NAM03S06-D DC-DC Converter

Technical Manual

Issue 1.1

Date 2020-06-03

HUAWEI TECHNOLOGIES CO., LTD.

About This Document

Purpose

This document describes the NAM03S06-D in terms of its physical structure, electrical characteristics, and simple application.

The figures provided in this document are for reference only.

Intended Audience

This document is intended for:

- Hardware engineers
- Software engineers
- System engineers
- Technical support engineers

Symbol Conventions

The symbols that may be found in this document are defined as follows.

Symbol	Description
⚠ DANGER	Indicates a hazard with a high level of risk which, if not avoided, will result in death or serious injury.
⚠ WARNING	Indicates a hazard with a medium level of risk which, if not avoided, could result in death or serious injury.
⚠ CAUTION	Indicates a hazard with a low level of risk which, if not avoided, could result in minor or moderate injury.
NOTICE	Indicates a potentially hazardous situation which, if not avoided, could result in equipment damage, data loss, performance deterioration, or unanticipated results. NOTICE is used to address practices not related to personal injury.
NOTE	Supplements the important information in the main text. NOTE is used to address information not related to personal injury, equipment damage, and environment deterioration.

Change History

Changes between document issues are cumulative. The latest document issue contains all updates made in previous issues.

Issue 1.1 (2020-06-03)

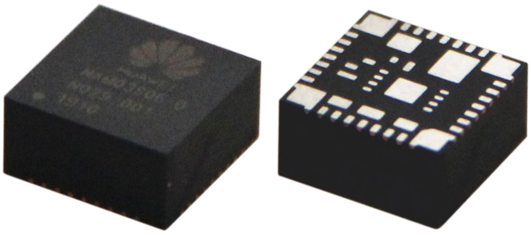
Updated "**2-Electrical Speciffications**" and "**11 Mechanical Consideration**"

Issue 1.0 (2019-05-15)

This issue is the first official release.

Contents

1 Product Overview



The NAM03S06-D is a Power System in Package (PSiP) DC-DC converter with an input voltage range of 3 V to 5.75 V and the maximum output current of 6 A. Its output voltage can be adjusted within a range of 0.9 V to 3.7 V.

Operational Features

- Input voltage: 3–5.75 V
- Output current: 0–6 A
- Output voltage: 0.9–3.7 V
- Efficiency: 96.5% (V_{in} = 5 V, V_{out} = 3.7 V, I_{out} = 3 A)

Protection Features

- Input undervoltage protection
- Output overcurrent protection (hiccup mode)
- Output short circuit protection (hiccup mode)
- Output overvoltage protection (self-recovery)
- Overtemperature protection (self-recovery)

Mechanical Features

- SMT
- Dimensions (L x W x H): 8 mm x 8 mm x 4 mm (0.31 in. x 0.31 in. x 0.16 in.)
- Weight: 0.86 g

Environmental Protection

- RoHS6 complaint, lead-free reflow soldering

Control Features

- Remote on/off
- Output voltage trim
- Monotonic start-up into pre-biased outputs

Applications

- Servers
- Telecom and datacom
- Point of load regulation
- General purpose step-down DC/DC

Model Naming Convention

NAM	03	S	06	–	D
1	2	3	4		5

1 — Non-isolated, analog, package type

2 — Input voltage: 3.3 V

3 — Single output

4 — Output current: 6 A

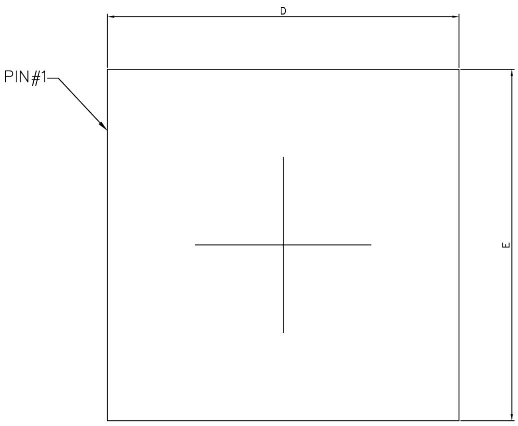
5 — Extension code

Mechanical Diagram

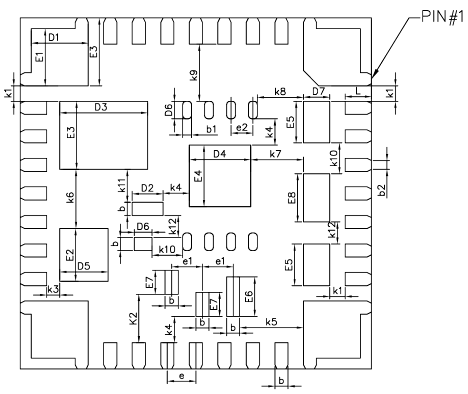
Figure 1-1 Mechanical diagram

NOTE

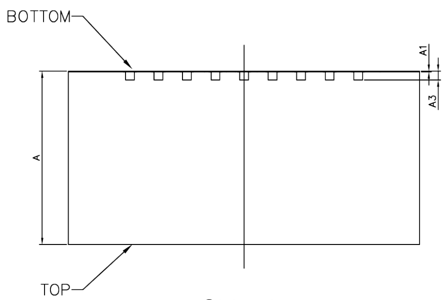
Solder: Sn (thickness: 6–15 µm).



Top view



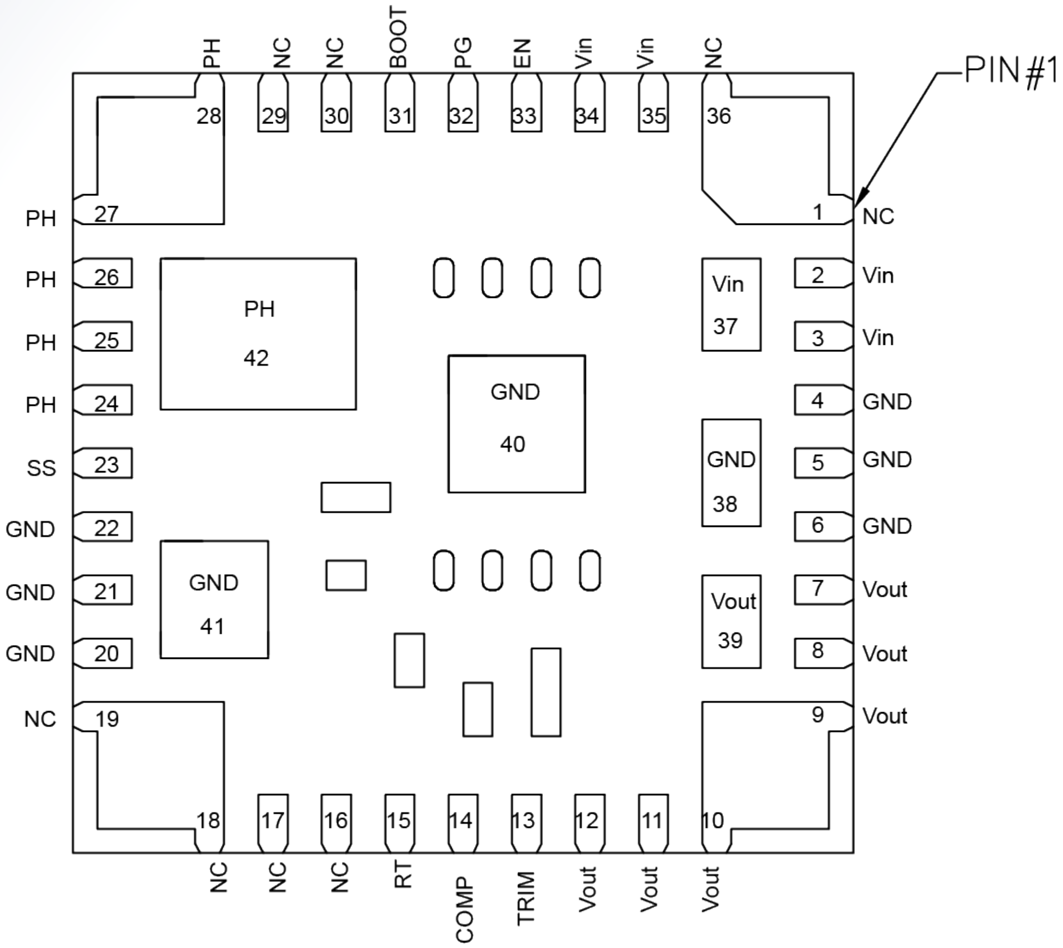
Bottom view



Side view

Symbol	Minimum	Maximum	Symbol	Minimum	Maximum
-	Dimensions in Millimeters (Inches)		-	Dimensions in Millimeters (Inches)	
A	3.900 (0.154)	4.000 (0.157)	E6	0.850 (0.033)	0.950 (0.037)
A1	0.000 (0.000)	0.050 (0.002)	E7	0.500 (0.020)	0.600 (0.024)
A3	0.203REF (0.008REF)		E8	1.050 (0.041)	1.150 (0.045)
b	0.250 (0.010)	0.350 (0.014)	L	0.550 (0.022)	0.650 (0.026)
b1	0.150 (0.006)	0.250 (0.010)	e	0.650BSC (0.026BSC)	
b2	0.200REF (0.008REF)		e1	0.700BSC (0.028BSC)	
D	7.900 (0.311)	8.100 (0.319)	e2	0.500BSC (0.020BSC)	
D1	1.250 (0.049)	1.350 (0.053)	k1	0.350REF (0.014REF)	
D2	0.650 (0.026)	0.750 (0.030)	k2	1.100REF (0.043REF)	
D3	1.950 (0.077)	2.050 (0.081)	k3	0.300REF (0.012REF)	
D4	1.350 (0.053)	1.450 (0.057)	k4	0.600REF (0.024REF)	
D5	1.050 (0.041)	1.150 (0.045)	k5	1.450REF (0.057REF)	
D6	0.350 (0.014)	0.450 (0.018)	k6	1.350REF (0.053REF)	
D7	0.550 (0.022)	0.650 (0.026)	k7	1.200REF (0.047REF)	
E	7.900 (0.311)	8.100 (0.319)	k8	1.050REF (0.041REF)	
E1	1.250 (0.049)	1.350 (0.053)	K9	1.300REF (0.051REF)	
E2	1.150 (0.045)	1.250 (0.049)	K10	0.700REF (0.028REF)	
E3	1.500 (0.059)	1.600 (0.063)	k11	0.750REF (0.030REF)	
E4	1.350 (0.053)	1.450 (0.057)	k12	0.500REF (0.020REF)	
E5	0.900 (0.035)	1.000 (0.039)	-	-	-

Figure 1-2 Pin Description



Pin No.	Name	Function
1, 16–19, 29, 30, 36	NC	Not connected: These pins must be soldered to PCB but not electrically connected to each other or to any external signal, voltage, or ground. These pins may be connected internally. Failure to follow this guideline may result in device damage.
2, 3, 34, 35, 37	Vin	Input voltage. Connect these pins to the input and place input capacitors between these pins and GND pins 4, 5, 6, 20.
4–6, 20–22, 38, 40, 41	GND	Input and output ground. Connect these pins to the ground electrode of the input and output capacitors. Refer to the descriptions of Vin and Vout.
7–12, 39	Vout	Output voltage. Connect these pins to loads and place output capacitors between these pins and GND pins 21, 22, 38, 40, 41.
13	TRIM	See Output Voltage Trim.

