WS4667E

4.5A, 22mΩ, Ultra-low Ron Load Switch with Quick Output Discharge

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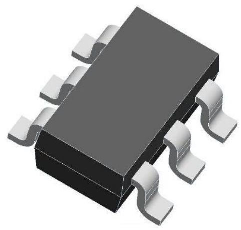
Descriptions

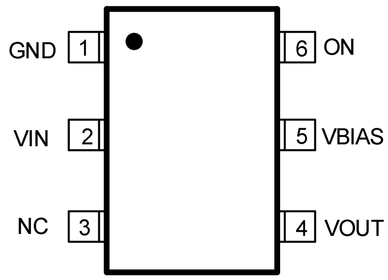
The WS4667E is a small, ultra-low Ron, single channel load switch with controlled turn on. The device contains an N-channel MOSFET that can operate over an input voltage range of 0.8V to 3.5V and supports a maximum continuous current of 4.5A .

This device is suitable for driving processor power rails with very strict voltage dropout tolerances. Quick rise time of the device allows for power rails to come up quickly when the device is enabled, thereby reducing response time for power distribution. The ON terminal can be directly connected with the low-voltage control signals generated by microcontrollers or low-voltage discrete logic circuit.

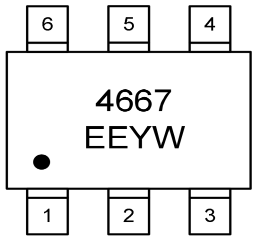
The WS4667E is available in SOT23-6L package. Standard product is Pb-free and Halogen-free.



SOT23-6L



Pin configuration (Top view)



SOT23-6L

For detail order information, please see page 2.

Features

- Input Voltage Range: 0.8V to 3.5V
- Ultra-Low On Resistance (R_{ON})
  R_{ON} = 22mΩ at V_{BIAS} = 5V
- 4.5 A Maximum Continuous Switch Current
- Low Control Input Threshold Enables Use of 1.2V, 1.8V, 2.5V and 3.3V Logic
- Quick Output Discharge (QOD)
- SOT23-6L Package
- ESD Performance Tested per JESD 22
  2kV HBM and 1kV CDM

Applications

- Ultrabook ™
- Notebooks/Netbooks
- Tablet PC
- Consumer Electronics
- Set-top Boxes/Residential Gateways
- Telecom Systems

Order Information

For detail order information, please see page 2.

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USA

Tel: + 1 408 567 3000
Fax: + 1 408 567 3001
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Order Information

Ordering No.	Continuous Current	Rise Time	Enable	Output Discharge Resistor	Package	Operating Temperature	Marking	Shipping
WS4667EAA-6/TR	4.5A	3.4us	Active High	Yes	SOT23-6L	-40~85°C	4667 EEYW	3000/Reel& Tape

Marking Information

4667 = Device code
EE = Special code
Y = Year code
W = Week code
Marking

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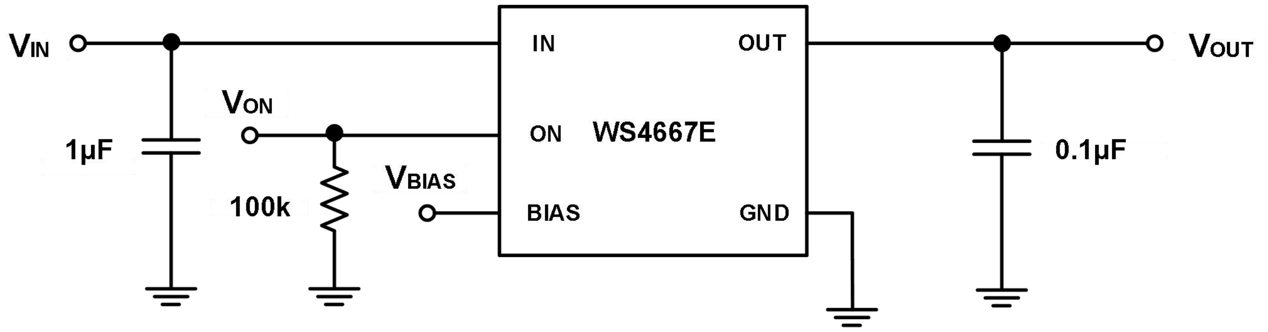
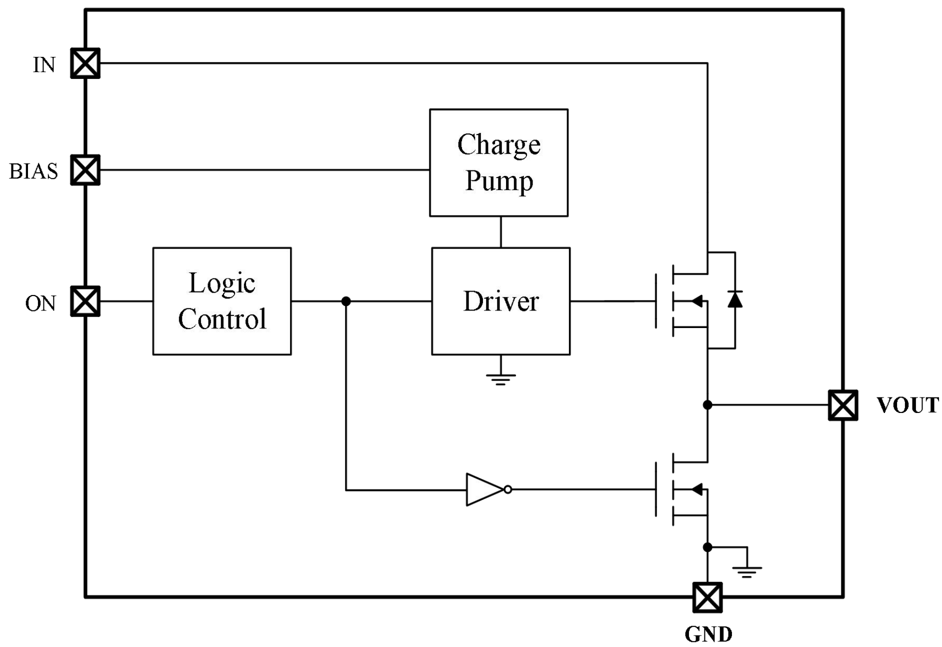
Typical Application



