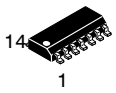
Low-Power, Slew-Rate-Limited RS-485/RS-422 Transceivers

The HT481, HT483, HT485, HT487–HT491, and HT1487 are low-power transceivers for RS-485 and RS-422 communication. Each part contains one driver and one receiver. The HT483, HT487, HT488, and HT489 feature reduced slew-rate drivers that minimize EMI and reduce reflections caused by improperly terminated cables, thus allowing error-free data transmission up to 250kbps. The driver slew rates of the HT481, HT485, HT490, HT491, and HT1487 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. Additionally, the HT481, HT483, and HT487 have a low-current shutdown mode in which they consume only 0.1µA. 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.

The HT487 and HT1487 feature quarter-unit-load receiver input impedance, allowing up to 128 HT487/ HT1487 transceivers on the bus. Full-duplex communi-cations are obtained using the HT488–HT491, while the HT481, HT483, HT485, HT487, and HT1487 are designed for half-duplex applications.

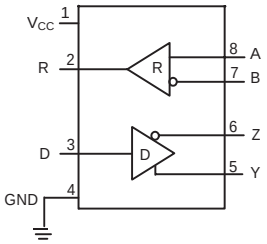


ORDERING INFORMATION

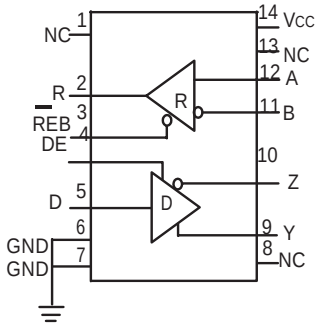
HT490EARZ SOP8

HT491EARZ SOP14

T_A = -40° to 85°C for all packages.



HT490



HT491

Applications

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

ABSOLUTE MAXIMUM RATINGS

Supply Voltage (V_{CC}) 12V
Control Input Voltage (RE, DE)..... -0.5V to (V_{CC} + 0.5V)
Driver Input Voltage (DI)..... -0.5V to (V_{CC} + 0.5V)
Driver Output Voltage (A, B)..... -8V to +12.5V
Receiver Input Voltage (A, B)..... -8V to +12.5V
Receiver Output Voltage (RO)..... -0.5V to (V_{CC} +0.5V)
Continuous Power Dissipation (T_A = +70°C)
8-Pin Plastic DIP (derate 9.09mW/°C above +70°C) 727mW
14-Pin Plastic DIP (derate 10.00mW/°C above +70°C) .. 800mW
8-Pin SO (derate 5.88mW/°C above +70°C)..... 471mW
14-Pin SO (derate 8.33mW/°C above +70°C)..... 667mW
8-Pin µMAX (derate 4.1mW/°C above +70°C) 830mW
8-Pin CERDIP (derate 8.00mW/°C above +70°C)..... 640mW
14-Pin CERDIP (derate 9.09mW/°C above +70°C)..... 727mW
Operating Temperature Ranges
HT4_ _C_ _/HT1487C_ A ..... 0°C to +70°C
HT4_ _E_ _/HT1487E_ A ..... -40°C to +85°C
HT4_ _MJ_/HT1487MJA ..... -55°C to +125°C
Storage Temperature Range ..... -65°C to +160°C
Lead Temperature (soldering, 10sec) ..... +300°C

DC ELECTRICAL CHARACTERISTICS

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

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
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	ΔV_{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	ΔV_{OD}	R = 27Ω or 50Ω, Figure 4				0.2	V
Input High Voltage	V_{IH}	DE, DI, RE		2.0			V
Input Low Voltage	V_{IL}	DE, DI, RE				0.8	V
Input Current	I_{IN1}	DE, DI, RE				±2	µA
Input Current (A, B)	I_{IN2}	DE = 0V; V_{CC} = 0V or 5.25V, all devices except HT487/HT1487	V_{IN} = 12V			1.0	mA
			V_{IN} = -7V			-0.8	
		HT487/HT1487, DE = 0V, V_{CC} = 0V or 5.25V	V_{IN} = 12V			0.25	mA
			V_{IN} = -7V			-0.2	
Receiver Differential Threshold Voltage	V_{TH}	-7V ≤ V_{CM} ≤ 12V		-0.2		0.2	V
Receiver Input Hysteresis	ΔV_{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
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, all devices except HT487/HT1487		12			kΩ
		-7V ≤ V_{CM} ≤ 12V, HT487/HT1487		48			kΩ

DC ELECTRICAL CHARACTERISTICS (continued)

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

PARAMETER	SYMBOL	CONDITIONS			MIN	TYP	MAX	UNITS
No-Load Supply Current (Note 3)	I_{CC}	HT488/HT489, DE, DI, RE = 0V or V_{CC}				120	250	µA
		HT490/HT491, DE, DI, RE = 0V or V_{CC}				300	500	
		HT481/HT485, RE = 0V or V_{CC}	DE = V_{CC}			500	900	
			DE = 0V			300	500	
		HT1487, RE = 0V or V_{CC}	DE = V_{CC}			300	500	
			DE = 0V			230	400	
		HT483/HT487, RE = 0V or V_{CC}	DE = 5V	HT483		350	650	
				HT487		250	400	
			DE = 0V			120	250	
Supply Current in Shutdown	I_{SHDN}	HT481/483/487, DE = 0V, RE = V_{CC}				0.1	10	µA
Driver Short-Circuit Current, V_O = High	I_{OSD1}	-7V ≤ V_O ≤12V (Note 4)			35		250	mA
Driver Short-Circuit Current, V_O = Low	I_{OSD2}	-7V ≤ V_O ≤12V (Note 4)			35		250	mA
Receiver Short-Circuit Current	I_{OSR}	0V ≤ V_O ≤ V_{CC}			7		95	mA

