

MAXIM

High-Side Power Supply

MAX1822

General Description

The MAX1822 high-side supply, using a regulated charge pump, generates a regulated output voltage 11V greater than the input supply voltage to power high-side switching and control circuits. The MAX1822 allows low-resistance N-channel MOSFETs (FETs) to be used in circuits that normally require costly, less efficient P-channel FETs and PNP transistors. The high-side output also eliminates the need for logic FETs in +5V and other low-voltage switching circuits.

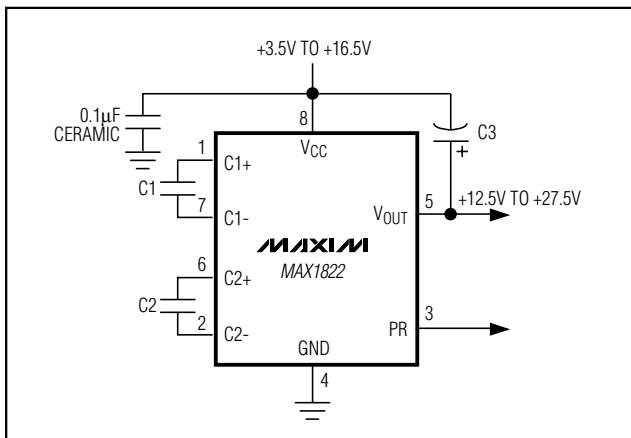
A +3.5V to +16.5V input supply range and a typical quiescent current of only 150 μ A make the MAX1822 ideal for a wide range of line- and battery-powered switching and control applications where efficiency is crucial. Also provided is a logic-level power-ready output (PR) to indicate when the high-side voltage reaches the proper level.

The MAX1822 comes in an 8-pin SO package and requires three inexpensive external capacitors. The MAX1822 is a pin-for-pin replacement to the MAX622.

Applications

- High-Side Power Control with N-Channel FETs
- Low-Dropout Voltage Regulators
- Power Switching from Low Supply Voltages
- H-Switches
- Stepper Motor Drivers
- Battery-Load Management
- Portable Computers

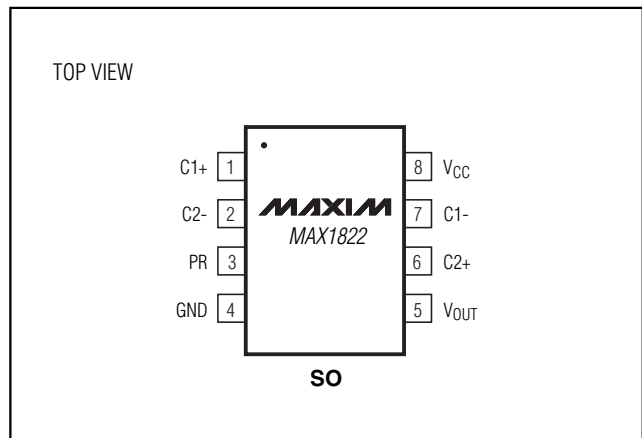
Typical Operating Circuit



Ordering Information

PART	TEMP. RANGE	PIN-PACKAGE
MAX1822ESA	-40°C to +85°C	8 SO

Pin Configuration



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ABSOLUTE MAXIMUM RATINGS

V _{CC}	+17V	Operating Temperature Range	-40°C to +85°C
V _{OUT}	+30V	Storage Temperature Range	-65°C to +160°C
I _{OUT}	25mA	Lead Temperature (soldering, 10s)	+300°C
Continuous Total Power Dissipation (T _A = +70°C)			
8-pin SO (derate 5.88mW/°C above +70°C)	471mW		

