Power-Distribution Switches with Soft Start

Features

- **90mΩ High Side MOSFET**
- **2A Continuous Current**
- **Soft-Start Time Programmable by External Capacitor**
- **Wide Supply Voltage Range: 2.7V to 5.5V**
- **Current-Limit and Short-Circuit Protections**
- **Under-Voltage Lockout Protection**
- **Reverse Current Blocking when Switch Disabled**
- **Over-Temperature Protection**
- **Logic Level Enable Input**
  APL3512A: Active High
  APL3512B: Active Low
- **Lead Free and Green Devices Available (RoHS Compliant)**

Applications

- **TFT LCD Modules**
- **Notebook and Desktop Computers**
- **USB Ports**
- **High-Side Power Protection Switches**

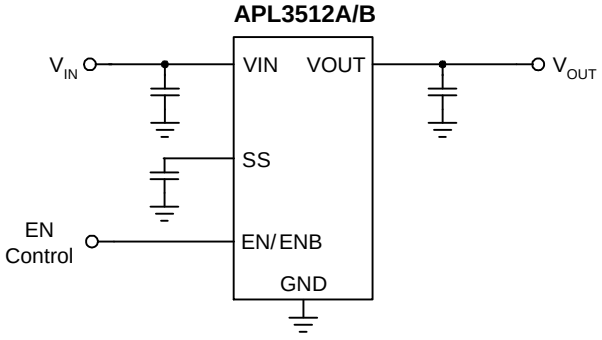
General Description

The APL3512A/B is a power-distribution switch with some protection functions that can deliver current up to 2A. The device incorporates a 90mΩ N-channel MOSFET power switch that is controlled by an enable logic pin and has a SS pin dedicated to soft-start ramp-up rate control that can be used in application where the inrush current is concerned.

The device integrates some protection features, including current-limit protection, short-circuit protection, over-temperature protection, and UVLO. The current-limit and short-circuit protection can protect down-stream devices from catastrophic failure by limiting the output current at current-limit threshold during over-load or short-circuit events. When V_{OUT} drops below V_{IN}-1.5V the devices limit the current to a lower and safe level. The over-temperature protection function shuts down the N-channel MOSFET power switch when the junction temperature rises beyond 140°C and will automatically turns on the power switch when the temperature drops by 20°C. The UVLO function keeps the power switch in off state until there is a valid input voltage present.

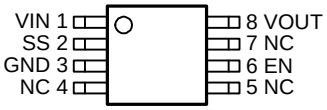
The device is available in lead free SOT-23-5, TDFN2x2-6 and SOP-8 packages with enable active-high(EN) and active-low(ENB) versions.

Simplified Application Circuit

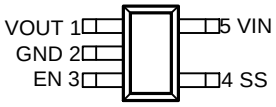


ANPEC reserves the right to make changes to improve reliability or manufacturability without notice, and advise customers to obtain the latest version of relevant information to verify before placing orders.

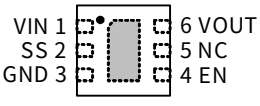
Pin Configuration



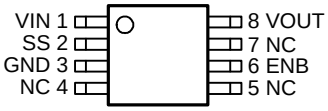
SOP-8
APL3512A



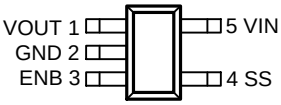
SOT-23-5
APL3512A



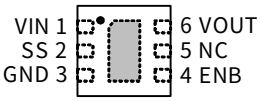
TDFN2x2-6
APL3512A



SOP-8
APL3512B



SOT-23-5
APL3512B



TDFN2x2-6
APL3512B

Exposed Pad, connect to large ground plane for heat dissipation

Ordering and Marking Information

APL3512 □□□-□□□ Assembly Material Handling Code Temperature Range Package Code EN Function	Package Code B : SOT-23-5 K : SOP-8 QB : TDFN2x2-6 Operating Ambient Temperature Range I : -40 to 85 °C Handling Code TR : Tape & Reel EN Function A : Active High B : Active Low Assembly Material G : Halogen and Lead Free Device

APL3512A B:	L2AX	X - Date Code
APL3512B B:	L2BX	X - Date Code
APL3512A K:	APL3512A XXXXX	XXXXX - Date Code
APL3512B K:	APL3512B XXXXX	XXXXX - Date Code
APL3512A QB:	L12A X	X - Date Code
APL3512B QB:	L12B X	X - Date Code

Note : ANPEC lead-free products contain molding compounds/die attach materials and 100% matte tin plate termination finish; which are fully compliant with RoHS. ANPEC lead-free products meet or exceed the lead-free requirements of IPC/JEDEC J-STD-020D for MSL classification at lead-free peak reflow temperature. ANPEC defines “Green” to mean lead-free (RoHS compliant)and halogen free (Br or Cl does not exceed 900ppm by weight in homogeneous material and total of Br and Cl does not exceed 1500ppm by weight).

