

MAXIM

Quad, High-Side Power Switch

MAX625

General Description

The MAX625 is a quad, high-side power switch that switches 1A steady-state loads with 4A peak currents. The switch resistances are typically 0.2Ω , and internal clamp diodes allow inductive load switching. The MAX625 is completely self-contained in a 24-pin, 0.300" narrow plastic DIP package and requires no external components for normal operation.

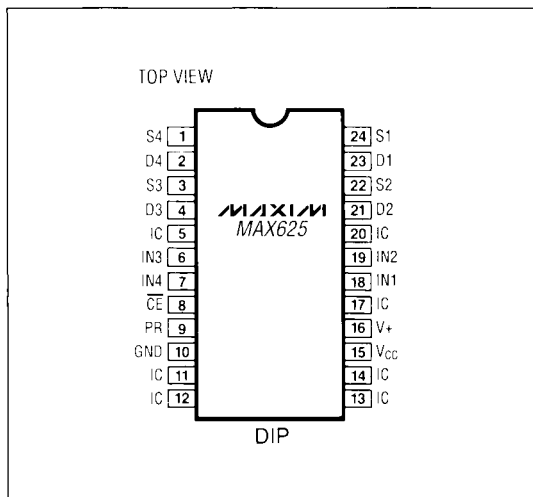
The +4.5V to +16.5V input supply range and a typical quiescent current of only $70\mu\text{A}$ make the MAX625 ideal for a wide range of line- and battery-powered switching and control applications that require high efficiency and small size.

An internal quad latch accepts four TTL/CMOS logic signals that control the four switches. The MAX625 eliminates expensive logic MOSFETs in +5V-only and other low-voltage switching circuits. It also replaces costly, bulky, less efficient P-channel MOSFETs or PNP transistors.

Applications

Portable Computer Battery-Load Management
 High-Side Power, N-Channel MOSFET Switching
 Low-Side Switching from Low Supply Voltages
 Solid-State Relay
 Quad-Latching Level Translators
 H-Bridge Motor Drivers
 Stepper Motor Drivers

Pin Configuration



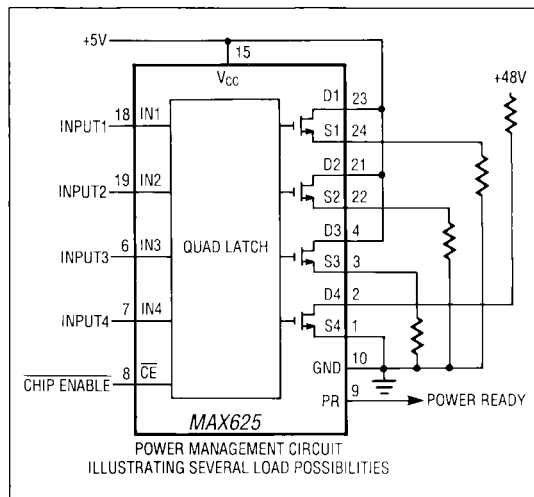
Features

- ◆ 0.2Ω Max Switch Resistance
- ◆ +4.5V to +16.5V Operating Supply Voltage Range
- ◆ Output Voltage Regulated to $V_{CC} + 11\text{V}$ (Typ) Available at V+
- ◆ $70\mu\text{A}$ Quiescent Current (Typ)
- ◆ Quad Latched TTL/CMOS Inputs
- ◆ Power-Ready Output
- ◆ Undervoltage Lockout

Ordering Information

PART	TEMP. RANGE	PIN-PACKAGE
MAX625CNG	0°C to $+70^\circ\text{C}$	24 Narrow Plastic DIP
MAX625ENG	-40°C to $+85^\circ\text{C}$	24 Narrow Plastic DIP

Typical Operating Circuit



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Maxim Integrated Products 1

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Quad, High-Side Power Switch

MAX625

ABSOLUTE MAXIMUM RATINGS

V _{CC}	17V	Continuous Total Power Dissipation	
V+ to GND	30V	to +70°C	1067mW
IN1-IN4, CE	(GND - 0.3V) to (V+ + 0.3V)	derate above +70°C	13.33mW/°C
Power Ready (PR) Output	(GND - 0.3V) to (V _{CC} + 0.3V)	Operating Temperature Ranges:	
V+ Output Current	25mA	MAX625CNG	0°C to +70°C
Drain-to-Source Breakdown Voltage	60V	MAX625ENG	-40°C to +85°C
Continuous Drain to Source Current		Storage Temperature Range	-65°C to +160°C
Single MOSFET	5A	Lead Temperature (soldering, 10 sec)	+300°C
All four MOSFETs	1.2A		

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.

