LP5241QVF

Dual-Channel 5V / 6A Load Switch with Ultra-Low On-Resistance

Features

- Independent dual-channel load switch
- 18mΩ (Typ) ultra-low on-state resistance
- 30μA (Typ) low current consumption
- Operating voltage range
  - BIAS voltage range: 2.5V to 5.7V
  - IN voltage range: 0.6V to V_{BIAS}
- Continuous current capability up to 6A
- Independent active-high enable control
- Programmable slew rate control
- Fast turn on with no CT capacitor
- Auto output discharge on OUT (optional)
- Thermal shutdown protection
- ESD Protection:
  - Human Body Model: 4kV
  - Charged Device Model: 0.5kV
- Package: DFN-14L

Applications

- Notebook and PC
- Cell phone and PDAs
- USB or other peripheral ports
- Camera

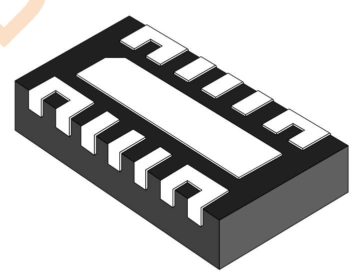
General Description

The LP5241 is a load switch device with integrated dual channel.

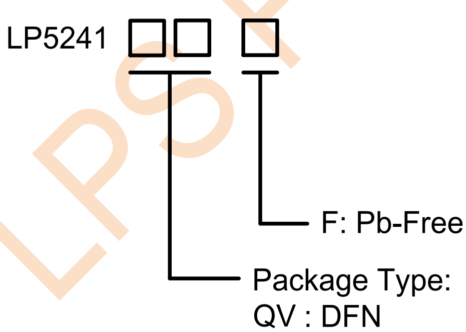
The device contains two independent N-type MOSFETs which can operate over an input voltage range from 0.6V to 5.7V. It supports maximum continuous current up to 6A.

The LP5241 has internal drivers to keep the MOSFETs in ON status. The turn-on slew rate can be programed via external capacitor on CT pins. The active-high enable pin can control every individual channel without impact the other one.

These parts are available in space-saving 14-pins DFN package DFN-14L.



Marking Information



Ordering and Package Information

Part Number	Top Mark	Package	T&R
LP5241QVF	LPS LP5241 YWX	DFN-14L	4K/REEL
Marking indication: Y: Production Year, W: Production week, X: Series Number			

Typical Application Circuitry

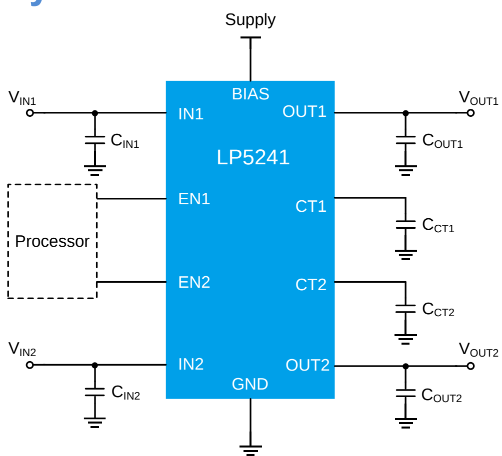
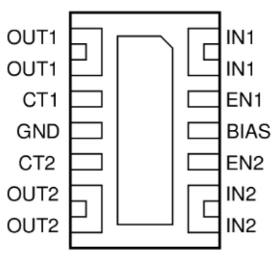
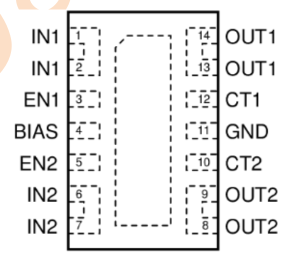


Figure 1. Typical Application Circuitry

Pin Configuration



DFN-14L (Bottom View)



DFN-14L (Top View)

Pin Description

No.	Pin	I/O	Description
1	IN1	I	Switch channel 1 input.
2	IN1	I	Switch channel 1 input.
3	EN1	I	Switch channel 1 control input.
4	BIAS	I	Bias supply.
5	EN2	I	Switch channel 2 control input.
6	IN2	I	Switch channel 2 input.
7	IN2	I	Switch channel 2 input.
8	OUT2	O	Switch channel 2 output.
9	OUT2	O	Switch channel 2 output.
10	CT2	O	Switch channel 2 slew rate control.
11	GND	-	Ground.
12	CT1	O	Switch channel 1 slew rate control.
13	OUT1	O	Switch channel 1 output.
14	OUT1	O	Switch channel 1 output.
-	Thermal Pad	-	Exposed thermal pad.

Functional Block Diagram

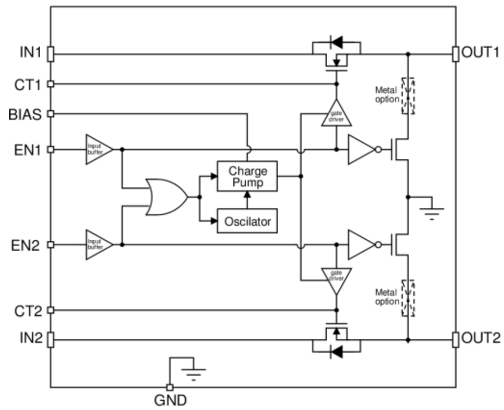


Figure 2. Internal Block Diagram

Absolute Maximum Ratings

- IN1 / IN2 to GND ---------- -0.3V to +6V
- OUT1 / OUT2 to GND ---------- -0.3V to +6V
- EN1 / EN2 to GND ---------- -0.3V to +6V
- BIAS to GND ---------- -0.3V to +6V
- Maximum continuous current per channel ---------- 6A
- Maximum pulse current per channel (pulse < 300µs, 3% duty cycle) ---------- 8A
- Maximum Junction Temperature (T_A) ---------- 150°C
- Maximum Soldering Temperature (at leads, 10 seconds) ---------- 260°C

Note 1: Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, instead of functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Thermal Information

- Maximum Power Dissipation (T_A <= 25℃) ---------- 2.3 W
- Thermal Resistance (θJ_A) (Note 2) ---------- 50 °C/W

Note 2: It is based on 2S2P JEDEC standard PCB.

