

## DRV8803 Quad Low-Side Driver IC

### 1 Features

- 4-Channel Protected Low-Side Driver
  - Four NMOS FETs With Overcurrent Protection
  - Integrated Inductive Clamp Diodes
  - Parallel Interface
- DW Package: 1.5A (Single Channel On) / 800mA (Four Channels On) Maximum Drive Current per Channel (at 25°C)
- PWP Package: 2A (Single Channel On) / 1A (Four Channels On) Maximum Drive Current per Channel (at 25°C, With Proper PCB Heatsinking)
- DYZ Package: 1.9A (Single Channel On) / 0.9A (Four Channels On) Maximum Drive Current per Channel (at 25°C, With Proper PCB Heatsinking)
- 8.2V to 60V Operating Supply Voltage Range
- Thermally Enhanced Surface Mount Package

### 2 Applications

- Relay Drivers
- Unipolar Stepper Motor Drivers
- Solenoid Drivers
- General Low-Side Switch Applications

### 3 Description

The DRV8803 provides a 4-channel low side driver with overcurrent protection. The device has built-in diodes to clamp turnoff transients generated by inductive loads and can be used to drive unipolar stepper motors, DC motors, relays, solenoids, or other loads.

In the SOIC (DW) package, the DRV8803 can supply up to 1.5A (one channel on) or 800mA (all channels on) continuous output current per channel, at 25°C. In the HTSSOP (PWP) package, the device can supply up to 2A (one channel on) or 1A (four channels on) continuous output current per channel, at 25°C. In the SOT-23-THN (DYZ) package, the DRV8803 can supply up to 1.9A (one channel on) or 900mA (all channels on) continuous output current per channel, at 25°C with proper PCB heatsinking.

The device is controlled through a simple parallel interface.

Internal shutdown functions are provided for over current protection, short circuit protection, undervoltage lockout and overtemperature and faults are indicated by a fault output pin.

The DRV8803 is available in a 20-pin thermally-enhanced SOIC package, 16-pin HTSSOP package and 16-pin SOT-23-THN package (Eco-friendly: RoHS & no Sb/Br).

#### Device Information <sup>(1)</sup>

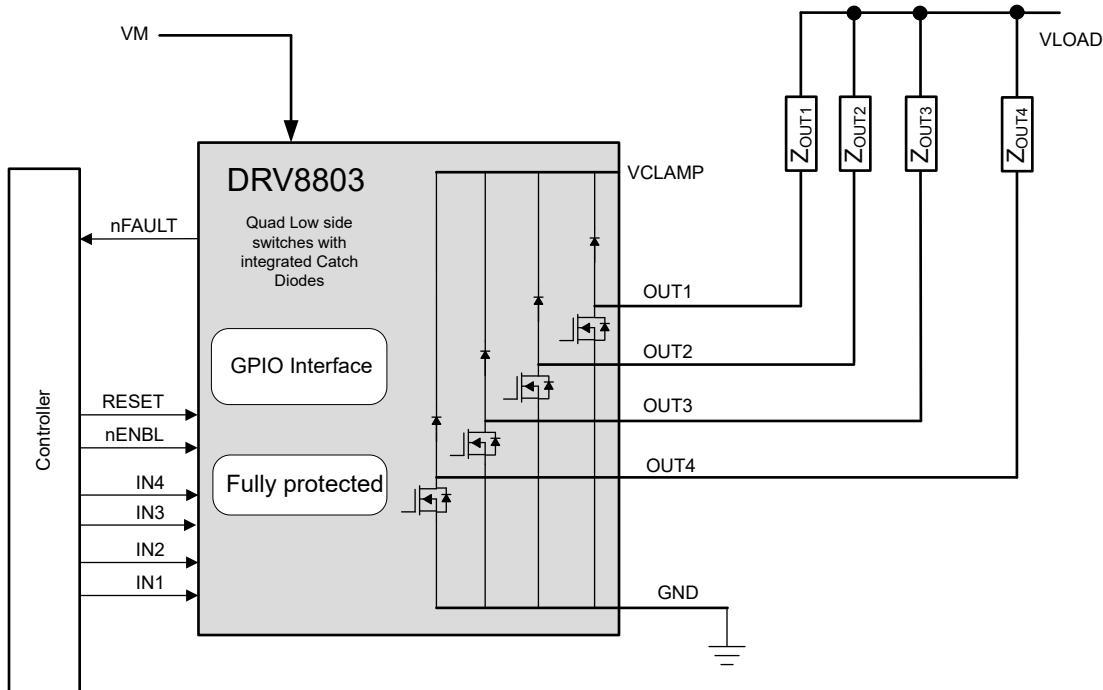
| PART NUMBER | PACKAGE         | PACKAGE SIZE <sup>(2)</sup> | BODY SIZE (NOM)  |
|-------------|-----------------|-----------------------------|------------------|
| DRV8803DW   | SOIC (20)       | 12.80mm × 10.30mm           | 12.80mm × 7.50mm |
| DRV8803PWP  | HTSSOP (16)     | 5.00mm × 6.40mm             | 5.00mm × 4.40mm  |
| DRV8803DYZ  | SOT-23-THN (16) | 4.20mm × 2.00mm             | 4.20mm × 2.00mm  |

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

(2) The package size (length × width) is a nominal value and includes pins, where applicable.



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.



Simplified Schematic

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## 4 Device Comparison

Following is the Summary of the  $R_{ON}$  and package offerings for DRV8803

| Part number | LS $R_{ON}$ (TYP) | Package         | Body Size (nominal) |
|-------------|-------------------|-----------------|---------------------|
| DRV8803     | 500m $\Omega$     | SOIC (20)       | 12.80mm x 7.50mm    |
|             |                   | HTSSOP (16)     | 5.00mm x 4.40mm     |
|             | 400m $\Omega$     | SOT-23-THN (16) | 4.20mm x 2mm        |

## 5 Pin Configuration and Functions

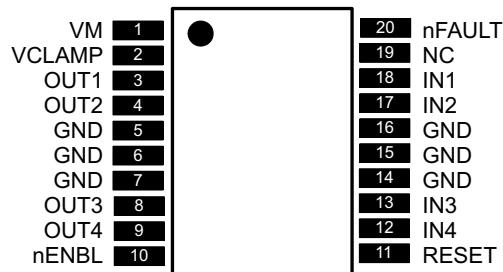


Figure 5-1. DW Package 20-Pin SOIC Top View

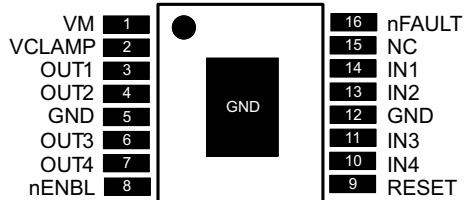


Figure 5-2. PWP Package 16-Pin HTSSOP Top View

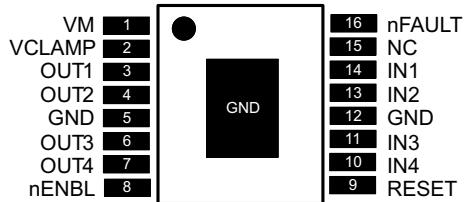


Figure 5-3. DYZ Package 16-Pin SOT-23-THN Top View

## Pin Functions

| NAME                    | PIN                    |                |                |   | I/O <sup>(1)</sup> | DESCRIPTION         | EXTERNAL COMPONENTS OR CONNECTIONS             |
|-------------------------|------------------------|----------------|----------------|---|--------------------|---------------------|--|
|                         | SOIC                   | HTSSOP         | SOT-23-THN     |   |                    |                     |  |
| <b>POWER AND GROUND</b> |                        |                |                |   |                    |                     |  |
| GND                     | 5, 6, 7,<br>14, 15, 16 | 5, 12,<br>PPAD | 5, 12,<br>PPAD | — | —                  | Device ground       | All pins must be connected to GND.             |
| VM                      | 1                      | 1              | 1              | — | —                  | Device power supply | Connect to motor supply (8.2V - 60V).          |
| <b>CONTROL</b>          |                        |                |                |   |                    |                     |  |
| nENBL                   | 10                     | 8              | 8              | I | —                  | Enable input        | Active low enables outputs – internal pulldown |

| PIN           |      |        |            | I/O <sup>(1)</sup> | DESCRIPTION          | EXTERNAL COMPONENTS OR CONNECTIONS                               |
|---------------|------|--------|------------|--------------------|----------------------|--|
| NAME          | SOIC | HTSSOP | SOT-23-THN |                    |                      |  |
| RESET         | 11   | 9      | 9          | I                  | Reset input          | Active high resets internal logic and OCP – internal pulldown    |
| IN1           | 18   | 14     | 14         | I                  | Channel 1 input      | IN1 = 1 drives OUT1 low – internal pulldown                      |
| IN2           | 17   | 13     | 13         | I                  | Channel 2 input      | IN2 = 1 drives OUT2 low – internal pulldown                      |
| IN3           | 13   | 11     | 11         | I                  | Channel 3 input      | IN3 = 1 drives OUT3 low – internal pulldown                      |
| IN4           | 12   | 10     | 10         | I                  | Channel 4 input      | IN4 = 1 drives OUT4 low – internal pulldown                      |
| <b>STATUS</b> |      |        |            |                    |                      |  |
| nFAULT        | 20   | 16     | 16         | OD                 | Fault                | Logic low when in fault condition (overtemperature, overcurrent) |
| <b>OUTPUT</b> |      |        |            |                    |                      |  |
| OUT1          | 3    | 3      | 3          | O                  | Output 1             | Connect to load 1  |
| OUT2          | 4    | 4      | 4          | O                  | Output 2             | Connect to load 2  |
| OUT3          | 8    | 6      | 6          | O                  | Output 3             | Connect to load 3  |
| OUT4          | 9    | 7      | 7          | O                  | Output 4             | Connect to load 4  |
| VCLAMP        | 2    | 2      | 2          | —                  | Output clamp voltage | Connect to VM supply, or zener diode to VM supply                |

(1) Directions: I = input, O = output, OD = open-drain output

## 6 Specification

### 6.1 Absolute Maximum Ratings

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

|                  |  | MIN                            | MAX | UNIT |
|------------------|--|--------------------------------|-----|------|
| VM               | Power supply voltage                                 | -0.3                           | 65  | V    |
| VOUTx            | Output voltage                                       | -0.3                           | 65  | V    |
| VCLAMP           | Clamp voltage  | -0.3                           | 65  | V    |
| nFAULT           | Output current                                       |                                | 20  | mA   |
|                  | Peak clamp diode current                             |                                | 2   | A    |
|                  | DC or RMS clamp diode current                        |                                | 1   | A    |
|                  | Digital input pin voltage                            | -0.5                           | 7   | V    |
| nFAULT           | Digital output pin voltage                           | -0.5                           | 7   | V    |
|                  | Peak motor drive output current, $t < 1 \mu\text{s}$ | Internally limited             |     | A    |
|                  | Continuous total power dissipation                   | See <i>Thermal Information</i> |     |      |
| T <sub>J</sub>   | Operating virtual junction temperature               | -40                            | 150 | °C   |
| T <sub>stg</sub> | Storage temperature                                  | -60                            | 150 | °C   |

(1) Stresses beyond those listed under *Absolute Maximum Ratings* may cause permanent damage to the device. These are stress ratings only, which do not imply functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Conditions*. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

### 6.2 ESD Ratings

|                    |                         |  | VALUE | UNIT |
|--------------------|-------------------------|--|-------|------|
| V <sub>(ESD)</sub> | Electrostatic discharge | Human body model (HBM), per ANSI/ESDA/JEDEC JS-001, all pins <sup>(1)</sup>              | ±3000 | V    |
|                    |                         | Charged device model (CDM), per JEDEC specification JESD22-C101, all pins <sup>(2)</sup> | ±1000 |      |

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

(2) JEDEC document JEP157 states that 250-V CDM allows safe manufacturing with a standard ESD control process.

### 6.3 Recommended Operating Conditions

|                    |                                     |  | MIN               | NOM | MAX | UNIT |
|--------------------|-------------------------------------|--|-------------------|-----|-----|------|
| V <sub>M</sub>     | Power supply voltage                |  | 8.2               |     | 60  | V    |
| V <sub>CLAMP</sub> | Output clamp voltage <sup>(2)</sup> |  | 0                 |     | 60  | V    |
| I <sub>OUT</sub>   | Continuous output current           | SOIC package <sup>(1)</sup> , $T_A = 25^\circ\text{C}$   | Single channel on |     | 1.5 | A    |
|                    |                                     |  | Four channels on  |     | 0.8 |      |
|                    |                                     | HTSSOP package <sup>(1)</sup> , $T_A = 25^\circ\text{C}$ | Single channel on |     | 2   |      |
|                    |                                     |  | Four channels on  |     | 1   |      |
|                    |                                     | DYZ package <sup>(1)</sup> , $T_A = 25^\circ\text{C}$    | Single channel on |     | 1.9 |      |
|                    |                                     |  | Four channels on  |     | 0.9 |      |

(1) Power dissipation and thermal limits must be observed.

(2) V<sub>CLAMP</sub> is used only to supply the clamp diodes. It is not a power supply input.

