# 1.3µA, 3.3V, RS-485 / RS-422 Transceiver
For Battery-Powered Systems

Features

- 2.5-V to 3.6-V Supply Voltage
- 1.3µA Supply Current with Receiver Enabled
- Half-duplex Transceiver
- -7V to 12V Bus Common Mode Input Range
- Open, Short, and Idle Fail-safe Functions
- ESD Protection for RS-485 I/O Pins
- Allow Up to 128 Transceivers on the Bus
- Small Packaging: MSOP8

Applications

- Power Inverters
- Motor Control
- Industrial Automation
- Battery-Powered Applications
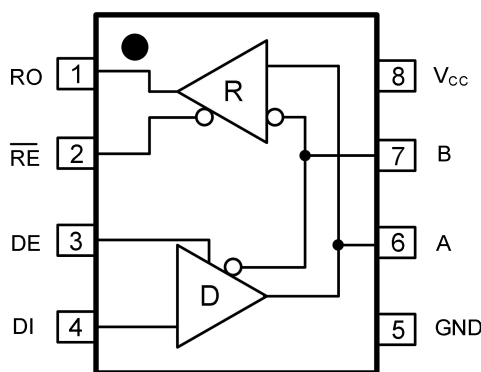
Pin Diagram

General Description

The COS3471-3.3 is a low power differential bus / line transceiver designed for multipoint data transmission standard RS485 applications with extended common mode range: -7V to 12V. It also meets the requirements of RS422.

The driver and receiver feature three-state outputs, with the driver outputs maintaining high impedance over the entire common mode range. Excessive power dissipation caused by bus contention or faults is prevented by a thermal shutdown circuit which forces the driver outputs into a high impedance state.

The receiver has a fail-safe feature which guarantees a high output state when the inputs are left open or shorted. Power-on reset circuits keep the outputs in a high impedance state until the supply voltage has stabilized.

The COS3471-3.3 operates from a single 2.5V to 3.6V supply. The device offers significant power saving without sacrificing ruggedness against overload or ESD damage. It is available in 8-lead small plastic MSOP8, and is specified for operation from –40°C to +125°C ambient temperature.

1. Pin Configuration and Functions
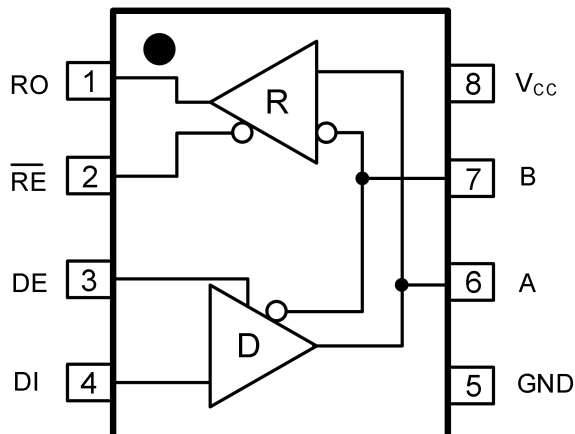
Figure 1 Pin Diagram

Pin Description

Pin	Name	Description
1	RO	Receiver output. When the receiver output is enabled ($\overline{\text{RE}}$ low), then if A > B by 200mV, RO will be high. If A < B by 200mV, then RO will be low.
2	$\overline{\text{RE}}$	Receiver output enable. A low enables the receiver output, RO. A high input forces the receiver output into a high impedance state.
3	DE	Driver output enable. A high on DE enables the driver outputs, A and B, and the chip will function as a line driver. A low input will force the driver outputs into a high impedance state and the chip will function as a line receiver.
4	DI	Driver input. If the driver outputs are enabled (DE high), then a low on DI forces the outputs A low and B high. A high on DI with the driver outputs enabled will force A high and B low.
5	GND	Ground
6	A	Non-inverting receiver input and non-inverting driver output
7	B	Inverting receiver input and inverting driver output
8	Vcc	Power Supply

Driver Truth Table

Inputs		Outputs		Function
DE	DI	A	B	
H	H	H	L	Actively drive bus High
H	L	L	H	Actively drive bus Low
L	X	Z	Z	Driver disabled
OPEN	X	Z	Z	Driver disabled by default
H	OPEN	H	L	Actively drive bus high by default

