Installation and Servicing Manual QDC 007 - 100, 24 V DC

Quiet Air fluid cooler with brushless DC Motor
for electrified mobile applications

Parker

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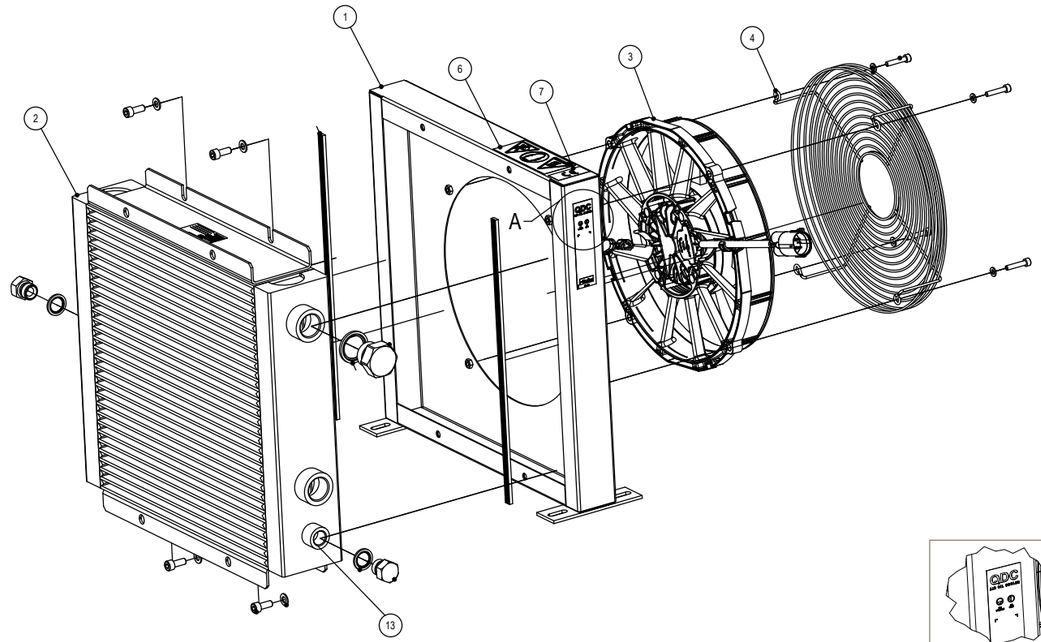
Parker declares that all products featured in this catalogue conform to REACH and RoHS regulations.

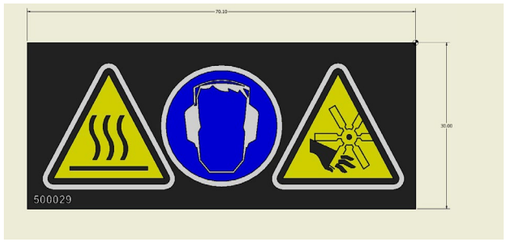
REACH compliant

RoHS compliant

1. Parts



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	



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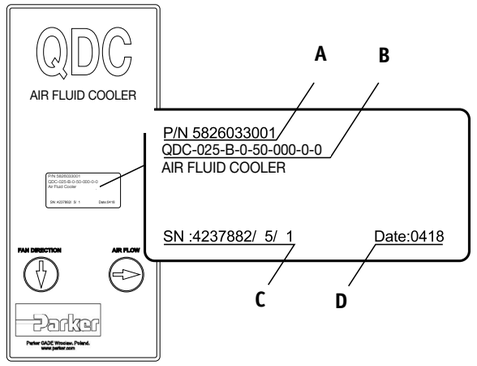

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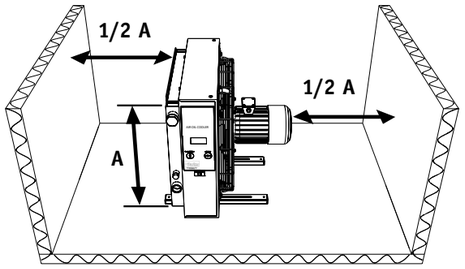

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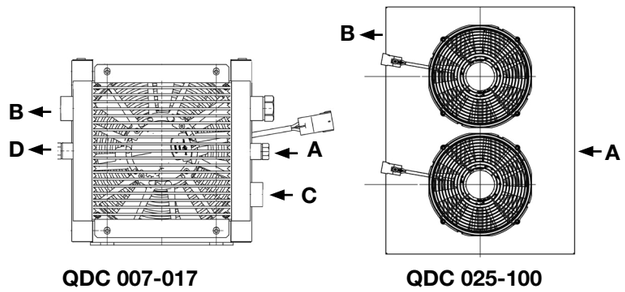

