1 FEATURES

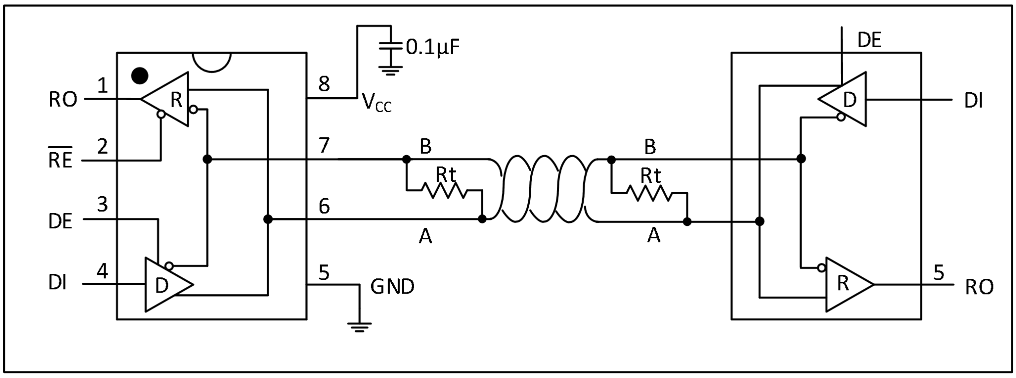
- 3.0~5.5V Operation
- Extended ESD Protection for RS-485/RS-422 I/O Pins ±15kV Human Body Model
- True Fail-Safe Receiver While Maintaining EIA/TIA-485 Compatibility
- Guaranteed 16Mbps Data Rate
- Hot-Swap Input Structures on DE and $\overline{RE}$ (GM13088E)
- Low-Current Shutdown Mode
- Allow Up to 256 Transceivers on the Bus
- Available in Industry-Standard SOP8/MSOP8/DFN Packages

2 APPLICATIONS

- Utility Meters
- Lighting Systems
- Industrial Control
- Telecom
- Security System
- Instrumentation
- Profibus

3 GENERAL DESCRIPTION

The GM3088E/GM13088E are 3.0~5.5V,+15kV ESD-protected, RS-485/RS-422 transceiver features one driver and one receiver.The device includes fail-safe circuitry, guaranteeing a logic-high receiver output when receiver inputs are open or shorted. The receiver outputs a logic-high if all transmitters on a terminated bus are disabled (high impedance). The GM13088E includes a hot-swap capability to eliminate false transitions on the bus during power-up or hot insertion.The GM3088E/GM13088E transmit at up to 16Mbps.The GM3088E/GM13088E is ideal for half-duplex communications and it draws 0.5mA of supply current when unloaded or when fully loaded with the drivers disabled. The GM3088E/GM13088E has a 1/8-unit load receiver input impedance, allowing up to 256 transceivers on the bus.The GM3088E/GM13088E is available in SOP8/MSOP8/DFN packages.



TYPICAL HALF-DUPLES OPERATING CIRCUIT

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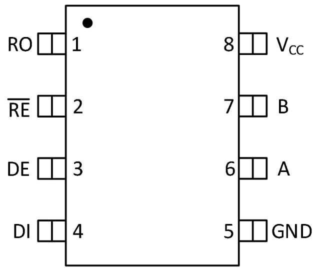
4 PIN CONFIGURATION AND FUNCTIONS

GM3088E/GM13088E
SOP8/MSOP8/DFN8
(Top View)



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;Drive $\overline{RE}$ high and DE low to enter low-power shutdown mode. $\overline{RE}$ is a Hot-swap input(see the Hot-Swap Capability section for details).
DE	3	Driver Output Enable.Drive DE high to enable driver outputs;These outputs are high-impedance when DE is low;Drive $\overline{RE}$ high and DE low to enter low-power shutdown mode.DE is a hot-swap input(see the Hot-Swap Capability section for details).
DI	4	Driver Input. With DE high, a low on DI forces noninverting output low and inverting output high. Similarly, a high on DI forces noninverting output high and inverting output low.
GND	5	Ground
A	6	Noninverting Receiver Input and Noninverting Driver Output
B	7	Inverting Receiver Input and Inverting Driver Output
V_{CC}	8	Positive Supply Vcc =3.0~5.5V.Bypass Vcc to GND with a 0.1μF capacitor.

5 ABSOLUTE MAXIMUM RATINGS

Parameter	Parameter	Rating	UNIT
V_{CC}	Supply Voltage	+6	V
/RE,DE	Control Input Voltage	-0.3 to +6	V
DI	Driver Input voltage	-0.3 to +6	V
A,B	Receiver Input Voltage	-8V to ±13	V
A,B	Driver Output Voltage	-8V to ±13	V
RO	Receiver Output Voltage	-0.3 to (V_{CC}+0.3)	V
P	SO(derate 5.9mW/°C above +70℃)	471	mW
T_{OP}	Operating Temperature Range	-40 to +85	℃
T_J	Junction Temperature	+150	℃
T_{STO}	Storage Temperature Range	-65 to +150	℃
T_L	Lead Temperature(soldering,10s)	+300	℃

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 in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

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6 DC ELECTRICAL CHARACTERISTICS

(V_{CC} = 5V ±5%, T_A = T_{MIN} to T_{MAX}.Typical values are at V_{CC}=+5V,T_A=25℃, unless otherwise noted.) (1)

