Micropower Dual CMOS Voltage Comparator

NCV2393, TS393

The NCV2393 and TS393 are micropower CMOS dual voltage comparators. They feature extremely low consumption of 6 μA typical per comparator and operate over a wide temperature range of T_A = −40 to 125°C. The NCV2393 and TS393 are available in an SOIC−8 package.

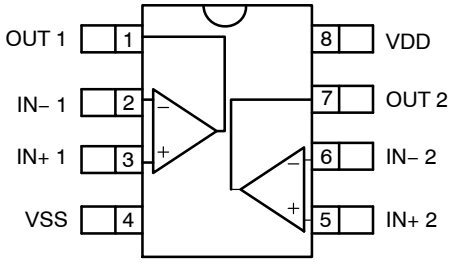
Features

- Extremely Low Supply Current: 6 μA Typical Per Channel
- Wide Supply Range: 2.7 to 16 V
- Extremely Low Input Bias Current: 1 pA Typical
- Extremely Low Input Offset Current: 1 pA Typical
- Input Common Mode Range Includes V_{SS}
- High Input Impedance: 10^{12} Ω
- Pin−to−Pin Compatibility with Dual Bipolar LM393
- NCV Prefix for Automotive and Other Applications Requiring Unique Site and Control Change Requirements; AEC−Q100 Qualified and PPAP Capable
- These Devices are Pb−Free, Halogen Free/BFR Free and are RoHS Compliant

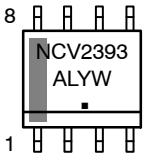


SOIC-8
CASE 751

PIN CONNECTIONS



MARKING DIAGRAM



A = Assembly Location
L = Wafer Lot
Y = Year
W = Work Week
▪ = Pb−Free Package

ORDERING INFORMATION

Device	Package	Shipping†
NCV2393DR2G	SOIC−8 (Pb−Free)	2,500 / Tape & Reel
TS393DR2G	SOIC−8 (Pb−Free)	2,500 / Tape & Reel

† For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specification Brochure, BRD8011/D.

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PIN DESCRIPTION

Pin	Name	Type	Description
1	OUT 1	Output	Output of comparator 1. The open−drain output requires an external pull−up resistor.
2	IN− 1	Input	Inverting input of comparator 1
3	IN+ 1	Input	Non−inverting input of comparator 1
4	VSS	Power	Negative supply
5	IN+ 2	Input	Non−inverting input of comparator 2
6	IN− 2	Input	Inverting input of comparator 2
7	OUT 2	Output	Output of comparator 2. The open−drain output requires an external pull−up resistor.
8	VDD	Power	Positive supply

ABSOLUTE MAXIMUM RATINGS (Note 1)

Over operating free−air temperature, unless otherwise stated

Parameter	Limit	Unit
Supply Voltage, V_S (V_{DD}−V_{SS})	18	V
INPUT AND OUTPUT PINS		
Input Voltage (Note 2)	18	V
Input Differential Voltage, V_{ID} (Note 3)	±18	V
Input Current (through ESD protection diodes)	50	mA
Output Voltage	18	V
Output Current	20	mA
TEMPERATURE		
Storage Temperature	−65 to +150	°C
Junction Temperature	150	°C
ESD RATINGS		
Human Body Model	1500	V
Machine Model	50	V
LATCH−UP RATINGS		
Latch−up Current	100	mA

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

1. Stresses beyond the absolute maximum ratings can lead to reduced reliability and damage.
2. Excursions of input voltages may exceed the power supply level. As long as the common mode voltage [V_{CM} = (V_{IN}+ + V_{IN}−)/2] remains within the specified range, the comparator will provide a stable output state. However, the maximum current through the ESD diodes of the input stage must strictly be observed.
3. Input differential voltage is the non−inverting input terminal with respect to the inverting input terminal. To prevent damage to the gates, each comparator includes back−to−back zener didoes between input terminals. When differential voltage exceeds 6.2 V, the diodes turn on. Input resistors of 1 kΩ have been integrated to limit the current in this event.
4. This device series incorporates ESD protection and is tested by the following methods:
   ESD Human Body Model tested per AEC−Q100−002 (JEDEC standard: JESD22−A114)
   ESD Machine Model tested per AEC−Q100−003 (JEDEC standard: JESD22−A115)
   Latch−up Current tested per JEDEC standard: JESD78.

