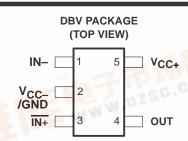
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- Low-Voltage and Single-Supply Operation
   V<sub>CC</sub> = 2 V to 7 V
- Common-Mode Voltage Range Includes Ground
- Fast Response Time . . . 0.7 μs Typ
- Low Supply Current ... 80 μA Typ and 150 μA Max
- Fully Specified at 3-V and 5-V Supply Voltages
- Available in SOT-23 (DBV) Packaging



### description

The TLV1391 is a differential comparator built using a Texas Instruments low-voltage, high-speed bipolar process. These devices have been developed specifically for low-voltage, single-supply applications. Their enhanced performance makes them excellent replacements for the LM393 in the improved 3-V and 5-V system designs of today.

The TLV1391, with its typical supply current of only 80 μA, is ideal for low-power systems. Response time also has been improved to 0.7 μs.

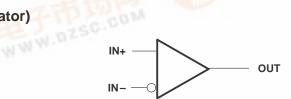
The TLV1391C is characterized for operation from 0°C to 70°C and the TLV1391I is characterized for operation from –40°C to 85°C.

#### **AVAILABLE OPTIONS**

т.	TA PACKAGED DEVICES		CHIP FORM
'A	SOT-23 (DBV)	SYMBOL	(Y)
0°C to 70°C	TLV1391CDBV	VABC	TLV1391Y
-40°C to 85°C	TLV1391IDBV	VABI	· WWW.

<sup>&</sup>lt;sup>†</sup> The DBV package is only available taped and reeled. Chip forms are specified for operation at 25°C only.

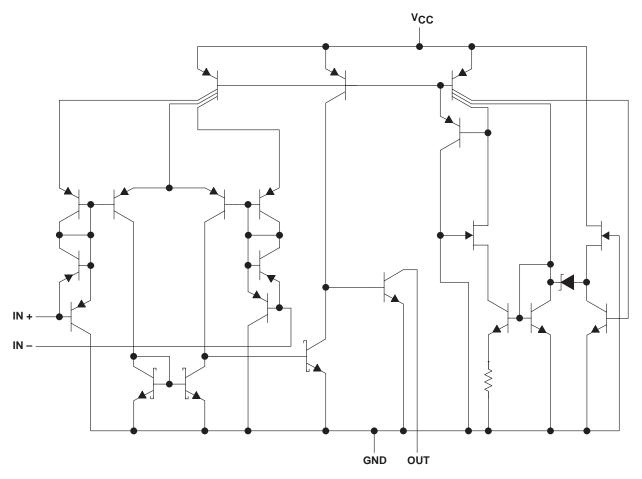
#### symbol (each comparator)



Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

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### TLV1391, TLV1391Y equivalent schematic



COMPONENT COUNT						
Transistors	26					
Resistors	1					
Diodes	4					
Epi-FET	1					

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

Supply voltage, V <sub>CC</sub> (see Note 1)		 7 V
Differential input voltage, VID (see No		
Input voltage, V <sub>I</sub> (any input)		 $-0.3 \text{ V to V}_{\text{CC}}$
Output voltage, VO		 7 V
Output current, IO (each output)		 20 mA
Duration of short-circuit current to GN	D (see Note 3)	 Unlimited
Package thermal impedance, θ <sub>JA</sub> (se	e Note 4 and 5)	 347°C/W
Lead temperature 1,6 mm (1/16 inch)	from case for 10 seconds	 260°C
Storage temperature range, T <sub>stg</sub>		 -65°C to 150°C

<sup>†</sup> 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<sub>CC</sub> can cause excessive heating and eventual destruction of the chip.
  - 4. Maximum power dissipation is a function of  $T_J(max)$ ,  $\theta_{JA}$ , and  $T_A$ . The maximum allowable power dissipation at any allowable ambient temperature is  $P_D = (T_J(max) T_A)/\theta_{JA}$ . Operating at the absolute maximum  $T_J$  of 150°C can impact reliability.
  - 5. The package thermal impedance is calculated in accordance with JESD 51.

