



## 3.3V-Input to Regulated 5V-Output Charge Pumps

### General Description

The MAX682/MAX683/MAX684 charge-pump regulators generate 5V from a 2.7V to 5.5V input. They are specifically designed to serve as high-efficiency auxiliary supplies in applications that demand a compact design. The MAX682, MAX683, and MAX684 deliver 250mA, 100mA, and 50mA output current, respectively.

These complete 5V regulators require only one resistor and three external capacitors—no inductors are needed. High switching frequencies (externally adjustable up to 2MHz) and a unique regulation scheme allow the use of capacitors as small as 1 $\mu$ F per 100mA of output current. The MAX683/MAX684 are offered in a space-saving 8-pin  $\mu$ MAX package that is only 1.1mm high, while the MAX682 is available in an 8-pin SO.

### Applications

Flash Memory Supplies  
 Battery-Powered Applications  
 Miniature Equipment  
 PCMCIA Cards  
 3.3V to 5V Local Conversion Applications  
 Backup-Battery Boost Converters  
 3V to 5V GSM SIMM Cards

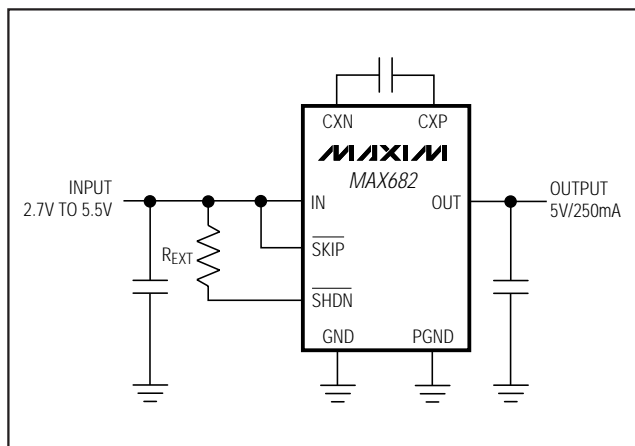
### Features

- ◆ Ultra-Small: 1 $\mu$ F Capacitors per 100mA of Output Current
- ◆ No Inductors Required
- ◆ 1.1mm Height in  $\mu$ MAX Package (MAX683/MAX684)
- ◆ Up to 250mA Output Current (MAX682)
- ◆ Regulated  $\pm$ 4% Output Voltage
- ◆ 50kHz to 2MHz Adjustable Switching Frequency
- ◆ 2.7V to 5.5V Input Voltage
- ◆ 100 $\mu$ A Quiescent Current in Pulse-Skipping Mode
- ◆ 0.1 $\mu$ A Shutdown Current

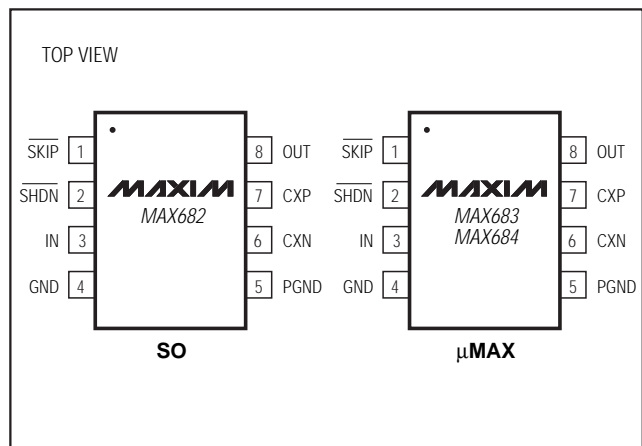
### Ordering Information

| PART      | TEMP. RANGE    | PIN-PACKAGE |
|-----------|----------------|-------------|
| MAX682ESA | -40°C to +85°C | 8 SO        |
| MAX683EUA | -40°C to +85°C | 8 $\mu$ MAX |
| MAX684EUA | -40°C to +85°C | 8 $\mu$ MAX |

### Typical Operating Circuit



### Pin Configurations



# 3.3V-Input to Regulated 5V-Output Charge Pumps

## ABSOLUTE MAXIMUM RATINGS

|   |   |  |
|---|---|--|
| IN, OUT, $\overline{\text{SHDN}}$ , $\overline{\text{SKIP}}$ to GND ..... | -0.3V to +6V                                | Continuous Power Dissipation ( $T_A = +70^\circ\text{C}$ )                             |
| PGND to GND .....   | $\pm 0.3\text{V}$                           | 8-Pin SO (derate 5.9mW/ $^\circ\text{C}$ above $+70^\circ\text{C}$ ).....              |
| CXN to GND .....  | -0.3V to ( $V_{\text{IN}} + 0.3\text{V}$ )  | 8-Pin $\mu\text{MAX}$ (derate 4.1mW/ $^\circ\text{C}$ above $+70^\circ\text{C}$ )..... |
| CXP to GND .....  | -0.3V to ( $V_{\text{OUT}} + 0.3\text{V}$ ) | Operating Temperature Range  |
| Continuous Output Current   |   | MAX68_E_A .....  |
| MAX682 .....  | 300mA                                       | Junction Temperature .....   |
| MAX683 .....  | 150mA                                       | Storage Temperature Range .....  |
| MAX684 .....  | 75mA  | Lead Temperature (soldering, 10sec) .....  |
| Output Short-Circuit Duration .....                                       | 5sec  |  |

