

1 FEATURES

- 1.6μA Supply Current with Receiver Enabled
- +2.5V to +5.5V Single Supply Operation
- True Fail-Safe Receiver Input
- Available in 8-pin MSOP Package and 8-pin SOP Package
- 1/8-Unit-Load Receiver Input
- -7V to +10V Common-Mode Input Voltage Range

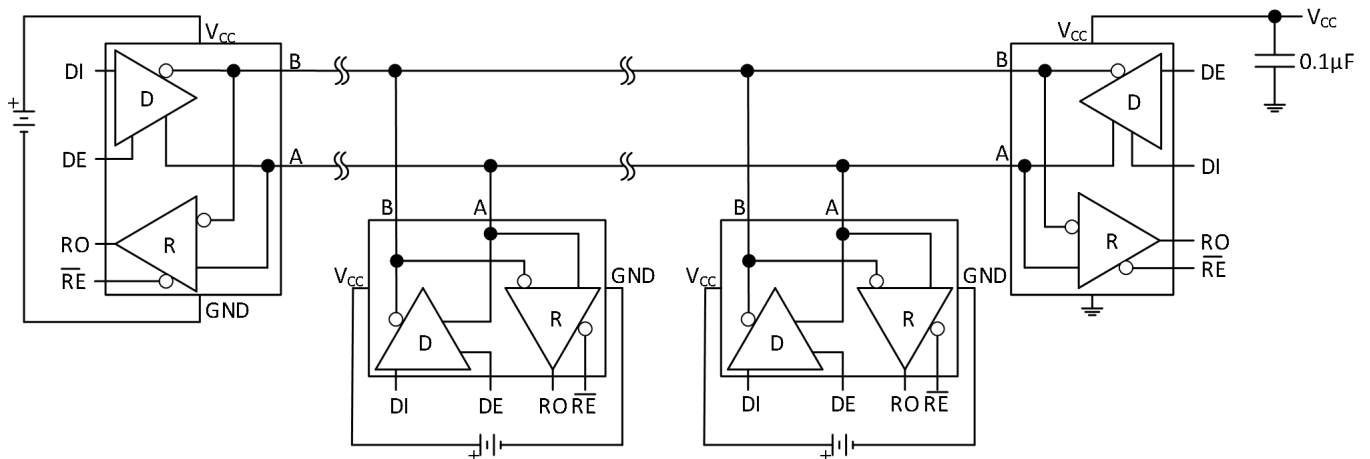
2 APPLICATIONS

- Remote Meter Reading
- Battery-Powered Differential Communications
- Level Translators

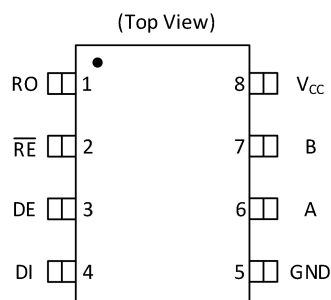
3 DESCRIPTION

The GM3471E half-duplex transceiver is intended for lithium battery-powered RS-485/RS-422 applications. It draws only 1.6μA (typical) supply current from a 3.6V supply with the receiver enabled and the driver disabled. Its wide 2.5V to 5.5V supply voltage guarantees operation over the lifetime of a lithium battery. This device features true fail-safe operation that guarantees a logic-high receiver output when the receiver inputs are open or shorted. This means that the receiver output will be a logic high if all transmitters on a terminated bus are disabled (high impedance). The GM3471E has a 1/8-unit load input resistance. When driver outputs are enabled and pulled above V_{CC} or below GND, internal circuitry prevents battery back charging. The GM3471E is available in an 8pin MSOP package and 8pin SOP package.

