

SK62536 32V 6.5A, 14mΩ Ultra-Low On-Resistance OVP

GENERAL DESCRIPTION

The SK62536 Over-Voltage Protection device features an ultra low R_{DS_ON} resistance, typical 14mΩ, internal nFET for USB VBUS line. The nFET switch ensures safe and right current flow in both charging and host modes such as OTG while protecting the internal system circuits from any over voltage conditions. Over-voltage threshold can be adjusted externally with a resistor divided network, or set internally by the built-in value.

The SK62536 features an open-drain output nACK, when $V_{IN_UVLO} < V_{IN} < V_{IN_OVLO}$ and the switch is on, nACK will be driven low to indicate a good power input, otherwise it is high impedance. This device features over-temperature protection that prevents itself from thermal damaging.

The SK62536 is available in a DFN3x3-10L package.

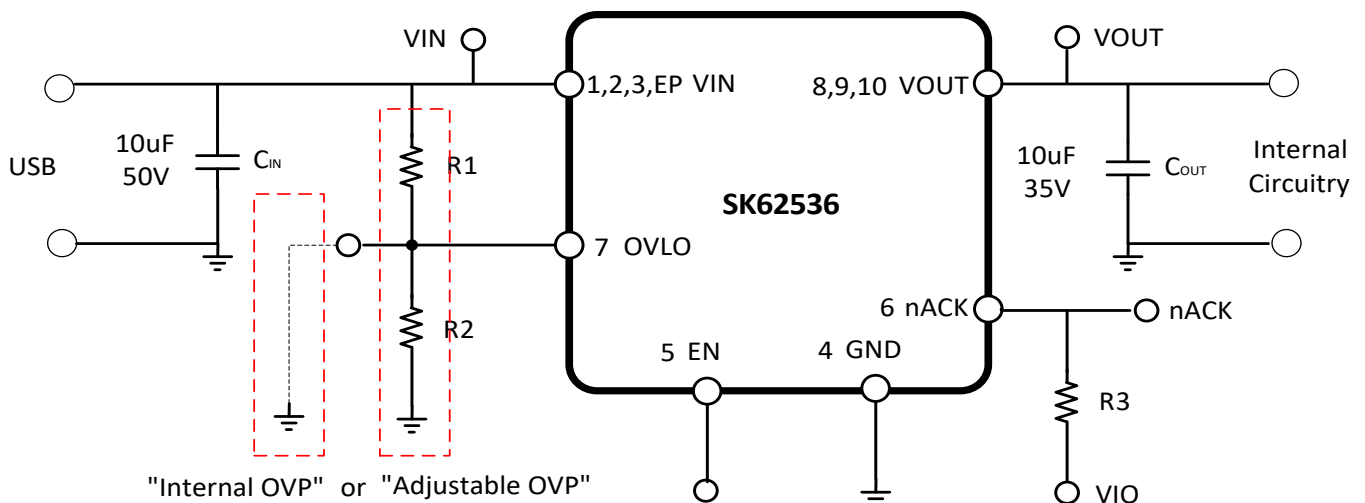
FEATURES

- Input DC Voltage Range: 3.0V ~ 32V
- Maximum Continuous Load Current: 6.5A
- Ultra Low R_{DS_ON} n-Channel MOSFET: 14mΩ (typ.)
- Fixed Internal OVP Lockout: 6.0V (typ.)
- Adjustable OVLO Range: 4V ~ 16V
- OVP Response Time: 60ns (typ.)
- No Inrush Current Design
- OTG Functionality on VBUS Path
- Active-low Switch Status Indicator Output

