# 13V,12A全集成同步升压转换器

## 13V,12A Fully-Integrated Synchronous Boost Converter

## ■ FEATURES

- Input voltage range $V_{IN}$: 2.7V to 13V
- Output voltage range $V_{OUT}$: 4.5V to 13V
- Programmable switch peak current limit: up to 12A
- High Efficiency
  93% ($V_{IN}$ = 7.4V, $V_{OUT}$=12V, $I_{OUT}$ =3A)
  92% ($V_{IN}$ = 3.6V, $V_{OUT}$=9V, $I_{OUT}$ =1A)
- Two modes of with fast or slow tr/tf for EMI solution
- 1.0μA current consumption during shutdown
- Adjustable switching frequency: 200k to 1.0MHz
- Programmable soft start
- Output overvoltage protection (at 14V), cycle-by-cycle overcurrent protection, thermal shutdown protection
- Pb-free Packages,DFN20L, 4.5mm*3.5mm

- 输入电压范围$V_{IN}$：2.7V-13V
- 输出电压范围$V_{OUT}$：4.5V-13V
- 可编程峰值电流：12A
- 高转换效率：
  93% ($V_{IN}$ = 7.4V, $V_{OUT}$=12V, $I_{OUT}$ =3A)
  92% ($V_{IN}$ = 3.6V, $V_{OUT}$=9V, $I_{OUT}$ =1A)
- 支持两种tr/tf模式，应对EMI挑战
- 低关断功耗，关断电流1uA
- 可调节的开关频率：200k-1.0M
- 可编程软启动
- 输出过压 (14V)、逐周期过流、热关断等保护
- DFN20L，4.5mm*3.5mm 无铅超薄封装

## ■ APPLICATIONS

- Wireless/ Speakers
- Portable Speakers
- Quick Charge Power Bank
- E-Cigarette
- Power Interface (USB Type-C, Thunderbolt)
- POS Terminal
- Tablet PC/Note Book

- 无线音箱
- 便携式音箱
- 快充移动电源
- 电子烟
- USB TYPE-C 电源传输
- 拉杆音箱
- 平板电脑，笔记本电脑
- POS机终端

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## ■ DESCRIPTION

The HT71672 is a high-power density, fully integrated synchronous boost converter with a 16mΩ power switch and a 23mΩ rectifier switch to provide a high efficiency and small size solution in portable systems. The HT71672 has wide input voltage range from 2.7 V to 13 V to support applications with single cell and two cell Lithium batteries. The device has 12A switch current capability and can provide an output voltage up to 13V.

The HT71672 uses adaptive constant off-time peak current control topology to regulate the output voltage. In moderate to heavy load condition, it works in the PWM mode. In light load condition, the device operates in PFM mode to improve the efficiency. The switching frequency in the PWM mode is adjustable ranging from 200kHz to 1.0MHz by an external resistor.

HT71672 integrates two modes with different tr/tf to balance EMI and efficiency in different applications.

The HT71672 also implements a programmable soft-start function and an adjustable switching peak current limit function. In addition, the device provides 14V output overvoltage protection, cycle-by-cycle overcurrent protection, and thermal shutdown protection.

HT71672是一款高功率、全集成升压转换器，集成16mΩ功率开关管和23mΩ同步整流管，为便携式系统提供高效的小尺寸解决方案。

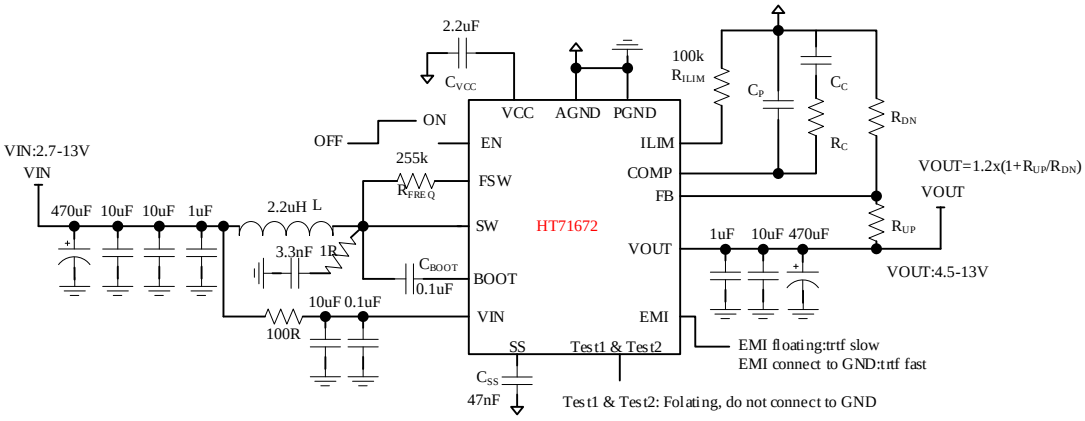
HT71672具有2.7V至13V宽输入电压范围，可为采用单节或两节锂电池的应用提供支持。该器件具备12A开关电流能力，并且能够提供13V的输出电压。

HT71672采用自适应恒定关断时间峰值电流控制拓扑结构来调节输出电压。在中等到重负载条件下，HT71672工作在PWM 模式。在轻负载条件下，该器件工作在可提高效率的PFM模式。PWM模式下，HT71672的开关频率可通过外部电阻调节，支持200kHz至1.0MHz的范围。

