# SM74104 High Voltage Half-Bridge Gate Driver with Adaptive Delay

## 1 Features

- Renewable Energy Grade
- Drives both a High Side and Low Side N-Channel MOSFET
- Adaptive Rising and Falling Edges with Programmable Additional Delay
- Single Input Control
- Bootstrap Supply Voltage Range up to 118V DC
- Fast Turn-Off Propagation Delay (25 ns Typical)
- Drives 1000 pF Loads with 15 ns Rise and Fall Times
- Supply Rail Under-Voltage Lockout

## 2 Typical Applications

- Current Fed Push-Pull Power Converters
- High Voltage Buck Regulators
- Active Clamp Forward Power Converters
- Half and Full Bridge Converters

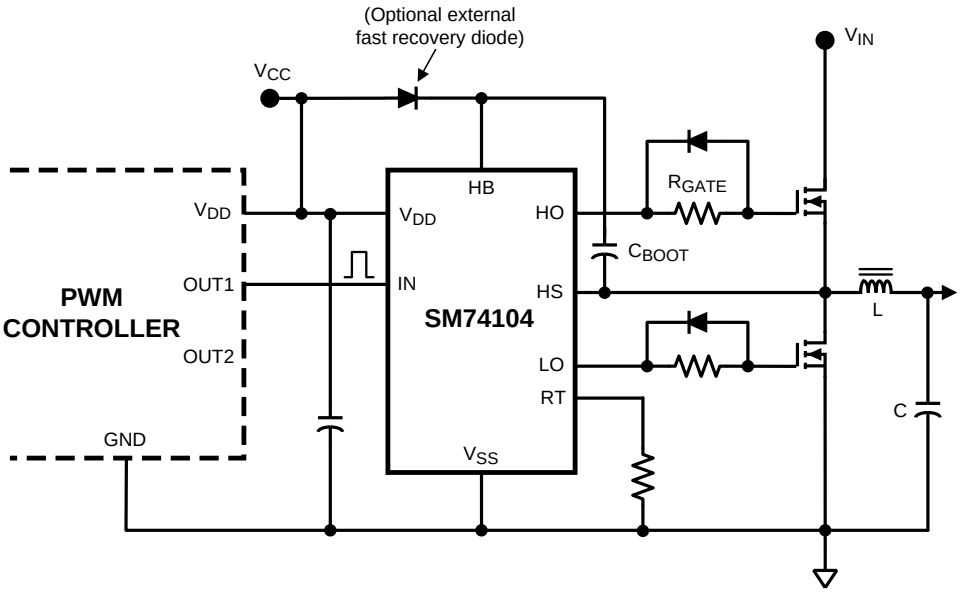
## 3 Description

The SM74104 High Voltage Gate Driver is designed to drive both the high side and the low side N-Channel MOSFETs in a synchronous buck configuration. The floating high-side driver is capable of working with supply voltages up to 100V. The high side and low side gate drivers are controlled from a single input. Each change in state is controlled in an adaptive manner to prevent shoot-through issues. In addition to the adaptive transition timing, an additional delay time can be added, proportional to an external setting resistor. An integrated high voltage diode is provided to charge the high side gate drive bootstrap capacitor. A robust level shifter operates at high speed while consuming low power and providing clean level transitions from the control logic to the high side gate driver. Under-voltage lockout is provided on both the low side and the high side power rails.

**Device Information(1)**

| PART NUMBER | PACKAGE | BODY SIZE (NOM) |
|---|---|---|
| SM74104 | WSON (10) | 4.0 mm x 4.0 mm |
| | SOIC (8) | 4.9 mm x 3.9 mm |

(1) For all available packages, see the orderable addendum at the end of the data sheet.




**SM74104 Driving MOSFETs Connected in Synchronous Buck Configuration**

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.

# Table of Contents

**1 Features** ... 1
**2 Typical Applications** ... 1
**3 Description** ... 1
**4 Revision History** ... 2
**5 Pin Configuration and Functions** ... 3
**6 Specifications** ... 4
**7 Absolute Maximum Ratings** ... 4
**8 ESD Ratings** ... 4
**9 Recommended Operating Conditions** ... 4
**10 Thermal Information** ... 4
**11 Electrical Characteristics** ... 5
**12 Switching Characteristics** ... 6
12.1 Typical Performance Characteristics ... 7
**13 Detailed Description** ... 10
13.1 Overview ... 10
13.2 Functional Block Diagram ... 10
13.3 Feature Description ... 10
13.4 Device Functional Modes ... 12
13.5 Power Dissipation Considerations ... 12
**14 Application and Implementation** ... 14
14.1 Application Information ... 14
14.2 Typical Application ... 14
**15 Power Supply Recommendations** ... 16
**16 Layout** ... 16
16.1 Layout Guidelines ... 16
16.2 Layout Example ... 16
**17 Device and Documentation Support** ... 18
17.1 Trademarks ... 18
17.2 Electrostatic Discharge Caution ... 18
17.3 Glossary ... 18

## 4 Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

**Changes from Revision C (April 2013) to Revision D** **Page**

- Added *ESD Ratings* table, *Thermal Information* table, *Feature Description* section, *Device Functional Modes*, *Application and Implementation* section, *Power Supply Recommendations* section, *Layout* section, *Device and Documentation Support* section, and *Mechanical, Packaging, and Orderable Information* section ... 1

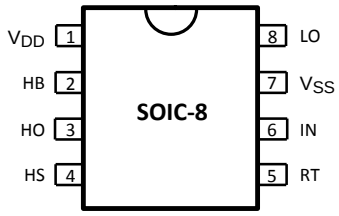
**Changes from Revision B (April 2013) to Revision C** **Page**

- Changed layout of National Data Sheet to TI format ... 1

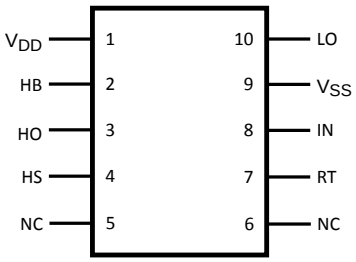

Copyright © 2011–2015, Texas Instruments Incorporated

# 5 Pin Configuration and Functions

**8-Pin SOIC**
**Package D**
**Top View**




**10-Pin WSON**
**Package DPR**
**Top View**




**Pin Functions**

| PIN | | | I/O | DESCRIPTION |
|---|---|---|---|---|
| NAME | NO. | | | |
| | D | DPR | | |
| VDD | 1 | 1 | I | Positive supply voltage input. |
| HB | 2 | 2 | I | Positive connection for high-side bootstrap capacitor. |
| HO | 3 | 3 | O | High-side output to drive the top MOSFET. |
| HS | 4 | 4 | I | Switch node pin. |
| RT | 5 | 7 | I | Delay timer pin. The additional delay of the timer prevents lower and upper MOSFETs from conducting simultaneously, thereby preventing shoot-through. Timer delay is set with a resistor to ground. |
| IN | 6 | 8 | I | PWM control input for LO and HO outputs. |
| VSS | 7 | 9 | - | Ground pin. |
| LO | 8 | 10 | O | Low-side output to drive the bottom MOSFET. |
| N/C | - | 5, 6 | - | No connect. |
| Exposed Pad | - | Exposed Pad | - | The exposed die attach pad (DAP) on the 10-pin WSON package functions as a thermal connection and can be soldered to a copper plane under the device. The DAP nas no direct electrical connection to any of the pins. It can be left floating, but it is recommended to connect this to $V_{SS}$. |

Copyright © 2011–2015, Texas Instruments Incorporated

# 6 Specifications

# 7 Absolute Maximum Ratings

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

| | MIN | MAX | UNIT |
|---|---|---|---|
| $V_{DD}$ to $V_{SS}$ | –0.3 | 18 | V |
| $V_{HB}$ to $V_{HS}$ | –0.3 | 18 | V |
| IN to $V_{SS}$ | –0.3 | $V_{DD}$ + 0.3 | V |
| LO Output | –0.3 | $V_{DD}$ + 0.3 | V |
| HO Output | $V_{HS}$ – 0.3 | $V_{HB}$ + 0.3 | V |
| $V_{HS}$ to $V_{SS}$ | –1 | 100 | V |
| $V_{HB}$ to $V_{SS}$ | | 118 | V |
| RT to $V_{SS}$ | –0.3 | 5 | V |
| $T_{stg}$ Storage Temperature Range | –55 | 150 | °C |
| Maximum Junction Temperature | | 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.

# 8 ESD Ratings

| | | | | VALUE | UNIT |
|---|---|---|---|---|---|
| $V_{(ESD)}$ | Electrostatic discharge | Human-body model (HBM), per ANSI/ESDA/JEDEC JS-001 (1) | All pins except 2, 3, and 4 | ±2000 | V |
| | | | Pins 2, 3, and 4 | ±500 | |

(1) JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process. Manufacturing with less than 500-V HBM is possible with the necessary precautions.

