NOVOSENSE

NSIP3266

26V H-Bridge Transformer Driver for Isolated Supplies

Datasheet (EN) 1.0

Product Overview

The NSIP3266 H-bridge transformer driver provides a simple solution for designing isolated power supplies. The device drives the primary coil of the transformer with a voltage range from 6.5V to 26V. The transformer's secondary-to-primary winding ratio defines the output voltage, allowing selection of virtually any isolated output voltage.

The NSIP3266 features adjustable switching frequency from 100 kHz to 1MHz with an external resistor, which provides the flexibility to optimize either efficiency or external component size.

A $\overline{\text{FAULT}}$ output is asserted when the device detects an overtemperature or overcurrent condition. In addition, the device features a low-power mode to reduce the overall supply current to 0.7mA (typ) when the driver is not in use.

The NSIP3266 is available in MSOP8 package with operating temperature range from -40°C to 125°C.

Key Features

- Wide supply voltage range: 6.5 to 26V
- Input 12V, the maximum output power is 5W
- Ability to handle negative swing of (-10V) at EN pin
- Fault Detection and Indication
- Adjustable Frequency: 100 kHz to 1MHz
- Over-Temperature Protection
- Over-Current Protection
- Low supply current
- Undervoltage Lockout
- Operating temperature range: -40°C to 125°C

Applications

- EV charging station, DC fast charging station
- GaN, IGBT and SiC gate transformer driver bias supply
- UPS and solar inverters
- Industrial motors, elevators and escalators

Device Information

Part Number	Package	Body Size
NSIP3266-DHMSR	EP-MSOP8	3.0 mm × 3.0 mm

Block Diagram

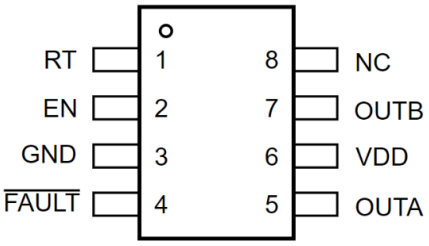

Figure 1. NSIP3266

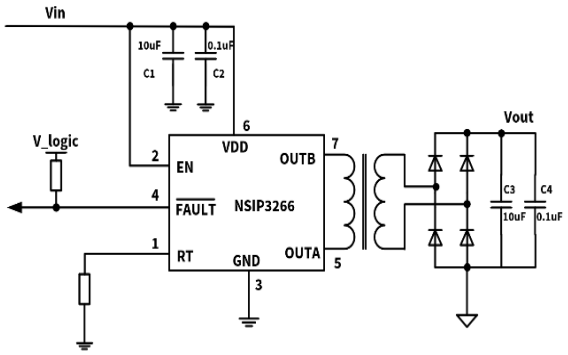

Figure 2. Simplified Schematic

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1. Pin Configuration and Functions

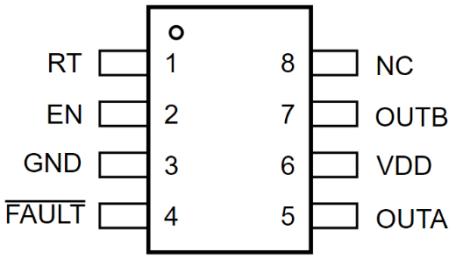


Figure. 1.1 NSIP3266 Pin Configuration

Table 1.1 NSIP3266 Pin Description

NSIP3266 PIN NO.	SYMBOL	FUNCTION
1	RT	Frequency setting pin. By adjusting the external resistor between RT and GND, the switching frequency can be configured between 100 kHz and 1 MHz. If the RT pin remain floating, the default frequency is 200 kHz.
2	EN	The EN pin controls the device on or off. Grounding this pin disables all internal circuitry. If this pin is used, it should be tied directly to V_{DD} or floating.
3	GND	Ground - Common ground reference for the device.
4	$\overline{\text{FAULT}}$	Open-Drain Fault Output. $\overline{\text{FAULT}}$ asserts during an overcurrent or overtemperature event. FAULT is high impedance during normal operation.
5	OUTA	Transformer Drive Output A.
6	VDD	Supply Voltage - Provides power to the device.
7	OUTB	Transformer Drive Output B.
8	NC	Not Connected. Not internally connected.
	EP	Exposed Pad. Internally connected to GND. Connect EP to a large ground plane to maximize thermal performance, and place multiple nearby vias to connect those planes.

2. Absolute Maximum Ratings

Parameters	Symbol	Min	Max	Unit	Comments
Supply Voltage	VDD	-0.3	30	V	
Output Voltage	V_{OUTA}, V_{OUTB}	-0.3	VDD+0.3	V	
		-2	VDD+0.3	V	Pulse<200ns
V_{OUTA}, V_{OUTB} I_{PK} current			0.8	A	
Enable pins Voltage	EN	-10	VDD	V	
$\overline{FAULT}$ to GND	$\overline{FAULT}$	-0.3	6	V	
RT to GND	RT	-0.3	6	V	
Operating Junction Temperature	T_J	-40	150	°C	
Storage Temperature	T_{STG}	-55	150	°C	

3. ESD Ratings

Parameters	Ratings	Value	Unit
Electrostatic discharge	Human body model (HBM), per AEC-Q100-002-PrevD ● All pins	±2.0	kV
	Charged device model (CDM), per AEC-Q100-011-RevB ● All pins	±2.0	kV

4. Recommended Operating Conditions

Parameters	Symbol	Min	Max	Unit
Supply Voltage	VDD	6.5	26	V
V_{OUTA}, V_{OUTB} continuous current(RMS)			0.5	A
Enable Pin Voltage	V_{EN}	-6	26	V
Operating Ambient Temperature	T_A	-40	125	℃

5. Thermal Information

Parameters	*Symbol*	EP-MSOP8	*Unit*
IC Junction-to-air thermal resistance	θ_{JA}	58.5	°C/W
Junction-to-board thermal resistance	θ_{JB}	28.2	°C/W
Junction-to-case (top) thermal resistance	$\theta_{JC(top)}$	57.6	°C/W
Junction-to-top characterization parameter	Ψ_{JT}	5.4	°C/W
Junction-to-board characterization parameter	Ψ_{JB}	27.9	°C/W

Notes

(1) Four layers 2s2p PCB JEDEC JESD 51-7.

