LM3103 同步 1MHz 0.75A 降压稳压器

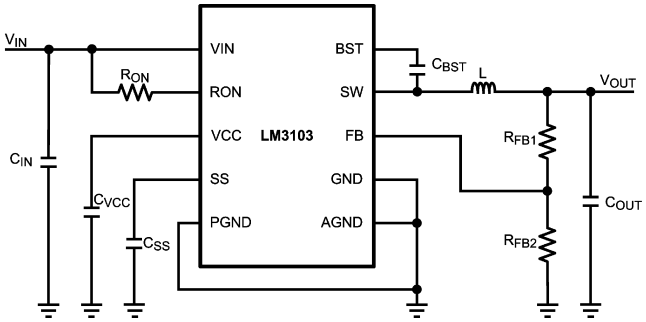
1 特性

- 输入电压范围为 4.5V 至 42V
- 0.75A 输出电流
- 0.6V，±2% 基准
- 集成双 N 沟道主 MOSFET 和同步 MOSFET
- 低组件数量和小型解决方案尺寸
- 与陶瓷电容和其他低等效串联电阻 (ESR) 电容一起工作时可保持稳定
- 无需环路补偿
- 可通过断续导通模式 (DCM) 操作在轻负载条件下实现高效率
- 预偏置启动
- 超快速瞬态响应
- 可编程软启动
- 可编程开关频率高达 1MHz
- 谷值电流限值
- 热关断
- 输出过压保护
- 精密内部基准实现可调节输出电压低至 0.6V
- 热增强型 HTSSOP-16 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

典型应用原理图



3 说明

LM3103 同步整流降压转换器 具有 实现低成本高效率的降压稳压器所需的全部功能。可为负载提供 0.75A 及低至 0.6V 的输出电压。双 N 沟道同步 MOSFET 同步开关允许使用少量组件，从而降低复杂性，并最大限度地减少布板尺寸。

LM3103 不同于大多数其他 COT 稳压器，因为它不依赖输出电容器 ESR 来获得稳定性，专为与陶瓷及其他 ESR 极低的输出电容器完美配合工作而设计。它无需环路补偿，从而实现快速负载瞬态响应，并简化电路实现。由于输入电压和导通时间之间呈反比关系，因此在线路发生变化时，器件的工作频率几乎保持恒定。通过外部编程，工作频率可高达 1MHz。保护 特性 包括 V_{CC} 欠压锁定、输出过压保护、热关断和栅极驱动欠压锁定。LM3103 采用热增强型 HTSSOP-16 封装。

器件信息(1)

器件型号	封装	封装尺寸（标称值）
LM3103	HTSSOP-16	5.00 mm × 4.40 mm

(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。

An IMPORTANT NOTICE at the end of this data sheet addresses availability, warranty, changes, use in safety-critical applications, intellectual property matters and other important disclaimers. PRODUCTION DATA.

目录

1 特性 ... 1
2 应用 ... 1
3 说明 ... 1
4 修订历史记录 ... 2
5 **Pin Configuration and Functions** ... 3
6 **Specifications** ... 4
6.1 Absolute Maximum Ratings ... 4
6.2 ESD Ratings ... 4
6.3 Recommended Operating Conditions ... 4
6.4 Thermal Information ... 4
6.5 Electrical Characteristics ... 5
6.6 Typical Characteristics ... 7
7 **Detailed Description** ... 10
7.1 Functional Block Diagram ... 10
7.2 Feature Description ... 10
8 **Applications and Implementation** ... 14
8.1 Application Information ... 14
9 器件和文档支持 ... 17
9.1 接收文档更新通知 ... 17
9.2 社区资源 ... 17
9.3 商标 ... 17
9.4 静电放电警告 ... 17
9.5 Glossary ... 17
10 机械、封装和可订购信息 ... 17

4 修订历史记录

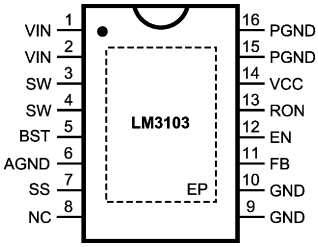
注：之前版本的页码可能与当前版本有所不同。

Changes from Revision F (April 2013) to Revision G	Page
• 已将美国国家半导体数据表的版面布局更改为 TI 格式	1

Copyright © 2007–2018, Texas Instruments Incorporated

5 Pin Configuration and Functions

PWP Package
16-Pin HTSSOP
Top View



Pin Functions

Pin	Name	Description	Application Information
1, 2	VIN	Input supply voltage	Supply pin to the device. Nominal input range is 4.5 V to 42 V.
3, 4	SW	Switch Node	Internally connected to the source of the main MOSFET and the drain of the synchronous MOSFET. Connect to the output inductor.
5	BST	Connection for bootstrap capacitor	Connect a 33 nF capacitor from the SW pin to this pin. This capacitor is charged through an internal diode during the main MOSFET off-time.
6	AGND	Analog Ground	Ground for all internal circuitry other than the PGND pin.
7	SS	Soft-start	A 70 µA internal current source charges an external capacitor of larger than 22 nF to provide the soft-start function.
8	NC	No Connection	This pin should be left unconnected.
9, 10	GND	Ground	Must be connected to the AGND pin for normal operation. The GND and AGND pins are not internally connected.
11	FB	Feedback	Internally connected to the regulation and over-voltage comparators. The regulation setting is 0.6 V at this pin. Connect to feedback resistors.
12	EN	Enable pin	Internal pull-up. Connect to a voltage higher than 1.6 V to enable the device.
13	RON	On-time Control	An external resistor from the VIN pin to this pin sets the main MOSFET on-time.
14	VCC	Startup regulator Output	Nominally regulated to 6 V. Connect a capacitor of larger than 1 µF between the VCC and AGND pins for stable operation.
15, 16	PGND	Power Ground	Synchronous MOSFET source connection. Tie to a ground plane.
DAP	EP	Exposed Pad	Thermal connection pad. Connect to the ground plane.

Copyright © 2007–2018, Texas Instruments Incorporated

6 Specifications

6.1 Absolute Maximum Ratings

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

	MIN	MAX	UNIT
VIN, RON to AGND	–0.3	43.5	V
SW to AGND	–0.3	43.5	V
SW to AGND (Transient)		–2 (< 100 ns)	V
VIN to SW	–0.3	43.5	V
BST to SW	–0.3	7	V
VCC to AGND	–0.3	7	V
FB to AGND	–0.3	5	V
All Other Inputs to AGND	–0.3	7	V
Junction Temperature, T_J		150	°C
Storage Temperature, T_{stg}	–65	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.

6.2 ESD Ratings

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

(1) JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process.

6.3 Recommended Operating Conditions

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

	MIN	MAX	UNIT
Supply Voltage Range (VIN)	4.5	42	V
Junction Temperature Range (T_J)	−40	125	°C

(1) *Absolute Maximum Ratings* are limits beyond which damage to the device may occur. *Recommended Operating Ratings* are conditions under which operation of the device is intended to be functional. For ensured specifications and test conditions, see the *Electrical Characteristics*.

6.4 Thermal Information

THERMAL METRIC[1]		LM3103 PWP (HTSSOP) 16 PINS	UNIT
$R_{\theta JA}$	Junction-to-ambient thermal resistance	35	°C/W

(1) For more information about traditional and new thermal metrics, see the *Semiconductor and IC Package Thermal Metrics* application report, SPRA953.

Copyright © 2007–2018, Texas Instruments Incorporated

6.5 Electrical Characteristics

Specifications with standard type are for T_J = 25°C unless otherwise specified. Minimum and Maximum limits are specified through test, design, or statistical correlation. Typical values represent the most likely parametric norm at T_J = 25°C, and are provided for reference purposes only. Unless otherwise stated the following conditions apply: V_{IN} = 18 V, V_{OUT} = 3.3 V.

PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
START-UP REGULATOR, V_{CC}							
V_{CC}	V_{CC} output voltage	C_{VCC} = 1 µF, no load	T_J = –40°C to +125°C	5.6	6.0	6.2	V
V_{IN} – V_{CC}	V_{IN} – V_{CC} dropout voltage	I_{CC} = 2 mA	T_J = –40°C to +125°C		55	150	mV
		I_{CC} = 10 mA	T_J = –40°C to +125°C		235	500	
$V_{CC\text{-}UVLO}$	V_{CC} undervoltage lockout threshold (UVLO)	V_{IN} increasing	T_J = –40°C to +125°C	3.5	3.7	4.1	V
$V_{CC\text{-}UVLO\text{-}HYS}$	V_{CC} UVLO hysteresis	V_{IN} decreasing			275		mV
I_{IN}	I_{IN} operating current	No switching, V_{FB} = 1 V	T_J = –40°C to +125°C		1.0	1.25	mA
$I_{IN\text{-}SD}$	I_{IN} operating current, device shutdown	V_{EN} = 0 V	T_J = –40°C to +125°C		20	40	µA
I_{VCC}	V_{CC} current limit	V_{CC} = 0 V	T_J = –40°C to +125°C	20	33	42	mA
SWITCHING CHARACTERISTICS							
$R_{DS\text{-}UP\text{-}ON}$	Main MOSFET $R_{DS(on)}$	T_J = –40°C to +125°C			0.370	0.7	Ω
$R_{DS\text{-}DN\text{-}ON}$	Syn. MOSFET $R_{DS(on)}$	T_J = –40°C to +125°C			0.220	0.4	Ω
SOFT-START							
I_{SS}	SS pin source current	V_{SS} = 0 V	T_J = –40°C to +125°C	45	70	95	µA

Copyright © 2007–2018, Texas Instruments Incorporated

Electrical Characteristics (continued)

Specifications with standard type are for T_J = 25°C unless otherwise specified. Minimum and Maximum limits are specified through test, design, or statistical correlation. Typical values represent the most likely parametric norm at T_J = 25°C, and are provided for reference purposes only. Unless otherwise stated the following conditions apply: V_{IN} = 18 V, V_{OUT} = 3.3 V.

PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
CURRENT LIMIT							
I_{CL}	Syn. MOSFET current limit threshold				0.9		A
ON/OFF TIMER							
t_{on}	ON timer pulse width	V_{IN} = 10 V, R_{ON} = 33 kΩ			0.350		µs
		V_{IN} = 18 V, R_{ON} = 33 kΩ			0.170		
$t_{on\text{-}MIN}$	ON timer minimum pulse width				100		ns
t_{off}	OFF timer pulse width				240		ns
ENABLE INPUT							
V_{EN}	EN Pin input threshold	V_{EN} rising	T_J = –40°C to +125°C		1.6	1.85	V
$V_{EN\text{-}HYS}$	Enable threshold hysteresis	V_{EN} falling			230		mV
I_{EN}	Enable Pull-up Current	V_{EN} = 0 V			1		µA
REGULATION AND OVERVOLTAGE COMPARATOR							
V_{FB}	In-regulation feedback voltage	T_J = –40°C to +125°C		0.588	0.6	0.612	V
$V_{FB\text{-}OV}$	Feedback overvoltage threshold	T_J = –40°C to +125°C		0.655	0.680	0.705	V
I_{FB}					1		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

Copyright © 2007–2018, Texas Instruments Incorporated

6.6 Typical Characteristics

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

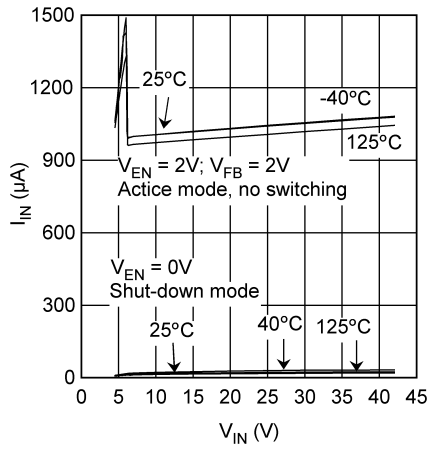


Figure 1. Quiescent Current, I_{IN} vs V_{IN}

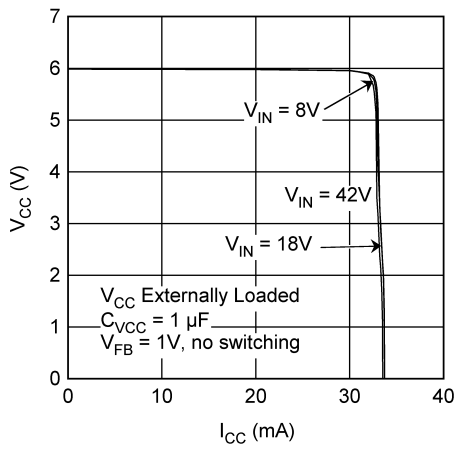


Figure 2. V_{CC} vs I_{CC}

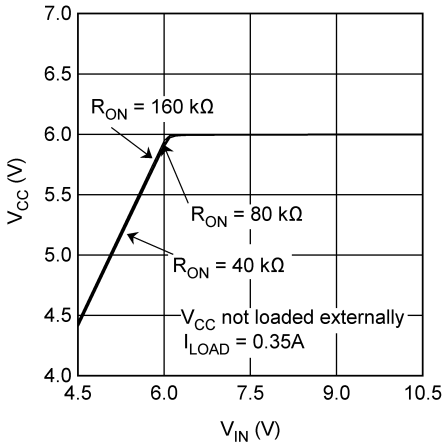


Figure 3. V_{CC} vs V_{IN}

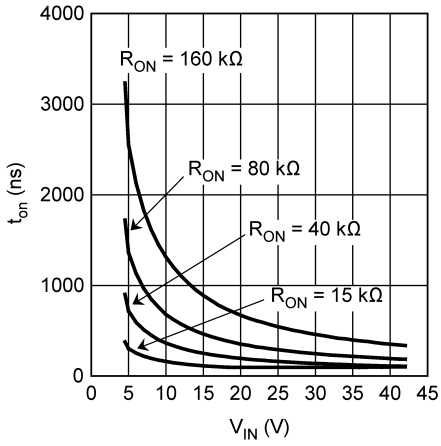


Figure 4. t_{on} vs V_{IN}

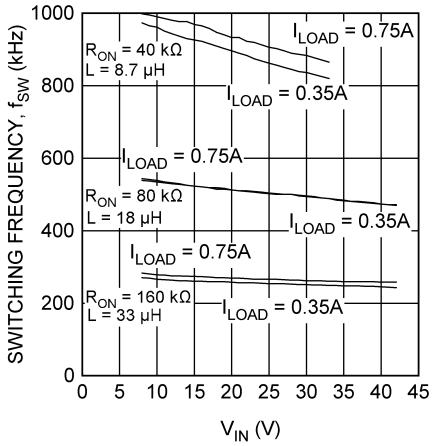


Figure 5. Switching Frequency, f_{SW} vs V_{IN}

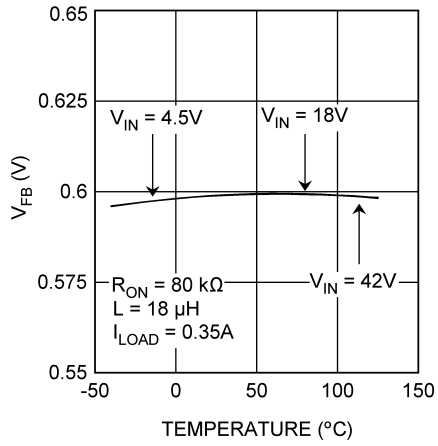


Figure 6. V_{FB} vs Temperature

Typical Characteristics (continued)