Pin Description

Pin Number	Symbol	I/O	Description
1	GND	--	Ground.
2	VIN	I	Switch input. Place ceramic bypass capacitor(s) between this terminal and GND.
3	NC	--	Not connected.
4	VOUT	O	Switch output. Place ceramic bypass capacitor(s) between this terminal and GND.
5	VBIAS	--	Bias voltage. Power supply to the device.
6	ON	I	Active high switch control input. Do not leave floating.

Block Diagram



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Absolute Maximum Ratings

Symbol	Parameter		Value	Unit
V_{IN}	Input voltage range		-0.3～5.5	V
V_{OUT}	Output voltage range		-0.3～5.5	V
V_{BIAS}	Bias voltage range		-0.3～5.5	V
V_{ON}	Input voltage range		-0.3～5.5	V
I_{MAX}	Maximum continuous switch current		4.5	A
T_{JMAX}	Maximum junction temperature		150	°C
T_{STG}	Storage temperature range		-60～150	°C
T_{LEAD}	Maximum lead temperature (10-s soldering time)		260	°C
ESD	Electrostatic discharge protection	Human-Body Model (HBM)	±2000	V
		Charged-Device Model (CDM)	±1000	

Thermal Information

Thermal Resistance	WS4667E SOT23-6L	Unit
Thermal Resistance, $R_{θJA}$（Junction-to-Ambient）Without Copper Pour	198	°C/W
Thermal Resistance, $R_{θJA}$（Junction-to-Ambient）With Copper Pour*	133	°C/W

*:Surface mounted on FR-4 Board using 2 oz, 1 square inch Cu area, PCB board size 1.5*1.5 square inches.

Recommended Operating Conditions

Symbol	Parameter	Value	Unit
V_{IN}	Input voltage range	0.8～V_{BIAS} – 2	V
V_{BIAS}	Bias voltage range	3～5.5	V
V_{ON}	ON voltage range	0～5.5	V
V_{OUT}	Output voltage range	0～V_{IN}	V
T_J	Junction temperature range	-40～125	°C
T_A	Ambient temperature range	0～85	°C
C_{IN}	Input capacitor	1	µF
C_L	Output capacitor	0.1	µF

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Electrical Characteristics

V_{BIAS}=5.0V, Cin=1uF, T_A=25°C, unless otherwise noted.

Parameter	Symbol	Test Conditions		Min	Typ	Max	Unit
V_{BIAS} Quiescent Current	$I_{Q,VBIAS}$	I_{OUT} =0mA, V_{IN} = 3.0V			20	40	μA
V_{BIAS} Shutdown Current	$I_{SD,VBIAS}$	V_{ON} = 0V , V_{OUT} = 0V			0.1	1	μA
V_{IN} Shutdown Current	$I_{SD,VIN}$	V_{ON} = 0V , V_{OUT} = 0V	V_{IN} = 3.0V		0.001	0.3	μA
			V_{IN} = 2.5V		0.001	0.3	
			V_{IN} = 2.0V		0.001	0.3	
			V_{IN} = 1.05V		0.001	0.3	
			V_{IN} = 0.8V		0.001	0.3	
ON Pin Input Leakage Current	I_{ON}	V_{ON} = 5.5V			0.1	1	μA
ON Logic High Input Voltage	$V_{ON,H}$	V_{BIAS} = 3.0V to 5.5V		1.2			V
ON Logic Low Input Voltage	$V_{ON,L}$	V_{BIAS} = 3.0V to 5.5V				0.4	V
ON-state Resistance	R_{ON}	I_{OUT} = -1.0A	V_{IN} = 3.0V		22	40	mΩ
			V_{IN} = 2.5V		22	40	
			V_{IN} = 2.0V		22	40	
			V_{IN} = 1.05V		22	40	
			V_{IN} = 0.8V		22	40	
Output Pull-down Resistance	R_{PD}	V_{IN} = V_{OUT}=5.0V, V_{ON} = 0V			260		Ω