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Absolute Maximum Ratings (Note 1)

Symbol	Parameter	Rating	Unit
V_{IN}	VIN to GND Voltage	-0.3 ~ 6	V
V_{OUT}	VOUT to GND Voltage	-0.3 ~ 6	V
V_{ENB}, V_{EN}	EN, ENB to GND Voltage	-0.3 ~ 6	V
V_{SS}	SS to GND Voltage	-0.3 ~ 6	V
I_{OUT}	Continuous Output Current	Internally Limited	A
T_J	Maximum Junction Temperature	-40 ~ 150	°C
T_{STG}	Storage Temperature	-65 ~ 150	°C
T_{SDR}	Maximum Lead Soldering Temperature, 10 Seconds	260	°C

Note1: Stresses beyond those listed under "absolute maximum ratings" may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these or any other conditions beyond those indicated under "recommended operating conditions" is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Thermal Characteristics

Symbol	Parameter	Typical Value	Unit
θ_{JA}	Junction-to-Ambient Resistance in Free Air (Note 2) SOT-23-5 SOP-8 TDFN2x2-6	 250 160 225	°C/W

Note 2: θ_{JA} is measured with the component mounted on a high effective thermal conductivity test board in free air.

Recommended Operating Conditions (Note 3)

Symbol	Parameter	Range	Unit
V_{IN}	VIN Input Voltage	2.7 ~ 5.5	V
I_{OUT}	OUT Output Current	0 ~2	A
C_{SS}	SS Pin Soft-Start Capacitor (Note 4)	0.3 ~470	nF
T_A	Ambient Temperature	-40 ~ 85	°C
T_J	Junction Temperature	-40 ~ 125	°C

Note 3: Refer to the typical application circuit.

Note 4: Attaching a capacitor on SS pin can adjust the V_{OUT} soft-start rate. If the C_{SS} is out of the recommended range, the soft-start rate could become internally controlled as if no C_{SS}.

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Electrical Characteristics

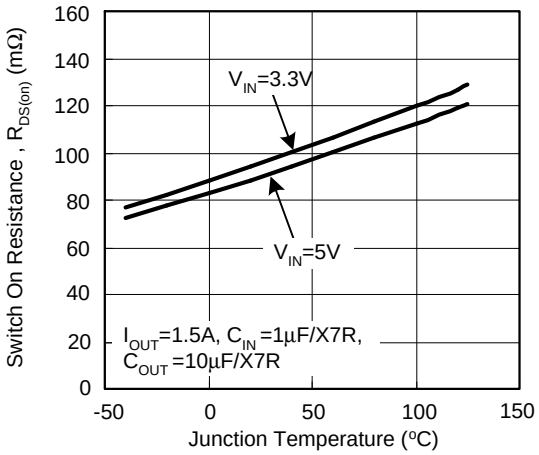
Unless otherwise specified, these specifications apply over V_{IN}=5V, V_{EN}=5V or V_{ENB}=0V and T_A=-40~85°C. Typical values are at T_A=25°C.

