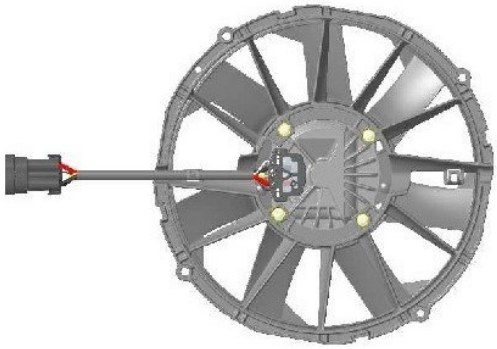
Novità Assoluta – Absolute Novelity

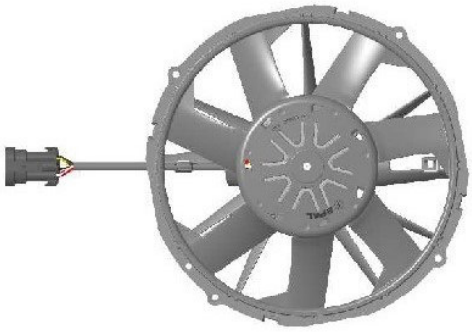
Ventola Assiale a 48 Volt – Axial Fan 48 Volt

080035	EV.AS.VA113-KBL360M/R/A/N-94A48V M/PACK 280-630

1 General

Fan diameter Ø:	305 mm
Nominal voltage:	48 V
Drive family	SBL500P
Part number:	080035



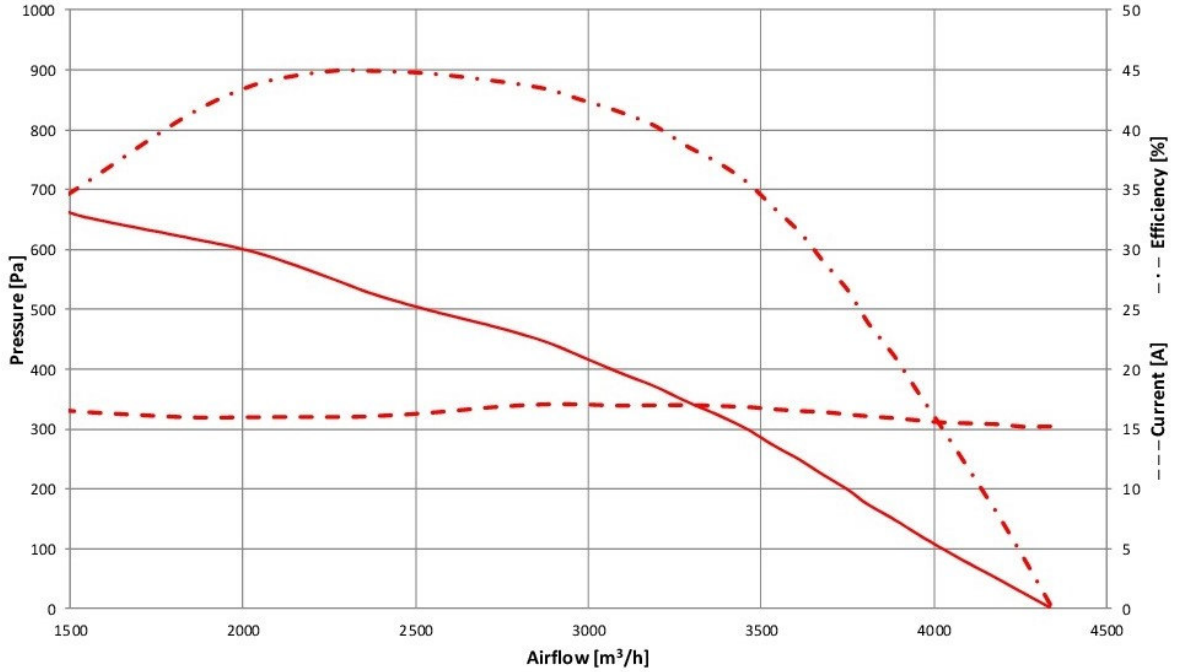


2 Features

Max direct fan speed	rpm	4750
Min direct fan speed	rpm	1200
Max reverse fan speed	rpm	4500
Min reverse fan speed	rpm	1200
Sound pressure level at max speed	dBA	85.5 – at 1 m from the fan module - lateral side
Weight	kg	2.6
Operating supply voltage range (48V)	V	20.0 .. 60.0 at the Drive connector
Supply voltage to reach max speed (48V)	V	36.0 .. 52.0 at the Drive connector
Logic PWM input high max.	V	32
Operating ambient temperature range	℃	-40 .. +120
Max operating ambient temperature @ max fan speed	℃	+85 (1)
Storage temperature range	℃	-40 .. +125
Lifetime	h	up to 40000 hours depending on mission profile
Time from 0 rpm to max speed	s	13

