3V to 5.5V RS-485 Transceivers with Auto-direction Control

UM3481D ***SOP8/MSOP8/DFN8 3.0×3.0***
UM13082D ***SOP8/MSOP8/DFN8 3.0×3.0***

1 Description

UM3481D and UM13082D are robust half-duplex RS-485 transceivers for industrial applications. The devices feature auto-direction control using the data input pin that reduces the reliance on separate pins for driver-enable and the receiver-enable functionality. This reduces the number of isolation channels needed or number of the GPIO pins needed for logic control. The bus pins are immune to high levels of IEC ESD events eliminating need of additional system level protection components.

These devices available in two speed grades. The UM3481D is available in 1Mbps. The UM13082D is available in 10Mbps. All devices operate from a single 3V to 5.5V supply. Extended ±15V common-mode range and low input leakage on bus pins make devices suitable for multi-point applications over long cable runs.

UM3481D and UM13082D are available in SOP8, MSOP8 and DFN8 3.0×3.0 packages for space-constrained applications. These devices are characterized over ambient free-air temperatures from -40°C to 125°C.

2 Features

- Meets or exceeds the requirements of the TIA/EIA-485A standards
- 3V to 5.5V supply voltage
- Auto-direction control using the data input pin
- Bus I/O protection
  - ±18V DC bus fault
  - ±8kV Human body model (HBM)
  - ±9kV IEC 61000-4-2 contact discharge
- Latch-up performance exceeds 200mA per JESD 78
- Extended operational common-mode range: ±15V
- Glitch-free power-up/down for hot plug-in capability
- Differential output exceeds 2.1 V for PROFIBUS compatibility with 5V supply
- Available in two speed grades:
  - 1Mbps (UM3481D)
  - 10Mbps (UM13082D)
- Extended ambient temperature range: -40°C to 125°C
- Enhanced receiver hysteresis for noise immunity
- Low power consumption:
  - Quiescent current during operation: 1.7 mA (typ)
- Open, short, and idle bus failsafe
- 1/8 unit load (up to 256 bus nodes)
- Thermal shutdown

3 Applications

- Factory automation and control
- HAVC systems
- Smart meters
- Building automation
- Video surveillance

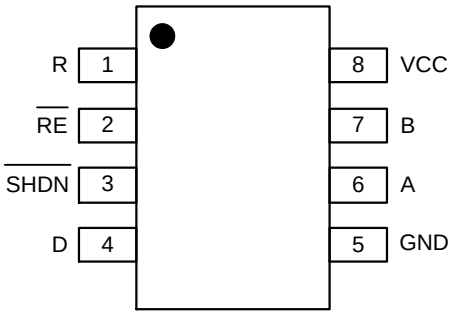
4 Selection Guide

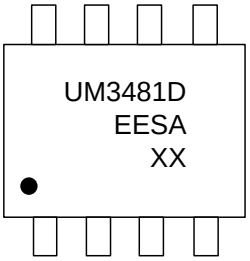
Part Number	Data Rate (Mbps)	V_{CC} Range (V)	Bus Fault Protection (V)
UM3481D	1	3.0 to 5.5	-18 to +18
UM13082D	10	3.0 to 5.5	-18 to +18

5 Ordering Information

Part Number	Mark Code	Package Type	Shipping Qty
UM3481DEESA	UM3481DEESA	SOP8	3000pcs/13Inch Tape & Reel
UM3481DEEM8	3481D	MSOP8	4000pcs/13Inch Tape & Reel
UM3481DEEDA	3481D	DFN8 3.0×3.0	3000pcs/13Inch Tape & Reel
UM13082DEESA	UM13082DEESA	SOP8	3000pcs/13Inch Tape & Reel
UM13082DEEM8	13082D	MSOP8	4000pcs/13Inch Tape & Reel
UM13082DEEDA	13082D	DFN8 3.0×3.0	3000pcs/13Inch Tape & Reel

6 Pin Configuration and Function





XX: Week Code
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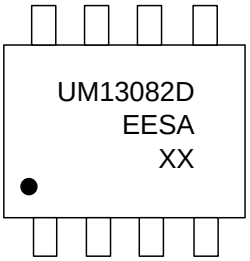
SOP8



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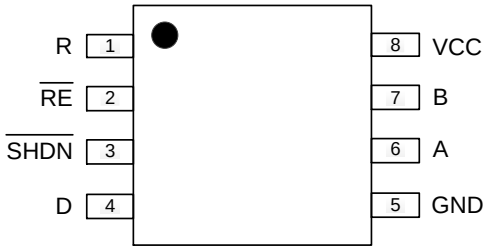
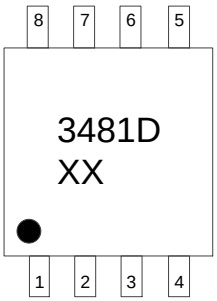
SOP8

6 Pin Configuration and Function (continued)





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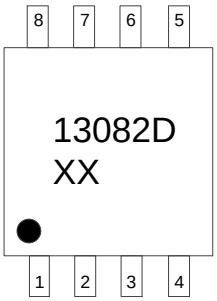

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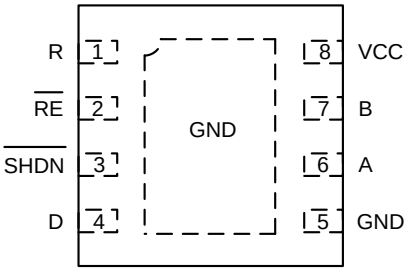
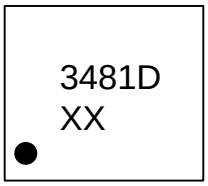
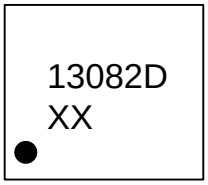




XX: Week Code
UM3481DEEDA
DFN8 3.0×3.0



XX: Week Code
UM13082DEEDA
DFN8 3.0×3.0

6 Pin Configuration and Function (continued)

Table 6-1. Pin Functions

Pin No.	Pin Name	Function
1	R	Receive data output
2	$\overline{RE}$	Receiver enable, active low; integrated pull-up
3	$\overline{SHDN}$	Shutdown enable, active low; integrated pull-up
4	D	Driver data input; integrated pull-up
5	GND	Local device ground
6	A	Driver output or receiver input (complementary to B)
7	B	Driver output or receiver input (complementary to A)
8	VCC	Supply voltage

