40V, 500mA 7-Channel Sink Driver

Check for Samples: TPL7407L

FEATURES

- **500mA-Rated Drain Current (Single Output)(1)**
- **High-Voltage Outputs . . . 40V max**
- **Extended Ambient Temperature Range: T_A= –40°C to 125°C**
- **Output Clamp Diodes**
- **Power Efficienct (Very low V_{OL})**
- **Compatible with 1.8V to 5.0V Micro-controllers and Logic Interface**
- **Internal Free-wheeling Diodes for Inductive Kick-back Protection**
- **Input Pull-down Resistors Allows Tri-stating the Input Driver**
- **Input RC-Snubber to Eliminate Spurious Operation in Noisy Environment**
- **Relay & Motor Driver Applications**
- **Very low output leakage <500nA max**
- **ESD Protection Exceeds JESD 22**
  - **2kV HBM, 500V CDM**
- **Available in 16-pin SOIC and TSSOP Packages**

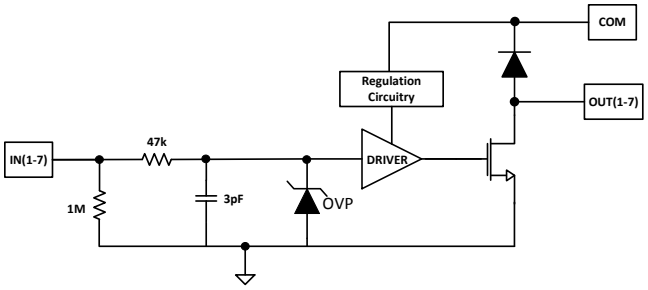
(1) Total current sink may be limited by the internal junction temperature, absolute maximum current levels etc - refer to the Electrical Specifications section for details.

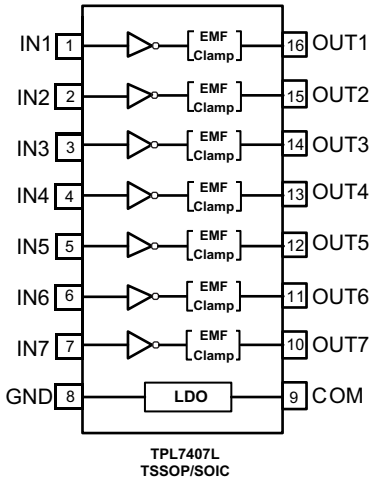
DESCRIPTION

The TPL7407L is a high-voltage, high-current NMOS transistor array. This device consists of seven NMOS transistors that feature high-voltage outputs with common-cathode clamp diodes for switching inductive loads. The drain-current rating of a single NMOS is 500 mA. New regulation and drive circuitry added to give maximum drive strength (500mA) across all GPIO ranges (1.8V-5.0V).The transistors can be paralleled for higher current capability. Applications include relay drivers, hammer drivers, lamp drivers, display drivers (LED and gas discharge), line drivers, and logic buffers.

The TPL7407L's key benefit is it's improved power efficiency and lower leakage than a Bipolar Darlington Implementation. With the lower V_{OL} the user is dissipating less than half the power than traditional relay drivers with currents less than 250mA per channel.

PRODUCT PREVIEW





TPL7407L
TSSOP/SOIC

Absolute Maximum Ratings(1)

at 25°C free-air temperature (unless otherwise noted)

			MIN	MAX	UNIT
V_{OUT}	Pins OUT1-OUT7 to GND voltage		-0.3	42	V
V_{OK}	Ouput Clamp diode reverse voltage(2)		-0.3	42	V
V_{COM}	COM pin voltage(2)		-0.3	42	V
V_{IN}	Pins IN1-IN7 to GND voltage (2)		-0.3	30	V
I_{DS}	Continuous drain current(3) (4)			600	mA
I_{OK}	Output clamp current			500	mA
I_{GND}	Total continuous GND-terminal current			–2	A
T_A	Operating free-air temperature range		–40	125	°C
θ_{JA}	Package thermal impedance(3) (4)	D package		91	°C/W
		PW package		128	
T_J	Operating virtual junction temperature		-40	150	°C
T_{stg}	Storage temperature range		–65	150	°C

(1) Stresses beyond those listed under "absolute maximum ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under "recommended operating conditions" is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
(2) All voltage values are with respect to the GND/substrate terminal, unless otherwise noted.
(3) Maximum power dissipation is a function of $T_J(max)$, θ_{JA}, and T_A. The maximum allowable power dissipation at any allowable ambient temperature is $P_D = (T_J(max) – T_A)/\theta_{JA}$. Operating at the absolute maximum T_J of 150°C can affect reliability.
(4) The package thermal impedance is calculated in accordance with JESD 51-7.