### 6.4 Thermal Information

| THERMAL METRIC <sup>(1)</sup> |  | DRV8803   |              |                   | UNIT |
|-------------------------------|--|-----------|--------------|-------------------|------|
|                               |  | DW (SOIC) | PWP (HTSSOP) | DYZ (SOT -23 THN) |      |
|                               |  | 20 PINS   | 16 PINS      | 16 PINS           |      |
| R <sub>θJA</sub>              | Junction-to-ambient thermal resistance | 67.7      | 39.6         | 53.2              | °C/W |

| THERMAL METRIC <sup>(1)</sup> |  | DRV8803   |              |                   | UNIT |
|-------------------------------|--|-----------|--------------|-------------------|------|
|                               |  | DW (SOIC) | PWP (HTSSOP) | DYZ (SOT -23 THN) |      |
|                               |  | 20 PINS   | 16 PINS      | 16 PINS           |      |
| $R_{\theta JC(\text{top})}$   | Junction-to-case (top) thermal resistance    | 32.9      | 24.6         | 76.8              | °C/W |
| $R_{\theta JB}$               | Junction-to-board thermal resistance         | 35.4      | 20.3         | 22.2              | °C/W |
| $\Psi_{JT}$                   | Junction-to-top characterization parameter   | 8.2       | 0.7          | 8.2               | °C/W |
| $\Psi_{JB}$                   | Junction-to-board characterization parameter | 34.9      | 20.1         | 22.2              | °C/W |
| $R_{\theta JC(\text{bot})}$   | Junction-to-case (bottom) thermal resistance | N/A       | 2.3          | 9.6               | °C/W |

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

## 6.5 Electrical Characteristics

$T_A = 25^\circ\text{C}$ , over recommended operating conditions (unless otherwise noted)

| PARAMETER  | TEST CONDITIONS  | MIN  | TYP  | MAX  | UNIT |    |
|--|--|--|------|------|------|----|
| <b>POWER SUPPLIES</b>  |  |  |      |      |      |    |
| $I_{VM}$   | $V_M = 24\text{ V}$  |  | 1.6  | 2.1  | mA   |    |
| $V_{UVLO}$   | $V_M$ rising   |  |      | 8.2  | V    |    |
| <b>LOGIC-LEVEL INPUTS (SCHMITT TRIGGER INPUTS WITH HYSTERESIS)</b> |  |  |      |      |      |    |
| $V_{IL}$   | Input low voltage  |  | 0.6  | 0.7  | V    |    |
| $V_{IH}$   | Input high voltage   | 2  |      |      | V    |    |
| $V_{HYS}$  | Input hysteresis   |  | 0.45 |      | V    |    |
| $I_{IL}$   | $V_{IN} = 0$   | -20  |      | 20   | μA   |    |
| $I_{IH}$   | $V_{IN} = 3.3\text{ V}$  |  |      | 100  | μA   |    |
| $R_{PD}$   | Pulldown resistance  |  | 100  |      | kΩ   |    |
| <b>nFAULT OUTPUT (OPEN-DRAIN OUTPUT)</b>                           |  |  |      |      |      |    |
| $V_{OL}$   | $I_O = 5\text{ mA}$  |  |      | 0.5  | V    |    |
| $I_{OH}$   | $V_O = 3.3\text{ V}$   |  |      | 1    | μA   |    |
| <b>LOW-SIDE FETS</b>   |  |  |      |      |      |    |
| $R_{ON}$   | FET on resistance, HTSSOP and SOIC package                             | $V_M = 24\text{ V}$ , $I_O = 700\text{ mA}$ , $T_J = 25^\circ\text{C}$ |      | 0.5  |      | Ω  |
|  |  | $V_M = 24\text{ V}$ , $I_O = 700\text{ mA}$ , $T_J = 85^\circ\text{C}$ |      | 0.75 | 0.8  |    |
|  | FET on resistance, SOT-23-THN package                                  | $V_M = 24\text{ V}$ , $I_O = 700\text{ mA}$ , $T_J = 25^\circ\text{C}$ |      | 0.4  |      | Ω  |
|  |  | $V_M = 24\text{ V}$ , $I_O = 700\text{ mA}$ , $T_J = 85^\circ\text{C}$ |      |      | 0.64 |    |
| $I_{OFF}$  | Off-state leakage current  |  | -50  |      | 50   | μA |
| <b>HIGH-SIDE DIODES</b>  |  |  |      |      |      |    |
| $V_F$  | $V_M = 24\text{ V}$ , $I_O = 700\text{ mA}$ , $T_J = 25^\circ\text{C}$ |  | 1.2  |      | V    |    |
| $I_{OFF}$  | Off-state leakage current  | $V_M = 24\text{ V}$ , $T_J = 25^\circ\text{C}$                         | -50  |      | 50   | μA |
| <b>OUTPUTS</b>   |  |  |      |      |      |    |
| $t_R$  | Rise time  | $V_M = 24\text{ V}$ , $I_O = 700\text{ mA}$ , Resistive load           | 50   |      | 300  | ns |
| $t_F$  | Fall time  | $V_M = 24\text{ V}$ , $I_O = 700\text{ mA}$ , Resistive load           | 50   |      | 300  | ns |
| <b>PROTECTION CIRCUITS</b>   |  |  |      |      |      |    |
| $I_{OCP}$  | Overcurrent protection trip level                                      |  | 2.3  |      | 3.8  | A  |
| $t_{OCP}$  | Overcurrent protection deglitch time                                   |  |      | 3.5  |      | μs |
| $t_{RETRY}$  | Overcurrent protection retry time                                      |  |      | 1.2  |      | ms |

$T_A = 25^\circ\text{C}$ , over recommended operating conditions (unless otherwise noted)

| PARAMETER |                              | TEST CONDITIONS                | MIN | TYP | MAX | UNIT |
|-----------|------------------------------|--------------------------------|-----|-----|-----|------|
| $t_{TSD}$ | Thermal shutdown temperature | Die temperature <sup>(1)</sup> | 150 | 160 | 180 | °C   |

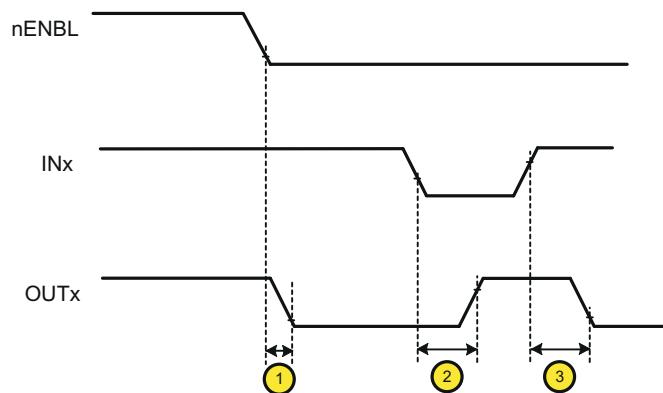
(1) Not production tested.

## 6.6 Timing Requirements

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

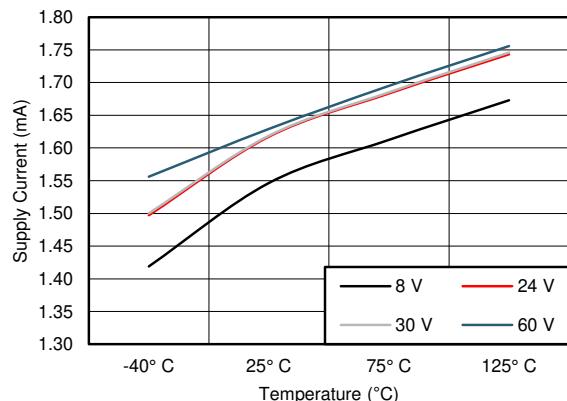
|   |                  |  | MIN | MAX | UNIT    |
|---|------------------|--|-----|-----|---------|
| 1 | $t_{OE(ENABLE)}$ | Enable time, nENBL to output low                 |     | 50  | ns      |
| 2 | $t_{PD(L-H)}$    | Propagation delay time, INx to OUTx, low to high |     | 800 | ns      |
| 3 | $t_{PD(H-L)}$    | Propagation delay time, INx to OUTx, high to low |     | 800 | ns      |
| — | $t_{RESET}$      | RESET pulse width                                | 20  |     | $\mu$ s |

(1) Not production tested.

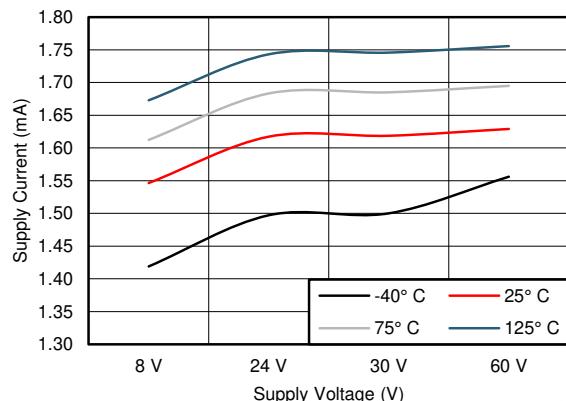


**Figure 6-1. DRV8803 Timing Requirements**

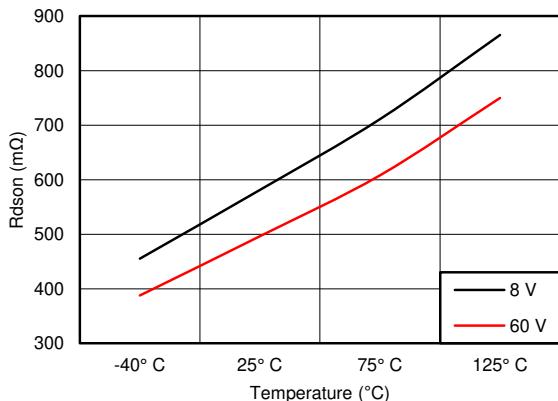
## 6.7 Typical Characteristics



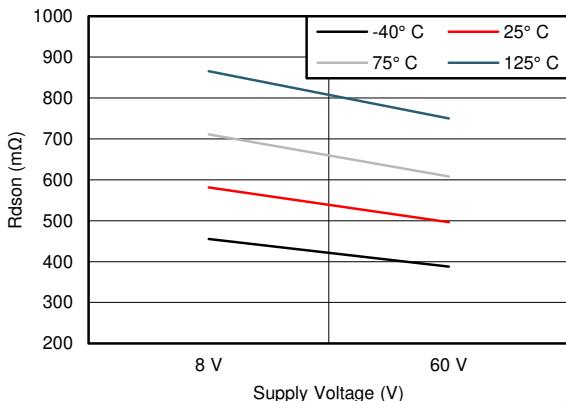
**Figure 6-2. Supply Current Over Temperature**



**Figure 6-3. Supply Current Over  $V_M$**



**Figure 6-4.  $R_{DS(on)}$  Over Temperature**



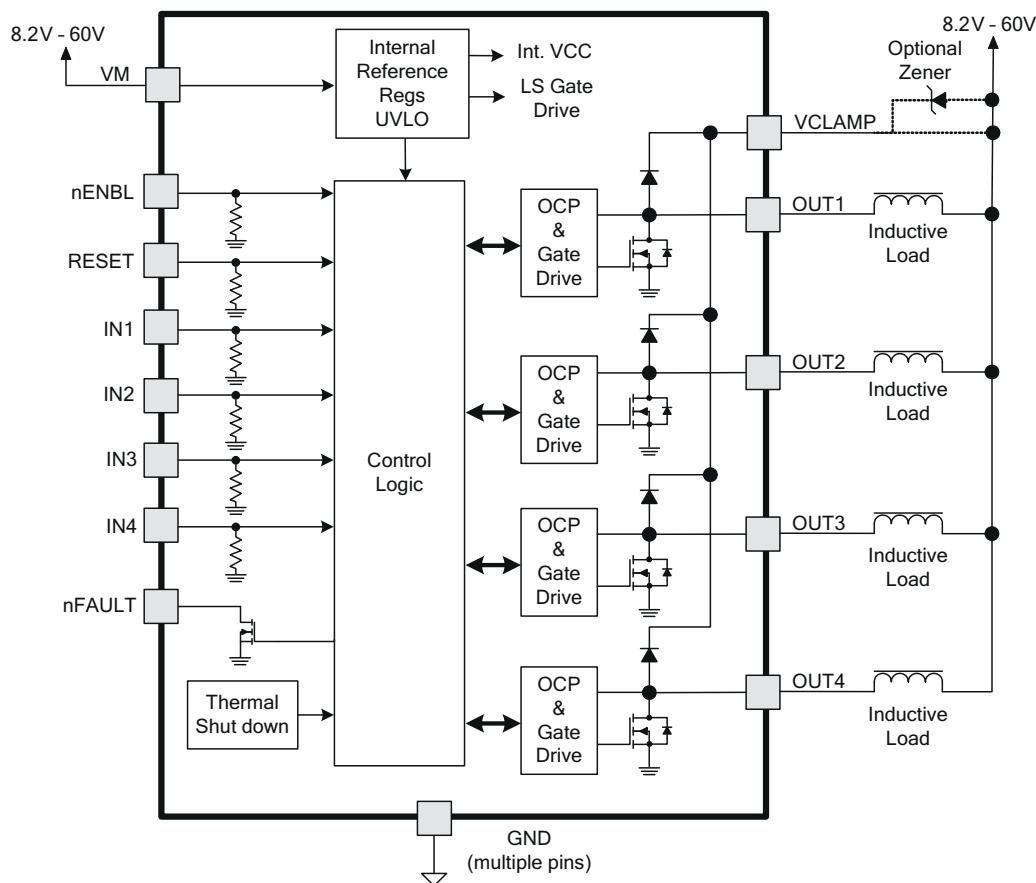
**Figure 6-5.  $R_{DS(on)}$  Over  $V_M$**

## 7 Detailed Description

### 7.1 Overview

The DRV8803 device is an integrated 4-channel low side driver solution for any low side switch application. The integrated overcurrent protection limits the motor current to a fixed maximum. Four logic inputs control the low-side driver outputs which consist of four N-channel MOSFETs that have a typical  $R_{DS(on)}$  of 500mΩ (PWP and DW package) and 400 mΩ (DYZ Package). A single power input VM serves as the device power and is internally regulated to power the internal low side gate drive. Motor speed can be controlled with pulse-width modulation from 0kHz to 100kHz. The device outputs can be disabled by bringing nENBL pin high. The thermal shutdown protection lets the device automatically shut down if the die temperature exceeds a TTSD limit. UVLO protection will disable all circuitry in the device if  $V_M$  drops below the undervoltage lockout threshold.