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	V _{CC}		3.5		16.5	V
High-Side Voltage (Note 1)	V _{OUT}	I _{OUT} = 0, V _{CC} = 3.5V, C1 = C2 = 0.047μF, C3 = 1μF	11.5	12.5	16.5	V
		I _{OUT} = 0, V _{CC} = 4.5V, C1 = C2 = 0.047μF, C3 = 1μF	14.5	15.5	17.5	
		I _{OUT} = 0, V _{CC} = 16.5V, C1 = C2 = 0.01μF, C3 = 1μF (Note 2)	26.5	27.5	29.5	
		I _{OUT} = 50μA, V _{CC} = 3.5V, C1 = C2 = 0.047μF, C3 = 1μF	8.5	10.5	16.5	
		I _{OUT} = 250μA, V _{CC} = 5V, C1 = C2 = 0.047μF, C3 = 1μF	15		18	
		I _{OUT} = 500μA, V _{CC} = 16.5V, C1 = C2 = 0.01μF, C3 = 1μF (Note 2)	26.5		29.5	
Power-Ready Threshold	PRT	I _{OUT} = 0 (Note 3)	12	13.5	14.5	V
Power-Ready Output High	PR _{OH}	I _{SOURCE} = 100μA	3.8	4.3	5	V
Power-Ready Output Low	PR _{OL}	I _{SINK} = 1mA			0.4	V
Output Voltage Ripple	VR	C1 = C2 = 0.01μF, C3 = 10μF, I _{OUT} = 1mA, V _{CC} = 16.5V		50		mV
Switching Frequency	F _O			90		kHz
Quiescent Supply Current	I _Q	I _{OUT} = 0, V _{CC} = 5V, C1 = C2 = 0.047μF, C3 = 1μF, T _A = +25°C		150	500	μA
		I _{OUT} = 0, V _{CC} = 16.5V, C1 = C2 = 0.047μF, C3 = 1μF, T _A = +25°C		150	350	

Note 1: High-side voltage measured with respect to ground.

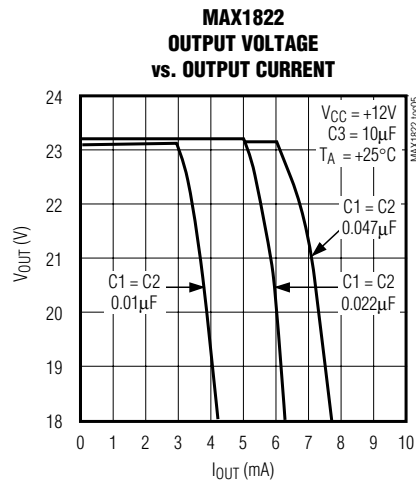
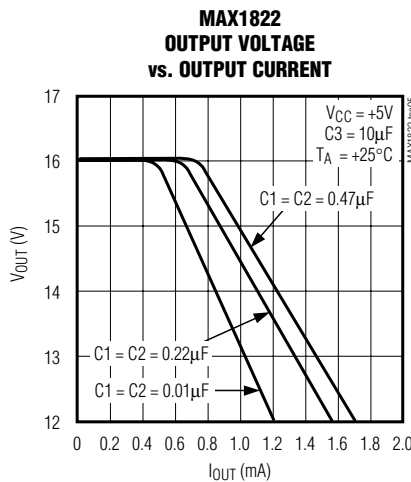
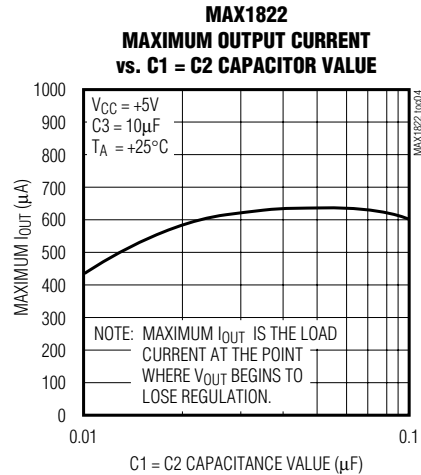
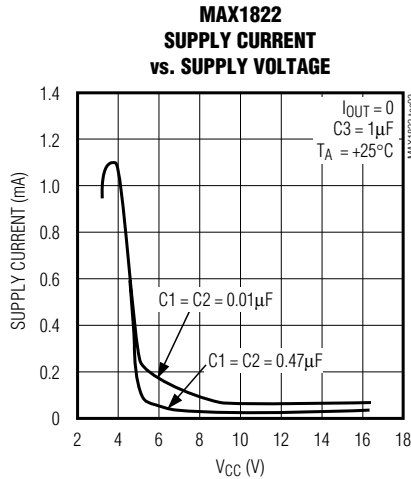
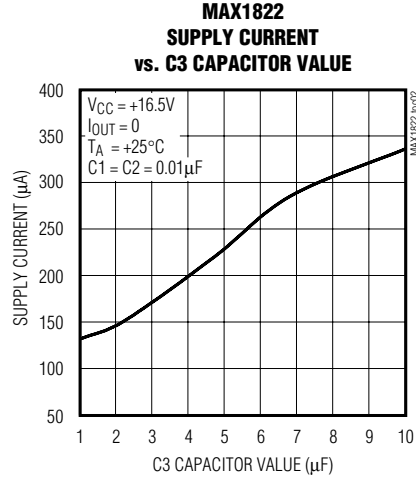
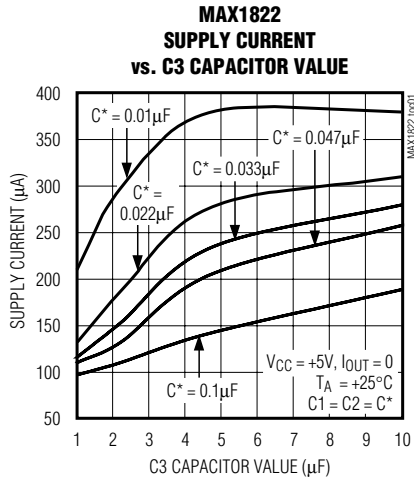
Note 2: For V_{CC} > +13V on the MAX1822, use C1 = C2 = 0.01μF.

