Single-Channel, High-Speed, Low-Side Gate Driver

GENERAL DESCRIPTION

The SiLM27531H-AQ single-channel, high-speed, low-side gate driver device can effectively drive MOSFET and IGBT power switches. Using a design that inherently minimizes shoot-through current, SiLM27531H-AQ products can source and sink high peak-current pulses into capacitive loads offering rail-to-rail drive capability and extremely small propagation delay, typically 21 ns.

The SiLM27531H-AQ can provide 5 A source, 5 A sink peak-drive current capability at 18 V VDD supply.

FEATURES

- Low-cost gate-driver device offering superior replacement of NPN and PNP discrete solutions
- 5 A peak source and 5 A peak sink current
- Fast propagation delay (21 ns typical)
- Fast rise time (9 ns typical)
- Fast fall time (8 ns typical)
- 13.5V to 30V single supply range
- Under-voltage lockout
- TTL and CMOS compatible input logic threshold
- Output held low when input pins are floating
- Operating temperature range of -40℃ to 125℃
- SOT23-6, package
- AEC-Q 100 qualified for automotive

TYPICAL APPLICATION CIRCUIT

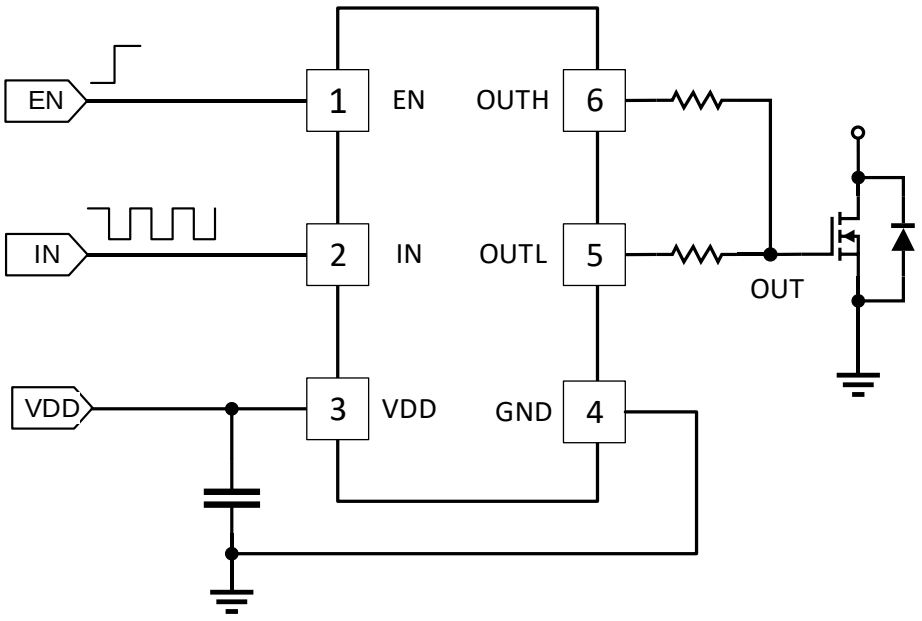

Figure 1. SiLM27531H-AQ Typical Application Circuit

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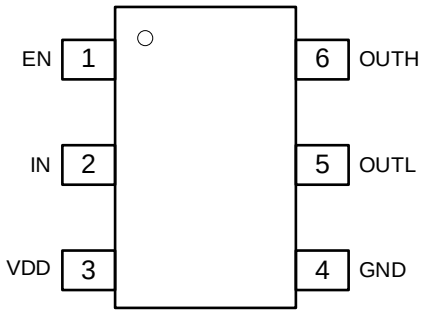
PIN CONFIGURATION

Package	Pin Configuration (Top View)
SOT23-6	

PIN DESCRIPTION

No.	Name	Function Description
1	EN	Enable pin. Connect this pin to VDD in order to enable output.
2	IN	Noninverting Input
3	VDD	Bias supply input.
4	GND	Ground.
5	OUTL	Sinking current output of driver. Connect resistor between OUTL and Gate of power-switching device to adjust turn off speed.
6	OUTH	Sourcing current output of driver. Connect resistor between OUTH and Gate of power-switching device to adjust turn on speed.

