Hi-performance Regurator IC Series for PCs

2Phase Switching Regulator Controllers for Graphic Card

Pb Free
ROHM Electronic Components

RoHS
Directive Compliance

BD95710MUV

No.09030EBT20

●Description

BD95710MUV is a dual-phase switching regulator controller with high output current which can achieve low output voltage (0.4V ~ 3.3V) from AC/DC 5V or 12V. High efficiency for the switching regulator can be realized by utilizing an external N-MOSFET power transistor. A new technology called H^3Reg^{TM} is a Rohm proprietary control method to realize ultra high transient response against load change without phase compensation capacitance and resistance. For various applications, it is available to select the 3 types of N-MOSFET gate drive voltage (12V: for drive ability, 8V: for intermediate drive ability, 5V: for small real estate).

●Features

1) H^3Reg^{TM} switching Regulator Controller without phase compensation capacitance and resistance
2) Ultra High Tolerance Internal Reference Voltage (+/- 1%)
3) Thermal Shut Down (TSD), Under Voltage LockOut (UVLO), Adjustable Over Current Protection (OCP), Over Voltage Protection (OVP), Short Circuit protection(SCP) built-in
4) Soft start function to minimize rush current during startup
5) switching Frequency Variable (f=200kHz~1000kHz)
6) Internal Bootstrap Diode
7) High Tolerance Current Balance Function
8) VQFN024V4040 Package (4.0mm x 4.0mm x 1.0mm)
9) Integrated 1-/2-phase switching Function

●Applications

Graphic Cards, Desktop PC, Gaming Equipments, Digital Components

●Maximum Absolute Ratings (Ta=25℃)

Parameter	Symbol	Limit	Unit
Input Voltage 1	VCC	15 [*1]	V
Input Voltage 2	VIN	15 [*1]	V
Input Voltage 3	VCCDRV	15 [*1]	V
Input Voltage 4	5VCC	7 [*1]	V
Input Voltage 5	REFIN/EN	7 [*1*2]	V
Input Voltage 6	BUSEN	7 [*1]	V
BOOT Voltage	BOOT1/2	30 [*1]	V
BOOT-PHASE Voltage	BOOT1/2-PHASE	15 [*1]	V
UG-PHASE Voltage	UGATE1/2_	15 [*1]	V
PHASE Voltage	PHASE1/2	15	V
Power Dissipation	Pd1	0.34	W
Operating Temperature Range	Topr	0～+70	℃
Storage Temperature Range	Tstg	-55～+150	℃
Junction Temperature	Tjmax	+150	℃

*1 Do not to exceed Pd.

*2 REFIN/EN voltage can not go up higher than 5VCC voltage.

●Operating Conditions (Ta=25℃)

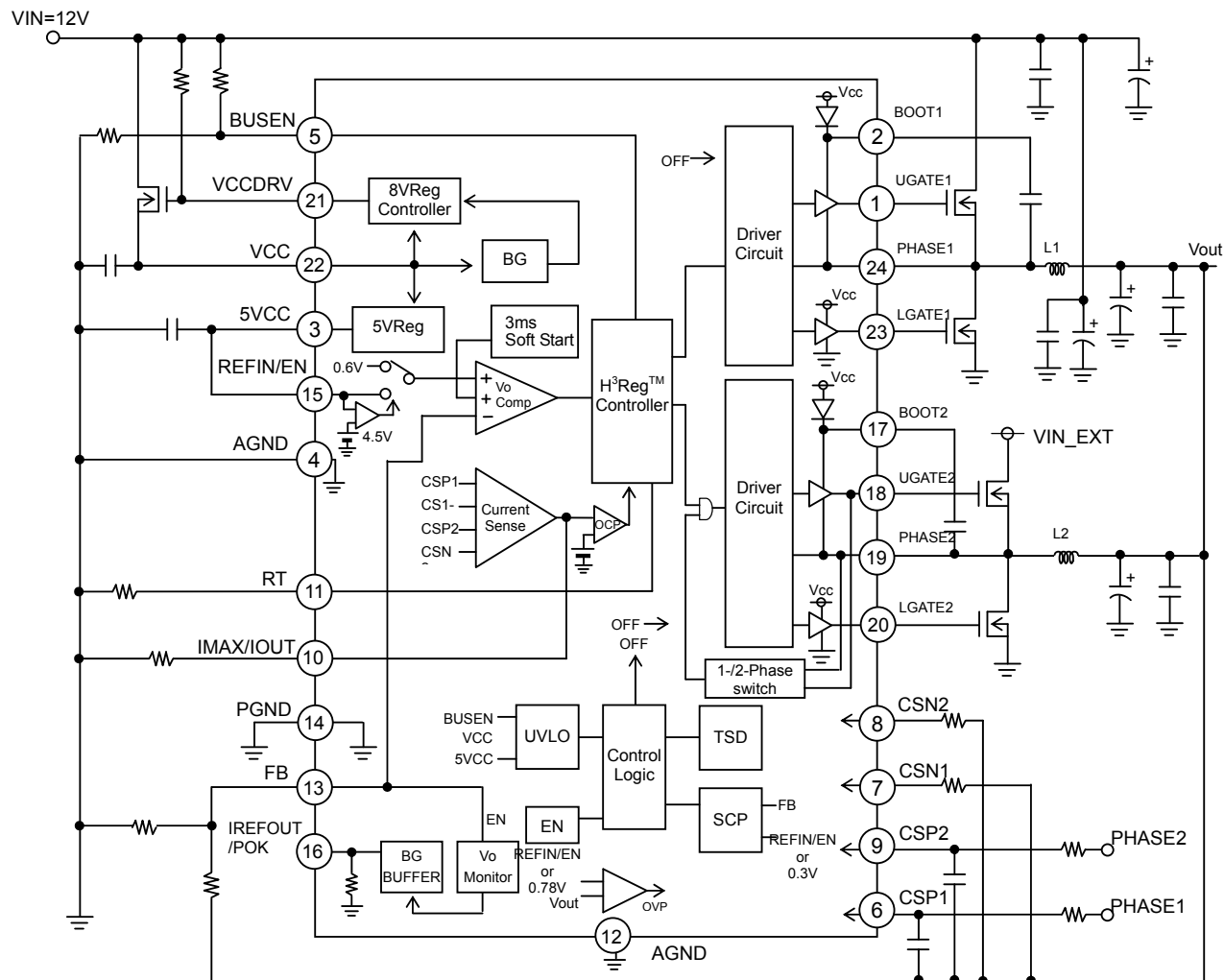| Parameter	Symbol	MIN	MAX	Unit
Input Voltage 1	VCC	4.7	13.2	V
Input Voltage 2	VIN	3.3	13.2	V
Input Voltage 5	REFIN/EN	0.4	3.3	V
Input Voltage 6	BUSEN	0	3.3	V
BOOT Voltage	BOOT1/2	4.5	27	V
BOOT-PHASE Voltage	BOOT1/2-PHASE1/2	4.5	13.2	V
CS Input Voltage	CSN1/CSP1/CSN2/CSP2	0.4	3.3	V
IOUT Setting Resistor	R_{IOUT}	0	5M	Ω
RT Setting Resistor	R_{RT}	10k	510k	Ω

* This product should not be used in a radioactive environment.