7 Specifications

7.1 Absolute Maximum Ratings (Note 1)

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V_{CC}	Supply voltage		-0.5		6.5	V
V_I	Voltage on A, B		-18		18	V
	Voltage on any logic pin (D, $\overline{SHDN}$, $\overline{RE}$)		-0.3		6.5	V
V_{ESD}	Human body model (HBM), per ANSI/ESDA/JEDEC JS-001	All pins		±8		kV
	Contact discharge, per IEC 61000-4-2	Bus terminals and GND		±9		kV
I_O	RXD output current		-24		24	mA
T_{STG}	Storage temperature		-65		150	℃
T_L	Lead Temperature for Soldering 10 Seconds				260	℃

Note 1: Operation outside the Absolute Maximum Ratings may cause permanent device damage. Absolute maximum ratings do not imply functional operation of the device at these or any other conditions beyond those listed under Recommended Operating Conditions. If briefly operating outside the Recommended Operating Conditions but within the Absolute Maximum Ratings, the device may not sustain damage, but it may not be fully functional. Operating the device in this manner may affect device reliability, functionality, performance, and shorten the device lifetime.

7.2 Recommended Operating Conditions

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V_{CC}	Supply Voltage		3		5.5	V
V_I	Input voltage at any bus terminal (separately or common mode)	Note 1	-15		15	V
V_{ID}	Differential input voltage		-15		15	V
I_O	Output current, driver		-60		60	mA
I_{OR}	Output current, receiver		-8		8	mA
R_L	Differential load resistance		54	60		Ω
$1/t_{UI}$	Signaling rate (UM3481D)				1	Mbps
	Signaling rate (UM13082D)				10	Mbps
T_A	Operating free-air temperature (see application section for thermal information)		-40		125	℃
T_J	Junction temperature		-40		150	℃

Note 1: The algebraic convention, in which the least positive (most negative) limit is designated as minimum is used in this data sheet.

7.3 Electrical Characteristics (Static)

over operating free-air temperature range (unless otherwise noted). All typical values are at 25°C and supply voltage of V_{CC}= 5 V.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Supply						
I_{CC}	Supply current, V_{CC} = 3.6 V	$\overline{SHDN}$ = V_{CC}, $\overline{RE}$ = 0, D = 0, No load (Driver and receiver enabled)		1.6	3	mA
		$\overline{SHDN}$= V_{CC}, $\overline{RE}$ = V_{CC}, D = 0, No load (Driver enabled, receiver disabled)		1.6	3	mA
		$\overline{SHDN}$ = 0 V, No load (Driver and receiver disabled)		3.3	15	μA
I_{CC}	Supply current, V_{CC} = 5.5 V	$\overline{SHDN}$ = V_{CC}, $\overline{RE}$ = 0, D = 0, No load (Driver and receiver enabled)		1.7	3	mA
		$\overline{SHDN}$= V_{CC}, $\overline{RE}$ = V_{CC}, D = 0, No load (Driver enabled, receiver disabled)		1.7	3	mA
		$\overline{SHDN}$ = 0 V, No load (Driver and receiver disabled)		5	15	μA
Driver						
$\|V_{OD}\|$	Driver differential output voltage magnitude	R_L = 60 Ω, −15 V ≤ V_{TEST} ≤ 15 V, See Figure 8-1	1.5	3.4		V
		R_L = 60 Ω, −15 V ≤ V_{TEST} ≤ 15V, 4.5 V ≤ V_{CC} ≤ 5.5 V, See Figure 8-1	2.1	3.4		V
		R_L = 100 Ω, See Figure 8-2	2	4		V
		R_L = 54 Ω, See Figure 8-2	1.5	3.4		V
		R_L = 54 Ω, 4.5 V ≤ V_{CC} ≤ 5.5 V, See Figure 8-2	2.1	3.4		V

7.3 Electrical Characteristics (Static) (continued)

over operating free-air temperature range (unless otherwise noted). All typical values are at 25°C and supply voltage of V_{CC}= 5 V.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$\Delta \lvert V_{OD} \rvert$	Change in magnitude of driver differential output voltage	R_L= 54 Ω or 100 Ω See Figure 8-2	-50		50	mV
V_{OC}	Common-mode output voltage	R_L= 54 Ω or 100 Ω See Figure 8-2	1	V_{CC}/2	3	V
$\Delta V_{OC(SS)}$	Change in differential driver common-mode output voltage	R_L= 54 Ω or 100 Ω See Figure 8-2	-50		50	mV
$V_{OC(PP)}$	Peak-to-peak driver common-mode output voltage	R_L= 54 Ω or 100 Ω, V_{CC} = 3.3V, See Figure 8-2		200		mV
I_{OS}	Short-circuit output current	-15V ≤ (V_A or V_B) ≤ 15V, or A pin shorted to B pin	-250		250	mA
Receiver						
I_I	Bus input current	V_{CC} = 0V or 5.5V, V_I =12V		70	125	μA
		V_{CC} = 0V or 5.5V, V_I =-7V	-100	-60		
V_{TH+}	Positive-going input threshold voltage	Over common-mode range of ± 15 V	40	125	200	mV
V_{TH-}	Negative-going input threshold voltage		-200	-125	-40	
V_{HYS}	Input hysteresis			250		
$C_{A,B}$	Input differential capacitance	Measured between A and B, f = 1 MHz		50		pF
V_{OH}	Output high voltage	I_{OH} = –8 mA	V_{CC}-0.4	V_{CC}-0.2		V
V_{OL}	Output low voltage	I_{OL} = 8 mA		0.2	0.4	V
I_{OZ}	Output high-impedance current	V_O = 0 V or V_{CC}, $\overline{RE}$ = V_{CC}	-1		1	μA
Logic						
V_{IH}	Input High Voltage	D, $\overline{RE}$, $\overline{SHDN}$	0.7V_{CC}			V
V_{IL}	Input low Voltage	D, $\overline{RE}$, $\overline{SHDN}$			0.3V_{CC}	V

7.3 Electrical Characteristics (Static) (continued)

over operating free-air temperature range (unless otherwise noted). All typical values are at 25°C and supply voltage of V_{CC}= 5 V.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
I_I	Input current on D, $\overline{RE}$, $\overline{SHDN}$ pin	3 V ≤ V_{CC} ≤ 5.5 V, 0 V ≤ V_{IN} ≤ V_{CC} V	-5		5	μA
Thermal Protection						
T_{SD}	Thermal shutdown threshold	Temperature rising	150	170		℃
T_{HYS}	Thermal shutdown hysteresis			10		℃

