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
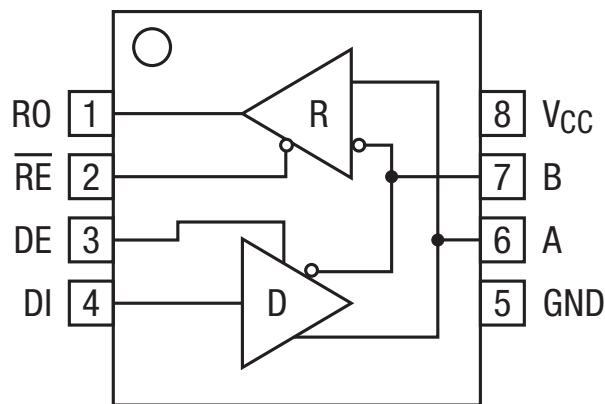
SP3485

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} 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_J ....125˚C

Power Dissipation.. 600mW

    (derate 6.90mW/°C above 70°C)

Operating Conditions

Package Power Dissipation

8-pin NSOIC $Θ_{JA}$ .... 128.4˚C/W

ESD Rating

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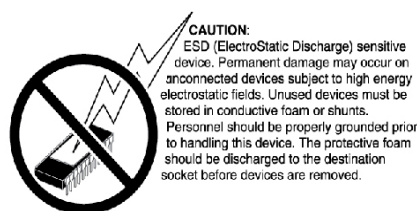
Electrical Characteristics

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

PARAMETERS	MIN.	TYP.	MAX.	UNITS	CONDITIONS
SP3485 Driver DC Characteristics					
Differential output voltage			Vcc	Volts	Unloaded; R = ∞Ω ; Figure 1
Differential output voltage	2		Vcc	Volts	With Load; R = 50Ω (RS-422); Figure 1
Differential output voltage	1.5		Vcc	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, $\overline{RE}$
Input low voltage			0.8	Volts	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; Figure 8
Driver short circuit current V_{OUT} = LOW			±250	mA	-7V ≤ V_O ≤ +12V; Figure 8
SP3485 Driver AC Characteristics					
Maximum data rate	10			Mbps	$\overline{RE}$ = V_{CC}, DE = V_{CC}
Driver input to output, t_{PLH}		17	60	ns	Figures 2 & 9
Driver input to output, t_{PHL}		17	60	ns	Figures 2 & 9
Differential driver skew		2	10	ns	$\left\|t_{DO1}- t_{DO2}\right\|$, 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_{PSH}			250	ns	C_L = 50pF, R_L = 500Ω. Figures 4, 5, and 11
Driver enable from shutdown to output low, t_{PSL}			250	ns	
Time to shutdown, t_{SHDN}	50	200	600	ns	Notes 1 and 2

Electrical Characteristics (Continued)

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

PARAMETERS	MIN.	TYP.	MAX.	UNITS	CONDITIONS
SP3485 Receiver DC Characteristics					
Differential input threshold	-0.2		0.2	Volts	$-7V \leq V_{CM} \leq 12V$
Input hysteresis		20		mV	$V_{CM} = 0V$
Output voltage HIGH	Vcc-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			±1	µA	$0V \leq V_O \leq V_{CC}$; $\overline{RE} = V_{CC}$
Input resistance	12			kΩ	$-7V \leq V_{CM} \leq 12V$
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
SP3485 Receiver AC Characteristics					
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°C, Vcc = 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°C, Vcc = 3.3V, Figures 6 and 12
Differential receiver skew		4		ns	$t_{RSKEW} = \left\| t_{RPHL} - t_{RPLH} \right\|$, 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 = 1kΩ. 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
Power Requirements					
Supply current , no load		425	2000	µA	$\overline{RE}$, DI = 0V or V_{CC} ; DE = V_{CC}
Supply current , no load		300	1500	µA	$\overline{RE}$ = 0V, DI = 0V or V_{CC}, DE = 0V

NOTES:
1. 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.
2. This spec is guaranteed by design and bench characterization.