ORDERING INFORMATION

Order Part No.	UVLO	Package	QTY
SiLM27531HAC-AQ	12.5V	SOT23-6	3000/Reel

FUNCTIONAL BLOCK DIAGRAM

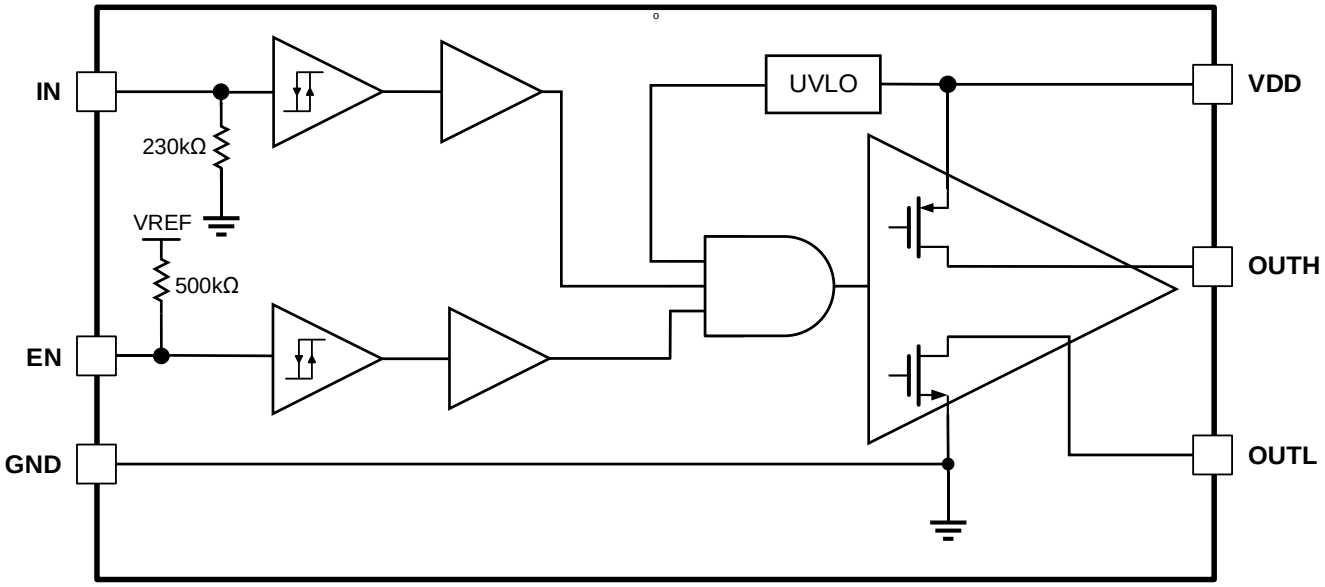


Figure 2. SiLM27531H-AQ Function Block Diagram

ABSOLUTE MAXIMUM RATINGS[1,2,3]

Over operating free-air temperature range (unless otherwise noted)

Symbol	Description	Min	Max	Unit
V_{DD}	Supply Voltage	-0.3	33	V
V_O	Continuous voltage on OUTH, OUTL	-0.3	V_{DD}+0.3	
	Repetitive pulse less than 200ns[4]	-2	V_{DD}+0.3	
IN, EN	Voltage on the IN, EN[5]	-6	33	
T_J	Junction temperature	-40	150	℃
T_L	Lead temperature (soldering, 10 seconds)		300	
T_S	Storage temperature	-65	150	

1) Stresses beyond those listed under Absolute Maximum Ratings may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these or any other conditions beyond those indicated under Recommended Operating Conditions is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

2) All voltages are with respect to GND unless otherwise noted. Currents are positive into, negative out of the specified terminal.

3) These devices are sensitive to electrostatic discharge; follow proper device-handling procedures.

4) Values are verified by characterization on bench.

5) Maximum voltage on input pins is not restricted by the voltage on the VDD pin.

