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NR131A

Jul/09/2015

General Descriptions

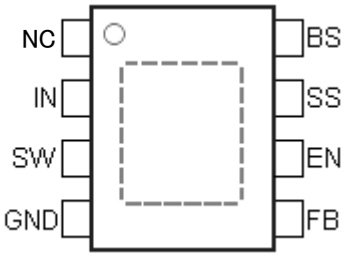
The NR131A is buck regulator ICs integrates High-side power MOSFETs. With the current mode control, ultra low ESR capacitors such as ceramic capacitors can be used. The ICs can realize super-high efficiency by performing pulse skip operation at light load condition. The ICs have protection functions 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 NR131A is available in an 8-pin eSOIC package with an exposed thermal pad on the back side.

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

- eSOIC8



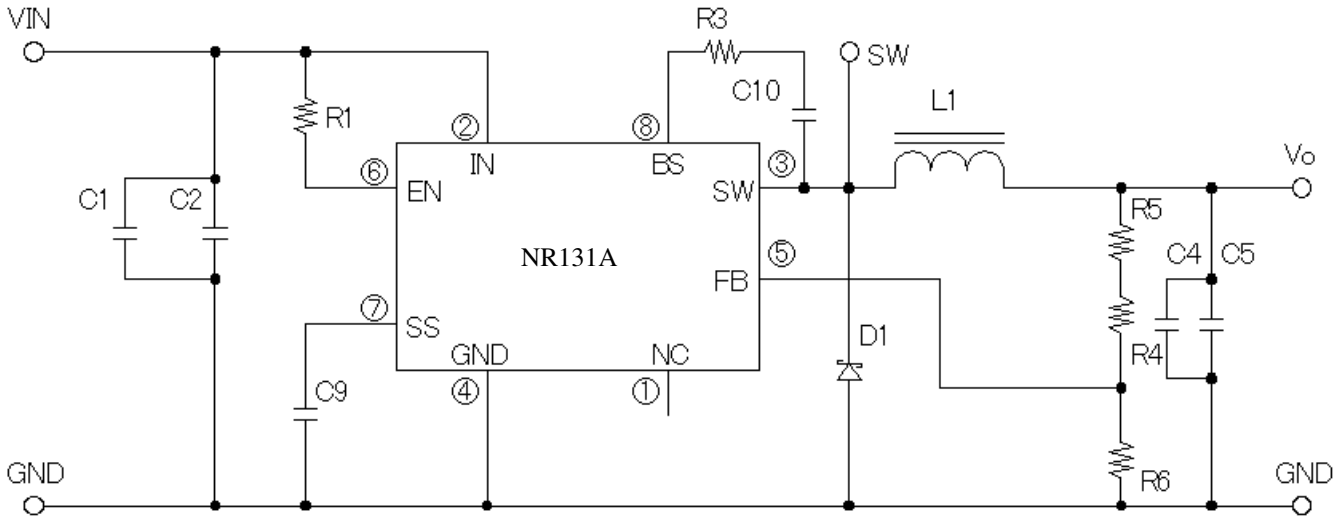
Electrical Characteristics

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

Applications

- LCD TV / Blue-ray / Set top box
- Green electronic products
- Other power supply

Typical Application Circuit



C1, C2: 10µF / 25V, C4, C5: 22µF / 16V, C9: 0.1µF, C10: 0.1µF, R1: 510kΩ , R3: 10Ω, R4: 36 kΩ, R5: 27kΩ (VO=5.0V), R6: 12kΩ, R7:510kΩ(Option), D1: SJPJ-L4, L1: 10µH

Series Lineup

Product Name	f_{SW}	V_{IN}		V_O		I_O	Package
NR131A	350kHz	4.5V to 17V	(1)	0.8V to 14V	(2)	3A	eSOIC8

