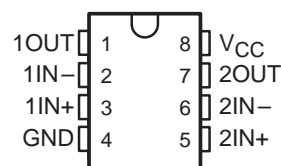


# TLV1393, TLV1393Y, TLV2393, TLV2393Y DUAL DIFFERENTIAL COMPARATORS

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- **Low-Voltage and Single-Supply Operation**  
 $V_{CC} = 2\text{ V to }7\text{ V}$
- **Common-Mode Voltage Range Includes Ground**
- **Fast Response Time**  
450 ns Typ (TLV2393)
- **Low Supply Current**  
0.16 mA Typ (TLV1393)
- **Fully Specified at 3-V and 5-V Supply Voltages**

D, P, OR PW PACKAGE  
(TOP VIEW)



## description

The TLV1393 and the TLV2393 are dual differential comparators built using a new Texas Instruments low-voltage, high-speed bipolar process. These devices have been specifically developed for low-voltage, single-supply applications. Their enhanced performance makes them excellent replacements for the LM393 in today's improved 3-V and 5-V system designs.

The TLV1393, with its typical supply current of only 0.16 mA, is ideal for low-power systems. Response time has also been improved to 0.7  $\mu\text{s}$ . For higher-speed applications, the TLV2393 features excellent ac performance with a response time of just 0.45  $\mu\text{s}$ , three times that of the LM393.

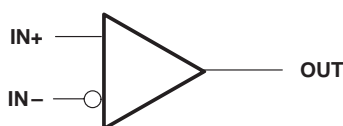
Package availability for these devices includes the TSSOP (thin-shrink small-outline package). With a maximum thickness of 1.1 mm and a package area that is 25% smaller than the standard surface-mount package, the TSSOP is ideal for high-density circuits, particularly in hand-held and portable equipment.

## AVAILABLE OPTIONS

$T_A$	PACKAGED DEVICES					CHIP FORM (Y)
	SUPPLY CURRENT (TYP)	RESPONSE TIME (TYP)	SMALL OUTLINE (D)	PLASTIC DIP (P)	TSSOP (PW) <sup>†</sup>	
-40°C to 105°C	0.16 mA 1.1 mA	0.7 $\mu\text{s}$ 0.45 $\mu\text{s}$	TLV1393ID TLV2393ID	TLV1393IP TLV2393IP	TLV1393IPWLE TLV2393IPWLE	TLV1393Y TLV2393Y

<sup>†</sup> The PW packages are only available left-ended taped and reeled (e.g., TLV1393IPWLE).

## symbol (each comparator)



PRODUCTION DATA information is current as of publication date. Products conform to specifications per the terms of Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.

 **TEXAS  
INSTRUMENTS**

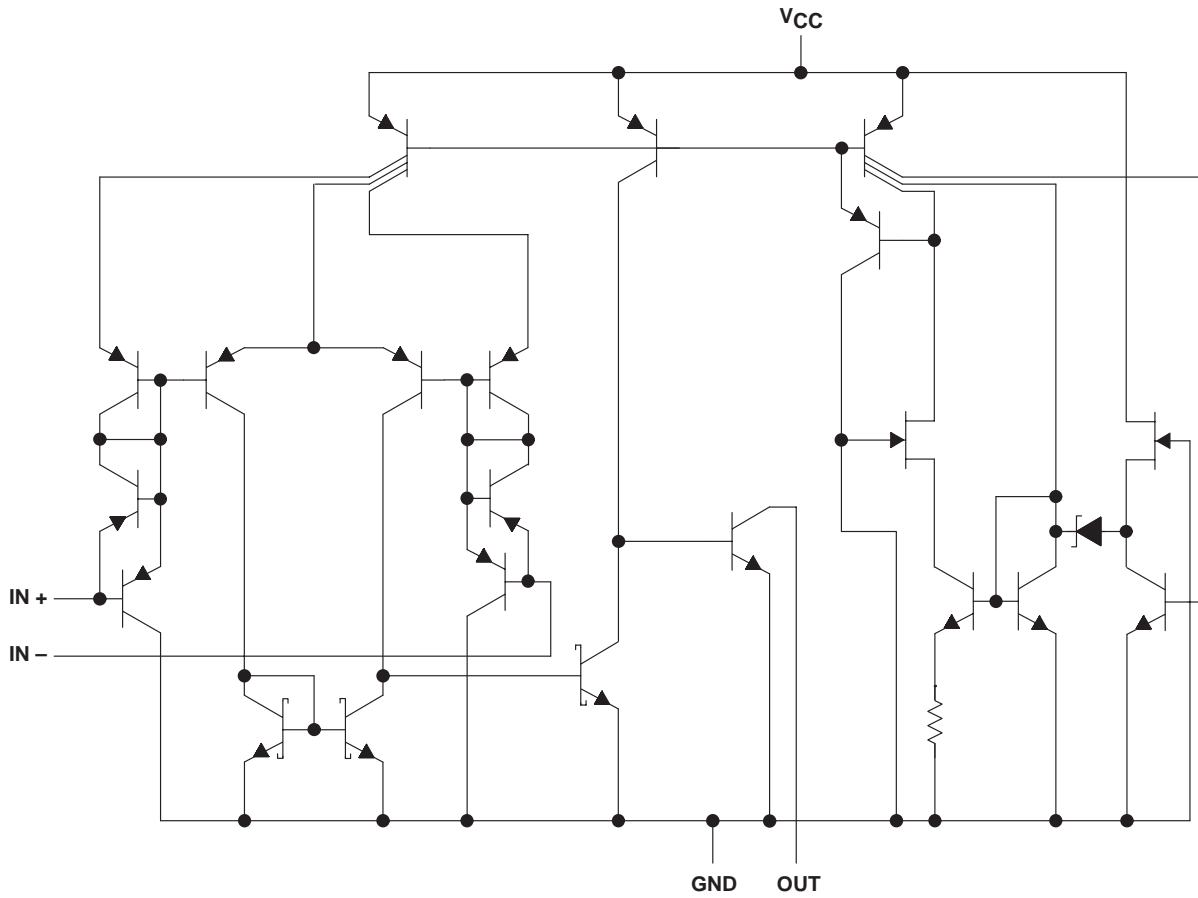
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# TLV1393, TLV1393Y, TLV2393, TLV2393Y DUAL DIFFERENTIAL COMPARATORS

