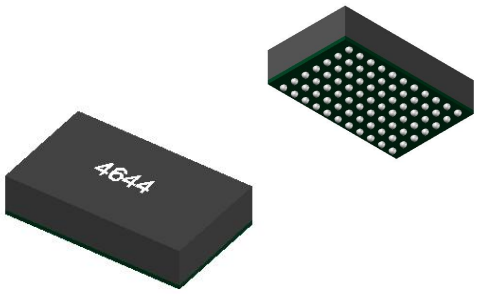
4-channel DC/DC, each output 4A Integrated encapsulated adjustable step-down power supply module



1 Features

- **4A full load output current per circuit**
- **Input voltage range: 4.5V-14V**
- **Output voltage: 0.6V-5.5V**
- **Switching frequency: 600KHz, 1.1MHz selectable**
- **Up to 92% efficiency**
- **Internal 1mS soft start (additional external 1mS optional)**
- **±2% total output voltage regulation**
- **Over-current protection, over-temperature protection, over-voltage protection, UVLO**
- **Flat and small size:**
  LGA package (9mm*15mm*4.32mm)
  BGA package (9mm*15mm*5.01mm).

2 Applications

- **Multi-rail load point regulation**
- **DSP, FPGA, ASIC applications**

3 Description

The FHT4644C/D is a non-isolated, step-down, one-piece, molded-point power supply for embedded, high-current negative with a size of only 9×15×4.32mm, it can be placed directly next to the FPGA/CPU, which is ideal for low output voltage and multiplexed applications.

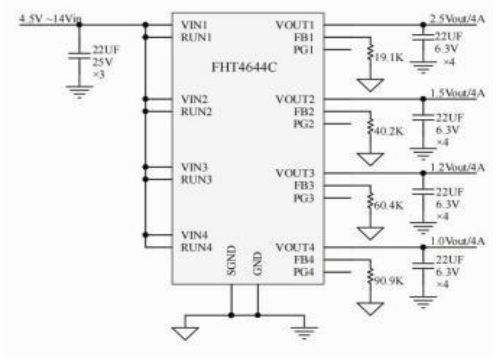
The small-sized LGA (Land Grid Array) and BGA (Ball Grid Array) packages integrate ICs, inductors, and corresponding components, requiring only a voltage-adjusting resistor and a few input and output ceramic capacitors on the periphery to rapidly complete the design of a multi-channel power supply system.

This simplifies the system design and maximizes PCB space savings.

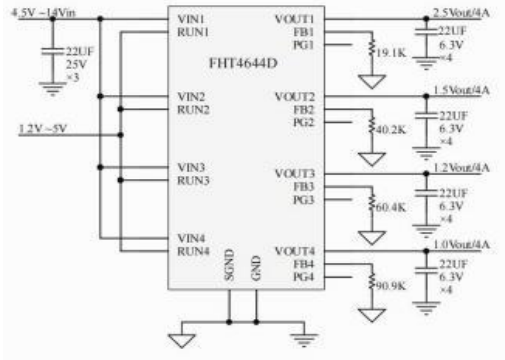
Designed based on synchronous rectification Buck topology, it supports a maximum current of 4A per channel and offers high power conversion efficiency. It can convert voltages from 4.5V to 14V to 0.6V to 5.5V, providing four-channel ON/OFF control and four-channel Power Good signals. Additionally, it features OCP (Over Current Protection), OVP (Over Voltage Protection), UVP (Under Voltage Protection), and OTP (Over Temperature Protection) functions.

