

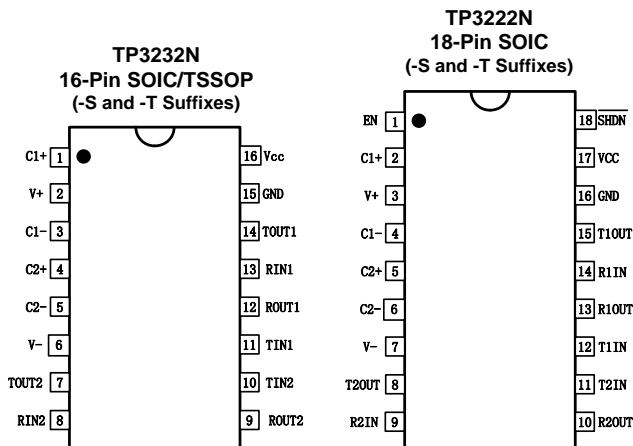
## Features

- Meets EIA/TIA-232 and V.28/V.24 Specifications at 3V
- Two Drivers and Two Receivers
- Constant Data Rate Under Different C-Loading
- Operates Up to 470kbps
- On-Chip Voltage Converters Require Only Four External 0.1 $\mu$ F Capacitors
- Wide Power Supply Range: Single +3V to +5.5V
- 1 $\mu$ A Low Power Shutdown With Receivers Active (TP3222N)
- Drop-in Replacements for SP3232, SP3222, MAX3232, MAX3222
- TP3232N is a Low Power Upgrade for 5V HIN232, HIN202, MAX232, MAX242

## Applications

- Battery-Powered Equipment
- Cell Phones Smart Phones
- Cell-Phone Data Cables
- Notebook, Subnotebook and Palmtop Computers
- Printers
- xDSL Modems

## Pin Configuration (Top View)



## Description

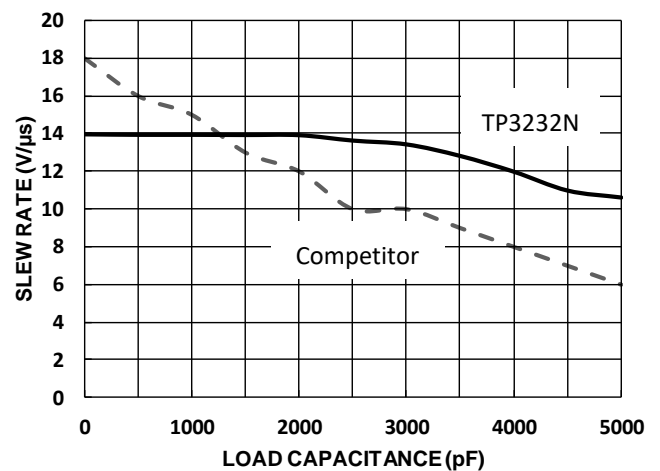
The 3PEAK TP32xxN devices are 3.0V to 5.5V RS-232 transmitters/receivers which meet EIA/TIA-232 and V.28/V.24 specifications, even at V<sub>CC</sub> = 3.0V. Each receiver converts TIA/RS-232-F inputs to TTL/CMOS levels.

The devices have a typical threshold of 1.26V, a typical hysteresis of 0.5V, and can accept  $\pm 25$ V inputs. Data rates greater than 470kbps are guaranteed at worst case load conditions. The devices are fully compatible with 3.3V-only systems, mixed 3.3V and 5.0V systems, and 5.0V-only systems.

The TP3232N/TP3222N has two receivers and two transmitters. The TP3222N features a 1 $\mu$ A shutdown mode that reduces power consumption in battery powered portable systems. The TP3222N receivers remain active in shutdown mode, allowing monitoring of external devices while consuming only 1 $\mu$ A of supply current.

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**TP3232N Slew Rate vs. Load Capacitance**



# TP3232N/TP3222N

Microamp Supply-Current, 3.0V to 5.5V, Up to 470kbps RS-232 Transceivers

## Order Information

Model Name	Order Number	Package	Transport Media, Quantity	Marking Information
TP3232N	TP3232N-SR	16-Pin SOIC	Tape and Reel, 2,500	3232N
TP3232N	TP3232N-TR	16-Pin TSSOP	Tape and Reel, 3,000	3232N
TP3222N	TP3222N-SR	18-Pin SOIC	Tape and Reel, 3,000	3222N

