3V to 5.5V,15kV ESD-protected RS485 transceiver

1. Features

- ESD Protection for RS-485 I/O Pins
- High Data Rates: 15Mbps at 5V Supply & 15Mbps at 3.3V Supply
- ESD Protection for RS-485 I/O Pins
- ±15kV—Human Body Model
- 3V to 5.5V Supply Voltage Range
- 1uA Low-Current Shutdown Mode
- -7V to +12V Common-Mode Input Voltage Range
- Allows up to 256 Transceivers on the Bus
- Thermal Shutdown
- Current-Limiting for Driver Overload Protection
- Full Fail-safe (Open, Short, Terminated) Receivers

Applications

- Telecommunications
- Low-Power RS-485 Transceivers
- Integrated Services Digital Networks
- Industrial-Control Local Area Networks
- Transceivers for EMI-Sensitive Applications
- Packet Switching
- Level Translators

2. Description

Elecsuper's ESP485 are 3V to 5.5V-powered, ±15kV ESD-protected, slew-rate-limited differential transceivers which provide full RS485 compatibility. Each part contains one driver and one receiver, which is designed for data transmission with extended common mode range (-7V to 12V).It transmits at data rates up to 15Mbps.

The ESP485 series also feature enhanced electrostatic discharge (ESD) protection. All of the transmitter outputs and receiver inputs are protected to ±15kV using the Human Body Model.

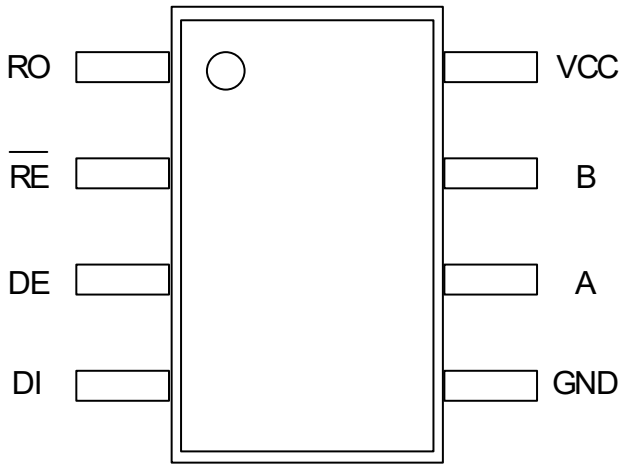
Drivers are short circuit current limited. When the driver outputs are placed into a high-impedance state by thermal shutdown circuitry, drivers are protected against excessive power dissipation. Receiver (Rx) inputs feature a "Full Fail-Safe" design, which ensures a logic high Rx output if Rx inputs are floating, shorted, or terminated but undriven.

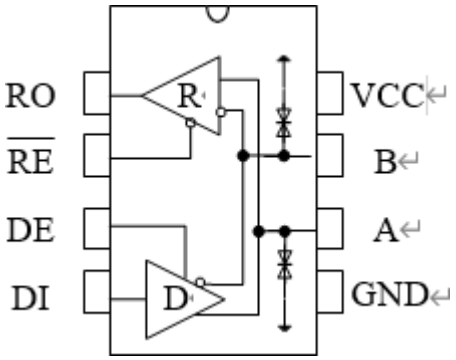
Both parts have power up/down mode, the glitch-free driver outputs permit live insertion or removal of the transceiver into/from the data bus. The CMOS design offers significant power savings without sacrificing ruggedness against overload or ESD damage. The typical quiescent current is only 300uA during operation and 1uA in shutdown mode. The ESP485 are intended for half-duplex communication and are available in SOP8.