### 7.2 Functional Block Diagram



### 7.3 Feature Description

#### 7.3.1 Output Drivers

The DRV8803 device contains four protected low-side drivers. Each output has an integrated clamp diode connected to a common pin, VCLAMP.

VCLAMP can be connected to the main power supply voltage, VM. VCLAMP can also be connected to a Zener or TVS diode to VM, allowing the switch voltage to exceed the main supply voltage VM. This connection can be beneficial when driving loads that require very fast current decay, such as unipolar stepper motors.

In all cases, the voltage on the outputs must not be allowed to exceed the maximum output voltage specification.

#### 7.3.2 Protection Circuits

The DRV8803 device is fully protected against undervoltage, overcurrent and overtemperature events.

### 7.3.2.1 Overcurrent Protection (OCP)

An analog current limit circuit on each FET limits the current through the FET by removing the gate drive. If this analog current limit persists for longer than the  $t_{OCP}$  deglitch time (approximately 3.5 $\mu$ s), the driver will be disabled and the nFAULT pin will be driven low. The driver will remain disabled for the  $t_{RETRY}$  retry time (approximately 1.2ms), then the fault will be automatically cleared. The fault will be cleared immediately if either the RESET pin is activated or the VM is removed and reapplied.

### 7.3.2.2 Thermal Shutdown (TSD)

If the die temperature exceeds safe limits, all output FETs will be disabled and the nFAULT pin will be driven low. Once the die temperature has fallen to a safe level, operation will automatically resume.

### 7.3.2.3 Undervoltage Lockout (UVLO)

If at any time the voltage on the VM pin falls below the undervoltage lockout threshold voltage, all circuitry in the device will be disabled, and internal logic will be reset. Operation will resume when VM rises above the UVLO threshold.

## 7.4 Device Functional Modes

### 7.4.1 Parallel Interface Operation

The DRV8803 device is controlled with a simple parallel interface. Logically, the interface is shown in Figure 7-1.

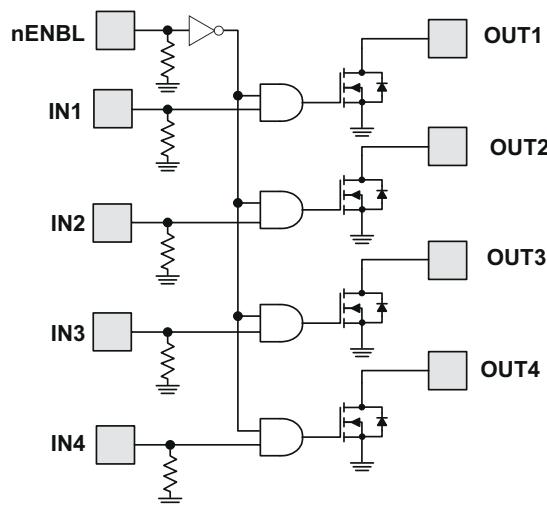


Figure 7-1. Parallel Interface Operation

### 7.4.2 nENBL and RESET Operation

The nENBL pin enables or disables the output drivers. nENBL must be low to enable the outputs. Note that nENBL has an internal pulldown.

The RESET pin, when driven active high, resets internal logic. All inputs are ignored while RESET is active. Note that RESET has an internal pulldown. An internal power-up reset is also provided, so it is not required to drive RESET at power up.

## 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

The DRV8803 device can be used to drive up to four independent unipolar loads such as unipolar BDCs, solenoids such as valves, relays etc. or to drive one unipolar stepper

#### 8.1.1 Application as Load driver

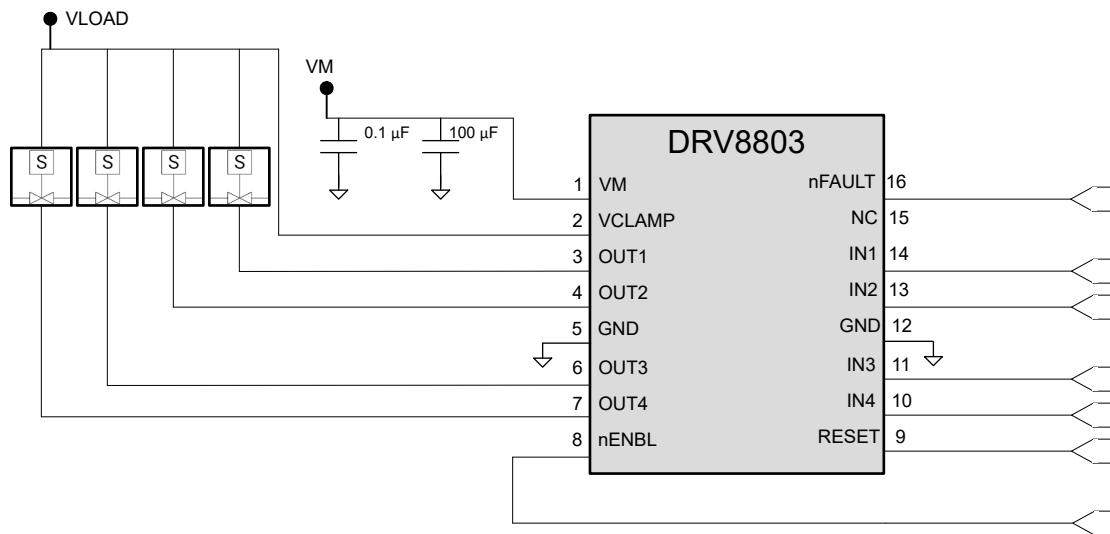


Figure 8-1. DRV8803 used to drive 4 Independent solenoid valves

#### 8.1.1.1 Design Requirements

Table 8-1 lists the design parameters for this design example.

Table 8-1. Design Parameters

| DESIGN PARAMETER        | REFERENCE       | EXAMPLE VALUE |
|-------------------------|-----------------|---------------|
| Supply Voltage          | $V_M, V_{LOAD}$ | 24V           |
| Valve Peak current      | $I_{PEAK}$      | 200mA         |
| Valve Peak current time | $t_{PEAK}$      | 100ms         |
| Valve Hold current      | $I_{HOLD}$      | 100mA         |
| PWM frequency           | $f_{PWM}$       | 25kHz         |

#### 8.1.1.2 Detailed Design Procedure

##### 8.1.1.2.1 Supply Voltage

This is characteristic to the loads used. A higher voltage allows for fast opening/closing of the solenoid, enabling faster operation.

### 8.1.1.2.2 Load Current

The current path starts from the supply VLOAD, and moves through the inductive winding load, and low-side sinking NMOS power FET. Power dissipation losses in one sink NMOS power FET are shown in [Equation 1](#).

$$P = I^2 \times R_{DS(on)} \quad (1)$$

The DRV8803 device has been measured to be capable of 1.5A Single Channel or 800-mA Four Channels with the DW package, 2A Single Channel or 1A Four Channels with the PWP, and 1.9A Single Channel or 0.9A Four Channels with the DYZ package at 25°C on standard FR-4 PCBs. The maximum RMS current varies based on PCB design and the ambient temperature.

With loads such as Relays and solenoid valves, the load tends to heat up and degrade if it is allowed to remain completely turned on. This can affect the long term reliability of the load and can even damage it in some cases. The DRV8803 offers an integrated Free wheeling diode and a simple-to-use parallel interface. Since such loads are inductive, the user can PWM the LSFET ON/OFF to regulate the current.

#### 8.1.1.2.2.1 Peak Current

Load such as Solenoid/Relay needs to be energized at a temporary higher level of Load current and his higher level of current needs to be maintained for as long as Peak time ( $t_{PEAK}$ ) in order for the load to reliably turn on. This Load current can be controlled by PWM control of the LSFET at required duty cycle.

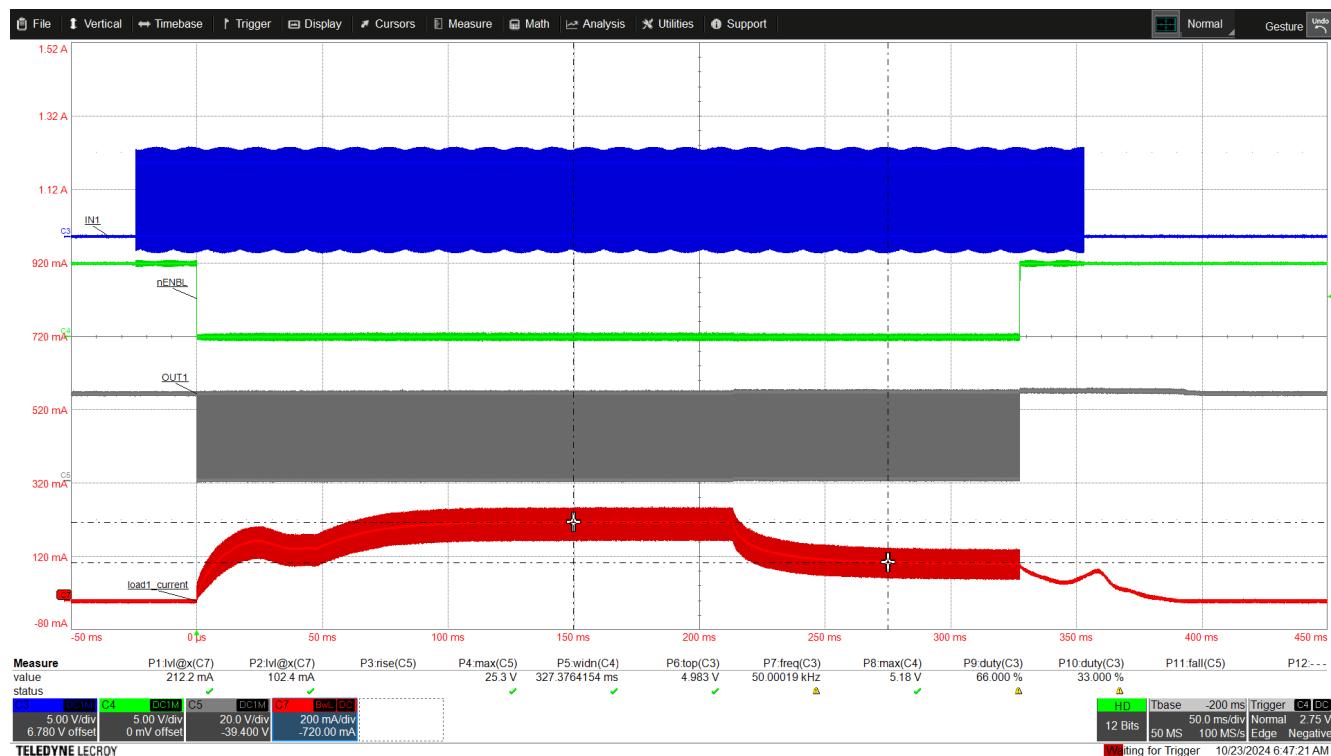
#### 8.1.1.2.2.2 Hold Current

Once the Peak time is elapsed, the Duty cycle and consequently Load current can be lowered to a Holding value of current. The Load can be kept on at this lower current for much longer durations

#### 8.1.1.2.2.3 Frequency

The LSFET can be PWM controlled at a frequency which can be decided based on factors such as Load Inductance, Load resistance, desired/ tolerable ripple in Load current. PWM can be done outside audio band (>20kHz) for low audible noise operation