THERMAL INFORMATION (Note 5)

Symbol	Thermal Metric	Value	Unit
θ_{JA}	Junction−to−Ambient (Note 6)	190	°C/W
Ψ_{JT}	Junction−to−Case Top	107	°C/W

5. Short−circuits can cause excessive heating and destructive dissipation. Values are typical.
6. Multilayer board, 1 oz. copper, 400 mm^2 copper area, both junctions heated equally

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OPERATING CONDITIONS

Symbol	Parameter	Limit	Unit
V_S	Supply Voltage (V_{DD} – V_{SS})	+2.7 to +16	V
T_A	Operating Free Air Temperature Range	–40 to +125	°C

Functional operation above the stresses listed in the Recommended Operating Ranges is not implied. Extended exposure to stresses beyond the Recommended Operating Ranges limits may affect device reliability.

ELECTRICAL CHARACTERISTICS: V_S = +3 V

(**Boldface** limits apply over the specified temperature range, T_A = –40°C to +125°C, guaranteed by characterization and/or design.)

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
INPUT CHARACTERISTICS						
V_{OS}	Offset Voltage	V_{CM} = mid–supply		1.4	13	mV
					14	mV
I_{IB}	Input Bias Current (Note 7)	V_{CM} = mid–supply		1		pA
					600	**pA**
I_{OS}	Input Offset Current (Note 7)	V_{CM} = mid–supply		1		pA
					300	**pA**
V_{CM}	Input Common Mode Range		V_{SS}		V_{DD} – 1.5	V
			V_{SS}		**V_{DD} – 2**	**V**
CMRR	Common Mode Rejection Ratio	V_{CM} = V_{SS} to V_{CM} = V_{DD} – 1.5 V		70		dB
OUTPUT CHARACTERISTICS						
V_{OL}	Output Voltage Low	V_{ID} = –1 V, I_{OL} = +6 mA		V_{SS} + 300	V_{SS} + 450	mV
					V_{SS} + 700	**mV**
I_{OH}	Output Current High	V_{ID} = +1 V, V_{OH} = +3 V		2	40	nA
					1000	**nA**
DYNAMIC PERFORMANCE						
t_{PLH}	Propagation Delay Low to High	V_{CM} = mid–supply, f = 10 kHz, R_{PU} = 5.1 kΩ, C_L = 50 pF; 5 mV overdrive		2.1		μs
		V_{CM} = mid–supply, f = 10 kHz, R_{PU} = 5.1 kΩ, C_L = 50 pF; TTL input		0.6		μs
t_{PHL}	Propagation Delay High to Low	V_{CM} = mid–supply, f = 10 kHz, R_{PU} = 5.1 kΩ, C_L = 50 pF; 5 mV overdrive		3.9		μs
		V_{CM} = mid–supply, f = 10 kHz, R_{PU} = 5.1 kΩ, C_L = 50 pF; TTL input		0.2		μs
POWER SUPPLY						
PSRR	Power Supply Rejection Ratio	V_S = +3 V to +5 V		70		dB
I_{DD}	Quiescent Current	Per channel, no load, output = LOW		6	15	μA
					20	**μA**

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

7. Guaranteed by characterization and/or design.

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ELECTRICAL CHARACTERISTICS: V_S = **+5 V**, unless otherwise noted
(**Boldface** limits apply over the specified temperature range, T_A = −40°C to +125°C, guaranteed by characterization and/or design.)

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
INPUT CHARACTERISTICS							
V_{OS}	Offset Voltage	V_{CM} = mid−supply V, V_S = 5 V to 10 V			1.4	13	mV
						14	mV
I_{IB}	Input Bias Current (Note 8)	V_{CM} = mid−supply			1		pA
						600	**pA**
I_{OS}	Input Offset Current (Note 8)	V_{CM} = mid−supply			1		pA
						300	**pA**
V_{CM}	Input Common Mode Range			V_{SS}		V_{DD} − 1.5	V
				V_{SS}		**V_{DD} − 2**	**V**
CMRR	Common Mode Rejection Ratio	V_{CM} = V_{SS} to V_{CM} = V_{DD} − 1.5 V			71		dB
OUTPUT CHARACTERISTICS							
V_{OL}	Output Voltage Low	V_{ID} = −1 V, I_{OL} = +6 mA			V_{SS} + 260	V_{SS} + 350	mV
						V_{SS} + 550	**mV**
I_{OH}	Output Current High	V_{ID} = +1 V, V_{OH} = +5 V			2	40	nA
						1000	**nA**
DYNAMIC PERFORMANCE							
t_{FALL}	Fall Time	50 mV overdrive, f = 10 kHz, R_{PU} = 5.1 kΩ, C_L = 50 pF			25		ns
t_{PLH}	Propagation Delay Low to High	V_{CM} = mid−supply, f = 10 kHz, R_{PU} = 5.1 kΩ, C_L = 50 pF	5 mV overdrive		2.1		μs
			10 mV overdrive		1.2		μs
			20 mV overdrive		0.8		μs
			40 mV overdrive		0.5		μs
			TTL input		0.6		μs
t_{PHL}	Propagation Delay High to Low	V_{CM} = mid−supply, f = 10 kHz, R_{PU} = 5.1 kΩ, C_L = 50 pF	5 mV overdrive		5.8		μs
			10 mV overdrive		3.2		μs
			20 mV overdrive		1.7		μs
			40 mV overdrive		1.0		μs
			TTL input		0.3		μs
POWER SUPPLY							
PSRR	Power Supply Rejection Ratio	VS = +5 V to = +10 V			80		dB
I_{DD}	Quiescent Current	Per channel, no load, output = LOW			6	15	μA
						20	**μA**