TYPICAL APPLICATION CIRCUIT



4 PIN CONFIGURATION AND FUNCTIONS



Pin		Description
Name	No.	
RO	1	Receiver Output. When $\overline{RE}$ is low and if $(A-B) \geq -50\text{mV}$, RO is high; if $(A-B) \leq -200\text{mV}$, RO is low.
$\overline{RE}$	2	Receiver Output Enable. Drive $\overline{RE}$ low to enable the RO; Drive $\overline{RE}$ high to let the RO in high-impedance.
DE	3	Driver Output Enable. Drive DE high to enable the outputs; These outputs are high impedance when DE is low.
DI	4	Driver Input. Drive DI low to force noninverting output low and inverting output high. Drive DI high to force noninverting output high and inverting output low.
GND	5	Ground
A	6	Noninverting Driver Output and Noninverting Receiver Input
B	7	Inverting Driver Output and Inverting Receiver Input
V _{CC}	8	Supply voltage: $2.5\text{V} \leq V_{CC} \leq 5.5\text{V}$

5 SPECIFICATIONS

5.1 ABSOLUTE MAXIMUM RATINGS⁽¹⁾

Parameter	Parameter	Rating	UNIT
V _{CC}	Supply Voltage	7	V
$\overline{RE}$, DE	Control Input Voltage	-0.3 to (V _{CC} + 0.3V)	V
DI	Transmitter Input	-0.3 to (V _{CC} + 0.3V)	V
A, B	Driver Output/Receiver Input Voltage	±10.5	V
RO	Receiver Output Voltage	-0.3 to (V _{CC} + 0.3V)	V
P	Continuous Power Dissipation μMAX (derate 4.5mW/°C above +70°C)	362	mW
T _{OP}	Operating Temperature Range	-40 to +85	°C
T _{STO}	Storage Temperature Range	-65 to +160	°C
T _L	Lead Temperature (soldering, 10sec)	+300	°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.

5.2 DC ELECTRICAL CHARACTERISTICS

($V_{CC}=+2.5V$ to $+5.5V$, $T_A=T_{MIN}$ to T_{MAX} , unless otherwise noted. Typical values are at $V_{CC} = +3.6V$ and $T_A = +25^{\circ}C$.) (Note 1)

Parameter	Symbol	Test Conditions		MIN	TYP	MAX	UNIT
Transmitter							
Differential Transmitter Output(No load)	V _{OD1}	No load,Figure1(R=open)				V _{CC}	V
Differential Transmitter Output	V _{OD2}	Fig.1,R=750Ω(RS-422)		1.8	3.6		V
		Fig.1,R=27Ω(RS-485)		0.6	1.2		
		Fig.1,R=27Ω(RS-485),V _{CC} = 5V, T _A = +25°C			1.8		
Change in Magnitude of Differential Output Voltage ⁽²⁾	ΔV _{OD}	Fig.1,R=750Ω or R=27Ω				0.2	V
Transmitter Common- Mode Output Voltage	V _{OC}	Fig.1,R=750Ω or R=27Ω				0.6V _{CC}	V
Change in Magnitude of Common- Mode Voltage ⁽²⁾	ΔV _{OC}	Fig.1,R=750Ω or R=27Ω				0.2	V
Input High Voltage	V _{IH}	DE,DI, $\overline{RE}$		0.7V _{CC}			V
Input Low Voltage	V _{IL}	DE,DI, $\overline{RE}$				0.3V _{CC}	V
DI Input Hysteresis	V _{HYS}				100		mV
Input Current	I _{IN1}				±0.001	±1	μA
Input Current for A and B(half-duplex)	I _{IN2}	DE=GND,V _{CC} =GND or 5.5V	V _{IN} =10V			0.075	mA
			V _{IN} =-7V			-0.045	
Transmitter Short-Circuit Output Current	I _{OSD}	-7V ≤ V _{OUT} ≤ 10V	V _{CC} ≤ 3.6V	-100		100	mA
			V _{CC} ≤ 5.5V	-110		110	
Receiver							
Receiver Differential Threshold Voltage	V _{TH}	-7V≤V _{CM} ≤10V		-200	-130	-50	mV
Receiver Input Hysteresis	ΔV _{TH}	V _{CM} = 0			30		mV
Receiver Output High Voltage	V _{OH}	I _O =-0.8mA,V _{ID} =-50mV		V _{CC} -0.4			V
Receiver Output Low Voltage	V _{OL}	I _O =2.2mA,V _{ID} =-450mV				0.4	V
Three- State Output Current	I _{OZR}	0≤V _O ≤V _{CC}				±1	μA
Receiver Input Resistance	R _{IN}	-7V≤V _{CM} ≤10V		96			kΩ
Receiver Output Short-Circuit Current	I _{OSR}	0V≤V _{RO} ≤V _{CC}	V _{CC} ≤ 3.6V	-20		50	mA
			V _{CC} ≤ 5.5V	-40		110	
Supply Current							
Supply current	I _{CC}	V _{CC} ≤ 3.6V, no load, $\overline{RE}$ =DI=GN D or V _{CC} ,V _A =V _B =0	DE = V _{CC}		90	100	μA
			DE = GND		1.6	2	
		V _{CC} ≤ 5.5V, no load, $\overline{RE}$ =DI=GN D or V _{CC} ,V _A =V _B =0	DE = V _{CC}		110	130	μA
			DE = GND		1.8	2.2	

