XC9306B05G0R-G

TOREX

ETR06003-002

Synchronous Rectification Buck-Boost DC/DC Converter IC

☆GreenOperation Compatible

■GENERAL DESCRIPTION

The XC9306B05G0R-G is a synchronous buck-boost DC/DC converter IC with built-in FETs. The circuit topology switches over between buck and boost smoothly based on the relationship of the input voltage and the output voltage which is observed by the internal PWM controller. Due to the internal FETs, the number of external components is reduced. Also, a 6MHz switching frequency enables smaller external components, such as a coil and capacitors, to be used. The input voltage range is 2.5V~5.5V and the output voltage is adjustable from 0.8V to 5.0V by using external resistors since the reference voltage circuit is embedded internally. Synchronous topology provides high efficiency performance and the control method is selectable from either PWM mode (MODE pin: H) or PFM mode (MODE pin: L). Under PFM mode, the efficiency at light load current will be improved. When a “L” signal level is fed to the CE pin, the product is in stand-by mode and the consumption current is going to be 2.0uA (Max.) or less. Regarding other functions, the product has UVLO, thermal shutdown protection and soft-start. The soft-start time is approx. 100us and the output voltage can rise up quickly.

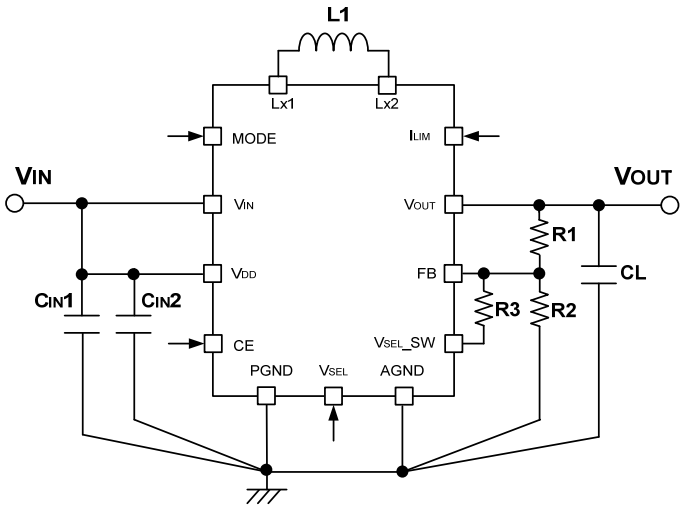
■APPLICATIONS

- RF Power Amplifiers
- Mobile Phones, Smart Phones
- Portable Information Devices
- MP3 Players
- Digital Still Cameras
- Products powered by Li-ion 1 cell batteries

■FEATURES

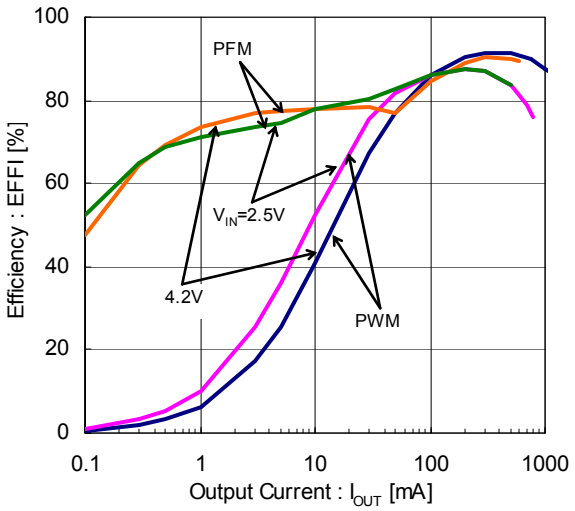
Input Voltage Range	: 2.5V～5.5V
Output Voltage Setting Range	: 0.8V～5.0V (FB=0.5V)
Oscillation Frequency	: 6.0MHz
Efficiency	: 92%(V_{IN}=4.2V, V_{OUT}=3.3V/300mA)
Control Methods	: PWM (Mode=High, I_{LIM}=Low)
Protection Circuit	: Current Limit Thermal Shutdown
Function	: Soft-start Power Save (Mode=Low) UVLO
Output Capacitor	: Ceramic Capacitor Compatible
Coil Value	: 0.5 (0.47) μH
Package	: WLP-20-01
Environmentally Friendly	: EU RoHS Compliant, Pb Free

■TYPICAL APPLICATION CIRCUIT

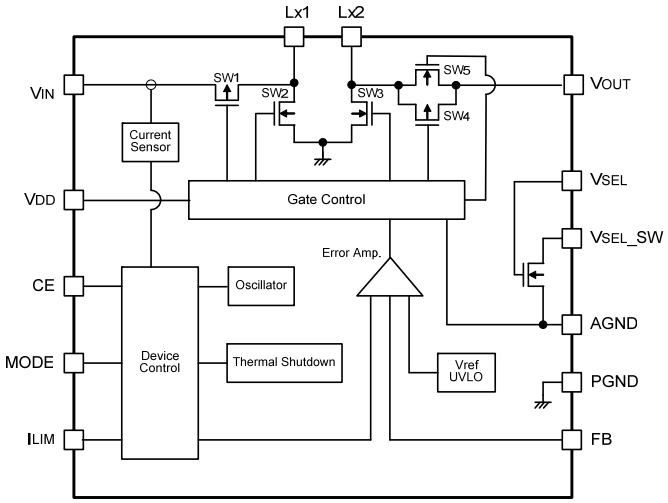


■ TYPICAL PERFORMANCE CHARACTERISTICS

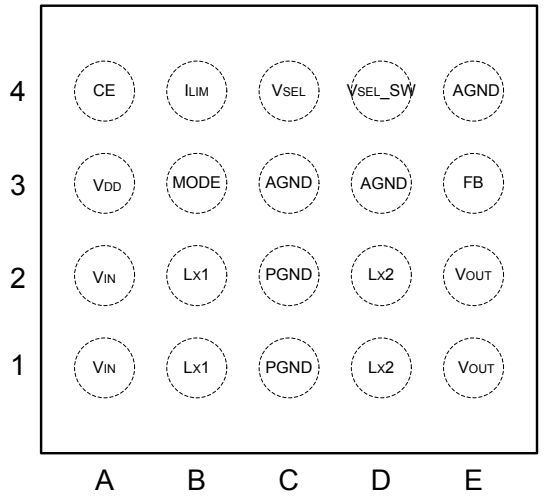
XC9306B05G0R-G Vout=3.3V



■BLOCK DIAGRAM



■PIN CONFIGURATION



(TOP VIEW)

NOTE:
Please connect the AGND pin and PGND pin when operating.

