±18V Fault-Protected, 3V to 5.5V, Full Duplex RS-485 Transceivers

UM3481F *SOP8/SOP14*
UM13082F *SOP8/SOP14*

1 Description

The UM3481F and the UM13082F are ±18V fault-protected, full-duplex, RS-422/RS-485 transceivers operating on a single 3V to 5.5V supply voltage. These devices are available in two speed grades. The UM3481F is available in 1Mbps. The UM13082F is available in 20Mbps. Bus interface pins are protected against overvoltage conditions during all modes of operation ensuring robust communication in rugged industrial environments.

These devices also feature integrated IEC ESD protection, eliminating the need for external system-level protection components. Extended ±15V input common-mode range ensures reliable data communication over longer cable run lengths and/or in the presence of large ground loop voltages. Enhanced 250mV receiver hysteresis provides high noise rejection. In addition, the receiver fail-safe feature provides a logic high when the bus inputs are open or shorted together.

The UM3481F and the UM13082F are available in SOP8 and SOP14 packages. All devices are designed for space-constrained applications and have extended ambient temperature range from -40°C to 125°C.

2 Features

- Meets or exceeds the requirements of the TIA/EIA-485A and TIA/EIA-422B standards
- 3V to 5.5V supply voltage
- Bus I/O protection
  - ±18V DC bus fault
  - ±8kV Human body model (HBM)
- Extended operational common-mode range: ±15V
- Latch-up performance exceeds 200mA per JESD 78
- 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 (UM3481F)
  - 20Mbps (UM13082F)
- Extended ambient temperature range: -40°C to 125°C
- Enhanced receiver hysteresis for noise immunity
- Open, short, and idle bus failsafe
- Thermal shutdown
- 1/8 unit load (up to 256 bus nodes)

3 Applications

- Automotive data links
- Industrial-Control Local Area Networks
- Integrated Services Digital Networks
- Building automation
- Electricity meters
- Transceivers for EMI-Sensitive Applications

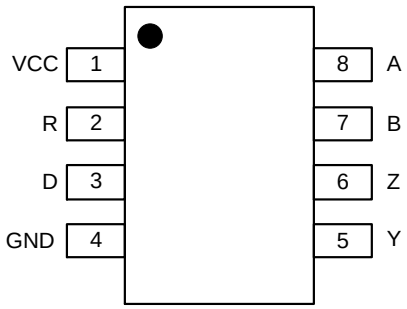
4 Selection Guide

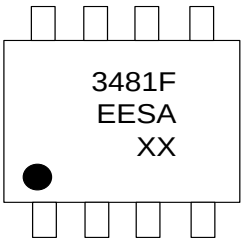
Part Number	Bus fault Voltage (V)	Data Rate (Mbps)
UM3481F	±18	1
UM13082F	±18	20

5 Ordering Information

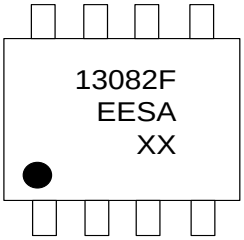
Part Number	Mark Code	Package Type	Shipping Qty
UM3481FEESA	3481FEESA	SOP8	3000pcs/13Inch Tape & Reel
UM3481FEESE	UM3481F	SOP14	2500pcs/13Inch Tape & Reel
UM13082FEESA	13082FEESA	SOP8	3000pcs/13Inch Tape & Reel
UM13082FEESE	UM13082F	SOP14	2500pcs/13Inch Tape & Reel

6 Pin Configuration and Function





XX: Week Code
UM3481FEESA
SOP8



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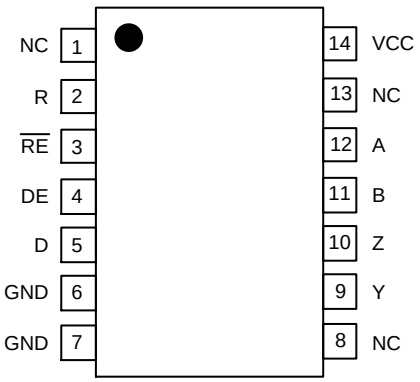
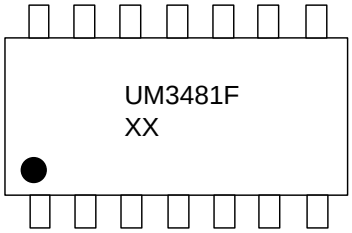
UM13082FEESA
SOP8

6 Pin Configuration and Function (continued)





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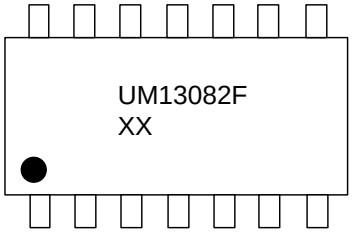


XX: Week Code
UM13082FEESE
SOP14

Table 6-1. Pin Functions

Pin Name	Function
R	Receiver data output.
$\overline{RE}$	Receiver enable, active low.
DE	Driver enable, active high.
D	Driver data input.
NC	Not connected internally.
GND	Ground.
Y	Driver non-inverting output.
Z	Driver inverting output.
B	Receiver inverting input.
A	Receiver non-inverting input.
VCC	3 V to 5.5 V bus supply.

