

# Quad-Channel Digital Isolators with Integrated DC to DC Converter

## Datasheet (EN) 1.4

### Product Overview

The NSIP894x devices are quad-channel digital isolators with integrated isolated DC-DC converter. The isolated DC-DC converter provides up to 500mW output power using on chip transformer. The feedback PWM signal is sent to primary side by a digital isolator based on Novosense capacity isolation technology. The high integrated solution can help to simplify system design and improve reliability. The NSIP894x device is safety certified by UL1577 support 5kVrms withstand voltages, while providing high electromagnetic immunity and low emissions. The data rate of the NSIP894x is up to 150Mbps, and the common-mode transient immunity (CMTI) is up to 150kV/μs. The NSIP894x devices provide 5V to 5V, 5V to 3.3V, 3.3V to 3.3V conversion mode, the output voltage can be set by SEL pin. The device can go into standby mode when the PDIS pin set to high, and there is no output voltage at VISO pin.

### Key Features

- Up to 5000Vrms Insulation voltage
- Power supply voltage: 3.3V to 5.5V
- 5V to 5V, 5V to 3.3V, support 100mA load current
- 3.3V to 3.3V, support 60mA load current
- Over current and over temperature protection
- Data rate: DC to 150Mbps
- High CMTI: 150kV/μs
- Propagation delay: <15ns
- High system level EMC performance:  
Enhanced system level ESD, EFT, Surge immunity
- Operation temperature: -40°C~125°C
- RoHS-compliant packages:  
SOW16

### Safety Regulatory Approvals

- UL recognition: up to 5000V<sub>rms</sub> for 1 minute per UL1577
- CQC certification per GB4943.1
- CSA component notice 5A
- DIN VDE V 0884-17

### Applications

- Industrial automation system
- Isolated SPI, RS232, RS485
- General-purpose multichannel isolation

### Device Information

| Part Number   | Package | Body Size        |
|---------------|---------|------------------|
| NSIP894x-DSWR | SOW16   | 10.30mm × 7.50mm |

### Functional Block Diagrams

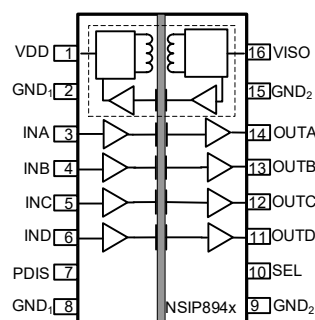


Figure 1. NSIP894x Block Diagram<sup>1</sup>

<sup>1</sup> The isolation channel direction can be either depend on different part number.

## INDEX

|                                                           |           |
|-----------------------------------------------------------|-----------|
| <b>1. PIN CONFIGURATION AND FUNCTIONS .....</b>           | <b>3</b>  |
| <b>2. ABSOLUTE MAXIMUM RATINGS .....</b>                  | <b>4</b>  |
| <b>3. RECOMMENDED OPERATING CONDITIONS .....</b>          | <b>5</b>  |
| <b>4. THERMAL CHARACTERISTICS .....</b>                   | <b>5</b>  |
| <b>5. SPECIFICATIONS .....</b>                            | <b>5</b>  |
| 5.1. ISOLATED DC/DC CONVERTER STATIC SPECIFICATIONS ..... | 5         |
| 5.2. DIGITAL ISOLATOR ELECTRICAL CHARACTERISTICS .....    | 7         |
| 5.3. TYPICAL PERFORMANCE CHARACTERISTICS .....            | 13        |
| 5.4. PARAMETER MEASUREMENT INFORMATION .....              | 14        |
| <b>6. HIGH VOLTAGE FEATURE DESCRIPTION .....</b>          | <b>14</b> |
| 6.1. INSULATION AND SAFETY RELATED SPECIFICATION .....    | 14        |
| 6.2. INSULATION CHARACTERISTICS .....                     | 15        |
| 6.3. REGULATORY INFORMATION .....                         | 17        |
| <b>7. FUNCTION DESCRIPTION .....</b>                      | <b>18</b> |
| 7.1. OVERVIEW .....                                       | 18        |
| 7.2. DEVICE FUNCTIONAL MODES .....                        | 18        |
| 7.3. EMI CONSIDERATIONS .....                             | 18        |
| 7.4. OUTPUT SHORT AND OVER TEMPERATURE PROTECTION .....   | 18        |
| <b>8. APPLICATION NOTE .....</b>                          | <b>19</b> |
| 8.1. TYPICAL APPLICATION .....                            | 19        |
| 8.2. PCB LAYOUT .....                                     | 20        |
| <b>9. PACKAGE INFORMATION .....</b>                       | <b>21</b> |
| <b>10. ORDER INFORMATION .....</b>                        | <b>22</b> |
| <b>11. DOCUMENTATION SUPPORT .....</b>                    | <b>22</b> |
| <b>12. TAPE AND REEL INFORMATION .....</b>                | <b>23</b> |
| <b>13. REVISION HISTORY .....</b>                         | <b>25</b> |

## 1. Pin Configuration And Functions

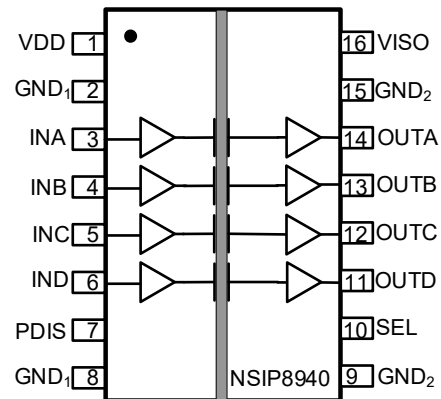


Figure 1.1 NSIP8940 Package

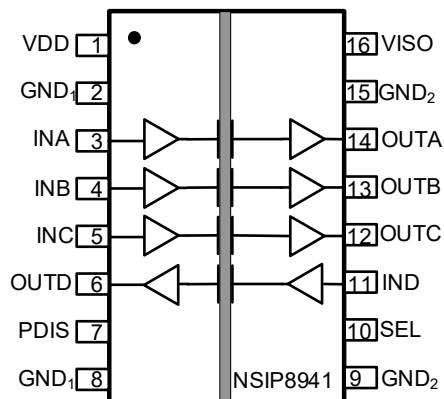


Figure 1.2 NSIP8941 Package

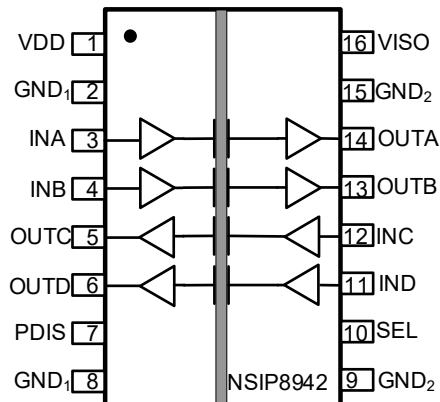


Figure 1.3 NSIP8942 Package

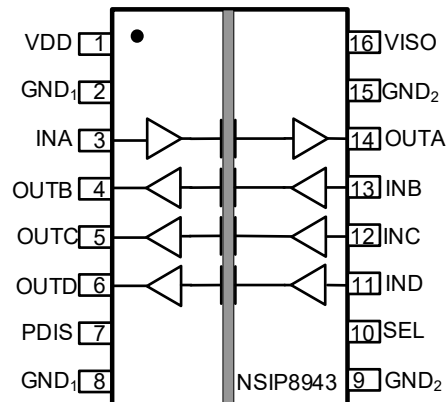


Figure 1.4 NSIP8943 Package

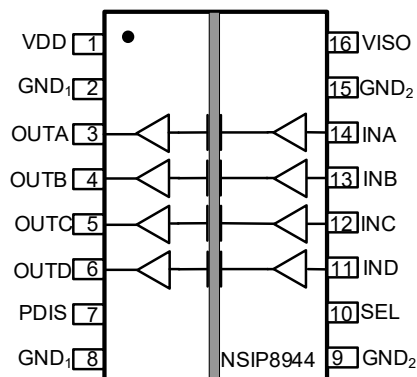


Figure 1.5 NSIP8944 Package

Table1.1 NSIP8940/ NSIP8941/ NSIP8942/ NSIP8943/NSIP8944 Pin Configuration and Description