Pin Functions

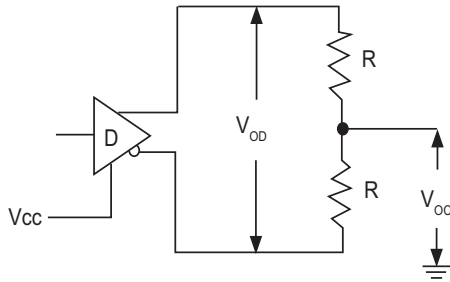| Pin	Name	Description
1	RO	Receiver output
2	$\overline{RE}$	Receiver output enable active LOW
3	DE	Driver output enable active HIGH
4	DI	Driver input
5	GND	Ground connection
6	A	Non-inverting driver output / receiver input
7	B	Inverting driver output / receiver input
8	V_{CC}	Positive supply
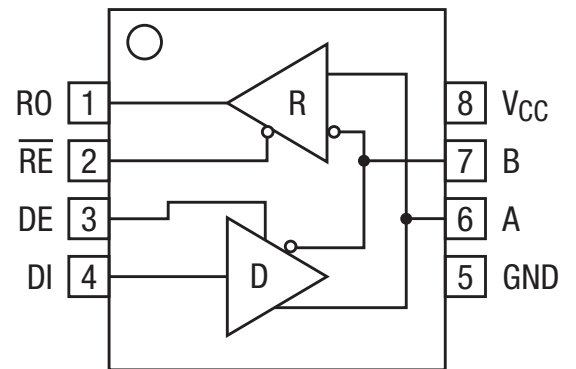
SP3485
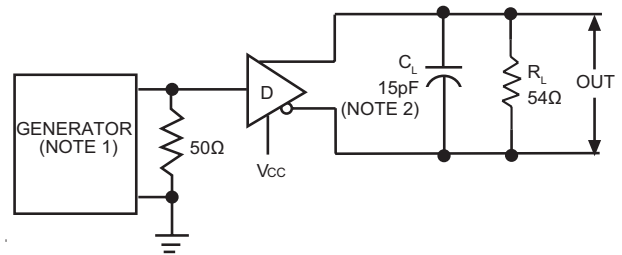Pinout (Top View)

Test Circuits

Figure 1: Driver DC Test Load Circuit

Figure 2: Driver Propagation Delay Test Circuit
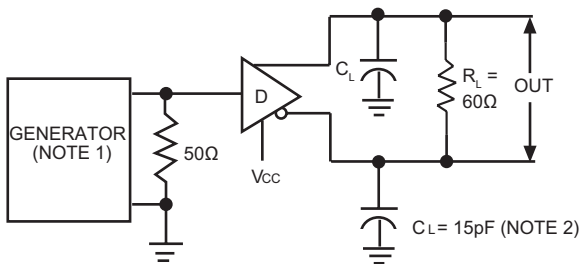
Figure 3: Driver Differential Output Delay
and Transition Time Circuit.
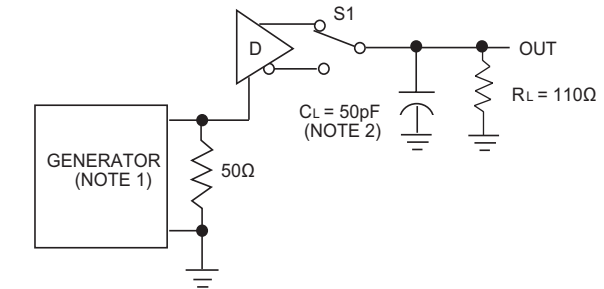
Figure 4: Driver Enable and Disable Timing Circuit,
Output High
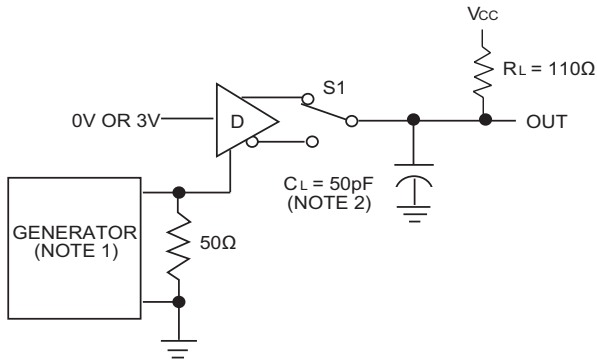
Figure 5: Driver Enable and Disable Timing Circuit,
Output Low
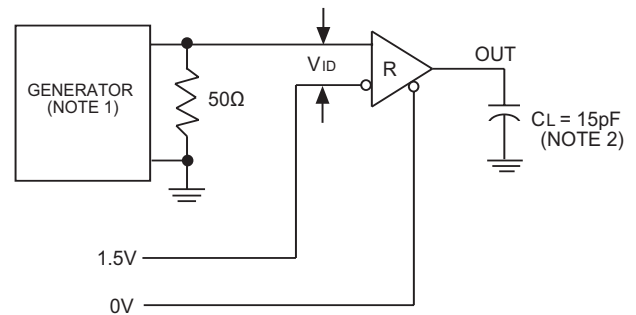
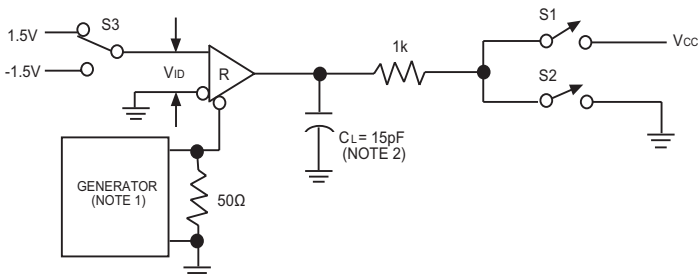Figure 6: Receiver Propagation Delay Test Circuit