7.4 Electrical Characteristics (Dynamic)_1Mbps

over recommended operating conditions. All typical values are at 25°C and supply voltage of V_{CC}=5V.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Driver						
t_R, t_F	Driver differential output rise/fall time	R_L = 54 Ω, C_L = 50 pF, see Figure 8-3	130	475	700	ns
t_{PHL}, t_{PLH}	Driver propagation delay time			300	350	ns
$t_{SK(P)}$	Driver differential output pulse skew, $\|t_{PHL} - t_{PLH}\|$			3.5	10	ns
t_{PHZ}, t_{PLZ}	Disable time	See Figure 8-4 and Figure 8-5		980	1200	ns
t_{PZH}, t_{PZL}	Enable time	see Figure 8-4 and Figure 8-5		2.5	4.6	μs
$t_{DEVICE(AUTO-DIR)}$	Driver active time in the auto-direction mode when $\overline{SHDN}$ is high and D switches from low to high	Driver active time in the auto-direction mode when $\overline{SHDN}$ is high and D turns from low to high, see Figure 8-8	4	10	14	μs
Receiver						
t_R, t_F	Receiver output rise/fall time	C_L = 15 pF, see Figure 8-6		9	20	ns
t_{PHL}, t_{PLH}	Receiver propagation delay time			53	80	ns
$t_{SK(P)}$	Receiver output pulse skew,$\|t_{PHL} - t_{PLH}\|$			1	12.5	ns
t_{PHZ}, t_{PLZ}	Receiver disable time			30	50	ns
t_{PZL}, t_{PZH}	Receiver enable time	Driver enabled, see Figure 8-7		30	120	ns

7.4 Electrical Characteristics (Dynamic)_10Mbps

over recommended operating conditions. All typical values are at 25°C and supply voltage of V_{CC}=5V.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Driver						
t_R, t_F	Driver differential output rise/fall time	R_L = 54 Ω, C_L = 50 pF, see Figure 8-3	3.5	13	15	ns
t_{PHL}, t_{PLH}	Driver propagation delay time		4	15	25	ns
$t_{SK(P)}$	Driver differential output pulse skew, $\|t_{PHL} - t_{PLH}\|$			0.5	3	ns
t_{PHZ}, t_{PLZ}	Disable time	See Figure 8-4 and Figure 8-5		830	1200	ns
t_{PZH}, t_{PZL}	Enable time	see Figure 8-4 and Figure 8-5		2.4	4.5	μs
$t_{DEVICE(AUTO-DIR)}$	Driver active time in the auto-direction mode when $\overline{SHDN}$ is high and D switches from low to high	Driver active time in the auto-direction mode when $\overline{SHDN}$ is high and D turns from low to high, see Figure 8-8	0.4	2.9	4	μs
Receiver						
t_R, t_F	Receiver output rise/fall time	C_L = 15 pF, see Figure 8-6		4	6	ns
t_{PHL}, t_{PLH}	Receiver propagation delay time		10	18	35	ns
$t_{SK(P)}$	Receiver output pulse skew,$\|t_{PHL} - t_{PLH}\|$			0.5	5	ns
t_{PHZ}, t_{PLZ}	Receiver disable time	see Figure 8-7		15	50	ns
t_{PZL}, t_{PZH}	Receiver enable time			15	82	ns

8 Parameter Measurement Information

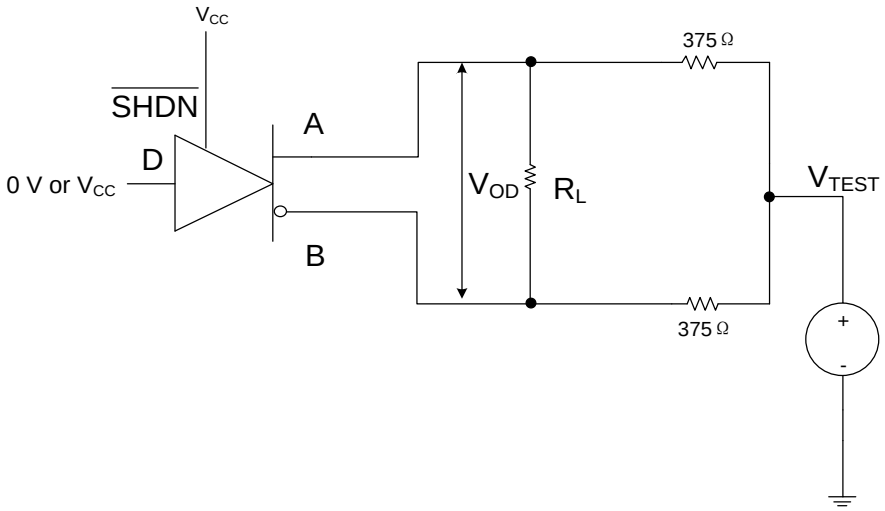


Figure 8-1. Measurement of Driver Differential Output Voltage With Common-Mode Load

