

DESCRIPTION

The HM1487A is a monolithic buck switching regulator based on I2 architecture for fast transient response. Operating with an input range of 4V~23V, HM1487A delivers 8A of continuous output current with two integrated N-Channel MOSFETs. The internal synchronous power switches provide high efficiency without the use of an external Schottky diode. At light loads, the regulator operates in low frequency to maintain high efficiency and low output ripples.

HM1487A guarantees robustness with output short protection, thermal protection, current run-away protection, and input under voltage lockout.

HM1487A is available in QFN3X3-20 package, which provide a compact solution with minimal external components.

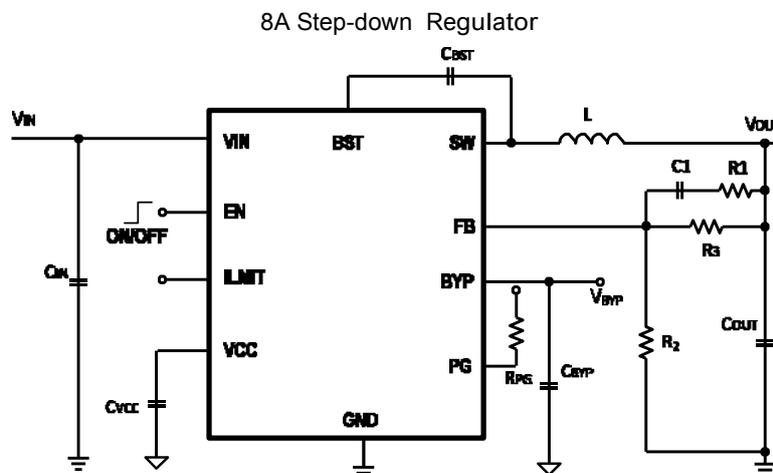
FEATURES

- 4V to 23V operating input range
- 8A continuous / 16A peak output current
- Up to 95% efficiency
- High efficiency at light load
- 500kHz switching frequency
- External bypass input
- Programmable valley current limit
- Power good indicator
- Input under voltage lockout
- Output discharge function
- Output Over Voltage latch off protection
- Output short protection
- Thermal protection
- Available in QFN3X3-20 package

APPLICATIONS

- Industrial and commercial low power system
- Notebook
- LDO monitors and TVs
- Green Electronics/ Appliances

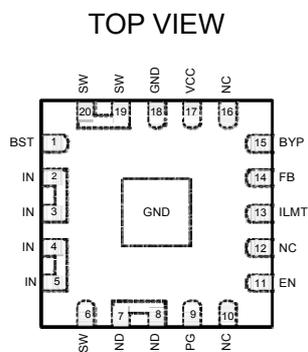
TYPICAL APPLICATION



ORDER INFORMATION

DEVICE ¹⁾	PACKAGE	TOP MARKING ²⁾
HM1487A	QFN3X3-20	HM1487A YYWW

PIN CONFIGURATION



ABSOLUTE MAXIMUM RATING

VIN, EN, PG, SW, ILMT Pin.....	-0.3V to 28V
BST Pin	SW-0.3V to SW+5V
All other Pins	-0.3V to 6V
Junction Temp. ²⁾³⁾	150°C
Lead Temperature	260°C
ESD Susceptibility (Human Body Model)	2kV

RECOMMENDED OPERATING CONDITIONS

Input Voltage VIN	4V to 23V
Output Voltage VOUT.....	0.6V to VIN-3V
Ambient Temperature Range	-40°C to 85°C

THERMAL PERFORMANCE

QFN3*3-20.....	30...4.5°C/W
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Note A

- Exceeding these ratings may damage the device.
- The HM1487A guarantees robust performance from -40°C to 150°C junction temperature. The junction temperature range specification is assured by design, characterization and correlation with statistical process controls.

- 3) The HM1487A includes thermal protection that is intended to protect the device in overload conditions. Thermal protection is active when junction temperature exceeds the maximum operating junction temperature. Continuous operation over the specified absolute maximum operating junction temperature may damage the device
- 4) Measured on JESD51-74-layer PCB

