

MAX232 Dual EIA-232 Drivers and Receivers

1 Features

- Meets or exceeds TIA/EIA-232-F and ITU recommendation V.28
- Operates from a single 5V power supply with 1μF charge-pump capacitors
- Operates up to 120kbit/s
- Two drivers and two receivers
- ±30V Input levels
- Low supply current: 8mA typical
- ESD protection exceeds JESD 22
 - 2000V Human-body model (A114-A)
- Upgrade with improved ESD (15kV HBM) and 0.1μF charge-pump capacitors is available with the MAX202 device

2 Applications

- TIA/EIA-232-F
- [Battery-powered systems](#)
- Terminals
- Modems
- Computers

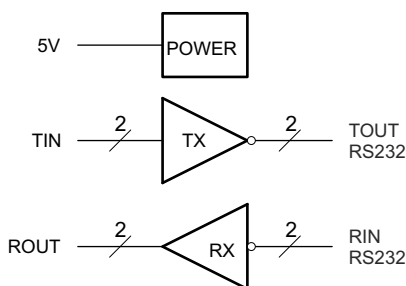
3 Description

The MAX232 device is a dual driver/receiver that includes a capacitive voltage generator to supply TIA/EIA-232-F voltage levels from a single 5V supply. Each receiver converts TIA/EIA-232-F inputs to 5V TTL/CMOS levels. These receivers have a typical threshold of 1.3 V, a typical hysteresis of 0.5V, and can accept ±30V inputs. Each driver converts TTL/CMOS input levels into TIA/EIA-232-F levels.

Package Information

PART NUMBER	PACKAGE ⁽¹⁾	PACKAGE SIZE ⁽²⁾
MAX232	SOIC (16)	9.9mm × 6mm
	SOIC (16)	10.4mm × 10.3mm
	PDIP (16)	19.3mm × 9mm
	SOP (16)	10.2mm × 7.8 mm

- (1) For more information, see [Section 11](#).
- (2) The package size (length × width) is a nominal value and includes pins, where applicable.

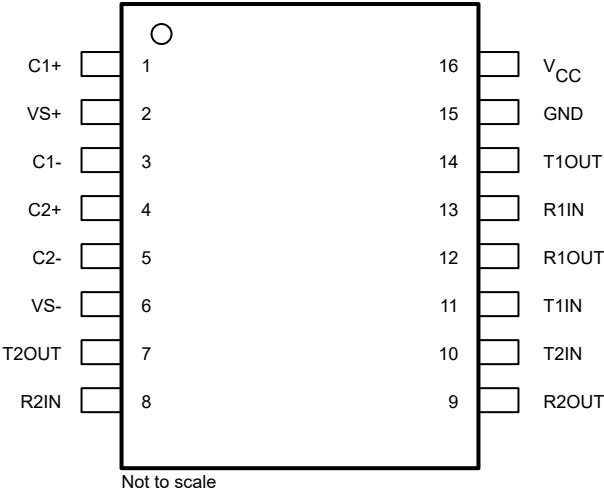


Simplified Schematic

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4 Pin Configuration and Functions



**Figure 4-1. MAX232: D, DW, N or NS Package
MAX232I: D, DW, or N Package
(Top View)**

Table 4-1. Pin Functions

PIN		TYPE	DESCRIPTION
NAME	NO.		
C1+	1	—	Positive lead of C1 capacitor
VS+	2	O	Positive charge pump output for storage capacitor only
C1-	3	—	Negative lead of C1 capacitor
C2+	4	—	Positive lead of C2 capacitor
C2-	5	—	Negative lead of C2 capacitor
VS-	6	O	Negative charge pump output for storage capacitor only
T2OUT	7	O	RS232 line data output (to remote RS232 system)
R2IN	8	I	RS232 line data input (from remote RS232 system)
R2OUT	9	O	Logic data output (to UART)
T2IN	10	I	Logic data input (from UART)
T1IN	11	I	Logic data input (from UART)
R1IN	13	I	RS232 line data input (from remote RS232 system)
T1OUT	14	O	RS232 line data output (to remote RS232 system)
GND	15	—	Ground
V _{CC}	16	—	Supply Voltage, Connect to external 5V power supply

