chanhvinh.com

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.

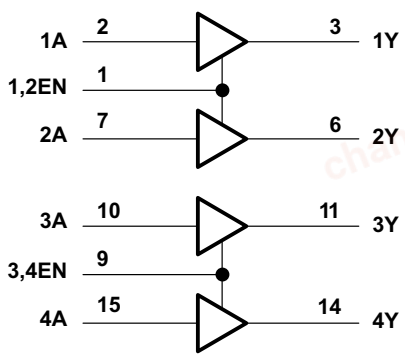
The L293 and L293D are characterized for operation from 0°C to 70°C.

Device Information(1)

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

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

Logic Diagram



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.

chanhvinh.com

Table of Contents

1 Features ... 1
2 Applications ... 1
3 Description ... 1
4 Revision History ... 2
5 Pin Configuration and Functions ... 3
6 Specifications ... 4
6.1 Absolute Maximum Ratings ... 4
6.2 ESD Ratings ... 4
6.3 Recommended Operating Conditions ... 4
6.4 Thermal Information ... 4
6.5 Electrical Characteristics ... 5
6.6 Switching Characteristics ... 5
6.7 Typical Characteristics ... 5
7 Parameter Measurement Information ... 6
8 Detailed Description ... 7
8.1 Overview ... 7
8.2 Functional Block Diagram ... 7
8.3 Feature Description ... 7
8.4 Device Functional Modes ... 8
9 Application and Implementation ... 9
9.1 Application Information ... 9
9.2 Typical Application ... 9
9.3 System Examples ... 10
10 Power Supply Recommendations ... 13
11 Layout ... 14
11.1 Layout Guidelines ... 14
11.2 Layout Example ... 14
12 Device and Documentation Support ... 15
12.1 Related Links ... 15
12.2 Community Resources ... 15
12.3 Trademarks ... 15
12.4 Electrostatic Discharge Caution ... 15
12.5 Glossary ... 15
13 Mechanical, Packaging, and Orderable Information ... 15

4 Revision History

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

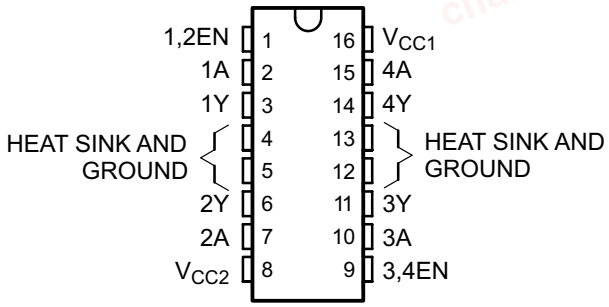
Changes from Revision C (November 2004) to Revision D	Page
• Removed *Ordering Information* table	1
• Added *ESD Ratings* and *Thermal Information* tables, *Feature Description* section, *Device Functional Modes*, *Application and Implementation* section, *Power Supply Recommendations* section, *Layout*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

Copyright © 1986–2016, Texas Instruments Incorporated

chanhvinh.com

5 Pin Configuration and Functions

NE Package
16-Pin PDIP
Top View



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

chanhvinh.com

chanhvinh.com

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 ≤ 5 ms): L293	–2	2	A
Peak output current, I_O (nonrepetitive, t ≤ 100 µs): 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	V
		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_{IH}	High-level input voltage	V_{CC1} ≤ 7 V	2.3		V_{CC1}	V
		V_{CC1} ≥ 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 NE (PDIP) 16 PINS	UNIT
$R_{\theta JA}$	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 JESD 51-7.

Copyright © 1986–2016, Texas Instruments Incorporated

chanhvinh.com

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°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