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## TLV1393, TLV1393Y equivalent schematic (each comparator)

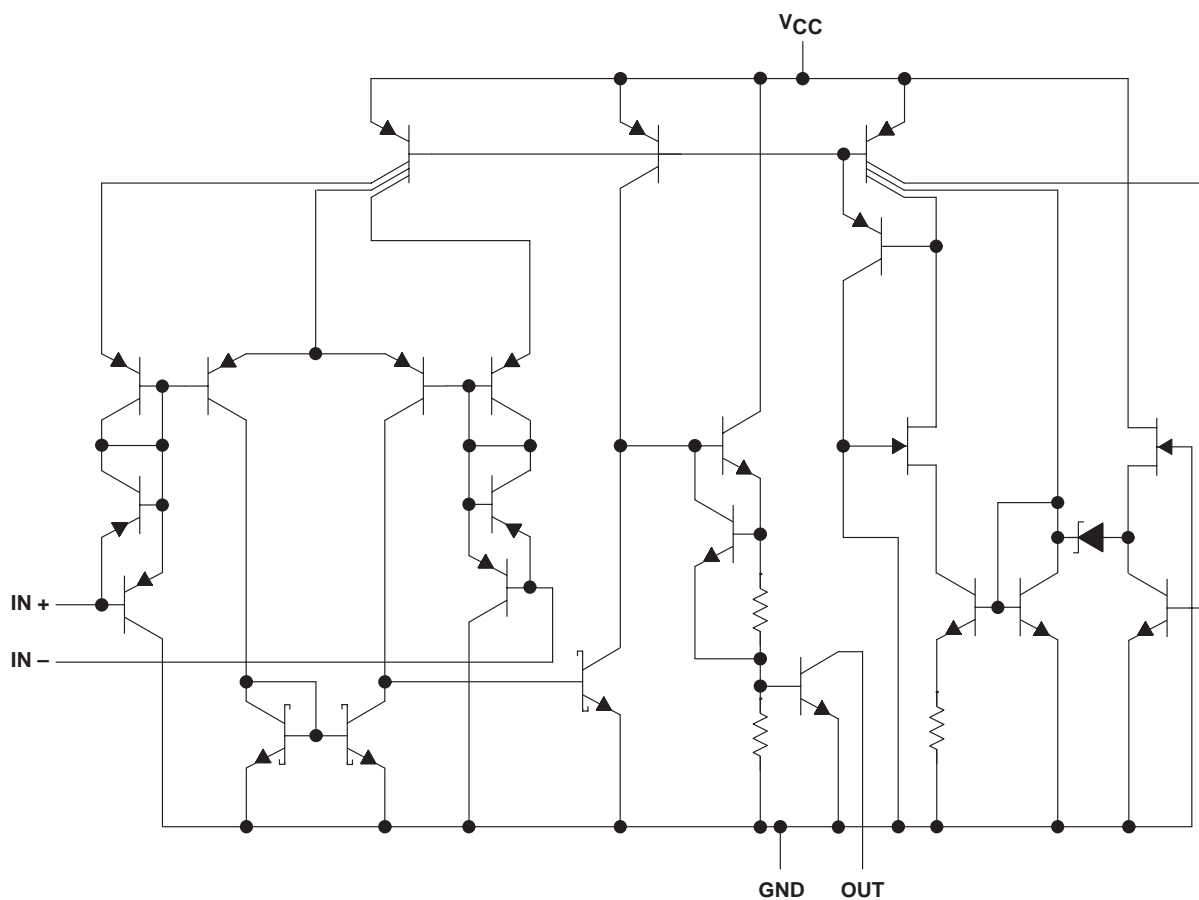


COMPONENT COUNT	
Transistors	44
Resistors	1
Diodes	7
Epi-FET	2

# TLV1393, TLV1393Y, TLV2393, TLV2393Y DUAL DIFFERENTIAL COMPARATORS

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## TLV2393, TLV2393Y equivalent schematic (each comparator)



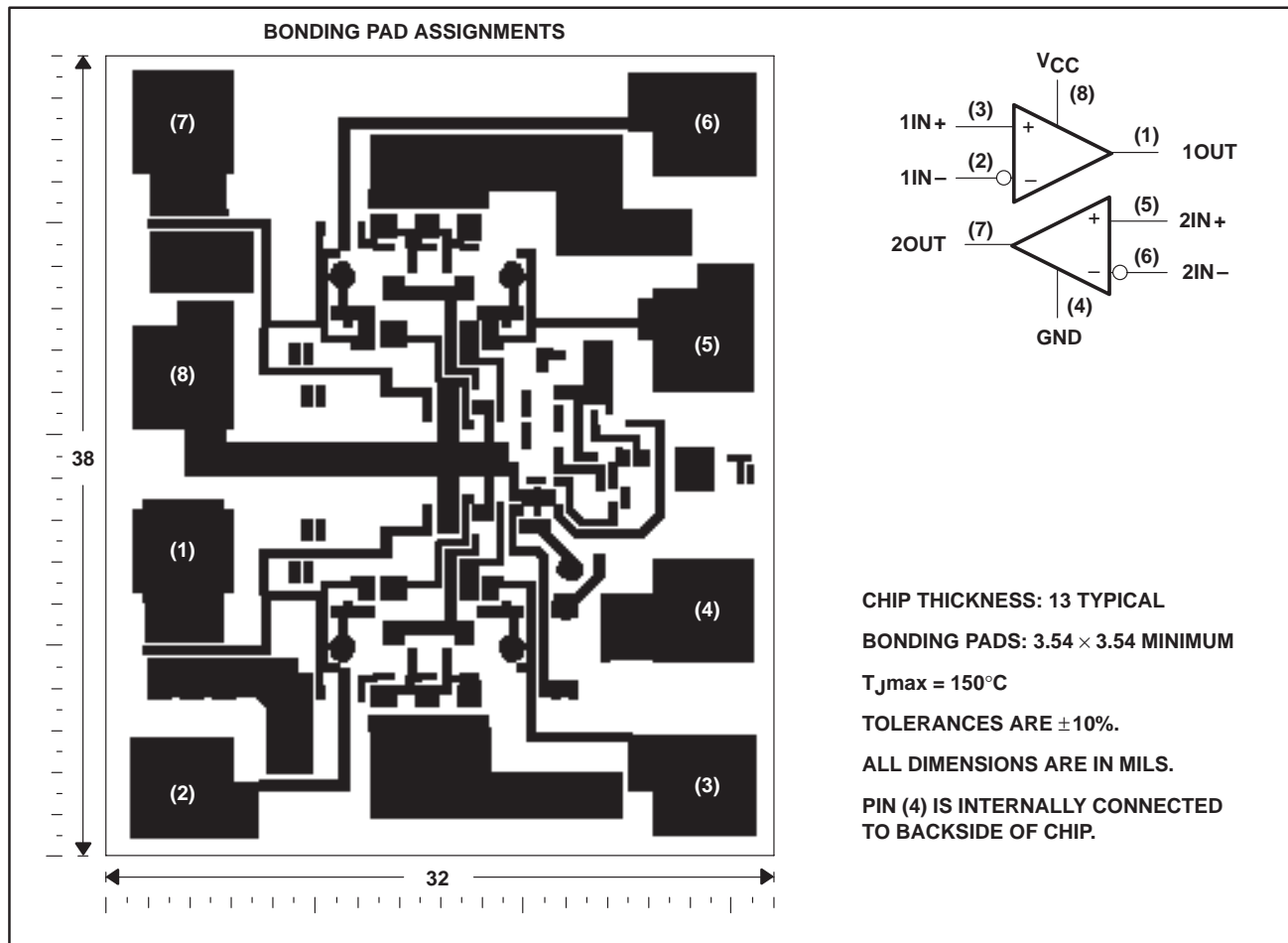
COMPONENT COUNT	
Transistors	44
Resistors	1
Diodes	7
Epi-FET	2

