High Efficiency Low Output Ripple 5V Power Supply

Features

- Output Voltage Accuracy: 5V±5%
- Maximum Load Current: 275mA @ OTG, 450mA @ Power Bank
- Low V_{OUT} Ripple: 100mVpp (typical)
- High Efficiency 1.5X / 2X Adaptive Charge pump
- Specific Q-modeTM Select Charge Pump Mode
- Two Operating modes: Normal Mode, Green Mode
- Low Quiescent Current: 0.6mA(Green Mode)
- Up to 90% Efficiency
- Built in Soft start
- 2mm x 2mm, DFN-8L package

Applications

Cell Phones, Smart Phones, PADs

Power Bank

USB On-The-Go Device

Digital Camera

General Description

The AW3632 is a High-efficiency Low Ripple charge pump power supply chip. With specific Q-modeTM , AW3632 can select Charge Pump operation mode between 1.5X and 2X.

The AW3632 can operate at normal mode and green mode by 1-wire pulse function. In the normal state, the charge pump has a higher operating frequency, the drive capacity is over 275mA. In the green state, the operating frequency is lower than normal state, the frequency is about 50 kHz, the quiescent current consume is only 0.6mA.

AW3632 builds in over current protection, over temperature protection and output short-ground protection, effectively protect chip from damage.

The AW3632 available in a tiny DFN 2mm×2mm package.

Typical Application Circuit

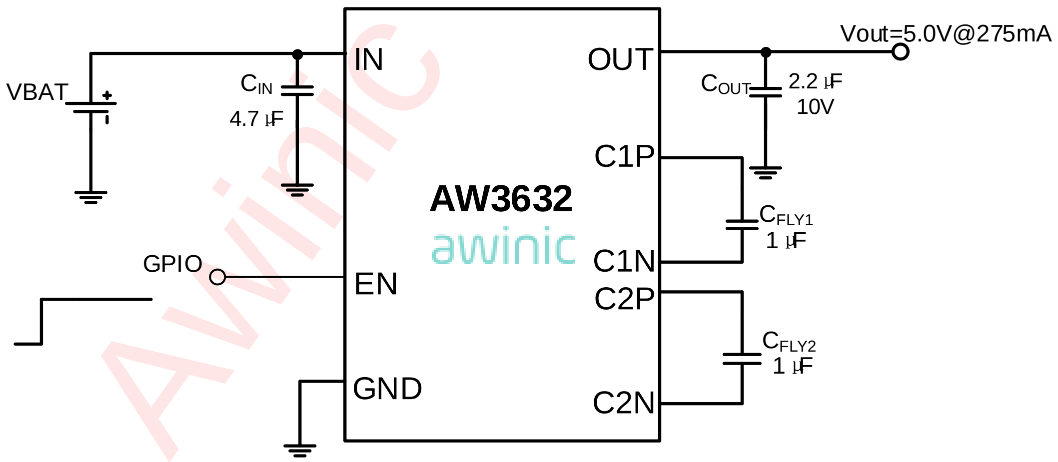

Figure 1 AW3632 Typical Application Circuit

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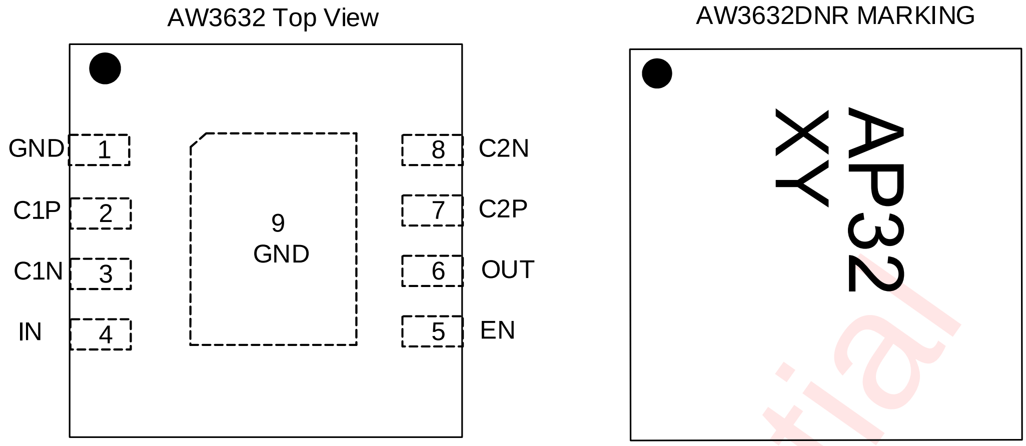
Pin Configuration And Top Mark



AP32-AW3632DNR
XY-Manufacture Tracing Code

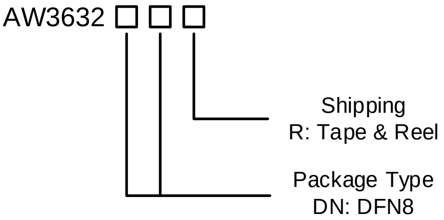
Figure 2 AW3632 Pin Configuration and Top Mark

Pin Definition

Pin No.	Pin Name	Description
1	GND	Ground.
2	C1P	Positive terminal of C_{FLY1}.
3	C1N	Negative terminal of C_{FLY1}.
4	IN	Power Supply, Connect directly to C_{IN}
5	EN	Enable and 1-wire pulse control pin, the operation status of chip can be selected via 1-wire pulse number.
6	OUT	Output terminal, Should be bypassed with a C_{OUT} capacitor
7	C2P	Positive terminal of C_{FLY2}.
8	C2N	Negative terminal of C_{FLY2}.
9	GND	Exposed pad

Ordering Information

Part Number	Temperature	Package	Marking	Moisture Sensitivity Level	Environmental Information	Delivery Form
AW3632DNR	-40℃～85℃	DFN-2mm*2mm-8L	AP32	MSL3	RoHS+HF	3000 units/ Tape and Reel



