4.5V to 18V, 3A 1ch Synchronous Buck Converter
BD95835EFJ

●Description
BD95835EFJ is a 1ch synchronous buck converter that can generate a wide range of output voltage at the input voltage range (4.5V to 18V). Space-saving and high efficient switching regulator can be achieved due to built-in N-MOSFET power transistors. The IC also incorporates constant ON TIME control mode which facilitates ultra-high transient response against changes in load. Variable soft start function, short circuit protection and over voltage protection are incorporated. The BD95835EFJ is designed for power supplies for Digital AV Equipment.

●Features
- Input Voltage Range: 4.5V to 18.0V
- Output Current: 3.0A (Max.)
- Reference Voltage: 0.750V±1.2%
- Output Voltage Range①: 0.9V to VIN x 0.7
  Using switching frequency 200kHz ≦Freq ≦ 600kHz
- Output Voltage Range②: 0.9V to VIN x 0.6
  Using switching frequency 600kHz ＜Freq ≦ 800kHz
- Built-in Power MOS FET
  High-side Nch FET ON resistance: 100mΩ(typ.)
  Low-side Nch FET ON resistance: 100mΩ(typ.)
- Fast Transient Responses due to ON TIME control
- Over Current Protection (OCP)
- Thermal Shut Down (TSD)
- Under-Voltage Lock-Out (UVLO)
- Short Circuit Protection (SCP)
- Over Voltage Protection (OVP)
- Variable Soft Start

●Applications
- LCD TVs
- Set Top Boxes (STB)
- DVD/Blu-ray players/recorders
- Broadband Network and Communication Interface
- Amusement, other.

●Package

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

●Typical Application

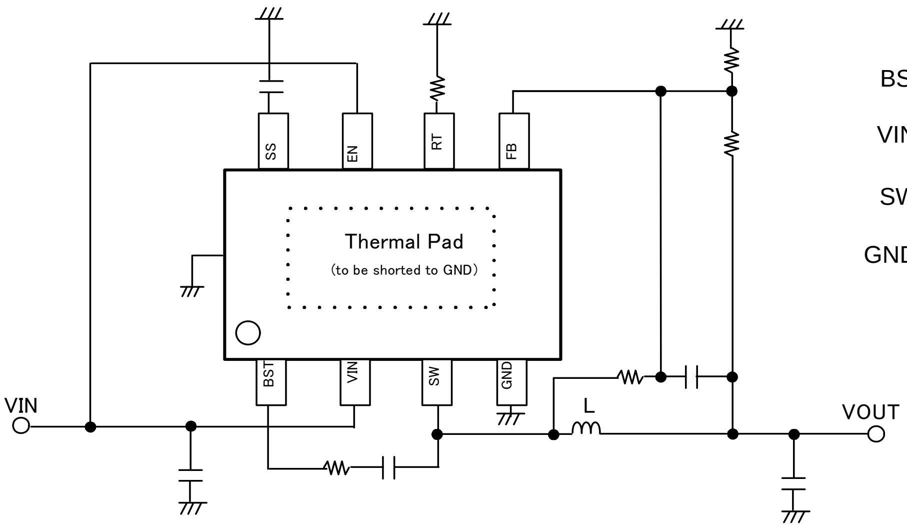


Figure 1. Typical Application Circuit

●Pin Configuration (TOP VIEW)

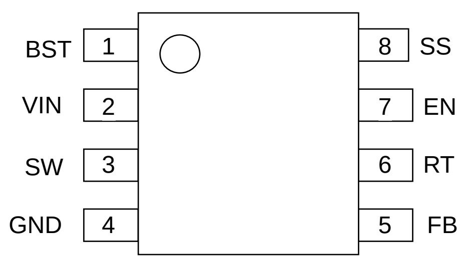


Figure 2. Pin Configuration

○Product structure：Silicon monolithic integrated circuit ○This product is not designed protection against radioactive rays.

●Block Diagram

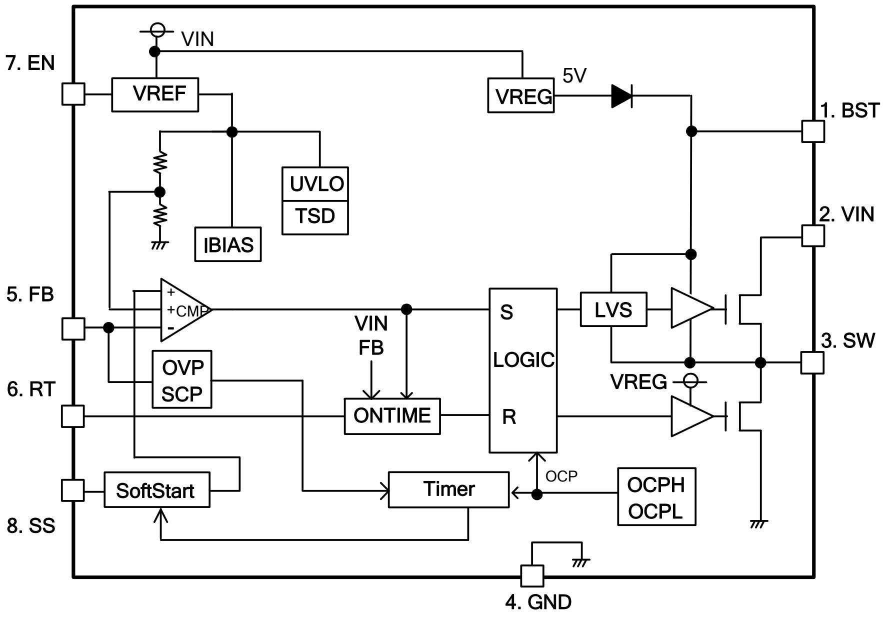


Figure 3. Block Diagram

●Pin Description

No.	Symbol	Description
1	BST	High side FET Gate Driver Power Supply pin. Connect 0.1μF capacitor and 82Ω resistor between BST and SW. BOOT voltage swings from VREG to (VIN + VREG) during normal switching operation.
2	VIN	Input Voltage Supply pin. Connect over 10μF ceramic capacitors for decoupling to PGND as near as these pins.
3	SW	Switch node connection between High side FET source and Low side FET drain. Connected to inductor (L).
4	GND	GND pin for the IC.
5	FB	Output Voltage Feedback pin. FB is compared with REF in the IC.
6	RT	Connect a resistor to determine ONTIME.
7	EN	Enable Input pin. When the input voltage of the EN pin reaches at least 1.2V, the switching regulator becomes active. At the voltage less than 0.2 V, the IC becomes standby mode.
8	SS	Connect a capacitor to determine soft start time.

●Absolute Maximum Ratings (Ta=25℃)

Parameter	Symbol	Limit	Unit
Input Voltage	VIN	20	V
SW voltage	V_{SW}	20	V
SW voltage (10ns transient)	V_{SW}(AC)	22	V
EN voltage	V_{EN}	20	V
BST voltage	V_{BST}	V_{SW}+7	V
SS, FB, RT voltage	V_{OTH}	7	V
Power dissipation	Pd	3760 *1	mW
θja *2	θja	29.27	℃/W
θjc *2	θjc	3.75	℃/W
Operating Temperature Range	Topr	-40 to +85	℃
Storage Temperature Range	Tstg	-55 to +150	℃
Junction Temperature	Tjmax	150	℃

*1 Derating in done 30.08 mW/℃ for operating above Ta≧25℃(Mount on 4-layer 70.0mm×70.0mm×1.6mm board)
*2 Moutn on 4-layer 50mm x 30mm x 1.6mm

●Operating Ratings (Ta= -40 to 85℃)

Parameter	Symbol	Limit			Unit
		Min	Typ	Max	
Input Voltage	V_{IN}	4.5	12	18	V
SW Voltage	V_{SW}	-0.5	-	18	V
Output Current	I_{SW3}	-	-	3	A
Output Voltage Range①※	$V_{RANGE}1$	0.9	-	V_{IN} x 0.7	V
Output Voltage Range②※	$V_{RANGE}2$	0.9	-	V_{IN} x 0.6	V

①※ Please use at the frequency range : 200kHz ≦Freq ≦ 600kHz.
②※ Please use at the frequency range : 600kHz ＜Freq ≦ 800kHz.

