1. Feature

- 1/8 Unit-load option available (up to 256 nodes on the bus)
- Bus-pin ESD protection exceeds 15kV
- Data transmission up to 1Mbps (2.5Mbps for GM490E and GM491E)
- Glitch-free power-up and power-down protection for hot-plugging applications
- Bus idle, open, and short circuit fail safe
- Designed for RS-422 and RS485 networks
- Driver current limiting and thermal shutdown
- 5V Devices available

2. APPLICATIONS

- Low-Power RS-485 Transceivers
- Low-Power RS-422 Transceivers
- Level Translators
- Transceivers for EMI-Sensitive Applications
- Industrial-Control Local Area Networks

3. General Description

The GM488E, GM489E, GM490E and GM491E are low-power transceivers for RS-485 and RS- 422 communication in harsh environments. Each driver output and receiver input is protected against ±15kV electrostatic discharge (ESD) shocks without latch-up. Each part contains one driver and one receiver. The GM488E and GM489E feature reduced slew-rate drivers that minimize EMI and reduce reflections caused by improperly terminated cables, thus allowing error-free data transmission up to 1Mbps. The driver slew rates of the GM490E and GM491E are not limited, allowing them to transmit up to 2.5Mbps.

These transceivers draw between 120µA and 500µA of supply current when unloaded or fully loaded with disabled drivers. All parts operate from a single 5V supply.

Drivers are short circuit current limited and are protected against excessive power dissipation by thermal shutdown circuitry that places the driver outputs into a high-impedance state. The receiver input has a fail-safe feature that guarantees a logic-high output if the input is open circuit.

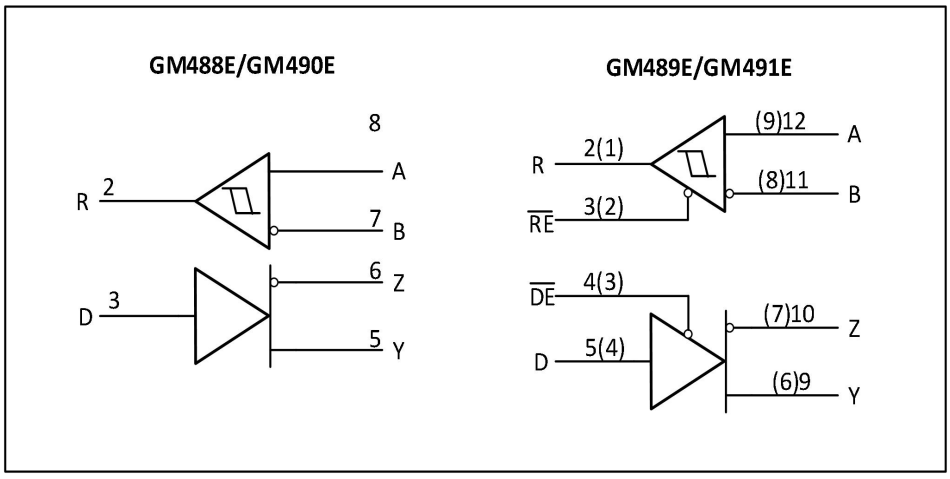

Figure 1 Simplified Schematic

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4. Specifications

4.1 ABSOLUTE GMIMUM RATINGS

Parameter	Description	MIN	MAX	UNIT
V_{CC}	Supply Voltage		6.5	V
$\overline{RE}$, DE	Control Input Voltage	0.5	V_{CC}+0.5V	V
DI	Driver Input Voltage	0.5	V_{CC}+0.5V	V
A, B	Driver Output Voltage	-8	+13V	V
A, B	Receiver Input Voltage	-8	+13V	V
RO	Receiver Output Voltage	0.5	V_{CC}+0.5V	
	Storage Temperature Range	-65	160	℃

4.2 DC ELECTRICAL CHARACTERISTICS

(V_{CC} = 5V ±5%, TA = T_{MIN} to T_{GM}, unless otherwise noted.) (Notes 1, 2)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNIT
Differential Driver Output (no load)	V_{OD1}					5	V
Differential Driver Output (with load)	V_{OD2}	R = 50Ω (RS-422)		2			V
		R = 27Ω (RS-485), Figure 4		1.5		5	
Change in Magnitude of Driver Differential Output Voltage for Complementary Output States	△V_{OD}	R = 27Ω or 50Ω, Figure 4				0.2	V
Driver Common-Mode Output Voltage	V_{OC}	R = 27Ω or 50Ω, Figure 4				3	V
Change in Magnitude of Driver Common-Mode Output Voltage for Complementary Output States	△V_{OD}	R = 27Ω or 50Ω, Figure 4				0.2	V
Input High Voltage	V_{IH}	DE, DI, $\overline{RE}$		2.0			V
Input Low Voltage	V_{IL}	DE, DI, $\overline{RE}$				0.8	V
Input Current	I_{IN1}	DE, DI, $\overline{RE}$, V_{CC} floating				±2	μA
Input Current (A, B)	I_{IN2}	DE = 0V; V_{CC} = 0V or 5.25V	V_{IN} = 12V			1.0	mA
			V_{IN} = -7V			-0.8	
Receiver Differential Threshold Voltage	△V_{TH}	-7V≤V_{CM} ≤12V		-0.2		0.2	V
Receiver Input Hysteresis	V_{TH}	V_{CM} = 0V			70		mV
Receiver Output High Voltage	V_{OH}	I_O = -4mA, V_{ID} = 200mV		3.5			V
Receiver Output Low Voltage	V_{OL}	I_O = 4mA, V_{ID} = -200mV				0.4	V

DC ELECTRICAL CHARACTERISTICS(continued)