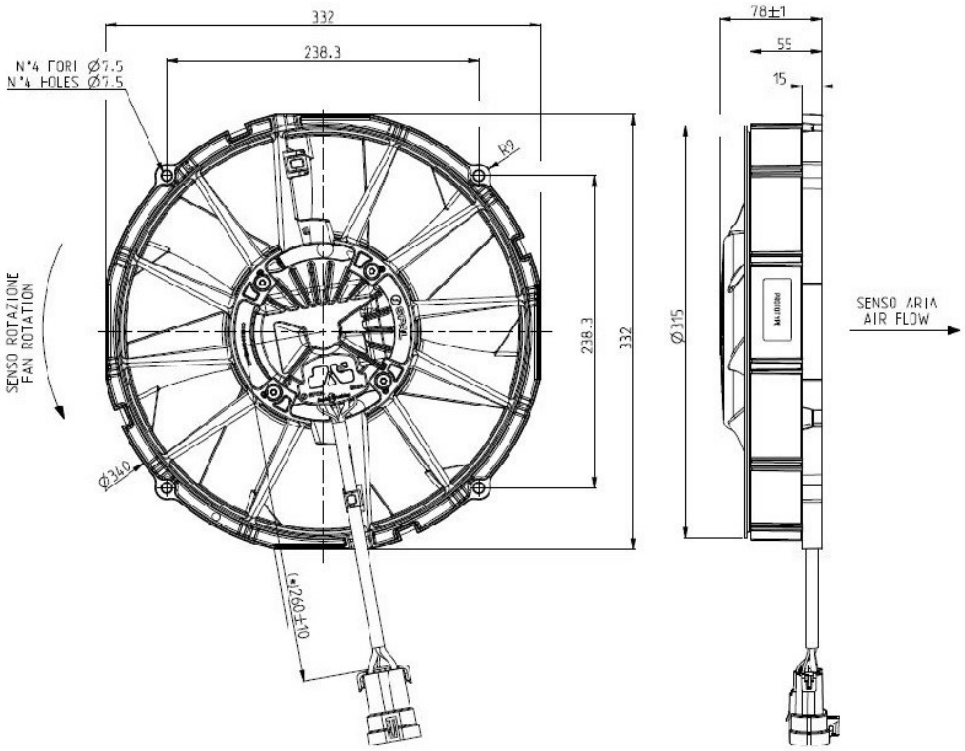
Notes: (1) Few minutes ambient temperature transients do not engage the derating owing to the thermal inertia of the system. Overloads may anticipate derating.

3 Air performance at maximum speed



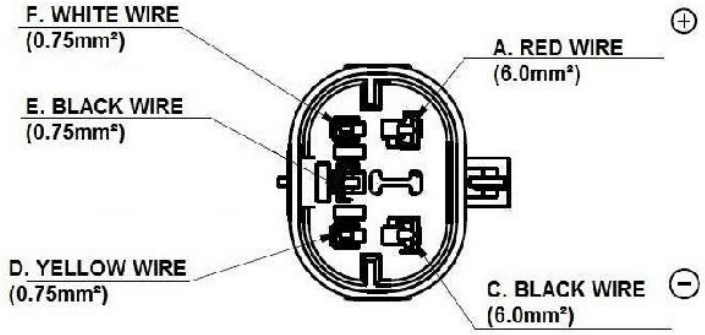
Air density 1.18 kg / m3 - Test number: #16082 – Test bench compliant to ANSI AMCA 210
TAMB = 20 °C ± 5 °C - UB = 48 V at the Drive connec tor

4 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 Connector and wires



Connector : DELPHI METRI-PACK 280-630 - Part number : DELPHI 13599647						
Secondary lock - Part number : DELPHI 12052290						
Identification (*)	+D (48V)	-	-D (48V)	PWM / E	GND 24V	FO*
Pin number	A	-	C	D	E	F
Wire Color	Red	-	Black	Yellow	Black	White
Sealing p/n	DELPHI 15324996	-	DELPHI 15324996	DELPHI 15324983	DELPHI 15324997	DELPHI 15324983
Pin p/n	DELPHI 15317330	-	DELPHI 15317330	DELPHI 12048159	DELPHI 12064734	DELPHI 12048159
Section [mm^2]	6.0	-	6.0	0.75	0.75	0.75