ESD Ratings

- HBM (Human Body Model, JEDEC JS-001) ---------- ±4000V
- CDM (Charged Device Model, JEDEC JS-002) ---------- ±500V

Recommended Operating Conditions

- Supply Voltage on BIAS ---------- 2.5V to 5.7V
- Input Voltage on IN1 / IN2 ---------- 0.6V to V_{BIAS}
- Output Voltage on OUT1 / OUT2 ---------- 0V to V_{IN}
- EN1 / EN2 Voltage ---------- 0V to 5.7V
- Input / Output Capacitance ---------- 0.1µF to 1µF
- Ambient Temperature ---------- -40°C to 85°C

Electrical Characteristics

The following parameters are guaranteed under condition V_{IN} =5V, T_A = -40°C to 85°C unless otherwise noted. T_A = 25°C for typical value.

Parameters	Symbol	Test conditions	Min	Typ	Max	Unit
On-resistance	$R_{DS(ON)}$	V_{BIAS} = 5V, V_{IN} = 0.6V to V_{BIAS}, I_{OUT}=-200mA, T_A = 25°C		18	23	mΩ
		V_{BIAS} = 5V, V_{IN} = 0.6V to V_{BIAS}, I_{OUT}=-200mA, T_A = -40°C to 85°C			27	
		V_{BIAS} = 2.5V, V_{IN} = 0.6V to V_{BIAS}, I_{OUT}=-200mA, T_A = 25°C		19	24	
		V_{BIAS} = 2.5V, V_{IN} = 0.6V to V_{BIAS}, I_{OUT}=-200mA, T_A = -40°C to 85°C			28	
Quiescent current on BIAS	I_{BIAS}	$V_{IN1,2}$ = V_{BIAS} = V_{EN1} = V_{EN2} = 5V, OUT floating, T_A = -40°C to 85°C		70	90	μA
		$V_{IN1,2}$ = V_{BIAS} = V_{EN1} = 5V, V_{EN2} = 0V, OUT floating, T_A = -40°C to 85°C		60		
		$V_{IN1,2}$ = V_{BIAS} = V_{EN1} = V_{EN2} = 2.5V, OUT floating, T_A = -40°C to 85°C		33	45	
		$V_{IN1,2}$ = V_{BIAS} = V_{EN1} = 2.5V, V_{EN2} = 0V, OUT floating, T_A = -40°C to 85°C		30		
Output auto discharge	R_{DIS}	V_{IN} = 5V, V_{EN} = 0V		250		Ω
Enable logic high voltage level	V_{IH}	V_{IN} = 2.4V to 6V	1.2			V
Enable logic high voltage level	V_{IL}	V_{IN} = 2.4V to 6V			0.5	V
Thermal shutdown trigger	T_{SD}	Temperature rising		160		°C
Thermal shutdown release	T_{SD_REL}	Temperature falling		140		°C

Note 3. The parameter is guaranteed by design and characterization.

Parametric Measurement Information

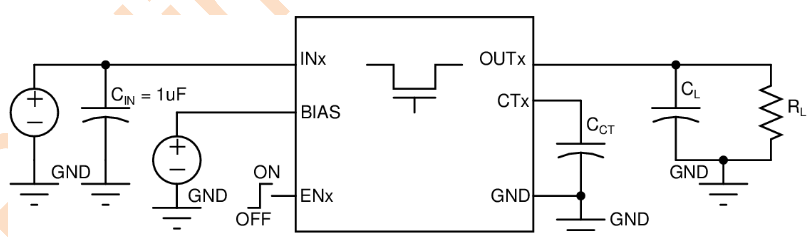


Figure 3 Test Circuitry

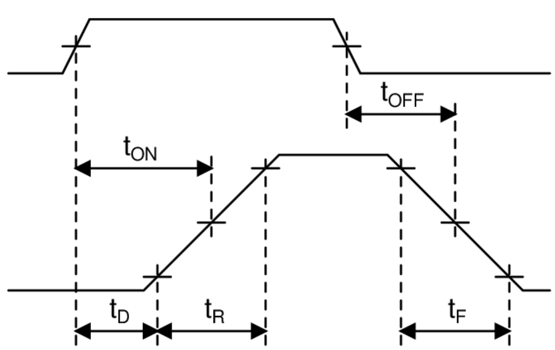


Figure 4 Timing Waveforms

Switching Characteristics

The following parameters are guaranteed by design and characterization only.

