WS4612

60mΩ, Current Limited, Power Distribution Switch

Http//:www.sh-willsemi.com

Descriptions

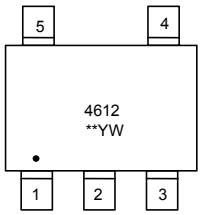
The WS4612 is a high-side switch with ultra-low ON resistance P-MOSFET. Integrated current-limit function can limit inrush current for heave capacitive load, over load current, and short-circuit current to protect power source.

The WS4612 is also integrated reverse protection function to eliminate any reverse current flow across the switch when the device is off. Output auto-discharge while the device shutdown made output voltage off quickly. Thermal shutdown function can protect the device and load.

The WS4612 is available in SOT-23-5L,SOT23-6, TSOT23-5(FC) packages. Standard product is Pb-free and Halogen-free.

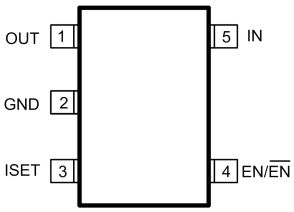


SOT-23-5L

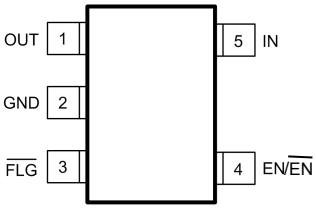


Marking

WS4612EA



WS4612E(B/C/D/E)



Pin configuration (Top view)

For detail marking information, please see page 14.

Order Information

For detail order information, please see page 14.

Features

- Input voltage range : 2.5-5.5V
- Main switch R_{ON} : 60mΩ@VIN=5.0V
- Current limit accurate : ±15%
- Adj. current limit range : 0.1A-2.0A(Typ.)
- Typical Rise Time : 600uS
- Quiescent Supply Current : 26uA
- Under Voltage Lockout
- Auto discharge
- Reverse block (No “body diode”)
- Over temperature protection

Applications

- USB peripherals
- USB Dongle
- USB 3G data card
- 3.3V or 5V Power Switch
- 3.3V or 5V Power Distribution

Ordering Information

WS4612□□□-- 5 /TR

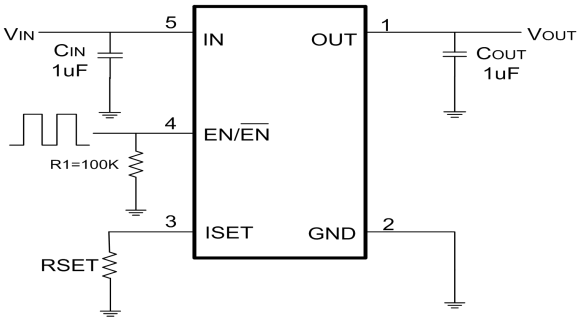
→ EN Function & Discharge
- A : EN high enable & Discharge
- B : EN low enable & Discharge
- C : EN high enable & no Discharge
- D : EN low enable & no Discharge

→ Output Current Limit
- A : Adjustable version
- B : 1.4A
- C : 2.1A
- D : 2.4A
- E : 3A

→ Package Code
- E : SOT23-5

Typical Applications

WS4612EA

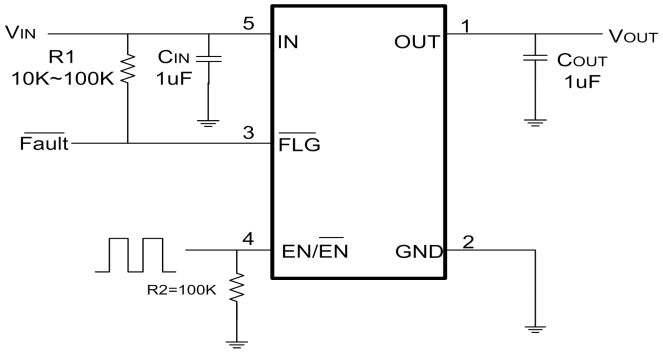


Note： a 100k ohm resistor is strongly recommended between enable pin and GND.

Pin Descriptions

	WS4612EA	
Pin Number	**Symbol**	**Descriptions**
1	OUT	Output Pin
2	GND	Ground
3	ISET	Current limit setting
4	EN/$\overline{EN}$	Enable Pin
5	IN	Input Pin

WS4612E(B/C/D/E)