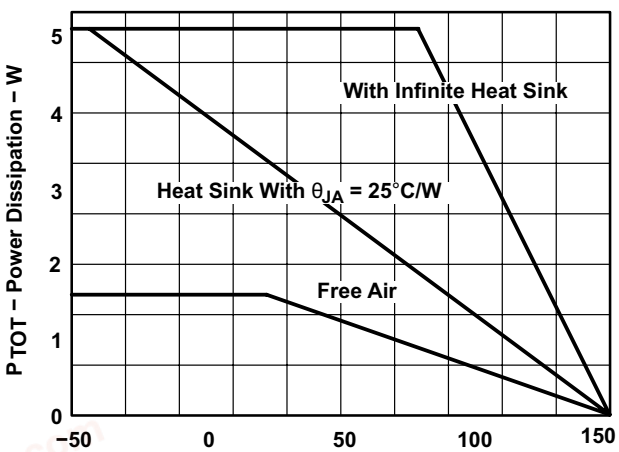
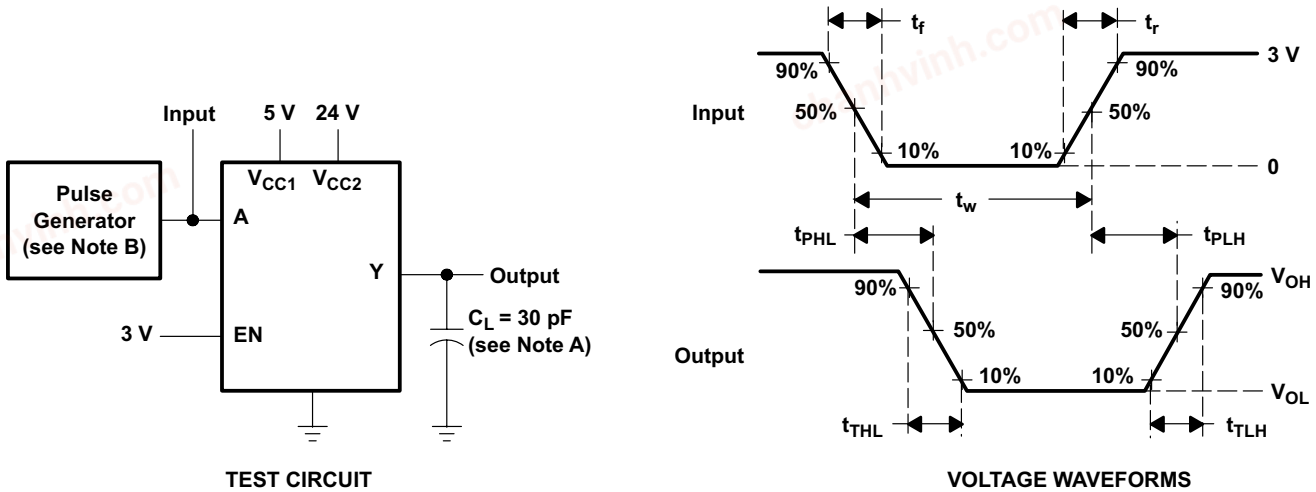


Figure 1. Maximum Power Dissipation vs Ambient Temperature

chanhvinh.com

7 Parameter Measurement Information



TEST CIRCUIT VOLTAGE WAVEFORMS

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, $t_w = 10$ µs, PRR = 5 kHz, $Z_O = 50$ Ω.

