4.5V to 18V Input, 4.0A Integrated MOSFET 1ch Synchronous Buck DC/DC Converter

Pb Free ROHM Electronic Components
RoHS Directive Compliance

BD9C401EFJ

●Description

BD9C401EFJ is a synchronous buck switching regulator with built-in low on-resistance power MOSFETs. With wide input voltage range, It is capable of providing current of up to 4 A. It is a current mode control DC/DC converter and features high-speed transient response. Phase compensation can also be set easily.

●Key Specifications

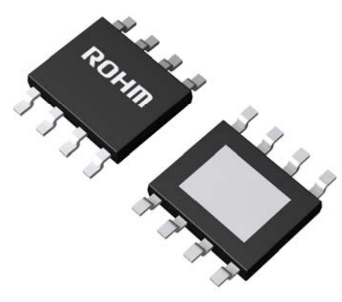
■ Input voltage range:	4.5V to 18.0V
■ Reference voltage:	0.8V ± 1%
■ Maximum operating current:	4A(Max.)
■ Switching frequency:	500kHz(Typ.)
■ Pch MOSFET On Resistance:	65mΩ(Typ.)
■ Nch MOSFET On Resistance:	35mΩ(Typ.)
■ Standby current:	1μA (Typ.)
■ Operating temperature range:	-40℃ to +85℃

●Features

- Synchronous 1 ch DC/DC converter
- Over Current protection
- Thermal Shutdown protection
- Under Voltage lockout protection
- Short Circuit Protection
- Fixed soft start function 1msec

●Package

	W(Typ.) x D(Typ.) x H(Max.)
HTSOP-J8	4.90mm x 6.00mm x 1.00mm



HTSOP-J8

●Applications

- LCD TVs
- Set-top boxes
- DVD/Blu-ray Disc players/recorders
- Broadband Network and Communication Interface
- Entertainment devices

●Typical Application Circuit

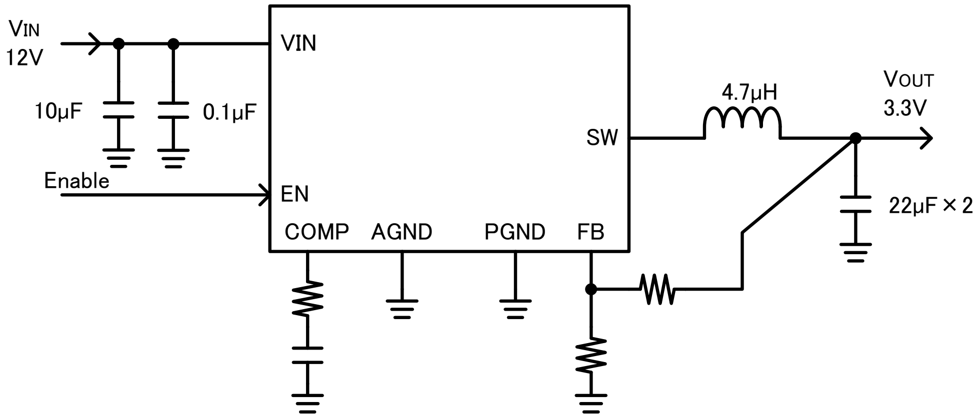


Figure 1. Application Circuit

○Product structure: silicon monolithic integrated circuit ○This product has no protection against radioactive rays.

●Pin Configuration

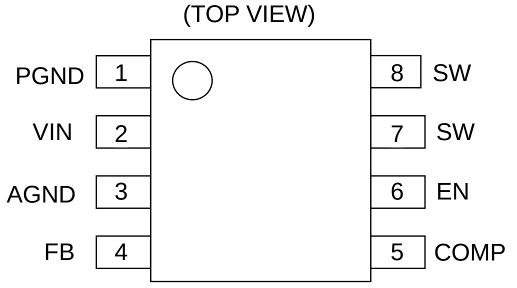


Figure 2. Pin Assignment

●Pin Descriptions

Pin No.	Symbol	Description
1	PGND	Ground terminals for the output stage of the switching regulator.
2	VIN	This terminals supply power to the control circuit and the output stage of the switching regulator. Connecting a 10 µF and a 0.1µF ceramic capacitor is recommended.
3	AGND	Ground terminal for the control circuit.
4	FB	An inverting input node for the gm error amplifier. See page 12 for how to calculate the resistance of the output voltage setting.
5	COMP	An input terminal for the switch current comparator and an output terminal for the gm error amplifier. Connect a frequency phase compensation component to this terminal. See page 12 - 13 for how to calculate the resistance and capacitance for phase compensation.
6	EN	Turning this terminal signal Low (0.8 V or lower) forces the device to enter the shutdown mode. Turning this terminal signal High (2.0 V or higher) enables the device. This terminal must be terminated.
7	SW	Switch nodes. These terminals are connected to the drain of Pch MOSFET and the drain of Nch MOSFET.
8	SW	Switch nodes. These terminals are connected to the drain of Pch MOSFET and the drain of Nch MOSFET.
-	FIN	A backside heat dissipation pad. Connecting to the internal PCB ground plane by using multiple vias provides excellent heat dissipation characteristics.

● **Block Diagram**

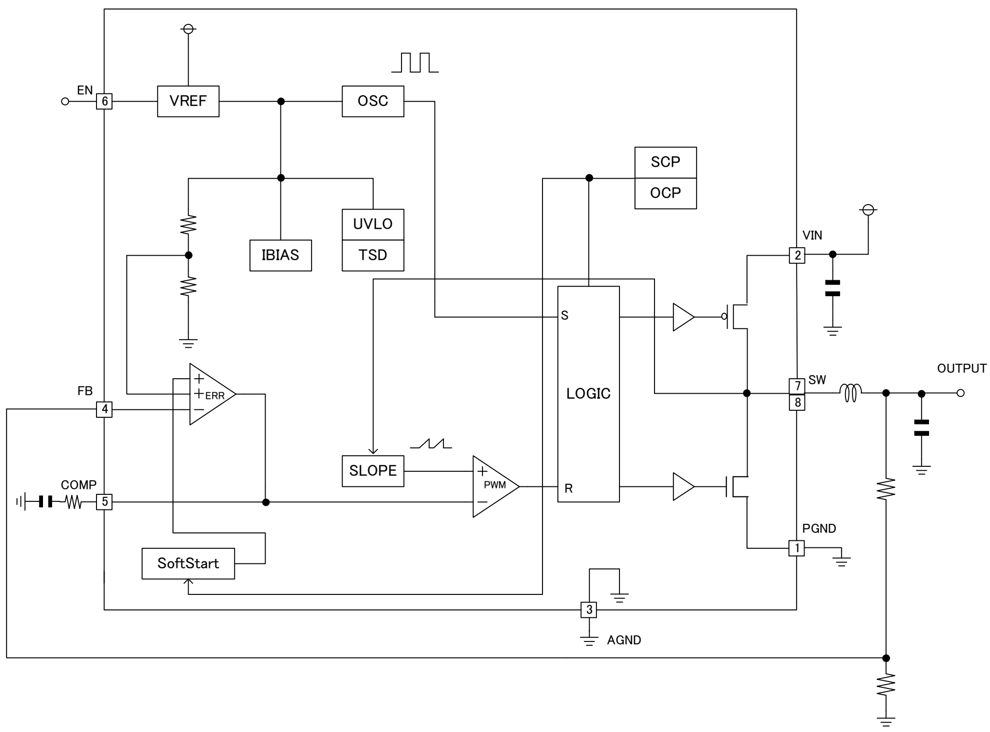


Figure 3. Block Diagram

●Absolute Maximum Ratings (Ta = 25°C)

Parameter	Symbol	Rating	Unit	Conditions
Supply Voltage	V_{IN}	20	V	
SW Terminal Voltage	V_{SW}	20	V	
EN Terminal Voltage	V_{EN}	20	V	
Allowable Power Dissipation	Pd	3760*	mW	When mounted on a 70 mm x 70 mm x 1.6 mm 4-layer glass epoxy board
Operating Temperature Range	Topr	-40 to +85	℃	
Storage Temperature Range	Tstg	-55 to +150	℃	
Maximum Junction temperature	Tjmax	150	℃	
FB, ITH Terminal Voltage	V_{LVPINS}	7	V	

* Derate by 30.08 mW when operating above 25°C.

● **Recommended Operating Range (Ta= -40℃ to 85℃)**

Parameter	Symbol	Rating			Unit
		Min	Typ	Max	
Supply Voltage	V_{IN}	4.5	-	18.0	V
Output Current	I_{OUT}	-	-	4.0	A
Output Voltage Setting Range	V_{RANGE}	$V_{IN}\times 0.125$*	-	$V_{IN}\times 0.7$	V

* $V_{IN}\times 0.125 \geqq 0.8$ [V]

● Electrical Characteristics

(Ta = 25°C, V_{IN} = 12 V, V_{EN} = 5 V unless otherwise specified)

Parameter	Symbol	Limits			Unit	Conditions
		Min	Typ	Max		
Circuit Current in Active State	I_{Q_active}	-	1.5	2.5	mA	V_{FB}= 0.75V, V_{EN}= 5V
Circuit Current in Standby State	I_{Q_stby}	-	1.0	10.0	μA	V_{EN} = 0V
FB Terminal Voltage	V_{FB}	0.792	0.800	0.808	V	FB-COMP Short (Voltage follower)
FB Inflow Current	I_{FB}	-	0	2	μA	
Switching Frequency	f_{OSC}	450	500	550	kHz	
High Side FET On Resistance	R_{ONH}	-	65	-	mΩ	V_{IN}= 12V , I_{SW} = -1A
Low Side FET On Resistance	R_{ONL}	-	35	-	mΩ	V_{IN}= 12V , I_{SW} = -1A
Power MOS Leakage Current	I_{LSW}	-	0	5	μA	V_{IN}= 18V , V_{SW} = 18V
Over Current Limit	I_{LIMIT}	4.5	-	-	A	
Minimum Duty	Min_duty	-	-	12.5	%	
UVLO Release Voltage	V_{UVLO}	3.75	4.0	4.25	V	V_{IN} Sweep up
UVLO Hysteresis Voltage	$V_{UVLOHYS}$	-	0.2	-	V	
EN Input High Level Voltage	V_{ENH}	2.0	-	-	V	
EN Input Low Level Voltage	V_{ENL}	-	-	0.8	V	
Soft Start (internal) Time	T_{SS}	0.5	1.0	2.0	msec	

- V_{FB} :FB Terminal Voltage, V_{EN} :EN Terminal Voltage, I_{SW} :SWTerminal Voltage
- Current capability should not exceed Pd.

