Description

APL0501B device is low R_{ON} MOSEFT controlled by external logic pin, allowing optimization of battery life, and portable device autonomy. It includes a P-channel MOSFET that operates over an input voltage range of 1.2V to 5.5V. An on/off input (ON) controls the switch that can interface with low voltage control signals. APL0501B is packaged in WLCSP-4 with 0.4mm pitch. It is characterized for operation over the free-air temperature range of -40°C to 85°C.

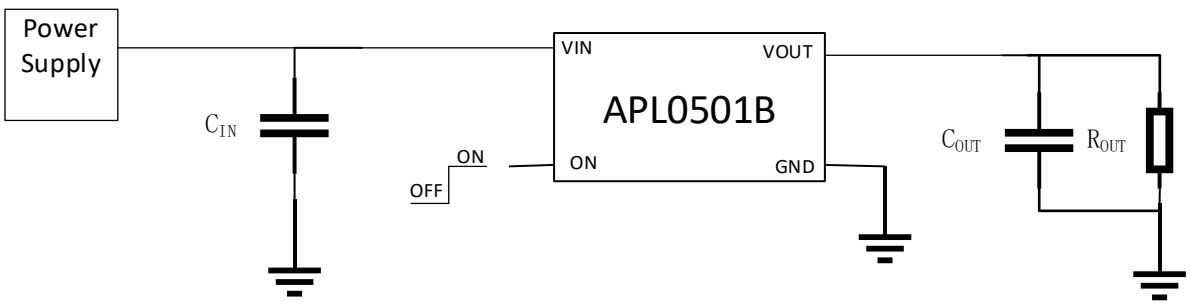
Applications

- Cellular Phones
- GPS Devices
- Digital Cameras
- Peripheral Ports
- Portable Instrumentation
- RF Modules
- Personal Digital Assistants (PDAs)
- MP3 Players

Features

- Low-Input Voltage: 1.2V to 5.5V
- Ultra-Low ON-State Resistance
  - R_{ON}=48mΩ at VIN=5.0V
  - R_{ON}=53mΩ at VIN=4.2V
  - R_{ON}=56mΩ at VIN=3.6V
  - R_{ON}=67mΩ at VIN=2.5V
  - R_{ON}=87mΩ at VIN=1.8V
  - R_{ON}=160mΩ at VIN=1.2V
- DC Current Up to 1.5A
- Ultra-Low Quiescent Current: 80nA at 1.8V
- Ultra-Low Shutdown Current: 5nA at 1.8V
- Low Control Input Thresholds Enable Use of 1.2V/1.8V/3.6V/4.2V/5.0V Logic
- Controlled Slew Rate to Avoid Inrush Current
- Reverse Current Protection
- Package: WLCSP-4 (0.4mm Pitch)

Typical Application

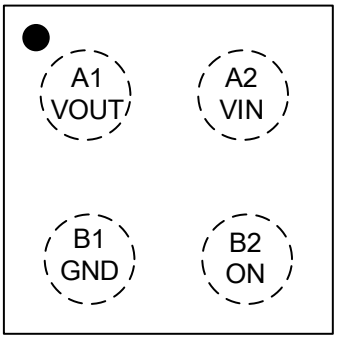


Package and Order Information

Part Number	Package Description	Temperature Range	Packaging Option	Marking Information
APL0501B	WLCSP-4	-40°C ~ 85°C	3000/Tape & Reel	BXX

Pin Configuration and Top Mark

(Top View)

