Microamp Supply-Current, 3V to 5.5V, Up to 470kbps RS-232 Transceivers

Features

- **Meets EIA/TIA-232 and V.28/V.24 Specifications at 3V**
- **Two Drivers and Two Receivers**
- **Constant Date Rate Under Different C-Loading**
- **Operates Up to 470kbps**
- **On-Chip Voltage Converters Require Only Four External 0.1µF Capacitors**
- **Wide Power Supply Range: Single +3V to +5.5V**
- **1µA 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

Description

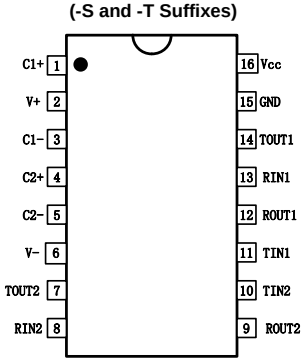
The 3PEAK TP32xxN devices are 3.0V to 5.5V RS-232 transmitters/receivers which meet EIA/TIA-232 and V.28 /V.24 specifications, even at V_{CC} = 3.0V. Each receiver converts TIA/RS-232-F inputs to TTL/CMOS levels.

The devices have a typical threshold of 1.26V, a typical hysteresis of 0.5V, and can accept ±25V 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.

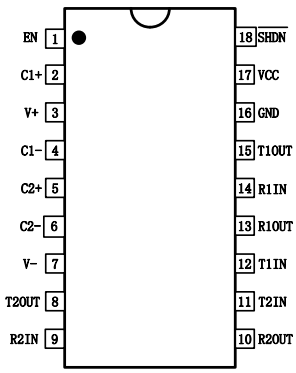
The TP3232N/TP3222N has two receivers and two transmitters. The TP3222N features a 1µA shutdown mode that reduces power consumption in battery powered portable systems. The TP3222N receivers remain active in shutdown mode, allowing monitoring of external devices while consuming only 1µA of supply current.

Pin Configuration (Top View)

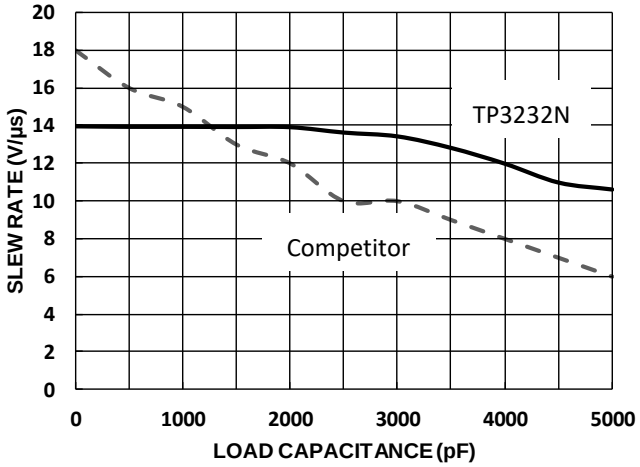
TP3232N
16-Pin SOIC/TSSOP
(-S and -T Suffixes)



TP3222N
18-Pin SOIC
(-S and -T Suffixes)



TP3232N Slew Rate vs. Load Capacitance



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 Note 1

V_{CC} to GND.....-0.3V to +6V

V_+ to GND (Note 1) .....-0.3V to +7V

V- to GND (Note 1) .....+0.3V to -7V

V_+ + |V-| (Note 1).....+13V

Input Voltages

TIN, $\overline{EN}$, $\overline{SHDN}$.....-0.3V to +6V

R_IN to GND .....±25V

Output Voltages

T_OUT to GND.....±6.0V

R_OUT, R_OUTB .....-0.3V to (VCC + 0.3V)

Short-Circuit Duration, T_OUT to GND.....Continuous

Recommended Operating Conditions Note 1

Temperature Range.....-40°C to +125°C

Supply Voltage (V_{CC}) ..... 3.3V or 5V

Rx Input Voltage ..... -15V to +15V

Thermal Resistance, Θ_{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+ and V- can have maximum magnitudes of 7V, but their absolute difference cannot exceed 13V.