SWITCHING CHARACTERISTICS—HT481/HT485, HT490/HT491, HT1487

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

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
Driver Input to Output	t_{PLH}	Figures 6 and 8, R_{DIFF} = 54Ω,		10	30	60	ns
	t_{PHL}	C_{L1} = C_{L2} = 100pF		10	30	60	
Driver Output Skew to Output	t_{SKEW}	Figures 6 and 8, R_{DIFF} = 54Ω, C_{L1} = C_{L2} = 100pF			5	10	ns
Driver Rise or Fall Time	t_R, t_F	Figures 6 and 8,	HT481, HT485, HT1487	3	15	40	ns
		R_{DIFF} = 54Ω,	HT490C/E, HT491C/E	5	15	25	
		C_{L1} = C_{L2} = 100pF	HT490M, HT491M	3	15	40	
Driver Enable to Output High	t_{ZH}	Figures 7 and 9, C_L = 100pF, S2 closed			40	70	ns
Driver Enable to Output Low	t_{ZL}	Figures 7 and 9, C_L = 100pF, S1 closed			40	70	ns
Driver Disable Time from Low	t_{LZ}	Figures 7 and 9, C_L = 15pF, S1 closed			40	70	ns
Driver Disable Time from High	t_{HZ}	Figures 7 and 9, C_L = 15pF, S2 closed			40	70	ns
Receiver Input to Output	t_{PLH}, t_{PHL}	Figures 6 and 10,	HT481, HT485, HT1487	20	90	200	ns
		R_{DIFF} = 54Ω,	HT490C/E, HT491C/E	20	90	150	
		C_{L1} = C_{L2} = 100pF	HT490M, HT491M	20	90	200	
$\lvert t_{PLH} - t_{PHL} \rvert$ Differential Receiver Skew	t_{SKD}	Figures 6 and 10, R_{DIFF} = 54Ω, C_{L1} = C_{L2} = 100pF			13		ns
Receiver Enable to Output Low	t_{ZL}	Figures 5 and 11, C_{RL} = 15pF, S1 closed			20	50	ns
Receiver Enable to Output High	t_{ZH}	Figures 5 and 11, C_{RL} = 15pF, S2 closed			20	50	ns
Receiver Disable Time from Low	t_{LZ}	Figures 5 and 11, C_{RL} = 15pF, S1 closed			20	50	ns
Receiver Disable Time from High	t_{HZ}	Figures 5 and 11, C_{RL} = 15pF, S2 closed			20	50	ns
Maximum Data Rate	f_{MAX}			2.5			Mbps
Time to Shutdown	t_{SHDN}	HT481 (Note 5)		50	200	600	ns

SWITCHING CHARACTERISTICS—HT481/HT485, HT490/HT491, HT1487 (continued)

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

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Driver Enable from Shutdown to Output High (HT481)	$t_{ZH(SHDN)}$	Figures 7 and 9, C_L = 100pF, S2 closed		40	100	ns
Driver Enable from Shutdown to Output Low (HT481)	$t_{ZL(SHDN)}$	Figures 7 and 9, C_L = 100pF, S1 closed		40	100	ns
Receiver Enable from Shutdown to Output High (HT481)	$t_{ZH(SHDN)}$	Figures 5 and 11, C_L = 15pF, S2 closed, A - B = 2V		300	1000	ns
Receiver Enable from Shutdown to Output Low (HT481)	$t_{ZL(SHDN)}$	Figures 5 and 11, C_L = 15pF, S1 closed, B - A = 2V		300	1000	ns

SWITCHING CHARACTERISTICS—HT483, HT487/HT488/HT489

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

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Driver Input to Output	t_{PLH}	Figures 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}	Figures 6 and 8, R_{DIFF} = 54Ω, C_{L1} = C_{L2} = 100pF		100	800	ns
Driver Rise or Fall Time	t_R, t_F	Figures 6 and 8, R_{DIFF} = 54Ω, C_{L1} = C_{L2} = 100pF	250		2000	ns
Driver Enable to Output High	t_{ZH}	Figures 7 and 9, C_L = 100pF, S2 closed	250		2000	ns
Driver Enable to Output Low	t_{ZL}	Figures 7 and 9, C_L = 100pF, S1 closed	250		2000	ns
Driver Disable Time from Low	t_{LZ}	Figures 7 and 9, C_L = 15pF, S1 closed	300		3000	ns
Driver Disable Time from High	t_{HZ}	Figures 7 and 9, C_L = 15pF, S2 closed	300		3000	ns
Receiver Input to Output	t_{PLH}	Figures 6 and 10, R_{DIFF} = 54Ω, C_{L1} = C_{L2} = 100pF	250		2000	ns
	t_{PHL}		250		2000	
| t_{PLH} - t_{PHL} | Differential Receiver Skew	t_{SKD}	Figures 6 and 10, R_{DIFF} = 54Ω, C_{L1} = C_{L2} = 100pF		100		ns
Receiver Enable to Output Low	t_{ZL}	Figures 5 and 11, C_{RL} = 15pF, S1 closed		20	50	ns
Receiver Enable to Output High	t_{ZH}	Figures 5 and 11, C_{RL} = 15pF, S2 closed		20	50	ns
Receiver Disable Time from Low	t_{LZ}	Figures 5 and 11, C_{RL} = 15pF, S1 closed		20	50	ns
Receiver Disable Time from High	t_{HZ}	Figures 5 and 11, C_{RL} = 15pF, S2 closed		20	50	ns
Maximum Data Rate	f_{MAX}	t_{PLH}, t_{PHL} < 50% of data period	250			kbps
Time to Shutdown	t_{SHDN}	HT483/HT487 (Note 5)	50	200	600	ns
Driver Enable from Shutdown to Output High	$t_{ZH(SHDN)}$	HT483/HT487, Figures 7 and 9, C_L = 100pF, S2 closed			2000	ns
Driver Enable from Shutdown to Output Low	$t_{ZL(SHDN)}$	HT483/HT487, Figures 7 and 9, C_L = 100pF, S1 closed			2000	ns
Receiver Enable from Shutdown to Output High	$t_{ZH(SHDN)}$	HT483/HT487, Figures 5 and 11, C_L = 15pF, S2 closed			2500	ns
Receiver Enable from Shutdown to Output Low	$t_{ZL(SHDN)}$	HT483/HT487, Figures 5 and 11, C_L = 15pF, S1 closed			2500	ns

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 T_A = +25°C.

Note 3: Supply current specification is valid for loaded transmitters when DE = 0V.

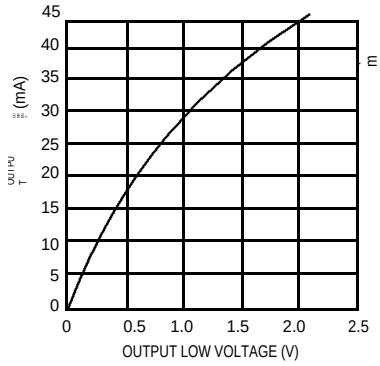
Note 4: Applies to peak current. See *Typical Operating Characteristics.*

Note 5: The HT481/HT483/HT487 are put into shutdown by bringing RE high and DE low. If the inputs are in this state for less than 50ns, the parts are guaranteed not to enter shutdown. If the inputs are in this state for at least 600ns, the parts are guaranteed to have entered shutdown. See *Low-Power Shutdown Mode* section.

