

## LM2734-Q1 薄型SOT、1A負荷の降圧DC/DCレギュレータ

### 1 特長

- 車載アプリケーション用にAEC-Q100認定済み:
  - デバイス温度グレード1:  $-40^{\circ}\text{C} \sim +125^{\circ}\text{C}$ ,  $T_A$
- 薄型のSOT-6パッケージ
- 入力電圧範囲: 3V~20V
- 出力電圧範囲: 0.8V~18V
- 1Aの出力電流
- 550kHz (LM2734Y)および1.6MHz (LM2734X)のスイッチング周波数
- 300mΩ NMOSスイッチ
- シャットダウン電流: 30nA
- 内部基準電圧:  $0.8\text{V} \pm 2\%$
- 内部的なソフトスタート
- 電流モード、PWMの動作
- サーマル・シャットダウン
- WEBENCH® Power Designerにより、LM2734-Q1を使用するカスタム設計を作成

### 2 アプリケーション

- 車載用
- ローカル・ポイント・オブ・ロード・レギュレーション
- 先進運転支援システム(ADAS)

### 3 概要

LM2734-Q1レギュレータはモノリシックで高周波数のPWM降圧DC/DCコンバータで、6ピンの薄型SOTパッケージで供給されます。ローカルDC/DC変換に必要なアクティブ機能をすべて内蔵し、高速過渡応答と正確なレギュレーションを、極めて小さなPCB面積で実現しています。

最小限の外付け部品と、WEBENCHでのオンライン設計サポートにより、LM2734-Q1レギュレータは簡単に使用できます。最先端の $0.5\mu\text{m}$  BiCMOSテクノロジーを使用する内蔵300mΩ NMOSスイッチにより1Aの負荷を駆動できるため、利用可能な最高の電力密度が得られます。世界最先端の制御回路により、最短で13nsのオン時間が可能なため、3V~20Vの入力動作範囲の全体から、最低0.8Vの出力電圧へ、非常に高い周波数で変換できます。スイッチング周波数は内部的に550kHz (LM2734Y)または1.6MHz (LM2734X)に設定されており、非常に小型の表面実装インダクタとチップ・コンデンサを使用できます。動作周波数が非常に高いにもかかわらず、最大90%の高い効率を簡単に実現できます。外部からのシャットダウン機能を備えており、スタンバイ電流が30nAと非常に低くなっています。

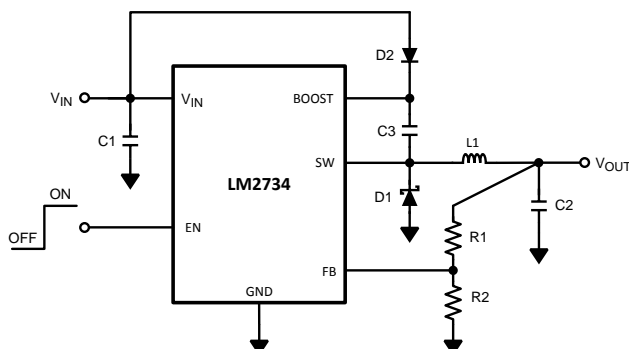
LM2734-Q1は電流モード制御と内部補償を活用して、広範な動作条件にわたって高性能のレギュレーションを行います。追加機能として、内部ソフトスタート回路による突入電流の低減、パルス単位の電流制限、サーマル・シャットダウン、出力過電圧保護が搭載されています。

#### 製品情報<sup>(1)</sup>

型番	パッケージ	本体サイズ(公称)
LM2734-Q1	SOT (6)	2.90mm×1.60mm

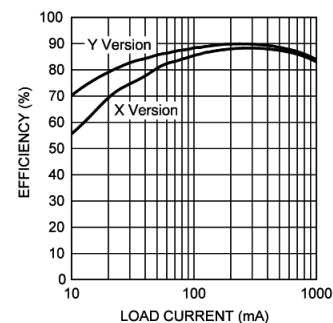
(1) 利用可能なすべてのパッケージについては、このデータシートの末尾にある注文情報を参照してください。

#### 代表的なアプリケーション回路



#### 効率と負荷電流との関係

$$V_{IN} = 5\text{V}, V_{OUT} = 3.3\text{V}$$



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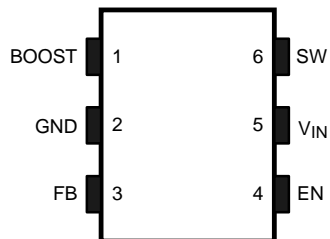
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## 4 改訂履歴

日付	リビジョン	注
2018年9月	*	2004年9月に作成された、商業用と車載用を組み合わせたデータシートSNVS288から、LM2734-Q1を分離。このドキュメントSNVSB80には、車載用のLM2734-Q1部分の詳細を記載。 絶対最大定格の最大FB電圧を「-0.3V」から「3V」に変更

## 5 Pin Configuration and Functions

**DDC Package  
6-Pin SOT-23-THIN  
Top View**



**Pin Functions**

PIN		I/O	DESCRIPTION
NAME	NO.		
BOOST	1	I	Boost voltage that drives the internal NMOS control switch. A bootstrap capacitor is connected between the BOOST and SW pins.
GND	2	GND	Signal and Power ground pin. Place the bottom resistor of the feedback network as close as possible to this pin for accurate regulation.
FB	3	I	Feedback pin. Connect FB to the external resistor divider to set output voltage.
EN	4	I	Enable control input. Logic high enables operation. Do not allow this pin to float or be greater than $V_{IN} + 0.3$ V.
$V_{IN}$	5	I	Input supply voltage. Connect a bypass capacitor to this pin.
SW	6	O	Output switch. Connects to the inductor, catch diode, and bootstrap capacitor.

## 6 Specifications

### 6.1 Absolute Maximum Ratings

over operating free-air temperature (unless otherwise noted)<sup>(1)(2)</sup>

	MIN	MAX	UNIT
V <sub>IN</sub>	-0.5	24	V
SW voltage	-0.5	24	V
Boost voltage	-0.5	30	V
Boost to SW voltage	-0.5	6	V
FB voltage	-0.5	3	V
EN voltage	-0.5	V <sub>IN</sub> + 0.3	V
Junction temperature		150	°C
Soldering information reflow peak pkg. temp.(15s)		260	°C
Storage temperature, T <sub>stg</sub>	-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.
- (2) If Military/Aerospace specified devices are required, contact the Texas Instruments Sales Office/ Distributors for availability and specifications.

### 6.2 ESD Ratings

		VALUE	UNIT
V <sub>(ESD)</sub>	Electrostatic discharge	Human-body model (HBM), per AEC Q100-002 <sup>(1)</sup> HBM ESD Classification Level 2	V
		Charged-device model (CDM), per AEC Q100-011 CDM ESD Classification Level C6	

- (1) AEC Q100-002 indicates that HBM stressing shall be in accordance with the ANSI/ESDA/JEDEC JS-001 specification.

### 6.3 Recommended Operating Conditions

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

	MIN	NOM	MAX	UNIT
V <sub>IN</sub>	3		20	V
SW voltage	-0.5		20	V
Boost voltage	-0.5		25	V
Boost to SW voltage	1.6		5.5	V
Junction temperature	-40		125	°C

### 6.4 Thermal Information

THERMAL METRIC <sup>(1)</sup>		LM2734-Q1	UNIT
		DDC (SOT-23-THIN)	
		6 PINS	
R <sub>θJA</sub>	Junction-to-ambient thermal resistance	158.1	°C/W
R <sub>θJC(top)</sub>	Junction-to-case (top) thermal resistance	46.5	°C/W
R <sub>θJB</sub>	Junction-to-board thermal resistance	29.5	°C/W
ψ <sub>JT</sub>	Junction-to-top characterization parameter	0.8	°C/W
ψ <sub>JB</sub>	Junction-to-board characterization parameter	29.2	°C/W
R <sub>θJC(bot)</sub>	Junction-to-case (bottom) thermal resistance	n/a	°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

$V_{IN} = 5V$ ,  $V_{BOOST} - V_{SW} = 5V$  unless otherwise specified. Datasheet min/max specification limits are ensured by design, test, or statistical analysis.

PARAMETER		TEST CONDITIONS	$T_J = 25^{\circ}C$			$T_J = -40^{\circ}C \text{ to } 125^{\circ}C$			UNIT
			MIN <sup>(1)</sup>	TYP <sup>(2)</sup>	MAX <sup>(1)</sup>	MIN	TYP	MAX	
$V_{FB}$	Feedback Voltage		0.800			0.784	0.816		V
$\Delta V_{FB}/\Delta V_{IN}$	Feedback Voltage Line Regulation	$V_{IN} = 3V \text{ to } 20V$	0.01						% / V
$I_{FB}$	Feedback Input Bias Current	Sink/Source	10			250			nA
UVLO	Undervoltage Lockout	$V_{IN}$ Rising	2.74			2.90			V
	Undervoltage Lockout	$V_{IN}$ Falling	2.3			2			
	UVLO Hysteresis		0.44			0.30 / 0.62			
$F_{SW}$	Switching Frequency	LM2734X	1.6			1.2 / 1.9			MHz
		LM2734Y	0.55			0.40 / 0.66			
$D_{MAX}$	Maximum Duty Cycle	LM2734X	92			85%			
		LM2734Y	96			90%			
$D_{MIN}$	Minimum Duty Cycle	LM2734X	2%						
		LM2734Y	1%						
$R_{DS(ON)}$	Switch ON Resistance	$V_{BOOST} - V_{SW} = 3V$	300			600			m $\Omega$
$I_{CL}$	Switch Current Limit	$V_{BOOST} - V_{SW} = 3V$	1.7			1.2 / 2.5			A
$I_Q$	Quiescent Current	Switching	1.5			2.5			mA
	Quiescent Current (shutdown)	$V_{EN} = 0V$	30						
$I_{BOOST}$	Boost Pin Current	LM2734X (50% Duty Cycle)	2.5			3.5			mA
		LM2734Y (50% Duty Cycle)	1.0			1.8			
$V_{EN\_TH}$	Shutdown Threshold Voltage	$V_{EN}$ Falling				0.4			V
	Enable Threshold Voltage	$V_{EN}$ Rising				1.8			
$I_{EN}$	Enable Pin Current	Sink/Source	10						nA
$I_{SW}$	Switch Leakage		40						nA

(1) Specified to Average Outgoing Quality Level (AOQL).

(2) Typicals represent the most likely parametric norm.

### 6.6 Typical Characteristics

All curves taken at  $V_{IN} = 5\text{ V}$ ,  $V_{BOOST} - V_{SW} = 5\text{ V}$  and  $T_A = 25^\circ\text{C}$ , unless specified otherwise.