ELECTRICAL CHARACTERISTICS

(V_{CC} = +5V, T_A = T_{MIN} to T_{MAX} unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Supply Voltage (Note 1)	V _{CC}		4.5		16.5	V
Internal MOSFET ON Resistance (Note 2)	R _{DS(ON)}	T _A = +25°C V _{CC} = 4.5V to 16.5V (High-side)		150	200	mΩ
		T _A = +25°C V _{CC} = 4.5V to 8V (Low-side)		140	200	
		T _A = T _{MIN} to T _{MAX} V _{CC} = 4.5V to 16.5V (High-side)			260	
		T _A = T _{MIN} to T _{MAX} V _{CC} = 4.5V to 8V (Low-side)			260	
Off Leakage Current	I _{DS(OFF)}	V _{DS} = 55V		0.05	1.0	μA
High-Side Voltage (Note 3)	V+	I _{OUT} = 0, V _{CC} = +4.5V	14.5	15.5	17.5	V
		I _{OUT} = 0, V _{CC} = 16.5V	26.5	27.5	29.5	
		I _{OUT} = 250μA, V _{CC} = 5V	15	16	18	
		I _{OUT} = 500μA, V _{CC} = 16.5V	26.5	27.5	29.5	
Power-Ready Threshold	PRT	I _{OUT} = 100μA Sink (Note 4)	12	13.5	14.5	V
Power-Ready Output High	PROH	I _{SOURCE} = 100μA	3.8	4.7	5	V
Power-Ready Output Low	PROL	I _{SINK} = 1mA		0.1	0.4	V
Switching Frequency	f ₀	I _{OUT} = 0, T _A = +25°C		70		kHz
Quiescent Supply Current	I _Q	T _A = +25°C, I _{OUT} = 0	V _{CC} = 16.5V	50	350	μA
			V _{CC} = 5V	70	500	

Quad, High-Side Power Switch

MAX625

ELECTRICAL CHARACTERISTICS (continued)

($V_{CC} = +5V$, $T_A = T_{MIN}$ to T_{MAX} unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Logic Inputs						
Input Threshold Low	V_{TL}				0.8	V
Input Threshold High	V_{TH}		2.4			V
Input Bias Current	I_B	$0V < V_{IN} < 5V$	-100		+100	nA
Chip Enable Threshold Low	CE_{LO}				0.8	V
Chip Enable Threshold High	CE_{HI}		2.4			V
Minimum CE Pulse Duration	t_{CE}		100	50		ns
Pull-Down Current	I_{CE}			10		μA
Data Hold Time	t_{DH}			-10	+10	ns
Data Set-Up Time	t_{SU}			50	100	ns
Data Delay Time	t_{OD}	$V_{CE} = 0V$		150		ns

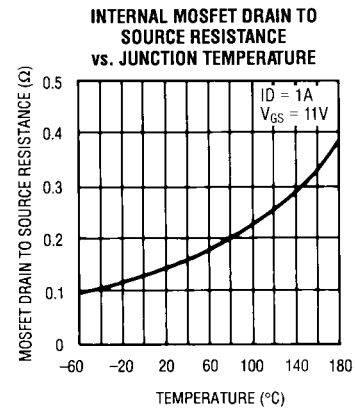
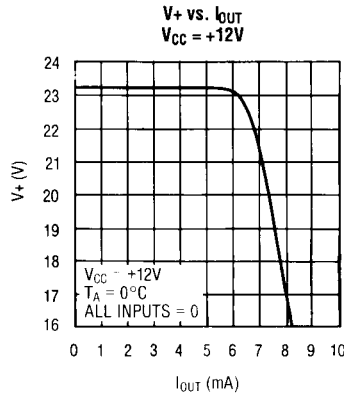
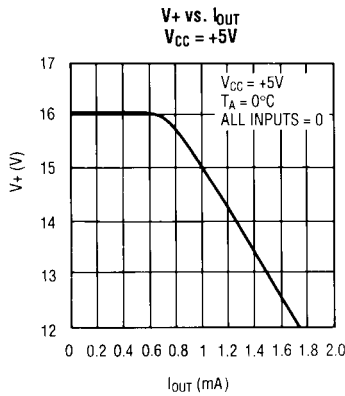
Note 1: To avoid exceeding the maximum V_{GS} rating of the internal N-channel MOSFET switches, V_{CC} must not exceed +8V in low-side switching applications.