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, Y, Z		-18		18	V
	Voltage on any logic pin (D, DE , $\overline{RE}$)		-0.3		6.5	V
V_{ESD}	Human body model (HBM), per ANSI/ESDA/JEDEC JS-001	Bus pins		±8		kV
		Other pins		±2		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	UM3481F			1	Mbps
		UM13082F			20	Mbps
T_A	Operating free-air temperature		-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) (Note 1)

V_{CC} = +3V to +5.5V, T_A = -40℃ to +125℃, 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						
$V_{UVD(VCC)RISING}$	Rising under-voltage threshold on VCC			2.6	2.8	V
$V_{UVD(VCC)FALLING}$	Falling under-voltage threshold on VCC		1.95	2.35		V
$V_{UVD(VCC)HYS}$	Hysteresis on under-voltage of VCC			250		mV
I_{CC}	Supply current, V_{CC} = 4.5 V to 5.5 V	$\overline{RE}$ = 0 V, DE = V_{CC}, No load (Driver and receiver enabled)		1.9	3	mA
		$\overline{RE}$= V_{CC}, DE = V_{CC}, No load (Driver enabled, receiver disabled)		1.9	3	mA
		$\overline{RE}$ = 0 V, DE = 0 V, No load (Driver disabled, receiver enabled)		1.2	2.4	mA
		$\overline{RE}$ = V_{CC}, DE = 0 V, D = open, No load (Driver and receiver disabled)		4.3	10	μA
I_{CC}	Supply current, V_{CC} = 3 V to 3.6 V	$\overline{RE}$ = 0 V, DE = V_{CC}, No load (Driver and receiver enabled)		1.8	2.7	mA
		$\overline{RE}$= V_{CC}, DE = V_{CC}, No load (Driver enabled, receiver disabled)		1.8	2.7	mA
		$\overline{RE}$ = 0 V, DE = 0 V, No load (Driver disabled, receiver enabled)		1.1	2.2	mA
		$\overline{RE}$ = V_{CC}, DE = 0 V, D = open, No load (Driver and receiver disabled)		3.2	8	μA

7.3 Electrical Characteristics (Static) (Note 1) (continued)

V_{CC} = +3V to +5.5V, T_A = -40℃ to +125℃, 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
Driver						
$\|V_{OD}\|$	Driver differential output voltage magnitude	R_L = 60 Ω, −15 V ≤ V_{TEST} ≤ 15 V, See Figure 8-1	1.5	3.3		V
		R_L = 60 Ω, −15 V ≤ V_{TEST} ≤ 15V, 4.5 V ≤ V_{CC} ≤ 5.5 V, See Figure 8-1	2.1	3.3		V
		R_L = 100 Ω, See Figure 8-2	2	4		V
		R_L = 54 Ω, See Figure 8-2	1.5	3.3		V
$\Delta\|V_{OD}\|$	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
$V_{OC(SS)}$	Steady-state common-mode output voltage	R_L= 54 Ω or 100 Ω See Figure 8-2	-50		50	mV
I_{OS}	Short-circuit output current	DE = V_{CC}, -18V ≤ (V_Y or V_Z) ≤ 18V	-250		250	mA
Receiver						
I_I	Bus input current	DE = 0V, V_{CC} = 0V or 5.5V, V_I =12V			125	μA
		DE = 0V, V_{CC} = 0V or 5.5V, V_I =-7V	-100			
V_{TH+}	Positive-going input threshold voltage	Over common-mode range of ±15 V		125	200	mV
V_{TH-}	Negative-going input threshold voltage		-200	-125		
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

7.3 Electrical Characteristics (Static) (Note 1) (continued)

V_{CC} = +3V to +5.5V, T_A = -40℃ to +125℃, 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
Logic						
V_{IH}	Input High Voltage on DE, D, $\overline{RE}$	V_{CC} = 4.5 to 5.5 V	2.8			V
		V_{CC} = 3.0 to 3.6 V	2.1			V
V_{IL}	Input low Voltage on DE, D, $\overline{RE}$	V_{CC} = 4.5 to 5.5 V			0.8	V
		V_{CC} = 3.0 to 3.6 V			0.8	V
I_I	Input current on DE pin	0 V ≤ V_{IN} ≤ V_{CC}		10	25	μA
	Input current on D, $\overline{RE}$ pin	0 V ≤ V_{IN} ≤ V_{CC}	-10			μA
Thermal Protection						
T_{SD}	Thermal shutdown threshold	Temperature rising		150		℃
T_{HYS}	Thermal shutdown hysteresis			10		℃

7.4 Electrical Characteristics (Dynamic)—1Mbps (Note 1)

V_{CC} = +3V to +5.5V, T_A = -40℃ to +125℃, unless otherwise noted. 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	V_{CC} = 3 to 3.6 V, Typical at 3.3 V	105	128	300	ns
			V_{CC} = 4.5 to 5.5 V, Typical at 5 V	130	180	300	ns
t_{PHL}, t_{PLH}	Driver propagation delay time		V_{CC} = 3 to 3.6 V, Typical at 3.3 V		125	240	ns
			V_{CC} = 4.5 to 5.5 V, Typical at 5 V		141	280	ns
$t_{SK(P)}$	Driver differential output pulse skew, $\|t_{PHL} - t_{PLH}\|$		V_{CC} = 3 to 3.6 V, Typical at 3.3 V		3	20	ns
			V_{CC} = 4.5 to 5.5 V, Typical at 5 V		2	15	ns
t_{PHZ}, t_{PLZ}	Disable time	See Figure 8-4 and Figure 8-5				200	ns
t_{PZH}, t_{PZL}	Enable time	$\overline{RE}$ = 0 V, See Figure 8-4 and Figure 8-5				300	ns
t_{PSH}, t_{PSL}		$\overline{RE}$ = V_{CC}, See Figure 8-4 and Figure 8-5			2.6	4.6	μs
t_{PHS}, t_{PLS}	Time to shutdown	$\overline{RE}$ = V_{CC}, See Figure 8-4 and Figure 8-5		50		500	ns
Receiver							
t_R, t_F	Receiver output rise/fall time	C_L = 15 pF, see Figure 8-6			8.5	15	ns
t_{PHL}, t_{PLH}	Receiver propagation delay time				55	85	ns
$t_{SK(P)}$	Receiver output pulse skew, $\|t_{PHL} - t_{PLH}\|$				1	12.5	ns

7.4 Electrical Characteristics (Dynamic)—1Mbps (continued) (Note 1)

V_{CC} = +3V to +5.5V, T_A = -40℃ to +125℃, unless otherwise noted. All typical values are at 25°C and supply voltage of V_{CC}=5V.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Receiver						
t_{PHZ}, t_{PLZ}	Receiver disable time			33	50	ns
t_{PZL}, t_{PZH}	Receiver enable time	DE = V_{CC}, see Figure 8-7		38	90	ns
t_{PSL}, t_{PSH}		DE = 0 V, see Figure 8-8		3	4.5	μs
t_{PHS}, t_{PLS}	Time to shutdown	DE = 0 V, see Figure 8-8	50		500	ns

