NISSHINBO

NC2702MA000A050-EV

28V Synchronous Back 6A Switching Regulator with Built-in Inductor/MOSFET Evaluation Board

No.EEV-MA000A050-250630

NC2702MA000A050-EV is the evaluation board for NC2702 which has the below features, benefits and specifications.

GENERAL DESCRIPTION

The NC2702MA is a 6 A synchronous step-down switching regulator module with a maximum input of 28 V that incorporates CMOS-based DC / DC controller IC, MOSFETs, and 2.2μH (DCR Typ. 13.7 mΩ) inductor. The space-saving power supply design is easy with the NC2702MA. Also, the switching frequency can be adjusted in the range from 250 kHz to 1 MHz by an external resistor. This product is a high-reliability device for industrial application, that has passed both the inspection at high temperature and the reliability test for considering industrial equipment.

FEATURES

- Input Voltage (Maximum Rating): 4.0 V to 28 V (29 V)
- Operating Temperature Range: -40 °C to 85 °C
- Start-Up Voltage: 4.5 V
- Output Voltage: 0.7 V to 5.3 V
- Feedback Voltage Tolerance: 0.64 V ± 1 %
- Oscillation Frequency: 250 kHz to 1 MHz
- Minimum On-Time: Typ. 100 ns
- Minimum OFF-Time: Typ. 120 ns (at regulation mode)
  At dropout, actual minimum off-time is reduced.
- Duty-Over: Min. 1/4
- Soft-Start
- Power-Good
- Thermal Shutdown
- Under Voltage Lockout (UVLO) Function: VCC = 3.3 V (Typ.)
- Overvoltage Detection (OVD), Undervoltage Detection (UVD)
- High-Side MOSFET ON-Resistance: 9.7mΩ
- Low-Side MOSFET ON-Resistance: 4.7mΩ
- For more details on NC2702 IC, please refer to
  https://www.nisshinbo-microdevices.co.jp/en/products/dc-dc-switching-regulator/spec/?product=nc2702ma

PART NUMBER INFORMATION

Product Name	Package
NC2702MA000A050	QFN0910-65-MA

Description of configuration

	Item	Description
000	Output Voltage	External Setting Type: 000 only

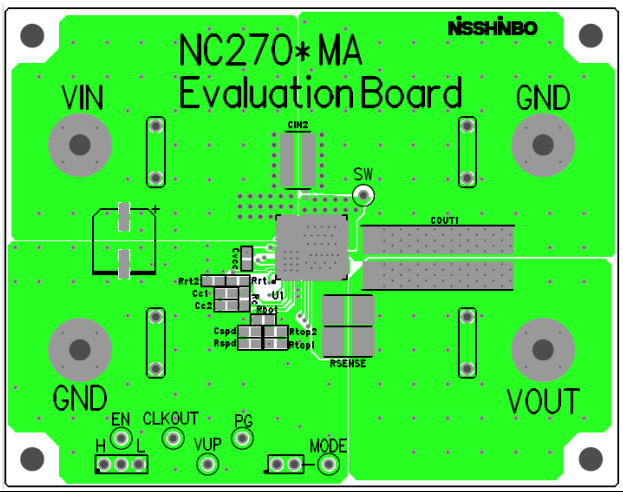
Version

	Overcurrent Protection
A	Non-Latch Type (Hiccup)