3. Device Information

Part Number	Operating Temperature	Mark Code	Package Type	Shipping Qty
ESP485ESA	-40°C to 160°C	ESP485ESA	SOP8	2500pcs/13 Inch Tape & Reel
ESP485EPA	-40°C to 160°C	ESP485EPA	DIP8	50pcs/Tube

4. Pin Configuration





Terminal		Type	Description
Name	Number		
RO	1	Output	Receiver output
/RE	2	Input	Receiver output enable
DE	3	Input	Driver enable
DI	4	Input	Driver input
GND	5	Power	Ground
A	6	IO	Non-Inverting receiver input and Non-inverting driver output
B	7	IO	Inverting receiver input and inverting driver output
Vcc	8	Power	Power supply for RS-485 transceiver

5. Absolute Maximum Ratings

Symbol	Parameters	Value	Unit
VCC	Supply Voltage	+7	V
	Control Input Voltage (/RE, DE)	-0.3V to (VCC + 0.3V)	V
	Driver Input Voltage (DI)	-0.3V to (VCC + 0.3V)	V
	Driver Output Voltage (A, B)	-8 to +15	V
	Receiver Input Voltage (A, B)	-8 to +15	V
	Receiver Output Voltage (RO)	-0.3V to (VCC + 0.3V)	V
TA	Ambient Temperature	-40 to 125	˚C
TSTG	Storage Temperature Range	-60 to 150	˚C

6. Electrical Characteristics

(VCC = 3V to 5.5V, TA = TMIN to TMAX, unless otherwise noted. Typical values are at TA = +25°C.)

Parameter	Symbol	Comments	Min.	Typ.	Max.	Unit
Supply						
supply voltage	Vcc		3	5	5.5	V
supply current	Icc	receiver mode: /RE =0; DE =0; Vcc=5V		240	650	uA
		driver mode: /RE= 1;DE=1;Vcc= 5V		270	750	uA
		receiver mode: /RE=0; DE =0; Vcc= 3.3V		250	650	uA
		driver mode: /RE= 1;DE=1;Vcc=3.3V		280	750	uA
shut down current	Ishdn	/RE=VCC,DE=0,VCC=3.3V		0.2	10	uA
		/RE=VCC,DE=0,VCC=5V		0.2	10	uA
Logic						
logic input high	VIH		2			V
logic input low	VIL				0.8	V
DI Input Hysteresis	VHYS		10	30		mV
Receiver						

Three -State Output Current at Receiver	IOZR	0.4V<VO<2.4V			± 1	uA
Receiver Output Short Circuit Current	IOSR	0V≤VO≤VCC	± 8		± 90	mA
Receiver Output High Voltage	VOH	Va=2. .8V, Vb=2.5V, IRO=8mA	Vcc-1.5			V
Receiver Output Low Voltage	VOL	Va=2.5V, Vb=2.8V, IRO= -8mA			0.4	V
Receiver Input Resistance	RIN	-7V≤VCM≤12V	96			kQ
Receiver Differential Threshold Voltage	VTH		-200		-50	mV
Receiver Input Hysteresis	ΔVTH	-7V≤VCM≤12V		25		mV
Driver						
Differential Driver Output	VOD1	No load, Figure 1	3		5.5	V
Differential Driver Output	VOD2	RL=54Ω,Vcc=5V, Figure 1	1.5		VCC	V
Change -in-Magnitude of Differential Output Voltage	ΔVOD	RL=54Ω			0.2	V
Driver Common-Mode Output Voltage	VOC	RL=54Ω			3	V
Change-in-Magnitude of Common-Mode Voltage	ΔVOC	RL=54Ω			0.3	V
Driver Short-Circuit Output Current	IOSD	Vout= -7V	-250			mA
		Vout= 12V			250	