(V_{CC} = 5V ±5%, TA = T_{MIN} to T_{GM}, unless otherwise noted.) (Notes 1, 2)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNIT
Three-State (high impedance) Output Current at Receiver	I_{OZR}	0.4V ≤ V_O ≤ 2.4V			±1	μA
Receiver Input Resistance	R_{IN}	-7V≤V_{CM} ≤12V	96			kΩ
No-Load Supply Current(Note 3)	I_{CC}	GM488E/GM489E, DE, DI, $\overline{RE}$ = 0V or V_{CC}		120	250	μA
		GM490E/GM491E, DE, DI, $\overline{RE}$ = 0V or V_{CC}		500	600	
Driver Short-Circuit Current,VO = High	I_{OSD1}	-7V≤V_{CM} ≤12V (Note 4)	35		250	mA
Driver Short-Circuit Current,VO = Low	I_{OSD2}	-7V≤V_{CM} ≤12V (Note 4)	35		250	mA
Receiver Short-Circuit Current	I_{OSR}	0V ≤ V_O ≤ V_{CC}	7		100	mA

4.3 SWITCHING CHARACTERISTICS—GM490E/GM491E

(V_{CC} = 5V ±5%, TA = T_{MIN} to T_{GM}, unless otherwise noted.) (Notes 1, 2)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNIT
Driver Input to Output	t_{PLH}	Figure 6 and 8, R_{DIFF} = 54Ω, C_{L1} = C_{L2} = 100pF		10	30	60	ns
	t_{PHL}			10	30	60	
Driver Output Skew to Output	t_{SKEW}	Figure 6 and 8, R_{DIFF} = 54Ω, C_{L1} = C_{L2} = 100pF			5	10	ns
Driver Rise or Fall Time	t_R, t_F	Figure 6 and 8, R_{DIFF}= 54Ω, C_{L1} =C_{L2} = 100pF	GM490E, GM491E	5	15	25	
			GM490E, GM491E	3	15	40	
Driver Enable to Output High	t_{ZH}	Figure 7 and 9, C_L = 100pF, S2 closed			40	70	ns
Driver Enable to Output Low	t_{ZL}	Figure 7 and 9, C_L = 100pF, S1 closed			40	70	ns
Driver Disable Time from Low	t_{LZ}	Figure 7 and 9, C_L = 15pF, S1 closed			40	70	ns
Driver Disable Time from High	t_{HZ}	Figure 7 and 9, C_L = 15pF, S2 closed			40	70	ns
Receiver Input to Output	t_{PLH}, t_{PHL}	Figure 6 and 10, R_{DIFF} = 54Ω, C_{L1}=C_{L2}=100pF	GM490E, GM491E	20	90	150	
			GM490E, GM491E	20	90	200	
| t_{PLH} - t_{PHL} | Differential Receiver Skew	t_{SKD}	Figure 6 and 10, R_{DIFF} = 54Ω, C_{L1} = C_{L2} = 100pF			13		ns
Receiver Enable to Output Low	t_{ZL}	Figure 5 and 11, C_{RL} = 15pF, S1 closed			20	50	ns

SWITCHING CHARACTERISTICS—GM490E/GM491E(continued)

(V_{CC} = 5V ±5%, TA = T_{MIN} to T_{GM}, unless otherwise noted.) (Notes 1, 2)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNIT
Receiver Enable to Output High	t_{ZH}	Figure 5 and 11, C_{RL} = 15pF, S2 closed		20	50	ns
Receiver Disable Time from Low	t_{LZ}	Figure 5 and 11, C_{RL} = 15pF, S1 closed		20	50	ns
Receiver Disable Time from High	t_{HZ}	Figure 5 and 11, C_{RL} = 15pF, S2 closed		20	50	ns
Maximum Data Rate	f_{GM}		2.5			Mbps

4.4 SWITCHING CHARACTERISTICS—GM488E/GM489E

(V_{CC} = 5V ±5%, TA = T_{MIN} to T_{GM}, unless otherwise noted.) (Notes 1, 2)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNIT
Driver Input to Output	t_{PLH}	Figure 6 and 8, R_{DIFF} = 54Ω, C_{L1} = C_{L2} = 100pF	250	800	2000	ns
	t_{PHL}		250	800	2000	
Driver Output Skew to Output	t_{SKEW}	Figure 6 and 8, R_{DIFF} = 54Ω, C_{L1} = C_{L2} = 100pF		100	800	ns
Driver Rise or Fall Time	t_R, t_F	Figure 6 and 8, R_{DIFF} = 54Ω, C_{L1} = C_{L2} = 100pF	250		2000	ns
Driver Enable to Output High	t_{ZH}	Figure 7 and 9, C_L = 100pF, S2 closed	250		2000	ns
Driver Enable to Output Low	t_{ZL}	Figure 7 and 9, C_L = 100pF, S1 closed	250		2000	ns
Driver Disable Time from Low	t_{LZ}	Figure 7 and 9, C_L = 15pF, S1 closed	300		3000	ns
Driver Disable Time from High	t_{HZ}	Figure 7 and 9, C_L = 15pF, S2 closed	300		3000	ns
Receiver Input to Output	t_{PLH}	Figure 6 and 10, R_{DIFF} = 54Ω,C_{L1} =C_{L2} = 100pF	250		2000	ns
	t_{PHL}		250		2000	
I t_{PLH} - t_{PHL} I Differential Receiver Skew	t_{SKD}	Figure 6and 10, R_{DIFF} = 54Ω,C_{L1} =C_{L2} = 100pF		100		ns
Receiver Enable to Output Low	t_{ZL}	Figure 5 and 11, C_{RL} = 15pF, S1 closed		20	50	ns
Receiver Enable to Output High	t_{ZH}	Figure 5 and 11, C_{RL} = 15pF, S2 closed		20	50	ns
Receiver Disable Time from Low	t_{LZ}	Figure 5 and 11, C_{RL} = 15pF, S1 closed		20	50	ns
Receiver Disable Time from High	t_{HZ}	Figure 5 and 11, C_{RL} = 15pF, S2 closed		20	50	ns
Maximum Data Rate	f_{GM}	t_{PLH}, t_{PHL} < 50% of data period		250		kbps