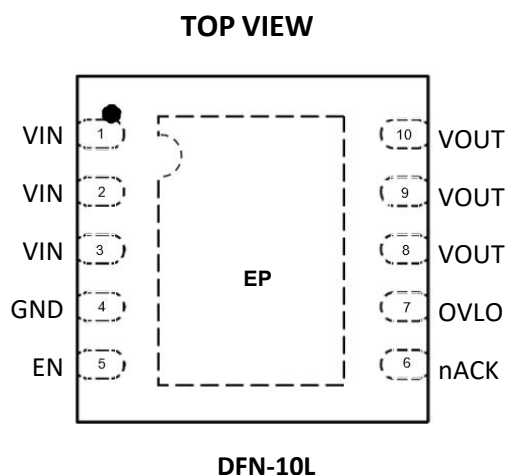
APPLICATIONS

- Mobile Handsets
- Tablets
- Wearable Devices
- Charging Ports

TYPICAL APPLICATION CIRCUIT



PIN CONFIGURATION



PIN DESCRIPTIONS

Pin	Name	Description
1/2/3	VIN	Voltage Input. Bypass with a typical 10 μ F/50V ceramic capacitor as close to the device as possible.
4	GND	Ground
5	EN	Enable pin. Active low.
6	nACK	Open-Drain Active-Low Output. Active-low logic output. It needs an external pull-up resistor, e.g. 10k Ω ~ 470 k Ω , to the System I/O. If not used, leave it open or tied to ground.
7	OVLO	OVP Threshold Adjustment. Connect the pin to ground to use a fixed internal threshold. Connect a resistor-divider to set a different threshold between 4V and 16V.
8/9/10	VOUT	Output Voltage. Bypass with a typical 10 μ F/35V ceramic capacitor as close to the device as possible. Capacitor breakdown voltage selected is depended on OVLO threshold set.
EP	EP	Exposed Pad. Voltage Input. Need to short to Pin 1 with wide metal trace.

ORDERING INFORMATION

Part Number	Temperature	Package	Quantity/ Reel
SK62536DC10-ADJ	-40°C ~ +85°C	DFN3x3-10L	5000

ABSOLUTE MAXIMUM RATINGS

$T_A = 25^{\circ}\text{C}$ unless otherwise specified

Parameter	Symbol	Min	Max	Unit
Input DC voltage	V_{IN}	-0.3	35	V
Output voltage	V_{OUT}	-0.3	18	V
OVLO voltage	V_{OVLO}	-0.3	7	V
nACK voltage	V_{ACK}	-0.3	7	V
EN voltage	V_{EN}	-0.3	7	V
Switch current (Continuous current)	I_{IN}		7	A
Ambient temperature	T_A	-40	85	$^{\circ}\text{C}$
Junction temperature	T_J	-40	125	$^{\circ}\text{C}$
Storage temperature	T_{STG}	-55	150	$^{\circ}\text{C}$
Soldering temperature (At leads, 10 seconds)	T_{LEAD}		260	$^{\circ}\text{C}$

THERMAL INFORMATION

Parameter	Symbol	Value	Unit
Thermal resistance from junction to ambient (In free air)	$R_{\theta JA}$	60	$^{\circ}\text{C/W}$

RECOMMENDED OPERATING CONDITIONS

Parameter	Symbol	Min	Max	Unit
Input DC Voltage Range	V_{IN}	3.0	32	V
Output DC Voltage Range	V_{OUT}	4	16	V
Input Capacitance	C_{IN}	4.7		μF
Switch current (Continuous current)	I_{IN}		6.5	A
Output Load Capacitance	C_{OUT}	4.7	220	μF
Human Body Model	V_{ESD}	± 2000		V
Charged Device Model		± 500		V
Latch-up	$I_{LATCH-UP}$	± 200		mA