● **Typical Performance Curves**

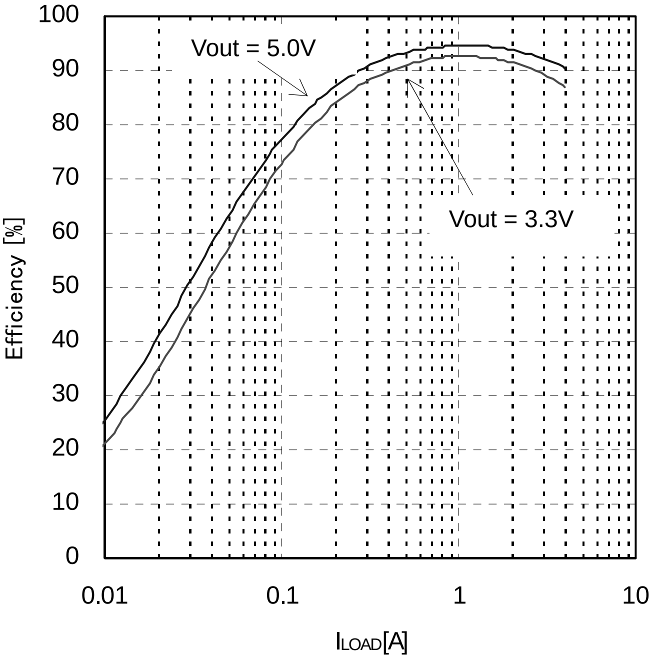


Figure 4. Efficiency
(VIN=12V, L=4.7µH (Vout=3.3/5.0V), Cout=44µF)

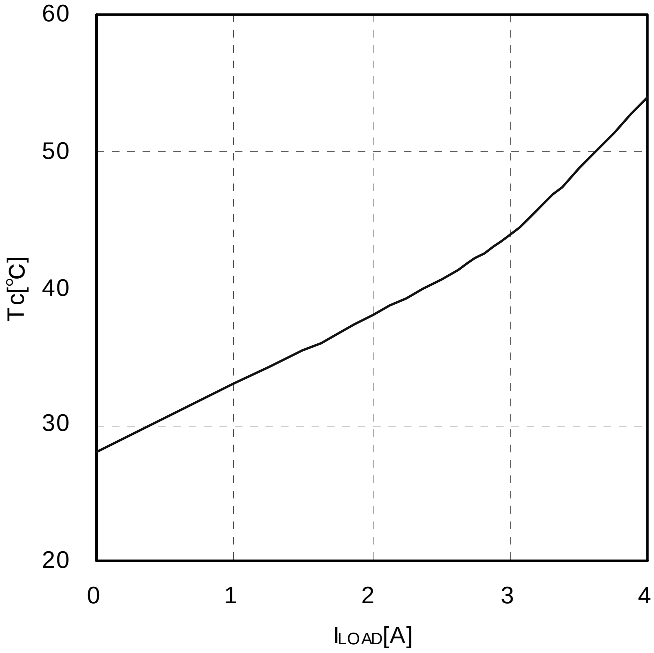


Figure 5. T_C-I_{LOAD}
(VIN=12V, Vout=3.3V, L=4.7µH, Cout=44µF)

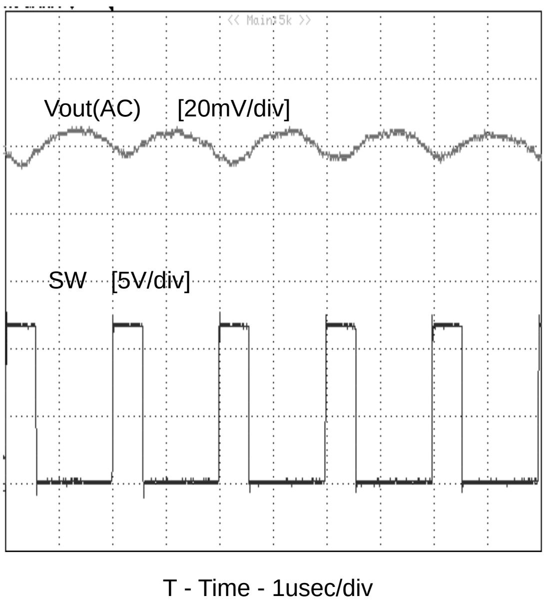


Figure 6. Output Ripple Voltage
(VIN=12V, Vout=3.3V, L=4.7µH, Cout=44µF, Iout=0A)

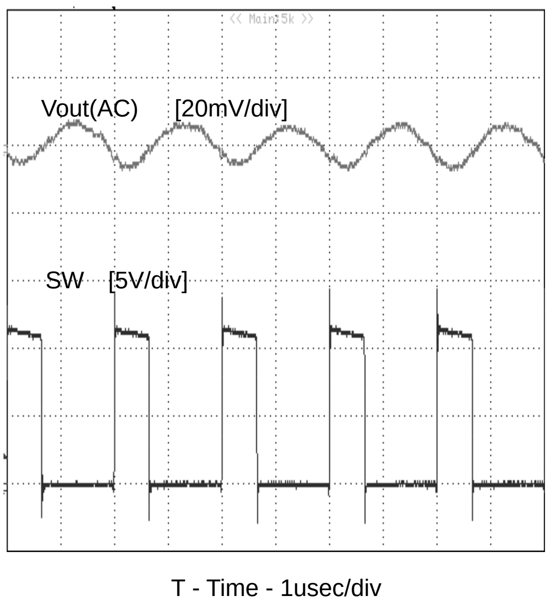


Figure 7. Output Ripple Voltage
(VIN=12V, Vout=3.3V, L=4.7µH, Cout=44µF, Iout=4A)

● **Typical Performance Curves (Continued)**

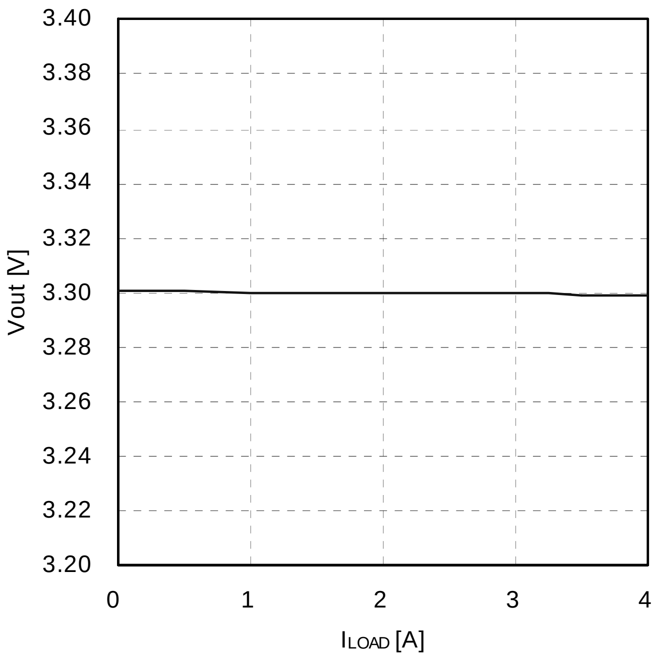


Figure 8. Vout Load regulation
(VIN=12V, Vout=3.3V, L=4.7µH, Cout=44µF)

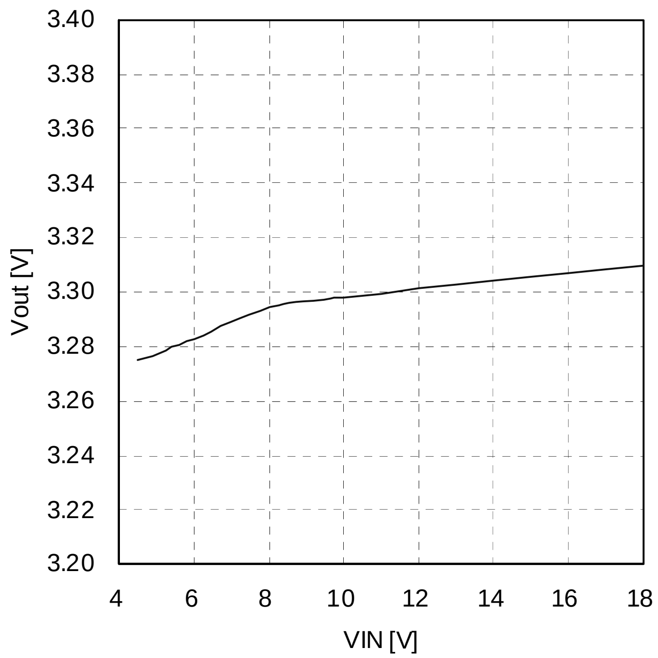


Figure 9. Vout Line regulation
(Vout=3.3V, L=4.7µH, Cout=44µF, Iout=0A)