### Absolute Maximum Ratings <sup>Note 1</sup>

V <sub>CC</sub> to GND	-0.3V to +6V
V <sub>+</sub> to GND (Note 1)	-0.3V to +7V
V <sub>-</sub> to GND (Note 1)	+0.3V to -7V
V <sub>+</sub> +  V <sub>-</sub>   (Note 1)	+13V
Input Voltages	
T <sub>IN</sub> , $\overline{\text{EN}}$ , $\overline{\text{SHDN}}$	-0.3V to +6V
R <sub>IN</sub> to GND	±25V
Output Voltages	
T <sub>OUT</sub> to GND	±6.0V
R <sub>OUT</sub> , R <sub>OUTB</sub>	-0.3V to (V <sub>CC</sub> + 0.3V)
Short-Circuit Duration, T <sub>OUT</sub> to GND	Continuous

### Recommended Operating Conditions <sup>Note 1</sup>

Temperature Range	-40°C to +125°C
Supply Voltage (V <sub>CC</sub> )	3.3V or 5V
Rx Input Voltage	-15V to +15V
Thermal Resistance, $\Theta_{JA}$ (Typical)	
16-Pin SOIC Package	100°C/W
16-Pin TSSOP Package	145°C/W
18-Pin SOIC Package	75°C/W
Maximum Junction Temperature (Plastic Package)	+150°C
Maximum Storage Temperature Range	-65°C to +150°C

**Note 1:** V<sub>+</sub> and V<sub>-</sub> can have maximum magnitudes of 7V, but their absolute difference cannot exceed 13V.

## Electrical Characteristics

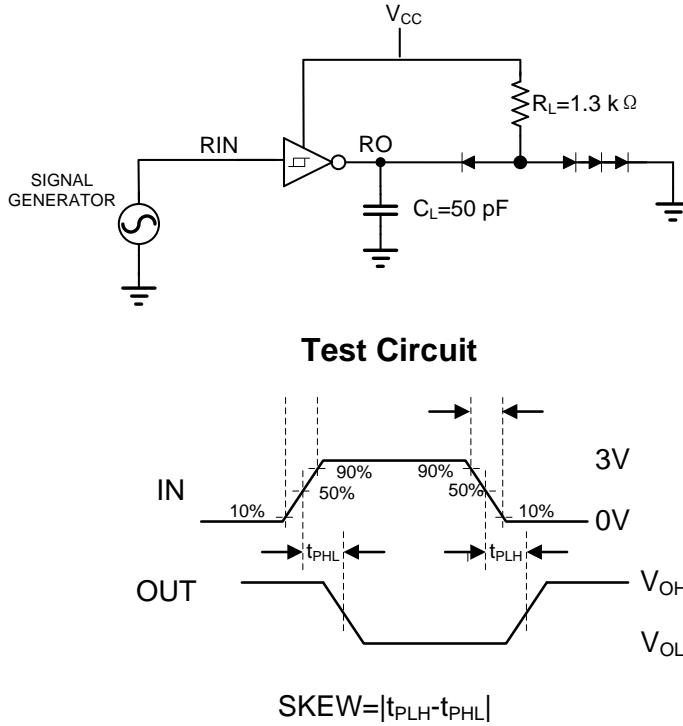
Test Conditions: V<sub>CC</sub> = 3.3V to 5.5V, T<sub>A</sub> = +25°C, C<sub>1</sub> - C<sub>4</sub> = 0.1μF, Unless Otherwise Specified. Boldface limits apply over the operating temperature range

PARAMETER	CONDITIONS	TEMP. (°C)	MIN	TYP	MAX	UNITS
<b>DC CHARACTERISTICS</b> (V <sub>CC</sub> = +3.3V or +5V, T <sub>A</sub> = +25°C)						
Supply Current	All R <sub>IN</sub> open	25		0.2	0.3	mA
Supply Current in Power-Down	SHDN = GND	25		1.0	3.0	μA
<b>LOGIC AND TRANSMITTER INPUTS AND RECEIVER OUTPUTS</b>						
Input Logic Threshold Low	T <sub>IN</sub> , EN, SHDN	V <sub>CC</sub> = 3.3V	Full	<b>0.53</b>	0.63	V
		V <sub>CC</sub> = 5.0V	Full	<b>0.57</b>	0.68	
Input Logic Threshold High	T <sub>IN</sub> , EN, SHDN	V <sub>CC</sub> = 3.3V	Full		0.84	<b>0.95</b>
		V <sub>CC</sub> = 5.0V	Full		0.9	<b>1.02</b>
Input Leakage Current	T <sub>IN</sub> , EN, SHDN	Full		±1.2	±1.5	μA
Output Leakage Current	EN = V <sub>CC</sub>	Full			±0.01	μA
Output Voltage Low	I <sub>OUT</sub> = 1.6mA	Full		0.18	<b>0.25</b>	V
Output Voltage High	I <sub>OUT</sub> = -1.0mA	Full	V <sub>CC</sub> - <b>0.2</b>	V <sub>CC</sub> - 0.15		V