# TLV1393, TLV1393Y, TLV2393, TLV2393Y DUAL DIFFERENTIAL COMPARATORS

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## TLV1393Y chip information

This chip, when properly assembled, displays characteristics similar to the TLV1393. Thermal compression or ultrasonic bonding may be used on the doped-aluminum bonding pads. Chips may be mounted with conductive epoxy or a gold-silicon preform.

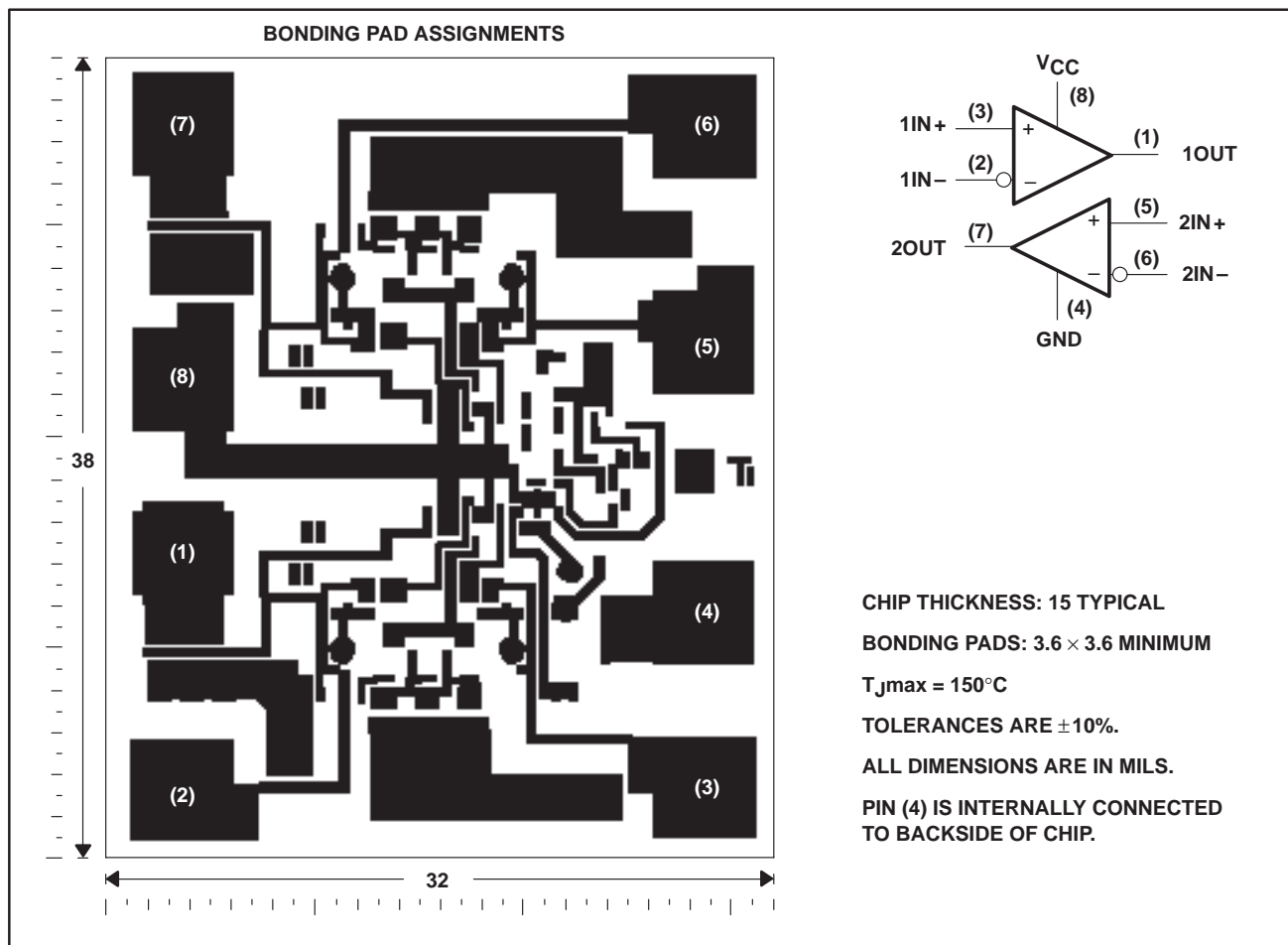


# TLV1393, TLV1393Y, TLV2393, TLV2393Y DUAL DIFFERENTIAL COMPARATORS

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## TLV2393Y chip information

This chip, when properly assembled, displays characteristics similar to the TLV2393. Thermal compression or ultrasonic bonding may be used on the doped-aluminum bonding pads. Chips may be mounted with conductive epoxy or a gold-silicon preform.



