Hi-performance Regurator IC Series for PCs

2phase Switching Regulator Controllers for Graphic Card

BD95700MUV

No. 09030EBT19

●Description

BD95700MUV is a 2 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^{3}Reg^{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^{3}Reg^{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=50kHz~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	7 *1*2	V
Input Voltage 6	BUSEN	7 *1	V
BOOT Voltage	BOOT1, BOOT2	30 *1	V
BOOT-SW Voltage	BOOT-SW	15 *1	V
UG-SW Voltage	UG-SW	15 *1	V
SW Voltage	SW	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 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	0.4	3.3	V
Input Voltage 6	BUSEN	0	3.3	V
BOOT Voltage	BOOT	4.5	27	V
BOOT-SW Voltage	BOOT-SW	4.5	13.2	V
CS Input Voltage	CS1-/CS1+/CS2-/CS2+	0.4	3.3	V
DROOP Setting Resistor	R_{DROOP}	0	510k	Ω
IOUT Setting Resistor	R_{IOUT}	0	5M	Ω
RT Setting Resistor	R_{RT}	10k	510k	Ω

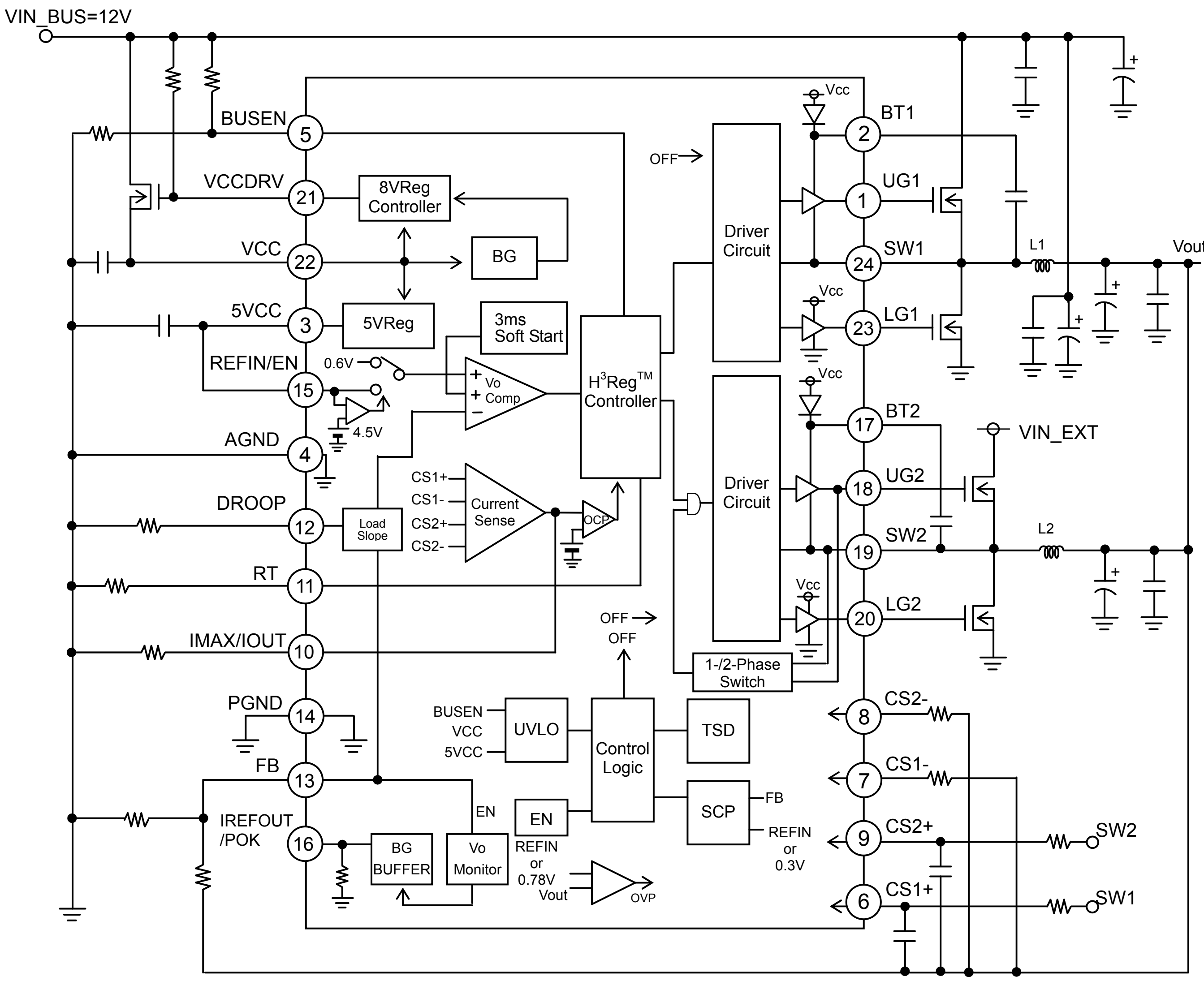
* This product should not be used in a radioactive environment.

●ELECTRICAL CHARACTERISTICS (Unless otherwise noted, Ta=25℃, VCC=5V, VIN=12V, REF=1.2V, RT=100kΩ)

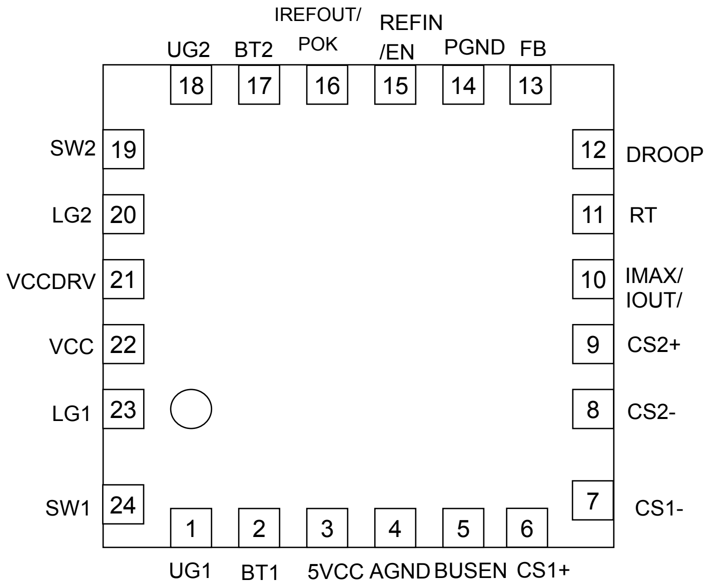
Parameter	Symbol	Standard Value			Unit	Condition
		MIN	TYP	MAX		
[Total Block]						
Vcc Bias Current	Icc	-	4	10	mA	
Vcc Standby Current	I_{STB}	-	1.5	2.0	mA	
[5Vcc Block]						
5Vcc Output Voltage	5Vcc	4.9	5	5.1	V	
5Vcc Output Current	I_{5Vcc}	20	-	-	mA	
[UVLO Block]						
VCC Threshold Voltage	Vcc_UVLO	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	V_{REF}	0.594	0.600	0.606	V	REFIN=5VCC
REFIN Offset Voltage	V_{REFIN}	REF_IN-10m	REF_IN	REF_IN+10m	V	
REFIN Input Voltage Range	V_{REF}	0.4	-	3.3	V	
REFIN Off Threshold Voltage	$V_{th\ REFIN}$	4.5	-	5Vcc	V	
[EN Threshold]						
EN Low voltage	Enlow	GND	-	0.3	V	REFIN pin voltage input
EN High voltage	Enhigh	0.4	-	5Vcc	V	REFIN pin voltage input
[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	Ω	
UG low side ON Resistance	R_{onHGL}	-	4	8	Ω	
LG high side ON Resistance	R_{onLGH}	-	6	12	Ω	
LG high side ON Resistance	R_{onLGL}	-	1	2	Ω	
[Regulator for VCC]						
Output Voltage	VCCDRV	7.2	8	8.8	V	
Vcc DRV Drive Current	I_{VCCDRV}	-	10	-	mA	
[Droop Block]						
Load Line Slope	$SLOPE_{LL}$	-	40	-	nA	DCR=5mΩ
Load Line Slope Gain	SLOPEGAIN	0.75	0.8	0.85		
[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=5Vcc
Over Voltage Threshold 2	OVP_{TH2}	REFINx1.25	REFINx1.3	REFINx1.35	V	
[SCP (Short Circuit Protection) Block]						
SCP Start up Voltage 1	$V_{SCP}1$	VREFx0.45	VREFx0.5	VREFx0.55	V	REFIN=5Vcc
SCP Start up Voltage 2	$V_{SCP}2$	REFINx0.45	REFINx0.5	REFINx0.55	V	
SCP Delay Time	T_{SCP}	-	1	-	ms	
[POK Detection Block]						
POK Threshold 1	POK_{THLOW1}	VREFx0.7	VREFx0.75	VREFx0.80	V	REFIN=5Vcc
POK Threshold 2	POK_{THLOW2}	VREFINx0.70	VREFINx0.75	VREFINx0.80	V	

