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
- 1/8-Unit-Load Receiver Input
- -7V to +10V Common-Mode Input Voltage Range

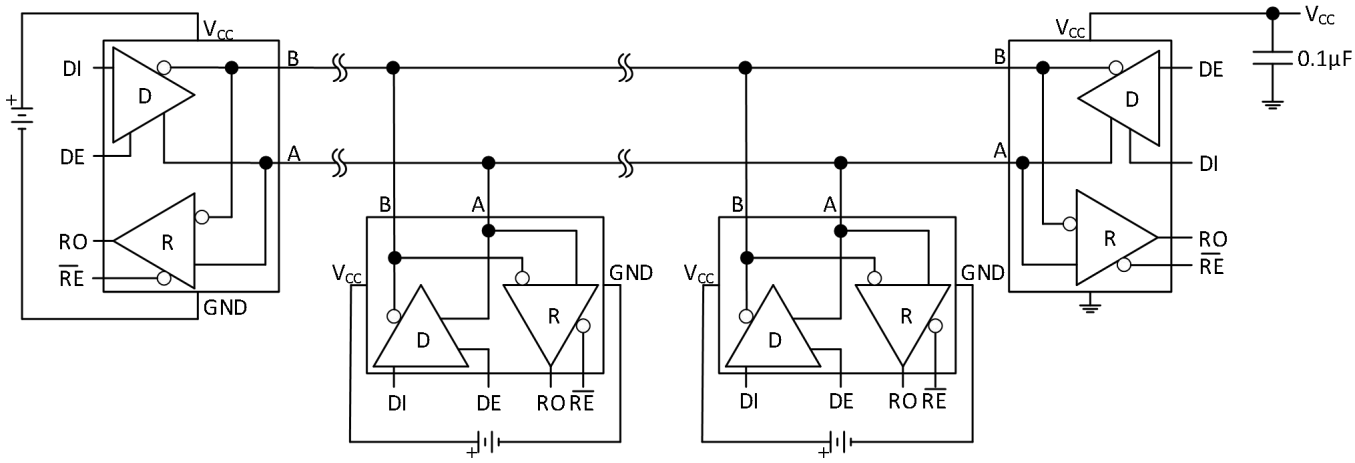
2 APPLICATIONS

- 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 8-pin MSOP package.

TYPICAL APPLICATION CIRCUIT



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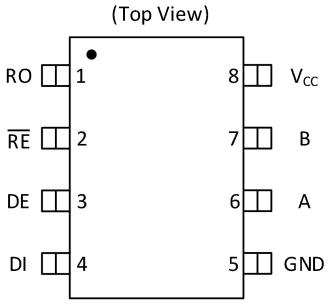
Email: sales@gmmicro.com

4 PIN CONFIGURATION AND FUNCTIONS



Pin		Description
Name	No.	
RO	1	Receiver Output. When $\overline{RE}$ is low and if (A-B)≥-50mV, RO is high; if (A-B)≤-200mV, 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:2.5V≤V_{CC}≤5.5V

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°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=GND 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=GND or V_{CC},V_A=V_B=0	DE = V_{CC}		110	130	μA
			DE = GND		1.8	2.2	

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Email: sales@gmmicro.com

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°C.)

Parameter	Symbol	Conditions	MIN	TYP	MAX	UNITS
Transmitter Input to Output Propagation Delay	t_{DPLH} ,t_{DPHL}	Fig.3 and Fig.5,R_{DIFF}=1.5KΩ C_{L1}=C_{L2}=100pF		1.40	2.00	μs
Transmitter Output Skew $\lvert t_{DPLH} - t_{DPHL} \rvert$	t_{DSKEW}	Fig.3 and Fig.5,R_{DIFF}=1.5KΩ C_{L1}=C_{L2}=100pF		0.025		μs
Transmitter Rise or Fall Time	t_{DR} , t_{DF}	Fig.3 and Fig.5,R_{DIFF}=1.5KΩ 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,$\lvert V_{ID} \rvert$=2.0V C_L = 15pF		0.6	1.2	μs
	t_{RPHL}			0.7	1.2	
Different Receiver Skew $\lvert t_{DPLH} - t_{DPHL} \rvert$	t_{RSKEW}	Fig.7 and Fig.9,$\lvert V_{ID} \rvert$=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

