XPA5145

5.5-V, 12-A, 3-mΩ On-Resistance Load Switch with Controlled Turn-on

1. Description

The XPA5145 is a single-channel load switch that provides a configurable rise time to minimize inrush current.

The device contains an N-channel MOSFET that can operate over an input voltage range of 0.2V to 5.5V and can support a maximum continuous current of 12A.

The switch is controlled by an on and off input (ON), which is capable of interfacing directly with low voltage control signals (V_{IH}=0.7V). The XPA5145 has a fixed quick output discharge when switch is turned off, pulling the output down to ground.

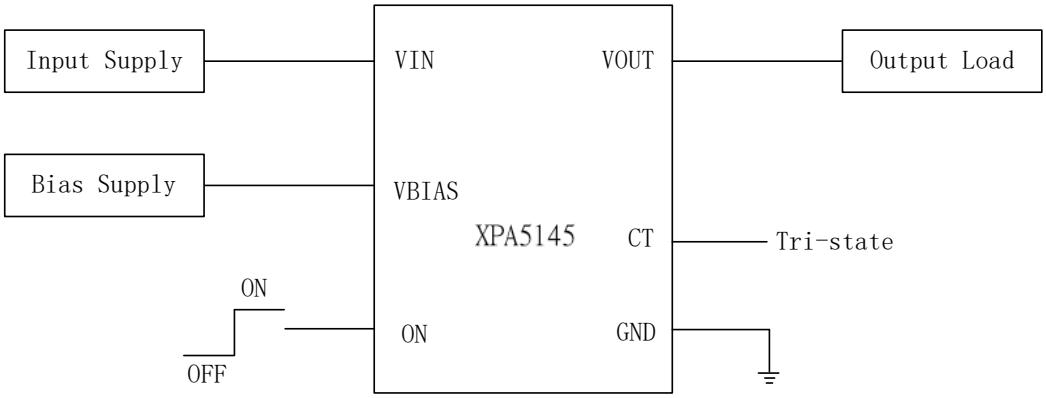
The XPA5145 is available in a 1.5mm x 2.0mm, 0.5mm pitch, 10-pin WQFN package and is characterized for operation over the extended free-air temperature range of -40℃ to +105℃.

2. Applications

- Optical module
- Solid state drive
- Industrial PC
- PC and notebooks

3. Features

- Input voltage range (V_{IN}): 0.2V to 5.5V
- Bias voltage range: 2.2V to 5.5V
- Maximum continuous current: 12A
- ON-Resistance (R_{ON}): 3mΩ (typ.)
- Adjustable slew rate with tri-state pin
- Quick Output Discharge: 50Ω
- Thermal shutdown
- Low power consumption:
  - ON state (I_Q): 27uA (typ.)
  - OFF state (I_{SD}): 2uA (typ.)



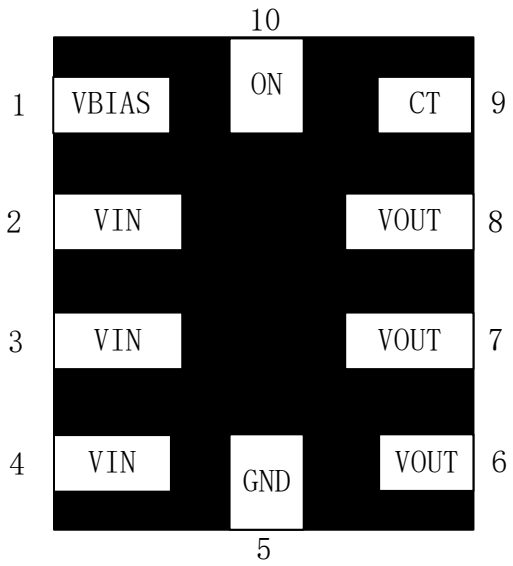
XPA5145 Typical Application Circuitry

4. Ordering Information

Family	Part Number	Current rating (A)	Top Marking	MPQ
XPA5145	XPA5145Q10R	12	5145	3000

MPQ means Minimum Packing Quantity.
For production orders greater than MPQ, the order must be a multiple of MPQ per package size above.

5. PIN Configuration and Functions



Top View

Pin	Name	Description
1	VBIAS	Device bias supply
2, 3, 4	VIN	Switch input
5	GND	Device ground
6, 7, 8	VOUT	Switch output
9	CT	Slew rate control – can be pulled up, left floating or tied to ground
10	ON	Enable pin

6. Absolute Maximum Ratings(1)

Parameter	Min	Max	Units
Input Voltage, V_{IN}	-0.3	6	V
Bias Voltage, V_{BIAS}	-0.3	6	V
Control Pin Voltage, V_{ON} and V_{CT}	-0.3	6	V
Maximum Current, I_{MAX}		12	A
Storage Temperature	-40	+150	°C
Junction Temperature	-40	+150	°C
Electrostatic Discharge (HBM)	-2000	+2000	V
Electrostatic Discharge (CDM)	-1000	+1000	V

Note: (1) Operation of the device outside of these parameters may cause permanent damage.

