LM3100 同步 1MHz 1.5A 降压稳压器

1 特性

- 输入电压范围：4.5V 至 36V
- 1.5A 输出电流
- 0.8V，±1.5% 基准
- 集成 40V 双 N 通道同步开关
- 组件数量少，解决方案尺寸小
- 无需环路补偿
- 超快瞬态响应
- 可在使用陶瓷电容和其他低 ESR 电容器时保持稳定
- 可编程开关频率高达 1MHz
- 启动时最大占空比受限
- 谷值电流限值
- 精密内部基准，可调节输出电压低至 0.8V
- 热关断
- 耐热增强型带散热片薄型小外形尺寸封装 (HTSSOP)-20 封装

2 应用

- 5VDC、12VDC、24VDC、12VAC 和 24VAC 系统
- 嵌入式系统
- 工业控制
- 汽车远程信息处理和车身电子装置
- 负载点稳压器
- 存储系统
- 宽带基础设施
- 直接对 2/3/4 节锂电池系统进行降压转换

3 说明

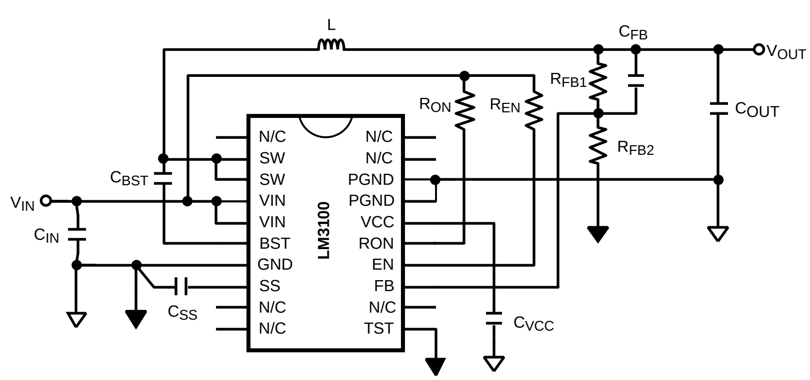
LM3100 同步整流降压转换器 采用了 可实现高效经济的降压稳压器所需的全部功能，能够为负载提供 1.5A 电流和低至 0.8V 的电压。双 40V N 通道同步 MOSFET 开关使用的外部组件较少，从而降低了复杂性，最大程度减少了布板空间。LM3100 专为与陶瓷及其他极低的 ESR 输出电容器出色配合而设计。恒定导通时间 (COT) 调节机制无需环路补偿，从而实现快速负载瞬态响应，并简化电路实现。与其他大多数 COT 稳压器不同，此款稳压器采用独特的设计，无需依赖 ESR 输出电容器也可实现稳定性。由于输入电压和导通时间之间的反比关系，线路和负载变化时，运行频率几乎保持恒定。通过外部编程，运行频率可高达 1MHz。保护功能 采用了 V_{CC} 欠压锁定、热关断和栅极驱动欠压锁定。此器件采用热增强型 HTSSOP-20 封装

器件信息

器件型号	封装	封装尺寸（标称值）
LM3100	HTSSOP (20)	6.50mm x 4.40mm

(1) 如需了解所有可用封装，请参阅数据表末尾的可订购产品附录。

图 1. 典型应用



目录

4 修订历史记录

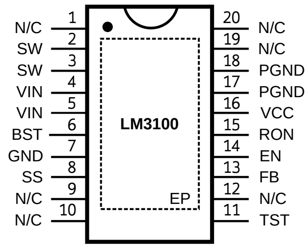
注：之前版本的页码可能与当前版本有所不同。

Changes from Revision F (December 2009) to Revision G	**Page**
• Changed layout of National Data Sheet to TI format	16

Changes from Revision G (April 2013) to Revision H	**Page**
• 已添加 添加了*应用和实现* 部分、*器件信息* 表、*引脚配置* 和*功能* 部分、*ESD 额定值* 表、*热性能信息* 表、*特性 说明* 部分、*器件功能模式*、*器件和文档支持部分以及机械、封装和可订购信息部分*	1
• 已删除 从标题中删除了 Simple Switcher	1

5 Pin Configuration and Functions

PWP Package
20-Pin HTSSOP
Top View



Pin Functions

PIN		DESCRIPTION
NO.	NAME	
1,9,10,12,19,20	N/C	No Connection These pins must be left unconnected.
2, 3	SW	Switching Node Internally connected to the buck switch source. Connect to output inductor.
4, 5	VIN	Input supply voltage Supply pin to the device. Nominal input range is 4.5 V to 36 V.
6	BST	Connection for bootstrap capacitor Connect a 0.033 µF capacitor from SW pin to this pin. An internal diode charges the capacitor during the high-side switch off-time.
7	GND	Analog Ground Ground for all internal circuitry other than the synchronous switches.
8	SS	Soft-start An internal 8 µA current source charges an external capacitor to provide the soft- start function.
11	TST	Test mode enable pin Force the device into test mode. Must be connected to ground for normal operation.
13	FB	Feedback Internally connected to the regulation and over-voltage comparators. The regulation setting is 0.8 V at this pin. Connect to feedback divider.
14	EN	Enable pin Connect a voltage higher than 1.26 V to enable the regulator.
15	RON	On-time Control An external resistor from VIN to this pin sets the high-side switch on-time.
16	VCC	Start-up regulator Output Nominally regulated to 6 V. Connect a capacitor of not less than 680 nF between VCC and GND for stable operation.
17, 18	PGND	Power Ground Synchronous rectifier MOSFET source connection. Tie to power ground plane.
DAP	EP	Exposed Pad Thermal connection pad, connect to GND.

6 Specifications

6.1 Absolute Maximum Ratings

over operating free-air temperature range (unless otherwise noted)(1)(2)

	MIN	MAX	UNIT
VIN, RON to GND	–0.3	40	V
SW to GND	–0.3	40	V
SW to GND (Transient)	–2	(< 100 ns)	V
VIN to SW	–0.3	40	V
BST to SW	–0.3	7	V
All Other Inputs to GND	–0.3	7	V
Junction Temperature, T_J	–65	150	°C
Storage temperature, T_{stg}		150	°C

(1) Stresses beyond those listed under *Absolute Maximum Ratings* may cause permanent damage to the device. These are stress ratings only, which do not imply functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Conditions*. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
(2) Military/Aerospace specified devices are required, please contact the Texas Instruments Sales Office/ Distributors for availability and specifications.

6.2 ESD Ratings

			VALUE	UNIT
$V_{(ESD)}$	Electrostatic discharge	Human-body model (HBM), per ANSI/ESDA/JEDEC JS-001(1)(2)	±2	kV

(1) JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process.
(2) The human body model is a 100-pF capacitor discharged through a 1.5-kΩ resistor into each pin.

6.3 Recommended Operating Conditions

over operating free-air temperature range (unless otherwise noted)

	MIN	MAX	UNIT
Supply Voltage Range V_{IN}	4.5	36	V
Junction Temperature Range T_J	–40	125	°C

6.4 Thermal Information

THERMAL METRIC(1)		LM3100 PWP (HTSSOP) 20 PINS	UNIT
$R_{\theta JC}$	Junction-to-case thermal resistance	6.5	°C/W

(1) For more information about traditional and new thermal metrics, see the *Semiconductor and IC Package Thermal Metrics* application report.