Parameter	Symbol	Test Conditions	MIN	TYP	MAX	UNIT
Driver						
Supply voltage	V_{CC}		3.0		5.5	V
Differential Driver Output(No load)	V_{OD1}	No load			V_{CC}	V
Differential Driver Output	V_{OD2}	RL=100Ω(RS-422),Figure 1	3		V_{CC}	V
		RL=54Ω(RS-485),Figure 1	2		V_{CC}	V
Change in Magnitude of Differential Output Voltage(2)	ΔV_{OD}	RL=100Ω or RL=54Ω,Figure 1			0.2	V
Driver Common- Mode Output Voltage	V_{OC}	RL=100Ω or RL=54Ω,Figure 1		$V_{CC}/2$	3	V
Change in Magnitude of Common- Mode Voltage(2)	ΔV_{OC}	RL=100Ω or RL=54Ω,Figure 1			0.2	V
Input-High Voltage	V_{IH1}	DE,DI,/RE	2			V
Input-Low Voltage	V_{IL1}	DE,DI,/RE			0.8	V
Input Hysteresis	V_{HYS}	DE,DI,/RE		300		mV
Input Current	I_{IN1}	DE,DI,/RE,V_{CC} floating			±2	μA
Input Impedance on First Transition at Power-Up	R_{PWUP}	V_{DE}, V_{RE} = V_{RE} = 2V	3.65		8.8	kΩ
Input Impedance on First Transition after POR Delay	R_{ft}	V_{DE} = V_{RE} = 2V	7		60	kΩ
Driver Short-Circuit Output Current	I_{OSD}	$0 \le V_{OUT} \le +12V$(3)	40		250	mA
		$-7V \le V_{OUT} \le V_{CC}$(3)	-250		-40	
Driver Short-Circuit Foldback Output Current	I_{OSDF}	$(V_{CC}-1V) \le V_{OUT} \le +12V$(3)	20			mA
		$-7V \le V_{OUT} \le \pm 1V$(3)			-20	
Thermal-Shutdown Threshold	T_{TS}			175		℃
Thermal-Shutdown Hysteresis	T_{TSH}			15		℃
Input Current for A and B	$I_{A,B}$	DE=GND,V_{CC}=GND or V_{CC}; V_{IN}=+12V			100	μA
		DE=GND,V_{CC}=GND or V_{CC}; V_{IN}=-7V	-100			
Receiver						
Receiver Differential Threshold Voltage	V_{TH}	$-7V \le V_{CM} \le 12V$	-200	-125	-50	mV
Receiver Input Hysteresis	ΔV_{TH}	V_A+V_B=0V		15		mV
Receiver Output-High Voltage	V_{OH}	I_O= -1mA	V_{CC}-0.6		V_{CC}	V
Receiver Output-Low Voltage	V_{OL}	I_O= 1mA			0.4	V
Three-State Output Current at Receiver	I_{OZR}	$0V \le V_O \le V_{CC}$			≤1	μA
Receiver Input Resistance	R_{IN}	$-7V \le V_{CM} \le 12V$	96			kΩ
Receiver Output Short-Circuit Current	I_{OSR}	$0V \le V_{RO} \le V_{CC}$			≤110	mV
Supply Current						
Supply current	I_{CC}	No load, /RE=GND DE=V_{CC}		0.5	0.7	mA
		No load, /RE=V_{CC}, DE=V_{CC}		0.5	0.7	
		No load, /RE=GND DE=GND		0.5	0.7	
Supply Current in Shutdown Mode	I_{SHDN}	/RE=GND DE=GND		2.0	10	μA
ESD Protection						
ESD Protection (A, B)	ESD	Human Body Mode		±15		kV
		Contact Discharge IEC 61000-4-2		±8		kV
		Air-Gap Discharge IEC 61000-4-2		±15		

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7 DRIVER SWITCHING CHARACTERISTICS

（V_{CC}=+5V±10%,T_A=T_{MIN}~T_{MAX},Typical values are at V_{CC}=+5V and T_A＝25℃;unless otherwise noted.(1)

Parameter	Symbol	Conditions	MIN	TYP	MAX	UNITS
Driver Propagation Delay	t_{DPLH}	R_L=54Ω,C_L=50pF,Figure 2 and Figure 3	1	22	35	ns
	t_{DPHL}		1	22	35	
Driver Output Skew $\|t_{DPLH} - t_{DPHL}\|$	t_{DHKEW}	R_L=54Ω,C_L=50pF,Figure 2 and Figure 3		-3	±10	ns
Driver Differential Output Rise or Fall Time	t_R , t_F	R_L=54Ω,C_L=50pF,Figure 2 and Figure 3	3	12	25	ns
Maximum Data Rate	F_{MAX}		12			Mbps
Driver Enable to Output High	t_{DZH}	Figure 4			150	ns
Driver Enable to Output Low	t_{DZL}	Figure 5			150	ns
Driver Disable Time from Low	t_{DLZ}	Figure 5			100	ns
Driver Disable Time from High	t_{DHZ}	Figure 4			100	ns
Driver Enable from Shutdown to Output High	$T_{DZH(SHDN)}$	Figure 4		650	900	ns
Driver Enable from Shutdown to Output Low	$t_{DZH(SHDN)}$	Figure 5		650	900	ns
Time to Shutdown	t_{SHDN}		50	340	700	ns

8 RECEIVER SWITCHING CHARACTERISTICS

（V_{CC}=+5V±10%,T_A=T_{MIN}~T_{MAX},Typical values are at V_{CC}=+5V and T_A＝25℃;unless otherwise noted.(1)

Parameter	Symbol	Conditions	MIN	TYP	MAX	UNITS
Receiver Propagation Delay	t_{RPLH}	C_L=15pF,Figure 6 and Figure 7		50		ns
	t_{RPHL}			50		
Receiver Output Skew $\|t_{DPLH} - t_{DPHL}\|$	t_{RSKEW}	C_L=15pF,Figure 6 and Figure 7		0	±10	ns
Maximum Data Rate	F_{MAX}		12			Mbps
Receiver Enable to Output Low	t_{RZL}	Figure 8		20	50	ns
Receiver Enable to Output High	t_{RZH}	Figure 8		20	50	ns
Receiver Disable Time from Low	t_{RLZ}	Figure 8		20	50	ns
Receiver Disable Time from High	t_{RHZ}	Figure 8		20	50	ns
Receiver Enable from Shutdown to Output High	$t_{RZH(SHDN)}$	Figure 8			3500	ns
Receiver Enable from Shutdown to Output Low	$t_{RZL(SHDN)}$	Figure 8			3500	ns
Time to Shutdown	t_{SHDN}		50	340	700	ns

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.
2.ΔV_{OD} and ΔV_{OC} are the changes in V_{OD} and V_{OC}, respectively, when the DI input changes state.
3.The short-circuit output current applies to peak current just prior to foldback current limiting. The short-circuit foldback output current applies during current limiting to allow a recovery from bus contention.

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9 TEST CIRCUITS AND WAVEFORMS