### 8.1.1.3 Application Curves



**Figure 8-2. DRV8803 used to drive Solenoid Valves**

### 8.1.2 Application as Unipolar Stepper Driver

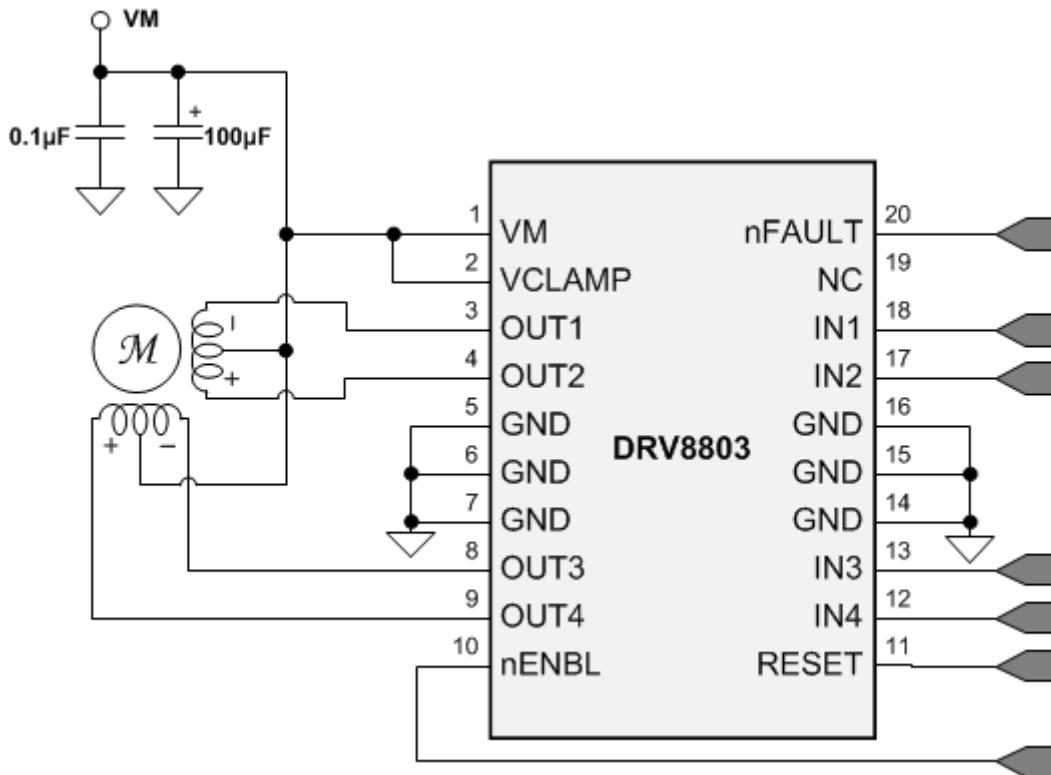


Figure 8-3. DRV8803 used to drive one 5-wire unipolar stepper

#### 8.1.2.1 Design Requirements

Following Table lists the Design parameters for this design example

Table 8-2. Design Parameters

| DESIGN PARAMETER         | REFERENCE       | EXAMPLE VALUE |
|--------------------------|-----------------|---------------|
| Supply Voltage           | $V_M$           | 24V           |
| Motor Winding Resistance | $R_L$           | 7.4Ω / phase  |
| Motor Full step Angle    | $\theta_{STEP}$ | 1.8° /step    |
| Motor Rated Current      | $I_{RATED}$     | 0.75A         |
| PWM frequency            | $f_{PWM}$       | 31.25kHz      |

#### 8.1.2.2 Detailed Design Procedure

##### 8.1.2.2.1 Motor Voltage

The motor voltage to use will depend on the ratings of the motor selected and the desired torque. A higher voltage shortens the current rise time in the coils of the stepper motor allowing the motor to produce a greater average torque. Using a higher voltage also allows the motor to operate at a faster speed than a lower voltage.

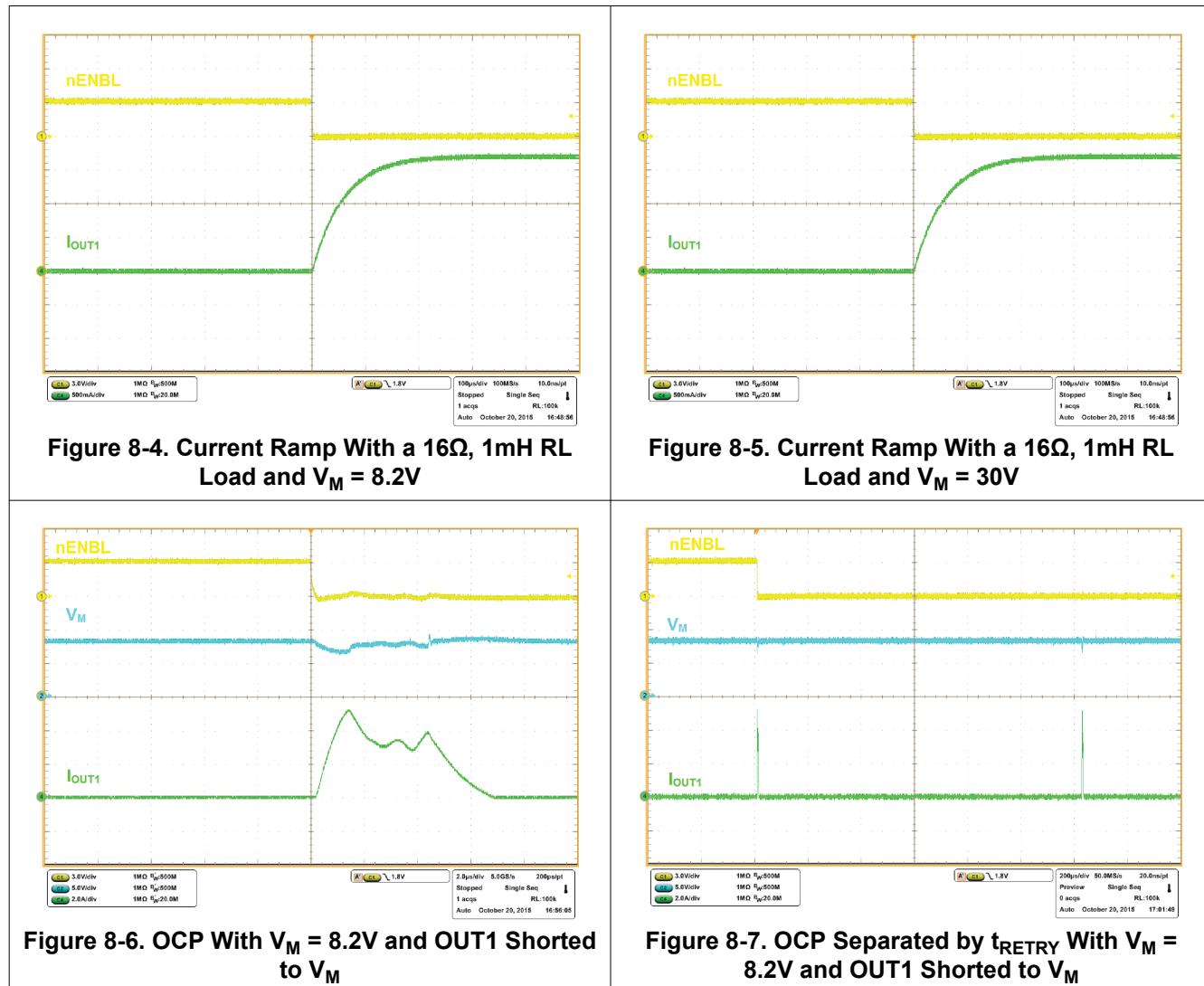
##### 8.1.2.2.2 Drive Current

The current path starts from the supply  $V_M$ , and moves through the inductive winding load, and low-side sinking NMOS power FET. Power dissipation losses in one sink NMOS power FET are shown in [Equation 1](#).

$$P = I^2 \times R_{DS(on)} \quad (2)$$

The DRV8803 device has been measured to be capable of 1.5A Single Channel or 800-mA Four Channels with the DW package, 2A Single Channel or 1A Four Channels with the PWP, and 1.9A Single Channel or 0.9A Four Channels with the DYZ package at 25°C on standard FR-4 PCBs. The maximum RMS current varies based on PCB design and the ambient temperature.

#### 8.1.2.3 Application Curves



### Power Supply Recommendations

#### 8.1 Bulk Capacitance

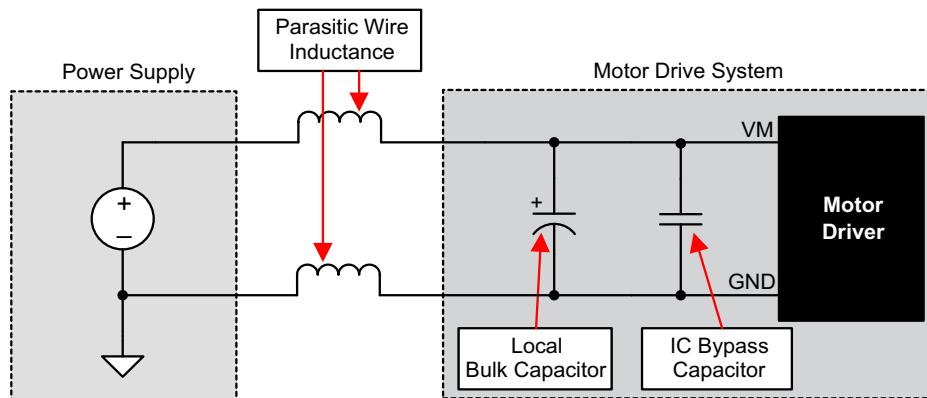
Having appropriate local bulk capacitance is an important factor in motor drive system design. It is generally beneficial to have more bulk capacitance, while the disadvantages are increased cost and physical size.

The amount of local capacitance needed depends on a variety of factors, including:

- The highest current required by the motor system.
- The power supply's capacitance and ability to source current.
- The amount of parasitic inductance between the power supply and motor system.
- The acceptable voltage ripple.
- The type of motor used (Brushed DC, Brushless DC, Stepper).

- The motor braking method.

The inductance between the power supply and the motor drive system will limit the rate of current that can change from the power supply. If the local bulk capacitance is too small, the system will respond to excessive current demands or dumps from the motor with a change in voltage. When adequate bulk capacitance is used, the motor voltage remains stable, and a high current can be quickly supplied.



Example Setup of Motor Drive System with External Power Supply

**Figure 8-8. Example Setup of Motor Drive System With External Power Supply**

The voltage rating for bulk capacitors should be higher than the operating voltage, to provide margin for cases when the motor transfers energy to the supply.

## 8.2 Layout

### 8.2.1 Layout Guidelines

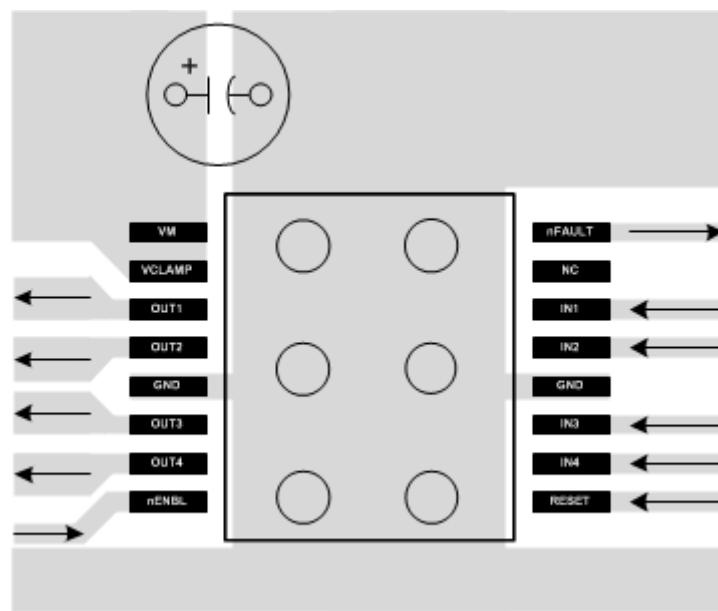
The bulk capacitor should be placed to minimize the distance of the high-current path through the motor driver device. The connecting metal trace widths should be as wide as possible, and numerous vias should be used when connecting PCB layers. These practices minimize inductance and allow the bulk capacitor to deliver high current.

Small-value capacitors should be ceramic, and placed closely to device pins.

The high-current device outputs should use wide metal traces.

The device thermal pad should be soldered to the PCB top-layer ground plane. Multiple vias should be used to connect to a large bottom-layer ground plane. The use of large metal planes and multiple vias help dissipate the  $I^2 \times R_{DS(on)}$  heat that is generated in the device.

### 8.2.2 Layout Example



**Figure 8-9. Recommended Layout**

### 8.2.3 Thermal Consideration

#### 8.2.3.1 Thermal Protection

The DRV8803 device has thermal shutdown (TSD) as described above. If the die temperature exceeds approximately 150°C, the device will be disabled until the temperature drops to a safe level.

Any tendency of the device to enter TSD is an indication of either excessive power dissipation, insufficient heatsinking, or too high an ambient temperature.

#### 8.2.3.2 Power Dissipation

Power dissipation in the DRV8803 device is dominated by the power dissipated in the output FET resistance, or  $R_{DS(on)}$ . Average power dissipation of each FET when running a static load can be roughly estimated by [Equation 3](#):

$$P = R_{DS(ON)} \cdot (I_{OUT})^2 \quad (3)$$

where

- $P$  is the power dissipation of one FET
- $R_{DS(ON)}$  is the resistance of each FET
- $I_{OUT}$  is equal to the average current drawn by the load.

At start-up and fault conditions, this current is much higher than normal running current; consider these peak currents and their duration. When driving more than one load simultaneously, the power in all active output stages must be summed.

The maximum amount of power that can be dissipated in the device is dependent on ambient temperature and heatsinking.

Note that  $R_{DS(ON)}$  increases with temperature, so as the device heats, the power dissipation increases. This must be taken into consideration when sizing the heatsink.

### 8.2.3.3 Heatsinking

The DRV8803DW package uses a standard SOIC outline, but has the center pins internally fused to the die pad to more efficiently remove heat from the device. The two center leads on each side of the package should be connected together to as large a copper area on the PCB as is possible to remove heat from the device. If the copper area is on the opposite side of the PCB from the device, thermal vias are used to transfer the heat between top and bottom layers.

In general, the more copper area that can be provided, the more power can be dissipated.

The DRV8803PWP (HTSSOP package) and the DRV8803DYZ (SOT-23-THN package) uses an exposed thermal pad. The exposed pad removes heat from the device. For proper operation, this pad must be thermally connected to copper on the PCB to dissipate heat. On a multi-layer PCB with a ground plane, this can be accomplished by adding a number of vias to connect the thermal pad to the ground plane. On PCBs without internal planes, copper area can be added on either side of the PCB to dissipate heat. If the copper area is on the opposite side of the PCB from the device, thermal vias are used to transfer the heat between top and bottom layers.

