

SiP32431

RoHS

COMPLIANT HALOGEN

FREE

Vishay Siliconix

1.0 A Slew Rate Controlled Load Switch with Reverse Blocking in SC70-6, and TDFN4 1.2 mm x 1.6 mm

DESCRIPTION

The SiP32431 is a slew rate controlled high side switch with reverse blocking capability. The switch is of a low ON resistance p-channel MOSFET that supports continuous current up to 1.0 A.

The SiP32431 operates with an input voltage from 1.5 V to 5.5 V.

The SiP32431 features low input logic level to interface with low control voltage from microprocessors. This device has a very low operating current, typically 50 pA.

The SiP32431 is available in lead (Pb)-free package options including 6 pin SC70-6, and 4 pin TDFN4 1.2 mm x 1.6 mm DFN4 packages. The operation temperature range is specified from - 40 $^{\circ}$ C to + 85 $^{\circ}$ C.

The SiP32431 compact package options, operation voltage range, and low operating current make it a good fit for battery power applications.

TYPICAL APPLICATION CIRCUIT

FEATURES

- 1.5 V to 5.5 V input voltage range
- Very low $R_{DS(on)},$ typically 105 m Ω at 5 V and 135 m Ω at 3 V for TDFN4 1.2 mm x 1.6 mm package
- Typical 147 m Ω at 5 V and 178 m Ω at 3 V for SC70-6 package
- Slew rate controlled turn-on time: 100 μs
- Low quiescent current < 1 μA
- Low shutdown current < 1 μA
- Reverse blocking capability
- SC70-6 and TDFN4 1.2 mm x 1.6 mm packages
- Compliant to RoHS Directive 2002/95/EC
- Halogen-free according to IEC 61249-2-21 definition

APPLICATIONS

- Cellular telephones
- Digital still cameras
- Personal digital assistants (PDA)
- Hot swap supplies
- Notebook computers
- · Personal communication devices
- Portable Instruments



Figure 1 - SiP32431 Typical Application Circuit

Document Number: 66597 S11-0175-Rev. B, 07-Feb-11



ORDERING INFORMATION				
Temperature Range	Package	Marking	Part Number	
- 40 °C to 85 °C	SC70-6	MAxx	SiP32431DR3-T1GE3	
	TDFN4 1.2 mm x 1.6 mm	ADx	SiP32431DNP3-T1GE4	

Notes:

x = Lot Code

-GE3 denotes halogen-free and RoHS compliant

Please use the SiP32431DR3-T1GE3 to replace SiP32431DR3-T1-E3

ABSOLUTE MAXIMUM RATINGS					
Parameter	Limit	Unit			
Supply Input Voltage (V _{IN})	- 0.3 to 6	V			
Enable Input Voltage (V _{ON/OFF})	- 0.3 to 6				
Output Voltage (V _{OUT})		- 0.3 to V _{IN} + 0.3			
Maximum Continuous Switch Current (I _{MAX})	SC70-6 package	1.2			
	TDFN4 1.2 mm x 1.6 mm	1.4	•		
Maximum Pulsed Current (IDM) VIN	$V_{IN} \ge 2.5 V$	3	A		
(Pulsed at 1 ms, 10 % Duty Cycle)	V _{IN} < 2.5 V	1.6			
ESD Rating (HBM)	4000	V			
Junction Temperature (T _J)		- 40 to 125	°C		
Thermal Resistance $(\theta_{JA})^a$	6 pin SC70-6 ^b	220	°C/M		
	4 pin TDFN4 1.2 mm x 1.6 mm ^c	170			
Dower Dissipation (D.)8	6 pin SC70-6 ^b	250			
Power Dissipation (PD)	4 pin TDFN4 1.2 mm x 1.6 mm ^c	324	mvv		

Notes:

a. Device mounted with all leads and power pad soldered or welded to PC board.

b. Derate 4.5 mW/°C above $T_A = 70$ °C.

c. Derate 5.9 mW/°C above T_A = 70 °C, see PCB layout.

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 in the operational sections of the specifications is not implied. Exposure to absolute maximum rating/conditions for extended periods may affect device reliability.

