

L293x Quadruple Half-H Drivers

1 Features

- Wide Supply-Voltage Range: 4.5 V to 36 V
- Separate Input-Logic Supply
- Internal ESD Protection
- High-Noise-Immunity Inputs
- Output Current 1 A Per Channel (600 mA for L293D)
- Peak Output Current 2 A Per Channel (1.2 A for L293D)
- Output Clamp Diodes for Inductive Transient Suppression (L293D)

2 Applications

- Stepper Motor Drivers
- DC Motor Drivers
- Latching Relay Drivers

3 Description

The L293 and L293D devices are quadruple high-current half-H drivers. The L293 is designed to provide bidirectional drive currents of up to 1 A at voltages from 4.5 V to 36 V. The L293D is designed to provide bidirectional drive currents of up to 600-mA at voltages from 4.5 V to 36 V. Both devices are designed to drive inductive loads such as relays, solenoids, DC and bipolar stepping motors, as well as other high-current/high-voltage loads in positive-supply applications.

Each output is a complete totem-pole drive circuit, with a Darlington transistor sink and a pseudo-Darlington source. Drivers are enabled in pairs, with drivers 1 and 2 enabled by 1,2EN and drivers 3 and 4 enabled by 3,4EN.

The L293 and L293D are characterized for operation from 0°C to 70°C.

Device Information⁽¹⁾

PART NUMBER	PACKAGE	BODY SIZE (NOM)
L293NE	PDIP (16)	19.80 mm x 6.35 mm
L293DNE	PDIP (16)	19.80 mm x 6.35 mm

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

Logic Diagram

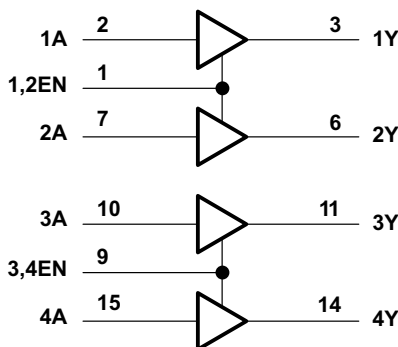


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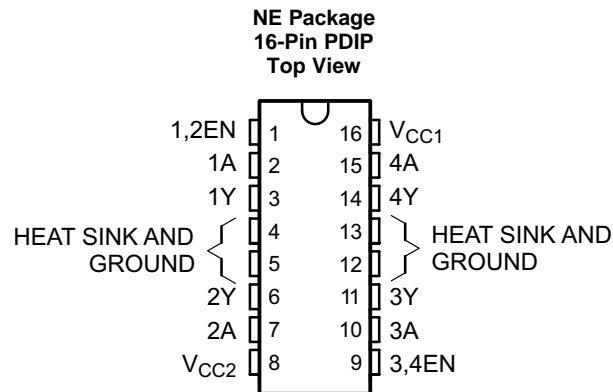
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4 Revision History

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

Changes from Revision C (November 2004) to Revision D	Page
• Removed <i>Ordering Information</i> table	1
• Added <i>ESD Ratings</i> and <i>Thermal Information</i> tables, <i>Feature Description</i> section, <i>Device Functional Modes</i> , <i>Application and Implementation</i> section, <i>Power Supply Recommendations</i> section, <i>Layout</i> section, <i>Device and Documentation Support</i> section, and <i>Mechanical, Packaging, and Orderable Information</i> section.	1

5 Pin Configuration and Functions



Pin Functions

PIN		TYPE	DESCRIPTION
NAME	NO.		
1,2EN	1	I	Enable driver channels 1 and 2 (active high input)
<1:4>A	2, 7, 10, 15	I	Driver inputs, noninverting
<1:4>Y	3, 6, 11, 14	O	Driver outputs
3,4EN	9	I	Enable driver channels 3 and 4 (active high input)
GROUND	4, 5, 12, 13	—	Device ground and heat sink pin. Connect to printed-circuit-board ground plane with multiple solid vias
V _{CC1}	16	—	5-V supply for internal logic translation
V _{CC2}	8	—	Power VCC for drivers 4.5 V to 36 V

6 Specifications

6.1 Absolute Maximum Ratings

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

	MIN	MAX	UNIT
Supply voltage, V_{CC1} ⁽²⁾		36	V
Output supply voltage, V_{CC2}		36	V
Input voltage, V_I		7	V
Output voltage, V_O	–3	$V_{CC2} + 3$	V
Peak output current, I_O (nonrepetitive, $t \leq 5$ ms): L293	–2	2	A
Peak output current, I_O (nonrepetitive, $t \leq 100$ μ s): L293D	–1.2	1.2	A
Continuous output current, I_O : L293	–1	1	A
Continuous output current, I_O : L293D	–600	600	mA
Maximum junction temperature, T_J		150	°C
Storage temperature, T_{stg}	–65	150	°C

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

6.2 ESD Ratings

	VALUE	UNIT
$V_{(ESD)}$ Electrostatic discharge	Human-body model (HBM), per ANSI/ESDA/JEDEC JS-001 ⁽¹⁾	± 2000
	Charged-device model (CDM), per JEDEC specification JESD22-C101 ⁽²⁾	± 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

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

	MIN	NOM	MAX	UNIT
Supply voltage	V_{CC1}	4.5	7	V
	V_{CC2}	V_{CC1}	36	V
V_{IH} High-level input voltage	$V_{CC1} \leq 7$ V	2.3	V_{CC1}	V
	$V_{CC1} \geq 7$ V	2.3	7	V
V_{IL} Low-level output voltage		–0.3 ⁽¹⁾	1.5	V
T_A Operating free-air temperature		0	70	°C

- (1) The algebraic convention, in which the least positive (most negative) designated minimum, is used in this data sheet for logic voltage levels.

