

# SN74LV8T139-EP Enhanced Product, Dual 2 to 4-Bit Decoders/Demultiplexers With Logic Level Shifter

## 1 Features

- Wide operating range of 1.65V to 5.5V
- 5.5V tolerant input pins
- Single-supply voltage translator (refer to *LVxT Enhanced Input Voltage*):
  - Up translation:
    - 1.2V to 1.8V
    - 1.5V to 2.5V
    - 1.8V to 3.3V
    - 3.3V to 5.0V
  - Down translation:
    - 5.0V, 3.3V, 2.5V to 1.8V
    - 5.0V, 3.3V to 2.5V
    - 5.0V to 3.3V
- Up to 150Mbps with 5V or 3.3V  $V_{CC}$
- Supports standard function pinout
- Latch-up performance exceeds 250mA per JESD 17
- Supports defense and aerospace applications:
  - Controlled baseline
  - One assembly and test site
  - One fabrication site
  - Extended product life cycle
  - Product traceability

## 2 Applications

- [Enable or disable a digital signal](#)
- [Controlling an indicator LED](#)
- [Translation between communication modules and system controllers](#)

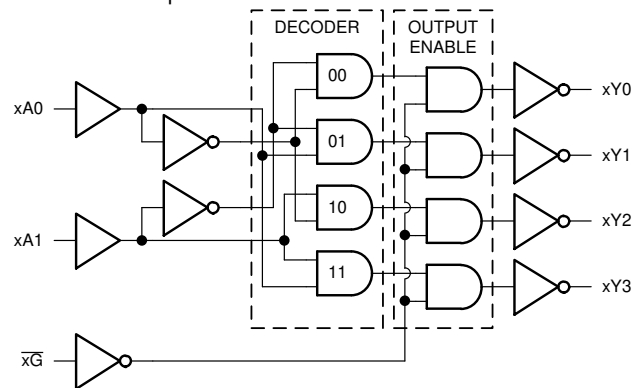
## 3 Description

The SN74LV8T139-EP contains two two-to-four decoders with one active low output strobe  $\overline{G}$ . When the outputs of one channel are gated by the strobe input, they are all forced into the high state. When the outputs are not disabled by the strobe input, only the selected output is low while all others are high.

### Package Information

PART NUMBER	PACKAGE <sup>(1)</sup>	PACKAGE SIZE <sup>(2)</sup>	BODY SIZE <sup>(3)</sup>
SN74LV8T139-EP	PW (TSSOP, 16)	5mm × 6.4mm	5mm × 4.4mm

- (1) For more information, see Mechanical Packaging and Orderable Information Section.
- (2) The package size (length × width) is a nominal value and includes pins, where applicable
- (3) The body size (length × width) is a nominal value and does not include pins.



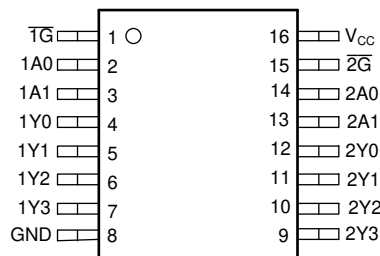
Logic Diagram (Positive Logic)



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## 4 Pin Configuration and Functions



**Figure 4-1. PW Package,  
16-Pin TSSOP  
(Top View)**

**Table 4-1. Pin Functions**

PIN		TYPE <sup>(1)</sup>	DESCRIPTION
NAME	NO.		
$\overline{1G}$	1	I	Channel 1 strobe input, active low
1A0	2	I	Channel 1 select input 0
1A1	3	I	Channel 1 select input 1
1Y0	4	O	Channel 1 output 0
1Y1	5	O	Channel 1 output 1
1Y2	6	O	Channel 1 output 2
1Y3	7	O	Channel 1 output 3
GND	8	G	Ground
2Y3	9	O	Channel 2 output 3
2Y2	10	O	Channel 2 output 2
2Y1	11	O	Channel 2 output 1
2Y0	12	O	Channel 2 output 0
2A1	13	I	Channel 2 input 1
2A0	14	I	Channel 2 input 0
$\overline{2G}$	15	I	Channel 2 strobe input, active low
V <sub>CC</sub>	16	P	Positive supply

(1) Signal Types: I = Input, O = Output, I/O = Input or Output, P = Power, G = Ground.

## 5 Specifications

### 5.1 Absolute Maximum Ratings

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

			MIN	MAX	UNIT
V <sub>CC</sub>	Supply voltage range		-0.5	7	V
V <sub>I</sub>	Input voltage range <sup>(2)</sup>		-0.5	7	V
V <sub>O</sub>	Voltage range applied to any output in the high-impedance or power-off state <sup>(2)</sup>		-0.5	7	V
V <sub>O</sub>	Output voltage range <sup>(2)</sup>		-0.5	V <sub>CC</sub> + 0.5	V
I <sub>IK</sub>	Input clamp current	V <sub>I</sub> < -0.5V		-20	mA
I <sub>OK</sub>	Output clamp current	V <sub>O</sub> < -0.5V or V <sub>O</sub> > V <sub>CC</sub> + 0.5V		±20	mA
I <sub>O</sub>	Continuous output current	V <sub>O</sub> = 0 to V <sub>CC</sub>		±25	mA
	Continuous output current through V <sub>CC</sub> or GND			±50	mA
T <sub>stg</sub>	Storage temperature		-65	150	°C

- (1) Operation outside the *Absolute Maximum Ratings* may cause permanent device damage. Absolute maximum ratings do not imply functional operation of the device at these or any other conditions beyond those listed under *Recommended Operating Conditions*. If briefly operating outside the *Recommended Operating Conditions* but within the *Absolute Maximum Ratings*, the device may not sustain damage, but it may not be fully functional. Operating the device in this manner may affect device reliability, functionality, performance, and shorten the device lifetime.
- (2) The input and output voltage ratings may be exceeded if the input and output current ratings are observed.

### 5.2 ESD Ratings

			VALUE	UNIT
V <sub>(ESD)</sub>	Electrostatic discharge	Human-body model (HBM), per ANSI/ESDA/JEDEC JS-001 <sup>(1)</sup>	±2000	V
		Charged-device model (CDM), per ANSI/ESDA/JEDEC JS-002 <sup>(2)</sup>	±1000	

- (1) JEDEC document JEP155 states that 500V HBM allows safe manufacturing with a standard ESD control process.
- (2) JEDEC document JEP157 states that 250V CDM allows safe manufacturing with a standard ESD control process.

