

General Descriptions

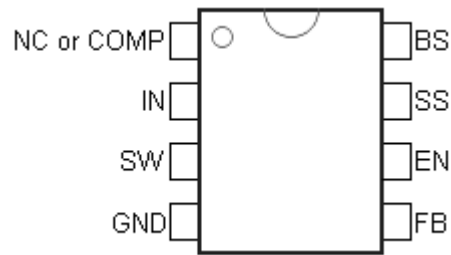
The NR130D series is buck regulator ICs integrates High-side power MOSFETs. With the current mode control, ultra low ESR capacitors such as ceramic capacitors can be used. The ICs can realize super-high efficiency by performing pulse skip operation at light load condition. The ICs have protection functions such as Over-Current Protection (OCP), Under-Voltage Lockout (UVLO) and Thermal Shutdown (TSD). Soft starting time can be set up by selecting an external capacitor value. The ON/OFF pin (EN Pin) turns the regulator on or off and helps to achieve low power consumption requirements. The NR130D series is available in an 8-pin DIP package.

Features & Benefits

- Current mode PWM control
- Up to 94% efficiency at normal load condition
- Up to 85% efficiency at light load condition
- Stable with low ESR ceramic output capacitors
- Built-in protection function
 - Over Current Protection (OCP)
 - Thermal Shutdown (TSD)
 - Under Voltage Lockout (UVLO)
- Built-in phase compensation
- Adjustable Soft-Start with an external capacitor
- Turn ON/OFF the regulator function
 - Programable Pulse-Skip operation

Package

- DIP8



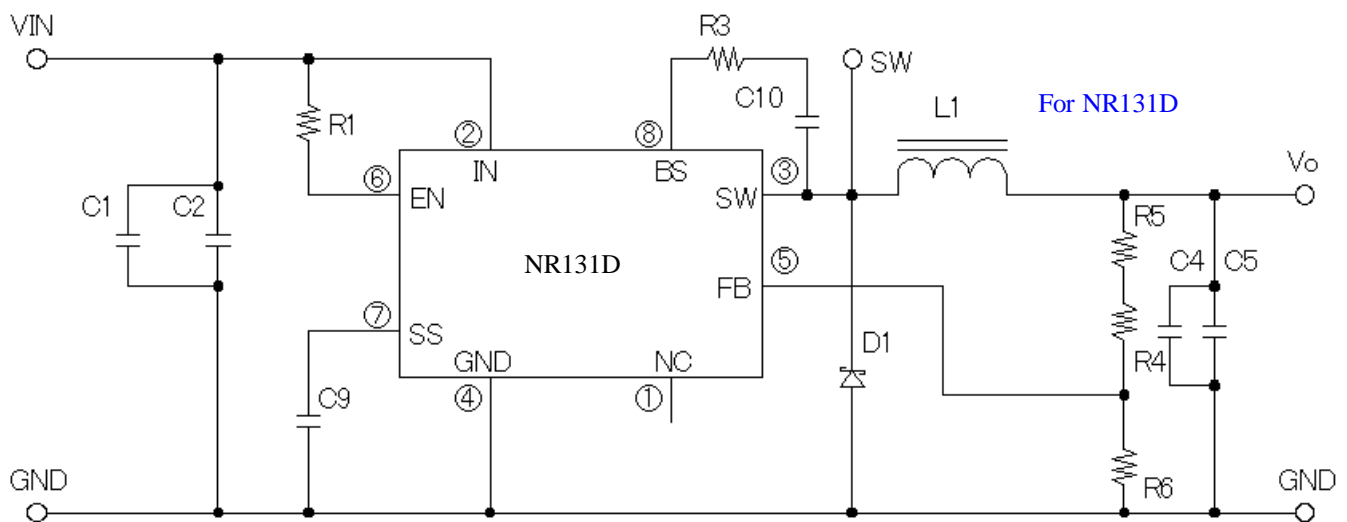
Electrical Characteristics

- 3A Continuous output current
- Operating input range $V_{IN} = 4.5V \sim 17V$
- Output adjustable $V_O = 0.8V \sim 14V$
- Fixed 350kHz frequency

Applications

- LCD TV / Blu-Ray / Set top box
- Green Electronic products
- Other power supply

Typical Application Circuit

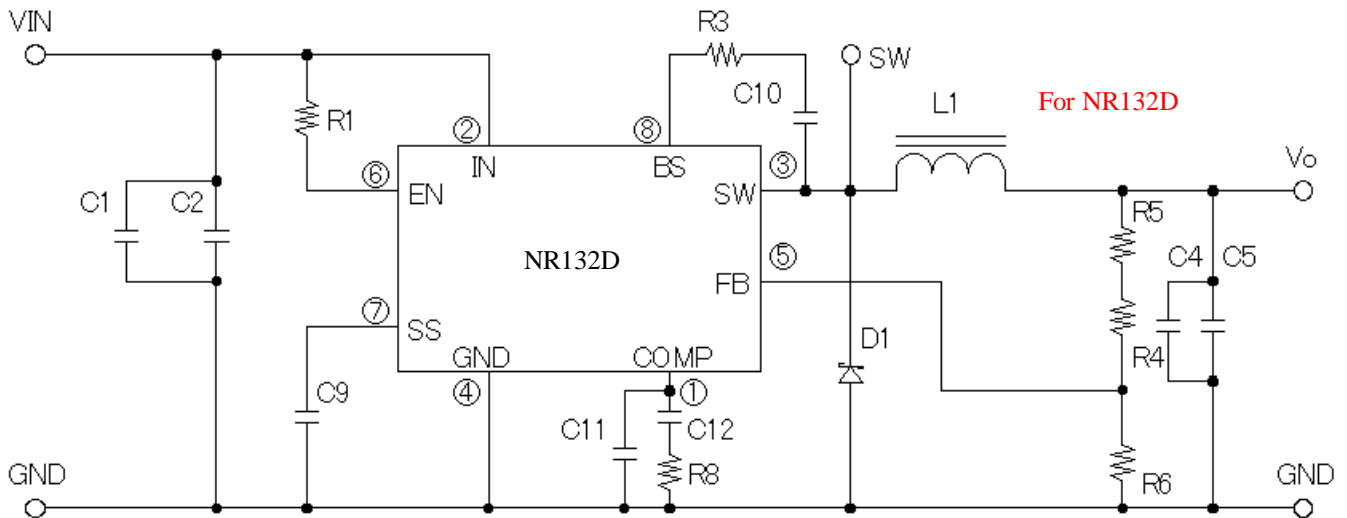


C1, C2: 10 μ F / 25V, C4, C5: 22 μ F / 16V, C7: 0.1 μ F, C9: 1800pF, C11: 220pF(Optional), R1: 510k Ω , R3: 10 Ω , R4: 36 k Ω , R5: 27k Ω (VO=5.0V), R6: 12k Ω , R7: 510k Ω (Optional), D1: S1PJ-L4, L1: 10 μ H