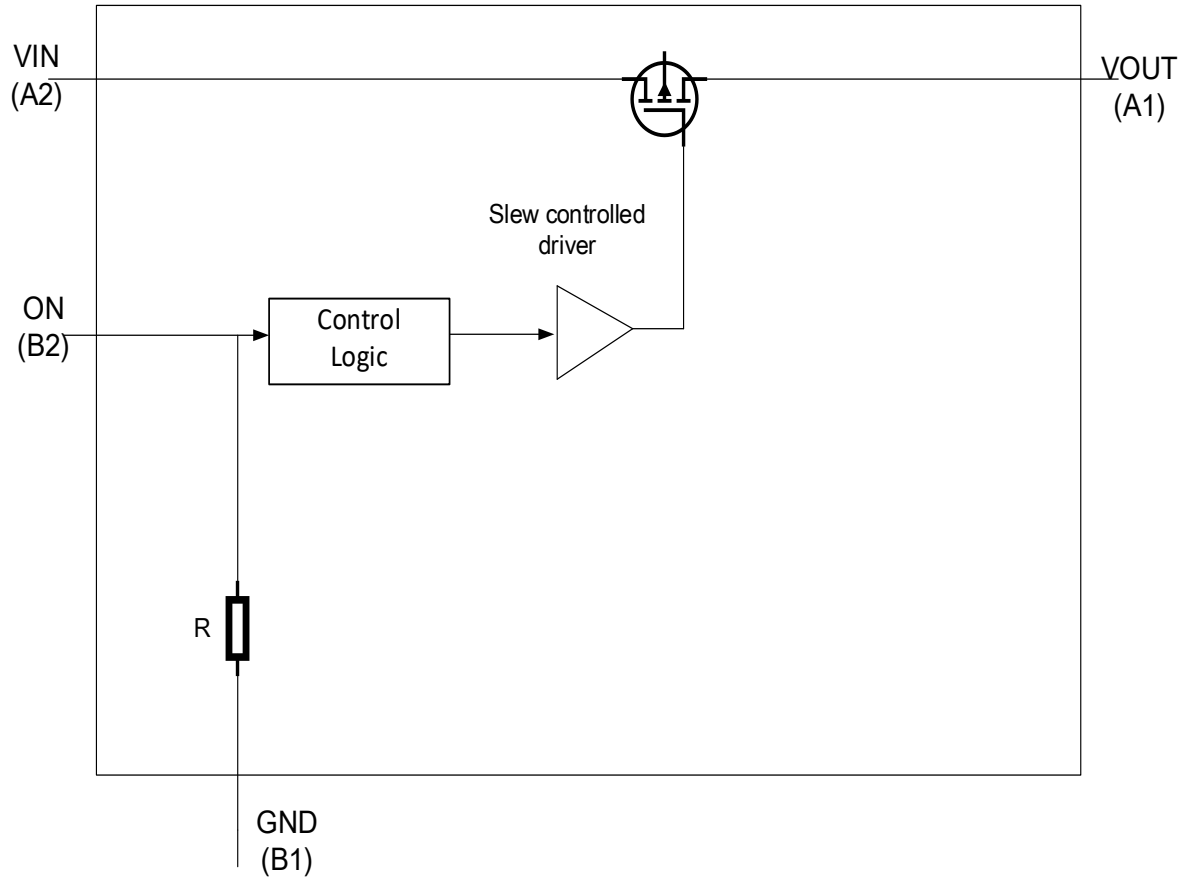


WLCSP-0.8x0.8-4B

Pin Assignments

Name	NO.	Description
VOUT	A1	Switch output
VIN	A2	Switch input, a bypass capacitor should be connected to ground together with it
GND	B1	Ground
ON	B2	Switch control input, active high

Functional Block Diagram



Absolute Maximum Ratings (T_A = 25°C unless otherwise specified)

Symbol	Parameter	Rating	Unit
V_{IN}	Input voltage	-0.3 to 6	V
V_{OUT}	Output voltage	V_{IN} + 0.3	V
V_{ON}	Input voltage	-0.3 to 6	V
P_D	Power dissipation at T_A=25°C	0.48	W
I_{MAX}	Maximum continuous switch current	2	A
T_A	Operating free air temperature range	-40 to 85	°C
T_{LEAD}	Maximum lead temperature (10s soldering time)	300	°C
T_{STG}	Storage temperature	-45 to 145	°C
θ_{JA}	Thermal Resistance	190	°C/W
ESD	HBM: All Pins	±4000	V
	CDM	±1000	
Latch up		±200	mA

Recommend Operating Conditions

Symbol	Parameter	Rating	Unit
V_{IN}	Input voltage range	1.2 to 5.5	V
V_{OUT}	Output voltage range	V_{IN}	V
C_{IN}	Input capacitor	1	µF

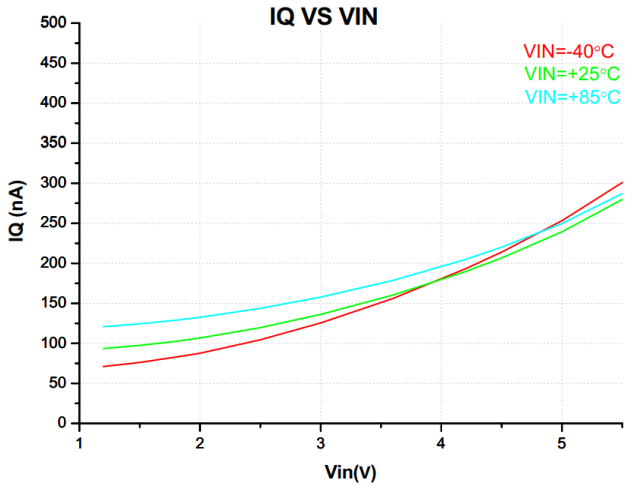
Electrical Characteristics (T_A = 25°C unless otherwise specified)

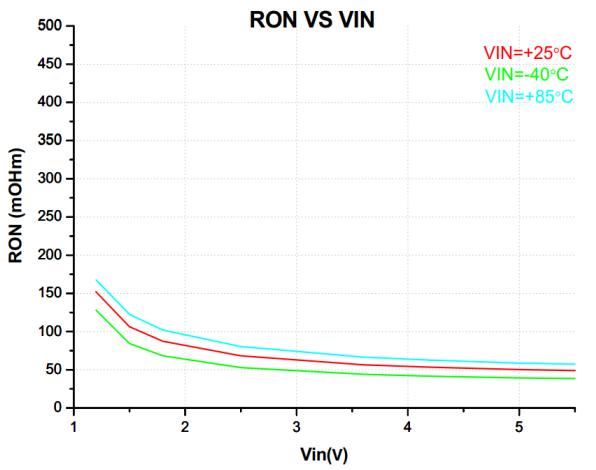
Symbol	Parameter	Conditions		Min.	Typ.	Max.	Unit
I_Q	Quiescent current	I_{OUT}=0, V_{IN}=V_{ON}	V_{IN}=1.2V	40	75	130	nA
			V_{IN}=1.8V		80		
			V_{IN}=3.6V	90	119	250	
			V_{IN}=4.2V		142		
			V_{IN}=5.0V	150	188	350	
I_{SD}	OFF-state supply current	V_{ON}=GND, V_{OUT}=Open	V_{IN}=1.2V		5	20	nA
			V_{IN}=1.8V		5		
			V_{IN}=3.6V		5.5	30	
			V_{IN}=4.2V		5.5		
			V_{IN}=5.0V		5.5	50	
I_{LKG}	OFF-state supply current	V_{ON}=GND, V_{OUT}=0	V_{IN}=1.2V		6.5		nA
			V_{IN}=1.8V		6.5		
			V_{IN}=3.6V		8		
			V_{IN}=4.2V		10		
			V_{IN}=5.0V		16		
R_{ON}	ON-state resistance	I_{OUT}=-200mA	V_{IN}=1.2V	140	160	190	mΩ
			V_{IN}=1.8V		87		
			V_{IN}=2.5V		68		
			V_{IN}=3.6V		56		
			V_{IN}=4.2V		53		
			V_{IN}=5.0V	30	48	70	
I_{REV}	Reverse current during disable	V_{OUT}=5.0V, V_{ON}=0, V_{IN}=0V			8		nA
R_{ON_PD}	ON pull down resistance				100		MΩ
V_{IH}	High level input voltage	V_{IN}=1.2V to 5.5V		1.0			V
V_{IL}	Low level input voltage	V_{IN}=1.2V to 5.5V				0.5	V

