GENERAL DESCRIPITION

MX5014S Gate driver is designed for gate control of N-channel, enhancement mode, power MOSFETs used as high or low side switches. The MX5014S can sustain an on state output indefinitely. The MX5014S operates from 2.75V to 30V supply. In high side configurations, the driver can control MOSFETs that switch loads of up to 50V. In low side configurations, with sperate supplies, the maximum switched voltage is limited only by the MOSFET.

The MX5014S has a TTL compatible control input. The MX5014S features an internal charge pump that can sustain a gate voltage greater than the available supply voltage. The driver is capable of turning on a logic level MOSFET from 2.75V supply or a standard MOSFET from a 5V supply. The gate to source output voltage is internally limited to approximately 15V.

The MX5014S is protected against automotive load dump, reversed battery, and inductive load spikes of -20V. the driver's overvoltage shutdown feature turns off the external MOSFET at approximately 35V to protect the load against power supply excursions.

The MX5014S is available in plastic 8 pin SOP packages.

FEATURES

- ♦ 2.75V to 50V operation supply voltage
- ♦ 100uA maximum supply current (5V supply)
- ♦ 15uA typical off-state current
- ♦ Internal charge pump
- ♦ TTL compatible input
- ♦ Withstands 65V transient (load dump)
- ♦ Internal 15Vgate clamp protection
- ♦ Maximum external parts
- ♦Operates in high side or low side configurations
- ♦1uA control input pull off
- ♦ noninverting configuration

APPLICATIONS

Battery Management System

Lamp Control

Heater Control

Power Bus Switching

Motor control

GENERAL INFORMATION

Ordering information

Part Number	Description
MX5014S	SOP-8L

Package dissipation rating

Package	RθJA（℃/W）
SOP-8L	170

Absolute maximum ratings

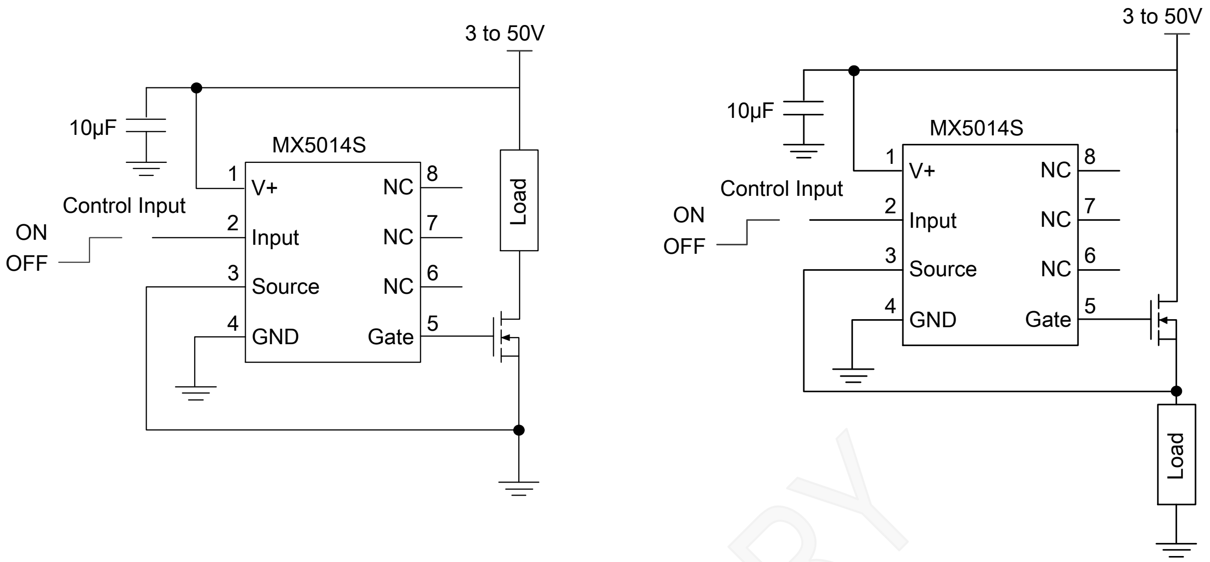
Parameter	Value
Supply voltage	-0.7to 60V
Input voltage	-0.7to V+
Source voltage	-0.7 to V+
Source current	50mA
Gate voltage	-0.7 to 55V
Junction temperature	150℃
Storage temperature, Tstg	-55 to 150℃
Leading temperature （soldering，10secs）	260℃
ESD Susceptibility HBM	±2000V