4.5 NOTES FOR ELECTRICAL/SWITCHING CHARACTERISTICS

Note 1: All currents into device pins are positive; all currents out of device pins are negative. All voltages are referenced to device ground unless otherwise specified.
Note 2: All typical specifications are given for V_{CC} = 5V and TA = +25°C.
Note 3: Supply current specification is valid for loaded transmitters when DE = 0V.
Note 4: Applies to peak current. See Typical Operating Characteristics.

4.6 Pin Description

PIN			NAME	FUNCTION
GM488E/ GM490E		GM489E/ GM491E		
SOP8	MSOP8	SOP14		
2	4	2	RO	Receiver Output: If A > B by 200mV, RO will be high; If A < B by 200mV, RO will be low.
—	—	3	$\overline{RE}$	Receiver Output Enable. RO is enabled when RE is low; RO is high impedance when RE is high.
—	—	4	DE	Driver Output Enable. The driver outputs, Y and Z, are enabled by bringing DE high. They are high impedance when DE is low. If the driver outputs are enabled, the parts function as line drivers. While they are high impedance, they function as line receivers if $\overline{RE}$ is low.
3	5	5	DI	Driver Input. A low on DI forces output Y low and output Z high. Similarly, a high on DI forces output Y high and output Z low.
4	6	6, 7	GND	Ground
5	7	9	Y	Non-inverting Driver Output
6	8	10	Z	Inverting Driver Output
—	—	—	A	Non-inverting Receiver Input and Non-inverting Driver Output
8	2	12	A	Non-inverting Receiver Input
—	—	—	B	Inverting Receiver Input and Inverting Driver Output
7	1	11	B	Inverting Receiver Input
1	3	14	V_{CC}	Positive Supply: 4.75V ≤ V_{CC} ≤ 5.25V
—	—	1, 8, 13	N.C.	No Connect—not internally connected