ELECTRICAL CHARACTERISTICS

VIN=12V, TA=25 Unless otherwise stated						
Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
VIN Under Voltage Lock-out Threshold	VIN_MIN	VIN rising	2.45	2.7	2.95	V
VIN Under voltage Lockout Hysteresis	VIN_MIN_HYST		130	180	230	mV
Shutdown Current	ISD	VEN=0V		2	5	μA
Supply Current	IQ	VEN=5V, VBYP=3.3V		45	70	μA
EN Rising Threshold	VEN_H		0.8			V
EN Falling Threshold	VEN_L				0.4	V
Feedback Voltage	VFB	4V<VIN<23V	594	600	606	mV
Top Switch Resistance ⁵⁾	RDS(ON)T			20		mΩ
Bottom Switch Resistance ⁵⁾	RDS(ON)B			10		mΩ
Top Switch Leakage Current	I _{LEAK_TOP}	VIN=23V, VSW=0V			1	μA
Bottom Switch Leakage Current	I _{LEAK_BOT}	VIN=23V, VSW=23V			2	μA
Bottom Switch Current Limit	ILIM	ILIM = "0"	8			A
		ILIM = Floating	12			A
		ILIM = "1"	16			A
ILMIT Rising Threshold ⁵⁾	V _{LIMTH}		VCC-0.8		VCC	V
ILMIT Falling Threshold ⁵⁾	V _{LIMTL}				0.8	V
Minimum On Time ⁵⁾	T _{ON_MIN}			100		ns
Minimum Off Time ⁵⁾	T _{OFF_MIN}	VFB=0.4V		100		ns
Switching Frequency ⁵⁾	Fs			500		kHz
Discharge FET Ron	R _{DIS}			50		Ω
Soft-Start Time ⁵⁾	T _{SS}			400		us
VCC Output	V _{CC}	VIN=12V	4.9	5	5.1	V
Power Good Threshold	PGD_TH	FB falling	93%	95%	97%	V _{REF}
Power Good Hysteresis ⁵⁾	PGD_HYS			5%		V _{REF}
Power Good Delay Time ⁵⁾	PGD_DLY			200		us
Power Good Sink Current	I _{PG}	PG=0.5V	8			mA
Output Over-voltage Threshold		VFB Rising	115%	120%	125%	V _{REF}
Output Over-voltage Hysteresis ⁵⁾				5%		V _{REF}
Output Over-voltage Delay Time ⁵⁾				20		us
Output Under-voltage Threshold		VFB Falling	55%	60%	65%	V _{REF}
Output Under-voltage Delay Time ⁵⁾		FB forced below UV threshold		200		us

VIN=12V, T _A =25 Unless otherwise stated						
Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
Bypass Switch Ron	R _{BYP}			3		Ω
Bypass Switch Turn-on Voltage	V _{BYP_ON}		4.5	4.7		V
Bypass Switch Switchover Hysteresis ⁵⁾	V _{BYP_HYS}			0.2		V
Thermal Shutdown ⁵⁾	T _{TSD}			150		°C
Thermal Shutdown hysteresis ⁵⁾	T _{TSD_HYST}			15		°C

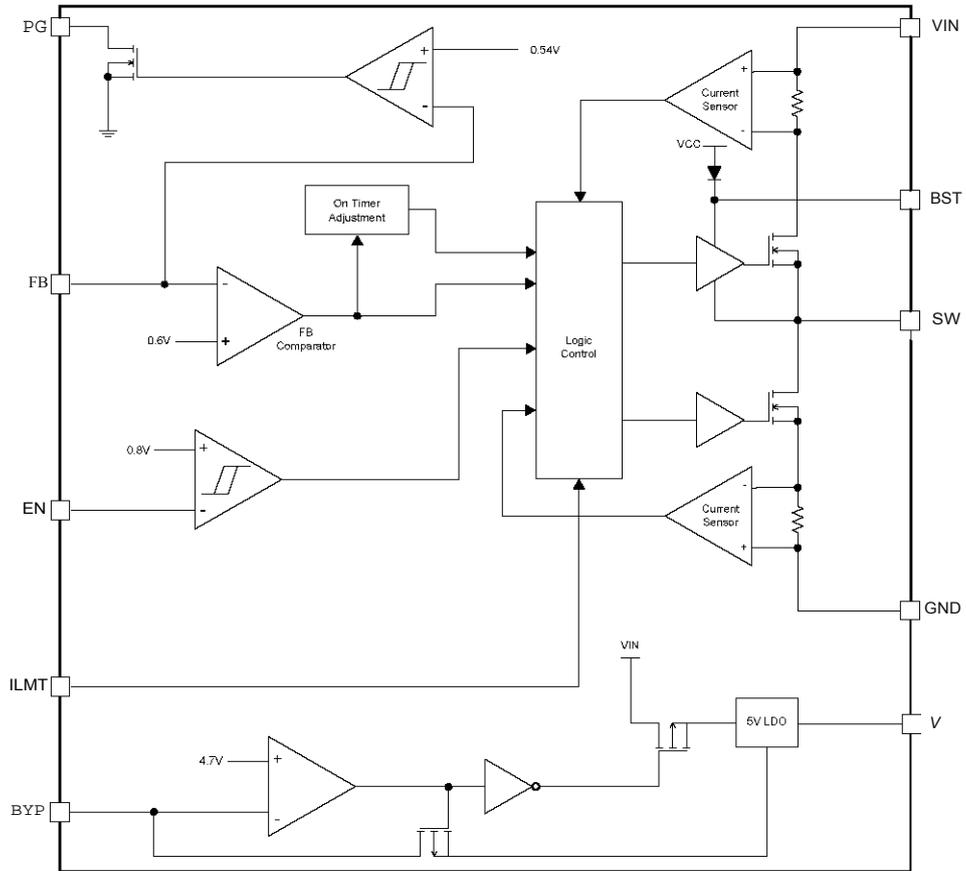
Note :

5) Guaranteed by design.

