

19-0103, Rev 0: 12/92

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

# MAXIM

## +12V, 30mA Flash Memory Programming Supply

MAX662/EV KIT

### General Description

The MAX662 is a regulated +12V, 30mA-output, charge-pump DC-DC converter. It provides the necessary +12V  $\pm 5\%$  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<sup>2</sup> 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.

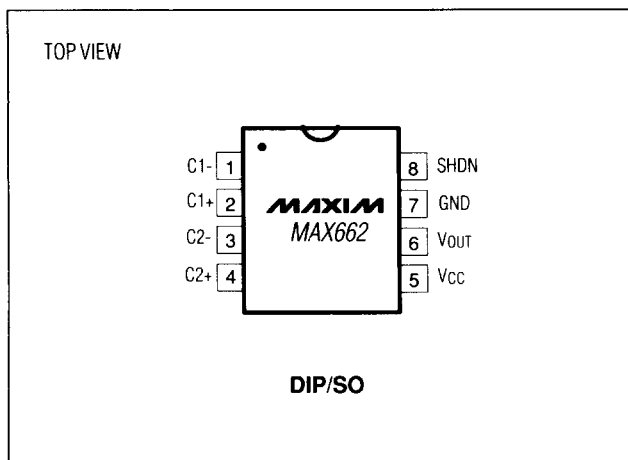
A logic-controlled shutdown pin that interfaces directly with microprocessors reduces the supply current to only 70 $\mu$ A. The MAX662 comes in 8-pin narrow SO and DIP packages.

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 VCC (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

### Pin Configuration



### Features

- ◆ Regulated +12V  $\pm 5\%$  Output Voltage
- ◆ 4.5V to 5.5V Supply Voltage Range
- ◆ Fits in 0.2in<sup>2</sup>
- ◆ Guaranteed 30mA Output
- ◆ No Inductor – Uses Only Capacitors
- ◆ 320 $\mu$ A Quiescent Current
- ◆ Logic-Controlled 70 $\mu$ A Shutdown
- ◆ 8-Pin Narrow SO and DIP Packages

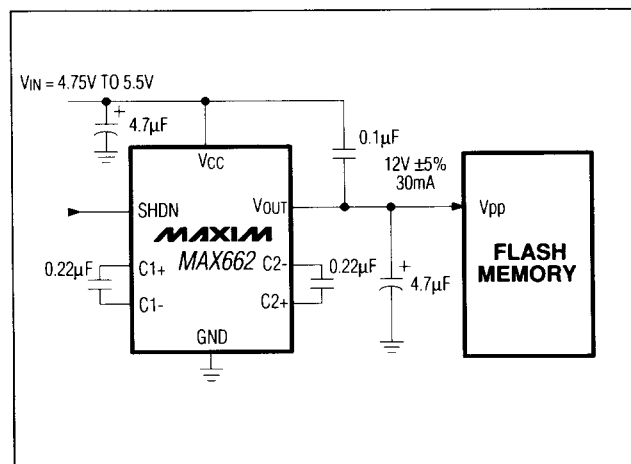
### Ordering Information

| 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.

### Typical Operating Circuit



MAXIM

Maxim Integrated Products 1

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# +12V, 30mA Flash Memory Programming Supply

## ABSOLUTE MAXIMUM RATINGS

|  |                      |                                     |                 |
|--|----------------------|-------------------------------------|-----------------|
| VCC to GND                                 | -0.3V to 6V          | Operating Temperature Range         | 0°C to +70°C    |
| SHDN                                       | -0.3V to (VCC +0.3V) | Storage Temperature Range           | -65°C to +160°C |
| IOUT Continuous                            | 50mA                 | Lead Temperature (soldering, 10sec) | +300°C          |
| Continuous Power Dissipation (TA = +70°C)  |                      |                                     |                 |
| Plastic DIP (derate 9.09mW/°C above +70°C) | .727mW               |                                     |                 |
| 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.