Switching Characteristics

Parameter	Symbol	Comments	Min.	Typ.	Max.	Unit
Driver						
Maximum Data Rate	f_{MAX}			15000		kbps
Driver Differential Output Delay	t_{DD}	RL=60Ω, Figure 3		20	40	ns
Driver Differential Output Transition Time	t_{TD}	RL=60Ω, Figure 3		12	28	ns
Driver Propagation Delay, Low-to-High Level	t_{PLH}	RL=27Ω, Figure 4		20	40	ns
Driver Propagation Delay, High-to-Low Level	t_{PHL}	RL=27Ω, Figure 4		20	40	ns
| tPLH – tPHL | Driver Propagation Delay Skew (Note2)	t_{PDS}	RL=27Ω, Figure 4		1	8	ns
Driver-Output Enable/Disable Times						
Driver Output Enable Time to Low Level	t_{PZL}	RL=110Ω, Figure 6			55	ns
Driver Output Enable Time to High Level	t_{PZH}	RL=110Ω, Figure 5			55	ns
Driver Output Disable Time from High Level	t_{PHZ}	RL=110Ω, Figure 5			85	ns
Driver Output Disable Time from Low Level	t_{PLZ}	RL=110Ω, Figure 6			85	ns
Driver Output Enable Time from Shutdown to Low Level	t_{PSL}	RL=110Ω, Figure 6		20	100	ns
Driver Output Enable Time from Shutdown to High Level	t_{PSH}	RL=110Ω, Figure 5		20	100	ns
Receiver						
Time to Shutdown	t_{SHDN}	(Note 3)	50		300	ns

Receiver Propagation Delay, Low-to-High Level	t_{RPLH}	VID=0 to 3.0V, CL=15pF, Figure 7		60		ns
Receiver Propagation Delay, High-to-Low Level	t_{RPHL}	VID=0 to 3.0V, CL=15pF, Figure 7		60		ns
| tRPLH – tRPHL | Receiver Propagation Delay Skew	t_{RPDS}	VID=0 to 3.0V, CL=15pF, Figure 7		3	10	ns
Receiver Output Enable Time to Low Level	t_{PRZL}	CL=15pF, Figure 8		100	300	ns
Receiver Output Enable Time to High Level	t_{PRZH}	CL=15pF, Figure 8		100	300	ns
Receiver Output Disable Time from High Level	t_{PRLZ}	CL=15pF, Figure 8		25	55	ns
Receiver Output Disable Time from Low Level	t_{PRLZ}	CL=15pF, Figure 8		25	55	ns
Receiver Output Enable Time from Shutdown to Low Level	t_{PRSL}	CL=15pF, Figure 8		100	300	ns
Receiver Output Enable Time from Shutdown to High Level	t_{PRSH}	CL=15pF, Figure 8		100	300	ns

Note 1: ΔV_{OD} and ΔV_{OC} are the changes in V_{OD} and V_{OC}, respectively, when the DI input changes state.

Note 2: Measured on $|t_{PLH}(A) - t_{PHL}(A)|$ and $|t_{PLH}(B) - t_{PHL}(B)|$.

Note 3: The transceivers 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 300ns, the parts are guaranteed to have entered shutdown. See Low-Power Shutdown Mode section.

7. Typical Operating Characteristics

(VCC = 3.3V, TA=+25ºC, unless otherwise noted.)

ESD Specifications

Parameter	Symbol	Comments	Min.	Typ.	Max.	Unit
ESD Protection for A, B to GND		Human Body Model		±15		kV
ESD Protection for other pins		Human Body Model		±8		kV

RS-485 Communication Function Table

Table1. Transmitting

INPUTS			OUTPUTS		MODE
$\overline{RE}$	DE	DI	B	A	
X	1	1	0	1	Normal
X	1	0	1	0	Normal
0	0	X	High-Z	High-Z	Normal
1	0	X	High-Z	High-Z	Shutdown

Table2. Receiving

INPUTS			OUTPUTS	MODE
$\overline{RE}$	DE	A, B	RO	
0	X	>-50mV	1	Normal
0	X	<-200mV	0	Normal
0	X	Inputs Open	1	Normal
1	0	X	High-Z	Shutdown

