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PWM Step-down DC-DC Controller IC
CN5208

General Descriptions:

The CN5208 is a switch-mode PWM step-down DC-DC controller using few external components. It achieves 5A continuous output current over a wide input supply range with excellent load and line regulation. The output voltage is internally set at 5V.

The high switching frequency of 550KHz allows tiny external components to be usable. The CN5208 is designed to be stable with ceramic output capacitor. Pulse skipping mode is adopted under light load for high efficiency. Furthermore, the low operating current and low dropout operation make the CN5208 is suitable for battery powered systems.

Fault protection includes cycle-by-cycle current limit, short output protection and output overvoltage protection. In shutdown mode, the CN5208 draws only 7.5μA(VCC=15V) of supply current. On-chip soft-start minimizes the inrush supply current and the output overshoot at initial startup.

The CN5208 is available in a space-saving 8-pin SOP package.

Applications:

- Car Charger
- Set-Top Box, Modems
- Pre-regulator
- Distributed Power Systems
- Battery Chargers

Features:

- Wide Input Voltage: 4.8V to 32V
- Operating with an External P-Channel MOSFET
- Output Current Up to 5A
- Fixed Switching Frequency: 550KHz
- Fixed Output Voltage with 1% Accuracy
- Efficiency up to 95%
- Low Drop-Out Mode
- Stable with Low-ESR Output Ceramic Capacitor
- On-Chip Power-On Delay to Debounce Input Supply
- Cycle-by-Cycle Current Limit
- Overvoltage protection
- Frequency Foldback for Output Short Circuit Protection
- Built-in Soft Start
- High Efficiency at Light Load with Pulse Skipping Mode
- Shutdown Curent: 7.5uA typical at 15V
- Operating Ambient Temperature $-40℃$ to $+85℃$
- Available in 8-Pin SOP Package
- Pb-free, Rohs-Compliant, Halogen Free

Pin Assignment:
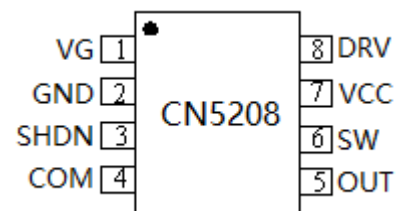
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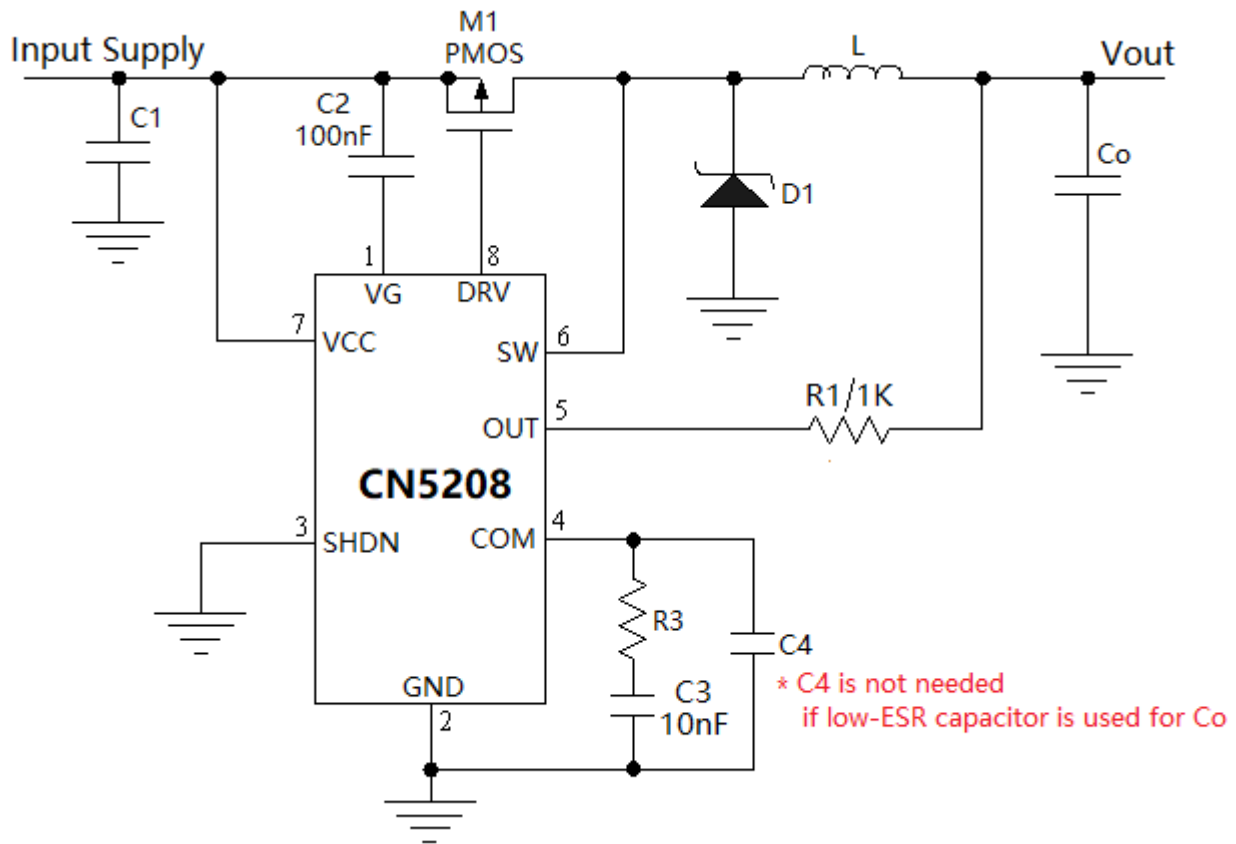## Typical Application Circuit:

Figure 1   Typical Application Circuit

In Figure 1,

- C2 is 100nF (0603)
- C3 is 10nF (0603)
- R1 is 1K ohm (0603 or 0402)
- Please refer to section of Application Information for the selection of the other components

Ordering Information:

Part No.	Shipment	Output Voltage	Operating Ambient Temperature
CN5208	Tape and Reel, 4000/Reel	5V	−40℃ to ＋85℃

CONSONANCE

Pin Description:

Pin No.	Name	Descriptions
1	VG	**Internal Voltage Regulator Output.** VG internally supplies power to gate driver, connect a 100nF capacitor between VG pin and VCC pin.
2	GND	**Ground.** Negative terminal of input supply.
3	SHDN	**Shutdown Input.** Applying a voltage of above 2.2V at this pin puts the CN5208 into low-current shutdown mode; The CN5208 will be back to normal operation if this pin voltage is pulled below 0.5V after a typical delay of 13ms. Do NOT apply a voltage between 0.5V to 2.2V to SHDN pin, otherwise the CN5208 may be in uncertain state.
4	COM	**Frequency Compensation Input.** The closed-loop's frequency compensation network is connected at this pin.
5	OUT	**Output Voltage Sensing Input.** It monitors the converter's output voltage, and the the positive terminal of the output bypass capacitor is connected.
6	SW	**Switching Node.** The inductor and the cathode of the freewheeling diode should be connected to this pin. The voltage swing of SW pin is from a diode drop below Ground to VCC.
7	VCC	**Unregulated DC Power Supply.** VCC is also the power supply for CN5208 internal circuit. Bypass this pin with capacitors.
8	DRV	**Gate Drive Pin.** Drive the gate of external P-channel MOSFET, connect DRV pin to the gate of the external P-channel MOSFET.

Absolute Maximum Ratings

Voltage from VCC, VG, SW, DRV, to GND…………….………………….…$-0.3V$ to 36V

Voltage from VG to VCC……………………………………………...……$-8V$ to $+0.3V$

Voltage from OUT, SHDN and COM to GND……………..………………$-0.3V$ to 6.5V

Storage Temperature……………………………………………………...…$-65℃$ to 150℃

Operating Ambient Temperature……………………………………..………$-40℃$ to 85℃

Lead Temperature(Soldering, 10 seconds)………………………………..……260℃

Stresses beyond those listed under 'Absolute Maximum Ratings' may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these or any other conditions above those indicated in the operational sections of the specifications is not implied. Exposure to Absolute Maximum Rating Conditions for extended periods may affect device reliability.

CONSONANCE

Electrical Characteristics:

(VCC＝15V, T_A＝－40℃ to 85℃, unless otherwise noted)

Parameters	Symbol	Conditions	Min	Typ	Max	Unit
Input Voltage Range	VCC		4.8		32	V
Under voltage lockout Threshold	UVLO		3.6	4.2	4.7	V
Operating Current	I_{VCC}	V_{OUT}＝5.5V, No switching	360	460	560	uA
Regulated Output Voltage	V_{OUT}		4.95	5	5.05	V
OUT Pin Current	I_{OUT}	V_{OUT}＝5V	6	9	12	uA
Overvoltage Trip Level	Vov	Output voltage rises	1.04	1.06	1.08	%V_{OUT}
Overvoltage Clear Level	Vclr	Output voltage falls	1.0	1.02	1.04	
Power-on Delay	t_{delay}		10	13	16	ms
Soft Start Time	tss		44	52	60	ms
Inductor Current Limit						
Current Limit Threshold	V_{ILIM}	VCC－V_{SW}, Temp＝25℃	108	120	132	mV
Temperature Coefficient	TC_{ILIM}			+0.35		mV/℃
Propagation Delay	PD	20mV Overdrive		220		ns
Oscillator						
Switching Frequency	f_{osc}		450	550	650	kHZ
Maximum Duty Cycle	Dmax			100		%
Foldback Frequency	f_{fold}	V_{OUT}＝0V	90	110	130	KHz
SHDN Pin						
Input Voltage High	V_{IH}		2.2			V
Input Voltage Low	V_{IL}				0.5	V
SHDN Bias Current	I_{SHDN}		－100	0	＋100	nA
DRV Pin						
V_{DRV} High (VCC－V_{DRV})	VH	I_{DRV}＝－10mA		60		mV
V_{DRV} Low (VCC－V_{DRV})	VL	I_{DRV}＝0mA		6.3		V
Rise Time	t_r	Cload＝2nF, 10% to 90%	30	40	65	ns
Fall Time	t_f	Cload＝2nF, 90% to 10%	30	40	65	ns

Note: V_{OUT} is the regulated output voltage.

Detailed Description:

The CN5208 is an asynchronous step-down (buck) DC to DC controller that drives an external P-channel MOSFET with few external components. The CN5208 regulates the output voltage with fixed frequency PWM mode, the wide input voltage range is from 4.8V to 32V, the output voltage is internally fixed at 5V, and the maximum output current can be up to 5A. The pulse skipping mode is adopted under light load conditions for high efficiency. The switching frequency is fixed at 550KHz, which makes the low-profile inductor usable in the application circuit.

The on-chip resistor divider, high precision bandgap voltage and error amplifier make the accuracy of the output voltage within 1%. CN5208's current consumption is only 460uA (Typical), also low drop-out mode is adopted when input voltage is close to the output voltage, which make the device suitable for battery powered system.