Symbol	Parameter	Test Conditions	APL3512A/B			Unit
			Min.	Typ.	Max.	
SUPPLY CURRENT						
	VIN Supply Current	No load, V_{EN}=0V or V_{ENB}=5V	-	-	1	μA
		No load, V_{EN}=5V or V_{ENB}=0V	-	60	100	μA
	Leakage Current	VOUT=GND, V_{EN}=0V or V_{ENB}=5V	-	-	1	μA
	Reverse Leakage Current	VIN=GND, V_{OUT}=5V, V_{EN}=0V or V_{ENB}=5V	-	-	1	μA
POWER SWITCH						
$R_{DS(ON)}$	Power Switch On Resistance	I_{OUT}=1.5A, T_A=25°C	-	90	110	mΩ
		I_{OUT}=1.5A, T_A=-40~85°C	-	90	140	mΩ
UNDER-VOLTAGE LOCKOUT						
	VIN UVLO Threshold Voltage	V_{IN} rising, T_A=-40~85°C	2.3	-	2.65	V
	VIN UVLO Hysteresis		-	0.2	-	V
CURRENT-LIMIT AND SHORT-CIRCUIT PROTECTIONS						
I_{LIM}	Current-Limit Threshold	V_{IN}=2.7V to 5.5V, T_A=-40~85°C	2.5	3.1	4.22	A
I_{SHORT}	Short-Circuit Output Current	V_{IN}=2.7V to 5.5V	-	0.8	-	A
SOFT-START CONTROL PIN						
	SS Current	V_{IN}=5V, T_A=-40~85°C	1	2	3	μA
t_{SS}	Soft-Start Time	V_{IN}=5V, No load, C_{OUT}=1μF, C_{SS}=10nF, T_A=-40~85°C	-	10	-	ms
		V_{IN}=3.3V, No load, C_{OUT}=1μF, C_{SS}=10nF, T_A=-40~85°C	-	6.6	-	ms
		V_{IN}=3.3V, No load, C_{OUT}=1μF, No C_{SS} or SS tied to V_{IN}, T_A=-40~85°C	1	2	3	ms
EN OR ENB INPUT PIN						
V_{IH}	Input Logic HIGH	V_{IN}=2.7V to 5V	2	-	-	V
V_{IL}	Input Logic LOW	V_{IN}=2.7V to 5V	-	-	0.8	V
	Input Current		-	-	1	μA
	VOUT Discharge Resistance	V_{EN}=0V or V_{ENB}=5V	-	150	-	Ω
OVER-TEMPERATURE PROTECTION (OTP)						
T_{OTP}	Over-Temperature Threshold	T_J rising	-	140	-	°C
	Over-Temperature Hysteresis		-	20	-	°C

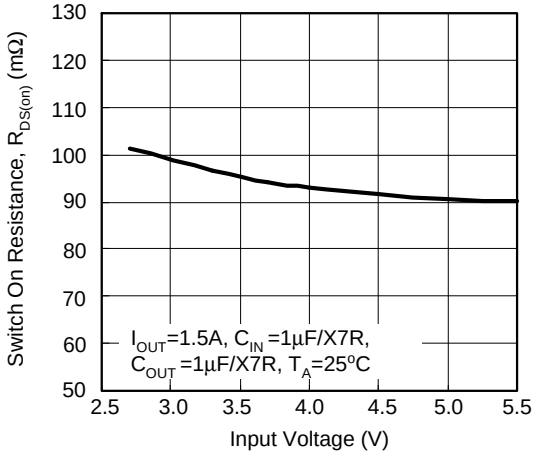
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Typical Operating Characteristics

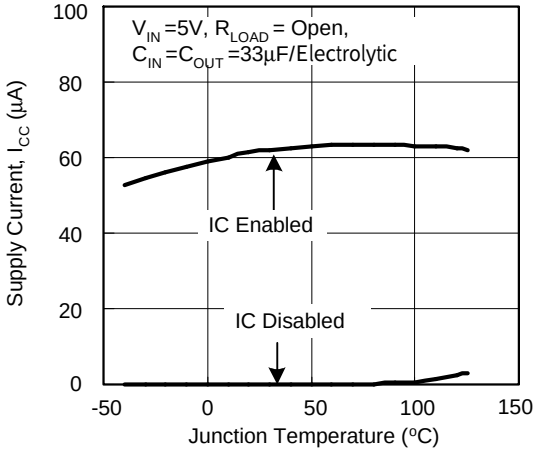
Switch On Resistance vs. Junction Temperature