Typical Applications

Quad Output Application Circuit



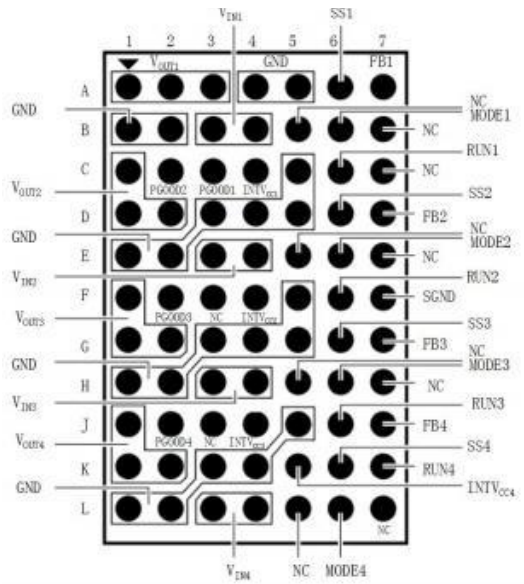
High voltage (input voltage) enable



Low voltage enable

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)	Four output voltage adjustment pins , connect 1% or more precision voltage adjustment resistor to GND.
RUN1 (C6) , RUN2 (F6) , RUN3 (J6) , RUN4 (K7)	Four-way enabling pin, 1. High-voltage version, can be connected to a switch to Vin to control the power module; 2. Low-voltage version, connected to an external switch to control the power module, with a voltage range of 1.2-4.5V.
PGOOD1 (C3) ,PGOOD2 (C2) , PGOOD3 (F2) ,PGOOD4 (J2)	Fault indication pin: This PG pin can be connected to a 10K resistor to INTVcc. When PG is pulled low, it indicates that the chip has encountered an abnormal condition (including but not limited to UV, OV, OC, OT, etc.). If the fault indication function is not required, this resistor can be omitted, and PGOOD can be left floating.
INTVCC1 (C4) , INTVCC2 (F4) , INTVCC3 (J4) , INTVCC4 (K5)	The internal power driver and control circuitry are powered by this pin, with each pin internally decoupled to GND using a 1μF low-ESR ceramic capacitor.
MODE1 (B6) , MODE2 (E6) , MODE3 (H6) , MODE4 (L6)	Operating mode pin: Each channel can select different operating modes. Under light load conditions, two modes are provided: Forced CCM (Constant Current Mode) operation and Pulse Skip mode. By switching the resistor RM between the mode pin and GND or VCC, two different switching frequencies and two light load modes can be achieved. This pin should not be left floating.
SGND (F7)	For signal ground, it is recommended that GND (power ground) and SGND be wired separately and eventually connected with a 0 ohm resistor.
SS1 (A6), SS2(D6), SS3(G6), SS4(K6)	External soft-start pin: An external 0.1uF ceramic capacitor can be connected to 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 (B7,E7,H7,L7,C7,L5,H5,E5,B5,J3,F3)	Empty

Electrical Characteristics

Absolute Maximum Ratings	Condition	Minimum value	Nominal value	Maximum value	Unit
V_{IN} (each way)		-0.3		18	V
V_{OUT} (each way)		-0.3		5.5	V
$INTV_{CC}$ (per channel)		-0.3		5.5	V
PGOOD, MODE, FB (each)		-0.3		5.5	V
RUN (each way, low voltage version)		-0.3		5.5	V
All other pins		-0.3		5.5	V
Storage temperature		-55		+150	℃
Reflow temperature				245	℃
Input Characteristics	**Condition**	**Minimum value**	**Nominal value**	**Maximum value**	**Unit**
Input Voltage Range		4.5		14	V
Power-on voltage threshold			4.2	4.4	V
Shutdown Voltage Threshold		3.6	3.7		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			600	1100	KHz
Efficiency				92	%
Soft start time			2		ms
Functionality	**Condition**	**Minimum value**	**Nominal value**	**Maximum value**	**Unit**
RUN enable voltage (high voltage version)		4.5	12	14	V
RUN enable voltage (low voltage version)		1.2	3.3	5.0	V
Output Characteristics	**Condition**	**Minimum value**	**Nominal value**	**Maximum value**	**Unit**
Output Voltage Range	Adjusted by FB pin resistor	0.6		5.5	V
Output Voltage	CIN = 22μF, COUT = 22uF x 4, MODE =INTVCC, VIN = 4V to 14V, IOUT = 0A to 4A	1.47	1.5	1.53	V
Linear Regulation	V_{OUT} = 1.5V , 5V < V_{IN} < 14V , I_{LOAD} = 4A			±0.5	%
Load Regulation	V_{IN} =12V , V_{OUT} =1.5V,0A < I_{LOAD} ≤ 4A			±1	%
Ripple and Noise	V_{IN} =12V , V_{OUT} =1.5V , I_{OUT} =4A, C_{out} =22uF×4 , 20MHz bandwidth		30	60	mV
Dynamic Load Response	50-100% full load , di/dt = 1A/μS C_{out} =22uF×4		150, 50		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	%
Overtemperature protection	Case temperature (Tc)	-	-	140	℃
Structural Characteristics	**Conditions**	**Minimum Value**	**Nominal value**	**Maximum value**	**Unit**
Packaging	LGA, BGA	-	-	-	-
Sizes	lga: 9*15*4.32; bga: 9*15*5.01	-	-	-	mm
Weights			1.7		g
Environmental Adaptability	**Condition**	**Minimum value**	**Nominal value**	**Maximum value**	**Unit**
Operating temperature (Case temperature)		-40		125	℃
High temperature storage (ambient temperature)	+125℃ , 48h			125	℃
High temperature operation (ambient temperature)	+85°C , 24h; Input low, standard and high pressure for 8h each; V_{IN} =60V , V_{OUT} =12V , I_{OUT} =2.4A			85	℃
Low temperature storage (ambient temperature)	-55°C, 24h	-55			℃
Low temperature operation (ambient temperature)	-40°C , 24h; Input low pressure, standard pressure, high pressure each 8h	-40			℃
Damp heat	High temperature and high humidity stage: 60°C, 95%; Low temperature and high humidity stage: 30℃, , 95%; 10 cycles, each cycle is 24h.	30		60	℃
Thermal shock	High temperature 125 ℃, low temperature -55 ℃, high and low temperature of an hour for a cycle, a total of 32 test cycles	-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.