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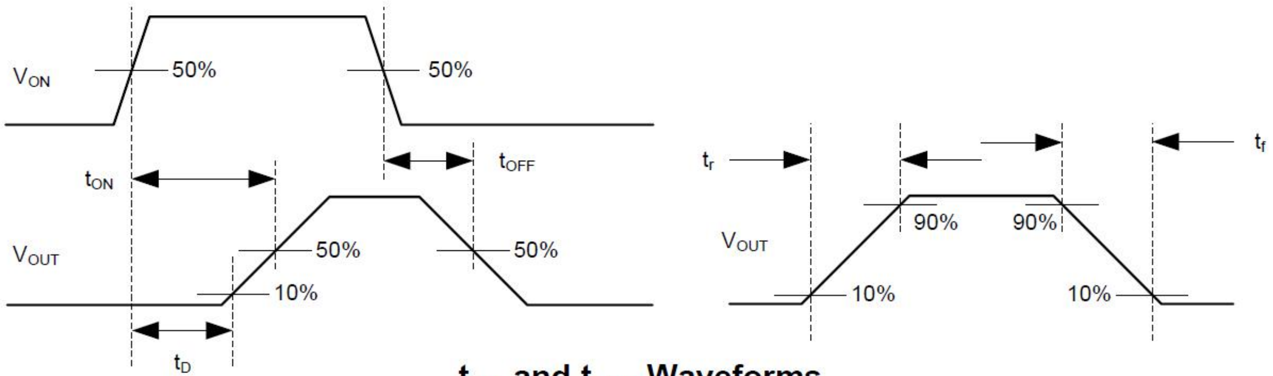
Electrical Characteristics (Continued)

V_{BIAS}=3.0V, Cin=1uF, T_A=25°C, unless otherwise noted.

Parameter	Symbol	Test Conditions		Min	Typ	Max	Unit
V_{BIAS} Quiescent Current	$I_{Q,VBIAS}$	I_{OUT} =0mA, V_{IN} = 1.0V			12	25	μA
V_{BIAS} Shutdown Current	$I_{SD,VBIAS}$	V_{ON} = 0V , V_{OUT} = 0V			0.1	1	μA
V_{IN} Shutdown Current	$I_{SD,VIN}$	V_{ON} = 0V , V_{OUT} = 0V	V_{IN} = 1.05V		0.001	0.3	μA
			V_{IN} = 0.8V		0.001	0.3	
ON Pin Input Leakage Current	I_{ON}	V_{ON} = 5.5V			0.1	1	μA
ON Logic High Input Voltage	$V_{ON,H}$	V_{IN} = 0.8V to 1.0V		1.2			V
ON Logic Low Input Voltage	$V_{ON,L}$	V_{IN} = 0.8V to 1.0V				0.4	V
ON-state resistance	R_{ON}	I_{OUT} = -1.0A	V_{IN} = 1.0V		22	40	mΩ
			V_{IN} = 0.8V		22	40	
Output pull-down resistance	R_{PD}	V_{IN} = V_{OUT}=1.0V, V_{ON} = 0V			260		Ω

Switching Characteristics Measurement Information



t_{ON} and t_{OFF} Waveforms

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Switching Characteristics

Parameter		Test Conditions	Min	Typ	Max	Unit
V_{IN} = 2.5V， V_{ON} = V_{BIAS} = 5V, T_A = 25 °C (unless otherwise noted)						
t_{ON}	Turn-on time	R_L = 10Ω, C_L = 0.1uF		4.1		μs
t_{OFF}	Turn-off time			1.2		
t_R	V_{OUT} rise time			3.4		
t_F	V_{OUT} fall time			2		
t_D	ON delay time			3.1		
V_{IN} = 1.05V, V_{ON} = V_{BIAS} = 5V, T_A = 25 °C (unless otherwise noted)						
t_{ON}	Turn-on time	R_L = 10Ω, C_L = 0.1uF		4		μs
t_{OFF}	Turn-off time			1.3		
t_R	V_{OUT} rise time			1.5		
t_F	V_{OUT} fall time			1.8		
t_D	ON delay time			3.4		
V_{IN} = 1.05V, V_{ON} = 5V, V_{BIAS} = 3.3V, T_A = 25 °C (unless otherwise noted)						
t_{ON}	Turn-on time	R_L = 10Ω, C_L = 0.1uF		7		μs
t_{OFF}	Turn-off time			2		
t_R	V_{OUT} rise time			5		
t_F	V_{OUT} fall time			2		
t_D	ON delay time			5.5		

