5V,15kV ESD-protected RS485 transceiver

1. Features

- ESD Protection for RS-485 I/O Pins
- 15kV—Human Body Model
- 15kV—IEC61000-4-2, Air-Gap Discharge
- 8kV—IEC61000-4-2, Contact Discharge
- 5V Supply Voltage Range
- Enhanced Slew-Rate Limiting Facilitates Error-Free Data Transmission
- 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
- Data transmission up to 2.5Mbps

2. 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

3. Description

The MAX485EESA+T(ES) are 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). The MAX485EESA+T(ES) features slew-rate-limited driver which minimizes EMI and reduces reflections resulted from improperly terminated cables.

The MAX485EESA+T(ES) also feature enhanced electrostatic discharge (ESD) protection. All of the transmitter outputs and receiver inputs are protected to ±15kV using IEC61000-4-2 Air-Gap Discharge, ±15kV using the Human Body Model and ±8kV using IEC61000-4-2 Contact Discharge.

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. And the fail-safe feature of the receiver input guarantees a logic-high output if both inputs are open, shorted or idle.

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 MAX485EESA+T(ES) are intended for half-duplex communication and are available in SOP8 and DIP8 packages.

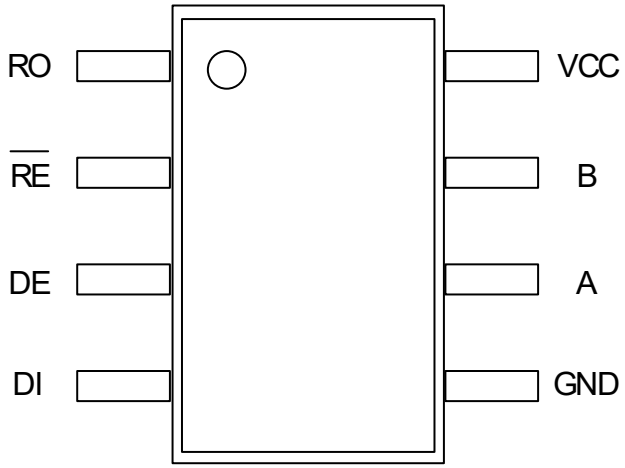
4. Device Information

Part Number	Operating Temperature	Mark Code	Package Type	Shipping Qty
MAX485EESA+T(ES)	-40°C to +85°C	MAX485EESA+T(ES)	SOP8	3000pcs/13 Inch Tape & Reel
MAX485EEPA+T(ES)	-40°C to +85°C	MAX485EEPA+T(ES)	DIP8	50pcs/Tube

5. Selection Guide

Part Number	Guaranteed Date Rate(Mbps)	Low-Power Shutdown	Slew-Rate Limited	Driver/Reciever Enable	Shutdown Current(uA)	Transceivers On Bus	±15KV ESD Protection
MAX485EESA+T(ES)	2.5	Yes	Yes	Yes	1	256	Yes

6. Pin Configuration



7. 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)		-7 to +12	V
	Receiver Input Voltage (A, B)		-7 to +12	V
	Receiver Output Voltage (RO)		-0.3V to (VCC + 0.3V)	V
PD	Continuous Power Dissipation at TA = 70°C	DIP8	727	mW
		SOP8	471	
TA	Ambient Temperature		-40 to +85	˚C
TSTG	Storage Temperature Range		-65 to 160	˚C
TL	Lead Temperature for Soldering 10 seconds		+300	˚C

8. Electrical Characteristics

(VCC = 5V, TA = TMIN to TMAX, unless otherwise noted. Typical values are at TA = +25°C.)