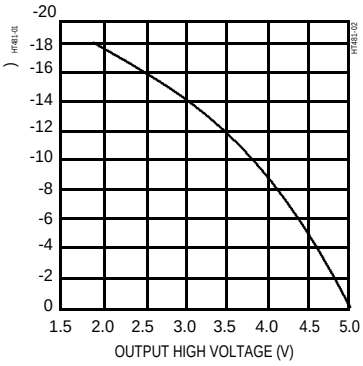
Typical Operating Characteristics

(V_{CC} = 5V, T_A = +25°C, unless otherwise noted.)

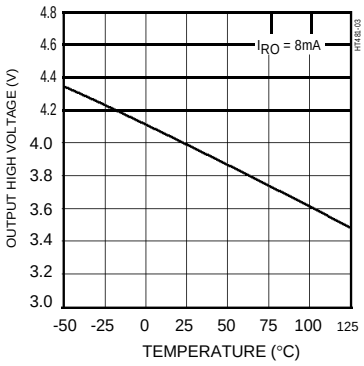
OUTPUT CURRENT vs. RECEIVER OUTPUT LOW VOLTAGE



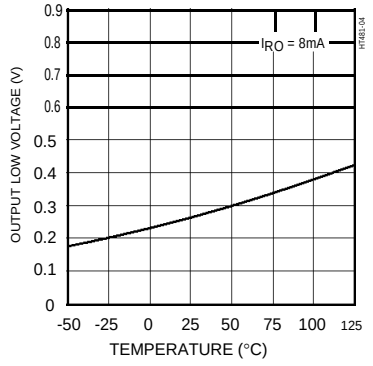
OUTPUT CURRENT vs. RECEIVER OUTPUT HIGH VOLTAGE



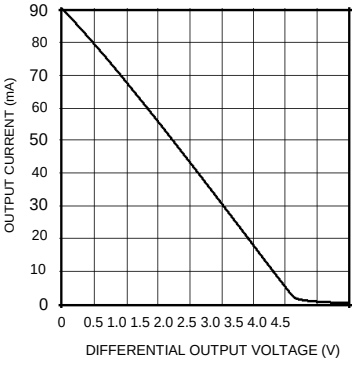
RECEIVER OUTPUT HIGH VOLTAGE vs. TEMPERATURE



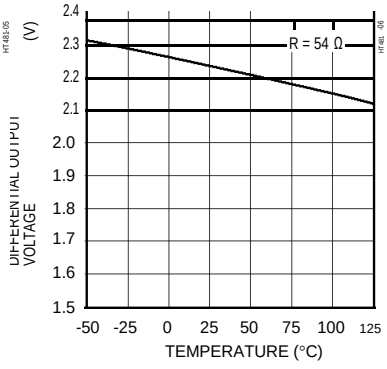
RECEIVER OUTPUT LOW VOLTAGE vs. TEMPERATURE



DRIVER OUTPUT CURRENT vs. DIFFERENTIAL OUTPUT VOLTAGE



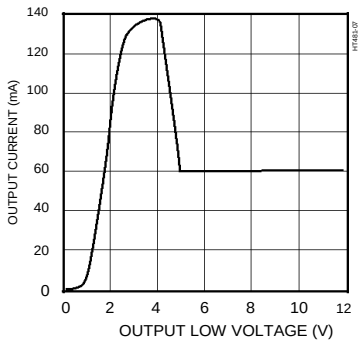
DRIVER DIFFERENTIAL OUTPUT VOLTAGE vs. TEMPERATURE



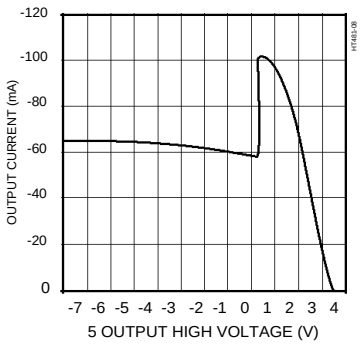
Typical Operating Characteristics (continued)

(V_{CC} = 5V, T_A = +25°C, unless otherwise noted.)

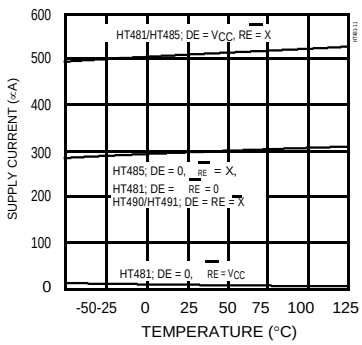
OUTPUT CURRENT vs. DRIVER OUTPUT LOW VOLTAGE



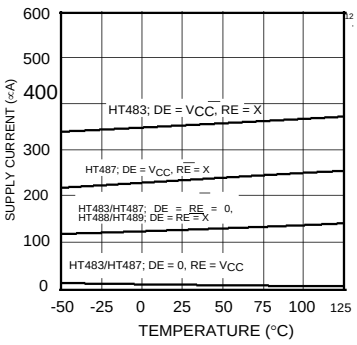
OUTPUT CURRENT vs. DRIVER OUTPUT HIGH VOLTAGE



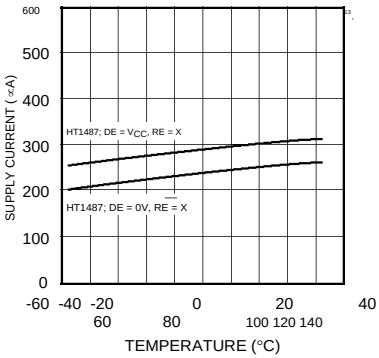
HT481/HT485/HT490/HT491 SUPPLY CURRENT vs. TEMPERATURE