QDC 007-017

QDC 025-100

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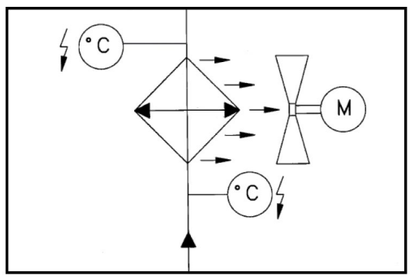

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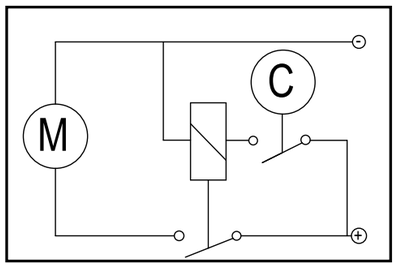

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2. Introduction/Safety instructions/Description

Introduction

The purpose of this manual is to serve as a reference guide for installation, maintenance and operation of the QDC series of air fluid coolers. Keep the manual at hand. A lost manual should be replaced as soon as possible.
For optimum performance and in order to prevent incorrect use, please read this manual carefully and observe all safety precautions prior to putting the air fluid cooler into service.
Installation and maintenance work should only be carried out by qualified personnel. Parker reserve the right to make technical alternations without notice.

Use

The QDC series of air fluid coolers is designed to cool liquids in systems for mobile applications.

Warranty and claims

In the event of breakdown, consult your local Parker office. Parker shall not be held responsible for any consequences due to modification and/or variation made by the customer

Safety instructions

The installation contractor as well as the user should be aware of, understand and observe all safety precautions in this manual, including any information mentioned on labels fixed to the product.

Definition of Safety Warning Levels…

…concerning personal safety

All precautions concerning personal safety are classified as per below, depending on how severe the consequences of an incident could be.

⚠ **Danger** This alerts you to an action or procedure that, if performed improperly, **will produce** bodily harm or death.

⚠ **Caution** This alerts you to an action or procedure that, if performed improperly, **is likely to produce** bodily harm or death.

⚠ **Precaution** This alerts you to an action or procedure that, if performed improperly, **is likely** to cause an accident with physical harm.

…..concerning other safety issues

Notifications concerning other safety issues (property, process or environment) and maintenance work are classified as follows:

Important This alerts you to an action or procedure that, if performed improperly, **is likely** to result in damages to the property, process or environment.

….concerning additional information

Additional information is marked as follows.

Note! This alerts you to important information related to the text in a paragraph.

Overall instructions

Handling, operation and maintenance

⚠ **Caution** Risk of bodily injury. To prevent physical harm when lifting the unit, use the correct lifting technique. Make sure that all lifting devices are free from damage and approved for the weight of the air fluid cooler.

⚠ **Precaution** Risk of bodily injury. Disconnect the motor power supply prior to maintenance.

⚠ **Caution** Risk of bodily injury. Before disconnecting hydraulic connections and hoses make sure the system is depressurized.

⚠ **Caution** Risk of severe burns. The oil cooler could become extremely hot during operation. Always make sure the cooler is cool before touching.

⚠ **Precaution** Risk of bodily injury. If the air fluid cooler is fitted with a thermo contact, the fan will start automatically when the preset temperature has been reached. Be careful when standing close to rotating units.

⚠ **Precaution** This indicates a toxic hazard. To prevent bodily injury, damage to property or environment, used fluid should be collected and taken to a special depôt.

Important Static electricity. Fans generate static electricity. Do not put sensitive devices (electronics etc.) in the immediate vicinity of the air fluid cooler.

Note! Use hearing protection when standing close to an operating air fluid cooler for long periods of time.

Warning label

The warning label shown below is fitted to the air fluid cooler at delivery. Always replace a damaged or missing label.

Caution! High temperature surface! Use hearing protection! Rotating fan!
request part number for label from Parker.
See Figure 1.

Description

Principally the QDC air fluid cooler consists of a cooler matrix, a fan housing and a fan with guard and DC motor. The DC motor, fan and fan guard are assembled as one unit.