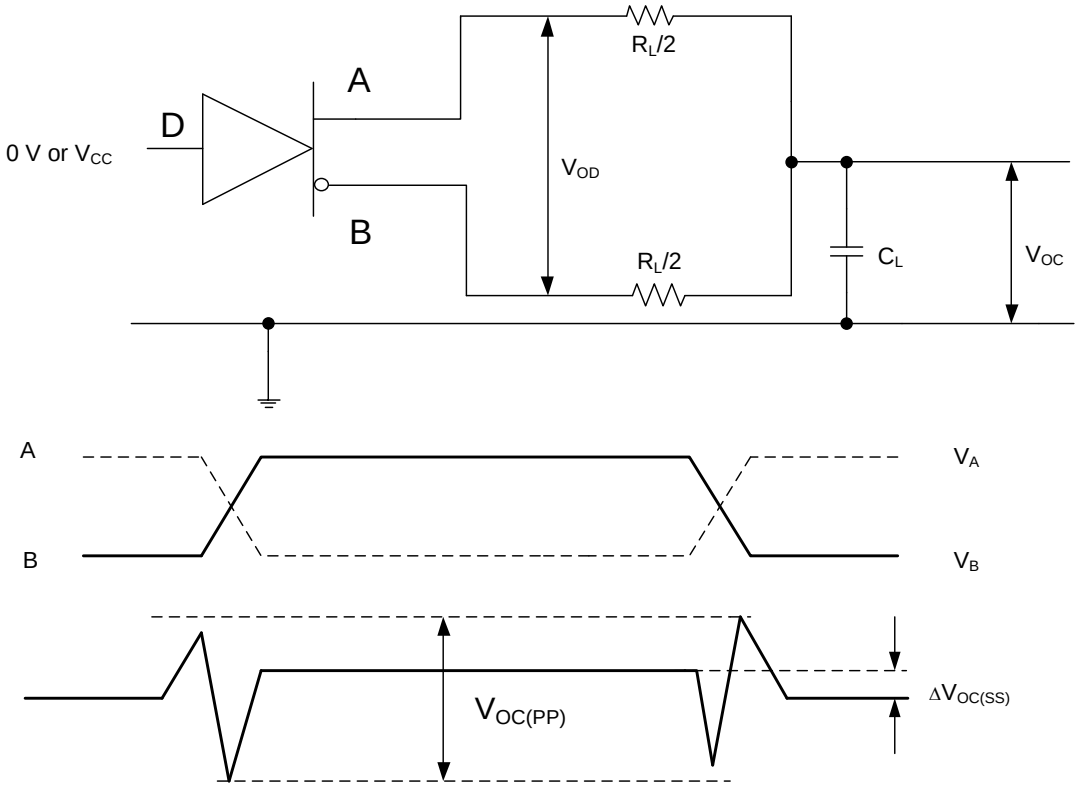


Figure 8-2. Measurement of Driver Differential and Common-Mode Output With RS-485 Load

8 Parameter Measurement Information (continued)

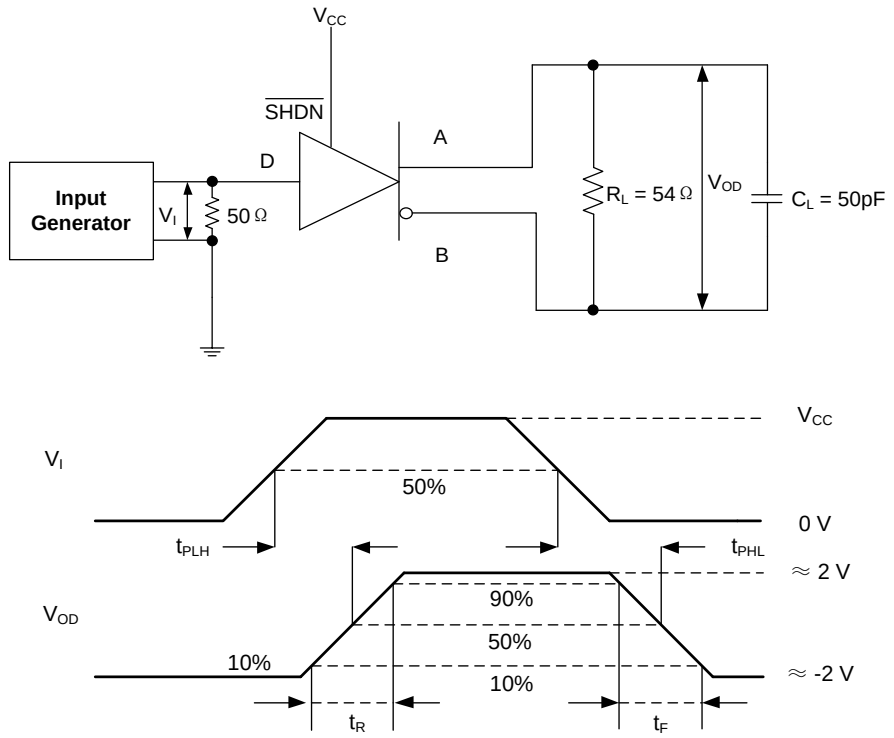


Figure 8-3. Measurement of Driver Differential Output Rise and Fall Times and Propagation Delays

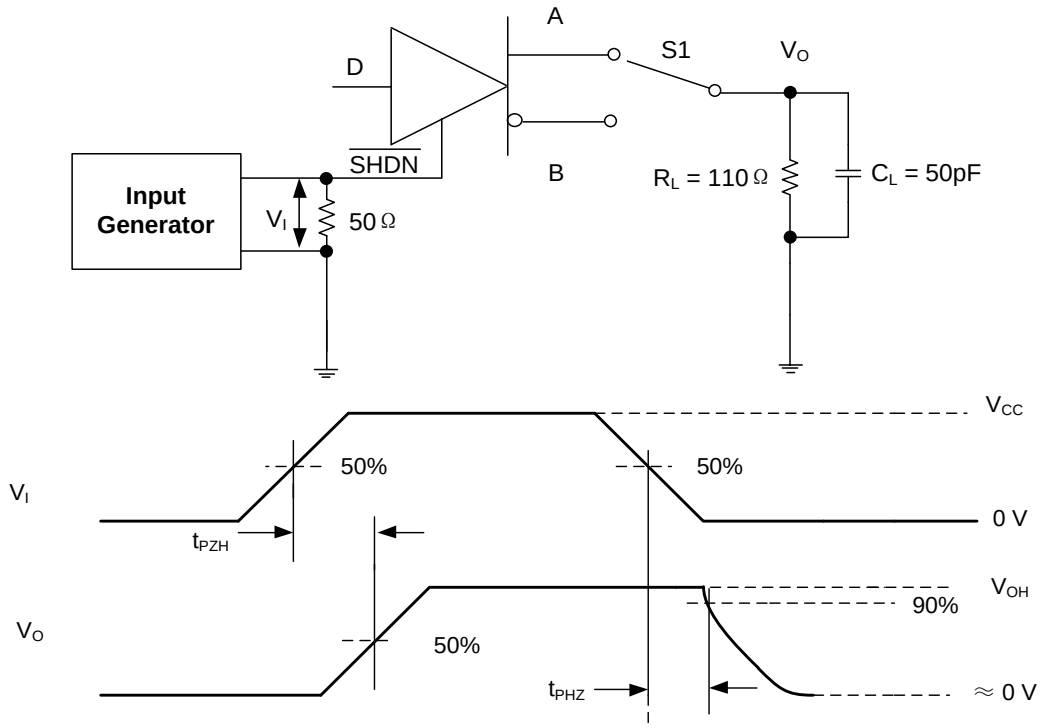


Figure 8-4. Measurement of Driver Enable and Disable Times With Active High Output and Pull-Down Load