Note: X = Don't care; Z = High impedance

Receiver Truth Table

Inputs		Outputs	Function
$\overline{\text{RE}}$	A-B	RO	
L	≥ -0.05V	H	Receiver valid bus High
L	≤ -0.45V	L	Receiver valid bus Low
L	≥ -0.05V ≤ -0.45V	?	Indeterminate bus state
H	X	Z	Receiver disabled
OPEN	X	Z	Receiver disabled by default
L	Open-circuit bus	H	Fail-safe high output
L	Short-circuit bus	H	Fail-safe high output
L	Idle bus	H	Fail-safe high output

Note: DE = L or OPEN

2. Product Specification

2.1 Absolute Maximum Ratings [1]

Parameter	Min	Max	Unit
DC supply voltage, Vcc		+6	V
Control input voltages	-0.5	Vcc + 0.5	V
Driver input voltages	-0.5	Vcc + 0.5	V
Driver output voltage at A or B		±16	V
Receiver input voltage		±16	V
Receiver output voltage	-0.5	Vcc + 0.5	V
Operating junction temperature	-40	+135	°C
Storage temperature	-55	+150	°C

(1) Stresses exceeding the absolute maximum ratings may damage the device. The device may not function or be operable above the recommended operating conditions and stressing the parts to these levels is not recommended. In addition, extended exposure to stresses above the recommended operating conditions may affect device reliability. The absolute maximum ratings are stress ratings only.

2.2 Thermal Data

Parameter	Rating	Unit
Package Thermal Resistance, $R_{\theta JA}$ (Juntion-to-ambient)	206 (MSOP8)	°C/W

2.4 Recommended Operating Conditions

Parameter	Min.	Typ.	Max.	Unit
DC supply voltage	2.5	3.3	3.6	V
Input voltage at any bus terminal	-7		12	V
Differential input voltage	-12		12	V
Differential load resistance	54	60		Ω
Data rate	0		500	kbps
Operating ambient temperature	-40		+85	°C
Operating junction temperature	-40		+125	°C

2.5 Electrical Characteristics

(Typical values are at T_A=+25 ºC, V_{CC}=+3.3V, unless otherwise noted.)

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Driver Electrical Characteristics						
Differential driver output (no load)	V_{OD1}	$I_O = 0$	2.0		V_{CC}	V
Differential driver output (with load)	V_{OD2}	$R_L = 50\,\Omega$ (RS422) $R_L = 27\,\Omega$ (RS485), (See Figure 2)	2.0 1.5	2.5 2.0		V
Change in magnitude of driver differential output voltage for complementary output states	ΔV_{OD}	$R_L = 27\Omega$ or 50Ω	-0.2	0	0.2	V
Driver common-mode output voltage	V_{OC}	$R_L = 27\Omega$ or 50Ω		$V_{CC}/2$	3	V
Change in magnitude of driver common-mode output voltage for complementary output states	ΔV_{OC}	$R_L = 27\Omega$ or 50Ω			0.2	V
Driver short-circuit current	I_{OS}	$V_O = -7V$ to $12V$	-80		80	mA
Logic Input high voltage	V_{IH}	RE, DE, DI	2.0			V
Logic Input low voltage	V_{IL}	RE, DE, DI			0.8	V
Logic Input current	I_{IN1}	RE, DE, DI			±5	µA
Receiver Electrical Characteristics						
Receiver differential threshold voltage	V_{TH}	$V_{CM} = -7V$ to $12V$	-200	-125	-50	V
Receiver input hysteresis	ΔV_{TH}	$V_{CM} = 0V$		30		mV
Receiver input resistance	R_{IN}	$V_{CM} = -7V$ to $12V$	96			kΩ
Input current (A, B)	I_{IN}	$V_{CC} = 0V$ or $3.3V$, $V_{DE} = 0V$ $V_{IN} = 12V$ $V_{IN} = -7V$			+200 -200	µA
Receiver output high voltage	V_{OH}	$I_O = -4mA$	V_{CC} -0.4	V_{CC} -0.2		V

Receiver output low voltage	V_{OL}	I_O = -8mA, V_{ID} = 200mV		0.2	0.4	V
Receiver short-circuit current	I_{OSR}	V_O = 0V to Vcc	7		30	mA
Tristate output leakage current	I_{OZR}	V_O = 0.4 to 2.4V	-1		+1	µA

