March 17, 2022

Description

The SP481E and SP485E are a family of half-duplex transceivers that meet the specifications of RS-485 and RS-422 serial protocols with enhanced ESD performance. The ESD tolerance has been improved on these devices to over ±15kV for both Human Body Model and IEC61000-4-2 Air Discharge Method. These devices are pin-to-pin compatible with MaxLinear's SP481 and SP485 devices as well as popular industry standards. As with the original versions, the SP481E and SP485E feature Maxlinear's BiCMOS design allowing low power operation without sacrificing performance. The SP481E and SP485E meet the requirements of the RS-485 and RS-422 protocols up to 10Mbps under load. The SP481E is equipped with a low power shutdown mode.

FEATURES
- 5V only
- Low power BiCMOS
- Driver / receiver enable for multi-drop configurations
- Low power shutdown mode (SP481E)
- Enhanced ESD specifications:
  - ±15kV Human Body Model
  - ±15kV IEC61000-4-2 Air Discharge
  - ±8kV IEC61000-4-2 Contact Discharge
- Available in RoHS compliant, lead free packaging.

Ordering Information - Back Page

Block Diagram
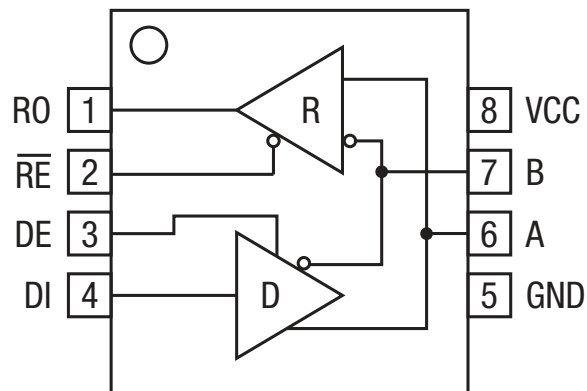
SP481E and SP485E

Absolute Maximum Ratings

These are stress ratings only and functional operation of the device at these ratings or any other above those indicated in the operation sections of the specifications below is not implied. Exposure to absolute maximum rating conditions for extended periods of time may affect reliability.

V_{CC}..7.0V

Input Voltages

Logic .... -0.3V to (V_{CC} + 0.5V)

Drivers......................-0.3V to (V_{CC} + 0.5V)

Receivers..±15V

Output

Logic .... -0.3V to (V_{CC} + 0.5V)

Drivers ....±15V

Receivers..................-0.3V to (V_{CC} + 0.5V)

Receiver output current ....±95mA

Storage Temperature ....-65˚C to +150˚C

Power Dissipation

8-pin NSOIC 550mW

(derate 6.60mW/°C above +70°C)

ESD Ratings

HBM - Human Body Model (A and B pins).................±15kV

HBM - Human Body Model (All other pins).................. ±3kV

IEC61000-4-2 Air Discharge (A and B pins)...............±15kV

IEC61000-4-2 Contact Discharge (A and B pins).........±8kV

Electrical Characteristics

T_{AMB} = T_{MIN} to T_{MAX} and V_{CC} = 5V ±5% unless otherwise noted.

PARAMETERS	MIN.	TYP.	MAX.	UNITS	CONDITIONS
SP481E / SP485E Driver DC Characteristics					
Differential output voltage			V_{CC}	V	Unloaded; R = ∞Ω ; Figure 1
Differential output voltage	2		V_{CC}	V	With load; R = 50Ω (RS-422); Figure 1
Differential output voltage	1.5		V_{CC}	V	With load; R = 27Ω (RS-485); Figure 1
Change in magnitude of driver differential output voltage for complimentary states			0.2	V	R = 27Ω or R = 50Ω; Figure 1
Driver common-mode output voltage			3	V	R = 27Ω or R = 50Ω; Figure 1
Input high voltage	2.0			V	Applies to DE, DI, $\overline{RE}$
Input low voltage			0.8	V	Applies to DE, DI, $\overline{RE}$
Input current			±10	µA	Applies to DE, DI, $\overline{RE}$
Driver short circuit current V_{OUT} = HIGH			±250	mA	-7V ≤ V_O ≤ 12V

Electrical Characteristics (Continued)

$T_{AMB} = T_{MIN}$ to T_{MAX} and V_{CC} = 5V ±5% unless otherwise noted.