ELECTRICAL CHARACTERISTICS

$V_{IN} = 5V$, $T_A = 25^{\circ}C$ unless otherwise specified

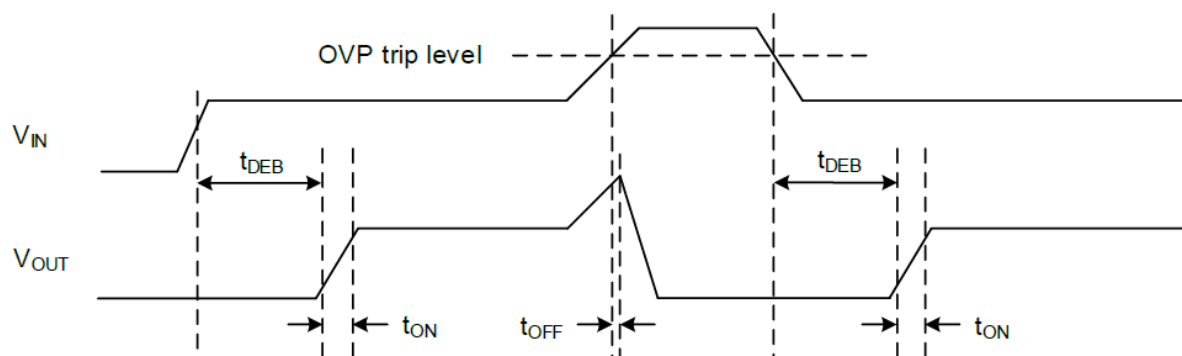
Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Switch on resistance	R_{DS_ON}	$V_{IN} = 12V$, $I_{OUT} = 1A$		14	20	mΩ
		$V_{IN} = 5V$, $I_{OUT} = 1A$		14	20	mΩ
		$V_{IN} = 3.3V$, $I_{OUT} = 1A$		16	22	mΩ
Shutdown current	I_{SD}	$V_{IN} = 5V$, EN floating		5	10	μA
Input quiescent current	I_Q	$V_{IN} = 5V$, $V_{OVLO} = 0V$, $I_{OUT} = 0A$		105	130	μA
Input current at over-voltage condition	I_{IN_OVLO}	$V_{IN} = 5V$, $V_{OVLO} = 3V$, $V_{OUT} = 0V$		99	130	μA
UVLO trip level	V_{IN_UVLO}	V_{IN} rising			2.8	V
		V_{IN} falling	2.1			
EN high input voltage	V_{IH}		1.2			V
EN low input voltage	V_{IL}				0.3	V
Protection						
OVP trip level	V_{IN_OVLO}	V_{IN} rising		6		V
		Hysteresis		0.15		
External OVLO select threshold	V_{OVLO_SEL}	OVLO Rising	0.26	0.29	0.32	V
		Hysteresis		0.04		
OVLO set threshold	V_{OVLO_TH}		1.16	1.20	1.24	V
OVP threshold adjustable range	V_{OVLO_RNG}		4		16	V
OVLO pin leakage current	I_{OVLO}	$V_{OVLO} = V_{OVLO_TH}$	-0.1		0.1	μA
Shutdown temperature	T_{SDN}			145		°C
Shutdown temperature hysteresis	T_{SDN_HYS}			30		°C

ELECTRICAL CHARACTERISTICS (CONT.)

($T_A = 25^\circ\text{C}$ unless otherwise specified)

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Timing Characteristics						
Debounce time	t_{DEB}	From $V_{\text{IN}} > V_{\text{IN_UVLO}}$ to 10% V_{OUT}		23	30	ms
Switch turn-on time	t_{ON}	$R_{\text{OUT}} = 100\Omega$, $C_{\text{OUT}} = 0.1\mu\text{F}$, V_{OUT} from 10% V_{IN} to 90% V_{IN}		305		μs
Switch turn-off time	t_{OFF}	$R_{\text{OUT}} = 100\Omega$, $C_{\text{OUT}} = 0.1\mu\text{F}$, $V_{\text{IN}} > V_{\text{IN_UVLO}}$ to V_{OUT} stop rising, V_{IN} rise at $10\text{V}/\mu\text{s}$		60		ns

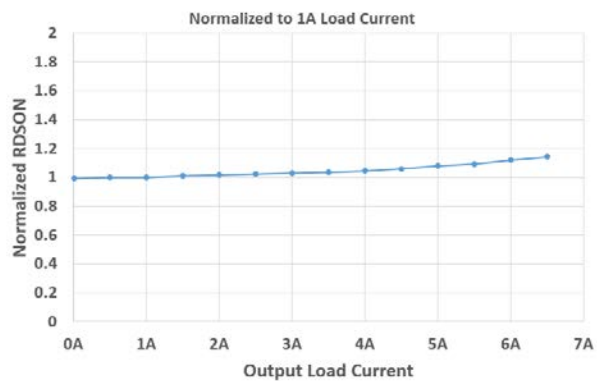
TIMING DIAGRAM



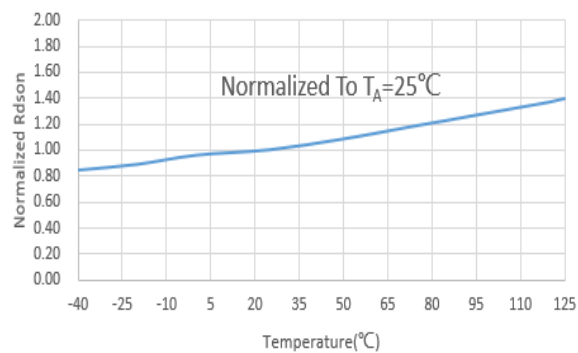
TYPICAL PERFORMANCE CHARACTERISTICS

($V_{IN} = 5V$, $C_{IN} = C_{OUT} = 0.1\mu F$, $T_A = 25^\circ C$)

