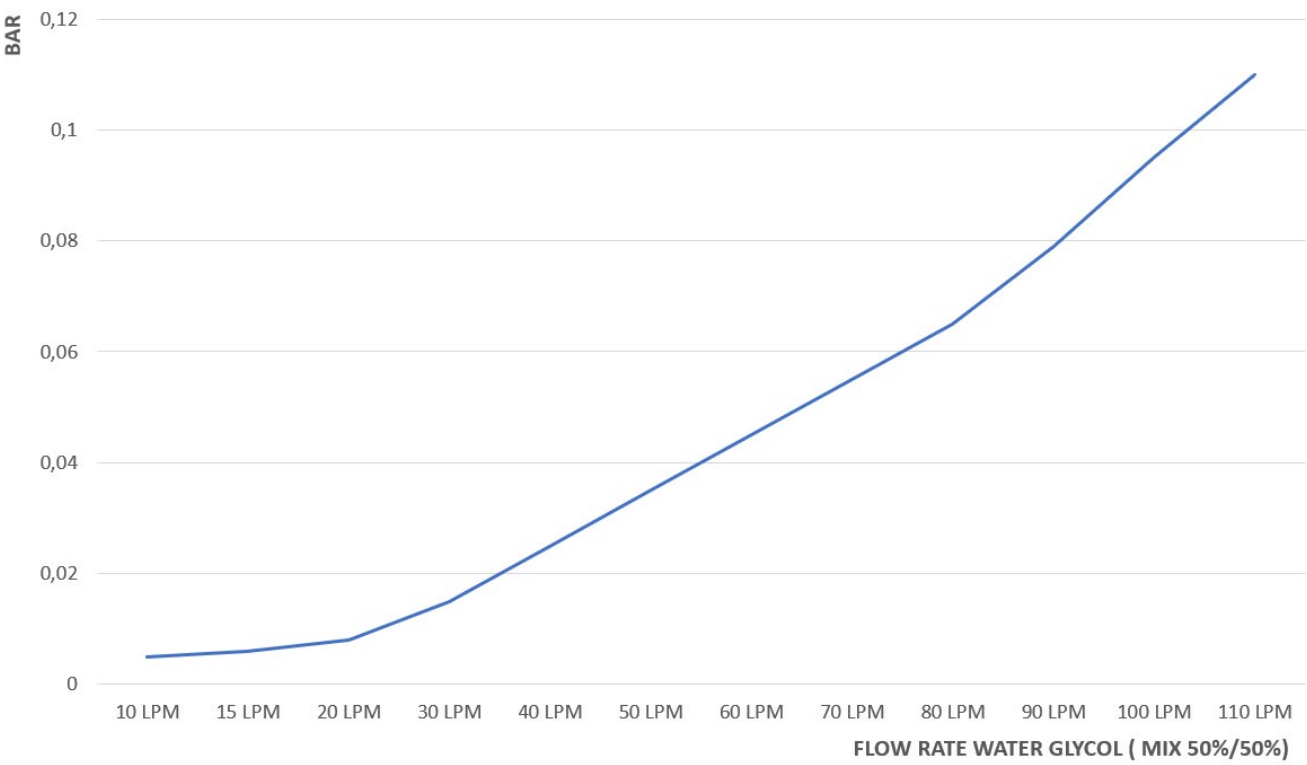
QDC 008

Type	P/N	Total Dimension	Weight kg	LpA dB(A)1 m
QDC 008	5847008001	345 x 335 x 238.5 mm	11.7	50 - 86*

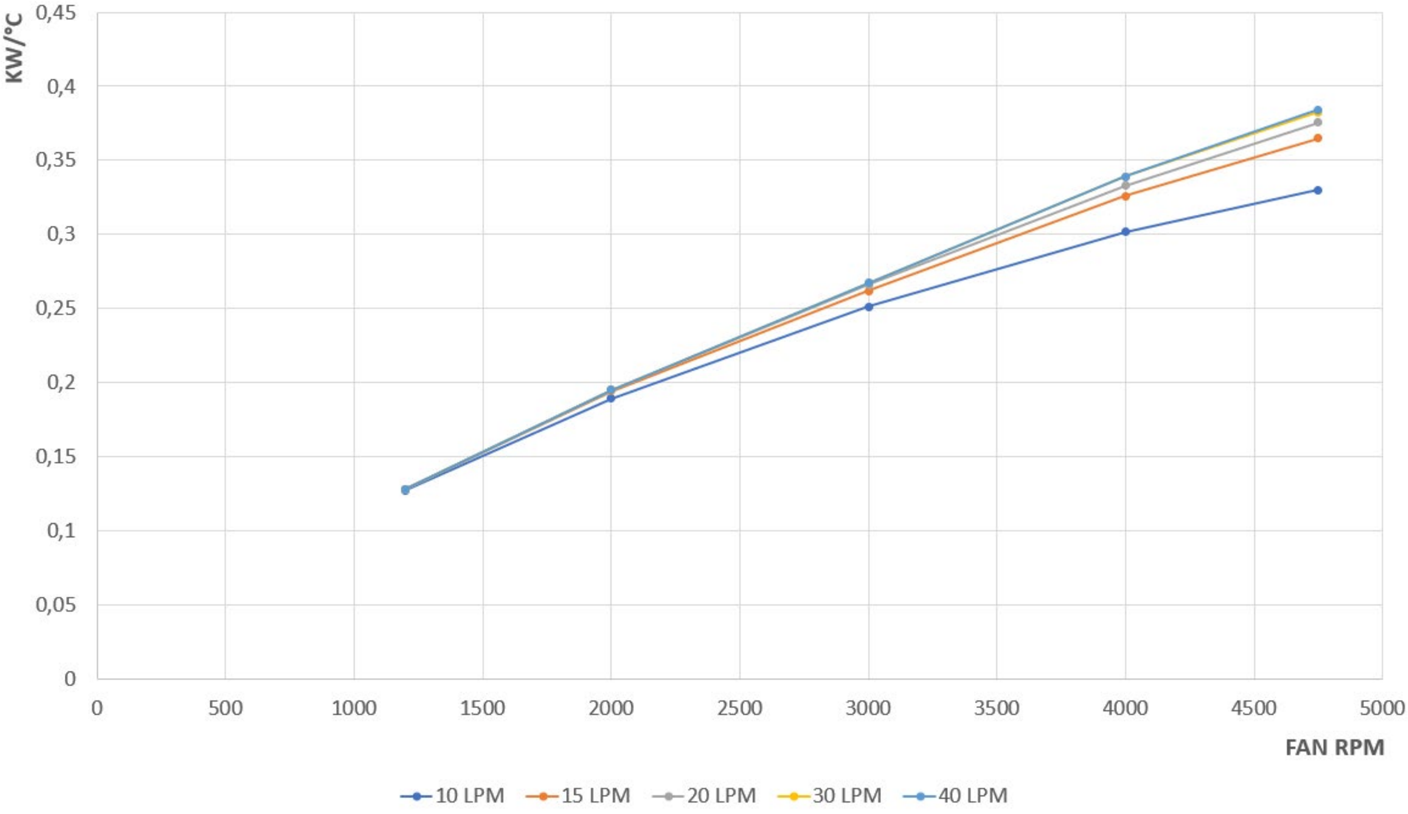
* = max. speed 4750 RPM / Noise level tolerance ± 3 dB(A)