6. Electrical Characteristics

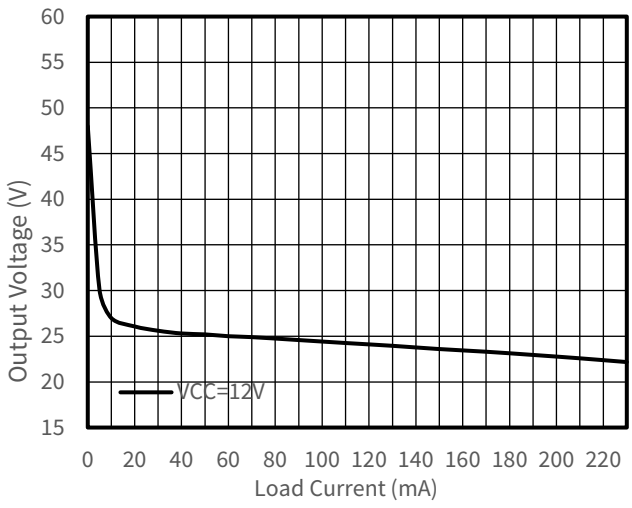
Over full range of recommended operating conditions, unless otherwise noted. All typical value are at T_A= 25°C, V_{DD}= 12 V.

Parameters	Symbol	Min	Typ	Max	Unit	Comments
Bias Currents						
Average supply current	I_{DD}		1.6	2	mA	V_{DD} = 12V, Fsw=200kHz, EN= V_{DD}
Disable supply current	I_{DIS}		0.7	0.9	mA	V_{DD} = 12V, EN=GND
Over current protection threshold	$I_{threshold}$	1.8	2.6	3	A	
Under Voltage Lockout (UVLO)						
V_{DD} turn-on threshold	$V_{DD\ ON}$	4.4	4.7	4.9	V	V_{DD} rising until UVLO triggers
V_{DD} turn-off threshold	$V_{DD\ OFF}$	4.1	4.4	4.6	V	V_{DD} falling until operation recovers
V_{DD} hysteresis	$V_{DD\ HYS}$		0.3		V	Rising to falling threshold
Input Characteristics						
Enable signal high transition	V_{EN_H}	1.7	2.1	2.6	V	
Enable signal low transition	V_{EN_L}	1.0	1.3	1.6	V	
Enable signal hysteresis	V_{ENHYS}		0.8		V	
Output Characteristics						
Output pull-up resistance	R_{OH}		1.26	2.0	Ω	I_{OUT}=-100mA, V_{DD}=12V
Output pulldown resistance	R_{OL}		0.65	1.5	Ω	I_{OUT}=100mA, V_{DD}=12V
Soft start time	SST		5		ms	The gate drive voltage of the power-MOSFETs rises from 0 V to 5 V
OUTA, OUTB leakage current	I_{LKG}	-1	0.1	1	μA	EN=GND, OUTA/OUTB is GND or V_{DD}
$\overline{\text{FAULT}}$ **Open Drain Output**						
Output low voltage	V_{OL}			0.5	V	Output is asserted, I_{OL}=5mA
Output high leakage current	I_{LKG_FAULT}		0.4	1	μA	$\overline{\text{FAULT}}$ is not asserted, V_{FAULT}=6V
Spread Spectrum Clocking						
Spread spectrum clocking	Δf_C		±6.7%			
Spread spectrum modulation frequency	fm		25		kHz	
Thermal Shut Down						
T_{SD} turn on temperature	T_{SD+}	154	175	181	°C	
T_{SD} turn off temperature	T_{SD-}	135	150	166	°C	
T_{SD} hysteresis	T_{SD-}	19	25		°C	

7. Switching Characteristics

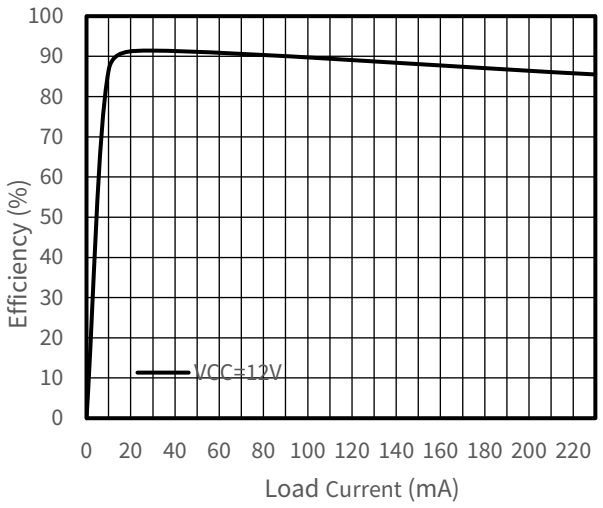
Parameters	Symbol	Min	Typ	Max	Unit	Comments
Fsw0	Initial fsw	160	200	230	kHz	RT pin floating
Fsw	Adj fsw	100		1000	kHz	
Fsw1		370	417	455	kHz	RT=39kΩ
Rise time	T_R		6		ns	OUTA/OUTB = 20% to 80% of V_{DD}, RL = 50Ω, CL = 50pF, V_{DD} =12V See Figure 9.1
Fall time	T_F		7		ns	OUTA/OUTB = 80% to 20% of V_{DD}, RL = 50Ω, CL = 50pF, V_{DD} =12V See Figure 9.2
Break-before-make time	T_{BBM}		4		ns	OUTA to OUTB series 20Ω resistor, See Figure 9.2
EN Blanking Time	T_{BLANK}		2.3	3	μs	
OUTA,OUTB deglitch time	T_{SCP}		500		ns	

