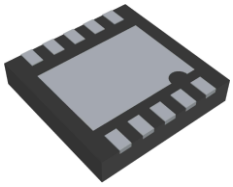
WS3212D

Over-Voltage Protection IC with 200X constant current source for Li+ charging

Http//:www.willsemi.com



DFN3x3-10L

Descriptions

The WS3212D is a fully integrated Over Voltage Protection IC with 200x constant current source for Li-ion charging applications. Over current protection and over temperature protection functions are integrated to prevent chip damage. The charging current is controlled by the GDRV pin. When sinking current from the GDRV pin, the BAT pin delivers the charging current with 200X current gain of GDRV's current.

The WS3212D is available in DFN3x3-10L package. Standard products are Pb-Free and halogen-Free.

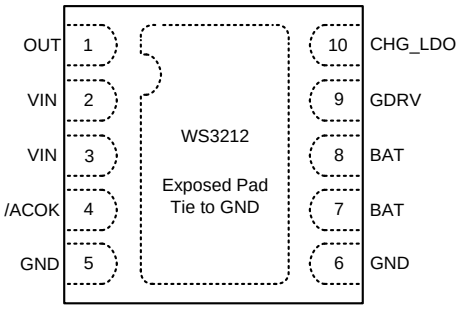
Features

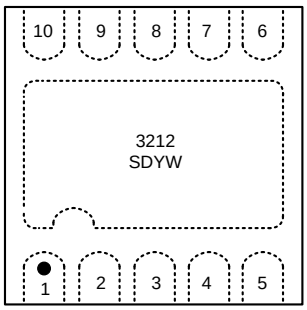
- Absolute Maximum Input Voltage : 30V
- Input OVP Threshold : 5.86V
- Constant Current Gain : 200
- Over-Current Protection Threshold : 2A
- Over-Temperature Threshold : 160°C
- VIN to BAT On-Resistance : 160mΩ
- Charging Status Indicator

Applications

- Cell Phones

Pin configuration (Top view)





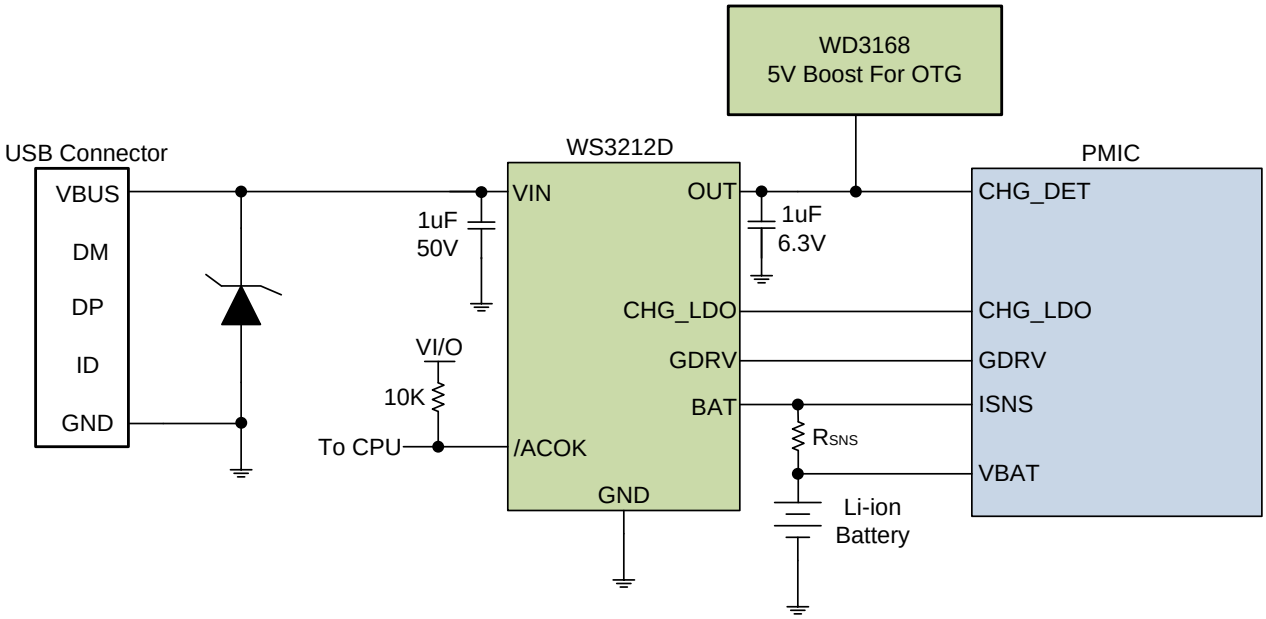
3212 = Device code
SD = Special code
Y = Year code
W = Week code