(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}	–0.3～19	V	
BS terminal voltage		V_{BS}	–0.3～25	V	
BS-SW Pin voltage		V_{BS-SW}	-0.3～6.0	V	DC
			–0.3～7.5		Pulse width≦30ns
SW terminal voltage		V_{SW}	–2～19	V	DC
			–4.5～19		Pulse width≦30ns
FB terminal voltage		V_{FB}	–0.3～5.5	V	
EN terminal voltage		V_{EN}	–0.3～19	V	
SS terminal voltage		V_{SS}	–0.3～7.4	V	
SS terminal allowable input current		Issb	5	mA	
Power dissipation	(3)	P_{D1}	1.76	W	Glass-epoxy board mounting in a 40×40mm. (copper area in a 25×25mm) Max T_J =150°C
Junction temperature	(4)	T_J	–40 ~ 150	°C	
Storage temperature		T_S	–40 ~ 150	°C	
Thermal resistance (junction- Pin No. 4)		θ_{JP}	26	°C /W	
Thermal resistance (junction-ambient air)		θ_{JA}	71	°C /W	Glass-epoxy board mounting in a 40×40mm. (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}		10		mV	V_{IN} = 8V～17V, V_o = 5.0V, I_o = 1A
Load regulation (8)		V_{Load}		70		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		Vuvlo		3.9	4.4	V	V_{IN} Rising
SS Pin	Charging current	I_{SS}	13	22	31	μA	V_{SS}=0V, 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

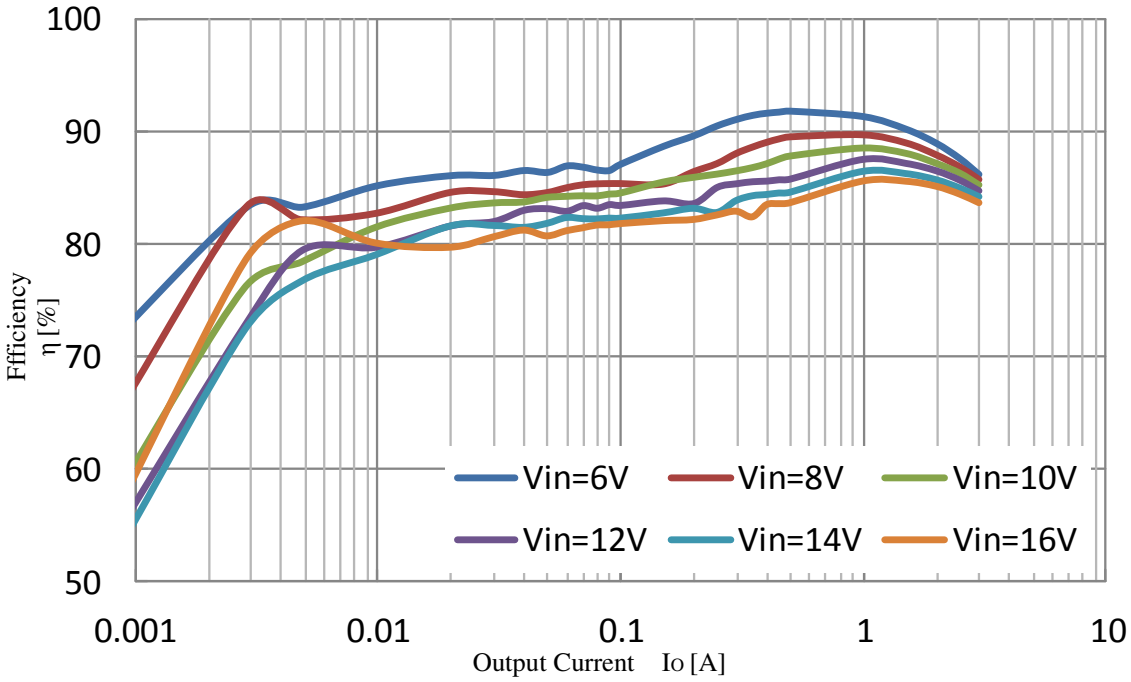
(8) Guaranteed by design,not tested.