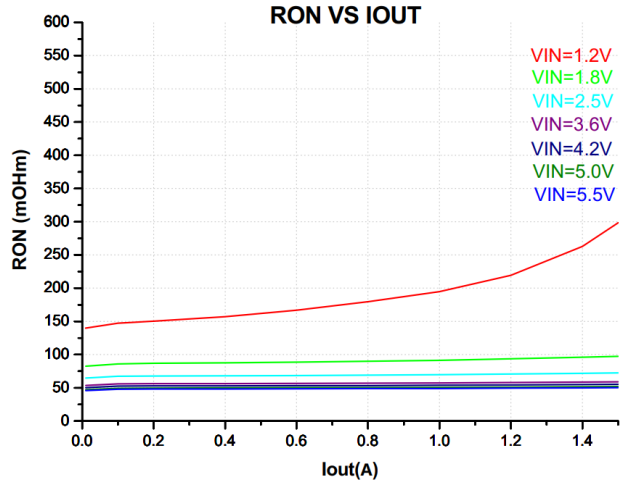
Switching Characteristics (T_A = 25°C unless otherwise specified)

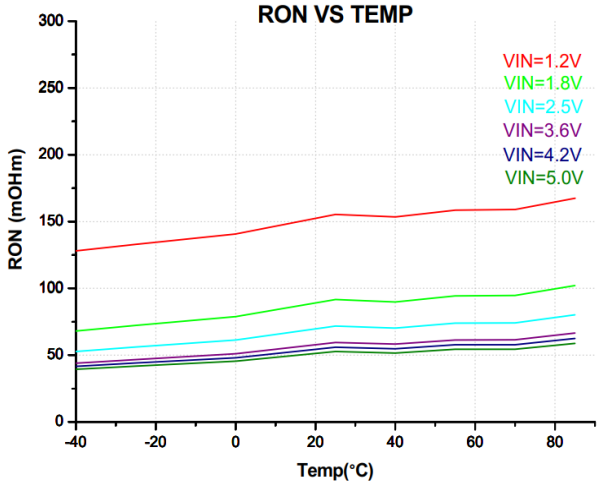
Symbol	Parameter	Conditions		Min.	Typ.	Max.	Unit
V_{IN}=1.2V							
t_{ON}	Turn on time	R_L=500Ω	C_L=0.1μF		162		μs
t_{OFF}	Turn off time	R_L=500Ω	C_L=0.1μF		40		us
t_R	VOUT rise time	R_L=500Ω	C_L=0.1μF		7		μs
t_F	VOUT fall time	R_L=500Ω	C_L=0.1μF		123		μs
V_{IN}=1.8V							
t_{ON}	Turn on time	R_L=500Ω	C_L=0.1μF		70		μs
t_{OFF}	Turn off time	R_L=500Ω	C_L=0.1μF		44		us
t_R	VOUT rise time	R_L=500Ω	C_L=0.1μF		10		μs
t_F	VOUT fall time	R_L=500Ω	C_L=0.1μF		122		μs
V_{IN}=3.6V							
t_{ON}	Turn on time	R_L=500Ω	C_L=0.1μF		41		μs
t_{OFF}	Turn off time	R_L=500Ω	C_L=0.1μF		46		us
t_R	VOUT rise time	R_L=500Ω	C_L=0.1μF		26		μs
t_F	VOUT fall time	R_L=500Ω	C_L=0.1μF		132		μs
V_{IN}=4.2V							
t_{ON}	Turn on time	R_L=500Ω	C_L=0.1μF		40		μs
t_{OFF}	Turn off time	R_L=500Ω	C_L=0.1μF		44		us
t_R	VOUT rise time	R_L=500Ω	C_L=0.1μF		32		μs
t_F	VOUT fall time	R_L=500Ω	C_L=0.1μF		135		μs
V_{IN}=5V							
t_{ON}	Turn on time	R_L=500Ω	C_L=0.1μF		42		μs
t_{OFF}	Turn off time	R_L=500Ω	C_L=0.1μF		47		us
t_R	VOUT rise time	R_L=500Ω	C_L=0.1μF		37		μs
t_F	VOUT fall time	R_L=500Ω	C_L=0.1μF		136		μs

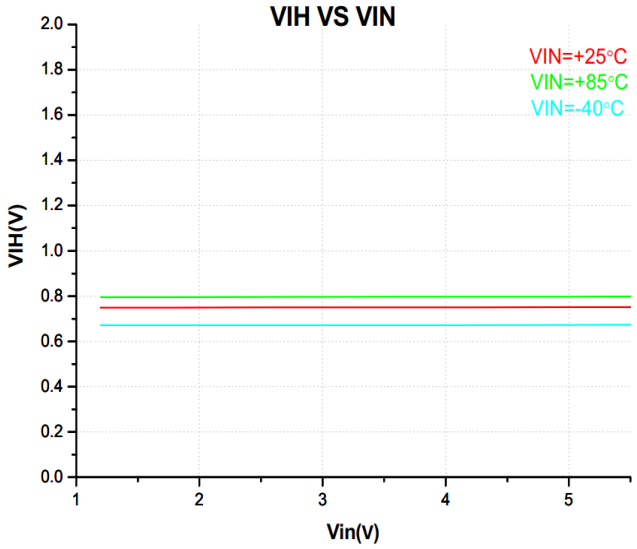
Typical Performance Characteristics (C_{IN} = 1μF, C_{OUT} = 0.1μF, R_{OUT} = 10Ω, T_A = 25°C unless otherwise specified)