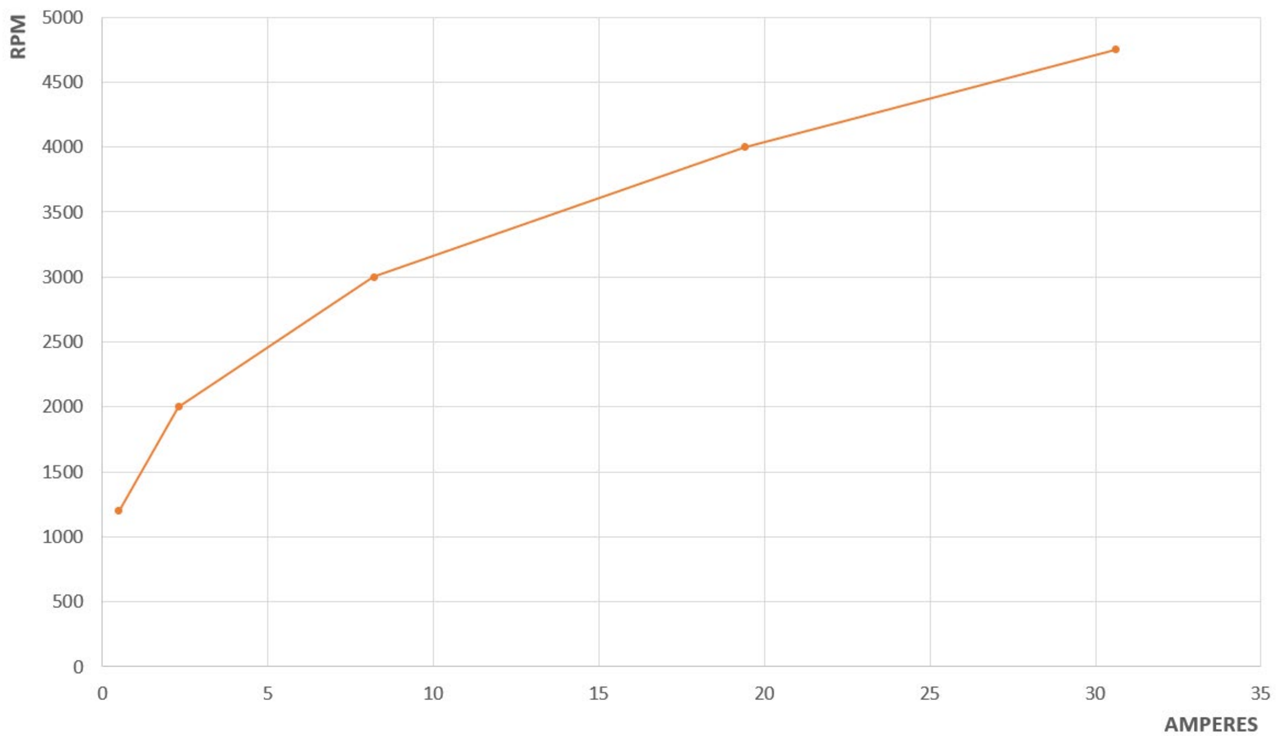
QDC 008 - Pressure Drop



QDC 008 - Cooling Capacity Water Glycol Mix 50% / 50%



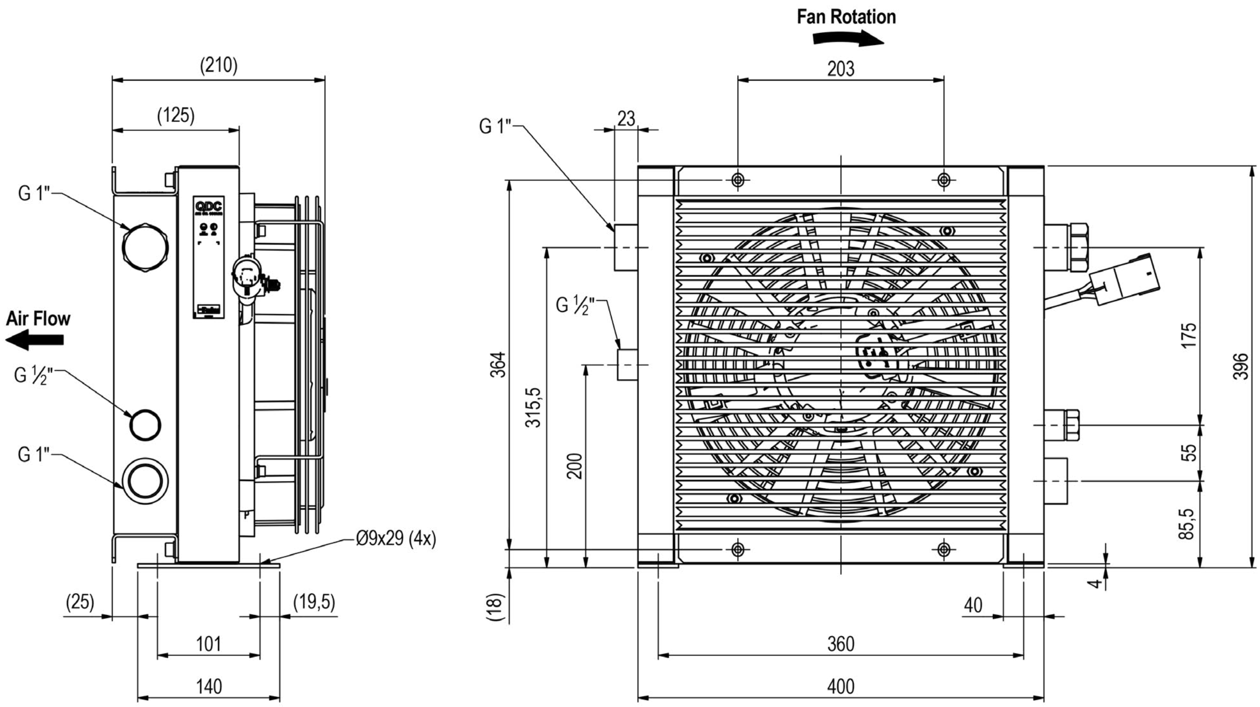
QDC 008 - A/RPM



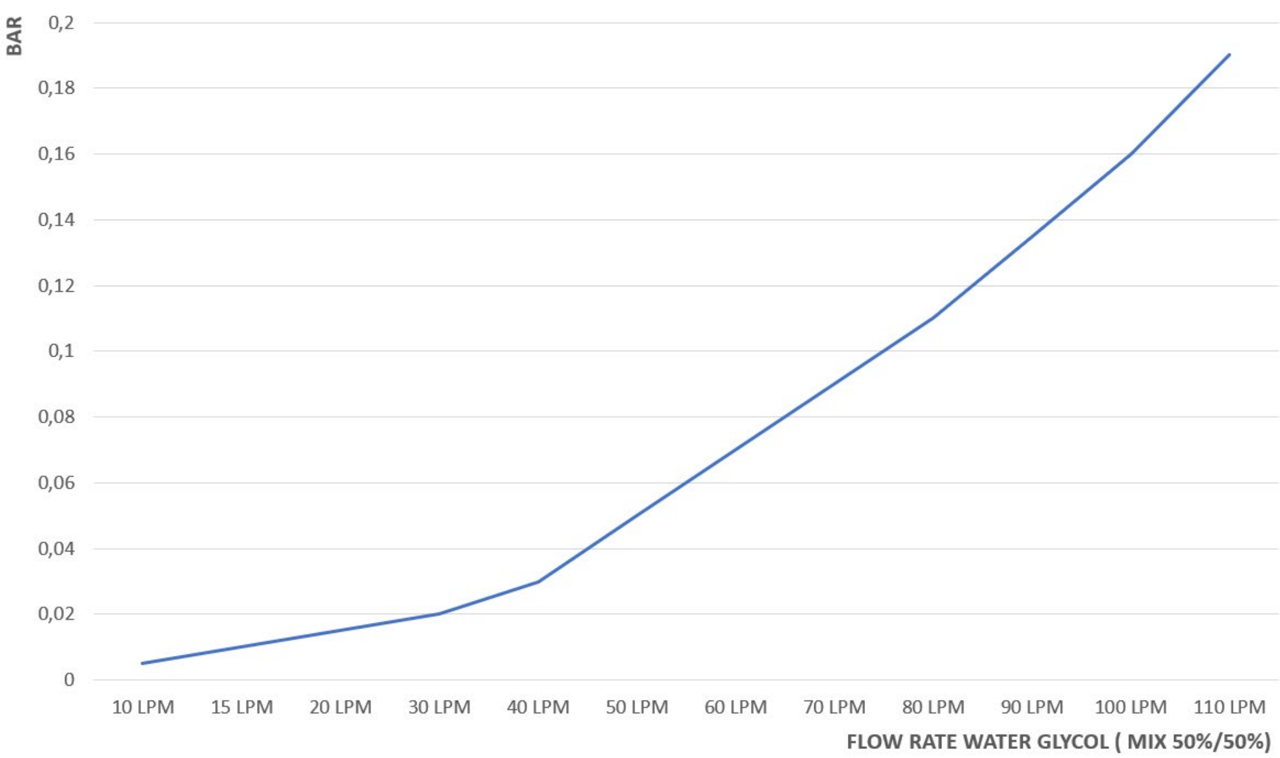
QDC 011

Type	P/N	Total Dimension	Weight kg	LpA dB(A)1 m
QDC 011	5847011001	396 x 400 x 210 mm	12	50 - 86*

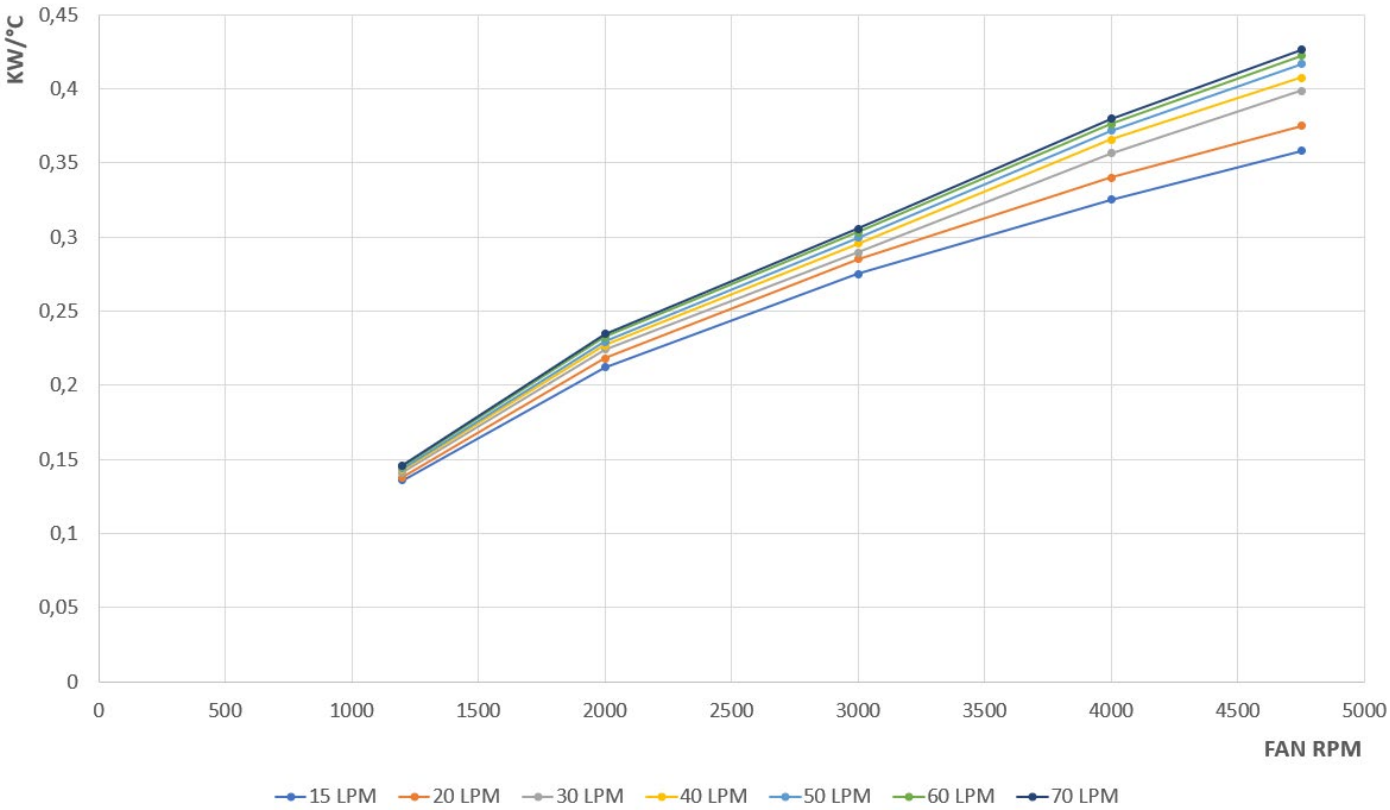
* = max. speed 4750 RPM / Noise level tolerance ± 3 dB(A)