Typical Application Circuits

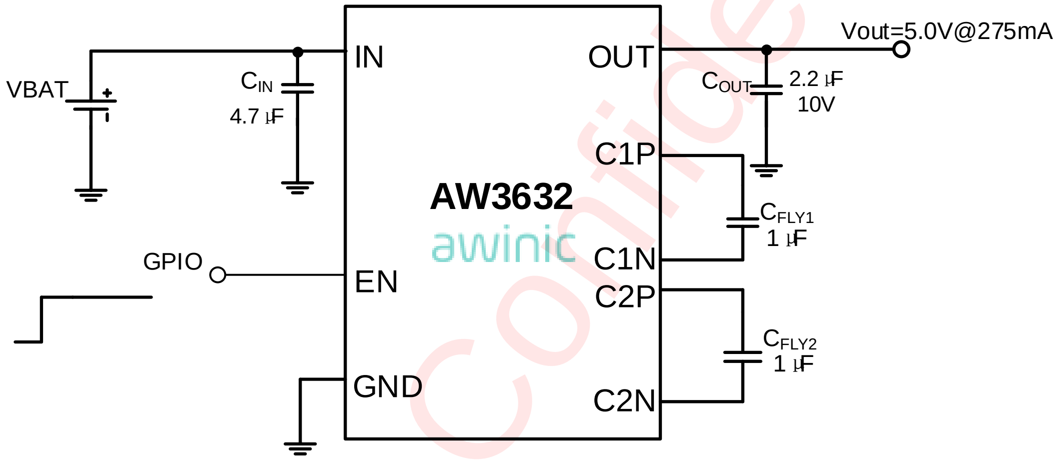


Figure 3 AW3632 Typical Application Circuit as OTG Driver

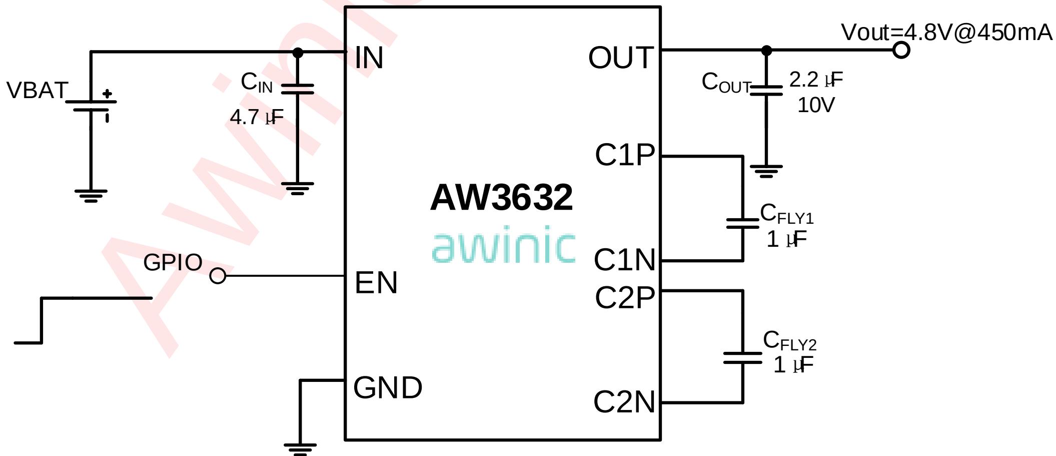


Figure 4 AW3632 Typical Application Circuit for Power Bank

Absolute Maximum Ratings(NOTE1)

PARAMETERS	Range
V_{IN}	-0.3V to 6V
INN, INP	-0.3V to V_{IN}+0.3V
Package Thermistor θJA	60℃/W
Ambient temperature	-40℃ to 85℃
Max Junction Temperature TJMAX	125℃
Storage Temperature TSTG	-65℃ to 150℃
Maximum lead temperature (soldering)	260℃
ESD(NOTE2)	
HBM	±2kV
Latch-up	
JEDEC STANDARD NO.78D NOVEMBER 2011	+IT：+450mA -IT：-450mA

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 test method per MIL-STD-883H Method 3015.8.

Electrical Characteristics

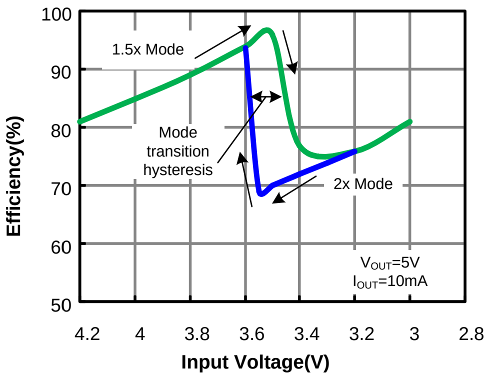
Recommended operating conditions, unless otherwise noted, circuit per Figure 1, C_{IN},C_{FLY1},C_{FLY2}=1μF，C_{OUT}=2.2μF，V_{IN}=2.8~5.5V, TA=-40℃~85℃. Typical values are given V_{IN}=3.8V and TA=25℃.

PARAMETER		TEST CONDITION	MIN	TYP	MAX	UNIT
V_{IN}	Supply Voltage		2.8		5.5	V
I_Q	Quiescent Current	V_{IN}=3.6V，1.5X normal mode		1.6		mA
		V_{IN}=3.0V，2X normal mode		2.0		mA
I_{SD}	Shut down current	V_{IN}=3.6V，EN=0V		0.1		μA
R_{EN}	Inside pull-down resistor			300		kΩ
T_{OTP}	Over heat protection temperature			155		℃
T_{HYS}	Over heat protection hysteresis			20		℃
Charge Pump						
V_{OUT}	Output Voltage	V_{IN}=2.8V to 5.5V，I_{OUT}=1mA	4.75	5.00	5.3	V
I_{LOAD_MAX}	Max current output	Continuous load mode，V_{IN}=3.3V to 4.2V	275			mA
V_{RIPPLE}	Output ripple	I_{OUT}≤275mA,C_{OUT}=2.2μF, ESR=20mΩ		100		mV
$V_{OUT,Hmax}$	Max output voltage (Shut down mode)	V_{IN}=3.8V,EN=0, V_{OUT} with high voltage		10		V
F_{OSC}	Oscillator Frequency	1.5X mode，V_{IN}=3.8V		800		kHz
		2X mode，V_{IN}=3.2V		700		kHz
T_{ON}	V_{OUT} Turn-on Time	From EN rising edge to V_{OUT} reach target value		500		μs
I_{SHORT}	Current limit while V_{OUT} short to ground			300		mA
R_{ON}	Open loop output impedance	1.5X mode，V_{IN}=3.8V		3.3		Ohm
		2X mode，V_{IN}=3.6V		4.0		Ohm
V_{TRANS}	Mode switching voltage	I_{LOAD}=100mA，From 1.5X to 2X		3.45		V
		I_{LOAD}=100mA，From 2X to 1.5X		3.7		V
Enable Pin						
V_{IH}	EN FLASH Logic High		1.4		V_{IN}	V
V_{IL}	EN FLASH Logic Low		0		0.4	V
T_H	High level width of EN	V_{IN}=2.8V to 5.5V	0.75	2	10	μs
T_L	Low level width of EN	V_{IN}=2.8V to 5.5V	0.75	2	10	μs
T_{OFF}	Shut down delay	V_{IN}=2.8V to 5.5V	500			μs

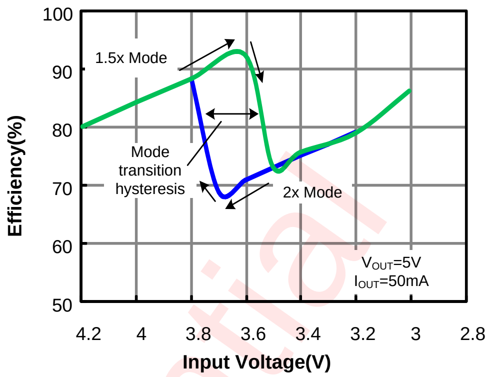
Typical Characteristics

Unless otherwise specified; V_{IN}=3.8V, V_{OUT}=5V, TA=25℃, circuit and components according to Figure1.