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RECOMMENDED OPERATING CONDITIONS

Over operating temperature range

		MIN	NOM	MAX	UNIT
V_{OUT}	OUT1- OUT7 pin voltage for recommended operation	0		40	V
V_{COM}	COM pin voltage range for full output drive	8.5		40	V
V_{IL}	IN1- IN7 input low voltage ("Off" high impedance output)			1.0	V
V_{IH}	IN1- IN7 input high voltage ("Full Drive" low impedance output)	1.5			V
T_J	Operating virtual junction temperature	-40		125	°C
I_{DS}	Continuous drain current	0		500	mA

Electrical Characteristics

$T_A=T_J$= –40°C to 125°C; Typical Values at $T_A=T_J$= 25°C

PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
V_{OL} ($V_{CE(sat)}$)	OUT1- OUT7 low-level output voltage	V_{IN} ≥ 1.5V	I_D = 100 mA		200	300	mV
			I_D = 200 mA		400	600	
RON/Ch	On resistance for each channel	V_{IN} ≥ 1.5V	I_D = 100 mA to 500mA		2.0	3.0	Ω
$I_{OUT(OFF)}$ (I_{CEX})	OUT1- OUT7 OFF-state leakage current	V_{DS} = 24V,	V_{IN} ≤ 1.0V		200	500	nA
V_F	Clamp forward voltage	I_F = 200 mA			1.0	1.25	V
$I_{IN(off)}$	IN1- IN7 Off-state input current	VINX= 0V	I_D = 10 µA			150	nA
$I_{IN(ON)}$	IN1- IN7 ON state input current	V_{INX}=1.5V-5.0V			5		µA
I_{COM}	Static current flowing through COM pin	V_{COM}=8.5V-40V			15	21	µA

Switching Characteristics

$T_A=T_J$= –40°C to 125°C; Typical Values at $T_A=T_J$= 25°C

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
t_{PLH}	Propagation delay time, low- to high-level output	VINX ≥1.65V, Vpullup=24V, Rpull-up = 48Ω		0.25	1	µs
t_{PHL}	Propagation delay time, high- to low-level output	VINX ≥1.65V, Vpullup=24V, Rpull-up = 48Ω		0.25	1	µs
C_i	Input capacitance	V_I = 0, f = 1 MHz		15	25	pF

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APPLICATION INFORMATION

TTL and other Logic Inputs

TPL7407L input interface is specified for standard 1.8V and 5V CMOS logic interface and can tolerate up to 30V. At any input voltage the output drivers will be driven at it's maximum when Vcom is greater than or equal to 8.5V.

Input RC Snubber

TPL7407L features an input RC snubber that helps prevent spurious switching in noisy environment. Connect an external 1kΩ to 5kΩ resistor in series with the input to further enhance TPL7407L's noise tolerance.

High-impedance Input Drivers

TPL7407L features a 300kΩ input pull-down resistor. The presence of this resistor allows the input drivers to be tri-stated. When a high-impedance driver is connected to a channel input the TPL7407L detects the channel input as a low level input and remains in the OFF position. The input RC snubber helps improve noise tolerance when input drivers are in the high-impedance state.

On-chip Power Dissipation

Use the below equation to calculate TPL7407L on-chip power dissipation P_D:

$$P_D = \sum_{i=1}^{N} V_{OLi} \times I_{Li} \quad (1)$$

Where:

N is the number of channels active together.

V_{OLi} is the OUT_i pin voltage for the load current I_{Li}.

Thermal Reliability

It is recommended to limit TPL7407L IC's die junction temperature to less than 125°C. The IC junction temperature is directly proportional to the on-chip power dissipation. Use the following equation to calculate the maximum allowable on-chip power dissipation for a target IC junction temperature:

$$PD_{(MAX)} = \left(T_{J(MAX)} - T_A\right) \Big/ \theta_{JA} \quad (2)$$

Where:

$T_{J(MAX)}$ is the target maximum junction temperature.

