

## Product Overview

NCA3485 is a half-duplex RS-485 transceiver. NCA3491 is a full-duplex RS-485 transceiver.

The devices have a 1/8-unit-load receiver input impedance that allows up to 256 transceivers on the bus. The data rate of the device is up to 12Mbps. The device is slew limited to reduce EMI and reflections with improperly terminated transmission line.

The Bus pins are protected from  $\pm 10\text{kV}$  system level ESD to GND. These devices feature fail-safe circuitry, which guarantees a logic-high receiver output when the receiver inputs are open or shorted.

## Key Features

- Power supply voltage: 3.0V to 5.5V
- High system level EMC performance:  
Bus Pins meet IEC61000-4-2  $\pm 10\text{kV}$  ESD
- Fail-safe protection receiver
- Up to 256 transceivers on the bus
- Operation temperature:  $-40^{\circ}\text{C} \sim 125^{\circ}\text{C}$
- RoHS-compliant packages:  
SOP8  
SOP14

## Applications

- Industrial automation system
- RS-485 communication

## Device Information

Part Number	Package	Body Size
NCA3485-DSPR	SOP8	4.90mm × 3.90mm
NCA3491-DSPKR	SOP14	8.63mm × 3.90mm

## Functional Block Diagrams

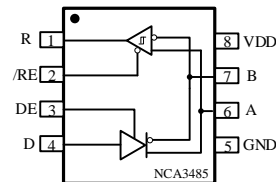


Figure 1. NCA3485 Block Diagrams

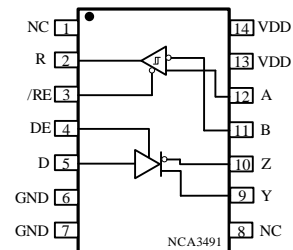


Figure 2. NCA3491 Block Diagrams

## INDEX

<b>1. PIN CONFIGURATION AND FUNCTIONS</b> .....	<b>3</b>
<b>2. ABSOLUTE MAXIMUM RATINGS</b> .....	<b>5</b>
<b>3. THERMAL INFORMATION</b> .....	<b>5</b>
<b>4. SPECIFICATIONS</b> .....	<b>6</b>
4.1. DC ELECTRICAL CHARACTERISTICS.....	6
4.2. SWITCHING ELECTRICAL CHARACTERISTICS.....	8
4.3. TYPICAL PERFORMANCE CHARACTERISTICS.....	10
4.4. PARAMETER MEASUREMENT INFORMATION.....	10
<b>5. FUNCTION DESCRIPTION</b> .....	<b>13</b>
5.1. DATA RATE.....	13
5.2. TRUE FAIL-SAFE RECEIVER INPUTS.....	13
5.3. TRUTH TABLES.....	13
5.4. THERMAL SHUTDOWN.....	13
<b>6. APPLICATION NOTE</b> .....	<b>14</b>
6.1. 256 TRANSCEIVERS ON THE BUS.....	14
6.2. ESD PROTECTION.....	14
6.3. LAYOUT CONSIDERATIONS.....	14
6.4. TYPICAL APPLICATION.....	14
<b>7. PACKAGE INFORMATION</b> .....	<b>15</b>
<b>8. ORDER INFORMATION</b> .....	<b>19</b>
<b>9. DOCUMENTATION SUPPORT</b> .....	<b>19</b>
<b>10. TAPE AND REEL INFORMATION</b> .....	<b>20</b>
<b>11. REVISION HISTORY</b> .....	<b>23</b>

# 1. Pin Configuration and Functions

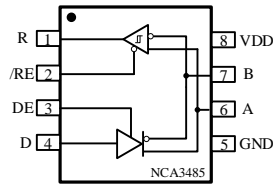


Figure 1.1 NCA3485 Package

Table1.1 NCA3485 Pin Configuration and Description

<i>NSi83085E</i> <i>PIN NO.</i>	<i>SYMBOL</i>	<i>FUNCTION</i>
1	R	Receive output
2	/RE	Receive enable input. This is an active low input.
3	DE	Driver enable input. This is an active high input
4	D	Driver transmit data input.
5	GND	Ground.
6	A	Noninverting Driver Output/Receiver Input. When the driver is disabled, or when VDD is powered down, Pin A is put into a high impedance state to avoid overloading the bus.
7	B	Inverting Driver Output/Receiver Input. When the driver is disabled, or when VDD is powered down, Pin B is put into a high impedance state to avoid overloading the bus.
8	VDD	Power Supply.

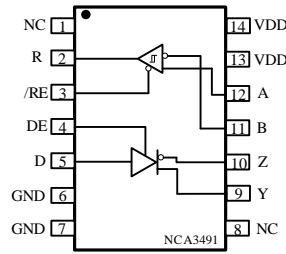


Figure 1.2 NCA3491 Package

Table1.2 NCA3491 Pin Configuration and Description

<i>NSi83085E</i> <i>PIN NO.</i>	<i>SYMBOL</i>	<i>FUNCTION</i>
1	NC	No Connection.
2	R	Receive output
3	/RE	Receive enable input. This is an active low input.
4	DE	Driver enable input. This is an active high input
5	D	Driver transmit data input.
6	GND	Ground.
7	GND	Ground.
8	NC	No Connection.
9	Y	Noninverting Driver Output. When the driver is disabled, or when VDD is powered down, Pin Y is put into a high impedance state to avoid overloading the bus.
10	Z	Inverting Driver Output. When the driver is disabled, or when VDD is powered down, Pin Z is put into a high impedance state to avoid overloading the bus.
11	B	Inverting Receiver Input.
12	A	Noninverting Receiver Input.
13	VDD	Power Supply.
14	VDD	Power Supply.

## 2. Absolute Maximum Ratings

Parameters	Symbol	Min	Typ	Max	Unit	Comments
Power Supply Voltage	VDD	-0.5		6	V	
Maximum Input Voltage	/RE, DE, D	-0.4		VDD+0.4	V	
Driver Output/Receiver Input Voltage	VA, VB, VY, VZ	-7		12	V	
Differential input voltage, A with respect to B	V <sub>ID</sub>	-18		18	V	
Receiver Output Current	I <sub>o</sub>	-15		15	mA	
Operating Temperature	Topr	-40		125	°C	
Storage Temperature	Tstg	-40		150	°C	
Electrostatic discharge	HBM (Bus pins and GND)			±8000	V	
	HBM (All pins)			±6000	V	
	CDM			±2000	V	

## 3. Thermal Information

Parameters	Symbol	SOP8	SOP14	Unit
IC Junction-to-Air Thermal Resistance	$\theta_{JA}$	67.9	86.4	°C/W
Junction-to-case (top) thermal resistance	$\theta_{JC (top)}$	27.7	43.7	°C/W
Junction-to-board thermal resistance	$\theta_{JB}$	29.4	42.5	°C/W

## 4. Specifications

### 4.1. DC Electrical characteristics

(VDD=3.0V~5.5V, Ta=-40°C to 125°C. Unless otherwise noted, Typical values are at VDD = 5V Ta = 25°C)