# TLV1393, TLV1393Y, TLV2393, TLV2393Y DUAL DIFFERENTIAL COMPARATORS

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## absolute maximum ratings over operating free-air temperature range (unless otherwise noted)†

Supply voltage, $V_{CC}$ (see Note 1)	7 V
Differential input voltage, $V_{ID}$ (see Note 2)	7 V
Input voltage, $V_I$ (any input)	7 V
Output voltage, $V_O$	7 V
Output current, $I_O$ (each output)	20 mA
Duration of short-circuit current to GND (see Note 3)	unlimited
Continuous total dissipation	See Dissipation Rating Table
Operating free-air temperature range, $T_A$	-40°C to 105°C
Storage temperature range	-65°C to 150°C
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds	260°C

† 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.

- NOTES:
1. All voltage values, except differential voltages, are with respect to the network GND.
  2. Differential voltages are at the noninverting input with respect to the inverting input.
  3. Short circuits from the outputs to  $V_{CC}$  can cause excessive heating and eventual destruction of the chip.

DISSIPATION RATING TABLE

PACKAGE	$T_A \leq 25^\circ\text{C}$ POWER RATING	DERATING FACTOR ABOVE $T_A = 25^\circ\text{C}$	$T_A = 70^\circ\text{C}$ POWER RATING	$T_A = 85^\circ\text{C}$ POWER RATING
D	725 mW	5.8 mW/°C	464 mW	377 mW
P	1000 mW	8.0 mW/°C	640 mW	520 mW
PW	525 mW	4.2 mW/°C	336 mW	273 mW

## recommended operating conditions

	MIN	MAX	UNIT
Supply voltage, $V_{CC}$	2	7	V
Operating free-air temperature, $T_A$	-40	105	°C



# TLV1393, TLV1393Y, TLV2393, TLV2393Y DUAL DIFFERENTIAL COMPARATORS

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## electrical characteristics, $V_{CC} = 3\text{ V}$

PARAMETER	TEST CONDITIONS	$T_A$ †	TLV1393			UNIT
			MIN	TYP	MAX	
$V_{IO}$ Input offset voltage	$V_O = 1.4\text{ V}$ , $V_{IC} = V_{ICRmin}$	25°C		1.5	5	mV
		Full range		120	9	
$V_{ICR}$ Common-mode input voltage range		25°C	0 to $V_{CC} - 1.5$	0 to $V_{CC} - 1.2$		V
		Full range	0 to $V_{CC} - 2$			
$V_{OL}$ Low-level output voltage	$V_{ID} = -1\text{ V}$ , $I_{OL} = 500\text{ }\mu\text{A}$	Full range		120	300	mV
$I_{IO}$ Input offset current	$V_O = 1.4\text{ V}$	25°C		5	50	nA
		Full range			150	
$I_{IB}$ Input bias current	$V_O = 1.4\text{ V}$	25°C		-40	-250	nA
		Full range			-400	
$I_{OH}$ High-level output current	$V_{ID} = 1\text{ V}$ , $V_{OH} = 3\text{ V}$	25°C		0.1		nA
	$V_{ID} = 1\text{ V}$ , $V_{OH} = 5\text{ V}$	Full range			100	
$I_{OL}$ Low-level output current	$V_{ID} = -1\text{ V}$ , $V_{OL} = 1.5\text{ V}$	25°C	500			$\mu\text{A}$
$I_{CCH}$ High-level supply current	$V_O = V_{OH}$	25°C		160	250	$\mu\text{A}$
		Full range			300	
$I_{CCL}$ Low-level supply current	$V_O = V_{OL}$	25°C		160	250	
		Full range			300	

† Full range is -40°C to 105°C.

## switching characteristics, $V_{CC} = 3\text{ V}$ , $C_L = 15\text{ pF}$ , $T_A = 25^\circ\text{C}$

PARAMETER	TEST CONDITIONS	TLV1393			UNIT
		MIN	TYP	MAX	
Response time	100-mV input step with 5-mV overdrive, $R_L$ connected to 5 V through 5.1 k $\Omega$		0.7		$\mu\text{s}$



# TLV1393, TLV1393Y, TLV2393, TLV2393Y DUAL DIFFERENTIAL COMPARATORS

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## electrical characteristics, $V_{CC} = 5\text{ V}$

PARAMETER	TEST CONDITIONS	$T_A$ †	TLV1393			UNIT
			MIN	TYP	MAX	
$V_{IO}$ Input offset voltage	$V_O = 1.4\text{ V}$ , $V_{IC} = V_{ICRmin}$	25°C		1.5	5	mV
		Full range			9	
$V_{ICR}$ Common-mode input voltage range		25°C	0 to $V_{CC} - 1.5$	0 to $V_{CC} - 1.2$		V
		Full range	0 to $V_{CC} - 2$			
$V_{OL}$ Low-level output voltage	$V_{ID} = -1\text{ V}$ , $I_{OL} = 500\text{ }\mu\text{A}$	Full range		120	300	mV
$I_{IO}$ Input offset current	$V_O = 1.4\text{ V}$	25°C		5	50	nA
		Full range			150	
$I_{IB}$ Input bias current	$V_O = 1.4\text{ V}$	25°C		-40	-250	nA
		Full range			-400	
$I_{OH}$ High-level output current	$V_{ID} = 1\text{ V}$ , $V_{OH} = 3\text{ V}$	25°C		0.1		nA
	$V_{ID} = 1\text{ V}$ , $V_{OH} = 5\text{ V}$	Full range		100		
$I_{OL}$ Low-level output current	$V_{ID} = -1\text{ V}$ , $V_{OL} = 1.5\text{ V}$	25°C	600			$\mu\text{A}$
$I_{CCH}$ High-level supply current	$V_O = V_{OH}$	25°C		200	300	$\mu\text{A}$
		Full range		350		
$I_{CCL}$ Low-level supply current	$V_O = V_{OL}$	25°C		200	300	$\mu\text{A}$
		Full range		350		

† Full range is  $-40^\circ\text{C}$  to  $105^\circ\text{C}$ .