| NSIP8940<br>PIN NO. | NSIP8941<br>PIN NO. | NSIP8942<br>PIN NO. | NSIP8943<br>PIN NO. | NSIP8944<br>PIN NO. | SYMBOL | FUNCTION                                                                                                                                                                                                                                                    |
|---------------------|---------------------|---------------------|---------------------|---------------------|--------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1                   | 1                   | 1                   | 1                   | 1                   | VDD    | Power Supply for Isolator Side 1                                                                                                                                                                                                                            |
| 2                   | 2                   | 2                   | 2                   | 2                   | GND1   | Ground 1, the ground reference for Isolator Side 1                                                                                                                                                                                                          |
| 3                   | 3                   | 3                   | 3                   | 14                  | INA    | Logic Input A                                                                                                                                                                                                                                               |
| 4                   | 4                   | 4                   | 13                  | 13                  | INB    | Logic Input B                                                                                                                                                                                                                                               |
| 5                   | 5                   | 12                  | 12                  | 12                  | INC    | Logic Input C                                                                                                                                                                                                                                               |
| 6                   | 11                  | 11                  | 11                  | 11                  | IND    | Logic Input D                                                                                                                                                                                                                                               |
| 7                   | 7                   | 7                   | 7                   | 7                   | PDIS   | Power Disable. When tied to any GND1 pin, the VISO output voltage is active. When a logic high voltage is applied, the VISO output voltage is shut down. Internal weak pull-down, can be floating (for better noise immunity, can connect this pin to GND1) |
| 8                   | 8                   | 8                   | 8                   | 8                   | GND1   | Ground 1, the ground reference for Isolator Side 1                                                                                                                                                                                                          |
| 9                   | 9                   | 9                   | 9                   | 9                   | GND2   | Ground 2, the ground reference for Isolator Side 2                                                                                                                                                                                                          |
| 10                  | 10                  | 10                  | 10                  | 10                  | SEL    | VISO output voltage select, VISO=5V when SEL short to VISO, VISO=3.3V when SEL short to GND2 or floating.                                                                                                                                                   |
| 11                  | 6                   | 6                   | 6                   | 6                   | OUTD   | Logic Output D                                                                                                                                                                                                                                              |
| 12                  | 12                  | 5                   | 5                   | 5                   | OUTC   | Logic Output C                                                                                                                                                                                                                                              |
| 13                  | 13                  | 13                  | 4                   | 4                   | OUTB   | Logic Output B                                                                                                                                                                                                                                              |
| 14                  | 14                  | 14                  | 14                  | 3                   | OUTA   | Logic Output A                                                                                                                                                                                                                                              |
| 15                  | 15                  | 15                  | 15                  | 15                  | GND2   | Ground 2, the ground reference for Isolator Side 2                                                                                                                                                                                                          |
| 16                  | 16                  | 16                  | 16                  | 16                  | VISO   | Secondary Supply Voltage Output for External Load.                                                                                                                                                                                                          |

## 2. Absolute Maximum Ratings

| Parameters             | Symbol                                                                         | Min  | Typ | Max                                 | Unit | Comments |
|------------------------|--------------------------------------------------------------------------------|------|-----|-------------------------------------|------|----------|
| Power Supply Voltage   | VDD                                                                            | -0.5 |     | 6                                   | V    |          |
| Maximum Input Voltage  | V <sub>INA</sub> , V <sub>INB</sub><br>V <sub>INC</sub> , V <sub>IND</sub>     | -0.4 |     | VCC1 <sup>2</sup> +0.4 <sup>1</sup> | V    |          |
| Maximum Output Voltage | V <sub>OUTA</sub> , V <sub>OUTB</sub><br>V <sub>OUTC</sub> , V <sub>OUTD</sub> | -0.4 |     | VCC2 <sup>2</sup> +0.4 <sup>1</sup> | V    |          |

| Parameters              | Symbol           | Min | Typ | Max   | Unit | Comments |
|-------------------------|------------------|-----|-----|-------|------|----------|
| Output current          | I <sub>o</sub>   | -15 |     | 15    | mA   |          |
| Operating Temperature   | T <sub>opr</sub> | -40 |     | 125   | °C   |          |
| Storage Temperature     | T <sub>stg</sub> | -40 |     | 150   | °C   |          |
| Electrostatic discharge | HBM              |     |     | ±6000 | V    |          |
|                         | CDM              |     |     | ±2000 | V    |          |

<sup>1</sup>VCC1 is input side supply,VCC2 is output side supply

### 3. Recommended Operating Conditions

| Parameters               | Symbol           | min                   | typ | max                   | unit |
|--------------------------|------------------|-----------------------|-----|-----------------------|------|
| Power Supply Voltage     | VDD              | 3                     |     | 5.5                   | V    |
| Operating Temperature    | T <sub>opr</sub> | -40                   |     | 125                   | °C   |
| High Level Input Voltage | V <sub>IH</sub>  | 0.7*VCC1 <sup>1</sup> |     | VCC1 <sup>1</sup>     | V    |
| Low Level Input Voltage  | V <sub>IL</sub>  | 0                     |     | 0.3*VCC1 <sup>1</sup> | V    |
| Data rate                | DR               |                       |     | 150                   | Mbps |

<sup>1</sup>VCC1 is input side supply

### 4. Thermal Characteristics

| Parameters                                | Symbol                | SOW16 | Unit |
|-------------------------------------------|-----------------------|-------|------|
| IC Junction-to-Air Thermal Resistance     | θ <sub>JA</sub>       | 56.8  | °C/W |
| Junction-to-case (top) thermal resistance | θ <sub>JC (top)</sub> | 15.6  | °C/W |
| Junction-to-board thermal resistance      | θ <sub>JB</sub>       | 28.5  | °C/W |

### 5. Specifications

#### 5.1. Isolated DC/DC Converter Static Specifications

(VDD=4.5V~5.5V, SEL=VISO, 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          |
|------------------------------------|-------------------------|------|-----|------|------|-------------------|
| Isolated Supply Voltage            | VISO                    | 4.75 | 5   | 5.25 | V    |                   |
| Line Regulation                    | V <sub>ISO(LINE)</sub>  |      |     | 2    | mV/V |                   |
| Load Regulation                    | V <sub>ISO(LOAD)</sub>  |      | 0.2 | 0.5  | %    |                   |
| Output Ripple                      | V <sub>ISO(RIP)</sub>   |      | 35  |      | mVpp |                   |
| Output Noise                       | V <sub>ISO(NOISE)</sub> |      | 150 |      | mVpp |                   |
| Efficiency at maximum load current | EFF                     | 39   | 50  |      | %    | IISO=100mA,PDIS=0 |

| Parameters                                  | Symbol                 | Min | Typ | Max | Unit | Comments                                                    |
|---------------------------------------------|------------------------|-----|-----|-----|------|-------------------------------------------------------------|
| Output supply current                       | I <sub>ISO</sub>       | 100 |     |     | mA   | VDD ≥ 5V                                                    |
|                                             |                        | 95  |     |     | mA   | VDD ≥ 4.75V                                                 |
|                                             |                        | 78  |     |     | mA   | VDD ≥ 4.5V                                                  |
| VDD supply current without digital isolator | I <sub>VDD_POWER</sub> |     | 2.5 | 30  | μA   | PDIS=VDD, INA (OUTA for 8944) on Side 1 tied to VDD or GND1 |
|                                             |                        |     | 10  | 20  | mA   | No VISO Load, PDIS=0                                        |
|                                             |                        |     | 197 | 270 | mA   | IISO=100mA, PDIS=0                                          |

(VDD=4.5V~5.5V, SEL=0, 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                                                    |
|---------------------------------------------|-------------------------|-------|------|-------|------|-------------------------------------------------------------|
| Isolated Supply Voltage                     | VISO                    | 3.135 | 3.3  | 3.465 | V    |                                                             |
| Line Regulation                             | V <sub>ISO(LINE)</sub>  |       |      | 2     | mV/V |                                                             |
| Load Regulation                             | V <sub>ISO(LOAD)</sub>  |       | 0.2  | 0.5   | %    |                                                             |
| Output Ripple                               | V <sub>ISO(RIP)</sub>   |       | 35   |       | mVpp |                                                             |
| Output Noise                                | V <sub>ISO(NOISE)</sub> |       | 150  |       | mVpp |                                                             |
| Efficiency at maximum load current          | EFF                     | 28    | 41.5 |       | %    | IISO=100mA, PDIS=0                                          |
| Output supply current                       | I <sub>ISO</sub>        | 100   |      |       | mA   | VDD ≥ 4.5V                                                  |
| VDD supply current without digital isolator | I <sub>VDD_POWER</sub>  |       | 2.5  | 30    | μA   | PDIS=VDD, INA (OUTA for 8944) on Side 1 tied to VDD or GND1 |
|                                             |                         |       | 8    | 20    | mA   | No VISO Load, PDIS=0                                        |
|                                             |                         |       | 157  | 230   | mA   | IISO=100mA, PDIS=0                                          |

