NSi8100/NSi8101: High Reliability Bidirectional I²C Isolators

Datasheet (EN) 1.6

Product Overview

The NSi810x devices are high reliability bidirectional isolators that are compatible with I²C interface. The NSi810x devices are AEC-Q100 qualified. The NSi810x devices are safety certified by UL1577 support several insulation withstand voltages (3.75kVrms, 5kVrms), while providing high electromagnetic immunity and low emissions at low power consumption. The I²C clock of the NSi810x is up to 2MHz, and the common-mode transient immunity (CMTI) is up to 150kV/us. Wide supply voltage of the NSi810x device support to connect with most digital interface directly, easy to do the level shift. High system level EMC performance enhance reliability and stability of use.

Key Features

- Up to 5000V_{RMS} Insulation voltage
- I²C Clock rate: up to 2MHz
- Power supply voltage: 2.5V to 5.5V
- AEC-Q100 Grade 1 qualified
- Suitable for hot swap applications
- High CMTI: 150kV/us
- Chip level ESD: HBM: ±6kV
- High system level EMC performance:
  Enhanced system level ESD, EFT, Surge immunity
- Isolation Barrier Life: >60 years
- Operation temperature: -40℃~125℃
- RoHS-compliant packages:
  SOIC-8 narrow body
  SOIC-16 wide body

Safety Regulatory Approvals (pending)

- UL recognition: up to 5000V_{RMS} for 1 minute per UL1577
- CQC certification per GB4943.1-2011
- CSA component notice 5A approval
  IEC60950-1 standard
- DIN V VDE V 0884-10(VDE V 0884-10): 2006-12

Applications

- Power over Ethernet
- Isolated I²C, SMBus, or PMBus interface
- I²C level shifting
- Battery Management

Functional Block Diagrams

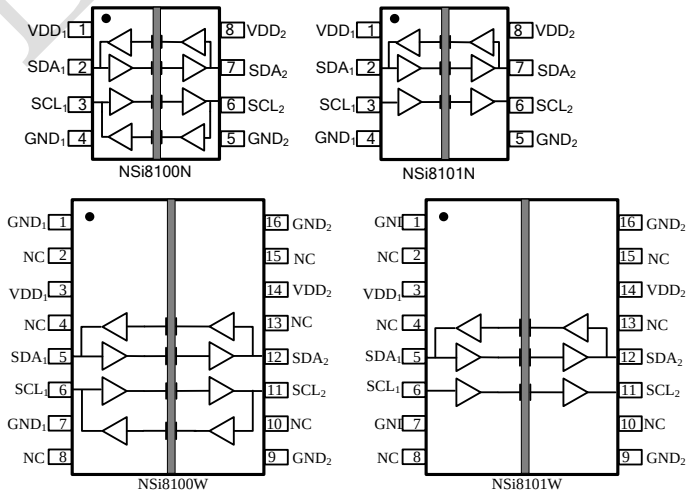

Figure1. NSi810x Functional Block Diagram

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1.0 ABSOLUTE MAXIMUM RATINGS

Parameters	*Symbol*	*Min*	*Typ*	*Max*	*Unit*	*Comments*
Power Supply Voltage	VDD1, VDD2	-0.5		6.5	V	
Maximum Input Voltage	SDA_1, SDA_2, SCL_1, SCL_2	-0.4		VDD+0.4[1]	V	
Maximum Input Pulse Voltage	SDA_1, SDA_2, SCL_1, SCL_2	-0.8		VDD+0.8	V	Pulse width should be less than 100ns, and the duty cycle should be less than 10%
Common-Mode Transients	CMTI			±150	kV/us	
Output current	Io	-15		15	mA	
Maximum Surge Isolation Voltage	V_{IOSM}			5.3	kV	
Operating Temperature	Topr	-40		125	℃	
Storage Temperature	Tstg	-40		150	℃	
Electrostatic discharge	HBM			±6000	V	
	CDM			±2000	V	

[1] The maximum voltage must not exceed 6.5V.

2.0 SPECIFICATIONS

2.1. ELECTRICAL CHARACTERISTICS

(VDD1=2.5V~5.5V, VDD2=2.5V~5.5V, Ta=-40℃ to 125℃. Unless otherwise noted, Typical values are at VDD1 = 5V, VDD2 = 5V, Ta = 25℃)

Parameters	*Symbol*	*Min*	*Typ*	*Max*	*Unit*	*Comments*
Power on Reset	VDD_{POR}		2.2		V	POR threshold as during power-up
	VDD_{HYS}		0.1		V	POR threshold Hysteresis
Start Up Time after POR	trbs		40		usec	
Common Mode Transient Immunity	CMTI	±100		±150	kV/us	
Side 1 Logic Level						
Input Threshold	V_{ILT1}	400			mV	Input Threshold at rising edge
	V_{IHT1}			600	mV	

	V_{IT_HYS1}		100		mV	Input Threshold Hysteresis
Low Level Output Voltage	V_{OL1}	650		800	mV	$I_{OL} \leq 4mA$
Low-level output voltage to high-level input voltage threshold difference	ΔV_{OIT1}	70			mV	
Side 2 Logic Level						
Input Threshold	V_{ILT2}		1.6		V	Input Threshold at rising edge
	V_{IT_HYS2}		0.4		V	Input Threshold Hysteresis
High Level Input Voltage	V_{IH2}	2.0			V	
Low Level Input Voltage	V_{IL2}			0.8	V	
Low Level Output Voltage	V_{OL}			0.5	V	$I_{OL} \leq 30mA$