T_A is the operating ambient temperature.

θ_{JA} is the package junction to ambient thermal resistance.

Improving Package Thermal Performance

θ_{JA} value depends on the PC board layout. An external heat sink and/or a cooling mechanism, like a cold air fan, can help reduce θ_{JA} and thus improve device thermal capabilities. Refer to TI's design support web page at www.ti.com/thermal for a general guidance on improving device thermal performance.

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Application Examples

Unipolar Stepper Motor Driver

Figure 1 shows an implementation of TPL7407L for driving a uniploar stepper motor. The unconnected input channels can be used for other functions. When an input pin is left open the internal 1MΩ pull down resistor pulls the respective input pin to GND potential. For higher noise immunity use an external short across an unconnected input and GND pins. The COM pin must be tied to the supply of whichever inductive load is to be protected by the free-wheeling diode.

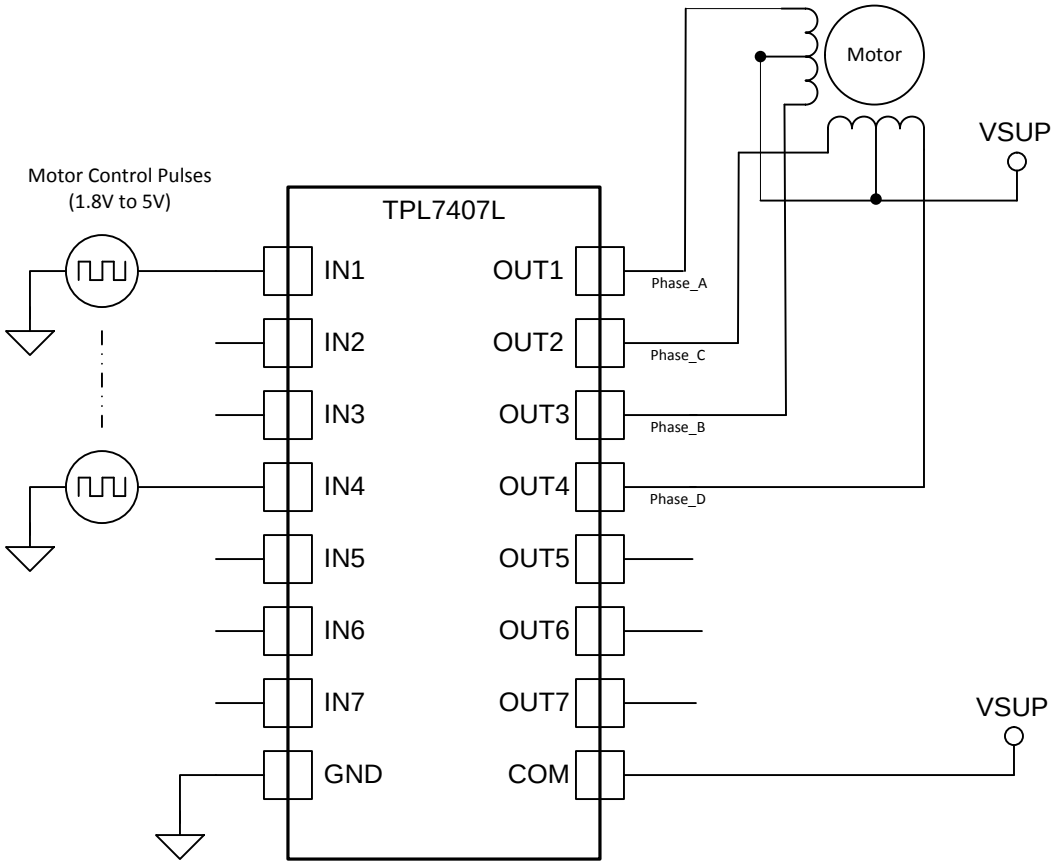

Figure 1. TPL7407L as a Stepper Motor Driver

Multi-Purpose Sink Driver

When configured as per Figure 2 TPL7407L can be used as a multi-purpose driver. The output channels can be tied together to sink more current. TPL7407L can easily drive motors, relays & LEDs with little power dissipation. COM must be tied to highest load voltage, which may or may not be same as inductive load supply.