7.4 Electrical Characteristics (Dynamic)—20Mbps (Note 1)

V_{CC} = +3V to +5.5V, T_A = -40℃ to +125℃, unless otherwise noted. 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	V_{CC} = 3 to 3.6 V, Typical at 3.3 V	3	4.4	15	ns
			V_{CC} = 4.5 to 5.5 V, Typical at 5 V	3	4	15	ns
t_{PHL}, t_{PLH}	Driver propagation delay time		V_{CC} = 3 to 3.6 V, Typical at 3.3 V	4	9	30	ns
			V_{CC} = 4.5 to 5.5 V, Typical at 5 V	4	7	25	ns
$t_{SK(P)}$	Driver differential output pulse skew, $\|t_{PHL} - t_{PLH}\|$		V_{CC} = 3 to 3.6 V, Typical at 3.3 V		1	3	ns
			V_{CC} = 4.5 to 5.5 V, Typical at 5 V		1	3	ns
t_{PHZ}, t_{PLZ}	Disable time	See Figure 8-4 and Figure 8-5				200	ns
t_{PZH}, t_{PZL}	Enable time	$\overline{RE}$ = 0 V, See Figure 8-4 and Figure 8-5				50	ns
t_{PSH}, t_{PSL}		$\overline{RE}$ = V_{CC}, See Figure 8-4 and Figure 8-5			2.5	4.5	μs
t_{PHS}, t_{PLS}	Time to shutdown	$\overline{RE}$ = V_{CC}, See Figure 8-4 and Figure 8-5		50		500	ns
Receiver							
t_R, t_F	Receiver output rise/fall time	C_L = 15 pF, see Figure 8-6			4.5	7	ns
t_{PHL}, t_{PLH}	Receiver propagation delay time			9	12	40	ns
$t_{SK(P)}$	Receiver output pulse skew, $\|t_{PHL} - t_{PLH}\|$				0.5	5	ns

7.4 Electrical Characteristics (Dynamic)—20Mbps (continued) (Note 1)

V_{CC} = +3V to +5.5V, T_A = -40 ℃ to +125 ℃, unless otherwise noted. All typical values are at 25°C and supply voltage of V_{CC}=5V.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Receiver						
t_{PHZ}, t_{PLZ}	Receiver disable time			13	30	ns
t_{PZL}, t_{PZH}	Receiver enable time	DE = V_{CC}, see Figure 8-7		17	50	ns
t_{PSL}, t_{PSH}		DE = 0 V, see Figure 8-8		2.9	5	μs
t_{PHS}, t_{PLS}	Time to shutdown	DE = 0 V, see Figure 8-8	50		500	ns

8 Parameter Measurement Information

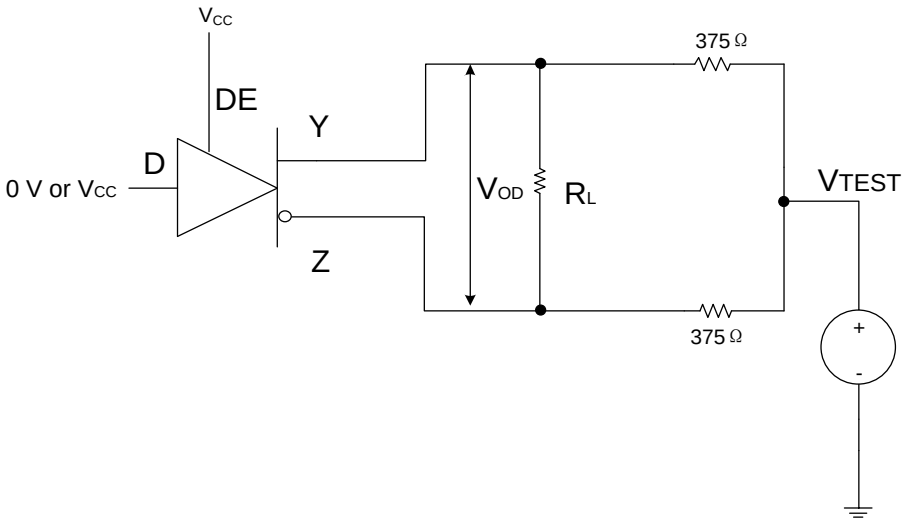


Figure 8-1. Measurement of Driver Differential Output Voltage With Common-Mode Load