Parameter	Symbols	Test Condition		Min	Typ	Max	Unit
SUPPLY CURRENT							
Supply Current	I_{CC}	No load, DI = GND or VCC	DE=VCC, /RE=0V or VCC	0.15		1	mA
			DE=0V, /RE=0V	0.15		1	
Supply Current in Shutdown Mode	I_{SHDN}	DE=0V, /RE=VCC, DI=VCC or 0				1	uA
LOGIC							
Input High Voltage	V_{IH}	DE, DI, /RE		2.0			V
Input Low Voltage	V_{IL}	DE, DI, /RE				0.8	V
Logic Input Current	I_{IN1}	DE, DI, /RE				1	uA
DRIVER							
Differential Driver Output	V_{OD}	No Load	VCC=5V			5	V
		RL=54	VCC=5V	1.2			
		RL=60	VCC=5V	1.3			
Change in Magnitude of Driver Differential Output Voltage for Complementary Output States (Note 1)	ΔV_{OD}	RL=54Ω or 100Ω				0.2	V

Driver Common-Mode Output Voltage	V_{OC}	RL=54Ω or 100 Ω			3	V
Change in Magnitude of Common-Mode Output Voltage (Note 1)	ΔV_{OC}	RL=54Ω or 100 Ω			0.2	V
Driver Short-Circuit Output Current	I_{OSD}	VOUT = -7V			-250	mA
		VOUT = 12V			+250	
RECEIVER						
Receiver Differential Threshold Voltage	V_{TH}	-7V≤VCM≤12V	-0.2	-0.05	0.2	V
Receiver Input Hysteresis	ΔV_{TH}	VCM=0V		25		mV
Receiver Input Resistance	R_{IN}	-7V≤VCM≤12V	96			kΩ
Input Current (A, B)	I_{IN2}	DE=0V, VCC=0V or 5V, VIN = 12V			1	mA
		DE=0V, VCC=0V or 5V, VIN = -7V			-0.8	
Receiver Output High Voltage	V_{OH}	IOUT=-1.5mA, VID=200mV	Vcc-1.5			V
Receiver Output Low Voltage	V_{OL}	IOUT=2.5mA, VID=200mV			0.4	V
Three-State (High Impedance) Output Current at Receiver	I_{OZR}	0V≤VOUT≤VCC			1	uA
Receiver Short-Circuit Output Current	I_{OSR}	0V≤VRO≤VCC	±20		±60	mA
ESD PROTECTION						
ESD Protection for A, B		Human Body Model		±15		kV
		IEC61000-4-2 Air Discharge		±15		
		IEC61000-4-2 Contact Discharge		±8		

Driver Switching Characteristics

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
Maximum Data Rate	f_{MAX}			2500		kbps
Driver Differential Output Delay	t_{DD}	R_L=60Ω	20	50	100	ns

Driver Differential Output Transition Time	t_{TD}	R_L=60Ω	20	50	100	ns
Driver Propagation Delay, Low-to-High Level	t_{PLH}	R_L=27Ω	25	55	100	ns
Driver Propagation Delay, High-to-Low Level	t_{PHL}	R_L=27Ω	25	55	100	ns
| t_{PLH} – t_{PHL} | Driver Propagation Delay Skew (Note 2)	t_{PDS}	R_L=27Ω		2	10	ns
Driver-Output Enable/Disable Times						
Driver Output Enable Time to Low Level	t_{PZL}	R_L=110Ω		60	100	ns
Driver Output Enable Time to High Level	t_{PZH}	R_L=110Ω		60	100	ns
Driver Output Disable Time from High Level	t_{PHZ}	R_L=110Ω		60	100	ns
Driver Output Disable Time from Low Level	t_{PLZ}	R_L=110Ω		60	100	ns
Driver Output Enable Time from Shutdown to Low Level	t_{PSL}	R_L=110Ω		500	800	ns
Driver Output Enable Time from Shutdown to High Level	t_{PSH}	R_L=110Ω		500	800	ns

Receiver Switching Characteristics

(VCC = 5V, TA = +25°C.)