(VDD1=5V±10%, VDD2=5V±10%, Ta=-40℃ to 125℃. Unless otherwise noted, Typical values are at VDD1 = 5V, VDD2 = 5V, Ta = 25℃)

Parameters	***Symbol***	***Min***	***Typ***	***Max***	***Unit***	***Comments***
Supply current	**NSi8100**					
	$I_{DD1}(Q0)$		5.10	7.5	mA	All Input 0V
	$I_{DD2}(Q0)$		3.96	5.7	mA	
	$I_{DD1}(Q1)$		2.52	3.6	mA	All Input at supply
	$I_{DD2}(Q1)$		1.78	2.5	mA	
	$I_{DD1}(2M)$		3.83	5.7	mA	All Input with 2MHz, C_L=15pF
	$I_{DD2}(2M)$		2.78	4.2	mA	
	NSi8101					
	$I_{DD1}(Q0)$		2.85	4.2	mA	All Input 0V
	$I_{DD2}(Q0)$		2.66	4	mA	
	$I_{DD1}(Q1)$		2.42	3.6	mA	All Input at supply
	$I_{DD2}(Q1)$		1.57	2.4	mA	
	$I_{DD1}(2M)$		2.89	4.3	mA	All Input with 2MHz, C_L=15pF
	$I_{DD2}(2M)$		2.64	4	mA	
Clock rate	DR	0		2	MHz	
Propagation Delay	t_{PLH12}		24.8	37.2	ns	See figure 2.6, R1=1500Ω， R2=500Ω, NO LOAD

	t_{PHL12}		32.8	49.2	ns	See figure 2.6, R1=1500Ω， R2=500Ω, NO LOAD
	t_{PLH21}		24	36	ns	See figure 2.6, R1=1500Ω， R2=500Ω, NO LOAD
	t_{PHL21}		38	57	ns	See figure 2.6, R1=1500Ω， R2=500Ω, NO LOAD
Pulse Width Distortion	PWD_{12}		8	12	ns	$\lvert t_{PHL12} - t_{PLH12} \rvert$
	PWD_{21}		14	21	ns	$\lvert t_{PHL21} - t_{PLH21} \rvert$
Falling Time	t_{f1}		10.6	15.9	ns	C_L = 30pF
	t_{f2}		22.8	34.2	ns	C_L = 300pF

(VDD1=3.3V±10%, VDD2=3.3V±10%, Ta=-40℃ to 125℃. Unless otherwise noted, Typical values are at VDD1 = 3.3V, VDD2 = 3.3V, Ta = 25℃)

Parameters	***Symbol***	***Min***	***Typ***	***Max***	***Unit***	***Comments***
Supply current	**NSi8100**					
	I_{DD1}(Q0)		4.96	7.4	mA	All Input 0V
	I_{DD2}(Q0)		3.85	5.6	mA	
	I_{DD1}(Q1)		2.40	3.5	mA	All Input at supply
	I_{DD2}(Q1)		1.68	2.4	mA	
	I_{DD1}(2M)		3.69	5.6	mA	All Input with 2MHz, C_L=15pF
	I_{DD2}(2M)		2.67	4.2	mA	
	NSi8101					
	I_{DD1}(Q0)		2.79	4.2	mA	All Input 0V
	I_{DD2}(Q0)		2.58	3.9	mA	
	I_{DD1}(Q1)		2.60	3.9	mA	All Input at supply
	I_{DD2}(Q1)		1.50	2.3	mA	
	I_{DD1}(2M)		2.65	4	mA	All Input with 2MHz, C_L=15pF
	I_{DD2}(2M)		2.40	3.6	mA	
Clock rate	DR	0		2	MHz	
Propagation Delay	t_{PLH12}		29	43.5	ns	See figure 2.6, R1=1500Ω， R2=500Ω, NO LOAD

	t_{PHL12}		39.8	59.7	ns	See figure 2.6, R1=1500Ω， R2=500Ω, NO LOAD
	t_{PLH21}		30	45	ns	See figure 2.6, R1=1500Ω， R2=500Ω, NO LOAD
	t_{PHL21}		61	91.5	ns	See figure 2.6, R1=1500Ω， R2=500Ω, NO LOAD
Pulse Width Distortion	PWD_{12}		10.8	16.2	ns	$\lvert t_{PHL12} - t_{PLH12} \rvert$
	PWD_{21}		31	46.5	ns	$\lvert t_{PHL21} - t_{PLH21} \rvert$
Falling Time	t_{f1}		15.6	23.4	ns	C_L = 30pF
	t_{f2}		32	48	ns	C_L = 300pF

(VDD1=2.5V±10%, VDD2=2.5V±10%, Ta=-40℃ to 125℃. Unless otherwise noted, Typical values are at VDD1 = 2.5V, VDD2 = 2.5V, Ta = 25℃)