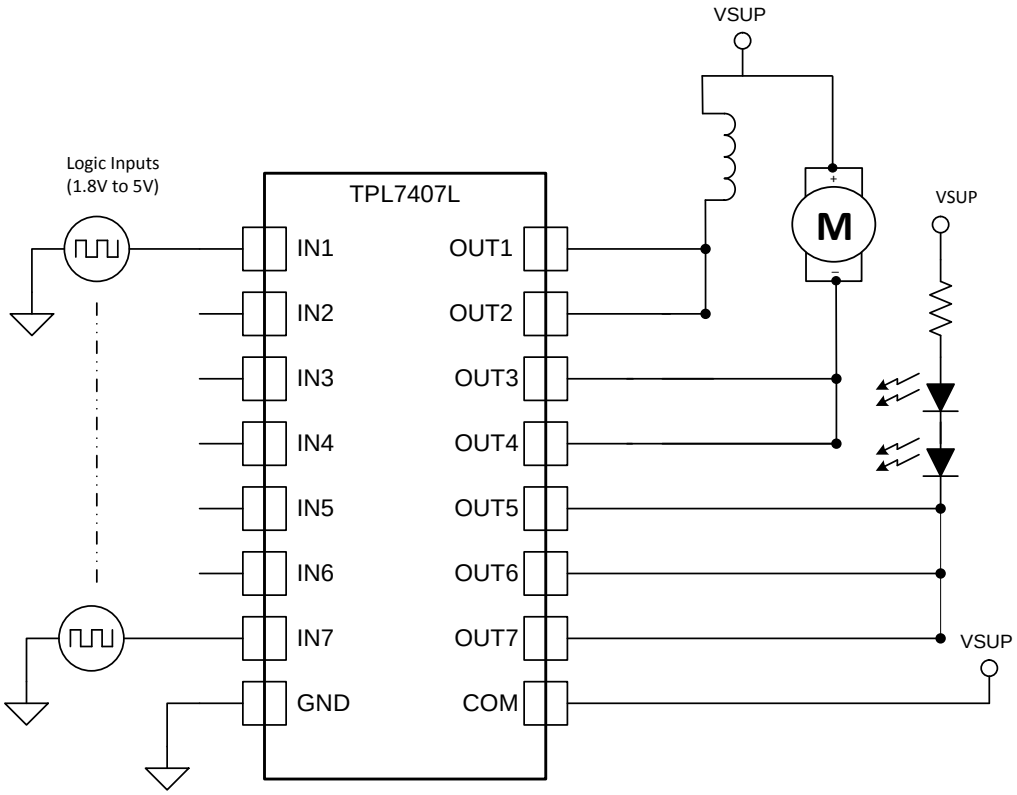

Figure 2. TPL7407L Multi-Purpose Sink Driver Application

24V Relay Driver

To drive lower resistance relays, like <48Ω , connect two or more adjacent channels in parallel as shown in Figure 3. Connecting several channels in parallel lowers the channel output resistance and increases the drive current. TPL7407L can be used for driving 12V, 24V & 36V relays with similar a implementation.