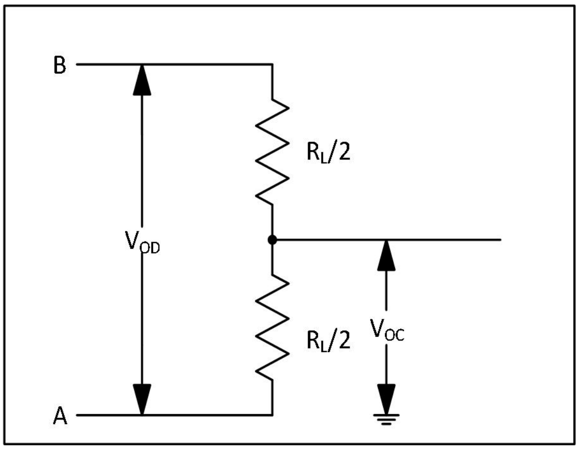

Figure 1. Driver DC Test Load

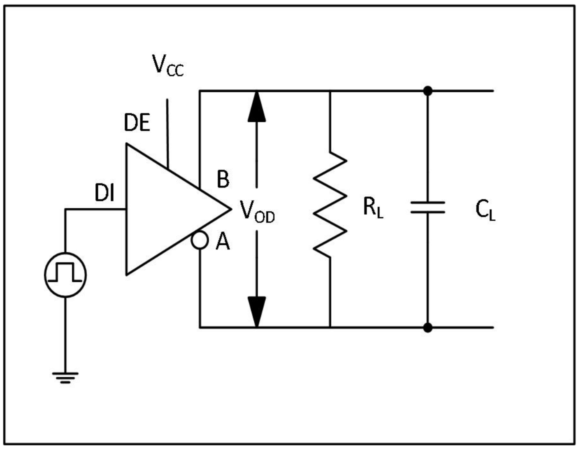

Figure 2.Driver timing test load

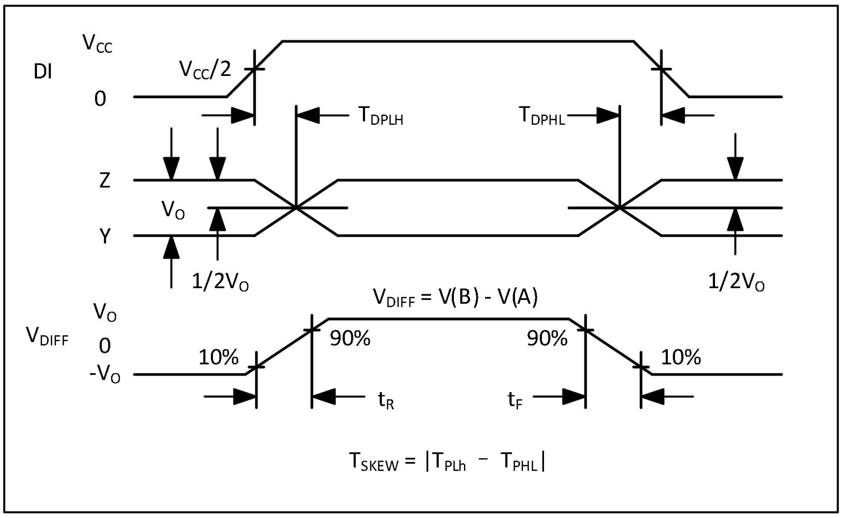

Figure 3.Driver Propagation Delays

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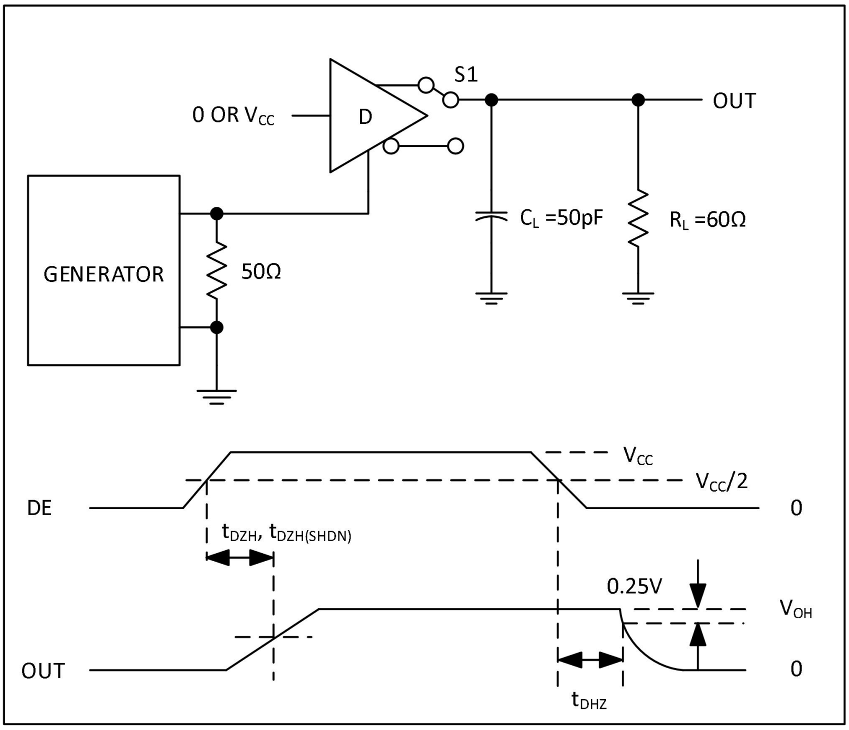

Figure 4. Driver Enable and Disable Times (t_{DHZ}, t_{DZH}, $t_{DZH(SHDN)}$)

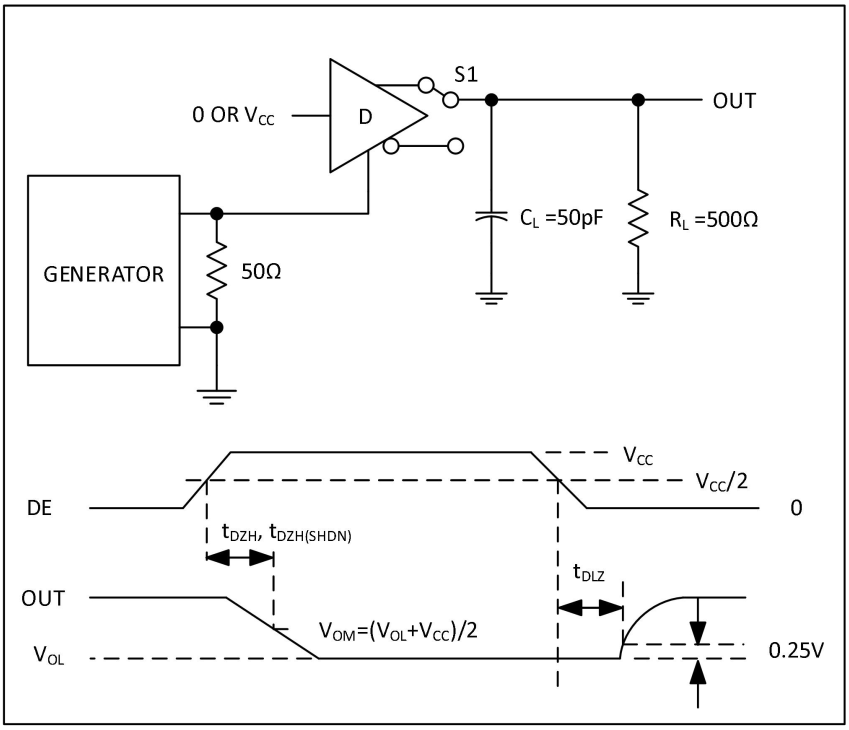

Figure 5. Driver Enable and Disable Times (t_{DZL}, t_{DLZ}, $t_{DLZ(SHDN)}$)

