EVALUATION KIT AVAILABLE

# MAX710/MAX711
## 3.3V/5V or Adjustable, Step-Up/Down DC-DC Converters

## General Description

The MAX710/MAX711 integrate a step-up DC-DC converter with a linear regulator to provide step-up/down voltage conversion. They are optimized for battery applications where the input varies above and below the regulated output voltage. They have an input range from +1.8V to +11V. Typical efficiency when boosting battery inputs is 85%.

The MAX710/MAX711 can be configured for minimum noise or optimum efficiency. Shutdown control turns off the part completely, disconnecting the input from the output ($I_{SHDN}$ = 0.2µA). Standby control turns off only the step-up converter and leaves the low-power linear regulator active ($I_Q$ = 7µA).

The MAX710 has a preset 3.3V or 5V output voltage. The MAX711 has an adjustable output that can be set from +2.7V to +5.5V with two resistors. Both devices come in 16-pin narrow SO packages.

## Features

**Step-Up/Down Voltage Conversion**

**+1.8V to +11V Input Range**

**Output:**
- **5V/250mA at $V_{IN}$ = 1.8V**
- **5V/500mA at $V_{IN}$ = 3.6V**

**No External FETs Required**

**Load Disconnected from Input in Shutdown**

**Battery Drain:**
- **200µA No-Load ($V_{IN}$ = 4V)**
- **7µA in Standby**
- **0.2µA when Off**

**Low-Noise and High-Efficiency Modes**

## Applications

Single-Cell, Lithium-Powered Portable Devices

Digital Cameras

2- to 4-Cell AA Alkaline Hand-Held Equipment

3.3V and Other Low-Voltage Systems

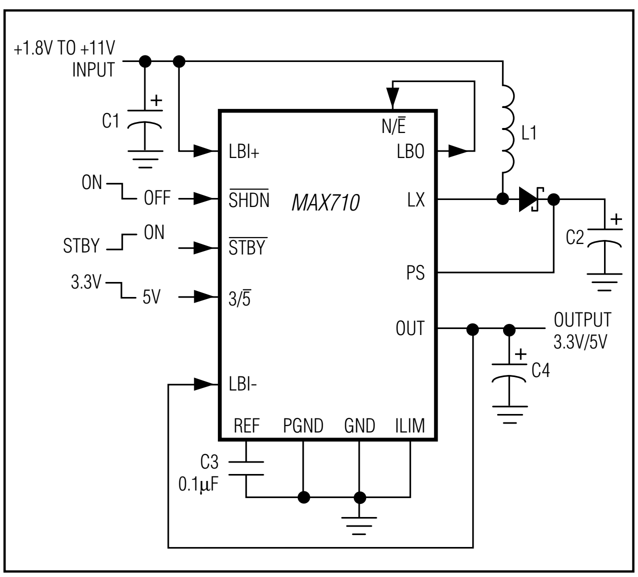
2-, 3-, and 4-Cell Battery-Powered Equipment

Battery-Powered Devices with AC Input Adapters

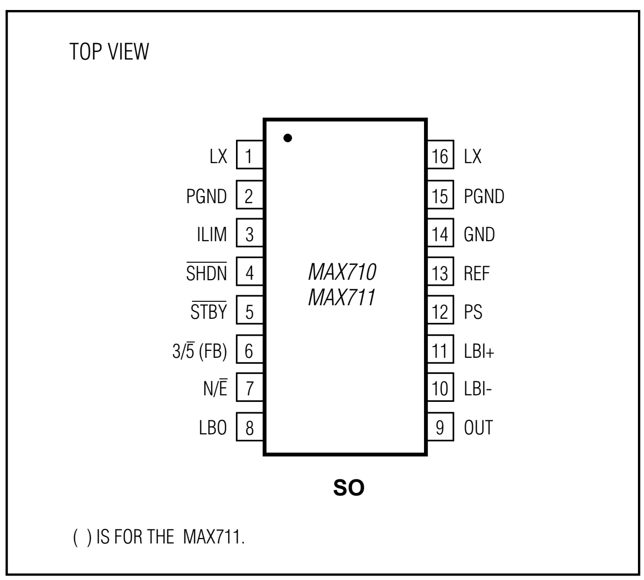
## Ordering Information

| PART | TEMP. RANGE | PIN-PACKAGE |
|---|---|---|
| **MAX710**C/D | 0°C to +70°C | Dice |
| MAX710ESE | -40°C to +85°C | 16 Narrow SO |
| **MAX711**C/D | 0°C to +70°C | Dice |
| MAX711ESE | -40°C to +85°C | 16 Narrow SO |

## Typical Operating Circuit




## Pin Configuration



## ABSOLUTE MAXIMUM RATINGS

PS, LX, OUT to GND...........................................-0.3V to +11.5V
ILIM, $\overline{SHDN}$, $\overline{STBY}$, FB, 3/$\overline{5}$, N/$\overline{E}$, LBO,
LBI-, LBI+, REF to GND ..........................-0.3V to ($V_{PS}$ + 0.3V)
PGND to GND ......................................................-0.3V to +0.3V
REF Short Circuit to GND..........................................Continuous
$I_{OUT}$.................................................................................700mA

Continuous Power Dissipation ($T_A$ = +70°C)
SO (derate 8.70mW/°C above +70°C)..........................696mW
Operating Temperature Range ..........................-40°C to +85°C
Storage Temperature Range ............................-65°C to +160°C
Junction Temperature.....................................................+150°C
Lead Temperature (soldering, 10sec) ............................+300°C

*Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.*

## ELECTRICAL CHARACTERISTICS

($V_{PS}$ = 5.6V, $\overline{STBY}$ = PS, $C_{REF}$ = 0.1µF, $C_{OUT}$ = 4.7µF, $T_A$ = -40°C to +85°C, unless otherwise noted. Typical values are at $T_A$ = +25°C.) (Note 1)

| PARAMETER | CONDITIONS | | MIN | TYP | MAX | UNITS |
|---|---|---|---|---|---|---|
| Input Voltage | N/$\overline{E}$ = PS | | 1.8 | | 11.0 | V |
| | N/$\overline{E}$ = GND (Note 2) | | 1.8 | | 7.0 | |
| Full Load Start-Up Voltage | | | | 0.9 | | V |
| Output Voltage (MAX710) | 3/$\overline{5}$ = low, $I_{OUT}$ = 0 to 250mA | $T_A$ = 0°C to +85°C | 4.8 | 5.0 | 5.2 | V |
| | | $T_A$ = -40°C to +85°C | 4.6 | 5.0 | 5.3 | |
| | 3/$\overline{5}$ = high, $I_{OUT}$ = 0 to 250mA, $V_{PS}$ = 4.7V | $T_A$ = 0°C to +85°C | 3.17 | 3.3 | 3.43 | |
| | | $T_A$ = -40°C to +85°C | 3.05 | 3.3 | 3.55 | |
| Output Voltage-Adjustment Range | MAX711 | | FB | | 5.5 | V |
| Output Voltage Load Regulation | 0 < $I_{OUT}$ < 250mA, $\overline{STBY}$ = PS | | | 0.5 | | % |
| Output Voltage Line Regulation | $\overline{STBY}$ = PS, 1.8V to 5V | | | 0.3 | | %/V |
| Quiescent Current | $V_{\overline{STBY}}$ = $V_{\overline{SHDN}}$ = logic high, current measured into PS pin; $I_{LOAD}$ = 0 | | | 100 | 140 | µA |
| Standby Quiescent Current | $V_{\overline{STBY}}$ = 0V | | | 7 | 16 | µA |
| Shutdown Quiescent Current | $V_{\overline{SHDN}}$ = 0V | | | 0.1 | 5 | µA |
| Reference Voltage | $T_A$ = 0°C to +85°C, $I_{REF}$ = 0 | | 1.24 | 1.28 | 1.31 | V |
| | $T_A$ = -40°C to +85°C, $I_{REF}$ = 0 | | 1.23 | 1.28 | 1.32 | |
| Standby Output Current | $V_{\overline{STBY}}$ = 0V, linear regulator | | | | 10 | mA |
| FB Voltage | MAX711, OUT = FB | $T_A$ = 0°C to +85°C | 1.20 | 1.25 | 1.29 | mV |
| | | $T_A$ = -40°C to +85°C | 1.18 | 1.25 | 1.31 | |
| Load Regulation | MAX711, OUT = FB | 0mA ≤ $I_{LOAD}$ ≤ 250mA | | 0.1 | 1 | % |
| FB Input Current | FB = 1.25V | | | 1 | 50 | nA |
| LX On-Resistance | $V_{PS}$ = 5.6V | | | 0.2 | 0.6 | Ω |
| | MAX710, $V_{PS}$ = 3.7V | | | 0.3 | 0.9 | |
| | MAX711, $V_{PS}$ = 2.7V | | | 0.6 | 1.2 | |
| LX Leakage Current | $V_{LX}$ = 5.6V | | | 0.1 | 1 | µA |
| LX Current Limit | ILIM = PS | | 0.5 | 0.8 | 1.3 | A |
| | ILIM = GND | | 1.1 | 1.5 | 1.95 | |

## ELECTRICAL CHARACTERISTICS (continued)

($V_{PS}$ = 5.6V, $\overline{STBY}$ = PS, $C_{REF}$ = 0.1µF, $C_{OUT}$ = 4.7µF, $T_A$ = -40°C to +85°C, unless otherwise noted. Typical values are at $T_A$ = +25°C.) (Note 1)

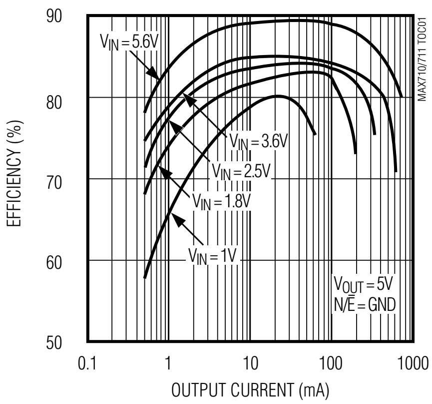
| PARAMETER | CONDITIONS | MIN | TYP | MAX | UNITS |
|---|---|---|---|---|---|
| Output PFET Resistance | $V_{OUT}$ = 5.0V | | 0.7 | 1.3 | Ω |
| | MAX710, $V_{OUT}$ = 3.0V | | 1.3 | 2.4 | |
| | MAX711, $V_{OUT}$ = 2.7V | | 1.6 | 3.0 | |
| Output PFET Leakage | $V_{PS}$ = 3V, $V_{OUT}$ = 0V | | 0.4 | 3 | µA |
| Thermal Shutdown | $\overline{STBY}$ = PS | | 150 | | °C |
| Thermal Shutdown Hysteresis | $\overline{STBY}$ = PS | | 20 | | °C |
| **LOGIC** | | | | | |
| Input Low Voltage | $\overline{STBY}$, $\overline{SHDN}$, N/$\overline{E}$, 3/$\overline{5}$, ILIM | | | 0.4 | V |
| Input High Voltage | $\overline{STBY}$, $\overline{SHDN}$, N/$\overline{E}$, 3/$\overline{5}$, ILIM | 1.6 | | | V |
| Input Bias Current | $\overline{STBY}$, $\overline{SHDN}$, N/$\overline{E}$, 3/$\overline{5}$, ILIM | | 1 | 50 | nA |
| **LBI/LBO COMPARATOR** | | | | | |
| Input Range LBI-, LBI+ | (Note 3) | 1.2 | | 10 | V |
| Input Bias Current LBI-, LBI+ | $V_{LBI-}$, $V_{LBI+}$ = 1.25V | | 1 | 50 | nA |
| Hysteresis | | 6 | 40 | 100 | mV |
| LBI/LBO Offset Voltage | $V_{LBI-}$ = 1.25V | -25 | | +25 | mV |
| LBO Output Voltage | $I_{LBO}$ = 2mA, $V_{LBI-}$ = 1.25V, $V_{LBI+}$ = 1V | | | 0.4 | V |
| | $I_{LBO}$ = -300µA, $V_{LBI-}$ = 1.25V, $V_{LBI+}$ = 2V | $V_{PS}$ - 0.2V | | | |

**Note 1:** Specifications at -40°C are guaranteed by design, not production tested.
**Note 2:** Guaranteed by design (see Table 1).
**Note 3:** The LBO comparator provides the correct result as long as one input is within the specified input range.