Frequency range is limited by input / output conditions.

●**Electrical Characteristics (Unless otherwise noted, VIN=12V, Ta=25℃)**

Parameters	Symbol	Limit			Unit	Conditions
		Min	Typ	Max		
[Output Voltage Detection Block]						
FB input bias current	I_{FB}	-	-	1	µA	FB = 1V
FB threshold voltage	V_{FB1}	0.741	0.750	0.759	V	
OVP threshold voltage	V_{FB1}	0.85	1.00	1.15	V	
SCP threshold voltage	V_{FB2}	0.40	0.500	0.60	V	
[Output Driver Block]						
High side FET ON resistance	R_{ONH}	-	100	-	mΩ	I_{SW} = -0.8A, BST = 16V
Low side FET ON resistance	R_{ONL}	-	100	-	mΩ	I_{SW} = 0.8A
High side FET Leak current	I_{LEAKH}	-	0	1	µA	V_{IN} = 18V V_{SW} = 0V
Low side FET Leak current	I_{LEAKL}	-	0	1	µA	V_{SW} = 18V
High side FET OCP threshold	I_{LIMIT1}	-	6	-	A	
Low side FET OCP threshold	I_{LIMIT2}	-	4	-	A	
Internal ONTIME	T_{ON}	360	440	520	ns	RT = 51kΩ, FB = 0.6V
MIN OFFTIME	T_{MOFF}	-	380	-	ns	VIN=12V
[Other Blocks]						
EN input bias current	I_{EN}	30	50	70	µA	V_{EN} = 12V
EN threshold voltage	V_{EN}	0.4	1.2	2.0	V	
EN hysterisys voltage	V_{ENHYS}	-	0.2	-	V	
UVLO disable voltage	V_{UVLO}	3.8	4.0	4.2	V	
UVLO hysterisys voltage	V_{HYS}	-	0.2	-	V	
SS charge current	I_{SS}	8	10	12	µA	
SS reset voltage	V_{SSL}	-	0.3	-	V	
Protection Latch Timer	T_{LATCH}	-	27	-	µs	
SS discharge resistance	R_{SS}	-	5	-	kΩ	
Output discharge resistance	R_{VOUT}	-	1	-	kΩ	
Circuit Current	I_{CC}	-	1.0	2	mA	V_{EN}= 12V
Stand by current	I_{QUI}	-	15	27	µA	V_{EN}= 0V

● Typical Performance Curves (Unless otherwise noted Ta=25℃, VIN=12V, VOUT=3.3V, freq=400kHz)

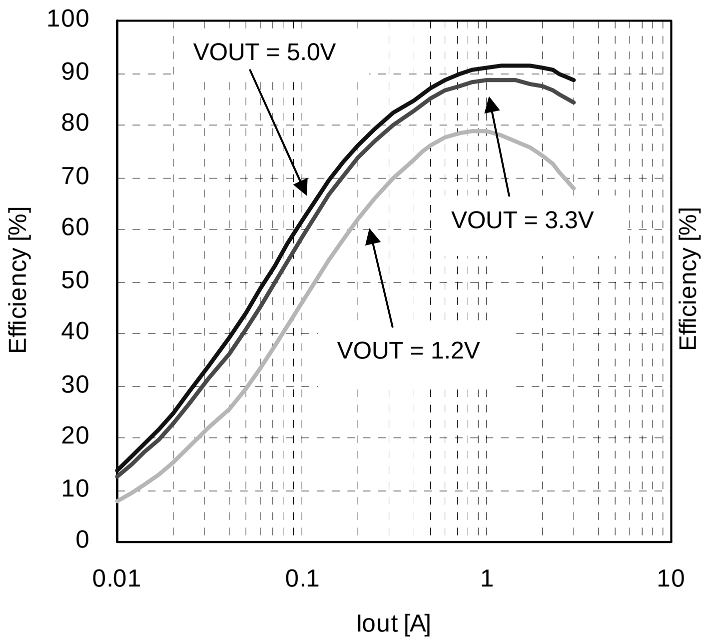


Figure 4. Efficiency 1
(VIN=12V, L=4.7μH, 400kHz)

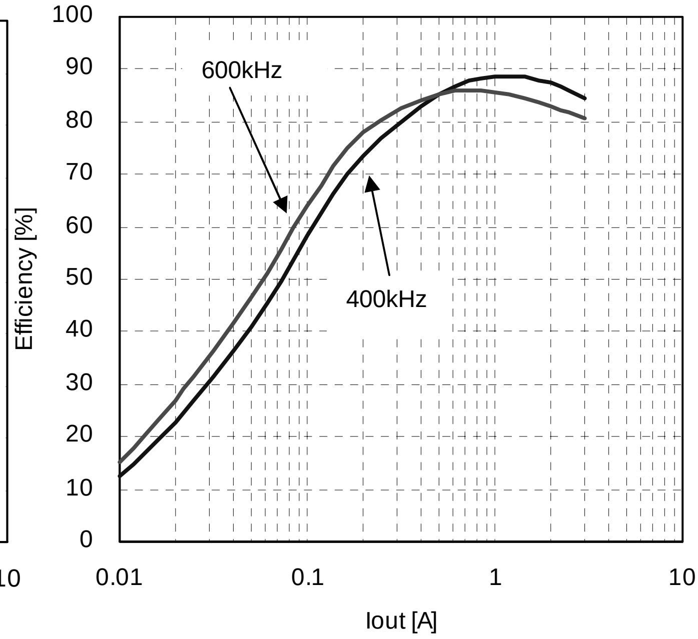


Figure 5. Efficiency 2
(VIN=12V, VOUT=3.3V, L=4.7μH)

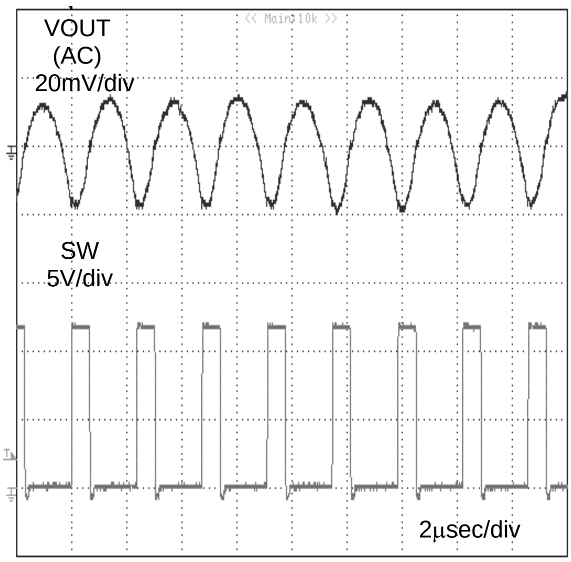


Figure 6. VOUT Ripple voltage
(VIN=12V, VOUT=3.3V, L=4.7μH, COUT=20μF, Iout=0A)