8. Typical Characteristics



Transformer ATWPEF131211B208T

Figure 8.1 Output Voltage vs Load Current



Transformer ATWPEF131211B208T

Figure 8.2 Efficiency vs Load Current

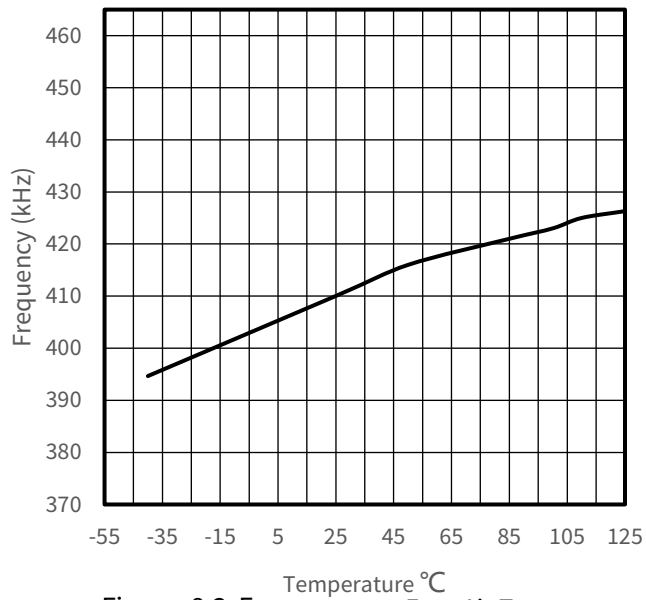


Figure 8.3 Frequency vs Free-Air Temperature

9. Parameter Measurement Information

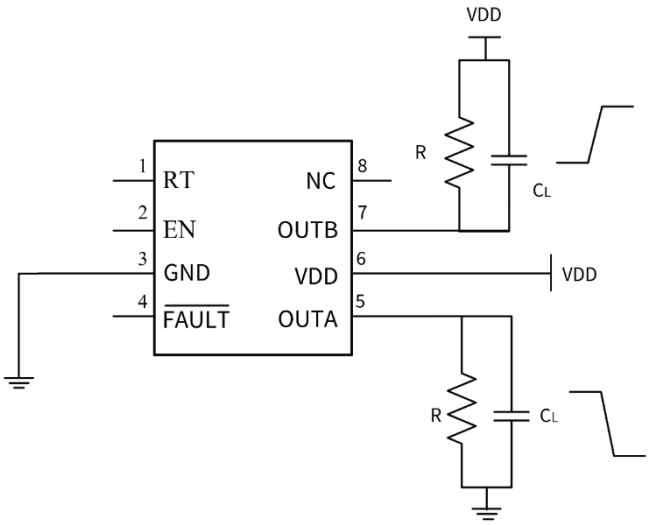


Figure 9.1 Test Circuit for $T_{r\text{-}D}$, $F_{f\text{-}D}$

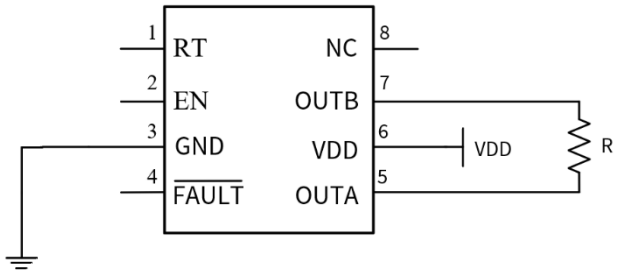


Figure 9.2 Test Circuit for T_{BBM}

10. Function Description

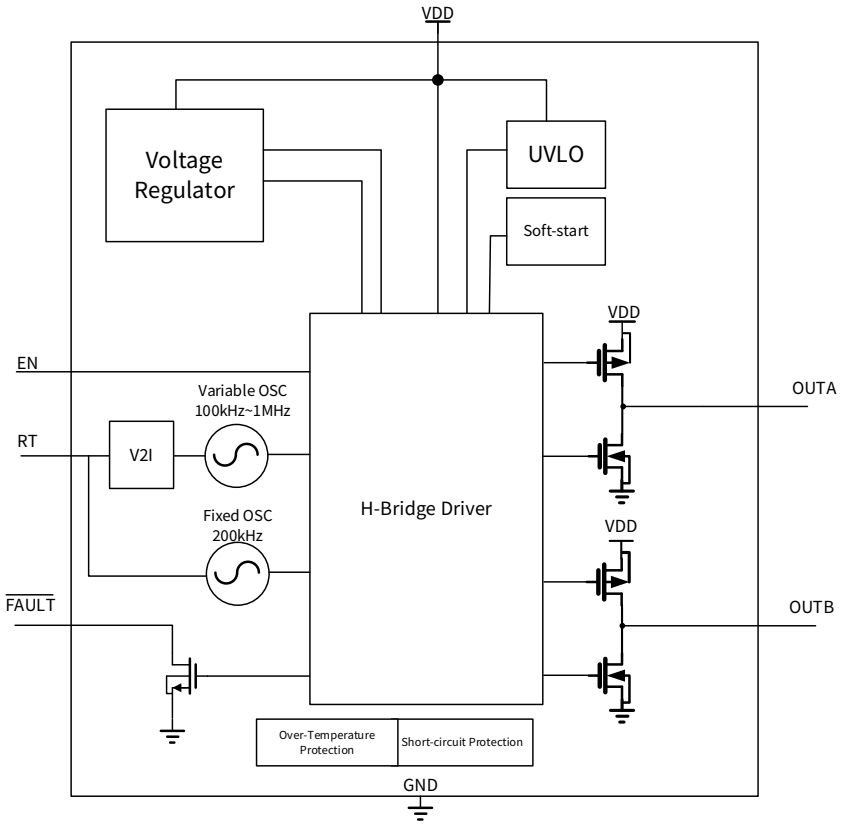
10.1 Overview

The NSIP3266 is a DC-DC isolated switching power supply controller designed for H-bridge topology. Compared with other solutions, the H-bridge topology offers a simpler design principle. The transformer doesn't require center tap, uses fewer peripheral components, and maintains lower costs. The device operates from a wide single-supply voltage range of 6.5V to 26V and provides strong compatibility.

It incorporates an overcurrent protection function that triggered when the current exceeds safe thresholds, ensuring the device operates within its safe operating area and protecting peripheral components from high-current surges. The NSIP3266 features an integrated crystal oscillator circuit, and its clock frequency can be programmed by an external resistor connected to the RT pin.

The NSIP3266 provides a fault alarm signal ($\overline{FAULT}$ pin). When the device enters an overcurrent or overtemperature state, the $\overline{FAULT}$ pin outputs a low-level signal. If this pin is used, it should be connected to a 5V or 3.3V supply through a 10kΩ pull-up resistor. Additionally, the device includes undervoltage protection and a soft-start function, which eliminates the need for external MCU control.

Functional Diagram



10.2 Feature Description

Start-Up Mode

When the voltage at V_{DD} reaches 4.7V, the internal oscillator begins operation. The output stage starts switching, but the drain voltage amplitude of D1 and D2 has not yet reached its maximum value.

Soft Start