Electrical Characteristics

Test Conditions: V_{CC} = 3.3V to 5.5V, T_A = +25°C, C_1 - C_4 = 0.1µF, Unless Otherwise Specified. Boldface limits apply over the operating temperature range

PARAMETER	CONDITIONS		TEMP. (°C)	MIN	TYP	MAX	UNITS
DC CHARACTERISTICS (V_{CC} = +3.3V or +5V, T_A = +25°C)							
Supply Current	All R_{IN} open		25		0.2	0.3	mA
Supply Current in Power-Down	SHDN = GND	TP3222N	25		1.0	3.0	µA
LOGIC AND TRANSMITTER INPUTS AND RECEIVER OUTPUTS							
Input Logic Threshold Low	TIN, EN, SHDN	V_{CC} = 3.3V	Full	**0.53**	0.63		V
		V_{CC} = 5.0V	Full	**0.57**	0.68		
Input Logic Threshold High	TIN, EN, SHDN	V_{CC} = 3.3V	Full		0.84	**0.95**	V
		V_{CC} = 5.0V	Full		0.9	**1.02**	V
Input Leakage Current	TIN, EN, SHDN		Full		±1.2	**±1.5**	µA
Output Leakage Current	EN = V_{CC}	TP3222N	Full			**±0.01**	µA
Output Voltage Low	I_{OUT} = 1.6mA		Full		0.18	**0.25**	V
Output Voltage High	I_{OUT} = -1.0mA		Full	**V_{CC} - 0.2**	V_{CC} - 0.15		V