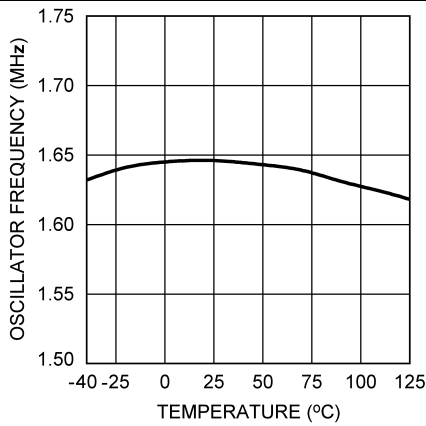


Figure 1. Oscillator Frequency vs Temperature - L1 = 4.7 μH

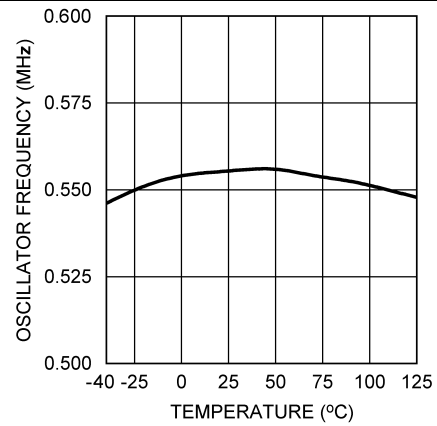


Figure 2. Oscillator Frequency vs Temperature - L1 = 10 μH

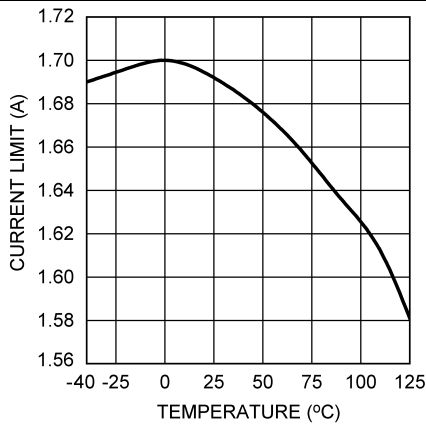


Figure 3. Current Limit vs Temperature

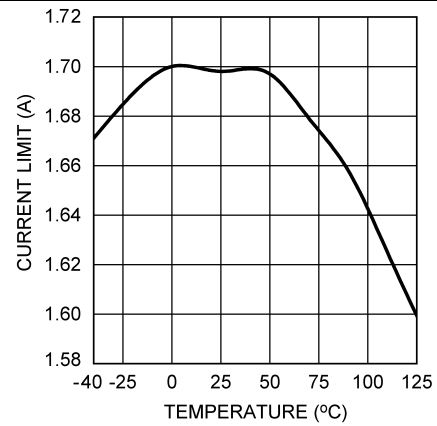


Figure 4. Current Limit vs Temperature  
 $V_{IN} = 20\text{ V}$

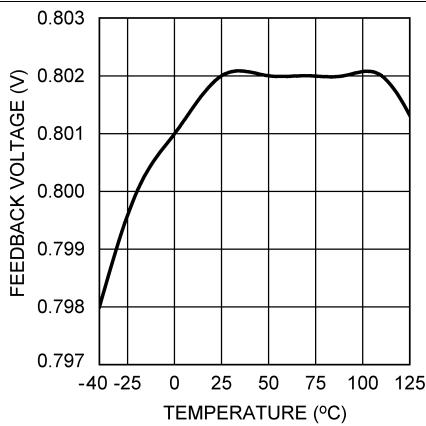


Figure 5.  $V_{FB}$  vs Temperature

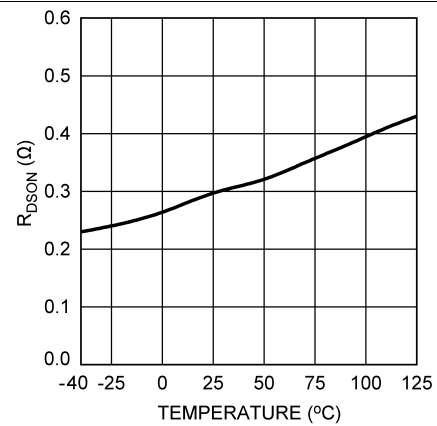


Figure 6.  $R_{DS(on)}$  vs Temperature

### Typical Characteristics (continued)

All curves taken at  $V_{IN} = 5\text{ V}$ ,  $V_{BOOST} - V_{SW} = 5\text{ V}$  and  $T_A = 25^\circ\text{C}$ , unless specified otherwise.

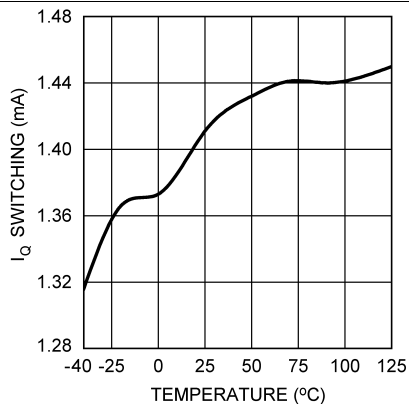


Figure 7. I<sub>Q</sub> Switching vs Temperature

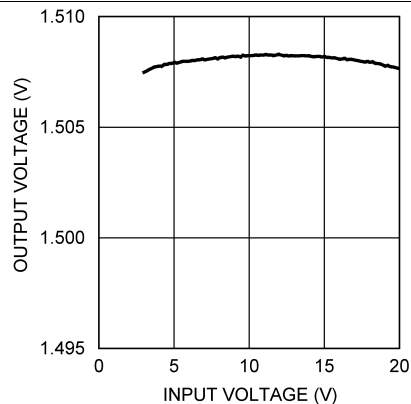


Figure 8. Line Regulation - L1 = 4.7  $\mu\text{H}$   
 $V_{OUT} = 1.5\text{ V}$ ,  $I_{OUT} = 500\text{ mA}$

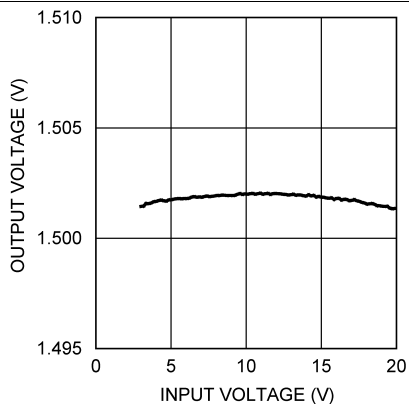


Figure 9. Line Regulation - L1 = 10  $\mu\text{H}$   
 $V_{OUT} = 1.5\text{ V}$ ,  $I_{OUT} = 500\text{ mA}$

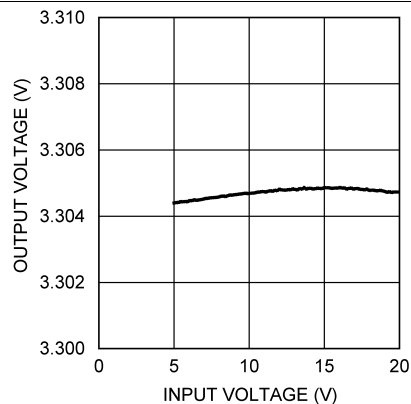


Figure 10. Line Regulation - L1 = 4.7  $\mu\text{H}$   
 $V_{OUT} = 3.3\text{ V}$ ,  $I_{OUT} = 500\text{ mA}$

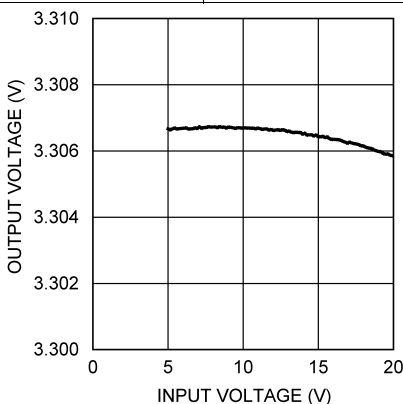


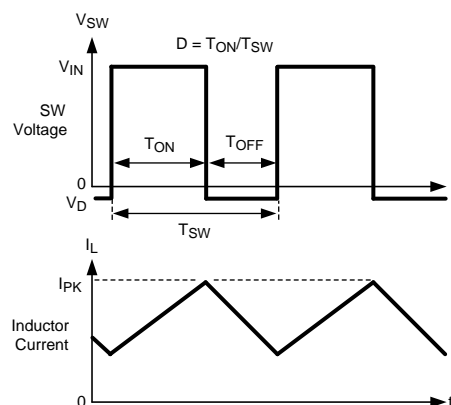
Figure 11. Line Regulation - L1 = 10  $\mu\text{H}$   
 $V_{OUT} = 3.3\text{ V}$ ,  $I_{OUT} = 500\text{ mA}$

## 7 Detailed Description

### 7.1 Overview

The LM2734-Q1 device is a constant frequency PWM buck regulator IC that delivers a 1-A load current. The regulator has a preset switching frequency of either 550 kHz (LM2734Y) or 1.6 MHz (LM2734X). These high frequencies allow the LM2734-Q1 device to operate with small surface-mount capacitors and inductors, resulting in DC/DC converters that require a minimum amount of board space. The LM2734-Q1 device is internally compensated, so it is simple to use, and requires few external components. The LM2734-Q1 device uses current-mode control to regulate the output voltage.

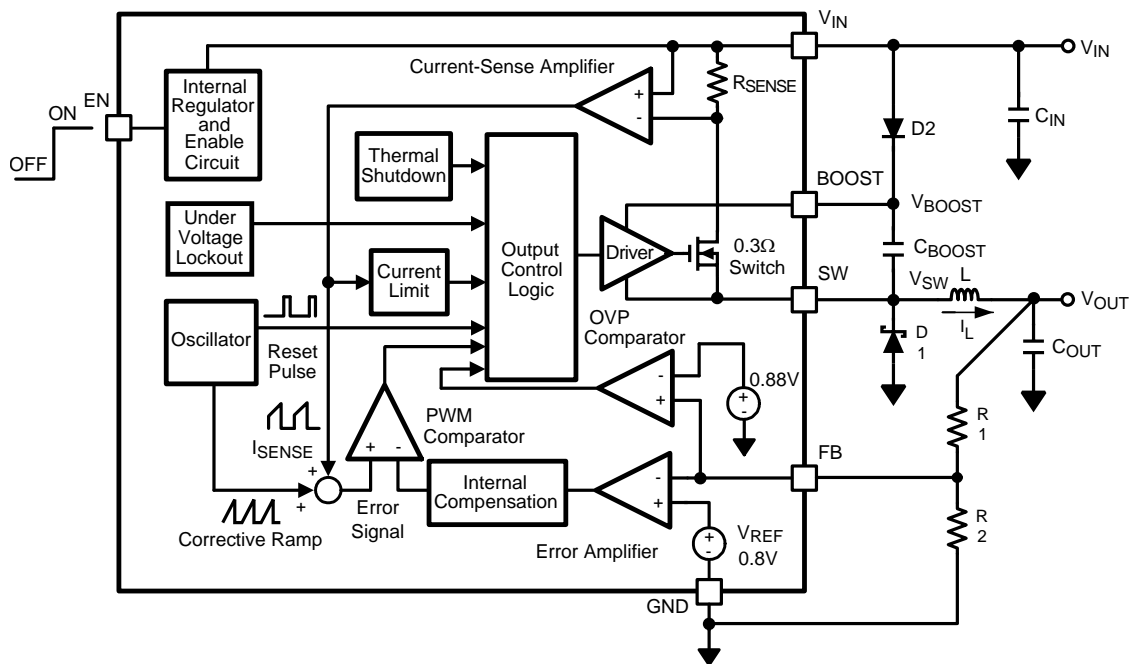
The following operating description of the LM2734-Q1 device will refer to the Simplified Block Diagram () and to the waveforms in Figure 12. The LM2734-Q1 device supplies a regulated output voltage by switching the internal NMOS control switch at constant frequency and variable duty cycle. A switching cycle begins at the falling edge of the reset pulse generated by the internal oscillator. When this pulse goes low, the output control logic turns on the internal NMOS control switch. During this on-time, the SW pin voltage ( $V_{SW}$ ) swings up to approximately  $V_{IN}$ , and the inductor current ( $I_L$ ) increases with a linear slope.  $I_L$  is measured by the current-sense amplifier, which generates an output proportional to the switch current. The sense signal is summed with the regulator's corrective ramp and compared to the error amplifier's output, which is proportional to the difference between the feedback voltage and  $V_{REF}$ . When the PWM comparator output goes high, the output switch turns off until the next switching cycle begins. During the switch off-time, inductor current discharges through Schottky diode D1, which forces the SW pin to swing below ground by the forward voltage ( $V_D$ ) of the catch diode. The regulator loop adjusts the duty cycle (D) to maintain a constant output voltage.



**Figure 12. LM2734-Q1 Waveforms of SW Pin Voltage and Inductor Current**



## 7.2 Functional Block Diagram



## 7.3 Feature Description

### 7.3.1 Output Overvoltage Protection

The overvoltage comparator compares the FB pin voltage to a voltage that is 10% higher than the internal reference  $V_{ref}$ . Once the FB pin voltage goes 10% above the internal reference, the internal NMOS control switch is turned off, which allows the output voltage to decrease toward regulation.

### 7.3.2 Undervoltage Lockout

Undervoltage lockout (UVLO) prevents the LM2734-Q1 from operating until the input voltage exceeds 2.74 V (typical).

The UVLO threshold has approximately 440 mV of hysteresis, so the part will operate until  $V_{IN}$  drops below 2.3 V (typical). Hysteresis prevents the part from turning off during power up if  $V_{IN}$  is nonmonotonic.

### 7.3.3 Current Limit

The LM2734-Q1 uses cycle-by-cycle current limiting to protect the output switch. During each switching cycle, a current limit comparator detects if the output switch current exceeds 1.7 A (typical), and turns off the switch until the next switching cycle begins.

