

## VIN = 2.5V to 5.5V 1.2A Synchronous DC-DC Step Down Regulator

### FEATURES

- Wide output voltage range : 1.15V to 2.80V
- Input voltage range : 2.5V to 5.5V
- Up to 1200mA Output Current
- Load transient response is fast
- Output current limit control of 1.8A to prevent Excessive current flows
- High efficiency over a wide load current area by DCM (discontinuous conductive mode) operation at light loads, CCM (continuous conductive mode) operation in heavy loads those two modes can be automatically switched
- Switching frequency of 2.6MHz during CCM.
- 100% duty operation when input voltage goes down to output voltage.
- 9 pin Wafer level chip size package (WLCSP Type)  
 Size : 1.46 × 1.46 mm ( 0.5 mm pitch)

### DESCRIPTION

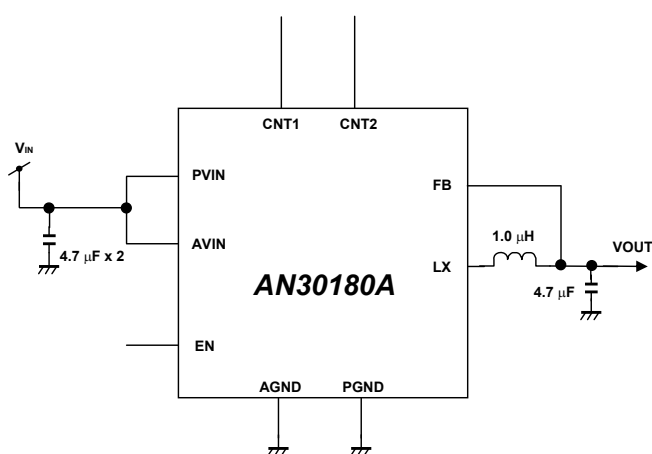
AN30180A is a synchronous DC-DC Step Down Regulator and employs the hysteretic control system. By this system, when load current charges suddenly, it responds at high speed and minimizes the changes of output voltage.

Since it is possible to use capacitors with small capacitance and it is unnecessary to add external parts for system phase compensation, this IC realizes downsizing of set and reducing in the number of external parts.

### APPLICATIONS

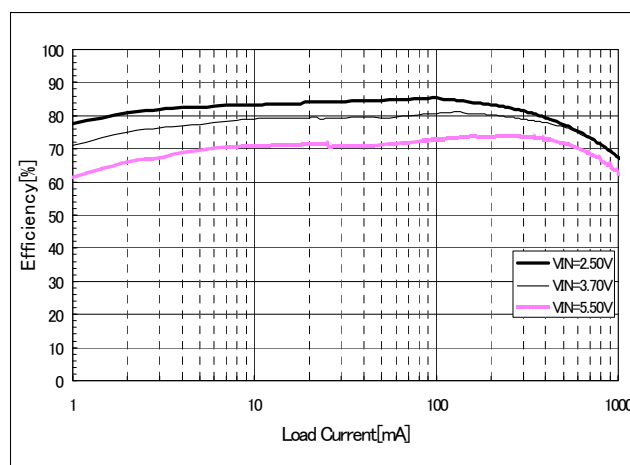
High Current Distributed Power Systems such as power amplifier in cellular phone etc.

### SIMPLIFIED APPLICATION



Notes) This application circuit is an example. The operation of mass production set is not guaranteed. You should perform enough evaluation and verification on the design of mass production set. You are fully responsible for the incorporation of the above application circuit and information in the design of your equipment.

### EFFICIENCY CURVE



Condition : VIN=2.5V , 3.7V , 5.5V , Vout=1.15V , Cout=4.7μF , Lout=1.0μH

**ABSOLUTE MAXIMUM RATINGS**

Parameter	Symbol	Rating	Unit	Notes
Supply voltage	$V_{IN}$	6.0	V	*1 *3
Operating free-air temperature	$T_{opr}$	- 30 to + 85	°C	*2
Operating junction temperature	$T_j$	- 40 to + 150	°C	*2
Storage temperature	$T_{stg}$	- 55 to + 150	°C	*2
Input Voltage Range	FB,EN,CTL1,CTL2	- 0.3 to ( $V_{IN} + 0.3$ )	V	*1 *3
Output Voltage Range	LX	- 0.3 to ( $V_{IN} + 0.3$ )	V	*1 *3
ESD	HBM (Human Body Model)	2	kV	-

Notes) Do not apply external currents and voltages to any pin not specifically mentioned.

This product may sustain permanent damage if subjected to conditions higher than the above stated absolute maximum rating. This rating is the maximum rating and device operating at this range is not guaranteeable as it is higher than our stated recommended operating range. When subjected under the absolute maximum rating for a long time, the reliability of the product may be affected.

\*1:The values under the condition not exceeding the above absolute maximum ratings and the power dissipation.

\*2:Except for the power dissipation, operating ambient temperature, and storage temperature, all ratings are for  $T_a = 25^{\circ}C$ .

\*3: $V_{IN}$  is voltage for AVIN, PVIN. AVIN = PVIN, ( $V_{IN} + 0.3$ ) V must not be exceeded 6 V.

**POWER DISSIPATION RATING**

PACKAGE	$\theta_{JA}$	PD( $T_a=25^{\circ}C$ )	PD( $T_a=85^{\circ}C$ )	Notes
9pin Wafer level chip size package (WLCSP Type)	436 °C /W	0.286 W	0.148 W	*1

Note). For the actual usage, please refer to the PD- $T_a$  characteristics diagram in the package specification, follow the power supply voltage, load and ambient temperature conditions to ensure that there is enough margin and the thermal design does not exceed the allowable value.