Typical Performance Characteristics

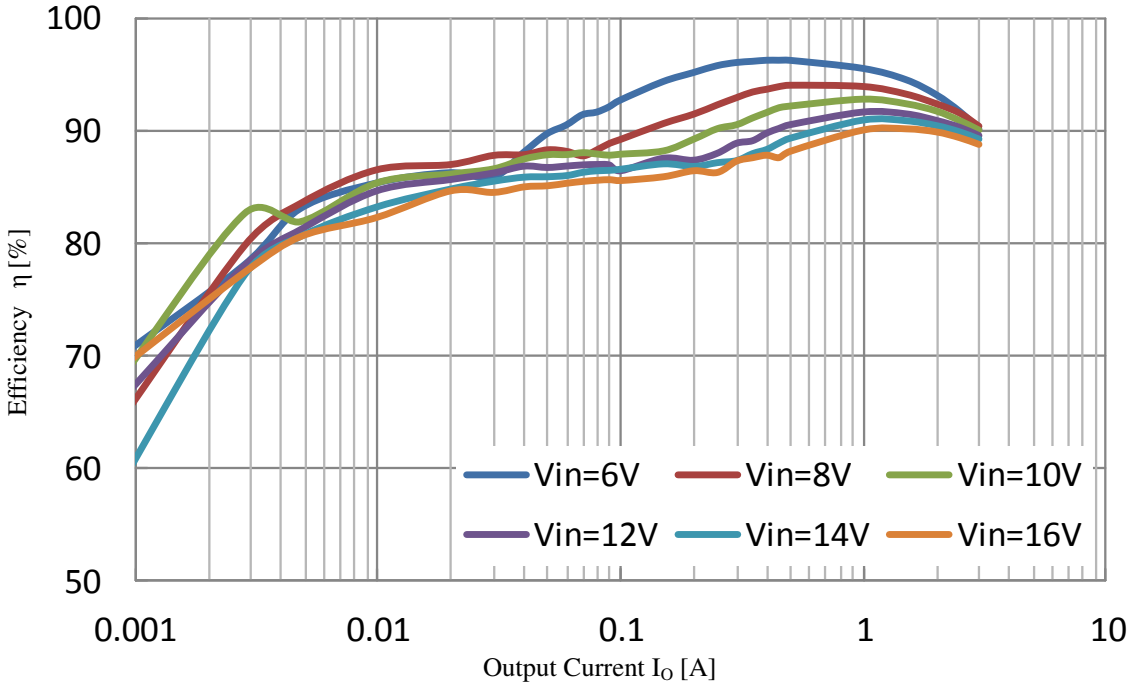
NR131A typical Performance Characteristics