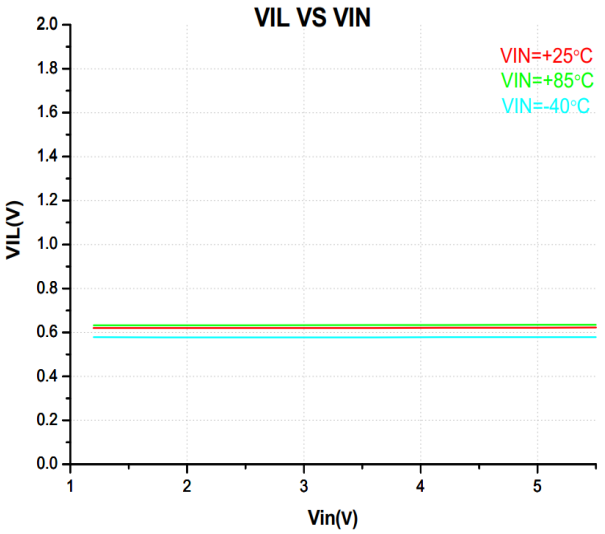






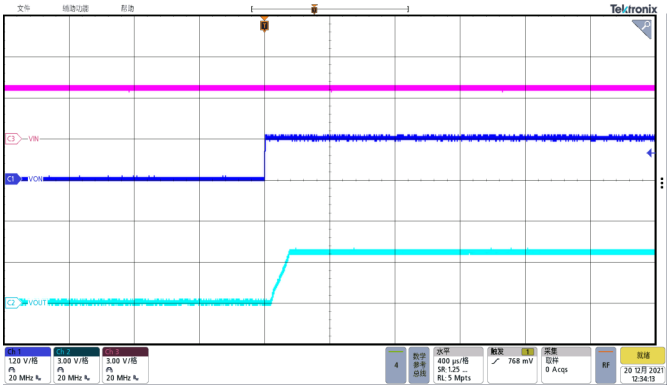






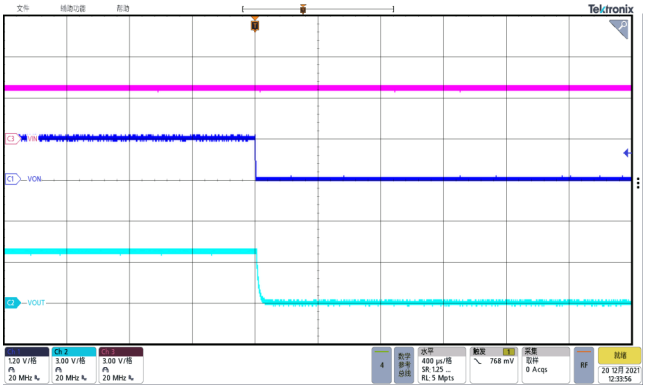
Typical Performance Characteristics (C_{IN} = 1μF, C_{OUT} = 0.1μF, R_{OUT} = 10Ω, T_A = 25°C unless otherwise specified)