Supply Current Characteristics

Supply current, DE=V_{CC}	I_{CC}	No Load, $\overline{RE}$ = DI = 0V or V_{CC} V_A=V_B=0		0.29	0.4	mA
Supply current, DE=0				1.3	2	µA

Driver Switching Characteristics

Propagation delay input to output	t_{PLH}	R_{DIFF} = 54Ω, C_{L1} = C_{L2} = 100pF (See Figure 4 and Figure 6)	3	5	10	ns
Propagation delay input to output	t_{PHL}		3	5	10	ns
Output to output skew	t_{SK}			2	5	ns
Rise or fall time	t_r, t_f		3	6	10	ns
Enable to output high	t_{PZH}	C_L = 100pF, S2 = Closed (See Figure 5 and Figure 7)		5	10	ns
Enable to output low	t_{PZL}	C_L = 100pF, S1 = Closed (See Figure 5 and Figure 7)		5	10	ns
Disable time from low	t_{PLZ}	C_L = 15pF, S1 = Closed (See Figure 5 and Figure 7)		8	15	ns
Disable time from high	t_{PHZ}	C_L = 15pF, S2 = Closed (See Figure 5 and Figure 7)		8	15	ns

Receiver Switching Characteristics

Propagation delay input to output	t_{PLH}	R_{DIFF} = 54Ω, C_{L1} = C_{L2} = 100pF (See Figure 4 and Figure 8)	30	105	150	ns
Propagation delay input to output	t_{PHL}		30	105	150	ns
Output to output skew	t_{SK}				10	ns
Enable to output high	t_{PZH}	C_{RL} = 15pF, S1 = Closed (See Figure 2 and Figure 9)		50	70	ns
Enable to output low	t_{PZL}	C_{RL} = 15pF, S2 = Closed (See Figure 2 and Figure 9)		50	70	ns
Disable time from low	t_{PLZ}	C_{RL} = 15pF, S1 = Closed (See Figure 2 and Figure 9)		50	70	ns
Disable time from high	t_{PHZ}	C_{RL} = 15pF, S2 = Closed (See Figure 2 and Figure 9)		50	70	ns
Maximum data rate	f_{MAX}		64			kbps

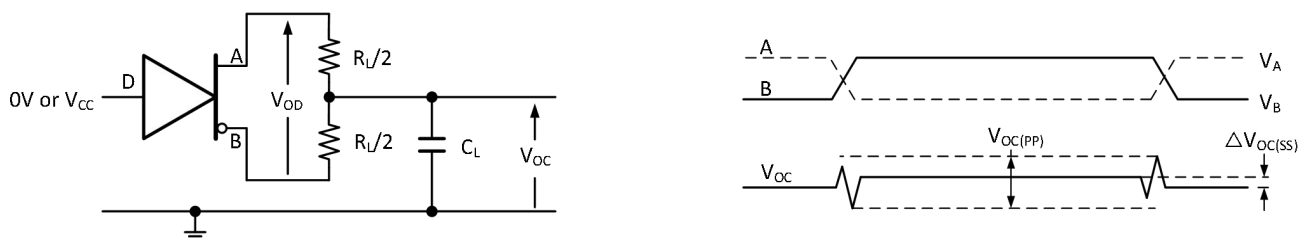## 3. Testing Circuits and Parameter Information

Figure 2. Measurement of Driver Differential and Common-Mode Output with RS-485 Load
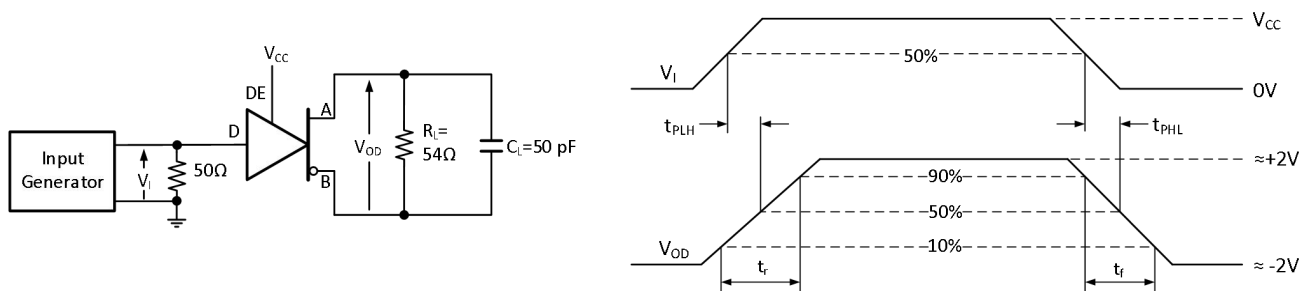

