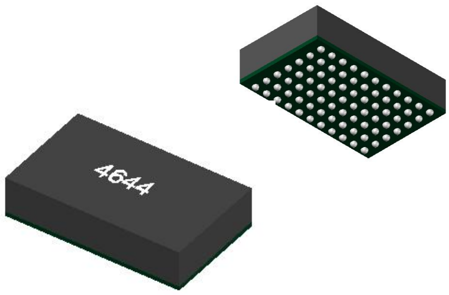
Four DC/DC converters, each outputting **4A**, capable of being paralleled for a total of **16A**

Ultra-thin **SIP** Packaged Power Module



1 Features

- **Utilize SMT technology and SIP plastic-encapsulated packaging**
- **General Specificatio： GJB 10164-2021**
- **Detailed Specification: SC-Q/GZX52013-2022**
- **Output Current: Each channel provides a continuous full-load output current of 4A, with a peak of 5.5A**
- **Parallel Connection: Four channels can be paralleled for a total output of 16A**
- **Operating Temperature (Tc)：-55℃ ~ +125℃**
- **Wide Input Voltage Range: 4.0V to 15V**
- **Output Voltage Range:0.8V to 5.5V**
- **Switching Frequency: Variable frequency, capable of automatic adjustment, typically 1MHz**
- **Operating Mode: Automatic adjustment mode**
- **Efficiency: 92%**
- **No-load Power Consumption: The total for four channels is 0.01W (at 12Vin, 5V output)**
- **Output Ripple Voltage: 15mVp-p (typical)**
- **Voltage Regulation: ±1.0% (typical)）**
- **Load Regulation: ±0.5% (typical)**
- **Soft-start: Internal 1ms soft-start (with an optional external 1ms soft-start)**
- **Protection Features: Protection against output overcurrent, overheating, output overvoltage, and input undervoltage**
- **Regular size:**
  LGA package(9.0*15.0*4.32mm)
  BGA package(9.0*15.0*5.01mm)
- **Ultra-thin size:**
  LGApackage(9.0*15.0*1.82mm)
  BGApackage(9.0*15.0*2.42mm)

2 Applications

- **Multi-rail Point-of-Load Regulation**
- **Power Supply for CPUs and GPUs**
- **Power Supply for ASIC Chips such as CPLDs, DSPs, and FPGAs**

3 Description

The FHT4644 is a non-isolated buck DC/DC power module with a wide input voltage range of 4 to 15V and an adjustable output voltage of 0.8 to 5.5V. It features four output channels, each capable of delivering up to 4A, and offers users the choice of LGA and BGA packaging options.

The FHT4644 is an SMT surface-mount module that is welded onto the PCB board using reflow soldering. It boasts high power density and a compact size, with an ultra-thin thickness of only 1.82mm and a power density reaching 300W/cm³.

The power module circuit integrates the power supply chip, inductor, and related components, allowing for the rapid design of a multi-channel power supply system by simply configuring a voltage-adjusting resistor and a few input/output ceramic capacitors for each output channel.

This simplified system design maximizes PCB layout space savings.

As a point-of-load power supply, the FHT4644 can be directly mounted next to the FPGA, providing high-precision voltages such as 5.0V, 3.3V, 2.5V, and 1.2V for digital circuits, FPGA control circuits, motherboards, CPUs, communication systems, storage, and other components in the system.

Each channel can continuously provide a current of 4A, and the four output channels can be combined and used in parallel, as well as paralleled with other FHT4644 power modules.

It is ideally suited for applications requiring low output voltages and multiple channels.

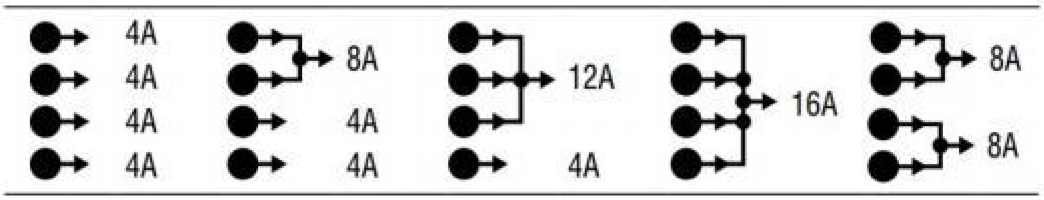
The operating mode and frequency of the FHT4644 can be automatically adjusted based on real-time input and output voltages and loads, which not only simplifies the peripheral circuitry but also minimizes no-load power consumption, ensuring that the power module always operates in the optimal state.

All components of the FHT4644 are domestically produced, and an autonomous and controllable report can be provided. Additionally, this power module is characterized by high reliability,high efficiency, and long life.

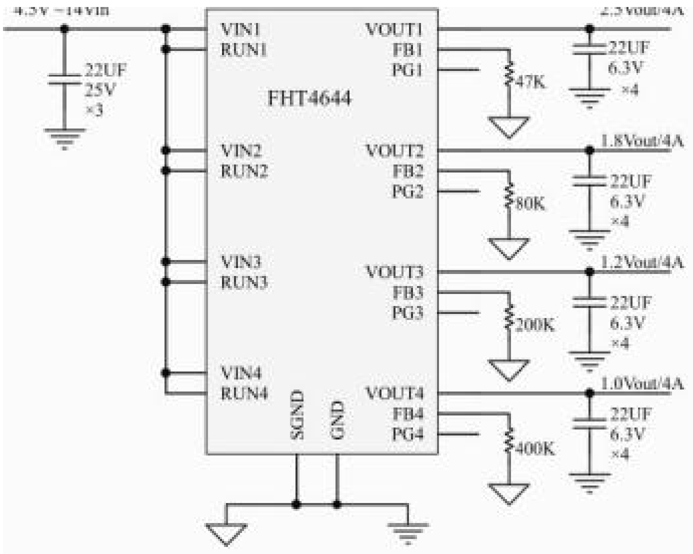
Especially when outputting low voltages, its efficiency is significantly higher than similar products, providing a more reliable and stable power supply for the system.