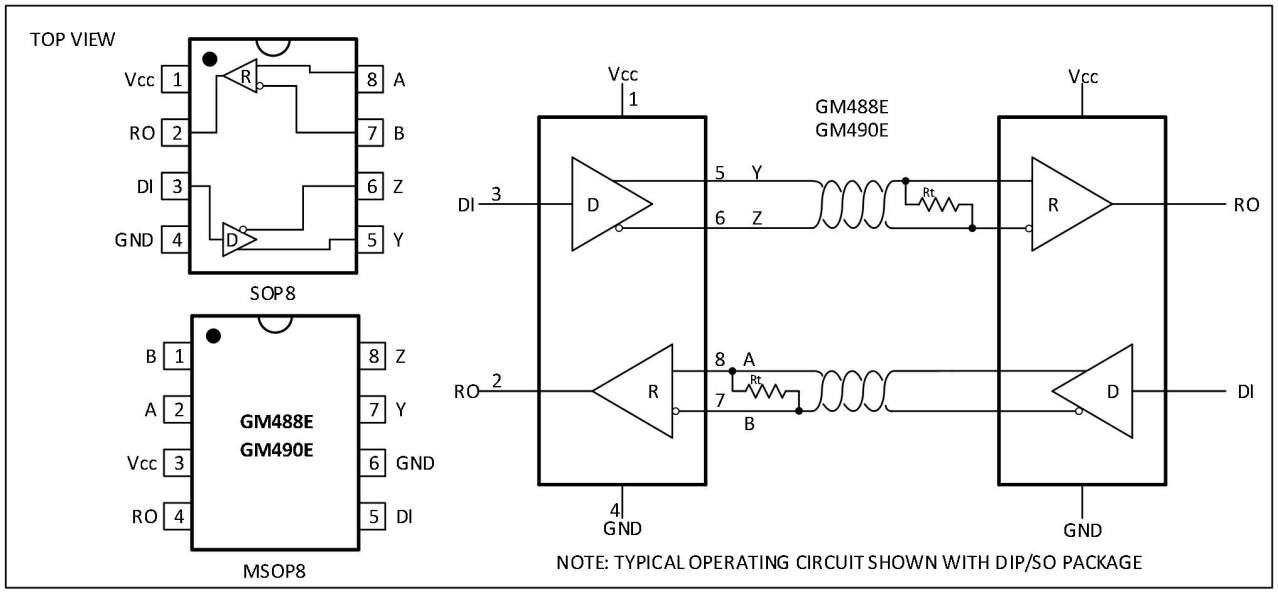


Figure 2. GM488E/GM490E Pin Configuration and Typical Operating Circuit

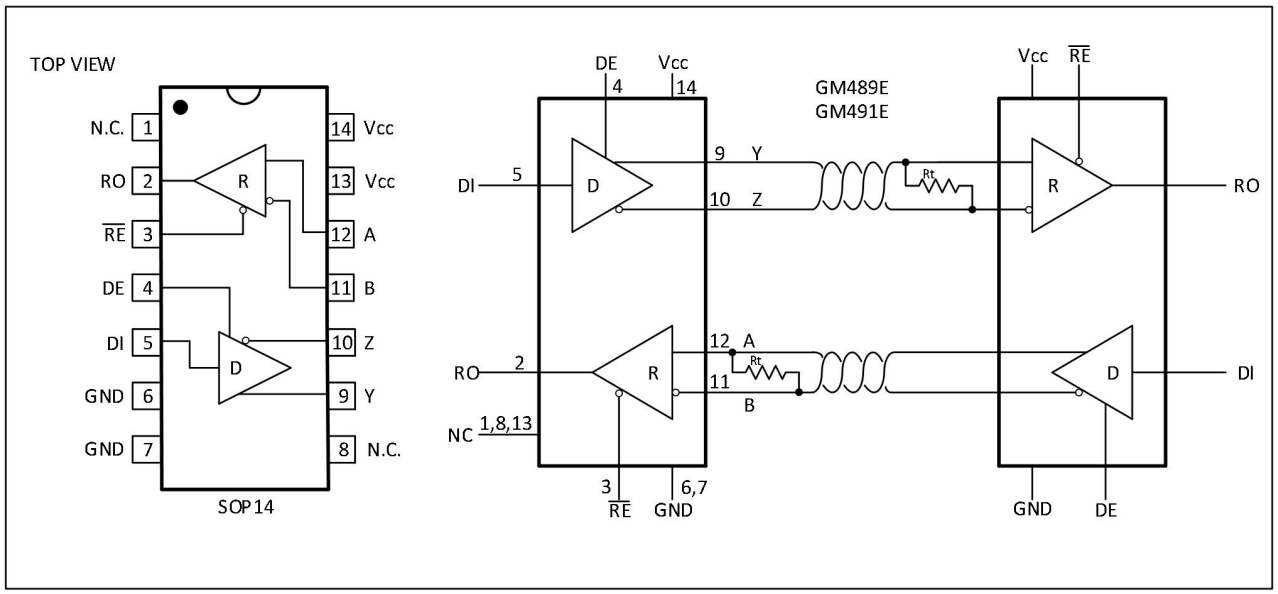


Figure 3. GM489E/GM491E Pin Configuration and Typical Operating Circuit

5. Applications Information

The GM488E/GM489E/GM490E and GM491E are low-power transceivers for RS-485 and RS- 422 communications. The GM490E and GM491E can transmit and receive at data rates up to 2.5Mbps, while the GM488E and GM489E are specified for data rates up to 1Mbps. The GM488E–GM491E are full-duplex transceivers. In addition, Driver Enable (DE) and Receiver Enable (RE) pins are included on the GM489E and GM491E. When disabled, the driver and receiver outputs are high impedance.

6. ±15kV ESD Protection

ESD-protection structures are incorporated on all pins to protect against electrostatic discharges (ESD) encountered during handling and assembly. The driver outputs and receiver inputs 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, GM488E–GM491E keep working without latch up. ESD protection can be tested in various ways; the transmitter outputs and receiver inputs of this product family are characterized for protection to ±15kV using the Human Body Model. Other ESD test methodologies include IEC10004-2 contact discharge and IEC1000-4-2 air-gap discharge.

7. Transceivers on the Bus

The 96kΩ, 1/8-unit-load receiver input impedance of the GM488E–GM491E allow up to 256 transceivers on a bus, compared to the 1-unit load (12kΩ input impedance) of standard RS-485 drivers (32 transceivers Maximum).

