Low Voltage Dual SPDT Analog Switch

Features

- CMOS Technology for Bus and Analog Applications
- Low propagation delay
- Low typical On-Resistance
- Signal passing bandwidth, 220 MHz
- Wide V_{DD} Range: 1.65V to 5.5V
- Rail-to-Rail Signal Range
- High Off Isolation: -65dB @ 10MHz
- Crosstalk Rejection Reduces Signal Distortion: -66dB @ 10MHz
- Break-Before-Make Switching
- Extended Industrial Temperature Range: -40°C to 125°C
- ESD protection : 2kV(HBM)
- Totally Lead-Free & Fully RoHS Compliant (Notes 1 & 2)
- Halogen and Antimony Free. "Green" Device (Note 3)
- For automotive applications requiring specific change control (i.e. parts qualified to AEC-Q100/101/104/200, PPAP capable, and manufactured in IATF 16949 certified facilities), please contact us or your local Diodes representative.
  https://www.diodes.com/quality/product-definitions/
- Packaging (Pb-free & Green):
  - 10-pin UQFN (ZUA), 2mm x 1.5mm
  - 10-pin MSOP (U), 3mm x 3mm

Applications

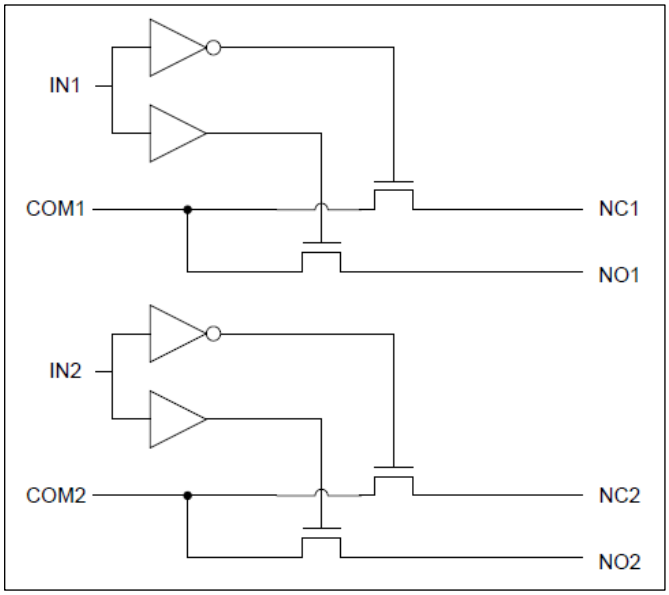
- Sample-and-Hold Circuits
- Battery-Powered Equipment
- Audio and Video Signal Routing
- Communication Circuits

Description

The DIODES™ PI5A23157 is a Dual SPDT Analog Switch. The device can be used as an analog switch or as a low-delay bus switch, and has a wide operating power supply voltage, 1.65V to 5.5V

Break-before-make switching prevents both switches being enabled simultaneously. This eliminates signal disruption during switching.

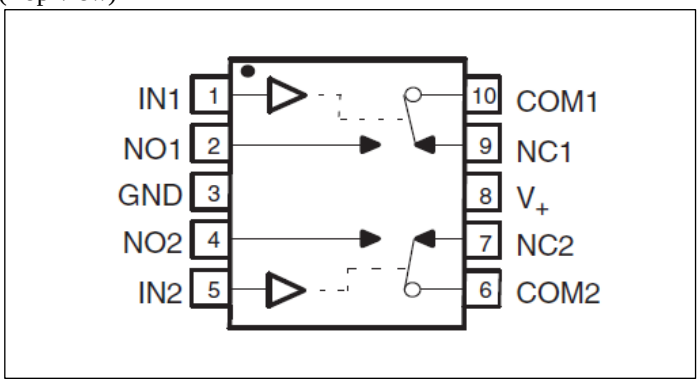
Block Diagram



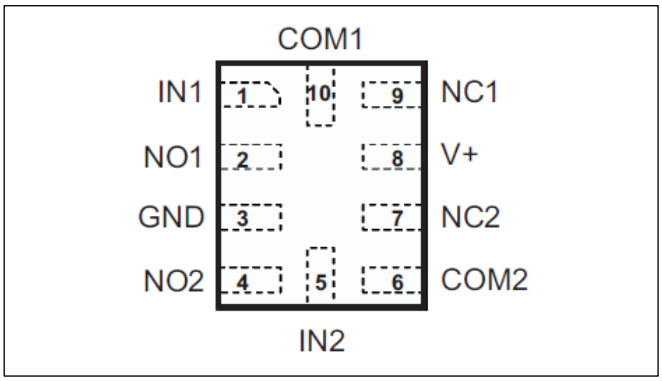
Notes:
1. No purposely added lead. Fully EU Directive 2002/95/EC (RoHS), 2011/65/EU (RoHS 2) & 2015/863/EU (RoHS 3) compliant.
2. See https://www.diodes.com/quality/lead-free/ for more information about Diodes Incorporated's definitions of Halogen- and Antimony-free, "Green" and Lead-free.
3. Halogen- and Antimony-free "Green" products are defined as those which contain <900ppm bromine, <900ppm chlorine (<1500ppm total Br + Cl) and <1000ppm antimony compounds.

Pin Configuration

(Top view)



MSOP-10



UQFN-10

Pin Description

Pin#	Pin Name	Type	Description
1	IN1	I	Select pin for Switch 1
2	NO1	I/O	Normally Open I/O for Switch 1
3	GND	-	Ground
4	NO2	I/O	Normally Open I/O for Switch 2
5	IN2	I	Select pin for Switch 2
6	COM2	I/O	Common I/O for Switch 2
7	NC2	I/O	Normally Closed I/O for Switch 2
8	V+	-	Power Supply Pin
9	NC1	I/O	Normally Closed I/O for Switch 1
10	COM1	I/O	Common I/O for Switch 1

Function Table

INx	NC TO COM, COM TO NC	NO TO COM, COM TO NO
L	ON	OFF
H	OFF	ON

Maximum Ratings

Storage Temperature…….…….. -65℃ to +150℃
Ambient Temperature with Power Applied.....-40℃ to +125℃
Supply Voltage V_{DD}……-0.5Vto +6V
Control Input Voltage V_{INx}……0Vto +6V
DC Input Voltage V_{INPUT}……-0.5Vto +6V
Continuous Current NO_NC_COM_……..……±50mA
ESD(HBM) ……2kV
ESD(CDM) ……1kV

Note: Stresses greater than those listed under MAXIMUM RATINGS may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect reliability.
The input and output negative voltage ratings may be exceeded if the input and output diode current ratings are observed.
Control input must be held HIGH or LOW; it must not float.