The NSIP3266 devices support soft start feature by limiting output current. When the device starts up either by powering up or EN rising edge, the device slowly ramps up output current limit. The soft start feature can prevent in-rush current upon starting up and protect transformer accordingly.

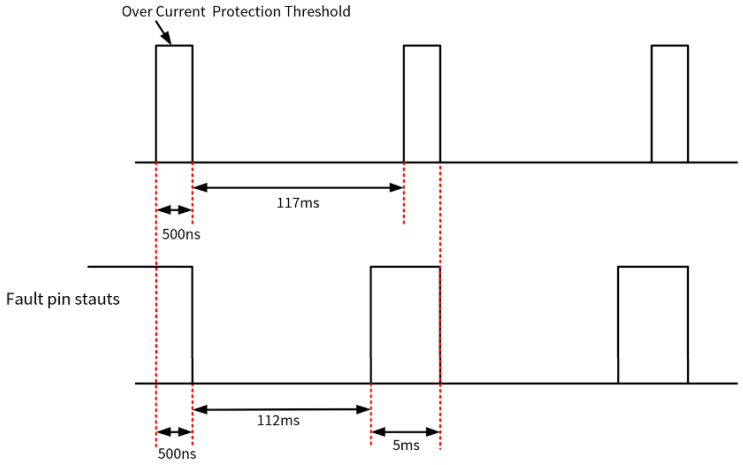
Disable Mode

The NSIP3266 provides a disabled mode to reduce current consumption. The OUTA and OUTB outputs are high impedance in disabled mode.

Over Current Protection and $\overline{\text{FAULT}}$ asserts

The NSIP3266 provides overcurrent protection. When the peak current of NMOS1 or NMOS2 reaches the protection current threshold, the device enters the overcurrent protection state and maintains a 500ns detection period. If the overcurrent condition persists, the chip change to hiccup mode, where both N/PMOS are turned off for 112ms, followed by another detection cycle. This process repeats until the overcurrent condition is resolved.

During this process, the $\overline{\text{FAULT}}$ pin is pulled low level after the overcurrent state lasts for 500ns. Once the hiccup mode ends, the chip restarts, and the $\overline{\text{FAULT}}$ pin returns to a high level. After the 5ms soft-start period completes, the chip continuously monitors for overcurrent conditions. If overcurrent state persists, the $\overline{\text{FAULT}}$ is pulled low again after 500ns. If the overcurrent condition is resolved, the $\overline{\text{FAULT}}$ remains at a high level.



Over Temperature Protection

The NSIP3266 device supports overtemperature protection. When the junction temperature of the device is exceeds the protection temperature threshold, the device will turn off output to protect the device from overheating damage. When the junction temperature is lower than the descending threshold, the device will resume startup.

Programming the Switching Frequency

The switching frequency of the NSIP3266 can be programmed by the resistor RT connected between the RT pin and GND. Determine the timing resistance for a given switching frequency. RT floating defaults to 200 kHz. Use Equation 1 or the curve in Figure 10-1.