For details about how to design the PCB, see the TI Application Report, *PowerPAD Thermally Enhanced Package (SLMA002)*, and TI Application Brief, *PowerPAD Made Easy (SLMA004)*, available at [www.ti.com](http://www.ti.com).

## 9 Device and Documentation Support

### 9.1 Documentation Support

#### 9.1.1 Related Documentation

For related documentation see the following:

- *PowerPAD Thermally Enhanced Package*, [SLMA002](#).
- *PowerPAD Made Easy*, [SLMA004](#).

### 9.2 Community Resources

### 9.3 Trademarks

All trademarks are the property of their respective owners.

## 10 Revision History

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

| <b>Changes from Revision C (November 2015) to Revision D (July 2024)</b>   | <b>Page</b>       |
|--|-------------------|
| • Added DYZ package drawing, thermal information, Updated Electrical characteristics to include DYZ Package Rdson..... | <a href="#">1</a> |
| • Added DYZ Package current capability.....  | <a href="#">6</a> |

| <b>Changes from Revision B (February 2012) to Revision C (November 2015)</b>   | <b>Page</b>       |
|--|-------------------|
| • Added ESD Ratings 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..... | <a href="#">1</a> |
| • Changed Continuous output current, single channel on, $T_A = 25^\circ\text{C}$ , HTSSOP package MAX value from 1.5A to 2A.....   | <a href="#">7</a> |
| • Changed Continuous output current, four channels on, $T_A = 25^\circ\text{C}$ , HTSSOP package MAX value from 0.8A to 1A.....  | <a href="#">7</a> |

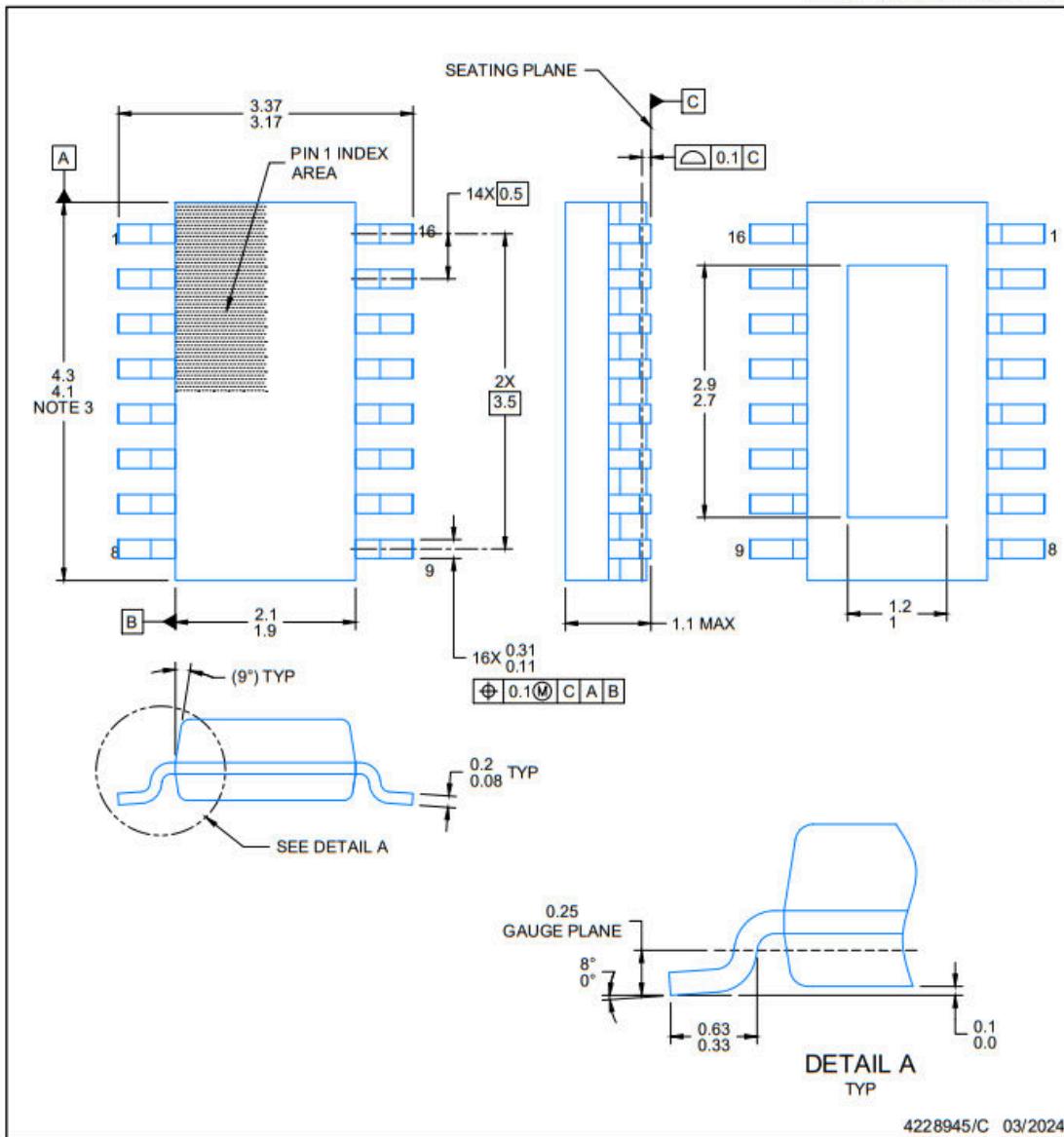
## 11 Mechanical, Packaging, and Orderable Information

The following pages include mechanical, packaging, and orderable information. This information is the most current data available for the designated devices. This data is subject to change without notice and revision of this document. For browser-based versions of this data sheet, refer to the left-hand navigation.

DYZ0016A

## PACKAGE OUTLINE

## PLASTIC SMALL OUTLINE



## NOTES:

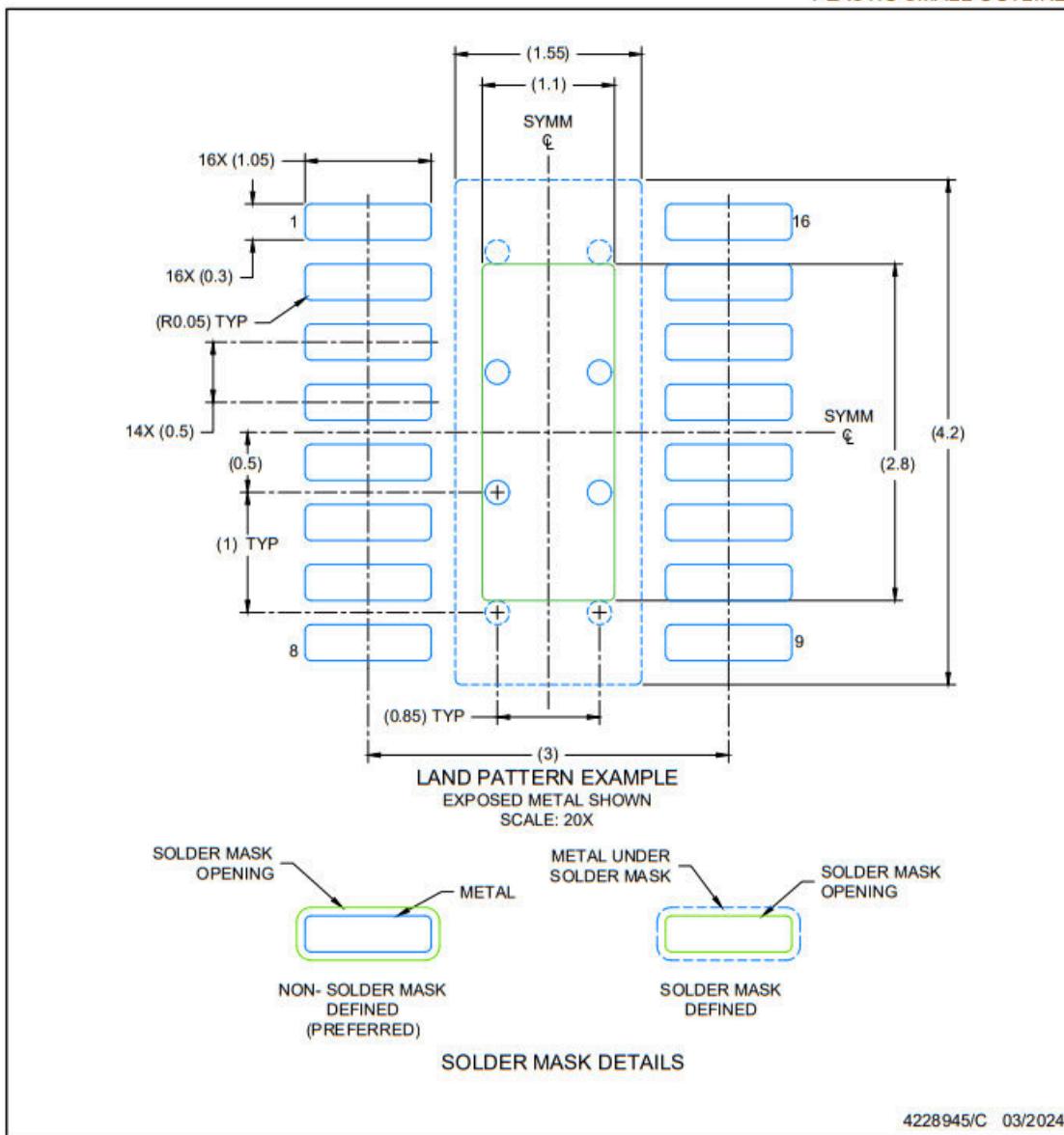
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 per side.
4. This dimension does not include interlead flash. Interlead flash shall not exceed 0.50 per side.
5. Reference JEDEC Registration MO-345, Variation AA



**DYZ0016A**

**EXAMPLE BOARD LAYOUT  
SOT-23-THIN - 1.1 mm max height**

PLASTIC SMALL OUTLINE

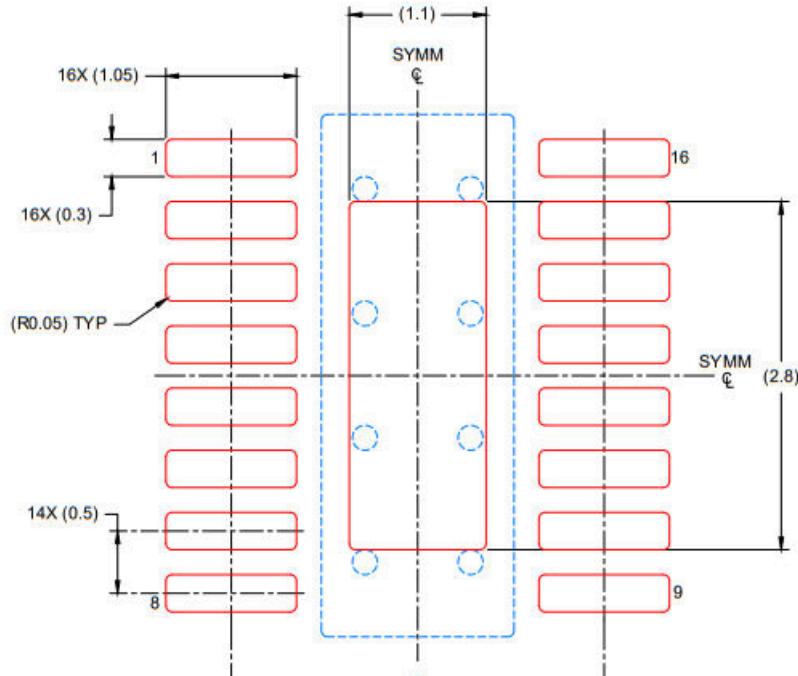


NOTES: (continued)

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

**DYZ0016A****EXAMPLE STENCIL DESIGN****SOT-23-THIN - 1.1 mm max height**

PLASTIC SMALL OUTLINE



**SOLDER PASTE EXAMPLE**  
 BASED ON 0.125 mm THICK STENCIL  
 SCALE: 20X

| STENCIL THICKNESS | SOLDER STENCIL OPENING |
|-------------------|------------------------|
| 0.1               | 1.23 X 3.13            |
| 0.125             | 1.10 X 2.80 (SHOWN)    |
| 0.15              | 1.00 X 2.56            |
| 0.175             | 0.93 X 2.37            |

4228945/C 03/2024

## 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.

**PACKAGING INFORMATION**

| Orderable part number | Status<br>(1) | Material type<br>(2) | Package   Pins            | Package qty   Carrier | RoHS<br>(3) | Lead finish/<br>Ball material<br>(4) | MSL rating/<br>Peak reflow<br>(5) | Op temp (°C) | Part marking<br>(6) |
|-----------------------|---------------|----------------------|---------------------------|-----------------------|-------------|--------------------------------------|-----------------------------------|--------------|---------------------|
| DRV8803DW             | Obsolete      | Production           | SOIC (DW)   20            | -                     | -           | Call TI                              | Call TI                           | -40 to 125   | DRV8803DW           |
| DRV8803DWR            | Active        | Production           | SOIC (DW)   20            | 2000   LARGE T&R      | Yes         | NIPDAU                               | Level-2-260C-1 YEAR               | -40 to 125   | DRV8803DW           |
| DRV8803DWR.A          | Active        | Production           | SOIC (DW)   20            | 2000   LARGE T&R      | Yes         | NIPDAU                               | Level-2-260C-1 YEAR               | -40 to 125   | DRV8803DW           |
| DRV8803DYZR           | Active        | Production           | SOT-23-THIN<br>(DYZ)   16 | 3000   LARGE T&R      | Yes         | SN                                   | Level-1-260C-UNLIM                | -40 to 125   | DRV8803             |
| DRV8803DYZR.A         | Active        | Production           | SOT-23-THIN<br>(DYZ)   16 | 3000   LARGE T&R      | Yes         | SN                                   | Level-1-260C-UNLIM                | -40 to 125   | DRV8803             |
| DRV8803PWP            | Obsolete      | Production           | HTSSOP (PWP)   16         | -                     | -           | Call TI                              | Call TI                           | -40 to 125   | DRV8803             |
| DRV8803PWPR           | Active        | Production           | HTSSOP (PWP)   16         | 2000   LARGE T&R      | Yes         | NIPDAU                               | Level-3-260C-168 HR               | -40 to 125   | DRV8803             |
| DRV8803PWPR.A         | Active        | Production           | HTSSOP (PWP)   16         | 2000   LARGE T&R      | Yes         | NIPDAU                               | Level-3-260C-168 HR               | -40 to 125   | DRV8803             |
| DRV8803PWPR.B         | Active        | Production           | HTSSOP (PWP)   16         | 2000   LARGE T&R      | Yes         | NIPDAU                               | Level-3-260C-168 HR               | -40 to 125   | DRV8803             |
| DRV8803PWPRG4.A       | Active        | Production           | HTSSOP (PWP)   16         | 2000   LARGE T&R      | Yes         | NIPDAU                               | Level-3-260C-168 HR               | -40 to 125   | DRV8803             |
| DRV8803PWPRG4.B       | Active        | Production           | HTSSOP (PWP)   16         | 2000   LARGE T&R      | Yes         | NIPDAU                               | Level-3-260C-168 HR               | -40 to 125   | DRV8803             |

<sup>(1)</sup> **Status:** For more details on status, see our [product life cycle](#).