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

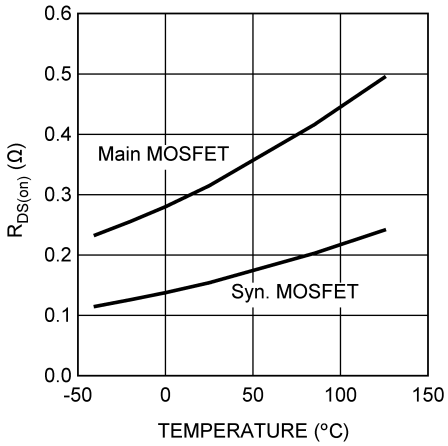


Figure 7. $R_{DS(on)}$ vs Temperature

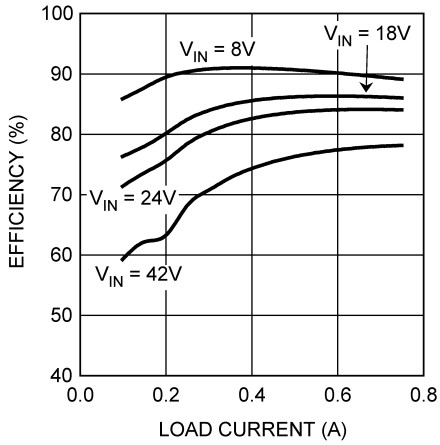


Figure 8. Efficiency vs Load Current (V_{OUT} = 3.3 V)

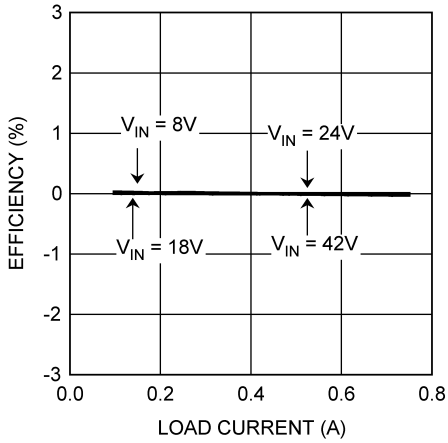


Figure 9. V_{OUT} Regulation vs Load Current (V_{OUT} = 3.3 V)

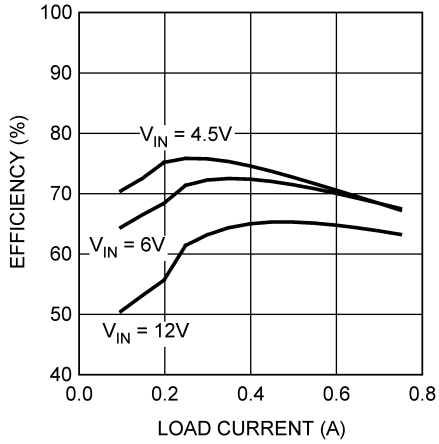


Figure 10. Efficiency vs Load Current (V_{OUT} = 0.6 V)

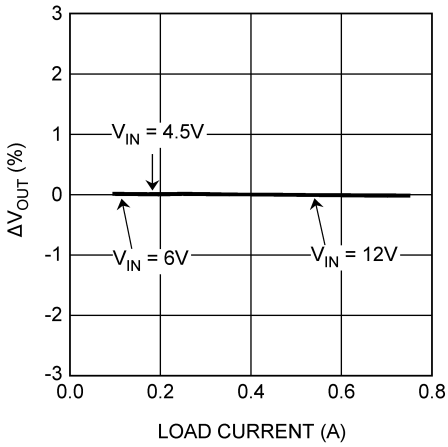


Figure 11. V_{OUT} Regulation vs Load Current (V_{OUT} = 0.6 V)

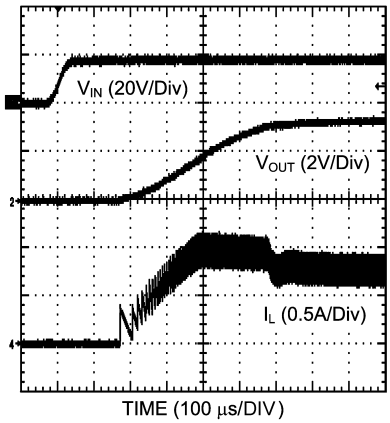


Figure 12. Power Up (V_{OUT} = 3.3 V, 0.75 A Loaded)

Copyright © 2007–2018, Texas Instruments Incorporated

Typical Characteristics (continued)

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

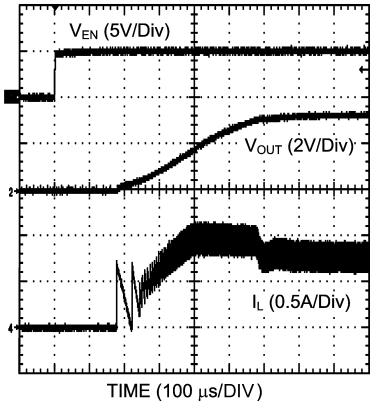


Figure 13. Enable Transient (V_{OUT} = 3.3 V, 0.75 A Loaded)

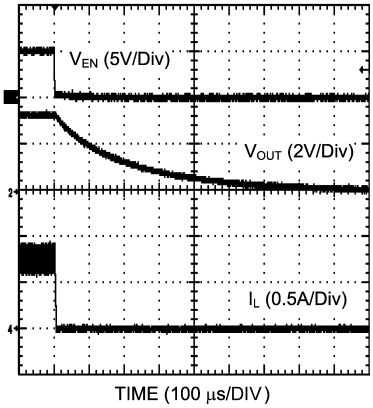


Figure 14. Shutdown Transient (V_{OUT} = 3.3 V, 0.75 A Loaded)

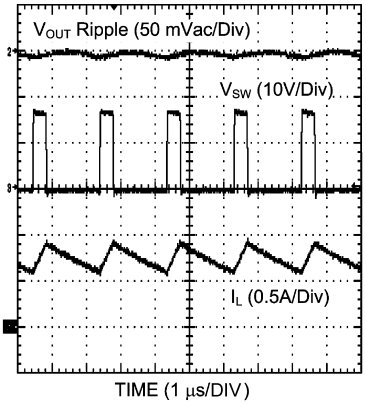


Figure 15. Continuous Mode Operation (V_{OUT} = 3.3 V, 2.5 A Loaded)

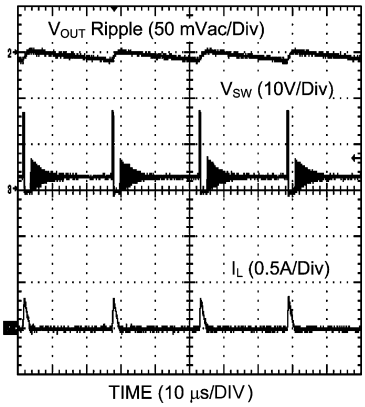


Figure 16. Discontinuous Mode Operation (V_{OUT} = 3.3 V, 0.02 A Loaded)

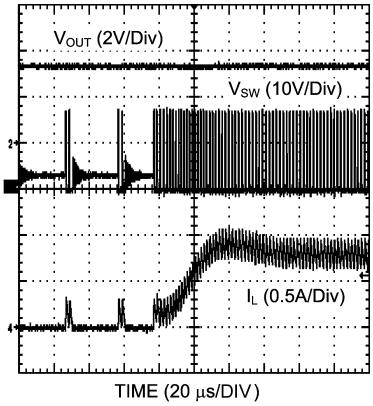


Figure 17. DCM to CCM Transition (V_{OUT} = 3.3 V, 0.01 A - 0.75 A Load)