Marking

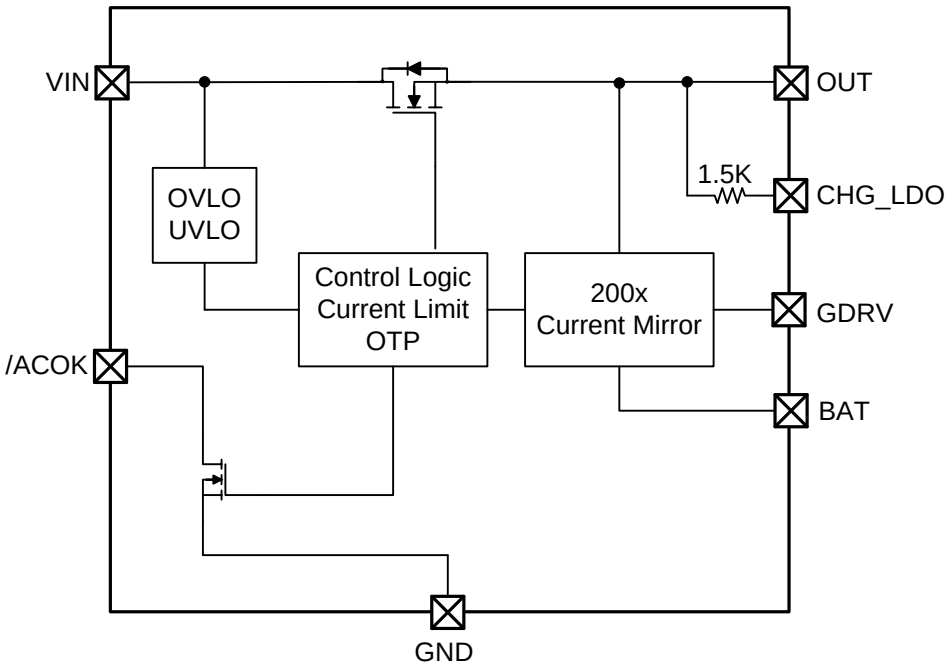
Order information

Device	Package	Shipping
WS3212D-10/TR	DFN3x3-10L	3000/Reel&Tape

Typical Applications



Block Diagram



Pin Descriptions

Pin No.	Symbol	Function
1	OUT	Power supply output pin. This pin provides supply voltage to the PMIC input. Bypass to GND with a 1uF (min.) ceramic capacitor.
2, 3	VIN	Power supply input pin. This pin is connected to external DC supply and bypassed to GND with a 1uF (min.) ceramic capacitor.
4	/ACOK	Open-drain charging status output pin. When charging battery, the ACOK pin is pulled low by an internal N-channel MOSFET.
5, 6	GND	Ground pin.
7, 8	BAT	Charging current output pin. This pin provides supply source current to battery.
9	GDRV	Charging current control pin. When sinking current from this pin, the BAT pin will source out a current whose magnitude is 200 X I_{GDRV}.
10	CHG_LDO	Charge_LDO output voltage with 1.5KΩ resistor.

Absolute Maximum Ratings

Parameter	Symbol	Rating	Unit
VIN Input Voltage (VIN to GND Voltage)	V_{IN}	-0.3~30	V
BAT Voltage	V_{BAT}	-0.3~7	V
BAT Charging Current	I_{BAT}	1.5	A
CHG_LDO to GND Voltage	V_{CHG_LDO}	7	V
GDRV to GND Voltage	V_{GDRV}	7	V
OUT to GND Voltage	V_{OUT}	9	V
Junction Temperature	T_J	160	^oC
Operation Temperature	T_{OPR}	-45~85	^oC
Storage Temperature	T_{STG}	-65~125	^oC
Lead Temperature (Soldering 10s)		260	^oC
ESD Ratings	HBM	5	kV
	MM	200	V
	CDM	2	kV
Latch-Up		800	mA

Note: 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 (T_A=25^{o}C, unless otherwise noted)

Parameter	Symbol	Rating	Unit
Supply Voltage	V_{IN}	4.5~5.5	V
Charge Current	I_{CC}	0.1~1.2	A
Ambient Temperature	T_A	-40~85	^OC
Junction Temperature	T_J	-40~125	^OC

Electronics Characteristics (V_{IN}=5V, T_A=25°C, V_{BAT}=4V, C_{OUT}=1uF, unless otherwise noted)