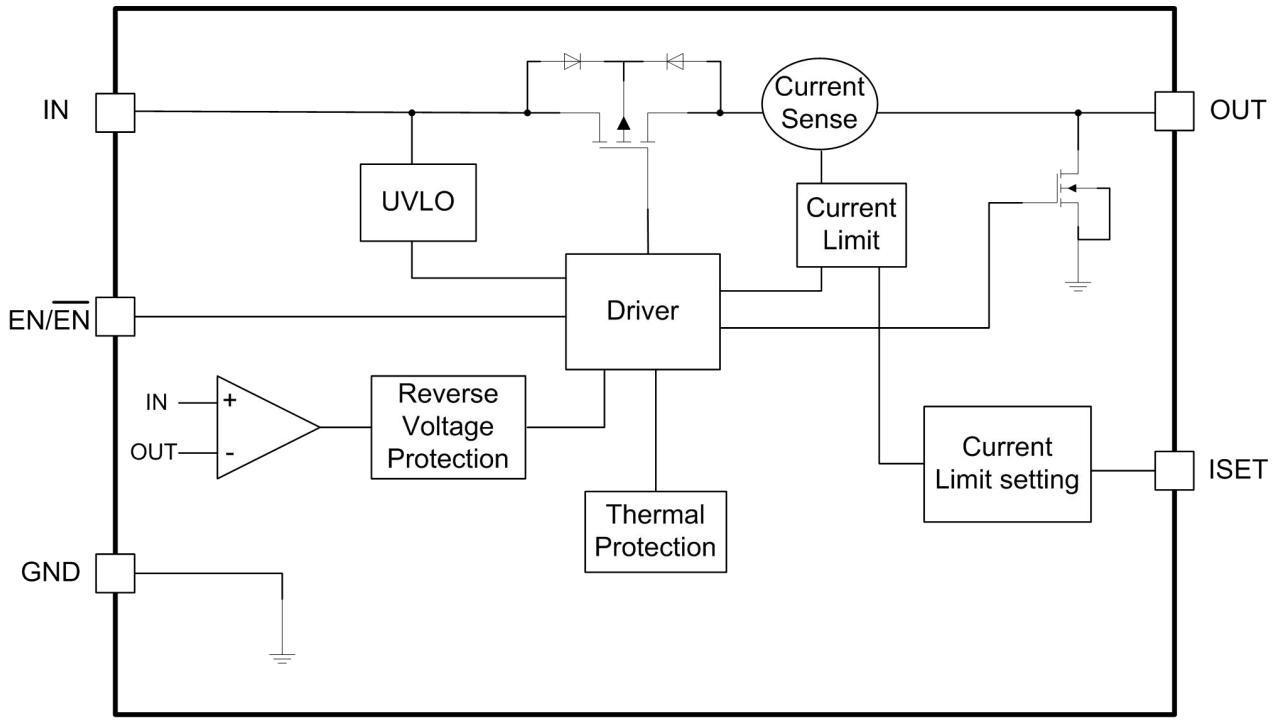


Note： a 100k ohm resistor is strongly recommended between enable pin and GND.

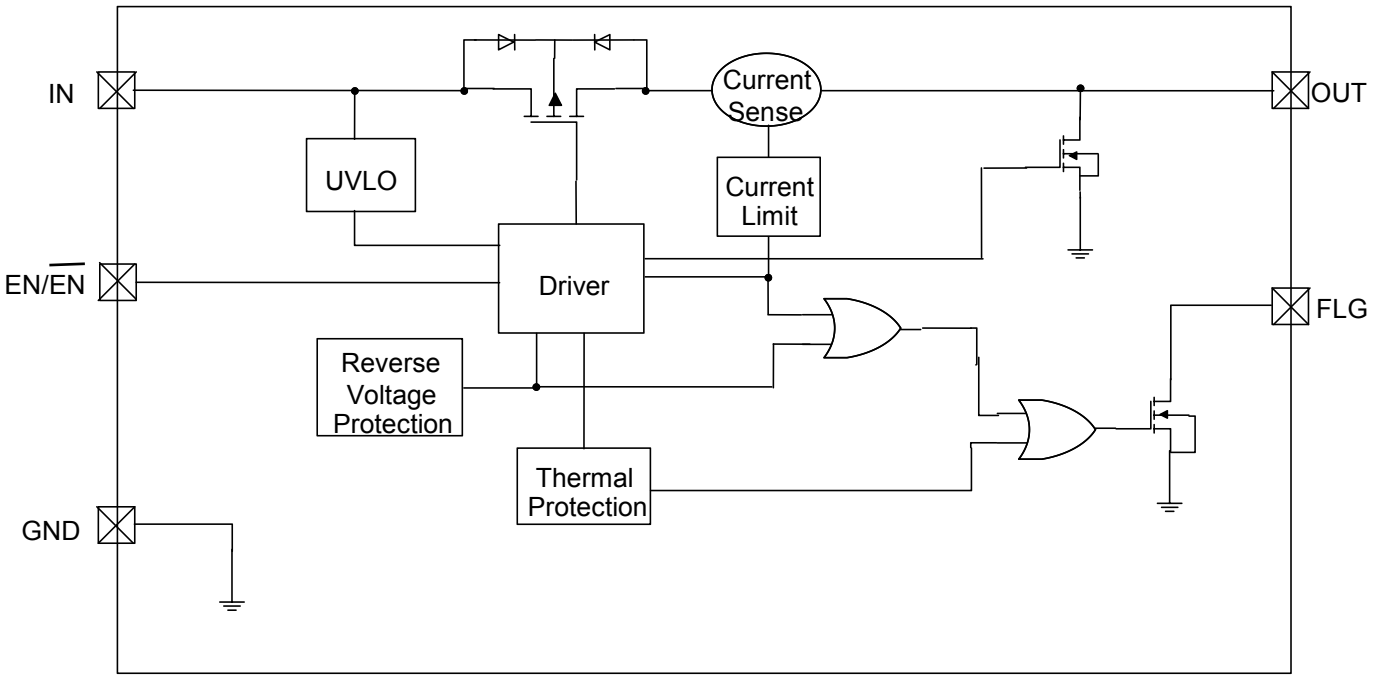
Pin Descriptions

	WS4612E(B/C/D/E)	
Pin Number	**Symbol**	**Descriptions**
1	OUT	Output Pin
2	GND	Ground
3	FLG	Fault Flag Pin, Open-Drain, Active Low
4	EN/$\overline{EN}$	Enable Pin
5	IN	Input Pin

Block Diagram(WS4612EA)



Block Diagram(WS4612E(B/C/D/E))



Absolute maximum ratings

Parameter	Symbol	Value	Unit
IN pin voltage range	V_{IN}	-0.3~6.5	V
OUT pin voltage range	V_{OUT}	-0.3~6.5	V
ISET pin voltage range	V_{ISET}	-0.3~6.5	V
FLG pin voltage range	V_{FLG}	-0.3~6.5	V
EN pin voltage range	V_{EN}	-0.3~6.5	V
Junction temperature	T_J	-40~150	°C
Lead temperature(Soldering, 10s)	T_L	260	°C
Storage temperature	Tstg	-55~150	°C
IN, OUT Pin ESD Ratings	HBM	8000	V
	MM	500	V
ISET, FLG, EN Pin ESD Ratings	HBM	7000	V
	MM	300	V

These are stress ratings only. Stresses exceeding the range specified under “Absolute Maximum Ratings” may cause substantial damage to the device. Functional operation of this device at other conditions beyond those listed in the specification is not implied and prolonged exposure to extreme conditions may affect device reliability.

