

## 3.3V Low Power Half-Duplex RS-485 Transceiver with 10Mbps Data Rate

August 5, 2021

### Description

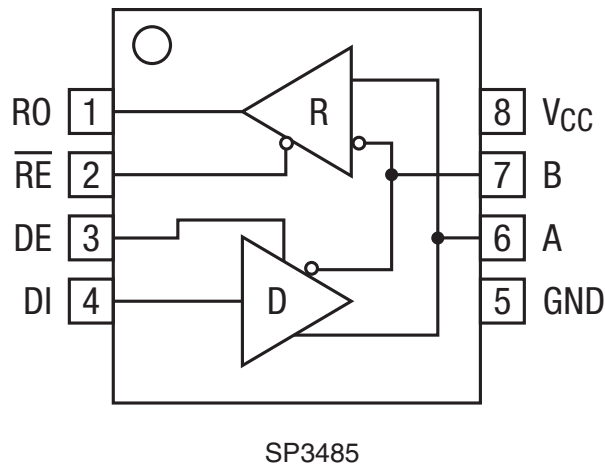
The [SP3485](#) device is a 3.3V low power half-duplex transceiver that meets the specifications of the RS-485 and RS-422 serial protocols. This device is pin-to-pin compatible with the MaxLinear SP481, SP483 and SP485 devices as well as popular industry standards. The SP3485 can meet the electrical specifications of the RS-485 and RS-422 serial protocols up to 10Mbps under load.

### FEATURES

- RS-485 and RS-422 transceiver
- Operates from a single 3.3V supply
- Interoperable with 5.0V logic
- Driver/receiver enable
- -7V to +12V common-mode input voltage range
- Allows up to 32 transceivers on the serial bus
- Compatibility with industry standard 75176 pinout
- Driver output short-circuit protection

Ordering Information - [Back Page](#)

### Block Diagram



## 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 <sub>CC</sub> .....	6.0V
Input Voltages	
Logic .....	-0.3V to 6.0V
Drivers .....	-0.3V to 6.0V
Receivers.....	±15V
Outputs	
Drivers .....	±15V
Receivers.....	-0.3V to 6.0V
Receiver Output Current.....	±60mA

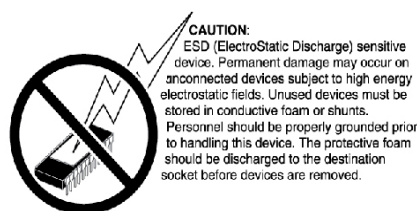
Storage Temperature .....	-65°C to 150°C
Maximum Junction Temperature, T <sub>J</sub> .....	125°C
Power Dissipation.....	600mW
	(derate 6.90mW/°C above 70°C)

## Operating Conditions

Package Power Dissipation	
8-pin NSOIC $\Theta_{JA}$ .....	128.4°C/W

## ESD Rating

Human Body Model (HBM).....	±2kV
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## Electrical Characteristics

Unless otherwise noted: T<sub>AMB</sub> = T<sub>MIN</sub> to T<sub>MAX</sub> and V<sub>CC</sub> = 3.3V ±5%.

