

GENERAL DESCRIPTION

The N2101 is a low-cost, full featured, synchronous voltage-mode controller designed for use in single ended power supply applications where efficiency is of primary concern. Synchronous operation allows for the elimination of heat sinks in many applications. The N2101 is ideal for implementing DC/DC converters needed to power advanced microprocessors in low cost systems, or in distributed power applications where efficiency is important. Internal level-shift, high-side drive circuitry, and preset shoot-thru control, allows the use of inexpensive N-channel power switches.

N2101 features include temperature compensated voltage reference, triangle wave oscillator and current sense comparator circuitry. Power good signaling, shut-down, and over voltage protection are also provided. The N2101 operates at a fixed 200kHz, providing an optimum compromise between efficiency, external component size, and cost.

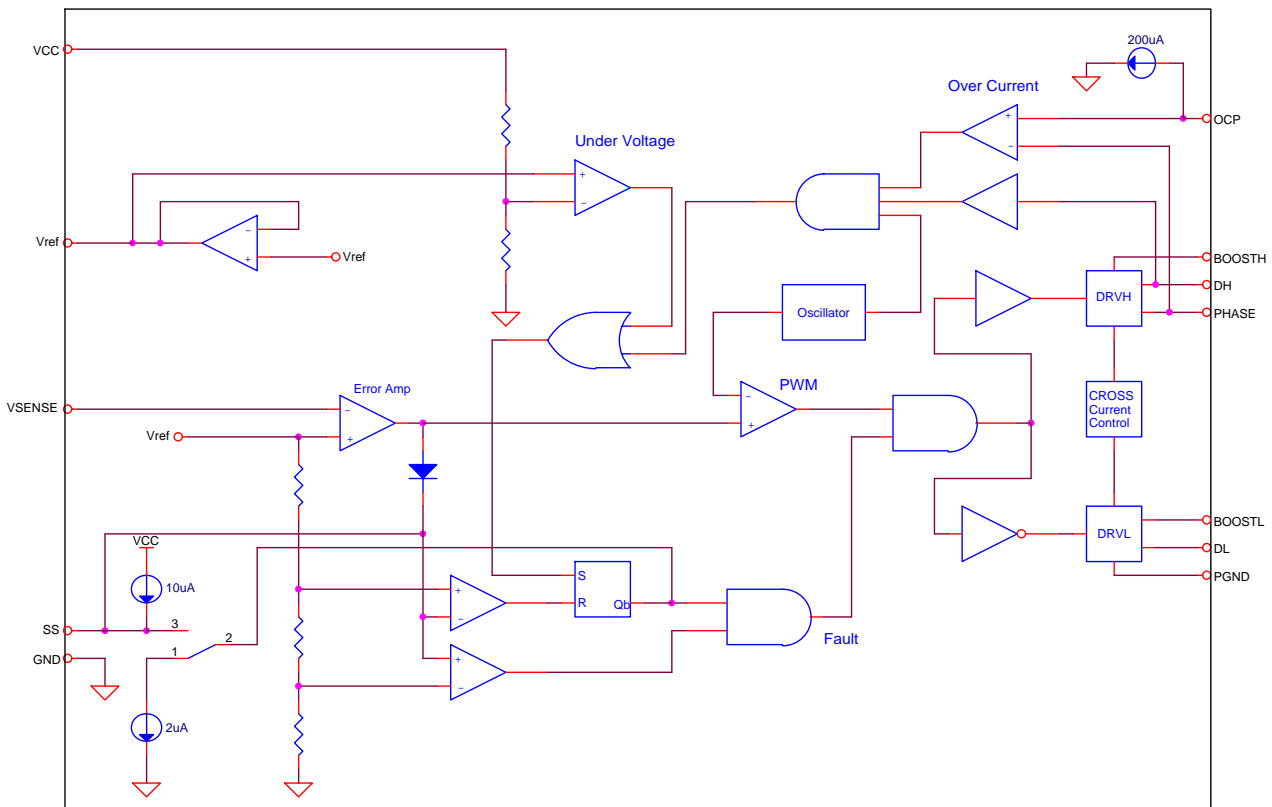
FEATURES

- 1.265V reference available
- Synchronous operation for high efficiency
- Soft start function
- Enable function
- $R_{DS(ON)}$ current sensing
- Small size with minimum external components

APPLICATIONS

- Microprocessor core supply
- Low cost synchronous applications
- Voltage Regulator Modules (VRM)
- Networking power supplies
- Sequenced power supplies
- DDR termination supplies

BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS

- VCC, BOOSTL to GND - 0.3V to 14V
- BOOSTH to PHASE 14V
- PHASE to GND -0.3V to 18V
- PGND to GND ±0.5V
- Thermal Resistance
 Junction to Case; θ_{JC} 45 $^{\circ}\text{C}/\text{W}$
- Thermal Resistance
 Junction to Ambient; θ_{JA} 115 $^{\circ}\text{C}/\text{W}$
- Operating Ambient
 Temperature Range, T_A 0 to 70 $^{\circ}\text{C}$
- Lead Temperature, T_{LEAD}
 (Soldering, 10 Seconds) 300 $^{\circ}\text{C}$
- Storage Temperature
 Range, T_{STG} -65 to +150 $^{\circ}\text{C}$

DC ELECTRICAL SPECIFICATIONS

<Unless specified: VCC =4.75V to 12.6V;GND=PGND;VSENSE=V_O;V_{BOOSTL}=12V;V_{BOOSTH-PHASE}=12V;T_A =25 $^{\circ}\text{C}$ >

Parameter	CONDITIONS	MIN	TYP	MAX	UNITS
Power Supply					
Supply Voltage	V _{CC}	4.2		12.6	V
Supply Current	EN=V _{CC}		6	10	mA
Line Regulation	V _O =2.5V		0.5		%
Reference					
Reference voltage		1.252	1.265	1.278	V
Accuracy		-1		+1	%
Protection					
Dead Time		45		100	nS
Over Current Protection I _{SINK}	2.0V V _{OCP} 12V	180	200	220	μA
Soft Start					
Charge Current	V _{SS} =1.5V	8	10	12	μA
Discharge Current	V _{SS} =1.5V	1.3	2	2.4	μA
Error Amplifier					
Gain(AOL)			35		dB
Input Bias			5	8	μA
Oscillator					
Oscillator Frequency		180	200	220	KHz
Oscillator Max Duty Cycle		90	95		%
MOSFET Drivers					
DH Source/Sink	V _{BOOSTH} -V _{DH} =4.5V,	1			A

NIKO-SEM Synchronous Voltage Mode Controller for Distributed Power Supply Application

N2101VG
SOP-14
Lead Free

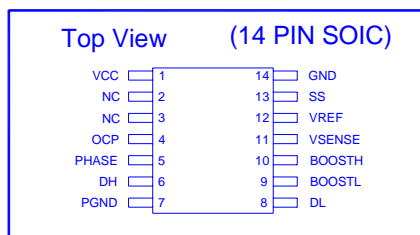
	$V_{DH} - V_{PHASE} = 2V$				
DL Source/Sink	$V_{BOOSTL} - V_{DL} = 4.5V,$ $V_{DL} - V_{PGND} = 2V$	1			A

Notes:

(1) This device is ESD sensitive. Use of standard ESD handling precautions is required.

Orders for parts with Lead-Free plating can be placed using the NXXXXXG parts name.