* Design Guarantee

●Block Diagram



●Pin Configuration



●Pin Function Table

PIN No.	PIN Name	PIN Function
1	UG1	High Side FET Gate Drive Pin 1
2	BT1	Supply Voltage for UG1
3	5VCC	5V Regulator Output (Iomin=20mA)
4	AGND	Sense GND
5	BUSEN	Bus Enable, Power Supply Monitoring Pin
6	CS1+	Positive Input of Current Sensing 1
7	CS1-	Negative Input of Current Sensing 1
8	CS2-	Negative Input of Current Sensing 2
9	CS2+	Positive Input of Current Sensing 2
10	IMAX / IOUT	Current Limit/Output Current Indication
11	RT	Switching Frequency Setting
12	DROOP	Droop Control of the Load Line
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	BT2	Supply Voltage for UG2
18	UG2	High Side FET Gate Drive Pin 2
19	SW2	Switch Node for Channel 2
20	LG2	Low Side FET Gate Drive Pin 2
21	VCCDRV	Driver for External Linear Regulator
22	VCC	Supply Voltage Pin
23	LG1	Low Side FET Gate Drive Pin 1
24	SW1	Switch Node for Channel 1
Exposed Pad		FIN

●Pin Descriptions

・UG1 (Pin 1), UG2 (Pin 18)
These are the voltage supply pins to drive the Gate of the high side FET. This voltage swings between BT1/2 and SW1/2. 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.

・BT1 (Pin 2), BT2 (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 SW1/2). BT1/2 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)
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.

・Cs1+ (Pin 6), Cs2+ (Pin 9), Cs1- (Pin 7), Cs2- (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. BD95700MUV 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.

・DROOP (Pin 12)
This pin can be used for the load slope setting of the output voltage.

・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≒FB. However, FB becomes 0.6V when REFIN=5VCC.

・PGND (Pin 14)
This is the power ground pin connected to the source of the low side FET.

・REFIN/EN (Pin 15)
This is an internal or external reference voltage selectable pin. If REFIN is pulled up to 5VCC, internal reference voltage (0.6V) is used. If REFIN is driven by an external voltage ranged 0.4V to 3.3V, external voltage of REFIN voltage is used. It is very convenient for synchronizing external voltage supply. The IC controls the output voltage (REFIN≒FB). And also this pin is used for enable function. If REFIN 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.

・SW1 (Pin 24), SW2 (Pin 19)
These are the source pins for the high side FET. The maximum absolute ratings are 15V (from GND). SW1/2 voltage swings between VIN and GND.

・LG1 (Pin 23), LG2 (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 LG1/2 is high, 0.5 ohm when LG1/2 is low) of the driver.

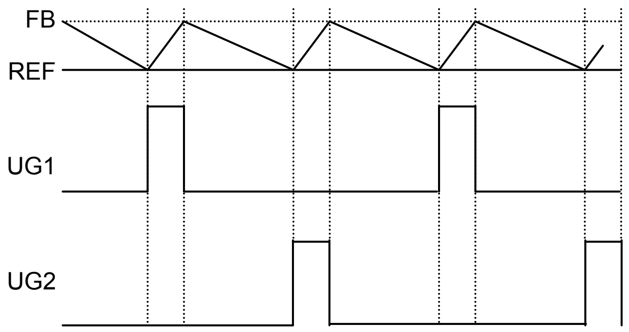
・VCCDRV (Pin 21)
This is the supply voltage pin to drive an external NPN/N_MOSFET for 8V linear regulator. The maximum absolute rating is 15V.

・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 BD95700MUV is a synchronous buck regulator controller incorporating ROHM's proprietary H[3]Reg[TM] CONTROLLA control system. When VOUT drops due to a rapid load change, the system quickly restores VOUT by extending the TON time interval. Thus, it serves to improve the regulator's transient response.

H[3]Reg[TM] control
(Normal operation)



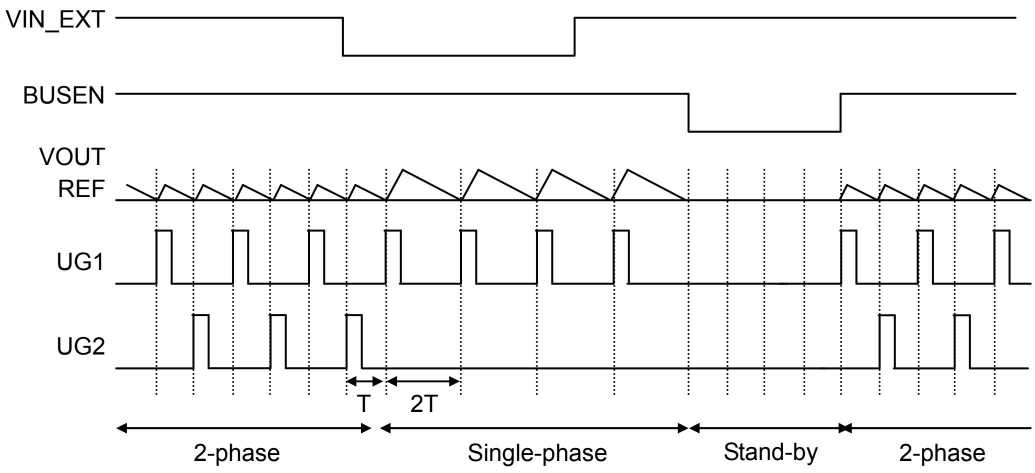
When FB pin voltage (Vout) falls to a threshold voltage REF, the drop is detected, activating the H[3]Reg[TM]CONTROLLA system.

$$T_{ON}=\frac{REF}{VIN}\times\frac{1}{f}\ [\mathrm{sec}]\cdots(1)$$

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

Note: REF is an internal or external reference voltage. If the internal reference is utilized, REF=0.6V. If the external reference is utilized, REF = REFIN pin voltage.

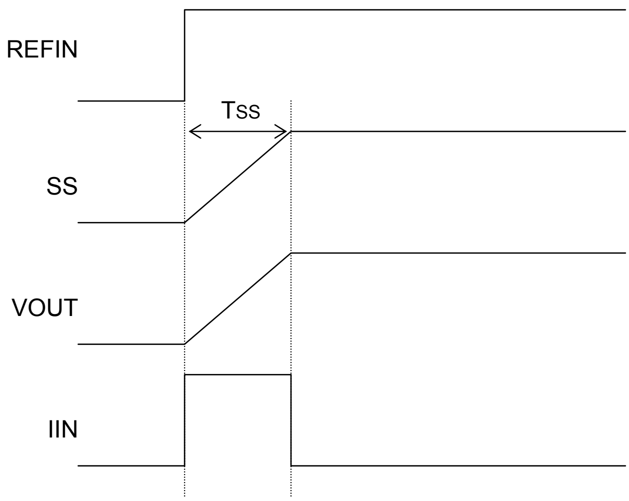
Phase switch function



The IC normally operates in 2-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



Soft start is activated when REF 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.