Figure 2. Test Circuit and Voltage Waveforms

Copyright © 1986–2016, Texas Instruments Incorporated

chanhvinh.com

8 Detailed Description

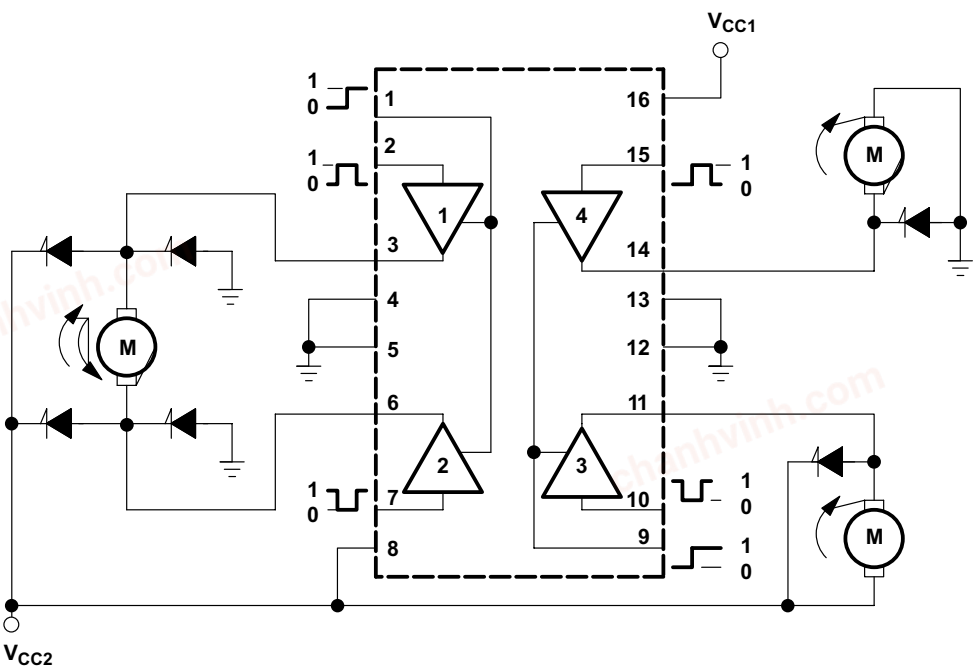
8.1 Overview

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



Output diodes are internal in L293D.

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.

chanhvinh.com

8.4 Device Functional Modes

Table 1 lists the fuctional 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.