6.4 Thermal Information

THERMAL METRIC ⁽¹⁾		L293, L293D	UNIT
		NE (PDIP)	
		16 PINS	
$R_{\theta JA}$	Junction-to-ambient thermal resistance ⁽²⁾	36.4	°C/W
$R_{\theta JC(top)}$	Junction-to-case (top) thermal resistance	22.5	°C/W
$R_{\theta JB}$	Junction-to-board thermal resistance	16.5	°C/W
Ψ_{JT}	Junction-to-top characterization parameter	7.1	°C/W
Ψ_{JB}	Junction-to-board characterization parameter	16.3	°C/W

- (1) For more information about traditional and new thermal metrics, see the *Semiconductor and IC Package Thermal Metrics* application report, [SPRA953](#).
- (2) The package thermal impedance is calculated in accordance with JEDEC 51-7.

6.5 Electrical Characteristics

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

PARAMETER			TEST CONDITIONS		MIN	TYP	MAX	UNIT	
V _{OH}	High-level output voltage		L293: I _{OH} = −1 A		V _{CC2} − 1.8	V _{CC2} − 1.4		V	
			L293D: I _{OH} = − 0.6 A						
V _{OL}	Low-level output voltage		L293: I _{OL} = 1 A			1.2	1.8	V	
			L293D: I _{OL} = 0.6 A						
V _{OKH}	High-level output clamp voltage		L293D: I _{OK} = −0.6 A		V _{CC2} + 1.3			V	
V _{OKL}	Low-level output clamp voltage		L293D: I _{OK} = 0.6 A		1.3			V	
I _{IH}	High-level input current	A	V _I = 7 V				0.2	100	μA
		EN					0.2	10	
I _{IL}	Low-level input current	A	V _I = 0				−3	−10	μA
		EN					−2	−100	
I _{CC1}	Logic supply current		I _O = 0	All outputs at high level			13	22	mA
				All outputs at low level			35	60	
				All outputs at high impedance			8	24	
I _{CC2}	Output supply current		I _O = 0	All outputs at high level			14	24	mA
				All outputs at low level			2	6	
				All outputs at high impedance			2	4	

6.6 Switching Characteristics

over operating free-air temperature range (unless otherwise noted) $V_{CC1} = 5$ V, $V_{CC2} = 24$ V, $T_A = 25^\circ\text{C}$

PARAMETER			TEST CONDITIONS	MIN	TYP	MAX	UNIT
t _{PLH}	Propagation delay time, low-to-high-level output from A input	L293NE, L293DNE	C _L = 30 pF; See Figure 2		800		ns
		L293DWP, L293N L293DN			750		
t _{PHL}	Propagation delay time, high-to-low-level output from A input	L293NE, L293DNE			400		ns
		L293DWP, L293N L293DN			200		
t _{TLH}	Transition time, low-to-high-level output	L293NE, L293DNE			300		ns
		L293DWP, L293N L293DN			100		
t _{THL}	Transition time, high-to-low-level output	L293NE, L293DNE			300		ns
		L293DWP, L293N L293DN			350		

6.7 Typical Characteristics

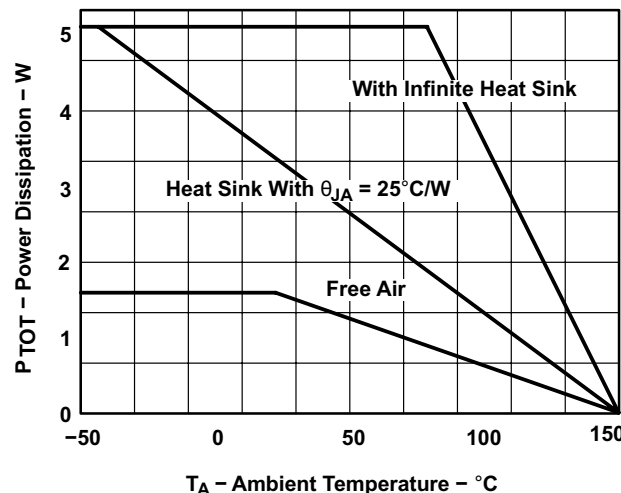
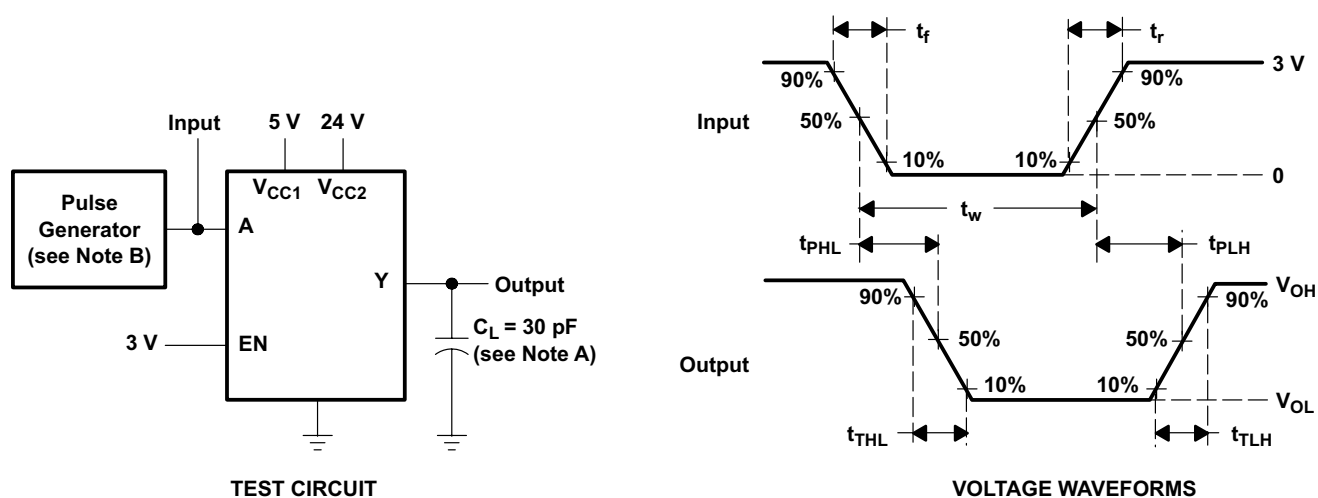