8. Test Circuits

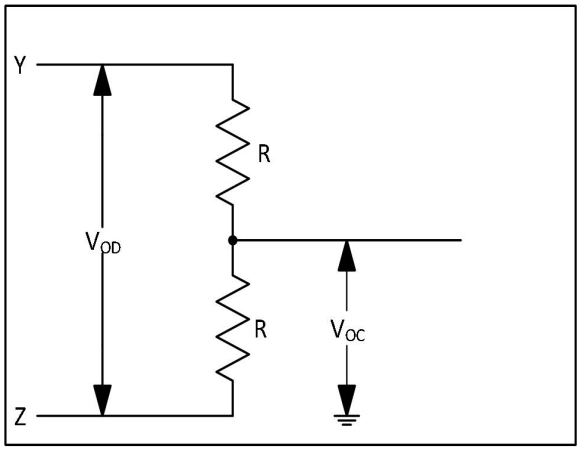


Figure 4. Driver DC Test Load

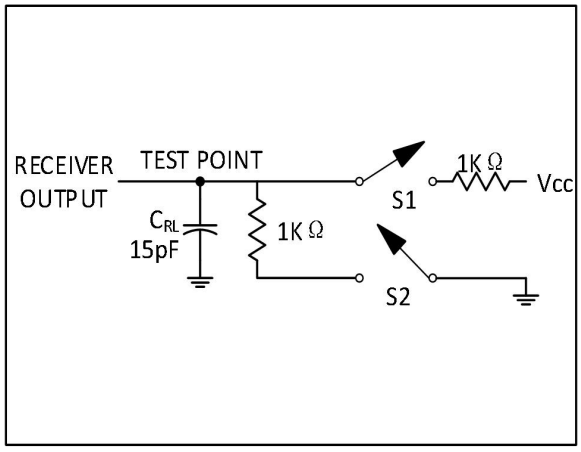


Figure 5. Receiver Timing Test Load

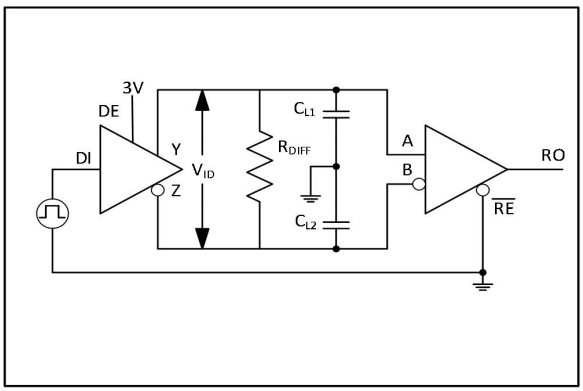


Figure 6. Driver/Receiver Timing Test Circuit

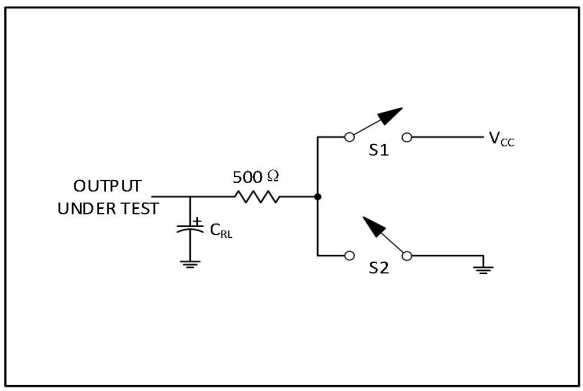


Figure 7. Driver Timing Test Load

9. Reduced EMI and Reflections

The GM488E and GM489E are slew-rate limited, minimizing EMI and reducing reflections caused by improperly terminated cables.

10. Switching Waveform

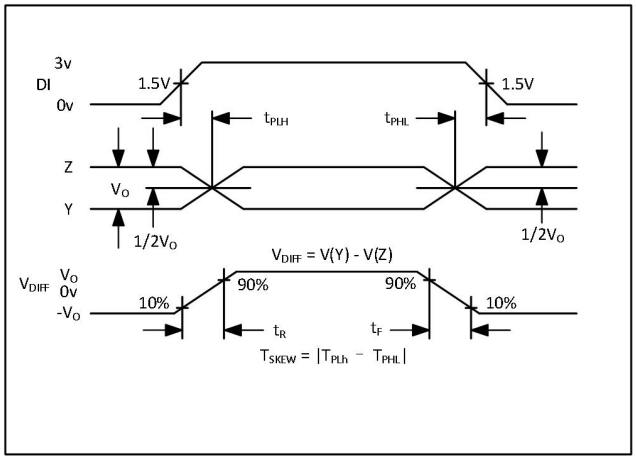


Figure 8. Driver Propagation Delays

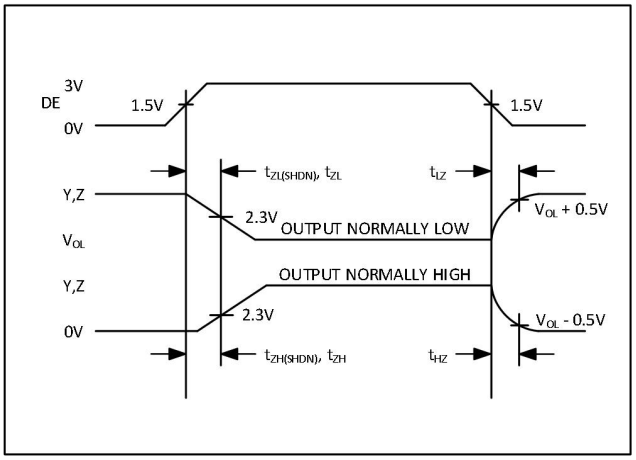


Figure 9. Driver Enable and Disable Times (except GM488E and GM490E)

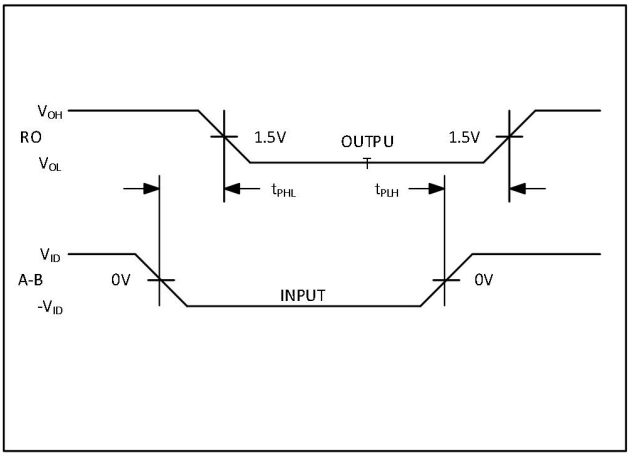


Figure 10. Receiver Propagation Delays

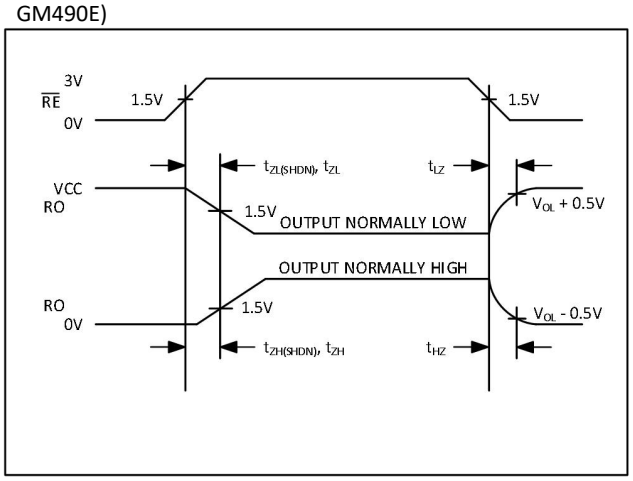


Figure 11. Receiver Enable and Disable Times (except GM488E and GM490E)

11. Function Tables (GM483/GM485/GM487)

Table 1. Transmitting

INPUTS			OUTPUTS	
RE	DE	DI	Z	Y
X	1	1	0	1
X	1	0	1	0
0	0	X	High-Z	High-Z
1	0	X	High-Z*	High-Z*

X = Don't care
High-Z = High impedance
*Shutdown mode for GM481/GM483/GM487

Table 2. Receiving

INPUTS			OUTPUT
RE	DE	A-B	RO
0	0	> +0.2V	1
0	0	< -0.2V	0
0	0	Inputs open	1
1	0	X	High-Z*

X = Don't care
High-Z = High impedance
*Shutdown mode for GM481/GM483/GM487

12. Driver Output Protection

Excessive output current and power dissipation causedby faults or by bus contention are prevented by two mechanisms. A current limit on the output stage provides immediate protection against short circuits over the whole common-mode voltage range. In addition, a thermal shutdown circuit forces the driver outputs into a high-impedance state if the die temperature rises excessively.