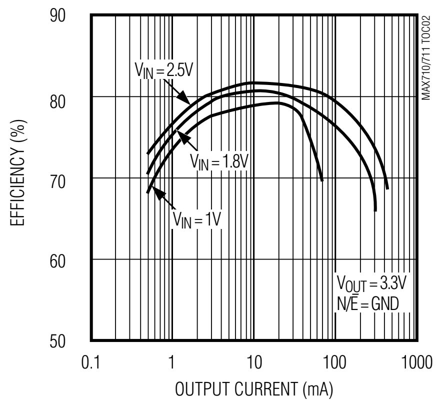
## Typical Operating Characteristics

($T_A$ = +25°C, unless otherwise noted.)

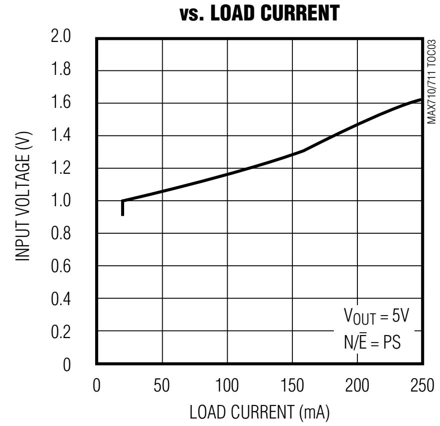
**EFFICIENCY vs. OUTPUT CURRENT— HIGH-EFFICIENCY MODE ($V_{OUT}$ = 5V)**



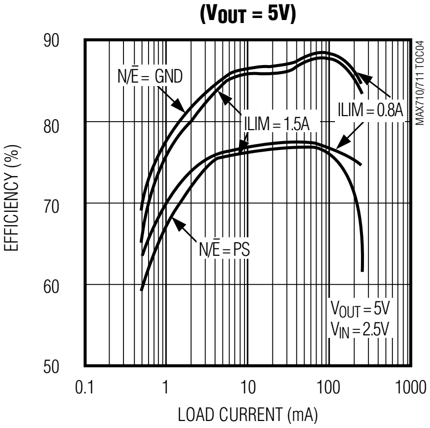

**EFFICIENCY vs. OUTPUT CURRENT— HIGH-EFFICIENCY MODE ($V_{OUT}$ = 3.3V)**



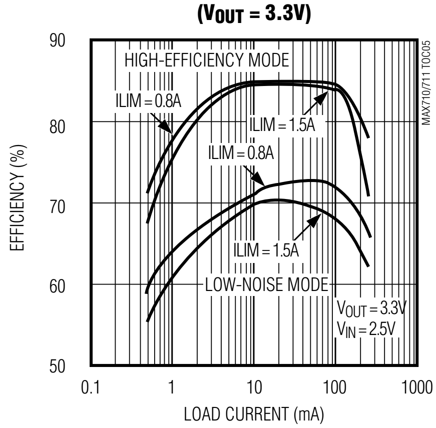

**MINIMUM START-UP INPUT VOLTAGE vs. LOAD CURRENT**



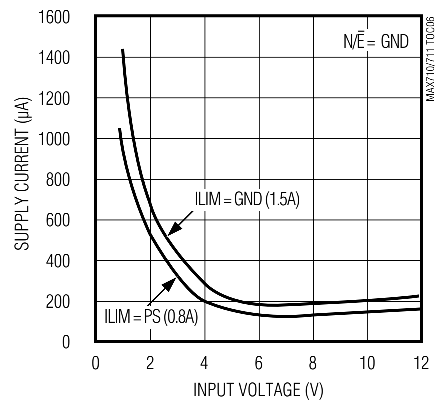

**EFFICIENCY vs. LOAD CURRENT— HIGH-EFFICIENCY AND LOW-NOISE MODES ($V_{OUT}$ = 5V)**



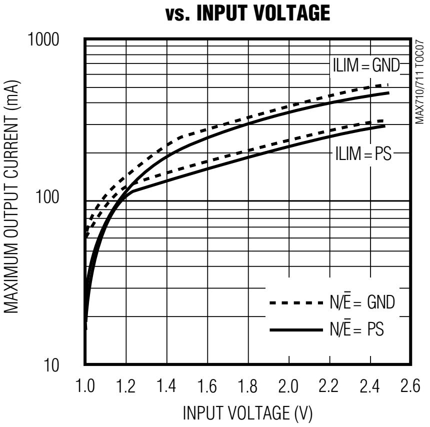

**EFFICIENCY vs. LOAD CURRENT— HIGH-EFFICIENCY AND LOW-NOISE MODES ($V_{OUT}$ = 3.3V)**



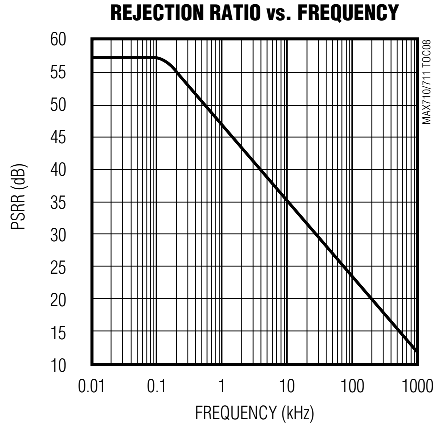

**NO-LOAD BATTERY CURRENT vs. INPUT VOLTAGE**



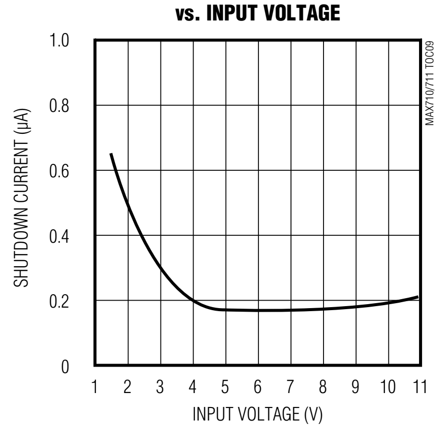

**MAXIMUM OUTPUT CURRENT vs. INPUT VOLTAGE**




**LINEAR-REGULATOR POWER-SUPPLY REJECTION RATIO vs. FREQUENCY**




**SHUTDOWN CURRENT vs. INPUT VOLTAGE**

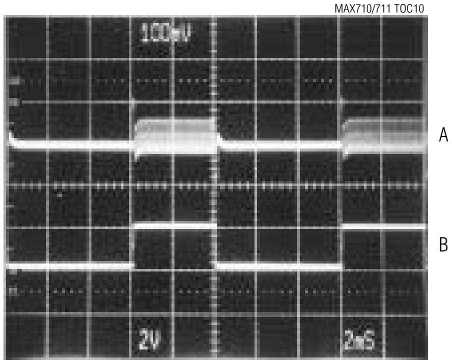