■ PIN ASSIGNMENT

PIN NUMBER	PIN NAME	FUNCTIONS
A1,A2	V_{IN}	Power Input
A3	V_{DD}	Analog Input
A4	CE	Chip Enable
B1,B2,D1,D2	Lx1,Lx2	Connection pins for Inductor
B3	MODE	Power Save Mode(High:PWM mode,Low:PFM mode)
B4	I_{LIM}	Current Limit Select
C1,C2	PGND	Power Ground
C3,D3,E4	AGND	Analog Ground
C4	V_{SEL}	Resistor(R3) ON/OFF Switch
E1,E2	V_{OUT}	Output
E3	FB	Output Voltage Monitior
D4	V_{SEL}_SW	Resistor(R3) Connection pin

■PRODUCT CLASSIFICATION

1) Ordering Information

XC9306B①②③④⑤−⑥

DESIGNATOR	ITEM	SYMBOL	DESCRIPTION
①②	Output Voltage	05	Reference Voltage is fixed at 0.5V
③	Oscillation Frequency	G	5.8MHz
④⑤−⑥(*1)	Package (Order Unit)	0R-G	WLP-20-01 (6,000/REEL)

(*1) The "-G" suffix denotes Halogen and Antimony free as well as being fully EU RoHS compliant.

■ CE PIN FUNCTION

1) CE pin Function

PIN NAME	SIGNAL	STATUS
CE pin	High	Active
	Low	Stand-by

* Please do not leave the CE pin open.

2) MODE pin, I_{LIM} pin Function

"OPERATION MODE" can be selected with the MODE pin.

"OVER CURRENT LIMIT" can be selected with the I_{LIM} pin.

OPERATION MODE	MODE pin SIGNAL	I_{LIM} pin SIGNAL	OVER CURRENT LIMIT	NOTES
PWM Mode	High	High	-	Disabled
		Low	3.1A	-
PFM Mode	Low	High	1.3A	-
		Low	-	Disabled

* Please do not leave the MODE pin, I_{LIM} pin open.

Input of (MODE pin ="High", I_{LIM} pin ="High") is prohibited.

Input of (MODE pin ="Low", I_{LIM} pin ="Low") is prohibited.

3) V_{SEL} pin Function

The V_{SEL} pin is enabled when a resistor (R3) for adjustment of the output voltage (V_{OUT}) is connected between the V_{SEL}_SW pin and FB pin.

PIN NAME	SIGNAL	STATUS
V_{SEL} pin	High	Output voltage adjustment switch ON
	Low	Output voltage adjustment switch OFF

* Please do not leave the V_{SEL} pin open.

* If you will not use output voltage adjustment, connect the V_{SEL} pin and V_{SEL}_SW pin to Low voltage.

■ABSOLUTE MAXIMUM RATINGS

Ta=25℃

PARAMETER	SYMBOL	RATINGS	UNITS
Power Input Voltage	V_{IN}	-0.3 ~ + 7.0	V
Analog Input Voltage	V_{DD}	-0.3 ~ + 7.0	V
Signal Input Voltage	CE,MODE,V_{SEL},I_{LIM}	- 0.3 ~ V_{IN} + 0.3	V
Power Dissipation	Pd	1080(*1)	mW
Maximum Junction Temperature(*2)	T_{jmax}	+ 95	℃
Operating Ambient Temperature	T_{opr}	- 40~+ 85	℃
Storage Temperature	T_{stg}	- 65 ~ + 150	℃

All voltages are described based on the GND (AGND and PGND) pin.

(*1) The power dissipation figure shown is PCB mounted. (JEDEC regulation board used)

(*2) The maximum temperature conditions for the of IC-Chip under recommended operating conditions.

Please design the heat radiation not to go beyond the maximum junction temperature.