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

8. Guaranteed by characterization and/or design

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TYPICAL OPERATING CHARACTERISTICS

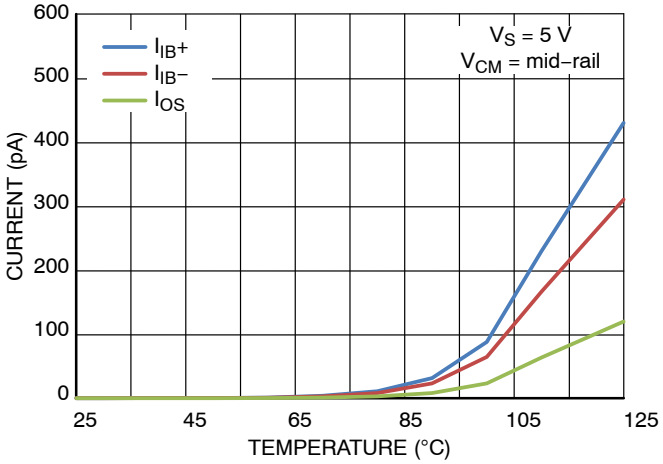

Figure 1. I_{IB} and I_{OS} vs. Temperature

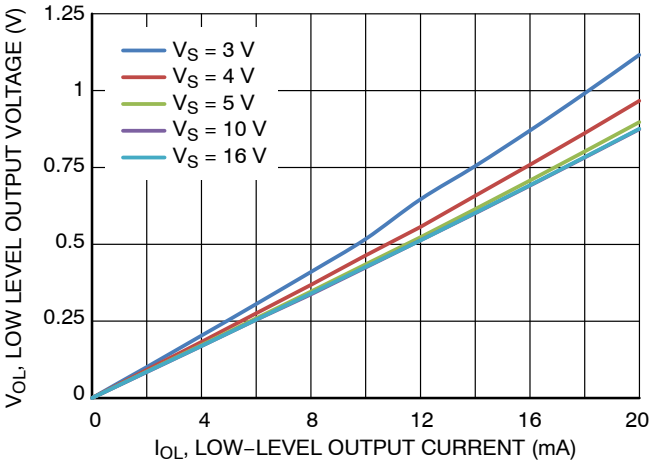

Figure 2. V_{OL} vs. I_{OL}

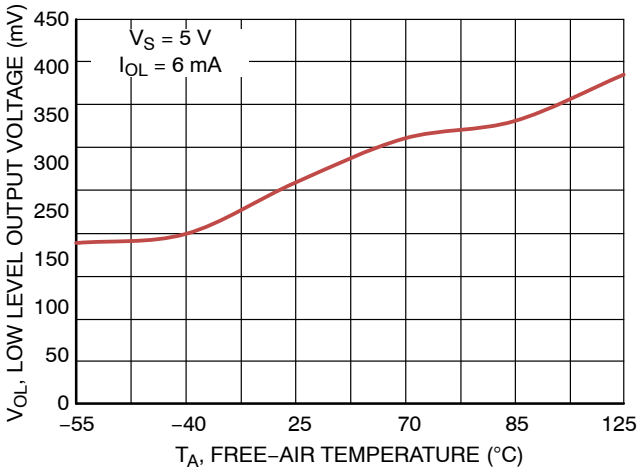

