

# STANDARD POWER PRODUCTS

*Selector Guide*

Fall 2016

## Buck Regulators, Boost Regulators and LDOs

Whether you are designing a medical device, a sensor, a programmable logic controller, or a portable, battery powered product, you will certainly need power in your system. Fortunately, Maxim's power components can turn the "must have" power supply circuit into a tangible advantage by reducing heat dissipation, decreasing circuit size, and extending battery life. Explore our product line, featured technology, and customer stories to understand why so many engineers are using Maxim. Then, find the part that works right for you.

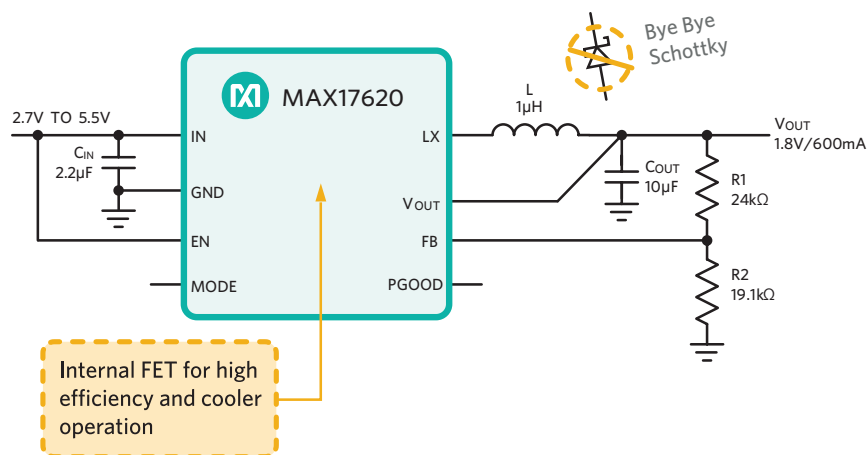
# HIGH-EFFICIENCY BUCK REGULATORS

Our robust portfolio of high efficiency, high integration, and wide temperature range step-down switching regulators offers solutions for a variety of applications including industrial, portable, and low-power applications.

## FEATURES AND BENEFITS

- Get superior conversion efficiency with “no-Schottky” synchronous operation
- Shrink component size and get fast transient response with high switching frequency
- Obtain high efficiency even for light loads with multi-mode operation
- Ensure reliable operation through EN55022 compliance

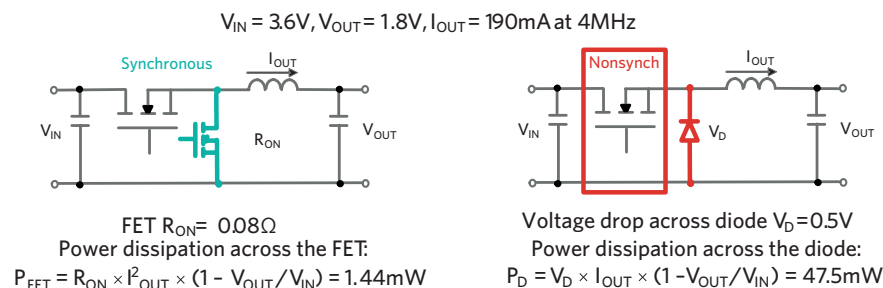
## TYPICAL APPLICATION CIRCUIT



## DESIGN TIP

Synchronous step-down regulators are a great choice for sensitive power designs that require a small battery for the power source. These devices provide much higher efficiency, reducing heat dissipation and improving battery life.

Here is a quick power loss calculation to compare synchronous versus nonsynchronous solutions.



As you can see, the synchronous solution reduces the power loss in the rectification diode by a factor of 33!

## CUSTOMER INSIGHT

The **MAX17620** buck converter has been designed into many top-selling consumer products by major name brand companies. “Due to its high switching frequency, synchronous design with internal FET, and PWM/skip mode feature, the **MAX17620** was the best choice for our battery-powered devices or point of load,” said one company. Customers like the fact that the synchronous design with internal FET makes this buck converter very efficient, which also means lower heat dissipation in the final products.

## BUCK REGULATORS WITH >90% EFFICIENCY

| Product    | Switch Type | $V_{IN}$ (min) (V) | $V_{IN}$ (max) (V) | $V_{OUT}$ (min) (V) | $V_{OUT}$ (max) (V)  | $I_{OUT}$ (A) | $F_{SW}$ (kHz)        | $I_Q$      | No. of Outputs | Peak Efficiency | Package       |
|------------|-------------|--------------------|--------------------|---------------------|----------------------|---------------|-----------------------|------------|----------------|-----------------|---------------|
| MAX17620   | Internal    | 2.7                | 5.5                | 1.5                 | $V_{IN}$             | 0.6           | 4000                  | 40 $\mu$ A | 1              | 91%             | 8-TDFN        |
| MAX17509   | Internal    | 4.5                | 16                 | 0.9                 | 5                    | 3             | 1000, 500, 1500, 2000 | 1mA        | 2              | 94%             | 32-TQFN       |
| MAX1836/7  | Internal    | 4.5                | 24                 | 1.25                | $V_{IN}$             | 0.125/0.25    | 200                   | 12 $\mu$ A | 1              | 94%             | 6-TDFN, 6-SOT |
| MAX15023   | External    | 4.5                | 28                 | 0.6                 | $0.85 \times V_{IN}$ | 12            | 200 to 1000           | 4.5mA      | 2              | 93%             | 24-TQFN       |
| MAX15026   | External    | 4.5                | 28                 | 0.6                 | $0.85 \times V_{IN}$ | 25            | 200 to 2000           | 1.75mA     | 1              | 90%             | 14-TDFN       |
| MAX15048/9 | External    | 4.7                | 23                 | 0.6                 | $V_{IN}$             | 15            | 200 to 1200           | 6mA        | 3              | 95%             | 32-TDFN       |

## FEATURED TECHNOLOGY

Many electronic devices require two or more separate, stable and precisely regulated supply voltages. For example, microprocessors require a precise supply voltage of 3.3V or less, together with a conventional supply voltage of 5V. Integration of multiple converters into a single device helps to reduce BOM cost and PCB board space. Although device sizes are decreasing, increasingly higher power and higher operating efficiency are being required. One problem that can arise when using multiple switching power supplies is high RMS current draw during the ramping cycle, which occurs when the switching frequencies are in-phase. Phase shifting is a technique used to help reduce this high current draw while reducing electromagnetic interference (EMI).