Pin No.	Name	Function
14	COMP	Error amplifier output and internal current comparator. Connect frequency compensation components to this pin. If the COMP pin is not used, the pin is left open.
15	RT	Resister timing and external clock input pin.
23	SS	A soft-start capacitor is connected between this pin and GND. The value of the capacitor controls the soft-start interval.
24–28, 42	PH	Phase switch node. These pins must be connected to one another using a small copper island under the device for thermal relief. Do not place any external component on these pins or tie them to a pin of another function. If the PH pin is not used, the pin is left open.
31	BOOT	A bootstrap capacitor is required between BOOT and PH. If the voltage on this capacitor is below the minimum required by the output device, the output is forced to switch off until the capacitor is refreshed. If the BOOT pin is not used, the pin is left open.
32	PG	Power good signal. The PG signal is pulled up to the Vin or fixed level (no more than 5.5 V) by a 10 kΩ resistor. If the PG signal is not used, the pin is left open. For details, see PG Signal.
33	EN	Enable pin. A left open pin enables the device while a low level disables the device. A high level is not allowed. For details, see Remote On/Off (EN).

2 Electrical Specifications

2.1 Absolute Maximum Ratings

Parameter	Minimum	Typical	Maximum	Unit	Notes & Conditions
Input voltage (continuous)	-	-	7	V	When the input voltage is 7 V, the converter will not be damaged. Not all the characteristic parameters conform to the specifications.
Operating ambient temperature (T_A)	–40	-	85	°C	See the thermal derating curve.
Storage temperature	–55	-	125	°C	-
Operating humidity	5	-	95	% RH	Non-condensing
External voltage applied to On/Off	-	-	5	V	-

2.2 Input Characteristics

Parameter	Minimum	Typical	Maximum	Unit	Notes & Conditions
Operating input voltage	3.0	3.3/5.0	5.75	V	-
Maximum input current	-	-	8	A	V_{in} = 0–5.75 V; I_{out} = I_{onom}
No-load loss	-	0.2	-	W	V_{in} = 5.0 V; I_{out} = 0 A
Input capacitance	20	47	-	µF	Ceramic capacitor
Inrush transient	-	-	1	A^2s	-

2.3 Output Characteristics

Parameter	Minimum	Typical	Maximum	Unit	Notes & Conditions
Output voltage setpoint	–2.0	-	2.0	%Voset	V_{in} = 3.3/5.0 V; I_{out} = 50%I_{onom}; Tested with 1% tolerance for external resistor used to set output voltage
Output voltage	0.9	-	3.7	V	V_{in} - V_{out} > 0.5 V; V_{out} = (1+10/R) x 0.6V
Output current	0	-	6	A	-
Line regulation	–0.5	-	0.5	%	V_{in} = 3–5.75 V; I_{out} = I_{onom}
Load regulation	–0.5	-	0.5	%	V_{in} = 5.0 V; I_{out} = I_{omin} – I_{onom}
Regulated voltage precision	–2	-	2	%	V_{in} = 3–5.75 V; I_{out} = I_{omin} – I_{onom}
Temperature coefficient	–0.02	-	0.02	%/°C	T_A = –40°C to +85°C (–40°F to +185°F)
External capacitance	47 x 2	-	1600	µF	47 µF: ceramic capacitor 1600 µF: polymer AL capacitor
Output ripple and noise (peak to peak)	-	10	20	mV	V_{out} ≤ 1.2 V Oscilloscope bandwidth: 20 MHz
	-	50	100	mV	V_{out} ≤ 1.2 V Oscilloscope bandwidth: 500 MHz
	-	20	30	mV	V_{out} > 1.2 V Oscilloscope bandwidth: 20 MHz
	-	60	150	mV	V_{out} > 1.2 V Oscilloscope bandwidth: 500 MHz

Parameter	Minimum	Typical	Maximum	Unit	Notes & Conditions
Output voltage overshoot	-	-	5	%	Full range of V_{in}, I_{out} and T_A
Output voltage delay time	-	3	10	ms	From V_{in} connection to 10% V_{out}
Output voltage rise time	-	0.2	10	ms	$V_{out} \leq 1.8$ V From 10% V_{out} to 90% V_{out}
	-	2.2	10	ms	$V_{out} > 1.8$ V From 10% V_{out} to 90% V_{out}
Switching frequency	-	1000	-	kHz	$V_{out} \leq 3.0$ V
	-	1150	-	kHz	$V_{out} > 3.0$ V

2.4 Protection

Table 2-1 Input Protection

Parameter	Minimum	Typical	Maximum	Unit	Notes & Conditions
Input undervoltage protection threshold	2.3	2.5	2.7	V	V_{in} = 3–4.5 V
Input undervoltage protection recovery threshold	2.65	2.85	3.0	V	
Input undervoltage protection hysteresis	0.10	0.35	0.7	V	
Input undervoltage protection threshold	3.4	3.65	4.0	V	V_{in} = 4.5–5.75 V V_{in} shutdown threshold (Minimum) > V_{out} + 0.1V
Input undervoltage protection recovery threshold	3.7	4.05	4.5	V	
Input undervoltage protection hysteresis	0.10	0.4	0.6	V	

Table 2-2 Output Protection

Parameter	Minimum	Typical	Maximum	Unit	Notes & Conditions
Output overcurrent protection	6.2	-	15	A	Hiccup mode
Output short circuit protection	-	-	-	-	Hiccup mode
Output overvoltage protection	105	-	120	$\%V_{oset}$	Self-recovery
Overtemperature protection threshold	125	135	150	°C	Self-recovery The overtemperature protection threshold is obtained by measuring the surface temperature of converter.
Overtemperature protection hysteresis	5	15	-	°C	

2.5 Dynamic Characteristics

Parameter	Minimum	Typical	Maximum	Unit	Notes & Conditions
Overshoot amplitude Recovery time	- -	- -	40 100	mV µs	V_{out} ≤ 1.2 V; Current change rate: 1 A/µs Load: 25%–50%–25%; 50%–75%–50%
Overshoot amplitude Recovery time	- -	- -	4 100	$\%V_{out}$ µs	V_{out} > 1.2 V; Current change rate: 1 A/µs Load: 25%–50%–25%; 50%–75%–50%

2.6 Efficiency

Parameter	Minimum	Typical	Maximum	Units	Notes & Conditions
50% load	86.0	88.0	-	%	V_{in} = 3.3 V; V_{out} = 0.9 V; T_A = 25°C
	87.0	89.0	-	%	V_{in} = 3.3 V; V_{out} = 1.0 V; T_A = 25°C

Parameter	Minimum	Typical	Maximum	Units	Notes & Conditions
	88.5	90.5	-	%	V_{in} = 3.3 V; V_{out} = 1.2 V; T_A = 25°C
	90.0	92.0	-	%	V_{in} = 3.3 V; V_{out} = 1.5 V; T_A = 25°C
	91.0	93.0	-	%	V_{in} = 3.3 V; V_{out} = 1.8 V; T_A = 25°C
	93.5	95.5	-	%	V_{in} = 3.3 V; V_{out} = 2.5 V; T_A = 25°C
	85.5	88.0	-	%	V_{in} = 5.0 V; V_{out} = 0.9 V; T_A = 25°C
	85.5	89.0	-	%	V_{in} = 5.0 V; V_{out} = 1.0 V; T_A = 25°C
	87.0	90.0	-	%	V_{in} = 5.0 V; V_{out} = 1.2 V; T_A = 25°C
	89.0	91.5	-	%	V_{in} = 5.0 V; V_{out} = 1.5 V; T_A = 25°C
	90.0	92.5	-	%	V_{in} = 5.0 V; V_{out} = 1.8 V; T_A = 25°C
	92.0	94.5	-	%	V_{in} = 5.0 V; V_{out} = 2.5 V; T_A = 25°C
	93.5	96.0	-	%	V_{in} = 5.0 V; V_{out} = 3.3 V; T_A = 25°C
	94.0	96.5	-	%	V_{in} = 5.0 V; V_{out} = 3.7 V; T_A = 25°C
100% load	80.5	82.5	-	%	V_{in} = 3.3 V; V_{out} = 0.9 V; T_A = 25°C
	82.0	84.0	-	%	V_{in} = 3.3 V; V_{out} = 1.0 V; T_A = 25°C
	84.0	86.0	-	%	V_{in} = 3.3 V; V_{out} = 1.2 V; T_A = 25°C
	87.0	89.0	-	%	V_{in} = 3.3 V; V_{out} = 1.5 V; T_A = 25°C