## Typical Operating Characteristics (continued)

($T_A$ = +25°C, unless otherwise noted.)

**LINE-TRANSIENT RESPONSE**

MAX710/711 TOC10

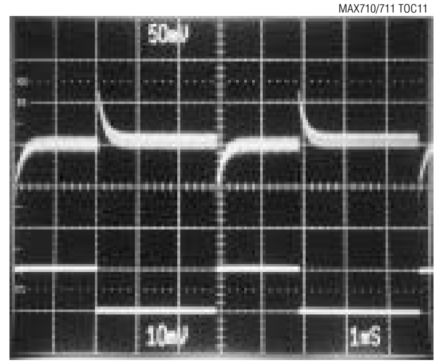



2ms/div

A: $V_{OUT}$ = 3.3V (100mV/div, AC COUPLED), N/$\overline{E}$ = GND
B: $V_{IN}$ = 2V TO 4V, $I_{OUT}$ = 100mA

**LOAD-TRANSIENT RESPONSE**

MAX710/711 TOC11

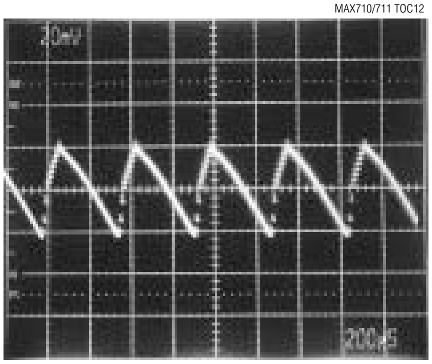



1ms/div

A: $V_{OUT}$ = 3.3V (50mV/div, AC COUPLED), N/$\overline{E}$ = PS
B: $I_{OUT}$ = 10mA TO 100mA

**OUTPUT RIPPLE (HIGH-EFFICIENCY MODE)**

MAX710/711 TOC12

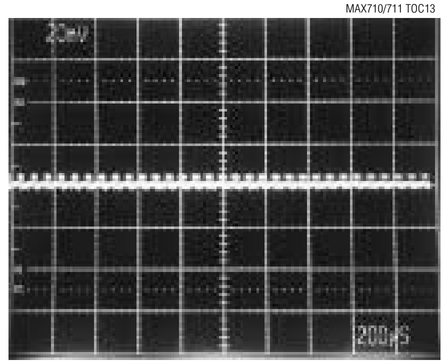



200µs/div

$V_{IN}$ = 2.5V, $I_{OUT}$ = 20mA, N/$\overline{E}$ = GND
$V_{OUT}$ = 5V (20mV/div, AC COUPLED), $I_{OUT}$ = 20mA

**OUTPUT RIPPLE (LOW-NOISE MODE)**

MAX710/711 TOC13

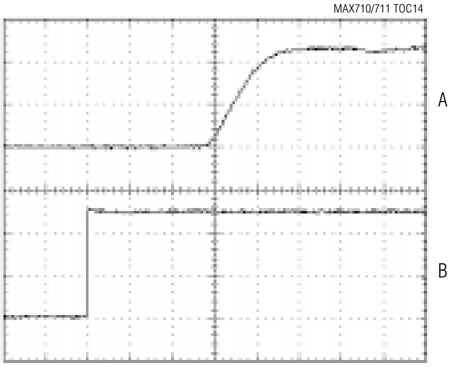



200µs/div

$V_{IN}$ = 2.5V, $I_{OUT}$ = 20mA, N/$\overline{E}$ = PS
$V_{OUT}$ = 5V (20mV/div, AC COUPLED), $I_{OUT}$ = 20mA

**START-UP DELAY**

MAX710/711 TOC14

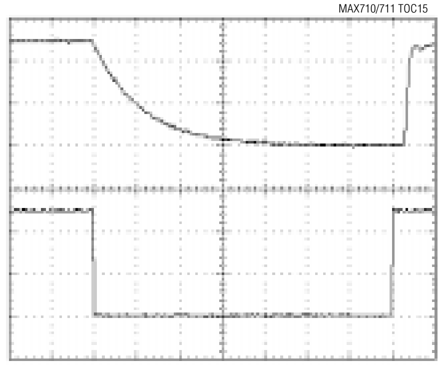



20µs/div

A: $V_{OUT}$ (2V/div), $I_{OUT}$ = 100mA
B: $V_{\overline{SHDN}}$ (2V/div)

