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AN30180AA

1.2 A Synchronous DC-DC Step Down Regulator
(V_{IN} = 2.5 V to 5.5 V, V_{OUT} = 1.20 V to 3.30 V)

FEATURES

- Wide output voltage range : 1.20 V to 3.30 V
- Input voltage range : 2.5 V to 5.5 V
- Maximum Output Current : 1.2 A
- Load transient response is fast
- Output current limit control of 1.8 A 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 2.6 MHz during CCM.
- 100 % duty operation when input voltage goes down to output voltage.
- Built-in Under Voltage Lockout (UVLO), Thermal Shut Down (TSD), Over Current Protection (OCP), Short Circuit Protection (SCP)
- 9 pin Wafer level chip size package (WLCSP) Size : 1.46mm × 1.46 mm (0.5 mm pitch)

DESCRIPTION

AN30180AA 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.
Output voltage is adjustable by control pin.
Maximum current is 1.2 A.

APPLICATIONS

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

SIMPLIFIED APPLICATION
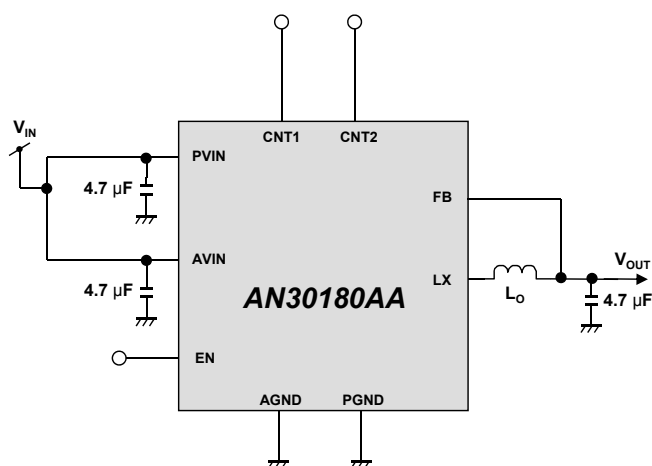
Note : The application circuit is an example. The operation of the mass production set is not guaranteed. Sufficient evaluation and verification is required in the design of the mass production set. The Customer is fully responsible for the incorporation of the above illustrated application circuit in the design of the equipment.

EFFICIENCY CURVE
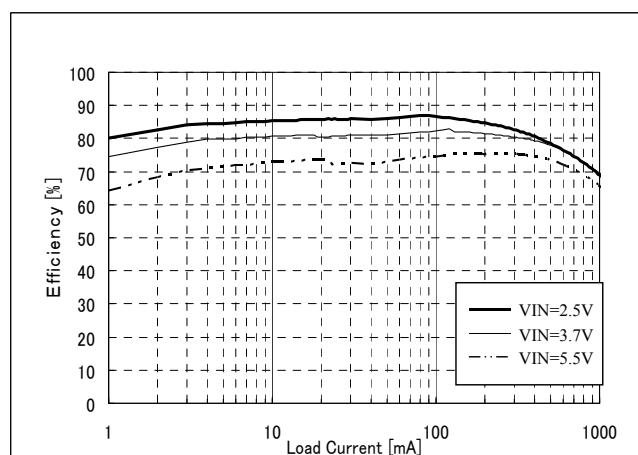
Condition :
   V_{IN} = 2.5 V, 3.7 V, 5.5 V, V_{OUT} = 1.20 V
   C_{OUT} = 4.7µF , L_{OUT} = 1.0 µH

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ORDERING INFORMATION

Order Number	Feature	Package	Output Supply
AN30180AA-PR	Maximum Output Current : 1.2 A	9 pin WLCSP	Emboss Taping

ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol	Rating	Unit	Notes
Supply voltage	V_{IN}	6.0	V	*1
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	V_{FB}, V_{EN}, V_{CTL1}, V_{CTL2}	– 0.3 to (V_{IN} + 0.3)	V	*1 *3
Output Voltage Range	V_{LX}	– 0.3 to (V_{IN} + 0.3)	V	*1 *3
ESD	HBM	2	kV	

Notes : 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 guaranteed 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.
V_{IN} is voltage for AVIN, PVIN. $V_{IN} = AV_{IN} = PV_{IN}$.
Do not apply external currents and voltages to any pin not specifically mentioned.
*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 °C.
*3 : (V_{IN} + 0.3) V must not exceed 6 V.

