General description

The MX5050D4005 high-side OR-ing works with an internal MOSFET and acts as an ideal diode rectifier when connected in series with the power supply. This OR-ing circuit enables MOSFETs to replace diode rectifiers in power distribution networks, reducing power loss and voltage drop.

The MX5050D4005 controller provides charge pump gate drive for an internal N-channel MOSFET and fast response comparator to turn off the FET when current flows in reverse. The MX5050D4005 can be connected to power supplies from 1V to 40V （a separate VS supply is needed when IN is 1V to 30V）and can withstand transient voltages up to 40V.

Features

- ♦ Wide operating input voltage range V_{IN}: 5V to 30V
- ♦40V transient voltage
- ♦ Charge pump gate driver for internal N-channel MOSFET
- ♦ 50ns fast response to current reversal
- ♦2A peak gate off current internal
- ♦Ultra-small V_{DS} turn-off voltage reduces turn-off time
- ♦ 8-Pin DFN5*6

Applications

Active OR-ing of redundant (N+1) power supplies

General information

Ordering information

Part Number	Description
MX5050D4005	DFN5*6-8L
MPQ	5000pcs

Package dissipation rating

Package	RθJA（℃/W）
DFN5*6-8L	108.1

Absolute maximum ratings

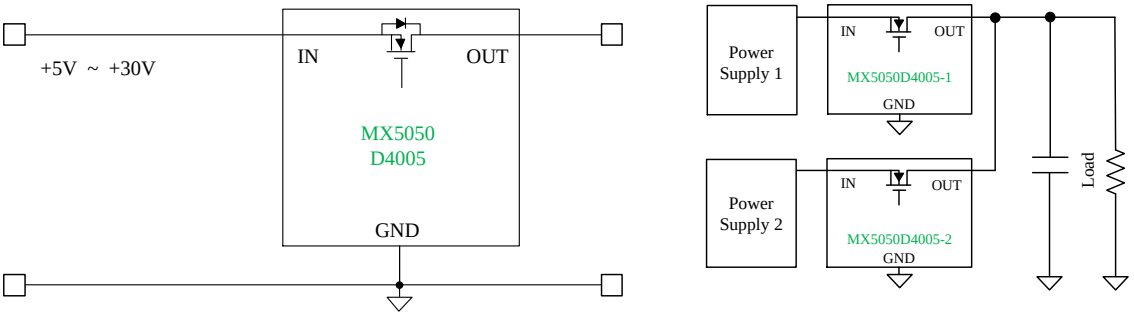
Parameter	Value
IN, OUT Pins to GND	-0.3 to 40V
VS Pin to Ground	-0.3 to 40V
Internal MOSFET VDS	≥40V
Junction temperature	150℃
Storage temperature, Tstg	-50 to 150℃
Leading temperature （soldering,10secs）	260℃
ESD Susceptibility HBM	±2000V

Stresses beyond those listed in Absolute Maximum Ratings may cause permanent damage to the device. Exposure to absolute maximum rating conditions for extended periods may affect reliability. Functional operation of the device at any conditions beyond those indicated in the Recommended Operating Conditions section is not implied.

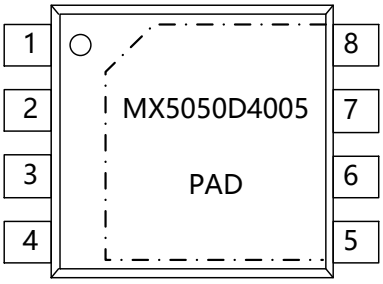
Recommended operating condition

Symbol	Range
IN, OUT Pins （VS≥4.5V for IN＜4V）	1-30V
VS Pin	5-30V
Operating temperature	-40~125℃