Operation

The FHT4644 is a four-channel independently outputting, non-isolated DC/DC switching regulator. It features four independent regulator channels, each capable of delivering up to 4A of continuous output current, requiring only a small amount of external input and output capacitors. Within an input voltage range of 4.5V to 14V, each regulation channel can provide a precisely adjustable output voltage ranging from 0.6V to 5.5V through an external resistor.

Input Voltage Setting

The FHT4644 is a step-down module where the output voltage is set to be less than the input voltage.

Table 1 Input and output voltage relationship table (in nominal voltage)

Input Voltage	Output Voltage
4.5-14V	1.2V, 1.8, 2.5V
4.8-14V	3.3V
7-14V	5V

Output Voltage Setting

Within the FHT4644, this pin is connected to the VOUT terminal of each channel through a 60.4kΩ precision resistor. The output voltage of the module can be controlled by programming the resistance between the FB and GND pins. The calculations are shown below: refer to the formula below:

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

Note: It is recommended to reserve two resistor positions for fine-tuning the output voltage.

Table 1 R_{FB} resistor vs. each output voltage

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

Operating mode and switching frequency selection

Two modes, Forced CCM and Pulse skip, are available under light load conditions. Two different switching frequencies and two light load modes can be realized by switching the resistor RM between the mode and GND or VCC. The recommended switching frequency is 600KHZ, Forced CCM, and higher switching frequencies will increase the switching losses of the power supply module.

Table 2 Rm resistance versus mode and frequency

Soft Start

MODE/Rm	Light-Load Mode	Switching Frequency
121 kΩ to SGND	Pulse skip (DCM)	600 kHz
VCC (INTVcc)	Pulse skip (DCM)	1.1MHz
60.4 kΩ to SGND	Forced CCM	600 kHz
SGND	Forced CCM	1.1MHz

The module has a built-in soft-start, and an external soft-start pin is available, which can be connected to a ceramic capacitor of about 0.1uF to increase the delay time.

Input under-voltage protection

A resistor divider is connected between V_{IN} and ground, with the center tap to the EN pin. When V_{IN} drops to a specific value, EN drops below 1.15V and under-voltage lockout occurs.

Output over-current protection

When the output current exceeds the current limit value, the FHT4644 enters the protection state. When the output current returns to the normal range, the converter enters normal operation.

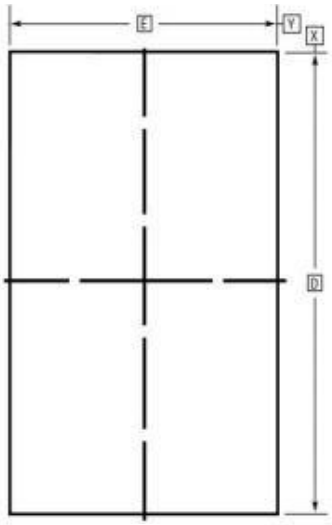
Over-temperature protection

When the case temperature of the FHT4644 rises above 140 °C, it enters an over-temperature protection state.