Figure 3. V_{OL} vs. Temperature

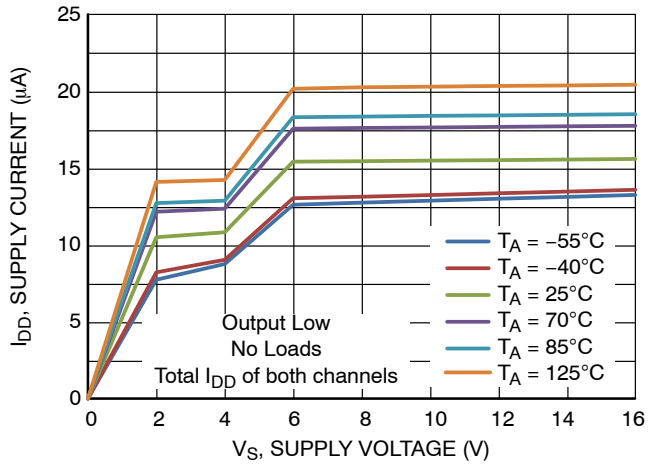

Figure 4. I_{DD} vs. V_S

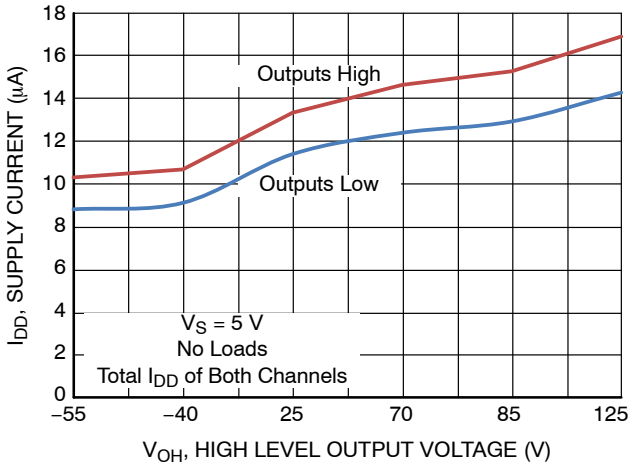

Figure 5. I_{DD} vs. Temperature

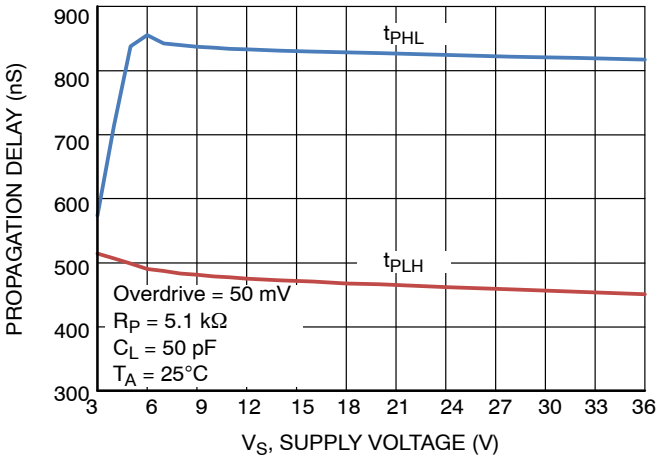

Figure 6. Propagation Delay vs. V_S

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TYPICAL OPERATING CHARACTERISTICS (continued)