RECOMMENDED OPERATING RANGE				
Parameter	Limit	Unit		
Input Voltage Range (V _{IN})	1.5 to 5.5	V		
Operating Temperature Range	- 40 to 85	°C		



SPECIFICATIONS							
		Test Conditions Unless Specified		Limits			
		$V_{IN} = 5.0$, $T_A = -40$ °C to 85 °C (Turied values are at T = 05 °C)		- 4	40 °C to 85	°C	
Parameter	Symbol	(Typical values are at $T_A = 25$	0)	Min. ^a	Typ. ^D	Max. ^a	Unit
Operating Voltage [®]	V _{IN}			1.5	-	5.5	V
Quiescent Current	Ι _Q	On/Off = active		-	0.00005	1	_
Off Supply Current	I _{Q(off)}	On/Off = inactive, Out = open		-	-	1	μА
Off Switch Current	I _{SD(off)}	On/Off = inactive, Out = 0		-	-	1	μΛ
Reverse Blocking Current	I _{RB}	$V_{OUT} = 5.5 \text{ V}, V_{IN} = 0, V_{on/off} = \text{inactive}$		-	0.13	1	
			SC70-6	-	147	230	
		$v_{\rm IN} = 5 v, t_{\rm L} = 500 \text{ mA}, t_{\rm A} = 25 \text{ C}$	TDFN4	-	105		
			SC70-6	-	155	250	
	R _{DS(on)}	$V_{IN} = 4.2 \text{ V}, I_L = 500 \text{ mA}, T_A = 25 \text{ °C}$	TDFN4	-	110		mΩ
On-Resistance		$V_{IN} = 3 \text{ V}, \text{ I}_{L} = 500 \text{ mA}, \text{ T}_{A} = 25 \text{ °C}$	SC70-6	-	178	290	
			TDFN4	-	135		
		V_{IN} = 1.8 V, I _L = 500 mA, T _A = 25 °C	SC70-6	-	275	- 480 - 520	
			TDFN4	-	230		
		$V_{IN} = 1.5 \text{ V}, \text{ I}_{L} = 500 \text{ mA}, \text{ T}_{A} = 25 ^{\circ}\text{C}$	SC70-6	-	395		
			TDFN4	-	350		
On-Resistance TempCoefficient	TD _{RDS}			-	2800	-	ppm/°C
		$V_{IN} \ge 1.5 \text{ V} \text{ to} < 1.8 \text{ V}$		-	-	0.3	
On/Off Input Low Voltage ^c	V _{IL}	$V_{IN} \ge 1.8 \text{ V to} < 2.7 \text{ V}$		-	-	0.4	
		$V_{IN} \ge 2.7 \text{ V}$ to $\le 5.5 \text{ V}$		-	-	0.6	V
On/Off Input Low Voltage ^c	V _{IH}	$V_{IN} \ge 1.5 \text{ V to} < 2.7 \text{ V}$		1.3	-	-	v
		$V_{IN} \ge 2.7 \text{ V to} < 4.2 \text{ V}$		1.5	-	-	
		$V_{IN} \ge 4.2 \text{ V to} \le 5.5 \text{ V}$		1.8	-	-	
On/Off Input Leakage	I _{SINK}	$V_{On/Off} = 5.5 V$		-	-	1	μA
Output Turn-On Delay Time	t _{d(on)}			-	20	40	
Output Turn-On Rise Time	t _(on)	$V_{IN} = 5 V$, $R_{LOAD} = 10 \Omega$, $T_A = 25$	5 °C	-	140	180	μs
Output Turn-Off Delay Time	t _{d(off)}			-	4	10	1

Notes:

a. The algebriac convention whereby the most negative value is a minimum and the most positive a maximum.

b. Typical values are for DESIGN AID ONLY, not guaranteed nor subject to production testing

c. For V_{IN} outside this range consult typical ON/OFF threshold curve.

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PIN CONFIGURATION







PIN DESCRIPTION				
Pin N	umber			
SC70-6	TDFN4	Name	Function	
4	3	IN	This pin is the p-channel MOSFET source connection. Bypass to ground through a 1 μ F capacitor.	
2, 5	2	GND	Ground connection	
3	4	ON/OFF	Enable input	
1	1	OUT	This pin is the p-channel MOSFET drain connection. Bypass to ground through a 0.1 µF capacitor.	