5.3 SWITCHING CHARACTERISTICS

($V_{CC} = +2.5V$ to $+5.5V$, $T_A = T_{MIN}$ to T_{MAX} , unless otherwise noted. Typical values are at $V_{CC} = +3.6V$ and $T_A = +25^{\circ}C$.)

Parameter	Symbol	Conditions	MIN	TYP	MAX	UNITS
Transmitter Input to Output Propagation Delay	t_{DPLH}, t_{DPLH}	Fig.3 and Fig.5, $R_{DIFF}=1.5K\Omega$ $C_{L1}=C_{L2}=100pF$		1.40	2.00	μs
Transmitter Output Skew $ t_{DPLH} - t_{DPLH} $	t_{DSKEW}	Fig.3 and Fig.5, $R_{DIFF}=1.5K\Omega$ $C_{L1}=C_{L2}=100pF$		0.025		μs
Transmitter Rise or Fall Time	t_{DR}, t_{DF}	Fig.3 and Fig.5, $R_{DIFF}=1.5K\Omega$ $C_{L1}=C_{L2}=100pF$	0.75	1.34	1.75	μs
Transmitter Enable Time to Output High	t_{DZH}	Fig.4 and Fig.6, $C_L=100pF$ S2 closed, S1 open		1.5	6.00	μs
Transmitter Enable Time to Output Low	t_{DZL}	Fig.4 and Fig.6, $C_L=100pF$ S1 closed, S2 open		0.86	4.00	μs
Transmitter Disable Time from Low	t_{DLZ}	Fig.4 and Fig.6, $C_L=15pF$ S1 closed, S2 open		0.4	1.5	μs
Transmitter Disable Time from High	t_{DHZ}	Fig.4 and Fig.6, $C_L=15pF$ S2 closed, S1 open		0.6	1.5	μs
Receiver Input to Output Propagation Delay	t_{RPLH}	Fig.7 and Fig.9, $ V_{ID} =2.0V$ $C_L = 15pF$		0.6	1.2	μs
	t_{RPHL}			0.7	1.2	
Different Receiver Skew $ t_{DPLH} - t_{DPLH} $	t_{RSKEW}	Fig.7 and Fig.9, $ V_{ID} =2.0V$		0.1		μs
Data Rate	f_{MAX}	Fig.9, $C_L = 100pF$	64			kbps
Receiver Enable Time to Output Low	t_{RZL}	Fig.2 and Fig.8, $C_L=15pF$ S1 closed, S2 open		70	500	μs
Receiver Enable Time to Output High	t_{RZH}	Fig.2 and Fig.8, $C_L=15pF$ S2 closed, S1 open		85	500	ns
Receiver Disable Time from Low	t_{RLZ}	Fig.2 and Fig.8, $C_L=15pF$ S1 closed, S2 open		50	200	ns
Receiver Disable Time from High	t_{RHZ}	Fig.2 and Fig.8, $C_L=15pF$ S2 closed, S1 open		35	200	ns

Note 1: All currents into the device are positive; all currents out of the device are negative. All voltages are referred to device ground unless otherwise noted.

Note 2: ΔV_{OD} and ΔV_{OC} are the changes in magnitude of V_{OD} and V_{OC} , respectively, when the DI input changes state.