X=Don’t care; High-Z=High impedance

8. Test circuit and Typical Operating Circuit

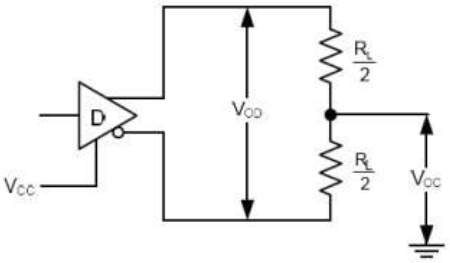


Figure 1 Driver V_{OD} and V_{OC}

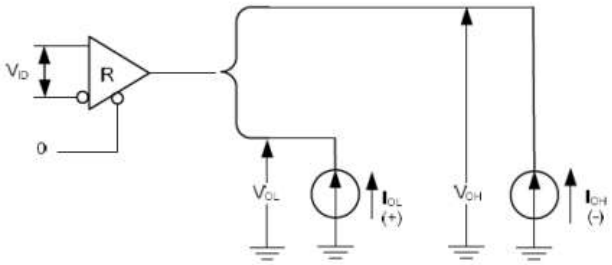
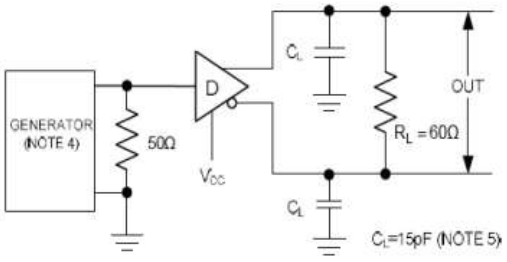


Figure 2 Receiver V_{OH} and V_{OL}



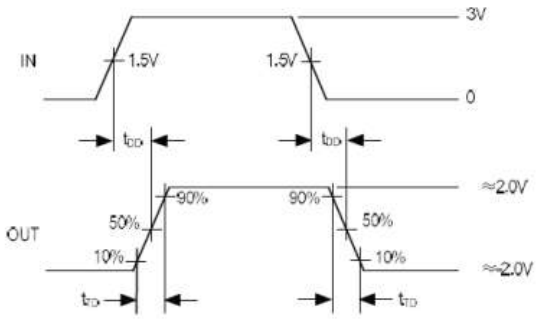
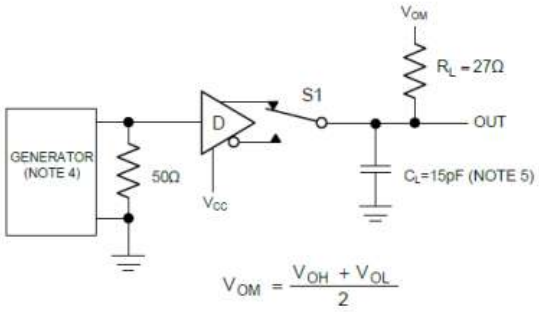


Figure 3 Driver Differential Output Delay and Transition Times



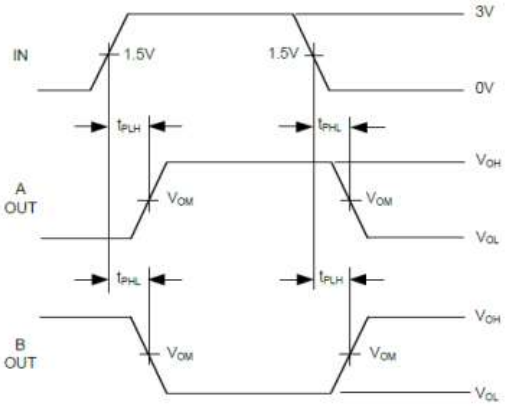
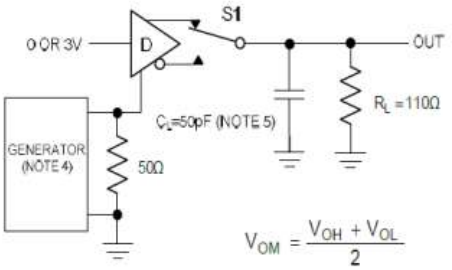


Figure 4 Driver Propagation Times



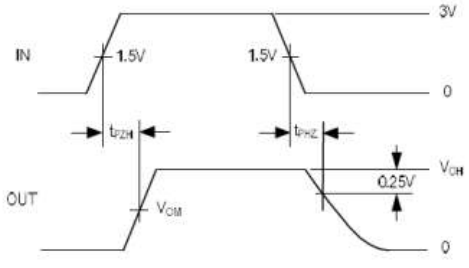


Figure 5 Driver Enable and Disable Times (t_{PZH}, t_{PSH}, t_{PHZ})