PIN DESCRIPTION

Pin	Name	Description
1	BST	Connect a 0.1uF capacitor between BST and SW pin to supply current for the top switch driver.
2,3,4,5	VIN	Input voltage pin. VIN supplies power to the IC. Connect a 4V to 23V supply to VIN and bypass VIN to GND with a suitably large capacitor to eliminate noise on the input to the IC.
6,19,20	SW	SW is the switching node that supplies power to the output. Connect the output LC filter from SW to the output load.
7,8,18,EP	GND	Ground pin
9	PG	Power good monitor output. Open drain output when the output voltage is within 95% to 120% of regulation point.
11	EN	Enable Control. Pull this pin high to turn on the Buck. Do not leave this pin floating.
10,12,16	NC	
13	ILMT	Current Limit Setting Pin. The current limit is set to 8A, 12A or 16A when this pin is pull low, floating or pull high respectively.
14	FB	Output feedback pin. FB senses the output voltage and is regulated by the control loop to 0.6V. Connect a resistive divider at FB.
15	BYP	Bypass input for the internal LDO. BYP is externally connected to the output of switching regulator. When the BYP voltage rises above the bypass switch turn-on threshold, the power supply of the internal LDO regulator changes to the external source.
17	VCC	5V Linear Regulator Output for Internal Control Circuit. A capacitor (typical 2.2uF) should be connected to GND. Don't connect to external Load.

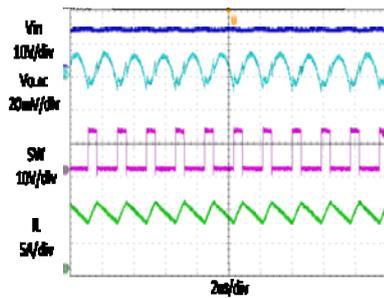
BLOCK DIAGRAM



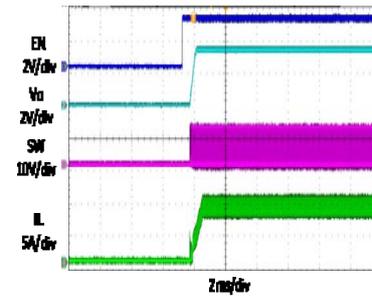
TYPICAL PERFORMANCE CHARACTERISTICS

VIN =12V, VOUT= 3.3V, L = 1.5 μ H, Cout = 3*22 μ F, TA = +25 $^{\circ}$ C, unless otherwise noted

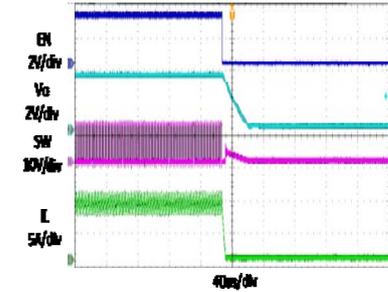
Steady State Test
 VIN=12V, VOUT=3.3V
 IOUT=8A



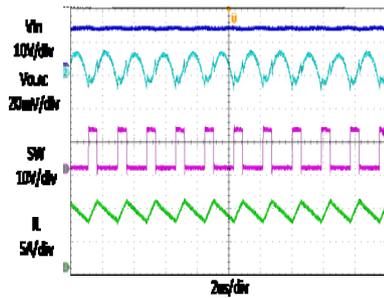
Startup through Enable
 VIN=12V, VOUT =3.3V
 IOUT =8A



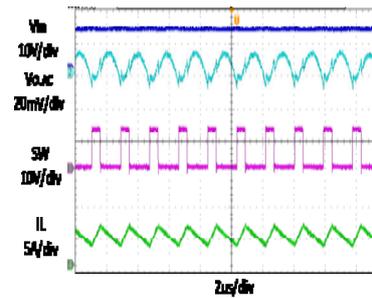
Shutdown through Enable
 VIN=12V, VOUT =3.3V
 IOUT =8A



