Click here to ask an associate for production status of specific part numbers.

MAX18000

500mV to 5.5V Input nanoPower Boost Converter with Short-Circuit Protection

General Description

The MAX18000 is a nanoPower boost converter with an input voltage range of 0.5V to 5.5V ($V_{OUT} > V_{IN} + 0.2V$) and a switching current limit of 3.6A. It features an ultra-low quiescent current of 512nA which makes it ideal for battery-powered applications requiring a long standby time. The IC operates in nanoPower mode at low loads and transitions into skip and CCM modes of operation at higher load currents to ensure high efficiency over a wide current range.

The output voltage can be varied between 2.5V and 5.5V using a single R_{SEL} resistor.

The IC features a True Shutdown™ mode, which disconnects V_{IN} and V_{OUT} when the EN pin is pulled low. It also features short-circuit protection circuitry that limits the current to 700mA when $V_{OUT} < 0.5V$ and automatically restarts the part when the fault is removed. The thermal-shutdown protection disables the part when the junction temperature crosses +165°C (typ).

The IC is available in 1.07mm x 1.57mm, 6-bump wafer-level package (WLP).

Benefits and Features

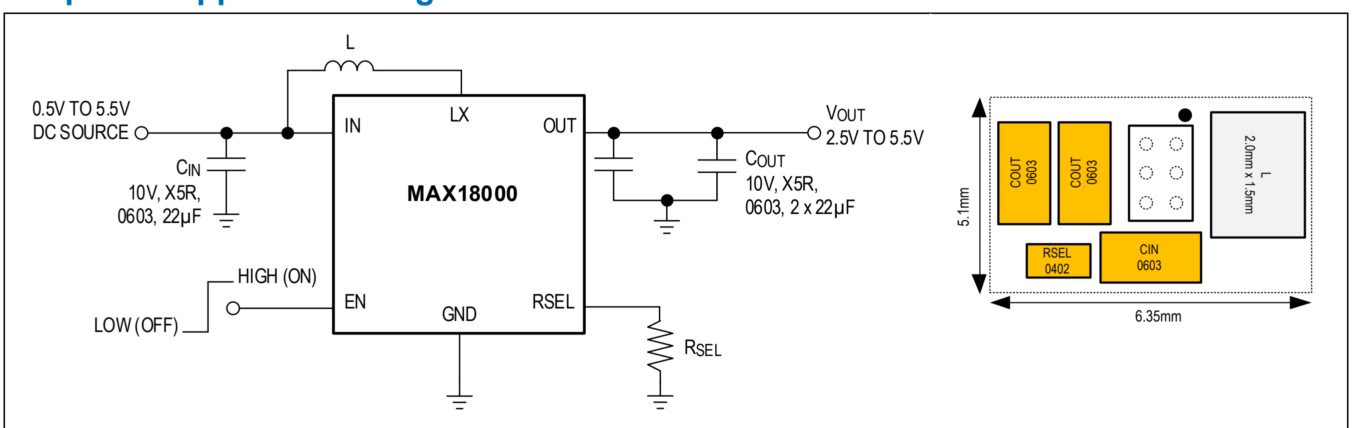
- 0.5V to 5.5V Input Voltage ($V_{OUT} > V_{IN} + 0.2V$)
- 1.8V Minimum Start-Up Voltage
- 2.5V to 5.5V (In 100mV Steps) Output Voltage
- 3.6A Cycle-by-Cycle Inductor Current Limit
- 512nA I_Q Supply Current into the Output
- True-Shutdown Mode
  - 7nA Shutdown Current
  - Output Disconnects from Input with no Forward or Reverse Current
- Output Short-Circuit Protection
- Thermal-Shutdown Protection
- 95% Peak Efficiency with 90% or Higher Efficiency for Load > 20µA
- 1.07mm x 1.57mm, 0.5mm Pitch 6-Bump WLP
- -40°C to +125°C Operating Temperature Range

Key Applications

- Wearable Applications
- IoT Applications
- Battery-Powered Applications
- Portable Devices
- Metering Applications

***Ordering Information** appears at end of data sheet.*

Simplified Application Diagram



19-101651; Rev 0; 2/23

Absolute Maximum Ratings

IN, EN, OUT, R_{SEL} to GND ....-0.3V to +6V

PGND to GND ....-0.3V to +0.3V

LX RMS current ....$-2.4A_{RMS}$ to $+2.4A_{RMS}$

LX to GND (Note 1) ....-0.3V to V_{OUT} + 0.3V

Output Short Circuit Duration...................................Continuous

Continuous Power Dissipation (T_A = +70°C (derate 12.34mW/°C above +70°C)) 980mW

Operating Temperature Range ....-40°C to +125°C

Maximum Junction Temperature.................................+150°C

Storage Temperature Range ....-65°C to +150°C

Lead Temperature (soldering, 10s) ....+300°C

Soldering Temperature (reflow)...................................+260°C

Note 1: LX pin has internal clamps to GND and OUT. These diodes may be forward biased during switching transitions. During these transitions, the max LX current should be within the Max RMS Current rating for safe operation.

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.