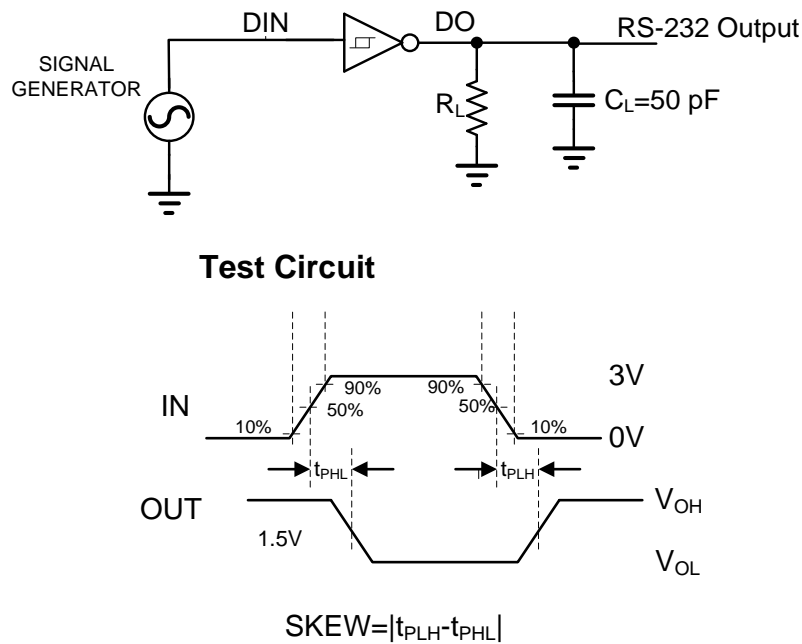
Microamp Supply-Current, 3.0V to 5.5V, Up to 470kbps RS-232 Transceivers

PARAMETER	CONDITIONS	TEMP. (°C)	MIN	TYP	MAX	UNITS	
<b>RECEIVER INPUTS</b>							
Input Voltage Range		25	-25		25	V	
Input Threshold Low	V <sub>CC</sub> = 3.3V	25	0.62	0.73		V	
	V <sub>CC</sub> = 5V	25	0.62	0.73		V	
Input Threshold High	V <sub>CC</sub> = 3.3V	25		1.26	1.45	V	
	V <sub>CC</sub> = 5V	25		1.29	1.45	V	
Input Hysteresis		25		0.5		V	
Input Resistance		25	3	5	7	kΩ	
<b>TRANSMITTER OUTPUTS</b>							
Output Voltage Swing	V <sub>CC</sub> = 3.3V	Full	±3.3			V	
	V <sub>CC</sub> = 5V	Full	±5			V	
Output Resistance	V <sub>CC</sub> = V <sub>+</sub> = V <sub>-</sub> = 0V, transmitter output = ±2V	25		50		Ω	
Output Short-Circuit Current		Full			±60	mA	
Output Leakage Current	V <sub>OUT</sub> = ±12V, V <sub>CC</sub> = 0V or 3V to 5.5V, SHDN = GND	Full			±0.01	μA	
<b>TIMING CHARACTERISTICS</b>							
Maximum Data Rate	R <sub>L</sub> = 3kΩ, C <sub>L</sub> = 1000pF, one transmitter, switching	Full	235	470		kbps	
Receiver Propagation Delay	Receiver input to receiver output, C <sub>L</sub> = 150pF	t <sub>PHL</sub>	25	0.3		μs	
		t <sub>PLH</sub>	25	0.3		μs	
Receiver Output Enable Time	Normal Operation	TP3222N	25	100		ns	
Receiver Output Disable time	Normal Operation	f = 1kHz, R <sub>L</sub> = 1kΩ	25	100		ns	
Transmitter Skew	t <sub>PHL</sub> to t <sub>PLH</sub>	25		150		ns	
Receiver Skew	t <sub>PHL</sub> to t <sub>PLH</sub>	25		100		ns	
Transition Region Slew Rate	V <sub>CC</sub> = 3.3V, R <sub>L</sub> = 3kΩ to 7kΩ, measured from 3V to -3V or -3V to 3V	C <sub>L</sub> = 150pF to 2500pF	25	13.5	14	16.5	V/μs
		C <sub>L</sub> = 150pF to 1000pF	25	13.9	14	16.5	V/μs
RS-232 Pins (T1OUT, T2OUT) ESD	Human Body Model	25		±8		kV	
RS-232 Pins (R1IN, R2IN) ESD	Human Body Model	25		±2		kV	