Parameters	***Symbol***	***Min***	***Typ***	***Max***	***Unit***	***Comments***
Supply current	**NSi8100**					
	I_{DD1}(Q0)		4.89	7.3	mA	All Input 0V
	I_{DD2}(Q0)		3.79	5.5	mA	
	I_{DD1}(Q1)		2.34	3.4	mA	All Input at supply
	I_{DD2}(Q1)		1.63	2.3	mA	
	I_{DD1}(2M)		3.61	5.4	mA	All Input with 2MHz, C_L=15pF
	I_{DD2}(2M)		2.59	4	mA	
	NSi8101					
	I_{DD1}(Q0)		2.75	4	mA	All Input 0V
	I_{DD2}(Q0)		2.54	3.8	mA	
	I_{DD1}(Q1)		2.57	3.9	mA	All Input at supply
	I_{DD2}(Q1)		1.47	2.2	mA	
	I_{DD1}(2M)		2.57	3.9	mA	All Input with 2MHz, C_L=15pF
	I_{DD2}(2M)		2.29	3.5	mA	
Clock rate	DR	0		2	MHz	
Propagation Delay	t_{PLH12}		33	49.5	ns	See figure 2.6, R1=1500Ω， R2=500Ω, NO LOAD

	t_{PHL12}		52	78	ns	See figure 2.6, R1=1500Ω, R2=500Ω, NO LOAD
	t_{PLH21}		47	70.5	ns	See figure 2.6, R1=1500Ω, R2=500Ω, NO LOAD
	t_{PHL21}		100	150	ns	See figure 2.6, R1=1500Ω, R2=500Ω, NO LOAD
Pulse Width Distortion	PWD_{12}		19	28.5	ns	$\lvert t_{PHL12} - t_{PLH12} \rvert$
	PWD_{21}		53	79.5	ns	$\lvert t_{PHL21} - t_{PLH21} \rvert$
Falling Time	t_{f1}		22	33	ns	C_L = 30pF
	t_{f2}		36	54	ns	C_L = 300pF