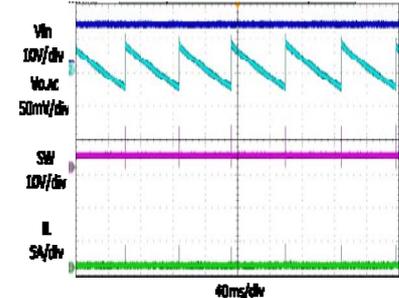
Heavy Load Operation
 8A LOAD



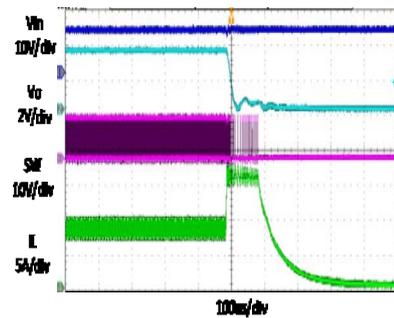
Medium Load Operation
 4A LOAD



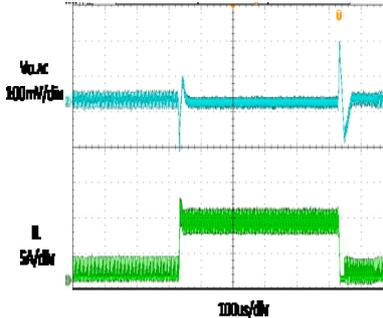
Light Load Operation
 0 A LOAD



Short Circuit Protection
 VIN=12V, VOUT =3.3V
 IOUT =8A- Short



Load Transient
 C1=10pF,R1=0k
 0.8A LOAD \rightarrow 8A LOAD \rightarrow 0.8A LOAD



TYPICAL PERFORMANCE CHARACTERISTICS (continued)

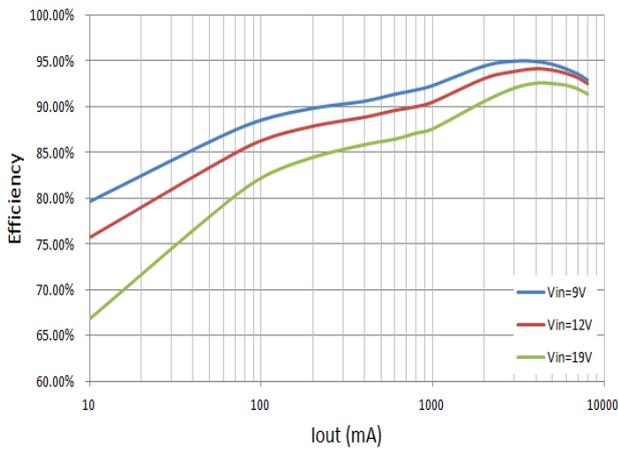


Figure 1. Efficiency vs Load Current
(Vout=3.3V, L=1.5uH)

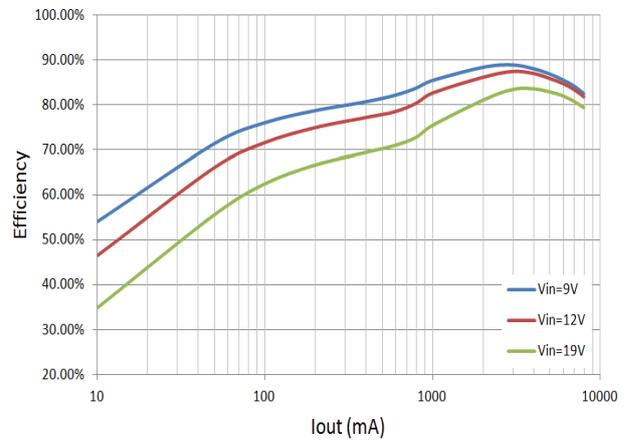


Figure 2. Efficiency vs Load Current
(Vout=1V, L=1uH)

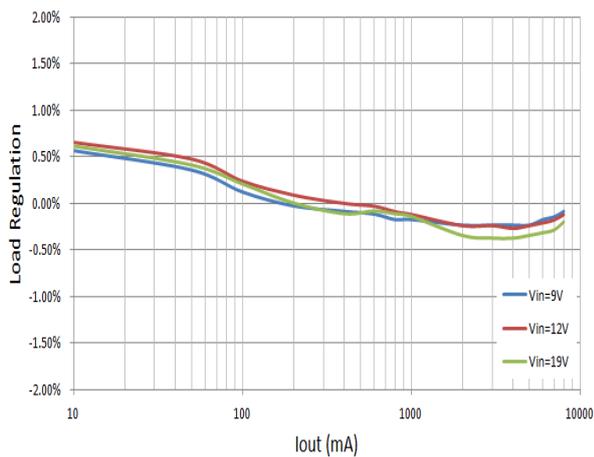


Figure 3. Load regulation vs Load Current
(Vout=3.3V, L=1.5uH)

FUNCTIONAL DESCRIPTION

HM1487A is a synchronous step-down regulator based on I2 control architecture. It regulates input voltages from 4V to 23V down to an output voltage as low as 0.6V, and is capable of supplying up to 8A continuous, 16A peak load current.