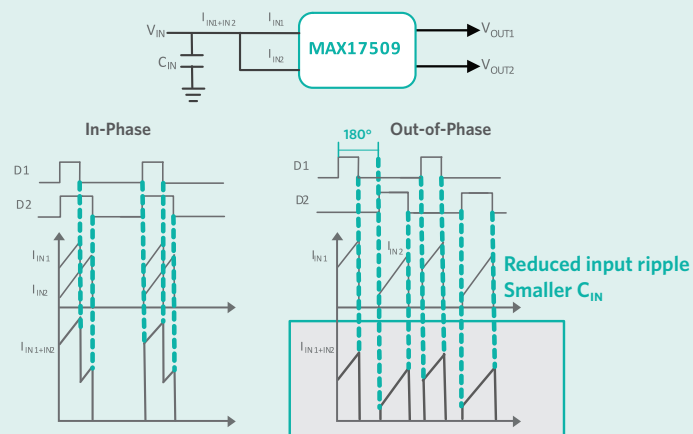
Phase shifting of multiple converters prevents "ON" time overlap and reduces RMS current, ripple and input capacitor requirements, which will improve system EMI and power efficiency. This approach also eliminates the need for high input filtering.

The MAX17509 dual output, step-down DC-DC converter offers the option to set the relative PWM phase-shift between the regulators to be in-phase (0°) or interleaved (180° out-of-phase). During in-phase operation, both regulators' low-side MOSFETs turn on at the same time. During out-of-phase operation, the second regulator's low-side MOSFET turns on with a time delay relative to that of the first

regulator, corresponding to half of the switching period. The instantaneous input current peaks of both regulators do not overlap, resulting in reduced RMS ripple current and input voltage

ripple. This reduces the required input capacitor ripple current rating, allows for fewer or less expensive capacitors, and reduces shielding requirements for EMI.

### Dual Channel 180° Out-of-Phase Operation



## BUCK REGULATORS PORTFOLIO

| Product  | Switch Type | V <sub>IN</sub> (min) (V) | V <sub>IN</sub> (max) (V) | V <sub>OUT</sub> (min) (V) | V <sub>OUT</sub> (max) (V) | I <sub>OUT</sub> (A) | Operating Frequency (kHz) | Package/<br>Pins                | NOTES |
|----------|-------------|---------------------------|---------------------------|----------------------------|----------------------------|----------------------|---------------------------|---------------------------------|-------|
| MAX17620 | Internal    | 2.7                       | 5.5                       | 1.5                        | V <sub>IN</sub>            | 0.6                  | 4000                      | TDFN/8                          |       |
| MAX17509 | Internal    | 4.5                       | 16                        | 0.9                        | 5                          | 3                    | 500, 1000, 1500, 2000     | THIN QFN/32                     |       |
| MAX15048 | External    | 4.7                       | 23                        | 0.6                        | V <sub>IN</sub>            | 15                   | 200 to 1200               | TQFN/32                         |       |
| MAX15049 | External    | 4.7                       | 23                        | 0.6                        | V <sub>IN</sub>            | 15                   | 200 to 1200               | TQFN/32                         |       |
| MAX15037 | Internal    | 4.5                       | 23                        | 0.6                        | 28                         | 3                    | 200 to 2200               | TQFN/16                         |       |
| MAX15023 | External    | 4.5                       | 28                        | 0.6                        | 0.85xV <sub>IN</sub>       | 12                   | 200 to 1000               | TQFN/24                         |       |
| MAX15026 | External    | 4.5                       | 28                        | 0.6                        | 0.85xV <sub>IN</sub>       | 25                   | 200 to 2000               | TDFN-EP/14                      |       |
| MAX15002 | External    | 4.5                       | 23                        | 0.6                        | 0.85xV <sub>IN</sub>       | 15                   | 200 to 2200               | TQFN/40                         |       |
| MAX8655  | Internal    | 4.5                       | 25                        | 0.7                        | 5.5                        | 25                   | 200 to 1000               | TQFN/56                         |       |
| MAX8640Z | Internal    | 2.7                       | 5.5                       | 0.8                        | 2.5                        | 0.5                  | 4000                      | μDFN/6, SC70/6                  |       |
| MAX8640Y | Internal    | 2.7                       | 5.5                       | 0.8                        | 2.5                        | 0.5                  | 2000                      | μDFN/6, SC70/6                  |       |
| MAX1927  | Internal    | 2.6                       | 5.5                       | 0.75                       | 5                          | 0.8                  | 1000                      | μMAX®/10                        |       |
| MAX1928  | Internal    | 2.6                       | 5.5                       | 1.5                        | 2.5                        | 0.8                  | 1000                      | μMAX/10                         |       |
| MAX1837  | Internal    | 4.5                       | 24                        | 1.25                       | V <sub>IN</sub>            | 0.25                 | 200                       | SOT/6, TDFN-EP/6                |       |
| MAX1836  | Internal    | 4.5                       | 24                        | 1.25                       | V <sub>IN</sub>            | 0.125                | 200                       | SOT/6, TDFN-EP/6                |       |
| MAX1644  | Internal    | 3                         | 5.5                       | 1.1                        | V <sub>IN</sub>            | 2                    | 350                       | SSOP/16                         |       |
| MAX653   | Internal    | 4                         | 11.5                      | 1.3                        | V <sub>IN</sub>            | 0.225                | Variable                  | CDIP(N)/8, PDIP(N)/8, SOIC(N)/8 |       |
| MAX639   | Internal    | 4                         | 11.5                      | 1.3                        | V <sub>IN</sub>            | 0.225                | Variable                  | CDIP(N)/8, PDIP(N)/8, SOIC(N)/8 |       |
| MAX640   | Internal    | 4                         | 11.5                      | 1.3                        | V <sub>IN</sub>            | 0.225                | Variable                  | CDIP(N)/8, PDIP(N)/8, SOIC(N)/8 |       |

[View parametric table >](#)