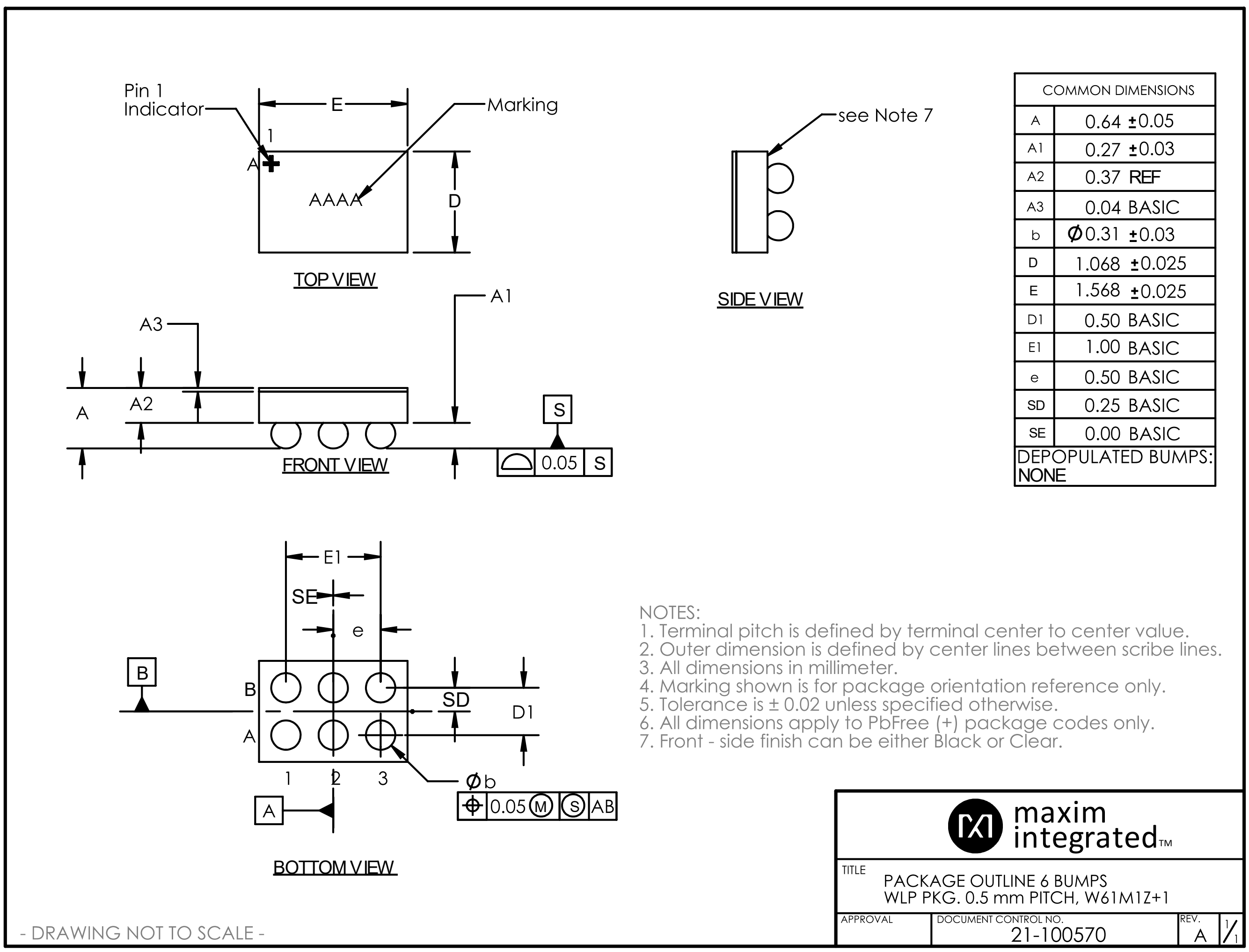
Recommended Operating Conditions

PARAMETER	SYMBOL	TYPICAL RANGE
Input Voltage Range	V_{IN}	0.5V to 5.5V
Switching Current Limit	I_{PEAK_LX}	0A to 3.6A
Operating Junction Temperature	T_J	-40°C to +125°C

Package Information

WLP

Package Code	W61M1Z+1
Outline Number	21-100570
Land Pattern Number	Refer to Application Note 1891
Thermal Resistance, Four-Layer Board:	
Junction to Ambient (θ_{JA})	81.03°C/W
Junction to Case Thermal Resistance (θ_{JC})	NA



Electrical Characteristics

(V_{IN} = 3V, V_{OUT} = 3.3V, EN = HIGH, T_J = -40°C to +125°C, unless otherwise specified, (Note 2).)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Input Voltage Range	V_{IN}	Input Range after start-up (Note 3)	0.5		5.5	V
Input Voltage UVLO	V_{IN_UVLO}	V_{IN} Rising, When V_{OUT} is 1V or below	1.75	1.8	1.85	V
		V_{IN} Falling, When V_{OUT} is 1V or below	1.65	1.7	1.75	
Supply Current Into OUT	I_{Q_OUT}	V_{EN} = V_{IN}, Not Switching, V_{OUT} = 105% of Target Voltage, T_J = +25°C, R_{SEL} = 191KΩ		512	800	nA
Supply Current Into IN	I_{Q_IN}	V_{EN} = V_{IN}, Not Switching, V_{OUT} = 105% of Target Voltage, T_J = +25°C	-100	+10	+100	nA
Input Shutdown Current	I_{SD_IN}	V_{EN} = V_{OUT} = 0V, T_J = +25°C		7	36	nA
LX Maximum Duty Cycle	DC_NPWR	T_J = +25°C (Note 4)		85		%
POWER SWITCHES						
High-Side R_{DSON}	R_{DS_H}			60	90	mΩ
Low-Side R_{DSON}	R_{DS_L}			30	60	mΩ
OUTPUT VOLTAGE						
Output Voltage Range	V_{OUT}	(Note 3, Note 8)	2.5		5.5	V
Output Accuracy	V_{OUT_ACC}	Measured when the part exits nanoPower Mode and is in Skip Mode (Note 5)	-1		+1	%
DC Load Regulation	ACC_{LOAD}	Load from 20mA to I_{OUT} at 80% of Peak Inductor Current		-1		%
DC Line Regulation	ACC_{LINE}	Duty Cycle varied from 25% to Maximum		-1		%
LX SWITCHING WAVEFORMS						
Switching Frequency	F_{SW}	V_{IN} = 3.3V, V_{OUT} - V_{IN} > 0.25V, PWM mode, T_J = 25°C		2		MHz
LX T_{ON}	$T_{ON\_3.3V}$	V_{IN} = 3.3V, V_{OUT} = 5V	136	170	204	ns
	$T_{ON\_1.8V}$	V_{IN} = 1.8V, V_{OUT} = 5V	256	320	384	
LX Minimum T_{ON}	T_{ONMIN}	V_{IN} = 3V, V_{OUT} = 3.3V	50	60	70	ns
LX Minimum T_{OFF}	T_{OFFMIN}	V_{IN} = 3V, V_{OUT} = 3.3V	50	60	70	ns
LIGHT LOAD CONDITION						
Zero-Crossing Threshold	I_{ZX_LX}	(Note 6)	75	150	225	mA
nanoPower regulation Hysteresis	V_{NPWR_HYS}	V_{IN} = 3V, V_{OUT} = 3.3V (Note 9)	66	83	132	mV
STARTUP						
Soft-Start Time	t_{SS_LINEAR}	Target V_{IN} = V_{OUT} = 3.6V, Linear Mode, C_{OUTEFF} = 22µF, T_J = 25°C; In linear phase		350		µs
Soft-Start Rate	dV/dt	V_{IN} = 3.6V, V_{OUT} from 3.3V to 5V, C_{OUTEFF} = 22µF, T_J = 25°C; In boost phase		3		V/ms
ENABLE, R_{SEL}, ACTIVE DISCHARGE						
Required Select Resistor Accuracy	ACC_{RSEL}	Use the resistor from R_{SEL} Selection Table.		±1		%