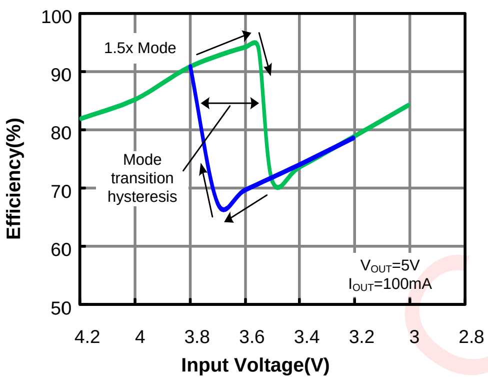
Efficiency vs Input Voltage



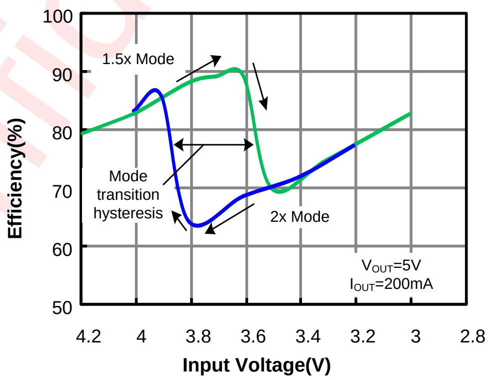
Efficiency vs Input Voltage



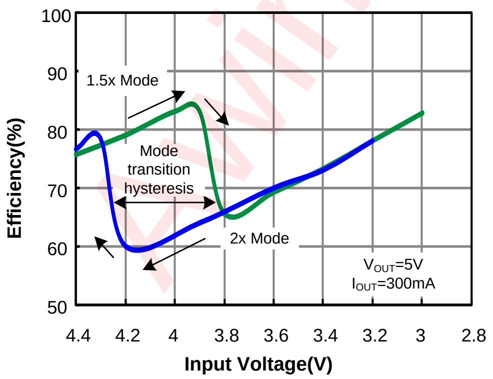
Efficiency vs Input Voltage



Efficiency vs Input Voltage

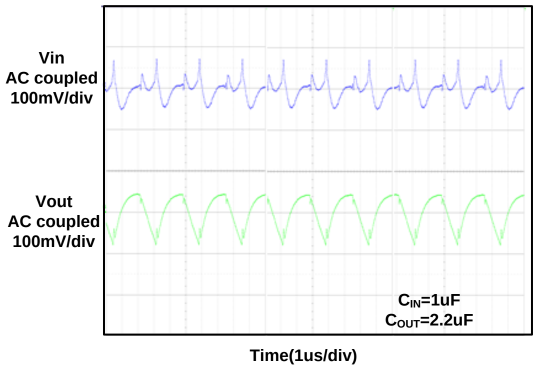


Efficiency vs Input Voltage



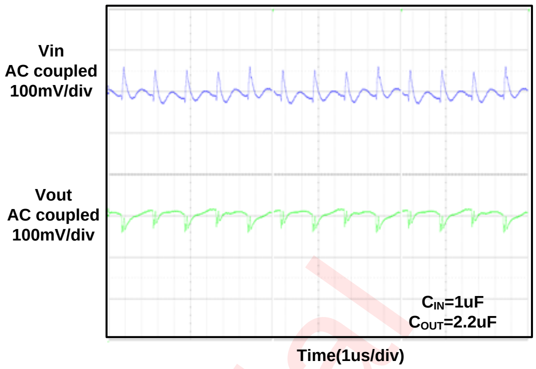
Output ripple

V_{IN}=4.2V, V_{OUT}=5V, I_{OUT}=300mA, 1.5X Mode



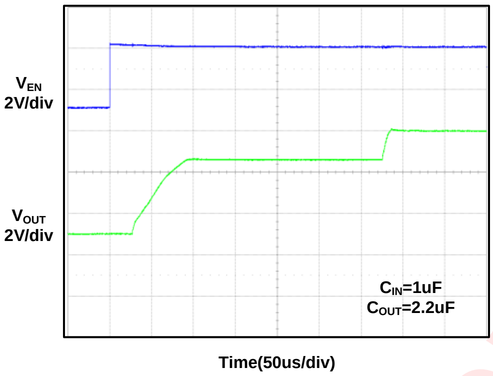
Output ripple

V_{IN}=4.2V, V_{OUT}=5V, I_{OUT}=400mA, 2X Mode



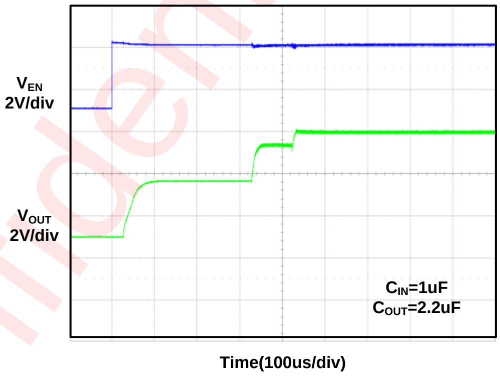
Startup - 0 mA

V_{IN}=3.6V, No Load,



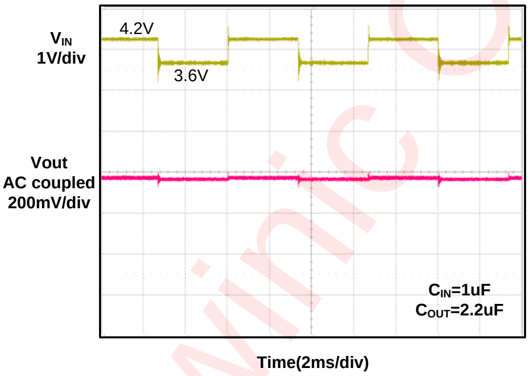
Startup - 400mA

V_{IN}=3.6V, I_{OUT}=400mA



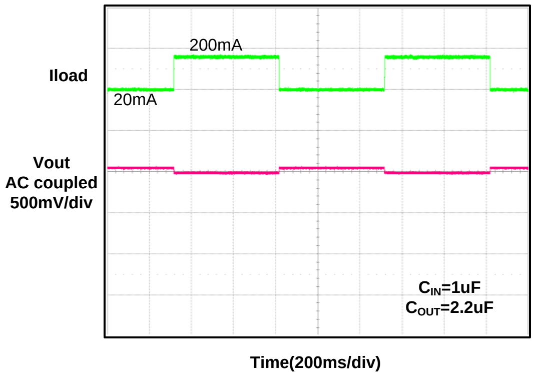
Line regulation

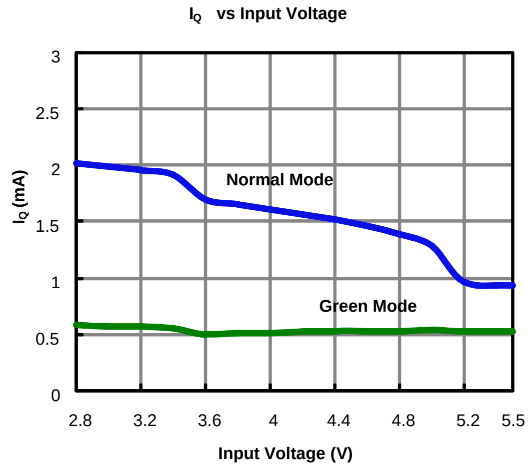
I_{OUT}=200mA

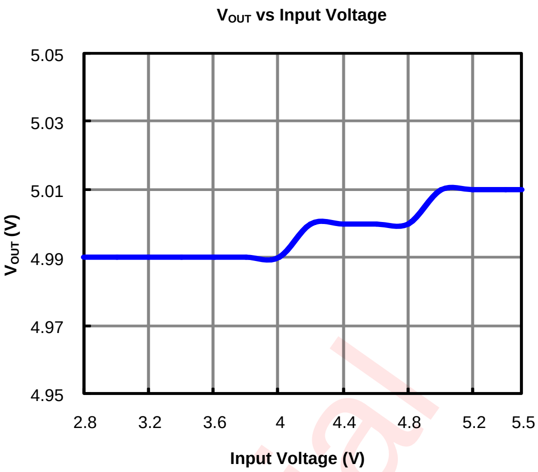


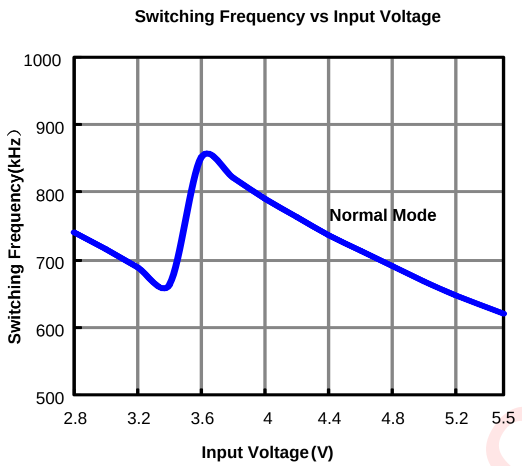
Load regulation

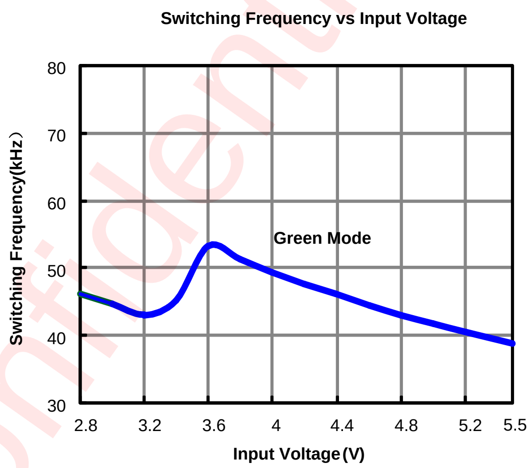
V_{IN}=3.8V

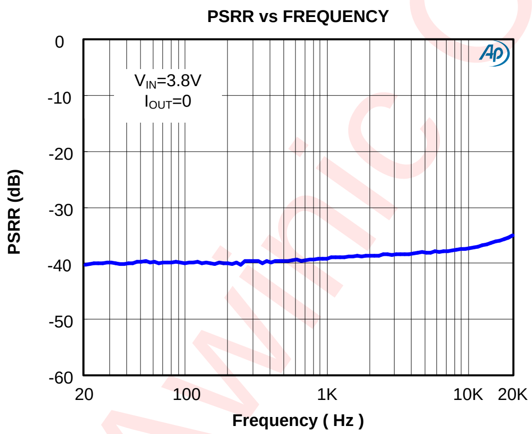


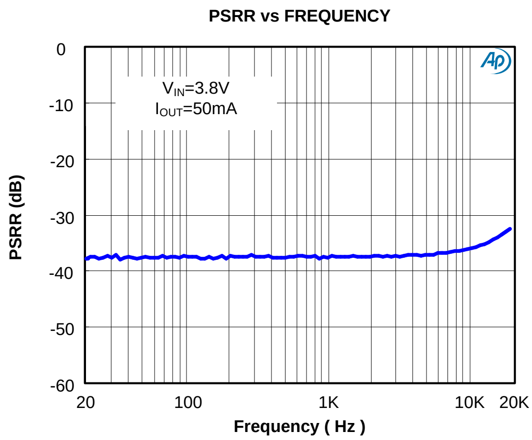

I_Q vs Input Voltage
I_Q (mA)
Normal Mode
Green Mode
3
2.5
2
1.5
1
0.5
0
2.8
3.2
3.6
4
4.4
4.8
5.2
5.5
Input Voltage (V)


V_{OUT} vs Input Voltage
V_{OUT} (V)
5.05
5.03
5.01
4.99
4.97
4.95
2.8
3.2
3.6
4
4.4
4.8
5.2
5.5
Input Voltage (V)


Switching Frequency vs Input Voltage
Switching Frequency(kHz)
Normal Mode
1000
900
800
700
600
500
2.8
3.2
3.6
4
4.4
4.8
5.2
5.5
Input Voltage(V)


Switching Frequency vs Input Voltage
Switching Frequency(kHz)
Green Mode
80
70
60
50
40
30
2.8
3.2
3.6
4
4.4
4.8
5.2
5.5
Input Voltage(V)


PSRR vs FREQUENCY
PSRR (dB)
V_{IN}=3.8V
I_{OUT}=0
0
-10
-20
-30
-40
-50
-60
20
100
1K
10K
20K
Frequency (Hz)


PSRR vs FREQUENCY
PSRR (dB)
V_{IN}=3.8V
I_{OUT}=50mA
0
-10
-20
-30
-40
-50
-60
20
100
1K
10K
20K
Frequency (Hz)

Detailed Functional Description