6.5 Electrical Characteristics

at T_J = 25°C, and V_{IN} = 18 V, V_{OUT} = 3.3 V (unless otherwise noted).[1]

PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
START-UP REGULATOR, V_{CC}							
V_{CC}	Output voltage	C_{CC} = 680 nF, no load	T_J = –40°C to 125°C	5.0	6.0	7.2	V
V_{IN} - V_{CC}	Dropout voltage	I_{CC} = 2 mA	T_J = –40°C to 125°C		50	140	mV
		I_{CC} = 20 mA	T_J = –40°C to 125°C		350	570	
I_{VCCL}	Current limit[1]	V_{CC} = 0 V	T_J = –40°C to 125°C	40	65		mA
$V_{CC\text{-}UVLO}$	Under-voltage lockout threshold	V_{IN} increasing	T_J = –40°C to 125°C	3.6	3.75	3.85	V
$V_{CC\text{-}UVLO\text{-}HYS}$	UVLO hysteresis	V_{IN} decreasing			130		mV
$t_{VCC\text{-}UVLO\text{-}D}$	UVLO filter delay				3		µs
I_{IN}	Operating current	No switching, V_{FB} = 1 V	T_J = –40°C to 125°C		0.7	1	mA
$I_{IN\text{-}SD}$	Operating current, Device shutdown	V_{EN} = 0 V	T_J = –40°C to 125°C		17	30	µA
SWITCHING CHARACTERISTICS							
$R_{DS\text{-}UP\text{-}ON}$	Main MOSFET Rds(on)		T_J = –40°C to 125°C		0.18	0.35	Ω
$R_{DS\text{-}DN\text{-}ON}$	Syn. MOSFET Rds(on)		T_J = –40°C to 125°C		0.11	0.2	Ω
$V_{G\text{-}UVLO}$	Gate drive voltage UVLO	V_{BST} - V_{SW} increasing	T_J = –40°C to 125°C		3.3	4	V
SOFT-START							
I_{SS}	SS pin source current	V_{SS} = 0.5 V	T_J = –40°C to 125°C	6	8	9.8	µA
CURRENT LIMIT							
I_{CL}	Syn. MOSFET current limit threshold				1.9		A
ON/OFF TIMER							
t_{ON}	ON timer pulse width	V_{IN} = 10 V, R_{ON} = 100 kΩ			1.38		µs
		V_{IN} = 30 V, R_{ON} = 100 kΩ			0.47		
$t_{ON\text{-}MIN}$	ON timer minimum pulse width				200		ns
t_{OFF}	OFF timer pulse width				260		ns
ENABLE INPUT							
V_{EN}	EN Pin input threshold	V_{EN} rising	T_J = –40°C to 125°C	1.236	1.26	1.285	V
$V_{EN\text{-}HYS}$	Enable threshold hysteresis	V_{EN} falling			90		mV
REGULATION and OVER-VOLTAGE COMPARATOR							
V_{FB}	In-regulation feedback voltage	V_{SS} ≥ 0.8 V	T_J = –40°C to 125°C	0.784	0.8	0.816	V
		V_{SS} ≥ 0.8 V	T_J = –40°C to 125°C	0.788		0.812	
$V_{FB\text{-}OV}$	Feedback over-voltage threshold		T_J = –40°C to 125°C	0.894	0.920	0.940	V
I_{FB}			T_J = –40°C to 125°C		5	100	nA
THERMAL SHUTDOWN							
T_{SD}	Thermal shutdown temperature	T_J rising			165		°C
$T_{SD\text{-}HYS}$	Thermal shutdown temperature hysteresis	T_J falling			20		°C

(1) V_{CC} provides self bias for the internal gate drive and control circuits. Device thermal limitations limit external loading.

6.6 Typical Characteristics

All curves taken at V_{IN} = 18 V with configuration in typical application circuit for V_{OUT} = 3.3 V shown in this datasheet. T_A = 25°C, unless otherwise specified.

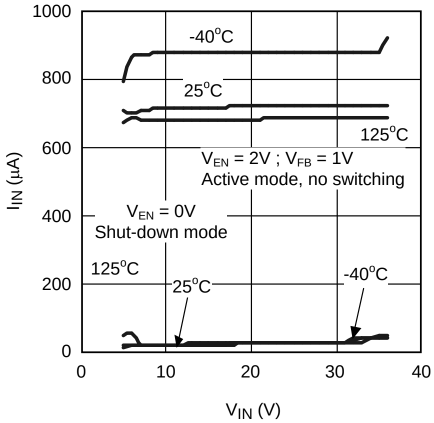


Figure 2. Quiescent Current, I_{IN} vs V_{IN}

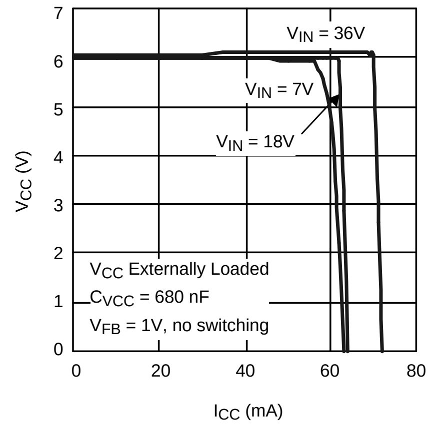


Figure 3. V_{CC} vs I_{CC}

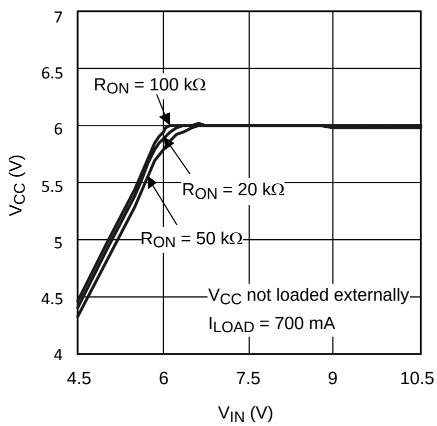


Figure 4. V_{CC} vs V_{IN}

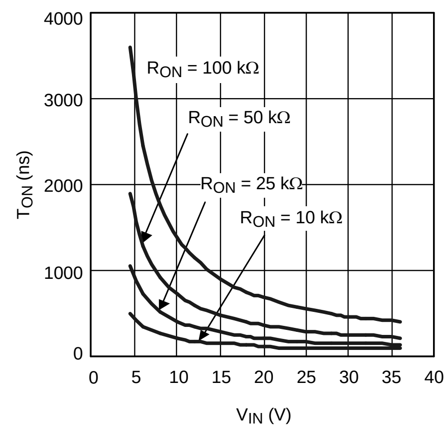


Figure 5. T_{ON} vs V_{IN}

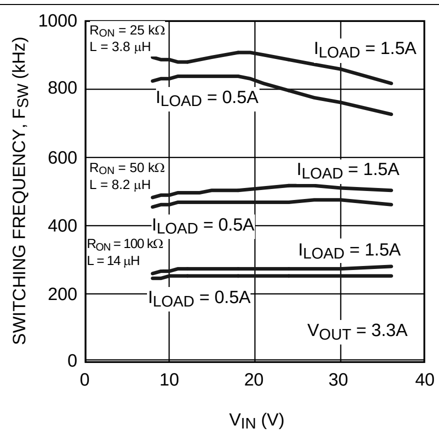


Figure 6. Switching Frequency, F_{SW} vs V_{IN}

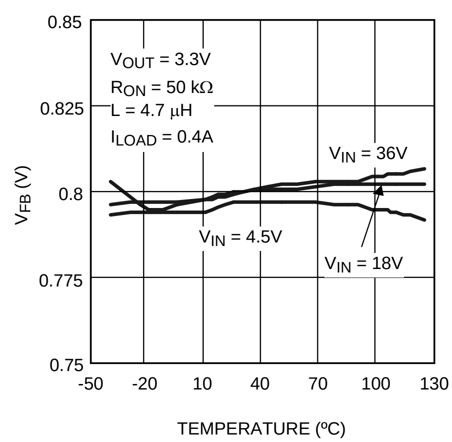


Figure 7. V_{FB} vs Temperature

Typical Characteristics (continued)

All curves taken at V_{IN} = 18 V with configuration in typical application circuit for V_{OUT} = 3.3 V shown in this datasheet. T_A = 25°C, unless otherwise specified.