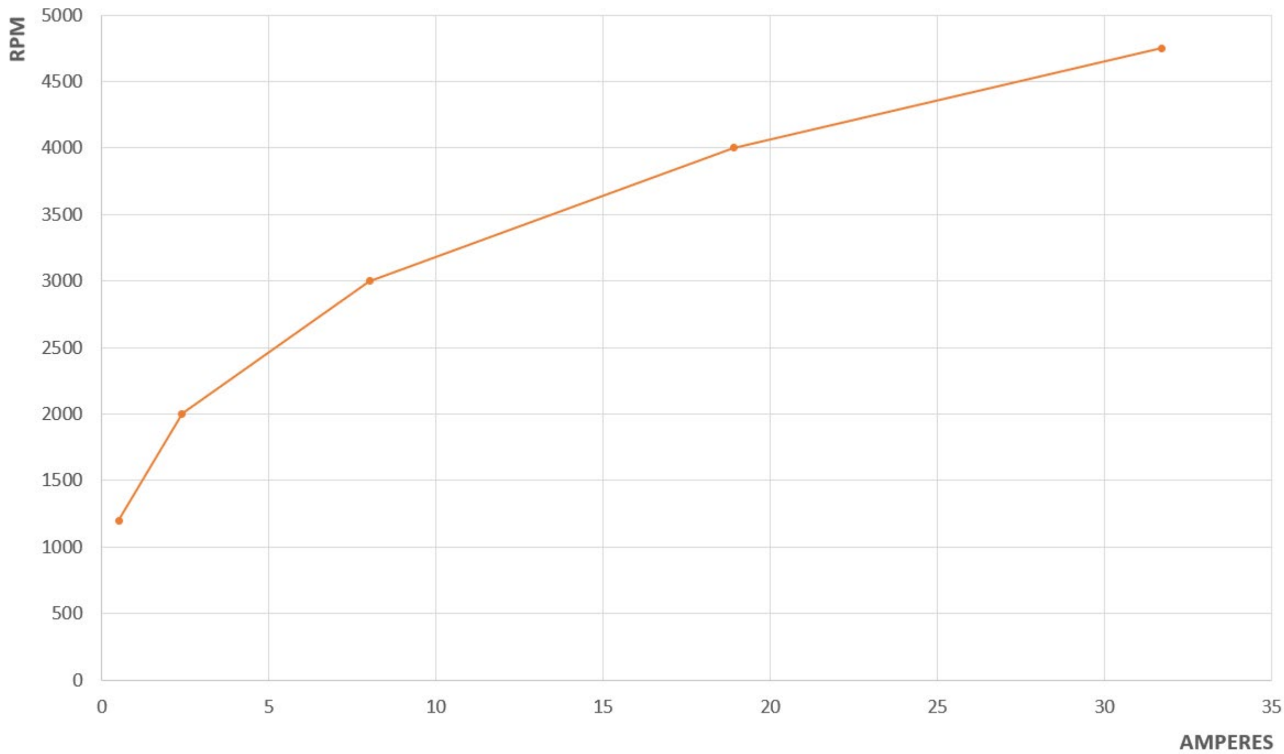
QDC 011 - Pressure Drop



QDC 011 - Cooling Capacity Water Glycol Mix 50% / 50%



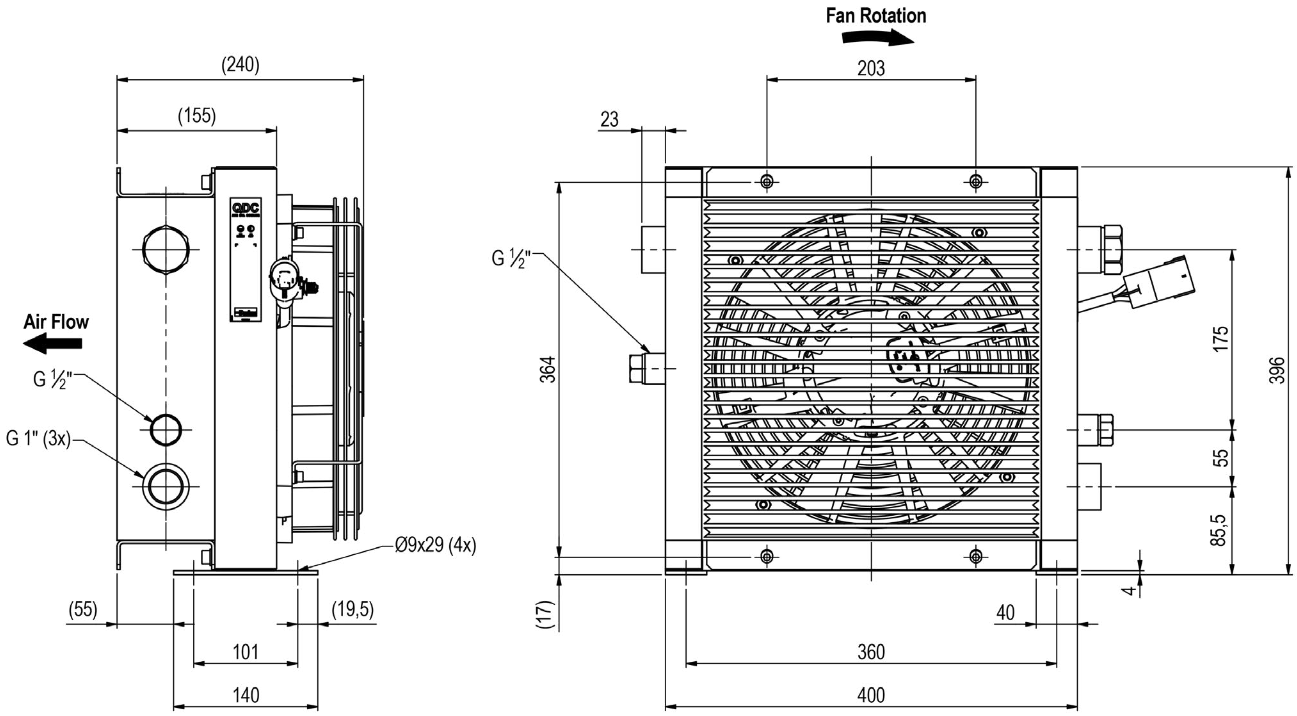
QDC 011 - A/RPM



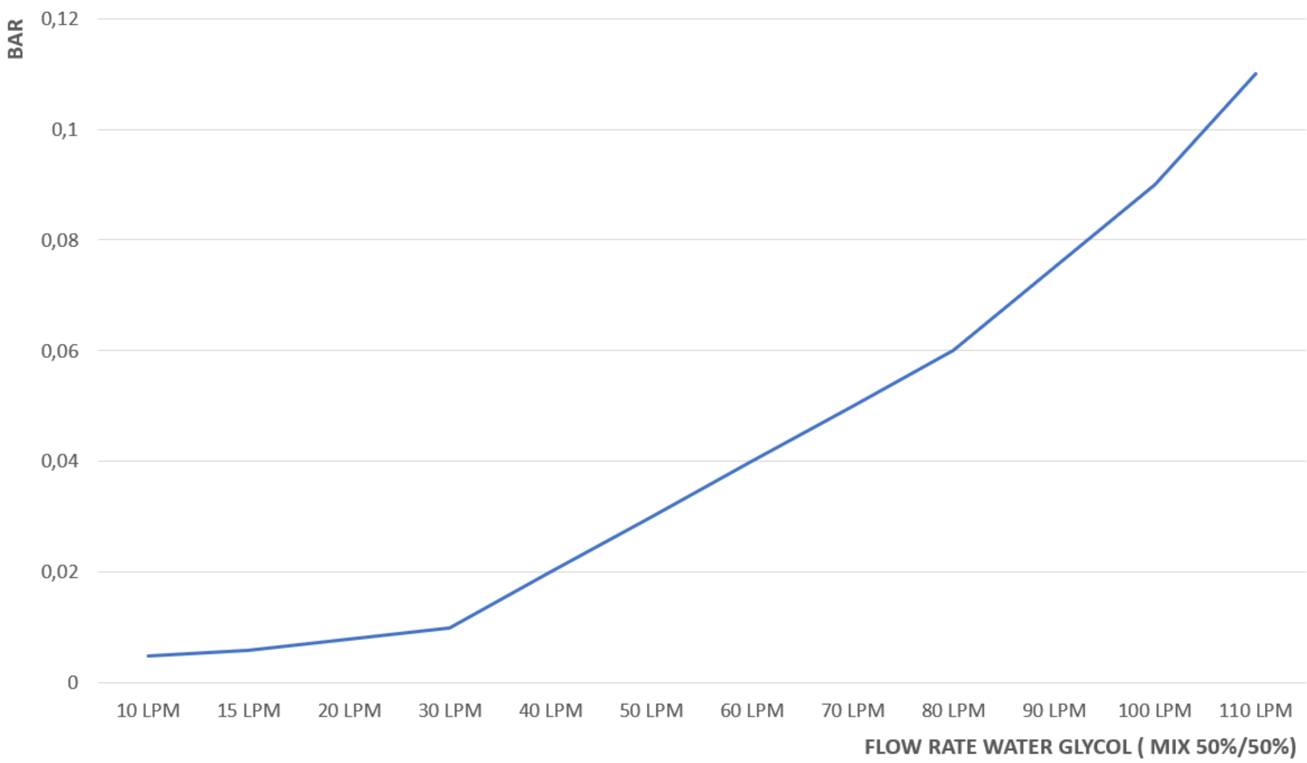
QDC 012

Type	P/N	Total Dimension	Weight kg	LpA dB(A)1 m
QDC 012	5847012001	396 x 400 x 240 mm	14.3	50 - 86

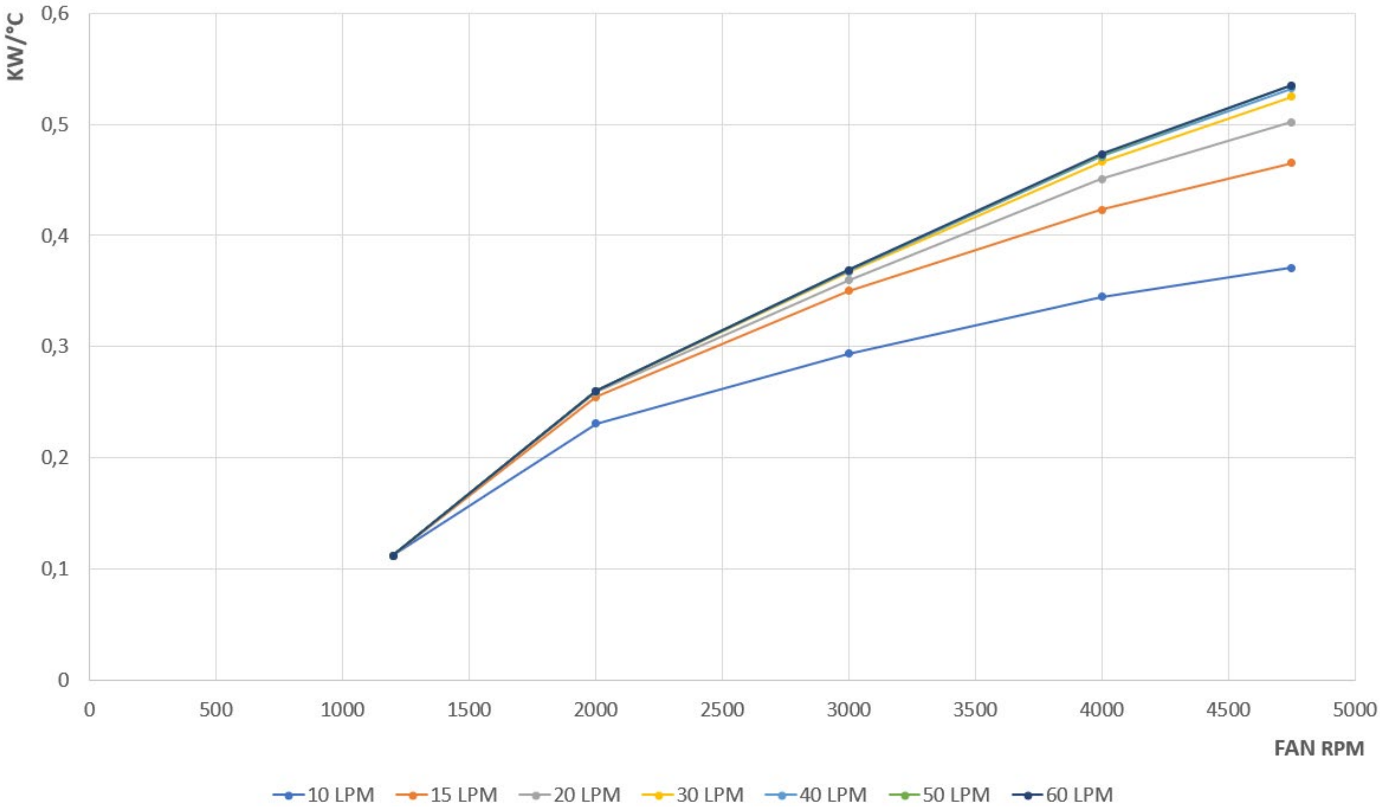
* = max. speed 4750 RPM / Noise level tolerance ± 3 dB(A)