Power Switch

N-Channel MOSFET switches are integrated on the HM1487A to down convert the input voltage to the regulated output voltage. Since the top MOSFET needs a gate voltage greater than the input voltage, a boost capacitor connected between BST and SW pins is required to drive the gate of the top switch. The boost capacitor is charged by the internal 3.7V rail when SW is low.

VIN Under-Voltage Protection

In addition to the enable function, the HM1487A provides an Under Voltage Lock-out (UVLO) function that monitors the input voltage. To prevent operation without fully-enhanced internal MOSFET switches, this function inhibits switching when input voltage drops below the UVLO-falling threshold. The IC resumes switching when input voltage exceeds the UVLO-rising threshold.

Soft Start

The HM1487A has an internal soft-start function to prevent large inrush current and output voltage overshoot when the converter starts up. The soft-start (SS) automatically begins once the chip is enabled. During soft-start, it clamps the ramping of internal reference voltage which is compared with FB signal. The typical soft-start duration is 0.4ms.

Enable and Disable

The HM1487A's EN is used to control converter, the enable voltage (EN) has low and high threshold voltage. When VEN is below its high threshold voltage, the IC enters shutdown mode. When VEN exceeds its high threshold voltage, the converter is fully operational. In shutdown mode, the entire regulator of HM1487A is off.

Power Good

The HM1487A has power-good (PG) output. The PG pin is the open drain of a MOSFET. Connect to Vcc or another voltage source through a resistor. It is high if the output voltage is higher than 95% or lower than 120% of the nominal voltage.

Output Voltage Over-voltage Protection

HM1487A integrates both output over-voltage protection and under-voltage protection. If the output voltage rises above the regulation level, the high-side MOSFET naturally remains off and the synchronous rectifier will turn on until the inductor current reaches the zero. If the output voltage exceeds the OVP threshold for longer than 20 us (typical), the OVP function is triggered. If the output voltage drops below the UVP trip threshold for longer than 200 us (typical), the UVP function is triggered.

HM1487A use latch-off mode in OVP and UVP. When the protection function is triggered, the IC will shut down. The IC stops switching and is latched off. To restart operation, toggle EN or power the IC off and then on again.

Current Limit

The HM1487A current limit is adjustable (8A,12A,16A) by ILMT pin and it is a cycle-by-cycle “ valley ” mechanism, measuring the inductor current through the synchronous rectifier during the off-time while the inductor current ramps down. The current is determined by measuring the voltage between source and drain of the synchronous rectifier, adding temperature compensation for greater accuracy. If the current exceeds the current limit, the turn-on signal of top MOSFET is inhibited until the inductor current ramps down below the current limit. Thus, only when the inductor current is well below the current limit, another on-time is permitted. If the output current exceeds the available inductor current (controlled by the current limit mechanism), the output voltage will drop. If it drops below the output under-voltage protection level, the IC will stop switching to avoid excessive heat.

Linear Regulator (VCC)

The HM1487A integrates a 5V linear regulator

(VCC). When the input voltage of BYP pin is lower than the switch over threshold 4.7V, the VCC regulator steps down input voltage to supply both internal circuitry and gate drivers. When the input voltage of BYP pin is higher than the switch over threshold 4.7V, an automatic circuit will change the power source of linear regulator from VIN path to external path, therefore the power dissipation of linear regulator will be decrease efficiently. A 2.2uF ceramic capacitor is recommended to bypass VCC to GND. Do not connect the VCC pin to external loads.

Thermal Protection

When the temperature of the HM1487A rises above 150°C, it is forced into thermal protection (OTP). The HM1487A uses latch-off mode in OTP. When the protection function is triggered, the IC will shut down. The IC stops switching and is latched off. To restart operation, toggle EN or power the IC off and then on again.

APPLICATION INFORMATION

Output Voltage Set

The output voltage is determined by the resistor divider connected at the FB pin, and the voltage ratio is:

$$V_{FB} = V_{OUT} * \frac{R_2}{R_2 + R_3}$$

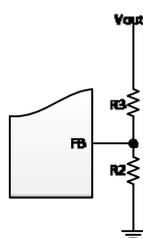
where V_{FB} is the feedback voltage and V_{OUT} is the output voltage.

Choose R_2 around 15k Ω , and then R_3 can be calculated by:

$$R_3 = R_2 * \left(\frac{V_{OUT}}{0.6} - 1 \right)$$

Too large resistance and the following table lists the recommended values.

$V_{OUT}(V)$	$R_2(k\Omega)$	$R_3(k\Omega)$
1	10	6.65
1.2	10	10
1.5	10	15
2.5	17.8	56.2
3.3	17.8	80.6
5	17.8	130



Input Capacitor

The input capacitor is used to supply the AC input current to the step-down converter and maintaining the DC input voltage. The ripple current through the input capacitor can be calculated by:

$$I_{CIN} = I_{OUT} * \sqrt{\frac{V_{OUT}}{V_{IN}} * \left(1 - \frac{V_{OUT}}{V_{IN}} \right)}$$

where I_{OUT} is the load current, V_{OUT} is the output

voltage, V_{IN} is the input voltage.