### 5.3 Recommended Operating Conditions

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

Specification	Description	Condition	MIN	MAX	UNIT
V <sub>CC</sub>	Supply voltage		1.8	5.5	V
V <sub>I</sub>	Input voltage		0	5.5	V
V <sub>O</sub>	Output voltage		0	V <sub>CC</sub>	V
V <sub>IH</sub>	High-level input voltage	V <sub>CC</sub> = 1.65V to 2V	1.1		V
		V <sub>CC</sub> = 2.25V to 2.75V	1.28		
		V <sub>CC</sub> = 3V to 3.6V	1.45		
		V <sub>CC</sub> = 4.5V to 5.5V	2		
V <sub>IL</sub>	Low-Level input voltage	V <sub>CC</sub> = 1.65V to 2V		0.5	V
		V <sub>CC</sub> = 2.25V to 2.75V		0.65	
		V <sub>CC</sub> = 3V to 3.6V		0.75	
		V <sub>CC</sub> = 4.5V to 5.5V		0.85	
I <sub>O</sub>	Output current	V <sub>CC</sub> = 1.6V to 2V		±3	mA
		V <sub>CC</sub> = 2.25V to 2.75V		±7	
		V <sub>CC</sub> = 3.3V to 5.0V		±15	
I <sub>O</sub>	Output Current	V <sub>CC</sub> = 4.5V to 5.5V		±25	mA
Δt/Δv	Input transition rise or fall rate	V <sub>CC</sub> = 1.6V to 5.0V		20	ns/V
T <sub>A</sub>	Operating free-air temperature		-55	125	°C

## 5.4 Thermal Information

PACKAGE	PINS	THERMAL METRIC <sup>(1)</sup>						UNIT
		R <sub>θJA</sub>	R <sub>θJC(top)</sub>	R <sub>θJB</sub>	Ψ <sub>JT</sub>	Ψ <sub>JB</sub>	R <sub>θJC(bot)</sub>	
PW (TSSOP)	16	117.4	52.5	75.2	4.7	74.5	-	°C/W

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

## 5.5 Electrical Characteristics

over operating free-air temperature range; typical ratings measured at T<sub>A</sub> = 25°C (unless otherwise noted).

PARAMETER	TEST CONDITIONS	V <sub>CC</sub>	MIN	TYP	MAX	UNIT
V <sub>OH</sub>	I <sub>OH</sub> = -50 μA	1.2V to 5.5V	V <sub>CC</sub> -0.2			V
	I <sub>OH</sub> = -1 mA	1.2V	0.8			
	I <sub>OH</sub> = -2 mA	1.65V to 2V	1.21	1.7 <sup>(1)</sup>		
	I <sub>OH</sub> = -3 mA	2.25V to 2.75V	1.93	2.4 <sup>(1)</sup>		
	I <sub>OH</sub> = -5.5 mA	3V to 3.6V	2.49	3.08 <sup>(1)</sup>		
	I <sub>OH</sub> = -8 mA	4.5V to 5.5V	3.95	4.65 <sup>(1)</sup>		
	I <sub>OH</sub> = -24 mA	4.5V to 5.5V	3.15			
V <sub>OL</sub>	I <sub>OL</sub> = 50 μA	1.2V to 5.5V			0.1	V
	I <sub>OL</sub> = 1 mA	1.2V			0.2	
	I <sub>OL</sub> = 2 mA	1.65V to 2V		0.1 <sup>(1)</sup>	0.25	
	I <sub>OL</sub> = 3 mA	2.25V to 2.75V		0.1 <sup>(1)</sup>	0.2	
	I <sub>OL</sub> = 5.5 mA	3V to 3.6V		0.2 <sup>(1)</sup>	0.25	
	I <sub>OL</sub> = 8 mA	4.5V to 5.5V		0.3 <sup>(1)</sup>	0.35	
	I <sub>OL</sub> = 24 mA	4.5V to 5.5V			0.75	
I <sub>I</sub>	V <sub>I</sub> = 0 V or V <sub>CC</sub>	0V to 5.5V		±0.1	±1	μA
I <sub>CC</sub>	V <sub>I</sub> = V <sub>CC</sub> or GND, I <sub>O</sub> = 0	1.8V to 5.5V		2	20	μA
ΔI <sub>CC</sub>	One input at 0.3 V or 3.4 V, other inputs at 0 or V <sub>CC</sub> , I <sub>O</sub> = 0	5.5V		1.35	1.5	mA
	One input at 0.3 V or 1.1 V, other inputs at 0 or V <sub>CC</sub> , I <sub>O</sub> = 0	1.8V			68	μA
C <sub>I</sub>	V <sub>I</sub> = V <sub>CC</sub> or GND	5V		3	5	pF
C <sub>O</sub>	V <sub>O</sub> = V <sub>CC</sub> or GND	V		5	8	pF
C <sub>PD</sub> <sup>(2) (3)</sup>	C <sub>L</sub> = 50 pF, F = 10 MHz	1.8V to 5.5V			200	pF

(1) Typical value at nearest nominal voltage (1.8V, 2.5V, 3.3V, and 5V)

(2) C<sub>PD</sub> is used to determine the dynamic power consumption, per channel.

(3) P<sub>D</sub> = V<sub>CC</sub><sup>2</sup> × F<sub>I</sub> × (C<sub>PD</sub> + C<sub>L</sub>) where F<sub>I</sub> = input frequency, C<sub>L</sub> = output load capacitance, V<sub>CC</sub> = supply voltage.

## 5.6 Switching Characteristics

over operating free-air temperature range; typical values measured at T<sub>A</sub> = 25°C (unless otherwise noted)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	Load Capacitance	V <sub>CC</sub>	-55°C to 125°C			UNIT
					MIN	TYP	MAX	
t <sub>PHL</sub>	A or B	Any Y	CL = 15pF	1.8V		32.6	38.5	ns
t <sub>PLH</sub>	A or B	Any Y	CL = 15pF	1.8V		24.5	28.0	ns
t <sub>PHL</sub>	G	Any Y	CL = 15pF	1.8V		27.4	32.0	ns
t <sub>PLH</sub>	G	Any Y	CL = 15pF	1.8V		18.9	22.0	ns
t <sub>PHL</sub>	A or B	Any Y	C <sub>L</sub> = 50pF	1.8V		37.2	43.0	ns
t <sub>PLH</sub>	A or B	Any Y	C <sub>L</sub> = 50pF	1.8V		28.1	31.5	ns
t <sub>PHL</sub>	G	Any Y	C <sub>L</sub> = 50pF	1.8V		32.2	37.0	ns
t <sub>PLH</sub>	G	Any Y	C <sub>L</sub> = 50pF	1.8V		22.5	25.8	ns

