

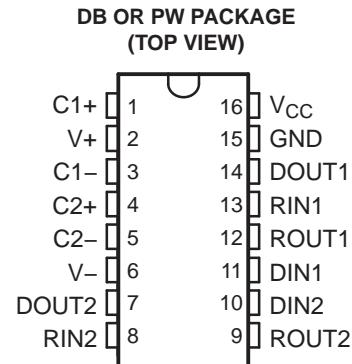
3-V TO 5.5-V MULTICHANNEL RS-232 LINE DRIVER/RECEIVER WITH ± 15 -kV ESD PROTECTION

FEATURES

- RS-232 Bus-Pin ESD Protection Exceeds ± 15 kV Using Human-Body Model (HBM)
- Meets or Exceeds the Requirements of TIA/EIA-232-F and ITU v.28 Standards
- Operates With 3-V to 5.5-V V_{CC} Supply
- Operates Up To 250 kbit/s
- Two Drivers and Two Receivers
- Low Supply Current . . . 300 μ A Typical
- External Capacitors . . . $4 \times 0.1 \mu$ F
- Accepts 5-V Logic Input With 3.3-V Supply
- Alternative High-Speed Pin-Compatible Device (1 Mbit/s)
 - SNx5C3232

APPLICATIONS

- Battery-Powered Systems, PDAs, Notebooks, Laptops, Palmtop PCs, and Hand-Held Equipment



SUPPORTS DEFENSE, AEROSPACE, AND MEDICAL APPLICATIONS

- Controlled Baseline
- One Assembly/Test Site
- One Fabrication Site
- Available in Military ($-55^{\circ}\text{C}/125^{\circ}\text{C}$) Temperature Range⁽¹⁾
- Extended Product Life Cycle
- Extended Product-Change Notification
- Product Traceability

(1) Additional temperature ranges are available - contact factory

ORDERING INFORMATION⁽¹⁾

T_A	PACKAGE ⁽²⁾		ORDERABLE PART NUMBER	TOP-SIDE MARKING
-55°C to 125°C	SSOP (DB)	Reel of 2000	MAX3232MDBREP	MB3232M
	TSSOP(PW)	Reel of 2000	MAX3232MPWREP	

(1) For the most current package and ordering information, see the Package Option Addendum at the end of this document, or see the TI website at www.ti.com.

(2) Package drawings, thermal data, and symbolization are available at www.ti.com/packaging.

DESCRIPTION

The MAX3232 device consists of two line drivers, two line receivers, and a dual charge-pump circuit with ± 15 -kV ESD protection pin to pin (serial-port connection pins, including GND). The device meets the requirements of TIA/EIA-232-F and provides the electrical interface between an asynchronous communication controller and the serial-port connector. The charge pump and four small external capacitors allow operation from a single 3-V to 5.5-V supply. The devices operate at data signaling rates up to 250 kbit/s and a maximum of 30-V/ μ s driver output slew rate.



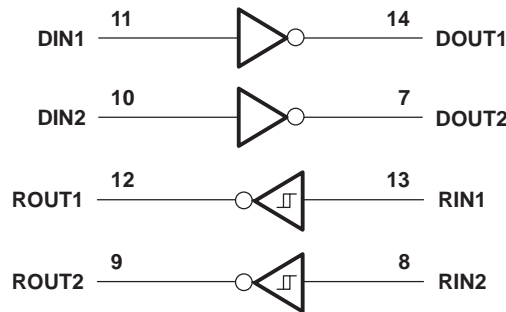
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FUNCTION TABLE

EACH DRIVER		EACH RECEIVER	
INPUT DIN	OUTPUT DOUT	INPUT RIN	OUTPUT ROUT
L	H	L	H
H	L	H	L
		Open	H

H = high level, L = low level, Open = input disconnected or connected driver off

LOGIC DIAGRAM (POSITIVE LOGIC)