V_{ON} ON Response w/o load



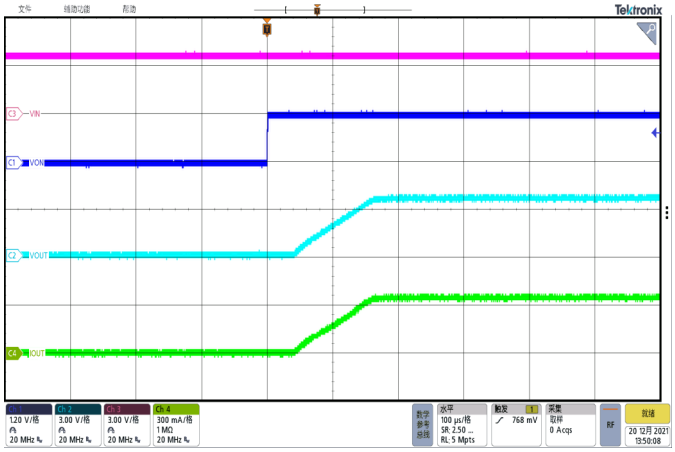
V_{IN}=3.7V, V_{ON}=1.2V

V_{ON} OFF Response w/o load



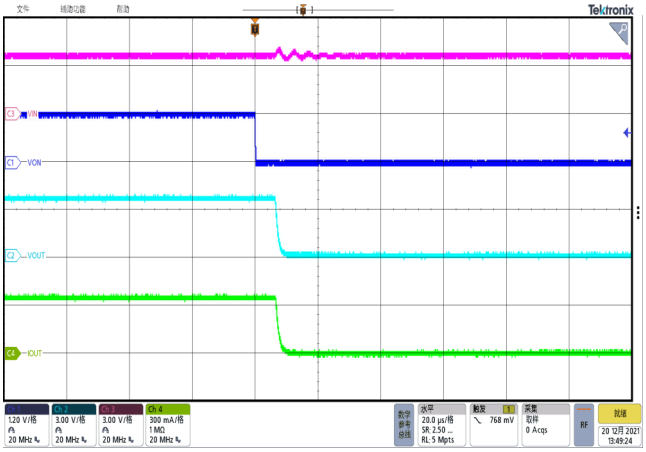
V_{IN}=3.7V, V_{ON}=1.2V

V_{ON} ON Response with 10Ω load



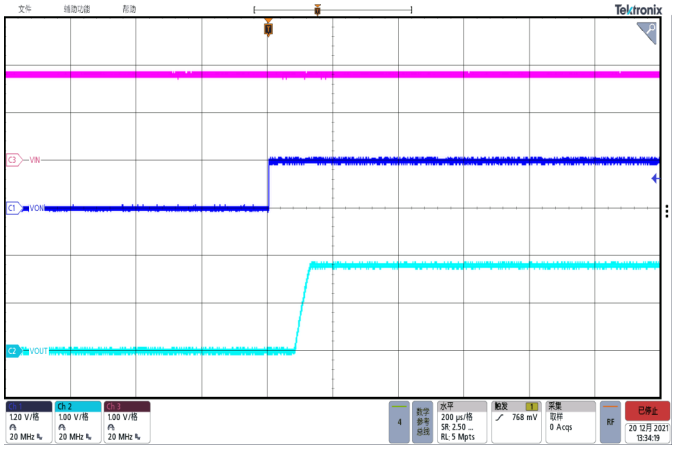
V_{IN}=3.7V, V_{ON}=1.2V

V_{ON} OFF Response with 10Ω load



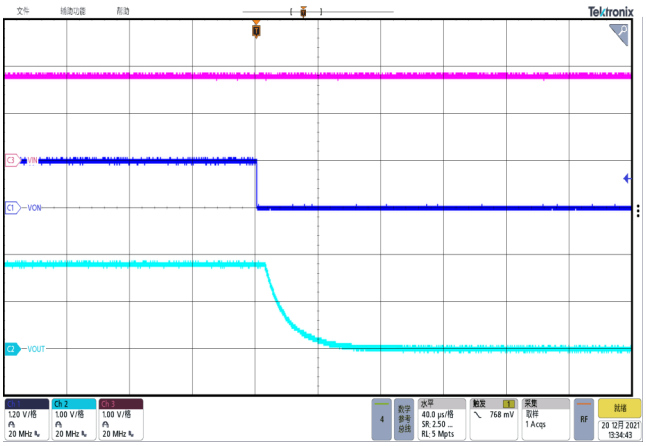
V_{IN}=3.7V, V_{ON}=1.2V

V_{ON} ON Response w/o load



V_{IN}=1.8V, V_{ON}=1.2V

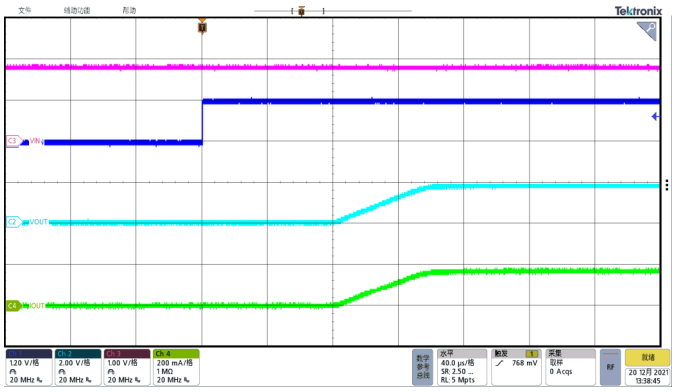
V_{ON} OFF Response w/o load



V_{IN}=1.8V, V_{ON}=1.2V

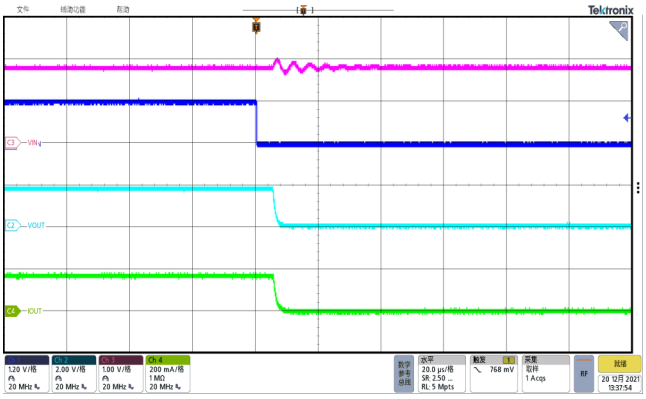
Typical Performance Characteristics (C_{IN} = 1μF, C_{OUT} = 0.1μF, R_{OUT} = 10Ω, T_A = 25°C unless otherwise specified)