(1)Efficiency

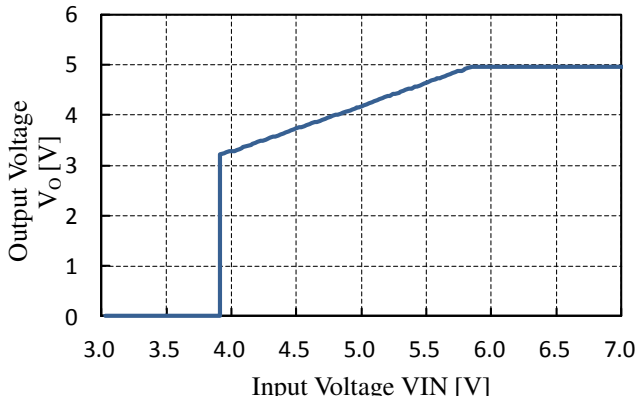
Condition: V_O=3.3V



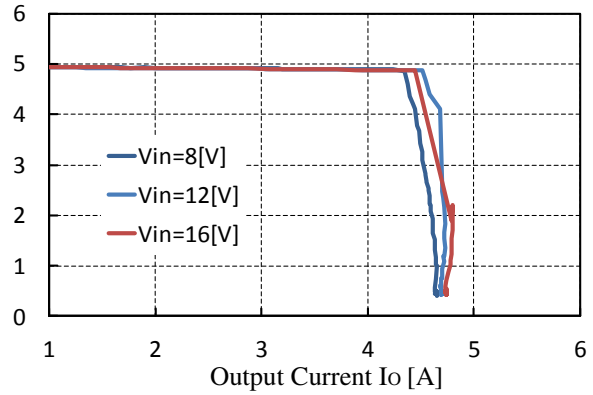
Condition:V_O=5.0V



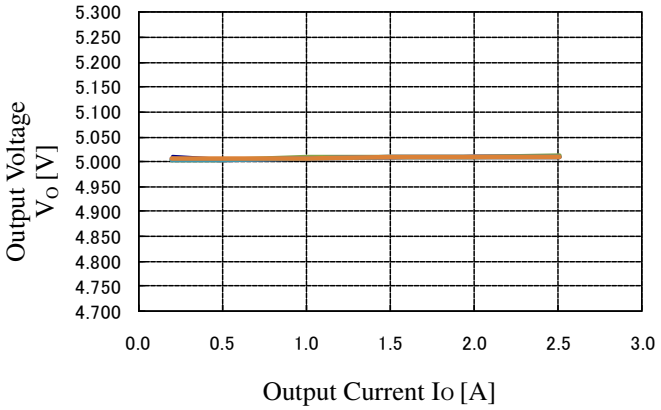
(2) Output startup Io=1A



(5)Over Current Protection

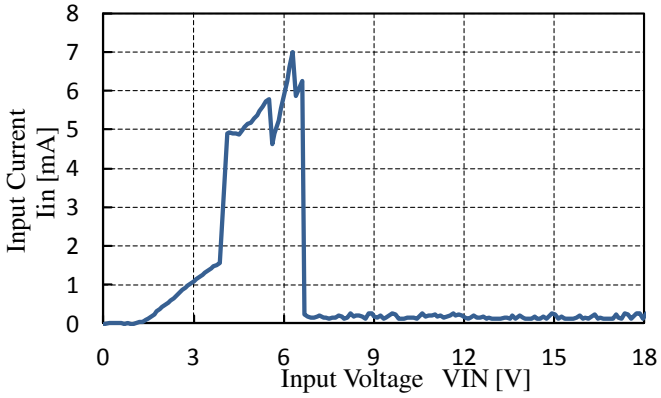


(3) Load Regulation : V_{Load}



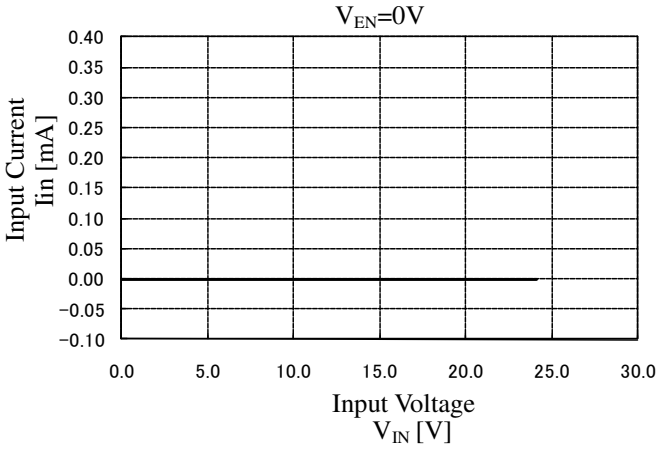
(6) Supply Current : I_{IN}

V_O=5.0V

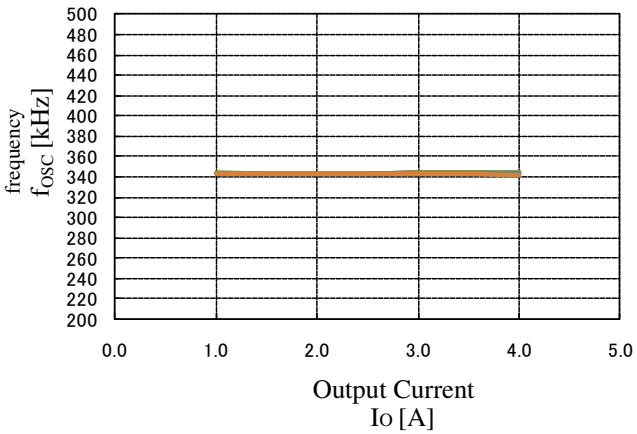


(4) Shutdown Supply Current : $I_{IN(off)}$

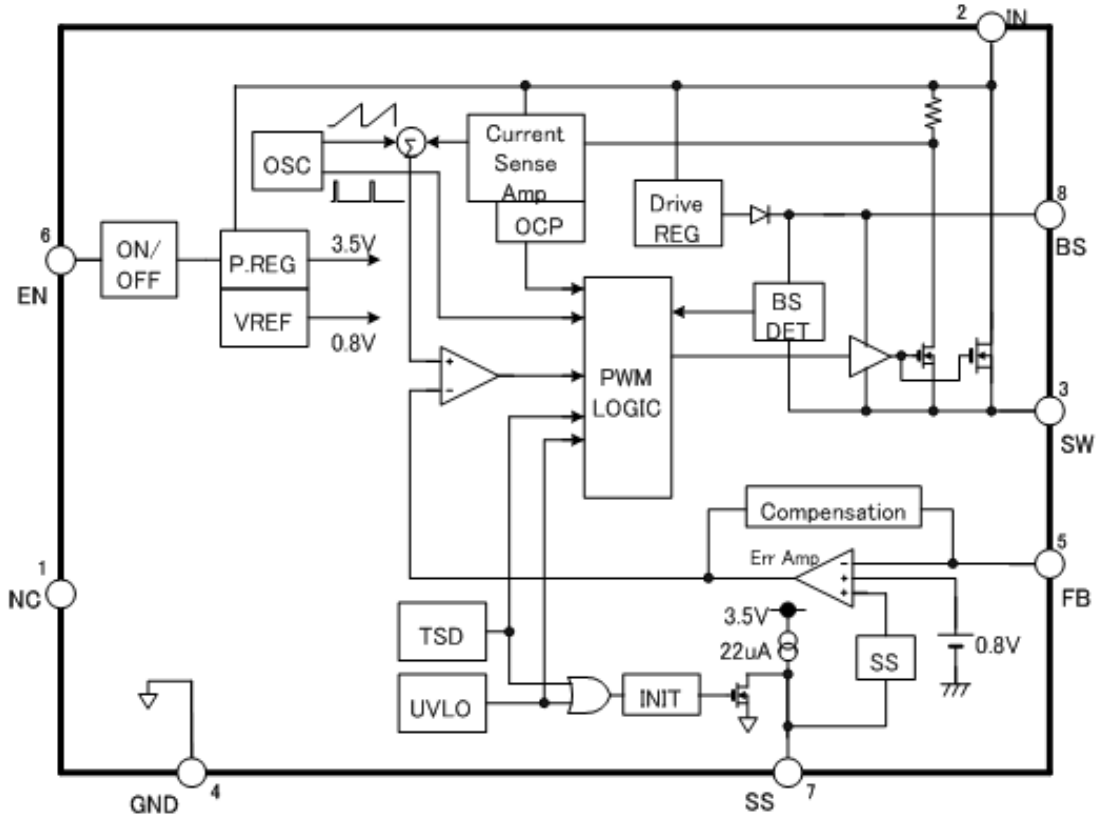