NR130D series

Tentative

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Series Lineup

Product Name	f _{sw}	V _{IN}	V _O	I _O	Pin No.1 Function	Package
NR131D	350kHz	4.5V to 17V ⁽¹⁾	0.8V to 14V ⁽²⁾	3A	NC	DIP8
NR132D					COMP	

⁽¹⁾ The minimum input voltage shall be either of 4.5V or VO+3V, whichever is higher.

⁽²⁾ The I/O condition limited by the Minimum on-time (TON(MIN)).

Absolute Maximum Ratings

Parameter	Symbol	Ratings	Units	Conditions
DC input voltage	V _{IN}	19	V	
BS terminal voltage	V _{BS}	24.5	V	
SW terminal voltage	V _{SW}	19	V	
FB terminal voltage	V _{FB}	5.5	V	
EN terminal voltage	V _{EN}	19	V	
SS terminal voltage	V _{SS}	7.4	V	
SS terminal allowable input current	I _{ssb}	5	mA	
Power dissipation	P _{DI}	TBD	W	Glass-epoxy board mounting in a 30×30mm. (copper area in a 25×25mm) Max T _J =150°C
Junction temperature	T _J	-40 ~ 150	°C	
Storage temperature	T _S	-40 ~ 150	°C	
Thermal resistance (junction- Pin No. 4)	θ_{JP}	TBD	°C/W	
Thermal resistance (junction-ambient air)	θ_{JA}	TBD	°C/W	Glass-epoxy board mounting in a 30×30mm. (copper area in a 25×25mm)

⁽³⁾ Limited by thermal shutdown.

⁽⁴⁾ The temperature detection of thermal shutdown is about 165°C

Recommended Operating Conditions

Parameter	Symbol	Ratings		Units	Conditions
		MIN	MAX		
DC input voltage ⁽⁵⁾	V _{IN}	V _o +3	17	V	
DC output current ⁽⁶⁾ ⁽⁷⁾	I _O	0	3.0	A	
Output voltage	V _O	0.8	14	V	
Ambient operating temperature ⁽⁷⁾	T _{OP}	-40	85	°C	

⁽⁵⁾The minimum value of input voltage is taken as the larger one of either 4.5V or V_O +3V.

In the case of V_{IN}=V_O+1~V_O+3V, it is set to I_O=Max. 2A

⁽⁶⁾Recommended circuit refers to Typical Application Circuit.

⁽⁷⁾To be used within the allowable package power dissipation characteristics.