Figure 3. Measurement of Driver Differential Output Rise and Fall Times and Propagation Delays
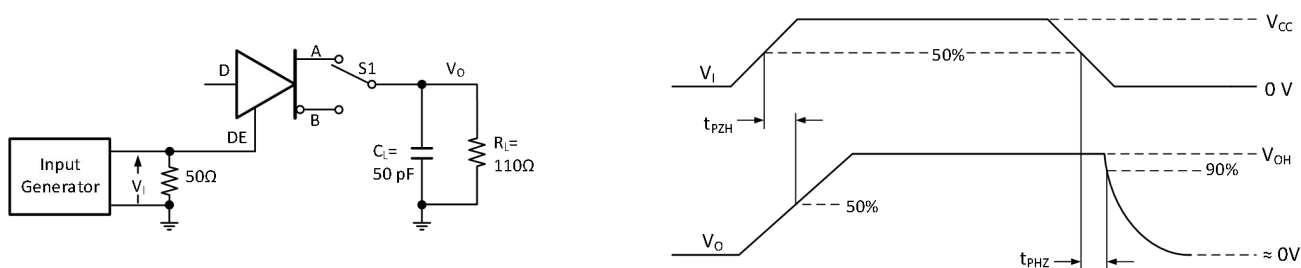

Figure 4. Measurement of Driver Enable and Disable Times with Active High Output
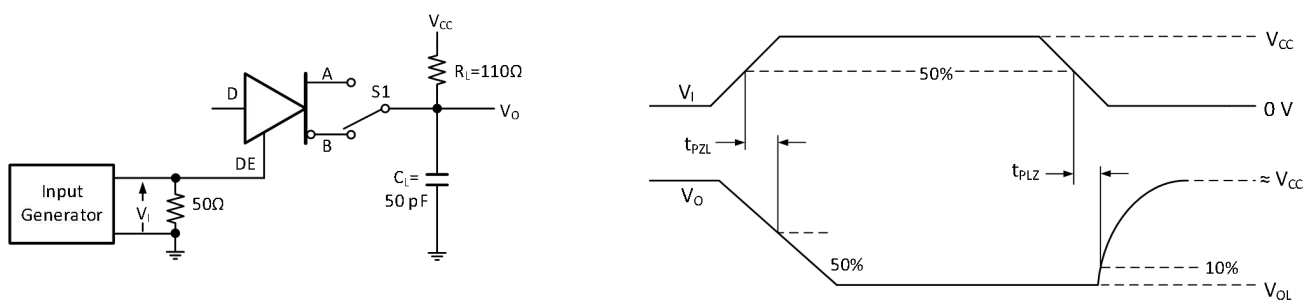and Pull-Down Load

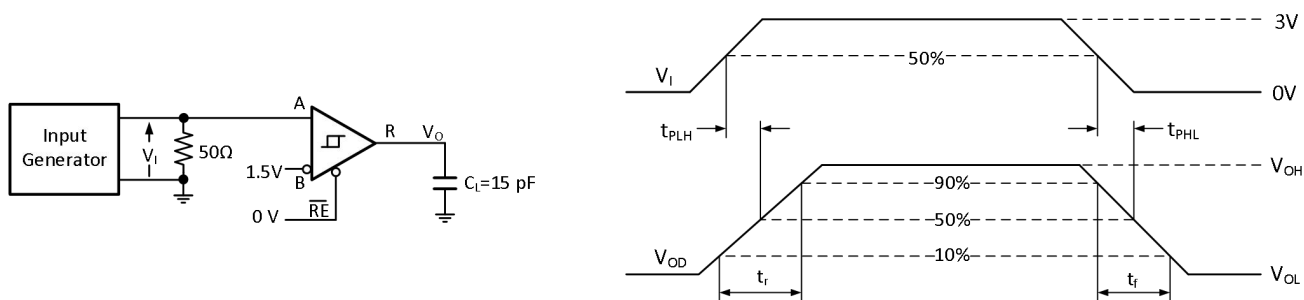Figure 5. Measurement of Driver Enable and Disable Times with Active Low Output and Pull-up Load

