

# SN65LBC031, SN65LBC031Q, SN75LBC031 HIGH-SPEED CONTROLLER AREA NETWORK (CAN) TRANSCEIVERS

SLRS048A – MAY 1998 – REVISED APRIL 2000

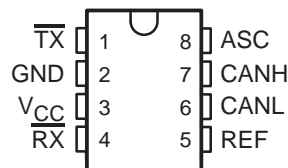
- **SN75LBC031 Meets Standard ISO/DIS 11898 (up to 500 k Baud)**
- **Driver Output Capability at 50 mA**
- **Wide Positive and Negative Input/output Bus Voltage Range**
- **Bus Outputs Short-Circuit-Protected to Battery Voltage and Ground**
- **Thermal Shutdown**
- **Available in Q-Temp Automotive**
  - **HighRel Automotive Applications**
  - **Configuration Control/Print Support**
  - **Qualification to Automotive Standards**

## description

The SN75LBC031 is a CAN transceiver used as an interface between a CAN controller and the physical bus for high speed applications of up to 500 kBaud. The device provides transmit capability to the differential bus and differential receive capability to the controller. The transmitter outputs (CANH and CANL), feature internal transition regulation to provide controlled symmetry resulting in low EMI emissions. Both transmitter outputs are fully protected against battery short circuits and electrical transients that can occur on the bus lines. In the event of excessive device power dissipation the output drivers are disabled by the thermal shutdown circuitry at a junction temperature of approximately 160°C. The inclusion of an internal pullup resistor on the transmitter input ensures a defined output during power up and protocol controller reset. For normal operation at 500 kBaud the ASC terminal is open or tied to GND. For slower speed operation at 125 kBaud the bus output transition times can be increased to reduce EMI by connecting the ASC terminal to V<sub>CC</sub>. The receiver includes an integrated filter that suppresses the signal into pulses less than 30 ns wide.

The SN75LBC031 is characterized for operation from –40°C to 85°C. The SN65LBC031 is characterized for operation from –40°C to 125°C. The SN65LBC031Q is characterized for operation over the automotive temperature range of –40°C to 125°C.

**D PACKAGE  
(TOP VIEW)**



**TERMINAL FUNCTIONS**

TERMINAL	DESCRIPTION
$\overline{\text{TX}}$	Transmitter input
GND	Ground
V <sub>CC</sub>	Supply voltage
$\overline{\text{RX}}$	Receiver output
REF	Reference output
CANL	Low side bus output driver
CANH	High side bus output driver
ASC	Adjustable slope control

**FUNCTION TABLE**

$\overline{\text{TX}}$	CANH	CANL	BUS STATE	$\overline{\text{RX}}$
L	H	L	Dominant	L
High or floating	Floating	Floating	Recessive	H

L = low, H = high



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 **TEXAS  
INSTRUMENTS**

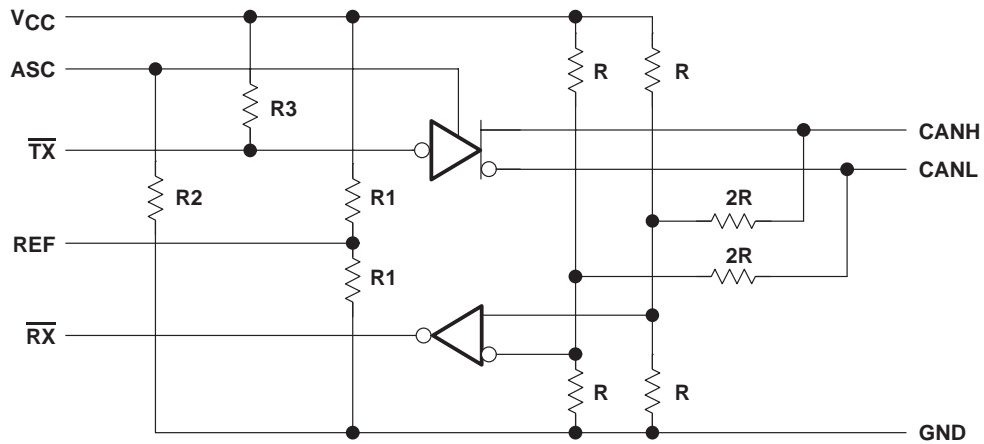
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## logic diagram



# SN65LBC031, SN65LBC031Q, SN75LBC031 HIGH-SPEED CONTROLLER AREA NETWORK (CAN) TRANSCEIVERS

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

Logic supply voltage, $V_{CC}$ (see Note 1)	7 V
Bus terminal voltage	-5 V to 20 V
Input current at $\overline{TX}$ and ASC terminal, $I_I$	$\pm 10$ mA
Input voltage at $\overline{TX}$ and ASC terminal, $V_I$	$2 \times V_{CC}$
Operating free-air temperature range, $T_A$ : SN65LBC031, SN65LBC031Q	-40°C to 125°C
SN75LBC031	-40°C to 85°C
Operating junction range, $T_J$	-40°C to 150°C
Continuous total power dissipation at (or below) 25°C free-air temperature	See Dissipation Rating Table
Storage temperature range, $T_{stg}$	-65°C to 150°C
Case temperature for 10 sec $T_C$ , D package	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.