13. Propagation Delay

Many digital encoding schemes depend on the difference between the driver and receiver propagation delay times. Typical propagation delays are shown in Figure 13–17 using Figure 12 test circuit.

The difference in receiver delay times, $| t_{PLH} - t_{PHL} |$, is typically under 13ns for GM490E and GM491E, is typically less than 100ns for the GM488E and GM489E.

The driver skew times are typically 5ns (10ns Max) for the GM490E and GM491E, and are typically 100ns (800ns Max) for the GM488E and GM489E.

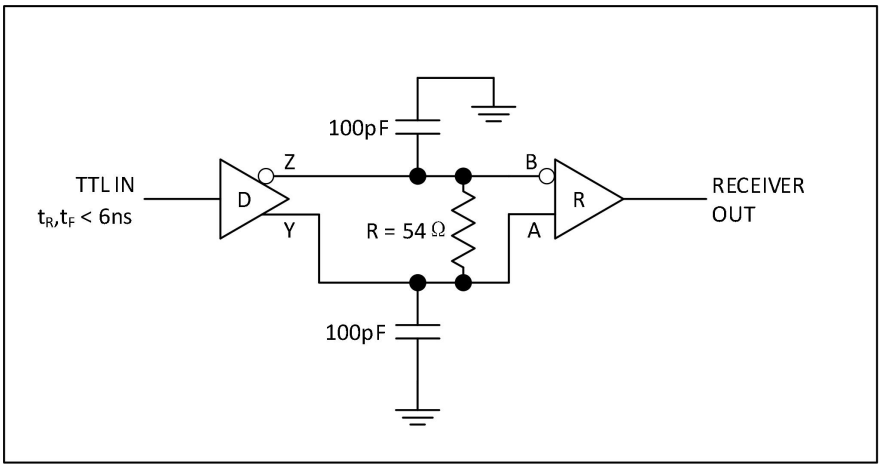


Figure 12. Receiver Propagation Delay Test Circuit

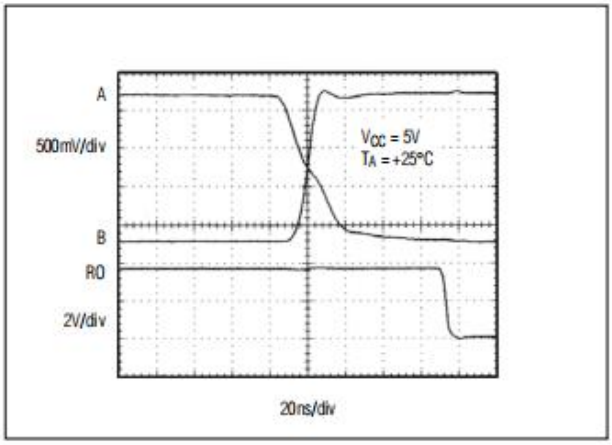


Figure 13. GM490E/GM491E Receiver t_{PHL}

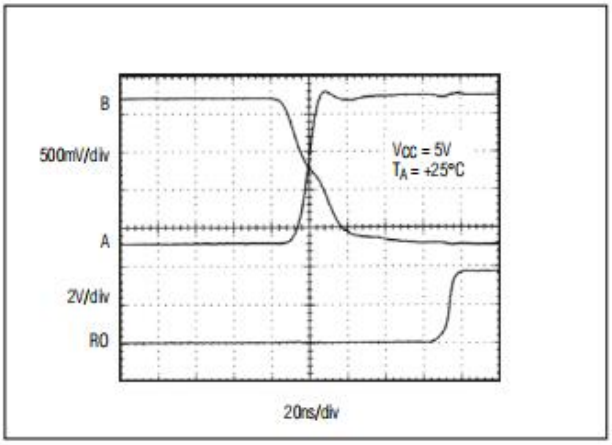


Figure 14.GM490E/GM491E Receiver t_{PLH}

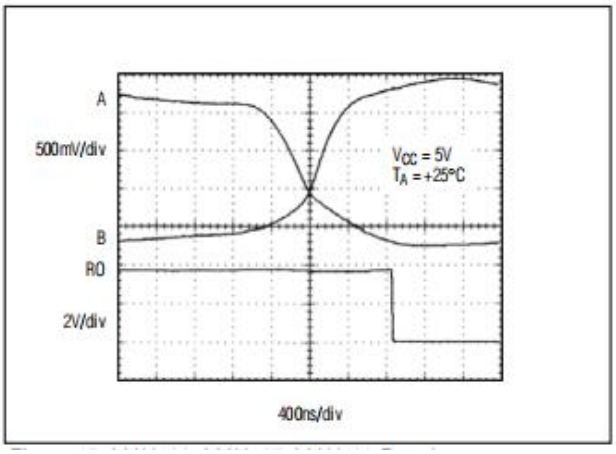


Figure 15.GM488E–GM489E Receiver t_{PHL}

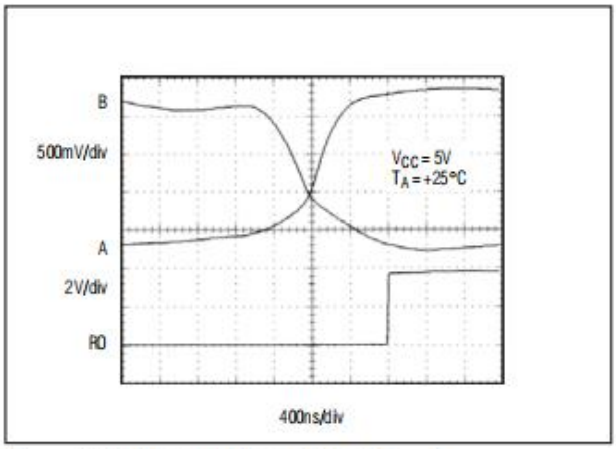


Figure 16.GM488E–GM489E Receiver t_{PLH}

14. Typical Applications

The GM488E–GM491E transceivers are designed for bidirectional data communications on multi point bus transmission lines. Figure 18 and 19 show typical network applications circuits. These parts can also be used as line repeaters, with cable lengths longer than 4000 feet, as shown in Figure 20.

To minimize reflections, the line should be terminated at both ends in its characteristic impedance, and stub lengths off the main line should be kept as short as possible. The slew-rate-limited GM483 and GM488E–GM489E are more tolerant of imperfect termination. Bypass the VCC pin with 0.1µF

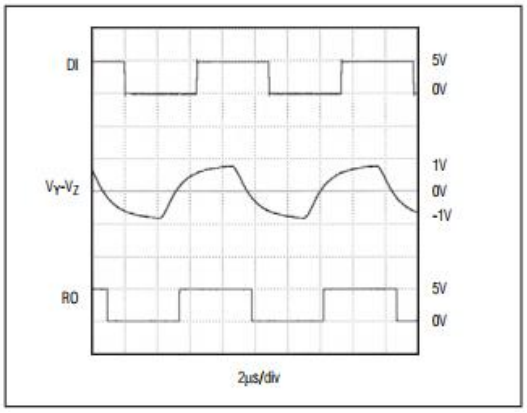


Figure 17.GM490E/GM491E System Differential Voltage at 110kHz Driving 4000ft of Cable

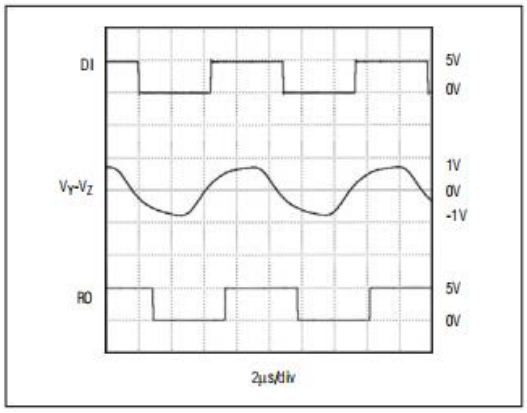


Figure 18.GM488E–GM489E System Differential Voltage at 110kHz Driving 4000ft of Cable