7. Recommended Operating Conditions

Parameter	Symbol	Min	Typ	Max	Units
Input Voltage	V_{IN}	0.2		5.5	V
Bias Voltage	V_{BIAS}	2.2		5.5	V
Control Pin Voltage	V_{CT}	0		5.5	V
Ambient Temperature	T_A	-40		+105	°C
Junction Temperature	T_J	-40		+125	°C

8. Thermal Information

Junction to ambient thermal resistance is a function of board layout and ambient air flow condition. This data is based on two-layer PCB in still air box in accordance with JEDEC standard JESD51 on natural convection.

Parameter	Symbol	Typ	Units
Junction-to-ambient thermal resistance	θ_{JA}	110	°C/W
Junction-to-case thermal resistance	θ_{JC}	80	°C/W

9. Electrical Specifications (VBIAS=5V)

(Typical values are at TA = +25°C. Unless otherwise noted.)

Parameter	Symbol	Test Condition	T_A	Min	Typ	Max	Units
VBIAS Shutdown Current	$I_{SD,VBIAS}$	ON =0V	25°C		1.7		uA
			-40°C to 85°C			1.9	uA
			-40°C to 105°C			2.0	uA
VBIAS Quiescent Current	$I_{Q,\ VBIAS}$	ON>V_{IH}	25°C		27.5		uA
			-40°C to 85°C			31	uA
			-40°C to 105°C			32	uA
VIN Shutdown Current	$I_{SD,VIN}$	ON =0V	25°C		10		uA
			-40°C to 85°C			20	uA
			-40°C to 105°C			30	uA
ON pin leakage	I_{ON}	ON=VBIAS	-40°C to 105°C		0.1		uA

On-Resistance	R_{ON}	V_{IN} = 0.2V to 5V	25°C		3		mΩ
			-40°C to 85°C			4	mΩ
			-40°C to 105°C			5	mΩ
Turn on threshold, rising	V_{IH}		-40°C to 105°C	0.72	0.80	0.87	V
Turn off threshold, falling	V_{IL}		-40°C to 105°C	0.68	0.78	0.86	V
ON pin hysteresis	$V_{ON,HYST}$		-40°C to 105°C		20		mV
ON pin deglitch time	$T_{ON,DEGLITCH}$		-40°C to 105°C	2	5	7	us
Output pulldown resistance	R_{PD}	VOUT=VIN	25°C		50		Ω
			-40°C to 105°C	35		55	Ω
Thermal Shutdown	TSD		-	130	150	170	°C
Thermal Shutdown Hysteresis	TSD_{HYS}		-		20		°C

10. Electrical Specifications (VBIAS=3.3V)

(Typical values are at TA = +25°C. Unless otherwise noted.)

Parameter	Symbol	Test Condition	T_A	Min	Typ	Max	Units
VBIAS Shutdown Current	$I_{SD,VBIAS}$	ON =0V	25°C		0.9		uA
			-40°C to 85°C			1	uA
			-40°C to 105°C			1.1	uA
VBIAS Quiescent Current	$I_{Q,\ VBIAS}$	ON>V_{IH}	25°C		20.5		uA
			-40°C to 85°C			23.5	uA
			-40°C to 105°C			24.0	uA
VIN Shutdown Current	$I_{SD,VIN}$	ON =0V	25°C		10		uA
			-40°C to 85°C			20	uA
			-40°C to 105°C			30	uA
ON pin leakage	I_{ON}	ON=VBIAS	-40°C to 105°C		0.1		uA
On-Resistance	R_{ON}	V_{IN} = 0.2V to 3.3V	25°C		3		mΩ
			-40°C to 85°C			4	mΩ
			-40°C to 105°C			5	mΩ
Turn on threshold, rising	V_{IH}		-40°C to 105°C	0.67	0.77	0.84	V
Turn off threshold, falling	V_{IL}		-40°C to 105°C	0.64	0.75	0.83	V
ON pin hysteresis	$V_{ON,HYST}$		-40°C to 105°C		20		mV
ON pin deglitch time	$T_{ON,DEGLITCH}$		-40°C to 105°C	2	5	6.5	us
Output pulldown resistance	R_{PD}	VOUT=VIN	25°C		50		Ω
			-40°C to 105°C	35		60	Ω
Thermal Shutdown	TSD		-	130	150	170	°C
Thermal Shutdown Hysteresis	TSD_{HYS}		-		20		°C

11. Electrical Specifications (VBIAS=2.2V)

(Typical values are at TA = +25°C. Unless otherwise noted.)

Parameter	Symbol	Test Condition	T_A	Min	Typ	Max	Units
VBIAS Shutdown Current	$I_{SD,VBIAS}$	ON =0V	25°C		0.45		uA
			-40°C to 85°C			0.5	uA
			-40°C to 105°C			0.6	uA

