SPECIFICATION

MODEL
K-DC305-A24-36

1.Product description

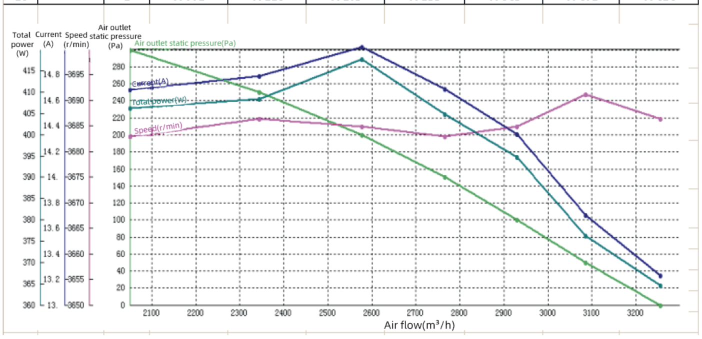
Unless otherwise noted, the parameters in this document are tested under the following conditions.

- TAMB = 20 ℃ ± 5 ℃
- UB = 27.0 V ± 0.2 V (measured value of connector end)

2.Curves

Axial flow fan air flow curves

No	Items	Unit	1	2	3	4	5	6	7
1	Air pressure	kpa	101.011	101.011	101.011	101.011	101.011	101.011	101.011
2	Temperature	℃	16.493	16.493	16.499	16.380	16.380	16.380	16.380
3	Humidity	%	67.030	67.155	67.280	67.393	67.518	67.518	67.642
4	Nozzle differential pressure	Pa	722.350	649.050	585.700	522.800	454.200	376.250	288.550
5	Air outlet static pressure	Pa	0.088	49.775	100.138	150.088	199.775	250.100	299.788
6	Speed	r/min	3686.400	3691.200	3684.960	3683.040	3684.960	3686.400	3683.040
7	Dynamic pressure	pa	0.495	0.444	0.400	0.357	0.310	0.256	0.196
8	Full pressure	pa	0.582	50.219	100.538	150.445	200.085	250.356	299.984
9	Air flow	m3/h	3255.817	3085.164	2929.795	2766.354	2577.233	2344.088	2050.742
10	Air density	g/cm3	1.209	1.209	1.209	1.210	1.210	1.210	1.210
11	Nozzle combination		Φ70+Φ80+Φ150	Φ70+Φ80+Φ150	Φ70+Φ80+Φ150	Φ70+Φ80+Φ150	Φ70+Φ80+Φ150	Φ70+Φ80+Φ150	Φ70+Φ80+Φ150
12	Voltage	V	27.00	27.00	27.00	27.00	27.00	27.00	27.00
13	Current	A	13.23	13.70	14.34	14.69	15.02	14.79	14.68
14	Total power	W	364.54	376.24	394.67	404.88	417.81	408.38	406.17
15	Input efficiency	1	0.001	0.115	0.209	0.288	0.346	0.402	0.424



Speed	3650±50rpm
Air density	1.209 kg / m^3

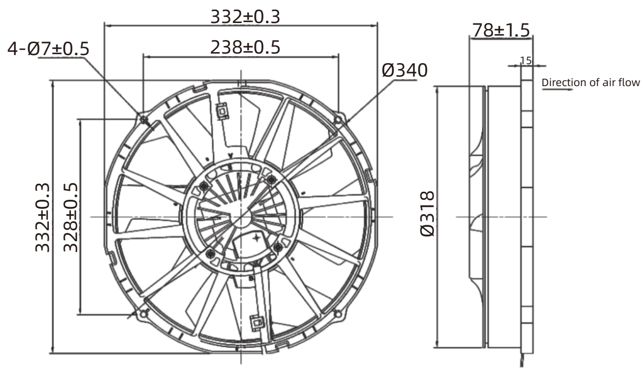
Table 1 Air Flow

3.Voltage

Item	Min. value	Min. value	Max. value	Unit
Nominal supply voltage		24.0		V
Operating supply voltage range (measured at the connector)	16.0		32.0	V
Mains voltage at which the fan reaches max. speed (measured at the connector)	26.0		32.0	V

Table 2 Power supply voltage specifications (measured at the connector)