PARAMETERS	MIN.	TYP.	MAX.	UNITS	CONDITIONS
Driver short circuit current V_{OUT} = LOW			±250	mA	-7V ≤ V_O ≤ 12V
SP481E / SP485E Driver AC Characteristics					
Maximum data rate	10			Mbps	$\overline{RE}$ = 5V, DE = 5V; R_{DIFF} = 54Ω, C_{L1} = C_{L2} = 100pF
Driver input to output, t_{PLH}		30	60	ns	See Figures 3 & 5, R_{DIFF} = 54Ω, C_{L1} = C_{L2} = 100pF
Driver input to output, t_{PLH} (SP485EMN ONLY)		30	80	ns	See Figures 3 & 5, R_{DIFF} = 54Ω, C_{L1} = C_{L2} = 100pF
Driver input to output, t_{PHL}		30	60	ns	See Figures 3 & 5, R_{DIFF} = 54Ω, C_{L1} = C_{L2} = 100pF
Driver input to output, t_{PHL} (SP485EMN ONLY)		30	80	ns	See Figures 3 & 5, R_{DIFF} = 54Ω, C_{L1} = C_{L2} = 100pF
Driver skew		5	10	ns	See Figures 3 and 5, t_{SKEW} = |t_{DPHL} - t_{DPLH}|
Driver rise or fall time		15	40	ns	From 10%-90%; R_{DIFF} = 54Ω C_{L1} = C_{L2} = 100pF; See Figures 3 and 6
Driver enable to output high		40	70	ns	C_L = 100pF, See Figures 4 and 6, S_2 closed
Driver enable to output low		40	70	ns	C_L = 100pF, See Figures 4 and 6, S_1 closed
Driver disable time from high		40	70	ns	C_L = 100pF, See Figures 4 and 6, S_2 closed
Driver disable time from low		40	70	ns	C_L = 100pF, See Figures 4 and 6, S_1 closed
SP481E / SP485E Receiver DC Characteristics					
Differential input threshold	-0.2		0.2	Volts	-7V ≤ V_{CM} ≤ 12V
Differential input threshold (SP485EMN ONLY)	-0.4		0.4	Volts	-7V ≤ V_{CM} ≤ 12V
Input hysteresis		20		mV	V_{CM} = 0V
Output voltage high	3.5			Volts	V_{ID} = 200mV, I_O = -4mA
Output voltage low			0.4	Volts	V_{ID} = 200mV, I_O = 4mA
Three-state (high impedance) output current			±1	µA	0.4V ≤ V_O ≤ 2.4V; $\overline{RE}$ = 5V
Input resistance	12	15		kΩ	-7V ≤ V_{CM} ≤ 12V
Input current (A, B); V_{IN} = 12V			1.0	mA	DE = 0V, V_{CC} = 0V or 5.25V, V_{IN} = 12V
Input current (A, B); V_{IN} = -7V			-0.8	mA	DE = 0V, V_{CC} = 0V or 5.25V, V_{IN} = -7V
SP481E / SP485E Receiver AC Characteristics					
Maximum data rate	10			Mbps	$\overline{RE}$ = 0V, DE = 0V
Receiver input to output	20	45	100	ns	t_{PLH} ; See Figures 3 & 7, R_{DIFF} = 54Ω, C_{L1} = C_{L2} = 100pF
Receiver input to output	20	45	100	ns	t_{PHL} ; See Figures 3 & 7, R_{DIFF} = 54Ω, C_{L1} = C_{L2} = 100pF
Differential receiver skew |t_{PHL} - t_{PLH}|		13		ns	R_{DIFF} = 54Ω, C_{L1} = C_{L2} = 100pF, See Figures 3 and 7
Receiver enable to output low		45	70	ns	C_{RL} = 15pF, Figures 2 & 8; S_1 Closed
Receiver enable to output high		45	70	ns	C_{RL} = 15pF, Figures 2 & 8; S_2 Closed
Receiver Disable from low		45	70	ns	C_{RL} = 15pF, Figures 2 & 8; S_1 Closed