Figure 1. Maximum Power Dissipation vs Ambient Temperature

7 Parameter Measurement Information



NOTES: A. C_L includes probe and jig capacitance.

B. The pulse generator has the following characteristics: $t_r \leq 10$ ns, $t_f \leq 10$ ns, $t_w = 10$ μ s, PRR = 5 kHz, $Z_O = 50$ Ω .

Figure 2. Test Circuit and Voltage Waveforms

8 Detailed Description

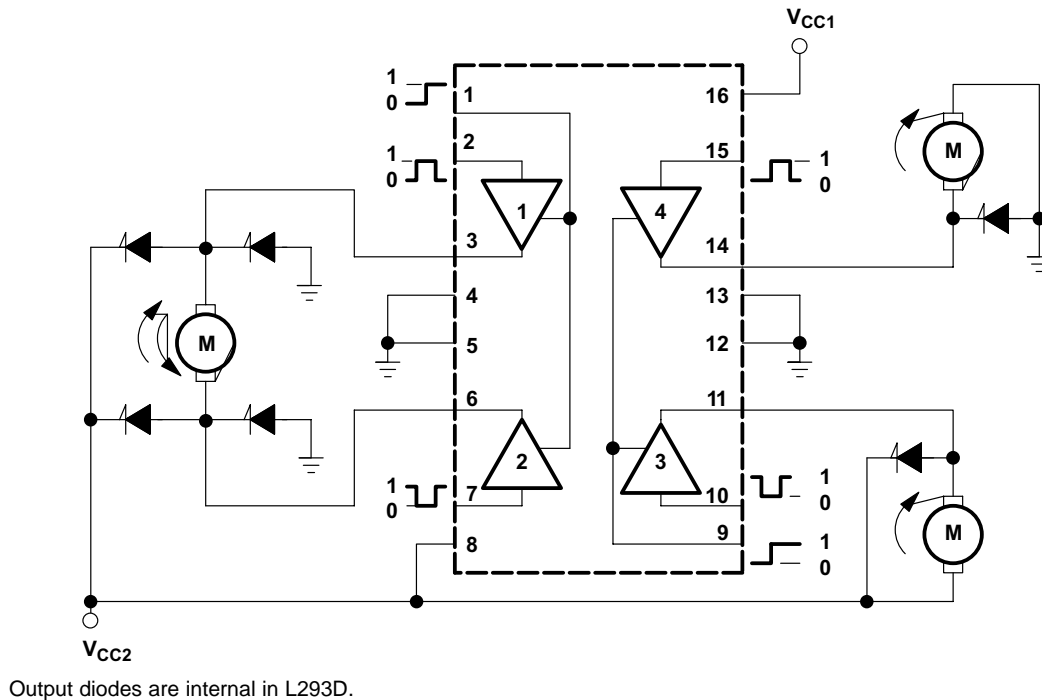
8.1 Overview

The L293 and L293D are quadruple high-current half-H drivers. These devices are designed to drive a wide array of inductive loads such as relays, solenoids, DC and bipolar stepping motors, as well as other high-current and high-voltage loads. All inputs are TTL compatible and tolerant up to 7 V.

Each output is a complete totem-pole drive circuit, with a Darlington transistor sink and a pseudo-Darlington source. Drivers are enabled in pairs, with drivers 1 and 2 enabled by 1,2EN and drivers 3 and 4 enabled by 3,4EN. When an enable input is high, the associated drivers are enabled, and their outputs are active and in phase with their inputs. When the enable input is low, those drivers are disabled, and their outputs are off and in the high-impedance state. With the proper data inputs, each pair of drivers forms a full-H (or bridge) reversible drive suitable for solenoid or motor applications.

On the L293, external high-speed output clamp diodes should be used for inductive transient suppression. On the L293D, these diodes are integrated to reduce system complexity and overall system size. A V_{CC1} terminal, separate from V_{CC2} , is provided for the logic inputs to minimize device power dissipation. The L293 and L293D are characterized for operation from 0°C to 70°C.

8.2 Functional Block Diagram



8.3 Feature Description

The L293x has TTL-compatible inputs and high voltage outputs for inductive load driving. Current outputs can get up to 2 A using the L293.

8.4 Device Functional Modes

Table 1 lists the functional modes of the L293x.

Table 1. Function Table (Each Driver)⁽¹⁾

INPUTS ⁽²⁾		OUTPUT (Y)
A	EN	
H	H	H
L	H	L
X	L	Z

(1) H = high level, L = low level, X = irrelevant, Z = high impedance (off)

(2) In the thermal shutdown mode, the output is in the high-impedance state, regardless of the input levels.