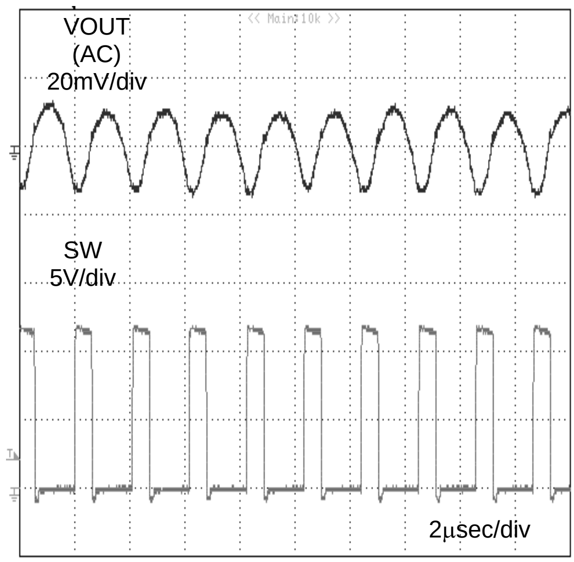


Figure 7. VOUT Ripple voltage
(VIN=12V, VOUT=3.3V, L=4.7μH, COUT=20μF, Iout=3A)

●Typical Performance Curves (Unless otherwise noted Ta=25℃, VIN=12V, VOUT=3.3V, freq=400kHz) (Continued)

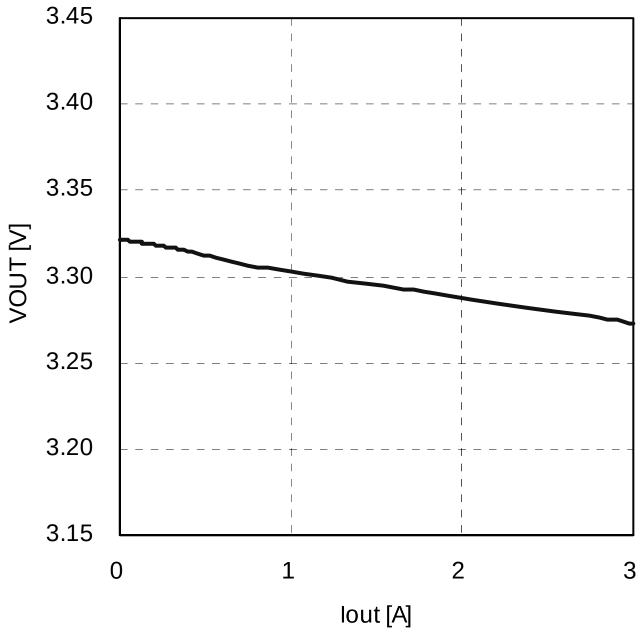


Figure 8. VOUT VOUT Load Regulation
(VIN=12V, VOUT=3.3V, L=4.7µH)

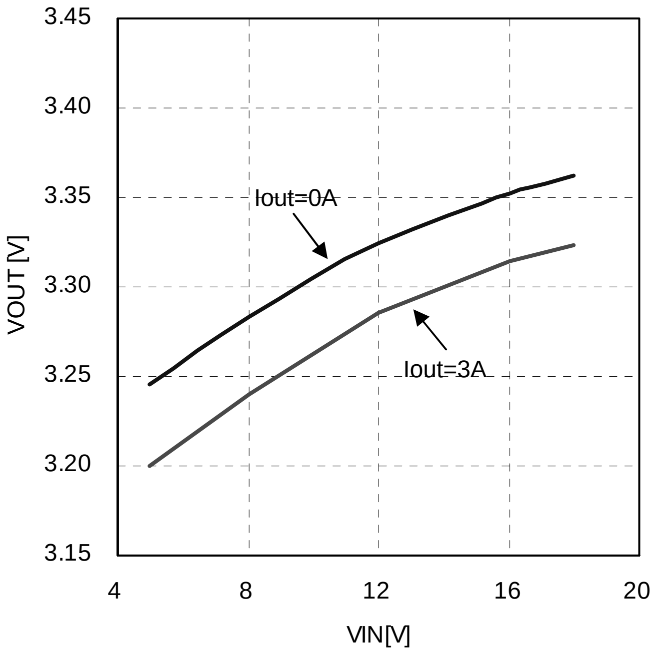


Figure 9. VOUT VOUT Line Regulation
(VOUT=3.3V, L=4.7µH, Iout=0A / 3A)

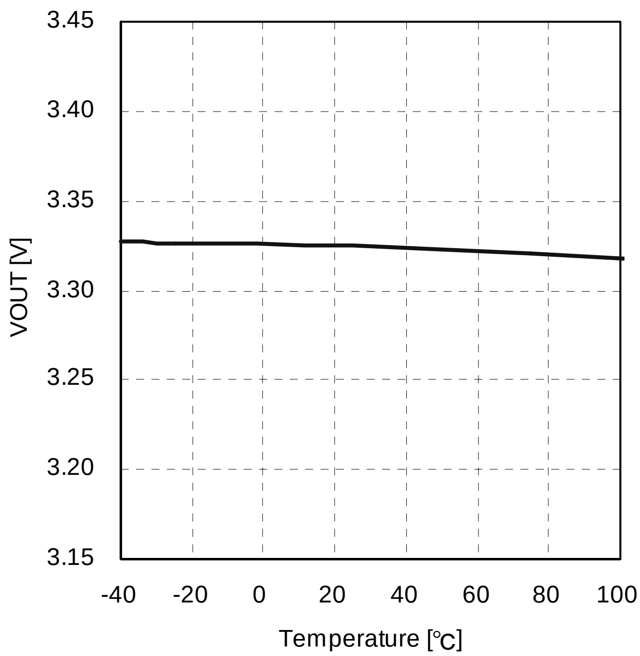


Figure 10. VOUT - Temperature
(VIN=12V, VOUT=3.3V, L=4.7µH, Iout=0A)

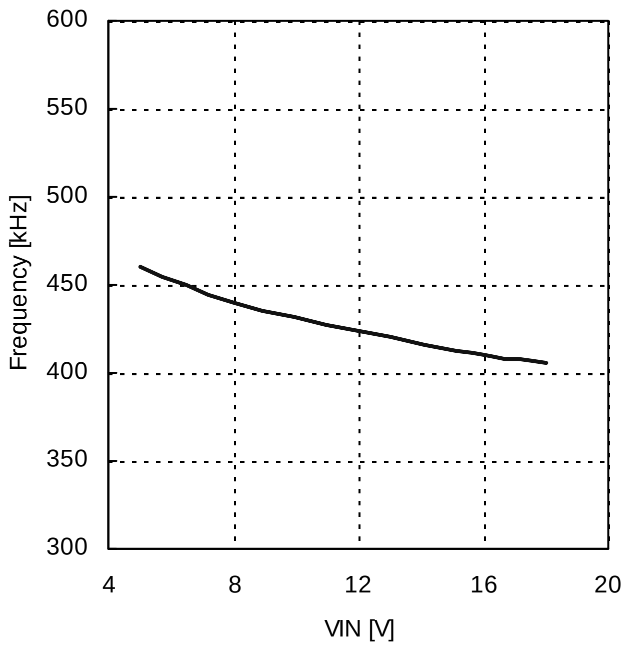


Figure 11. Frequency - VIN
(VIN=12V, VOUT=3.3V, L=4.7µH, Iout=0A)

●Typical Performance Curves (Unless otherwise noted Ta=25℃, VIN=12V, VOUT=3.3V, freq=400kHz) (Continued)