HT483/HT487–HT489 SUPPLY CURRENT vs. TEMPERATURE

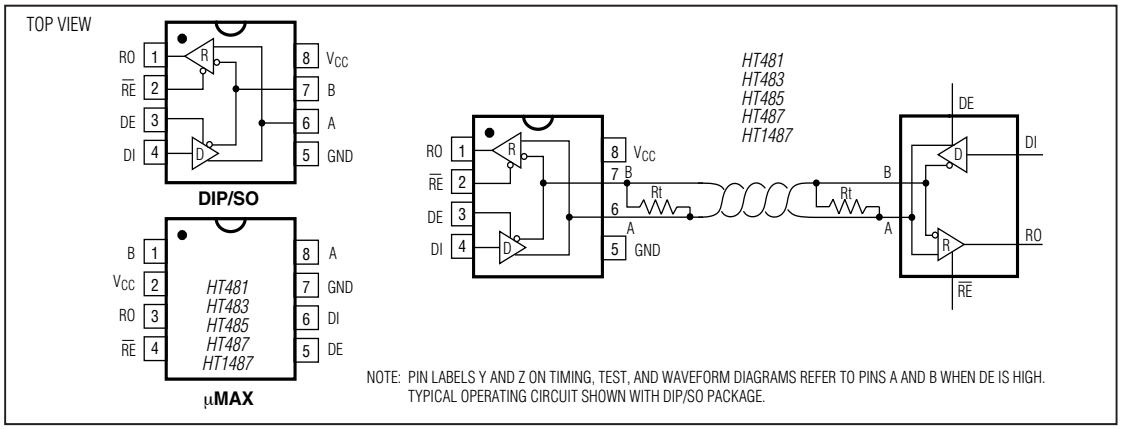


HT1487 SUPPLY CURRENT vs. TEMPERATURE

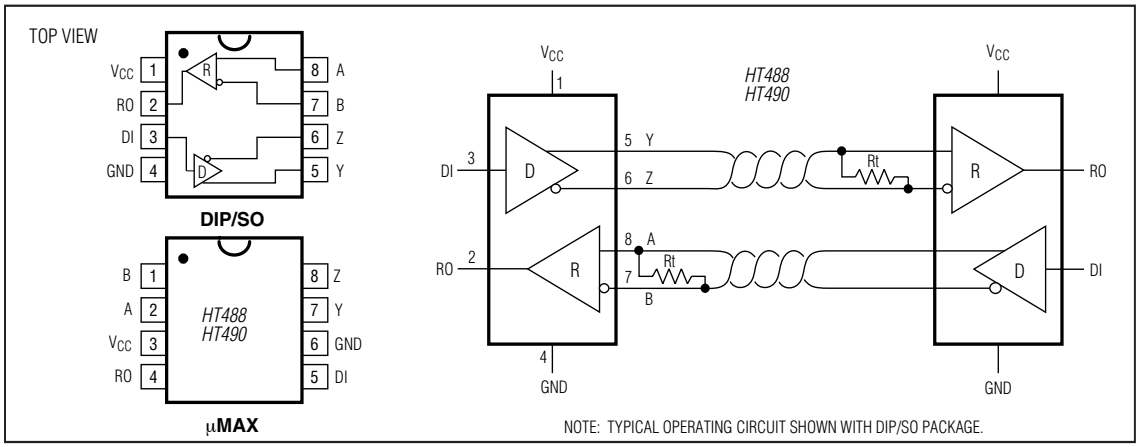


Pin Description

PIN					NAME	FUNCTION
HT481/HT483/ HT485/HT487/ HT1487		HT488/ HT490		HT489/ HT491		
DIP/SO	µMAX	DIP/SO	µMAX	DIP/SO		
1	3	2	4	2	RO	Receiver Output: If A > B by 200mV, RO will be high; If A < B by 200mV, RO will be low.
2	4	—	—	3	$\overline{RE}$	Receiver Output Enable. RO is enabled when $\overline{RE}$ is low; RO is high impedance when $\overline{RE}$ is high.
3	5	—	—	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.
4	6	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.
5	7	4	6	6, 7	GND	Ground
—	—	5	7	9	Y	Noninverting Driver Output
—	—	6	8	10	Z	Inverting Driver Output
6	8	—	—	—	A	Noninverting Receiver Input and Noninverting Driver Output
—	—	8	2	12	A	Noninverting Receiver Input
7	1	—	—	—	B	Inverting Receiver Input and Inverting Driver Output
—	—	7	1	11	B	Inverting Receiver Input
8	2	1	3	14	V_{CC}	Positive Supply: 4.75V ≤ V_{CC} ≤ 5.25V
—	—	—	—	1, 8, 13	N.C.	No Connect—not internally connected



NOTE: PIN LABELS Y AND Z ON TIMING, TEST, AND WAVEFORM DIAGRAMS REFER TO PINS A AND B WHEN DE IS HIGH. TYPICAL OPERATING CIRCUIT SHOWN WITH DIP/SO PACKAGE.