Recommended Operating Conditions

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
V_+	Operating Voltage	-	1.65	-	5.5	V
V_{IN}	Control Input Voltage	-	0	-	V_{DD}	V
V_{INPUT}	Switch Input Voltage	-	-0.3	-	V_{DD}	V
T_A	Operating Temperature	-	-40	25	125	℃

DC Electrical Characteristics

+5V Supply (V+ = 4.5V to 5.5V, T_A = –40℃ to 85℃, unless otherwise noted. Typical values are at 5V and +25℃.)

Parameter	Symbol	Test Conditions	Temp.	Min.	Typ.	Max.	Units
ANALOG SWITCH							
Analog Signal Range	V_{NO}, V_{NC}, V_{COM}			0	-	V+	V
On-Resistance	R_{ON}	I_{COM} = -30mA, 0 ≤ V_{NO} or V_{NC} ≤ V+, *Test Circuit 1*	-40℃ to 85℃	-		10	Ω
			-40℃ to 125℃	-		15	
On-Resistance Match Between Channels	ΔR_{ON}	I_{COM} = -30mA, V_{NO} or V_{NC} = 3.15V, *Test Circuit 1*	+25℃		0.15		Ω
On-Resistance Flatness	R_{ONF}	I_{COM} = -30mA, 0 ≤ V_{NO} or V_{NC} ≤ V+, *Test Circuit 1*	+25℃		4		Ω
NC/NO Channel-Off Leakage Current	$I_{OFF\ (NO)}$ or $I_{OFF\ (NC)}$	V_{NO} or V_{NC} = 0 to V+, V_{COM} = 0 to V+	+25℃	-1	0.05	1	µA
			-40℃ to 85℃	-1		1	
NC/NO Channel-ON Leakage Current	$I_{ON\ (NO)}$ or $I_{ON\ (NC)}$	V_{NO} or V_{NC} = 0 to V+, V_{COM} = 0 to V+	+25℃	-0.1		0.1	µA
			-40℃ to 85℃	-1		1	
COM - On Leakage Current	$I_{COM\ (ON)}$	V_{NO} or V_{NC} = open & V_{COM} = 0 to V+	+25℃	-0.1		0.1	µA
			-40℃ to 85℃	-1		1	
DIGITAL INPUTS (IN1, IN2)							
Input Logic High	V_{IH}	-	-40℃ to 85℃	0.7xV+			V
			-40℃ to 125℃	3.1			
Input Logic Low	V_{IL}	-	-40℃ to 85℃			0.3xV+	
IN Input Leakage Current	I_{IN}	V+ = 5.5, V_{IN}=0 or 5.5V	+25℃	-1	0.05	1	µA
			-40℃ to 85℃	-1		1	
DYNAMIC CHARACTERISTICS							
Turn-On Time	t_{ON}	V_{NC}=GND, V_{NO} = V+ or V_{NC}= V+, V_{NO}=GND, R_L=500Ω, C_L=50pF. *See Test Circuit Figure 2.*	-40℃ to 85℃	1.7		11.5	ns
			-40℃ to 125℃	1.2		12	ns
Turn-Off Time	t_{OFF}	V_{NC}=GND, V_{NO} = V+ or V_{NC}= V+, V_{NO}=GND, R_L=500Ω, C_L=50pF. *See Test Circuit Figure 2.*	-40℃ to 85℃	0.8		7.5	ns
			-40℃ to 125℃	0.5		8	ns
Break-Before-Make Delay	t_{BBM}	V_{NC}=V_{NO}=V+/2, R_L=50Ω, C_L=35pF *See Test Circuit Figure 3.*	-40℃ to 85℃	0.5			ns
Charge injection	Qc	Vgen=0V; Rgen=0 RL=1Mohm, CL=35pF	+25℃		7		pC

Parameter	Symbol	Test Conditions	Temp.	Min.	Typ.	Max.	Units
3dB Bandwidth	f_{3dB}	R_L=50 Ω. *See Test Circuit Figure 6.*	+25℃	-	220	-	MHz
COM-NC/NO and NC-NO Isolations	O_{ISO}	R_L=50 Ω, f=10MHz *See Test Circuit Figure 4.*	+25℃	-	-65	-	dB
Channel-to-Channel Crosstalk	X_{TALKD}	R_L=50 Ω, f=10MHz *See Test Circuit Figure 5.*	+25℃	-	-66	-	dB
Total harmonic distortion	THD	R_L=600Ω, C_L=50pF f=600Hz ~ 20KHz.	+25℃		0.01%		
SUPPLY							
Power Supply Current	I_{CC}	V_{IN}=GND or V+, Switch ON or OFF	+25℃	-	-	1	µA
			-40℃ to 85℃	-	-	10	

+3.3V Supply (V+ = 3V to 3.6V, T_A = –40℃ to 85℃, unless otherwise noted. Typical values are at 3.3V and +25℃.)

