400mA 1-Wire Configurable Front Flash LED Driver

FEATURES

- Front Flash LED Driving
- 400mA Maximum Flash/Torch Current
- 64 LED Current Levels Selectable by 1-wire Interface
- Flash Timeout Protection: 1.2s
- LED Current Accuracy: ±8%
- Low Dropout Voltage: 100mV@400mA
- LED Short Protection
- Under Voltage Lock Out (UVLO)
- Over Thermal Protection(OTP)
- DFN 1.5×1.5×0.55(mm)-8L Package
- Compatible with AW36406

APPLICATIONS

- Cell Phone

GENERAL DESCRIPTION

The AW36404 is a low voltage-drop current sink LED driver, which supports both flash and torch modes. The current-regulation sink integrated in the chip makes the LED current be capable of keeping constant when input voltage, LED forward voltage or temperature are changing. The LED current can be adjusted among 64 steps by sending 1-wire pulses into the EN pin, and the maximum value is 400mA.

For AW36404, only one multi-layer ceramic capacitor is needed for the peripheral of the solution.

In shut down mode, the AW36404 turns off all internal circuit and the consumption is less than 1μA.

The device requires 2.7V~5.5V input voltage range and an operating temperature range of -40℃~85℃.

TYPICAL APPLICATION CIRCUIT

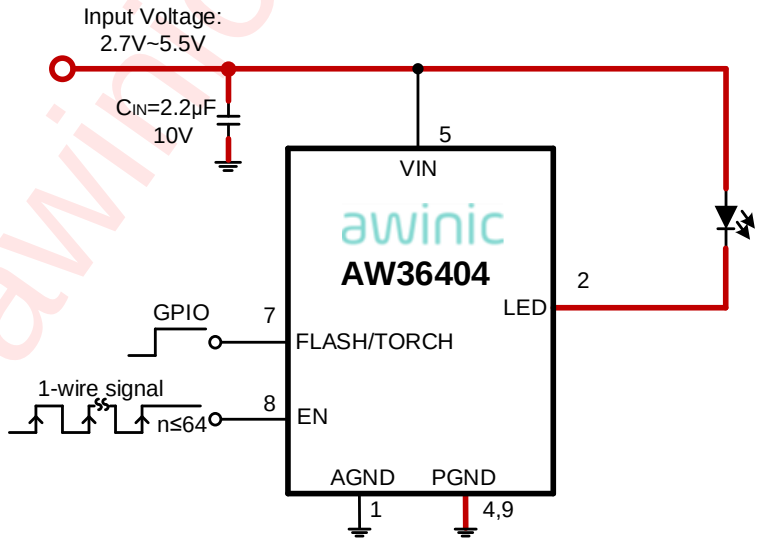
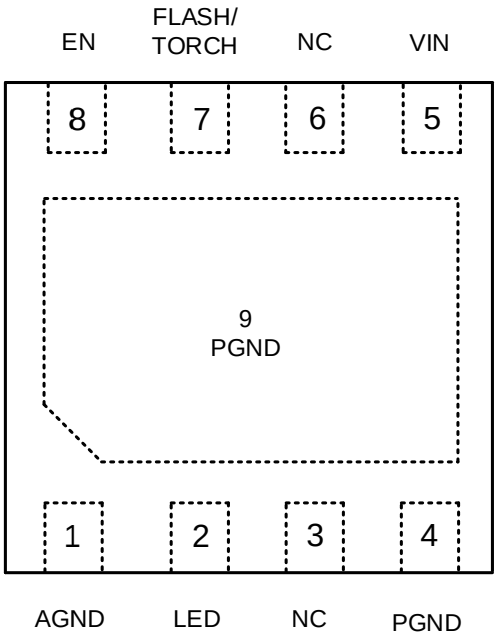


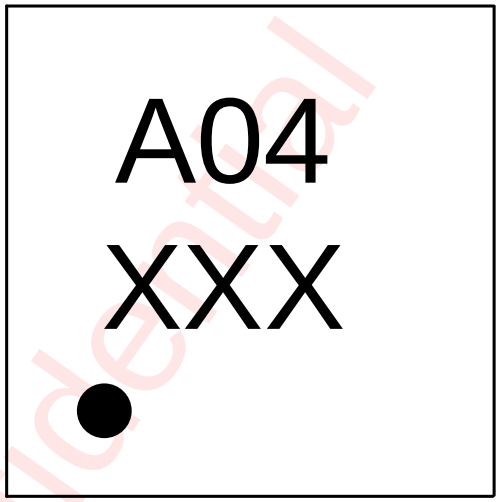
Figure 1. The AW36404 Application Circuit for Single LED

PIN CONFIGURATION AND TOP MARK

AW36404DNR Pin Configuration (Top View)



AW36404DNR Marking (Top View)



A04 ---- AW36404DNR
XXX ---- Production Tracing Code

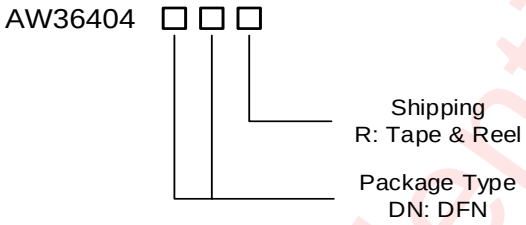
Figure 2. The AW36404 Pin Configuration and Top Mark

PIN DEFINITION

No.	NAME	TYPE	DESCRIPTION
1	AGND	Ground	Analog Ground.
2	LED	I/O	Low-Side Current Sink Output For LED.
3	NC	I/O	No Connect. This Pin Can be Floating or Connected to AGND.
4	PGND	Ground	Power Ground.
5	VIN	Power	Power Supply (2.7V-5.5V)
6	NC	I/O	No Connect. This Pin Can be Floating or Connected to AGND.
7	FLASH/TORCH	I/O	Flash/Torch Mode Setting FLASH/TORCH="H"，Flash Mode； FLASH/TORCH="L"，Torch Mode；
8	EN	I/O	Enable Pin. LED Current Can Be Adjusted By Sending 1-Wire Pulse Into This Pin.
9	PGND	Ground	Power Ground.