### recommended operating conditions

		MIN	MAX	UNIT
Supply voltage, V <sub>CC</sub>		2	7	V
Operating free-air temperature, T <sub>A</sub>	TLV1391C	0	70	°C
Operating nee-all temperature, 14	TLV1391I	-40	85	Ò



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

	PARAMETER		CONDITIONS	_ +	1	TLV1391C		UNIT
	PARAMETER	1531	CONDITIONS	T <sub>A</sub> †	MIN	TYP	MAX	UNII
\/:o	Input offset voltage	\/o = 1.4.\/	\/10 = \/10p(min)	25°C		1.5	5	mV
VIO	input onset voitage	VO = 1.4 V,	VIC = VICR(min)	Full range			9	IIIV
				25°C	0 to	0 to		
VICR	Common-mode input voltage range			25 0	V <sub>CC</sub> – 1.5	V <sub>CC</sub> -1.2		V
VICR	CR Common-mode input voltage range			Full range	0 to			v l
				Full range	V <sub>CC</sub> -2			
VOL	Low-level output voltage	$V_{ID} = -1 V$ ,	$I_{OL} = 500 \mu\text{A}$	Full range		120	300	mV
l. a	Input offset current V	\/- 1.4\/		25°C		5	50	~^
110		V <sub>O</sub> = 1.4 V	ν <sub>O</sub> = 1.4 ν		Full range			150
1	Input bigg gurrent	\/a = 1.4.\/		25°C		-40	-250	nA
IВ	Input bias current	V <sub>O</sub> = 1.4 V		Full range			-400	IIA
lau	High-level output current	$V_{ID} = 1 V$	V <sub>OH</sub> = 3 V	25°C		0.1		nA
ЮН	rign-level output current	V <sub>ID</sub> = 1 V,	V <sub>OH</sub> = 5 V	Full range			100	IIA
loL	Low-level output current	$V_{ID} = -1 V$ ,	V <sub>OL</sub> = 1.5 V	25°C	500			μΑ
loo##	High lovel cumply current	\\a - \\a\\		25°C		80	125	
ICC(H)	High-level supply current	VO = VOH		Full range			150	μΑ
loous	Low lovel supply surrent	\\a\\a_\		25°C		80	125	
ICC(L)	Low-level supply current	VO = VOL		Full range			150	μΑ

<sup>†</sup> Full range is 0°C to 70°C.

## switching characteristics, $V_{CC}$ = 3 V, $C_L$ = 15 pF‡, $T_A$ = 25°C

PARAMETER	TEST CONDITIONS	Τl	_V13910		UNIT
FARAIVIETER	TEST CONDITIONS		TYP	MAX	UNIT
Response time	100-mV input step with 5-mV overdrive, $R_L = 5.1 \text{ k}\Omega$		0.7		μs

<sup>‡</sup>C<sub>L</sub> includes the probe and jig capacitance.

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

	PARAMETER	TEST (	CONDITIONS	T. †	7	TLV1391C		UNIT
	PARAMETER	lE31 (	CONDITIONS	T <sub>A</sub> †	MIN	TYP	MAX	UNIT
\/\c	Input offset voltage	\\a = 1.4.\\	\/.o - \/.o \/min\	25°C		1.5	5	mV
VIO	input onset voltage	VO = 1.4 V,	VIC = VICR(min)	Full range			9	IIIV
				25°C	0 to	0 to		
VICR	Common-mode input voltage range			200	V <sub>CC</sub> – 1.5	V <sub>CC</sub> -1.2		V
VICK	Common mode input voltage range			Full range	0 to V <sub>CC</sub> -2			V
VOL	Low-level output voltage	$V_{ID} = -1 V$ ,	I <sub>OL</sub> = 500 μA	Full range		120	300	mV
1.0	lanut offect ourrent	\/- 1.4.\/		25°C		5	50	~ ^
110	Input offset current	put offset current V <sub>O</sub> = 1.4 V Full range			150	nA		
1.5	Input bias current	V <sub>O</sub> = 1.4 V		25°C		-40	-250	nA
IB	input bias current	VO = 1.4 V		Full range			-400	ПА
lau	High-level output current	$V_{ID} = 1 V$	V <sub>OH</sub> = 3 V	25°C		0.1		nA
IОН	nigh-level output current	V <sub>ID</sub> = 1 V,	V <sub>OH</sub> = 5 V	Full range			100	IIA
loL	Low-level output current	$V_{ID} = -1 V$ ,	V <sub>OL</sub> = 1.5 V	25°C	600			μΑ
laann	High lavel comply comment	\/a \/a		25°C		100	150	^
ICC(H)	High-level supply current	VO = VOH		Full range			175	μΑ
loou:	Low-level supply current	\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\		25°C		100	150	
ICC(L)	Low-level supply current	VO = VOL		Full range			175	μΑ