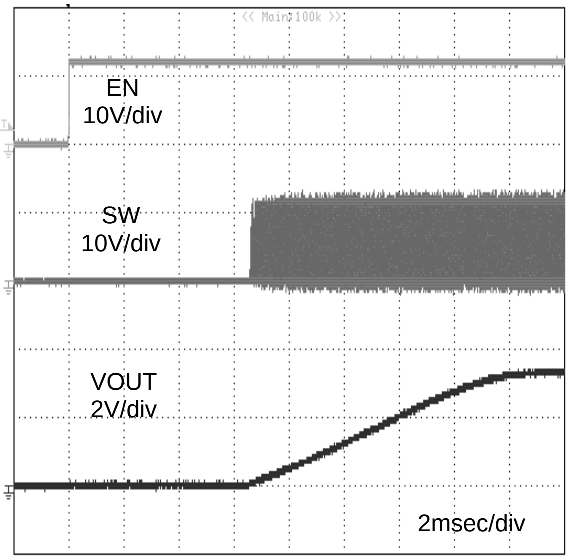


Figure 12. Start up wave form
(VIN=12V, VOUT=3.3V, L=4.7µH, COUT=20µF, Iout=0A)

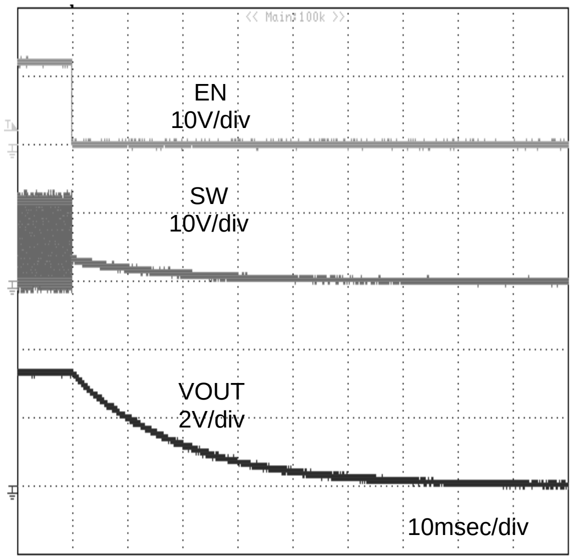


Figure 13. Off wave form
(VIN=12V, VOUT=3.3V, L=3.3µH, COUT=20µF, Iout=0A)

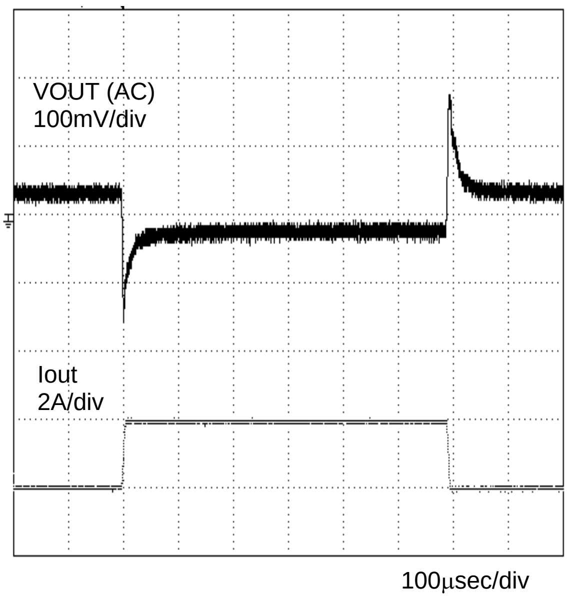


Figure 14. VOUT Transient Response
(VIN=12V, VOUT=3.3V, L=4.7µH, COUT=20µF)
Iout=0⇔2A

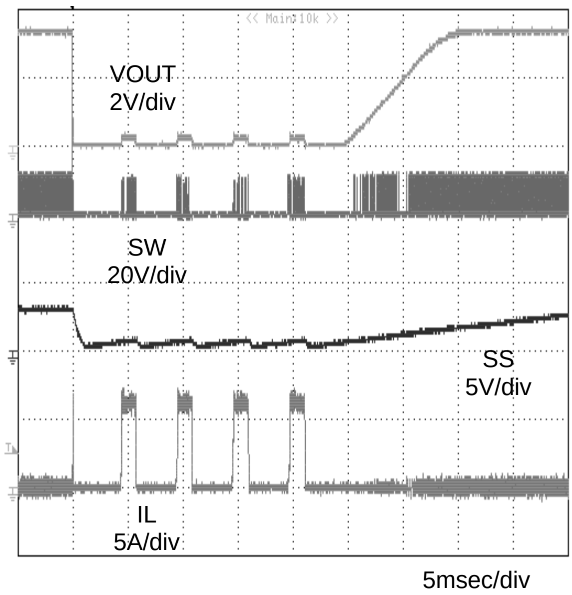


Figure 15. OCP function
(VIN=12V, VOUT=3.3V, L=4.7µH, COUT=20µF)
(VOUT is shorted to GND)

●Selection of Components Externally Connected

1. Constant ONTIME and operating frequency

ONTIME (Ton) can be determined by VIN input voltage and RT resistor.

$$Ton = FB \times 154pF \times (1 / VIN) \times (RT + 5k\Omega) + 10nsec$$

$$Freq = VOUT / VIN \times 1 / Ton$$

- FB : FB threshold voltage (0.765V, typ.).
- 154pF, 5kΩ, 10nsec are constant values in the IC.

ONTIME and Frequency are calculated as below when VIN=12V, VOUT=3.3V, RT=62kΩ.

$$Ton = 0.750\,[V] \times 154p\,[F] \times (1 / 12\,[V]) \times (62k\,[\Omega] + 5k\,[\Omega]) + 10n\,[sec]$$
$$= 655n\,[sec]$$

$$Freq = 3.3\,[V] / 12\,[V] \times 1 / 655n\,[sec]$$
$$= 420k\,[Hz]$$

ONTIME and frequency also depends on other conditions such as output current load.

2. Inductor (L) Selection

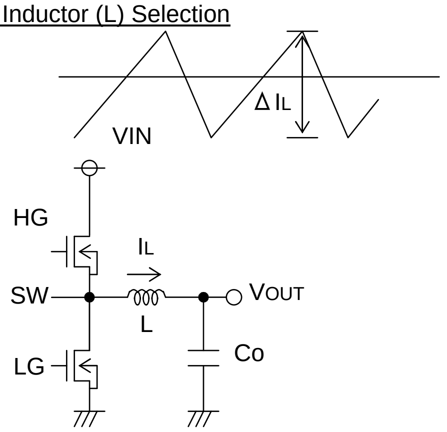


Figure 16. Inductor Ripple Current

The value of ΔI_L is shown as formula below. The larger value of the inductance or the faster switching frequency make the lower ripple voltage.

$$\Delta I_L = \frac{(V_{IN} - V_{OUT}) \times V_{OUT}}{L \times V_{IN} \times f} \quad [A]$$

The proper output ripple current setting is about 30% of maximum output current.

$$\Delta I_L = 0.3 \times I_{OUT}max. \, [A]$$

$$L = \frac{(V_{IN} - V_{OUT}) \times V_{OUT}}{\Delta I_L \times V_{IN} \times f} \quad [H]$$

(ΔI_L: Inductor ripple current, f:switching frequency

※A larger current than the inductor's rated current will cause magnetic saturation in the inductor, and decrease efficiency. When selecting an inductor, be sure to allow enough margins to assure that peak current does not exceed the inductor's rated current value.

