1. General Description

WP3116 features an ultra-low $R_{DS(ON)}$ nFET switch with over voltage protection for input voltage. When input voltage exceeds the OVLO threshold, the switch is turned off immediately to prevent damage to the protected downstream devices.

The device features internal Thermal Shutdown Protection. The device features an open-drain output FLAG, when $V_{UVLO} < V_{IN} < V_{OVLO}$, FLAG is low and indicate a good input, otherwise it is high impedance.

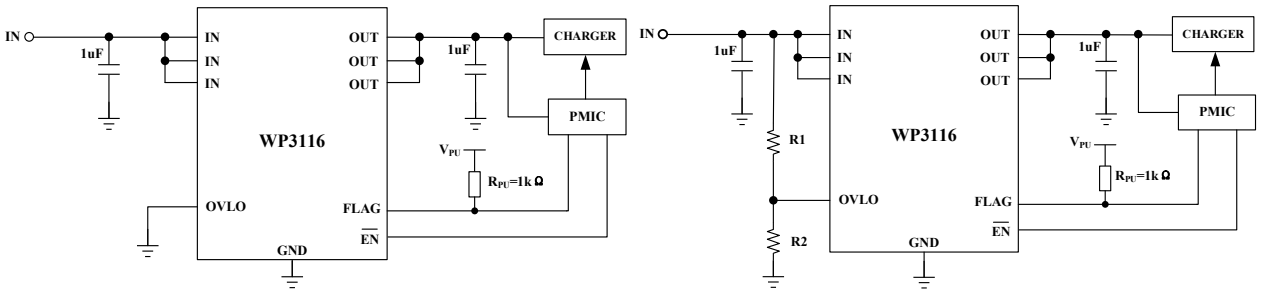
2. Features

- 4.8A Continuous Current Capability
- Ball pitch:0.4mm
- $R_{DS(ON)}$:30mΩ(Typ.)
- Surge protection:±100V
- OVP Response Time:50ns
- Under-Voltage Lockout
- Thermal Shutdown
- ESD:4KV
- Package: WLCSP12, DFN1814-12

3. Applications

- Smart Phones
- Tablet PC
- Charging Ports

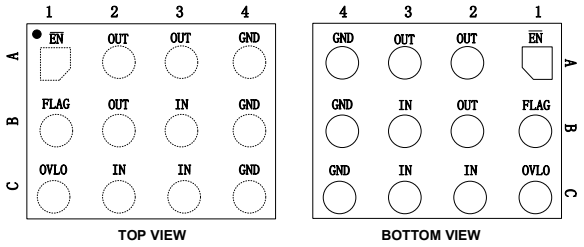
4. Typical Application



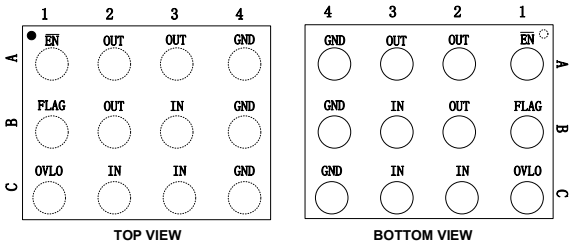
Note1： $V_{IN_OVLO}=\frac{R_1+R_2}{R_2}V_{OVLO_TH}$

Note2： Recommend 30 kΩ ≤ R_2 ≤ 51kΩ

5. Pin Configuration



DFN1814-12



WLCSP12

6. Pin Description

PIN NUMBER	PIN NAME	I/O	PIN FUNCTIONS		
A1	$\overline{EN}$	I	Device Enable, Active low.		
A2 A3 B2	OUT	O	Output Voltage.		
A4 B4 C4	GND		Ground.		
B1	FLAG	O	Power status indicator.	0	$V_{UVLO} < V_{IN} < V_{OVLO}$, $T_J < T_{SD}$
				1	Others
B3 C2 C3	IN	I	Input Voltage.		
C1	OVLO	I	External OVLO Adjustment. Connect OVLO to GND when using the internal fix threshold. Connect a resistor-divider to OVLO to set a different OVLO threshold.		

7. Absolute Maximum Ratings [3]

T_A=25℃, unless otherwise noted.

PARAMETER		RATING	UNIT
Input Voltage Range[4]		-0.3 to 35	V
Output Voltage Range [4]		-0.3 to 29	V
EN Voltage Range [4]		-0.3 to 7	V
OVLO Voltage Range[4]		-0.3 to 7	V
FLAG Voltage Range[4]		-0.3 to 7	V
Maximum Continuous Current IN to OUT		4.8	A
Maximum Peak Current IN to OUT		8	A
Power Dissipation @T_A= 25℃		800	mW
Junction Temperature		150	℃
Lead Temperature Range		260	℃
Storage Temperature Range		-65 ~ 150	℃
Surge	IEC61000-4-5	-100~100	V

Note3: Stresses beyond those listed under Absolute Maximum Ratings may cause permanent damage to the device. These are stress ratings only, which do not imply functional operation of the device at these or any other conditions beyond those indicated under Recommended Operating Conditions. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

Note4: Tested by 1ms width pulse voltage.