ABSOLUTE MAXIMUM RATINGS

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

		VALUE	UNIT
V_{CC}	Supply voltage range ⁽¹⁾	-0.3 to 6	V
$V+$	Positive output supply voltage range ⁽¹⁾	-0.3 to 7	V
$V-$	Negative output supply voltage range ⁽¹⁾	0.3 to -7	V
$V+ - V-$	Supply voltage difference ⁽¹⁾	13	V
V_I	Input voltage range	Drivers	-0.3 to 6
		Receivers	-25 to 25
V_O	Output voltage range	Drivers	-13.2 to 13.2
		Receivers	-0.3 to $V_{CC} + 0.3$
θ_{JA}	Package thermal impedance ⁽²⁾	DB package	82
		PW package	108
T_J	Operating virtual junction temperature	150	°C
T_{stg}	Storage temperature range	-65 to 150	°C

(1) All voltages are with respect to network GND.

(2) Maximum power dissipation is a function of $T_J(max)$, θ_{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 affect reliability.

RECOMMENDED OPERATING CONDITIONS (see ⁽¹⁾and Figure 4)

		MIN	NOM	MAX	UNIT
Supply voltage		$V_{CC} = 3.3\text{ V}$	3	3.3	3.6
		$V_{CC} = 5\text{ V}$	4.5	5	5.5
V_{IH}	Driver high-level input voltage	DIN	$V_{CC} = 3.3\text{ V}$	2	V
			$V_{CC} = 5\text{ V}$	2.4	
V_{IL}	Driver low-level input voltage	DIN		0.8	V

(1) Test conditions are C1–C4 = 0.1 μF at $V_{CC} = 3.3\text{ V} \pm 0.3\text{ V}$; C1 = 0.047 μF , C2–C4 = 0.33 μF at $V_{CC} = 5\text{ V} \pm 0.5\text{ V}$.

RECOMMENDED OPERATING CONDITIONS (see and [Figure 4](#)) (continued)

				MIN	NOM	MAX	UNIT
V _I	Driver input voltage	DIN		0		5.5	V
	Receiver input voltage			-25		25	
T _A	Operating free-air temperature	MAX3232M		-55		125	°C

ELECTRICAL CHARACTERISTICS

over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted) (see ⁽¹⁾ and [Figure 4](#))

PARAMETER		TEST CONDITIONS	MIN	TYP ⁽²⁾	MAX	UNIT
I _{CC}	Supply current	No load, V _{CC} = 3.3 V or 5 V		0.3	2	mA

(1) Test conditions are C1–C4 = 0.1 μF at V_{CC} = 3.3 V ±0.3 V; C1 = 0.047 μF, C2–C4 = 0.33 μF at V_{CC} = 5 V ±0.5 V.

(2) All typical values are at V_{CC} = 3.3 V or V_{CC} = 5 V, and T_A = 25°C.

DRIVER SECTION

ELECTRICAL CHARACTERISTICS

over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted) (see ⁽¹⁾and Figure 4)

PARAMETER		TEST CONDITIONS	MIN	TYP ⁽²⁾	MAX	UNIT
V _{OH}	High-level output voltage	DO _{UT} at R _L = 3 kΩ to GND, DIN = GND	5	5.4		V
V _{OL}	Low-level output voltage	DO _{UT} at R _L = 3 kΩ to GND, DIN = V _{CC}	–5	–5.4		V
I _{IH}	High-level input current	V _I = V _{CC}		±0.01	±1	μA
I _{IL}	Low-level input current	V _I at GND		±0.01	±1	μA
I _{OS} ⁽³⁾	Short-circuit output current	V _{CC} = 3.6 V, V _O = 0 V		±35	±60	mA
		V _{CC} = 5.5 V, V _O = 0 V				
r _o	Output resistance	V _{CC} , V+, and V– = 0 V, V _O = ±2 V	300	10M		Ω

(1) Test conditions are C1–C4 = 0.1 μF at V_{CC} = 3.3 V ±0.3 V; C1 = 0.047 μF, C2–C4 = 0.33 μF at V_{CC} = 5 V ±0.5 V.

(2) All typical values are at V_{CC} = 3.3 V or V_{CC} = 5 V, and T_A = 25°C.

(3) Short-circuit durations should be controlled to prevent exceeding the device absolute power dissipation ratings, and not more than one output should be shorted at a time.