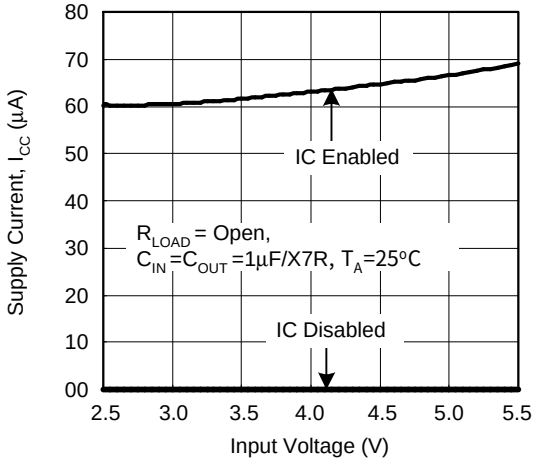
Switch On Resistance vs. Input Voltage



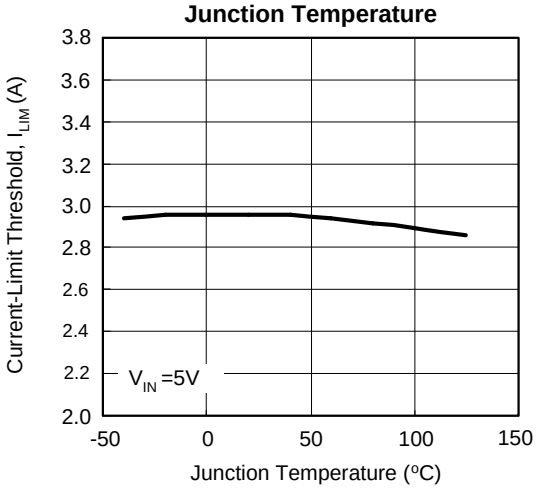
Supply Current vs. Junction Temperature



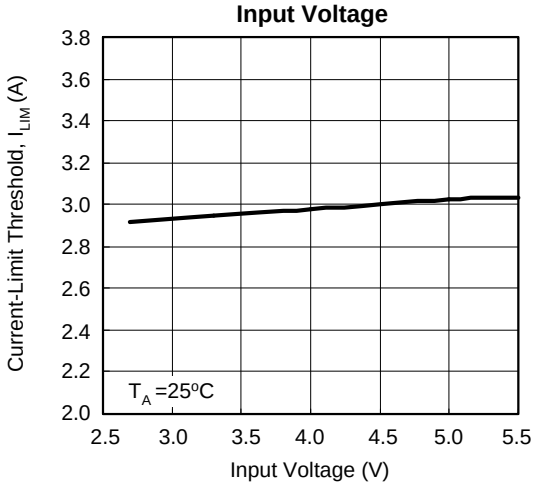
Supply Current vs. Input Voltage



Current-Limit Threshold vs. Junction Temperature



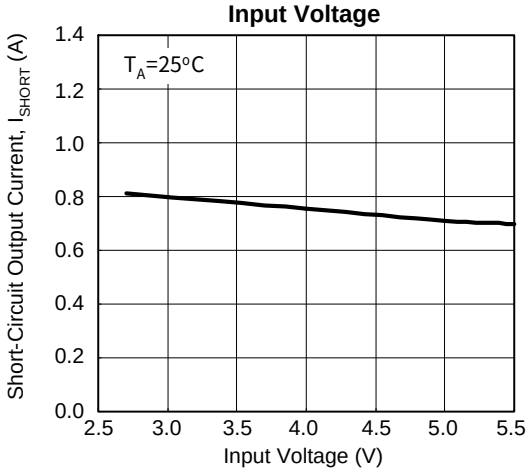
Current-Limit Threshold vs. Input Voltage



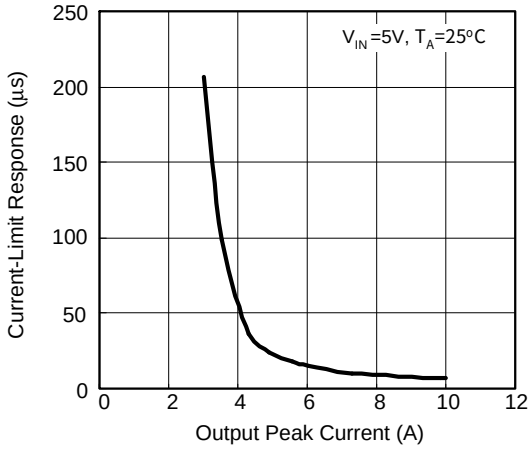
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Typical Operating Characteristics (Cont.)