Figur HT488/HT490 Pin Configuration and Typical Operating Circuit

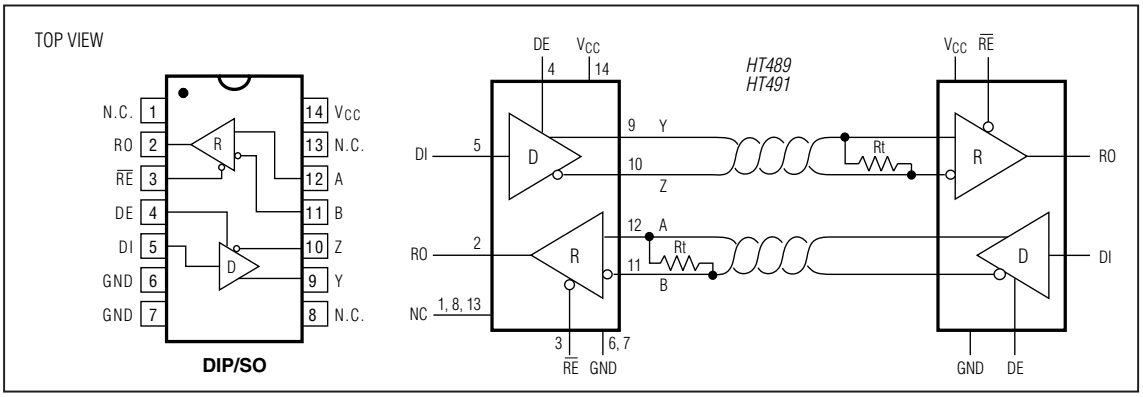


Figure 3. HT489/HT491 Pin Configuration and Typical Operating Circuit

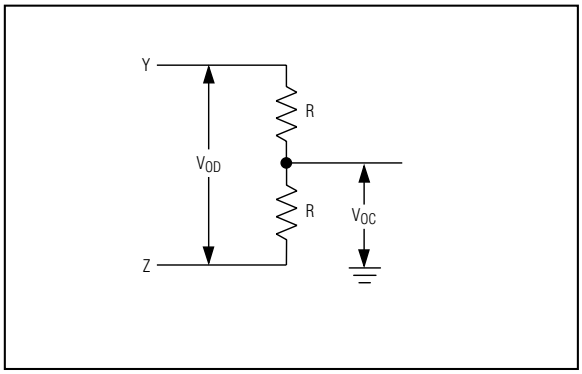


Figure 4. Driver DC Test Load

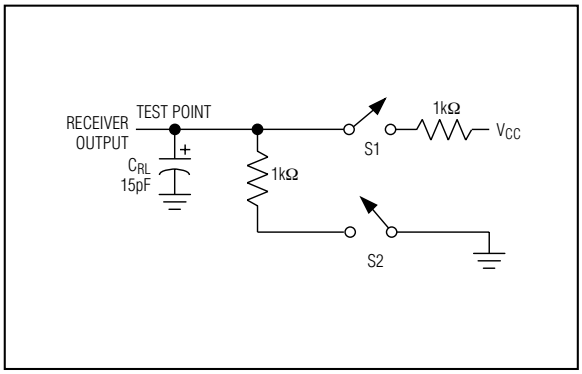


Figure 5. Receiver Timing Test Load

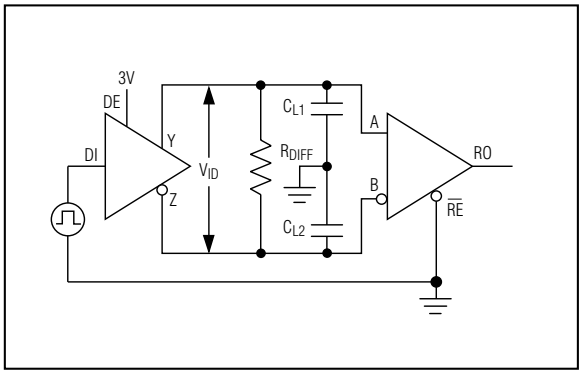


Figure 6. Driver/Receiver Timing Test Circuit

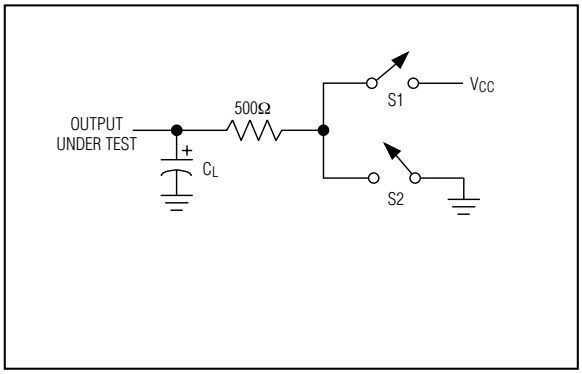


Figure 7. Driver Timing Test Load

Switching Waveforms

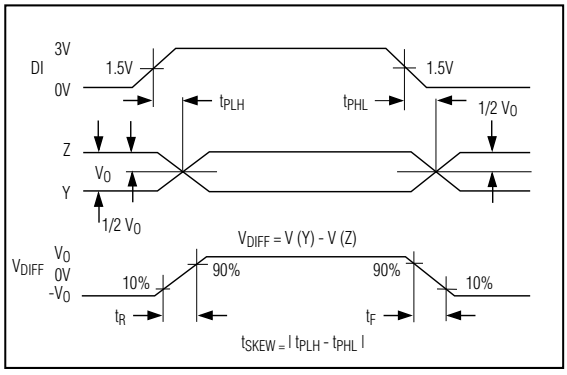


Figure 8. Driver Propagation Delays

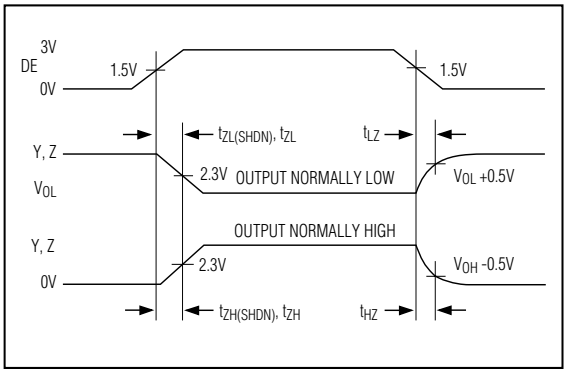


Figure 9. Driver Enable and Disable Times (except HT488 and HT490)

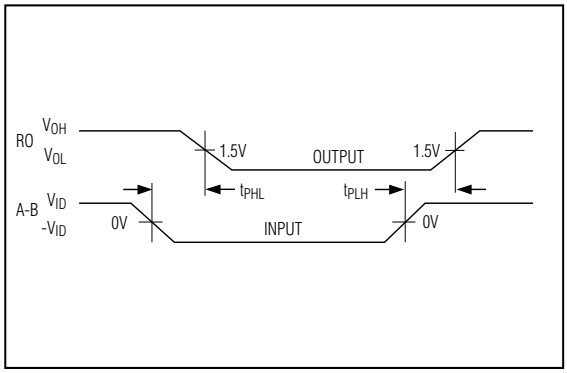


Figure 10. Receiver Propagation Delays

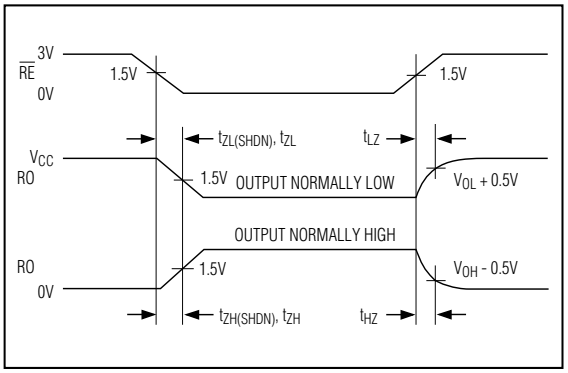


Figure 11. Receiver Enable and Disable Times (except HT488 and HT490)

Function Tables *(HT481/HT483/HT485/HT487/HT1487)*

Table 1. Transmitting

INPUTS			OUTPUTS	
$\overline{RE}$	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 HT481/HT483/HT487

Table 2. Receiving

INPUTS			OUTPUT
$\overline{RE}$	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 HT481/HT483/HT487