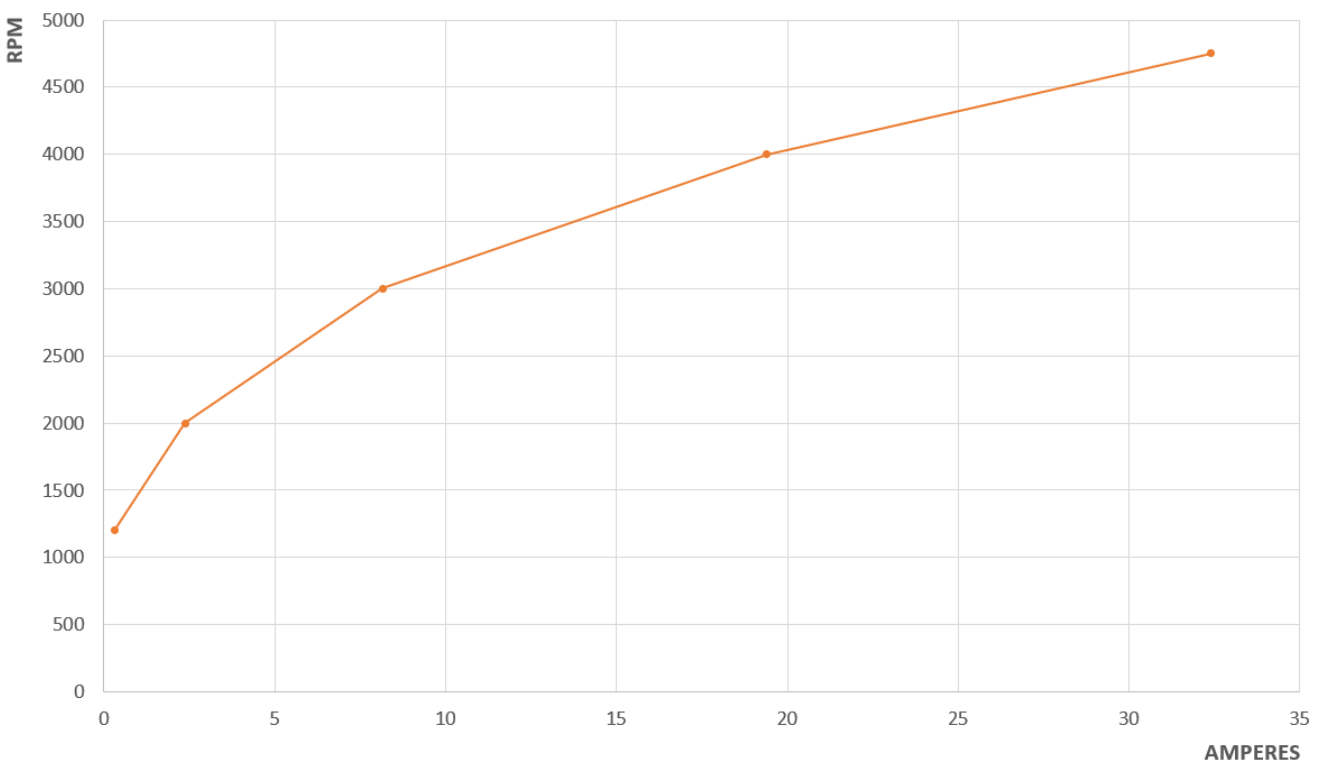
QDC 012 - Pressure Drop



QDC 012 - Cooling Capacity Water Glycol Mix 50% / 50%



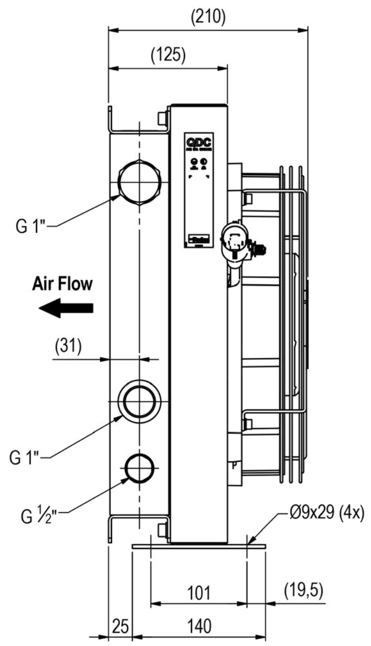
QDC 012 - A/RPM

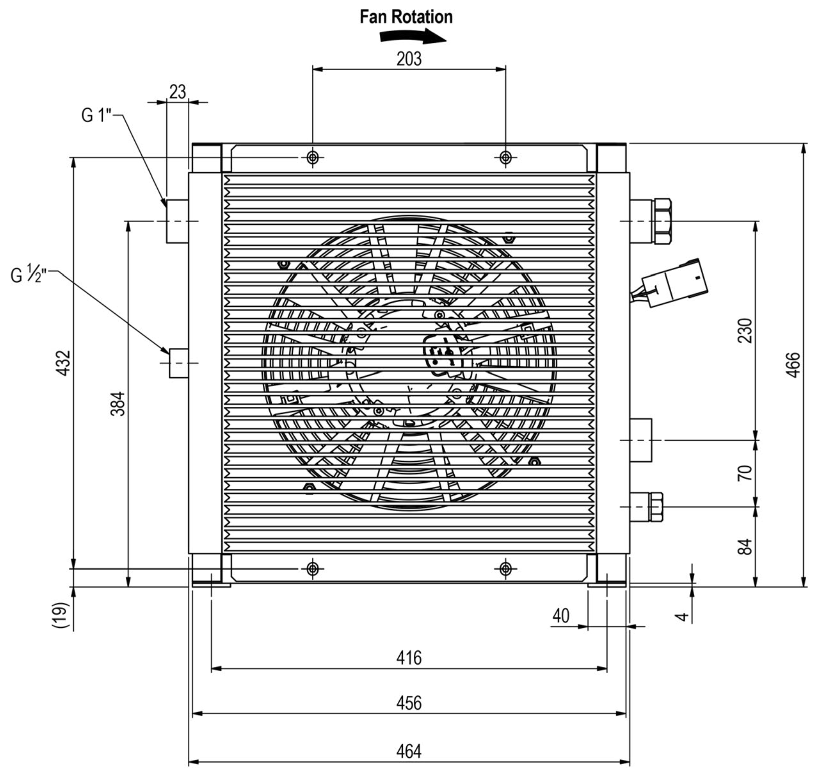


QDC 016

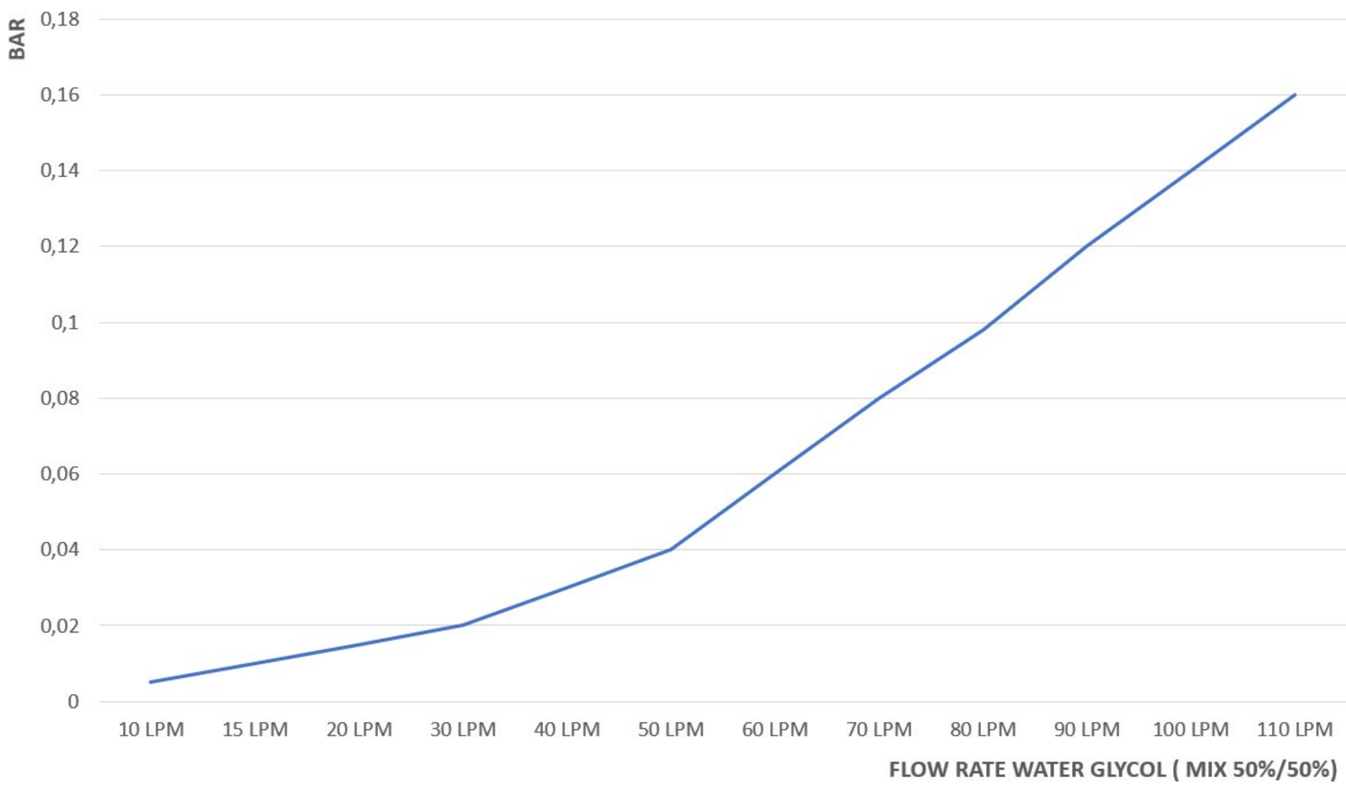
Type	P/N	Total Dimension	Weight kg	LpA dB(A)1 m
QDC 016	5847016001	464 x 466 x 210 mm	15	50 - 86*

* = max. speed 4750 RPM / Noise level tolerance ± 3 dB(A)

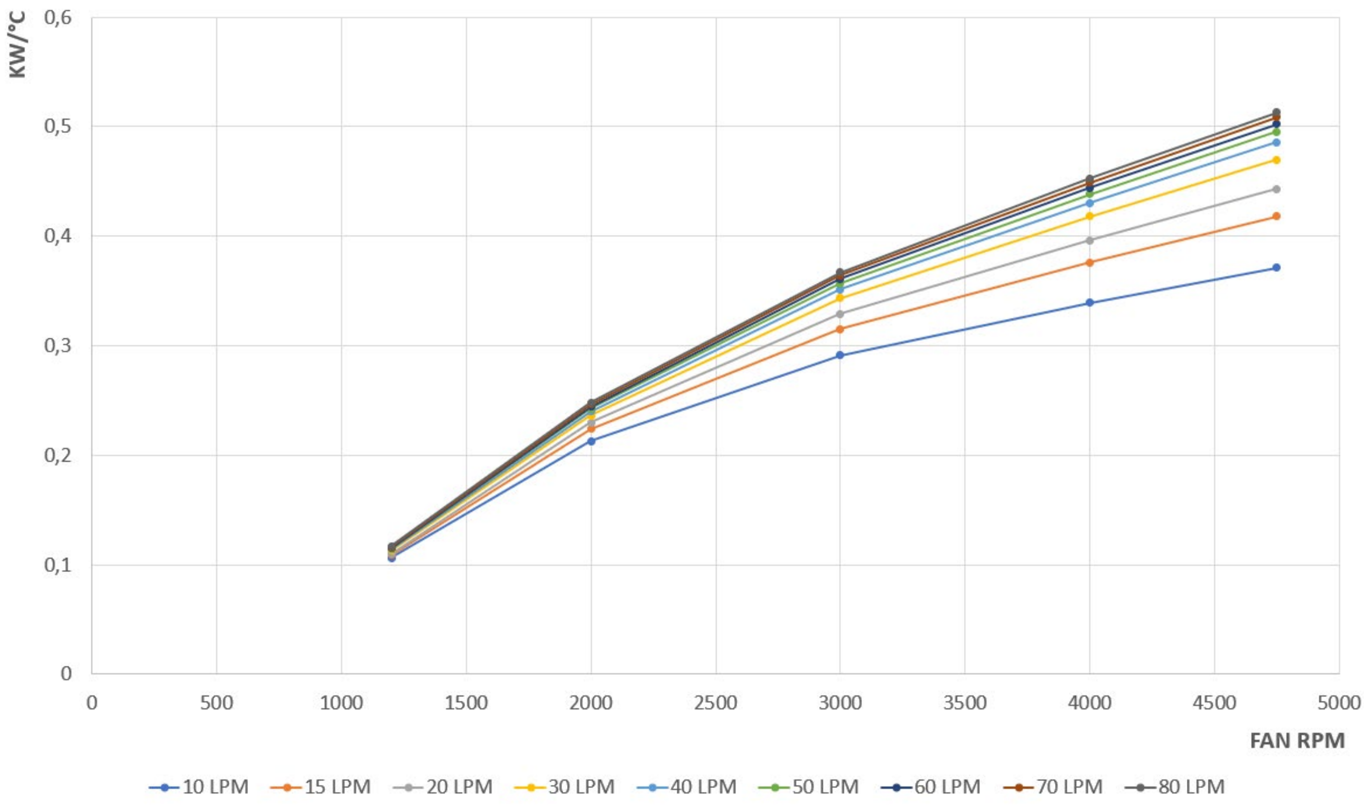




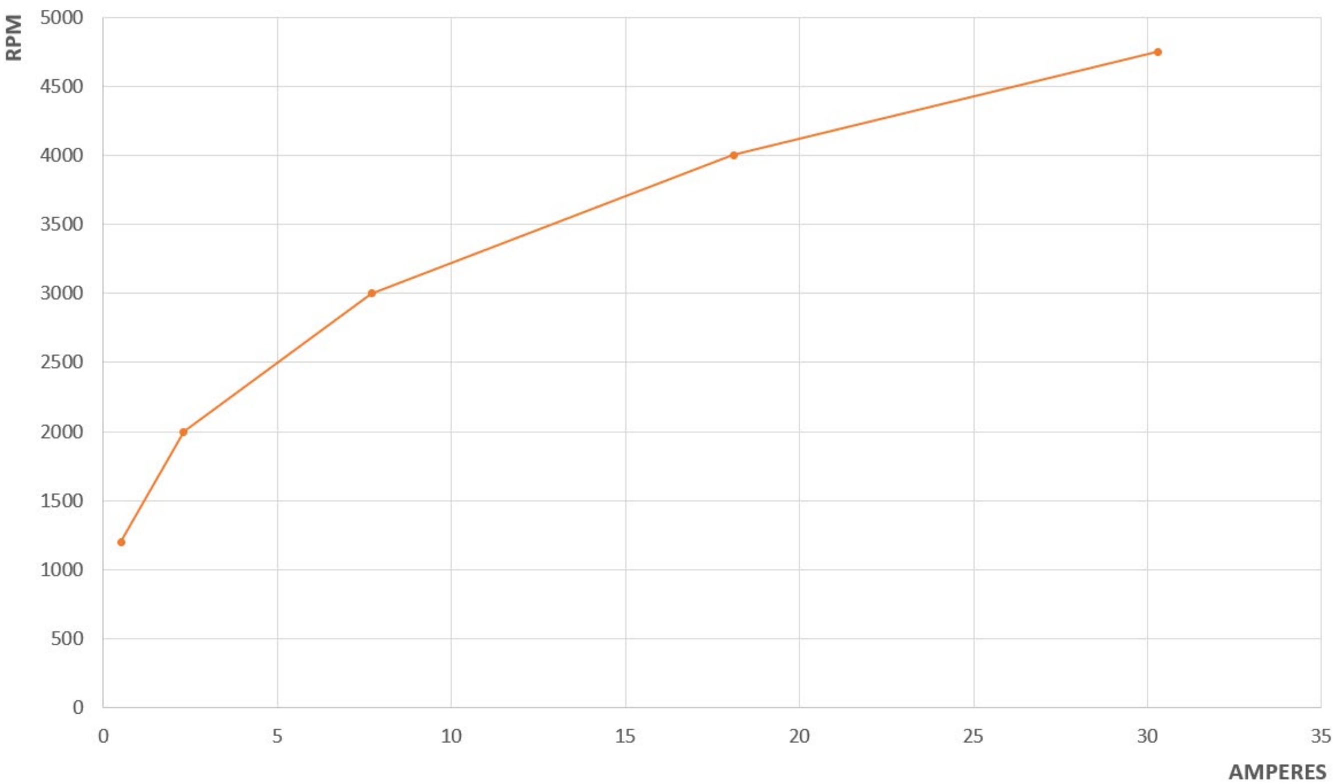
QDC 016 - Pressure Drop



QDC 016 - Cooling Capacity Water Glycol Mix 50% / 50%



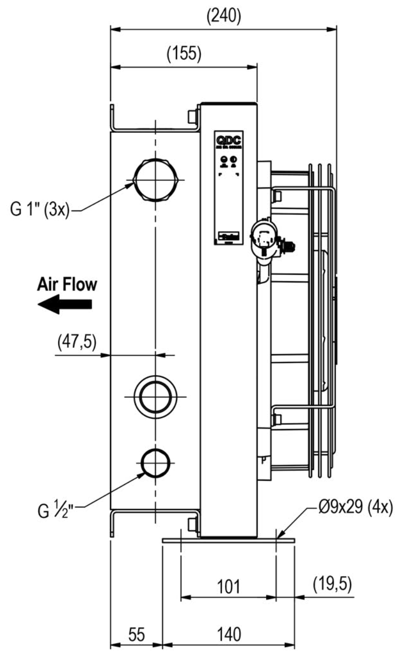
QDC 016 - A/RPM

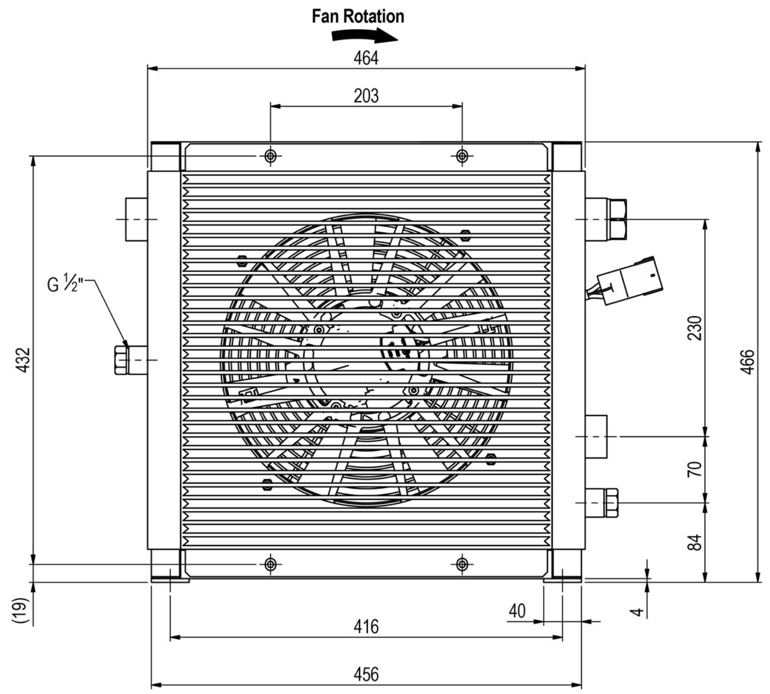


QDC 017

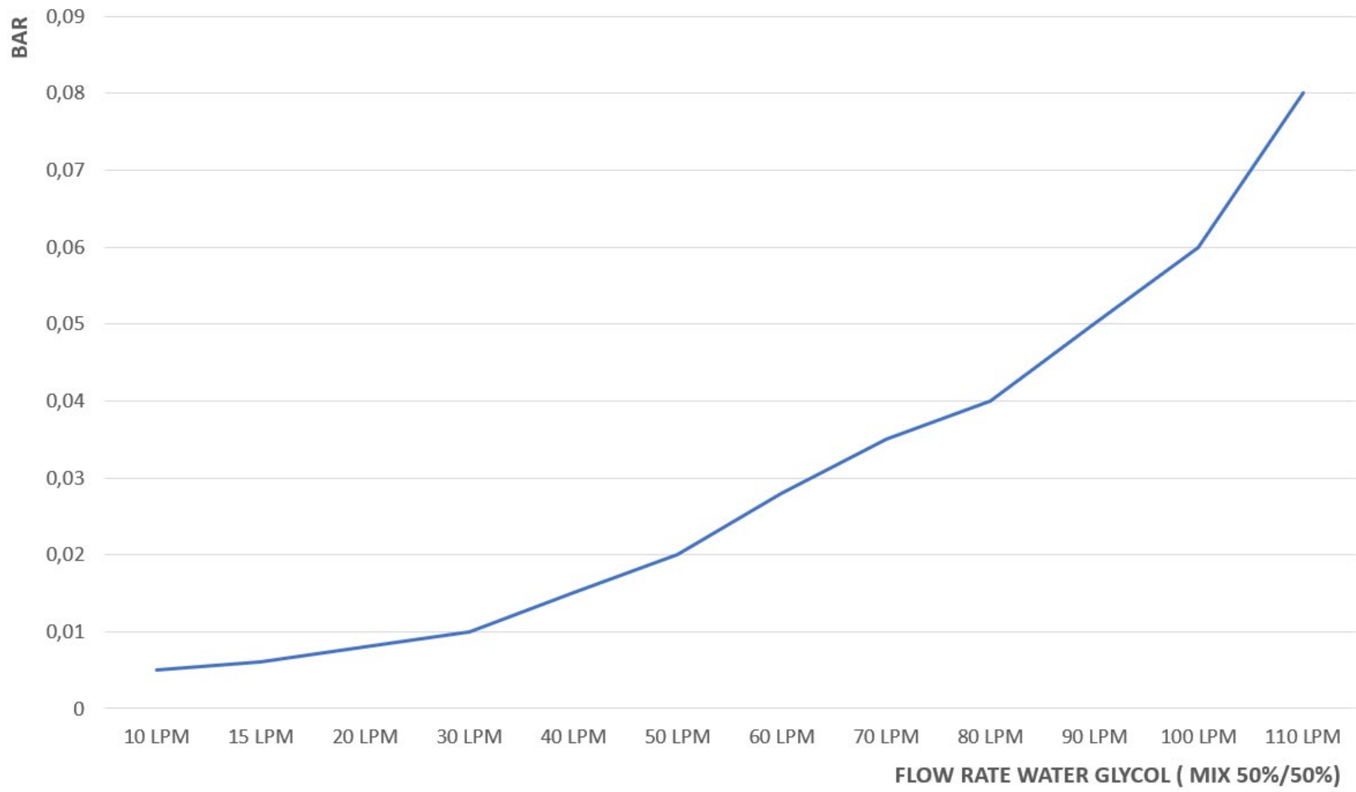
Type	P/N	Total Dimension	Weight kg	LpA dB(A)1 m
QDC 017	5847017001	464 x 466 x 240 mm	19.8	50 - 86