V_{ON} ON Response with 10Ω load



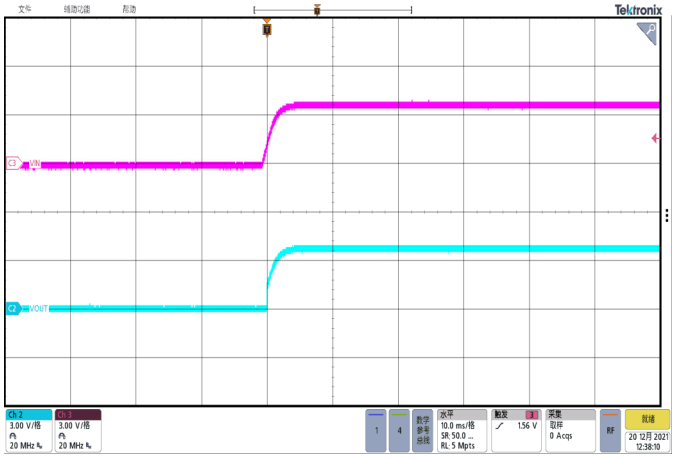
V_{IN}=1.8V, V_{ON}=1.2V

V_{ON} OFF Response with 10Ω load



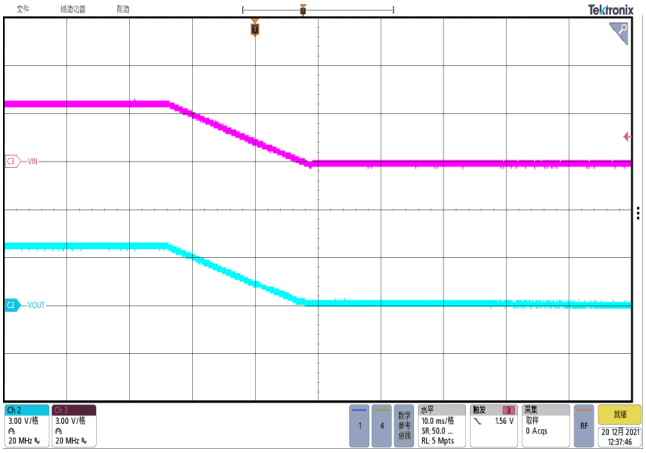
V_{IN}=1.8V, V_{ON}=1.2V

V_{IN} Power ON w/o load



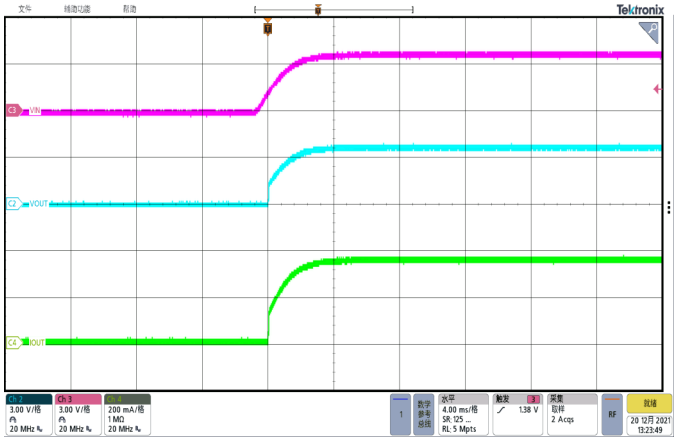
V_{IN}=V_{ON}=3.7V

V_{IN} Power OFF w/o load



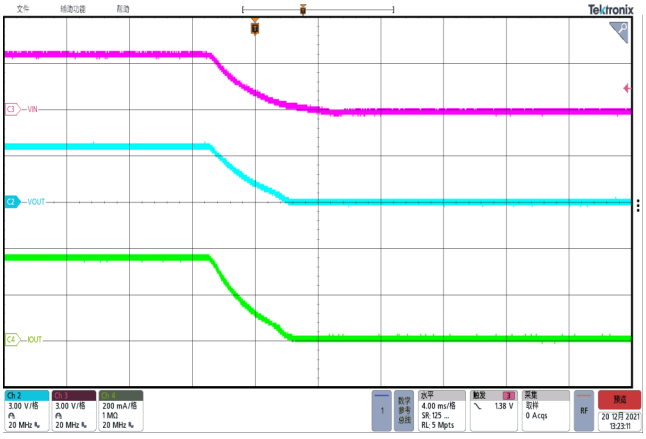
V_{IN}=V_{ON}=3.7V

V_{IN} Power ON with 10Ω load



V_{IN}=V_{ON}=3.7V

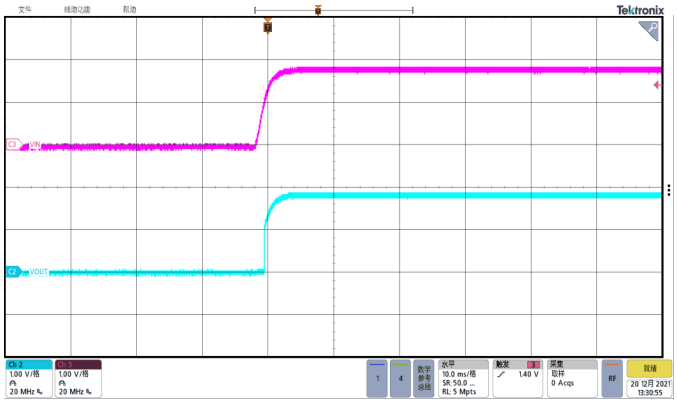
V_{IN} Power OFF with 10Ω load



V_{IN}=V_{ON}=3.7V

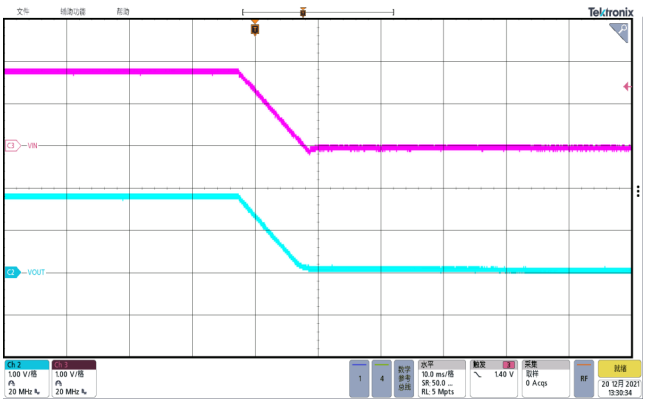
Typical Performance Characteristics (C_{IN} = 1μF, C_{OUT} = 0.1μF, R_{OUT} = 10Ω, T_A = 25°C unless otherwise specified)