V_{EN}=0V



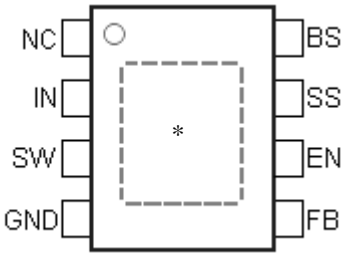
(7) Switching Frequency: f_{SW}



Functional Block Diagram



Pin Asignments & Functions



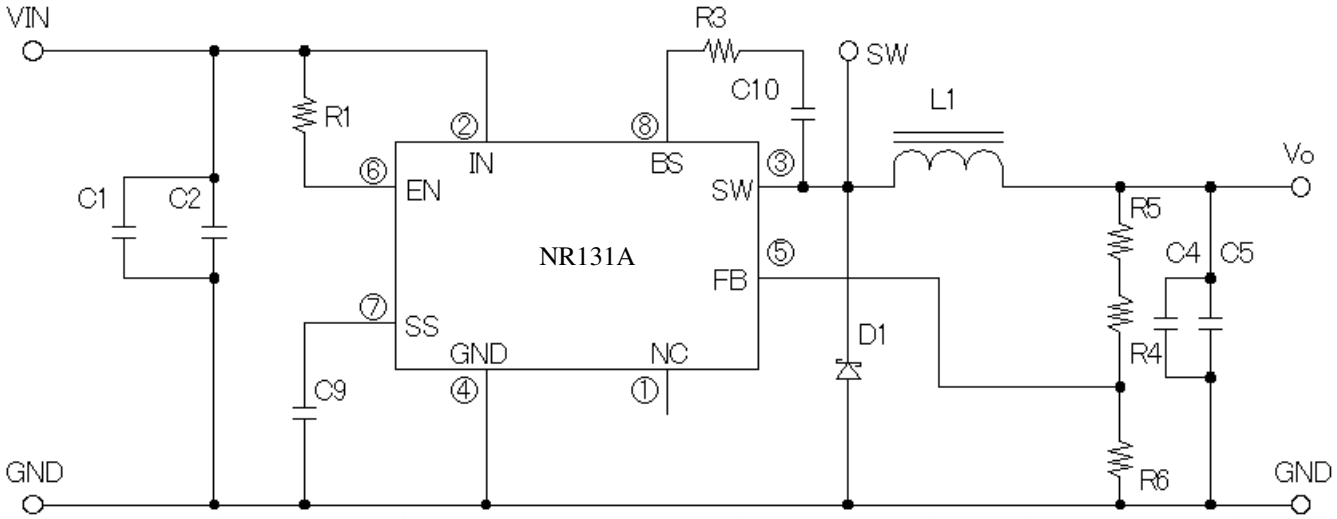
* Exposed thermal pad on the back side.

Pin Assignments

Pin assignments & functions of NR130A series

Pin No.	Symbol	Description
1	NC	No Connection.(NC)
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 resister 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