Parameters	Symbol	Min	Typ	Max	Unit	Comments
Power supply voltage	VDD	3.0		5.5	V	
Logic-side supply current	I <sub>DD</sub>		600	900	µA	DE=high, /RE=low, no load
			520	800	µA	DE=high, /RE=high, no load
			540	700	µA	DE=low, /RE=low, no load
			0.5	10	µA	DE=low, /RE=high, no load
Thermal-Shutdown Threshold	T <sub>TS</sub>		165		°C	
Thermal-Shutdown Hysteresis	T <sub>TSH</sub>		15		°C	
<b>Logic Side</b>						
Input High Voltage	V <sub>IH</sub>	2			V	DE, D, /RE
Input Low Voltage	V <sub>IL</sub>			0.8	V	DE, D, /RE
Input Current	I <sub>IN</sub>	-2		2	µA	DE, D, /RE
Output Voltage High	V <sub>OH</sub>	VDD-0.4			V	I <sub>OH</sub> = -4mA
Output Voltage Low	V <sub>OL</sub>			0.4	V	I <sub>OL</sub> = 4mA
Output Short-Circuit Current	I <sub>OSR</sub>	-150		150	mA	0 ≤ V <sub>R</sub> ≤ VDD
Three-State Output Current	I <sub>OZ</sub>			1	µA	0 ≤ V <sub>R</sub> ≤ VDD, /RE = high
<b>Driver</b>						
Differential Output Voltage	V <sub>OD</sub>			VDD	V	No Load
		2.7		VDD	V	<a href="#">See Figure 4.2</a> , R <sub>L</sub> =100Ω (RS-422), VDD=5V
		1.5		VDD	V	<a href="#">See Figure 4.2</a> , R <sub>L</sub> =100Ω (RS-422), VDD=3.3V
		2.1		VDD	V	<a href="#">See Figure 4.2</a> , R <sub>L</sub> =54Ω (RS-485), VDD=5V
		1.3		VDD	V	<a href="#">See Figure 4.2</a> , R <sub>L</sub> =54Ω (RS-485), VDD=3.3V
Change in magnitude of the differential output voltage	Δ V <sub>OD</sub>			0.2	V	<a href="#">See Figure 4.2</a> , R <sub>L</sub> =100Ω or R <sub>L</sub> =54Ω
Common-Mode Output Voltage	V <sub>OC</sub>		VDD/2		V	<a href="#">See Figure 4.2</a> , R <sub>L</sub> =100Ω or R <sub>L</sub> =54Ω

Change in Magnitude of Common-Mode Voltage	$\Delta V_{OC} $			0.2	V	See Figure 4.2, $R_L=100\Omega$ or $R_L=54\Omega$
Driver Short-Circuit Output Current	$I_{OSD}$			250	mA	$0 \leq V_{OUT} \leq +12V$
		-250			mA	$-7V \leq V_{OUT} \leq V_{DD}$
Output Leakage Current (Y and Z) Full-Duplex	$I_o$			200	$\mu A$	DE=GND, $V_{IN}=12V$
		-150			$\mu A$	DE=GND, $V_{IN}=-7V$
<b>Receiver</b>						
Input Current (A and B)	$I_A, I_B$			200	$\mu A$	DE=GND, $V_{DD}=GND, V_{IN}=12V$
		-200			$\mu A$	DE=GND, $V_{DD}=GND, V_{IN}=-7V$
Receiver Differential Threshold Voltage	$V_{TH}$	-200	-125	-10	mV	$-7V \leq V_{CM} \leq 12V$
Receiver Input Hysteresis	$\Delta V_{TH}$		15		mV	$V_A+V_B=0$
Receiver Input Resistance	$R_{IN}$	96			k $\Omega$	$-7V \leq V_{CM} \leq 12V, DE=low$

## 4.2. Switching Electrical Characteristics

(VDD=3.0V~5.5V, Ta=-40°C to 125°C. Unless otherwise noted, Typical values are at VDD = 5V Ta = 25°C)

Parameters	Symbol	Min	Typ	Max	Unit	Comments
<b>Driver</b>						
Maximum Data Rate	f <sub>MAX</sub>	12			Mbps	
Driver Propagation Delay	t <sub>PLH</sub>		30	50	ns	<a href="#">See Figure 4.3, R<sub>I</sub>=54Ω, C<sub>I</sub>=50pF</a>
	t <sub>PHL</sub>		30	50	ns	<a href="#">See Figure 4.3, R<sub>I</sub>=54Ω, C<sub>I</sub>=50pF</a>
Driver Pulse Width Distortion,  t <sub>PHL</sub> - t <sub>PLH</sub>	PWD		1		ns	<a href="#">See Figure 4.3, R<sub>I</sub>=54Ω, C<sub>I</sub>=50pF</a>
Driver Output Falling Time or Rising time	t <sub>F</sub>		8		ns	<a href="#">See Figure 4.3, R<sub>I</sub>=54Ω, C<sub>I</sub>=50pF</a>
	t <sub>R</sub>		7		ns	<a href="#">See Figure 4.3, R<sub>I</sub>=54Ω, C<sub>I</sub>=50pF</a>
Driver Enable to Output High	t <sub>ZH</sub>		17.2	60	ns	Receiver enabled, <a href="#">See Figure 4.4, R<sub>I</sub>=110Ω, C<sub>I</sub>=50pF</a>
			500	900	ns	Receiver disabled, <a href="#">See Figure 4.4, R<sub>I</sub>=110Ω, C<sub>I</sub>=50pF</a>
Driver Enable to Output Low	t <sub>ZL</sub>		26.8	60	ns	Receiver enabled, <a href="#">See Figure 4.4, R<sub>I</sub>=110Ω, C<sub>I</sub>=50pF</a>
			500	900	ns	Receiver disabled, <a href="#">See Figure 4.4, R<sub>I</sub>=110Ω, C<sub>I</sub>=50pF</a>
Driver Output High to Disable	t <sub>HZ</sub>		17	60	ns	<a href="#">See Figure 4.4, R<sub>I</sub>=110Ω, C<sub>I</sub>=50pF</a>
Driver Output Low to Disable	t <sub>LZ</sub>		24	60	ns	<a href="#">See Figure 4.4, R<sub>I</sub>=110Ω, C<sub>I</sub>=50pF</a>
<b>Receiver</b>						
Maximum Data Rate	f <sub>MAX</sub>	12			Mbps	
Receiver Propagation Delay	t <sub>PLH</sub>		76	120	ns	<a href="#">See Figure 4.5, C<sub>I</sub>=15pF</a>
	t <sub>PHL</sub>		78	120	ns	<a href="#">See Figure 4.5, C<sub>I</sub>=15pF</a>
Receiver Pulse Width Distortion	PWD		4		ns	t <sub>PHL</sub> - t <sub>PLH</sub>  , <a href="#">See Figure 4.5, C<sub>I</sub>=15pF</a>

Receiver Output Falling Time or Rising time	$t_F$		2.4		ns	<a href="#">See Figure 4.5, <math>C_I=15pF</math></a>
	$t_R$		3.4		ns	<a href="#">See Figure 4.5, <math>C_I=15pF</math></a>
Receiver Enable to Output High	$t_{ZH}$		16	60	ns	Driver enabled, <a href="#">See Figure 4.6, <math>R_I=1k\Omega</math>, <math>C_I=15pF</math></a>
			200	1400	ns	Driver disabled, <a href="#">See Figure 4.6, <math>R_I=1k\Omega</math>, <math>C_I=15pF</math></a>
Receiver Enable to Output Low	$t_{ZL}$		16	60	ns	Driver enabled, <a href="#">See Figure 4.6, <math>R_I=1k\Omega</math>, <math>C_I=15pF</math></a>
			200	1400	ns	Driver disabled, <a href="#">See Figure 4.6, <math>R_I=1k\Omega</math>, <math>C_I=15pF</math></a>
Receiver Disable to Output High	$t_{HZ}$		17	60	ns	<a href="#">See Figure 4.6, <math>R_I=1k\Omega</math>, <math>C_I=15pF</math></a>
Receiver Disable to Output Low	$t_{LZ}$		14	60	ns	<a href="#">See Figure 4.6, <math>R_I=1k\Omega</math>, <math>C_I=15pF</math></a>
Shutdown time	$t_{SD}$	80		5000	ns	