Parameters	Symbol	Test conditions	Min	Typ	Max	Unit
V_{IN} = V_{EN} = V_{BIAS} = 5V, T_A = 25°C						
Turn-on time	t_{ON}	R_L = 10Ω, C_L = 0.1μF, C_{CT} = 1000pF		670		μs
Turn-off time	t_{OFF}	R_L = 10Ω, C_L = 0.1μF, C_{CT} = 1000pF		0.6		μs
Rising time	t_R	R_L = 10Ω, C_L = 0.1μF, C_{CT} = 1000pF		720		μs
Falling time	t_F	R_L = 10Ω, C_L = 0.1μF, C_{CT} = 1000pF		1.4		μs
Delay time	t_D	R_L = 10Ω, C_L = 0.1μF, C_{CT} = 1000pF		310		μs
V_{IN} = 1.05V, V_{EN} = V_{BIAS} = 5V, T_A = 25°C						
Turn-on time	t_{ON}	R_L = 10Ω, C_L = 0.1μF, C_{CT} = 1000pF		310		μs
Turn-off time	t_{OFF}	R_L = 10Ω, C_L = 0.1μF, C_{CT} = 1000pF		0.7		μs
Rising time	t_R	R_L = 10Ω, C_L = 0.1μF, C_{CT} = 1000pF		200		μs
Falling time	t_F	R_L = 10Ω, C_L = 0.1μF, C_{CT} = 1000pF		1.3		μs
Delay time	t_D	R_L = 10Ω, C_L = 0.1μF, C_{CT} = 1000pF		210		μs
V_{IN} = 0.6V, V_{EN} = V_{BIAS} = 5V, T_A = 25°C						
Turn-on time	t_{ON}	R_L = 10Ω, C_L = 0.1μF, C_{CT} = 1000pF		265		μs
Turn-off time	t_{OFF}	R_L = 10Ω, C_L = 0.1μF, C_{CT} = 1000pF		0.8		μs
Rising time	t_R	R_L = 10Ω, C_L = 0.1μF, C_{CT} = 1000pF		130		μs
Falling time	t_F	R_L = 10Ω, C_L = 0.1μF, C_{CT} = 1000pF		1.3		μs
Delay time	t_D	R_L = 10Ω, C_L = 0.1μF, C_{CT} = 1000pF		200		μs
V_{IN} = V_{EN} = V_{BIAS} = 2.5V, T_A = 25°C						
Turn-on time	t_{ON}	R_L = 10Ω, C_L = 0.1μF, C_{CT} = 1000pF		990		μs
Turn-off time	t_{OFF}	R_L = 10Ω, C_L = 0.1μF, C_{CT} = 1000pF		1.7		μs
Rising time	t_R	R_L = 10Ω, C_L = 0.1μF, C_{CT} = 1000pF		840		μs
Falling time	t_F	R_L = 10Ω, C_L = 0.1μF, C_{CT} = 1000pF		1.4		μs
Delay time	t_D	R_L = 10Ω, C_L = 0.1μF, C_{CT} = 1000pF		570		μs

Parameters	Symbol	Test conditions	Min	Typ	Max	Unit
V_{IN} = 1.05V, V_{EN} = V_{BIAS} = 2.5V, T_A = 25°C						
Turn-on time	t_{ON}	R_L = 10Ω, C_L = 0.1μF, C_{CT} = 1000pF		770		μs
Turn-off time	t_{OFF}	R_L = 10Ω, C_L = 0.1μF, C_{CT} = 1000pF		1.7		μs
Rising time	t_R	R_L = 10Ω, C_L = 0.1μF, C_{CT} = 1000pF		440		μs
Falling time	t_F	R_L = 10Ω, C_L = 0.1μF, C_{CT} = 1000pF		1.3		μs
Delay time	t_D	R_L = 10Ω, C_L = 0.1μF, C_{CT} = 1000pF		450		μs
V_{IN} = 0.6V, V_{EN} = V_{BIAS} = 2.5V, T_A = 25°C						
Turn-on time	t_{ON}	R_L = 10Ω, C_L = 0.1μF, C_{CT} = 1000pF		570		μs
Turn-off time	t_{OFF}	R_L = 10Ω, C_L = 0.1μF, C_{CT} = 1000pF		1.7		μs
Rising time	t_R	R_L = 10Ω, C_L = 0.1μF, C_{CT} = 1000pF		280		μs
Falling time	t_F	R_L = 10Ω, C_L = 0.1μF, C_{CT} = 1000pF		1.5		μs
Delay time	t_D	R_L = 10Ω, C_L = 0.1μF, C_{CT} = 1000pF		430		μs

Typical Performance Characteristics

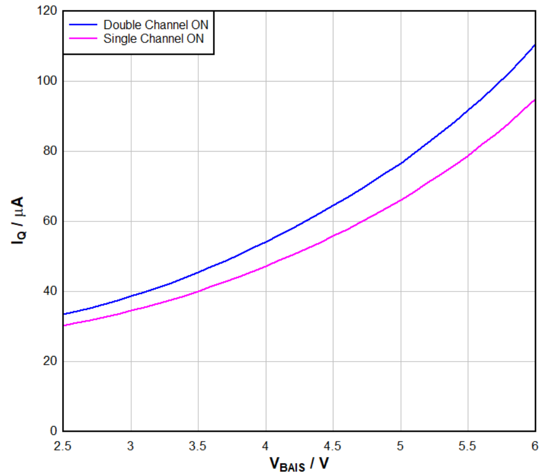


Figure 4. Quiescent Current vs V_{BIAS}
(C_{IN} = C_{OUT} = 1µF, V_{ENx} = V_{BIAS}, no load)