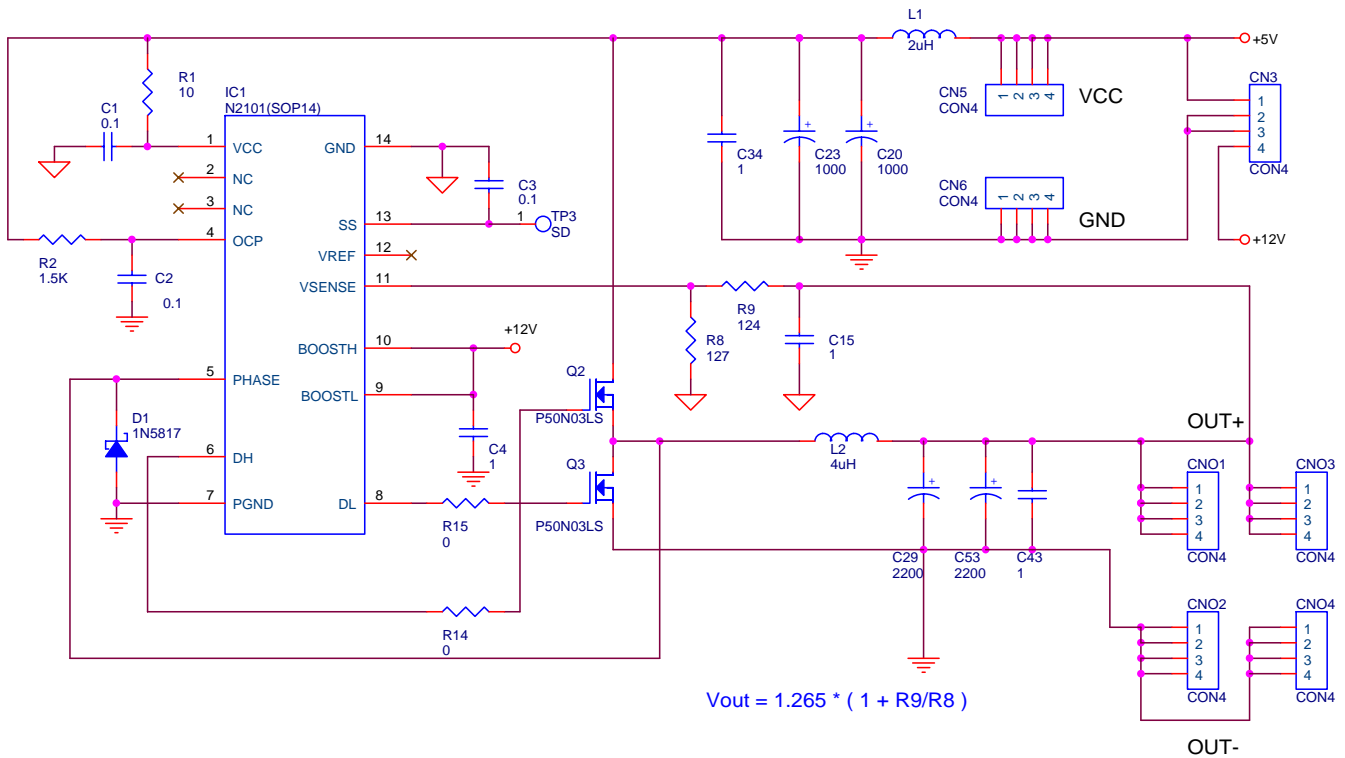
PIN CONFIGURATIONS



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TYPICAL APPLICATION



PIN DEFINITIONS

Pin #	Pin Name	Pin Function Description
1	VCC	Chip supply voltage
2	NC	No connection.
3	NC	No connection.
4	OCP	Sets the converter over current trip point.
5	PHASE	Input from the phase node between the MOSFET'S.
6	DH	High side driver output.
7	PGND	Power ground.
8	DL	Low side driver output.
9	BOOSTL	Bootstrap, low side driver.
10	BOOSTH	Bootstrap, high side driver.
11	VSENSE	Output Voltage Sense input.
12	VREF	Buffered band gap voltage reference.
13	SS	Soft start. Connecting a capacitor from this pin to AGND. Set the slow start time.
14	GND	Small Signal Analog.

APPLICATIONS INFORMATION – FUNCTIONAL DESCRIPTION

Synchronous Buck Converter

Primary V_{CORE} power is provided by a synchronous, voltage-mode pulse width modulated (PWM) controller. This section has all the features required to build a high efficiency synchronous buck converter, shut-down, and cycle-by-cycle current limit.

The output voltage of the synchronous converter is set and controlled by the output of the error amplifier. The external resistive divider reference voltage is derived from an internal trimmed-bandgap voltage reference (See Fig.1). The inverting input of the error amplifier receives its voltage from the VSENSE pin.

The internal oscillator uses an on-chip capacitor and trimmed precision current sources to set the oscillation frequency to 200kHz. The triangular output of the oscillator sets the reference voltage at the inverting input of the comparator. The non-inverting input of the comparator receives its input voltage from the error amplifier. When the oscillator output voltage drops below the error amplifier output voltage, the comparator output goes high. This pulls DL low, turning off the low-side FET, and DH is pulled high, turning on the high-side FET (once the cross-current control allows it). When the oscillator voltage rises back above the error amplifier output voltage, the comparator output goes low. This pulls DH low, turning off the high-side

FET, and DL is pulled high, turning on the low-side FET (once the cross-current control allows it).

As VSENSE increases, the output voltage of the error amplifier decreases. This causes a reduction in the on-time of the high-side MOSFET connected to DH, hence lowering the output voltage.

Under Voltage Lockout

The under voltage lockout circuit of the N2101 assures that the high-side MOSFET driver outputs remain in the off state whenever the supply voltage drops below set parameters. Lockout occurs if VCC falls below 4.1V. Normal operation resumes once VCC rises above 4.2V.

