HT45FH4J Emergency Light Applications

D/N: AN0368E

Introduction

The HT45FH4J device is especially designed for emergency lighting applications and includes fully integrated functions such as a 5V LDO, LED driver, Buzzer driver functions etc. These features reduce the need for peripheral components, resulting not only in reduced component cost but also reduced PCB size. As this device has powerful driving capacity, it can directly drive LEDs with 100mA of current as well as buzzers with 140mA of current. During battery charging or discharging, the complementary PWM output, which includes dead time control circuitry, is used to drive an internal PMOS and external NMOS transistor to form a complete synchronous rectification function. With this function, the device is able to reduce the power consumption to a minimum, improve the operating efficiency and extend the LED illumination time. As for protection features, the over current protection circuitry ensures that the LEDs and battery remain free from damage under situations of over current.

HT45FH4J Main Features

**MCU Basic Features**

- Integrated LDO with a high input voltage of up to 12V and an output voltage of 5V as the MCU operating voltage
- Oscillator Types
  - Internal 12/16/20MHz RC -- HIRC
  - Internal Low Speed 32kHz RC -- LIRC
- Flash Program Memory: 2K×16
- RAM Data Memory: 128×8 Bytes
- EEPROM Memory: 64×8 Bytes
- Watchdog Timer
- 6 external channels 12-bit A/D converter
- 3 Timer Modules
- Dual Time-Base functions for generation of fixed time interrupt signals
- 2 complementary PWM outputs with dead time control
- 2 over current protection functions with interrupt
Low voltage reset function
Low voltage detect function
Internal LED and Buzzer driver circuits
Package Types: 16-pin NSOP and 20-pin SSOP

Hardware Block Diagram

Functional Description

- The Holtek HT45FH4J Flash MCU is especially designed for emergency light applications. When compared with traditional MCU solutions for such applications, in addition to its increased functionality and pin count, the HT45FH4J also includes a 5V LDO as well as LED and Buzzer driver functions etc. These features extensively reduce the need for external components, resulting not only in reduced BOM cost but also reduced PCB size.

- The device includes a Flash Program Memory capacity of 2K×16, a Data Memory capacity of 128 bytes and a Data EEPROM capacity of 64 bytes. The internal LDO can be supplied with a maximum input voltage of 12V and can output 5V with a current of 50mA which can then be used to supply the MCU as well as peripheral circuitry. Additional features include three fully internal high accuracy 12MHz, 16MHz and 20MHz RC oscillators, an external 6-channel 12-bit A/D converter and three 10-bit Periodic Timers, one of which can be used for generating two complementary PWM outputs. This latter function is used for the required DC to DC boost and buck circuitry. A range of protection features are provided, such as an over current protection, Low Voltage Detector and Low Voltage Reset, which are used for system voltage monitoring. If the system voltage falls below the LVR value, then the microcontroller will be automatically reset to reduce the possibility of unstable operation.

- In traditional emergency light circuitry, the microcontroller usually requires additional transistors to drive the LED light source and buzzer as well as the boost or buck circuits. However, as the HT45FH4J includes powerful driving capability, it can drive LEDs with 100mA of current as well as buzzers with 140mA of current directly. During battery charging and discharging, the complementary PWM output, which also includes dead time control circuitry, is used to drive an internal PMOS transistor and an external NMOS transistor to form a complete synchronous rectification function. As the device offers low power and high efficiency it is able to extend the LED illumination time. As for protection features, the over current protection circuitry ensures that the LEDs and battery remain free from damage under situations of over current.
The HT45FH4J device is supplied in both 16-pin NSOP and 20-pin SSOP packages and in addition meets with industrial specifications and has excellent noise immunity.

Demo Board

Application Notes
- Rated Voltage: AC 220V, Mains Power: < 5W
- Ensure that the battery and LED lighting connectors are connected to the PCB
- After connecting to the 220V AC power supply, the three red, yellow and green indicators should all be on for 2 sec. If the LED and battery are operational the indicators will show normal for main power and charging status.

Technical Data
- Rated Voltage: AC 220V, Mains Power: < 5W
- Emergency Conversion Time: < 1S, Emergency Output Luminous Flux: ≧ 50 lm
- Charging Time: < 24H
- Emergency Operation Duration: ≧ 90min.
- Conversion Voltage: AC165 ~ 189V
- Standard: GB17945-2010 (Chinese National Standards)
Performance & States

- **Features**
  - Main Power: The green indicator is on, mains power is properly connected.
  - Charging: The red indicator is on and the battery is charging. When the battery is fully charged (determined by using a delta V method), the red indicator will be off.
  - Fault: The yellow indicator is on with a voice signal sounding once every 2~3 seconds. Only when the AC power supply is disconnected will the indicator and voice stop. This means there is something wrong with the LED lighting. When operating with a mains power supply, the failure reason can be identified based on the following conditions:
    - If the fault is no battery, bad battery contacts, a short battery circuit or a failure battery, the fault indicator flashes at a frequency of 3Hz.
    - If the fault is a light source short-circuit or open-circuit, the fault indicator flashes at a frequency of 1Hz.
    - If a monthly self-check is underway, the green indicator flashes at a frequency of 1Hz and the emergency lighting will be on for less than 30s.
    - If an annual self-check is underway, the green indicator flashes at a frequency of 1Hz and the emergency lighting will be on for less than 30 minutes.