Typical Application

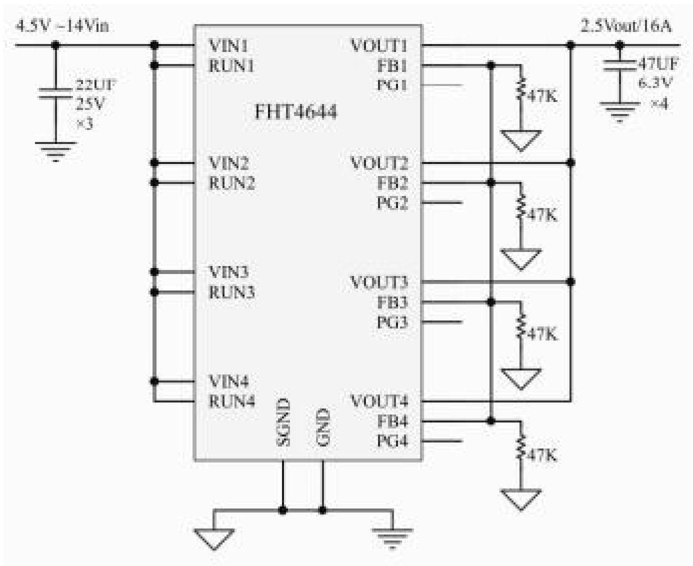
Configurable output array



Non-parallel Application

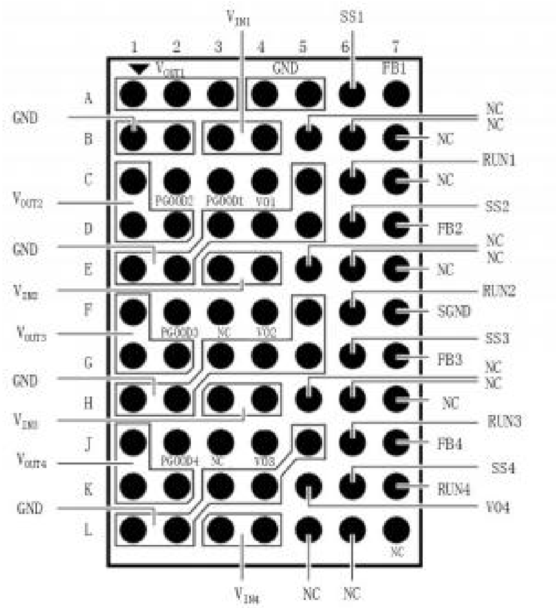


Parallel Application



PIN CONFIGURATION

TOP VIEW



Pin	Description
VOUT1（A1,A2,A3）,VOUT2（C1,D1,D2）, VOUT3（F1,G1,G2）,VOUT4（J1,K1,K2）,	Power Module Quad Output Pins
VIN1（B3,B4）,VIN2（E3,E4）,VIN3（H3,H4） ,VIN4（L3,L4）	Power Module Quad Input Pins
GND（A4,A5, B1,B2, C5, D3,D4,D5, E1,E2,F5, G3,G4,G5,H1,H2, J5,K3, K4,L1,L2)	Ground pin
FB1（A7）, FB2（D7）,FB3（G7）, FB4(J7)	The four output voltage adjustment pins can be connected to GND with 0.5% accuracy voltage adjustment resistors.
RUN1（C6）, RUN2（F6）, RUN3（J6）, RUN4（K7）	The four enable pins can be directly connected to the input voltage, or connected to an external power supply to control the power module. The minimum enable voltage is 1.1V, and when the enable voltage is lower than 0.95V, the power supply will be turned off. It is recommended that the enable voltage is greater than 1.2V, this pin can not be suspended.
PGOOD1（C3）,PGOOD2（C2）, PGOOD3 (F2）,PGOOD4（J2）	The fault indicator pin, PG=High indicates that VOUT is within the voltage range, while PG=Low indicates that VOUT is below the specified value. The PGOOD pin can be connected to the VO pin through a 100K resistor (note: it is necessary to evaluate whether the actual voltage at the VO pin meets the voltage requirements of the subsequent FPGA or other chip I/O ports). Alternatively, an external voltage can be supplied to PGOOD. When PGOOD is set to Low, it indicates an abnormality in the power module (including undervoltage (UV), overvoltage (OV), overcurrent (OC), overtemperature (OT), etc.). If the fault indication function is not required, this resistor can be omitted, and PGOOD can be left floating.
VO1（C4), VO2（F4), VO3（J4), VO4(K5)	VO can serve as the power supply pin for PG. The four sets of VO have been respectively connected to the four output terminals within the power module, i.e., VO1=VOUT1, VO2=VOUT2, VO3=VOUT3, and VO4=VOUT4.
MODE1(B6), MODE2(E6), MODE3(H6), MODE4(L6)	Unused pins, without electrical function, can be connected to any pin. (The FHT4644 can automatically adjust its operating frequency and mode, with a typical operating frequency of 1MHz.)
SGND（F7)	Signal ground. It is recommended to separate the wiring of GND (power ground) and SGND, and ultimately connect them using a 0-ohm resistor.
SS1（A6), SS2(D6), SS3(G6), SS4(K6)	External soft-start pin. An external 3.3nF ceramic capacitor can be connected to the signal ground. If the external soft-start function is not required, this capacitor can be omitted, and the SS pin can be left floating.
NC（E7,H7,L7,C7,L5,H5,E5,B5,J3,F3)	Unused pin without electrical function, it can be connected to any pin.

Electrical Characteristics

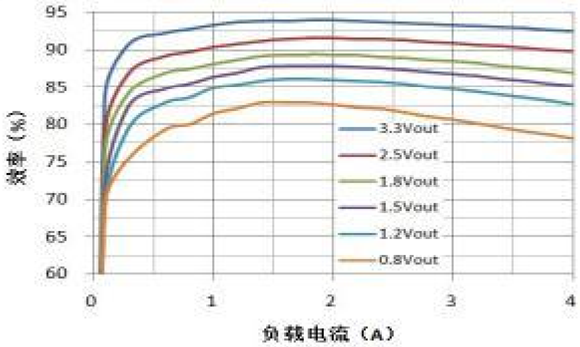
Limit Value	Condition	Minimum value	Nominal value	Maximum value	Unit
V_{IN} (each way)		-0.3		17	V
FB、V_{OUT} (each way)		-0.3		7	V
PGOOD (each way)		-0.3		12	V
PGOOD (each way)				10	mA
VO, SS/TR (each way)		-0.3		7	V
RUN (each way)		-0.3		17	V
Storage temperature		-55		150	℃
Reflow temperature				245	℃
Input Characteristics	**Condition**	**Minimum value**	**Nominal value**	**Maximum value**	**Unit**
Input Voltage Range		4.0	12	14	V
Power-on voltage threshold			3.95		V
Shutdown Voltage Threshold		3.5	3.6	3.9	V
Input current at full load	V_{IN} =12V, V_{OUT} =1.5V, I_{OUT} =4A		0.6		A
Input current at low voltage full load	V_{IN} =5V, V_{OUT} =1.5V, I_{OUT} =4A		1.5		A
Input current at no load	V_{IN} =12V, V_{OUT} =1.5V, I_{OUT} =0A		650		μA
Static Input Current	ON/OFF=OFF		15		μA
General Requirements	**Condition**	**Minimum Value**	**Nominal Value**	**Maximum Value**	**Unit**
Switching Frequency	Automatic Adjustment		1000		KHz
Efficiency	Vin=5V , Vout=3.3V			92	%
Soft Start Time	SS pin with 3.3nF ceramic capacitor		2		ms
Enable	**Condition**	**Minimum value**	**Nominal value**	**Maximum value**	**Unit**
RUN enable voltage		1.2	-	14	V
Output Characteristics	**Condition**	**Minimum value**	**Nominal value**	**Maximum value**	**Unit**
Output Voltage Range	Adjusted by FB pin resistor	0.8		5.5	V
Output Voltage	C_{IN} = 22μF, C_{OUT} = 22uF×4,VIN = 4V to 14V, I_{OUT} = 0A to 4A	1.47	1.5	1.53	V
Linear Regulation	V_{OUT} = 1.5V , 4V < V_{IN} < 14V , I_{LOAD} = 4A		±0.5	±1	%
Load Regulation	V_{IN} =12V , V_{OUT} =1.5V,1A < I_{LOAD} ≤ 4A		±1	±2	%
Ripple and Noise	V_{IN} =12V , V_{OUT} =1.5V , I_{OUT} =4A, C_{out} =22uF×4 , 20MHz bandwidth		10	50	mV
Dynamic Load Response	75-100% full load , di/dt = 1A/μS Cout =22uF×4		50, 40		mV, μs

Electrical Characteristics

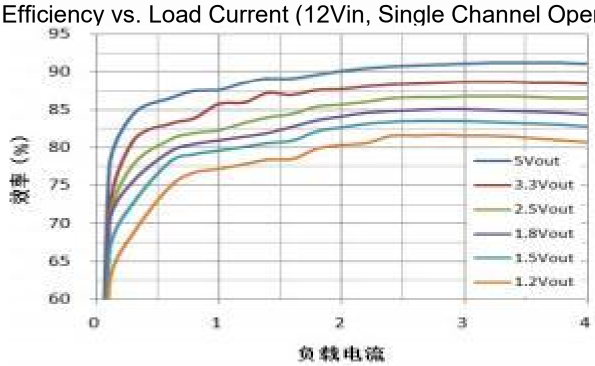
Output Characteristics	Condition	Minimum value	Nominal value	Maximum value	Unit
Output Overcurrent Protection	Iout%	115	120	125	%
Output Overvoltage Protection	Vout%	115	115	130	%
Over-Temperature Protection	Case temperature（Tc）	-	-	135	℃
Structural Characteristics	**Conditions**	**Minimum Value**	**Nominal value**	**Maximum value**	**Unit**
Packaging	LGA、BGA	-	-	-	-
Standard Size	LGA: 9*15*4.32; BGA: 9*15*5.01	-	-	-	mm
Ultra-thin Size	LGA: 9*15*1.82; BGA: 9*15*2.42	-	-	-	mm
Weight			1.6		g
Environmental Adaptability	**Condition**	**Minimum value**	**Nominal value**	**Maximum value**	**Unit**
Operating temperature (Case temperature)		-55		125	℃
High temperature storage (ambient temperature)	+125℃，48h			125	℃
High temperature operation (ambient temperature)	+85℃，24h; Input: 8 hours each for low voltage, standard voltage, load derating, and high voltage			85	℃
Low temperature storage (ambient temperature)	-55℃，24h	-55			℃
Low temperature operation (ambient temperature)	-55℃，24h; nput low pressure, standard pressure, high pressure each 8h	-55			℃
Damp heat	High temperatu re and high humidity stage: 60℃, 95%; Low temperature and high humidity stage: 30℃, 95%; 10 cycles, each cycle is 24h.	30		60	℃
Temperature shock	High temperature 125 ℃, low temperature -55 ℃, high and low temperature of an hour for a cycle, a total of 32 cycles of the test	-55		125	℃

NOTE : Stresses above the values listed in the "Limit Values" section may cause permanent damage to the device. Prolonged exposure to any of the absolute maximum ratings may affect the reliability and life of the device.