Note 3: Power-Ready Threshold is the voltage with respect to ground at V_{OUT} when PR switches high (PR = V_{CC}).

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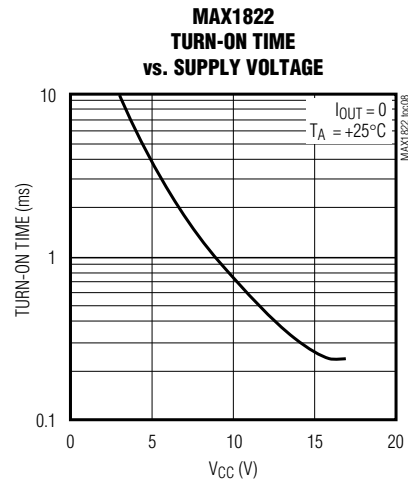
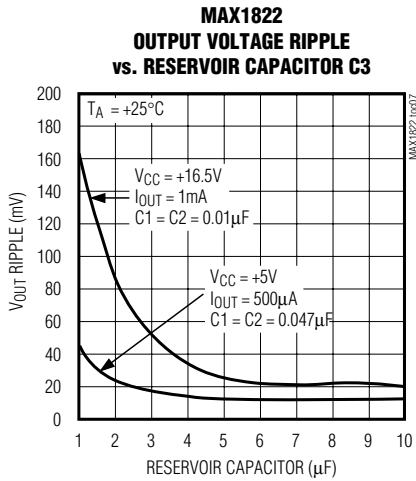
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Typical Operating Characteristics



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Typical Operating Characteristics (continued)



Pin Description

PIN	NAME	FUNCTION
1	C1+	Positive terminal to primary charge-pump capacitor
2	C2-	Negative terminal to secondary charge-pump capacitor
3	PR	Power-Ready Output. High when V _{OUT} is ≥ V _{CC} + 8.5V with respect to GND.
4	GND	Ground
5	V _{OUT}	High-Side Voltage Out
6	C2+	Positive terminal to secondary charge-pump capacitor
7	C1-	Negative terminal to primary charge-pump capacitor
8	V _{CC}	Input Supply