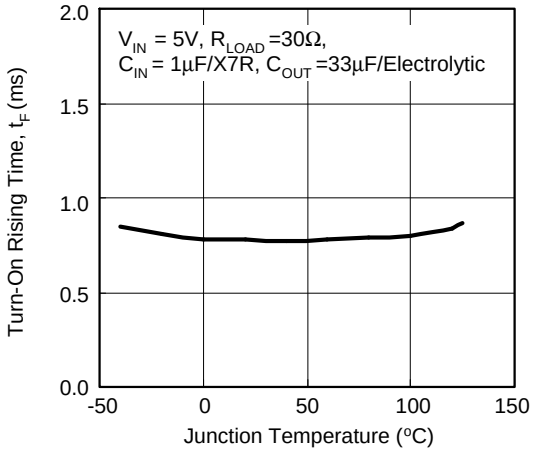
Short-Circuit Output Current vs. Input Voltage



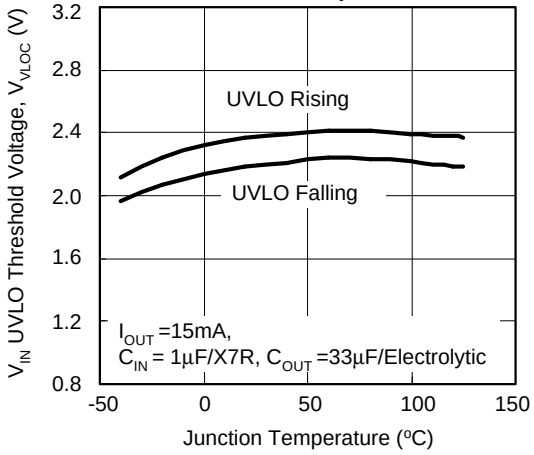
Current-Limit Response vs. Output Peak Current



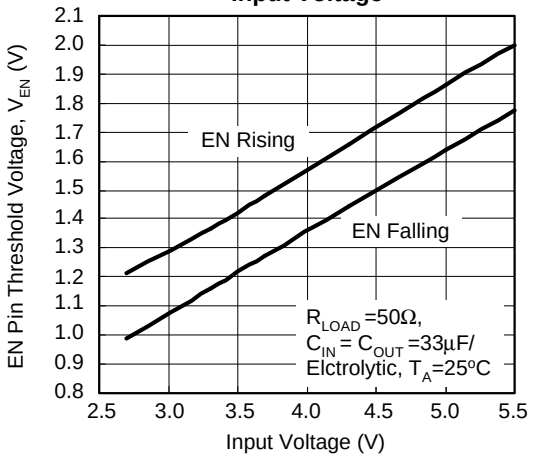
Turn-On Rising Time vs. Junction Temperature



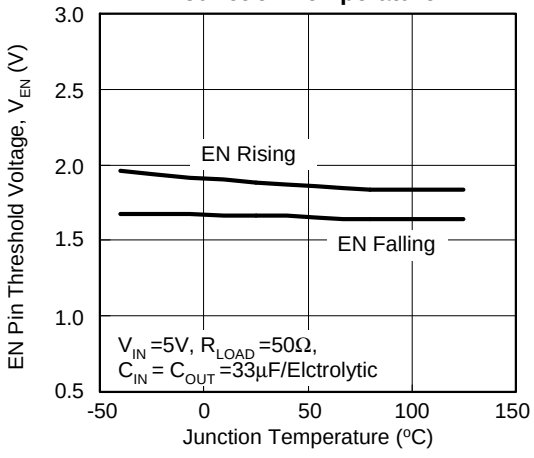
V_{IN} UVLO Threshold Voltage vs. Junction Temperature