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POWER DISSIPATION RATING

PACKAGE	θ_{JA}	PD(Ta=25°C)	PD(Ta=85°C)	Notes
9 pin 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-Ta 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	V_{FB}	– 0.3	—	V_{IN} + 0.3	V	*3
	V_{EN}	– 0.3	—	V_{IN} + 0.3	V	*3
	V_{CNT1}	– 0.3	—	V_{IN} + 0.3	V	*3
	V_{CNT2}	– 0.3	—	V_{IN} + 0.3	V	*3
Output Voltage Range	V_{LX}	– 0.3	—	V_{IN} + 0.3	V	*3

Note : Do not apply external currents and voltages to any pin not specifically mentioned.
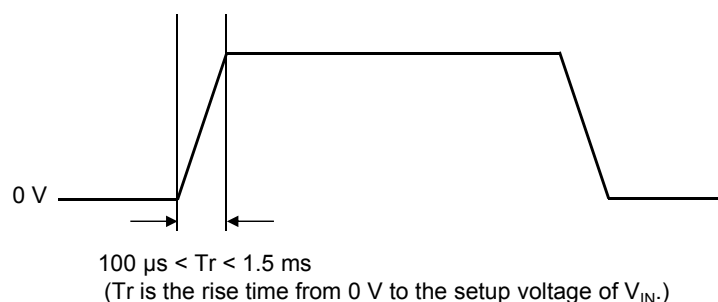   Voltage values, unless otherwise specified, are with respect to GND. GND is voltage for AGND, PGND. AGND = PGND
    Vin is voltage for AVIN, PVIN. V_{IN} = AV_{IN} = PV_{IN}
   *1 : Please set the rising time of power input pin to the following range.
     In addition, please input the voltage with the 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.

0 V

100 μs < Tr < 1.5 ms
(Tr is the rise time from 0 V to the setup voltage of V_{IN}.)

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ELECTRICAL CHARACTERISTICS

C_{OUT} = 4.7 µF, L_{OUT} = 1.0 µH, V_{OUT} Setting = 1.20 V , V_{IN} = AV_{IN} = PV_{IN} = 3.7 V,
T_a = 25 °C $\pm$ 2 °C unless otherwise noted.

Parameter	Symbol	Conditions	Limits			Unit	Notes
			Min	Typ	Max		
Current Consumption							
Current Consumption	I_{INQ}	I_{OUT} = 0 A, V_{OUT} = 1.20 V	—	40	80	µA	—
OFF Current Consumption	I_{STB}	EN = "L"	—	0	1	µA	—
DC-DC Characteristics							
Output Voltage Setting 1	V_{OUT1}	CNT1 = "L", CNT2 = "L", I_{OUT} = 600 mA	1.164	1.200	1.236	V	—
Output Voltage Setting 2	V_{OUT2}	CNT1 = "H", CNT2 = "L", I_{OUT} = 600 mA	1.310	1.350	1.390	V	—
Output Voltage Setting 3	V_{OUT3}	CNT1 = "L" , CNT2 = "H", I_{OUT} = 600 mA	1.790	1.850	1.910	V	—
Output Voltage Setting 4	V_{OUT4}	CNT1 = "H" , CNT2 = "H", I_{OUT} = 600 mA	3.200	3.300	3.400	V	—
Line Regulation	REGIN	V_{IN} = 2.5 V to 5.5 V, V_{OUT} = 1.20 V, I_{OUT} = 600 mA	—	0.25	0.75	% / V	—
Load Regulation	REGLD	V_{OUT} = 1.20 V, I_{OUT} = 10 µA to 1.2 A	—	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	I_{OUT} = 600mA (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	—

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ELECTRICAL CHARACTERISTICS (Continued)

C_{OUT} = 4.7 μF, L_{OUT} = 1.0 μH, V_{OUT} Setting = 1.20 V, V_{IN} = AV_{IN} = PV_{IN} = 3.7 V,
T_a = 25 °C ± 2 °C unless otherwise noted.