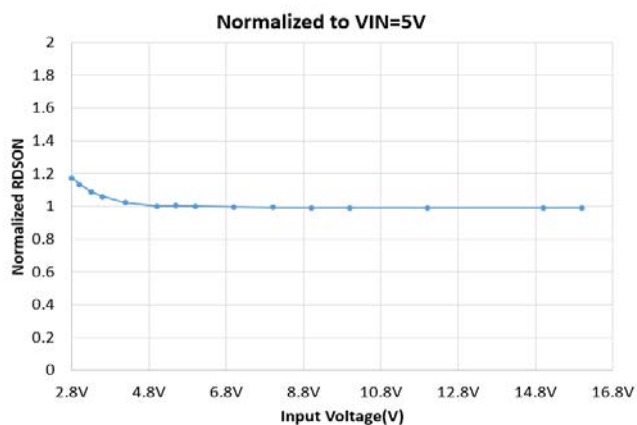
Normalized R_{DS_ON} vs Output Current. ($V_{IN}=5V$)



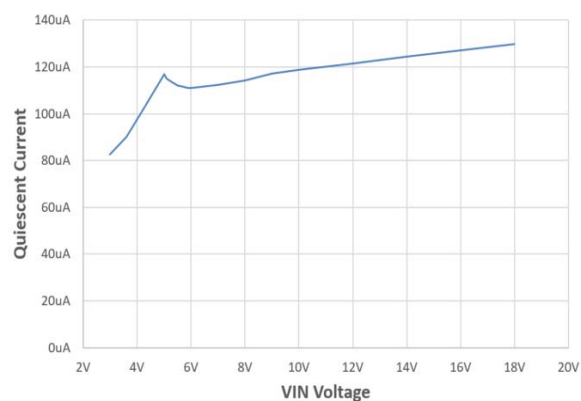
Normalized R_{DS_ON} vs Temp. ($I_{OUT}=1A$)



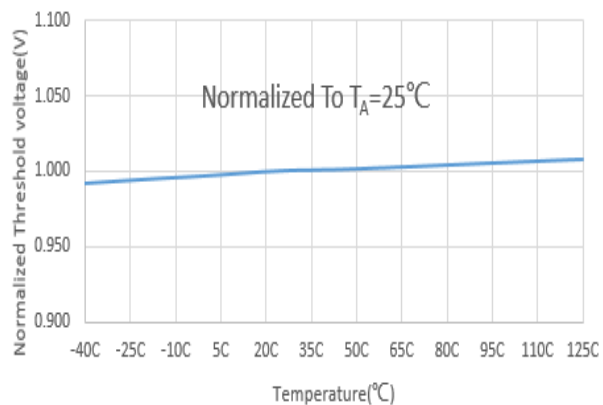
Normalized R_{DS_ON} vs Input Voltage ($I_{OUT}=1A$)



Input Supply Current vs Supply Voltage



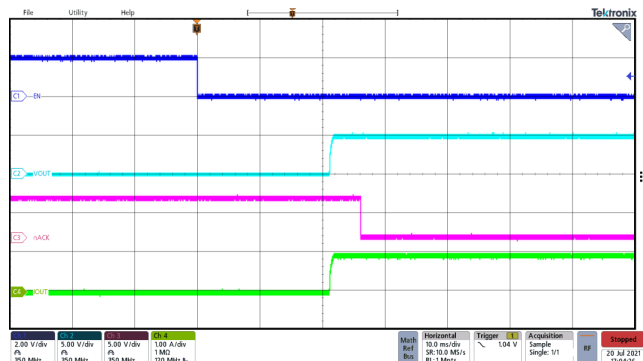
Normalized Internal OVP Threshold



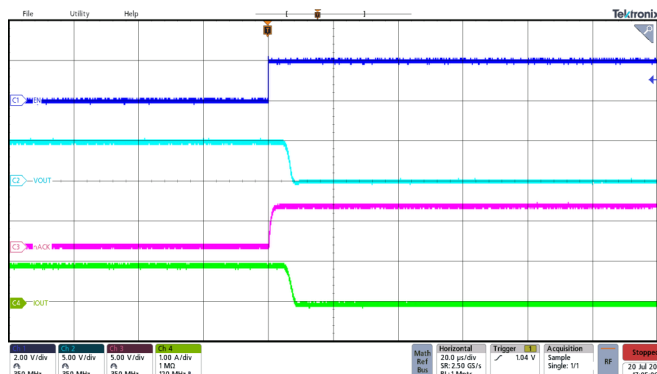
TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