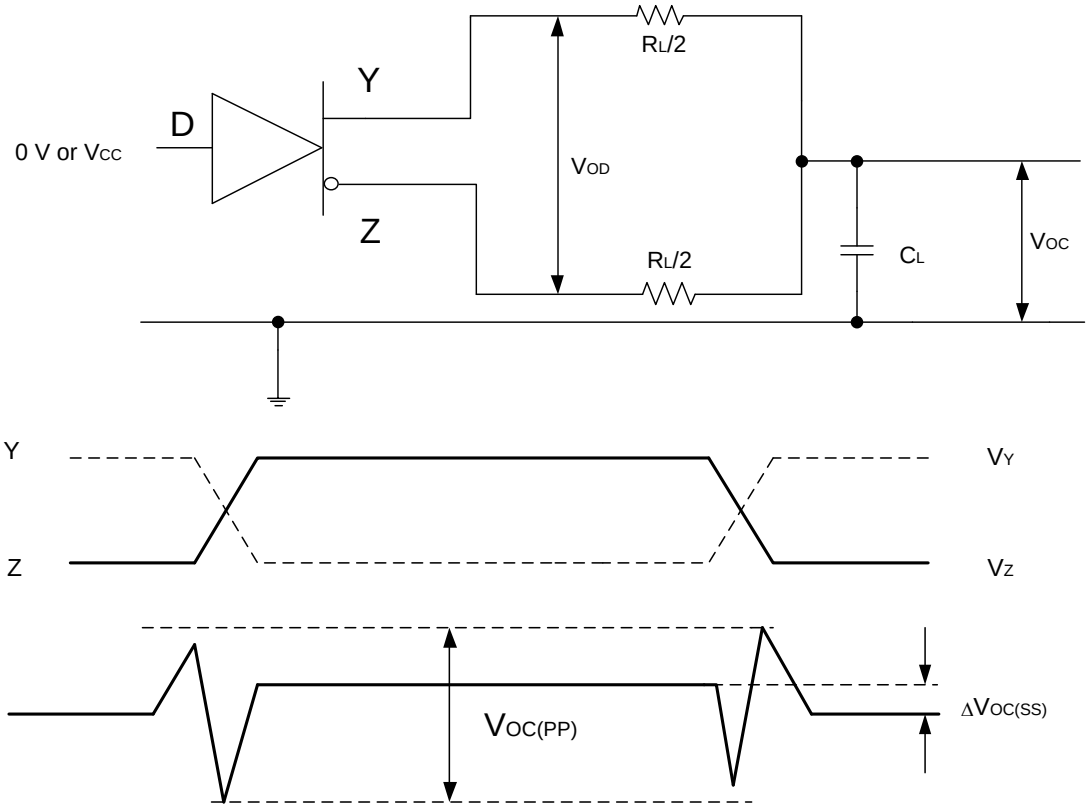


Figure 8-2. Measurement of Driver Differential and Common-Mode Output With RS-485/RS-422 Load

8 Parameter Measurement Information (continued)

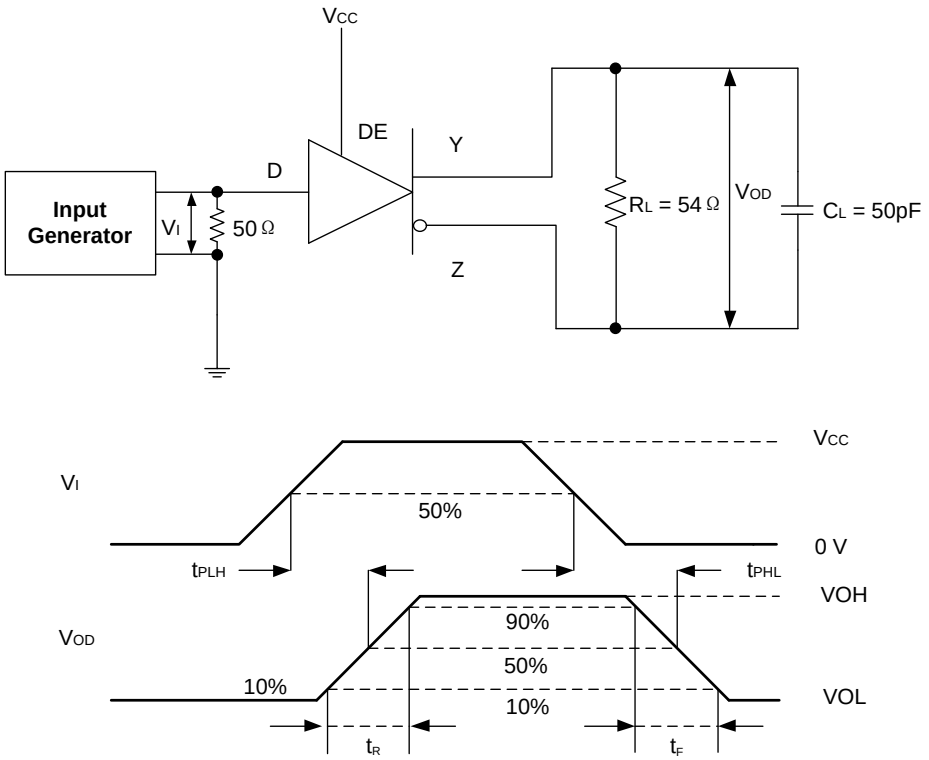


Figure 8-3. Measurement of Driver Differential Output Rise and Fall Times and Propagation Delays

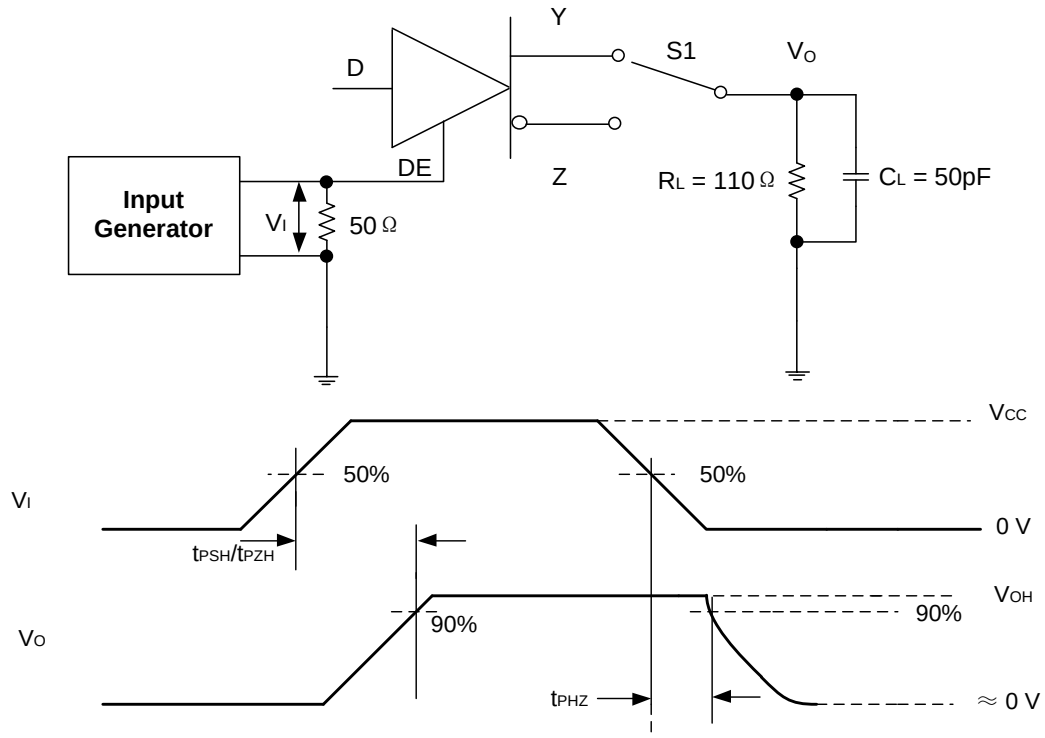


Figure 8-4. Measurement of Driver Enable and Disable Times With Active High Output and Pull-Down Load