CONSONANCE

The frequency foldback reduces the switching frequency to 110KHz by increasing off time during overcurrent conditions or short circuit condition to help control the inductor current.

The other fault protection includes overvoltage protection, cycle-by-cycle inductor current limit, etc.

The input high level of shutdown input (SHDN) puts the CN5208 into low-current shut down state

The on-chip soft start can limit the inrush current on power up, or SHDN being pulled low from high level, or release from short circuit.

Application Information

Under voltage Lockout (UVLO)

An under voltage lockout circuit monitors the input voltage and keeps CN5208 off if VCC falls below 4.7V (Maximum). The CN5208 begins functioning only after VCC rises above 4.7V and a 13ms (Typical) delay expires. The delay can debounce the input supply.

Shutdown Mode

The SHDN pin is active high shutdown input. Pulling this pin above 2.2V causes the CN5208 to completely shut down and enters a low current state, in which the current consumption is only 7.5uA typical when VCC is 15V. Pulling SHDN pin below 0.5V brings the CN5208 back to normal operation after a delay of 13ms (Typical). Do NOT apply a voltage between 0.5V to 2.2V to SHDN pin, otherwise the CN5208 may be in uncertain state.

Soft Start

The built-in soft start circuit can limit the inrush current, and can be activated by events of power up, or SHDN being pulled low from high level, or release from short circuit.

The typical duration time of soft start is 52ms.

Overvoltage Protection

An overvoltage comparator guards against transient overshoots and other conditions that may overvoltage the output. Once the over voltage is asserted, the P-channel MOSFET is turned off until the overvoltage condition is cleared. Typically the over voltage is asserted when output voltage is 5.8% higher than the nominal value, and is cleared when the output voltage falls below 102.2% of nominal value.

Cycle-by-Cycle Current Limit

The CN5208 has cycle-by-cycle current limit control, the inductor current is monitored during the on-state of the external P-channel MOSFET by sensing the voltage drop across the on-resistance of the P-channel MOSFET. If the voltage across the on-resistance exceeds the preset threshold, the power MOSFET is turned off to prevent the inductor current from further increasing. The CN5208 supports temperature-compensated current limit threshold.

The propagation delay with the current limit circuit block is 220ns (20mV Overdrive). So the actual maximum inductor current is decided by the following equation after taking the propagation delay into consideration:

$$I_{LMAX} = \frac{V_{ILIM}}{Rdson} + 220 \times 10^{-9} \times \frac{VIN-Vout}{L}$$

Where:

I_{LMAX} is the maximum inductor current

V_{ILIM} is the current limit threshold

Rdson is the on resistance of the external P-channel MOSFET

Short-Circuit Protection and Frequency Foldback

In addition to the cycle-by-cycle current limit, the CN5208 also includes the frequency foldback circuit to further limit the inductor current from runaway or short circuit at the output. In these cases, the switching frequency is reduced to 110KHz from 550KHz by increasing the off time, the duty cycle is kept very low, hence the inductor current is further limited.

CONSONANCE

Gate Drive

The CN5208's gate driver can provide high transient current to drive the external pass transistor. The rise and fall times are typically 35ns when driving a 2000pF load, which is typical for a P-channel MOSFET with Rds(on) in the range of 20m Ω .

A voltage clamp is added to limit the gate drive to 8V max. below VCC. For example, if VCC is 20V, then the DRV pin output will be pulled down to 12V min. This allows low voltage P-channel MOSFETs with superior Rds(on) to be used as the pass transistor, which increases efficiency.

Input Capacitor

The input voltage source impedance and cable length determine the size of the input capacitor, which is typically in the range of 10μF to 50μF. The input bypass capacitor should have low impedance at the frequency of 550KHz. A low ESR capacitor or two type of capacitors in parallel is recommended. For the low ESR capacitors, high-quality ceramic type X5R or X7R is recommended. The voltage rating should be greater than the maximum input voltage.

The input ripple voltage can be approximated by the following equation:

$$V_{INrip} = \frac{0.25 \times I_{OMAX}}{f_{SW} \times C1} + ESR \times I_{OMAX}$$

Where,

V_{INrip} is the ripple voltage at input supply

I_{OMAX} is the maximum output current in Ampere

f_{SW} is the switching frequency (550KHz)

C1 is the intput bypass capacitor in Farad

ESR is the equivalent series resistance of C1

Please note that the input capacitor can see a very high surge current during loading transient and solid tantalum capacitors can fail catastrophically under these conditions.

Output Capacitor

The output capacitor keeps the output voltage ripple small and ensures feedback loop stability. The CN5208 is designed to be stable with low-ESR ceramic capacitor at output. The output capacitor impedance should be low at the switching frequency. Ceramic capacitors with X5R or X7R dielectrics are highly recommended for their low ESR characteristics. When choosing the output capacitor, special consideration should be given to the voltage coefficient of the capacitor, since the capacitance may be reduced by the applied DC bias voltage.

The output voltage ripple can be estimated by the following equation:

$$Vripple = 0.3 I_{oMAX} \times \left[ESR + \frac{1}{8 f_{SW} \times Co} \right]$$

Where,

V_{ripple} is the output voltage ripple in Volt

I_{OMAX} is the maximum output current in Ampere

f_{SW} is the switching frequency (550KHz)

C_O is the output bypass capacitor in Farad

ESR is the equivalent series resistance of C_O

If an electrolytic capacitor is used, it is highly recommended to put a low-ESR ceramic capacitor in parallel with the electrolytic capacitor.