over operating free-air temperature range; typical values measured at  $T_A = 25^\circ\text{C}$  (unless otherwise noted)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	Load Capacitance	$V_{CC}$	-55°C to 125°C			UNIT
					MIN	TYP	MAX	
$t_{PHL}$	A or B	Any Y	$C_L = 15\text{pF}$	2.5V		17.2	22.0	ns
$t_{PLH}$	A or B	Any Y	$C_L = 15\text{pF}$	2.5V		13.5	16.5	ns
$t_{PHL}$	G	Any Y	$C_L = 15\text{pF}$	2.5V		14.9	19.0	ns
$t_{PLH}$	G	Any Y	$C_L = 15\text{pF}$	2.5V		10.2	12.0	ns
$t_{PHL}$	A or B	Any Y	$C_L = 50\text{pF}$	2.5V		20.2	25.5	ns
$t_{PLH}$	A or B	Any Y	$C_L = 50\text{pF}$	2.5V		15.8	19.0	ns
$t_{PHL}$	G	Any Y	$C_L = 50\text{pF}$	2.5V		18.1	22.0	ns
$t_{PLH}$	G	Any Y	$C_L = 50\text{pF}$	2.5V		12.5	14.5	ns
$t_{PHL}$	A or B	Any Y	$C_L = 15\text{pF}$	3.3V		12.1	15.7	ns
$t_{PLH}$	A or B	Any Y	$C_L = 15\text{pF}$	3.3V		9.51	14.7	ns
$t_{PHL}$	G	Any Y	$C_L = 15\text{pF}$	3.3V		10.4	14.7	ns
$t_{PLH}$	G	Any Y	$C_L = 15\text{pF}$	3.3V		7.09	14.7	ns
$t_{PHL}$	A or B	Any Y	$C_L = 50\text{pF}$	3.3V		14.4	18.5	ns
$t_{PLH}$	A or B	Any Y	$C_L = 50\text{pF}$	3.3V		11.4	14.7	ns
$t_{PHL}$	G	Any Y	$C_L = 50\text{pF}$	3.3V		12.9	16.5	ns
$t_{PLH}$	G	Any Y	$C_L = 50\text{pF}$	3.3V		8.88	14.7	ns
$t_{PHL}$	A or B	Any Y	$C_L = 15\text{pF}$	5V		8.26	10.8	ns
$t_{PLH}$	A or B	Any Y	$C_L = 15\text{pF}$	5V		6.4	10.5	ns
$t_{PHL}$	G	Any Y	$C_L = 15\text{pF}$	5V		7.06	10.5	ns
$t_{PLH}$	G	Any Y	$C_L = 15\text{pF}$	5V		5.43	10.5	ns
$t_{PHL}$	A or B	Any Y	$C_L = 50\text{pF}$	5V		10.1	12.5	ns
$t_{PLH}$	A or B	Any Y	$C_L = 50\text{pF}$	5V		7.8	10.5	ns
$t_{PHL}$	G	Any Y	$C_L = 50\text{pF}$	5V		8.82	11.0	ns
$t_{PLH}$	G	Any Y	$C_L = 50\text{pF}$	5V		6.89	10.5	ns

## 5.7 Typical Characteristics

$T_A = 25^\circ\text{C}$  (unless otherwise noted)

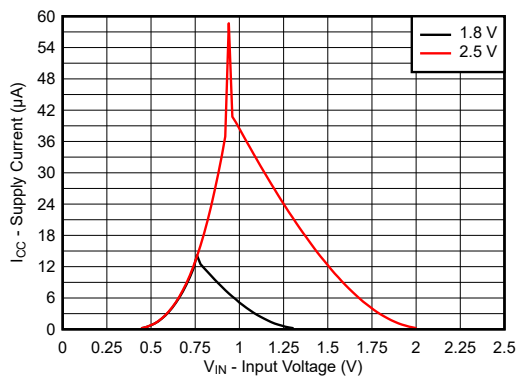


Figure 5-1. Supply Current Across Input Voltage 1.8V and 2.5V Supply

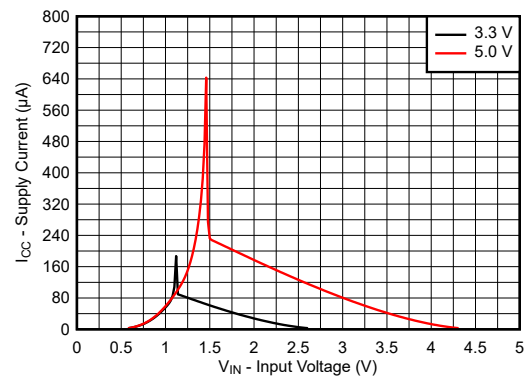
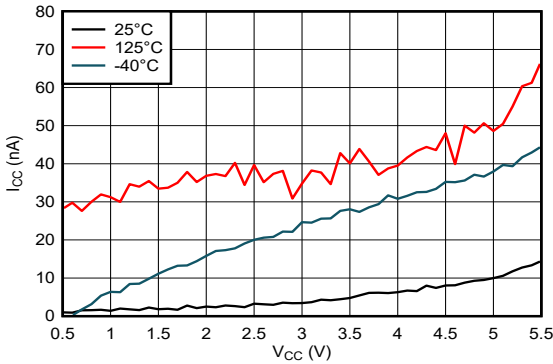


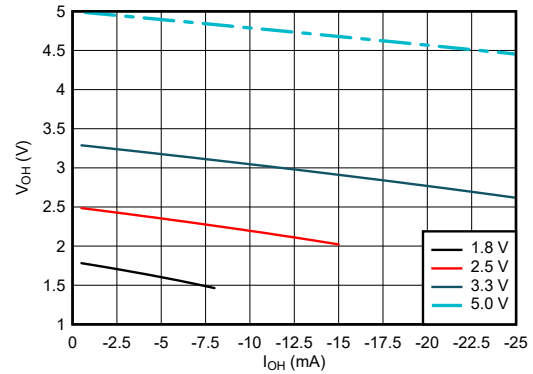
Figure 5-2. Supply Current Across Input Voltage 3.3V and 5.0V Supply

## 5.7 Typical Characteristics (continued)

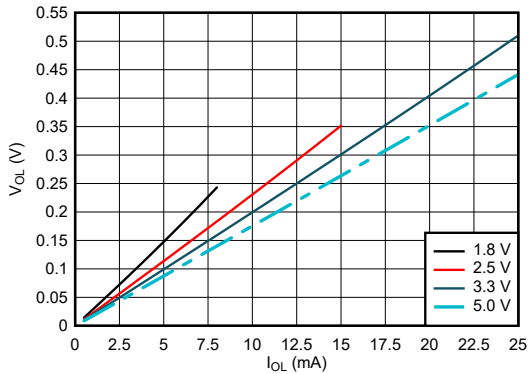
$T_A = 25^\circ\text{C}$  (unless otherwise noted)



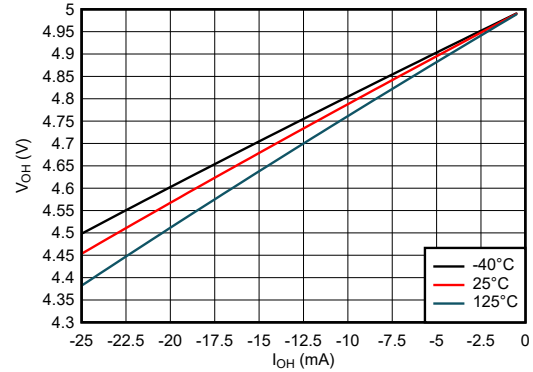
**Figure 5-3. Supply Current Across Supply Voltage**