Parameter	Minimum	Typical	Maximum	Units	Notes & Conditions
	88.5	90.5	-	%	V_{in} = 3.3 V; V_{out} = 1.8 V; T_A = 25°C
	91.0	93.0	-	%	V_{in} = 3.3 V; V_{out} = 2.5 V; T_A = 25°C
	80.0	84.0	-	%	V_{in} = 5.0 V; V_{out} = 0.9 V; T_A = 25°C
	81.0	85.5	-	%	V_{in} = 5.0 V; V_{out} = 1.0 V; T_A = 25°C
	83.0	87.0	-	%	V_{in} = 5.0 V; V_{out} = 1.2 V; T_A = 25°C
	85.5	89.0	-	%	V_{in} = 5.0 V; V_{out} = 1.5 V; T_A = 25°C
	87.5	90.5	-	%	V_{in} = 5.0 V; V_{out} = 1.8 V; T_A = 25°C
	90.0	93.0	-	%	V_{in} = 5.0 V; V_{out} = 2.5 V; T_A = 25°C
	91.5	94.5	-	%	V_{in} = 5.0 V; V_{out} = 3.3 V; T_A = 25°C
	92.5	95.5	-	%	V_{in} = 5.0 V; V_{out} = 3.7 V; T_A = 25°C

2.7 Other Characteristics

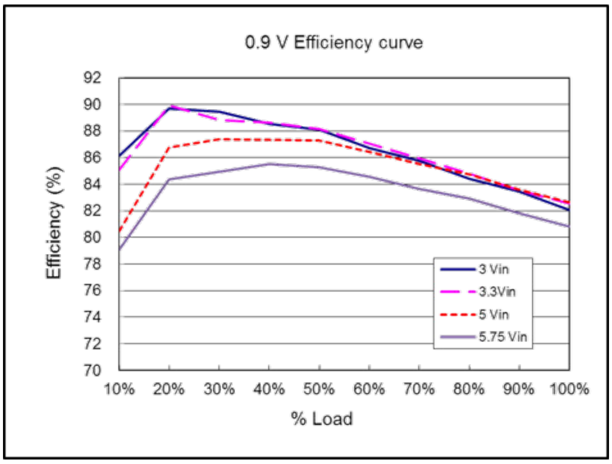
Parameter	Minimum	Typical	Maximum	Unit	Notes & Conditions
Remote On/Off voltage low level	–0.2	-	0.5	V	Positive logic
Remote On/Off voltage high level	1.5	-	5.0	V	

Parameter	Minimum	Typical	Maximum	Unit	Notes & Conditions
Mean time between failures (MTBF)	-	2.5	-	Million hours	Telcordia, SR332 Method 1 Case 3; 80% load; normal input; rated output; airflow rate = 1.5 m/s (300 LFM); T_A = 40°C

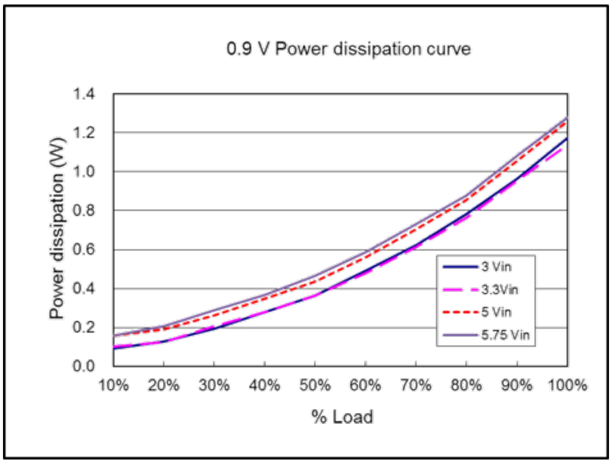
3 Characteristic Curves

3.1 Efficiency and Power Dissipation Curves

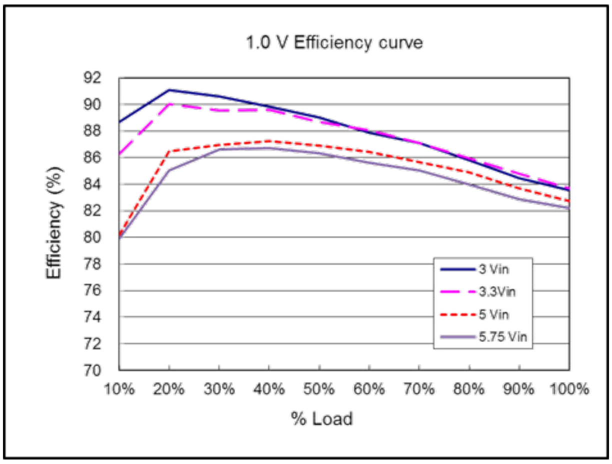
Conditions: T_A = 25°C, unless otherwise specified



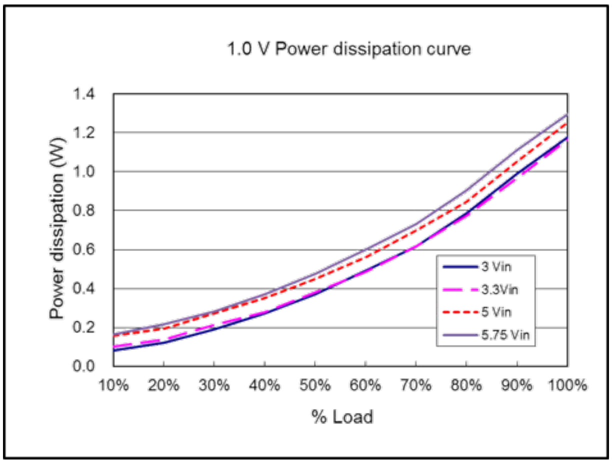
Efficiency curve (V_{out} = 0.9 V)



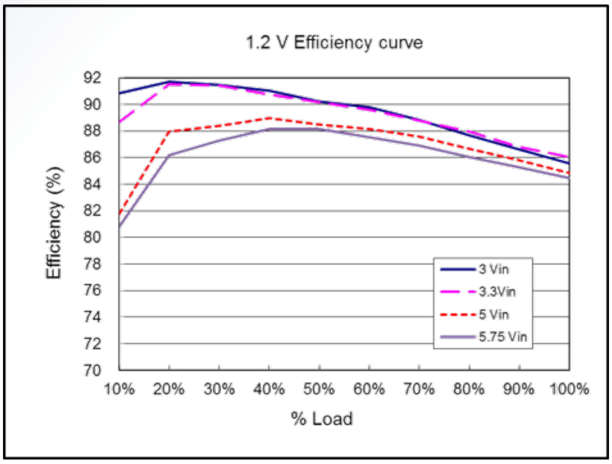
Power dissipation curve (V_{out} = 0.9 V)



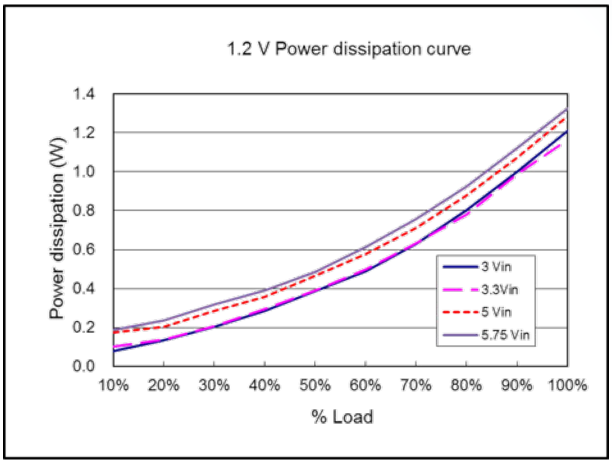
Efficiency curve (V_{out} = 1.0 V)



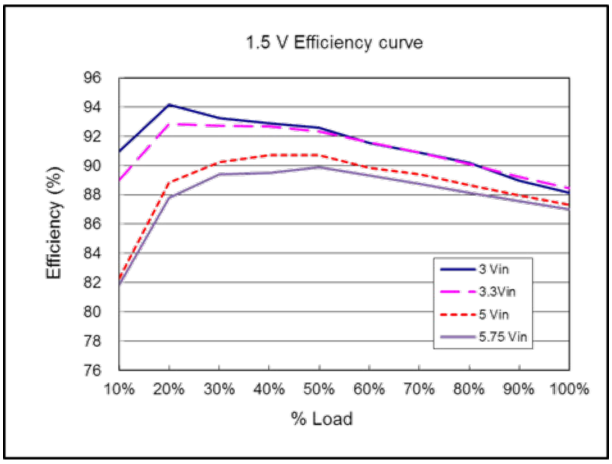
Power dissipation curve (V_{out} = 1.0 V)



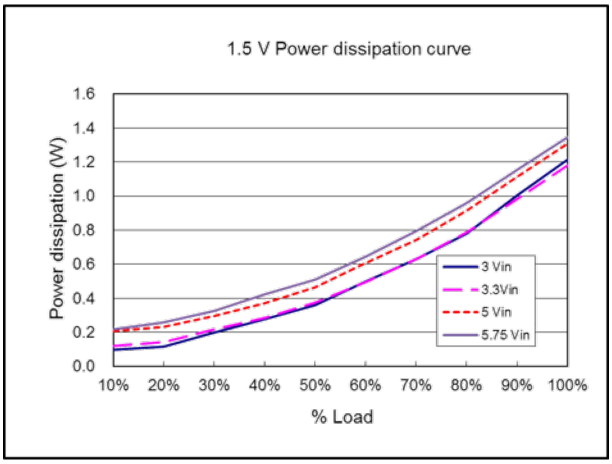
Efficiency curve (V_{out} = 1.2 V)