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

( $V_{\text{IN}} = 3\text{V}$ ,  $V_{\overline{\text{SKIP}}} = 0\text{V}$ ,  $C_{\text{IN}} = 1\mu\text{F}$ ,  $C_X = 0.47\mu\text{F}$ ,  $C_{\text{OUT}} = 2\mu\text{F}$ ,  $I_{\overline{\text{SHDN}}} = 22\mu\text{A}$ ;  $I_{\text{MAX}} = 250\text{mA}$  for MAX682,  $I_{\text{MAX}} = 100\text{mA}$  for MAX683,  $I_{\text{MAX}} = 50\text{mA}$  for MAX684;  $T_A = T_{\text{MIN}}$  to  $T_{\text{MAX}}$ , unless otherwise noted. Typical values are at  $T_A = +25^\circ\text{C}$ .) (Note 1)

| PARAMETER                                    | SYMBOL                       | CONDITIONS  | MIN   | TYP  | MAX  | UNITS         |     |
|--|------------------------------|---|---|------|------|---------------|-----|
| Input Voltage Range                          | $V_{\text{IN}}$              | Regulation with $V_{\text{IN}} > 3.6\text{V}$ requires $\overline{\text{SKIP}} = \text{high}$   | 2.7   |      | 5.5  | V             |     |
| Input Undervoltage Lockout Threshold         |                              |   | 2.0   | 2.35 | 2.6  | V             |     |
| Input Undervoltage Lockout Hysteresis        |                              |   |   | 100  |      | mV            |     |
| Output Voltage                               | $V_{\text{OUT}}$             | $0 < I_{\text{LOAD}} \leq I_{\text{MAX}}$ :<br>$3.0\text{V} \leq I_{\text{N}} \leq 3.6\text{V}$ for $\overline{\text{SKIP}} = 0$ ,<br>$3.0\text{V} \leq I_{\text{N}} \leq 5.5\text{V}$ for $\overline{\text{SKIP}} = \text{IN}$ | 4.80  | 5.05 | 5.20 | V             |     |
| Maximum Output Current                       | $I_{\text{MAX}}$             | MAX682  | 250   |      |      | mA            |     |
|  |                              | MAX683  | 100   |      |      |               |     |
|  |                              | MAX684  | 50  |      |      |               |     |
| No-Load Input Current                        | $I_{\text{Q}}$               | $\overline{\text{SKIP}} = 0$ , $V_{\text{IN}} = 3.6\text{V}$  |   | 0.1  | 0.18 | mA            |     |
|  |                              | $\overline{\text{SKIP}} = V_{\text{IN}} = 3.6\text{V}$  | MAX682  | 7.5  |      |               |     |
|  |                              |   | MAX683  | 2.5  |      |               |     |
|  |                              | MAX684  | 1.7   |      |      |               |     |
| Load Regulation                              | $\Delta V_{\text{LDR}}$      | $\overline{\text{SKIP}} = \text{high}$ , $0 \leq I_{\text{LOAD}} \leq I_{\text{MAX}}$   |   | -3   |      | %             |     |
| $\overline{\text{SHDN}}$ Logic Low Input     | $V_{\text{INL, SHDN}}$       |   |   |      | 0.35 | V             |     |
| $\overline{\text{SHDN}}$ On Bias Voltage     | $V_{\text{ON, SHDN}}$        | $T_A = +25^\circ\text{C}$   | 630   | 690  | 750  | mV            |     |
| $\overline{\text{SHDN}}$ Input Current Range | $I_{\overline{\text{SHDN}}}$ | (Note 2)  | 1   |      | 50   | $\mu\text{A}$ |     |
| Switching Frequency (Note 2)                 |                              | $I_{\overline{\text{SHDN}}} = 22\mu\text{A}$  | $0^\circ\text{C} < T_A < +85^\circ\text{C}$   | 850  | 1000 | 1200          | kHz |
|  |                              |   | $-40^\circ\text{C} < T_A < +85^\circ\text{C}$ | 750  | 1000 | 1300          |     |
|  |                              | $I_{\overline{\text{SHDN}}} = 4.4\mu\text{A}$   | $0^\circ\text{C} < T_A < +85^\circ\text{C}$   | 160  | 200  | 250           |     |
|  |                              |   | $-40^\circ\text{C} < T_A < +85^\circ\text{C}$ | 150  | 200  | 270           |     |
| Shutdown Supply Current                      | $I_{\text{Q, SHDN}}$         | $\overline{\text{SHDN}} = 0$ , $V_{\text{IN}} = 5.5\text{V}$ , $V_{\text{OUT}} = 0$   |   | 0.1  | 5    | $\mu\text{A}$ |     |
| Shutdown Exit Time                           | $t_{\text{START}}$           | $R_L = 5\text{V}/I_{\text{MAX}}$  |   | 50   |      | $\mu\text{s}$ |     |

# 3.3V-Input to Regulated 5V-Output Charge Pumps

MAX682/MAX683/MAX684

## ELECTRICAL CHARACTERISTICS (continued)

( $V_{IN} = 3V$ ,  $V_{SKIP} = 0V$ ,  $C_{IN} = 1\mu F$ ,  $C_X = 0.47\mu F$ ,  $C_{OUT} = 2\mu F$ ,  $I_{SHDN} = 22\mu A$ ;  $I_{MAX} = 250mA$  for MAX682,  $I_{MAX} = 100mA$  for MAX683,  $I_{MAX} = 50mA$  for MAX684;  $T_A = T_{MIN}$  to  $T_{MAX}$ , unless otherwise noted. Typical values are at  $T_A = +25^\circ C$ .) (Note 1)