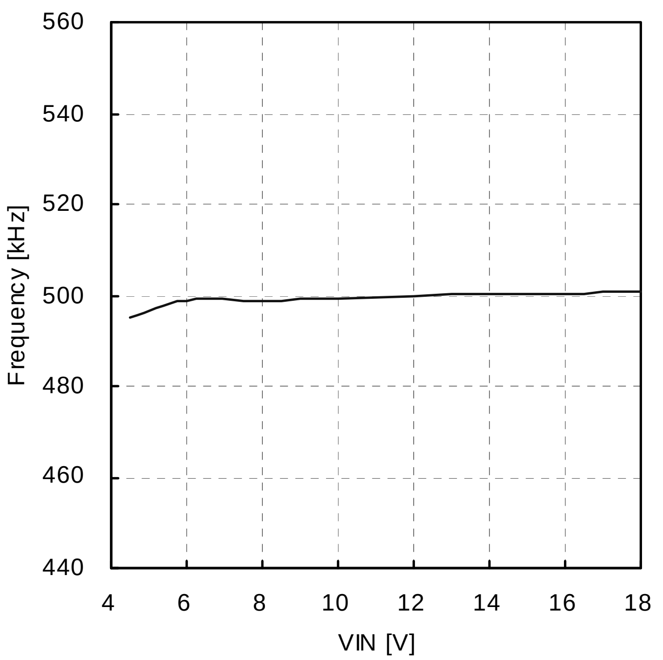


Figure 10. Switching Frequency
(Vout=3.3V, L=4.7µH, Cout=44µF, Iout=0A)

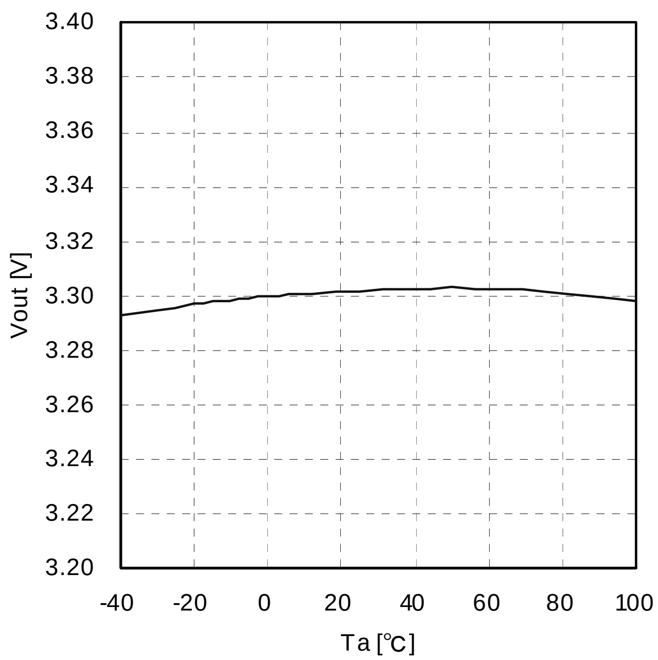
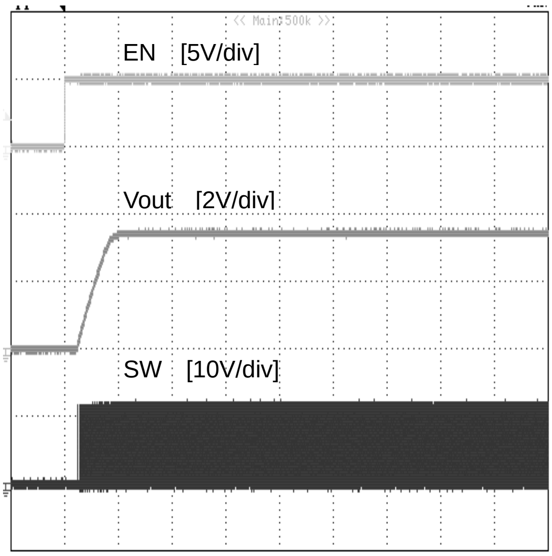


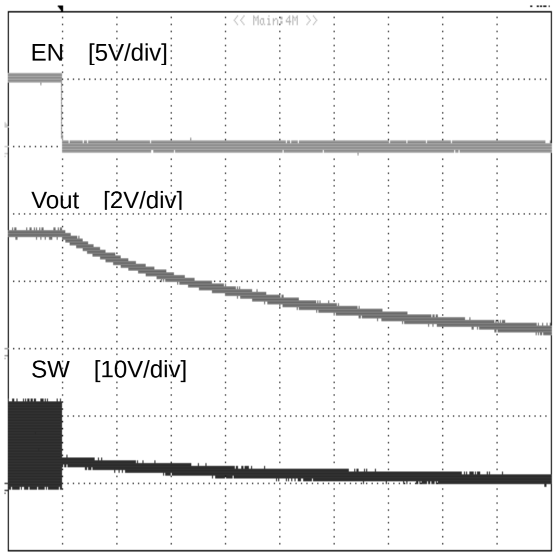
Figure 11. Vout-Temperature
(Vin=12V, Vout=3.3V, L=4.7µH, Cout=44µF, Iout=0A)

● **Typical Performance Curves (Continued)**



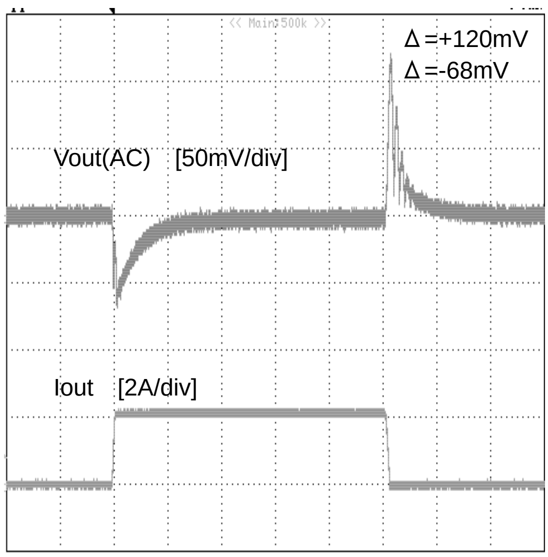
T - Time – 1msec/div

Figure 12. Start up with EN
(Vin=12V, Vout=3.3V, L=4.7µH, Cout=44µF, Iout=0A)



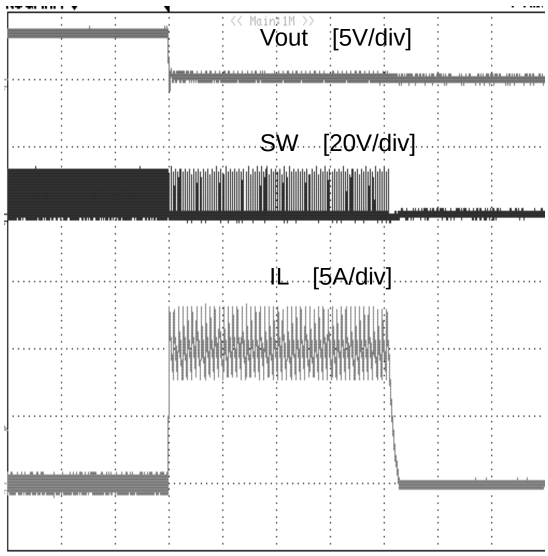
T - Time – 200msec/div

Figure 13. Shutdown wave form
(Vin=12V, Vout=3.3V, L=4.7µH, Cout=44µF, Iout=0A)



T - Time - 100µsec/div

Figure 14. Load Transient response
(Vin=12V, Vout=3.3V, L=4.7µH, Cout=44µF, Iout=2A)



T - Time - 200usec/div

Figure 15. OCP function
(Vin=12V, Vout=3.3V, L=4.7µH, Cout=44µF, Vout is short to GND)

● Function Explanations

1 Basic Operations

<u>1 Enable control</u>

The IC shutdown can be controlled by the voltage applied to the EN terminal.
When VEN reaches 2.0 V (Typ), the internal circuit is activated and the IC starts up.

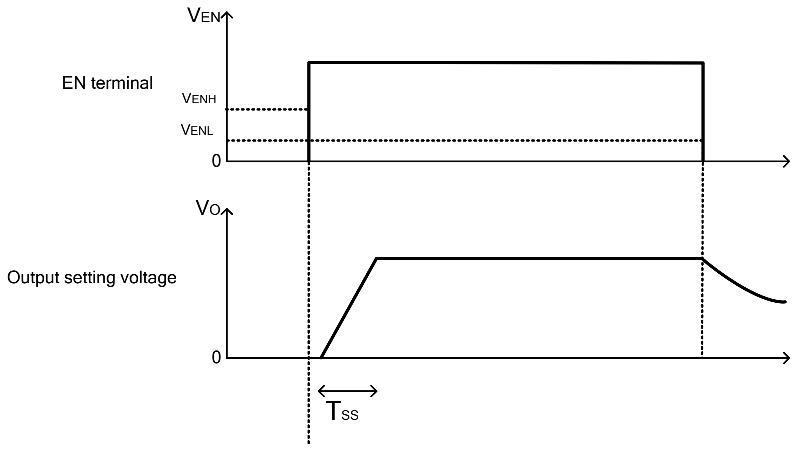


Figure 16. On/Off Switching during Enable Control

2 Protective Functions

The protective circuits are intended for prevention of damage caused by unexpected accidents. Do not use them for continuous protective operation.