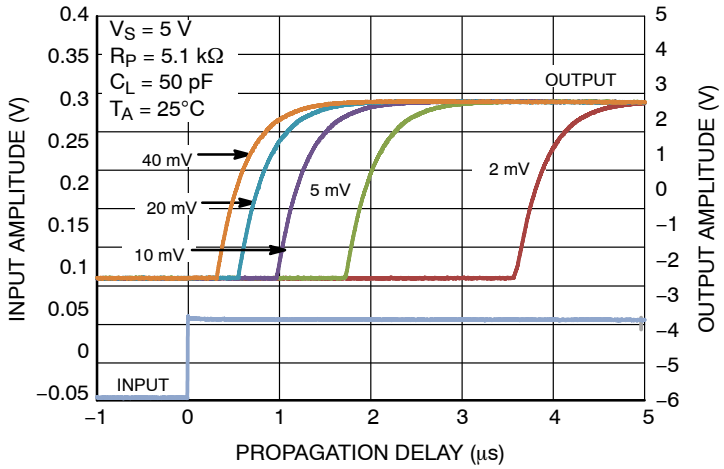

Figure 7. t_{PLH} vs. Overdrive

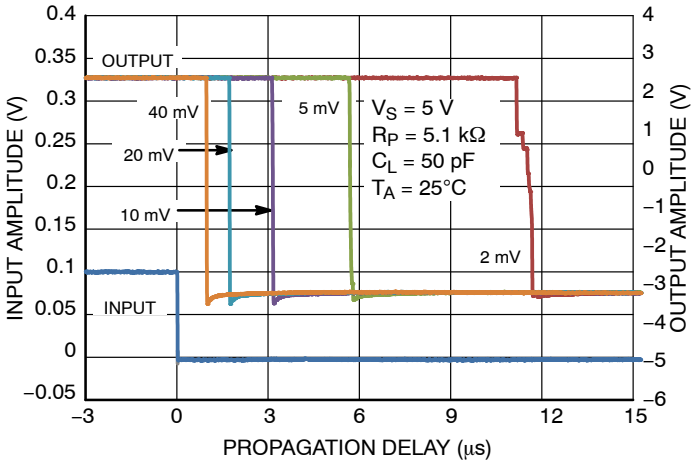

Figure 8. t_{PHL} vs. Overdrive

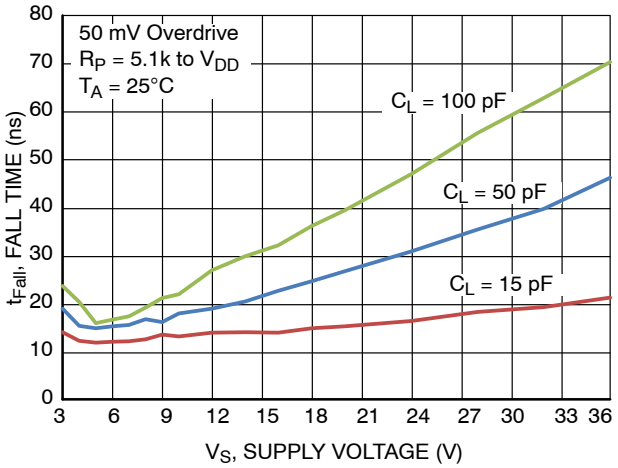

Figure 9. Fall Time vs. V_S

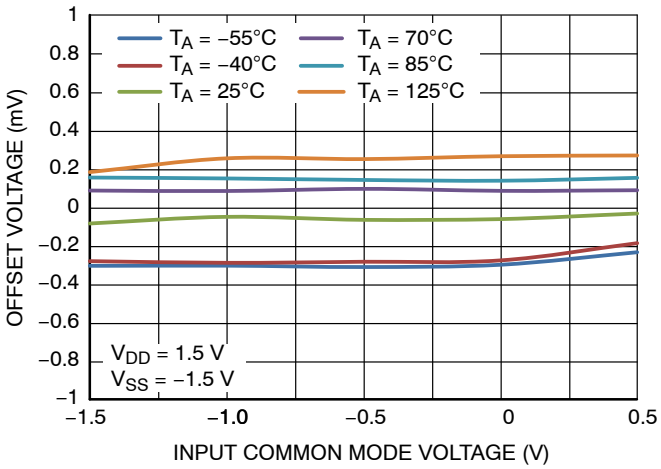

Figure 10. V_{OS} vs. V_{CM} (V_S = 3 V)

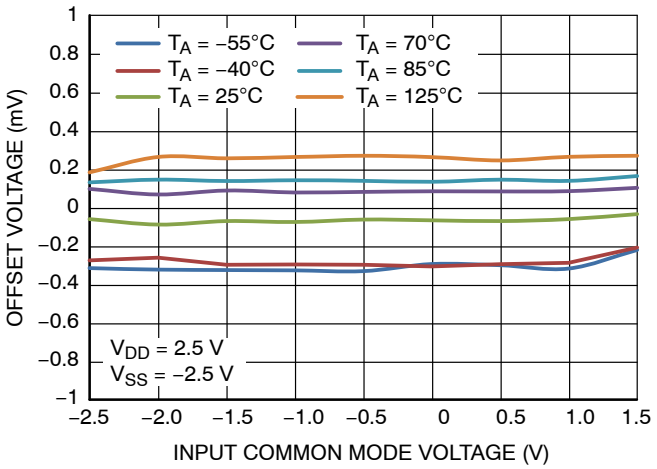

Figure 11. V_{OS} vs. V_{CM} (V_S = 5 V)

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TYPICAL OPERATING CHARACTERISTICS (continued)