Recommend Operating Conditions

Parameter	Symbol	Value	Unit
Supply input voltage range	V_{IN}	2.5~5.5	V
Operating ambient temperature	T_A	-40~85	°C
Thermal Resistance	$R_{\theta JA}$	250	°C/W

Electronics Characteristics(WS4612EA)

Ta=25°C, V_{IN}=5V, C_{IN}=C_{OUT}=1uF, unless otherwise noted

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Units
Quiescent supply current	I_Q	I_{OUT}=0, V_{IN}=V_{EN}=5V		26	50	uA
Shutdown current	I_{SD}	V_{EN}=0V			1.0	uA
Reverse current	I_{REV}	V_{IN}=V_{EN}=0V, V_{OUT}=5V, Current flow to V_{IN}			1.0	uA
Main-FET ON resistance	R_{ON}	V_{IN}=V_{EN}=5V, I_{OUT}=500mA		60	70	mΩ
Auto-discharge FET ON resistance	R_{DCHG}	V_{EN}=0V, V_{IN} =V_{OUT}=5V		50	100	Ω
Current Limit(1)	I_{LIM}	RSET=6.8K	0.9	1.0	1.1	A
Short-circuit output current	I_{OS}	OUT shorted to GND,Rset=6.8K		0.65		A
Short circuit current limiting response time	t_{SHORT}	OUT connected to GND，C_L=1uF		1.0		us
EN input low voltage	V_{IL}	VIN=5V			0.4	V
EN input high voltage	V_{IH}	VIN=5V	1.2			V
OUT pin turn-on time after EN ON	t_{ON}	C_L=1uF, R_L=5ohm		600		us
Fault flag output blanking time	t_{BLANK}	VIN=5.0V		7.5		ms
Over-temperature shutdown threshold	T_{SD}			160		°C
Over-temperature threshold hysteresis	T_{HYS}			20		°C
Under voltage lock out threshold	V_{UVLO}			2.1	2.4	V
Under voltage lock out hysteresis	$V_{UVLO-HYS}$			200		mV

(1) Pulse test,T_p=380uS。

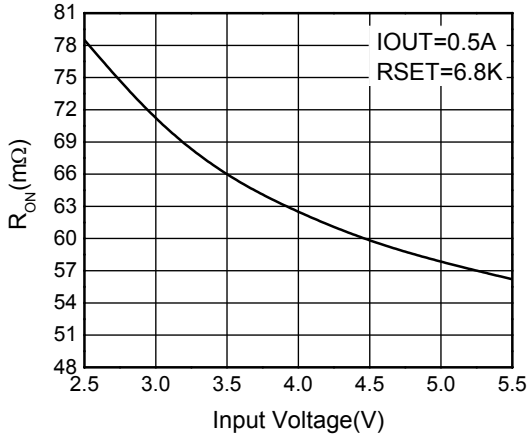
Electronics Characteristics(WS4612E)

Ta=25°C, V_{IN}=5V, C_{IN}=C_{OUT}=1uF, unless otherwise noted

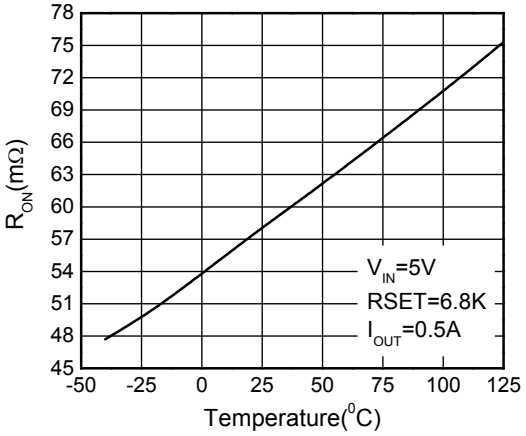
Parameter	Symbol	Conditions	Min.	Typ.	Max.	Units
Quiescent supply current	I_Q	I_{OUT}=0, V_{IN}=V_{EN}=5V		26	50	uA
Shutdown current	I_{SD}	V_{EN}=0V			1.0	uA
Reverse current	I_{REV}	V_{IN}=V_{EN}=0V, V_{OUT}=5V, Current flow to V_{IN}			1.0	uA
Main-FET ON resistance	R_{ON}	V_{IN}=V_{EN}=5V, I_{OUT}=500mA		60	70	mΩ
Current Limit(1)	I_{LIM}	WS4612EB	1.2	1.4	1.6	A
		WS4612EC	1.8	2.1	2.4	A
		WS4612ED	2.1	2.4	2.7	A
		WS4612EE	2.7	3	3.3	A
Auto-discharge FET ON resistance	R_{DCHG}	V_{EN}=0V, V_{IN} =V_{OUT}=5V		50	100	Ω
Short circuit current limiting response time	t_{SHORT}	OUT connected to GND，C_L=1uF		1.0		us
EN input low voltage	V_{IL}	VIN=5V			0.4	V
EN input high voltage	V_{IH}	VIN=5V	1.2			V
OUT pin turn-on time after EN ON	t_{ON}	VIN=5V C_L=1uF R_L=5ohm		600		us
Fault flag output blanking time	t_{BLANK}	VIN=5.0V		7.5		ms
Over-temperature shutdown threshold	T_{SD}			160		°C
Over-temperature threshold hysteresis	T_{HYS}			20		°C
Under voltage lock out threshold	V_{UVLO}			2.1	2.4	V
Under voltage lock out hysteresis	$V_{UVLO-HYS}$			200		mV

(1) Pulse test,T_p=380uS。

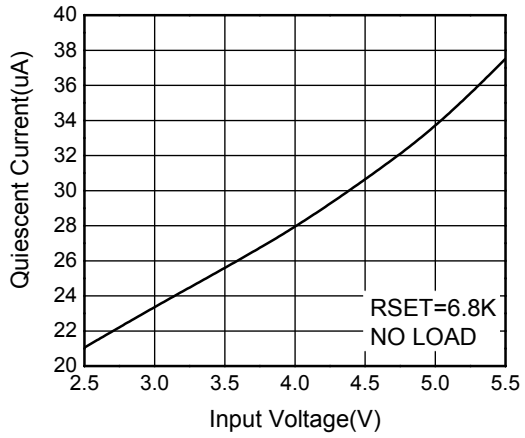
Typical Characteristics (WS4612EEA, Ta=25°C, unless otherwise noted)