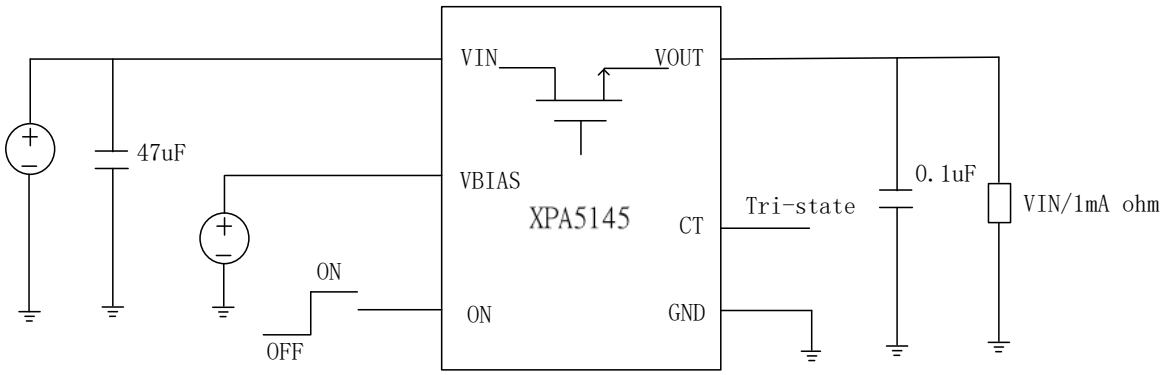
VBIAS Quiescent Current	$I_{Q, VBIAS}$	ON>V_{IH}	25°C		17		uA
			-40°C to 85°C			19	uA
			-40°C to 105°C			20	uA
VIN Shutdown Current	$I_{SD,VIN}$	ON =0V	25°C		10		uA
			-40°C to 85°C			20	uA
			-40°C to 105°C			30	uA
ON pin leakage	I_{ON}	ON=VBIAS	-40°C to 105°C		0.1		uA
On-Resistance	R_{ON}	V_{IN} = 0.2V to 2.2V	25°C		3		mΩ
			-40°C to 85°C			4	mΩ
			-40°C to 105°C			5	mΩ
Turn on threshold, rising	V_{IH}		-40°C to 105°C	0.63	0.73	0.80	V
Turn off threshold, falling	V_{IL}		-40°C to 105°C	0.60	0.71	0.79	V
ON pin hysteresis	$V_{ON,HYST}$		-40°C to 105°C		20		mV
ON pin deglitch time	$T_{ON,DEGLITCH}$		-40°C to 105°C	2	4.5	6.5	us
Output pulldown resistance	R_{PD}	VOUT=VIN	25°C		50		Ω
			-40°C to 105°C	40		65	Ω
Thermal Shutdown	TSD		-	130	150	165	°C
Thermal Shutdown Hysteresis	TSD_{HYS}		-		20		°C

12. Switching Characteristics (VBIAS=2.2V to 5V)

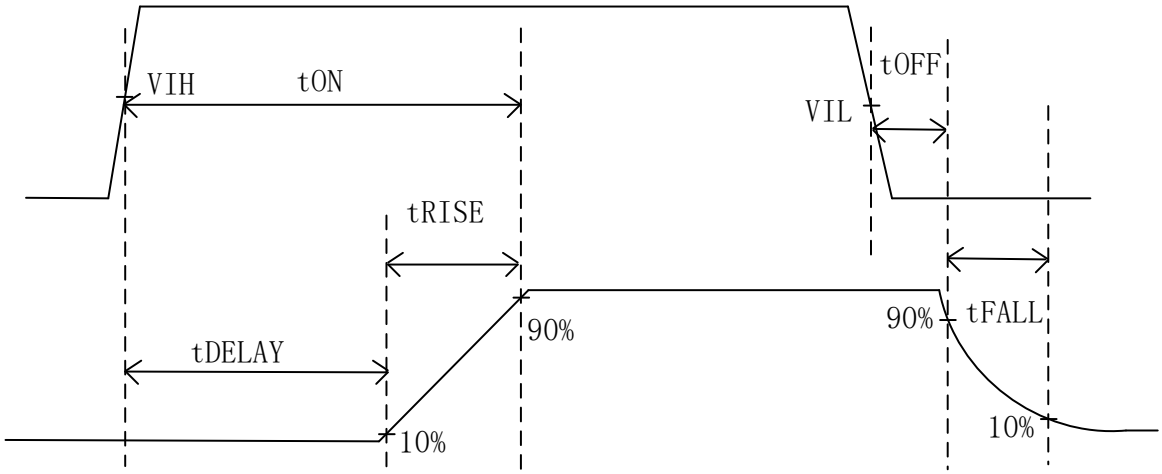
Parameter	Symbol	Test Condition		Min	Typ	Max	Units
TA = +25°C, VIN=5.0V, unless otherwise noted							
Turn-on Time	t_{ON}	CT=Open	C_{IN}=47uF, C_L=0.1uF, I_L=1mA		300		us
Turn-on Time	t_{ON}	CT=VBIAS	C_{IN}=47uF, C_L=0.1uF, I_L=1mA		2659		us
Turn-on Time	t_{ON}	CT=GND	C_{IN}=47uF, C_L=0.1uF, I_L=1mA		5088		us
Vout rise time	t_r	CT=Open	C_{IN}=47uF, C_L=0.1uF, I_L=1mA		260		us