Electrical Characteristics

Ta = 25°C

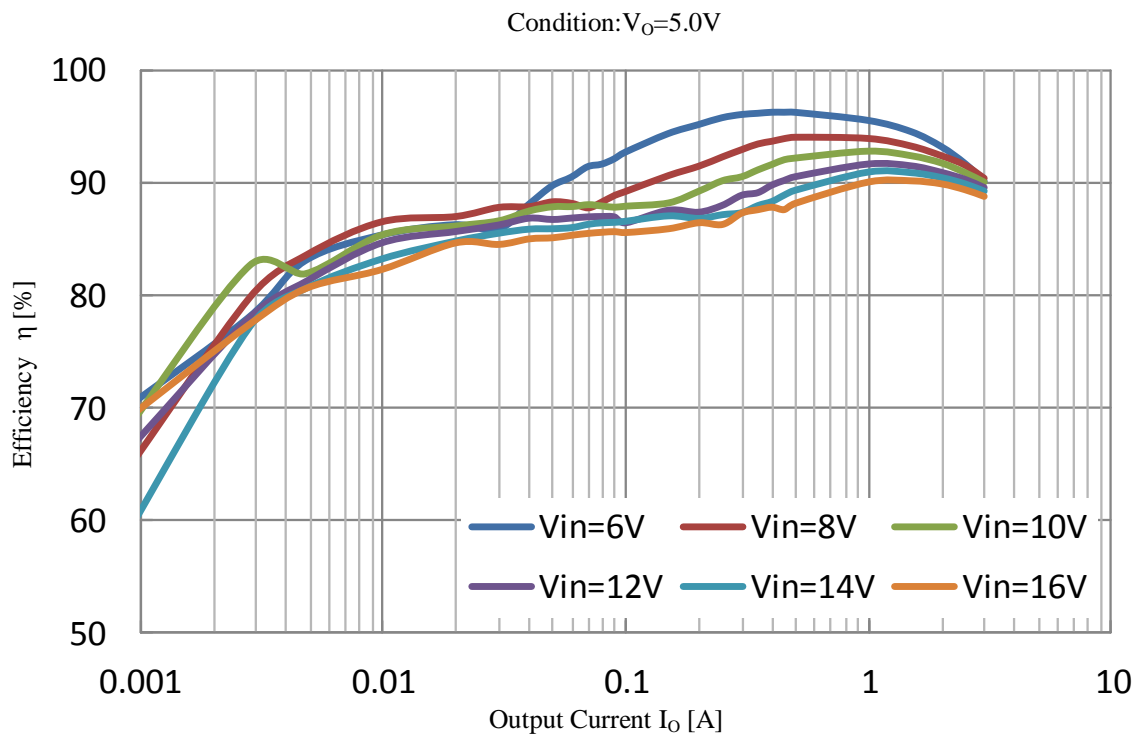
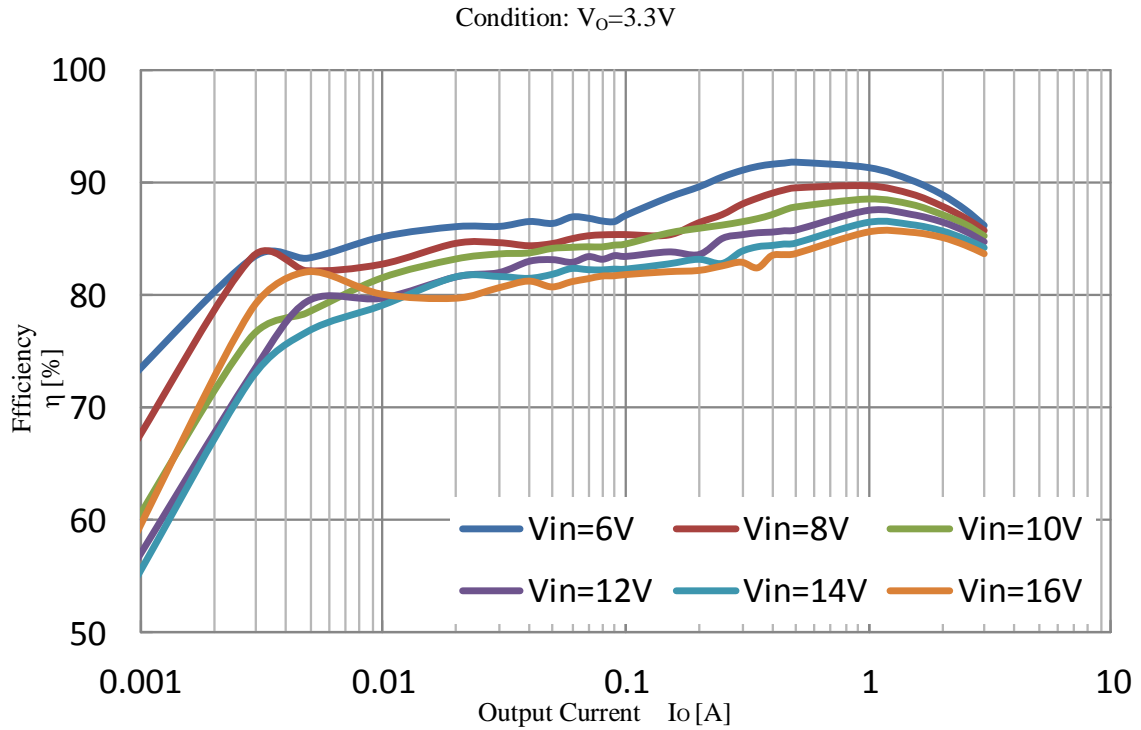
Parameter	Symbol	Ratings			Units	Test conditions	
		MIN	TYP	MAX			
Reference voltage	V _{REF}	0.780	0.800	0.820	V	V _{IN} = 12V, I _o = 1.0A	
Output voltage temperature coefficient	$\Delta V_{REF}/\Delta T$		±0.05		mV/°C	V _{IN} = 12V, I _o = 1.0A -40°C to +85°C	
Switching frequency	f _{SW}	245	350	455	kHz	V _{IN} =12V, V _o =5.0V, I _o =1A	
Line regulation ⁽⁸⁾	V _{Line}		50		mV	V _{IN} = 8V ~ 17V, V _o = 5.0V, I _o = 1A	
Load regulation ⁽⁸⁾	V _{Load}		50		mV	V _{IN} = 12V, V _o = 5.0V, I _o = 0.1A ~ 2.0A	
Over current protection threshold	I _S	3.1	4.5		A	V _{IN} = 12V, V _o = 5.0V	
Supply Current(Non-switching)	I _{IN}		100		μA	V _{IN} = 12V, V _{EN} =12V	
Shutdown Supply Current	I _{IN(off)}		1		μA	V _{IN} =12V, V _{EN} =0V	
Input Under Voltage Lockout threshold	V _{uvlo}		3.9	4.4	V	V _{IN} Rising	
SS Pin	Charging current	I _{SS}	13	22	31	μA	V _{SS} =0V, V _{IN} =12V
	SS start voltage	V _{SS1}		0.5			V _{IN} =12V
	SS finish voltage	V _{SS2}		1.4			V _{IN} =12V
EN Pin	Sink current	I _{EN}		5	10	μA	V _{EN} = 12V
	Threshold voltage	V _{EN}	0.7	1.3	2.1	V	V _{IN} =12V
Max on-duty ⁽⁸⁾	D _{MAX}		90		%	V _{IN} =12V	
Minimum on-time ⁽⁸⁾	T _{ON(MIN)}		170		nsec	V _{IN} =12V	
Thermal shutdown threshold temperature ⁽⁸⁾	TSD	151	165		°C	V _{IN} =12V	
Thermal shutdown restart hysteresis of temperature ⁽⁸⁾	TSD_hys		15		°C	V _{IN} =12V	
COMP Pin	Transconductance ⁽⁹⁾	G _m		750		μA/V	V _{IN} =12V
	Voltage gain ⁽⁹⁾	A _v		900		V/V	V _{IN} =12V
	Conversion factor ⁽⁹⁾	G _{cs}		5.7		A/V	V _{IN} =12V
	Max. sink current ⁽⁹⁾	I _{sink}		50		μA	V _{IN} =12V
	Max. source current ⁽⁹⁾	I _{source}		50		μA	V _{IN} =12V

⁽⁸⁾ Guaranteed by design, not tested.⁽⁹⁾ This is applicable to only NR132D that 8 pin is a COMP terminal.