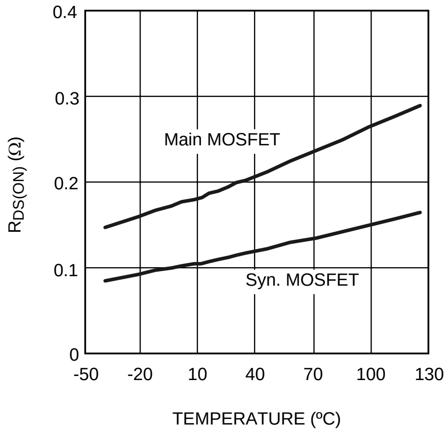


Figure 8. $R_{DS(ON)}$ vs Temperature

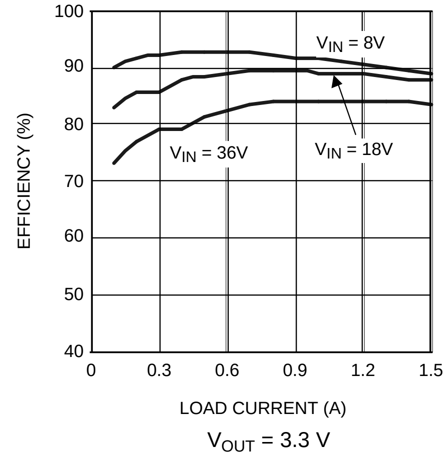


Figure 9. Efficiency vs Load Current

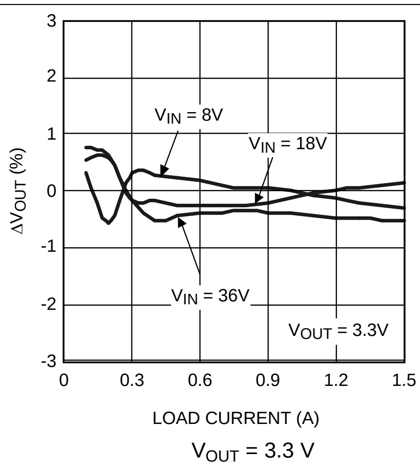


Figure 10. V_{OUT} Regulation vs Load Current

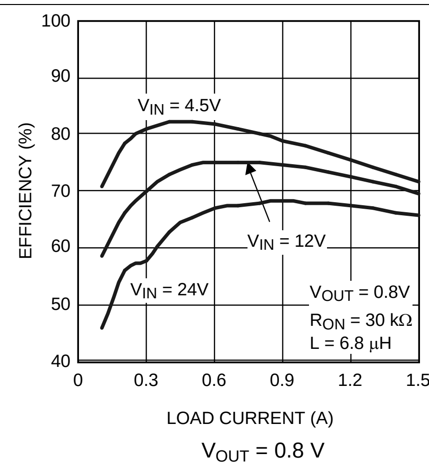


Figure 11. Efficiency vs Load Current

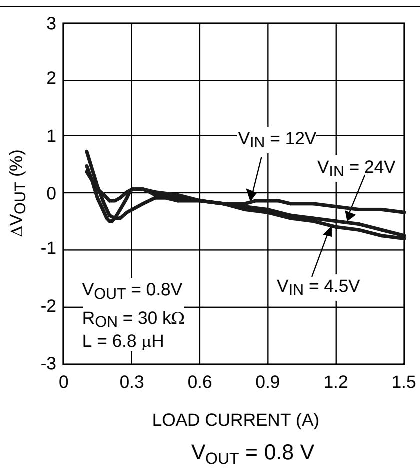


Figure 12. V_{OUT} Regulation vs Load Current

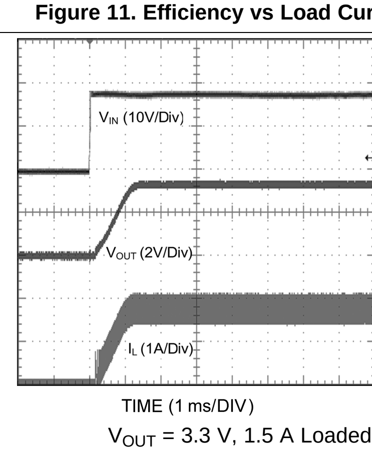
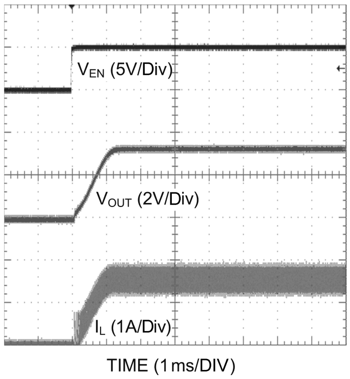


Figure 13. Power Up

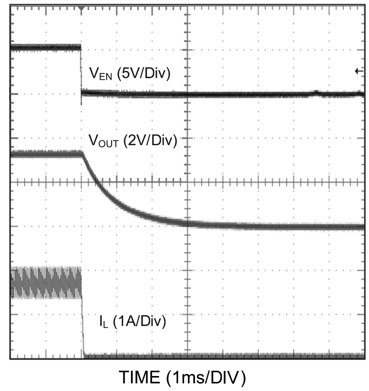
Typical Characteristics (continued)

All curves taken at V_{IN} = 18 V with configuration in typical application circuit for V_{OUT} = 3.3 V shown in this datasheet. T_A = 25°C, unless otherwise specified.