## BUCK REGULATORS PORTFOLIO

| Product | Switch Type | $V_{IN}$ (min) (V) | $V_{IN}$ (max) (V) | $V_{OUT}$ (min) (V) | $V_{OUT}$ (max) (V) | $I_{OUT}$ (A) | Operating Frequency (kHz) | Package/<br>Pins                      | NOTES |
|---------|-------------|--------------------|--------------------|---------------------|---------------------|---------------|---------------------------|---------------------------------------|-------|
| MAX649  | External    | 4                  | 16.5               | 1.5                 | $V_{IN}$            | 2.5           | 300                       | CDIP(N)/8,<br>PDIP(N)/8,<br>SOIC(N)/8 |       |
| MAX1684 | Internal    | 2.7                | 14                 | 1.25                | $V_{IN}$            | 1             | 300                       | QSOP/16                               |       |
| MAX1685 | Internal    | 2.7                | 14                 | 1.25                | $V_{IN}$            | 1             | 600                       | QSOP/16                               |       |
| MAX1692 | Internal    | 2.7                | 5.5                | 1.25                | $V_{IN}$            | 0.6           | 750                       | μMAX/10                               |       |
| MAX1651 | External    | 3                  | 16                 | 1.5                 | $V_{IN}$            | 2.5           | 300                       | PDIP(N)/8,<br>SOIC(N)/8               |       |
| MAX1649 | External    | 3                  | 16                 | 1.5                 | $V_{IN}$            | 2.5           | 300                       | PDIP(N)/8,<br>SOIC(N)/8               |       |
| MAX1652 | External    | 4.5                | 30                 | 2.5                 | 5.5                 | 10            | 340                       | QSOP/16                               |       |
| MAX1654 | External    | 4.5                | 30                 | 2.5                 | 5.5                 | 10            | 340                       | QSOP/16                               |       |
| MAX1655 | External    | 4.5                | 30                 | 1                   | 5.5                 | 10            | 340                       | QSOP/16,<br>SOIC(N)/16                |       |
| MAX1653 | External    | 4.5                | 30                 | 2.5                 | 5.5                 | 10            | 340                       | QSOP/16,<br>SOIC(N)/16                |       |
| MAX1639 | External    | 4.5                | 5.5                | 1.1                 | 4.5                 | 35            | 300, 600, 1000            | SOIC(N)/16                            |       |
| MAX1637 | External    | 3.15               | 5.5                | 1.1                 | 5.5                 | 0.1           | 350                       | QSOP/16                               |       |
| MAX1672 | Internal    | 1.8                | 11                 | 1.25                | 5.5                 | 0.3           | -                         | QSOP/16                               |       |
| MAX1638 | External    | 4.5                | 5.5                | 1.3                 | 3.5                 | 35            | 300, 600, 1000            | SSOP/24                               |       |
| MAX887  | Internal    | 3.5                | 11                 | 1.25                | 10.5                | 0.6           | 300                       | SOIC(N)/8                             |       |
| MAX1626 | External    | 2.6                | 16.5               | 3.3                 | 5                   | 3             | 300                       | SOIC(N)/8                             |       |
| MAX1627 | External    | 2.6                | 16.5               | 1.3                 | $V_{IN}$            | 3             | 300                       | SOIC(N)/8                             |       |
| MAX735  | Internal    | 4                  | 6.2                | -5.25               | -4.75               | 0.275         | 160                       | SOIC(N)/8                             |       |
| MAX755  | Internal    | 2.7                | 9                  | -5.25               | -4.75               | 0.275         | 160                       | SOIC(N)/8                             |       |
| MAX750  | Internal    | 4                  | 11                 | 4.75                | 5.25                | 0.450         | 160                       | SOIC(N)/8                             |       |

[View parametric table >](#)

## NOTES

## EXPLORE



## Reference Design Using the MAX15026 for an Auxiliary Power Supply for LCD TVs or Set-Top Boxes



## Power Supply for LCD TVs or Set-Top Boxes

### Palo Verde (MAXREFDES33#): Step-Down Converter



### Palo Verde (MAXREFDES33#): Step-Down Converter



VA/AS

TCH

In The Lab: High-Efficiency Power Supply Reference Designs (Video)



## In The Lab: High-Efficiency Power Supply Reference Designs (Video)

## WATCH



## In The Lab: High-Efficiency Power Supply Reference Designs (Video)

## NOTES

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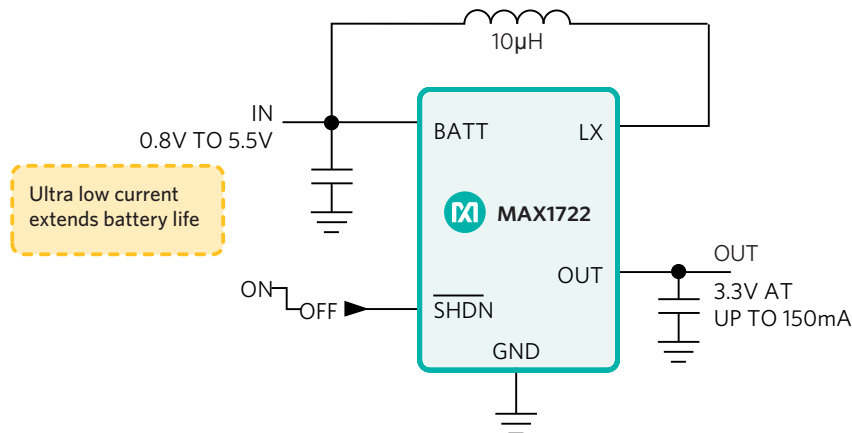
# SMALL, LOW-POWER BOOST REGULATORS

Our high-efficiency, low-noise, and tiny packages make these step-up switching regulator solutions ideal for today's portable applications.

## FEATURES AND BENEFITS

- Increase battery life with low quiescent current and True Shutdown™ mode
- Easily adapt to design requirements with single- or dual-cell battery input
- High switching frequencies provide fast transient response and shrink component size
- Minimize EMI in noise-sensitive applications using our proprietary LX-damping circuitry

## TYPICAL APPLICATION CIRCUIT



## DESIGN TIP

### Addressing New Designs for the Wearable Market

Many companies are looking at wearables as the next big market opportunity following mobile phones. Smart watches appear to be the most popular wearable devices today, and the healthcare sector—including medical, fitness, and wellness—promises even broader opportunities. These devices require very small form factors and prolonged operating times, creating very difficult design challenges.



**MAX1722** is a boost converter optimized for these wearable applications, delivering up to 150mA of current in a small 2mm x 2mm 6-pin µDFN package. Aggressive power savings techniques are utilized in order to reduce current consumption when the system is in sleep mode and the regulator is shutdown. In shutdown all the regulator control circuits are switched off, leaving only the unavoidable parasitic leakages producing minimal discharges of the battery and the output capacitor. Leakages of a few nanoamps are obtained at BATT, and tens of nanoamps at OUT.

## CUSTOMER INSIGHT

Maxim offers a superior selection of DC-DC step-up converters for all types of applications. Utilized in a variety of applications, the **MAX1722** PWM step-up converter was the best choice for a portable audio device in a major consumer product. This boost converter features a patented idle mode that reduces operating current under light loads and maximizes efficiency. This solution is ideal for battery-powered portable devices that require high efficiency for prolonged battery life.