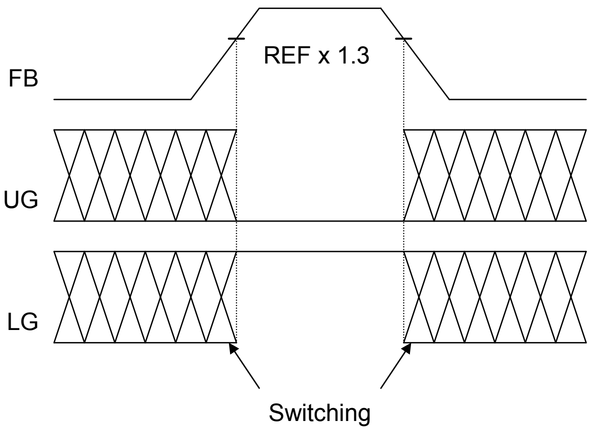
Soft start time (TSS) ≒ 3msec (fixed)

Incoming current

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

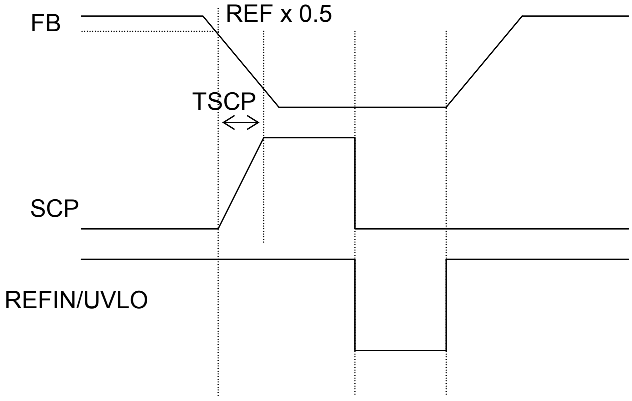
(Co: Output capacitor)

・Output Over Voltage Protection



When the FB pin voltage becomes REF 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.

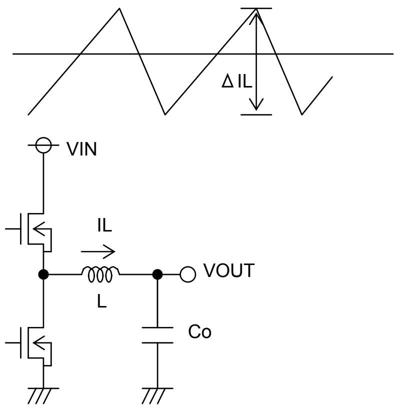
・Short Circuit Protection with Timer Latch



Short Circuit Protection kicks in when output falls to or below REF 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 pin (ON → OFF → ON) or disabling UVLO (HIGH → Low → High).

● External Component Selection

1. Inductor (L) selection



Output Ripple Current

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.

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

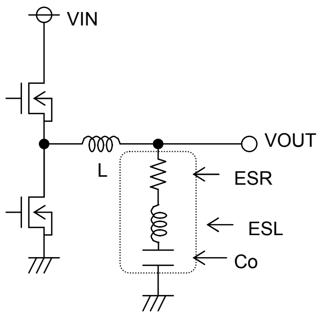
$$L = \frac{(VIN-VOUT) \times VOUT}{\Delta IL \times VIN \times f} \ [H] \cdots (5)$$

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

※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



Output Capacitor

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.

$$\Delta VOUT = \Delta IL \times ESR + ESL \times \Delta IL/T_{ON} \cdots (6)$$

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

※ 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.

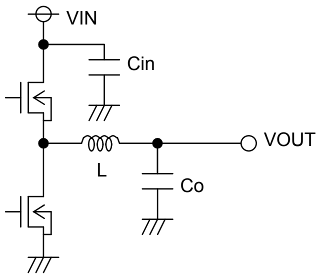
Please give due consideration to the conditions in formula (7) below for output capacity, bearing in mind that output rise time must be established within the soft start time frame.

$$Co \leqq \frac{3msec \times (Limit-IOUT/2)}{VOUT} \cdots (7)$$

Limit: Current Limit Value

Note: Improper capacitor may cause startup malfunctions.

3. Input Capacitor (Cin) Selection



Input Capacitor

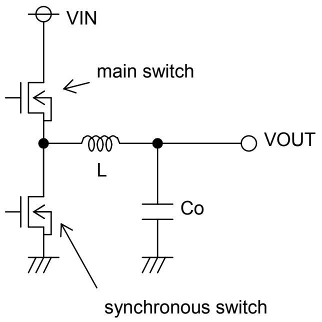
The input capacitor selected must have low enough ESR resistance to fully support large ripple output, in order to prevent extreme over current. The formula for ripple current IRMS is given in (8) below.

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

Where $V_{IN} = 2 \times V_{OUT}$, $I_{RMS} = \frac{IOUT}{4}$

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

4.MOSFET Selection



Pmain=PRON+PGATE+PTRAN

Loss on the main MOSFET

$$= \frac{VOUT}{4 \times VIN} \times R_{ON} \times I_{OUT}^2 + Ciss \times f \times VDD + \frac{VIN^2 \times Crss \times I_{OUT} \times f}{2 \times I_{DRIVE}} \quad \cdots (9)$$

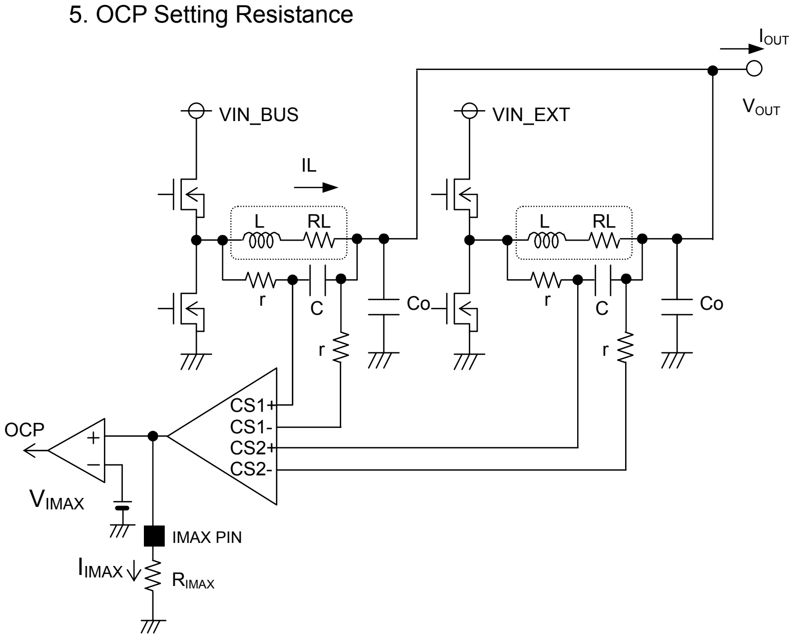
(Ron: On-resistance of FET; Ciss: FET gate capacity;
f: Switching frequency Crss: FET inverse transfer function;
I_{DRIVE}: Gate peak current)

Loss on the synchronous MOSFET

Psyn=PRON+PGATE

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

5. OCP Setting Resistance



OCP threshold is determined by external OCP setting resistance (RIMAX) and IMAX calculated below.

$$I_{IMAX} = \frac{V_{CS1+} - V_{CS1-}}{250k\Omega} + \frac{V_{CS2+} - V_{CS2-}}{250k\Omega} \quad \cdots (11)$$

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

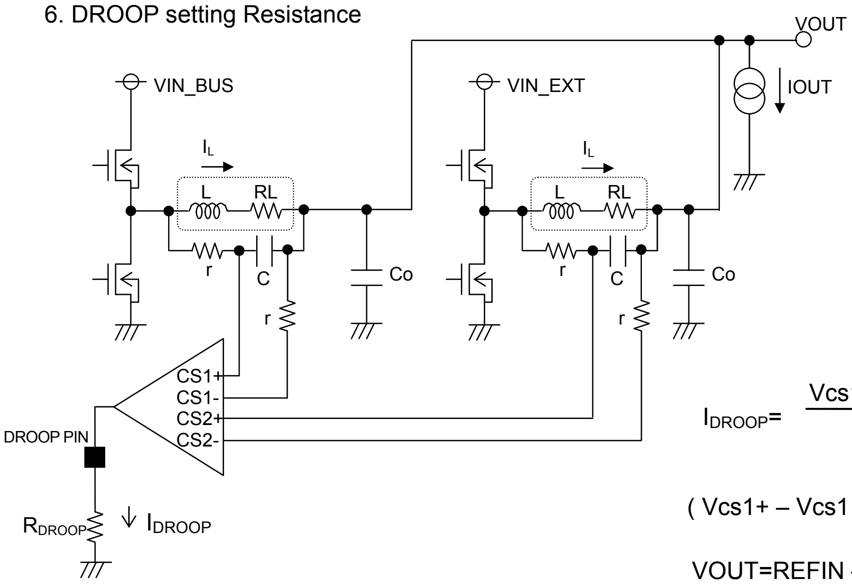
(RL: the DCR value of coil)

If VIMAX meet the following condition, OCP becomes activated.