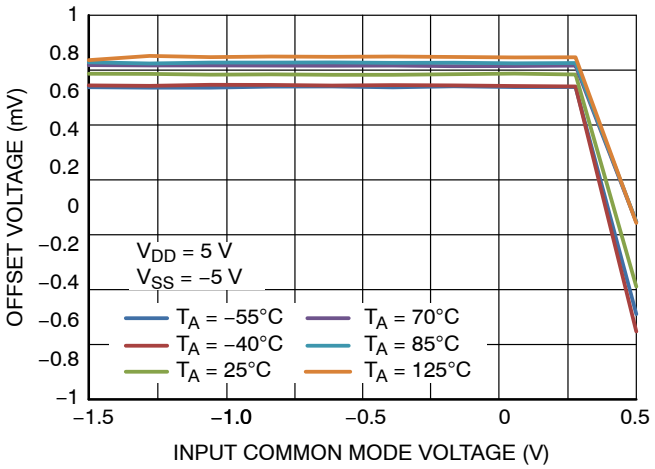

Figure 12. V_{OS} vs. V_{CM} (V_S = 10 V)

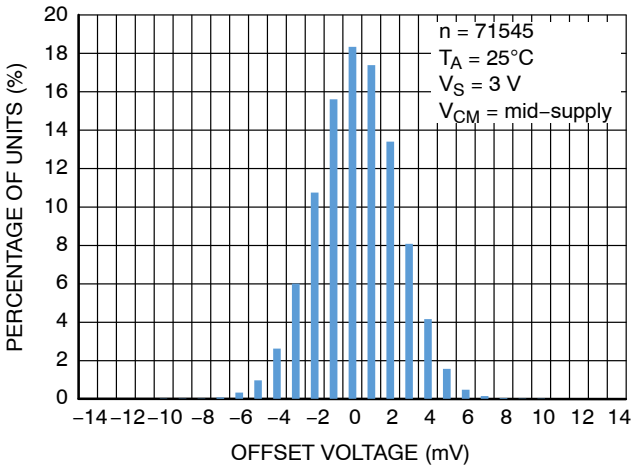

Figure 13. Offset Voltage Distribution

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REVISION HISTORY

Revision	Description of Changes	Date
6	Rebranded the Data Sheet to **onsemi** format.	5/20/2025

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SCALE 1:1

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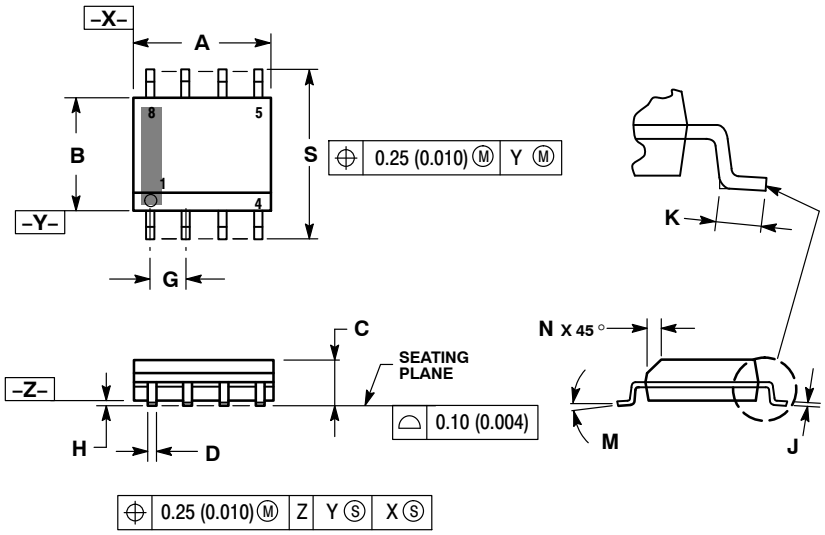
CASE 751−07
ISSUE AK

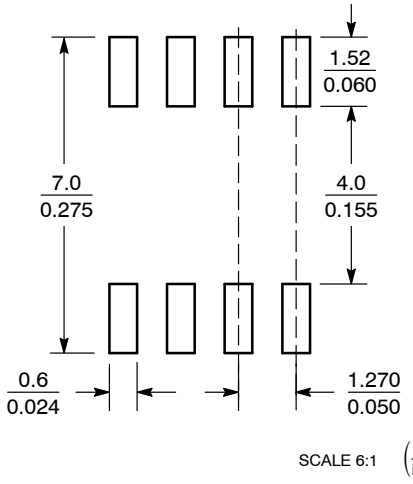
DATE 16 FEB 2011



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSION A AND B DO NOT INCLUDE MOLD PROTRUSION.
4. MAXIMUM MOLD PROTRUSION 0.15 (0.006) PER SIDE.
5. DIMENSION D DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.127 (0.005) TOTAL IN EXCESS OF THE D DIMENSION AT MAXIMUM MATERIAL CONDITION.
6. 751−01 THRU 751−06 ARE OBSOLETE. NEW STANDARD IS 751−07.