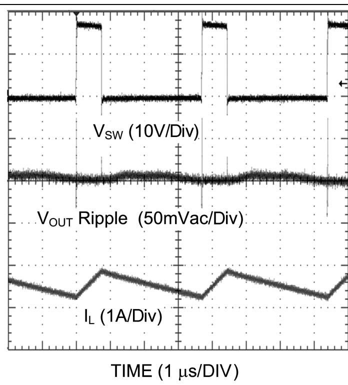
V_{OUT} = 3.3 V, 1.5 A Loaded

Figure 14. Enable Transient



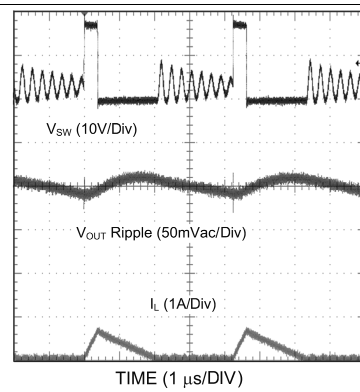
V_{OUT} = 3.3 V, 1.5 A Loaded

Figure 15. Shutdown Transient



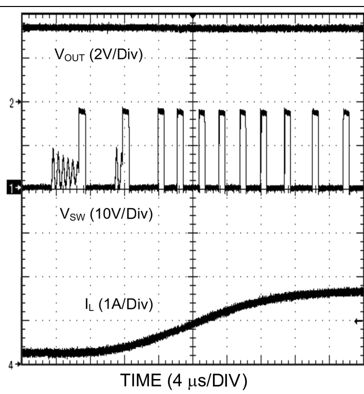
V_{OUT} = 3.3 V, 1.5 A Loaded

Figure 16. Continuous Mode Operation



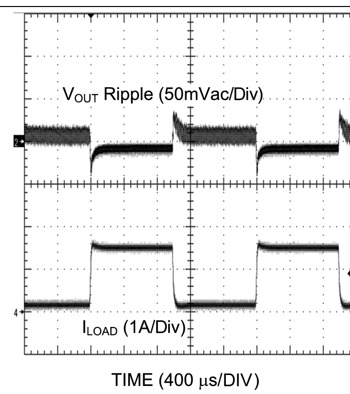
V_{OUT} = 3.3 V, 0.15 A Loaded

Figure 17. Discontinuous Mode Operation



V_{OUT} = 3.3 V, 0.15 A - 1.5 A Load

Figure 18. CCM to DCM Transition



V_{OUT} = 3.3 V, 0.15 A - 1.5 A Load   Current slew-rate: 2.5 A/µs

Figure 19. Load Transient

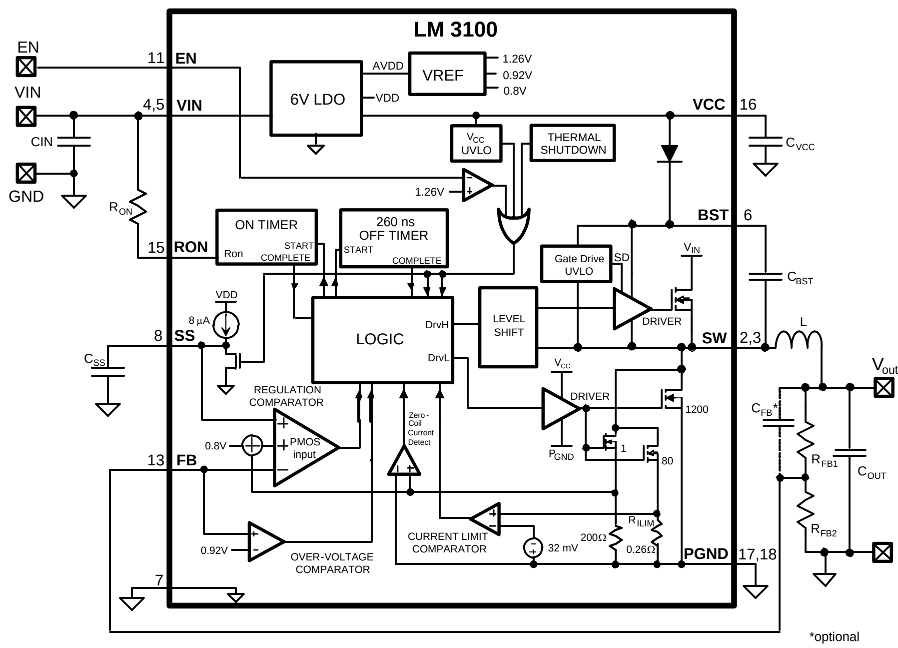
7 Detailed Description

7.1 Overview

The LM3100 Step Down Switching Regulator features all functions needed to implement a cost effective, efficient buck power converter capable of supplying 1.5 A to a load. This voltage regulator contains Dual 40-V N-Channel buck synchronous switches and is available in a thermally enhanced HTSSOP-20 package. The Constant ON-Time (COT) regulation scheme requires no loop compensation, results in fast load transient response, and simplifies circuit implementation. It will work correctly even with an all ceramic output capacitor network and does not rely on the output capacitor's ESR for stability. The operating frequency remains constant with line and load variations due to the inverse relationship between the input voltage and the on-time. The valley current limit detection circuit, internally set at 1.9 A, inhibits the high-side switch until the inductor current level subsides. Please refer to the functional block diagram with a typical application circuit.

The LM3100 can be applied in numerous applications and can operate efficiently from inputs as high as 36 V. Protection features include: Thermal shutdown, V_{CC} under-voltage lockout, gate drive under-voltage lockout.

7.2 Functional Block Diagram



7.3 Feature Description

7.3.1 Hysteretic Control Circuit Overview

The LM3100 buck DC-DC regulator employs a control scheme in which the high-side switch on-time varies inversely with the line voltage (V_{IN}). Control is based on a comparator and the one-shot on-timer, with the output voltage feedback (FB) compared with an internal reference of 0.8 V. If the FB level is below the reference the buck switch is turned on for a fixed time determined by the input voltage and a programming resistor (R_{ON}). Following the on-time, the switch remains off for a minimum of 260 ns. If FB is below the reference at that time the switch turns on again for another on-time period. The switching will continue until regulation is achieved.

The regulator will operate in discontinuous conduction mode at light load currents, and continuous conduction mode with heavy load current. In discontinuous conduction mode (DCM), current through the output inductor starts at zero and ramps up to a peak during the on-time, then ramps back to zero before the end of the off-time. The next on-time period starts when the voltage at FB falls below the internal reference. Until then the inductor current remains zero and the load is supplied entirely by the output capacitor. In this mode the operating frequency is lower than in continuous conduction mode, and varies with load current. Conversion efficiency is maintained since the switching losses are reduced with the reduction in load and switching frequency. The discontinuous operating frequency can be calculated approximately as follows:

Feature Description (continued)

$$F_{SW} = \frac{V_{OUT}\,(V_{IN} - 1) \times L \times 1.18 \times 10^{20} \times I_{OUT}}{(V_{IN} - V_{OUT}) \times R_{ON}^{2}} \quad (1)$$

In continuous conduction mode (CCM), current always flows through the inductor and never reaches zero during the off-time. In this mode, the operating frequency remains relatively constant with load and line variations. The CCM operating frequency can be calculated approximately as follows:

$$F_{SW} = \frac{V_{OUT}}{1.3 \times 10^{-10} \times R_{ON}} \quad (2)$$

The output voltage is set by two external resistors (R_{FB1}, R_{FB2}). The regulated output voltage is calculated as follows:

$$V_{OUT} = 0.8\text{ V} \times (R_{FB1} + R_{FB2})/R_{FB2} \quad (3)$$

7.4 Device Functional Modes

7.4.1 Start-up Regulator (V_{CC})

The start-up regulator is integrated within LM3100. The input pin (VIN) can be connected directly to line voltage up to 36 V, with transient capability of 40 V. The V_{CC} output regulates at 6 V, and is current limited to 65 mA. Upon power up, the regulator sources current into the external capacitor at V_{CC} (C_{VCC}). C_{VCC} must be at least 680 nF for stability. When the voltage on the VCC pin reaches the under-voltage lockout threshold of 3.75 V, the buck switch is enabled and the Soft-start pin is released to allow the soft-start capacitor (C_{SS}) to charge.

The minimum input voltage is determined by the dropout voltage of V_{CC} regulator, and the V_{CC} UVLO falling threshold (≅3.7 V). If VIN is less than ≅4.0 V, the V_{CC} UVLO activates to shut off the output.

7.4.2 Regulation Comparator

The feedback voltage at FB pin is compared to the internal reference voltage of 0.8 V. In normal operation (the output voltage is regulated), an on-time period is initiated when the voltage at FB falls below 0.8 V. The buck switch stays on for the on-time, causing the FB voltage to rise above 0.8 V. After the on-time period, the buck switch stays off until the FB voltage falls below 0.8 V again. Bias current at the FB pin is nominally 100 nA.

7.4.3 Over-Voltage Comparator

The voltage at FB pin is compared to an internal 0.92 V reference. If the feedback voltage rises above 0.92 V the on-time pulse is immediately terminated. This condition can occur if the input voltage, or the output load, changes suddenly. Once the OVP is activated, the buck switch remains off until the voltage at FB pin falls below 0.92 V. The low side switch will stay on to discharge the inductor energy until the inductor current decays to zero. The low side switch will be turned off.

7.4.4 ON-Time Timer, Shutdown

The ON-Time of LM3100 main switch is determined by the R_{ON} resistor and the input voltage (V_{IN}), and is calculated from:

$$t_{ON} = \frac{1.3 \times 10^{-10} \times R_{ON}}{V_{IN}} \quad (4)$$

The inverse relationship of t_{ON} and V_{IN} results in a nearly constant switching frequency as V_{IN} is varied. R_{ON} should be selected for a minimum on-time (at maximum V_{IN}) greater than 200 ns for proper current limit operation. This requirement limits the maximum frequency for each application, depending on V_{IN} and V_{OUT}, calculated from Equation 5:

$$F_{SW(MAX)} = \frac{V_{OUT}}{V_{IN(MAX)} \times 200\text{ ns}} \quad (5)$$

The LM3100 can be remotely shut down by taking the EN pin below 1.1 V. Refer to Figure 20. In this mode the SS pin is internally grounded, the on-timer is disabled, and bias currents are reduced. Releasing the EN pin allows normal operation to resume.

Device Functional Modes (continued)

For normal operation, the voltage at the EN pin is set between 1.5 V and 3.0 V, depending on V_{IN} and the external pull-up resistor. For all cases, this voltage must be limited not to exceed 7 V.

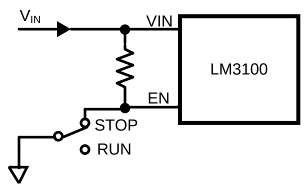


Figure 20. Shutdown Implementation

7.4.5 Current Limit

Current limit detection occurs during the off-time by monitoring the re-circulating current through the low-side synchronous switch. Referring to Functional Block Diagram, when the buck switch is turned off, inductor current flows through the load, into PGND, and through the internal low-side synchronous switch. If that current exceeds 1.9 A the current limit comparator toggles, forcing a delay to the start of the next on-time period. The next cycle starts when the re-circulating current falls back below 1.9 A and the voltage at FB is below 0.8 V. The inductor current is monitored during the low-side switch on-time. As long as the overload condition persists and the inductor current exceeds 1.9 A, the high-side switch will remain inhibited. The operating frequency is lower during an over-current due to longer than normal off-times.