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
Time to Shutdown	t_{SHDN}	Note 3	50	200	600	ns
Receiver Propagation Delay, Low-to-High Level	t_{RPLH}	V_{ID}=0 to 3.0V, C_L=15pF		100	200	ns
Receiver Propagation Delay, High-to-Low Level	t_{RPHL}	V_{ID}=0 to 3.0V, C_L=15pF		100	200	ns
| tRPLH – tRPHL | Receiver Propagation Delay Skew	t_{RPDS}	V_{ID}=0 to 3.0V, C_L=15pF			30	ns
Receiver Output Enable Time to Low Level	t_{PRZL}	C_L=15pF		20	100	ns

Receiver Output Enable Time to High Level	t_{PRZH}	C_L=15pF		20	100	ns
Receiver Output Disable Time from High Level	t_{PRHZ}	C_L=15pF		30	200	ns
Receiver Output Disable Time from Low Level	t_{PRLZ}	C_L=15pF		30	200	ns
Receiver Output Enable Time from Shutdown to Low Level	t_{PRSL}	C_L=15pF		20	100	ns
Receiver Output Enable Time from Shutdown to High Level	t_{PRSH}	C_L=15pF		20	100	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 80ns, 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.

9. Typical Operating Characteristics

(VCC = 5V, TA=+25ºC, unless otherwise noted.)

Pin Description

Pin Number	Symbol	Function
1	RO	Receiver Output. If A＞B by -50mV, RO will be high; if A＜B by 200mV, RO will be low.
2	$\overline{RE}$	Receiver Output Enable. RO is enabled when $\overline{RE}$ is low; RO is high impedance when RE is high. Drive $\overline{RE}$ high and DE low to enter low-power shutdown mode.
3	DE	Driver Output Enable. The driver outputs are enabled by bringing DE high. They are high impedance when DE is low. If $\overline{RE}$ is high and DE is low, the device will enter a low-power shutdown mode. 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	DI	Driver Input. A low on DI forces output A low and output B high. Similarly, a high on DI forces output A high and output B low.
5	GND	Ground
6	A	Non-inverting Receiver Input and Non-inverting Driver Output
7	B	Inverting Receiver Input and Inverting Driver Output.

8	Vcc	Positive Supply: 5V

RS-485 Communication Function Table

Table1. Transmitting

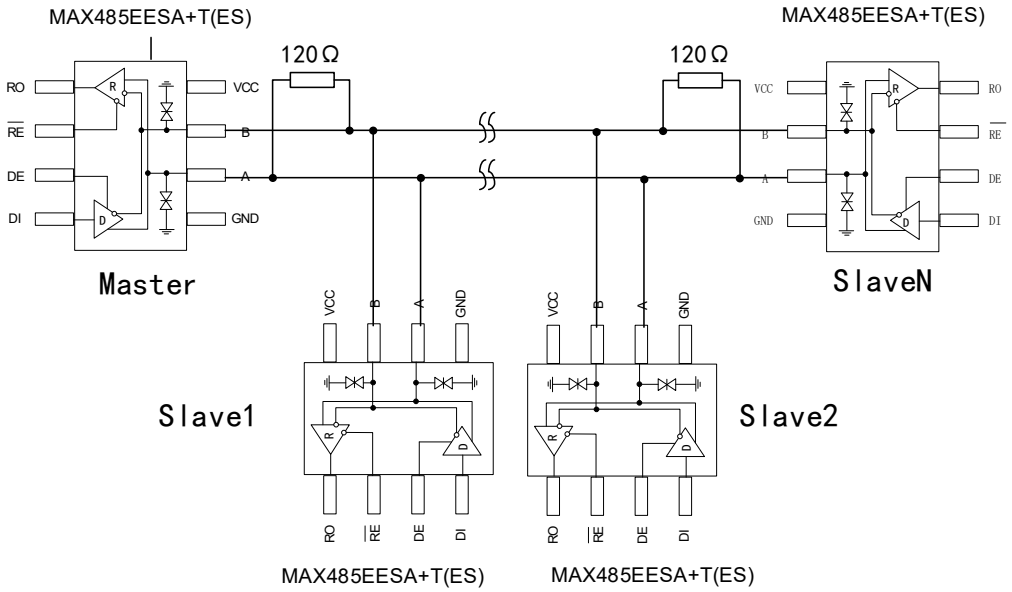
INPUTS			OUTPUTS		MODE
$\overline{RE}$	DE	DI	B	A	
X	1	1	0	1	Normal
X	1	0	1	0	Normal
0	0	X	High-Z	High-Z	Normal
1	0	X	High-Z	High-Z	Shutdown

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

10. Tipical Operating Circuit



11. Detail Description

The MAX485EESA+T(ES) are low-power transceivers for RS-485 communications. MAX485EESA+T(ES) realizes error-free data transmission up to 2.5Mbps. The MAX485EESA+T(ES) are half-duplex. Driver Enable (DE) and Receiver Enable (/RE) pins are included on the MAX485EESA+T(ES). When disabled, the driver and receiver outputs are high impedance.