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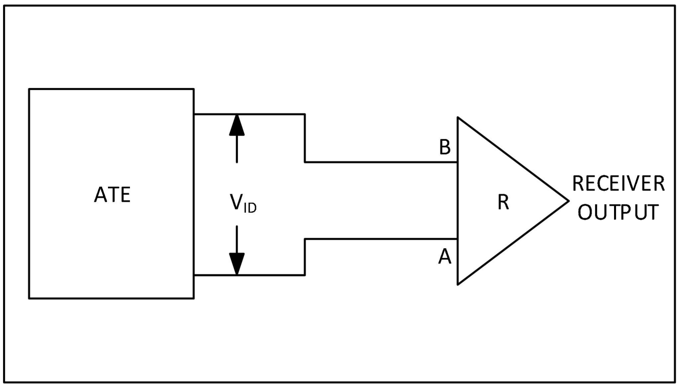


Figure 6. Receiver Propagation Delay Test Circuit

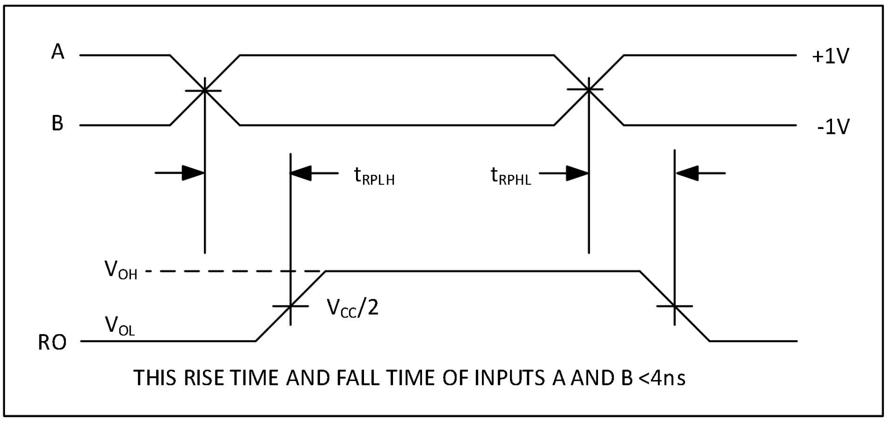
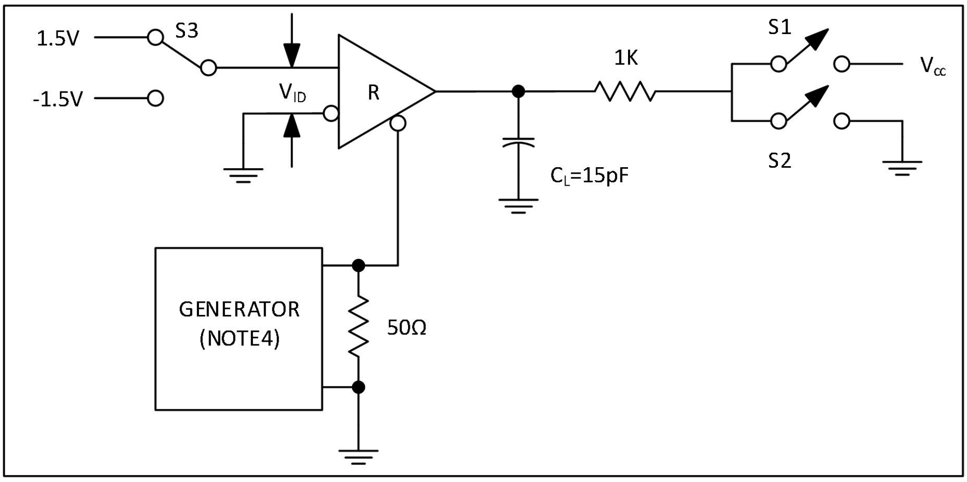


Figure 7. Receiver Propagation Delays



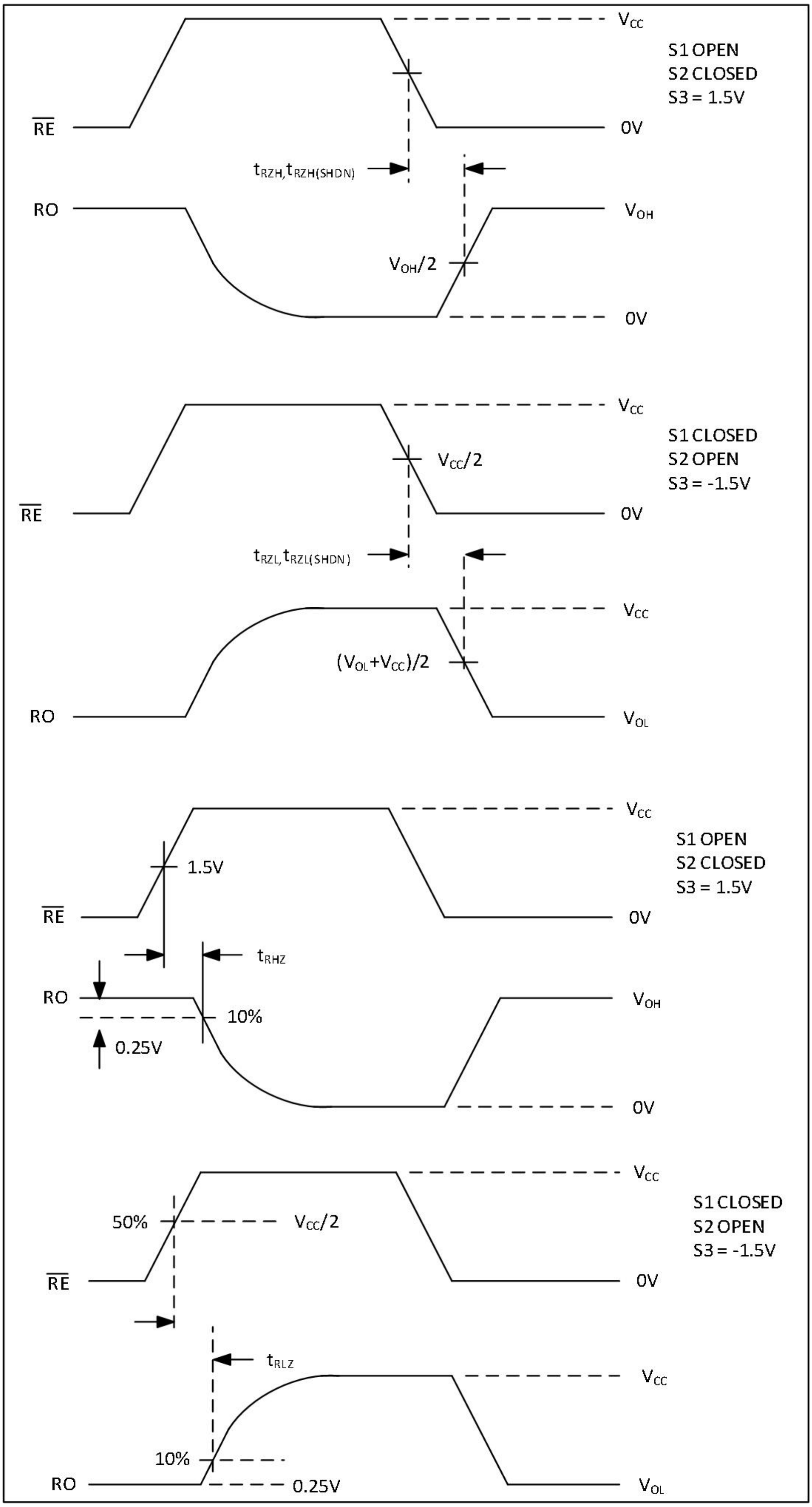
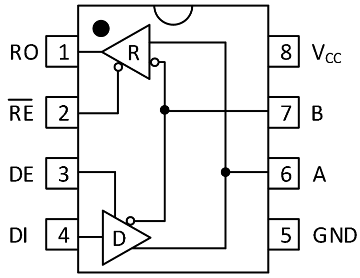


