MAXIM

19-0103; Rev 1; 6/93

The MAX662 replaces the MAX661. The MAX662 pin configuration has been rotated to improve output current performance, and is recommended for new designs.

+12V, 30mA Flash Memory Programming Supply

MAX662

General Description

The MAX662 is a regulated +12V, 30mA-output, charge-pump DC-DC converter. It provides the necessary +12V ±5% output to program byte-wide flash memories, and requires no inductors to deliver a guaranteed 30mA output from inputs as low as 4.75V. It fits into less than 0.2in^2 of board space.

The MAX662 is the first charge-pump boost converter to provide a regulated +12V output. It requires only a few inexpensive capacitors, and the entire circuit is completely surface-mountable.

A logic-controlled shutdown pin that interfaces directly with microprocessors reduces the supply current to only 70µA. The MAX662 comes in 8-pin narrow SO and DIP packages.

For higher-current flash memory programming solutions, refer to the MAX734 and the MAX732 PWM switch-mode DC-DC converter data sheets. They have guaranteed output currents of 120mA and 200mA respectively. Or, refer to the MAX717-MAX721 data sheet for dual-output power supply ICs that integrate both main V_{CC} (3V/3.3V or 5V) and auxiliary +12V flash memory power supplies on a single device, and operate from 2V minimum inputs.

Applications

+12V Flash Memory Programming Supplies

Compact +12V Op-Amp Supplies

Switching MOSFETs in Low-Voltage Systems

Dual-Output +12V and +20V Supplies

Features

- ♦ Regulated +12V ±5% Output Voltage
- ♦ 4.5V to 5.5V Supply Voltage Range
- ♦ Fits in 0.2in^2
- ♦ Guaranteed 30mA Output
- ♦ No Inductor – Uses Only Capacitors
- ♦ 320µA Quiescent Current
- ♦ Logic-Controlled 70µA Shutdown
- ♦ 8-Pin Narrow SO and DIP Packages

MAXIM INTEGRATED PRODUCTS

Ordering Information

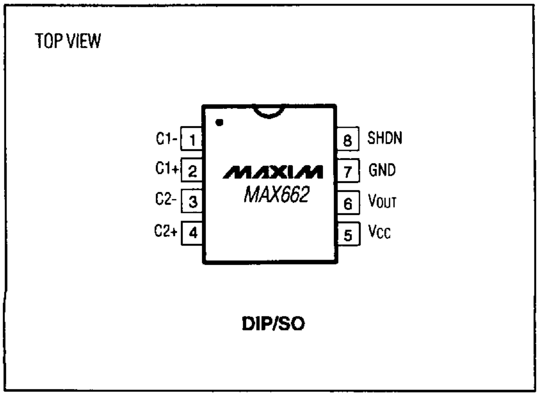
PART	TEMP. RANGE	PIN-PACKAGE
MAX662CPA	0°C to +70°C	8 Plastic DIP
MAX662CSA	0°C to +70°C	8 SO
MAX662C/D	0°C to +70°C	Dice*

PART	TEMP. RANGE	BOARD TYPE
MAX662EVKIT-SO	0°C to +70°C	Surface Mount

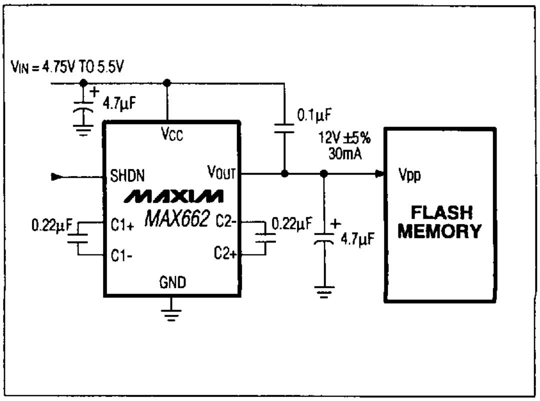
* Dice are tested at +25°C.

4

Pin Configuration



Typical Operating Circuit



+12V, 30mA Flash Memory Programming Supply

ABSOLUTE MAXIMUM RATINGS

V_{CC} to GND .... -0.3V to 6V
SHDN .... -0.3V to (V_{CC} +0.3V)
I_{OUT} Continuous 50mA
Continuous Power Dissipation (T_A = +70°C)
Plastic DIP (derate 9.09mW/°C above +70°C) 727mW
SO (derate 5.88mW/°C above 70°C) 471mW

Operating Temperature Range .... 0°C to +70°C
Storage Temperature Range .... -65°C to +160°C
Lead Temperature (soldering, 10sec) .... +300°C