8 Parameter Measurement Information (continued)

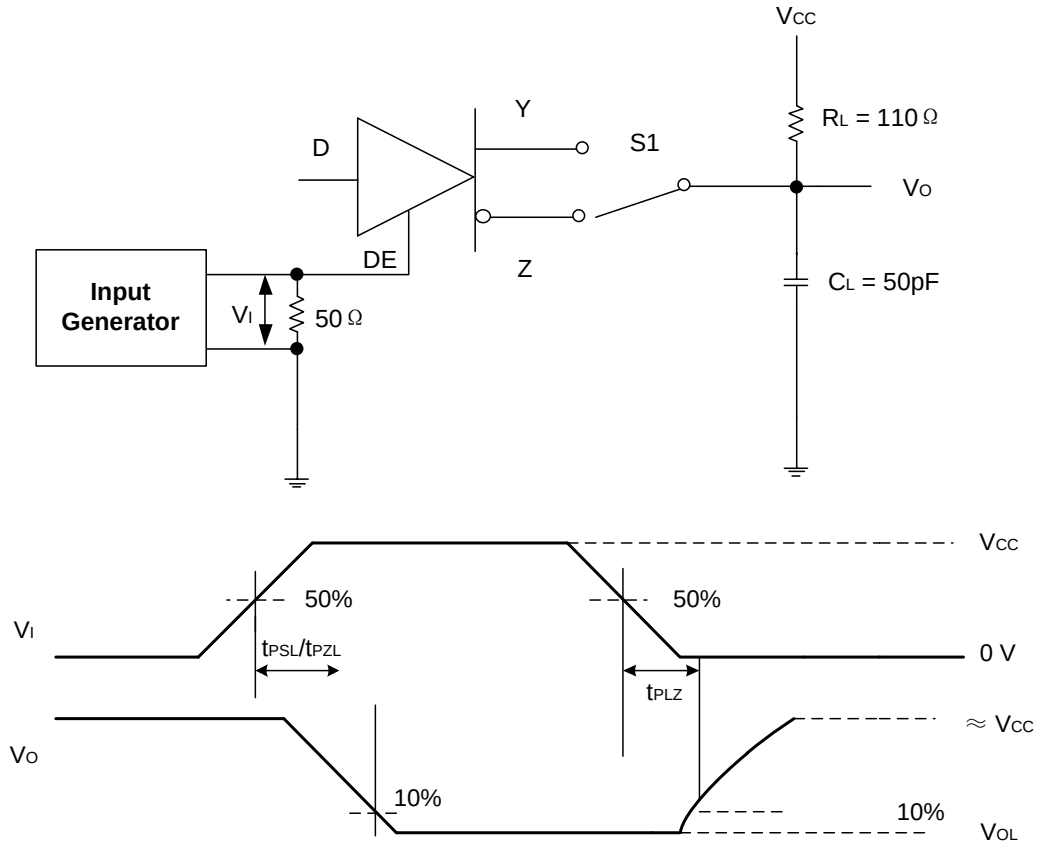


Figure 8-5. Measurement of Driver Enable and Disable Times With Active Low Output and Pull-up Load

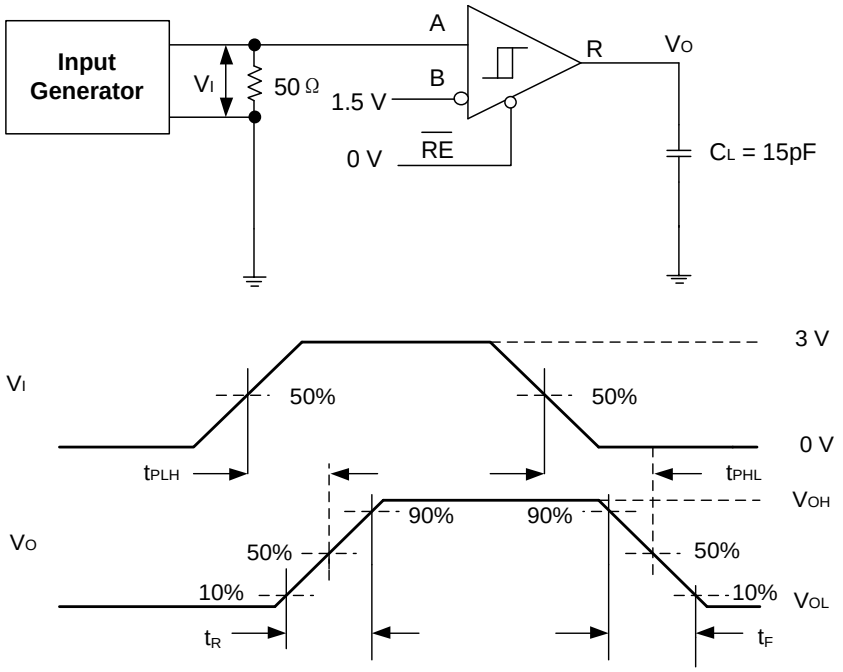


Figure 8-6. Measurement of Receiver Output Rise and Fall Times and Propagation Delays