Package Description (77 pins)

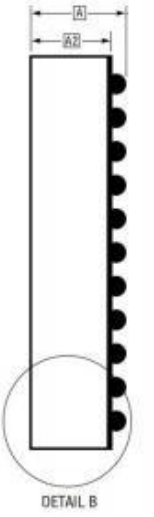
LGA package (9mm x 15mm x 4.32mm)

BGA package (9mm x 15mm x 5.01mm)

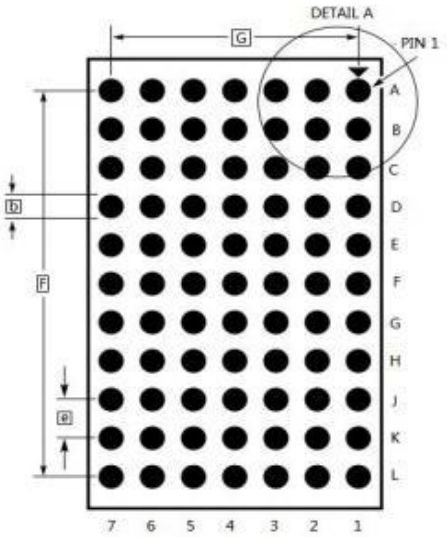


Top view

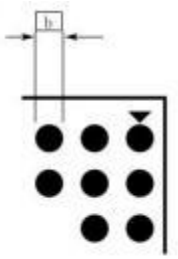
Lga side view



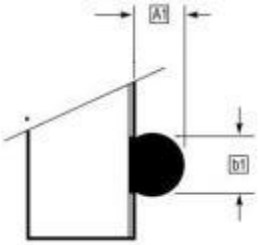
Bga side view



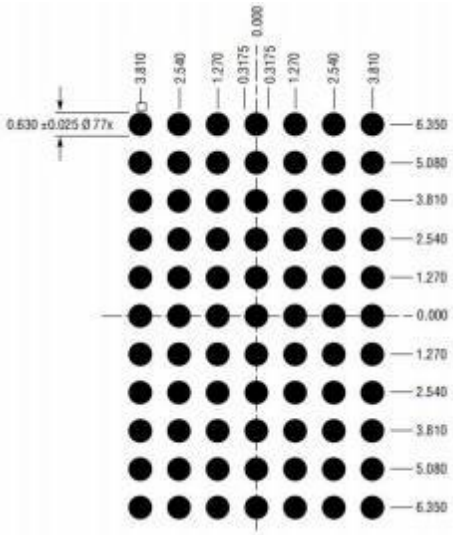
Bottom view



Detail A



Detail B



Top View (Pcb Layout Recommended Size)

LGA Size

SYMBOL	MIN	NOM	MAX
A2	4.12	4.32	4..52
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	

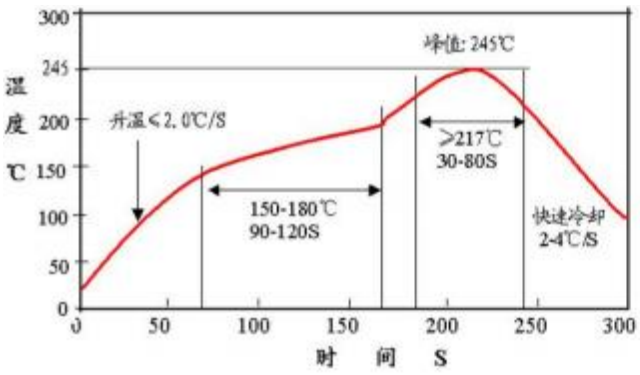
BGA Size

SYMBOL	MIN	NOM	MAX
A	4.82	5.01	5..22
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	

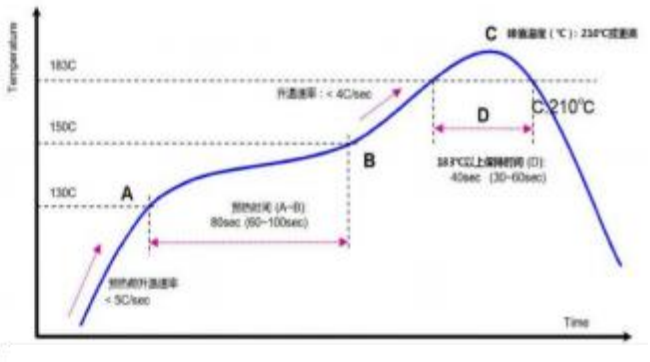
Soldering and Storage Precautions

For lead-free BGA solder ball products, the peak temperature should not exceed 245℃; For leaded BGA solder ball products, the peak temperature should not exceed 225℃.