CONSONANCE

MOSFET Selection

The CN5208 uses a P-channel power MOSFET to regulate the output voltage. The MOSFET must be selected to meet the maximum output current and the efficiency or power dissipation requirements of the application circuit as well as the maximum temperature of the MOSFET. The important parameters for the power MOSFET are the breakdown voltage BV_{DSS}, the turn-on voltage, the on resistance R_{dson}, the total gate charge Q_g, the reverse transfer capacitance C_{RSS} and the maximum drain current I_D.

The peak-to-peak gate drive voltage is set internally, this voltage is typically 6V. Consequently, logic-level threshold MOSFETs must be used. The maximum turn-on voltage should be less than 3V.

The MOSFET power dissipation at maximum output current is approximated by the equation:

$$Pd = \frac{V_{OUT}}{VCC} \times Rds(on) \times I_{OUT}^2 \times (1 + 0.005 dT)$$

Where:

Pd is the power dissipation of the power MOSFET

V_{OUT} is the maximum battery voltage

VCC is the minimum input voltage

Rds(on) is the power MOSFET's on resistance at room temperature

I_{OUT} is the output current

dT is the temperature difference between actual ambient temperature and room temperature(25℃)

In addition to the $I^2Rds(on)$ loss, the power MOSFET still has transition loss, which are highest at the highest input voltage. Generally speaking, for VIN＜20V, the $I^2Rds(on)$ loss may be dominant, so the MOSFET with lower Rds(on) should be selected for better efficiency; for VIN＞20V, the transition loss may be dominant, so the MOSFET with lower C_{RSS} can provide better efficiency. C_{RSS} is usually specified in the MOSFET characteristics; if not, then C_{RSS} can be calculated using $C_{RSS} = Q_{GD}/\Delta V_{DS}$.

The CN5208 performs cycle-by-cycle inductor current sensing by monitoring the voltage across the on-resistance of the power MOSFET, so the MOSFET's on-resistance should be chosen based on the required output current. The current limit threshold voltage is temperature compensated to comply with the MOSFET's on-resistance variation with temperature. The following equation is a good guide for determining the required $R_{dson(MAX)}$ at V_{GS}=4.5V, 25°C (manufacturer's specification), allowing some margin for ripple current, current limit and variations in the CN5208 and external component values:

$$Rdson(MAX) \cong \frac{90mV}{Io(MAX)}$$

Diode Selection

The diode D1 in Figure 1 is Schottky diode that has the current rating larger than the output current limit, and the reverse breakdown voltage exceeding the maximum expected input voltage.

However, if the Schottky diode The diode that is much larger than that is sufficient can result in larger transition losses due to their larger junction capacitance.

Inductor Selection

The inductor current ramps up/down when the P-channel MOSFET is turned on/off, its ripple increases with lower inductance or higher input voltage. Higher inductor ripple current results in higher ripple voltage and greater core losses. So the inductor's ripple current should be limited within a reasonable range.

An inductor should be chosen that can carry the maximum output current, also the ripple current is limited to 30% of maximum output current. The inductor's saturation current should be at least 1.5 times of the maximum output current.

CONSONANCE

The following equation is used to calculate the minimum value of the inductor:

$$L_{MIN} = \frac{V_{OUT(MAX)} \times \left(V_{IN(MAX)} - V_{OUT}\right)}{V_{IN(MAX)} \times 0.3 \times I_{OUT} \times f_{SW}}$$

Where, f_{SW} is the switching frequency, here is 550KHz.

For most applications, a 4.7µH to 27µH inductor with a DC current rating of at least 30% higher than the maximum output current is recommended.

Frequency Compensation Network Design

Figure. 2 shows the AC response-related circuit of a step-down DC-DC Converter using the CN5208.
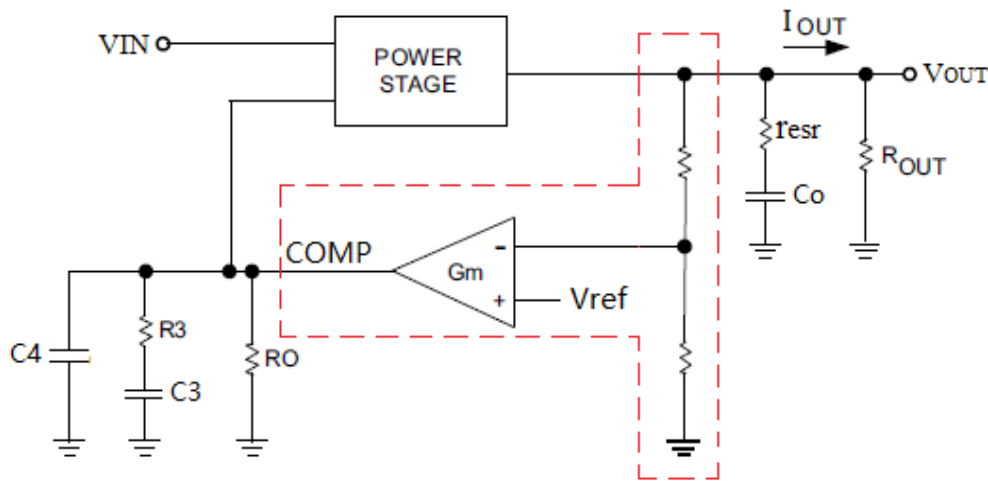

Figure 2   AC Response-Related Circuit

The inductor, output bypass capacitor and the load resistance R_{OUT} form 2 poles and 1 zero, they are:

● The double pole formed by inductor and output capacitor:

$$\omega_{p1,P2} = \frac{1}{\sqrt{LC_O}}$$

● The zero formed by the output capacitor and its equivalent series resistance(ESR)

$$\omega_{z1} = \frac{1}{r_{esr} C_O}$$

This zero ω_{z1} can be neglected if low ESR ceramic capacitor is used.