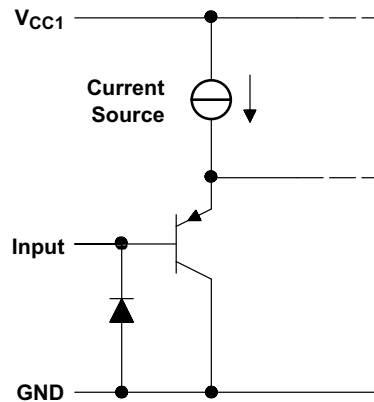


Figure 3. Schematic of Inputs for the L293x

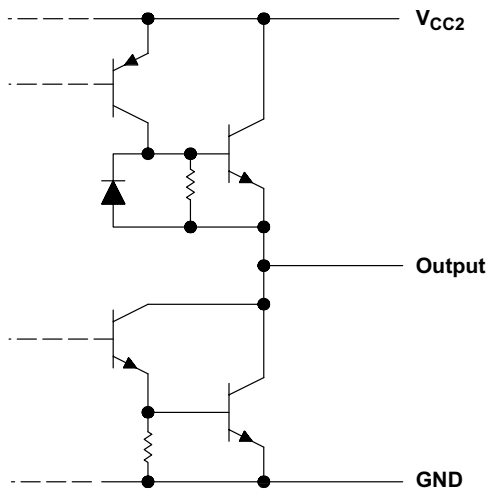


Figure 4. Schematic of Outputs for the L293

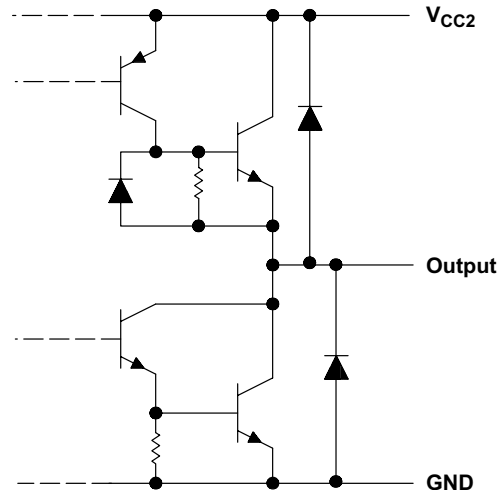


Figure 5. Schematic of Outputs for the L293D

9 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.

9.1 Application Information

A typical application for the L293 device is driving a two-phase motor. Below is an example schematic displaying how to properly connect a two-phase motor to the L293 device.

Provide a 5-V supply to V_{CC1} and valid logic input levels to data and enable inputs. V_{CC2} must be connected to a power supply capable of supplying the needed current and voltage demand for the loads connected to the outputs.

9.2 Typical Application

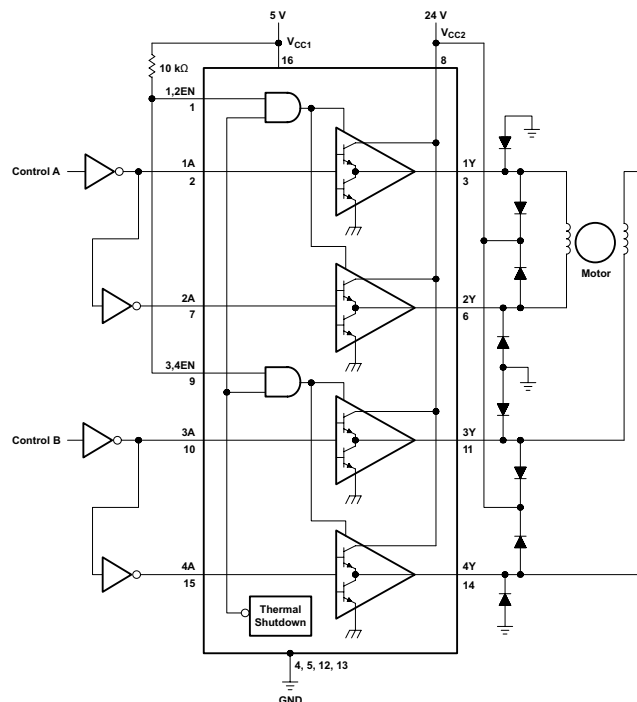


Figure 6. Two-Phase Motor Driver (L293)

9.2.1 Design Requirements

The design techniques in the application above as well as the applications below should fall within the following design requirements.

1. V_{CC1} should fall within the limits described in the [Recommended Operating Conditions](#).
2. V_{CC2} should fall within the limits described in the [Recommended Operating Conditions](#).
3. The current per channel should not exceed 1 A for the L293 (600mA for the L293D).

9.2.2 Detailed Design Procedure

When designing with the L293 or L293D, careful consideration should be made to ensure the device does not exceed the operating temperature of the device. Proper heatsinking will allow for operation over a larger range of current per channel. Refer to the [Power Supply Recommendations](#) as well as the [Layout Example](#).

Typical Application (continued)

9.2.3 Application Curve

Refer to [Power Supply Recommendations](#) for additional information with regards to appropriate power dissipation. [Figure 7](#) describes thermal dissipation based on [Figure 14](#).