HT71672还支持可编程的软启动，以及可调节的开关峰值电流限制。另外，HT71672支持两种不同的tr/tf，以适应不同的EMI和效率需求。

此外，该器件还提供有14V输出过压保护、逐周期过流保护和热关断保护。

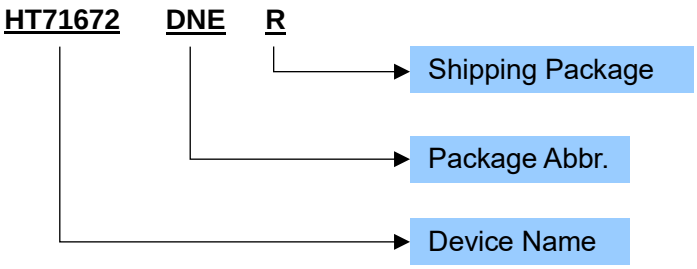
## ■ TYPICAL APPLICATION



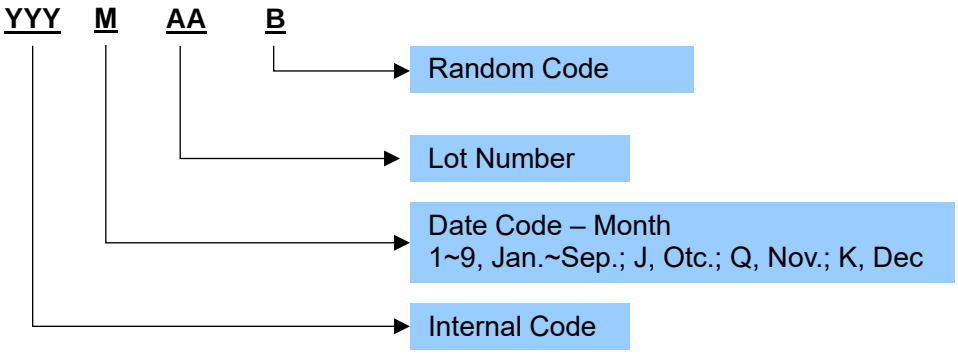
## ■ ORDERING INFORMATION

| Part Number | Package Type | Package Abbr. | Marking | Shipping Package / MOQ |
|---|---|---|---|---|
| HT71672DNER | DFN4.5×3.5-20L | DNE | HT71672<br>YYYMAAB[1] | TBD |

### Part Number

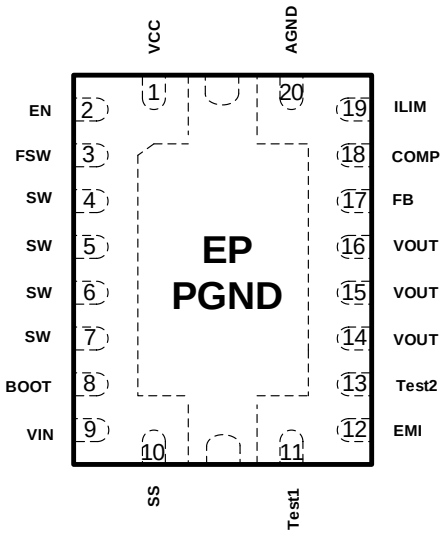



### Production Tracking Code




[1] YYYMAAB is production tracking code

## ■ TERMINAL CONFIGURATION




Top View

## ■ TERMINAL FUNCTION

| Terminal No. | Name | I/O[1] | Description |
|---|---|---|---|
| 1 | VCC | O | Output of the internal regulator. A ceramic capacitor of 2.2uF is required between this pin and ground. 接2.2uF到地。 |
| 2 | EN | I | Enable logic input. Logic high level enables the device. Logic low level disables the device and turns it into shutdown mode. 使能输入，接高电平使能，低电平关断 |
| 3 | FSW | I | The switching frequency is programmed by a resister between this pin and the SW pin. 接电阻到SW脚，调节PWM开关频率 |
| 4,5,6,7 | SW | P | The switching node pin of the converter. 升压开关节点 |
| 8 | BOOT | O | Power supply for high-side MOSTFET gate driver. A ceramic capacitor of 0.1μF must be connected between this pin and the SW pin. 接0.1uF电容到SW |
| 9 | VIN | P | IC power supply input. 电源输入脚 |
| 10 | SS | O | Soft-start programming pin. An external capacitor connected to ground sets the ramp rate of the internal error amplifier's reference voltage during soft-start. 接电容到地，设置软起动时间。 |
| 11 | Test1 | I | For internal test, must be float, do not pull up or down. 内部测试用，必须悬空，不能上拉或下拉。 |
| 12 | EMI | O | Selection for fast or slow tr/tf. Tr/tf模式选择 |
| 13 | Test2 | I | For internal test, must be float, do not pull up or down. 内部测试用，必须悬空，不能上拉或下拉。 |
| 14,15,16 | VOUT | P | Boost converter output. 升压输出 |
| 17 | FB | I | Voltage feedback. 电压反馈 |
| 18 | COMP | O | Output of the internal error amplifier, the loop compensation network should be connected between this pin and the AGND pin. 接阻容补偿网络到地。 |
| 19 | ILIM | O | Adjustable switch peak current limit. An external resister should be connected between this pin and the AGND pin. 接电阻到地，调节开关峰值限制电流 |
| 20 | AGND | G | Signal ground of the IC. 器件信号地 |
| EP | PGND | G | Provides both electrical and thermal connection from the device to the board. A matching ground pad must be provided on the PCB and the device connected to it via solder. For proper electrical operation, this ground pad must be connected to the system ground. 既是地，又是散热PAD |

[1] I: Input; O: Output; G: Ground; P: Power; BST: BOOT Strap; OD: Open drain

## ■ SPECIFICATIONS[1]

### ● Absolute Maximum Ratings*2

| PARAMETER | | Symbol | MIN | MAX | UNIT |
|---|---|---|---|---|---|
| Voltage range | BOOT | / | -0.3 | SW+7 | V |
| | EN, SW, FSW, $V_{OUT}$, $V_{IN}$ | | -0.3 | 14.2 | |
| | VCC, SS, COMP, MODE | | -0.3 | 7 | |
| | ILIM, FB | | -0.3 | 3.6 | |
| Operating temperature range | | $T_A$ | -40 | 85 | ℃ |
| Operating junction temperature range | | $T_J$ | -40 | 150 | ℃ |
| Storage temperature range | | $T_{STG}$ | -50 | 150 | ℃ |