$V_{IN} = 5V$, $C_{IN} = C_{OUT} = 0.1\mu F$, $R_{OUT} = 100\Omega$, $OVLO = GND$, $T_A = 25^\circ C$, $V_{IO} = 5V$, $R_3 = 47K\Omega$

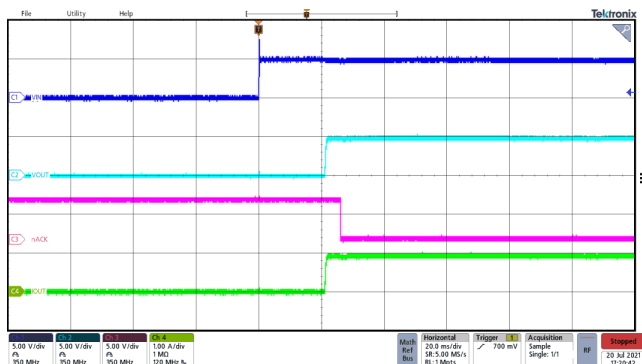
EN ON with 5Ω Load



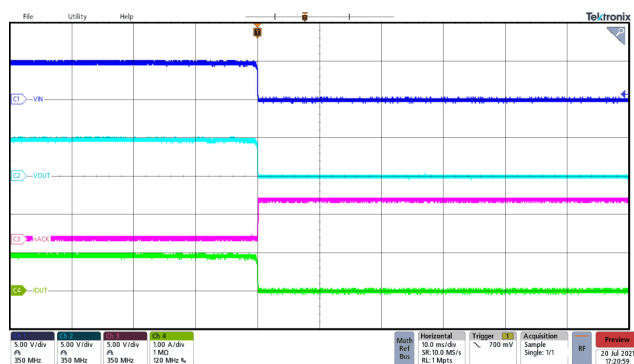
EN OFF with 5Ω Load



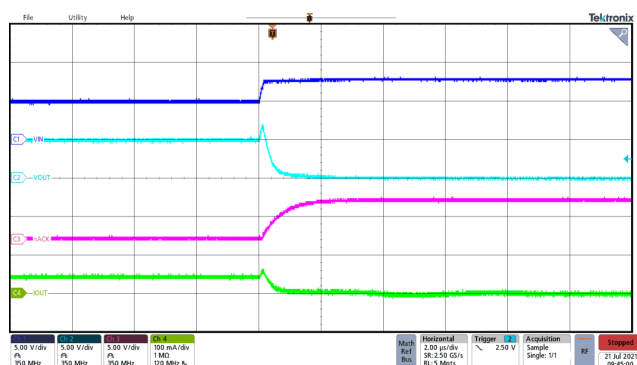
Power on with 5Ω Load



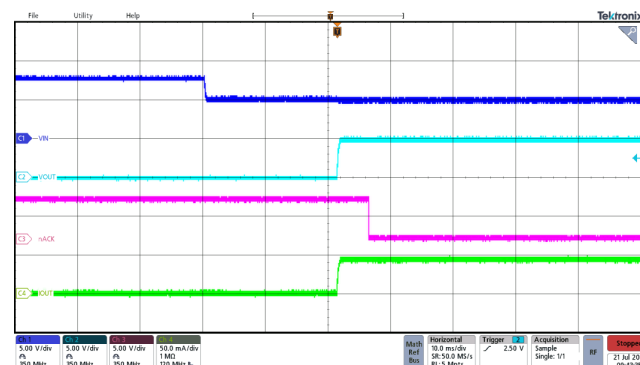
Power off with 5Ω Load



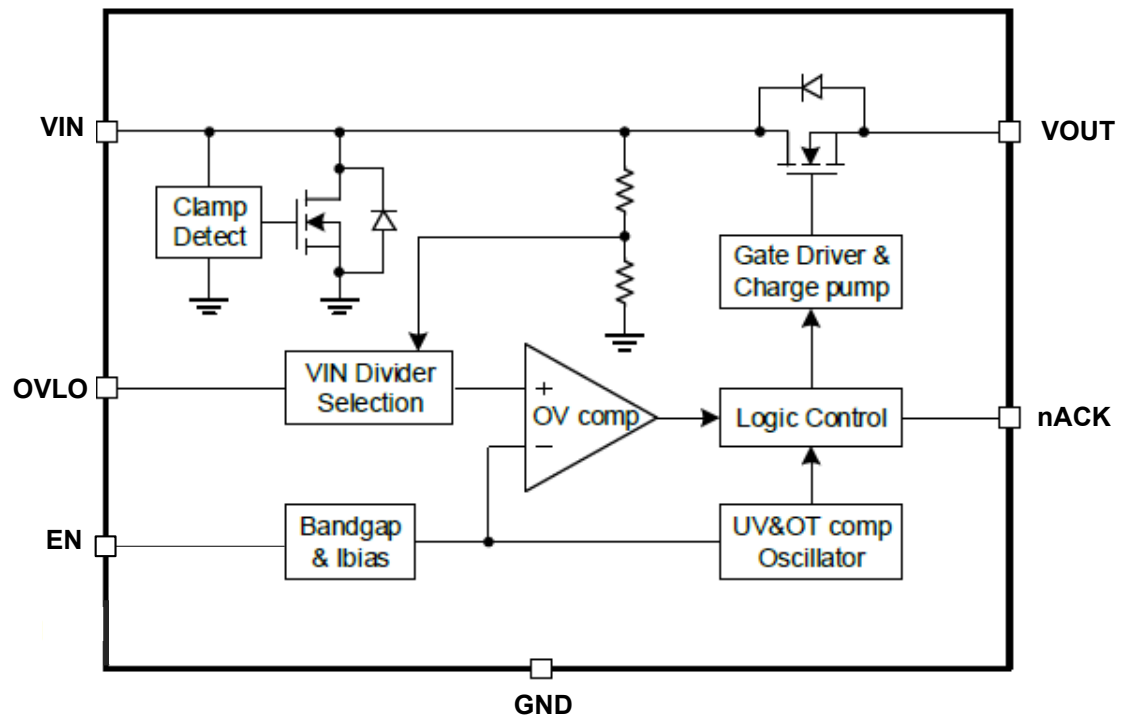
OVP Response



Recovery from OVP



BLOCK DIAGRAM



FUNCTIONAL DESCRIPTION

Device Operation

If the input voltage is between UVLO and OVP threshold, the internal charge pump begins to work after debounce time, the gate of the nFET switch will be slowly charged high till the switch is fully on. If the input voltage exceeds the OVP trip level, the switch will be turned off in about 60ns. If input voltage falls below UVLO threshold, or over-temperature happens, the switch will also be turned off.

Over-Voltage Protection

If the input voltage exceeds the OVP rising trip level, the switch will be turned off in typical 60ns. The switch will remain off until VIN falls below the OVP falling trip level.

OVP Threshold Adjustment

If OVLO pin is not grounded, and by connecting external resistor divider to OVLO pin as shown in the typical application circuit, between IN and GND, the OVP threshold can be set as following formula:

$$V_{IN_OVLO} = V_{OVLO_TH} * (1 + R1/R2)$$