For abbreviations see chapter **8.2 Drive pin functions**
NOTE: Never handle the fan module via the cable harness

6 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	rms	1 % - contact SPAL 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)

7 Measurement conditions

The below conditions are assumed:

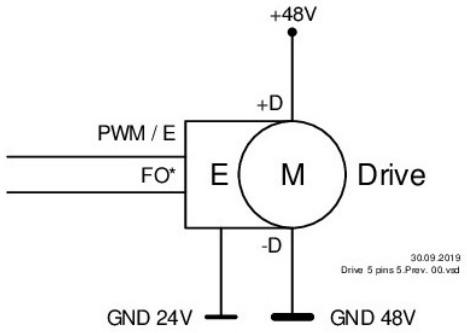
- T_{AMB} = 20 °C ± 5 °C and
- Supply voltage **UB** typ. 48 V at the **Drive** connector

unless otherwise specified.

8 Hardware functions

8.1 Drive diagram

The Drive diagram is shown below.



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

8.2 Drive pin functions

The electrical Drive interface consists of 5 pins:
Power pins:

- supply voltage plus: +D 48V
- supply voltage minus: -D GND 48V
- supply voltage minus: GND 24V

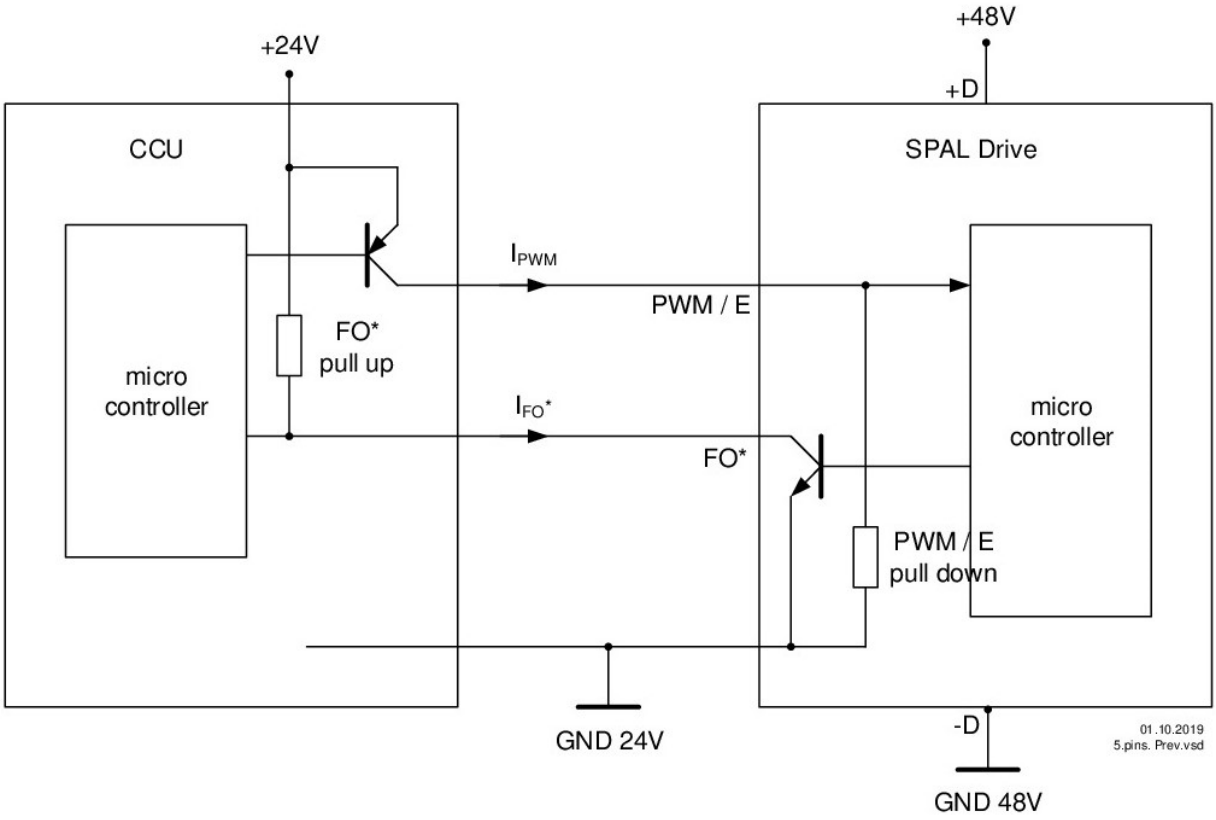
Signal pins:

1. Input: digital PWM input / active high: PWM / E
2. Output: feedback output / active low: FO*

The signal pin PWM / E is used to control the Drive mode, it is the control input.
The signal pin FO* is used to feedback the Drive speed and in case of a failure to notify it.