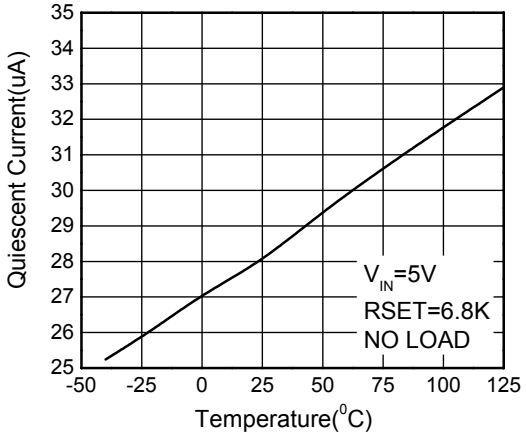
ON Resistance vs. Input Voltage



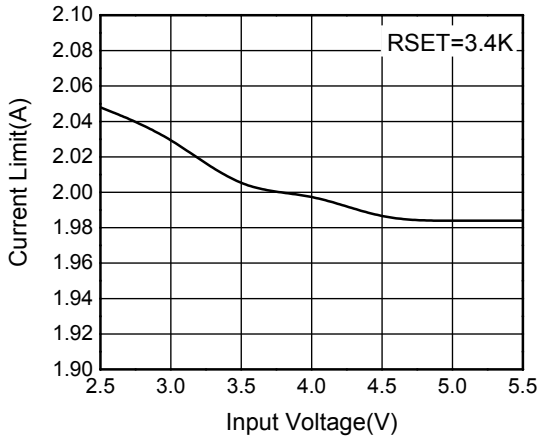
ON Resistance vs. Temperature



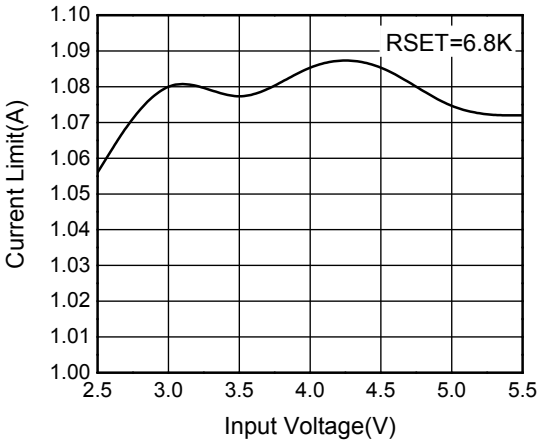
Quiescent current vs. Input Voltage



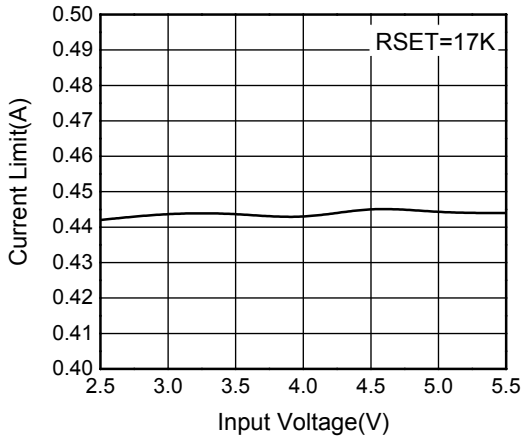
Quiescent current vs. Temperature



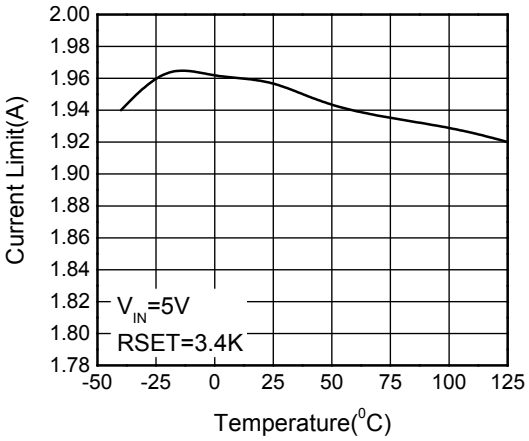
Current Limit vs. Input Voltage



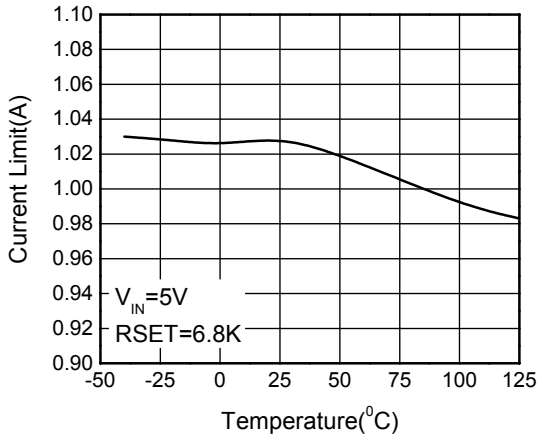
Current Limit vs. Input Voltage



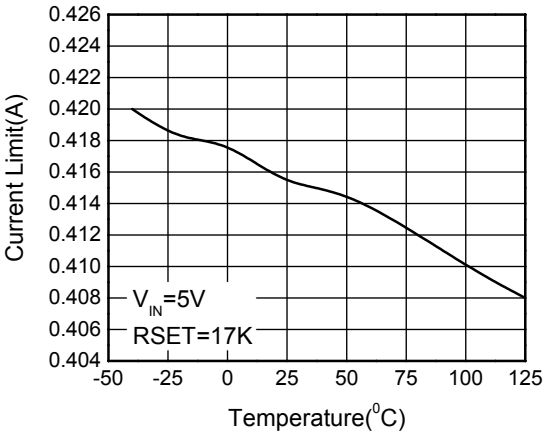
Current Limit vs. Input Voltage



Current Limit vs. Temperature

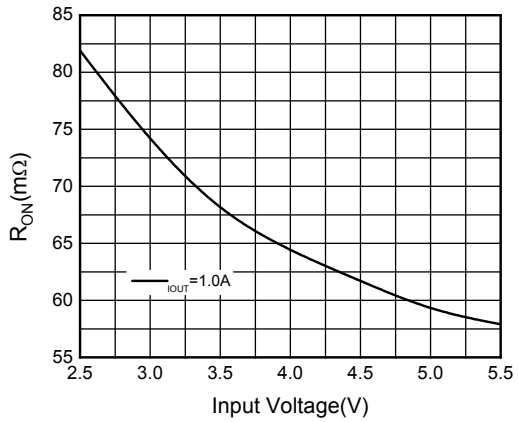


Current Limit vs. Temperature

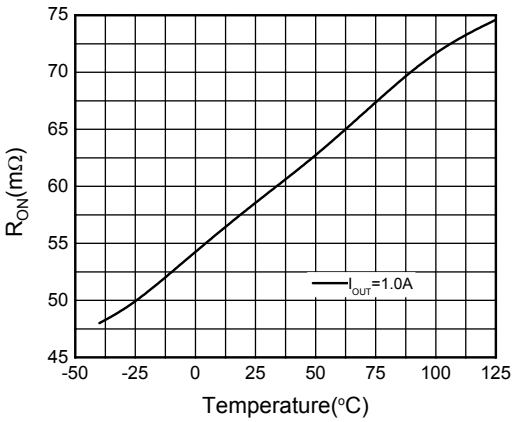


Current Limit vs. Temperature

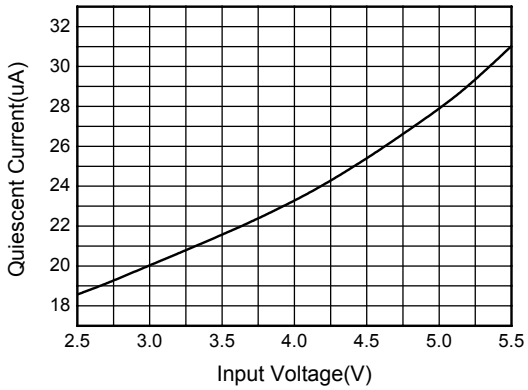
Typical Characteristics (WS4612EE, Ta=25°C, unless otherwise noted)