Parameter	Symbol	Conditions	Limits			Unit	Notes
			Min	Typ	Max		
Logic Pin Characteristics							
EN Control Voltage L	VENTL	—	—	—	0.3	V	—
EN Control Voltage H	VENTH	—	1.5	—	—	V	—
EN Leak Current	IENL	V_{IN} = V_{EN} = 5.5 V	− 1	0	1	μA	—
CNT1 Control Voltage L	VCNT1L	—	—	—	0.3	V	—
CNT1 Control Voltage H	VCNT1H	—	V_{IN} − 0.3	—	—	V	—
CNT1 Leak Current	ICNT1L	V_{IN} = V_{CNT1} = 5.5 V	− 1	0	1	μA	—
CNT2 Control Voltage L	VCNT2L	—	—	—	0.3	V	—
CNT2 Control Voltage H	VCNT2H	—	V_{IN} − 0.3	—	—	V	—
CNT2 Leak Current	ICNT2L	V_{IN} = V_{CNT2} = 5.5 V	− 1	0	1	μA	—
Under Voltage Lock out (UVLO)							
UVLO Detection Voltage	VUON	V_{IN} rising to Start Operation	2.3	2.4	2.5	V	—
UVLO Hysteresis Voltage	VUHY	—	25	75	125	mV	—

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ELECTRICAL CHARACTERISTICS (Continued)

C_{OUT} = 4.7 µF, L_{OUT} = 1.0 µH, V_{OUT} Setting = 1.20 V, V_{IN} = AV_{IN} = PV_{IN} = 3.7 V,
T_a = 25 °C $\pm$ 2 °C unless otherwise noted.

Parameter	Symbol	Conditions	Reference values			Unit	Notes
			Min	Typ	Max		
DC-DC Characteristics							
Output current limit	ILMT	at V_{OUT} drops from 1.20 V to 1.08 V, CNT1 = "L", CNT2 = "L"	—	1.8	—	A	*1
LX leak current	ILXL	V_{IN} = 5.5 V, Shutdown, V_{LX} = 0 V or 5.5 V	—	0	—	µA	*1
Efficiency 1	EF1	V_{OUT} = 1.35 V, I_{OUT} = 200 mA	—	82	—	%	*1
Output ripple voltage 1	VRPL1	V_{OUT} = 1.20 V, I_{OUT} = 600 mA	—	5	—	mV [p-p]	*1
Output ripple voltage 2	VRPL2	V_{OUT} = 1.20 V, I_{OUT} = 10 mA	—	20	—	mV [p-p]	*1
Load transient response 1	VLSU	C_{OUT} = 4.7 µF, V_{OUT} = 1.20 V, I_{OUT} = 10 µA to 400 mA , Δ t = 1 µs	—	25	—	mV	*1
Load transient response 2	VLSD	C_{OUT} = 4.7 µF, V_{OUT} = 1.20 V, I_{OUT} = 400 mA to 10 µA, Δ t = 1 µs	—	50	—	mV	*1
Stabilization time when increased load current	TLSU	V_{OUT} = 1.20 V, I_{OUT} = 10 µA to 400 mA, Δ t = 1 µs	—	5	—	µs	*1

Note :   *1 : Typical design value

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PIN CONFIGURATION

Top View
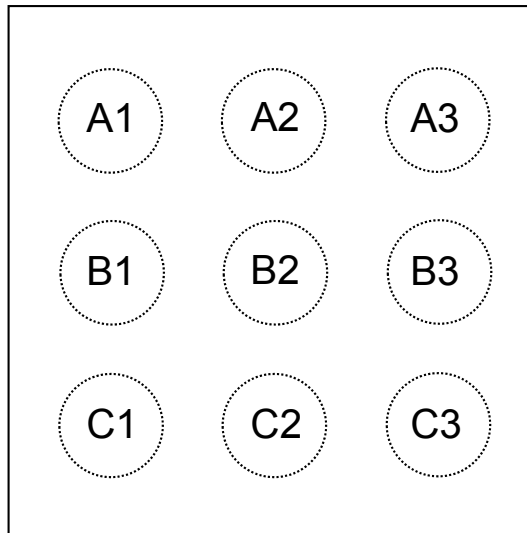
PIN FUNCTION

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

Note : Detailed pin descriptions are provided in the OPERATION and APPLICATION INFORMATION section.