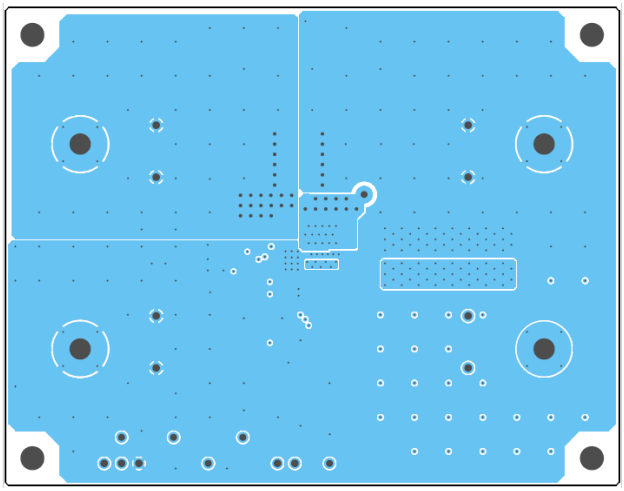
050: 5.0 V, Output Voltage

PCB LAYOUT

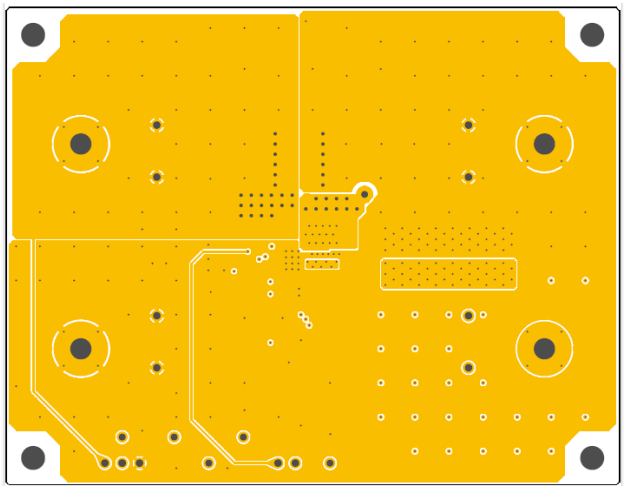
Evaluation board of NC2702MA (Package: QFN0910-65-MA)



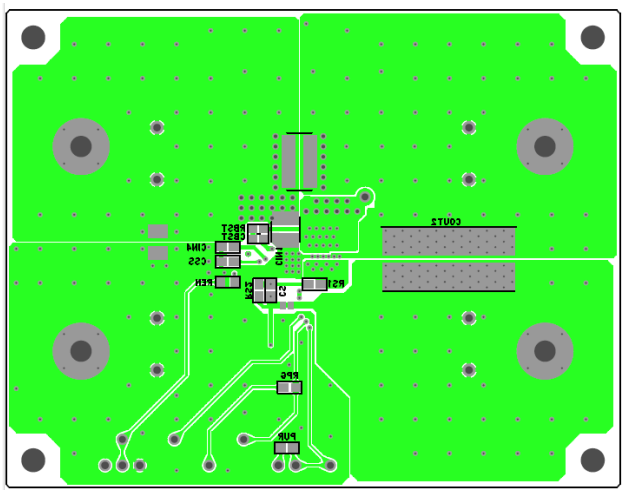
1st Layer (Top Layer)