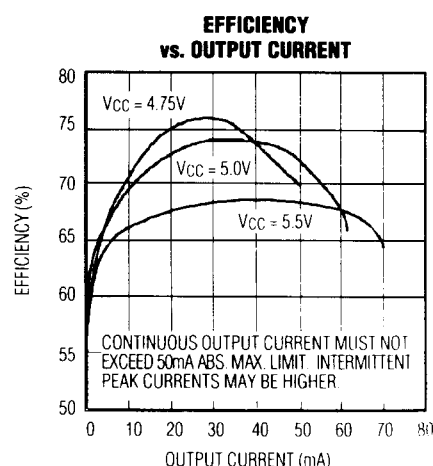
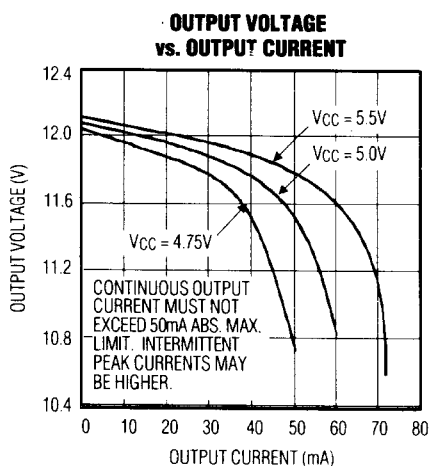
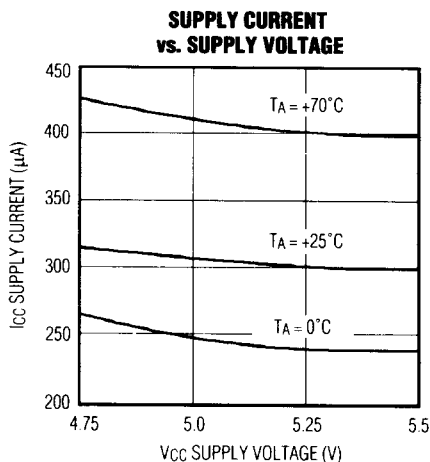
## ELECTRICAL CHARACTERISTICS

(Circuit of Figure 3, VCC = 4.75V to 5.5V, TA = TMIN to TMAX, unless otherwise noted.)

| PARAMETER                    | SYMBOL | CONDITIONS                     | MIN  | TYP  | MAX  | UNITS |
|------------------------------|--------|--------------------------------|------|------|------|-------|
| Output Voltage               | VOUT   | 0mA ≤ IOUT ≤ 30mA              | 11.4 |      | 12.6 | V     |
|                              |        | IOUT = 1mA, VCC = 4.5V to 5.5V | 11.4 |      | 12.6 |       |
| Supply Current               | ICC    | No load, VSHDN = 0V            |      | 0.32 | 1    | mA    |
| Shutdown Current             |        | No load, VSHDN = VCC           |      | 70   |      | μA    |
| Oscillator Frequency         | fosc   | VCC = 5V, IOUT = 30mA          |      | 400  |      | kHz   |
| Power Efficiency             |        | VCC = 5V, IOUT = 30mA          |      | 74   |      | %     |
| VCC-to-VOUT Switch Impedance | Rsw    | VCC = VSHDN = 5V, IOUT = 0mA   |      | 1    | 2    | kΩ    |
| Shutdown Input Threshold     | VIH    |                                | 2.4  |      |      | V     |
|                              | VIL    |                                |      |      | 0.4  |       |
| SHDN Pin Current             |        | VCC = 5V, VSHDN = 0V           | -200 | -25  | -5   | μA    |
|                              |        | VCC = VSHDN = 5V               |      | 0    |      |       |

## Typical Operating Characteristics

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

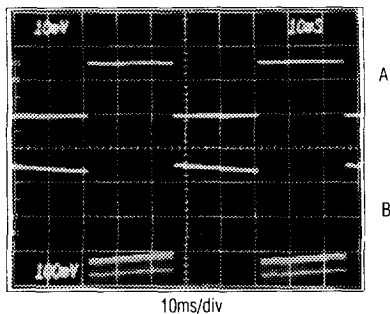


# +12V, 30mA Flash Memory Programming Supply

## Typical Operating Characteristics (continued)

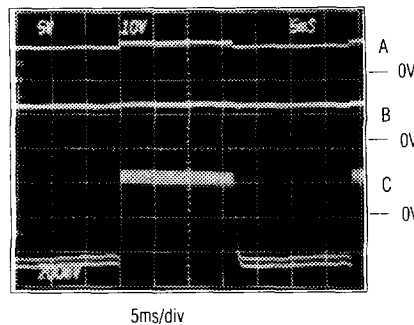
(Circuit of Figure 3,  $T_A = +25^\circ\text{C}$ , unless otherwise noted.)