$V_{IMAX} \leqq I_{IMAX} \times R_{IMAX}$

(V_{IMAX}: OCP Setting Voltage, V_{IMAX}=1V)

6. DROOP setting Resistance



The slope of the DROOP (VDROOP) can be set by the voltage drop caused by IDROOP and RDROOP. The equation is as follows.

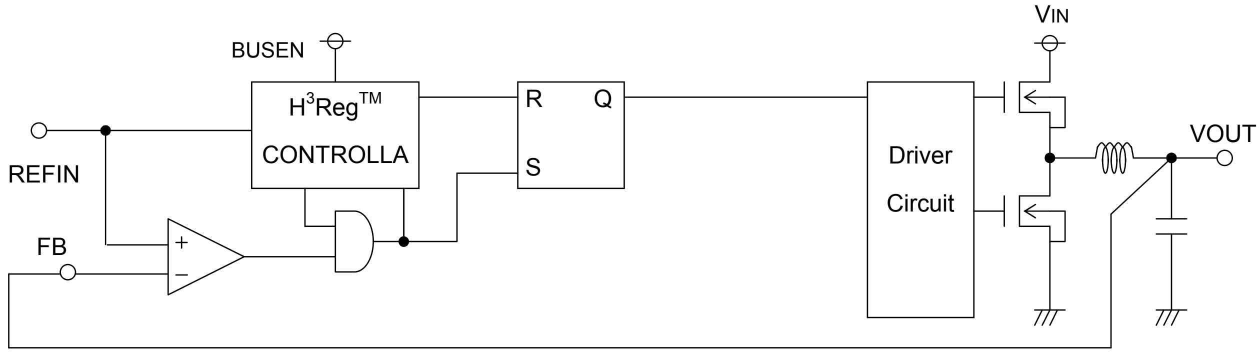
$$I_{DROOP} = \frac{Vcs1+ - Vcs1-}{250k\Omega} + \frac{Vcs2+ - Vcs2-}{250k\Omega}$$

$$(Vcs1+ - Vcs1- = I_L \times RL, RL = \frac{L}{r \times c}, I_{OUT} \fallingdotseq 2I_L)$$

$$VOUT = REFIN - R_{DROOP} \times I_{DROOP} \quad \cdots (12)$$

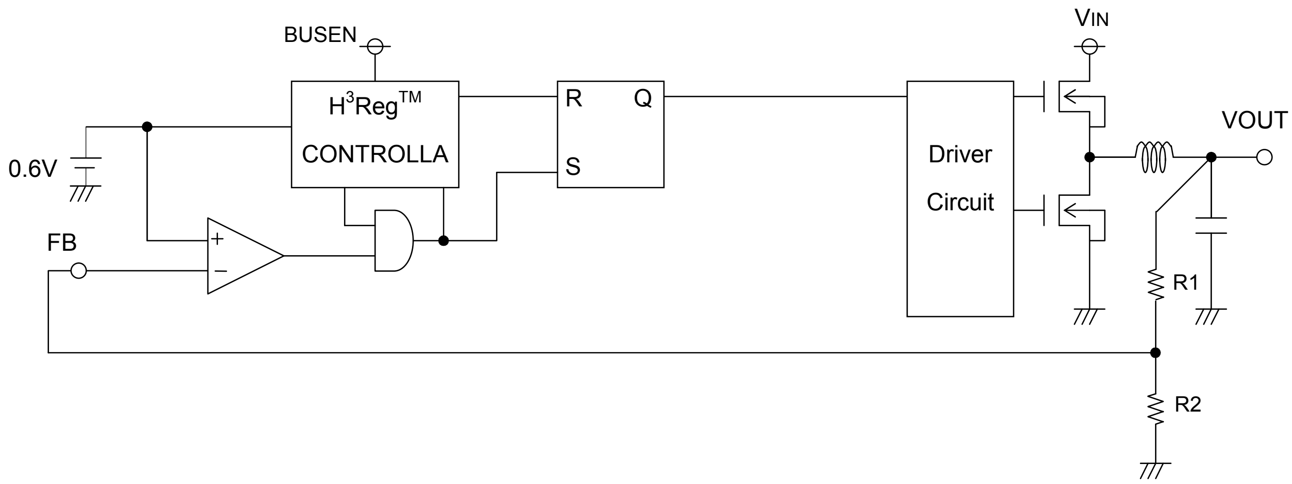
7. Setting output voltage

The output voltage is REFIN = VOUT when VOUT is tied to the FB directly. The range of VOUT is 0.4V ~ 3.3V.



The output voltage is calculated as follows when resistor divider network is connected between the FB and VOUT. REFIN set 5Vcc. The range of Vout is 0.6～3.3V

$$Vout = \frac{R1+R2}{R2} \times 0.6\ [V] \cdots (13)$$



8. Frequency Setting Resistance

The Frequency at steady state is determined by resistance value connected to RT pin.
But actual SW 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.

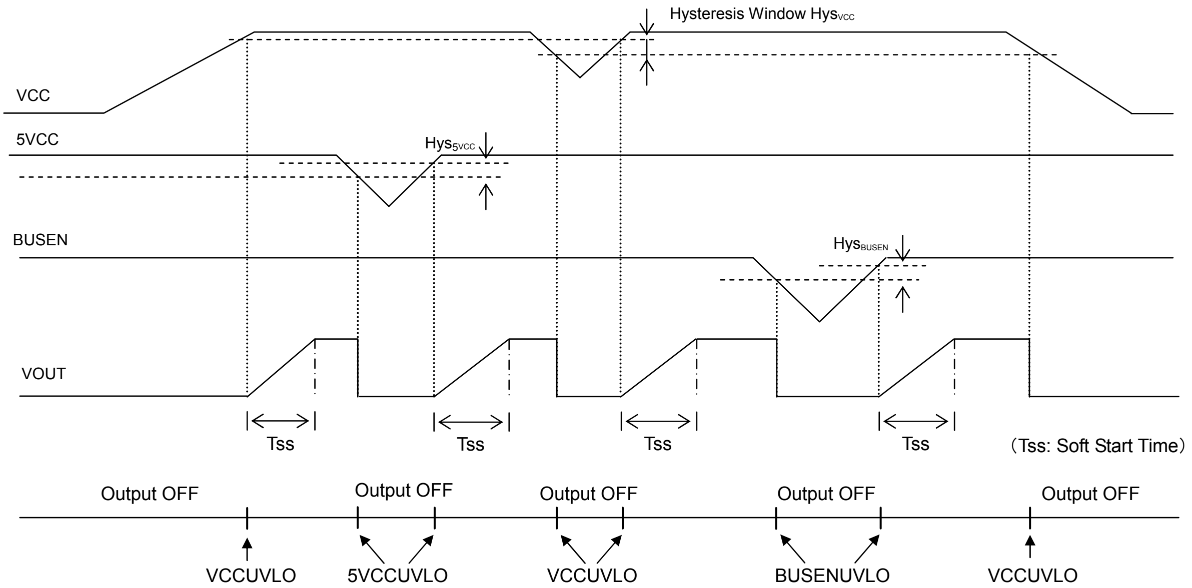
$$f\ [Hz] = \frac{VOUT}{VIN} \times \frac{1}{Ton} \cdots (14)$$

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

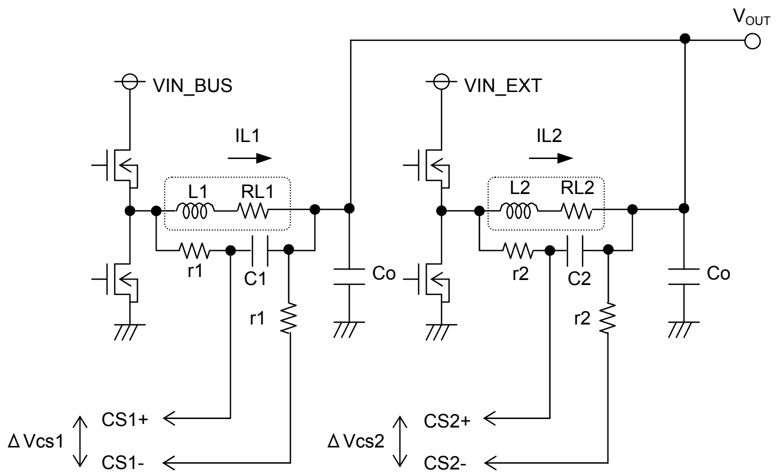
Consequently, total frequency becomes lower than the formula above.
On-Time increases by Dead Time on the condition of zero cross point of inductor current. And also switching frequency increases as the output current increases due to the fixed On-Time and the influence of conduction loss.
It is recommended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

9. UVLO

BD95700MUV 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.