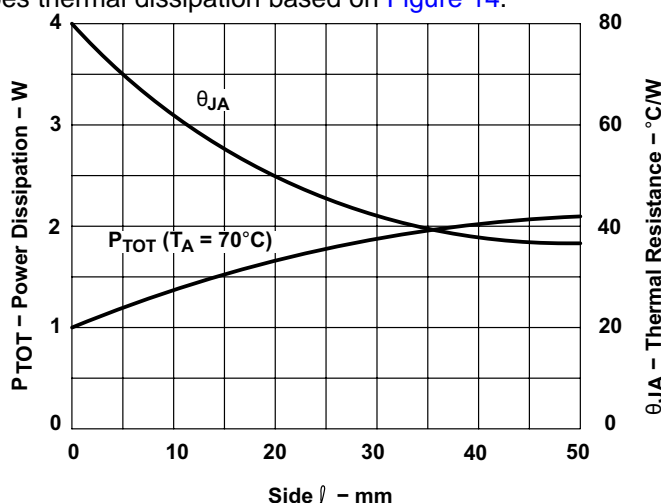


Figure 7. Maximum Power and Junction vs Thermal Resistance

9.3 System Examples

9.3.1 L293D as a Two-Phase Motor Driver

[Figure 8](#) below depicts a typical setup for using the L293D as a two-phase motor driver. Refer to the [Recommended Operating Conditions](#) when considering the appropriate input high and input low voltage levels to enable each channel of the device.

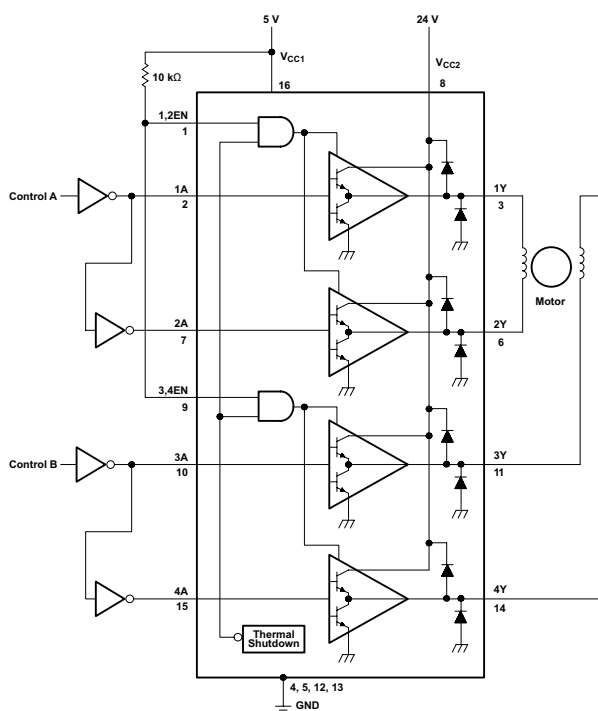
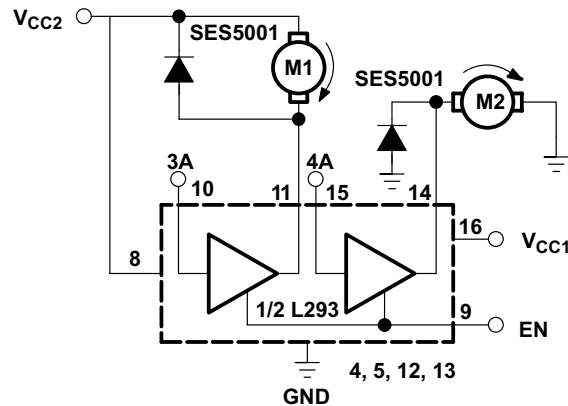


Figure 8. Two-Phase Motor Driver (L293D)

System Examples (continued)

9.3.2 DC Motor Controls

Figure 9 and Figure 10 below depict a typical setup for using the L293 device as a controller for DC motors. Note that the L293 device can be used as a simple driver for a motor to turn on and off in one direction, and can also be used to drive a motor in both directions. Refer to the function tables below to understand unidirectional vs bidirectional motor control. Refer to the [Recommended Operating Conditions](#) when considering the appropriate input high and input low voltage levels to enable each channel of the device.



Connections to ground and to supply voltage

Figure 9. DC Motor Controls

Table 2. Unidirectional DC Motor Control

EN	3A	M1 ⁽¹⁾	4A	M2
H	H	Fast motor stop	H	Run
H	L	run	L	Fast motor stop
L	X	Free-running motor stop	X	Free-running motor stop

(1) L = low, H = high, X = don't care

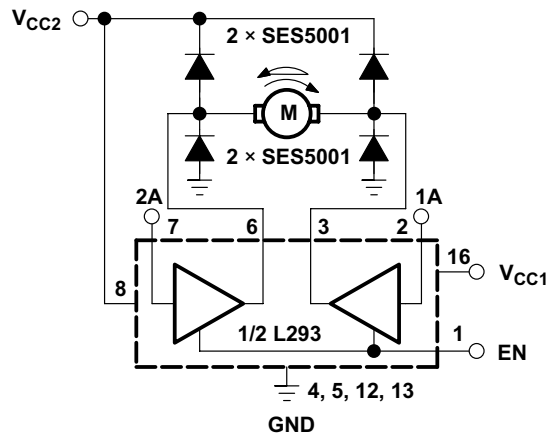


Figure 10. Bidirectional DC Motor Control

Table 3. Bidirectional DC Motor Control

EN	1A	2A	FUNCTION ⁽¹⁾
H	L	H	Turn right
H	H	L	Turn left

(1) L = low, H = high, X = don't care

EN	1A	2A	FUNCTION ⁽¹⁾
H	L	L	Fast motor stop
H	H	H	Fast motor stop
L	X	X	Free-running motor stop

Figure 11 below depicts a typical setup for using the L293D as a two-phase motor driver. Refer to the *Recommended Operating Conditions* when considering the appropriate input high and input low voltage levels to enable each channel of the device.