V_{IN} Power ON w/o load



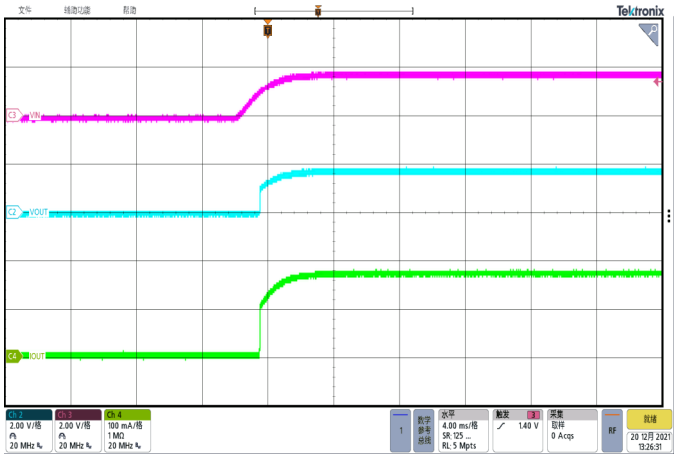
V_{IN}=V_{ON}=1.8V

V_{IN} Power OFF w/o load



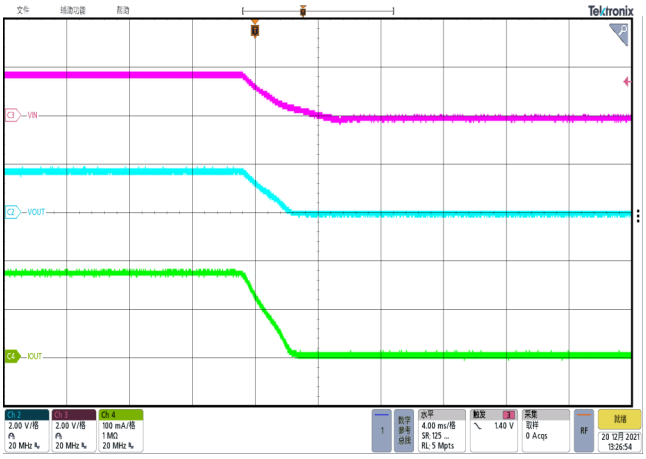
V_{IN}=V_{ON}=1.8V

V_{IN} Power ON with 10Ω load



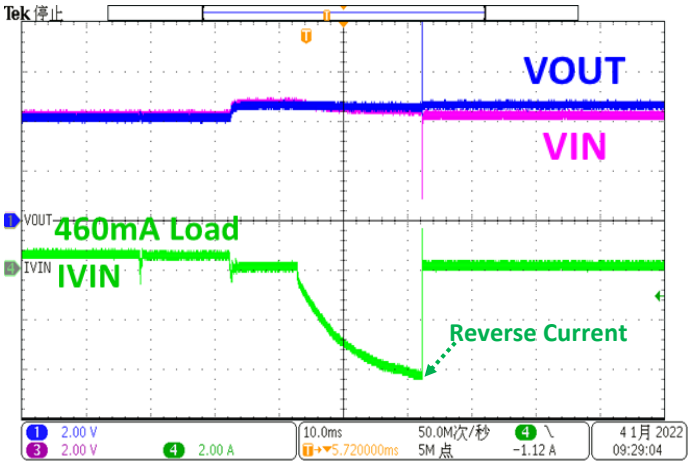
V_{IN}=V_{ON}=1.8V

V_{IN} Power OFF with 10Ω load



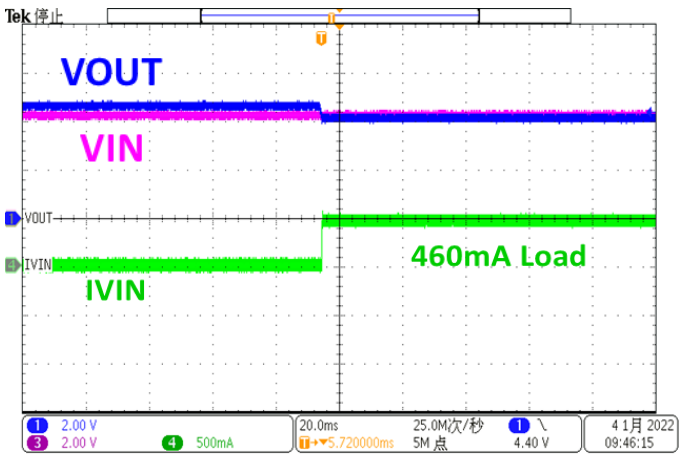
V_{IN}=V_{ON}=1.8V

Reverse Protection with 10Ω load



V_{IN}=V_{ON}=4.2V

Reverse Protection Recovery with 10Ω load



V_{IN}=V_{ON}=4.2V

Functional Description

Device Operation

The APL0501B is a low on-resistance (R_{ON}) load switch with controlled turn on, up to 1.5A output current. It contains a P-channel MOSFET and can be turned on with a wide range application of battery from 1.2V to 5.5V. An on/off input (ON) controls the switch, which can interface with low-threshold 1.2V GPIO control signal.

ON/OFF Control

The pin of ON controls the state of the switch. ON is active HI pin and has a low threshold making it capable of interfacing with low voltage GPIO control signals. It can be used with any microcontroller with 1.2V, 1.8V, 2.5V, 3.3V GPIOs. Applying VIH on the ON pin will put the switch in the on-state and VIL will put the switch in the off-state.

ON (Control Input)	VIN to VOUT
L	OFF
H	ON

Reverse Current Protection

The device includes a reverse current protection circuit, which stops a reverse current flowing from the VOUT pin to the VIN or GND pin when the voltage on VOUT becomes higher than VIN. This feature is particularly useful when the output of device needs to be driven by another voltage source, whichever device is both disabled and enabled (for example in a power multiplexer application). In order for this feature to work, device has to be disabled, and either of the following conditions shall be met: VIN > 1.2V or VOUT > 1.2V. Meanwhile considering of heat dissipation , VIN input voltage should be limited less than 4.8V voltage when VON is active high.

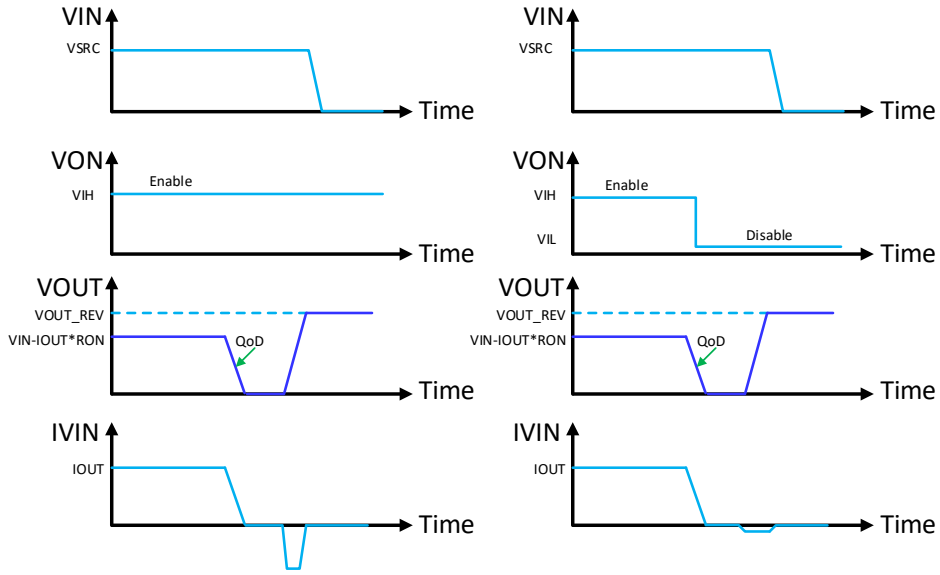


Figure 1

Functional Description (Continued)