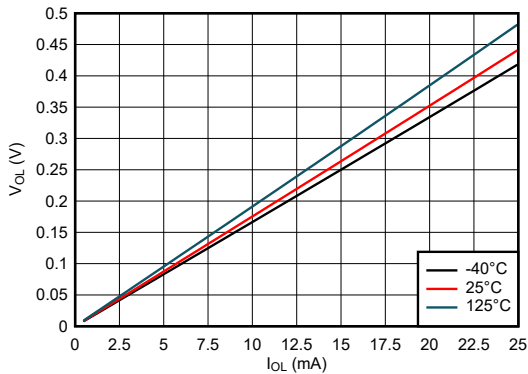
**Figure 5-4. Output Voltage vs Current in HIGH State**



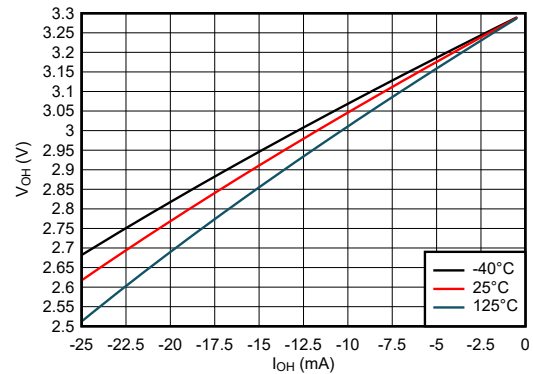
**Figure 5-5. Output Voltage vs Current in LOW State**



**Figure 5-6. Output Voltage vs Current in HIGH State; 5V Supply**



**Figure 5-7. Output Voltage vs Current in LOW State; 5V Supply**



**Figure 5-8. Output Voltage vs Current in HIGH State; 3.3V Supply**

## 5.7 Typical Characteristics (continued)

$T_A = 25^\circ\text{C}$  (unless otherwise noted)

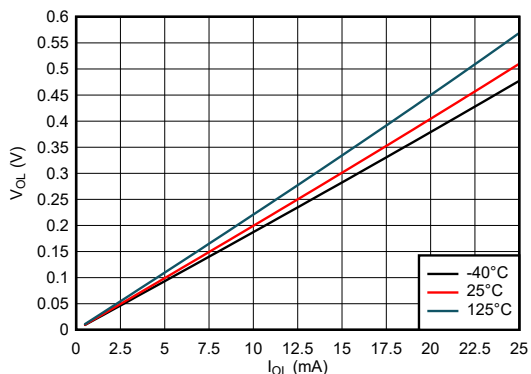


Figure 5-9. Output Voltage vs Current in LOW State; 3.3V Supply

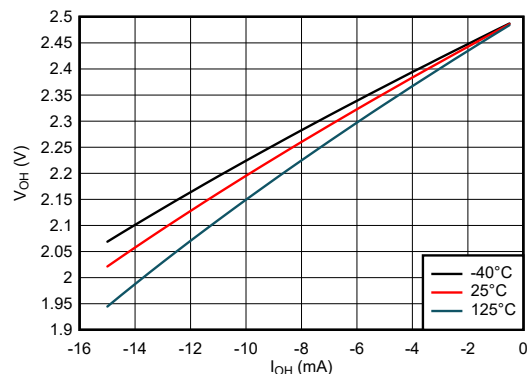


Figure 5-10. Output Voltage vs Current in HIGH State; 2.5V Supply

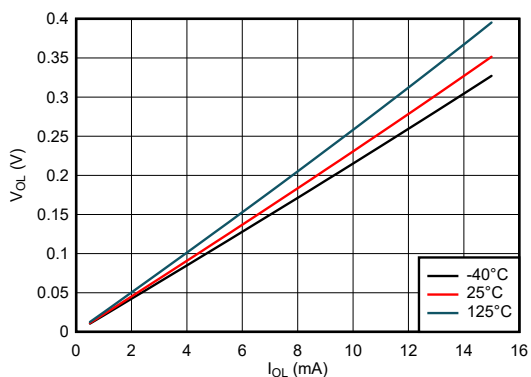


Figure 5-11. Output Voltage vs Current in LOW State; 2.5V Supply

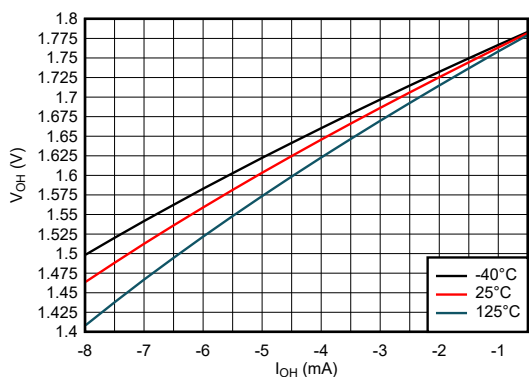


Figure 5-12. Output Voltage vs Current in HIGH State; 1.8V Supply

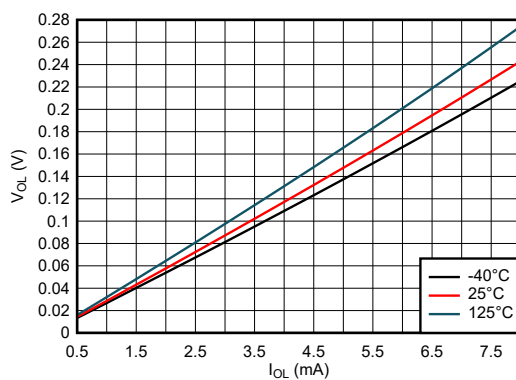


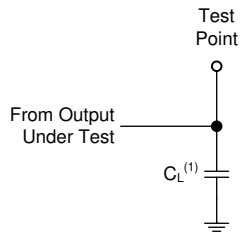
Figure 5-13. Output Voltage vs Current in LOW State; 1.8V Supply



## 6 Parameter Measurement Information

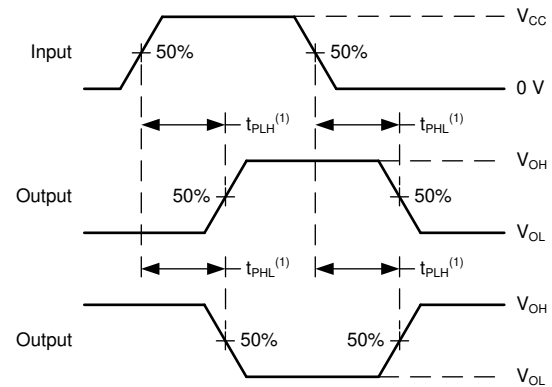
Phase relationships between waveforms were chosen arbitrarily for the examples listed in the following table. All input pulses are supplied by generators having the following characteristics:  $PRR \leq 1\text{MHz}$ ,  $Z_O = 50\Omega$ ,  $t_t < 2.5\text{ns}$ .