The fan is equipped with a 24V brushless DC motor, which meets the requirements of the Automotive EMC directive: ECE Reg. 10-04 and updates - 2002/95/EC RoHS - Hazardous Substances and 2000/53/EC and updates (End of Life Vehicle)

DC motor The electrical Drive interface consists of 4 pins:
Power pins:
- supply voltage plus: +D | - supply voltage minus: -D
Signal pins:
1. Input: digital PWM input / active low: PWM* / E*
2. Input: analog input: A
The signal pin PWM* / E* is used to control the Drive mode, it is the control input.
The signal pin A can be used to control the speed of the Drive.
Please use in combination with Origianal Yazaki connector: YAZAKI HYBRID (USCAR-2 compliant) - 7282-8497-90

Detailed information about DC motor: go here (English only)

3. Installation/Handling

Acoustic pressure level could reach 50 - 86 dB(A) at 1 m distance depending on air fluid cooler size and rotation speed under normal operating conditions. An inappropriate location or operation under extreme conditions could cause an increase in acoustic pressure level and a decrease in cooling capacity.

Identification plate
The identification plate of the air fluid cooler is fitted on the fan housing and contains the following information: See Figure 2.

A – Part number. **B** – Designation. **C** – Serial number.
D – Date of delivery
(year and week, e.g. 1018, i.e. year 2010 and week 18).

Replace a damaged or missing identification plate as soon as possible.

Fluids

WATER: add corrosion inhibitors to the water to avoid corrosion. All materials included in the cooling circuit must be considered for choice of correct inhibitor.
GLYCOL: Mix glycol and water in a ratio of 50% / 50% before filling! Never mix different types and different brands of glycol. We recommend the use of demineralized or osmosis water.
Additives like Glysantin G48 or TYFOCOR have demonstrated their ability to prevent corrosion in a closed cooling circuit.
See supplier information regarding water quality, additive quantity and periodic replacements.
CAUTION: Follow material safety data sheets (MSDS) of glycol manufacturers! Please note that the coolant is considered hazardous waste and needs to be disposed accordingly.

Filtration

The use of a filter allows reducing the presence of impurities or chips in the liquid circuit in order to prevent any obstruction.

Check the contamination with particles and biological changes, the composition of the water-glycol mixture and the current possible temperature range in which it can be operated at regular intervals. Change the filter elements if the values deviate from the values at initial start-up. Follow the filter manufacturer's instructions and the fluid manufacturer's MSDS.

Suggestion : use spin-on filter design in a bypass channel.

Installation

Lifting

Caution Risk of bodily injury. To prevent physical harm when lifting the unit, use the correct lifting technique. Make sure that all lifting devices are free from damage and approved for the weight of the air fluid cooler.

Mounting
The QDC air fluid cooler can be mounted in any position. However, an upright installation standing on its feet is recommended. A free space corresponding to a minimum of half the height of the matrix should be available in front of and behind the air fluid cooler to allow for optimal cooling capacity and low acoustic power level. See Figure 3.

An inappropriate location or operation under extreme conditions could cause an increase in acoustic pressure level and a decrease in cooling capacity.

Precaution Risk of bodily harm. Make sure that the air fluid cooler is securely fixed.

Connection of the cooler matrix
Connect the cooler matrix using flexible hydraulic hoses. Make sure that all connections and hoses are sized according to the system pressure, flow, temperature and type of liquid.

Connect the hoses to the cooler matrix as illustrated below. See Figure 4.

A – Inlet | **B** – Outlet | **C** – Inlet G 1/2 sensor port
D – Outlet G 1/2 sensor port

Dimensions on connections are cooler matrix size dependent, see catalogue.
Connection chart, See Figure 5.

Important The cooler matrix is designed for maximum dynamic working pressure 14 bar. When the cooler is installed in a return line, there should be no pressure spikes. If this is not possible, an offline cooling system should be used.

Electrical connection

Precaution Prior to connecting the DC motor to the supply system, make sure the information on the motor label corresponds to specified direct current.

The DC motor must only be installed according to general and electrical safety rules. Circuit diagram, see Figure 6 and Interface Hardware for digital control, see p.12 (5.07)

Precaution Be careful when connecting. Improperly made connections, damaged cables, etc. could cause components to become live or result in the incorrect direction of rotation of the DC motor and fan.

Note! A motor overload protection is recommended. The size of the overload protection/fuse, depends on fan size and air flow across the cooler. Contact Parker concerning motor protection/fuse size. 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).