EN Pin Threshold Voltage vs. Input Voltage

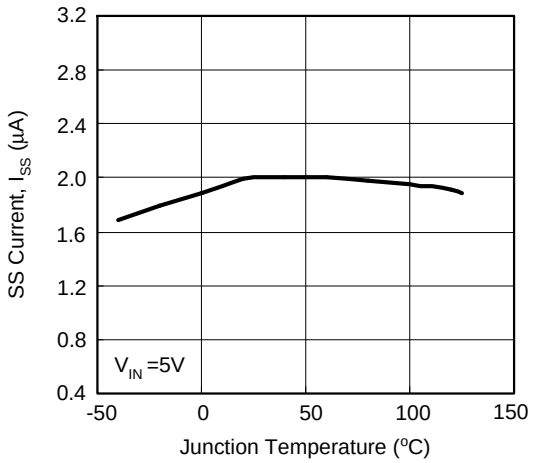


EN Pin Threshold Voltage vs. Junction Temperature

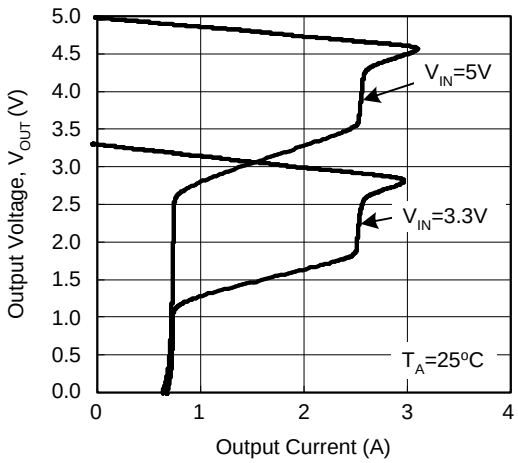


Typical Operating Characteristics (Cont.)

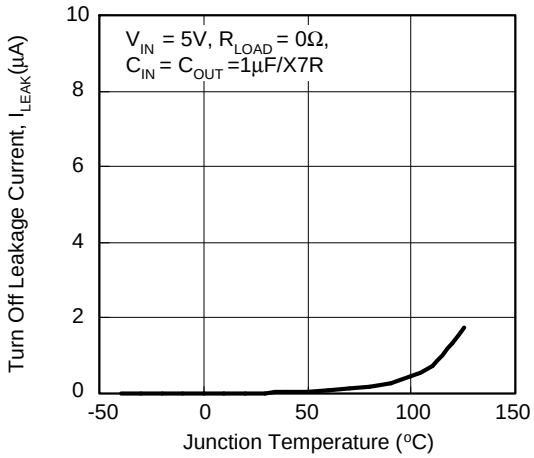
SS Current vs. Junction Temperature



Output Voltage vs. Output Current



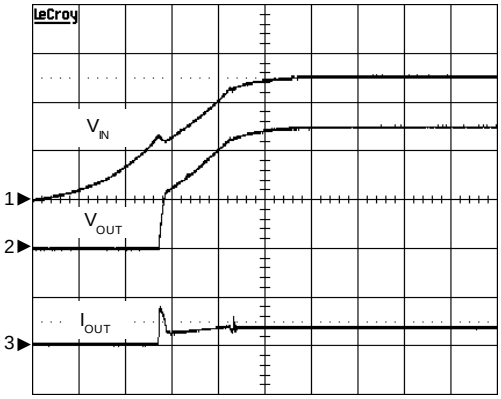
Turn Off Leakage Current vs. Junction Temperature



Operating Waveforms

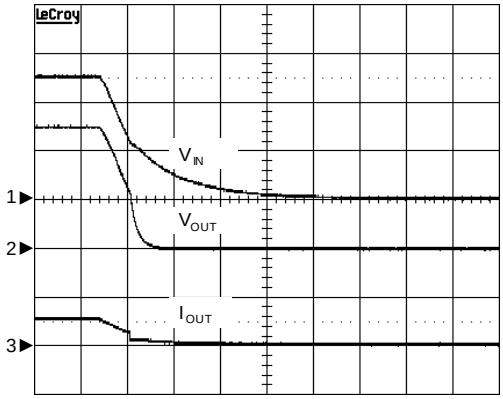
The test condition is V_{IN}=5V, T_A= 25°C unless otherwise specified.

Power On



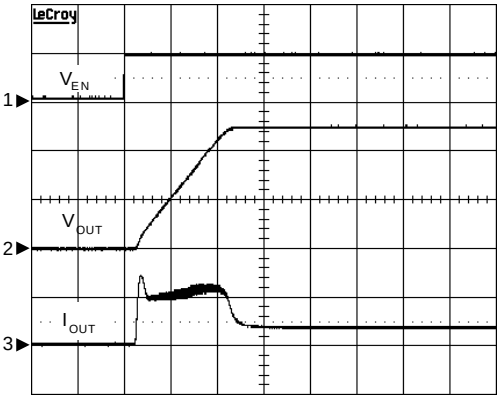
V_{IN} =5V, R_{LOAD} =30Ω, C_{IN} =1μF/MLCC,
C_{OUT} =100μF/Electrolytic, SS open
CH1: V_{IN}, 2V/Div, DC
CH2: V_{OUT}, 2V/Div, DC
CH3: I_{OUT}, 0.5A/Div, DC
TIME:5ms/Div