**Test Circuits and Waveforms**



**Figure 1. Receiver Test Circuit and Waveforms for  $t_{PHL}$  and  $t_{PLH}$  Measurements**



**Figure 2. Driver Test Circuit and Waveforms for  $t_{PHL}$  and  $t_{PLH}$  Measurements**

**Pin Functions**

PIN	FUNCTION
VCC	System power supply input (3.0V to 5.5V).
V+	Internally generated positive transmitter supply (+5.5V).
V-	Internally generated negative transmitter supply (-5.5V).
GND	Ground connection.
C1+	External capacitor (voltage doubler) is connected to this lead.
C1-	External capacitor (voltage doubler) is connected to this lead.
C2+	External capacitor (voltage inverter) is connected to this lead.
C2-	External capacitor (voltage inverter) is connected to this lead.
TIN	TTL/CMOS compatible transmitter Inputs.
TOUT	RS-232 level (nominally $\pm 5.5V$ ) transmitter outputs.
RIN	RS-232 compatible receiver inputs.
ROUT	TTL/CMOS level receiver outputs.
EN	Active low receiver enable control; doesn't disable ROUTB outputs.
SHDN	Active low input to shut down transmitters and on-board power supply, to place device in low power mode.

**Detailed Description**

**Charge-Pump Voltage Converter**

The integrated charge pump in TP3232N/TP3222N generates negative power supply from a single supply VCC. The charge pump requires a flying capacitors (C1, C2) and a reservoir capacitors (C3, C4) to generate V- supplies(Figure1). At the same time a decoupling capacitor shall be applied between VCC and ground. Typical value for the flying capacitor is 0.1uF. Typical value of the decoupling capacitor shall be same as or larger than that of the flying capacitor. The TP3232N/TP3222N's charge pump could provides output voltages of +5V and -5V under single +5V VCC.

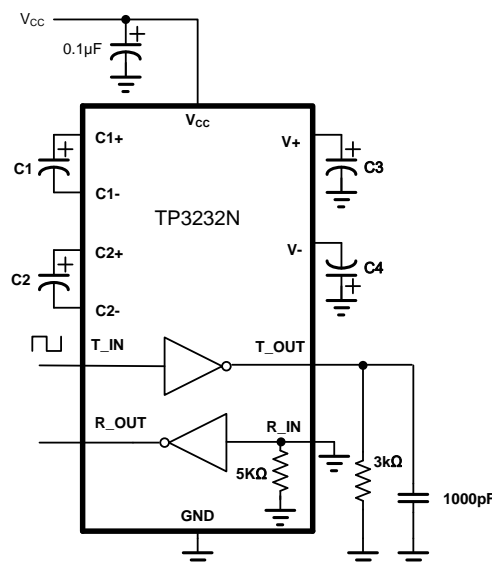


Figure 1. Slew-Rate Test Circuits

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## RS-232 Transmitters

The transmitters are inverting level translators that convert TTL/CMOS-logic levels to  $\pm 5V$  EIA/TIA-232-compliant levels. The TP3232N/TP3222N transmitters guarantee a 470kbps data rate with worst-case loads of 3k $\Omega$  in parallel with 1000pF, providing compatibility with PC-to-PC communication software. Transmitters can be paralleled to drive multiple receivers or mice. The TP3222N transmitters are disabled and the outputs are forced into a high-impedance state when the device is in shutdown mode (SHDN = GND). The TP3232N/TP3222N's transmitter inputs have a 400k $\Omega$  active positive-feedback resistor, allowing unused inputs to be left unconnected.

## RS-232 Receivers

The receivers convert RS-232 signals to CMOS-logic output levels. The TP3222N receivers have inverting three-state outputs. Drive EN high to place the receiver(s) into a high impedance. Receivers can be either active or inactive in shutdown (Table 1).