\*1:Glass Epoxy Substrate(4 Layers) [Glass-Epoxy: 50 X 50 X 0.8t(mm)]

Die Pad Exposed , Soldered.



**CAUTION**

Although this has limited built-in ESD protection circuit, but permanent damage may occur on it. Therefore, proper ESD precautions are recommended to avoid electrostatic damage to the MOS gates

**RECOMMENDED OPERATING CONDITIONS**

Parameter	Symbol	Min.	Typ.	Max.	Unit	Notes
Supply voltage range	$V_{IN}$	2.5	3.7	5.5	V	*1 *2
Input Voltage Range	FB	-0.3	—	$V_{IN} + 0.3$	V	*3
	EN	-0.3	—	$V_{IN} + 0.3$	V	*3
	CNT1	-0.3	—	$V_{IN} + 0.3$	V	*3
	CNT2	-0.3	—	$V_{IN} + 0.3$	V	*3
Output Voltage Range	LX	-0.3	—	$V_{IN} + 0.3$	V	*3

Note) Do not apply external currents and voltages to any pin not specifically mentioned.

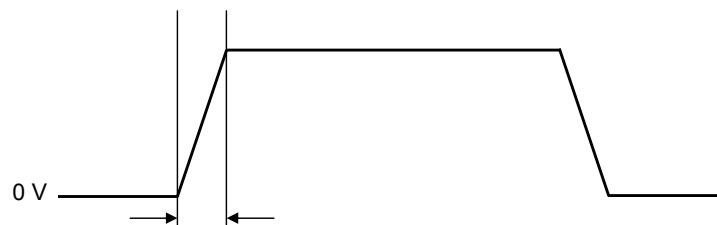
Voltage values, unless otherwise specified, are with respect to GND. GND is voltage for AGND, PGND. AGND = PGND  
 $V_{in}$  is voltage for AVIN, PVIN. AVIN = PVIN

\*1 : Please set the rising time of power input pin to the following range.

In addition, please input the voltage with the rising time which has margin enough in consideration of the variation in external parts.

\*2 : The values under the condition not exceeding the above absolute maximum ratings and the power dissipation.

\*3 :  $(V_{IN} + 0.3)$  V must not be exceeded 6 V.



$100 \mu\text{s} < T_r < 1.5 \text{ ms}$   
 ( $T_r$  is the rise time from 0 V to the setup voltage of  $V_{IN}$ .)

**ELECTRICAL CHARACTERISTICS**

Cout = 4.7 μF (Murata), Lout = 1.0 μH (FDK) , VOUT Setting = 1.15 V , VIN = AVIN = PVIN = 3.7 V,  
Ta = 25 °C ± 2 °C unless otherwise noted.

Parameter	Symbol	Conditions	Limits			Unit	Notes
			Min	Typ	Max		
<b>[Current Consumption] (DCDC step down regulator)</b>							
Current Consumption	IINQ	IOUT = 0A, VOUT = 1.15 V,	—	40	80	μA	—
OFF Current Consumption	ISTB	EN = L	—	0	1	μA	—
<b>[DCDC Characteristics] (DCDC step down regulator)</b>							
Output Voltage Setting 1	VOUT1	CNT1 = L , CNT2 = L IOUT = 600 mA	1.115	1.150	1.185	V	—
Output Voltage Setting 2	VOUT2	CNT1 = H , CNT2 = L IOUT = 600 mA	1.260	1.300	1.340	V	—
Output Voltage Setting 3	VOUT3	CNT1 = L , CNT2 = H IOUT = 600 mA	1.745	1.800	1.855	V	—
Output Voltage Setting 4	VOUT4	CNT1 = H , CNT2 = H IOUT = 600 mA	2.715	2.800	2.885	V	—
Line Regulation	REGIN	VIN = 2.5 V to 5.5 V, VOUT = 1.15 V IOUT = 600m A	—	0.25	0.75	% / V	—
Load Regulation	REGLD	VOUT = 1.15 V, IOUT = 10 μA to 1200 mA	—	3.3	5.8	%	—
Pch-MOS ON Resistance	RONP		—	0.2	0.4	Ω	—
Nch-MOS ON Resistance	RONN		—	0.2	0.4	Ω	—
SW Frequency	FSW	IOUT = 600 mA ( CCM )	2.0	2.6	3.2	MHz	—
Rising Time	TSTU	Load resistance = 12 Ω Settling time to reach 90 % of setting voltage from EN rising edge	—	—	120	μs	—
Output discharge resistance	RDIS	EN = L	—	10	20	Ω	—

**ELECTRICAL CHARACTERISTICS (Continued)**

Cout = 4.7 μF (Murata), Lout = 1.0 μH (FDK) , VOUT Setting = 1.15V , VIN = AVIN = PVIN = 3.7 V,  
Ta = 25 °C ± 2 °C unless otherwise noted.