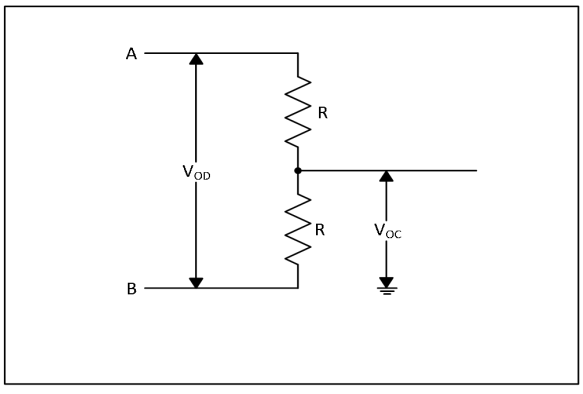

Figure 1. Driver DC Test Load

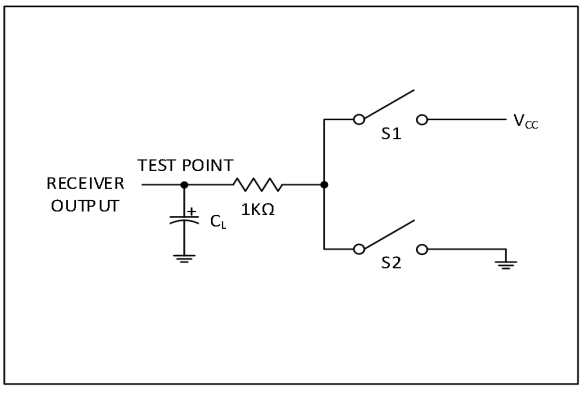

Figure2. Receiver Enable/Disable Timing Test Load

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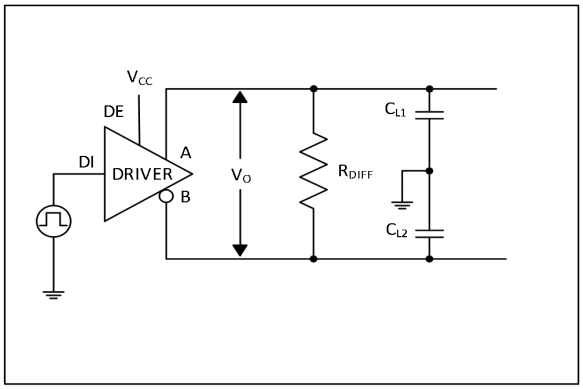