The adjustment range is 4V to 16V. When the OVLO pin voltage V_{OVLO} exceeds V_{OVLO_SEL} (0.29V typical), V_{OVLO} is compared with the reference voltage V_{OVLO_TH} (1.2V typical) to judge whether input supply is over-voltage.

USB On-The-Go (OTG) Operation

If $V_{IN} = 0V$ and OUT is supplied by OTG voltage, the body diode of the load switch conducts current from OUT to IN and the voltage drop from OUT to IN is approximately 0.7V. When $V_{IN} > V_{IN_UVLO}$, internal charge pump begins to open the load switch after debounce time. After switch is fully on, current is supplied through switch channel and the voltage drop from OUT to IN is minimum.

Load Switch Status Indicator

The device has a load switch status indicator to notify load switch on/off status to other devices. When load switch is on status, the device pulls nACK pin down to the GND. To avoid glitch during power up, it is recommended to limit rising slew rate at VIN less than 1V/uS or de-assert EN after power-up.

Enable function

The device has a enable pin that it is available with active low. When it is active high, the device will enter ECO mode with typical 2μA low standby current.

Thermal Protection

The device has an Over-Temperature Protection circuit to protect device against system fault or improper use. When the junction temperature exceeds the threshold (145°C typical), the device shuts down and stays off until the temperature cools down to a safe region (below falling threshold). Once the falling threshold, the device will automatically resume the normal operation with embedded timings.