2nd Layer

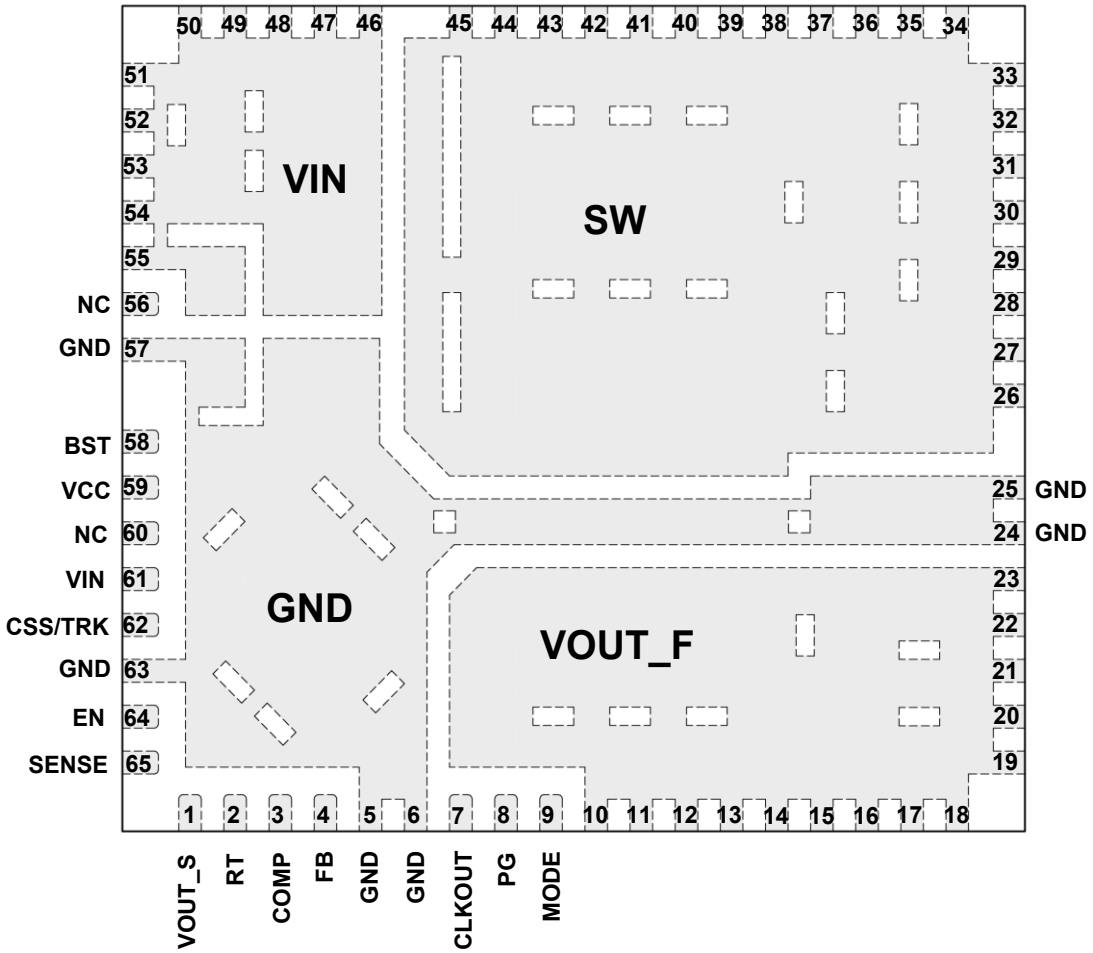


3rd Layer



4th Layer (Bottom Layer)

PIN DESCRIPTIONS



QFN0910-65-MA Pin Configuration

※This is a pin layout image diagram (Top view)

Pin Descriptions

Pin No.	Pin Name	I/O	Description
1	VOUT_S	I	Output Voltage Feedback Input Pin
2	RT	I	Oscillation Adjustment Pin Connecting a resistor to ground from this pin sets the switching frequency. Switching frequency range is from 250 kHz to 1 MHz.
3	COMP	I	A Phase Compensation network connected Pin. Connect a capacitor and a resistor to compensate the loop.
4	FB	I	Feedback Input Pin Set the output voltage by connecting an external resistor.
5, 6	GND	-	GND Pin ※Be sure to tie these pins on the board.
7	CLKOUT	O	Clock Output Pin Clock output pin synchronized with internal switching frequency. CMOS output with VCC as power supply.
8	PG	O	Power-Good Output Pin NMOS open drain pin. Output that is pulled-up node ”High” in normal state.
9	MODE	I	Mode-Select Input Pin High: to select Forced PWM Control, External Clock Synchronization with PLL Input. Low: prohibited
10 to 23	VOUT_F	O	Power Output Pin Mount the RSENSE for Peak Current Limit between the Vout load and these pins .
24, 25	GND	-	GND Pin ※ Connect these pins together on the board.
26 to 45	SW	O	Switching Pin The inductor is connected inside the IC to this pin. To enforce the power dissipation, refer to the footprint and PCB layout.
46 to 55	VIN	Power	Power Supply Input Pin ※ Be sure to connect the VIN pins together on the board.
56, 60	NC	-	No Connection It is recommended to be left open to reduce the risk of adjacent pins’ short.
57, 63	GND	-	GND Pin ※Be sure to connect the GND pins together on the board.
58	BST	I	Bootstrapped Pin By connecting a capacitor (C_{BST}) between the SW and BST pin, the voltage between the SW and BST pin is controlled to Typ.5V.
59	VCC	O	VCC Output Pin
61	VIN	Power	Power Supply Input Pin ※ Be sure to connect the VIN pins together on the board.
62	CSS/TRK	I	Soft-Start Adjustment Pin Soft-start time can be adjusted by connecting a capacitor between this pin and GND.
64	EN	I	Enable Pin ("High” active) Input “Low” to this pin shuts down the IC. Input “High” to this pin enables the IC.
65	SENSE	I	Sense Pin for Inductor Current

For details, refer to " *TYPICAL APPLICATION CIRCUIT* " and " *THEORY OF OPERATION* ".