The QDC air fluid cooler can be fitted with a thermo sensor on the inlet and outlet side for temperature control. The fan RPM can be controlled by the integrated inverter, see p.12 (5.07)

Handling

Prior to initial start-up

Precaution Check that the air fluid cooler is securely fixed and correctly connected.

We recommend that you proceed as follows prior to start-up:
1. Run the air fluid cooler with the system fluid.
2. Filter the fluid before passing through the cooler.
See Technical specification for recommended fluid compatibility.

Prior to start up

Precaution Do not start the air fluid cooler if there is a risk of damage to person, property or environment.

Check that:
- all air fluid cooler parts are free from damage
- the air fluid cooler is correctly connected
- the fan rotates freely (use hand force)
- all liquid connections are tight
- the inside of the fan housing is free from objects that could be thrown around and cause bodily injury or damage to property.

At start-up

Check that:
- the direction of rotation of the fan and the air flow corresponds to indications on the fan housing
- the air fluid cooler is free from abnormal noise and vibrations.
- the air fluid cooler is free from leaks

In order to protect the cooler matrix, use a by-pass valve when operating in cold start mode/with thick lubricating oils.

During operation

Caution Risk of severe burns. The air fluid cooler could become extremely hot during operation. Make sure that the air fluid cooler is cool before touching.

Maximum permitted fluid temperature in the cooler matrix is 120 °C.

The cooler matrix is designed for maximum allowed dynamic working pressure of 14 bar.

Do not overload the DC motor (see p.12 (5.07)). See identification plate.

Note! Use hearing protection when standing in the immediate vicinity of an operating air fluid cooler for long periods of time.

Preventive maintenance

Preventive maintenance work must be carried out at regular intervals. Make sure that:
- there is no abnormal noise or vibrations
- air fluid cooler is securely fixed
- the cooler matrix is clean - debris will reduce the cooling capacity
- the air fluid cooler is free from damage, replace damaged components
- the air fluid cooler is free from leaks, take appropriate measures
- warning labels are in good condition, replace any damaged/ missing label immediately.

Annually: Check the electrical installation.

Cleaning

Precaution Risk of bodily injury. Prior to cleaning, disconnect all motor power supplies.

Caution Risk of severe burns. The air fluid cooler could become extremely hot during operation. Make sure the air fluid cooler is cool before touching.

Air fluid cooler When cleaning the exterior of the cooler, for instance using water, disconnect all power supplies. Be aware of the DC motor protection standard.

Cooler matrix The air fins of the matrix can be cleaned by blowing through with compressed air[1]. If necessary a high-pressure water system can be used[3]. When using a high-pressure water system point the jet parallel to the air fins. See Figure 7.

Fan housing Remove the cooler matrix when cleaning the inside of the fan housing. To clean the inside of the fan housing, use compressed air[1]. If necessary suitable cleaning agents[2] can be used. Blow with compressed air[1] from the electric motor side through the fan guard.

Maintenance

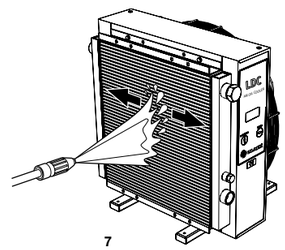
Parker shall not be held responsible for any consequences due to repair and/or modification made by the customer.

Caution Risk of severe burns. The air fluid cooler could become extremely hot during operation. Make sure the air fluid cooler is cool before touching.

Caution Risk of bodily injury. Disconnect the motor power supply prior to maintenance.

Dismounting the cooler matrix
1. Turn off the system.
2. Disconnect the electric motor power and control supply.
3. Make sure that the system is depressurized.
4. Disconnect the liquid inlets and outlets.
5. Disconnect the flexible hoses from the cooler matrix.
6. Unscrew the screws with washers fixing the cooler matrix to the fan housing: See Figure 8.
7. Remove the cooler matrix.

Mounting of the cooler matrix
1. Locate the cooler matrix.
2. Fit the cooler matrix to the fan housing. See Figure 8.
3. Connect the flexible hoses to the cooler matrix. See Figure 4.
4. Connect the electric motor power and control supply.
5. Proceed to Paragraph Handling:
Prior to start-up and At start-up.