Typical application



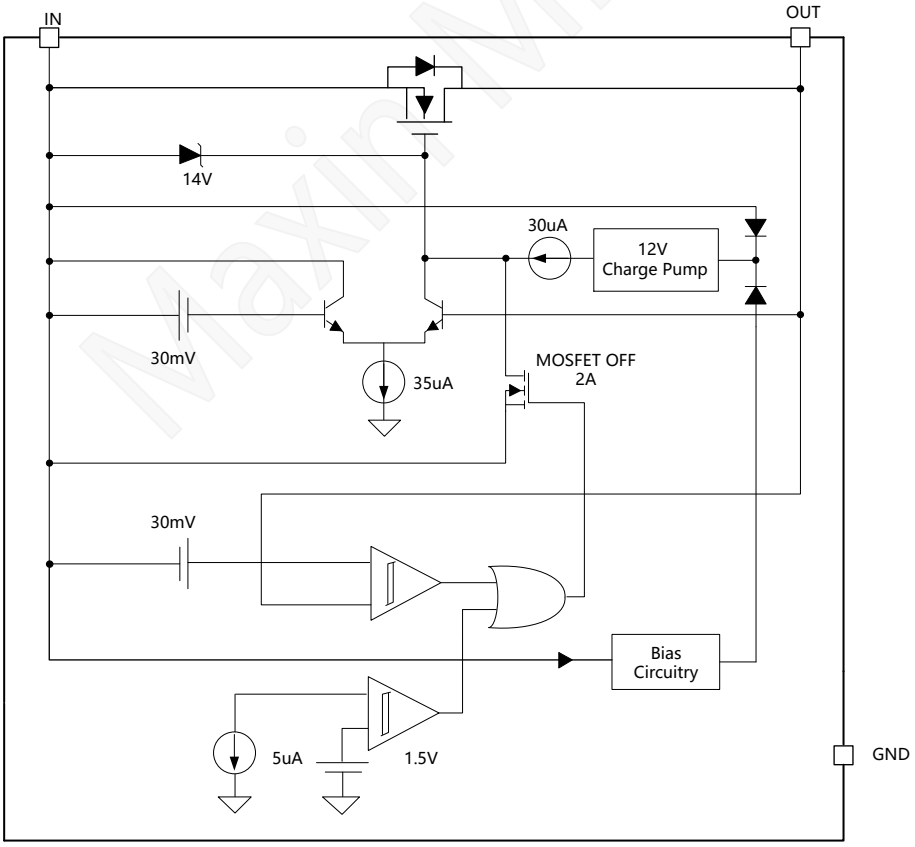
Terminal assignments



Pin information

PIN NO.	PIN name	Description
1、2、3	IN	Voltage sense connection to the external MOSFET source pin.
4	GND	Ground return for the controller
5~8	OUT	Voltage sense connection to the external MOSFET drain pin.
PAD	OUT	Voltage sense connection to the external MOSFET drain pin.

Block diagram



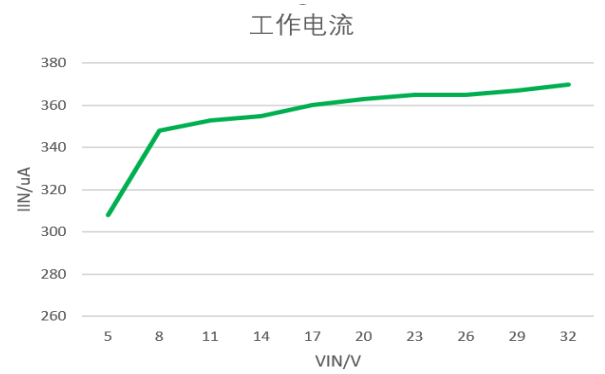
Electrical characteristics

（V_{IN} =12V , TA = 25℃, unless otherwise noted）

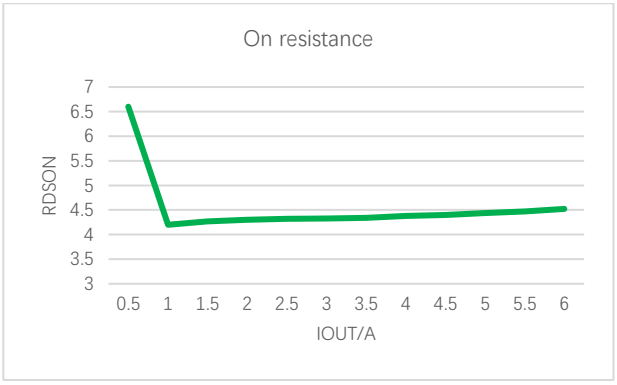
Symbol	Parameter	Test condition	Min	Typ.	Max	Unit
IN PIN						
V_{IN}	Operating Input Voltage Range		5		30	V
I_{IN}	IN Pin current	V_{IN} =5V	150	240	300	uA
		V_{IN} = 12V to 30V	200	300	400	
OUT PIN						
V_{OUT}	Operating Output Voltage Range		5		30	V
I_{OUT}	OUT Pin Current	V_{IN} = 5V to 30V		4.1		uA
INTERNAL REGULATOR						
$V_{SD(REV)}$	Reverse V_{SD} Threshold V_{IN} < V_{OUT}	V_{IN} - V_{OUT}	-40	–28	-20	mV
$V_{SD(REG)}$	Regulated Forward V_{SD} Threshold V_{IN} > V_{OUT}	V_{IN} = 5V, V_{IN} - V_{OUT}	1	30	40	mV
		V_{IN} = 12V, V_{IN} - V_{OUT}	5	60	80	
INTERNAL MOSFET						
V_{DS}	Drain to source voltage	I_{DS} = 250uA	40			V
R_{ON}	On resistance	I_D = 1A		4.2	5.5	mΩ