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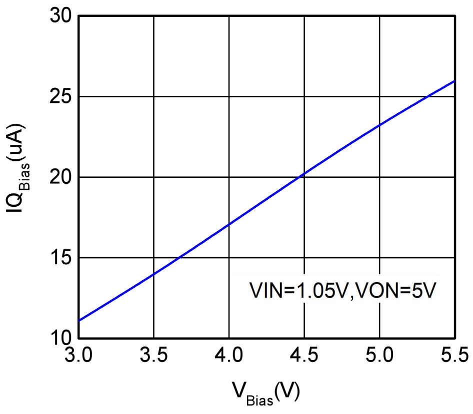
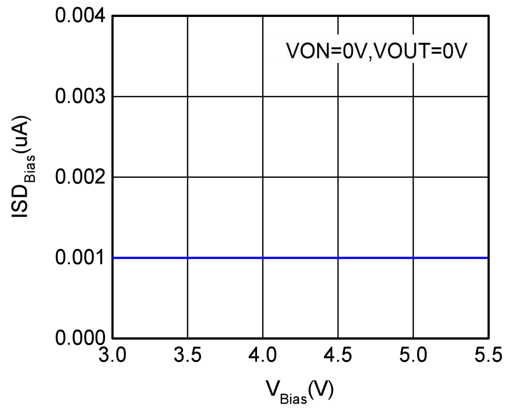
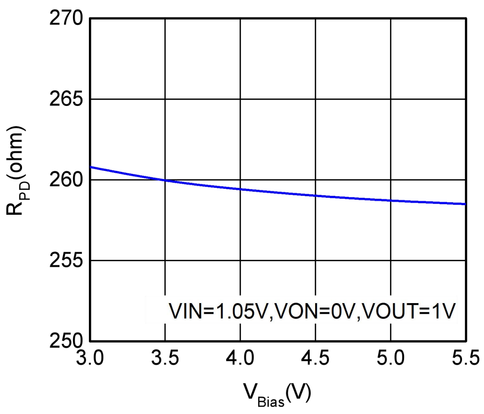
Typical Characteristics