## switching characteristics, $V_{CC} = 5\text{ V}$ , $C_L = 15\text{ pF}$ , $T_A = 25^\circ\text{C}$

PARAMETER	TEST CONDITIONS	TLV1393			UNIT
		MIN	TYP	MAX	
Response time	100-mV input step with 5-mV overdrive, $R_L$ connected to 5 V through 5.1 k $\Omega$		0.65		$\mu\text{s}$
	TTL-level input step, $R_L$ connected to 5 V through 5.1 k $\Omega$		0.18		

## electrical characteristics, $V_{CC} = 3\text{ V}$ , $T_A = 25^\circ\text{C}$

PARAMETER	TEST CONDITIONS	TLV1393Y			UNIT
		MIN	TYP	MAX	
$V_{IO}$ Input offset voltage	$V_O = 1.4\text{ V}$ , $V_{IC} = V_{ICRmin}$		1.5	5	mV
$V_{ICR}$ Common-mode input voltage range		0 to $V_{CC} - 1.5$	0 to $V_{CC} - 1.2$		V
$I_{IO}$ Input offset current	$V_O = 1.4\text{ V}$		5	50	nA
$I_{IB}$ Input bias current	$V_O = 1.4\text{ V}$		-40	-250	nA
$I_{OH}$ High-level output current	$V_{ID} = 1\text{ V}$ , $V_{OH} = 3\text{ V}$		0.1		nA
$I_{OL}$ Low-level output current	$V_{ID} = -1\text{ V}$ , $V_{OL} = 1.5\text{ V}$	500			$\mu\text{A}$
$I_{CCH}$ High-level supply current	$V_O = V_{OH}$		160	250	$\mu\text{A}$
$I_{CCL}$ Low-level supply current	$V_O = V_{OL}$		160	250	

## switching characteristics, $V_{CC} = 3\text{ V}$ , $C_L = 15\text{ pF}$ , $T_A = 25^\circ\text{C}$

PARAMETER	TEST CONDITIONS	TLV1393Y			UNIT
		MIN	TYP	MAX	
Response time	100-mV input step with 5-mV overdrive, $R_L$ connected to 5 V through 5.1 k $\Omega$		0.7		$\mu\text{s}$



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# TLV1393, TLV1393Y, TLV2393, TLV2393Y DUAL DIFFERENTIAL COMPARATORS

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## electrical characteristics, $V_{CC} = 5\text{ V}$ , $T_A = 25^\circ\text{C}$

PARAMETER	TEST CONDITIONS	TLV1393Y			UNIT
		MIN	TYP	MAX	
$V_{IO}$ Input offset voltage	$V_O = 1.4\text{ V}$ , $V_{IC} = V_{ICRmin}$		1.5	5	mV
$V_{ICR}$ Common-mode input voltage range		0 to $V_{CC} - 1.5$	0 to $V_{CC} - 1.2$		V
$I_{IO}$ Input offset current	$V_O = 1.4\text{ V}$		5	50	nA
$I_{IB}$ Input bias current	$V_O = 1.4\text{ V}$		-40	-250	nA
$I_{OH}$ High-level output current	$V_{ID} = 1\text{ V}$ , $V_{OH} = 3\text{ V}$		0.1		nA
$I_{OL}$ Low-level output current	$V_{ID} = -1\text{ V}$ , $V_{OL} = 1.5\text{ V}$	600			$\mu\text{A}$
$I_{CCH}$ High-level supply current	$V_O = V_{OH}$		200	300	$\mu\text{A}$
$I_{CCL}$ Low-level supply current	$V_O = V_{OL}$		200	300	

## switching characteristics, $V_{CC} = 5\text{ V}$ , $C_L = 15\text{ pF}$ , $T_A = 25^\circ\text{C}$

PARAMETER	TEST CONDITIONS	TLV1393Y			UNIT
		MIN	TYP	MAX	
Response time	100-mV input step with 5-mV overdrive, $R_L$ connected to 5 V through 5.1 k $\Omega$		0.65		$\mu\text{s}$
	TTL-level input step, $R_L$ connected to 5 V through 5.1 k $\Omega$		0.18		



# TLV1393, TLV1393Y, TLV2393, TLV2393Y DUAL DIFFERENTIAL COMPARATORS

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## electrical characteristics, $V_{CC} = 3\text{ V}$

PARAMETER	TEST CONDITIONS	$T_A$ †	TLV2393			UNIT
			MIN	TYP	MAX	
$V_{IO}$ Input offset voltage	$V_O = 1.4\text{ V}$ , $V_{IC} = V_{ICRmin}$	25°C		1.5	5	mV
		Full range			9	
$V_{ICR}$ Common-mode input voltage range		25°C	0 to $V_{CC} - 1.5$	0 to $V_{CC} - 1.2$		V
		Full range	0 to $V_{CC} - 2$			
$V_{OL}$ Low-level output voltage	$V_{ID} = -1\text{ V}$ , $I_{OL} = 1\text{ mA}$	25°C		80	300	mV
	$V_{ID} = -1\text{ V}$ , $I_{OL} = 4\text{ mA}$	Full range		250	700	
$I_{IO}$ Input offset current	$V_O = 1.4\text{ V}$	25°C		5	50	nA
		Full range			150	
$I_{IB}$ Input bias current	$V_O = 1.4\text{ V}$	25°C		-100	-250	nA
		Full range			-400	
$I_{OH}$ High-level output current	$V_{ID} = 1\text{ V}$ , $V_{OH} = 3\text{ V}$	25°C		0.1		nA
	$V_{ID} = 1\text{ V}$ , $V_{OH} = 5\text{ V}$	Full range			100	
$I_{OL}$ Low-level output current	$V_{ID} = -1\text{ V}$ , $V_{OL} = 1.5\text{ V}$	25°C	4			mA
$I_{CCH}$ High-level supply current	$V_O = V_{OH}$	25°C		450	600	$\mu\text{A}$
		Full range			700	
$I_{CCL}$ Low-level supply current	$V_O = V_{OL}$	25°C		1.1	1.3	mA
		Full range			1.4	

† Full range is -40°C to 105°C.