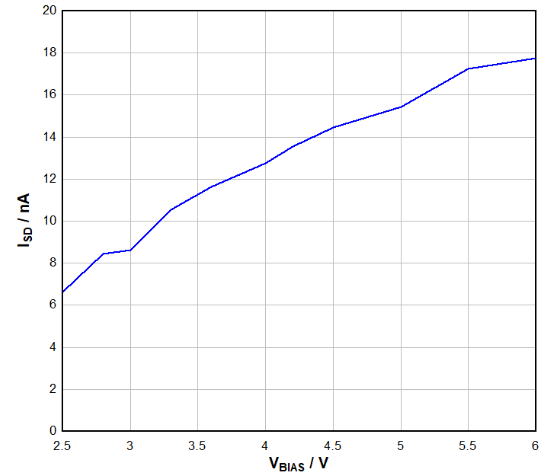


Figure 5. Shutdown Current vs V_{BIAS}
(C_{IN} = C_{OUT} = 1µF, V_{EN1} = V_{EN2} = 0V, no load)

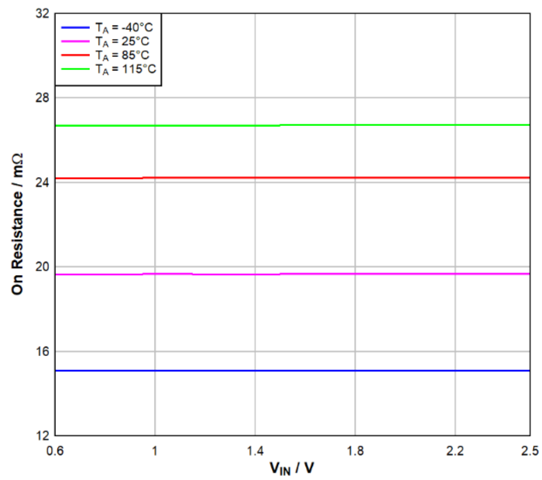


Figure 6. On-resistance vs Temperature
(V_{BIAS} = 2.5V, V_{EN} = V_{BIAS}, I_{LOAD} = 200mA)

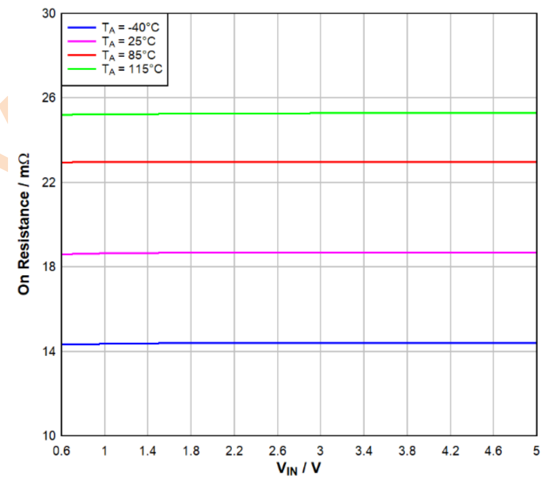


Figure 7. On-resistance vs Temperature
(V_{BIAS} = 5V, V_{EN} = V_{BIAS}, I_{LOAD} = 200mA)

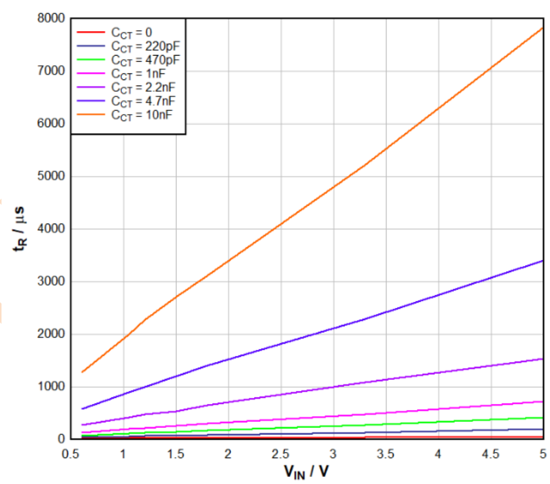


Figure 8. Slew Rate vs Input Voltage
(C_{IN}=1µF, C_{OUT}=0.1µF, V_{ENx} = V_{BIAS} = 5V, R_{LOAD} = 10Ω)

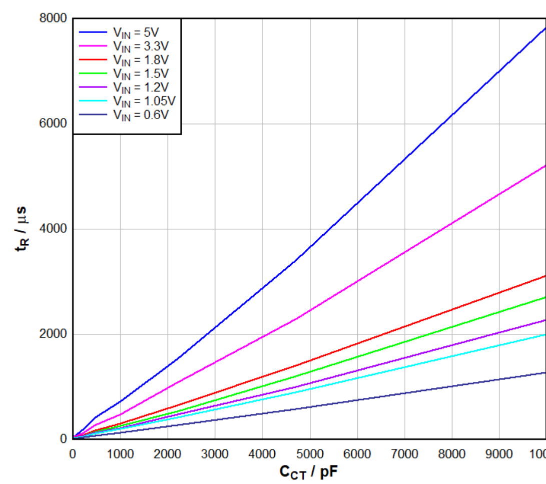


Figure 9. Slew Rate vs CT capacitance
(C_{IN}=1µF, C_{OUT}=0.1µF, V_{ENx} = V_{BIAS} = 5V, R_{LOAD} = 10Ω)