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FUNCTIONAL BLOCK DIAGRAM
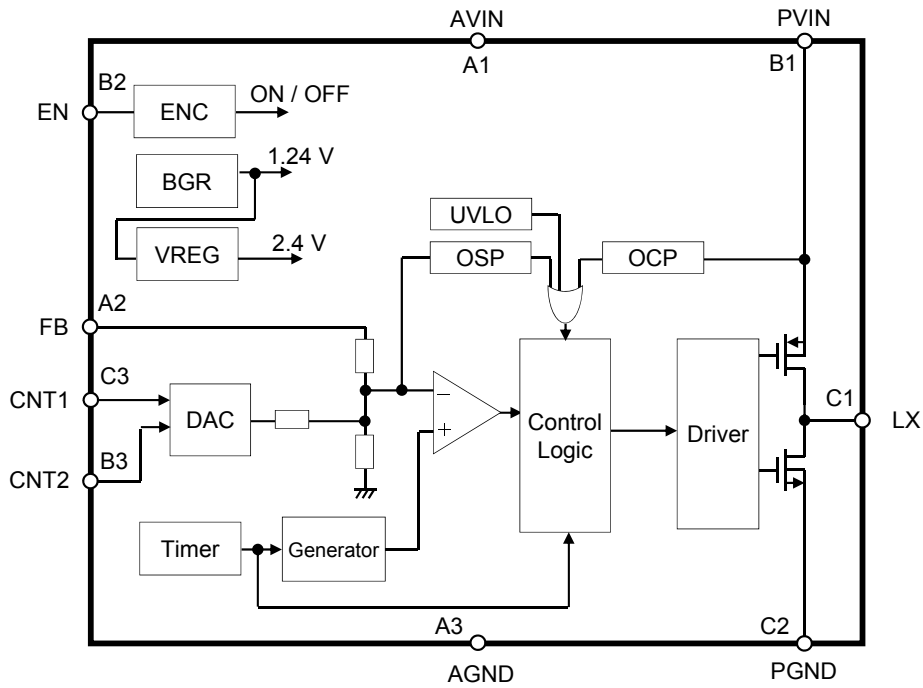
Note : This block diagram is for explaining functions. Part of the block diagram may be omitted, or it may be simplified.

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TYPICAL CHARACTERISTICS CURVES

1. Output ripple voltage

V_{IN} = 3.7 V, V_{OUT} = 1.20 V, C_{OUT} = 4.7 μF, L_{OUT} = 1.0 μH

I_{OUT} = 600 mA
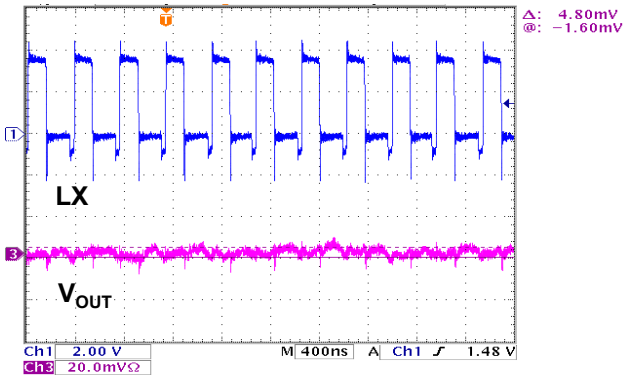
I_{OUT} = 1200 mA
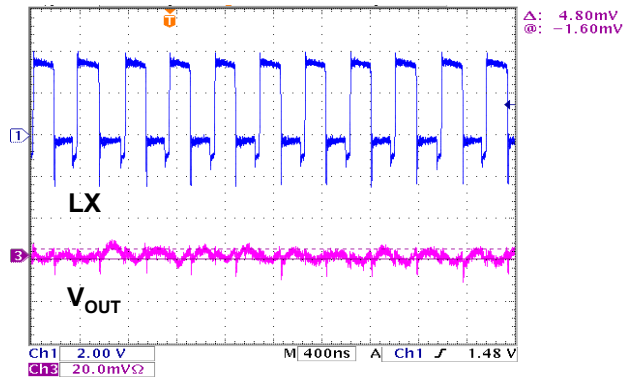
2. Load transient response