### LOAD TRANSIENT RESPONSE



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

### LINE TRANSIENT RESPONSE



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

**MAX662/EV Kit**

## 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   | VCC  | Supply Voltage  |
| 6   | VOUT | +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 VCC. Connect to GND for normal operation. In shutdown mode, the charge pumps are turned off and $V_{OUT} = V_{CC}$ . |

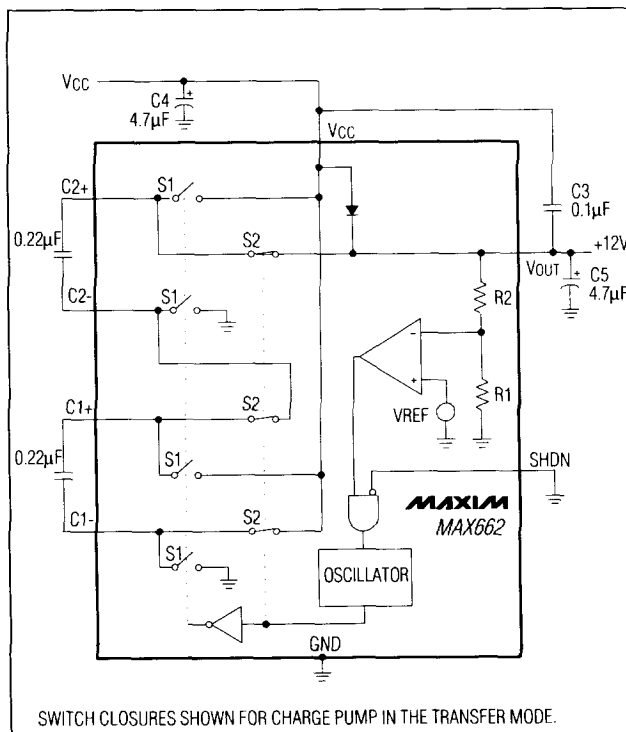


Figure 1. Block Diagram

# +12V, 30mA Flash Memory Programming Supply

## Detailed Description

### Operating Principle

The MAX662 provides a regulated 12V output voltage at 30mA from a 5V  $\pm 5\%$  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 VCC. The S1 switches are then opened and the S2 switches are closed so that capacitors C1 and C2 are connected in series between VCC and VOUT. This performs a voltage tripling function. A pulse-skipping feedback scheme adjusts the output voltage to 12V  $\pm 5\%$ . The efficiency of the MAX662 with VCC = 5V and IOUT = 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

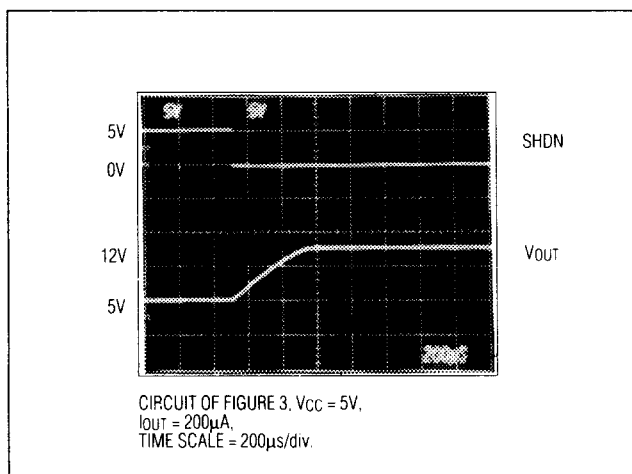


Figure 2. MAX662 Exiting Shutdown

is internally pulled up to VCC. In shutdown mode, the charge-pump switching action is halted and VIN is connected to VOUT through a 1kΩ switch. When entering shutdown, VOUT declines to VCC in typically 13ms. Connect SHDN to ground for normal operation. When VCC = 5V, it takes typically 600µs for the output to reach 12V after SHDN goes low (see Figure 2).

## 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 VCC increases above 5V, and the output current decreases, the amount of ripple at VOUT 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

**MAX662/EV Kit**

**Table 1. Capacitor Suppliers**

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

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

## Flash EEPROM Applications

The circuit of Figure 3 is a +12V  $\pm$ 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<sub>PP</sub> supply-voltage pin) rises to +12V to facilitate programming the flash memory. When SHDN is high, the output voltage is connected to V<sub>IN</sub> through an internal 1k $\Omega$  resistor.