### ● Recommended Operating Conditions

| PARAMETER | Symbol | CONDITION | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| Input power voltage range | $V_{IN}$ | | 2.7 | | 13.2 | V |
| IC power supply voltage range | $V_{IN}$ | | 2.7 | | 13.2 | V |
| Output voltage range | $V_{OUT}$ | | 4.5 | | 13.8 | V |
| Inductance, effective value | L | | 0.47 | 2.2 | 10 | μH |
| Input capacitance, effective value | $C_I$ | | 10 | | | μF |
| Output capacitance, effective value | $C_O$ | | 6.8 | 47 | 1000 | μF |
| Operating temperature | $T_a$ | | -40 | 25 | 85 | ℃ |
| Operating junction temperature | $T_J$ | | -40 | | 125 | ℃ |

[1] Depending on parts and PCB layout, characteristics may be changed.
[2] Stresses beyond those listed under absolute maximum ratings may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under recommended operating conditions is not implied. Exposure to absolute–maximum–rated conditions for extended periods may affect device reliability.

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## Electrical Characteristics[*1]

Condition: Ta = 25ºC, $V_{IN}$ = 2.7V-13.2V, $V_{OUT}$=4.5-13.2V, unless otherwise specified.

**Power Supply**

| PARAMETER | Symbol | CONDITION | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| Input power voltage range | $V_{IN}$ | | 2.7 | | 13.2 | V |
| IC power supply voltage range | $V_{IN}$ | | 2.7 | | 13.2 | V |
| Under-voltage lockout (UVLO) threshold | $V_{IN_UVLO}$ | VIN rising | | 2.5 | | V |
| | | VIN falling | | 2.3 | | V |
| VIN UVLO hysteresis | $V_{IN_HYS}$ | | | 200 | | mV |
| VCC UVLO threshold | $V_{CC_UVLO}$ | | | 2.1 | | V |
| Operating quiescent current from $V_{IN}$ | $I_Q$ | IC enabled, no load, $V_{FB}$ = 1.3V, $V_{OUT}$ = 12V | | 1 | | uA |
| Operating quiescent current from $V_{OUT}$ | | | | 150 | | |
| Shutdown current into $V_{IN}$ | $I_{SD}$ | IC disabled, no load, no feedback resistor divider | | 1 | | uA |
| VCC regulation | $V_{CC}$ | $V_{IN}$ = 4.0V, $V_{OUT}$ = 12V, light load | | 5.3 | | V |
| | | $V_{IN}$ = 4.0V, $V_{OUT}$ = 12V, $I_{LOAD}$ = 1A | | 5.05 | | V |

**EN and Mode Input**

| PARAMETER | Symbol | CONDITION | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| EN high threshold voltage | $V_{ENH}$ | | 0.94 | | | V |
| EN low threshold voltage | $V_{ENL}$ | | | | 0.84 | V |
| EN internal pull-down resistance | $R_{EN}$ | | | 1300 | | kΩ |

**OUTPUT**

| PARAMETER | Symbol | CONDITION | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| Output voltage range | $V_{OUT}$ | | 4.5 | | 13.2 | V |
| Output overvoltage protection | $V_{OVP}$ | | | 14.4 | | V |
| Reference voltage at the FB pin | $V_{REF}$ | | 1.197 | 1.204 | 1.227 | V |
| Soft-start charging current | $I_{SS}$ | | | 5 | | uA |

**ERROR AMPLIFIER**

| PARAMETER | Symbol | CONDITION | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| COMP pin sink current | $I_{SINK}$ | $V_{FB}$ = $V_{REF}$ +200 mV, $V_{COMP}$ = 1.5 V | | 20 | | uA |
| COMP pin source current | $I_{SOURCE}$ | $V_{FB}$ = $V_{REF}$ –200 mV, $V_{COMP}$ = 1.5 V | | 20 | | uA |
| High clamp voltage at the COMP pin | $V_{CC_LPH}$ | $V_{FB}$ = 1 V, $R_{ILIM}$ = 100 kΩ | | 2.14 | | V |
| Low clamp voltage at the COMP pin | $V_{CC_LPL}$ | $V_{FB}$ = 1.5 V, $R_{ILIM}$ = 100 kΩ, | | 0.94 | | V |
| Error amplifier transconductance | $G_{EA}$ | $V_{COMP}$ = 1.5 V | | 204 | | uA/V |

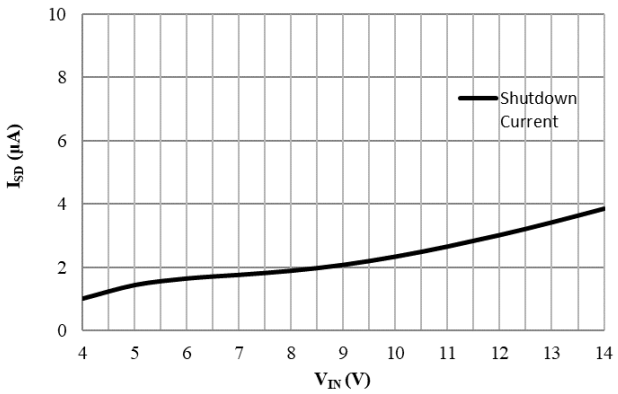
[1] Depending on parts and pattern layout, characteristics may be changed