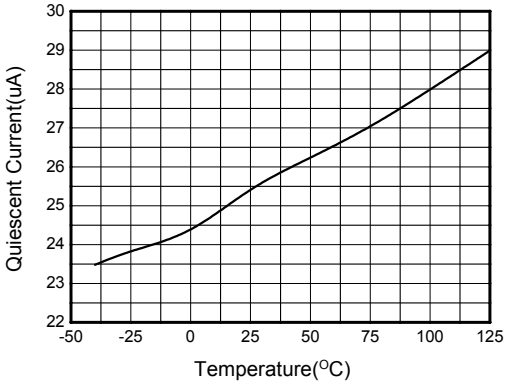
ON Resistance vs. Input Voltage



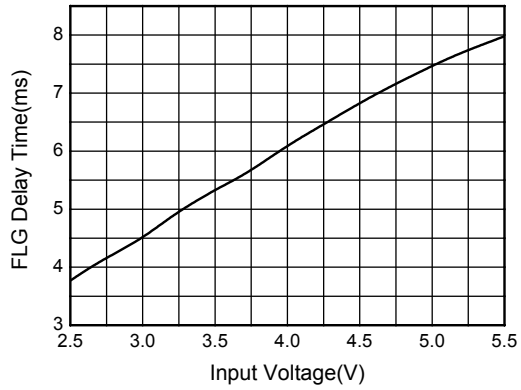
ON Resistance vs. Temperature



Quiescent current vs. Input Voltage

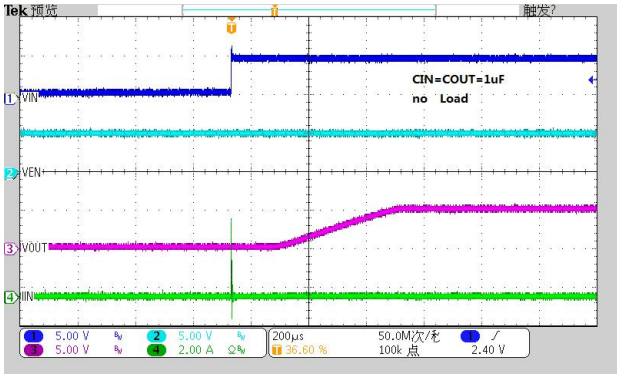


Quiescent current vs. Temperature

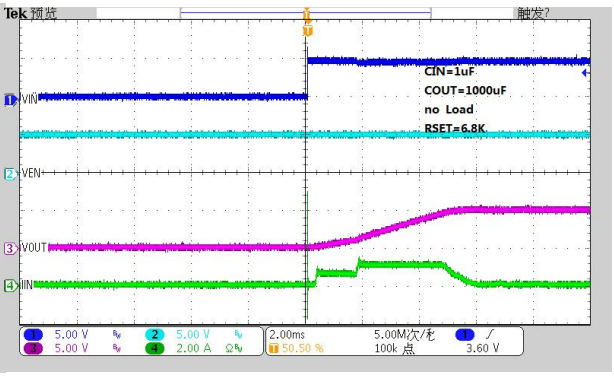


FLAG delay time vs. Input Voltage

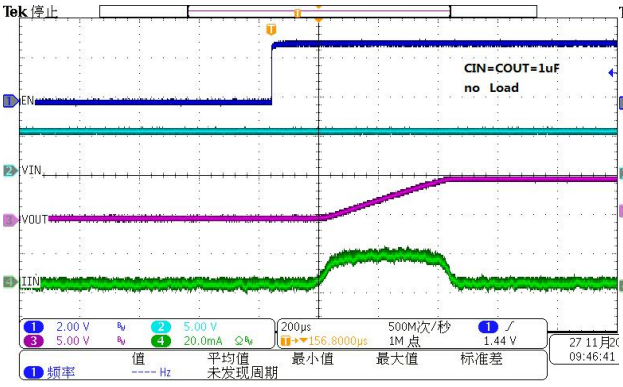
Typical Characteristics (WS4612EAA , Ta=25°C, unless otherwise noted)