C1, C2: 10µF / 25V, C4, C5: 22µF / 16V, C9: 0.1µF, C10: 0.1µF, R1: 510kΩ , R3: 10Ω, R4: 36 kΩ, R5: 27kΩ (VO=5.0V), R6: 12kΩ, R7:510kΩ(Option), D1: SJPJ-L4, L1: 10µH

A design guide for add-on parts around of the NR130A 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(ADJ) = 66 μ A, R4, R5, R6 are calculated by the next equation .

$$R6 = \frac{VFB}{I(ADJ)} = \frac{0.8V}{66\,\mu\,A} = 12k\,\Omega$$

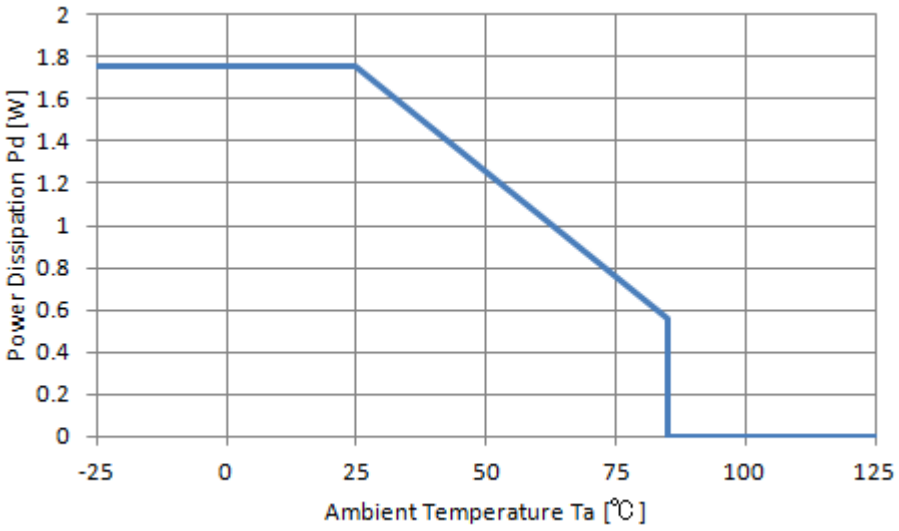
$$Vo = VFB\left(1 + \frac{R4 + R5}{R6}\right) \quad \Rightarrow \quad R4 + R5 = \frac{R6 \times (Vo - VFB)}{VFB}$$