Figure 3. Transmitter Timing Test Load

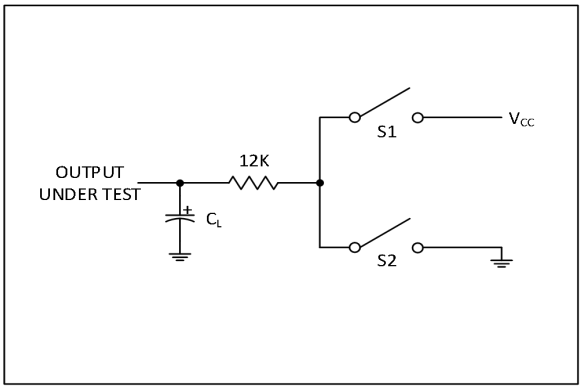

Figure 4. Transmitter Enable/Disable Timing Test Load

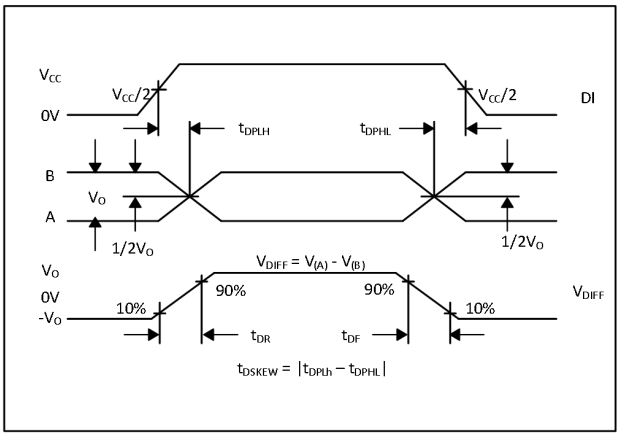

Figure 5. Transmitter Propagation Delays

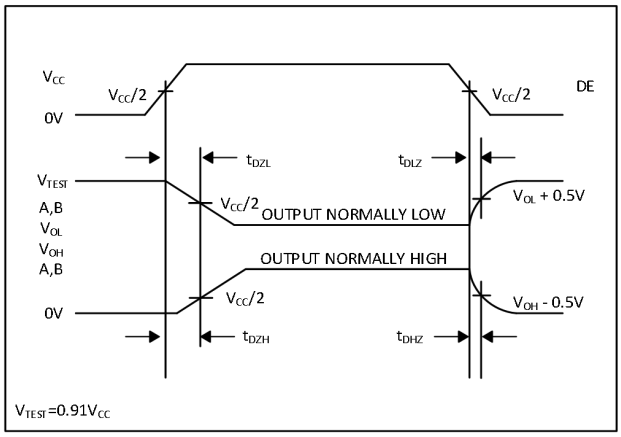

Figure 6. Transmitter Enable and Disable Time

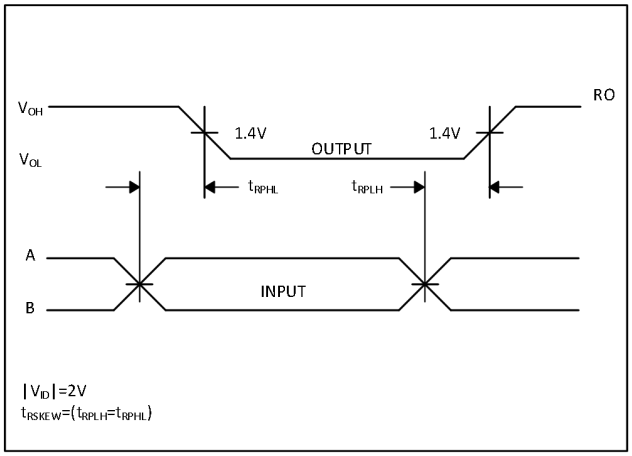

Figure 7. Receiver Propagation Delays

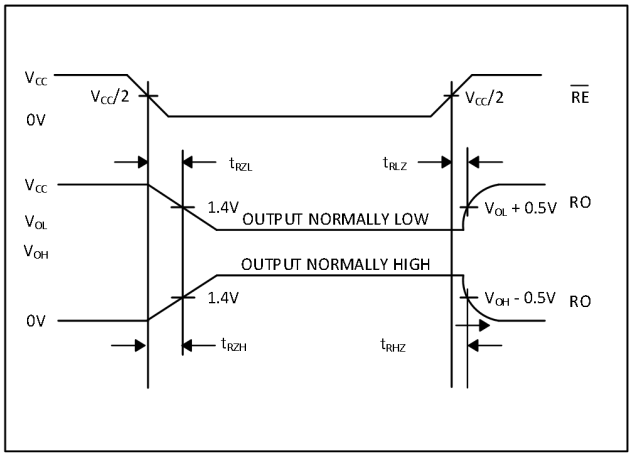

Figure 8. Receiver Enable and Disable Time

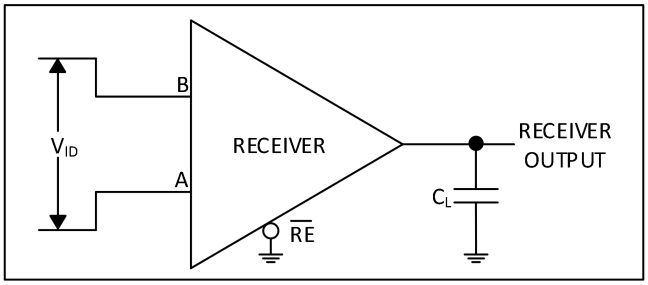

Figure 9. Receiver Propagation Delay and Maximum Data Rate Test Circuit