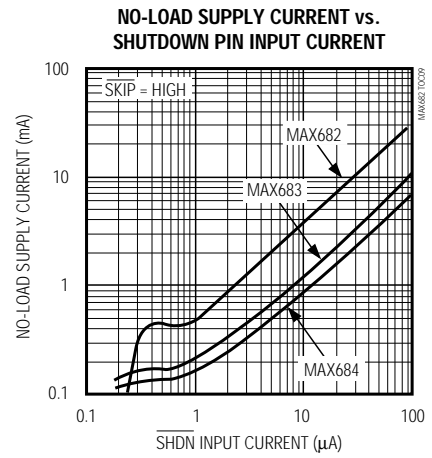
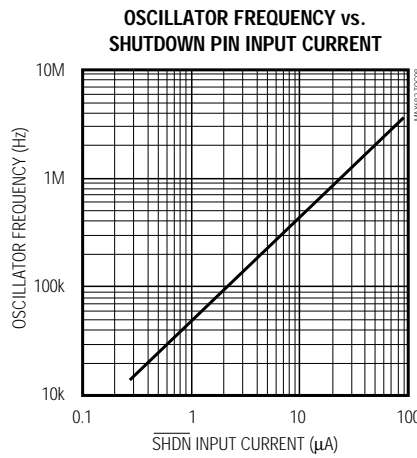
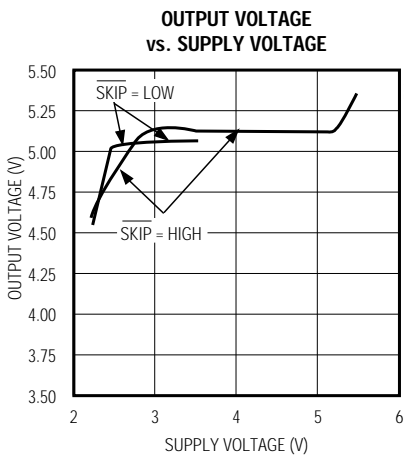
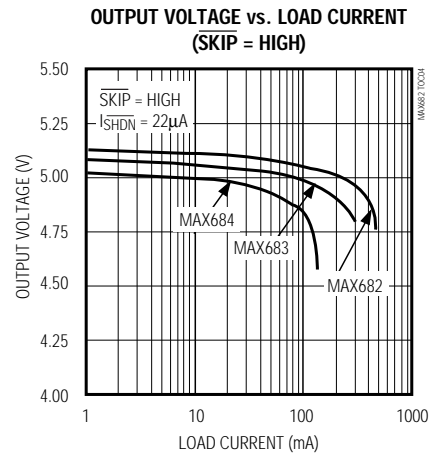
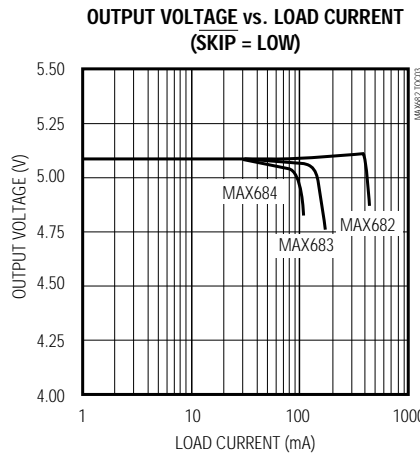
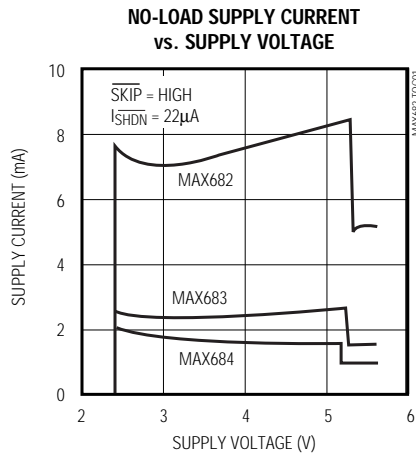
| PARAMETER                  | SYMBOL          | CONDITIONS                                  | MIN | TYP | MAX | UNITS   |
|----------------------------|-----------------|---|-----|-----|-----|---------|
| SKIP Input Voltage Low     | $V_{INL, SKIP}$ |   |     |     | 0.8 | V       |
| SKIP Input Voltage High    | $V_{INH, SKIP}$ | $V_{IN} = 5.5V$                             | 2.4 |     |     |         |
| SKIP Input Leakage Current | $I_{SKIP}$      | $V_{IN} = 5.5V$ , $V_{SKIP} = 0V$ or $5.5V$ | -1  |     | 1   | $\mu A$ |

**Note 1:** Specifications to  $-40^\circ C$  are guaranteed by design and not production tested.

**Note 2:** Current into SHDN determines oscillator frequency:  $R_{EXT} (k\Omega) = 45000 (V_{IN} - 0.69V) / f_{OSC} (kHz)$