V_{IN} = 3.7 V, V_{OUT} = 1.20 V , C_{OUT} = 4.7 μF , L_{OUT} = 1.0 μH

I_{OUT} = 10 μA to 400 mA, Δ t = 1 μs

I_{OUT} = 400 mA to 10 μA, Δ t = 1 μs

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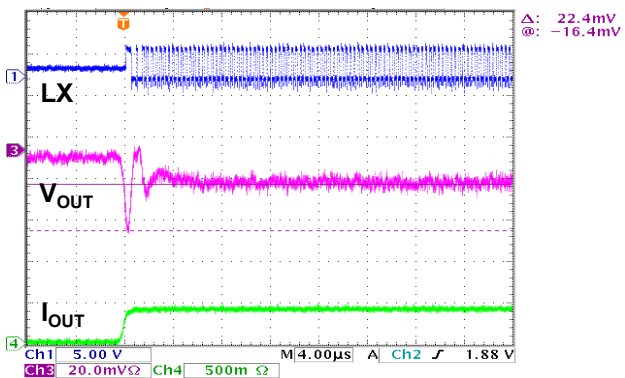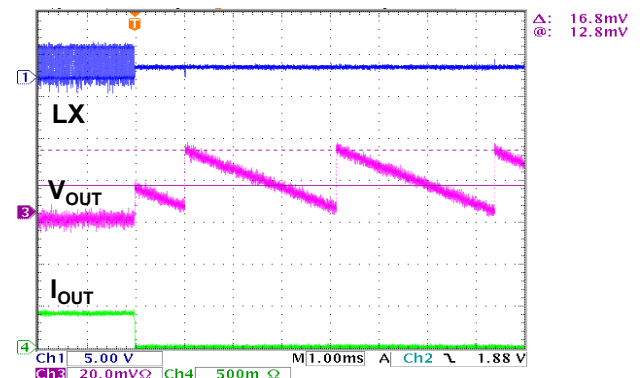
TYPICAL CHARACTERISTICS CURVES (Continued)

3. Efficiency

V_{IN} = 2.5 V, 3.7 V, 5.5 V, V_{OUT} = 1.20 V, C_{OUT} = 4.7 µF, L_{OUT} = 1.0 µH
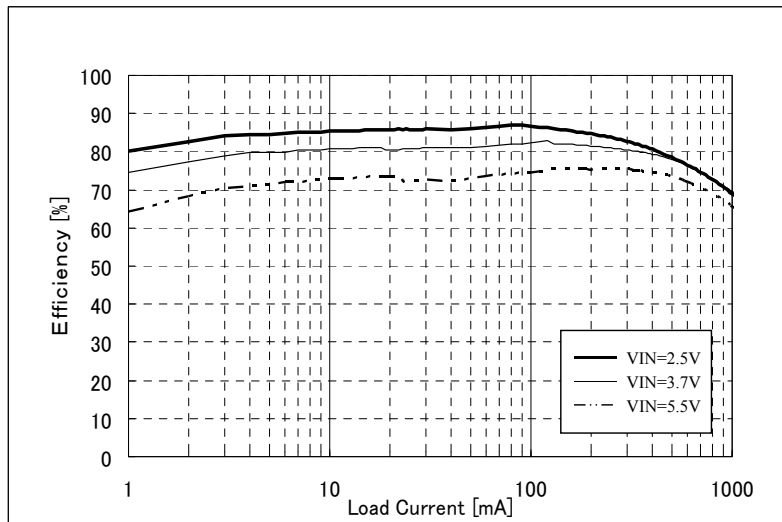
4. Load regulation

V_{IN} = 2.5 V, 3.7 V, 5.5 V, V_{OUT} = 1.20 V, C_{OUT} = 4.7 µF, L_{OUT} = 1.0 µH

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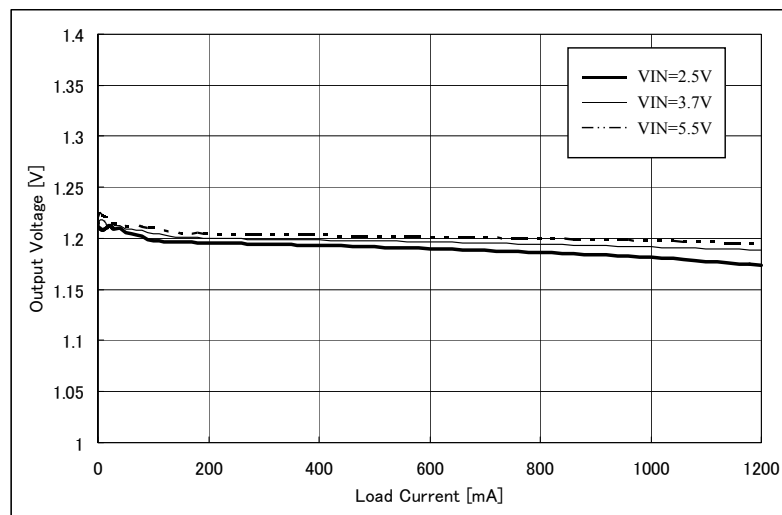
OPERATION