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

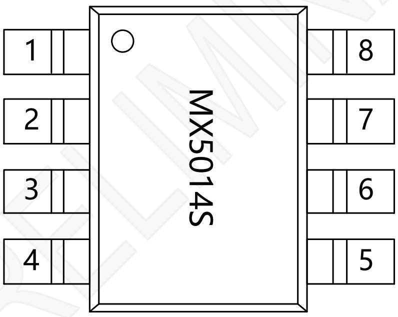
Symbol	Parameter	Range
Supply	Supply voltage	2.75-50V
Junction temperature		-40~125℃
PD	Power dissipation	0.59W

TYPICAL APPLICATION



Noninverting input and source/sink current can be adjusted independently

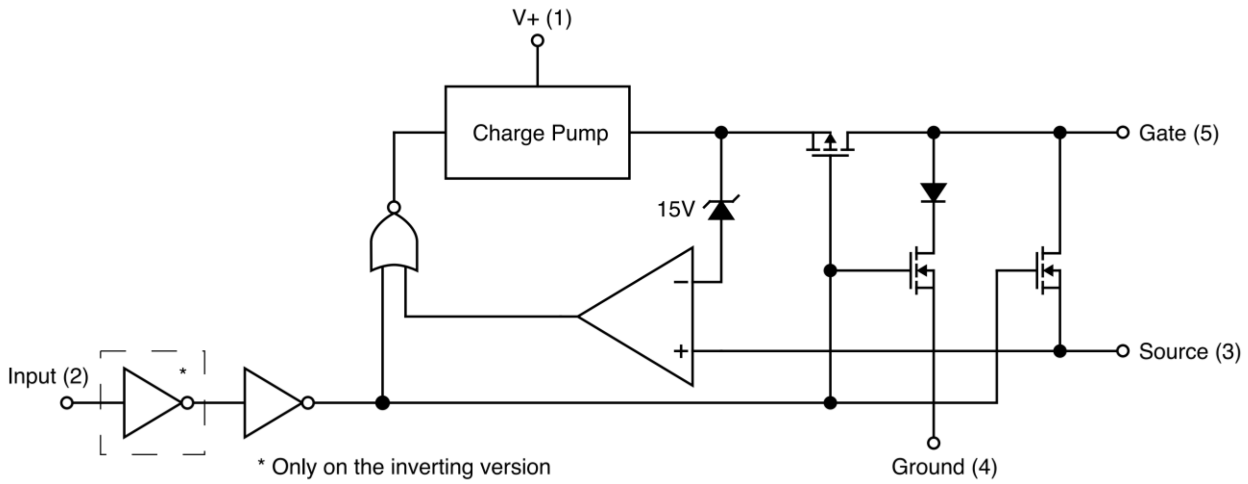
TERMINAL ASSIGMENTS



Pin information

PIN NO.	PIN name	Description
1	**V+**	Supply. Must be decoupled to isolate from large transients caused by the power MOSFET drain. 10uF is recommended close to this pin to GND.
2	**Input**	Turns on power MOSFET when taken above or below threshold (1.0V typical). This pin requires ~1uA to switch.
3	**Source**	Connects to source lead of power MOSFET and is the return for the gate clamp Zener. This pin can safely swing to -20V when turning off inductive loads.
4	**GND**	Ground All signals are referenced to this ground.
5	**Gate**	Drives and clamps the gate of the power MOSFET
6、7、8	**NC**	Not internally connected。