Characteristic plots

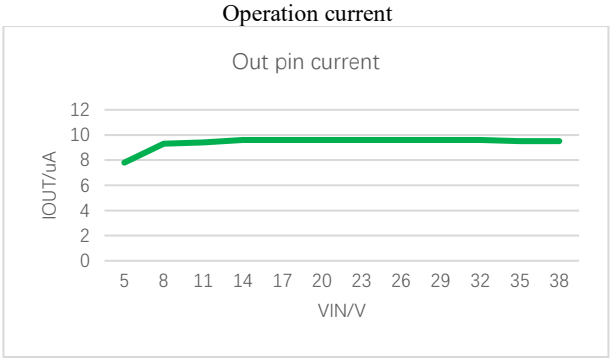
（V_{IN} = V_{VS} = V_{OUT}, T_A = 25℃, unless otherwise noted）



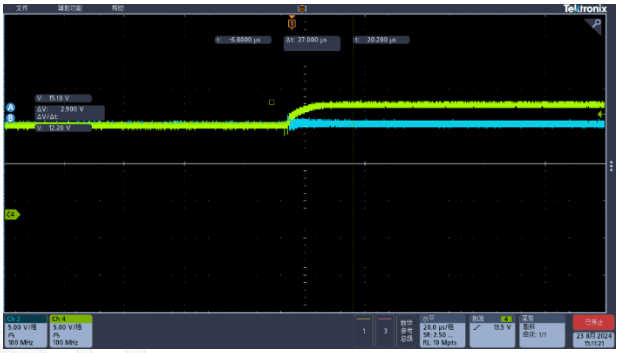
Operation current



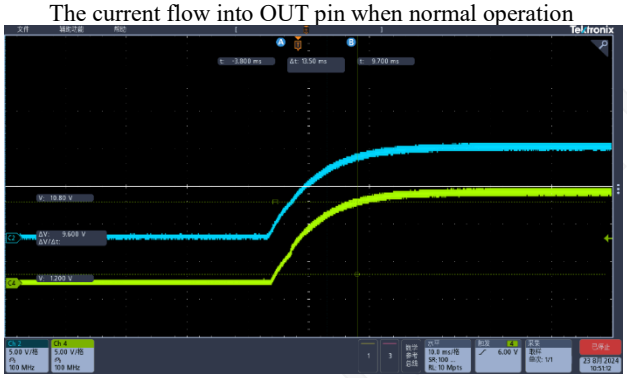
The on resistance



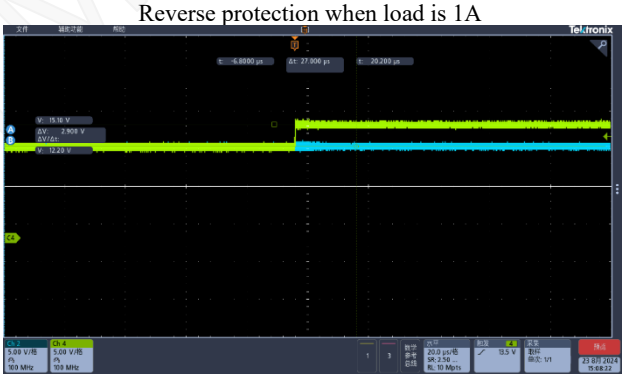
The current flow into OUT pin when normal operation