<sup>(2)</sup> **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.

<sup>(3)</sup> **RoHS values:** Yes, No, RoHS Exempt. See the [TI RoHS Statement](#) for additional information and value definition.

<sup>(4)</sup> **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.

<sup>(5)</sup> **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.

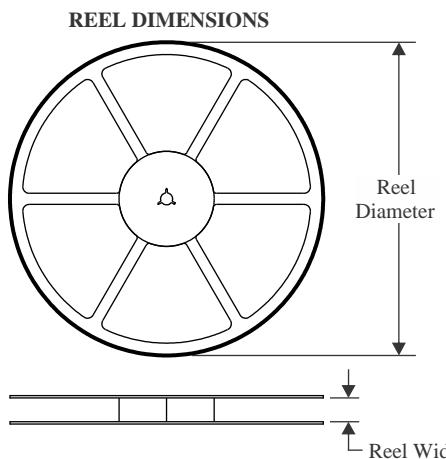
<sup>(6)</sup> **Part marking:** There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

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.

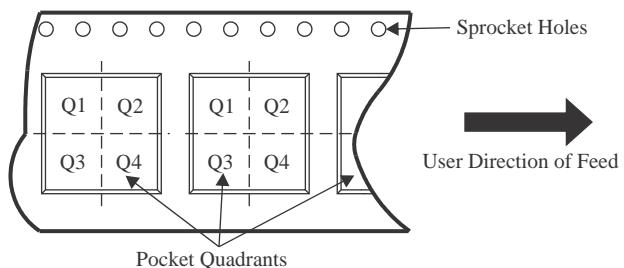
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In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

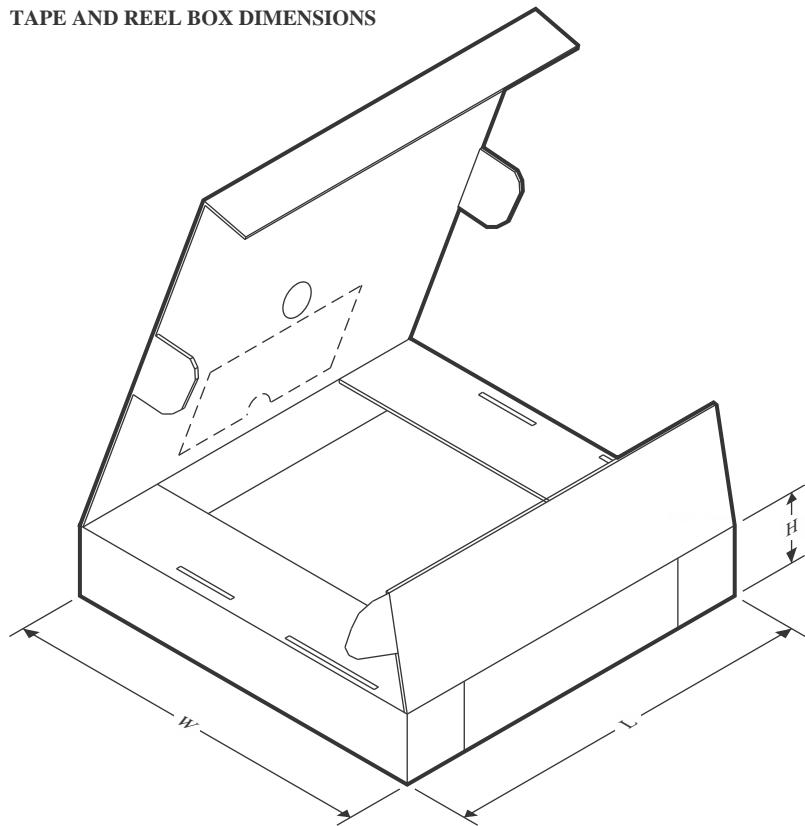
**TAPE AND REEL INFORMATION**


|    |   |
|----|---|
| 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 |
|-------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| DRV8803DWR  | SOIC         | DW              | 20   | 2000 | 330.0              | 24.4               | 10.8    | 13.3    | 2.7     | 12.0    | 24.0   | Q1            |
| DRV8803DYZR | SOT-23-THIN  | DYZ             | 16   | 3000 | 330.0              | 12.4               | 4.5     | 3.56    | 1.35    | 8.0     | 12.0   | Q3            |
| DRV8803PWPR | HTSSOP       | PWP             | 16   | 2000 | 330.0              | 12.4               | 6.9     | 5.6     | 1.6     | 8.0     | 12.0   | Q1            |

**TAPE AND REEL BOX DIMENSIONS**


\*All dimensions are nominal

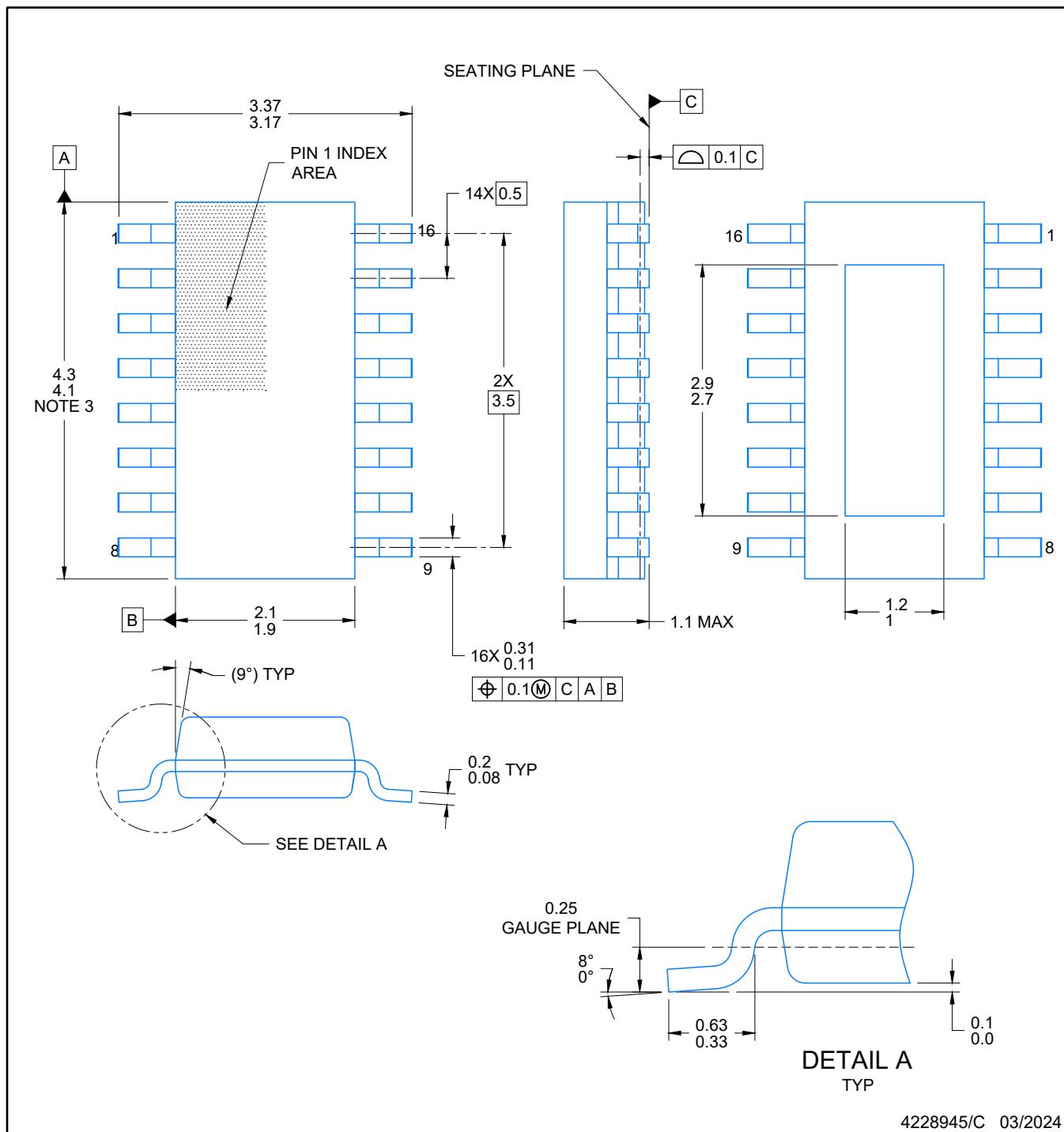
| Device      | Package Type | Package Drawing | Pins | SPQ  | Length (mm) | Width (mm) | Height (mm) |
|-------------|--------------|-----------------|------|------|-------------|------------|-------------|
| DRV8803DWR  | SOIC         | DW              | 20   | 2000 | 356.0       | 356.0      | 45.0        |
| DRV8803DYZR | SOT-23-THIN  | DYZ             | 16   | 3000 | 360.0       | 360.0      | 36.0        |
| DRV8803PWPR | HTSSOP       | PWP             | 16   | 2000 | 350.0       | 350.0      | 43.0        |

## PACKAGE OUTLINE

**DYZ0016A**

## **SOT-23-THIN - 1.1 mm max height**

## PLASTIC SMALL OUTLINE



## NOTES:

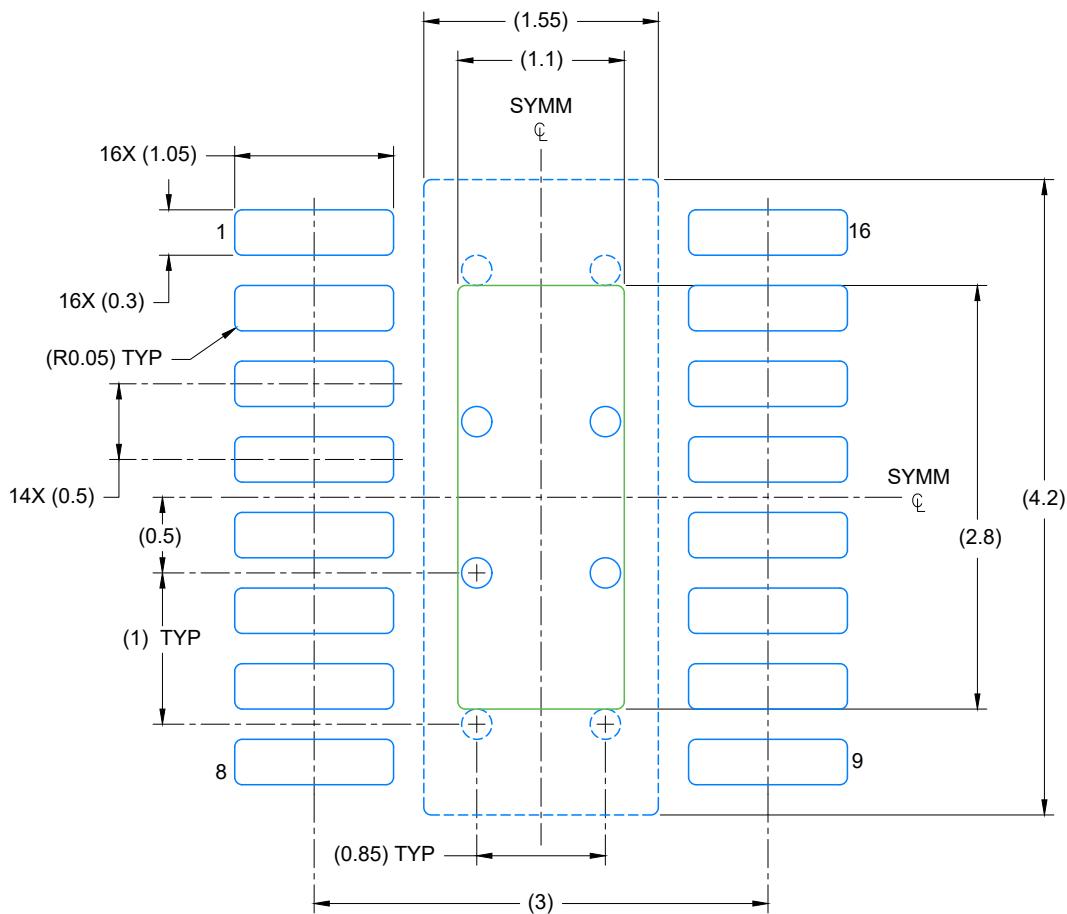
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 per side.
4. This dimension does not include interlead flash. Interlead flash shall not exceed 0.50 per side.
5. Reference JEDEC Registration MO-345, Variation AA