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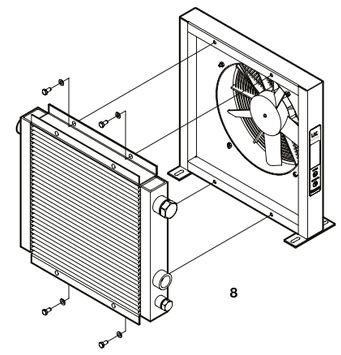

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[1] *Follow resp. country safety guidelines when using compressed air.*
[2] *Use 99% isopropyl alcohol on surface and follow MSDS.*
[3] *If needed, use cleaning agents. Make sure they are suitable for dissolving the contamination without damaging the materials or coatings, follow MSDS.*

4. Technical specification

Cooler matrix	
Maximum static working pressure	21 bar
Maximum dynamic working pressure (Tested according to ISO/DIS 10771-1)	14 bar
Heat transfer allowance	± 6 %
Maximum oil temperature	120 °C

Fluid compatibility	
Mineral oil (according to DIN 51524)	HL/HLP
Oil/water emulsion (according to CETOP RP 77H)	HFA, HFB
Water glycol (according to CETOP RP 77H)	HFC
Phosfatester (according to CETOP RP 77H)	HFD-R

For operation with other fluids or operation under extreme conditions, always consult Parker

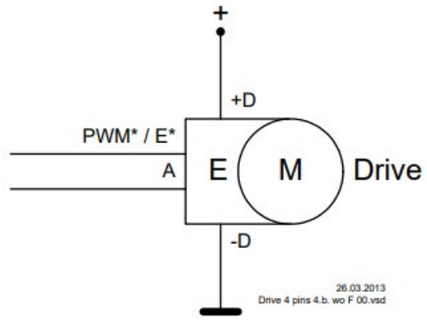
Material	
Cooler matrix	Aluminium
Fan housing	Steel
Fan blades/hub	Plastic
Fan guard	Plastic
Surface treatment (fan housing and cooler matrix)	Electrostatic powder coated

For long motor life, make sure that:

- max. ripple voltage of the supply current is 1 %
- max. nominal supply current is ± 10% of 24V.

5. Fan Data

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

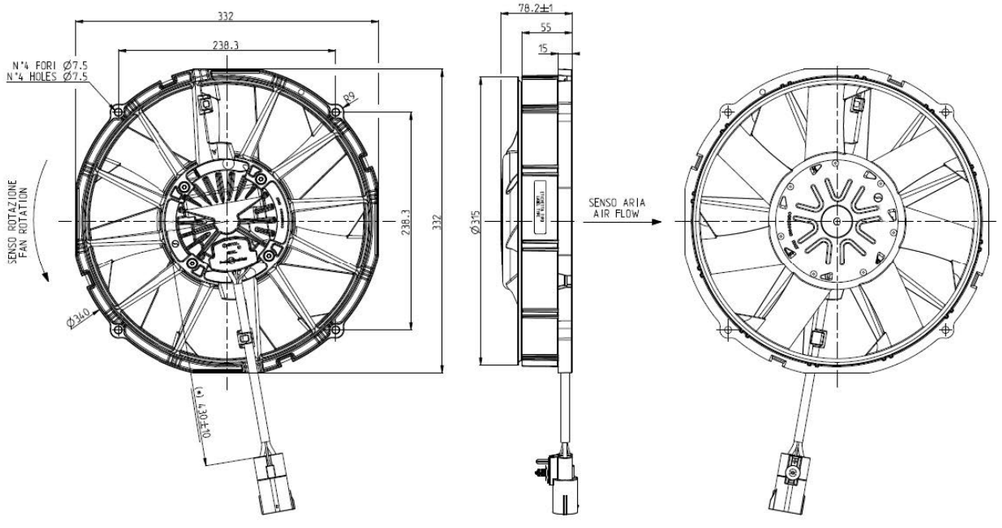


1. Features

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

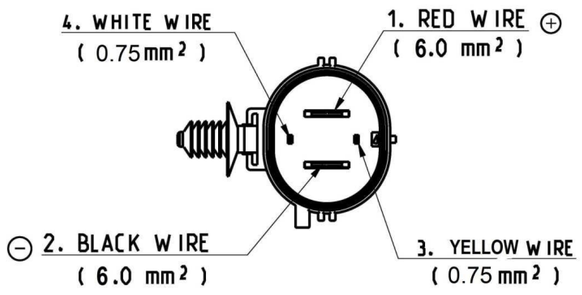
* =Few minutes ambient temperature transients do not engage the derating owing to the thermal inertia of the system. Overloads may anticipate derating.