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	
	Low	Low	1.20 V
Pin Voltage (*1)	High	Low	1.35 V
	Low	High	1.85 V
	High	High	3.30 V

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

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OPERATION (Continued)

2. Power ON / OFF sequence
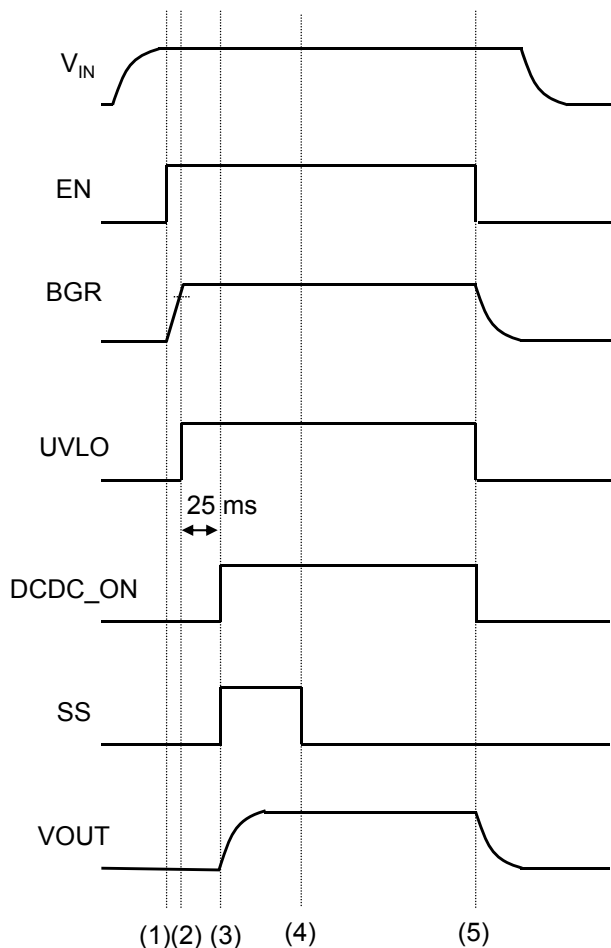
(1) When the EN pin is set to "High" after the V_{IN} settles, the BGR start-up.

(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 resister and load resistance.

3. 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.
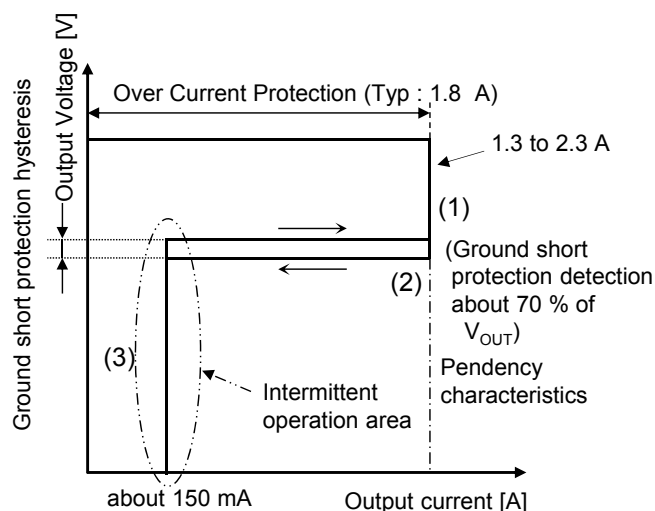
Figure : OCP and OSP Operation