Symbol	Parameter	Condition	Min.	Typ.	Max.	Unit
DC Characteristics						
R_{ON1}	VIN to OUT On Resistance	I_{OUT}=1A		75	150	mΩ
R_{ON2}	Charge (OUT to BAT) On Resistance			85		
R_{LDO}	CHG_LDO Output Series Resistance		1.2	1.5	1.8	kΩ
I_{VIN}	VIN Supply Current	I_{OUT}=0A, CHG_LDO and GDRV pins open	100	188	300	uA
$I_{VIN(OVP)}$	VIN Supply Current under OVP	V_{IN}=6.5V	50	104	200	
$I_{CHG(min)}$	Minimum Charge Current (BAT pin)			25		mA
I_{OC}	Over-Current Limit Level		2			A
N_{CUR}	Current Mirror Gain	I_{BAT}=1A	180	200	220	A/A
V_{ASD}	V_{OUT}-V_{BAT} Lockout Release Threshold	V_{OUT} rising		100		mV
	V_{OUT}-V_{BAT} Lockout Threshold	V_{OUT} falling	5	60		mV
V_{UVP}	VIN UVP Threshold	V_{IN} falling	2.803	2.92	3.037	V
	VIN UVP Hysteresis	V_{IN} rising		3.08		V
V_{OVP}	VIN OVP Threshold	V_{IN} rising	5.626	5.86	6.094	V
	VIN OVP Hysteresis	V_{IN} falling		5.74		V
Thermal Protection and Timers						
T_{OTP}	Thermal Shutdown Threshold	T_A rising		160		°C
	Thermal Shutdown Hysteresis	T_A falling		25		
T_{OVP}	VIN OVP Propagation Delay	V_{IN} rise from 5V to 6V		80		ns
$T_{ON(OVP)}$	VIN OVP Recovery Time			10		ms
T_{ON}	V_{OUT} Power-On Time	V_{OUT}=90%V_{IN}	5	10	15	
T_{START}	ACOK Start-Up Time		10	20	30	

Operation Information

VIN Under-Voltage Protection (UVP)

The WS3212D integrates an under-voltage protection circuit to shut off the output when input voltage falls below the UVP threshold. The UVP circuit has hysteresis and a de-glitch feature so that it will typically ignore undershoot transients on the input.

VIN Over-Voltage Protection (OVP)

If the input voltage rises above V_{OVP}, the internal switch MOSFET will turn off immediately to protect the system connected to OUT pin. When the input voltage falls below the input OVP hysteresis, the MOSFET is turned on again after 10ms recovery time. The OVP recovery time $T_{ON(OVP)}$ is designed to provide noise immunity against transient conditions.

Power-On Operation

When input voltage satisfies both UVP and OVP restrictions for 10ms blanking time, the output voltage starts a soft-start to reduce the inrush current. For battery charging circuit to start work, VIN should remain in this valid status for another 10ms time.

Internal N-Channel Power MOS and Bootstrap Gate Control

The WS3212D integrates an N-channel MOSFET with bootstrap gate control to replace the external NPN transistor for cell phone's PMIC. When valid input voltage is established, the bootstrap gate control circuitry will pull up the N-channel MOSFET's gate voltage gradually to turn on its N-channel. The N-channel MOSFET achieves lower on resistance within limited area, comparing to its P-channel counterpart.

Current Limit

The output current is monitored by the internal current limit circuit. When the output current exceeds the current limit threshold, the device clamps the output current by modifying the gate voltage of N-channel power MOS.

Charging Status Indicator (/ACOK)

/ACOK pin is an open-drain charging status indicator with two states: pull-down, and high impedance. The pull-down state indicates that the WS3212D is in charging status, while the high impedance indicates the opposite. Charging circuitry is powered by OUT pin. Charging soft-start timer of 10ms is added to make sure OUT is ready. /ACOK can also be used to detect charging states by a microprocessor using a pull-up resistor.

Charging Current Control

The charging current is controlled by the GDRV pin. When sourcing current from the GDRV pin, the BAT pin delivers the charging current whose magnitude is 200-fold of GDRV's current. The I_{BAT} current can be calculated by the following equation:

$$I_{BAT}=200XI_{GDRV}$$

where

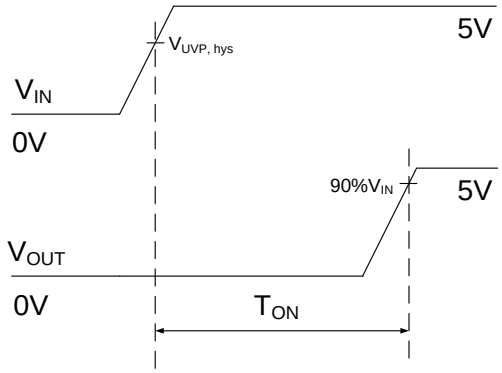
I_{BAT} is the current flowing out from the BAT pin.

I_{GDRV} is the current flowing out from the GDRV pin.

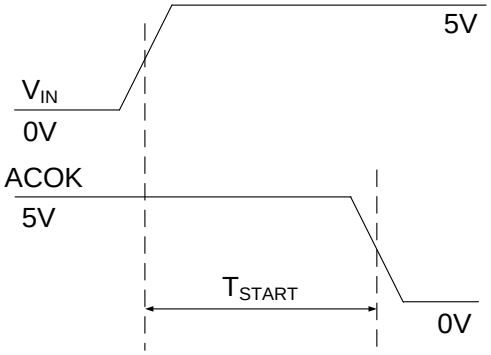
Temperature Protection

When the junction temperature exceeds 160°C, the internal thermal sense circuit turns off the power MOS to cool down the chip. When the device's junction temperature cools by 25°C, the internal thermal sense circuit will enable the device, resulting in a pulsed output during continuous thermal protection. Thermal protection is designed to protect the IC in the event of over temperature conditions. For normal operation, the junction temperature cannot exceed 125°C.