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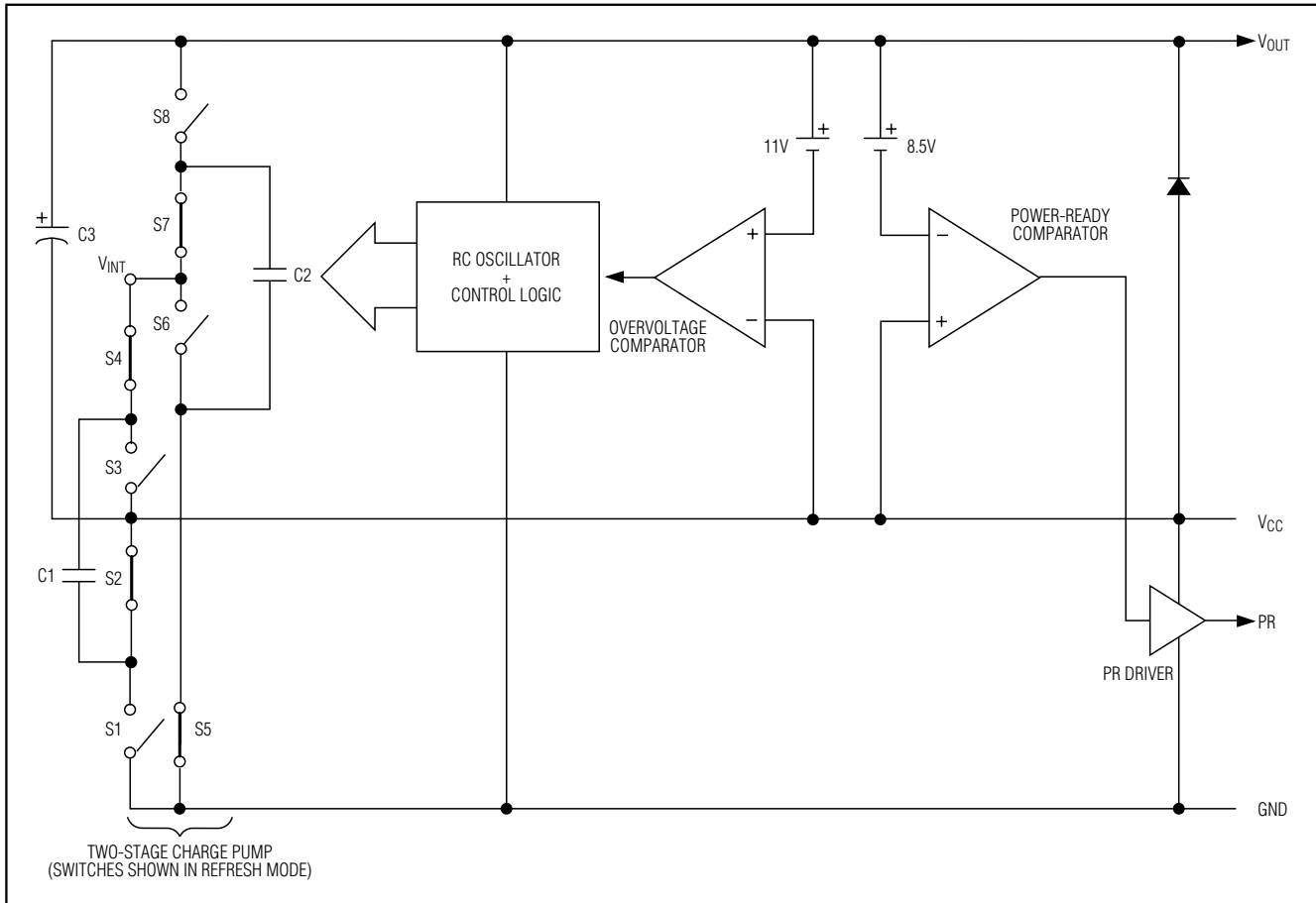


Figure 1. MAX1822 Block Diagram

Detailed Description

Charge-Pump Operation

The MAX1822 is a multistage charge-pump power supply. Although the charge pump is capable of multiplying V_{CC} up to four times, the output is regulated to $V_{CC} + 11V$ by an internal feedback circuit for inputs above 4V. The charge pump typically operates at 90kHz, but regulates by pulse skipping. When V_{OUT} exceeds $V_{CC} + 11V$, the oscillator shuts off. As V_{OUT} dips below $V_{CC} + 11V$, the oscillator turns on.

Power-Ready Output

The Power-Ready Output (PR) signals control circuitry when the high-side voltage reaches a preset level. This feature can be used to protect external FET switches from excess dissipation and damage by preventing them from turning on, except when adequate gate drive levels are present. When power is applied, PR remains low until

V_{OUT} reaches approximately $V_{CC} + 8.5V$. PR also goes low if V_{OUT} falls below this level during operation, i.e., if the output is overloaded. The PR high level is V_{CC} .