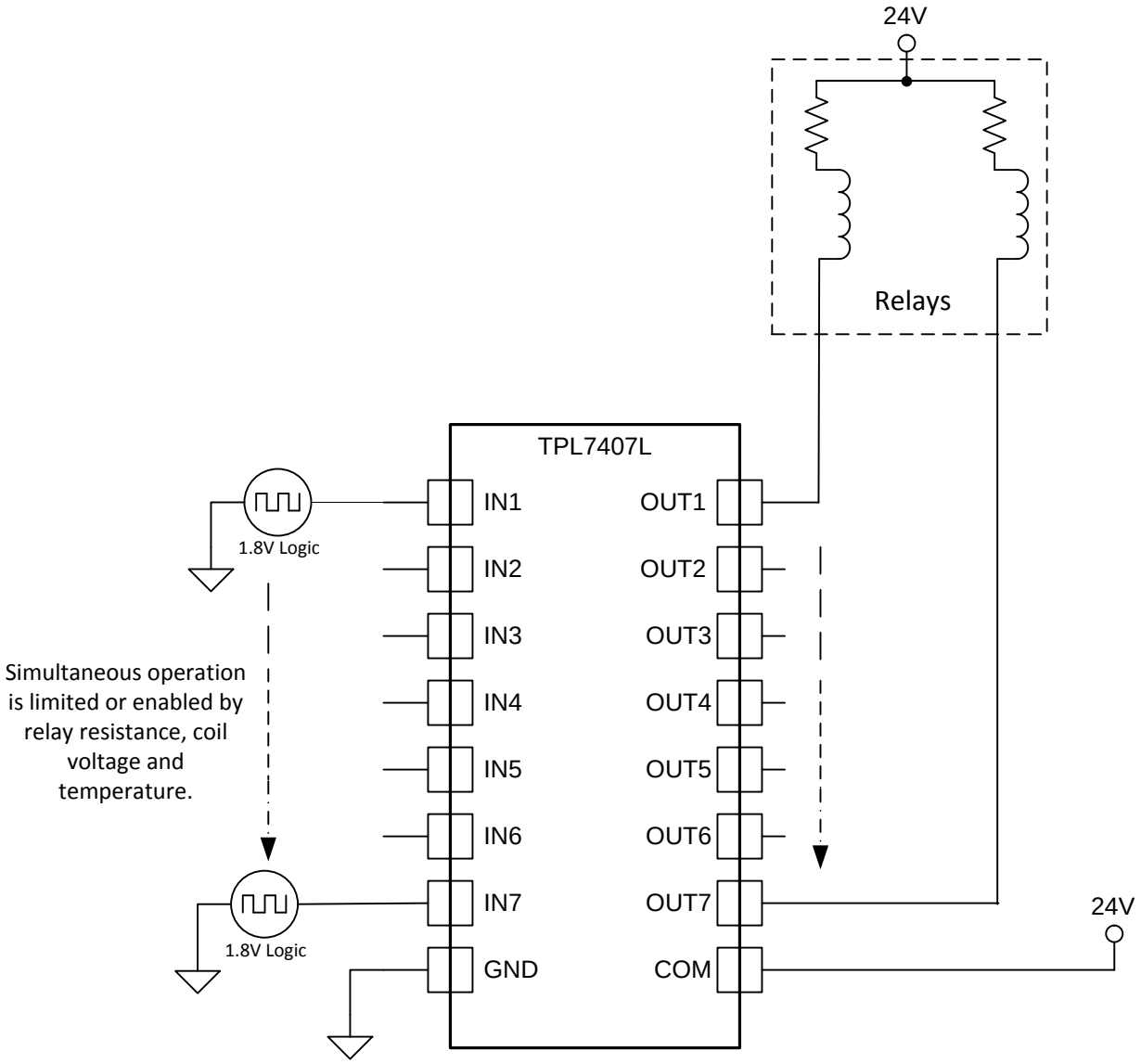

Figure 3. TPL7407L Driving 24V Relays

Typical Characteristics

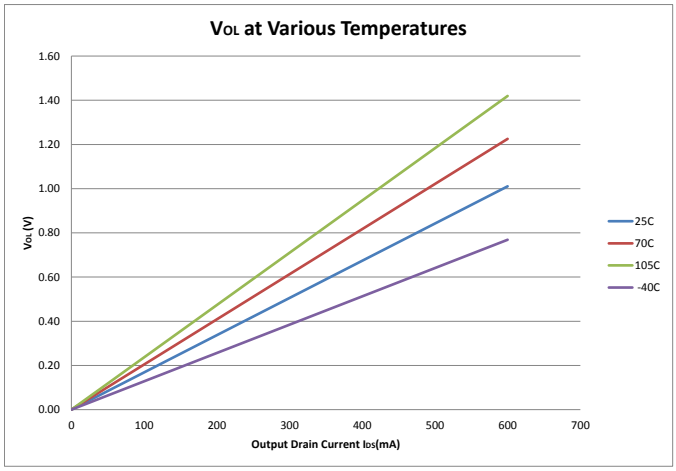

Figure 4. VOL (V_{CESAT})