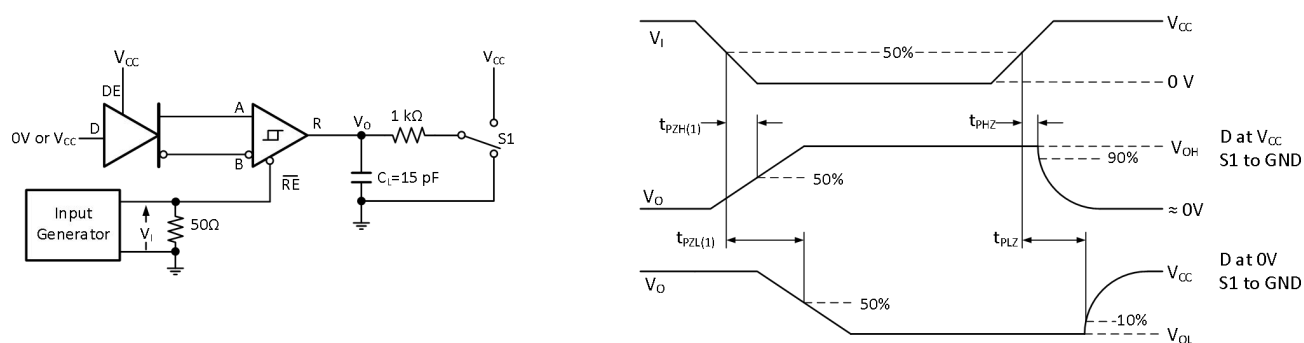Figure 6. Measurement of Receiver Output Rise and Fall Times and Propagation Delays

Figure 7. Measurement of Receiver Enable/Disable Times with Driver Enabled
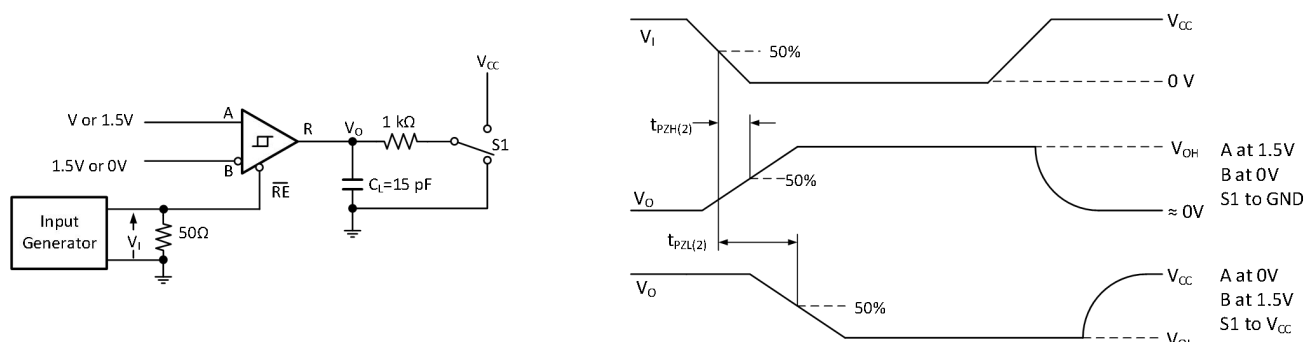
Figure 8. Measurement of Receiver Enable Times with Driver Disabled