2-1 Short Circuit Protection Function (SCP)

The short circuit protection block (SCP) compares the FB terminal voltage with the internal reference voltage VREF. When the FB terminal voltage fall below V_{SCP} (= VREF – 240mV) and with that situation continuing for off latch time, it latches output in off situation.

Table 1 Short Circuit Protection Function

EN Terminal	FB Terminal	Short Circuit Protection Function	Short Circuit Protection Operation
2.0 V or higher	$<V_{SCP}$	Enabled	ON
	$>V_{SCP}$		OFF
0.8 V or lower	-	Disabled	OFF

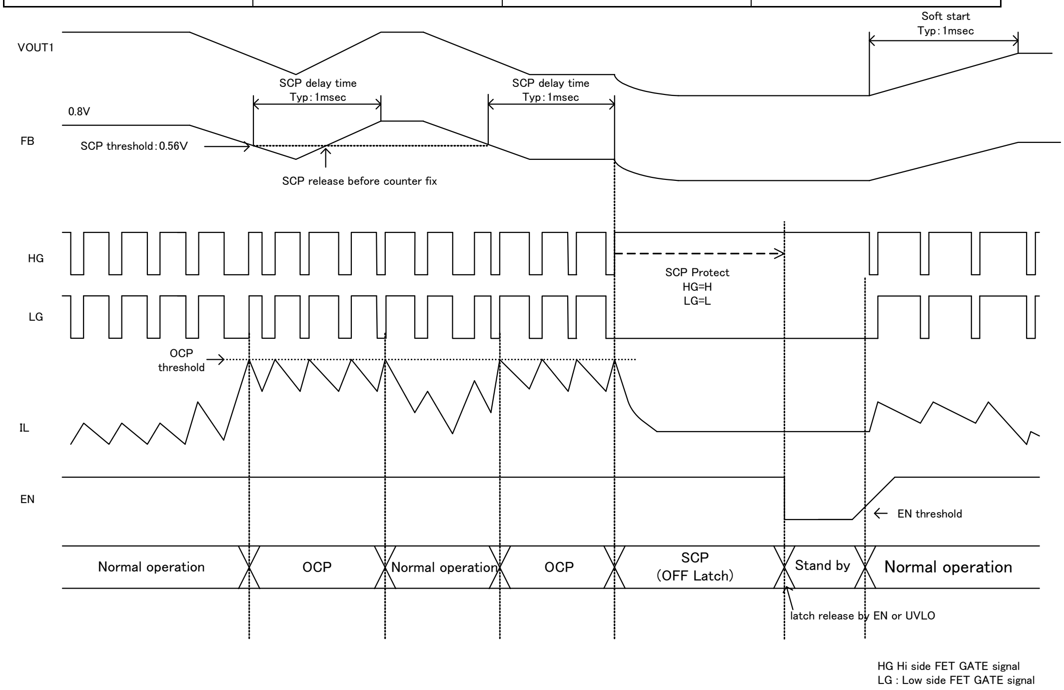


Figure 17. Short Circuit Protection function (SCP) timing chart

2-2 Under Voltage Lockout Protection (UVLO)

The Under Voltage Lockout Protection circuit monitors the AVIN terminal voltage.
The operation enters standby when the VIN terminal voltage is 3.8 V (Typ) or lower.
The operation starts when the AVIN terminal voltage is 4.0 V (Typ) or higher.

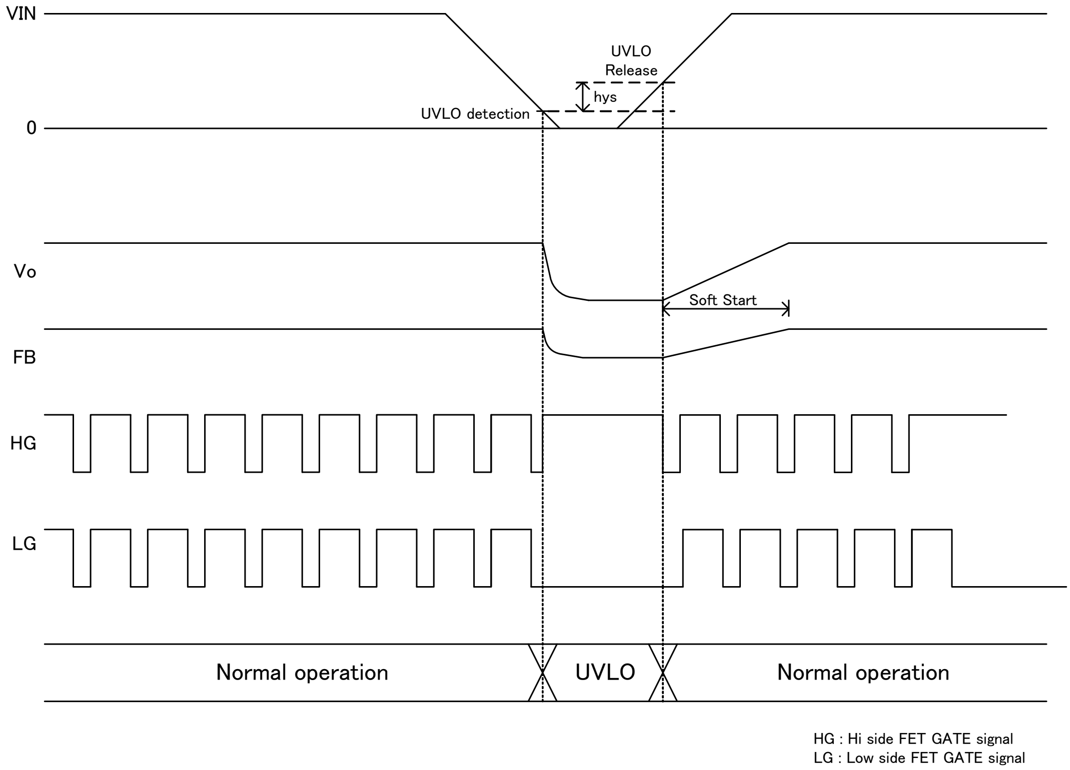


Figure 18. UVLO Timing Chart

2-3 Thermal Shutdown

When the chip temperature exceeds Tj = 175°C, the DC/DC converter output is stopped. The thermal shutdown circuit is intended for shutting down the IC from thermal runaway in an abnormal state with the temperature exceeding Tjmax = 150°C. It is not meant to protect or guarantee the soundness of the application. Do not use the function of this circuit for application protection design.

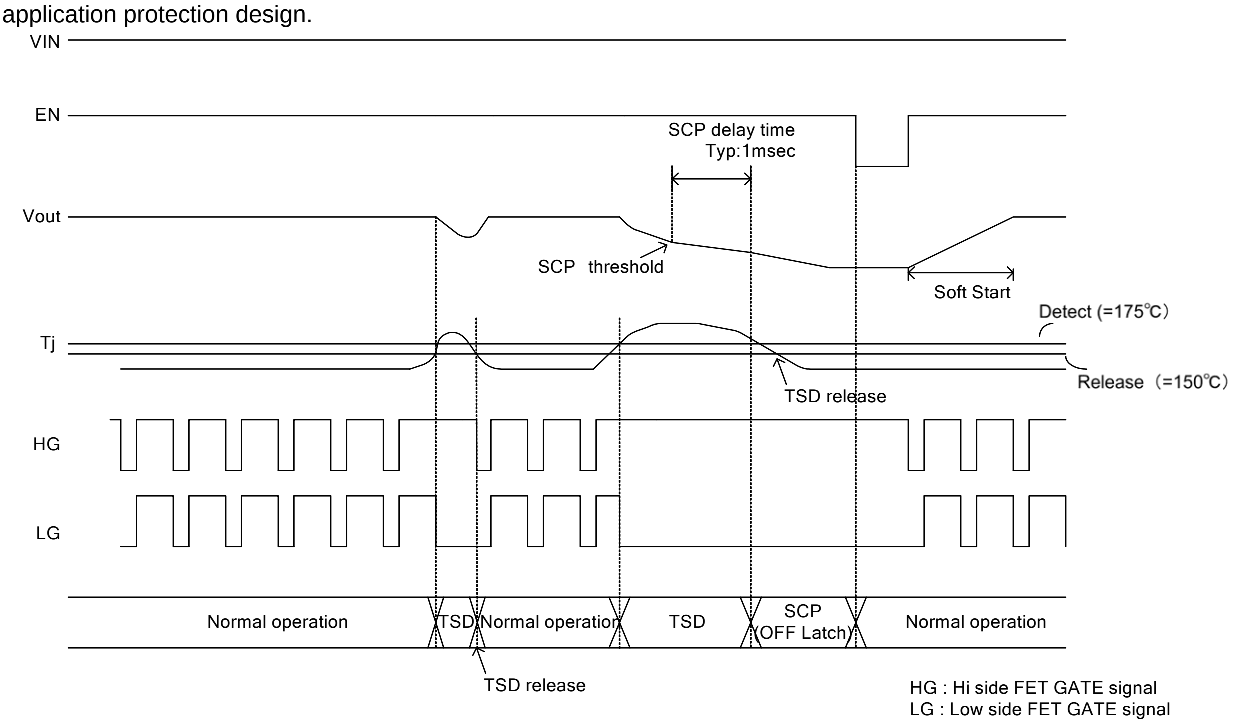


Figure 19. TSD Timing chart

2-4 Over Current Protection

The Over Current Protection operates by using the current mode control to limit the current that flows through the top MOSFET at each cycle of the switching frequency. When an abnormal state continues, the output is fixed in a low level.