ORDERING INFORMATION

Part Number	Temperature	Package	Marking	Moisture Sensitivity Level	Environmental Information	Delivery Form
AW36404DNR	-40℃～85℃	DFN1.5X1.5-8L	A04	MSL1	ROHS+HF	3000 units/ Tape and Reel



AWINIC FLASH LED DRIVER SERIES

Product	Channels	Type	Description	Package
AW3644	2	Boost	High Efficiency, Dual Independent 1.5A Flash LED Driver	CSP-12
AW36414	2	Boost	High Efficiency, Dual Independent 1.5A Flash LED Driver	CSP-12
AW3643	2	Boost	High Efficiency, Dual 1.5A Flash LED Driver	CSP-12
AW36413	2	Boost	High Efficiency, Dual 1.5A Flash LED Driver	CSP-12
AW3648	1	Boost	High Efficiency, 1.5A Flash LED Driver	CSP-12
AW3641E	1	Charge Pump	Flash Current & Flash Timer Programmable 1A Flash LED Driver	DFN-10
AW3640	1	Current Sink	200mA 1-Wire Configurable Front Flash LED Driver	DFN-6
AW36402	1	Current Sink	200mA 1-Wire Configurable Front Flash LED Driver	DFN-6
AW36404	1	Current Sink	400mA 1-Wire Configurable Front Flash LED Driver	DFN-8
AW36406	1	Current Sink	600mA PWM Configurable Front Flash LED Driver	DFN-8

TYPICAL APPLICATION CIRCUIT

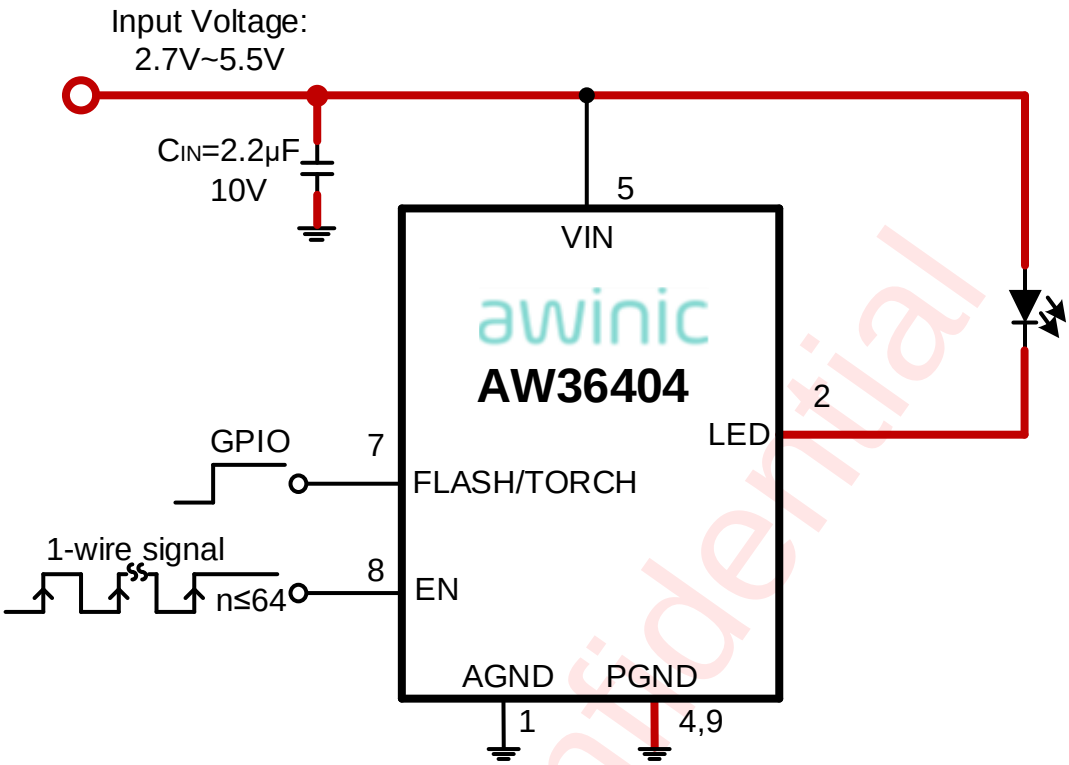


Figure 3. Application Circuit for Single LED

Notice for Typical Application Circuits:

1. *C_{IN} should be close to the pin of VIN.*
2. *Red line is high current path. Considering driving ability, for example, the power path INPUT--VIN--LED should be as short and wide as possible.*
3. *For better thermal performance and noise performance, the AGND and PGND pins should be connected directly to a large area of the PCB ground plane.*

ABSOLUTE MAXIMUM RATINGS(NOTE1)

PARAMETERS		Range	Unit
VIN, LED		-0.3 to 6	V
EN		−0.3 to (VIN+0.3)	V
FLASH/TORCH		−0.3 to (VIN+0.3)	V
Max Junction Temperature T_{JMAX}		150	℃
Storage Temperature T_{STG}		-65 to 150	℃
Maximum lead temperature (soldering)		260	℃
Junction to Ambient Thermal Resistance θ_{JA}		121	℃/W
ESD, All Pins(NOTE2)	HBM	±2000	V
	MM	±200	V
	CDM	±2000	V
Latch-Up JEDEC STANDARD NO.78E SEPTEMBER 2016		+IT：+350 -IT：-350	mA

RECOMMENDED OPERATING CONDITIONS

PARAMETERS	Range	Unit
VIN	2.7 to 5.5	V
Junction temperature (T_J)	-40 to 125	℃
Ambient temperature (T_A)	-40 to 85	℃

NOTE1: *Conditions out of those ranges listed in "absolute maximum ratings" may cause permanent damages to the device. In spite of the limits above, functional operation conditions of the device should within the ranges listed in "recommended operating conditions". Exposure to absolute-maximum-rated conditions for prolonged periods may affect device reliability.*

NOTE2: *The human body model is a 100pF capacitor discharged through a 1.5kΩ resistor into each pin. Test method: MIL-STD-883J Method 3015.9*