Note 3: Maximum and minimum current levels apply to peak current just prior to foldback-current limiting

6 TEST CIRCUITS AND WAVEFORMS

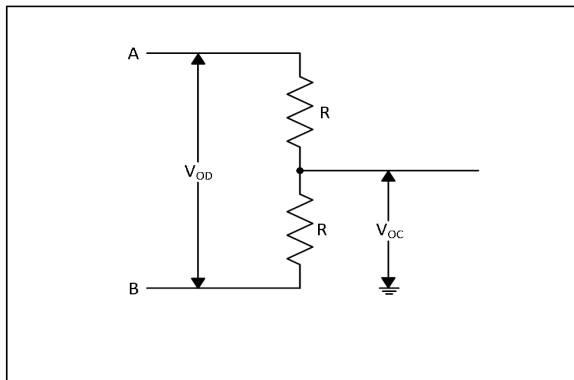


Figure 1. Driver DC Test Load

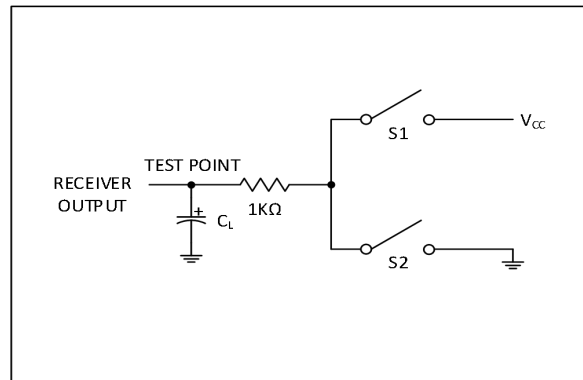


Figure2. Receiver Enable/Disable Timing Test Load

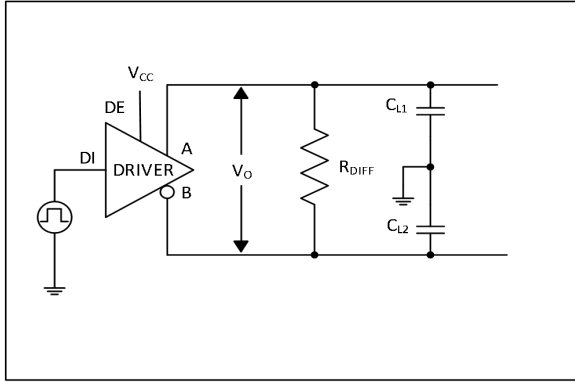


Figure 3. Transmitter Timing Test Load

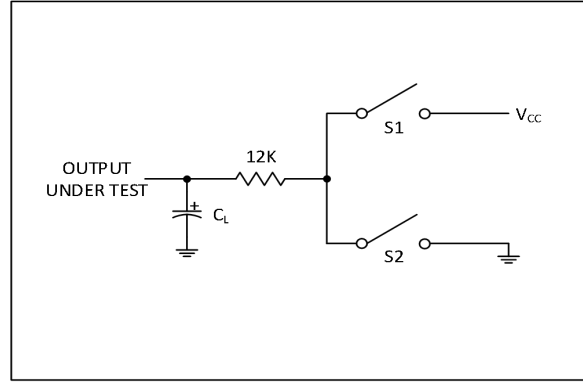


Figure 4. Transmitter Enable/Disable Timing Test Load

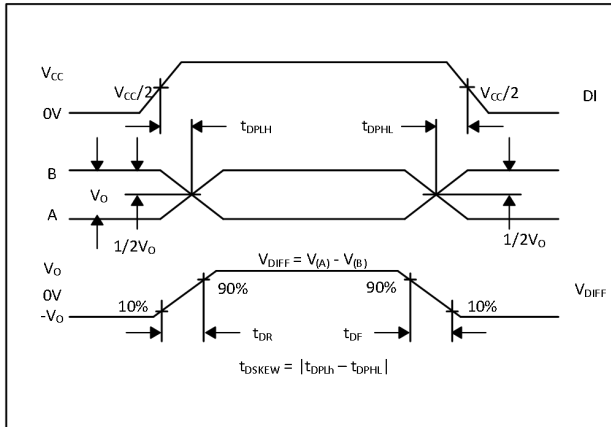


Figure 5. Transmitter Propagation Delays

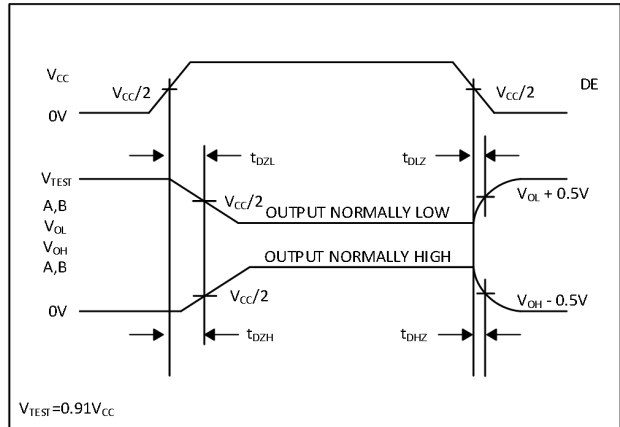


Figure 6. Transmitter Enable and Disable Time

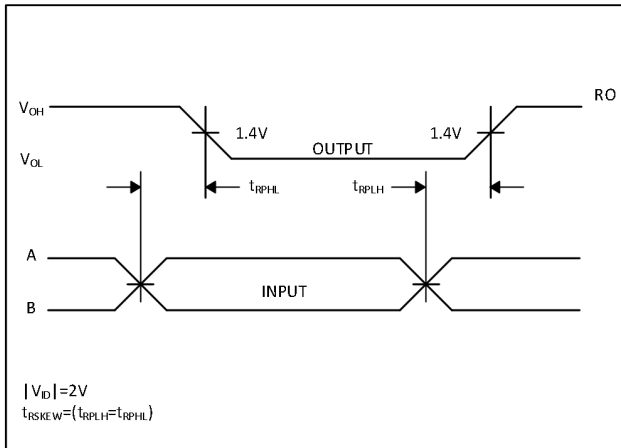


Figure 7. Receiver Propagation Delays

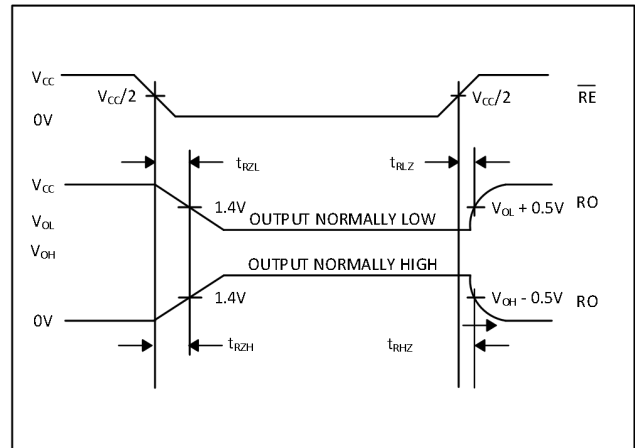