5.01 Mechanical Data



Fixing recommendation: Use M6 bolts for fixing. Nominal tightening torque 3 + 1/0 Nm
Nominal torque defined for brand new, clean and lubricant-free bolts.

5.02 Connector and Wires



Connector: YAZAKI HYBRID (USCAR-2 compliant)
P/N: 7282-8497-90

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

5.03 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)

5.04 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.

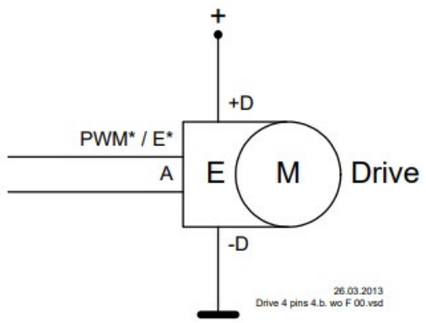
5.05 Drive Pin Functions

The electrical Drive interface consists of 4 pins.

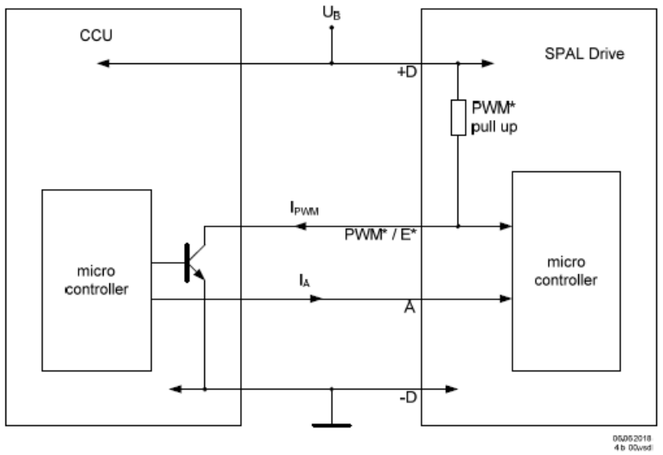
Power Pins:
-supply voltage plus: +D
-supply voltage minus: -D

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.



5.06 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.

5.07 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	µA	I_{PWM*}
PWM* / E* wage up voltage	U_B - 2V			V	U_{PWMWU}
PWM* / E* wake up pulse	150			µs	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!

5.08 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}

5.09 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.

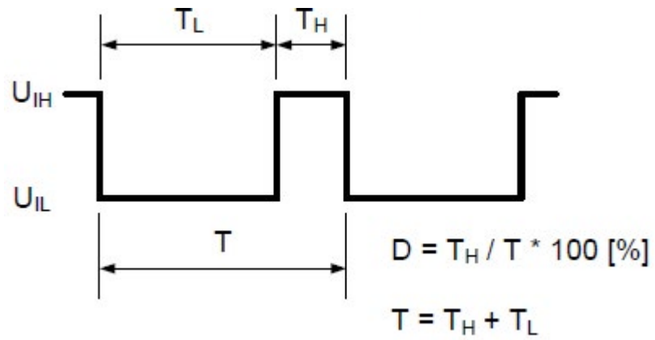
No.	Drive Mode	Current Consumption	Drive Speed
1	Quiescent current mode	< 100 µA	0
2	Electronics active mode	< 40 µA	0
3	Run mode	depending on the requested speed and on the load	depending on the PWM duty cycle or the analog input voltage level
4	Failure mode	< 40 µA	depending on the failure

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)