2-5 Error detection (off latch) release method

BD9C401EFJ enters the state of off latch when the protection function operates.
To release the off latch state, the VIN terminal voltage should be changed to less than UVLO level (=3.8V [Typ]) or, the EN terminal voltage falls below V_{ENL}.voltage.

● **Application Example**

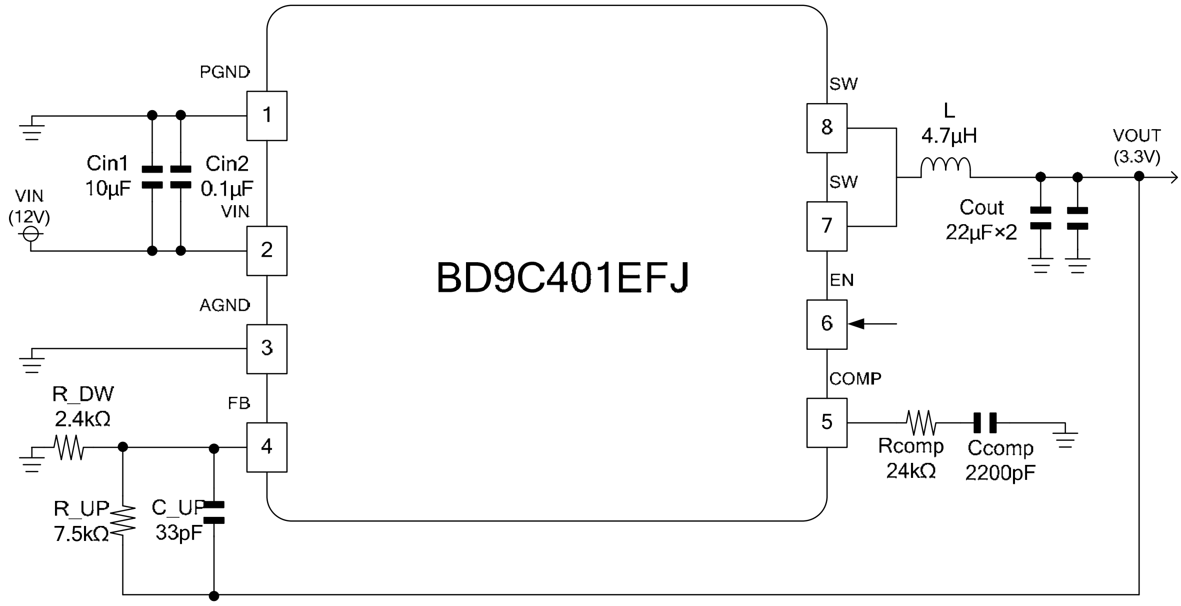


Figure 20. Application Circuit

		Maker	Part No
Input capacitor(Cin1)	10µF/25V	TDK	C3225JB1E106K
Input capacitor(Cin2)	0.1µF/25V	TDK	C1608JB1H104K
Output capacitor(Cout)	22µF/16V × 2	TDK	C3216JB1C226M × 2
Inductor (L)	4.7µH	TDK	SPM6530-4R7

	FB	
Vo(V)	R_UP [kΩ]	R_DW [kΩ]
5	4.3	0.82
3.3	7.5	2.4
1.8	15	12
1.5	16	18
1.2	10	20
1	5.1	20

● PCB Layout Design

In the step-down DC/DC converter, a large pulse current flows into two loops. The first loop is the one into which the current flows when the top FET is turned ON. The flow starts from the input capacitor C_{IN}, runs through the FET, inductor L and output capacitor C_{OUT} and back to GND of C_{IN} via GND of C_{OUT}. The second loop is the one into which the current flows when the bottom FET is turned on. The flow starts from the bottom FET, runs through the inductor L and output capacitor C_{OUT} and back to GND of the bottom FET via GND of C_{OUT}. Route these two loops as thick and as short as possible to allow noise to be reduced for improved efficiency. It is recommended to connect the input and output capacitors directly to the GND plane. The PCB layout has a great influence on the DC/DC converter in terms of all of the heat generation, noise and efficiency characteristics.

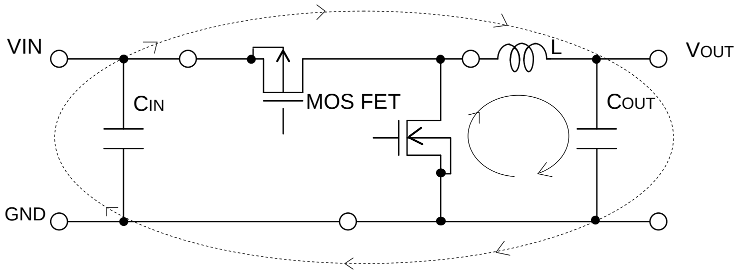


Fig 21. Current Loop of Buck Converter

Accordingly, design the PCB layout considering the following points.

- Connect an input capacitor as close as possible to the IC VIN terminal on the same plane as the IC.
- If there is any unused area on the PCB, provide a copper foil plane for the GND node to assist heat dissipation from the IC and the surrounding components.
- Switching nodes such as SW are susceptible to noise due to AC coupling with other nodes. Route the coil pattern as thick and as short as possible.
- Provide lines connected to FB and COMP far from the SW nodes.
- Place the output capacitor away from the input capacitor in order to avoid the effect of harmonic noise from the input.

● Selection of Components Externally Connected

(1) Output LC Filter Constant

The DC/DC converter requires an LC filter for smoothing the output voltage in order to supply a continuous current to the load. Selecting an inductor with a large inductance causes the ripple current ΔI_L that flows into the inductor to be small. However, decreasing the ripple voltage generated in the output is not advantageous in terms of the load transient response characteristic. An inductor with a small inductance improves the transient response characteristic but causes the inductor ripple current to be large which increases the ripple voltage in the output voltage, showing a trade-off relationship. It is recommended to select an inductance such that the size of the ripple current component of the coil will be 20% to 40% of the average output current (average inductor current).

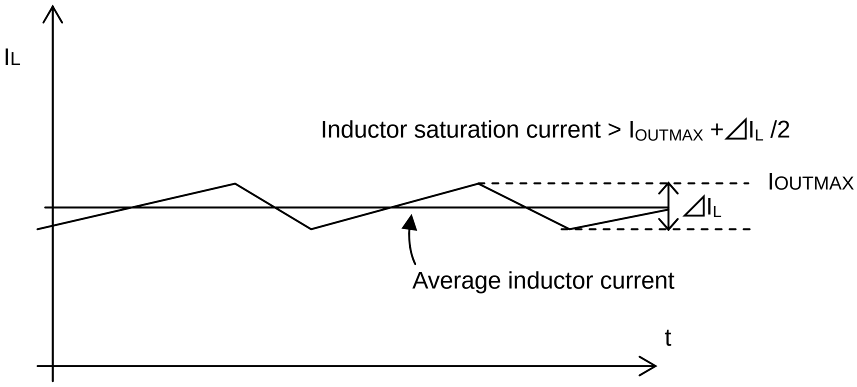


Figure 22. Waveform of current through inductor

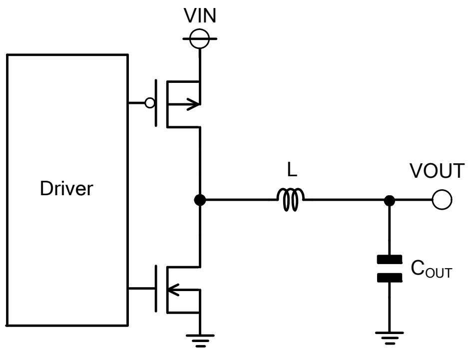


Figure 23. Output LC filter circuit

With VIN = 12 V, VOUT = 3.3 V and the switching frequency F_{OSC} = 500 kHz, the calculation is shown in the following equation.
Coil ripple current ΔI_L = 30% x Average output current (3 A) = 0.9 [A]

$$L = V_{OUT} \times (V_{IN} - V_{OUT}) \times \frac{1}{V_{IN} \times F_{OSC} \times \Delta I_L} = 5.31\mu \fallingdotseq 4.7\mu \quad [H]$$

F_{OSC} is a switching frequency

The saturation current of the inductor must be larger than the sum of the maximum output current and 1/2 of the inductor ripple current ΔI_L.

The output capacitor C_{OUT} affects the output ripple voltage characteristics. The output capacitor C_{OUT} must satisfy the required ripple voltage characteristics.

The output ripple voltage can be represented by the following equation.

$$\Delta V_{RPL} = \Delta I_L \times \left(R_{ESR} + \frac{1}{8 \times C_{OUT} \times F_{OSC}} \right) [V]$$

R_{ESR} is the Equivalent Series Resistance (ESR) of the output capacitor.
* The capacitor rating must allow a sufficient margin with respect to the output voltage.
  The output ripple voltage can be decreased with a smaller ESR.
  A ceramic capacitor of about 22 µF to 100 µF is recommended.

Also this IC provides 1msec[Typ] soft start function to reduce sudden current which flows in output capacitor when startup. But when capacity value of output capacitor C_{OUT} becomes bigger than the following method, correct soft start waveform may not appear in some cases. (ex. Vout over shoot at soft start .)
Select output capacitor C_{OUT} fulfilling the following condition including scattering and margin..