## Typical Operating Characteristics

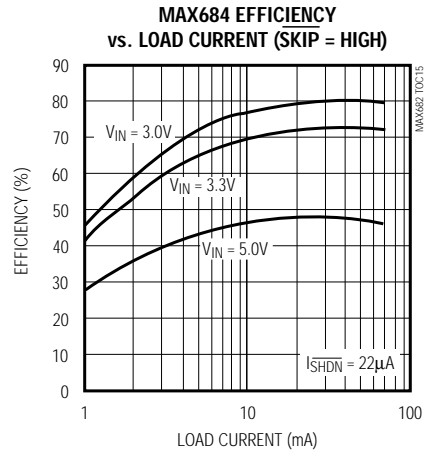
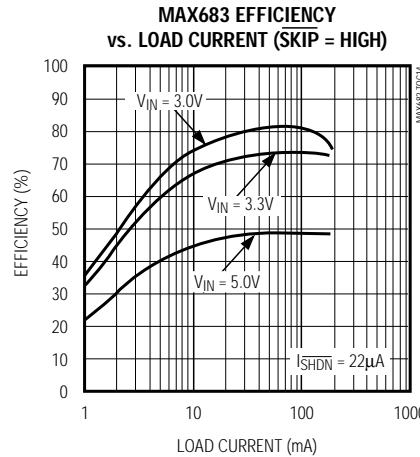
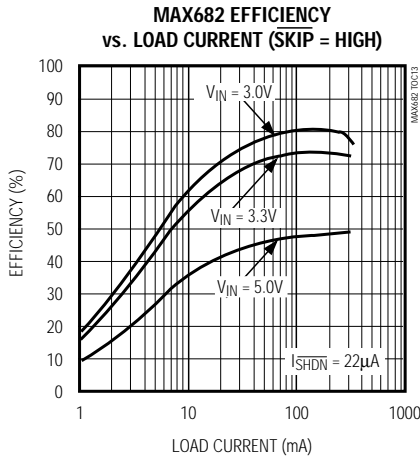
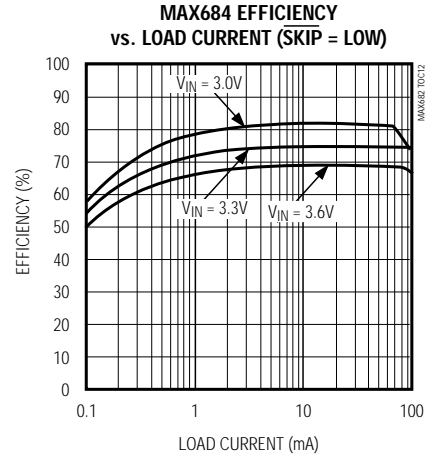
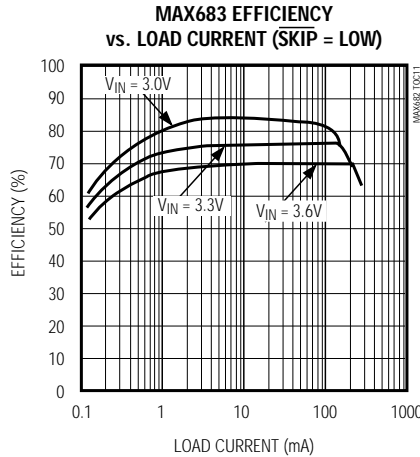
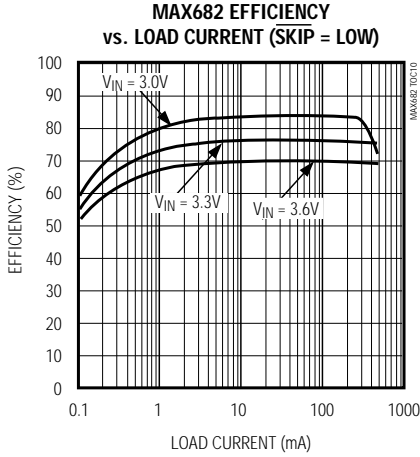
(Circuit of Figure 5,  $V_{IN} = 3.3V$ , component values from Tables 2 and 3,  $T_A = +25^\circ C$ , unless otherwise noted.)



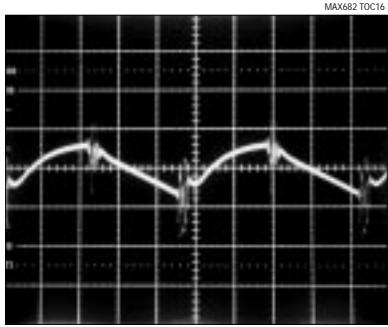
# 3.3V-Input to Regulated 5V-Output Charge Pumps

## Typical Operating Characteristics (continued)

(Circuit of Figure 5,  $V_{IN} = 3.3V$ , component values from Tables 2 and 3,  $T_A = +25^\circ C$ , unless otherwise noted.)

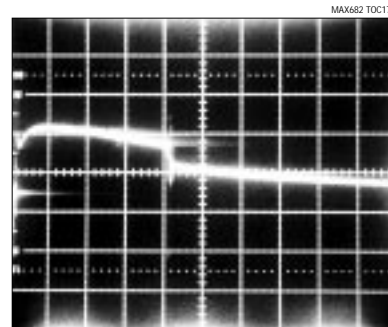


**OUTPUT WAVEFORM (SKIP = HIGH)**



SKIP = HIGH,  $I_{SHDN} = 22\mu A$ ,  $I_{LOAD} = 250mA$ , MAX682

**OUTPUT WAVEFORM (SKIP = LOW)**



SKIP = LOW,  $I_{LOAD} = 250mA$ , MAX682

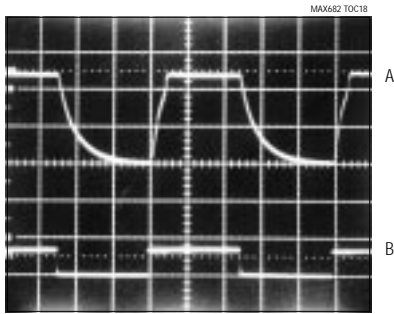
# 3.3V-Input to Regulated 5V-Output Charge Pumps

MAX682/MAX683/MAX684

## Typical Operating Characteristics (continued)

(Circuit of Figure 5,  $V_{IN} = 3.3V$ , component values from Tables 2 and 3,  $T_A = +25^\circ C$ , unless otherwise noted.)