RECOMMENDED OPERATION CONDITIONS

Over operating free-air temperature range (unless otherwise noted)

Symbol	Definition	Min	Max	Unit
V_{DD}	Supply voltage range	13.5	30	V
IN, EN	Input voltage	-5	30	
T_A	Operation temperature range	-40	125	°C

DYNAMIC ELECTRICAL CHARACTERISTICS

Over operating free-air temperature range (unless otherwise noted)

Symbol	Parameter	Condition	Min.	Typ.	Max.	Unit
t_{D1}	Input to output turn-on propagation delay	V_{DD}=18V, 5V input pulse, C_{LOAD}=1.8nF		21	28	ns
t_{D2}	Input to output turn-off propagation delay	V_{DD}=18V, 5V input pulse, C_{LOAD}=1.8nF		21	28	
t_R	Turn-on rise time	V_{DD}=18V, C_{LOAD}=1.8nF		9	13	
t_F	Turn-off fall time	V_{DD}=18V, C_{LOAD}=1.8nF		8	11	
t_{PW}	Minimum input pulse width that changes the output state[1]			10	15	

1) only bench test

STATIC ELECTRICAL CHARACTERISTICS

V_{DD}= 18 V,10uF capacitor from VDD to GND. T_A = -40°C to +125°C unless otherwise specified.

Symbol	Parameter	Condition	Min.	Typ.	Max.	Unit
V_{IH}	Logic high input voltage threshold for IN, EN pin	Output high	1.7	2	2.3	V
V_{IL}	Logic low input voltage threshold for IN, EN pin	Output low	0.8	1	1.2	
V_{OH}	High level output voltage, V_{DD} - V_O	I_O = -10 mA		7	13	mV
V_{OL}	Low level output voltage, V_O	I_O = 10 mA		5	9	
$I_{DD(off)}$	Startup current	V_{DD} =3.4V	40	86	150	uA
V_{DDUV+}	Undervoltage positive going threshold		11.5	12.5	13.5	V
V_{DDUV-}	Undervoltage negative going threshold		10.5	11.5	12.5	V
I_O	Output high short circuit pulsed current[2]	V_O = 0 V V_{IN} = Logic “1” PW ⩽ 10 µs		-5		A
	Output low short circuit pulsed current[2]	V_O = 18 V V_{IN} = Logic “0” PW ⩽ 10 µs		5		