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●ELECTRICAL CHARACTERISTICS (Unless otherwise noted, Ta=25℃, VCC=5V, VIN=12V, REF=1.2V, RT=100kΩ)
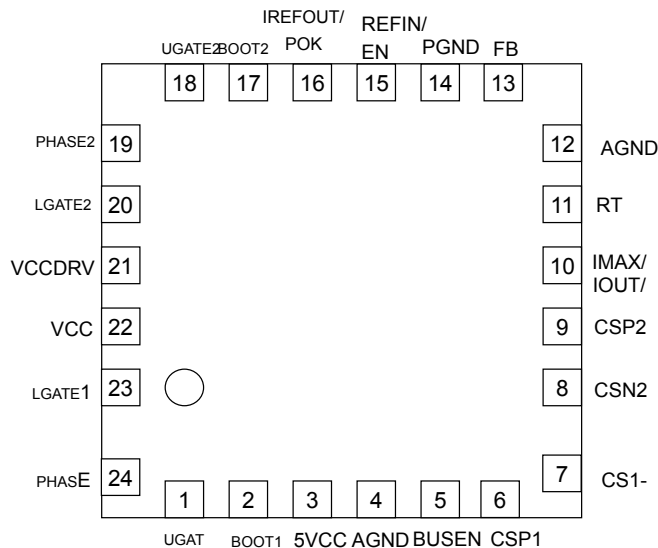
Parameter	Symbol	Standard Value			Unit	Condition
		MIN	TYP	MAX		
[Total Block]						
Vcc Bias Current	Icc	-	4	10	mA	
Vcc Standby Current	I_{STB}	-	1.5	2.0	mA	
[5Vcc Block]						
5Vcc Output Voltage	5Vcc	4.9	5	5.1	V	
5Vcc Output Current	I_{5Vcc}	20	-	-	mA	
[UVLO Block]						
VCC Threshold Voltage	Vcc_UVLO	4.2	4.5	4.7	V	Low → High
VCC Hysteresis Voltage	dVcc_UVLO	130	180	230	mV	
BUS EN Threshold Voltage	BUS_UVLO	0.6	0.8	0.9	V	Low → High
BUS EN Hysteresis Voltage	dBUS_UVLO	5	25	50	mV	
5Vcc Threshold Voltage	5Vcc_UVLO	4.1	4.3	4.5	V	Low → High
5Vcc Hysteresis Voltage	dVcc_UVLO	100	150	200	mV	
[Reference Voltage Block]						
Internal Reference Voltage	REFIN/EN	0.594	0.600	0.606	V	REFIN/EN=5VCC
REFIN/EN Offset Voltage	$Voff_{REFIN/EN}$	REF_IN-10m	REF_IN	REF_IN+10m	V	
REFIN/EN Input Voltage Range	$V_{REFIN/EN}$	0.4	-	3.3	V	
REFIN/EN Off Threshold Voltage	$V_{th REFIN/EN}$	4.5	-	5Vcc	V	
[EN Threshold]						
EN Low voltage	Enlow	GND	-	0.3	V	REFIN/EN voltage
EN High voltage	Enhigh	0.4	-	5Vcc	V	REFIN/EN voltage
[Operating Frequency]						
Oscillation Frequency	F_{OSC}	-	500	-	kHz	
ON Time	T_{ON}	100	200	300	nsec	
MIN OFF Time	T_{Offmin}	-	400	500	nsec	
[IREFOUT voltage Block]						
IREFOUT Voltage	$V_{IREFOUT}$	1.176	1.2	1.224	V	
IREFOUT Drive Current	$I_{IREFOUT}$	3	5	-	mA	
[FET Gate Driver Block]						
UG high side ON Resistance	R_{onHGH}	-	6	12	ohm	
UG low side ON Resistance	R_{onHGL}	-	4	8	ohm	
LG high side ON Resistance	R_{onLGH}	-	6	12	ohm	
LG high side ON Resistance	R_{onLGL}	-	1	2	ohm	
[Regulator for VCC]						
Output Voltage	VCCDRV	7.2	8	8.8	V	
Vcc DRV Drive Current	I_{VCCDRV}	-	10	-	mA	
[OCP (Over Current Protection) Block]						
Over Current Threshold	OCP_{TH}	0.95	1	1.05	V	
[OVP (Over Voltage Protection) Block]						
Over Voltage Threshold 1	OVP_{TH1}	VREFx1.25	VREFx1.3	VREFx1.35	V	REFIN/EN=5Vcc
Over Voltage Threshold 2	OVP_{TH2}	REFIN/EN x1.25	REFIN/EN x1.3	REFIN/EN x1.35	V	
[SCP (Short Circuit Protection) Block]						
SCP Start up Voltage 1	$V_{SCP}1$	VREFx0.45	VREFx0.5	VREFx0.55	V	REFIN/EN=5Vcc
SCP Start up Voltage 2	$V_{SCP}2$	REFIN/EN x0.45	REFIN/EN x0.5	REFIN/EN x0.55	V	
SCP Delay Time	T_{SCP}	-	1	-	ms	
[POK Detection Block]						
POK Threshold 1	POK_{THLOW1}	VREFx0.7	VREFx0.75	VREFx0.80	V	REFIN/EN=5Vcc
POK Threshold 2	POK_{THLOW2}	VREFIN/EN x0.70	VREFIN/EN x0.75	VREFIN/EN x0.80	V	

* Design Guarantee

● Block Diagram

VIN=12V

BUSEN — 5
VCCDRV — 21 — 8VReg Controller
VCC — 22 — BG
5VCC — 3 — 5VReg
REFIN/EN — 15 — 0.6V — 4.5V
3ms Soft Start
+ Vo + Comp −
H³Reg™ Controller
AGND — 4
CSP1
CS1−
CSP2
CSN
Current Sense — OCP
RT — 11
IMAX/IOUT — 10
PGND — 14
FB — 13
IREFOUT /POK — 16 — BG BUFFER — EN — Vo Monitor
EN
BUSEN VCC 5VCC — UVLO
Control Logic — TSD
SCP — FB
REFIN/EN or 0.78V Vout — OVP
REFIN/EN or 0.3V
AGND — 12

OFF →
Vcc — BOOT1 — 2
Driver Circuit — UGATE1 — 1
PHASE1 — 24 — L1 — Vout
Vcc — LGATE1 — 23
Vcc — BOOT2 — 17 — VIN_EXT
Driver Circuit — UGATE2 — 18
PHASE2 — 19 — L2
Vcc — LGATE2 — 20
1-/2-Phase switch
OFF → OFF

CSN2 — 8
CSN1 — 7
CSP2 — 9 — PHASE2
CSP1 — 6 — PHASE1

●Pin Configuration

●Pin Function Table

PIN No.	PIN Name	PIN Function
1	UGATE1	High Side FET Gate Drive Pin 1
2	BOOT1	Supply Voltage for UGATE1
3	5VCC	5V Regulator Output (Iomin=20mA)
4	AGND	Sense GND
5	BUSEN	Bus Enable, Power Supply Monitoring Pin
6	CSP1	Positive Input of Current Sensing 1
7	CSN1	Negative Input of Current Sensing 1
8	CSN2	Negative Input of Current Sensing 2
9	CSP2	Positive Input of Current Sensing 2
10	IMAX / IOUT	Current Limit/Output Current Indication
11	RT	PHASEitching Frequency Setting
12	AGND	Sense GND
13	FB	Output Voltage Feedback Pin
14	PGND	Power GND Pin
15	REFIN/EN	External Reference Input and Enable Pin
16	INREFOUT/ POK	Internal Reference Voltage Output and Power Good Output Pin
17	BOOT2	Supply Voltage for UGATE2
18	UGATE2	High Side FET Gate Drive Pin 2
19	PHASE2	switch Node for Channel 2
20	LGATE2	Low Side FET Gate Drive Pin 2
21	VCCDRV	Driver for External Linear Regulator
22	VCC	Supply Voltage Pin
23	LGATE1	Low Side FET Gate Drive Pin 1
24	PHASE1	PHASEitch Node for Channel 1
Exposed Pad		FIN

●Pin Descriptions

・UGATE1 (Pin 1), UGATE2 (Pin 18)

These are the voltage supply pins to drive the Gate of the high side FET. This voltage PHASEings between BOOT1/2 and PHASE1/2. High-speed Gate driving for the high side FET is achieved due to the low on-resistance (3 ohm when UG is high, 2 ohm when UG is low) of the driver.

・BOOT1 (Pin 2), BOOT2 (Pin 17)

These are the voltage supply pins to drive the high side FET. The maximum absolute ratings are 35V (from GND) and 15V (from PHASE1/2). BOOT1/2 voltages swing between VIN+VCC and VCC during active operation.

・5VCC (Pin 3)

This is the internal 5V regulator output pin. The minimum output current capability is 20mA.

・AGND (Pin 4 , Pin12)

This is the ground pin for IC internal circuits. It is equivalent to FIN voltage.

・BUSEN (Pin 5)

This pin monitors the supply input VIN through resistance divider. The POR rising threshold level is set to 0.8V.

・CsN1 (Pin 6), CsP2 (Pin 9), CsN1 (Pin 7), CsN2 (Pin 8)

These pins are connected to both sides of the current sense resistance or Inductance (DCR sensing) to detect output current.

・IMAX / IOUT (Pin 10)

This pin has multiple functions such as the output current indication, OCP (Over Current Protection) limit setting, and the output voltage load line adjustment pin. BD95710MUV detects the voltage between Cs+ pin and Cs- pin and limits the output current (OCP) using resistance connected between IMAX/IOUT/Droop and GND. A very low current sense resistor or inductor DCR can also be used for this platform.

・RT (Pin 11)

This is the pin to adjust the switching frequency based on the resistance value. The frequency range is f=50KHz - 1000KHz.

・FB (Pin 13)

This is the output voltage feedback pin. It is possible to adjust the output voltage using external resistor divider based on the equation, REFIN/EN≒FB. However, FB becomes 0.6V when REFIN/EN=5VCC.

・PGND (Pin 14)

This is the power ground pin connected to the source of the low side FET.

・REFIN/EN/EN (Pin 15)

This is an internal or external reference voltage selectable pin. If REFIN/EN is pulled up to 5VCC, internal reference voltage (0.6V) is used. If REFIN/EN is driven by an external voltage ranged 0.4V to 3.3V, external voltage of REFIN/EN voltage is used. It is very convenient for synchronizing external voltage supply. The IC controls the output voltage (REFIN/EN≒FB). And also this pin is used for enable function. If REFIN/EN is less than 0.3V, the whole circuit is shut down.