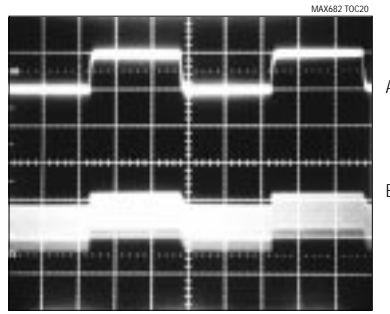
**SHUTDOWN TIMING**



100 $\mu$ s/div

A: OUTPUT VOLTAGE:  $\overline{SKIP} = \text{HIGH}$ ,  $R_L = 5V / I_{MAX}$ , 2V/div  
B:  $\overline{SHDN}$  VOLTAGE: 1V/div

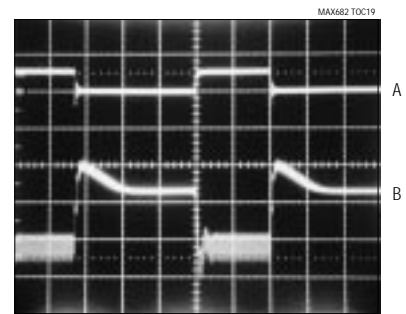
**LINE-TRANSIENT RESPONSE**



2ms/div

A: INPUT VOLTAGE:  $V_{IN} = 3.1V$  TO  $3.6V$ , 500mV/div  
B: OUTPUT VOLTAGE:  $\overline{SKIP} = \text{HIGH}$ ,  $I_{SHDN} = 22\mu A$ ,  
 $I_{LOAD} = 250mA$ , 50mV/div, MAX682

**LOAD-TRANSIENT RESPONSE**



2ms/div

A: LOAD CURRENT:  $I_{LOAD} = 5mA$  TO  $250mA$ , 500mA/div  
B: OUTPUT VOLTAGE:  $\overline{SKIP} = \text{HIGH}$ ,  $I_{SHDN} = 22\mu A$ ,  
100mV/div, MAX682

## Pin Description

| PIN | NAME              | FUNCTION   |
|-----|-------------------|--|
| 1   | $\overline{SKIP}$ | When $\overline{SKIP} = \text{low}$ , the regulator operates in low-quiescent-current skip mode. When $\overline{SKIP} = \text{high}$ , the regulator operates in constant-frequency mode, minimizing output ripple and noise. $\overline{SKIP}$ must be tied high for input voltages above 3.6V.  |
| 2   | $\overline{SHDN}$ | Shutdown Input. Drive $\overline{SHDN}$ through an external resistor. When $\overline{SHDN} = \text{low}$ , the device turns off. When current is sourced into $\overline{SHDN}$ through $R_{EXT}$ , the device activates, and the $\overline{SHDN}$ pin input current sets the oscillator's switching frequency. $R_{EXT} (k\Omega) = 45000 (V_{IN} - 0.69V) / f_{OSC} (kHz)$ . |
| 3   | IN                | Input Supply Pin. Can range from 2.7V to 5.5V for $\overline{SKIP} = \text{high}$ , and 2.7V to 3.6V for $\overline{SKIP} = \text{low}$ . Bypass to PGND with a suitable value capacitor (see <i>Capacitor Selection</i> section).   |
| 4   | GND               | Ground Pin. Connect to PGND through a short trace.   |
| 5   | PGND              | Power Ground Pin   |
| 6   | CXN               | Negative Terminal of the Charge-Pump Transfer Capacitor  |
| 7   | CXP               | Positive Terminal of the Charge-Pump Transfer Capacitor  |
| 8   | OUT               | Fixed 5V Power Output. Bypass to PGND with output filter capacitor.  |

# 3.3V-Input to Regulated 5V-Output Charge Pumps

## Detailed Description

The MAX682/MAX683/MAX684 charge pumps provide a regulated 5V output from a 2.7V to 5.5V input. They deliver a maximum of 250mA, 100mA, or 50mA load current, respectively. Designed specifically for compact applications, a complete regulator circuit requires only three small external capacitors and one resistor. An externally adjustable switching frequency and innovative control scheme allow the circuit to be optimized for efficiency, size, or output noise. The devices also contain a shutdown feature.

The MAX682/MAX683/MAX684 consist of an error amplifier, a 1.23V bandgap reference, an internal resistive feedback network, an oscillator, high-current MOSFET switches, and shutdown and control logic (Figure 1). Figure 2 shows an idealized unregulated charge-pump voltage doubler. The oscillator runs at a 50% duty cycle. During one half of the period, the transfer capacitor ( $C_x$ ) charges to the input voltage. During the other half, the doubler stacks the voltage across  $C_x$  and the input voltage, and transfers the sum of the two voltages to the output filter capacitor ( $C_{OUT}$ ). Rather than simply doubling the input voltage, the MAX682/MAX683/MAX684 provide a regulated fixed output voltage (5V) using either skip mode or constant-frequency mode. Skip mode and constant-frequency mode are externally selected via the SKIP input pin.