Table 10-1 gives typical RT values for a given f_{SW}.

$$R_t\,(k\Omega) = 28860 * fsw(kHz)^{-1.104} \quad (1)$$

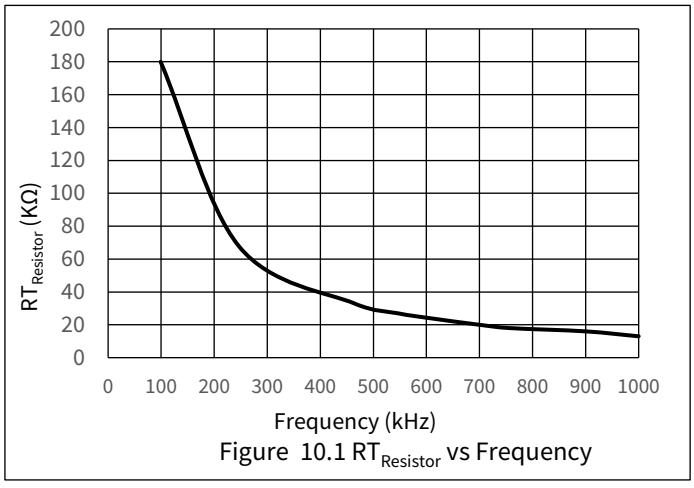


Figure 10.1 $RT_{Resistor}$ vs Frequency

Table 10-1. Typical Frequency Setting RT Resistance

RT(KΩ)	fsw(kHz)
180	100
68	246
33	464
24	607
20	700
16	900
13	1000

11. Application Note

11.1 Typical Application

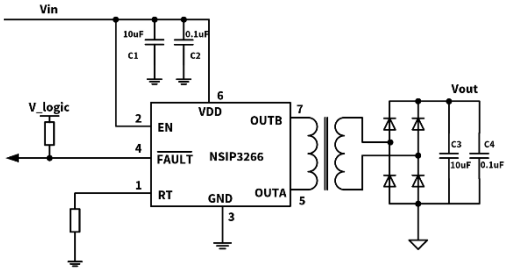


Figure 11.1 Typical Application Schematic

11.2 Design Requirements

For this design example, use the parameters listed in Table 11-1 as design parameters.

Table 11-1. Design Parameters

DESIGN PARAMETER	EXAMPLE VALUE
Input voltage range	12 V ± 5%
Output full load	23 V
Maximum load current	170mA
Switching frequency	417kHz

11.2.1 Detailed Design Requirements

The following sections focus on the design of efficient H-bridge conversions with high voltage drive capability.

11.2.1.2 Input capacitance selection

As shown in Figure 11.1, the input capacitor C1 has the functions of energy storage、filtering and decoupling. C2 is a ceramic decoupling capacitor. The capacitor is placed as close to the chip as possible. During H-bridge converter operation, the capacitor C1 provides a certain amount of transient current to the converter, Therefore the capacitance is recommended to be selected in the range of 1uF-10uF to reduce the input voltage ripple.

The capacitor's voltage rating must exceed the maximum input voltage with sufficient derating margin. Multilayer ceramic capacitors (MLCCs) with low ESR and stable temperature performance are preferred.

The power circuit traces should be as thick and short as possible. Avoid unwanted voltage spikes caused by alternating current flowing through the PCB lead inductor during operation.

11.2.1.2 Output capacitance selection

The H-bridge converter can theoretically achieve a 100% duty cycle to transfer energy to the secondary side. However, to ensure reliable operation, a specific dead time must be implemented during the switching transitions of the two bridge arms to prevent shoot-through. During this dead time, the output energy is primarily supplied by the output filter capacitor C3.

For practical applications, C3 is recommended to be a ceramic capacitor in the range of 4.7μF to 10μF, which provides optimal filtering performance for the converter.

11.2.1.3 Output rectifier diode selection

The selection of Schottky diodes needs to consider the following two points:

- Selecting a diode for the power supply, it is recommended to choose a low forward voltage and fast recovery diode. A low forward voltage helps improve the output efficiency of the power supply. For a low-cost option, the MBRS140T3G Schottky rectifier diode is recommend, with a typical forward voltage of 300mV and forward current of 200mA.
- Considering the impact of temperature on forward voltage, it is advisable to select a rectifier with a low forward voltage drop, especially at low temperatures.
- Considering the increase in output voltage caused by the oscillation of rectifier diode junction capacitance and transformer leakage inductance under light load, it is recommended to choose rectifier diodes with smaller junction capacitance as much as possible.

11.2.1.4 Transformer Selection

11.2.1.4.1 V-t Product Calculation

Transformer selection needs to consider the Vt factor. The purpose is to prevent transformer saturation. The Vt_{min} is calculated by the maximum input voltage multiplying 50% of the maximum cycle time.

$$Vt_{min} \geq V_{IN-max} \times \frac{T_{max}}{2} = \frac{V_{IN-max}}{2 \times f_{min}} \quad (1)$$

Taking an example of f_{min} as 360kHz for NSIP3266, Equation 2 yields the minimum V-t products of:

$$Vt_{min} \geq \frac{12V*105\%}{2 \times 370kHz} = 17\ V\mu s \quad \text{for 12V} \quad (2)$$

Other important factors such as isolation voltage, transformer power and turns ratio must be considered before the final selection decision is made.

11.2.1.4.2 Turns Ratio Estimate

Assuming the rectifier diode have been selected, the V-t product of the selected transformer is not less than 17.5Vμs. The minimum turns ratio that allows the H-bridge converter to operate perfectly over a specified current and temperature range needs to be determined.