SWITCHING CHARACTERISTICS

over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted) (see ⁽¹⁾and Figure 4)

PARAMETER		TEST CONDITIONS	MIN	TYP ⁽²⁾	MAX	UNIT	
	Maximum data rate	C _L = 1000 pF, One DO _{UT} switching, R _L = 3 kΩ, See Figure 1	150	250		kbit/s	
t _{sk(p)}	Pulse skew ⁽¹⁾	CL = 150 pF to 2500 pF, R _L = 3 kΩ to 7 kΩ, See Figure 2		300		ns	
SR(tr)	Slew rate, transition region (see Figure 1)	RL = 3 kΩ to 7 kΩ, V _{CC} = 3.3 V		C _L = 150 pF to 1000 pF	6	30	V/μs
				C _L = 150 pF to 2500 pF	4	30	

(1) Short-circuit durations should be controlled to prevent exceeding the device absolute power dissipation ratings, and not more than one output should be shorted at a time.

(2) All typical values are at V_{CC} = 3.3 V or V_{CC} = 5 V, and T_A = 25°C.

RECEIVER SECTION

ELECTRICAL CHARACTERISTICS

over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted (see ⁽¹⁾and Figure 4)

PARAMETER		TEST CONDITIONS	MIN	TYP ⁽²⁾	MAX	UNIT
V _{OH}	High-level output voltage	I _{OH} = -1 mA	V _{CC} -0.6	V _{CC} -0.1		V
V _{OL}	Low-level output voltage	I _{OL} = 1.6 mA			0.4	V
V _{IT+}	Positive-going input threshold voltage	V _{CC} = 3.3 V		1.5	2.4	V
		V _{CC} = 5 V		1.8	2.4	
V _{IT-}	Negative-going input threshold voltage	V _{CC} = 3.3 V	0.6	1.2		V
		V _{CC} = 5 V	0.8	1.5		
V _{hys}	Input hysteresis (V _{IT+} - V _{IT-})			0.3		V
r _i	Input resistance	V _i = ±3 V to ±25 V	3	5	8	kΩ

(1) Test conditions are C1–C4 = 0.1 μF at V_{CC} = 3.3 V ±0.3 V; C1 = 0.047 μF, C2–C4 = 0.33 μF at V_{CC} = 5 V ±0.5 V.

(2) All typical values are at V_{CC} = 3.3 V or V_{CC} = 5 V and T_A = 25°C.

SWITCHING CHARACTERISTICS

over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted (see ⁽¹⁾and Figure 3)

PARAMETER		TEST CONDITIONS	MIN	TYP ⁽²⁾	MAX	UNIT
t _{PLH}	Propagation delay time, low- to high-level output	C _L = 150 pF		300		ns
t _{PHL}	Propagation delay time, high- to low-level output			300		ns
t _{sk(p)}	Pulse skew ⁽³⁾			300		ns

(1) Test conditions are C1–C4 = 0.1 μF at V_{CC} = 3.3 V ±0.3 V; C1 = 0.047 μF, C2–C4 = 0.33 μF at V_{CC} = 5 V ±0.5 V.

(2) All typical values are at V_{CC} = 3.3 V or V_{CC} = 5 V and T_A = 25°C.

(3) Pulse skew is defined as |t_{PLH} - t_{PHL}| of each channel of the same device.