# 9 Recommended Operating Conditions

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

| | MIN | MAX | UNIT |
|---|---|---|---|
| $V_{DD}$ | 9 | 14 | V |
| HS | –1 | 100 | V |
| HB | $V_{HS}$ + 8 | $V_{HS}$ + 14 | V |
| HS Slew Rate | | 50 | V/ns |
| Junction Temperature | –40 | 125 | °C |

# 10 Thermal Information

| THERMAL METRIC (1) | | SM74104 | | UNIT |
|---|---|---|---|---|
| | | D | DPR | |
| | | 8 PINS | 10 PINS | |
| $R_{\theta JA}$ | Junction-to-ambient thermal resistance | 114.5 | 37.9 | °C/W |
| $R_{\theta JC(top)}$ | Junction-to-case (top) thermal resistance | 61.1 | 38.1 | |
| $R_{\theta JB}$ | Junction-to-board thermal resistance | 55.6 | 14.9 | |
| $\psi_{JT}$ | Junction-to-top characterization parameter | 9.7 | 0.4 | |
| $\psi_{JB}$ | Junction-to-board characterization parameter | 54.9 | 15.2 | |
| $R_{\theta JC(bot)}$ | Junction-to-case (bottom) thermal resistance | - | 4.4 | |

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


Copyright © 2011–2015, Texas Instruments Incorporated

## 11 Electrical Characteristics

Over operating junction temperature range, $V_{DD}$ = $V_{HB}$ = 12 V, $V_{SS}$ = $V_{HS}$ = 0 V, RT = 100 kΩ, no load on LO or HO, unless otherwise specified.

| PARAMETER | | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| **SUPPLY CURRENTS** | | | | | | |
| $I_{DD}$ | $V_{DD}$ Quiescent Current | LI = HI = 0V | | 0.4 | 0.6 | mA |
| $I_{DDO}$ | $V_{DD}$ Operating Current | f = 500 kHz | | 1.9 | 3 | mA |
| $I_{HB}$ | Total HB Quiescent Current | LI = HI = 0V | | 0.06 | 0.2 | mA |
| $I_{HBO}$ | Total HB Operating Current | f = 500 kHz | | 1.3 | 3 | mA |
| $I_{HBS}$ | HB to $V_{SS}$ Current, Quiescent | $V_{HS}$ = $V_{HB}$ = 100V | | 0.05 | 10 | µA |
| $I_{HBSO}$ | HB to $V_{SS}$ Current, Operating | f = 500 kHz | | 0.08 | | mA |
| **INPUT PINS** | | | | | | |
| $V_{IL}$ | Low Level Input Voltage Threshold | | 0.8 | 1.8 | | V |
| $V_{IH}$ | High Level Input Voltage Threshold | | | 1.8 | 2.2 | V |
| $R_I$ | Input Pulldown Resistance | | 100 | 200 | 500 | kΩ |
| **TIME DELAY CONTROLS** | | | | | | |
| $V_{RT}$ | Nominal Voltage at RT | | 2.7 | 3 | 3.3 | V |
| $I_{RT}$ | RT Pin Current Limit | RT = 0V | 0.75 | 1.5 | 2.25 | mA |
| $T_{D1}$ | Delay Timer, RT = 10 kΩ | | 58 | 90 | 130 | ns |
| $T_{D2}$ | Delay Timer, RT = 100 kΩ | | 140 | 200 | 270 | ns |
| **UNDER VOLTAGE PROTECTION** | | | | | | |
| $V_{DDR}$ | $V_{DD}$ Rising Threshold | | 6.0 | 6.9 | 7.4 | V |
| $V_{DDH}$ | $V_{DD}$ Threshold Hysteresis | | | 0.5 | | V |
| $V_{HBR}$ | HB Rising Threshold | | 5.7 | 6.6 | 7.1 | V |
| $V_{HBH}$ | HB Threshold Hysteresis | | | 0.4 | | V |
| **BOOT STRAP DIODE** | | | | | | |
| $V_{DL}$ | Low-Current Forward Voltage | $I_{VDD-HB}$ = 100 µA | | 0.60 | 0.9 | V |
| $V_{DH}$ | High-Current Forward Voltage | $I_{VDD-HB}$ = 100 mA | | 0.85 | 1.1 | V |
| $R_D$ | Dynamic Resistance | $I_{VDD-HB}$ = 100 mA | | 0.8 | 1.5 | Ω |
| **LO GATE DRIVER** | | | | | | |
| $V_{OLL}$ | Low-Level Output Voltage | $I_{LO}$ = 100 mA | | 0.25 | 0.4 | V |
| $V_{OHL}$ | High-Level Output Voltage | $I_{LO}$ = –100 mA<br>$V_{OHL}$ = $V_{DD}$ – $V_{LO}$ | | 0.35 | 0.55 | V |
| $I_{OHL}$ | Peak Pullup Current | $V_{LO}$ = 0V | | 1.6 | | A |
| $I_{OLL}$ | Peak Pulldown Current | $V_{LO}$ = 12V | | 1.8 | | A |
| **HO GATE DRIVER** | | | | | | |
| $V_{OLH}$ | Low-Level Output Voltage | $I_{HO}$ = 100 mA | | 0.25 | 0.4 | V |
| $V_{OHH}$ | High-Level Output Voltage | $I_{HO}$ = –100 mA,<br>$V_{OHH}$ = $V_{HB}$ – $V_{HO}$ | | 0.35 | 0.55 | V |
| $I_{OHH}$ | Peak Pullup Current | $V_{HO}$ = 0V | | 1.6 | | A |
| $I_{OLH}$ | Peak Pulldown Current | $V_{HO}$ = 12V | | 1.8 | | A |

Copyright © 2011–2015, Texas Instruments Incorporated

## 12 Switching Characteristics

Over operating junction temperature range, $V_{DD} = V_{HB} = 12$ V, $V_{SS} = V_{HS} = 0$ V, no load on LO or HO, unless otherwise specified.

| Symbol | Parameter | Conditions | Min | Typ | Max | Units |
|---|---|---|---|---|---|---|
| $t_{LPHL}$ | Lower Turn-Off Propagation Delay (IN Rising to LO Falling) | | | 25 | 56 | ns |
| $t_{HPHL}$ | Upper Turn-Off Propagation Delay (IN Falling to HO Falling) | | | 25 | 56 | ns |
| $t_{RC}$, $t_{FC}$ | Either Output Rise/Fall Time | $C_L$ = 1000 pF | | 15 | | ns |
| $t_R$, $t_F$ | Either Output Rise/Fall Time (3V to 9V) | $C_L$ = 0.1 µF | | 0.6 | | µs |
| $t_{BS}$ | Bootstrap Diode Turn-Off Time | $I_F$ = 20 mA, $I_R$ = 200 mA | | 50 | | ns |