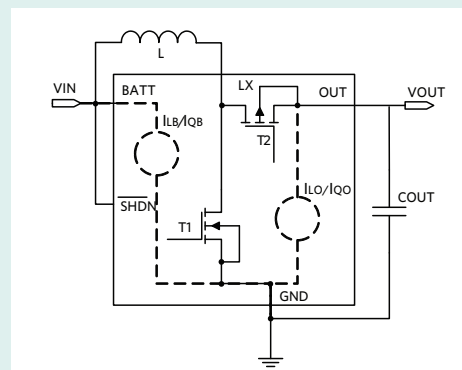
## BOOST REGULATORS WITH >90% EFFICIENCY

| Product     | Switch Type | V <sub>IN</sub><br>(min) (V) | V <sub>IN</sub><br>(max) (V) | V <sub>OUT</sub><br>(min) (V) | V <sub>OUT</sub><br>(max) (V) | I <sub>IN</sub> Limit* (A) | F <sub>SW</sub> (kHz) | I <sub>Q</sub> (μA) | Peak Efficiency | Package           |
|-------------|-------------|------------------------------|------------------------------|-------------------------------|-------------------------------|----------------------------|-----------------------|---------------------|-----------------|-------------------|
| MAX668/9    | External    | 1.8                          | 28                           | 2.7                           | 100                           | 6                          | 500                   | 220                 | 92%             | 10-μMAX           |
| MAX8627     | Internal    | 0.9                          | 5.5                          | 3                             | 5                             | 1                          | 1000                  | 20                  | 95%             | 14-TDFN           |
| MAX1674/5/6 | Internal    | 0.7                          | 5.5                          | 2                             | 5.5                           | 0.5/1                      | 500                   | 16                  | 94%             | 8-μMax            |
| MAX1722/3/4 | Internal    | 0.9                          | 5.5                          | 2                             | 5.5                           | 0.15                       | PFM                   | 1.5                 | 90%             | 5-TSOT,<br>6-μDFN |
| MAX1795/6/7 | Internal    | 0.7                          | 5.5                          | 2                             | 5.5                           | 0.55                       | PFM                   | 25                  | 95%             | 8-μMax            |

$$*I_{OUT} = I_{IN\ Limit} \times (V_{OUT}/V_{IN}) \times \text{Efficiency}$$

### FEATURED TECHNOLOGY

Our step-up converters contain an internal damping switch to minimize ringing at LX. The damping switch connects a resistor across the inductor when the inductor's energy is depleted. Normally, when the energy in the inductor is insufficient to supply current to the output, the capacitance and inductance at LX form a resonant circuit that causes ringing. The ringing continues until the energy is dissipated through the series resistance of the inductor. The damping switch supplies a path to quickly dissipate this energy, minimizing the ringing at LX. Damping LX ringing does not reduce V<sub>OUT</sub> ripple, but does reduce EMI.





## BOOST REGULATORS PORTFOLIO

| Product                  | Switch Type | V <sub>IN</sub> (min) (V) | V <sub>IN</sub> (max) (V) | V <sub>OUT</sub> (min) (V) | V <sub>OUT</sub> (max) (V) | I <sub>OUT</sub> (A) | Operating Frequency (kHz) | Package/<br>Pins                      | NOTES |
|--------------------------|-------------|---------------------------|---------------------------|----------------------------|----------------------------|----------------------|---------------------------|---------------------------------------|-------|
| <a href="#">MAX8815A</a> | Internal    | 1.2                       | 5.5                       | 3.3                        | 5.5                        | 1                    | 2000                      | TDFN-EP/10                            |       |
| <a href="#">MAX8627</a>  | Internal    | 0.9                       | 5.5                       | 3                          | 5                          | 1                    | 1000                      | TDFN-EP/14                            |       |
| <a href="#">MAX8569</a>  | Internal    | 1.5                       | 5.5                       | 2                          | 5.5                        | 0.25                 | -                         | SOT/6, TDFN-EP/6                      |       |
| <a href="#">MAX5026</a>  | Internal    | 3                         | 11                        | V <sub>IN</sub>            | 36                         | 0.04                 | 500                       | SOT/6                                 |       |
| <a href="#">MAX1723</a>  | Internal    | 1.2                       | 5.5                       | 2                          | 5.5                        | 0.15                 | -                         | μDFN/6, TSOT/5                        |       |
| <a href="#">MAX1722</a>  | Internal    | 0.9                       | 5.5                       | 2                          | 5.5                        | 0.15                 | -                         | μDFN/6, TSOT/5                        |       |
| <a href="#">MAX1724</a>  | Internal    | 0.9                       | 5.5                       | 2.7                        | 5                          | 0.15                 | -                         | μDFN/6, TSOT/5                        |       |
| <a href="#">MAX1524</a>  | External    | 1.5                       | 5.5                       | 2.5                        | 5                          | 0.95                 | 1000                      | SOT/6                                 |       |
| <a href="#">MAX1522</a>  | External    | 2.5                       | 5.5                       | 2.5                        | 100                        | 1                    | 1000                      | SOT/6                                 |       |
| <a href="#">MAX1523</a>  | External    | 2.5                       | 5.5                       | 2.5                        | 100                        | 10                   | 1000                      | SOT/6                                 |       |
| <a href="#">MAX1797</a>  | Internal    | 0.7                       | 5.5                       | 2                          | 5.5                        | 0.55                 | 500                       | μMAX/8                                |       |
| <a href="#">MAX1795</a>  | Internal    | 0.7                       | 5.5                       | 2                          | 5.5                        | 0.18                 | 500                       | μMAX/8                                |       |
| <a href="#">MAX1796</a>  | Internal    | 0.7                       | 5.5                       | 2                          | 5.5                        | 0.3                  | 500                       | μMAX/8                                |       |
| <a href="#">MAX1832</a>  | Internal    | 1.5                       | 5.5                       | 2                          | 5.5                        | 0.15                 | 500                       | SOT/6                                 |       |
| <a href="#">MAX1833</a>  | Internal    | 1.5                       | 5.5                       | 3                          | 3.3                        | 0.15                 | 500                       | SOT/6, TDFN-EP/6                      |       |
| <a href="#">MAX1834</a>  | Internal    | 1.5                       | 5.5                       | 2                          | 5.5                        | 0.15                 | 500                       | SOT/6                                 |       |
| <a href="#">MAX1771</a>  | External    | 2                         | 16.5                      | 2                          | 100                        | 2                    | 300                       | CDIP(N)/8,<br>PDIP(N)/8,<br>SOIC(N)/8 |       |
| <a href="#">MAX856</a>   | Internal    | 0.8                       | 6                         | 3.3                        | 5                          | 0.5                  | 500                       | μMAX/8,<br>PDIP(N)/8,<br>SOIC(N)/8    |       |
| <a href="#">MAX858</a>   | Internal    | 0.8                       | 6                         | 3.3                        | 5                          | 0.125                | 500                       | μMAX/8,<br>PDIP(N)/8,<br>SOIC(N)/8    |       |