Vout rise time	t_r	CT=VBIAS	C_{IN}=47uF, C_L=0.1uF, I_L=1mA		2624		us
Vout rise time	t_r	CT=GND	C_{IN}=47uF, C_L=0.1uF, I_L=1mA		5056		us
Delay time	t_D	CT=Open	C_{IN}=47uF, C_L=0.1uF, I_L=1mA		44		us
Delay time	t_D	CT=VBIAS	C_{IN}=47uF, C_L=0.1uF, I_L=1mA		42		us
Delay time	t_D	CT=GND	C_{IN}=47uF, C_L=0.1uF, I_L=1mA		42		us
Vout fall time	t_f	CT=Open	C_{IN}=47uF, C_L=0.1uF, I_L=1mA		13		us
Turn-off Time	t_{OFF}	CT=Open	C_{IN}=47uF, C_L=0.1uF, I_L=1mA		6.8		us
TA = +25°C, VIN=3.3V, unless otherwise noted							
Turn-on Time	t_{ON}	CT=Open	C_{IN}=47uF, C_L=0.1uF, I_L=1mA		256		us
Turn-on Time	t_{ON}	CT=VBIAS	C_{IN}=47uF, C_L=0.1uF, I_L=1mA		2124		us
Turn-on Time	t_{ON}	CT=GND	C_{IN}=47uF, C_L=0.1uF, I_L=1mA		4060		us
Vout rise time	t_r	CT=Open	C_{IN}=47uF, C_L=0.1uF, I_L=1mA		212		us
Vout rise time	t_r	CT=VBIAS	C_{IN}=47uF, C_L=0.1uF, I_L=1mA		2102		us
Vout rise time	t_r	CT=GND	C_{IN}=47uF, C_L=0.1uF, I_L=1mA		4008		us
Delay time	t_D	CT=Open	C_{IN}=47uF, C_L=0.1uF, I_L=1mA		44		us
Delay time	t_D	CT=VBIAS	C_{IN}=47uF, C_L=0.1uF, I_L=1mA		46		us
Delay time	t_D	CT=GND	C_{IN}=47uF, C_L=0.1uF, I_L=1mA		47		us
Vout fall time	t_f	CT=Open	C_{IN}=47uF, C_L=0.1uF, I_L=1mA		12		us
Turn-off Time	t_{OFF}	CT=Open	C_{IN}=47uF, C_L=0.1uF, I_L=1mA		7.5		us