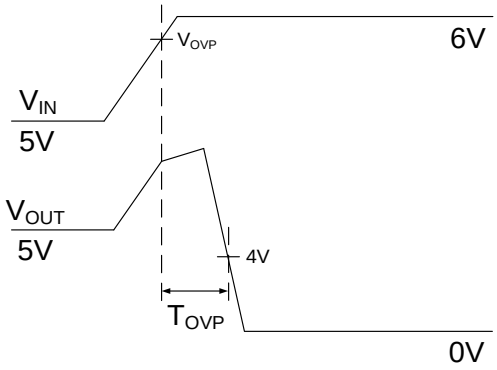
Typical Characteristics (T_A=25°C, unless otherwise noted)



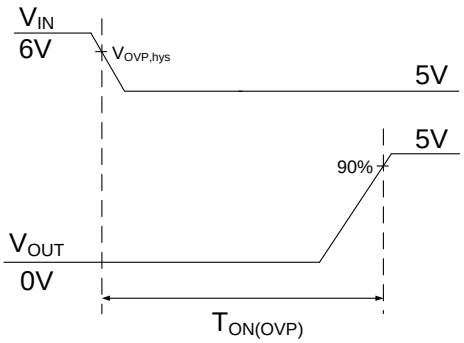
V_{OUT} Power on



ACOK Start up

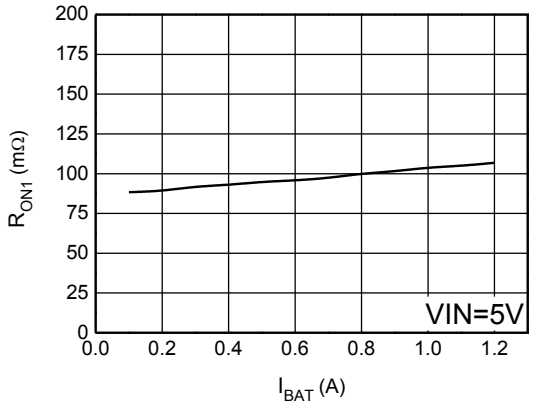


OVP Propagation

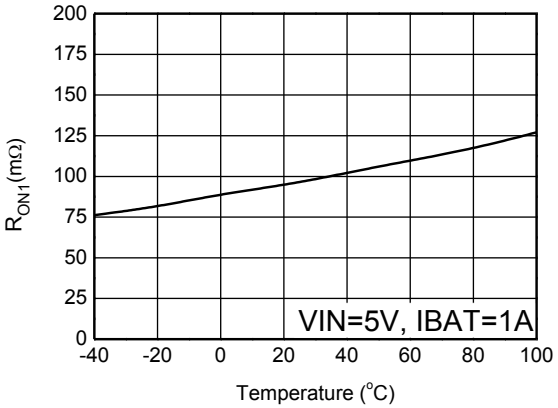


OVP Recovery

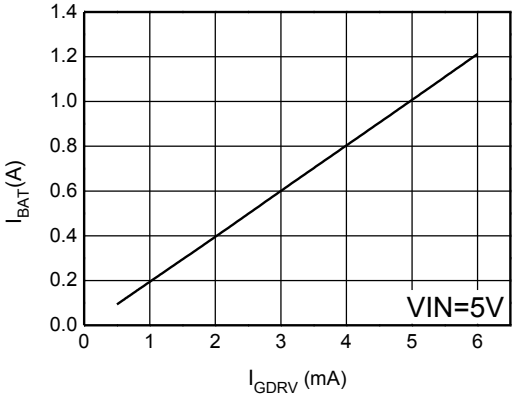
Typical Characteristics (T_A=25°C, unless otherwise noted)



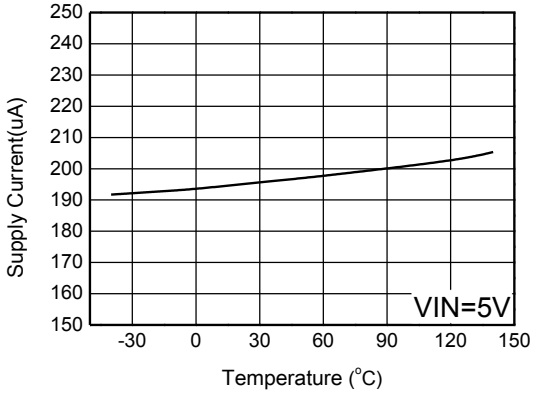
VIN to OUT On Resistance
vs. Charge Current



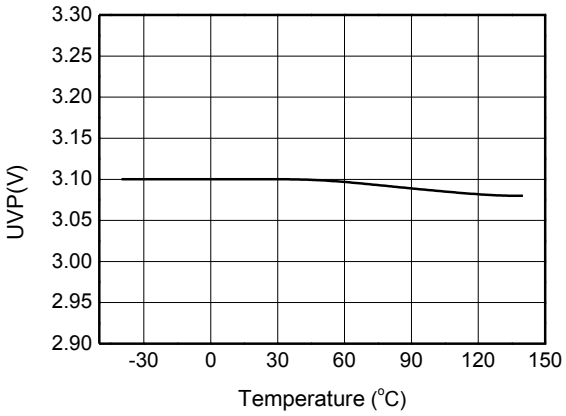
VIN to OUT On Resistance
vs. Junction Temperature