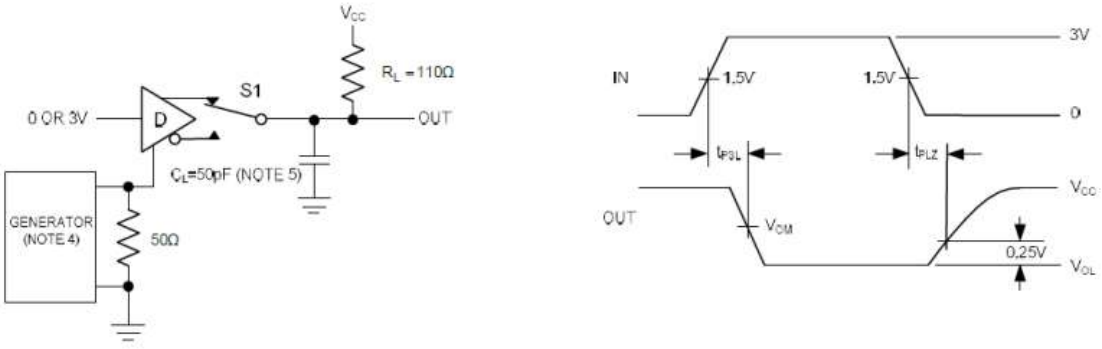


Figure 6 Driver Enable and Disable Times (t_{PZL}, t_{PSL}, t_{PLZ})