Note 2: A "low-side" switch connects between the load and ground.
A "high-side" switch connects between the voltage source and load.

Note 3: The High-Side Voltage (V_+) is measured with respect to ground.

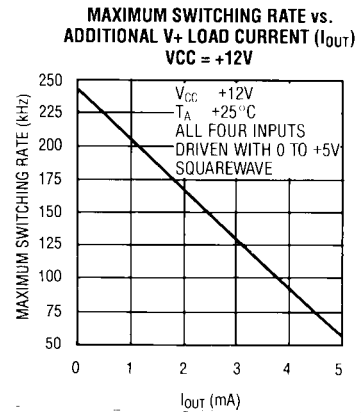
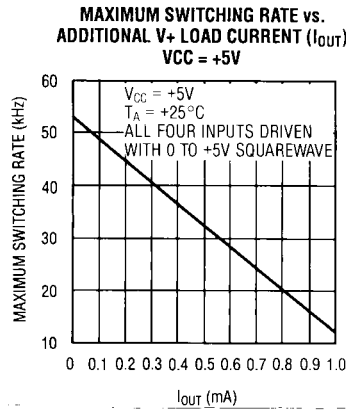
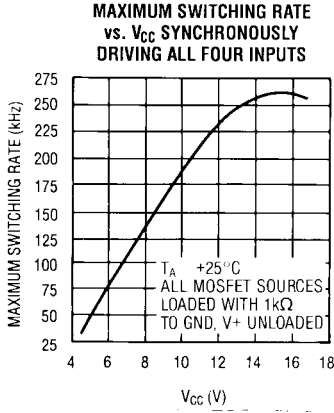
Note 4: Power Ready Threshold is the voltage measured with respect to ground at V_+ when PR switches high (PR HIGH = V_{CC}).

Typical Operating Characteristics

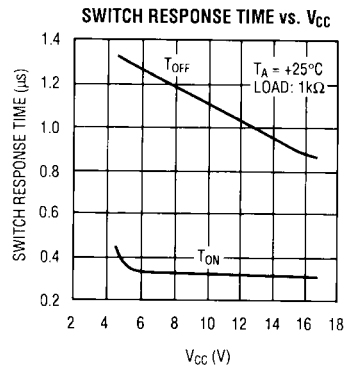
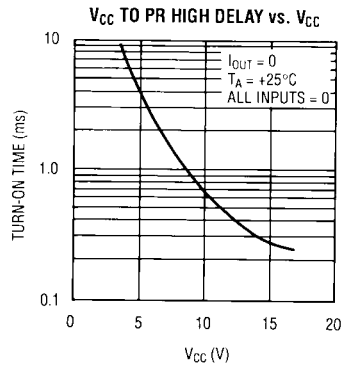
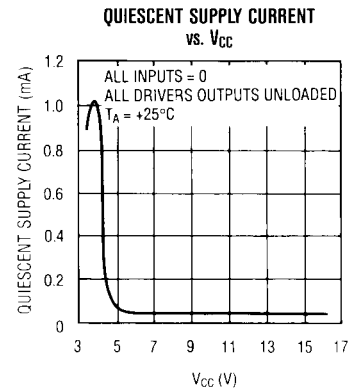
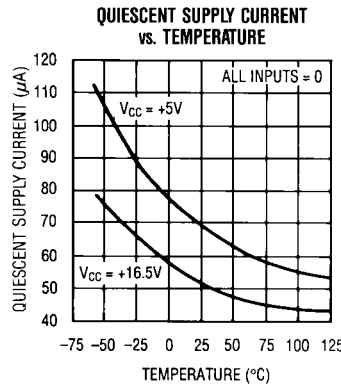
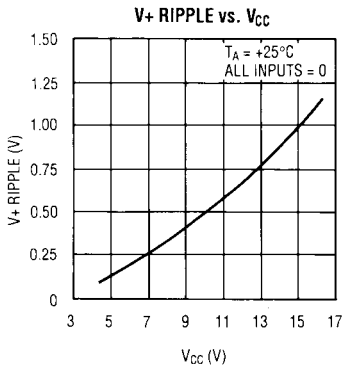