Figure 8. Receiver Enable and Disable Times

10 FUNCTION TABLES



SO

TRANSMITTING				
INPUTS			OUTPUTS	
DI	DE	RE	A	B
1	1	X	1	0
0	1	X	0	1
X	0	0	Z	Z
X	0	1	Shutdown	
RECEIVING				
INPUTS			OUTPUTS	
/RE	DE	A - B	RO	
0	X	≥ -50mV	1	
0	X	≤ -200mV	0	
0	X	Open/Shorted	1	
1	1	X	Z	
1	0	X	Shutdown	

11 DETAILED DESCRIPTION

The GM3088E/GM13088E high-speed transceiver for RS-485/RS-422 communication contains one driver and one receiver. This device features fail-safe circuitry, which 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 (see the Fail-Safe section). The GM13088E also features a hot-swap capability allowing line insertion without erroneous data transfer (see the Hot-Swap Capability section). The GM3088E/GM13088E transmit at up to 16Mbps.The GM3088E/GM13088E is a half-duplex transceiver and operates from a single +3.0~5.5V supply. Drivers are output short-circuit current limited. Thermal-shutdown circuitry protects drivers against excessive power dissipation. When activated, the thermal-shutdown circuitry places the driver outputs into a high-impedance state.

Fail-Safe

The GM3088E/GM13088E 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 done by setting the receiver input threshold between -50mV and -200mV. If the differential receiver input voltage (A - B) is greater than or equal to -50mV, RO is logic-high. If (A - B) is less than or equal to -200mV, RO is 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 receiver threshold of the GM3088E/GM13088E, this results in a logic-high with a 50mV minimum noise margin. Unlike previous fail-safe devices, the -50mV to -200mV threshold complies with the ±200mV EIA/TIA-485 standard.

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Hot-Swap Capability (GM13088E)

Hot-Swap Inputs

When circuit boards are inserted into a hot or powered backplane, differential disturbances to the data bus can lead to data errors. Upon initial circuit board insertion, the data communication processor undergoes its own power-up sequence. During this period, the processor's logic-output drivers are high impedance and are unable to drive the DE and RE inputs of these devices to a defined logic level. Leakage currents up to ±10µA from the high-impedance state of the processors logic drivers could cause standard CMOS enable inputs of a transceiver to drift to an incorrect logic level.Additionally, parasitic circuit board capacitance could cause coupling of V_{CC} or GND to the enable inputs. Without the hot-swap capability, these factors could improperly enable the transceiver's driver or receiver.When V_{CC} rises, an internal pulldown circuit holds DE low and RE high. After the initial power-up sequence, the pulldown circuit becomes transparent, resetting the hot-swap tolerable input.

Hot-Swap Input Circuitry

The enable inputs feature hot-swap capability. At the input there are two nMOS devices, M1 and M2 (Figure 9).

When V_{CC} ramps from zero, an internal 7µs timer turns on M2 and sets the SR latch, which also turns on M1. Transistors M2, a 500µA current sink, and M1, a 100µA current sink, pull DE to GND through a 5kΩ resistor. M2 is designed to pull DE to the disabled state against an external parasitic capacitance up to 100pF that can drive DE high. After 7µs, the timer deactivates M2 while M1 remains on, holding DE low against three-state leak ages that can drive DE high. M1 remains on until an external source overcomes the required input current. At this time, the SR latch resets and M1 turns off. When M1 turns off, DE reverts to a standard, high-impedance CMOS input. Whenever V_{CC} drops below 1V, the hot swap input is reset.For RE there is a complementary circuit employing two pMOS devices pulling RE to V_{CC}.

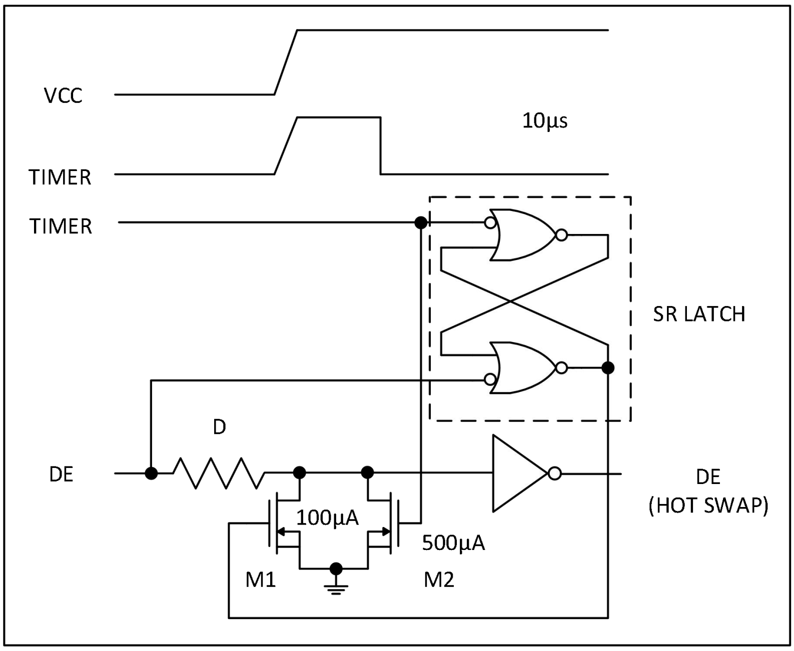

Figure 9. Simplified Structure of the Driver Enable Pin (DE)

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±15kV ESD Protection

The driver output and receiver input of the GM3088E/GM13088E have extra protection against static electricity.The ESD structures withstand high ESD in all states: normal operation, shutdown, and powered down. After an ESD event, the GM3088E/GM13088E keeps working without latchup or damage.ESD protection can be tested in various ways. The transmitter output and receiver input of the GM3088E/GM13088E are characterized for protection to the following limits:

- ±15kV using the Human Body Model
- ±8kV using the Contact Discharge method specified in IEC 61000-4-2
- ±15kV using the Air-Gap Discharge method specified in IEC 61000-4-2

ESD Test Conditions

ESD performance depends on a variety of conditions.