Parameter	Symbol	Test Conditions	Temp.	Min.	Typ.	Max.	Units
ANALOG SWITCH							
Analog Signal Range	V_{NO}, V_{NC}, V_{COM}			0	-	V+	V
On-Resistance	R_{ON}	I_{COM} = -24mA, 0 ≤ V_{NO} or V_{NC} ≤ V+, *Test Circuit 1*	-40℃ to 85℃	-		18	Ω
			-40℃ to 125℃	-		23	
On-Resistance Match Between Channels	ΔR_{ON}	I_{COM} = -24mA, V_{NO} or V_{NC} = 2.1V, *Test Circuit 1*	+25℃		0.2		Ω
On-Resistance Flatness	R_{ONF}	I_{COM} = -24mA, 0 ≤ V_{NO} or V_{NC} ≤ V+, *Test Circuit 1*	+25℃		9		Ω
NC/NO Channel-Off Leakage Current	$I_{OFF\ (NO)}$ or $I_{OFF\ (NC)}$	V_{NO} or V_{NC} = 0 to V+, V_{COM} = 0 to V+	+25℃	-1	0.05	1	µA
			-40℃ to 85℃	-1		1	
NC/NO Channel-ON Leakage Current	$I_{ON\ (NO)}$ or $I_{ON\ (NC)}$	V_{NO} or V_{NC} = 0 to V+, V_{COM} = 0 to V+	+25℃	-0.1		0.1	µA
			-40℃ to 85℃	-1		1	
COM - On Leakage Current	$I_{COM\ (ON)}$	V_{NO} or V_{NC} = open & V_{COM} = 0 to V+	+25℃	-0.1		0.1	µA
			-40℃ to 85℃	-1		1	
DIGITAL INPUTS (IN1, IN2)							
Input Logic High	V_{IH}	-	-40℃ to 85℃	0.7xV+			V
Input Logic Low	V_{IL}	-	-40℃ to 85℃			0.3xV+	
IN Input Leakage Current	I_{IN}	V+ = 3.6, V_{IN}=0 or 3.6V	+25℃	-1	0.05	1	µA
			-40℃ to 85℃	-1		1	
DYNAMIC CHARACTERISTICS							
Turn-On Time	t_{ON}	V_{NC}=GND, V_{NO} = V+ or V_{NC}= V+, V_{NO}=GND, R_L=500Ω, C_L=50pF. *See Test Circuit Figure 2.*	-40℃ to 85℃	2.5		13	ns
			-40℃ to 125℃	2.0		14	ns
Turn-Off Time	t_{OFF}	V_{NC}=GND, V_{NO} = V+ or V_{NC}= V+, V_{NO}=GND, R_L=500Ω, C_L=50pF. *See Test Circuit Figure 2.*	-40℃ to 85℃	1.5		8.5	ns
			-40℃ to 125℃	1.0		9	ns
Break-Before-Make Delay	t_{BBM}	V_{NC}=V_{NO}=V+/2, R_L=50Ω, C_L=35pF *See Test Circuit Figure 3.*	-40℃ to 85℃	0.5			ns
Charge injection	Qc	Vgen=0V; Rgen=0 RL=1Mohm, CL=35pF	+25℃		3		pC
3dB Bandwidth	f_{3dB}	R_L=50Ohm. *See Test Circuit Figure 6.*	+25℃	-	220	-	MHz
COM-NC/NO and NC-NO Isolations	O_{ISO}	R_L=50Ohm, f=10MHz *See Test Circuit Figure 4.*	+25℃	-	-65	-	dB
Channel-to-Channel Crosstalk	X_{TALKD}	R_L=50Ohm, f=10MHz *See Test Circuit Figure 5.*	+25℃	-	-66	-	dB
Total harmonic	THD	R_L=600Ω, C_L=50pF f=600Hz ~	+25℃		0.015%		

Parameter	Symbol	Test Conditions	Temp.	Min.	Typ.	Max.	Units
distortion		20KHz.					
SUPPLY							
Power Supply Current	I_{CC}	V_{IN}=GND or V+, Switch ON or OFF	+25℃	-	-	1	µA
			-40℃ to 85℃	-	-	10	

+2.5V Supply (V+ = 2.3V to 2.7V, T_A = –40℃ to 85℃, unless otherwise noted. Typical values are at 2.5V and +25℃.)

Parameter	Symbol	Test Conditions	Temp.	Min.	Typ.	Max.	Units
ANALOG SWITCH							
Analog Signal Range	V_{NO}, V_{NC}, V_{COM}			0	-	V+	V
On-Resistance	R_{ON}	I_{COM} = -8mA, 0 ≤ V_{NO} or V_{NC} ≤ V+, *Test Circuit 1*	-40℃ to 85℃	-		45	Ω
			-40℃ to 125℃	-		50	
On-Resistance Match Between Channels	ΔR_{ON}	I_{COM} = -8mA, V_{NO} or V_{NC} = 1.6V, *Test Circuit 1*	+25℃		0.5		Ω
On-Resistance Flatness	R_{ONF}	I_{COM} = -8mA, 0 ≤ V_{NO} or V_{NC} ≤ V+, *Test Circuit 1*	+25℃		27		Ω
NC/NO Channel-Off Leakage Current	$I_{OFF\ (NO)}$ or $I_{OFF\ (NC)}$	V_{NO} or V_{NC} = 0 to V+, V_{COM} = 0 to V+	+25℃	-1	0.05	1	µA
			-40℃ to 85℃	-1		1	
NC/NO Channel-ON Leakage Current	$I_{ON\ (NO)}$ or $I_{ON\ (NC)}$	V_{NO} or V_{NC} = 0 to V+, V_{COM} = 0 to V+	+25℃	-0.1		0.1	µA
			-40℃ to 85℃	-1		1	
COM - On Leakage Current	$I_{COM\ (ON)}$	V_{NO} or V_{NC} = open & V_{COM} = 0 to V+	+25℃	-0.1		0.1	µA
			-40℃ to 85℃	-1		1	
DIGITAL INPUTS (IN1, IN2)							
Input Logic High	V_{IH}	-	-40℃ to 85℃	0.7xV+			V
Input Logic Low	V_{IL}	-	-40℃ to 85℃			0.3xV+	
IN Input Leakage Current	I_{IN}	V+ = 2.7, V_{IN}=0 or 2.7V	+25℃	-1	0.05	1	µA
			-40℃ to 85℃	-1		1	
DYNAMIC CHARACTERISTICS							
Turn-On Time	t_{ON}	V_{NC}=GND, V_{NO} = V+ or V_{NC}= V+, V_{NO}=GND, R_L=500Ω, C_L=50pF. *See Test Circuit Figure 2.*	-40℃ to 85℃	3.5		14	ns
			-40℃ to 125℃	2.5		17	ns
Turn-Off Time	t_{OFF}	V_{NC}=GND, V_{NO} = V+ or V_{NC}= V+, V_{NO}=GND, R_L=500Ω, C_L=50pF. *See Test Circuit Figure 2.*	-40℃ to 85℃	2		9.5	ns
			-40℃ to 125℃	1.5		10	ns
Break-Before-Make Delay	t_{BBM}	V_{NC}=V_{NO}=V+/2, R_L=50Ω, C_L=35pF *See Test Circuit Figure 3.*	-40℃ to 85℃	0.5			ns
3dB Bandwidth	f_{3dB}	R_L=50Ohm. *See Test Circuit Figure 6.*	+25℃	-	220	-	MHz
COM-NC/NO and NC-NO Isolations	O_{ISO}	R_L=50Ohm, f=10MHz *See Test Circuit Figure 4.*	+25℃	-	-65	-	dB
Channel-to-Channel Crosstalk	X_{TALKD}	R_L=50Ohm, f=10MHz *See Test Circuit Figure 5.*	+25℃	-	-66	-	dB
Total harmonic distortion	THD	R_L=600Ω, C_L=50pF f=600Hz ~ 20KHz.	+25℃		0.025%		
SUPPLY							
Power Supply Current	I+	V_{IN}=GND or V+, Switch ON or OFF	+25℃	-	-	1	µA
			-40℃ to 85℃	-	-	10	

+1.8V Supply (V+ = 1.65V to 1.95V, T_A = –40℃ to 85℃, unless otherwise noted. Typical values are at 1.8V and +25℃.)