TA = +25°C, VIN=1.8V, unless otherwise noted					
Turn-on Time	t_{ON}	CT=Open	C_{IN}=47uF, C_L=0.1uF, I_L=1mA	175	us
Turn-on Time	t_{ON}	CT=VBIAS	C_{IN}=47uF, C_L=0.1uF, I_L=1mA	1463	us
Turn-on Time	t_{ON}	CT=GND	C_{IN}=47uF, C_L=0.1uF, I_L=1mA	2900	us
Vout rise time	t_r	CT=Open	C_{IN}=47uF, C_L=0.1uF, I_L=1mA	135	us
Vout rise time	t_r	CT=VBIAS	C_{IN}=47uF, C_L=0.1uF, I_L=1mA	1423	us
Vout rise time	t_r	CT=GND	C_{IN}=47uF, C_L=0.1uF, I_L=1mA	2859	us
Delay time	t_D	CT=Open	C_{IN}=47uF, C_L=0.1uF, I_L=1mA	40	us
Delay time	t_D	CT=VBIAS	C_{IN}=47uF, C_L=0.1uF, I_L=1mA	45	us
Delay time	t_D	CT=GND	C_{IN}=47uF, C_L=0.1uF, I_L=1mA	40	us
Vout fall time	t_f	CT=Open	C_{IN}=47uF, C_L=0.1uF, I_L=1mA	12	us
Turn-off Time	t_{OFF}	CT=Open	C_{IN}=47uF, C_L=0.1uF, I_L=1mA	6.7	us
TA = +25°C, VIN=0.6V, unless otherwise noted					
Turn-on Time	t_{ON}	CT=Open	C_{IN}=47uF, C_L=0.1uF, I_L=1mA	96	us
Turn-on Time	t_{ON}	CT=VBIAS	C_{IN}=47uF, C_L=0.1uF, I_L=1mA	544	us
Turn-on Time	t_{ON}	CT=GND	C_{IN}=47uF, C_L=0.1uF, I_L=1mA	1082	us
Vout rise time	t_r	CT=Open	C_{IN}=47uF, C_L=0.1uF, I_L=1mA	55	us
Vout rise time	t_r	CT=VBIAS	C_{IN}=47uF, C_L=0.1uF, I_L=1mA	500	us
Vout rise time	t_r	CT=GND	C_{IN}=47uF, C_L=0.1uF, I_L=1mA	1046	us
Delay time	t_D	CT=Open	C_{IN}=47uF, C_L=0.1uF, I_L=1mA	42	us
Delay time	t_D	CT=VBIAS	C_{IN}=47uF, C_L=0.1uF, I_L=1mA	41	us
Delay time	t_D	CT=GND	C_{IN}=47uF, C_L=0.1uF, I_L=1mA	43	us
Vout fall time	t_f	CT=Open	C_{IN}=47uF, C_L=0.1uF, I_L=1mA	9	us
Turn-off Time	t_{OFF}	CT=Open	C_{IN}=47uF, C_L=0.1uF, I_L=1mA	7	us
TA = +25°C, VIN=0.285V, unless otherwise noted					
Turn-on Time	t_{ON}	CT=Open	C_{IN}=47uF, C_L=0.1uF, I_L=1mA	60	us
Turn-on Time	t_{ON}	CT=VBIAS	C_{IN}=47uF, C_L=0.1uF, I_L=1mA	195	us
Turn-on Time	t_{ON}	CT=GND	C_{IN}=47uF, C_L=0.1uF, I_L=1mA	308	us
Vout rise time	t_r	CT=Open	C_{IN}=47uF, C_L=0.1uF, I_L=1mA	22	us
Vout rise time	t_r	CT=VBIAS	C_{IN}=47uF, C_L=0.1uF, I_L=1mA	155	us
Vout rise time	t_r	CT=GND	C_{IN}=47uF, C_L=0.1uF, I_L=1mA	268	us
Delay time	t_D	CT=Open	C_{IN}=47uF, C_L=0.1uF, I_L=1mA	40	us
Delay time	t_D	CT=VBIAS	C_{IN}=47uF, C_L=0.1uF, I_L=1mA	40	us
Delay time	t_D	CT=GND	C_{IN}=47uF, C_L=0.1uF, I_L=1mA	40	us
Vout fall time	t_f	CT=Open	C_{IN}=47uF, C_L=0.1uF, I_L=1mA	7	us
Turn-off Time	t_{OFF}	CT=Open	C_{IN}=47uF, C_L=0.1uF, I_L=1mA	7	us