Parameter	Symbol	Conditions	Limits			Unit	Notes
			Min	Typ	Max		
<b>[Logic Pin Characteristics] (DCDC step down regulator)</b>							
EN Control Voltage L	VENTL		—	—	0.3	V	—
EN Control Voltage H	VENTH		1.5	—	—	V	—
EN Leak Current	IENL	VIN = VEN = 5.5 V	-1	0	1	μA	—
CNT1 Control Voltage L	VCNT1 L		—	—	0.3	V	—
CNT1 Control Voltage H	VCNT1 H		VIN - 0.3	—	—	V	—
CNT1 Leak Current	ICNT1L	VIN = VCNT1 = 5.5 V	-1	0	1	μA	—
CNT2 Control Voltage L	VCNT2 L		—	—	0.3	V	—
CNT2 Control Voltage H	VCNT2 H		VIN - 0.3	—	—	V	—
CNT2 Leak Current	ICNT2L	VIN = VCNT2 = 5.5 V	-1	0	1	μA	—
<b>[Under Voltage Lock out] (DCDC step down regulator)</b>							
UVLO Detection Voltage	VUON	VIN rising to Start Operation	2.3	2.4	2.5	V	—
UVLO Hysteresis Voltage	VUHY		25	75	125	mV	—

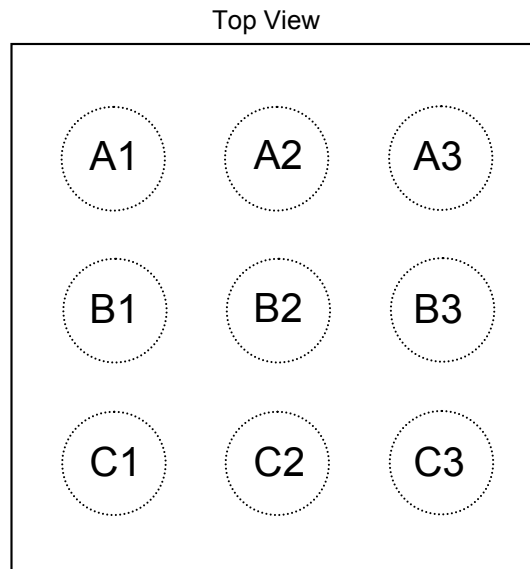
**ELECTRICAL CHARACTERISTICS (Continued)**

Cout = 4.7  $\mu$ F (Murata), Lout = 1.0  $\mu$ H (FDK) , VOUT Setting = 1.15V , VIN = AVIN = PVIN = 3.7 V,  
Ta = 25 °C  $\pm$  2 °C unless otherwise noted.

Parameter	Symbol	Conditions	Reference values			Unit	Notes
			Min	Typ	Max		
[DCDC] (DCDC step down regulator)							
Output current limit	ILMT	at VOUT drops from 1.15 V to 1.035 V CNT1 = L , CNT2 = L	—	1.8	—	A	*1
LX leak current	ILXL	VIN = 5.5 V, SHUTDOWN, VLX = 0 V or 5.5 V	—	0	—	$\mu$ A	*1
Efficiency 1	EF1	VOUT = 1.3 V, IOU = 200mA	—	82	—	%	*1
Output ripple voltage 1	VRPL1	VOUT = 1.15 V, IOU=600mA	—	5	—	mV[p-p]	*1
Output ripple voltage 2	VRPL2	VOUT = 1.15 V, IOU = 10 $\mu$ A	—	20	—	mV[p-p]	*1
Output voltage fluctuation during load increase	VLSU	C = 4.7 $\mu$ F, VOUT = 1.15 V, IOU = 10 $\mu$ A to 400 mA , $\Delta$ t = 1 $\mu$ s	—	25	—	mV	*1
Output voltage fluctuation during load decrease	VLSD	C = 4.7 $\mu$ F, VOUT = 1.15 V, IOU = 400 mA to 10 $\mu$ A, $\Delta$ t = 1 $\mu$ s	—	50	—	mV	*1
Stabilization time when increased load current	TLSU	VOUT = 1.15 V, IOU = 10 $\mu$ A to 400 mA, $\Delta$ t = 1 $\mu$ s	—	5	—	$\mu$ s	*1

\*1 : Typical Value checked by design.