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

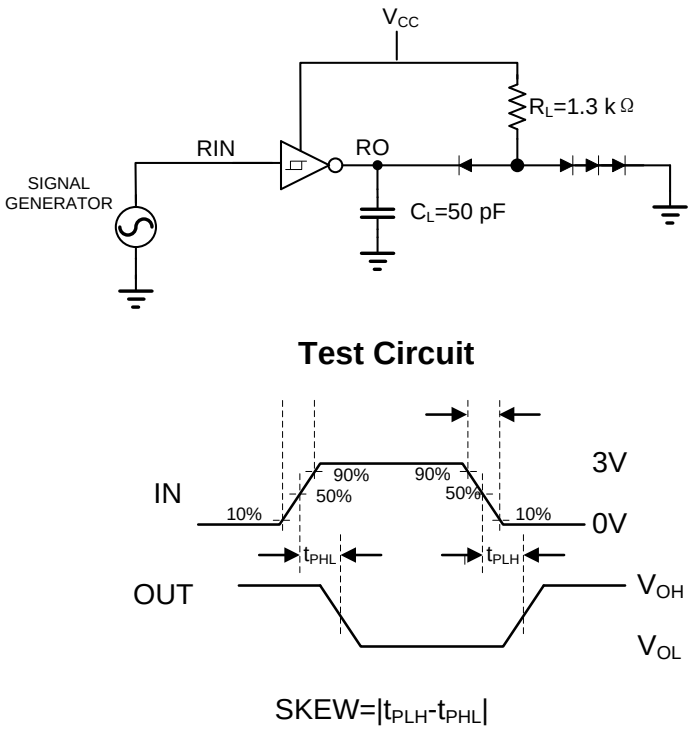


Figure 1. Receiver Test Circuit and Waveforms for tPHL and tPLH Measurements

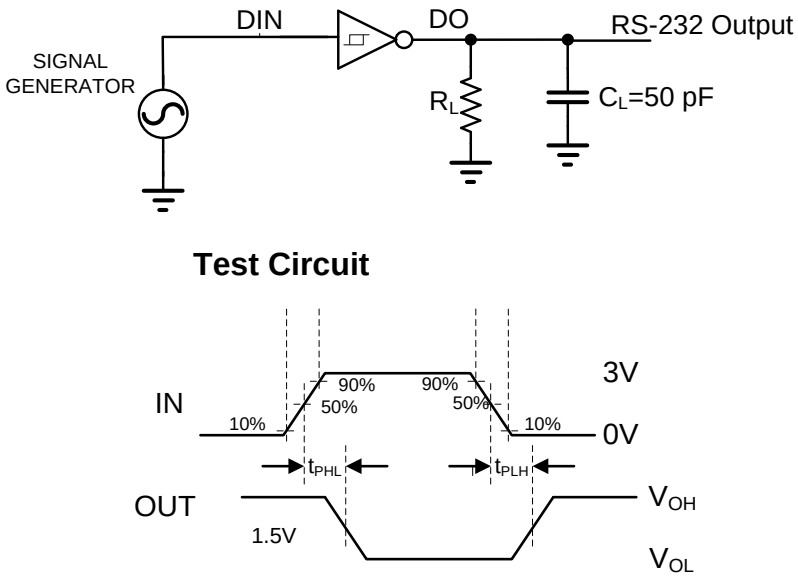


Figure 2. Driver Test Circuit and Waveforms for t_{PHL} and t_{PLH} Measurements

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 ±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.

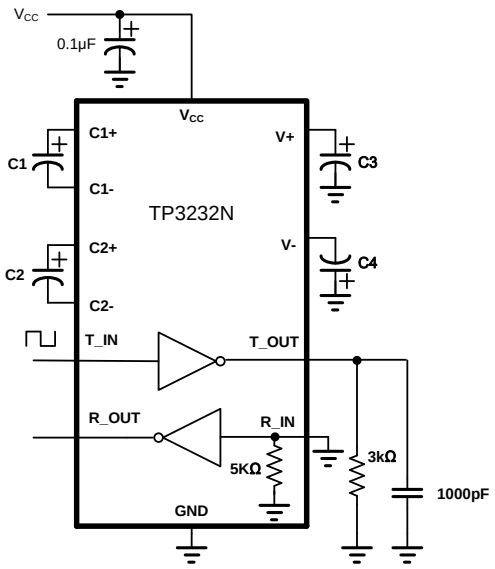


Figure 1. Slew-Rate Test Circuits

RS-232 Transmitters

The transmitters are inverting level translators that convert TTL/CMOS-logic levels to ±5V EIA/TIA-232-compliant levels. The TP3232N/TP3222N transmitters guarantee a 470kbps data rate with worst-case loads of 3kΩ 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 400kΩ 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 1μA 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 80μs.

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 0.1μF 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.