5 Specifications

5.1 Absolute Maximum Ratings⁽¹⁾

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

			MIN	MAX	UNIT
V _{CC}	Input Supply voltage range ⁽²⁾		−0.3	6	V
V _{S+}	Positive output supply voltage range		V _{CC} − 0.3	15	V
V _{S−}	Negative output supply voltage range		−0.3	−15	V
V _I	Input voltage range	T1IN, T2IN	−0.3	V _{CC} + 0.3	V
		R1IN, R2IN		±30	
V _O	Output voltage range	T1OUT, T2OUT	V _{S−} − 0.3	V _{S+} + 0.3	V
		R1OUT, R2OUT	−0.3	V _{CC} + 0.3	
	Short-circuit duration	T1OUT, T2OUT	Unlimited		
T _J	Operating virtual junction temperature			150	°C

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

5.2 ESD Ratings

			MIN	MAX	UNIT
T _{stg}	Storage temperature range		−65	150	°C
V _(ESD)	Electrostatic discharge	Human body model (HBM), per ANSI/ESDA/ JEDEC JS-001, all pins ⁽¹⁾	0	2000	V
		Charged device model (CDM), per JEDEC specification JESD22-C101, all pins ⁽²⁾	0	1000	

- (1) JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process.
- (2) JEDEC document JEP157 states that 250-V CDM allows safe manufacturing with a standard ESD control process.

5.3 Recommended Operating Conditions

			MIN	NOM	MAX	UNIT
V _{CC}	Supply voltage		4.5	5	5.5	V
V _{IH}	High-level input voltage (T1IN,T2IN)		2			V
V _{IL}	Low-level input voltage (T1IN, T2IN)				0.8	V
R1IN, R2IN	Receiver input voltage				±30	V
T _A	Operating free-air temperature	MAX232	0		70	°C
		MAX232I	−40		85	

5.4 Thermal Information

THERMAL METRIC ⁽¹⁾		SOIC (D)	SOIC wide (DW)	PDIP (N)	SOP (NS)	UNIT
		16 PINS	16 PINS	16 PINS	16 PINS	
R _{θJA}	Junction-to-ambient thermal resistance	84.6	71.7	60.6	88.5	°C/W
R _{θJC(top)}	Junction-to-case (top) thermal resistance	43.5	37.6	48.1	46.2	°C/W
R _{θJB}	Junction-to-board thermal resistance	43.2	36.8	40.6	50.7	°C/W
ψ _{JT}	Junction-to-top characterization parameter	10.4	13.3	27.5	13.5	°C/W
ψ _{JB}	Junction-to-board characterization parameter	42.8	36.4	40.3	50.3	°C/W

- (1) For more information about traditional and new thermal metrics, see the *IC Package Thermal Metrics* application report ([SPRA953](#)).

5.5 Electrical Characteristics, Device

over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted) (see [Figure 8-1](#))

PARAMETER		TEST CONDITIONS ⁽²⁾	MIN	TYP ⁽¹⁾	MAX	UNIT
I _{CC}	Supply current	V _{CC} = 5.5V, all outputs open, T _A = 25°C		8	10	mA

- (1) All typical values are at V_{CC} = 5V, and T_A = 25°C.
(2) Test conditions are C1–C4 = 1μF at V_{CC} = 5V ± 0.5V

5.6 Electrical Characteristics, Driver

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

PARAMETER		TEST CONDITIONS ⁽²⁾	MIN	TYP ⁽¹⁾	MAX	UNIT
V _{OH}	High-level output voltage	T1OUT, T2OUT R _L = 3kΩ to GND	5	7		V
V _{OL}	Low-level output voltage ⁽²⁾	T1OUT, T2OUT R _L = 3kΩ to GND		–7	–5	V
r _O	Output resistance	T1OUT, T2OUT V _{S+} = V _{S–} = 0, V _O = ±2V	300			Ω
I _{OS} ⁽³⁾	Short-circuit output current	T1OUT, T2OUT V _{CC} = 5.5V, V _O = 0V		±10		mA
I _{IS}	Short-circuit input current	T1IN, T2IN V _I = 0			200	μA

- (1) All typical values are at V_{CC} = 5V, T_A = 25°C.
(2) The algebraic convention, in which the least-positive (most negative) value is designated minimum, is used in this data sheet for logic voltage levels only.
(3) Not more than one output should be shorted at a time.