## PIN CONFIGURATION

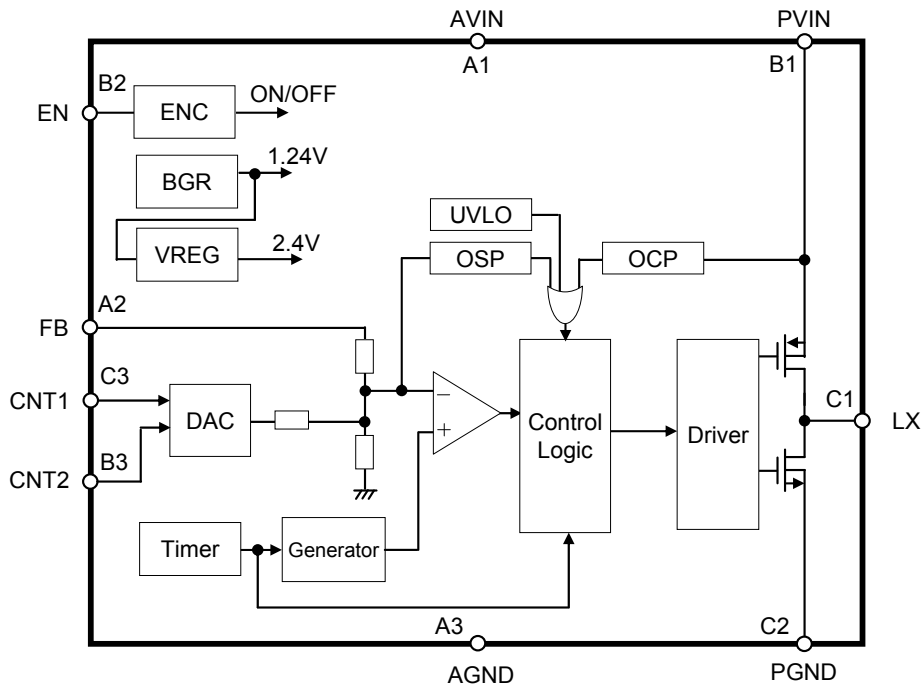


## PIN FUNCTION

Pin No.	Pin name	Type	Description
A1	AVIN	Power supply	Power supply pin
A2	FB	Input	Feed Back voltage pin
A3	AGND	Ground	Ground pin
B1	PVIN	Power supply	Power supply pin for internal Power MOS
B2	EN	Input	ON / OFF Control pin
B3	CNT2	Input	Output voltage control 2 pin
C1	LX	Output	LX Terminal Output
C2	PGND	Ground	Power Ground
C3	CNT1	Input	Output voltage control 1 pin

Notes) Concerning detail about pin description, please refer to OPERATION and APPLICATION INFORMATION section.

**FUNCTIONAL BLOCK DIAGRAM**



Notes) This block diagram is for explaining functions. Part of the block diagram may be omitted, or it may be simplified.