Copyright © 2011–2015, Texas Instruments Incorporated

## 12.1 Typical Performance Characteristics

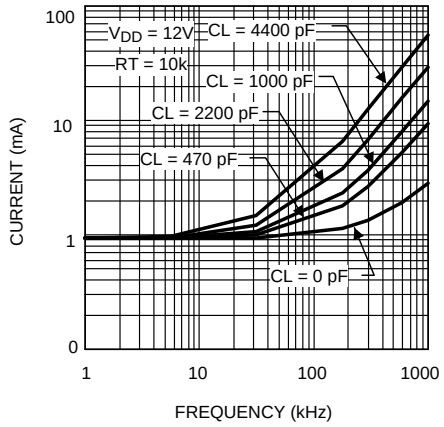



**Figure 1. $I_{DD}$ vs Frequency**

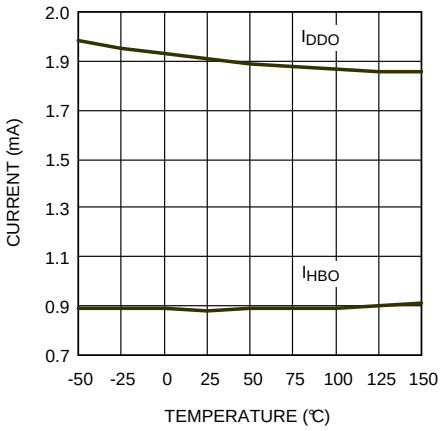



**Figure 2. Operating Current vs Temperature**

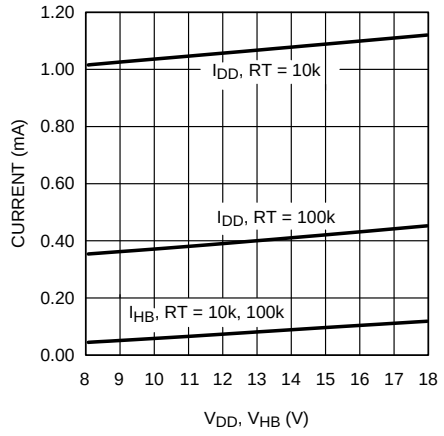



**Figure 3. Quiescent Current vs Supply Voltage**

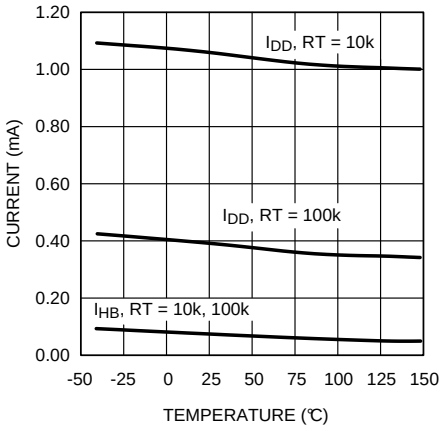



**Figure 4. Quiescent Current vs Temperature**

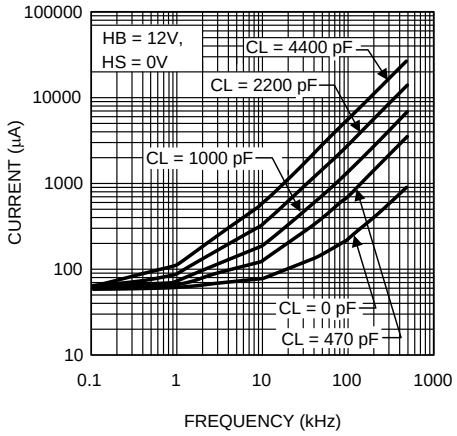



**Figure 5. $I_{HB}$ vs Frequency**

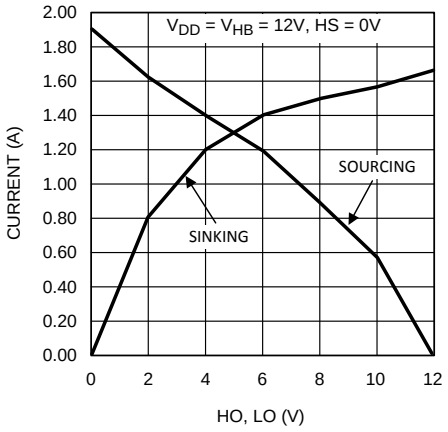



**Figure 6. HO & LO Peak Output Current vs Output Voltage**

Copyright © 2011–2015, Texas Instruments Incorporated

## Typical Performance Characteristics (continued)

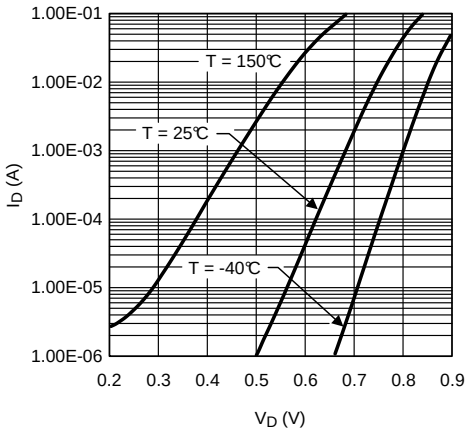



**Figure 7. Diode Forward Voltage**

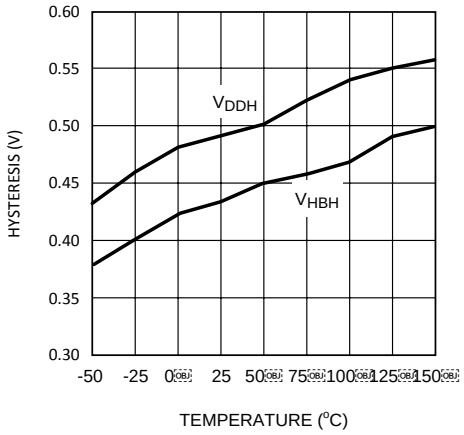



**Figure 8. Undervoltage Threshold Hysteresis vs Temperature**

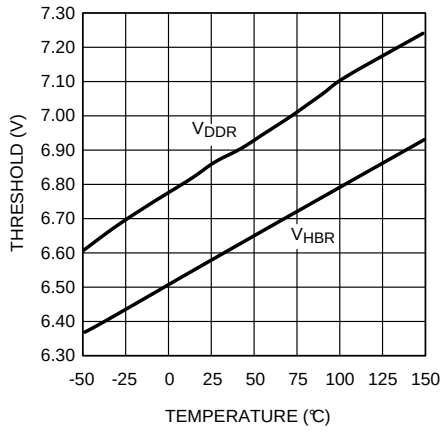



**Figure 9. Undervoltage Rising Threshold vs Temperature**

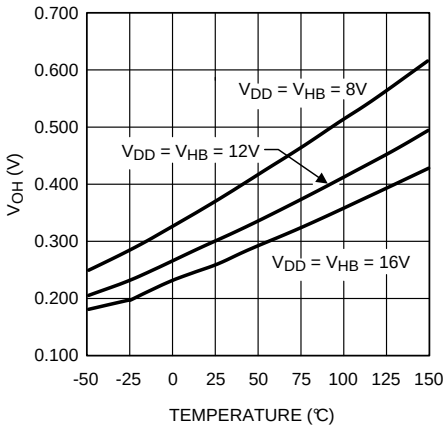



**Figure 10. LO & HO Gate Drive—High Level Output Voltage vs Temperature**

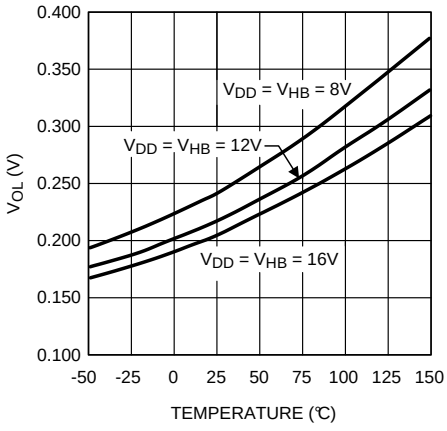



**Figure 11. LO & HO Gate Drive—Low Level Output Voltage vs Temperature**

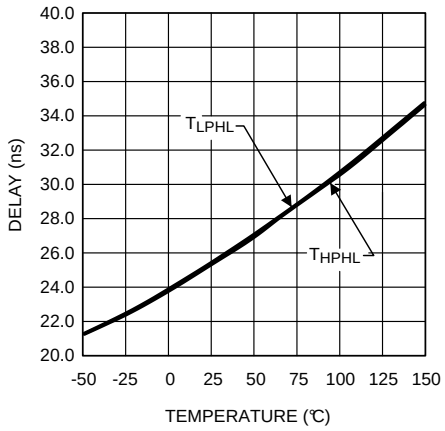



**Figure 12. Turn Off Propagation Delay vs Temperature**


Copyright © 2011–2015, Texas Instruments Incorporated

## Typical Performance Characteristics (continued)

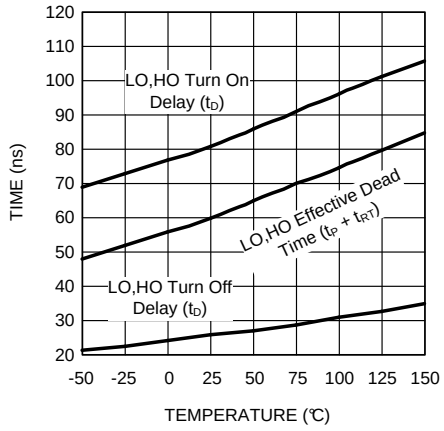



**Figure 13. Timing vs Temperature RT = 10K**

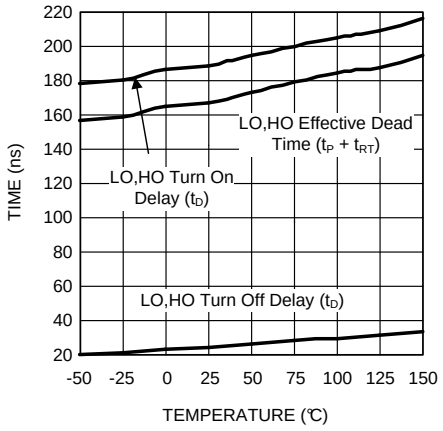



**Figure 14. Timing vs Temperature RT = 100K**

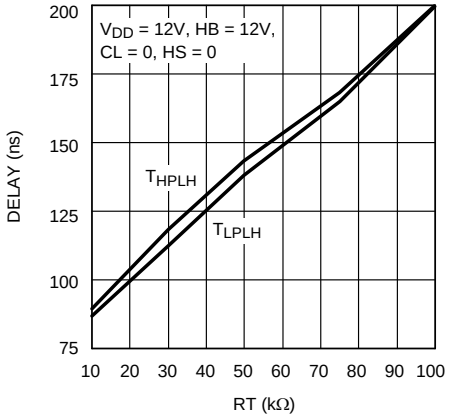


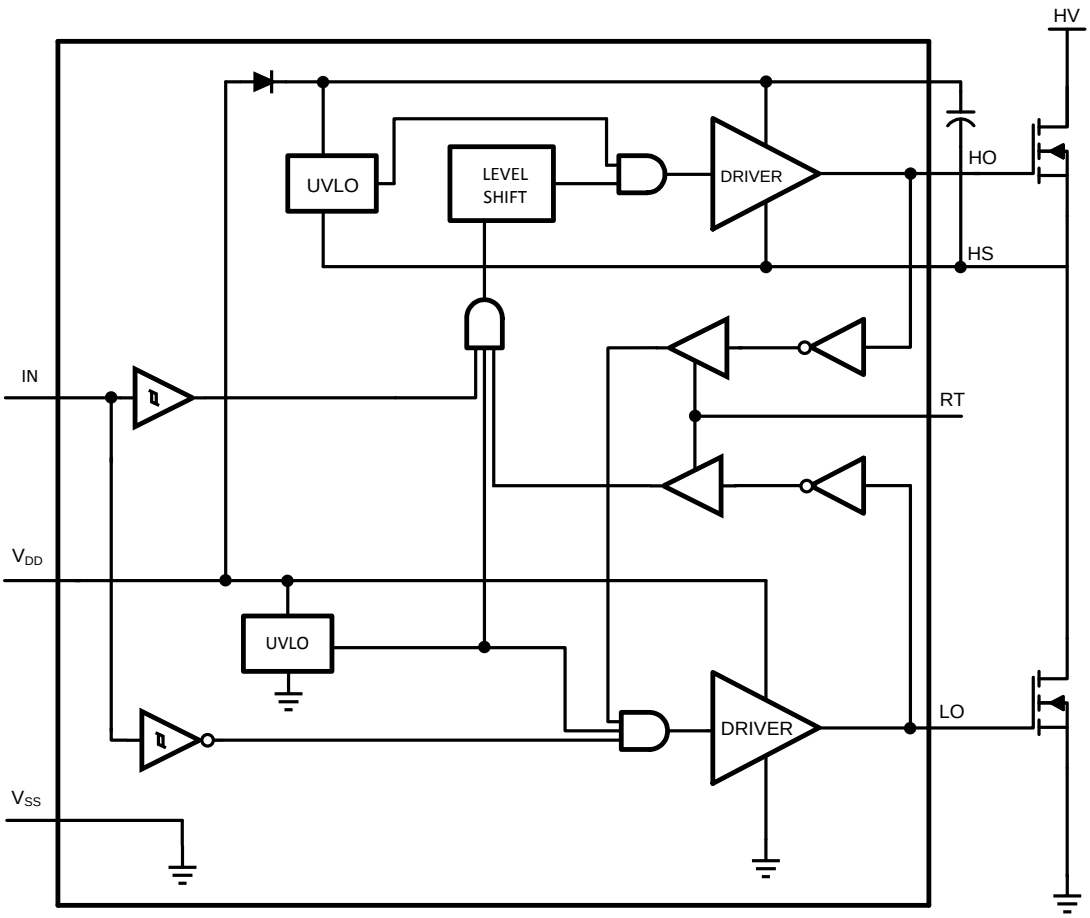

**Figure 15. Turn On Delay vs RT Resistor Value**

# 13 Detailed Description

## 13.1 Overview

SM74104 is a high voltage, high speed, dual output driver designed to drive top and bottom MOSFETs connected in synchronous buck or half-bridge configuration. SM74104 also features adaptive delay to prevent shoot-through current through top and bottom MOSFETs during switching transitions. The outputs that drive the top and bottom MOSFETs are controlled by one externally provided PWM signal.