(V_{IN} = 3V, V_{OUT} = 3.3V, EN = HIGH, T_J = -40°C to +125°C, unless otherwise specified, (Note 2).)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Select Resistor Detection Time	t_{RSEL}	C_{RSEL} < 2pF, (Note 7)		600	1320	µs
Active Discharge Resistance	R_{DIS}	Between OUT and GND, when EN = low		100		Ω
Enable Input Leakage	I_{LEAK_EN}	T_J = 25°C, V_{EN} = 5.5V		1.5	100	nA
Enable Voltage Threshold	V_{IH}	V_{EN} rising, LX begins switching		0.8	1.2	V
	V_{IL}	V_{EN} falling, LX stops switching	0.4			
PROTECTION						
Inductor Peak Current Limit	I_{PEAK_LX}	V_{OUT} = 3.3V (Note 6)	3	3.6	4	A
Short Circuit Current Limit	I_{SC}	V_{IN} = V_{EN} = 2.5V, V_{OUT} < 0.5V, V_{OUT} Hysteresis = 100mV	400	700	1000	mA
Short Circuit Detection Time	t_{SC}	V_{IN} – V_{OUT} = 0.7V		100		ns
Thermal Shutdown Threshold	T_{SHUT_R}	T_J Rising		165		˚C
	T_{SHUT_F}	T_J Falling		150		

Note 2: Limits over the specified operating temperature and supply voltage range are guaranteed by design and characterization, and production is tested at room temperature only.

Note 3: V_{IN} should be at least 200mV lower than V_{OUT}, so that part operates in boost mode.

Note 4: Guaranteed by measuring LX frequency and duty cycle. Maximum duty cycle is a function of input voltage since LX on time varies with V_{IN}.

Note 5: This does not account for ripple, load regulation, and line regulation.

Note 6: This is a static measurement. The actual peak current limit and zero-crossing threshold depend on V_{IN} and L due to propagation delays.

Note 7: This is the time required to determine the R_{SEL} value. This time adds to the startup time.

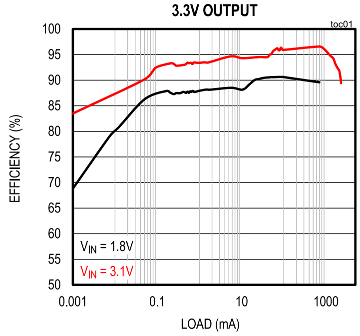
Note 8: nanoPower is disabled when OUT regulation is set above 5V.

Note 9: The 83mV (typical) was measured at 3.3V_{IN}, 3.3V_{OUT}. The regulation hysteresis is typically set to 2.5% of the output voltage for other V_{OUT} levels. The hysteresis measurement does not account for ripple.

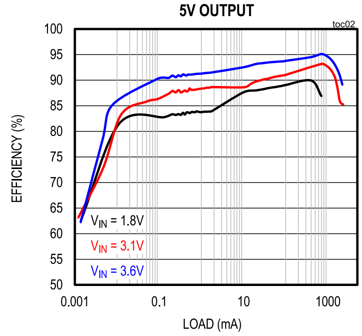
Typical Operating Characteristics

(V_{IN} = 3.6V, V_{OUT} = 5V, L = 470nH (DFE201612E-R47M for V_{OUT} = 5V) and 330nH (DFE201612E-R33M for V_{OUT} = 3.3V), C_{OUT} = 2 x 22µF (C1608X5R1A226M080AC), T_A = +25°C unless otherwise noted. Measurement is limited by switching the current limit. Actual maximum output current depends on system thermal performance.)