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

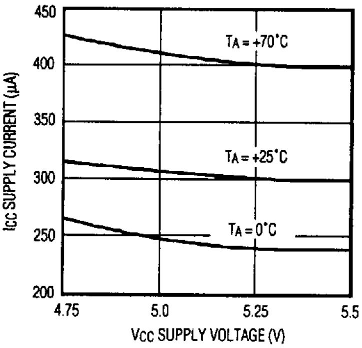
(Circuit of Figure 3, V_{CC} = 4.75V to 5.5V, T_A = T_{MIN} to T_{MAX}, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Output Voltage	V_{OUT}	0mA ≤ I_{OUT} ≤ 30mA	11.4		12.6	V
		I_{OUT} = 1mA, V_{CC} = 4.5V to 5.5V	11.4		12.6	
Supply Current	I_{CC}	No load, V_{SHDN} = 0V		0.32	1	mA
Shutdown Current		No load, V_{SHDN} = V_{CC}		35	100	µA
Oscillator Frequency	f_{osc}	V_{CC} = 5V, I_{OUT} = 30mA		400		kHz
Power Efficiency		V_{CC} = 5V, I_{OUT} = 30mA		74		%
V_{CC}-to-V_{OUT} Switch Impedance	R_{SW}	V_{CC} = V_{SHDN} = 5V, I_{OUT} = 0mA		1	2	kΩ
Shutdown Input Threshold	V_{IH}		2.4			V
	V_{IL}				0.4	
SHDN Pin Current		V_{CC} = 5V, V_{SHDN} = 0V	-200	-25	-5	µA
		V_{CC} = V_{SHDN} = 5V		0		

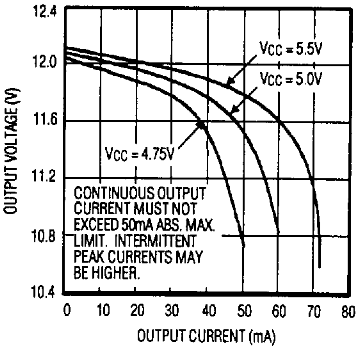
Typical Operating Characteristics

(Circuit of Figure 3, T_A = +25°C, unless otherwise noted.)

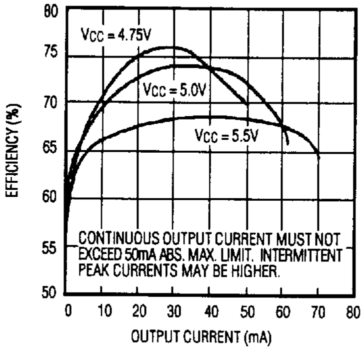
SUPPLY CURRENT vs. SUPPLY VOLTAGE



OUTPUT VOLTAGE vs. OUTPUT CURRENT



EFFICIENCY vs. OUTPUT CURRENT

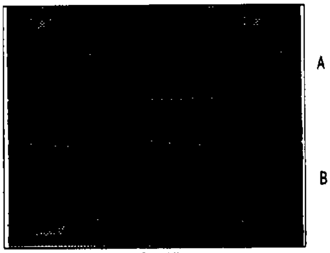


+12V, 30mA Flash Memory Programming Supply

Typical Operating Characteristics (continued)

(Circuit of Figure 3, T_A = +25°C, unless otherwise noted.)

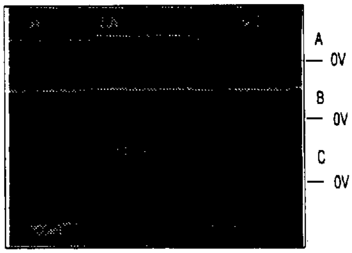
LOAD TRANSIENT RESPONSE



10ms/div

A = OUTPUT CURRENT, 20mA/div.
I_{OUT} = 0.2mA to 30mA
B = OUTPUT VOLTAGE RIPPLE, 100mV/div.
V_{CC} = 4.75V

LINE TRANSIENT RESPONSE

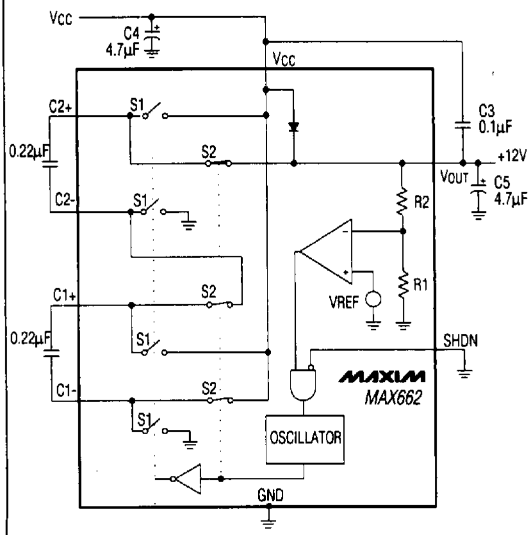


5ms/div

A = SUPPLY VOLTAGE, 4.75V to 5.5V
B = OUTPUT VOLTAGE, 10V/div.
C = OUTPUT VOLTAGE RIPPLE, 200mV/div.