### 4.3. Typical Performance Characteristics

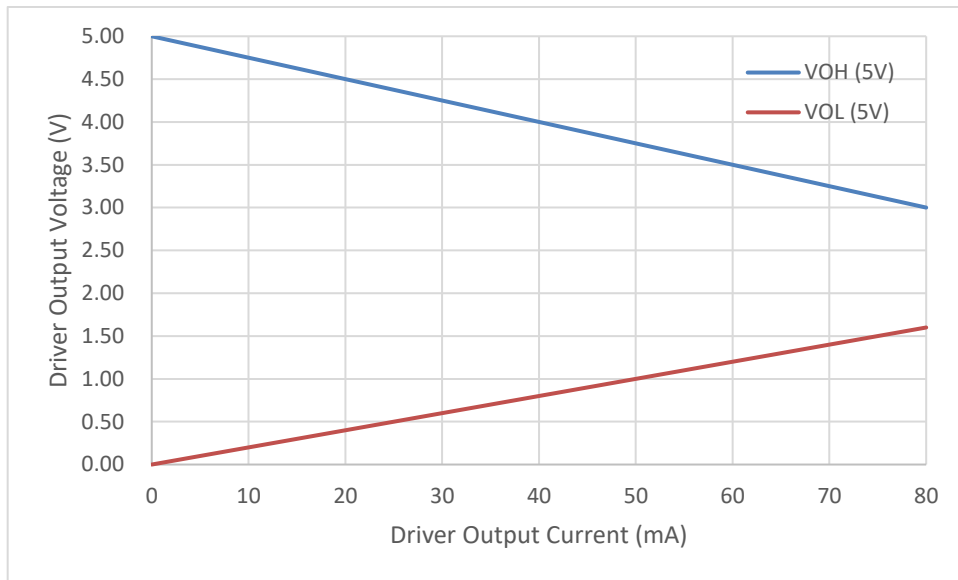


Figure 4.1 Receiver output voltage vs Output current

### 4.4. Parameter Measurement Information

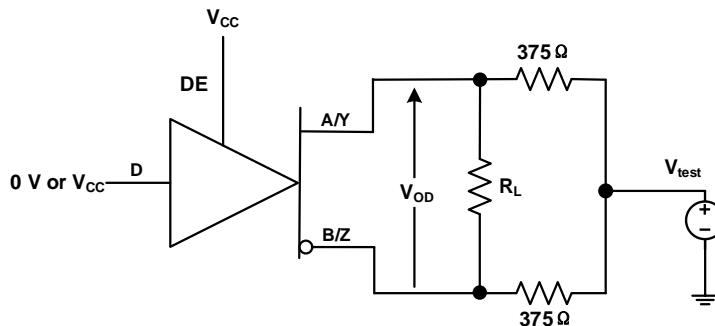


Figure 4.2 Driver DC Test Load

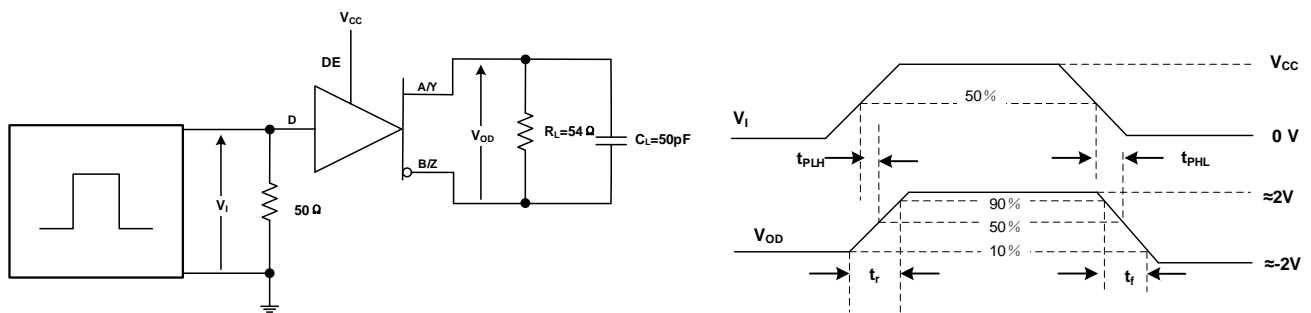


Figure 4.3 Driver Timing Test Circuit and waveform

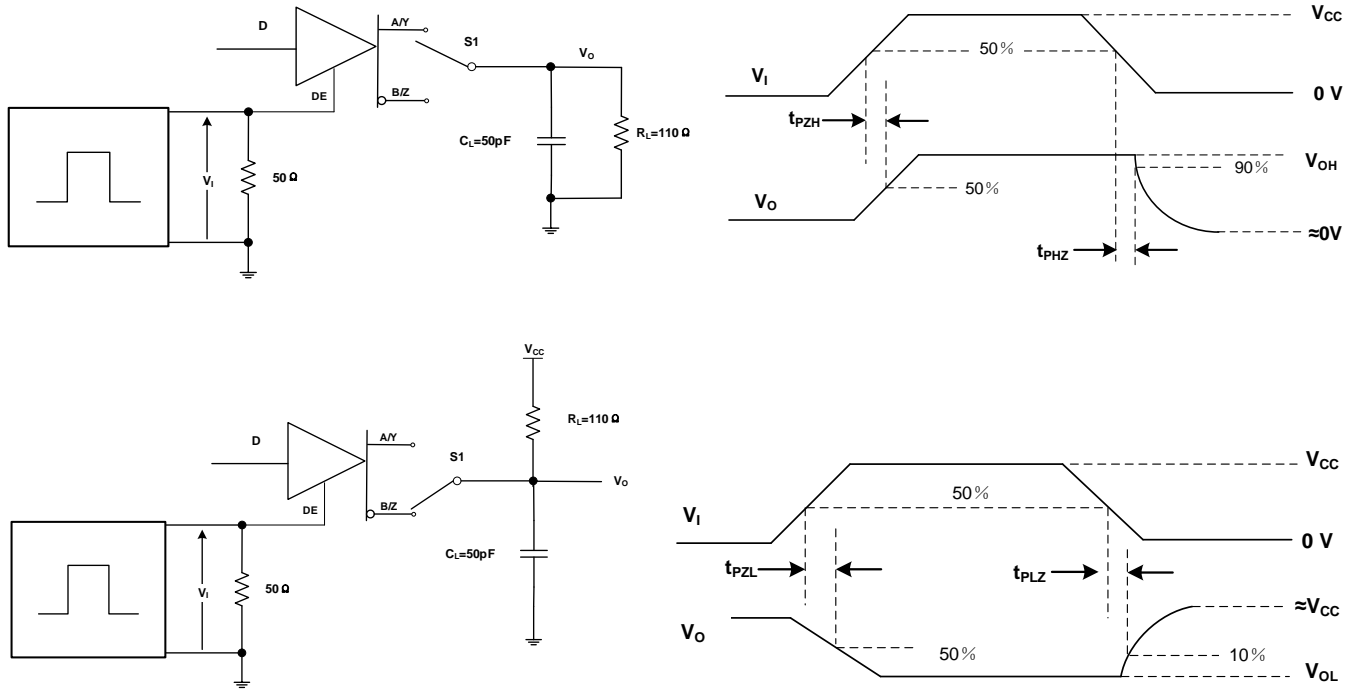


Figure 4.4 Driver Enable or Disable Timing Test Circuit and waveform

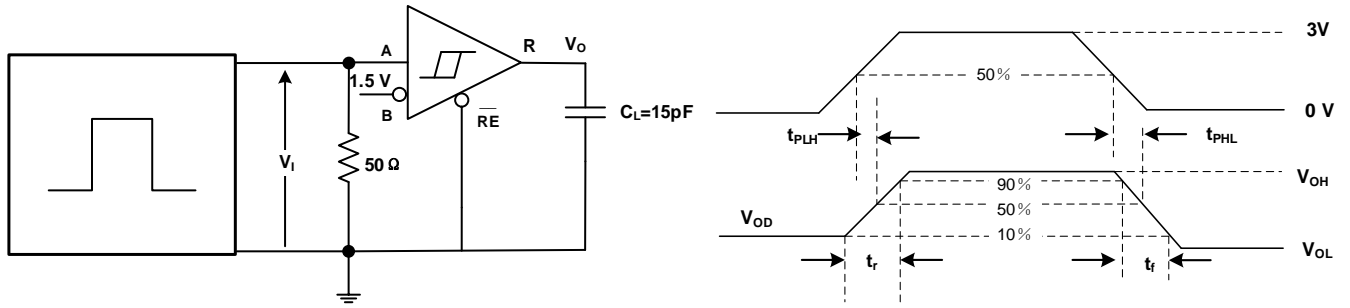
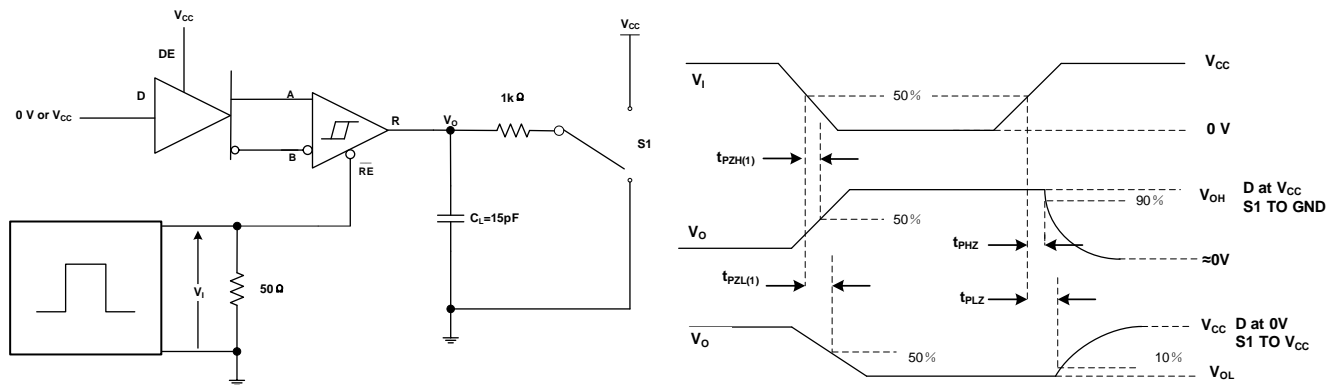


Figure 4.5 Receiver Propagation Delay Test Circuit and waveform



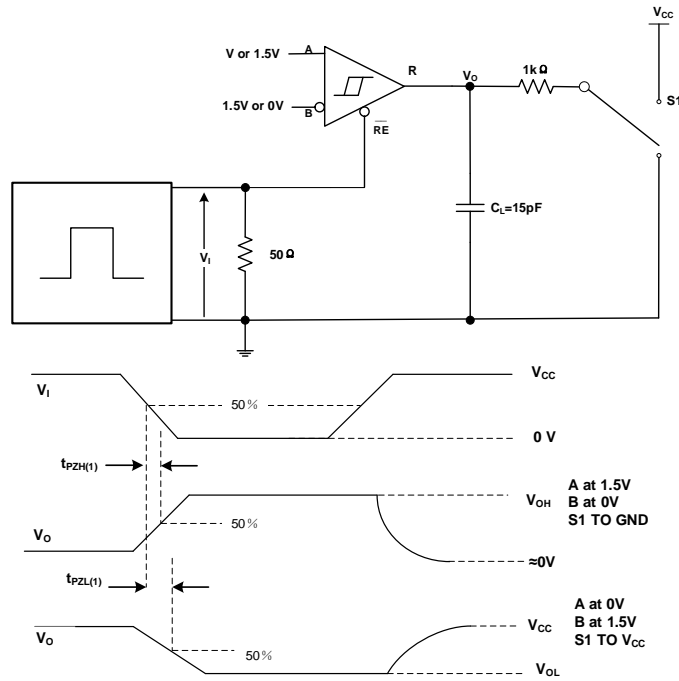


Figure 4.6 Receiver Enable or Disable Timing Test Circuit and waveform

## 5. Function Description

### 5.1. Data rate

The data rate of NCA3485/NCA3491 is 12Mbps. The device is slew limited to reduce EMI and reflections with improperly terminated transmission line.

### 5.2. True Fail-safe receiver inputs

The devices feature fail-safe circuitry, which guarantees a logic-high receiver output when the receiver inputs are open or shorted. The receiver threshold is fixed between -10mV and -200mV, which meets EIA/TIA-485 standard. If the differential