Typical Operating Waveforms

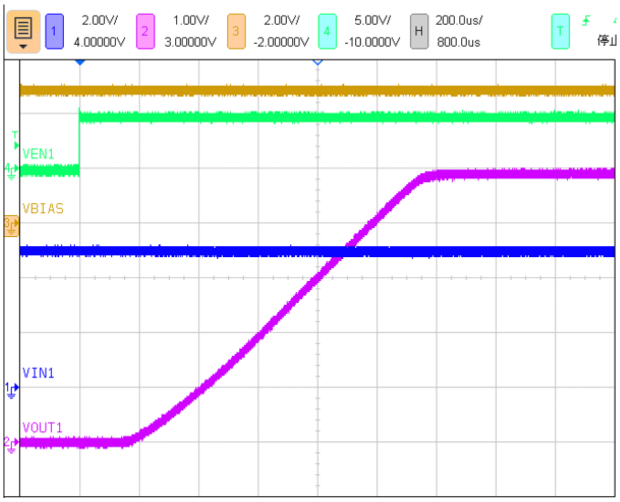


Figure 8. Start-up with V_{BIAS} = 5V, V_{IN} = 5V, (C_{IN} = 1µF, C_{OUT} = 0.1µF, C_{CT} = 1nF, R_{LOAD} = 10Ω)

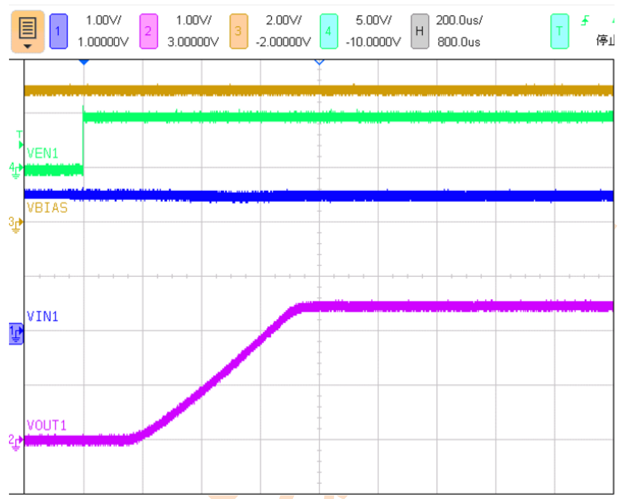


Figure 9. Start-up with V_{BIAS} = 5V, V_{IN} = 2.5V, (C_{IN} = 1µF, C_{OUT} = 0.1µF, C_{CT} = 1nF, R_{LOAD} = 10Ω)

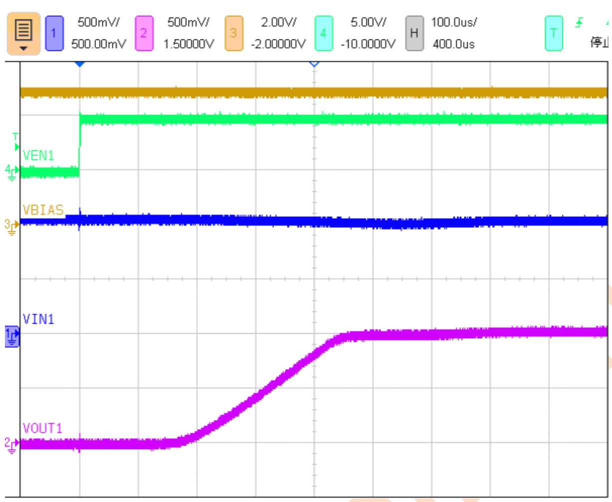


Figure 10. Start-up with V_{BIAS} = 5V, V_{IN} = 1.05V, (C_{IN} = 1µF, C_{OUT} = 0.1µF, C_{CT} = 1nF, R_{LOAD} = 10Ω)

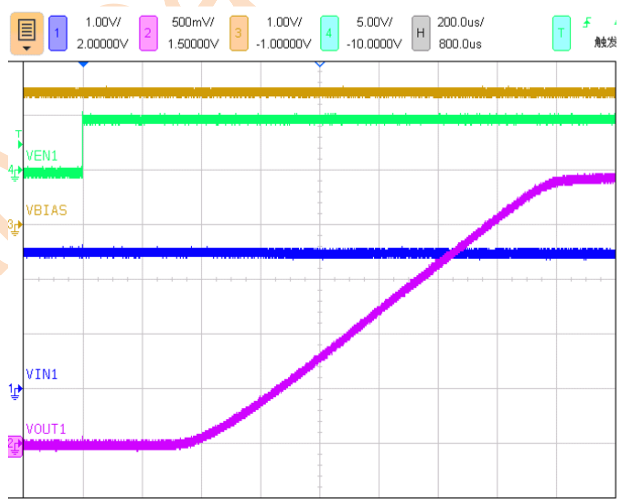


Figure 11. Start-up with V_{BIAS} = 2.5V, V_{IN} = 2.5V, (C_{IN} = 1µF, C_{OUT} = 0.1µF, C_{CT} = 1nF, R_{LOAD} = 10Ω)