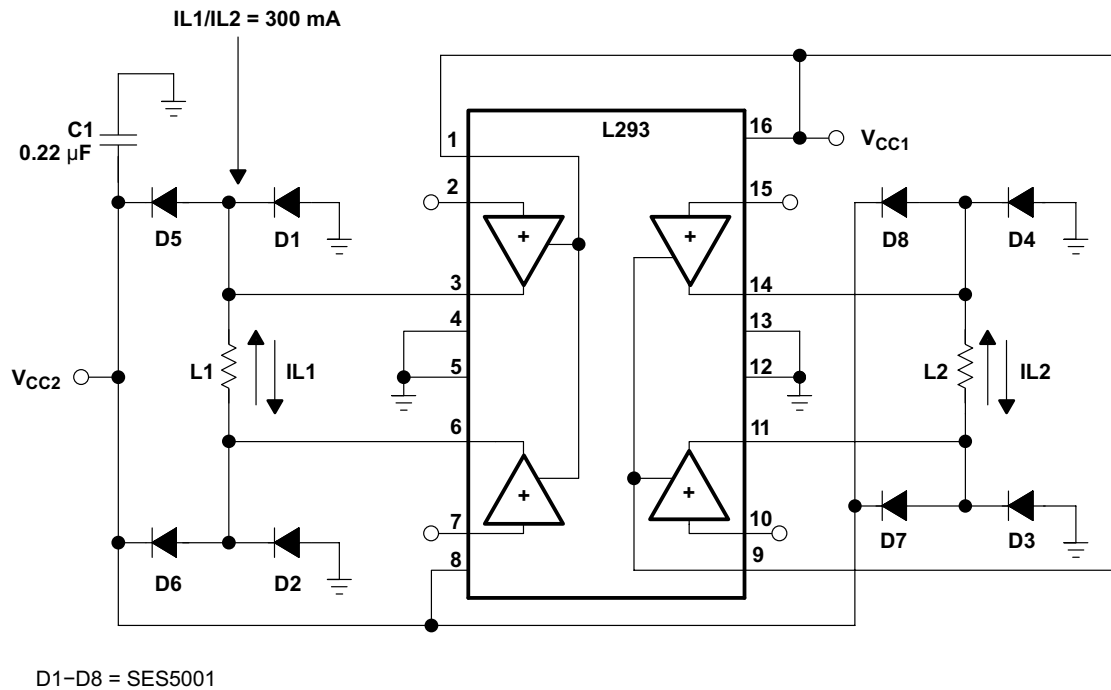


Figure 11. Bipolar Stepping-Motor Control

10 Power Supply Recommendations

V_{CC1} is $5\text{ V} \pm 0.5\text{ V}$ and V_{CC2} can be same supply as V_{CC1} or a higher voltage supply with peak voltage up to 36 V. Bypass capacitors of 0.1 μF or greater should be used at V_{CC1} and V_{CC2} pins. There are no power up or power down supply sequence order requirements.

Properly heatsinking the L293 when driving high-current is critical to design. The $R_{thj-amp}$ of the L293 can be reduced by soldering the GND pins to a suitable copper area of the printed circuit board or to an external heat sink.

Figure 14 shows the maximum package power $PTOT$ and the θ_{JA} as a function of the side of two equal square copper areas having a thickness of 35 μm (see Figure 14). In addition, an external heat sink can be used (see Figure 12).

During soldering, the pin temperature must not exceed 260°C, and the soldering time must not exceed 12 seconds.

The external heatsink or printed circuit copper area must be connected to electrical ground.

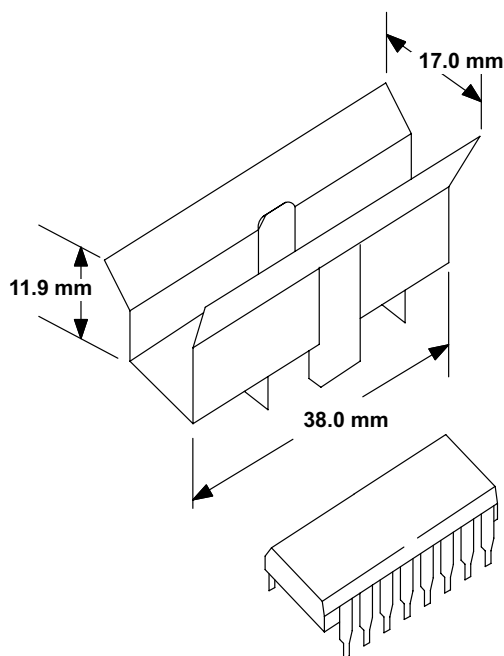


Figure 12. External Heat Sink Mounting Example ($\theta_{JA} = 25^{\circ}\text{C/W}$)

11 Layout

11.1 Layout Guidelines

Place the device near the load to keep output traces short to reduce EMI. Use solid vias to transfer heat from ground pins to ground plane of the printed-circuit-board.