input voltage ( $V_A - V_B$ ) is greater than or equal to -10mV, receiver output R is logic high. In the case of a terminated bus with all transmitters disabled, the differential input voltage is pulled to zero by the termination resistors. Due to the receiver threshold, the receiver output R is logic high.

### 5.3. Truth tables

Table 5.1 Driver Function Table<sup>1</sup>

Input (D)	Enable Input (DE)	Outputs <sup>1</sup>	
		A/Y	B/Z
H	H	H	L
L	H	L	H
X	L	Z	Z
X	OPEN	Z	Z
OPEN	H	L	H

<sup>1</sup> PD= Powered down; PU= Powered up; H= Logic High; L= Logic Low; X= Irrelevant; Z= High Impedance.

Table 5.2 Receiver Function Table<sup>1</sup>

Differential Input ( $V_A - V_B$ )	Enable Input (/RE)	Output (R)
$\geq -10\text{mV}$	L/Open	H
$\leq -200\text{mV}$	L/Open	L
Open/Short	L/Open	H
X	H	Z
Idle	L	H

<sup>1</sup> PD= Powered down; PU= Powered up; H= Logic High; L= Logic Low; X= Irrelevant; Z= High Impedance.

### 5.4. Thermal shutdown

The device is protected from over temperature damage by integrated thermal shutdown circuitry. When the junction temperature (T<sub>J</sub>) exceeds +165°C (typ), the driver outputs go high-impedance. The device resumes normal operation when T<sub>J</sub> falls below +145°C (typ).