・IREFOUT/POK (Pin 16)

This pin is internal reference voltage output and power good output. During start up, this pin voltage is low. This pin becomes high impedance when FB pin voltage goes beyond 75% of specified FB voltage after soft start ends.

・PHASE1 (Pin 24), PHASE2 (Pin 19)

These are the source pins for the high side FET. The maximum absolute ratings are 15V (from GND). PHASE1/2 voltage swings between VIN and GND.

・LGATE1 (Pin 23), LGATE2 (Pin 20)

This is the voltage supply to drive the Gate of the low side FET. This voltage swings between VCC and PGND. High-speed Gate driving for the low side FET is achieved due to the low on-resistance (2 ohm when LGATE1/2 is high, 0.5 ohm when LGATE1/2 is low) of the driver.

・VCCDRV (Pin 21)

This is the supply voltage pin to drive an external NPN/N_MOSFET for 8V linear regulator. The maximum absolute rating is 15V.

・VCC (Pin 22)

This is the power supply pin for IC internal circuit and driver circuit. The maximum circuit current is 10mA. There are 3 usages depending on a supply voltage for driver (5V, 8V, and 12V). It is recommended that a 0.1uF bypass capacitor be put in this pin to avoid voltage fluctuation when the VCC is supplied from 5V or 12V rail directly from the actual platforms. If 8V is used for the supply voltage, this pin is connected to the LDO output. In this case, it is recommended that at least 10uF ceramic capacitor be input to avoid oscillation.

●Explanation of Operation

The BD95710MUV is a synchronous buck regulator controller incorporating ROHM's proprietary H³Reg^{TM} CONTROLLA control system. When V$_{OUT}$ drops due to a rapid load change, the system quickly restores V$_{OUT}$ by extending the T$_{ON}$ time interval. Thus, it serves to improve the regulator's transient response.

H³Reg^{TM} control
(Normal operation)
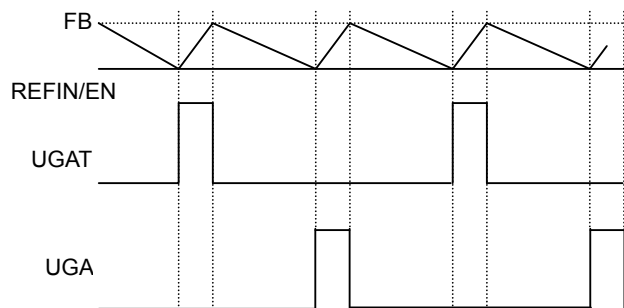
When FB pin voltage (Vout) falls to a threshold voltage REFIN/EN, the drop is detected, activating the H³Reg^{TM} CONTROLLA system.

$$T_{ON} = \frac{REFIN/EN}{VIN} \times \frac{1}{f} \quad [sec] \cdot \cdot \cdot (1)$$

UGATE ONTIME is determined with the formula above. LG outputs until the status of VOUT is lower than REF after the status of UG is off.

Phase PHASEitch function

T   2T

dual-phase   Single-phase   Stand-by   dual-phase
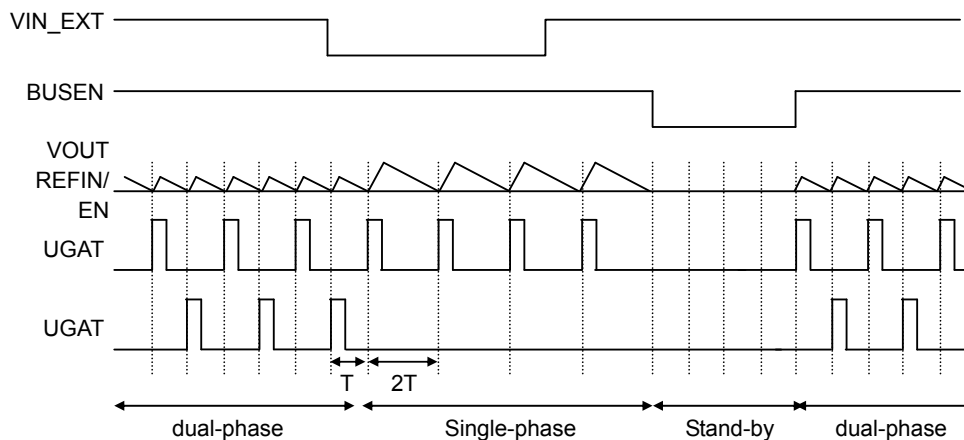
The IC normally operates dual-phase mode, but when the input voltage on the VIN_EXT pin is cut off, the IC latches into single-phase mode. The IC will remain latched in this mode (even if a voltage is reintroduced onto the VIN_EXT pin) until the voltage is cycled on any of the EN, VCC or BUSEN pins. It will then return to two-phase mode.

●Timing Chart
・Soft Start Function

REFIN/EN

Tss

SS

VOUT

IIN
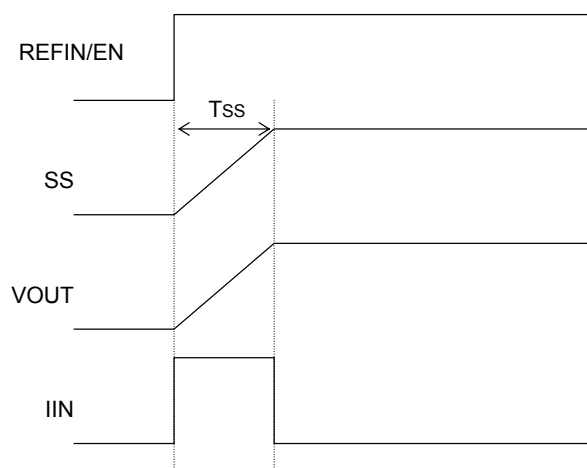
Soft start is activated when REFIN/EN hits its enabling threshold (VCC, 5VCC, and BUSEN have to be beyond their own UVLO thresholds). Current control takes effect at startup, enabling an output voltage "ramping start." Soft start timing and incoming current are calculated with formulas (2) and below.

Soft start time (TSS) ≒ 3msec (fixed)

Incoming current

$$IIN = \frac{Co \times VOUT}{3msec} \ [A] \quad \cdot\cdot\cdot(2)$$

(Co: Output capacitor)

・Output Over Voltage Protection

REFIN/EN x 1.3

FB

UG

LG

switching
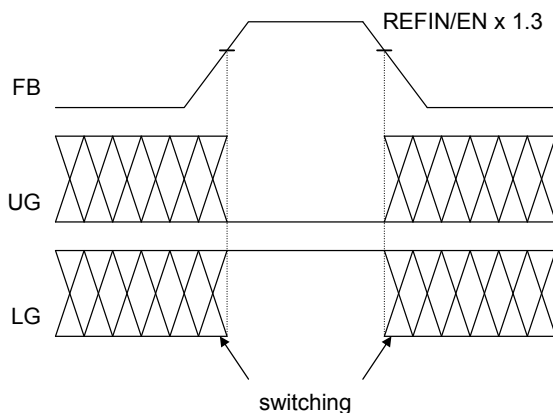
When the FB pin voltage becomes REFIN/EN x 1.3, the output over voltage protection is activated and Low side MOSFET becomes ON to lower the output voltage (LG=High, UG=Low). When the output voltage goes back down to the specified level, the whole circuit becomes the normal operation mode.

・Short Circuit Protection with Timer Latch

REFIN/EN x 0.5

FB

TSCP

SCP

REFIN/EN or UVLO
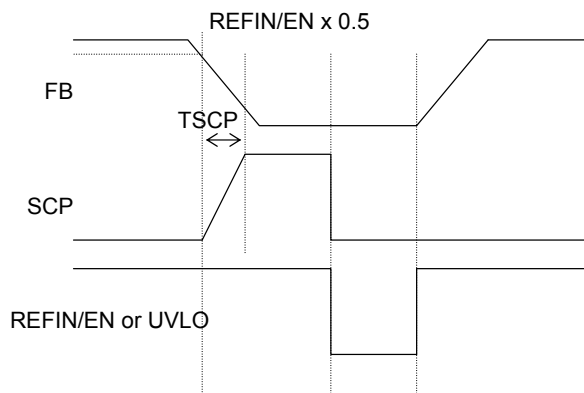
Short Circuit Protection kicks in when output falls to or below REFIN/EN x 0.5. When the programmed time period elapses, output is latched OFF to prevent destruction of the IC. Output voltage can be restored either by reconnecting the REFIN/EN pin (ON → OFF → ON) or disabling UVLO (HIGH → Low → High).