ELECTRICAL CHARACTERISTICS

VIN=3.6V, T_A=25℃ for typical values (unless otherwise noted)。

Symbol	Description	Test Conditions	Min	Typ	Max	Units
Power supply						
VIN	Input Operation Voltage		2.7		5.5	V
UVLO	Input Under Voltage Lock Out	Rising edge		2.4		V
		Falling edge	1.9	2.2	2.5	V
I_{SD}	Current In Shutdown Mode	EN=0		0.1	1	μA
I_Q	Quiescent Current	EN=1.8V, LED pin open		180		μA
LED Driver						
I_{LED}	Total Output Current, Flash/Torch Mode	Step Num=64	-8%	400	8%	mA
V_{DROP}	Dropout Voltage	I_{LED}=400mA		100	160	mV
I_{SHORT}	LED Short Detecting Current			2.5		mA
$T_{SOFTSTART}$	Current Rising Time			200		μs
Control						
V_{IL}	Logic Input Low Level				0.4	V
V_{IH}	Logic Input High Level		1.3			V
R_{EN}	Internal Pull Down Resistor of EN Pin			500		kΩ
T_{SD}	Thermal Shutdown Threshold			155		℃
	Thermal Shutdown Hysteresis			20		℃
T_{FLASH}	Flash Timeout Duration			1.2		s
$R_{FLA/TOR}$	Internal Pull Down Resistor of FLASH/TORCH Pin			500		kΩ
1-Wire Dimming Pulse Timing						
T_{LO}	EN Pulse Low Time		0.5	2	10	μs
T_{HI}	EN Pulse High Time		0.5	2	10	μs
T_{ON_DELAY}	Time Between EN Pulled To High And Soft-Start			350	450	μs
T_{SHDN}	Chip Shutdown Delay	Measure from EN falling edge to the chip entering shut down mode	0.5		2.5	ms

TYPICAL CHARACTERISTICS

VIN=3.6V, T_A=25℃ , unless otherwise noted.