In the above 2 equations, C_O is the output bypass capacitance, r_{esr} is the ESR of output bypass capacitor, and L is the inductance.

In Fig. 2, C3, C4 and R3 form the compensation network. The design procedure of the compensation network is:

Step 1: Calculate ω_{P1}, ω_{p2} and ω_{z1} based on the above 2 equations

Step 2: Make the zero ω_z formed by R3 and C3 around $0.7*\omega_{P1}$, and make C3 equal to 10nF, then R3 value can be calculated by the following equation:

$$R3 = \frac{1}{\omega_z C3} - 1800$$

Where, ω_z equals to $0.7\omega_{P1}$

R3's unit is ohm.

Step 3: Determine C4's value in Farad (F)

R3 and C4 form a pole to cancel the effect of ω_{z1}. If low ESR capacitor is used for output capacitor Co, ω_{z1} can be neglected. To be exact, C4 is not needed if ω_{z1} is greater than 250KHz. If needed, C4 can be calculated by the following equation:

$$C4 = \frac{0.8}{R3 \bullet \omega_{z1}}$$

Application Circuit for Input Voltage Beyond 20V

When the input supply is applied to the input bypass low-ESR ceramic capacitors of the DC-DC converter, voltage spikes may be created in case of long cable, and these voltage spikes can easily be twice the amplitude of input voltage, which may damage the CN5208 or P-channel MOSFET shown in Figure 1 if the input voltage is high..

To prevent the CN5208 and P-channel MOSFET from being damaged by the voltage spike, the voltage rating of the P-channel MOSFET should be higher than the voltage spike. A low-pass RC filter should be added to protect CN5208 as shown in Figure 3 if the input voltage is higher than 20V. Resistor R5 and capacitor C5 are used to filter out the input voltage spike. R5's value can be 5.1ohm (0805), C5's capacitance can be 10uF (0805).
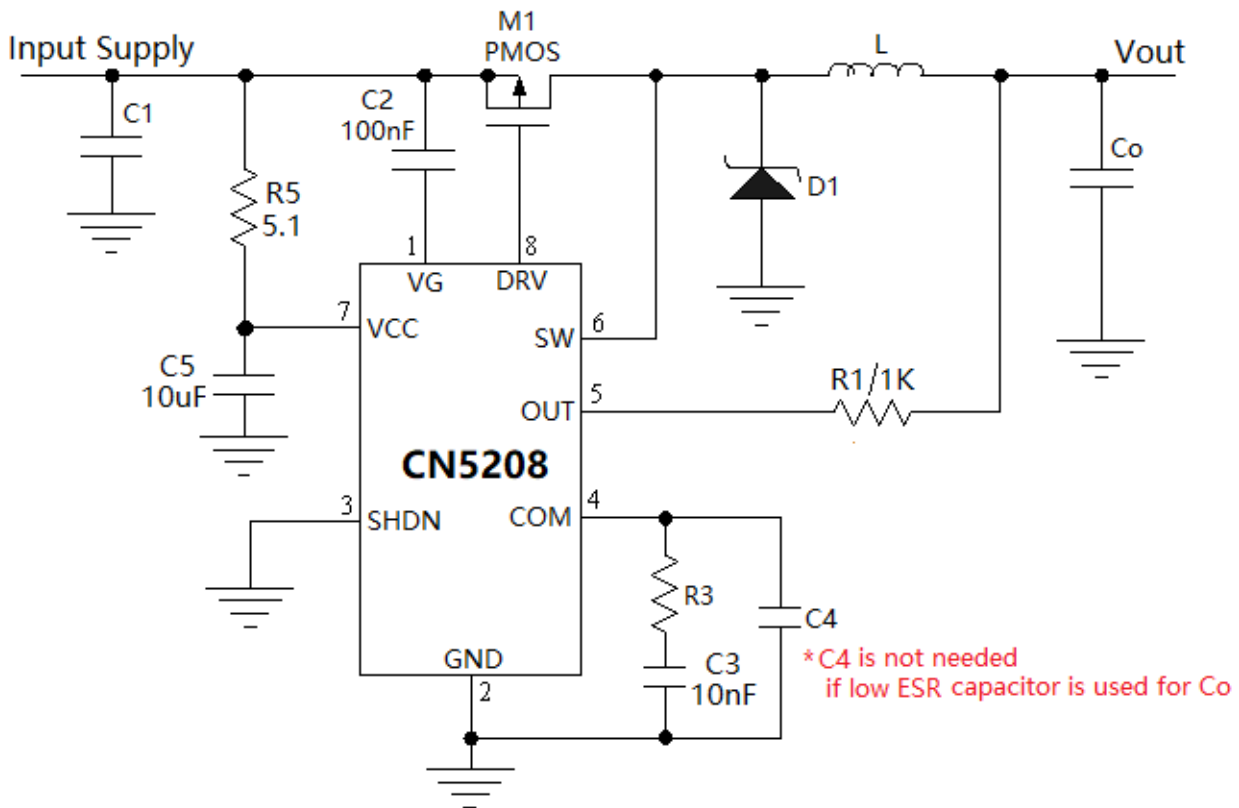

Figure 3   Protect CN5208 from Input Voltage Spike

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Design Procedure

The following 6 steps of design procedure should be followed to determine the converter's circuit parameters.

Step 1: Select Input Capacitor

The input bypass capacitor is decided by the requirement of the ripple voltage at input supply.