4.Product drawing



Unit：mm

Figure 1. Two-dimensional view

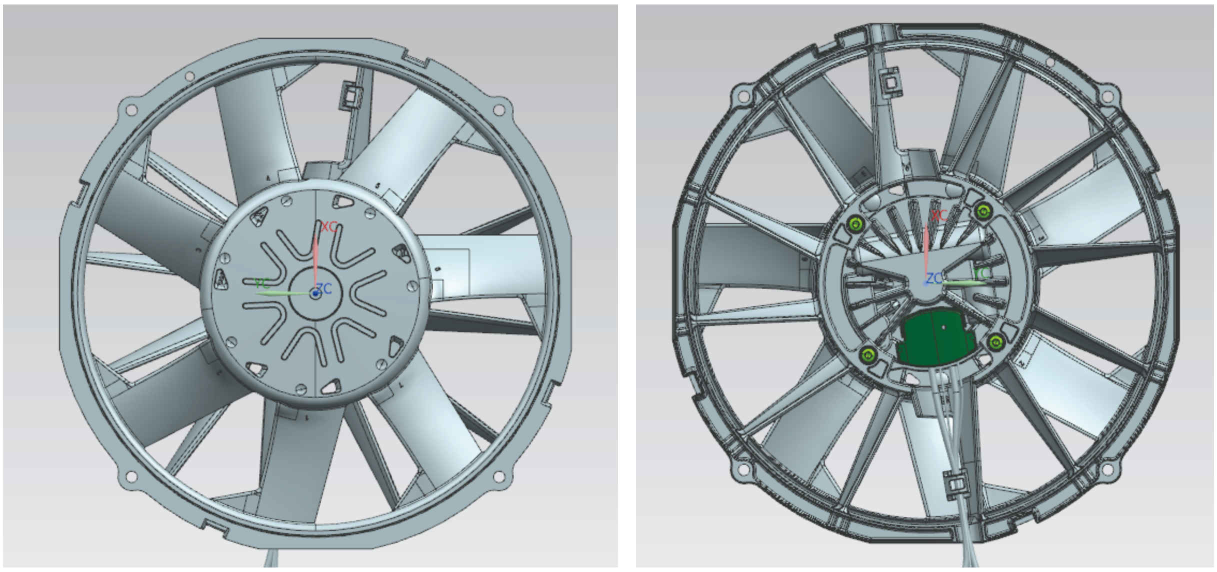


Figure 2. Three-dimensional view

5.Connectors

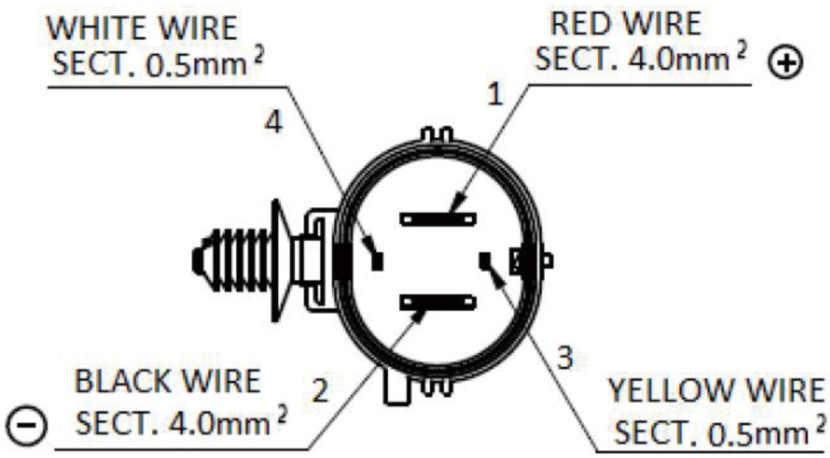


Figure 3. Lead arrangement diagram of the connector

Connector :YAZAKI HYBRID				
Part number:282-497-90				
Identification number	Input power positive +D	Input power negative -D	Analog input	Digital PWM input with feedback output/active-low PWM*/E*
Pin number	1	2	3	4
Color	Red	Black	Yellow	White
Sealing sleeve part number	157-582-90	157-582-90	158-030-50	158-030-50
Pin part number	114-3251	114-3251	114-102-02	114-102-02
Cross-sectional area(mm²)	4.0	4.0	0.5	0.5

Table 3. Connector Lead Table

Note: It is forbidden to lift the fan directly by the wire harness.

6.6.Hardware Function

Unless otherwise noted, the parameters in this document are tested under the following conditions.

- TAMB = 20 ℃ ± 5 ℃ and
- UB = 27.0 V ± 0.2 V (measured at connector end)

6-1. Fan drive

Figure 4 shows a schematic diagram of the fan drive.

E represents the entire circuit part, and M represents the motor. Drive stands for motor and circuit integration.

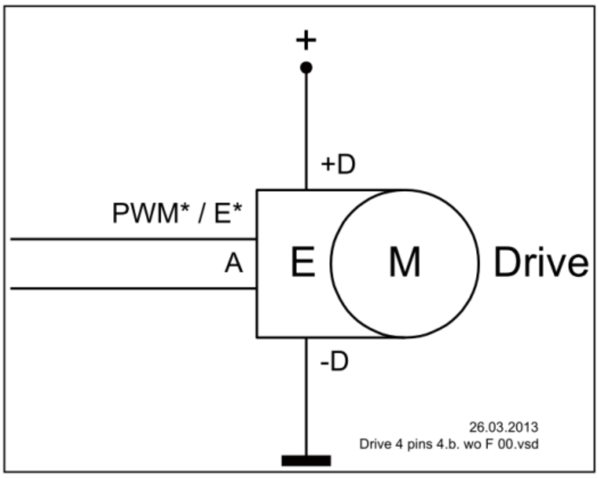


Figure 4. Fan drive diagram

6-2. Lead wire function of fan drive part

The circuit part of the driver consists of four leads:

Power leads:

- Positive input power supply: +D
- Input power supply negative: -D

Signal leads:

1).Input: Active low digital PWM input: PWM*/E*

2).Input: Analog Input: A

The signal lead PWM*/E* is used to control the driving mode, that is, the control input.

Signal lead A can be used to control the speed of the drive.

6-3.Hardware interface for digital control: PWM*/E* leads

Input PWM*/E* is used to activate the fan drive from static mode. Any PWM duty cycle corresponding to a pulse that tends to the dominant level and lasts longer than Twakeup can activate the drive circuit.

Item	Min. value	Typical value	Max. value	Unit	Code
PWM/E* frequency range	50	100	500	Hz	f_{PWM}
PWM/E* duty cycle range	0		100	%	dc_{min} .. dc_{max}
PWM* high level	U_B * 0.65			V	U_{PWMH}
PWM/E* low level			U_B * 0.40	V	U_{PWML}
PWM/E* resolution		1		%	dc_{resol}
PWM/E* accuracy		1		%	dc_{accu}
PWM/E* current	-10%	5.5	+10%	mA	I_{PWM}
PWM*/E*activation pulse	150			μs	T_{wakeup}