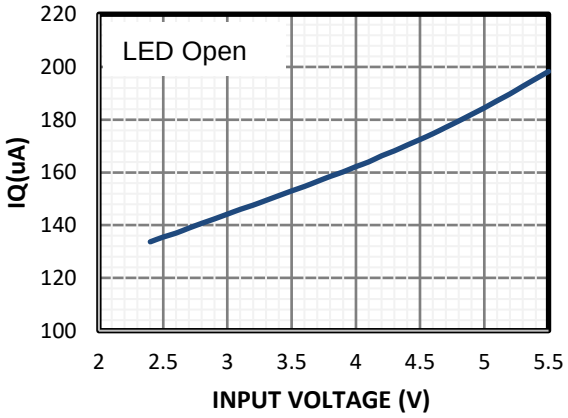


Figure 4. Quiescent Current vs Input Voltage

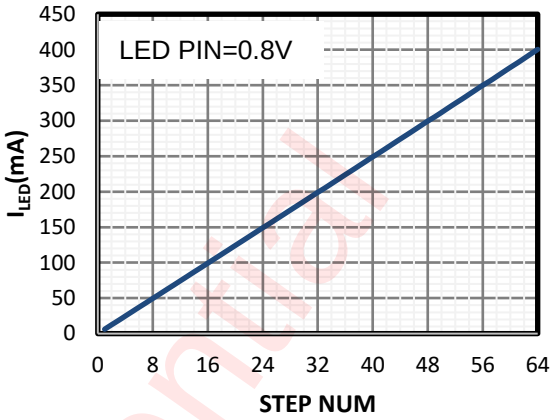


Figure 5. LED Current vs Step Num

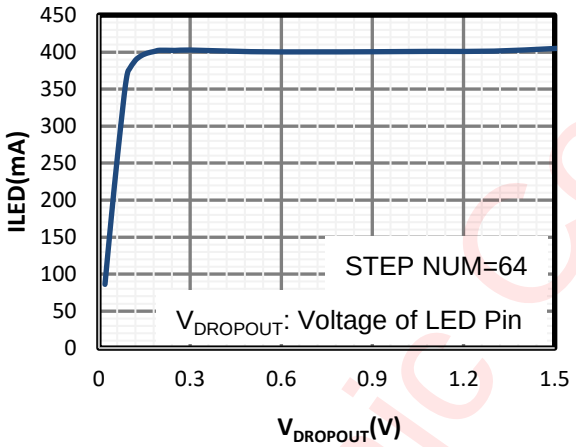


Figure 6. LED Current vs Voltage of LED Pin

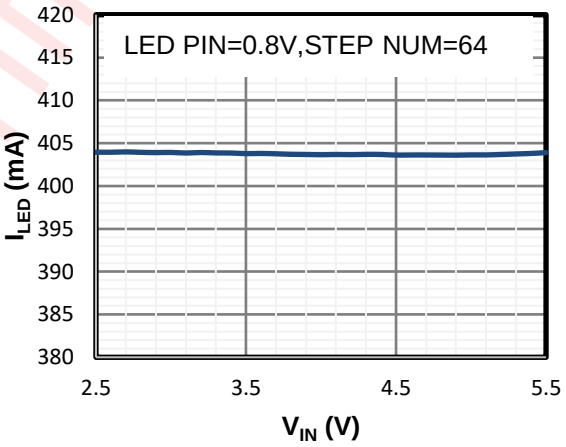


Figure 7. LED Current vs VIN

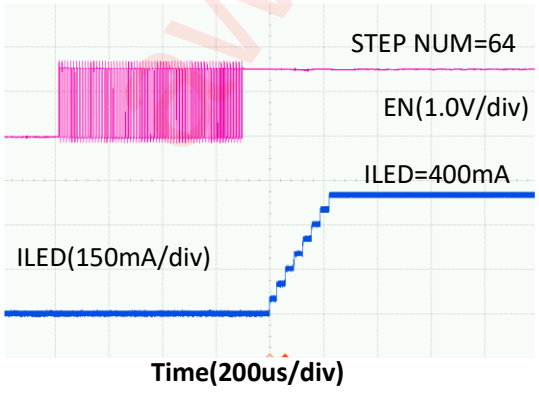


Figure 8. Startup Wave

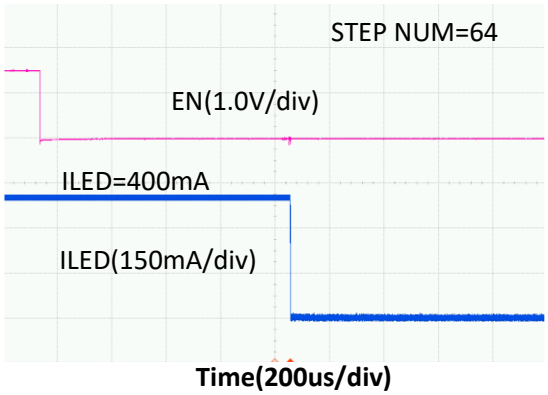


Figure 9. Shutdown Wave

FUNCTION BLOCK

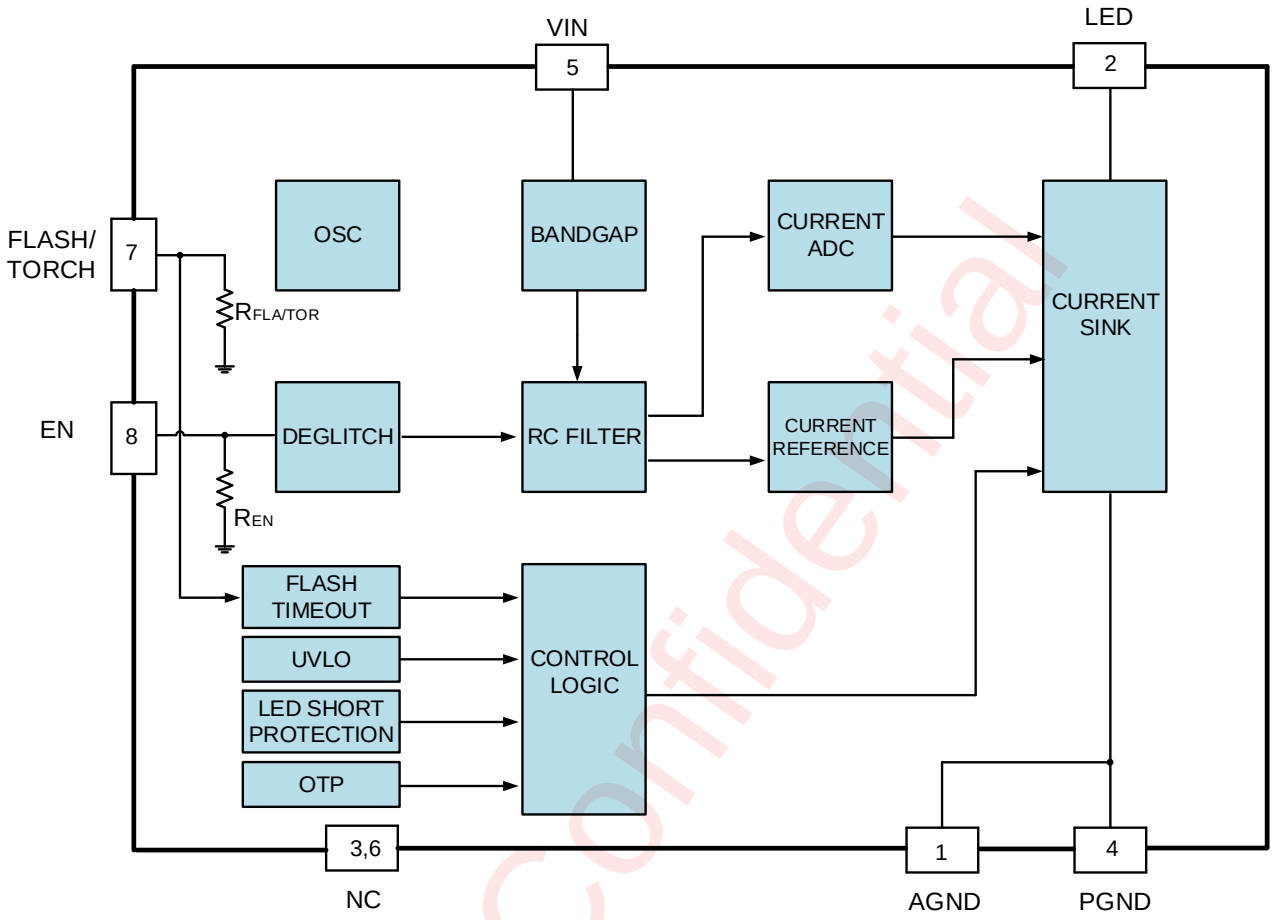


Figure 10. The AW36404 Function Block

DETAILED DESCRIPTION

The AW36404 is a low voltage-drop current sink LED driver, which supports both flash and torch modes. The current-regulation sink integrated in the chip makes the LED current capable of keeping constant when input voltage, LED forward voltage or temperature are changing. The LED current can be adjusted among 64 steps by sending 1-wire pulse into the EN pin, and the maximum value is 400mA.

EN Control

The voltage level at EN pin determines the operation state of the chip. When the EN pin is set to high, the AW36404 operates in normal state. And the chip would enter shutdown mode if the EN pin is set to low for over 2.5ms, as a built-in shutdown delay circuit in the AW36404. The shutdown current dissipated by the AW36404 is less than 1μA.

The AW36404 built in deglitch circuit. The interference between signals inside the portable device is unavoidable, thus deglitch circuit is necessary at the EN pin. The deglitch circuit inside the AW36404 is capable of eliminating the glitch which is narrower than 80ns, preventing the incorrect trigger at the EN pin effectively.

FLASH MODE

When Flash/Torch pin is pulled to high, AW36404 will work in flash mode. In flash mode, the chip is protected by flash timeout function，and the typical value of flash timeout duration is 1.2s. The LED current in flash mode can be adjusted among 64 steps by sending 1-wire pulse into the EN pin, and the maximum value is 400mA.

TORCH MODE

When Flash/Torch pin is pulled to low, AW36404 will work in torch mode. In torch mode, LED current sink can also provide maximum 400mA but timeout function is disabled. So we must pay attention to the heat dissipation, and a good PCB layout design should be considered if the chip need working at a large current state. The LED current can only be shut off by EN if the device does not trigger any protection(refer to Figure 11).