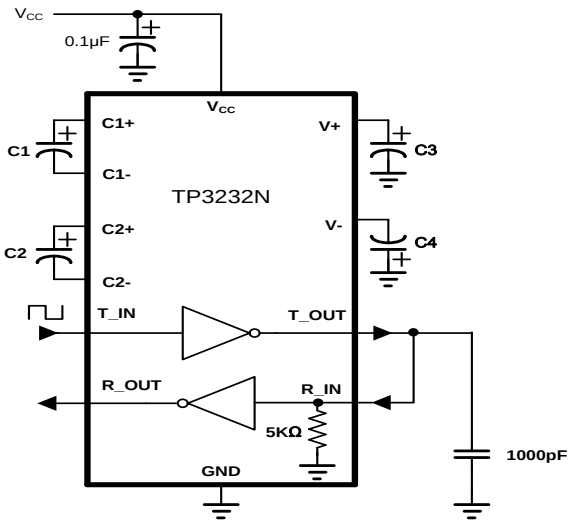


Figure 4. Loopback Test Circuit

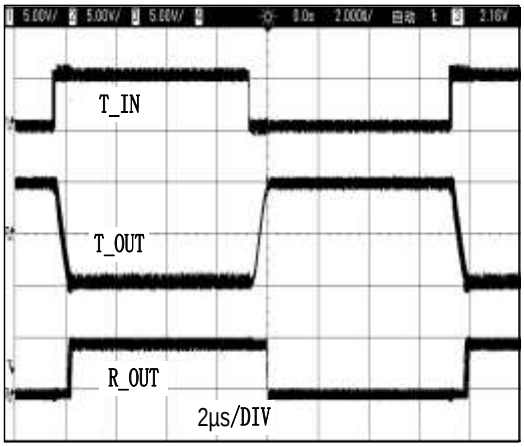
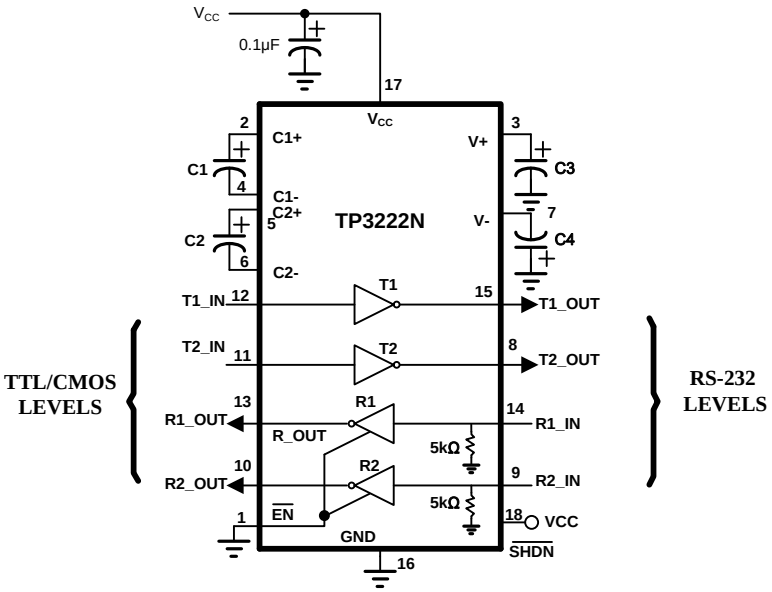
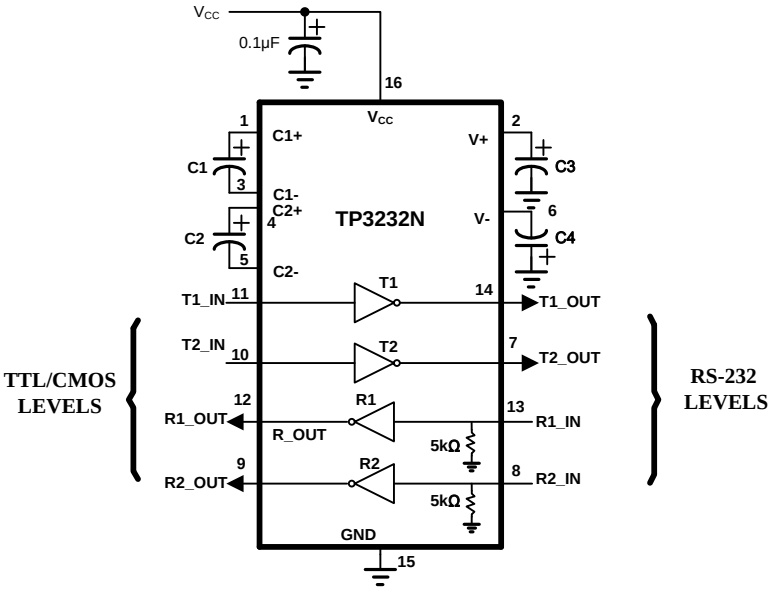


Figure 5. Loopback Test At 333kbps

Typical Application Circuits



TP3222N



TP3232N

Typical Performance Curves

V_{CC} = 5V, T_A = +25°C.