| PARAMETER | Symbol | CONDITION | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| **POWER SWITCH** | | | | | | |
| MOSFET on-resistance | $R_{DS(on)}$ | High-side MOSFET | | 23 | | mΩ |
| | | Low-side MOSFET | | 16 | | mΩ |
| **CURRENT LIMIT** | | | | | | |
| Peak switch current limit | $I_{LIM}$ | $R_{ILIM}$ = 82 kΩ | | 12.2 | | A |
| | | $R_{ILIM}$ = 100 kΩ | | 10.1 | | |
| Reference voltage at the ILIM pin | $V_{ILIM}$ | | | 1.204 | | V |
| **SWITCHING FREQUENCY** | | | | | | |
| Switching frequency | $f_{SW}$ | $R_{FREQ}$ = 200 kΩ, $V_{IN}$ = 3.7V, $V_{OUT}$ = 12V | | 520 | | kHz |
| Minimum on-time | $t_{ON_min}$ | $R_{FREQ}$ = 200 kΩ, $V_{IN}$ = 3.6V, $V_{OUT}$ = 12V | | 200 | | ns |
| **THERMAL SHUTDOWN** | | | | | | |
| Thermal shutdown threshold | $T_{SD}$ | | | 160 | | ℃ |
| Thermal shutdown hysteresis | $T_{SD_HYS}$ | | | 20 | | ℃ |

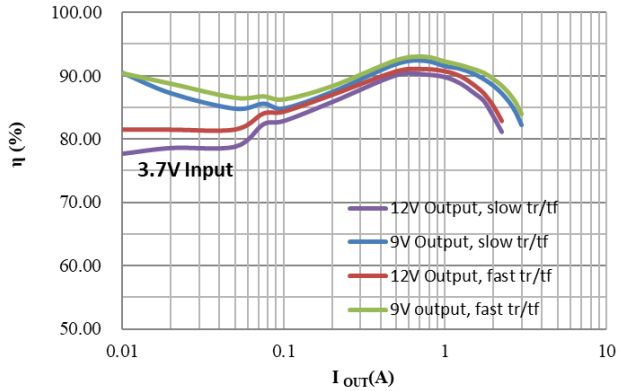
## ■ TYPICAL OPERATING CHARACTERISTICS

Condition: L = 2.2uH, $R_{ILIM}$ = 100k， $R_{FREQ}$ = 200k, Output Capacitor = 1uF//10uF//10uF//220uF, otherwise specified.

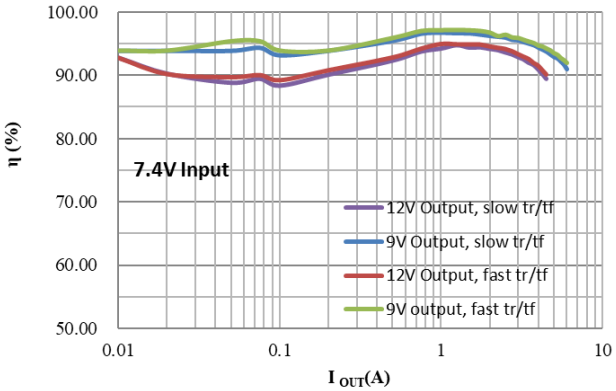
### Shutdown Current



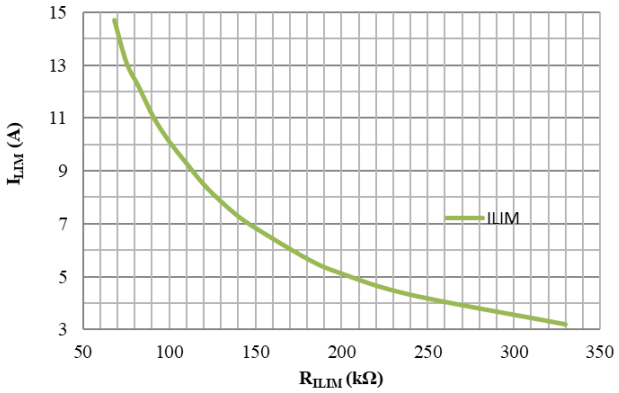

### $I_{OUT}$ vs η



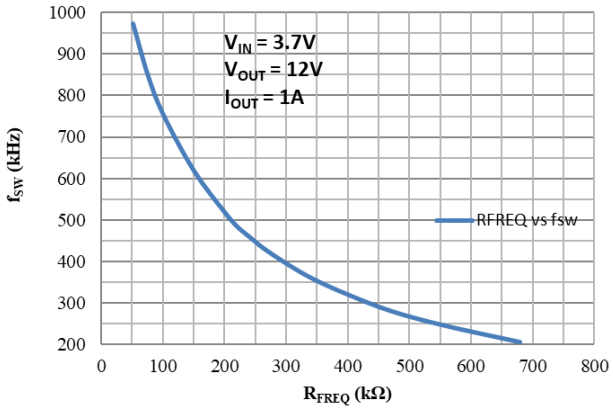

### $I_{OUT}$ vs η




### $R_{ILIM}$ vs $I_{LIM}$




### $R_{FREQ}$ vs $f_{SW}$



## ■ APPLICATION INFORMATION

### 1 Enable and Startup (EN and SS pin)

The HT71672 has an adjustable soft start function to prevent high inrush current during start-up. To minimize the inrush current during start-up, an external capacitor, connected to the SS pin and charged with a constant current, is used to slowly ramp up the internal positive input of the error amplifier. The larger the capacitance at the SS pin, the slower the ramp of the output voltage and the longer the soft-start time. A 47-nF capacitor is usually sufficient for most applications.

When the EN pin is pulled into logic low, the HT71672 goes into the shutdown mode and stops switching. Only when EN pin is pulled into logic high, the HT71672 works.