<sup>†</sup> Full range is 0°C to 70°C.

# switching characteristics, $V_{CC}$ = 5 V, $C_L$ = 15 pF<sup>‡</sup>, $T_A$ = 25°C

PARAMETER	TEST CONDITIONS			TLV1391C			
PARAMETER	TEST CONDITIONS		MIN	TYP	MAX	UNIT	
Response time	100-mV input step with 5-mV overdrive,	$R_L = 5.1 \text{ k}\Omega$		0.65			
Response une	TTL-level input step,	$R_L = 5.1 \text{ k}\Omega$		0.18		μs	

<sup>‡</sup>C<sub>L</sub> includes the probe and jig capacitance.

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

	PARAMETER	TEST	CONDITIONS	- +		TLV1391I		UNIT
	PARAMETER	1531 (	CONDITIONS	T <sub>A</sub> †	MIN	TYP	MAX	UNIT
V10	Input offset voltage	Vo = 1.4.V	V <sub>IC</sub> = V <sub>ICR</sub> (min)	25°C		1.5	5	mV
VIO	input onset voltage	VO = 1.4 V,	AIC = AICK(IIIIII)	Full range			9	IIIV
				25°C	0 to	0 to		
VICR	Common-mode input voltage range			20 0	V <sub>CC</sub> – 1.5	V <sub>CC</sub> -1.2		V
VICK	Common mode input voltage range			Full range	0 to V <sub>CC</sub> -2			Ů
VOL	Low-level output voltage	$V_{ID} = -1 V$ ,	I <sub>OL</sub> = 500 μA	Full range		120	300	mV
li o	Input offset current	Vo = 1.4.V		25°C		5	50	nA
110	Input offset current	V <sub>O</sub> = 1.4 V	Full range			150	IIA	
1	Input bias current	V= -1.4.V		25°C		-40	-250	nA
IB	input bias current	V <sub>O</sub> = 1.4 V		Full range			-400	IIA
lau	High lovel output ourrent	$V_{ID} = 1 V$	V <sub>OH</sub> = 3 V	25°C		0.1		nA
ЮН	High-level output current	V <sub>ID</sub> = 1 V,	V <sub>OH</sub> = 5 V	Full range			100	IIA
loL	Low-level output current	$V_{ID} = -1 V$ ,	V <sub>OL</sub> = 1.5 V	25°C	500			μΑ
10000	High lovel comply comment	V- V		25°C		80	125	^
ICC(H)	High-level supply current	VO = VOH		Full range			150	μA
loons	Low lovel cumply current	Vo - Vo.		25°C		80	125	
ICC(L)	Low-level supply current	VO = VOL		Full range			150	μA

<sup>†</sup> Full range is -40°C to 85°C.

## switching characteristics, $V_{CC}$ = 3 V, $C_L$ = 15 pF‡, $T_A$ = 25°C

PARAMETER	TEST CONDITIONS	Т	LV1391I		UNIT
FARAMETER	TEST CONDITIONS M		TYP	MAX	ONIT
Response time	100-mV input step with 5-mV overdrive, $R_L = 5.1 \text{ k}\Omega$		0.7		μs

<sup>‡</sup>C<sub>L</sub> includes the probe and jig capacitance.