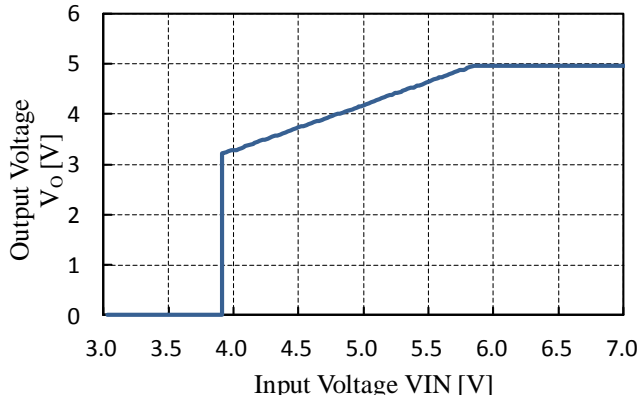
Typical Performance Characteristics

NR131D typical Performance Characteristics

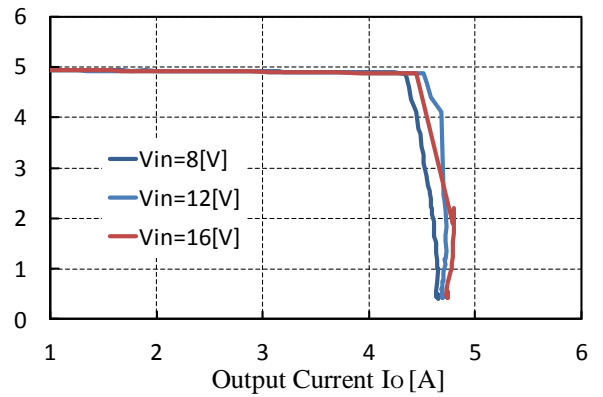
(1)Efficiency



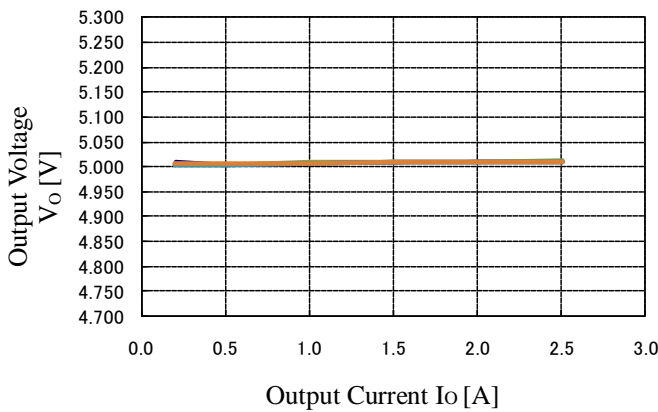
(2) Output startup Io=1A



(5) Over Current Protection

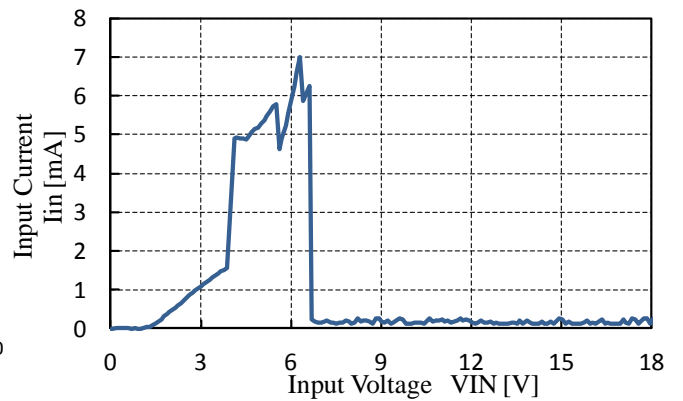


(3) Load Regulation : VLoad



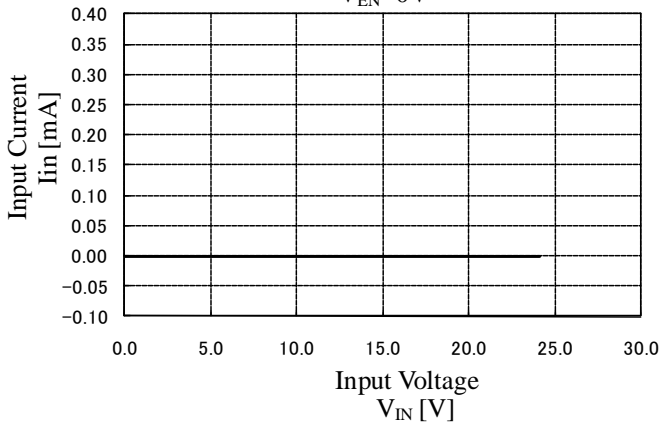
(6) Supply Current : IIN

VO=5.0V

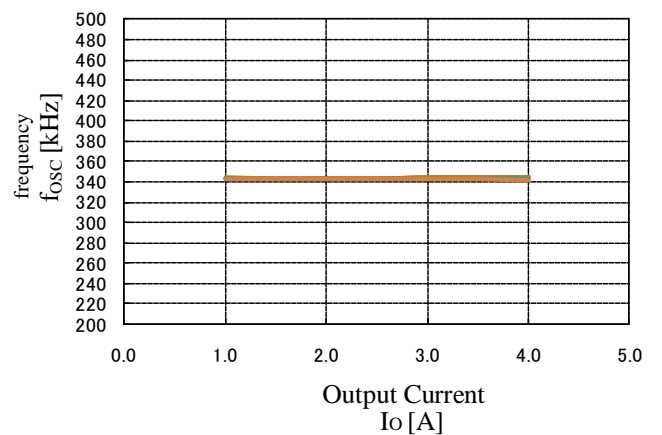


(4) Shutdown Supply Current : IIN(off)