# EXAMPLE BOARD LAYOUT

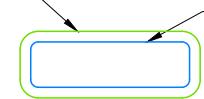
## SOT-23-THIN - 1.1 mm max height

DYZ0016A

PLASTIC SMALL OUTLINE

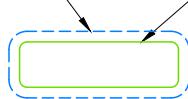


SOLDER MASK  
OPENING



NON- SOLDER MASK  
DEFINED  
(PREFERRED)

METAL UNDER  
SOLDER MASK



SOLDER MASK  
DEFINED

SOLDER MASK DETAILS

4228945/C 03/2024

NOTES: (continued)

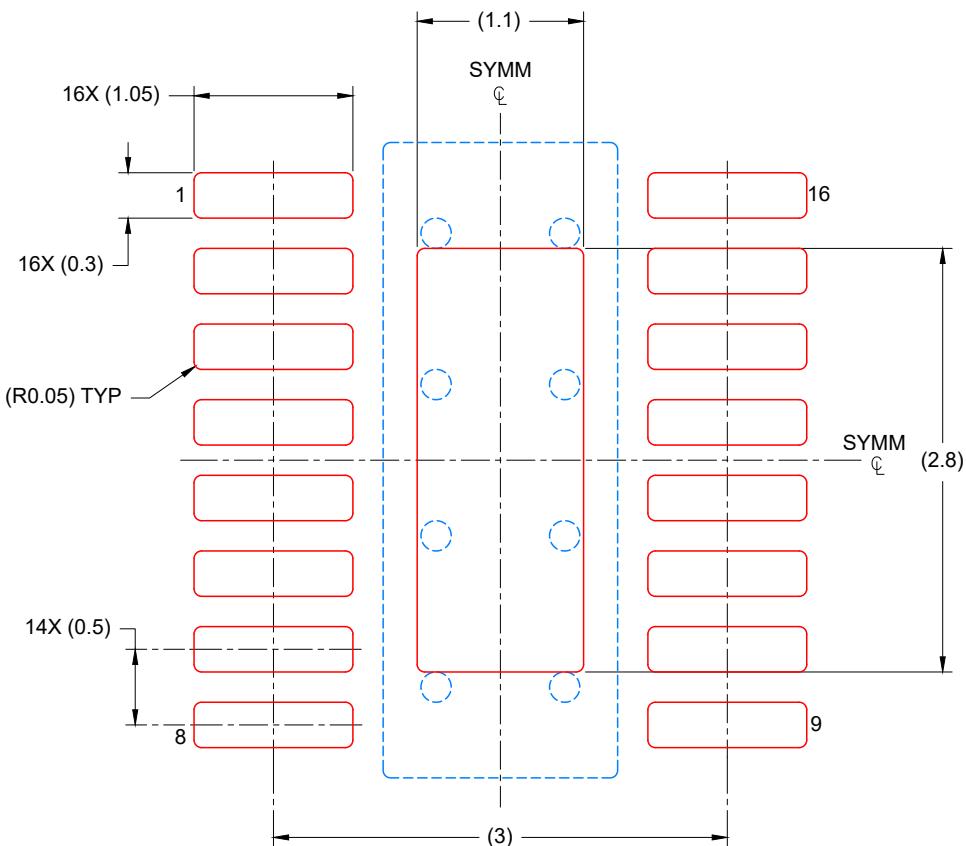
6. Publication IPC-7351 may have alternate designs.
7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

## EXAMPLE STENCIL DESIGN

### SOT-23-THIN - 1.1 mm max height

**DYZ0016A**

## PLASTIC SMALL OUTLINE



**SOLDER PASTE EXAMPLE  
BASED ON 0.125 mm THICK STENCIL  
SCALE: 20X**

| STENCIL THICKNESS | SOLDER STENCIL OPENING |
|-------------------|------------------------|
| 0.1               | 1.23 X 3.13            |
| 0.125             | 1.10 X 2.80 (SHOWN)    |
| 0.15              | 1.00 X 2.56            |
| 0.175             | 0.93 X 2.37            |

4228945/C 03/2024

#### 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.

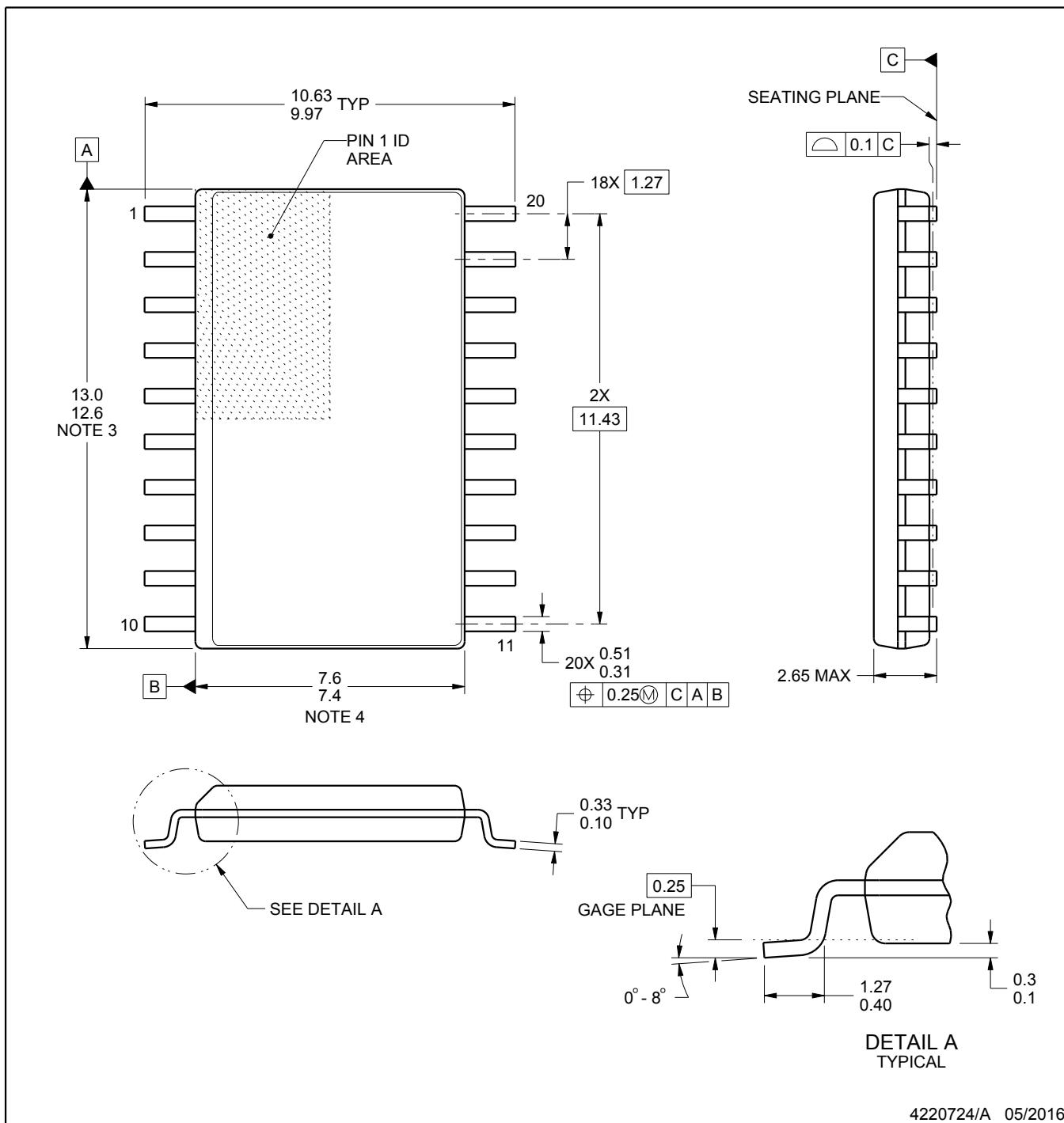
# PACKAGE OUTLINE

DW0020A



SOIC - 2.65 mm max height

SOIC

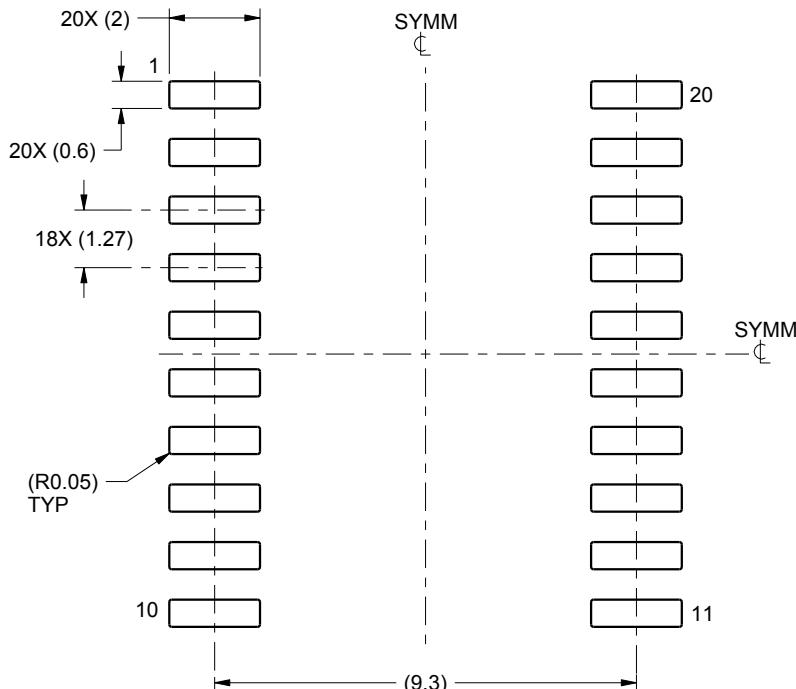


# EXAMPLE BOARD LAYOUT

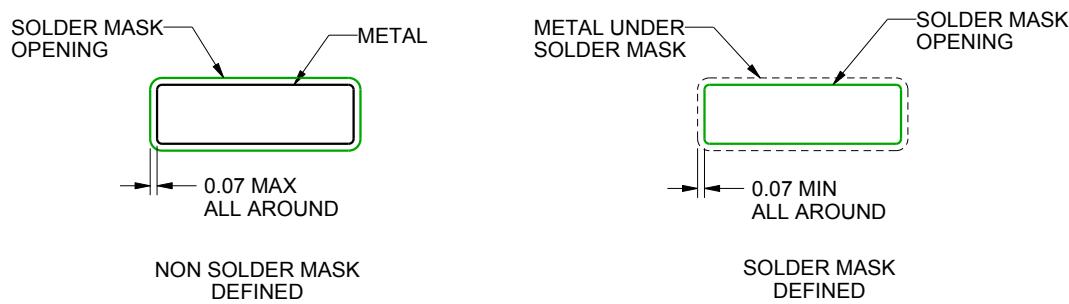
DW0020A

SOIC - 2.65 mm max height

SOIC



LAND PATTERN EXAMPLE  
SCALE:6X



SOLDER MASK DETAILS

4220724/A 05/2016

NOTES: (continued)

6. Publication IPC-7351 may have alternate designs.

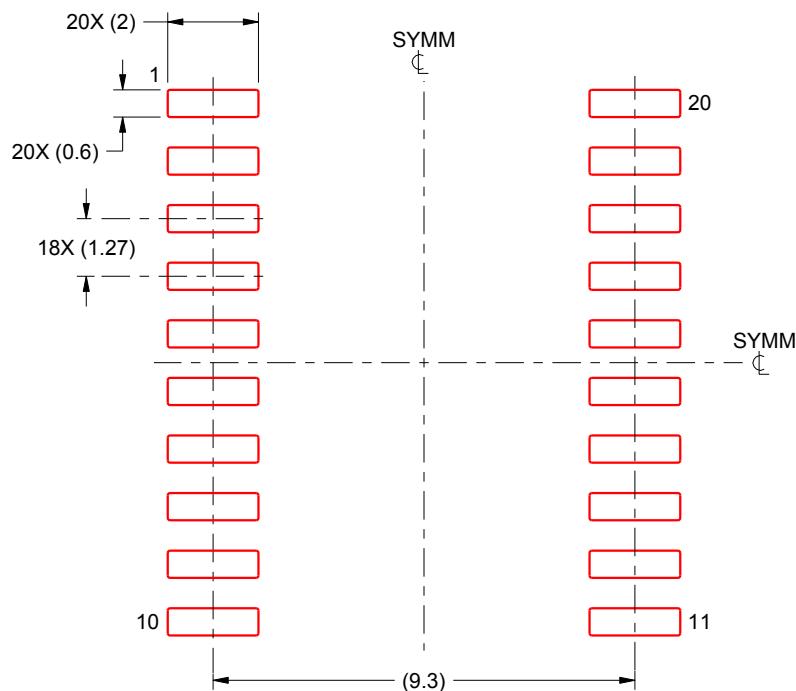
7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