8. ESD Ratings—JEDEC Specification

PARAMETER			Rating	UNIT
Electrostatic discharge	IEC 61000-4-2 system on IN pin	Contact Discharge	±8000	V
		Air-gap Discharge	±15000	V
	Human-body model (HBM), per ANSI/ESDA/JEDEC JS-001-2017		±4000	V
	Charged device model (CDM), per ANSI/ESDA/JEDEC JS-002-2018		±1000	V
	Machine model, per JEDEC JESD-A115C-2010		±200	V
	Latch-up model, per JEDEC JESD78F-2022		±150	mA

9. Recommended Operating Conditions

SYMBOL	PARAMETER	MIN	MAX	UNIT
V_{IN}	Input voltage	2.5	28	V
T_A	Operating Ambient Temperature	-40	85	℃
T_J	Operating Junction Temperature	-40	125	℃

10. Electrical Characteristics

(T_A=25ºC, V_{IN}=5V, C_{IN}=1μF, unless otherwise noted)

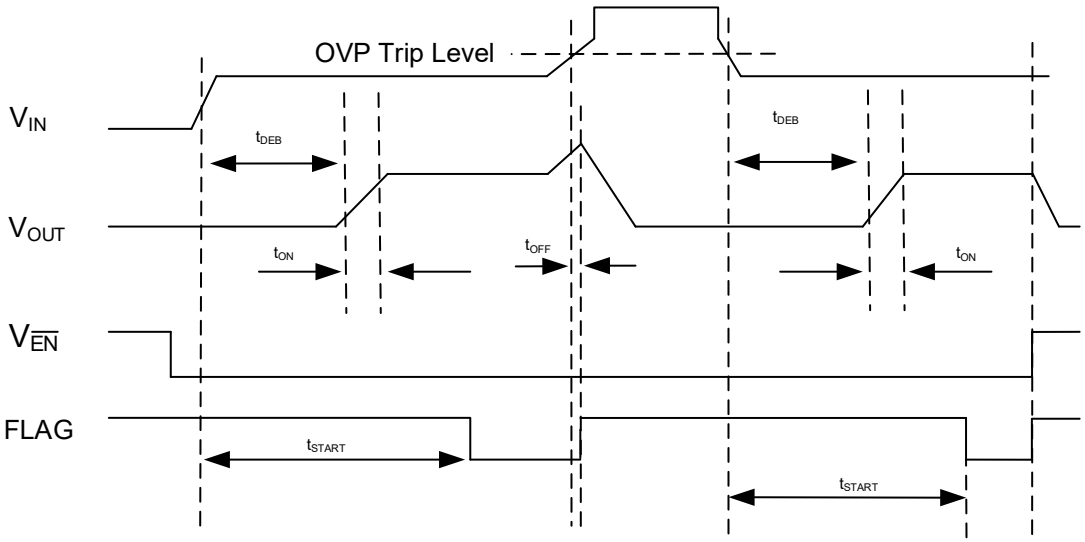
SYMBOL	PARAMETER	TEST CONDITIONS		MIN	TYP	MAX	UNIT
V_{IN}	Input Voltage			2.5		28	V
I_{IN}	IN Quiescent Current	V_{IN}=5V, OUT Floating			90		uA
I_{IN_OVLO}	IN Current at OVP	V_{IN}=12V, V_{OVLO} > 1.2V, OUT Floating			100		uA
$R_{DS(ON)}$	On-Resistance of Switch IN-OUT	V_{IN}=5.0V, I_{OUT}=1A, T_A=25 ºC			30		mΩ
V_{IN_OVLO}	Default OVP Threshold (V_{OVLO}=GND)	A	V_{IN} Rising	5.90	5.95	5.99	V
			Hysteresis		0.13		
		B	V_{IN} Rising	6.66	6.80	6.94	
			Hysteresis		0.14		
		C	V_{IN} Rising	10.29	10.50	10.71	
			Hysteresis		0.21		
		D	V_{IN} Rising	13.7	14.0	14.3	
			Hysteresis		0.28		
	Adjustable OVP Threshold Range			4		20	V
V_{OVLO_TH}	OVLO Set Threshold	V_{IN} =5V		1.18	1.2	1.22	V
V_{OVLO_SELECT}	External OVLO Select Threshold			0.2		0.3	V
V_{UVLO_R}	Under Voltage Lockout Threshold	V_{IN} Rising, V_{OVLO}=GND			2.1		V
V_{UVLO_F}		V_{IN} Falling, V_{OVLO}=GND			1.9		V
V_{FLAG_OL}	FLAG Output Logic Low Voltage	V_{PU}=1.8V, I_{SINK}=1mA			0.1	0.2	V
I_{FLAG_LEAK}	FLAG Output HIGH Leakage Current	V_{FLAG}=5V				0.5	μA
I_{OVLO}	OVLO Input Leakage Current	V_{OVLO}=V_{OVLO_TH}		-100		100	nA
V_{IH}	EN Input Logic High Voltage	V_{IN}=5V, V_{OVLO}=GND		1.4			V
V_{IL}	EN Input Logic Low Voltage	V_{IN}=5V, V_{OVLO}=GND				0.3	V
T_{SD}	Thermal Shutdown	V_{IN} = 5V			150		℃

SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
ΔT_{SD}	Thermal-shutdown Hysteresis	V_{IN} = 5V		20		℃
t_{DEB}	Debounce Time	From V_{IN} > V_{UVLO} to 10% V_{OUT}		15		ms
t_{START}	Start-up time	From V_{IN} > V_{UVLO} to FLAG turn low		30		ms
t_{ON}	Switch turn-on time	R_L=100Ω，C_L=22μF，V_{OUT} from 10%V_{IN} to 90%V_{IN}		2		ms
t_{OFF}[5]	Switch turn-off time	R_L=100Ω，C_L=0μF，V_{IN} > V_{OVLO} to V_{OUT} stop rising		50		ns

Note5: Guaranteed by design.

Note6: Limits over full temperature are guaranteed by design, but not tested in production.