2) only bench test

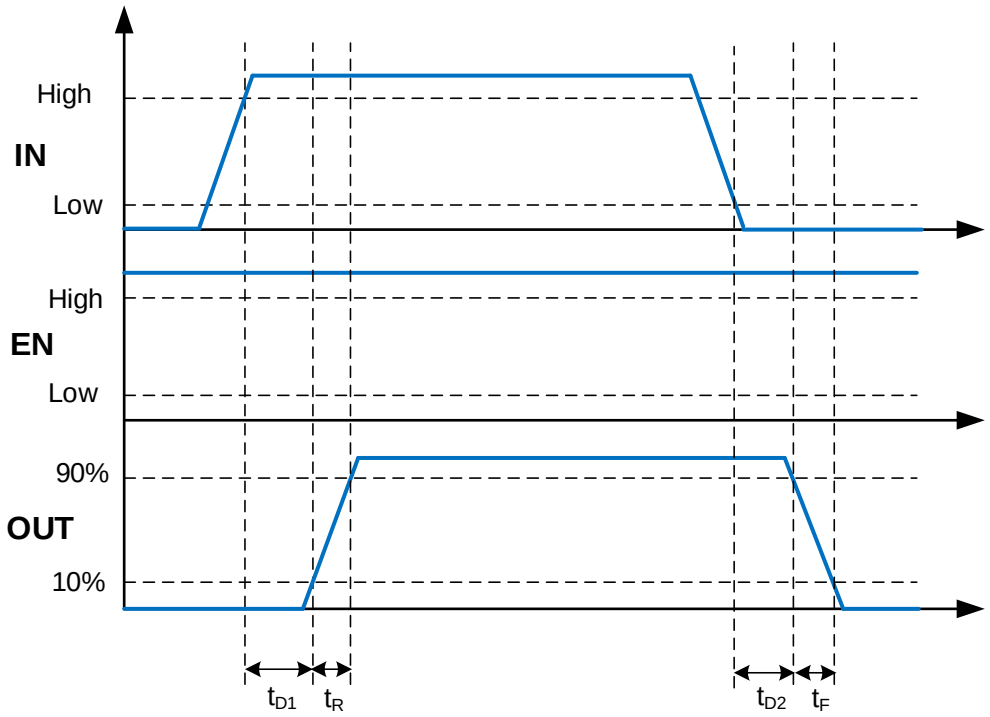


Figure 3. SiLM27531H-AQ(OUT = OUTH tied to OUTL) Input Driver Operation

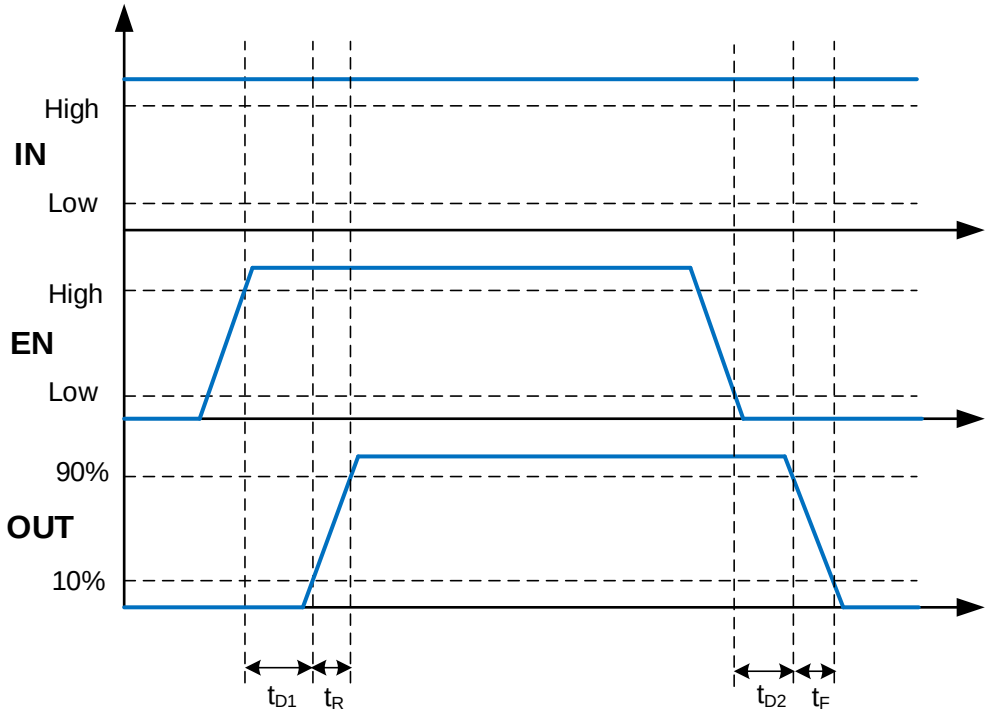


Figure 4 SiLM27531H-AQ(OUT = OUTH tied to OUTL) Enable Function

FEATURE DESCRIPTION

Overview

The SiLM27531H-AQ single-channel, high-speed, low-side gate-driver device can effectively drive MOSFET and IGBT power switches. The device can source and sink high peak-current pulses into capacitive loads, offering rail-to-rail drive capability and extremely small propagation delay of 21ns (typical). The SiLM27531H-AQ device provides 5A source, 5A sink peak drive current capability. The SiLM27531H-AQ device can also feature a split-output configuration where the gate-drive current is sourced through the OUTH pin and sunk through the OUTL pin. This pin arrangement allows the user to apply independent turn-on and turn-off resistors to the OUTH and OUTL pins, respectively, and easily control the switching slew rates.

The input threshold of SiLM27531H-AQ is based on TTL and CMOS compatible low-voltage logic, which is fixed and independent of VDD supply voltage. The 1-V typical hysteresis offers excellent noise immunity. For system robustness, internal pull up and pull down resistors on the input pins ensure that outputs are held low when the input pins are in floating condition. Therefore, the unused input pin is not left floating and must be properly biased to ensure that driver output is in enabled for normal operation. The driver has an EN pin with fixed TTL compatible threshold. EN is internally pulled up; pulling EN low disables the driver, while leaving EN open provides normal operation.

The SiLM27531H-AQ is designed to operate over a wide V_{DD} range of 13.5 to 20 V, and a wide temperature range of -40°C to 125°C.