AW3632 is a low static current, high efficiency, low ripple 1.5X / 2X charge pump power chip. In the Li+ battery voltage range, provides a constant 5V power output, and can provide a maximum of 275mA driving capacity, very suitable for use as OTG driver and flash driver chip.

AW3632 uses EN pin to select working conditions. AW3632 provides two different working conditions: normal and environmentally mode. Under normal condition, the working frequency of charge pump is relatively high, and the driving capacity can reach above 275mA.In the environmental protection state, the working frequency is reduced to cut down the standby power consumption of the system.

AW3632 built-in Q_ModeTM technology enables adaptive switching between 1.5X and 2X fold charge pump modes, requiring only C_{IN}, C_{OUT}, C_{FLY1}, and C_{FLY2} capacitors with small capacitance values. The chip has built-in functions of short circuit protection, overheating protection, current limiting protection and anti-reverse irrigation, which can shut off the chip under abnormal working conditions and effectively protect the chip from damage. When the abnormal conditions are eliminated, AW3632 will automatically resume working.

Functional Block Diagram

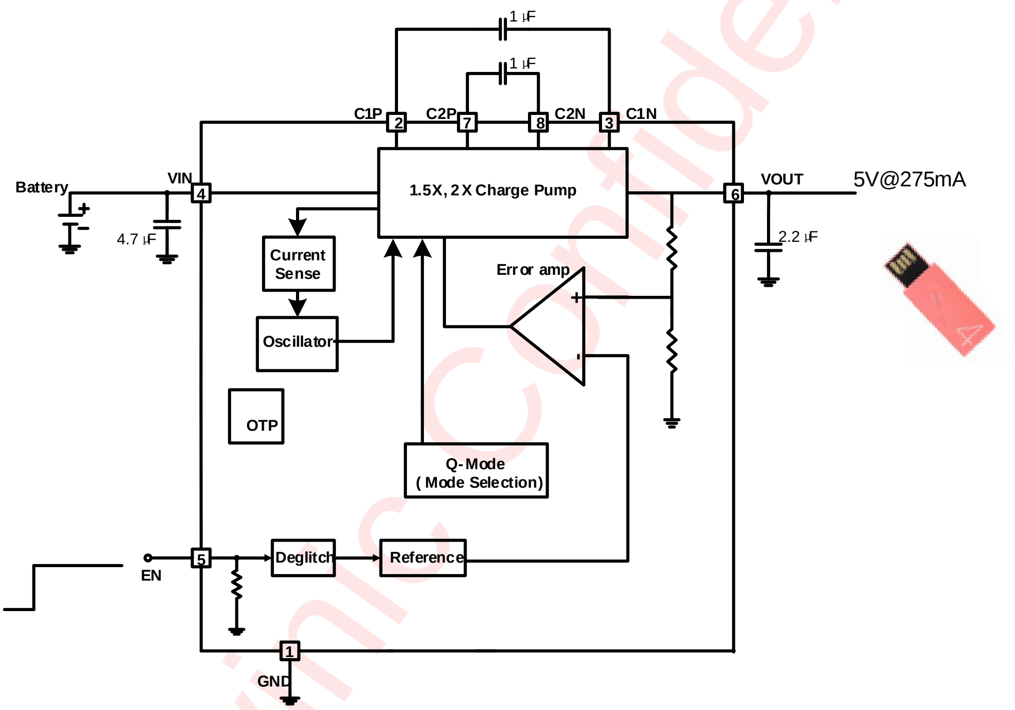


Figure 5 Functional Block Diagram

Anti-Interference 1-Wire Control Openration

AW3632 selects the working state through the EN pin. The timing of selection is as shown in Figure 4: AW3632 provides two different working states: normal, green. The recommended range of THI and TLO is between 2μs~10μs, the working state is the cycle mode. When power is turned on, the EN pin sends a pulse, then it will enter the first working state: Normal state. In normal state, EN sends another pulse and enters the second state: Green state. In the green state, EN sends two pulses and returns to the first working state. If you need to turn off the chip, you need to send a low level that is at least longer than TOFF. The V_{OUT} pin has an internal 5kΩ pull-down resistance.