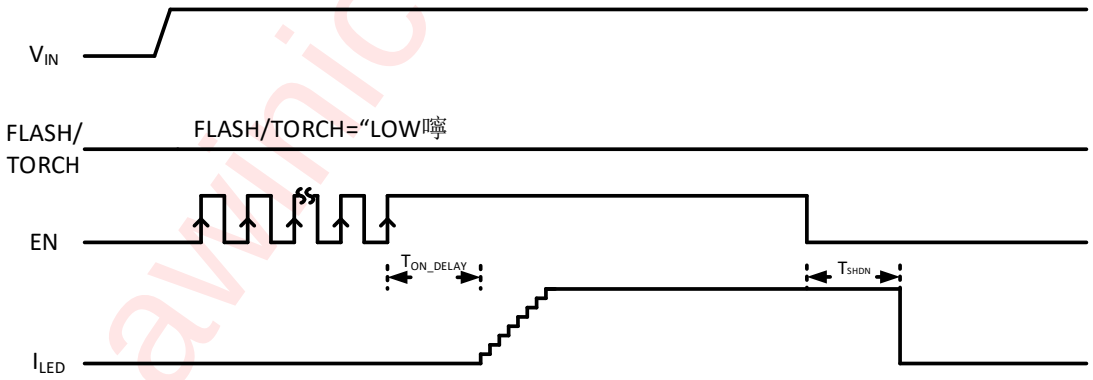


Figure 11. Timing Diagram of Torch Mode

Flash Timeout

The AW36404 has flash timeout protection function. If FLASH/TORCH pin is pulled to high, the chip will work in flash mode. If the time of a flash event exceeds a certain value(about 1.2s), the LED current will be shut off to prevent LED from overheating. LED current can be restarted only by resetting EN again. While if a flash event is not finished but interrupted by EN shutdown, the flash timeout function will be reset and the chip will enter into shutdown mode (refer to Figure 12).

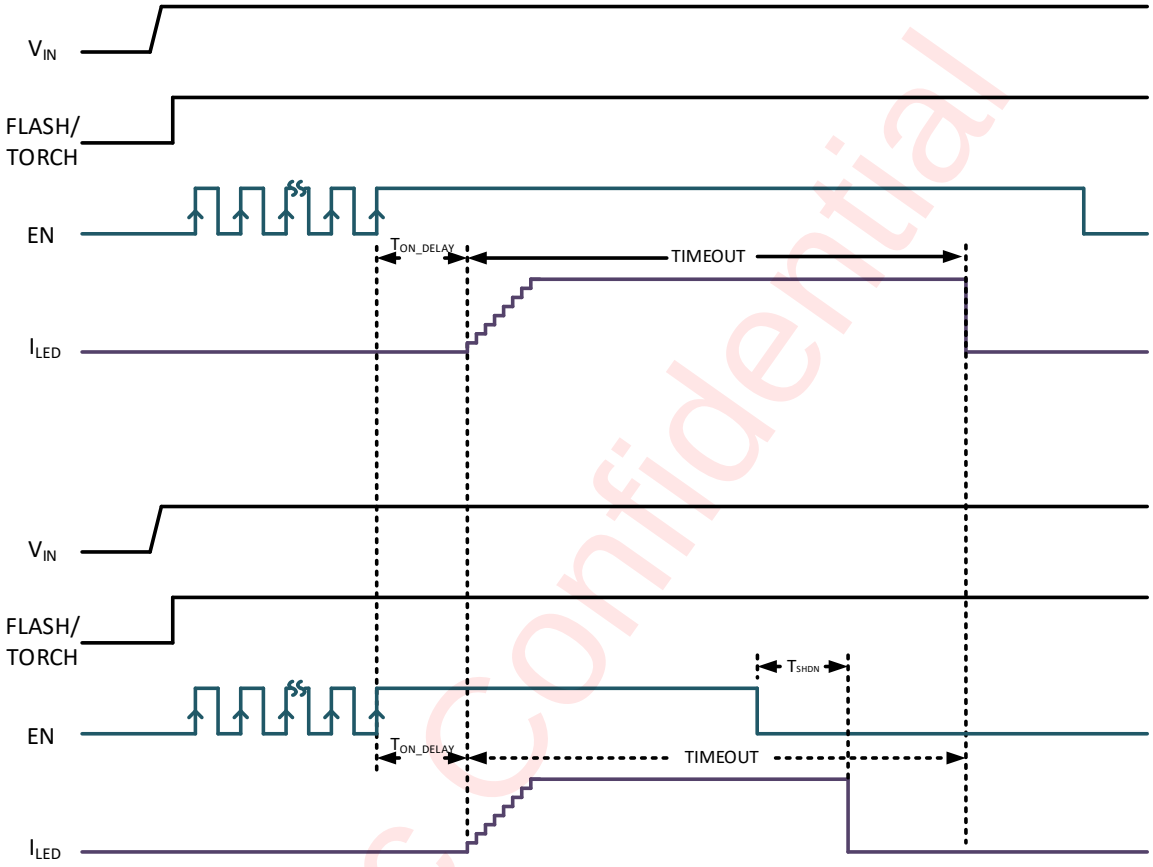


Figure 12. Timing Diagram of Flash Mode

Soft-Start

To decrease VBAT voltage fluctuation caused by inrush current, the AW36404 built in soft-start function. It takes 8 steps to ramp up to setting current and the ramp time is about 200μs.

UVLO

The device has under voltage lock-out (UVLO) function to monitor the input voltage. Once the input voltage VIN drops below UVLO falling threshold (around 2.2V), the output current is disabled. Once the input voltage increases above UVLO rising threshold (around 2.4V), the output current resumes its previous setting.

LED Short Protection

Short protection function will be enabled after the 1_{st} step of soft-start. The IC internally compares the voltage difference between VIN and the sink node (LED pin) with a preset threshold. If this difference is below the preset threshold, AW36404 will treat the LED as shorted and disable its Flash/Torch mode current through the LED pin. However, a 2.5mA detecting current will be kept to generate the LED's voltage drop. Because some normal flash LEDs may have larger than desired leakage current (up to hundreds of micro-amps) even if it's not fully turned on, this 2.5mA sensing current can guarantee that a properly functioning LED will not mistakenly be treated as a shorted LED. If the short circuit is removed during operation, the LED will automatically recover to the programmed current setting.

Thermal Shutdown

In flash or torch mode, the device has thermal shutdown protection, when the IC temperature goes above thermal shutdown rising threshold (around 155℃), the output current is shut off. There are 2 conditions should be satisfied at the same time to resume output current: one is the IC temperature drops below thermal shutdown falling threshold (around 135℃); the other is that the chip is reset through EN.