8 Parameter Measurement Information (continued)

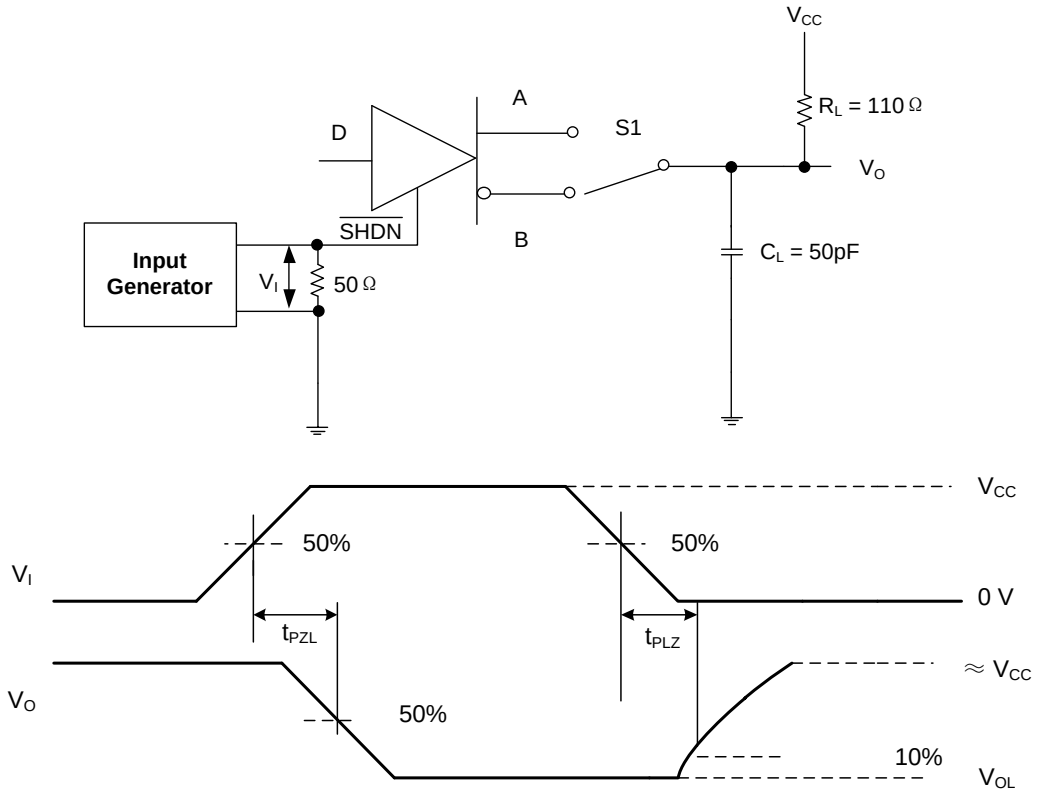


Figure 8-5. Measurement of Driver Enable and Disable Times With Active Low Output and Pull-up Load

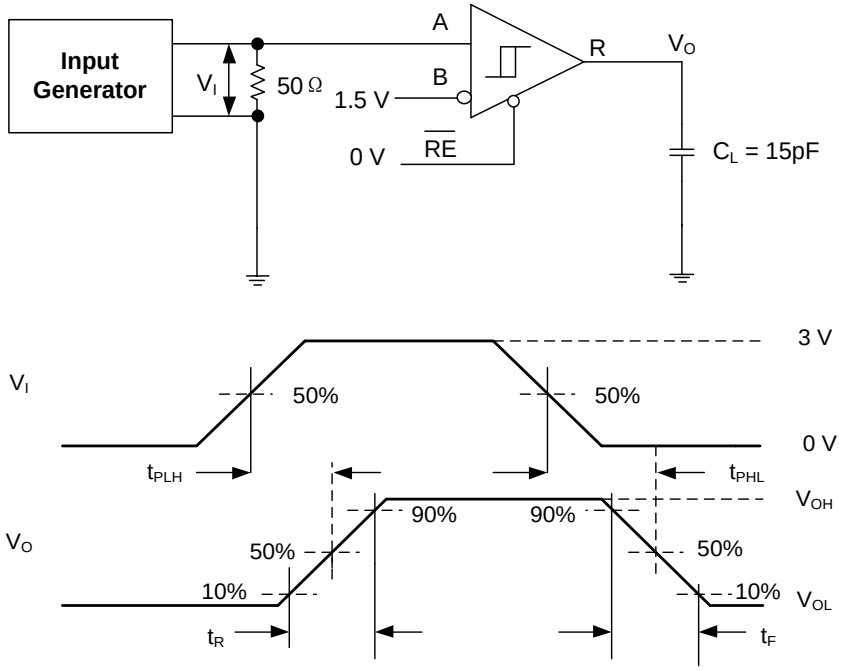


Figure 8-6. Measurement of Receiver Output Rise and Fall Times and Propagation Delays