PARAMETERS	MIN.	TYP.	MAX.	UNITS	CONDITIONS
<b>SP3485 Driver DC Characteristics</b>					
Differential output voltage			V <sub>CC</sub>	Volts	Unloaded; R = ∞Ω ; Figure 1
Differential output voltage	2		V <sub>CC</sub>	Volts	With Load; R = 50Ω (RS-422); Figure 1
Differential output voltage	1.5		V <sub>CC</sub>	Volts	With Load; R = 27Ω (RS-485); Figure 1
Change in magnitude of driver differential output voltage for complimentary states			0.2	Volts	R = 27Ω or R = 50Ω; Figure 1
Driver common mode output voltage			3	Volts	R = 27Ω or R = 50Ω; Figure 1
Input high voltage	2.0			Volts	Applies to DE, DI, RE
Input low voltage			0.8	Volts	Applies to DE, DI, RE
Input current			±10	μA	Applies to DE, DI, RE
Driver short circuit current V <sub>OUT</sub> = HIGH			±250	mA	-7V ≤ V <sub>O</sub> ≤ +12V; Figure 8
Driver short circuit current V <sub>OUT</sub> = LOW			±250	mA	-7V ≤ V <sub>O</sub> ≤ +12V; Figure 8
<b>SP3485 Driver AC Characteristics</b>					
Maximum data rate	10			Mbps	RE = V <sub>CC</sub> , DE = V <sub>CC</sub>
Driver input to output, t <sub>PLH</sub>		17	60	ns	Figures 2 & 9
Driver input to output, t <sub>PHL</sub>		17	60	ns	Figures 2 & 9
Differential driver skew		2	10	ns	t <sub>DO1</sub> - t <sub>DO2</sub>  , Figures 2 and 10
Driver rise or fall time		5	20	ns	From 10%-90%; Figures 3 and 10
Driver enable to output high		35	120	ns	Figures 4 and 11
Driver enable to output low		30	120	ns	Figures 5 and 11
Driver disable time from low		20	120	ns	Figures 5 and 11
Driver disable time from high		20	120	ns	Figures 4 and 11
Driver enable from shutdown to output high, t <sub>PSH</sub>			250	ns	C <sub>L</sub> = 50pF, R <sub>L</sub> = 500Ω.
Driver enable from shutdown to output low, t <sub>PSL</sub>			250	ns	Figures 4, 5, and 11
Time to shutdown, t <sub>SHDN</sub>	50	200	600	ns	Notes 1 and 2

## Electrical Characteristics (Continued)

Unless otherwise noted:  $T_{AMB} = T_{MIN}$  to  $T_{MAX}$  and  $V_{CC} = 3.3V \pm 5\%$ .

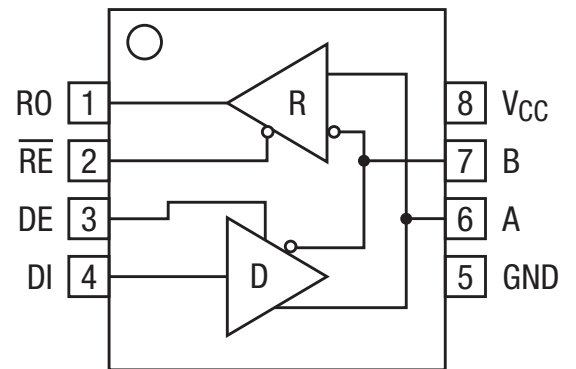
PARAMETERS	MIN.	TYP.	MAX.	UNITS	CONDITIONS
<b>SP3485 Receiver DC Characteristics</b>					
Differential input threshold	-0.2		0.2	Volts	$-7V \leq V_{CM} \leq 12V$
Input hysteresis		20		mV	$V_{CM} = 0V$
Output voltage HIGH	$V_{CC}-0.4$			Volts	$V_{ID} = 200mV, -1.5mA$
Output voltage LOW			0.4	Volts	$V_{ID} = -200mV, 2.5mA$
Three-state (high impedance) output current			$\pm 1$	$\mu A$	$0V \leq V_O \leq V_{CC}; RE = V_{CC}$
Input resistance	12			k $\Omega$	$-7V \leq V_{CM} \leq 12V$
Input current (A, B); $V_{IN} = 12V$			1.0	mA	$DE = 0V, V_{CC} = 0V$ or $3.6V, V_{IN} = 12V$
Input current (A, B); $V_{IN} = -7V$			-0.8	mA	$DE = 0V, V_{CC} = 0V$ or $3.6V, V_{IN} = -7V$
<b>SP3485 Receiver AC Characteristics</b>					
Maximum data rate	10			Mbps	$\overline{RE} = 0V, DE = 0V$
Receiver input to output, $t_{PLH}$		40	100	ns	Figures 6 and 12
Receiver input to output, $t_{PLH}$			70	ns	$T_{AMB} = 25^\circ C, V_{CC} = 3.3V,$ Figures 6 and 12
Receiver input to output, $t_{PHL}$		35	100	ns	Figures 6 and 12
Receiver input to output, $t_{PHL}$			70	ns	$T_{AMB} = 25^\circ C, V_{CC} = 3.3V,$ Figures 6 and 12
Differential receiver skew		4		ns	$t_{RSKEW} =  t_{RPHL} - t_{RPLH} ,$ Figures 6 and 12
Receiver enable to output low		10	60	ns	Figures 7 and 13, $S_1$ closed, $S_2$ open
Receiver enable to output high		10	60	ns	Figures 7 and 13, $S_2$ closed, $S_1$ open
Receiver disable from low		10	60	ns	Figures 7 and 13, $S_1$ closed, $S_2$ open
Receiver disable from high		10	60	ns	Figures 7 and 13, $S_2$ closed, $S_1$ open
Receiver enable from shutdown to output high, $t_{PRSH}$			1800	ns	$C_L = 15pF, R_L = 1k\Omega,$ Figures 7 and 13
Receiver enable from shutdown to output low, $t_{PRSL}$			1800	ns	
Time to shutdown, $t_{SHDN}$	50	200	600	ns	Notes 1 and 2
<b>Power Requirements</b>					
Supply current, no load		425	2000	$\mu A$	$\overline{RE}, DI = 0V$ or $V_{CC}; DE = V_{CC}$
Supply current, no load		300	1500	$\mu A$	$\overline{RE} = 0V, DI = 0V$ or $V_{CC}, DE = 0V$