9 Drive interface

The CCU electronics and the Drive electronics are connected via two unidirectional lines.
These connections are depicted in the following pictures.



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

9.1 PWM input

The PWM signal for the input PWM / E comes from the CCU electronics and uses a pull down resistor (PWM / E pull down) located in the Drive electronics to determine the recessive level.
This pull down resistor is connected to the 24V GND.
The dominant level on the input PWM / E is high level (24V), provided by the switching to plus stage depicted in above figure as a bipolar pnp transistor in the CCU..

9.2 Feedback output

The output FO* comes from the Drive electronics and uses a pull up resistor (FO* pull up) located in the CCU electronics. This pull up resistor is connected to an internal CCU FO* pull up voltage +24V.
The dominant level on output FO* is low level, provided by the switching to low stage depicted in figure above as a bipolar npn transistor in the Drive.

10 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 T_{wakeup} 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 voltage range	0	24	32	V	U_{PWM}
PWM / E high level voltage	16			V	U_{PWMH} 2)
PWM / E low level voltage			5	V	U_{PWML} 2)
PWM / E resolution		1		%	dc_{resol}
PWM / E accuracy		1		%	dc_{accu}
PWM / E current	-10 %	6.5	+10 %	mA	I_{PWM} 3)
PWM / E leakage (quiescent) current			10	µA	I_{leak} 4)
PWM / E wake up voltage	6			V	U_{PWMWU} 5)
PWM / E wakeup pulse	20			µs	T_{wakeup} 6)
PWM pull down		4.7		kΩ	

1) for SPAL 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.
2) the PWM thresholds are defined for a temperature range of -40 °C to 120 °C
3) I_{PWM} is defined as peak current for a U_{PWM} of 26V
4) I_{leak} is defined for switch open on CCU
5) the wake up voltage level U_{PWMWU} is defined for a temperature range of -40 °C to 12 0 °C
6) T_{wakeup} is defined for a U_{PWM} of 26V

11 FO*: feedback output / active low

Parameters	Min	Typical	Max	Unit	Denomination
FO* voltage dominant level (I_{FO} = 10 mA)			1	V	U_{FO}
FO* recessive voltage level	80% U_{24V}		U_{24V}	V	U_{FOH} 1)
FO* pullup resistor	4.7	10	47	kΩ	R_{FO}
FO* current			30	mA	I_{FO}

FO*: feedback output / active low parameters

1) The FO* recessive voltage level depends on FO*pull up voltage (U_{24V}) and on FO* pull up resistor (R_{FO}). See also above figure for the circuit concept.

12 Software functions

12.1 Drive modes

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

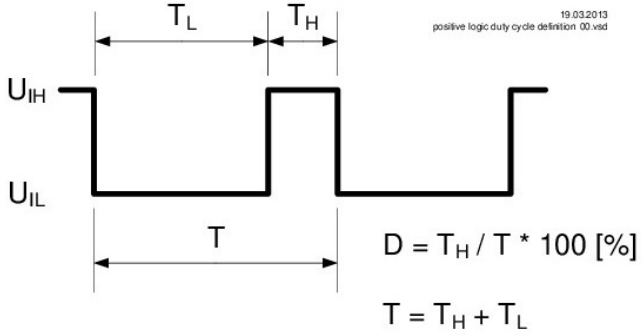
The Drive mode changes accordingly to the control input duty cycle on pin PWM / E.

No.	Drive mode	Current consumption	Drive speed	FO
1	Quiescent current mode	< 100 µA	0	Recessive
2	Electronics active mode	< 40 mA	0	Recessive
3	Run mode	depending on the requested speed and on the load	depending on the PWM duty cycle	Recessive
4	Failure mode	< 40 mA	depending on the failure	Dominant

The Quiescent current mode is entered when the pin PWM / E is on 0 % 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 (T_{wakeup}).
The Run mode is entered if the PWM duty cycle on pin PWM / E has a value where the Drive is asked to run (see chapter 12.2)
The Failure mode is entered in case of failures of the Drive (see chapter 12.4).

12.2 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 high: PWM / E.