## 13.2 Functional Block Diagram




## 13.3 Feature Description

### 13.3.1 PWM Input Control

Referring to the timing diagram in Figure 16, the rising edge of the PWM input (IN) turns off the bottom MOSFET (LO) after a short propagation delay ($t_P$). An adaptive circuit in the SM74104 monitors the bottom gate voltage (LO) and triggers a programmable delay generator when the LO pin falls below an internally set threshold (≈ Vdd/2). The gate drive of the upper MOSFET (HO) is disabled until the deadtime expires. The upper gate is enabled after the TIMER delay ($t_P$+$T_{RT}$), and the upper MOSFET turns-on. The additional delay of the timer prevents lower and upper MOSFETs from conducting simultaneously, thereby preventing shoot-through.


Copyright © 2011–2015, Texas Instruments Incorporated

## Feature Description (continued)

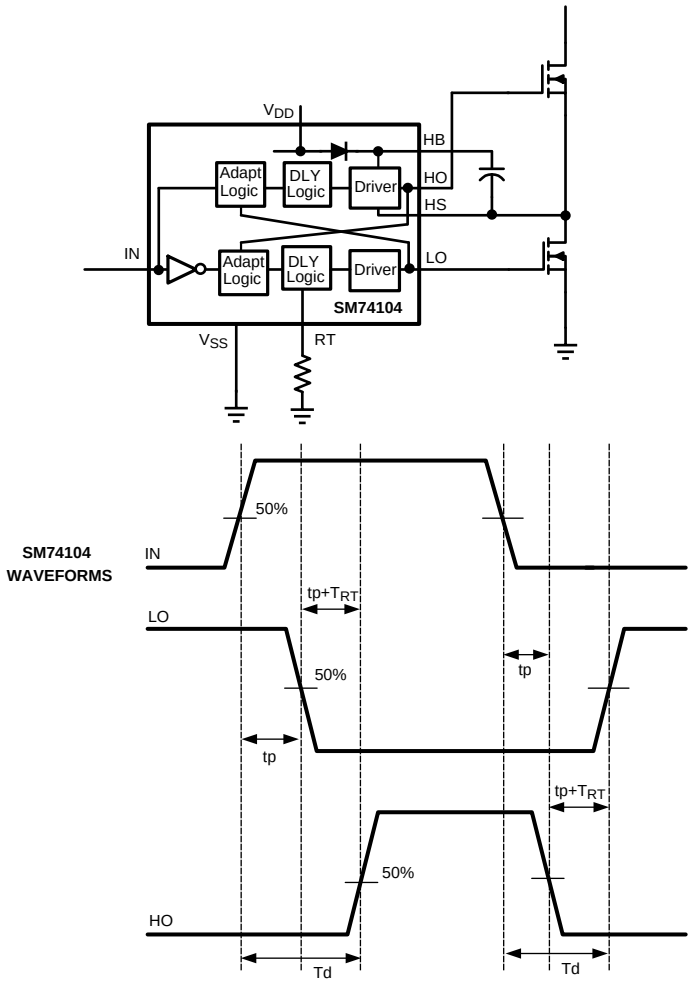



**Figure 16. Application Timing Waveforms**

A falling transition on the PWM signal (IN) initiates the turn-off of the upper MOSFET and turn-on of the lower MOSFET. A short propagation delay ($t_P$) is encountered before the upper gate voltage begins to fall. Again, the adaptive shoot-through circuitry and the programmable deadtime TIMER delays the lower gate turn-on time. The upper MOSFET gate voltage is monitored and the deadtime delay generator is triggered when the upper MOSFET gate voltage with respect to ground drops below an internally set threshold (≈ Vdd/2). The lower gate drive is momentarily disabled by the timer and turns on the lower MOSFET after the deadtime delay expires ($t_P$+$T_{RT}$).

### 13.3.2 Setting the Delay Timer with RT

The RT pin is biased at 3V and current limited to 1mA. It is designed to accommodate a resistor between 5K and 100K, resulting in an effective dead-time proportional to RT and ranging from 90ns to 200ns. RT values below 5K will saturate the timer and are not recommended.

Copyright © 2011–2015, Texas Instruments Incorporated

## 13.4 Device Functional Modes

### 13.4.1 Startup and UVLO

Both top and bottom drivers include under-voltage lockout (UVLO) protection circuitry which monitors the supply voltage ($V_{DD}$) and bootstrap capacitor voltage ($V_{HB} – V_{HS}$) independently. The UVLO circuit inhibits each driver until sufficient supply voltage is available to turn-on the external MOSFETs, and the built-in hysteresis prevents chattering during supply voltage transitions. When the supply voltage is applied to $V_{DD}$ pin of SM74104, the top and bottom gates are held low until $V_{DD}$ exceeds UVLO threshold, typically about 6.9V. Any UVLO condition on the bootstrap capacitor will disable only the high side output (HO).

## 13.5 Power Dissipation Considerations

The total IC power dissipation is the sum of the gate driver losses and the bootstrap diode losses. The gate driver losses are related to the switching frequency (f), output load capacitance on LO and HO ($C_L$), and supply voltage ($V_{DD}$) and can be roughly calculated as:

$$P_{DGATES} = 2 \bullet f \bullet C_L \bullet V_{DD}^2 \quad (1)$$

There are some additional losses in the gate drivers due to the internal CMOS stages used to buffer the LO and HO outputs. The following plot shows the measured gate driver power dissipation versus frequency and load capacitance. At higher frequencies and load capacitance values, the power dissipation is dominated by the power losses driving the output loads and agrees well with the above equation. This plot can be used to approximate the power losses due to the gate drivers.

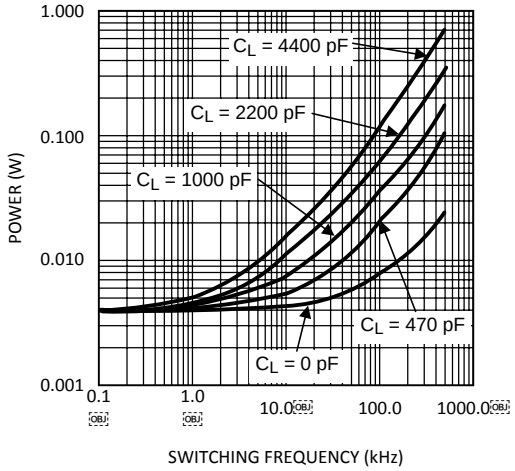



**Figure 17. Gate Driver Power Dissipation (LO + HO)**
**$V_{CC}$ = 12V, Neglecting Diode Losses**

The bootstrap diode power loss is the sum of the forward bias power loss that occurs while charging the bootstrap capacitor and the reverse bias power loss that occurs during reverse recovery. Since each of these events happens once per cycle, the diode power loss is proportional to frequency. Larger capacitive loads require more current to recharge the bootstrap capacitor resulting in more losses. Higher input voltages ($V_{IN}$) to the half bridge result in higher reverse recovery losses. The following plot was generated based on calculations and lab measurements of the diode recovery time and current under several operating conditions. This can be useful for approximating the diode power dissipation.


Copyright © 2011–2015, Texas Instruments Incorporated

## Power Dissipation Considerations (continued)

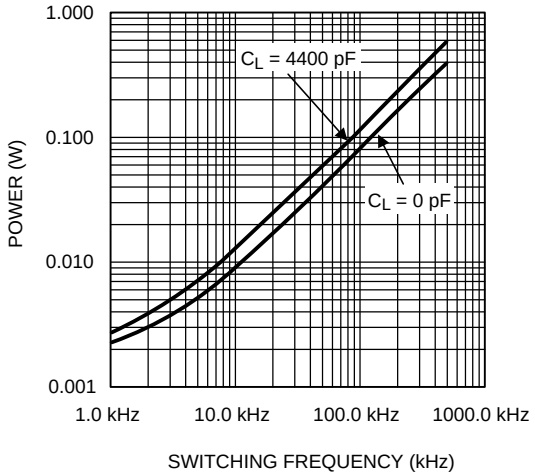



**Figure 18. Diode Power Dissipation $V_{IN}$ = 80V**

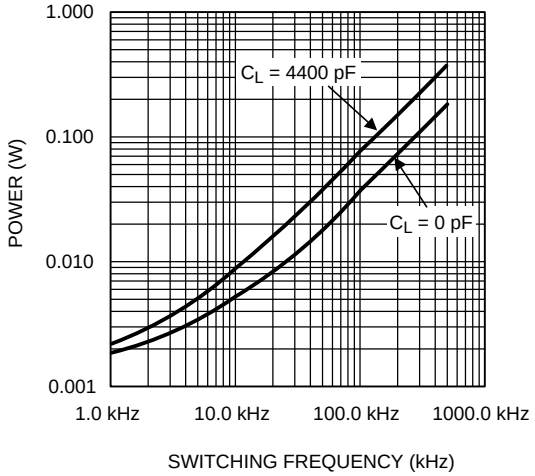



**Figure 19. Diode Power Dissipation $V_{IN}$ = 40V**

The total IC power dissipation can be estimated from the above plots by summing the gate drive losses with the bootstrap diode losses for the intended application. Because the diode losses can be significant, an external diode placed in parallel with the internal bootstrap diode (refer to Figure 20) can be helpful in removing power from the IC. For this to be effective, the external diode must be placed close to the IC to minimize series inductance and have a significantly lower forward voltage drop than the internal diode.

Copyright © 2011–2015, Texas Instruments Incorporated

# 14 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.

## 14.1 Application Information

The SM74104 can drive both a high-side and a low-side MOSFET using only one PWM input control signal. The internal level shifter provides a means for the control input to drive the high-side MOSFET. The SM74104 prevents shoot-through issues through adaptive transition timing and an additional time delay can be added by use of an external resistor at the RT pin.