Generally speaking, the ripple voltage of input supply should be kept below 0.2V. The ripple voltage is approximately decided by the following equation:

$$V_{INrip} = \frac{0.25 \times I_{OMAX}}{f_{SW} \times C1} + ESR \times I_{OMAX}$$

Step 2: Select Output Capacitor

The output bypass capacitor is also decided by the requirement of output ripple voltage. Ceramic capacitors with X5R or X7R dielectrics are highly recommended for their low ESR characteristics. The output ripple voltage is estimated by the following equation:

$$V_{ripple} = 0.3 I_{oMAX} \times \left[ESR + \frac{1}{8 f_{SW} \times C_o} \right]$$

Step 3: Select P-channel MOSFET

The important parameters for the P-channel MOSFET are the breakdown voltage BV_{DSS}, the turn-on voltage, the on resistance R_{dson}, the total gate charge Q_g, the reverse transfer capacitance and the maximum drain current I_D. The maximum turn-on voltage should be less than 3V.

The maximum on-resistance at V_{GS}=4.5V, 25°C (manufacturer's specification) should meet the requirement of the following equation:

$$R_{dson(MAX)} \cong \frac{90mV}{I_{o(MAX)}}$$

Step 4: Select Diode

The diode D1 in Figure 1 is Schottky diode that has the current rating larger than the output current limit, and the reverse breakdown voltage exceeding the maximum expected input voltage.

Step 5: Select Inductor

An inductor should be chosen that can carry the maximum output current, also the ripple current is limited to 30% of maximum output current.

The inductor's saturation current should be at least 1.5 times of the maximum output current.

The inductance is estimated by the following equation:

$$L_{MIN} = \frac{V_{OUT(MAX)} \times \left(V_{IN(MAX)} - V_{OUT} \right)}{V_{IN(MAX)} \times 0.3 \times I_{OUT} \times f_{SW}}$$

Step 6: Design Compensation Network

Design the parameters of R3, C3 and C4 in Figure 1 according to the converter's poles and zero decided by the inductor, output capacitor and its ESR, etc.

CONSONANCE

Design Example

For this design example, use the following as the input parameters:

Design Parameter	Example Value
Input Voltage	20V
Output Voltage	5.0V
Maximum Output Current	5A
Input Ripple Voltage	0.2V
Output Ripple Voltage	50mV

(1) Choose the input capacitor C1

The ceramic capacitor is chosen for input bypass capacitor, it is supposed that its ESR is 20mohm. The required input capacitance can be calculated by solving the following equation with the input parameters of V_{INrip}=0.2V, I_{OMAX}=5A, f_{SW}=550KHz, ESR=20mohm:

$$V_{INrip} = \frac{0.25 \times I_{OMAX}}{f_{SW} \times C1} + ESR \times I_{OMAX}$$

The input bypass capacitor should be 22.7uF at least, so two 22uF(1206) ceramic capacitors in parallel can be used as the input bypass capacitor in light of the capacitor's voltage coefficient.

(2) Choose the output capacitor C_O

The ceramic capacitor is chosen for output bypass capacitor, it is supposed that the ESR is 20mohm. The required output capacitance can be calculated by solving the following equation with the input parameters of V_{ripple}=50mV, I_{OMAX}=5A, f_{SW}=550KHz, ESR=20mohm:

$$Vripple = 0.3 I_{oMAX} \times \left[ESR + \frac{1}{8 f_{SW} \times Co} \right]$$

The output bypass capacitor should be 17uF at least, so two 22uF(1206) ceramic capacitors in parallel are used as the output bypass capacitor, or at least three 10uF(0805) ceramic capacitors in parallel are used as the output bypass capacitor in light of the capacitor's voltage coefficient.

(3) Select the P-channel MOSFET

The P-channel MOSFET's on resistance should meet the following requirement:

$$Rdson_{(MAX)} \cong \frac{90mV}{Io_{(MAX)}}$$

The Rdson(max) is 20mohm, so AOD4185 with 20mohm on-resistance at 4.5V is selected.

(4) Select the Schottky diode D1

The schottky diode 1N5824 is selected.

(5) Select the inductor

The inductor should have a saturation current of at least 7.5A, and inductance should meet the requirement of the following equation:

$$L_{MIN} = \frac{V_{OUT(MAX)} \times \left(V_{IN(MAX)} - V_{OUT} \right)}{V_{IN(MAX)} \times 0.3 \times I_{OUT} \times f_{SW}}$$

The inductance should be 4.5uH at least, so we choose a 4.7uH inductor.

CONSONANCE

(6) Calculate the compensation network

With inductor of 4.7uH and C_O of 44uF, the poles ω_{P1} and ω_{p2} are calculated by the following equation:

$$\omega_{p1,P2} = \frac{1}{\sqrt{LC_O}}$$

So ω_{P1} and ω_{p2} are at 69.5KHz, then the zero formed by R3 and C3 should be at $0.7\omega_{P1}$, namely ω_z is at 48.7KHz. According to the equation:

$$R3 = \frac{1}{\omega_z C3} - 1800$$

With C3 at 10nF and ω_z at 48.7KHz, R3 is calculated at 253ohm, round up to the nearest standard value, the 270ohm resistor can be chosen for R3.

Since low-ESR ceramic capacitor is used for output capacitor C_O, C4 is not needed.

Circuit Parameters for some Typical Cases

Table 1 to Table 4 list the circuit parameters under some typical application conditions, the circuit parameters in the tables are corresponding to the application circuit shown in Figure 1.