HT71672 具有软起动功能，防止启动时的高浪涌电流。SS 脚需外界电容到地，一般 47nF，SS 使用恒定电流对该电容充电，电容越大，充电时间越长，即软起动时间越长。

EN 为芯片使能脚，EN 拉低，芯片进入关断模式，停止开关；EN 拉高，芯片进入工作状态。

### 2 Adjustable Switching Frequency (FSW pin)

This device features a wide adjustable switching frequency ranging from 200 kHz to 1.0MHz. The switching frequency is set by a resistor ($R_{FREQ}$) connected between the FSW pin and the SW pin of the HT71672. The switching frequency can be calculated by:

HT71672 的开关频率可通过 FSW 与 SW 之间的电阻 $R_{FREQ}$ 调节，范围 200 kHz 到 1.0MHz。

$$R_{FREQ} = \frac{4\times(\frac{1}{f_{SW}} - t_{DELAY}\times\frac{V_{OUT}}{V_{IN}})}{C_{FREQ}} \quad \text{Equation 1}$$

where

- $R_{FREQ}$ is the resistance connected between the FSW pin and the SW pin.
- $C_{FREQ}$ = 27pF.
- $f_{SW}$ is the desired switching frequency.
- $t_{DELAY}$ = 174 ns.
- $V_{IN}$ is the input voltage.
- $V_{OUT}$ is the output voltage.

其中：

- $R_{FREQ}$即SW和FSW间电阻；
- $C_{FREQ}$ = 27pF.
- $f_{SW}$即开关频率.
- $t_{DELAY}$ = 174ns.
- $V_{IN}$ 是输入电压.
- $V_{OUT}$ 是输出电压。

### 3 Adjustable Peak Current Limit (ILIM pin)

To avoid an accidental large peak current, an internal cycle-by-cycle current limit is adopted. The low-side switch is turned off immediately as soon as the switch current touches the limit. The peak switch current limit can be set by a resistor (RILIM) at the ILIM pin to ground. The relationship between the current limit and the resistance is as follows:

芯片采用逐周期电流限制，避免意外的大峰值电流。当开关电流达到设置的限流值，低侧开关管立即断开。峰值开关电流限制（限流值 ILIM）可以通过 ILIM 引脚对地接 $R_{ILIM}$ 进行设置。限制值 ILIM 和电阻 $R_{ILIM}$ 之间的关系如下：

$$I_{LIM} = \frac{1000000}{R_{ILIM}} \quad \text{Equation 2}$$

### 4 Output Voltage Setting (FB pin)

The output voltage is set by an external resistor divider ($R_{UP}$, $R_{DN}$ in the Typical Application Circuit):

输出电压由外部电阻分压器（$R_{UP}$，典型应用电路中的 $R_{DN}$）设置：

$$V_{OUT} = V_{REF} \times (1 + \frac{R_{UP}}{R_{DN}})$$ Equation 3

Where $V_{REF}$ = 1.204V.

Some typical output voltages can be set as the following parameters.

其中 $V_{REF}$ = 1.204V。

部分典型电压可参考如下：

Table 1 Typical Output Voltage Settings

| $V_{OUT}$(V) | $R_{UP}$(Ω) | $R_{DN}$(Ω) |
|---|---|---|
| 5.3 | 510k | 150k |
| 7.4 | 510k | 100k |
| 9.4 | 510k | 75k |
| 12.2 | 510k | 56k |

## 5 Inductor Selection (SW pin)

The inductor is the most important component in switching power regulator design. Three most important specifications to the performance of the inductor are the inductor value, DC resistance, and saturation current.

To be simplified, the inductor value can be set as 2.2uH which can be used in most cases.

The rated current, especially the saturation current should be larger than the peak current during the whole operation. The peak current can be calculated as follows.

电感是该芯片的关键器件，影响性能的主要是其电感值，直流阻抗，饱和电流。

对于电感值，使用 2.2uH 的电感可以满足大部分应用。

对于额定电流，特别是饱和电流，必须大于所有工作条件下的最大峰值电流，最大峰值电流计算如下：

$$I_{Lpeak} = I_{DC} + \frac{I_{PP}}{2}$$ Equation 4

$$I_{DC} = \frac{V_{OUT} \times I_{OUT}}{V_{IN} \times \eta}$$ Equation 5

$$I_{PP} = \frac{1}{L \times (\frac{1}{V_{OUT} - V_{IN}} + \frac{1}{V_{IN}}) \times f_{SW}}$$ Equation 6

Boost converter efficiency is affected significantly by the inductor's DC resistance (DCR), equivalent series resistance (ESR) at the switching frequency, and the core loss. An inductor with lower DCR and ESR would increase the efficiency significantly.

The inductor should be placed as close as possible to the SW pin. For a lower EMI radiation, connecting a resistor and a capacitor in series to the ground would be helpful. 1ohm resistor and 3.3nF capacitor would be recommended in most cases.

升压效率受电感的直流阻抗、开关频率下的等效 ESR、磁心损耗等影响。选择小的 DCR 和 ESR 可提升效率。

电感应尽可能靠近 SW 引脚放置，并靠近 SW 引脚放置 1ohm 串联 3.3nF 到地。

## 6 Input Capacitor Selection (VIN, VCC pin)

For good input voltage filtering and small voltage ripple, we recommend low-ESR capacitors of 1uF//10uF//10uF//220uF ("//" represents paralleled) be placed as close as possible to the inductor.

The VIN pin is the power supply for the HT71672, a 1uF paralleled with 10uF ceramic capacitor should be placed as close as possible to the VIN pin. A resistor of 100R is recommended between input power supply and VIN pin so that the power supply of HT71672 would be more stable. An extensive power supply such as the logic power supply connecting to VIN would be another choice.

The VCC pin is the output of internal LDO. A ceramic capacitor of 2.2uF is required at the VCC pin to get a stable operation of LDO.