Power Off



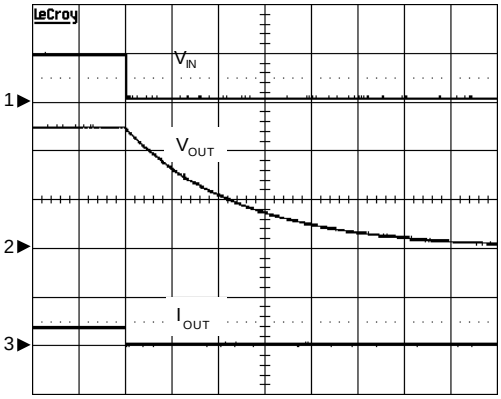
V_{IN} =5V, R_{LOAD} =30Ω, C_{IN} =1μF/MLCC,
C_{OUT} =100μF/Electrolytic, SS open
CH1: V_{IN}, 2V/Div, DC
CH2: V_{OUT}, 2V/Div, DC
CH3: I_{OUT}, 0.5A/Div, DC
TIME:20ms/Div

Turn On Response



V_{IN} =5V, R_{LOAD} =30Ω, C_{IN} =1μF/MLCC,
C_{OUT} =100μF/Electrolytic, SS open
CH1: V_{EN}, 5V/Div, DC
CH2: V_{OUT}, 2V/Div, DC
CH3: I_{OUT}, 0.5A/Div, DC
TIME:0.5ms/Div

Turn Off Response



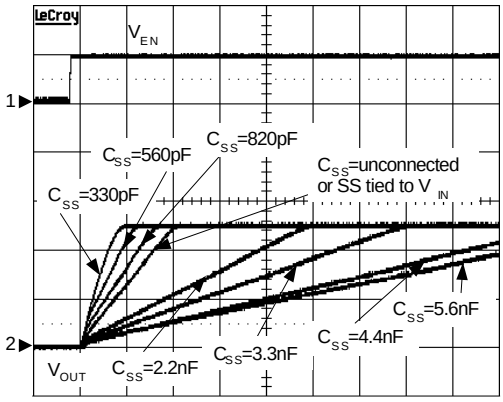
V_{IN} =5V, R_{LOAD} =30Ω, C_{IN} =1μF/MLCC,
C_{OUT} =100μF/Electrolytic, SS open
CH1: V_{EN}, 5V/Div, DC
CH2: V_{OUT}, 2V/Div, DC
CH3: I_{OUT}, 0.5A/Div, DC
TIME:1ms/Div

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Operating Waveforms (Cont.)

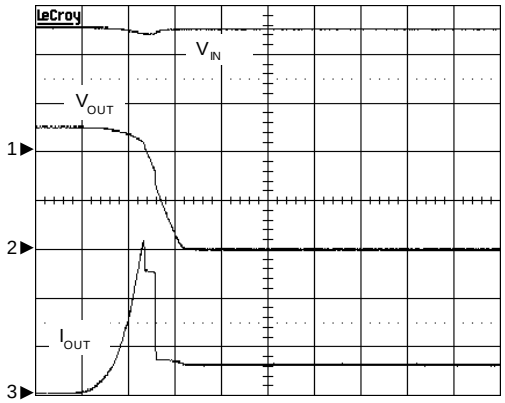
The test condition is V_{IN}=5V, T_A= 25°C unless otherwise specified.

Soft Start Ramp-up Control



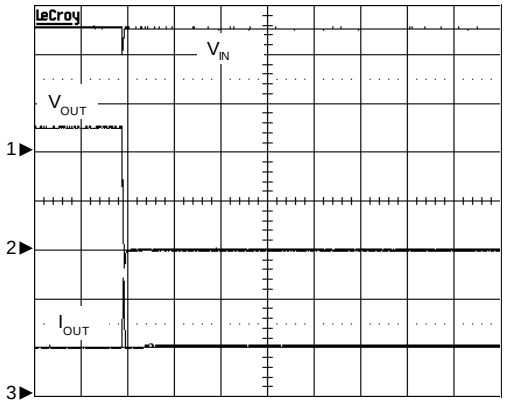
V_{IN} =5V, R_{LOAD} =30Ω, C_{IN} =1µF/MLCC,
C_{OUT}=33µF/Electrolytic
CH1: V_{EN}, 5V/Div, DC
CH2: V_{OUT}, 2V/Div, DC
TIME: 0.5ms/Div