Disclaimer:

The circuit parameters listed in the following 4 tables are for reference only, it is not a suggestion, and may or may not be followed. The actual application circuit and its parameters should be strictly designed based on each application's operating conditions and environment.

Table 1   Input Voltage VCC＝8V, V_{OUT}＝5V with I_{OMAX}＝1A,2A,3.5A and 5A

Parameters	I_{OMAX}＝1A	I_{OMAX}＝2A	I_{OMAX}＝3.5A	I_{OMAX}＝5A
C1	Ceramic capacitor, 10uF,0805	Ceramic capacitor, 22uF,1206	Ceramic capacitor, Two (22uF,1206) in parallel	Ceramic capacitor, Two (22uF,1206) in parallel
C2	100nF, 0603	100nF, 0603	100nF, 0603	100nF, 0603
Co	Ceramic capacitor, (10uF,0805) or (22uF,1206)	Ceramic capacitor, (22uF,1206)	Ceramic capacitor, Two (22uF,1206) in parallel	Ceramic capacitor, Two (22uF,1206) in parallel
C3	10nF, 0603	10nF, 0603	10nF, 0603	10nF, 0603
C4	No need	No need	No need	No need
R1	1Kohm, 0603/0402	1Kohm, 0603/0402	1Kohm, 0603/0402	1Kohm, 0603/0402
R3	510 ohm, 0603/0402	150 ohm, 0603/0402	300 ohm, 0603/0402	390 ohm, 0603/0402
M1(P-MOS)	AO3401A,AO3407A SI2305	SI4435	AO4407A,AON7403	AO4407A, SI4425
D1	SS24 or SS34	SS34	SS54,1N5824	1N5824
L	12uH or 15uH	6.8uH or 10uH	4.7uH or 6.8uH	4.7uH

CONSONANCE

Table 2   Input Voltage VCC＝15V, V$_{OUT}$＝5V with I$_{OMAX}$＝1A,2A,3.5A and 5A

Parameters	I$_{OMAX}$＝1A	I$_{OMAX}$＝2A	I$_{OMAX}$＝3.5A	I$_{OMAX}$＝5A
C1	Ceramic capacitor, 22uF,1206	Ceramic capacitor, 22uF,1206	Ceramic capacitor, Two (22uF,1206) in parallel	Ceramic capacitor, Two (22uF,1206) in parallel
C2	100nF, 0603	100nF, 0603	100nF, 0603	100nF, 0603
Co	Ceramic capacitor, (10uF,0805) or (22uF,1206)	Ceramic capacitor, (22uF,1206)	Ceramic capacitor, Two (22uF,1206) in parallel	Ceramic capacitor, Two (22uF,1206) in parallel
C3	10nF, 0603	10nF, 0603	10nF, 0603	10nF, 0603
C4	No need	No need	No need	No need
R1	1Kohm, 0603/0402	1Kohm, 0603/0402	1Kohm, 0603/0402	1Kohm, 0603/0402
R3	820 ohm, 0603/0402	390 ohm, 0603/0402	560 ohm, 0603/0402	560 ohm, 0603/0402
M1(P-MOS)	AO3401A,SI3407A	AO4435, SI4435	AO4407A,AON7403	AO4407A, SI4425
D1	SS24 or SS34	SS34	SS54,1N5824	1N5824
L	22uH	12uH	6.8uH	4.7uH

Table 3   Input Voltage VCC＝24V, V$_{OUT}$＝5V with I$_{OMAX}$＝1A,2A,3.5A and 5A

Parameters	I$_{OMAX}$＝1A	I$_{OMAX}$＝2A	I$_{OMAX}$＝3.5A	I$_{OMAX}$＝5A
C1	Ceramic capacitor, 22uF,1206	Ceramic capacitor, 2 (22uF,1206) in parallel	Ceramic capacitor, Two (22uF,1206) in parallel	Ceramic capacitor, Three (22uF,1206) in parallel
C2	100nF, 0603	100nF, 0603	100nF, 0603	100nF, 0603
Co	Ceramic capacitor, (10uF,0805) or (22uF,1206)	Ceramic capacitor, (22uF,1206)	Ceramic capacitor, Two (22uF,1206) in parallel	Ceramic capacitor, Two (22uF,1206) in parallel
C3	10nF, 0603	10nF, 0603	10nF, 0603	10nF, 0603
C4	No need	No need	No need	No need
R1	1Kohm, 0603/0402	1Kohm, 0603/0402	1Kohm, 0603/0402	1Kohm, 0603/0402
R3	1.2Kohm, 0603/0402	390 ohm, 0603/0402	560 ohm, 0603/0402	5600 ohm, 0603/0402
M1(P-MOS)	SI2319,AO3407A	SI4909,SI7611	AON7403	AOD4185
D1	SS24 or SS34	SS34	SS54,1N5824	1N5824
L	27uH	12uH	6.8uH	4.7uH

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Table 4   Input Voltage VCC＝32V, V$_{OUT}$＝5V with I$_{OMAX}$＝1A,2A,3.5A and 5A

| Parameters	I$_{OMAX}$＝1A	I$_{OMAX}$＝2A	I$_{OMAX}$＝3.5A	I$_{OMAX}$＝5A
C1	Ceramic capacitor, 22uF,1206	Ceramic capacitor, Two (22uF,1206) in parallel	Ceramic capacitor, Two (22uF,1206) in parallel	Ceramic capacitor, Three (22uF,1206) in parallel
C2	100nF, 0603	100nF, 0603	100nF, 0603	100nF, 0603
Co	Ceramic capacitor, (10uF,0805) or (22uF,1206)	Ceramic capacitor, (22uF,1206)	Ceramic capacitor, Two (22uF,1206) in parallel	Ceramic capacitor, Two (22uF,1206) in parallel
C3	10nF, 0603	10nF, 0603	10nF, 0603	10nF, 0603
C4	No need	No need	No need	No need
R1	1Kohm, 0603/0402	1Kohm, 0603/0402	1Kohm, 0603/0402	1Kohm, 0603/0402
R3	1.2Kohm, 0603/0402	1.8Kohm, 0603/0402	1Kohm, 0603/0402	1Kohm, 0603/0402
M1(P-MOS)	SI2319	SI4909, AO4421	AOD4185	AOD4185
D1	SS24 or SS34	SS34	SS54,1N5824	1N5824
L	27uH	15uH	10uH	6.8uH