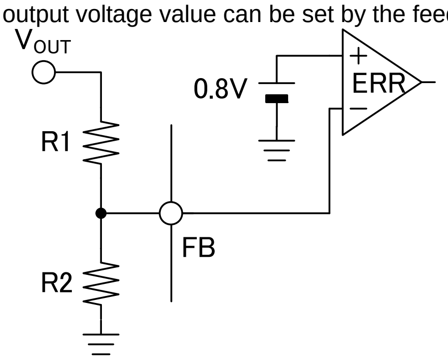
$$C_{OUT} < \frac{I_{OCP}(=4.5A\ [min]) \times T_{SS}\ (=0.5msec\ [min])}{V_{OUT}} \quad [F]$$

Here I_{OCP} is switch current restricted value, T_{SS} is soft start time

<u>Caution) Concerning C_{OUT} total the capacity value of every part connected to Output line.</u>

(2) Output Voltage Setting

The output voltage value can be set by the feedback resistance ratio.



$$V_{OUT} = \frac{R1 + R2}{R2} \times 0.8 \quad [V]$$

Figure 24. Feedback Resistor Circuit

(3) Phase Compensation Component

A current mode control buck DC/DC converter is a two-pole, one-zero system. Two poles are formed by an error amplifier and load and the one zero point is added by phase compensation. The phase compensation resistor R_{ITH} determines the crossover frequency F_{CRS} where the total loop gain of the DC/DC converter is 0 dB. A high value crossover frequency F_{CRS} provides a good load transient response characteristic but inferior stability. Conversely, a low value crossover frequency F_{CRS} greatly stabilizes the characteristics but the load transient response characteristic is impaired. Here, select the constant so that the crossover frequency F_{CRS} will be 1/10 of the switching frequency.

(i) Selection of Phase Compensation Resistor R_{CMP}

The Phase Compensation Resistance R_{ITH} can be determined by using the following equation.

$$R_{CMP} = \frac{2\pi \times V_{OUT} \times F_{CRS} \times C_{OUT}}{V_{FB} \times G_{MP} \times G_{MA}} \quad [\Omega]$$

V_{OUT}: Output Voltage
F_{CRS}: Crossover Frequency
C_{OUT}: Output Capacitance
V_{FB}: Feedback Reference Voltage (0.8 V (Typ))
G_{MP}: Current Sense Gain (7.8 A/V (Typ))
G_{MA}: Error Amplifier Trans conductance (300 µA/V (Typ))

(ii) Selection of Phase Compensation Capacitance C_{ITH}

For stable operation of the DC/DC converter, inserting a zero point at 1/6 of the zero crossover frequency cancels the phase delay due to the pole formed by the load often provides favorable characteristics.

The phase compensation capacitance C_{ITH} can be determined by using the following equation.

Compensation Capacitor $$C_{CMP} = \frac{Vout \times Cout}{Iout \times R_{CMP}} \quad [F]$$

Compensation Capacitor $$C_{CMP} = \frac{3.3 \times 44\mu}{3 \times 24k} = 2.02n \fallingdotseq 2200p \quad [F]$$

(iii) Loop Stability

To ensure the stability of the DC/DC converter, make sure that a sufficient phase margin is provided. A phase margin of at least 45º in the worst conditions is recommended. The feed forward capacitor C_{RUP} is used for the purpose of forming a zero point together with the resistor R_{UP} to increase the phase margin within the limited frequency range. Using a C_{RUP} is effective when the R_{UP} resistance is larger than the combined parallel resistance of R_{UP} and R_{DW}.

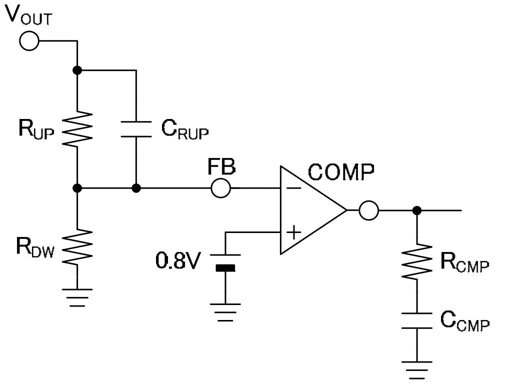


Figure 25. Phase Compensation Circuit

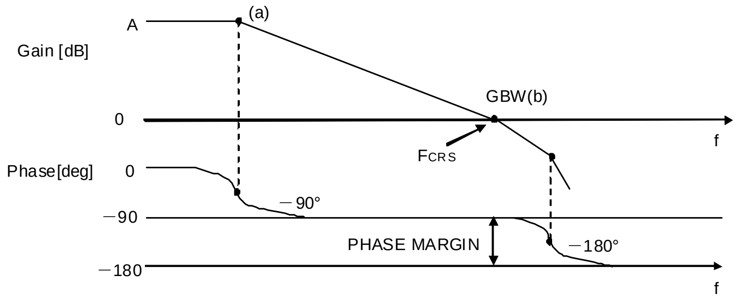


Figure 26. Bode Plot

● I/O Equivalent Circuit Diagram

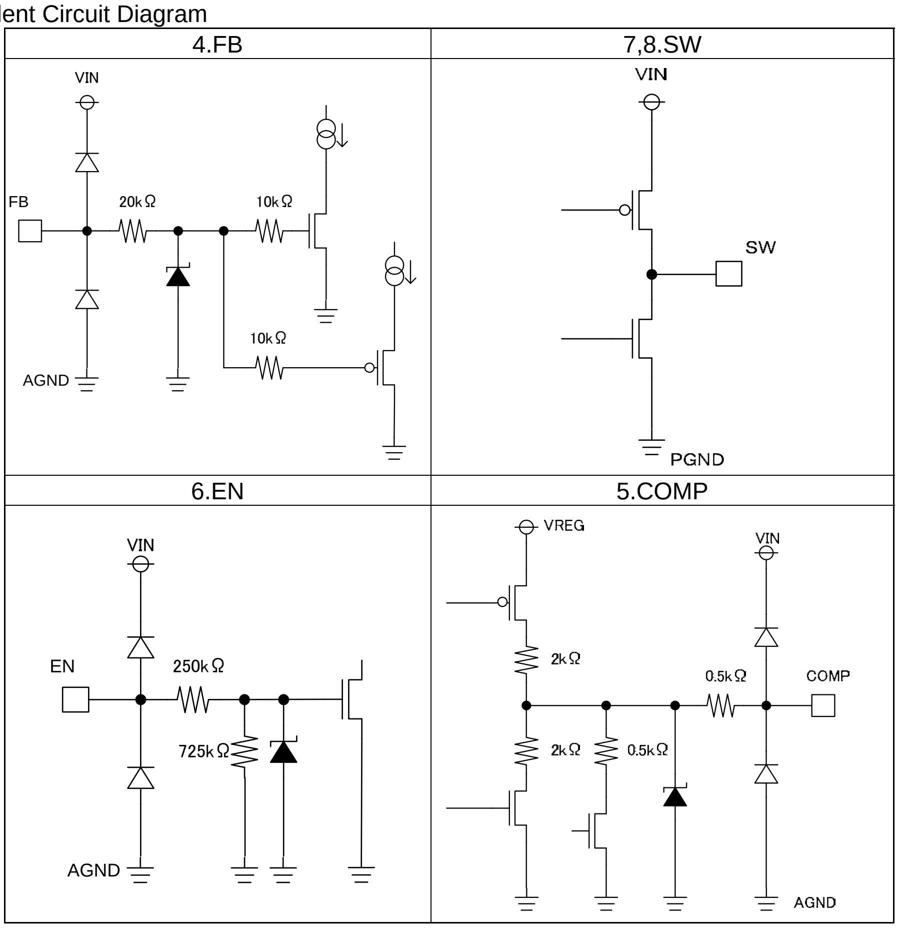


Figure 27.

● Operational Notes

1) Absolute Maximum Ratings
Operating the IC over the absolute maximum ratings may damage the IC. In addition, it is impossible to predict all destructive situations such as short-circuit modes, open circuit modes, etc. Therefore, it is important to consider circuit protection measures, like adding a fuse, in case the IC is operated in a special mode exceeding the absolute maximum ratings.

2) GND Voltage
The voltage of the ground pin must be the lowest voltage of all pins of the IC at all operating conditions. Ensure that no pins are at a voltage below the ground pin at any time, even during transient condition.

3) Thermal Consideration
Use a thermal design that allows for a sufficient margin by taking into account the permissible power dissipation (Pd) in actual operating conditions. Consider Pc that does not exceed Pd in actual operating conditions (Pc≥Pd).

Package Power dissipation : Pd (W)=(Tjmax－Ta)/ θ ja
Power dissipation : Pc (W)=(Vcc－Vo)×Io+Vcc×Ib

(Tjmax : Maximum junction temperature=150℃, Ta : Peripheral temperature[℃] ,
θ ja : Thermal resistance of package-ambience[℃/W], Pd : Package Power dissipation [W],
Pc : Power dissipation [W], Vcc : Input Voltage, Vo : Output Voltage, Io : Load, Ib : Bias Current)

4) Short between pins and Mounting errors
Be careful when mounting the IC on printed circuit boards. The IC may be damaged if it is mounted in a wrong orientation or if pins are shorted together. Short circuit may be caused by conductive particles caught between the pins.

5) Operation under strong Electromagnetic field
Operating the IC in the presence of a strong electromagnetic field may cause the IC to malfunction.

6) Testing on Application Boards
When testing the IC on an application board, connecting a capacitor directly to a low-impedance output pin may subject the IC to stress. Always discharge capacitors completely after each process or step. The IC's power supply should always be turned off completely before connecting or removing it from the test setup during the inspection process. To prevent damage from static discharge, ground the IC during assembly and use similar precautions during transport and storage.