●External Component Selection

1. Inductor (L) selection
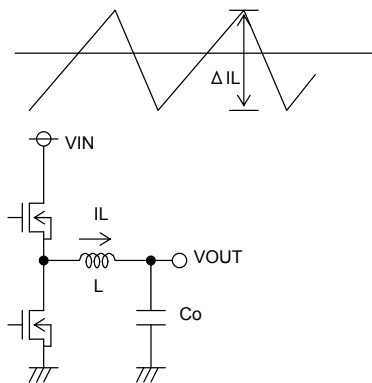
The inductor value is a major influence on the output ripple current. As formula (3) below indicates, the greater the inductor or the switching frequency, the lower the ripple current.

$$\Delta IL = \frac{(VIN-VOUT) \times VOUT}{L \times VIN \times f} \quad [A] \cdots (3)$$

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

$$\Delta IL = 0.3 \times IOUTmax/2. \ [A] \cdots (4)$$

$$L = \frac{(VIN-VOUT) \times VOUT}{\Delta IL \times VIN \times f} \ [H] \cdots (5)$$

(ΔIL: output ripple current; f: switch frequency)

Output Ripple Current

※Passing a current larger than the inductor's rated current will cause magnetic saturation in the inductor and decrease system efficiency. In selecting the inductor, be sure to allow enough margin to assure that peak current does not exceed the inductor rated current value.

※To minimize possible inductor damage and maximize efficiency, choose a inductor with a low (DCR, ACR) resistance.

2. Output Capacitor (C_O) Selection
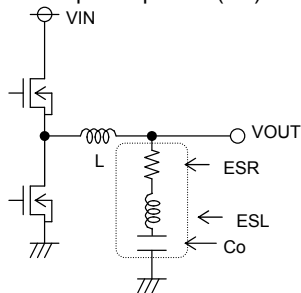
At least 20mV ripple voltage of the FB voltage is recommended by taking the equivalent series resistance and inductance into account.

Output ripple voltage is determined as in formula (6) below.

$$\Delta VOUT = \Delta IL \times ESR + ESL \times \Delta IL/TON \cdots (6)$$

(ΔIL: Output ripple current; ESR: C_O equivalent series resistance, ESL: equivalent series inductance)

Output Capacitor

※ In selecting a capacitor, make sure the capacitor rating allows sufficient margin relative to output voltage. Note that a lower ESR can minimize output ripple voltage.

Please give due consideration to the conditions in formula (7) below for output capacity, bearing in mind that output rise time must be established within the soft start time frame.

$$Co \leq \frac{3msec \times (Limit-IOUT/2)}{VOUT} \cdots (7)$$ Limit: Current Limit Value

Note: Improper capacitor may cause startup malfunctions.

3. Input Capacitor (Cin) Selection
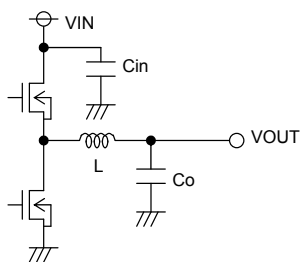
The input capacitor selected must have low enough ESR resistance to fully support large ripple output, in order to prevent extreme over current. The formula for ripple current IRMS is given in (8) below.

$$IRMS = \frac{I_{OUT}}{2} \times \frac{\sqrt{VOUT(VIN-VOUT)}}{VIN} \quad [A] \cdots (8)$$

Where $VIN = 2 \times VOUT$, $IRMS = \frac{IOUT}{4}$

Input Capacitor

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

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4.MOSFET Selection

$$P_{main} = P_{RON} + P_{GATE} + P_{TRAN}$$
Loss on the main MOSFET

$$= \frac{VOUT}{4 \times VIN} \times R_{ON} \times I_{OUT}^2 + C_{iss} \times f \times VDD + \frac{VIN^2 \times C_{rss} \times I_{OUT} \times f}{2 \times I_{DRIVE}} \quad \cdots (9)$$
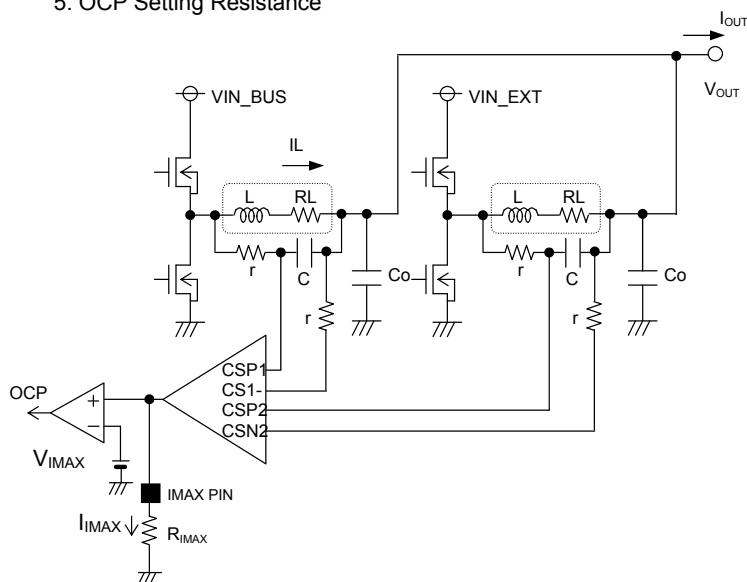
(Ron: On-resistance of FET; Ciss: FET gate capacity;
f: switching frequency Crss: FET inverse transfer function;
I_{DRIVE}: Gate peak current)

Loss on the synchronous MOSFET

$$P_{syn} = P_{RON} + P_{GATE}$$

$$= \frac{VIN - VOUT}{4 \times VIN} \times R_{ON} \times I_{OUT}^2 + C_{iss} \times f \times VDD \quad \cdots (10)$$

5. OCP Setting Resistance

OCP threshold is determined by external OCP setting resistance (R_{IMAX}) and I_{MAX} calculated below.

$$I_{IMAX} = \frac{V_{CSP1} - V_{CS1-}}{250k\Omega} + \frac{V_{CSP2} - V_{CSN2}}{250k\Omega} \quad \cdots (11)$$

$$(V_{CSP1} - V_{CS1-} = I_L \times RL \quad , RL = \frac{L}{r \times C})$$

(RL: the DCR value of coil)

If V_{IMAX} meet the following condition, OCP becomes activated.

$$V_{IMAX} \leq I_{IMAX} \times R_{IMAX}$$
(V_{IMAX}: OCP Setting Voltage, $V_{IMAX} = 1V$)

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6. Setting output voltage

The output voltage is REFIN/EN = VOUT when VOUT is tied to the FB directly. The range of VOUT is 0.4V ~ 3.3V.
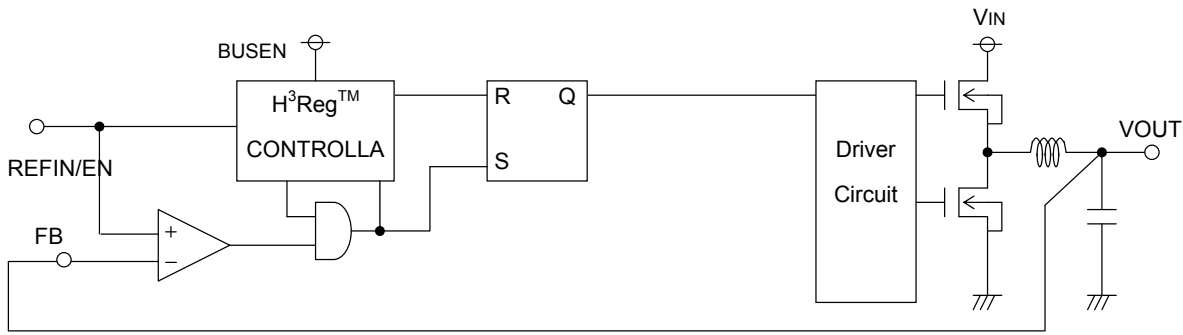
The output voltage is calculated as follow when resistor divider network is connected between the FB and VOUT. REFIN/EN set 5Vcc.