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 set ting 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 fol lowing equation expresses this relationship conservatively:

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

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	
$\overline{RE}$	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

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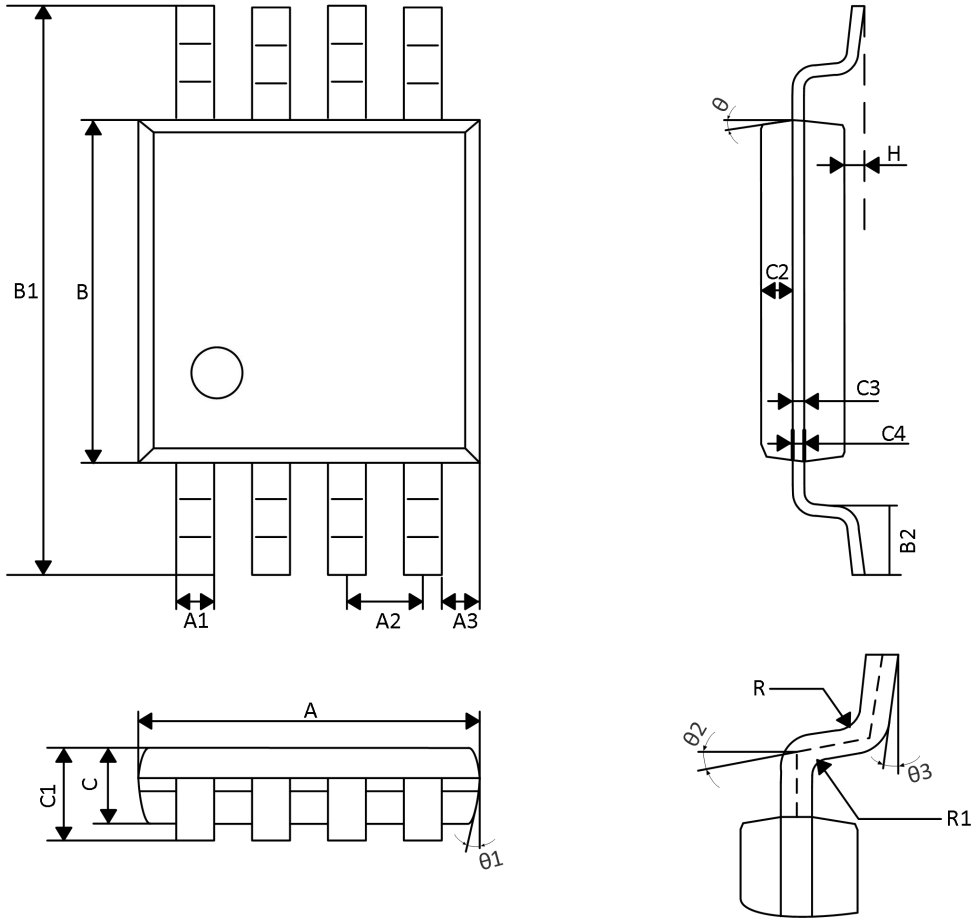
Email: sales@gmmicro.com

Receiving

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

(1) Z_D = 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				

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