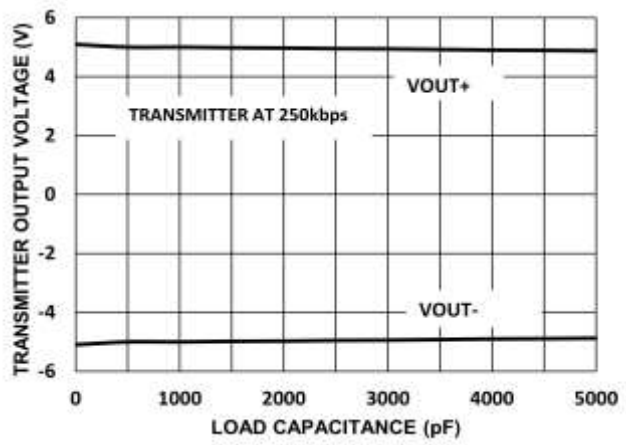


Figure 6. Transmitter Output Voltage vs Load Capacitance

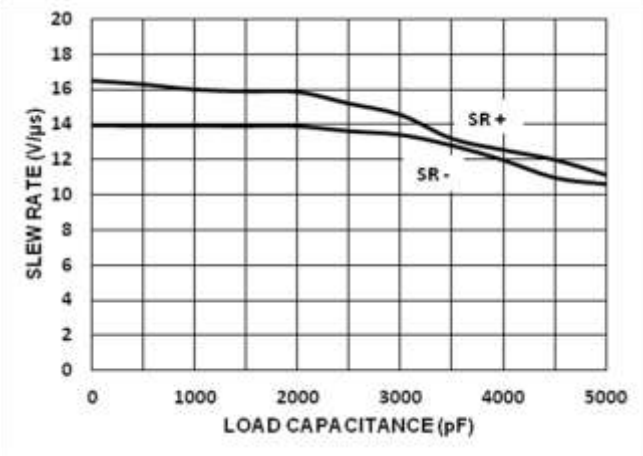


Figure 7. Slew Rate vs Load Capacitance

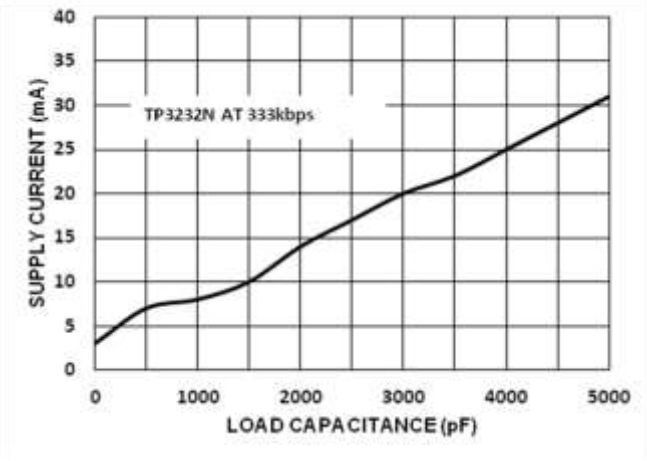


Figure 8. Supply Current vs Load Capacitance When Transmitting Data

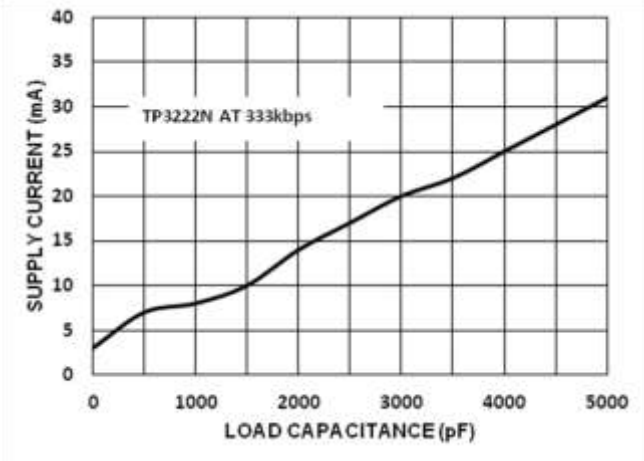
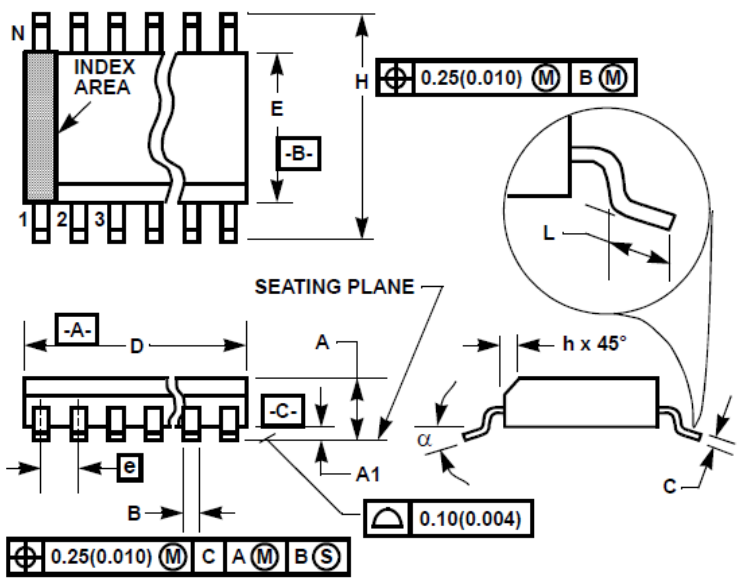