7) PCB Layout
Connect PVIN and AVIN to the power supply of the board and connect PGND and AGND to the GND of the board. Ensure that the wiring for PVIN, AVIN, PGND and AGND are thick and short for sufficiently lowering impedance.
Take the output voltage of the DC/DC converter from the two ends of the output capacitor.
The PCB layout and peripheral components may influence the performance of the DC/DC converter. Give sufficient consideration to the design of the peripheral circuitry.

8) Regarding input pins of the IC
This monolithic IC contains P+ isolation and P substrate layers between adjacent elements in order to keep them isolated. P-N junctions are formed at the intersection of the P layers with the N layers of other elements, creating a parasitic diode or transistor. For example (refer to figure 19):

When GND > Pin A and GND > Pin B, the P-N junction operates as a parasitic diode.
When GND > Pin B, the P-N junction operates as a parasitic transistor.

Parasitic diodes inevitably occur in the structure of the IC. The operation of parasitic diodes can result in mutual interference among circuits, operational faults, or physical damage. Therefore, conditions that cause these diodes to operate, such as applying a voltage lower than the GND voltage to an input pin (and thus to the P substrate) should be avoided. For a SW terminal, which has a potential lower than the GND during use, connect a Schottky barrier diode with a sufficiently low forward voltage between it and the GND.

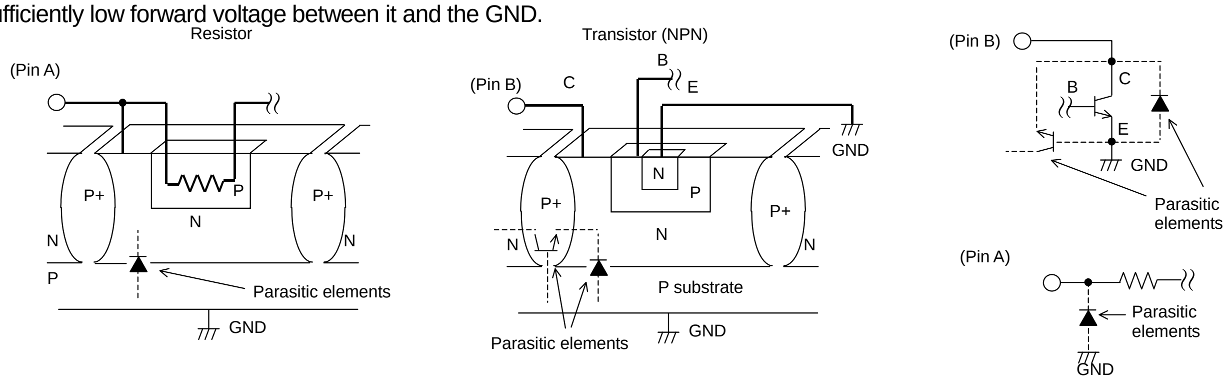


Figure 28: Example of simplified structure of monolithic IC

9) Over Current Protection Circuit (OCP)
The IC incorporates an over-current protection circuit that operates in accordance with the rated output capacity. This circuit protects the IC from damage when the load becomes shorted. It is also designed to limit the output current (without latching) in the event of a large transient current flow, such as from a large capacitor or other component connected to the output pin. This protection circuit is effective in preventing damage to the IC in cases of sudden and unexpected current surges. The IC should not be used in applications where the over current protection circuit will be activated continuously.

10) Thermal Shutdown Circuit (TSD)
The IC incorporates a built-in thermal shutdown circuit, which is designed to turn off the IC when the internal temperature of the IC reaches a specified value. It is not designed to protect the IC from damage or guarantee its operation. Do not continue to operate the IC after this function is activated. Do not use the IC in conditions where this function will always be activated.

11) Enable Function
If the rate of fall of the EN terminal signal is too slow, chattering may occur. Chattering with the output voltage remaining may generate a reverse current that boosts the voltage from the output to the input, possibly leading to damage. For on/off control with the EN signal, ensure that the signal falls within 100 µsec.

12) Area of Safe Operation (ASO)
Operate the IC such that the output voltage, output current, and power dissipation are all within the Area of Safe Operation (ASO).

13) Load at Startup
Ensure that the respective output has light load at startup of this IC. Also, restrain the power supply line noise at startup and voltage drop generated by operating current within the hysteresis width of UVLO. Noise exceeding the hysteresis noise width may cause the IC to malfunction.

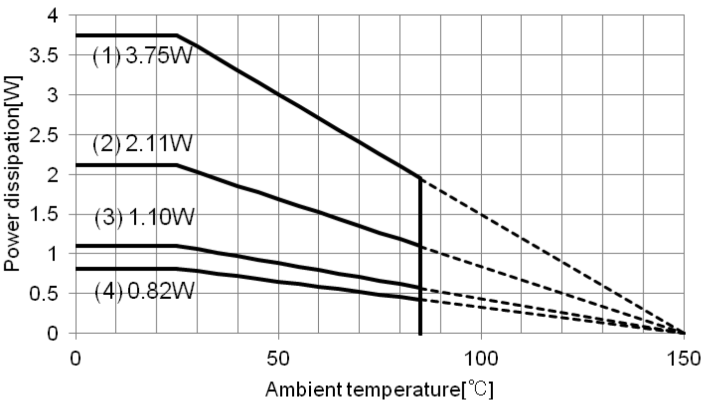
14) External Elements
Use a ceramic capacitor with low ESR for the bypass capacitor between PVIN and PGND and connect it as close as possible to the IC. For external components such as inductors and capacitors, use the recommended values in this specification and connect these components as close to the IC as possible. For those traces in which large current flows, in particular, ensure that the wiring is thick and short.

15) IC Applications
This IC is not developed for automotive or military applications or equipment/devices that may affect human lives. Do not use the IC for such applications. If this IC is used by customers in any of such applications as described above, ROHM shall not be held responsible for failure to satisfy the requirements concerned.

16) Usage Environment
The operating temperature range is intended to guarantee functional operation and does not guarantee the life of the LSI within this range. The life of the LSI is subject to derating depending on usage environment such as the voltage applied, ambient temperature and humidity. Consider derating in the design of equipment and devices.

●Power Dissipation

When designing the PCB layout and peripheral circuitry, sufficient consideration must be given to ensure that the power dissipation is within the allowable dissipation curve.



(1) 4-layer board (surface heat dissipation copper foil 70mm × 70mm)
(2) 2-layer board (surface heat dissipation copper foil 70mm × 70mm)
(3) 2-layer board (surface heat dissipation copper foil 15mm × 15mm)
(4) 2-layer board (surface heat dissipation copper foil 0mm × 0mm)

●**Ordering Information**

B D 9 C 4 0 1 E F J - E2

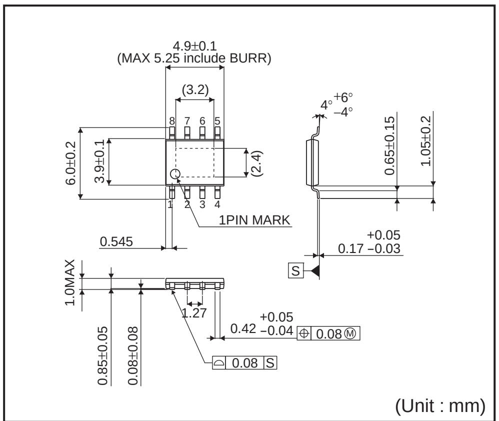
Part Number

Package
EFJ: HTSOP-J8

Packaging and forming specification
E2: Embossed tape and reel

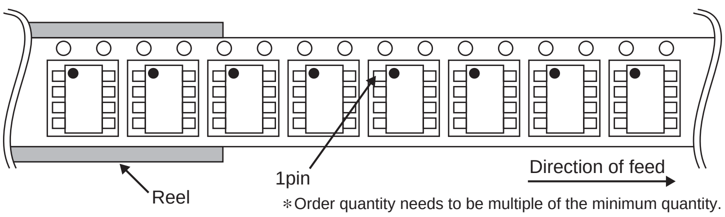
●**Physical Dimension Tape and Reel Information**

HTSOP-J8



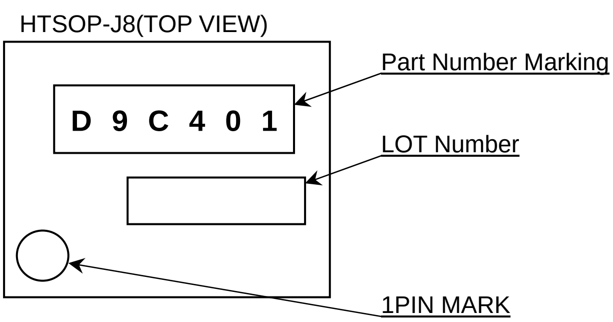
<Tape and Reel information>

Tape	Embossed carrier tape
Quantity	2500pcs
Direction of feed	E2 (The direction is the 1pin of product is at the upper left when you hold reel on the left hand and you pull out the tape on the right hand)



∗Order quantity needs to be multiple of the minimum quantity.

●Marking Diagram(s)(TOP VIEW)



●**Revision History**

Date	Revision	Changes
7.MAR.2013	001	New Release

Notice

●General Precaution

1) Before you use our Products, you are requested to carefully read this document and fully understand its contents. ROHM shall not be in any way responsible or liable for failure, malfunction or accident arising from the use of any ROHM's Products against warning, caution or note contained in this document.

2) All information contained in this document is current as of the issuing date and subject to change without any prior notice. Before purchasing or using ROHM's Products, please confirm the latest information with a ROHM sales representative.