### NOTES:

- The transceivers are put into shutdown by gringing  $\overline{RE}$  high and DE low simultaneously for at least 600ns. If the control inputs are in this state for less than 50ns, the device is guaranteed to not enter shutdown. If the enable inputs are held in this state for at least 600ns, the device is assured to be in shutdown. Note that the receiver and driver times increase significantly when coming out of shutdown.
- This spec is guaranteed by design and bench characterization.

Pin Functions

Pin	Name	Description
1	RO	Receiver output
2	$\overline{\text{RE}}$	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	V <sub>CC</sub>	Positive supply



SP3485  
Pinout (Top View)

Test Circuits

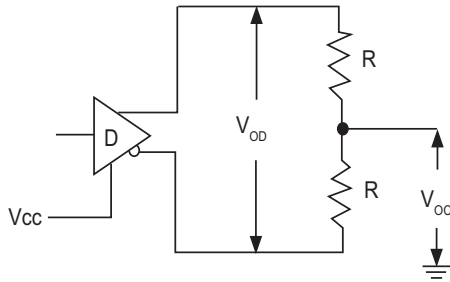


Figure 1: Driver DC Test Load Circuit

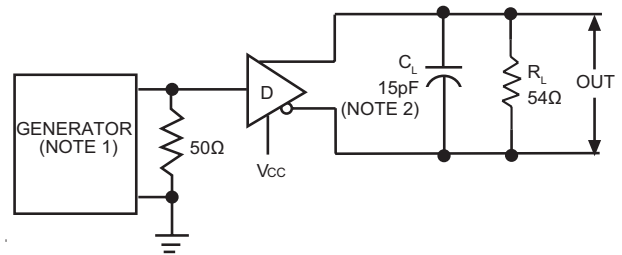


Figure 2: Driver Propagation Delay Test Circuit

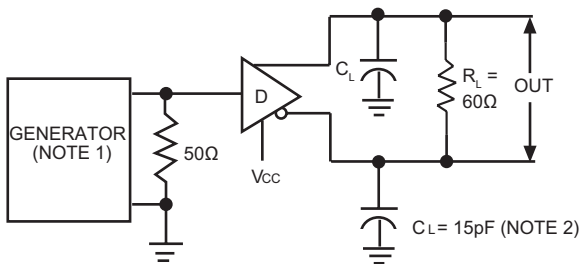


Figure 3: Driver Differential Output Delay and Transition Time Circuit.