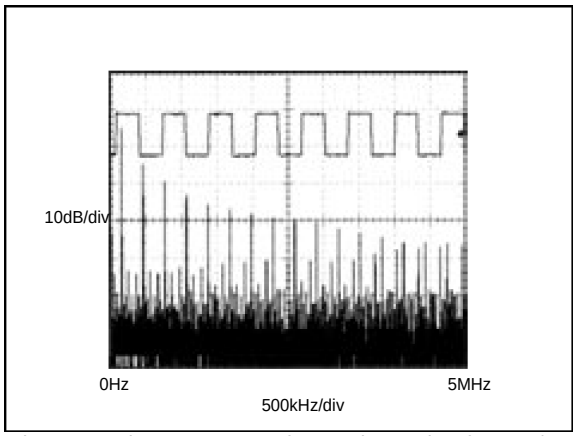


Figure 12. Driver Output Waveform and FFT Plot of HT481/ HT485/HT490/HT491/HT1487 Transmitting a 150kHz Signal

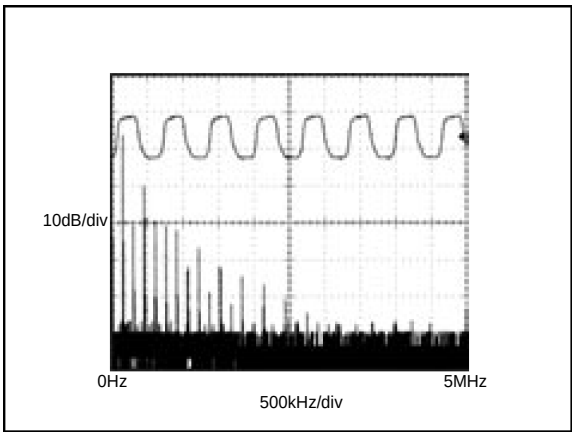


Figure 13. Driver Output Waveform and FFT Plot of HT483/ HT487–HT489 Transmitting a 150kHz Signal

Low-Power Shutdown Mode (HT481/HT483/HT487)

A low-power shutdown mode is initiated by bringing both RE high and DE low. The devices will not shut down unless both the driver and receiver are disabled. In shutdown, the devices typically draw only 0.1µA of supply current.

RE and DE may be driven simultaneously; the parts 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 600ns, the parts are guaranteed to enter shutdown.

For the HT481, HT483, and HT487, the t_{ZH} and t_{ZL} enable times assume the part was not in the low-power shutdown state (the HT485/HT488–HT491 and HT1487 can not be shut down). The $t_{ZH(SHDN)}$ and $t_{ZL(SHDN)}$ enable times assume the parts were shut down (see *Electrical Characteristics*).

It takes the drivers and receivers longer to become enabled from the low-power shutdown state ($t_{ZH(SHDN)}$, $t_{ZL(SHDN)}$) than from the operating mode (t_{ZH}, t_{ZL}). (The parts are in operating mode if the RE , DE inputs equal a logical 0,1 or 1,1 or 0, 0.)

Driver Output Protection

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

Propagation Delay

Many digital encoding schemes depend on the difference between the driver and receiver propagation delay times. Typical propagation delays are shown in Figures 15–18 using Figure 14's test circuit.

The difference in receiver delay times, $|t_{PLH} - t_{PHL}|$, is typically under 13ns for the HT481, HT485, HT490, HT491, and HT1487 and is typically less than 100ns for the HT483 and HT487–HT489.

The driver skew times are typically 5ns (10ns max) for the HT481, HT485, HT490, HT491, and HT1487, and are typically 100ns (800ns max) for the HT483 and HT487–HT489.