### 7.3.4 Thermal Shutdown

Thermal shutdown limits total power dissipation by turning off the output switch when the IC junction temperature exceeds 165°C. After thermal shutdown occurs, the output switch does not turn on until the junction temperature drops to approximately 150°C.

## 7.4 Device Functional Modes

### 7.4.1 Enable Pin / Shutdown Mode

The LM2734-Q1 has a shutdown mode that is controlled by the enable pin (EN). When a logic low voltage is applied to EN, the part is in shutdown mode and its quiescent current drops to typically 30 nA. Switch leakage adds another 40 nA from the input supply. The voltage at this pin must never exceed  $V_{IN} + 0.3$  V.

### 7.4.2 Soft Start

This function forces  $V_{OUT}$  to increase at a controlled rate during start up. During soft start, the error amplifier's reference voltage ramps from 0 V to its nominal value of 0.8 V in approximately 200  $\mu$ s. This forces the regulator output to ramp up in a more linear and controlled fashion, which helps reduce inrush current. Under some circumstances at start-up, an output voltage overshoot may still be observed. This may be due to a large output load applied during start-up. Large amounts of output external capacitance can also increase output voltage overshoot. A simple solution is to add a feed forward capacitor with a value between 470 pf and 1000 pf across the top feedback resistor (R1). See [Figure 23](#) for further detail.

## 8 Application 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 Boost Function

Capacitor  $C_{\text{BOOST}}$  and diode D2 in Figure 13 are used to generate a voltage  $V_{\text{BOOST}}$ .  $V_{\text{BOOST}} - V_{\text{SW}}$  is the gate drive voltage to the internal NMOS control switch. To properly drive the internal NMOS switch during its on-time,  $V_{\text{BOOST}}$  needs to be at least 1.6 V greater than  $V_{\text{SW}}$ . Although the LM2734-Q1 device will operate with this minimum voltage, it may not have sufficient gate drive to supply large values of output current. Therefore, it is recommended that  $V_{\text{BOOST}}$  be greater than 2.5 V above  $V_{\text{SW}}$  for best efficiency.  $V_{\text{BOOST}} - V_{\text{SW}}$  should not exceed the maximum operating limit of 5.5 V.

$5.5 \text{ V} > V_{\text{BOOST}} - V_{\text{SW}} > 2.5 \text{ V}$  for best performance.

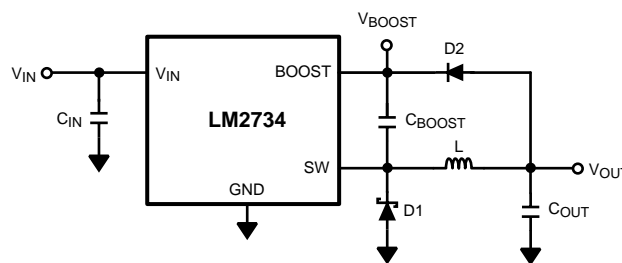


Figure 13.  $V_{\text{OUT}}$  Charges  $C_{\text{BOOST}}$

When the LM2734-Q1 device starts up, internal circuitry from the BOOST pin supplies a maximum of 20 mA to  $C_{\text{BOOST}}$ . This current charges  $C_{\text{BOOST}}$  to a voltage sufficient to turn the switch on. The BOOST pin continues to source current to  $C_{\text{BOOST}}$  until the voltage at the feedback pin is greater than 0.76 V.

There are various methods to derive  $V_{\text{BOOST}}$ :

1. From the input voltage ( $V_{\text{IN}}$ )
2. From the output voltage ( $V_{\text{OUT}}$ )
3. From an external distributed voltage rail ( $V_{\text{EXT}}$ )
4. From a shunt or series Zener diode

In the simplified block diagram of *Functional Block Diagram*, capacitor  $C_{\text{BOOST}}$  and diode D2 supply the gate-drive current for the NMOS switch. Capacitor  $C_{\text{BOOST}}$  is charged via diode D2 by  $V_{\text{IN}}$ . During a normal switching cycle, when the internal NMOS control switch is off ( $T_{\text{OFF}}$ ) (refer to Figure 12),  $V_{\text{BOOST}}$  equals  $V_{\text{IN}}$  minus the forward voltage of D2 ( $V_{\text{FD2}}$ ), during which the current in the inductor (L) forward biases the Schottky diode D1 ( $V_{\text{FD1}}$ ). Therefore, the voltage stored across  $C_{\text{BOOST}}$  is:

$$V_{\text{BOOST}} - V_{\text{SW}} = V_{\text{IN}} - V_{\text{FD2}} + V_{\text{FD1}} \quad (1)$$

When the NMOS switch turns on ( $T_{\text{ON}}$ ), the switch pin rises to:

$$V_{\text{SW}} = V_{\text{IN}} - (R_{\text{DS(on)}} \times I_{\text{L}}), \quad (2)$$

forcing  $V_{\text{BOOST}}$  to rise thus reverse biasing D2. The voltage at  $V_{\text{BOOST}}$  is then:

$$V_{\text{BOOST}} = 2 V_{\text{IN}} - (R_{\text{DS(on)}} \times I_{\text{L}}) - V_{\text{FD2}} + V_{\text{FD1}} \quad (3)$$

which is approximately:

$$2V_{\text{IN}} - 0.4 \text{ V} \quad (4)$$

## Application Information (continued)

for many applications. Thus the gate-drive voltage of the NMOS switch is approximately:

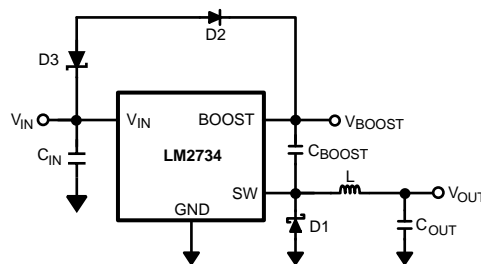
$$V_{IN} - 0.2 \text{ V} \quad (5)$$

An alternate method for charging  $C_{BOOST}$  is to connect D2 to the output as shown in [Figure 13](#). The output voltage should be from 2.5 V and 5.5 V, so that proper gate voltage will be applied to the internal switch. In this circuit,  $C_{BOOST}$  provides a gate drive voltage that is slightly less than  $V_{OUT}$ .

In applications where both  $V_{IN}$  and  $V_{OUT}$  are greater than 5.5 V, or less than 3 V,  $C_{BOOST}$  cannot be charged directly from these voltages. If  $V_{IN}$  to  $V_{OUT}$  are greater than 5.5 V,  $C_{BOOST}$  can be charged from  $V_{IN}$  or  $V_{OUT}$  minus a Zener voltage by placing a Zener diode D3 in series with D2, as shown in [Figure 14](#). When using a series Zener diode from the input, ensure that the regulation of the input supply does not create a voltage that falls outside the recommended  $V_{BOOST}$  voltage.

$$(V_{INMAX} - V_{D3}) < 5.5 \text{ V} \quad (6)$$

$$(V_{INMIN} - V_{D3}) > 1.6 \text{ V} \quad (7)$$



**Figure 14. Zener Reduces Boost Voltage from  $V_{IN}$**

An alternative method is to place the Zener diode D3 in a shunt configuration as shown in [Figure 15](#). A small 350 mW to 500 mW 5.1-V Zener diode in a SOT or SOD package can be used for this purpose. A small ceramic capacitor such as a 6.3 V, 0.1- $\mu$ F capacitor ( $C_4$ ) should be placed in parallel with the Zener diode. When the internal NMOS switch turns on, a pulse of current is drawn to charge the internal NMOS gate capacitance. The 0.1- $\mu$ F parallel shunt capacitor ensures that the  $V_{BOOST}$  voltage is maintained during this time.

Resistor R3 should be chosen to provide enough RMS current to the Zener diode (D3) and to the BOOST pin. A recommended choice for the Zener current ( $I_{ZENER}$ ) is 1 mA. The current  $I_{BOOST}$  into the BOOST pin supplies the gate current of the NMOS control switch and varies typically according to the following formula for the X version:

$$I_{BOOST} = 0.56 \times (D + 0.54) \times (V_{ZENER} - V_{D2}) \text{ mA} \quad (8)$$

$I_{BOOST}$  can be calculated for the Y version using the following:

$$I_{BOOST} = 0.22 \times (D + 0.54) \times (V_{ZENER} - V_{D2}) \mu\text{A} \quad (9)$$

where D is the duty cycle,  $V_{ZENER}$  and  $V_{D2}$  are in volts, and  $I_{BOOST}$  is in milliamps.  $V_{ZENER}$  is the voltage applied to the anode of the boost diode (D2), and  $V_{D2}$  is the average forward voltage across D2. Note that this formula for  $I_{BOOST}$  gives typical current. For the worst case  $I_{BOOST}$ , increase the current by 40%. In that case, the worst case boost current will be:

$$I_{BOOST-MAX} = 1.4 \times I_{BOOST} \quad (10)$$

R3 will then be given by:

$$R3 = (V_{IN} - V_{ZENER}) / (1.4 \times I_{BOOST} + I_{ZENER}) \quad (11)$$

For example, using the X-version let  $V_{IN} = 10 \text{ V}$ ,  $V_{ZENER} = 5 \text{ V}$ ,  $V_{D2} = 0.7 \text{ V}$ ,  $I_{ZENER} = 1 \text{ mA}$ , and duty cycle D = 50%. Then:

$$I_{BOOST} = 0.56 \times (0.5 + 0.54) \times (5 - 0.7) \text{ mA} = 2.5 \text{ mA} \quad (12)$$

$$R3 = (10 \text{ V} - 5 \text{ V}) / (1.4 \times 2.5 \text{ mA} + 1 \text{ mA}) = 1.11 \text{ k}\Omega \quad (13)$$

Application Information (continued)

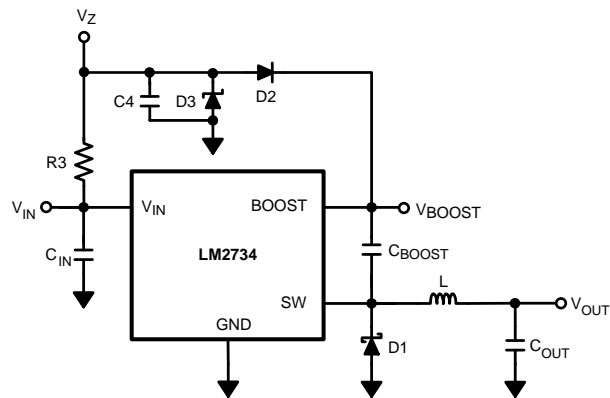


Figure 15. Boost Voltage Supplied from the Shunt Zener on  $V_{IN}$

## 8.2 Typical Applications

### 8.2.1 LM2734X (1.6 MHz) $V_{BOOST}$ Derived from $V_{IN}$ 5V to 1.5 V/1 A

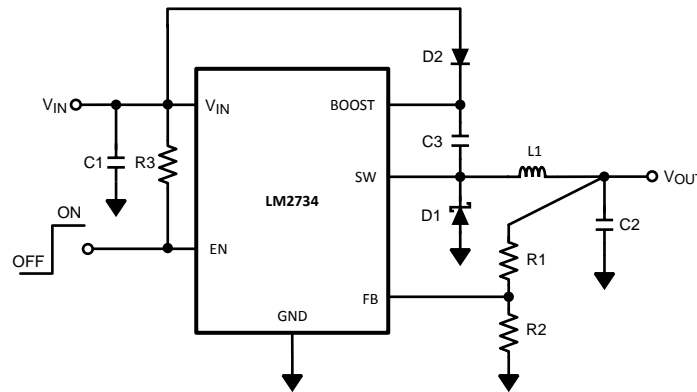


Figure 16. LM2734X (1.6 MHz)  $V_{BOOST}$  Derived from  $V_{IN}$  5 V to 1.5-V/1-A Schematic

#### 8.2.1.1 Design Requirements

Derive charge for  $V_{BOOST}$  from the input supply ( $V_{IN}$ ).  $V_{BOOST} - V_{SW}$  should not exceed the maximum operating limit of 5.5V.