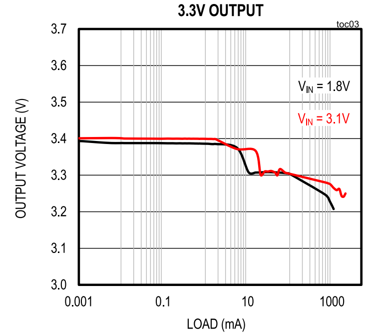
EFFICIENCY vs. LOAD
3.3V OUTPUT



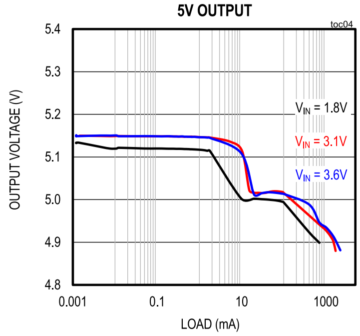
EFFICIENCY vs. LOAD
5V OUTPUT



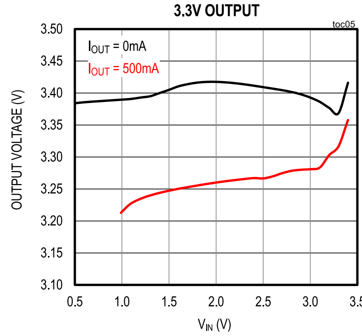
LOAD REGULATION
3.3V OUTPUT



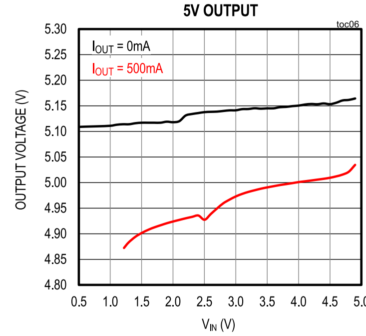
LOAD REGULATION
5V OUTPUT



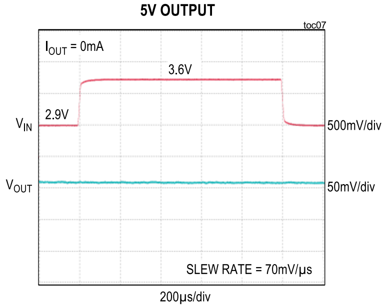
LINE REGULATION
3.3V OUTPUT



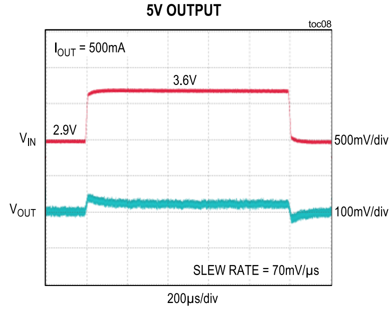
LINE REGULATION
5V OUTPUT



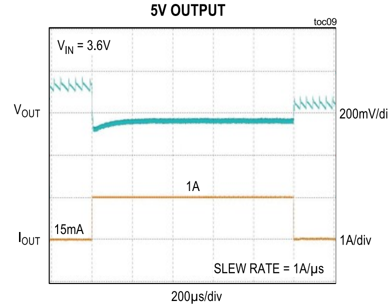
LINE TRANSIENT RESPONSE
5V OUTPUT



LINE TRANSIENT RESPONSE
5V OUTPUT

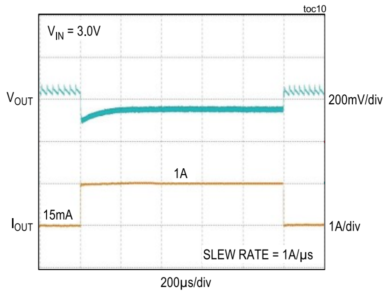


LOAD TRANSIENT RESPONSE
5V OUTPUT

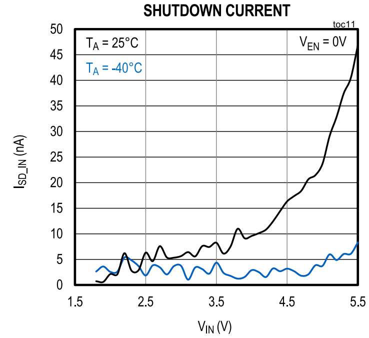


(V_{IN} = 3.6V, V_{OUT} = 5V, L = 470nH (DFE201612E-R47M for V_{OUT} = 5V) and 330nH (DFE201612E-R33M for V_{OUT} = 3.3V), C_{OUT} = 2 x 22µF (C1608X5R1A226M080AC), T_A = +25°C unless otherwise noted. Measurement is limited by switching the current limit. Actual maximum output current depends on system thermal performance.)