Quad, High-Side Power Switch

Typical Operating Characteristics (continued)



NOTE: THE MAXIMUM SWITCHING RATE OCCURS JUST BELOW THE POINT WHERE DRIVER OUTPUT AND $V+$ LOADING PULLS $V+$ TO PRT ($\text{PRT} = V_{CC} + 8.5\text{V}$).



NOTE: MEASURED FROM THE DRIVER INPUT EDGE TO THE POINT WHERE THE SWITCH IS FULLY ON OR OFF

Quad, High-Side Power Switch

MAX625

Pin Description

PIN	NAME	FUNCTION
1	S4	MOSFET Source 4.
2	D4	MOSFET Drain 4.
3	S3	MOSFET Source 3.
4	D3	MOSFET Drain 3.
5	IC	Internal Connection. Make no connection to this pin.
6	IN3	TTL/CMOS Compatible Input to Switch 3. Connect to GND if unused.
7	IN4	TTL/CMOS Compatible Input to Switch 4. Connect to GND if unused.
8	CE	Chip Enable. Logic high inhibits input data. Logic low transfers data to switches. CE pulse must be at least 100ns. Connect to GND for direct data transfer.
9	PR	Power-Ready Output is a logic high equal to V_{CC} when $V+ \geq V_{CC} + 8.5V$.
10	GND	Ground.
11	IC	Internal Connection. Make no connection to this pin.
12	IC	Internal Connection. Make no connection to this pin.

PIN	NAME	FUNCTION
13	IC	Internal Connection. Make no connection to this pin.
14	IC	Internal Connection. Make no connection to this pin.
15	V_{CC}	Supply Voltage. Connect to positive supply.
16	$V+$	High-side voltage out. Typically equal to $V_{CC} + 11V$.
17	IC	Internal Connection. Make no connection to this pin.
18	IN1	TTL/CMOS Compatible input to switch 1. Connect to GND if unused.
19	IN2	TTL/CMOS Compatible input to switch 2. Connect to GND if unused.
20	IC	Internal Connection. Make no connection to this pin.
21	D2	MOSFET Drain 2.
22	S2	MOSFET Source 2.
23	D1	MOSFET Drain 1.
24	S1	MOSFET Source 1.

Detailed Description

Figure 1 shows the MAX625 functional block diagram. A regulated multistage charge pump supplies four MOSFET drivers with $V_{CC} + 11V$ for driving the internal MOSFETs (Figure 2). Logic inputs to the four drivers are stored in a quad latch. Data is latched by pulling CE high. An undervoltage lockout prevents the internal MOSFETs from turning on until $V+$ reaches the Power Ready Threshold (PRT) voltage ($V_{CC} + 8.5V$) and V_{CC} is greater than +3V.

The Dual-Charge Pump

A high-side voltage of approximately $V_{CC} + 11V$ is generated by a multistage charge pump (Figure 2). Although the charge pump is capable of multiplying V_{CC} by up to four times, the output is regulated to $V_{CC} + 11V$ by an internal feedback circuit. The charge pump typically operates at 70kHz, but regulates by pulse-skipping. When $V+$ exceeds $V_{CC} + 11V$, the charge pump shuts off. As $V+$ falls below $V_{CC} + 11V$, the charge pump turns on.