#### 8.2.1.2 Detailed Design Procedure

Table 1. Bill of Materials for Figure 16

PART ID	PART VALUE	MANUFACTURER	PART NUMBER
U1	1-A Buck Regulator	Texas Instruments	LM2734X
C1, Input Cap	10 $\mu$ F, 6.3V, X5R	TDK	C3216X5ROJ106M
C2, Output Cap	10 $\mu$ F, 6.3V, X5R	TDK	C3216X5ROJ106M
C3, Boost Cap	0.01 $\mu$ F, 16V, X7R	TDK	C1005X7R1C103K
D1, Catch Diode	0.3 $V_F$ Schottky 1 A, 10 VR	ON Semi	MBRM110L
D2, Boost Diode	1 $V_F$ @ 50-mA Diode	Diodes, Inc.	1N4148W
L1	4.7 $\mu$ H, 1.7A,	TDK	VLCF4020T- 4R7N1R2
R1	8.87 k $\Omega$ , 1%	Vishay	CRCW06038871F
R2	10.2 k $\Omega$ , 1%	Vishay	CRCW06031022F
R3	100 k $\Omega$ , 1%	Vishay	CRCW06031003F

#### 8.2.1.2.1 Custom Design With WEBENCH® Tools

[Click here](#) to create a custom design using the XXXXXXXX device with the WEBENCH® Power Designer.

1. Start by entering the input voltage ( $V_{IN}$ ), output voltage ( $V_{OUT}$ ), and output current ( $I_{OUT}$ ) requirements.
2. Optimize the design for key parameters such as efficiency, footprint, and cost using the optimizer dial.
3. Compare the generated design with other possible solutions from Texas Instruments.

The WEBENCH Power Designer provides a customized schematic along with a list of materials with real-time pricing and component availability.

In most cases, these actions are available:

- Run electrical simulations to see important waveforms and circuit performance
- Run thermal simulations to understand board thermal performance
- Export customized schematic and layout into popular CAD formats
- Print PDF reports for the design, and share the design with colleagues

Get more information about WEBENCH tools at [www.ti.com/WEBENCH](http://www.ti.com/WEBENCH).

### 8.2.1.2.2 Inductor Selection

The Duty Cycle (D) can be approximated quickly using the ratio of output voltage ( $V_O$ ) to input voltage ( $V_{IN}$ ):

$$D = \frac{V_O}{V_{IN}} \quad (14)$$

The catch diode (D1) forward voltage drop and the voltage drop across the internal NMOS must be included to calculate a more accurate duty cycle. Calculate D by using the following formula:

$$D = \frac{V_O + V_D}{V_{IN} + V_D - V_{SW}} \quad (15)$$

$V_{SW}$  can be approximated by:

$$V_{SW} = I_O \times R_{DS(ON)} \quad (16)$$

The diode forward drop ( $V_D$ ) can range from 0.3 V to 0.7 V depending on the quality of the diode. The lower  $V_D$  is, the higher the operating efficiency of the converter.

The inductor value determines the output ripple current. Lower inductor values decrease the size of the inductor, but increase the output ripple current. An increase in the inductor value will decrease the output ripple current. The ratio of ripple current ( $\Delta I_L$ ) to output current ( $I_O$ ) is optimized when it is set between 0.3 and 0.4 at 1 A. The ratio  $r$  is defined as:

$$r = \frac{\Delta I_L}{I_O} \quad (17)$$

One must also ensure that the minimum current limit (1.2 A) is not exceeded, so the peak current in the inductor must be calculated. The peak current ( $I_{LPK}$ ) in the inductor is calculated as shown in [Equation 18](#):

$$I_{LPK} = I_O + \Delta I_L / 2 \quad (18)$$

If  $r = 0.5$  at an output of 1 A, the peak current in the inductor will be 1.25 A. The minimum specified current limit over all operating conditions is 1.2 A. One can either reduce  $r$  to 0.4 resulting in a 1.2-A peak current, or make the engineering judgement that 50 mA over is safe enough with a 1.7-A typical current limit and 6 sigma limits. When the designed maximum output current is reduced, the ratio  $r$  can be increased. At a current of 0.1 A,  $r$  can be made as high as 0.9. The ripple ratio can be increased at lighter loads because the net ripple is actually quite low, and if  $r$  remains constant the inductor value can be made quite large. An equation empirically developed for the maximum ripple ratio at any current less than 2 A is:

$$r = 0.387 \times I_{OUT}^{-0.3667} \quad (19)$$

Note that this is just a guideline.

The LM2734-Q1 operates at frequencies allowing the use of ceramic output capacitors without compromising transient response. Ceramic capacitors allow higher inductor ripple without significantly increasing output ripple. See [Output Capacitor](#) for more details on calculating output voltage ripple.

Now that the ripple current or ripple ratio is determined, the inductance is calculated as shown in [Equation 20](#):

$$L = \frac{V_O + V_D}{I_O \times r \times f_s} \times (1-D)$$

where

- $f_s$  is the switching frequency
  - $I_O$  is the output current.
- (20)

When selecting an inductor, make sure that it is capable of supporting the peak output current without saturating. Inductor saturation will result in a sudden reduction in inductance and prevent the regulator from operating correctly. Because of the speed of the internal current limit, it necessary to specify the peak current of the inductor only for the required maximum output current. For example, if the designed maximum output current is 0.5 A and the peak current is 0.7 A, then the inductor should be specified with a saturation current limit of >0.7 A.

There is no need to specify the saturation or peak current of the inductor at the 1.7-A typical switch current limit. The difference in inductor size is a factor of 5. Because of the operating frequency of the LM2734-Q1, ferrite based inductors are preferred to minimize core losses. This presents little restriction because the variety of ferrite based inductors is huge. Lastly, inductors with lower series resistance (DCR) will provide better operating efficiency. For recommended inductors see example circuits.

### 8.2.1.2.3 Input Capacitor

An input capacitor is necessary to ensure that  $V_{IN}$  does not drop excessively during switching transients. The primary specifications of the input capacitor are capacitance, voltage, RMS current rating, and ESL (Equivalent Series Inductance). The recommended input capacitance is 10  $\mu\text{F}$ , although 4.7  $\mu\text{F}$  is sufficient for input voltages below 6 V. The input voltage rating is specifically stated by the capacitor manufacturer. Make sure to check any recommended deratings and also verify if there is any significant change in capacitance at the operating input voltage and the operating temperature. The input capacitor maximum RMS input current rating ( $I_{\text{RMS-IN}}$ ) must be greater than:

$$I_{\text{RMS-IN}} = I_O \times \sqrt{D \times \left(1 - D + \frac{r^2}{12}\right)} \quad (21)$$

From Equation 21 from the above equation that maximum RMS capacitor current occurs when  $D = 0.5$ . Always calculate the RMS at the point where the duty cycle,  $D$ , is closest to 0.5. The ESL of an input capacitor is usually determined by the effective cross sectional area of the current path. A large leaded capacitor will have high ESL and a 0805 ceramic chip capacitor will have very low ESL. At the operating frequencies of the LM2734-Q1 device, certain capacitors may have an ESL so large that the resulting impedance ( $2\pi fL$ ) will be higher than that required to provide stable operation. As a result, surface-mount capacitors are strongly recommended. Sanyo POSCAP, Tantalum or Niobium, Panasonic SP or Cornell Dubilier ESR, and multilayer ceramic capacitors (MLCC) are all good choices for both input and output capacitors and have very low ESL. For MLCCs it is recommended to use X7R or X5R dielectrics. Consult the capacitor manufacturer data sheet to see how rated capacitance varies over operating conditions.

### 8.2.1.2.4 Output Capacitor

The output capacitor is selected based upon the desired output ripple and transient response. The initial current of a load transient is provided mainly by the output capacitor. The output ripple of the converter is:

$$\Delta V_O = \Delta i_L \times \left( R_{\text{ESR}} + \frac{1}{8 \times f_S \times C_O} \right) \quad (22)$$

When using MLCCs, the ESR is typically so low that the capacitive ripple may dominate. When this occurs, the output ripple will be approximately sinusoidal and 90° phase shifted from the switching action. Given the availability and quality of MLCCs and the expected output voltage of designs using the LM2734-Q1 device, there is really no need to review any other capacitor technologies. Another benefit of ceramic capacitors is their ability to bypass high frequency noise. A certain amount of switching edge noise will couple through parasitic capacitances in the inductor to the output. A ceramic capacitor will bypass this noise while a tantalum will not. Because the output capacitor is one of the two external components that control the stability of the regulator control loop, most applications will require a minimum at 10  $\mu\text{F}$  of output capacitance. Capacitance can be increased significantly with little detriment to the regulator stability. Like the input capacitor, recommended multilayer ceramic capacitors are X7R or X5R. Again, verify actual capacitance at the desired operating voltage and temperature.

Check the RMS current rating of the capacitor. The RMS current rating of the capacitor chosen must also meet the following condition:

$$I_{\text{RMS-OUT}} = I_O \times \frac{r}{\sqrt{12}} \quad (23)$$

### 8.2.1.2.5 Catch Diode

The catch diode (D1) conducts during the switch off-time. A Schottky diode is recommended for its fast switching times and low forward voltage drop. The catch diode should be chosen so that its current rating is greater than:

$$I_{D1} = I_O \times (1 - D) \quad (24)$$



The reverse breakdown rating of the diode must be at least the maximum input voltage plus appropriate margin. To improve efficiency choose a Schottky diode with a low forward voltage drop.

#### 8.2.1.2.6 Boost Diode

A standard diode such as the 1N4148 type is recommended. For  $V_{\text{BOOST}}$  circuits derived from voltages less than 3.3 V, a small-signal Schottky diode is recommended for greater efficiency. A good choice is the BAT54 small signal diode.

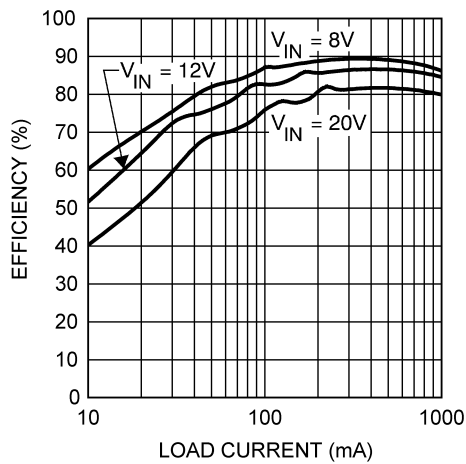
#### 8.2.1.2.7 Boost Capacitor

A ceramic 0.01- $\mu\text{F}$  capacitor with a voltage rating of at least 16 V is sufficient. The X7R and X5R MLCCs provide the best performance.

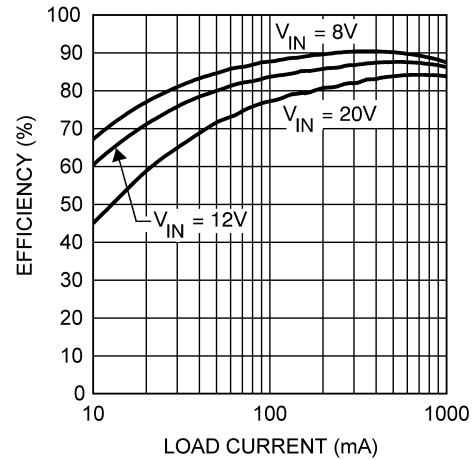
**8.2.1.2.8 Output Voltage**

The output voltage is set using the following equation where R2 is connected between the FB pin and GND, and R1 is connected between V<sub>O</sub> and the FB pin. A good value for R2 is 10 kΩ.