10. Current Phase Balance

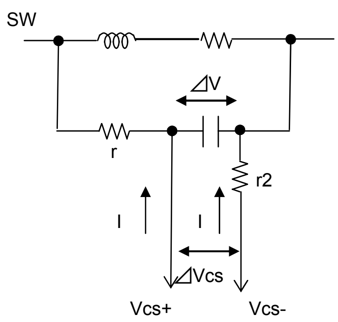


BD95700MUV keeps the current phase balance between coil current IL1 and IL2 by controlling the status $\Delta Vcs1 = \Delta Vcs2$.And for that, it is needed to meet the reference formula below.

$$L1 = L2\ (RL1 = RL2),\ r1 = r2,\ C1 = C2. \quad \cdots (15)$$

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

$$RL1 = \frac{L1}{r1 \times C1} \quad \cdots (16)$$



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 (16). Refer to formula (17) below:

$$\Delta Vcs = \Delta V - I \times r \quad \cdots (17)$$

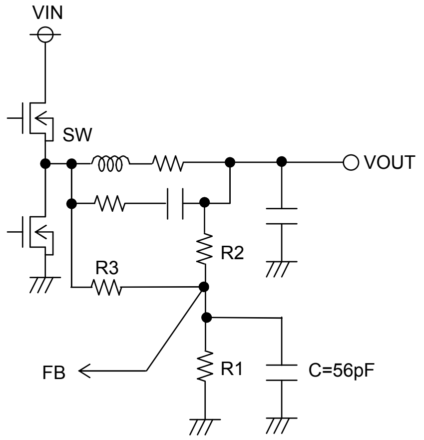
This difference can be compensated for by adding resistor r2.

$$\Delta Vcs = (\Delta V - I \times r) + I \times r2 \quad \cdots (18)$$

To eliminate the difference, choose r2 to have the same value as r.

$$\Delta Vcs = \Delta V \quad \cdots (19)$$

11. 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 (20) below

$$R1+R2 \leqq 20k\Omega, 10 \times R1 \leqq R3 \quad \cdots (20)$$

●Reference Data

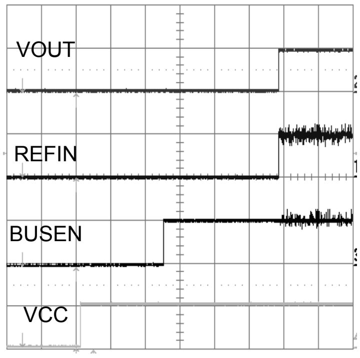


Fig1.Sequence

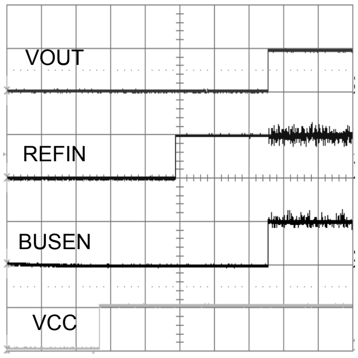


Fig2.Sequence

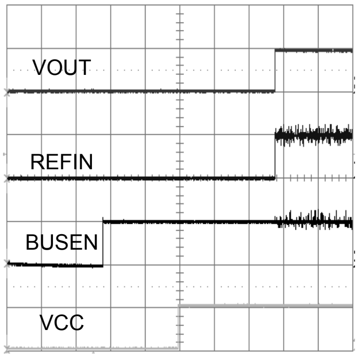


Fig3.Sequence

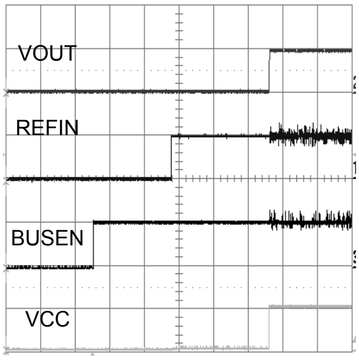


Fig4.Sequence

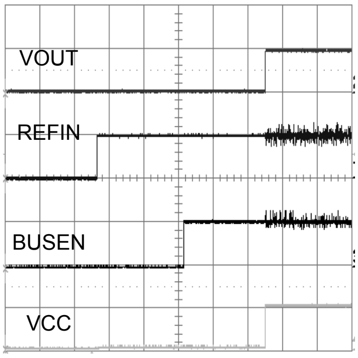


Fig5.Sequence

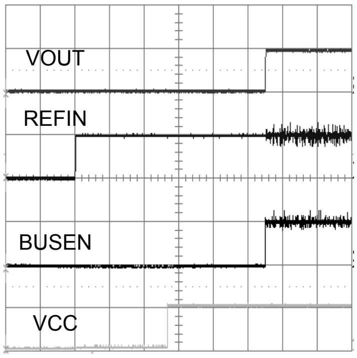


Fig6.Sequence

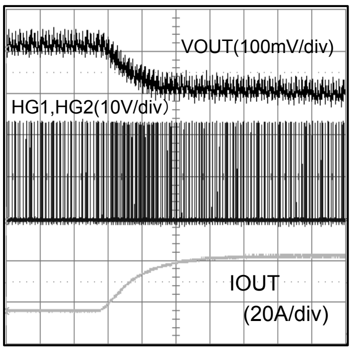


Fig7.Load Transient Response
(VCC=12V)

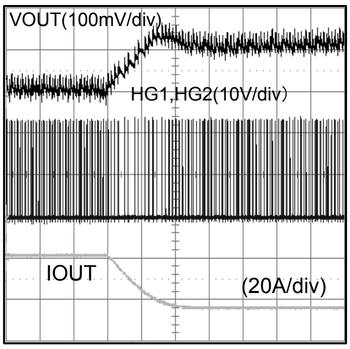


Fig8.Load Transient Response
(VCC=12V)

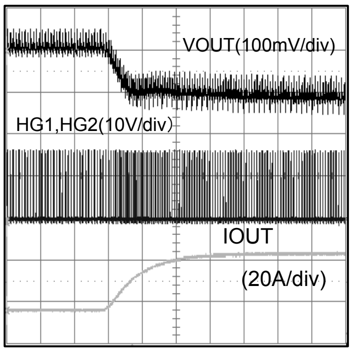


Fig9.Load Transient Response
(VCC=5V)

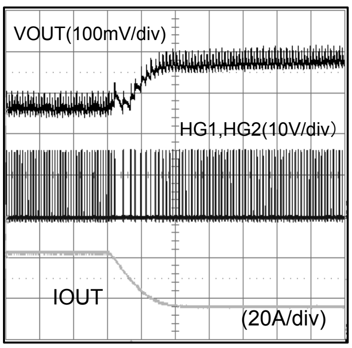


Fig10.Load Transient Response
(VCC=5V)

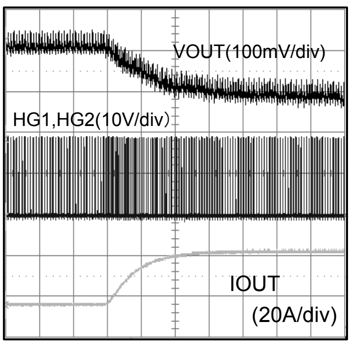


Fig11.Load Transient Response
(VCC=8V)