(VDD=3V~3.6V, SEL=0, Ta=-40°C to 125°C. Unless otherwise noted, Typical values are at VDD = 3.3V, Ta = 25°C)

| Parameters                         | Symbol                  | Min | Typ | Max | Unit | Comments          |
|------------------------------------|-------------------------|-----|-----|-----|------|-------------------|
| Isolated Supply Voltage            | VISO                    | 3.2 | 3.3 | 3.5 | V    |                   |
| Line Regulation                    | V <sub>ISO(LINE)</sub>  |     |     | 2   | mV/V |                   |
| Load Regulation                    | V <sub>ISO(LOAD)</sub>  |     | 0.2 | 2.1 | %    |                   |
| Output Ripple                      | V <sub>ISO(RIP)</sub>   |     | 40  |     | mVpp |                   |
| Output Noise                       | V <sub>ISO(NOISE)</sub> |     | 100 |     | mVpp |                   |
| Efficiency at maximum load current | EFF                     | 39  | 48  |     | %    | IISO=60mA, PDIS=0 |

| Parameters                                  | Symbol                 | Min | Typ | Max | Unit | Comments                                                    |
|---------------------------------------------|------------------------|-----|-----|-----|------|-------------------------------------------------------------|
| Output supply current                       | I <sub>ISO</sub>       | 60  |     |     | mA   | VDD ≥ 3.3V                                                  |
|                                             |                        | 48  |     |     | mA   | VDD ≥ 3.135V                                                |
|                                             |                        | 35  |     |     | mA   | VDD ≥ 3V                                                    |
| VDD supply current without digital isolator | I <sub>VDD_POWER</sub> |     | 2.5 | 30  | μA   | PDIS=VDD, INA (OUTA for 8944) on Side 1 tied to VDD or GND1 |
|                                             |                        |     | 10  | 20  | mA   | No VISO Load, PDIS=0                                        |
|                                             |                        |     | 123 | 160 | mA   | IISO=60mA, PDIS=0                                           |

## 5.2. Digital Isolator Electrical Characteristics

| Parameters                     | Symbol             | Min      | Typ | Max      | Unit  | Comments                         |
|--------------------------------|--------------------|----------|-----|----------|-------|----------------------------------|
| Power on Reset                 | V <sub>DDPOR</sub> |          | 2.5 | 3        | V     | POR threshold as during power-up |
|                                | V <sub>DDHYS</sub> |          | 0.2 |          | V     | POR threshold Hysteresis         |
| High Level Input Voltage       | V <sub>IH</sub>    | 0.7*VCC1 |     |          | V     |                                  |
| Low Level Input Voltage        | V <sub>IL</sub>    |          |     | 0.3*VCC1 | V     |                                  |
| High Level Output Voltage      | V <sub>OH</sub>    | 0.8*VCC2 |     |          | V     | IOH ≥ - 4mA                      |
| Low Level Output Voltage       | V <sub>OL</sub>    |          |     | 0.2*VCC2 | V     | IOL ≤ 4mA                        |
| Output Impedance               | R <sub>out</sub>   |          | 50  |          | ohm   |                                  |
| Input Pull high or low Current | I <sub>pull</sub>  |          | 8   | 15       | μA    |                                  |
| Common Mode Transient Immunity | CMTI               | 100      | 150 |          | kV/μs |                                  |
| Thermal Shutdown Temperature   |                    |          | 165 |          | °C    |                                  |

<sup>1</sup>VCC1 is input side supply, VCC2 is output side supply

(VDD=4.5V~5.5V, SEL=VISO, Ta=-40°C to 125°C, no load. Unless otherwise noted, Typical values are at VDD = 5V, Ta = 25°C)

| Parameters          | Symbol              | Min | Typ  | Max | Unit | Comments                                                          |
|---------------------|---------------------|-----|------|-----|------|-------------------------------------------------------------------|
| Supply current      | NSIP8940            |     |      |     |      |                                                                   |
|                     | I <sub>DD(Q0)</sub> |     | 10.3 | 20  | mA   | All Input 0V for NSIP8940W0 or All Input at supply for NSIP8940W1 |
|                     | I <sub>DD(Q1)</sub> |     | 11   | 30  | mA   | All Input at supply for NSIP8940W0 or All Input 0V for NSIP8940W1 |
|                     | I <sub>DD(1M)</sub> |     | 11.6 | 35  | mA   | All Input with 1Mbps, C <sub>L</sub> =15pF                        |
|                     | NSIP8941            |     |      |     |      |                                                                   |
|                     | I <sub>DD(Q0)</sub> |     | 10.3 | 20  | mA   | All Input 0V for NSIP8941W0 or All Input at supply for NSIP8941W1 |
|                     | I <sub>DD(Q1)</sub> |     | 12.3 | 30  | mA   | All Input at supply for NSIP8941W0 or All Input 0V for NSIP8941W1 |
|                     | I <sub>DD(1M)</sub> |     | 12.7 | 35  | mA   | All Input with 1Mbps, C <sub>L</sub> =15pF                        |
|                     | NSIP8942            |     |      |     |      |                                                                   |
|                     | I <sub>DD(Q0)</sub> |     | 10.3 | 20  | mA   | All Input 0V for NSIP8942W0 or All Input at supply for NSIP8942W1 |
|                     | I <sub>DD(Q1)</sub> |     | 14.3 | 30  | mA   | All Input at supply for NSIP8942W0 or All Input 0V for NSIP8942W1 |
|                     | I <sub>DD(1M)</sub> |     | 20   | 35  | mA   | All Input with 1Mbps, C <sub>L</sub> =15pF                        |
|                     | NSIP8943            |     |      |     |      |                                                                   |
|                     | I <sub>DD(Q0)</sub> |     | 10.3 | 20  | mA   | All Input 0V for NSIP8943W0 or All Input at supply for NSIP8943W1 |
|                     | I <sub>DD(Q1)</sub> |     | 16.3 | 30  | mA   | All Input at supply for NSIP8943W0 or All Input 0V for NSIP8943W1 |
|                     | I <sub>DD(1M)</sub> |     | 27.3 | 50  | mA   | All Input with 1Mbps, C <sub>L</sub> =15pF                        |
|                     | NSIP8944            |     |      |     |      |                                                                   |
|                     | I <sub>DD(Q0)</sub> |     | 10.3 | 20  | mA   | All Input 0V for NSIP8944W0 or All Input at supply for NSIP8944W1 |
|                     | I <sub>DD(Q1)</sub> |     | 18.3 | 30  | mA   | All Input at supply for NSIP8944W0 or All Input 0V for NSIP8944W1 |
|                     | I <sub>DD(1M)</sub> |     | 35   | 50  | mA   | All Input with 1Mbps, C <sub>L</sub> =15pF                        |
| Data Rate           | DR                  | 0   |      | 150 | Mbps |                                                                   |
| Minimum Pulse Width | PW                  |     |      | 5.0 | ns   |                                                                   |
| Propagation Delay   | t <sub>PLH</sub>    | 5   | 9.0  | 16  | ns   |                                                                   |
|                     | t <sub>PHL</sub>    | 5   | 9.0  | 16  | ns   |                                                                   |

| <i>Parameters</i>             | <i>Symbol</i> | <i>Min</i> | <i>Typ</i> | <i>Max</i> | <i>Unit</i> | <i>Comments</i>       |
|-------------------------------|---------------|------------|------------|------------|-------------|-----------------------|
| Pulse Width Distortion        | PWD           |            |            | 5.0        | ns          | $ t_{PHL} - t_{PLH} $ |
| Rising Time                   | $t_r$         |            |            | 5.0        | ns          | $C_L = 15\text{pF}$   |
| Falling Time                  | $t_f$         |            |            | 5.0        | ns          | $C_L = 15\text{pF}$   |
| Channel-to-Channel Delay Skew | $t_{SK(c2c)}$ |            |            | 2.5        | ns          |                       |
| Part-to-Part Delay Skew       | $t_{SK(p2p)}$ |            |            | 5.0        | ns          |                       |

(VDD=4.5V~5.5V, SEL=0, Ta=-40°C to 125°C, no load. . Unless otherwise noted, Typical values are at VDD = 5V, Ta = 25°C)