Soft Start

Initially, SS pin sources 10uA of current to charge an external capacitor. The outputs of the error amplifiers are clamped to a voltage proportional to the voltage on SS pin. This limits the on-time of the high-side MOSFETs, thus leading to a controlled ramp-up of the output voltages.

$R_{DS(ON)}$ Current Limiting

The current limit threshold is set by connecting an external resistor from the VCC supply to OCP pin. The voltage drop across this resistor is due the 200uA internal sink sets the voltage at the pin. This voltage is compared to the voltage at the PHASE node. This comparison is made only when the high-side drive is high to avoid false current limit triggering due to uncontributing measurements from the MOSFETs off-voltage. When the voltage at PHASE is less than the voltage at OCP, an over current condition occurs and the soft start cycle is initiated. The synchronous switch turns off and SS starts to sink 2uA. When SS reaches 0.8V, it then starts to source 10uA and a new cycle begins.

Hiccup Mode

During power up, the SS pin is internally pulled low until VCC reaches the under voltage lockout level of 4.2V. Once VCC has reached 4.2V, the SS pin is released and begins to source 10μ A of current to the external soft-start capacitor. As the soft-start voltage rises, the output of the internal error amplifier is clamped to this voltage. When the error signal reaches the level of the internal triangular oscillator, which swings from 1V to 2V at a fixed frequency of 200kHz, switching occurs. As the error signal crosses over the oscillator signal, the duty cycle of the PWM signal continues to increase until the output comes into regulation.

If an over-current condition has not occurred the soft-start voltage will continue to rise and level off at about 2.2V.

An over-current condition occurs when the high-side drive is turned on, but the PHASE node does not reach the voltage level set at the OCP pin. The PHASE node is sampled only once per cycle during the valley of the triangular oscillator. Once an over-current occurs, the high-side drive is turned off and the low-side drive turns on and SS pin begins to sink 2uA. The soft-start voltage will begin to decrease as the 2uA of current discharges the external capacitor. When the soft-start voltage reaches 0.8V, the SS pin will begin to source 10uA and begin to charge the external capacitor causing the soft-start voltage to rise again. Again, when the soft-start voltage reaches the level of the internal oscillator, switching will occur.

If the over-current condition is no longer present, normal operation will continue. If the over-current condition is still present, the SS pin will again begin to sink 2uA. This cycle will continue indefinitely until the over-current condition is removed.

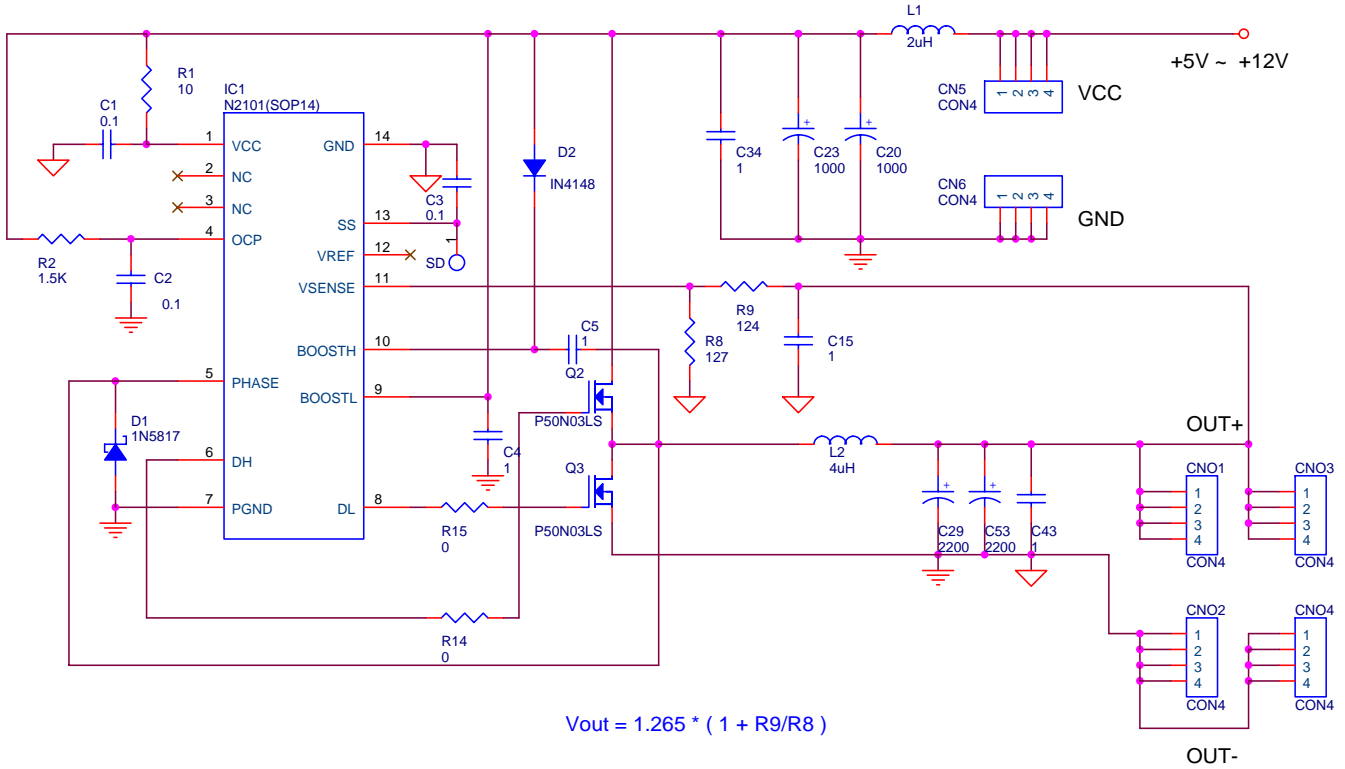
In conclusion, below is shown a typical "12V Application Circuit" which has a BOOSTH voltage derived by bootstrapping input voltage to the PHASE node through diode D1. This circuit is very useful in cases where only input power of 12V is available.