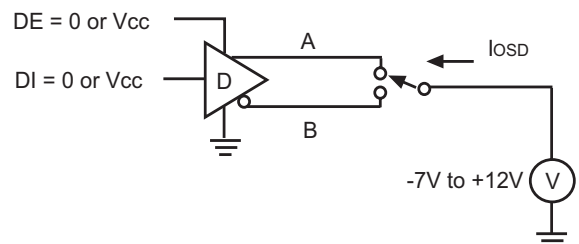Figure 7: Receiver Enable and Disable Timing Circuit

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 < 6.0ns, Z_O = 50Ω.
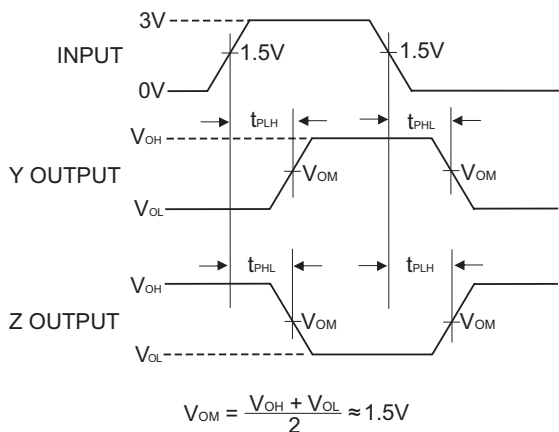2: C_L includes probe and stray capacitance.

Switching Waveforms

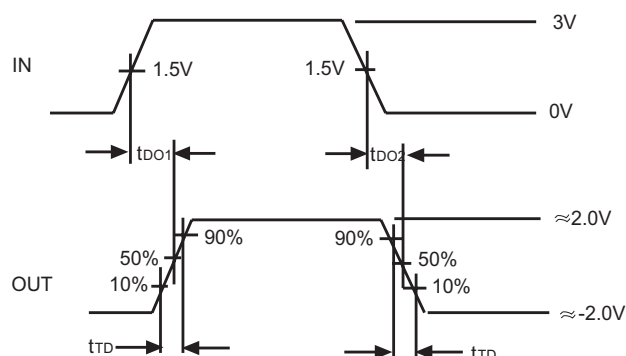Figure 9: Driver Propagation Delay Waveforms

Figure 10: Driver Differential Output Delay and Transition Time Waveforms
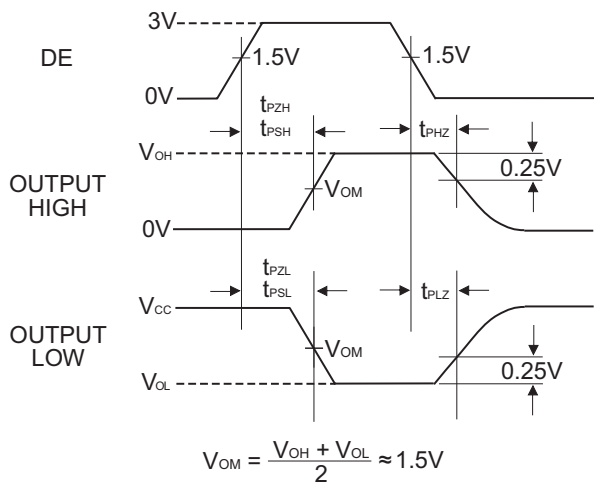