SHDN	EN	T_OUT	R-OUT	R_OUTB
0	0	High impedance	Active	Active
0	1	High impedance	High impedance	Active
1	0	Active	Active	Active
1	1	Active	High impedance	Active

TABLE 1 Shutdown and Enable Control Truth Table

## TP3222N

Supply current falls to less than 1 $\mu A$  in shutdown mode (SHDN = low). When shut down, the device's charge pumps are shut off, V- is pulled to ground, and the transmitter outputs are disabled (high impedance). The time required to recover from shutdown is typically 80 $\mu s$ .

## Applications Information

### Capacitor Selection

The capacitor type used for C1–C4 is not critical for proper operation; polarized or nonpolarized capacitors can be used. The charge pump requires 0.1 $\mu F$  capacitors for 3.3V operation. Increasing the capacitor values (e.g., by a factor of 2) reduces ripple on the transmitter outputs and slightly reduces power consumption. C2, C3, and C4 can be increased without changing C1's value. **However, do not increase C1 without also increasing the values of C2, C3, C4, and CBYPASS to maintain the proper ratios (C1 to the other capacitors).** When using the minimum required capacitor values, make sure the capacitor value does not degrade excessively with temperature. If in doubt, use capacitors with a larger nominal value. The capacitor's equivalent series resistance (ESR), which usually rises at low temperatures, influences the amount of ripple on V+ and V-.

### Power-Supply Decoupling

In most circumstances, a 0.1µF VCC bypass capacitor is adequate. In applications sensitive to power-supply noise, use a capacitor of the same value as charge pump capacitor C1. Connect bypass capacitors as close to the IC as possible.

### Operation Down to 3V

Transmitter outputs meet EIA/TIA-562 levels of ±3V with supply voltages as low as 3V.

### From Shutdown

As they become active, the two transmitter outputs are shown going to opposite RS-232 levels (one transmitter input is high; the other is low). Each transmitter is loaded with 3kΩ in parallel with 2500pF. The transmitter outputs display no ringing or undesirable transients as they come out of shutdown. Note that the transmitters are enabled about 80µs after power up.

### High Data Rates

The TP3232N/TP3222N maintain the RS-232 ±3V minimum transmitter output voltage even at high data rates. All transmitters were driven simultaneously at 470kbps into RS-232 loads in parallel with 5000pF. For Figure 4, a single transmitter was driven at 333kbps, and all transmitters were loaded with an RS-232 receiver in parallel with 1000pF.