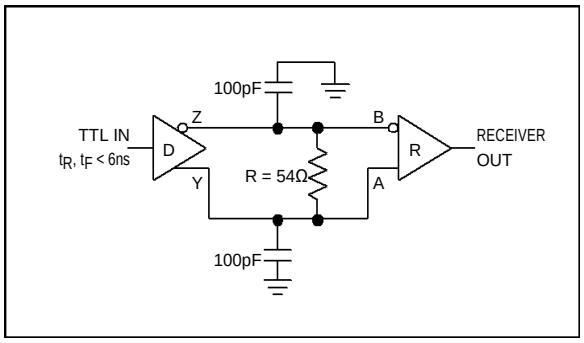


Figure 14. Receiver Propagation Delay Test Circuit

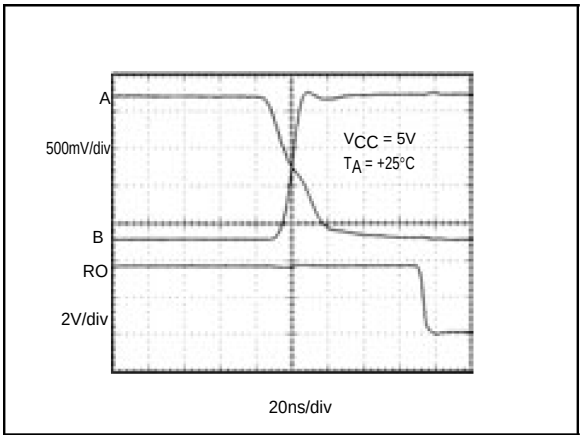


Figure 15. HT481/HT485/HT490/HT491/HT1487 Receiver t_{PHL}

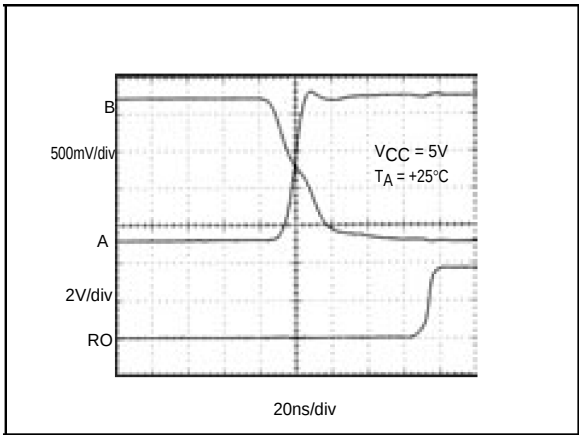


Figure 16. HT481/HT485/HT490/HT491/HT1487 Receiver t_{PLH}

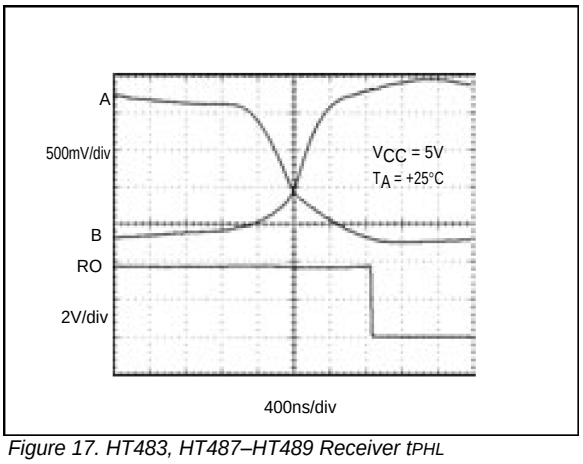


Figure 17. HT483, HT487–HT489 Receiver t_{PHL}

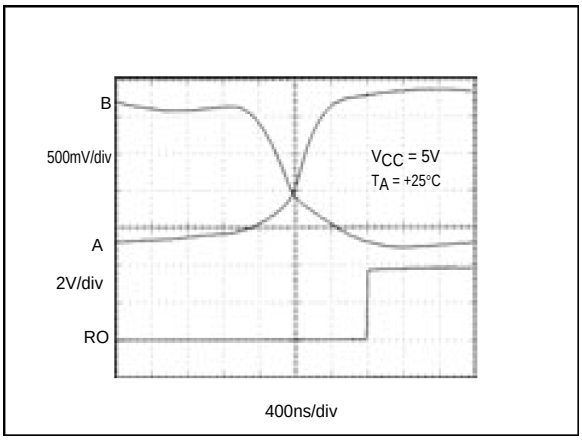


Figure 18. HT483, HT487–HT489 Receiver t_{PLH}

Line Length vs. Data Rate

The RS-485/RS-422 standard covers line lengths up to 4000 feet. For line lengths greater than 4000 feet, see Figure 23.

Figures 19 and 20 show the system differential voltage for the parts driving 4000 feet of 26AWG twisted-pair wire at 110kHz into 120Ω loads.

Typical Applications

The HT481, HT483, HT485, HT487–HT491, and HT1487 transceivers are designed for bidirectional data communications on multipoint bus transmission lines.

Figures 21 and 22 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 23.

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 possi-ble. The slew-rate-limited HT483 and HT487–HT489 are more tolerant of imperfect termination.

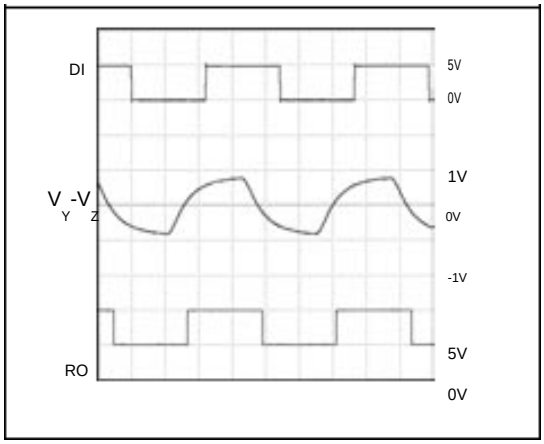


Figure 19. HT481/HT485/HT490/HT491/HT1487 System Differential Voltage at 110kHz Driving 4000ft of Cable

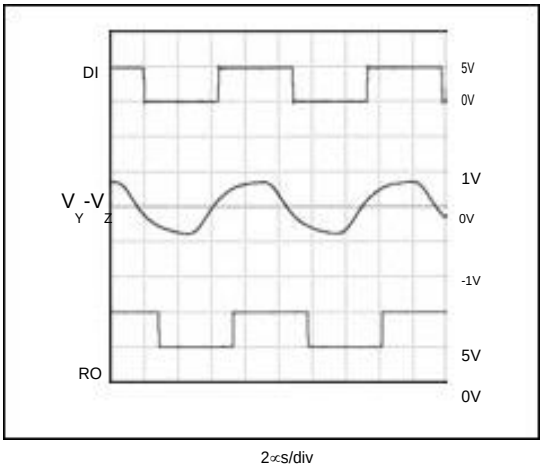
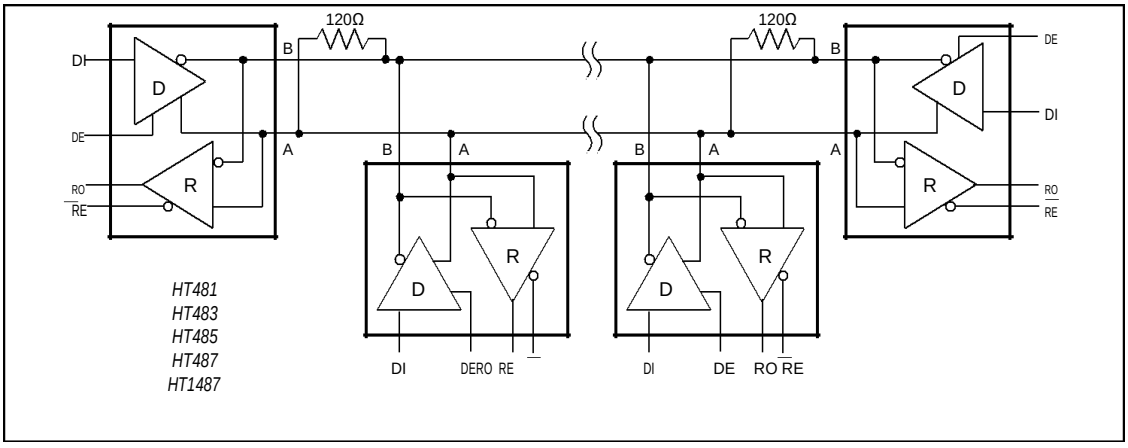


Figure 20. HT483, HT487–HT489 System Differential Voltage at 110kHz Driving 4000ft of Cable