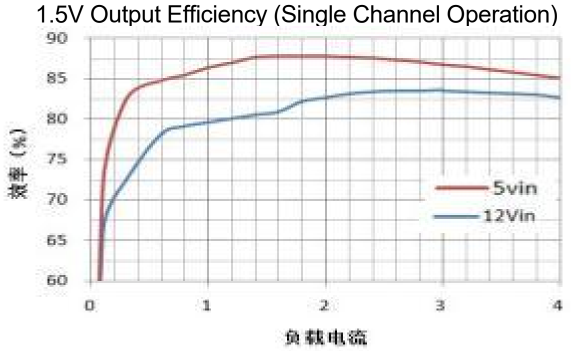
Efficiency vs. Load Current (5Vin, Single Channel Operation)



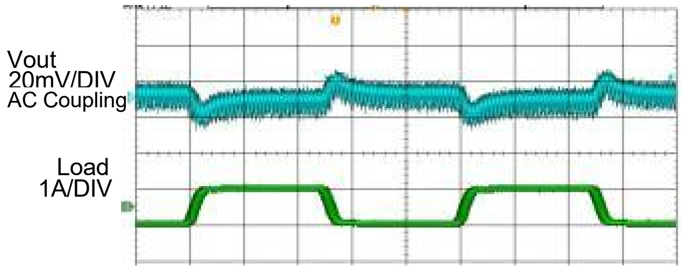
Efficiency vs. Load Current (12Vin, Single Channel Operation)



1.5V Output Efficiency (Single Channel Operation)

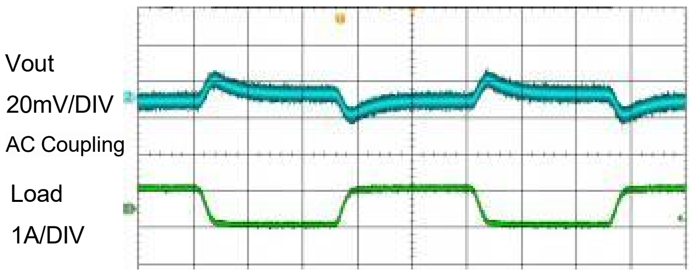


Dynamic Load Response at 1.0V



Vin =12V， Vout=1.0V,Iout=3A-4A， 1A/us Output Capacitance=4*22uF+0.1uFCeramic Capacitor

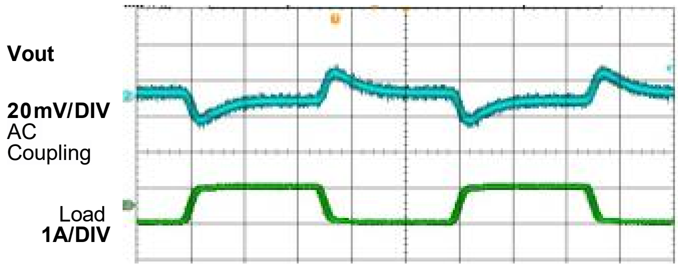
Dynamic Load Response at 1.5V



40us/DIV

Vin =12V， Vout=1.5V,Iout=3A-4A， 1A/us Output Capacitance=4*22uF+0.1uFCeramic Capacitor

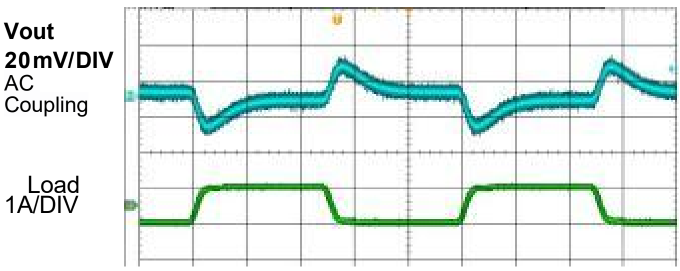
2.5V动态负载响应



40us/DIV

Vin=12V， Vout=2.5V,Iout=3A-4A， 1A/us Output Capacitance=4*22uF+0.1uFCeramic Capacitor

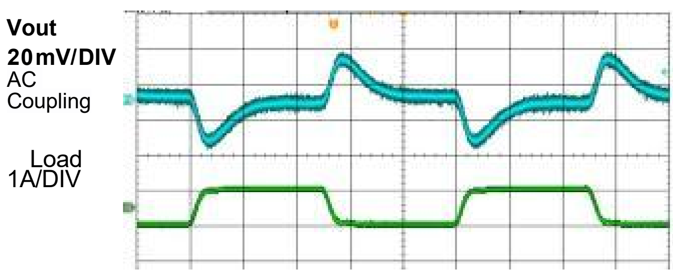
Dynamic Load Response at 3.3V



40us/DIV

Vin=12V， Vout=3.3V,Iout=3A-4A， 1A/us Output Capacitance=4*22uF+0.1uFCeramic Capacitor

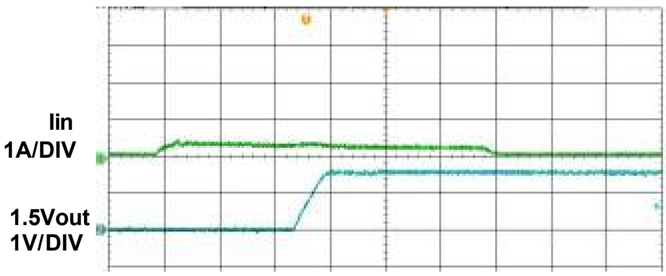
Dynamic Load Response at 5.0V



40us/DIV

Vin=12V， Vout=3.3V,Iout=3A-4A， 1A/us Output Capacitance=4*22uF+0.1uFCeramic Capacitor

Output Startup - No Load

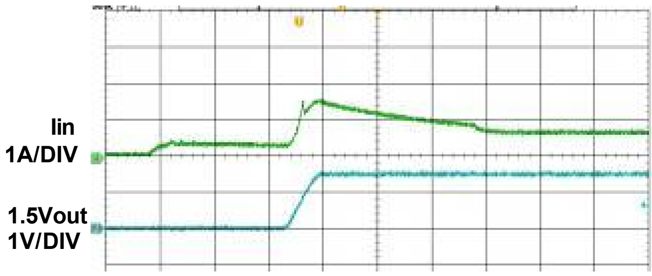


2ms/DIV

Vin=12V， Vout=1.5V,Iout=0A

Input Capacitance = 150uF electrolytic capacitor + 4 * 22uF + 0.1uF ceramic capacitor
Output Capacitance = 4 * 22uF + 0.1uF ceramic capacitor

Output Startup with 4A Load

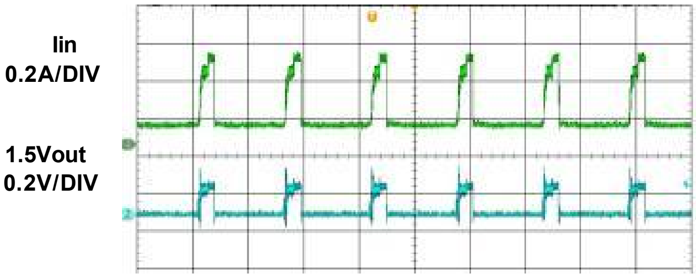


2ms/DIV

Vin=12V， Vout=1.5V,Iout=4.0A

Input Capacitance = 150uF electrolytic capacitor + 4 * 22uF + 0.1uF ceramic capacitor
Output Capacitance = 4 * 22uF + 0.1uF ceramic capacitor

Normal State and Hiccup Mode underOutput Short-Circuit and No-Load Condition

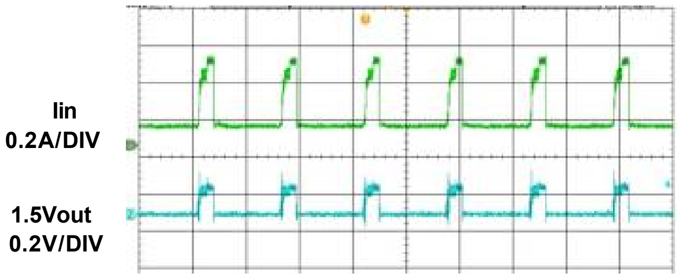


4ms/DIV

Vin=12V， Vout=1.5V,Iout=0A

Input Capacitance = 150uF electrolytic capacitor + 4 * 22uF + 0.1uF ceramic capacitor
Output Capacitance = 4 * 22uF + 0.1uF ceramic capacitor

Output Short-Circuit with 4A Load in Normal and Hiccup Modes

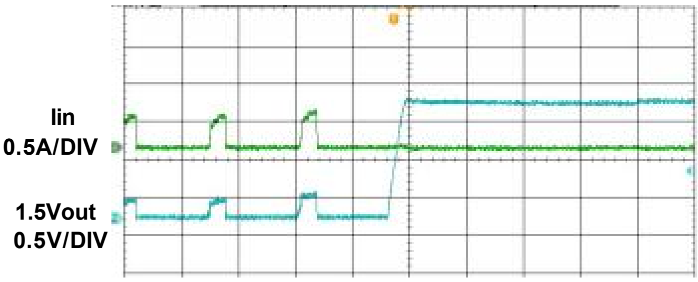


4ms/DIV

Vin=12V， Vout=1.5V,Iout=4.0A

Input Capacitance = 150uF electrolytic capacitor + 4 * 22uF + 0.1uF ceramic capacitor
Output Capacitance = 4 * 22uF + 0.1uF ceramic capacitor

Output Short-Circuit Removal - No-Load (Transient, Hiccup Mode)