## switching characteristics, $V_{CC} = 3\text{ V}$ , $C_L = 15\text{ pF}$ , $T_A = 25^\circ\text{C}$

PARAMETER	TEST CONDITIONS	TLV2393			UNIT
		MIN	TYP	MAX	
Response time	100-mV input step with 5-mV overdrive, $R_L$ connected to 5 V through 5.1 k $\Omega$		0.45	1	$\mu\text{s}$



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# TLV1393, TLV1393Y, TLV2393, TLV2393Y DUAL DIFFERENTIAL COMPARATORS

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## electrical characteristics, $V_{CC} = 5\text{ V}$

PARAMETER	TEST CONDITIONS	$T_A$ †	TLV2393			UNIT
			MIN	TYP	MAX	
$V_{IO}$ Input offset voltage	$V_O = 1.4\text{ V}$ , $V_{IC} = V_{ICRmin}$	25°C		1.5	5	mV
		Full range			9	
$V_{ICR}$ Common-mode input voltage range		25°C	0 to $V_{CC} - 1.5$	0 to $V_{CC} - 1.2$		V
		Full range	0 to $V_{CC} - 2$			
$V_{OL}$ Low-level output voltage	$V_{ID} = -1\text{ V}$ , $I_{OL} = 1\text{ mA}$	25°C		70	300	mV
	$V_{ID} = -1\text{ V}$ , $I_{OL} = 4\text{ mA}$	Full range		200	700	
$I_{IO}$ Input offset current	$V_O = 1.4\text{ V}$	25°C		5	50	nA
		Full range			150	
$I_{IB}$ Input bias current	$V_O = 1.4\text{ V}$	25°C		-100	-250	nA
		Full range			-400	
$I_{OH}$ High-level output current	$V_{ID} = 1\text{ V}$ , $V_{OH} = 3\text{ V}$	25°C		0.1		nA
	$V_{ID} = 1\text{ V}$ , $V_{OH} = 5\text{ V}$	Full range			100	
$I_{OL}$ Low-level output current	$V_{ID} = -1\text{ V}$ , $V_{OL} = 1.5\text{ V}$	25°C	6			mA
$I_{CCH}$ High-level supply current	$V_O = V_{OH}$	25°C		550	700	$\mu\text{A}$
		Full range			800	
$I_{CCL}$ Low-level supply current	$V_O = V_{OL}$	25°C		1.2	1.5	mA
		Full range			1.6	

† Full range is  $-40^\circ\text{C}$  to  $105^\circ\text{C}$ .

## switching characteristics, $V_{CC} = 5\text{ V}$ , $C_L = 15\text{ pF}$ , $T_A = 25^\circ\text{C}$

PARAMETER	TEST CONDITIONS	TLV2393			UNIT
		MIN	TYP	MAX	
Response time	100-mV input step with 5-mV overdrive, $R_L$ connected to 5 V through 5.1 k $\Omega$		0.4	0.8	$\mu\text{s}$
	TTL-level input step, $R_L$ connected to 5 V through 5.1 k $\Omega$		0.15	0.3	



# TLV1393, TLV1393Y, TLV2393, TLV2393Y DUAL DIFFERENTIAL COMPARATORS

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## electrical characteristics, $V_{CC} = 3\text{ V}$ , $T_A = 25^\circ\text{C}$

PARAMETER	TEST CONDITIONS	TLV2393Y			UNIT
		MIN	TYP	MAX	
$V_{IO}$ Input offset voltage	$V_O = 1.4\text{ V}$ , $V_{IC} = V_{ICRmin}$		1.5	5	mV
$V_{ICR}$ Common-mode input voltage range		0 to $V_{CC} - 1.5$	0 to $V_{CC} - 1.2$		V
$V_{OL}$ Low-level output voltage	$V_{ID} = -1\text{ V}$ , $I_{OL} = 1\text{ mA}$		80	300	mV
$I_{IO}$ Input offset current	$V_O = 1.4\text{ V}$		5	50	nA
$I_{IB}$ Input bias current	$V_O = 1.4\text{ V}$		-100	-250	nA
$I_{OH}$ High-level output current	$V_{ID} = 1\text{ V}$ , $V_{OH} = 3\text{ V}$		0.1		nA
$I_{OL}$ Low-level output current	$V_{ID} = -1\text{ V}$ , $V_{OL} = 1.5\text{ V}$	4			mA
$I_{CCH}$ High-level supply current	$V_O = V_{OH}$		450	600	$\mu\text{A}$
$I_{CCL}$ Low-level supply current	$V_O = V_{OL}$		1.1	1.3	mA

## switching characteristics, $V_{CC} = 3\text{ V}$ , $C_L = 15\text{ pF}$ , $T_A = 25^\circ\text{C}$

PARAMETER	TEST CONDITIONS	TLV2393Y			UNIT
		MIN	TYP	MAX	
Response time	100-mV input step with 5-mV overdrive, $R_L$ connected to 5 V through 5.1 k $\Omega$		0.45	1	$\mu\text{s}$

## electrical characteristics, $V_{CC} = 5\text{ V}$ , $T_A = 25^\circ\text{C}$

PARAMETER	TEST CONDITIONS	TLV2393Y			UNIT
		MIN	TYP	MAX	
$V_{IO}$ Input offset voltage	$V_O = 1.4\text{ V}$ , $V_{IC} = V_{ICRmin}$		1.5	5	mV
$V_{ICR}$ Common-mode input voltage range		0 to $V_{CC} - 1.5$	0 to $V_{CC} - 1.2$		V
$V_{OL}$ Low-level output voltage	$V_{ID} = -1\text{ V}$ , $I_{OL} = 1\text{ mA}$		70	300	mV
$I_{IO}$ Input offset current	$V_O = 1.4\text{ V}$		5	50	nA
$I_{IB}$ Input bias current	$V_O = 1.4\text{ V}$		-100	-250	nA
$I_{OH}$ High-level output current	$V_{ID} = 1\text{ V}$ , $V_{OH} = 3\text{ V}$		0.1		nA
$I_{OL}$ Low-level output current	$V_{ID} = -1\text{ V}$ , $V_{OL} = 1.5\text{ V}$	6			mA
$I_{CCH}$ High-level supply current	$V_O = V_{OH}$		550	700	$\mu\text{A}$
$I_{CCL}$ Low-level supply current	$V_O = V_{OL}$		1.2	1.5	mA