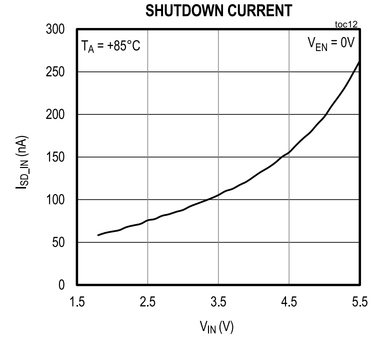
LOAD TRANSIENT RESPONSE
5V OUTPUT



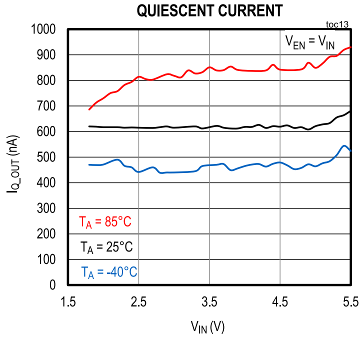
SHUTDOWN CURRENT



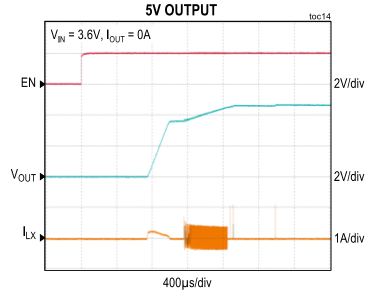
SHUTDOWN CURRENT



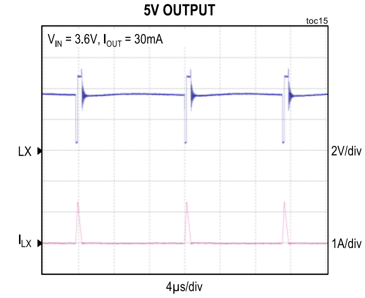
QUIESCENT CURRENT



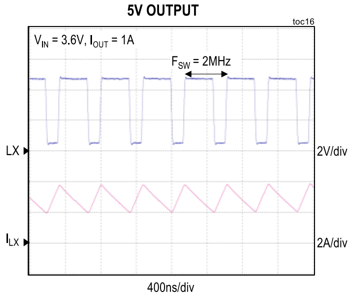
SOFT-START WAVEFORM
5V OUTPUT



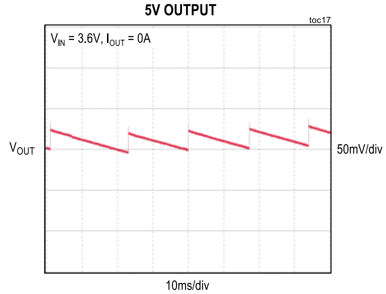
SWITCHING WAVEFORM
5V OUTPUT



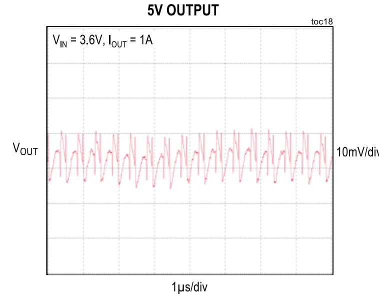
SWITCHING WAVEFORM
5V OUTPUT



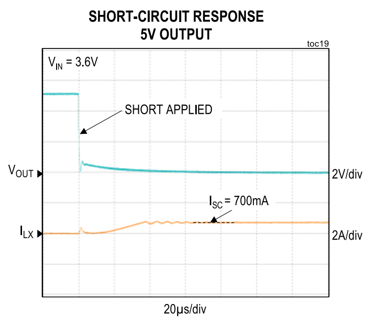
OUTPUT RIPPLE WAVEFORM
5V OUTPUT

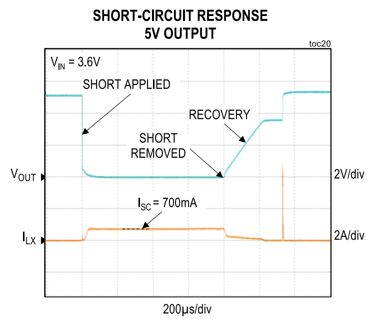


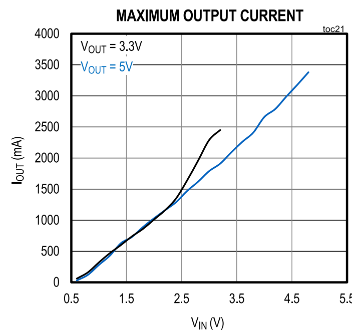
OUTPUT RIPPLE WAVEFORM
5V OUTPUT



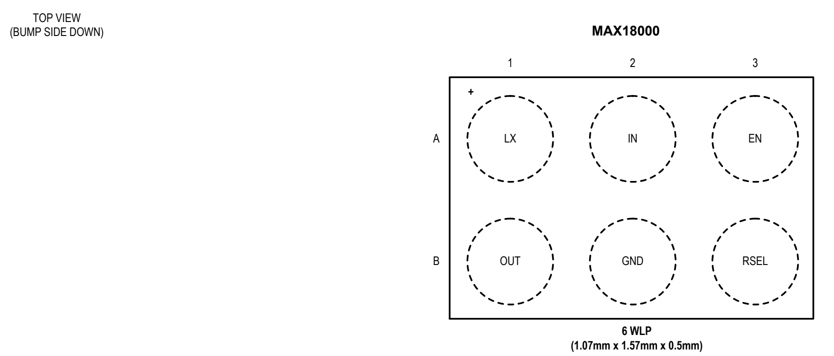
(V_{IN} = 3.6V, V_{OUT} = 5V, L = 470nH (DFE201612E-R47M for V_{OUT} = 5V) and 330nH (DFE201612E-R33M for V_{OUT} = 3.3V), C_{OUT} = 2 x 22µF (C1608X5R1A226M080AC), T_A = +25°C unless otherwise noted. Measurement is limited by switching the current limit. Actual maximum output current depends on system thermal performance.)







Pin Configuration



Pin Descriptions

PIN	NAME	FUNCTION	Type
A1	LX	Switching Node. Connect the inductor (See the *Inductor Selection* section for more information) from LX to IN.	Power
A2	IN	Input Pin. Connect a 22µF X7R ceramic capacitor from IN to ground. Depending on the specific application requirements, more capacitance may be needed.	Power
A3	EN	Enable Input Pin. Force this pin to higher than 1.2V to enable the boost converter. Force this pin below 0.4V to disable the part and enter True Shutdown Mode.	Digital
B1	OUT	Output Pin. Connect a 2 x 22µF X7R ceramic capacitor from OUT to GND.	Power
B2	PGND	Power Ground. Connect to System GND	Ground
B3	RSEL	Output Voltage Select Pin. Connect a resistor from R_{SEL} to GND based on the desired output voltage. See *Table 1* for more information. R_{SEL} floats in shutdown. Care must be taken that the total capacitance on this pin should be less than 2pF.	Analog