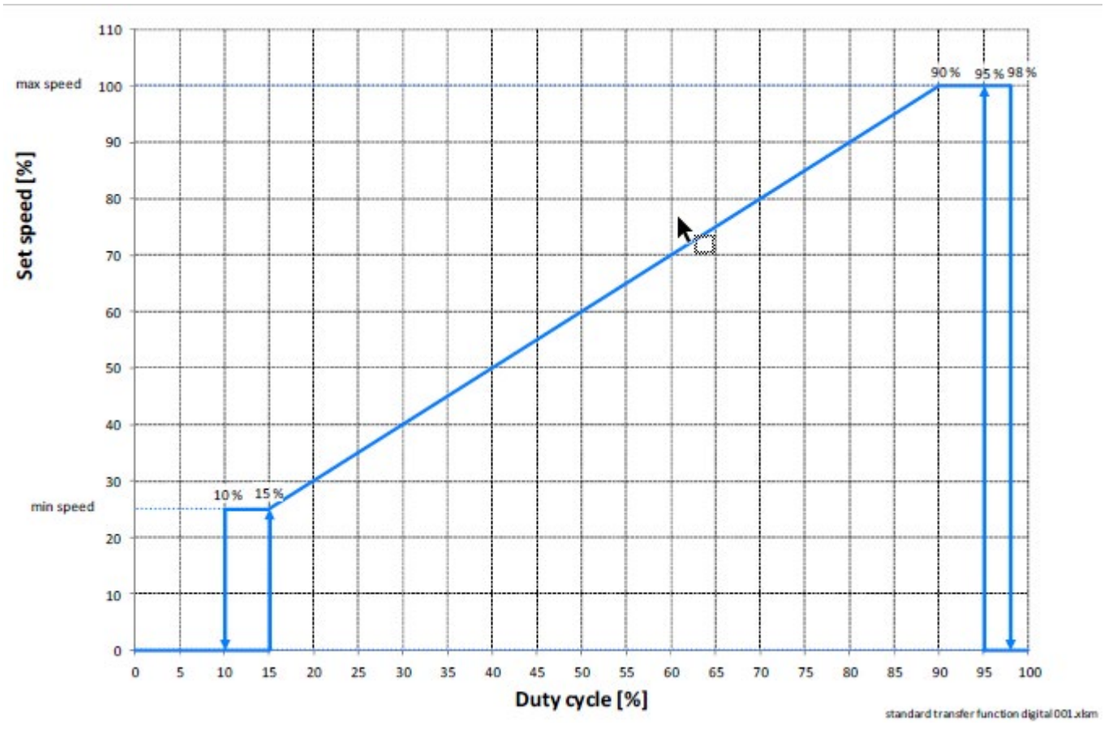
The Failure mode is entered in case of failures of the Drive (see p.12)

5.10 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*.



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.

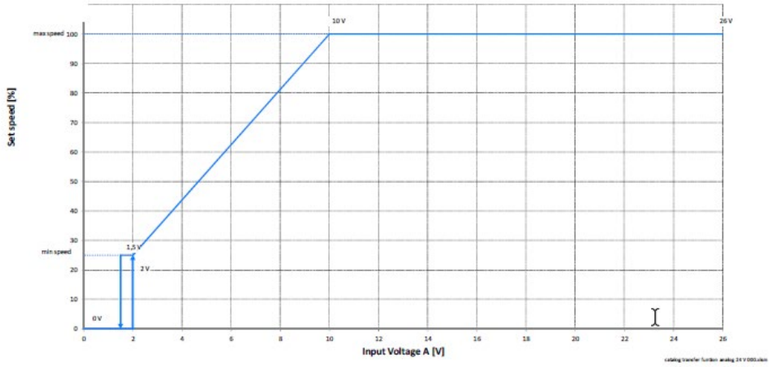


5.11 Drive Speed Set Point with Digital Control

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.

5.12 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).



5.13 Drive Mode - Failure Modes

Failure Mode	Handling of Failure	Notification
Drive blocked	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	Notification is not available as no feedback is provided to the CCU.
Drive overloaded	Fan speed is reduced in case of overload detection by means of current draw measurement.	
Over current	The Drive will stop if the over current safety threshold is reached.	
Drive overheated	Fan speed is reduced in case of overheating detection (derating). Over the max operating temperature, the Drive will stop.	
Under / Over voltage	If the supply voltage is outside the specified range the Drive will stop.	
Internal Drive Failure	The Drive will stop if a failure is detected during the startup self check procedure.	

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

5.14 Operating Modes

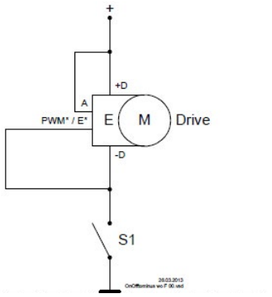
The Drive interface (the connection between the Drive and the user system) can be done in 8 ways depending if and how the two signal inputs PWM* / E* and A are used. See the following table:

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

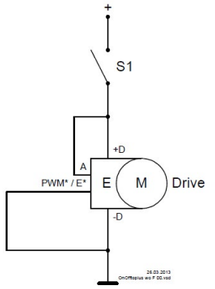
5.15.01 Interface Mode 1: On / Off to Minus

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.



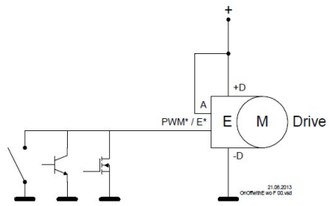
5.15.02 Interface Mode 2: On / Off to Plus

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.