**TURN-OFF DELAY**

MAX710/711 TOC15




200µs/div

A: $V_{OUT}$ (2V/div), $I_{OUT}$ = 100mA
B: $V_{\overline{SHDN}}$ (2V/div)

## Pin Description

| PIN | | NAME | FUNCTION |
|---|---|---|---|
| MAX710 | MAX711 | | |
| 1 | 1 | LX | Drain Connection for internal N-channel power MOSFET |
| 2 | 2 | PGND | Power Ground |
| 3 | 3 | ILIM | Inductor Current-Limit-Select Input. Connect to GND for 1.5A limit and to PS for 0.8A limit. |
| 4 | 4 | $\overline{SHDN}$ | Shutdown Input. When low, the entire circuit is off and OUT is actively pulled to GND. |
| 5 | 5 | $\overline{STBY}$ | Standby Input. Connect to GND to disable boost circuit. Connect to PS for normal operation. |
| 6 | — | 3/$\overline{5}$ | Selects the output voltage. Connect to GND for 5V output and to OUT for 3.3V output. |
| — | 6 | FB | Feedback Input |
| 7 | 7 | N/$\overline{E}$ | Selects low-noise or high-efficiency mode. Connect to GND for high efficiency and to PS for lowest noise. See *Operating Configurations* section. |
| 8 | 8 | LBO | Low-Battery Comparator Output |
| 9 | 9 | OUT | Linear-Regulator Output. Bypass with a 4.7µF capacitor to GND. |
| 10 | 10 | LBI- | Negative Input to Low-Battery Comparator |
| 11 | 11 | LBI+ | Positive Input to Low-Battery Comparator |
| 12 | 12 | PS | Source of internal PFET regulator. The IC is powered from PS. |
| 13 | 13 | REF | 1.28V Reference Voltage Output. Bypass with a 0.1µF capacitor to GND. |
| 14 | 14 | GND | Analog Ground. Must be low impedance. Solder directly to ground plane. |
| 15 | 15 | PGND | Power Ground |
| 16 | 16 | LX | Drain Connection for internal N-channel power MOSFET |

## Detailed Description

The MAX710/MAX711 integrate a step-up DC-DC converter with a linear regulator to provide step-up/down voltage conversion. The step-up switch-mode regulator contains an N-channel power MOSFET switch. It also shares a precision voltage reference with a linear regulator that contains a P-channel MOSFET pass element (Figure 1).

### Step-Up Operation

A pulse-frequency-modulation (PFM) control scheme with a constant 1µs off-time and variable on-time controls the N-channel MOSFET switch. The N-channel switch turns off when the part reaches the peak current limit or the 4µs maximum on-time. The ripple frequency is a function of load current and input voltage.

### Step-Down Operation

The low-dropout linear regulator consists of a reference, an error amplifier, and a P-channel MOSFET. The reference is connected to the error amplifier's inverting input. The error amplifier compares this reference with the selected feedback voltage and amplifies the difference. The difference is conditioned and applied to the P-channel pass transistor's gate.

### Operating Configurations

The MAX710/MAX711 have several operating configurations to minimize noise and optimize efficiency for different input voltage ranges. These configurations are accomplished via the N/$\overline{E}$ input, which controls operation of the on-chip linear regulator.

With N/$\overline{E}$ low, the linear regulator behaves as a 0.7Ω (at 5V output) PFET switch when the IC is boosting, and as a conventional linear regulator when $V_{IN} > V_{OUT}$. This provides optimum boost efficiency, but the PFET does little to reject boost-converter output ripple. With N/$\overline{E}$ high, boost ripple rejection is optimized by maintaining headroom ($V_{FV}$, typically 0.5V at 5V output) across the linear regulator. Boost mode efficiency is then about 10% lower than with N/$\overline{E}$ high.