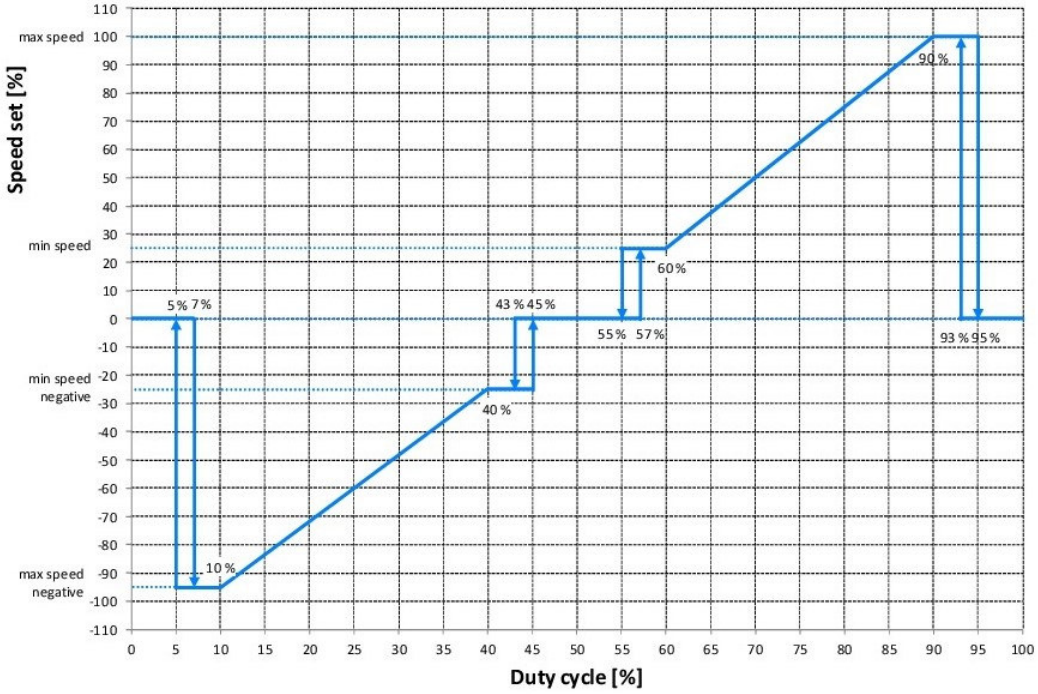


It is called "positive logic duty cycle definition".

Considering this definition,

- continuous high voltage is 100 % duty cycle (dominant level)
- continuous low voltage is 0 % duty cycle (recessive level)

Based on this duty cycle definition the transfer function PWM input is shown in the following figure.



12.3 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.

12.4 Drive mode Failure modes

The feedback output FO* signal is used for the notification of the Drive mode Failure mode.
In the Drive mode Quiescent current mode, Electronics active mode and Run mode (before reaching the minimum speed) the output FO* is set to recessive level.
In case of the Drive mode Failure mode the output FO* goes to dominant level.
If the Failure mode disappears the pin FO* goes to to recessive level again.
There are the following cases where the Drive will go into Failure mode and stop the Drive:

Failure modes	Handling of the 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	Dominant
Drive overloaded	Fan speed is reduced in case of overload detection by means of current draw measurement.	Recessive
Over current	The Drive will stop if the over current safety threshold is reached.	Dominant
Drive overheated	Fan speed is reduced in case of overheating detection (derating). Over the max operating temperature, the Drive will stop.	Dominant (over the max operating temperature)
Under and Over voltage	If the supply voltage is outside the specified range the Drive will stop.	Recessive
Internal Drive failure	The Drive will stop if a failure is detected during the startup self check procedure.	Dominant

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

13 Units of measurements

Unit		Physical Quantity	Prefix	Dimension	
%	percent	Proportionality	M	10^{6}	mega
Ω	Ohm	Electrical Resistance	k	10^{3}	kilo
℃	degree Celsius	Temperature	m	10^{-3}	milli
A	Ampere	Current	µ	10^{-6}	micro
h	hours	Time	n	10^{-9}	nano
dBA	deciBel (A-weighting)	Sound pressure level	p	10^{-12}	pico
Hz	Hertz	Frequency			
min	minute	Time			
Pa	Pascal	Pressure			
rpm	Revolutions per minute	Rotation frequency			
s	second	Time			
V	Volt	Voltage			
W	Watt	Power			

Table 1: Units and acronyms

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

14 Document change history

Initial document author: document author
Latest revision: 000

Date	Revision	Comment
08/10/2019	000	Initial Version.

Table 2: Document change history

Document status: released