[View parametric table >](#)

## BOOST REGULATORS PORTFOLIO

| Product | Switch Type | V <sub>IN</sub><br>(min) (V) | V <sub>IN</sub><br>(max) (V) | V <sub>OUT</sub><br>(min) (V) | V <sub>OUT</sub><br>(max) (V) | I <sub>OUT</sub> (A) | Operating<br>Frequency (kHz) | Package/<br>Pins                         | NOTES |
|---------|-------------|------------------------------|------------------------------|-------------------------------|-------------------------------|----------------------|------------------------------|------------------------------------------|-------|
| MAX857  | Internal    | 0.8                          | 6                            | 2.7                           | 6                             | 0.5                  | 500                          | μMAX/8,<br>PDIP(N)/8,<br>SOIC(N)/8       |       |
| MAX859  | Internal    | 0.8                          | 6                            | 2.7                           | 6                             | 0.125                | 500                          | μMAX/8,<br>PDIP(N)/8,<br>SOIC(N)/8       |       |
| MAX618  | Internal    | 3                            | 28                           | 3                             | 28                            | 0.5                  | 250                          | QSOP/16                                  |       |
| MAX669  | External    | 1.8                          | 28                           | 3                             | 28                            | 6                    | 500                          | μMAX/10                                  |       |
| MAX668  | External    | 3V                           | 28                           | 3                             | 100                           | 6                    | 500                          | μMAX/10                                  |       |
| MAX1675 | Internal    | 0.7                          | 5.5                          | 2                             | 5.5                           | 0.22                 | 500                          | μMAX/8                                   |       |
| MAX1676 | Internal    | 0.7                          | 5.5                          | 2                             | 5.5                           | 0.42                 | 500                          | μMAX/10                                  |       |
| MAX1674 | Internal    | 0.7                          | 5.5                          | 2                             | 5.5                           | 0.42                 | 500                          | μMAX/8                                   |       |
| MAX1678 | Internal    | 0.7                          | 5.5                          | 2                             | 5.5                           | 0.1                  | 150                          | μMAX/8                                   |       |
| MAX685  | Internal    | 2.7                          | 5.5                          | 2.7                           | 24                            | 0.01                 | 480                          | QSOP/16,<br>TQFN/24                      |       |
| MAX686  | Internal    | 0.8                          | 27                           | -27                           | 27                            | 0.5                  | 300                          | QSOP/16                                  |       |
| MAX629  | Internal    | 0.8                          | 28                           | -28                           | 28                            | 0.5                  | 300                          | SOIC(N)/8                                |       |
| MAX863  | External    | 1.5                          | 11                           | 1.25                          | 100                           | 2                    | -                            | QSOP/16                                  |       |
| MAX1706 | Internal    | 0.7                          | 5.5                          | 2.5                           | 5.5                           | 0.4                  | 400                          | QSOP/16                                  |       |
| MAX1705 | Internal    | 0.7                          | 5.5                          | 2.5                           | 5.5                           | 0.8                  | 400                          | QSOP/16                                  |       |
| MAX849  | Internal    | 0.7                          | 5.5                          | 2.7                           | 5.5                           | 1                    | 400                          | SOIC(N)/16                               |       |
| MAX848  | Internal    | 0.7                          | 5.5                          | 2.7                           | 5.5                           | 0.3                  | 400                          | SOIC(N)/16                               |       |
| MAX743  | Internal    | 4.2                          | 6                            | 12                            | 15                            | 0.125                | 200                          | CDIP(N)/16,<br>PDIP(N)/16,<br>SOIC(W)/16 |       |
| MAX710  | Internal    | 1.8                          | 11                           | 3.3                           | 5                             | 1.5                  | -                            | SOIC(N)/16                               |       |
| MAX711  | Internal    | 1.8                          | 11                           | 1.25                          | 5.5                           | 1.5                  | -                            | SOIC(N)/16                               |       |

[View parametric table >](#)

## RELATED RESOURCES

### READ

-  Small, High-Voltage Boost Converters
-  Negative-to-Negative Switch-Mode Converter Offers High Current and High Efficiency
-   $\pm 15V$  or  $\pm 12V$  Output Switch-Mode Power Supply Has Wide Input-Voltage Range
-  Current Limited DC-DC Controller Used as Step-Up Step-Down SEPIC Power Supply for USB Device
-  Step-up Converter with LDO Beats SEPIC Efficiency
-  Boost Converter Switches Between Battery and USB Power
-  Protection from Blackouts: Dirt Cheap to Fully Integrated
-  Introduction to Hearing Aids and Important Design Considerations
-  Important Design Considerations for Digital Thermometers
-  Charging Batteries Using USB Power

### EXPLORE

-  Oceanside (MAXREFDES9#): 3.3V To 15V Input,  $\pm 15V$  ( $\pm 12V$ ) Output, Isolated Power Supply

## NOTES

## NOTES

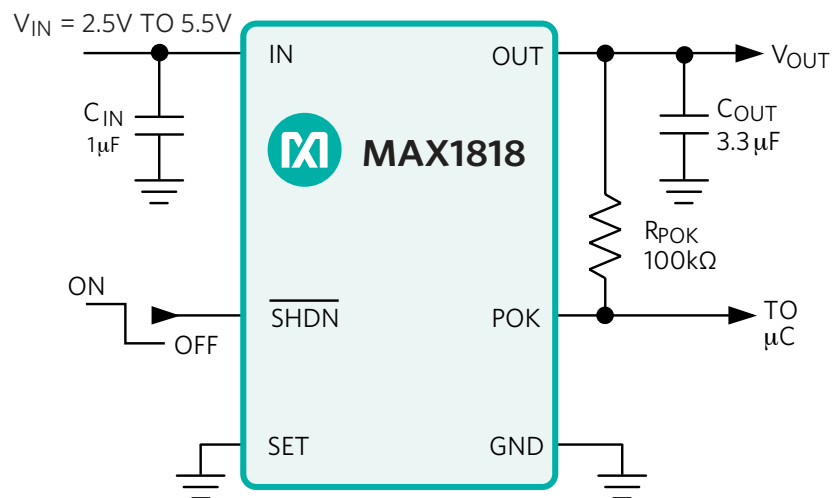
## HIGH-ACCURACY, LOW-NOISE LDOs

High-accuracy, low-noise operation makes our low-dropout linear regulators ideal for a variety of portable applications.