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Electrical Characteristics, Continued

$T_{AMB} = T_{MIN}$ to T_{MAX} and V_{CC} = 5V ±5% unless otherwise noted

PARAMETERS	MIN.	TYP.	MAX.	UNITS	CONDITIONS
Receiver Disable from high		45	70	ns	C_{RL} = 15pF, Figures 2 & 8; S_2 Closed
SP481E Shutdown Timing					
Time to shutdown	50	200	600	ns	$\overline{RE}$ = 5V, DE = 0V
Driver enable from shutdown to output high		40	100	ns	C_L = 100pF; See Figures 4 and 6; S_2 Closed
Driver enable from shutdown to output low		40	100	ns	C_L = 100pF; See Figures 4 and 6; S_1 Closed
Receiver enable from shutdown to output high		300	1000	ns	C_L = 15pF; See Figures 2 and 8; S_2 Closed
Receiver enable from shutdown to output low		300	1000	ns	C_L = 15pF; See Figures 2 and 8; S_1 Closed
Power Requirements					
Supply voltage V_{CC}	4.75		5.25	Volts	
Supply current					
No load		900		µA	$\overline{RE}$, DI = 0V or V_{CC}; DE = V_{CC}
		600		µA	$\overline{RE}$ = 0V, DI = 0V or 5V; DE = 0V
Shutdown mode (SP481E)			10	µA	DE = 0V, $\overline{RE}$ = V_{CC}
Environmental and Mechanical					
Operating Temperture					
Commercial (_C_)	0		70	°C	
Industrial (_E_)	-40		85	°C	
(_M_)	-40		125	°C	
Storage Temperature	-65		150	°C	
Package					
NSOIC (_N)					

Pin Functions

RO 1
$\overline{RE}$ 2
DE 3
DI 4
R
D
8 VCC
7 B
6 A
5 GND
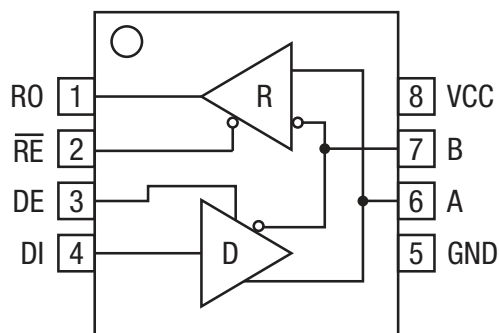
SP481E and SP485E
Pinout (Top View)

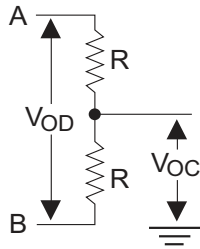| Pin Number	Pin Name	Description
1	RO	Receiver output
2	$\overline{RE}$	Receiver output enable active LOW
3	DE	Driver output enable active HIGH
4	DI	Driver input
5	GND	Ground connection
6	A	Non-inverting driver output / receiver input
7	B	Inverting driver output / receiver input
8	VCC	Positive supply 4.75V ≤ Vcc ≤ 5.25V

Test Circuits

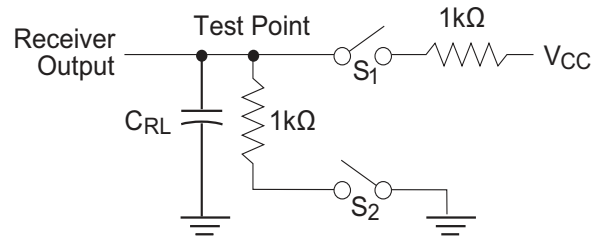Figure 1: RS-485 Driver DC Test Load Circuit