13. Parameter Measurement Information

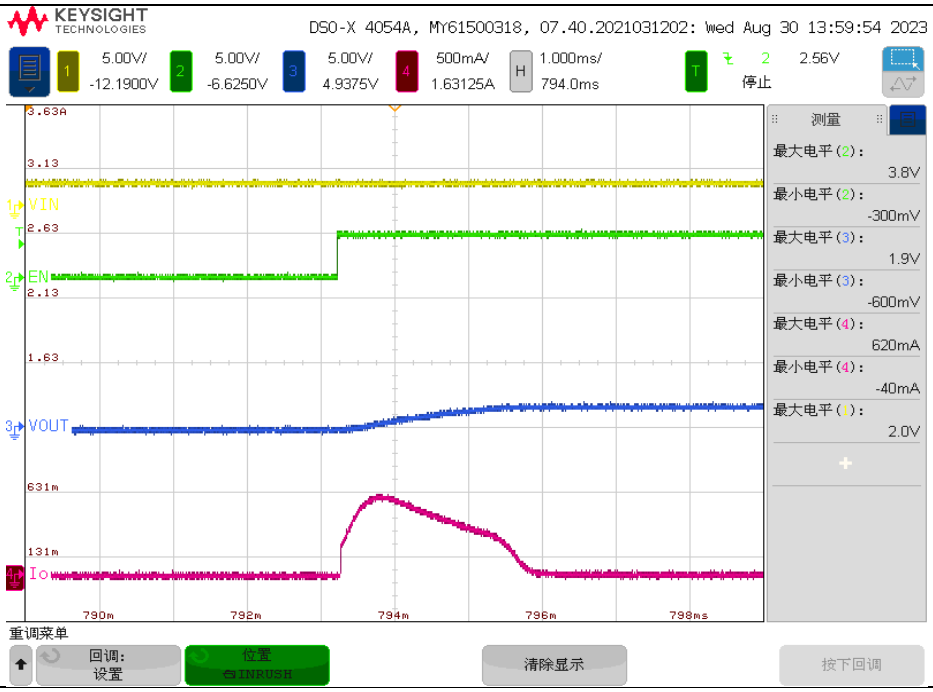


Test circuit



Timing Diagram

14. Typical Characteristics

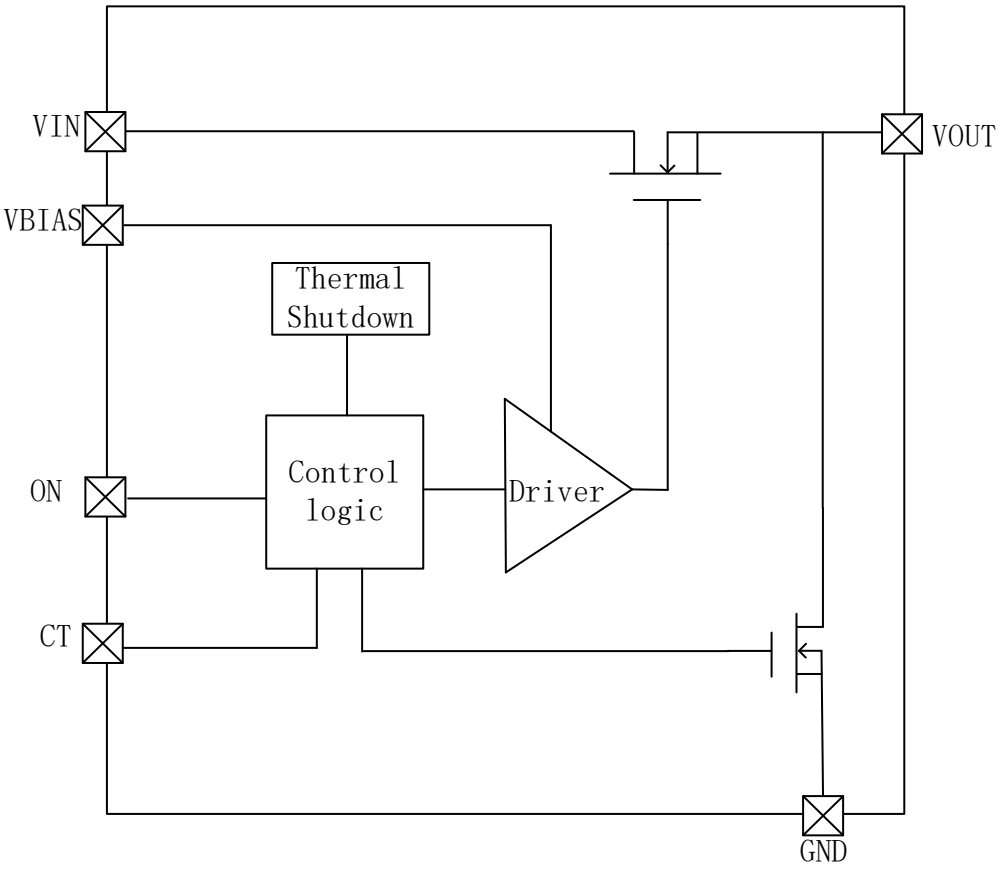


Inrush current, XPA5145 turn-on into 560uF Cout (CT=VBIAS)
VIN=1.8V, VBIAS=3.3V

15. Functional Description

The XPA5145 device is a single-channel load switch with a 3- mΩ power MOSFET designed to operate up to 12A. The voltage range is 0.2V to 5.5V. A configurable rise time provides flexibility for power sequencing and minimizes inrush current for high capacitance loads.

An enable pin (ON) controls the switch, which is capable of interfacing directly with low voltage GPIO signals. The XPA5145 device uses quick output discharge when switch turns off, pulling the output down to 0V through an internal 50-Ω resistor.



Block Diagram

ON and OFF Control

The ON pin controls the state of the switch. The ON pin is compatible with standard GPIO logic threshold so it can be used in a wide variety of applications. When this pin is pulled high, the device is enabled, and when it is low, the device is switched off.

Adjustable Slew Rate

The CT pin is a tri-state pin, meaning that it has three different slew rates depending on the connection to the pin. The CT pin can be grounded, pulled high ,or left floating. Floating defines as an effective resistance to GND or other pins greater than 10MΩ.

Active Output Discharge

When the device is disabled through the ON pin, a discharge path for the output capacitor is created between V_{OUT} and ground through a resistance.

Thermal Shutdown

When junction temperature of the XPA5145 reaches 150℃ (typical), the device shuts itself off to prevent thermal damage. After it cools off by about 20℃, the device turns back on.

Device Function Modes

ON	Fault Condition	Output Discharge(1)
L	None	Active
H	None	Disabled
H	Thermal Shutdown	Active

Note (1): This feature discharges the output of the switch to ground through a 50ohm resistor, preventing the output from floating.

16. Application Information

Input and Output Capacitors

When the switch being enabled, the output capacitors are immediately charged up from 0V to VIN voltage. This charge arrives in the form of inrush current.

Higher output capacitance can be used but inrush current during startup should be considered and managed. Inrush current can be calculated by below formula.

$$\text{I\_Inrush} = Cout \times \frac{dv}{dt}$$

Where:

- C_{OUT} is Output capacitance
- d_V = Output voltage
- d_t = Rise time

Power Dissipation

The MOSFET power dissipation is the main contributor to device junction temperature.
Assuming this, the power dissipation and the junction temperature in stable status can be calculated with the following equations.

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

Where:

- P_D = Power dissipation (W)
- R_{ON} = Power MOSFET on-resistance (Ω)
- I_{OUT} = Output current (A)