Figure 21 illustrates an inductor current waveform, the average inductor current is equal to the output current, I_{OUT} in steady state. When an overload occurs, the inductor current will increase until it exceeds the current limit threshold, 1.9 A. Then the control keeps the high-side switch off until the inductor current ramps down below 1.9 A. Within each on-time period, the current ramps up an amount equal to:

$$\Delta I = \frac{(V_{IN} - V_{OUT}) \times t_{ON}}{L} \tag{6}$$

During this time the LM3100 is in a constant current mode, with an average load current (I_{OCL}) equal to 1.9 A +ΔI/2.

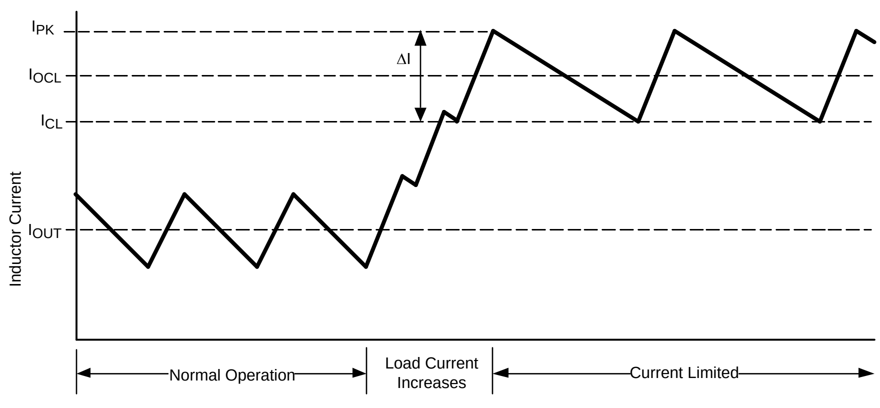


Figure 21. Inductor Current - Current Limit Operation

7.4.6 N-Channel Buck Switch and Driver

The LM3100 integrates an N-Channel buck (high-side) switch and associated floating high voltage gate driver. The gate drive circuit works in conjunction with an external bootstrap capacitor and an internal high voltage diode. A 33 nF capacitor (C_{BST}) connected between BST and SW pins provides voltage to the high-side driver during the buck switch on-time. During each off-time, the SW pin falls to approximately –1 V and C_{BST} charges from the V_{CC} supply through the internal diode. The minimum off-time of 260 ns ensures adequate time each cycle to recharge the bootstrap capacitor.

Device Functional Modes (continued)

7.4.7 Soft-Start

The soft-start feature allows the converter to gradually reach a steady state operating point, thereby reducing start-up stresses and current surges. Upon turn-on, after V_{CC} reaches the under-voltage threshold, an internal 8 µA current source charges up the external capacitor at the SS pin. The ramping voltage at SS (and the non-inverting input of the regulation comparator) ramps up the output voltage in a controlled manner.

An internal switch grounds the SS pin if any of the following cases happen: (i) VCC falls below the under-voltage lock-out threshold; (ii) a thermal shutdown occurs; or (iii) the EN pin is grounded. Alternatively, the converter can be disabled by connecting the SS pin to ground using an external switch. Releasing the switch allows the SS pin return to pull high and the output voltage returns to normal. The shut-down configuration is shown in Figure 22 .

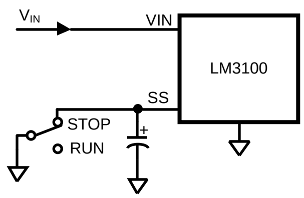


Figure 22. Alternate Shutdown Implementation

7.4.8 Thermal Protection

The LM3100 should be operated so the junction temperature does not exceed the maximum limit. An internal Thermal Shutdown circuit, which activates (typically) at 165°C, takes the controller to a low power reset state by disabling the buck switch and the on-timer, and grounding the SS pin. This feature helps prevent catastrophic failures from accidental device overheating. When the junction temperature falls back below 145°C (typical hysteresis = 20°C), the SS pin is released and normal operation resumes.

8 Applications and Implementation

NOTE

Information in the following applications sections is not part of the TI component specification, and TI does not warrant its accuracy or completeness. TI's customers are responsible for determining suitability of components for their purposes. Customers should validate and test their design implementation to confirm system functionality.

8.1 Applications Information

8.1.1 External Components

The following guidelines can be used to select the external components.

8.1.1.1 R_{FB1} and R_{FB2}

The ratio of these resistors is calculated from:

$$\frac{R_{FB1}}{R_{FB2}} = \frac{V_{OUT}}{0.8V} - 1 \tag{7}$$

R_{FB1} and R_{FB2} should be chosen from standard value resistors in the range of 1.0 kΩ - 10 kΩ which satisfy the above ratio.

For V_{OUT} = 0.8 V, the FB pin can be connected to the output directly. However, the converter operation needs a minimum inductor current ripple to maintain good regulation when no load is connected. This minimum load is about 10 µA and can be implemented by adding a pre-load resistor to the output.

8.1.1.2 R_{ON}

The minimum value for R_{ON} is calculated from:

$$R_{ON} \geq \frac{200 \text{ ns} \times V_{IN(MAX)}}{1.3 \times 10^{-10}} \tag{8}$$

Equation 2 in Hysteretic Control Circuit Overview section can be used to select R_{ON} if a specific frequency is desired as long as the above limitation is met.

8.1.1.3 L

The main parameter affected by the inductor is the output current ripple amplitude (I_{OR}). The maximum allowable (I_{OR}) must be determined at both the minimum and maximum nominal load currents. At minimum load current, the lower peak must not reach 0 A. At maximum load current, the upper peak must not exceed the current limit threshold (1.9 A). The allowable ripple current is calculated from the following equations:

$$I_{OR(MAX1)} = 2 \times I_{O(min)} \tag{9}$$

or

$$I_{OR(MAX2)} = 2 \times (1.9 \text{ A} - I_{O(max)}) \tag{10}$$

The lesser of the two ripple amplitudes calculated above is then used in the following equation:

$$L = \frac{V_{OUT} \times (V_{IN} - V_{OUT})}{I_{OR} \times F_S \times V_{IN}} \tag{11}$$

where V_{IN} is the maximum input voltage and Fs is determined from Equation 1. This provides a value for L. The next larger standard value should be used. L should be rated for the I_{PK} current level shown in Figure 21.

Applications Information (continued)

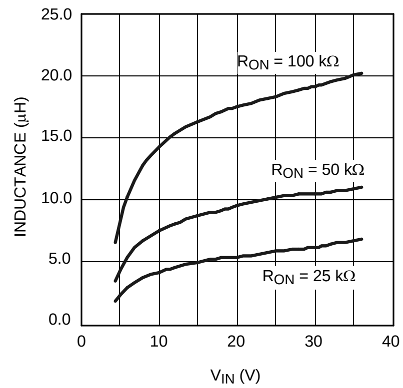


Figure 23. Inductor Selector for V_{OUT} = 3.3 V

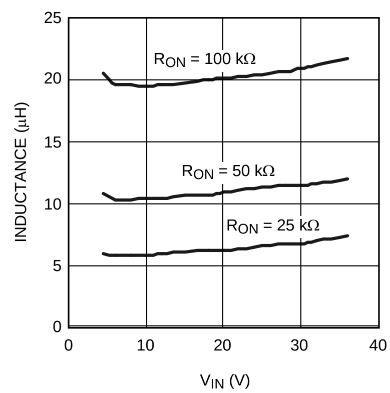


Figure 24. Inductor Selector for V_{OUT} = 0.8 V

8.1.1.4 C_{VCC}

The capacitor on the V_{CC} output provides not only noise filtering and stability, but also prevents false triggering of the V_{CC} UVLO at the buck switch on/off transitions. For this reason, C_{VCC} should be no smaller than 680 nF for stability, and should be a good quality, low ESR, ceramic capacitor.