In the normal state, the charge pump has a higher operating frequency, the drive capacity is over 275mA. In the green state, the operating frequency is lower than normal state, the frequency is about 50 kHz, the quiescent current consume is only 0.6mA. When USB device hangs, or the system is in standby state, it can enter the green state to reduce the standby current of system and extend the battery life. The maximum drive current of green state is about 15mA. The third pulses of the EN pin enter the reserved state, which is used for chip testing. Do not enter the reserved state by the user.

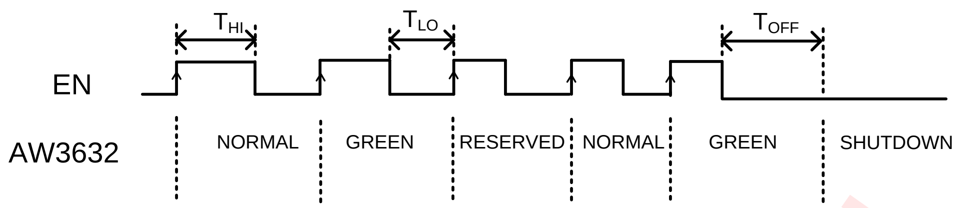


Figure 6 1-Wire Pulse Control Diagram

Glitch Elimination

AW3632 has an internal Deglitch circuit. In portable applications such as mobile phones and digital cameras, interference between various signal lines on the PCB is inevitable. AW3632 has an internal Deglitch circuit for the specificity of the EN pin, which eliminates the high level glitch of the EN pin of less than 16ns, which avoids wrong triggering of the 1-wire pulse count dimming due to external circuit interference.

Q-Mode Technology

The charge pump of AW3632 has two modes: 1.5 times and 2 times. Working mode is automatically selected according to input voltage V_{IN} and output load current. When V_{IN} is higher, the charge pump works in 1.5 times mode, and the power current is about 1.5 times of the load current.

When V_{IN} drops to Vin_down, the insufficient driving capacity of the charge pump will make V_{OUT} drop. In order to keep V_{OUT}, the voltage charge pump will automatically jump to the 2 times mode. After entering 2 times mode, the power supply current is about twice of the load current. At this point, if V_{IN} rises to Vin_up, the charge pump will return to 1.5 times mode after a period of waiting. In order to prevent mode switching back and forth, there is a hysteresis voltage V_{HYS} between Vin_up and Vin_down, and the voltage of V_{HYS} is generally between 0.2V and 0.3V.

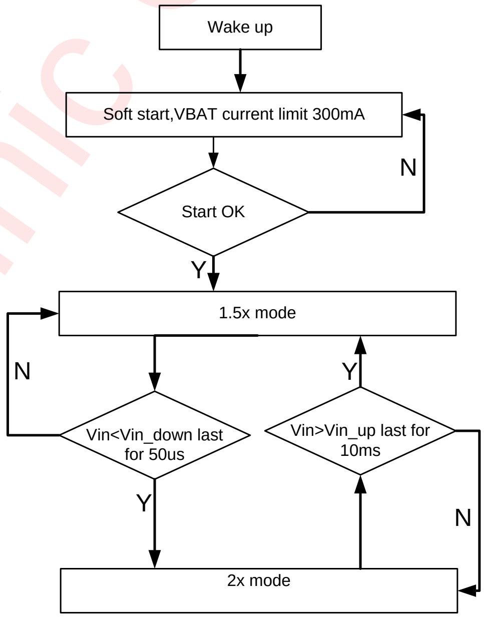


Figure 7 Q_Mode Control Diagram

Application Information

Capacitors Selection

For the best performance, the choice of peripheral devices is very important. AW3632 requires four capacitors to operate. The input voltage V_{IN} and the output voltage V_{OUT} each require a bypass capacitor to ground. The recommended capacitance values of these two capacitors are 4.7μF and 2.2μF, respectively. There are also two charge pump boost capacitors. The recommended capacitor value is 1μF. Considering performance and taking into account space-constrained applications such as cell phones, it is recommended to use X5R and X7R ceramic capacitors with a package size of 0402 or 0603. Tantalum capacitors cannot filter high-frequency ripple. They are not recommended as decoupling capacitors for input voltage V_{IN}. If a tantalum capacitor is used at the V_{IN} terminal, an in parallel 0.1μF~1μF ceramic capacitor is required.

Input Capacitor

The capacitance on the V_{IN} power supply can filter out the interference on the power supply, and the size of the capacitance will also affect the input ripple. There are parasitic inductors, resistors and capacitors on the PCB wiring, and when the switching current flows through the inductors, a voltage drop is formed. If the power supply to the chip is not synchronized with the ground potential change, the internal logic circuit may be flipped by mistake, making the chip function wrong. Therefore, C_{IN} must be placed as close as possible to the chip, and it is advisable that the parasitic inductance from C_{IN} to the pin of the chip should not exceed 10nH.

Output Capacitor C_{OUT}

The capacitance on V_{OUT} affects the output drive capability, system stability, and ripple size on the output V_{OUT}. If the C_{OUT} is too small, it may cause instability of the system. If the C_{OUT} is too large, the current required to charge the C_{OUT} when the chip is enabled will be larger, and the current required by the power supply will be larger. When the chip is turned off, the discharge time on the V_{OUT} will be longer. When the C_{OUT} = 2.2μF, ESR = 20mΩ, I_{LOAD} = 275 mA, in all kinds of work mode the output ripple is not more than 100mVpp. The larger ESR of the capacitance, the larger output ripple, and 2.2μF capacitance is recommended for V_{OUT} to reduce output ripple and load adjustment.

Flying Capacitor

The size of the two Flying capacitors affects the charge pump's load regulation and output drive capability. The larger the Flying capacitance, the stronger the load regulation and the stronger the drive capability. Two 1μF Flying capacitors are recommended for 275mA load.

Capacitance can be affected by package size and dc bias voltage. The larger the package size is, the higher the rated withstand voltage and the smaller the capacitance loss will be. Therefore, the capacitance withstand voltage needs to leave a certain margin relative to the working voltage. When working, the voltage of V_{IN} decoupling capacitor and Flying capacitor generally does not exceed the battery voltage of 4.2V. Capacitors with a voltage of 6.3V from 1μF to 2.2μF can be selected. The normal voltage on the V_{OUT} is around 5.0V, in order to prevent the USB plug when the surge voltage on the power supply is too high breakdown device, recommended to choose a 2.2μF capacitor within 10V withstand voltage, or in the V_{OUT} end with zener diode to do voltage embedding. Table 1 shows the recommended capacitor types and typical values.