Pin Description

PIN	NAME	FUNCTION
1	C1-	Negative terminal for the first charge-pump capacitor
2	C1+	Positive terminal for the first charge-pump capacitor
3	C2-	Negative terminal for the second charge-pump capacitor
4	C2+	Positive terminal for the second charge-pump capacitor
5	V_{CC}	Supply Voltage
6	V_{OUT}	+12V Output Voltage. V_{OUT} = V_{CC} when in shutdown mode.
7	GND	Ground
8	SHDN	Active-High CMOS Logic Level Shutdown Input. SHDN is internally pulled up to V_{CC}. Connect to GND for normal operation. In shutdown mode, the charge pumps are turned off and V_{OUT} = V_{CC}.



SWITCH CLOSURES SHOWN FOR CHARGE PUMP IN THE TRANSFER MODE.

Figure 1. Block Diagram

+12V, 30mA Flash Memory Programming Supply

Detailed Description

Operating Principle

The MAX662 provides a regulated 12V output voltage at 30mA from a 5V ±5% power supply, making it ideal for flash EEPROM programming applications. It uses internal charge pumps and external capacitors to generate +12V, eliminating inductors. Regulation is provided by a pulse-skipping scheme that monitors the output voltage level and turns on the charge pumps when the output voltage begins to droop.

Figure 1 shows a simplified block diagram of the MAX662. When the S1 switches are closed and the S2 switches are open, capacitors C1 and C2 are charged up to V_{CC}. The S1 switches are then opened and the S2 switches are closed so that capacitors C1 and C2 are connected in series between V_{CC} and V_{OUT}. This performs a voltage tripling function. A pulse-skipping feedback scheme adjusts the output voltage to 12V ±5%. The efficiency of the MAX662 with V_{CC} = 5V and I_{OUT} = 30mA is typically 74%. See the Efficiency vs. Output Current graph in the *Typical Operating Characteristics*.

During one oscillator cycle, energy is transferred from the charge-pump capacitors to the output filter capacitor and the load. The number of cycles within a given time frame increases as the load current increases or as the input supply voltage decreases. In the limiting case, the charge pumps operate continuously, and the oscillator frequency is nominally 400kHz.

Shutdown Mode

The MAX662 enters shutdown mode when SHDN is a logic high. SHDN is a CMOS-compatible input signal that is internally pulled up to V_{CC}. In shutdown mode, the charge-pump switching action is halted and V_{IN} is connected to V_{OUT} through a 1kΩ switch. When entering shutdown, V_{OUT} declines to V_{CC} in typically 13ms. Connect SHDN to ground for normal operation. When V_{CC} = 5V, it takes typically 600µs for the output to reach 12V after SHDN goes low (see Figure 2).

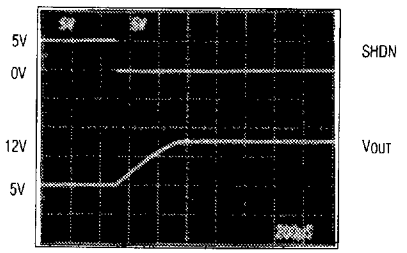


Figure 2. MAX662 Exiting Shutdown

Applications Information

Capacitor Selection

Charge-Pump Capacitors, C1 and C2

The capacitance values of the charge-pump capacitors C1 and C2 are critical. Use values in the range of 0.22µF to 1.0µF. Ceramic or tantalum capacitors are recommended.

Decoupling Capacitor, C3

The capacitance of C3 is also critical. Use a 0.1µF ceramic capacitor placed as close to the device as possible.

Input and Output Capacitors, C4 and C5

The type of input bypass capacitor (C4) and output filter capacitor (C5) used is not critical, but it does affect performance. Tantalums, ceramics or aluminum electrolytics are suggested. For smallest size, use Sprague 595D745X9016A7 surface-mount capacitors, which are 3.51mm x 1.81mm. For lowest ripple, use low effective series resistance (ESR) through-hole ceramic or tantalum capacitors. For lowest cost, use aluminum electrolytic or tantalum capacitors.

Figure 3 shows the component values for proper operation using minimum board space. The input bypass capacitor (C4) and output filter capacitor (C5) should both be at least 4.7µF when using Sprague's miniature 595D series of tantalum chip capacitors.

The values of C4 and C5 can be reduced to 2µF and 1µF, respectively, when using ceramic capacitors. If using aluminum electrolytics, use capacitance values of 10µF or larger for C4 and C5. Note that as V_{CC} increases above 5V, and the output current decreases, the amount of ripple at V_{OUT} increases due to the slower oscillator frequency combined with the higher input voltage. Increase the input and output bypass capacitance to reduce output ripple.