ABSOLUTE MAXIMUM RATINGS

	Symbol	Ratings	Unit
Input Voltage	V_{IN}	−0.3 to 29	V
EN Pin Input Voltage	V_{EN}	−0.3 to V_{IN} + 0.3 ≤ 29	V
CSS/TRK Pin Input Voltage	$V_{CSS/TRK}$	-0.3 to 3	V
VOUT_S Pin Voltage	V_{OUT_S}	-0.3 to 6	V
VOUT_F Pin Voltage	V_{OUT_F}	-0.3 to 6	V
SENSE Pin Voltage	V_{SENSE}	-0.3 to 6	V
RT Pin Voltage	V_{RT}	-0.3 to 3	V
COMP Pin Voltage	V_{COMP}	-0.3 to V_{CC} + 0.3 ≤ 6	V
FB Pin Voltage	V_{FB}	-0.3 to 3	V
VCC Pin Voltage	V_{CC}	-0.3 to 6	V
Output Current for VCC Pin		Internally limited	mA
BST Pin Voltage	V_{BST}	SW-0.3 to SW+6	V
SW Pin Voltage	V_{SW}	−0.3 to V_{IN} + 0.3 ≤ 29	V
MODE Pin Voltage	V_{MODE}	-0.3 to 6	V
PG Pin Voltage	V_{PG}	-0.3 to 6	V
CLKOUT Pin Voltage	V_{CLKOUT}	-0.3 to V_{CC} + 0.3 ≤ 6	V
Junction Temperature [*1]	T_j	−40 to 150	°C
Storage Temperature Range	T_{stg}	−55 to 150	°C

ABSOLUTE MAXIMUM RATINGS

Electronic and mechanical stress momentarily exceeded absolute maximum ratings may cause permanent damage and may degrade the lifetime and safety for both device and system using the device in the field. The functional operation at or over these absolute maximum ratings is not assured.

[*1] Calculate the power consumption of the IC from the operating conditions and calculate the junction temperature with the thermal resistance.
Please refer to "*THERMAL CHARACTERISTICS*" for the thermal resistance under our measurement board conditions.

RECOMMENDED OPERATING CONDITIONS

	Symbol	Ratings	Unit
Input Voltage	V_{IN}	4.0 to 28	V
Operating Temperature Range	T_a	−40 to 85	°C
Output Voltage	V_{OUT}	0.7 to 5.3	V
Output Current (NC2702MA)	I_{OUT}	0 to 6	A

RECOMMENDED OPERATING CONDITIONS

All of electronic equipment should be designed that the mounted semiconductor devices operate within the recommended operating conditions. The semiconductor devices cannot operate normally over the recommended operating conditions, even if they are used over such conditions by momentary electronic noise or surge. And the semiconductor devices may receive serious damage when they continue to operate over the recommended operating conditions.

ELECTRICAL CHARACTERISTICS

V_{IN} = 12 V, V_{EN} = V_{IN} unless otherwise specified.
For parameter that does not describe the temperature condition, the MIN / MAX value under the condition of −40°C ≤ T_a ≤ 85°C is described.