The forward voltage drop V_F of the rectifier diode at maximum output load is to be considered.

$$V_{S-min} = V_{F-max} + V_{O-max} \quad (3)$$

The minimum available primary voltage V_{P-min} is calculated. Drain-source voltage of the NSIP3266 is V_{DS-max}. The minimum converter input voltage is V_{IN-min}:

$$V_{P-min} = V_{IN-min} - V_{DS-max} \quad (4)$$

V_{DS-max} is the product of the maximum $R_{DS(on)}$ and I_D values for a given supply specified in the NSIP3266 data sheet:

$$V_{DS-max} = (R_{OH-max} + R_{OL-max}) \times I_{Dmax} \quad (5)$$

Then inserting Equation 5 into Equation 4 yields:

$$V_{P-min} = V_{IN-min} - (R_{OH-max} + R_{OL-max}) \times I_{Dmax} \quad (6)$$

Inserting Equation 6 and Equation 3 into Equation 7 provides the minimum turns ratio:

$$N_{sp-min} = \frac{V_{F-max} + V_{O-max}}{V_{IN-min} - \frac{P_{O-max}}{\eta \times V_{IN-min}} \times (R_{OH-max} + R_{OL-max})} \quad (7)$$

Example:

For a 12 V_{IN} to 23 V_{OUT} converter using the rectifier diode MBRS140T3G, at a load current of 170 mA and a maximum temperature of 125°C , V_{F-max} = 0.19 V, $V_{O\_FullLoad\_max}$ = 23 V, and $I_{OUT-max}$ = 0.17A.

Assume that the input power supply accuracy is ±5%, VIN-min = 11.4 V. From the NSIP3266 data sheet with R_{OH-max} = 2.0 Ω,
R_{OL-max} = 1.5Ω, I_{D-max} = 0.17A.

Inserting these values and performing calculations:

$$N_{sp-min} = \frac{0.19V + 23V}{12V - \frac{23V \times 0.17A}{0.85 \times 11.4} \times (2.0+1.5)\Omega} = 2.2 \quad (8)$$

11.3 Layout

- A 1 μF to 10 μF low-ESR ceramic bypass capacitor should be connected between the VDD pin and ground to ensure stable power supply operation. The capacitor should be placed as close as possible to the VDD pin to minimize high-frequency impedance.
- Refering to Figure 11.2 for PCB layout. The GND pin must be connected to the PCB ground plane via two vias to minimize inductance.
- The OUTA and OUTB pins of the device should be connected with the primary terminal of the transformer. The wiring connections must be as close together as possible to reduce the inductance of the wires.
- The recommended rectifier diode is the Schottky diode, which has a low forward voltage to maximize efficiency.
- The V_{OUT} pins must be decoupled to the ISO ground with low-ESR ceramic bypass capacitors. A 10μF capacitor should be used in parallel with a 0.1μF capacitor, and the rated voltage of both capacitors is at least 35V.

Layout Example

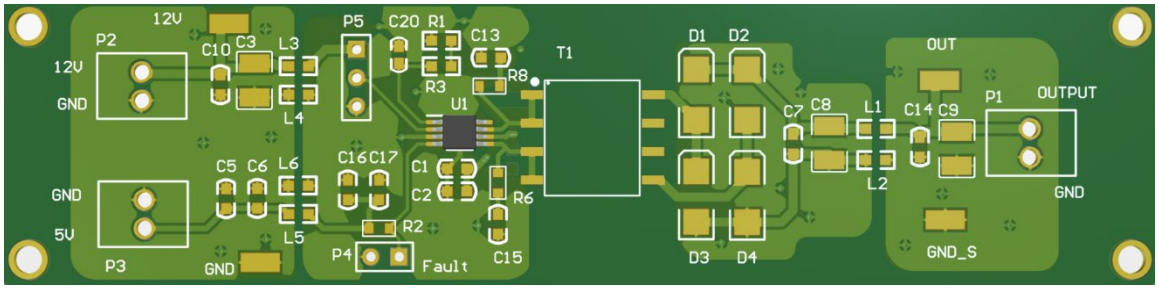
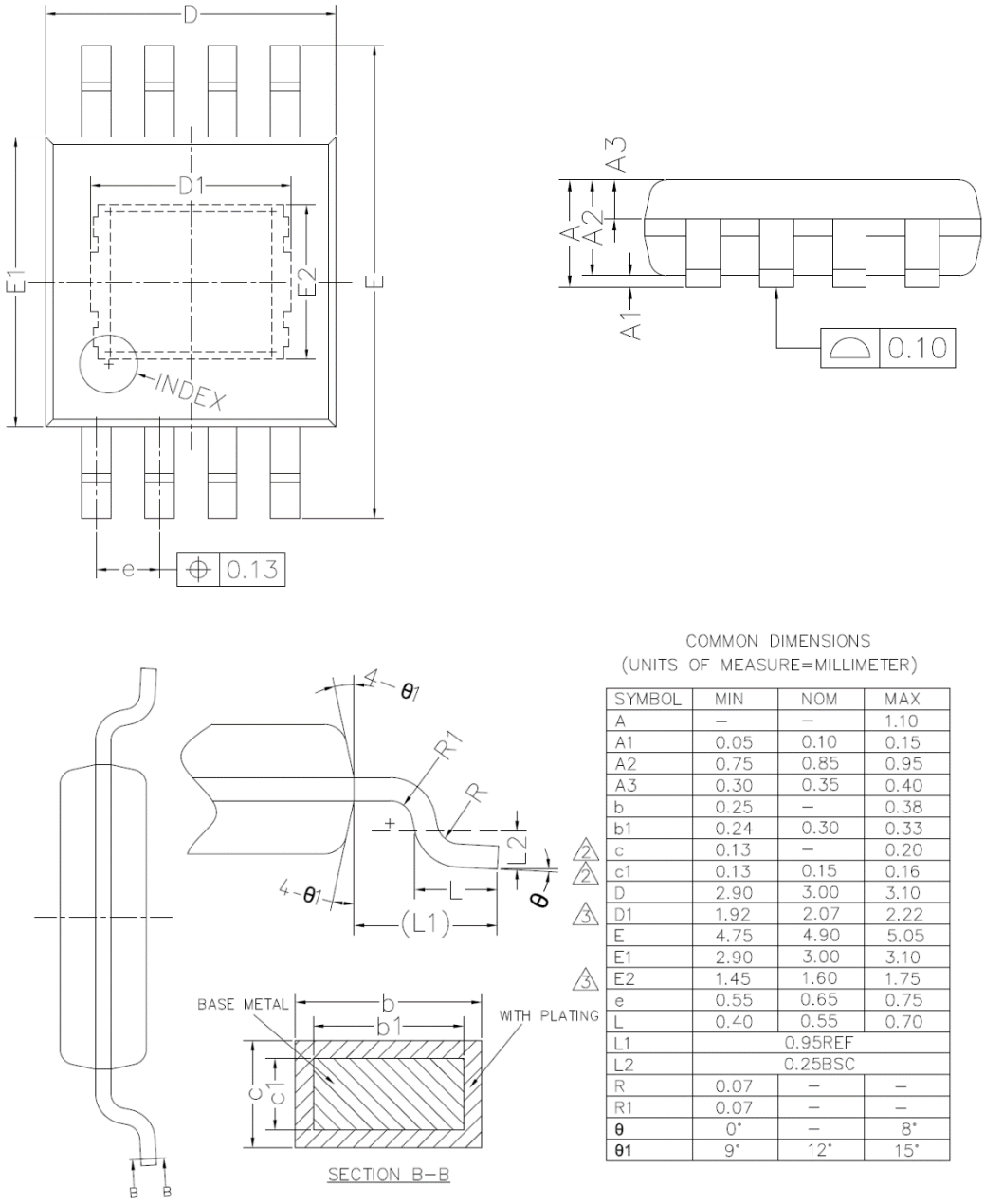