※To minimize loss of inductor and improve efficiency, choose a inductor with a low resistance (DCR, ACR).

3. Output Capacitor (C_{OUT}) Selection

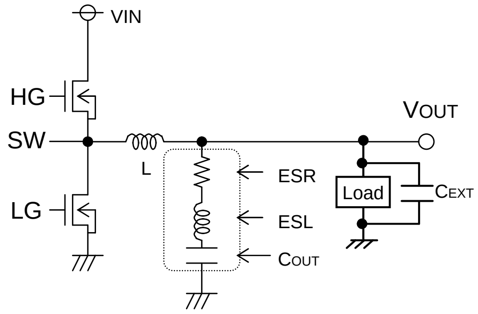


Figure 17. Output Capacitor

Output Capacitor (C_{OUT}) has a considerable influence on output voltage regulation due to a rapid load change and smoothing output ripple voltage. Determine the capacitor by considering the value of capacity, the equivalent series resistance, and equivalent series inductance. Also, make sure the capacitor's voltage rating is high enough for the set output voltage (including ripple).

Output ripple voltage is determined as in formula below.

$$\Delta V_{OUT}=\Delta I_L/(8\times COUT\times f)+ESR\times\Delta I_L+ESL\times\Delta I_L/T_{ON}$$

(ESR: Equivalent series resistance、ESL: Equivalent series inductance)

Also, give consideration to the conditions in formula below for output capacitance, bearing in mind that output rise time must be established within the fixed soft start time. As output capacitance, bypass capacitor will be also connected to output load side (C_{EXT}, Figure 23). Please set the over current detection value with regards to these capacitance.

$$C_o+C_{EXT}\leqq\frac{Tss\times(Limit-I_{OUT})}{V_{OUT}}$$

Limit: OCP current limit
I_{OUT}: Output current
Tss: soft start time

Note: an improper output capacitor may cause startup malfunctions.

4. Input Capacitor (CIN) Selection

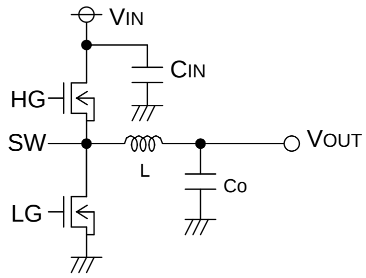


Figure 18. Input Capacitor

In order to prevent transient spikes in voltage, the input capacitor should have a low enough ESR resistance to fully support a large ripple current. The formula for ripple current I_{RMS} is given as below.

$$I_{RMS}=I_{OUT}\times\frac{\sqrt{V_{OUT}(V_{IN}-V_{OUT})}}{V_{IN}}\ [A]$$

Where $V_{IN}=2\times V_{OUT}$, $I_{RMS}=\frac{I_{OUT}}{2}$

A low ESR capacitor is recommended to reduce ESR loss and improve efficiency.

5. Output Voltage Setting

In the case of ceramic capacitors with small ESR, the FB ripple is very small. So it needs external ripples to stabilize the system. The FB voltage ramp is expected around 50mV. The external ramp is generated through the circuit as follows.

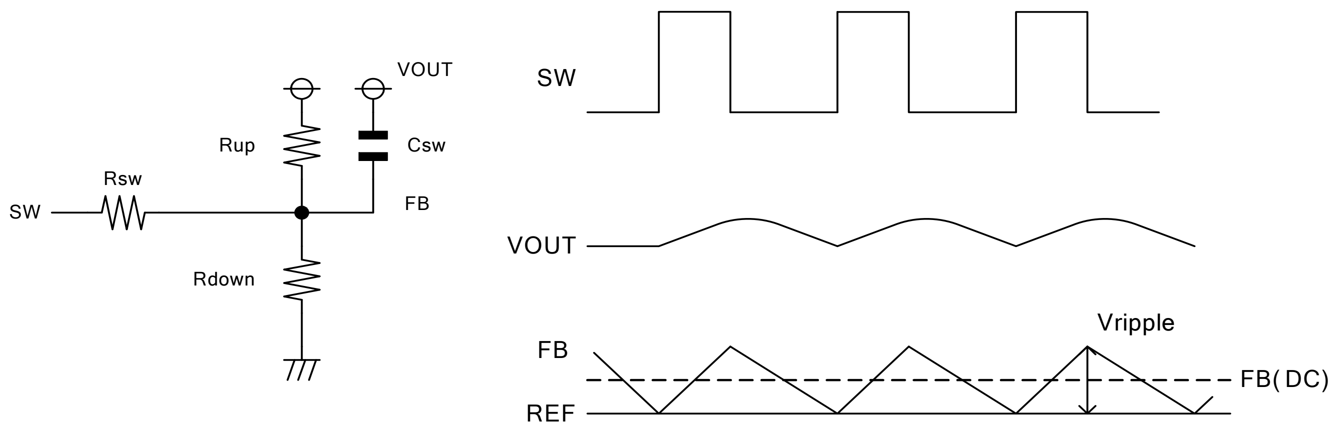


Figure 19. Ripple Injection Circuit

The FB ramp follows:

Vripple = (VIN – VOUT) × Ton / (Csw Rsw) （T < Csw Rup//Rdown << Csw Rsw）

So, average FB voltage follows:

FB(DC) = 0.75V + Vripple/2

Periodically averaged, SW voltage is equal to VOUT. So output voltage VOUT follows:

VOUT = FB(DC) × {1 + Rup//Rsw / Rdown}.

In case of output capacitor with large ESR, no external ramp circuit is needed. VOUT follows:

VOUT = FB(DC) × {1 + Rup / Rdown}

6. Soft start time

Soft start delay Td、Soft star time Tss determines as follows:

$Td = Css \times Vth / Iss$ [sec]

$Tss = Css \times VREF / Iss$ [sec]

Css：SS pin external capacitor
Vth：Internal MOS Vth typ 0.7V
VREF：reference voltage typ. 0.75V
Iss：SS charge current typ. 10uA

Rush current is determined as follows:

$IIN = COUT \times VOUT / Tss$ [A]

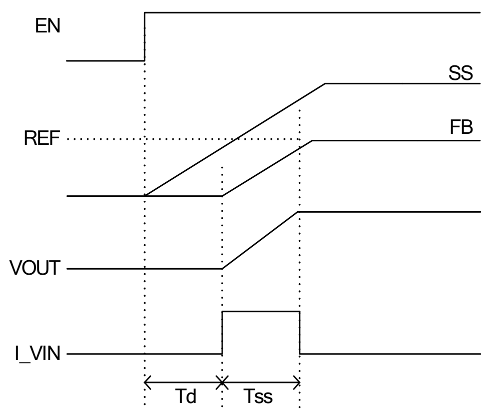


Figure 20. Soft start Timing Chart

When EN=L, UVLO, TSD operates, SS is discharged.
In case of Self-resume type, SS is also discharged after 30us latch off delay detecting OVP or SCP.
（SS discharge resistance：Rss = 5kΩ typ）

●Operation Description

1. Load transient operation

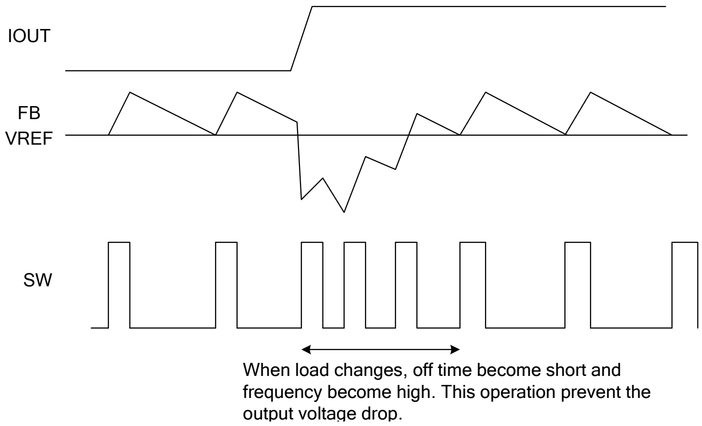


Figure 22. Load transient operation

When FB bellows REF voltage, SW goes high for constant ONTIME.
When load changes fast, short SW=L time cause high frequency and small VOUT drop.
SW=L time is normally limited by MIN_OFFTIME depending on VIN voltage.
External ramp circuit influence Load response characteristics.