## 14.2 Typical Application

The SM74104 is used to drive MOSFETs connected in a synchronous buck configuration as shown in Figure 20. A single control signal from an external PWM controller provides the control input to drive both the high-side and low-side MOSFET. The HO and LO outputs of the SM74104 can provide very fast switching of the MOSFETs, thereby reducing switching losses and improving the overall efficiency of the system.

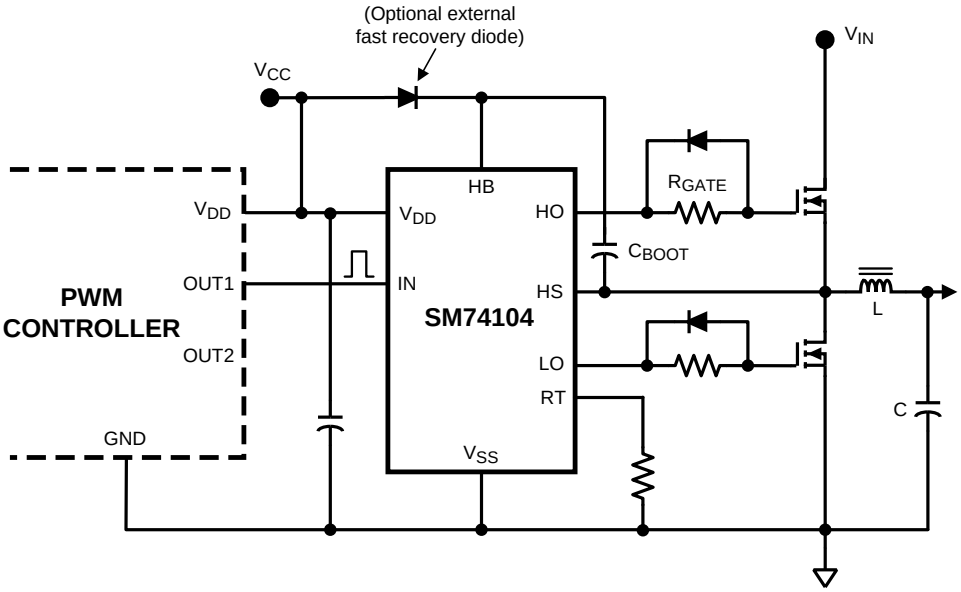



**Figure 20. Typical Application**

### 14.2.1 Design Requirements

The RT resistor should be sized such that the appropriate time delay is added between the switching transitions of the top and bottom MOSFETs. The exact RT value will depend on the selected MOSFETs, their switching speeds, and the desired delay time needed to prevent shoot-through. An optional external fast recovery diode should be placed between the VDD and HB pins to minimize the stress on the internal bootstrap diode and decrease the average power dissipation in the IC. An $R_{GATE}$ resistor and a parallel diode may also be placed in the path of the MOSFET gates. The $R_{GATE}$ resistor will decrease the ON switching speed of the MOSFET and can help damp possible oscillations on the line. The parallel diode will provide a current path around $R_{GATE}$ during the OFF switching of the MOSFET, which can ensure fast shut off of the MOSFET to further prevent shoot-through.


Copyright © 2011–2015, Texas Instruments Incorporated

## Typical Application (continued)

### 14.2.2 Detailed Design Procedure

See Power Supply Recommendations, Layout, and Power Dissipation Considerations for key design considerations regarding the input supply, grounding, component placement, and power calculations specific to the SM74104.

### 14.2.3 Application Curve

An adaptive circuit in the SM74104 monitors the gate voltages of the top and bottom MOSFETs and triggers a programmable delay generator to prevent both MOSFETs from conducting simultaneously. The timer delay, $T_{RT}$, can be programmed with a resistor placed between RT and VSS. The value of $T_{RT}$ will vary with the RT resistor value as shown in Figure 21.

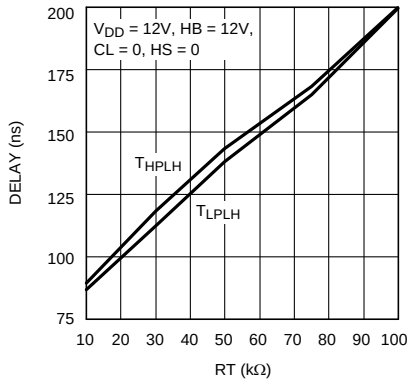



**Figure 21. Turn On Delay vs RT Resistor Value**

# 15 Power Supply Recommendations

A low ESR/ESL capacitor must be connected as close as possible to the IC between $V_{DD}$ and $V_{SS}$ pins and between HB and HS pins to support high peak currents being drawn from $V_{DD}$ during turn-on of the external MOSFET. Also, to prevent large voltage transients at the drain of the top MOSFET, a low ESR electrolytic capacitor must be connected between MOSFET drain and ground ($V_{SS}$). In both cases, the traces should be as short as possible to reduce the series resistance.

# 16 Layout

## 16.1 Layout Guidelines

The optimum performance of high and low side gate drivers cannot be achieved without taking due considerations during circuit board layout. The following points are emphasized.

1. In order to avoid large negative transients on the switch node (HS) pin, the parasitic inductances in the source of top MOSFET and in the drain of the bottom MOSFET (synchronous rectifier) must be minimized.
2. Grounding considerations:
   - The first priority in designing grounding connections is to confine the high peak currents from charging and discharging the MOSFET gate in a minimal physical area. This will decrease the loop inductance and minimize noise issues on the gate terminal of the MOSFET. The MOSFETs should be placed as close as possible to the gate driver.
   - The second high current path includes the bootstrap capacitor, the bootstrap diode, the local ground referenced bypass capacitor and low side MOSFET body diode. The bootstrap capacitor is recharged on a cycle-by-cycle basis through the bootstrap diode from the ground referenced $V_{DD}$ bypass capacitor. The recharging occurs in a short time interval and involves high peak current. Minimizing this loop length and area on the circuit board is important to ensure reliable operation.
3. The resistor on the RT pin must be placed very close to the IC and separated from high current paths to avoid noise coupling to the time delay generator which could disrupt timer operation.

## 16.2 Layout Example

Figure 22 shows an example layout for the SM74104 in the 8-pin SOIC package option.


Copyright © 2011–2015, Texas Instruments Incorporated

## Layout Example (continued)

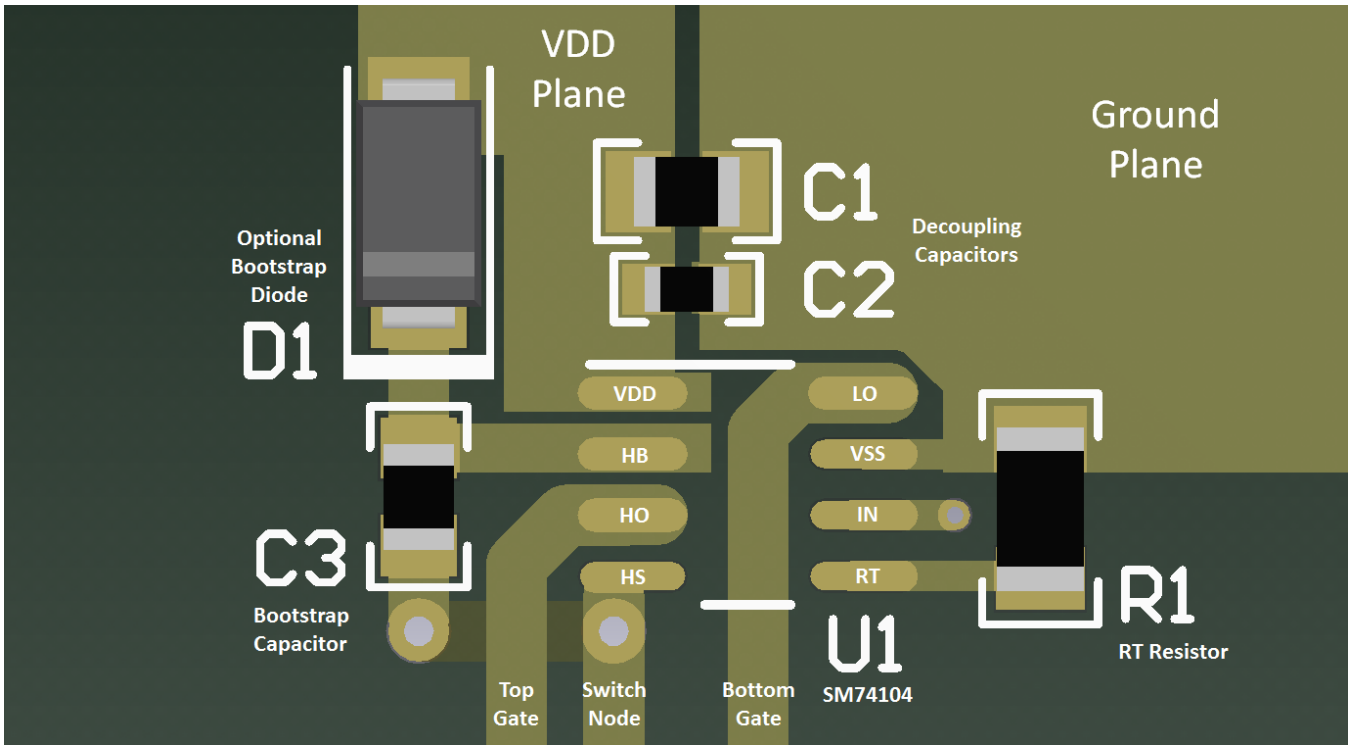



**Figure 22. SM74104 Layout Example**

# 17 Device and Documentation Support

## 17.1 Trademarks

All trademarks are the property of their respective owners.

## 17.2 Electrostatic Discharge Caution



These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

## 17.3 Glossary

SLYZ022 — *TI Glossary*.