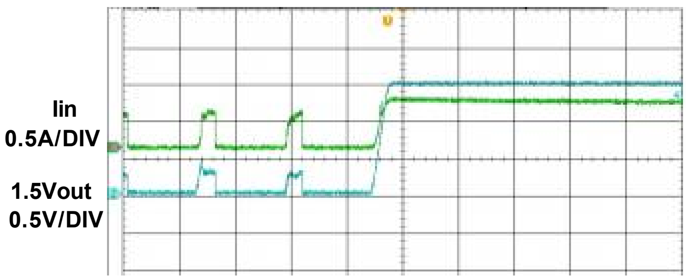


4ms/DIV

Vin=12V， Vout=1.5V,Iout=0A

Input capacitance = 150uF electrolytic capacitor + 4*22uF + 0.1uF ceramic capacitor Output capacitance = 4*22uF + 0.1uF ceramic capacitor

Output Short-Circuit Removal - 4A Load (Transient, Hiccup Mode)



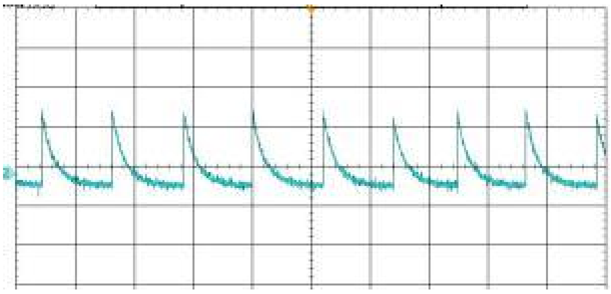
4ms/DIV

Vin=12V， Vout=1.5V,Iout=4.0A

Input capacitance = 150uF electrolytic capacitor + 4*22uF + 0.1uF ceramic capacitor Output capacitance = 4*22uF + 0.1uF ceramic capacitor

1.5V output

1.5Vout
20mV/DIV



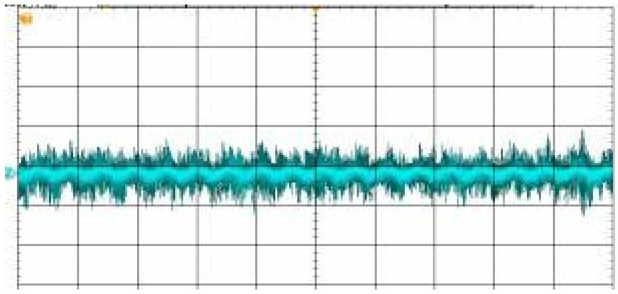
100ms/DIV

Vin=12V， Vout=1.5V,Iout=0A

Input capacitance = 4*22uF+0.1uF ceramic capacitor
Output capacitance = 4*22uF+0.1uF ceramic capacitor
20MHZ bandwidth limitation

1.5V Output Ripple - 4A Load

1.5Vout
10mV/DIV



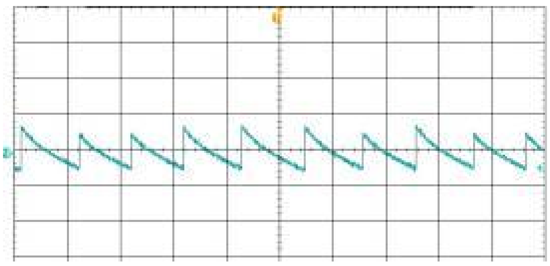
2us/DIV

Vin=12V， Vout=1.5V,Iout=4.0A

Input capacitance = 4*22uF+0.1uF ceramic capacitor Output capacitance = 4*22uF+0.1uF ceramic capacitor 20MHZ bandwidth limitation

3.3V output ripple-no load

3.3Vout
50mV/DIV



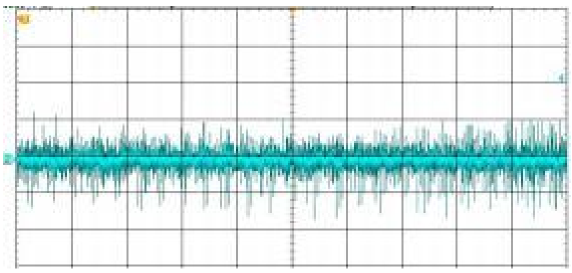
20ms/DIV

Vin=12V， Vout=3.3V,Iout=0A

Input capacitance = 4*22uF+0.1uF ceramic capacitor Output capacitance = 4*22uF+0.1uF ceramic capacitor 20MHZ bandwidth limitation

3.3V Output Ripple under 4A Load

3.3Vout
5mV/DIV



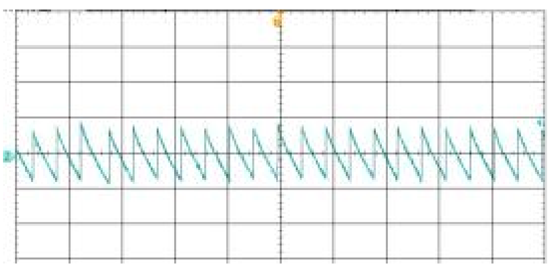
100us/DIV

Vin=12V， Vout=3.3V,Iout=4.0A

Input capacitance = 4*22uF+0.1uF ceramic capacitor Output capacitance = 4*22uF+0.1uF ceramic capacitor 20MHZ bandwidth limitation

5V Output Ripple-No Load

5Vout
50mV/DIV



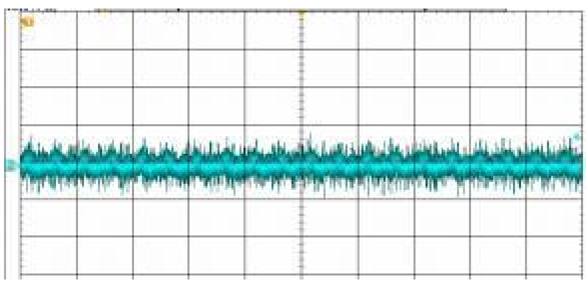
20ms/DIV

Vin=12V， Vout=5.0V,Iout=0A

Input capacitance = 4*22uF+0.1uF ceramic capacitor Output capacitance = 4*22uF+0.1uF ceramic capacitor 20MHZ bandwidth limitation

5V Output Ripple-4A Load

5.0Vout
10mV/DIV



100us/DIV

Vin=12V， Vout=5.0V,Iout=4.0A

Input capacitance = 4*22uF+0.1uF ceramic capacitor Output capacitance = 4*22uF+0.1uF ceramic capacitor 20MHZ bandwidth limitation

Operation

FHT4644 is a four-channel independent output non-isolated DC/DC switching regulator. It has four independent regulator channels, each capable of providing up to 4A of continuous output current, requiring only a small amount of external input and output capacitance. Within the input voltage range of 4.0V to 15V, each regulated channel can provide an accurately regulated output voltage through an external resistor, with a voltage range of 0.8V to 5.5V.

RUN Start

Pulling the RUN pin of each regulator channel to ground forces the regulator into shutdown mode, turning off the power MOSFET and most of the internal control circuits. Keeping the RUN pin above 0.7V only turns on the internal reference while still keeping the power MOSFET off. Further increasing the RUN pin voltage above 1.2V will turn on the entire regulator channel.

The output voltage setting is internal to the FHT4644, with the FB pin connected to the VOUT terminal of each channel through a 100kΩ precision resistor. The output voltage of this module can be adjusted by the resistor RFB between FB and GND, with the calculation as follows:：

$$R_{FB}(K) = \frac{100k}{\frac{Vout}{0.8} - 1}$$

Note 1: It is recommended to reserve two resistor positions with a precision of 0.5% for fine-tuning the output voltage.

Below is List 1, which shows the relationship between the RFB resistor and various output voltages:

Vout (V)	0.8	1.0	1.2	1.5	1.8	2.5	3.3	5.0
RFB (kΩ)	open	400	200	114.3	80	47.06	32	19.05

Note 2: When used in parallel, such as N parallel circuits, the RFB resistor value at this time is the single-channel RFB resistor value divided by N. For example, when four circuits are paralleled for a 3.3V output, the RFB resistor value would be 32kΩ divided by 4, which equals 8kΩ.

Soft Start

The FHT4644 module incorporates a built-in soft-start feature with a duration of 1 millisecond (mS). Additionally, an external soft-start pin is available for selection, allowing for increased delay time by connecting a ceramic capacitor of approximately 3.3 nanofarads (nF). The following formula can be used to calculate the soft-start capacitor value:Css=4XT SS

Css represents the capacitance value of the soft-start capacitor, measured in nanofarads (nF). Tss stands for the soft-start time, measured in milliseconds (mS). For example, when an additional soft-start time of 1 millisecond is desired, the required soft-start capacitor would be 4 nanofarads.

Input Under-Voltage Protection

The FHT4644 features input under-voltage protection. When the VIN (input voltage) drops below 3.7V, the under-voltage lockout (UVLO) function is activated.

Note: If the input cable is relatively long, there may be a voltage drop along the cable due to resistance. To ensure normal output, it is necessary to guarantee that the voltage at the module's input pin is greater than 4.0V.