	MILLIMETERS		INCHES	
DIM	MIN	MAX	MIN	MAX
A	4.80	5.00	0.189	0.197
B	3.80	4.00	0.150	0.157
C	1.35	1.75	0.053	0.069
D	0.33	0.51	0.013	0.020
G	1.27 BSC		0.050 BSC	
H	0.10	0.25	0.004	0.010
J	0.19	0.25	0.007	0.010
K	0.40	1.27	0.016	0.050
M	0°	8°	0°	8°
N	0.25	0.50	0.010	0.020
S	5.80	6.20	0.228	0.244

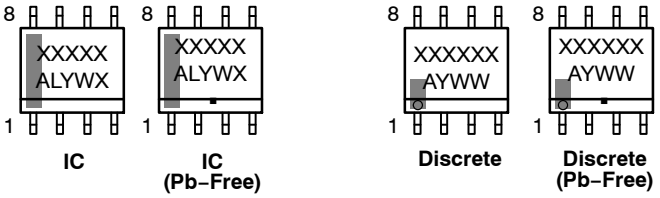
SOLDERING FOOTPRINT*



SCALE 6:1 (mm / inches)

*For additional information on our Pb−Free strategy and soldering details, please download the **onsemi** Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

GENERIC MARKING DIAGRAM*



XXXXX = Specific Device Code
A = Assembly Location
L = Wafer Lot
Y = Year
W = Work Week
▪ = Pb−Free Package

XXXXXX = Specific Device Code
A = Assembly Location
Y = Year
WW = Work Week
▪ = Pb−Free Package

*This information is generic. Please refer to device data sheet for actual part marking. Pb−Free indicator, "G" or microdot "▪", may or may not be present. Some products may not follow the Generic Marking.

STYLES ON PAGE 2

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CASE 751−07
ISSUE AK

DATE 16 FEB 2011

STYLE 1:
PIN 1. EMITTER
2. COLLECTOR
3. COLLECTOR
4. EMITTER
5. EMITTER
6. BASE
7. BASE
8. EMITTER

STYLE 2:
PIN 1. COLLECTOR, DIE, #1
2. COLLECTOR, #1
3. COLLECTOR, #2
4. COLLECTOR, #2
5. BASE, #2
6. EMITTER, #2
7. BASE, #1
8. EMITTER, #1

STYLE 3:
PIN 1. DRAIN, DIE #1
2. DRAIN, #1
3. DRAIN, #2
4. DRAIN, #2
5. GATE, #2
6. SOURCE, #2
7. GATE, #1
8. SOURCE, #1

STYLE 4:
PIN 1. ANODE
2. ANODE
3. ANODE
4. ANODE
5. ANODE
6. ANODE
7. ANODE
8. COMMON CATHODE

STYLE 5:
PIN 1. DRAIN
2. DRAIN
3. DRAIN
4. DRAIN
5. GATE
6. GATE
7. SOURCE
8. SOURCE

STYLE 6:
PIN 1. SOURCE
2. DRAIN
3. DRAIN
4. SOURCE
5. SOURCE
6. GATE
7. GATE
8. SOURCE

STYLE 7:
PIN 1. INPUT
2. EXTERNAL BYPASS
3. THIRD STAGE SOURCE
4. GROUND
5. DRAIN
6. GATE 3
7. SECOND STAGE Vd
8. FIRST STAGE Vd

STYLE 8:
PIN 1. COLLECTOR, DIE #1
2. BASE, #1
3. BASE, #2
4. COLLECTOR, #2
5. COLLECTOR, #2
6. EMITTER, #2
7. EMITTER, #1
8. COLLECTOR, #1

STYLE 9:
PIN 1. EMITTER, COMMON
2. COLLECTOR, DIE #1
3. COLLECTOR, DIE #2
4. EMITTER, COMMON
5. EMITTER, COMMON
6. BASE, DIE #2
7. BASE, DIE #1
8. EMITTER, COMMON