8.1.1.5 C_O and C_{O3}

C_O should generally be no smaller than 10 µF. Experimentation is usually necessary to determine the minimum value for C_O, as the nature of the load may require a larger value. A load which creates significant transients requires a larger value for C_O than a fixed load.

C_{O3} is a small value ceramic capacitor to further suppress high frequency noise at V_{OUT}. A 47 nF is recommended, located close to the LM3100.

8.1.1.6 C_{IN} and C_{IN3}

C_{IN}'s purpose is to supply most of the switch current during the on-time, and limit the voltage ripple at V_{IN}, assume the voltage source feeding V_{IN} has an output impedance greater than zero. If the source's dynamic impedance is high (effectively a current source), C_{IN} supplies the average input current, but not the ripple current.

At maximum load current, when the buck switch turns on, the current into V_{IN} suddenly increases to the lower peak of the inductor's ripple current, ramps up to the peak value, then drop to zero at turn-off. The average current during the on-time is the load current. For a worst case calculation, C_{IN} must supply this average load current during the maximum on-time. C_{IN} is calculated from:

Applications Information (continued)

$$C_{IN} = \frac{I_{OUT} \times t_{ON}}{\Delta V} \quad (12)$$

where I_{OUT} is the load current, t_{ON} is the maximum on-time, and ΔV is the allowable ripple voltage at V_{IN}.

C_{IN3}'s purpose is to help avoid transients and ringing due to long lead inductance at V_{IN}. A low ESR, 0.1 µF ceramic chip capacitor is recommended, located close to the LM3100.

8.1.1.7 C_{BST}

The recommended value for C_{BST} is 33 nF. A high quality ceramic capacitor with low ESR is recommended as C_{BST} supplies a surge current to charge the buck switch gate at turn-on. A low ESR also helps ensure a complete recharge during each off-time.

8.1.1.8 C_{SS}

The capacitor at the SS pin determines the soft-start time, i.e. the time for the reference voltage at the regulation comparator, and the output voltage, to reach their final value. The time is determined from the following:

$$t_{SS} = \frac{C_{SS} \times 0.8V}{8\ \mu A} \quad (13)$$

8.1.1.9 C_{FB}

If output voltage is higher than 1.6 V, this feedback capacitor is needed for Discontinuous Conduction Mode to improve the output ripple performance, the recommended value for C_{FB} is 10 nF.

8.2 Typical Application

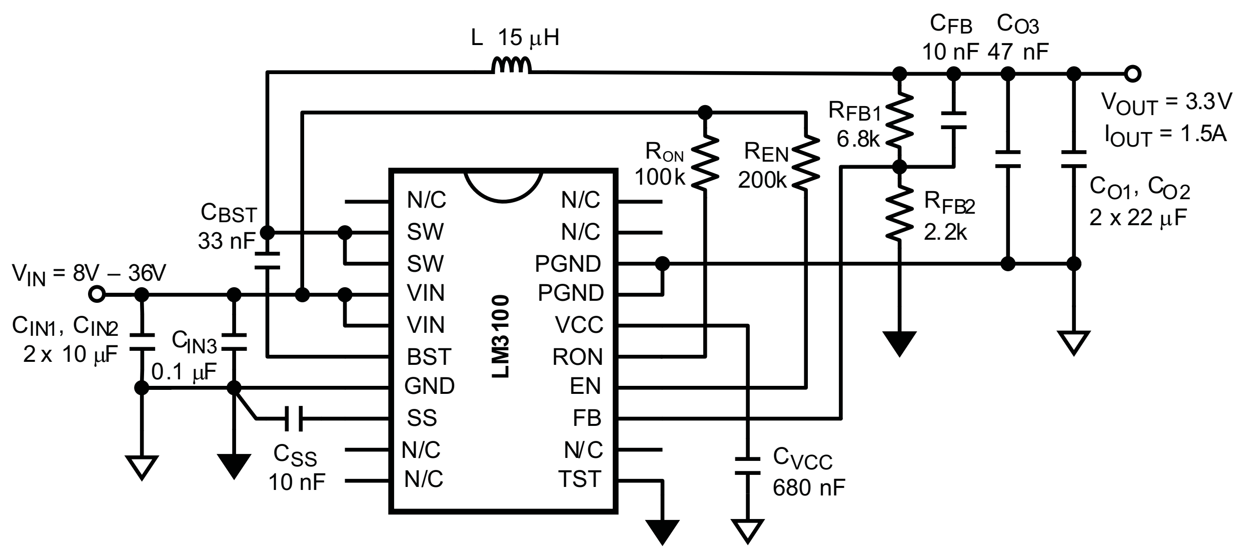


Figure 25. Typical Application Schematic for V_{OUT} = 3.3 V

Typical Application (continued)

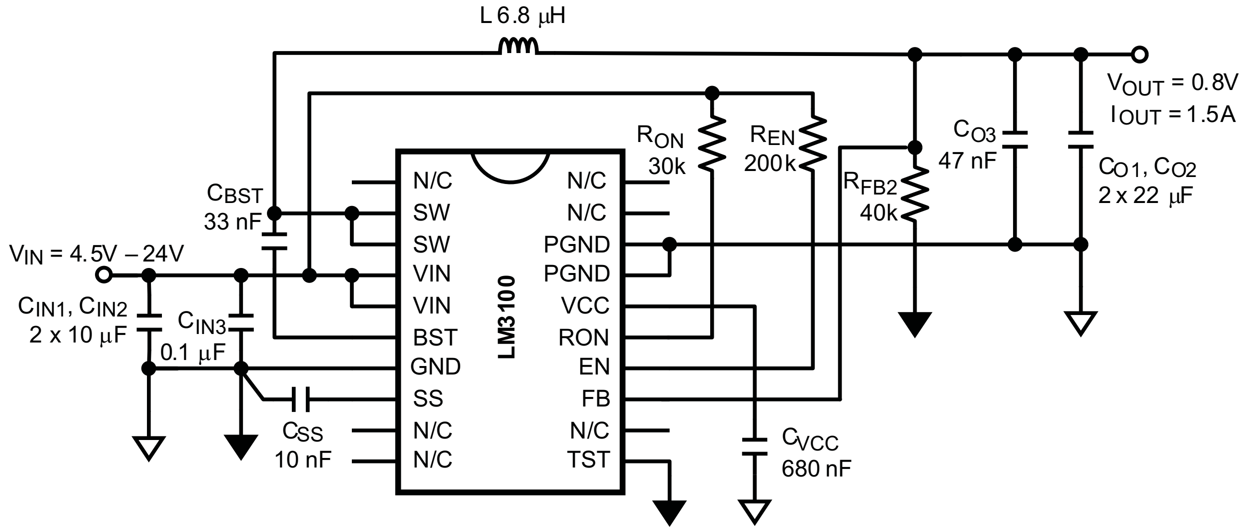


Figure 26. Typical Application Schematic for V_{OUT} = 0.8 V

9 Layout

9.1 Layout Guidelines

9.1.1 PC Board Layout

The LM3100 regulation, over-voltage, and current limit comparators are very fast, and will respond to short duration noise pulses. Layout considerations are therefore critical for optimum performance. The layout must be as neat and compact as possible, and all external components must be as close as possible to their associated pins. Refer to the functional block diagram, the loop formed by C_{IN}, the high and low-side switches internal to the IC, and the PGND pin should be as small as possible. The PGND connection to Cin should be as short and direct as possible. There should be several vias connecting the Cin ground terminal to the ground plane placed as close to the capacitor as possible. The boost capacitor should be connected as close to the SW and BST pins as possible. The feedback divider resistors and the C_{FB} capacitor should be located close to the FB pin. A long trace run from the top of the divider to the output is generally acceptable since this is a low impedance node. Ground the bottom of the divider directly to the GND (pin 7). The output capacitor, C_{OUT}, should be connected close to the load and tied directly into the ground plane. The inductor should connect close to the SW pin with as short a trace as possible to help reduce the potential for EMI (electro-magnetic interference) generation.