Functional Diagram

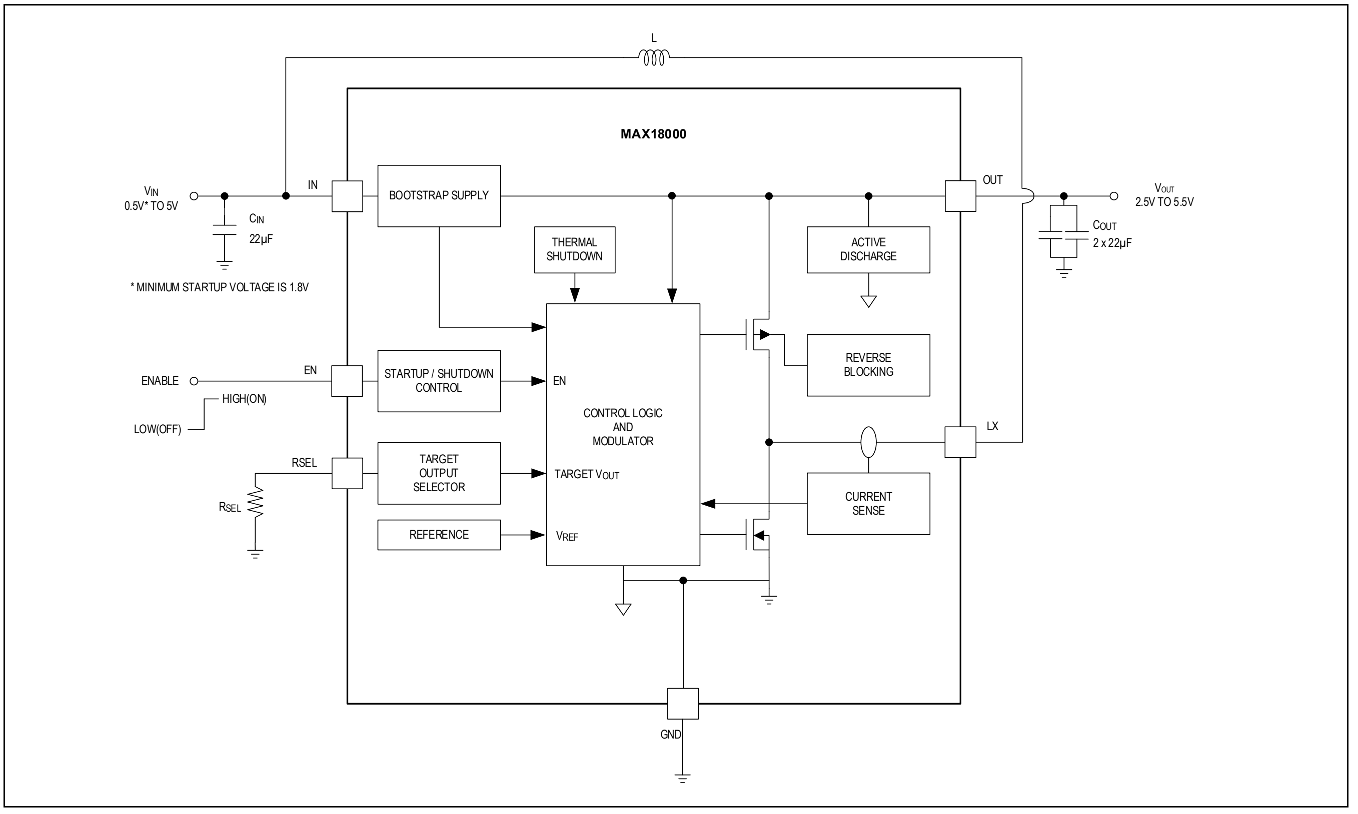


Figure 1. MAX18000 Simplified Block Diagram

Detailed Description

The MAX18000 is a nanoPower boost converter with an input voltage range of 500mV to 5.5V ideal for battery power applications with long standby times. The start-up voltage required for the IC is about 1.8V (typical). The output voltage is adjustable between 2.5V and 5.5V (in steps of 100mV) using a single external resistor connected between R_{SEL} and GND. For the part to operate in boost mode, it is essential to keep the V_{IN} level at least 200mV below the V_{OUT} level.

The low quiescent current helps the part maintain high efficiency at low loads (about 90% at a load of 20μA). The IC operates in three modes according to the load current: nanoPower mode, skip mode, and continuous conduction mode (CCM). In nanoPower mode, the part deactivates the error amplifier and other internal blocks to lower I_Q.

The part is equipped with a cycle-to-cycle switch current limit, thermal shutdown, and short-circuit protection to protect the system and the device itself.

Output-Voltage Selection

The MAX18000 has a unique single resistor output selection method where the resistor connected between R_{SEL} and GND is used to select different output voltages from 2.5V to 5.5V (nanoPower mode disabled for target V_{OUT} > 5V) in 100mV steps as shown in *Table 1*. The advantages of using a single R_{SEL} for output voltage selection are as follows:

- Lower cost and smaller size, since only one resistor is needed versus the two resistor strings needed in typical feedback connections.
- No power loss through feedback resistors during operation, leading to higher efficiency.
- Allows customers to stock just one part in their inventory system and use it in multiple projects with different output voltages just by changing a single standard 1% resistor.

Table 1. R_{SEL} Selection Table

OUTPUT VOLTAGE (V)	R_{SEL} (kΩ)**
2.5	768
2.6	634
2.7	536
2.8	452
2.9	383
3.0	324
3.1	267
3.2	226
3.3	191
3.4	162
3.5	133
3.6	113
3.7	95.3
3.8	80.6
3.9	66.5
4.0	56.2
4.1	47.5
4.2	40.2
4.3	34
4.4	28
4.5	23.7

4.6	20
4.7	16.9
4.8	14
4.9	11.8
5.0	10.0
5.1*	8.45
5.2*	7.15
5.3*	5.9
5.4*	4.99
5.5*	Short to Ground

**nanoPower mode disabled for V_{OUT} > 5V.*

***Use a standard 1% resistor at R_{SEL} pin.*

Soft-Start

When the EN logic goes high and $V_{IN} > V_{IN\_UVLO}$, the MAX18000 starts up by turning on the bias circuitry, after which the resistance value at the R_{SEL} pin is read to set theP V_{OUT} target voltage level. The IC addresses the issue of high inrush current during startup by having the high-side PMOS operate in linear mode (PMOS slew) till $V_{OUT} = V_{IN}$. The PMOS slew phase typically takes about 350µs.

After the PMOS slew is complete, the high-side PMOS turns off, and the IC enters a boost-slew mode. In the boost slew mode of operation, the part switches such that the output voltage ramps up at a slew rate of 3V/ms (typical) until the regulation target.

If the IC sees an output voltage level of less than 0.5V after the PMOS slew timer expires (350µs typical), it enters short-circuit protection mode. In short-circuit protection mode, the IC stops switching, and the PMOS current is limited to 700mA (typical).

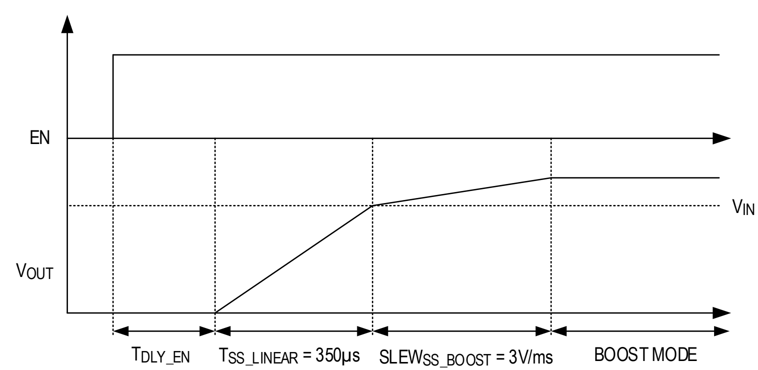


Figure 2. Soft-Start Behavior

Boost Control Scheme

The MAX18000 operates based on an adaptive on-time current-mode control. Adaptive on-time is used to get a fast transient response and better efficiency across the operating range. In both continuous conduction mode (CCM) and discontinuous conduction mode (DCM), the on-time is adjusted depending on the input voltage and target output voltage.