2.2. TYPICAL PERFORMANCE CHARACTERISTICS

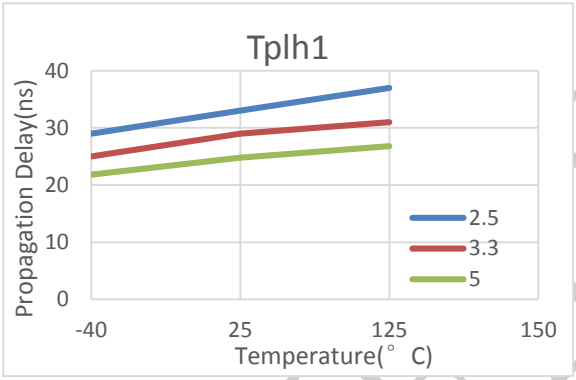

Figure 2.1 Rising Edge Propagation Delay Vs Temp

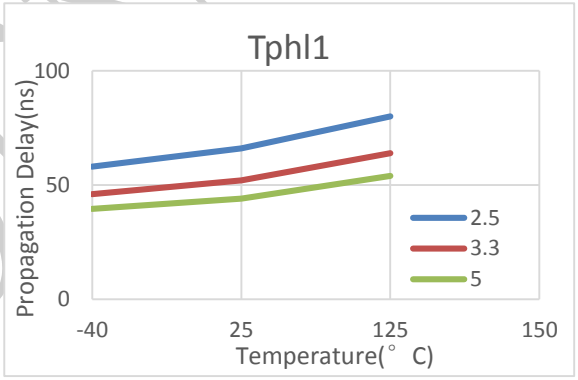

Figure 2.2 Falling Edge Propagation Delay Vs Temp

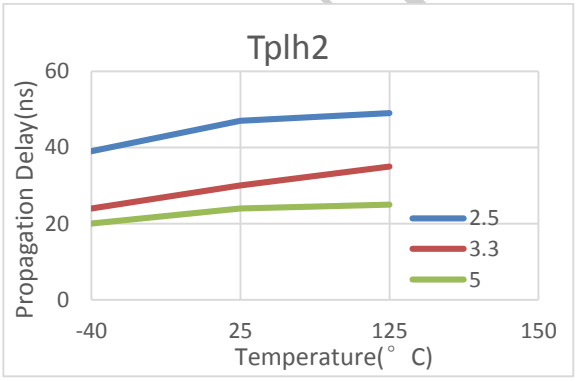

Figure 2.3 Rising Edge Propagation Delay Vs Temp

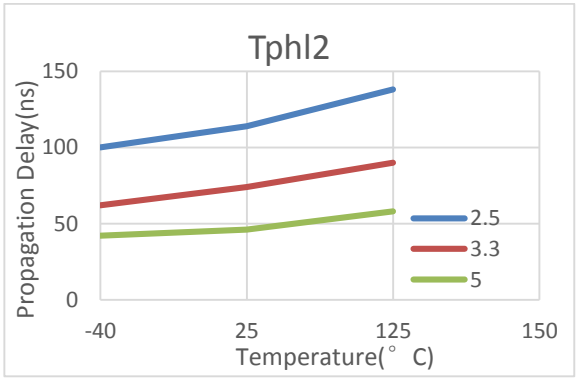

Figure 2.4 Falling Edge Propagation Delay Vs Temp

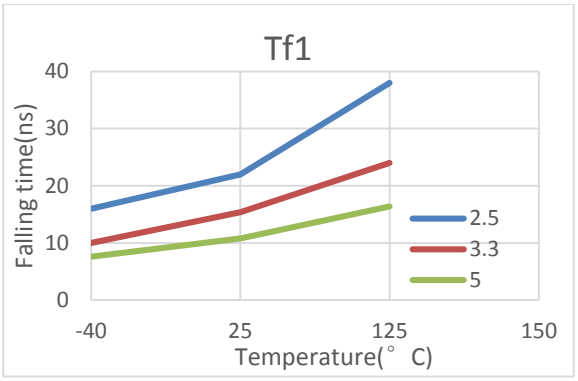

Figure 2.5 falling time(@27pF) Vs Temp

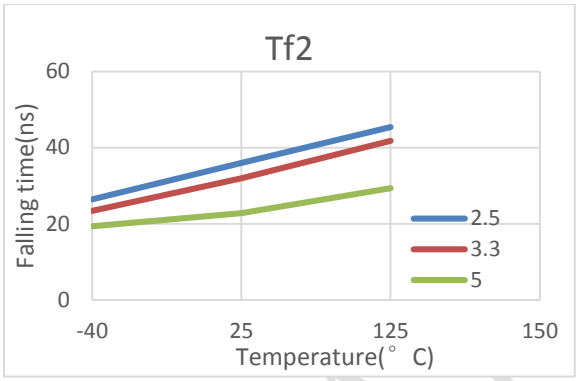

Figure 2.6 Falling time(@300pF) Vs Temp

2.3. PARAMETER MEASUREMENT INFORMATION

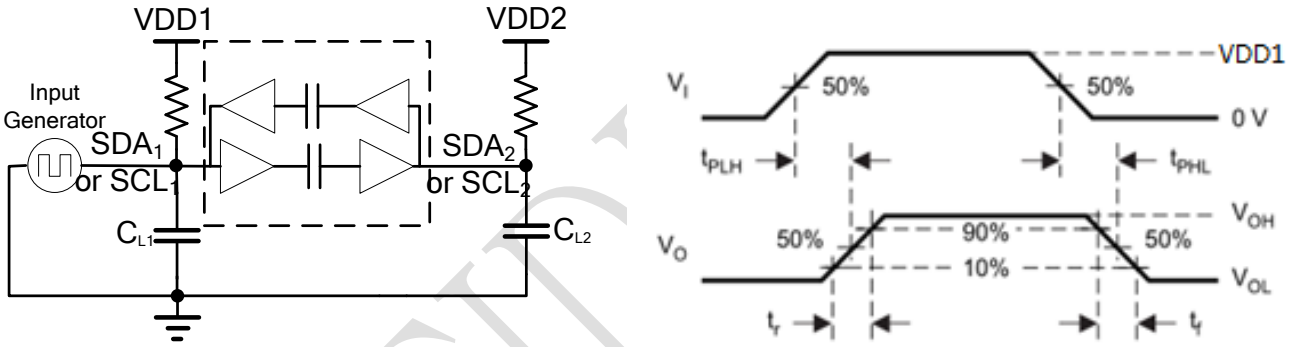

Figure 2.6 Switching Characteristic Test Circuit and Voltage Waveforms

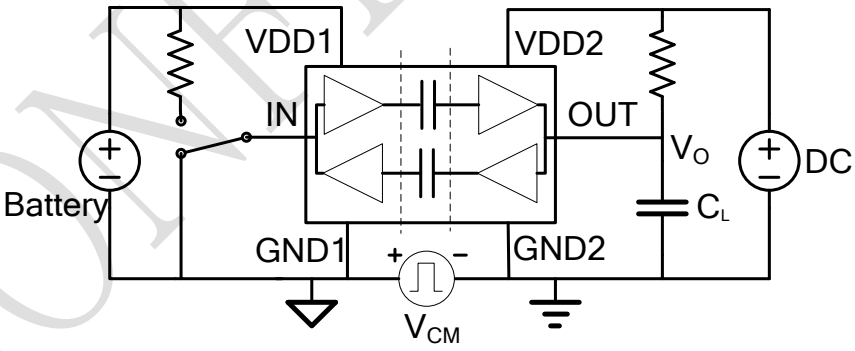

Figure 2.7 Common-Mode Transient Immunity Test Circuit

3.0 HIGH VOLTAGE FEATURE DESCRIPTION

3.1. INSULATION AND SAFETY RELATED SPECIFICATIONS

Parameters	*Symbol*	*Value*	*Unit*	*Comments*

		SOIC-8	SOIC-16		
Minimum External Air Gap (Clearance)	L(I01)	4.0	7.8	mm	Shortest terminal-to-terminal distance through air
Minimum External Tracking (Creepage)	L(I02)	4.0	7.8	mm	Shortest terminal-to-terminal distance across the package surface
Minimum internal gap	DTI	20		um	Distance through insulation
Tracking Resistance(Comparative Tracking Index)	CTI	>600		**V**	DIN EN 60112 (VDE 0303-11); IEC 60112
Material Group		Ⅰ			

3.2. DIN VDE V 0884-10 (VDE V 0884-10) INSULATION CHARATERISTICS

Description	*Test Condition*	*Symbol*	*Value*		*Unit*
			SOIC-8	SOIC-16	
Installation Classification per DIN VDE 0110					
For Rated Mains Voltage ≤ 150Vrms			Ⅰ to Ⅳ	Ⅰ to Ⅳ	
For Rated Mains Voltage ≤ 300Vrms			Ⅰ to Ⅲ	Ⅰ to Ⅳ	
For Rated Mains Voltage ≤ 400Vrms			Ⅰ to Ⅲ	Ⅰ to Ⅳ	
Climatic Classification			10/105/21	10/105/21	
Pollution Degree per DIN VDE 0110, Table 1			2	2	
Maximum repetitive isolation voltage		V_{IORM}	565	800	Vpeak
Input to Output Test Voltage, Method B1	$V_{IORM} \times 1.5 = V_{pd(m)}$, 100% production test, $t_{ini} = t_m = 1$ sec, partial discharge < 5 pC	$V_{pd(m)}$	847	1200	Vpeak
Input to Output Test Voltage, Method A					
After Environmental Tests Subgroup 1	$V_{IORM} \times 1.2 = V_{pd(m)}$, t_{ini} = 60 sec, t_m = 10 sec, partial discharge < 5 pC	$V_{pd(m)}$	678	960	Vpeak
After Input and /or Safety Test Subgroup 2 and Subgroup 3	$V_{IORM} \times 1.2 = V_{pd(m)}$, t_{ini} = 60 sec, t_m = 10 sec, partial discharge < 5 pC	$V_{pd(m)}$	678	960	Vpeak
Maximum transient isolation voltage	t = 60 sec	V_{IOTM}	5300	7000	Vpeak
Maximum Surge Isolation Voltage	Test method per IEC60065,1.2/50us waveform, $V_{TEST}=1.6 \times V_{IOSM}$	V_{IOSM}	5384	5384	Vpeak
Isolation resistance	V_{IO} =500V	R_{IO}	$>10^9$	$>10^9$	Ω