Parameter	Symbol	Test Conditions	Temp.	Min.	Typ.	Max.	Units
ANALOG SWITCH							
Analog Signal Range	V_{NO}, V_{NC}, V_{COM}			0	-	V+	V
On-Resistance	R_{ON}	I_{COM} = -4mA, 0 ≤ V_{NO} or V_{NC} ≤ V+, *Test Circuit 1*	-40℃ to 85℃	-		140	Ω
			-40℃ to 125℃	-		180	
On-Resistance Match Between Channels	ΔR_{ON}	I_{COM} = -4mA, V_{NO} or V_{NC} = 1.15V, *Test Circuit 1*	+25℃		1		Ω
On-Resistance Flatness	R_{ONF}	I_{COM} = -4mA, 0 ≤ V_{NO} or V_{NC} ≤ V+, *Test Circuit 1*	+25℃		110		Ω
NC/NO Channel-Off Leakage Current	$I_{OFF\ (NO)}$ or $I_{OFF\ (NC)}$	V_{NO} or V_{NC} = 0 to V+, V_{COM} = 0 to V+	+25℃	-1	0.05	1	µA
			-40℃ to 85℃	-1		1	
NC/NO Channel-ON Leakage Current	$I_{ON\ (NO)}$ or $I_{ON\ (NC)}$	V_{NO} or V_{NC} = 0 to V+, V_{COM} = 0 to V+	+25℃	-0.1		0.1	µA
			-40℃ to 85℃	-1		1	
COM - On Leakage Current	$I_{COM\ (ON)}$	V_{NO} or V_{NC} = open & V_{COM} = 0 to V+	+25℃	-0.1		0.1	µA
			-40℃ to 85℃	-1		1	
DIGITAL INPUTS (IN1, IN2)							
Input Logic High	V_{IH}	-	-40℃ to 85℃	0.75xV+			V
Input Logic Low	V_{IL}	-	-40℃ to 85℃			0.25xV+	
IN Input Leakage Current	I_{IN}	V+ =1.95, V_{IN}=0 or 1.95V	+25℃	-1	0.05	1	µA
			-40℃ to 85℃	-1		1	
DYNAMIC CHARACTERISTICS							
Turn-On Time	t_{ON}	V_{NC}=GND, V_{NO} = V+ or V_{NC}= V+, V_{NO}=GND, R_L=500Ω, C_L=50pF. *See Test Circuit Figure 2.*	-40℃ to 85℃	7		24	ns
			-40℃ to 125℃	5.5		27	ns
Turn-Off Time	t_{OFF}	V_{NC}=GND, V_{NO} = V+ or V_{NC}= V+, V_{NO}=GND, R_L=500Ω, C_L=50pF. *See Test Circuit Figure 2.*	-40℃ to 85℃	3		13	ns
			-40℃ to 125℃	2		16	ns
Break-Before-Make Delay	t_{BBM}	V_{NC}=V_{NO}=V+/2, R_L=50Ω, C_L=35pF *See Test Circuit Figure 3.*	-40℃ to 85℃	0.5			ns
3dB Bandwidth	f_{3dB}	R_L=50Ohm. *See Test Circuit Figure 6.*	+25℃	-	220	-	MHz
COM-NC/NO and NC-NO Isolations	O_{ISO}	R_L=50Ohm, f=10MHz *See Test Circuit Figure 4.*	+25℃	-	-65	-	dB
Channel-to-Channel Crosstalk	X_{TALKD}	R_L=50Ohm, f=10MHz *See Test Circuit Figure 5.*	+25℃	-	-66	-	dB
Total harmonic distortion	THD	R_L=600Ω, C_L=50pF f=600Hz ~ 20KHz.	+25℃		0.015%		
SUPPLY							
Power Supply Current	I+	V_{IN}=GND or V+, Switch ON or OFF	+25℃	-	-	1	µA
			-40℃ to 85℃	-	-	10	

Capacitance

Parameter	Symbol	Test Conditions	Min.	Typ.	Max.	Units
NC/NO Off Capacitance	$C_{NC/NO\ (OFF)}$	V_{NC} or V_{NO} = V_{DD} or GND, Switch OFF f = 1MHz, *See Test Circuit Figure 7.*	-	5.5	-	pF
NC/NO On Capacitance	$C_{NC/NO\ (ON)}$	V_{NC} or V_{NO} = V_{DD} or GND, Switch ON f = 1MHz, *See Test Circuit Figure 8.*	-	17.5	-	
COM On Capacitance	$C_{COM\ (ON)}$	V_{NC} or V_{NO} = V_{DD} or GND, Switch ON f = 1MHz, *See Test Circuit Figure 8.*	-	17.5	-	
Digital Input Capacitance	C_{IN}	f = 1MHz	-	2.8	-	