BLOCK DIAGRAM



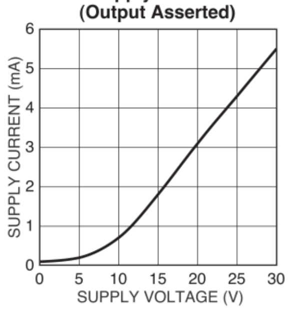
Electrical characteristics

(TA=25°C, VDD=12V, unless otherwise noted)

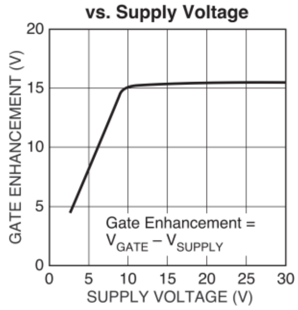
Symbol	Parameter	Test condition	Min	Typ.	Max	Unit
POWER SUPPLY						
Supply current	V+=30V	Input De-Asserted		10	25	µA
		Input Asserted		90	200	µA
	V+=5V	Input De-Asserted		10	25	µA
		Input Asserted		60	100	µA
	V+=3V	Input De-Asserted		10	25	µA
		Input Asserted		60	100	µA
Logic input voltage threshold	3.0V≤V+≤30V, TA=25℃	Digital low level			1.5	V
		Digital high level	1.6			V
Logic input current	3.0V≤V+≤30V	Input Low	-2.0	0		µA
		Input High		1.0	2.0	µA
Input capacitance				5.0		pF
Gate enhancement V_{GATE}-V_{SOURCE}	3.0V≤V+≤30V	Input asserted	4.0	10	13	V
Zener clamp V_{GATE}-V_{SOURCE}	3.0V≤V+≤30V	Input asserted	13	15	17	V
Gate turn on time	V+=4.5V, C_L=1000pF	Input switched on, measure time for V_{GATE} to reach 4v+V+		0.5	0.8	ms
	V+=12V, C_L=1000pF	Input switched on, measure time for V_{GATE} to reach 4v+V+		100	200	µs
Gate turn off time	V+=4.5V, C_L=1000pF	Input switched off, measure time for V_{GATE} to reach 1V		6.0	30.0	µs
	V+=12V, C_L=1000pF	Input switched off, measure time for V_{GATE} to reach 1V		6.0	30.0	µs

Characteristic plots

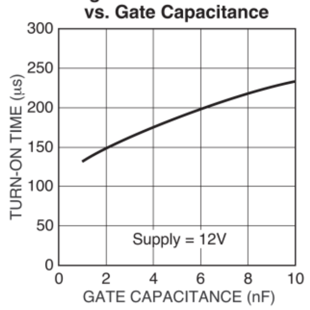
Supply Current (Output Asserted)



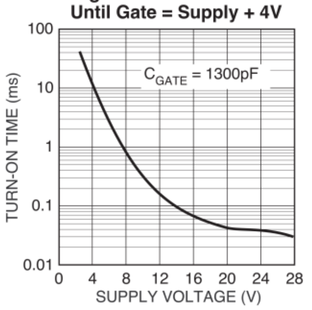
Gate Enhancement vs. Supply Voltage



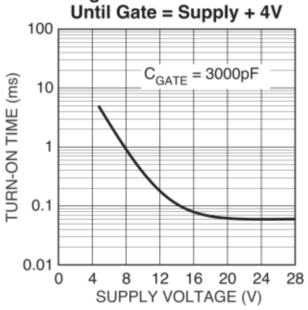
High-Side Turn-On Time vs. Gate Capacitance