Table 4 Active low digital PWM input: PWM*/E* parameter table

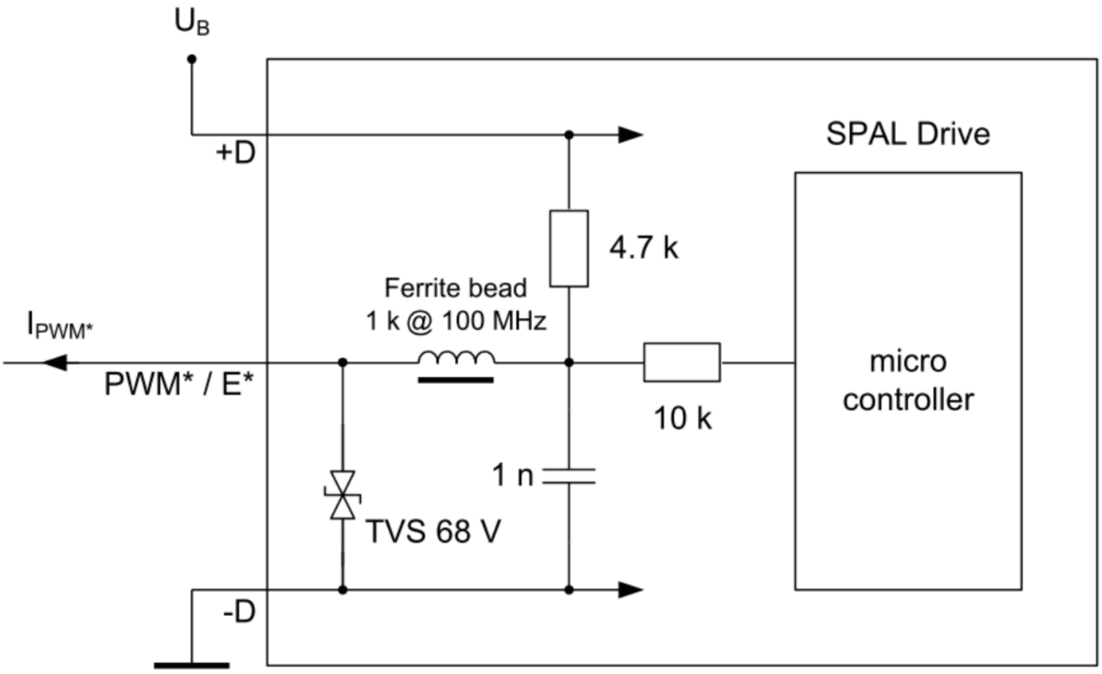


Figure 5 Active Low Digital PWM Input: PWM*/E* Circuit Diagram

6-4. Hardware Interface Parameters of Analog Control: Lead A

Item	Min. value	Typical value	Max. value	Unit	Code
A voltage range	0		10	V	U_A
A Unconditional maximum 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}

Table 5 Analog input: A parameter table

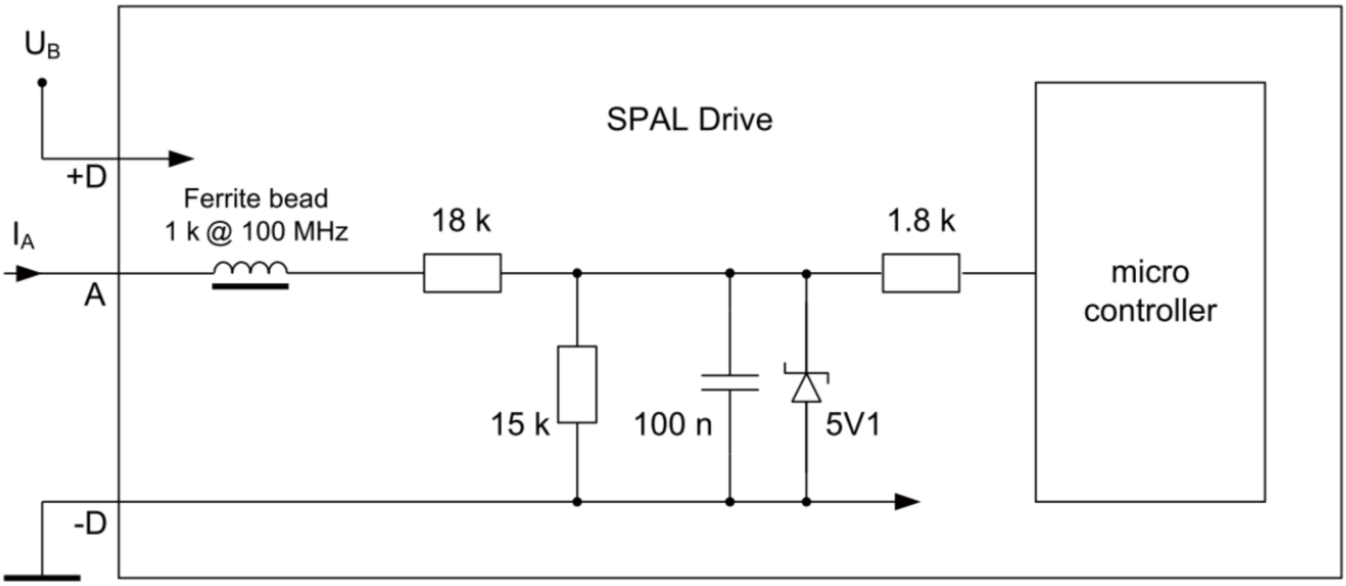


Figure 6 Analog input: A lead circuit diagram

7.Software function parameters

7-1. Drive mode

There are four working modes for fan drive, the main difference is the difference in current consumption:

1).Static mode

2).Activation mode

3).Operating mode

4).Failure modes

The drive mode of the fan (see Table 6) varies with the duty cycle of the control input pin PWM*/E* (see Figure 11) and the analog input voltage level at pin A (Figure 12).