Test Circuits and Timing Diagrams

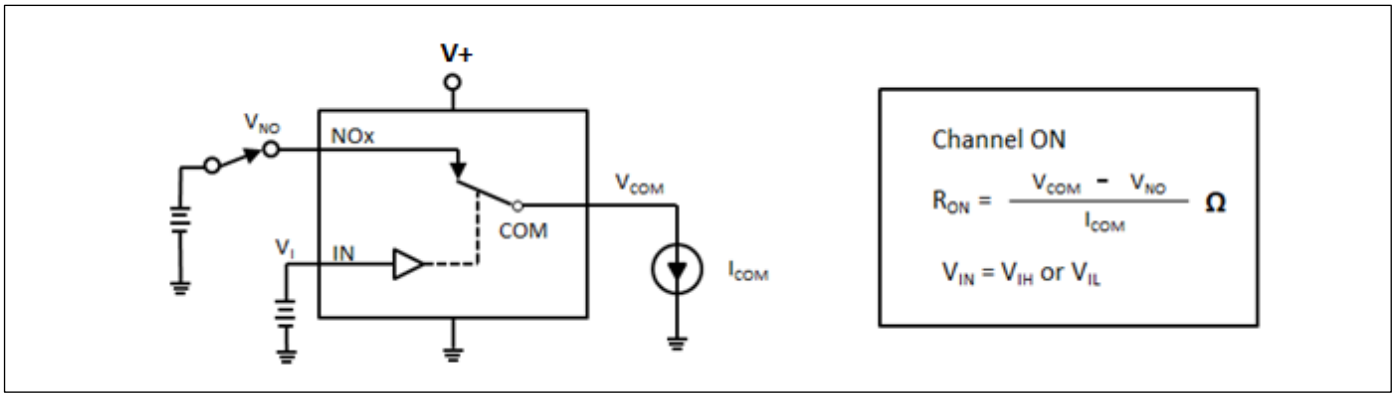
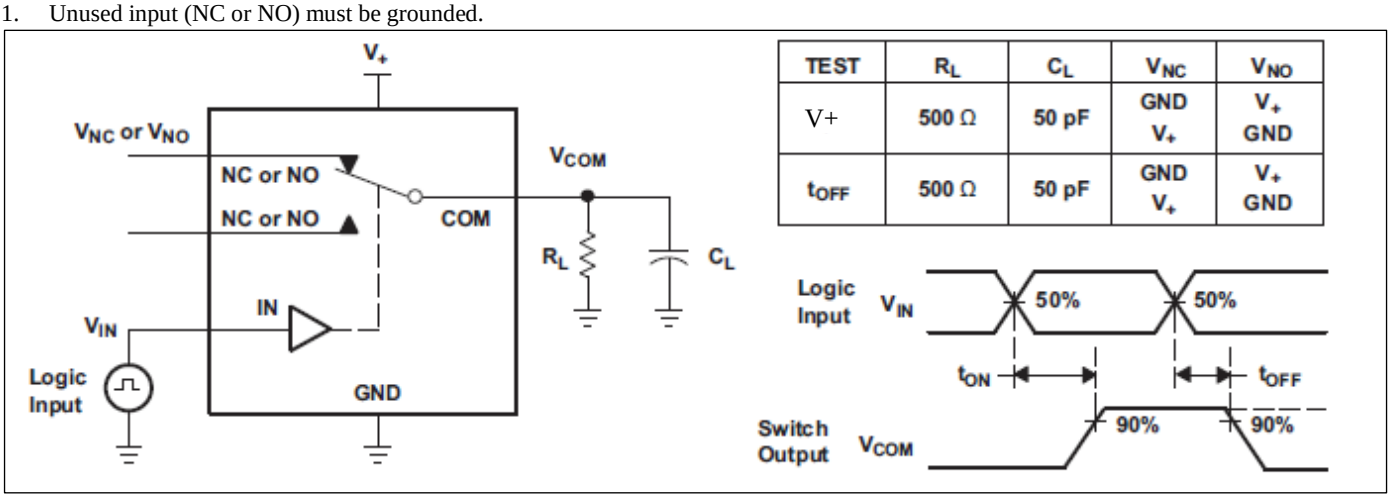


Figure 1. On Resistance

Notes:

1. Unused input (NC or NO) must be grounded.



TEST	R_L	C_L	V_{NC}	V_{NO}
V+	500 Ω	50 pF	GND V_+	V_+ GND
t_{OFF}	500 Ω	50 pF	GND V_+	V_+ GND

Figure 2. Switching Times

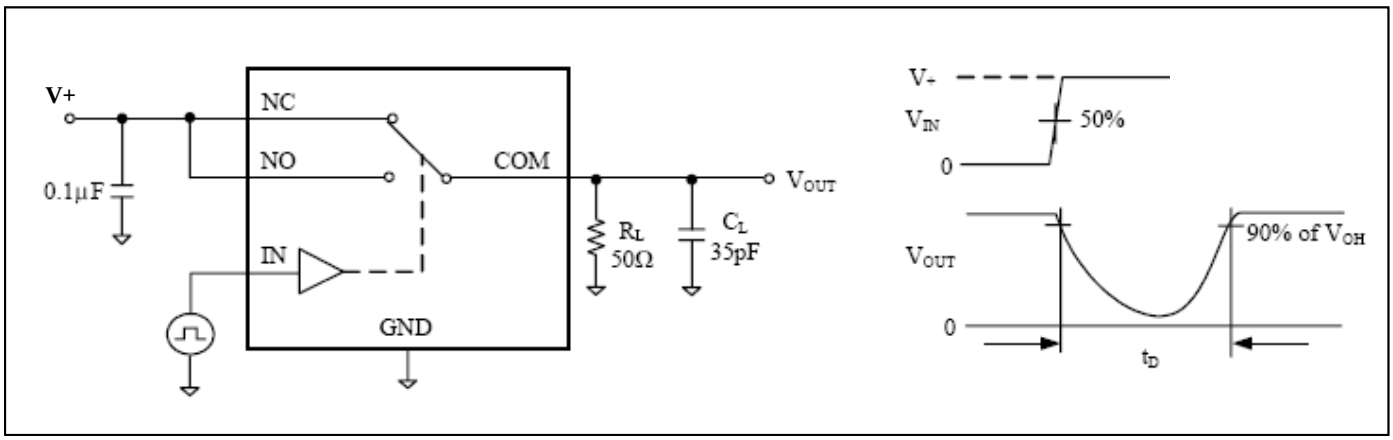


Figure 3. Break Before Make Interval Timing

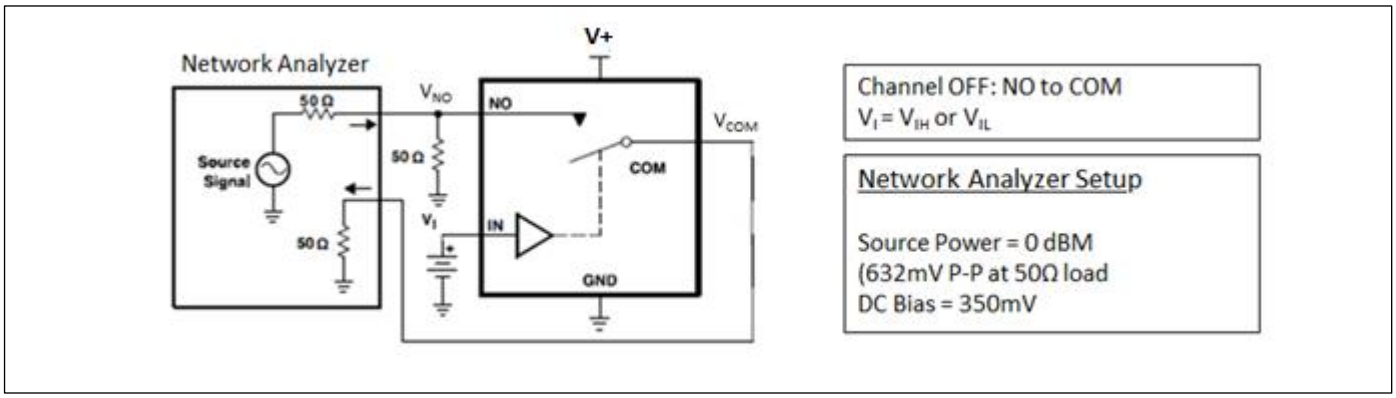


Figure 4. OFF Isolation (O_{ISO})