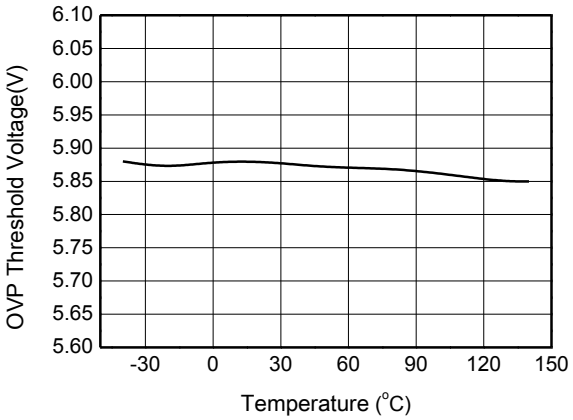
Charge Current vs. GDRV Current



VIN Supply Current
vs. Junction Temperature



VIN UVP Threshold
Vs. Junction Temperature



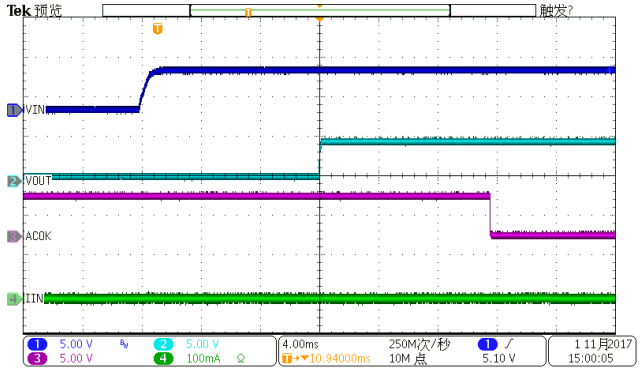
VIN OVP Threshold
vs. Junction Temperature

Operating Waveforms

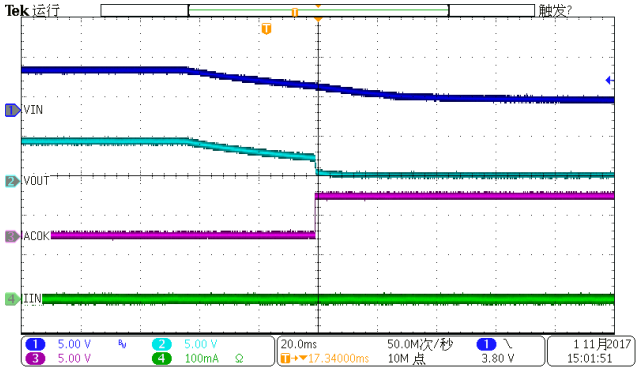
Refer to the typical application circuit. The test condition is V_{IN}=5V, T_A=25 °C unless otherwise specified.