Thus the input capacitor can be calculated by the following equation when the input ripple voltage is determined.

$$C_{IN} = \frac{I_{OUT}}{f_s * \Delta V_{IN}} * \frac{V_{OUT}}{V_{IN}} * \left(1 - \frac{V_{OUT}}{V_{IN}} \right)$$

where C_{IN} is the input capacitance value, f_s is the switching frequency, V_{IN} is the input ripple voltage. The input capacitor can be electrolytic, tantalum or ceramic. To minimizing the potential noise, a small X5R or X7R ceramic capacitor, i.e. 0.1 μ F, should be placed as close to the IC as possible when using electrolytic capacitors.

A 10 μ F*4 ceramic capacitor is recommended in typical application.

Output Capacitor

The output capacitor is required to maintain the DC output voltage, and the capacitance value determines the output ripple voltage. The output voltage ripple can be calculated by:

$$\Delta V_{OUT} = \frac{V_{OUT}}{f_s * L} * \left(1 - \frac{V_{OUT}}{V_{IN}} \right) * \left(R_{ESR} + \frac{1}{8 * f_s * C_{OUT}} \right)$$

where C_{OUT} is the output capacitance value and R_{ESR} is the equivalent series resistance value of the output capacitor.

The output capacitor can be low ESR electrolytic, tantalum or ceramic, which lower ESR capacitors get lower output ripple voltage. The output capacitors also affect the system stability and transient response, and a 66 μ F~88 μ F ceramic capacitor is recommended in typical application.

Inductor

The inductor is used to supply constant current to the output load, and the value determines the

ripple current which affect the efficiency and the output voltage ripple. The ripple current is typically allowed to be 40% of the maximum switch current limit, thus the inductance value can be calculated by:

$$L = \frac{V_{OUT}}{f_s * \Delta I_L} * \left(1 - \frac{V_{OUT}}{V_{IN}}\right)$$

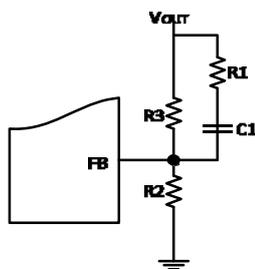
where V_{IN} is the input voltage, V_{OUT} is the output voltage, f_s is the switching frequency, and ΔI_L is the peak-to-peak inductor ripple current.

External Bootstrap Capacitor

A bootstrap capacitor is required to supply voltage to the top switch driver. A 0.1uF low ESR ceramic capacitor is recommended to be connected to the BST pin and SW pin.

Feedforward Capacitor

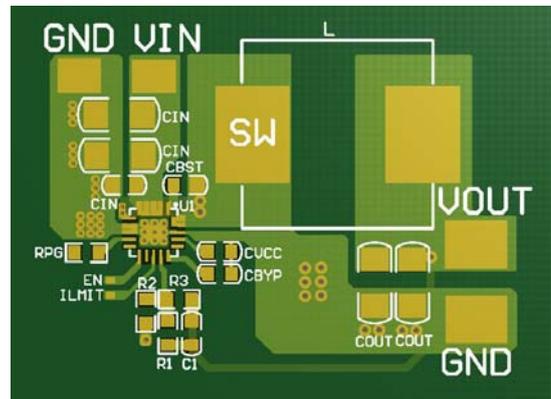
In order to minimize the ripple of output voltage at load transient, a feedforward capacitor in series with a resistor should be in parallel to the upper divider resistor. Choose R_1 around 0kΩ and C_1 around 10pF.



PCB Layout Note

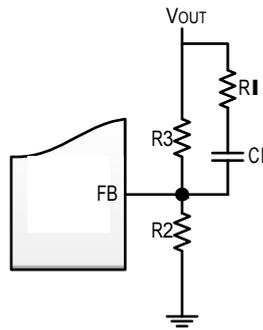
For minimum noise problem and best operating performance, We should place the following components close to the IC: C_{IN} , C_{VCC} , L , R_2 and R_3 .

1. Place the input decoupling capacitor as close to HM1487A (V_{IN} pin and GND) as possible to eliminate noise at the input pin. The loop area formed by input capacitor and GND must be minimized.
2. Put the feedback trace as far away from the inductor and noisy power traces as possible.
3. The ground plane on the PCB should be as large as possible for better heat dissipation.