### FEATURES AND BENEFITS

- Very low dropout voltages reduce heat dissipation
- High output accuracy provides closely regulated voltages
- Ultra low noise ensures precise system measurements

### TYPICAL APPLICATION CIRCUIT



### DESIGN TIP

#### Choosing the Correct LDO Linear Regulator for Mobile Devices

Low-dropout linear regulators (LDOs) are used to power many sections of a typical mobile device. The baseband, RF, and audio sections have different requirements that influence which low-dropout linear regulator is most appropriate.

Ideally, one IC would have all these characteristics so only one LDO would be needed. But in practice, the various blocks are best powered by LDOs with different performance characteristics. For example, most cellular phone baseband chipsets require power supplies for three circuit blocks: internal digital circuitry, analog circuitry, and peripheral interface circuitry.

Internal digital circuits typically operate from 1.8V to 2.6V with plenty of battery headroom so dropout is not critical. Output noise and the PSRR are not critical specs for the digital circuits. This supply requires low quiescent current such as the **MAX1725**, at light loads because this LDO stays on at all times.

The RF circuits require low-noise and high PSRR LDOs. In particular, the VCO and PLL blocks' overall performance affects the radio's critical specifications. Noise can alter the oscillator's phase and amplitude characteristic and the oscillator's loop circuitry amplifies the noise. An LDO such as the **MAX8840** is more suited for this application.

High current LDOs like the **MAX1793** are required for audio circuit demands such as hands-free, game, and multimedia applications in cellular phones. This power supply requires low noise and high PSRR at audio frequency range (20Hz to 20kHz) in order to provide good audio quality.



## HIGH-ACCURACY LDOs WITH LOW DROPOUT VOLTAGES

| Product            | V <sub>IN</sub> (V) | V <sub>OUT</sub> (V)                                    | I <sub>OUT</sub> (A) | I <sub>Q</sub> (uA) | V <sub>DROPOUT</sub> (mV) | Accuracy (%) | PSRR-10kHz (dB) | No. of Outputs | Package          |
|--------------------|---------------------|---------------------------------------------------------|----------------------|---------------------|---------------------------|--------------|-----------------|----------------|------------------|
| <b>MAX8902</b>     | 1.7 to 5.5          | 0.6 to 5.3                                              | 0.5                  | 80                  | 50                        | 1.5          | 92              | 1              | 8-TDFN           |
| <b>MAX8510</b>     | 2 to 6              | 1.5 to 4.5                                              | 0.12                 | 40                  | 120                       | 3            | 72/78           | 1              | 8-TDFN<br>5-SC70 |
| <b>MAX8840/1/2</b> | 2 to 6              | 1.5 to 4.5; 1.5/1.8/2.5/2.6/2.7/<br>2.8/2.85/3/3.33/4.5 | 0.15                 | 40                  | 120                       | 3            | 72/78           | 1              | 6-μDFN           |
| <b>MAX1793</b>     | 2.5 to 5.5          | 1.25 to 5                                               | 1                    | 125                 | 210                       | 3            | 55              | 1              | 16-TSSOP         |
| <b>MAX1806</b>     | 2.25 to 5.5         | 0.8 to 4.5                                              | 0.5                  | 210                 | 200                       | 1            | 45              | 1              | 8-μDFN           |
| <b>MAX1818</b>     | 2.5 to 5.5          | 1.25 to 5                                               | 0.5                  | 125                 | 120                       | 3            | 63              | 1              | 6-SOT23          |
| <b>MAX1725/6</b>   | 2.5 to 12           | 1.5 to 5; 1.8/2.5/3.3/5                                 | 0.02                 | 2                   | 300                       | 3            | 40              | 1              | 5-SOT23          |
| <b>MAX8880/1</b>   | 2.5 to 12           | 1.25 to 5; 1.8/2.5/3.3                                  | 0.2                  | 3.5                 | 100                       | 1.5          | 40              | 1              | 6-TDFN 6-SOT23   |
| <b>MAX667</b>      | 3.5 to 16.5         | 1.3 to 16                                               | 0.25                 | 20                  | 150                       | 4            | 40              | 1              | 8 SO; 8 PDIP     |
| <b>MAX1615/6</b>   | 4 to 28             | 1.24 to 28; 3.5/5                                       | 0.03                 | 6.2                 | 350*                      | 2            | 65              | 1              | 5-SOT23          |

\*max

## FEATURED TECHNOLOGY

To know which LDO you need, you must first define the application of your LDO and then examine which parameters are most important. With so many different LDO applications and the multiple parameters that characterize a particular LDO, it is not easy to determine which LDO is best suited. There are three basic design specs that will determine the overall functionality of the LDO. There are tradeoffs made in IC design to accommodate the various LDO requirements for specific applications.

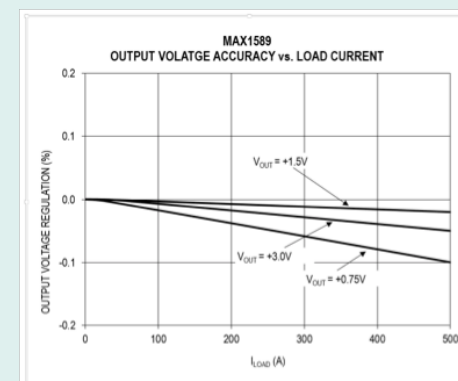
For example, to design an LDO with a high input voltage range and very low quiescent (I<sub>Q</sub>) current a tradeoff must be made at the FET level between low PSRR and higher noise. To design an LDO with wide input voltage range, a tradeoff must be made between wide input range and high output current.

Ultra-low noise LDOs, designed for sensitive applications, must tradeoff high PSRR with low I<sub>Q</sub>. For applications such as in system measurement or RF circuits, the low I<sub>Q</sub> is not a primary system requirement and the low noise LDO is a suitable choice.

There are many applications where the functionality of a circuit or device is highly dependent on the quality and accuracy of the power supply. For example

power supplies that are used in applications to supply power sensitive CPUs, precision regulator applications or data-converter references must have a very high degree of accuracy. Due to IC design limitations, high accuracy output LDOs do not have a wide input supply range. Increasing the input range decreases accuracy. The **MAX1589** was designed to meet these tough accuracy requirements by achieving a typical line regulation accuracy of 0.02% at 25°C and no greater than 0.5% over the entire operating temperature range.

Maxim has addressed these needs and created many LDOs to meet the important criteria for specific applications to provide the very best solution for any given system.