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

	PARAMETER	TEST (	CONDITIONS	- +		TLV1391I		UNIT	
	PARAMETER	lE31 (	CONDITIONS	T <sub>A</sub> †	MIN	TYP	MAX	UNIT	
\/.0	Input offset voltage	\\a = 1.4.\\	\/.o - \/.o = (min)	25°C		1.5	5	mV	
VIO	input onset voitage	VO = 1.4 V,	VIC = VICK(min)	Full range			9	IIIV	
				25°C	0 to	0 to			
VICR	Common-mode input voltage range			200	V <sub>CC</sub> – 1.5	V <sub>CC</sub> –1.2		V	
VICK	Common mode input voltage range			Full range	0 to V <sub>CC</sub> -2			V	
VOL	Low-level output voltage	$V_{ID} = -1 V$ ,	I <sub>OL</sub> = 500 μA	Full range		120	300	mV	
1	lanut affact current	V= 4.4.V		25°C		5	50	~ ^	
110	Input offset current	V <sub>O</sub> = 1.4 V	VO = 1.4 V		Full range			150	nA
1	Input bigg gurrant	\/a = 1.4.\/		25°C		-40	-250	nA	
IB	Input bias current	V <sub>O</sub> = 1.4 V		Full range			-400	IIA	
lau	High lovel output gurrent	$V_{ID} = 1 V$	V <sub>OH</sub> = 3 V	25°C		0.1		nA	
Іон	High-level output current	V <sub>ID</sub> = 1 V,	V <sub>OH</sub> = 5 V	Full range			100	IIA	
loL	Low-level output current	$V_{ID} = -1 V$ ,	V <sub>OL</sub> = 1.5 V	25°C	600			μΑ	
laan.	Lligh lovel events evenest	V- V		25°C		100	150	^	
ICC(H)	High-level supply current	VO = VOH		Full range			175	μΑ	
loo#:	Low lovel supply surrent	\\\ \( \) = \\\\ \( \) = \( \)		25°C		100	150		
ICC(L)	Low-level supply current	AO = AOF		Full range			175	μΑ	

<sup>†</sup>Full range is –40°C to 85°C.

# switching characteristics, $V_{CC}$ = 5 V, $C_L$ = 15 pF<sup>‡</sup>, $T_A$ = 25°C

PARAMETER  esponse time  100-mV input ste	TEST CONDITIONS		Т	LV1391I		UNIT
PARAMETER	TEST CONDITIONS		MIN	TYP	MAX	UNIT
Bognongo timo	100-mV input step with 5-mV overdrive,	$R_L = 5.1 \text{ k}\Omega$		0.65		
Response une	TTL-level input step,	$R_L = 5.1 \text{ k}\Omega$		0.18		μs

<sup>‡</sup>C<sub>L</sub> includes the probe and jig capacitance.

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## electrical characteristics, $V_{CC}$ = 3 V, $T_A$ = 25°C

PARAMETER		TEST CONDITIONS		1	UNIT		
				MIN	TYP	MAX	UNIT
VIO	Input offset voltage	$V_0 = 1.4 V$ ,	$V_{IC} = V_{ICR}(min)$		1.5	5	mV
VICR	Common-mode input voltage range			0 to V <sub>CC</sub> – 1.5	0 to V <sub>CC</sub> -1.2		V
IIO	Input offset current	V <sub>O</sub> = 1.4 V			5	50	nA
I <sub>IB</sub>	Input bias current	V <sub>O</sub> = 1.4 V			-40	-250	nA
IOH	High-level output current	$V_{ID} = 1 V$ ,	V <sub>OH</sub> = 3 V		0.1		nA
IOL	Low-level output current	$V_{ID} = -1 V$ ,	V <sub>OL</sub> = 1.5 V	500			μΑ
I <sub>CC(H)</sub>	High-level supply current	$V_O = V_{OH}$	·		80	125	μΑ
I <sub>CC(L)</sub>	Low-level supply current	$V_O = V_{OL}$			80	125	μΑ

## switching characteristics, V<sub>CC</sub> = 3 V, C<sub>L</sub> = 15 pF $^{\dagger}$ , T<sub>A</sub> = 25 $^{\circ}$ C

PARAMETER	TEST CONDITIONS		TLV1391Y		
PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Response time	100-mV input step with 5-mV overdrive, $R_L = 5.1 \text{ k}\Omega$		0.7		μs

<sup>†</sup> C<sub>L</sub> includes the probe and jig capacitance.