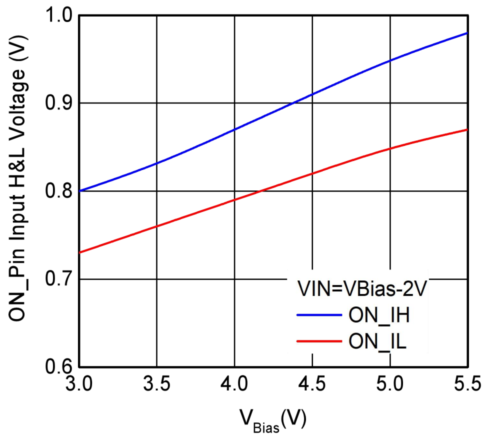
$I_{Q,BIAS}$ vs. V_{BIAS}



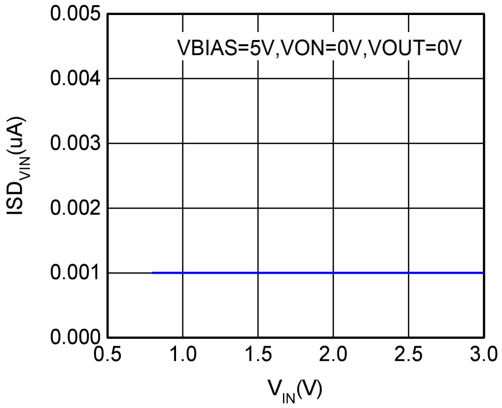
$I_{SD,BIAS}$ vs. V_{BIAS}



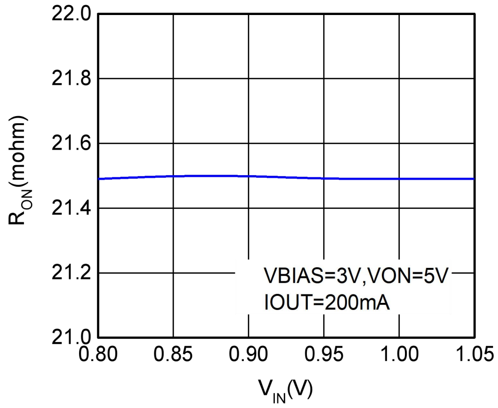
R_{PD} vs. V_{BIAS}



$V_{IH,ON}$ & $V_{IL,ON}$ vs. V_{BIAS}



$I_{SD,VIN}$ vs. V_{IN}



R_{ON} VS. V_{IN}

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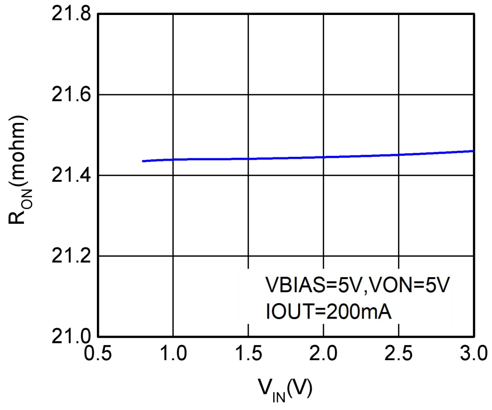
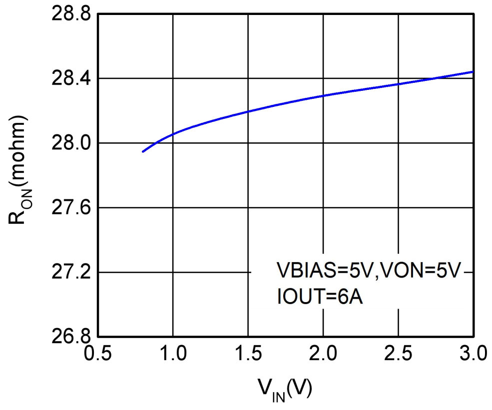
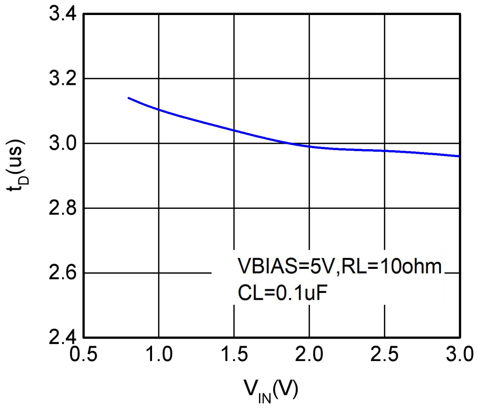