VDD and Under-Voltage Lockout

The SiLM27531H-AQ device has internal UVLO protection feature on the VDD pin supply circuit blocks. Whenever the driver is in UVLO condition (for example when V_{DD} voltage is less than V_{DDUV+} during power up or when VDD voltage is less than V_{DDUV-} during power down), this circuit holds all outputs LOW, regardless of the status of the inputs. The UVLO is typically 12.5 V with 1000mV typical hysteresis. This hysteresis helps prevent chatter when low V_{DD} supply voltage have noise from the power supply and also when there are droops in the VDD bias voltage when the system starts switching and there is a sudden increase in I_{DD}.

Because the driver draws current from the VDD pin to bias all internal circuits, for the best high speed circuit performance, two VDD bypass capacitors are recommended to prevent noise problems. The use of surface- mount components is highly recommended. A 0.1μF ceramic capacitor should be located as close as possible to the VDD to GND pins of the gate driver. In addition, a larger capacitor (such as 1μF or higher value) with relatively low ESR should be connected in parallel and close proximity, in order to help deliver the high-current peaks required by the load. The parallel combination of capacitors characteristic for the expected current levels and switching frequencies in the application.

Input Stage

The input pins of the SiLM27531H-AQ gate driver are based on a TTL and CMOS compatible input threshold logic that is independent of the VDD supply voltage. With typically high threshold = 2 V and typically low threshold = 1 V, the logic level thresholds are conveniently driven with PWM control signals derived from 3.3V and 5V digital power-controller devices. SiLM27531H-AQ also features tight control of the input pin threshold voltage levels which eases system design considerations and ensures stable operation across temperature. The very low input capacitance on these pins reduces loading and increases switching speed.

The input stage of the driver should preferably be driven by a signal with a short rise or fall time. Caution must be exercised whenever the driver is used with slowly-varying input signals, especially in situations where the device is located in a mechanical socket or PCB layout is not optimal:

- High dI/dt current from the driver output coupled with board layout parasitic causes ground bounce. Because the device features just one GND pin, which may be referenced to the power ground, the differential voltage between input pins and GND is modified and triggers an unintended change of output state. Because of fast 21ns propagation delay, high-frequency oscillations ultimately occur, which increases power dissipation and poses risk of damage.
- 1V input-threshold hysteresis boosts noise immunity compared to most other industry-standard drivers.
- In the worst case, when a slow input signal is used and PCB layout is not optimal, adding a small capacitor(1nF) between input pin and ground very close to the driver device is necessary. This helps to convert the differential mode noise with respect to the input logic circuitry into common-mode noise and avoid unintended change of output state.

If limiting the rise or fall times to the power device is the primary goal, then an external resistance is highly recommended between the output of the driver and the power device instead of adding delays on the input signal. This external resistor has the additional benefit of reducing part of the gate charge related power dissipation in the gate-driver device package and transferring the gate driver into the external resistor.