The outputs are measured individually with one input transition per measurement.



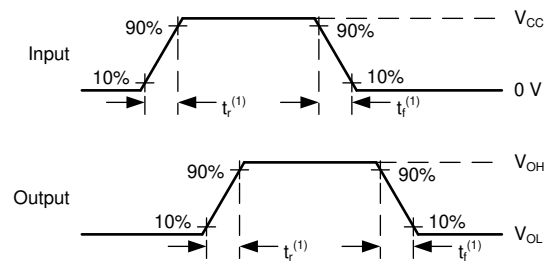
(1)  $C_L$  includes probe and test-fixture capacitance.

**Figure 6-1. Load Circuit for Push-Pull Outputs**



(1) The greater between  $t_{PLH}$  and  $t_{PHL}$  is the same as  $t_{pd}$ .

**Figure 6-2. Voltage Waveforms Propagation Delays**



(1) The greater between  $t_r$  and  $t_f$  is the same as  $t_t$ .

**Figure 6-3. Voltage Waveforms, Input and Output Transition Times**

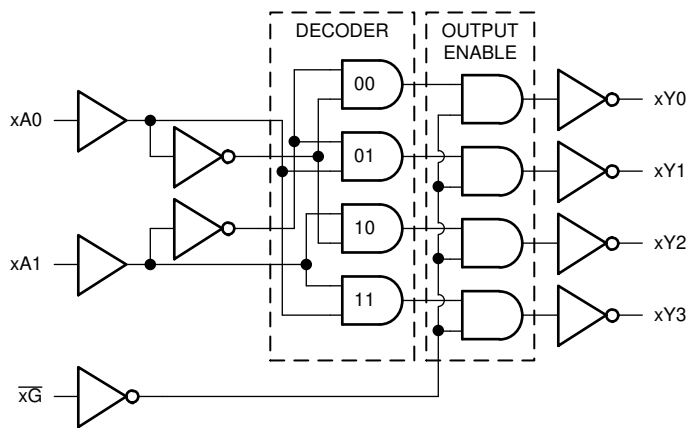
## 7 Detailed Description

### 7.1 Overview

The devices are designed for high-performance memory-decoding or data-routing applications requiring very short propagation delay times. In high-performance memory systems, these decoders can minimize the effects of system decoding. When employed with high-speed memories utilizing a fast enable circuit, the delay time of these decoders and the enable time of the memory usually are less than the typical access time of the memory. This means that the effective system delay introduced by the decoders is negligible.

The devices comprise two individual 2-line to 4-line decoders in a single package. The active-low enable ( $\overline{G}$ ) input can be used as a data line in demultiplexing applications. These decoders/demultiplexers feature fully buffered inputs, each of which represents only one normalized load to its driving circuit.

### 7.2 Functional Block Diagram



### 7.3 Functional Block Diagram

#### 7.4 Feature Description

##### 7.4.1 Balanced CMOS Push-Pull Outputs

This device includes balanced CMOS push-pull outputs. The term *balanced* indicates that the device can sink and source similar currents. The drive capability of this device may create fast edges into light loads, so routing and load conditions should be considered to prevent ringing. Additionally, the outputs of this device are capable of driving larger currents than the device can sustain without being damaged. It is important to limit the output power of the device to avoid damage due to overcurrent. The electrical and thermal limits defined in the *Absolute Maximum Ratings* must be followed at all times.

Unused push-pull CMOS outputs must be left disconnected.

### 7.4.2 LVxT Enhanced Input Voltage

The SN74LV8T139-EP belongs to TI's LVxT family of logic devices with integrated voltage level translation. This family of devices was designed with reduced input voltage thresholds to support up-translation, and inputs tolerant of signals with up to 5.5V levels to support down-translation. For proper functionality, input signals must remain at or above the specified  $V_{IH(MIN)}$  level for a HIGH input state, and at or below the specified  $V_{IL(MAX)}$  for a LOW input state. Figure 7-1 shows the typical  $V_{IH}$  and  $V_{IL}$  levels for the LVxT family of devices, as well as the voltage levels for standard CMOS devices for comparison.

The inputs are high impedance and are typically modeled as a resistor in parallel with the input capacitance given in the *Electrical Characteristics*. The worst case resistance is calculated with the maximum input voltage, given in the *Absolute Maximum Ratings*, and the maximum input leakage current, given in the *Electrical Characteristics*, using Ohm's law ( $R = V \div I$ ).

Input signals must transition between valid logic states quickly, as defined by the input transition rate in the *Recommended Operating Conditions* table. Failing to meet this specification will result in excessive power consumption and could cause oscillations. More details can be found in the *Implications of Slow or Floating CMOS Inputs* application report.

Do not leave inputs floating at any time during operation. Unused inputs must be terminated at a valid high or low voltage level. If a system will not be actively driving an input at all times, then a pull-up or pull-down resistor can be added to provide a valid input voltage during these times. The resistor value will depend on multiple factors; however, a 10kΩ resistor is recommended and will typically meet all requirements.