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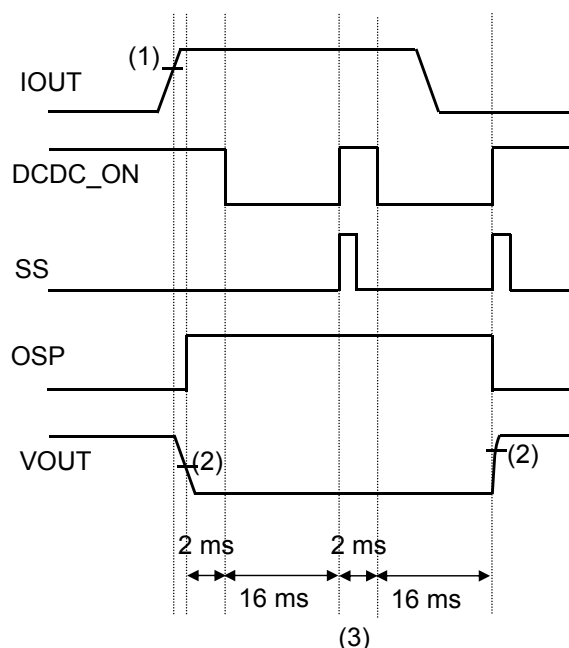
APPLICATIONS INFORMATION

1. Application circuit
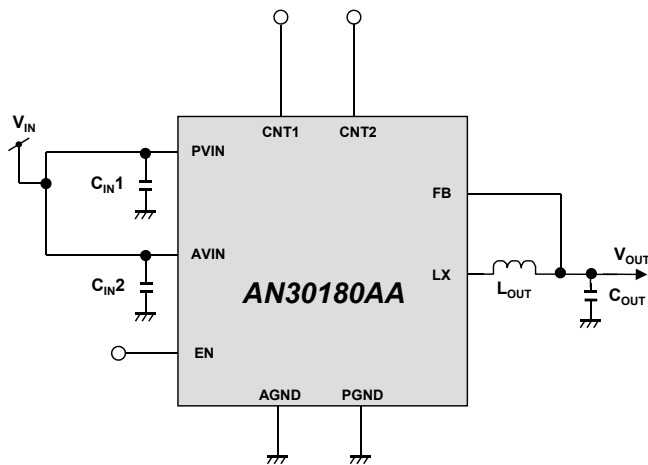
2. Recommended component

Reference Designator	QTY	Value	Manufacturer	Part Number	Note
$C_{IN}1$	1	4.7 µF	Murata	GRM21BB31E475KA75B	—
$C_{IN}2$	1	4.7 µF	Murata	GRM21BB31E475KA75B	—
C_{OUT}	1	4.7 µF	Murata	GRM21BB31E475KA75B	—
L_{OUT}	1	1.0 µH	FDK	MIPSZ2012D1R0	—

3. Evaluation board layout
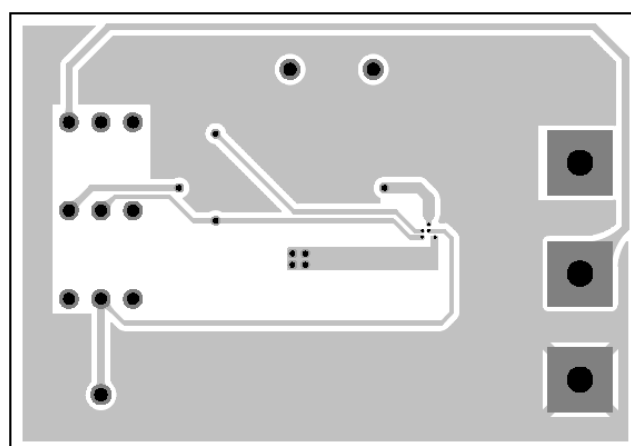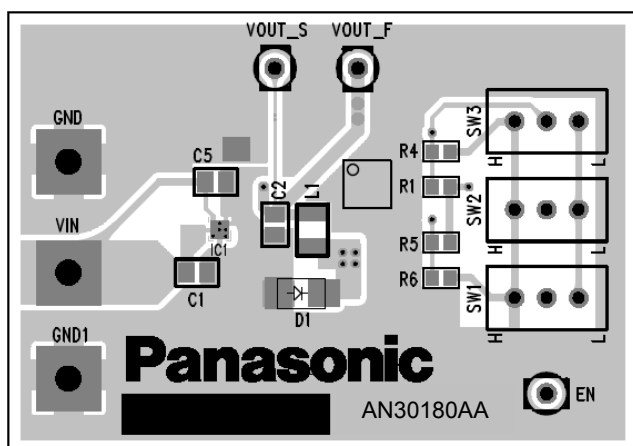
Figure Top Layer with silk screen
(Top View) with Evaluation board

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.