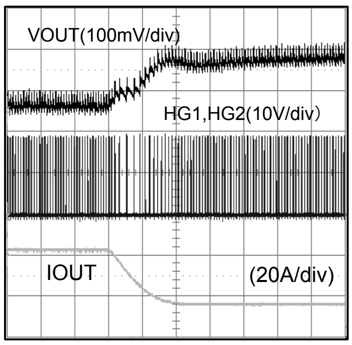


Fig12.Load Transient Response
(VCC=8V)

●Reference Data

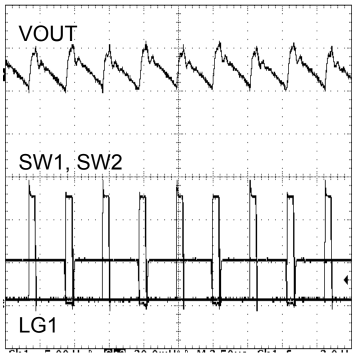


Fig13.Continuos MODE
(VCC=5V)

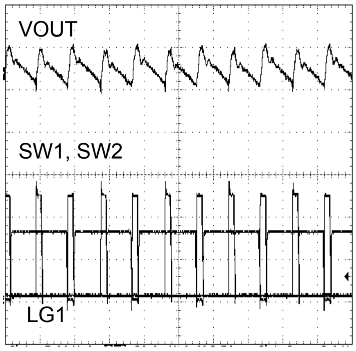


Fig14.Continuos MODE
(VCC=8V)

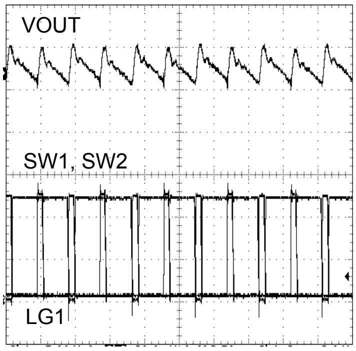


Fig15.Continuos MODE
(VCC=12V)

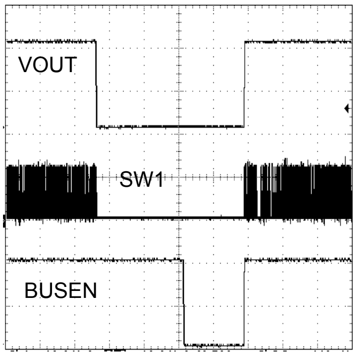


Fig16.SCP Function

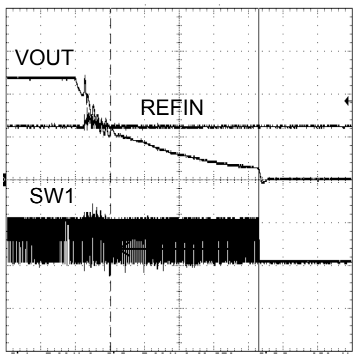


Fig17.SCP Function

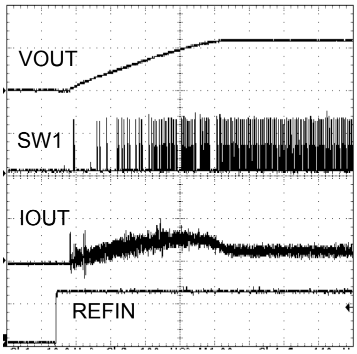


Fig18.Soft Start

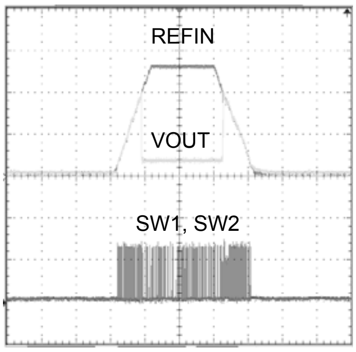


Fig19.Reference Function

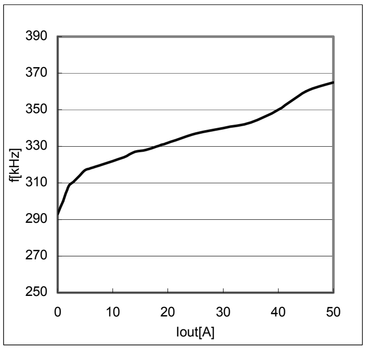


Fig20.Frequency range functionally

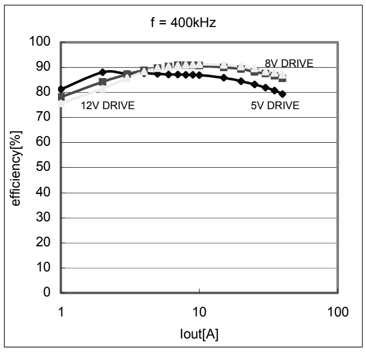


Fig21.Efficiency

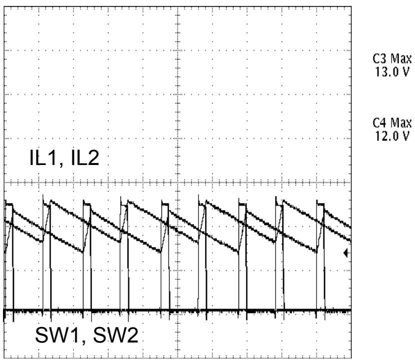


Fig22.Current balance
(Io=20A)

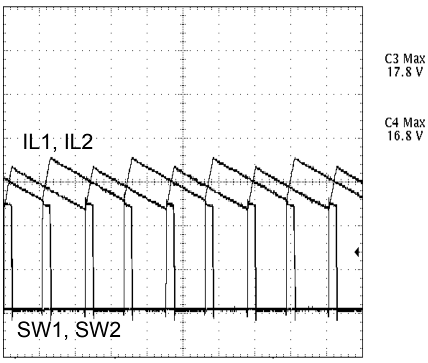


Fig23.Current balance
(Io=30A)

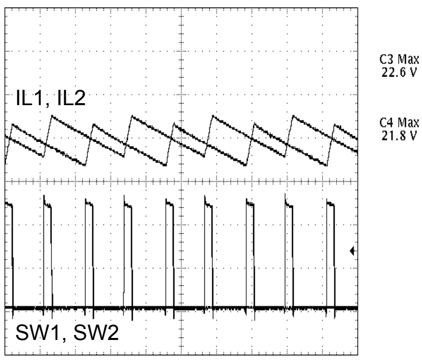
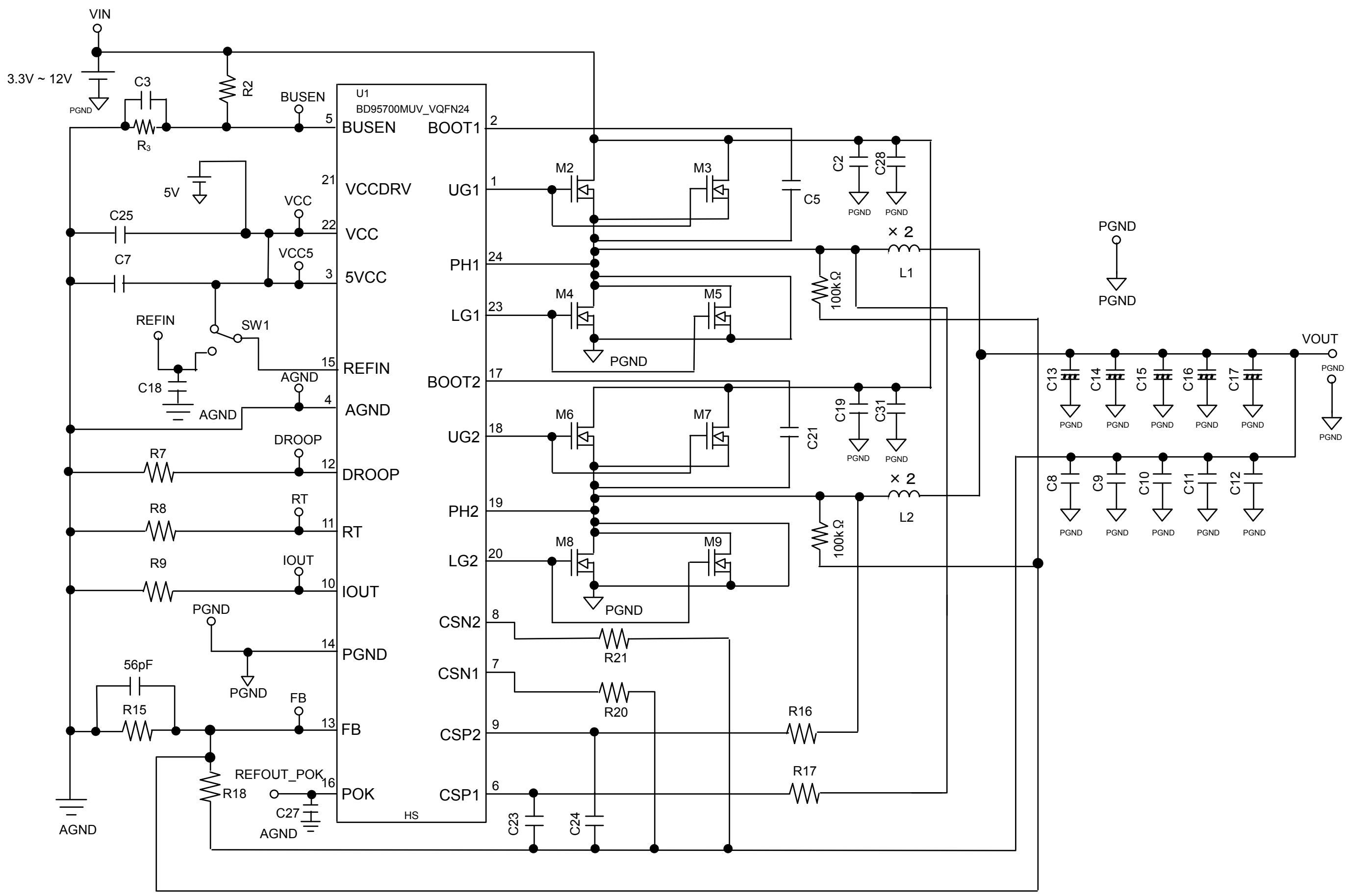