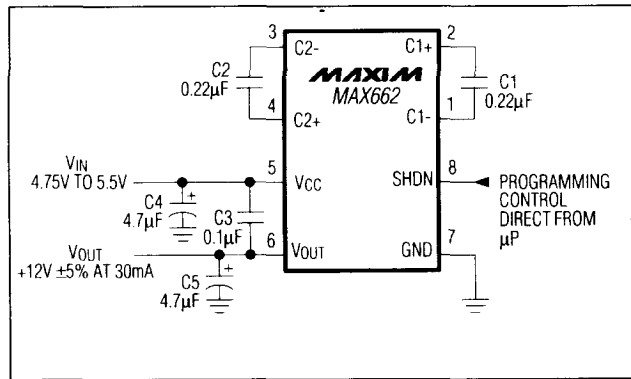


Figure 3. Flash EEPROM programming power supply

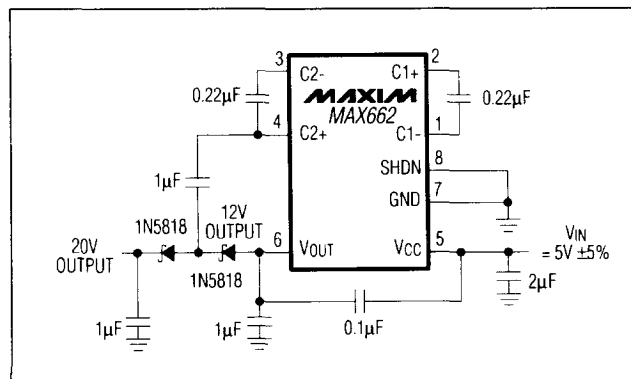


Figure 4. +12V and +20V Dual Supply from a +5V Input

## Paralleling Devices

Two MAX662s can be placed in parallel to increase output drive capability. The V<sub>CC</sub>, V<sub>OUT</sub> 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.

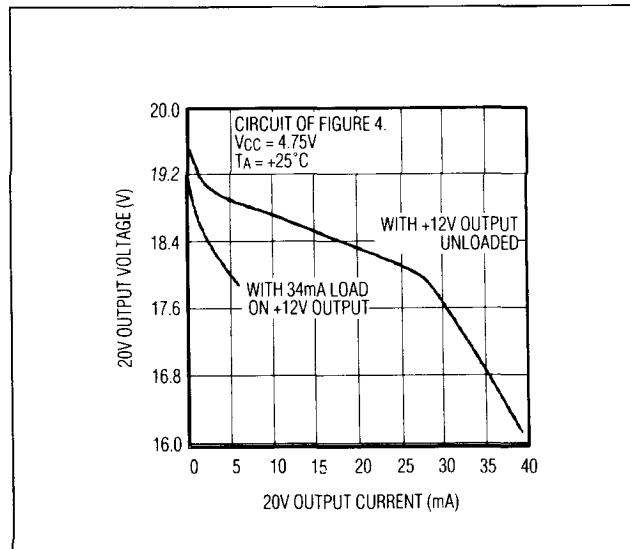


Figure 5. +20V Supply Output Current Capability

# MAX662 Evaluation Kit

## EV Kit General Description

The MAX662 evaluation kit (EV kit) is an assembled surface-mount board that allows easy evaluation of the MAX662. A 3-pin jumper connector and shunt are included, which allow easy control of normal-operation and shutdown modes.

## Operating Instructions

Pin 1 of the 3-pin jumper connector is tied to ground, pin 2 is tied to the SHDN pin of the MAX662, and pin 3 is tied to VCC (see Figure 6). Connect the jumper shunt across pins 1 and 2 of jumper connector J1 for normal operation.

**Note: The MAX662 EV kit will be in shutdown mode if the jumper shunt is not inserted across J1. The SHDN pin has an internal pull-up to VCC, and therefore must be connected to ground for proper operation.** Connect the jumper shunt across jumper connector pins 2 and 3, or simply remove the jumper shunt to observe shutdown-mode operation.

Observe the power-supply input voltage limits specified in the data sheet. Do not short the output to ground. Also, do not excessively load the output – VOUT should not fall below VCC. If the above conditions are violated, the device may be damaged.

## Component List

| DESIGNATION | QTY | DESCRIPTION                              |
|-------------|-----|--|
| C1, C2      | 2   | 0.22 $\mu$ F ceramic SMD chip capacitors |
| C3          | 1   | 0.1 $\mu$ F ceramic SMD chip capacitor   |
| C4, C5      | 2   | 4.7 $\mu$ F low-ESR tantalum capacitors  |
| J1          | 1   | 3-pin jumper                             |
| NONE        | 1   | Shunt                                    |
| U1          | 1   | MAX662CSA                                |
| NONE        | 1   | MAX662 data sheet                        |
| NONE        | 1   | 1.5" x 1.1" printed circuit board        |

## PC Board Layout

The EV kit PC board layouts (Figures 7 and 8) can be copied directly and incorporated into production boards.