APPLICATION INFORMATION

1-Wire Pulse Dimming

The AW36404 adopts the 1-wire pulse dimming to avoid the switch noise. A 6-bit DAC inside the AW36404 allows counting the rising edge at the EN pin to set the LED current (refer to Figure 13). Figure 13 shows that high level time 0.5μs<T_{HI}<10μs; and low level time 0.5μs<T_{LO}<10μs. If high time of EN is larger than T_{ON_DELAY}, then LED current will start to ramp up to setting value. But if add another pulse after soft-start, LED current will changed to a new setting value directly. If low time of EN is larger than T_{SHDN}, then the AW36404 will be shut down.

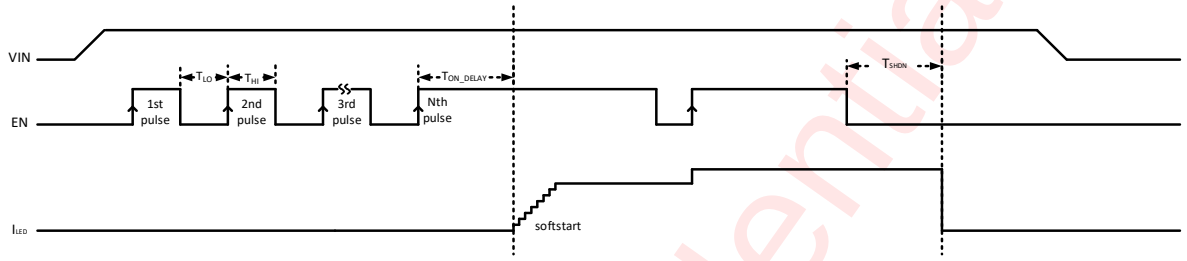


Figure 13. The AW36404 1-Wire Dimming Timing Diagram

The LED current steps up along with the increasing number of EN pulse rising edge. After the current setting process, the EN pin should be set to high level.
LED current can be calculated as below:

$$ILED \approx 6.25mA * N$$

N is number of EN pulse rising edge. N is integer and changed from 1 to 64. Please note that every 64 pulses is a cycle when N>64.

Efficiency

The AW36404 is a low voltage-drop current sink LED driver, its operation efficiency can be approximately calculated as below.

$$\eta = \frac{P_{OUT}}{P_{IN}} = \frac{V_F \times I_{OUT}}{V_{IN} \times I_{IN}} \approx \frac{V_F \times I_{OUT}}{V_{IN} \times I_{OUT}} = \frac{V_F}{V_{IN}}$$

V_F in the formula represents the forward voltage of LED. If VIN is 3.6V, V_F is 3.4V, the chip efficiency is about 94%.

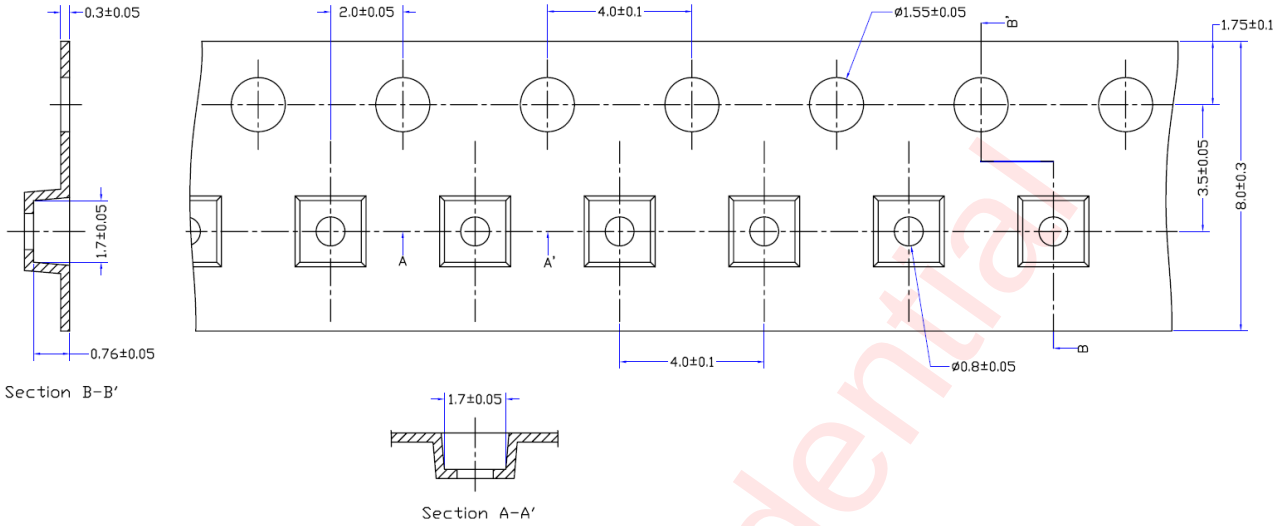
PCB LAYOUT CONSIDERATION

To make fully use of the performance of the AW36404, the guidelines below should be followed:

1. All the peripherals should be placed as close to the device as possible. Place the input capacitor C_{IN} on the top layer (same layer as the AW36404) and close to VIN.
2. Route the power line (shown in Figure 3) as widely and shortly as possible to reduce parasitic impedance.
3. To optimize the heat dissipation performance, the AGND and PGND pins should be connected to the PCB ground plane using as many vias as possible.