PARAMETER MEASUREMENT INFORMATION

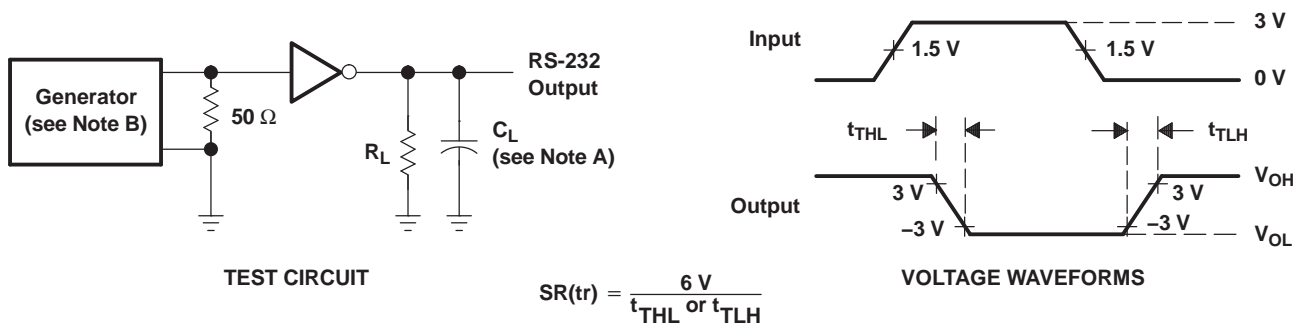
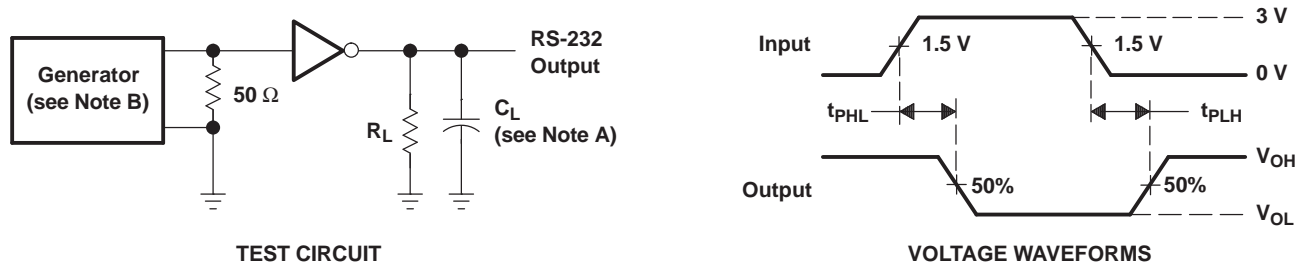