11.2 Layout Example

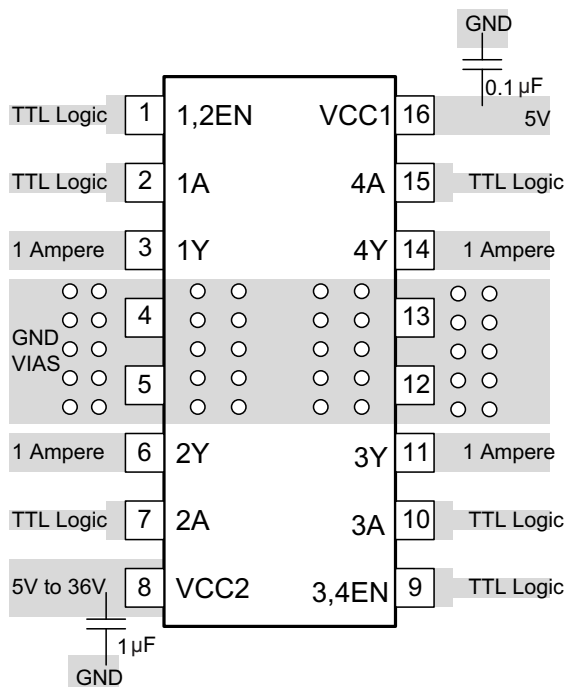


Figure 13. Layout Diagram

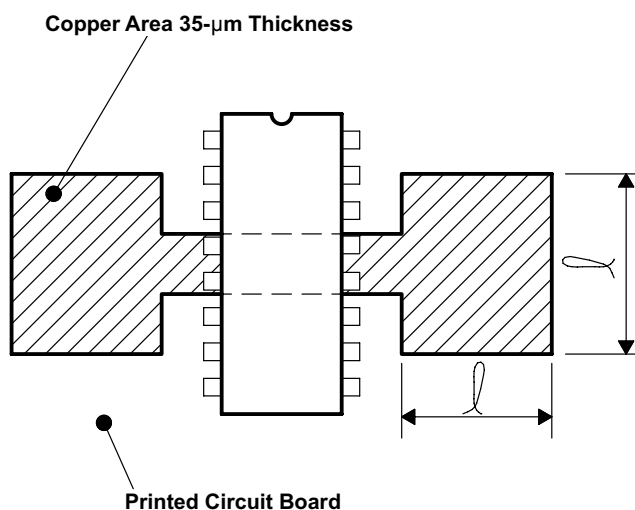


Figure 14. Example of Printed-Circuit-Board Copper Area (Used as Heat Sink)

N (R-PDIP-T**)

16 PINS SHOWN

PLASTIC DUAL-IN-LINE PACKAGE



PINS **	14	16	18	20
DIM				
A MAX	0.775 (19,69)	0.775 (19,69)	0.920 (23,37)	1.060 (26,92)
A MIN	0.745 (18,92)	0.745 (18,92)	0.850 (21,59)	0.940 (23,88)
MS-001 VARIATION	AA	BB	AC	AD



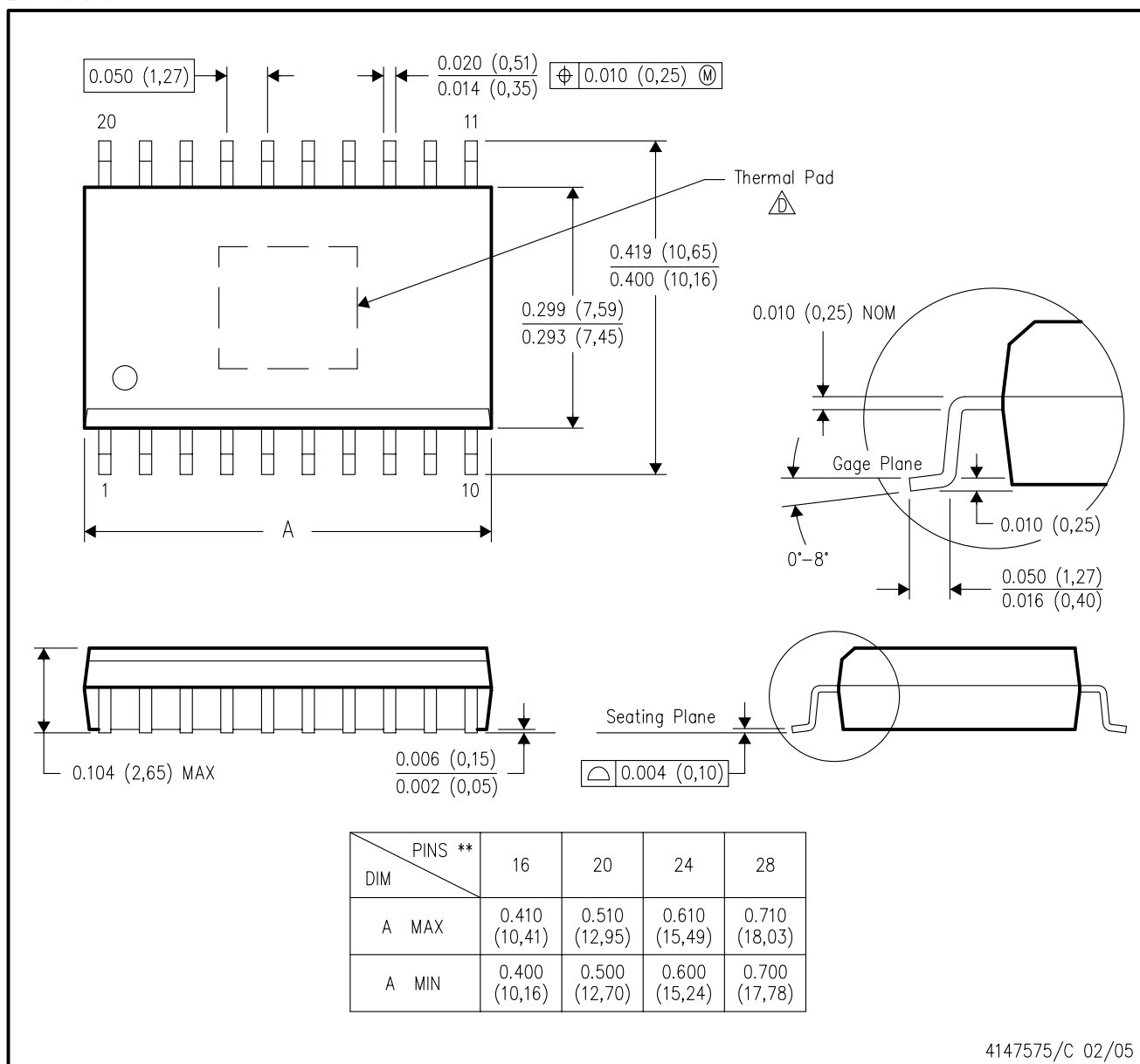
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- NOTES:
- A. All linear dimensions are in inches (millimeters).
 - B. This drawing is subject to change without notice.
 - Falls within JEDEC MS-001, except 18 and 20 pin minimum body length (Dim A).
 - The 20 pin end lead shoulder width is a vendor option, either half or full width.