为了良好的储能和滤波以及减小电压波动，建议电源输入端使用 1uF//10uF//10uF//220uF 组合，放置在靠近电感的大电流路径上。

VIN 脚是 HT71672 的电源供电端，1uF 并联 10uF 对地电容放置在靠近 VIN 脚。输入电源和 VIN 脚之间可以串联 1 个 100R 电阻，已稳定 VIN 电压。VIN 还可以有系统中的逻辑电源供电。

VCC 是内部 LDO 输出，接 2.2uF 电容到地。

## 7 Output Capacitor Selection (VOUT pin)

To be simplified, we recommend low-ESR capacitors of 1uF//10uF//10uF//470uF ("//" represents paralleled) be placed as close as possible to VOUT pin for small output voltage ripple.

In detail, for the require output voltage ripple, use the following equations to calculate the minimum required effective capacitance $C_{OUT}$

简单来说，升压输出到地滤波电容建议使用 1uF//10uF//10uF//470uF 的组合，尽量靠近 Vout 引脚放置。

具体的，可以根据需要的输出电压纹波，得到需要的输出电容值：

$$V_{ripple_dis} = \frac{(V_{OUT} - V_{IN_{MIN}}) \times I_{OUT}}{V_{OUT} \times f_{SW} \times C_{OUT}}$$ Equation 7

$$V_{ripple_ESR} = I_{Lpeak} \times R_{C_ESR}$$ Equation 8

Where

- $V_{ripple_dis}$ is output voltage ripple caused by charging and discharging of the output capacitor.
- $V_{ripple_ESR}$ is output voltage ripple caused by ESR of the output capacitor.
- $V_{IN_MIN}$ is the minimum input voltage of boost converter..
- $V_{OUT}$ is the output voltage..
- $I_{OUT}$ is the output current.
- $I_{Lpeak}$ is the peak current of the inductor.
- $f_{SW}$ is the converter switching frequency.
- $R_{C_ESR}$ is the ESR of the output capacitors.

其中：

- $V_{ripple_dis}$ 是对电容充放电引起的输出电压纹波.
- $V_{ripple_ESR}$ 是输出电容ESR引起的输出电压纹波.
- $V_{IN_MIN}$ 是最小输入电压.
- $V_{OUT}$ 是输出电压.
- $I_{OUT}$ 是输出电流.
- $I_{Lpeak}$ 是电感峰值电流.
- $f_{SW}$ 是开关频率.
- $R_{C_ESR}$ 是输出电容 ESR.

## 8 Loop Stability (COMP pin)

The HT71672 requires external compensation, which allows the loop response to be optimized for each application. The COMP pin is the output of the internal error amplifier. An external compensation network comprised of resister $R_C$, ceramic capacitors $C_C$ and $C_P$ is connected to the COMP pin.

To be simplified, $R_C$ is 56kΩ, $C_C$ is 3.3nF, and $C_P$ can be floating. But notice that this setting can only be adopted in most cases. In detail, the compensation network parameters can be calculated as follows.

(1) Set the cross over frequency, $f_c$

The first step is to set the loop crossover frequency, $f_C$. The higher crossover frequency, the faster the loop response is. It is generally accepted that the loop gain cross over no higher than the lower of either 1/10 of the switching frequency, $f_{SW}$, or 1/5 of the RHPZ frequency, $f_{RHPZ}$. It's proper to use a fixed parameter of 10kHz for $f_C$.

$$f_{RHPZ} = \frac{R_O \times (1-D)^2}{2\pi \times L}$$ Equation 9

(2) Set the compensation resistor, $R_C$.

$$R_C = \frac{2\pi \times V_{OUT} \times R_{sense} \times f_C \times C_O}{(1-D) \times V_{REF} \times G_{EA}}$$ Equation 10

(3) Set the compensation resistor, $C_C$.

$$C_C = \frac{R_O \times C_O}{2 \times R_C}$$ Equation 11

(4) Set the compensation resistor, $C_P$.

$$C_P = \frac{R_{ESR} \times C_O}{R_C}$$ Equation 12

If the $C_P$ is less than 10pF, it can be left open.

- $R_O$ is the output load resistance.
- D is the switching duty cycle. 1 - D = $V_{IN}$ / $V_{OUT}$
- $R_{sense}$ is the equivalent internal current sense resistor, which is 0.091 Ω.
- $C_O$ is output capacitor.
- $V_{REF}$ is the reference voltage at the FB pin, which is 1.204V.
- $G_{EA}$ is the amplifier's transconductance, which is 204uA/V.
- $R_{ESR}$ is the equivalent series resistance of the output capacitor.

.

HT71672 需要外部补偿，在 COMP 引脚外接 Rc, Cc, Cp。简单来说，$R_C$=56kΩ, $C_C$=3.3nF，$C_P$ 悬空可以满足大部分应用。以下是补偿网络的计算过程：

(1) 设置交叉频率 fc

Fc 越大，响应越快。一般其设置为开关频率的 1/10 或 1/5 的 $f_{RHPZ}$，或直接为 10kHz.

(2) 设置补偿网络 Rc

(3) 设置补偿网络 Cc

(4) 设置补偿网络 Cp

如果 Cp 小于 10pF，可以悬空。

其中 Ro 是输出负载；

D 是占空比，1 - D = $V_{IN}$ / $V_{OUT}$

$R_{sense}$ 是内部等效电流感应电阻，0.091 Ω

Co 是输出电容

VREF 是 FB 电压，1.204V

$G_{EA}$ 是跨导，204uA/V

$R_{ESR}$ 是输出电容的等效串联电阻。

## 9 Selecting the Bootstrap Capacitor (BOOT pin)

The bootstrap capacitor ($C_{BST}$) between the BOOT and SW pin supplies the gate current to charge the high-side FET device gate during each cycle's turn-on and supplies charge for the bootstrap capacitor. The recommended value of the bootstrap capacitor is 0.1μF to 1μF. $C_{BST}$ should be a good quality, low ESR, ceramic capacitor located at the pins of the device to minimize potentially damaging voltage transients caused by trace inductance. A value of 0.1μF can be used in most cases.