Reverse protection when load is 1A



The output voltage with input



Reverse protection

Operation description

IN and OUT Pins

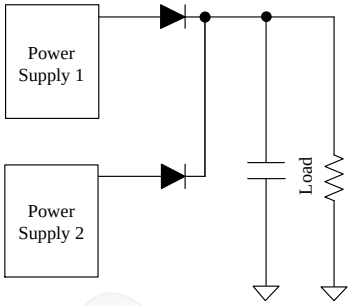
When power is initially applied, the load current will flow from source to drain through the body diode of the MOSFET. Once the voltage across the body diode exceeds $V_{SD(REG)}$ then the MX5050D4005 begins charging the internal MOSFET gate through a 30 µA (typical) charge pump current source. In forward operation, the gate of the internal MOSFET is charged. The MX5050D4005 is designed to regulate the internal MOSFET gate-to-source voltage. If the MOSFET current decreases to the point that the voltage across the MOSFET falls below the $V_{SD(REG)}$ voltage regulation point of 30mV (typical), the internal MOSFET gate voltage will be decreased until the voltage across the MOSFET is regulated at 30mV. If the source-to-drain voltage is greater than the $V_{SD(REG)}$ voltage, the gate-to-source voltage will increase and eventually reach the 12V gate to IN pin Zener clamp level.

If the MOSFET current reverses, possibly due to failure of the input supply, such that the voltage across the MX5050D4005 IN and OUT pins is more negative than the $V_{SD(REV)}$ voltage of -28mV (typical), the MX5050D4005 will quickly discharge the internal MOSFET gate through a strong gate to IN pin discharge transistor. If the input supply fails abruptly, as would occur if the supply was shorted directly to ground, a reverse current will temporarily flow through the MOSFET until the gate can be fully discharged. This reverse current is sourced from the load capacitance and from the parallel connected supplies. The MX5050D4005 responds to a voltage reversal condition typically within 50ns. The actual time required to turn off the MOSFET will depend on the charge held by the gate capacitance of the MOSFET being used. For MX5050D4005, the gate capacitance of the internal MOSFET is 4.6nF and the typical turn off time is 25ns. This fast turnoff time minimizes voltage disturbances at the output, as well as the current transients from the redundant supplies.

Application and Implementation

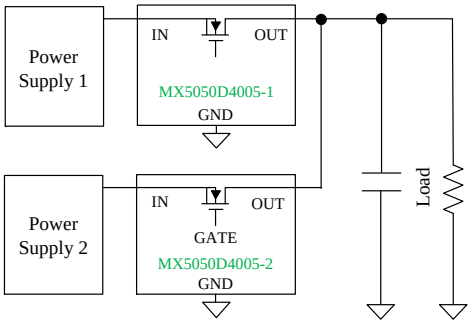
Application Information

Systems that require high availability often use multiple, parallel-connected redundant power supplies to improve reliability. Schottky OR-ing diodes are typically used to connect these redundant power supplies to a common point at the load. The disadvantage of using OR-ing diodes is the forward voltage drop, which reduces the available voltage and the associated power losses as load currents increase. Using an N-channel MOSFET to replace the OR-ing diode requires a small increase in the level of complexity, but reduces, or eliminates, the need for diode heat sinks or large thermal copper area in circuit board layouts for high power applications.



OR-ing with Diodes

The MX5050D4005 is a positive voltage (that is, high-side) OR-ing controller that will drive an external N-channel MOSFET to replace an OR-ing diode. The voltage across the MOSFET source and drain pins is monitored by the MX5050D4005 at the IN and OUT pins, while the internal MOSFET gate drives the MOSFET to control its operation based on the monitored source-drain voltage. The resulting behavior is that of an ideal rectifier with source and drain pins of the MOSFET acting as the anode and cathode pins of a diode respectively.



OR-ing with internal MOSFETs

Short Circuit Failure of an Input Supply

An abrupt 0Ω short circuit across the input supply will cause the highest possible reverse current to flow while the internal MX5050D4005 control circuitry discharges the gate of the MOSFET. During this time, the reverse current is limited only by the $R_{DS(ON)}$ of the MOSFET, along with parasitic wiring resistances and inductances. Worst case instantaneous reverse

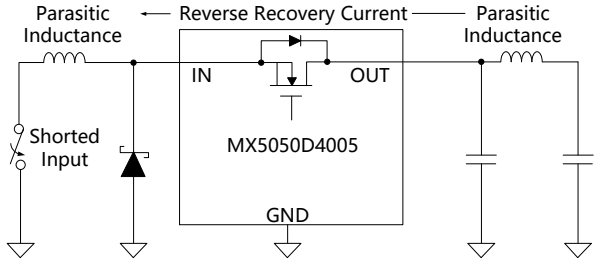
current would be limited to:

$I_{D(REV)} = (V_{OUT} - V_{IN}) / R_{DS(ON)}$ (1)

The internal Reverse Comparator will react, and will start the process of discharging the internal MOSFET gate, when the reverse current reaches:

$I_{D(REV)} = V_{SD(REV)} / R_{DS(ON)}$ (2)