●Precaution on using ROHM Products

1) Our Products are designed and manufactured for application in ordinary electronic equipments (such as AV equipment, OA equipment, telecommunication equipment, home electronic appliances, amusement equipment, etc.). If you intend to use our Products in devices requiring extremely high reliability (such as medical equipment, transport equipment, traffic equipment, aircraft/spacecraft, nuclear power controllers, fuel controllers, car equipment including car accessories, safety devices, etc.) and whose malfunction or failure may cause loss of human life, bodily injury or serious damage to property ("Specific Applications"), please consult with the ROHM sales representative in advance. Unless otherwise agreed in writing by ROHM in advance, ROHM shall not be in any way responsible or liable for any damages, expenses or losses incurred by you or third parties arising from the use of any ROHM's Products for Specific Applications.

2) ROHM designs and manufactures its Products subject to strict quality control system. However, semiconductor products can fail or malfunction at a certain rate. Please be sure to implement, at your own responsibilities, adequate safety measures including but not limited to fail-safe design against the physical injury, damage to any property, which a failure or malfunction of our Products may cause. The following are examples of safety measures:
   [a] Installation of protection circuits or other protective devices to improve system safety
   [b] Installation of redundant circuits to reduce the impact of single or multiple circuit failure

3) Our Products are designed and manufactured for use under standard conditions and not under any special or extraordinary environments or conditions, as exemplified below. Accordingly, ROHM shall not be in any way responsible or liable for any damages, expenses or losses arising from the use of any ROHM's Products under any special or extraordinary environments or conditions. If you intend to use our Products under any special or extraordinary environments or conditions (as exemplified below), your independent verification and confirmation of product performance, reliability, etc, prior to use, must be necessary:
   [a] Use of our Products in any types of liquid, including water, oils, chemicals, and organic solvents
   [b] Use of our Products outdoors or in places where the Products are exposed to direct sunlight or dust
   [c] Use of our Products in places where the Products are exposed to sea wind or corrosive gases, including Cl_2, H_2S, NH_3, SO_2, and NO_2
   [d] Use of our Products in places where the Products are exposed to static electricity or electromagnetic waves
   [e] Use of our Products in proximity to heat-producing components, plastic cords, or other flammable items
   [f] Sealing or coating our Products with resin or other coating materials
   [g] Use of our Products without cleaning residue of flux (even if you use no-clean type fluxes, cleaning residue of flux is recommended); or Washing our Products by using water or water-soluble cleaning agents for cleaning residue after soldering
   [h] Use of the Products in places subject to dew condensation

4) The Products are not subject to radiation-proof design.

5) Please verify and confirm characteristics of the final or mounted products in using the Products.

6) In particular, if a transient load (a large amount of load applied in a short period of time, such as pulse) is applied, confirmation of performance characteristics after on-board mounting is strongly recommended. Avoid applying power exceeding normal rated power; exceeding the power rating under steady-state loading condition may negatively affect product performance and reliability.

7) De-rate Power Dissipation (Pd) depending on Ambient temperature (Ta). When used in sealed area, confirm the actual ambient temperature.

8) Confirm that operation temperature is within the specified range described in the product specification.

9) ROHM shall not be in any way responsible or liable for failure induced under deviant condition from what is defined in this document.

●Precaution for Mounting / Circuit board design

1) When a highly active halogenous (chlorine, bromine, etc.) flux is used, the residue of flux may negatively affect product performance and reliability.

2) In principle, the reflow soldering method must be used; if flow soldering method is preferred, please consult with the ROHM representative in advance.

For details, please refer to ROHM Mounting specification

●Precautions Regarding Application Examples and External Circuits

1) If change is made to the constant of an external circuit, please allow a sufficient margin considering variations of the characteristics of the Products and external components, including transient characteristics, as well as static characteristics.

2) You agree that application notes, reference designs, and associated data and information contained in this document are presented only as guidance for Products use. Therefore, in case you use such information, you are solely responsible for it and you must exercise your own independent verification and judgment in the use of such information contained in this document. ROHM shall not be in any way responsible or liable for any damages, expenses or losses incurred by you or third parties arising from the use of such information.

●Precaution for Electrostatic

This Product is electrostatic sensitive product, which may be damaged due to electrostatic discharge. Please take proper caution in your manufacturing process and storage so that voltage exceeding the Products maximum rating will not be applied to Products. Please take special care under dry condition (e.g. Grounding of human body / equipment / solder iron, isolation from charged objects, setting of Ionizer, friction prevention and temperature / humidity control).

●Precaution for Storage / Transportation

1) Product performance and soldered connections may deteriorate if the Products are stored in the places where:
   [a] the Products are exposed to sea winds or corrosive gases, including Cl2, H2S, NH3, SO2, and NO2
   [b] the temperature or humidity exceeds those recommended by ROHM
   [c] the Products are exposed to direct sunshine or condensation
   [d] the Products are exposed to high Electrostatic

2) Even under ROHM recommended storage condition, solderability of products out of recommended storage time period may be degraded. It is strongly recommended to confirm solderability before using Products of which storage time is exceeding the recommended storage time period.

3) Store / transport cartons in the correct direction, which is indicated on a carton with a symbol. Otherwise bent leads may occur due to excessive stress applied when dropping of a carton.

4) Use Products within the specified time after opening a humidity barrier bag. Baking is required before using Products of which storage time is exceeding the recommended storage time period.

●Precaution for Product Label

QR code printed on ROHM Products label is for ROHM's internal use only.

●Precaution for Disposition

When disposing Products please dispose them properly using an authorized industry waste company.

●Precaution for Foreign Exchange and Foreign Trade act

Since our Products might fall under controlled goods prescribed by the applicable foreign exchange and foreign trade act, please consult with ROHM representative in case of export.

●Precaution Regarding Intellectual Property Rights

1) All information and data including but not limited to application example contained in this document is for reference only. ROHM does not warrant that foregoing information or data will not infringe any intellectual property rights or any other rights of any third party regarding such information or data. ROHM shall not be in any way responsible or liable for infringement of any intellectual property rights or other damages arising from use of such information or data.:

2) No license, expressly or implied, is granted hereby under any intellectual property rights or other rights of ROHM or any third parties with respect to the information contained in this document.

●Other Precaution

1) The information contained in this document is provided on an “as is” basis and ROHM does not warrant that all information contained in this document is accurate and/or error-free. ROHM shall not be in any way responsible or liable for any damages, expenses or losses incurred by you or third parties resulting from inaccuracy or errors of or concerning such information.

2) This document may not be reprinted or reproduced, in whole or in part, without prior written consent of ROHM.

3) The Products may not be disassembled, converted, modified, reproduced or otherwise changed without prior written consent of ROHM.

4) In no event shall you use in any way whatsoever the Products and the related technical information contained in the Products or this document for any military purposes, including but not limited to, the development of mass-destruction weapons.

5) The proper names of companies or products described in this document are trademarks or registered trademarks of ROHM, its affiliated companies or third parties.

OCEAN CHIPS
Океан Электроники
Поставка электронных компонентов

Компания «Океан Электроники» предлагает заключение долгосрочных отношений при поставках импортных электронных компонентов на взаимовыгодных условиях!

Наши преимущества:

- Поставка оригинальных импортных электронных компонентов напрямую с производств Америки, Европы и Азии, а так же с крупнейших складов мира;
- Широкая линейка поставок активных и пассивных импортных электронных компонентов (более 30 млн. наименований);
- Поставка сложных, дефицитных, либо снятых с производства позиций;
- Оперативные сроки поставки под заказ (от 5 рабочих дней);
- Экспресс доставка в любую точку России;
- Помощь Конструкторского Отдела и консультации квалифицированных инженеров;
- Техническая поддержка проекта, помощь в подборе аналогов, поставка прототипов;
- Поставка электронных компонентов под контролем ВП;
- Система менеджмента качества сертифицирована по Международному стандарту ISO 9001;
- При необходимости вся продукция военного и аэрокосмического назначения проходит испытания и сертификацию в лаборатории (по согласованию с заказчиком);
- Поставка специализированных компонентов военного и аэрокосмического уровня качества (Xilinx, Altera, Analog Devices, Intersil, Interpoint, Microsemi, Actel, Aeroflex, Peregrine, VPT, Syfer, Eurofarad, Texas Instruments, MS Kennedy, Miteq, Cobham, E2V, MA-COM, Hittite, Mini-Circuits, General Dynamics и др.);

Компания «Океан Электроники» является официальным дистрибьютором и эксклюзивным представителем в России одного из крупнейших производителей разъемов военного и аэрокосмического назначения **«JONHON»**, а так же официальным дистрибьютором и эксклюзивным представителем в России производителя высокотехнологичных и надежных решений для передачи СВЧ сигналов **«FORSTAR»**.

«JONHON» (основан в 1970 г.)

Разъемы специального, военного и аэрокосмического назначения:

(Применяются в военной, авиационной, аэрокосмической, морской, железнодорожной, горно- и нефтедобывающей отраслях промышленности)

«FORSTAR» (основан в 1998 г.)

ВЧ соединители, коаксиальные кабели, кабельные сборки и микроволновые компоненты:

(Применяются в телекоммуникациях гражданского и специального назначения, в средствах связи, РЛС, а так же военной, авиационной и аэрокосмической отраслях промышленности).

Телефон: 8 (812) 309-75-97 (многоканальный)
Факс: 8 (812) 320-03-32
Электронная почта: ocean@oceanchips.ru
Web: http://oceanchips.ru/
Адрес: 198099, г. Санкт-Петербург, ул. Калинина, д. 2, корп. 4, лит. А