NOTE 1: All voltage values, except differential bus voltage, are measured with respect to GND.

**DISSIPATION RATING TABLE**

PACKAGE	$T_A \leq 25^\circ\text{C}$ POWER RATING	OPERATING FACTOR ABOVE $T_C = 25^\circ\text{C}$	$T_C = 125^\circ\text{C}$ POWER RATING
D	725 mW	5.8 mW/°C	145 mW

**DISSIPATION DERATING CURVE  
vs  
FREE-AIR TEMPERATURE**

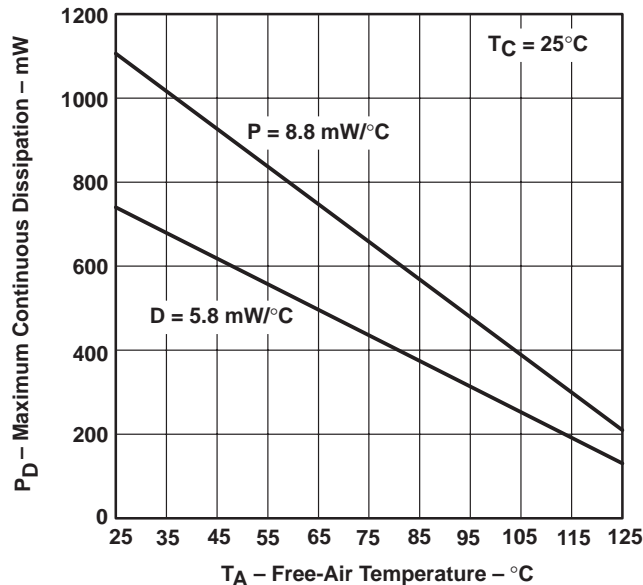


Figure 1

# SN65LBC031, SN65LBC031Q, SN75LBC031 HIGH-SPEED CONTROLLER AREA NETWORK (CAN) TRANSCEIVERS

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## recommended operating conditions

		MIN	NOM	MAX	UNIT
Logic supply voltage, $V_{CC}$		4.5	5	5.5	V
Voltage at any bus terminal (separately or common mode), $V_I$ or $V_{IC}$ (see Note 3)		-2		7	V
High-level input voltage, $V_{IH}$	$\overline{TX}$	2		$V_{CC}$	V
Low-level input voltage, $V_{IL}$	$\overline{TX}$	0		0.8	V
High-level output current, $I_{OH}$	Transmitter			-50	mA
	Receiver			-400	$\mu$ A
Low-level output current, $I_{OL}$	Transmitter			50	mA
	Receiver			1	
Operating free-air temperature, $T_A$	SN75LBC031	-40		85	$^{\circ}$ C
	SN65LBC031, SN65LBC031Q	-40		125	

NOTES: 2. All voltage values, except differential bus voltage, are measured with respect to the ground terminal.  
3. For bus voltages from -5 V to -2 V and 7 V to 20 V the receiver output is stable.

## SYMBOL DEFINITION

DATA SHEET PARAMETER	DEFINITION
$V_{O(CANHR)}$	CANH bus output voltage (recessive state)
$V_{O(CANLR)}$	CANL bus output voltage (recessive state)
$V_{O(CANHD)}$	CANH bus output voltage (dominant state)
$V_{O(CANLD)}$	CANL bus output voltage (dominant state)
$V_{O(DIFFR)}$	Bus differential output voltage (recessive state)
$V_{O(DIFFD)}$	Bus differential output voltage (dominant state)
$V_I(ASC)$	Adjustable slope control input voltage

## electrical characteristics over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$V_{O(REF)}$	Reference source output voltage	$I_{REF} = \pm 20 \mu$ A	$0.45 V_{CC}$		$0.55 V_{CC}$	V
$R_{O(REF)}$	Reference source output resistance		5		10	k $\Omega$
$I_{CC(REC)}$	Logic supply current, recessive state	See Figure 2, S1 closed		12	20	mA
$I_{CC(DOM)}$	Logic supply current, dominant state			55	80	