NC2702MA000xE2D

Parameter	Symbol	Conditions	MIN	TYP	MAX	Unit
Start-Up Voltage	V_{START}				4.5	V
VCC Pin Voltage (VCC-GND)	V_{CC}	V_{IN} = 28 V, −40°C ≤ T_a ≤ 85°C	4.9	5.1	5.3	V
Shutdown Current	I_{sd}	V_{IN} = 28 V, V_{EN} = 0 V		3	20	μA
Quiescent Current at no switching in PWM Mode	I_Q	V_{IN} = 12 V, V_{FB} = 0.672 V, V_{OUT_S} = V_{SENSE} = 1.5 V, V_{SW} = 1.5 V		1.2	1.9	mA
UVLO Release Voltage	$V_{UVLOREL}$	V_{IN} = V_{CC} = Low to High	3.85	4.0	4.2	V
UVLO Detection Voltage	$V_{UVLODET}$	V_{IN} = V_{CC} = High to Low	3.1	3.3	3.4	V
FB Voltage Accuracy	V_{FB}	V_{IN} = 12 V, Ta=25°C	0.6336	0.64	0.6464	V
		-40°C ≤ Ta ≤ 85°C	0.6272		0.6528	
Oscillation Frequency 0	f_{OSC0}	R_{RT} = 135 kΩ	225	250	275	kHz
Oscillation Frequency 1	f_{OSC1}	R_{RT} = 32 kΩ	900	1000	1100	kHz
Minimum OFF Time	t_{OFF}	V_{IN} = 5 V, V_O = 5 V		120	190	ns
Minimum ON Time	t_{ON}	V_{IN} = 5 V, V_O = 0.7 V		100	120	ns
Synchronizing Frequency	f_{SYNC}	f_{OSC} Criteria	fosc×0.5		fosc×1.5	kHz
			250		1000	kHz
Soft-Start Time 1	t_{SS1}	V_{IN} = 12 V, CSS/TRK = OPEN	0.4		0.75	ms
Soft-Start Time 2	t_{SS2}	V_{IN} = 12 V, C_{SS} = 4.7nF	1.4		2.0	ms
Charge Current for Soft-Start Pin	I_{TSS}	V_{IN} = 12 V, $V_{CSS/TRK}$ = 0 V	1.8	2	2.2	μA
CSS/TRK Pin Voltage at End of Soft-Start	V_{SSEND}		V_{FB}	V_{FB} +0.03	V_{FB}+0.06	V
Discharge FET On-resistance for CSS/TRK Pin	R_{ONDISD_CSS}	V_{IN} = 4.5 V, V_{EN} = 0 V, $V_{CSS/TRK}$ = 3 V	2.0	3.0	5.0	kΩ

All electrical characteristic parameters that specify the minimum and maximum specifications are tested under the condition of
$T_j \approx T_a$ = 25 °C / 85°C

V_{IN} = 12 V, V_{EN} = V_{IN} unless otherwise specified.
For parameter that do not describe the temperature condition, the MIN / MAX value under the condition of −40°C ≤ T_a ≤ 85°C is described.