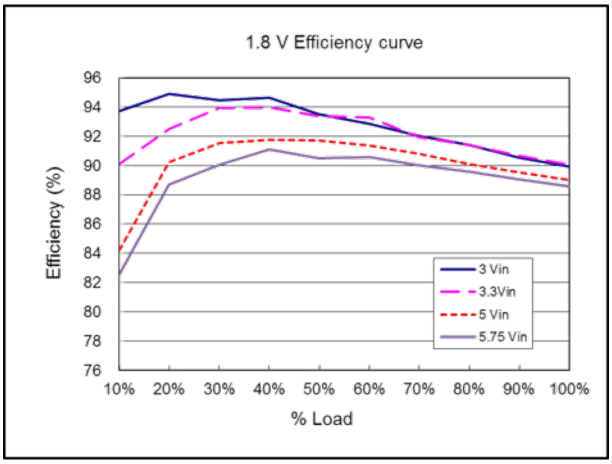
Power dissipation curve (V_{out} = 1.2 V)



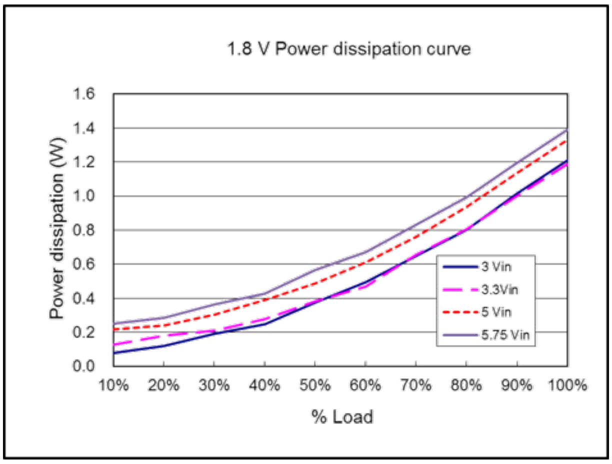
Efficiency curve (V_{out} = 1.5 V)



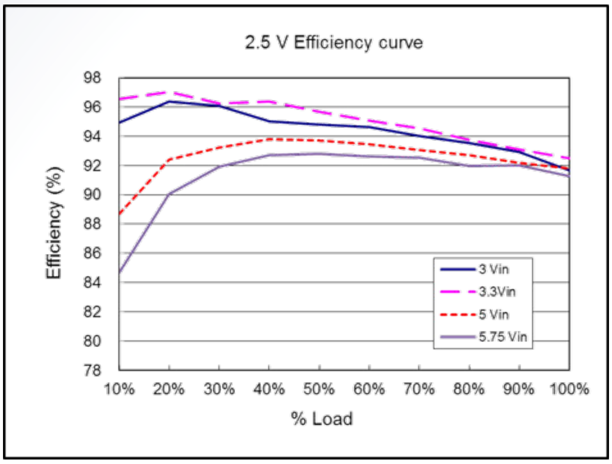
Power dissipation curve (V_{out} = 1.5 V)



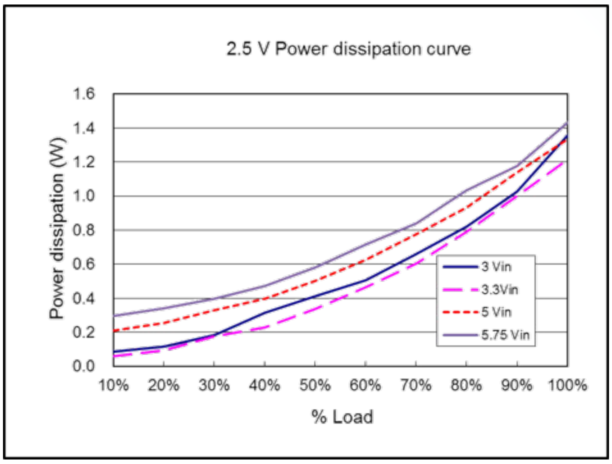
Efficiency curve (V_{out} = 1.8 V)



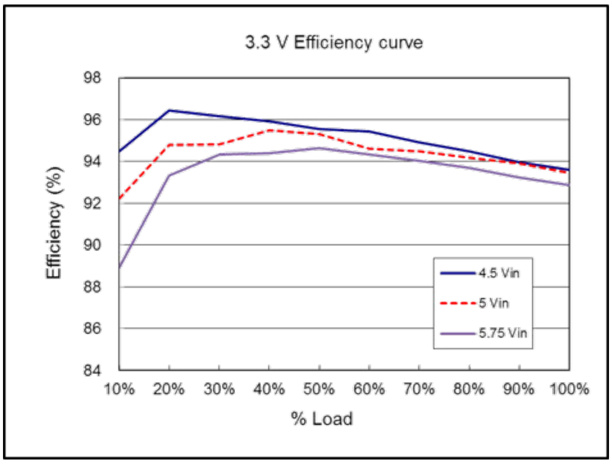
Power dissipation curve (V_{out} = 1.8 V)



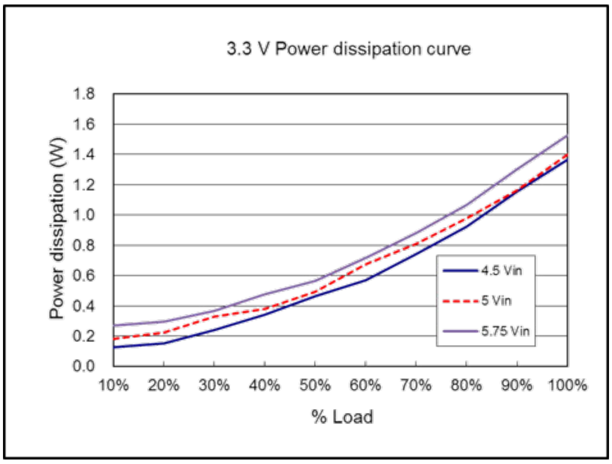
Efficiency curve (V_{out} = 2.5 V)



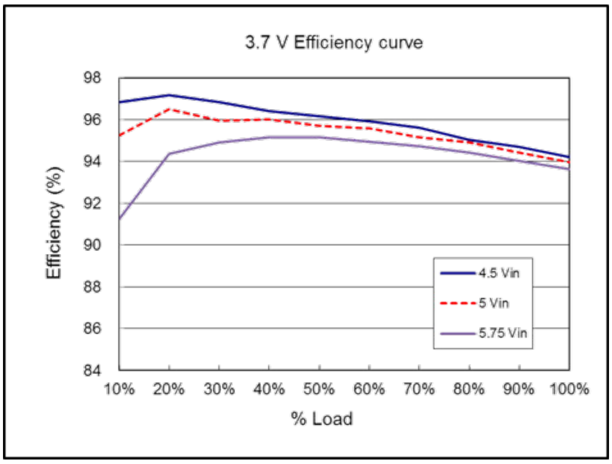
Power dissipation curve (V_{out} = 2.5 V)



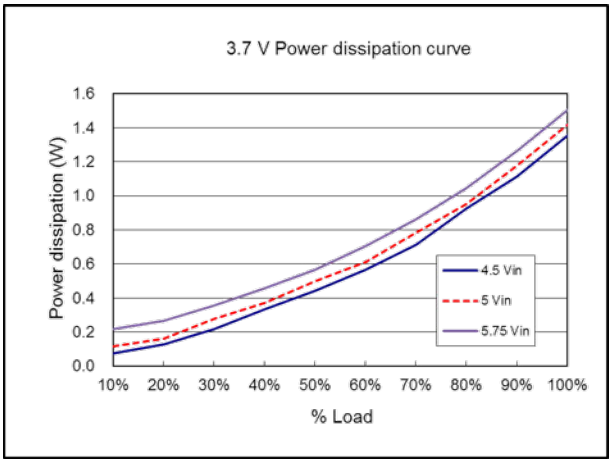
Efficiency curve (V_{out} = 3.3 V)



Power dissipation curve (V_{out} = 3.3 V)

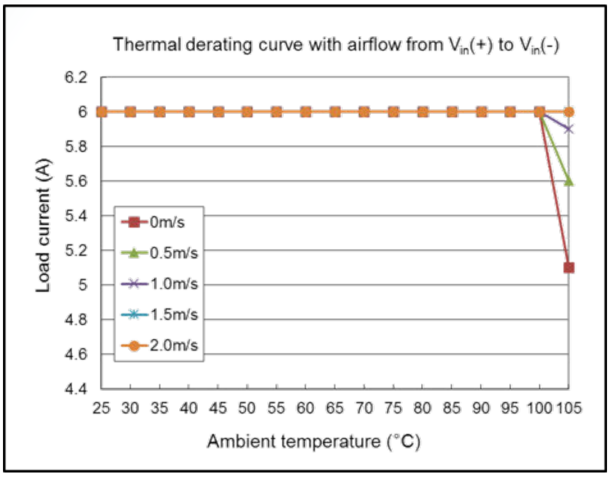


Efficiency curve (V_{out} = 3.7 V)

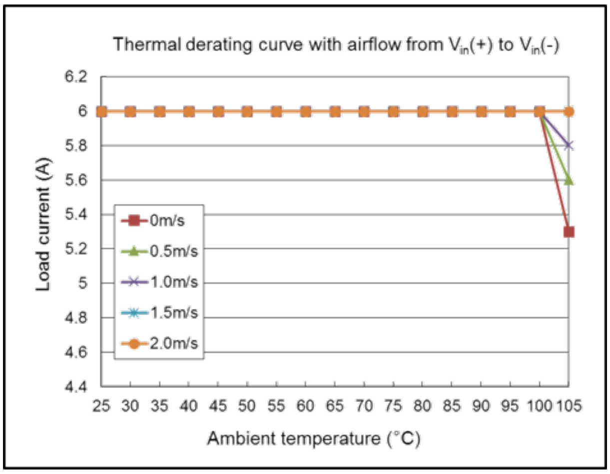


Power dissipation curve (V_{out} = 3.7 V)