* = max. speed 4750 RPM / Noise level tolerance ± 3 dB(A)

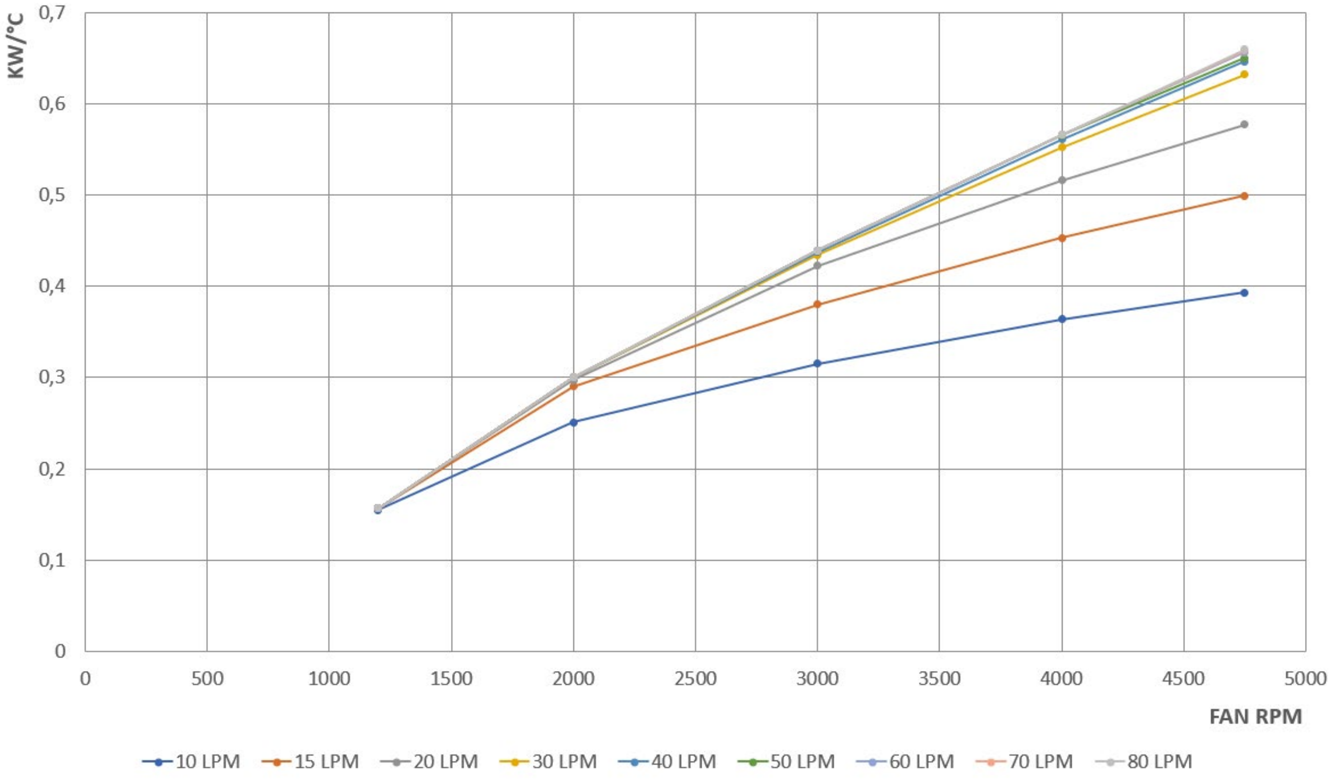




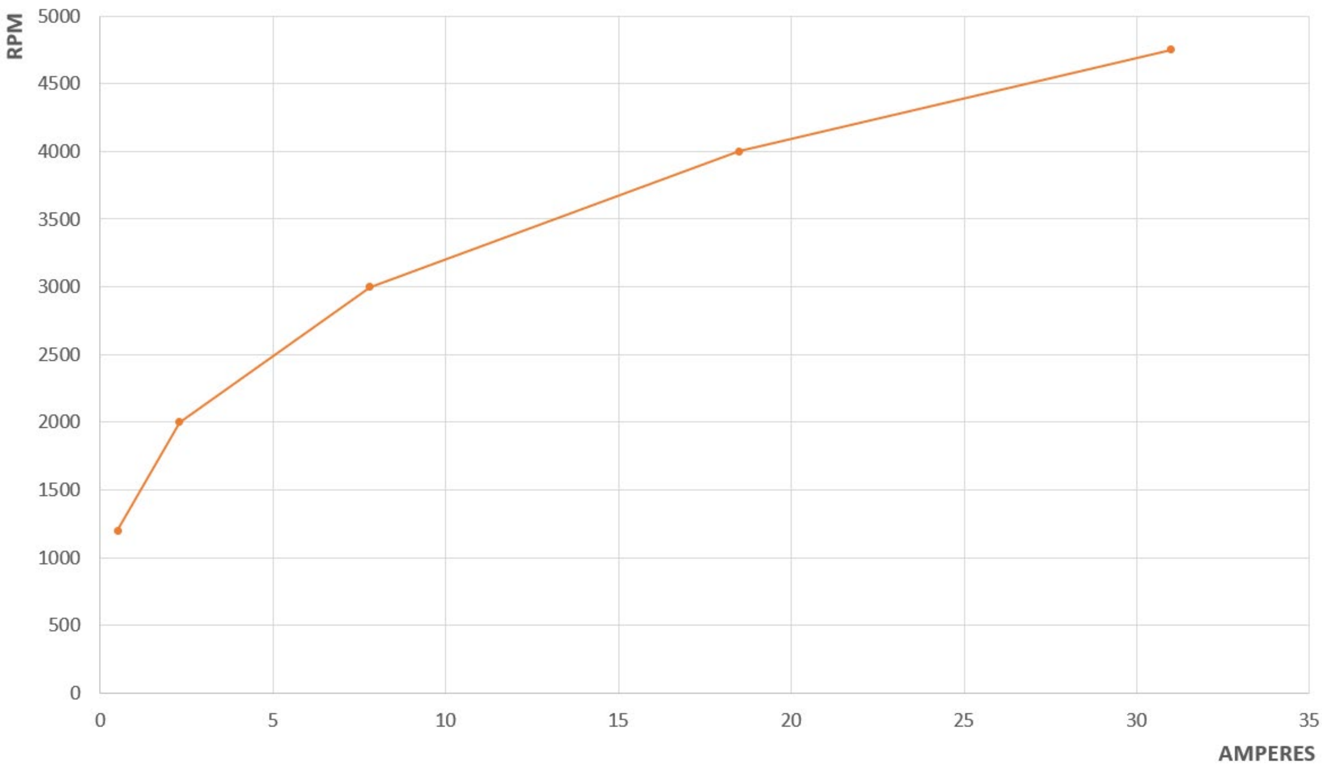
QDC 017 - Pressure Drop



QDC 017 - Cooling Capacity Water Glycol Mix 50% / 50%

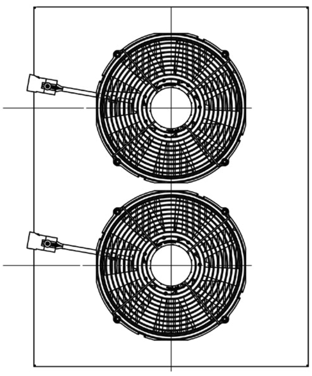


QDC 017 - A/RPM

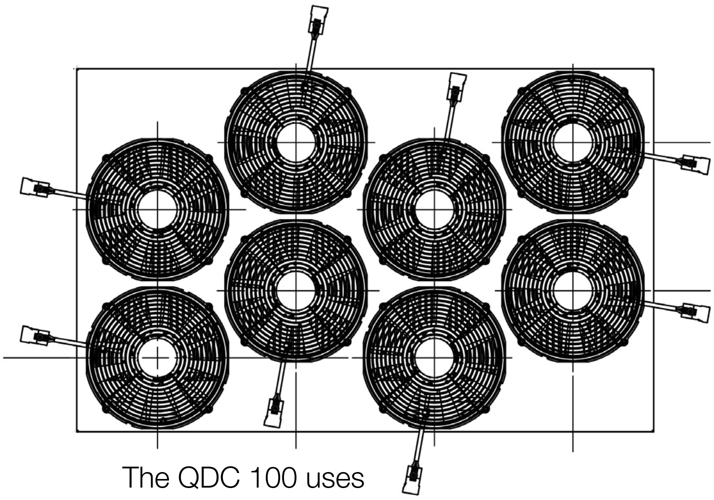


QDC 025 / 050 / 075 / 100

The QDC cooler series is available in sizes 025, 050, 075 and 100, too.
For detailed information, please contact your Parker Sales Representative.



The QDC 025 uses 2-fan technology.



The QDC 100 uses 8-fan technology.

The larger sized QDC coolers feature multiple fans, to ensure most efficient cooling.

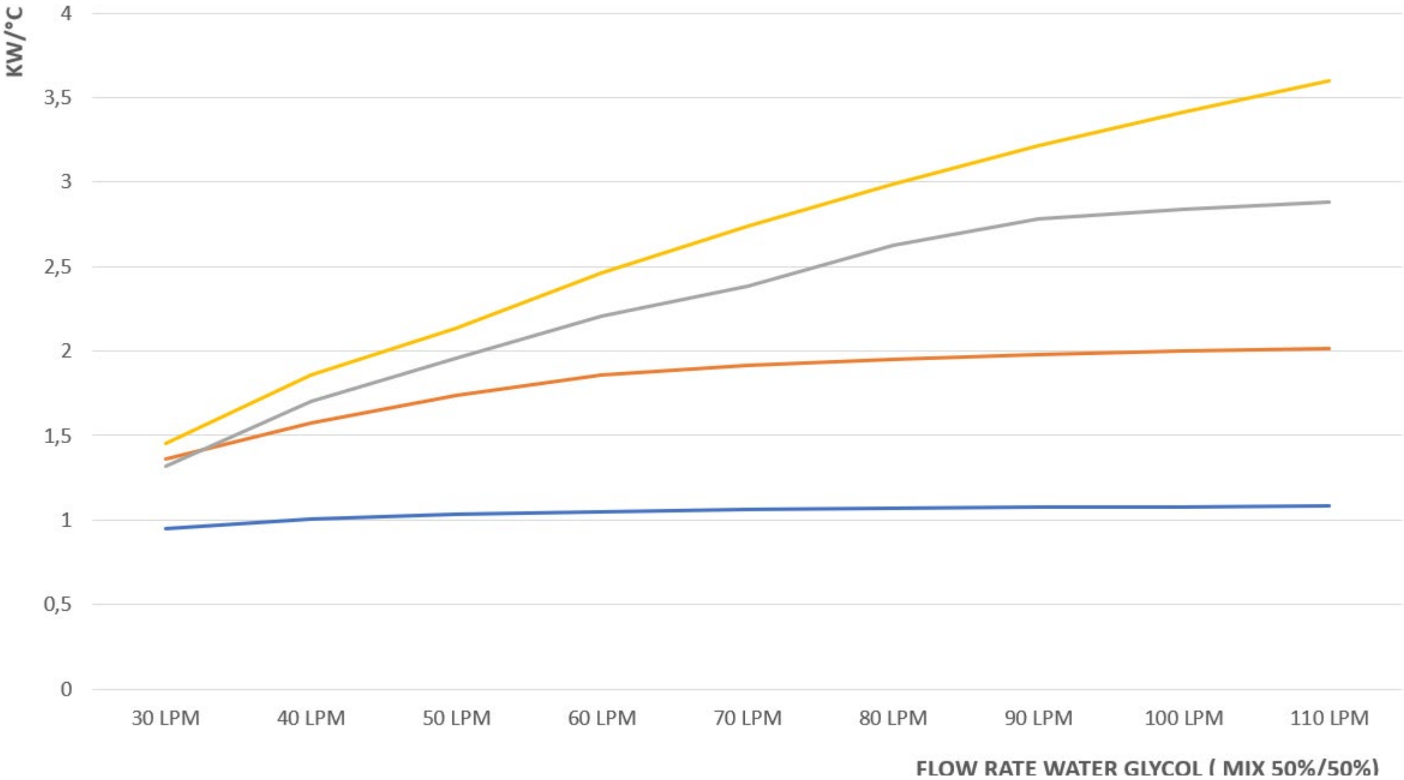
QDC 600 VDC performance overview

High Power 600VDC Brushless Fan Drive eMotor Air Cooled | Pull or Push Fan Air Flow Technology | HIGH Power Density
Option: GVI Inverter optimized for the QDC Range | 1-5 Cooling Circle in a Single Matrix
Voltage Range on Request 96-650VDC