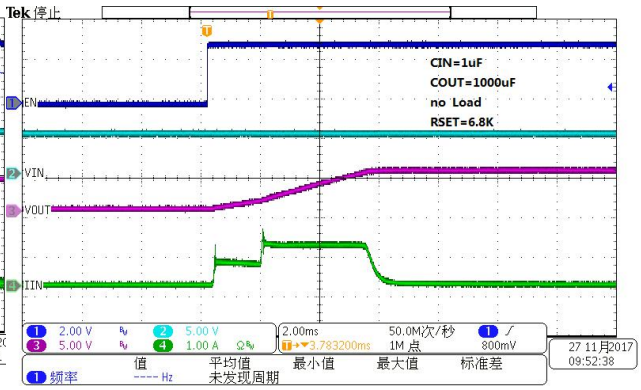
Startup from Power ON



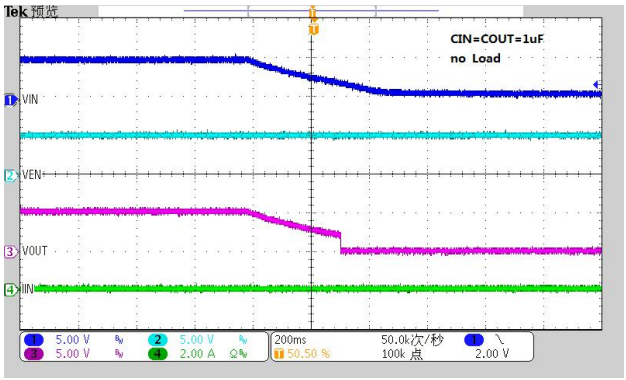
Startup from Power ON



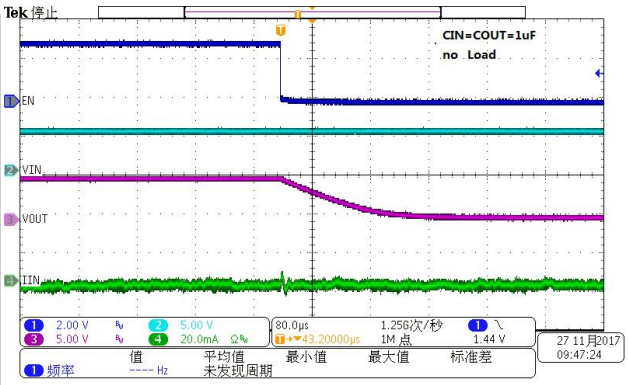
Startup from Enable ON



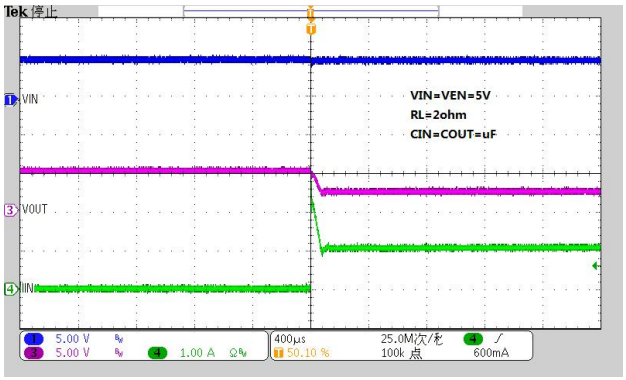
Startup from Enable ON



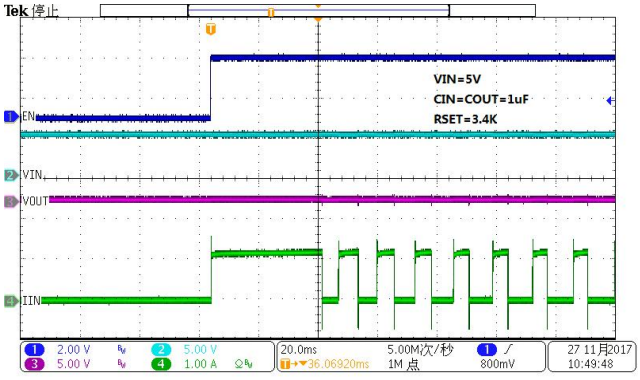
Shutdown from Power OFF



Shutdown from Enable OFF

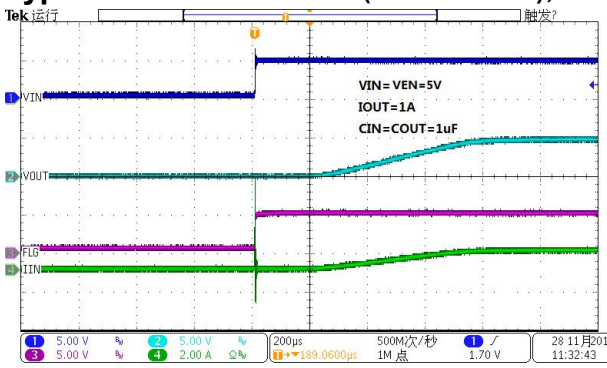


Current Limit Response

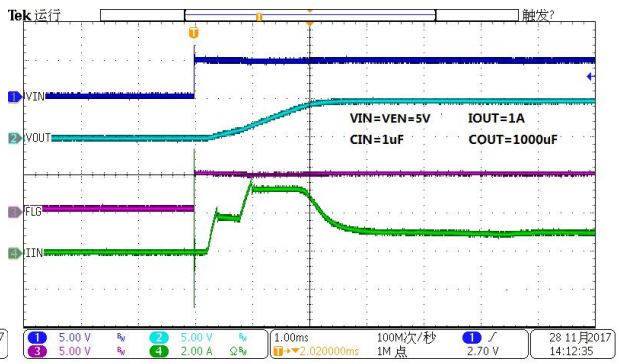


Short Circuit Response

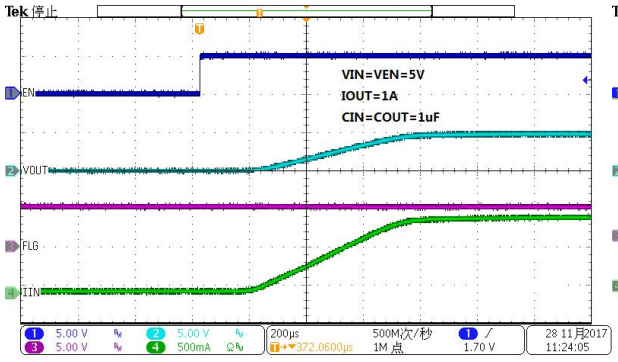
Typical Characteristics (WS4612EEA), Ta=25°C, unless otherwise noted)