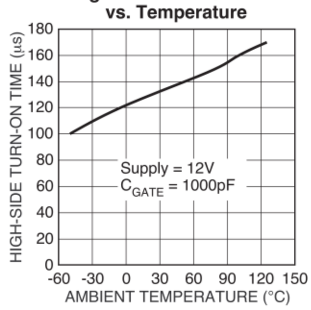
High-Side Turn-On Time Until Gate = Supply + 4V



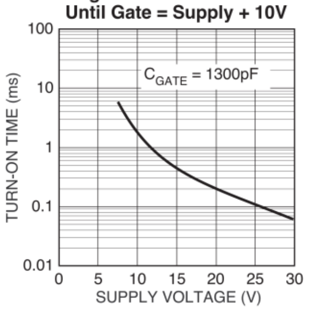
High-Side Turn-On Time Until Gate = Supply + 4V



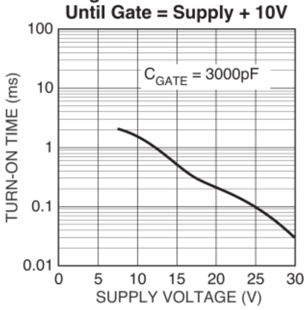
High-Side Turn-On Time vs. Temperature



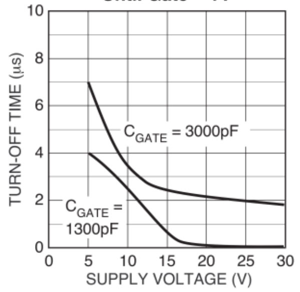
High-Side Turn-On Time Until Gate = Supply + 10V



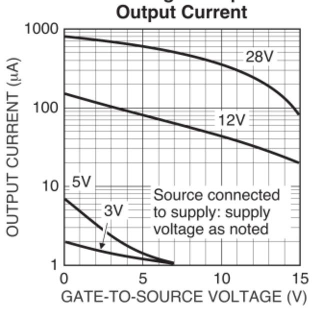
High-Side Turn-On Time Until Gate = Supply + 10V



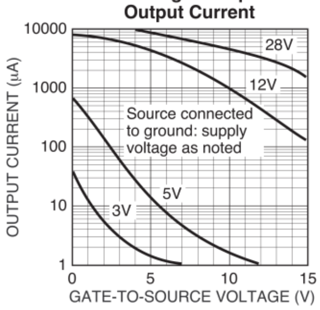
High-Side Turn-Off Time Until Gate = 1V



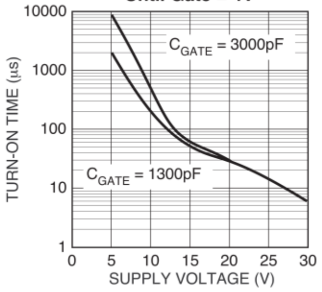
Charge-Pump Output Current



Charge-Pump Output Current



Low-Side Turn-On Time Until Gate = 4V



Operation description

The internal functions of these devices are controlled via a logic block connected to the control input pin. When the input is off, all functions are turned off, and the gate of the external power MOSFET is held low via two N-channel switches. This results in a very low standby current; 15uA typical, which is necessary to power an internal bandgap. When the input is driven to the “ON” state, the N-channel switches are turned off, the charge pump is turned on, and the P-channel switch between the charge pump and the gate turns on, allowing the gate of the power MOSFET to be charged. The op amp and internal Zener from an active regulator which shuts off the charge pump when the gate voltage is high enough.

The charge pump incorporates a 100kHz oscillator and on chip pump capacitors capable of charging a 1000pF load in 90us typical. In addition to providing active regulation, the internal 15V Zener is included to prevent exceeding the GS rating of the power MOSFET at high supply voltages.

The MX5014S devices have been improved for greater ruggedness and durability.