5.7 Electrical Characteristics, Receiver

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

PARAMETER		TEST CONDITIONS ⁽³⁾	MIN	TYP ⁽¹⁾	MAX	UNIT
V _{OH}	High-level output voltage	R1OUT, R2OUT I _{OH} = –1mA	3.5			V
V _{OL}	Low-level output voltage ⁽²⁾	R1OUT, R2OUT I _{OL} = 3.2mA			0.4	V
V _{IT+}	Receiver positive-going input threshold voltage	R1IN, R2IN V _{CC} = 5V, T _A = 25°C		1.7	2.4	V
V _{IT–}	Receiver negative-going input threshold voltage	R1IN, R2IN V _{CC} = 5V, T _A = 25°C	0.8	1.2		V
V _{hys}	Input hysteresis voltage	R1IN, R2IN V _{CC} = 5V	0.2	0.5	1	V
r _I	Receiver input resistance	R1IN, R2IN V _{CC} = 5V, T _A = 25°C	3	5	7	kΩ

- (1) All typical values are at V_{CC} = 5V, T_A = 25°C.
(2) The algebraic convention, in which the least-positive (most negative) value is designated minimum, is used in this data sheet for logic voltage levels only.
(3) Test conditions are C1–C4 = 1μF at V_{CC} = 5V ± 0.5V.

5.8 Switching Characteristics

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

PARAMETER		TEST CONDITIONS ⁽¹⁾	MIN	TYP ⁽¹⁾	MAX	UNIT
SR	Driver slew rate	R _L = 3kΩ to 7kΩ, see Figure 6-2			30	V/μs
SR(t)	Driver transition region slew rate	see Figure 6-3		3		V/μs
	Data rate	One TOUT switching		120		kbit/s
t _{PLH} Ⓢ	Receiver propagation delay time, low- to high-level output	TTL load, see Figure 6-1		500		ns
t _{PHL} Ⓢ	Receiver propagation delay time, high- to low-level output	TTL load, see Figure 6-1		500		ns

- (1) Test conditions are C1–C4 = 1μF at V_{CC} = 5V ± 0.5V.

5.9 Typical Characteristics

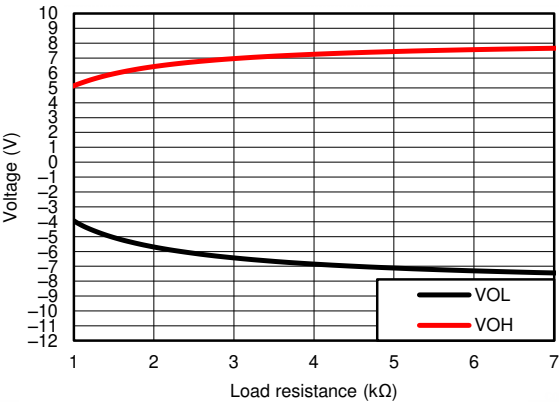


Figure 5-1. TOUT VOH & VOL vs Load Resistance, Both Drivers Loaded

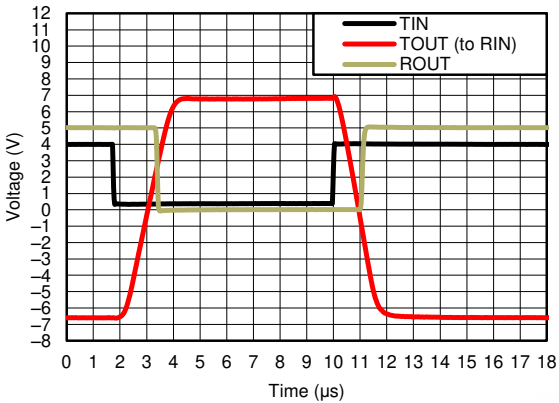
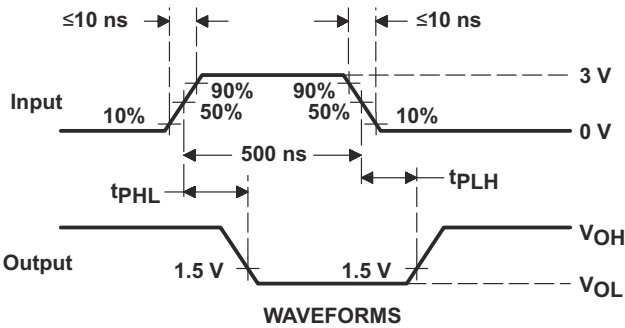
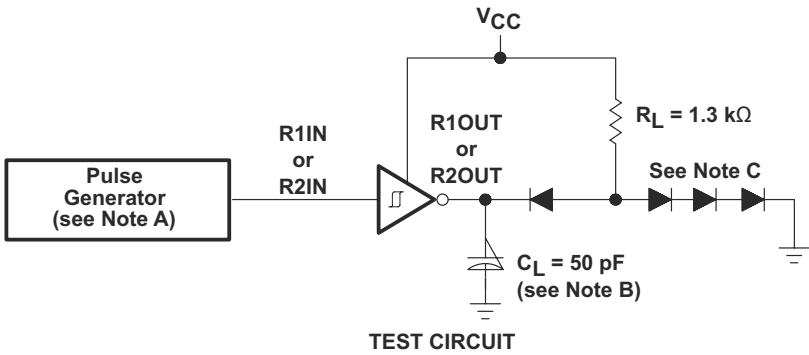