2. High-side FET OCP function

When high-side FET current exceeds OCP limit, high-side FET is off. SW=L time is normally limited by MIN OFFTIME, but is limited by 10 times MIN OFFTIME after OCP detected. This operation decrease coil current,

3. Low-side FET OCP function

When low-side FET current from SW to GND exceeds OCP limit, low-side FET is off.

4. SCP function

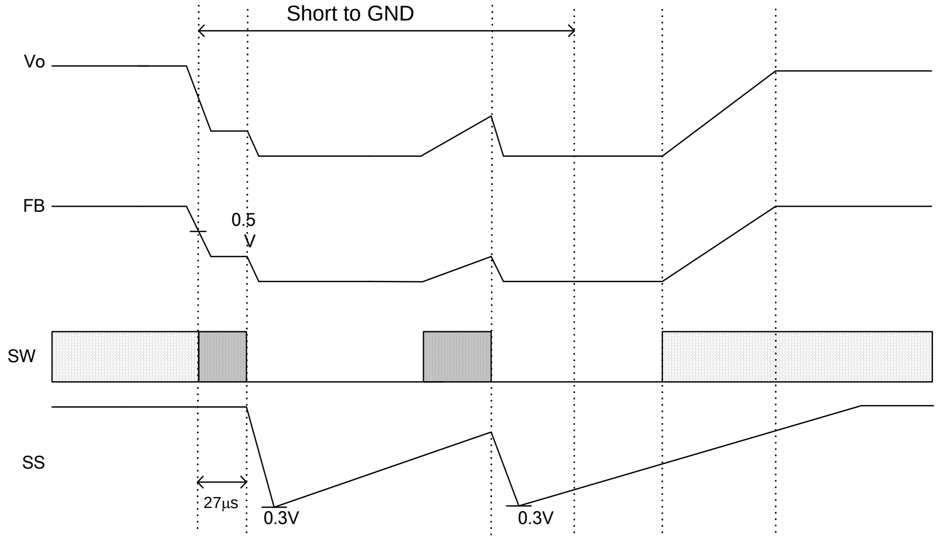


Figure 22. SCP Timing Chart

SCP monitors FB voltage. When FB falls below 0.5V, 27μs later, SW=HiZ and SS is discharged
When SS<0.3V, the IC is reset and restart.

5. OVP function

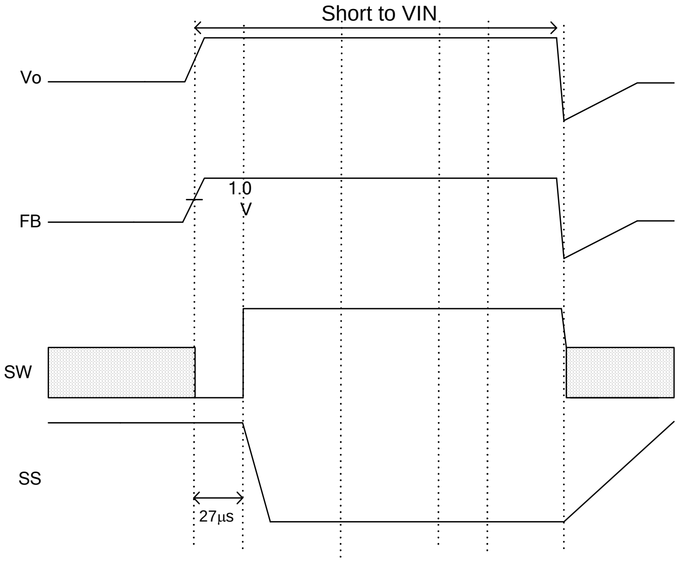


Figure 23. OVP Timing Chart

SCP monitors FB voltage. When FB exceeds 1.0V, 27μs later, SW=HiZ and SS is discharged
When SS<0.3V, the IC is reset and restart.

6. TSD Operation (Self Recovery)

If the junction temperature exceeds Tj = 175℃, SW=HiZ and SS is discharged.
When Tj falls below 160℃, it returns to standard operation.

7. UVLO Operation

When VCC falls below 3.8V, UVLO operates. SW=HiZ and SS is discharged.
UVLO is released when VCC goes up to 4.0V, and starts normal operation.

●**PCB Layout Guide**

Two high pulsing current flowing loops exist in the buck regulator system.
The first loop, when FET is ON, starts from the input capacitors, to the VIN terminal, to the SW terminal, to the inductor, to the output capacitors, and then returns to the input capacitor through GND.
The second loop, when FET is OFF, starts from the low FET, to the inductor, to the output capacitor, and then returns to the low FET through GND.
To reduce the noise and improve the efficiency, please minimize these two loop area.
Especially input capacitor and output capacitor should be connected to GND (PGND) plain.
PCB Layout may affect the thermal performance, noise and efficiency greatly. So please take extra care when designing PCB Layout patterns.

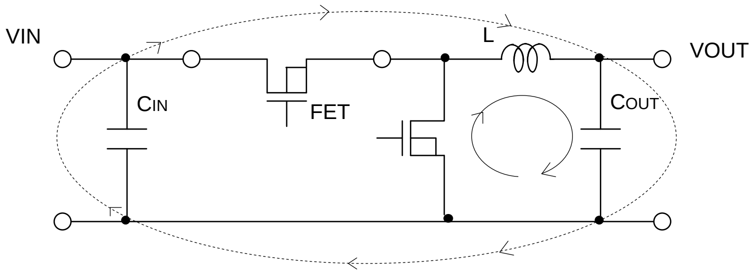


Figure 24. Current loop Buck regulator system

- The thermal Pad on the back side of IC has the great thermal conduction to the chip. So using the GND plain as broad and wide as possible can help thermal dissipation. And a lot of thermal via for helping the spread of heat to the different layer is also effective.
- The input capacitors should be connected to PGND as close as possible to the VIN terminal.
- The inductor and the output capacitors should be placed close to SW pin as much as possible.