Construction Hints

High current pulse circuits demand equipment and assembly techniques that are more stringent than normal, low current lab practices. The following are the sources of pitfalls most often encountered during prototyping: Supplies: Many bench power supplies have poor transient response. Circuits that are being pulse tested, or those that operate by pulse width modulation will produce strange results when used with a supply that has poor ripple rejection, or a peaked transient response. Always monitor the power supply voltage that appears at the drain of a high side driver (or the supply side of the load for a low side driver) with an oscilloscope. It is not uncommon to find bench power supplies in the 1kW class that overshoot or undershoot by as much as 50% when pulse loaded. Not only will the load current and voltage measurements be affected, but it is possible to overstress various components, especially electrolytic capacitors, with possible catastrophic results. A 10uF supply bypass capacitor at the chip is recommended. Residual resistances: resistances in circuit connections may also cause confusing results. For example, a circuit may employ a 50mΩ power MOSFET for low voltage drop, but unless careful construction techniques are used, one could easily add 50 to 100mΩ resistance. Do not use a socket for the MOSFET. If the MOSFET is a TO-220 type package, make high current connections to the drain tab. Wiring losses have profound effect on high current circuits. A floating million meter can identify connections that are contributing excess drop under load.

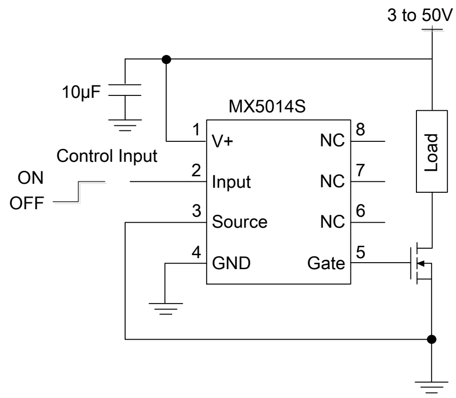
Low voltage testing

As the MX5014S has relatively high output impedances, a normal oscilloscope probe will load the device. This is especially pronounced at low voltage operation. It is recommended that a FET probe or unity gain buffer be used for all testing.

Circuit topologies

The MX5014S is well suited for use with standard power MOSFETs in both low and high side driver configurations. In addition, the lower supply voltage requirements of these devices make them ideal for use with logic level FETs in high side applications with a supply 3 to 50V. In addition, a standard IGBT can be driven using these devices.

Choice of one topology over another is usually based on speed vs. safety. The fastest topology is the low side driver, however, it is not usually considered as safe as high side driving as it is easier to accidentally short a load to ground than to V+. The slowest, but safest topology is the high side driver; with speed being inversely proportional to supply voltage. It is the preferred topology for most military and automotive applications. Speed can be improved considerably by bootstrapping from the supply.

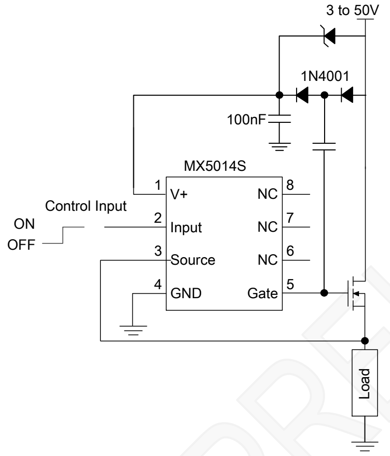


Low side driver

Low side driver: A key advantage of this topology, as previously mentioned, is speed. The MOSFET gate is driven to near supply immediately when the MX5014S is turned on. Typical circuits reach full enhancement in 50us or less with a

15V supply.

Bootstrapped high side driver the turn on time of a high side driver can be improved to faster than 40us by bootstrapping the supply with a MOSFET source. The Schottky barrier diode prevents the supply pin from dropping more than 200mV below the drain supply and improves turn on time. Since the supply current in the off state in only a small leakage, the 100nF bypass capacitor tends to remain charged for several seconds after the MX5014 is turned off. Faster speeds can be obtained at the expense of supply voltage (the over voltage shutdown will turn the part off when the bootstrapping action pulls the supply pin above 35) by using a larger capacitor at the junction of the two 1N4001 diodes. In a PWM application (this circuit can be used for either PWM'ed or continuously energized loads), the chip supply is sustained at a higher potential than the system supply, which improves switching time.