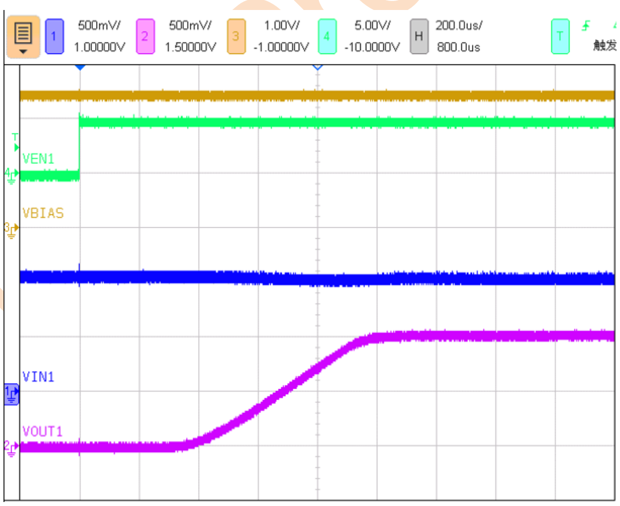


Figure 12. Start-up with V_{BIAS} = 2.5V, V_{IN} = 1.05V, (C_{IN} = 1µF, C_{OUT} = 0.1µF, C_{CT} = 1nF, R_{LOAD} = 10Ω)

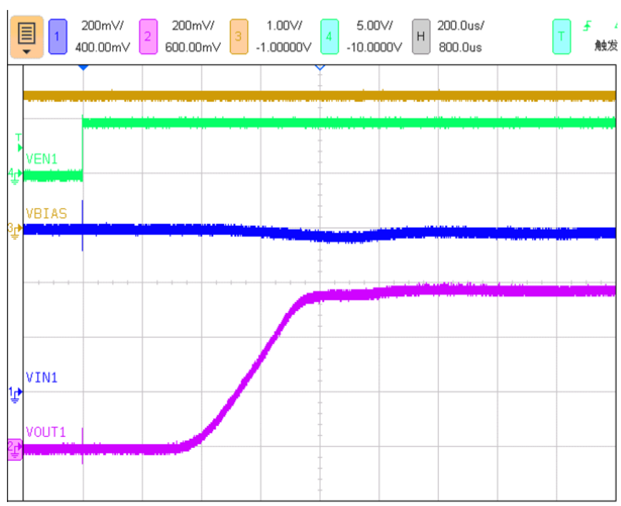


Figure 13. Start-up with V_{BIAS} = 2.5V, V_{IN} = 0.6V, (C_{IN} = 1µF, C_{OUT} = 0.1µF, C_{CT} = 1nF, R_{LOAD} = 10Ω)

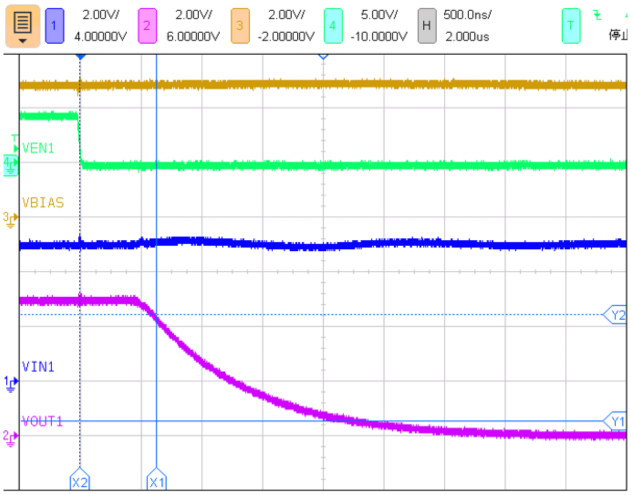


Figure 14. Disable with V_{BIAS} = 5V, V_{IN} = 5V, (C_{IN} = 1μF, C_{OUT} = 0.1μF, C_{CT} = 1nF, R_{LOAD} = 10Ω)

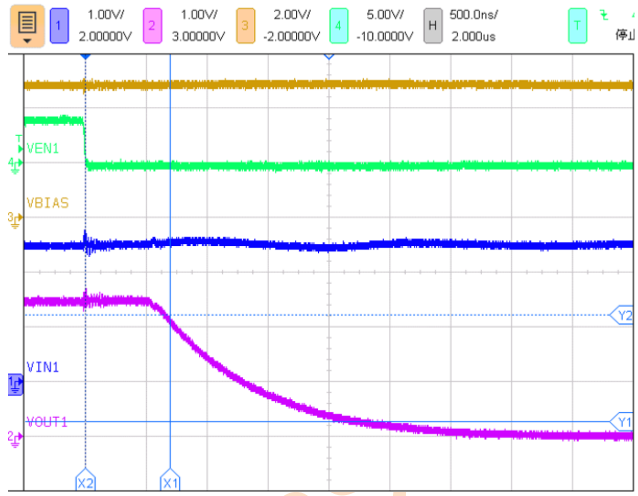


Figure 15. Disable with V_{BIAS} = 5V, V_{IN} = 2.5V, (C_{IN} = 1μF, C_{OUT} = 0.1μF, C_{CT} = 1nF, R_{LOAD} = 10Ω)

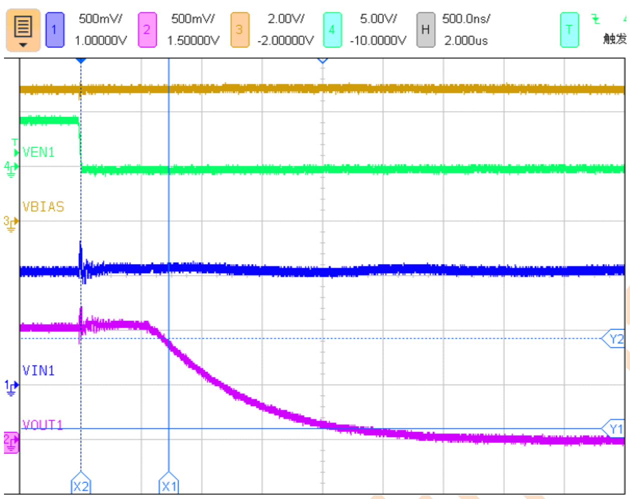


Figure 16. Disable with V_{BIAS} = 5V, V_{IN} = 1.05V, (C_{IN} = 1μF, C_{OUT} = 0.1μF, C_{CT} = 1nF, R_{LOAD} = 10Ω)