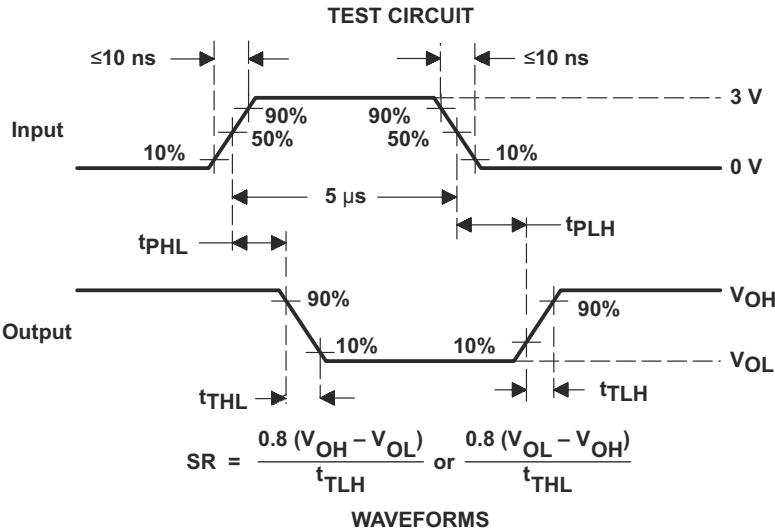
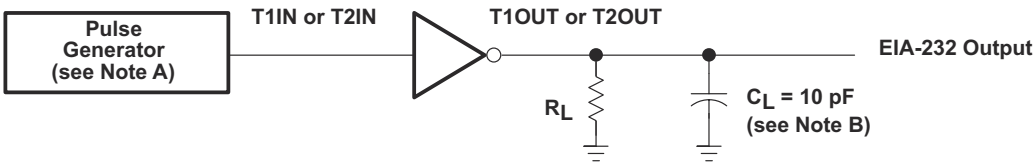
Figure 5-2. Driver to Receiver Loopback Timing Waveform

6 Parameter Measurement Information



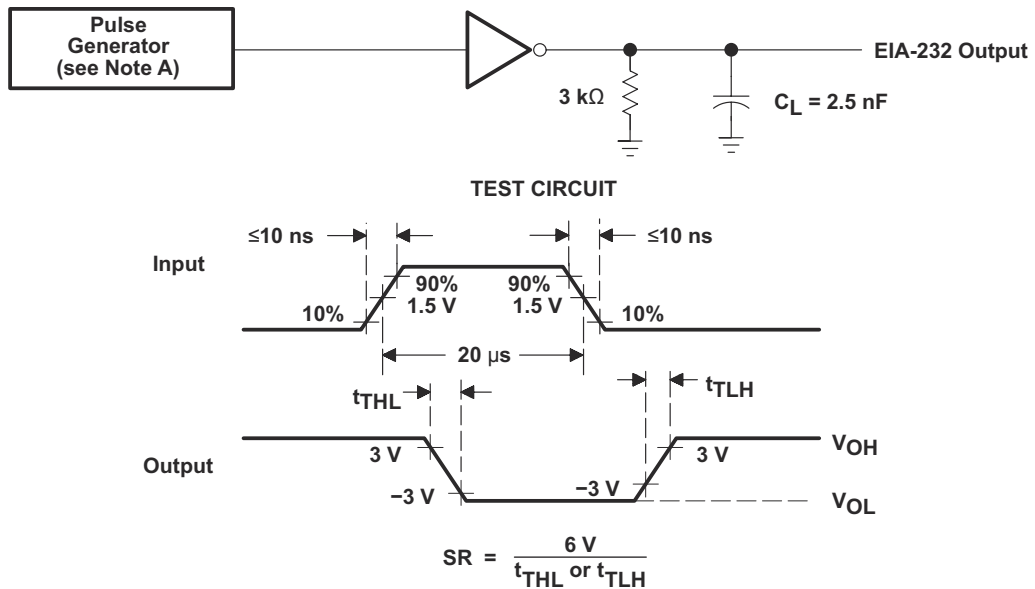
- A. The pulse generator has the following characteristics: $Z_O = 50\Omega$, duty cycle $\leq 50\%$.
- B. C_L includes probe and jig capacitance.
- C. All diodes are 1N3064 or equivalent.