nanoPower Mode

The MAX18000 automatically enters nanoPower mode when the load current is very low to achieve high efficiency at light loads. When the load current is reduced, the switching frequency also reduces. When the switching frequency reduces below 28kHz (typical), the part enters nanoPower mode. In nanoPower mode, the part turns off the error amplifier and other internal blocks to reduce the power consumption and goes to sleep. Once the V_{OUT} level drops below the threshold, the part wakes up and initiates switching cycles to bring the output voltage into regulation. The device regulates to 102.5% of the target voltage when operating in nanoPower mode. When the load is increased and the V_{OUT} level drops below the threshold, the part starts switching and enters normal operation (DCM or CCM mode).

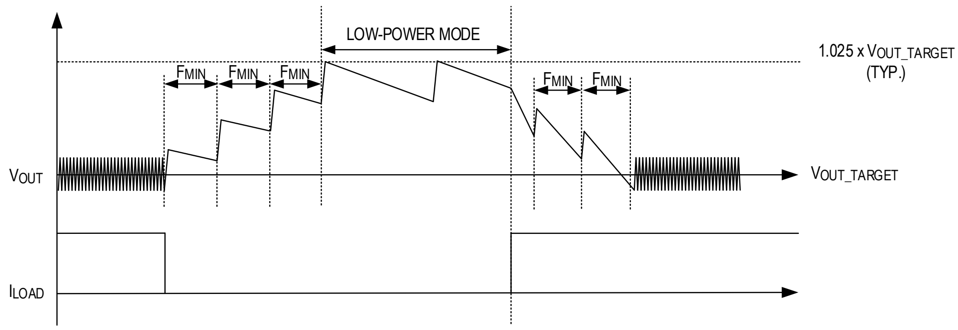


Figure 3. nanoPower Mode of Operation

Thermal Shutdown

When the junction temperature exceeds T_{SHUT_R} (+165°C typical), the converter is turned off until the temperature drops to T_{SHUT_F} (+150°C typical), after which the part starts up again. If the fault condition persists, power is cycled on and off until the fault is cleared.

Overcurrent Protection

The IC features a cycle-to-cycle peak current limit of 3.6A (typical) to protect the IC and the system from overload conditions. When the IC is in boost mode and the inductor current hits the current limit, the PMOS is turned on to start a discharge cycle and bring the inductor current down.

Short-Circuit Protection

When the MAX18000 is hard shorted and the output voltage falls below 0.5V, it enters the hard short state. In the hard-short condition, the part stops switching, and the PMOS switch limits the short-circuit current from the input to 0.7A (typical).

If the fault persists, the heat generated in the PMOS switch due to the short-circuit current may cause the part to enter thermal shutdown.

When the fault is removed, the part enters the PMOS slew until V_{IN} = V_{OUT}. After the PMOS slew is complete, the IC skips the boost slew phase (that is observed during startup) and enters the boost mode of operation. This operation could lead to an overshoot in output voltage of about 10% (typical) when V_{IN} and V_{OUT} are close to each other.

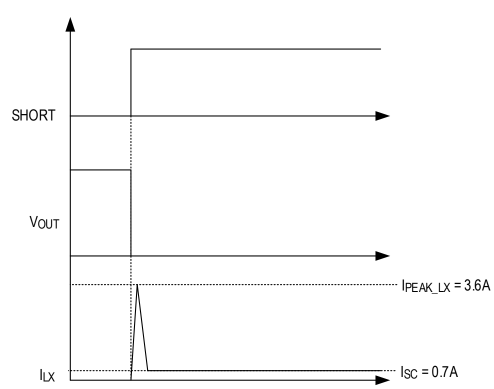


Figure 4. Short-Circuit Operation

Applications Information

Inductor Selection

Select an inductor with a saturation current rating (I_{SAT}) greater than or equal to the maximum high-side switching current limit threshold (I_{LIM}) setting. In general, inductors with lower saturation current and higher DCR ratings are physically small. Higher values of DCR reduce converter efficiency. Choose the RMS current rating (I_{RMS}) of the inductor (the current at which the temperature rises appreciably) based on the expected load current.

The chosen inductor value should ensure that the peak inductor ripple current (I_{PEAK}) is below the I_{LIM} setting so that the converter can maintain regulation. The inductors recommended for different ranges of output voltages are shown in *Table 2*.

Table 2. Inductor and Output Capacitance Values vs. Output Voltage

OUTPUT VOLTAGE (V)	RECOMMENDED INDUCTOR (nH)	EFFECTIVE OUTPUT CAPACITANCE (µF)*
5	470	9
3.3V–5V	330	20
2.5V–3.3V	220	20

**The effective capacitance for all voltage levels can be achieved using 2 x 22µF, X5R, 0603 capacitors.*

Table 3. Inductor Recommendations

VENDOR	PART NUMBER	NOMINAL INDUCTANCE (nH)	TYPICAL DCR (mΩ)	I_{SAT} (A)	I_{RMS} (A)	DIMENSIONS (L x W x H (mm))	OUTPUT VOLTAGE (V)
Murata	DFE201612E-R47M	470	26	5.5	4.5	2.0 x 1.6 x 1.2	5
Taiyo Yuden	MEKK2016HR47M	470	26	6.1	4.7	2.0 x 1.6 x 1.0	5
Murata	DFE201612E-R33M	330	21	6.3	4.8	2.0 x 1.6 x 1.2	3.3
Bourns	SRP2010TMA-R33M	330	29	5.0	3.8	2.0 x 1.6 x 1.0	3.3
Vishay	IHHP0806ABERR22M01	220	13	5.8	5.3	2.0 x 1.6 x 1.2	2.5
Taiyo Yuden	MAKK2016HR22M	220	26	5.8	4	2.0 x 1.6 x 1.0	2.5

Input Capacitor Selection

For most applications, bypass the IN pin with a 10V 22µF nominal ceramic input capacitors (C_{IN}) that maintain 5µF or higher effective capacitance at its working voltage. Effective C_{IN} is the actual capacitance value seen from the converter input during operation. Larger values improve decoupling for the converter but increase the inrush current from the voltage supply when connected. C_{IN} reduces the current peaks drawn from the input power source and reduces switching noise in the system. The ESR/ESL of C_{IN} and its series PCB trace should be very low (i.e., < 15mΩ + < 2nH) for frequencies up to the converter's switching frequency.