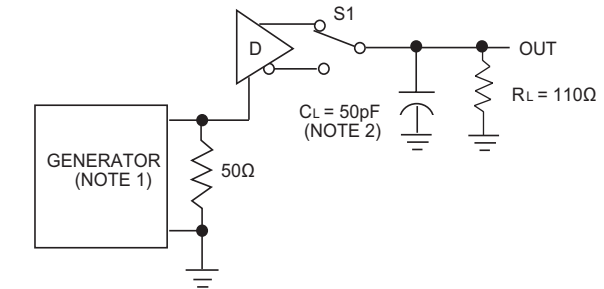


Figure 4: Driver Enable and Disable Timing Circuit, Output High

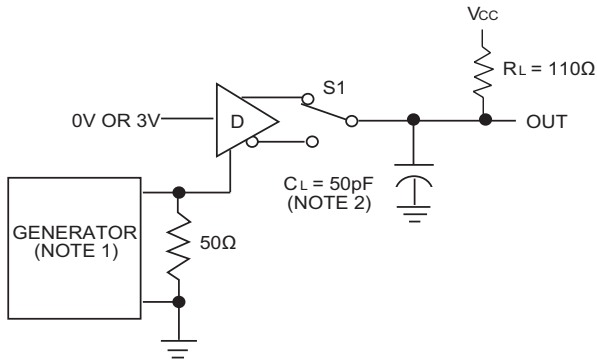


Figure 5: Driver Enable and Disable Timing Circuit, Output Low

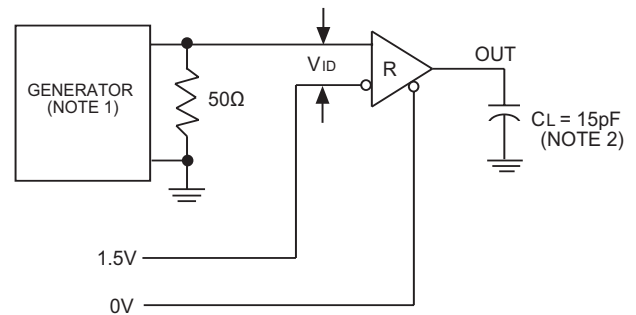


Figure 6: Receiver Propagation Delay Test Circuit

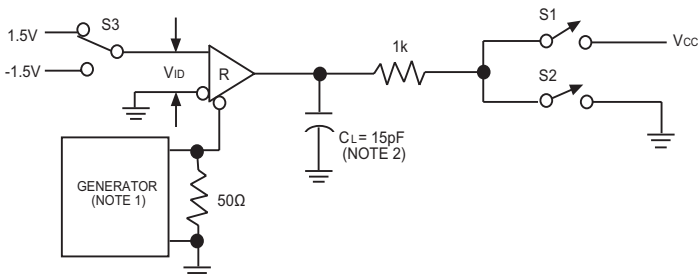


Figure 7: Receiver Enable and Disable Timing Circuit

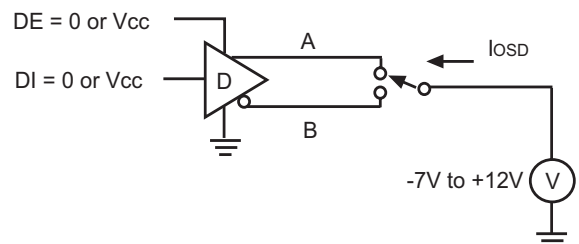


Figure 8: Driver Short Circuit Current Limit Test

NOTES

1: The input pulse is supplied by a generator with the following characteristics:  
 PRR = 250kHz, 50% duty cycle,  $t_R < 6.0\text{ns}$ ,  $Z_O = 50\Omega$ .

2:  $C_L$  includes probe and stray capacitance.