Figure 6-1. Receiver Test Circuit and Waveforms for t_{PHL} and t_{PLH} Measurements



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

Figure 6-2. Driver Test Circuit and Waveforms for t_{PHL} and t_{PLH} Measurements (5μs Input)



WAVEFORMS

- A. The pulse generator has the following characteristics: $Z_O = 50 \Omega$, duty cycle $\leq 50\%$.

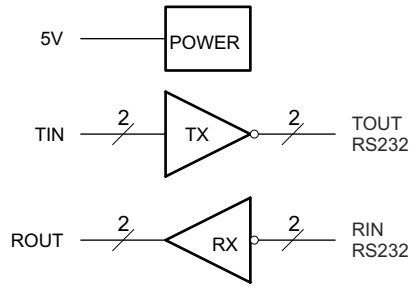
Figure 6-3. Test Circuit and Waveforms for t_{THL} and t_{TLH} Measurements (20 μs Input)

7 Detailed Description

7.1 Overview

The MAX232 device is a dual driver/receiver that includes a capacitive voltage generator using four capacitors to supply TIA/EIA-232-F voltage levels from a single 5-V supply. Each receiver converts TIA/EIA-232-F inputs to 5-V TTL/CMOS levels. These receivers have a typical threshold of 1.3 V, a typical hysteresis of 0.5 V, and can accept ± 30 -V inputs. Each driver converts TTL/CMOS input levels into TIA/EIA-232-F levels. The driver, receiver, and voltage-generator functions are available as cells in the Texas Instruments LinASIC™ library. Outputs are protected against shorts to ground.

7.2 Functional Block Diagram



7.3 Feature Description

7.3.1 Power

The power block increases and inverts the 5V supply for the RS232 driver using a charge pump that requires four 1 μ F external capacitors.

7.3.2 RS232 Driver

Two drivers interface standard logic level to RS232 levels. Internal pull up resistors on TIN inputs ensures a high input when the line is high impedance.

7.3.3 RS232 Receiver

Two receivers interface RS232 levels to standard logic levels. An open input will result in a high output on ROUT.

7.4 Device Functional Modes

7.4.1 V_{CC} powered by 5V

The device will be in normal operation.

7.4.2 V_{CC} unpowered

When MAX232 is unpowered, it can be safely connected to an active remote RS232 device.

7.4.3 Function Tables

Table 7-1. Each Driver

INPUT ⁽¹⁾	OUTPUT
T _{IN}	T _{OUT}
L	H
H	L

(1) H = high level, L = low level, X = irrelevant, Z = high impedance

INPUTS ⁽¹⁾	OUTPUT
R _{IN}	R _{OUT}
L	H
H	L
Open	H

8 Application and Implementation

Information in the following applications sections is not part of the TI component specification, and TI does not warrant its accuracy or completeness. TI's customers are responsible for determining suitability of components for their purposes, as well as validating and testing their design implementation to confirm system functionality.

For proper operation add capacitors as shown in [Figure 8-1](#). Pins 9 through 12 connect to UART or general purpose logic lines. EIA-232 lines will connect to a connector or cable.

Figure 8-1. Typical Operating Circuit

- V_{CC} minimum is 4.5V and maximum is 5.5V.
- Maximum recommended bit rate is 120kbps.

Use 1uF tantalum or ceramic capacitors.