Isolation capacitance	f = 1MHz	C_{IO}	0.6	0.6	pF
Input capacitance		C_I	2	2	pF
Total Power Dissipation at 25℃		Ps		1499	mW
Safety input, output, or supply current	θ_{JA} = 140 ℃/W, V_I = 5.5 V, T_J = 150 ℃, T_A = 25 ℃	Is	160		mA
	θ_{JA} = 84 ℃/W, V_I = 5.5 V, T_J = 150 ℃, T_A = 25 ℃			237	mA
Case Temperature		Ts	150	150	℃

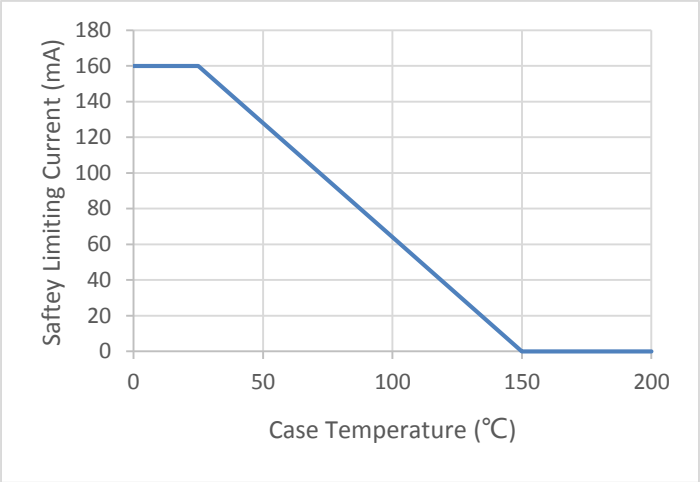

Figure 3.1 NSi8100N/NSi8101N Thermal Derating Curve, Dependence of Safety Limiting Values with Case Temperature per DIN V VDE V 0884-10

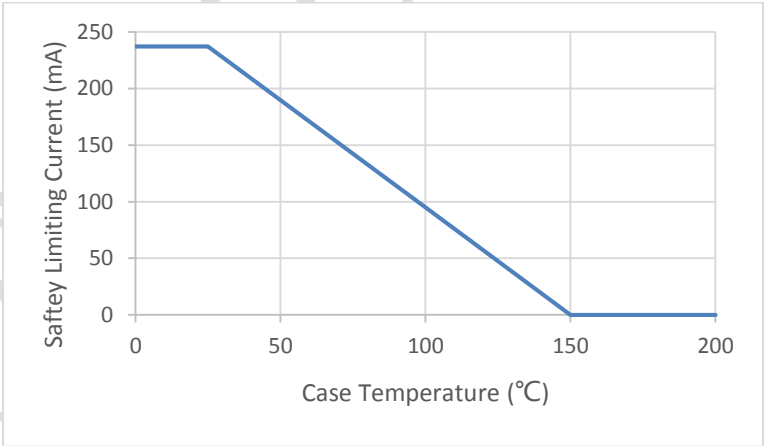

Figure 3.2 NSi8100W/NSi8101W Thermal Derating Curve, Dependence of Safety Limiting Values with Case Temperature per DIN V VDE V 0884-10

3.3. REGULATORY INFORMATION

The NSi8100N/NSi8101N are approved or pending approval by the organizations listed in table.

UL	*CSA*	*VDE*	*CQC*
UL 1577 Component Recognition Program[1]	Approved under CSA Component Acceptance Notice 5A	DIN V VDE V0884-10 (VDE V 0884-	Certified by CQC11-471543-2012

	IEC60950-1	10):2006-12[2]	GB4943.1-2011
Single Protection, 3750Vrms Isolation voltage	$400V_{RMS}$ basic insulation working voltage	Basic Insulation 565Vpeak, V_{IOSM}=6000Vpeak	Basic insulation at $400V_{RMS}$ (565Vpeak)
File (E500602)	File (pending)	File (pending)	File (pending)

[1] In accordance with UL 1577, each NSi8100N/NSi8101N is proof tested by applying an insulation test voltage ≥ 4500 V rms for 1 sec.

[2] In accordance with DIN V VDE V 0884-10, each NSi8100N/NSi8101N is proof tested by applying an insulation test voltage ≥ 1059 V peak for 1 sec (partial discharge detection limit = 5 pC). The * marking branded on the component designates DIN V VDE V 0884-10 approval.

The NSi8100W/NSi8101W are approved or pending approval by the organizations listed in table.