■RECOMMENDED OPERATING CONDITIONS

Ta=25℃

PARAMETER	SYMBOL	CONDITIONS	MIN.	TYP.	MAX.	UNITS
Power Supply Voltage	V_{IN}	V_{IN},V_{DD}	2.5	3.7	5.5	V
Signal Input Voltage	-	CE,MODE,V_{SEL},I_{LIM}	0.0	-	V_{DD}	V
V_{OUT}=5.0V Maximum Output Current	I_{OUT_MAX}	V_{IN} =5.5V, PWM mode(MODE =H), I_{LIM} =L	-	-	1.2	A
		V_{IN} =3.7V, PWM mode(MODE =H), I_{LIM} =L	-	-	0.9	
		V_{IN} =2.5V, PWM mode(MODE =H), I_{LIM} =L	-	-	0.6	
		V_{IN} =5.5V, PFM mode(MODE =L), I_{LIM} =H	-	-	0.6	
		V_{IN} =3.7V, PFM mode(MODE =L), I_{LIM} =H	-	-	0.5	
		V_{IN} =2.5V, PFM mode(MODE =L) ,I_{LIM} =H	-	-	0.3	
V_{OUT}=4.4V Maximum Output Current	I_{OUT_MAX}	V_{IN} =5.5V, PWM mode(MODE =H), I_{LIM} =L	-	-	1.2	A
		V_{IN} =3.7V, PWM mode(MODE =H), I_{LIM} =L	-	-	1.0	
		V_{IN} =2.5V, PWM mode(MODE =H), I_{LIM} =L	-	-	0.7	
		V_{IN} =5.5V, PFM mode(MODE =L), I_{LIM} =H	-	-	0.6	
		V_{IN} =3.7V, PFM mode(MODE =L), I_{LIM} =H	-	-	0.6	
		V_{IN} =2.5V, PFM mode(MODE =L) ,I_{LIM} =H	-	-	0.35	
V_{OUT}=3.6V Maximum Output Current	I_{OUT_MAX}	V_{IN} =5.5V, PWM mode(MODE =H), I_{LIM} =L	-	-	1.2	A
		V_{IN} =4.2V, PWM mode(MODE =H), I_{LIM} =L	-	-	1.2	
		V_{IN} =2.5V, PWM mode(MODE =H), I_{LIM} =L	-	-	0.7	
		V_{IN} =5.5V, PFM mode(MODE =L), I_{LIM} =H	-	-	0.6	
		V_{IN} =4.2V, PFM mode(MODE =L), I_{LIM} =H	-	-	0.6	
		V_{IN} =2.5V, PFM mode(MODE =L) ,I_{LIM} =H	-	-	0.4	
V_{OUT}=3.3V Maximum Output Current	I_{OUT_MAX}	V_{IN} =5.5V, PWM mode(MODE =H), I_{LIM} =L	-	-	1.2	A
		V_{IN} =3.7V, PWM mode(MODE =H), I_{LIM} =L	-	-	1.2	
		V_{IN} =2.5V, PWM mode(MODE =H), I_{LIM} =L	-	-	0.8	
		V_{IN} =5.5V, PFM mode(MODE =L), I_{LIM} =H	-	-	0.6	
		V_{IN} =3.7V, PFM mode(MODE =L), I_{LIM} =H	-	-	0.6	
		V_{IN} =2.5V, PFM mode(MODE =L) ,I_{LIM} =H	-	-	0.5	
V_{OUT}=2.0V Maximum Output Current	I_{OUT_MAX}	V_{IN} =5.5V, PWM mode(MODE =H), I_{LIM} =L	-	-	1.2	A
		V_{IN} =3.7V, PWM mode(MODE =H), I_{LIM} =L	-	-	1.2	
		V_{IN} =2.5V, PWM mode(MODE =H), I_{LIM} =L	-	-	1.2	
		V_{IN} =5.5V, PFM mode(MODE =L), I_{LIM} =H	-	-	0.6	
		V_{IN} =3.7V, PFM mode(MODE =L), I_{LIM} =H	-	-	0.5	
		V_{IN} =2.5V, PFM mode(MODE =L) ,I_{LIM} =H	-	-	0.5	
V_{OUT}=1.2V Maximum Output Current	I_{OUT_MAX}	V_{IN} =5.5V, PWM mode(MODE =H), I_{LIM} =L	-	-	0.7	A
		V_{IN} =3.7V, PWM mode(MODE =H), I_{LIM} =L	-	-	0.6	
		V_{IN} =2.5V, PWM mode(MODE =H), I_{LIM} =L	-	-	0.6	
		V_{IN} =5.5V, PFM mode(MODE =L), I_{LIM} =H	-	-	0.4	
		V_{IN} =3.7V, PFM mode(MODE =L), I_{LIM} =H	-	-	0.3	
		V_{IN} =2.5V, PFM mode(MODE =L) ,I_{LIM} =H	-	-	0.3	
V_{OUT}=0.8V Maximum Output Current	I_{OUT_MAX}	V_{IN} =5.5V, PWM mode(MODE =H), I_{LIM} =L	-	-	0.6	A
		V_{IN} =3.7V, PWM mode(MODE =H), I_{LIM} =L	-	-	0.5	
		V_{IN} =2.5V, PWM mode(MODE =H), I_{LIM} =L	-	-	0.25	
		V_{IN} =5.5V, PFM mode(MODE =L), I_{LIM} =H	-	-	0.4	
		V_{IN} =3.7V, PFM mode(MODE =L), I_{LIM} =H	-	-	0.2	
		V_{IN} =2.5V, PFM mode(MODE =L) ,I_{LIM} =H	-	-	0.2	
Operating Ambient temperature	Ta	-	-40	-	+85	℃
Junction temperature range	Tj	-	-40	-	+95	℃
Inductor value	L	-	-	0.5	-	μH

NOTE:

For the setting conditions for the MODE pin and I_{LIM} pin, refer to the Function Table.

The recommended operating conditions are required in order to ensure the normal operation of the semiconductor device. All of the device's electrical characteristics are warranted when the device is operated under these conditions.

No warranty is made with respect to any use, operating conditions or combinations not represented on this data sheet.

■ELECTRICAL CHARACTERISTICS

The specifications apply under the recommended operating condition.