11.Timing Diagram



12. Typical Performance Characteristics

(V_{IN} = 5V, C_{IN}=1μF, C_{OUT}=1μF, T_A=25℃, unless otherwise noted)

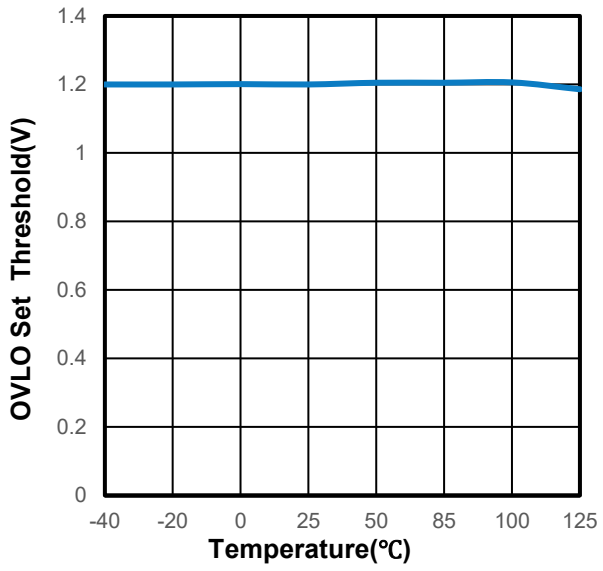


Figure 1. OVLO Set Threshold vs. Ambient Temperature

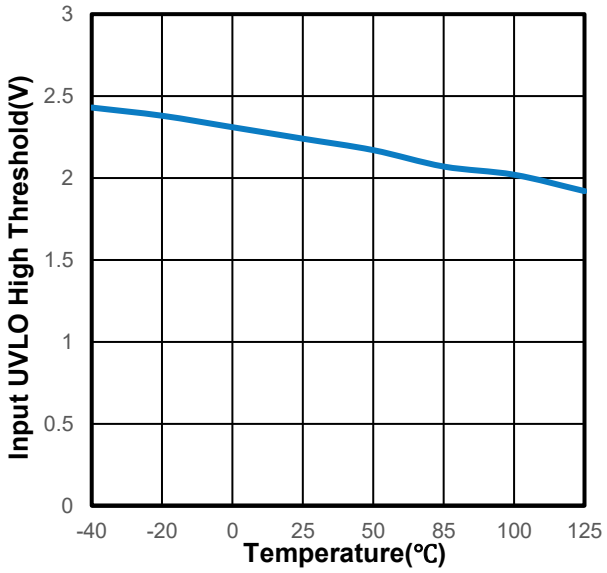


Figure 2. Input UVLO High Threshold vs. Ambient Temperature

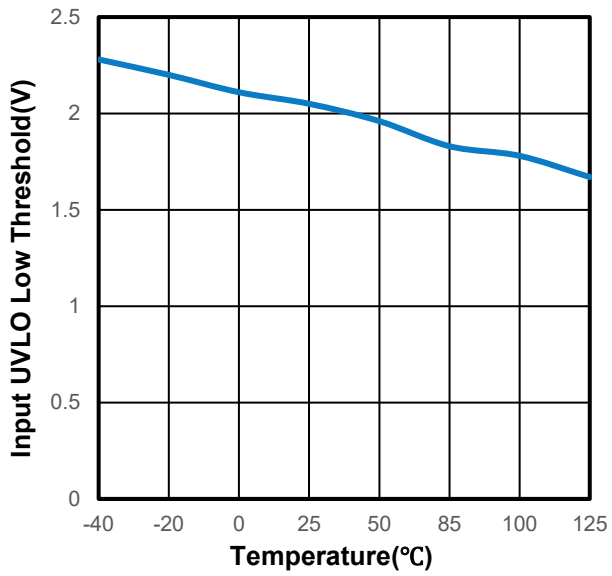


Figure 3. Input UVLO Low Threshold vs. Ambient Temperature

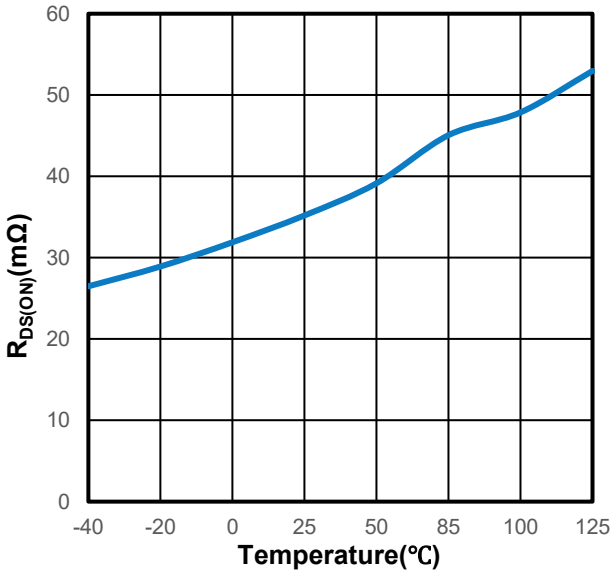


Figure 4. $R_{DS(ON)}$ vs. Ambient Temperature

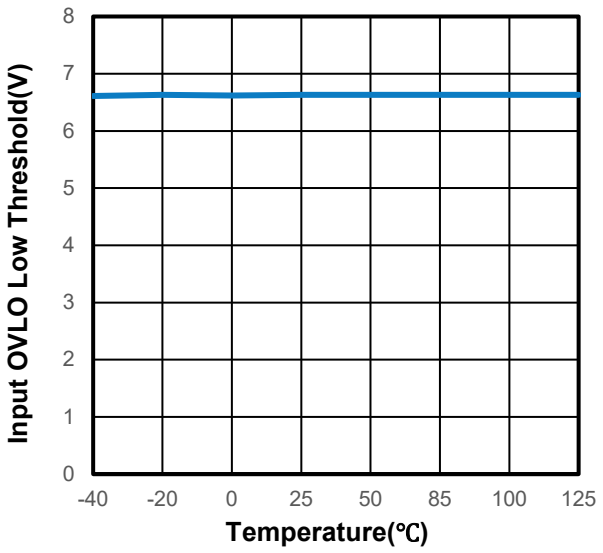


Figure 5. Input OVLO Low Threshold vs. Ambient Temperature (WP3116-B)