TAPE AND REEL INFORMATION

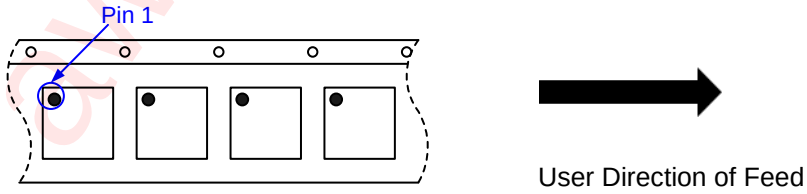
CARRIER TAPE



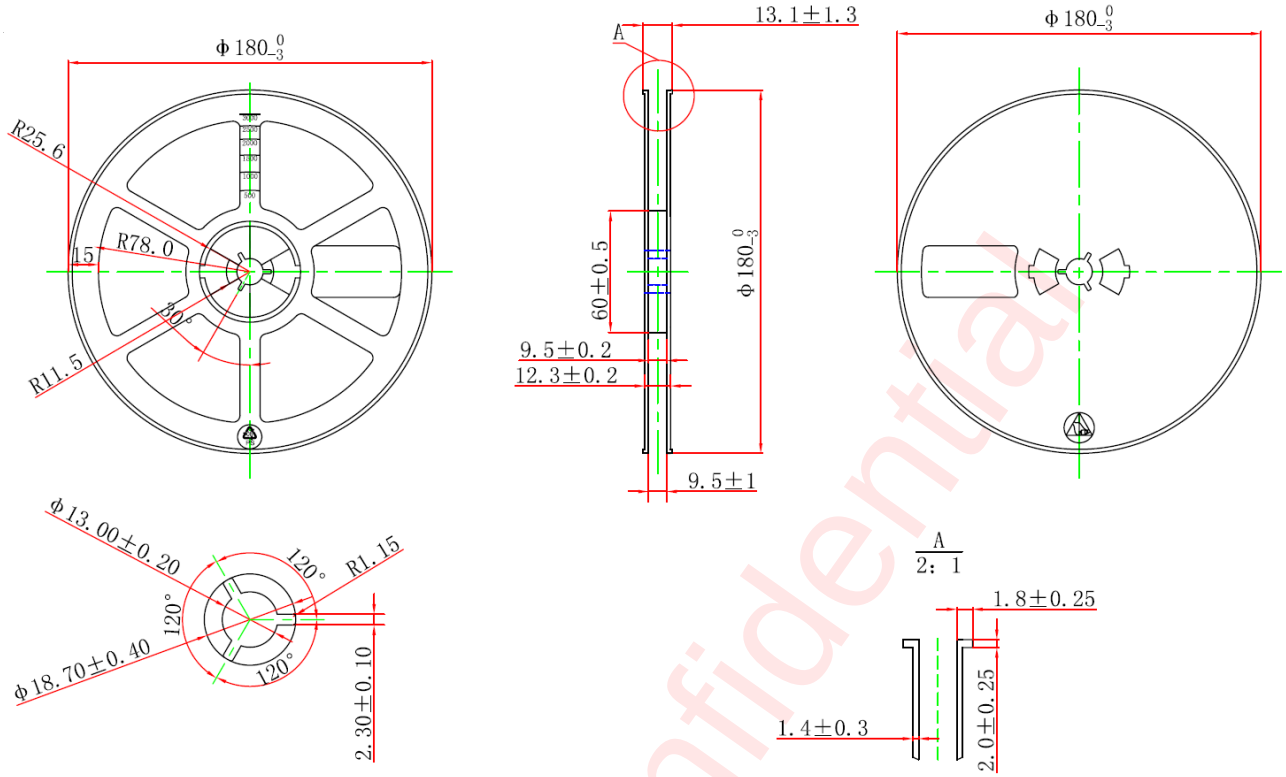
NOTES:

1. 10 pocket hole pitch cumulative tolerance ±0.2.
2. Carrier camber is within 1mm in 100mm.
3. MATERIAL: CONDUCTIVE POYSTYRENE.
4. All DIMS in MM.
5. Surface resistance 1X10E11(max) OHMS/SQ.

Pin 1



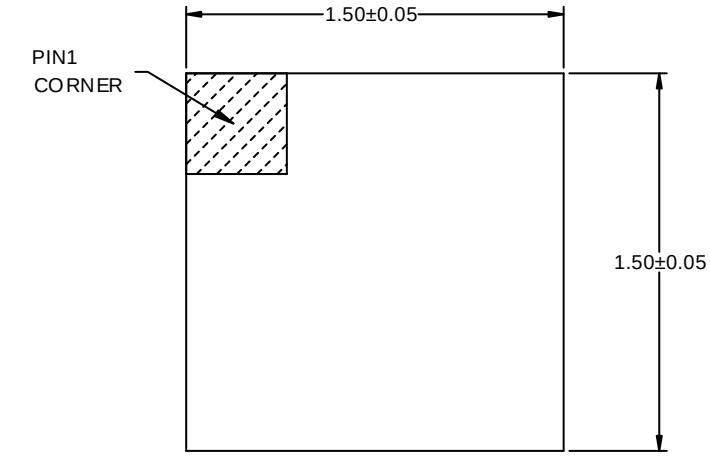
REEL



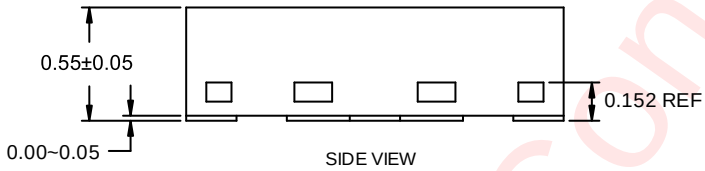
NOTES：

1. All DIMS in mm.
2. General tolerance ±0.25mm.
3. Material: Dissipative.
4. Flange Warpage: 3mm maximum.
5. Surface resistivity：10E5~10E11 OHMS/SQ.