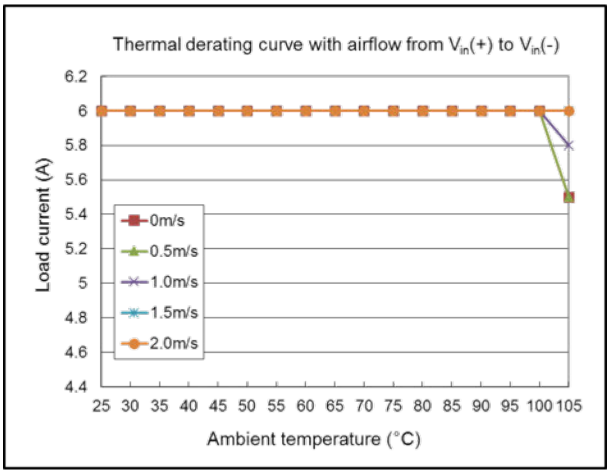
3.2 Thermal Considerations



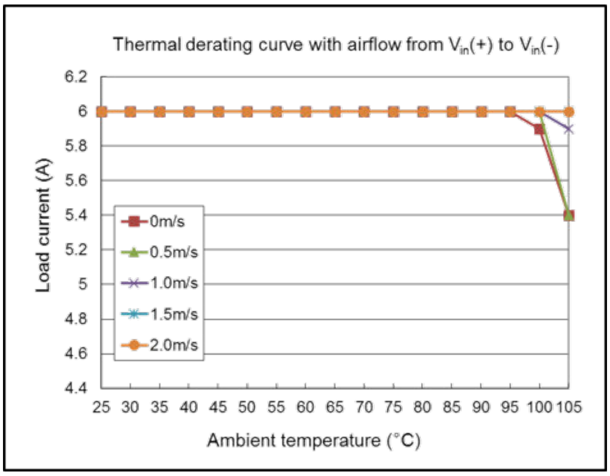
Thermal derating with airflow from V_{in}(+) to V_{in}(-) (V_{in} = 5.0 V; V_{out} = 0.9 V)



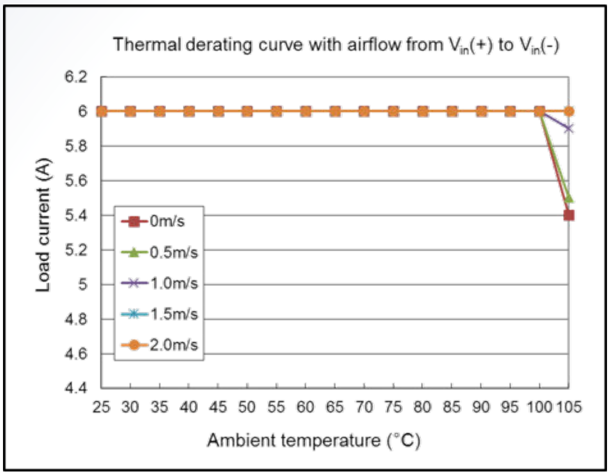
Thermal derating with airflow from V_{in}(+) to V_{in}(-) (V_{in} = 5.0 V; V_{out} = 1.0 V)



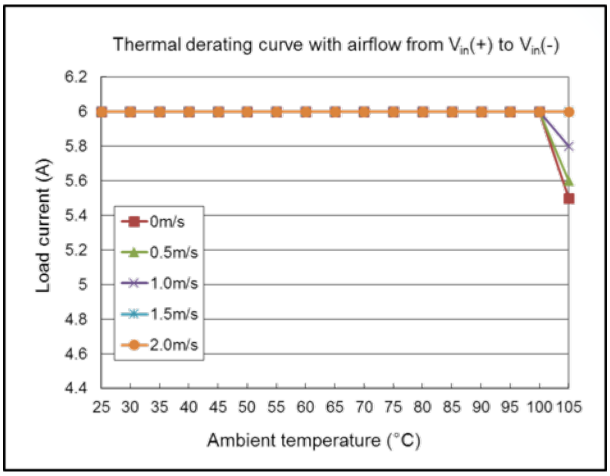
Thermal derating with airflow from V_{in}(+) to V_{in}(-) (V_{in} = 5.0 V; V_{out} = 1.2 V)



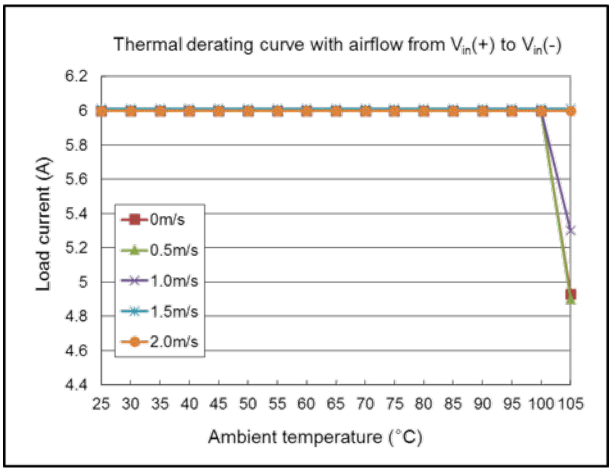
Thermal derating with airflow from V_{in}(+) to V_{in}(-) (V_{in} = 5.0 V; V_{out} = 1.5 V)



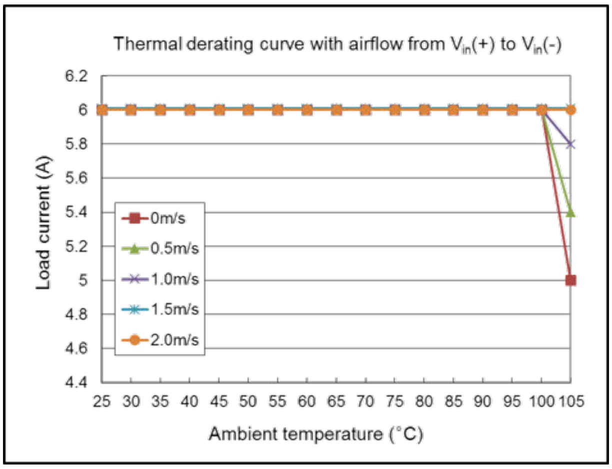
Thermal derating with airflow from V_{in}(+) to V_{in}(-) (V_{in} = 5.0 V; V_{out} = 1.8 V)



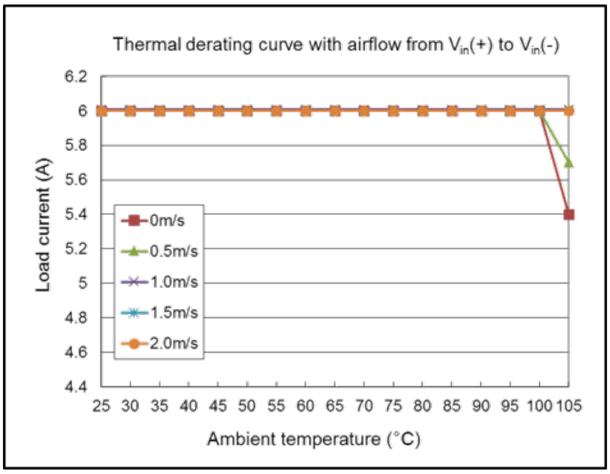
Thermal derating with airflow from V_{in}(+) to V_{in}(-) (V_{in} = 5.0 V; V_{out} = 2.5 V)

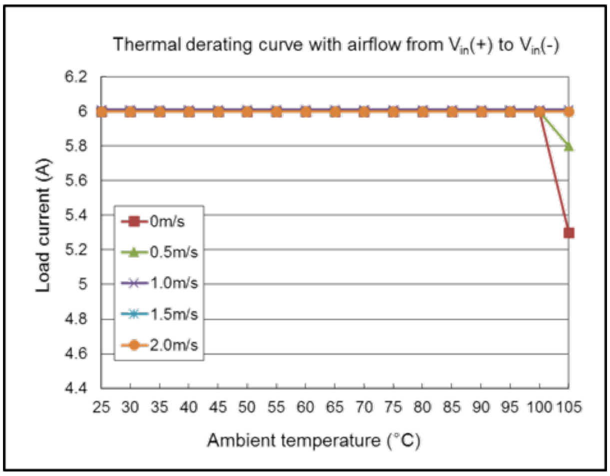


Thermal derating with airflow from V_{in}(+) to V_{in}(-) (V_{in} = 5.0 V; V_{out} = 3.3 V)

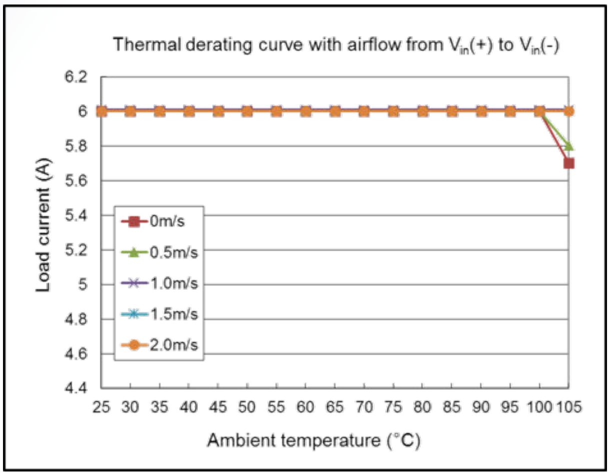


Thermal derating with airflow from V_{in}(+) to V_{in}(-) (V_{in} = 5.0 V; V_{out} = 3.7 V)