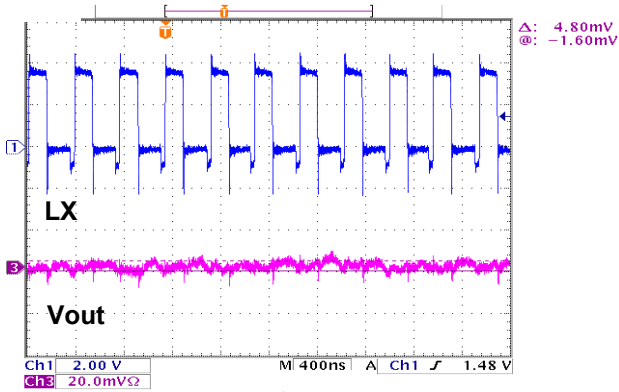


## TYPICAL CHARACTERISTICS CURVES

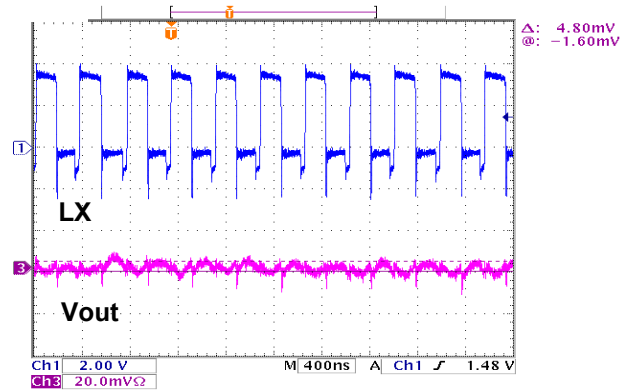
### (1) Output ripple voltage

VIN = 3.7 V, Vout = 1.15 V, Cout = 4.7  $\mu$ F, Lout = 1.0  $\mu$ H

Iout = 600 mA



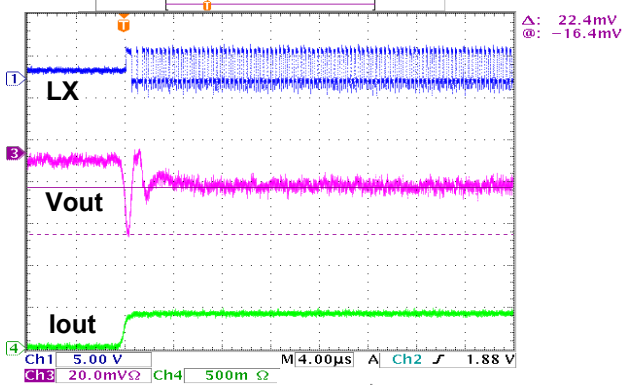
Iout = 1200 mA



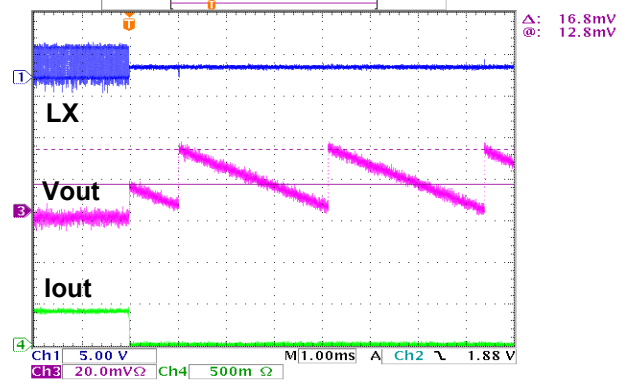
### (2) Load transient response

VIN = 3.7 V, Vout = 1.15 V, Cout = 4.7  $\mu$ F, Lout = 1.0  $\mu$ H

Iout = 10  $\mu$ A to 400 mA,  $\Delta t = 1 \mu$ sec



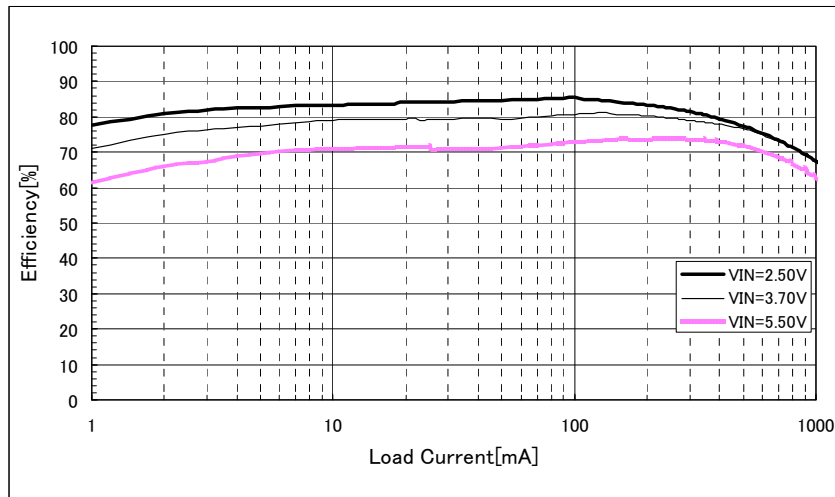
Iout = 400 mA to 10  $\mu$ A,  $\Delta t = 1 \mu$ sec



TYPICAL CHARACTERISTICS CURVES (Continued)

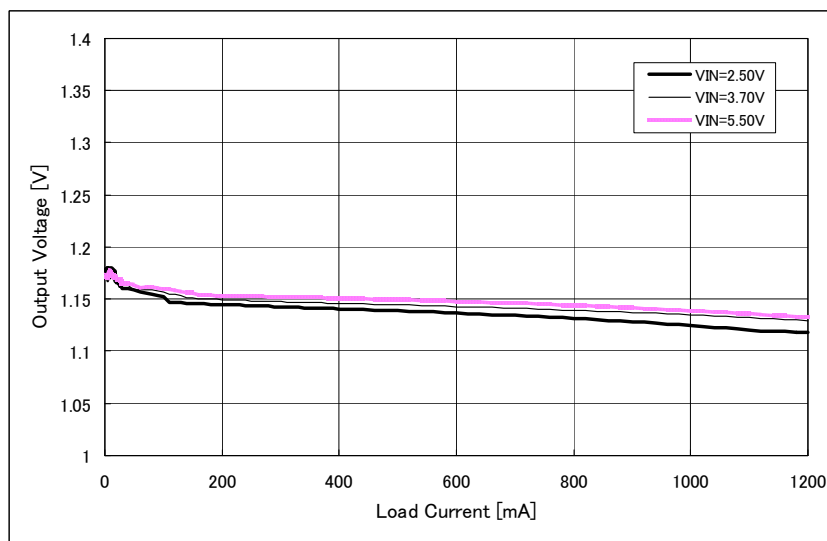
(3) Efficiency

VIN = 2.5 V or 3.7 V or 5.5 V , Vout = 1.15 V , Cout = 4.7  $\mu$ F , Lout = 1.0  $\mu$ H



(4) Load regulation

VIN = 2.5 V or 3.7 V or 5.5 V , Vout = 1.15 V , Cout = 4.7  $\mu$ F , Lout = 1.0  $\mu$ H



**OPERATION**

**1. Pin Setting**

Pin No.	Description	Pin Voltage		Remarks
		Low	High	
B2	ON/OFF Control For DC-DC	OFF	ON	

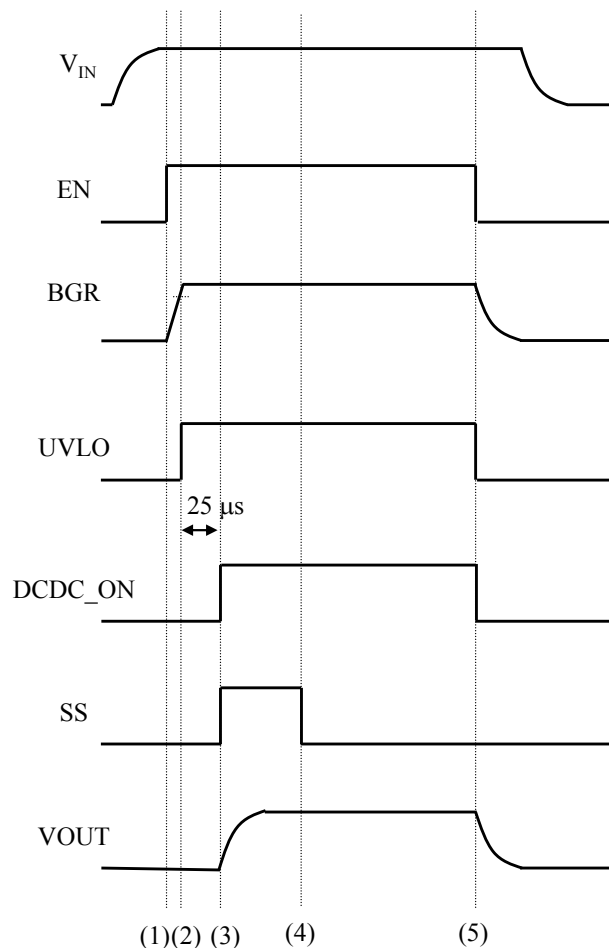
Pin No.	C3	B3	Output Voltage
Pin name	CNT1	CNT2	
Pin Voltage (*1)	Low	Low	1.15 V
	High	Low	1.30 V
	Low	High	1.80 V
	High	High	2.80 V

\*1 : If CNT1 , CNT2 is set to open, DCDC converter does not operate normally.

**OPERATION**

Note) The characteristics listed below are reference values derived from the design of the IC and are not guaranteed.