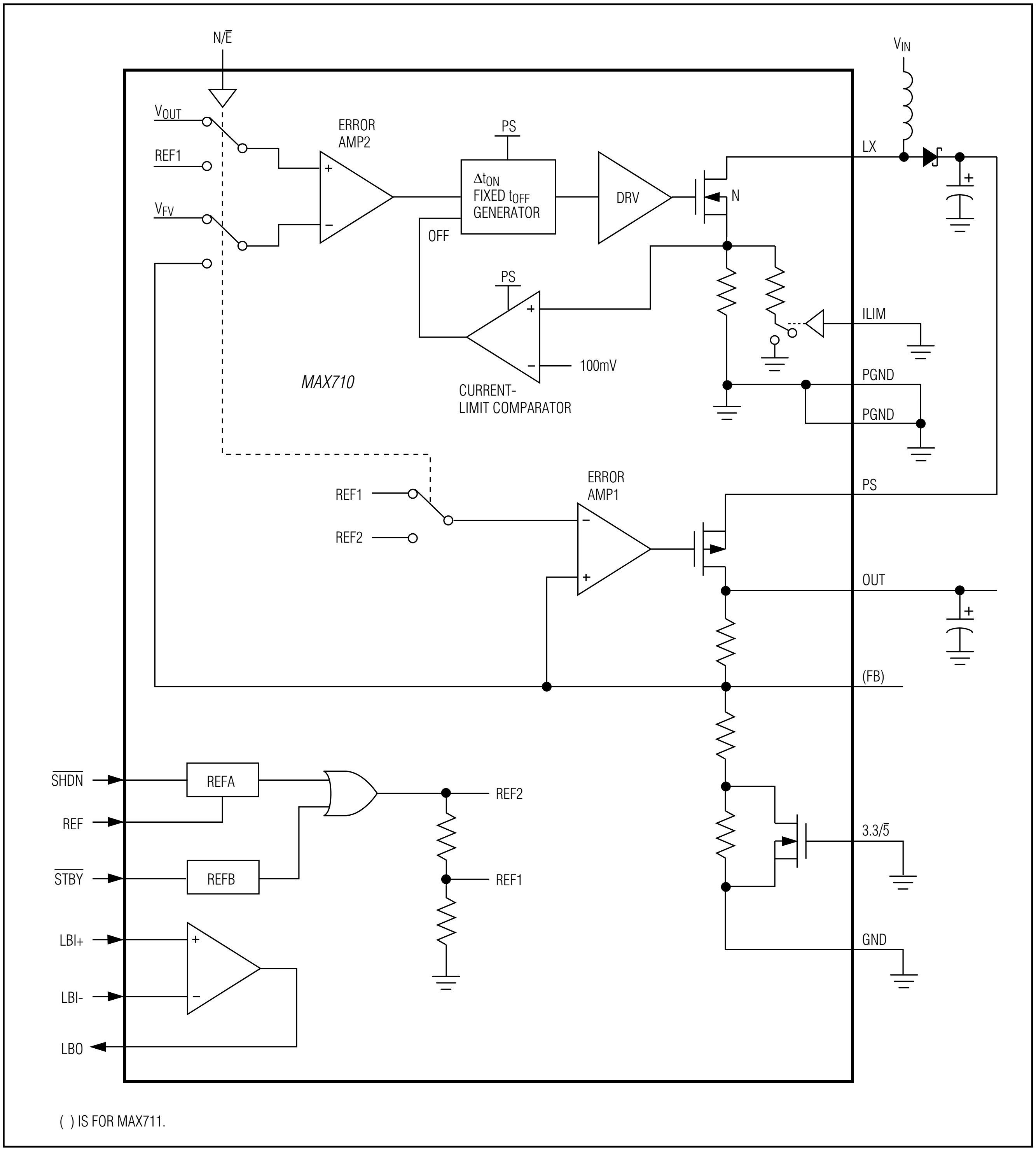



*Figure 1. Functional Diagram*

**In high-efficiency mode ($N/\overline{E}$ = low), the maximum input voltage is limited to 7V.** This voltage limitation is easily overcome, however, by configuring the LBO output to change modes based on input voltage, allowing an 11V maximum input with high-efficiency configurations. Four operating configurations are described in Table 1 and in the following subsections.

### Table 1. Operating Configurations

| NO. | DESCRIPTION | INPUT VOLTAGE | CONNECTIONS |
|---|---|---|---|
| 1 | High efficiency, 7V max $V_{IN}$ | Up to 7V | $N/\overline{E}$ = GND |
| 2 | High efficiency, $V_{BATT} < V_{OUT}$ (Figure 2a) | Up to 11V | LBO = $N/\overline{E}$<br>LBI- = $V_{OUT}$<br>LBI+ = $V_{IN}$ |
| 3 | High efficiency, 11V, $V_{BATT}$ < 6.5V (Figure 2b) | Up to 11V | LBO = $N/\overline{E}$<br>LBI- = REF<br>LBI+ = R5, R6 |
| 4 | Low noise | Up to 11V | $N/\overline{E}$ = PS |

***Configuration 1: High Efficiency, 7V Max $V_{IN}$***

With $N/\overline{E}$ connected to GND, when the IC boosts, the linear regulator operates only as a switch, with minimum forward drop, until $V_{IN} > V_{OUT}$ (where linear regulation begins). This configuration is limited to no more than 7V input, but provides best efficiency for battery-only operation or low-voltage AC adapter usage.

***Configuration 2: High Efficiency, $V_{BATT} < V_{OUT}$***

In this configuration, $N/\overline{E}$ is driven high by LBO when $V_{IN} > V_{OUT}$ (Figure 2a). When $V_{IN} < V_{OUT}$, the IC boosts, and the linear regulator operates as a switch, with minimum forward drop. When $V_{IN} > V_{OUT}$, the linear regulator operates with $V_{FV}$ forward drop, while $V_{PS}$ increases by $V_{FV}$ so that OUT maintains regulation. $V_{FV}$ is set inside the IC to approximately 0.5V (at 5V $V_{OUT}$). When $V_{IN}$ is only slightly higher than $V_{OUT}$, conversion efficiency is poorer than in configuration 1, so configuration 2 is most suitable when the battery voltage is less than $V_{OUT}$, but the AC adapter output is greater than $V_{OUT}$.