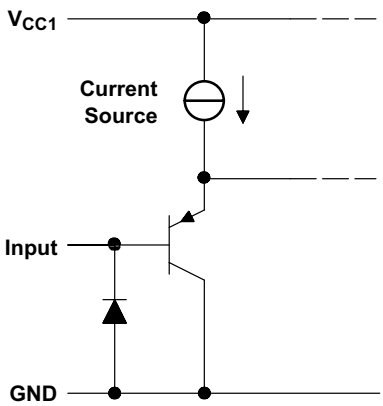


Figure 3. Schematic of Inputs for the L293x

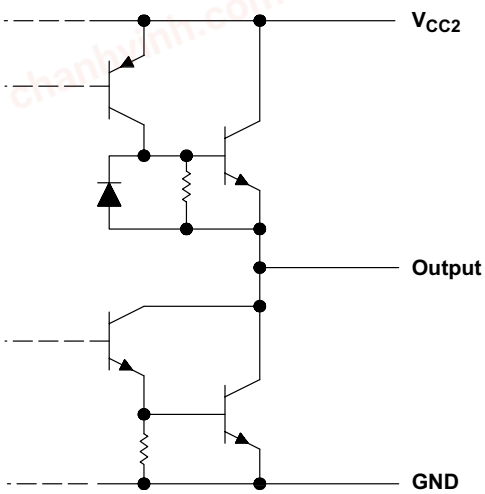


Figure 4. Schematic of Outputs for the L293

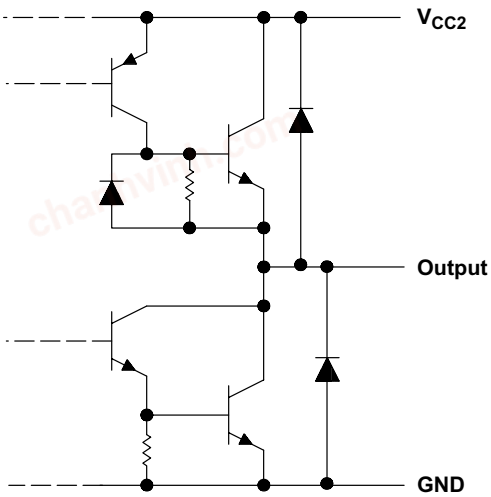


Figure 5. Schematic of Outputs for the L293D

Copyright © 1986–2016, Texas Instruments Incorporated

chanhvinh.com

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

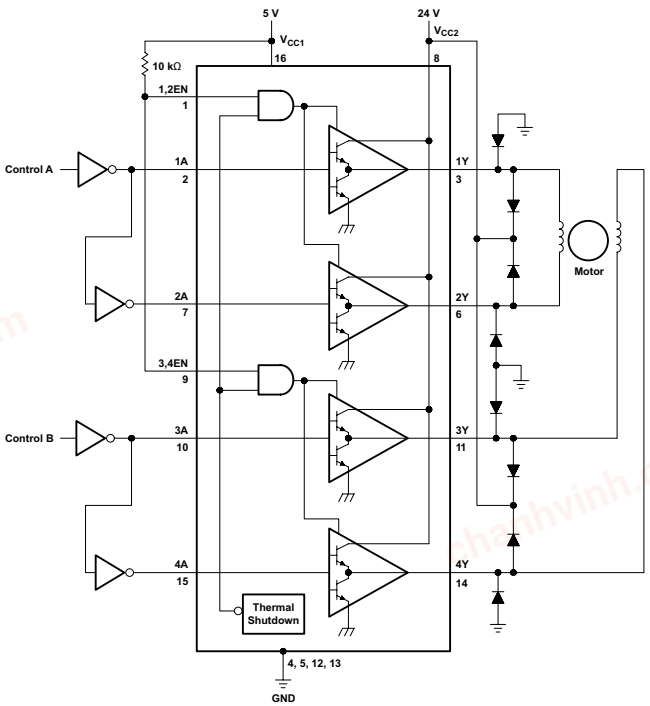


Figure 6. Two-Phase Motor Driver (L293)

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*.

Copyright © 1986–2016, Texas Instruments Incorporated

chanhvinh.com

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.

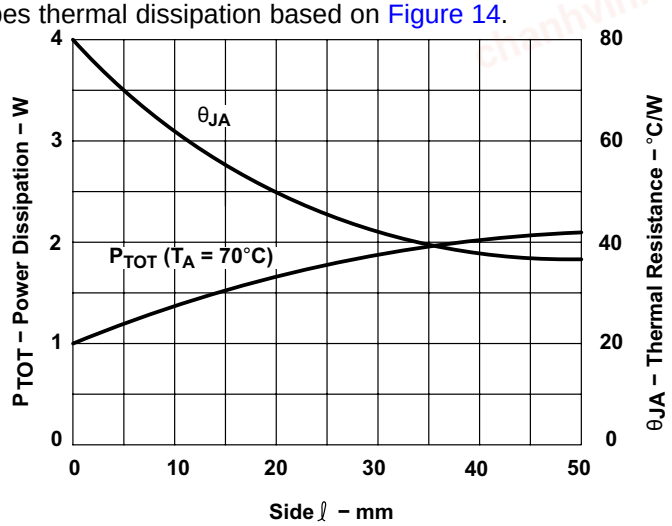


Figure 7. Maximum Power and Junction vs Thermal Resistance

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.

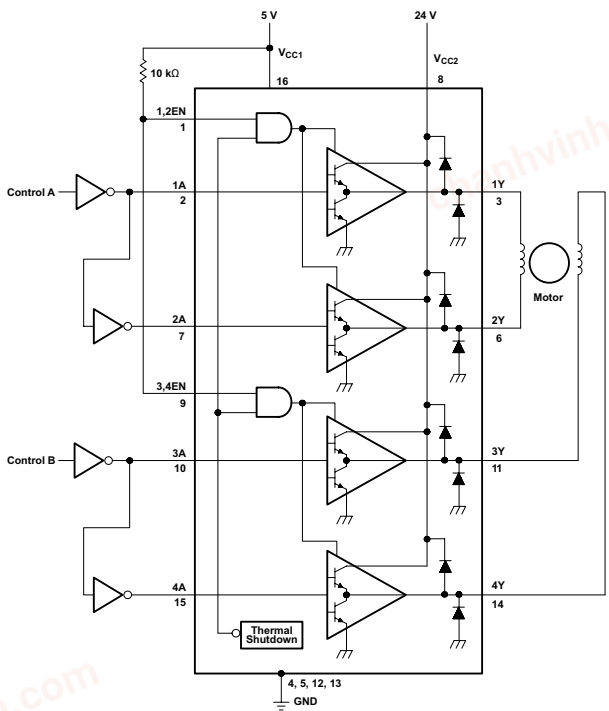


Figure 8. Two-Phase Motor Driver (L293D)