Table 1 lists various capacitor suppliers.

Layout Considerations

Layout is critical, due to the MAX662's high oscillator frequency. A good layout ensures stability and helps maintain the output voltage under heavy loads. For best performance, use very short connections to the capacitors. The order of importance is: C4, C5, C3, C1, C2.

+12V, 30mA Flash Memory Programming Supply

Table 1. Capacitor Suppliers

Supplier	Phone Number	Fax Number	Capacitor	Capacitor Type*
Murata Erie	(814) 237-1431	(814) 238-0490	GRM42-65ZU104M50	0.1μF Ceramic (SM)
			GRM42-6Z5U224M50	0.22μF Ceramic (SM)
			RPE123Z5U105M50V	1.0μF Ceramic (TH)
			RPE121Z5U104M50V	0.1μF Ceramic (TH)
Sprague Electric (smallest size)	(603) 224-1961 (207) 324-4140	(603) 224-1430 (207) 324-7223	595D475X9016A7	4.7μF Tantalum (SM)
			595D685X9016A7	6.8μF Tantalum (SM)

* Note: (SM) denotes surface-mount component, (TH) denotes through-hole component

Flash EEPROM Applications

The circuit of Figure 3 is a +12V ±5% 30mA flash EEPROM programming power supply. A microprocessor controls the programming voltage via the SHDN pin. When SHDN is low, the output voltage (which is connected to the flash memory V_{PP} supply-voltage pin) rises to +12V to facilitate programming the flash memory. When SHDN is high, the output voltage is connected to V_{IN} through an internal 1kΩ resistor.

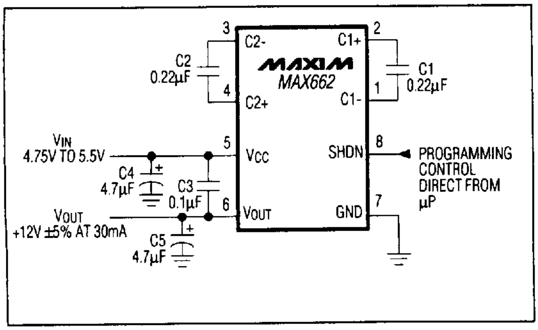


Figure 3. Flash EEPROM programming power supply

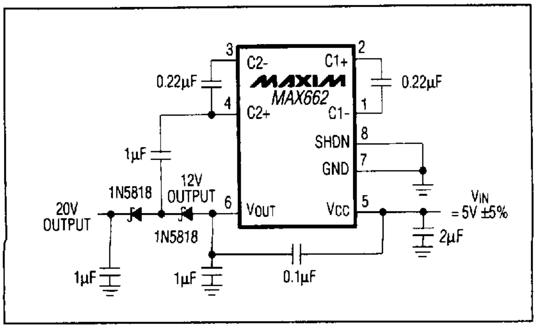


Figure 4. +12V and +20V Dual Supply from a +5V Input

Paralleling Devices

Two MAX662s can be placed in parallel to increase output drive capability. The V_{CC}, V_{OUT} and GND pins can be paralleled, reducing pin count. Use a single bypass capacitor and a single output filter capacitor with twice the capacitance value if the two devices can be placed close to each other. If the MAX662s cannot be placed close together, use separate bypass and output capacitors. The amount of output ripple observed will determine whether single input bypass and output filter capacitors can be used.

12V and 20V Dual-Output Power Supply

Using the charge-pump voltage-doubler circuit of Figure 4, the MAX662 can produce a +20V supply from a single +5V supply. Figure 5 shows the current capability of the +20V supply.

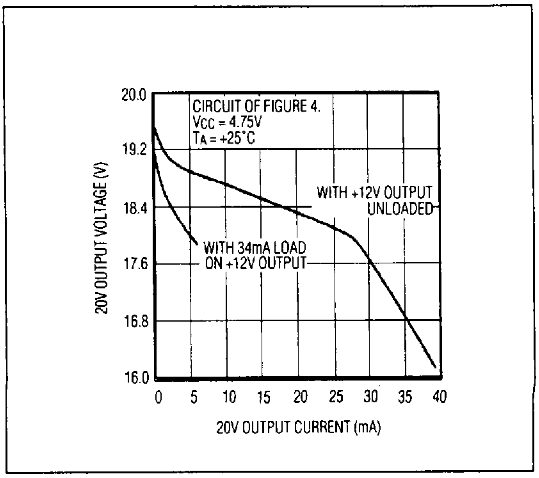


Figure 5. +20V Supply Output Current Capability