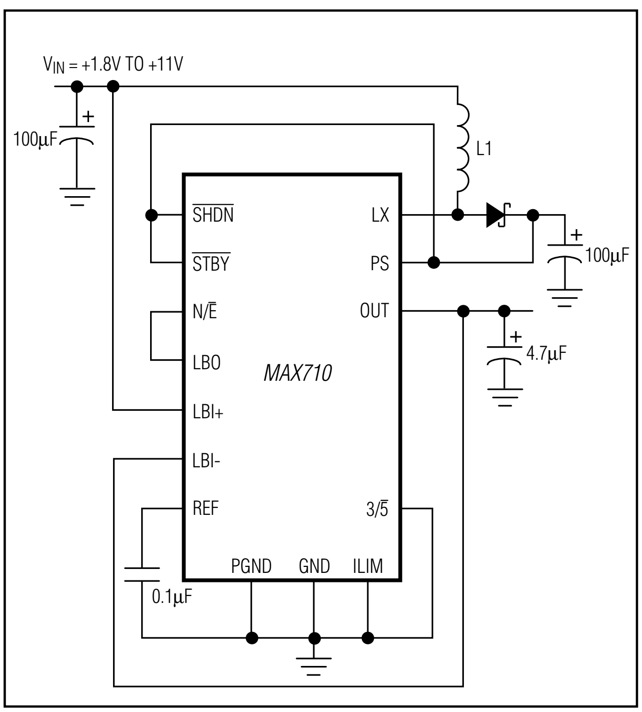



*Figure 2a. High-Efficiency Operating Configuration for $V_{BATT} < V_{OUT}$*

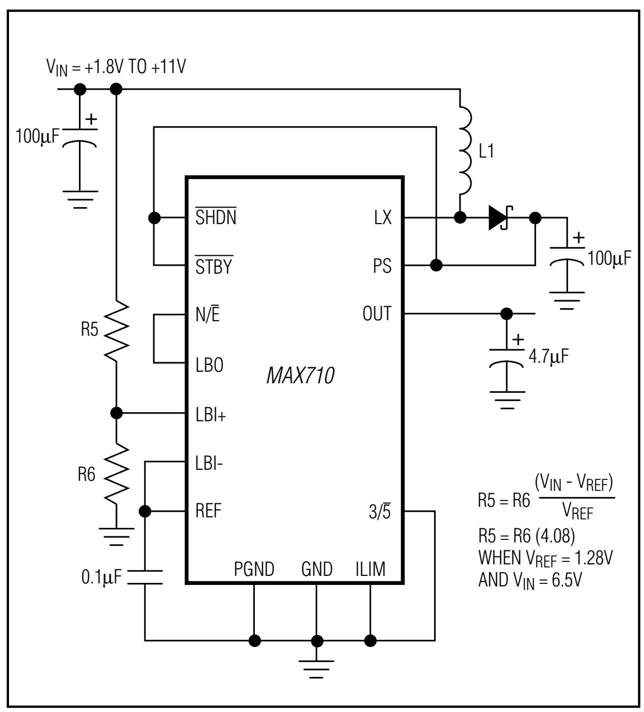



*Figure 2b. High-Efficiency Operating Configuration for $V_{BATT}$ < 6.5V*

#### *Configuration 3: High Efficiency, 11V, $V_{BATT}$ < 6.5V*

In this configuration, N/$\overline{E}$ is driven high by LBO when $V_{IN}$ > 6.5V (Figure 2b). When $V_{IN}$ < $V_{OUT}$, the IC boosts, and the linear regulator operates as a switch, with minimum forward drop. When $V_{IN}$ > $V_{OUT}$, linear regulation begins. When $V_{IN}$ > 6.5V (set by R5 and R6), the linear regulator forces a minimum forward drop of $V_{FV}$ (typically 0.5V at 5V $V_{OUT}$) as LBO drives N/$\overline{E}$ high. This transition is not seen at the output, since the linear regulator already has an input-output voltage difference of 6.5V - 5V. Efficiency with $V_{IN}$ slightly higher than $V_{OUT}$ is equal to that of configuration 1, so configuration 3 is most suitable when the battery voltage may be near $V_{OUT}$. This hookup has no functional shortcomings compared with configuration 2, except that two additional resistors (R5 and R6) are needed.

#### *Configuration 4: Low Noise*

With N/$\overline{E}$ connected to PS, when the IC is boosting, the linear regulator operates with $V_{FV}$ forward voltage (typically 0.5V at 5V $V_{OUT}$) for optimum noise rejection. Linear regulation occurs when $V_{IN}$ > $V_{OUT}$ + $V_{FV}$. The $V_{FV}$ voltage differential results in boost efficiency typically 10% lower than with the high-efficiency configurations.

### *ILIM*

The current-limit-select input, ILIM, selects between the two peak current limits: 1.5A (ILIM = GND) and 0.8A (ILIM = PS). If the application requires 200mA or less from the MAX710/MAX711, select 0.8A. The lower peak current limit permits the use of smaller, low-cost inductors. The ILIM input is internally diode clamped to GND and PS, and should not be connected to signals outside this range.

### *Shutdown and Standby Modes*

Grounding $\overline{SHDN}$ turns off the MAX710/MAX711 completely, disconnecting the input from the output. Tie $\overline{SHDN}$ to PS for normal operation.

The MAX710/MAX711 have a standby mode that shuts down the step-up converter. The linear regulator remains on with a 7µA (typ) LDO quiescent current. Connect $\overline{STBY}$ to ground to enter standby mode; otherwise, connect $\overline{STBY}$ to PS.

## *Design Procedure*

### *Output Voltage Selection*

For the MAX710, you can obtain a 3.3V or 5V output voltage by tying 3/$\overline{5}$ to GND or PS. Efficiency is typically 85% over a 2mA to 250mA load range. The device is bootstrapped, with power derived from the step-up voltage output (at PS). Under all load conditions, the MAX710/MAX711 typically start up with a 1V input. If the battery voltage exceeds the programmed output voltage, the output will linear regulate down to the selected output voltage.

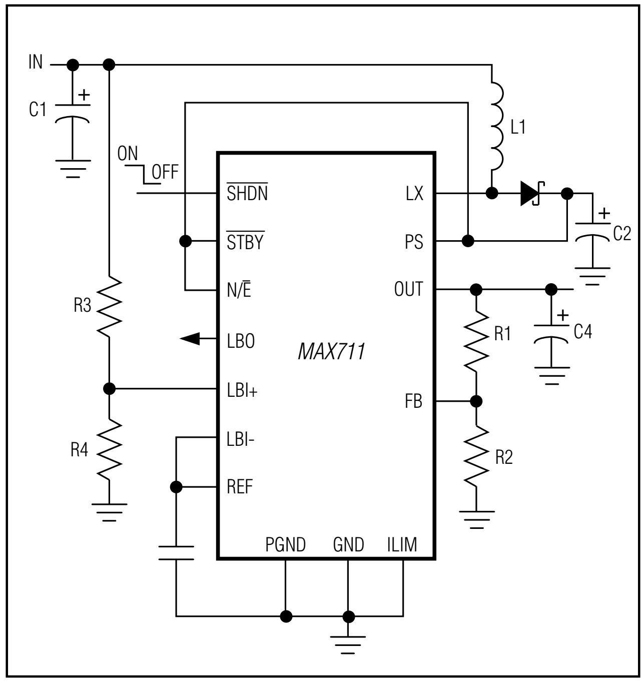



*Figure 3. MAX711 Adjustable Output Voltage*

The MAX711's adjustable output voltage is set by two resistors, R1 and R2 (Figure 3), which form a voltage divider between the output and FB. Use the following equation to determine the resistor values:

$$R1 = R2 [(V_{OUT} / V_{REF}) - 1]$$

where $V_{REF}$ = 1.25V.