Applications Information

Quiescent Supply Current

MAX1822 quiescent supply current varies with V_{CC} and with the values of $C1$, $C2$, and $C3$ (*Typical Operating Characteristics*). Even with no external load, the device must still pump to overcome internal losses. Large ratios between $C3$ and $C1$ or $C2$ require more charge-pump cycles to restore V_{OUT} . As V_{CC} falls below 5V, quiescent current rises fairly rapidly to about 1mA at 4V (*Typical Operating Characteristics*). This rise occurs because V_{OUT} no longer pulse skips to regulate at low input voltages; the oscillator runs continuously, so supply current is higher. Figure 2 shows the test circuit for the MAX1822 quiescent supply current.

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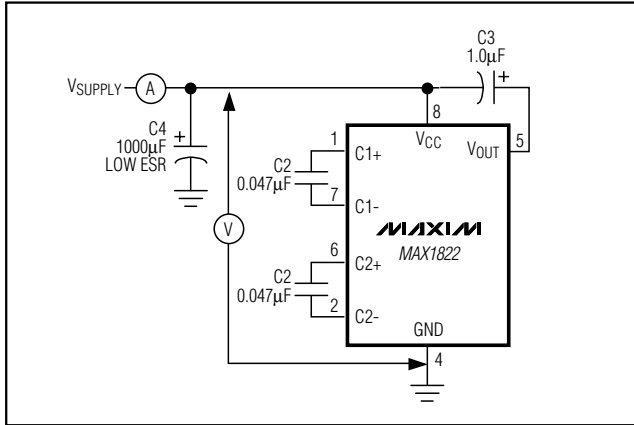


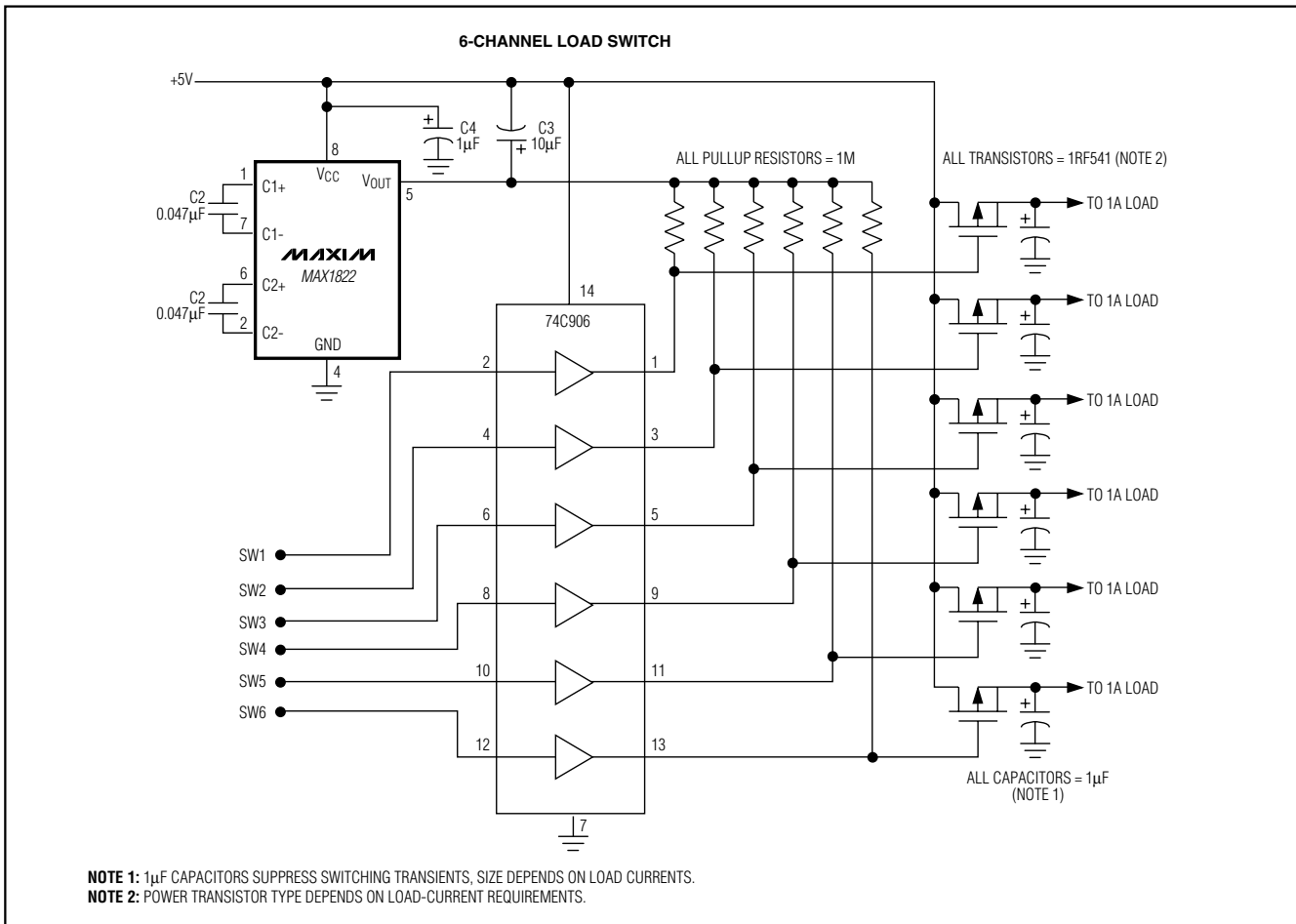
Figure 2. MAX1822 Quiescent Supply-Current Test Circuit