$$Vout = \frac{R1+R2}{R2} \times 0.6 \ [V] \cdot \cdot \cdot (12)$$
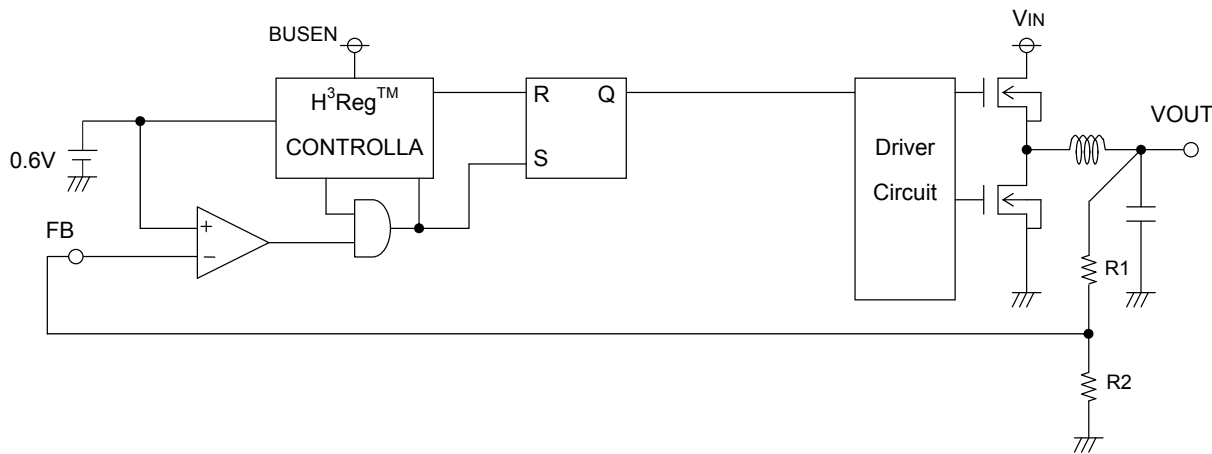
7. Frequency Setting Resistance

The Frequency at steady state is determined by resistance value connected to RT pin.
But actual PHASE rising time and falling time are factored in due to the external MOSFET gate capacity or switching speed.
As a result, On-Time increases.
The frequency is determined by the following formula.

$$f\ [Hz] = \frac{VOUT}{VIN} \times \frac{1}{Ton} \cdot \cdot \cdot (13)$$

$$\left(Ton = \frac{10^{-12} \times REFIN/EN \times R_{RT}}{2 \times BUSEN} + 170 \times 10^{-9} \right) \quad Ton : ON\ TIME$$

Consequently, total frequency becomes lower than the formula above.
On-Time increases by Dead Time on the condition of zero cross point of inductor current. And also switching frequency increases as the output current increases due to the fixed On-Time and the influence of conduction loss.
It is recommended that switching frequency be checked on large current condition (at the point where the inductor current doesn't become reversed from Vout).

8. UVLO

BD95710MUV has function to detect input UVLO voltage in each VCC, 5VCC, and BUSEN for output voltage to start up.
If all these inputs go beyond their own UVLO threshold voltage, the soft start function kicks in.
These threshold voltages have their own hysteresis voltage to avoid faulty operation caused by input noises and glitchs.
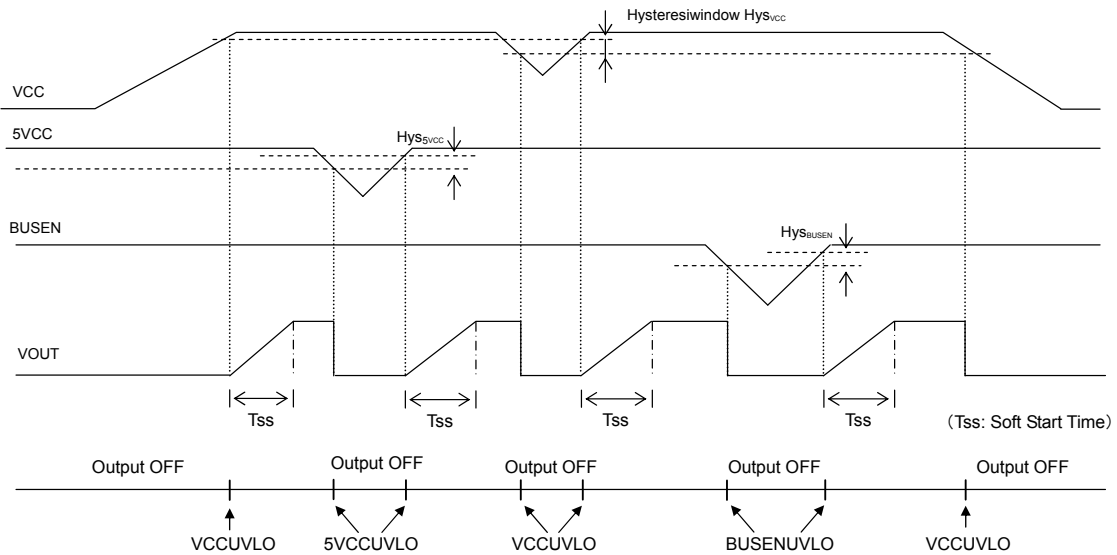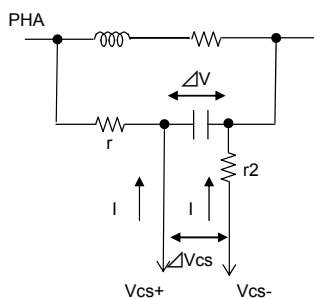

9. Current Phase Balance
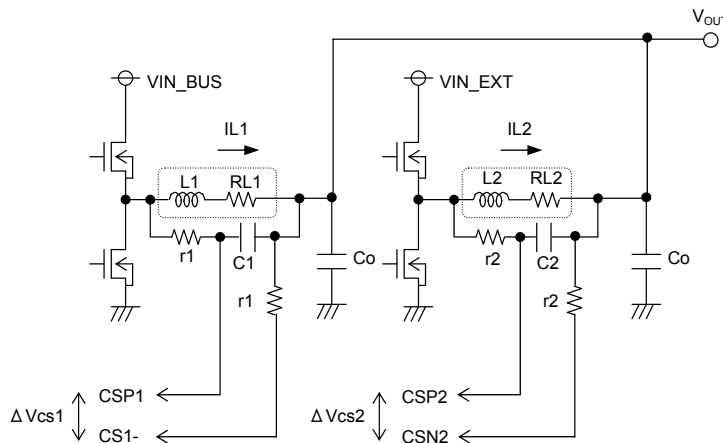
BD95710MUV keeps the current phase balance between coil current IL1 and IL2 by controlling the status $\Delta Vcs1 = \Delta Vcs2$. And for that, it is needed to meet the reference formula below.

$$L1 = L2 \ (RL1 = RL2), \ r1 = r2, \ C1 = C2. \quad \cdot \cdot \cdot (14)$$

For detecting the value of $\Delta Vcs1$ or $\Delta Vcs2$ exactly, it is also needed to meet the formula below.

$$RL1 = \frac{L1}{r1 \times C1} \quad \cdot \cdot \cdot (15)$$

However, Vcs+ and Vcs- are fed a small current from current sense amplifier, and this current causes a slight difference in the actual value obtained from formula (15).   Refer to formula (16) below:

$$\Delta Vcs = \Delta V - I \times r \quad \cdot \cdot \cdot (16)$$

This difference can be compensated for by adding resistor r2.

$$\Delta Vcs = (\Delta V - I \times r) + I \times r2 \cdot \cdot \cdot (17)$$

To eliminate the difference, choose r2 to have the same value as r.
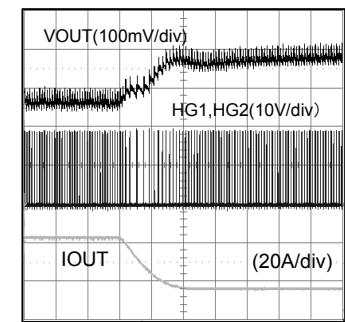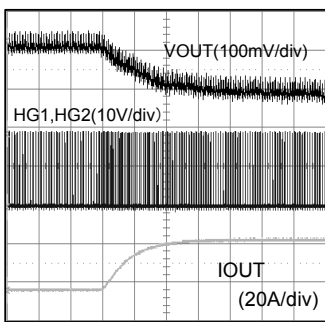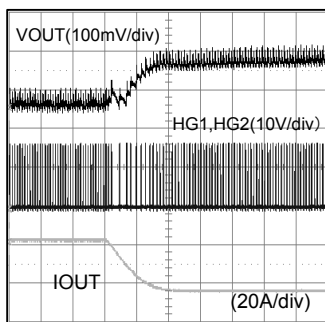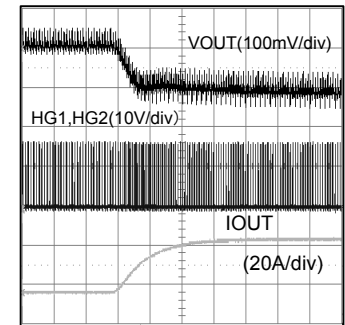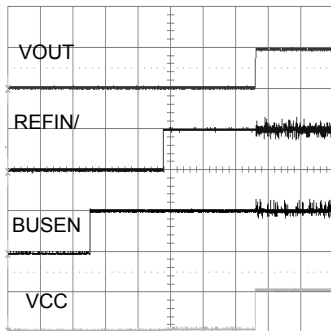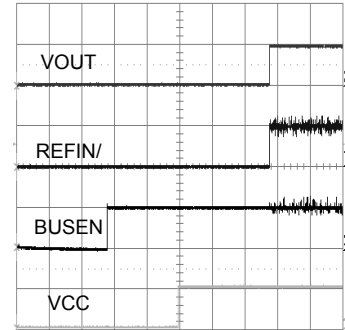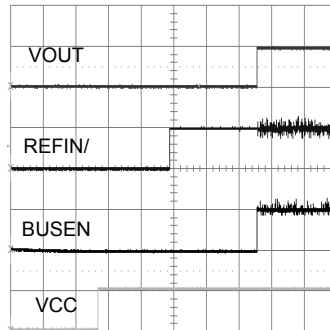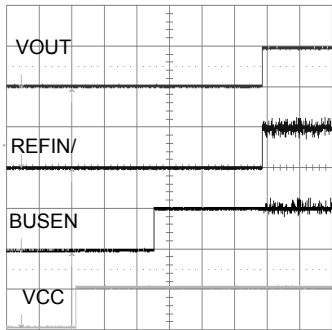
$$\Delta Vcs = \Delta V \quad \cdot \cdot \cdot (18)$$