Output Over-Current Protection

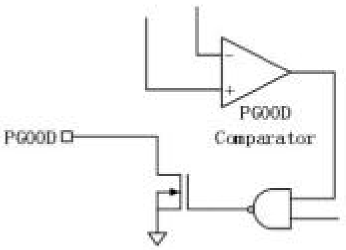
The FHT4644 also incorporates output over-current protection. When the output current exceeds the preset current limit, the converter enters a protection state to prevent damage to the load or the converter itself. Once the output current returns to within the normal range, the converter automatically resumes normal operation.。

PGOOD电路

Power Good

The PGOOD pin is an open-drain pin that can be used to monitor each valid output voltage. When the Vout falls below the threshold voltage set for the output voltage, the PGOOD pin goes high. It can also be used to monitor protective functions such as UVLO (Under-Voltage Lockout) and OTP (Over-Temperature Protection). By connecting a resistor to pull the PGOOD pin up to a specific supply voltage, monitoring can be achieved.

Below is a schematic diagram of the PGOOD circuit, and List 2 provides the logic table for the PGOOD pin:



Monitoring Items	Conditions	PG States
UVLO	0.7V < VIN < VUVLO	Low Level
On(RUN=High Level)	VFB≥VTH_PG	High Level
	VFB≤VTH_PG	Low Level
Off (RUN=High Level		Low Level
Temperature Protection Shutdown	TJ > TSD	Low Level
Power Removal	VIN < 0.7V	High Level

VFB stands for the voltage feedback pin voltage, VTH_PG represents the PGOOD threshold voltage, TJ denotes the junction temperature, and TSD signifies the temperature at which the power supply protection shutdown occurs.

Over-Temperature Protection

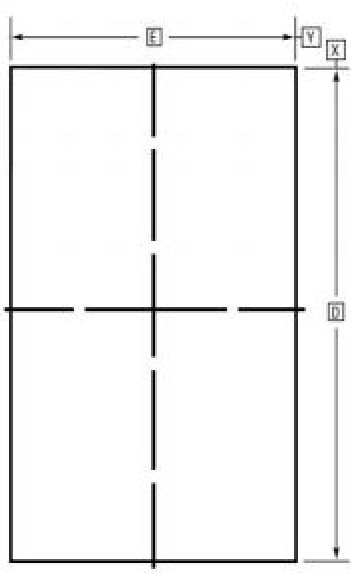
When the case temperature of the FHT4644 rises above 135°C, it enters an over-temperature protection state.

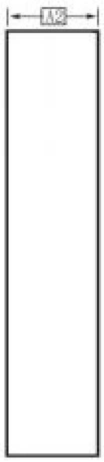
PGOOD电路

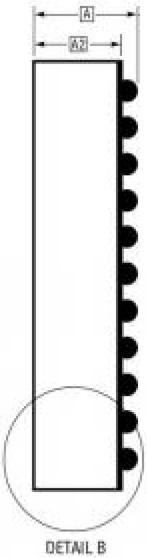
Package Description (77-pin)

LGA package （9mm×15mm×4.32/1.82mm）

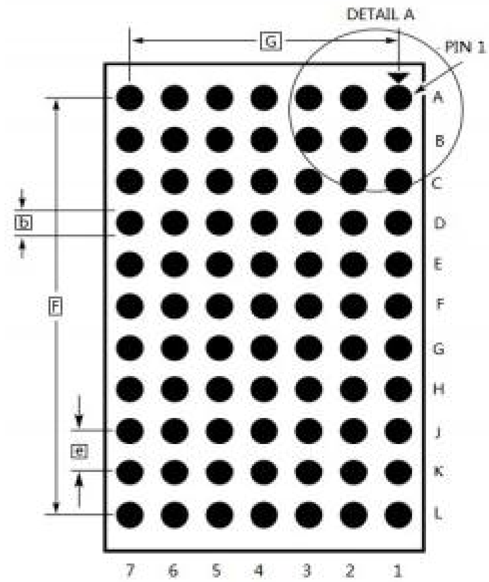
BGA package （9mm×15mm×5.01/2.42mm）



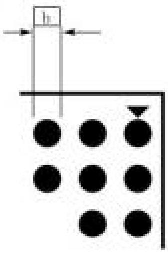




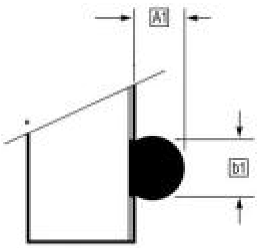
TOP VIEW　　LGA SIDE VIEW　　BGA SIDE VIEW



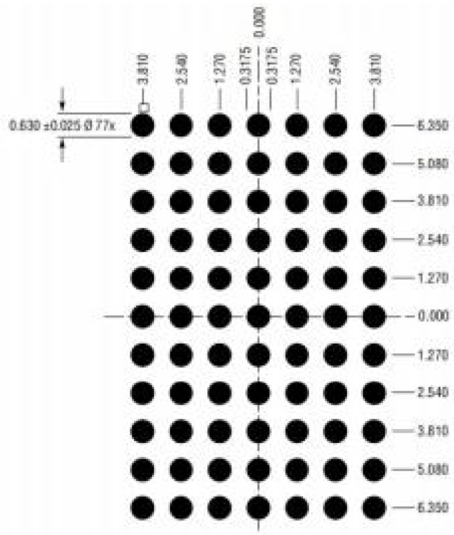
BOTTOM VIEW



DETAIL A



DETAIL B



TOP VIEW(PCB LAYOUT 建议尺寸)

LGA Size

SYMBOL	MIN	NOM	MAX
A2 (regular)	4.12	4.32	4..52
A2 (ultra-thin)	1.62	1.82	2.02
b	0.60	0.70	0.90
D	14.8	15	15.2
E	8.8	9	9.2
e		1.27	
F		12.70	
G		7.62	

BGA Size

SYMBOL	MIN	NOM	MAX
A (regular)	4.81	5.01	5.21
A (ultra-thin)	2.22	2.42	2.62
b	0.60	0.75	0.90
A1	0.50	0.60	0.70
b1	0.60	0.63	0.66
D	14.8	15	15.2
E	8.8	9	9.2
e		1.27	
F		12.70	
G		7.62	

Operating Conditions、Testing and Special Application Notes

1、Recommended Operating Conditions for This Module：

★Input Voltage Range：VIN = 4.0V～ 15V（It is recommended that the minimum input voltage be greater than 4.2V）

★ Output Voltage Range：VOUT = 1.0V～5.0V

★ Output Current Range： （Recommendation for 80% Derating Usage)）

Iout= 0～4A Operating independently in a single channel

Iout=N ×（ 0～4A） N represents the number of parallel channels

★ Operating Case Temperature TC： -55℃ ~ 125℃

2、Testing and Application Instructions

It is not recommended to use a linear power supply for functional testing of this power module (as linear power supplies tend to generate transient voltage fluctuations when adjusting the output, posing a risk of exceeding the maximum rated voltage). Instead, it is recommended to use a switching power supply or a DC/DC module power supply.

★ This power module features a high power density circuit, and it is recommended to use a PCB board with 4 layers or more for layout. Considering long-term stable operation under high temperature conditions, it is advisable to implement appropriate load derating (80% of rated load) or thermal management measures (options include: system-level air cooling, attaching a heatsink above the power module, increasing the copper-clad area on the PCB board beneath the power module, etc.).

★ For the PCB board application of this power module, it is recommended to use wider copper foil for the layout of VIN, VOUT, and GND to reduce conduction losses and thermal stress caused by high currents. It is advisable to place the input and output filtering capacitors close to the power module. To avoid interference, it is recommended to layout the input capacitors and output capacitors with a distance greater than 1 cm between them.

★ If you were previously using an LTM4644 peripheral circuit design, you will need to recalculate RFB according to the following formula.，Only the resistance value needs to be changed, and there is no need to modify the PCB layout.

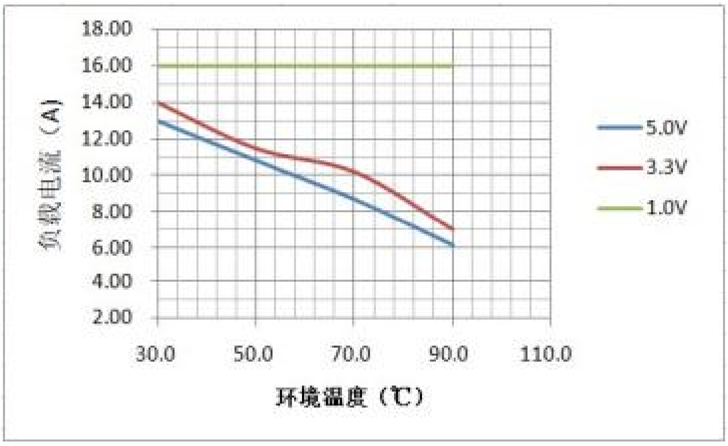
$$R_{FB}(K) = \frac{100k}{\frac{Vout}{0.8} - 1}$$

★ This power module is a hermetically sealed product. Before soldering, check the changes on the humidity indicator card to determine if pre-baking treatment is necessary.