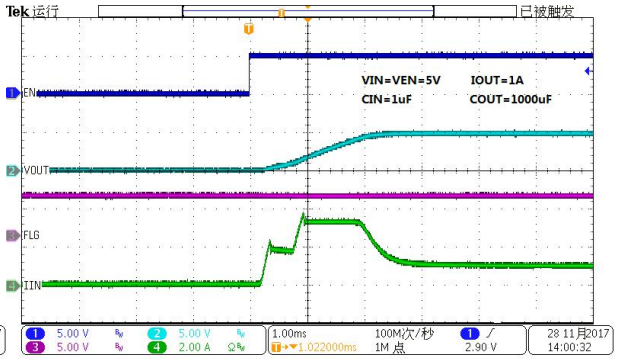
Startup from Power ON



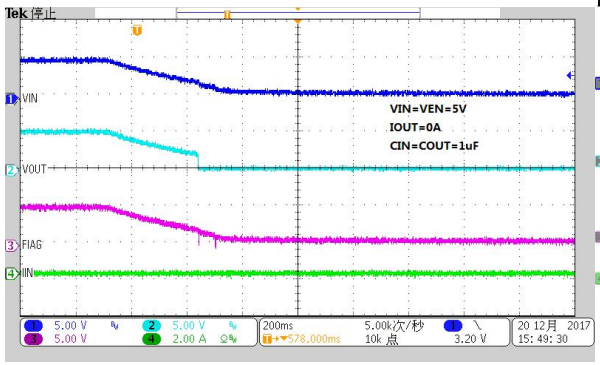
Startup from Power ON



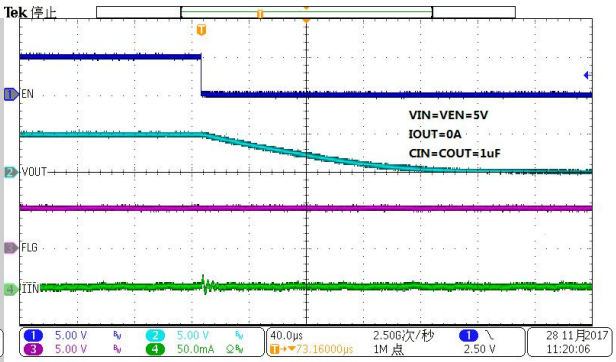
Startup from Enable ON



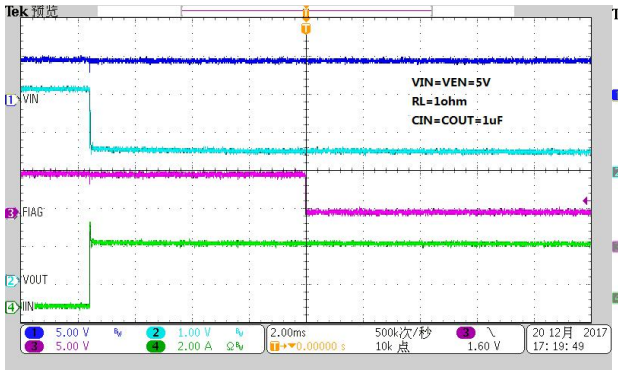
Startup from Enable ON



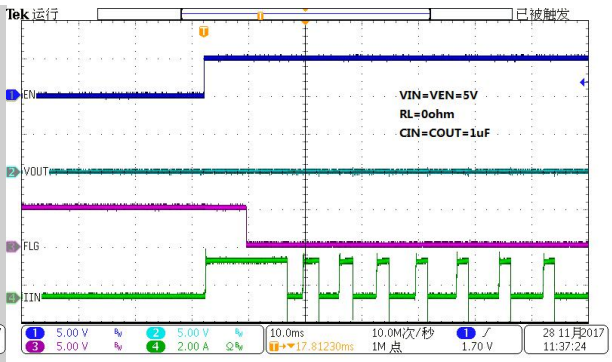
Shutdown from Power OFF



Shutdown from Enable OFF



Current Limit Response



Short Circuit Response

Operation Information

Power Switch

The power switch is a P-channel MOSFET with low $R_{DS(ON)}$ for power management or USB power distribution applications. The WS4612 has reverse voltage protection to prevents current flow from OUT to IN and IN to OUT when device is off.

Current-Limit Protection(WS4612EA)

The WS4612 provide current limit protection function to protect power source when over-current condition occurs. The current limit Ioc can be adjusted by external resistor connected between ISET pin and GND. The Ioc typical value can be calculated using following equation:

$$I_{OC}(A) = \frac{6.8K}{R_{SET}}$$

Current-Limit Protection(WS4612E(B/C/D/E))

The WS4612 provide current limit protection function to protect power source when over-current condition occurs. The typical current limit threshold is set internally to approximately 1.4A(WS4612EB), 2.1A(WS4612EC), 3.5A(WS4612ED), 4.2A(WS4612EE).

Short-Circuit Protection

The WS4612 provide short circuit protection function. The output current will be limited to safe level. The short-circuit protection is used to reduce power dissipation of the device and protect power source during short-circuit condition.

Fault indicate(WS4612E(B/C/D/E))

The $\overline{\text{FLG}}$ open drain output is asserted (active low) with 7.5ms(Typ.) delay when an over-current or over-temperature condition is encountered. The $\overline{\text{FLG}}$ signal will remain asserted until the over-current or over-temperature condition is removed.

UVLO Protection

To avoid malfunction of the WS4612 at low input voltages, an under voltage lockout is included that disables the device, until the input voltage exceeds 2.1V (Typ.)

Shutdown Mode

Drive EN to place the WS4612 in shutdown mode. In shutdown mode, input current falls to smaller than 1uA.

Thermal Shutdown

As soon as the junction temperature (T_J) exceeds 160°C (Typ.), the WS4612 goes into thermal shutdown. In this mode, the device is turned off and will turn on again until Junction temperature falls below 140°C (Typ.).

Application Information

Input Capacitor

A 1uF input bypass ceramic capacitor(C_{IN}) from IN to GND, located near the WS4612 is strongly recommended to suppress the voltage overshooting during short circuit fault event. Without the bypass capacitor, the output short may cause sufficient ringing on the input (from supply lead inductance) to damage the device.

Output Capacitor

A low ESR, 150uF aluminum electrolytic or tantalum between OUT and GND is strongly recommended to reduce the voltage droop during hot-plug of downstream peripheral. Higher value output capacitor is better when the output load is heavy. Additionally, bypassing the output with a 1uF ceramic capacitor improves the immunity of the device to short-circuit transients.

PCB Layout consideration

The PCB layout should be carefully performed to maximize thermal dissipation and to minimize voltage drop. The following guidelines must be considered:

1. Please place the input capacitors near the IN pin as close as possible.
2. Output decoupling capacitors for load must be placed near the load as close as possible for decoupling high frequency ripples.
3. Locate WS4612 and output capacitors near the load to reduce parasitic resistance and inductance for excellent load transient performance.
4. The negative pins of the input and output capacitors and the GND pin must be connected to the ground plane of the load.
5. Keep IN and OUT traces as wide and short as possible.