10. Vout small Ripple Voltage
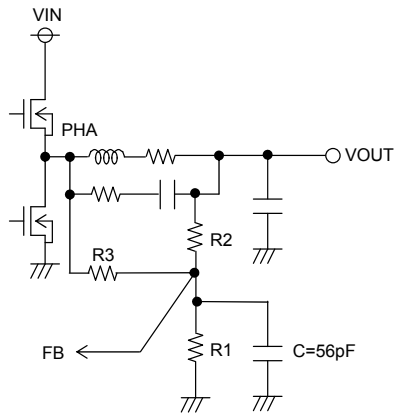
Resistor R3 and capacitor C (=56pF)are needed to stabilize switching operation when Vout ripple voltage is less than 20mV. The values of R1, R2 and R3 are determined as in the formula (19) below

R1+R2 $\leqq$ 20kΩ,10×R1 $\leqq$ R3 ・・・(19)

●Reference Data

Fig1.Sequence

Fig2.Sequence

Fig3.Sequence

Fig4.Sequence

Fig5.Sequence

Fig6.Sequence

Fig7.Load Transient Response
(VCC=12V)

Fig8.Load Transient Response
(VCC=12V)

Fig9.Load Transient Response
(VCC=5V)

Fig10.Load Transient Response
(VCC=5V)

Fig11.Load Transient Response
(VCC=8V)

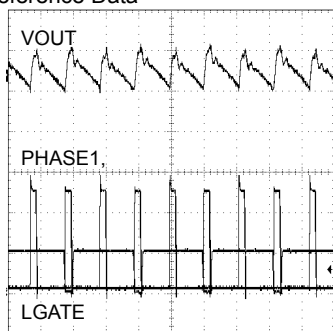Fig12.Load Transient Response
(VCC=8V)
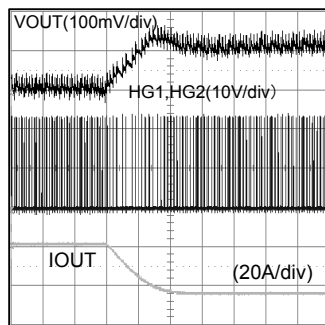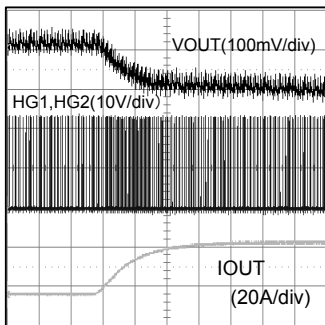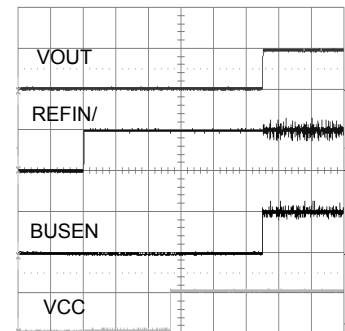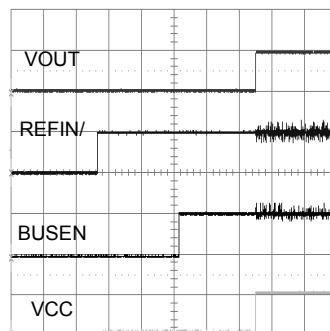
●Reference Data

Fig13.Continuos MODE
(VCC=5V)

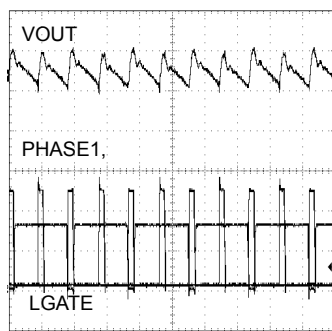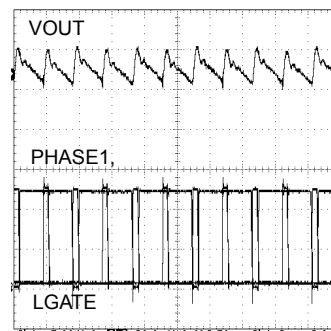
Fig14.Continuos MODE
(VCC=8V)

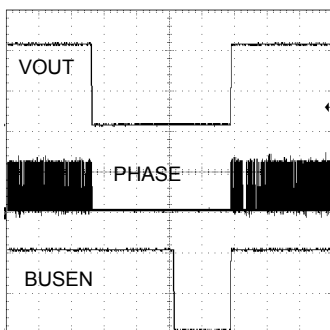Fig15.Continuos MODE
(VCC=12V)

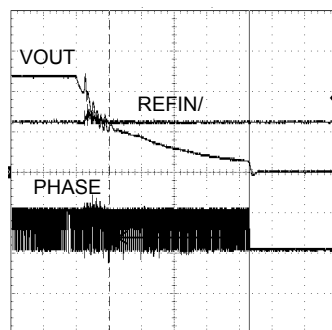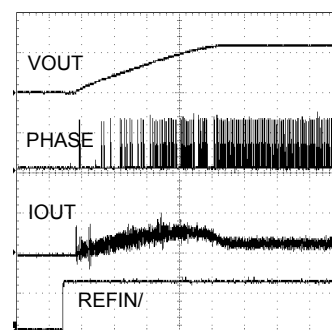Fig16.SCP Function

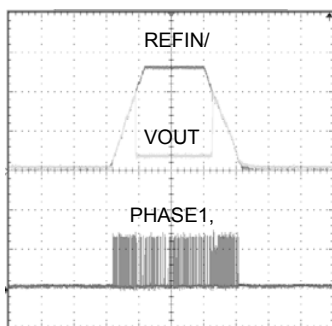Fig17.SCP Function

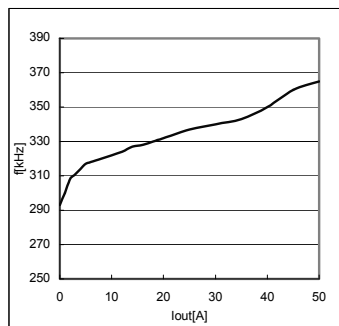Fig18.Soft Start

Fig19.Reference Function
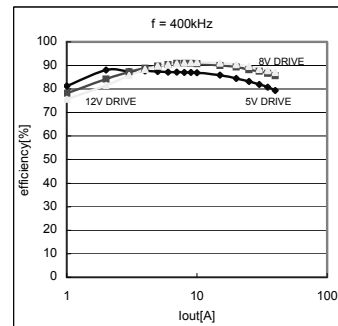

Fig20.Frequency range functionally
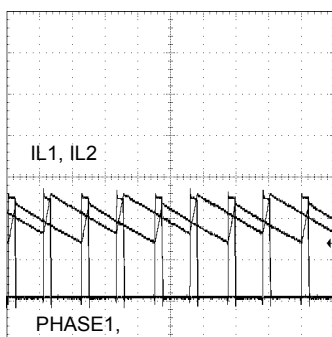

Fig21.Efficiency

Fig22.Current balance
(Io=20A)

Fig23.Current balance
(Io=30A)
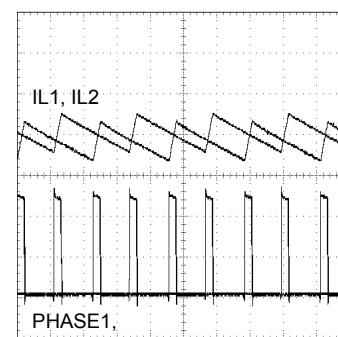

Fig24.Current balance
(Io=40A)

■**BD95710MUV Evaluation Board Circuit with 5V Drive (VCC=5V input , VIN=3.3~12V input , REFIN/EN=5VCC, Vout=1.2V)**