## 6. Application Note

### 6.1. 256 transceivers on the bus

The devices have a 1/8-unit-load receiver input impedance (96kΩ) that allows up to 256 transceivers on the bus. Connect any combination of these devices, and/or other RS-485 devices, for a maximum of 32 unit-loads to the line.

### 6.2. ESD protection

ESD protection structures are enhanced on all pins to protect against electrostatic discharge encountered during handling and assembly.

ESD protection can be tested in various ways. Below is the ESD spec of the devices.

Bus pins:

- ± 8kV HBM.
- ±10kV using the Contact Discharge method specified in IEC 61000-4-2

Other pins except bus pins:

- ±6kV HBM.
- ±7kV using the Contact Discharge method specified in IEC 61000-4-2

### 6.3. Layout considerations

The NCA3485 requires a 0.1 μF bypass capacitor between VDD and GND. The capacitor should be placed as close as possible to the package. To eliminate line reflections, each cable end is terminated with a resistor, whose value matches the characteristic impedance of the cable. It's good practice to have the bus connectors and termination resistor as close as possible to the A and B pins.

### 6.4. Typical application

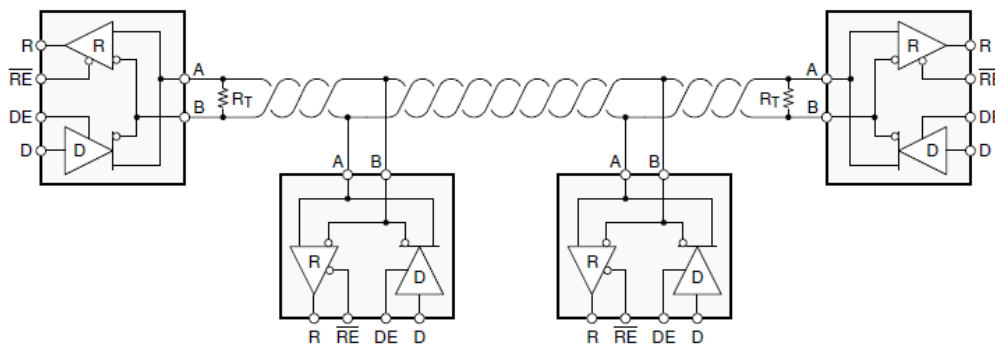


Figure 6.1 Typical Half-Duplex RS-485 application

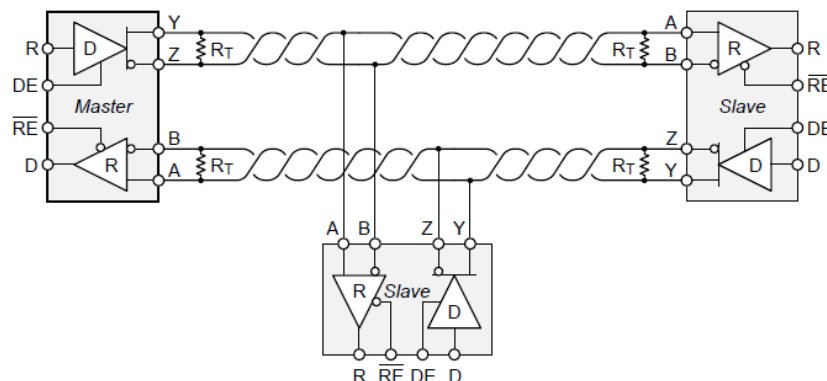
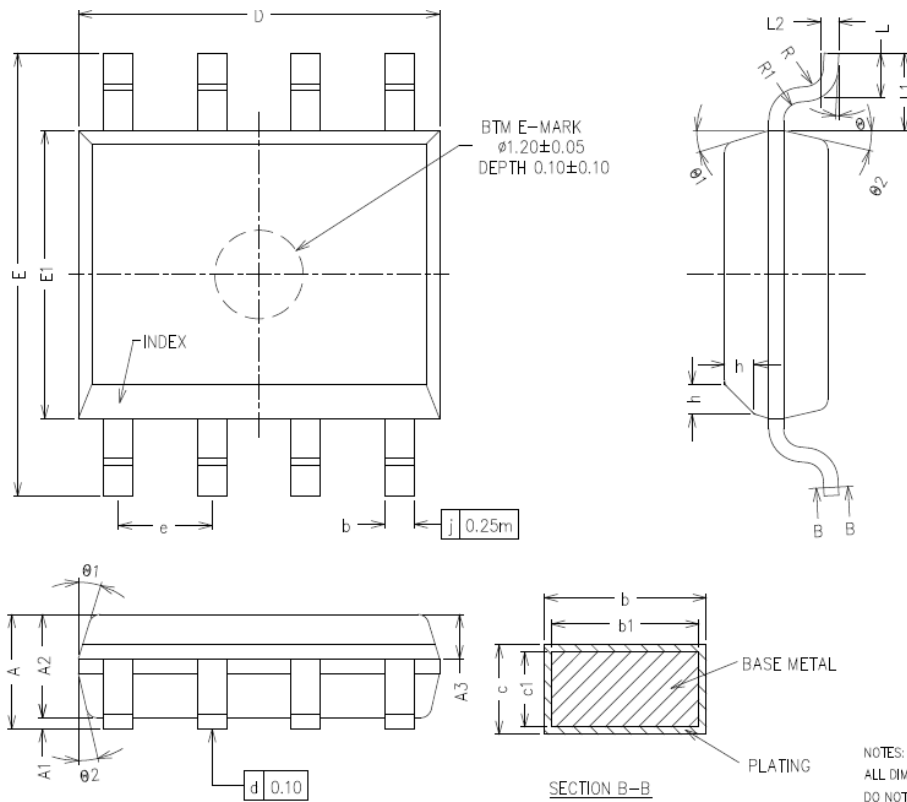


Figure 6.2 Typical Full-Duplex RS-485 application

### 7. Package Information



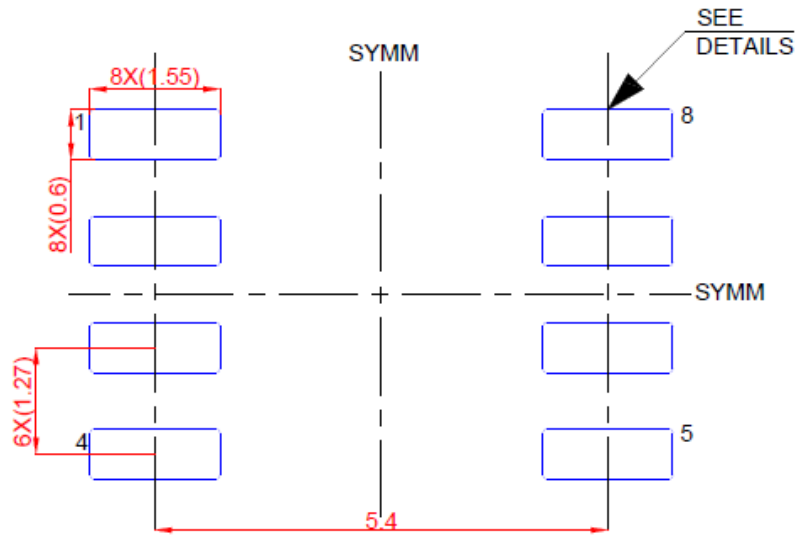
COMMON DIMENSIONS  
 (UNITS OF MEASURE=MILLIMETER)