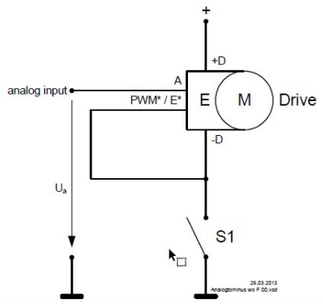
5.15.03 Interface Mode 3: On / Off with Enable Low

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”.



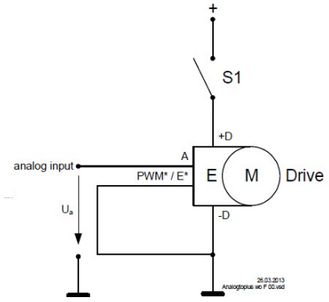
5.15.4 Interface Mode 04: Analog Control 1

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.



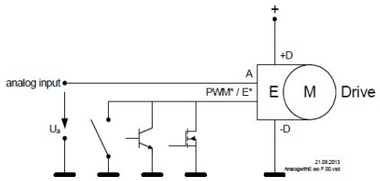
5.15.5 Interface Mode 05: Analog Control 2

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.



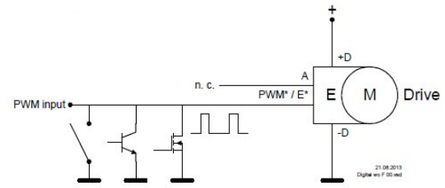
5.15.6 Interface Mode 06: Analog Control with Enable Low

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.



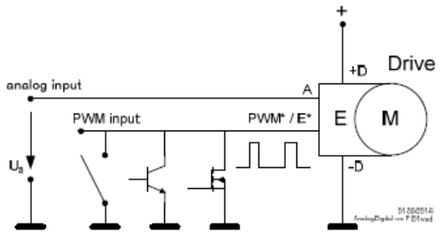
5.15.7 Interface Mode 07: Digital Control

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.



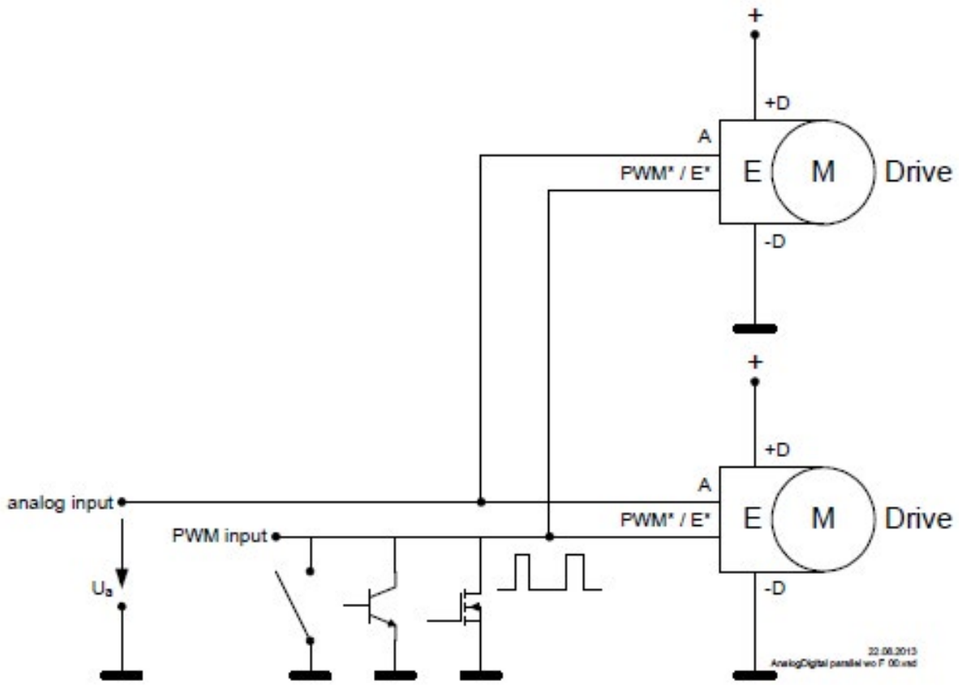
5.15.8 Interface Mode 08: Mixed Analog / Digital Control

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.



5.16 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.

5.17 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
µ	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

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