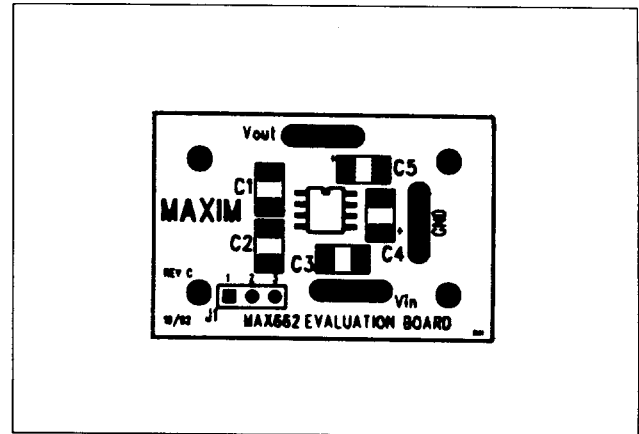


Figure 6. Surface-Mount Component Placement Diagram (1 x Scale)

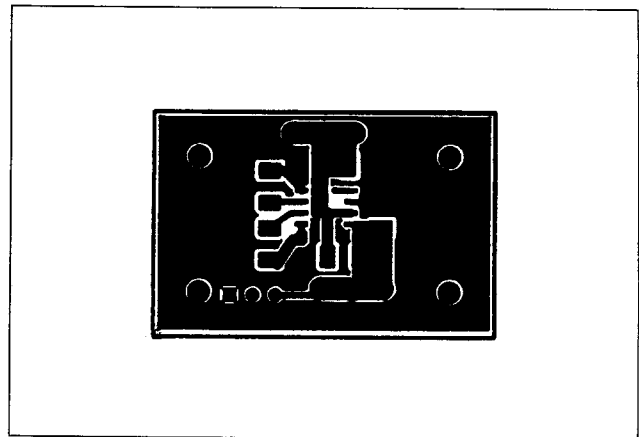


Figure 7. SO Printed-Circuit Layout, Component Side (1 x Scale)

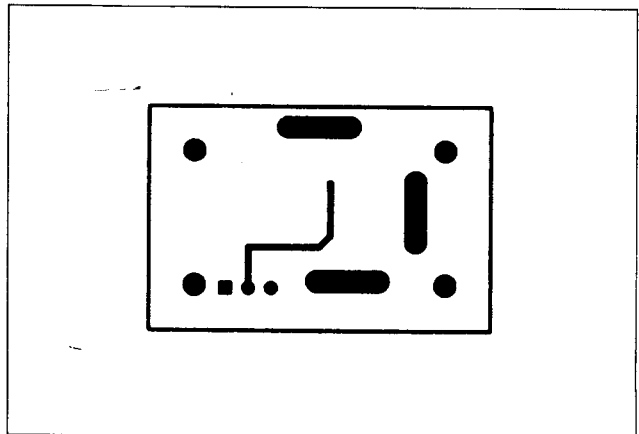
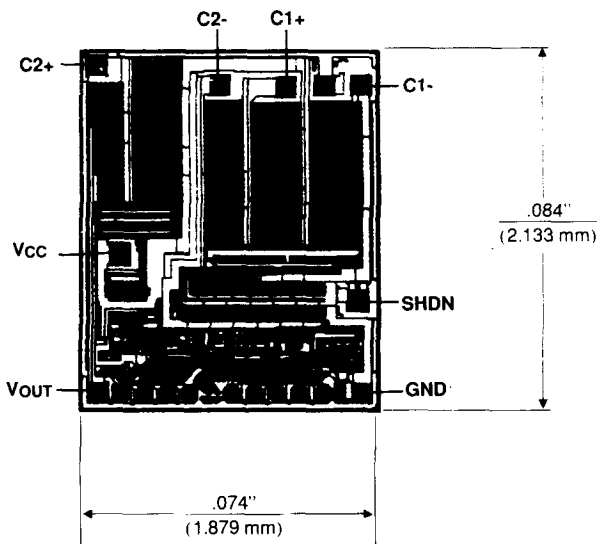


Figure 8. SO Printed-Circuit Layout, Solder Side (1 x Scale)

# MAX662 Evaluation Kit

MAX662/EV Kit

## Chip Topography



SUBSTRATE CONNECTED TO VOUT;  
TRANSISTOR COUNT: 130.

**MAX662/EV Kit**

# **MAX662 Evaluation Kit**

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