## LOW-NOISE LDOs PORTFOLIO

| Product | V <sub>IN</sub> (min) (V) | V <sub>IN</sub> (max) (V) | Preset V <sub>OUT</sub> (V)                                         | V <sub>DROPOUT</sub> at Rated I <sub>LOAD</sub> (typ) (V) | Rated I <sub>LOAD</sub> (mA) | I <sub>CC</sub> (typ) (μA) | Output Voltage Noise (typ) (μV <sub>RMS</sub> ) | Package/Pins      | NOTES |
|---------|---------------------------|---------------------------|---------------------------------------------------------------------|-----------------------------------------------------------|------------------------------|----------------------------|-------------------------------------------------|-------------------|-------|
| MAX8940 | 2.8                       | 6                         | 2.8, 3                                                              | 0.12                                                      | 120                          | 40                         | 13                                              | SC70/5            |       |
| MAX8891 | 2                         | 6                         | 1.5, 1.8, 2.5, 2.6, 2.8, 2.85, 2.9, 3.1, 3.3, 4.5                   | 0.15                                                      | 150                          | 40                         | 230                                             | SC70/5            |       |
| MAX8892 | 2                         | 6                         | -                                                                   | 0.15                                                      | 150                          | 40                         | 230                                             | SC70/5            |       |
| MAX8902 | 1.7                       | 5.5                       | 1.5, 1.8, 2, 2.5, 3, 3.1, 3.3, 4.6, 4.7                             | 0.05                                                      | 500                          | 80                         | 16                                              | TDFN-EP/8         |       |
| MAX8840 | 2                         | 6                         | 1.5, 1.6, 1.8, 1.9, 2.5, 2.6, 2.7, 2.8, 2.85, 2.9, 3, 3.1, 3.3, 4.5 | 0.12                                                      | 150                          | 40                         | 11                                              | μDFN/6, UTLGA/6   |       |
| MAX8842 | 2                         | 6                         | -                                                                   | 0.12                                                      | 150                          | 40                         | 230                                             | μDFN/6            |       |
| MAX8841 | 2                         | 6                         | 1.5, 1.6, 1.8, 1.9, 2.5, 2.6, 2.7, 2.8, 2.85, 2.9, 3, 3.1, 3.3, 4.5 | 0.12                                                      | 150                          | 40                         | 230                                             | μDFN/6            |       |
| MAX8510 | 2                         | 6                         | 1.5, 1.8, 2.5, 2.7, 2.8, 2.85, 3, 3.3, 4.5                          | 0.12                                                      | 120                          | 40                         | 11                                              | SC70/5, TDFN-EP/8 |       |
| MAX8512 | 2                         | 6                         | -                                                                   | 0.12                                                      | 120                          | 40                         | 230                                             | SC70/5, TDFN-EP/8 |       |
| MAX8511 | 2                         | 6                         | 1.5, 1.8, 2.5, 2.6, 2.8, 2.85, 2.9, 3.1, 3.3, 4.5                   | 0.12                                                      | 120                          | 40                         | 230                                             | SC70/5, TDFN-EP/8 |       |
| MAX1935 | 2.25                      | 5.5                       | 1.5                                                                 | 0.175                                                     | 500                          | 200                        | 300                                             | TDFN-EP/8         |       |
| MAX1806 | 2.25                      | 5.5                       | 0.8, 1.5, 1.8, 2.5, 3.3                                             | 0.17                                                      | 500                          | 210                        | 300                                             | μMAX-EP/8         |       |
| MAX8867 | 2.5                       | 5.5                       | 2.5, 2.8, 2.84, 3, 3.15, 3.3, 3.6, 5                                | 0.16                                                      | 150                          | 85                         | 20                                              | SOT/5, TSOT/5     |       |
| MAX8868 | 2.5                       | 5.5                       | 2.5, 2.8, 2.84, 3, 3.15, 3.3, 3.6, 5                                | 0.16                                                      | 150                          | 85                         | 20                                              | SOT/5, TSOT/5     |       |
| MAX8865 | 2.5                       | 5.5                       | 2.8, 2.84, 3.15                                                     | 0.11                                                      | 100                          | 105                        | 220                                             | μMAX/8            |       |
| MAX8873 | 2.5                       | 6.5                       | 2.8, 2.84, 3.15                                                     | 0.13                                                      | 120                          | 73                         | 220                                             | SOT/5             |       |
| MAX8874 | 2.5                       | 6.5                       | 2.8, 2.84, 3.15                                                     | 0.13                                                      | 120                          | 73                         | 220                                             | SOT/5             |       |
| MAX8878 | 2.5                       | 6.5                       | 1.5, 1.8, 2.5, 2.8, 2.84, 3, 3.15, 3.3, 3.6, 5                      | 0.16                                                      | 150                          | 85                         | 20                                              | SOT/5, TSOT/5     |       |
| MAX1857 | 2.5                       | 5.5                       | 4.75                                                                | 0.12                                                      | 500                          | 135                        | 115                                             | μMAX/8            |       |

[View parametric table ›](#)