# SN65LBC031, SN65LBC031Q, SN75LBC031 HIGH-SPEED CONTROLLER AREA NETWORK (CAN) TRANSCEIVERS

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## transmitter electrical characteristics over recommended ranges of supply and operating free-air temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$V_{O(CANHR)}$ $V_{O(CANLR)}$	Output voltage (recessive state)	See Figure 2, S1 open	2	$0.5V_{CC}$	3	V
$V_{O(DIFFR)}$	Differential output voltage (recessive state)		-500	0	50	mV
$V_{O(CANHD)}$ $V_{O(CANLD)}$	Output voltage (dominant state)	See Figure 2, S1 closed	2.75	3.5	4.5	V
$V_{O(DIFFD)}$	Differential output voltage (dominant state)		0.5	1.5	2.25	
$I_{IH(TX)}$	High-level input current (TX)	$V_{IH} = 2.4\text{ V}$		-100	-185	$\mu\text{A}$
		$V_{IH} = V_{CC}$			$\pm 2$	
$I_{IH(ASC)}$	High-level input current (ASC)	$V_{IH} = 2.4\text{ V}$		100	165	$\mu\text{A}$
		$V_{IH} = V_{CC}$		200	340	
$I_{IL(TX)}$	Low-level input current ( $\overline{\text{TX}}$ )	$V_{IL} = 0.4\text{ V}$		-180	-400	$\mu\text{A}$
$I_{IL(ASC)}$	Low-level input current (ASC)	$V_{IL} = 0.4\text{ V}$		15	25	$\mu\text{A}$
$C_I(TX)$	$\overline{\text{TX}}$ input capacitance			8		pF
$I_{O(ssH)}$	CANH short circuit output current	$V_{O(CANH)} = -2\text{ V to } 20\text{ V}$		-95	-200	mA
$I_{O(ssL)}$	CANL short circuit output current	$V_{O(CANL)} = 20\text{ V to } -2\text{ V}$		140	250	mA

NOTE 2: All voltage values, except differential bus voltage, are measured with respect to the ground terminal.

## transceiver dynamic characteristics over recommended operating free-air temperature range and $V_{CC} = 5\text{ V}$

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$t_{(loop)}$	Loop time	See Figures 2 and 3, $V_I(ASC) = 0\text{ V}$ or open circuit, S1 closed, S2 open			280	ns
		See Figures 2 and 3, $V_I(ASC) = V_{CC}$ , S1 closed, S2 closed			400	ns
$SR(RD)$	Differential-output slew rate (recessive to dominant)	See Figures 2 and 4, $V_I(ASC) = 0$ or open circuit, S1 closed, S2 open		35		$\text{V}/\mu\text{s}$
		See Figures 2 and 4, $V_I(ASC) = V_{CC}$ , S1 closed, S2 closed		10		$\text{V}/\mu\text{s}$
$SR(DR)$	Differential-output slew rate (dominant to recessive)	See Figures 2 and 4, $V_I(ASC) = 0$ or open circuit, S1 closed, S2 open		10		$\text{V}/\mu\text{s}$
		See Figures 2 and 4, $V_I(ASC) = V_{CC}$ , S1 closed, S2 closed		10		$\text{V}/\mu\text{s}$
$t_{d(RD)}$	Differential-output delay time	See Figure 2, S1 closed		55		ns
$t_{d(DR)}$				160		ns
$t_{pd(RECRD)}$ $t_{pd(RECDR)}$	Receiver propagation delay time	See Figures 2 and 5		90		ns
				55		ns

NOTE 4: Receiver input pulse width should be  $>50\text{ ns}$ . Input pulses of  $<30\text{ ns}$  are suppressed.