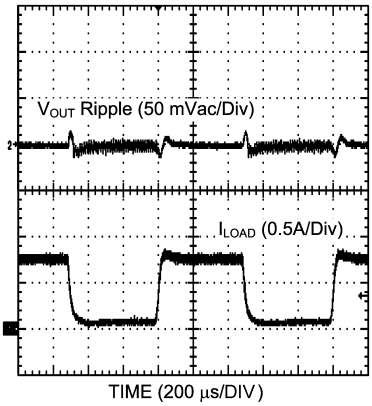
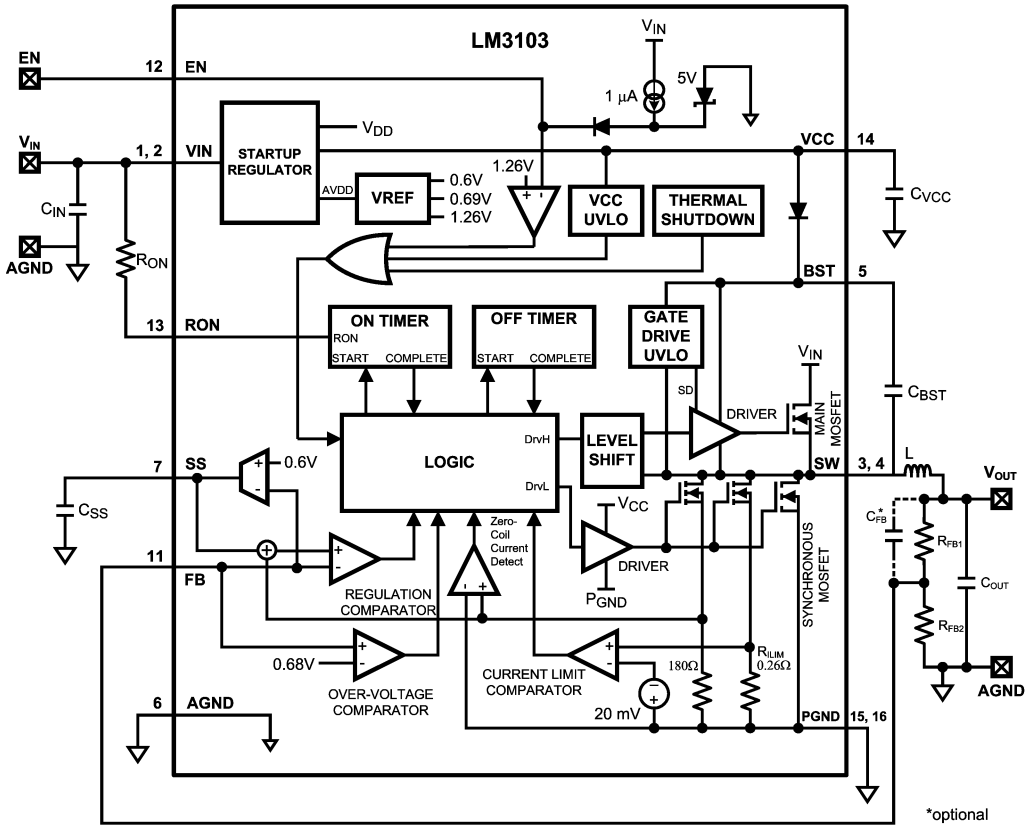


Figure 18. Load Transient (V_{OUT} = 3.3 V, 0.075 A - 0.75 A Load, Current slew-rate: 2.5 A/µs)

Copyright © 2007–2018, Texas Instruments Incorporated

7 Detailed Description

7.1 Functional Block Diagram



7.2 Feature Description

The LM3103 Step Down Switching Regulator features all required functions to implement a cost effective, efficient buck power converter which is capable of supplying 0.75 A to loads. It contains dual N-Channel main and synchronous MOSFETs. The Constant ON-Time (COT) regulation scheme requires no loop compensation, results in a fast load transient response and simple circuit implementation. The regulator can function properly 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 variations due to the inverse relationship between the input voltage and the on-time. The valley current limit detection circuit, with a limit set internally at 0.9 A, inhibits the main MOSFET until the inductor current level subsides.

The LM3103 can be applied in numerous applications and can operate efficiently for inputs as high as 42 V. Protection features include V_{CC} under-voltage lockout, output over-voltage protection, thermal shutdown, gate drive under-voltage lock-out. The LM3103 is available in the thermally enhanced HTSSOP-16 package.

7.2.1 COT Control Circuit Overview

COT control is based on a comparator and a one-shot on-timer, with the output voltage feedback (feeding to the FB pin) compared with a 0.6 V internal reference. If the voltage of the FB pin is below the reference, the main MOSFET is turned on for a fixed on-time determined by a programming resistor RON and the input voltage V_{IN}, upon which the on-time varies inversely. Following the on-time, the main MOSFET remains off for a minimum of 240 ns. Then, if the voltage of the FB pin is below the reference, the main MOSFET is turned on again for another on-time period. The switching will continue to achieve regulation.

Copyright © 2007–2018, Texas Instruments Incorporated

Feature Description (continued)

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

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

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

$$f_{SW} = \frac{V_{OUT}}{8.3 \times 10^{-11} \times R_{ON}} \tag{2}$$

The output voltage is set by two external resistors R_{FB1} and R_{FB2}. The regulated output voltage is

$$V_{OUT} = 0.6V \times (R_{FB1} + R_{FB2})/R_{FB2} \tag{3}$$

7.2.2 Startup Regulator (V_{CC})

A startup regulator is integrated within the LM3103. The input pin VIN can be connected directly to a line voltage up to 42 V. The V_{CC} output regulates at 6 V, and is current limited to 30 mA. Upon power up, the regulator sources current into an external capacitor C_{VCC}, which is connected to the VCC pin. For stability, C_{VCC} must be at least 1 µF. When the voltage on the VCC pin is higher than the under-voltage lock-out (UVLO) threshold of 3.7 V, the main MOSFET is enabled and the SS pin is released to allow the soft-start capacitor C_{SS} to charge.

The minimum input voltage is determined by the dropout voltage of the regulator and the V_{CC} UVLO falling threshold (≅3.4 V). If V_{IN} is less than ≅4.0 V, the regulator shuts off and V_{CC} goes to zero.

7.2.3 Regulation Comparator

The feedback voltage at the FB pin is compared to a 0.6 V internal reference. In normal operation (the output voltage is regulated), an on-time period is initiated when the voltage at the FB pin falls below 0.6 V. The main MOSFET stays on for the programmed on-time, causing the output voltage to rise and consequently the voltage of the FB pin to rise above 0.6 V. After the on-time period, the main MOSFET stays off until the voltage of the FB pin falls below 0.6 V again. Bias current at the FB pin is nominally 1 nA.

7.2.4 Zero Coil Current Detect

The current of the synchronous MOSFET is monitored by a zero coil current detection circuit which inhibits the synchronous MOSFET when its current reaches zero until the next on-time. This circuit enables the DCM operation, which improves the efficiency at a light load.

7.2.5 Over-Voltage Comparator

The voltage at the FB pin is compared to a 0.68 V internal reference. If it rises above 0.68 V, the on-time is immediately terminated. This condition is known as over-voltage protection (OVP). It can occur if the input voltage or the output load changes suddenly. Once the OVP is activated, the main MOSFET remains off until the voltage at the FB pin falls below 0.6 V. The synchronous MOSFET will stay on to discharge the inductor until the inductor current reduces to zero and then switch off.

7.2.6 ON-Time Timer, Shutdown

The on-time of the LM3103 main MOSFET is determined by the resistor R_{ON} and the input voltage V_{IN}. It is calculated as follows:

$$t_{ON} = \frac{8.3 \times 10^{-11} \times R_{ON}}{V_{IN}} \tag{4}$$

Copyright © 2007–2018, Texas Instruments Incorporated

Feature Description (continued)

The inverse relationship of t_{on} and V_{IN} gives a nearly constant frequency as V_{IN} is varied. R_{ON} should be selected such that the on-time at maximum V_{IN} is greater than 100 ns. The on-timer has a limiter to ensure a minimum of 100 ns for t_{on}. This limits the maximum operating frequency, which is governed by the following equation:

$$f_{SW(MAX)} = \frac{V_{OUT}}{V_{IN(MAX)} \times 100\ ns} \tag{5}$$

The LM3103 can be remotely shut down by pulling the voltage of the EN pin below 1.6 V. In this shutdown 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 because the EN pin is internally pulled up.

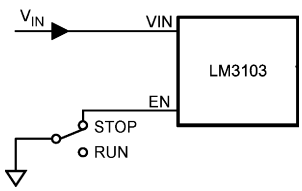


Figure 19. Shutdown Implementation

7.2.7 Current Limit

Current limit detection is carried out during the off-time by monitoring the re-circulating current through the synchronous MOSFET. Referring to the Functional Block Diagram, when the main MOSFET is turned off, the inductor current flows through the load, the PGND pin and the internal synchronous MOSFET. If this current exceeds 0.9 A, the current limit comparator toggles, and as a result the start of the next on-time period is disabled. The next switching cycle starts when the re-circulating current falls back below 0.9 A (and the voltage at the FB pin is below 0.6 V). The inductor current is monitored during the on-time of the synchronous MOSFET. As long as the inductor current exceeds 0.9 A, the main MOSFET will remain inhibited to achieve current limit. The operating frequency is lower during current limit owing to a longer off-time.