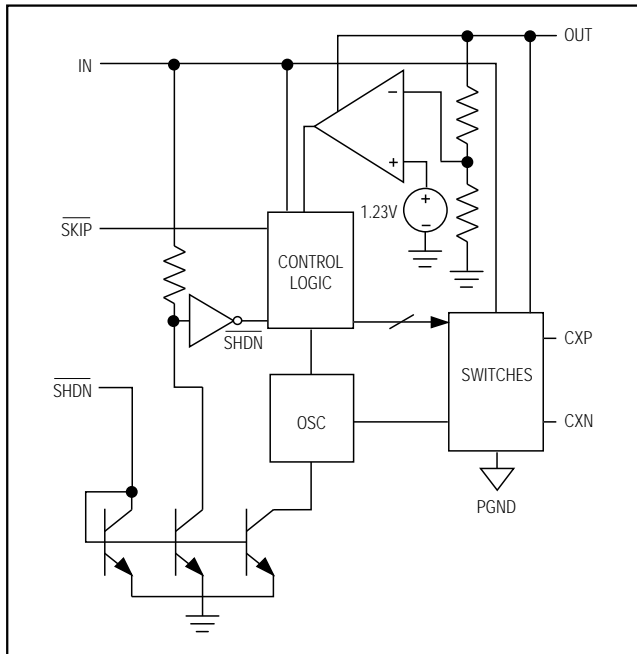


Figure 1. Functional Block Diagram

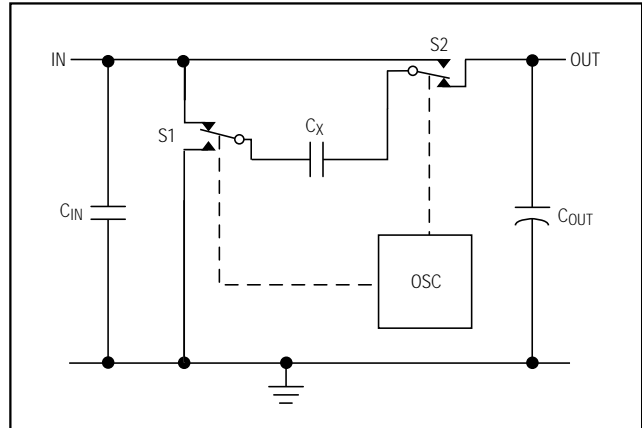


Figure 2. Unregulated Voltage Doubler

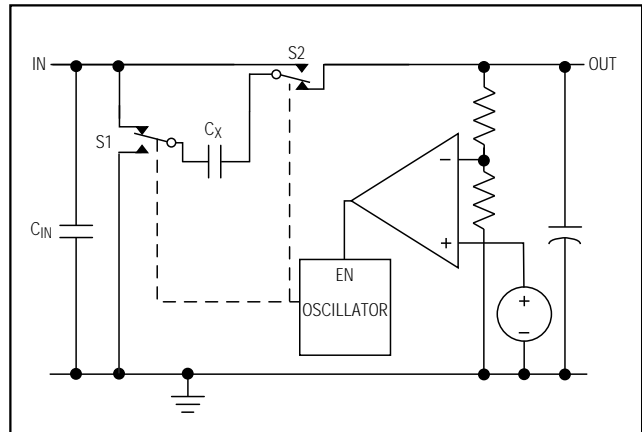


Figure 3. Skip-Mode Regulation

### Skip Mode

In skip mode ( $\overline{\text{SKIP}} = \text{low}$ ), the error amplifier disables switching when it detects an output higher than 5V. The device then skips switching cycles until the output voltage drops. Then the error amplifier reactivates the oscillator. Figure 3 illustrates the regulation scheme. This regulation method minimizes operating current because the device does not switch continuously. SKIP is a logic input and should not remain floating.

### Constant-Frequency Mode

When  $\overline{\text{SKIP}}$  is high, the charge pump runs continuously at the selected frequency. Figure 4 shows a block diagram of the device in constant-frequency mode. The error amplifier controls the charge on  $C_x$  by driving the gate of the N-channel FET. When the output voltage falls, the gate drive increases, resulting in a larger voltage across  $C_x$ . This regulation scheme minimizes output ripple. Since the device switches continuously, the

## 3.3V-Input to Regulated 5V-Output Charge Pumps

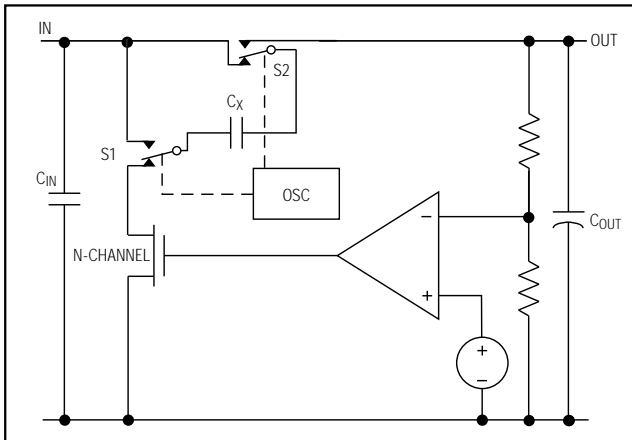


Figure 4. Constant-Frequency-Mode Regulation

**Table 1. Tradeoffs Between Operating Modes**

| FEATURE                               | SKIP MODE<br>(SKIP = LOW)                      | CONSTANT-FREQUENCY MODE<br>(SKIP = HIGH)       |
|---------------------------------------|--|--|
| Best Light-Load Efficiency            | ✓  |  |
| Smallest External Component Size      |  | ✓  |
| Output Ripple Amplitude and Frequency | Relatively large amplitude, variable frequency | Relatively small amplitude, constant frequency |
| Load Regulation                       | Very Good                                      | Good   |

output noise contains well-defined frequency components, and the circuit requires much smaller external capacitors for a given output ripple. However, constant-frequency mode, due to higher operating current, is less efficient at light loads than skip mode. Note: For input voltages above 3.6V, the devices must operate in constant-frequency mode. Table 1 summarizes the tradeoffs between the two operating modes.

### Frequency Selection and Shutdown

The  $\overline{\text{SHDN}}$  pin on the MAX682/MAX683/MAX684 performs a dual function: it shuts down the device and determines the oscillator frequency. The  $\overline{\text{SHDN}}$  input looks like a diode to ground and should be driven through a resistor.

Driving  $\overline{\text{SHDN}}$  low places the device in shutdown mode. This disables all switches, the oscillator, and control logic. The device typically draws 0.1 $\mu\text{A}$  (5 $\mu\text{A}$

max) of supply current in this mode and the output presents a 50k $\Omega$  impedance to ground. The device exits shutdown once  $\overline{\text{SHDN}}$  is forward biased (minimum of 1 $\mu\text{A}$  of current). The typical no-load shutdown exit time is 50 $\mu\text{s}$ .