UL	*CSA*	*VDE*	*CQC*
UL 1577 Component Recognition Program	Approved under CSA Component Acceptance Notice 5A IEC60950-1	DIN V VDE V0884-10 (VDE V 0884-10):2006-12	Certified by CQC11-471543-2012 GB4943.1-2011
Single Protection, 5000Vrms Isolation voltage	$800V_{RMS}$ basic insulation working voltage $400V_{RMS}$ Reinforced insulation working voltage	Basic Insulation 800Vpeak, V_{IOSM}=5384Vpeak	Basic insulation at $800V_{RMS}$ (1131Vpeak) Reinforced insulation at $400V_{RMS}$ (565Vpeak)
File (pending)	File (pending)	File (pending)	File (pending)

[1] In accordance with UL 1577, each NSi8100W/NSi8101W is proof tested by applying an insulation test voltage ≥ 6000 V rms for 1 sec.

[2] In accordance with DIN V VDE V 0884-10, each NSi8100W/NSi8101W is proof tested by applying an insulation test voltage ≥ 1592 V peak for 1 sec (partial discharge detection limit = 5 pC). The * marking branded on the component designates DIN V VDE V 0884-10 approval.

4.0 FUNCTION DESCRIPTION

The NSi810x is a bidirectional isolator based on a capacitive isolation barrier technique. The NSi810x devices are compatible with I^2C interface. Internally, the I^2C interface is split into two unidirectional channels communicating in opposing directions via a dedicate capacitive isolation channel for each. The digital signal is modulated with RF carrier generated by the internal oscillator at the Transmitter side. Then it is transferred through the capacitive isolation barrier and demodulated at the Receiver side.

The NSi8100 devices are high reliability dual-channel bidirectional isolators for clock and data lines while NSi8101 has a bidirectional data and a unidirectional clock channel. The NSi8100 is suitable for multi-master application while NSi8101 is useful in a single master application.

The Side 2 logic levels of NSi810x are standard I^2C value, and the maximum load for side 2 is ≤ 400pF. So multiple NSi810x devices connected to a bus by their Side 2 pins can communicate with each other and with other I^2C compatible devices.

The Side 1 logic levels of NSi810x are not standard value. The output low level of NSi810x is 650mV, while low-level output voltage to high-level input voltage threshold is 50mV. This prevents an output logic low at Side 1 being transmitted back to Side 2 and pulling down the I^2C bus.

The NSi810x devices are AEC-Q100 qualified. The NSi810x device is safety certified by UL1577 support several insulation withstand voltages (3.75kVrms, 5kVrms), while providing high electromagnetic immunity and low emissions at low power consumption. The I2C clock of the NSi810x is up to 2MHz, and the common-mode transient immunity (CMTI) is up to 150kV/us. Wide supply voltage of the NSi810x device support to connect with most digital interface directly, easy to do the level shift. High system level EMC performance enhance reliability and stability of use.

The Table 4.1 shows the functional of NSi810x.The NSi810x is high impedance output when VDDIN is unready and VDDOUT is ready as shown in.

Table 4.1 Output status vs. power status

Input	VDD1	VDD2	Output	Comment

	status	status		
H	Ready	Ready	Z	Normal operation.
L	Ready	Ready	L	
X	Unready	Ready	Z	The output follows the same status with the input within 60us after input side VDD1 is powered on.
X	Ready	Unready	X	The output follows the same status with the input within 60us after output side VDD2 is powered on.

5.0 APPLICATION NOTE

5.1. PCB LAYOUT

The NSi810x requires a 0.1 μF bypass capacitor between VDD1 and GND1, VDD2 and GND2. The capacitor should be placed as close as possible to the package. Figure 5.1 to Figure 5.4 show the recommended PCB layout, make sure the space under the chip should keep free from planes, traces, pads and via. The pull-up resistors required for both Side 1 and Side 2 buses. And the value of the resistors depend on the number of I^2C devices on the bus.