Fail-Safe

The MAX485EESA+T(ES) 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 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 thresholds of the MAX485EESA+T(ES), 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.

±15kV ESD Protection

As with all ElecSuper devices, ESD-protection structures are incorporated on all pins to protect against electrostatic discharges encountered during handling and assembly. The driver outputs and receiver inputs of the MAX485EESA+T(ES) have extra protection against static electricity. ElecSuper's engineers have developed state-of-the-art structures to protect these pins against ESD of ±15kV without damage. The ESD-protected pins are tested with reference to the ground pin in a power-down condition. They are tested to ±15kV using the Human Body Model.

Applications Information

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 ElecSuper family of 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.

Reduced EMI and Reflections

The MAX485EESA+T(ES) are slew-rate-limited, minimizing EMI and reducing reflections caused by improperly terminated cables. In general, a transmitter's rise time relates directly to the length of an unterminated stub, which can be driven with only minor waveform reflections. The following equation expresses this relationship conservatively:

Length=tRISE/(10×1.5ns/ft)

Where tRISE is the transmitter's rise time.A system can work well with longer unterminated stubs, even with severe reflections, if the waveform settles out before the UART samples them.

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 600ns, the parts are guaranteed to enter shutdown. Enable times tPZH and tPZL in the Switching Characteristics tables assume the part was not in a low-power shutdown state. Enable times tPSH and tPSL assume the parts were shut down. It takes drivers and receivers longer to become enabled from low-power shutdown mode (tPSH, tPSL) than from driver/receiver-disable mode (tPZH, tPZL).

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.

Propagation Delay

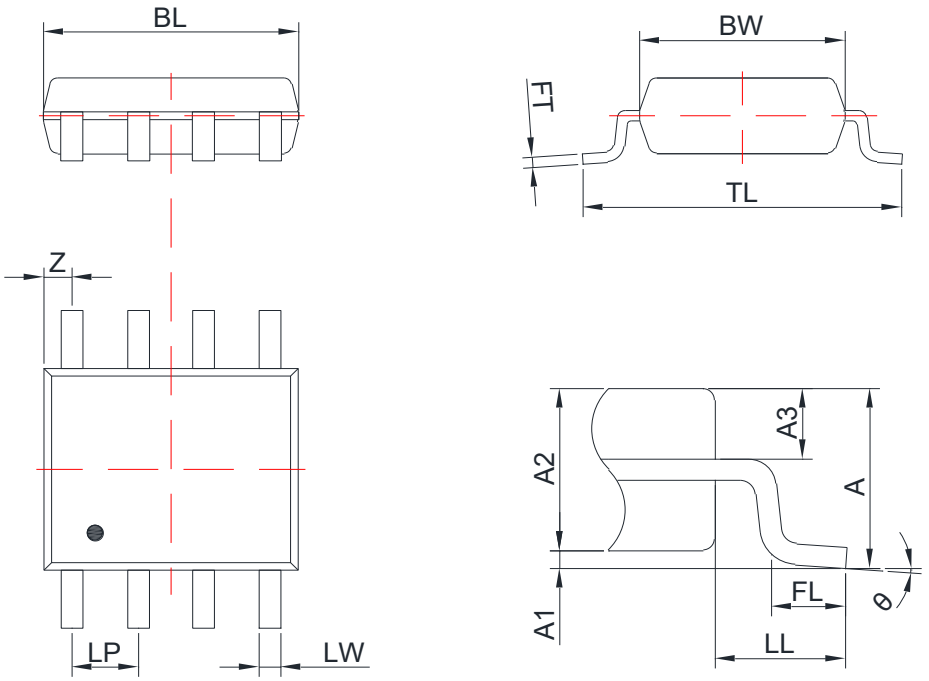
Skew time is simply the difference between the low-to-high and high-to-low propagation delay. Small driver/receiver skew times help maintain a symmetrical mark-space ratio (50% duty cycle). The driver skew times 12ns for the MAX485EESA+T(ES).