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


Copyright © 2011–2015, Texas Instruments Incorporated

## 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) |
|---|---|---|---|---|---|---|---|---|---|
| SM74104MA/NOPB | Active | Production | SOIC (D) \| 8 | 95 \| TUBE | Yes | SN | Level-1-260C-UNLIM | -40 to 125 | 74104 MA |
| SM74104MA/NOPB.A | Active | Production | SOIC (D) \| 8 | 95 \| TUBE | Yes | SN | Level-1-260C-UNLIM | -40 to 125 | 74104 MA |
| SM74104MA/NOPB.B | Active | Production | SOIC (D) \| 8 | 95 \| TUBE | Yes | SN | Level-1-260C-UNLIM | -40 to 125 | 74104 MA |
| SM74104MAX/NOPB | Active | Production | SOIC (D) \| 8 | 2500 \| LARGE T&R | Yes | SN | Level-1-260C-UNLIM | -40 to 125 | 74104 MA |
| SM74104MAX/NOPB.A | Active | Production | SOIC (D) \| 8 | 2500 \| LARGE T&R | Yes | SN | Level-1-260C-UNLIM | -40 to 125 | 74104 MA |
| SM74104MAX/NOPB.B | Active | Production | SOIC (D) \| 8 | 2500 \| LARGE T&R | Yes | SN | Level-1-260C-UNLIM | -40 to 125 | 74104 MA |
| SM74104SD/NOPB | Active | Production | WSON (DPR) \| 10 | 1000 \| SMALL T&R | Yes | SN | Level-1-260C-UNLIM | -40 to 125 | S74104 |
| SM74104SD/NOPB.A | Active | Production | WSON (DPR) \| 10 | 1000 \| SMALL T&R | Yes | SN | Level-1-260C-UNLIM | -40 to 125 | S74104 |
| SM74104SD/NOPB.B | Active | Production | WSON (DPR) \| 10 | 1000 \| SMALL T&R | Yes | SN | Level-1-260C-UNLIM | -40 to 125 | S74104 |
| SM74104SDX/NOPB | Active | Production | WSON (DPR) \| 10 | 4500 \| LARGE T&R | Yes | SN | Level-1-260C-UNLIM | -40 to 125 | S74104 |
| SM74104SDX/NOPB.A | Active | Production | WSON (DPR) \| 10 | 4500 \| LARGE T&R | Yes | SN | Level-1-260C-UNLIM | -40 to 125 | S74104 |
| SM74104SDX/NOPB.B | Active | Production | WSON (DPR) \| 10 | 4500 \| LARGE T&R | Yes | SN | Level-1-260C-UNLIM | -40 to 125 | S74104 |

(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.

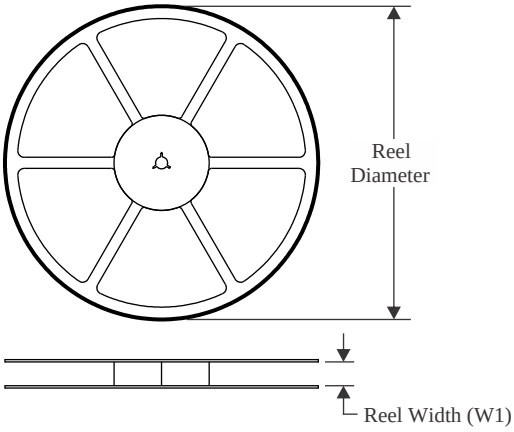
Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "~" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

**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.

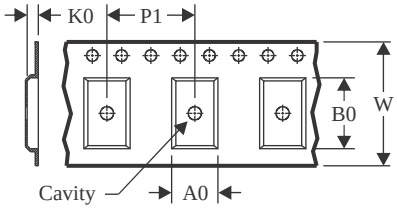
In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

## TAPE AND REEL INFORMATION

**REEL DIMENSIONS**

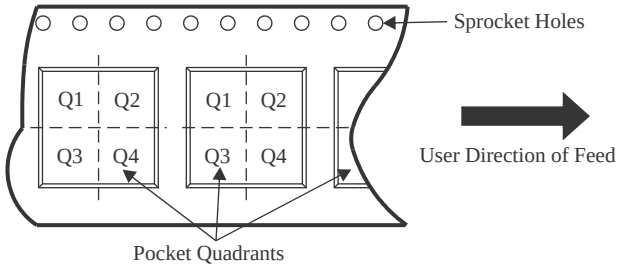



**TAPE DIMENSIONS**




| | |
|---|---|
| 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 |

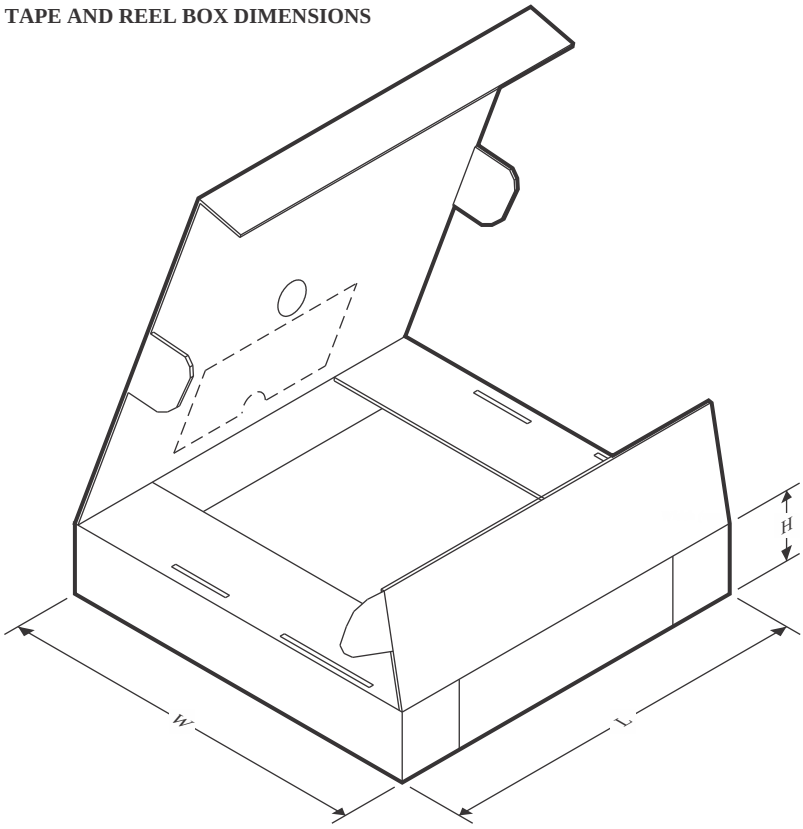
**QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE**




*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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SM74104MAX/NOPB | SOIC | D | 8 | 2500 | 330.0 | 12.4 | 6.4 | 5.2 | 2.1 | 8.0 | 12.0 | Q1 |
| SM74104SD/NOPB | WSON | DPR | 10 | 1000 | 177.8 | 12.4 | 4.3 | 4.3 | 1.3 | 8.0 | 12.0 | Q1 |
| SM74104SDX/NOPB | WSON | DPR | 10 | 4500 | 330.0 | 12.4 | 4.3 | 4.3 | 1.3 | 8.0 | 12.0 | Q1 |

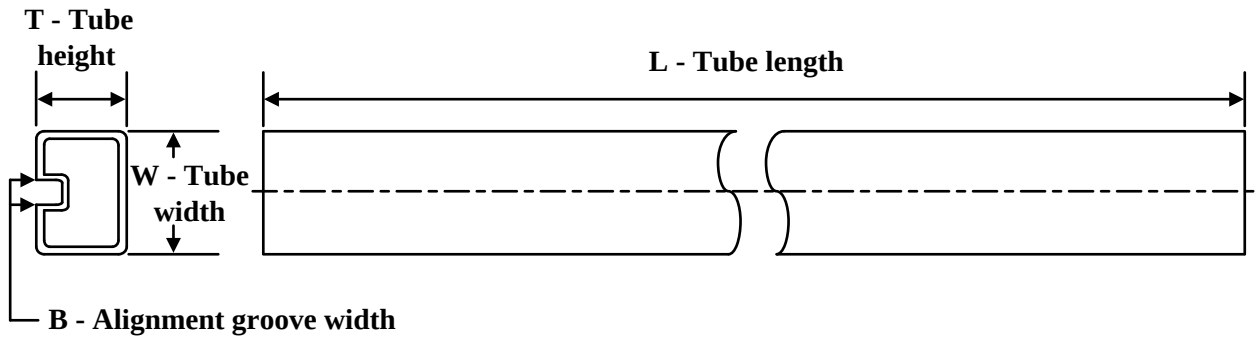
TAPE AND REEL BOX DIMENSIONS




*All dimensions are nominal

| Device | Package Type | Package Drawing | Pins | SPQ | Length (mm) | Width (mm) | Height (mm) |
|---|---|---|---|---|---|---|---|
| SM74104MAX/NOPB | SOIC | D | 8 | 2500 | 367.0 | 367.0 | 35.0 |
| SM74104SD/NOPB | WSON | DPR | 10 | 1000 | 208.0 | 191.0 | 35.0 |
| SM74104SDX/NOPB | WSON | DPR | 10 | 4500 | 367.0 | 367.0 | 35.0 |