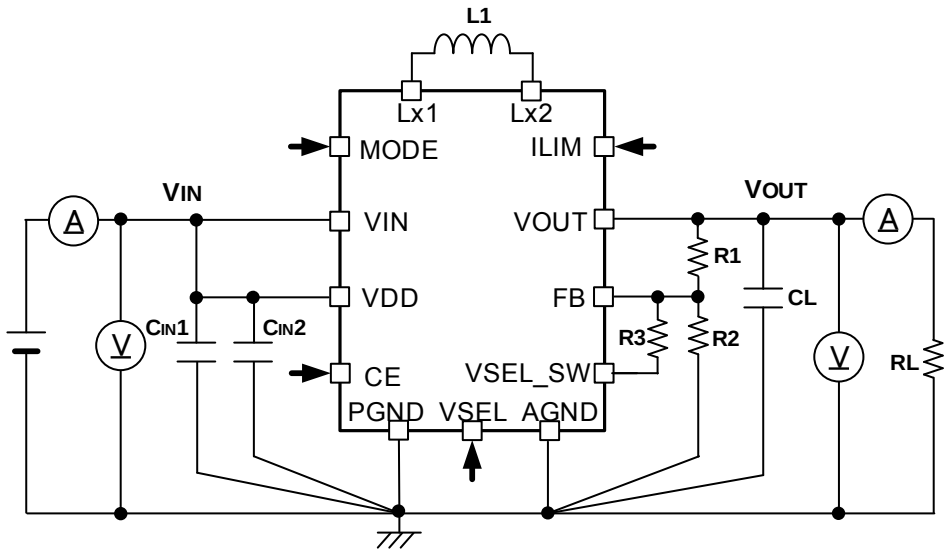
XC9306B05G0R-G Ta=25℃

PARAMETER	SYMBOL	CONDITIONS	MIN.	TYP.	MAX.	UNITS	CIRCUIT
Output Voltage Range	V_{OUT}	-	0.8	-	5.0	V	–
Feedback Voltage	V_{FB}	V_{IN} =V_{DD} =5.5V, V_{OUT} =4.28V setting, FB Measurement	490	500	510	mV	①
Maximum Output Current	I_{OUT_MAX}	V_{IN} =V_{DD} =3.1V, V_{OUT} =4.5V setting, MODE=H, I_{LIM}=L	0.8	-	-	A	①
Oscillation Frequency	f_{OSC}	MODE=H, I_{LIM}=L	5.2	5.8	6.4	MHz	①
Current Limit	I_{PK}	V_{IN} =V_{DD} =4.8V, V_{OUT}=3.3V setting, MODE=H, I_{LIM}=L	2.50	3.10	3.75	A	②
		V_{IN} =V_{DD} =4.8V, V_{OUT}=3.3V setting, MODE=L, I_{LIM}=H	1.05	1.30	1.60		
Stand-by Current	I_{STB}	CE=L	-	-	2	μA	①
Quiescent Current (PFM mode)	Iq	V_{IN} =3.7V, V_{OUT} =3.3V setting, I_{OUT}=0mA, MODE=L, CE=H	-	50	90	μA	①
FET Switch ON Resistance	R_{ON}1	V_{IN} =V_{DD} =3.7V,V_{OUT} =3.3V setting	-	63	84	mΩ	–
	R_{ON}2		-	124	175		
	R_{ON}3		-	82	116		
	R_{ON}4		-	123	164		
	R_{ON}5		-	51	72		
Signal Input Current (CE/MODE/V_{SEL}/I_{LIM})	I_{TH}	CE, MODE, V_{SEL}, I_{LIM}	-	-	0.1	μA	①
UVLO Threshold Voltage	V_{UVLO_H}	-	1.9	2.0	2.1	V	①
	V_{UVLO_L}	-	1.8	1.9	2.0		
Signal Input Threshold Voltage (CE/MODE/V_{SEL}/I_{LIM})	V_{THH}	CE, MODE, V_{SEL}, I_{LIM}	1.5	-	V_{DD}	V	①
	V_{THL}		0	-	0.25		
Thermal Shutdown Temperature	T_{TSD_H}	-	-	135(*1)	-	℃	①
	T_{TSD_L}		-	110(*1)	-		

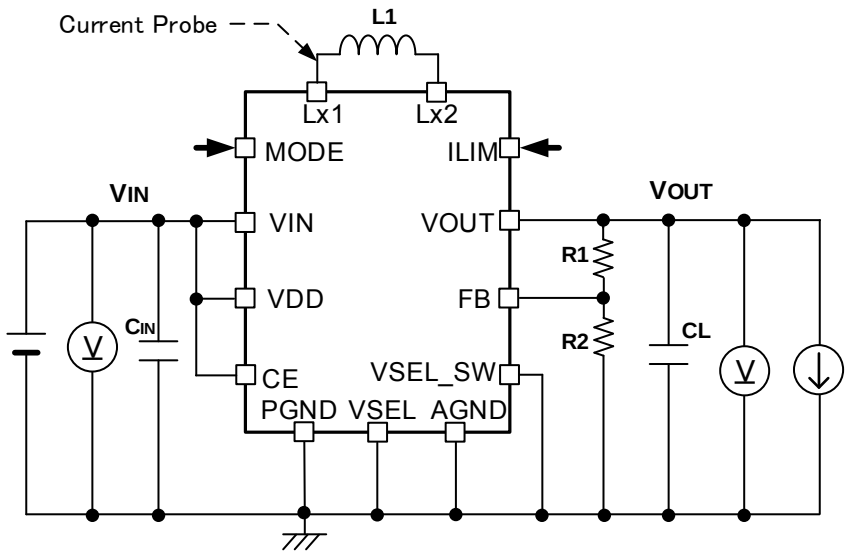
(*1)This parameter is not be specified. This should be used as a reference to support designing the circuits.

■TEST CIRCUITS

<Circuit No.①>

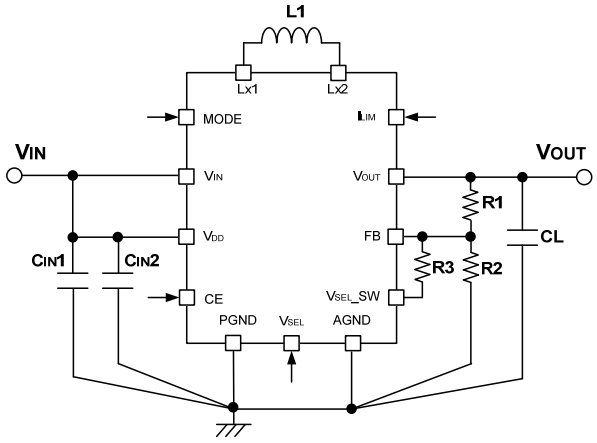


<Circuit No.②>



L1: XPL2010-501ML (0.5μH)
C_{IN}1: LMK107BBJ106MALT (10V/10μF)
C_{IN}2: C1005JB1E104K (25V/0.1μF)
CL: LMK107BBJ106MALT (10V/10μF)
R1: 620kΩ

■TYPICAL APPLICATION CIRCUIT



	VALUE	PARTS NUMBER	MANUFACTURER
L1	0.5µH (0.47µH)	XPL2010-501ML	Coilcraft
		MLP2016WR47M	TDK
		MIB2010M-R50W	MARUWA
		MHCD201610A-R47M-A8S	Chilisin
$C_{IN}1$	10V/10µF	C1608JB1A106M	TDK
		LMK107BBJ106MALT	TaiyoYuden
$C_{IN}2$	25V/0.1µF	C1005JB1E104K	TDK
		TMK105BJ104KV	TaiyoYuden
C_L(*1)	10V/2.2µF	C1608JB1A225K	TDK
		LMK107BJ225KA	TaiyoYuden
	10V/10µF	C1608JB1A106M	TDK
		LMK107BBJ106MALT	TaiyoYuden
	10V/22µF	C2012JB1A226M	TDK
		LMK212BBJ226MG	TaiyoYuden

(*1) The recommended standard capacity of the output capacitor is 2.2µF in PWM mode.
When using in PFM mode, the capacitor with larger capacity (around 22µF) is recommended to reduce the ripple voltage.
To suppress the decrease of output voltage during the load change, adjust with a larger capacitor.

1) Programming the Output Voltage

(1) When R3 is not used

The output voltage can be obtained from the equation below. VFB = 0.5V and R1 = 620kΩ.

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

(2) When R3 is used

The output voltage can be obtained from the equation below. VFB = 0.5V and R1 = 620kΩ.