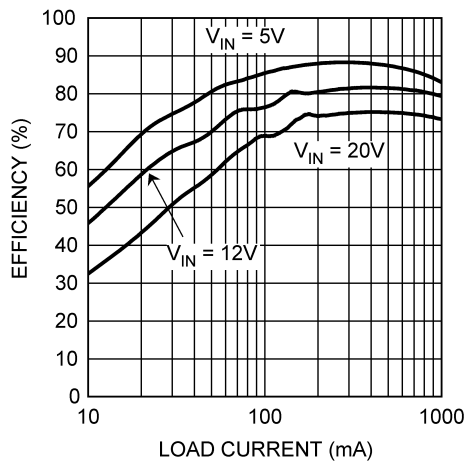
$$R1 = \left( \frac{V_O}{V_{REF}} - 1 \right) \times R2 \quad (25)$$

**8.2.1.3 Application Curves**


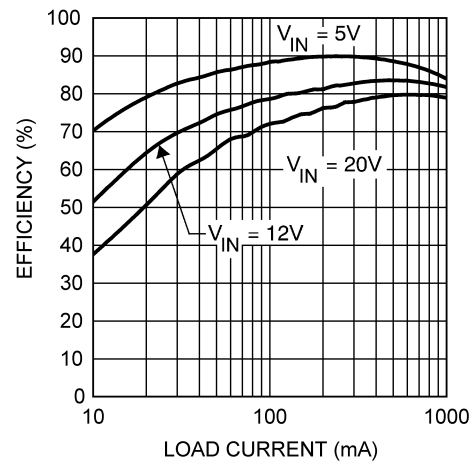
**Figure 17. Efficiency vs Load Current - L1 = 4.7 μH V<sub>OUT</sub> = 5 V**



**Figure 18. Efficiency vs Load Current - L1 = 10 μH V<sub>OUT</sub> = 5 V**



**Figure 19. Efficiency vs Load Current - L1 = 4.7 μH V<sub>OUT</sub> = 3.3 V**



**Figure 20. Efficiency vs Load Current - L1 = 10 μH V<sub>OUT</sub> = 3.3 V**

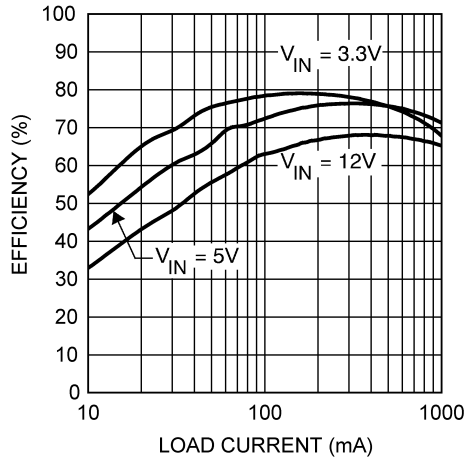


Figure 21. Efficiency vs Load Current - L1 = 4.7 μH V<sub>OUT</sub> = 1.5 V

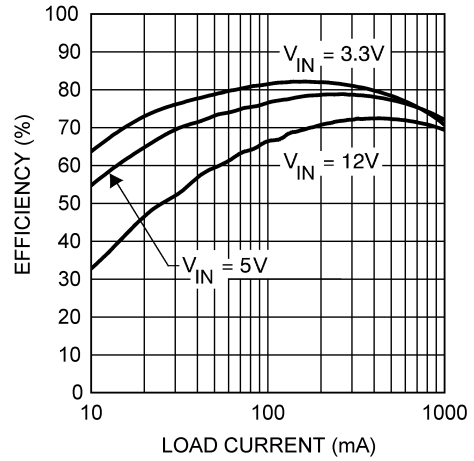


Figure 22. Efficiency vs Load Current - L1 = 10 μH V<sub>OUT</sub> = 1.5 V

**8.2.2 LM2734X (1.6 MHz)  $V_{BOOST}$  Derived from  $V_{OUT}$  12 V to 3.3 V /1 A**

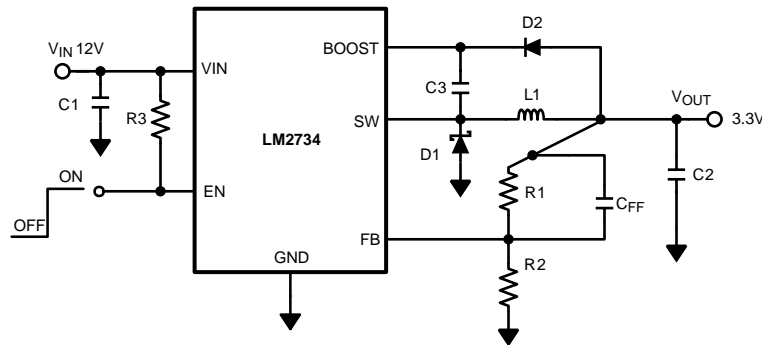


Figure 23. LM2734X (1.6 MHz)  $V_{BOOST}$  Derived from  $V_{OUT}$  12 V to 3.3 V /1-A Schematic

**8.2.2.1 Design Requirements**

Derive charge for  $V_{BOOST}$  from the output voltage, ( $V_{OUT}$ ). The output voltage should be between 2.5 V and 5.5 V.

**8.2.2.2 Detailed Design Procedure**

See [Detailed Design Procedure](#).

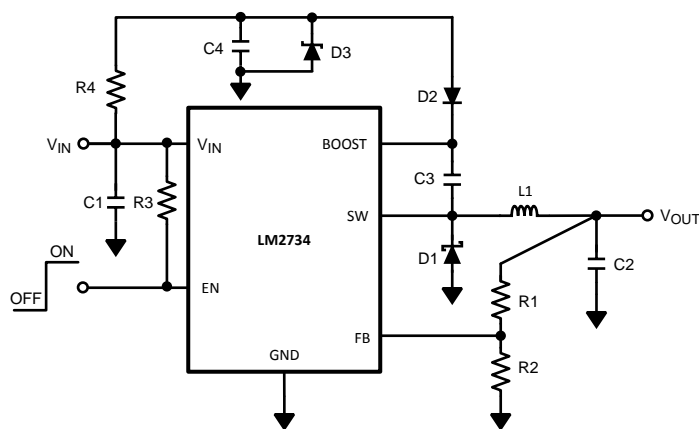
Table 2. Bill of Materials for [Figure 23](#)

PART ID	PART VALUE	MANUFACTURER	PART NUMBER
U1	1-A Buck Regulator	Texas Instruments	LM2734X
C1, Input Cap	10 µF, 25 V, X7R	TDK	C3225X7R1E106M
C2, Output Cap	22 µF, 6.3 V, X5R	TDK	C3216X5ROJ226M
C3, Boost Cap	0.01 µF, 16 V, X7R	TDK	C1005X7R1C103K
CFF	1000 pF 25 V	TDK	C0603X5R1E102K
D1, Catch Diode	0.34 $V_F$ Schottky 1 A, 30 VR	Vishay	SS1P3L
D2, Boost Diode	1 $V_F$ @ 50-mA Diode	Diodes, Inc.	1N4148W
L1	4.7µH, 1.7 A	TDK	VLCF4020T- 4R7N1R2
R1	31.6 kΩ, 1%	Vishay	CRCW06033162F
R2	10 kΩ, 1%	Vishay	CRCW06031002F
R3	100 kΩ, 1%	Vishay	CRCW06031003F

**8.2.2.3 Application Curves**

See [Application Curves](#).

### 8.2.3 LM2734X (1.6 MHz) $V_{\text{BOOST}}$ Derived from $V_{\text{SHUNT}}$ 18 V to 1.5 V /1 A



**Figure 24. LM2734X (1.6 MHz)  $V_{\text{BOOST}}$  Derived from  $V_{\text{SHUNT}}$  18 V to 1.5 V /1-A Schematic**

#### 8.2.3.1 Design Requirements

An alternative method when  $V_{\text{IN}}$  is greater than 5.5 V is to place the zener diode D3 in a shunt configuration. A small 350 mW to 500 mW 5.1 V zener in a SOT or SOD package can be used for this purpose. A small ceramic capacitor such as a 6.3 V, 0.1  $\mu\text{F}$  capacitor (C4) should be placed in parallel with the zener diode. When the internal NMOS switch turns on, a pulse of current is drawn to charge the internal NMOS gate capacitance. The 0.1  $\mu\text{F}$  parallel shunt capacitor ensures that the  $V_{\text{BOOST}}$  voltage is maintained during this time.

#### 8.2.3.2 Detailed Design Procedure

See [Detailed Design Procedure](#).

**Table 3. Bill of Materials for Figure 24**

PART ID	PART VALUE	MANUFACTURER	PART NUMBER
U1	1-A Buck Regulator	Texas Instruments	LM2734X
C1, Input Cap	10 $\mu\text{F}$ , 25 V, X7R	TDK	C3225X7R1E106M
C2, Output Cap	22 $\mu\text{F}$ , 6.3 V, X5R	TDK	C3216X5ROJ226M
C3, Boost Cap	0.01 $\mu\text{F}$ , 16 V, X7R	TDK	C1005X7R1C103K
C4, Shunt Cap	0.1 $\mu\text{F}$ , 6.3 V, X5R	TDK	C1005X5R0J104K
D1, Catch Diode	0.4 $V_{\text{F}}$ Schottky 1 A, 30 VR	Vishay	SS1P3L
D2, Boost Diode	1 $V_{\text{F}}$ @ 50-mA Diode	Diodes, Inc.	1N4148W
D3, Zener Diode	5.1 V 250 Mw SOT	Vishay	BZX84C5V1
L1	6.8 $\mu\text{H}$ , 1.6 A,	TDK	SLF7032T-6R8M1R6
R1	8.87 $\text{k}\Omega$ , 1%	Vishay	CRCW06038871F
R2	10.2 $\text{k}\Omega$ , 1%	Vishay	CRCW06031022F
R3	100 $\text{k}\Omega$ , 1%	Vishay	CRCW06031003F
R4	4.12 $\text{k}\Omega$ , 1%	Vishay	CRCW06034121F

#### 8.2.3.3 Application Curves

See [Application Curves](#).

8.2.4 LM2734X (1.6 MHz)  $V_{BOOST}$  Derived from Series Zener Diode ( $V_{IN}$ ) 15 V to 1.5 V / 1 A

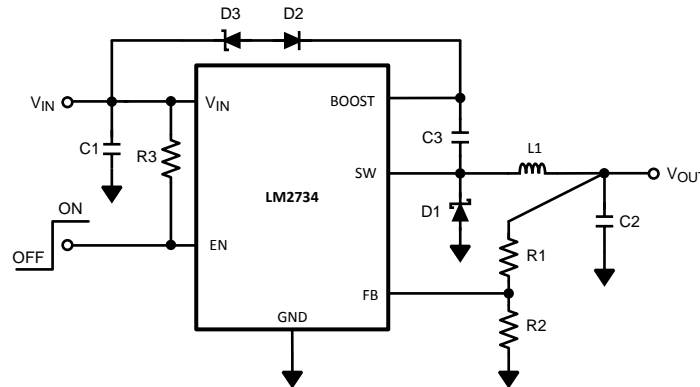


Figure 25. LM2734X (1.6 MHz)  $V_{BOOST}$  Derived from Series Zener Diode ( $V_{IN}$ ) 15 V to 1.5 V / 1-A Schematic

8.2.4.1 Design Requirements

In applications where both  $V_{IN}$  and  $V_{OUT}$  are greater than 5.5 V, or less than 3 V,  $C_{BOOST}$  cannot be charged directly from these voltages. If  $V_{IN}$  is greater than 5.5 V,  $C_{BOOST}$  can be charged from  $V_{IN}$  minus a zener voltage by placing a zener diode D3 in series with D2. When using a series zener diode from the input, ensure that the regulation of the input supply doesn't create a voltage that falls outside the recommended  $V_{BOOST}$  voltage.

$$(V_{INMAX} - V_{D3}) < 5.5 \text{ V} \tag{26}$$

$$(V_{INMIN} - V_{D3}) > 1.6 \text{ V} \tag{27}$$

8.2.4.2 Detailed Design Procedure

See [Detailed Design Procedure](#).

Table 4. Bill of Materials for Figure 25

PART ID	PART VALUE	MANUFACTURER	PART NUMBER
U1	1-A Buck Regulator	Texas Instruments	LM2734X
C1, Input Cap	10 $\mu$ F, 25V, X7R	TDK	C3225X7R1E106M
C2, Output Cap	22 $\mu$ F, 6.3 V, X5R	TDK	C3216X5ROJ226M
C3, Boost Cap	0.01 $\mu$ F, 16 V, X7R	TDK	C1005X7R1C103K
D1, Catch Diode	0.4 $V_F$ Schottky 1 A, 30 VR	Vishay	SS1P3L
D2, Boost Diode	1 $V_F$ @ 50-mA Diode	Diodes, Inc.	1N4148W
D3, Zener Diode	11 V 350 Mw SOT	Diodes, Inc.	BZX84C11T
L1	6.8 $\mu$ H, 1.6 A,	TDK	SLF7032T-6R8M1R6
R1	8.87 k $\Omega$ , 1%	Vishay	CRCW06038871F
R2	10.2 k $\Omega$ , 1%	Vishay	CRCW06031022F
R3	100 k $\Omega$ , 1%	Vishay	CRCW06031003F

8.2.4.3 Application Curves

See [Application Curves](#).