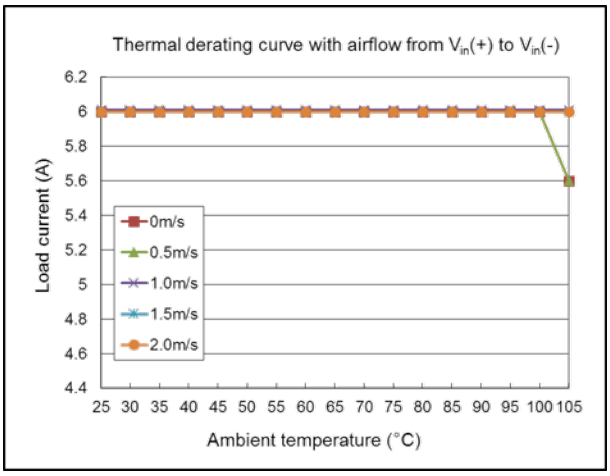




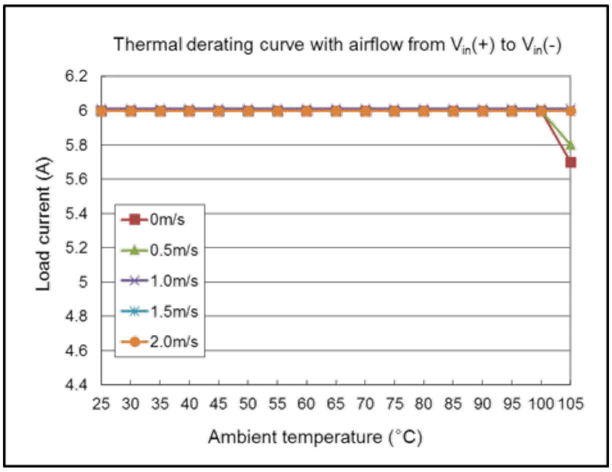
Thermal derating with airflow from $V_{in}(+)$ to $V_{in}(-)$ (V_{in} = 3.3 V; V_{out} = 0.9 V)



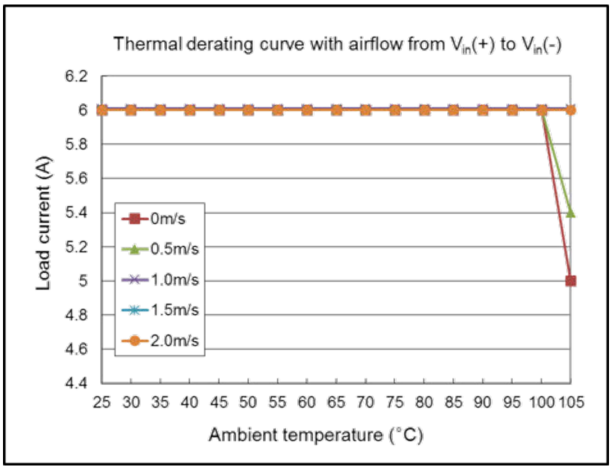
Thermal derating with airflow from $V_{in}(+)$ to $V_{in}(-)$ (V_{in} = 3.3 V; V_{out} = 1.0 V)



Thermal derating with airflow from $V_{in}(+)$ to $V_{in}(-)$ (V_{in} = 3.3 V; V_{out} = 1.2 V)



Thermal derating with airflow from $V_{in}(+)$ to $V_{in}(-)$ (V_{in} = 3.3 V; V_{out} = 1.5 V)



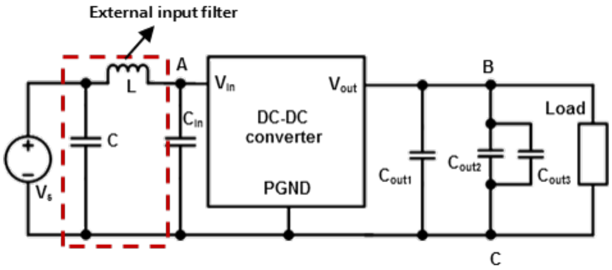
Thermal derating with airflow from $V_{in}(+)$ to $V_{in}(-)$ (V_{in} = 3.3 V; V_{out} = 1.8 V)

Thermal derating with airflow from $V_{in}(+)$ to $V_{in}(-)$ (V_{in} = 3.3 V; V_{out} = 2.5 V)

4 Typical Waveforms

4.1 Test Setup Diagram & Fundamental Circuit Diagram

Figure 4-1 Test setup diagram



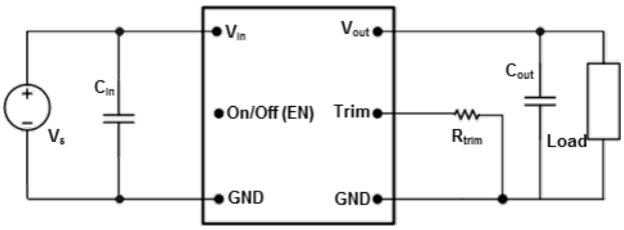
C_{in}: The 20 µF ceramic capacitor is recommended.

C_{out1}: The 47 µF x 2 ceramic capacitor is recommended.

C_{out2}: The 0.1 µF ceramic capacitor is recommended.

C_{out3}: The 10 µF polymer tantalum capacitor is recommended.

Figure 4-2 Application circuit



C_{in}: The 20 µF ceramic capacitor is recommended.

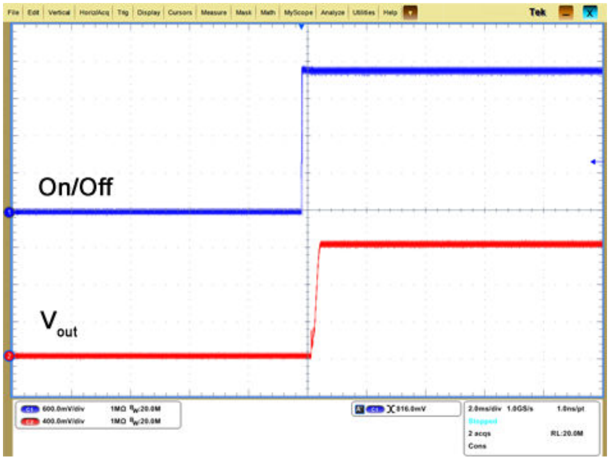
C_{out}: The 47 µF x 2 ceramic capacitor is recommended.

NOTE

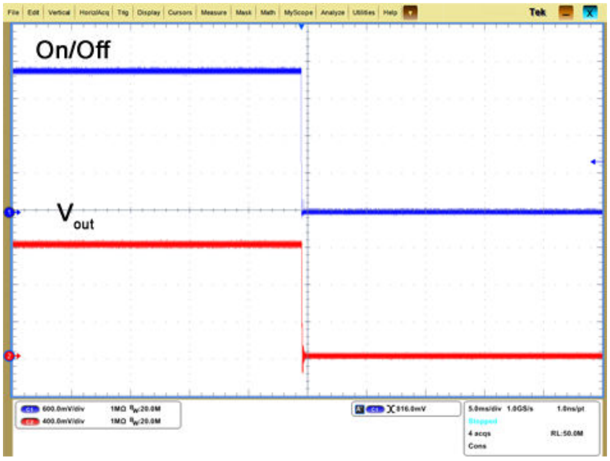
1. Measure the output voltage ripple at B (25 mm [0.98 in.] away from the V_{out} pin) shown in **Figure 4-1**.
2. During the test of input reflected ripple current, the input must be connected to an external input filter (including a 12 µH inductor and a 220 µF electrolytic capacitor), which is not required in other tests.
3. The test platform is a 1oz four-layer board with the dimensions (L x W) being 100 mm x 100 mm (3.94 in. x 3.94 in.).

4.2 Turn-on/Turn-off

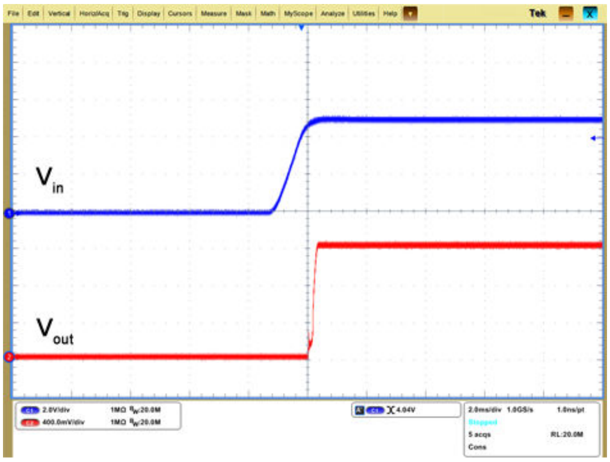
Conditions: T_A = 25°C, V_{in} = 5 V, V_{out} = 1.2 V