Recommended reflow soldering profile for reference recommended curves for reference:

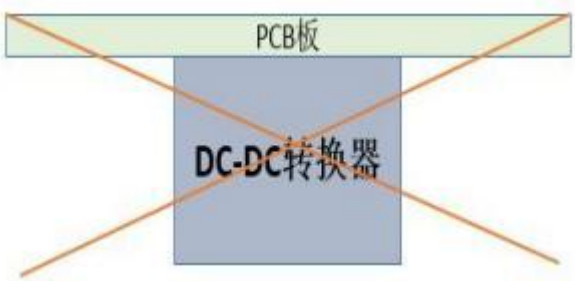


Lead Free Processes



Leaded Processes

Caution:



1.Due to the large size of the module, please do not place the module under the board for reflow soldering to avoid falling off.

2.For bulk products and those that have been taken out of their original packaging, they should be stored in a desiccator (with a relative humidity of less than 10% inside). For products still in their original packaging, they should also be stored in a desiccator whenever possible.

3.Before mounting on the board, it is necessary to strictly follow the baking conditions to dry the samples: bake at 125°C for more than 48 hours, and control the reflow soldering temperature within 245°C.

Ordering Information

FHT4644C ,High voltage enable, enable voltage 4.5-14V

Product Model	Input		Output		Efficiency	Enable Voltage	Packaging	Grade	Temperature range (Case temperature)	Packaging
	Input Range	Nominal Input	Output range	Nominal Output						
FHT4644CIY	4.5-14V	12V	0.6-5.5V	5.0, 3.3, 2.5,1.5V	92%	4.5-14V	BGA (leaded)	industrial grade	-40-125°C	Tray
FHT4644CIY#PBF	4.5-14V	12V	0.6-5.5V	5.0, 3.3, 2.5,1.5V	92%	4.5-14V	BGA (lead-free)	industrial grade	-40-125°C	Tray
FHT4644CIV#PBF	4.5-14V	12V	0.6-5.5V	5.0, 3.3, 2.5,1.5V	92%	4.5-14V	LGA (lead-free)	industrial grade	-40-125°C	Tray
FHT4644CMY	4.5-14V	12V	0.6-5.5V	5.0, 3.3, 2.5,1.5V	92%	4.5-14V	BGA (leaded)	general military grade	-55-125°C	Tray
FHT4644CMY#PBF	4.5-14V	12V	0.6-5.5V	5.0, 3.3, 2.5,1.5V	92%	4.5-14V	BGA (lead-free)	general military grade	-55-125°C	Tray
FHT4644CMV#PBF	4.5-14V	12V	0.6-5.5V	5.0, 3.3, 2.5,1.5V	92%	4.5-14V	LGA (lead-free)	general military grade	-55-125°C	Tray

FHT4644D ,Low voltage enable, enable voltage 1.2-4.5V

Product Model	Input		Output		Efficiency	Enable Voltage	Packaging	Grade	Temperature range (case temperature)	Packaging
	Input Range	Nominal Input	Output range	Nominal Output						
FHT4644DIY	4.5-14V	12V	0.6-5.5V	5.0, 3.3, 2.5,1.5V	92%	1.2-4.5V	BGA (leaded)	industrial grade	-40-125°C	Tray
FHT4644DIY#PBF	4.5-14V	12V	0.6-5.5V	5.0, 3.3, 2.5,1.5V	92%	1.2-4.5V	BGA (lead-free)	industrial grade	-40-125°C	Tray
FHT4644DIV#PBF	4.5-14V	12V	0.6-5.5V	5.0, 3.3, 2.5,1.5V	92%	1.2-4.5V	LGA (lead-free)	industrial grade	-40-125°C	Tray
FHT4644DMY	4.5-14V	12V	0.6-5.5V	5.0, 3.3, 2.5,1.5V	92%	1.2-4.5V	BGA (leaded)	general military grade	-55-125°C	Tray
FHT4644DMY#PBF	4.5-14V	12V	0.6-5.5V	5.0, 3.3, 2.5,1.5V	92%	1.2-4.5V	BGA (lead-free)	general military grade	-55-125°C	Tray
FHT4644DMV#PBF	4.5-14V	12V	0.6-5.5V	5.0, 3.3, 2.5,1.5V	92%	1.2-4.5V	LGA (lead-free)	general military grade	-55-125°C	Tray