Since the input bias current at FB has a maximum value of 50nA, R1 and R2 can be large with no significant accuracy loss. Choose R2 in the 100kΩ to 1MΩ range and calculate R1 using the formula above. For 1% error, the current through R1 should be at least 100 times FB's bias current.

### *Low-Battery Comparator*

The MAX710/MAX711 contain a comparator for low-battery detection. If the voltage at LBI+ falls below that at LBI- (typically connected to REF), LBO goes low. Hysteresis is typically 50mV. Set the low-battery monitor's threshold with two resistors, R3 and R4 (Figure 2), using the following equation:

$$R3 = R4 [(V_{LBT} / V_{LBI-}) - 1]$$

## Table 2. Component Selection

| INDUCTORS (L1) | CAPACITORS | RECTIFIERS (D1) |
|---|---|---|
| Sumida CD75-220 (1.5A), CDRH-74-220 (1.23A), or CD54-220 | 100µF, 16V low-ESR tantalum capacitor AVX TPSE107M016R0100 or Sprague 593D107X0016E2W | Schottky diode Motorola MBRS130T3 |
| Coilcraft DO33-08P-223 | 4.7µF, 16V tantalum capacitor Sprague 595D475X0016A2T | |

where $V_{LBT}$ is the desired threshold of the low-battery detector and $V_{LBI-}$ is the voltage applied to the inverting input of the low-battery comparator. Since LBI current is less than 50nA, R3 and R4 can be large (typically 100kΩ to 1MΩ), minimizing input supply loading. If the low-battery comparator is not used, connect LBI+ to PS and LBI- to REF, leaving LBO unconnected.

### Inductor Selection

A 22µH inductor value performs well in most MAX710/MAX711 applications. The inductance value is not critical, however, since the MAX710/MAX711 work with inductors in the 18µH to 100µH range. Smaller inductance values typically offer a smaller size for a given series resistance, allowing the smallest overall circuit dimensions. Circuits using larger inductance values exhibit higher output current capability and larger physical dimensions for a given series resistance. The inductor's incremental saturation current rating should be greater than the peak switch-current limit, which is 1.5A for ILIM = GND and 0.8A for ILIM = PS. However, it is generally acceptable to bias most inductors into saturation by as much as 20%, although this slightly reduces efficiency. The inductor's DC resistance significantly affects efficiency. See Tables 2 and 3 for a list of suggested inductors and suppliers.

### Capacitor Selection

A 100µF, 16V, 0.1Ω equivalent series resistance (ESR), surface-mount tantalum (SMT) output filter capacitor, C2, typically exhibits 50mV output ripple when stepping up from 2V to 5V at 100mA. Smaller capacitors (down to 10µF with higher ESRs) are acceptable for light loads or in applications that can tolerate higher output ripple. The ESR of both bypass and filter capacitors affects efficiency and output ripple. Output voltage ripple is the product of the peak inductor current and the output capacitor's ESR. Use low-ESR capacitors for best performance, or connect two or more filter capacitors in parallel. Low-ESR, SMT capacitors are currently available from Sprague (595D series) and AVX (TPS series). Sanyo OS-CON organic-semiconductor through-hole capacitors also exhibit very low ESR and are especially useful for operation at cold temperatures. The output capacitor, C3, needs to be only 4.7µF to maintain linear regulator stability. See Tables 2 and 3 for a list of suggested capacitors and suppliers.

### Rectifier Diode

For optimum performance, use a switching Schottky diode. Refer to Tables 2 and 3 for the suggested diode and supplier.

## Applications Information

The MAX710/MAX711 high-frequency operation makes PC layout important for minimizing ground bounce and noise. Keep the IC's GND pin and the ground leads of C1 and C2 (Figure 1) less than 0.2in. (5mm) apart. Also keep all connections to the FB and LX pins as short as possible. To maximize output power and efficiency and minimize output ripple voltage, use a ground plane and solder the IC's GND pin directly to the ground plane.

## Table 3. Component Suppliers

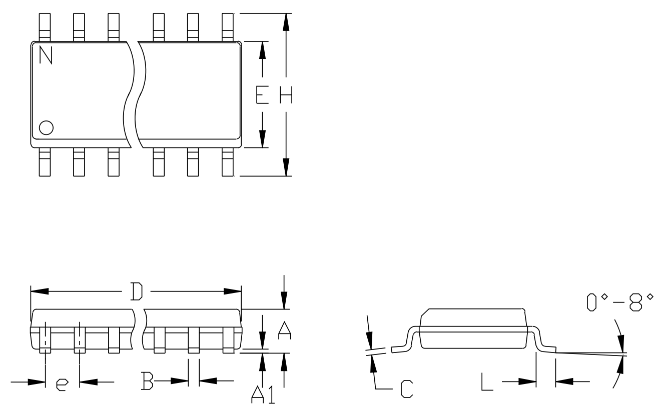
| SUPPLIER | PHONE | FAX |
|---|---|---|
| AVX | (803) 946-0690 | (803) 626-3123 |
| Coilcraft | (847) 639-6400 | (847) 639-1469 |
| Motorola | (602) 303-5454 | (602) 994-6430 |
| Sanyo | (619) 661-6835 | (619) 661-1055 |
| Sprague | (603) 224-1961 | (603) 224-1430 |
| Sumida | (847) 956-0666 | (847) 956-0702 |

## Chip Information

TRANSISTOR COUNT: 661

SUBSTRATE CONNECTED TO GND

## 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 | | | |
|---|---|---|---|---|---|---|
| | MIN | MAX | MIN | MAX | N | MS012 |
| 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

PROPRIETARY INFORMATION | TITLE: PACKAGE FAMILY OUTLINE: SOIC .150" | 1/1 | DOCUMENT CONTROL NUMBER: 21-0041 | REV: A

NOTES





***Maxim Integrated 160 Rio Robles, San Jose, CA 95134 USA 1-408-601-1000***