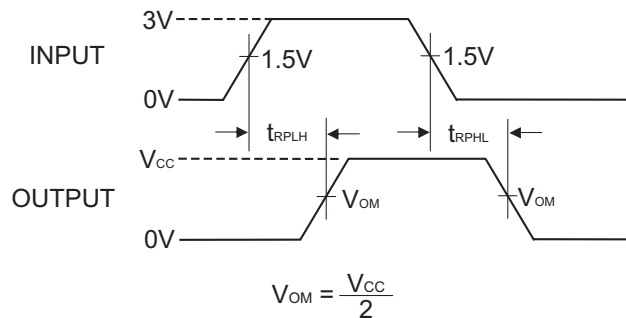Figure 11: Driver Enable and Disable Timing Waveforms

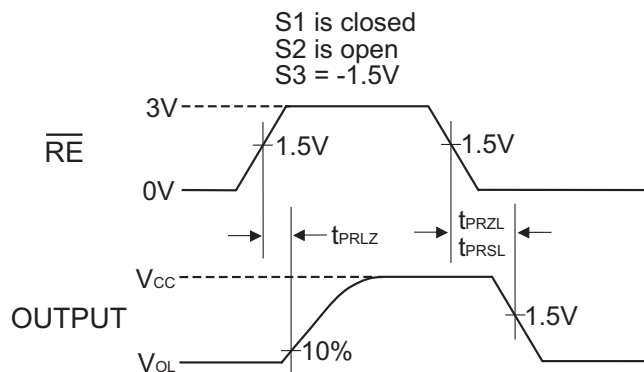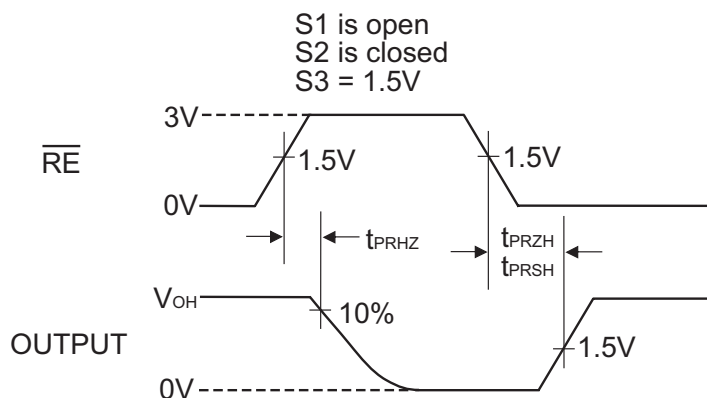Figure 12: Receiver Propagation Delay Waveforms

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 operationwithout 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 ±200mV. 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 $\overline{RE}$ (pin 2) will enable the differential receiver. A logic HIGH on $\overline{RE}$ (pin 2) of the SP3485 will disable the receiver.

Low Power Shutdown Mode

Low-power shutdown mode is initiated by bringing both $\overline{RE}$ high and DE low. In shutdown, the devices typically draw only 50nA of supply current. $\overline{RE}$ and DE can be driven simultaneously; the part is guaranteed not to enter shutdown if $\overline{RE}$ 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	
$\overline{RE}$	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
$\overline{RE}$	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
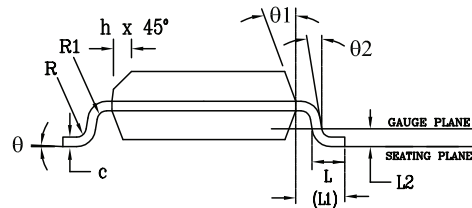
MAXLINEAR

Mechanical Dimensions

NSOIC8

Top View
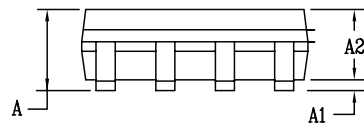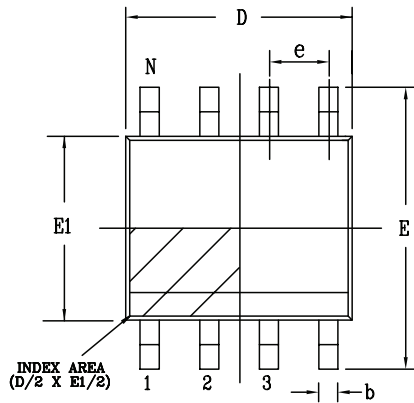
Side View

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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