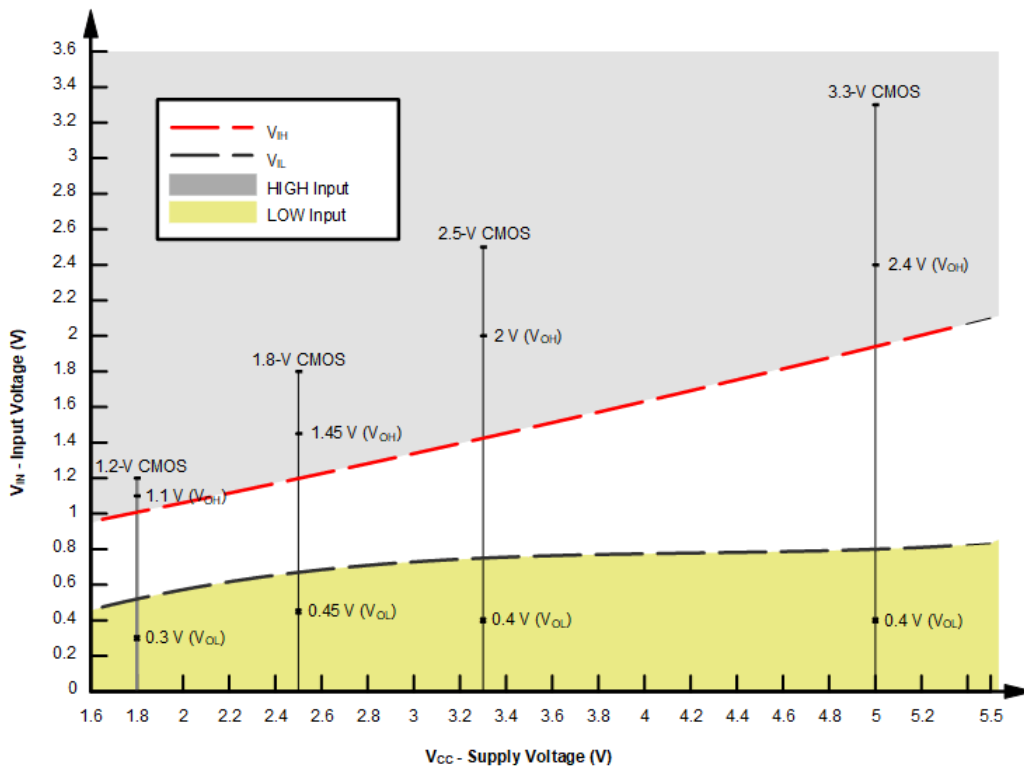


Figure 7-1. LVxT Input Voltage Levels

### 7.4.2.1 Up Translation

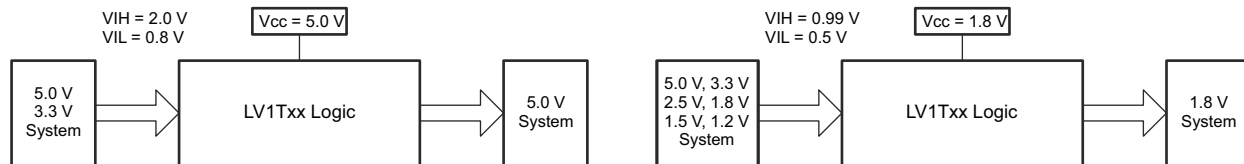
Input signals can be up translated using the SN74LV8T139-EP. The voltage applied at  $V_{CC}$  will determine the output voltage and the input thresholds as described in the *Recommended Operating Conditions* and *Electrical Characteristics* tables. When connected to a high-impedance input, the output voltage will be approximately  $V_{CC}$  in the HIGH state, and 0V in the LOW state.

The inputs have reduced thresholds that allow for input HIGH state levels, which are much lower than standard values. For example, standard CMOS inputs for a device operating at a 5V supply will have a  $V_{IH(MIN)}$  of 3.5V. For the SN74LV8T139-EP,  $V_{IH(MIN)}$  with a 5V supply is only 2V, which would allow for up-translation from a typical 2.5V to 5V signals.

Ensure that the input signals in the HIGH state are above  $V_{IH(MIN)}$  and input signals in the LOW state are lower than  $V_{IL(MAX)}$  as shown in [Figure 7-2](#).

*Up Translation Combinations* are as follows:

- 1.8V  $V_{CC}$  – Inputs from 1.2V
- 2.5V  $V_{CC}$  – Inputs from 1.8V
- 3.3V  $V_{CC}$  – Inputs from 1.8V and 2.5V
- 5.0V  $V_{CC}$  – Inputs from 2.5V and 3.3V



**Figure 7-2. LVxT Up and Down Translation Example**

### 7.4.2.2 Down Translation

Signals can be translated down using the SN74LV8T139-EP. The voltage applied at the  $V_{CC}$  will determine the output voltage and the input thresholds as described in the *Recommended Operating Conditions* and *Electrical Characteristics* tables.

When connected to a high-impedance input, the output voltage will be approximately  $V_{CC}$  in the HIGH state, and 0V in the LOW state. Ensure that the input signals in the HIGH state are between  $V_{IH(MIN)}$  and 5.5V, and input signals in the LOW state are lower than  $V_{IL(MAX)}$  as shown in [Figure 7-1](#).

For example, standard CMOS inputs for devices operating at 5.0V, 3.3V or 2.5V can be down-translated to match 1.8V CMOS signals when operating from 1.8V  $V_{CC}$ . See [Figure 7-2](#).

*Down Translation Combinations* are as follows:

- 1.8V  $V_{CC}$  – Inputs from 2.5V, 3.3V, and 5.0V
- 2.5V  $V_{CC}$  – Inputs from 3.3V and 5.0V
- 3.3V  $V_{CC}$  – Inputs from 5.0V

### 7.4.3 Clamp Diode Structure

As [Figure 7-3](#) shows, the outputs to this device have both positive and negative clamping diodes, and the inputs to this device have negative clamping diodes only.

#### CAUTION

Voltages beyond the values specified in the *Absolute Maximum Ratings* table can cause damage to the device. The input and output voltage ratings may be exceeded if the input and output clamp-current ratings are observed.

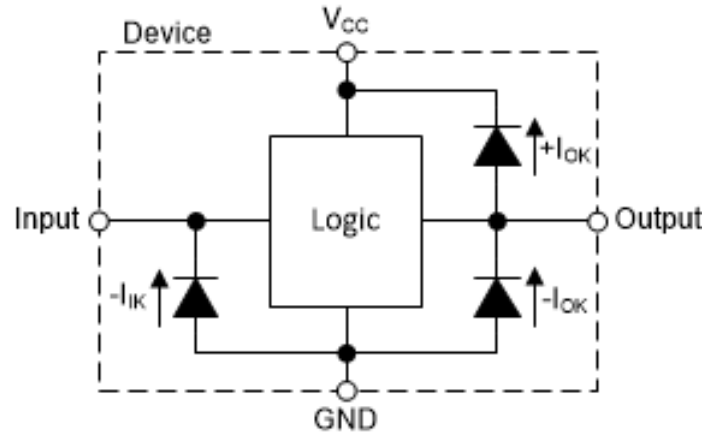


Figure 7-3. Electrical Placement of Clamping Diodes for Each Input and Output

### 7.5 Device Functional Modes

INPUTS			OUTPUTS			
$\bar{G}$	SELECT		Y0	Y1	Y2	Y3
	B	A				
H	X	X	H	H	H	H
L	L	L	L	H	H	H
L	L	H	H	L	H	H
L	H	L	H	H	L	H
L	H	H	H	H	H	L

## 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, as well as validating and testing their design implementation to confirm system functionality.

### 8.1 Application Information

The SN74LV8T139-EP is used to control multiple devices that operate on a shared data bus. A decoder provides the capability to have a binary encoded input activate only one of the device's outputs. This is ideal for solid state memory applications where multiple devices have to be read or written to with a limited number of GPIO pins used on the system controller. The decoder is used to activate the chip select (CS) input to the selected memory device, and the controller can then read or write from that device alone when using a shared bus.