4. Typical Application

The COS3471-3.3 device is a half-duplex RS-485 transceiver suitable for data transmission at rates up to 500kbps over controlled-impedance transmission media (such as twisted-pair cabling). Up to 128 units of the COS3471 device can share a common RS-485 bus due to the low bus-input currents of the device. A typical application showing a multi-point transmission network is illustrated in Figure 9. Only one driver can transmit at a particular time, but multiple receivers may be enabled simultaneously. As with any transmission line, it is important that reflections are minimized. This can be achieved by terminating the extreme ends of the line using resistors equal to the characteristic impedance of the line. Stub lengths off the main line must also be kept as short as possible. A properly terminated transmission line appears purely resistive to the driver.
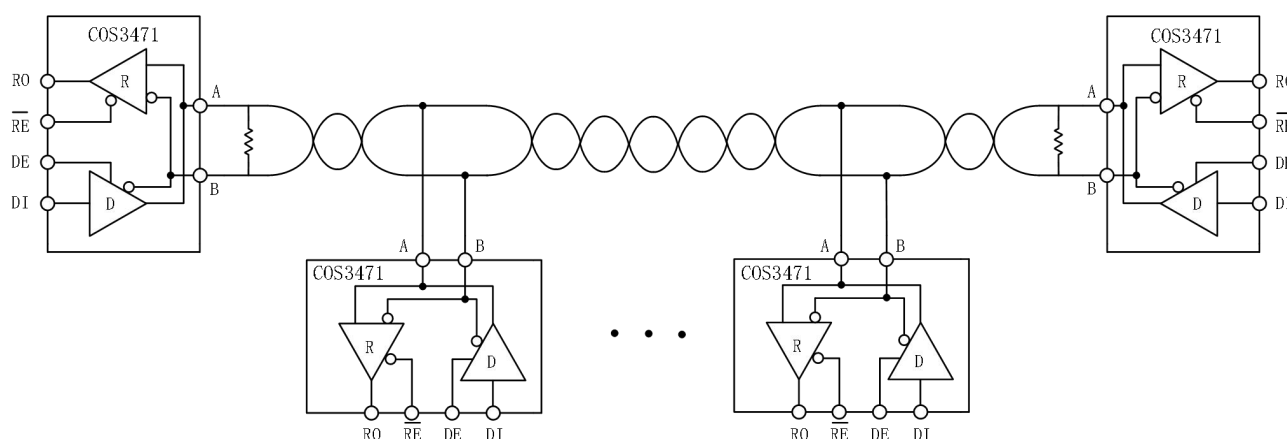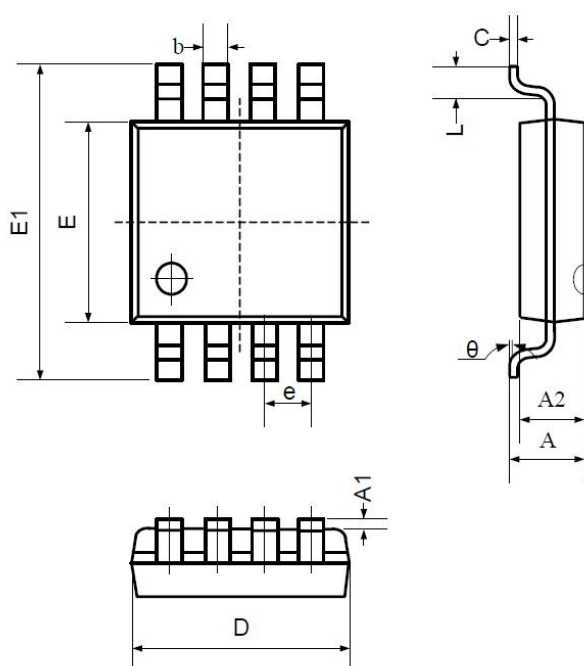

Figure 9. Multi-point Transmission Networks

5. Ordering Information

Model	Order Number	Package	Package Option	Marking Information
COS3471-3.3	COS3471MR-3.3	MSOP-8	Tape and Reel, 3000	COS3471

6. Package Information

6.1 MSOP8 (Package Outline Dimensions)

Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	0.800	1.200	0.031	0.047
A1	0.000	0.200	0.000	0.008
A2	0.760	0.970	0.030	0.038
b	0.30 TYP		0.012 TYP	
c	0.15 TYP		0.006 TYP	
D	2.900	3.100	0.114	0.122
e	0.65 TYP		0.026 TYP	
E	2.900	3.100	0.114	0.122
E1	4.700	5.100	0.185	0.201
L	0.410	0.650	0.016	0.026
θ	0°	6°	0°	6°