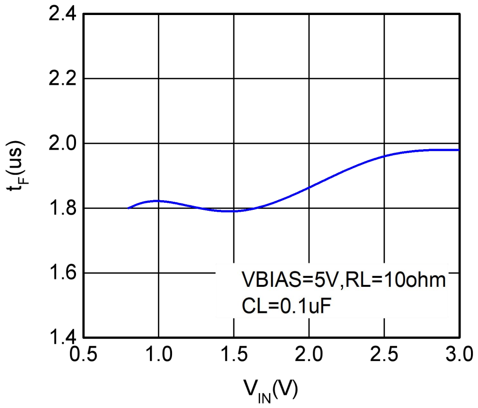
R_{ON} vs. V_{IN}



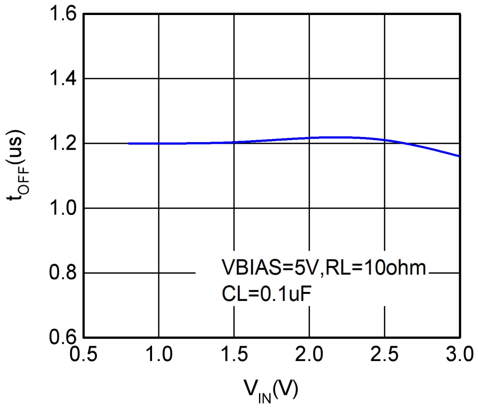
R_{ON} vs. V_{IN}



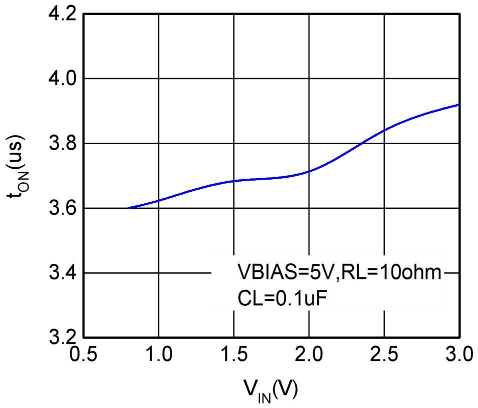
t_D vs. V_{IN}



t_F vs. V_{IN}



t_{OFF} vs. V_{IN}



t_{ON} vs. V_{IN}

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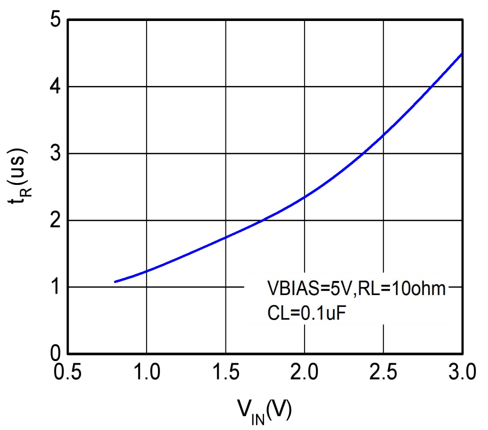
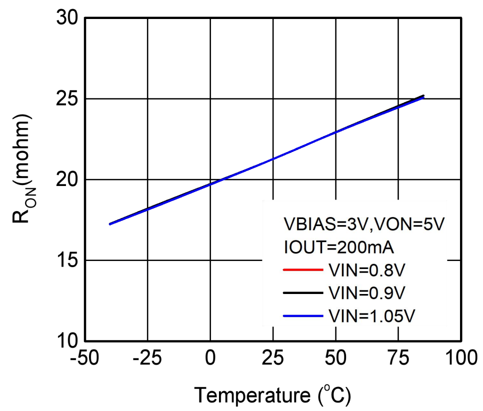
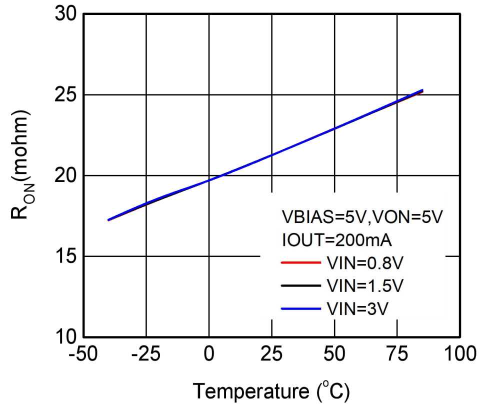


t_R vs. V_{IN}



R_{ON} vs. Temperature



R_{ON} vs. Temperature

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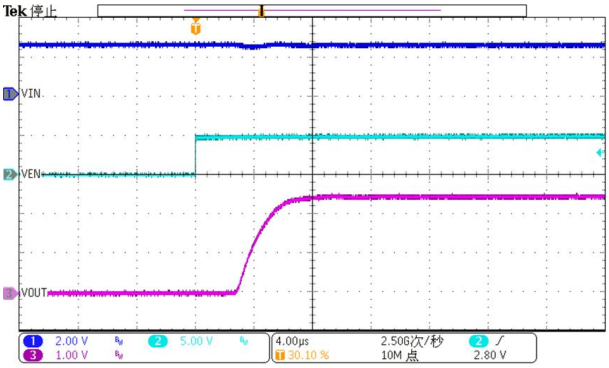
Working Waveforms