## 8.2.5 LM2734X (1.6 MHz) $V_{\text{BOOST}}$ Derived from Series Zener Diode ( $V_{\text{OUT}}$ ) 15 V to 9 V /1 A

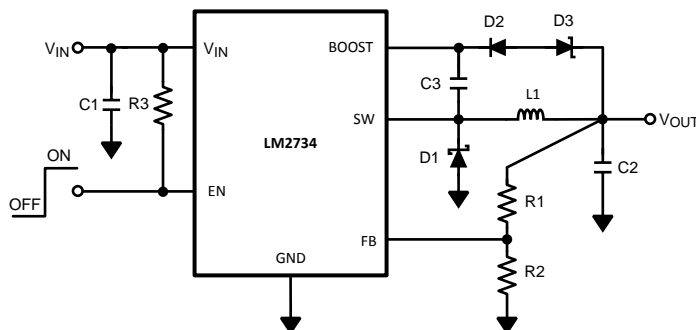


Figure 26. LM2734X (1.6 MHz)  $V_{\text{BOOST}}$  Derived from Series Zener Diode ( $V_{\text{OUT}}$ ) 15 V to 9 V /1-A Schematic

### 8.2.5.1 Design Requirements

In applications where both  $V_{\text{IN}}$  and  $V_{\text{OUT}}$  are greater than 5.5 V, or less than 3 V,  $C_{\text{BOOST}}$  cannot be charged directly from these voltages. If  $V_{\text{IN}}$  and  $V_{\text{OUT}}$  are greater than 5.5 V,  $C_{\text{BOOST}}$  can be charged from  $V_{\text{OUT}}$  minus a zener voltage by placing a zener diode D3 in series with D2.

### 8.2.5.2 Detailed Design Procedure

See [Detailed Design Procedure](#).

Table 5. Bill of Materials for [Figure 26](#)

PART ID	PART VALUE	MANUFACTURER	PART NUMBER
U1	1-A Buck Regulator	Texas Instruments	LM2734X
C1, Input Cap	10 $\mu\text{F}$ , 25 V, X7R	TDK	C3225X7R1E106M
C2, Output Cap	22 $\mu\text{F}$ , 16 V, X5R	TDK	C3216X5R1C226M
C3, Boost Cap	0.01 $\mu\text{F}$ , 16 V, X7R	TDK	C1005X7R1C103K
D1, Catch Diode	0.4 $V_{\text{F}}$ Schottky 1 A, 30 VR	Vishay	SS1P3L
D2, Boost Diode	1 $V_{\text{F}}$ @ 50-mA Diode	Diodes, Inc.	1N4148W
D3, Zener Diode	4.3 V 350-mw SOT	Diodes, Inc.	BZX84C4V3
L1	6.8 $\mu\text{H}$ , 1.6 A,	TDK	SLF7032T-6R8M1R6
R1	102 k $\Omega$ , 1%	Vishay	CRCW06031023F
R2	10.2 k $\Omega$ , 1%	Vishay	CRCW06031022F
R3	100 k $\Omega$ , 1%	Vishay	CRCW06031003F

### 8.2.5.3 Application Curves

See [Application Curves](#).

### 8.2.6 LM2734Y (550 kHz) $V_{BOOST}$ Derived from $V_{IN}$ 5 V to 1.5 V / 1 A

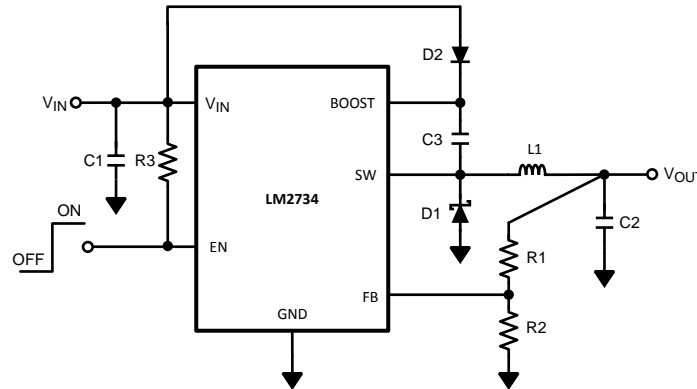


Figure 27. LM2734Y (550 kHz)  $V_{BOOST}$  Derived from  $V_{IN}$  5 V to 1.5 V / 1-A Schematic

#### 8.2.6.1 Design Requirements

Derive charge for  $V_{BOOST}$  from the input supply ( $V_{IN}$ ).  $V_{BOOST} - V_{SW}$  should not exceed the maximum operating limit of 5.5 V.

#### 8.2.6.2 Detailed Design Procedure

See [Detailed Design Procedure](#).

Table 6. Bill of Materials for Figure 27

PART ID	PART VALUE	MANUFACTURER	PART NUMBER
U1	1-A Buck Regulator	Texas Instruments	LM2734Y
C1, Input Cap	10 $\mu$ F, 6.3 V, X5R	TDK	C3216X5ROJ106M
C2, Output Cap	22 $\mu$ F, 6.3 V, X5R	TDK	C3216X5ROJ226M
C3, Boost Cap	0.01 $\mu$ F, 16 V, X7R	TDK	C1005X7R1C103K
D1, Catch Diode	0.3 $V_F$ Schottky 1 A, 10 VR	ON Semi	MBRM110L
D2, Boost Diode	1 $V_F$ @ 50-mA Diode	Diodes, Inc.	1N4148W
L1	10 $\mu$ H, 1.6 A,	TDK	SLF7032T-100M1R4
R1	8.87 k $\Omega$ , 1%	Vishay	CRCW06038871F
R2	10.2 k $\Omega$ , 1%	Vishay	CRCW06031022F
R3	100 k $\Omega$ , 1%	Vishay	CRCW06031003F

#### 8.2.6.3 Application Curves

See [Application Curves](#).



### 8.2.7 LM2734Y (550 kHz) $V_{\text{BOOST}}$ Derived from $V_{\text{OUT}}$ 12 V to 3.3 V / 1 A

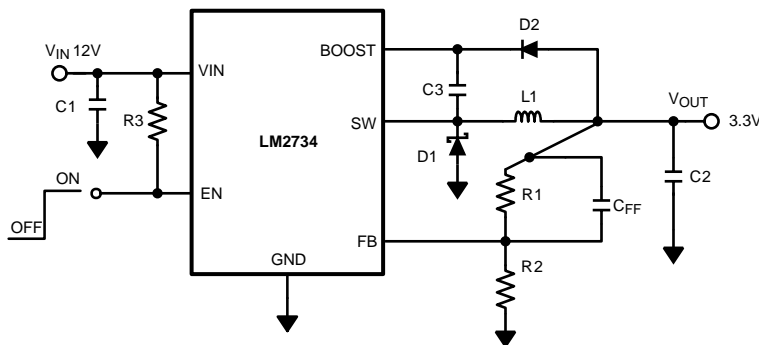


Figure 28. LM2734Y (550 kHz)  $V_{\text{BOOST}}$  Derived from  $V_{\text{OUT}}$  12 V to 3.3 V / 1 A Schematic

#### 8.2.7.1 Design Requirements

Derive charge for  $V_{\text{BOOST}}$  from the output voltage, ( $V_{\text{OUT}}$ ). The output voltage should be between 2.5 V and 5.5 V.

#### 8.2.7.2 Detailed Design Procedure

See [Detailed Design Procedure](#).

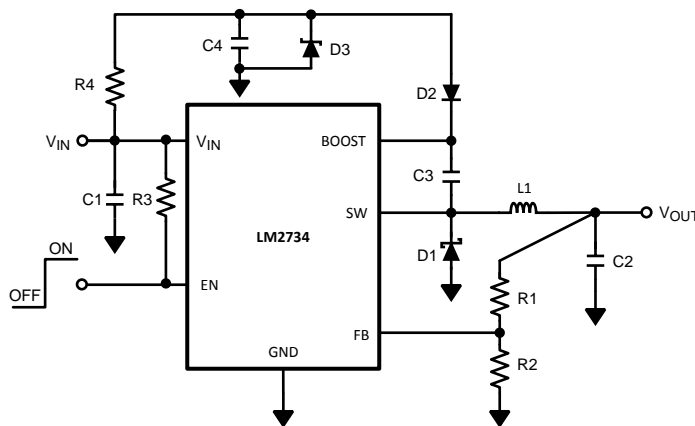
Table 7. Bill of Materials for [Figure 28](#)

PART ID	PART VALUE	MANUFACTURER	PART NUMBER
U1	1-A Buck Regulator	Texas Instruments	LM2734Y
C1, Input Cap	10 $\mu\text{F}$ , 25 V, X7R	TDK	C3225X7R1E106M
C2, Output Cap	22 $\mu\text{F}$ , 6.3 V, X5R	TDK	C3216X5ROJ226M
C3, Boost Cap	0.01 $\mu\text{F}$ , 16 V, X7R	TDK	C1005X7R1C103K
D1, Catch Diode	0.34 $V_F$ Schottky 1 A, 30VR	Vishay	SS1P3L
D2, Boost Diode	0.6 $V_F$ @ 30-mA Diode	Vishay	BAT17
L1	10 $\mu\text{H}$ , 1.6 A	TDK	SLF7032T-100M1R4
R1	31.6 k $\Omega$ , 1%	Vishay	CRCW06033162F
R2	10.0 k $\Omega$ , 1%	Vishay	CRCW06031002F
R3	100 k $\Omega$ , 1%	Vishay	CRCW06031003F

#### 8.2.7.3 Application Curves

See [Application Curves](#).

**8.2.8 LM2734Y (550 kHz)  $V_{BOOST}$  Derived from  $V_{SHUNT}$  18 V to 1.5 V / 1 A**



**Figure 29. LM2734Y (550 kHz)  $V_{BOOST}$  Derived from  $V_{SHUNT}$  18 V to 1.5 V / 1-A**

**8.2.8.1 Design Requirements**

An alternative method when  $V_{IN}$  is greater than 5.5 V is to place the zener diode D3 in a shunt configuration. A small 350 mW to 500 mW 5.1 V zener in a SOT or SOD package can be used for this purpose. A small ceramic capacitor such as a 6.3 V, 0.1  $\mu$ F capacitor (C4) should be placed in parallel with the zener diode. When the internal NMOS switch turns on, a pulse of current is drawn to charge the internal NMOS gate capacitance. The 0.1  $\mu$ F parallel shunt capacitor ensures that the  $V_{BOOST}$  voltage is maintained during this time.

**8.2.8.2 Detailed Design Procedure**

See [Detailed Design Procedure](#).

**Table 8. Bill of Materials for Figure 29**

PART ID	PART VALUE	MANUFACTURER	PART NUMBER
U1	1-A Buck Regulator	Texas Instruments	LM2734Y
C1, Input Cap	10 $\mu$ F, 25 V, X7R	TDK	C3225X7R1E106M
C2, Output Cap	22 $\mu$ F, 6.3 V, X5R	TDK	C3216X5ROJ226M
C3, Boost Cap	0.01 $\mu$ F, 16 V, X7R	TDK	C1005X7R1C103K
C4, Shunt Cap	0.1 $\mu$ F, 6.3 V, X5R	TDK	C1005X5R0J104K
D1, Catch Diode	0.4 $V_F$ Schottky 1 A, 30VR	Vishay	SS1P3L
D2, Boost Diode	1 $V_F$ @ 50-mA Diode	Diodes, Inc.	1N4148W
D3, Zener Diode	5.1 V 250 Mw SOT	Vishay	BZX84C5V1
L1	15 $\mu$ H, 1.5 A	TDK	SLF7045T-150M1R5
R1	8.87 k $\Omega$ , 1%	Vishay	CRCW06038871F
R2	10.2 k $\Omega$ , 1%	Vishay	CRCW06031022F
R3	100 k $\Omega$ , 1%	Vishay	CRCW06031003F
R4	4.12 k $\Omega$ , 1%	Vishay	CRCW06034121F

**8.2.8.3 Application Curves**

See [Application Curves](#).