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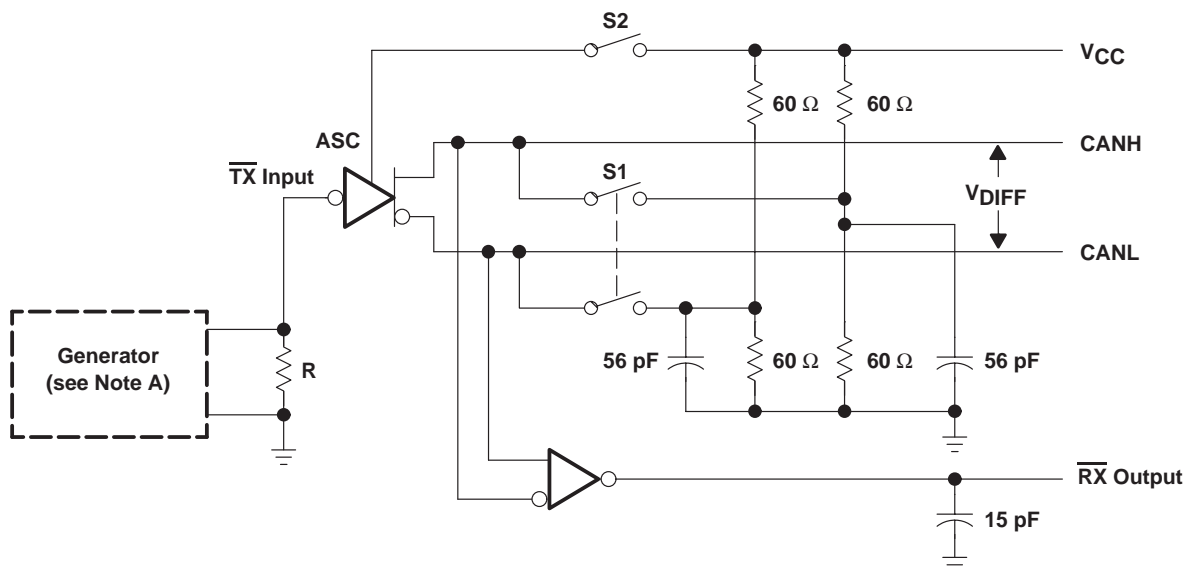
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receiver electrical characteristics over recommended ranges of common-mode input voltage, supply voltage, and operating free-air temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$V_{IT(REC)}$	Differential input threshold voltage for recessive state	$V_{IC} = -2\text{ V to }7\text{ V}$			500	mV
$V_{IT(DOM)}$	Differential input threshold voltage for dominant state		900			
$V_{hys}$	Recessive-dominant input hysteresis		100	180		mV
$V_{OH(RX)}$	High-level output voltage	$V_{O(DIFF)} = 500\text{ mV}$ , $I_{OH} = -400\text{ }\mu\text{A}$	$V_{CC} - 0.5\text{ V}$		$V_{CC}$	V
$V_{OL(RX)}$	Low-level output voltage	$V_{O(DIFF)} = 900\text{ mV}$ , $I_{OL} = 1\text{ mA}$	0		0.5	V
$r_{I(REC)}$	CANH and CANL input resistance in recessive state	dc, no load	5		50	k $\Omega$
$r_{I(DIFF)}$	Differential CANH and CANL input resistance in recessive state	dc, no load	10		100	k $\Omega$
$C_i$	CANH and CANL input capacitance			20		pF
$C_i(DHL)$	Differential CANH and CANL input capacitance			10		pF

NOTE 2: All voltage values, except differential bus voltage, are measured with respect to the ground terminal.

## PARAMETER MEASUREMENT INFORMATION



NOTE A: The input pulse is supplied to  $\overline{\text{TX}}$  by a generator having a  $t_r$  and  $t_f = 5\text{ ns}$ .

Figure 2. Test Circuit

PARAMETER MEASUREMENT INFORMATION

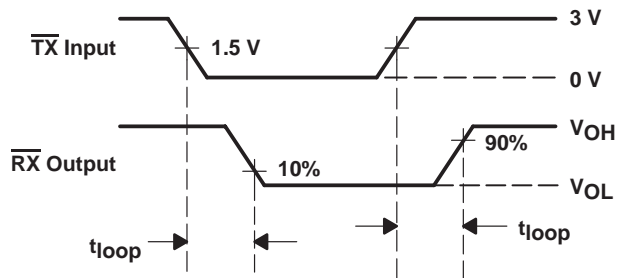


Figure 3. Loop Time

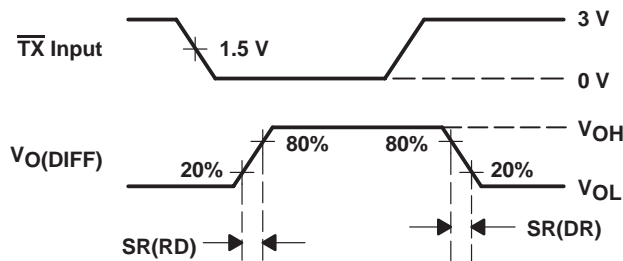
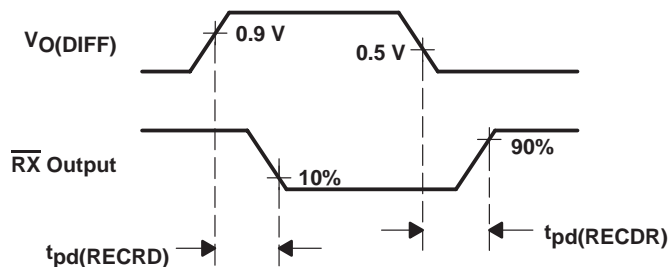


Figure 4. Slew Rate

NOTE A: The input pulse is supplied to  $\overline{\text{TX}}$  by a generator having a  $t_r$  and  $t_f = 5$  ns.