Output Ripple

V_{OUT} ripple is typically 50mVp-p with V_{CC} = +5V, C1 and C2 = 0.047µF, and C3 = 1µF (*Typical Operating Characteristics*). Ripple can be reduced by increasing the ratio between the output storage capacitors C3 and C1 and C2. This is usually accomplished by increasing C3 and keeping C1 and C2 in the 0.01µF to 0.047µF range. For example, if C1 and C2 are 0.047µF (V_{CC} must not exceed 13V) and C3 is 10µF, output ripple typically falls to 15mV (*Typical Operating Characteristics*).

Capacitor Selection

Capacitor type is unimportant when selecting capacitors for the MAX1822. However, when V_{CC} exceeds 13V, C1 and C2 must be no greater than 0.01µF. Using larger value capacitors with input voltages above 13V causes excessive amounts of energy to pass through



NOTE 1: 1µF CAPACITORS SUPPRESS SWITCHING TRANSIENTS, SIZE DEPENDS ON LOAD CURRENTS.
 NOTE 2: POWER TRANSISTOR TYPE DEPENDS ON LOAD-CURRENT REQUIREMENTS.

Figure 3. Single MAX1822 Driving Six High-Side Switches

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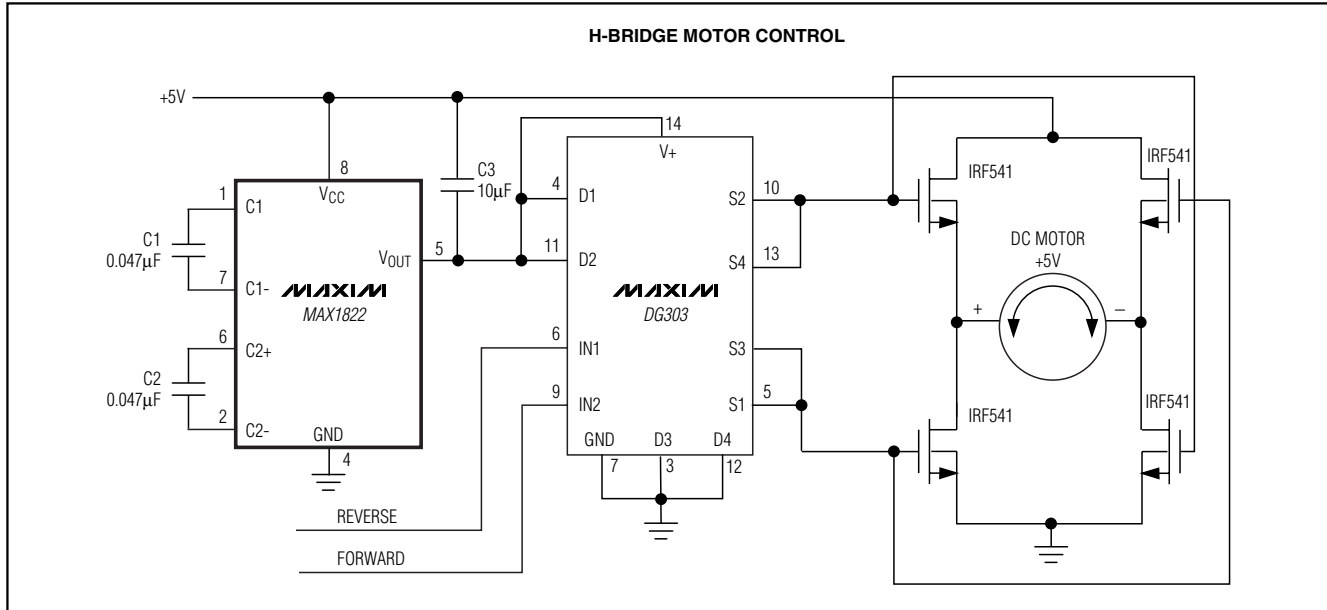