Figure 20 illustrates an inductor current waveform. On average, the output current I_{OUT} is the same as the inductor current I_L, which is the average of the rippled inductor current. In case of current limit (the current limit portion of Figure 20), the next on-time will not initiate until that the current drops below 0.9 A (assume the voltage at the FB pin is lower than 0.6 V). During each on-time the current ramps up an amount equal to:

$$I_{LR} = \frac{(V_{IN} - V_{OUT}) \times t_{on}}{L} \tag{6}$$

During current limit, the LM3103 operates in a constant current mode with an average output current $I_{OUT(CL)}$ equal to 0.9 A + I_{LR} / 2.

Copyright © 2007–2018, Texas Instruments Incorporated

Feature Description (continued)

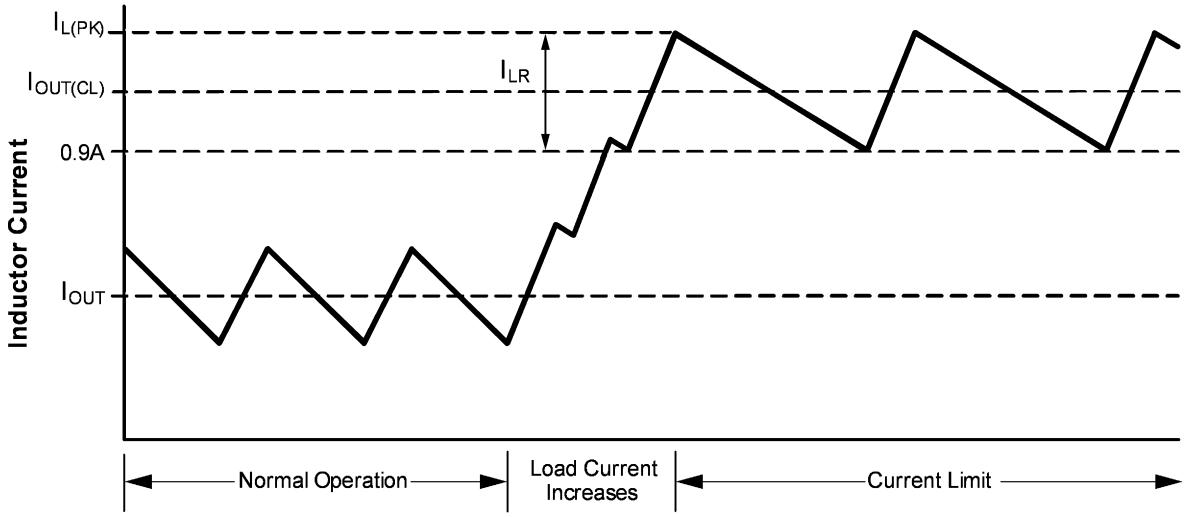


Figure 20. Inductor Current - Current Limit Operation

7.2.8 N-Channel MOSFET and Driver

The LM3103 integrates an N-Channel main MOSFET and an associated floating high voltage main MOSFET gate driver. The gate drive circuit works in conjunction with an external bootstrap capacitor C_{BST} and an internal high voltage diode. C_{BST} connected between the BST and SW pins powers the main MOSFET gate driver during the main MOSFET on-time. During each off-time, the voltage of the SW pin falls to approximately –1 V, and C_{BST} charges from V_{CC} through the internal diode. The minimum off-time of 240 ns provides enough time for charging C_{BST} in each cycle.

7.2.9 Soft-Start

The soft-start feature allows the converter to gradually reach a steady state operating point, thereby reducing startup stresses and current surges. Upon turn-on, after V_{CC} reaches the under-voltage threshold and a 180 µs fixed delay, a 70 µA internal current source charges an external capacitor C_{SS} connecting to the SS pin. The ramping voltage at the SS pin (and the non-inverting input of the regulation comparator as well) ramps up the output voltage V_{OUT} in a controlled manner. An internal switch grounds the SS pin if any of the following three cases happen: (i) V_{CC} is below the under-voltage lockout threshold; (ii) a thermal shutdown occurs; or (iii) the EN pin is grounded. Alternatively, the output voltage can be shut off by connecting the SS pin to the ground using an external switch. Releasing the switch allows the voltage of the SS pin to ramp up and the output voltage to return to normal. The shutdown configuration is shown in Figure 21.

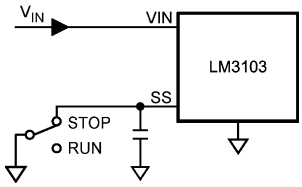


Figure 21. Alternate Shutdown Implementation

7.2.10 Thermal Protection

The junction temperature of the LM3103 should not exceed the maximum limit. Thermal protection is implemented by an internal Thermal Shutdown circuit, which activates (typically) at 165°C to make the controller enter a low power reset state by disabling the main MOSFET, disabling the on-timer, and grounding the SS pin. Thermal protection 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.

Copyright © 2007–2018, Texas Instruments Incorporated

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 Application Information

8.1.1 External Components

The following guidelines can be used to select external components.

R_{FB1} and R_{FB2} : These resistors should be chosen from standard values in the range of 1.0 kΩ to 10 kΩ, satisfying the following ratio:

$$R_{FB1}/R_{FB2} = (V_{OUT}/0.6\ V) - 1 \tag{7}$$

For V_{OUT} = 0.6 V, the FB pin can be connected to the output directly with a pre-load resistor drawing more than 20 µA. This is because the converter operation needs a minimum inductor current ripple to maintain good regulation when no load is connected.

R_{ON}: Equation 2 can be used to select R_{ON} if a desired operating frequency is selected. But the minimum value of R_{ON} is determined by the minimum on-time. It can be calculated as follows:

$$R_{ON} \geq \frac{V_{IN(MAX)} \times 100\ ns}{8.3 \times 10^{-11}} \tag{8}$$

If R_{ON} calculated from Equation 2 is smaller than the minimum value determined in Equation 8, a lower frequency should be selected to re-calculate R_{ON} by Equation 2. Alternatively, $V_{IN(MAX)}$ can also be limited in order to keep the frequency unchanged. The relationship of $V_{IN(MAX)}$ and R_{ON} is shown in Figure 22.

On the other hand, the minimum off-time of 240 ns can limit the maximum duty ratio. This may be significant at low V_{IN}. A larger R_{ON} should be selected in any application requiring a large duty ratio.

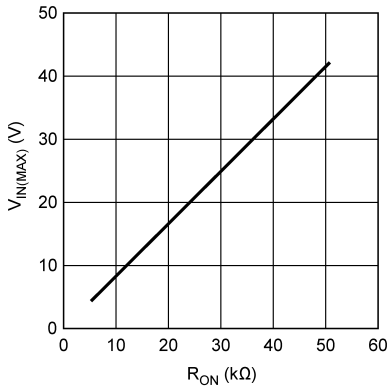


Figure 22. Maximum V_{IN} for selected R_{ON}

L: The main parameter affected by the inductor is the amplitude of the inductor current ripple (I_{LR}), which is recommended to be greater than 0.3 A. Once I_{LR} is selected, L can be determined by:

$$L = \frac{V_{OUT} \times (V_{IN} - V_{OUT})}{I_{LR} \times f_{SW} \times V_{IN}} \tag{9}$$

where V_{IN} is the input voltage and f_{SW} is determined from Equation 2.

Copyright © 2007–2018, Texas Instruments Incorporated

Application Information (continued)

If the output current I_{OUT} is known, by assuming that $I_{OUT} = I_L$, the peak and valley of I_{LR} can be determined. Beware that the peak of I_{LR} should not be larger than the saturation current of the inductor and the current rating of the main and synchronous MOSFETs. Also, the valley of I_{LR} must be positive if CCM operation is required.