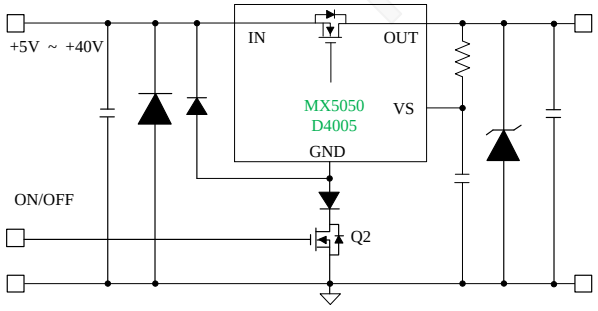
When the MOSFET is finally switched off, the energy stored in the parasitic wiring inductances will be transferred to the rest of the circuit. As a result, the MX5050D4005 IN pin will see a negative voltage spike while the OUT pin will see a positive voltage spike. The IN pin can be protected by diode clamping the pin to GND in the negative direction. The OUT pin can be protected with a TVS protection diode, a local bypass capacitor, or both.



Reverse Recovery Current Generates Spikes at V_{IN} and V_{OUT}

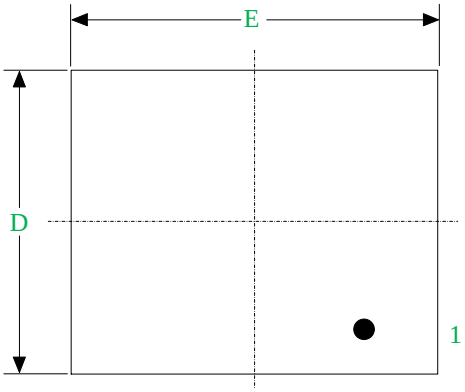
Reverse Input Voltage Protection with IQ Reduction

In battery powered applications, whenever MX5050D4005 functionality is not needed, the supply to the MX5050D4005 can be disconnected by turning off Q2, as shown in the following figure. This disconnects to the ground path of the MX5050D4005 and eliminates the current leakage from the battery.

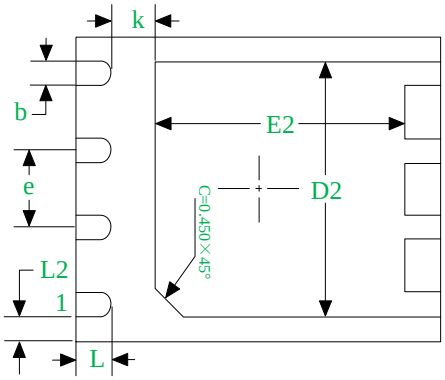


Reverse input voltage protection with IQ reduction schematic

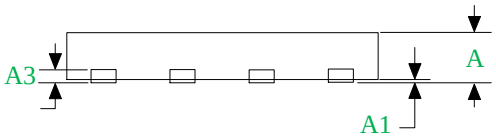
Package information



TOP VIEW



BOTTOM VIEW



SIDE VIEW

SYMBOL	MILLIMETERS			MIL		
	MIN	NOM	MAX	MIN	NOM	MAX
A	0.700	0.750	0.800	27.5	29.5	31.5
A1	0.000	0.025	0.050	0	1	2
A3		0.203REF			8REF	
D	4.950	5.000	5.050	195	197	199
E	5.950	6.000	6.050	234	236	238
D2	3.900	4.100	4.300	153	161	169
E2	4.000	4.200	4.400	157	165	173
k		0.700REF			27.5REF	
b	0.350	0.400	0.450	14	16	18
e		1.270BCS			50BSC	
L	0.500	0.600	0.700	20	24	28
L2	0.350	0.400	0.450	14	16	18

DFN5*6-8L for MX5050D4005

Restrictions on Product Use

◆ MAXIN micro is continually working to improve the quality and reliability of its products. Nevertheless, semiconductor devices in general can malfunction or fail due to their inherent electrical sensitivity and vulnerability to physical stress. It is the responsibility of the buyer, when utilizing MAXIN products, to comply with the standards of safety in making a safe design for the entire system, and to avoid situations in which a malfunction or failure of such MAXIN products could cause loss of human life, bodily injury or damage to property.

◆ In developing your designs, please ensure that MAXIN products are used within specified operating ranges as set forth in the most recent MAXIN products specifications.

◆ The information contained herein is subject to change without notice.

Version update record:

V10 The original version

V11 change the block diagram: the VS is internal connected to IN