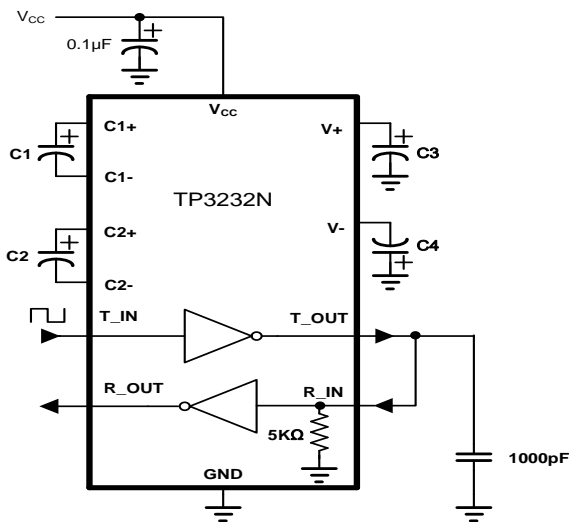


Figure 4. Loopback Test Circuit

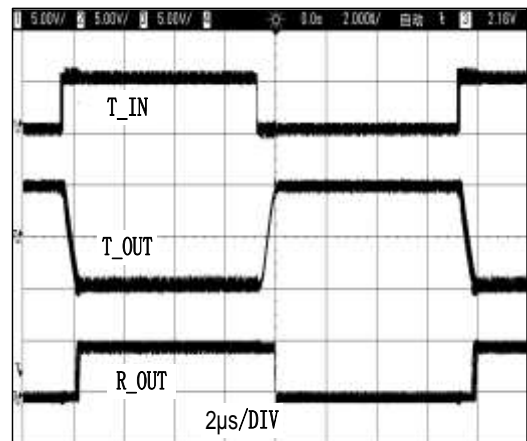
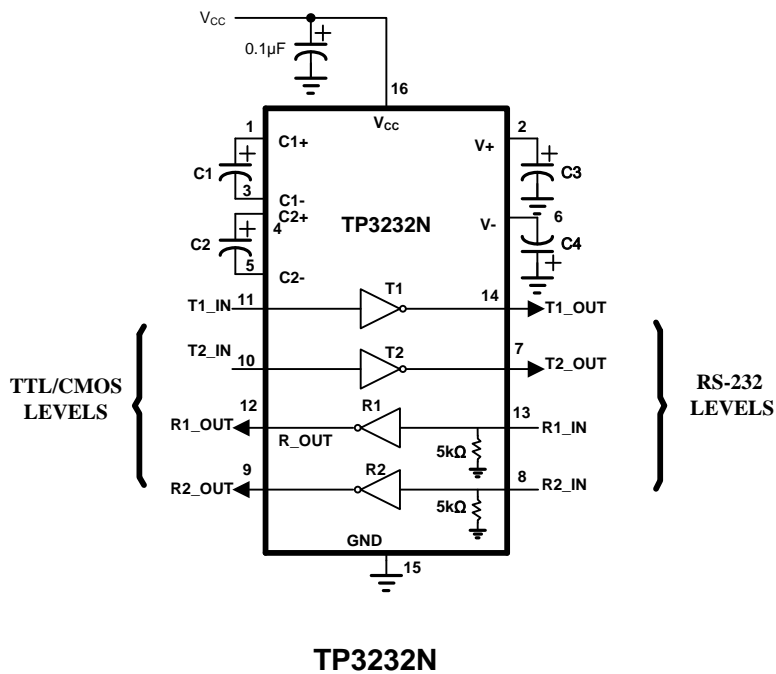
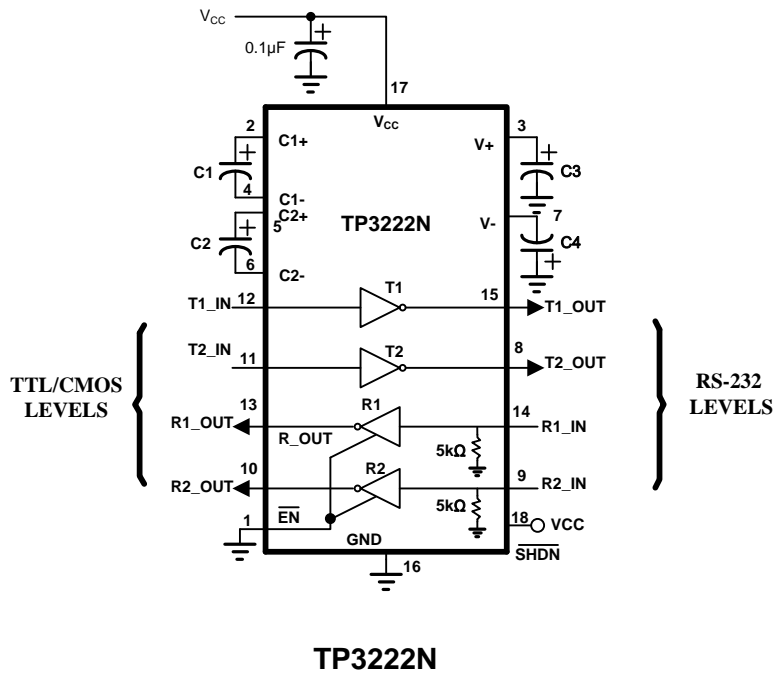


Figure 5. Loopback Test At 333kbps

# TP3232N/TP3222N

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## Typical Application Circuits