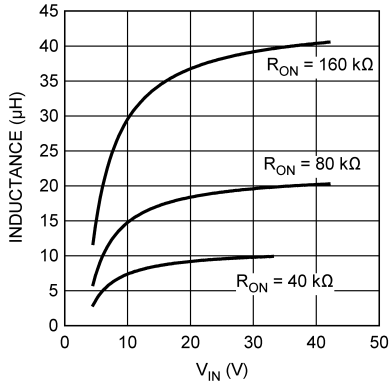


Figure 23. Inductor selection for V_{OUT} = 3.3 V

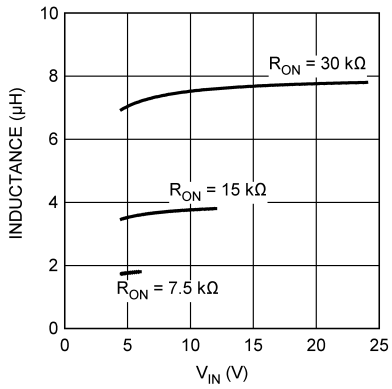


Figure 24. Inductor selection for V_{OUT} = 0.6 V

Figure 23 and Figure 24 show curves on inductor selection for various V_{OUT} and R_{ON}. According to Equation 8, V_{IN} is limited for small R_{ON}. Some curves are therefore limited as shown in the figures.

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 main MOSFET on/off transitions. C_{VCC} should be no smaller than 1 µF for stability, and should be a good quality, low ESR, ceramic capacitor.

C_{OUT} and C_{OUT3}: C_{OUT} should generally be no smaller than 10 µF. Experimentation is usually necessary to determine the minimum value for C_{OUT}, as the nature of the load may require a larger value. A load which creates significant transients requires a larger C_{OUT} than a fixed load.

C_{OUT3} is a small value ceramic capacitor located close to the LM3103 to further suppress high frequency noise at V_{OUT}. A 47 nF capacitor is recommended.

C_{IN} and C_{IN3}: The function of C_{IN} is to supply most of the main MOSFET current during the on-time, and limit the voltage ripple at the VIN pin, assuming that the voltage source connecting to the VIN pin has finite output impedance. If the voltage source's dynamic impedance is high (effectively a current source), C_{IN} supplies the difference between the instantaneous input current and the average input current.

At the maximum load current, when the main MOSFET turns on, the current to the VIN pin suddenly increases from zero to the valley of the inductor's ripple current and ramps up to the peak value. It then drops to zero at turn-off. The average current during the on-time is the load current. For a worst case calculation, C_{IN} must be capable of supplying this average load current during the maximum on-time. C_{IN} is calculated from:

Copyright © 2007–2018, Texas Instruments Incorporated

Application Information (continued)

$$C_{IN} = \frac{I_{OUT} \times t_{ON}}{\Delta V_{IN}} \tag{10}$$

where I_{OUT} is the load current, t_{on} is the maximum on-time, and ΔV_{IN} 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 the VIN pin. A low ESR 0.1 µF ceramic chip capacitor located close to the LM3103 is recommended.

C_{BST}: A 33 nF high quality ceramic capacitor with low ESR is recommended for C_{BST} since it supplies a surge current to charge the main MOSFET gate driver at each turn-on. Low ESR also helps ensure a complete recharge during each off-time.

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 therefore, the output voltage to reach their final value. The time is determined from the following equation:

$$t_{SS} = 180\ \mu s + \frac{C_{SS} \times 0.6V}{70\ \mu A} \tag{11}$$

C_{FB}: If the output voltage is higher than 1.6 V, C_{FB} is needed in the Discontinuous Conduction Mode to reduce the output ripple. The recommended value for C_{FB} is 10 nF.

版权 © 2007–2018, Texas Instruments Incorporated

9 器件和文档支持

9.1 接收文档更新通知

如需接收文档更新通知，请导航至 TI.com.cn 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。

9.2 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》。

TI E2E™ 在线社区 ***TI 的工程师对工程师 (E2E) 社区。***此社区的创建目的在于促进工程师之间的协作。在 e2e.ti.com 中，您可以咨询问题、分享知识、拓展思路并与同行工程师一道帮助解决问题。

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。

9.3 商标

E2E is a trademark of Texas Instruments.
All other trademarks are the property of their respective owners.

9.4 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。

9.5 Glossary

SLYZ022 — *TI Glossary*.

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

10 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。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 part number	Status (1)	Material type (2)	Package | Pins	Package qty | Carrier	RoHS (3)	Lead finish/ Ball material (4)	MSL rating/ Peak reflow (5)	Op temp (°C)	Part marking (6)
LM3103MH/NOPB	Active	Production	HTSSOP (PWP) | 16	92 | TUBE	Yes	SN	Level-1-260C-UNLIM	-40 to 125	LM3103 MH
LM3103MH/NOPB.A	Active	Production	HTSSOP (PWP) | 16	92 | TUBE	Yes	SN	Level-1-260C-UNLIM	-40 to 125	LM3103 MH
LM3103MH/NOPB.B	Active	Production	HTSSOP (PWP) | 16	92 | TUBE	Yes	SN	Level-1-260C-UNLIM	-40 to 125	LM3103 MH
LM3103MHX/NOPB	Active	Production	HTSSOP (PWP) | 16	2500 | LARGE T&R	Yes	SN	Level-1-260C-UNLIM	-40 to 125	LM3103 MH
LM3103MHX/NOPB.A	Active	Production	HTSSOP (PWP) | 16	2500 | LARGE T&R	Yes	SN	Level-1-260C-UNLIM	-40 to 125	LM3103 MH
LM3103MHX/NOPB.B	Active	Production	HTSSOP (PWP) | 16	2500 | LARGE T&R	Yes	SN	Level-1-260C-UNLIM	-40 to 125	LM3103 MH

(1) **Status:** For more details on status, see our product life cycle.

(2) **Material type:** When designated, preproduction parts are prototypes/experimental devices, and are not yet approved or released for full production. Testing and final process, including without limitation quality assurance, reliability performance testing, and/or process qualification, may not yet be complete, and this item is subject to further changes or possible discontinuation. If available for ordering, purchases will be subject to an additional waiver at checkout, and are intended for early internal evaluation purposes only. These items are sold without warranties of any kind.

(3) **RoHS values:** Yes, No, RoHS Exempt. See the TI RoHS Statement for additional information and value definition.

(4) **Lead finish/Ball material:** Parts 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.

(5) **MSL rating/Peak reflow:** The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will be used to mount the part to the printed circuit board.

(6) **Part marking:** There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

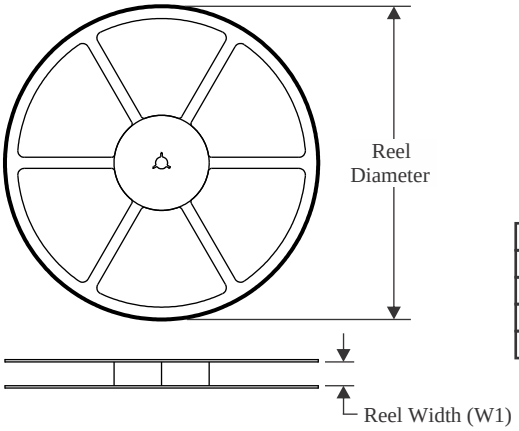
Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "~" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

Important Information and Disclaimer: The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

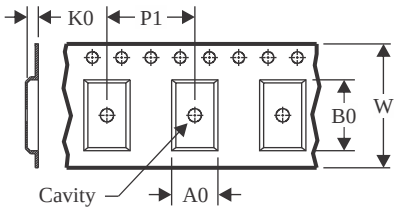
In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