8.2.3 Application Curves

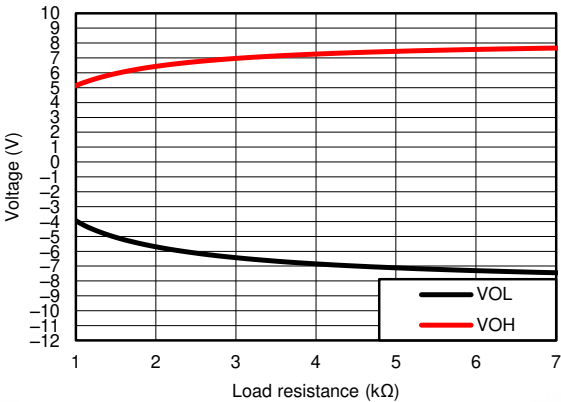


Figure 8-2. TOUT VOH & VOL vs Load Resistance, Both Drivers Loaded

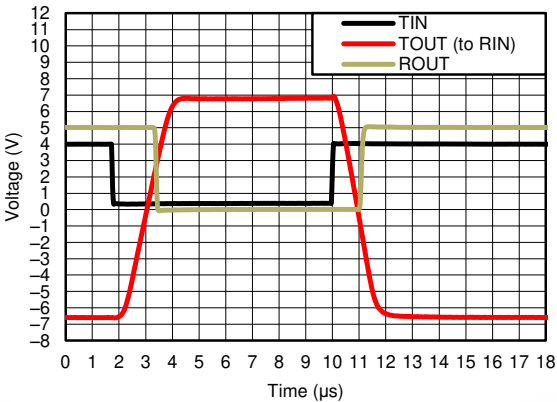


Figure 8-3. Driver to Receiver Loopback Timing Waveform

8.3 Power Supply Recommendations

The V_{CC} voltage should be connected to the same power source used for logic device connected to TIN pins. V_{CC} should be between 4.5V and 5.5V.

8.4 Layout

8.4.1 Layout Guidelines

Keep the external capacitor traces short. This is more important on C1 and C2 nodes that have the fastest rise and fall times.

8.4.2 Layout Example

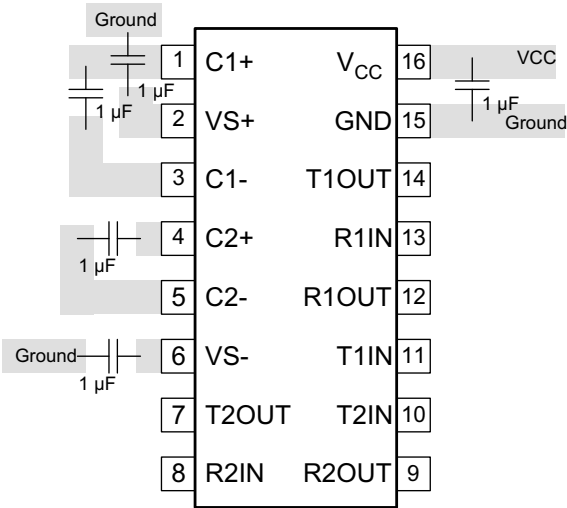


Figure 8-4. Layout Schematic

9 Device and Documentation Support

9.1 Receiving Notification of Documentation Updates

To receive notification of documentation updates, navigate to the device product folder on ti.com. In the upper right corner, click on *Alert me* to register and receive a weekly digest of any product information that has changed. For change details, review the revision history included in any revised document.

9.2 Support Resources


TI E2E™ support forums are an engineer's go-to source for fast, verified answers and design help — straight from the experts. Search existing answers or ask your own question to get the quick design help you need.

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9.3 Trademarks

TI E2E™ is a trademark of Texas Instruments.
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9.4 Electrostatic Discharge Caution



This integrated circuit can be damaged by ESD. Texas Instruments recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

9.5 Glossary

TI Glossary This glossary lists and explains terms, acronyms, and definitions.

10 Revision History

Changes from Revision M (November 2004) to Revision N (February 2024)	Page
• Changed the Handling Ratings table to the <i>ESD Ratings</i> table.....	4
• Changed the <i>Thermal Information</i> table.....	4

Changes from Revision L (March 2004) to Revision M (November 2014)	Page
• Removed Ordering Information table.....	1
• Added Handling Rating table, Feature Description section, Device Functional Modes, Application and Implementation section, Power Supply Recommendations section, Layout section, Device and Documentation Support section, and Mechanical, Packaging, and Orderable Information section.....	1
• Changed the Device Information table to the <i>Package Information</i> table.....	1
• Moved T _{stg} to Handling Ratings table.....	4

11 Mechanical, Packaging, and Orderable Information

The following pages include mechanical packaging and orderable information. This information is the most current data available for the designated devices. This data is subject to change without notice and revision of this document. For browser based versions of this data sheet, refer to the left hand navigation.