Normal Power-On and Power-Off

I_{OUT}=0A：

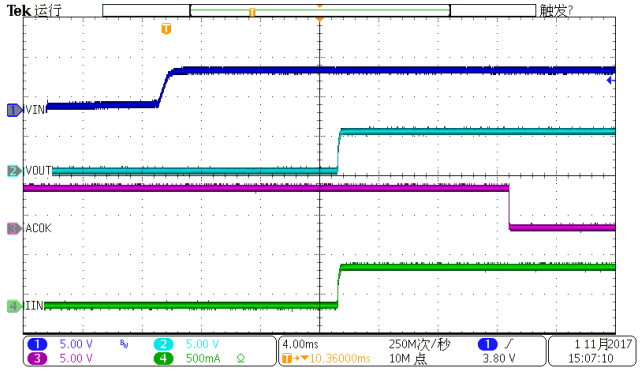


Power-On

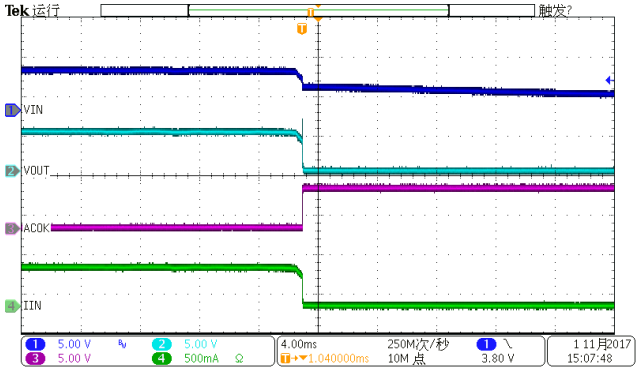


Power-Off

I_{OUT}=0.5A：

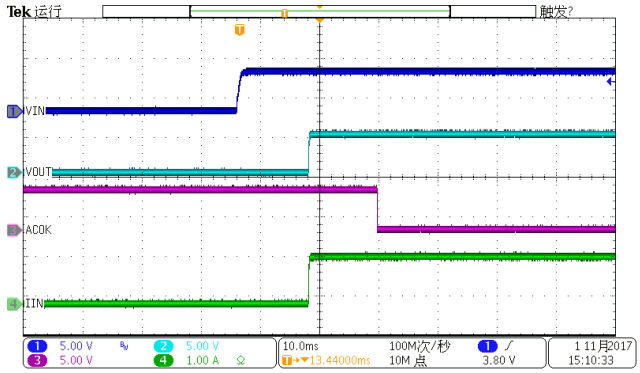


Power-On

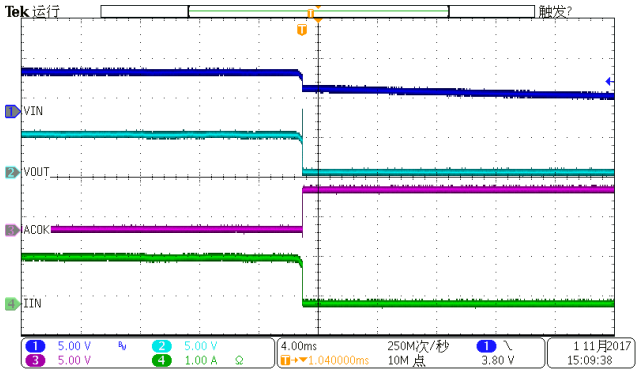


Power-Off

I_{OUT}=1A：



Power-On



Power-Off

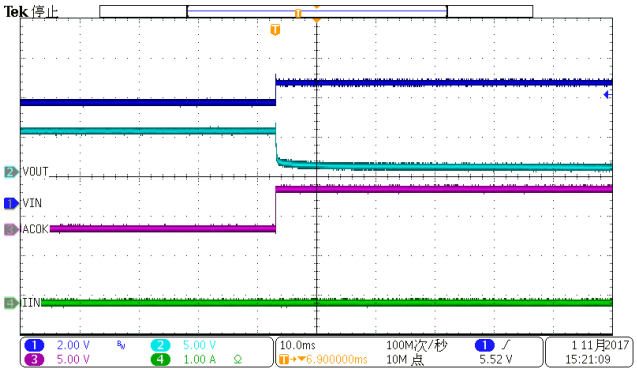
Operating Waveforms

Refer to the typical application circuit. The test condition is V_{IN}=5V, T_A=25 °C unless otherwise specified.

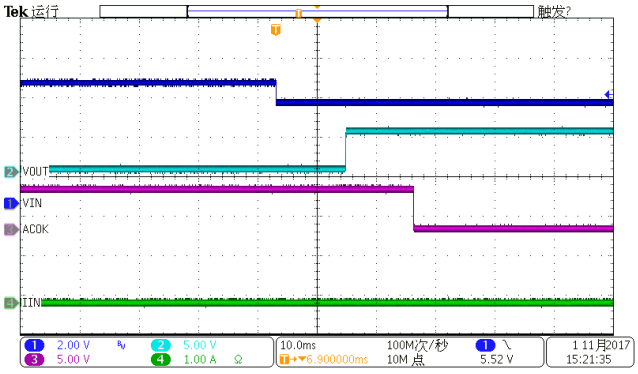
Input OVP and Recovery

(V_{IN} rises from 5V to 6V, then drops to 5V)