●**Evaluation Board Circuit**

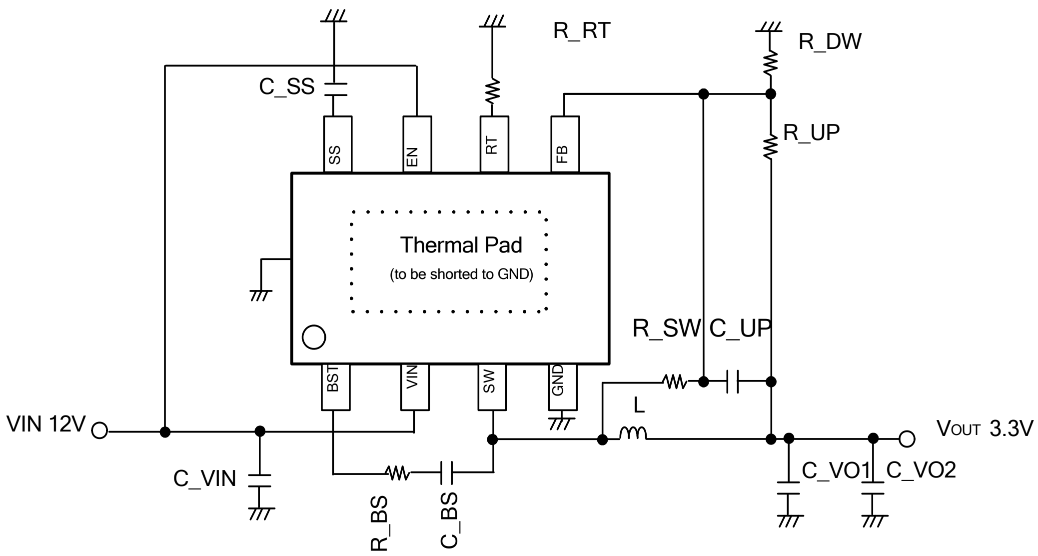


Figure 25. Typical Application Circuit

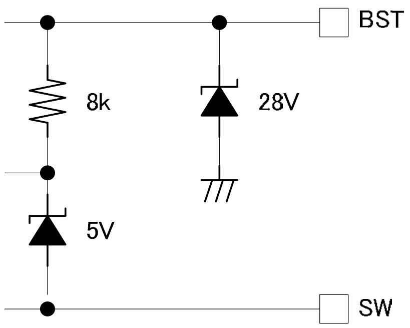
・Recommended Components List (VIN=12V, VOUT=3.3V, Freq=420kHz)

Symbol	Part	Value	Manufacture	Series
L	Coil	4.7µH	TOKO	FDVC0630-4R7M
			TDK	SPM6530-4R7M
C_VIN	Ceramic capacitor	10µF / 25V	Murata	GRM31CR71E16KA12
C_VO1	Ceramic capacitor	10µF / 25V	Murata	GRM31CR71E16KA12
C_VO2	Ceramic capacitor	10µF / 25V	Murata	GRM31CR71E16KA12
C_BS	Ceramic capacitor	0.1µF / 50V	Murata	GRM18 Series
R_BS	Resistance	82Ω	Rohm	MCR03 Series
C_SS	Ceramic capacitor	0.1µF / 50V	Murata	GRM18 Series
R_RT	Resistance	62kΩ	Rohm	GRM18 Series
R_UP	Resistance	36kΩ	Rohm	GRM18 Series
R_DW	Resistance	10kΩ	Rohm	MCR03 Series
R_SW	Resistance	360kΩ	Rohm	MCR03 Series
C_UP	Ceramic capacitor	390pF / 50V	Rohm	GRM18 Series

※The above components list is an example. Please check actual circuit characteristics on the application carefully before use.

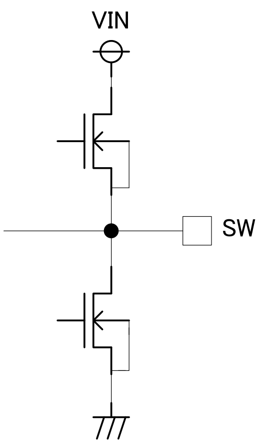
●I/O Equivalence circuit

1. BST



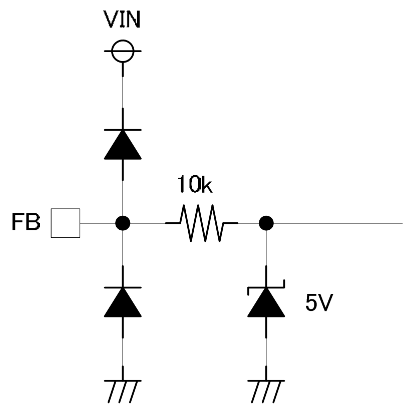
2. VIN

3. SW

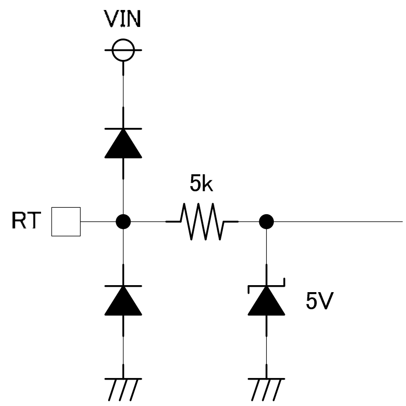


4. GND

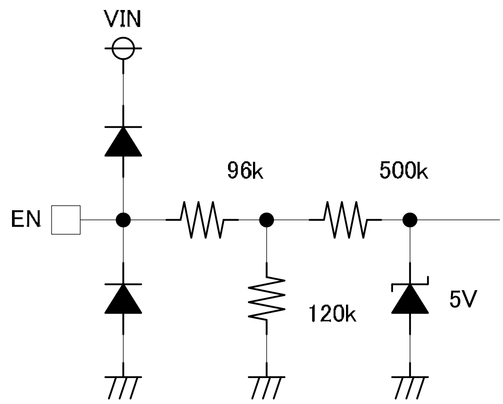
5. FB



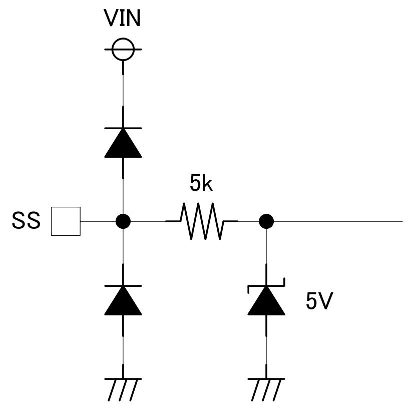
6. RT



7. EN



8. SS



●Operational Notes

(1) Absolute Maximum Ratings
Use of the IC in excess of absolute maximum ratings may result in damage to the IC. Assumptions should not be made regarding the state of the IC (e.g., short mode or open mode) when such damage is suffered. If operational values are expected to exceed the maximum ratings for the device, consider adding protective circuitry (such as fuses) to eliminate the risk of damaging the IC.

(2) GND voltage
The potential of the GND, PGND pin must be the minimum potential in the system in all operating conditions.

(3) Thermal design
Use a thermal design that allows for a sufficient margin for power dissipation (Pd) under actual operating conditions

(4) Inter-pin Shorts and Mounting Errors
Use caution when orienting and positioning the IC for mounting on printed circuit boards. Improper mounting may result in damage to the IC. Shorts between output pins or between output pins and the power supply and GND pins caused by poor soldering or foreign objects may result in damage to the IC.

(5) Operation in Strong Electromagnetic Fields
Using this product in strong electromagnetic fields may cause IC malfunction. Caution should be exercised in applications where strong electromagnetic fields may be present.

(6) ASO (Area of Safe Operation)
When using the IC, ensure that operating conditions do not exceed absolute maximum ratings or ASO of the output transistors.

(7) Testing on application boards
When testing the IC on an application board, connecting a capacitor directly to a low-impedance 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 a jig or fixture during the evaluation process. To prevent damage from static discharge, ground the IC during assembly and use similar precautions during transport and storage.

(8) Electrical Characteristics
The electrical characteristics indicated in this datasheet may change upon the conditions of temperature, supply voltage, and external components. Please validate/verify your design at the worst case conditions.

(9) Not of a radiation-resistant design.

(10) Back Electromotive Force
If a large inductive load is connected at the output pin that might cause introducing back electromotive force at the start up and at the output disable, please insert protection diodes.