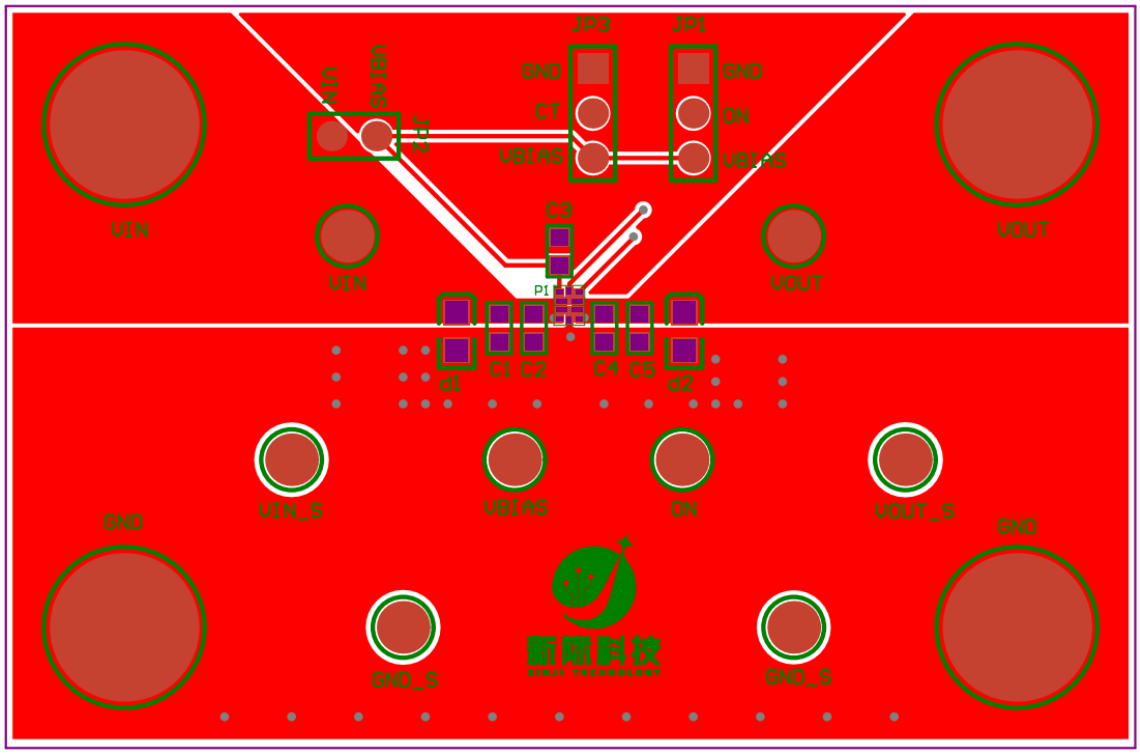
$$T^J = P_D \times \theta_{JA} + T_A$$

Where:

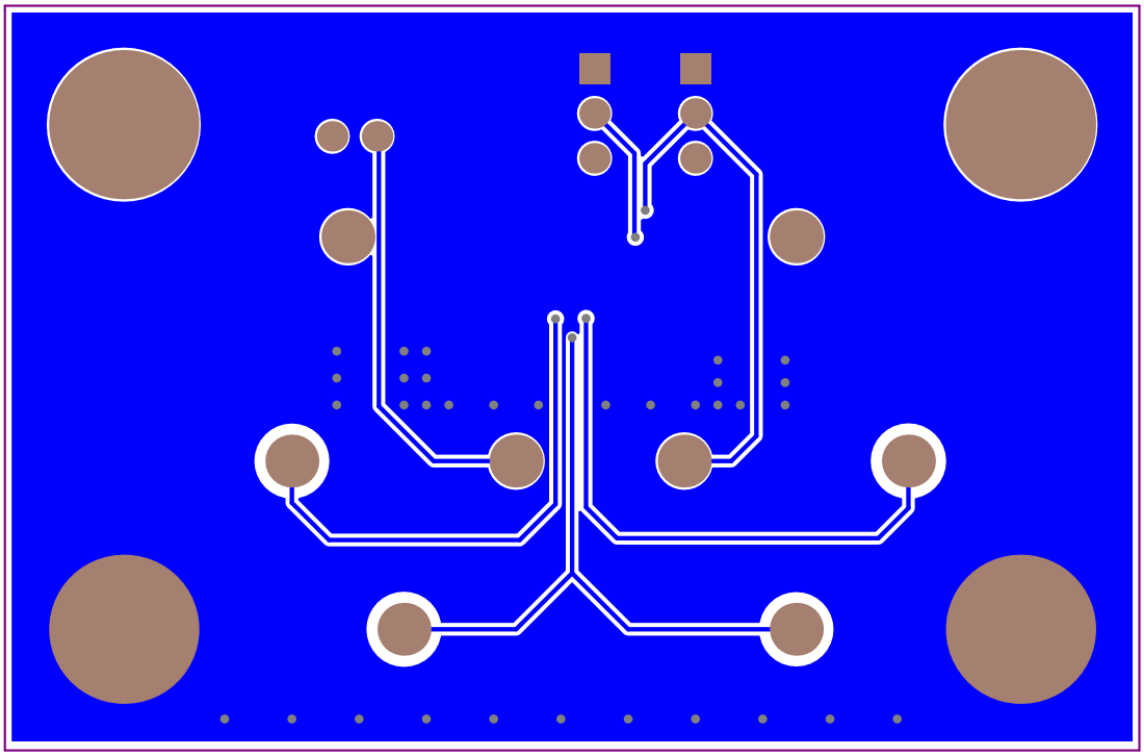
- T_J = Junction temperature (°C)
- θ_{JA} = Junction-to-Ambient Thermal Resistance (°C/W)
- T_A = Ambient temperature (°C)

PCB Layout

For best performance, all traces should be as short as possible. To be most effective, place theinput and output capacitors close to the device to minimize the effects that parasitic trace inductances in normal operation. Use wide traces for VIN, VOUT and GND helps minimize the parasitic electrical effects as well.