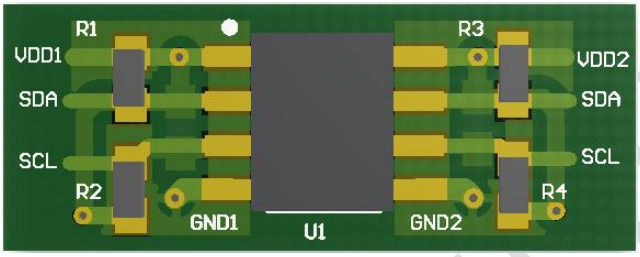

Figure5.1 Recommended PCB Layout — Top Layer

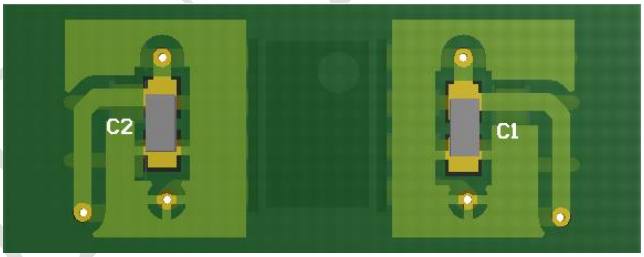

Figure5.2 Recommended PCB Layout — Bottom Layer

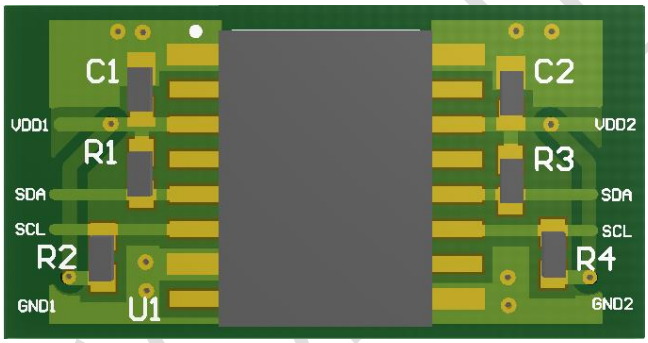

Figure5.3 Recommended PCB Layout — Top Layer

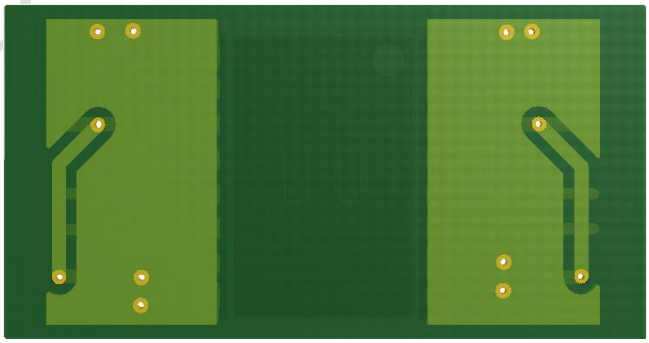

Figure5.4 Recommended PCB Layout — Bottom Layer

6.0 PACKAGE INFORMATION

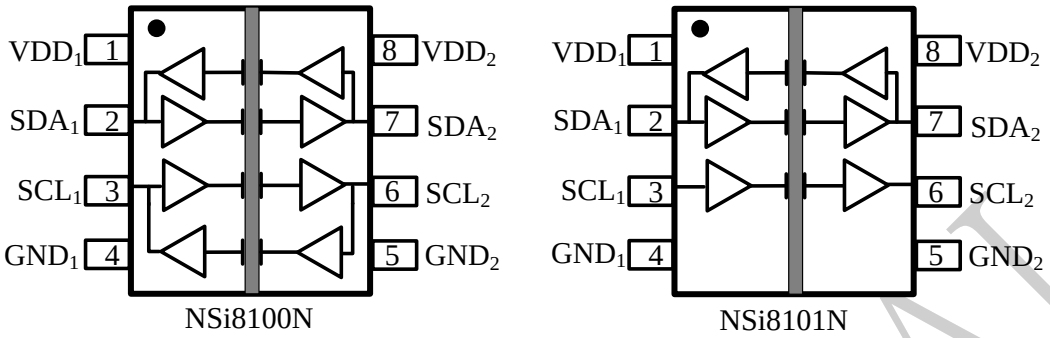

Figure 6.1 NSi8100N/NSi8101N Package

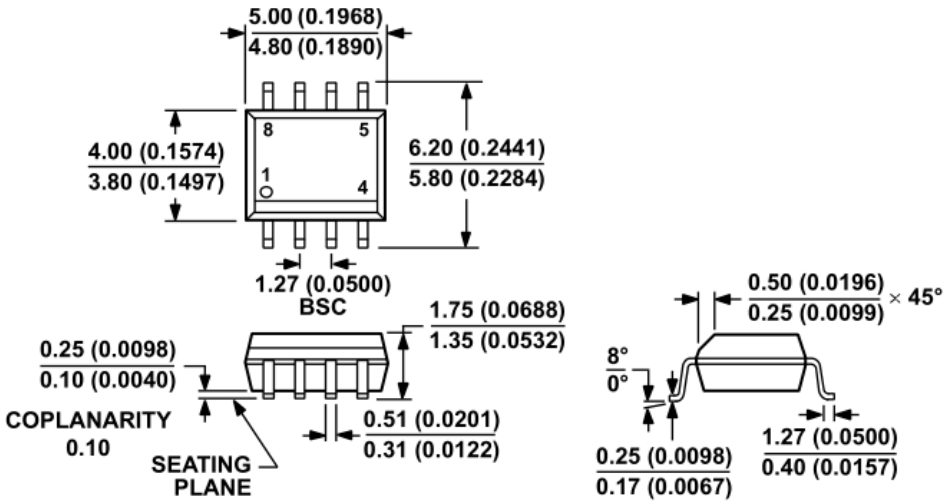

Figure 6.3 SOIC8 Package Shape and Dimension

Dimensions shown in millimeters and (inches)

Table6.1 NSi8100N/ NSi8101N Pin Configuration and Description

NSi8100N PIN NO.	*NSi8101N PIN NO.*	*SYMBOL*	*FUNCTION*
1	1	VDD_1	Power Supply for Isolator Side 1
2	2	SDA_1	Serial data input /output, Side 1
3	3	SCL_1	Serial clock input /output, Side 1
4	4	GND_1	Ground 1, the ground reference for Isolator Side 1
5	5	GND_2	Ground 2, the ground reference for Isolator Side 2
6	6	SCL_2	Serial clock input /output, Side 2
7	7	SDA_2	Serial data input /output, Side 2
8	8	VDD_2	Power Supply for Isolator Side 2