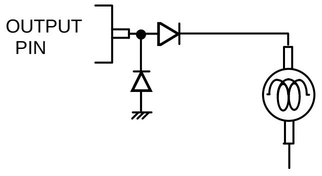


Figure 26. Back Electromotive Force

(11) 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. PN junctions are formed at the intersection of these P layers with the N layers of other elements, creating parasitic diodes and/or transistors. For example (refer to the figure below):、

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

Parasitic diodes occur inevitably in the structure of the IC, and the operation of these parasitic diodes can result in mutual interference among circuits, operational faults, or physical damage. Accordingly, 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.

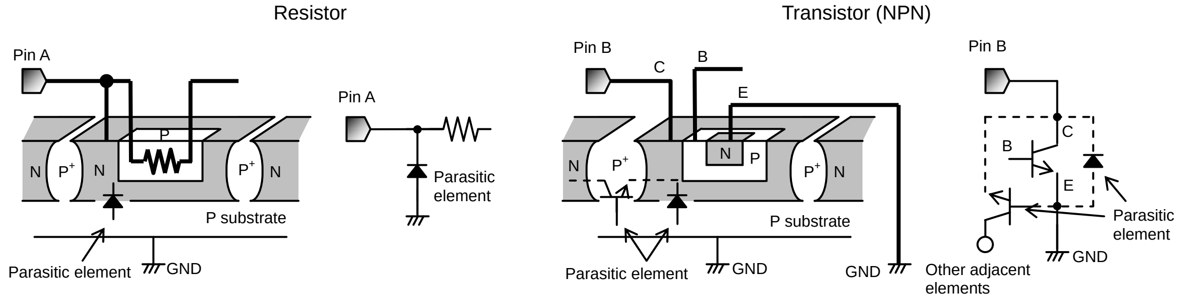


Figure 27. Example of IC structure

(12) Ground Wiring Pattern

When using both small-signal and large-current GND traces, the two ground traces should be routed separately but connected to a single ground potential within the application in order to avoid variations in the small-signal ground caused by large currents. Also ensure that the GND traces of external components do not cause variations on GND voltage.

(13) Operating Condition

The electrical characteristics indicated in this datasheet are not guaranteed for the whole operational and temperature ranges, however these characteristics do not significantly fluctuate within the operational and temperature ranges.

(14) Thermal shutdown (TSD) circuit

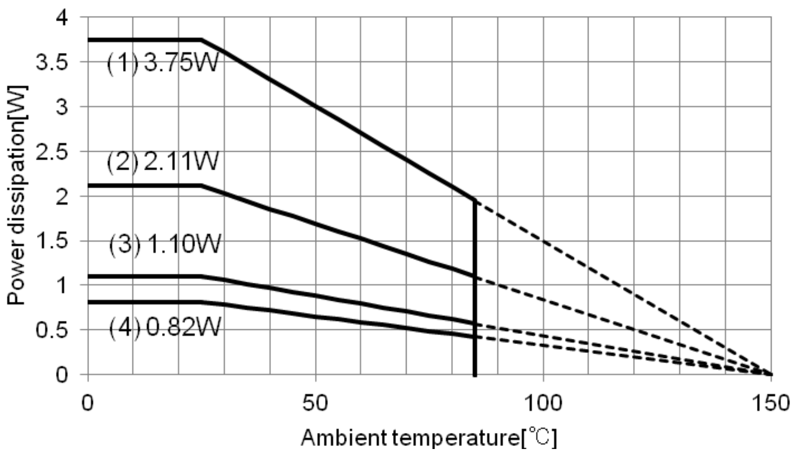
The IC incorporates a built-in thermal shutdown circuit, which is designed to turn the IC off completely in the event of thermal overload. It is not designed to protect the IC from damage or guarantee its operation. ICs should not be used after this function has activated, or in applications where the operation of this circuit is assumed. If the thermal shutdown is activated while the load current exists, the output may possibly be latched off at the release of the thermal shutdown.

TSD ON Temp.[℃]　(typ.)	Hysteresis Temp[℃]　(typ.)
175	15

(15) Heat Sink (FIN)

The heat sink (FIN) is connected to the substrate. Please connect it to GND.

●Thermal Derating Curves



HTSOP-J8 Package
On 70 × 70 × 1.6 mm glass epoxy PCB
(1) 4-layer board (Backside copper foil area 70 mm × 70 mm)
(2) 2-layer board (Backside copper foil area 70 mm × 70 mm)
(3) 2-layer board (Backside copper foil area 15 mm × 15 mm)
(4) 1-layer board (Backside copper foil area 0 mm× 0 mm)

●Ordering Information

B D 9 5 8 3 5 E F J - E 2

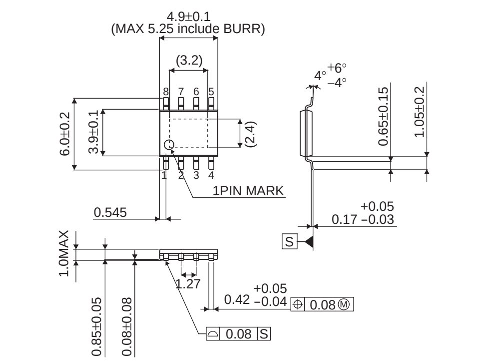
Part Number

Package
EFJ: HTSOP-J8

Packaging and forming specification
E2: Embossed tape and reel

●Physical Dimension Tape and Reel Information

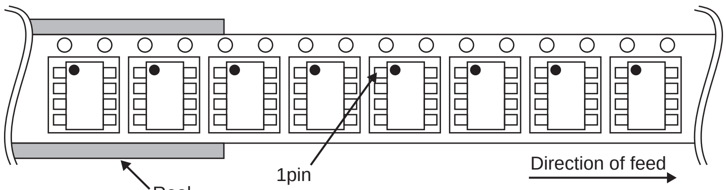
HTSOP-J8



(Unit : mm)

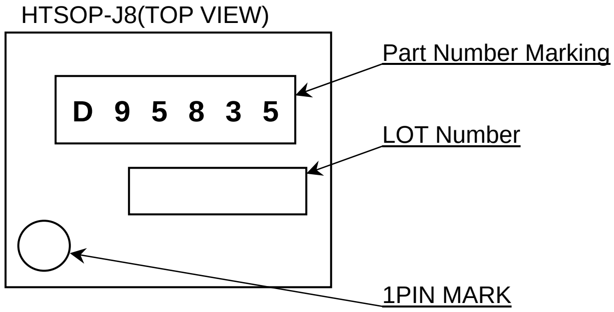
<Tape and Reel information>

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



●**Revision History**

Date	Revision	Changes
31.Aug.2012	001	New Release
14.Feb.2013	002	2/19 page Block Diagram（7.SS→8.SS、 4.GND added） 2/19 page Pin Description（BOOT→BST） 3/19 page Operating Ratings（VIN min. 4.2V→4.5V same as 1/19 page） 4/19 page Electrical Characteristics（BOOT→BST） 15/19 page I/O Equivalence circuit（BOOT→BST）
08.Apr.2013	003	8/20 page Constant ON time and operating frequency (Revised the description and calculation formula)
29.May.2013	004	1/20 page Output Voltage Range (Revised the description) 3/20 page Output Voltage Range (Revised the description)

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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 (Note 1), 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.

(Note1) Medical Equipment Classification of the Specific Applications

JAPAN	USA	EU	CHINA
CLASSⅢ	CLASSⅢ	CLASSⅡb	CLASSⅢ
CLASSⅣ		CLASSⅢ	

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

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   [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.

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

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

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