If it is expected that the internal dissipation of the LM3100 will produce excessive junction temperatures during normal operation, good use of the PC board’s ground plane can help considerably to dissipate heat. The exposed pad on the bottom of the IC package can be soldered to a ground plane and that plane should extend out from beneath the IC to help dissipate the heat. The exposed pad is internally connected to the IC substrate. Additionally the use of thick copper traces, where possible, can help conduct heat away from the IC. Using numerous vias to connect the die attach pad to an internal ground plane is a good practice. Judicious positioning of the PC board within the end product, along with the use of any available air flow (forced or natural convection) can help reduce the junction temperature.

10 器件和文档支持

10.1 接收文档更新通知

要接收文档更新通知，请转至 TI.com 上的器件产品文件夹。单击右上角的*通知我* 进行注册，即可每周接收产品信息更改摘要。有关更改的详细信息，请查看任何已修订文档中包含的修订历史记录。

10.2 社区资源

下列链接提供到 TI 社区资源的连接。链接的内容由各个分销商"按照原样"提供。这些内容并不构成 TI 技术规范，并且不一定反映 TI 的观点；请参阅 TI 的 《使用条款》。

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设计支持 ***TI 参考设计支持*** 可帮助您快速查找有帮助的 E2E 论坛、设计支持工具以及技术支持的联系信息。

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All other trademarks are the property of their respective owners.

10.4 静电放电警告

ESD 可能会损坏该集成电路。德州仪器 (TI) 建议通过适当的预防措施处理所有集成电路。如果不遵守正确的处理措施和安装程序，可能会损坏集成电路。

ESD 的损坏小至导致微小的性能降级，大至整个器件故障。 精密的集成电路可能更容易受到损坏，这是因为非常细微的参数更改都可能会导致器件与其发布的规格不相符。

10.5 Glossary

SLYZ022 — *TI Glossary*.

This glossary lists and explains terms, acronyms, and definitions.

11 机械、封装和可订购信息

以下页面包含机械、封装和可订购信息。这些信息是指定器件的最新可用数据。这些数据如有变更，恕不另行通知和修订此文档。如欲获取此数据表的浏览器版本，请参阅左侧的导航。

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead finish/ Ball material (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
LM3100MH/NOPB	ACTIVE	HTSSOP	PWP	20	73	RoHS & Green	SN	Level-1-260C-UNLIM	-40 to 125	LM3100 MH	Samples
LM3100MHX/NOPB	ACTIVE	HTSSOP	PWP	20	2500	RoHS & Green	SN	Level-1-260C-UNLIM	-40 to 125	LM3100 MH	Samples

(1) The marketing status values are defined as follows:
ACTIVE: Product device recommended for new designs.
LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.
NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.
PREVIEW: Device has been announced but is not in production. Samples may or may not be available.
OBSOLETE: TI has discontinued the production of the device.

(2) **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".
RoHS Exempt: TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.
Green: TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

(3) MSL, Peak Temp. - The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

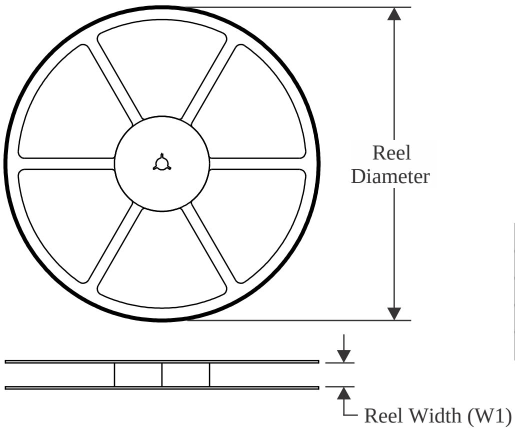
(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

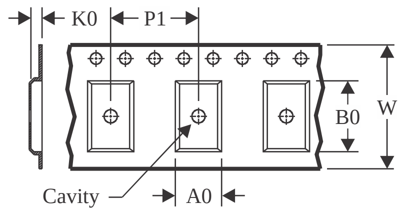
(6) Lead finish/Ball material - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

TAPE AND REEL INFORMATION

REEL DIMENSIONS

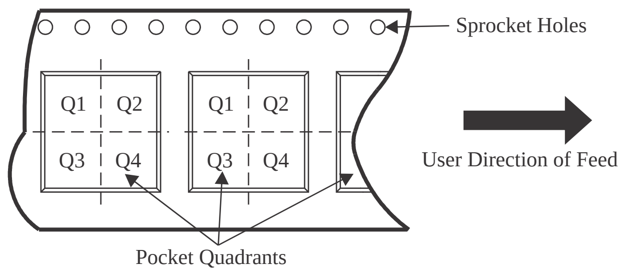


TAPE DIMENSIONS



A0	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

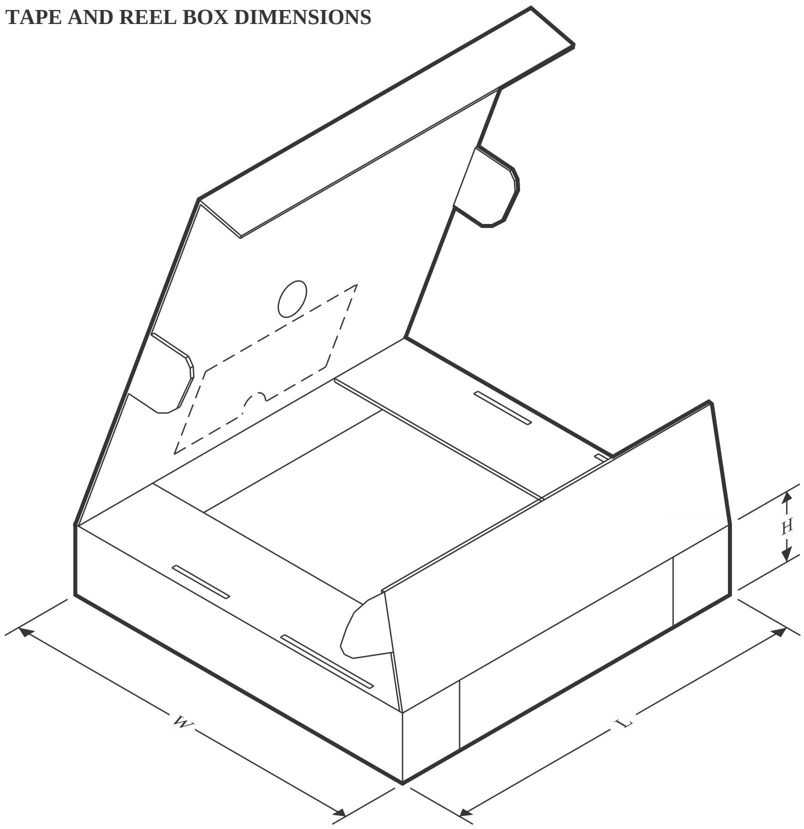
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
LM3100MHX/NOPB	HTSSOP	PWP	20	2500	330.0	16.4	6.95	7.0	1.4	8.0	16.0	Q1

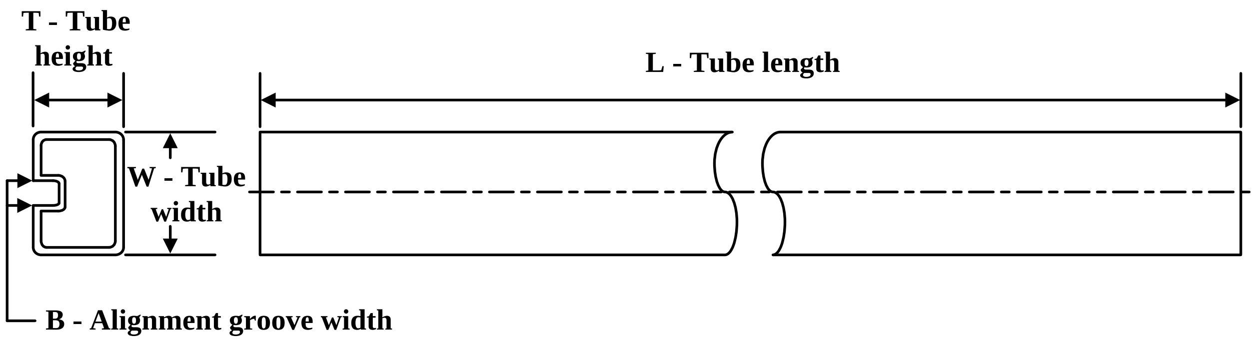
TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
LM3100MHX/NOPB	HTSSOP	PWP	20	2500	367.0	367.0	35.0