Fig24.Current balance
(Io=40A)

■BD95700MUV Evaluation Board Circuit with 5V Drive (VCC=5V input , VIN=3.3~12V input , REFIN=5VCC, Vout=1.2V)

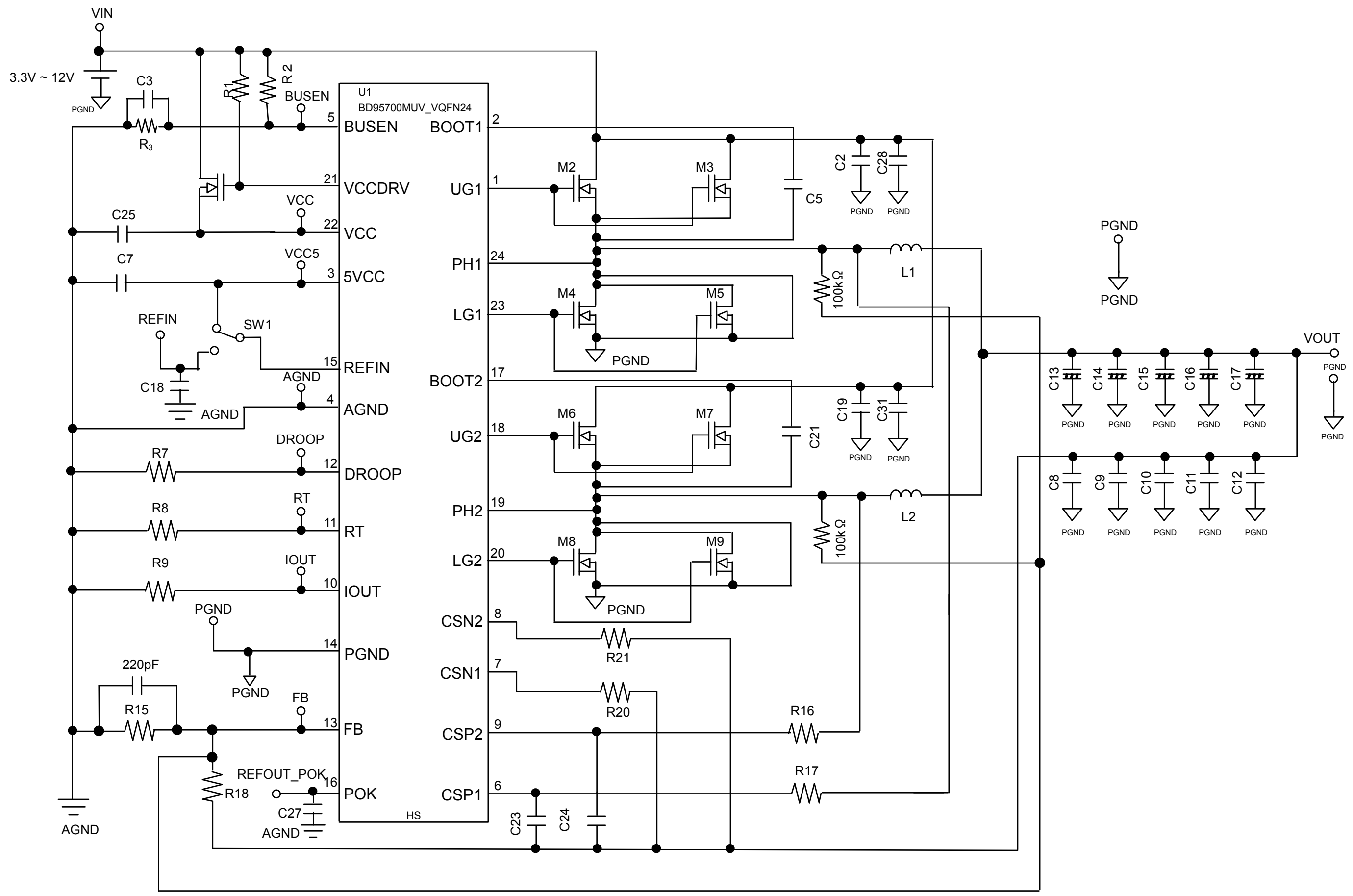


■BD95700MUV Evaluation Board Parts List

Part No	Value	Company	Part name
U1		ROHM	BD95700MUV
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
R7	0Ω	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

■BD95700MUV Evaluation Board Circuit with 8V Drive (VIN=10.8~13.2V input , REFIN=5VCC, Vout=1.2V)