Figure 2: Receiver Timing Test Load Circuit

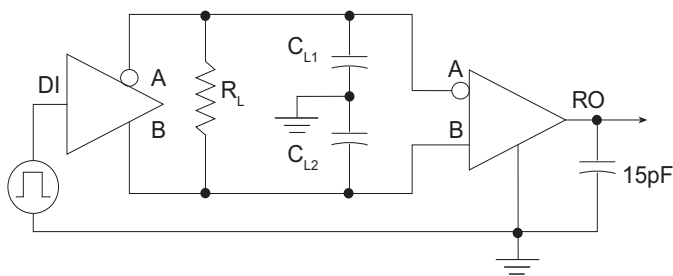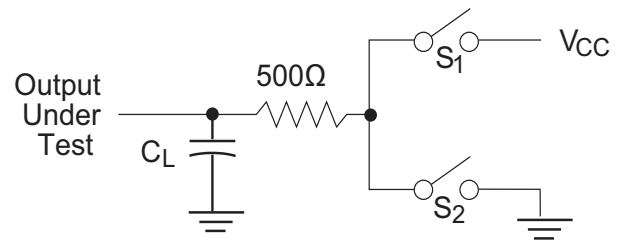Figure 3: RS-485 Driver/Receiver Timing Test Circuit

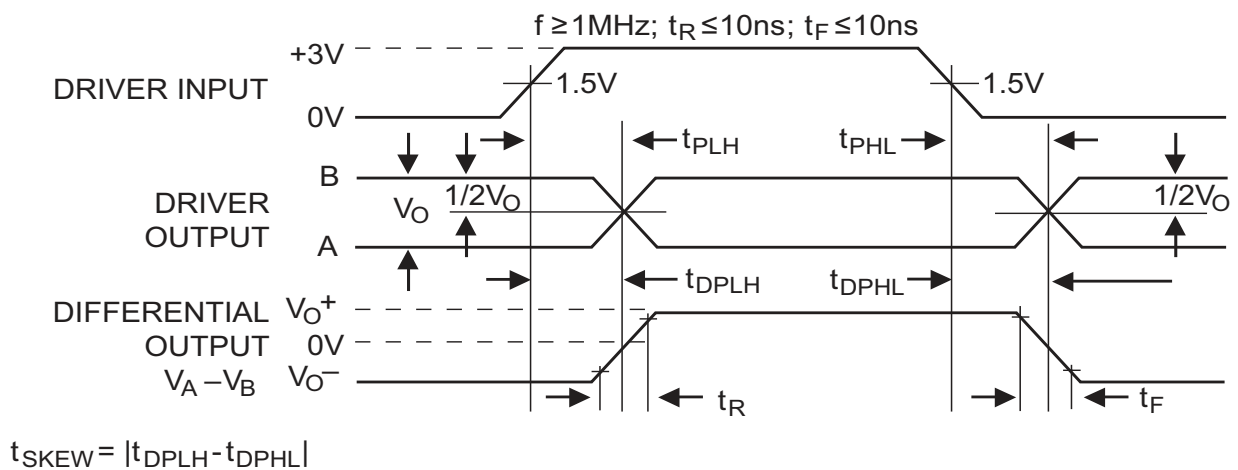Figure 4: Driver Timing Test Load #2 Circuit

Switching Waveforms

$f \geq 1MHz; t_R \leq 10ns; t_F \leq 10ns$

$t_{SKEW} = |t_{DPLH} - t_{DPHL}|$

Figure 5: Driver Propagation Delays

Switching Waveforms (Continued)