VEN=0V



(7) Switching Frequency: fsw

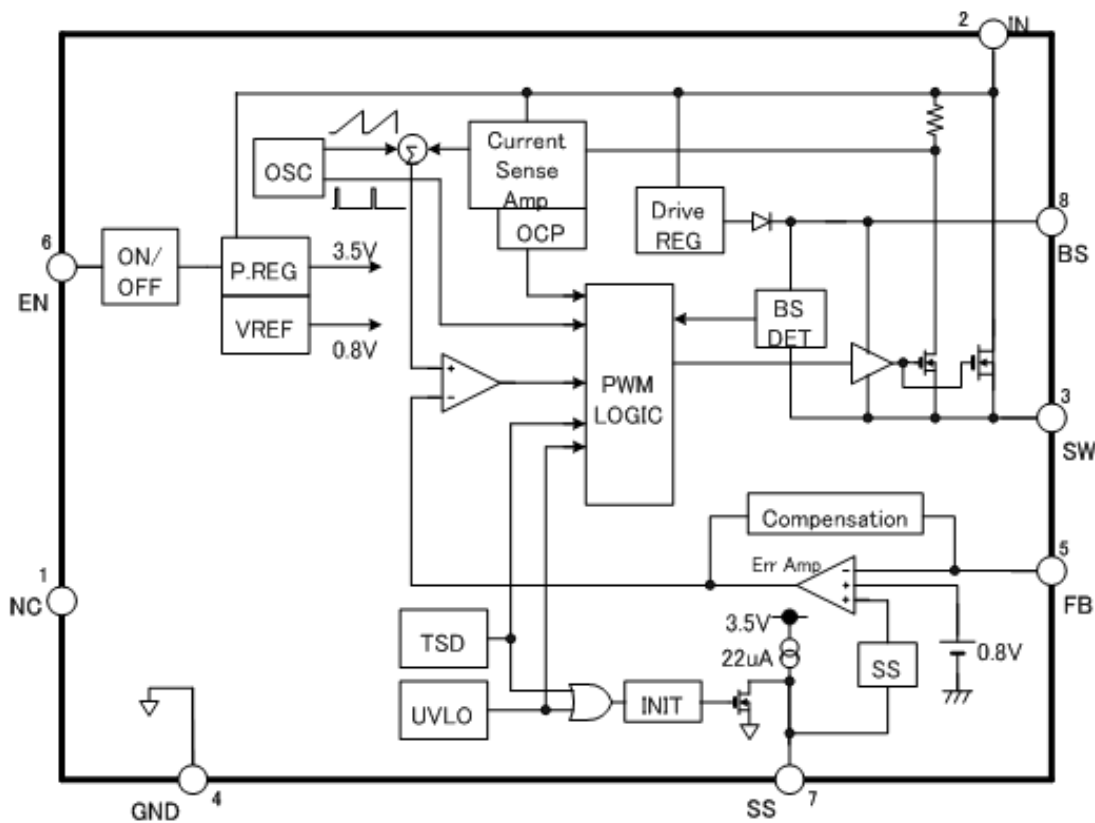


NR130D series

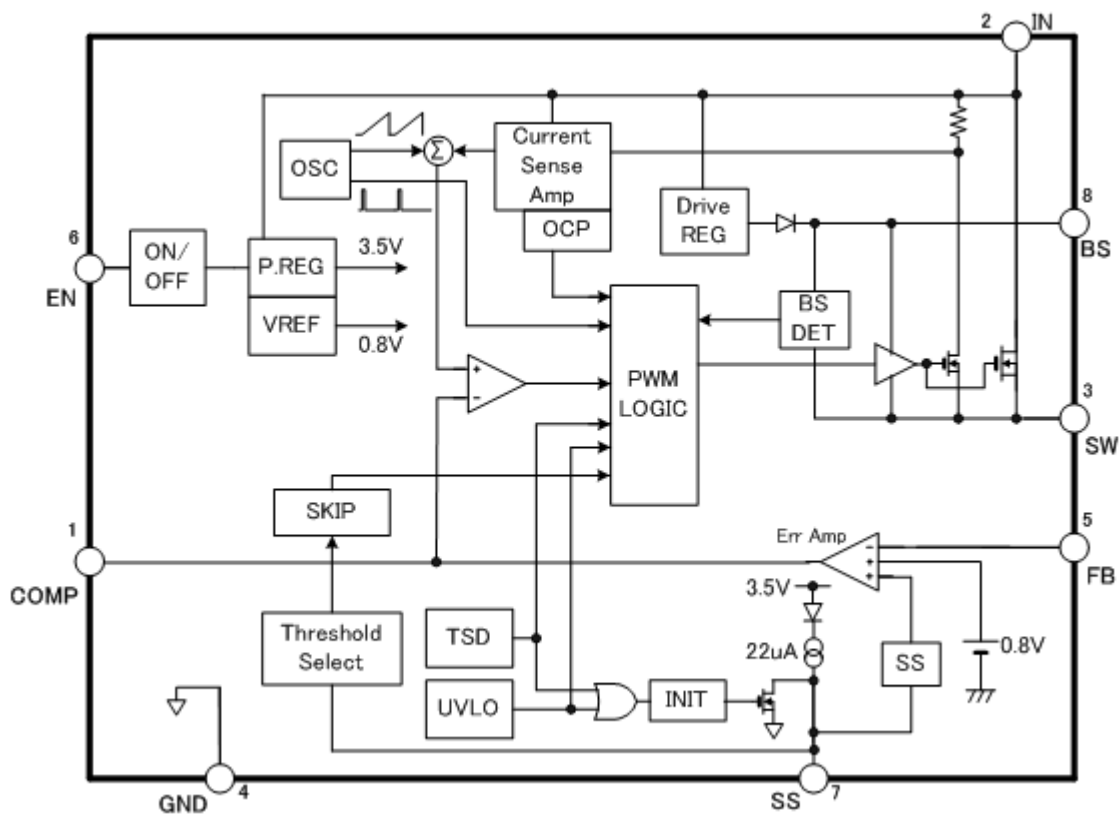
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Functional Block Diagram