**1. Power ON / OFF sequence**



- (1) When the EN pin is set to "High" after the  $V_{IN}$  settles, the BGR start-up.
- (2) When the BGR exceeds its threshold value, the UVLO is released and the SS(SOFT START) sequence is enabled. During soft start the current limit of DC-DC Step Down Regulator is set to be lower than Normal current limit for preventing rush current. Internal circuit power supply is turned on and wait for the time determined by internal timer.
- (3) DCDC\_ON is turned on then DC-DC Step Down Regulator is enabled. VOUT is risen up to reaches the set voltage.
- (4) After a Soft start timer current limit is set to be Normal current limit.
- (5) When the EN pin is set to "Low", the BGR and UVLO stop operation. The VOUT pin voltage starts to drop by output discharge resistor and load resistance.

**2. Protection**

Output Over-Current Protection (OCP) function and Short-Circuit Protection (OSP) function

- (1) The Over-Current Protection is activated at about 1.8 A (Typ.). During the OCP, the output voltage continues to drop at the specified current.
- (2) The Short-Circuit Protection function is implemented when the output voltage decreases and the VFB pin reaches to about 70 % of the output voltage setting.
- (3) The OSP operates intermittently at 2ms-ON, 16ms-OFF intervals.

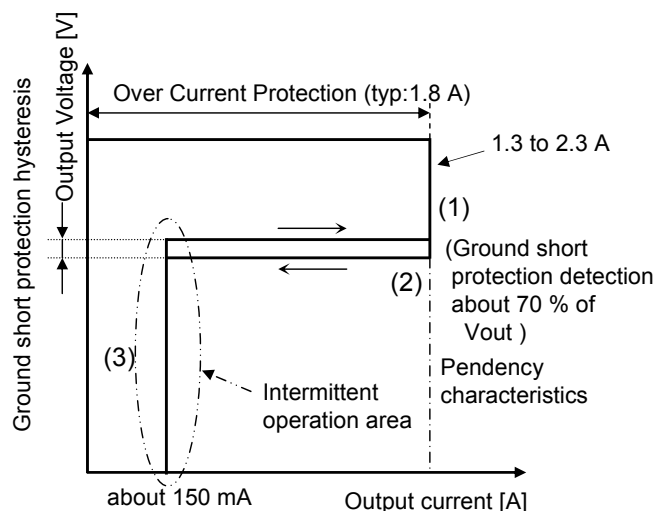
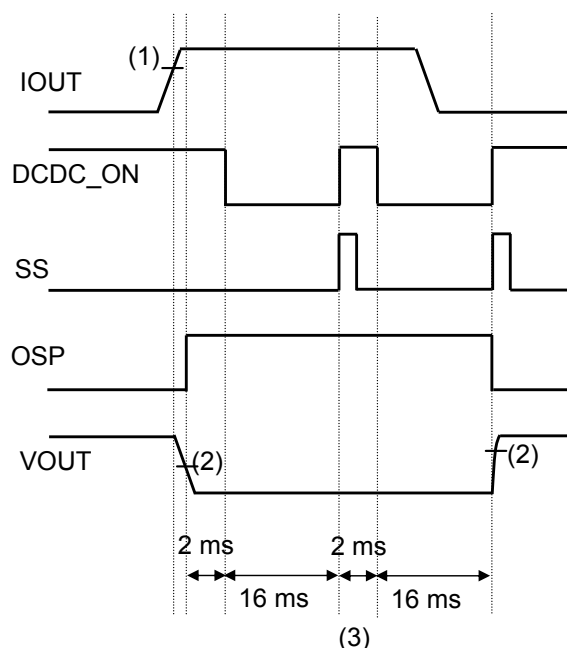
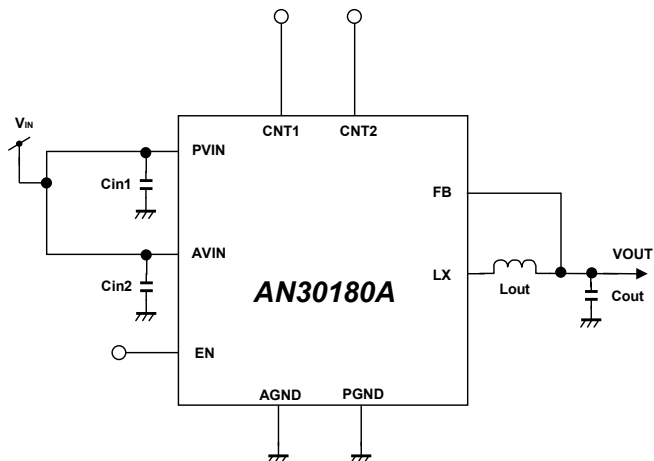


Figure : OCP and OSP Operation



**APPLICATIONS INFORMATION**

**1. Application circuit**



**2. Recommended component**

Reference Designator	QTY	Value	Manufacturer	Part Number	Note
Cin1	1	4.7 $\mu$ F	Murata	GRM21BB31E475KA75B	—
Cin2	1	4.7 $\mu$ F	Murata	GRM21BB31E475KA75B	—
Cout	1	4.7 $\mu$ F	Murata	GRM21BB31E475KA75B	—
Lout	1	1.0 $\mu$ H	FDK	MIPSZ2012D1R0	—