Figure 4. H-Bridge Motor Controller

internal switches during charge-pump cycles. This may damage the device.

Output Protection

The MAX1822 is not internally short-circuit protected. In applications where the output is susceptible to short circuit, external output short-circuit protection must be provided. Accomplish this by connecting a resistor between V_{OUT} and the load to limit output current to less than 25mA. The resistor value is determined by the following formula:

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

Typical Applications

One MAX1822 Drives Six High-Side Switches

Multiple subsystems or modules can be turned on and off using a single MAX1822 and an open-drain hex buffer such as the 74C906 (Figure 3). The drains of all buffer outputs are pulled through resistors to the MAX1822's V_{OUT} . The pullup resistance depends on the number of channels being used with the MAX1822 and power-dissipation limitations. The minimum pullup resistor value is determined by the number of channels paralleled on each high-side power supply and the

high-side output current from the MAX1822 at a given supply voltage, calculated as follows:

$$R_{MIN} = \frac{V_{OUT} \times (\text{number of channels})}{I_{OUT}}$$

where V_{OUT} is the high-side output voltage and I_{OUT} is the output current of the MAX1822.

For example, assuming an output current of 1mA and six channels, as in Figure 3, the minimum pullup resistor value that will not excessively load the MAX1822 is about 100k Ω , assuming all six channels are pulled low at the same time. The value of the pullup resistor also affects the turn-on time of each FET, and hence the amount of energy dissipated in the FET during turn-on. The rate of rise of V_{GS} is limited by the RC time constant of the pullup resistor and FET gate capacitance; waste power will be dissipated in the FET equal to $(I_{LOAD})^2 \times r_{DS}$ during the RC time period.

H-Bridge Motor Driver

An H-bridge motor driver is shown in Figure 4. The motor direction can be controlled by toggling between IN1 and IN2 of the DG303 analog switch. Each switch section turns on the appropriate FET pair, which passes current through the motor in the desired direction.

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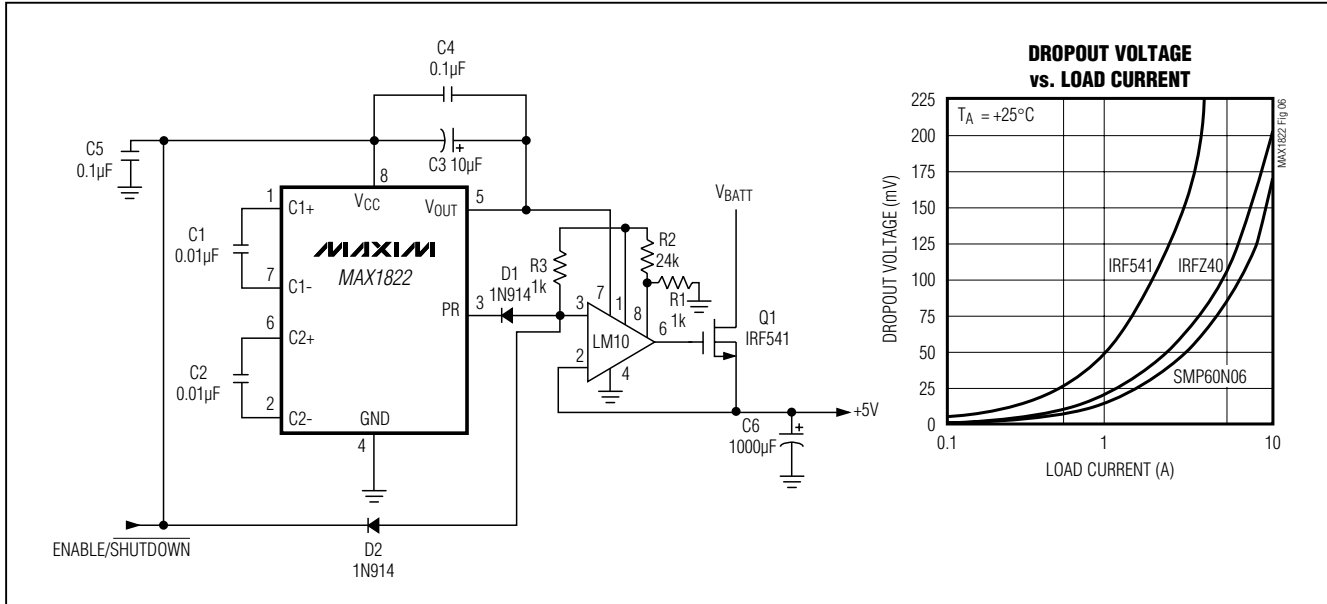