Recommended Components List

Type	Capacitor	Rating Voltage	Manufacturer	Size	Website
C0402X5R105M6R3NT	1μF	6.3V	EYANG	0402	WWW.SZEYANG.COM
C0402X5R225M6R3NT	2.2μF	6.3V		0402	
C0603X5R225M100NT	2.2μF	10V		0603	
GRM155R60J105ME	1μF	6.3V	Murata	0402	WWW.MURATA.COM
GRM155R60J225ME	2.2μF	6.3V		0402	
GRM155R61A225ME	2.2μF	10V		0402	

PCB Layout Considerations

The AW3632 is a charge-pumped DC/DC converter. In order to full performance of the AW3632, PCB layout must be carefully considered. AW3632 PCB layout shall strictly comply with the following rule:

1. All peripheral devices should be as close as possible to the chip. C_{IN}, C_{OUT}, C_{FLY1} and C_{FLY2} are close to the corresponding V_{IN}, V_{OUT}, C1P, C1N, C2P and C2N pins. The device solder pad and chip pins should be directly connected with the same layer of copper wire, avoiding two layers of copper connection through the hole.
2. The power line connected to V_{IN} pin should be as wide as possible to reduce the influence of parasitic inductance and parasitic resistance. The power line from the battery to the V_{IN} pin of the chip should be carefully layout and shielded between with other line.
3. Input capacitor C_{IN}, output capacitor C_{OUT} and boost capacitor, C_{FLY1} and C_{FLY2} should be as close to the chip as possible, and the connection between capacitor solder pad and chip's corresponding pin should be as wide and short as possible to reduce noise and EMI interference.
4. C_{FLY1} and C_{FLY2} have strong switching signals when working, and should be far away from FM, RF PA and other modules to avoid interference on high-frequency devices.
5. In order to obtain better heat dissipation performance and noise performance, the chip's heat sink, GND pin and PGND pin must be directly connected to a large area of PCB's GND layer, and at the same time, the GND layer below the heat sink is connected to the intermediate GND layer of PCB through a hole.

Demo Information

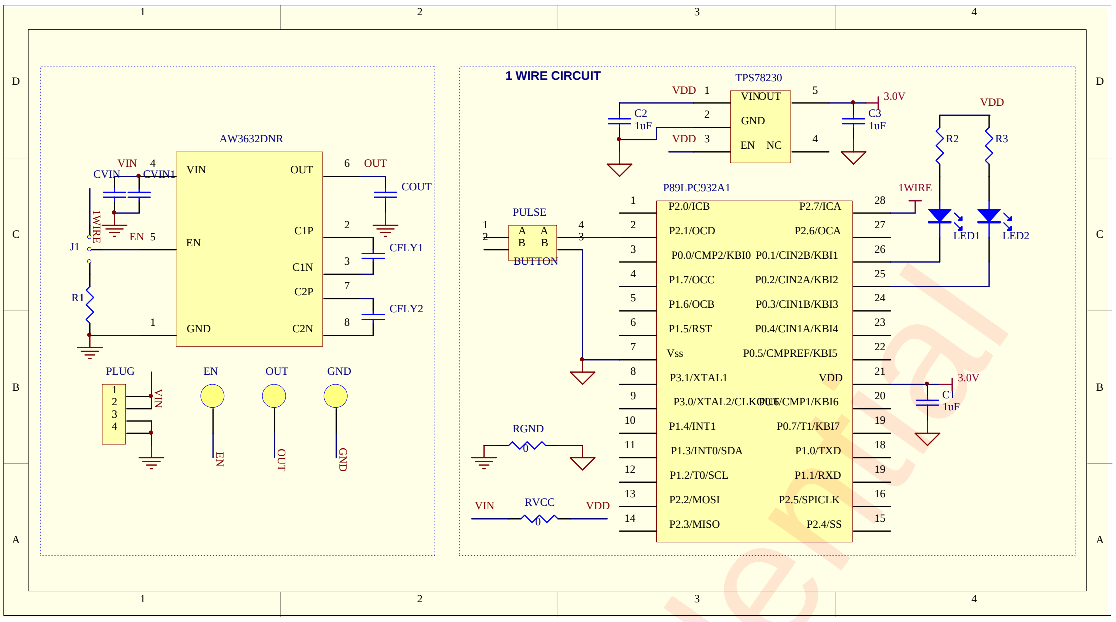


Figure 8 AW3632 Demo Schematic

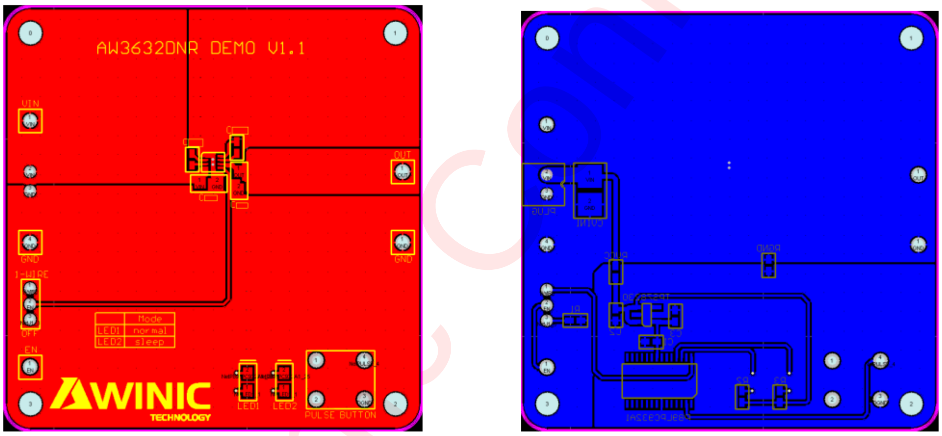
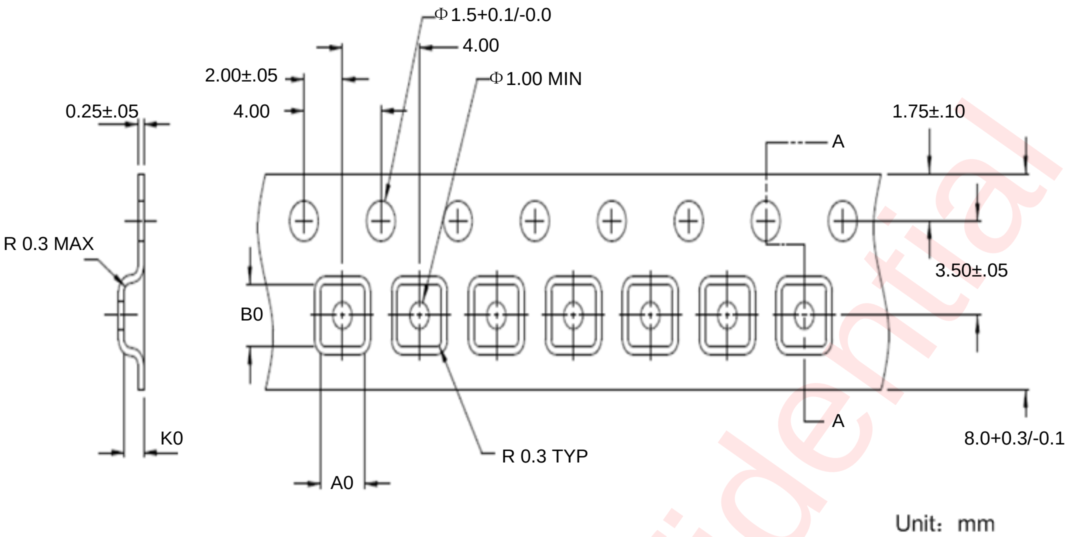