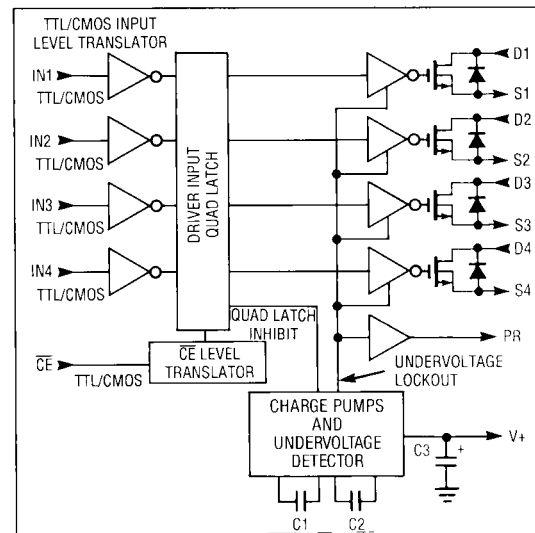


Figure 1. MAX625 Functional Diagram

Quad, High-Side Power Switch

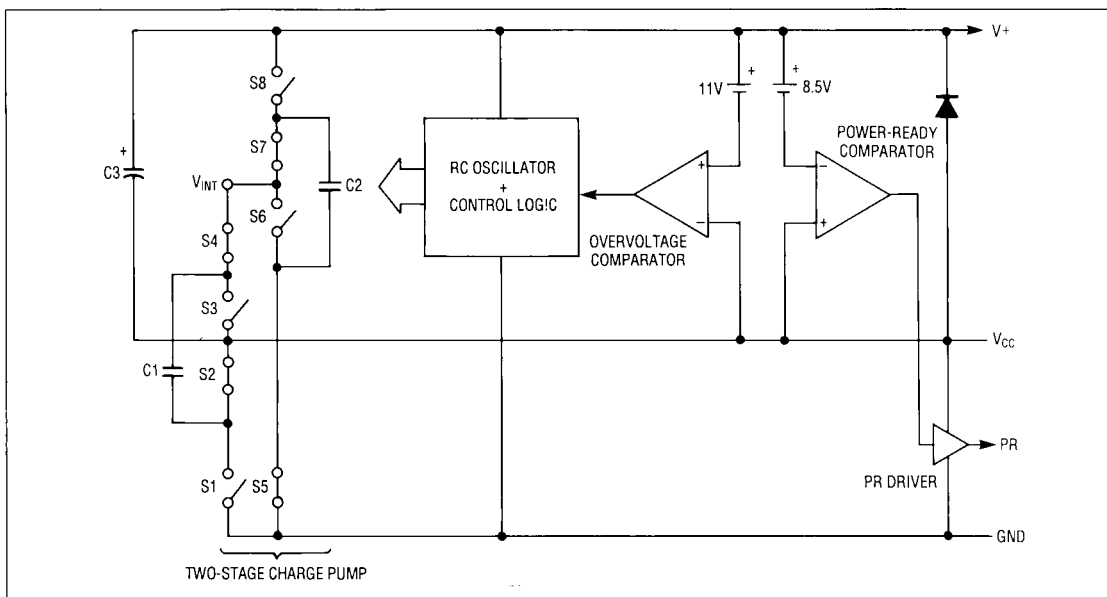


Figure 2. MAX625 Charge-Pump Diagram

MOSFET Drivers

Four MOSFET drivers level shift TTL/CMOS input signals, without an inversion, to levels that switch between ground and V_{CC} + 11V. These outputs drive the internal N-channel power MOSFETs in either high-side or low-side switching applications (a bridge arrangement would contain two high-side and two low-side N-channel MOSFET switches).

Internal MOSFETs

Each internal MOSFET will handle 4A current peaks. When all four MOSFETs are on, the steady-state I_{DS(ON)} is limited to 1A due to power dissipation limitations.

A body diode connects from source-to-drain on each MOSFET, making them suitable for driving inductive loads. However, the body diode prohibits applications where two different voltages are being switched to the same load. For example, if one MOSFET drain connects to a +12V supply, the other to a +5V supply, and both sources connect to the same load: when the +12V MOSFET turns on, the body diode in the +5V MOSFET forward biases, shorting the two supplies together.