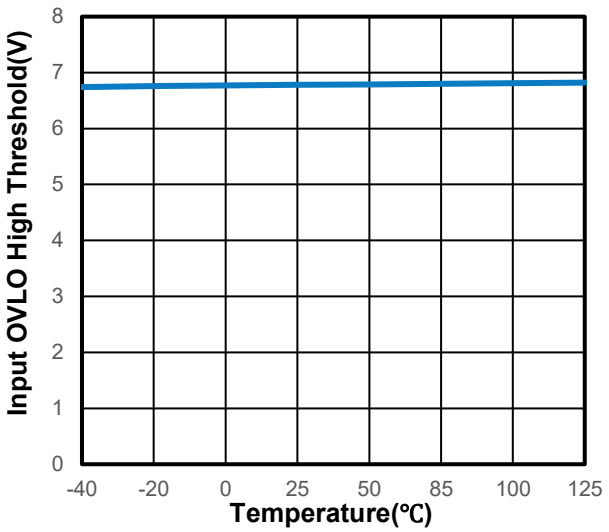


Figure 6. Input OVLO High Threshold vs. Ambient Temperature (WP3116-B)

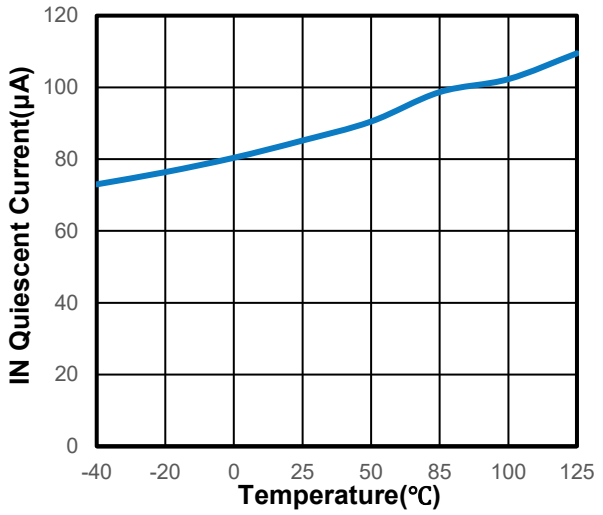


Figure 7. IN Quiescent Current vs. Ambient Temperature

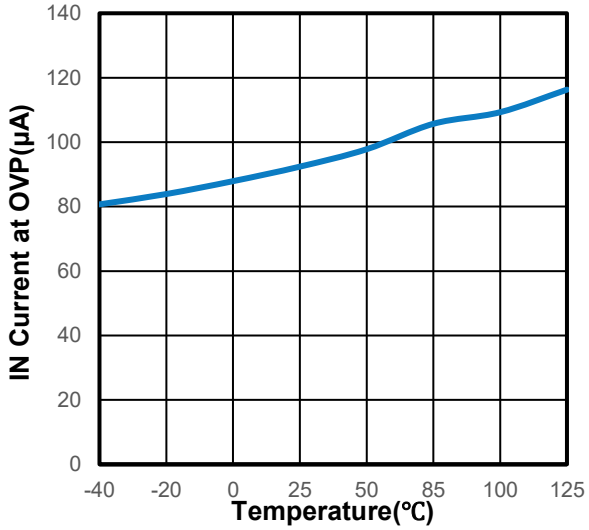


Figure 8. IN Current at OVP vs. Ambient Temperature

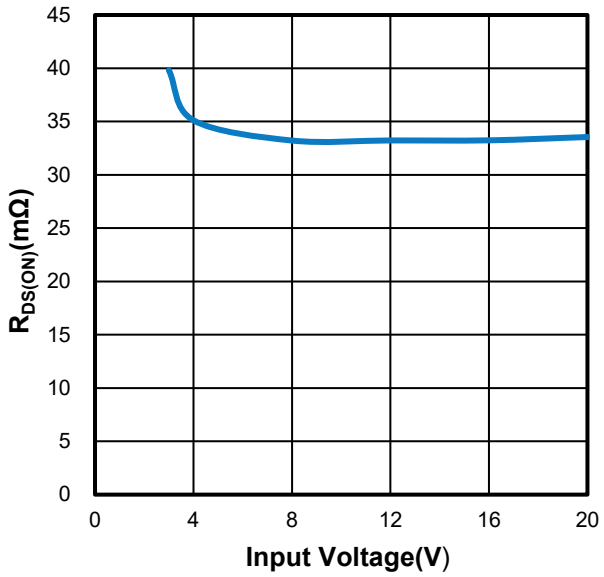


Figure 9. $R_{DS(ON)}$ vs. Input Voltage (I_{OUT} = 1A)