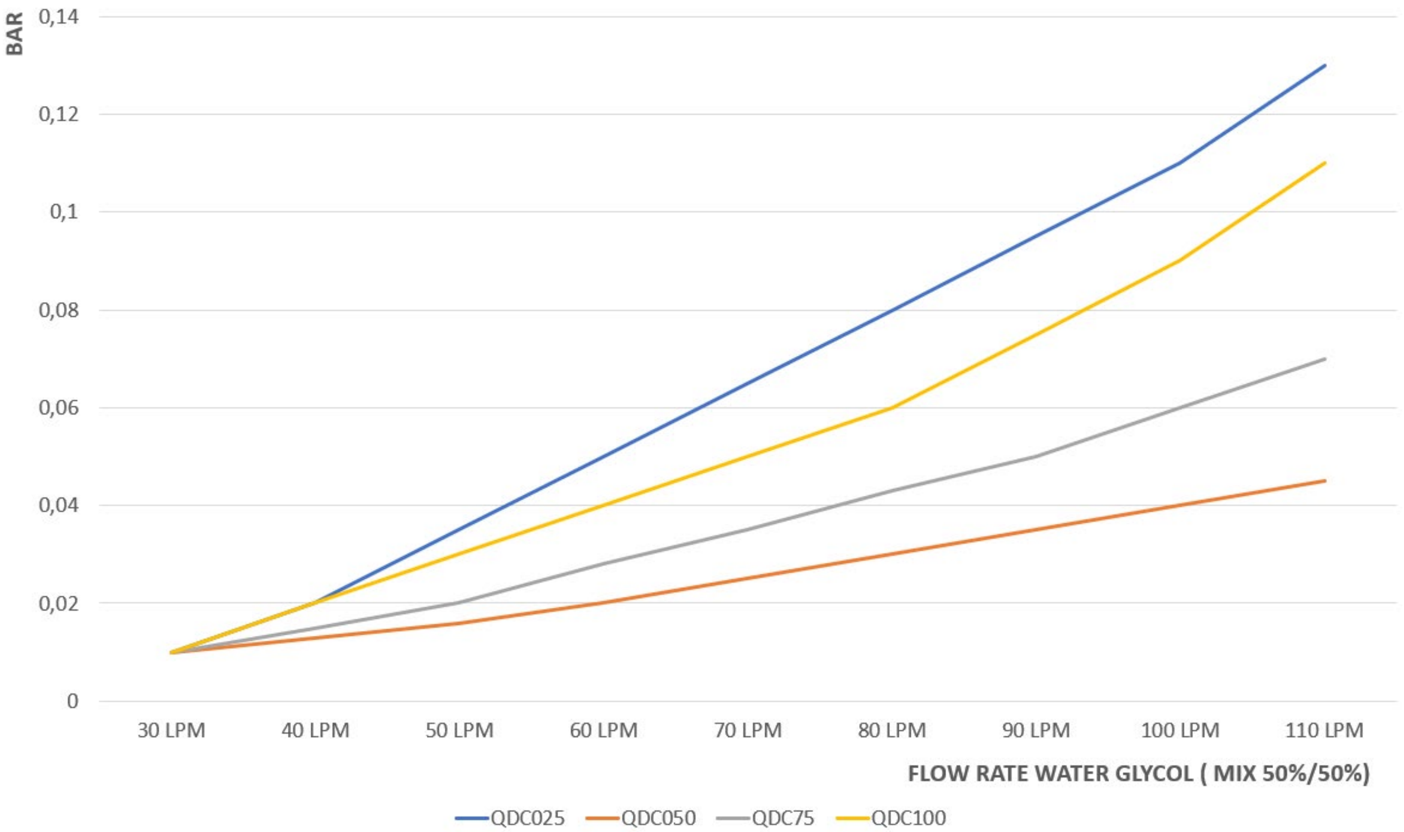
600 VDC High Power Single Matrix	@ Delta T 25°C*	@ Delta T 40°C*
QDC 026 Matrix 140 mm	50 kW	80 kW
QDC 051 Matrix 140 mm	100 kW	160 kW
QDC 076 Matrix 140 mm	150 kW	240 kW
QDC 101 Matrix 140 mm	210 kW	340 kW

* Temperature difference between ambient / inlet temperature cooler.

QDC 025 to QDC 100 - Cooling Capacity Water Glycol Mix 50% / 50%

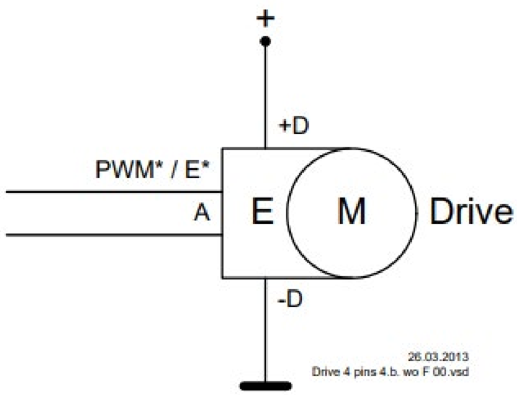


QDC 025 to QDC 100 - Pressure Drop



Fan Data

E stands for integrated electronics. M stands for motor. Drive stands for motor with axial integrated electronics.

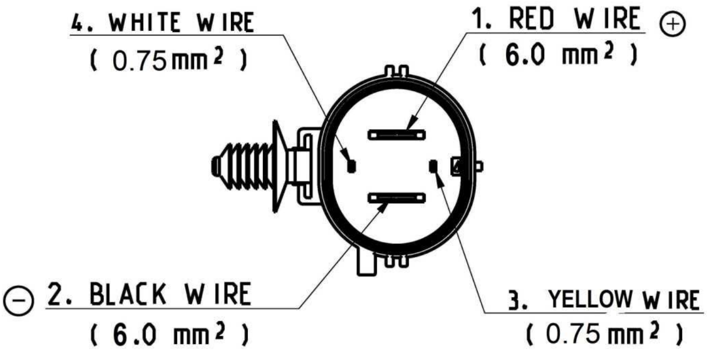


1. Features

Operating Supply Voltage Range	V	16.0 ... 32.0 at the Drive Connector
Supply Voltage to reach max. Speed	V	26.0 ... 32.0 at the Drive Connector
Operating Ambient Temperature	°C	-40 to +110
Max. Operating Ambient Temperature @ Max. Fan Speed	°C	+85*
Time from 0 RPM to Max. Speed	s	10
Load Dump Protection (Pulse 5b)	V	65 - Pulse Peak Voltage (U_s) - ISO16750-2:2010
Reverse Polarity Protection		ISO16750-1 Functional Status Class C - Device Fully Functional after Correcting the Polarity

* =Few minutes ambient temperature transients do not engage the derating owing to the thermal inertia of the system. Overloads may anticipate derating.

2. Connector and Wires



Connector: YAZAKI HYBRID (USCAR-2 compliant)

Identification (*)	+D	-D	A	PWM* / E*
Pin Number	1	2	3	4
Wire Colour	Red	Black	Yellow	White
Section (mm²)	6.0	6.0	0.75	0.75

3. Further Features

Compliance		ECE Reg. 10-04 and updates - Automotive EMC directive
		2002/95/EC RoHS - Hazardous Substances
		2000/53/EC and updates - End-of Life Vehicle
Ingress Protection		IP 68 and IP6K9K design
Allowed Power Supply Max. Ripple	ms	1 % - contact Parker for special needs
Fuse protection		An automotive fuse according ISO8820 must be chosen and used by the customer in the application wire harness. Each drive must be protected by the unique proper fuse (e.g. in case of double fan modules, two fuses are needed)

4. Measurement Conditions

The below conditions are assumed:

T_{AMB} = 20°C +/- 5°C

Supply Voltage **UB** = 26.0V at the **Drive** Connector - unless otherwise specified.

5. Drive Pin Functions

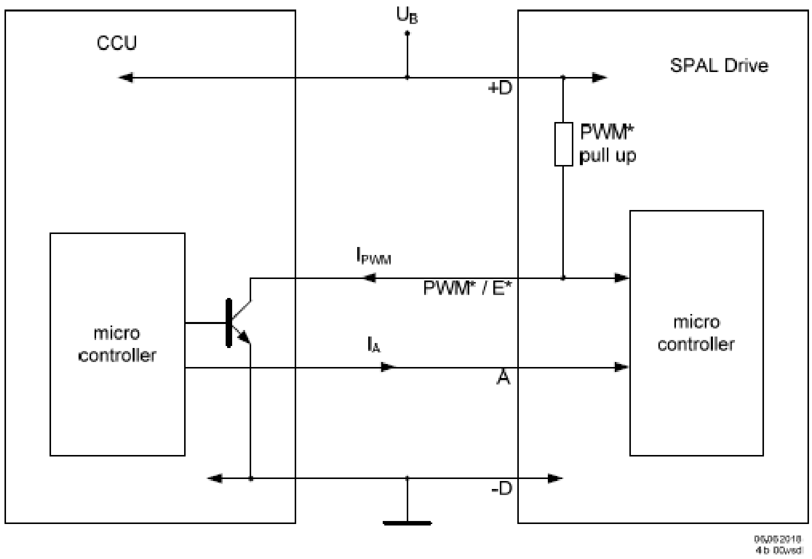
The electrical Drive interface consists of 4 pins.

Power Pins:
-supply voltage plus: +D
-supply voltage minus: -D

Signal Pins:
-Input: digital PWM input / active low: PWM* / E*
-Input: analog input: A

The signal pin PWM* / E* is used to control the Drive mode, it is not the control input.
The signal pin A can be used to control the speed of the Drive.

6. Drive Interface



The Drive interface, i.e. the connections between the CCU (Custom Control Unit) and the Drive, is depicted in the picture above.

The CCU electronics and the Drive electronics are connected via two unidirectional lines.

The PWM signal for the input PWM* / E* comes from the CCU electronics and uses a pull up resistor (PWM* / E* pull up) located in the Drive electronics to determine the recessive level.

This pull up resistor is connected to the supply voltage plus: +D / UB.

The dominant level on the input PWM* / E* is low level, provided by the switching to ground stage depicted in above figure. as a bipolar npn transistor in the CCU.

7. Interface Hardware for Digital Control: Pin PWM* / E*

The input PWM* / E* is used to wake up the Drive from Quiescent current mode. Any PWM duty cycle that guarantees a pulse going to the dominant level for more than Twakeup will wake up the Drive electronics.

Parameters	Min	Typical	Max	Unit	Denomination
PWM* / E* frequency range	50	100	500	Hz	f_{PWM} 1)
PWM* / E* duty cycle range	0		100	%	dc_{min} ...dc_{max}
PWM* / E* high level voltage	U_B *0.65			V	U_{PWMH}
PWM* / E* low level voltage			U_B *0.45	V	U_{PWMl}
PWM* / E* resolution		1		%	dc_{resol}
PWM* / E* accuracy		1		%	dca_{ccu}
PWM* / E* current	-10%	5.5	+10%	mA	I_{PWM*}
PWM* / E* leakage current			200	ɥA	I_{PWM*}
PWM* / E* wage up voltage	U_B - 2V			V	U_{PWMWU}
PWM* / E* wake up pulse	150			ɥs	T_{wakeup}
PWM* pull up		4.7		kΩ	

1): for production line internal reasons there is a test mode implemented which is activated at a PWM frequency range from 1400 Hz to 1600 Hz with dedicated duty cycles for various test modes.
The application must not use this frequency range!

8. Interface Hardware for Analog Control: PIN A

Parameters	Min	Typical	Max	Unit	Denomination
A voltage range	0		10	V	U_A
Absolute maximum A voltage	-32		35	V	U_{Amax}
A current range	0		0.32	mA	I_A
A maximum current	-1.8		1.8	mA	I_{Amax}

9. Software Functions

The Drive has different working modes related mainly to the Drive current consumption:
1. Quiescent current mode
2. Electronics active mode
3. Run mode
4. Failure mode

The Drive mode changes accordingly to the control input duty cycle on pin PWM* / E* and the voltage level on analog input A.