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PACKAGE INFORMATION (Reference Data)

Outline Drawing

Package Code : UBGA009-W-1515AEL   Unit:mm
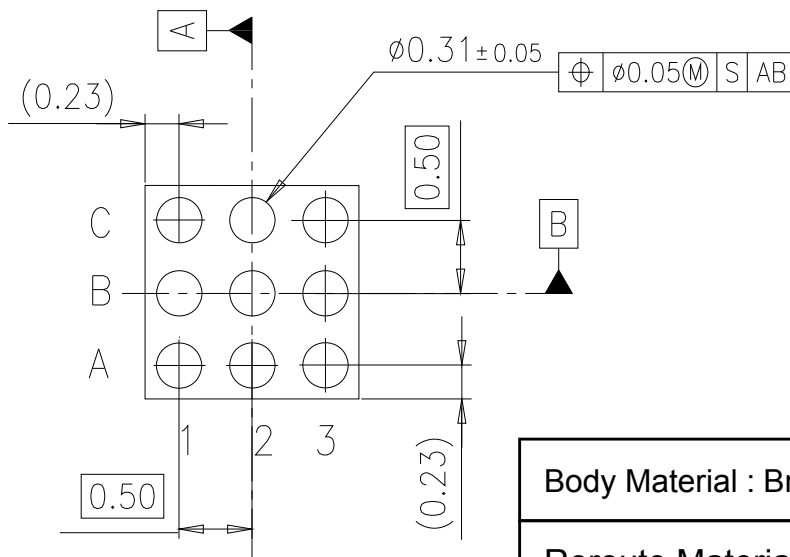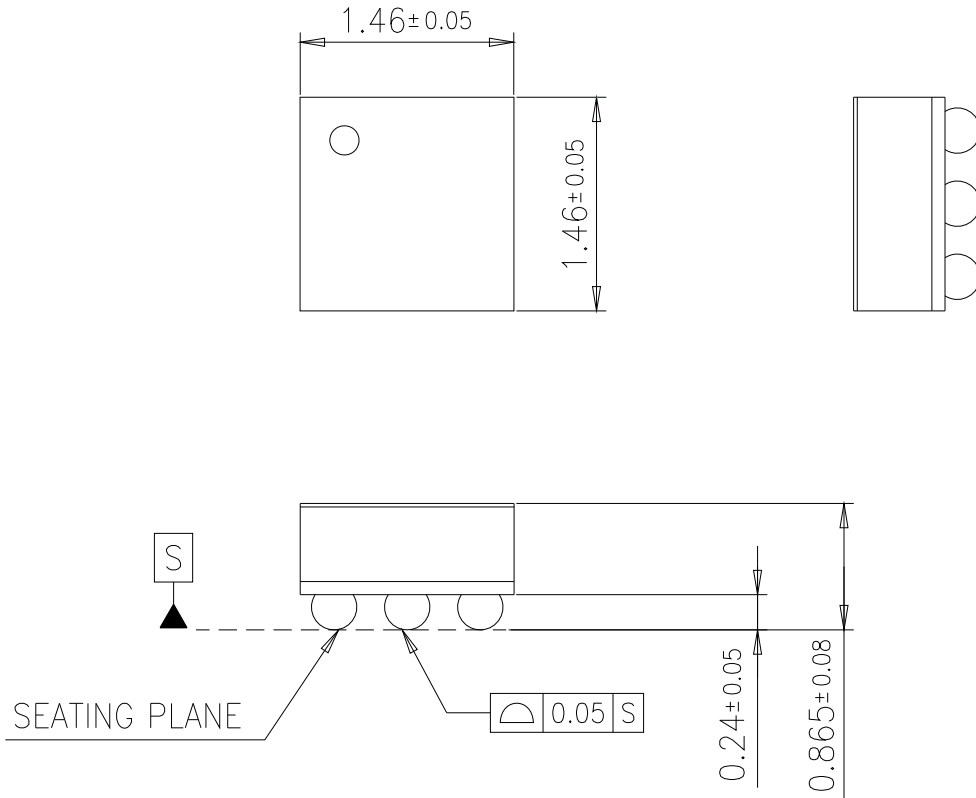
| Body Material : Br/Sb Free Epoxy Resin |
| Reroute Material : Cu |
| Bump : SnAgCu |

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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 required

   Our 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.

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