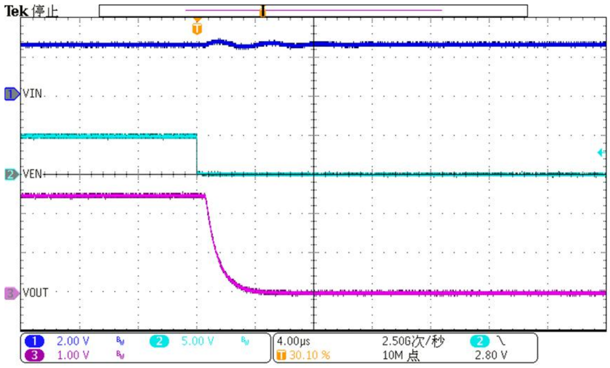
Start up by EN

V_{BIAS}=5V,V_{IN}=2.5V,C_{IN}=1uF,C_{OUT}=0.1uF,R_{LOAD}=10Ω



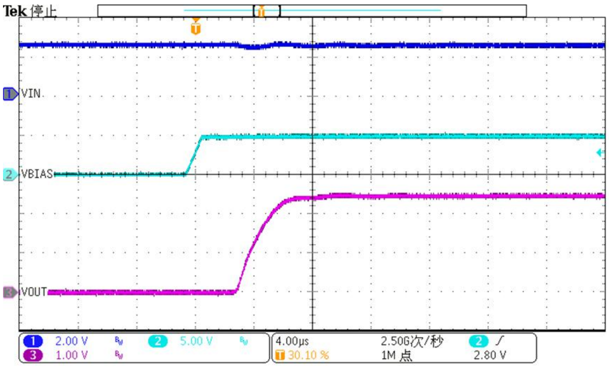
Shutdown by EN

V_{BIAS}=5V,V_{IN}=2.5V,C_{IN}=1uF,C_{OUT}=0.1uF,R_{LOAD}=10Ω



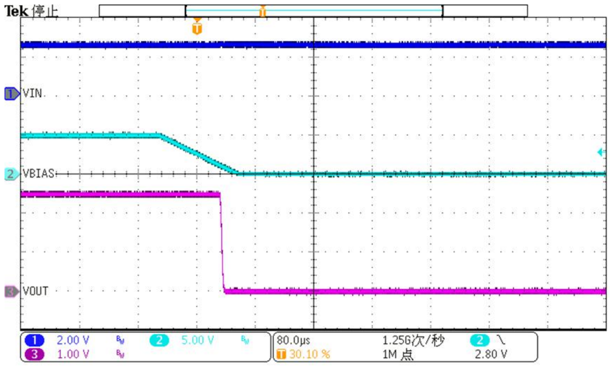
Start up by V_{BIAS}

V_{BIAS}=5V,V_{IN}=2.5V,C_{IN}=1uF,C_{OUT}=0.1uF,R_{LOAD}=10Ω



Shutdown by V_{BIAS}

V_{BIAS}=5V,V_{IN}=2.5V,C_{IN}=1uF,C_{OUT}=0.1uF,R_{LOAD}=10Ω



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Detailed Description

Overview

The WS4667E device is a 3.5V, 4.5A load switch in a DFN3x2-8L package. To reduce voltage drop for low voltage and high current rails, the device implements an ultra-low resistance N-channel MOSFET.
The device has a controlled, fixed slew rate for applications that require a specific rise-time. During shutdown, the device has very low leakage currents, thereby reducing unnecessary leakages for downstream modules during standby. The integrated control logic, driver and output discharge FET eliminates the need for any external components, which reduces solution size and bill of materials (BOM) count.

ON and OFF Control

The ON pin controls the state of the load switch. ON is active high and has a 1.2 V ON pin enable threshold, making it capable of interfacing with low-voltage signals. The ON pin is compatible with standard GPIO logic thresholds. It can be used with any microcontroller with 1.2 V or higher GPIO voltage. This pin cannot be left floating and must be driven either high or low for proper functionality.

Input Capacitor (C_{IN}) (Optional)

To limit the voltage drop on the input supply caused by transient inrush currents when the switch turns on into a discharged load capacitor or short-circuit, a capacitor needs to be placed between VIN and GND. A 1μF ceramic capacitor, C_{IN}, placed close to the pins, is usually sufficient. Higher values of C_{IN} can be used to further reduce the voltage drop in high-current applications. When switching heavy loads, it is recommended to have an input capacitor about 10 times higher than the output capacitor (C_L) to avoid excessive voltage drop.

Output Capacitor (C_L) (Optional)

Because of the integrated body diode in the NMOS switch, a C_{IN} greater than C_L is highly recommended. A C_L greater than C_{IN} can cause V_{OUT} to exceed V_{IN} when the system supply is removed. This could result in current flow through the body diode from V_{OUT} to V_{IN}. A C_{IN} to C_L ratio of 10 to 1 is recommended for minimizing V_{IN} dip caused by inrush currents during startup; however, a 10 to 1 ratio for capacitance is not required for proper functionality of the device. A ratio smaller than 10 to 1 (such as 1 to 1) could cause slightly more VIN dip upon turn-on because of inrush currents.

Quick-Output Discharge

When the switch is disabled， an internal discharge resistance is connected between VOUT and GND to remove the remaining charge from the output. This resistance has a typical value of 260 Ω and prevents the output from floating while the switch is disabled. For best results, it is recommended that the device gets disabled before VBIAS falls below the minimum recommended voltage.

Layout guide

For best performance, all traces should be as short as possible. To be most effective, the input and output capacitors should be placed close to the device to minimize the effect that parasitic trace inductance may have on normal and short-circuit operation. Using wide traces for VIN, VOUT, GND helps minimize parasitic electrical effects along with minimizing the case-to-ambient thermal impedance.