External Components Suggestion:

Vout(V)	R2 (kΩ)	R3 (kΩ)	R1 (kΩ)	C1 (pF)	L(uH)	COU(uF)
1	10	6.65	0	10	1	66~88
1.2	10	10	0	10	1	66~88
1.5	10	15	0	10	1	66~88
2.5	17.8	56.2	0	10	1.5	66~88
3.3	17.8	80.6	0	10	1.5	66~88
5	17.8	130	0	10	1.5	66~88



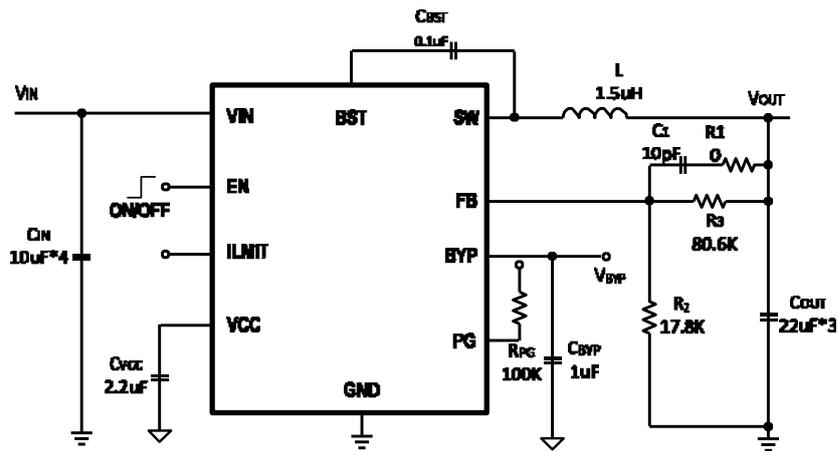
REFERENCE DESIGN

Reference 1:

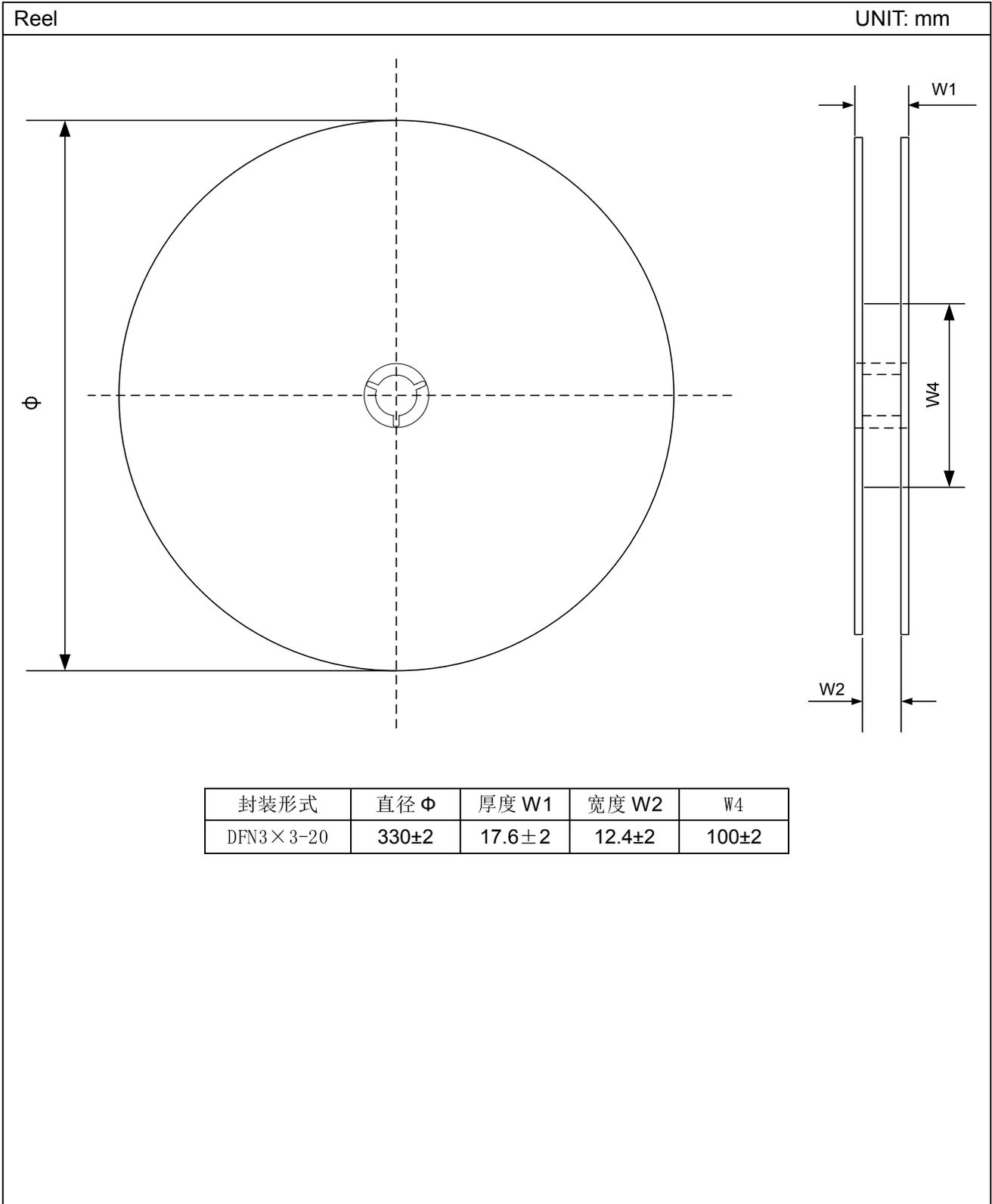
V_{IN} : 4V~23V

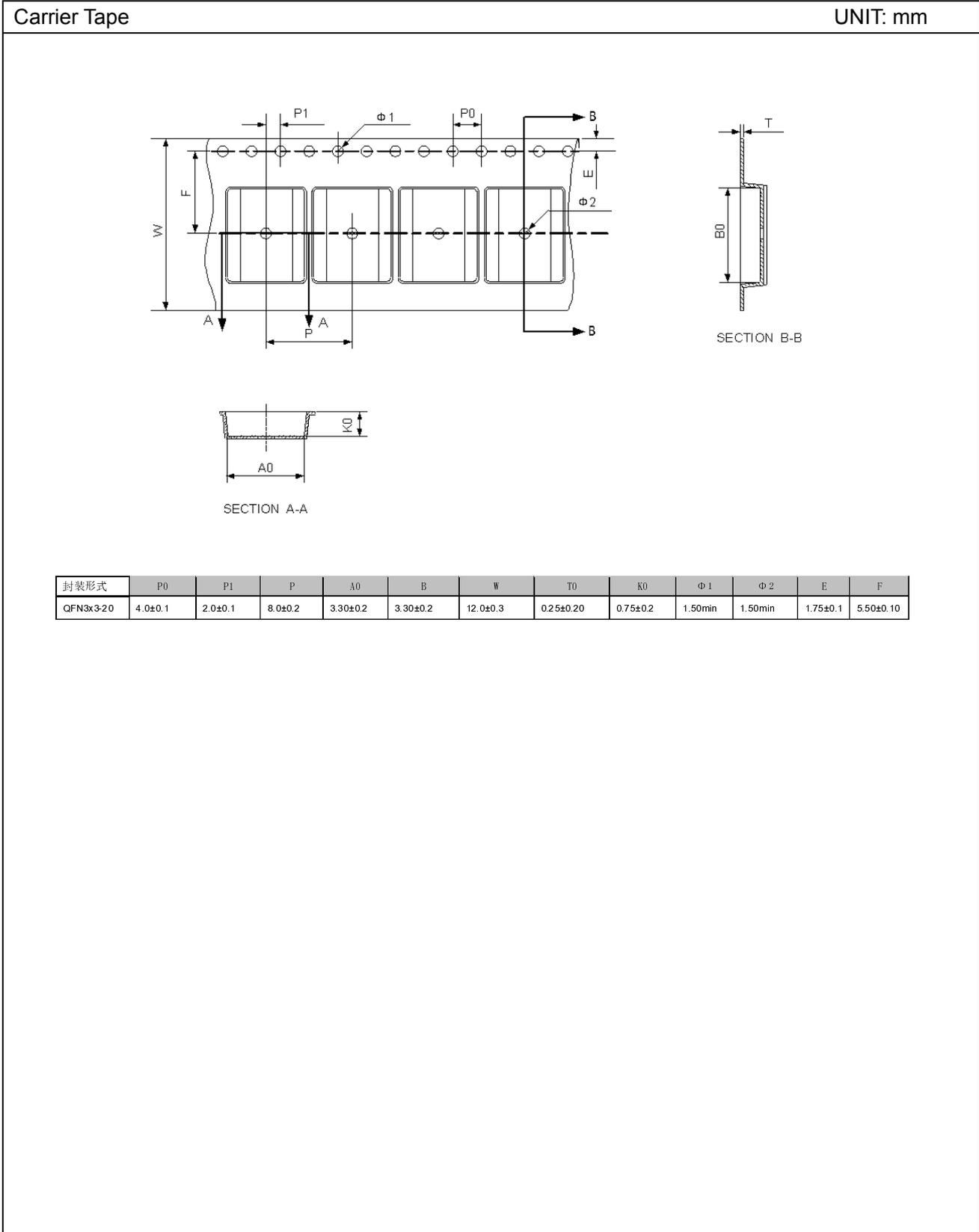
V_{OUT}: 3.3V

I_{OUT}: 0~8A



TAPE AND REEL INFORMATION





PACKAGE OUTLINE