■**BD95710MUV Evaluation Board Parts List**

Part No	Value	Company	Part name	Part No	Value	Company	Part name
U1		ROHM	BD95710MUV	C17	-	-	-
M2		infineon	BSC119N03SG	C18	1uF	KYOCERA	CM05B105K06A
M3		infineon	BSC119N03SG	C19	10uF	KYOCERA	CT32X5R106K25A
M4		Infineon	BSC032N03SG	C21	1uF	KYOCERA	CM105B105K16A
M5		Infineon	BSC032N03SG	C23	0.1uF	KYOCERA	CM105X5R224K25A
M6		Infineon	BSC119N03SG	C24	0.1uF	KYOCERA	CM105X5R224K25A
M7		Infineon	BSC119N03SG	C25	10uF	KYOCERA	CM316X5R106M10A
M8		Infineon	BSC032N03SG	C27	10uF	KYOCERA	CM316X5R106M06A
M9		infineon	BSC032N03SG	C28	10uF	KYOCERA	CT32X5R106K25A
C2	10uF	KYOCERA	CT32X5R106K25A	C31	10uF	KYOCERA	CT32X5R106K25A
C3	1uF	KYOCERA	CM05B105K16A	R2	300kΩ	ROHM	MCR03
C5	1uF	KYOCERA	CM105B105K16A	R3	30kΩ	ROHM	MCR03
C7	10uF	KYOCERA	CM316X5R106M06A	R8	240kΩ	ROHM	MCR03
C8	10uF	KYOCERA	CM21B106M06A	R9	3.6MΩ	ROHM	MCR03
C9	10uF	KYOCERA	CM21B106M06A	R15	10kΩ	ROHM	MCR03
C10	10uF	KYOCERA	CM21B106M06A	R16	4.87kΩ	ROHM	MCR03
C11	10uF	KYOCERA	CM21B106M06A	R17	4.87kΩ	ROHM	MCR03
C12	-	-	-	R18	10kΩ	ROHM	MCR03
C13	820uF	SANYO	NC641-643	R20	4.87kΩ	ROHM	MCR03
C14	820uF	SANYO	NC641-643	R21	4.87kΩ	ROHM	MCR03
C15	820uF	SANYO	NC641-643	L1	0.47uH	Cyntec	PCMB105T-R47MS
C16	-	-	-	L2	0.47uH	Cyntec	PCMB105T-R47MS

■**BD95710MUV Evaluation Board Circuit with 8V Drive (VIN=10.8~13.2V input , REFIN/EN=5VCC, Vout=1.2V)**

■**BD95710MUV Evaluation Board Parts List**
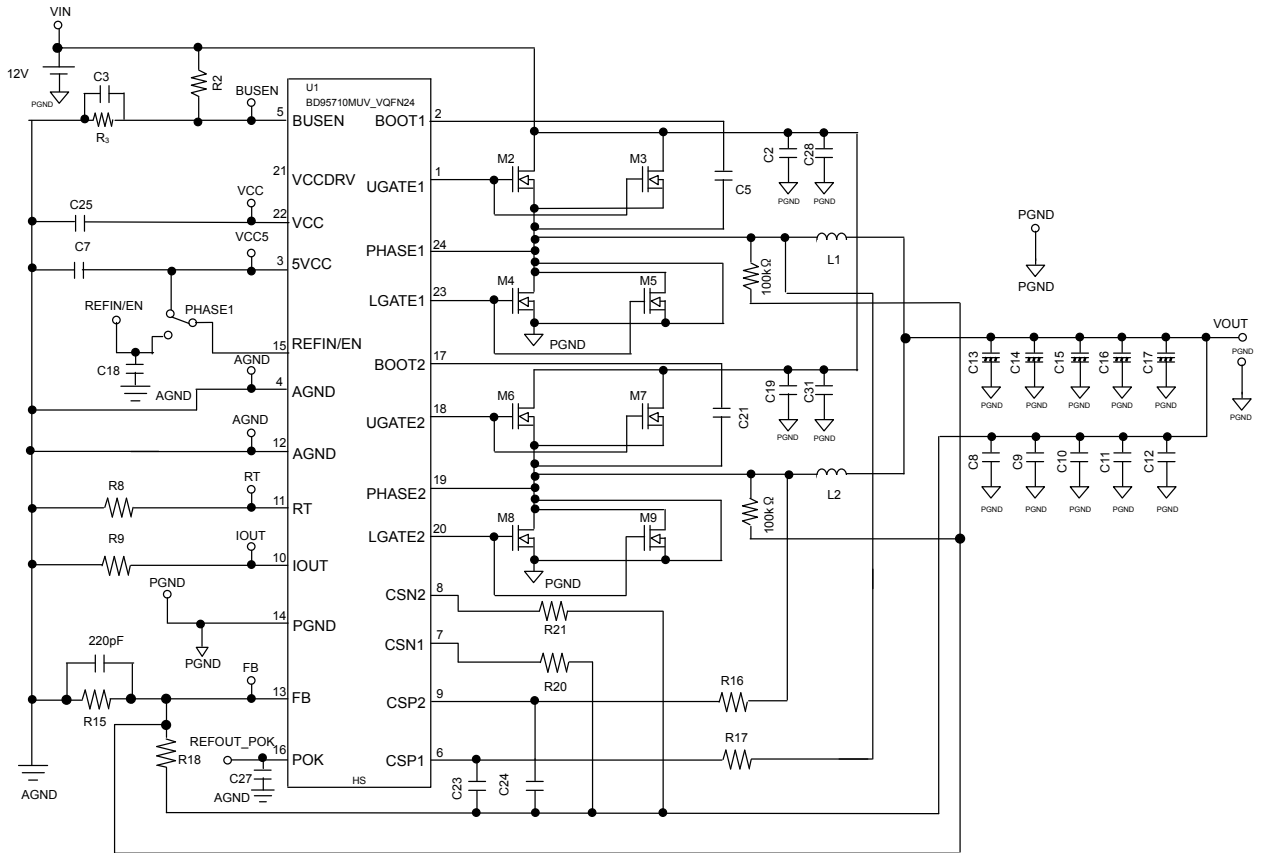
Part No	Value	Company	Part name		Part No	Value	Company	Part name
U1		ROHM	BD95710MUV		C18	1uF	KYOCERA	CM05B105K06A
M2		infineon	BSC119N03SG		C19	10uF	KYOCERA	CT32X5R106K25A
M3		infineon	BSC119N03SG		C21	1uF	KYOCERA	CM105B105K16A
M4		Infineon	BSC032N03SG		C23	0.1uF	KYOCERA	CM105X5R224K25A
M5		Infineon	BSC032N03SG		C24	0.1uF	KYOCERA	CM105X5R224K25A
M6		Infineon	BSC119N03SG		C25	10uF	KYOCERA	CM316X5R106M10A
M7		Infineon	BSC119N03SG		C27	10uF	KYOCERA	CM316X5R106M06A
M8		Infineon	BSC032N03SG		C28	10uF	KYOCERA	CT32X5R106K25A
M9		infineon	BSC032N03SG		C31	10uF	KYOCERA	CT32X5R106K25A
C2	10uF	KYOCERA	CT32X5R106K25A		R1	10kΩ	ROHM	MCR03
C3	1uF	KYOCERA	CM05B105K16A		R2	300kΩ	ROHM	MCR03
C5	1uF	KYOCERA	CM105B105K16A		R3	30kΩ	ROHM	MCR03
C7	10uF	KYOCERA	CM316X5R106M06A		R8	240kΩ	ROHM	MCR03
C8	10uF	KYOCERA	CM21B106M06A		R9	3.6MΩ	ROHM	MCR03
C9	10uF	KYOCERA	CM21B106M06A		R15	10kΩ	ROHM	MCR03
C10	10uF	KYOCERA	CM21B106M06A		R16	4.87kΩ	ROHM	MCR03
C11	10uF	KYOCERA	CM21B106M06A		R17	4.87kΩ	ROHM	MCR03
C12	-	-	-		R18	10kΩ	ROHM	MCR03
C13	820uF	SANYO	NC641-643		R20	4.87kΩ	ROHM	MCR03
C14	820uF	SANYO	NC641-643		R21	4.87kΩ	ROHM	MCR03
C15	820uF	SANYO	NC641-643		L1	0.47uH	Cyntec	PCMB105T-R47MS
C16	-	-	-		L2	0.47uH	Cyntec	PCMB105T-R47MS
C17	-	-	-					

2009.04 - Rev.B

■**BD95710MUV Evaluation Board Circuit with 12V Drive (VIN=12V input, VCC=8V input, REFIN/EN=5VCC, Vout=1.2V)**