DWP (R-PDSO-G**)

PowerPAD™ PLASTIC SMALL-OUTLINE PACKAGE

20 PINS SHOWN

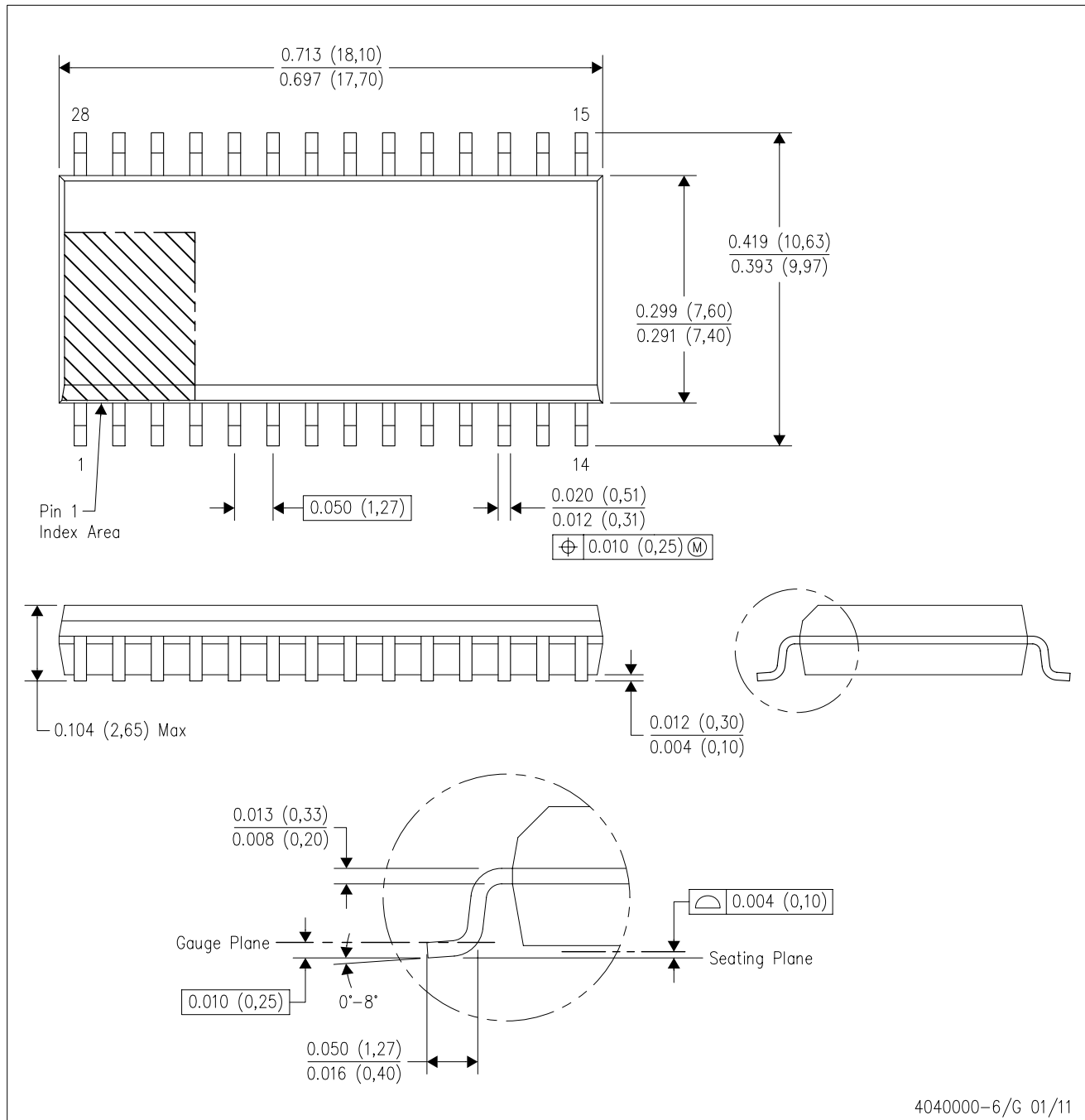


- NOTES:
- A. All linear dimensions are in inches (millimeters).
 - B. This drawing is subject to change without notice.
 - C. Body dimensions do not include mold flash or protrusion not to exceed 0.006 (0,15).
- This package is designed to be soldered to a thermal pad on the board. Refer to Technical Brief, PowerPAD Thermally Enhanced Package, Texas Instruments Literature No. SLMA002 for information regarding recommended board layout. This document is available at www.ti.com <<http://www.ti.com>>. See the product data sheet for details regarding the exposed thermal pad dimensions.

PowerPAD is a trademark of Texas Instruments.

DW (R-PDSO-G28)

PLASTIC SMALL OUTLINE



- NOTES:
- All linear dimensions are in inches (millimeters). Dimensioning and tolerancing per ASME Y14.5M-1994.
 - This drawing is subject to change without notice.
 - Body dimensions do not include mold flash or protrusion not to exceed 0.006 (0,15).
 - Falls within JEDEC MS-013 variation AE.