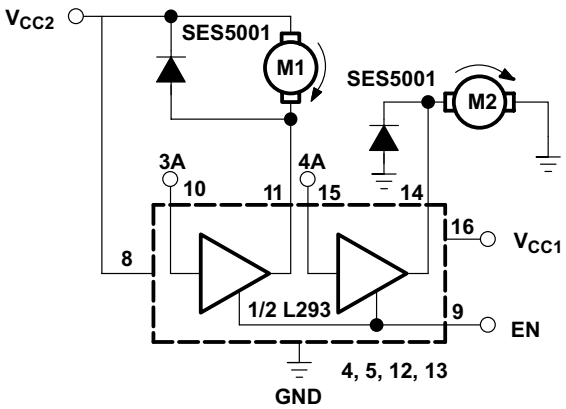
Copyright © 1986–2016, Texas Instruments Incorporated

chanhvinh.com

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

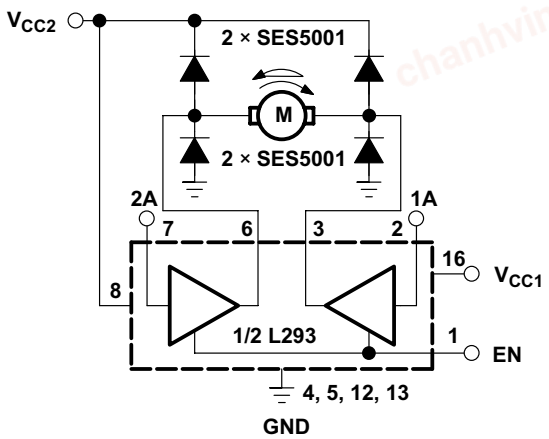


Figure 10. Bidirectional DC Motor Control

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

Copyright © 1986–2016, Texas Instruments Incorporated

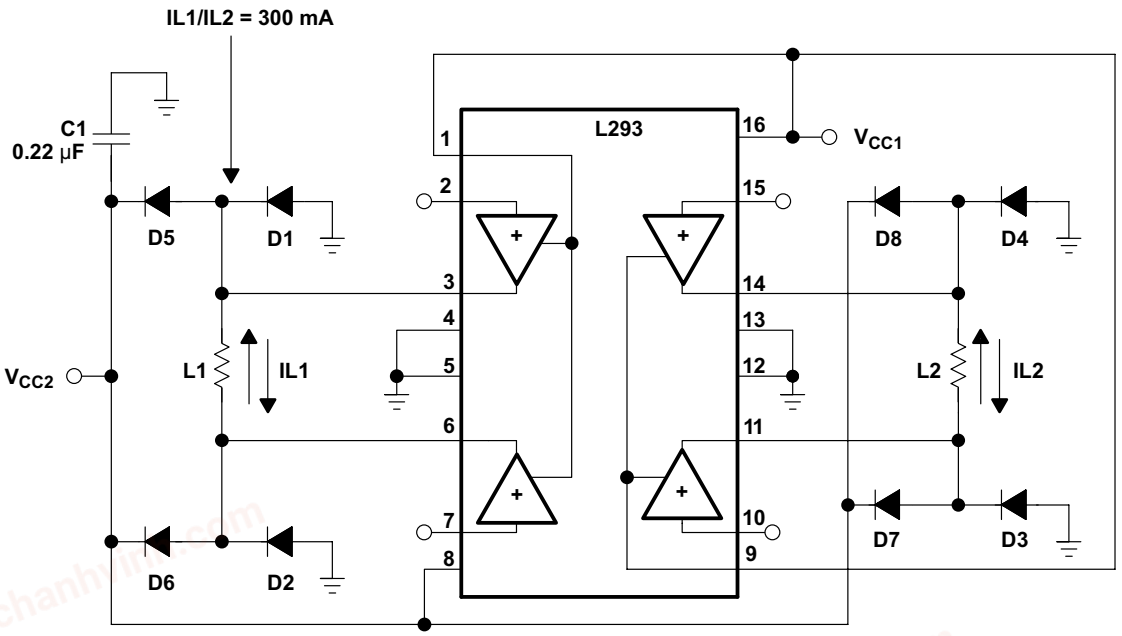
chanhvinh.com

Table 3. Bidirectional DC Motor Control (continued)

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

9.3.3 Bipolar Stepping-Motor Control

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.



D1−D8 = SES5001

Figure 11. Bipolar Stepping-Motor Control

Copyright © 1986–2016, Texas Instruments Incorporated

chanhvinh.com

10 Power Supply Recommendations

V_{CC1} is 5 V ± 0.5 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 uF 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 Rthj-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 θJA 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.