Figure 8. Receiver Enable and Disable Time

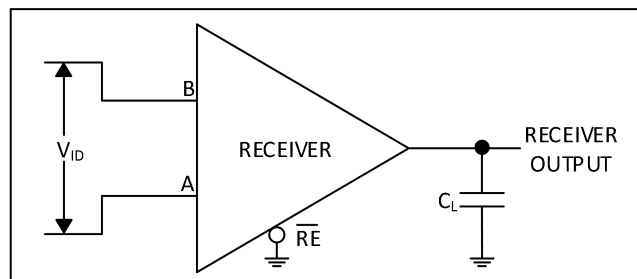


Figure 9. Receiver Propagation Delay and Maximum Data Rate Test Circuit

7 DETAILED DESCRIPTION

The GM3471E half-duplex transceiver consumes only 1.6μA from a single +3.6V supply. Its wide 2.5V to 5.5V supply voltage guarantees operation over the lifetime of a lithium battery. This device contains one driver and one receiver. Its true fail-safe receiver input guarantees a logic-high receiver output when the receiver inputs are open or shorted, or when they are connected to a terminated transmission line with all drivers disabled. Reduced-slew-rate drivers minimize EMI and reduce reflections caused by improperly terminated cables, allowing error-free data transmission up to 64kbps.