No.	Operation Mode	Consumption of current	Fan Speed
1	Static mode	<100 μA	0
2	Activation mode	<40 mA	0
3	Operating mode	Depends on required speed and load conditions	Depends on the duty cycle of the PWM signal
4	Failure modes	<40 mA	Depending on specific failure

Table 6 Drive Mode

When the PWM*/E* line receives a signal with a 100% duty cycle (recessive level) within a period exceeding (n/f_{PWM}+2s) ±2%, the fan drive will enter the static mode, n is the The number of samples of the PWM period for plausibility checking (see 7-2), f_{PWM} is the PWM base frequency. Therefore, the time at which the fan drive enters static mode depends on the actual PWM base frequency and the number of samples for the plausibility check. After detecting that the PWM signal is recessive, it needs to wait for another 2 seconds before the driver enters the static mode.

When the PWM duty cycle of the fan is between 0% and 100%, and the condition of 6-3 (T_{wakeup}) is met, the fan drive enters the active mode.

The conditions for the fan to enter the running mode are:

-The duty cycle of the PWM signal at the PWM*/E* terminal reaches the ratio required for fan drive operation (see Figure 11 and 7-4), and the value of the duty cycle is valid according to 7-3. or.

-The analog signal at analog input A reaches the value required for fan operation (see Figure 12 and 7-5).

When there is a fault in operation, the fan drive will enter the failure mode (see 7-6).

7-2. Drive speed set point

The drive electronics checks the PWM signal on the control input signal PWM* /E*. To improve the signal-to-noise ratio, the speed of the drive is set only if the PWM signal is active and is the same for more than np out of n consecutive duty cycles (see Figures 7 and 8).

The value of n is set to 6 (the total number of plausibility check duty cycles), and the value of np is set to 4 (the same number of duty cycles is required), the first duty cycle of the plausibility check box will be used as the remaining n- 1 reference value for duty cycle measurement.

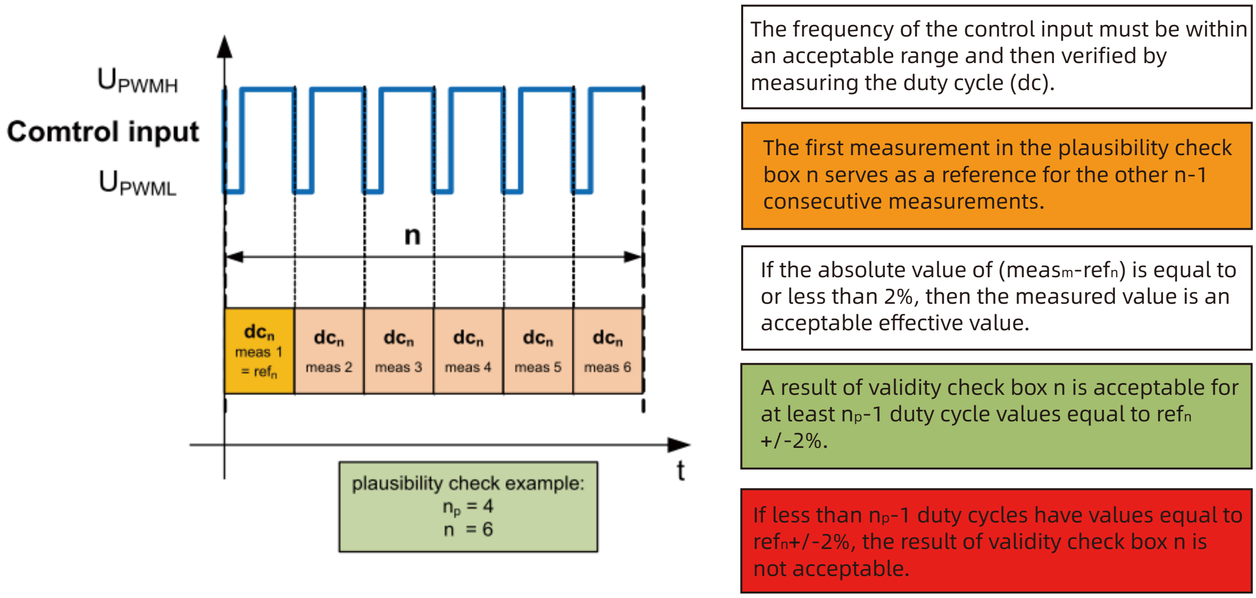


Figure 7 Plausibility check box n

The plausibility check delays the response to the PWM value.

Delay can be added for too low PWM frequency: for example 50Hz add 0.22s (in the worst case 4/6 plausibility check will lose 11 samples!) This time (TPWMDELAY) depends on the value of n, np and the value of fPWM Frequency, see 7-3.

The speed setting refers to Figure 11: Digital Control: PWM Input Transfer Function and 7-4.