Human Body Model

Figure 10a shows the Human Body Model, and Figure 10b shows the current waveform it generates when discharged into a low impedance. This model consists of a 100pF capacitor charged to the ESD voltage of interest, which is then discharged into the test device through a 1.5kΩ resistor.

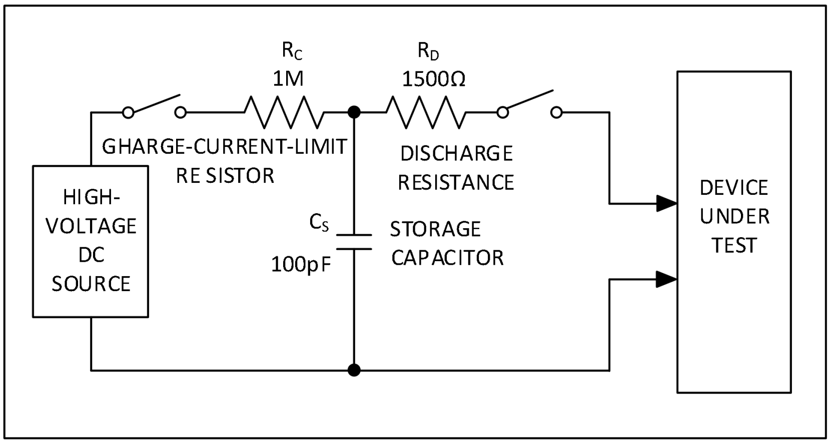

Figure 10a. Human Body ESD Test Model

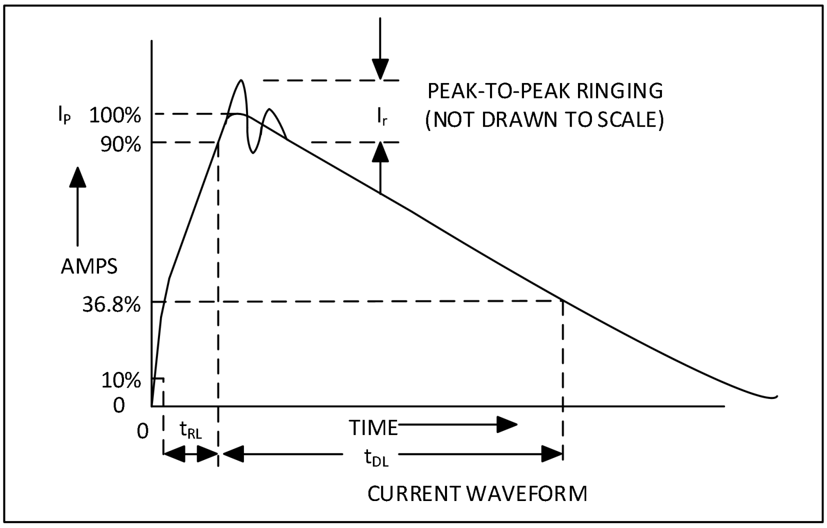

Figure 10b. Human Body Current Waveform

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IEC 61000-4-2

The IEC 61000-4-2 standard covers ESD testing and performance of finished equipment. However, it does not specifically refer to integrated circuits. The GM3088E/GM13088E helps you design equipment to meet IEC 61000-4-2, with out the need for additional ESD-protection components.The major difference between tests done using the Human Body Model and IEC 61000-4-2 is higher peak current in IEC 61000-4-2 because series resistance is lower in the IEC 61000-4-2 model. Hence, the ESD withstand voltage measured to IEC 61000-4-2 is generally lower than that measured using the Human Body Model. Figure 10c shows the IEC 61000-4-2 model, and Figure 10d shows the current waveform for IEC 61000-4-2 ESD Contact Discharge test.

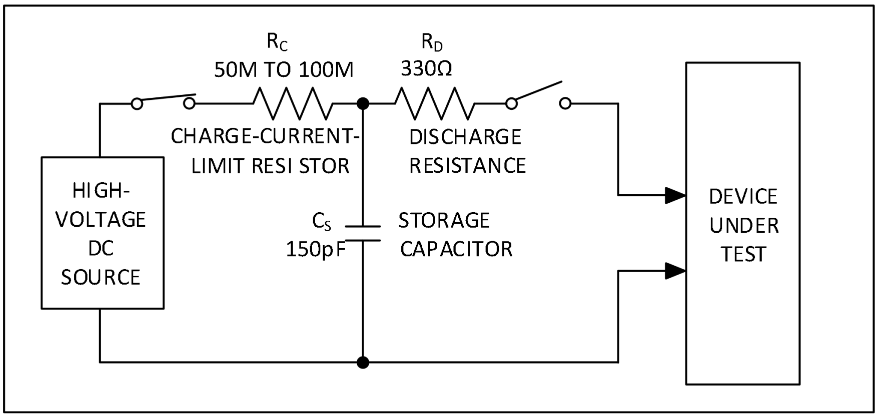

Figure 10c. IEC 61000-4-2 ESD Test Model

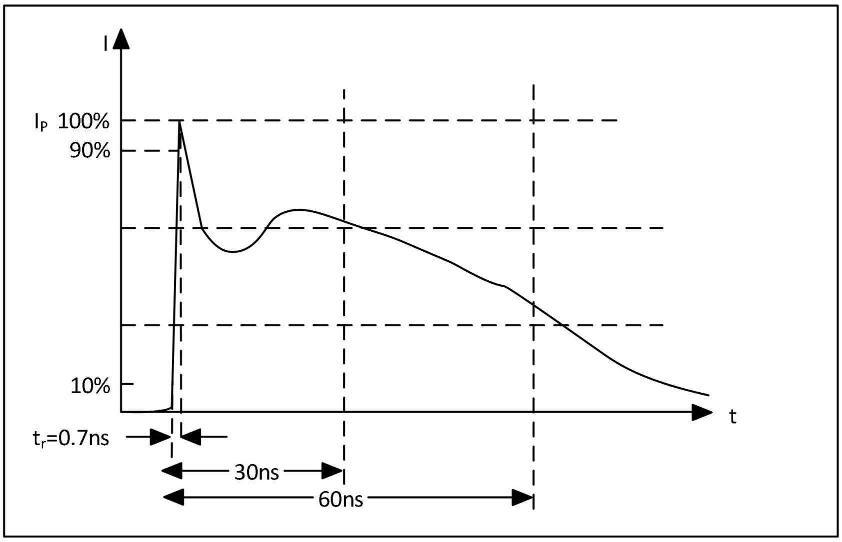

Figure 10d. IEC 61000-4-2 ESD Generator Current Waveform

Machine Model

The machine model for ESD tests all pins using a 200pF storage capacitor and zero discharge resistance. The objective is to emulate the stress caused when I/O pins are contacted by handling equipment during test and assembly. Of course, all pins require this protection, not just RS-485 inputs and outputs.