8 Parameter Measurement Information (continued)

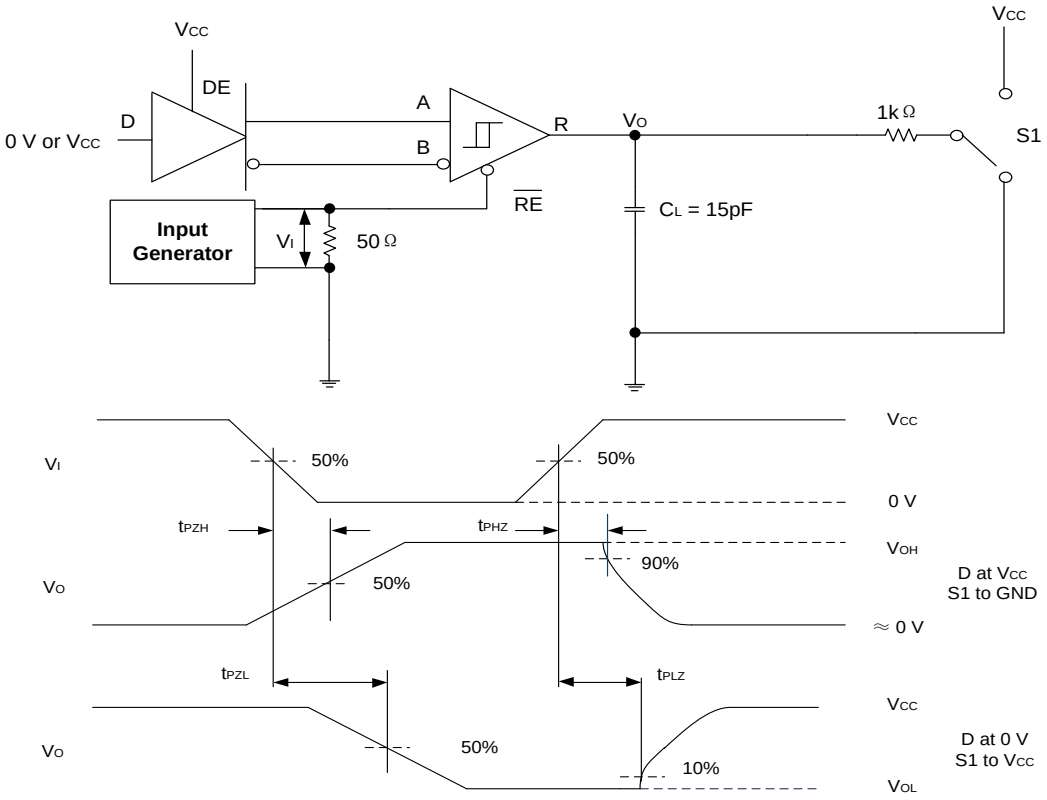


Figure 8-7. Measurement of Receiver Enable/Disable Times With Driver Enabled

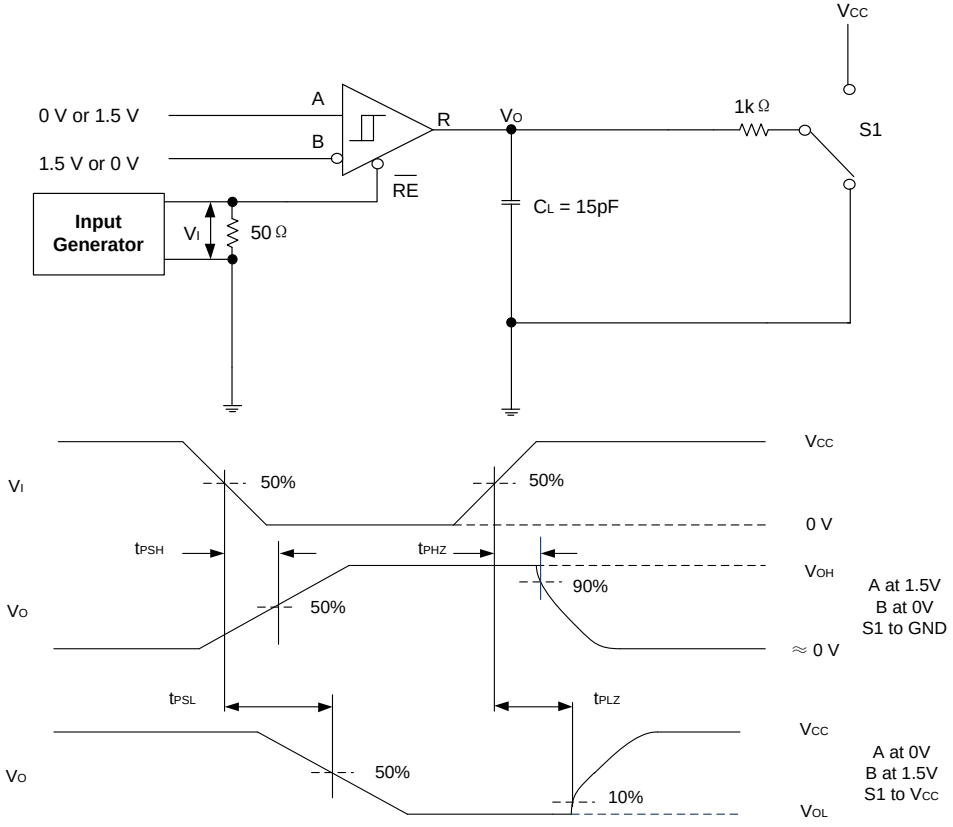


Figure 8-8. Measurement of Receiver Enable Times With Driver Disabled

9 Detailed Description

9.1 Overview

The UM3481F is fault-protected, full duplex RS-485 transceivers available in speed grade suitable for data transmission up to 1Mbps. The UM13082F is fault-protected, full duplex RS-485 transceivers available in speed grade suitable for data transmission up to 20 Mbps. This is beneficial as customers can qualify one device and use it in two different end-applications.