In order to prevent substrate glitching, a small-signal diode should be placed in close proximity to the chip with cathode connected to PHASE and anode connected to PGND.

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TYPICAL SINGLE VOLTAGE APPLICATION CIRCUIT WITH BOOTSTRAPPED BOOSTH



Typical Characteristics

VCC=5V VO=2.5V IO=10A

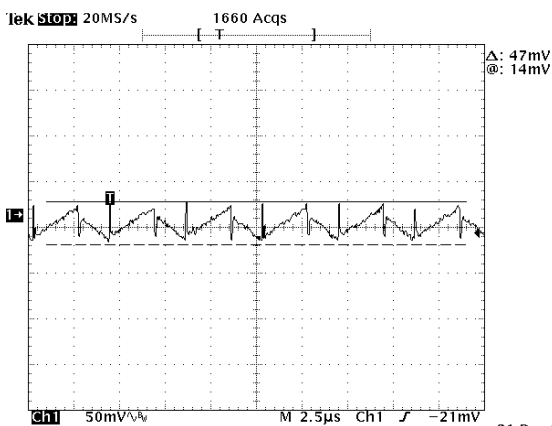


FIG.1 OUTPUT RIPPLE VOLTAGE

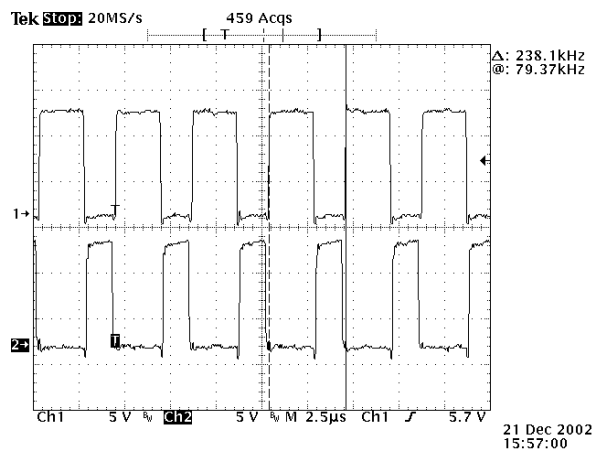


FIG.2 GATE DRIVER WAVEFORMS

UPPER : HIGH SIDE

LOWER : LOW SIDE

SOIC-14 (D) MECHANICAL DATA

Dimension	mm			Dimension	mm		
	Min.	Typ.	Max.		Min.	Typ.	Max.
A	8.5		8.8	H	0.4		1.27
B	3.8		4.0	I	0.18		0.25
C	5.8		6.2	J		0.22	
D	0.33		0.51	K	0°		8°
E		1.27		L			
F			1.75	M			
G	0.1		0.3	N			