I_{OUT}=0A：

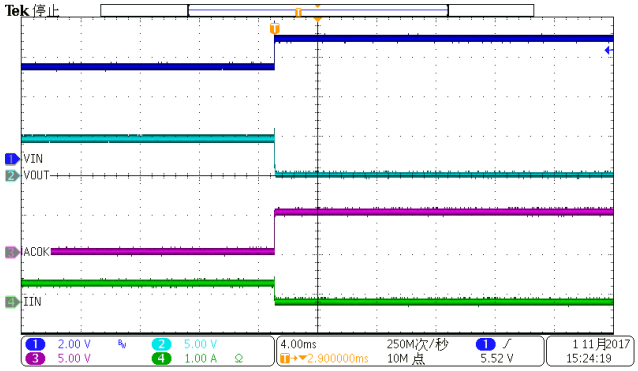


OVP

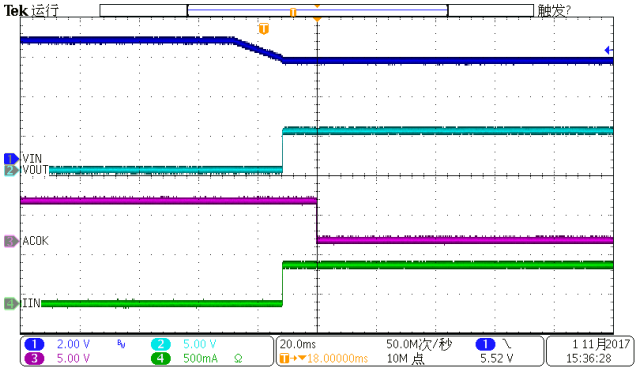


OVP Recovery

I_{OUT}=0.5A：

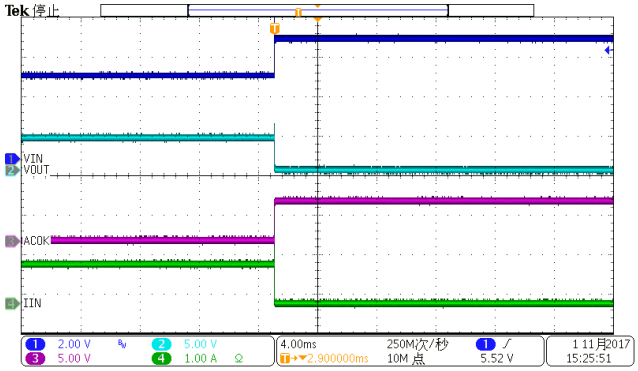


OVP

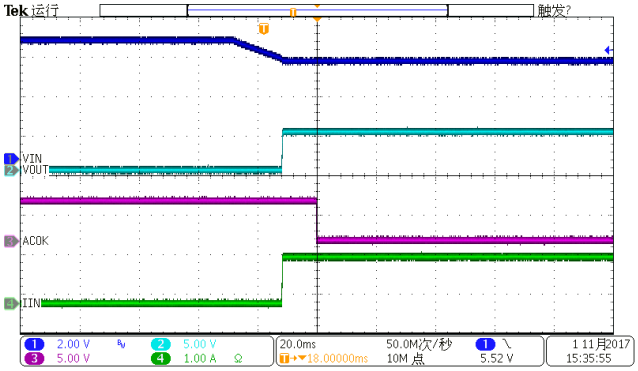


OVP Recovery

I_{OUT}=1A：



OVP



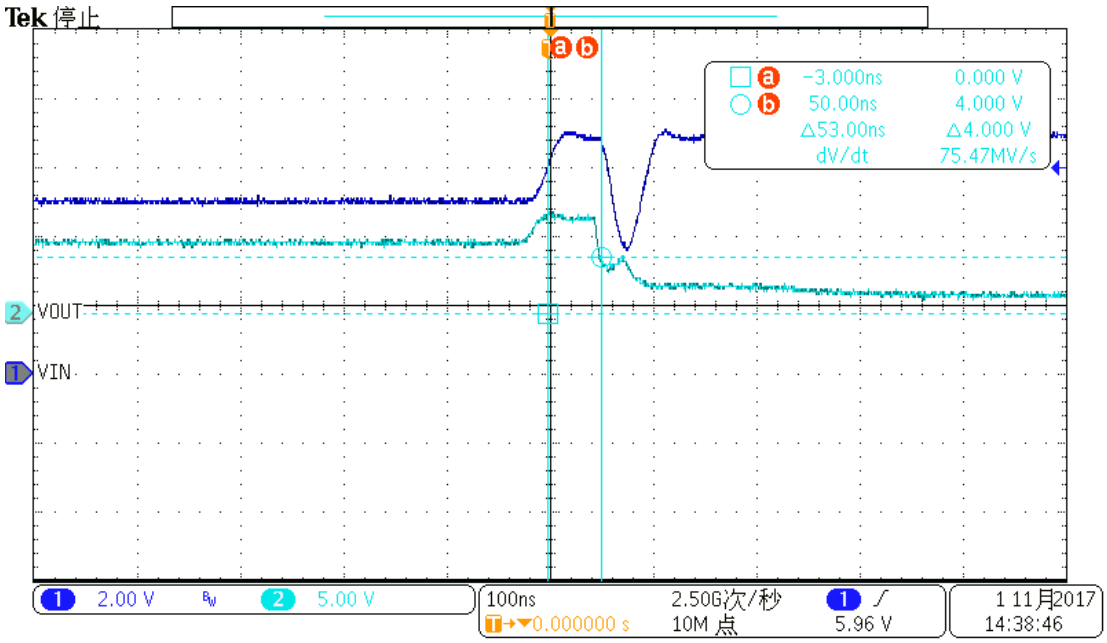
OVP Recovery

Operating Waveforms

Refer to the typical application circuit but remove capacitors on VIN pin and OUT pin. The test condition is V_{IN}=5V, T_A=25 ^oC unless otherwise specified.