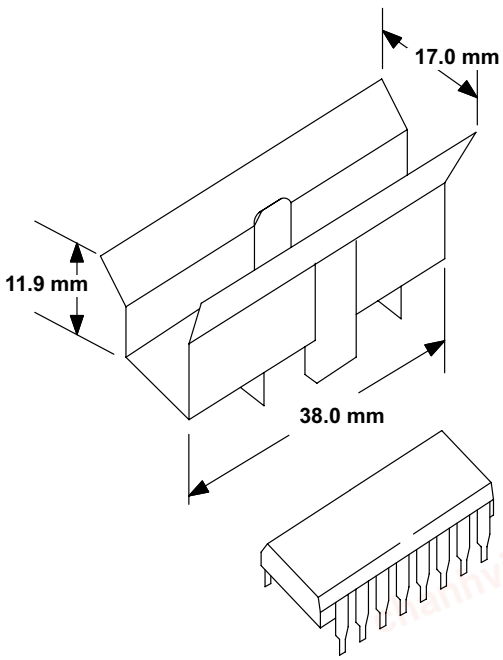


Figure 12. External Heat Sink Mounting Example (θ_{JA} = 25°C/W)

chanhvinh.com

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

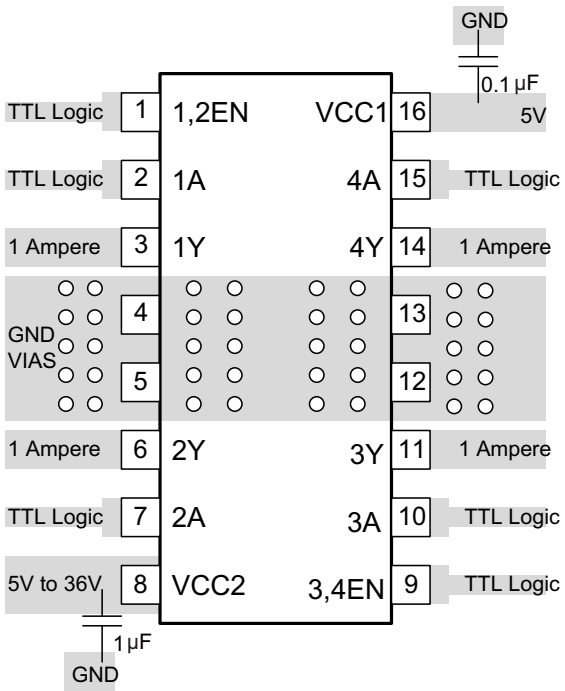


Figure 13. Layout Diagram

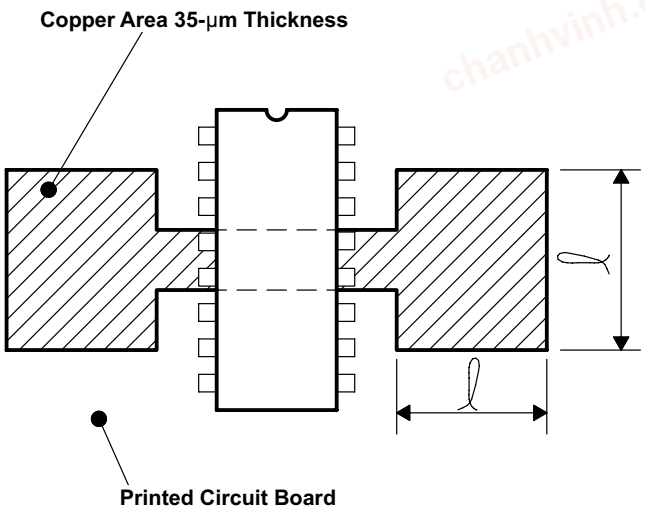


Figure 14. Example of Printed-Circuit-Board Copper Area (Used as Heat Sink)

Copyright © 1986–2016, Texas Instruments Incorporated

chanhvinh.com

12 Device and Documentation Support

12.1 Related Links

The table below lists quick access links. Categories include technical documents, support and community resources, tools and software, and quick access to sample or buy.