## switching characteristics, $V_{CC} = 5\text{ V}$ , $C_L = 15\text{ pF}$ , $T_A = 25^\circ\text{C}$

PARAMETER	TEST CONDITIONS	TLV2393Y			UNIT
		MIN	TYP	MAX	
Response time	100-mV input step with 5-mV overdrive, $R_L$ connected to 5 V through 5.1 k $\Omega$		0.4	0.8	$\mu\text{s}$
	TTL-level input step, $R_L$ connected to 5 V through 5.1 k $\Omega$		0.15	0.3	



TYPICAL CHARACTERISTICS

Table of Graphs

		FIGURE
Input overdrives for TLV1393	vs Low-to-high-level output response time	1, 3
	vs High-to-low-level output response time	2, 4
Input overdrives for TLV2393	vs Low-to-high-level output response time	5, 7
	vs High-to-low-level output response time	6, 8

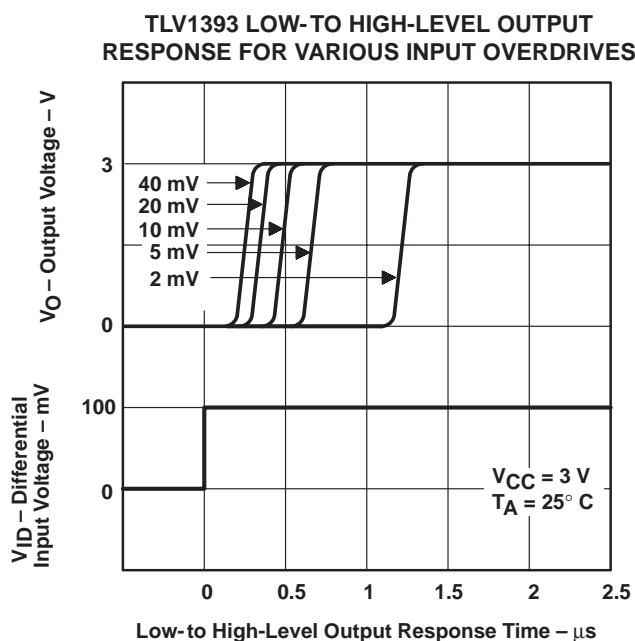


Figure 1

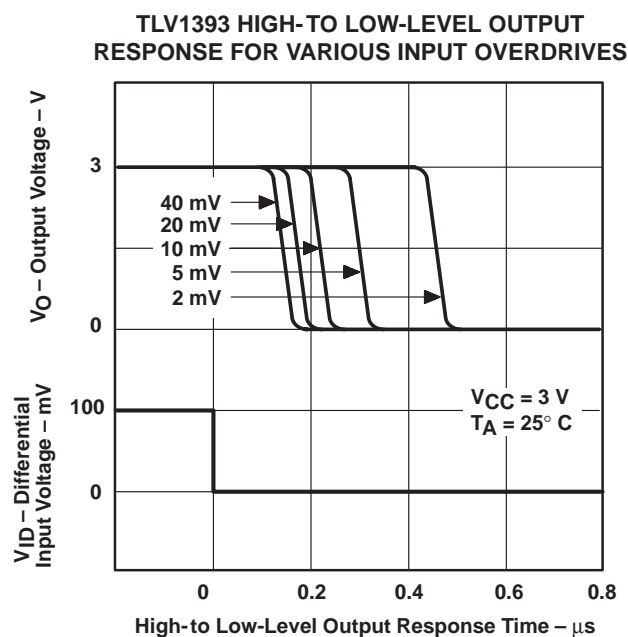


Figure 2

# TLV1393, TLV1393Y, TLV2393, TLV2393Y DUAL DIFFERENTIAL COMPARATORS

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## TYPICAL CHARACTERISTICS