Switching Waveforms

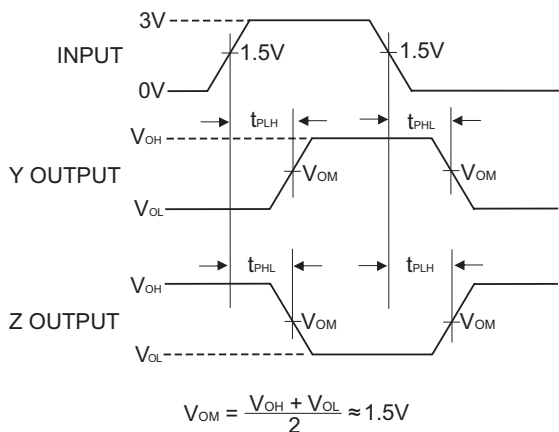


Figure 9: Driver Propagation Delay Waveforms

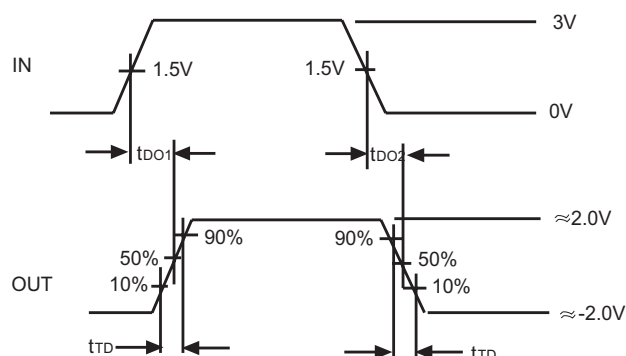


Figure 10: Driver Differential Output Delay and Transition Time Waveforms

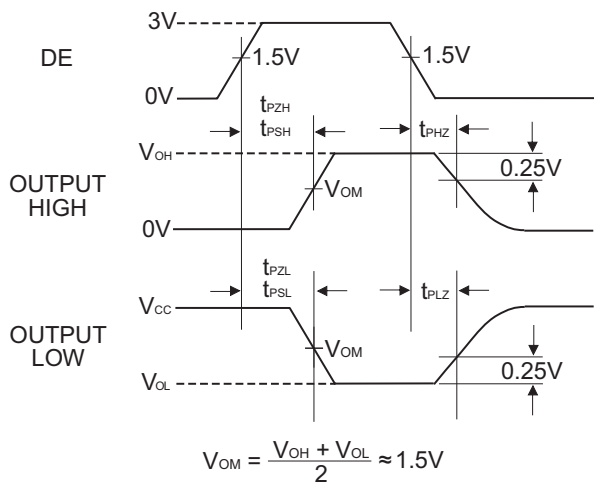


Figure 11: Driver Enable and Disable Timing Waveforms

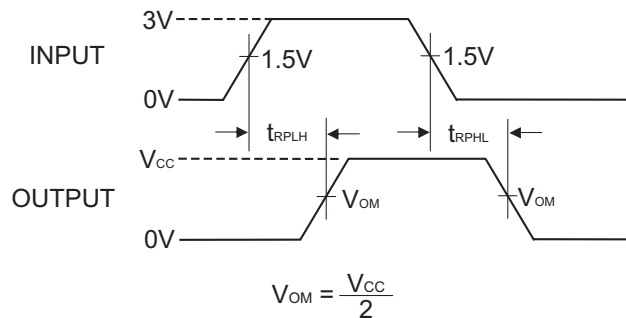


Figure 12: Receiver Propagation Delay Waveforms

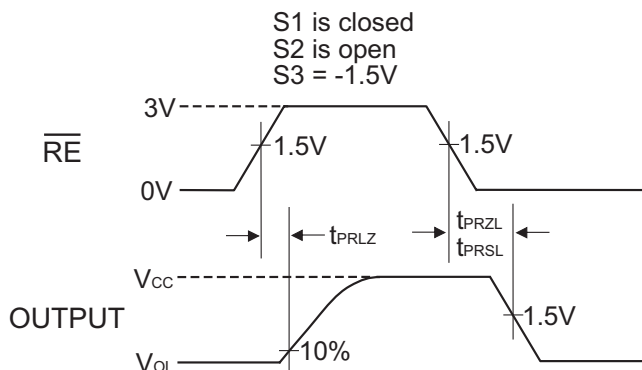
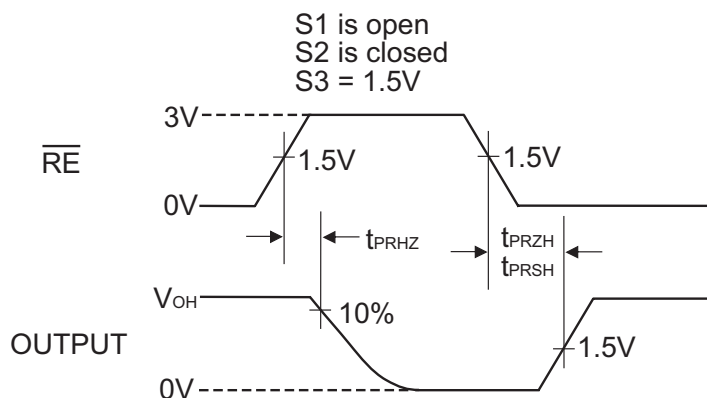


Figure 13: Receiver Enable and Disable Waveforms

## Description

The SP3485 is a member in the family of 3.3V low power half-duplex transceivers that meet the electrical specifications of the RS-485 and RS-422 serial protocols. This device is pin-to-pin compatible with the MaxLinear SP481, SP483 and SP485 devices as well as popular industry standards. The SP3485 feature MaxLinear's BiCMOS process allowing low power operation without sacrificing performance.