■**BD95710MUV Evaluation Board Parts List**

Part No	Value	Company	Part name
U1		ROHM	BD95710MUV
M2		infineon	BSC119N03SG
M3		infineon	BSC119N03SG
M4		Infineon	BSC032N03SG
M5		Infineon	BSC032N03SG
M6		Infineon	BSC119N03SG
M7		Infineon	BSC119N03SG
M8		Infineon	BSC032N03SG
M9		infineon	BSC032N03SG
C2	10uF	KYOCERA	CT32X5R106K25A
C3	1uF	KYOCERA	CM05B105K16A
C5	1uF	KYOCERA	CM105B105K16A
C7	10uF	KYOCERA	CM316X5R106M06A
C8	10uF	KYOCERA	CM21B106M06A
C9	10uF	KYOCERA	CM21B106M06A
C10	10uF	KYOCERA	CM21B106M06A
C11	10uF	KYOCERA	CM21B106M06A
C12	-	-	-
C13	820uF	SANYO	NC641-643
C14	820uF	SANYO	NC641-643
C15	820uF	SANYO	NC641-643
C16	-	-	-

Part No	Value	Company	Part name
C17	-	-	-
C18	1uF	KYOCERA	CM05B105K06A
C19	10uF	KYOCERA	CT32X5R106K25A
C21	1uF	KYOCERA	CM105B105K16A
C23	0.1uF	KYOCERA	CM105X5R224K25A
C24	0.1uF	KYOCERA	CM105X5R224K25A
C25	10uF	KYOCERA	CM316X5R106M10A
C27	10uF	KYOCERA	CM316X5R106M06A
C28	10uF	KYOCERA	CT32X5R106K25A
C31	10uF	KYOCERA	CT32X5R106K25A
R2	300kΩ	ROHM	MCR03
R3	30kΩ	ROHM	MCR03
R8	240kΩ	ROHM	MCR03
R9	3.6MΩ	ROHM	MCR03
R15	10kΩ	ROHM	MCR03
R16	4.87kΩ	ROHM	MCR03
R17	4.87kΩ	ROHM	MCR03
R18	10kΩ	ROHM	MCR03
R20	4.87kΩ	ROHM	MCR03
R21	4.87kΩ	ROHM	MCR03
L1	0.47uH	Cyntec	PCMB105T-R47MS
L2	0.47uH	Cyntec	PCMB105T-R47MS

●Operation Notes

1. Absolute maximum ratings
   An excess in the absolute maximum ratings, such as supply voltage, temperature range of operating conditions, etc., can break down the devices, thus making impossible to identify breaking mode, such as a short circuit or an open circuit. If any over rated values wll expect to exceed the absolute maximum ratings, consider adding circuit protection devices, such as fuses.

2. Connecting the power supply connector backward
   Connecting of the power supply in reverse polarity can damage IC. Take precautions when connecting the power supply lines. An external direction diode can be added.

3. Power supply lines
   Design PCB layout pattern to provide low impedance GND and supply lines. To obtain a low noise ground and supply line, separate the ground section and supply lines of the digital and analog blocks. Furthermore, for all power supply terminals to ICs, connect a capacitor between the power supply and the GND terminal. When applying electrolytic capacitors in the circuit, not that capacitance characteristic values are reduced at low temperatures.

4. GND voltage
   The potential of GND pin must be minimum potential in all operating conditions.

5. Thermal design
   Use a thermal design that allows for a sufficient margin in light of the power dissipation (Pd) in actual operating conditions.

6. Inter-pin shorts and mounting errors
   Use caution when positioning the IC for mounting on printed circuit boards. The IC may be damaged if there is any connection error or if pins are shorted together.

7. Actions in strong electromagnetic field
   Use caution when using the IC in the presence of a strong electromagnetic field as doing so may cause the IC to malfunction.

8. ASO
   When using the IC, set the output transistor so that it does not exceed absolute maximum ratings or ASO.

9. Thermal shutdown circuit
   The IC incorporates a built-in thermal shutdown circuit (TSD circuit). The thermal shutdown circuit (TSD circuit) is designed only to shut the IC off to prevent thermal runaway. It is not designed to protect the IC or guarantee its operation. Do not continue to use the IC after operating this circuit or use the IC in an environment where the operation of this circuit is assumed.

	TSD on temperature [°C] (typ.)	Hysteresis temperature [°C] (typ.)
BD95710MUV	175	15

10. Testing on application boards
    When testing the IC on an application board, connecting a capacitor to a pin with low impedance subjects the IC to stress. Always discharge capacitors after each process or step. Always turn the IC's power supply off before connecting it to or removing it from a jig or fixture during the inspection process. Ground the IC during assembly steps as an antistatic measure. Use similar precaution when transporting or storing the IC.

11. Regarding input pin 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 these Payers w the N layers of other elements, creating a parasitic diode or transistor. For example, the relation between each potential is as follows:

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 can occur inevitable in the structure of the IC. The operation of parasitic diodes can result in mutual interference among circuits, operational faults, or physical damage. Accordingly, methods by which parasitic diodes operate, such as applying a voltage that is lower than the GND (P substrate) voltage to an input pin, should not be used.
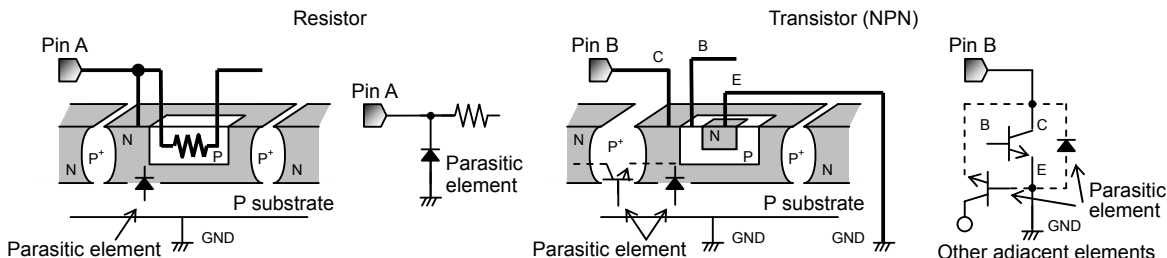
12. Ground Wiring Pattern

When using both small signal and large current GND patterns, it is recommended to isolate the two ground patterns, placing a single ground point at the ground potential of application so that the pattern wiring resistance and voltage variations caused by large currents do not cause variations in the small signal ground voltage. Be careful not to change the GND wiring pattern of any external components, either.
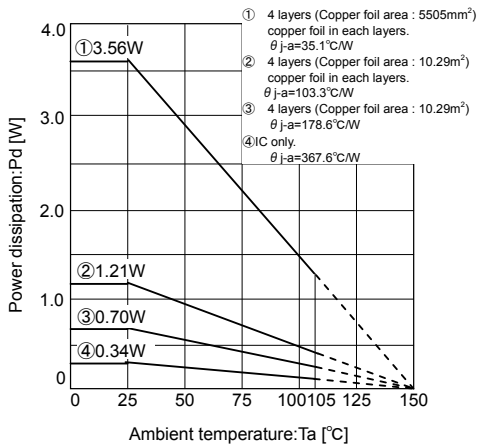
●Power Dissipation

① 4 layers (Copper foil area : 5505mm^2) copper foil in each layers. θ j-a=35.1℃/W
② 4 layers (Copper foil area : 10.29m^2) copper foil in each layers. θ j-a=103.3℃/W
③ 4 layers (Copper foil area : 10.29m^2) θ j-a=178.6℃/W
④ IC only. θ j-a=367.6℃/W

Fig.25 Thermal derating curve
(VQFN020V4040)

●Type Designations (Selections) for Ordering

| B | D | | 9 | 5 | 7 | 1 | 0 | | M | U | V | - | E | 2 |

Part No.　　Part No.

Package
MUV : VQFN024V4040

Packaging and forming specification
E2: Embossed tape and reel

VQFN024V4040

(Unit : mm)

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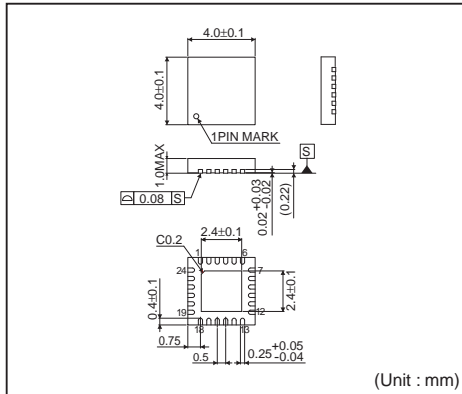
Tape	Embossed carrier tape
Quantity	2500pcs
Direction of feed	E2 (The direction is the 1pin of product is at the upper left when you hold reel on the left hand and you pull out the tape on the right hand)

Reel　　1pin　　Direction of feed

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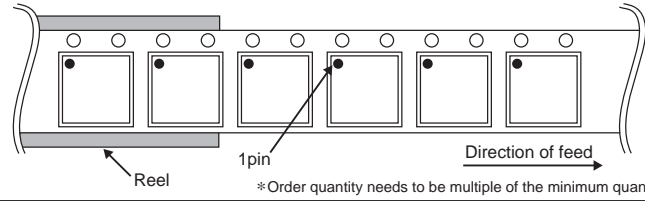
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