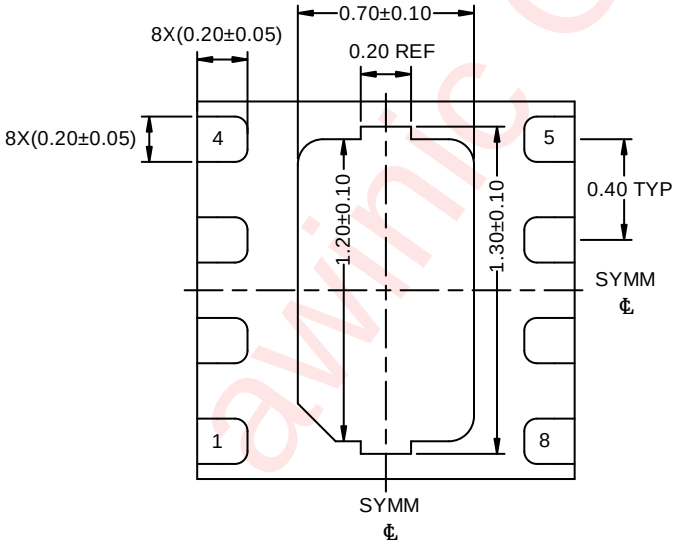
PACKAGE INFORMATION



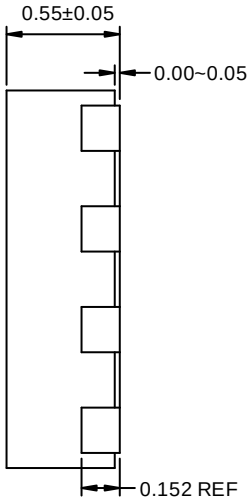
TOP VIEW



SIDE VIEW



BOTTOM VIEW



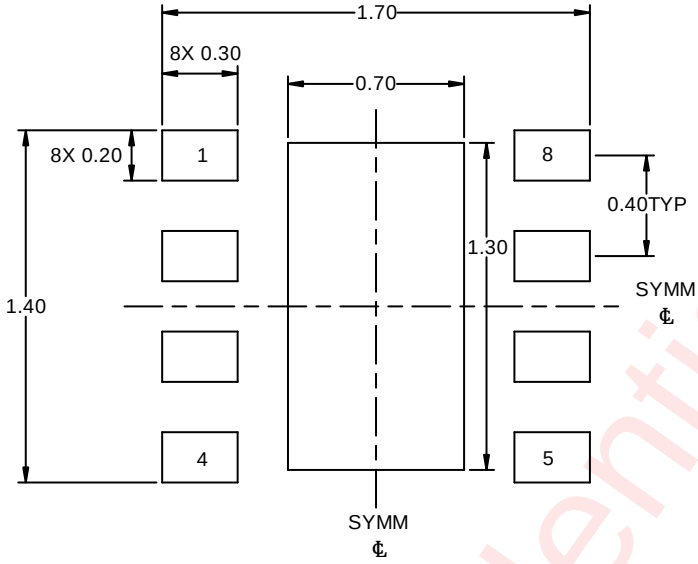
SIDE VIEW

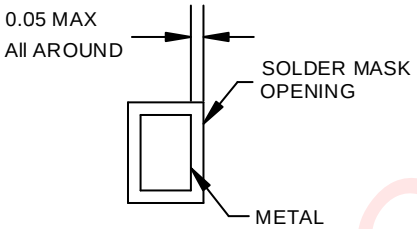
Unit：mm

NOTE:

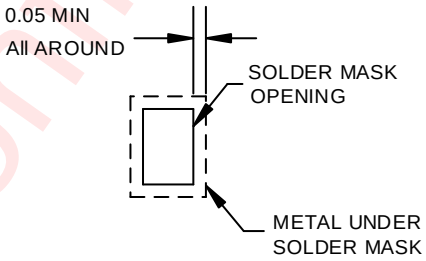
1、 All dimensions do not include mold flash or protrusion.

LAND PATTERN EXAMPLE





NON-SOLDER MASK DEFINED

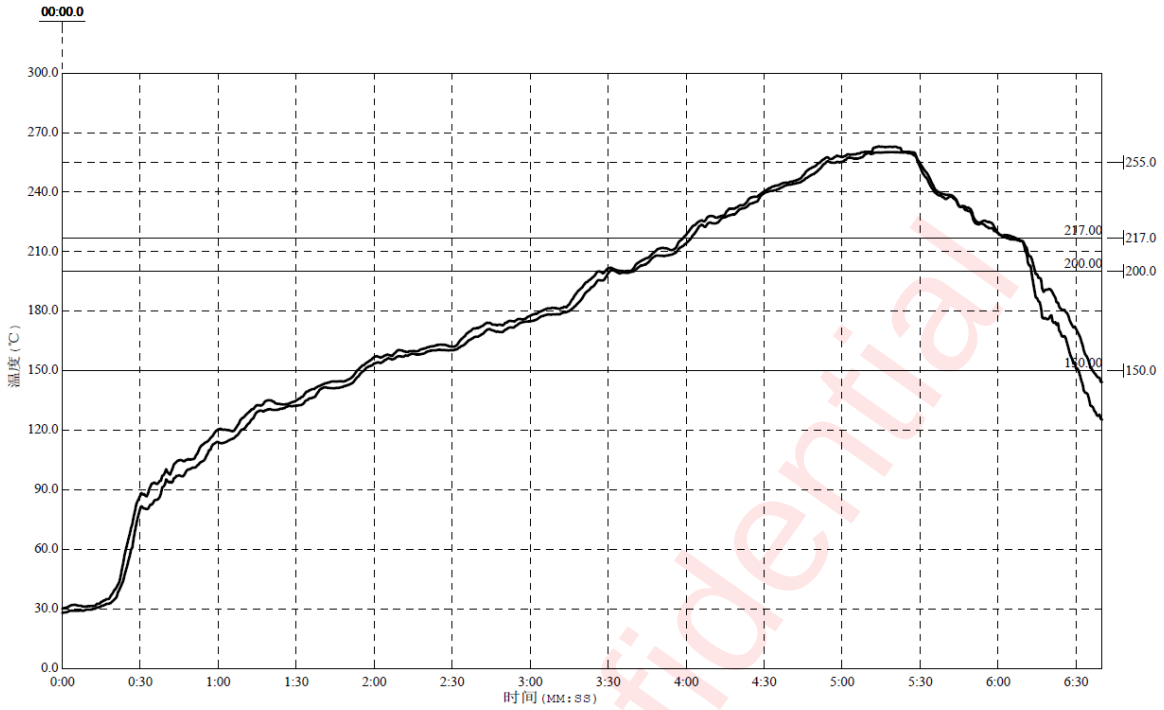


SOLDER MASK DEFINED

Unit: mm

NOTE:
Dimensions are in millimeters.

REFLOW



Reflow Note	Spec
Average ramp-up rate (217℃ to Peak)	Max. 3℃ /sec
Time of Preheat temp.(from 150℃ to 200℃)	60-120sec
Time to be maintained above 217℃	60-150sec
Peak Temperature	>260℃
Time within 5℃ of actual peak temp	20-40sec.
Ramp-down rate	Max. 6℃ /sec
Time from 25℃ to peak temp	Max. 8min.

Version information

VERSION	DATE	Change Record
V1.0	2017.10	Datasheet V1.0 Released
V1.1	2018.1	Add User Direction of Feed. (P12)
V1.2	2018.4	1. Add Spec of Torch Current.(P6) 2. Rotate Pin Configuration(Figure 2) by 90 degrees.(P2) 3. Add upper limit of V_{DROP}.(P6)
V1.3	2018.5	1.Modify “Max Junction Temperature T_{JMAX}” from125℃ to 155℃.(P5)
V1.4	2019.12	Update the Package information and Land pattern

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