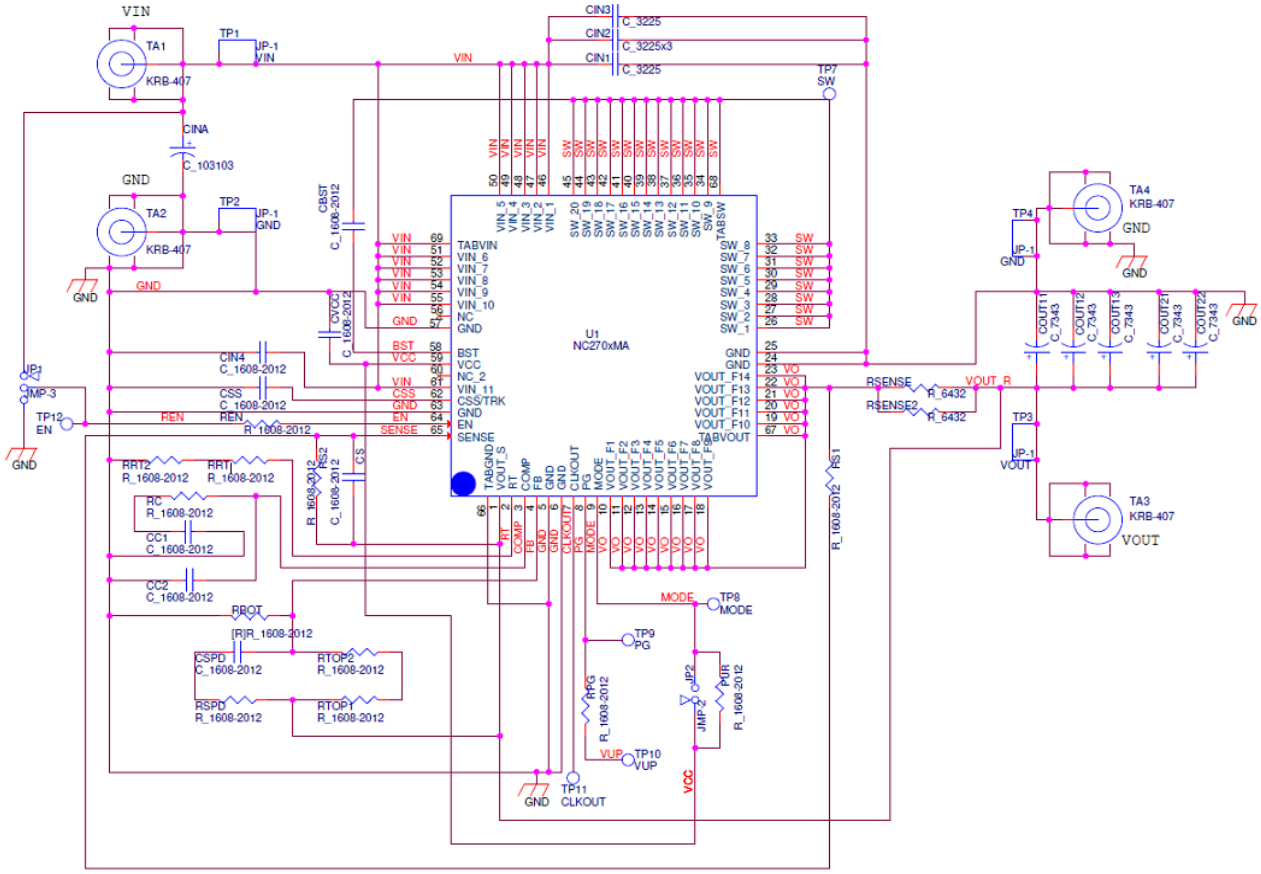
NC2702MA000xE2D

Parameter	Symbol	Conditions	MIN	TYP	MAX	Unit
Current Limit Threshold Voltage (SENSE – VOUT_S)	V_{ILIMIT}		40	50	60	mV
Reverse Current Sense Threshold Voltage (SENSE – VOUT_S)	$V_{IREVLIMIT}$		40	50	60	mV
SW Short to GND Detector Threshold Voltage (VIN – SW)	$V_{SWSHORTDET}$		0.345	0.43	0.520	V
SW Short to VCC Detector Threshold Voltage (SW – GND)	$V_{SWSHORTDET}$		0.330	0.43	0.515	V
EN Input High Voltage	V_{ENH}	V_{IN} = V_{CE} = 28 V	1.30			V
EN Input Low Voltage	V_{ENL}	V_{IN} = 28 V, V_{CE} = 0 V			1.10	V
EN Input High Current	I_{ENH}	V_{EN} = 28 V	0.20		2.45	μA
FB Input High Current	I_{FBH}	V_{IN} = 28 V, V_{FB} = 3 V	-0.1	0	0.1	μA
FB Input Low Current	I_{FBL}	V_{IN} = 28 V, V_{FB} = 0 V	-0.1	0	0.1	μA
MODE Input High Voltage	V_{MODEH}	V_{IN} = 28 V	1.33			V
MODE Input High Current	I_{MODEH}	V_{IN} = 28 V, V_{MODE} = 6 V	1.00		6.60	μA
CLKOUT Output High Voltage	$V_{CLKOUTH}$	CLKOUT = Hi-Z	4.7		VCC	V
CLKOUT Output Low Voltage	$V_{CLKOUTL}$	CLKOUT = Hi-Z	0		0.1	V
PG Output Low Voltage	V_{PGOFF}	V_{IN} = 4.0 V, I_{PG} = 1 mA		0.26	0.54	V
PG Pin Leakage Current	I_{PGOFF}	V_{IN} = 28 V, V_{PG} = 6 V	-0.1	0	0.1	μA
FB Pin OVD Threshold Voltage	$V_{FBOVDDET}$	V_{IN} = 5.0 V, V_{FB} = Low to High	0.680	V_{FB}×1.10	0.740	V
	$V_{FBOVDREL}$	V_{IN} = 5.0 V, V_{FB} = High to Low	0.664	V_{FB}×1.07	0.712	V
FB Pin UVD Threshold Voltage	$V_{FBUVDDET}$	V_{IN} = 5.0 V, V_{FB} = High to Low	0.556	V_{FB}×0.90	0.604	V
	$V_{FBUVDREL}$	V_{IN} = 5.0 V, V_{FB} = Low to High	0.574	V_{FB}×0.93	0.628	V
Thermal Shutdown Detection Temperature	T_{SDDET}	T_j *1 = Low to High	-	130	-	°C
Thermal Shutdown Release Temperature	T_{SDREL}	T_j *1 = High to Low	-	110	-	°C