When  $\overline{\text{SHDN}}$  is pulled high through an external resistor to  $V_{\text{IN}}$ , the bias current into  $\overline{\text{SHDN}}$  determines the charge-pump frequency. To select the frequency, calculate the external resistor value,  $R_{\text{EXT}}$ , using the following formula:

$$R_{\text{EXT}} = 45000 (V_{\text{IN}} - 0.69\text{V}) / f_{\text{OSC}}$$

where  $R_{\text{EXT}}$  is in k $\Omega$  and  $f_{\text{OSC}}$  is in kHz. Program the frequency in the 50kHz to 2MHz range. This frequency range corresponds to  $\overline{\text{SHDN}}$  input currents between 1 $\mu\text{A}$  and 50 $\mu\text{A}$ . Proper operation of the oscillator is not guaranteed beyond these limits. Currents lower than 1 $\mu\text{A}$  may shut down the device. The forward-biased diode voltage from the  $\overline{\text{SHDN}}$  input to GND has a temperature coefficient of -2mV/ $^{\circ}\text{C}$ .

### Undervoltage Lockout

The MAX682/MAX683/MAX684 have an undervoltage-lockout feature that deactivates the devices when the input voltage falls below 2.25V. Regulation at low input voltages cannot be maintained. This safety feature ensures that the device shuts down before the output voltage falls out of regulation by a considerable amount (typically 10% with no load). Once deactivated, hysteresis holds the device in shutdown until the input voltage rises 100mV above the lockout threshold.

## Applications Information

### Capacitor Selection

The MAX682/MAX683/MAX684 require only three external capacitors (Figure 5). Their values are closely linked to the output current capacity, oscillator frequency, output noise content, and mode of operation.

Generally, the transfer capacitor ( $C_X$ ) will be the smallest, and the input capacitor ( $C_{\text{IN}}$ ) is twice as large as  $C_X$ . Higher switching frequencies allow the use of smaller  $C_X$  and  $C_{\text{IN}}$ . The output capacitor ( $C_{\text{OUT}}$ ) can be anywhere from 5-times to 50-times larger than  $C_X$ , depending on the mode of operation and ripple tolerance. In continuous switching mode, smaller output ripple allows smaller  $C_{\text{OUT}}$ . In skip mode, a larger  $C_{\text{OUT}}$  is required to maintain low output ripple. Tables 2 and 3 show capacitor values recommended for lowest supply-current operation (skip mode) and smallest size operation (constant-frequency mode), respectively.

## 3.3V-Input to Regulated 5V-Output Charge Pumps

**Table 2. Recommended Capacitor Values for Quiescent Current (Skip Mode)**

| PART   | OUTPUT (mA) | C <sub>IN</sub> (μF) | C <sub>X</sub> (μF) | C <sub>OUT</sub> (μF) |         | V <sub>OUT</sub> RIPPLE (mV) |
|--------|-------------|----------------------|---------------------|-----------------------|---------|------------------------------|
|        |             |                      |                     | TANTALUM              | CERAMIC |                              |
| MAX682 | 250         | 2.2                  | 1                   | 47                    | 10      | 100                          |
| MAX683 | 100         | 1                    | 0.47                | 22                    | 4.7     | 100                          |
| MAX684 | 50          | 0.47                 | 0.22                | 10                    | 2.2     | 100                          |

**Table 3. Recommended Capacitor Values for Smallest Size (Constant-Frequency Mode, I<sub>SHDN</sub> = 22μA, 1MHz)**

| PART   | OUTPUT (mA) | C <sub>IN</sub> (μF) | C <sub>X</sub> (μF) | CERAMIC C <sub>OUT</sub> (μF) | V <sub>OUT</sub> RIPPLE (mV) |
|--------|-------------|----------------------|---------------------|-------------------------------|------------------------------|
| MAX682 | 250         | 1                    | 0.47                | 2.2                           | 80                           |
| MAX683 | 100         | 0.47                 | 0.22                | 1                             | 80                           |
| MAX684 | 50          | 0.22                 | 0.1                 | 0.47                          | 80                           |

**Table 4. Recommended Capacitor Manufacturers**

| VALUE          | DESCRIPTION                        | MANUFACTURER | PHONE NUMBER   |
|----------------|------------------------------------|--------------|----------------|
| 47μF to 10μF   | 595D-series tantalum surface mount | Sprague      | (603) 224-1961 |
| 47μF to 10μF   | TPS-series surface mount           | AVX          | (803) 946-0690 |
| 0.1μF to 2.2μF | Ceramic surface mount              | TDK          | (847) 390-4373 |

In addition, the following two equations approximate output ripple for each mode. In skip mode, output ripple is dominated by ESR, and is approximately:

$$V_{\text{RIPPLE(SKIP)}} \approx (2V_{\text{IN}} - V_{\text{OUT}}) \text{ESR}_{\text{COUT}} / R_{\text{TX}}$$