NOTE A: The input pulse is supplied as  $V_{\text{DIFF}}$  using CANH and CANL respectively by a generator having a  $t_r$  and  $t_f = 5$  ns.

Figure 5. Receiver Delay Times

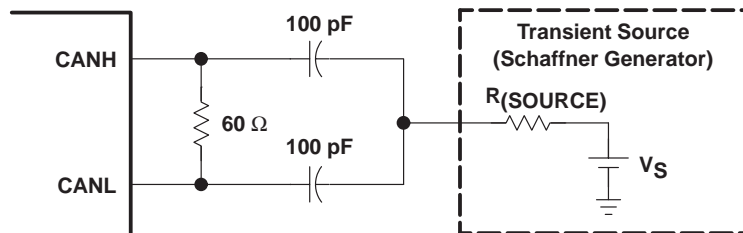


Figure 6. Transient Stress Capability Test Circuit

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## PARAMETER MEASUREMENT INFORMATION

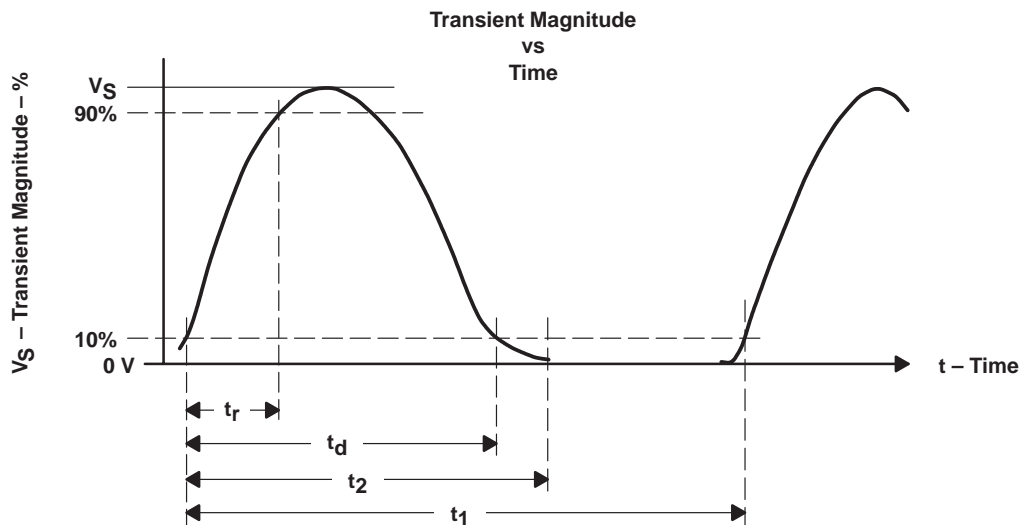


Figure 7. Transient Stress Capability Waveform

Table 1. Test Circuit Results According to DIN 40839

TEST PULSE	TRANSIENT MAGNITUDE $V_S$	SOURCE IMPEDANCE $R_{SOURCE}$	PULSE WIDTH $t_d$ (see Note 5)	PULSE RISE TIME, $t_r$ (see Note 6)	PULSE TIME, $t_2$ (see Figure 7)	REPETITION PERIOD, $t_1$ (see Figure 7)	NUMBER OF PULSES
1	-100 V	10 $\Omega$	2 ms	1 $\mu$ s	200 ms	5 s	5000
2	100 V	10 $\Omega$	50 $\mu$ s	1 $\mu$ s	200 ms	5 s	5000
3a	-150 V	50 $\Omega$	0.1 $\mu$ s	5 ns	100 $\mu$ s	100 $\mu$ s	See Note 7
3b	100 V	50 $\Omega$	0.1 $\mu$ s	5 ns	100 $\mu$ s	100 $\mu$ s	See Note 7
5	60 V	1 $\Omega$	400 ms	5 ms	—	—	1

- NOTES: 5. Measured from 10% on rising edge to 10% on falling edge  
 6. Measured from 10% to 90% of pulse  
 7. Pulse package for a period of 3600 s, 10 ms pulse time, 90 ms stop time