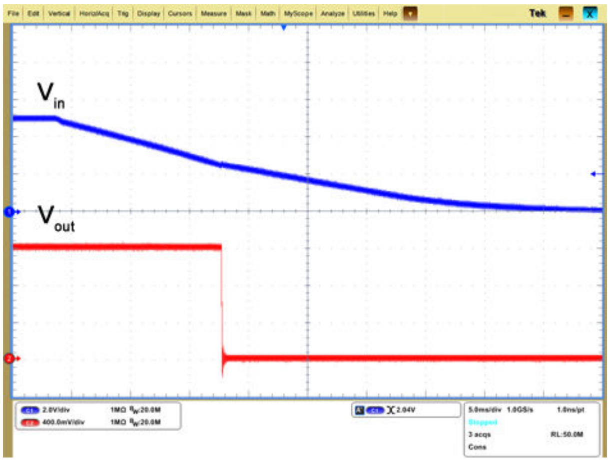
Startup from On/Off



Shutdown from On/Off

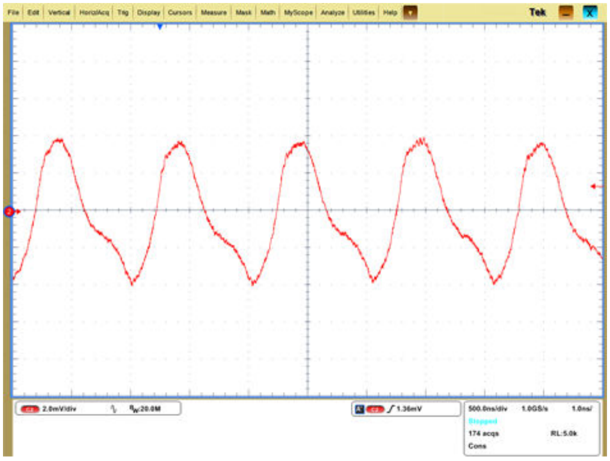


Startup by power-on



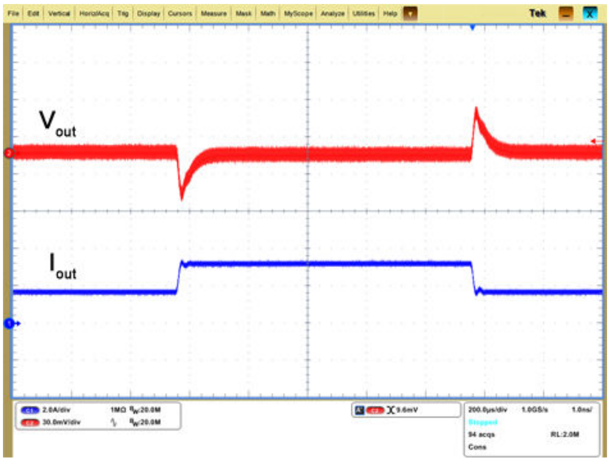
Shutdown by power-off

4.3 Output voltage ripple

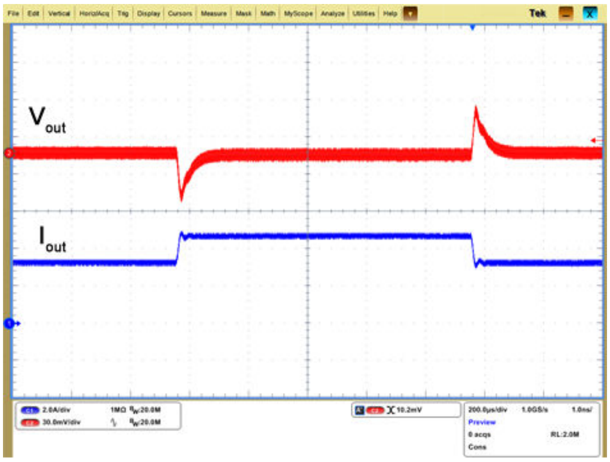


Output voltage ripple (for points B and C in the test set-up diagram, V_{in} = 5 V, V_{out} = 1.2 V, I_{out} = 6 A)

4.4 Output Voltage Dynamic Response

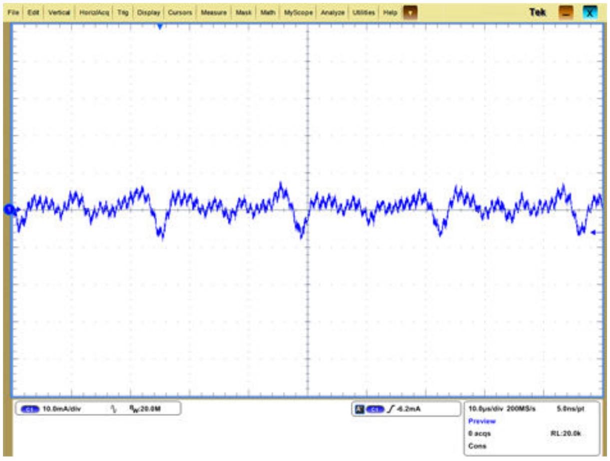


Load: 25%–50%–25%, di/dt = 1 A/µs



Load: 50%–75%–50%, di/dt = 1 A/µs

4.5 Input reflected ripple current



Input reflected ripple current (for point A in the test set-up diagram, V_{in} = 5 V, V_{out} = 1.2 V, I_{out} = 6 A)

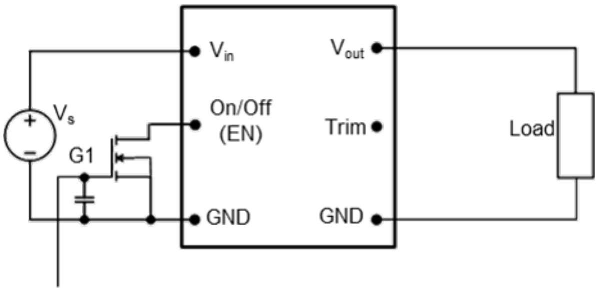
5 Control Features

5.1 Remote On/Off

EN Pin Level	Status
Low level	Off
High level	On

It is recommended that the On/Off pin be controlled using an open collector transistor or a similar device.

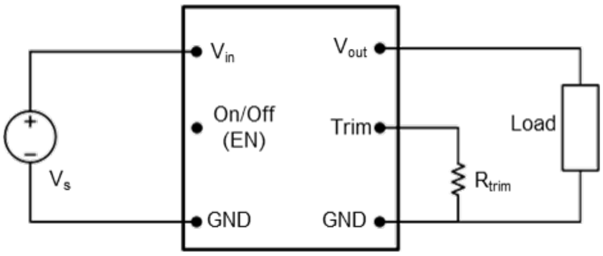
Figure 5-1 Circuit configuration for On/Off function



5.2 Output Voltage Trim

The output voltage can be adjusted by connecting an external resistor between the Trim pin and the GND pin.

Figure 5-2 R_{trim} external connections



Relationship between R_{trim} and V_{out}:

$$R_{trim} = \left[\frac{6}{V_{out} - 0.6}\right] k\Omega$$

NOTE

The output voltage varies depending on R_{trim}. Note that the trim resistor tolerance directly affects the output voltage accuracy. It is recommended that ±1% trim resistors be used.

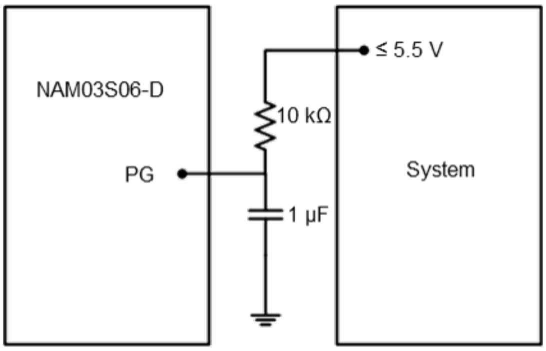
The following table describes the mapping between V_{out} and R_{trim}.

V_{out} (V)	R_{trim} (kΩ)
0.9	20
1.0	15
1.2	10
1.5	6.66
1.8	5
2.5	3.15
3.3	2.22
3.7	1.93

5.3 Power Good Signal (PG)

The power good (PG) signal is pulled up to Vin or a fixed level not exceeding 5.5 V through a 10 kΩ resistor when in use. If the PG function is not required, the pin is left open.

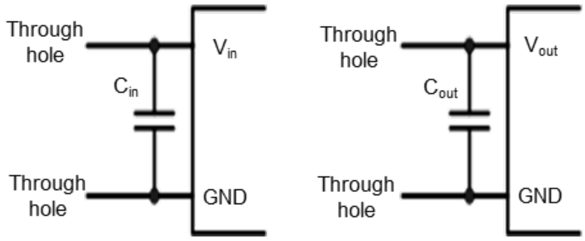
Figure 5-3 Configuration diagram of PG



5.4 PCB Layout Considerations

To ensure the filtering effects, place the C_{in} and C_{out} symmetrically near the pins. The following figure shows the cable hole layouts at the input and output terminals.

Figure 5-4 Recommended PCB layout



6 Protection Features

Input Undervoltage Protection

The converter will shut down if the input voltage drops below the undervoltage protection threshold. The converter will start to work again if the input voltage reaches the input undervoltage recovery threshold.

Output Overcurrent Protection

The converter equipped with current limiting circuitry can provide protection from an output overload or short circuit condition. If the output current exceeds the output overcurrent protection set point, the converter enters hiccup mode. When the fault condition is removed, the converter will automatically restart.

Output Overvoltage Protection

The converter will shut down if the output voltage exceeds the output overvoltage protection threshold. The converter will start to work again if the output voltage normal.

Overtemperature Protection

A temperature sensor on the converter senses the average temperature of the converter. It protects the converter from being damaged at high temperatures. When the temperature exceeds the overtemperature protection threshold, the output will shut down. It will allow the converter to turn on again when the temperature of the sensed location falls by the value of the overtemperature protection hysteresis.

7 Qualification Testing

Precondition test required for test items 5, 6, and 13: Visual inspection -> Electrical test -> C-SCAN (or X-RAY) -> T/C (5 cycles) -> Bake (24 h, 125°C) -> Soak (Moisture soaking) -> Reflow (3 cycles, 250°C) -> Visual inspection -> Electrical test -> C-SCAN

MSL 3: 60°C, 60% RH, 40 hours

No.	Test Item	Units	Condition
1	Highly accelerated life test	3	Low temperature limit: –60°C; high temperature limit: 110°C; vibration limit: 40 G; temperature slope: 40°C per minute; vibration frequency range: 10–10000 Hz
2	Thermal shock	32	500 temperature cycles between –40°C and +125°C with the temperature change rate of 20°C per minute; lasting for 30 minutes both at –40°C and +125°C
3	Temperature humidity bias	76	Maximum input voltage; 85°C; 85% RH; 1000 operating hours under lowest load power
4	High temperature operation bias	32	Rated input voltage; airflow rate: 0.5 m/s (100 LFM) to 5 m/s (1000 LFM); ambient temperature between +45°C and +55°C; 1000 operating hours; 50% to 80% load
5	Power and temperature cycling test	32	Rated input voltage; airflow rate: 0.5 m/s (100 LFM) to 5 m/s (1000 LFM); ambient temperature between –40°C and +85°C; 1000 cycles under 50% load
6	Long life test	16	Air temperature: 30°C to 60°C; 50% to 80% load; test time: 6 months
7	Tin whisker test	6	Air temperature: –55°C to 85°C; hold time: 5–10 minutes, 3 cycles/h; test time: 1000 h

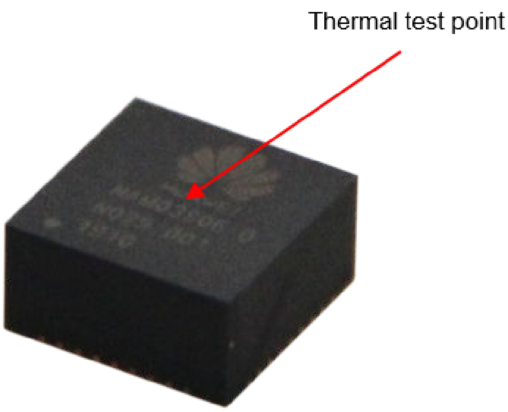
No.	Test Item	Units	Condition
8	Reflow warpage test	3	The simulation of the actual reflow curve. For details, see JEITA ED -7306.
9	High temperature storage life test	22	High temperature: 125°C; 100% RH; 1 bar above atmosphere
10	Destructive physical analysis	5	For details, see MIL-STD-1580.
11	Mechanical shock	39	Y1 plane only, 5 pulses, 0.5 ms duration, 1500 G peak acceleration
12	High accelerated temperature and humidity stress test	45	High temperature: 130°C/110°C; 85% RH; V_{out}-rated ≥ 80% of maximum-rated breakdown voltage; test time: 96/264 h

8 Thermal Consideration

Thermal Test Point

Sufficient airflow should be provided to ensure reliable operating of the converter. Therefore, thermal components are mounted on the top surface of the converter to dissipate heat to the surrounding environment by conduction, convection, and radiation. Proper airflow can be verified by measuring the temperature at the surface of the converter.