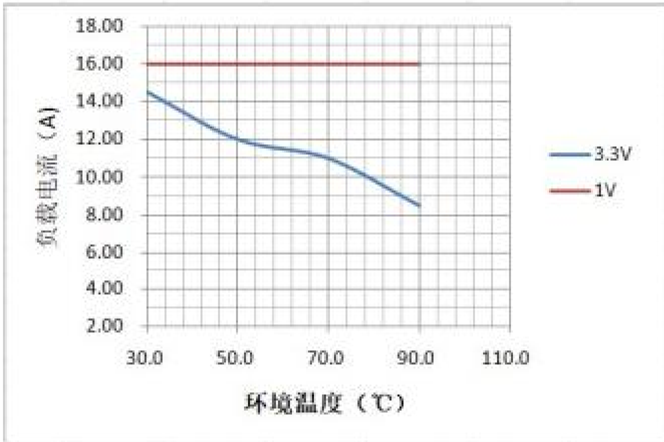
★ Attention should be paid to electrostatic protection during product transportation.

Operating Conditions、Testing and Special Application Notes

3、Thermal Derating Curve Reference Diagram (Load Current vs. Ambient Temperature, Tested in Temperature Chamber, Without Additional Cooling Devices, Evaluating Loading Conditions of Power Supply Module at Different Ambient Temperatures)

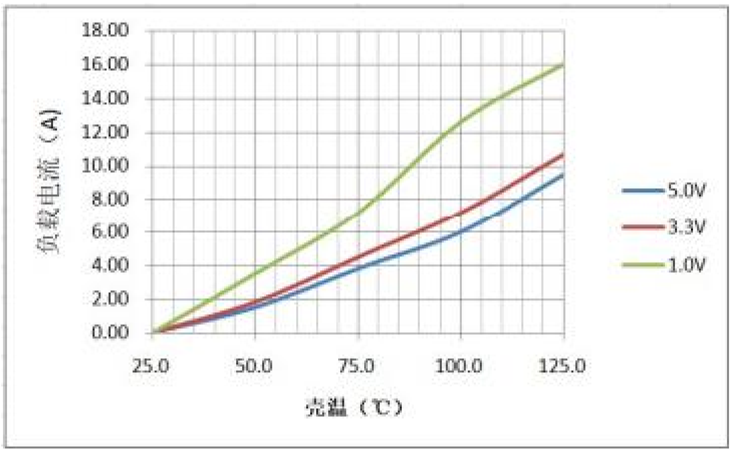


12Vin Derating Curve for Ambient Temperature with 4 Channels in Parallel Configuration

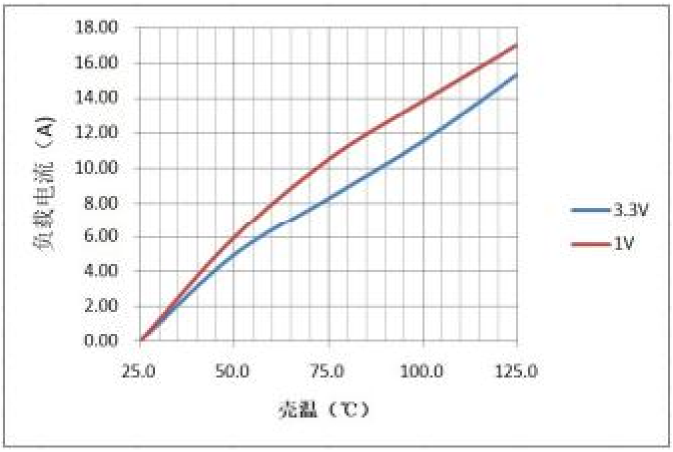


5Vin Derating Curve for Ambient Temperature with 4 Channels in Parallel

4、Thermal Derating Curve Reference Diagram (Load Current vs. Case Temperature, Tested at Room Temperature, Without Additional Cooling Devices, Evaluating the Rise in Case Temperature of the Power Supply Module Under Different Load Conditions)



12Vin Derating Curve for Case Temperature with 4 Channels in Parallel Configuration



5Vin Derating Curve for Case Temperature with 4 Channels in Parallel

Precautions for Reflow Soldering

1. Products that are well-packaged must undergo baking at 125°C for 24 hours before use. If the packaging bag is found to be torn or if the desiccant or indicator label has changed color, the products must undergo baking at 125°C for 48 hours before use. For more information, please refer to the IPC/JEDEC J-STD-033 standard.

2. For reflow soldering of lead-free BGA solder ball products, the peak temperature should not exceed 245°C; for lead-containing BGA solder ball products, the peak temperature should not exceed 225°C.

3. It is recommended to use a stencil thickness of 125um-160um, with stencil openings slightly smaller than the solder pads. Taking a Φ0.635mm solder pad as an example, the recommended stencil opening size is Φ0.620mm.

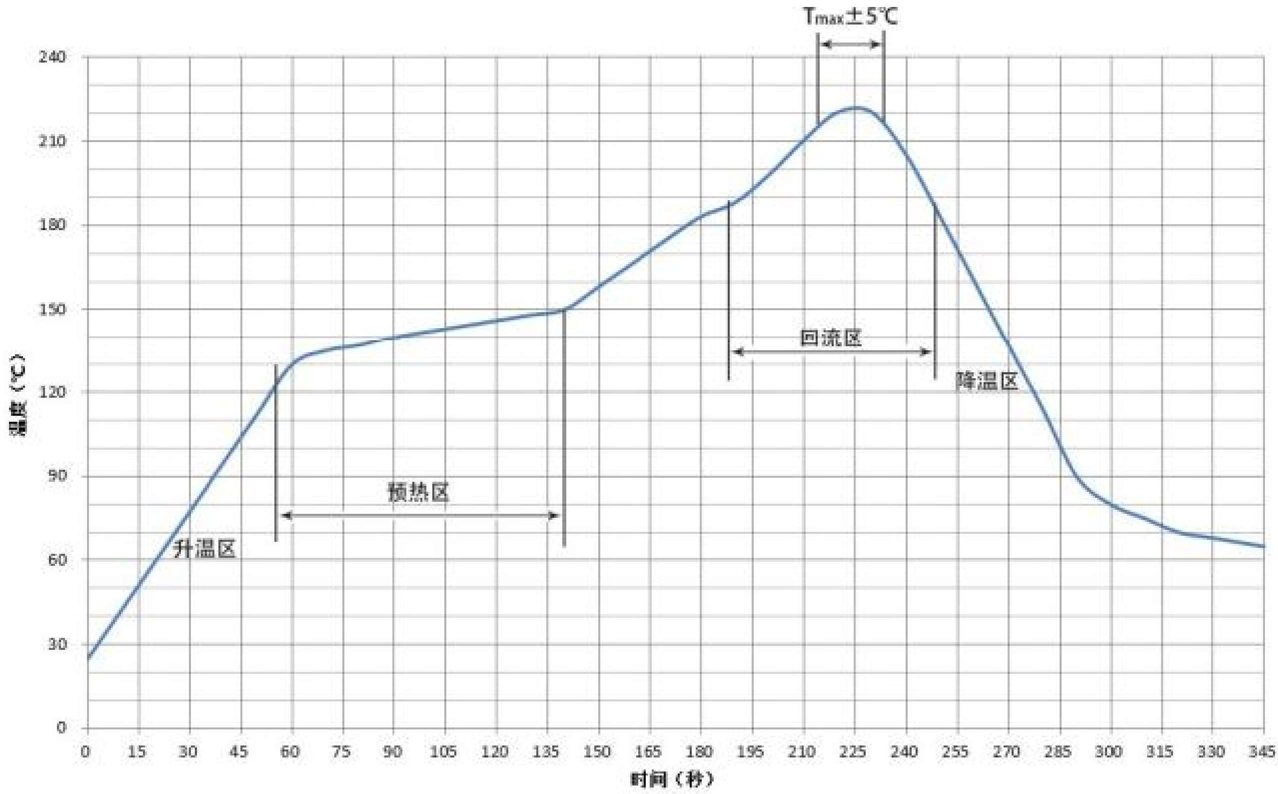
4. The solder paste can be either lead-free SAC or SnPb (with lead). Powder types 3 or 4 are recommended. Different brands of solder paste may have different welding recommendations, so please pay attention to the references. The porosity rate is recommended to not exceed 25%.