# SN65LBC031, SN65LBC031Q, SN75LBC031 HIGH-SPEED CONTROLLER AREA NETWORK (CAN) TRANSCEIVERS

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## APPLICATION INFORMATION

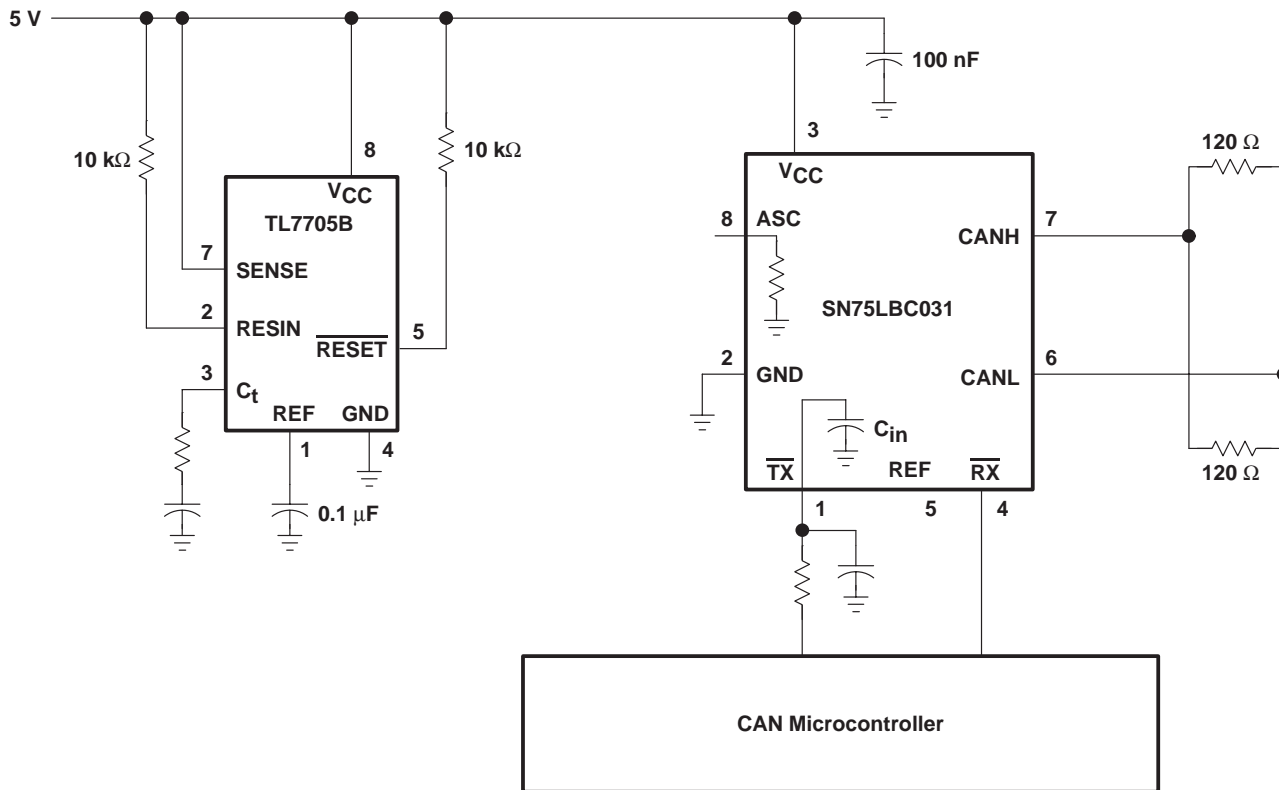


Figure 8. Typical SN75LBC031 Application

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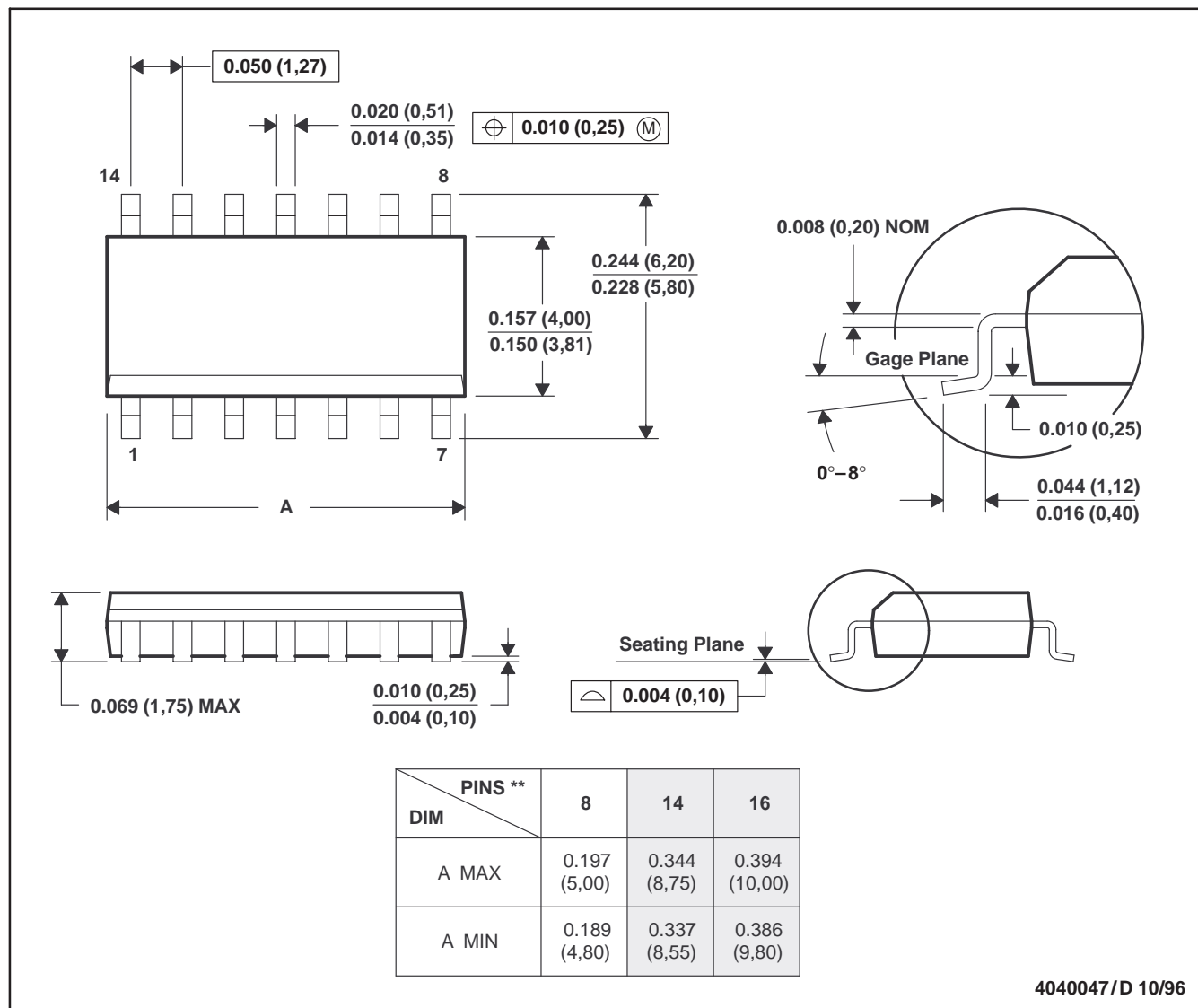
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## MECHANICAL DATA

D (R-PDSO-G\*\*)

PLASTIC SMALL-OUTLINE PACKAGE

14 PIN SHOWN



- NOTES: A. All linear dimensions are in inches (millimeters).  
 B. This drawing is subject to change without notice.  
 C. Body dimensions do not include mold flash or protrusion, not to exceed 0.006 (0,15).  
 D. Falls within JEDEC MS-012

**PACKAGING INFORMATION**

Orderable Device	Status <sup>(1)</sup>	Package Type	Package Drawing	Pins	Package Qty	Eco Plan <sup>(2)</sup>	Lead/Ball Finish	MSL Peak Temp <sup>(3)</sup>
SN65LBC031D	ACTIVE	SOIC	D	8	75	TBD	CU NIPDAU	Level-1-220C-UNLIM
SN65LBC031DG4	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
SN65LBC031DRG4	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
SN65LBC031P	OBSOLETE	PDIP	P	8		TBD	Call TI	Call TI
SN75LBC031D	ACTIVE	SOIC	D	8	75	TBD	CU NIPDAU	Level-1-220C-UNLIM
SN75LBC031DR	ACTIVE	SOIC	D	8	2500	TBD	CU NIPDAU	Level-1-220C-UNLIM
SN75LBC031P	OBSOLETE	PDIP	P	8		TBD	Call TI	Call TI

<sup>(1)</sup> The marketing status values are defined as follows:

**ACTIVE:** Product device recommended for new designs.

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<sup>(2)</sup> 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.

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**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)