| Parameters          | Symbol              | Min | Typ  | Max | Unit | Comments                                                          |
|---------------------|---------------------|-----|------|-----|------|-------------------------------------------------------------------|
| Supply current      | NSIP8940            |     |      |     |      |                                                                   |
|                     | I <sub>DD(Q0)</sub> |     | 7.8  | 20  | mA   | All Input 0V for NSIP8940W0 or All Input at supply for NSIP8940W1 |
|                     | I <sub>DD(Q1)</sub> |     | 8    | 25  | mA   | All Input at supply for NSIP8940W0 or All Input 0V for NSIP8940W1 |
|                     | I <sub>DD(1M)</sub> |     | 8.78 | 20  | mA   | All Input with 1Mbps, C <sub>L</sub> =15pF                        |
|                     | NSIP8941            |     |      |     |      |                                                                   |
|                     | I <sub>DD(Q0)</sub> |     | 7.8  | 20  | mA   | All Input 0V for NSIP8941W0 or All Input at supply for NSIP8941W1 |
|                     | I <sub>DD(Q1)</sub> |     | 9.8  | 25  | mA   | All Input at supply for NSIP8941W0 or All Input 0V for NSIP8941W1 |
|                     | I <sub>DD(1M)</sub> |     | 11.7 | 30  | mA   | All Input with 1Mbps, C <sub>L</sub> =15pF                        |
|                     | NSIP8942            |     |      |     |      |                                                                   |
|                     | I <sub>DD(Q0)</sub> |     | 7.8  | 20  | mA   | All Input 0V for NSIP8942W0 or All Input at supply for NSIP8942W1 |
|                     | I <sub>DD(Q1)</sub> |     | 11.8 | 25  | mA   | All Input at supply for NSIP8942W0 or All Input 0V for NSIP8942W1 |
|                     | I <sub>DD(1M)</sub> |     | 15.3 | 30  | mA   | All Input with 1Mbps, C <sub>L</sub> =15pF                        |
|                     | NSIP8943            |     |      |     |      |                                                                   |
|                     | I <sub>DD(Q0)</sub> |     | 7.8  | 20  | mA   | All Input 0V for NSIP8943W0 or All Input at supply for NSIP8943W1 |
|                     | I <sub>DD(Q1)</sub> |     | 13.8 | 25  | mA   | All Input at supply for NSIP8943W0 or All Input 0V for NSIP8943W1 |
|                     | I <sub>DD(1M)</sub> |     | 20.3 | 40  | mA   | All Input with 1Mbps, C <sub>L</sub> =15pF                        |
|                     | NSIP8944            |     |      |     |      |                                                                   |
|                     | I <sub>DD(Q0)</sub> |     | 7.8  | 20  | mA   | All Input 0V for NSIP8944W0 or All Input at supply for NSIP8944W1 |
|                     | I <sub>DD(Q1)</sub> |     | 15.8 | 25  | mA   | All Input at supply for NSIP8944W0 or All Input 0V for NSIP8944W1 |
|                     | I <sub>DD(1M)</sub> |     | 25.3 | 40  | mA   | All Input with 1Mbps, C <sub>L</sub> =15pF                        |
| Data Rate           | DR                  | 0   |      | 150 | Mbps |                                                                   |
| Minimum Pulse Width | PW                  |     |      | 5.0 | ns   |                                                                   |
| Propagation Delay   | t <sub>PLH</sub>    | 5   | 9.0  | 16  | ns   |                                                                   |
|                     | t <sub>PHL</sub>    | 5   | 9.0  | 16  | ns   |                                                                   |

| <i>Parameters</i>             | <i>Symbol</i> | <i>Min</i> | <i>Typ</i> | <i>Max</i> | <i>Unit</i> | <i>Comments</i>       |
|-------------------------------|---------------|------------|------------|------------|-------------|-----------------------|
| Pulse Width Distortion        | PWD           |            |            | 5.0        | ns          | $ t_{PHL} - t_{PLH} $ |
| Rising Time                   | $t_r$         |            |            | 5.0        | ns          | $C_L = 15\text{pF}$   |
| Falling Time                  | $t_f$         |            |            | 5.0        | ns          | $C_L = 15\text{pF}$   |
| Channel-to-Channel Delay Skew | tSK(c2c)      |            |            | 2.5        | ns          |                       |
| Part-to-Part Delay Skew       | tSK(p2p)      |            |            | 5.0        | ns          |                       |

(VDD=3V~3.6V, SEL=0, Ta=-40°C to 125°C, no load. Unless otherwise noted, Typical values are at VDD = 3.3V, Ta = 25°C)

| Parameters          | Symbol              | Min | Typ   | Max | Unit | Comments                                                          |
|---------------------|---------------------|-----|-------|-----|------|-------------------------------------------------------------------|
| Supply current      | NSIP8940            |     |       |     |      |                                                                   |
|                     | I <sub>DD(Q0)</sub> |     | 9     | 20  | mA   | All Input 0V for NSIP8940W0 or All Input at supply for NSIP8940W1 |
|                     | I <sub>DD(Q1)</sub> |     | 10    | 25  | mA   | All Input at supply for NSIP8940W0 or All Input 0V for NSIP8940W1 |
|                     | I <sub>DD(1M)</sub> |     | 10    | 30  | mA   | All Input with 1Mbps, CL=15pF                                     |
|                     | NSIP8941            |     |       |     |      |                                                                   |
|                     | I <sub>DD(Q0)</sub> |     | 9     | 20  | mA   | All Input 0V for NSIP8941W0 or All Input at supply for NSIP8941W1 |
|                     | I <sub>DD(Q1)</sub> |     | 11.25 | 25  | mA   | All Input at supply for NSIP8941W0 or All Input 0V for NSIP8941W1 |
|                     | I <sub>DD(1M)</sub> |     | 10.14 | 30  | mA   | All Input with 1Mbps, CL=15pF                                     |
|                     | NSIP8942            |     |       |     |      |                                                                   |
|                     | I <sub>DD(Q0)</sub> |     | 9     | 20  | mA   | All Input 0V for NSIP8942W0 or All Input at supply for NSIP8942W1 |
|                     | I <sub>DD(Q1)</sub> |     | 13.5  | 25  | mA   | All Input at supply for NSIP8942W0 or All Input 0V for NSIP8942W1 |
|                     | I <sub>DD(1M)</sub> |     | 16.5  | 30  | mA   | All Input with 1Mbps, CL=15pF                                     |
|                     | NSIP8943            |     |       |     |      |                                                                   |
|                     | I <sub>DD(Q0)</sub> |     | 9     | 20  | mA   | All Input 0V for NSIP8943W0 or All Input at supply for NSIP8943W1 |
|                     | I <sub>DD(Q1)</sub> |     | 15.75 | 25  | mA   | All Input at supply for NSIP8943W0 or All Input 0V for NSIP8943W1 |
|                     | I <sub>DD(1M)</sub> |     | 21.4  | 50  | mA   | All Input with 1Mbps, CL=15pF                                     |
|                     | NSIP8944            |     |       |     |      |                                                                   |
|                     | I <sub>DD(Q0)</sub> |     | 9     | 20  | mA   | All Input 0V for NSIP8944W0 or All Input at supply for NSIP8944W1 |
|                     | I <sub>DD(Q1)</sub> |     | 18    | 30  | mA   | All Input at supply for NSIP8944W0 or All Input 0V for NSIP8944W1 |
|                     | I <sub>DD(1M)</sub> |     | 26.5  | 50  | mA   | All Input with 1Mbps, CL=15pF                                     |
| Data Rate           | DR                  | 0   |       | 150 | Mbps |                                                                   |
| Minimum Pulse Width | PW                  |     |       | 5.0 | ns   |                                                                   |
| Propagation Delay   | t <sub>PLH</sub>    | 5   | 9.0   | 16  | ns   |                                                                   |

| Parameters                    | Symbol        | Min | Typ | Max | Unit | Comments              |
|-------------------------------|---------------|-----|-----|-----|------|-----------------------|
|                               | $t_{PHL}$     | 5   | 9.0 | 16  | ns   |                       |
| Pulse Width Distortion        | PWD           |     |     | 5.0 | ns   | $ t_{PHL} - t_{PLH} $ |
| Rising Time                   | $t_r$         |     |     | 5.0 | ns   | $C_L = 15pF$          |
| Falling Time                  | $t_f$         |     |     | 5.0 | ns   | $C_L = 15pF$          |
| Channel-to-Channel Delay Skew | $t_{SK(c2c)}$ |     |     | 2.5 | ns   |                       |
| Part-to-Part Delay Skew       | $t_{SK(p2p)}$ |     |     | 5.0 | ns   |                       |