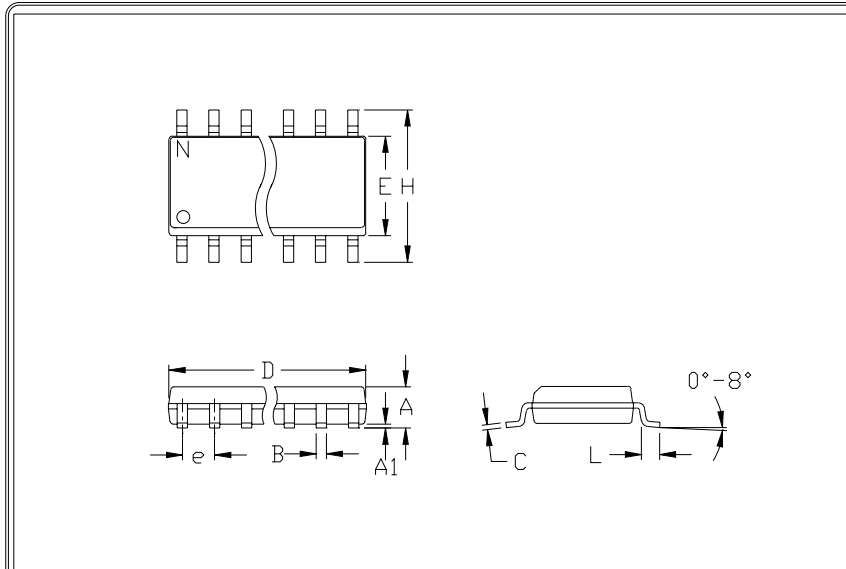
Figure 6. Ultra-Low Dropout Positive Voltage Regulator with Logic-Controlled Enable/Shutdown.

Chip Information

TRANSISTOR COUNT: 158

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Package Information



	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.053	0.069	1.35	1.75
A1	0.004	0.010	0.10	0.25
B	0.014	0.019	0.35	0.49
C	0.007	0.010	0.19	0.25
e	0.050		1.27	
E	0.150	0.157	3.80	4.00
H	0.228	0.244	5.80	6.20
h	0.010	0.020	0.25	0.50
L	0.016	0.050	0.40	1.27

	INCHES		MILLIMETERS		N	MS012
	MIN	MAX	MIN	MAX		
D	0.189	0.197	4.80	5.00	8	A
D	0.337	0.344	8.55	8.75	14	B
D	0.386	0.394	9.80	10.00	16	C

- NOTES:
1. D&E DO NOT INCLUDE MOLD FLASH
 2. MOLD FLASH OR PROTRUSIONS NOT TO EXCEED .15mm (.006")
 3. LEADS TO BE COPLANAR WITHIN .102mm (.004")
 4. CONTROLLING DIMENSION: MILLIMETER
 5. MEETS JEDEC MS012-XX AS SHOWN IN ABOVE TABLE
 6. N = NUMBER OF PINS

MAXIM
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 PROPRIETARY INFORMATION

PACKAGE FAMILY OUTLINE: SOIC .150

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DOCUMENT CONTROL NUMBER REV

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