BOOT 和 SW 之间需放置一个 $C_{BST}$ 电容，用于高端管开启时的栅极驱动。一般使用 0.1uF~1uF，大部分情况下可使用 0.1uF 电容。

## 10 Protection Function

### 10.1 Under-voltage Lockout (UVLO)

The UVLO circuit prevents the device from malfunctioning at low input voltage and the battery from excessive discharge. The HT71672 has both VIN UVLO function and VCC UVLO function. It disables the device from switching when the falling voltage at the VIN pin trips the UVLO threshold $V_{IN_UVLO}$, which is typically 2.3V. The device starts operating when the rising voltage at the VIN pin is 200mV above the $V_{IN_UVLO}$. It also disables the device when the falling voltage at the VCC pin trips the UVLO threshold $V_{CC_UVLO}$, which is typically 2.1V.

HT71672 具有 VIN 和 VCC 欠压保护。当 VIN 小于 $V_{IN_UVLO}$（典型 2.3V）时，器件停止开关，直至 VIN 大于 $V_{IN_UVLO}$（典型 2.5V）,器件重新工作。当 VCC 小于 $V_{CC_UVLO}$（典型 2.1V）时，器件同样停止工作。

### 10.2 Over-voltage Protection

If the output voltage at the VOUT pin is detected above 14.4 V (typical value), the HT71672 stops switching immediately until the voltage at the VOUT pin drops the hysteresis value lower than the output overvoltage protection threshold. This function prevents overvoltage on the output and secures the circuits connected to the output from excessive overvoltage.

当 VOUT 电压高于 14.4V (典型值)，HT71672 停止工作，直到 VOUT 低于 14V （典型值）。

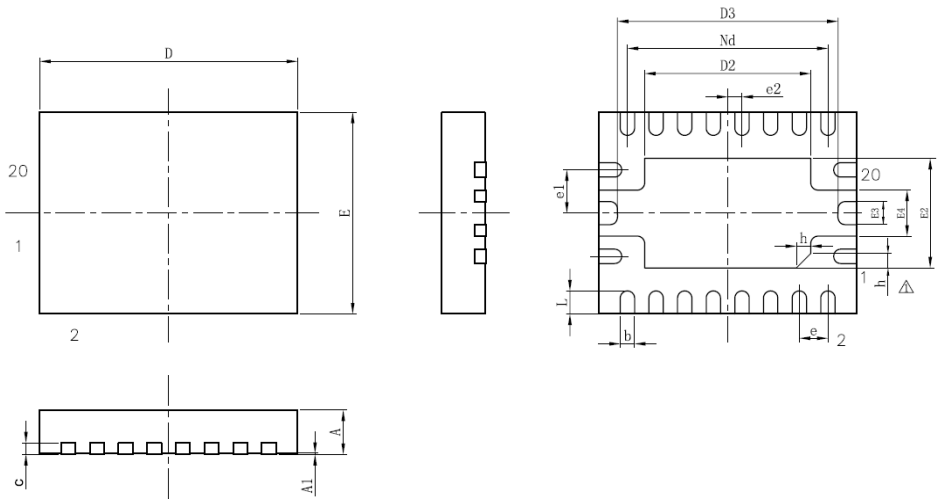
### 10.3 Thermal Shutdown

A thermal shutdown is implemented to prevent damages due to excessive heat and power dissipation. Typically, the thermal shutdown happens at a junction temperature of 150°C. When the thermal shutdown is triggered, the device stops switching until the junction temperature falls below typically 130°C, then the device starts switching again.