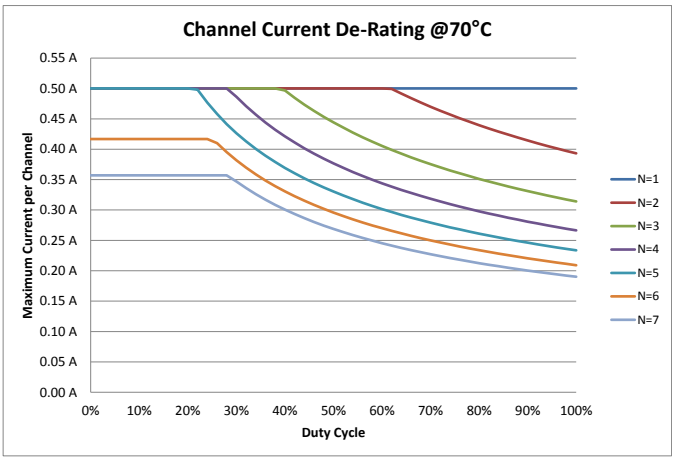

Figure 5. D Package Maximum Collector Current Vs. Duty Cycle

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PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
TPL7407LD	PREVIEW	SOIC	D	16	40	TBD	Call TI	Call TI	-40 to 125		
TPL7407LDR	PREVIEW	SOIC	D	16	2500	TBD	Call TI	Call TI	-40 to 125		
TPL7407LPW	PREVIEW	TSSOP	PW	16	90	TBD	Call TI	Call TI	-40 to 125		
TPL7407LPWR	PREVIEW	TSSOP	PW	16	2000	TBD	Call TI	Call TI	-40 to 125		

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

(2) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check http://www.ti.com/productcontent for the latest availability information and additional product content details.
TBD: The Pb-Free/Green conversion plan has not been defined.
Pb-Free (RoHS): TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.
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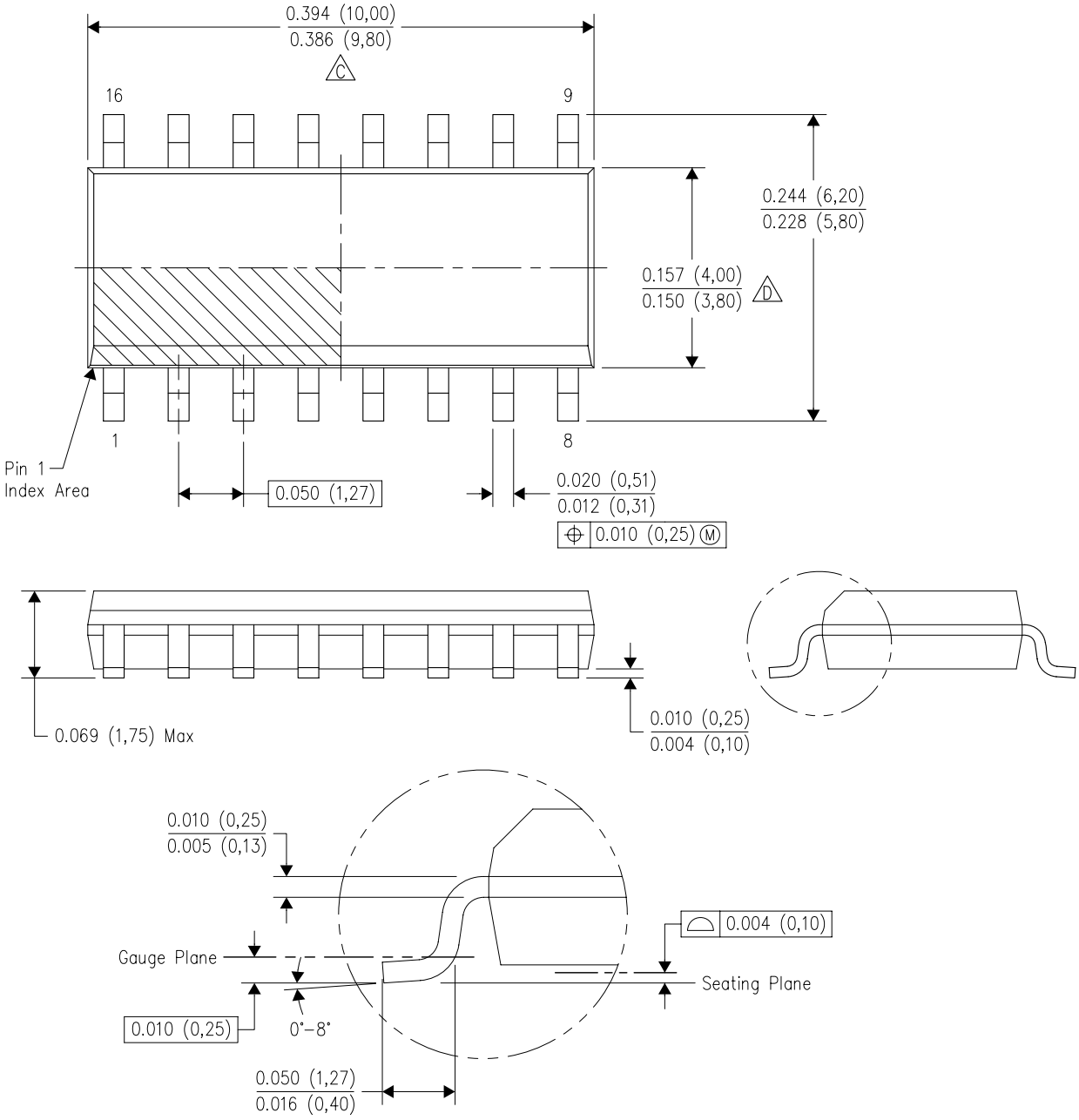
Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