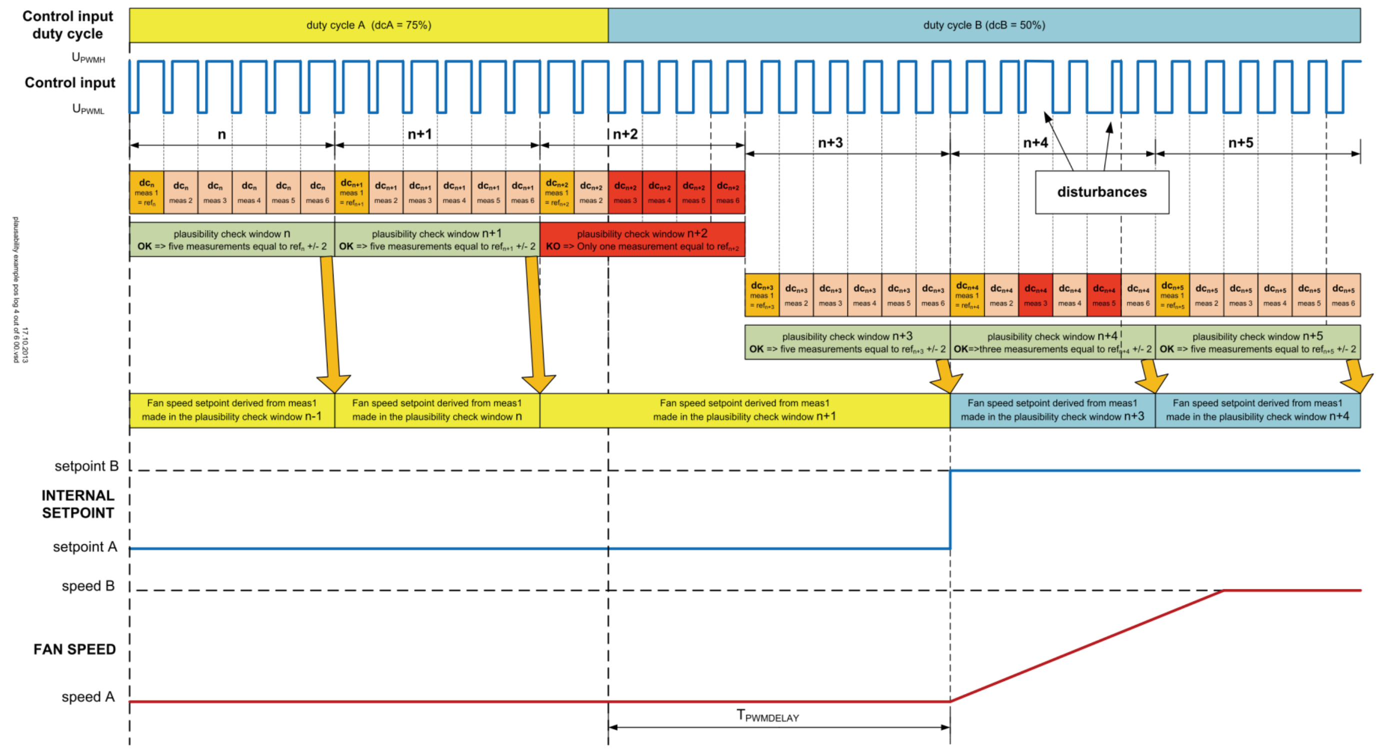


Figure 8 Example of authenticity check 4/6

7-3. Response time of drive speed set point

If the duty cycle of the PWM*/E* terminal changes, the driver will start to change the speed after a delay time, the delay time is $T_{PWMDELAY}$. This delay is caused by the plausibility check and depends on the PWM frequency at the PWM*/E*terminal, and the delay time is in the range of n/f_{PWM} ~ $(n+ n_p)/f_{PWM}$.

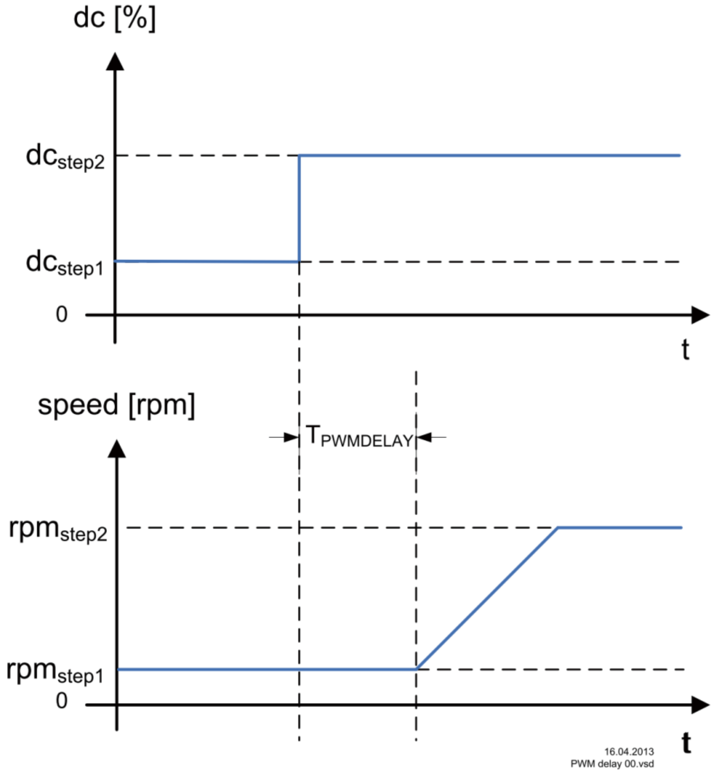


Figure 9 Drive Speed Setpoint Reaction Time

The speed setting refers to digital control: PWM input transfer function (see Figure 11).

7-4. Digital Control: PWM Input Transfer Function

The transfer function of the PWM input is the relationship between the drive speed and the duty cycle of the active low digital PWM input-PWM*/E* terminals.

Refer to Figure 10 for the definition of the duty cycle, that is, "Positive Logic Duty Cycle Definition".

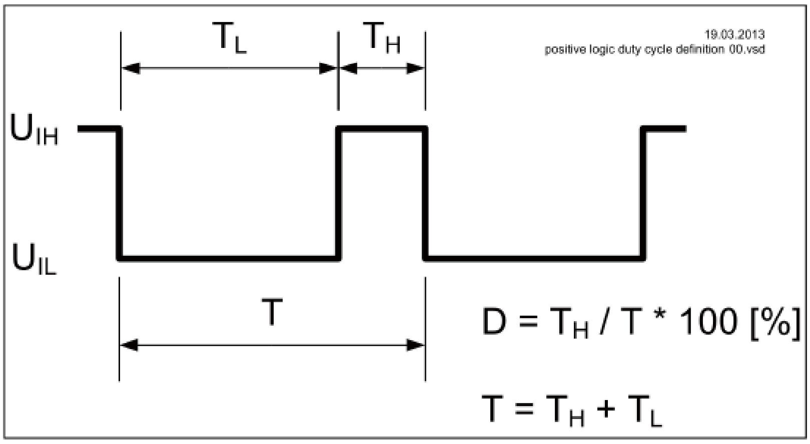


Figure 10 "Positive Logic Duty Cycle" in Duty Cycle Definition

Refer to the definition below:

- Continuous low state is 0% duty cycle (dominant level)
- Continuous high state is 100% duty cycle (recessive level)

Based on the duty cycle definition, the PWM input transfer function is shown in Figure 11

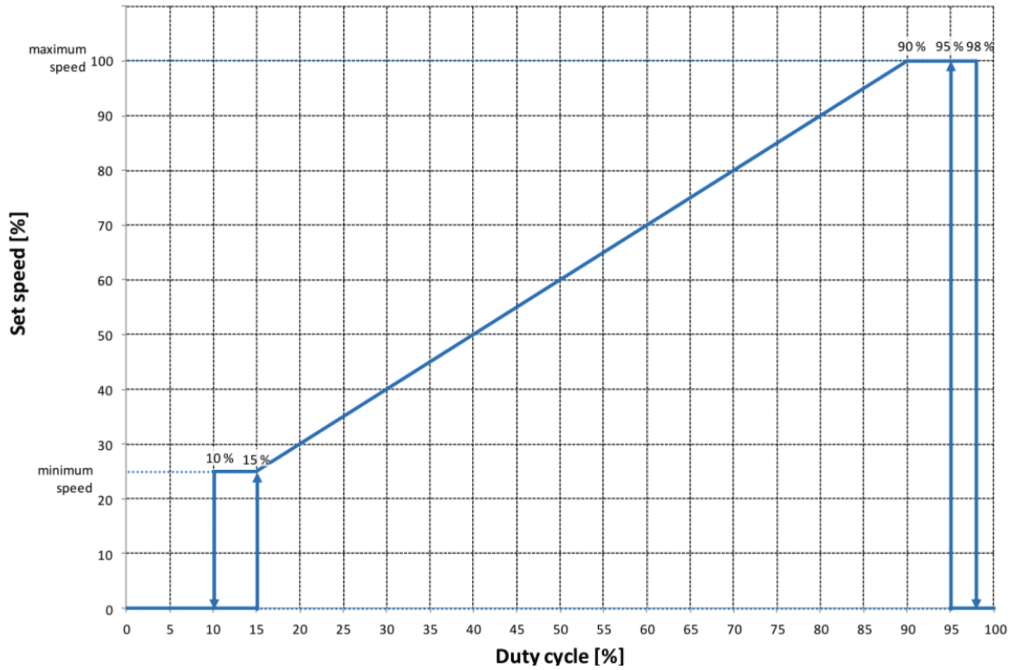


Figure 11 Digital Control: Transfer Function of PWM Input

The PWM input transfer function is used to:

- Mode 7: Digital Control
- Mode 8: Mixed analog/digital control

7-5. Analog control: transfer function of analog input

The analog input transfer function is the relationship between the drive speed and the duty cycle of the analog input A terminal (see Figure 12).

The analog input transfer function is used to:

- Mode 4: Analog Control 1
- Mode 5: Analog Control 2
- Mode 6: Analog Control with Enable Low
- Mode 8: Mixed analog/digital control

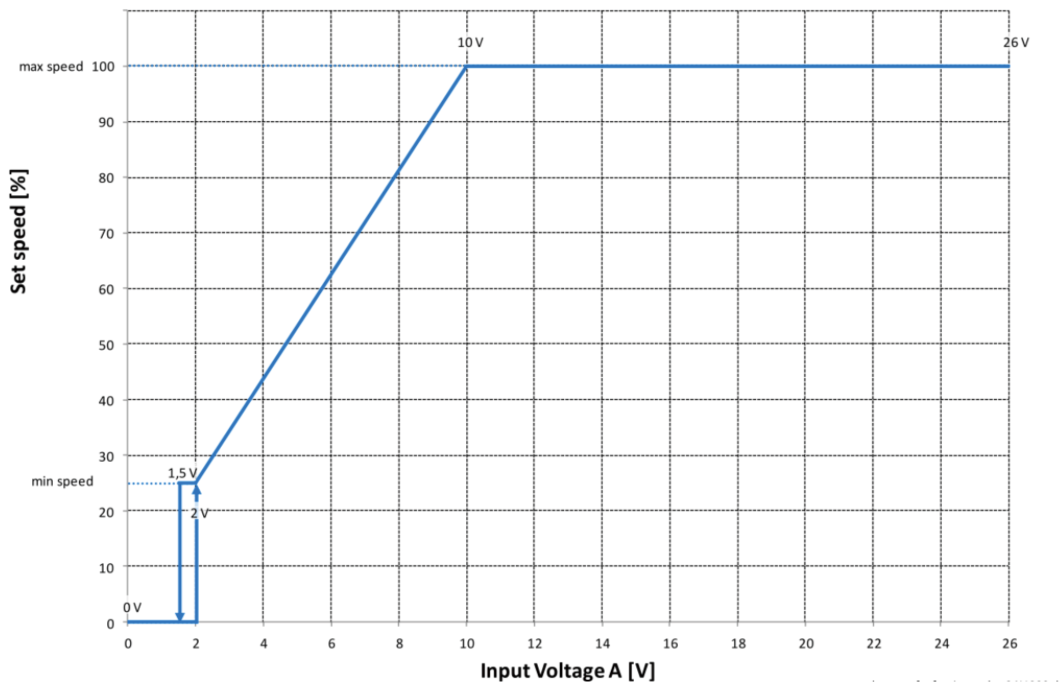


Figure 12 Analog Control: Transfer Function of Analog Input

7-6. Failure mode of driving mode

When encountering the following conditions, the fan driver will enter the failure mode and stop driving.