### 8.2 Typical Application

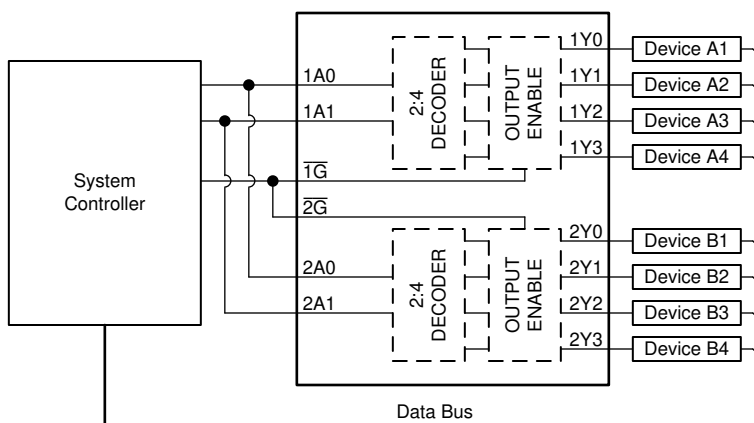


Figure 8-1. Typical Application Block Diagram

## 8.2.1 Design Requirements

### 8.2.1.1 Power Considerations

Ensure the desired supply voltage is within the range specified in the *Recommended Operating Conditions*. The supply voltage sets the device's electrical characteristics as described in the *Electrical Characteristics* section.

The positive voltage supply must be capable of sourcing current equal to the total current to be sourced by all outputs of the SN74LV8T139-EP plus the maximum static supply current,  $I_{CC}$ , listed in the *Electrical Characteristics*, and any transient current required for switching. The logic device can only source as much current that is provided by the positive supply source. Be sure to not exceed the maximum total current through  $V_{CC}$  listed in the *Absolute Maximum Ratings*.

The ground must be capable of sinking current equal to the total current to be sunk by all outputs of the SN74LV8T139-EP plus the maximum supply current,  $I_{CC}$ , listed in the *Electrical Characteristics*, and any transient current required for switching. The logic device can only sink as much current that can be sunk into its ground connection. Be sure to not exceed the maximum total current through GND listed in the *Absolute Maximum Ratings*.

The SN74LV8T139-EP can drive a load with a total capacitance less than or equal to 50pF while still meeting all of the data sheet specifications. Larger capacitive loads can be applied; however, it is not recommended to exceed 50pF.

The SN74LV8T139-EP can drive a load with total resistance described by  $R_L \geq V_O / I_O$ , with the output voltage and current defined in the *Electrical Characteristics* table with  $V_{OH}$  and  $V_{OL}$ . When outputting in the HIGH state, the output voltage in the equation is defined as the difference between the measured output voltage and the supply voltage at the  $V_{CC}$  pin.

Total power consumption can be calculated using the information provided in [CMOS Power Consumption and Cpd Calculation](#).

Thermal increase can be calculated using the information provided in [Thermal Characteristics of Standard Linear and Logic \(SLL\) Packages and Devices](#).

#### CAUTION

The maximum junction temperature,  $T_{J(max)}$  listed in the *Absolute Maximum Ratings*, is an additional limitation to prevent damage to the device. Do not violate any values listed in the *Absolute Maximum Ratings*. These limits are provided to prevent damage to the device.

### 8.2.1.2 Input Considerations

Input signals must cross to be considered a logic LOW, and to be considered a logic HIGH. Do not exceed the maximum input voltage range found in the *Absolute Maximum Ratings*.

Unused inputs must be terminated to either  $V_{CC}$  or ground. The unused inputs can be directly terminated if the input is completely unused, or they can be connected with a pull-up or pull-down resistor if the input will be used sometimes, but not always. A pull-up resistor is used for a default state of HIGH, and a pull-down resistor is used for a default state of LOW. The drive current of the controller, leakage current into the SN74LV8T139-EP (as specified in the *Electrical Characteristics*), and the desired input transition rate limits the resistor size. A 10k $\Omega$  resistor value is often used due to these factors.

Refer to the *Feature Description* section for additional information regarding the inputs for this device.

### 8.2.1.3 Output Considerations

The positive supply voltage is used to produce the output HIGH voltage. Drawing current from the output will decrease the output voltage as specified by the  $V_{OH}$  specification in the *Electrical Characteristics*. The ground voltage is used to produce the output LOW voltage. Sinking current into the output will increase the output voltage as specified by the  $V_{OL}$  specification in the *Electrical Characteristics*.

Push-pull outputs that could be in opposite states, even for a very short time period, should never be connected directly together. This can cause excessive current and damage to the device.

Two channels within the same device with the same input signals can be connected in parallel for additional output drive strength.

Unused outputs can be left floating. Do not connect outputs directly to  $V_{CC}$  or ground.

Refer to the *Feature Description* section for additional information regarding the outputs for this device.

### 8.2.2 Detailed Design Procedure

1. Add a decoupling capacitor from  $V_{CC}$  to GND. The capacitor needs to be placed physically close to the device and electrically close to both the  $V_{CC}$  and GND pins. An example layout is shown in the *Layout* section.
2. Ensure the capacitive load at the output is  $\leq 50$  pF. This is not a hard limit; by design, however, it will optimize performance. This can be accomplished by providing short, appropriately sized traces from the SN74LV8T139-EP to one or more of the receiving devices.
3. Ensure the resistive load at the output is larger than  $(V_{CC} / I_{O(max)}) \Omega$ . Doing this will not violate the maximum output current from the *Absolute Maximum Ratings*. Most CMOS inputs have a resistive load measured in M $\Omega$ ; much larger than the minimum calculated previously.
4. Thermal issues are rarely a concern for logic gates; the power consumption and thermal increase, however, can be calculated using the steps provided in the application report, [CMOS Power Consumption and Cpd Calculation](#).

### 8.2.3 Application Curve

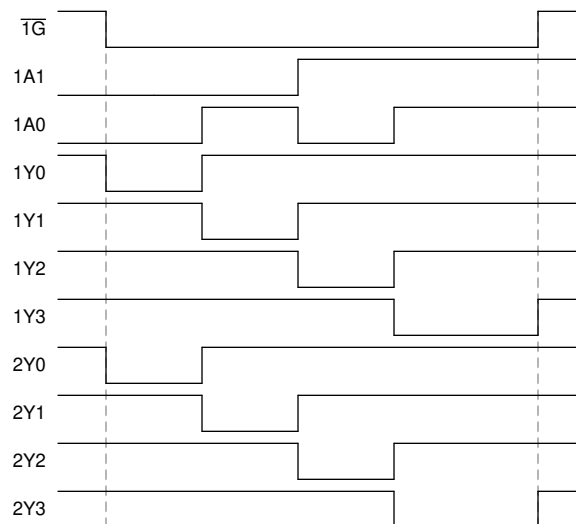


Figure 8-2. Application Timing Diagram

## 8.3 Power Supply Recommendations

The power supply can be any voltage between the minimum and maximum supply voltage rating located in the *Recommended Operating Conditions*. Each  $V_{CC}$  terminal should have a good bypass capacitor to prevent power disturbance. A 0.1  $\mu\text{F}$  capacitor is recommended for this device. It is acceptable to parallel multiple bypass capacitors to reject different frequencies of noise. The 0.1  $\mu\text{F}$  and 1  $\mu\text{F}$  capacitors are commonly used in parallel. The bypass capacitor should be installed as close to the power terminal as possible for best results.