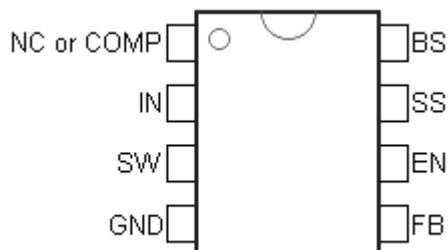


NR131D



NR132D

Pin Assignments & Functions

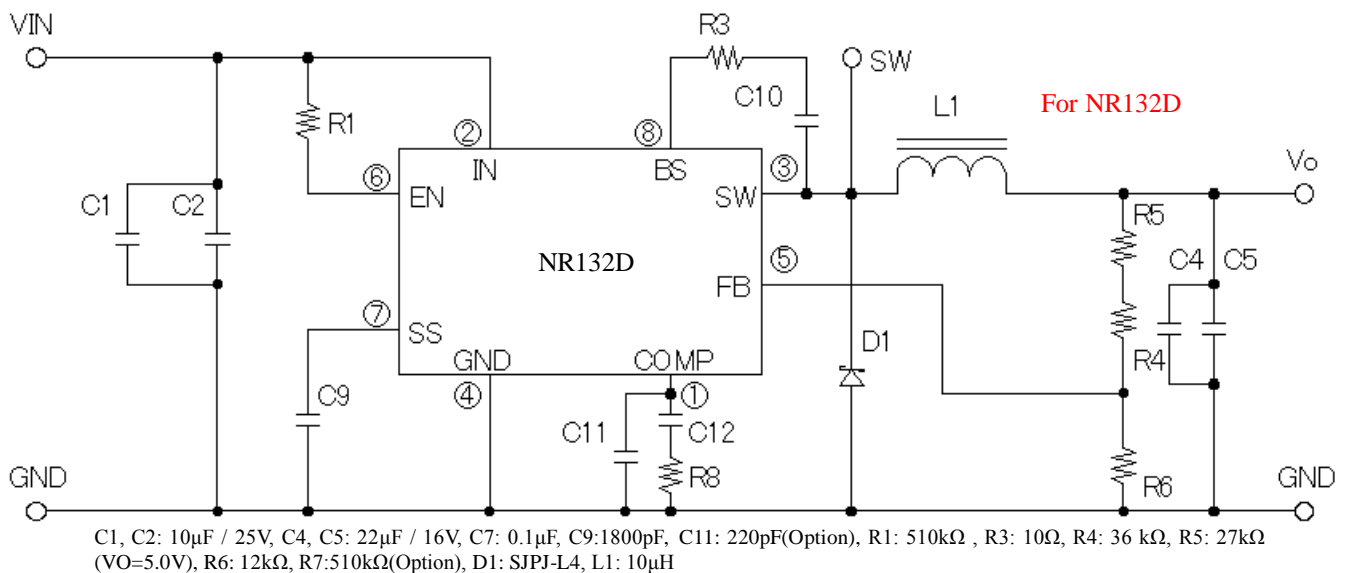
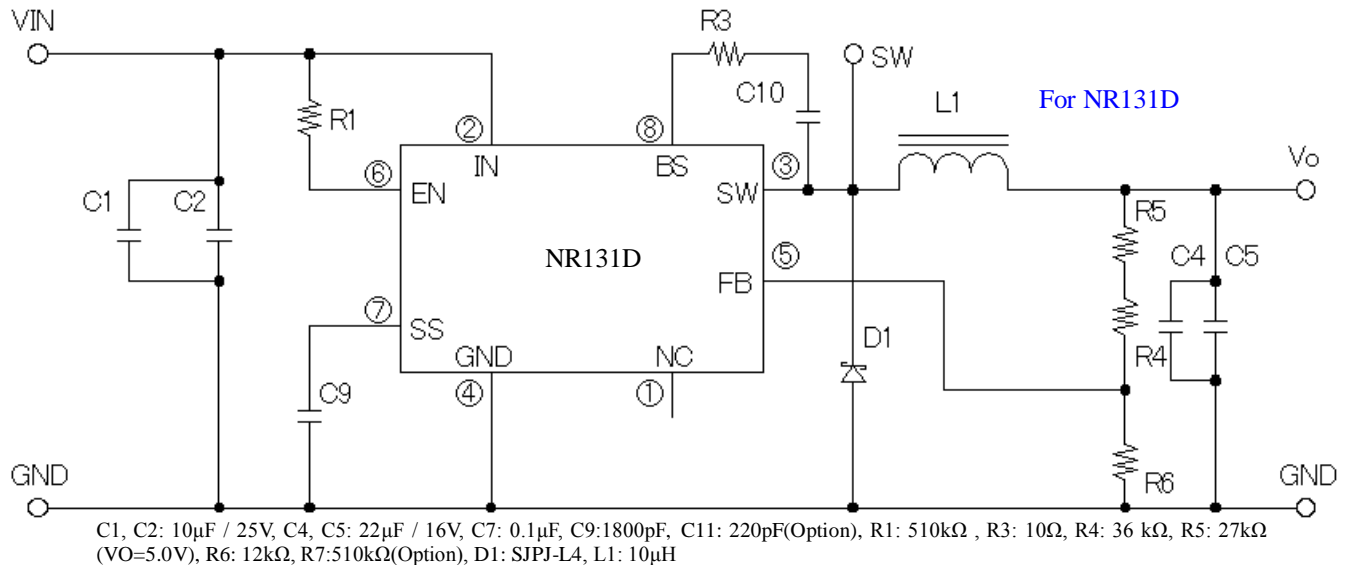


Pin Assignments

Pin assignments & functions of NR130D series

Pin No.	Symbol	Description
1	NC or COMP	NR131D: No Connection.(NC) NR132D: External phase compensation terminal(COMP)
2	IN	Power input. VIN supplies the power to the IC.as well as the regulator switches
3	SW	Power switching output. SW supplies power to the output. Connect the LC filter from SW to the output. Connect a Schottky Barrier Diode between SW and GND. Note that a capacitor is required from SW to BS to supply the power the High-side switch
4	GND	Ground Connect the exposed pad to Pin No.4
5	FB	Feedback input Pin to compare Reference Voltage. The feedback threshold is 0.8V. To set the output voltage, FB Pin is required to connect between resistive voltage divider R4 and R6.
6	EN	Enable input. Drive EN Pin high to turn on the regulator, low to turn it off.
7	SS	Soft-Start and SKIP operation control input. To set the soft-start period, connect to a capacitor between GND. To set the Low Ripple SKIP operation, add the resistor 510k ohm between SS terminal and IN terminal.
8	BS	High-side Boost input. BS supplies the drive for High-side Nch-MOSFET switch. Connect a capacitor and a resistor between SW to BS.

Example Application Circuit



A design guide for add-on parts around of the NR130D series.

(1)Diode D1

- The schottky-barrier diode must be used for D1. If other diodes like fast recovery diodes are used, IC may be damaged because of the reverse voltage applied by the recovery voltage or ON voltage.

(2)Choke coil L1

- If the winding resistance of the choke coil is too high, the efficiency may go down to the extent that it is out of the rating.
- As the start current of the over current protection is approximately 4A, attention must be paid to the heating of the choke coil by the magnetic saturation due to overload or short-circulated load.