1).Drive stalled

2).Driver overheating

3).Drive overload

4).Undervoltage

5).Overvoltage

6).Overcurrent

7).Drive internal failure

7-6-1. Failure mode drive overload

If the fan current is greater than the current + tolerance value derived from the fan curve, the drive will reduce the speed. Soft stall is also included in this case.

This behavior of the drive can also be understood as the speed of the fan is limited by the current limit.

7-6-2. Failure mode of drive stall

There are two possibilities to cause the drive to stall: drive internal factors (small probability) and drive external factors (high probability). For example, snow accumulation may cause the fan to stall, but after a certain period of operation, the heat accumulated due to the fan stalling will make the fault (snow accumulation) disappear, and the fan can then run again. The following recovery strategies are used to improve availability.

After the first detection of a drive stall, the drive waits for 5 seconds before attempting to start again. If it still fails, the driver will increase the wait time by 5 seconds and try to start again. The interval increases all the way up to 25 seconds, and the driver will keep trying to start for as long as there is a valid PWM duty cycle to run the drive.

The maximum interval is set to allow the fan not to overheat due to frequent start attempts at the highest ambient temperature.

7-6-3. Drive overheating failure mode

The following two overheating modes must be distinguished:

1).The drive is overheated but can be operated by reducing the speed (relative to the required speed);

2).The drive is overheating and cannot continue to operate.

7-6-4. Failure modes of undervoltage and overvoltage

If the voltage of the input power is outside the specified voltage range, the drive will stop running.

If the input power voltage is lower than the design voltage of the drive, the actual speed of the fan may be lower than the required speed.

7-6-5. Failure Mode Overcurrent

In addition to the above mentioned limits where the fan speed is limited by the current (see section 7.6.1), there is also a circuit overcurrent protection function which shuts down the drive.

7-6-6. Failure mode of drive internal failure

The failure causes of the internal failure mode of the drive can be roughly summarized as the following points:

- failure of the voltage measurement chain
- faulty current measurement chain
- failure of the temperature measurement chain
- failure of the rotor position signal measuring chain
- MOSFET drive circuit failure

7-6-7. Fault recovery strategy

The design of the driver complies with the following basic and mandatory requirements:

Under no circumstances can any driver failure trigger a subsequent failure that could lead to a major accident of the vehicle.

After ensuring the above security requirements, it is still necessary to meet the maximum availability requirements of the driver.

This means that a corresponding restart process or method should be configured for all failure modes.

In any case, the driver will attempt to recover from the fault when it receives a valid PWM signal that requires the driver to operate.

8.Application Notes

8-1. Driver interface

According to the use of PWM*/E* and A signal input, there are 8 ways of driver interface (connection between driver and user system) (see Table 7)

Mode description	Mode	+D	-D	PWM*/E*	A	Pin	
ON/OFF to Negative	1	+	⏚—/—•→ -D	-	+		4
ON/OFF to Negative	2	+•—/—•→ +D	-	-	+		4
ON/OFF until the enable terminal is low level	3	+	-	⏚—/—•→ E*	+		4
Analog Control 1	4	+	⏚—/—•→ -D	-	analog		4
Analog Control 2	5	+•—/—•→ +D	-	-	analog		4
Active Low Analog Control	6	+	-	⏚—/—•→ E*	analog		4
Digital control	7	+	-	PWM	n.c.	3	
Analog/Digital Hybrid Control	8	+	-	PWM	analog		4