RECEIVER INPUT FILTERING

The GM3471E receiver operates at up to 64kbps and incorporates input filtering in addition to input hysteresis. This filtering enhances noise immunity when differential signals have very slow rise and fall times. The GM3471E guarantees a logic-high receiver output when the receiver inputs are shorted or open, or when they are connected to a terminated transmission line with all drivers disabled. This is accomplished by setting the receiver threshold between -50mV and -200mV. If the differential receiver input voltage (A-B) is greater than or equal to -50mV, RO is a logic high. If A-B is less than or equal to -200mV, RO is a logic low. In the case of a terminated bus with all transmitters disabled, the receiver's differential input voltage is pulled to 0V by the termination. With the GM3471E's receiver thresholds, this results in a logic high with a 50mV minimum noise margin.

TRANSCEIVERS ON THE BUS

The GM3471E is optimized for the unterminated bus normally used in slow, low-power systems. With a +2.5V supply, the part is guaranteed to drive up to eight standard loads. Drive capability increases significantly with supply. For example, with a +5V supply, the GM3471E typically meets the RS-485 driver output specifications (1.8V with 54Ω differential termination). See the Typical Operating Characteristics.

REDUCED EMI AND REFLECTIONS

The GM3471E is slew-rate limited, minimizing EMI and reducing reflections caused by improperly terminated cables. In general, the rise time of a transmitter directly relates to the length of an unterminated stub, which can be driven with only minor waveform reflections. The following equation expresses this relationship conservatively:

$$\text{Length} = t_{\text{RISE}} / (10 \times 1.5\text{ns/foot})$$

where t_{RISE} is the transmitter's rise time.

For example, the GM3471E's rise time is typically 1.3μs, which results in excellent waveforms with a stub length up to 82 feet. In general, systems operate well with longer unterminated stubs, even with severe reflections, if the waveform settles out before the UART samples them.

DRIVER OUTPUT PROTECTION

The output stage uses a foldback current limiting method to prevent excessive output current and high power consumption caused by faults or bus conflicts. The foldback current limiting at the output stage can provide fast short-circuit protection across the entire common-mode voltage range (refer to typical operating characteristics).

8 FUNCTION TABLES

Transmitting				
INPUTS			OUTPUTS	
$\overline{\text{RE}}$	DE	DI	A	B
X	1	1	1	0
X	1	0	0	1
0	0	X	Z_D	Z_D
1	0	X	Z_D	Z_D

Receiving

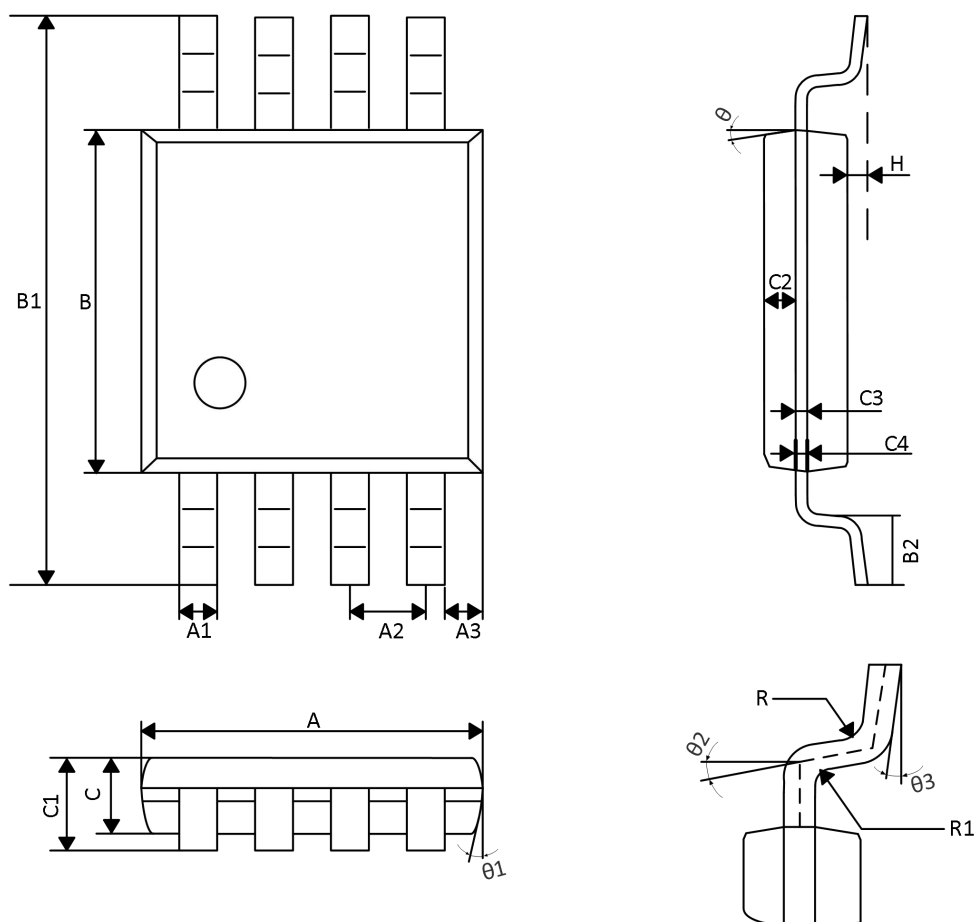
INPUTS			OUTPUTS
$\overline{\text{RE}}$	DE	A - B	RO
0	0	$\geq -0.05\text{V}$	1
0	0	$\leq -0.20\text{V}$	0
0	0	Open/Shorted	1
1	0	X	Z