Enable Function

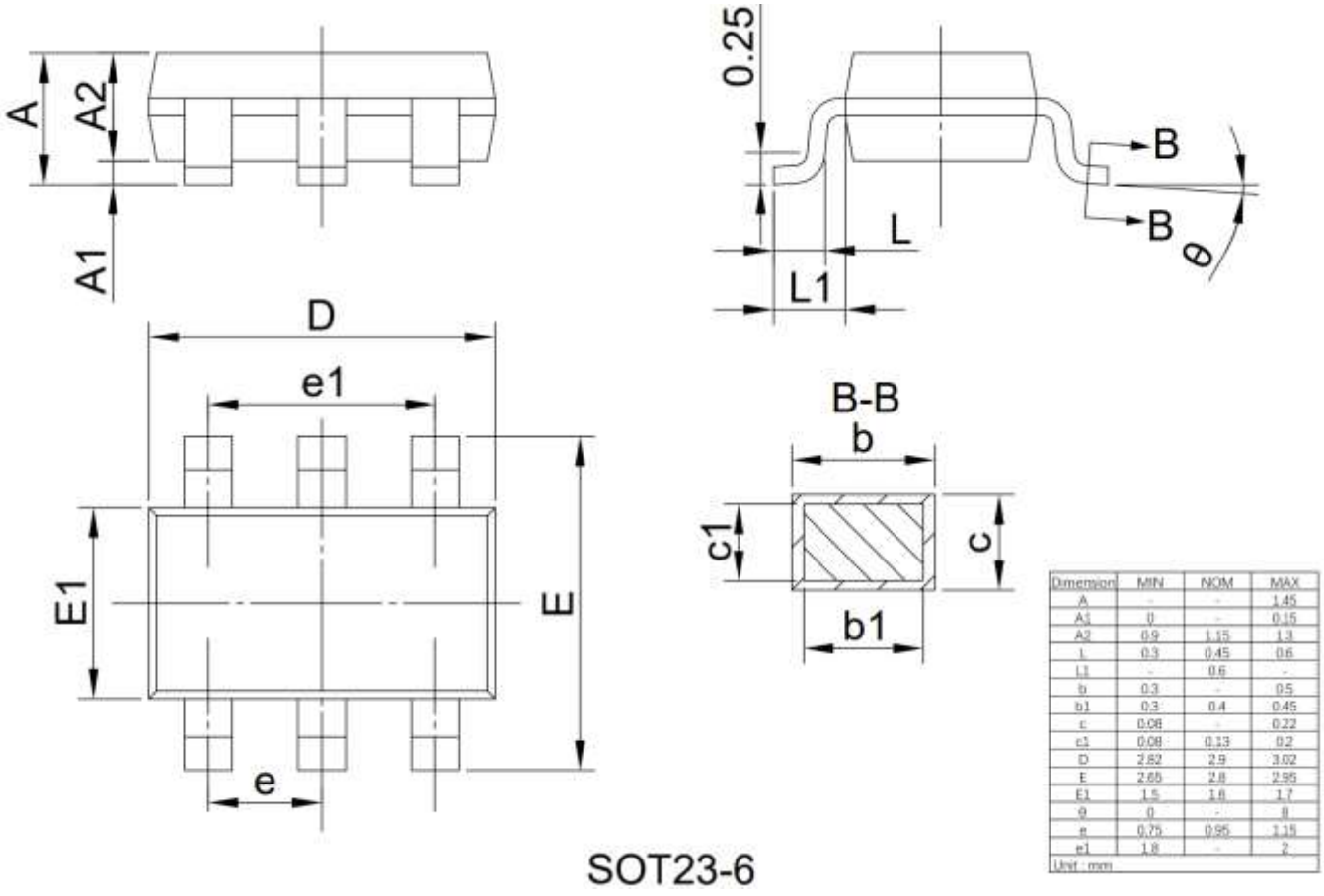
The Enable (EN) pin of the SiLM27531H-AQ has an internal pull-up resistor to an internal reference voltage so leaving Enable floating turns on the driver and allows it to send output signals properly. If desired, the Enable can also be driven by low-voltage logic to enable and disable the driver.

Output Stage

The SiLM27531H-AQ device output stage delivers the highest peak-source current when it is most needed during the Miller plateau region of the power-switch turn-on transition (when the power switch drain or collector voltage experiences dV/dt). It is capable of supplying 5A peak source and 5A peak sink current pulses. Strong sink capability results in a very low pull-down impedance in the driver output stage which boosts immunity against the parasitic Miller turn-on (high slew rate dV/dt turn on) effect that is seen in both IGBT and FET power switches. The output voltage swings between VDD and GND providing rail-to-rail operation.

The SiLM27531H-AQ has the split output OUTH and OUTL. Connecting a resistor between OUTH and the gate of power-switching device to adjust turn on speed. Connecting a resistor between OUTL and the gate of power-switching device to adjust turn off speed.

PACKAGE CASE OUTLINES



Dimension	MIN	NOM	MAX
A	-	-	1.45
A1	0	-	0.15
A2	0.9	1.15	1.3
L	0.3	0.45	0.6
L1	-	0.6	-
b	0.3	-	0.5
b1	0.3	0.4	0.45
c	0.08	-	0.22
c1	0.08	0.13	0.2
D	2.82	2.9	3.02
E	2.65	2.8	2.95
E1	1.5	1.6	1.7
θ	0	-	8
e	0.75	0.95	1.15
e1	1.8	-	2

Unit : mm

Figure 5. SOT23-6 Outline Dimensions

REVISION HISTORY

Note: page numbers for previous revisions may differ from page numbers in current version

Page or Item	Subjects (major changes since previous revision)
Rev 1.0 Datasheet, 2024-03-25	
Whole document	Datasheet initial released