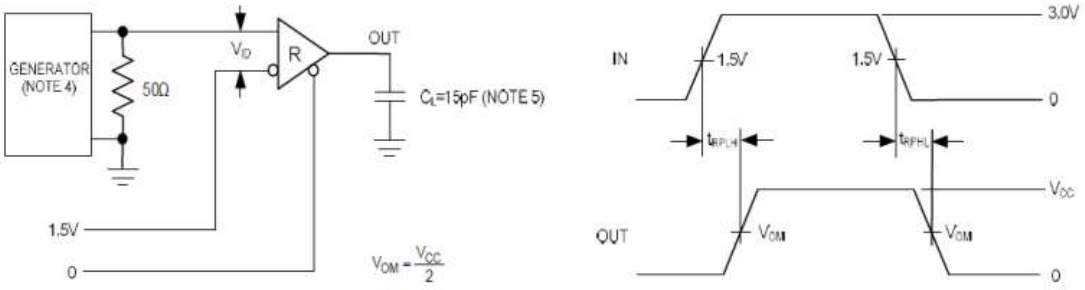


Figure 7 Receiver Propagation Delay

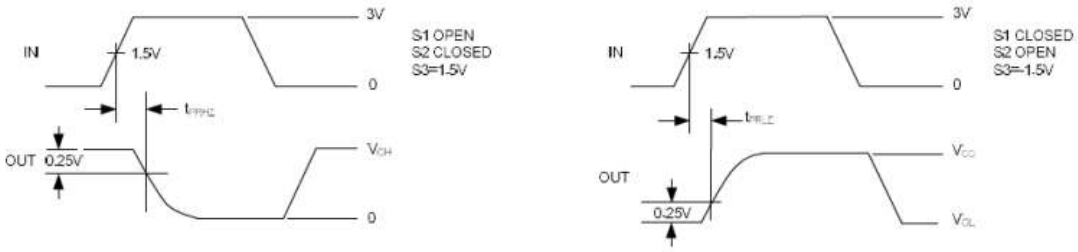


Figure 8 Receiver Enable and Disable Times

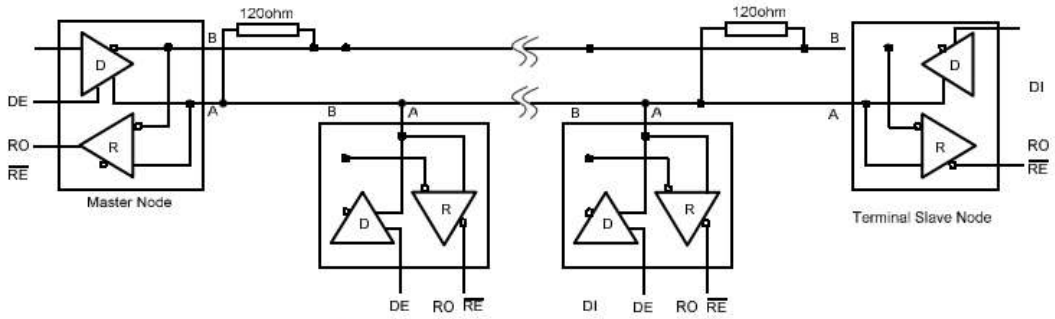


Figure 9 Typical Half-Duplex RS-485 Network

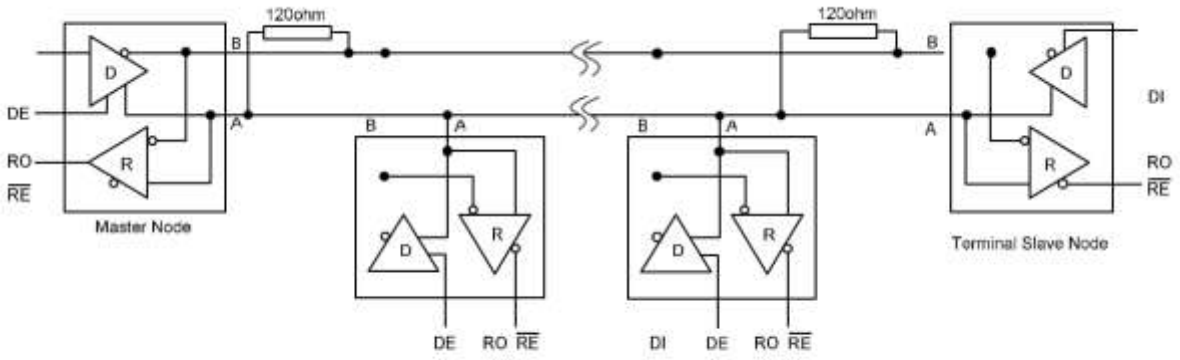


Figure 9 Typical Half-Duplex RS-485 Network

9. Detail Description

Detail Function Description

ESP485 series are low-power transceivers for RS-485 communications, which could support the data rates up to 15 Mbps. All parts are half-duplex. Driver Enable (DE) and Receiver Enable ($\overline{RE}$) pins are included. When disabled, the driver and receiver outputs are high impedance.

Full Fail-Safe

All the receivers include a “full fail-safe” function that guarantees a high-level receiver output if the receiver inputs are unconnected (floating), shorted together, or connected to a terminated bus with all the transmitters disabled. Receivers easily meet the data rates supported by the corresponding driver, and all receiver outputs are three-stable via the active low RE input.

ESD Protection

All pins on these devices include 2kV Human Body Model (HBM) ESD protection structures, but the RS-485 pins (driver outputs and receiver inputs) incorporate advanced structures allowing them to survive ESD events in excess of ±15kV HBM.

Low-Power Shutdown Mode

Low-power shutdown mode is initiated by bringing both /RE high and DE low. In shutdown, the device typically draws only 1uA 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 300ns, the parts are guaranteed to enter shutdown. Enable times t_{PZH} and t_{PZL} in the Switching Characteristics tables assume the part was not in a low-power shutdown state. Enable times t_{PSH} and t_{PSL} assume the parts were shut down. It takes drivers and receivers longer to become enabled from low-power shutdown mode (t_{PSH}, t_{PSL}) than from driver/receiver-disable mode (t_{PZH}, t_{PZL}).