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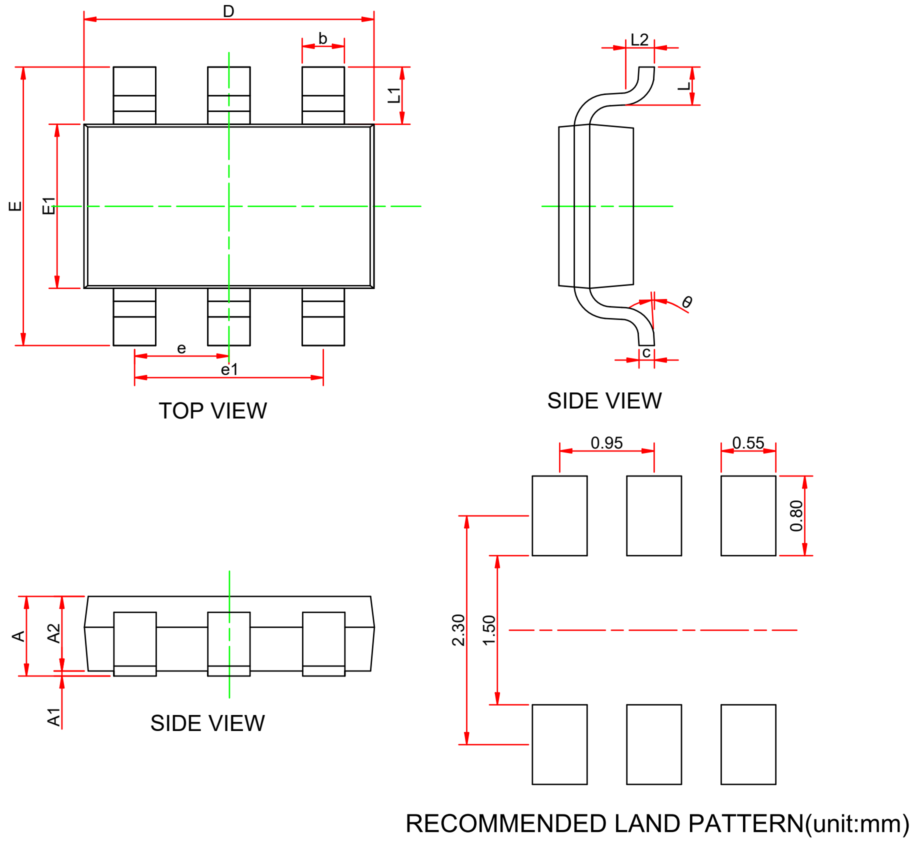
PACKAGE OUTLINE DIMENSIONS

SOT-23-6L



Symbol	Dimensions in Millimeters		
	Min.	Typ.	Max.
A	1.05	-	1.25
A1	0	-	0.15
A2	1.00	1.10	1.20
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	0.95BSC		
e1	1.80	1.90	2.00
L	0.30	-	0.60
L1	0.59Ref		
L2	0.25Ref		
θ	0 °	-	8 °

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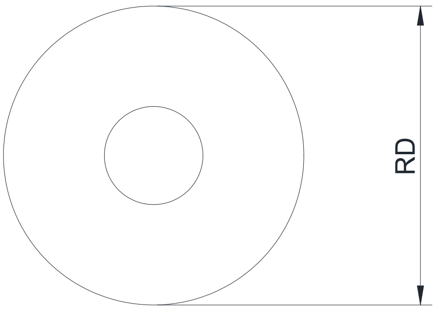
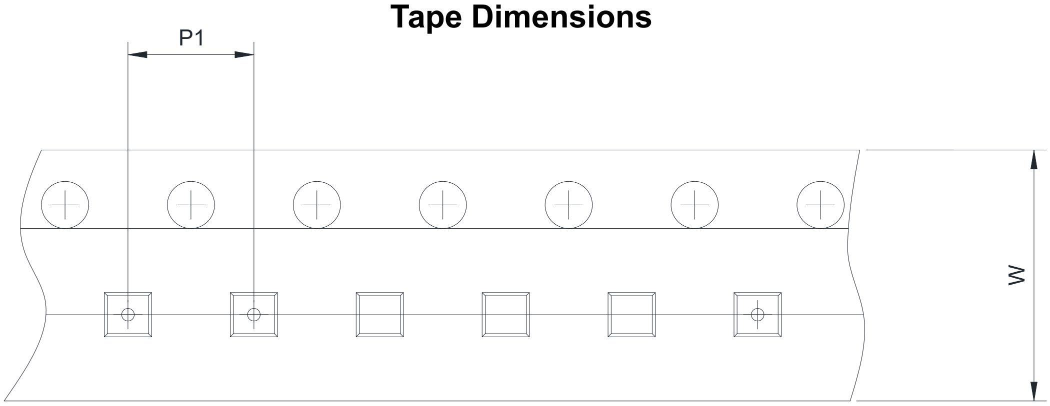
TAPE AND REEL INFORMATION

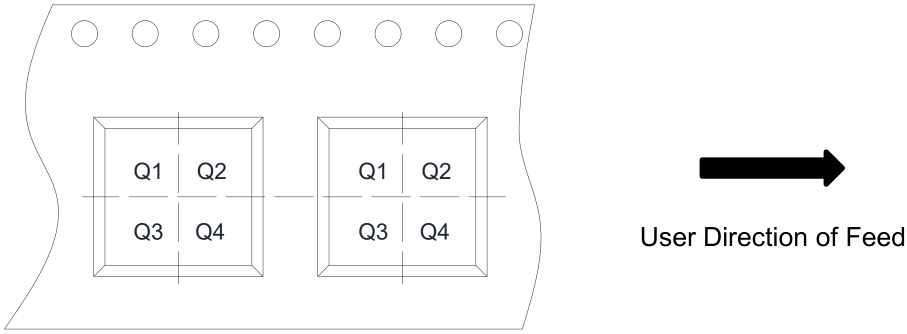
Reel Dimensions



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

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