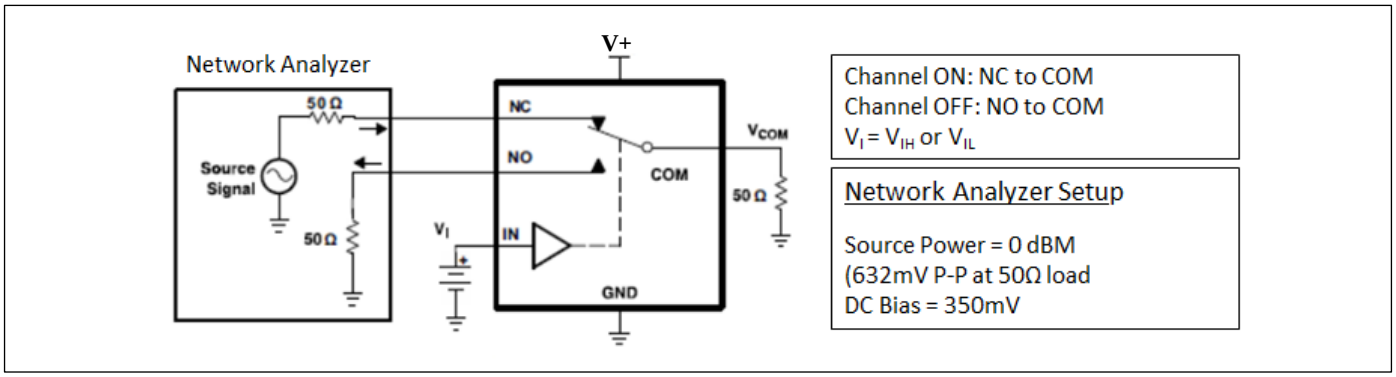


Figure 5. Channel-to-Channel Crosstalk

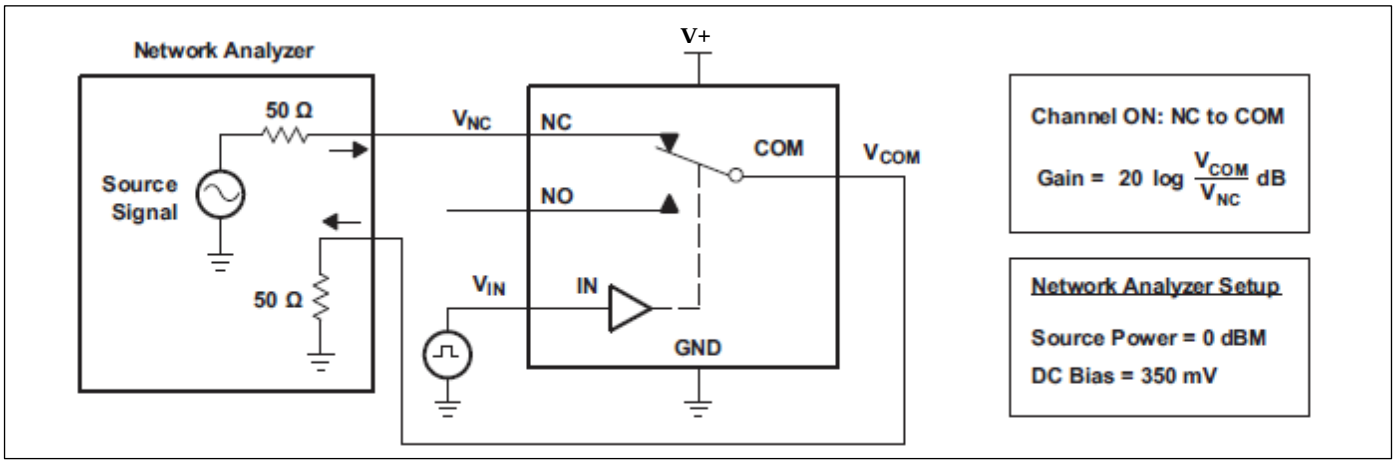


Figure 6. Bandwidth

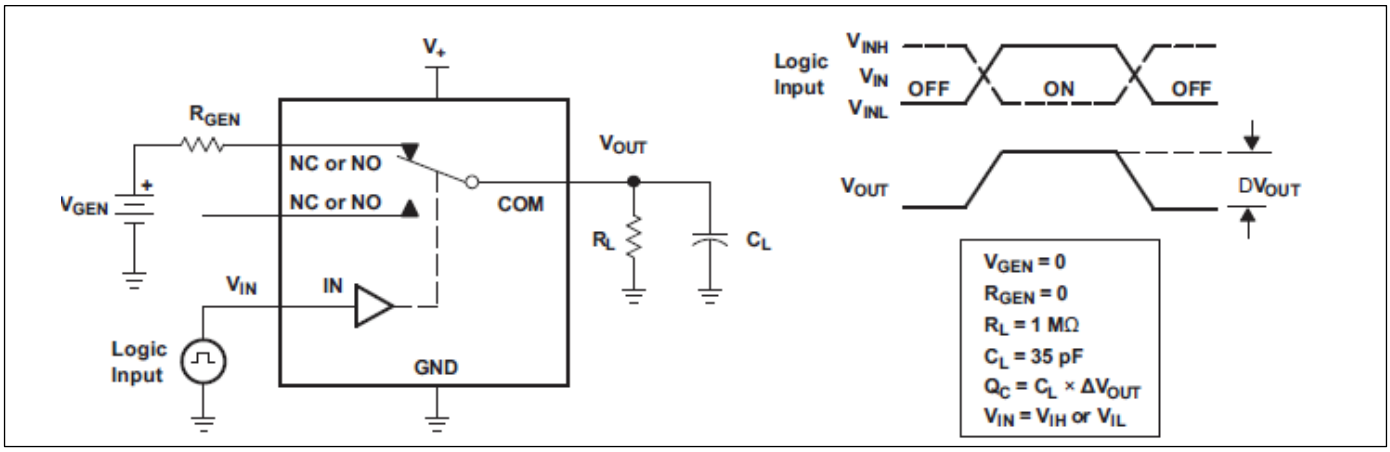


Figure 7. Charge Injection (Q_C)