Support 256 transceivers on the bus

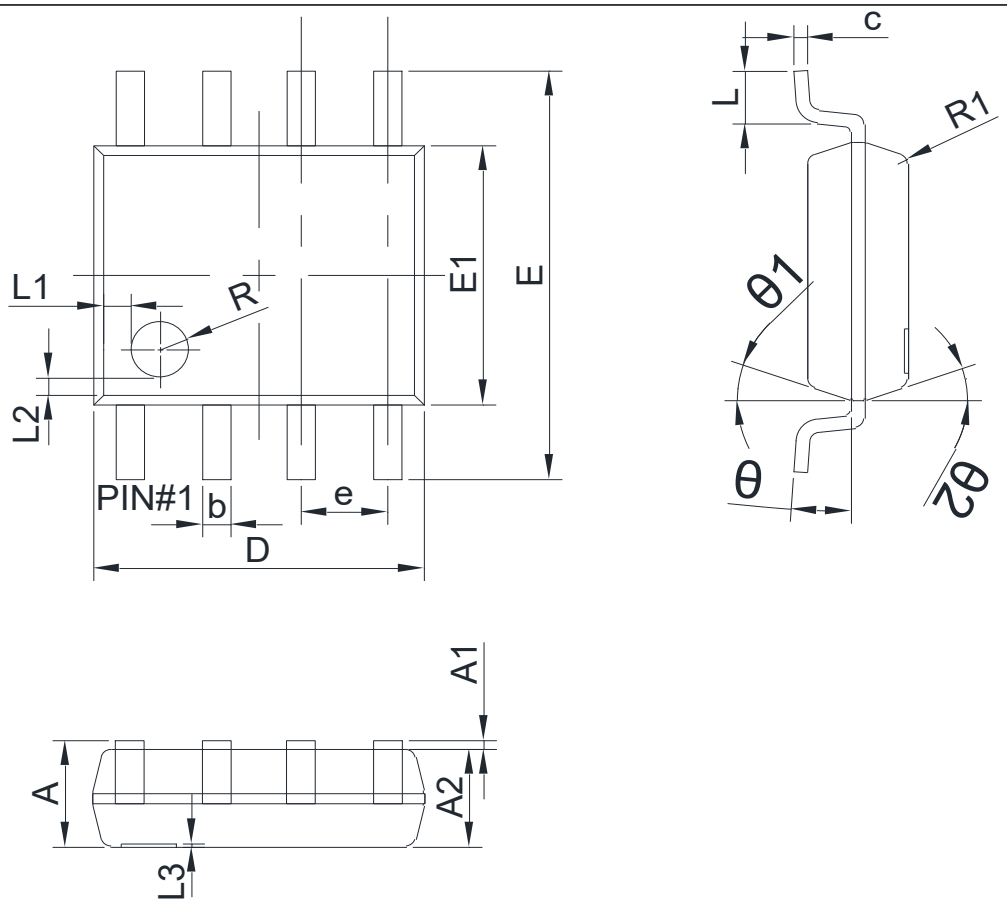
The standard RS-485 receiver input impedance is 12kΩ (one unit load), and the standard driver can drive up to 32-unit loads. The transceivers have a 1/8-unit load receiver input impedance (96kΩ), allowing up to 256 transceivers to be connected in parallel on one communication line. Any combination of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

Driver Output Protection

Two mechanisms prevent excessive output current and power dissipation caused by faults or bus contention. First, a foldback current limit on the output stage, provides immediate protection against short circuits over the whole common-mode voltage range. Second, a thermal shutdown circuit, forces the driver outputs into a high-impedance state if the die temperature becomes excessive.