SYMBOL	MIN	NOM	MAX
A	1.35	1.55	1.75
A1	0.10	—	0.25
A2	1.30	1.40	1.50
A3	0.50	0.60	0.70
b	0.38	—	0.47
b1	0.37	0.40	0.43
c	0.17	—	0.25
c1	0.17	0.20	0.23
D	4.80	4.90	5.00
E	5.80	6.00	6.20
E1	3.80	3.90	4.00
e	1.17	1.27	1.37
L	0.45	0.60	0.80
L1	1.04REF		
L2	0.25BSC		
R	0.07	—	—
R1	0.07	—	—
h	0.30	0.40	0.50
$\theta$	0°	—	8°
$\theta 1$	15°	17°	19°
$\theta 2$	11°	13°	15°

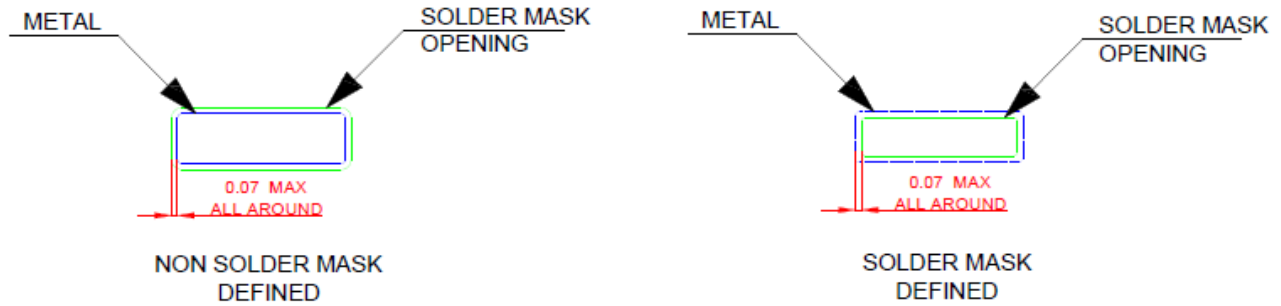
ONLY FOR HFTF

NOTES:  
 ALL DIMENSIONS REFER TO JEDEC STANDARD MS-012 AA  
 DO NOT INCLUDE MOLD FLASH OR PROTRUSION.

Figure 7.1 SOP8 Package Shape and Dimension in millimeters

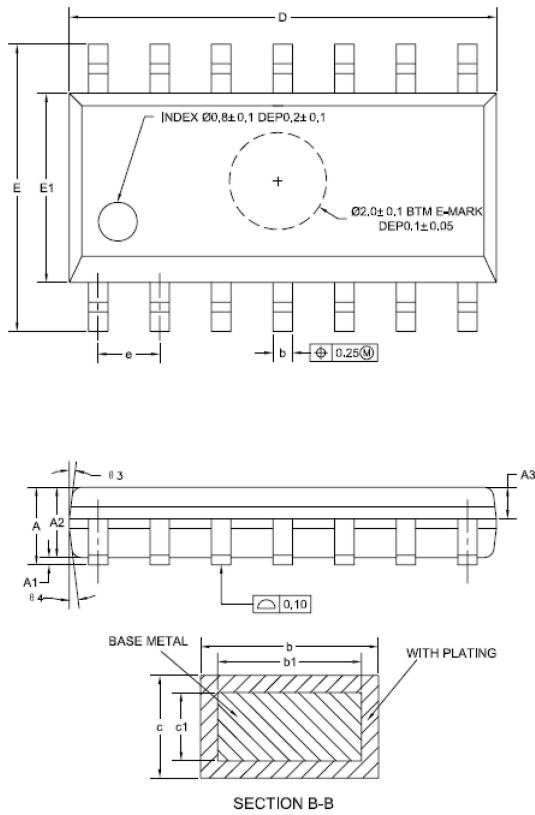


### LAND PATTERN EXAMPLE(mm)



### SOLDER MASK DETAILS

Figure 7.2 SOP8 Package Board Layout Example

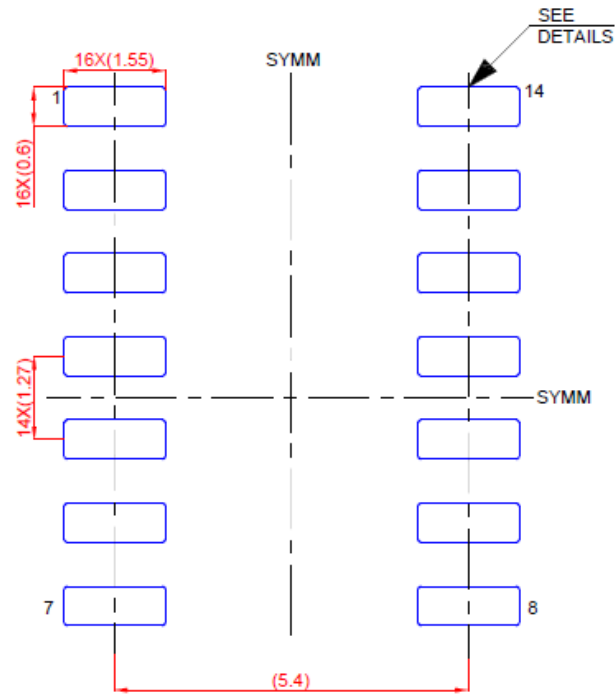


COMMON DIMENSIONS  
(UNITS OF MEASURE=MILLIMETER)

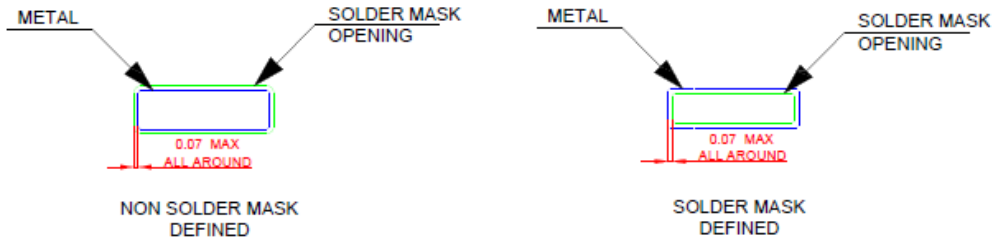
SYMBOL	MIN	NOM	MAX
A	1.35	1.60	1.75
A1	0.10	0.15	0.25
A2	1.25	1.45	1.65
A3	0.55	0.65	0.75
b	0.36	-	0.49
b1	0.35	0.40	0.45
c	0.17	-	0.25
c1	0.17	0.20	0.23
D	8.53	8.63	8.73
E	5.90	6.00	6.20
E1	3.80	3.90	4.00
e	1.27BSC		
L	0.45	0.60	0.80
L1	1.04REF		
L2	0.25BSC		
R	0.07	-	-
R1	0.07	-	-
h	0.30	0.40	0.50
θ	0°	-	8°
θ 1	6°	8°	10°
θ 2	6°	8°	10°
θ 3	5°	7°	9°
θ 4	5°	7°	9°

NOTES:  
ALL DIMENSIONS MEET JEDEC STANDARD MS-012 AB  
DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS.