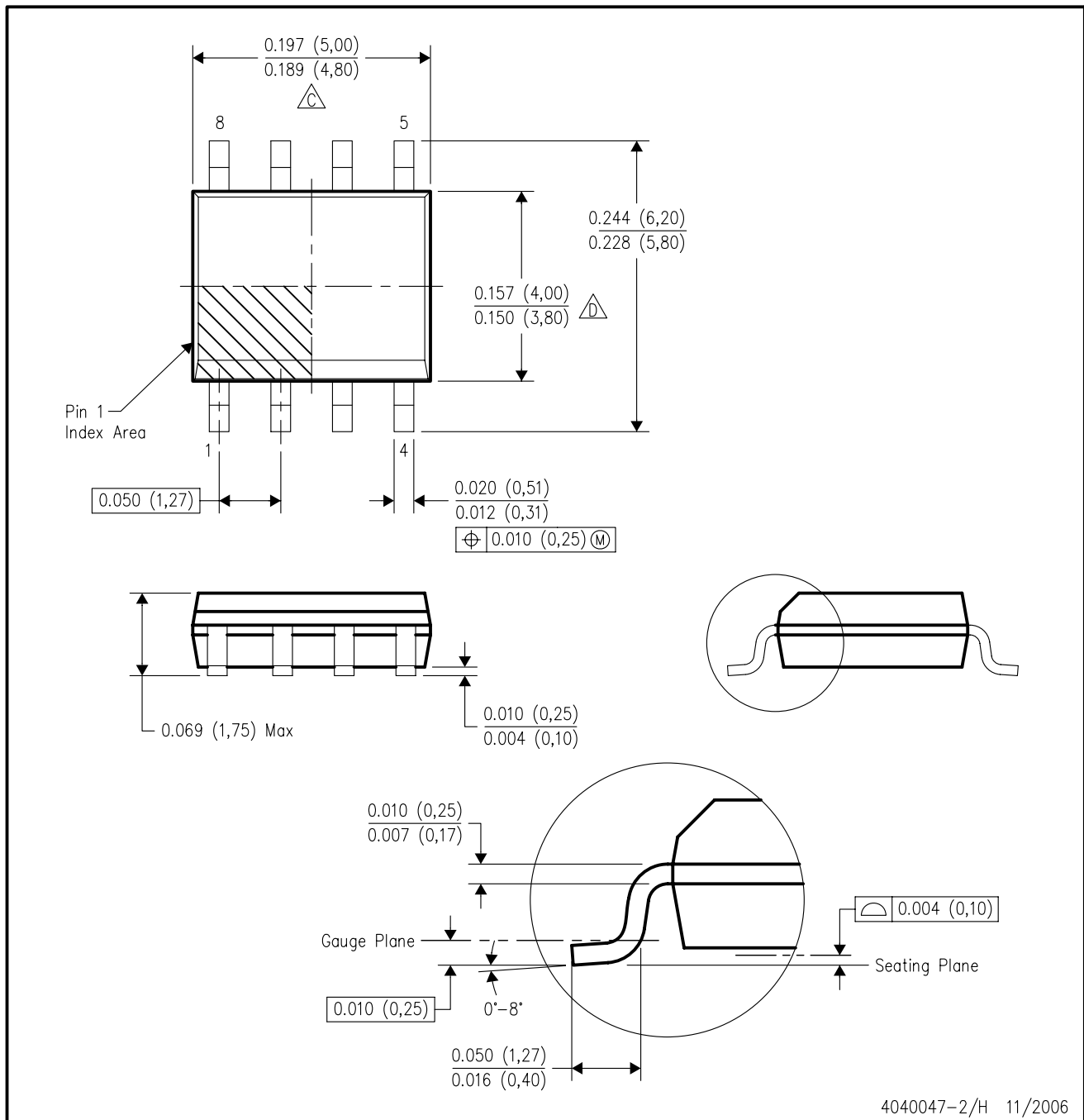
<sup>(3)</sup> MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

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D (R-PDSO-G8)

PLASTIC SMALL-OUTLINE PACKAGE



- NOTES:
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  - C. Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed .006 (0,15) per end.
  - D. Body width does not include interlead flash. Interlead flash shall not exceed .017 (0,43) per side.
  - E. Reference JEDEC MS-012 variation AA.

P (R-PDIP-T8)

PLASTIC DUAL-IN-LINE



- NOTES: A. All linear dimensions are in inches (millimeters).  
 B. This drawing is subject to change without notice.  
 C. Falls within JEDEC MS-001

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Clocks and Timers	<a href="http://www.ti.com/clocks">www.ti.com/clocks</a>
Interface	<a href="http://interface.ti.com">interface.ti.com</a>
Logic	<a href="http://logic.ti.com">logic.ti.com</a>
Power Mgmt	<a href="http://power.ti.com">power.ti.com</a>
Microcontrollers	<a href="http://microcontroller.ti.com">microcontroller.ti.com</a>
RFID	<a href="http://www.ti-rfid.com">www.ti-rfid.com</a>
RF/IF and ZigBee® Solutions	<a href="http://www.ti.com/lprf">www.ti.com/lprf</a>

### Applications

Audio	<a href="http://www.ti.com/audio">www.ti.com/audio</a>
Automotive	<a href="http://www.ti.com/automotive">www.ti.com/automotive</a>
Broadband	<a href="http://www.ti.com/broadband">www.ti.com/broadband</a>
Digital Control	<a href="http://www.ti.com/digitalcontrol">www.ti.com/digitalcontrol</a>
Medical	<a href="http://www.ti.com/medical">www.ti.com/medical</a>
Military	<a href="http://www.ti.com/military">www.ti.com/military</a>
Optical Networking	<a href="http://www.ti.com/opticalnetwork">www.ti.com/opticalnetwork</a>
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