# EXAMPLE STENCIL DESIGN

DW0020A

SOIC - 2.65 mm max height

SOIC



SOLDER PASTE EXAMPLE  
BASED ON 0.125 mm THICK STENCIL  
SCALE:6X

4220724/A 05/2016

NOTES: (continued)

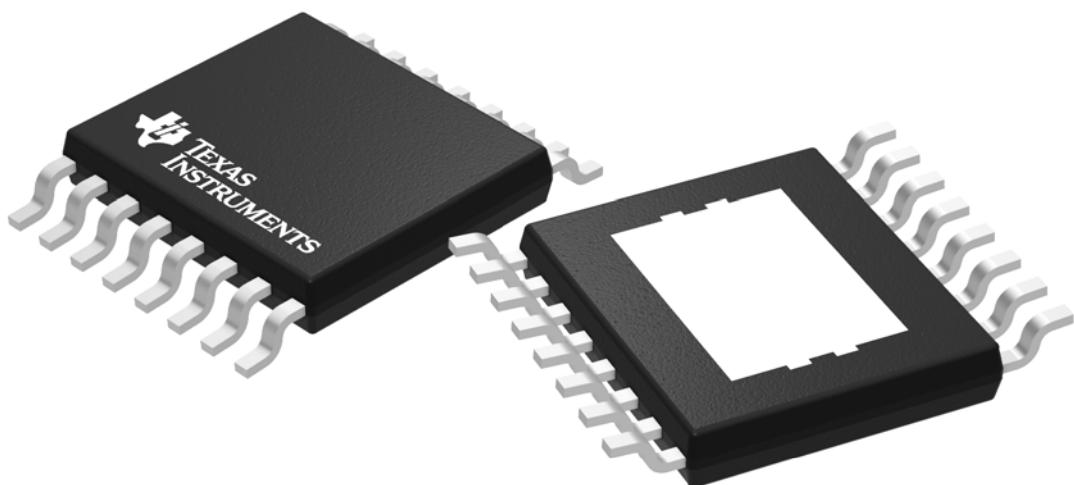
8. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
9. Board assembly site may have different recommendations for stencil design.

## GENERIC PACKAGE VIEW

PWP 16

PowerPAD™ TSSOP - 1.2 mm max height

PLASTIC SMALL OUTLINE



Images above are just a representation of the package family, actual package may vary.  
Refer to the product data sheet for package details.

4073225-3/J

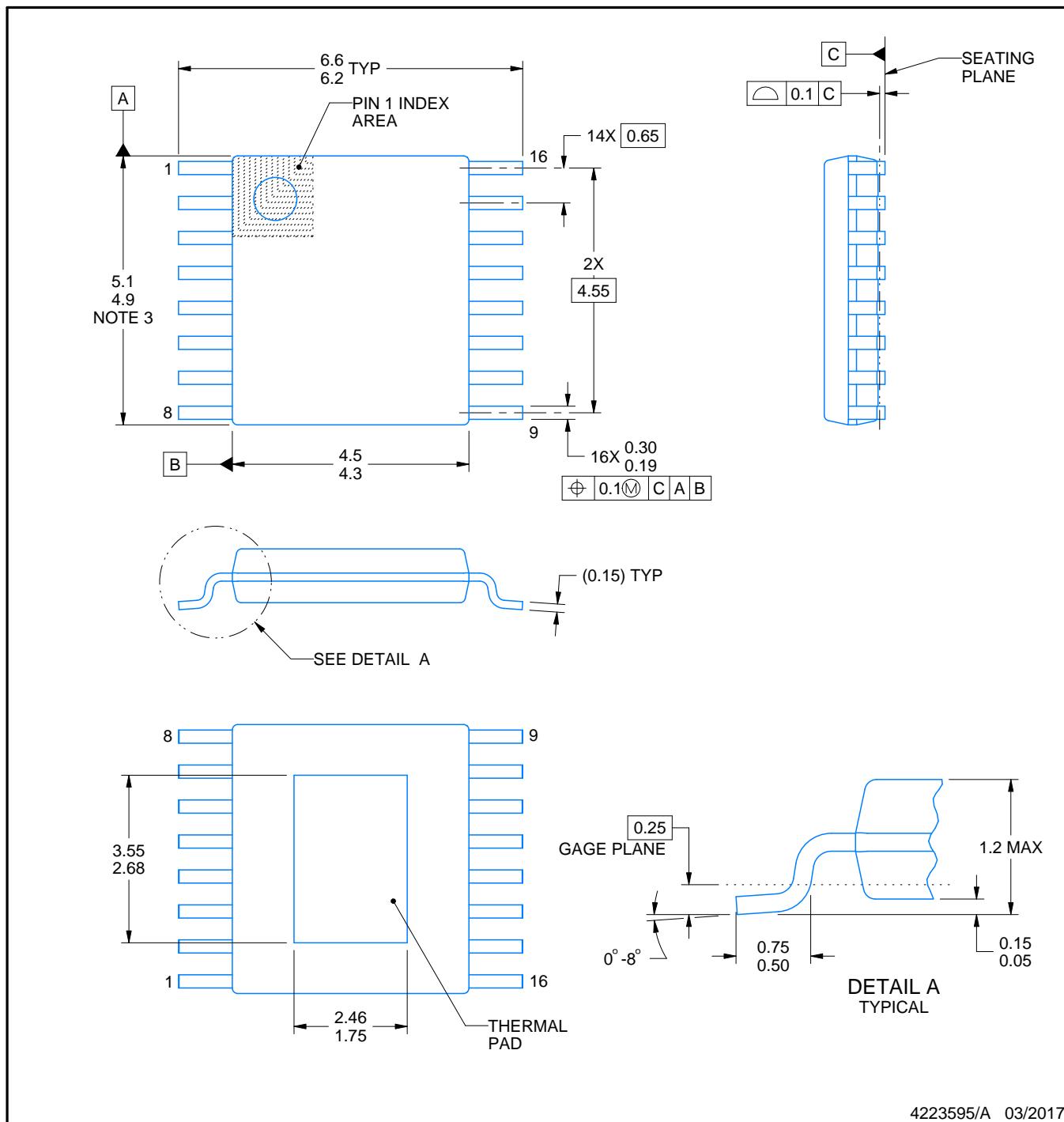
## PACKAGE OUTLINE

PWP0016J



## PowerPAD™ TSSOP - 1.2 mm max height

## SMALL OUTLINE PACKAGE



## NOTES:

PowerPAD is a trademark of Texas Instruments.

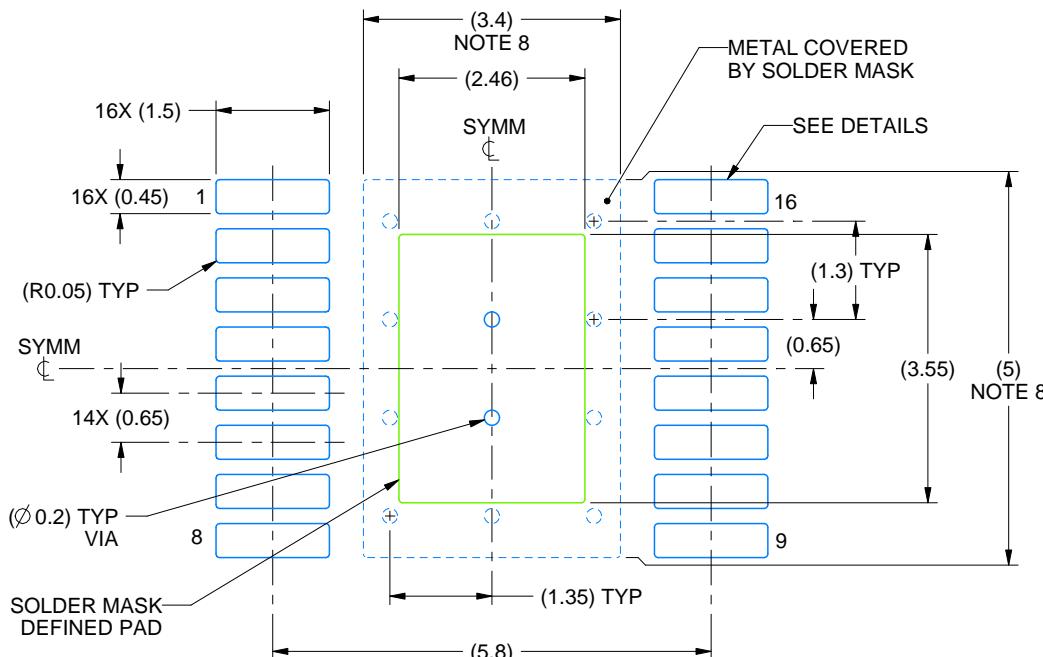
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or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

# EXAMPLE BOARD LAYOUT

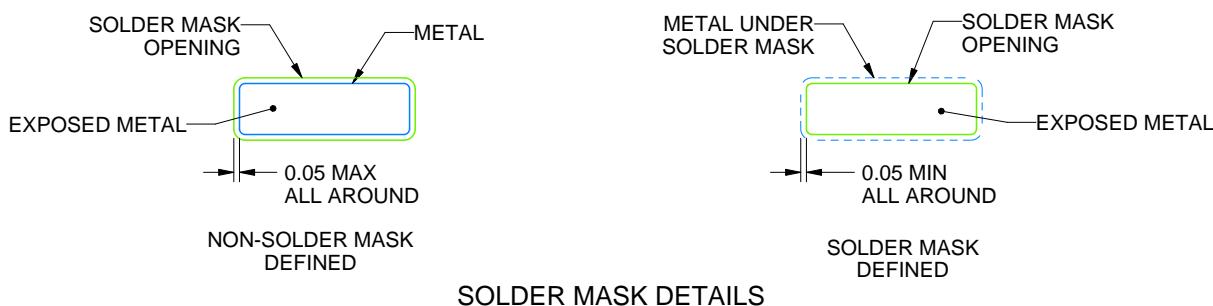
PWP0016J

PowerPAD™ TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



LAND PATTERN EXAMPLE  
EXPOSED METAL SHOWN  
SCALE: 10X



SOLDER MASK DETAILS

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NOTES: (continued)

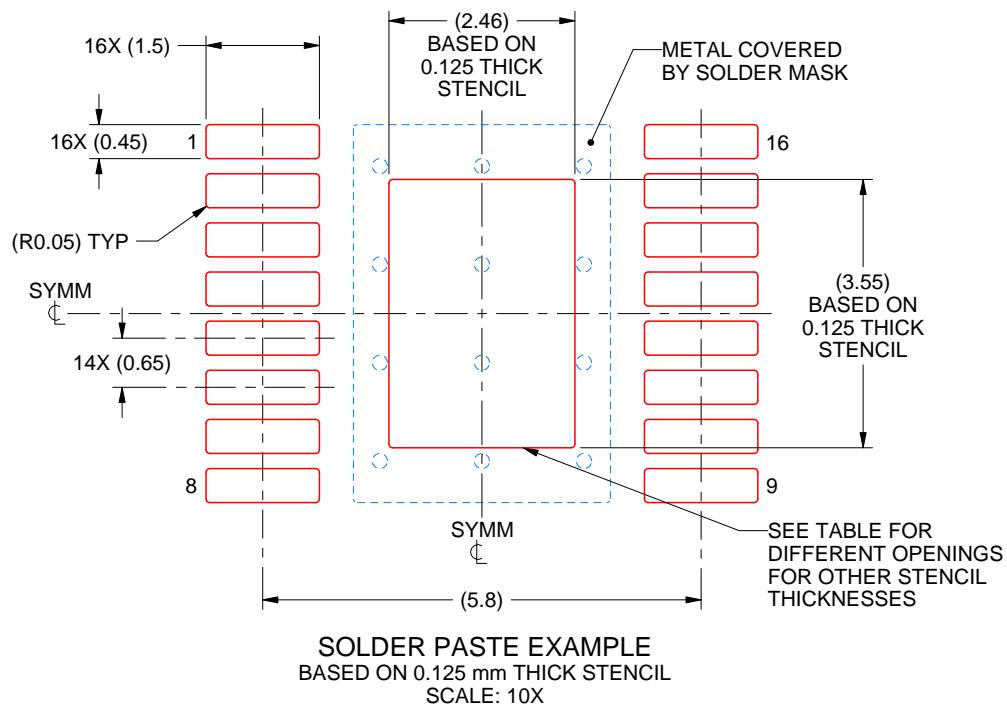
5. Publication IPC-7351 may have alternate designs.
6. Solder mask tolerances between and around signal pads can vary based on board fabrication site.
7. This package is designed to be soldered to a thermal pad on the board. For more information, see Texas Instruments literature numbers SLMA002 ([www.ti.com/lit/slma002](http://www.ti.com/lit/slma002)) and SLMA004 ([www.ti.com/lit/slma004](http://www.ti.com/lit/slma004)).
8. Size of metal pad may vary due to creepage requirement.
9. Vias are optional depending on application, refer to device data sheet. It is recommended that vias under paste be filled, plugged or tented.

# EXAMPLE STENCIL DESIGN

PWP0016J

PowerPAD™ TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



| STENCIL THICKNESS | SOLDER STENCIL OPENING |
|-------------------|------------------------|
| 0.1               | 2.75 X 3.97            |
| 0.125             | 2.46 X 3.55 (SHOWN)    |
| 0.15              | 2.25 X 3.24            |
| 0.175             | 2.08 X 3.00            |

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NOTES: (continued)

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

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