f = 1MHz; $t_R \le$ 10ns; $t_F \le$ 10ns

DE +3V / 0V 1.5V t_{ZL} 1.5V t_{LZ}

A,B 5V / V_{OL} 2.3V Output normally LOW 0.5V

A,B V_{OH} / 0V 2.3V Output normally HIGH 0.5V t_{ZH} t_{HZ}
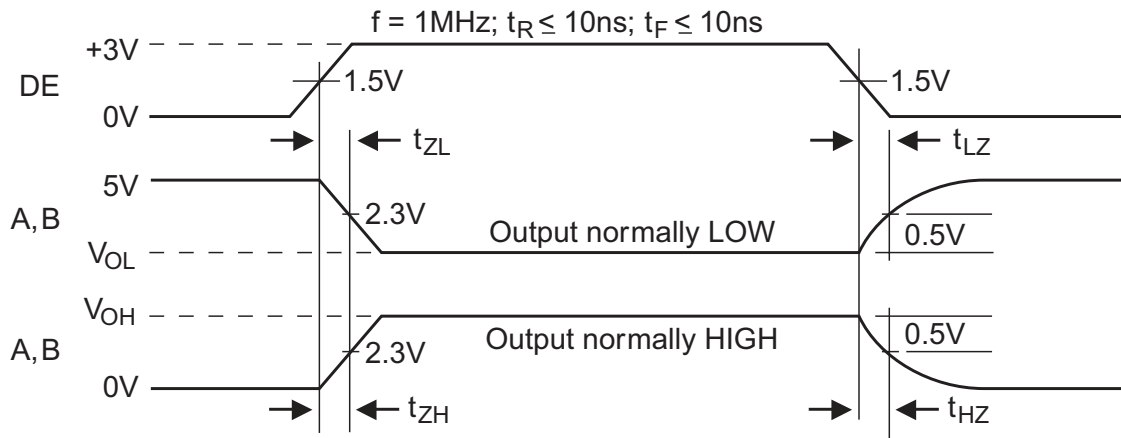
Figure 6: Driver Enable and Disable Times

f = 1MHz; $t_R \le$ 10ns; $t_F \le$ 10ns

A − B $V_{OD2}+$ / $V_{OD2}-$ 0V INPUT 0V

R V_{OH} / V_{OL} 1.5V OUTPUT 1.5V t_{PHL} t_{PLH}
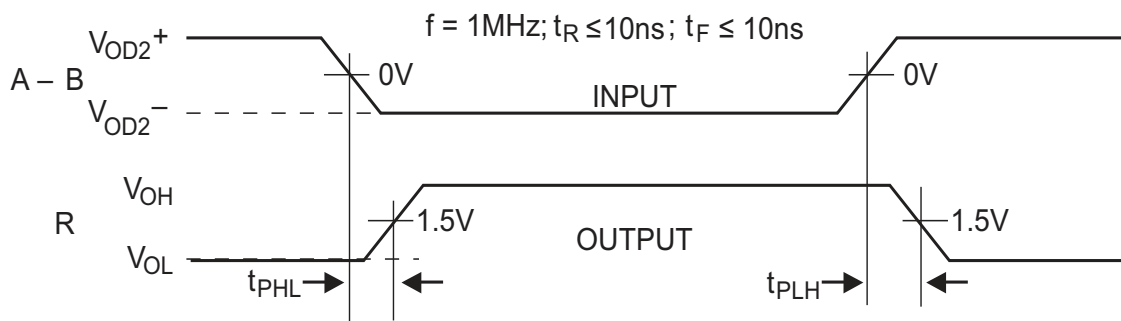
Figure 7: Receiver Propagation Delays

$\overline{RE}$ +3V / 0V 1.5V f = 1MHz; $t_R \le$ 10ns; $t_F \le$ 10ns 1.5V t_{ZL} t_{LZ}