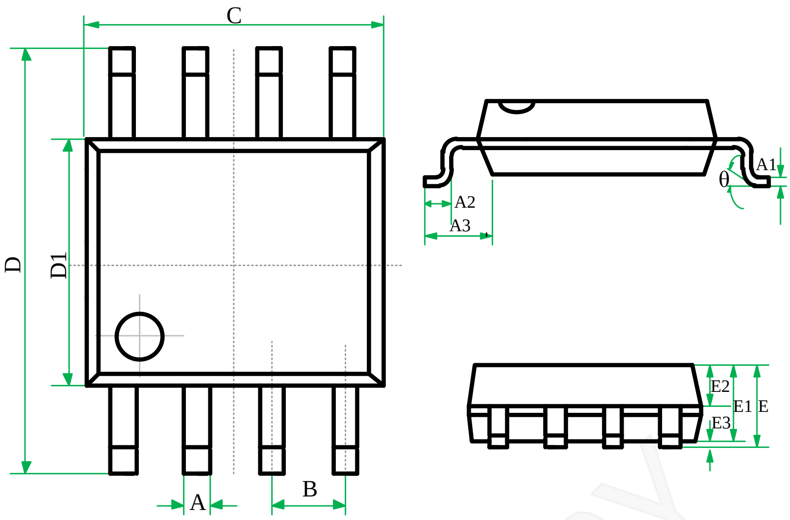
High side driver with current sense although no current sense function is included on the MX5014S devices, a simple current sense function can be realized via the addition of one more active component; an op amp used as a comparator. The positive rail of the op amp is tied to V+, and the negative rail is tied to ground. This op amp was chosen as it can withstand having input transients that swing below the negative rail, and has common mode range almost to the positive rail.

The inverting side of this comparator is tied to a voltage divider which sets the voltage to V+-VTRIP. The non-inverting side is tied to the node between the drain of the FET and sense resistor. If the overcurrent trip point is not exceeded, this node will always be pulled above V+-VTRIP, and the output of the comparator will be high which feeds the control input of the MX5014S. One the overcurrent trip point has been reached. The comparator will go low, which shuts off the MX5014S. When the short is removed, feedback to the input pin insures that the MX5014S will turn back on. This output can also be level shifted and sent to an I/O port of a microcontroller for intelligent control.

Current shunts

Low valued resistors are necessary for use at RS. Resistors are available with values ranging from 1 to 50mΩ, at 2 to 10W. If a precise overcurrent trip point is not necessary, then a non-precision resistor or even a measured PCB trace can serve as RS. The major cause of drift in resistor values with such resistors is temperature coefficient; the designer should be aware that a linear, 500ppm/℃ change will contribute as much as 10% shift in the overcurrent trip point. If this is not acceptable, a power resistor designed for current shunt service (drifts less than 100ppm/℃), or a Kelvin-sensed resistor may be used.

Package information



SYMBOL	MILLIMETERS			INCHES		
	MIN	NOM	MAX	MIN	NOM	MAX
A	0.39	-	0.48	0.0154	-	0.0189
A1	0.21	-	0.28	0.008	-	0.011
A2	0.50	-	0.80	0.020	-	0.031
A3	1.05BSC			0.041BSC		
B	1.27BSC			0.050BSC		
C	4.70	4.90	5.10	0.185	0.193	0.201
D	5.80	6.00	6.20	0.228	0.236	0.244
D1	3.70	3.90	4.10	0.146	0.154	0.161
E	-	-	1.75	-	-	0.069
E1	1.30	1.40	1.50	0.051	0.055	0.059
E2	0.60	0.65	0.70	0.024	0.026	0.028
E3	0.10	-	0.225	0.004	-	0.009
θ	0	-	8°	0	-	8°

SOP8 for MX5014S

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.