Figure 9. Supply Current vs Load Capacitance When Transmitting Data

Package Outline Dimensions

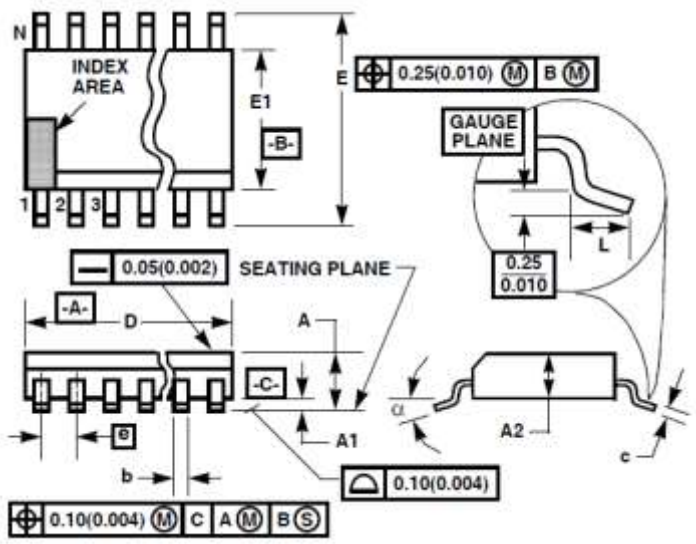
SOIC-16



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		
α	0°	4°	8°

Package Outline Dimensions

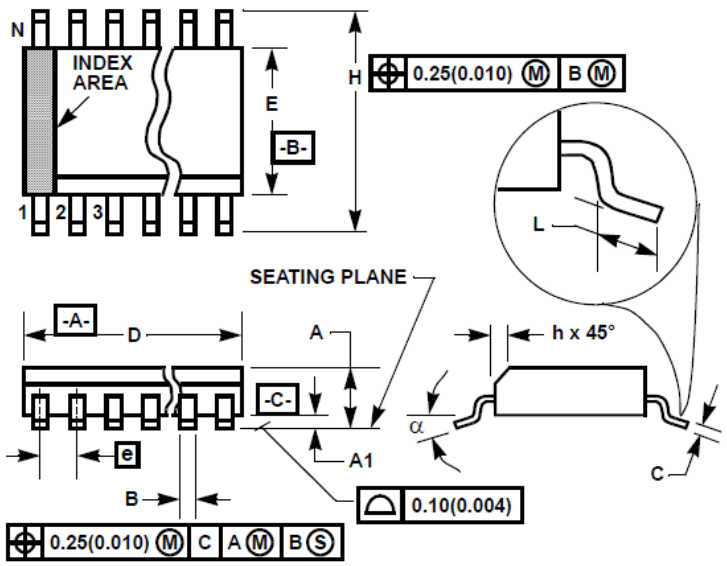
TSSOP-16



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°

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		
α	0°	4°	8°

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