## 8.2.9 LM2734Y (550 kHz) $V_{BOOST}$ Derived from Series Zener Diode ( $V_{IN}$ ) 15 V to 1.5 V / 1 A

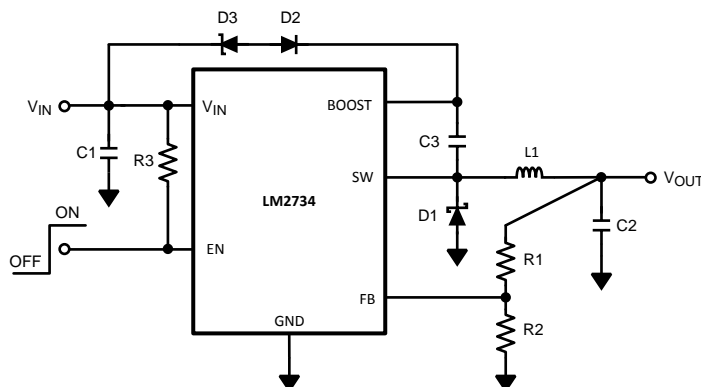


Figure 30. LM2734Y (550 kHz)  $V_{BOOST}$  Derived from Series Zener Diode ( $V_{IN}$ ) 15 V to 1.5 V / 1-A Schematic

### 8.2.9.1 Design Requirements

In applications where both  $V_{IN}$  and  $V_{OUT}$  are greater than 5.5 V, or less than 3 V,  $C_{BOOST}$  cannot be charged directly from these voltages. If  $V_{IN}$  is greater than 5.5 V,  $C_{BOOST}$  can be charged from  $V_{IN}$  minus a zener voltage by placing a zener diode D3 in series with D2. When using a series zener diode from the input, ensure that the regulation of the input supply doesn't create a voltage that falls outside the recommended  $V_{BOOST}$  voltage.

$$(V_{INMAX} - V_{D3}) < 5.5 \text{ V} \quad (28)$$

$$(V_{INMIN} - V_{D3}) > 1.6 \text{ V} \quad (29)$$

### 8.2.9.2 Detailed Design Procedure

See [Detailed Design Procedure](#).

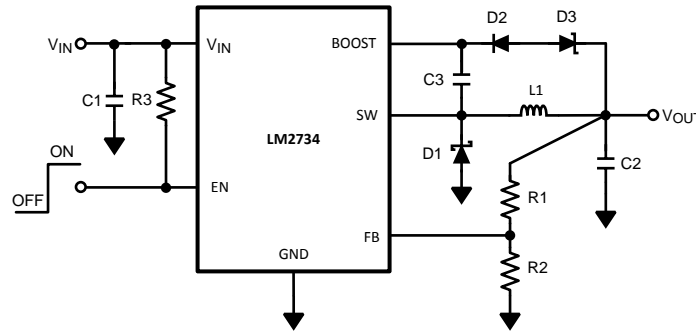
Table 9. Bill of Materials for Figure 30

PART ID	PART VALUE	MANUFACTURER	PART NUMBER
U1	1-A Buck Regulator	Texas Instruments	LM2734Y
C1, Input Cap	10 $\mu$ F, 25 V, X7R	TDK	C3225X7R1E106M
C2, Output Cap	22 $\mu$ F, 6.3 V, X5R	TDK	C3216X5ROJ226M
C3, Boost Cap	0.01 $\mu$ F, 16 V, X7R	TDK	C1005X7R1C103K
D1, Catch Diode	0.4 V <sub>F</sub> Schottky 1 A, 30 VR	Vishay	SS1P3L
D2, Boost Diode	1 V <sub>F</sub> @ 50-mA Diode	Diodes, Inc.	1N4148W
D3, Zener Diode	11 V 350 Mw SOT	Diodes, Inc.	BZX84C11T
L1	15 $\mu$ H, 1.5 A,	TDK	SLF7045T-150M1R5
R1	8.87 k $\Omega$ , 1%	Vishay	CRCW06038871F
R2	10.2 k $\Omega$ , 1%	Vishay	CRCW06031022F
R3	100 k $\Omega$ , 1%	Vishay	CRCW06031003F

### 8.2.9.3 Application Curves

See [Application Curves](#).

**8.2.10 LM2734Y (550 kHz)  $V_{BOOST}$  Derived from Series Zener Diode ( $V_{OUT}$ ) 15 V to 9 V / 1 A**



**Figure 31. LM2734Y (550 kHz)  $V_{BOOST}$  Derived from Series Zener Diode ( $V_{OUT}$ ) 15 V to 9 V / 1-A**

**8.2.10.1 Design Requirements**

In applications where both  $V_{IN}$  and  $V_{OUT}$  are greater than 5.5 V, or less than 3 V,  $C_{BOOST}$  cannot be charged directly from these voltages. If  $V_{IN}$  and  $V_{OUT}$  are greater than 5.5 V,  $C_{BOOST}$  can be charged from  $V_{OUT}$  minus a zener voltage by placing a zener diode D3 in series with D2.

**8.2.10.2 Detailed Design Procedure**

See [Detailed Design Procedure](#).

**Table 10. Bill of Materials for Figure 31**

PART ID	PART VALUE	MANUFACTURER	PART NUMBER
U1	1-A Buck Regulator	Texas Instruments	LM2734Y
C1, Input Cap	10 $\mu$ F, 25 V, X7R	TDK	C3225X7R1E106M
C2, Output Cap	22 $\mu$ F, 16 V, X5R	TDK	C3216X5R1C226M
C3, Boost Cap	0.01 $\mu$ F, 16 V, X7R	TDK	C1005X7R1C103K
D1, Catch Diode	0.4 $V_F$ Schottky 1 A, 30 VR	Vishay	SS1P3L
D2, Boost Diode	1 $V_F$ @ 50-mA Diode	Diodes, Inc.	1N4148W
D3, Zener Diode	4.3 V 350 Mw SOT	Diodes, Inc.	BZX84C4V3
L1	22 $\mu$ H, 1.4 A,	TDK	SLF7045T-220M1R3-1PF
R1	102 k $\Omega$ , 1%	Vishay	CRCW06031023F
R2	10.2k $\Omega$ , 1%	Vishay	CRCW06031022F
R3	100k $\Omega$ , 1%	Vishay	CRCW06031003F

**8.2.10.3 Application Curves**

See [Application Curves](#).

## 9 Power Supply Recommendations

Input voltage is rated as 3 V to 18 V; however, care must be taken in certain circuit configurations (for example,  $V_{\text{BOOST}}$  derived from  $V_{\text{IN}}$  where the requirement that  $V_{\text{BOOST}} - V_{\text{SW}} < 5.5 \text{ V}$  should be observed) Also, for best efficiency  $V_{\text{BOOST}}$  should be at least 2.5-V above  $V_{\text{SW}}$ .

The voltage on the Enable pin should not exceed  $V_{\text{IN}}$  by more than 0.3 V.

## 10 Layout

### 10.1 Layout Guidelines

When planning layout there are a few things to consider when trying to achieve a clean, regulated output. The most important consideration when completing the layout is the close coupling of the GND connections of the  $C_{\text{IN}}$  capacitor and the catch diode D1. These ground ends should be close to one another and be connected to the GND plane with at least two through-holes. Place these components as close to the IC as possible. Next in importance is the location of the GND connection of the  $C_{\text{OUT}}$  capacitor, which should be near the GND connections of  $C_{\text{IN}}$  and D1.

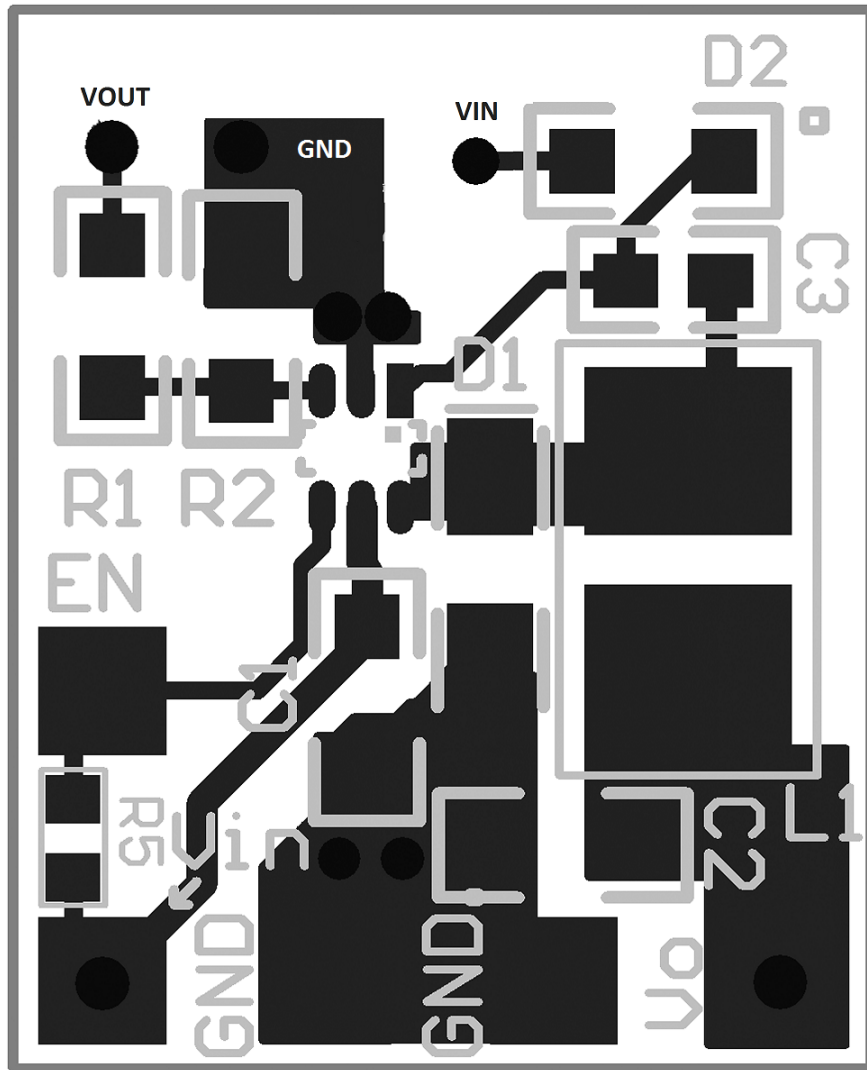
There should be a continuous ground plane on the bottom layer of a two-layer board except under the switching node island.

The FB pin is a high-impedance node — take care to make the FB trace short to avoid noise pickup and inaccurate regulation. The feedback resistors should be placed as close as possible to the IC, with the GND of R2 placed as close as possible to the GND of the IC. The  $V_{\text{OUT}}$  trace to R1 should be routed away from the inductor and any other traces that are switching.

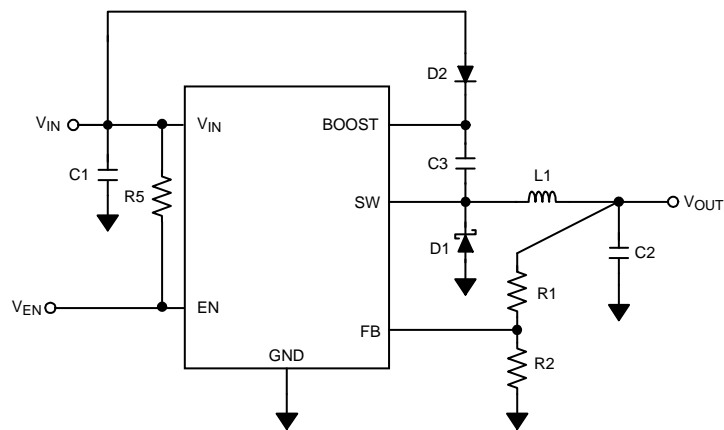
High AC currents flow through the  $V_{\text{IN}}$ , SW and  $V_{\text{OUT}}$  traces, so they should be as short and wide as possible. However, making the traces wide increases radiated noise, so the designer must make this trade-off. Radiated noise can be decreased by choosing a shielded inductor.

The remaining components should also be placed as close as possible to the IC. See Application Note AN-1229 ([SNVA054](#)) for further considerations and the LM2734-Q1 demo board as an example of a four-layer layout.