R 5V / V_{IL} 1.5V Output normally LOW 0.5V

R V_{IH} / 0V 1.5V Output normally HIGH 0.5V t_{ZH} t_{HZ}
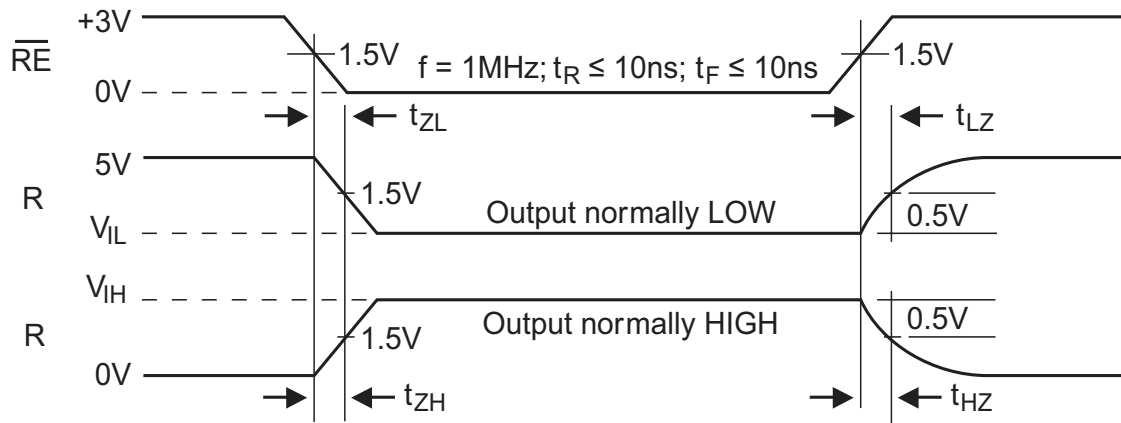
Figure 8: Receiver Enable and Disable Times

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Description

The SP481E and SP485E are half-duplex differential transceivers that meet the requirements of RS-485 and RS-422. Fabricated with an Maxlinear proprietary BiCMOS process, this product requires a fraction of the power of older bipolar designs.

The RS-485 standard is ideal for multi-drop applications and for long-distance interfaces. RS-485 allows up to 32 drivers and 32 receivers to be connected to a data bus, making it an ideal choice for multi-drop applications. Since the cabling can be as long as 4,000 feet, RS-485 transceivers are equipped with a wide (-7V to 12V) common mode range to accommodate ground potential differences. Because RS-485 is a differential interface, data is virtually immune to noise in the transmission line.

Drivers

The driver outputs of the SP481E and SP485E are differential outputs meeting the RS-485 and RS-422 standards. The typical voltage output swing with no load will be 0 Volts to 5 Volts. With worst case loading of 54Ω across the differential outputs, the drivers can maintain greater than 1.5V voltage levels. The drivers of the SP481E and SP485E have an enable control line which is active HIGH. A logic HIGH on DE (pin 3) will enable the differential driver outputs. A logic LOW on the DE (pin 3) will tri-state the driver outputs.

The transmitters of the SP481E and SP485E will operate up to at least 10Mbps.

Receivers

The SP481E and SP485E receivers have differential inputs with an input sensitivity as low as ±200mV. Input impedance of the receivers is typically 15kΩ (12kΩ minimum). A wide common mode range of -7V to +12V allows for large ground potential differences between systems. The receivers of the SP481E and SP485E have a tri-state enable control pin. A logic LOW on $\overline{RE}$ (pin 2) will enable the receiver, a logic HIGH on $\overline{RE}$ (pin 2) will disable the receiver.

The receiver for the SP481E and SP485E will operate up to at least 10Mbps. The receiver for each of the two devices is equipped with the fail-safe feature. Fail-safe guarantees that the receiver output will be in a HIGH state when the input is left unconnected.

Shutdown Mode

The SP481E is equipped with a Shutdown mode. To enable the shutdown state, both driver and receiver must be disabled simultaneously. A logic LOW on DE (pin 3) and a Logic HIGH on $\overline{RE}$ (pin 2) will put the SP481E into Shutdown mode. In Shutdown, supply current will drop to typically 1µA.

INPUTS				OUTPUTS	
$\overline{RE}$	DE	DI	LINE CONDITION	A	B
X	1	1	No Fault	1	0
X	1	0	No Fault	0	1
X	0	X	X	Z	Z
X	1	X	Fault	Z	Z

Table 1: Transmit Function Truth Table

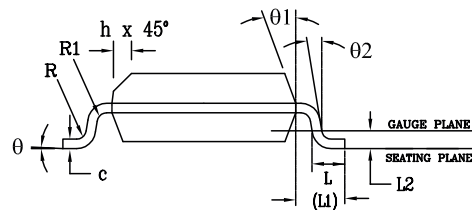| INPUTS			OUTPUTS
$\overline{RE}$	DE	A - B	R
0	0	0.2V	1
0	0	-0.2V	0
0	0	Inputs Open	1
1	0	X	Z