Recommended Reflow Soldering Parameters Table

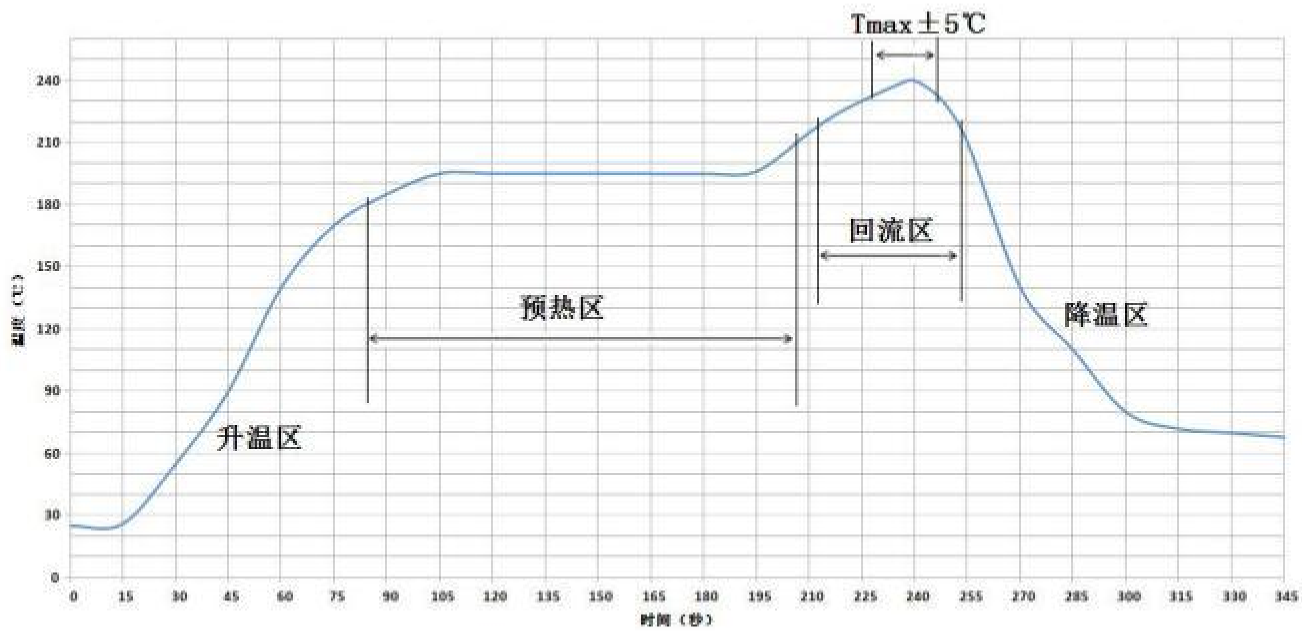
		Lead-free solder paste	SnPb (lead-containing) solder paste
Preheat	Minimum Preheat Temperature	150℃	100℃
	Maximum Preheat Temperature	200℃	150℃
	Preheat Duration	(60-120) seconds	(60-120) seconds
Reflow Soldering	Melting Point	217℃	183℃
	Duration Above Melting Point	(30-90) seconds	(30-90) seconds
Peak Temperature of the Welding Curve		245℃	225℃
Maximum Duration within ±5℃ of Peak Temperature		30 seconds	
Maximum Average Heating Rate		2.5℃/second	
Maximum Cooling Rate		2.5℃/second	
Maximum Time to Reach Peak Temperature from 25℃		8 minutes	

Recommended Reflow Soldering Profile (for reference)

Reflow soldering profile for SnPb solder paste



Reflow soldering profile for lead-free solder paste



Ordering Information

1. Product Naming Convention

FHT 4644 L M Y #PBF

① ② ③ ④ ⑤ ⑥

① Manufacturer Code

② Product Series Number

③ The presence of "L" signifies an ultra-thin size model, while its absence indicates a regular size model

④ Usage Grade: "M" stands for Military Grade (general military use), "I" for Industrial Grade, and "E" for Consumer Grade

⑤ Lead Configuration: "Y" or "V". "V" represents Land Grid Array (LGA) packaging, while "Y" represents Ball Grid Array (BGA) packaging

⑥BGA Solder Ball Characteristics: "#PBF" indicates lead-free, while the absence of this notation signifies lead-based

2. Selection Table for Regular Size Products

Product Model	Input		Output		Efficiency	Enable Voltage	Packaging	Grade	Temperature Range (Case Temperature)	Packaging
	Input Range	Nominal Input	Output range	Nominal Output						
FHT4644MY	**4.0-15V**	**12V**	**0.8-5.5V**	**5.0，3.3, 2.5,1.5V**	**92%**	**1.2-15V**	**BGA**	general military grade	**-55-125℃**	Tray
FHT4644MY#PBF	**4.0-15V**	**12V**	**0.8-5.5V**	**5.0，3.3, 2.5,1.5V**	**92%**	**1.2-15V**	**BGA**	general military grade	**-55-125℃**	Tray
FHT4644MV#PBF	**4.0-15V**	**12V**	**0.8-5.5V**	**5.0，3.3, 2.5,1.5V**	**92%**	**1.2-15V**	**LGA**	general military grade	**-55-125℃**	Tray
FHT4644IY	**4.0-15V**	**12V**	**0.8-5.5V**	**5.0，3.3, 2.5,1.5V**	**92%**	**1.2-15V**	**BGA**	industrial grade	**-40-125℃**	Tray
FHT4644IY#PBF	**4.0-15V**	**12V**	**0.8-5.5V**	**5.0，3.3, 2.5,1.5V**	**92%**	**1.2-15V**	**BGA**	industrial grade	**-40-125℃**	Tray
FHT4644IV#PBF	**4.0-15V**	**12V**	**0.8-5.5V**	**5.0，3.3, 2.5,1.5V**	**92%**	**1.2-15V**	**LGA**	industrial grade	**-40-125℃**	Tray
FHT4644EY#PBF	**4.0-15V**	**12V**	**0.8-5.5V**	**5.0，3.3, 2.5,1.5V**	**92%**	**1.2-15V**	**BGA**	Consumer Grade	**-40-125℃**	Tray

Ordering Information

3. Selection Table for Ultra-thin Size Products

Product Model	Input		Output		Efficiency	Enable Voltage	Packaging	Grade	Temperature Range (Case Temperature)	Packaging
	Input Range	Nominal Input	Output range	Nominal Output						
FHT4644LMY	**4.0-15V**	**12V**	**0.8-5.5V**	**5.0，3.3, 2.5,1.5V**	**92%**	**1.2-15V**	BGA (leaded)	general military grade	**-55-125℃**	Tray
FHT4644LMY#PBF	**4.0-15V**	**12V**	**0.8-5.5V**	**5.0，3.3, 2.5,1.5V**	**92%**	**1.2-15V**	BGA (lead-free)	general military grade	**-55-125℃**	Tray
FHT4644LMV#PBF	**4.0-15V**	**12V**	**0.8-5.5V**	**5.0，3.3, 2.5,1.5V**	**92%**	**1.2-15V**	LGA (lead-free)	general military grade	**-55-125℃**	Tray
FHT4644LIY	**4.0-15V**	**12V**	**0.8-5.5V**	**5.0，3.3, 2.5,1.5V**	**92%**	**1.2-15V**	BGA (leaded)	industrial grade	**-40-125℃**	Tray
FHT4644LIY#PBF	**4.0-15V**	**12V**	**0.8-5.5V**	**5.0，3.3, 2.5,1.5V**	**92%**	**1.2-15V**	BGA (lead-free)	industrial grade	**-40-125℃**	Tray
FHT4644LIV#PBF	**4.0-15V**	**12V**	**0.8-5.5V**	**5.0，3.3, 2.5,1.5V**	**92%**	**1.2-15V**	LGA (lead-free)	industrial grade	**-40-125℃**	Tray
FHT4644LEY#PBF	**4.0-15V**	**12V**	**0.8-5.5V**	**5.0，3.3, 2.5,1.5V**	**92%**	**1.2-15V**	BGA (lead-free)	Consumer Grade	**-40-125℃**	Tray

Appendix I: Key Differences and Explanation between FHT4644 and LTM4644

1. Functional Differences

	LTM4644	FHT4644
Input Voltage	4-14V	4-14V
Output Voltage	0.6-5.5V	0.8-5.5V
Operating Frequency	Nominal value of 1M, externally adjustable	Nominal value of 1M, automatically adjustable
Operating Mode	CCM/DCM adjustable	CCM/DCM automatically adjustable
Total Output Voltage Regulation	±1.5% (Typical Value)	±1.5% (Typical Value)
Output Voltage Setting	FB=0.6V, R1=60.4K	FB=0.8V, R1=100K
Output Voltage Tracking	Yes	Yes
Output Clock Signal	Yes	Internal power supply chip
Internal Temperature Sensing	Yes	Internal power supply chip
Stability Compensation	Yes	Internal power supply chip
Dimensions	9mm×15mm×5.01mm	9mm×15mm×5.01mm

Note: Due to differences in the calculation formula for the external voltage regulation resistor, the resistance values of the voltage regulation resistors for FHT4644 and LTM4644 are not the same.