Figure 9 AW3632 Demo PCB Layout

Tape And Reel Information

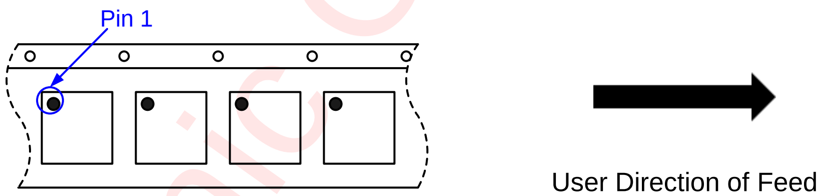
Carrier Tape



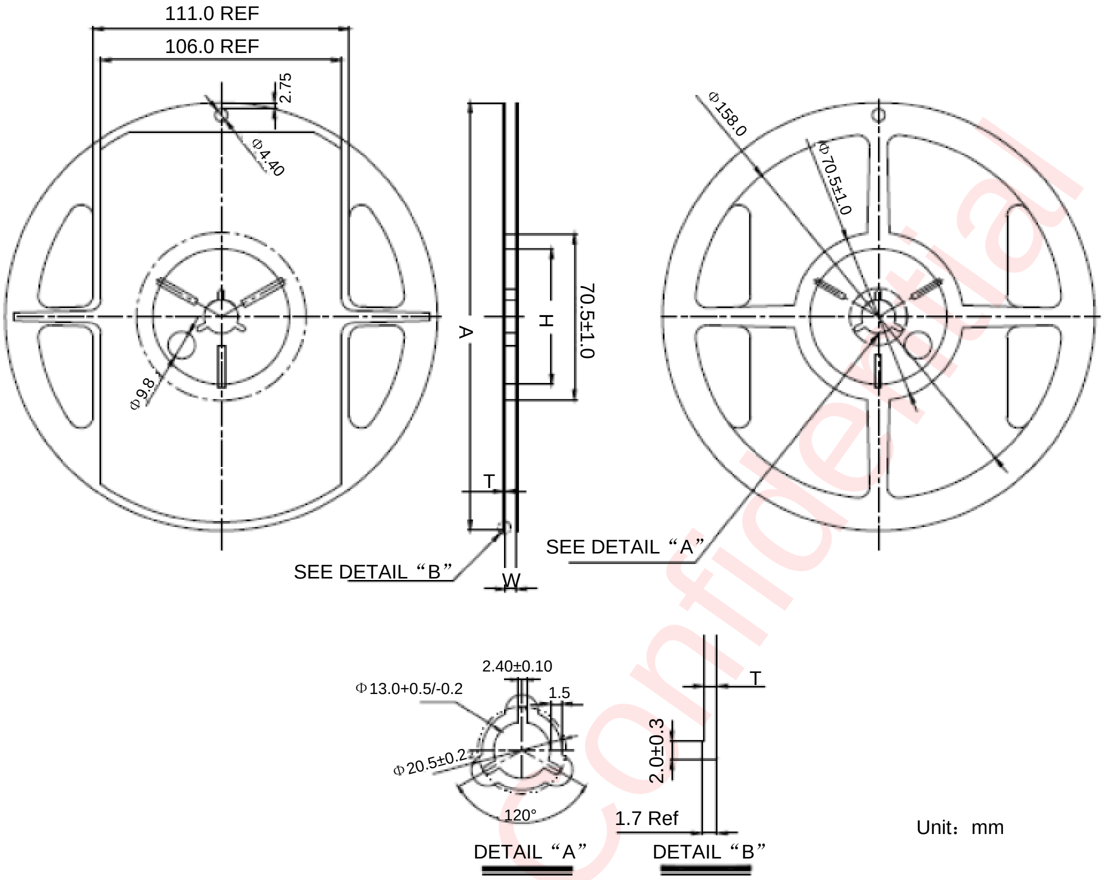
A0=2.3mm
B0=2.3mm
K0=1.0mm

NOTE: All dimensions are in millimeter (mm).

Pin 1 Direction



Reel



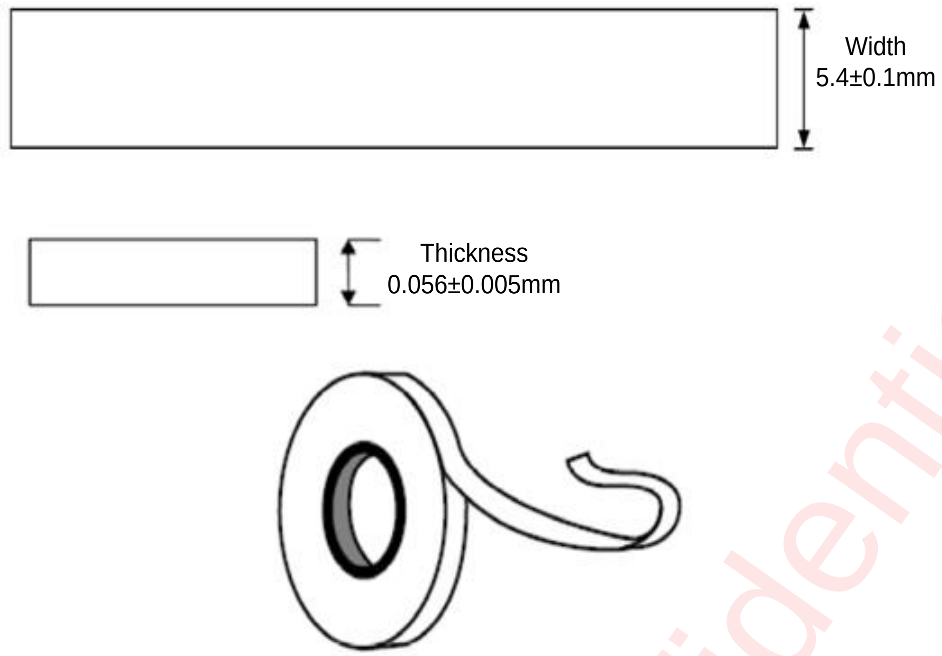
P/N	A±1.0	H±1.0	T±0.3	W±0.5
RD27608(-BK,-BL)	Φ178.0	Φ60.0	1.40	9.0
RS27608(-BK,-BL)	Φ178.0	Φ60.0	1.40	9.0
RD27612(-BK,-BL)	Φ178.0	Φ60.0	1.40	13.2
RS27612(-BK,-BL)	Φ178.0	Φ60.0	1.40	13.2

Notes:

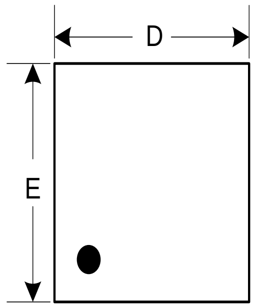
1. RD stands for Reel Dipped;
2. RS stands for Reel Standard;
3. BK stands for black Reel;
4. BL stands for blue Reel;

NOTE: All dimensions are in millimeter (mm).