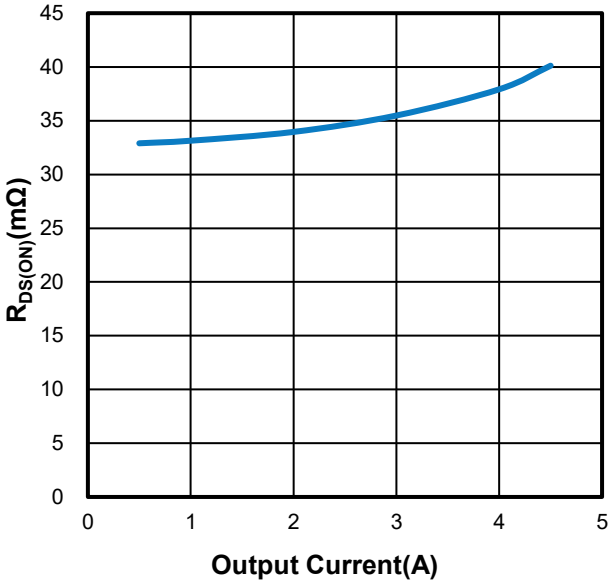


Figure 10. $R_{DS(ON)}$ vs. Output Current

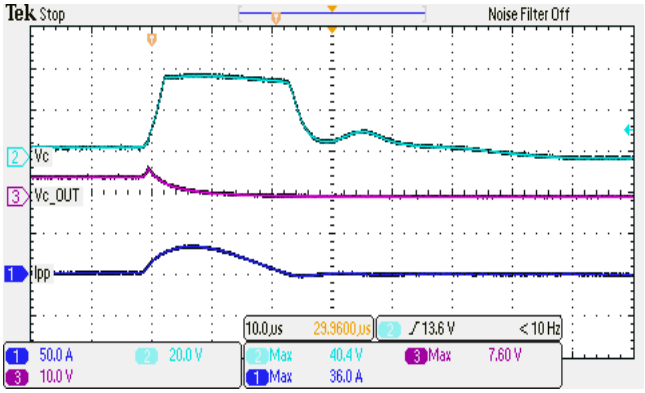


Figure 11. +100V Surge Response

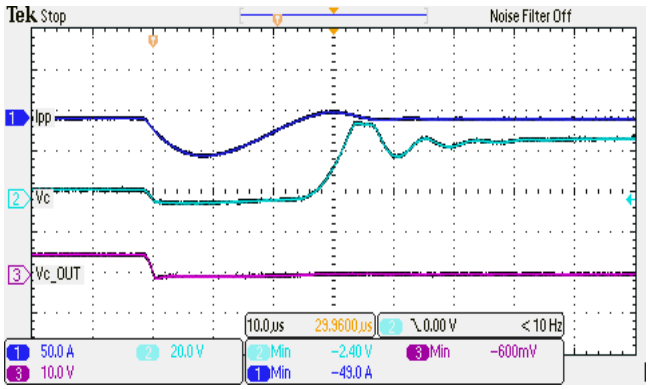


Figure 12. -100V Surge Response

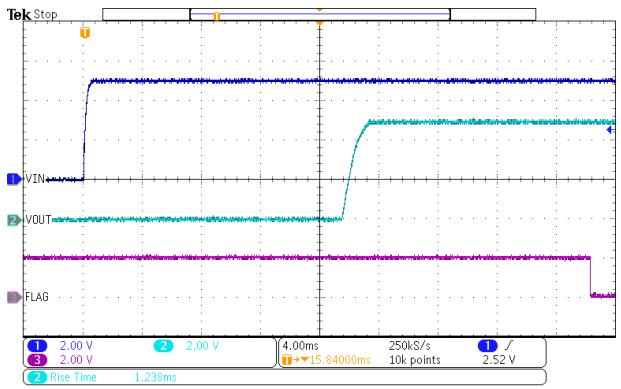


Figure 13. t_{DEB} & t_{START} & t_{ON}

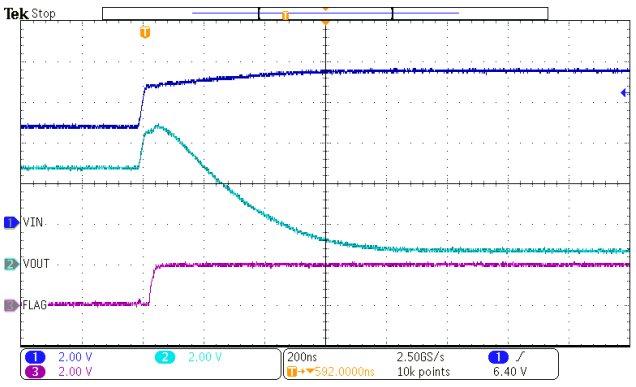


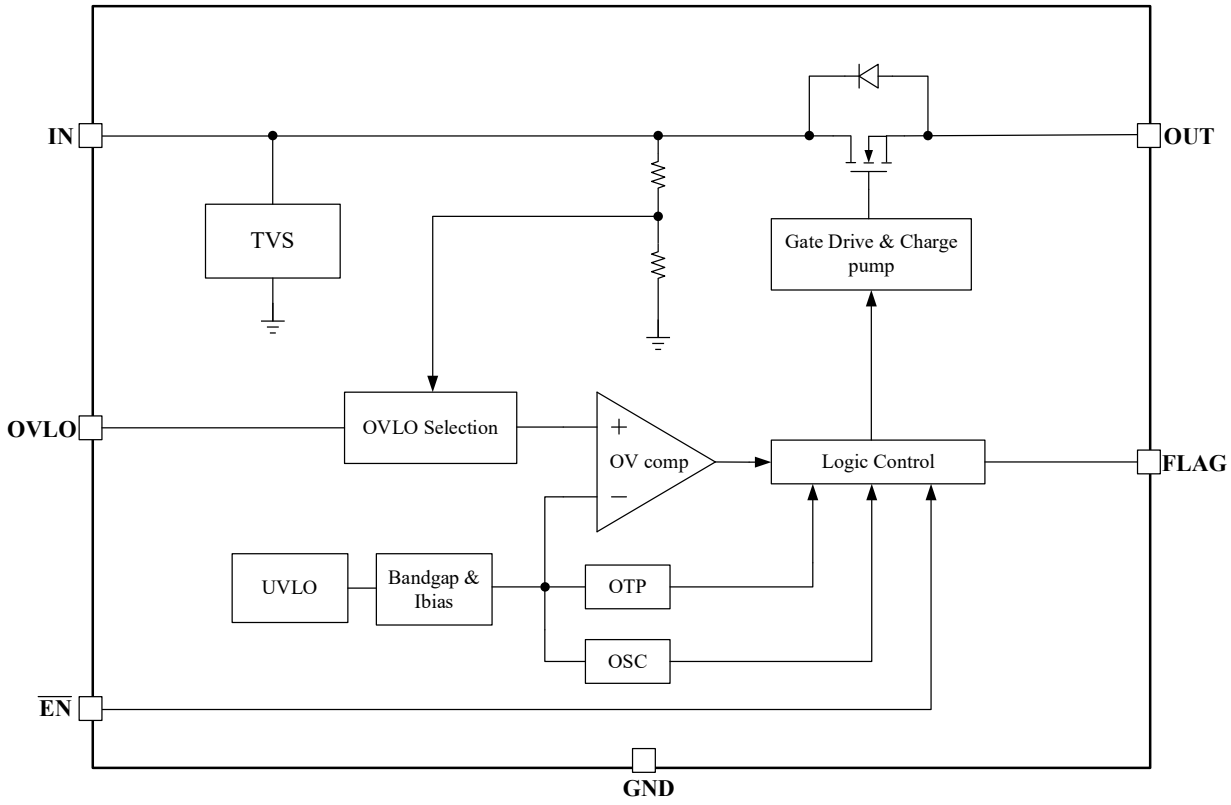
Figure 14. t_{OFF}

13. Function Description

13.1 Overview

If $\overline{EN}$ is pulled low and the input voltage is between UVLO threshold and Overvoltage Protect 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. FLAG will be driven low after start-up time(30ms), indicating the switch is on with a good power input. If the input voltage exceeds the Overvoltage Protect Threshold, the switch will be turned off in about 50ns. If the input voltage falls below UVLO threshold or $\overline{EN}$ is pulled high, or Thermal Shutdown happens, the switch will also be turned off.

13.2 Block Diagram



13.3 Feature Description

13.3.1 FLAG Output

The FLAG pin is an open-drain MOSFET and requires a pull up resistor. when any protection event occurs (Input OVP, Input UVLO, Thermal Shutdown) or $\overline{EN}$ is pulled high, the FLAG pin indicates a high signal. If $\overline{EN}$ is pulled low and $V_{IN_UVLO} < V_{IN} < V_{IN_OVLO}$, the FLAG pin indicates a low signal.

13.3.2 Over-Voltage Protection

If the input voltage exceeds the Overvoltage Protect Threshold, the switch will be turned off in about 50ns. The switch will remain off until V_{IN} falls below the Overvoltage Protect Threshold.

13.3.3 OVP Threshold Adjustment

If V_{OVLO}=GND, the OVP threshold is default OVP threshold. If OVLO pin is not grounded, the OVP threshold can be adjusted by external resistor divider connecting to OVLO pin as shown in the typical application circuit, between IN and GND.

The OVP threshold can be adjusted as following:

$$V_{IN_OVLO}=\frac{R_1+R_2}{R_2}V_{OVLO_TH}$$