PCB Layout Considerations

When laying out the printed circuit board, the following considerations should be taken to ensure proper operation of the CN5208.

(1) Input bypass capacitor, P-channel MOSFET, diode, inductor and output bypass capacitor are the power components, and must be placed on one side of PCB (Solder side). The traces of these power components should have sufficient width to handle the required output current.

(2) To minimize radiation, the diode, P-channel MOSFET, inductor, the input bypass capacitor and the output bypass capacitor traces should be kept as short as possible. The positive side of the input capacitor should be close to the source of the P-channel MOSFET; it provides the AC current to the pass transistor. The connection between the diode and P-channel MOSFET should also be kept as short as possible.

(3) The compensation capacitor connected at the COM pin should return to the ground pin of the IC. This will prevent ground noise from disrupting the loop stability.

(4) Output bypass capacitor ground and freewheeling diode (D1 in Figure 1) ground connections need to feed into same copper that connects to the input capacitor ground before flying back into system ground.

(5) Analog ground and power ground (or switching ground) should return to system ground separately.

(6) The ground pins also works as a heat sink, therefore use a generous amount of copper around the ground pins. This is especially important for high VCC and/or high gate capacitance applications.

(7) Place the sensitive small signal nodes such as CN5208's pin 4 (COM) and pin 5 (OUT) away from the switching nodes such as SW pin (Freewheeling diode and inductor are connected) and DRV pin.

(8) For applications with multiple switching power converters connected to the same input supply, ensure that the input bypass capacitance for the CN5208 is not shared with the other converters. AC input current from another converter will cause substantial input voltage ripple that may interfere with proper operation of the CN5208.

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Package Information

SOP8 PACKAGE OUTLINE DIMENSIONS
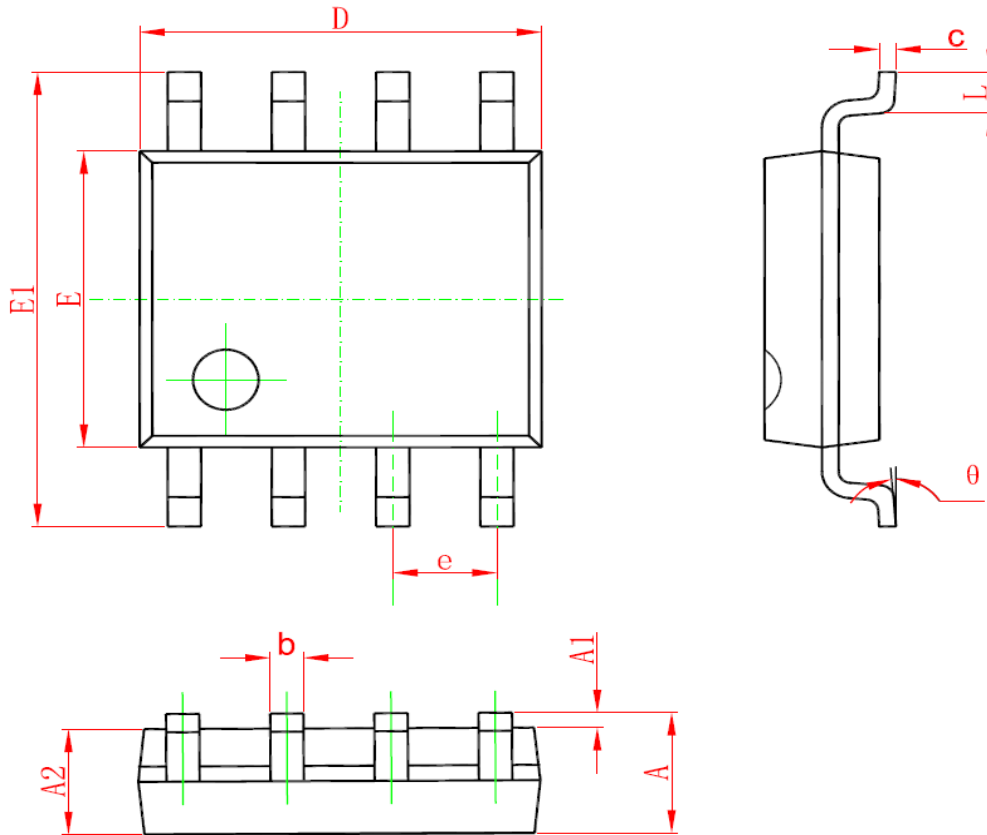
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.350	1.750	0.053	0.069
A1	0.100	0.250	0.004	0.010
A2	1.350	1.550	0.053	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.006	0.010
D	4.700	5.100	0.185	0.200
E	3.800	4.000	0.150	0.157
E1	5.800	6.200	0.228	0.244
e	1.270 (BSC)		0.050 (BSC)	
L	0.400	1.270	0.016	0.050
θ	0°	8°	0°	8°

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