**10.2 Layout Example**



**Figure 32. Top Layer**



**Figure 33. Layout Schematic**

## 11 デバイスおよびドキュメントのサポート

### 11.1 開発サポート

#### 11.1.1 WEBENCH®ツールによるカスタム設計

[ここをクリック](#)すると、WEBENCH® Power Designerにより、LM2734-Q1デバイスを使用するカスタム設計を作成できます。

1. 最初に、入力電圧( $V_{IN}$ )、出力電圧( $V_{OUT}$ )、出力電流( $I_{OUT}$ )の要件を入力します。
2. オプティマイザのダイヤルを使用して、効率、占有面積、コストなどの主要なパラメータについて設計を最適化します。
3. 生成された設計を、テキサス・インスツルメンツが提供する他の方式と比較します。

WEBENCH Power Designerでは、カスタマイズされた回路図と部品リストを、リアルタイムの価格と部品の在庫情報と併せて参照できます。

通常、次の操作を実行可能です。

- 電氣的なシミュレーションを実行し、重要な波形と回路の性能を確認する。
- 熱シミュレーションを実行し、基板の熱特性を把握する。
- カスタマイズされた回路図やレイアウトを、一般的なCADフォーマットで出力する。
- 設計のレポートをPDFで印刷し、設計を共有する。

WEBENCHツールの詳細は、[www.ti.com/WBENCH](http://www.ti.com/WBENCH)でご覧になれます。

### 11.2 ドキュメントの更新通知を受け取る方法

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### 11.3 コミュニティ・リソース

The following links connect to TI community resources. Linked contents are provided "AS IS" by the respective contributors. They do not constitute TI specifications and do not necessarily reflect TI's views; see TI's [Terms of Use](#).

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**設計サポート** TIの設計サポート役に立つE2Eフォーラムや、設計サポート・ツールをすばやく見つけることができます。技術サポート用の連絡先情報も参照できます。

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## 11.7 Glossary

[SLYZ022](#) — *TI Glossary*.

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

## 12 メカニカル、パッケージ、および注文情報

以降のページには、メカニカル、パッケージ、および注文に関する情報が記載されています。この情報は、そのデバイスについて利用可能な最新のデータです。このデータは予告なく変更されることがあり、ドキュメントが改訂される場合もあります。本データシートのブラウザ版を使用されている場合は、画面左側の説明をご覧ください。



**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
LM2734XQMK/NOPB	ACTIVE	SOT-23-THIN	DDC	6	1000	RoHS & Green	SN	Level-1-260C-UNLIM	-40 to 125	SUKB	<a href="#">Samples</a>
LM2734XQMKE/NOPB	ACTIVE	SOT-23-THIN	DDC	6	250	RoHS & Green	SN	Level-1-260C-UNLIM	-40 to 125	SUKB	<a href="#">Samples</a>
LM2734XQMKX/NOPB	ACTIVE	SOT-23-THIN	DDC	6	3000	RoHS & Green	SN	Level-1-260C-UNLIM	-40 to 125	SUKB	<a href="#">Samples</a>
LM2734YQMK/NOPB	ACTIVE	SOT-23-THIN	DDC	6	1000	RoHS & Green	SN	Level-1-260C-UNLIM	-40 to 125	SVCB	<a href="#">Samples</a>
LM2734YQMKE/NOPB	ACTIVE	SOT-23-THIN	DDC	6	250	RoHS & Green	SN	Level-1-260C-UNLIM	-40 to 125	SVCB	<a href="#">Samples</a>
LM2734YQMKX/NOPB	ACTIVE	SOT-23-THIN	DDC	6	3000	RoHS & Green	SN	Level-1-260C-UNLIM	-40 to 125	SVCB	<a href="#">Samples</a>

(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.

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**TAPE AND REEL INFORMATION**

**QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE**

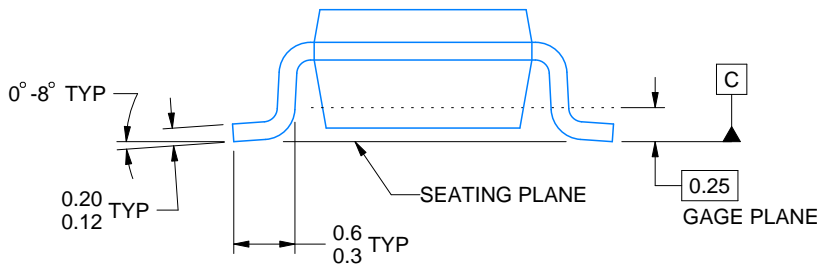
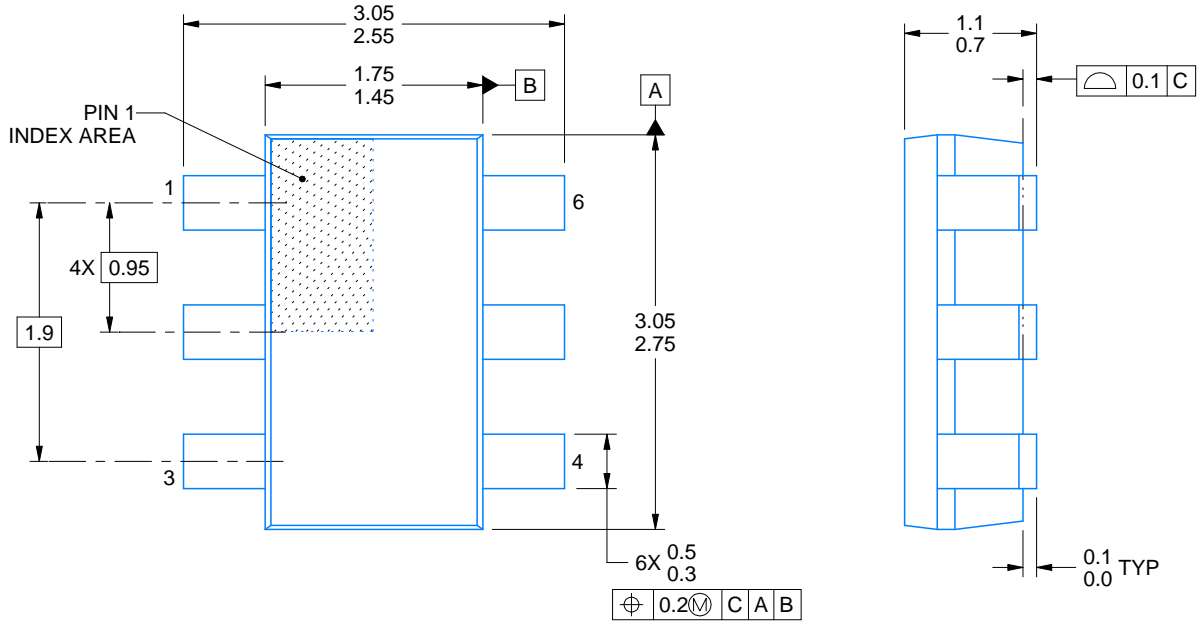

\*All dimensions are nominal

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
LM2734XQMK/NOPB	SOT-23-THIN	DDC	6	1000	178.0	8.4	3.2	3.2	1.4	4.0	8.0	Q3
LM2734XQMKE/NOPB	SOT-23-THIN	DDC	6	250	178.0	8.4	3.2	3.2	1.4	4.0	8.0	Q3
LM2734XQMKX/NOPB	SOT-23-THIN	DDC	6	3000	178.0	8.4	3.2	3.2	1.4	4.0	8.0	Q3
LM2734YQMK/NOPB	SOT-23-THIN	DDC	6	1000	178.0	8.4	3.2	3.2	1.4	4.0	8.0	Q3
LM2734YQMKE/NOPB	SOT-23-THIN	DDC	6	250	178.0	8.4	3.2	3.2	1.4	4.0	8.0	Q3
LM2734YQMKX/NOPB	SOT-23-THIN	DDC	6	3000	178.0	8.4	3.2	3.2	1.4	4.0	8.0	Q3

**TAPE AND REEL BOX DIMENSIONS**


\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
LM2734XQMK/NOPB	SOT-23-THIN	DDC	6	1000	210.0	185.0	35.0
LM2734XQMKE/NOPB	SOT-23-THIN	DDC	6	250	210.0	185.0	35.0
LM2734XQMXX/NOPB	SOT-23-THIN	DDC	6	3000	210.0	185.0	35.0
LM2734YQMK/NOPB	SOT-23-THIN	DDC	6	1000	210.0	185.0	35.0
LM2734YQMKE/NOPB	SOT-23-THIN	DDC	6	250	210.0	185.0	35.0
LM2734YQMXX/NOPB	SOT-23-THIN	DDC	6	3000	210.0	185.0	35.0



ALTERNATIVE PACKAGE SINGULATION VIEW

NOTES:

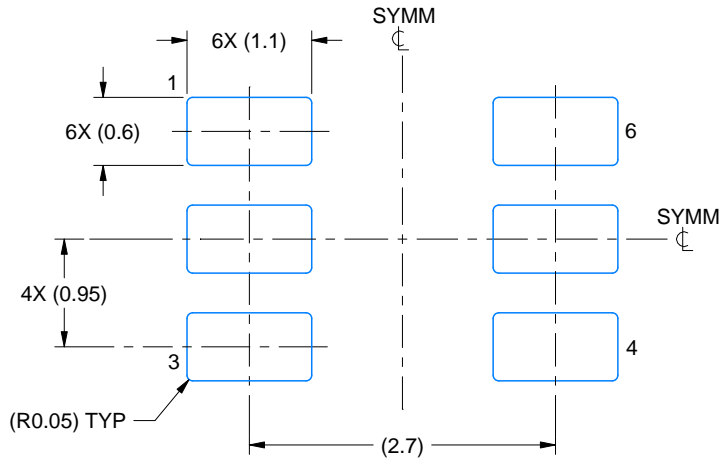
- 1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
- 2. This drawing is subject to change without notice.
- 3. Reference JEDEC MO-193.

# EXAMPLE BOARD LAYOUT

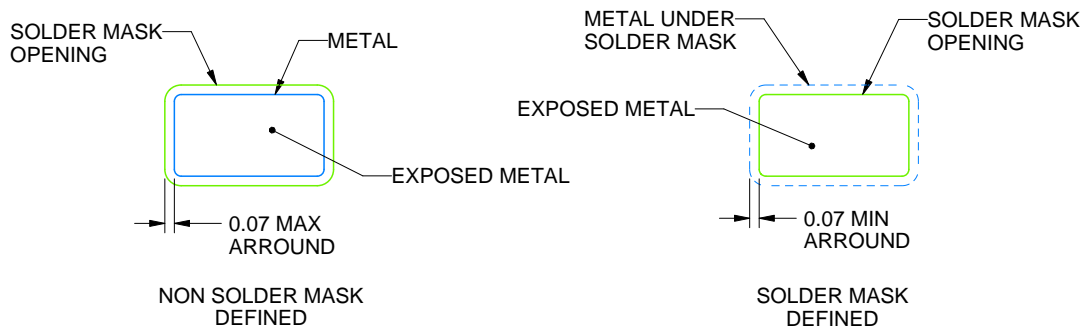
DDC0006A

SOT-23 - 1.1 max height

SMALL OUTLINE TRANSISTOR



LAND PATTERN EXAMPLE  
EXPLODED METAL SHOWN  
SCALE:15X



SOLDEMASK DETAILS

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NOTES: (continued)

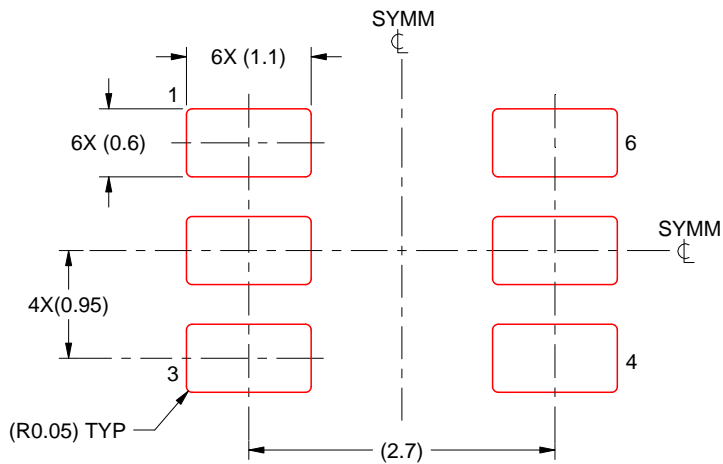
- 4. Publication IPC-7351 may have alternate designs.
- 5. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

# EXAMPLE STENCIL DESIGN

DDC0006A

SOT-23 - 1.1 max height

SMALL OUTLINE TRANSISTOR



SOLDER PASTE EXAMPLE  
BASED ON 0.125 THICK STENCIL  
SCALE:15X

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NOTES: (continued)

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

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