Figure 7.3 SOP14 Package Shape and Dimension in millimeters



LAND PATTERN EXAMPLE(mm)



SOLDER MASK DETAILS

Figure 7.4 SOP14 Package Board Layout Example

## 8. Order Information

<i>Part Number</i>	<i>Duplex</i>	<i>Max Data Rate (Mbps)</i>	<i>No. of Nodes</i>	<i>Temperature</i>	<i>MSL</i>	<i>Package Type</i>	<i>Package Drawing</i>	<i>SPQ</i>
NCA3485-DSPR	Half	12	256	-40 to 125°C	3	SOP8 (150mil)	SOP8	2500
NCA3491-DSPKR	Full	12	256	-40 to 125°C	3	SOP14(150mil)	SOP14	2500

NOTE: All packages are RoHS-compliant with peak reflow temperatures of 260 °C according to the JEDEC industry standard classifications and peak solder temperatures.

## 9. Documentation Support

<i>Part Number</i>	<i>Product Folder</i>	<i>Datasheet</i>	<i>Technical Documents</i>	<i>Isolator selection guide</i>
NCA3485	<a href="#">Click here</a>	<a href="#">Click here</a>	<a href="#">Click here</a>	<a href="#">Click here</a>
NCA3491	<a href="#">Click here</a>	<a href="#">Click here</a>	<a href="#">Click here</a>	<a href="#">Click here</a>

### 10. Tape and Reel Information

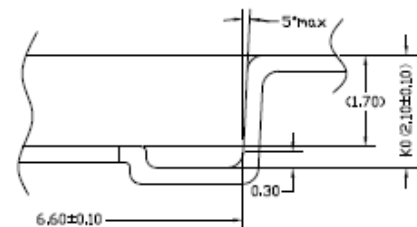
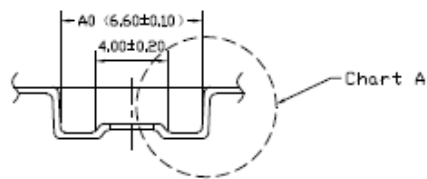
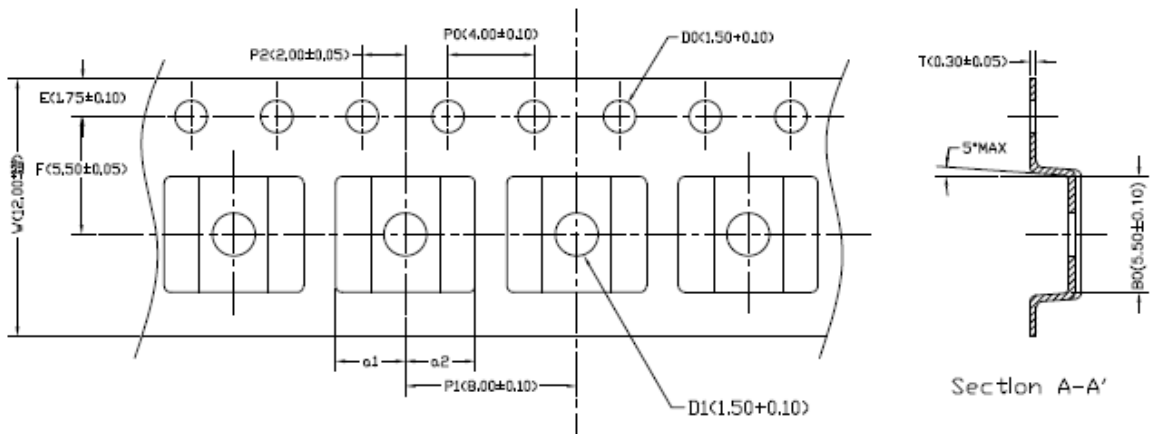
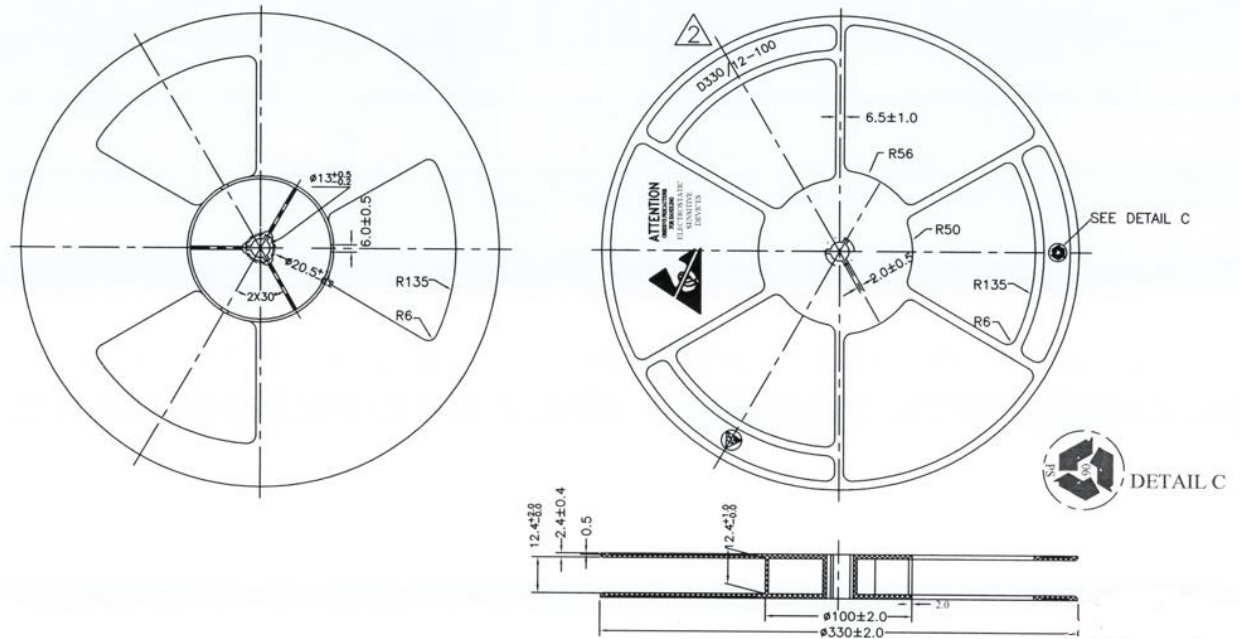


Chart A(3:1)