Table 2: Receive Function Truth Table

Mechanical Dimensions

NSOIC8

Top View
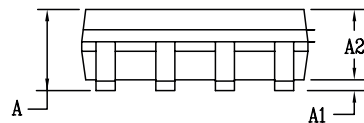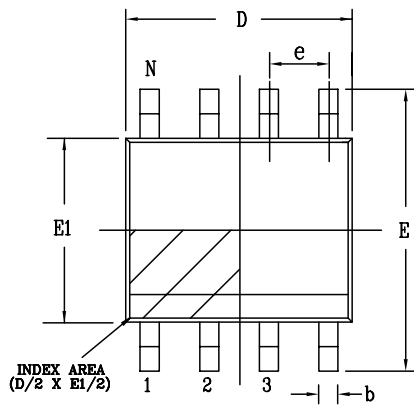
Side View

Front View

PACKAGE OUTLINE NSOIC .150" BODY JEDEC MS-012 VARIATION AA						
SYMBOLS	COMMON DIMENSIONS IN MM (Control Unit)			COMMON DIMENSIONS IN INCH (Reference Unit)		
	MIN	NOM	MAX	MIN	NOM	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
b	0.31	—	0.51	0.012	—	0.020
c	0.17	—	0.25	0.007	—	0.010
E	6.00 BSC			0.236 BSC		
E1	3.90 BSC			0.154 BSC		
e	1.27 BSC			0.050 BSC		
h	0.25	—	0.50	0.010	—	0.020
L	0.40	—	1.27	0.016	—	0.050
L1	1.04 REF			0.041 REF		
L2	0.25 BSC			0.010 BSC		
R	0.07	—	—	0.003	—	—
R1	0.07	—	—	0.003	—	—
q	0°	—	8°	0°	—	8°
q1	5°	—	15°	5°	—	15°
q2	0°	—	—	0°	—	—
D	4.90 BSC			0.193 BSC		
N	8					

Drawing No: POD-00000108

Revision: A

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Ordering Information

Part Number	Operating Temperature Range	Lead-Free	Package	Packaging Method
SP481ECN-L/TR	0°C to 70°C	Yes	8-pin NSOIC	Reel
SP481EEN-L/TR	-40°C to 85°C			Reel
SP485ECN-L	0°C to 70°C			Tube
SP485ECN-L/TR				Reel
SP485EEN-L	-40°C to 85°C			Tube
SP485EEN-L/TR				Reel
SP485EMN-L/TR	-40°C to 125°C			Reel

NOTE: For more information about part numbers, as well as the most most up-to-date ordering information and information rating, go to www.maxlinear.com/SP481E and www.maxlinear.com/SP485E.

Revision History

Revision	Date	Description
--	05/11/07	Legacy Sipex Datasheet
1.0.0	12/18/08	Convert to Exar Format. Update ordering information as a result of discontinued Lead type package options per PDN 081126-01. Remove "Top Mark" information from ordering page.
1.0.1	11/19/09	Correct table 1 error for driver output A and B outputs
1.0.2	08/08/10	Change SP485EMN-L and SP485EMN-L/TR temperature range error from +85C to +125C in ordering information section.
1.0.3	05/27/11	Remove driver minimum limits of propagation delay and Rise/Fall time. Remove SP481ECP-L and SP481EEP-L per PDN 110510-01
1.0.4	05/24/13	Correct type errors per PCN 13-0503-01
1.0.5	03/12/18	Update to MaxLinear logo. Remove GND from Differential Output Voltage min (page 2). Update format and ordering information table. Truth Tables moved to page 7 description section. Removed obsolete PDIP from absolute maximums, mechanicals and mechanical dimensions. ESD IEC61000-4-2 Contact Discharge rating added.
1.0.6	March 17, 2022	**Updated:** • In the "Electrical Characteristics" table, the "Short circuit current" parameter removed from the "SP481E / SP485E Receiver DC Characteristics" • In the "Absolute Maximum Ratings" section, "Output Voltage" replaced with "Output" and "Receiver output current" added.