- **Automatic regular self-check**
  - After the lights have been working for 48 hours, every 30 (+/-2) days, it will switch from mains power operation to emergency operation for 30s (±3). It will then return to the mains power operation once again. If the emergency time is less than 30s, the light will send a sound and light alarming signal, which can shut off only when the AC power is disconnected.
  - In mains power operations, every other year, the light enters the emergency operating condition and after all the stored energy is discharged, the light will return to mains power operation once again. If the emergency time is less than 30 minutes, the light will send a sound and light alarming signal, which can shut off only when the AC power is disconnected.
  - The above functions can be executed manually without affecting the self-check timing, e.g. when the light power goes off or the light enters the emergency operation and discharging ends. The timer can restart timing after connecting to the mains power again.

- **Key Function Simulation**
  - Mains Power normal
    Double short press: simulates a mains power failure
    Long press of 3s: long press for 2~5s results in the emergency light initiating the monthly self-check function.
    A long press of 5s: long press of over 5s results in the emergency light initiating the annual self-check function.
  - Mains Power abnormal
    Double short press: turn off the light
Emergency Light Application Description

In emergency light products, a MCU determines either a buck or boost mode to provide the required emergency lighting power according to the conditions of the mains supply and the rechargeable battery. The device has a range of functions related to emergency lighting. Using an internal power MOS, the device can easily implement the relevant functions while meeting the associated Chinese national standards. The related operations are described as below.

**Charging under Normal Mains Supply**

An emergency light is usually powered by the mains supply with AC power being converted to DC power. When the voltage is within 12V, it can be directly connected to the HV_IN pin to provide power for the MCU and other circuits. In this case, for a 1.2V chargeable battery, a buck charge mode can be implemented by turning on the internal switches, M0 and M4 (controlled by PWM outputs) as well as the BAT_IN pin which is externally connected with an inductor, a Schottky diode and a battery. The A/D converter can be used for charging current control. For improved buck charge implementation, connect an external NMOS to the PA7 pin for synchronous rectification.
Simulate Battery Boost for lighting under Normal Mains Supply

Turn off M0 and use M4 and the PA7 pin for complementary PWM control. Then connect an external NMOS and an inductor to boost the battery voltage or current to the higher level required by the LED lighting. After the high voltage has been generated, it can be read by the internal resistor divider which is enabled using the SW_EN bit to implement constant voltage feedback control. For a better boost charge result, connect a Schottky diode in parallel between the BAT_IN pin and the HV_OUT pin. Refer to the application circuit section for more details.

Buzzer Driving

M1 and M2 together form the buzzer dedicated output pin which is controlled by the BZ_S0 and BZ_S1 bits to output a PWM signal or a constant high/low level.

LED Driving

The LED_OUT pin is the LED driving output pin. The internal high voltage power is transmitted to the pin by M3 to drive the lighting LED. Whether a PWM signal is used for LED dimming and constant current control or to enable/disable the LDO_OUT pin output is determined by the LED_S0 and LED_S1 bits.

Demo Conversion Efficiency

![Conversion Efficiency Curve – up to 70.6%](image)
Conclusion

The HT45FH4J device is a highly functionally integrated MCU. The need for peripheral components is greatly reduced, resulting not only in reduced BOM cost but also reduced PCB size. The internal LDO can be supplied with a maximum input voltage of 12V and can output 5V with a current of 50mA which can then be used to supply the MCU as well as peripheral circuitry. Additional features include three fully internal high accuracy 12MHz, 16MHz and 20MHz RC oscillators, an external 6-channel 12-bit A/D converter and three 10-bit Periodic Timers, one of which can be used for generating two complementary PWM outputs. This latter function is used for the required DC to DC boost and buck circuitry. A range of protection features are provided, such as an over current protection, low voltage detector and a low voltage reset which are used for system voltage monitoring. As the HT45FH4J has a powerful driving capability, it can drive LEDs with 100mA of current as well as buzzers with 140mA of current directly. During battery charging and discharging, the complementary PWM output, which also includes dead time control circuitry, is used to drive an internal PMOS transistor and an external NMOS transistor to form a complete synchronous rectification function. As the device offers low power and high efficiency it is able to extend the LED illumination time. As for protection features, the over current protection circuitry ensures that the LEDs and battery remain free from damage under situations of over current. A Firmware Library is provided which users can modify the parameters based on their requirements. Additionally, the general I/O pins of the HT45FH4J can also be used to communicate with other product hardware, allowing for greater application flexibility and enhanced product competitiveness.