### Driver

The driver outputs of the SP3485 are differential outputs meeting the RS-485 and RS-422 standards. The typical voltage output swing with no load will be 0 volts to 3.3 Volts. With a load of 54Ω across the differential outputs, the drivers can maintain greater than 1.5V voltage levels.

The driver of the SP3485 has a driver 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 driver of the SP3485 operates up to 10Mbps. The 250mA  $I_{SC}$  maximum limit on the driver output allows the SP3485 to withstand an infinite short circuit over the -7.0V to 12V common mode range without catastrophic damage to the IC.

### Receiver

The SP3485 receiver has differential inputs with an input sensitivity of  $\pm 200\text{mV}$ . Input impedance of the receiver is 12kΩ minimum. A wide common mode range of -7V to 12V allows for large ground potential differences between systems. The receiver is equipped with a fail-safe feature that guarantees the receiver output will be in a HIGH state when the input is left unconnected. The receiver of the SP3485 operates up to 10Mbps.

The receiver of the SP3485 has an enable control line which is active LOW. A logic LOW on  $\overline{\text{RE}}$  (pin 2) will enable the differential receiver. A logic HIGH on  $\overline{\text{RE}}$  (pin 2) of the SP3485 will disable the receiver.

### Low Power Shutdown Mode

Low-power shutdown mode is initiated by bringing both  $\overline{\text{RE}}$  high and DE low. In shutdown, the devices typically draw only 50nA of supply current.  $\overline{\text{RE}}$  and DE can be driven simultaneously; the part is guaranteed not to enter shutdown if  $\overline{\text{RE}}$  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  $t_{PRZH}$ ,  $t_{PZH}$ ,  $t_{PRZL}$  and  $t_{PZL}$  assume the part was not in a low-power shutdown state. Enable times  $t_{PRSH}$ ,  $t_{PSH}$ ,  $t_{PRSL}$  and  $t_{PSL}$  assume the parts were shut down. It takes drivers and receivers longer to become enabled from low-power shutdown mode ( $t_{PRSH}$ ,  $t_{PSH}$ ,  $t_{PRSL}$ ,  $t_{PSL}$ ) than from driver/receiver-disable mode ( $t_{PRZH}$ ,  $t_{PZH}$ ,  $t_{PRZL}$ ,  $t_{PZL}$ ).

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

Table 1: Transmit Function Truth Table

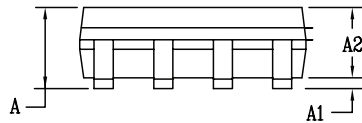
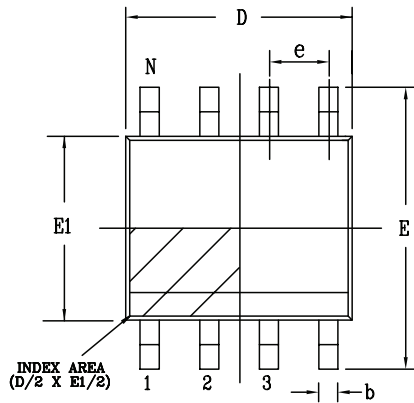
INPUTS			OUTPUTS
$\overline{\text{RE}}$	DE	$V_A - V_B$	RO
0	X	-50mV	1
0	X	-200mV	0
X	X	Open/Shorted	1
1	1	X	High-Z
1	0	X	Shutdown

Table 2: Receive Function Truth Table

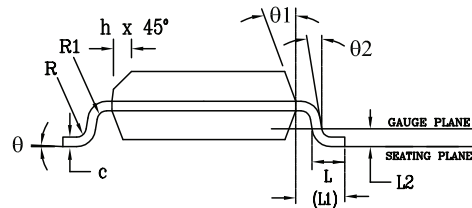
Mechanical Dimensions

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			8		

Drawing No: POD-00000108

Revision: A