9.2 Functional Block Diagram

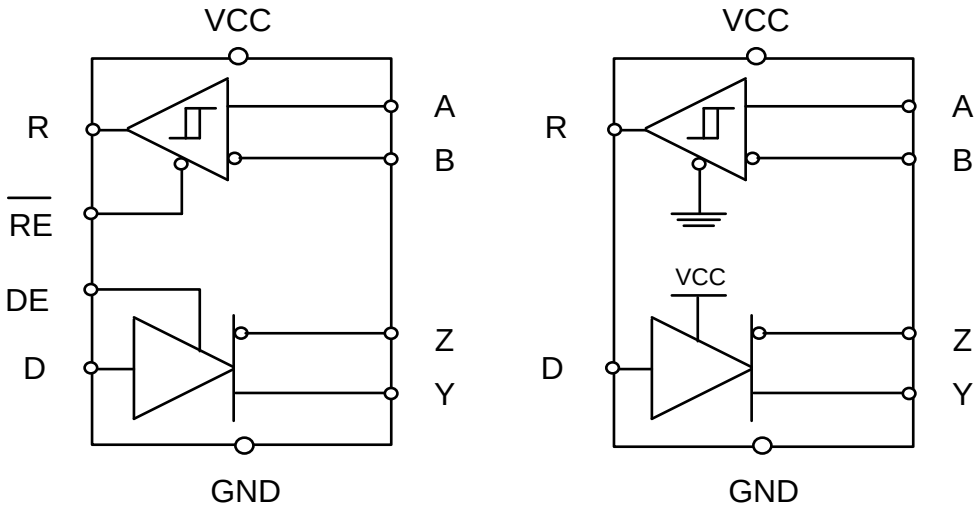


Figure 9-1. Block Diagram

10 Feature Description

10.1 Receiver Fail-Safe Operation

The receivers are fail-safe to invalid bus states caused by the following:

- Open bus conditions, such as a disconnected connector
- Shorted bus conditions, such as cable damage shorting the twisted-pair together
- Idle bus conditions that occur when no driver on the bus is actively driving

10.2 Low-Power Shutdown Mode (SOP14 versions)

Driving DE low and $\overline{RE}$ high for longer than 500 ns puts the devices into the shutdown mode. If either DE goes high or $\overline{RE}$ goes low, the counters reset. All devices do not enter the shutdown mode if the enable pins are in disable state for less than 50 ns. This feature prevents the devices from accidentally going into shutdown mode due to skew between DE and $\overline{RE}$.

10.3 Device Functional Modes

When the driver enable pin, DE, is logic high, the differential outputs Y and Z follow the logic states at data input D. A logic high at D causes Y to turn high and Z to turn low. In this case, the differential output voltage defined as $V_{OD} = V_Y - V_Z$ is positive. When D is low, the output states reverse: Z turns high, Y becomes low, and V_{OD} is negative.

When DE is low, both outputs turn high-impedance. In this condition, the logic state at D is irrelevant. The DE pin has an internal pull-down resistor to ground, thus when left open the driver is disabled (high-impedance) by default. The D pin has an internal pull-up resistor to V_{CC}, thus, when left open while the driver is enabled, output A turns high and B turns low.

Table 10-1. Driver Function Table

Enable	Input	Output		Function
DE	**D**	**Y**	**Z**	
L	X	Z	Z	Driver disabled
Open	X	Z	Z	Driver disabled by default
H	H	H	L	Actively drive bus high
H	L	L	H	Actively drive bus low
H	Open	H	L	Actively drive bus high by default

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, 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 he bus lines are shorted to one another (short-circuit), or the bus is not actively driven (idle bus).

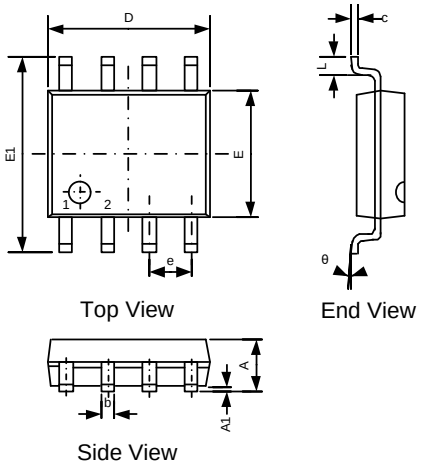
Table 10-2. Receiver Function Table

Enable	Differential Input	Output	Function
$\overline{RE}$	**$V_{ID} = V_A - V_B$**	**R**	
H	X	Z	Receiver disabled
Open	X	Z	Receiver disabled by default
L	$V_{TH+} < V_{ID}$	H	Receive valid bus high
L	$V_{TH-} < V_{ID} < V_{TH+}$	N/A	Indeterminate bus state
L	$V_{ID} < V_{TH-}$	L	Receive valid bus low
L	Open-circuit bus	H	Fail-safe high output
L	Short-circuit bus	H	Fail-safe high output
L	Idle (terminated) bus	H	Fail-safe high output

Package Information

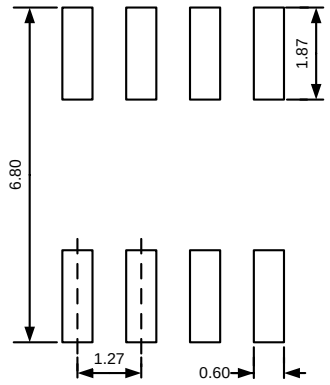
SOP8

Outline Drawing



DIMENSIONS						
Symbol	MILLIMETERS			INCHES		
	Min	Typ	Max	Min	Typ	Max
A	1.35	1.55	1.75	0.053	0.061	0.069
A1	0.00	-	0.25	0.000	-	0.010
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	3.70	3.90	4.10	0.148	0.154	0.164
E1	5.80	-	6.25	0.228	-	0.250
e	1.27BSC			0.050 BSC		
L	0.40	-	1.27	0.016	-	0.050
θ	0 °	-	8 °	0 °	-	8 °

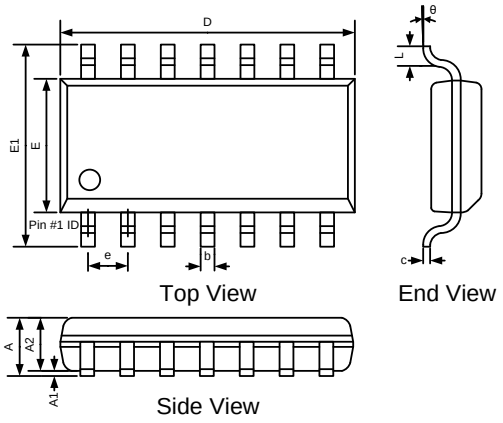
Land Pattern



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.