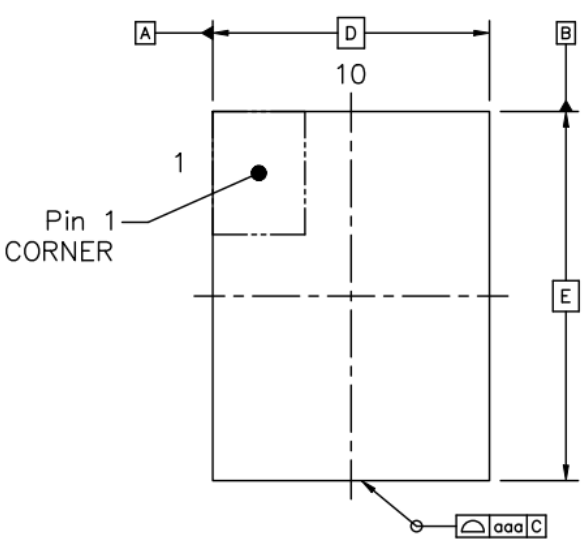


Layout Example – Top Layer

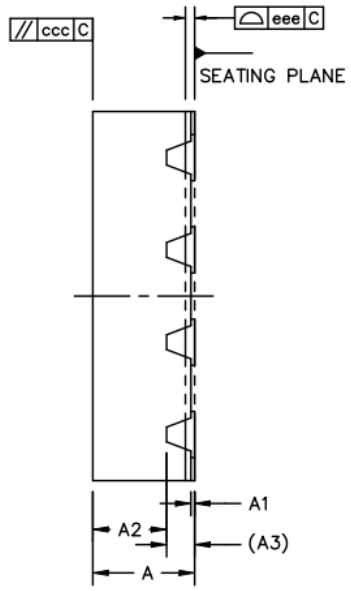


Layout Example – Bottom Layer

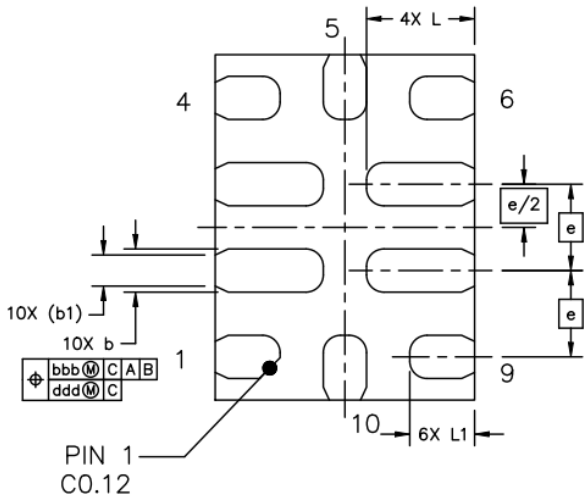
17. Physical Dimensions



TOP VIEW



SIDE VIEW

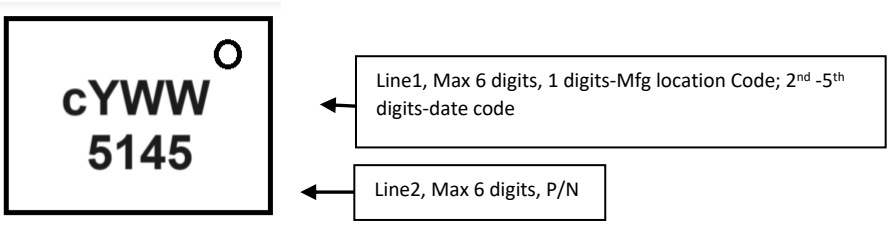


BOTTOM VIEW

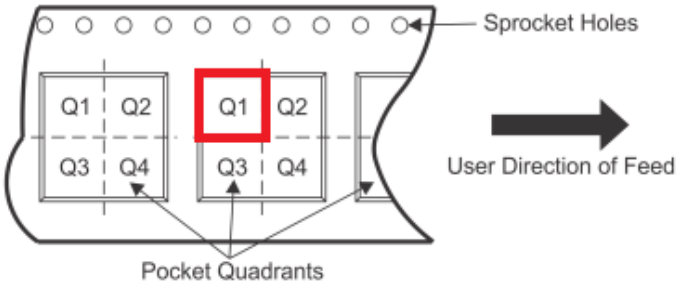
		SYMBOL	MIN	NOM	MAX
TOTAL THICKNESS		A	0.5	0.55	0.6
STAND OFF		A1	0	0.02	0.05
MOLD THICKNESS		A2	---	0.4	---
L/F THICKNESS		A3	0.152 REF		
LEAD WIDTH		b	0.2	0.25	0.3
		b1	0.18 REF		
BODY SIZE	X	D	1.5 BSC		
	Y	E	2 BSC		
LEAD PITCH		e	0.5 BSC		
LEAD LENGTH		L	0.575	0.625	0.675
		L1	0.325	0.375	0.425
PACKAGE EDGE TOLERANCE		aaa	0.1		
MOLD FLATNESS		ccc	0.1		
COPLANARITY		eee	0.05		
LEAD OFFSET		bbb	0.1		
		ddd	0.05		

18. Tape and Reel Information

Format:



Pin 1 located in Q1 direction in T&R



LOGO

Due to limited space, there is no logo on this marking.

Trace-ability Code:

1. Manufacturing Location Code + Date code Line 1
The first digit named as Manufacturing Location Code, 2nd -4th digit named date code .

a) Assembly location code: Hexin: c
b) 2nd digit: Year code, Last digit of the year should be marked as year code.

Year	2020	2021	2022	2023	2024	2025
Code	0	1	2	3	4	5

3rd & 4th digit: Week code, 01 means the 1st Work Week base on Xinji's calendar.

2. Product Number Code: Line 2

Product Name	P/N Code	Remark
XPA5145Q10R	5145	