The OVP threshold adjustment range is from 4V to 20V. OVLO pin must not be floated.

13.3.4 Thermal Shutdown (OTP)

The WP3116 monitors its own internal temperature to prevent thermal failures. The chip turns off the MOSFET when the internal temperature reaches 150℃. The chip automatically turns on the MOSFET again if the temperature of the die drops below the threshold temperature by 20℃.

13.3.5 Surge Protection

The WP3116 integrates a clamp circuit with the clamp voltage (V_{IN_CLAMP}) to suppress input surge voltage. For surge voltages between V_{IN_OVLO} and V_{IN_CLAMP}, the internal MOSFET will be turned off but the clamp circuit will not work. For surge voltages greater than V_{IN_CLAMP}, the internal clamp circuit will work and discharge the surge energy to ground. The device can suppress surge voltages up to 100V.

13.3.6 USB On-The-Go (OTG) Operation

If V_{IN} = 0V and OUT is supplied by OTG voltage, the body diode of the MOSFET 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 turn on the MOSFET after debounce time (about 15ms). After switch is fully on, current is supplied through switch channel and the voltage drop from OUT to IN is minimum.

14. Application and Implementation

14.1 Application Information

14.1.1 Power Up Enable Control

The WP3116 offers an enable $\overline{EN}$ input. When the $\overline{EN}$ pin is pulled to logic high (>1.4V), the WP3116 will be shut down. When the $\overline{EN}$ pin is pulled to logic low (<0.3V), the WP3116 will be powered on.

14.1.2 Input Capacitor

To limit the voltage drop on the input supply caused by transient in-rush currents when the MOSFET turns on into a discharged load capacitor or a short-circuit, a capacitor needs to be placed between V_{IN} and GND. A 1-μF 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.

14.1.3 Output Capacitor

A 1-μF capacitor, C_{OUT}, should be placed between V_{OUT} and GND. This capacitor will prevent parasitic board inductances from forcing V_{OUT} below GND when the switch turns off.