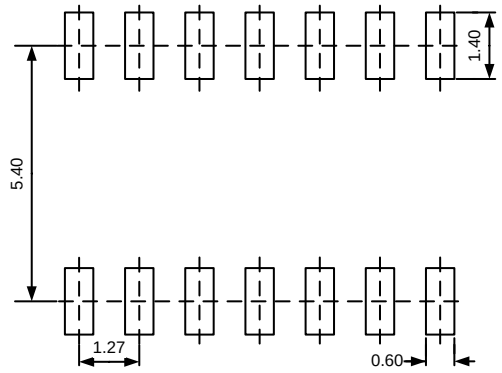
SOP14

Outline Drawing



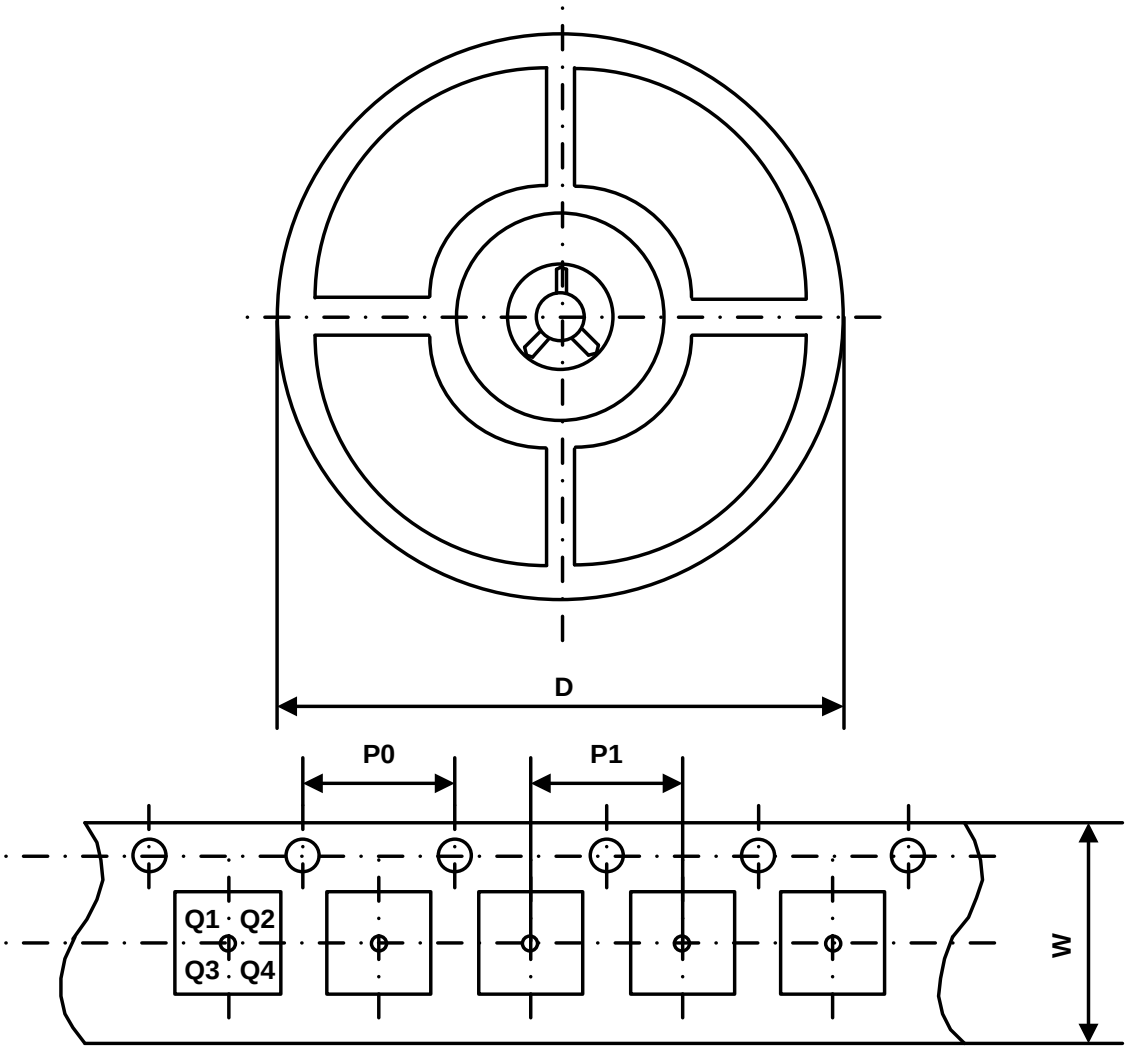
Symbol	DIMENSIONS					
	MILLIMETERS			INCHES		
	Min	Typ	Max	Min	Typ	Max
A	-	-	1.75	-	-	0.069
A1	0.10	0.15	0.25	0.004	0.006	0.010
A2	1.25	1.45	1.65	0.049	0.057	0.065
b	0.35	-	0.51	0.014	-	0.020
c	0.17	-	0.25	0.007	-	0.010
D	8.50	-	8.80	0.340	-	0.352
E	3.80	3.90	4.00	0.150	0.154	0.157
E1	5.80	6.00	6.20	0.228	0.236	0.244
e	1.27BSC			0.050BSC		
L	0.40	-	0.80	0.016	-	0.031
θ	0 °	-	8 °	0 °	-	8 °

Land Pattern



NOTES:
1. Compound dimension: 8.63×3.90 ;
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
UM3481FEESA	SOP8	12 mm	4 mm	8 mm	330 mm	Q1
UM3481FEESE	SOP14	16 mm	4 mm	8 mm	330 mm	Q1
UM13082FEESA	SOP8	12 mm	4 mm	8 mm	330 mm	Q1
UM130821FEESE	SOP14	16 mm	4 mm	8 mm	330 mm	Q1

GREEN COMPLIANCE

Union Semiconductor is committed to environmental excellence in all aspects of its operations including meeting or exceeding regulatory requirements with respect to the use of hazardous substances. Numerous successful programs have been implemented to reduce the use of hazardous substances and/or emissions.
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https://www.union-ic.com/Quality.html

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