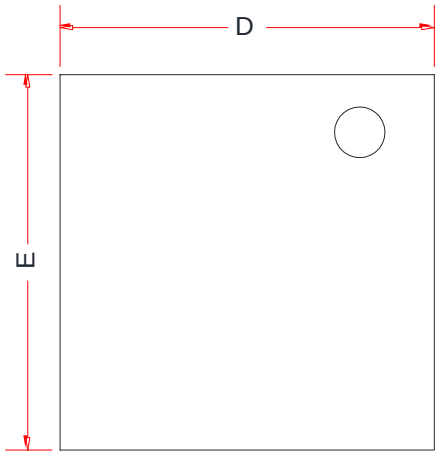
Input OVP Propagation Delay

(V_{IN} rises from 5V to 6.5V)

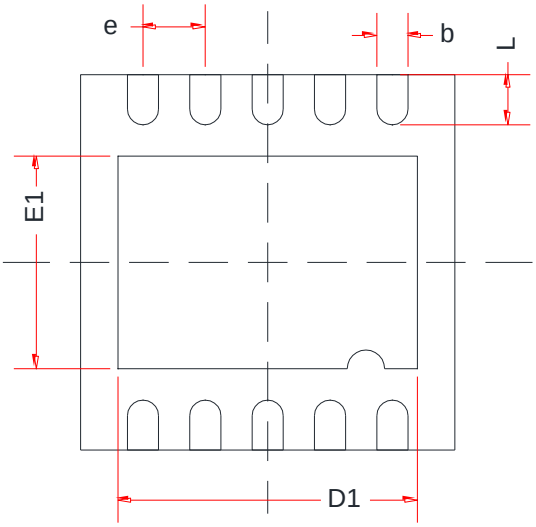


Package Outline Dimensions

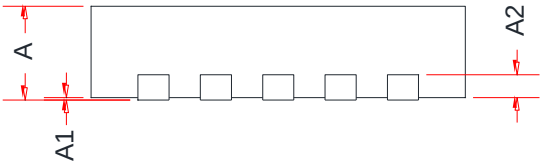
DFN3x3-10L



TOP VIEW



BOTTOM VIEW

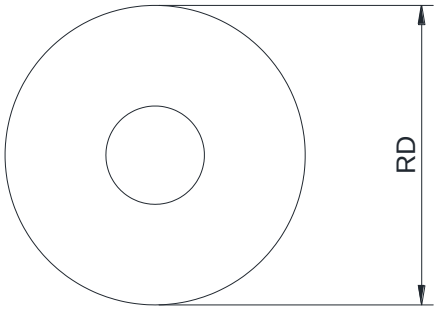


SIDE VIEW

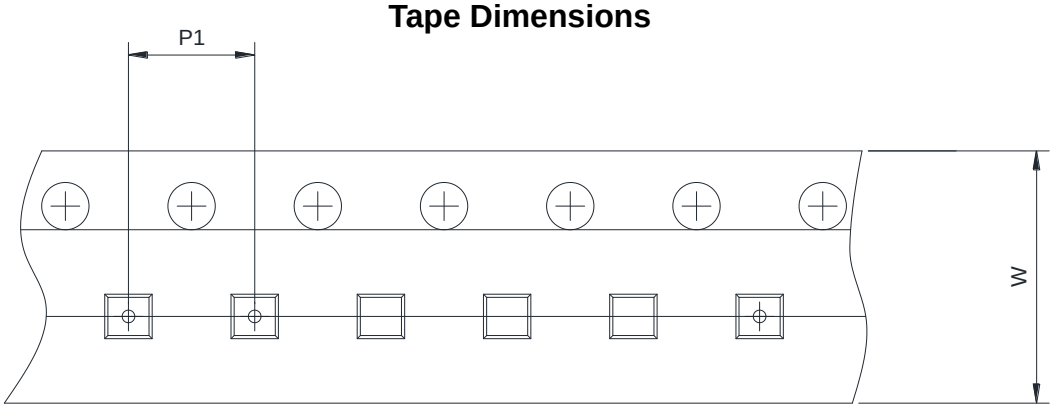
Symbol	Dimensions in Millimeters		
	Min.	Typ.	Max.
A	0.700	0.750	0.800
A1	0.000	0.020	0.050
A2		0.203 Ref.	
D	2.900	3.000	3.100
E	2.900	3.000	3.100
D1	2.300	2.400	2.500
E1	1.600	1.700	1.800
b	0.200	0.250	0.300
e		0.500 Typ.	
L	0.324	0.400	0.476

TAPE AND REEL INFORMATION

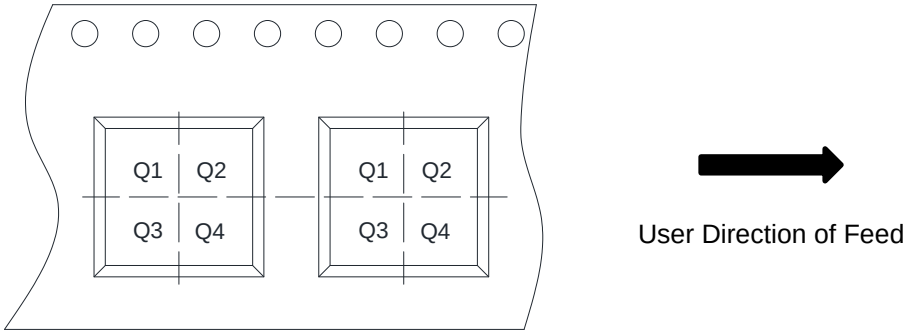
Reel Dimensions



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