### 5.3. Typical Performance Characteristics

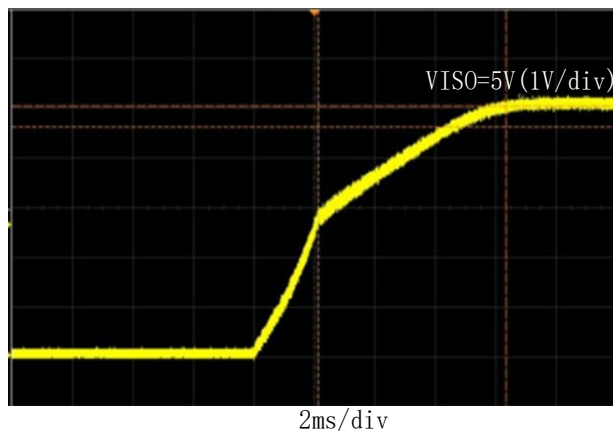


Figure 5.1 5V→5V Soft start at no load



Figure 5.2 5V→5V Soft start at full load

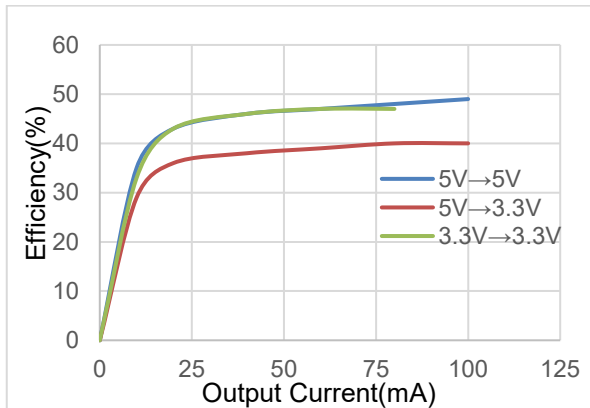


Figure 5.3 Output current vs efficiency

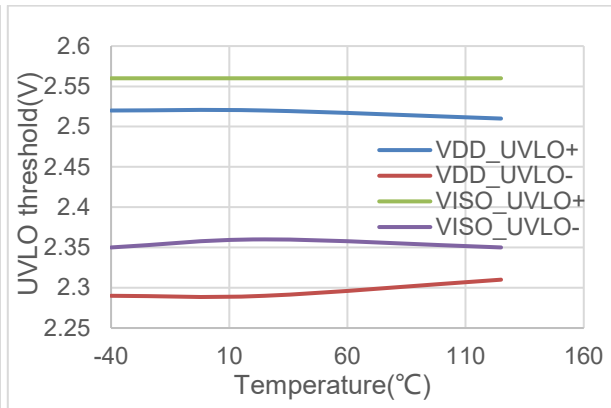


Figure 5.4 Power-Supply Undervoltage Threshold vs Temperature

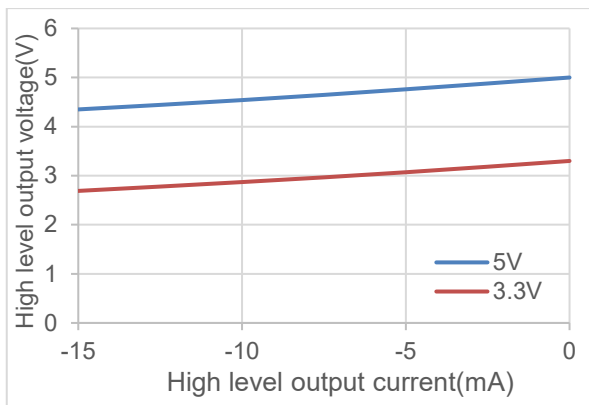


Figure 5.5 High-Level Output Voltage vs. Output Current

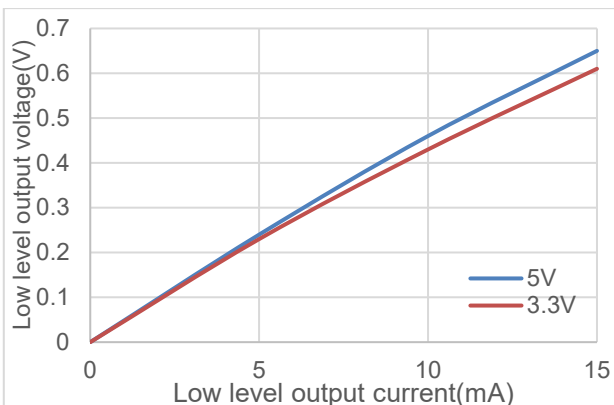


Figure 5.6 Low-Level Output Voltage vs. Output Current

## 5.4. Parameter Measurement Information

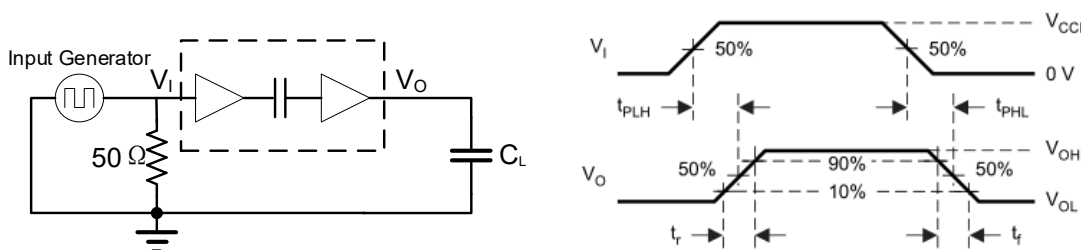


Figure 5.7 Switching Characteristics Test Circuit and Waveform

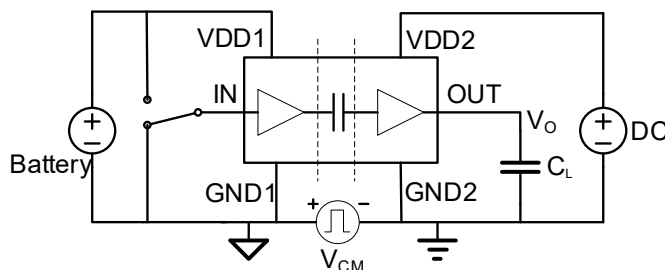


Figure 5.8 Common-Mode Transient Immunity Test Circuit

## 6. High Voltage Feature Description

### 6.1. Insulation and Safety Related Specification

| Parameters                           | Symbol | Value | Unit | Comments                                                          |
|--------------------------------------|--------|-------|------|-------------------------------------------------------------------|
| Minimum External Air Gap (Clearance) | CLR    | 8     | mm   | Shortest terminal-to-terminal distance through air                |
| Minimum External Tracking (Creepage) | CPG    | 8     | mm   | Shortest terminal-to-terminal distance across the package surface |
| Distance Through Insulation          | DTI    | 20    | μm   | Distance through insulation                                       |

| Parameters                                          | Symbol | Value | Unit | Comments                                 |
|-----------------------------------------------------|--------|-------|------|------------------------------------------|
| Tracking Resistance<br>(Comparative Tracking Index) | CTI    | >600  | V    | DIN EN 60112 (VDE 0303-11);<br>IEC 60112 |
| Material Group                                      |        | I     |      | IEC 60664-1                              |

| Description                            | Test Condition                                | Value     |
|----------------------------------------|-----------------------------------------------|-----------|
| Overvoltage Category per<br>IEC60664-1 | For Rated Mains Voltage $\leq 150\text{Vrms}$ | I to IV   |
|                                        | For Rated Mains Voltage $\leq 300\text{Vrms}$ | I to III  |
|                                        | For Rated Mains Voltage $\leq 600\text{Vrms}$ | I to II   |
| Climatic Classification                |                                               | 40/125/21 |
| Pollution Degree per DIN VDE<br>0110,  |                                               | 2         |

## 6.2. Insulation Characteristics

| Description                          | Test Condition                                                                                                                                                                                                                                        | Symbol     | Value | Unit       |
|--------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|-------|------------|
| Maximum repetitive isolation voltage |                                                                                                                                                                                                                                                       | $V_{IORM}$ | 565   | $V_{PEAK}$ |
| Maximum working isolation voltage    | AC Voltage                                                                                                                                                                                                                                            | $V_{IOWM}$ | 400   | $V_{RMS}$  |
|                                      | DC Voltage                                                                                                                                                                                                                                            |            | 565   | $V_{DC}$   |
| Apparent Charge                      | Method a, after<br>Input/output safety test<br>subgroup 2/3,<br>$V_{ini}=V_{IOTM}$ , $t_{ini}=60\text{s}$ ,<br>$V_{pd(m)}=1.2*V_{IORM}$ , $t_m=10\text{s}$ .                                                                                          | $q_{pd}$   | <5    | pC         |
|                                      | Method a, after<br>environmental tests<br>subgroup 1, $V_{ini}=V_{IOTM}$ ,<br>$t_{ini}=60\text{s}$ , $V_{pd(m)}=1.3*V_{IORM}$ ,<br>$t_m=10\text{s}$                                                                                                   |            |       | pC         |
|                                      | Method b, routine test<br>(100% production) and<br>preconditioning (type<br>test); $V_{ini}=1.2*V_{IOTM}$ , $t_{ini}=1\text{s}$<br>$V_{pd(m)}=1.5*V_{IORM}$ , $t_m=1\text{s}$<br>(method b1) or<br>$V_{pd(m)}=V_{ini}$ , $t_m=t_{ini}$ (method<br>b2) |            |       | pC         |
| Maximum transient isolation voltage  | $t=60\text{s}$                                                                                                                                                                                                                                        | $V_{IOTM}$ | 5300  | $V_{PEAK}$ |
| Maximum impulse voltage              | Tested in air, 1.2/50 $\mu\text{s}$<br>waveform per IEC62368-1                                                                                                                                                                                        | $V_{IMP}$  | 7000  | $V_{PEAK}$ |
| Maximum Surge Isolation Voltage      | Test method per<br>IEC62368-1, 1.2/50 $\mu\text{s}$                                                                                                                                                                                                   | $V_{IOSM}$ | 9100  | $V_{PEAK}$ |