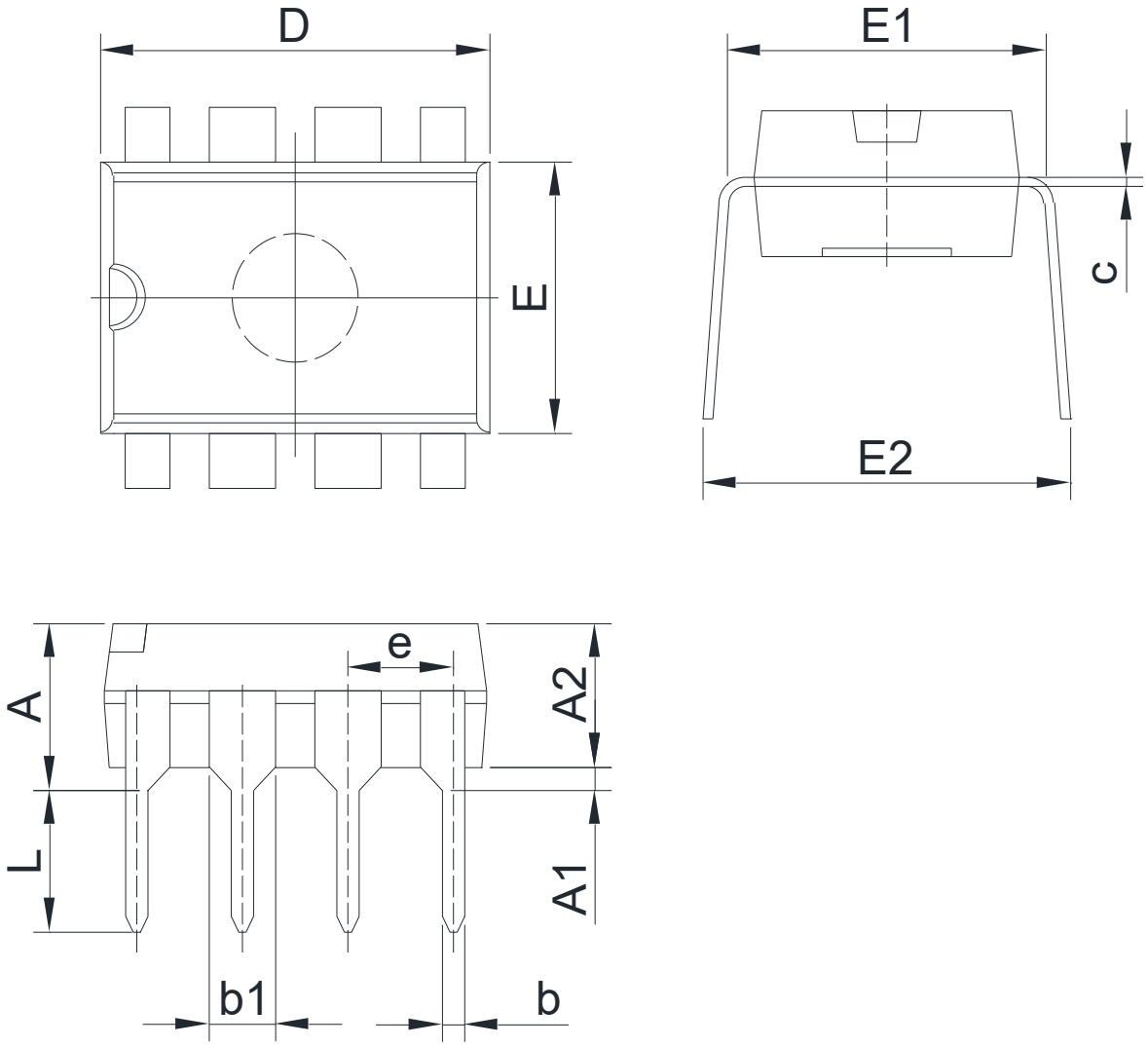
10. Package Information

SOP-8



Symbol	Millimeters			Symbol	Millimeters		
	Min	Typ	Max		Min	Typ	Max
A	1.35	1.57	1.75	L	0.40	0.60	0.80
A1	0.10	0.17	0.25	L1	0.30	0.40	0.50
A2	1.35	1.45	1.55	L2	0.20	0.25	0.30
b	0.33	0.43	0.53	L3	0.035	0.040	0.045
c	0.17	0.22	0.25	θ	0°	-	8°
D	4.70	4.90	5.10	θ1	9°	10°	11°
E	5.80	6.00	6.20	θ2	11°	12°	13°
E1	3.80	3.90	4.00	R	0.35	0.40	0.45
e	1.27(BSC)			R1	0.10	0.15	0.20

DIP8



Symbol	Millimeters		Symbol	Millimeters	
	Min	Max		Min	Max
A	3.71	4.80	D	9.00	9.50
A1	0.38	-	E	6.20	6.60
A2	3.20	3.60	E1	7.32	7.92
b	0.38	0.57	E2	8.40	9.05
b1	1.52 BSC		e	2.54 TYP	
c	0.20	0.36	L	3.00	3.60

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