TAPE AND REEL INFORMATION

REEL DIMENSIONS

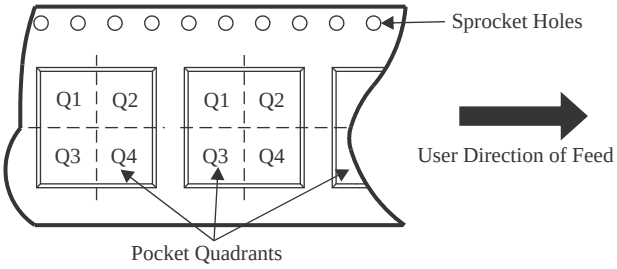


TAPE DIMENSIONS



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

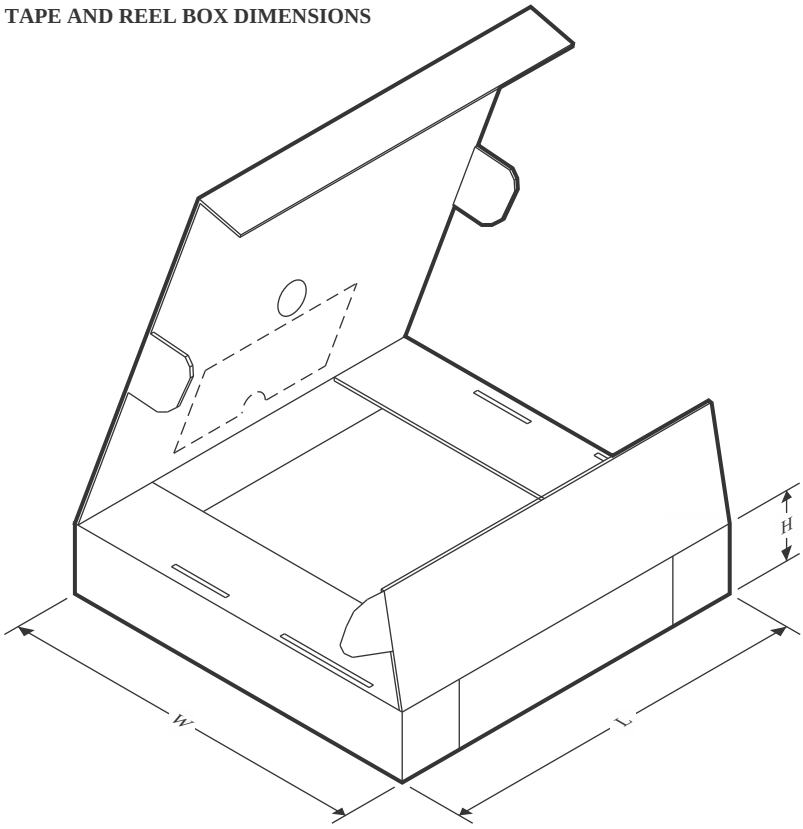
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*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
LM3103MHX/NOPB	HTSSOP	PWP	16	2500	330.0	12.4	6.9	5.6	1.6	8.0	12.0	Q1

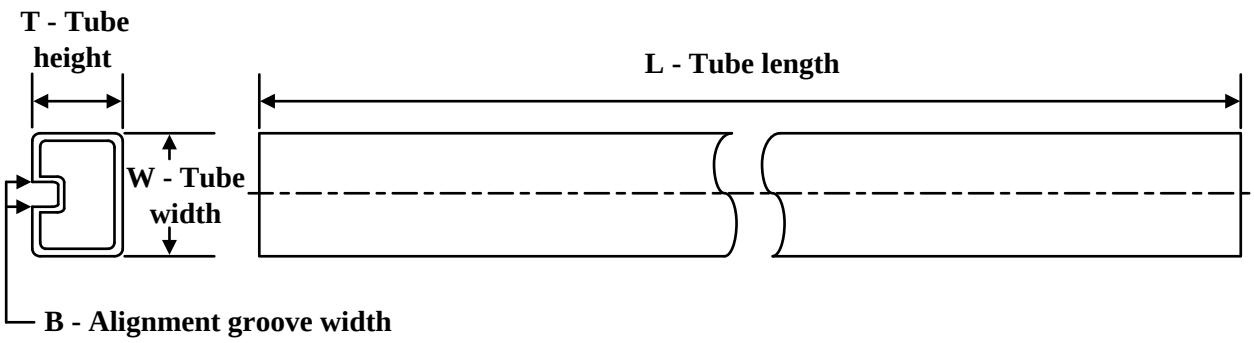
TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

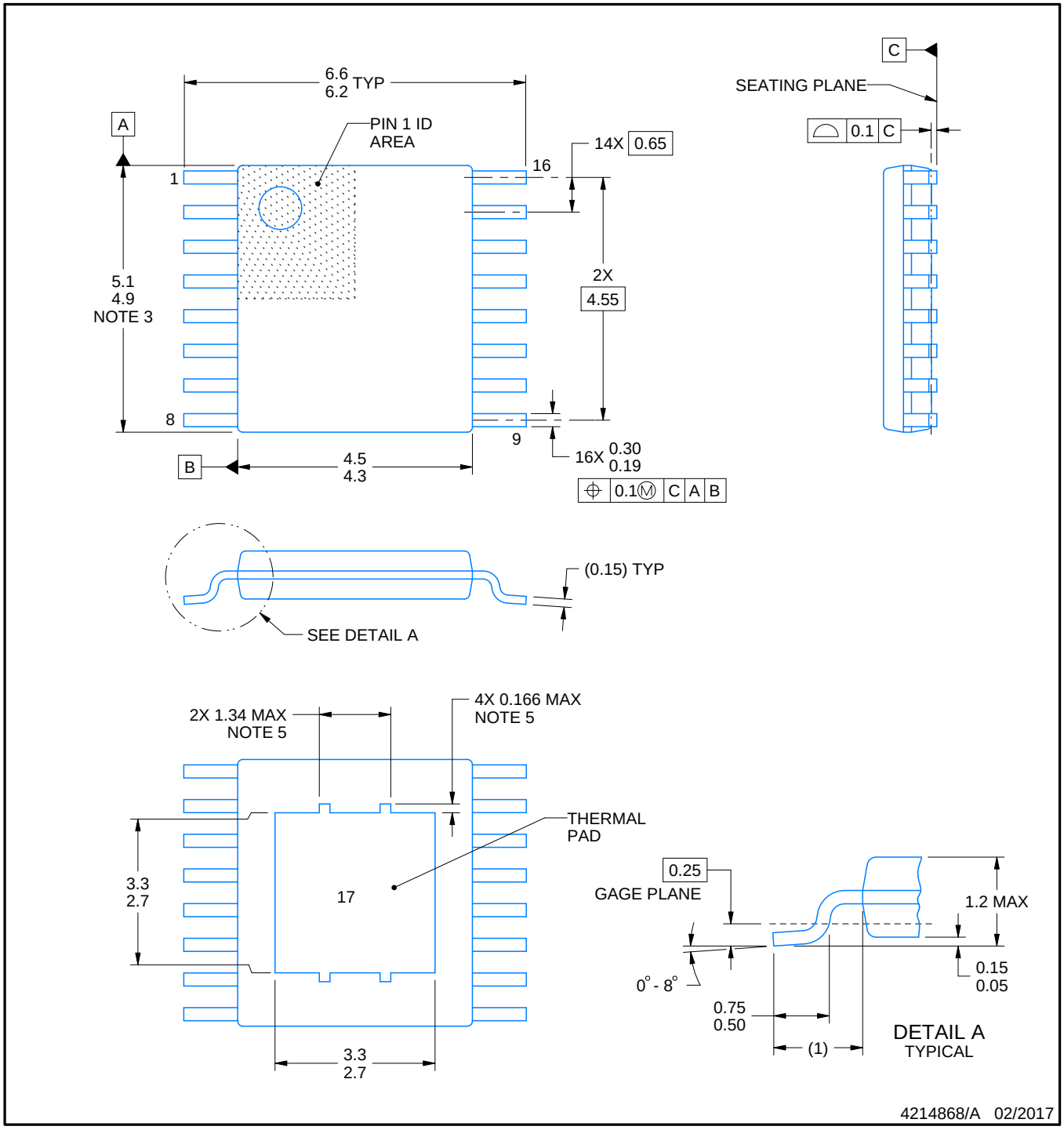
Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
LM3103MHX/NOPB	HTSSOP	PWP	16	2500	367.0	367.0	35.0