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

*63k Ω = 27k Ω ＋36k Ω

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

Allowable package power dissipation



Allowable package powe disspation 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.

$$P_D = V_O \times I_O \left(\frac{100}{\eta x} - 1 \right) \quad \cdots(1)$$

V_O: Output voltage

V_{IN} : Input voltage

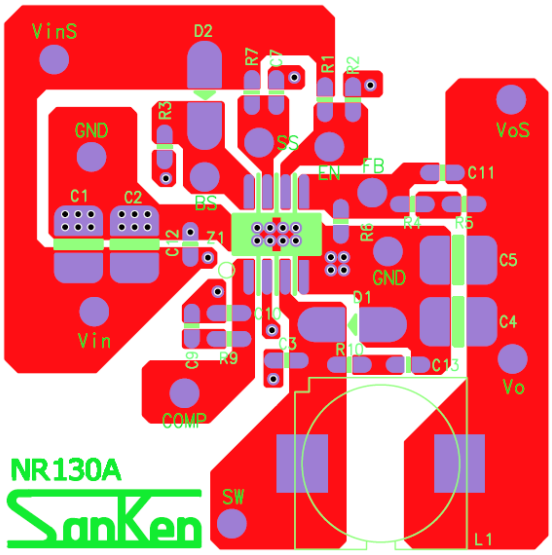
I_O : Output current

η x : Efficiency (%)

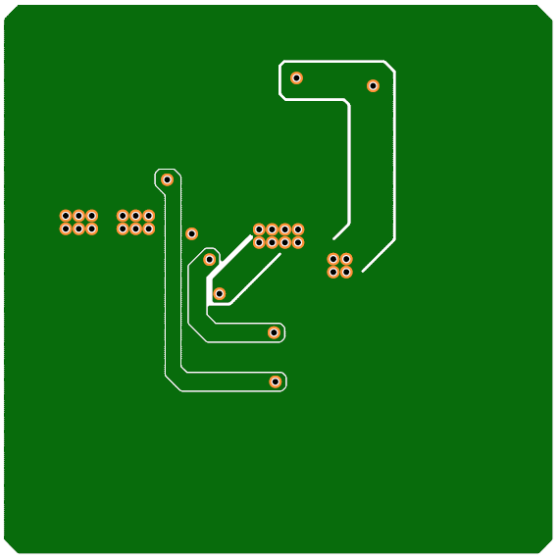
Vf: SJPB-L4 Io=3A/Vf=0.55V
Diode forward voltage (A to K)

PCB layout recommendation

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



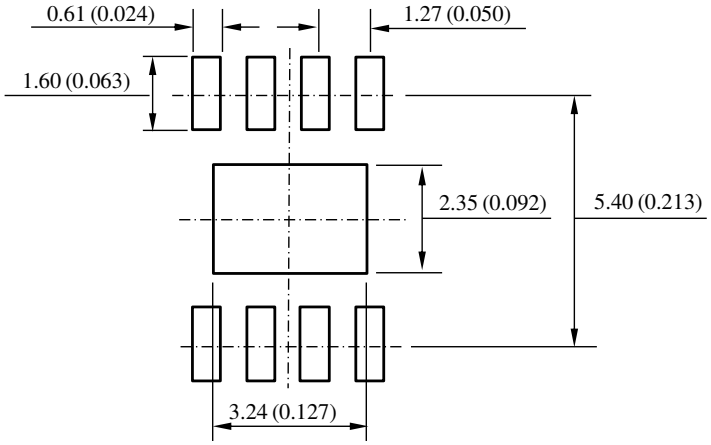
Front Side: Component Side (double sided board)