## TUBE




*All dimensions are nominal

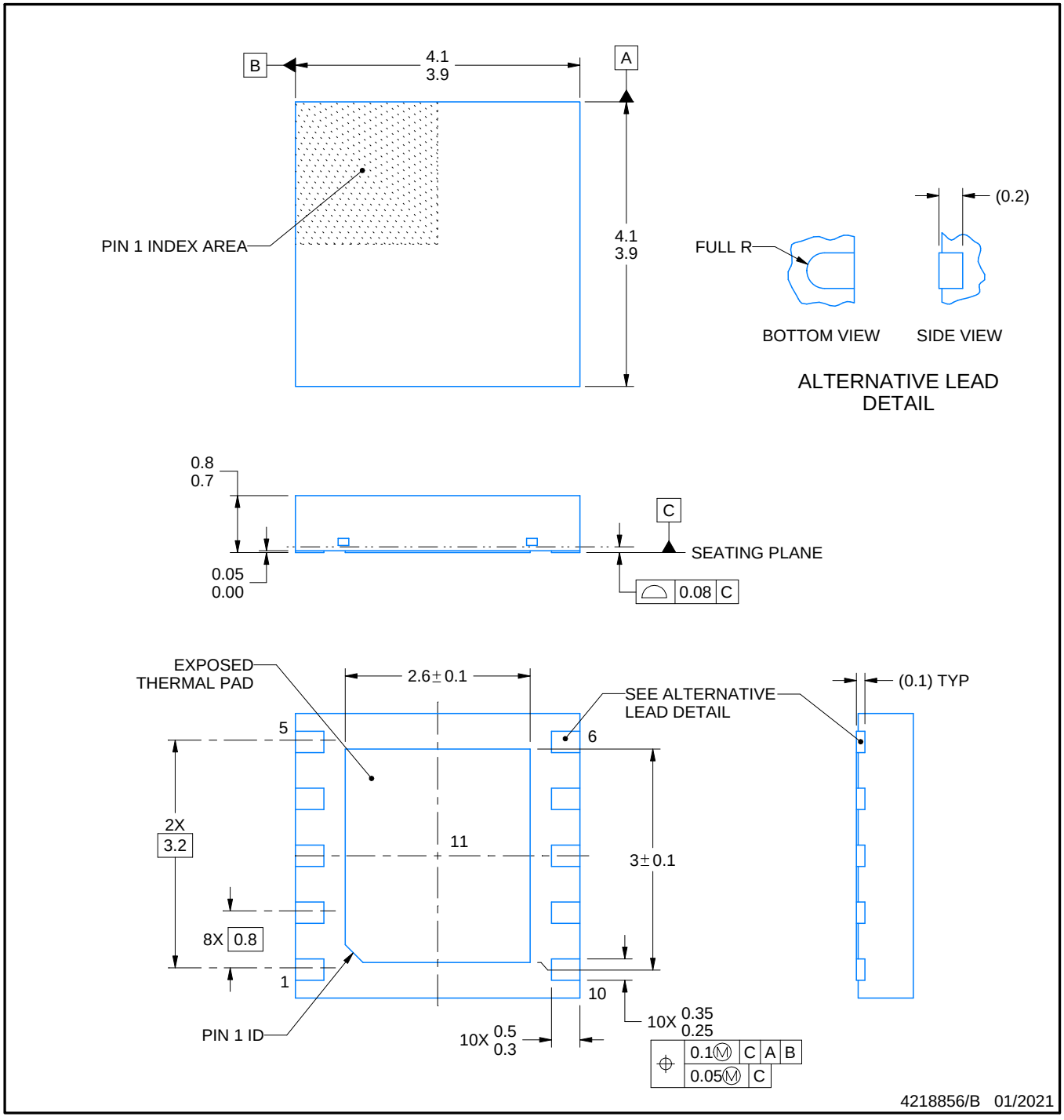
| Device | Package Name | Package Type | Pins | SPQ | L (mm) | W (mm) | T (µm) | B (mm) |
|---|---|---|---|---|---|---|---|---|
| SM74104MA/NOPB | D | SOIC | 8 | 95 | 495 | 8 | 4064 | 3.05 |
| SM74104MA/NOPB.A | D | SOIC | 8 | 95 | 495 | 8 | 4064 | 3.05 |
| SM74104MA/NOPB.B | D | SOIC | 8 | 95 | 495 | 8 | 4064 | 3.05 |

# PACKAGE OUTLINE

## DPR0010A

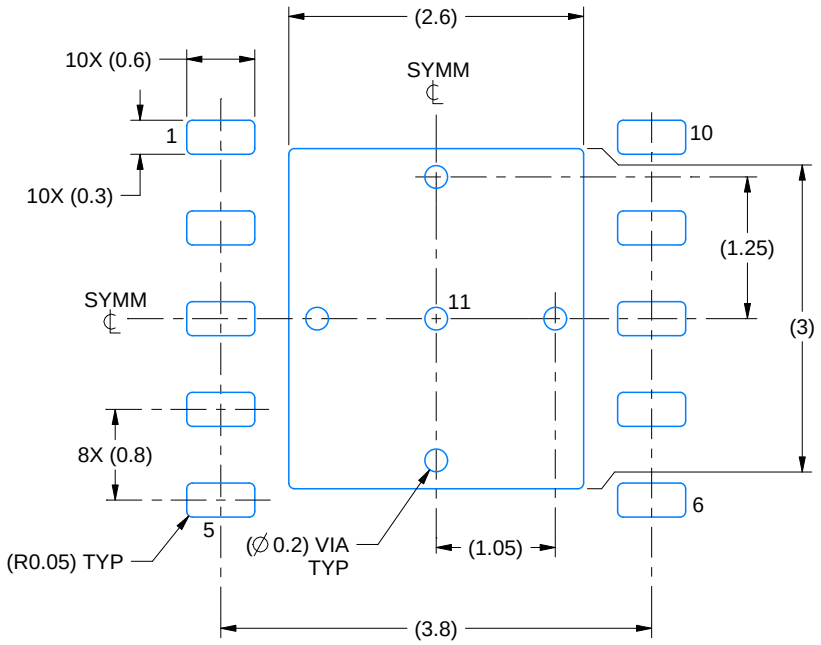
## WSON - 0.8 mm max height

PLASTIC SMALL OUTLINE - NO LEAD

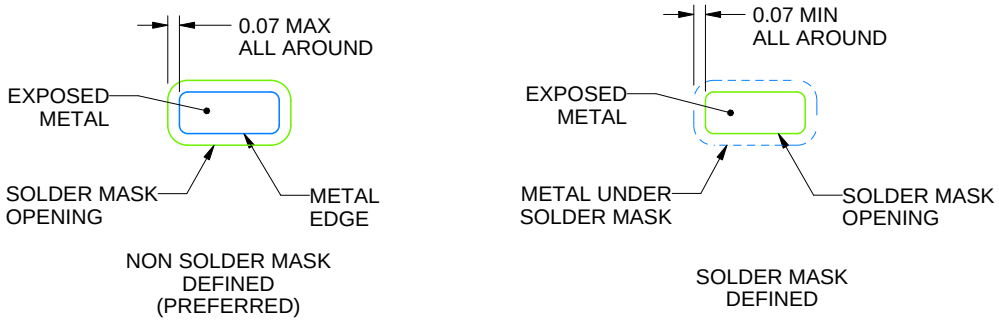



NOTES:

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. The package thermal pad must be soldered to the printed circuit board for thermal and mechanical performance.




LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE:15X

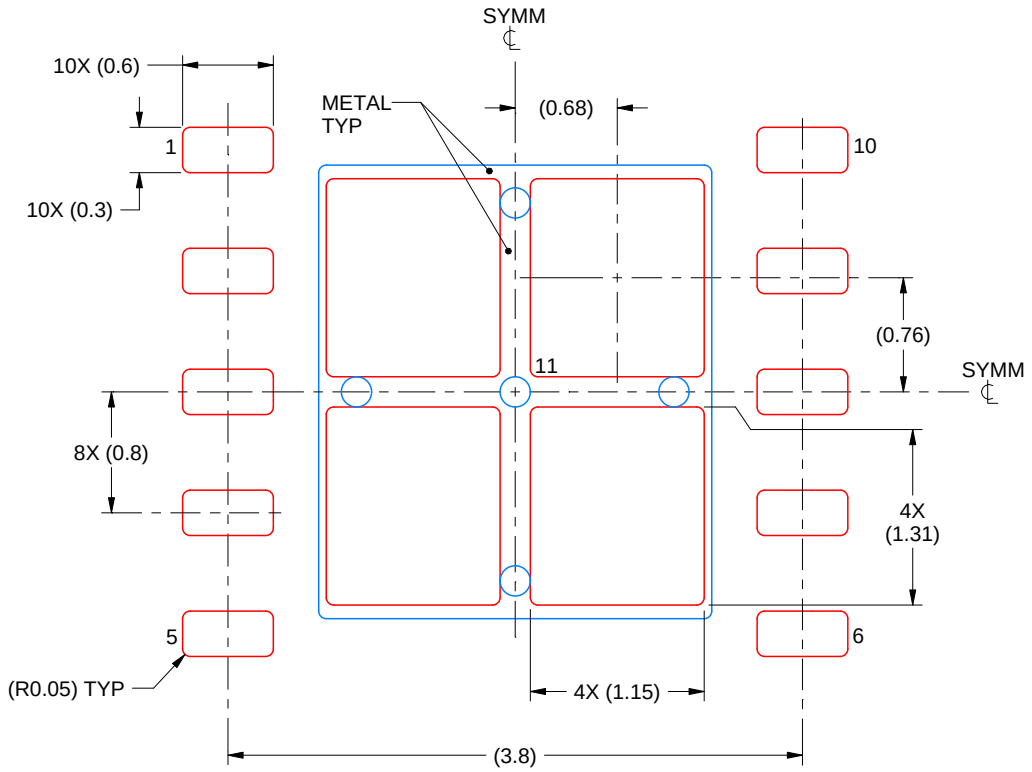



SOLDER MASK DETAILS

4218856/B 01/2021

NOTES: (continued)

4. This package is designed to be soldered to a thermal pad on the board. For more information, see Texas Instruments literature number SLUA271 (www.ti.com/lit/slua271).



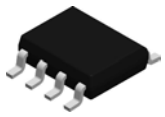

SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL

EXPOSED PAD 11:
77% PRINTED SOLDER COVERAGE BY AREA
SCALE:20X

4218856/B 01/2021

NOTES: (continued)

5. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.