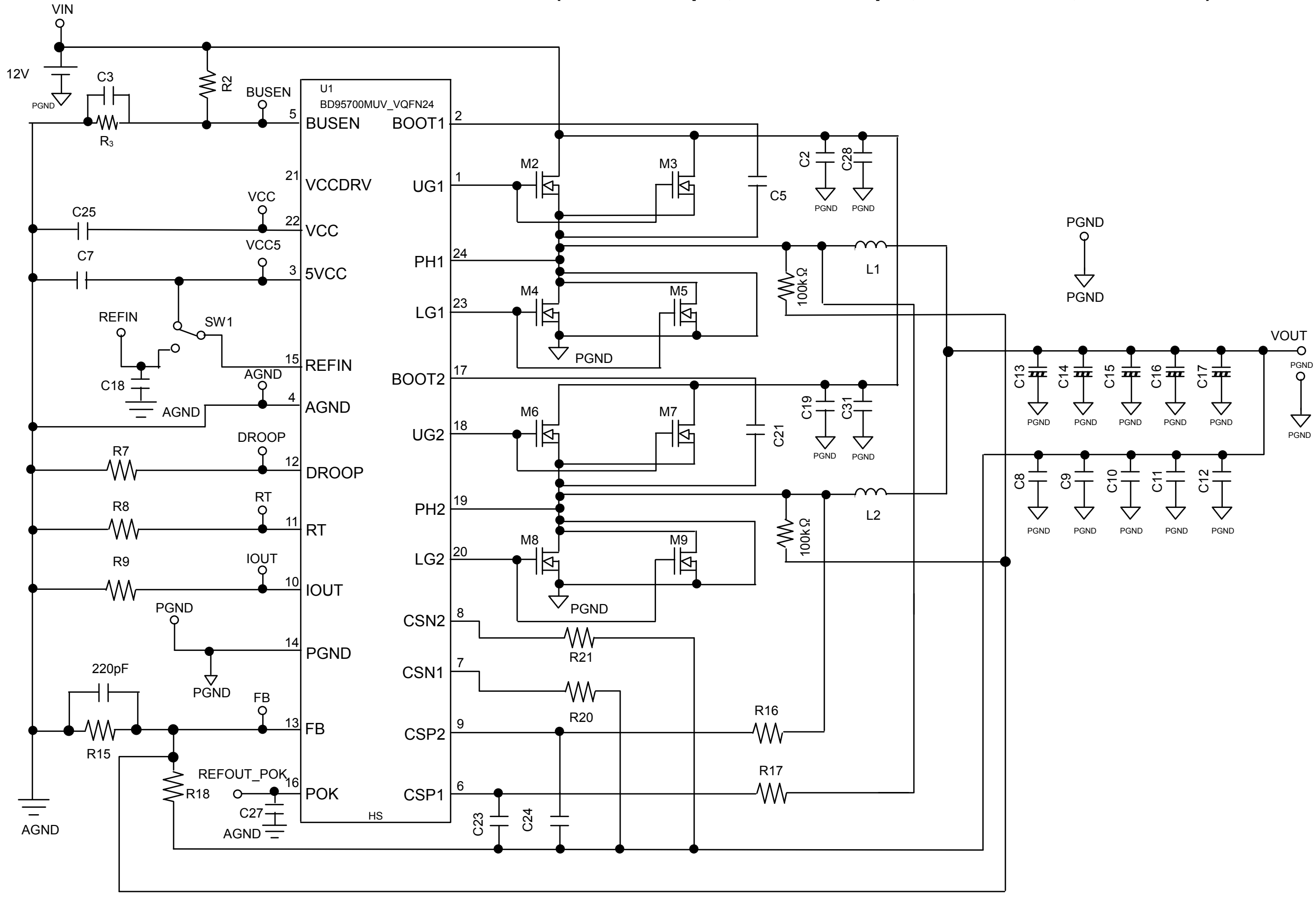


■BD95700MUV Evaluation Board Parts List

Part No	Value	Company	Part name
U1		ROHM	BD95700MUV
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	-	-	-
C17	-	-	-

Part No	Value	Company	Part name
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
R1	10kΩ	ROHM	MCR03
R2	300kΩ	ROHM	MCR03
R3	30kΩ	ROHM	MCR03
R7	0Ω	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

■BD95700MUV Evaluation Board Circuit with 12V Drive (VIN=12V input, VCC=12V input, REFIN=5VCC, Vout=1.2V)



■BD95700MUV Evaluation Board Parts List

Part No	Value	Company	Part name
U1		ROHM	BD95700MUV
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
R7	0Ω	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 will 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.

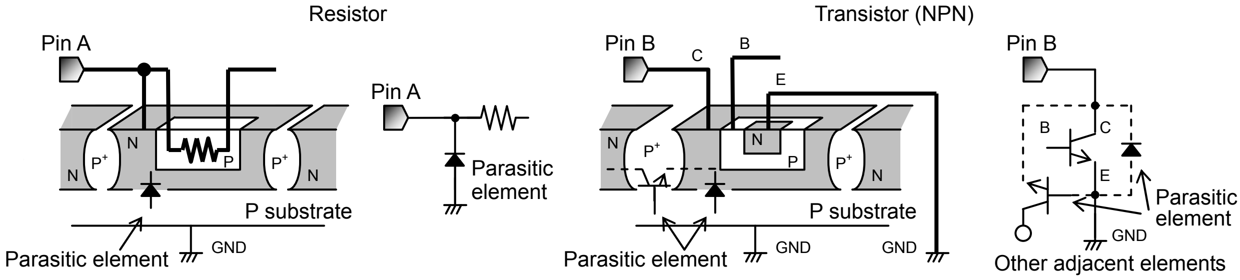
8. ASO
When using the IC, set the output transistor so that it does not exceed absolute maximum ratings or ASO.

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.)
BD95700MUV	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 P layers with 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

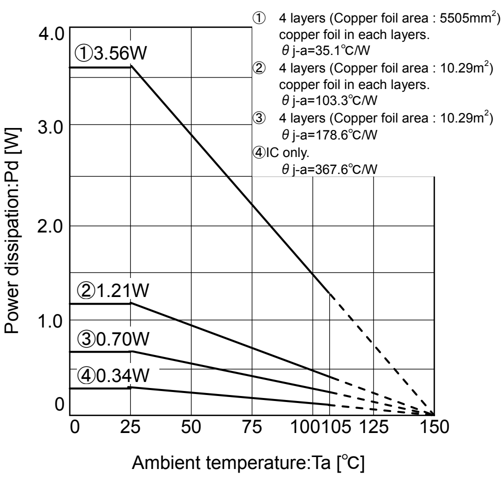


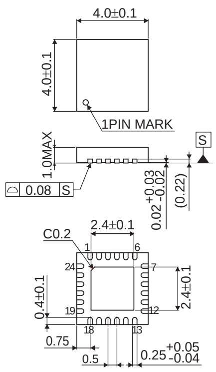
Fig.25 Thermal derating curve
(VQFN020V4040)

●Type Designations (Selections) for Ordering

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

- BD: Part No.
- 95700: Part No.
- MUV: Package
  MUV : VQFN024V4040
- E2: Packaging and forming specification
  E2: Embossed tape and reel

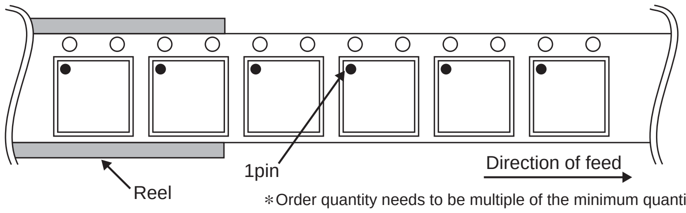
VQFN024V4040



(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)



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

Notes

No copying or reproduction of this document, in part or in whole, is permitted without the consent of ROHM Co.,Ltd.

The content specified herein is subject to change for improvement without notice.

The content specified herein is for the purpose of introducing ROHM's products (hereinafter "Products"). If you wish to use any such Product, please be sure to refer to the specifications, which can be obtained from ROHM upon request.

Examples of application circuits, circuit constants and any other information contained herein illustrate the standard usage and operations of the Products. The peripheral conditions must be taken into account when designing circuits for mass production.

Great care was taken in ensuring the accuracy of the information specified in this document. However, should you incur any damage arising from any inaccuracy or misprint of such information, ROHM shall bear no responsibility for such damage.

The technical information specified herein is intended only to show the typical functions of and examples of application circuits for the Products. ROHM does not grant you, explicitly or implicitly, any license to use or exercise intellectual property or other rights held by ROHM and other parties. ROHM shall bear no responsibility whatsoever for any dispute arising from the use of such technical information.

The Products specified in this document are intended to be used with general-use electronic equipment or devices (such as audio visual equipment, office-automation equipment, communication devices, electronic appliances and amusement devices).

The Products specified in this document are not designed to be radiation tolerant.

While ROHM always makes efforts to enhance the quality and reliability of its Products, a Product may fail or malfunction for a variety of reasons.

Please be sure to implement in your equipment using the Products safety measures to guard against the possibility of physical injury, fire or any other damage caused in the event of the failure of any Product, such as derating, redundancy, fire control and fail-safe designs. ROHM shall bear no responsibility whatsoever for your use of any Product outside of the prescribed scope or not in accordance with the instruction manual.

The Products are not designed or manufactured to be used with any equipment, device or system which requires an extremely high level of reliability the failure or malfunction of which may result in a direct threat to human life or create a risk of human injury (such as a medical instrument, transportation equipment, aerospace machinery, nuclear-reactor controller, fuel-controller or other safety device). ROHM shall bear no responsibility in any way for use of any of the Products for the above special purposes. If a Product is intended to be used for any such special purpose, please contact a ROHM sales representative before purchasing.

If you intend to export or ship overseas any Product or technology specified herein that may be controlled under the Foreign Exchange and the Foreign Trade Law, you will be required to obtain a license or permit under the Law.