TUBE



*All dimensions are nominal

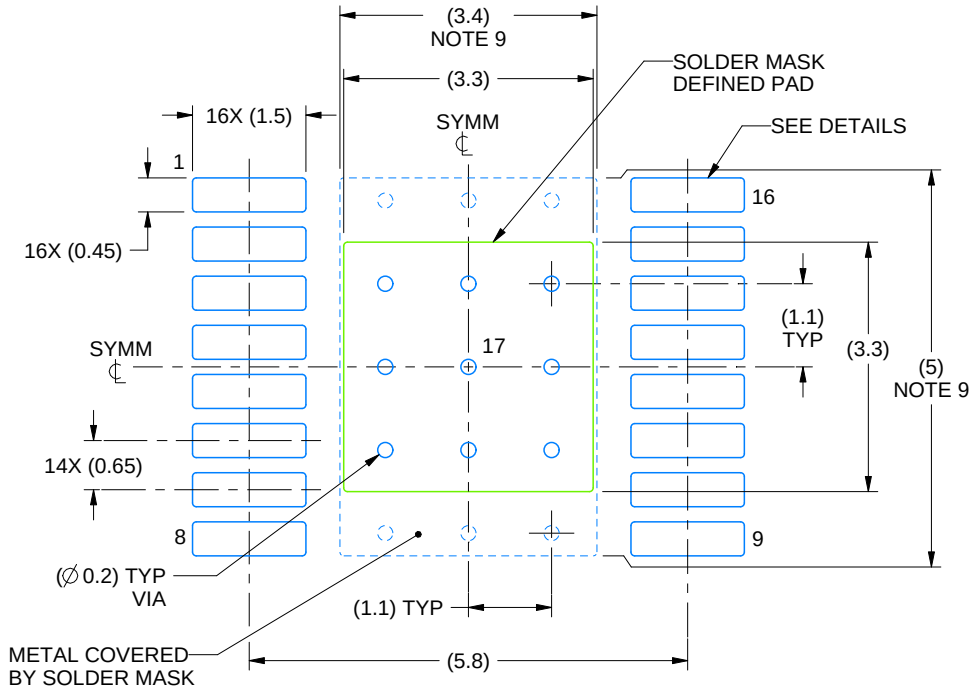
Device	Package Name	Package Type	Pins	SPQ	L (mm)	W (mm)	T (µm)	B (mm)
LM3103MH/NOPB	PWP	HTSSOP	16	92	495	8	2514.6	4.06
LM3103MH/NOPB.A	PWP	HTSSOP	16	92	495	8	2514.6	4.06
LM3103MH/NOPB.B	PWP	HTSSOP	16	92	495	8	2514.6	4.06



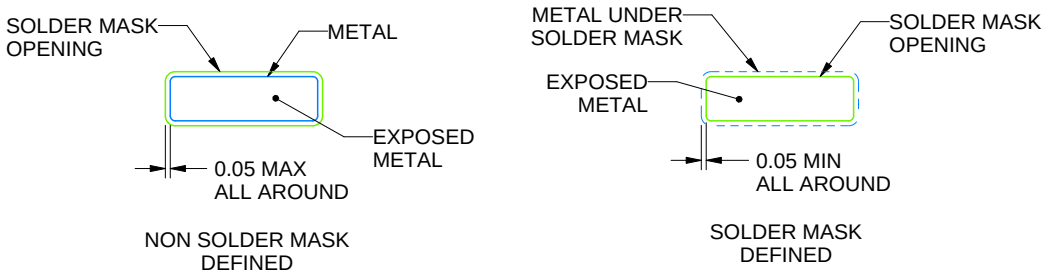
PowerPAD is a trademark of Texas Instruments.

NOTES:

1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 mm per side.
4. Reference JEDEC registration MO-153.
5. Features may not be present.



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE:10X

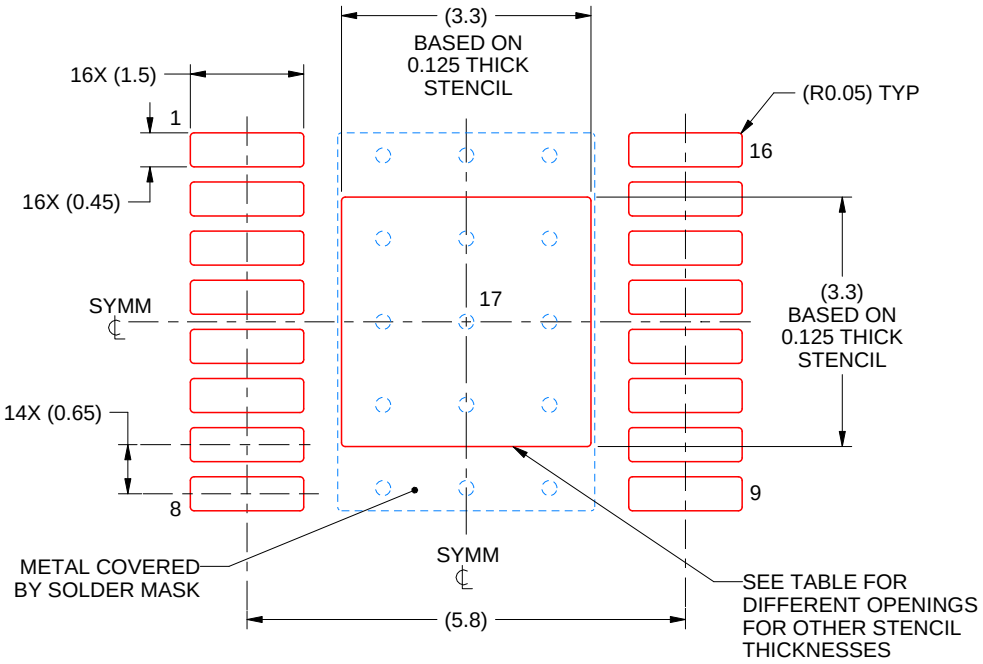


SOLDER MASK DETAILS
PADS 1-16

4214868/A 02/2017

NOTES: (continued)

6. Publication IPC-7351 may have alternate designs.
7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.
8. This package is designed to be soldered to a thermal pad on the board. For more information, see Texas Instruments literature numbers SLMA002 (www.ti.com/lit/slma002) and SLMA004 (www.ti.com/lit/slma004).
9. Size of metal pad may vary due to creepage requirement.



SOLDER PASTE EXAMPLE
EXPOSED PAD
100% PRINTED SOLDER COVERAGE BY AREA
SCALE:10X

STENCIL THICKNESS	SOLDER STENCIL OPENING
0.1	3.69 X 3.69
0.125	3.3 X 3.3 (SHOWN)
0.15	3.01 X 3.01
0.175	2.79 X 2.79

4214868/A 02/2017

NOTES: (continued)

10. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
11. Board assembly site may have different recommendations for stencil design.

重要通知和免责声明

TI“按原样”提供技术和可靠性数据（包括数据表）、设计资源（包括参考设计）、应用或其他设计建议、网络工具、安全信息和其他资源，不保证没有瑕疵且不做出任何明示或暗示的担保，包括但不限于对适销性、与某特定用途的适用性或不侵犯任何第三方知识产权的暗示担保。

这些资源可供使用 TI 产品进行设计的熟练开发人员使用。您将自行承担以下全部责任：(1) 针对您的应用选择合适的 TI 产品，(2) 设计、验证并测试您的应用，(3) 确保您的应用满足相应标准以及任何其他安全、安保法规或其他要求。

这些资源如有变更，恕不另行通知。TI 授权您仅可将这些资源用于研发本资源所述的 TI 产品的相关应用。严禁以其他方式对这些资源进行复制或展示。您无权使用任何其他 TI 知识产权或任何第三方知识产权。对于因您对这些资源的使用而对 TI 及其代表造成的任何索赔、损害、成本、损失和债务，您将全额赔偿，TI 对此概不负责。

TI 提供的产品受 TI 销售条款)、TI 通用质量指南 或 ti.com 上其他适用条款或 TI 产品随附的其他适用条款的约束。TI 提供这些资源并不会扩展或以其他方式更改 TI 针对 TI 产品发布的适用的担保或担保免责声明。 除非德州仪器 (TI) 明确将某产品指定为定制产品或客户特定产品，否则其产品均为按确定价格收入目录的标准通用器件。

TI 反对并拒绝您可能提出的任何其他或不同的条款。

版权所有 © 2026，德州仪器 (TI) 公司

最后更新日期：2025 年 10 月