Typical Applications

The MAX485EESA+T(ES) transceivers are designed for bidirectional data communications on multipoint bus transmission lines. To minimize reflections, the line should be terminated at both ends in its characteristic impedance, and stub lengths of the main line should be kept as short as possible. The partially slew-rate-limited MAX485EESA+T(ES) are more tolerant of imperfect termination.

12. Package Information

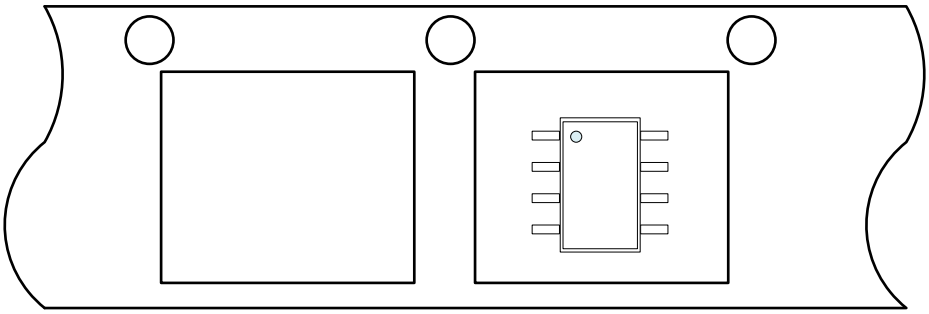
SOP8



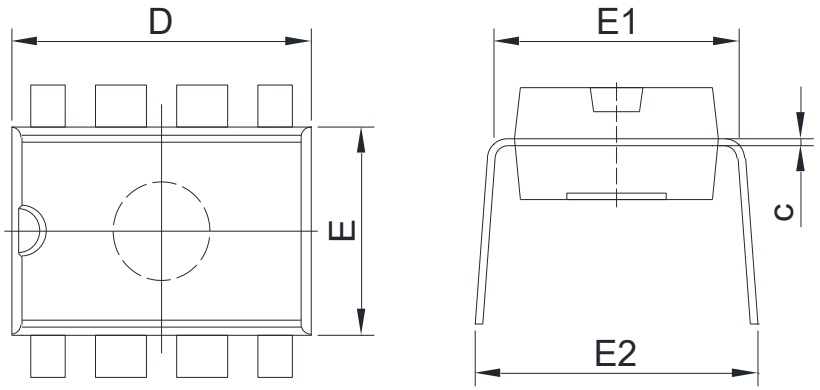
Units:milimeter

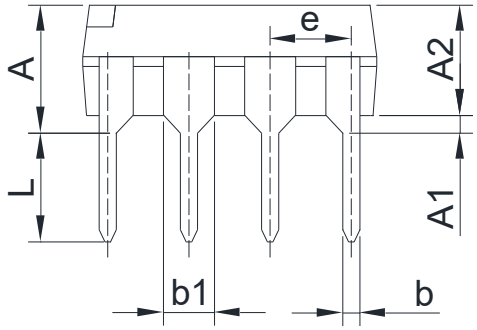
Symbol	Dimensions		Symbol	Dimensions	
	Min.	Max.		Min.	Max.
A	1.35	1.75	FL-L	0.40	1.27
A1	0.10	0.25	LP-e	1.27BSC	
A2	1.25	1.65	LL 无	0.90	1.10
A3 无	0.600	0.65	LW-b	0.30	0.51
BL-D	4.70	5.10	TL-E1	5.80	6.20
BW-E	3.80	4.00	Z 无	0.50	0.55
FT-C	0.15	0.25	θ	0°	8°

Tape and Reel Orientation



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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