| Description                             | Test Condition                                                                                                         | Symbol    | Value      | Unit        |
|-----------------------------------------|------------------------------------------------------------------------------------------------------------------------|-----------|------------|-------------|
|                                         | waveform,<br>$V_{IOSM} \geq V_{IMP} \times 1.3$                                                                        |           |            |             |
| Isolation resistance                    | $V_{IO} = 500V, T_{amb} = 25^{\circ}C$                                                                                 | $R_{IO}$  | $>10^{12}$ | $\Omega$    |
|                                         | $V_{IO} = 500V, 100^{\circ}C \leq T_{amb} \leq 125^{\circ}C$                                                           | $R_{IO}$  | $>10^{11}$ | $\Omega$    |
|                                         | $V_{IO} = 500V, T_{amb} = T_s$                                                                                         | $R_{IO}$  | $>10^9$    | $\Omega$    |
| Isolation capacitance                   | $f = 1MHz$                                                                                                             | $C_{IO}$  | 0.6        | pF          |
| Safety total power dissipation          | $\theta_{JA} = 56.8^{\circ}C/W, V_I = 5.5V,$<br>$T_J = 150^{\circ}C, T_A = 25^{\circ}C$                                | $P_s$     | 2201       | mW          |
| Safety input, output, or supply current | $\theta_{JA} = 56.8^{\circ}C/W, V_I = 5.5V,$<br>$T_J = 150^{\circ}C, T_A = 25^{\circ}C$                                | $I_s$     | 400        | mA          |
| Maximum safety temperature              |                                                                                                                        | $T_s$     | 150        | $^{\circ}C$ |
| <b>UL1577</b>                           |                                                                                                                        |           |            |             |
| Insulation voltage per UL               | $V_{TEST} = V_{ISO}, t = 60s$<br>(qualification),<br>$V_{TEST} = 1.2 \times V_{ISO}, t = 1s$<br>(100% production test) | $V_{ISO}$ | 5000       | $V_{RMS}$   |

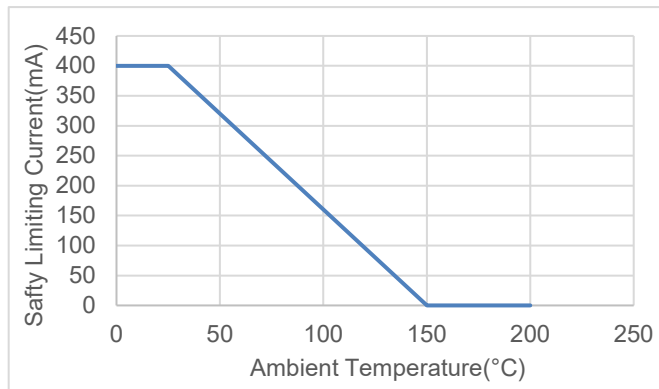


Figure 6.1 NSIP894x Thermal Derating Curve, Dependence of Safety Limiting Values with Case Temperature per DIN VDE V 0884-17

### 6.3. Regulatory Information

The NSIP894x are approved by the organizations listed in table.

| <i>UL</i>                                                 |                                                           | <i>VDE</i>                                                                                                                                          | <i>CQC</i>                      |
|-----------------------------------------------------------|-----------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------|
| UL 1577 Component Recognition Program                     | Approved under CSA Component Acceptance Notice 5A         | Certified according to DIN EN IEC 60747-17 (VDE 0884-17)                                                                                            | Certified according to GB4943.1 |
| Single Protection, 5000V <sub>rms</sub> Isolation voltage | Single Protection, 5000V <sub>rms</sub> Isolation voltage | Basic Insulation<br>V <sub>IORM</sub> =565V <sub>peak</sub><br>V <sub>IOTM</sub> =5300V <sub>peak</sub><br>V <sub>IOSM</sub> =9100V <sub>peak</sub> | Basic insulation                |
| E500602                                                   | E500602                                                   | 40057024                                                                                                                                            | CQC20001264939                  |

## 7. Function Description

### 7.1. Overview

The NSIP894x devices are quad-channel digital isolators with integrated isolated DC-DC converter. The digital isolators are based on Novosense capacity isolation barrier technique. The isolated DC-DC converter provides up to 500mW output power using on chip transformer. The feedback PWM signal is sent to primary side by a digital isolator based on capacity isolation technology. The NSIP894x device are safety certified by UL1577 support 5kVrms insulation withstand voltages, while providing high electromagnetic immunity and low emissions. The data rate of the NSIP894x is up to 150Mbps, and the common-mode transient immunity (CMTI) is up to 150kV/ $\mu$ s. The device can go into standby mode when the PDIS pin set to high, and there is no output voltage at VISO pin.

The high integrated solution can help to simplify system design and improve reliability. The NSIP894x devices are suitable for the limited PCB space applications. The devices are also suitable for wide temperature application which the most the power module can not support.

### 7.2. Device Functional Modes

The NSIP894x devices provide 5V to 5V, 5V to 3.3V, 3.3V to 3.3V conversion mode, the output voltage can be set by SEL pin. Supply configuration table showed below.

| PDIS PIN        | SEL PIN         | VDD     | VISO |
|-----------------|-----------------|---------|------|
| Shorted to GND1 | Shorted to VISO | 5V      | 5V   |
| Shorted to GND1 | Shorted to GND2 | 5V      | 3.3V |
| Shorted to GND1 | Shorted to GND2 | 3.3V    | 3.3V |
| Shorted to VDD1 | X               | 3.3V/5V | 0V   |

### 7.3. EMI Considerations

The NSIP894x devices are using on chip transformer, so the power transfer must operate at high frequency allow higher efficiency transfer using the small transformer. This will cause emissions which need to pay attention to PCB layout if the application allow low emission. Please see the application note if needed.

### 7.4. Output Short and Over Temperature Protection

The NSIP894x devices are protected against output short. When the devices detect the output is short, the device will be in Hiccup mode and the transfer power will be limited. So the temperature of the device will be low, and the device is protected.

The NSIP894x devices are also protected against over temperature. When the devices detect the chip is over 165°C, the device will be shut down until the temperature of the device is below 145°C.

## 8. Application Note

### 8.1. Typical Application

The NSIP894x requires a 0.1  $\mu\text{F}$  and 10 $\mu\text{F}$  bypass capacitors between VDD and GND1, VISO and GND2. The capacitor should be placed as close as possible to the package. This is very important for the performance of the device. The figure 8.1 is the basic schematic of NSIP894x and the figure 8.2 is the typical isolated RS485 schematic using NSIP894x.

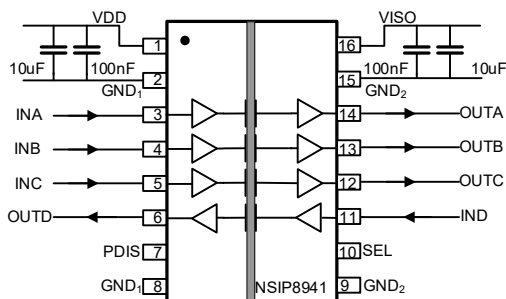


Figure 8.1 Basic schematic of NSIP894x

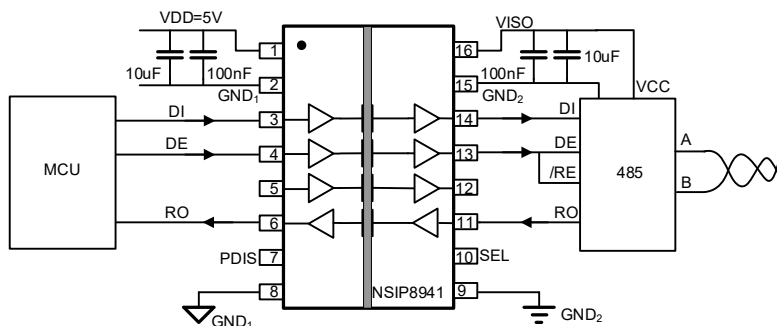


Figure 8.2 Isolated RS485 schematic using NSIP894x

## 8.2. PCB Layout

The recommended PCB layout shown below. The low ESR capacitor C1 should be closed to PIN1 and PIN2, the distance should be less than 10mm. The low ESR capacitor C3 should be closed to PIN15 and PIN16, the distance should be less than 1mm.