## LOW-NOISE LDOs PORTFOLIO

| Product | V <sub>IN</sub><br>(min) (V) | V <sub>IN</sub><br>(max) (V) | Preset V <sub>OUT</sub> (V)                    | V <sub>DROPOUT</sub><br>at Rated I <sub>LOAD</sub><br>(typ) (V) | Rated I <sub>LOAD</sub><br>(mA) | I <sub>CC</sub><br>(typ) (μA) | Output<br>Voltage Noise<br>(typ) (μV <sub>RMS</sub> ) | Package/Pins                    | NOTES |
|---------|------------------------------|------------------------------|------------------------------------------------|-----------------------------------------------------------------|---------------------------------|-------------------------------|-------------------------------------------------------|---------------------------------|-------|
| MAX8877 | 2.5                          | 6.5                          | 1.5, 1.8, 2.5, 2.8, 2.84, 3, 3.15, 3.3, 3.6, 5 | 0.16                                                            | 150                             | 85                            | 20                                                    | SOT/5, TSOT/5                   |       |
| MAX1818 | 2.5                          | 5.5                          | 1.5, 1.8, 2, 2.5, 3.3, 5                       | 0.12                                                            | 500                             | 125                           | 115                                                   | SOT/6                           |       |
| MAX1793 | 2.5                          | 5.5                          | 1.5, 1.8, 2, 2.5, 3.3, 5                       | 0.21                                                            | 1000                            | 125                           | 115                                                   | TSSOP-EP/16                     |       |
| MAX8883 | 2.5                          | 6.5                          | 1.8, 2.5, 2.85, 3.3                            | 0.15                                                            | 160                             | 165                           | 320                                                   | SOT/6                           |       |
| MAX8882 | 2.5                          | 6.5                          | 1.8, 2.5, 2.85, 3.3                            | 0.15                                                            | 160                             | 165                           | 40                                                    | SOT/6                           |       |
| MAX8881 | 2.5                          | 12                           | 1.8, 2.5, 3.3, 5                               | 0.1                                                             | 200                             | 3.5                           | 300                                                   | SOT/6                           |       |
| MAX8880 | 2.5                          | 12                           | -                                              | 0.1                                                             | 200                             | 3.5                           | 300                                                   | SOT/6, TDFN-EP/6                |       |
| MAX1725 | 2.5                          | 12                           | -                                              | 0.3                                                             | 20                              | 2                             | 350                                                   | SOT/5                           |       |
| MAX1726 | 2.5                          | 12                           | 1.8, 2.5, 3.3, 5                               | 0.3                                                             | 20                              | 2                             | 350                                                   | SOT/5                           |       |
| MAX883  | 2.7                          | 11.5                         | 5                                              | 0.22                                                            | 200                             | 11                            | 250                                                   | PDIP(N)/8, SOIC(N)/8            |       |
| MAX884  | 2.7                          | 11.5                         | 3.3                                            | 0.32                                                            | 200                             | 11                            | 250                                                   | PDIP(N)/8, SOIC(N)/8            |       |
| MAX882  | 2.7                          | 11.5                         | 3.3                                            | 0.32                                                            | 200                             | 11                            | 250                                                   | PDIP(N)/8, SOIC(N)/8            |       |
| MAX8860 | 2.5                          | 6.5                          | 1.8, 2.5, 2.77, 2.82, 3, 3.3                   | 0.15                                                            | 300                             | 120                           | 55                                                    | μMAX/8                          |       |
| MAX1749 | 2.5                          | 6.5                          | 1.25                                           | 0.13                                                            | 120                             | 80                            | -                                                     | SOT/5                           |       |
| MAX664  | -2                           | -16.5                        | -5                                             | 0.35                                                            | 40                              | 6                             | -                                                     | CDIP(N)/8, PDIP(N)/8, SOIC(N)/8 |       |
| MAX666  | 2                            | 16.5                         | 5                                              | 0.9                                                             | 40                              | 6                             | -                                                     | CDIP(N)/8, PDIP(N)/8, SOIC(N)/8 |       |
| MAX663  | 2                            | 16.5                         | 5                                              | 0.9                                                             | 40                              | 6                             | -                                                     | CDIP(N)/8, PDIP(N)/8, SOIC(N)/8 |       |

[View parametric table >](#)

## LOW-NOISE LDOs PORTFOLIO

| Product  | V <sub>IN</sub> (min) (V) | V <sub>IN</sub> (max) (V) | Preset V <sub>OUT</sub> (V)                                                       | V <sub>DROPOUT</sub> at Rated I <sub>LOAD</sub> (typ) (V) | Rated I <sub>LOAD</sub> (mA) | I <sub>CC</sub> (typ) (μA) | Output Voltage Noise (typ) (μV <sub>RMS</sub> ) | Package/Pins                            | NOTES |
|----------|---------------------------|---------------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------|------------------------------|----------------------------|-------------------------------------------------|-----------------------------------------|-------|
| ICL7663A | 2                         | 16                        | -                                                                                 | 0.9                                                       | 40                           | 3.5                        | -                                               | CDIP(N)/8, PDIP(N)/8, SOIC(N)/8, TO99/8 |       |
| MAX1616  | 4                         | 28                        | -                                                                                 | 0.35                                                      | 30                           | 6.2                        | -                                               | SOT/5                                   |       |
| MAX1615  | 4                         | 28                        | -                                                                                 | 0.35                                                      | 30                           | 6.2                        | -                                               | SOT/5                                   |       |
| MAX667   | 3.5                       | 16.5                      | 5                                                                                 | 0.15                                                      | 250                          | 20                         | -                                               | CDIP(N)/8, PDIP(N)/8, SOIC(N)/8         |       |
| MAX1659  | 2.7                       | 16.5                      | 5                                                                                 | 0.49                                                      | 350                          | 30                         | 2500                                            | SOIC(N)/8                               |       |
| MAX1658  | 2.7                       | 16.5                      | 3.3                                                                               | 0.65                                                      | 350                          | 30                         | 2500                                            | SOIC(N)/8                               |       |
| MAX1976A | 1.62                      | 3.6                       | 0.75, 0.85, 0.9, 0.75 to 3.0, 1, 1.1, 1.2, 1.3, 1.5, 1.6, 1.8, 1.85, 2.5, 2.85, 3 | 0.1                                                       | 300                          | 70                         | 86                                              | TDFN-EP/6, TDFN-EP/8, TSOT/6            |       |
| MAX1589A | 1.62                      | 3.6                       | 0.75, 1, 1.3, 1.5, 1.8, 2.5, 3                                                    | 0.175                                                     | 500                          | 70                         | 86                                              | TDFN-EP/6, TSOT/6                       |       |
| MAX8864  | 2.5                       | 6.5                       | 2.8, 2.84, 3.15                                                                   | 0.055                                                     | 120                          | 70                         | 220                                             | SOT/5                                   |       |
| MAX8863  | 2.5                       | 6.5                       | 2.8, 2.84, 3.15                                                                   | 0.055                                                     | 120                          | 70                         | 220                                             | SOT/5                                   |       |
| MAX8866  | 2.5                       | 5.5                       | 2.8, 2.84, 3.15                                                                   | 0.055                                                     | 100                          | 105                        | 220                                             | μMAX/8                                  |       |

## CUSTOMER INSIGHT

The **MAX1716** is an ultra-low supply current, low-dropout linear regulator intended for low-power applications that demand the longest possible battery life. It was selected to support a power-sensitive smoke detector system. The system was required to run in idle mode until a detection occurred. Low I<sub>Q</sub> was essential so the system could run for an extended period of time while powered by a 9V battery. Reverse polarity protection was also required in case the battery was installed incorrectly. The **MAX1725** was the perfect choice for this application offering a mere 2μA quiescent current with reverse-battery protection.





## RELATED RESOURCES

### READ

-  [Reduce the Chances of Human Error: Part 1, Power and Ground](#)
-  [Spare Op Amp Generates Its Own Regulated Negative Supply](#)
-  [Draw 150mW of Isolated Power from Off-Hook Phone Line](#)
-  [Selecting LDO Linear Regulators for Cellphone Designs](#)
-  [Design Considerations for a Low-Cost Sensor and A/D Interface](#)
-  [Using a Linear Regulator to Produce a Constant Current Source](#)
-  [Analog ICs for Low Voltage Systems](#)
-  [Complete Stand-Alone GPS Receiver Solution with MAX2742](#)
-  [Improved Power-Supply Rejection for Linear Regulators](#)

### EXPLORE

-  [Reference Circuit 2765: Flexible Fault Protection](#)
-  [System Board 6147: MAXREFDES73#: Wearable, Galvanic Skin Response System](#)

## NOTES

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