Figure 1. Driver Slew Rate

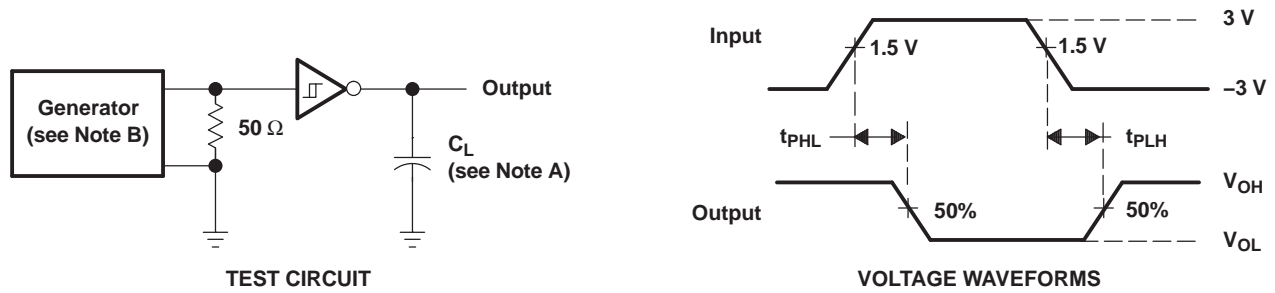


A. C_L includes probe and jig capacitance.

B. The pulse generator has the following characteristics: Z_O = 50 Ω, 50% duty cycle, tr ≤ 10 ns, tf ≤ 10 ns.

Figure 2. Driver Pulse Skew

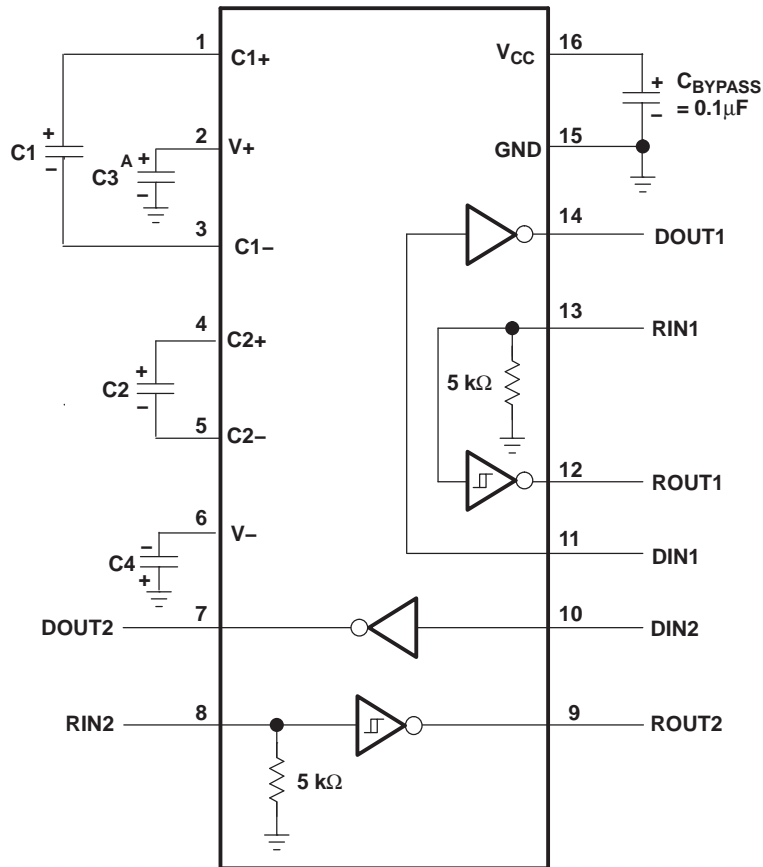
PARAMETER MEASUREMENT INFORMATION (continued)



- A. C_L includes probe and jig capacitance.
- B. The pulse generator has the following characteristics: $Z_O = 50 \Omega$, 50% duty cycle, $t_r \leq 10 \text{ ns}$, $t_f \leq 10 \text{ ns}$.

Figure 3. Receiver Propagation Delay Times

APPLICATION INFORMATION



V_{CC} vs CAPACITOR VALUES

V _{CC}	C1	C2, C3, C4
3.3 V ± 0.3 V	0.1 μF	0.1 μF
5 V ± 0.5 V	0.047 μF	0.33 μF
3 V to 5.5 V	0.1 μF	0.47 μF

- A. C3 can be connected to V_{CC} or GND.
- B. Resistor values shown are nominal.
- C. Nonpolarized ceramic capacitors are acceptable. If polarized tantalum or electrolytic capacitors are used, they should be connected as shown.

Figure 4. Typical Operating Circuit and Capacitor Values

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
MAX3232MDBREP	ACTIVE	SSOP	DB	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-55 to 125	MB3232M	Samples
MAX3232MPWREP	ACTIVE	TSSOP	PW	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-55 to 125	MB3232M	Samples
V62/06623-01XE	ACTIVE	SSOP	DB	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-55 to 125	MB3232M	Samples
V62/06623-01YE	ACTIVE	TSSOP	PW	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-55 to 125	MB3232M	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.

OBSOLETE: TI has discontinued the production of the device.

(2) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

TBD: The Pb-Free/Green conversion plan has not been defined.

Pb-Free (RoHS): TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

Pb-Free (RoHS Exempt): This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

(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/Ball Finish - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead/Ball Finish values may wrap to two lines if the finish value exceeds the maximum column width.

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OTHER QUALIFIED VERSIONS OF MAX3232-EP :

- Catalog: [MAX3232](#)

NOTE: Qualified Version Definitions:

- Catalog - TI's standard catalog product

TAPE AND REEL INFORMATION

QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE


*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
MAX3232MPWREP	TSSOP	PW	16	2000	330.0	12.4	6.9	5.6	1.6	8.0	12.0	Q1

TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
MAX3232MPWREP	TSSOP	PW	16	2000	367.0	367.0	35.0



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



SOLDER MASK DETAILS

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.

DB (R-PDSO-G**)

PLASTIC SMALL-OUTLINE

28 PINS SHOWN



- NOTES: A. All linear dimensions are in millimeters.
 B. This drawing is subject to change without notice.
 C. Body dimensions do not include mold flash or protrusion not to exceed 0,15.
 D. Falls within JEDEC MO-150

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