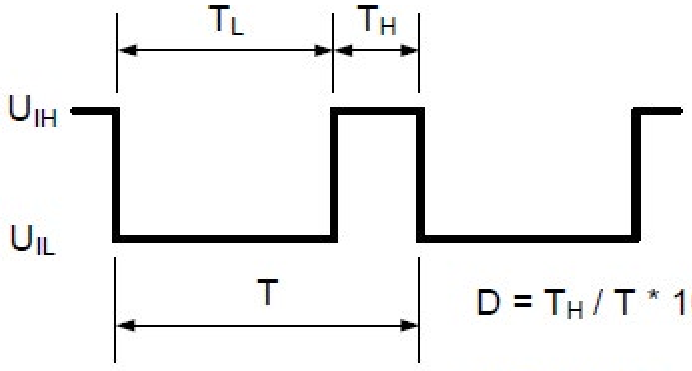
No.	Drive Mode	Current Consumption	Drive Speed
1	Quiescent current mode	< 100 μA	0
2	Electronics active mode	< 40 μA	0
3	Run mode	depending on the requested speed and on the load	depending on the PWM duty cycle or the analog input voltage level
4	Failure mode	< 40 μA	depending on the failure

The Quiescent current mode is entered when the pin PWM* / E* is on 100 % duty cycle (recessive level).
The time to go into Quiescent current mode depends on the actual PWM base frequency and the number of samples for the plausibility check (see chapter 12.3). Additionally 2 s are waited after the detection of the absence of the PWM signal before finally going into Quiescent current mode.
The Electronics active mode is entered with any PWM duty cycle value between 0 % and < 100 % if the condition from chapter 10 is fulfilled (Twakeup).
The Run mode is entered in the following cases:
- if the PWM duty cycle on pin PWM* / E* has a value where the Drive is asked to run (see p.11)
- if the analog signal on pin analog input A has a value where the Drive is asked to run (see p.12)

The Failure mode is entered in case of failures of the Drive (see p.12)

10. Digital Control: Transfer Function PWM Input

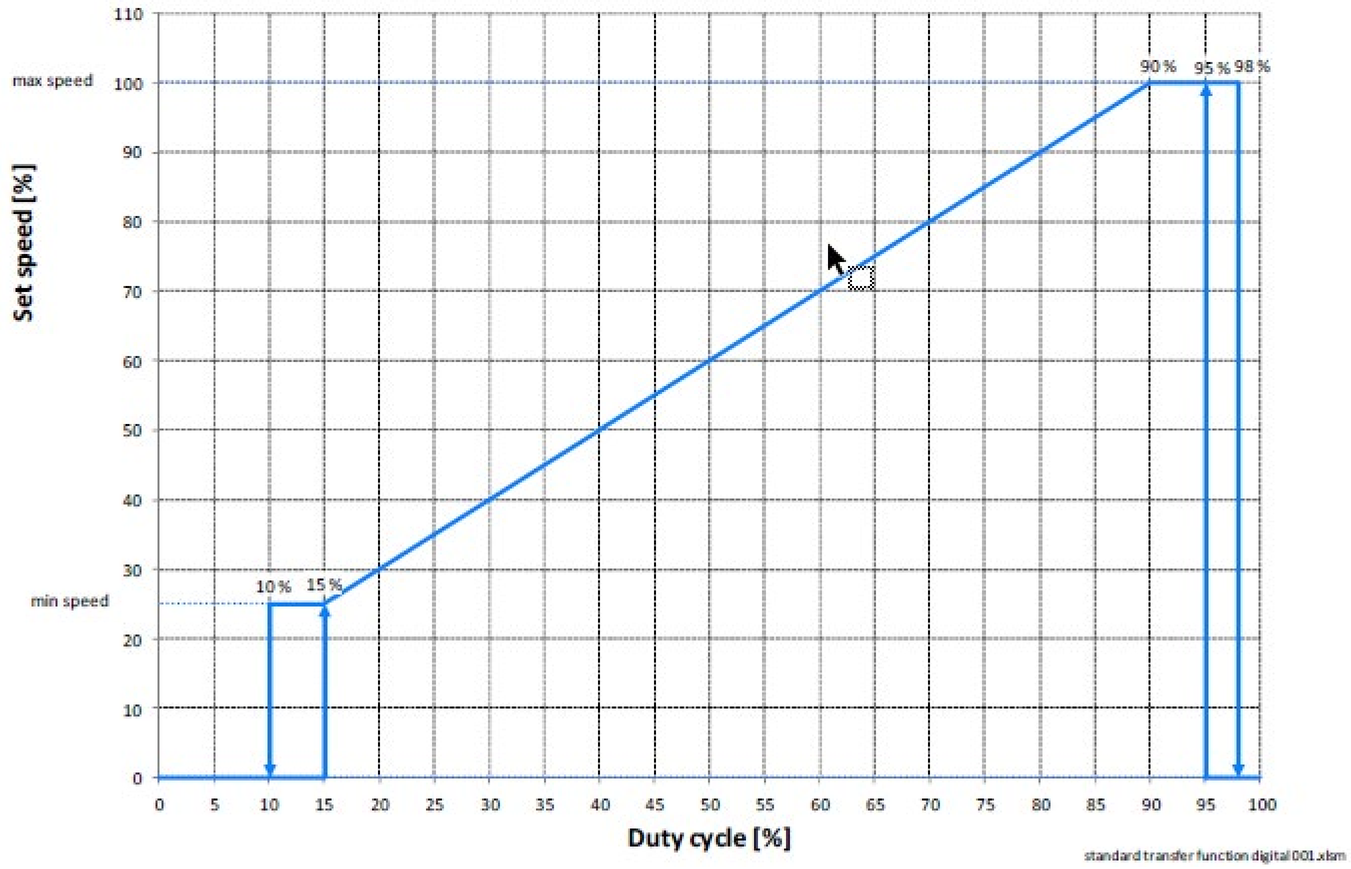
The transfer function PWM input is the relation between the Drive speed and the duty cycle on the pin digital PWM input / active low: PWM* / E*.



$$D = T_H / T * 100\ [\%]$$

$$T = T_H + T_L$$

It is called ”positive logic duty cycle definition”.
Considering this definition, - continuous low voltage is 0 % duty cycle (dominant level)
- continuous high voltage is 100 % duty cycle (recessive level)
Based on this duty cycle definition the transfer function PWM input is shown in the following figure.

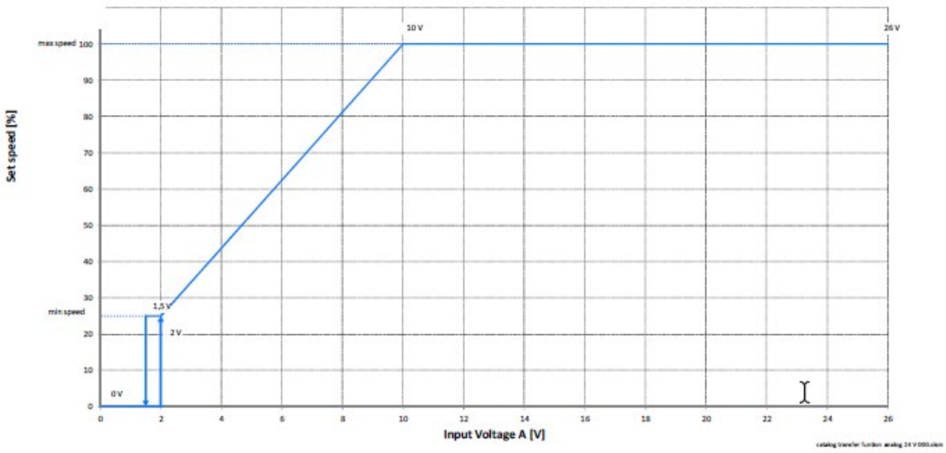


11. Drive Speed Set Point with Digital Control

The PWM signal on the control input PWM* / E* is measured by the Drive electronics. For improving noise to signal ratio the PWM signal becomes only valid and is only used to set the speed of the Drive when a sufficient number of consecutive duty cycle measurements are equal.
This plausibility test slightly delays the response to the change of the duty cycle PWM value.
This delay is in the range of 0.2 s or less.

12. Analog Control: Transfer Function Analog Input

The transfer function analog input is the relation between the Drive speed and the duty cycle on the pin analog input A (see following figure).



13. Drive Mode - Failure Modes

<table>
<tr><th>Failure Mode</th><th>Handling of Failure</th><th>Notification</th></tr>
<tr><td>Drive blocked</td><td>In case of detection of a rotor locked the following strategy is used: a delay of 5 s till the next start attempt is introduced. If this start attempt fails again a delay increased by further 5 s till the next start attempt is introduced. This delay increase is repeated till the delay between the attempts is 25 s. Then this delay is kept for ever as long a valid PWM duty cycle is detected which asks the Drive to run</td><td rowspan="6">Notification is not available as no feedback is provided to the CCU.</td></tr>
<tr><td>Drive overloaded</td><td>Fan speed is reduced in case of overload detection by means of current draw measurement.</td></tr>
<tr><td>Over current</td><td>The Drive will stop if the over current safety threshold is reached.</td></tr>
<tr><td>Drive overheated</td><td>Fan speed is reduced in case of overheating detection (derating).
Over the max operating temperature, the Drive will stop.</td></tr>
<tr><td>Under / Over voltage</td><td>If the supply voltage is outside the specified range the Drive will stop.</td></tr>
<tr><td>Internal Drive Failure</td><td>The Drive will stop if a failure is detected during the startup self check procedure.</td></tr>
</table>

In all cases the Drive tries to recover from failures when a valid PWM signal is detected which asks the Drive to run.

14. Operating Modes

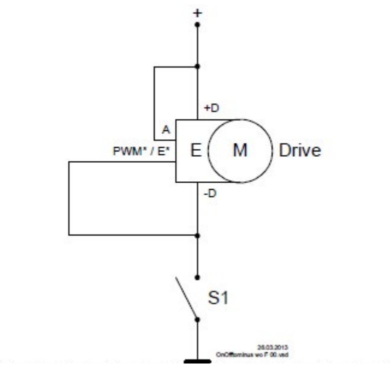
The Drive interface (the connection between the Drive and the user system) can be done in 8 ways depending if and how the two signal inputs PWM* / E* and A are used. See the following table:

Mode description	Mode	+D	-D	PWM* / E*	A	Pins to connect
On / off to minus	1	+	↔ -D	-	+	4
On / off to plus	2	+ ↔ +D	-	-	+	4
On / off with enable low	3	+	-	↔ E*	+	4
Analog control 1	4	+	↔ -D	-	analog	4
Analog control 2	5	+ ↔ +D	-	-	analog	4
Analog control with enable low	6	+	-	↔ E*	analog	4
Digital control	7	+	-	PWM	n. c.	3
Mixed analog / digital control	8	+	-	PWM	analog	4

analog	:	analog voltage signal (input)
PWM	:	PWM signal (input)
n. c.	:	not connected
+ ↔ +D	:	switch of the Drive positive supply to plus
↔ -D	:	switch of the Drive negative supply to minus / GND
↔ E*	:	switch active low enable input to minus / GND

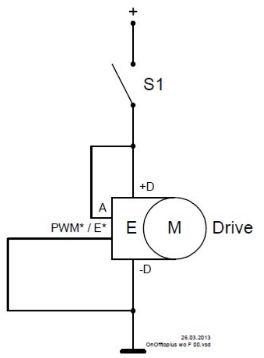
15.1 Interface Mode 1: On / Off to Minus

When the switch S1 is switched on the Drive goes after the initialization of the electronics to full speed.
This mode can be used if the CCU which controls the Drive has limited capabilities or does not even exist.
The Drive is just switched on and off via any power switch like a relay, MOS FET, or even just a switch.
The appropriate current rating for this “switch” has to be dimensioned according to the current consumption of the Drive.



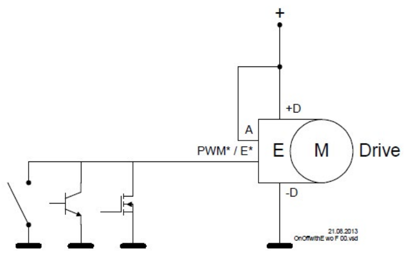
15.2 Interface Mode 2: On / Off to Plus

When the switch S1 is switched on the Drive goes after the initialization of the electronics to full speed.
This mode can be used if the CCU which controls the Drive has limited capabilities or does not even exist.
The Drive is just switched on and off via any power switch like a relay, MOS FET, or even just a switch.
The appropriate current rating for this “switch” has to be dimensioned according to the current consumption of the Drive.



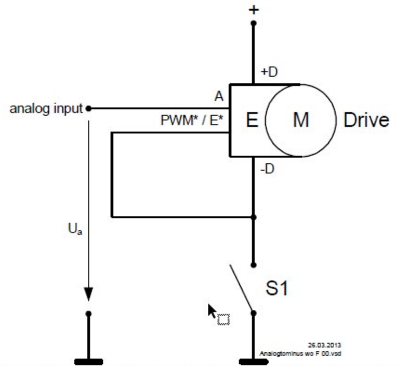
15.3 Interface Mode 3: On / Off with Enable Low

The Drive can stay always on supply voltage and is controlled by a low current enable input which can be driven by simple low cost low side signal driver in the CCU.
When the enable input PWM* / E* goes to high, the Drive goes after a short time into the quiescent current mode.
When the enable pin PWM* / E* is driven low, the Drive goes to full speed after the initialization of the electronics.
This mode can be used if the CCU which controls the Drive has limited capabilities or does not even exist.
The appropriate sink current rating of the driver for the enable pin PWM* / E* has to be dimensioned according to the current consumption of the pin PWM* / E*.
The circuit structure to drive the pin PWM* / E* can be any active low “open collector”.



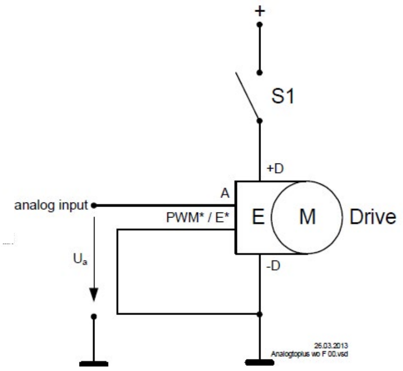
15.4 Interface Mode 4: Analog Control 1

When the switch S1 is switched on the Drive goes after the initialization of the electronics to the speed requested by the analog input A.
The appropriate current rating for this “switch” has to be dimensioned according to the current consumption of the Drive.



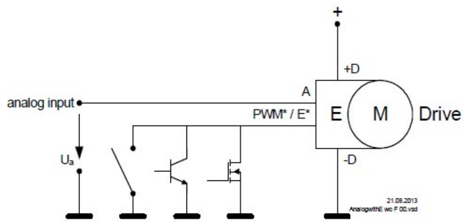
15.5 Interface Mode 5: Analog Control 2

When the switch S1 is switched on the Drive goes after the initialization of the electronics to the speed requested by the analog input A.
The appropriate current rating for this “switch” has to be dimensioned according to the current consumption of the Drive.