Table 4. Related Links

PARTS	PRODUCT FOLDER	SAMPLE & BUY	TECHNICAL DOCUMENTS	TOOLS & SOFTWARE	SUPPORT & COMMUNITY
L293	Click here	Click here	Click here	Click here	Click here
L293D	Click here	Click here	Click here	Click here	Click here

12.2 Community Resources

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

TI E2E™ Online Community ***TI's Engineer-to-Engineer (E2E) Community.*** Created to foster collaboration among engineers. At e2e.ti.com, you can ask questions, share knowledge, explore ideas and help solve problems with fellow engineers.

Design Support ***TI's Design Support*** Quickly find helpful E2E forums along with design support tools and contact information for technical support.

12.3 Trademarks

E2E is a trademark of Texas Instruments.
All other trademarks are the property of their respective owners.

12.4 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.

12.5 Glossary

SLYZ022 — *TI Glossary*.

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

13 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.

Copyright © 1986–2016, Texas Instruments Incorporated

chanhvinh.com

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)
L293DNE	Active	Production	PDIP (NE) | 16	25 | TUBE	Yes	NIPDAU	N/A for Pkg Type	0 to 70	L293DNE
L293DNE.A	Active	Production	PDIP (NE) | 16	25 | TUBE	Yes	NIPDAU	N/A for Pkg Type	0 to 70	L293DNE
L293DNEE4	Active	Production	PDIP (NE) | 16	25 | TUBE	Yes	NIPDAU	N/A for Pkg Type	0 to 70	L293DNE
L293NE	Active	Production	PDIP (NE) | 16	25 | TUBE	Yes	NIPDAU	N/A for Pkg Type	0 to 70	L293NE
L293NE.A	Active	Production	PDIP (NE) | 16	25 | TUBE	Yes	NIPDAU	N/A for Pkg Type	0 to 70	L293NE
L293NEE4	Active	Production	PDIP (NE) | 16	25 | TUBE	Yes	NIPDAU	N/A for Pkg Type	0 to 70	L293NE

(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.

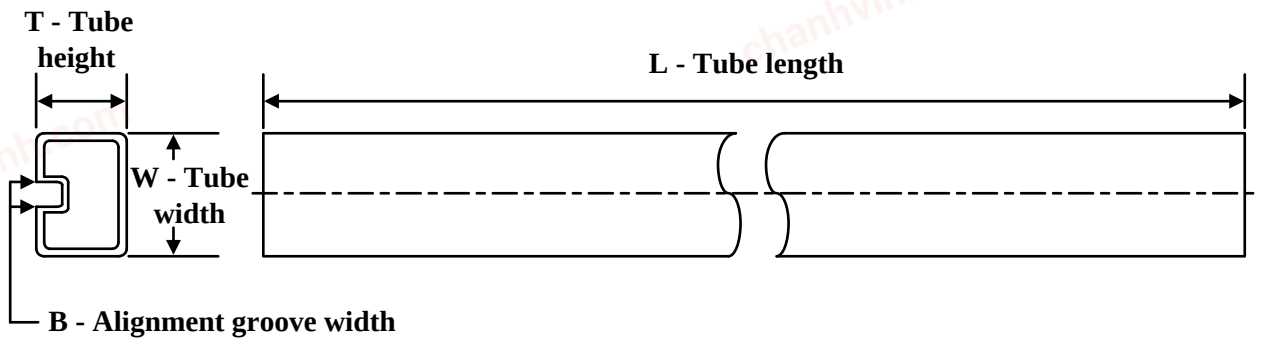
chanhvinh.com

chanhvinh.com
chanhvinh.com
chanhvinh.com
chanhvinh.com
chanhvinh.com
chanhvinh.com

chanhvinh.com

PACKAGE MATERIALS INFORMATION

TUBE



*All dimensions are nominal

Device	Package Name	Package Type	Pins	SPQ	L (mm)	W (mm)	T (µm)	B (mm)
L293DNE	NE	PDIP	16	25	506	13.97	11230	4.32
L293DNE.A	NE	PDIP	16	25	506	13.97	11230	4.32
L293DNEE4	NE	PDIP	16	25	506	13.97	11230	4.32
L293NE	NE	PDIP	16	25	506	13.97	11230	4.32
L293NE.A	NE	PDIP	16	25	506	13.97	11230	4.32
L293NEE4	NE	PDIP	16	25	506	13.97	11230	4.32

chanhvinh.com

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 © 2025, Texas Instruments Incorporated

Last updated 10/2025

chanhvinh.com