TLV1393 LOW-TO-HIGH-LEVEL OUTPUT RESPONSE FOR VARIOUS INPUT OVERDRIVES

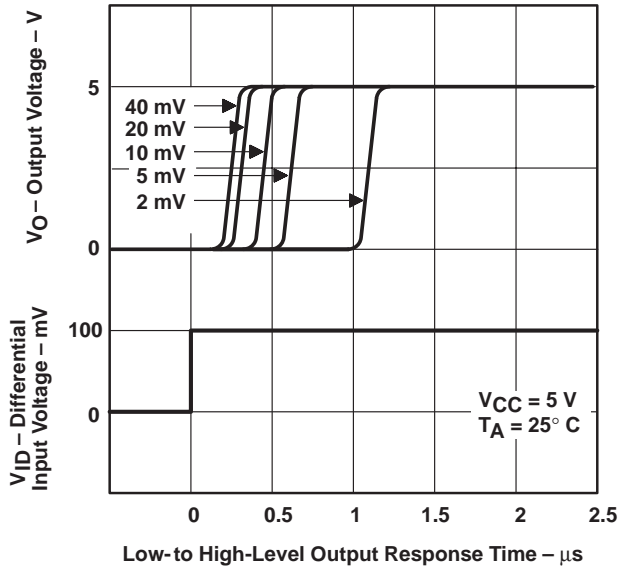


Figure 3

TLV1393 HIGH-TO-LOW-LEVEL OUTPUT RESPONSE FOR VARIOUS INPUT OVERDRIVES

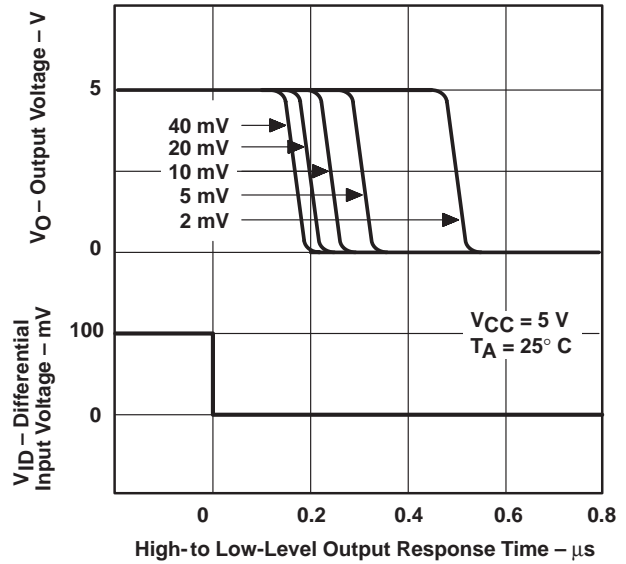


Figure 4

TLV2393 LOW-TO-HIGH-LEVEL OUTPUT RESPONSE FOR VARIOUS INPUT OVERDRIVES

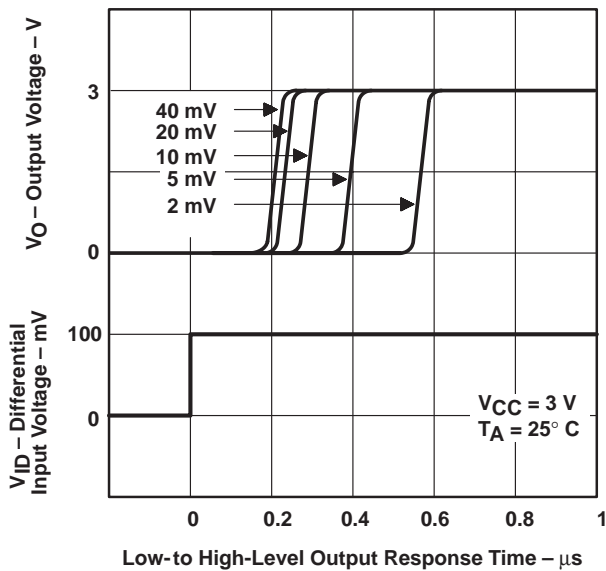


Figure 5

TLV2393 HIGH-TO-LOW-LEVEL OUTPUT RESPONSE FOR VARIOUS INPUT OVERDRIVES

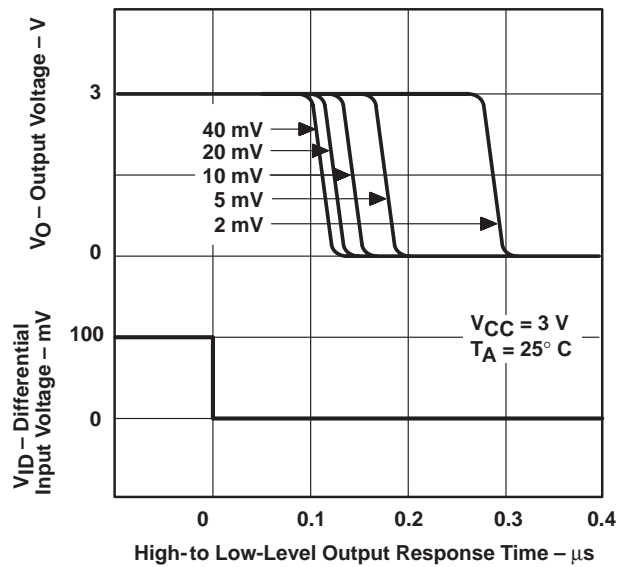


Figure 6



TYPICAL CHARACTERISTICS

TLV2393 LOW-TO HIGH-LEVEL OUTPUT  
 RESPONSE FOR VARIOUS INPUT OVERDRIVES

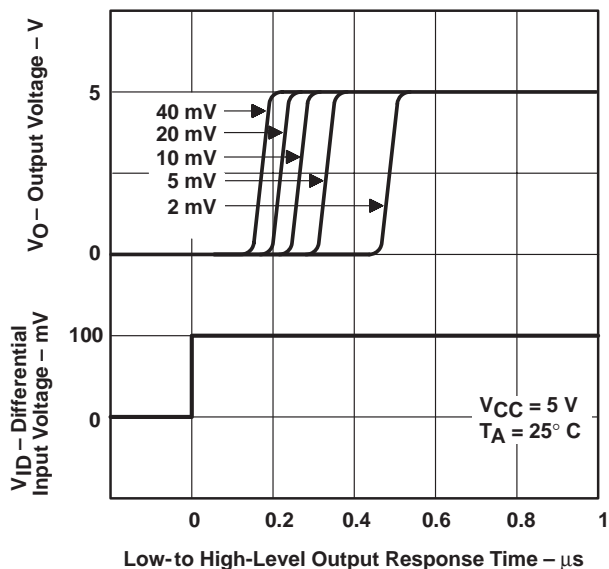


Figure 7

TLV2393 HIGH-TO LOW-LEVEL OUTPUT  
 RESPONSE FOR VARIOUS INPUT OVERDRIVES

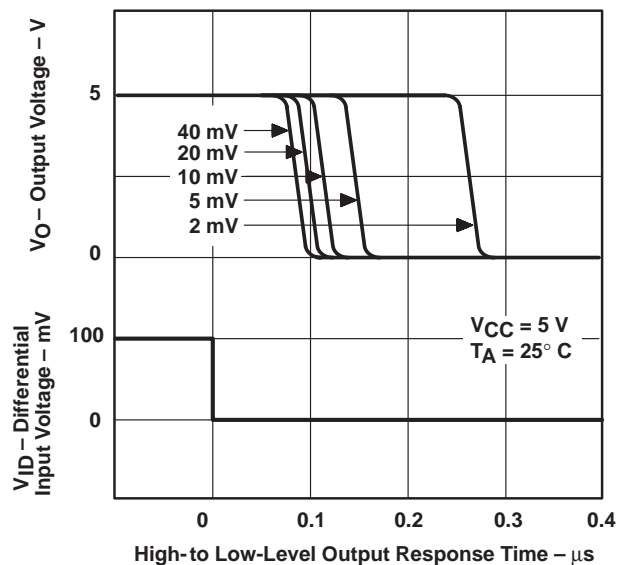


Figure 8

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