Order Information

Ordering No.	Current	ENABLE	Output Shutdown Resistor	Package	Operating Temperature	Marking	Shipping
WS4612EBB-5/TR	1A	Active Low	Yes	SOT23-5L	-40~85°C	4612 BBYW	3000/Reel&Tape
WS4612ECC-5/TR	1.5A	Active High	No	SOT23-5L	-40~85°C	4612 CCYW	3000/Reel&Tape
WS4612EDA-5/TR	2A	Active High	Yes	SOT23-5L	-40~85°C	4612 DAYW	3000/Reel&Tape
WS4612EDB-5/TR	2A	Active Low	Yes	SOT23-5L	-40~85°C	4612 DBYW	3000/Reel&Tape
WS4612EAA-5/TR	ADJ	Active High	Yes	SOT23-5L	-40~85°C	4612 AAYW	3000/Reel&Tape
WS4612EAC-5/TR	ADJ	Active High	No	SOT23-5L	-40~85°C	4612 ACYW	3000/Reel&Tape

Marking Information

4612 = Device code

**** =Special code**

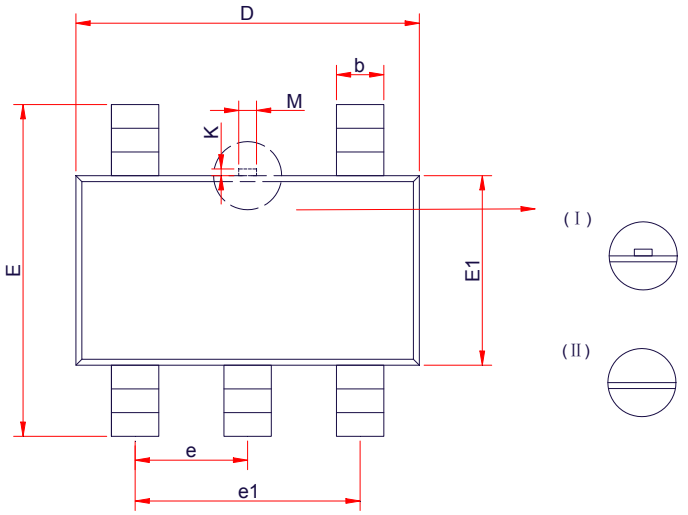
Y = Year code

W = Week code

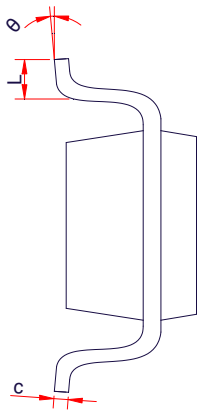
Marking

Package outline dimensions

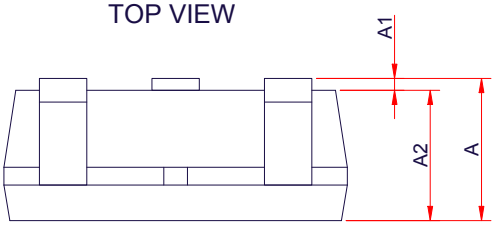
SOT-23-5L



TOP VIEW



SIDE VIEW

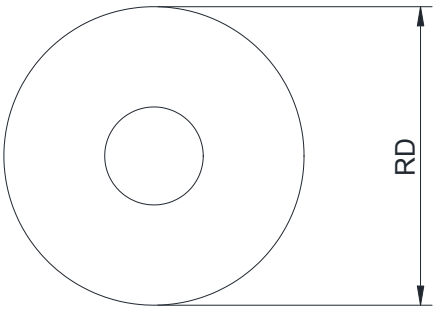


SIDE VIEW

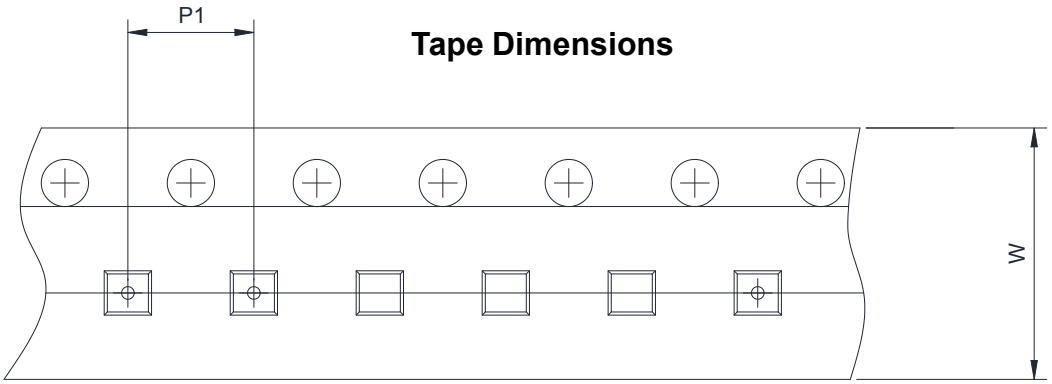
Symbol	Dimensions in Millimeters		
	Min.	Typ.	Max.
A	-	-	1.45
A1	0.00	-	0.15
A2	0.90	1.10	1.30
b	0.30	0.40	0.50
c	0.10	-	0.21
D	2.72	2.92	3.12
E	2.60	2.80	3.00
E1	1.40	1.60	1.80
e	0.95 BSC		
e1	1.90 BSC		
L	0.30	0.45	0.60
M	0.10	0.15	0.25
K	0.00	-	0.25
θ	0°	-	8°

TAPE AND REEL INFORMATION

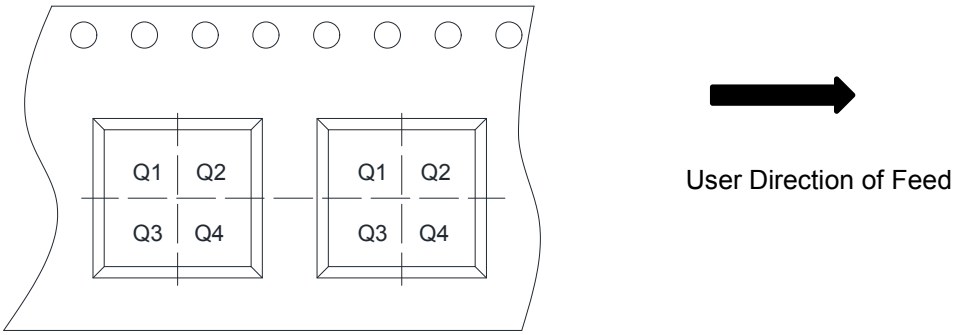
Reel Dimensions



Tape Dimensions



Quadrant Assignments For PIN1 Orientation In Tape



RD	Reel Dimension	☑ 7inch ☐ 13inch
W	Overall width of the carrier tape	☑ 8mm ☐ 12mm ☐ 16mm
P1	Pitch between successive cavity centers	☐ 2mm ☑ 4mm ☐ 8mm
Pin1	Pin1 Quadrant	☐ Q1 ☐ Q2 ☑ Q3 ☐ Q4