Figure 11.2 Layout Example of 2-Layer Board (NSIP3266)

12. Package Information



COMMON DIMENSIONS
(UNITS OF MEASURE=MILLIMETER)

SYMBOL	MIN	NOM	MAX
A	–	–	1.10
A1	0.05	0.10	0.15
A2	0.75	0.85	0.95
A3	0.30	0.35	0.40
b	0.25	–	0.38
b1	0.24	0.30	0.33
c	0.13	–	0.20
c1	0.13	0.15	0.16
D	2.90	3.00	3.10
D1	1.92	2.07	2.22
E	4.75	4.90	5.05
E1	2.90	3.00	3.10
E2	1.45	1.60	1.75
e	0.55	0.65	0.75
L	0.40	0.55	0.70
L1	0.95REF		
L2	0.25BSC		
R	0.07	–	–
R1	0.07	–	–
θ	0°	–	8°
θ1	9°	12°	15°

NOTES: 1. ALL DIMENSIONS IN MILLIMETERS REFER TO JEDEC STANDARD MO-187 AA-T
DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS.
2. INDEX ø0.60±0.10 WITH 0.05MAX DEPTH.
3.'D1' AND 'E2' ARE VARIABLES DEPENDING ON DIE PAD SIZES.

Figure 12.1 EP-MSOP8 Package Shape and Dimension

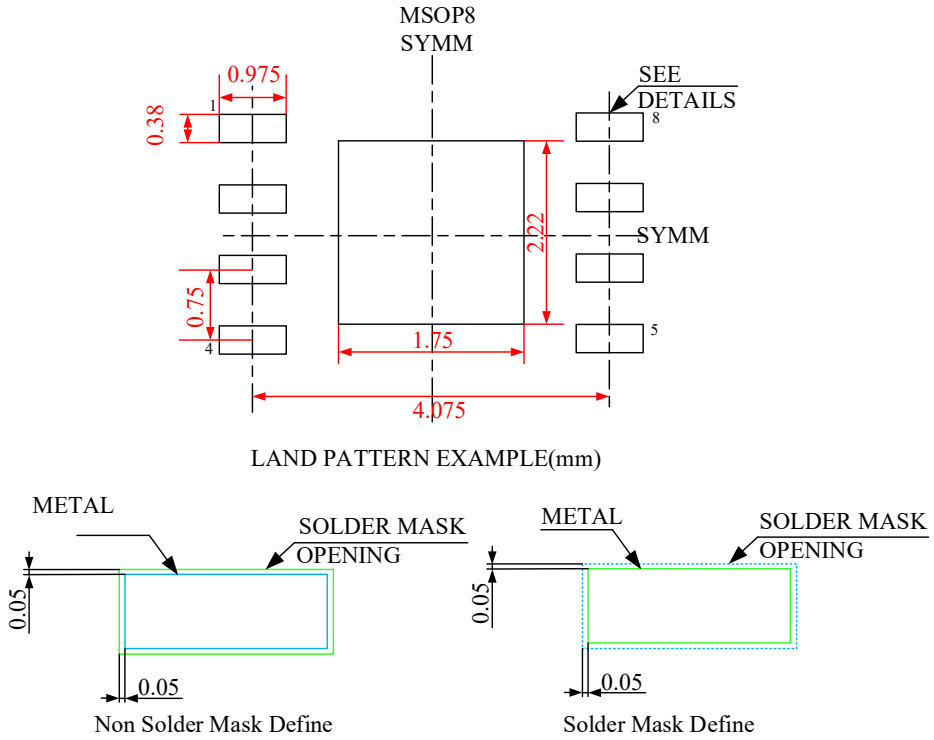


Figure 12.2 EP-MSOP8 Package Board Layout Example

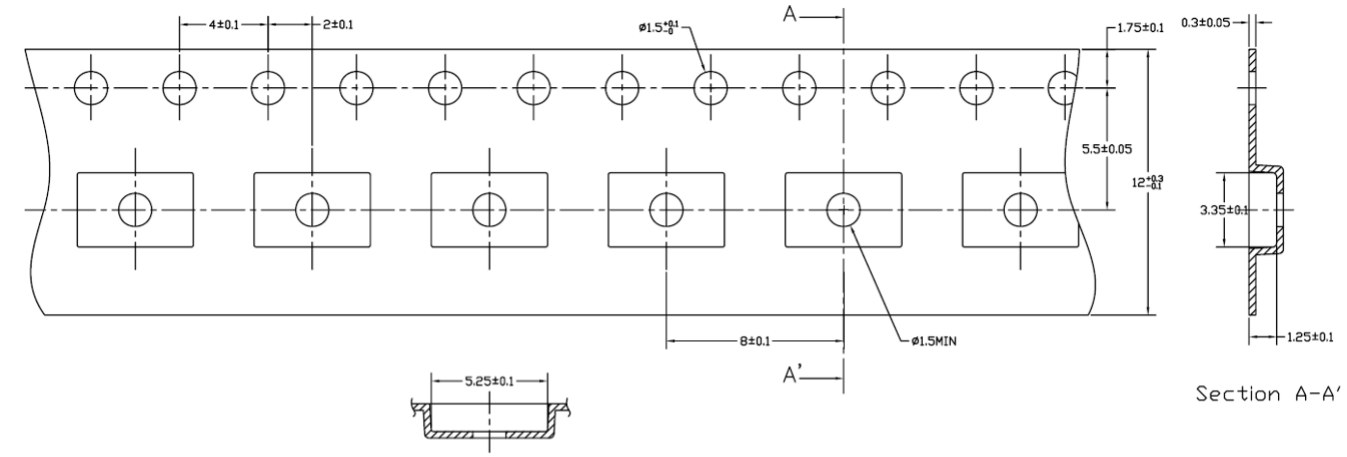
13. Ordering Information

Part No.	Temperature	Auto-motive	Package Drawing	MSL	SPQ
NSIP3266- DHMSR	-40 to 125℃	N	EP-MSOP8	2	2500

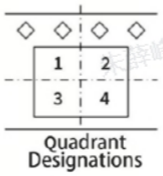
14. Documentation Support