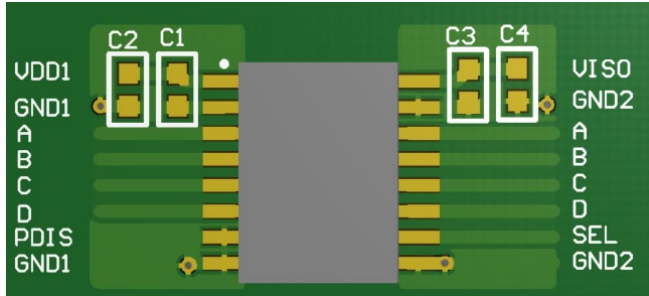


Figure 8.3 Recommended PCB Layout — Top Layer



Figure 8.4 Recommended PCB Layout — Bottom Layer

9. Package Information

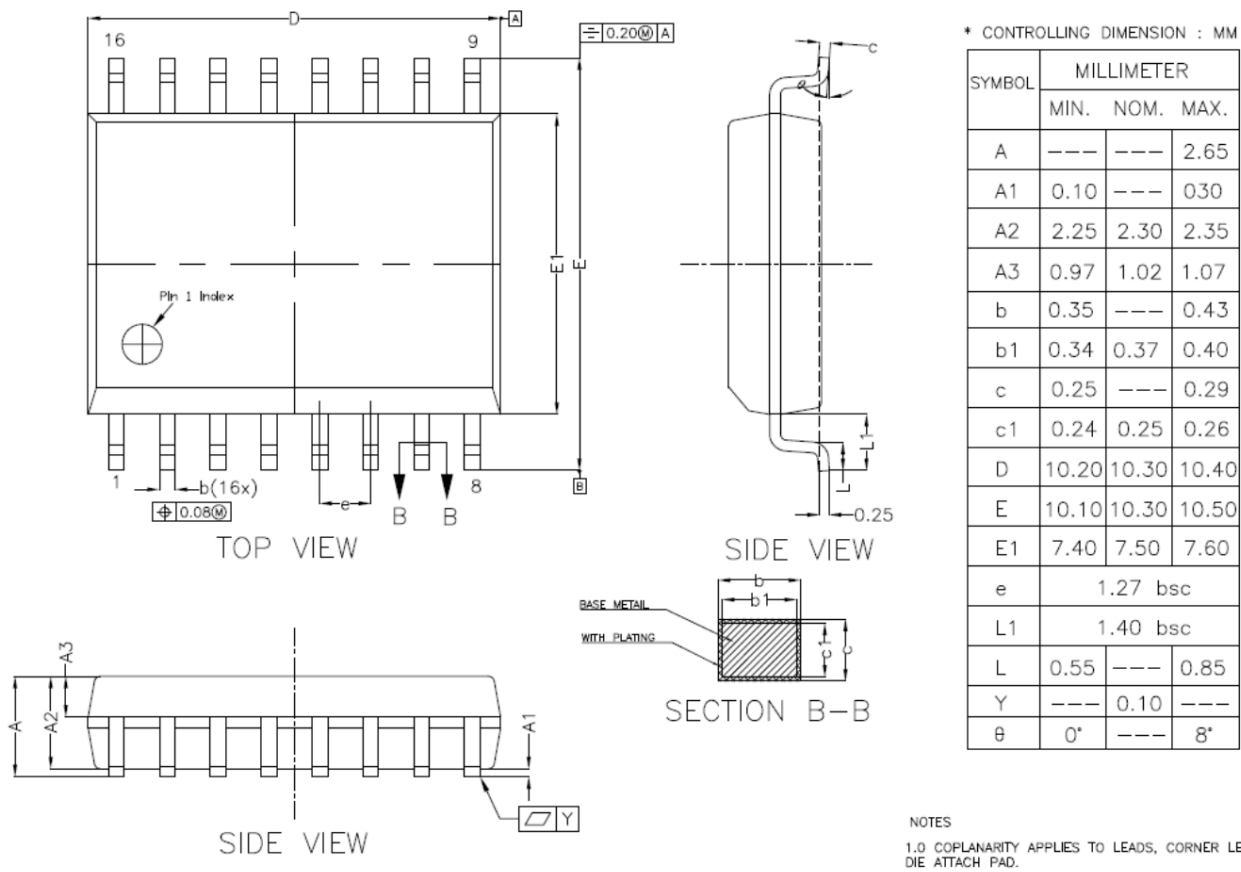
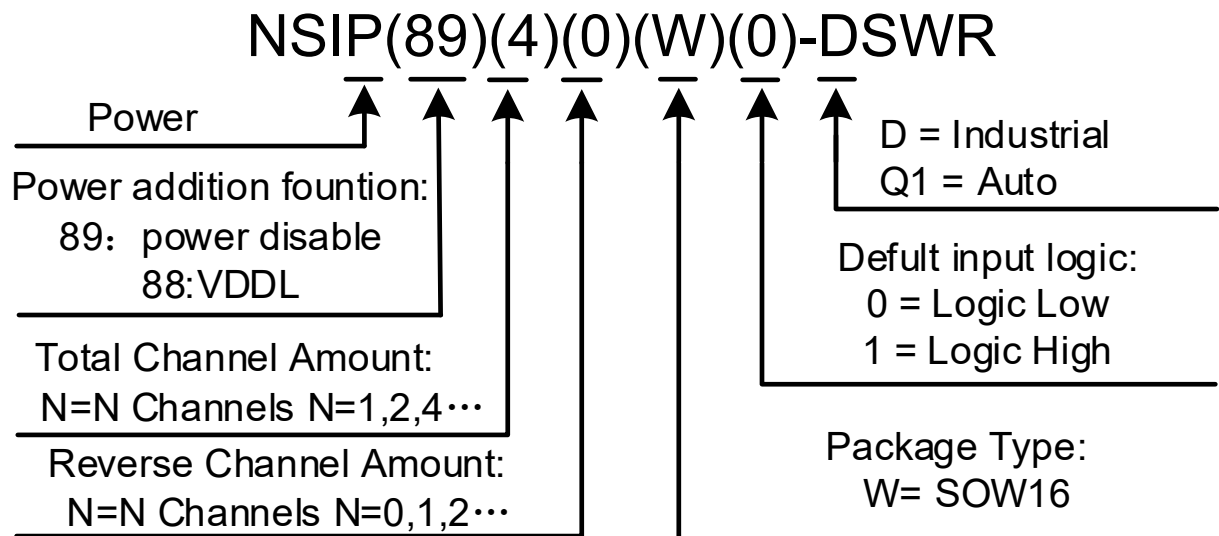


Figure 9.1 SOW16 Package Shape and Dimension in millimeters

## 10. Order Information

| Part Number      | Isolation Rating (kV) | Number of side 1 inputs | Number of side 2 inputs | Max Data Rate (Mbps) | Default Output logic | Temperature  | MSL | Package Type   | Package Drawing | SPQ  |
|------------------|-----------------------|-------------------------|-------------------------|----------------------|----------------------|--------------|-----|----------------|-----------------|------|
| NSIP8940 W0-DSWR | 5                     | 4                       | 0                       | 150                  | Low                  | -40 to 125°C | 3   | SOP16 (300mil) | SOW16           | 1000 |
| NSIP8941 W0-DSWR | 5                     | 3                       | 1                       | 150                  | Low                  | -40 to 125°C | 3   | SOP16 (300mil) | SOW16           | 1000 |
| NSIP8941 W1-DSWR | 5                     | 3                       | 1                       | 150                  | High                 | -40 to 125°C | 3   | SOP16 (300mil) | SOW16           | 1000 |
| NSIP8942 W1-DSWR | 5                     | 2                       | 2                       | 150                  | High                 | -40 to 125°C | 3   | SOP16 (300mil) | SOW16           | 1000 |
| NSIP8944 W0-DSWR | 5                     | 0                       | 4                       | 150                  | Low                  | -40 to 125°C | 3   | SOP16 (300mil) | SOW16           | 1000 |
| NSIP8944 W1-DSWR | 5                     | 0                       | 4                       | 150                  | High                 | -40 to 125°C | 3   | SOP16 (300mil) | SOW16           | 1000 |

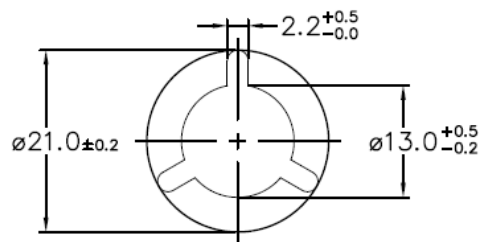
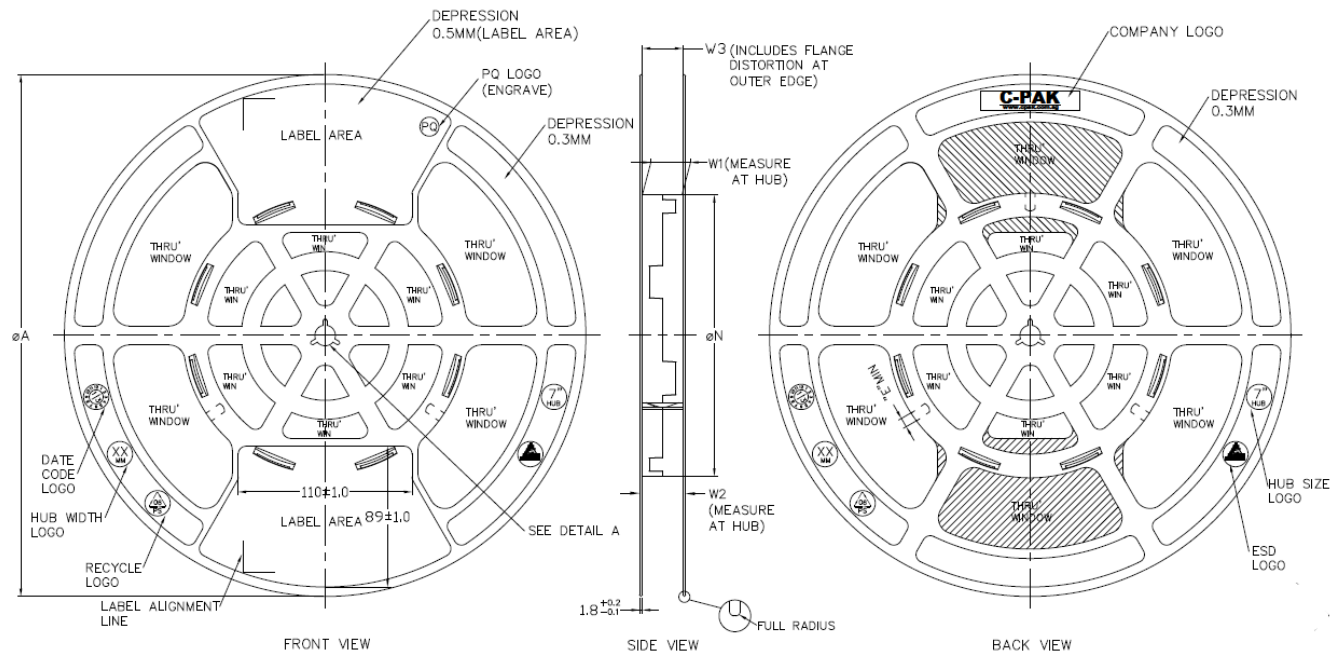
Part Number Rule:



## 11. Documentation Support

| Part Number | Product Folder             | Datasheet                  | Technical Documents        | Isolator selection guide   |
|-------------|----------------------------|----------------------------|----------------------------|----------------------------|
| NSIP894x    | <a href="#">Click here</a> | <a href="#">Click here</a> | <a href="#">Click here</a> | <a href="#">Click here</a> |

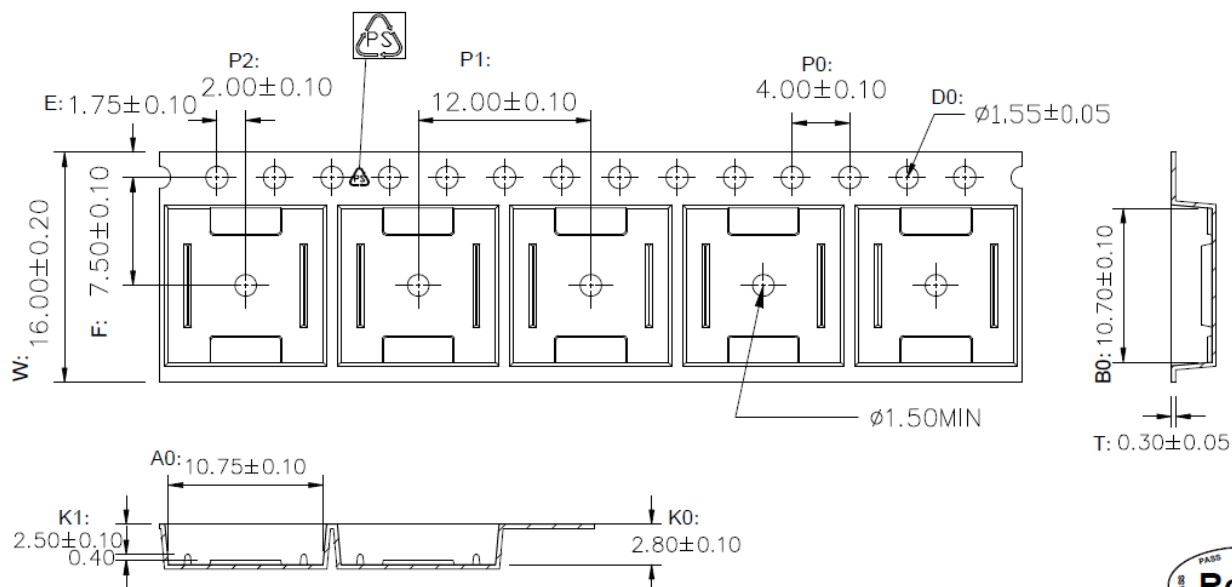
## 12. Tape And Reel Information



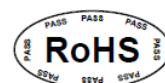
ARBOR HOLE  
DETAIL A  
SCALE : 3:1

| PRODUCT SPECIFICATION |                       |                       |                      |             |                                                               |            |
|-----------------------|-----------------------|-----------------------|----------------------|-------------|---------------------------------------------------------------|------------|
| TAPE WIDTH            | $\phi A$<br>$\pm 2.0$ | $\phi N$<br>$\pm 2.0$ | W1                   | W2<br>(MAX) | W3                                                            | E<br>(MIN) |
| 08MM                  | 330                   | 178                   | $8.4^{+1.5}_{-0.6}$  | 14.4        | SHALL<br>ACCOMMODATE<br>TAPE WIDTH<br>WITHOUT<br>INTERFERENCE | 5.5        |
| 12MM                  | 330                   | 178                   | $12.4^{+2.0}_{-0.6}$ | 18.4        |                                                               | 5.5        |
| 16MM                  | 330                   | 178                   | $16.4^{+2.0}_{-0.6}$ | 22.4        |                                                               | 5.5        |
| 24MM                  | 330                   | 178                   | $24.4^{+2.0}_{-0.6}$ | 30.4        |                                                               | 5.5        |
| 32MM                  | 330                   | 178                   | $32.4^{+2.0}_{-0.6}$ | 38.4        |                                                               | 5.5        |

| SURFACE RESISTIVITY |                       |                      |            |
|---------------------|-----------------------|----------------------|------------|
| LEGEND              | SR RANGE              | TYPE                 | COLOUR     |
| A                   | BELOW $10^{12}$       | ANTISTATIC           | ALL TYPES  |
| B                   | $10^8$ TO $10^{11}$   | STATIC DISSIPATIVE   | BLACK ONLY |
| C                   | $10^5$ & BELOW $10^5$ | CONDUCTIVE (GENERIC) | BLACK ONLY |
| E                   | $10^8$ TO $10^{11}$   | ANTISTATIC (COATED)  | ALL TYPES  |



1. 10 sprocket hole pitch cumulative tolerance  $\pm 0.20$  .
2. Carrier camber is within 1 mm in 250 mm.
3. Material : Black Conductive Polystyrene Alloy .
4. All dimensions meet EIA-481 requirements.
5. Thickness :  $0.30 \pm 0.05$ mm.
6. Packing length per 22" reel : 378 Meters.(復巻 N=122)
7. Component load per 13" reel : 1000 pcs.
8. Surface resistivity :  $10^5 \sim 10^{10} \Omega/\square$



|    |            |
|----|------------|
| W  | 16.00±0.20 |
| A0 | 10.75±0.10 |
| B0 | 10.70±0.10 |
| K0 | 2.80±0.10  |
| K1 | 2.50±0.10  |

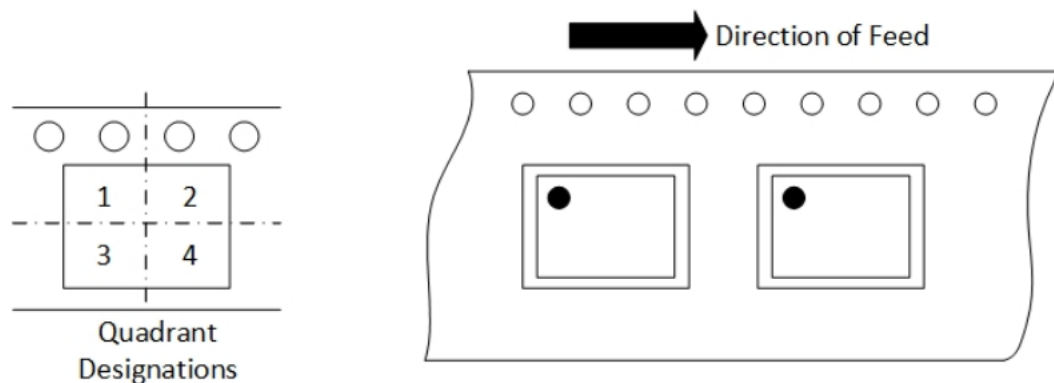


Figure 12.1 Tape and Reel Information of SOW16

### 13. Revision History

| Revision | Description                                                                                                                                                                                              | Date      |
|----------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| 1.0      | Initial version                                                                                                                                                                                          | 2021/3/28 |
| 1.1      | Modifying the description of PIN 7                                                                                                                                                                       | 2021/12/1 |
| 1.2      | Updating relative figures                                                                                                                                                                                | 2022/5/9  |
| 1.3      | Describe the test method of $I_{VDD\_POWER}(PDIS=VDD)$ in detail.<br>Update safety certification info throughout the document.                                                                           | 2023/11/2 |
| 1.4      | 1. Update the values of MIN output supply current under different input voltage ranges.<br>2. The part numbers that are currently suspended for production have been removed from the order information. | 2026/3/31 |

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