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12 APPLICATIONS INFORMATION

The standard RS-485 receiver input impedance is 12kΩ (1-unit load), and the standard driver can drive up to 32-unit loads. The GM3088E/GM13088E has a 1/8-unit load receiver input impedance (96kΩ), allowing up to 256 transceivers to be connected in parallel on one communication line. Any combination of the GM3088E/GM13088E, as well as other RS-485 transceivers with a total of 32-unit loads or fewer, can be connected to the line.

Low-Power Shutdown Mode

Low-power shutdown mode is initiated by bringing both RE high and DE low. In shutdown, the devices typically draw only 2.0µA of supply current.RE and DE can be driven simultaneously; the devices are guaranteed not to enter shutdown if RE is high and DE is low for less than 50ns. If the inputs are in this state for at least 700ns, the devices are guaranteed to enter shutdown.Enable times t_{ZH} and t_{ZL} (see the Switching Characteristics section) assume the devices were not in a low-power shutdown state. Enable times t_{ZH}(SHDN) and t_{ZL}(SHDN) assume the devices were in shutdown state. It takes drivers and receivers longer to become enabled from low-power shutdown mode (t_{ZH}(SHDN), t_{ZL}(SHDN)) than from driver/receiver-disable mode (t_{ZH}, t_{ZL}).

Driver Output Protection

Two mechanisms prevent excessive output current and power dissipation caused by faults or by bus contention. The first, a foldback current limit on the output stage, provides immediate protection against short circuits over the whole common-mode voltage range (see the Typical Operating Characteristics). The second, a thermal-shutdown circuit, forces the driver outputs into a high-impedance state if the die temperature exceeds +175°C (typ).

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13 TYPICAL APPLICATIONS

The GM3088E/GM13088E transceiver is designed for bidirectional data communications on multipoint bus transmission lines. Figure 11 shows a typical network applications circuit.To minimize reflections, terminate the line at both ends in its characteristic impedance, and keep stub lengths off the main line as short as possible.

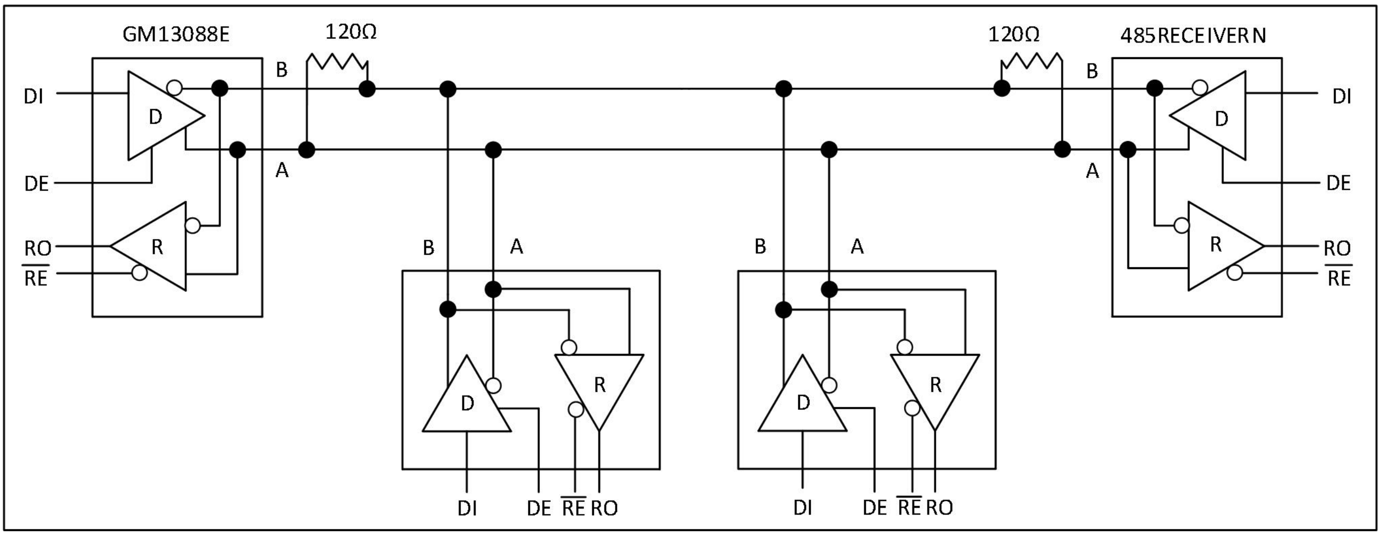

Figure 11. Typical Half-Duplex RS-485 Network

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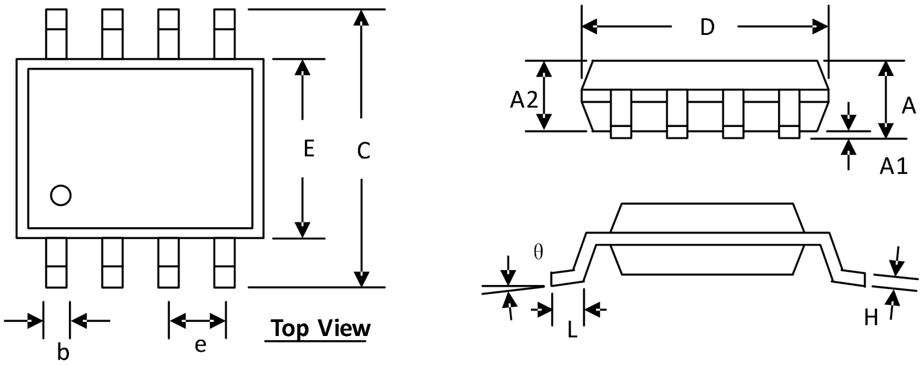
PACKAGE DIMENSION SOP8-L