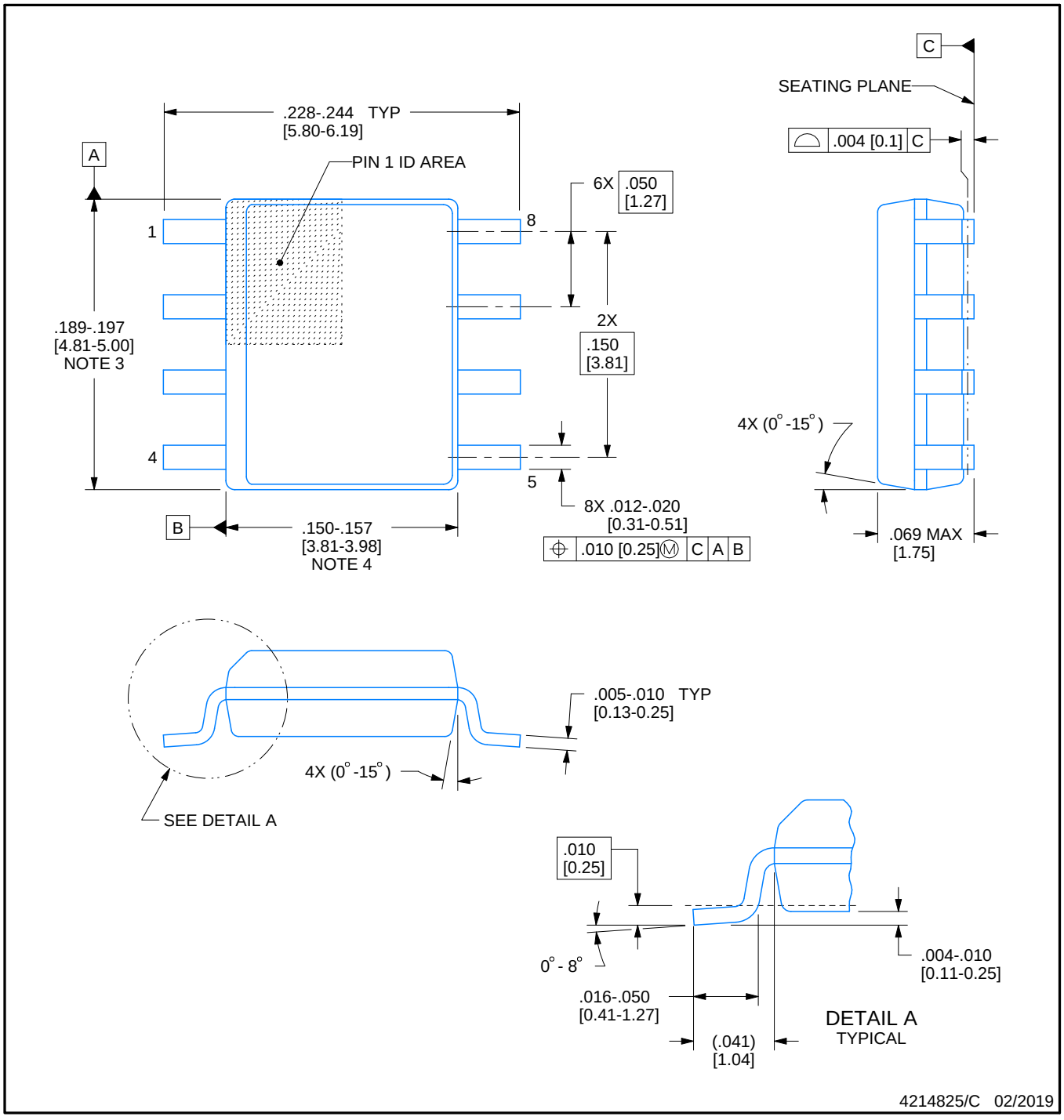


# PACKAGE OUTLINE

## D0008A

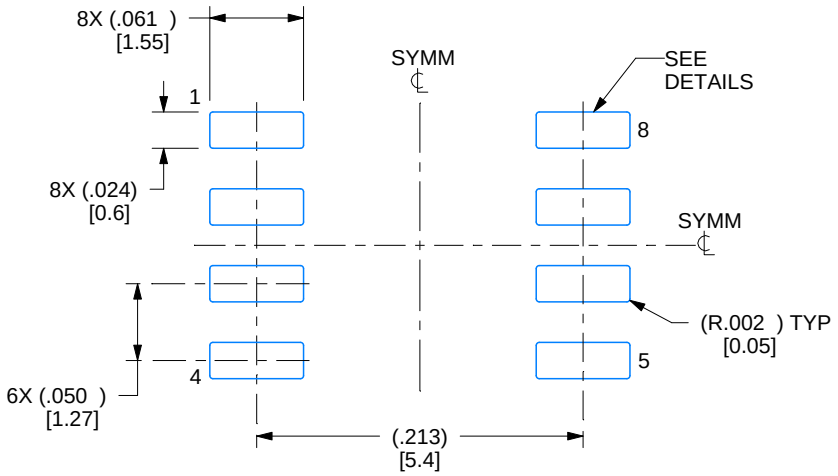
## SOIC - 1.75 mm max height

SMALL OUTLINE INTEGRATED CIRCUIT

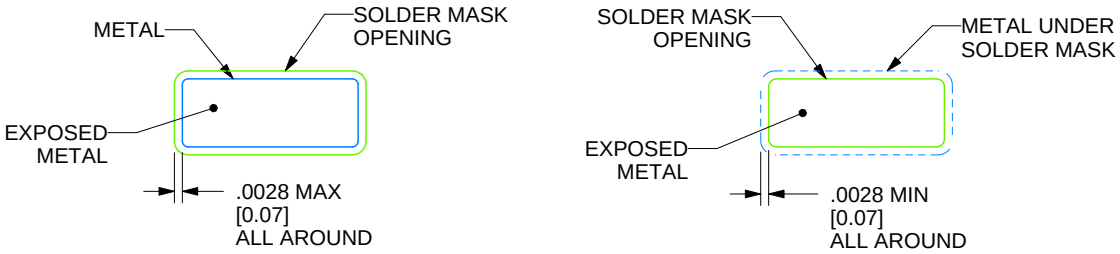



NOTES:

1. Linear dimensions are in inches [millimeters]. Dimensions in parenthesis are for reference only. Controlling dimensions are in inches. 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 .006 [0.15] per side.
4. This dimension does not include interlead flash.
5. Reference JEDEC registration MS-012, variation AA.




LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE:8X




SOLDER MASK DETAILS

4214825/C 02/2019

NOTES: (continued)

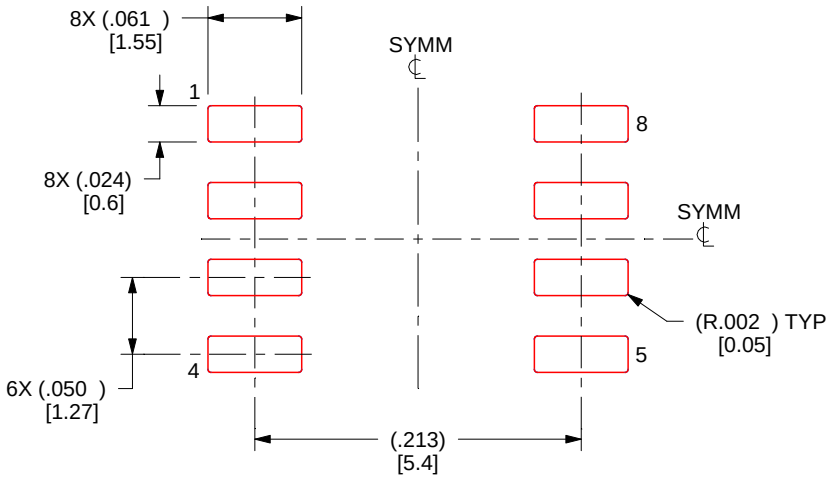
6. Publication IPC-7351 may have alternate designs.
7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

# EXAMPLE STENCIL DESIGN

## D0008A

## SOIC - 1.75 mm max height

SMALL OUTLINE INTEGRATED CIRCUIT




SOLDER PASTE EXAMPLE
BASED ON .005 INCH [0.125 MM] THICK STENCIL
SCALE:8X

4214825/C 02/2019

NOTES: (continued)

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

# IMPORTANT NOTICE AND DISCLAIMER

TI PROVIDES TECHNICAL AND RELIABILITY DATA (INCLUDING DATASHEETS), DESIGN RESOURCES (INCLUDING REFERENCE DESIGNS), APPLICATION OR OTHER DESIGN ADVICE, WEB TOOLS, SAFETY INFORMATION, AND OTHER RESOURCES “AS IS” AND WITH ALL FAULTS, AND DISCLAIMS ALL WARRANTIES, EXPRESS AND IMPLIED, INCLUDING WITHOUT LIMITATION ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF THIRD PARTY INTELLECTUAL PROPERTY RIGHTS.

These resources are intended for skilled developers designing with TI products. You are solely responsible for (1) selecting the appropriate TI products for your application, (2) designing, validating and testing your application, and (3) ensuring your application meets applicable standards, and any other safety, security, regulatory or other requirements.

These resources are subject to change without notice. TI grants you permission to use these resources only for development of an application that uses the TI products described in the resource. Other reproduction and display of these resources is prohibited. No license is granted to any other TI intellectual property right or to any third party intellectual property right. TI disclaims responsibility for, and you fully indemnify TI and its representatives against any claims, damages, costs, losses, and liabilities arising out of your use of these resources.

TI’s products are provided subject to TI’s Terms of Sale, TI’s General Quality Guidelines, or other applicable terms available either on ti.com or provided in conjunction with such TI products. TI’s provision of these resources does not expand or otherwise alter TI’s applicable warranties or warranty disclaimers for TI products. Unless TI explicitly designates a product as custom or customer-specified, TI products are standard, catalog, general purpose devices.

TI objects to and rejects any additional or different terms you may propose.

Copyright © 2026, Texas Instruments Incorporated

Last updated 10/2025