**3. Evaluation board layout**

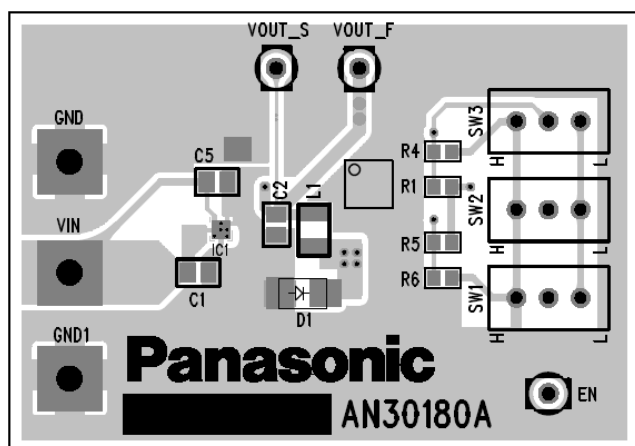


Figure Top Layer with silk screen  
 ( Top View ) with Evaluation board

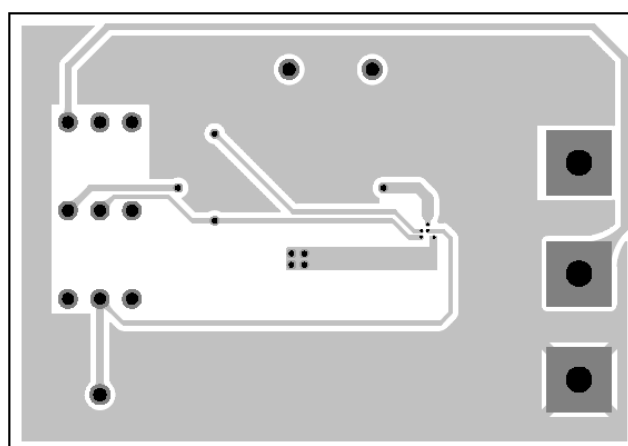


Figure Bottom Layer with silk screen  
 ( Bottom View ) with Evaluation board

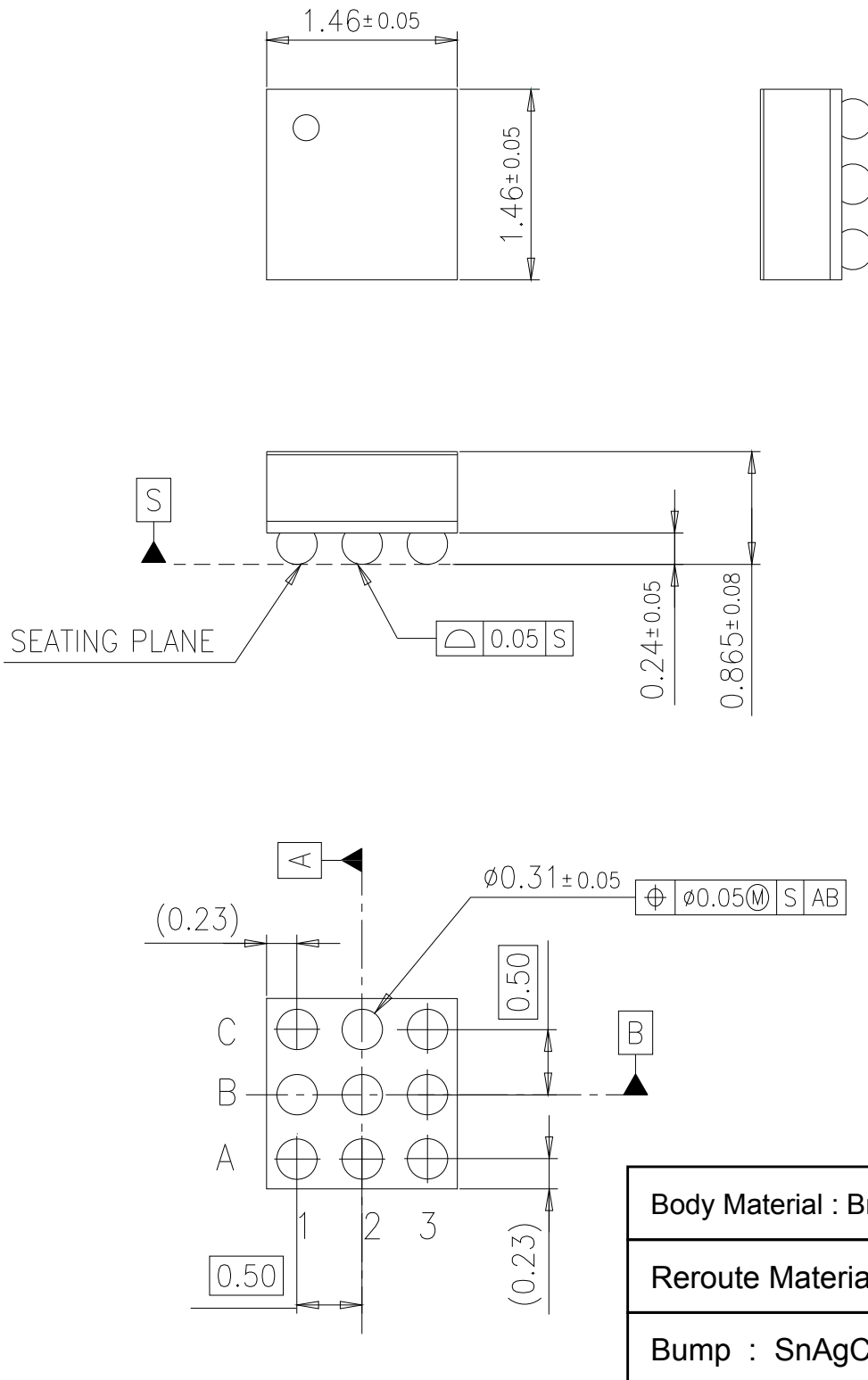
Notes) This application circuit and layout is an example. The operation of mass production set is not guaranteed. You should perform enough evaluation and verification on the design of mass production set. You are fully responsible for the incorporation of the above application circuit and information in the design of your equipment.