FHT4644 voltage regulation resistance calculation formula and voltage regulation resistance value list:

$$R_{FB}(K) = \frac{100k}{\frac{Vout}{0.8} - 1}$$

Vout (V)	0.8	1.0	1.2	1.5	1.8	2.5	3.3	5.0
R_{FB} (kΩ)	open	400	200	114.3	80	47.06	32	19.05

LTM4644 voltage regulation resistance calculation formula and voltage regulation resistance value list:

$$R_{FB}(K) = \frac{60.4K}{\frac{V_{OUT}}{0.6} - 1}$$

Vout (V)	0.6	1.0	1.2	1.5	1.8	2.5	3.3	5.0
R_{FB} (kΩ)	open	90.9	60.4	40.2	30.1	19.1	13.3	8.25

2. Pin Configuration Comparison

Pin	LTM4644	FHT4644
Same Pin Configuration		
Input	V_{IN1} （B3,B4）， V_{IN2} （E3,E4）， V_{IN3} （ H3,H4）， V_{IN4} (L3,L4)	V_{IN1} （B3,B4）， V_{IN2} （E3,E4）， V_{IN3} （ H3,H4）， V_{IN4} (L3,L4)
Output	V_{OUT1} （A1,A2,A3）， V_{OUT2} （C1,D1,D2）， V_{OUT3} （F1,G1,G2）， V_{OUT4} (J1,K1,K2)	V_{OUT1} （A1,A2,A3）， V_{OUT2} （C1,D1,D2）， V_{OUT3} （F1,G1,G2）， V_{OUT4} (J1,K1,K2)
Ground Pin	GND（A4,A5, B1,B2, C5, D3,D4,D5, E1,E2, F5, G3,G4,G5, H1,H2, J5,K3, K4,L1,L2)	GND（A4,A5, B1,B2, C5, D3,D4,D5, E1,E2, F5, G3,G4,G5, H1,H2, J5,K3, K4,L1,L2)
Feedback Pin	FB1（A7），FB1（D7）,FB3（G7），FB4（J 7)	FB1（A7），FB2（D7）,FB3（G7），FB4（J 7)
Enable Pin,	RUN1（C6），RUN2（F6） RUN3（J6），RUN4（K7)	RUN1（C6），RUN（F6）， RUN3（J6），RUN4（K7)
PG Signal	PGOOD1（C3）,PGOOD2（C2）， PGOOD3（F2）,PGOOD4（J2)	PGOOD1（C3）,PGOOD2（C2）， PGOOD3（F2）,PGOOD4（J2)
Signal Ground	SGND（F7)	SGND（F7)
Soft Start and Output Voltage Tracking Pin	SS1/TRACK1（A6), SS2/TRACK2(D6), SS3/TRACK3（G6), SS4/TRACK4 (K6)	SS1/TRACK1（A6), SS2/TRACK2(D6), SS3/TRACK3（G6), SS4/TRACK4 (K6)

DC DC POWER MODULES

2. Pin Configuration Comparison

Pin	LTM4644	FHT4644
Different Pin Configuration		
Mode Select Pin	MODE1(B6), MODE2(E6), MODE3(H6), MODE4(L6)	B6, E6, H6, L6 are left floating and are not required. The mode can be automatically adjusted。
INTvcc (Internal Voltage Source)	INTvcc1 (C4), INTvcc1 (F4), INTvcc1 (J4), INTvcc1 (K5)	VO1 (C4), VO2 (F4), VO3 (J4), VO4 (K5), There is no INTvcc, and the PG power supply can be provided by the VO pin, VO=Vout。
Svin (Internal Power Supply)	SVIN1, SVIN2, SVIN, SVIN4 (B5, E5, H5, L5)	B5, E5, H5, L5 are left floating, and the internal power supply chip does not require SVIN
Stability Compensation Pin	COMP1, COMP2, COMP3, COMP4 (B7, E7, H7, L7)	B7, E7, H7, L7 are left floating and are not required as they are already integrated into the power supply chip
Output Clock Signal	CLKOUT (J3)	Left floating, not required, automatically adjustable.
ync Signal	CLKIN (C7): External synchronization input module detector for phase.	Left floating, not required, automatically adjustable.
Junction Temperature Sense Pin	TEMP (F3)	Left floating, the power supply chip has built-in over-temperature protection.

Through the above comparison, due to the automatic frequency conversion technology adopted by FHT4644, the operating mode does not require additional circuit control, and the peripheral circuitry is simpler than that of LTM4644. This allows for more component layout savings. By simply changing the voltage regulation resistor RFB, FHT4644 can be used as a drop-in replacement for LTM4644 without the need to modify the existing PCB layout.

Appendix II: Efficiency Comparison between FHT4644 and Other 4644 Models

1. Vin=12V

(1)Efficiency comparison

测试条件：输入电压Vin=12V，输出电压Vout分7组（0.8V，1.0V，1.2V，1.5V，1.8V，2.5V，3.3V）进行测试，每组四路输出电压都分别设定到一样的值，每路输出电流Iout=4A，实验室常温条件下测试。
效率=四路输出总功率/输入功率。

组别	Vout	Iout	FHT4644 效率(%)	某国产4644 效率(%)	进口4644 效率(%)
1	0.8V	4A	75.94	66.68	66.79
2	1.0V	4A	79.08	71.25	71.84
3	1.2V	4A	80.81	74.01	74.23
4	1.5V	4A	82.76	78.79	78.59
5	1.8V	4A	84.39	80.76	80.36
6	2.5V	4A	87.25	86.15	87.13
7	3.3V	4A	88.98	89.51	89.61

表1 测试数据

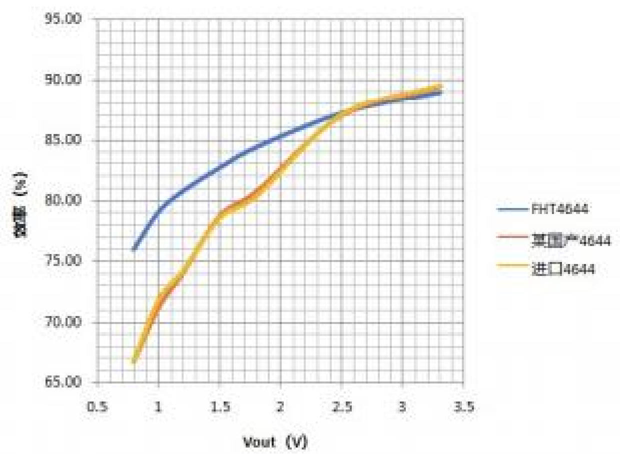


图1 效率比较曲线图

(2)high-temperature test comparison

测试条件：输入电压Vin=12V，四路输出电压都设定到1.0V，每路分别加载4A（电阻负载），在高温箱内测试。

	高温条件下电源模块工作状况			
电源型号	环境温度55℃	环境温度60℃	环境温度75℃	环境温度85℃
FHT4644	正常工作 (连续加载2小时)	正常工作 (连续加载2小时)	正常工作 (连续加载8小时)	正常工作 (连续加载8小时)
某型号4644	正常工作 (连续加载2小时)	输出掉电 (加载5分钟后)	-	-
进口4644	正常工作 (连续加载2小时)	输出掉电 (加载5分钟后)	-	-

2. Vin=5.0V

(1)Efficiency comparison

测试条件：Vin=5V，输出电压分7组（0.8V，1.0V，1.2V，1.5V，1.8V，2.5V，3.3V）进行测试，每组四路输出电压都分别设定到一样的值，每路输出电流Iout=4A，实验室常温条件下测试。
效率=四路输出总功率/输入功率。

组别	Vout	Iout	FHT4644 效率	某国产4644 效率	进口4644 效率
1	0.8V	4A	78.48	72.44	71.52
2	1.0V	4A	81.71	76.13	76.35
3	1.2V	4A	83.09	77.88	79.52
4	1.5V	4A	85.33	82.14	82.46
5	1.8V	4A	87.11	83.76	83.64
6	2.5V	4A	90.25	89.62	90.07
7	3.3V	4A	92.77	90.24	90.43

表2 测试数据

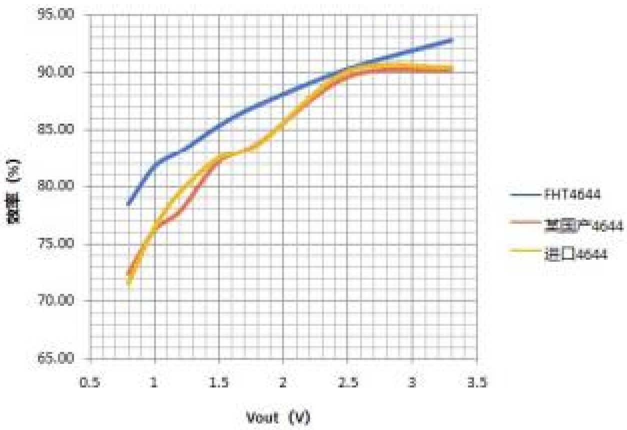


图2 效率比较曲线图

(2)high-temperature test comparison

测试条件：输入电压Vin=5V，四路输出电压都设定到1.0V，每路分别加载4A（电阻负载），在高温箱内测试。

	高温条件下电源模块工作状况			
电源型号	环境温度55℃	环境温度60℃	环境温度75℃	环境温度85℃
FHT4644	正常工作 (连续加载2小时)	正常工作 (连续加载2小时)	正常工作 (连续加载8小时)	正常工作 (连续加载8小时)
某型号4644	正常工作 (连续加载2小时)	输出掉电 (加载5分钟后)	-	-
进口4644	正常工作 (连续加载2小时)	输出掉电 (加载5分钟后)	-	-