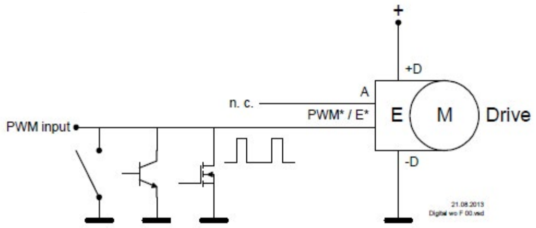


15.6 Interface Mode 6: Analog Control with Enable Low

In mode 6 the Drive can stay always on supply voltage and is controlled by a low current enable input which can be driven by simple low cost low side signal driver in the CCU.
When the enable input PWM* / E* goes to high, the Drive goes after a short time into the quiescent current mode.
When the enable pin PWM* / E* is driven low, the Drive goes to the speed requested by the analog input A after the initialization of the electronics.
The appropriate sink current rating of the driver for the enable pin PWM* / E* has to be dimensioned according to the current consumption of the pin PWM* / E*.
The circuit structure to drive the pin PWM* / E* can be any active low “open collector”.
In this operating mode the supply voltage plus is usually connected permanently. To run the Drive first the pin PWM* / E* has to be connected to supply voltage minus and afterwards the Drive speed can be then controlled with an analog voltage on the pin A.

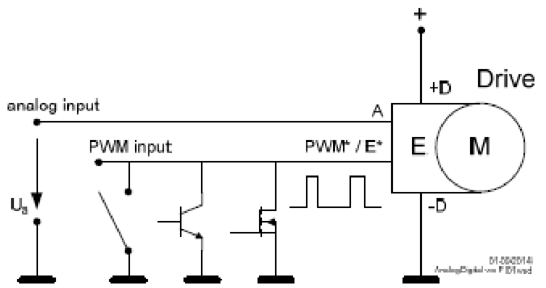


15.7 Interface Mode 7: Digital Control



In mode 7 the Drive can stay always on supply voltage and is controlled by a low current PWM and enable PWM* / E* input which can be driven by simple low cost low side signal driver in the CCU.
When the enable input PWM* / E* goes to high, the Drive goes after a short time into the quiescent current mode.
When the enable pin PWM* / E* is driven with PWM, the Drive goes to the speed requested by the duty cycle after the initialization of the electronics.
The appropriate sink current rating of the driver for the enable pin PWM* / E* has to be dimensioned according to the current consumption of the pin PWM* / E*.
The circuit structure to drive the pin PWM* / E* can be any active low “open collector”.
In this operating mode the supply voltage plus is usually connected permanently. To run the Drive on the pin PWM* / E* a PWM signal has to be applied and with the duty cycle of the PWM signal the Drive speed can be then controlled.

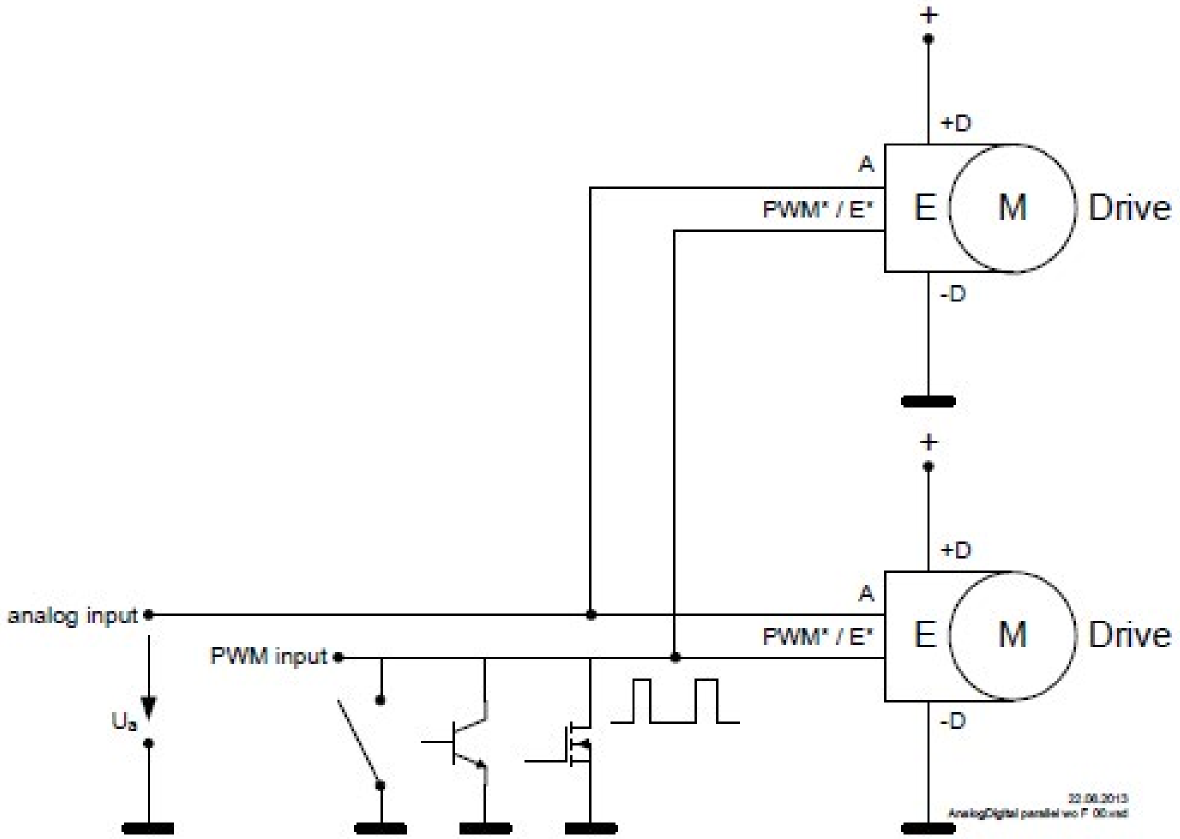
15.8 Interface Mode 8: Mixed Analog / Digital Control



In mode 8 the Drive can stay always on supply voltage and is controlled by a low current PWM and enable PWM* / E* input which can be driven by simple low cost low side signal driver in the CCU.
When the enable input PWM* / E* goes to high, the Drive goes after a short time into the quiescent current mode.
When the enable pin PWM* / E* is driven low (switched to supply voltage minus), the Drive goes to the speed requested by the analog input A after the initialization of the electronics (if the electronics is not already activated).
When the enable pin PWM* / E* is driven with PWM, the Drive goes to the speed requested by the duty cycle after the initialization of the electronics (if the electronics is not already activated).
The appropriate sink current rating of the driver for the enable pin PWM* / E* has to be dimensioned according to the current consumption of the pin PWM* / E*.
The circuit structure to drive the pin PWM* / E* can be any active low “open collector”.
In this operating mode the supply voltage plus is usually connected permanently. To run the Drive on the pin PWM* / E* a PWM signal has to be applied and with the duty cycle of the PWM signal the Drive speed can be then controlled. If the pin PWM* / E* is switched to supply voltage minus the Drive speed can be then controlled with an analog voltage on the pin A.
So a mixed control with either digital or analog input is possible. The priority has the digital PWM signal.

16. Interface Parallel Configuration

The Drives can be used in a parallel configuration in the PWM driven modes as well as in analog driven modes and also in the combines analog / PWM mode in such a way that the control lines are connected in parallel as shown in below for the example of two Drives.



There is no limitation from the Drive‘s point of view in paralleling them. Nevertheless from the CCU’s point of view it has to be considered that all of the Drives needs a certain current each on the signal lines PWM* / E* and A. This has to be taken into account for dimensioning the driver stage which controls digitally via the PWM* / E* inputs of the Drives or which controls analog via the A inputs of the Drives. The output driver stage of the CCU needs to be capable of driving minimum the input currents of PWM* / E* and / or A times the number of the Drives.

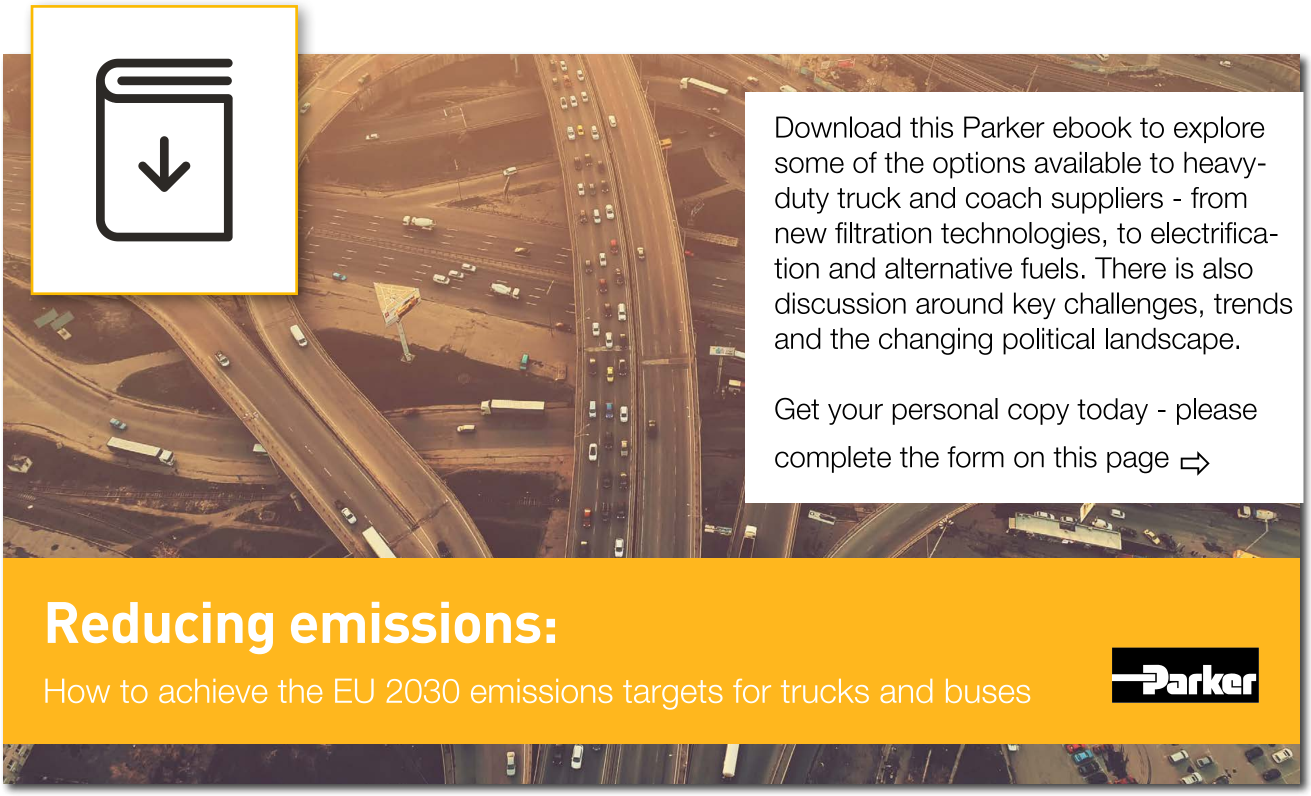
17. Units and Acronyms

Unit		Physical Quantity
%	percent	Proportionality
Ω	Ohm	Electrical Resistance
°C	degree Celsius	Temperature
A	Ampere	Current
h	hours	Time
dBA	deciBel (A-weighting)	Sound Pressure Level
Hz	Hertz	Frequency
min	minute	Time
Pa	Pascal	Pressure
RPM	Revolutions per minute	Rotation Frequency
s	second	Time
V	Volt	Voltage
W	Watt	Power

Prefix	Dimension	
M	10^{6}	mega
k	10^{3}	kilo
m	10^{-3}	milli
ɥ	10^{-6}	micro
n	10^{-9}	nano
p	10^{-12}	pico

Key Word	Description
AMPL_IN	Amplitude PWM Input Signal
CCU	Custom Control Unit
Drive	Motor with axially Integrated Electronics
IGN	Ignition (KL15)
PWM	Pulse Width Modulation
R_i	Input Resistance
SBL	Sealed Brushless
T	Temperature
T_{AMB}	Ambient Temperature
U_B	Supply Voltage
U_N	Nominal Supply Voltage
rms	Root Mean Square

More components of the Thermal Management System



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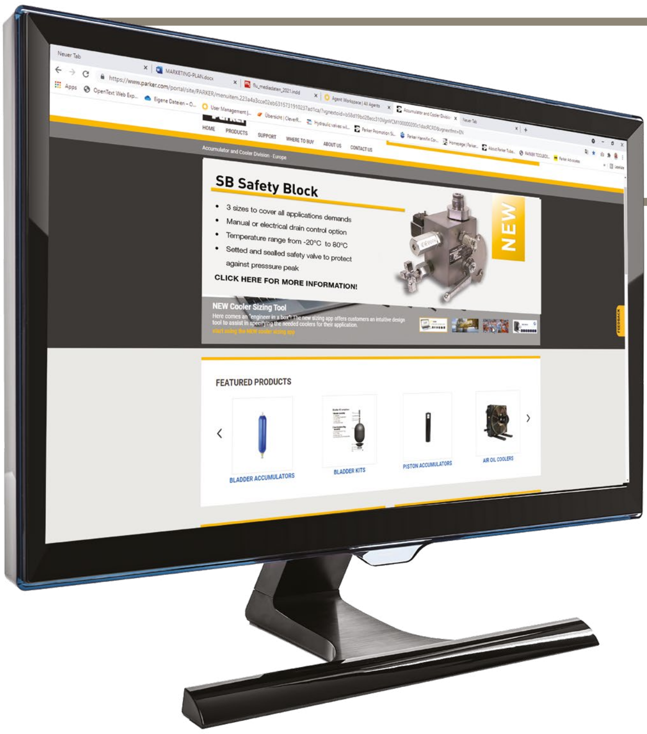

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