Figure 8-1 Thermal test point



Power Dissipation

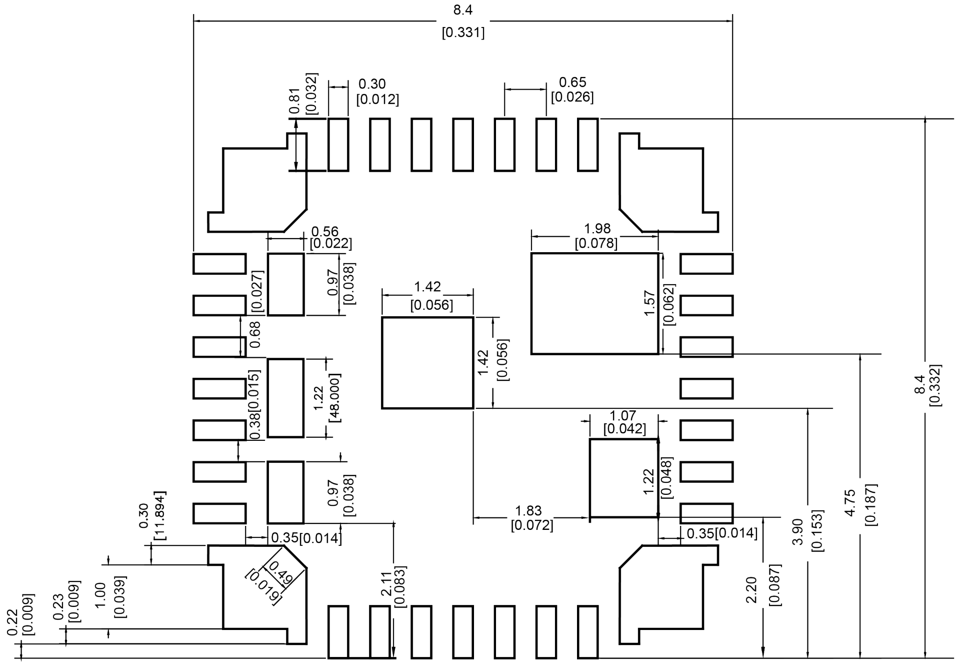
The converter power dissipation is calculated based on efficiency. The following formula reflects the relationship between the consumed power (P_d), efficiency (η), and output power (P_o):

$$P_d = P_o (1 - \eta)/\eta$$

9 Encapsulation Size Diagram

Unit of measurement: mm [in.]

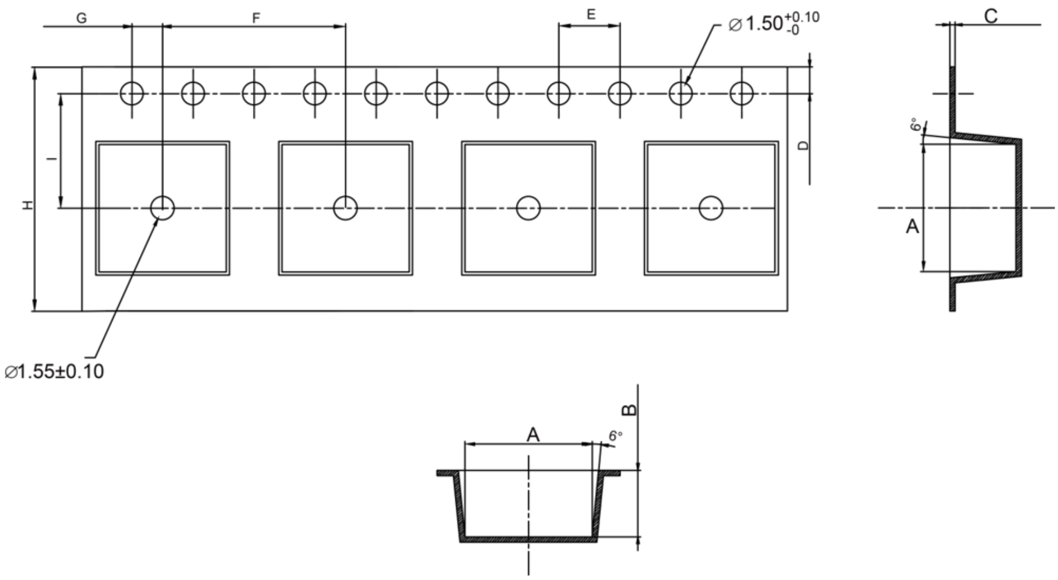
Figure 9-1 Encapsulation Size Diagram



10 Package Information

The converter is supplied in tape and reel packaging. The following figure shows the tape dimensions.

Unit of measurement: mm



Item	A	B	C	D	E	F	G	H	I
Specifications	8.70	4.35	0.35	1.75	4.00	12.00	2.00	16.00	7.50
Tolerance	±0.10	±0.10	±0.05	±0.10	±0.10	±0.10	±0.10	±0.30	±0.10

NOTE

1. Carrier tape color: black.
2. Cover tape width: 13.30 mm ± 0.10 mm.
3. Cover tape color: transparent.
4. 10 sprocket hole pitch cumulative tolerance: ±0.20 mm (maximum).
5. Camber not to exceed 1 mm in 100 mm.
6. After wrapped with coiled tape, the converter is then packaged in a sealed bag together with desiccant.

11 Mechanical Consideration

Surface Mount Information

The converter uses a PSiP structure and is designed for a fully automated assembly process.

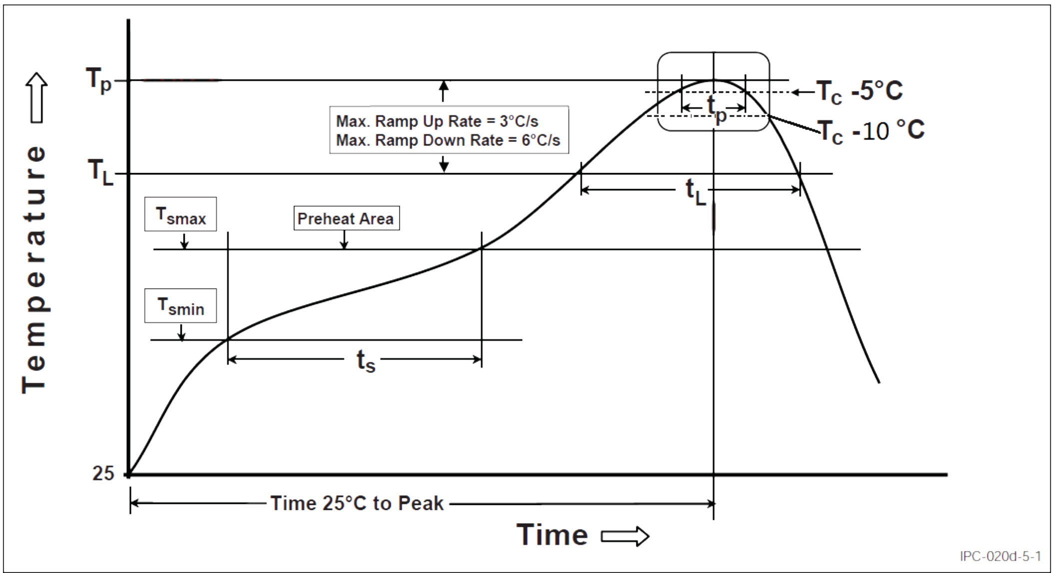
The flat surface of the label on the large inductor can be the patch mounting surface. The converter weight can be borne by a standard surface mount device (SMD). For most SMDs, the converter is heavy, and mounting on the capacitor surface will cause deviation. The solution is to optimize the model and size of the suction nozzle and increase the mounting speed and vacuum pressure.

The label meets all the requirements for surface mount processing, as well as safety standards, and is able to withstand reflow temperatures of up to 300°C. The label also carries product information such as product code and manufacturing date.

Soldering

The converter supports reflow soldering techniques. Wave soldering and hand soldering are not allowed. During the reflow process, the peak temperature must not exceed 260°C at any time.

Figure 11-1 Recommended reflow profile using lead-free solder



Item	JEDEC
Preheat & Soak Time-t_s (T_{smin} 150°C–T_{smax} 200°C)	60–120s
Ramp-up rate (from T_L: 217°C to T_{peak} 260°C)	≤ 3 °C/s
Liquidous Temperature Time–t_L T > T_L: 217°C	60–120s
Peak package body temperature T_{peak}	260°C
Time within 5°C of the specified classification temperature T_{peak} -5°C	t_p ≤ 25s
Time within 10°C of the specified classification temperature T_{peak} -10°C	t_p ≤ 35s
Ramp-down rate (from T_{peak} to T_L)	≤ 6 °C/s
Time 25°C to Peak temperature (from 25°C to T_{peak})	≤ 8 min

Moisture Resistance Requirements

Store and transport the converter as required by the MSL rating 3 specified in the IPC/JEDEC J-STD-033.

The surface of a soldered converter must be clean and dry. Otherwise, the assembly, test, or even reliability of the converter will be negatively affected.

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