(1) Z_O = Driver output disabled

(2) X = Don't care

(3) Z = Receiver output high impedance

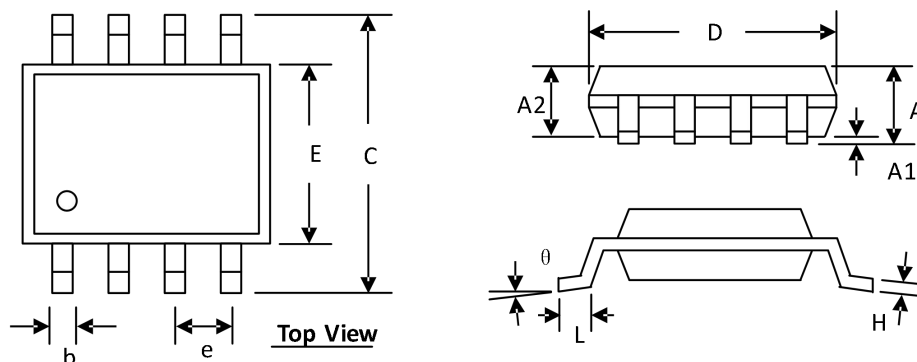
PACKAGE DIMENSION
MSOP8



DIMENSION SYMBOLS	MIN (mm)	MAX (mm)	DIMENSION SYMBOLS	MIN (mm)	MAX (mm)
A	2.90	3.10	C3	0.152	
A1	0.28	0.35	C4	0.15	0.23
A2	0.65TYP		H	0.00	0.09
A3	0.375TYP		θ	12° TYP4	
B	2.90	3.10	θ1	12° TYP4	
B1	4.70	5.10	θ2	14° TYP	
B2	0.45	0.75	θ3	0° ~ 6°	
C	0.75	0.95	R	0.15TYP	
C1	--	1.10	R1	0.15TYP	
C2	0.328TYP				

PACKAGE DIMENSION

SOP8



SYMBOLS	DIMENSION (MM)		DIMENSION (INCH)	
	MIN	MAX	MIN	MAX
A	1.300	1.752	0.051	0.069
A1	0.000	0.203	0.000	0.008
A2	1.350	1.550	0.053	0.061
b	0.330	0.510	0.013	0.020
C	5.790	6.200	0.228	0.244
D	4.700	5.110	0.185	0.201
E	3.800	4.000	0.150	0.157
e	1.270 BSC		0.050 BSC	
H	0.170	0.254	0.007	0.010
L	0.400	1.270	0.016	0.050
θ	0°	8°	0°	8°

Order Information

Order number	Package	Marking information	Operation Temperature Range	MSL Grade	Ship, Quantity	Green
GM3471EMA	MSOP8	GM3471E	-40 to 85°C	3	T&R, 2500	Rohs
GM3471ESA	SOP8	GM3471E	-40 to 85°C	3	T&R, 2500	Rohs