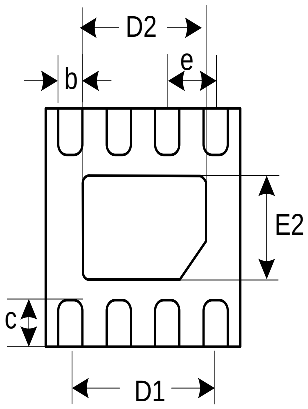
Cover Tape



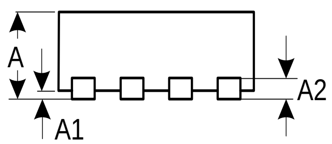
Package Description



Top View



Bottom View

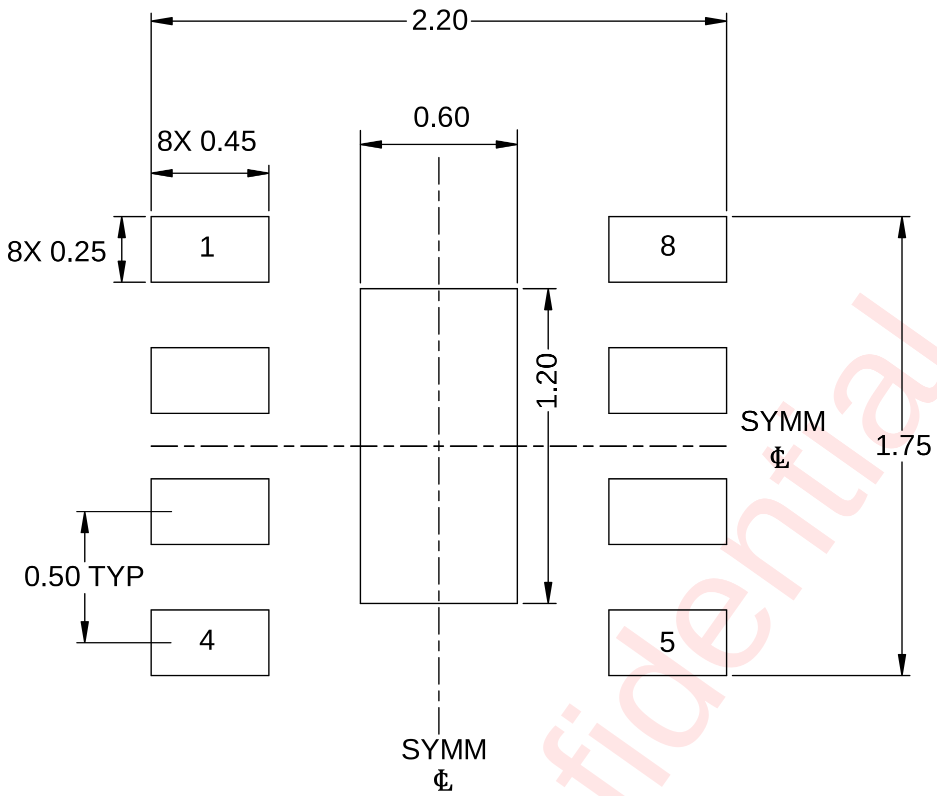


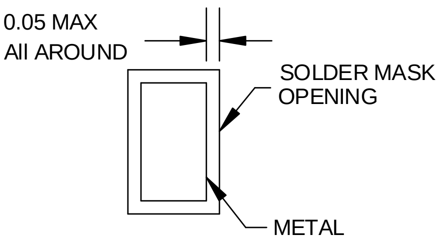
Side View

Unit:mm	DFN-8L		
Symbol	Min	Typ	Max
A	0.700	0.850	0.900
A1	0.000		0.050
A2	0.203(Ref.)		
b	0.200	0.250	0.300
c	0.300	0.350	0.400
D	1.950	2.000	2.050
D2	1.150	1.200	1.250
D1	1.500 (Ref.)		
e	0.500 (BSC)		
E	1.950	2.000	2.050
E2	0.550	0.600	0.650

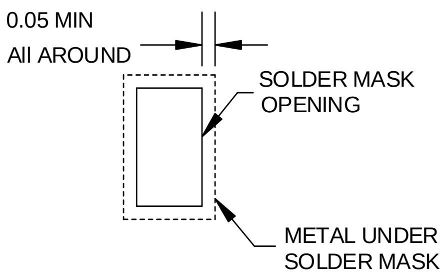
NOTE: All dimensions are in millimeter (mm).

Land Pattern Data





NON-SOLDER MASK DEFINED



SOLDER MASK DEFINED

Unit：mm

Reflow

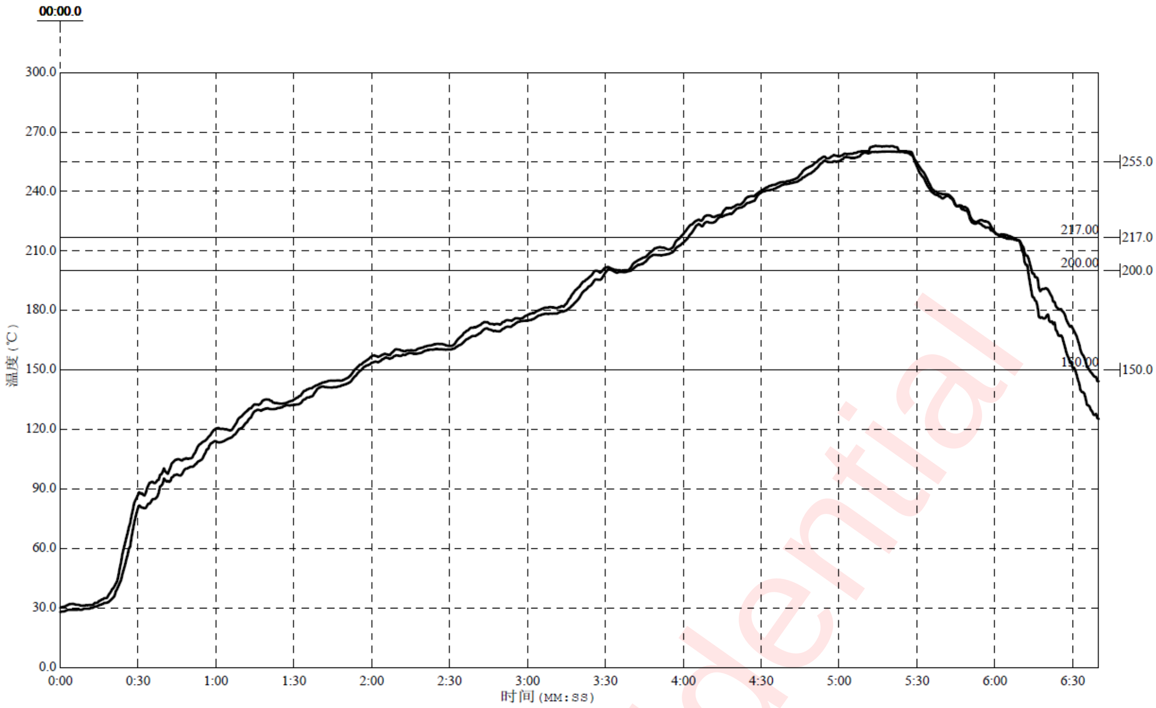


Figure 10 Package Reflow Oven Thermal Profile

Table 1 Reflow Data

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	250℃-260℃
Time within 5℃ of actμAl peak temp	20-40sec.
Ramp-down rate	Max. 6℃/sec
Time from 25℃ to peak temp	Max. 8min.

Revision History

Version	Date	Change Record
V1.0	May 2019	English Version Draft created
V1.1	Jan 2021	1. Add Land pattern data 2. Refresh the document version

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