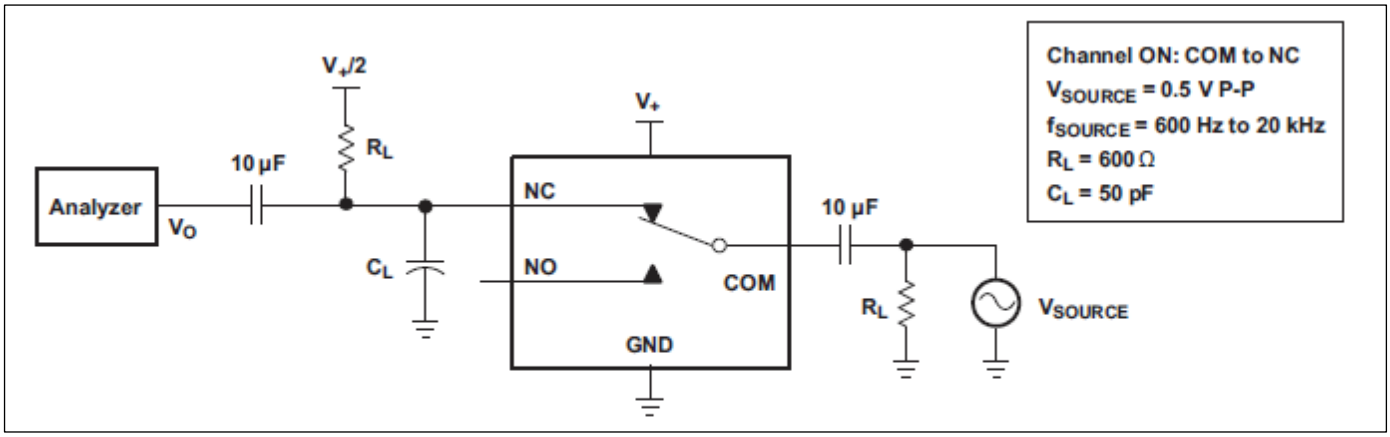


Figure 8. Total Harmonic Distortion (THD)

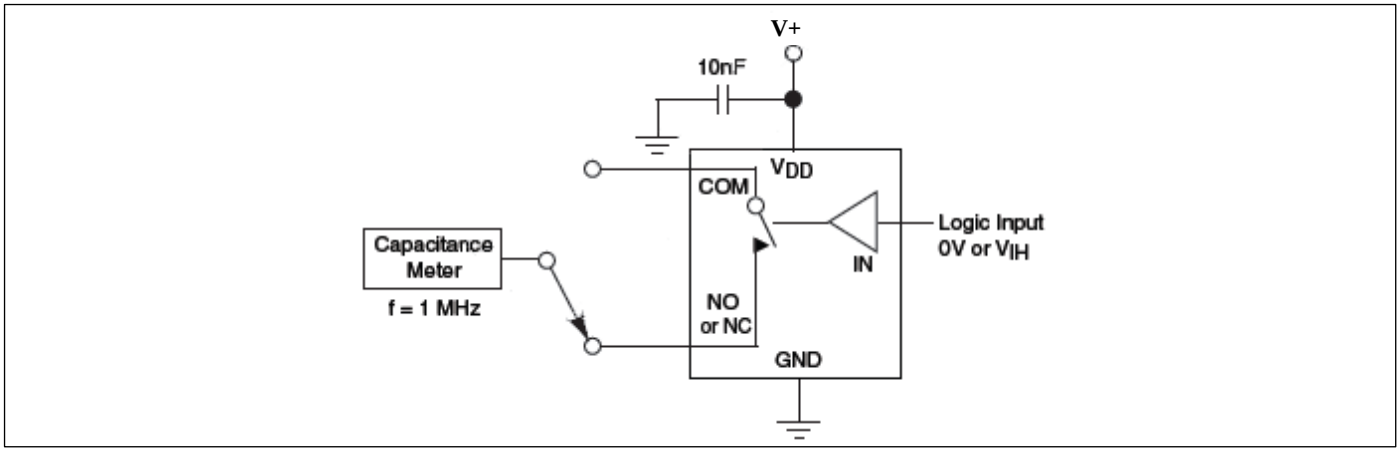


Figure 9. Channel Off Capacitance

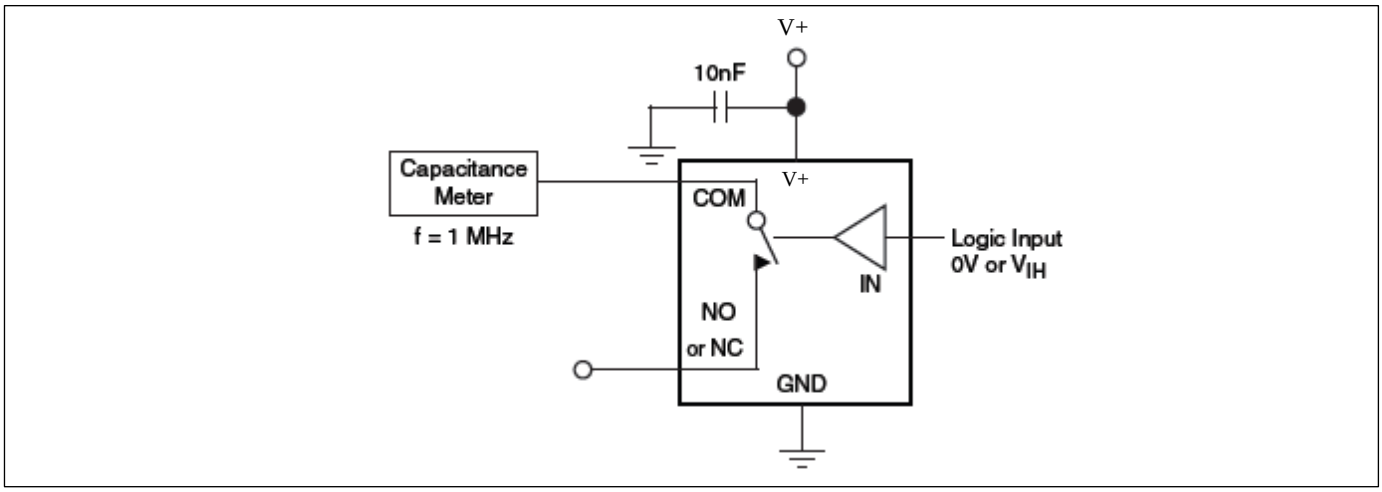


Figure 10. Channel On Capacitance

Part Marking

ZUA Package

FE: PI5A23157ZUAE

Y: Date Code (Year)
W: Date Code (Workweek)

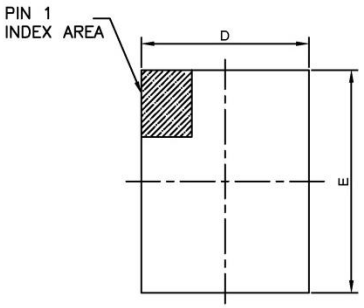
Line above 1st chatacter denotes Lead-free and pin 1 indicator

U Package

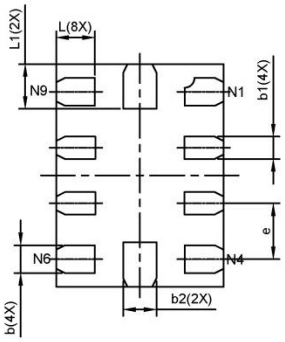
Y: Date Code (Year)
W: Date Code (Workweek)
1st X: Assembly Site Code
2nd X: Fab Site Code
Bar above 2nd "X" means Cu wire