Data Input Latch

Driver outputs are buffered from data inputs by a quad latch. When \overline{CE} is pulled low, the latch is transparent, and data transfers directly to driver outputs. When \overline{CE} goes high, the latch enters hold mode, and new input data is ignored. Input data must be valid 100ns before the rising edge of \overline{CE} and held 10ns (max over temp). The minimum \overline{CE} pulse width is 100ns (Figure 3). If latched operation is not required, connect \overline{CE} to GND.

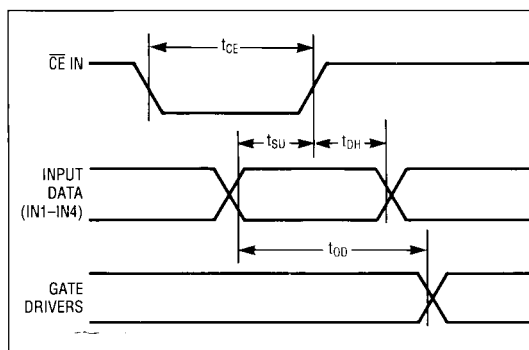


Figure 3. Digital Interface Timing Diagram

Quad, High-Side Power Switch

MAX625

Undervoltage Latch Inhibit

If V_{CC} falls below +3V due to power failure, or while powering down, or $V+$ falls below $V_{CC} + 8.5V$, the quad latch immediately resets, forcing the driver outputs low. The quad latch remains reset until V_{CC} rises above +3V and $V+$ exceeds $V_{CC} + 8.5V$. This prevents the latch from being corrupted with erroneous data during a momentary power failure.

Undervoltage Detector

The MAX625 contains an undervoltage detector which forces all driver outputs low when the high-side voltage ($V+$) is less than the Power Ready Threshold ($PRT = V_{CC} + 8.5V$) or when V_{CC} is less than +3V. This ensures that the internal N-channel MOSFETs have sufficient gate drive to operate without dissipating excess power. On power up, the quad latch remains reset until the charge pump boosts the high-side voltage to the PRT. As soon as $V+$ reaches the PRT, the undervoltage lockout disables, the quad latch is enabled, and Power Ready (PR) goes high. The undervoltage lockout feature also forces the driver outputs low if $V+$ is pulled below the PRT, e.g. if the driver output(s) or $V+$ are overloaded.

Power Ready Output

The MAX625's PR output is a direct extension of the undervoltage lockout feature. When power is applied, PR remains a logic low until $V+$ reaches the PRT and V_{CC} exceeds +3V. The PR output high level is V_{CC} .

Sourcing Current from $V+$

A small amount of current may be sourced from $V+$ (pin 16) to drive other circuitry. The amount of current is a function of V_{CC} , and the driver switching rate. (See "Maximum Switching Rate vs. Additional $V+$ Load Current", *Typical Operating Characteristics*).

The MAX625 $V+$ output is not internally short-circuit protected. In applications where $V+$ is susceptible to short circuit, external output short-circuit protection must be provided. To accomplish this, connect a resistor between $V+$ and the load to limit the $V+$ current to less than 25mA. The resistor value is determined by the following formula:

$$R_{CL} \geq \frac{V_{CC}}{25mA}$$

Application Information

Data Input Transition Time

The MAX625 is microprocessor-compatible and easy to interface. However, the driver input voltage must not remain between V_{IL} and V_{IH} for more than 500ns. In clocked databus systems, this is most easily accomplished by setting the data on the driver input lines before clocking CE low. However, most CMOS and TTL gates easily meet the 500ns transition speed requirement. Connect unused inputs to ground.

Maximum Driver Switching Rate

The maximum driver switching rate is the rate at which loading causes $V+$ to fall to the PRT ($V_{CC} + 8.5V$) and the MOSFETs turn off. It is a function of the maximum charge-pump output current available to the drivers at a given supply voltage. For example, with $V_{CC} = +5V$ and no external load on $V+$, the maximum switching rate while driving all four inputs is 52kHz. (See "Maximum Switching Rate vs. V_{CC} ", *Typical Operating Characteristics*).

Typical Application Circuits

For typical application circuits, see the MAX620/621 datasheet.