When V_{SEL}=Low

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

When V_{SEL}=High

$$V_{OUT} = V_{FB} \times \frac{R1 + (R2 \,//\, R3)}{R2 \,//\, R3} \ [V]$$

<Reference>

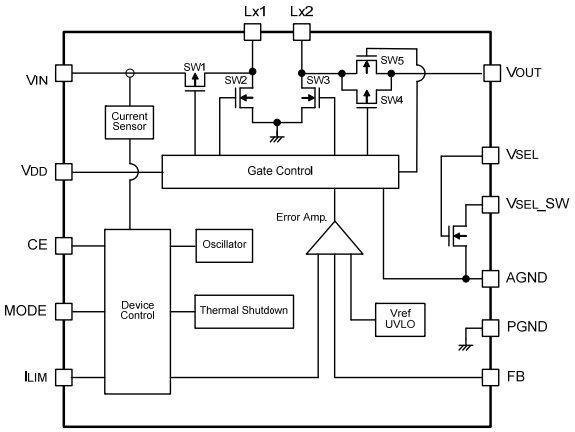
V_{OUT} [V]	R1 [Ω]	R2 [Ω]
2.5	620k	155k
3.0		124k
3.3		110.7k
3.7		96.9k
4.0		88.6k
4.5		77.5k
5.0		68.9k

■OPERATIONAL DESCRIPTION

This IC consists of a reference voltage (Vref), error amplifier, phase compensation circuit, MOSFET (SW1 to SW5), oscillator circuit, UVLO circuit, gate control circuit, current limiting circuit, and other components.

An internal PWM controller monitors the input/output voltage, and operation takes place in either step-up or step-down mode. The states of the MOSFET (SW1 to SW5) during operation are shown below.

	SW1	SW2	SW3	SW4	SW5
Step-Up	Fixed at ON	Fixed at OFF	Switching	Switching	Switching
Step-Down	Switching	Switching	Fixed at OFF	Fixed at ON	Fixed at ON



<Reference voltage source>
This is the reference voltage that keeps the output voltage of the IC stable.

<Oscillator>
The internal oscillator output a 5.8MHz (TYP.) clock signal to set a switching frequency.

<Error amp>
The error amp monitors the output voltage.The voltage divided by the internal R1 and R2 resistors is a feedback voltage for Error Amp. and compared to the reference voltage. The output voltage of the error amp becomes higher when the feedback voltage is higher than the reference voltage.

<UVLO>
To prevent unstable operation of the internal circuitry when the input voltage drops below 1.9V (TYP.), this function forcibly stops operation. When the input voltage rises above 2.0V (TYP.), switching operation takes place.

<Gate control circuit>
Controls ON/OFF of the MOSFET of SW1 to SW5.

<Soft-start>
XC9306B05G0R-G has the soft-start function to prevent rush current upon turning on of the power.
The startup time is approximately 0.1ms.

<Thermal Shutdown>
The over temperature protection circuit is built-in as a protection circuit. When junction temperature reaches +135°C, the over temperature protection circuit turns off MOSFET. Also, when the junction temperature falls to +110°C, this IC operates normally.

<Over current protection circuit>
The over current protection circuit detects peak value (ILpeak) of the inductor current flowing through the inductor from the internal MOSFET (SW1).

<PFM mode>
To improve efficiency when the load is light, the IC has PFM mode. This mode is enabled by setting the MODE pin to "Low" voltage. When in PFM mode, the mode will automatically change to PWM mode if the load current increases. The maximum output current of PFM mode is lower than PWM mode.

■NOTE ON USE

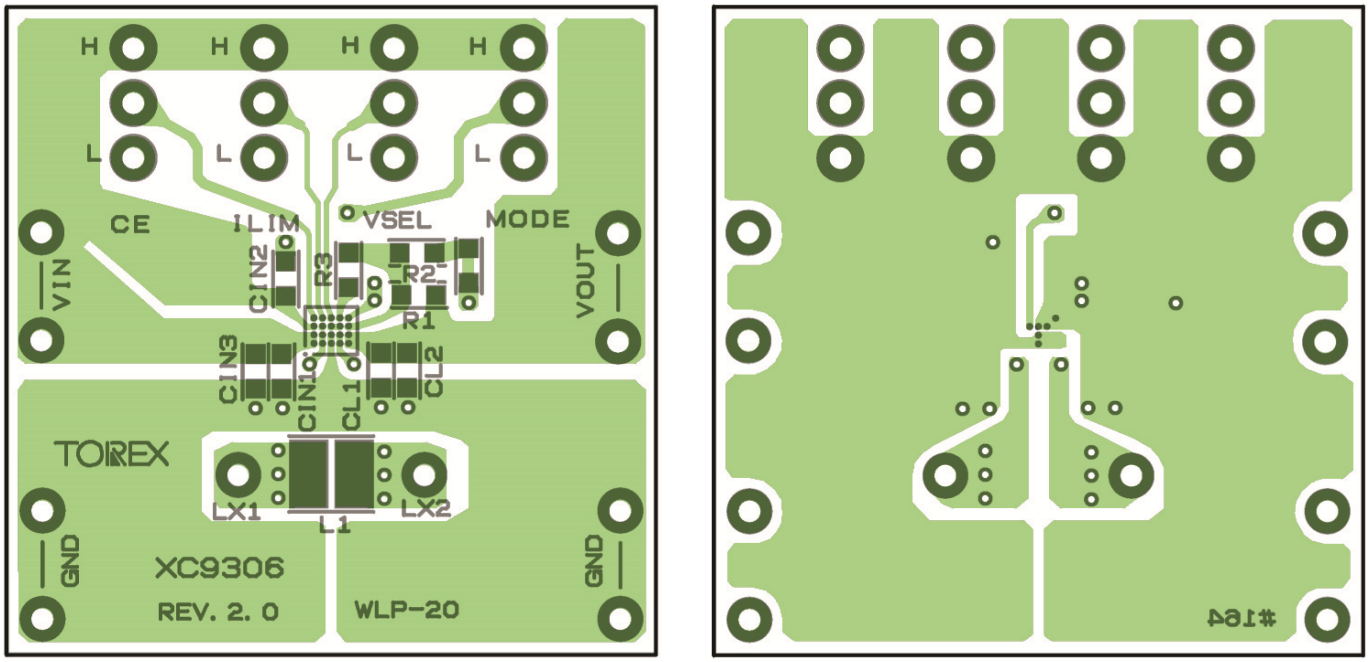
1) For the phenomenon of temporal and transitional voltage decrease or voltage increase, the IC may be damaged or deteriorated if IC is used beyond the absolute MAX. specifications.