STYLE 10:
PIN 1. GROUND
2. BIAS 1
3. OUTPUT
4. GROUND
5. GROUND
6. BIAS 2
7. INPUT
8. GROUND

STYLE 11:
PIN 1. SOURCE 1
2. GATE 1
3. SOURCE 2
4. GATE 2
5. DRAIN 2
6. DRAIN 2
7. DRAIN 1
8. DRAIN 1

STYLE 12:
PIN 1. SOURCE
2. SOURCE
3. SOURCE
4. GATE
5. DRAIN
6. DRAIN
7. DRAIN
8. DRAIN

STYLE 13:
PIN 1. N.C.
2. SOURCE
3. SOURCE
4. GATE
5. DRAIN
6. DRAIN
7. DRAIN
8. DRAIN

STYLE 14:
PIN 1. N−SOURCE
2. N−GATE
3. P−SOURCE
4. P−GATE
5. P−DRAIN
6. P−DRAIN
7. N−DRAIN
8. N−DRAIN

STYLE 15:
PIN 1. ANODE 1
2. ANODE 1
3. ANODE 1
4. ANODE 1
5. CATHODE, COMMON
6. CATHODE, COMMON
7. CATHODE, COMMON
8. CATHODE, COMMON

STYLE 16:
PIN 1. EMITTER, DIE #1
2. BASE, DIE #1
3. EMITTER, DIE #2
4. BASE, DIE #2
5. COLLECTOR, DIE #2
6. COLLECTOR, DIE #2
7. COLLECTOR, DIE #1
8. COLLECTOR, DIE #1

STYLE 17:
PIN 1. VCC
2. V2OUT
3. V1OUT
4. TXE
5. RXE
6. VEE
7. GND
8. ACC

STYLE 18:
PIN 1. ANODE
2. ANODE
3. SOURCE
4. GATE
5. DRAIN
6. DRAIN
7. CATHODE
8. CATHODE

STYLE 19:
PIN 1. SOURCE 1
2. GATE 1
3. SOURCE 2
4. GATE 2
5. DRAIN 2
6. MIRROR 2
7. DRAIN 1
8. MIRROR 1

STYLE 20:
PIN 1. SOURCE (N)
2. GATE (N)
3. SOURCE (P)
4. GATE (P)
5. DRAIN
6. DRAIN
7. DRAIN
8. DRAIN

STYLE 21:
PIN 1. CATHODE 1
2. CATHODE 2
3. CATHODE 3
4. CATHODE 4
5. CATHODE 5
6. COMMON ANODE
7. COMMON ANODE
8. CATHODE 6

STYLE 22:
PIN 1. I/O LINE 1
2. COMMON CATHODE/VCC
3. COMMON CATHODE/VCC
4. I/O LINE 3
5. COMMON ANODE/GND
6. I/O LINE 4
7. I/O LINE 5
8. COMMON ANODE/GND

STYLE 23:
PIN 1. LINE 1 IN
2. COMMON ANODE/GND
3. COMMON ANODE/GND
4. LINE 2 IN
5. LINE 2 OUT
6. COMMON ANODE/GND
7. COMMON ANODE/GND
8. LINE 1 OUT

STYLE 24:
PIN 1. BASE
2. EMITTER
3. COLLECTOR/ANODE
4. COLLECTOR/ANODE
5. CATHODE
6. CATHODE
7. COLLECTOR/ANODE
8. COLLECTOR/ANODE

STYLE 25:
PIN 1. VIN
2. N/C
3. REXT
4. GND
5. IOUT
6. IOUT
7. IOUT
8. IOUT

STYLE 26:
PIN 1. GND
2. dv/dt
3. ENABLE
4. ILIMIT
5. SOURCE
6. SOURCE
7. SOURCE
8. VCC

STYLE 27:
PIN 1. ILIMIT
2. OVLO
3. UVLO
4. INPUT+
5. SOURCE
6. SOURCE
7. SOURCE
8. DRAIN

STYLE 28:
PIN 1. SW_TO_GND
2. DASIC_OFF
3. DASIC_SW_DET
4. GND
5. V_MON
6. VBULK
7. VBULK
8. VIN

STYLE 29:
PIN 1. BASE, DIE #1
2. EMITTER, #1
3. BASE, #2
4. EMITTER, #2
5. COLLECTOR, #2
6. COLLECTOR, #2
7. COLLECTOR, #1
8. COLLECTOR, #1

STYLE 30:
PIN 1. DRAIN 1
2. DRAIN 1
3. GATE 2
4. SOURCE 2
5. SOURCE 1/DRAIN 2
6. SOURCE 1/DRAIN 2
7. SOURCE 1/DRAIN 2
8. GATE 1

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