**PACKAGE INFORMATION (Reference Data)**

Outline Drawing

Package Code : UBGA009-W-1515AEL

Unit:mm



### IMPORTANT NOTICE

1. When using the IC for new models, verify the safety including the long-term reliability for each product.
2. When the application system is designed by using this IC, please confirm the notes in this book.  
Please read the notes to descriptions and the usage notes in the book.
3. This IC is intended to be used for general electronic equipment.  
Consult our sales staff in advance for information on the following applications: Special applications in which exceptional quality and reliability are required, or if the failure or malfunction of this IC may directly jeopardize life or harm the human body.  
Any applications other than the standard applications intended.
  - (1) Space appliance (such as artificial satellite, and rocket)
  - (2) Traffic control equipment (such as for automotive, airplane, train, and ship)
  - (3) Medical equipment for life support
  - (4) Submarine transponder
  - (5) Control equipment for power plant
  - (6) Disaster prevention and security device
  - (7) Weapon
  - (8) Others : Applications of which reliability equivalent to (1) to (7) is requiredOur company shall not be held responsible for any damage incurred as a result of or in connection with the IC being used for any special application, unless our company agrees to the use of such special application.  
However, for the IC which we designate as products for automotive use, it is possible to be used for automotive.
4. This IC is neither designed nor intended for use in automotive applications or environments unless the IC is designated by our company to be used in automotive applications.  
Our company shall not be held responsible for any damage incurred by customers or any third party as a result of or in connection with the IC being used in automotive application, unless our company agrees to such application in this book.
5. Please use this IC in compliance with all applicable laws and regulations that regulate the inclusion or use of controlled substances, including without limitation, the EU RoHS Directive. Our company shall not be held responsible for any damage incurred as a result of our IC being used by our customers, not complying with the applicable laws and regulations.
6. Pay attention to the direction of the IC. When mounting it in the wrong direction onto the PCB (printed-circuit-board), it might be damaged.
7. Pay attention in the PCB (printed-circuit-board) pattern layout in order to prevent damage due to short circuit between pins. In addition, refer to the Pin Description for the pin configuration.
8. Perform visual inspection on the PCB before applying power, otherwise damage might happen due to problems such as solder-bridge between the pins of the IC. Also, perform full technical verification on the assembly quality, because the same damage possibly can happen due to conductive substances, such as solder ball, that adhere to the IC during transportation.
9. Take notice in the use of this IC that it might be damaged when an abnormal state occurs such as output pin-VCC short (Power supply fault), output pin-GND short (Ground fault), or output-to-output-pin short (load short). Safety measures such as installation of fuses are recommended because the extent of the above-mentioned damage will depend on the current capability of the power supply.
10. The protection circuit is for maintaining safety against abnormal operation. Therefore, the protection circuit should not work during normal operation.  
Especially for the thermal protection circuit, if the area of safe operation or the absolute maximum rating is momentarily exceeded due to output pin to VCC short (Power supply fault), or output pin to GND short (Ground fault), the IC might be damaged before the thermal protection circuit could operate.
11. Unless specified in the product specifications, make sure that negative voltage or excessive voltage are not applied to the pins because the IC might be damaged, which could happen due to negative voltage or excessive voltage generated during the ON and OFF timing when the inductive load of a motor coil or actuator coils of optical pick-up is being driven.
12. Product which has specified ASO (Area of Safe Operation) should be operated in ASO
13. Verify the risks which might be caused by the malfunctions of external components.
14. Due to the unshielded structure of this IC, functions and characteristics of the IC cannot be guaranteed under the exposure of light. During normal operation or even under testing condition, please ensure that the IC is not exposed to light.
15. Please ensure that your design does not have metal shield parts touching the chip surface as the surface potential is GND voltage.

## Request for your special attention and precautions in using the technical information and semiconductors described in this book

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- (4) The products and product specifications described in this book are subject to change without notice for modification and/or improvement. At the final stage of your design, purchasing, or use of the products, therefore, ask for the most up-to-date Product Standards in advance to make sure that the latest specifications satisfy your requirements.
- (5) When designing your equipment, comply with the range of absolute maximum rating and the guaranteed operating conditions (operating power supply voltage and operating environment etc.). Especially, please be careful not to exceed the range of absolute maximum rating on the transient state, such as power-on, power-off and mode-switching. Otherwise, we will not be liable for any defect which may arise later in your equipment.  
Even when the products are used within the guaranteed values, take into the consideration of incidence of break down and failure mode, possible to occur to semiconductor products. Measures on the systems such as redundant design, arresting the spread of fire or preventing glitch are recommended in order to prevent physical injury, fire, social damages, for example, by using the products.
- (6) Comply with the instructions for use in order to prevent breakdown and characteristics change due to external factors (ESD, EOS, thermal stress and mechanical stress) at the time of handling, mounting or at customer's process. When using products for which damp-proof packing is required, satisfy the conditions, such as shelf life and the elapsed time since first opening the packages.
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