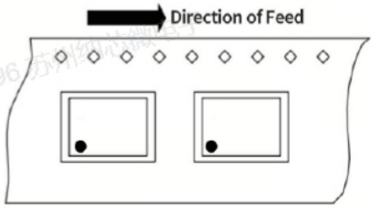
Part Number	Product Folder	Datasheet	Application Note
NSIP3266-DHMSR	Click here	Click here	Click here

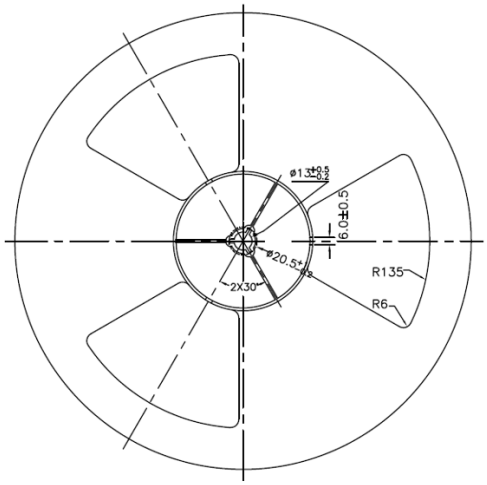
15. Tape and Reel Information

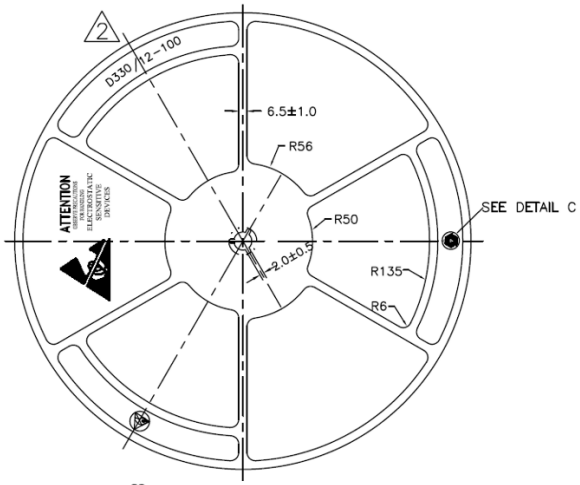


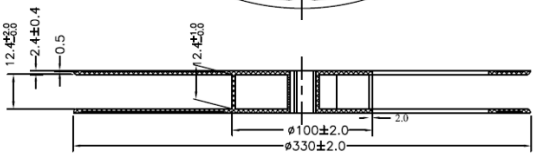
NOTES:
1.MATERIAL:Hard polystyrene(PS)
2.ALL DIMS IN MM
3.There must not be foreign body adhesion and the state of the surface must be excellent
4.The meander of the tape is assumed with 1mm or less every 100mm between 250mm
5.A permissible difference of the accumulation pitch of the sending hole is assumed to be ±0.3 up to 50 pitches
6.ø560 Paper-Reel, 60000 pockets(480M)
7.Corner R=0.3max
8.Surface resistance 1X10E5≤Rs≤1X10E9 OHMS/SQ











NOTES:
1、Material: Polystyrene (black).
2、Flatness: Maximum allowed 3mm.
3、All dimensions are in millimeters.
4、Surface resistivity: 1*10E5 to 1*10E10 OHMS/SQ.
5、All unmarked tolerances: ±0.25.

Figure 15.1 Tape and Reel Information of EP-MSOP8

16. Doc History

Revision	Description	Date
1.0	Initial Version	2025/3/19

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