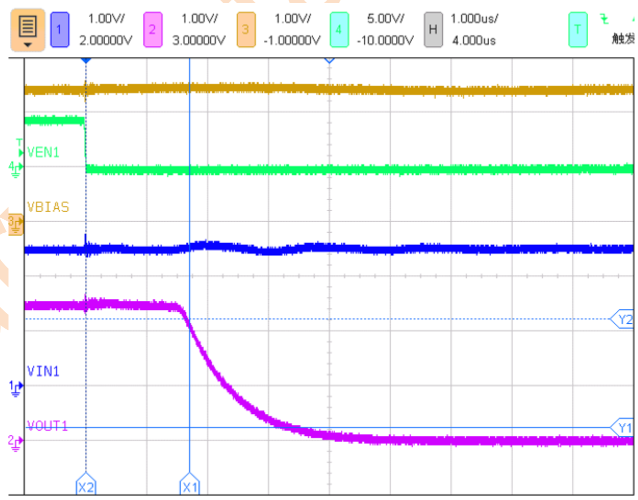


Figure 17. Disable with V_{BIAS} = 2.5V, V_{IN} = 2.5V, (C_{IN} = 1μF, C_{OUT} = 0.1μF, C_{CT} = 1nF, R_{LOAD} = 10Ω)

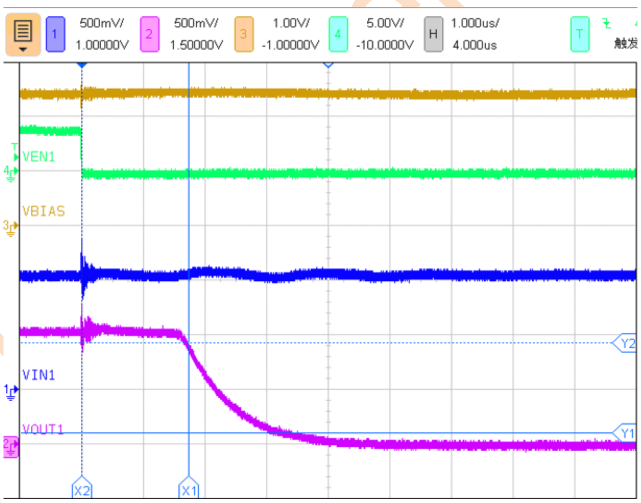


Figure 18. Disable with V_{BIAS} = 2.5V, V_{IN} = 1.05V, (C_{IN} = 1μF, C_{OUT} = 0.1μF, C_{CT} = 1nF, R_{LOAD} = 10Ω)

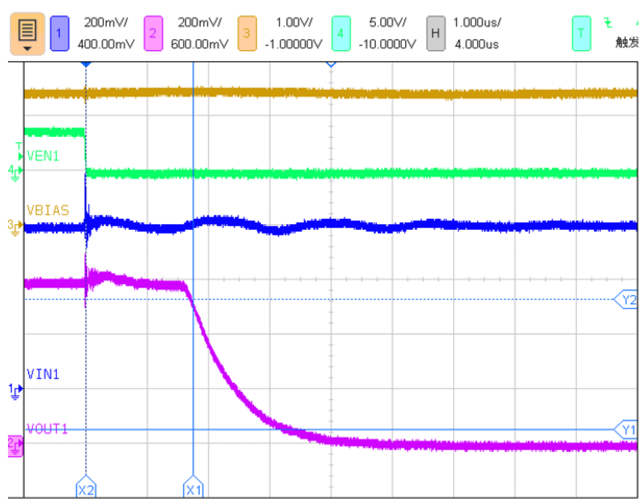


Figure 19. Disable with V_{BIAS} = 2.5V, V_{IN} = 0.6V, (C_{IN} = 1μF, C_{OUT} = 0.1μF, C_{CT} = 1nF, R_{LOAD} = 10Ω)

Function Description

General Description

LP5241 is a dual-channel integrated slew rate controlled load switch. The device contains two 18mΩ N-channel MOSFETs and independent driver.

LP5241 has supply pin as BIAS independent of input. As long as BIAS voltage is high enough, the switches could be enabled even with very low voltage on inputs.

Enable Control

The EN1 and EN2 pin controls the state of the two channel N-MOSFET individually. When EN1 or EN2 is pulled high, the MOSFET is turned on. Activating EN1 or EN2 pin continuously holds the switch in the on state so long as there is no fault. The junction temperature in excess of 160°C overrides the EN control to turn off the switch. Pulling EN1 or EN2 to low will disable channel 1 or channel 2 switch. However, for instance, channel 1 switch will not be impact by EN2 and vice versa.

Output Discharge

The LP5241 has auto-discharge paths on every OUT node. As long as the EN pin is pulled low to disable one channel switch, the path will discharge the relevant OUT.

Voltage Range

The LP5241 has independent supply pin BIAS. To have the switches work under turned-on status, the BIAS voltage should be kept in 2.5V to 5.7V.

The input voltage of IN1 and IN2, on the other hand, could work from 0.6V to V_{BIAS} as long as the BIAS voltage is in normal range.