2) The operation may become unstable due to noise and/or phase lag from the output current when the wire impedance is high.

3) Torex places an importance on improving our products and their reliability.We request that users incorporate fail-safe designs and post-aging protection treatment when using Torex products in their systems.

4) Instructions of pattern layouts
Please place the input capacitor (C_{IN}) and the output capacitor (C_L) as close to the IC as possible.
Route a large current flows, please wiring short in the surface layer.
The pattern on which the IC is mounted should be sufficiently large to allow the IC to dissipate heat.

<Reference pattern layout>



5) NOTES ON MOUNTING
In general, the underfill material and sealing method affect the reliability of mounting.
Spansion does not evaluate the mounting using the underfill material.
It is advisable for each customer to evaluate the mounting enough.

6) Handling cautions
The structure of the wafer-level CSP (WLP) is such that the silicon chip is exposed at the back and on the side of the package. Silicon is a hard and brittle substance. When handling, take care that the silicon is not subjected to mechanical shock. Silicon is also a conductor, and thus this should be taken into consideration when developing the design.

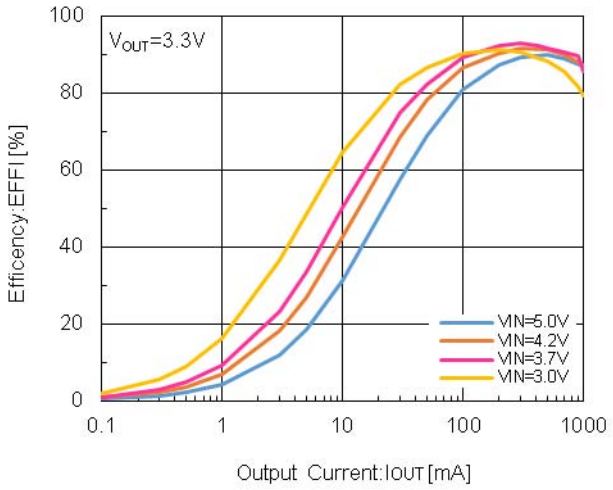
6)-1
Do not use metal tweezers or other sharp tool or jig to handle the product.
Use a tool such as suction-type tweezers with plastic or soft rubber tips.

6)-2
Take care that the silicon parts are not subjected to mechanical shock after mounting on the board.

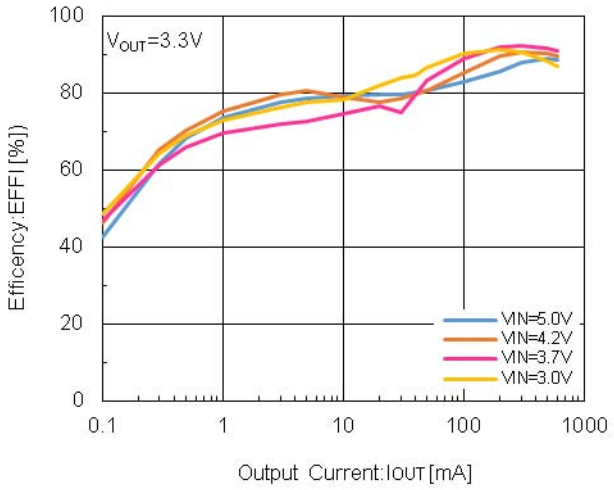
■TYPICAL PERFORMANCE CHARACTERISTICS

(1) Efficiency vs. Output Current

V_{OUT}=3.3V, PWM Mode

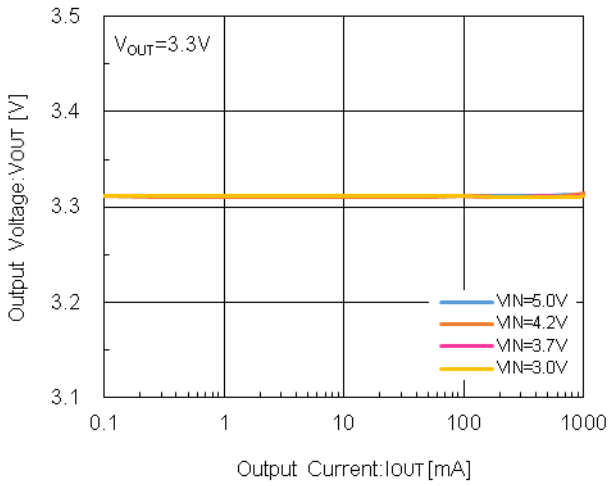


V_{OUT}=3.3V, PFM Mode (Power Save)

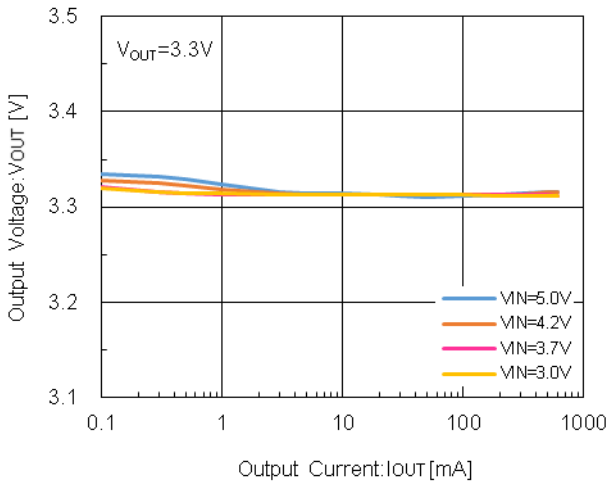


(2) Output Voltage vs. Output Current

V_{OUT}=3.3V, PWM Mode

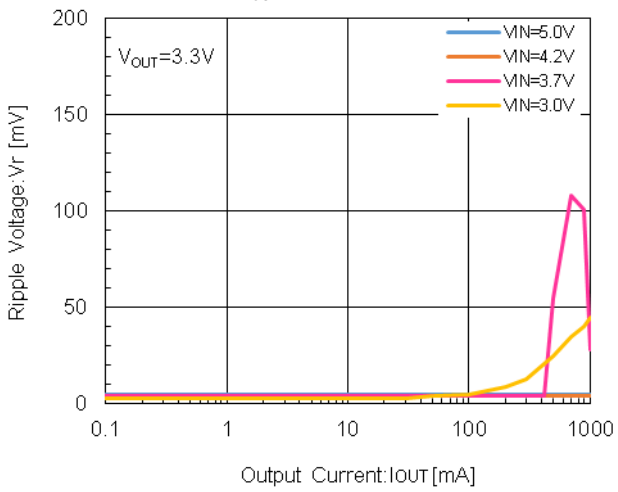


V_{OUT}=3.3V, PFM Mode (Power Save)