Pay special attention to the capacitor's voltage rating, initial tolerance, variation with temperature, and DC bias characteristic when selecting the C_{IN}. Ceramic capacitors with X7R dielectrics are highly recommended due to their small size, low ESR, and small temperature coefficients. All ceramic capacitors derate with DC bias voltage (effective capacitance goes down as DC bias goes up). Generally, smaller case-size capacitors derate more heavily compared to larger case sizes (0603 case size performs better than 0402). Consider the effective capacitance value carefully by consulting the manufacturer's data sheet. Refer to *Tutorial 5527* for more information.

Output Capacitor Selection

Sufficient output capacitance (C_{OUT}) is required for the stable operation of the converter. For minimum effective output capacitances for different output voltage targets are shown in *Table 2*. Effective C_{OUT} is the actual capacitance value seen by the converter output during operation. Larger values (above the required effective minimum) improve load transient performance but increase input surge currents during soft-start and output voltage changes. The output filter capacitor must have a low enough ESR for frequencies up to the converter's switching frequency to meet output ripple and load transient requirements. The output capacitance must be high enough to absorb the inductor energy while transitioning from full-load to no-load conditions. For most applications, 2 x 22µF capacitors ($10V_{DC}$) are recommended for C_{OUT}.

Pay special attention to the capacitor's voltage rating, initial tolerance, variation with temperature, and DC bias characteristic when selecting C_{OUT}. Ceramic capacitors with X7R dielectrics are highly recommended due to their small size, low ESR, and small temperature coefficients. All ceramic capacitors derate with DC bias voltage (effective capacitance goes down as DC bias goes up). Generally, smaller case-size capacitors derate more heavily compared to larger case sizes (0603 case size performs better than 0402). Consider the effective capacitance value carefully by consulting the manufacturer's data sheet. Refer to *Tutorial 5527* for more information.

Other Required Component Selection

The resistor between the R_{SEL} pins and GND should have a tolerance of ±1% for the internal ADC to read the value accurately.

PCB Layout Guideline

Careful circuit board layout is critical to achieve low switching power loss and clean, stable operation.

Use the following guidelines when designing the PCB:

- Place the input capacitors (C_{IN}) and output capacitors (C_{OUT}) immediately next to the IN pin and OUT pin of the IC, respectively. Since the IC operates at a high switching frequency with fast LX edges, this placement is critical for minimizing parasitic inductance within the input and output current loops, which can cause high voltage spikes and damage the internal switching MOSFETs.
- Place the inductor next to the LX bumps (as close as possible) and make the traces between the LX bumps and the inductor short and wide to minimize PCB trace impedance. Excessive PCB impedance reduces converter efficiency. When routing LX traces on a separate layer, make sure to include enough vias to minimize trace impedance. Routing LX traces on multiple layers is recommended to further reduce trace impedance. Furthermore, do not make LX traces take up an excessive amount of area. The voltage on this node switches very quickly, and an additional area creates more radiated emissions.
- Connect the inner GND bumps to the low-impedance ground plane on the PCB with vias placed next to the bumps. Do not create GND islands, as they risk interrupting the hot loops.
- Keep the power traces and load connections short and wide. This is essential for high converter efficiency.
- Do not neglect ceramic capacitor DC voltage derating. Choose capacitor values and case sizes carefully. See the *Output Capacitor Selection* section and refer to *Tutorial 5527* for more information.

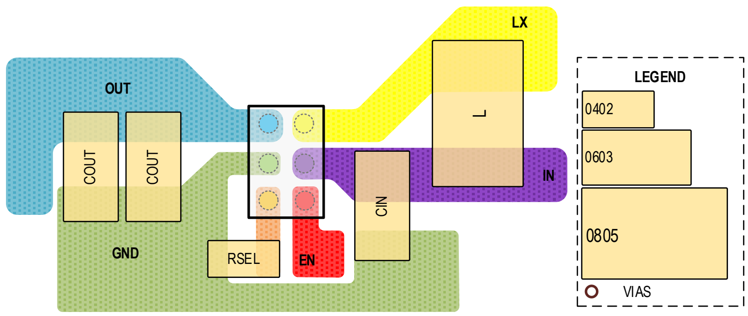
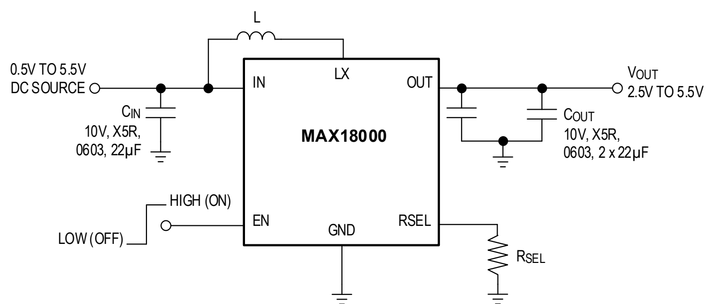


Figure 5. PCB Layout Recommendation for WLP Package

Typical Application Diagram



Ordering Information

PART NUMBER	TEMPERATURE RANGE	PACKAGE	FEATURES
MAX18000AWT+T	-40°C to +125°C	6-Bump WLP, 1.05mm x 1.55mm	3.6A I_{PEAK}, nanoPower PFM mode, True Shutdown/Active Discharge

+Denotes lead(Pb)-free/RoHS packaging.
T = Tape and reel

Revision History

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
0	2/23	Release for Market Intro	—