Current Limit Response



V_{IN} =5V, C_{IN} =1µF/MLCC,
C_{OUT}=33µF/Electrolytic
CH1: V_{IN}, 2V/Div, DC
CH2: V_{OUT}, 2V/Div, DC
CH3: I_{OUT}, 1A/Div, DC
TIME: 2ms/Div

Short Circuit Protection



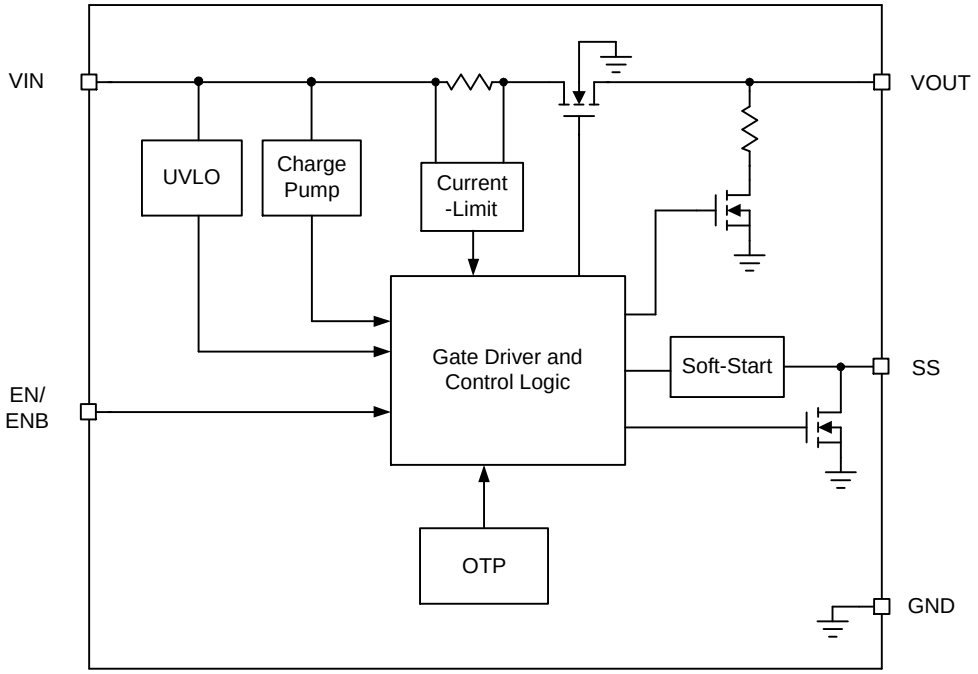
V_{IN} =5V, VOUT short to ground,
C_{IN} =1µF/MLCC, C_{OUT}=33µF/Electrolytic
CH1: V_{IN}, 2V/Div, DC
CH2: V_{OUT}, 2V/Div, DC
CH3: I_{OUT}, 20A/Div, DC
TIME: 100µs/Div

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Pin Description

PIN			NAME	FUNCTION
NO.				
SOT-23-5	SOP-8	TDFN2x2-6		
1	8	6	VOUT	Output Voltage Pin. The output voltage follows the input voltage. When ENB is high or EN is low the output voltage is discharged by an internal resistor.
2	3	3	GND	Ground
3	6	4	EN (APL3512A)	Enable Input. Pull this pin to high to enable the device and pull this pin to low to disable device. The EN pin cannot be left floating.
			ENB (APL3512B)	Enable Input. Pull this pin to high to disable the device and pull this pin to low to enable device. The ENB pin cannot be left floating.
4	2	2	SS	Soft-Start Control Pin. Connect a capacitor to GND to control the soft-tart rate. If the SS pin is left floating or tied to V_{IN} the soft-tart time is 2ms when V_{IN}=5V.
5	1	1	VIN	Power Supply Input. Connect this pin to external DC supply.
-	4, 5, 7	5	NC	Internally not connected.

Block Diagram



Typical Application Circuit