15. Evaluation Modules

Evaluation Modules (EVMs) are available to help evaluate initial circuit performance. We have evaluation modules for different packages, you can contact us by phone or address at the end to get the evaluation module or schematic.

The module names are listed in the table below.

NAME	PACKAGE	EVALUATION MODULE
WP3116	WLCSP12	WAYON OVP EVM V1.1 -WLCSP12
	DFN1814-12	WAYON OVP EVM V1.1 -WLCSP12

Layout Guidelines

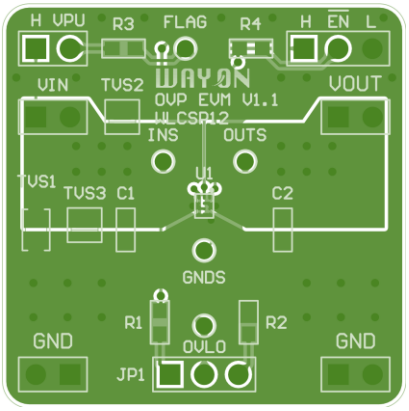
To make fully use of the performance of WP3116, the guidelines below should be followed.

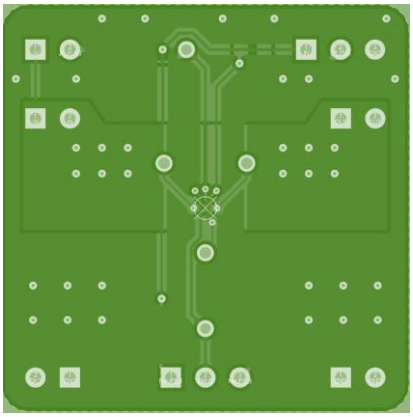
1. All the peripherals should be placed as close to the device as possible. Place the input capacitor C_{IN} on the top layer (same layer as the WP3116) and close to IN pin, and place the output capacitor C_{OUT} on the top layer (same layer as the WP3116) and close to OUT pin.

2. If external TVS is used, IN pin routing passes through the external TVS firstly, and then connect WP3116.

3. If R_1 and R_2 are used, route OVLO line on PCB as short as possible to reduce parasitic capacitance.

Layout Example





16. Naming Conventions

WP AB CC-D EEE F

WP: WAYON Protection IC;

A: Product Category –3: OVP;

B: Whether TVS is integrated –1: Integrated;

CC: Serial number;

D: Overvoltage Protect of V_{IN} – A: 5.95V

B: 6.80V

C:10.50V

D: 14V;

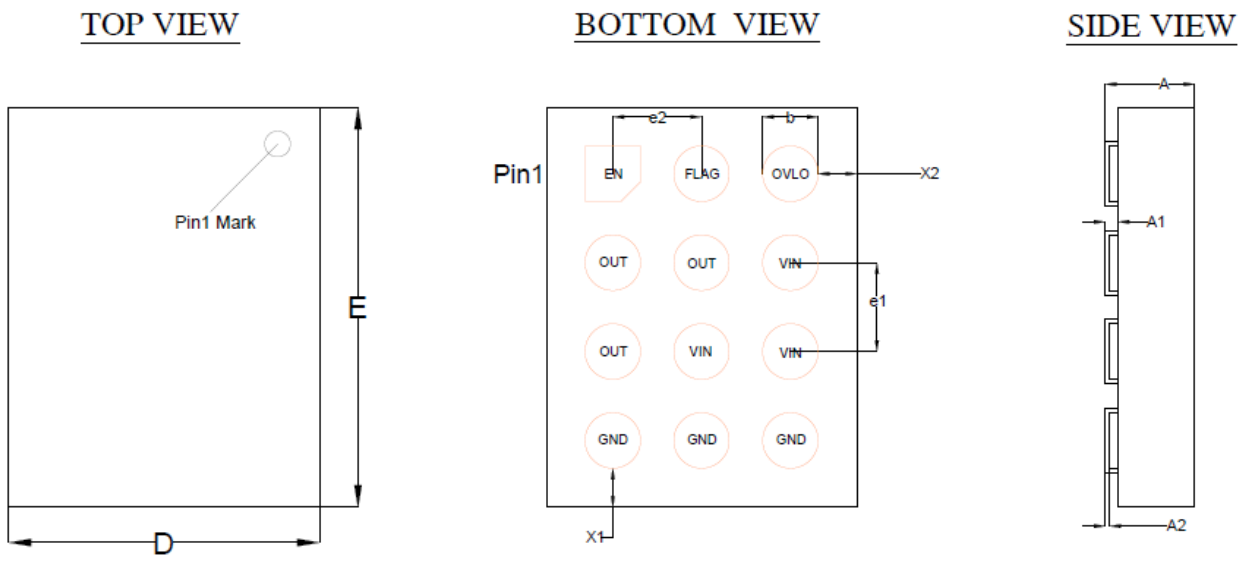
EEE: Package – PB2: DFN1814-12

C12: WLCSP12;

F: R-Reel & T-tube;