8 Parameter Measurement Information (continued)

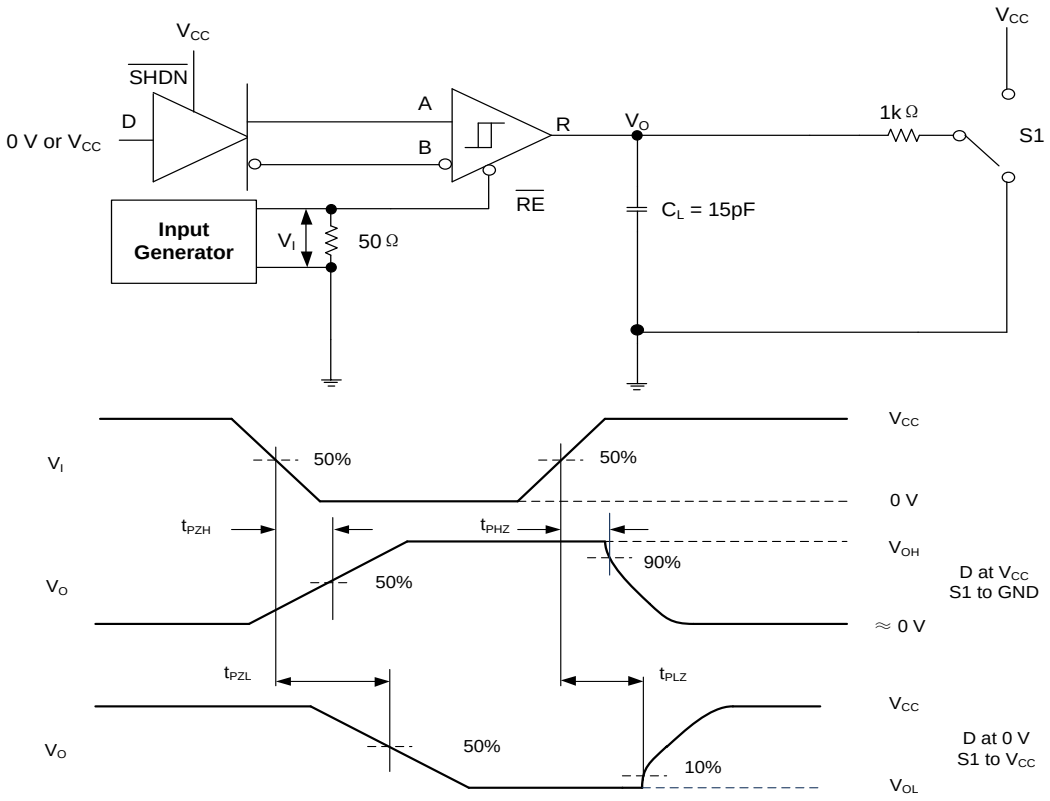


Figure 8-7. Measurement of Receiver Enable/Disable Times With Driver Enabled

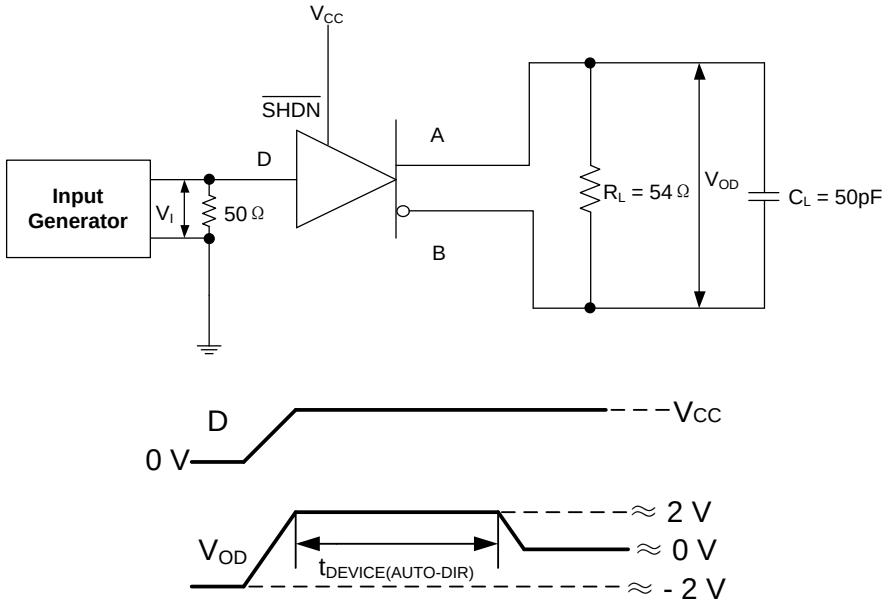


Figure 8-8. Measurement of Auto-direction Control Timing Parameter ($t_{DEVICE(AUTO-DIR)}$)

9 Detailed Description

9.1 Overview

UM3481D and UM13082D feature auto-direction control using the data input pin that reduces the reliance on separate pins for driver-enable and the receiver-enable functionality. The UM3481D is available in speed grade suitable for data transmission up to 1 Mbps. The UM13082D is available in speed grade suitable for data transmission up to 10 Mbps.

9.2 Functional Block Diagram

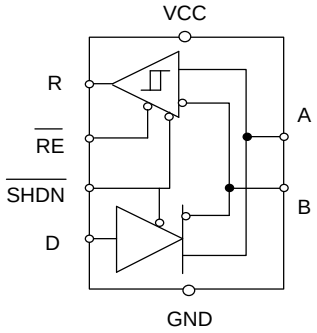


Figure 9-1. UM3481D and UM13082D Block Diagram

10 Feature Description

10.1 ±18-V Fault Protection

The devices have extended bus fault protection compared to standard RS-485 devices. Transceivers that operate in rugged industrial environments are often exposed to voltage transients greater than the -7 V to +12 V defined by the TIA/EIA-485A standard. To protect against such conditions, the generic RS-485 devices with lower absolute maximum ratings requires expensive external protection components. To simplify system design and reduce overall system cost, the devices are protected up to ±18 V without the need for any external components.

10.2 Device Functional Modes

When the shutdown pin, $\overline{SHDN}$, is logic high, the differential outputs A and B follow the logic states at data input D. When D is low, the output states reverse, B turns high, A becomes low, and V_{OD} is negative. A logic high at D causes A to turn high and B to turn low for a duration. In this case, the differential output voltage defined as $V_{OD} = V_A - V_B$ is positive for $t_{DEVICE(AUTO-DIR)}$. After this duration, the driver turns off and the receiver is enabled. The device can be used in auto-direction mode by tying $\overline{SHDN}$ and $\overline{RE}$ pins together to logic high and controlling the driver and receiver using the data input pin, D. This enables reducing the number of GPIO pins or the number of isolation channels required to operate the device. Please refer to Driver Function Table and Receiver Function Table for further details.

When $\overline{SHDN}$ is low, both the driver and the receiver are turned off and the device is in shutdown mode. In this condition, the logic state at D is irrelevant. The $\overline{SHDN}$ pin has an internal pull-up resistor to V_{CC}; thus when left open, the driver is dependent on the status of the D pin. The D pin has an internal pull-up resistor to V_{CC}, thus, when left open while the driver is enabled for $t_{DEVICE(AUTO-DIR)}$, before bring disabled.

10.2 Device Functional Modes (continued)

Table 10-1. Driver Function Table

Input	Enable	Output		Function
D	$\overline{SHDN}$	A	B	
X	L	Z	Z	Driver disabled. Device in shutdown mode.
H	H / Open	H	L	Actively drive bus high for $t_{DEVICE(AUTO-DIR)}$ and then bus is in high impedance.
L	H / Open	L	H	Actively drive bus low.
Open	H / Open	H	L	Actively drive bus high for $t_{DEVICE(AUTO-DIR)}$ and then bus is in high impedance.

When the receiver enable pin, $\overline{RE}$, is logic low, the receiver is enabled. When the differential input voltage defined as $V_{ID} = V_A - V_B$ is higher than the positive input threshold, V_{TH+}, the receiver output, R, turns high. When V_{ID} is lower than the negative input threshold, V_{TH-}, the receiver output, R, turns low. If V_{ID} is between V_{TH+} and V_{TH-}, the output is indeterminate.