Back Side: GND Side (double sided board)

Note

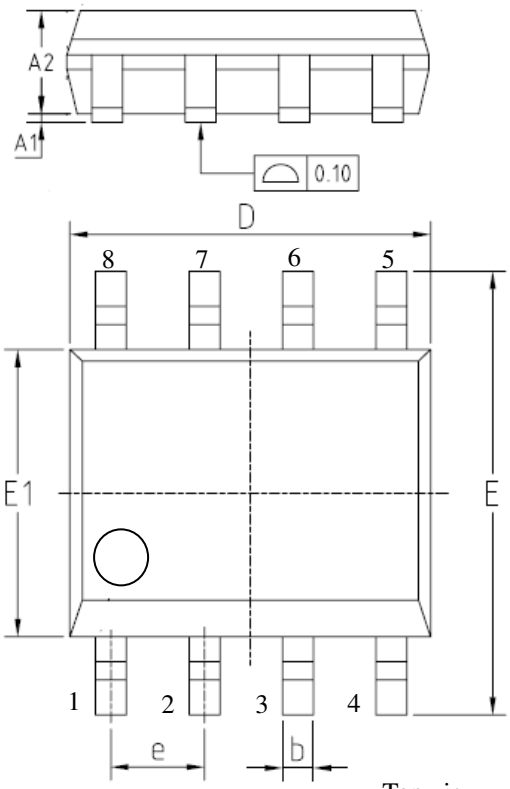
1) Size of the PCB is about 40mm × 40mm
2)Dimension is in millimeters, dimension in bracket is in inches.
3) Drawing is not to scale.



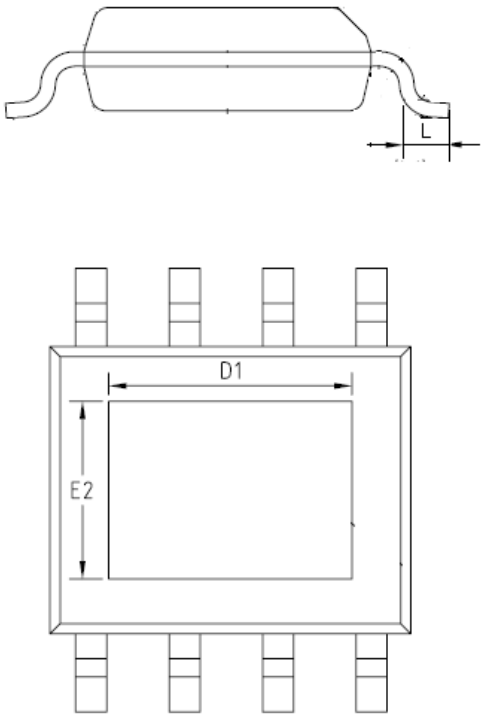
Recommended land pattern

Package outline, dimensions

eSOIC8 package (Units : mm)



Top view



Bottom view

Marking

*1. Product number

NR131A

*2. Lot number (three digit)

1st letter : The last digit of the year

2nd letter : Month

January to September : 1 to 9

October : O

November : N

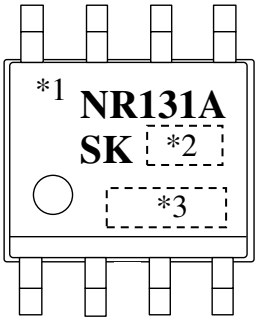
December : D

3rd letter : manufacturing week

First week to 5th week : 1 to 5

*3. Control number (four digit)

Symbol	Dimension is in millimeters(mm)		
	MIN	TYP	MAX
A1	0.05	0.15	0.25
A2	1.25	1.40	1.65
b	0.38	—	0.51
D	4.80	4.90	5.00
E	5.80	6.00	6.20
E1	3.80	3.90	4.00
e	—	1.27	—
L	0.45	0.6	0.8



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 NR130Aseries 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 1MΩof 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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