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°

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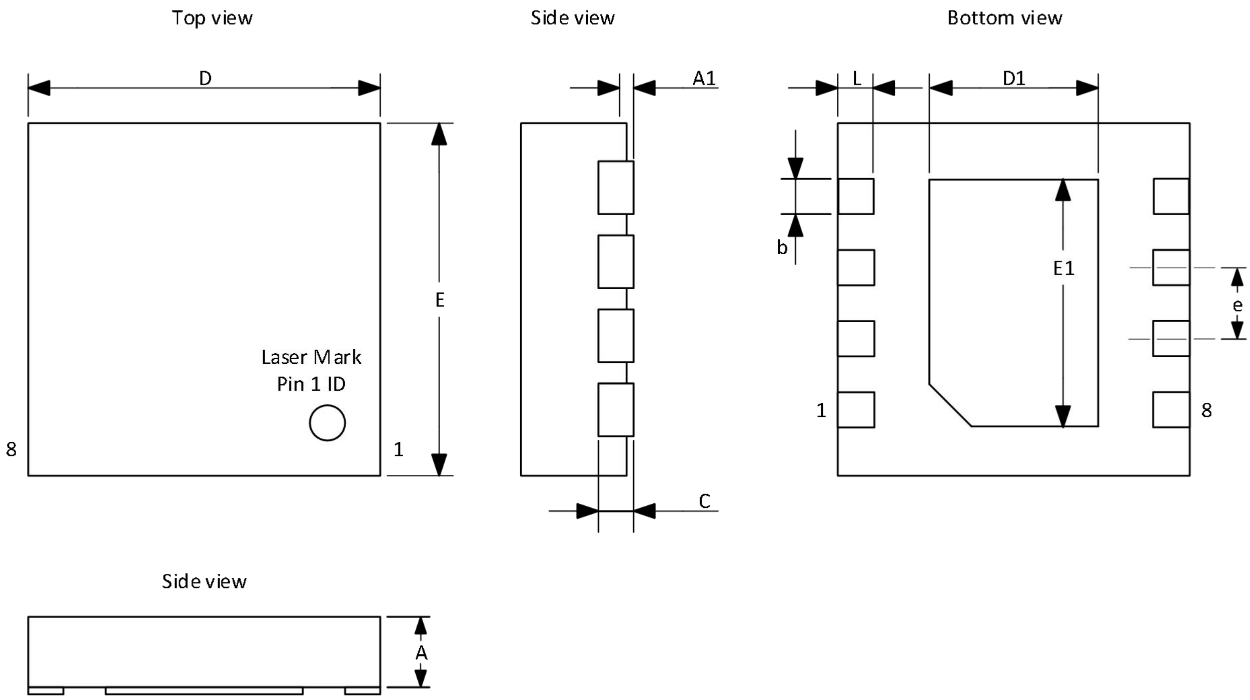
PACKAGE DIMENSION DFN-8-EP(3x3)



SYMBOLS	MIN	TYPICAL	MAX
A	0.70	0.75	0.80
A1	0.00	-	0.05
b	0.23	0.28	0.33
c	0.203REF		
D	2.925	3.00	3.075
D1	1.40	1.50	1.60
E	2.925	3.00	3.075
E1	2.20	2.30	2.40
e	0.650BSC		
L	0.25	0.30	0.35

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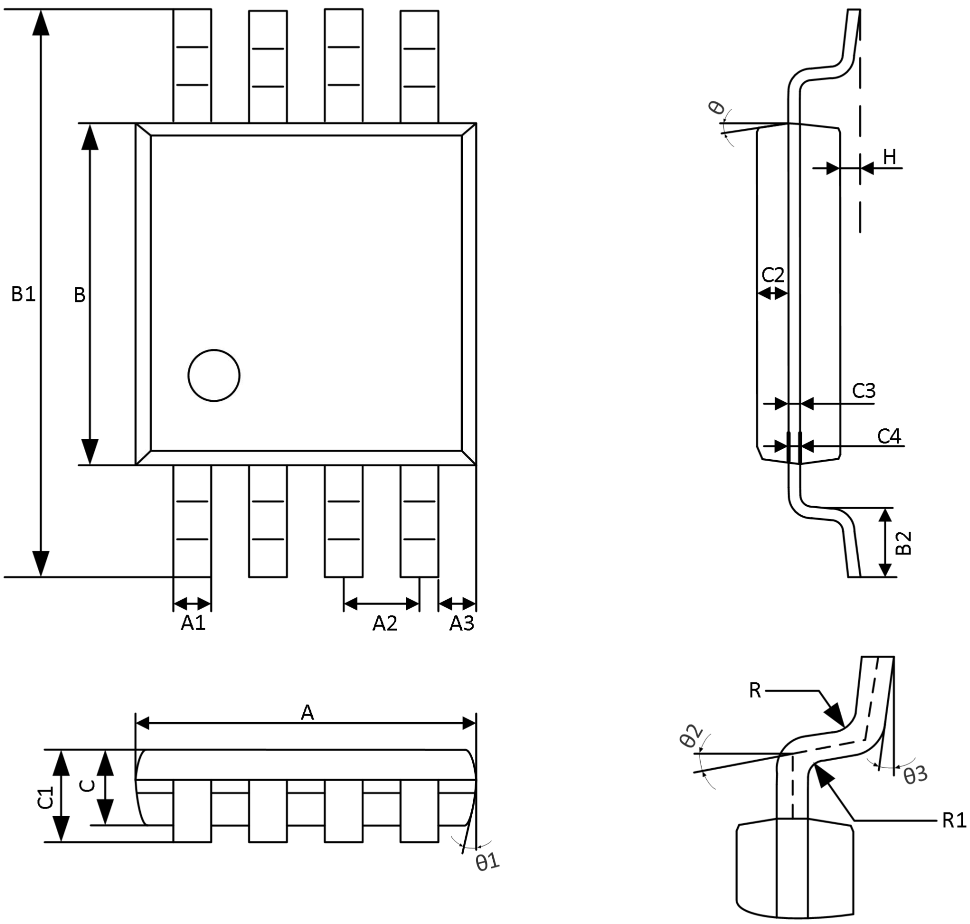
PACKAGE DIMENSION MSOP8-L



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				

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Order Information

Order number	Package	Marking information	Operation Temperature Range	MSL Grade	Ship, Quantity	Green
GM13088ESA	SOP8-L	GM13088E	-40 to 85°C	3	T&R, 2500	Rohs
GM13088EMA	MSOP8-L	GM13088E	-40 to 85°C	3	T&R, 2500	Rohs
GM13088ENA	DFN8	GM13088E	-40 to 85°C	3	T&R, 3000	Rohs
GM3088ESA	SOP8-L	GM3088E	-40 to 85°C	3	T&R, 2500	Rohs
GM3088EMA	MSOP8-L	GM3088E	-40 to 85°C	3	T&R, 2500	Rohs
GM3088ENA	DFN8	GM3088E	-40 to 85°C	3	T&R, 3000	Rohs

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