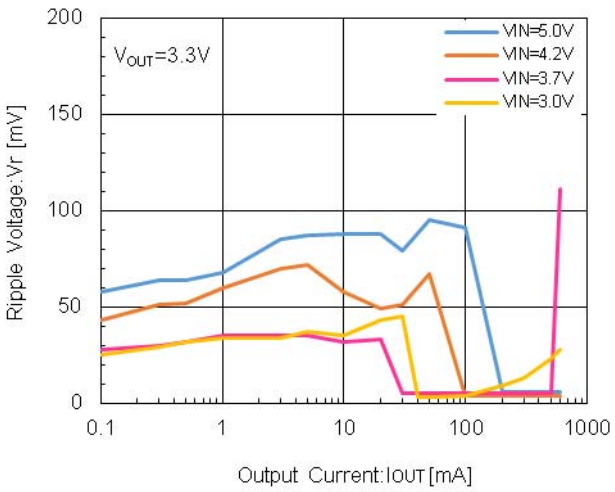


(3) Ripple Voltage vs. Output Current

V_{OUT}=3.3V, PWM Mode

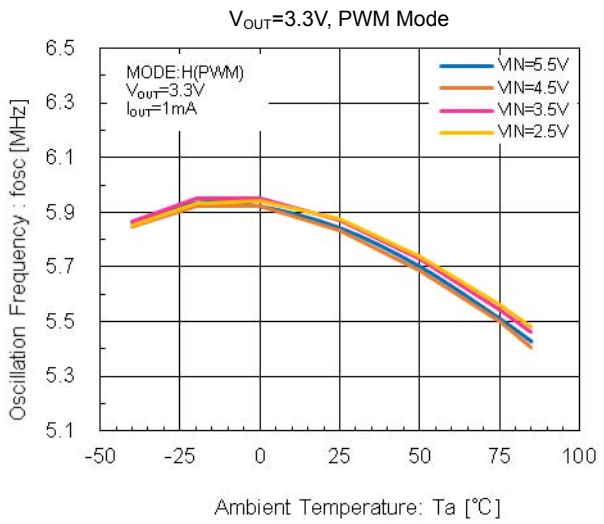


V_{OUT}=3.3V, PFM Mode (Power Save)

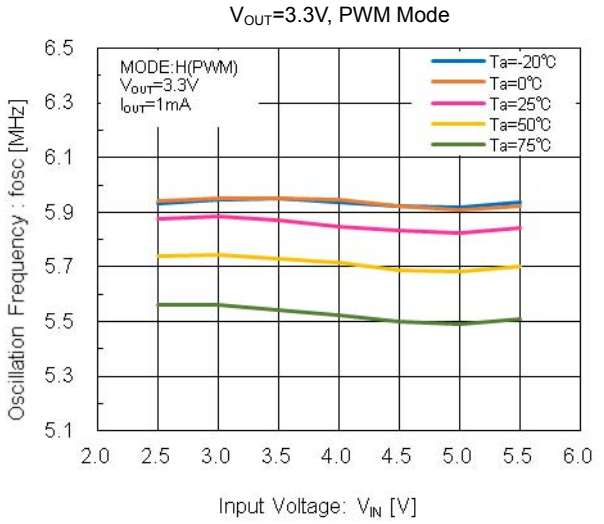


■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

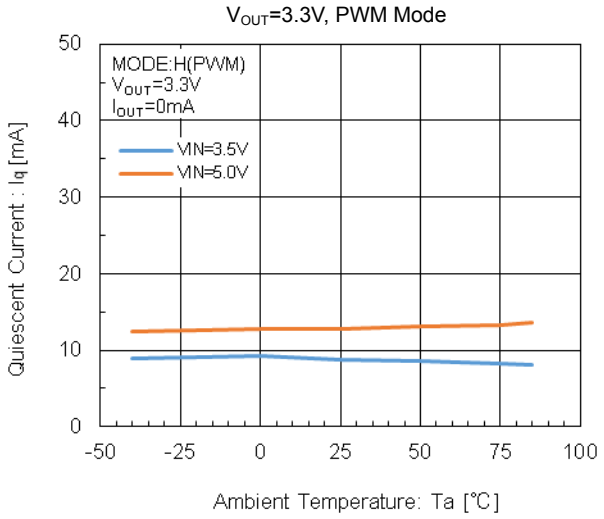
(4) Oscillation Frequency vs. Ambient Temperature