**Typical Performance Curves**  $V_{CC} = 5V, T_A = +25^{\circ}C.$

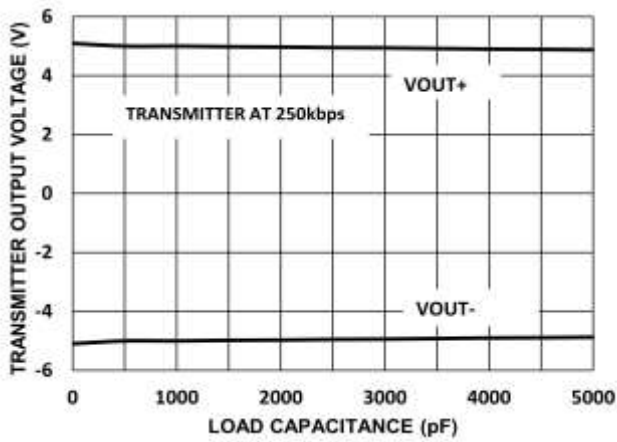


Figure 6. Transmitter Output Voltage vs Load Capacitance

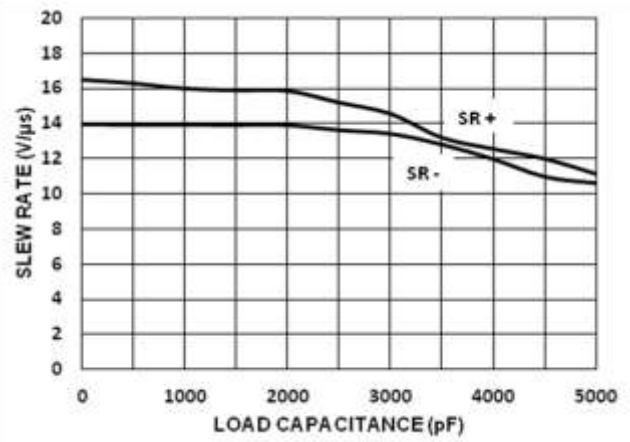


Figure 7. Slew Rate vs Load Capacitance

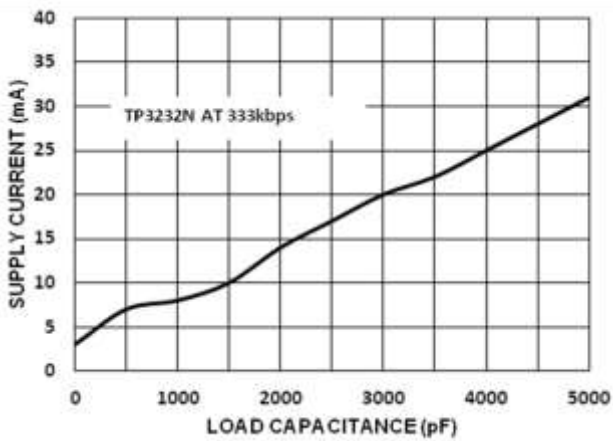


Figure 8. Supply Current vs Load Capacitance When Transmitting Data

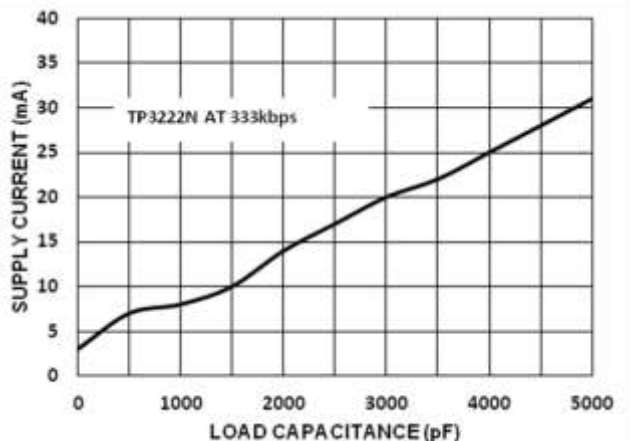


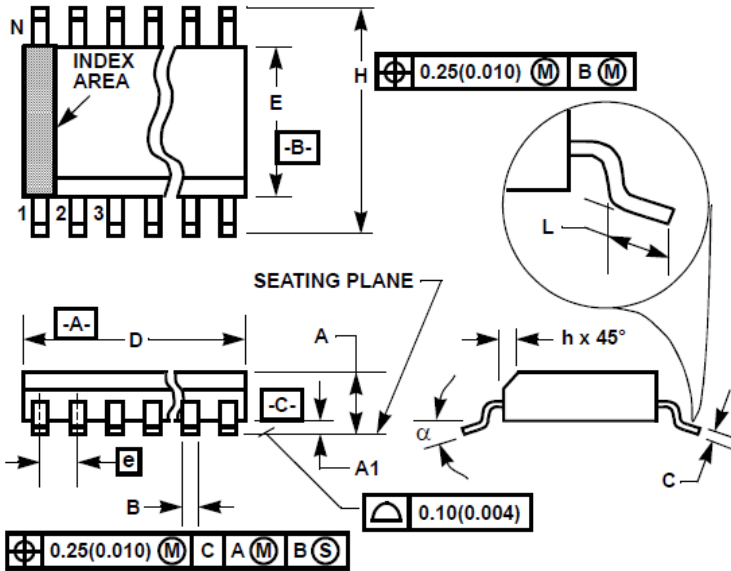
Figure 9. Supply Current vs Load Capacitance When Transmitting Data