芯片具有过温关断保护功能。当结温大于 160°C（典型值），芯片关断；当结温低于 140°C（典型值），芯片恢复工作。

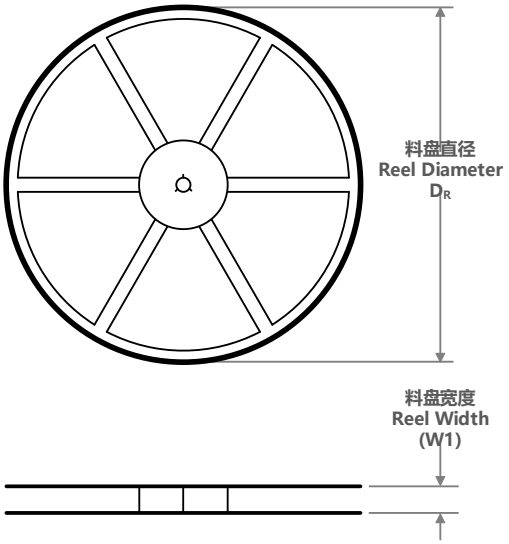
## ■ PACKAGE OUTLINE

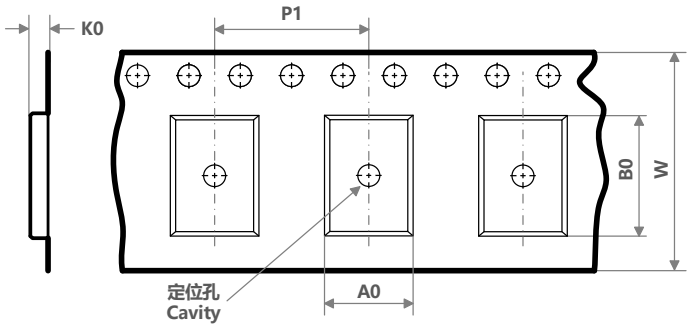
**DNE (DFN4.5×3.5-20L)**




| SYMBOL | MILLIMETER | | |
|---|---|---|---|
| | MIN | NOM | MAX |
| A | 0. 70 | 0.75 | 0. 80 |
| A1 | — | 0.01 | 0. 05 |
| b | 0. 18 | 0.25 | 0. 30 |
| c | 0. 18 | 0.20 | 0. 25 |
| D | 4. 40 | 4. 50 | 4. 60 |
| D2 | 3. 10 | 3. 20 | 3. 30 |
| D3 | 3. 85REF | | |
| e | 0. 50BSC | | |
| e1 | 0. 75BSC | | |
| e2 | 0. 25BSC | | |
| Nd | 3. 50BSC | | |
| E | 3. 40 | 3. 50 | 3. 60 |
| E2 | 2. 10 | 2. 20 | 2. 30 |
| E3 | 0. 35REF | | |
| E4 | 0. 75REF | | |
| L | 0. 35 | 0.40 | 0. 45 |
| h | 0. 20 | 0.25 | 0. 30 |
| 载体尺寸 (mil) | 134*94 | | |

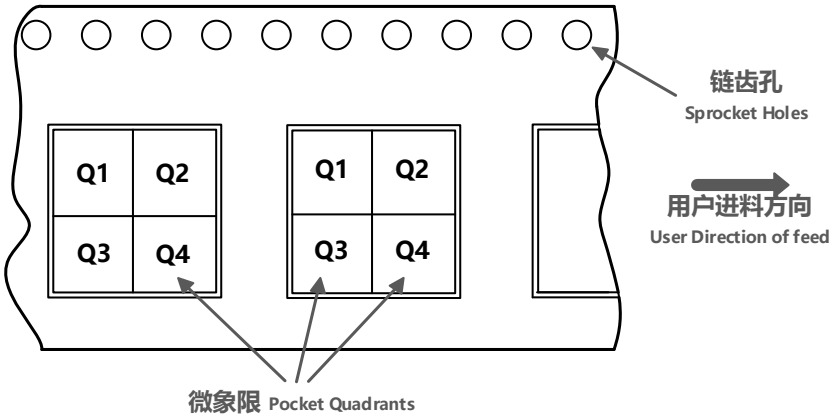
## ■ TAPE AND REEL INFORMATION



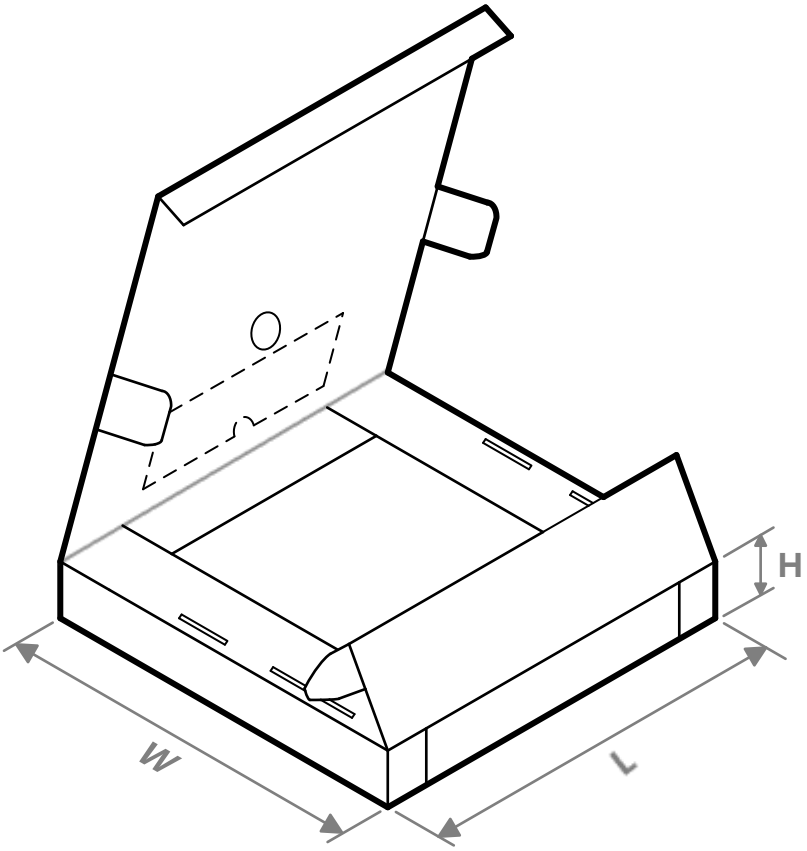

| | |
|---|---|
| **A0** | Dimension designed to accommodate the component width; 料槽宽度 |
| **B0** | Dimension designed to accommodate the component length; 料槽长度 |
| **K0** | Dimension designed to accommodate the component thickness; 料槽厚度 |
| **W** | Overall width of the carrier tape; 载带整体宽度 |
| **P1** | Pitch between successive cavity centers; 相邻槽中心间距 |

**编带 PIN1 方位象限分配**
**Quadrant Assignments for Pin1 Orientation in Tape**




| 器件料号 Part No. | 封装类型 Package Type | 封装标识 Package Code | 引脚数 Pins | SPQ | 料盘直径 $D_R$(mm) | 料盘宽度 W1 (mm) | A0 (mm) | B0 (mm) | K0 (mm) | P1 (mm) | W (mm) | Pin1 象限 Quadrant |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| HT71672DNER | DFN4.5 ×3.5 | DNE | 20 | TBD | TBD | TBD | TBD | TBD | TBD | TBD | TBD | TBD |

## ■ TAPE AND REEL BOX INFORMATION




| 器件料号 Part No. | 封装类型 Package Type | 封装标识 Package Code | 引脚数 Pins | SPQ | 长度 Length (mm) | 宽度 Width (mm) | 高度 Height (mm) |
|---|---|---|---|---|---|---|---|
| HT71672DNER | DFN4.5 ×3.5 | DNE | 20 | TBD | TBD | TBD | TBD |

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