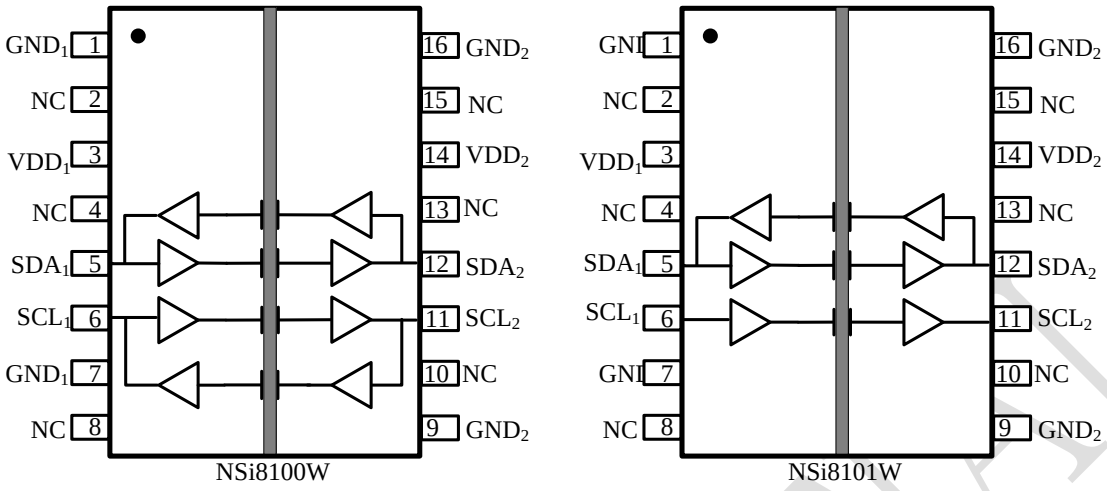

Figure 6.2 NSi8100W/ NSi8101W Package

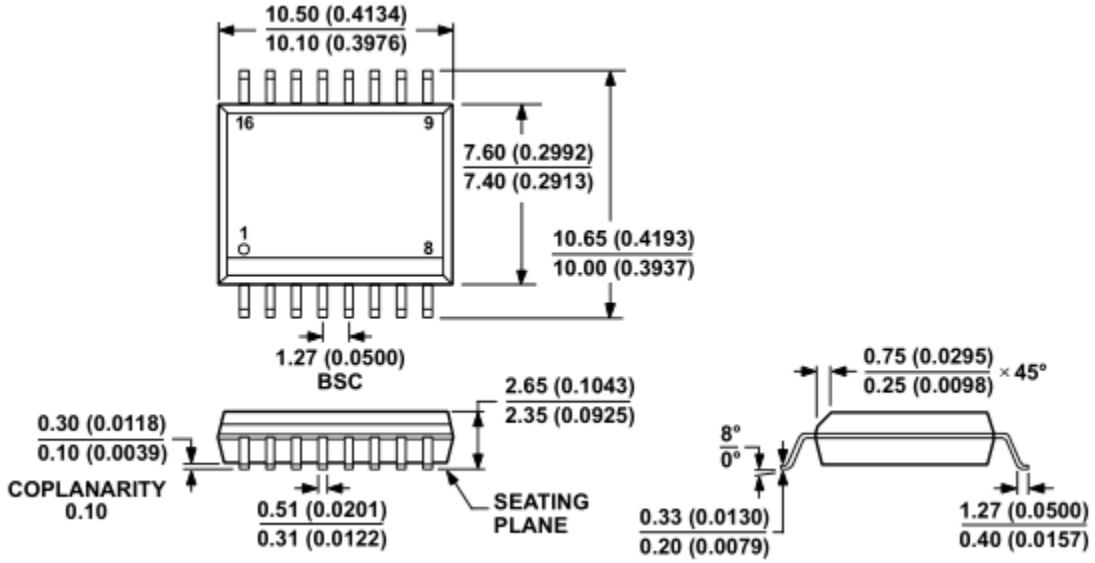

Figure 6.6 SOIC16 Package Shape and Dimension

Dimensions shown in millimeters and (inches)

Table6.2 NSi8100W/ NSi8101W Pin Configuration and Description

NSi8100W PIN NO.	*NSi8101W PIN NO.*	*SYMBOL*	*FUNCTION*
1	1	GND_1	Ground 1, the ground reference for Isolator Side 1
2	2	NC	No Connection.
3	3	VDD_1	Power Supply for Isolator Side 1
4	4	NC	No Connection.
5	5	SDA_1	Serial data input /output, Side 1
6	6	SCL_1	Serial clock input /output, Side 1
7	7	GND_1	Ground 1, the ground reference for Isolator Side 1

8	8	NC	No Connection.
9	9	GND_2	Ground 2, the ground reference for Isolator Side 2
10	10	NC	No Connection.
11	11	SCL_2	Serial clock input /output, Side 1
12	12	SDA_2	Serial data input /output, Side 1
13	13	NC	No Connection.
14	14	VDD_2	Power Supply for Isolator Side 2
15	15	NC	No Connection.
16	16	GND_2	Ground 2, the ground reference for Isolator Side 2

7.0 ORDER INFORMATION

Part No.	Isolation Rating(kV)	Number of side 1 inputs	Number of side 2 inputs	Max Clock Rate (MHz)	Temperature	Automotive	Package
NSi8100N	3.75	2	2	2	-40 to 125℃	NO	SOIC8
NSi8100NQ	3.75	2	2	2	-40 to 125℃	YES	SOIC8
NSi8101N	3.75	2	1	2	-40 to 125℃	NO	SOIC8
NSi8101NQ	3.75	2	1	2	-40 to 125℃	YES	SOIC8
NSi8100W	5	2	2	2	-40 to 125℃	NO	WB SOIC16
NSi8101W	5	2	1	2	-40 to 125℃	NO	WB SOIC16
NOTE: All packages are RoHS-compliant with peak reflow temperatures of 260 ° C according to the JEDEC industry standard classifications and peak solder temperatures. All devices are AEC-Q100 qualified.							

8.0 REVISION HISTORY

Revision	Description	Date
1.0	Original	2017/11/15
1.1	Change to Ordering information	2018/3/26
1.2	Add maximum operation current specification.	2018/6/20
1.3	Change block diagram	2018/7/28
1.4	Change “Start Up Time after POR” specification to 40us	2018/8/25
1.5	Add “Maximum Input Pulse Voltage”	2018/10/9
1.6	Change to Ordering information	2018/12/20

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