TYPICAL CHARACTERISTICS (internally regulated, 25 °C, unless otherwise noted)



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TYPICAL CHARACTERISTICS (internally regulated, 25 °C, unless otherwise noted)



Figure 14 - ON/OFF Threshold vs. Input Voltage









Figure 17 - Switching ($V_{IN} = 5 V$)







Figure 18 - Turn-Off (V_{IN} = 5 V)

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BLOCK DIAGRAM



Figure 19 - Functional Block Diagram

PCB LAYOUT



Figure 20 - TDFN4 1.2 mm x 1.6 mm PCB Layout

DETAILED DESCRIPTION

The SiP32431 is a P-Channel MOSFET power switches designed for high-side slew rate controlled load-switching applications. Once turned on, the slew-rate control circuitry is activated and current is ramped in a linear fashion until it reaches the level required for the output load condition. This is accomplished by first elevating the gate voltage of the MOSFET up to its threshold voltage and then by linearly increasing the gate voltage until the MOSFET becomes fully enhanced. At this point, the gate voltage is then quickly increased to the full input voltage to reduce $R_{DS(on)}$ of the MOSFET switch and minimize any associated power losses.

APPLICATION INFORMATION

Input Capacitor

While a bypass capacitor on the input is not required, a 1 μ F or larger capacitor for C_{IN} is recommended in almost all applications. The bypass capacitor should be placed as physically close as possible to the SiP32431 to be effective in minimizing transients on the input. Ceramic capacitors are recommended over tantalum because of their ability to withstand input current surges from low impedance sources such as batteries in portable devices.

Output Capacitor

A 0.1 μ F capacitor or larger across V_{OUT} and GND is recommended to insure proper slew operation. C_{OUT} may be increased without limit to accommodate any load transient condition with only minimal affect on the SiP32431 turn on slew rate time. There are no ESR or capacitor type requirement.

Enable

The On/Off pin is compatible with both TTL and CMOS logic voltage levels.

Protection Against Reverse Voltage Condition

The SiP32431 contains a body snatcher that normally connect the body to the Source (IN) when the device is enable. In case where the device is disabled but the V_{OUT} is higher than the V_{IN}, the n-type body is switched to OUT, reverse bias the body diode to prevent the current from going back to the input.

Thermal Considerations

The SiP32431 is designed to maintain a constant output load current. Due to physical limitations of the layout and assembly of the device the maximum switch current is 1.0 A, as stated in the Absolute Maximum Ratings table. However, another limiting characteristic for the safe operating load current is the thermal power dissipation of the package. To obtain the highest power dissipation (and a thermal resistance of 170 °C/W) the power pad of the device should be connected to a heat sink on the printed circuit board.



The maximum power dissipation in any application is dependant on the maximum junction temperature, $T_{J(MAX)} = 125 \text{ °C}$, the junction-to-ambient thermal resistance for the TDFN4 1.2 mm x 1.6 mm package, $\theta_{J-A} = 170 \text{ °C/W}$, and the ambient temperature, T_A , which may be formulaically expressed as:

P (max.) =
$$\frac{T_{J} (max.) - T_{A}}{\theta_{J-A}} = \frac{125 - T_{A}}{170}$$

It then follows that, assuming an ambient temperature of 70 $^{\rm o}C$, the maximum power dissipation will be limited to about 324 mW.

So long as the load current is below the 1.0 A limit, the maximum continuous switch current becomes a function two things: the package power dissipation and the $R_{DS(on)}$ at the ambient temperature.

As an example let us calculate the worst case maximum load current at $T_A = 70$ °C. The worst case $R_{DS(on)}$ at 25 °C occurs at an input voltage of 1.5 V and is equal to 520 m Ω . The $R_{DS(on)}$ at 70 °C can be extrapolated from this data using the following formula

 $R_{DS(on)}$ (at 70 °C) = $R_{DS(on)}$ (at 25 °C) x (1 + T_C x ΔT) Where T_C is 3300 ppm/°C. Continuing with the calculation we have

 $R_{DS(on)}$ (at 70 °C) = 520 mΩ x (1 + 0.0033 x (70 °C - 25 °C)) = 597 mΩ

The maximum current limit is then determined by

$$I_{LOAD}$$
 (max.) < $\sqrt{\frac{P(max.)}{R_{DS}(on)}}$

which in case is 0.74 A. Under the stated input voltage condition, if the 0.74 A current limit is exceeded the internal die temperature will rise and eventually, possibly damage the device.

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