When $\overline{RE}$ is logic high or left open and D input is logic low, the receiver output is high-impedance and the magnitude and polarity of V_{ID} are irrelevant. Internal biasing of the receiver inputs causes the output to go failsafe-high when the transceiver is disconnected from the bus (open-circuit), or the bus lines are shorted to one another (short-circuit), or the bus is not actively driven (idle bus).

When $\overline{RE}$ is logic high or left open and D input switches from logic low to logic high, the receiver output is high-impedance for the duration of $t_{DEVICE(AUTO-DIR)}$. After the duration of $t_{DEVICE(AUTO-DIR)}$, the receiver turns ON and outputs a logic high or low depending upon the differential bus input voltage.

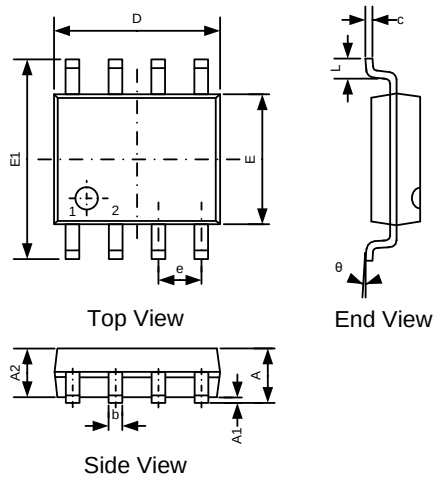
Table 10-2. Receiver Function Table

Differential Input	Enable	Input	Output	Function
$V_{ID} = V_A - V_B$	$\overline{RE}$	D	R	
X	H / Open	L	Z	Receiver disabled
X	H / Open	H	Z for $t_{DEVICE(AUTO-DIR)}$ followed by L or H depending upon bus input voltage	Receiver disabled by for $t_{DEVICE(AUTO-DIR)}$ after D switches from L to H. Receiver output follows bus input voltage after $t_{DEVICE(AUTO-DIR)}$
$V_{TH+} < V_{ID}$	L	X	H	Receive valid bus high
$V_{TH-} < V_{ID} < V_{TH+}$	L	X	N/A	Indeterminate bus state
$V_{ID} < V_{TH-}$	L	X	L	Receive valid bus low
Open-circuit bus	L	X	H	Fail-safe high output
Short-circuit bus	L	X	H	Fail-safe high output
Idle (terminated) bus	L	X	H	Fail-safe high output

Package Information

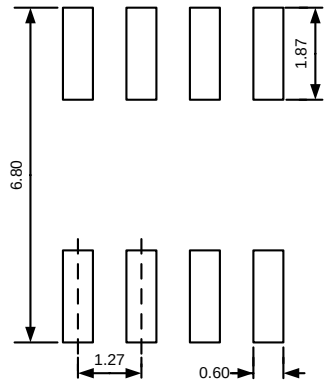
SOP8

Outline Drawing



Symbol	DIMENSIONS					
	MILLIMETERS			INCHES		
	Min	Typ	Max	Min	Typ	Max
A	1.35	1.55	1.75	0.053	0.061	0.069
A1	0.10	-	0.25	0.004	-	0.010
A2	1.25	-	1.65	0.049	-	0.065
b	0.30	-	0.51	0.012	-	0.020
c	0.15	-	0.25	0.006	-	0.010
D	4.70	4.90	5.10	0.185	0.193	0.200
E	3.80	3.90	4.00	0.150	0.154	0.157
E1	5.80	6.00	6.20	0.228	0.236	0.244
e	1.27BSC			0.050 BSC		
L	0.40	-	1.27	0.016	-	0.050
θ	0 °	-	8 °	0 °	-	8 °

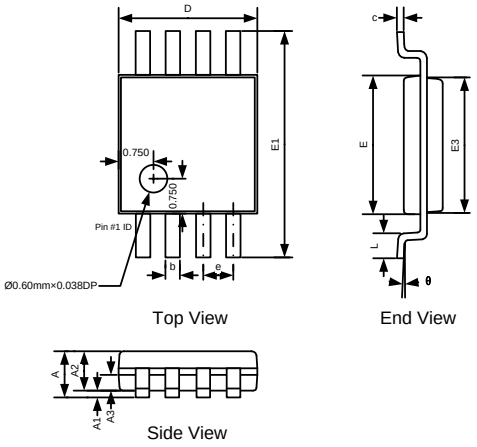
Land Pattern



NOTES:
1. Compound dimension: 4.90×3.90;
2. Unit: mm;
3. General tolerance ±0.05mm unless otherwise specified;
4. The layout is just for reference.

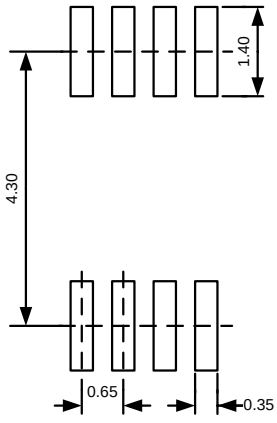
MSOP8

Outline Drawing



DIMENSIONS						
Symbol	MILLIMETERS			INCHES		
	Min	Typ	Max	Min	Typ	Max
A	-	-	1.10	-	-	0.043
A1	0.02	-	0.15	0.0008	-	0.006
A2	0.75	0.86	0.95	0.030	0.034	0.037
A3	0.29	0.39	0.49	0.011	0.015	0.019
b	0.22	-	0.38	0.009	-	0.015
c	0.08	0.15	0.23	0.003	0.006	0.009
D	2.90	3.00	3.10	0.114	0.118	0.122
E	2.90	3.00	3.10	0.114	0.118	0.122
E1	4.70	4.90	5.10	0.185	0.193	0.201
E3	2.85	2.95	3.05	0.112	0.116	0.120
e	0.65BSC			0.026BSC		
L	0.40	0.60	0.80	0.016	0.024	0.031
θ	0°	-	8°	0°	-	8°

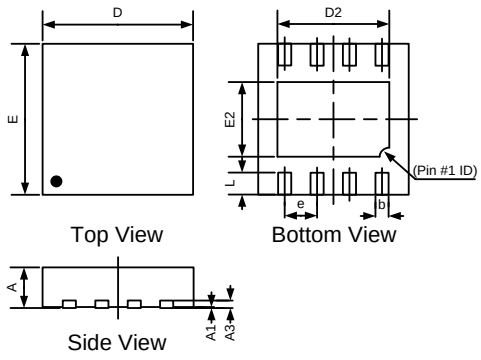
Land Pattern



NOTES:
1. Compound dimension: 3.00×3.00;
2. Unit: mm;
3. General tolerance ±0.05mm unless otherwise specified;
4. The layout is just for reference.