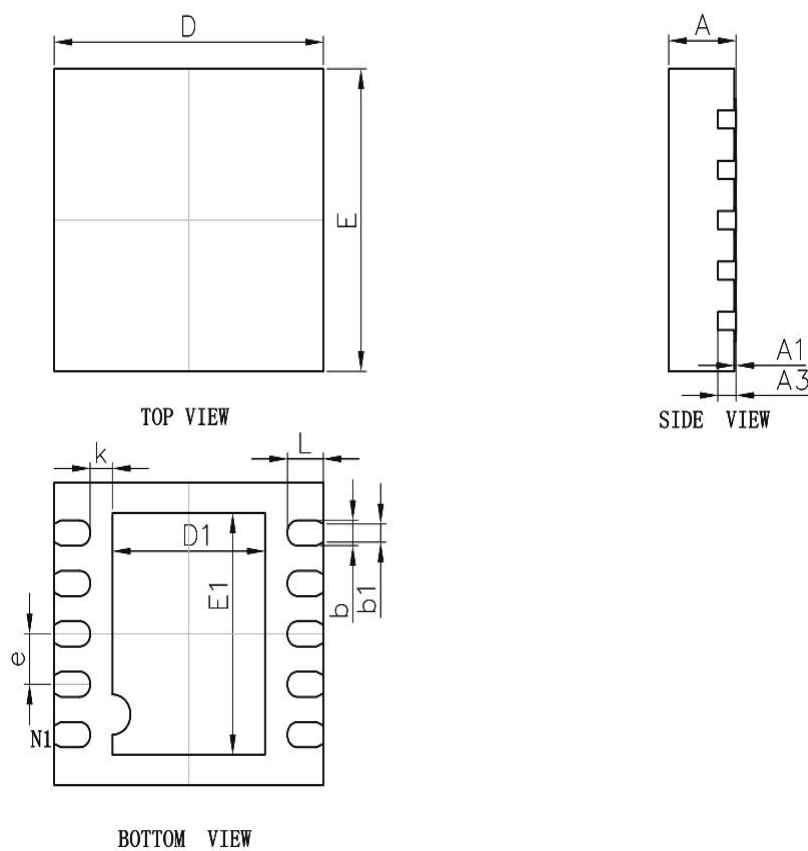
Device Operation Summary

Conditions		Operations			
V_{IN}	V_{OUT}	Current Direction	nFET	nACK	Mode
< OVP Threshold	< V_{IN}	$V_{IN} \rightarrow V_{OUT}$	On	Low	Charge
< OVP Threshold	> V_{IN}	$V_{OUT} \rightarrow V_{IN}$	On	Low	OTG
$\geq$ OVP Threshold	< V_{IN}	No Current flowing	Off	Hi-z	OVP
$\geq$ OVP Threshold	> V_{IN}	$V_{OUT} \rightarrow V_{IN}$ (via the junction body diode)	Off	Hi-z	OVP
< UVLO Threshold	< V_{IN}	No Current flowing	Off	Hi-z	UVLO

PCB LAYOUT CONSIDERATION

1. All the peripherals should be placed as close to the device as possible. Place the input capacitor C_{IN} on the top layer and close to V_{IN} pin, and place the output capacitor C_{OUT} on the top layer and close to V_{OUT} pin.
2. Exposed Pad (EP) connects to V_{IN} , which is USB connector, and conducts large current during normal operation as well as surge protection. Route it out as straight, wide and short as possible. Also keep other traces away from it to minimize possible EMI coupling.
3. GND pin conducts large current during surge protection. Make sure no signal trace blocks the path for current flow.
4. Use rounded corners on the power trace to decrease EMI.
5. If R_1 and R_2 are used, route OVLO line as short as possible to reduce parasitic capacitance.

PACKAGE DIMENSIONS: DFN3x3-10L



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN.	MAX.	MIN.	MAX.
A	0.700	0.800	0.028	0.031
A1	0.000	0.050	0.000	0.002
A3	0.203REF.		0.008REF.	
D	2.924	3.076	0.115	0.121
E	2.924	3.076	0.115	0.121
D1	1.600	1.800	0.063	0.071
E1	2.300	2.500	0.091	0.098
b	0.200	0.300	0.008	0.012
b1	0.180REF		0.007REF	
e	0.500BSC.		0.020BSC.	
k	0.250REF		0.010REF	
L	0.324	0.476	0.013	0.019