All electrical characteristic parameters that specify the minimum and maximum specifications are tested under the condition of
T_j ≈ T_a = 25 °C / 85°C

*1 This product is a module product. T_j is the junction temperature of the controller chip.

TYPICAL APPLICATION CIRCUIT



NC2702MA Typical Application Circuit

Recommended Values for components

Symbol	Value
Cin1,2	10uF*4
Cin4	Open
Cout1	47uF*2
Cout2	Open
Cbst	0.22uF
Cvcc	2.2uF
Rrt1	39kΩ
Rrt2	1.5kΩ
Css	3.3nF
Rc	8.2kΩ
Cc1	2.2nF
Cc2	Open
Cspd	68pF
Rspd	short
Rtop1	150kΩ
Rtop2	0Ω
Rbot	22kΩ
Rs1	1kΩ
Cs	100pF
Rsense	3mΩ*2
Ren	0Ω
Rbst	0Ω
Rpg	100kΩ

TECHNICAL NOTES

The performance of power source circuits using this IC largely depends on peripheral circuits. When selecting the peripheral components, please consider the conditions of use. Do not allow each component, PCB pattern or the IC to exceed their respected rated values (voltage, current, and power) when designing the peripheral circuits.

- External components must be connected as close as possible to the ICs and make wiring as short as possible. Especially, the capacitor connected in between VIN pin and GND pin must be wiring the shortest. If their impedance is high, internal voltage of the IC may shift by the switching current, and the operating may be unstable. Make the power supply and GND lines sufficient.
- Put a capacitor (C_{OUT}) to keep a distance from C_{IN} to avoid the high-frequency noise by input.
- Put a capacitor (C_{BST}) as close as possible to the SW pin and the BST pin. If controlling a slew rate of the high-side MOSFET for EMI, a resistor (R_{BST}) should be in series between the BST pin and the capacitor (C_{BST}).
- Do not use the MODE pin with “open” or “Low”.
- If V_{OUT} is a negative voltage, start-up may not impossible.
- The thermal shutdown function prevents the IC from fuming and ignition but does not ensure the IC’s reliability or keep the IC below the absolute maximum ratings. The thermal shutdown function does not operate on the heat generated by other than the normal IC operation such as latch-up and overvoltage application.
- The thermal shutdown function operates in state over the absolute maximum ratings; therefore, the thermal shutdown function should not be used for a system design.
- The connection between GND pins should be near the IC in common to avoid impedance difference.
- When the load current, I_{OUT} is large, the sense resistance, R_{SENSE} should be small, in such a case, current limit threshold may shift by the effect of wiring resistance. The countermeasure against it is by connecting R_{S1} and R_{S2} resistances to SENSE pin as close as possible to R_{SENSE}. Refer to the explanation of “Current Limit Function”.
- As a noise filter, setting a capacitor, C_S between SENSE pin and VOUT_S as close as possible to the IC is also recommended.

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