Packaging Mechanical

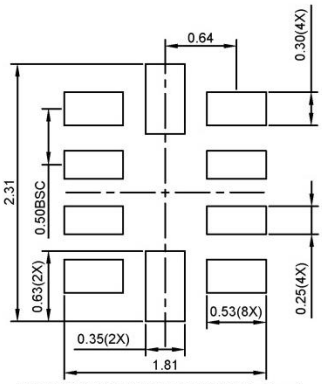
10-UQFN (ZUA)



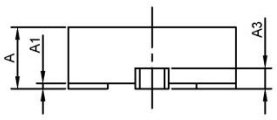
TOP VIEW



BOTTOM VIEW



RECOMMENDED LAND PATTERN(unit:mm)



SIDE VIEW

PKG. DIMENSIONS(MM)			
SYMBOL	Min	NOM	Max
A	0.50	0.60	0.65
A1	0.00	0.02	0.05
A3		0.15 REF	
D	1.45	1.50	1.55
E	1.95	2.00	2.05
b	0.20	0.25	0.30
b1	0.15	0.20	0.25
b2	0.25	0.30	0.35
e		0.50 BSC	
L	0.25	0.35	0.45
L1	0.30	0.40	0.50

Notes:
1. Ref: JEDEC MO-288B.

DATE: 01/06/17

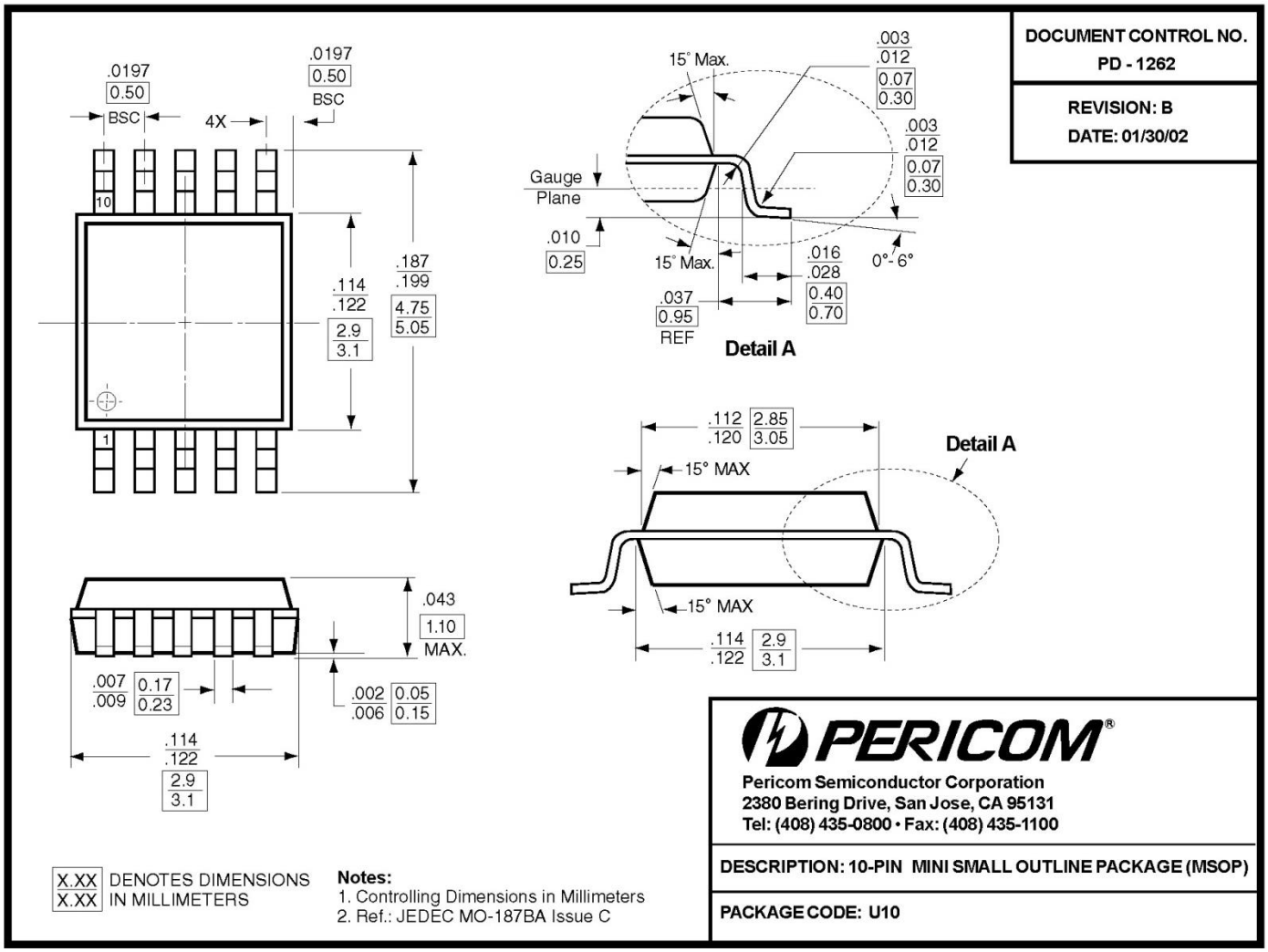
DESCRIPTION: 10-Pin, UQFN, 1.5X2.0

PACKAGE CODE: ZUA(ZUA10)

DOCUMENT CONTROL#: PD-2220 REVISION: --

17-0002

10-MSOP (U)



For latest package info.

please check: http://www.diodes.com/design/support/packaging/pericom-packaging/packaging-mechanicals-and-thermal-characteristics/

Ordering Information

Part Number	Packaging Code	Package Description
PI5A23157ZUAEX	ZUA	10-Pin, 1.5mm x 2.0mm (UQFN)
PI5A23157UEX	U	10-Pin, Mini Small Outline Package (MSOP)

Notes:

1. No purposely added lead. Fully EU Directive 2002/95/EC (RoHS), 2011/65/EU (RoHS 2) & 2015/863/EU (RoHS 3) compliant.
2. See https://www.diodes.com/quality/lead-free/ for more information about Diodes Incorporated's definitions of Halogen- and Antimony-free, "Green" and Lead-free.
3. Halogen- and Antimony-free "Green" products are defined as those which contain <900ppm bromine, <900ppm chlorine (<1500ppm total Br + Cl) and <1000ppm antimony compounds.
4. E = Pb-free and Green
5. X suffix = Tape/Reel

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