## 8.4 Layout

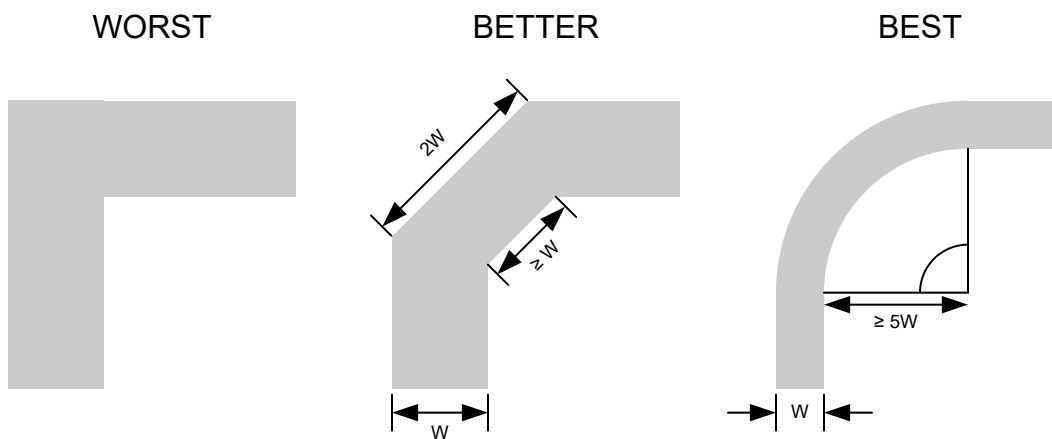
### 8.4.1 Layout Guidelines

- Bypass capacitor placement
  - Place near the positive supply terminal of the device

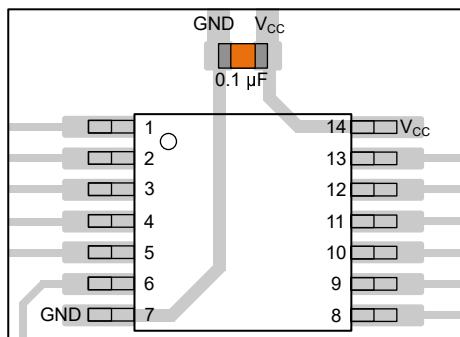


- Provide an electrically short ground return path
- Use wide traces to minimize impedance
- Keep the device, capacitors, and traces on the same side of the board whenever possible
- Signal trace geometry
  - 8mil to 12mil trace width
  - Lengths less than 12cm to minimize transmission line effects
  - Avoid 90° corners for signal traces
  - Use an unbroken ground plane below signal traces
  - Flood fill areas around signal traces with ground
  - For traces longer than 12cm
    - Use impedance controlled traces
    - Source-terminate using a series damping resistor near the output
    - Avoid branches; buffer signals that must branch separately

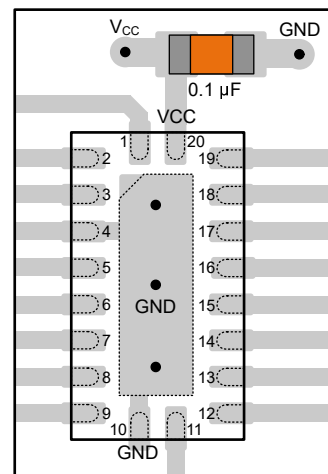
**8.4.2 Layout Example**



**Figure 8-3. Example Trace Corners for Improved Signal Integrity**



**Figure 8-4. Example Bypass Capacitor Placement for TSSOP and Similar Packages**



**Figure 8-5. Example Bypass Capacitor Placement for WQFN and Similar Packages**

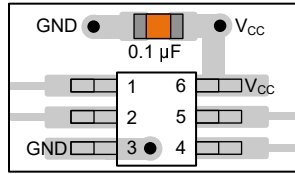


Figure 8-6. Example Bypass Capacitor Placement for SOT, SC70 and Similar Packages

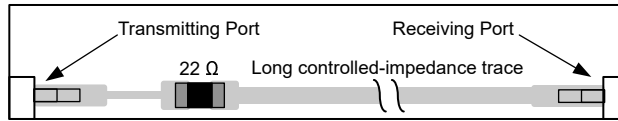


Figure 8-7. Example Damping Resistor Placement for Improved Signal Integrity

## 9 Device and Documentation Support

TI offers an extensive line of development tools. Tools and software to evaluate the performance of the device, generate code, and develop solutions are listed below.

### 9.1 Documentation Support

#### 9.1.1 Related Documentation

For related documentation, see the following:

- Texas Instruments, [CMOS Power Consumption and  \$C\_{pd}\$  Calculation application report](#)
- Texas Instruments, [Designing With Logic application report](#)
- Texas Instruments, [Thermal Characteristics of Standard Linear and Logic \(SLL\) Packages and Devices application report](#)

### 9.2 Receiving Notification of Documentation Updates

To receive notification of documentation updates, navigate to the device product folder on [ti.com](http://ti.com). Click on *Notifications* to register and receive a weekly digest of any product information that has changed. For change details, review the revision history included in any revised document.

### 9.3 Support Resources

TI E2E™ [support forums](#) are an engineer's go-to source for fast, verified answers and design help — straight from the experts. Search existing answers or ask your own question to get the quick design help you need.

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### 9.4 Trademarks

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### 9.5 Electrostatic Discharge Caution



This integrated circuit can be damaged by ESD. Texas Instruments recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

### 9.6 Glossary

[TI Glossary](#) This glossary lists and explains terms, acronyms, and definitions.

## 10 Revision History

DATE	REVISION	NOTES
January 2025	*	Initial Release

## 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.

**PACKAGING INFORMATION**

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead finish/ Ball material (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
SN74LV8T139MPWREP	ACTIVE	TSSOP	PW	16	3000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM		LV139EP	Samples

(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.

**OBSELETE:** TI has discontinued the production of the device.

(2) **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".

**RoHS Exempt:** TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.

**Green:** TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

(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.

(6) Lead finish/Ball material - Orderable Devices 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.

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4220204/A 02/2017

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 mm per side.
4. This dimension does not include interlead flash. Interlead flash shall not exceed 0.25 mm per side.
5. Reference JEDEC registration MO-153.

# EXAMPLE BOARD LAYOUT

PW0016A

TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



LAND PATTERN EXAMPLE  
EXPOSED METAL SHOWN  
SCALE: 10X



4220204/A 02/2017

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

PW0016A

TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



SOLDER PASTE EXAMPLE  
BASED ON 0.125 mm THICK STENCIL  
SCALE: 10X

4220204/A 02/2017

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.

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