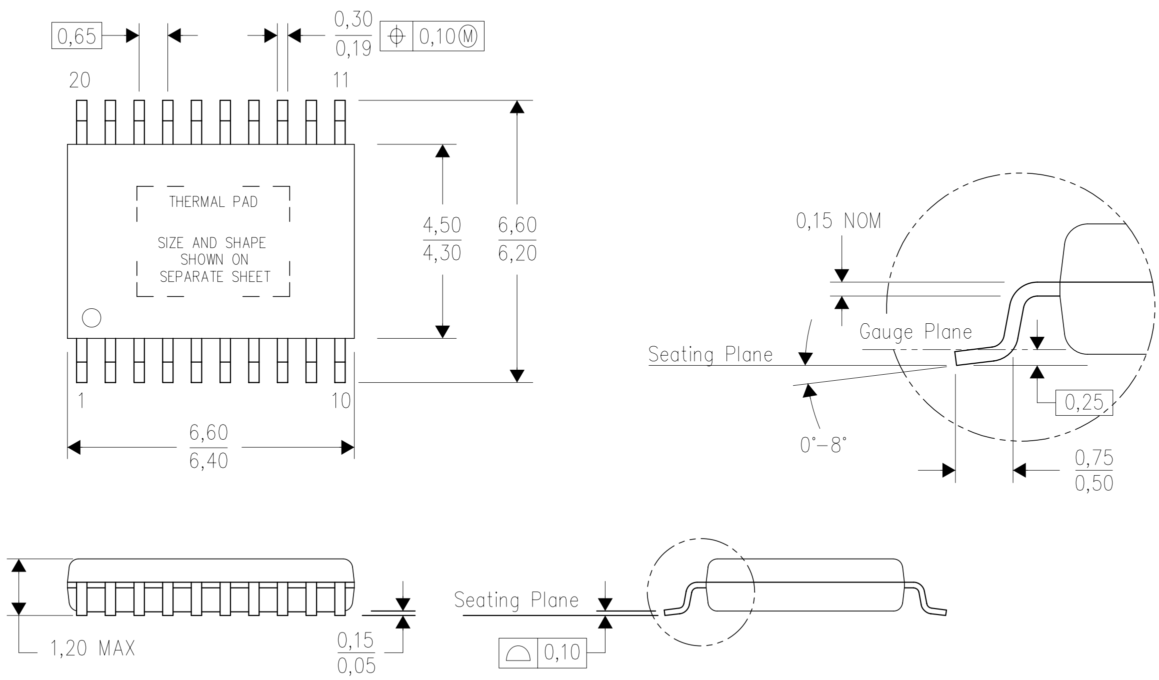
TUBE



*All dimensions are nominal

Device	Package Name	Package Type	Pins	SPQ	L (mm)	W (mm)	T (µm)	B (mm)
LM3100MH/NOPB	PWP	HTSSOP	20	73	495	8	2514.6	4.06

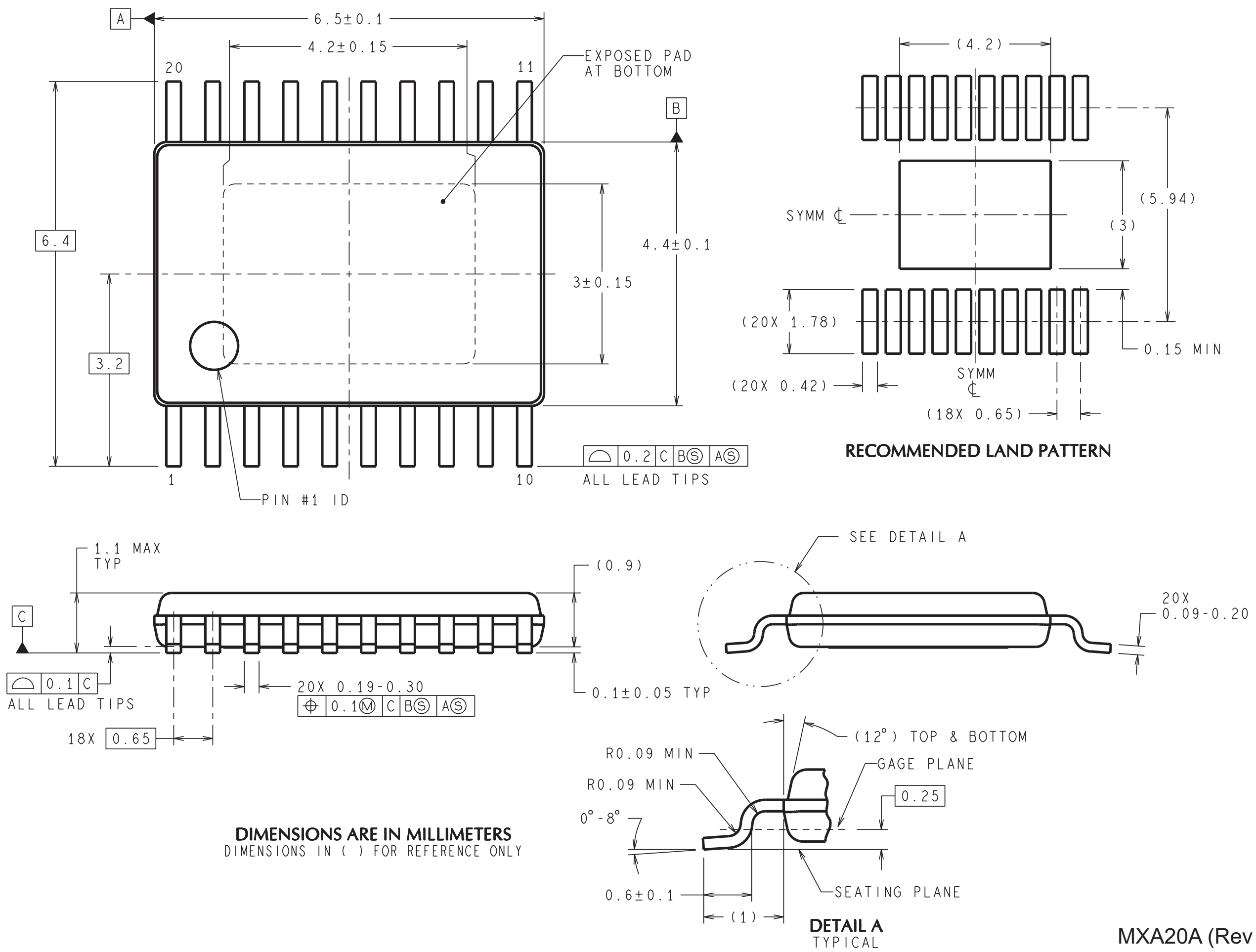
PWP (R-PDSO-G20) PowerPAD™ PLASTIC SMALL OUTLINE



4073225-4/I 05/11

NOTES:
- A. All linear dimensions are in millimeters.
- B. This drawing is subject to change without notice.
- C. Body dimensions do not include mold flash or protrusions. Mold flash and protrusion shall not exceed 0.15 per side.
- D. This package is designed to be soldered to a thermal pad on the board. Refer to Technical Brief, PowerPad Thermally Enhanced Package, Texas Instruments Literature No. SLMA002 for information regarding recommended board layout. This document is available at www.ti.com <http: //www.ti.com>.
- E. See the additional figure in the Product Data Sheet for details regarding the exposed thermal pad features and dimensions.
- E. Falls within JEDEC MO-153

PWP0020A



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