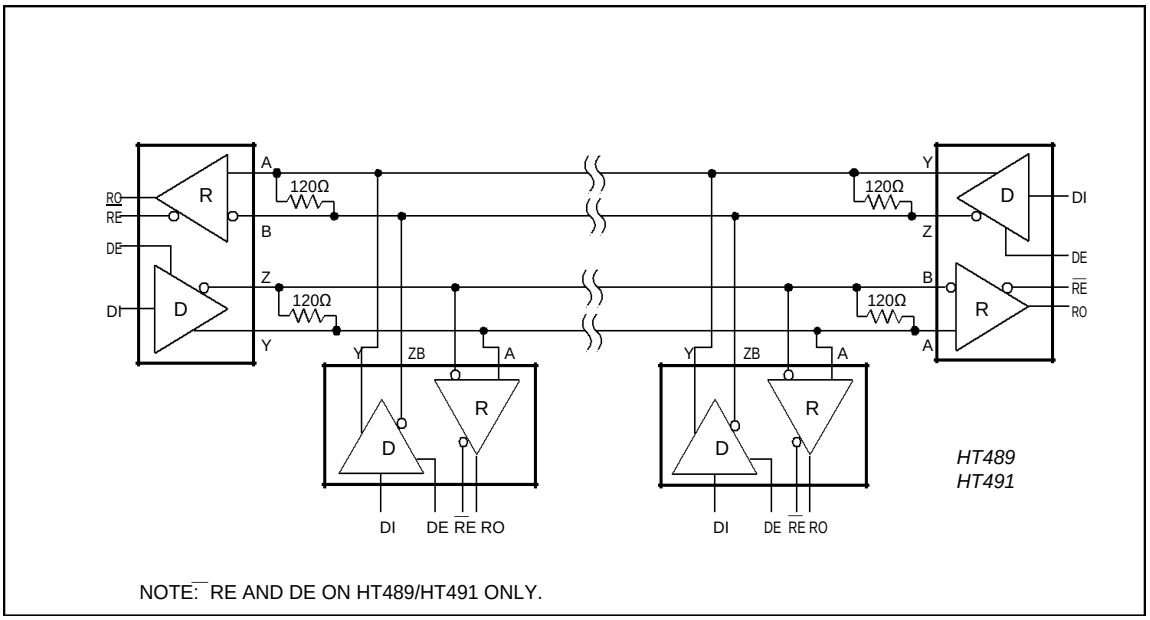


Figure 22. HT488–HT491 Full-Duplex RS-485 Network

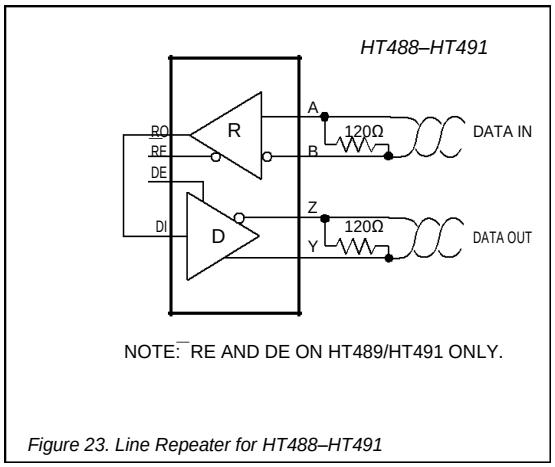
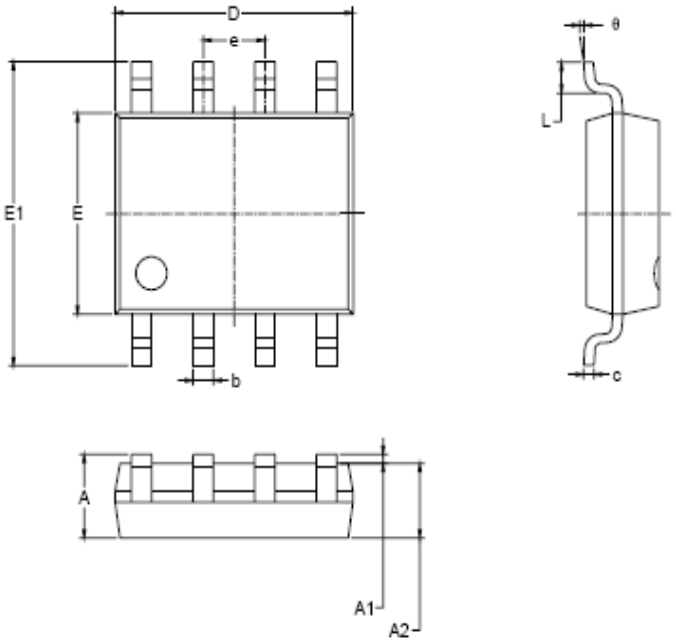


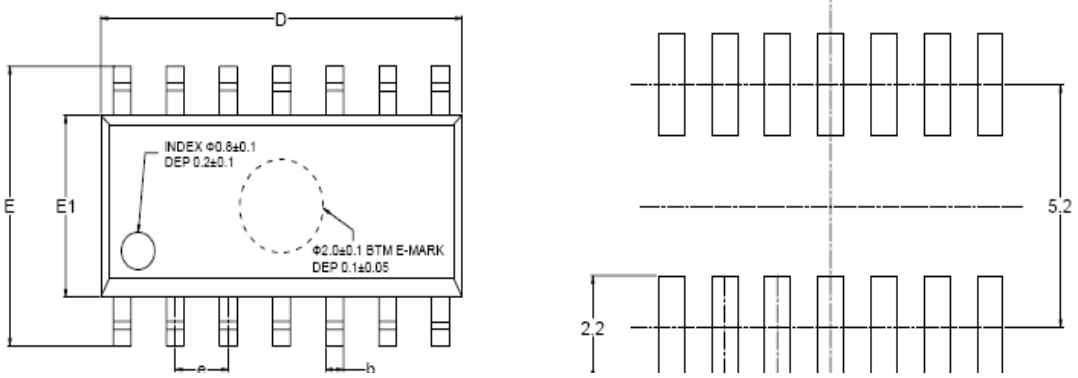
Figure 23. Line Repeater for HT488–HT491

SOP-8



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.350	1.750	0.053	0.069
A1	0.100	0.250	0.004	0.010
A2	1.350	1.550	0.053	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.006	0.010
D	4.700	5.100	0.185	0.200
E	3.800	4.000	0.150	0.157
E1	5.800	6.200	0.228	0.244
e	1.27 BSC		0.050 BSC	
L	0.400	1.270	0.016	0.050
θ	0°	8°	0°	8°

SOP-14



Symbol	Dimensions In Millimeters			Dimensions In Inches		
	MIN	MOD	MAX	MIN	MOD	MAX
A	1.35		1.75	0.053		0.069
A1	0.10		0.25	0.004		0.010
A2	1.25		1.65	0.049		0.065
A3	0.55		0.75	0.022		0.030
b	0.36		0.49	0.014		0.019
D	8.53		8.73	0.336		0.344
E	5.80		6.20	0.228		0.244
E1	3.80		4.00	0.150		0.157
e	1.27 BSC			0.050 BSC		
L	0.45		0.80	0.018		0.032
L1	1.04 REF			0.040 REF		
L2	0.25 BSC			0.01 BSC		
R	0.07			0.003		
R1	0.07			0.003		
h	0.30		0.50	0.012		0.020
θ	0°		8°	0°		8°