(3)Capacitor C1(C2), C4(C5), C9

- As large ripple current across C1 (C2) and C4 (C5), capacitors with high frequency and low impedance for SMPS must be used. Especially when the impedance of C4 (C5) is high, the switching waveform may not be normal at low temperature.
- C9 is a capacitor for soft start. In case soft start function is not used, please keep Pin No.2 open.

(4) Resistor R1, R2

• R4, R5, R6 are resistor to the Output Voltage. In case of the $I(\text{ADJ}) = 66 \mu\text{A}$, R4, R5, R6 are calculated by the next equation .

$$R6 = \frac{V_{FB}}{I(\text{ADJ})} = \frac{0.8\text{V}}{66 \mu\text{A}} = 12\text{k}\Omega$$

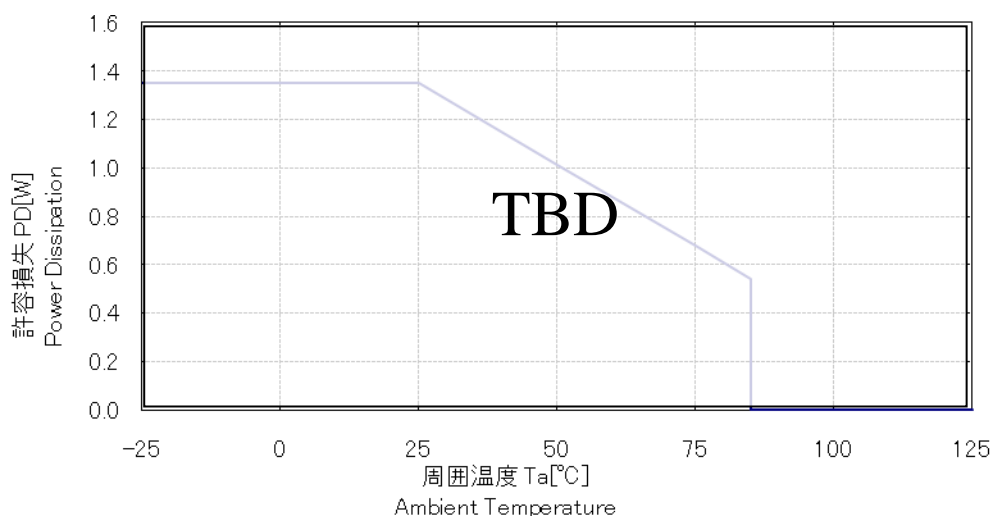
$$V_o = V_{FB} \left(1 + \frac{R4 + R5}{R6} \right) \Rightarrow R4 + R5 = \frac{R6 \times (V_o - V_{FB})}{V_{FB}}$$

$$R4 + R5 = \frac{12\text{k}\Omega \times (5\text{V} - 0.8\text{V})}{0.8\text{V}} = 63\text{k}\Omega$$

$$*63\text{k}\Omega = 27\text{k}\Omega + 36\text{k}\Omega$$

In order to have optimum operating condition, each component must be connected with the minimum distance.

Allowable package power dissipation



Allowable package power dissipation of NR130A series

NOTES:

- 1) Glass-epoxy board mounting in a 30×30mm
- 2) copper area : 25×25mm
- 3) The power dissipation is calculated at the junction temperature 125 °C
- 4) Losses can be calculated by the following equation.
As the efficiency is subject to the input voltage and output current, it shall be obtained from the efficiency curve and substituted in percent
- 5) Thermal design for D1 shall be made separately.

$$P_D = V_O \times I_O \left(\frac{100}{\eta_x} - 1 \right) \dots (1)$$

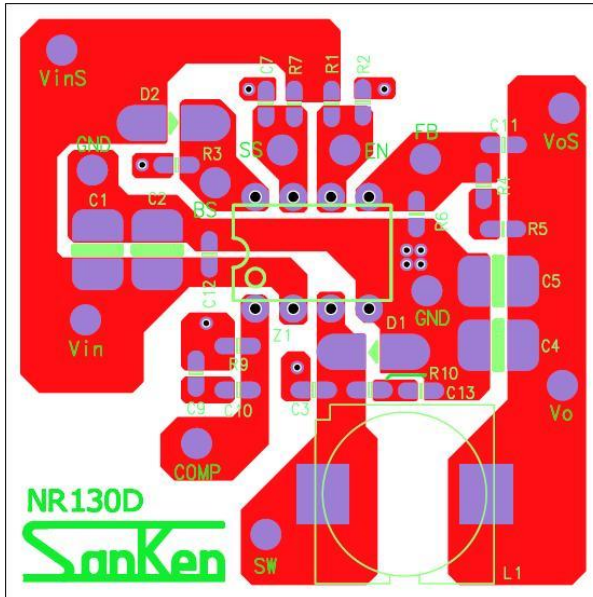
V_O: Output voltageV_{IN}: Input voltageI_O: Output current

η x : Efficiency (%)

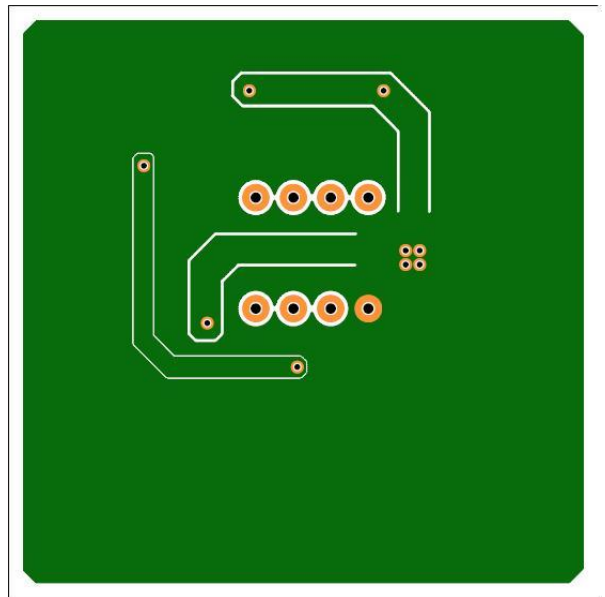
V_f: SJPB-L4 I_O=3A/V_f=0.55V
Diode forward voltage (A to K)

PCB layout recommendation

*The demonstration Printed circuit board. It can mount a part for the experiment ,except for the Example Application Circuit.