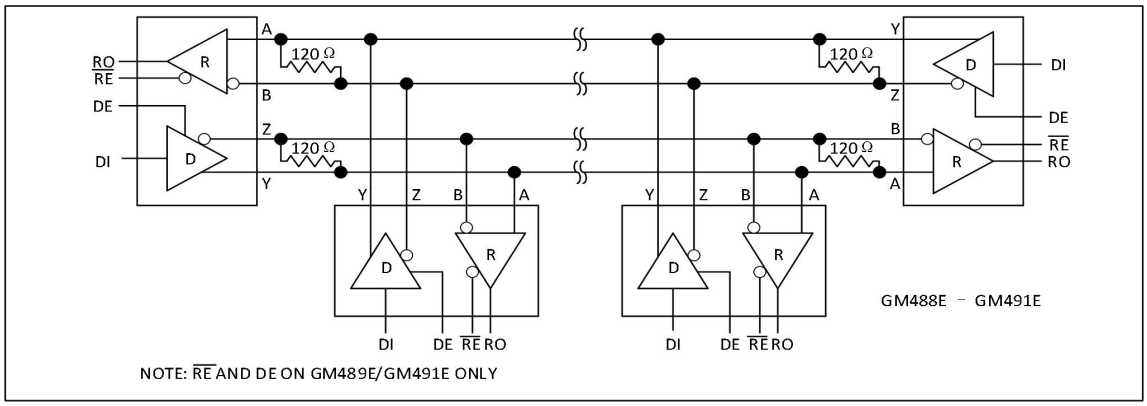


Figure 19. GM488E–GM491E Full-Duplex RS-485 Network

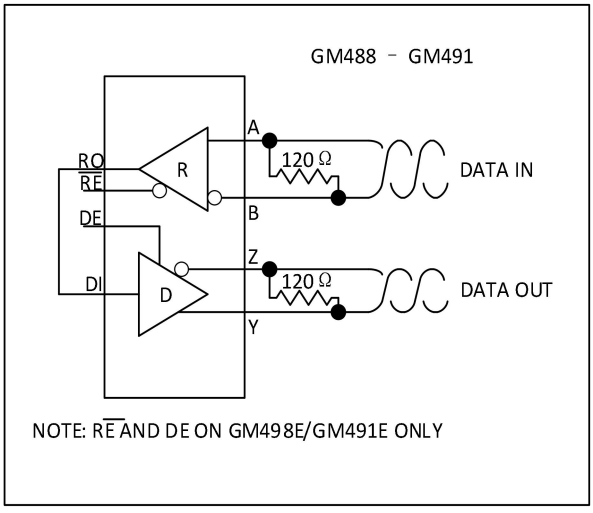
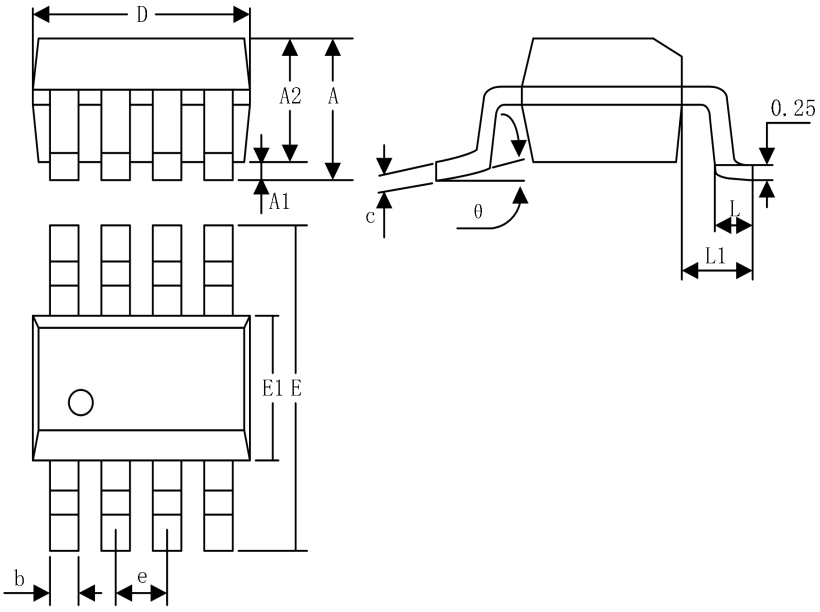


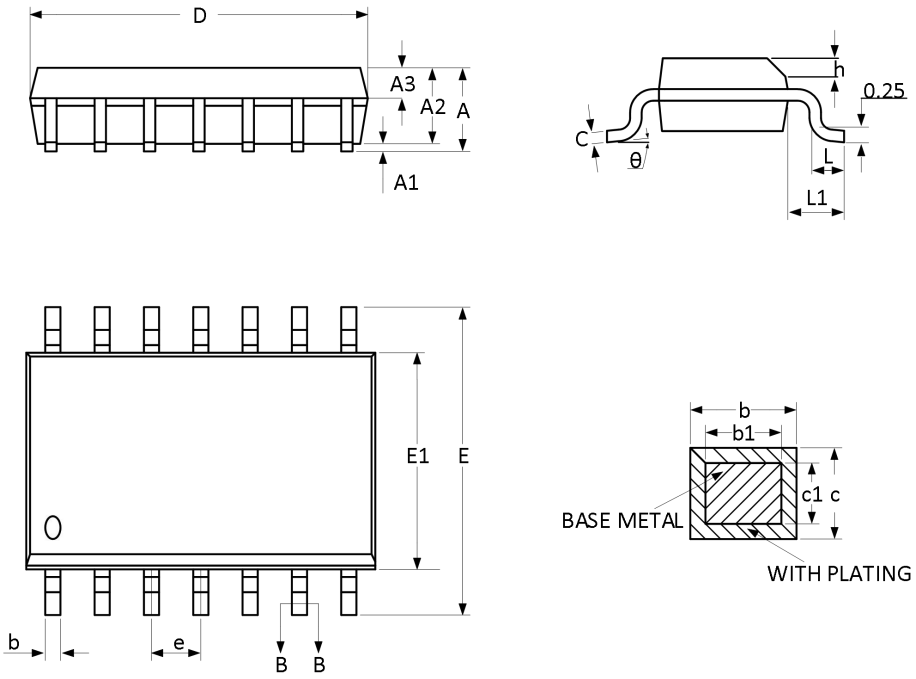
Figure 20. Line Repeater for GM488E–GM491E

SOP-8L



SYMBOLS	MILLIMETER		
	MIN	NOM	MAX
A	1.5	-	1.7
A1	0.1	-	0.25
A2	1.3	1.4	1.5
b	0.33	0.4	0.47
C	0.2	-	0.25
D	4.7	4.9	5.1
E	5.9	6	6.1
E1	3.8	3.9	4
e	1.27(BSC)		
L	0.55	0.6	0.75
L1	1.05(BSC)		
θ	0°	4°	8°

SOP-14



SYMBOLS	MILLIMETER		
	MIN	NOM	MAX
A	-	-	1.75
A1	0.05	-	0.225
A2	1.30	1.40	1.50
A3	0.60	0.65	0.70
b	0.39	-	0.47
b1	0.38	0.41	0.44
c	0.20	-	0.24
c1	0.19	0.20	0.21
D	8.55	8.65	8.75
E	5.80	6.00	6.20
E1	3.80	3.90	4.00
e	1.24BSC		
h	0.25	-	0.50
L	0.50	-	0.80
L1	1.05REF		
θ	0°	-	8°

Order Information

Order number	Package	Marking information	Operation Temperature Range	MSL Grade	Ship, Quantity	Green
GM488ESA	SOP8	GM488E	-40 to 85°C	3	T&R, 2500	Rohs
GM488EMA	MSOP8	GM488E	-40 to 85°C	3	T&R, 2500	Rohs
GM490ESA	SOP8	GM490E	-40 to 85°C	3	T&R, 2500	Rohs
GM490EMA	MSOP8	GM490E	-40 to 85°C	3	T&R, 2500	Rohs
GM489ESA	SOP14	GM489E	-40 to 85°C	3	T&R, 2500	Rohs
GM491ESA	SOP14	GM491E	-40 to 85°C	3	T&R, 2500	Rohs

Version modification record

version	Modify the description	page	time	Modify personnel
1.1	1.Original:GM490_1.0 →GM490_1.1		On June 21,2024	Fan
	2.Input Current testing environment.Increase the VCC Floating	2		
	3.Receiver Short-Circuit Current MAX=95mA → MAX= 100mA	3		

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