Input Bypass Capacitor

A low ESR ceramic capacitor, X5R or X7R, needs to be placed between VIN and GND to limit the voltage drop on the input supply caused by transient in-rush currents. A typical 1μF ceramic capacitor, C_{IN}, placed close to the pins is usually needed. C_{IN}'s higher values can be used to further reduce the voltage drop during high current output application. It is recommended that the input capacitor is approximately 10 times higher than the output capacitor to prevent excessive voltage drop when switching heavy loads.

Output Bypass Capacitor

A low ESR ceramic capacitor, X5R or X7R, should be placed between VOUT and GND. A 0.1μF ceramic capacitor that is placed close to the IC pins is usually sufficient. This capacitor will prevent parasitic board inductances from forcing VOUT below GND when the switch turns off. It is recommended that C_{IN} is 10times higher than C_{OUT} so that once the switch is turned on, COUT can be charged up to VIN without VIN dropping significantly.

Power Supply Sequencing without a GPIO Input Control Port

In many terminal devices, each module needs to be powered up in a pre-determined manner. The device can solve the power sequencing problem without increasing any complexity to the overall system. Figure 2 shows the configuration required to power up the two modules in a fixed sequence. The output of the first load switch is tied to the enable of the second load switch, so when load1 is powered, the second load switch is enabled and load2 is powered.

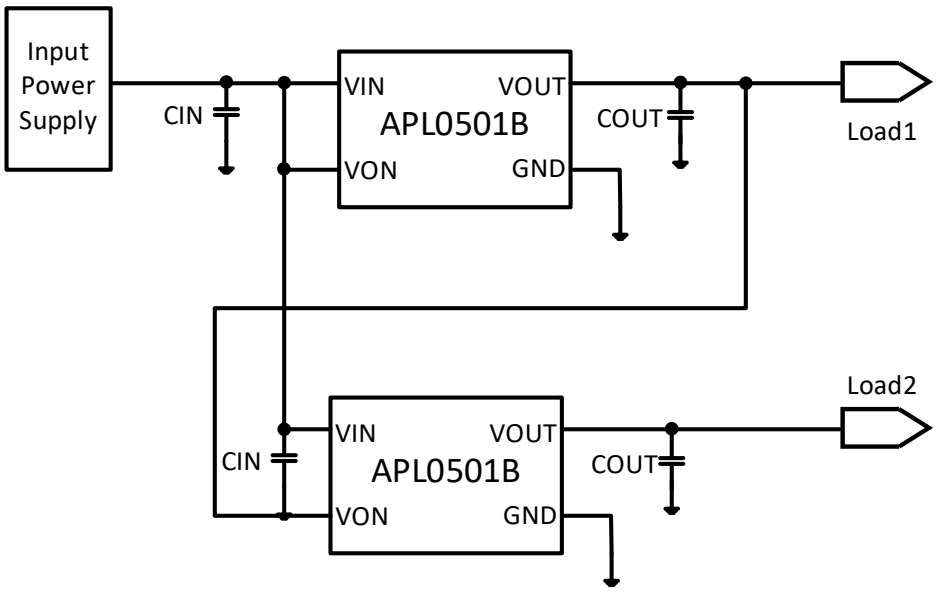
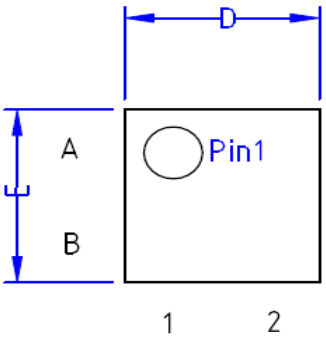
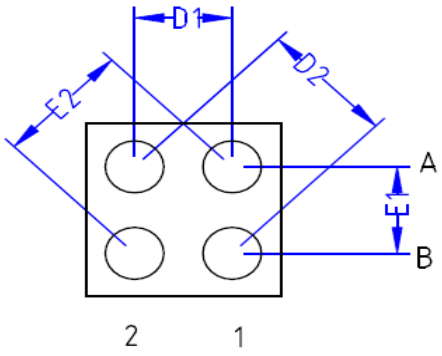


Figure 2

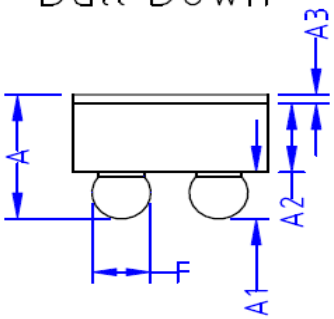
Package Outline Drawing



TOP VIEW
Ball Down



BOTTOM VIEW
Ball Up



SIDE VIEW

Unit:mm

		NO.	Mean	Tolerance
Top Thickness		A	0.449	±0.036
Ball Height+UBM Thickness		A1	0.194	±0.023
Wafer/Grinding Thickness		A2	0.215	±0.0125
Backside Coating Thickness		A3	0.04	±0.005
Pkg Die Size	X	D	0.775	±0.025
	Y	E	0.775	±0.025
Ball Size afer reflow		F	0.268	±0.020
Ball Pitch		D1	0.4	NA
		D2	0.565	NA
		E1	0.4	NA
		E2	0.565	NA

Contact Information

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