# TP3232N/TP3222N

Microamp Supply-Current, 3.0V to 5.5V, Up to 470kbps RS-232 Transceivers

## Package Outline Dimensions

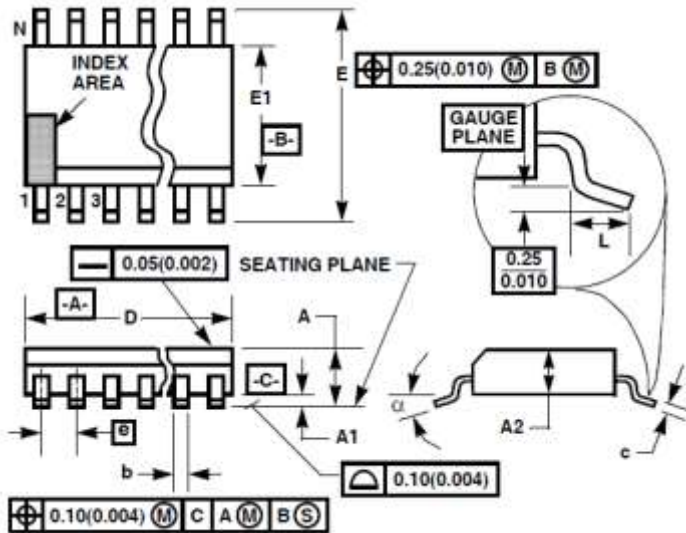
SOIC-16



Symbol	Dimensions In Millimeters		
	MIN	NOM	MAX
A	1.35	1.60	1.75
A1	0.10	0.15	0.25
B	0.33	0.42	0.51
C	0.19	0.22	0.25
D	9.8	9.9	10
E	3.8	3.9	4
H	5.8	6.0	6.2
h	0.25	0.38	0.5
L	0.4	0.835	1.27
N	16		
e	1.27 BSC		
$\alpha$	0°	4°	8°

**Package Outline Dimensions**

TSSOP-16



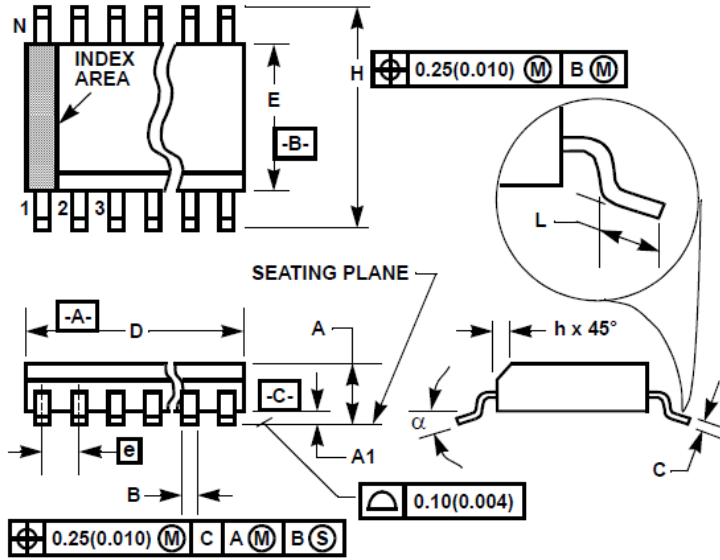
Symbol	Dimensions In Millimeters		
	MIN	NOM	MAX
A	-	0.55	1.10
A1	0.05	0.10	0.15
A2	0.85	0.90	0.95
b	0.19	0.25	0.30
c	0.09	0.15	0.20
D	4.90	5.00	5.10
E1	4.30	4.40	4.50
E	6.25	6.38	6.5
L	0.50	0.60	0.70
N	16		
e	0.65 BSC		
α	0°	4°	8°

# TP3232N/TP3222N

Microamp Supply-Current, 3.0V to 5.5V, Up to 470kbps RS-232 Transceivers

## Package Outline Dimensions

SOIC-18



Symbol	Dimensions In Millimeters		
	MIN	NOM	MAX
A	2.35	2.5	2.65
A1	0.10	0.20	0.30
B	0.33	0.42	0.51
C	0.23	0.26	0.32
D	11.35	11.55	11.75
E	7.40	7.50	7.60
H	10.00	10.32	10.65
h	0.25	0.50	0.75
L	0.40	0.84	1.27
N	18		
e	1.27 BSC		
$\alpha$	0°	4°	8°

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