Table 7 Working Mode

+D： Drive positive power

-D： Drive Negative Supply

PWM*/E*： Active low PWM input

A： Analog input

+： Connect to positive

-： Connect to Negative

Analog： Analog voltage signal

PWM： PWM signal

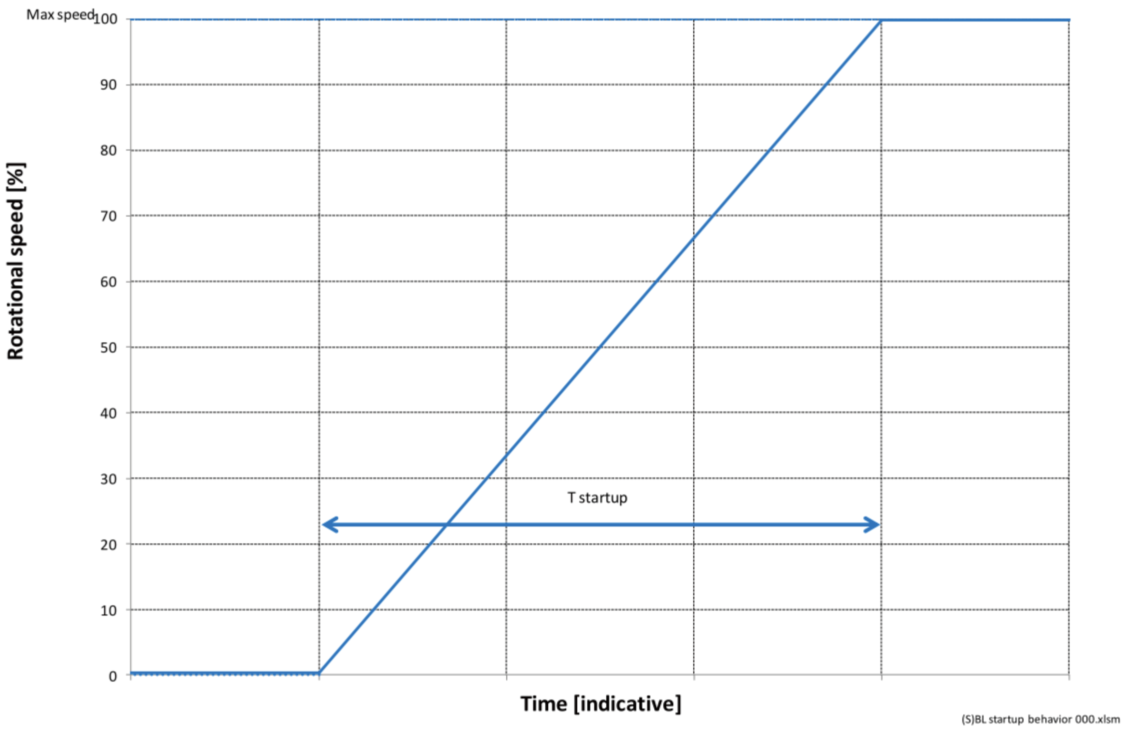
n.c.： Not connected

+•—/—•→ +D ： Drives the switch between the positive supply and the positive

⏚—/—•→ -D ： Drives the switch between the negative supply and negative/ground

⏚—/—•→ E* ： Active low enable switch between input and negative/ground

9.Startup Features



Item	Min. value	Typical value	Max. value	Unit
Start-up time (acceleration time from 0 RPM to max. forward speed)	14.0	15.0	16.0	s

10.Fuse protection

According to ISO8820 part 3, specified fuses must be used in the wiring. The specific fuse rating needs to be determined by the customer with reference to the specific application (such as the harness length of the application vehicle, the section thickness of the power harness, and the type of fuse).

11.Residual ripple of power supply

The max. value of power supply residual ripple RMS that the driver can accept is 1%.

12.Reverse polarity protection

The drive circuit is protected against reverse polarity, which ensures that the drive will not malfunction when the power line is temporarily or permanently reversed during application. In this case, the motor stops working, as defined by ISO16750-1 Class C functional status (fan is properly connected and fully functional after completion of the reverse polarity test). The requirements of fuse protection must be applied.

Reverse polarity protection test parameters

Item	Data	Unit
Reverse supply voltage	-27.0	V
Temperature	Room temperature	K
Time	2	Min.

Table 8 Reverse polarity protection test parameters

13.Throw load protection

The limit value of load dump refers to section 4.6.4.2.2 of ISO16750-2:2010 specification

Type of pulse:5b(inhibited)		
Item	Value	Unit
Peak pulse voltage (US*)	65	V
Power voltage(U_A)	28.0 ± 0.2	V
Internal resistance(R_i)	6	Ω
Pulse duration(t_d)	350	ms
Rising slope(t_r)	10 (0/-5)	ms
Pulse number	10	#
Pulse interval	60	s

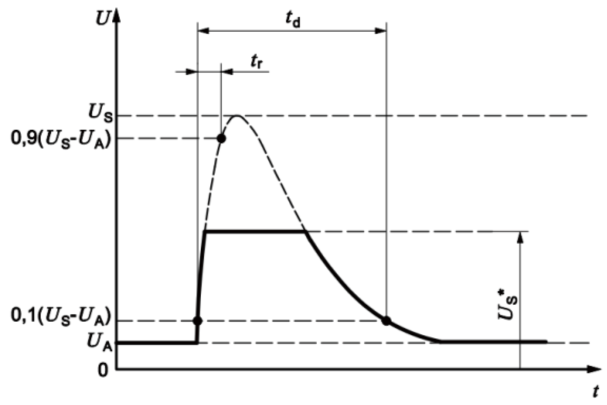


Table 9 Load dump parameters

·Working temperature range: -40 ~ +95℃
·Storage temperature range: -40 ~ +120 ℃
·Service life: up to 40,000 hours depending on the application environment.

14.Derating Curve

Min. speed	900	rpm	Derating temperature($T_{DERATING}$)	+85	℃
Max. speed	3650	rpm	Max. temperature(T_{MAX})	+95	℃

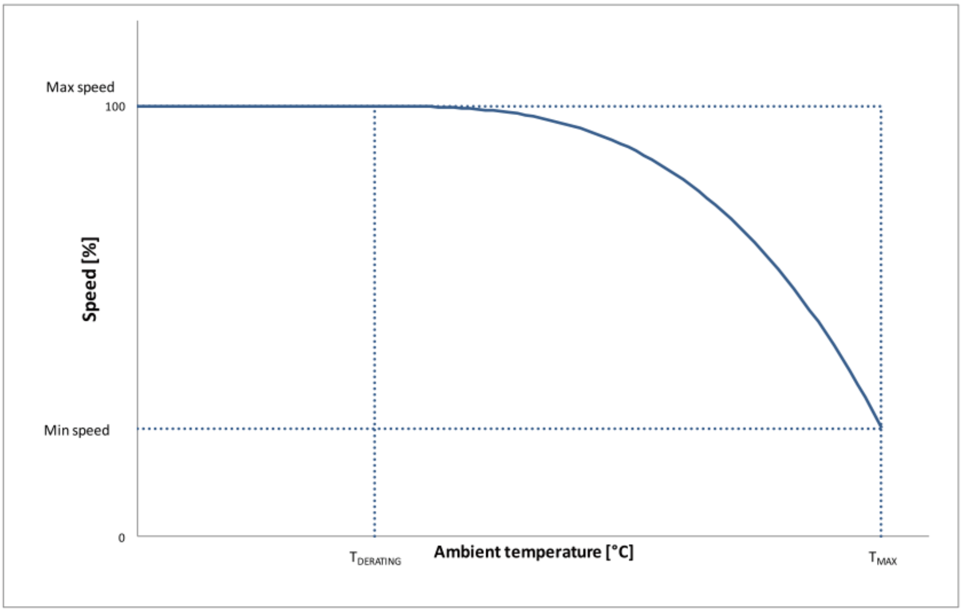


Table 10 Normalized thermal derating indication curve table

The above thermal derating curves are measured under quasi-static conditions.
Due to the thermal inertia of the system, rapid temperature changes will not affect the speed of the axial fan.

15.Performance of sealing

The fan is designed according to IP6K9K and IP68 protection levels.