## electrical characteristics, $V_{CC}$ = 5 V, $T_A$ = 25°C

PARAMETER		TEST CONDITIONS		1	UNIT		
				MIN	TYP	MAX	UNIT
VIO	Input offset voltage	$V_0 = 1.4 V$ ,	$V_{IC} = V_{ICR}(min)$		1.5	5	mV
VICR	Common-mode input voltage range			0 to V <sub>CC</sub> – 1.5	0 to V <sub>CC</sub> -1.2		V
I <sub>IO</sub>	Input offset current	$V_0 = 1.4 \text{ V}$			5	50	nA
I <sub>IB</sub>	Input bias current	V <sub>O</sub> = 1.4 V			-40	-250	nA
lOH	High-level output current	$V_{ID} = 1 V$	V <sub>OH</sub> = 3 V		0.1		nA
lOL	Low-level output current	$V_{ID} = -1 V$ ,	V <sub>OL</sub> = 1.5 V	600			μΑ
ICC(H)	High-level supply current	VO = VOH			100	150	μΑ
I <sub>CC(L)</sub>	Low-level supply current	VO = VOL			100	150	μΑ

## switching characteristics, $V_{CC}$ = 5 V, $C_L$ = 15 pF‡, $T_A$ = 25°C

PARAMETER	TEST CONDITIONS		TLV1391Y			UNIT
PARAMETER			MIN	TYP	MAX	ONIT
Response time	100-mV input step with 5-mV overdrive,	$R_L = 5.1 \text{ k}\Omega$	0.65			
Response time	TTL-level input step,	$R_L = 5.1 \text{ k}\Omega$		0.18		μs

<sup>‡</sup>C<sub>L</sub> includes the probe and jig capacitance.



#### TYPICAL CHARACTERISTICS

#### **LOW-TO HIGH-LEVEL OUTPUT RESPONSE FOR VARIOUS INPUT OVERDRIVES** 4.5 Vo - Output Voltage - V 3 40 mV 20 mV 10 mV 1.5 5 mV 2 mV 0 V I(STEP) – Input Voltage Step – mV 100 $V_{CC} = 3 V$ $T_{A} = 25^{\circ} C$ 0 0 2 2.5 0.5 1 1.5 Low-to High-Level Output Response Time – $\mu$ s

Figure 1

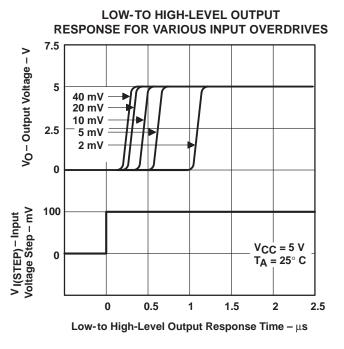


Figure 3

## **HIGH-TO LOW-LEVEL OUTPUT RESPONSE FOR VARIOUS INPUT OVERDRIVES**

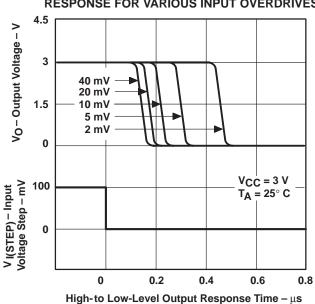


Figure 2

### **HIGH-TO LOW-LEVEL OUTPUT RESPONSE FOR VARIOUS INPUT OVERDRIVES**

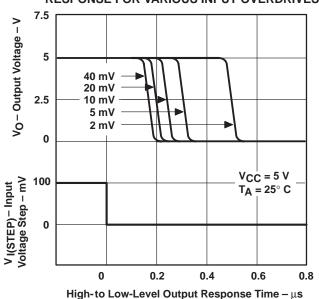


Figure 4

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