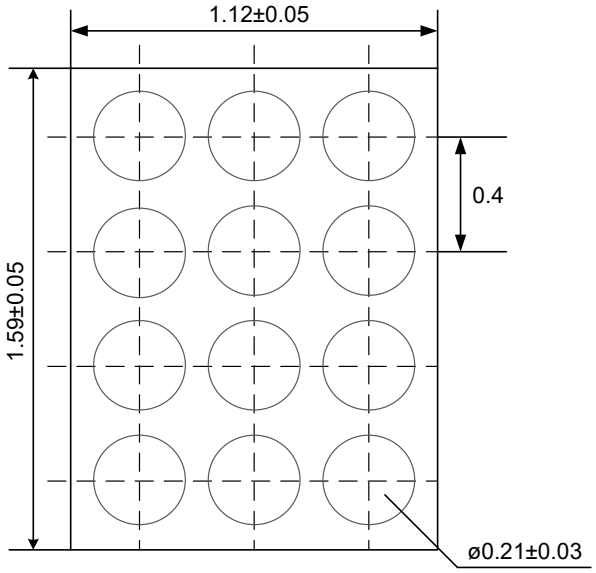
17. Package Information

DFN1814-12

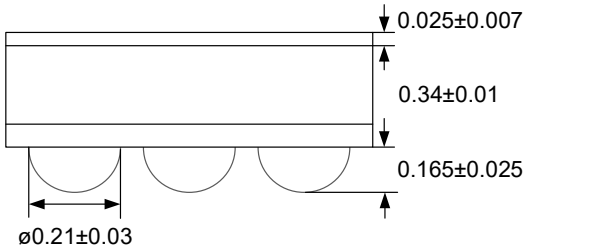


SYMBOL	DIMENSIONS IN MILLIMETERS		
	MIN	NOM	MAX
A	0.520	0.550	0.580
A1	-	0.030	0.075
A2	0.007	0.012	0.017
D	1.300	1.400	1. 500
E	1.700	1.800	1.900
e1	0.350	0.400	0.450
e2	0.350	0.400	0.450
b	0.220	0.250	0.280
X1	0.125	0.175	0.225
X2	0.125	0.175	0.225

WLCSP12



Bottom View



Unit: mm

Side View

18. Ordering Information

PART NUMBER	V_{OVLO}	PACKAGE	PACKING QUANTITY	MARKING*
WP3116-APB2R	5.95V	DFN1814-12L	5k/Reel	316A XXXX
WP3116-BPB2R	6.8V	DFN1814-12L	5k/Reel	316B XXXX
WP3116-CPB2R	10.5V	DFN1814-12L	5k/Reel	316C XXXX
WP3116-DPB2R	14V	DFN1814-12L	5k/Reel	316D XXXX
WP3116-AC12R	5.95V	WLCSP12	3k/Reel	316A XXXX
WP3116-BC12R	6.8V	WLCSP12	3k/Reel	316B XXXX
WP3116-CC12R	10.5V	WLCSP12	3k/Reel	316C XXXX
WP3116-DC12R	14V	WLCSP12	3k/Reel	316D XXXX

* XXXX is variable.

Contact Information

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WAYON website: http://www.way-on.com
For additional information, please contact your local Sales Representative.
WAYON® is registered trademark of Wayon Corporation.

Specifications are subject to change without notice.
The device characteristics and parameters in this data sheet can and do vary in different applications and actual device performance may vary over time.
Users should verify actual device performance in their specific applications.

Product Specification Statement

- The product specification aims to provide users with a reference regarding various product parameters, performance, and usage. It presents certain aspects of the product's performance in graphical form and is intended solely for users to select product and make product comparisons, enabling users to better understand and evaluate the characteristics and advantages of the product. It does not constitute any commitment, warranty, or guarantee.
- The product parameters described in the product specification are numerical values, characteristics, and functions obtained through actual testing or theoretical calculations of the product in an independent or ideal state. Due to the complexity of product applications and variations in test conditions and equipment, there may be slight fluctuations in parameter test values. WAYON shall not guarantee that the actual performance of the product when installed in the customer's system or equipment will be entirely consistent with the product specification, especially concerning dynamic parameters. It is recommended that users consult with professionals for product selection and system design. Users should also thoroughly validate and assess whether the actual parameters and performance when installed in their respective systems or equipment meet their requirements or expectations. Additionally, users should exercise caution in verifying product compatibility issues, and WAYON assumes no responsibility for the application of the product.
- WAYON strives to provide accurate and up-to-date information to the best of our ability. However, due to technical, human, or other reasons, WAYON cannot guarantee that the information provided in the product specification is entirely accurate and error-free. WAYON shall not be held responsible for any losses or damages resulting from the use or reliance on any information in these product specifications. WAYON reserves the right to revise or update the product specification and the products at any time without prior notice, and the user's continued use of the product specification is considered an acceptance of these revisions and updates. Prior to purchasing and using the product, users should verify the above information with WAYON to ensure that the product specification is the most current, effective, and complete. If users are particularly concerned about product parameters, please consult WAYON in detail or request relevant product test reports. Any data not explicitly mentioned in the product specification shall be subject to separate agreement.
- Users are advised to pay attention to the parameter limit values specified in the product specification and maintain a certain margin in design or application to ensure that the product does not exceed the parameter limit values defined in the product specification. This precaution should be taken to avoid exceeding one or more of the limit values, which may result in permanent irreversible damage to the product, ultimately affecting the quality and reliability of the system or equipment.
- The design of the product is intended to meet civilian needs and is not guaranteed for use in harsh environments or precision equipment. It is not recommended for use in systems or equipment such as medical devices, aircraft, nuclear power, and similar systems, where failures in these systems or equipment could reasonably be expected to result in personal injury. WAYON shall assume no responsibility for any consequences resulting from such usage.
- Users should also comply with relevant laws, regulations, policies, and standards when using the product specification. Users are responsible for the risks and liabilities arising from the use of the product specification and must ensure that it is not used for illegal purposes. Additionally, users should respect the intellectual property rights related to the product specification and refrain from infringing upon any third-party legal rights. WAYON shall assume no responsibility for any disputes or controversies arising from the above-mentioned issues in any form.