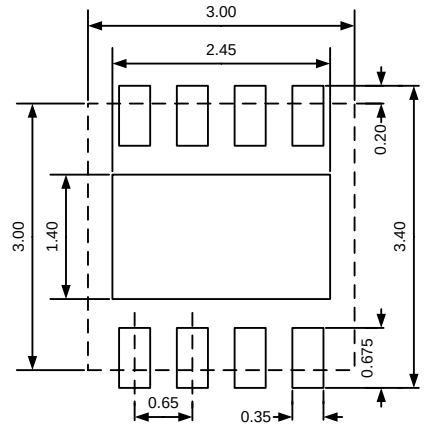
DFN8 3.0×3.0

Outline Drawing



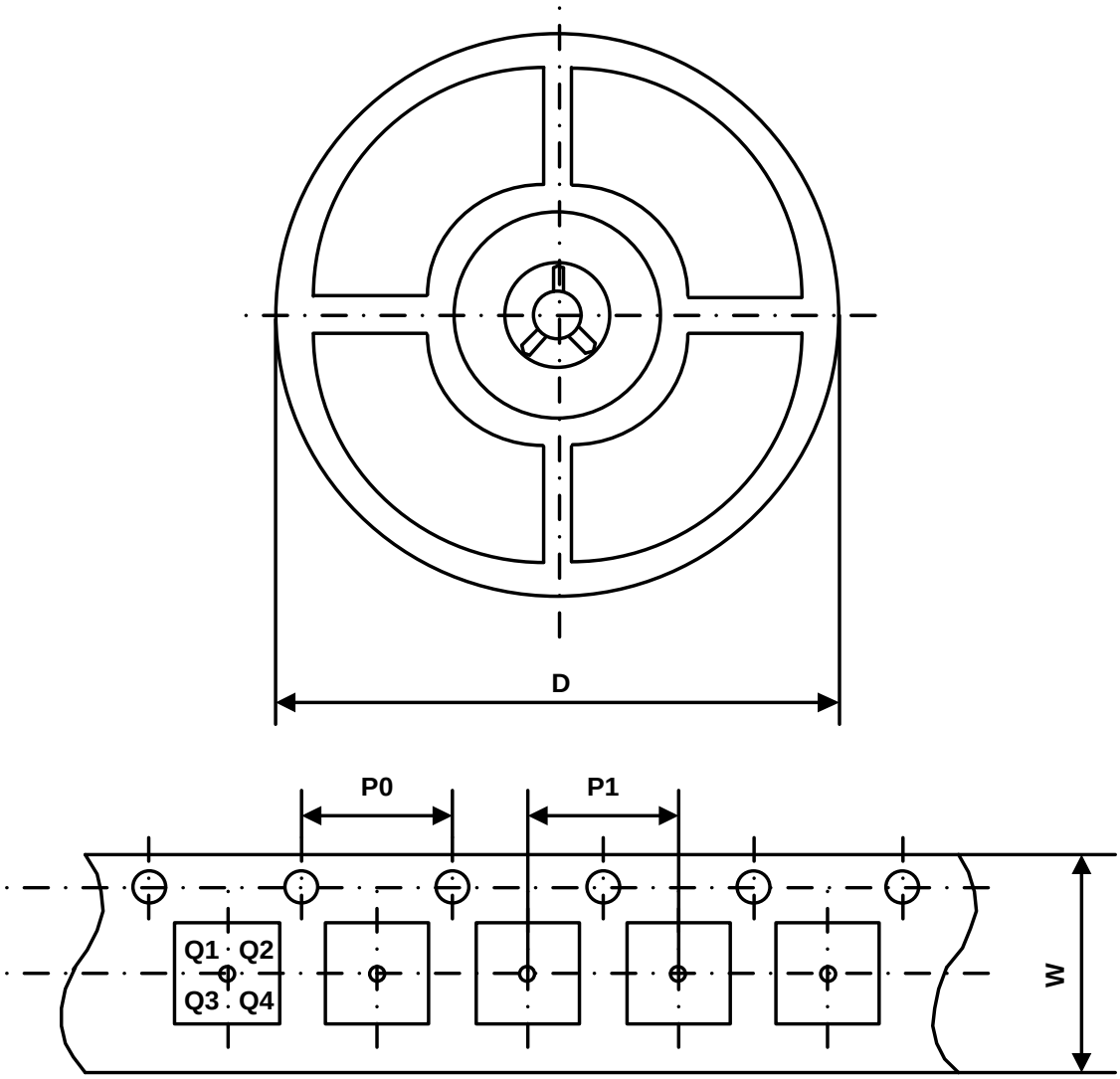
DIMENSIONS						
Symbol	MILLIMETERS			INCHES		
	Min	Typ	Max	Min	Typ	Max
A	0.57	-	0.80	0.022	-	0.031
A1	0.00	-	0.05	0.000	-	0.002
A3	0.20REF			0.008REF		
b	0.20	-	0.35	0.008	-	0.014
D	2.90	3.00	3.10	0.114	0.118	0.122
D2	2.15	-	2.55	0.085	-	0.100
E	2.90	3.00	3.10	0.114	0.118	0.122
E2	1.40	-	1.75	0.055	-	0.069
e	0.65BSC			0.026BSC		
L	0.30	-	0.60	0.012	-	0.024

Land Pattern



NOTES:
1. Compound dimension: 3.00×3.00;
2. Unit: mm;
3. General tolerance ±0.05mm unless otherwise specified;
4. The layout is just for reference.

Packing Information



Part Number	Package Type	Carrier Width (W)	Pitch (P0)	Pitch (P1)	Reel Size (D)	PIN 1 Quadrant
UM3481DEESA	SOP8	12 mm	4 mm	8 mm	330 mm	Q1
UM3481DEEM8	MSOP8	12 mm	4 mm	8 mm	330 mm	Q1
UM3481DEEDA	DFN8 3.0×3.0	12 mm	4 mm	8 mm	330 mm	Q1
UM13082DEESA	SOP8	12 mm	4 mm	8 mm	330 mm	Q1
UM13082DEEM8	MSOP8	12 mm	4 mm	8 mm	330 mm	Q1
UM13082DEEDA	DFN8 3.0×3.0	12 mm	4 mm	8 mm	330 mm	Q1

GREEN COMPLIANCE

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All Union components are compliant with the RoHS directive, which helps to support customers in their compliance with environmental directives. For more green compliance information, please visit:
https://www.union-ic.com/Quality.html

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