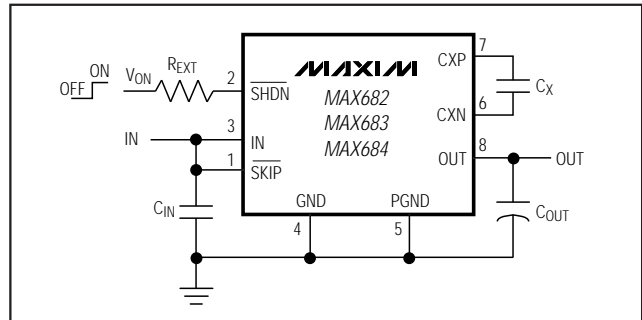


Figure 5. Standard Operating Circuit

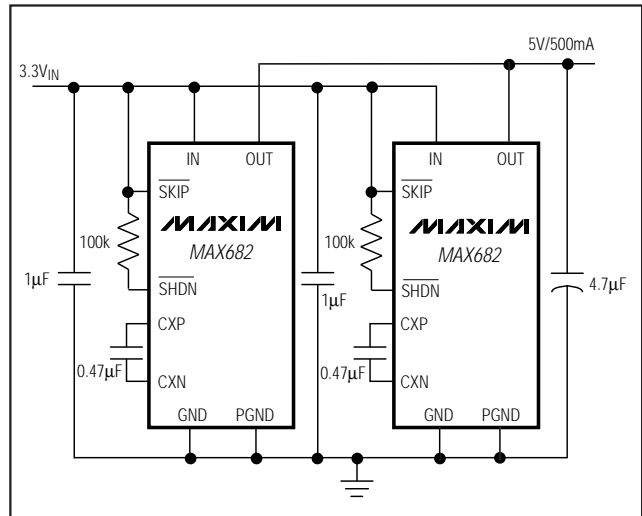


Figure 6. Paralleling Two MAX682s

where  $\text{ESR}_{\text{COUT}}$  is the ESR of the output filter capacitance, and  $R_{\text{TX}}$  is the open-loop output transfer resistance of the IC.  $R_{\text{TX}}$  is typically  $0.8\Omega$  for the MAX682,  $1.6\Omega$  for the MAX683, and  $3\Omega$  for the MAX684. In constant-frequency mode, output ripple is dominated by  $\text{C}_{\text{OUT}}$  and is approximately:

$$V_{\text{RIPPLE(const-freq)}} \approx I_{\text{OUT}} / (2 \times f_{\text{OSC}} \times \text{C}_{\text{OUT}})$$

All capacitors must maintain a low ( $<100\text{m}\Omega$ ) equivalent series resistance (ESR). Table 4 lists the manufacturers of recommended capacitors. Surface-mount tantalum capacitors will work well for most applications. Ceramic capacitors will provide the lowest ripple due to their typically lower ESR.

If the source impedance or inductance of the input supply is large, additional input bypassing ( $2.2\mu\text{F}$  to  $22\mu\text{F}$ ) may be needed. This additional capacitance need not be a low-ESR type.



# 3.3V-Input to Regulated 5V-Output Charge Pumps

## Power Dissipation

The power dissipated in the MAX682/MAX683/MAX684 depends on output current and is accurately described by:

$$P_{DISS} = I_{OUT} (2V_{IN} - V_{OUT})$$

$P_{DISS}$  must be less than that allowed by the package rating. See the *Absolute Maximum Ratings* for 8-pin  $\mu$ MAX (MAX683/MAX684) and SO (MAX682) power-dissipation limits and deratings.

## Layout Considerations

All capacitors should be soldered in close proximity to the IC. Connect ground and power ground through a short, low-impedance trace. If a high-value resistor is driving the shutdown input and is picking up noise (i.e., frequency jitter at CXP and CXN), bypass  $\overline{SHDN}$  to GND with a small capacitor (0.01 $\mu$ F).

## Paralleling Devices

The MAX682/MAX683/MAX684 can be paralleled to yield higher load currents. The circuit of Figure 6 can deliver 500mA at 5V. It uses two MAX682s in parallel. The devices can share the output capacitors, but each one requires its own transfer capacitor ( $C_X$ ) and input capacitor. For best performance, the paralleled devices should operate in the same mode (skip or constant frequency).

## Chip Information

TRANSISTOR COUNT: 659

SUBSTRATE CONNECTED TO GND

## Package Information

|          | INCHES |       | MILLIMETERS |      |
|----------|--------|-------|-------------|------|
|          | MIN    | MAX   | MIN         | MAX  |
| A        | 0.036  | 0.044 | 0.91        | 1.11 |
| A1       | 0.004  | 0.008 | 0.10        | 0.20 |
| B        | 0.010  | 0.014 | 0.25        | 0.36 |
| C        | 0.005  | 0.007 | 0.13        | 0.18 |
| D        | 0.116  | 0.120 | 2.95        | 3.05 |
| e        | 0.0256 |       | 0.65        |      |
| E        | 0.116  | 0.120 | 2.95        | 3.05 |
| H        | 0.188  | 0.198 | 4.78        | 5.03 |
| L        | 0.016  | 0.026 | 0.41        | 0.66 |
| $\alpha$ | 0°     | 6°    | 0°          | 6°   |

NOTES:  
 1. D&E DO NOT INCLUDE MOLD FLASH.  
 2. MOLD FLASH OR PROTRUSIONS NOT TO EXCEED .15mm(.006").  
 3. CONTROLLING DIMENSION: INCHES

**MAXIM**  
 PROPRIETARY INFORMATION  
 TITLE:  
 8LD  $\mu$ MAX PACKAGE OUTLINE DWG.  
 APPROVAL: \_\_\_\_\_ DOCUMENT CONTROL NO: 21-0036 REV: D 1/1

MAX682/MAX683/MAX684

# 3.3V-Input to Regulated 5V-Output Charge Pumps

## 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**  
 1250 AVENUE OF THE SCIENCES, FORT LEWIS, CO 80504  
 PROPRIETARY INFORMATION

PACKAGE FAMILY OUTLINE: SOIC .150"  $\frac{1}{1}$

21-0041 A  
 DOCUMENT CONTROL NUMBER REV

## *3.3V-Input to Regulated 5V-Output Charge Pumps*

### NOTES

MAX682/MAX683/MAX684

# 3.3V-Input to Regulated 5V-Output Charge Pumps

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## NOTES

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