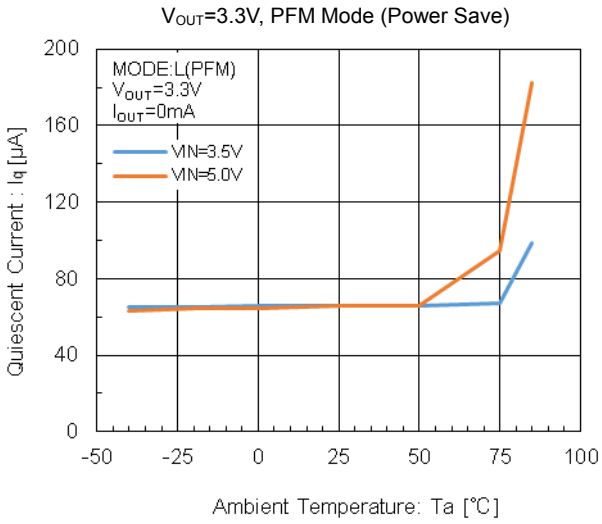


(5) Oscillation Frequency vs. Input Voltage

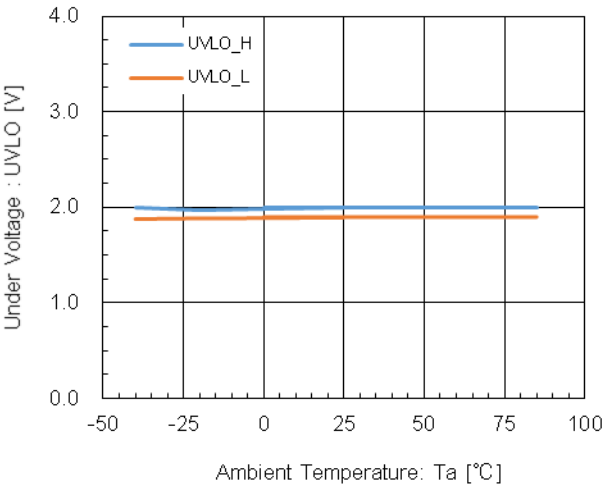


(6) Quiescent Current vs. Ambient Temperature

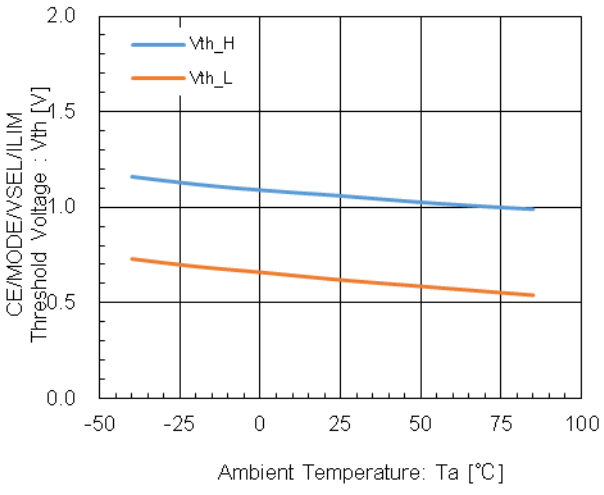




(7) UVLO Voltage vs. Ambient Temperature

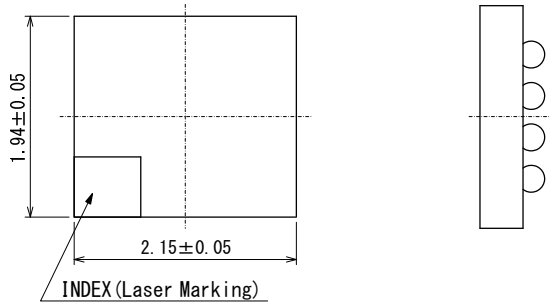


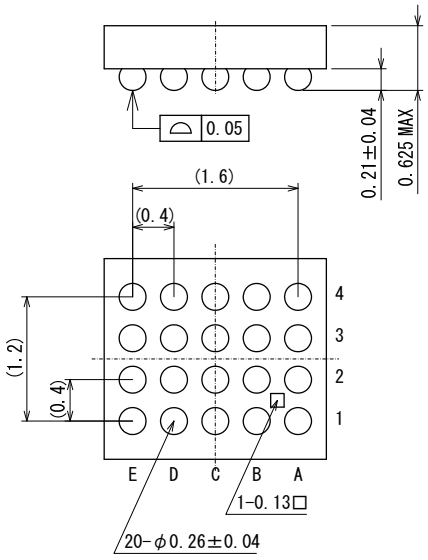
(8) CE/MODE/VSEL/ILIM Threshold Voltage vs. Ambient Temperature



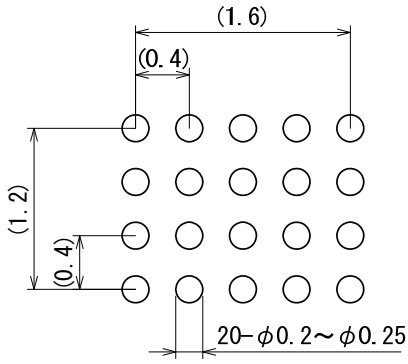
■PACKAGING INFORMATION

●WLP-20-01 (unit: mm)



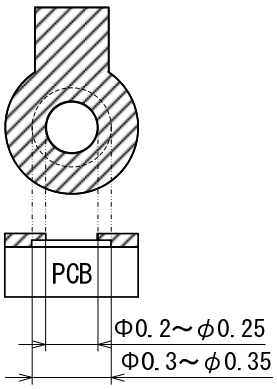


WLP-20-01 Recommended Pattern Layout (Reference)

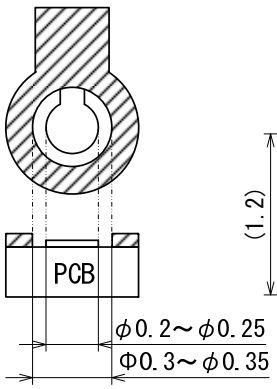


WLP-20-01 Recommended Pattern Layout detail (Reference)

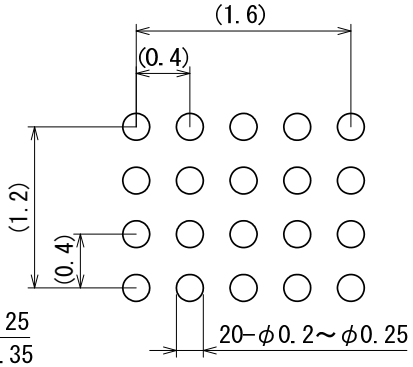
SMD(solder-mask-defined)



NSMD(nonsolder-mask-defined)



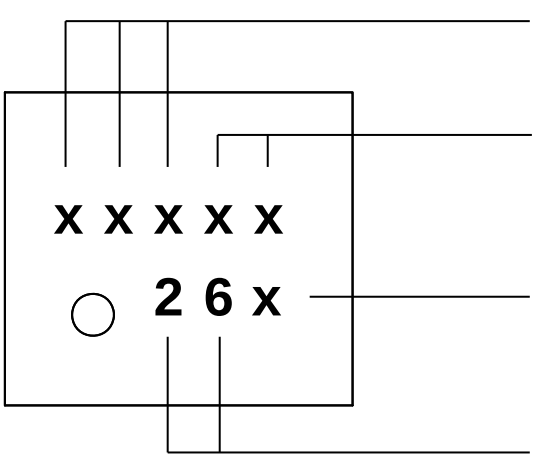
WLP-20-01 Recommended Metal Mask Design (Reference)





■MARKING RULE

WLP-20-01



Denotes of year and week code.

Denotes Reference No.

Denotes Control code.

Denotes XC9306B05G0R-G.

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