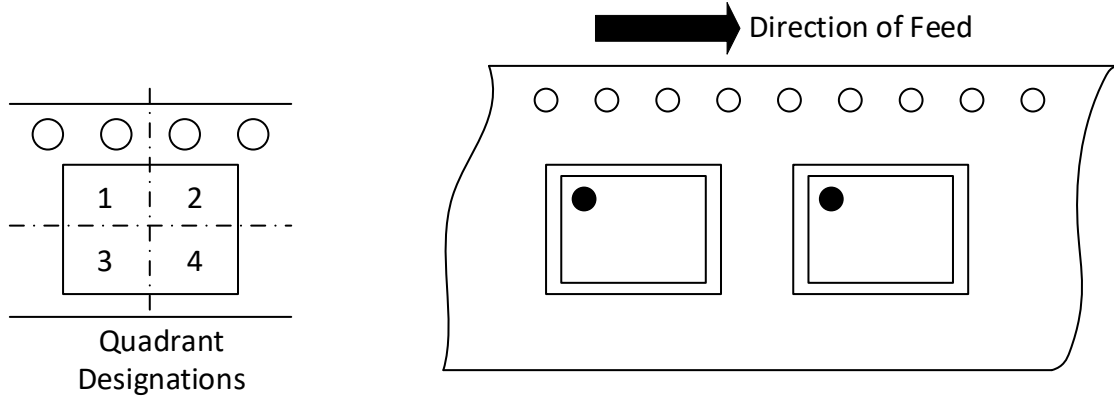
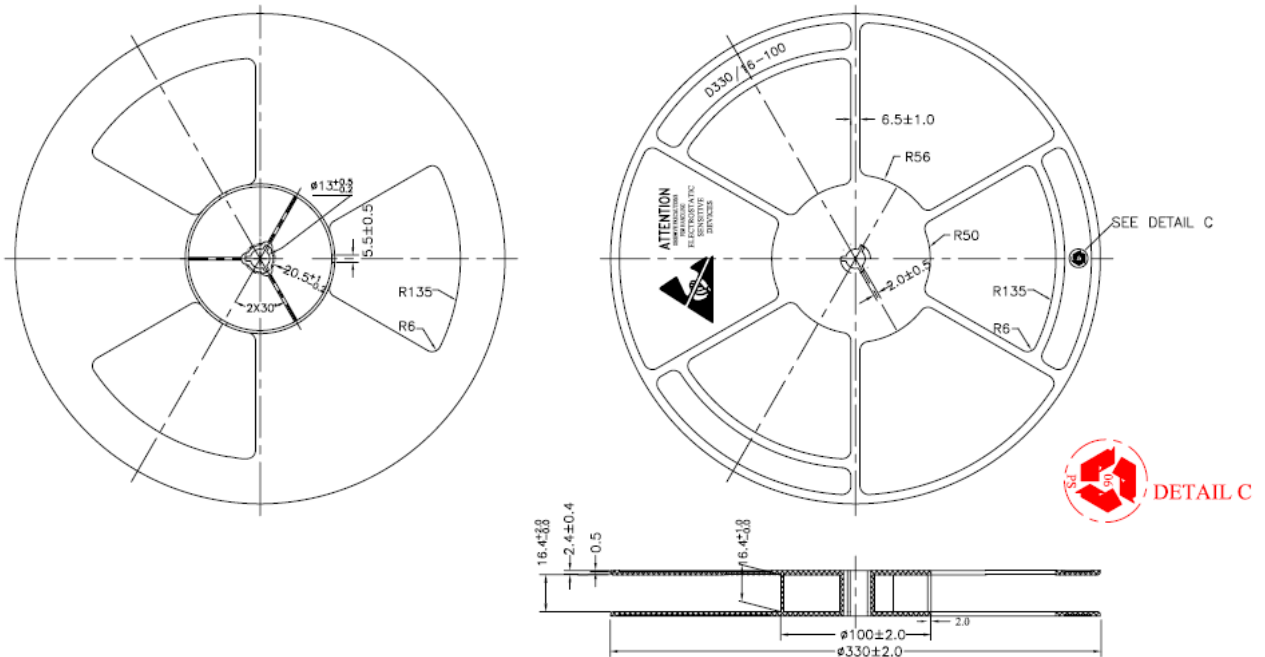


Figure 10.1 Tape and Reel Information of SOP8



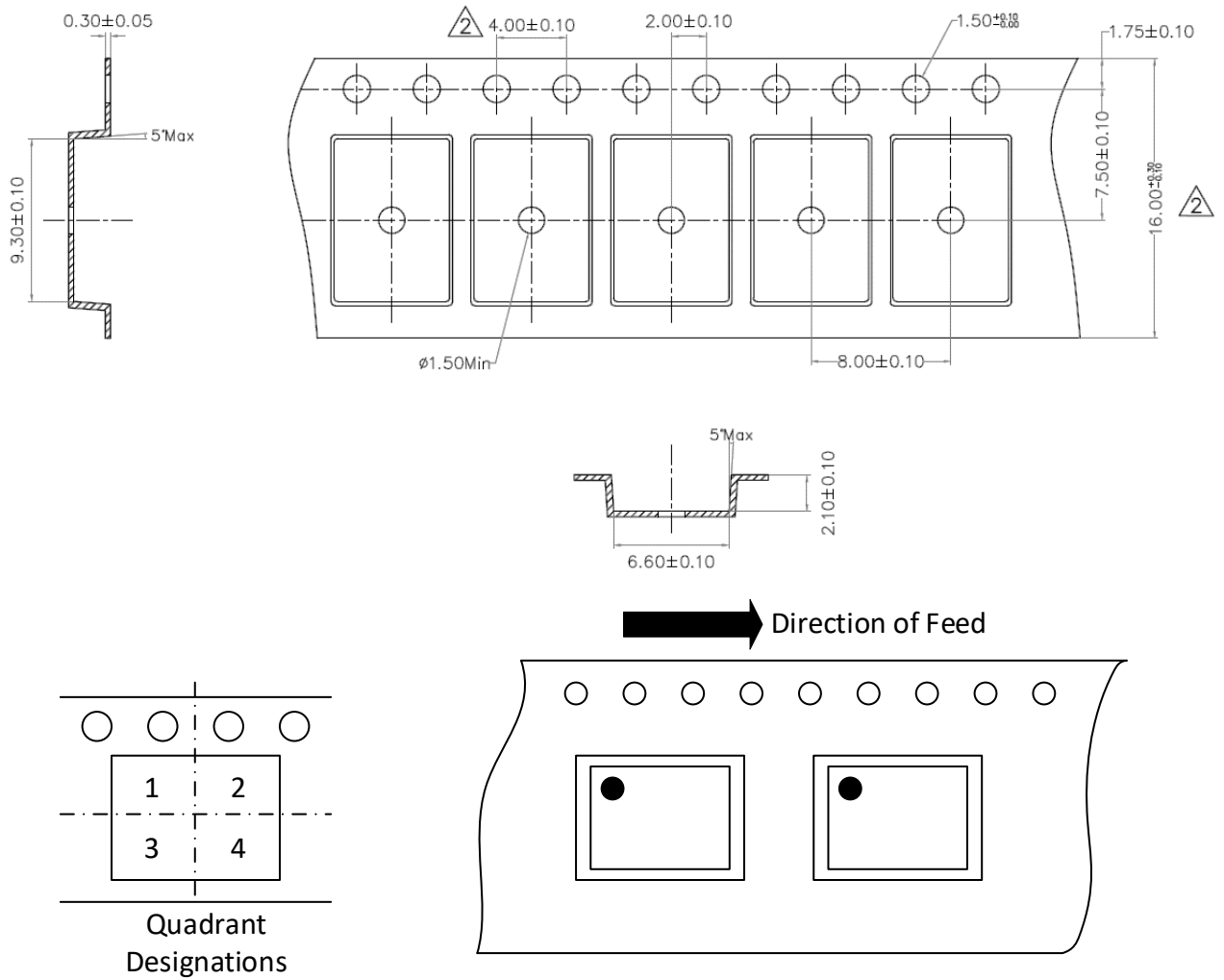


Figure 10.2 Tape and Reel Information of SOP14

## 11. Revision History

Revision	Description	Date
1.0	Initial version	2022/10/19
1.1	Changed the operation temperature	2023/3/6

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