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

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

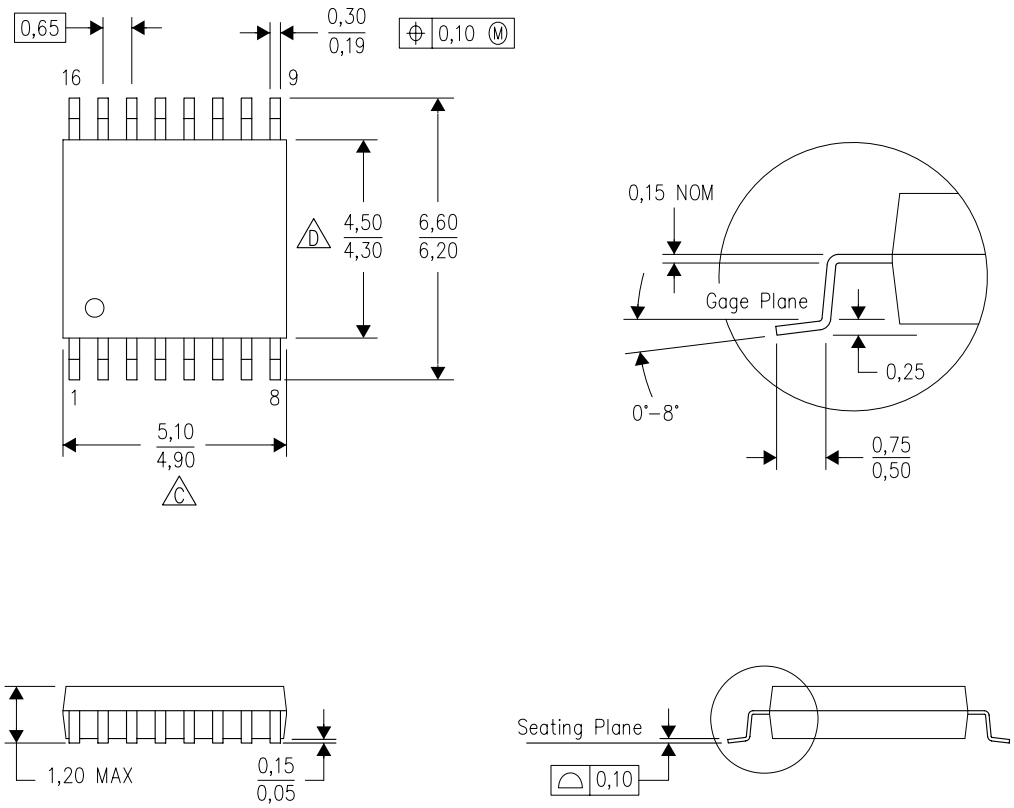
(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

D (R–PDSO–G16) PLASTIC SMALL OUTLINE



NOTES:
A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.006 (0,15) each side.
D. Body width does not include interlead flash. Interlead flash shall not exceed 0.017 (0,43) each side.
E. Reference JEDEC MS–012 variation AC.

PW (R–PDSO–G16) PLASTIC SMALL OUTLINE



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NOTES:
A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M–1994.
B. This drawing is subject to change without notice.
C. Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0,15 each side.
D. Body width does not include interlead flash. Interlead flash shall not exceed 0,25 each side.
E. Falls within JEDEC MO–153

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