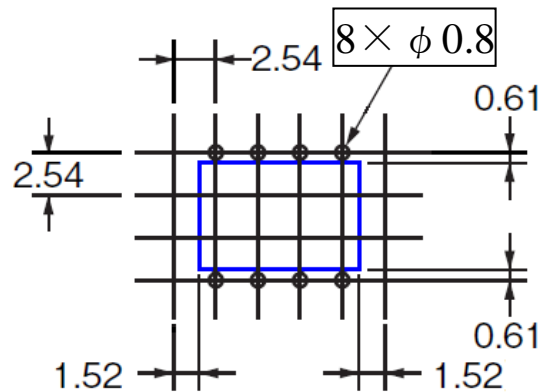
Front Side: Component Side (double sided board)



Back Side: GND Side (double sided board)

Note

- 1) Size of the PCB is about 40mm × 40mm
- 2) Dimension is in millimeters, dimension in bracket is in inches.
- 3) Drawing is not to scale.



(Reference)
 DIP8 package
 About the position of the lead-insertion hole

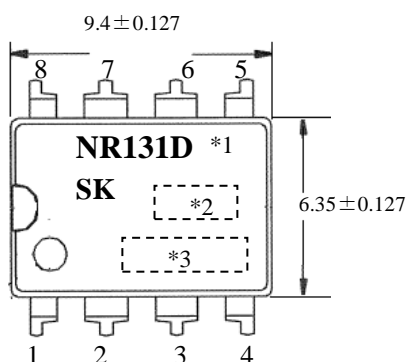
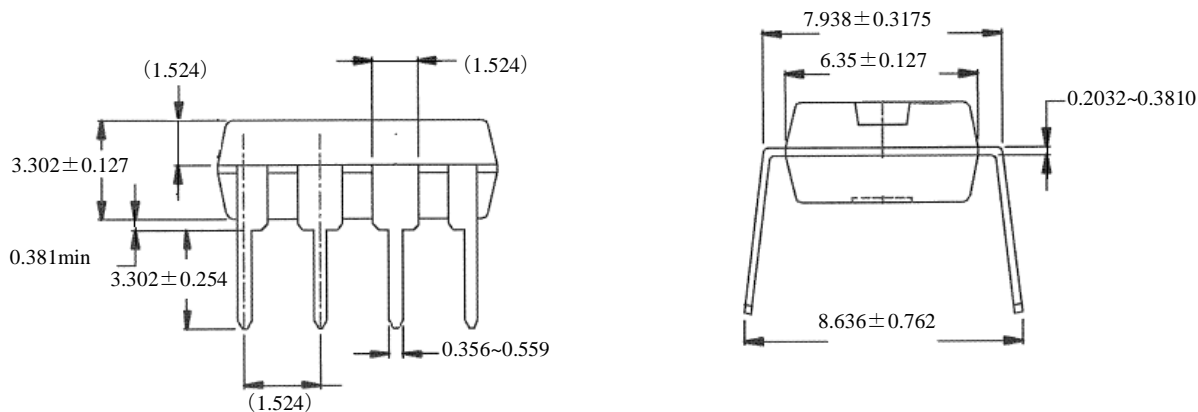
NR130D series

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Package outline, dimensions

DIP8 package (Units : mm)



- *1. Part number Unit : mm
- *2. Lot number (three digit)
- | | |
|--|---|
| 1 st letter | The last digit of year |
| 2 nd letter | Month (1 to 9 for Jan. to Sept.,
O for Oct. N for Nov. D for Dec.) |
| 3 rd & 4 th letter | Week code (01 ~ 03) |
- *3. Control number (four digit)

External terminal processing : Sn plating (Sn100)

- PIN Assignment
1. NC or COMP
 2. IN
 3. SW
 4. GND
 5. FB
 6. EN
 7. SS
 8. BS

Package outline and Marking of NR130D series

OPERATING PRECAUTIONS

Reliability can be affected adversely by improper storage environments and handling methods. Please observe the following cautions.

Heat dissipation and reliability

Thermal performance of the surface mount package IC depends on the material and area size of PCB and its copper plane. Design thermal condition with sufficient margin

Parallel operation

The parallel operation to increase the current is not available.

Thermal shut down

The NR130A series has a thermal protection circuit.

This circuit protects the IC from the heat generation by the over load.

This circuit cannot guarantee the long-term reliability against the continuously over load status.

Cautions for Storage

- Ensure that storage conditions comply with the standard temperature (5 to 35°C) and the standard relative humidity (around 40 to 75%); avoid storage locations that experience extreme changes in temperature or humidity.
- Avoid locations where dust or harmful gases are present and avoid direct sunlight.
- Reinspect for rust on leads and solderability of products that have been stored for a long time.

Cautions for Testing and Handling

- When tests are carried out during inspection testing and other standard test periods, protect the products from power surges from the testing products, shorts between the product pins, and wrong connections. In addition, avoid tests exceeded ratings

Soldering

When soldering the products, please be sure to minimize the working time, within the following limits.

- Reflow Preheat ; 180°C / 90±30s
Heat ; 250°C / 10±1s (260°C peak ,2times)
- Soldering iron ; 380±10°C / 3.5±0.5s (1time)

Electrostatic Discharge

- When handling the products, the operator must be grounded. Grounded wrist straps worn should have at least 1MΩ of resistance from the operator to ground to prevent shock hazard, and it should be placed near the operator.
- Workbenches where the products are handled should be grounded and be provided with conductive table and floor mats.
- When using measuring equipment such as a curve tracer, the equipment should be grounded.
- When soldering the products, the head of a soldering irons or the solder bath must be grounded in order to prevent leak voltages generated by them from being applied to the products.
- The products should always be stored and transported in Sanken shipping containers or conductive containers, or be wrapped in aluminum foil.

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In addition, it should be noted that since power devices or IC's including power devices have large self-heating value, the degree of derating of junction temperature affects the reliability significantly.
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