Thermal Shutdown

The thermal shutdown protects the device from internally or externally generated excessive temperatures. During an over temperature condition, the switches are turned off. The switch automatically turns on again if the temperature drops below the threshold temperature.

Application Information

Slew Rate Control

The LP5241 supports slew rate control for both channel through external capacitor on CT pins. To guarantee the performance, a capacitor with minimum voltage rating of 25V is recommended on CT pins. The slew rate control relationship to CT pin capacitor could be calculated by the following formula:

$$SR = 0.238 \times C_{CT}^{0.944} + 6$$

Where

SR is the slew rate (in µs/V)

C_{CT} is the capacitor value on the CT pin (in pF)

The units for the constant 0.238 is in µs/V

Rising time can be calculated by multiplying the input voltage by the slew rate. The following table shows the rising time measured on a typical device. The values showed below are only valid for the power-up sequence where V_{IN} and V_{BIAS} are already in steady state condition and the EN pin is asserted high.

CT (pF)	Rise time (µs) 10% to 90%, C_L=0.1µF, C_{IN}=1µF, R_L=10Ω						
	5V	3.3V	1.8V	1.5V	1.2V	1.05V	0.6V
0	48	37	29	26	25	23	18
220	199	137	88	77	69	62	43
470	415	281	167	147	129	117	77
1000	719	484	303	262	222	202	131
2200	1534	1082	653	538	477	423	269
4700	3406	2293	1409	1209	1001	901	574
10000	7842	5214	3109	2712	2280	2007	1271

Capacitor consideration

External capacitors on IN and OUT are recommended in application, 0.1µF for C_{OUT} and 1µF for C_{IN} at least. Closer placement of the capacitors to the device, both IN and OUT, would be better for stability.

Power Dissipation

The internal power dissipation from the power MOSFET, when it is turned on, is the main source of junction temperature rising. In this case, the power dissipation and the junction temperature in conducting mode can be calculated as following:

$$P_D = R_{ON} \times I_{OUT}^2$$

P_D: Power Dissipation (W)

V_{IN}: Input voltage (V)

V_{OUT}: Output voltage (V)

I_{OUT}: Output current (A)

$$T_J = P_D \times \theta_{JA} + T_A$$

T_J: Junction temperature (°C)

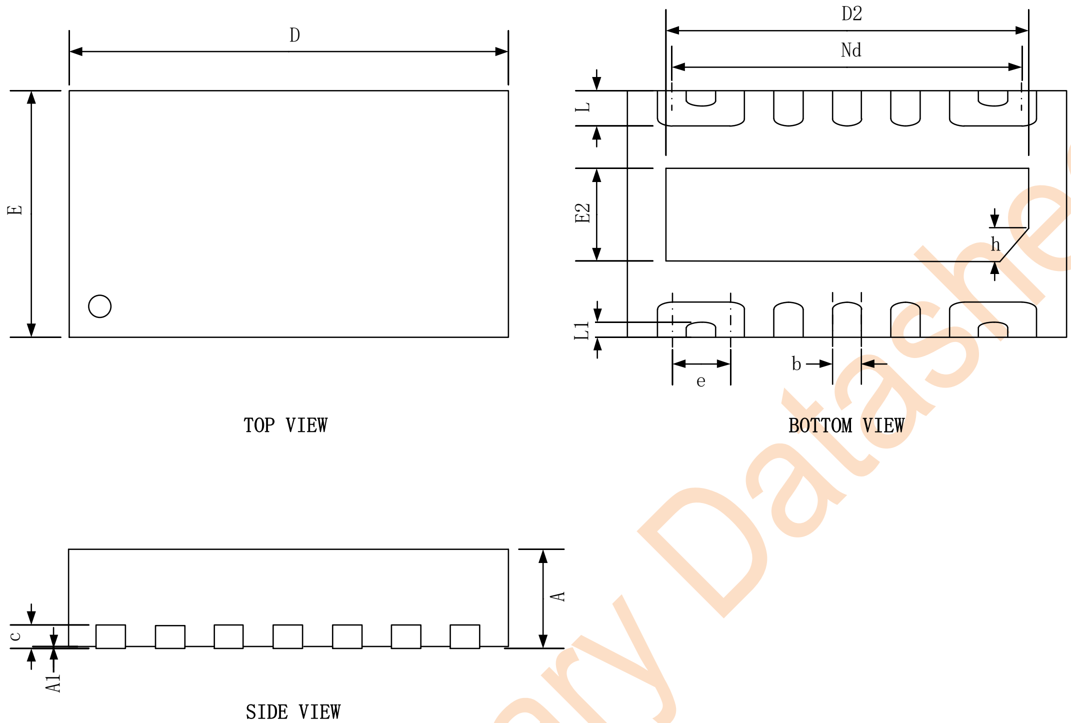
θ_{JA}: Package thermal resistance (°C /W) (Note 4)

T_A: Ambient temperature (°C)

***Note 4: The calculation base on thermal resistance is only valid in Lab condition. The value of θ_{JA} could change in customer PCB environment.**

Package Information

DFN-14L



SYMBOL	Dimensions In Millimeters		
	MIN	NOM	MAX
A	0.70	0.75	0.80
A1	0.01	0.02	0.05
b	0.13	0.18	0.23
c	0.15	0.20	0.25
D	2.95	3.00	3.05
D2	2.45	2.50	2.55
e	0.40 BSC		
Nd	2.40 BSC		
E	1.95	2.00	2.05
E2	0.85	0.90	0.95
L	0.25	0.30	0.35
L1	0.06	0.11	0.16
h	0.20 REF		