BA45FH0082 + HT45F2020 Networked Encoded Sound and Light Alarm Application

Overview

Holtek’s BA45FH0082 Flash MCU and Sound Effect Generator Flash MCU, the HT45F2020, are used for fire protection system terminal devices and products with custom sound effects. This application example illustrates the functions and features of these two devices. It demonstrates how the power supply line data communication receiving/transmitting operation is implemented to generate sound effects using the sound platform.

Audible and light alarms are an indispensable feature of fire protection system. Their main purpose is that when the detector senses an environmental abnormality, the host will send a start command to the sound and light alarm, after which a warning signal is sent to warn people of the danger using sound and light. The sound and light alarm can be divided into two types, a non-coding type and an encoding type. As the name implies, the encoding type has a communication function and its own address, so that each optical alarm can be given different addresses via an electronic encoder. When compared with non-encoding light and sound alarms, encoded alarms have the advantages of being able to use signals to interrogate the alarms to eliminate faults, as well as being able to activate groups of alarms in specific areas.

Basic Characteristics

**BA45FH0082**

- Full power-line data transceiver function
- Input Voltage Range: 7~42V
- Fully integrated low voltage dropout regulator, comparator
- Open drain NMOS driver
- Oscillator Types
  - Internal High Speed 4MHz RC – HIRC (Accuracy ±3% @ -40°C ~ 85°C)
  - Internal Low Speed 32kHz RC – LIRC
- Flash Memory: 2K×15
- RAM Data Memory: 128x8
- True EEPROM Memory: 64x8
- Watchdog Timer
- 8 External Channel 12-bit A/D Converter
- 2 Timer Module (STM)
- Dual Time Base Functions can provide fixed time interrupt signals
- Low Voltage Detector and Low Voltage Reset Functions
- Multiple Operating Modes: NORMAL, SLOW, IDLE and SLEEP
- Package Types: 16-pin NSOP and 20-pin SSOP

**HT45F2020**

- Input Voltage Range: 8V~16V
- Internal Shunt regulator output: 5V
- Operating Voltage: 2.2V~5.5V
- Oscillator Types
  - Internal High Speed RC – HIRC
  - Internal Low Speed 32kHz RC – LIRC
- Multiple Operating Modes: NORMAL, SLOW, IDLE and SLEEP
- Flash Memory: 1K×15
- RAM Data Memory: 32x8
- Watchdog Timer
- 1 Timer Module (PTM)
- Single Time Base Function can provide fixed time interrupt signals
- Package Types: 6-pin SOT23 and 8-pin SOP

**Functional Description**

![Functional Description Diagram](image-url)

**Fig. 1. Internal Block Diagram**
Networked sound and light alarms include the functions of communication, addressing, fault detection, illumination and audible alarms. For such solutions Holtek has the BA45FH0082 and HT45F2020 devices. When compared with traditional solutions, which require external buck and communication circuits, the Holtek solution fully integrates these functions. This makes this solution suitable for other products which require power bus communication, ADC detection, simple control and sound effects.

The BA45FH0082 includes a high 7V~42V input voltage range linear regulator (LDO), a power bus communication receive and return code circuit, EEPROM storage, a 10-bit and a 16-bit Timer Modules, multi-channel 12-bit ADC, low power HIRC as well as many other functions. In sound and light alarm systems, the main function is to manage the Master to the Slave voltage modulation signals and the current modulated return signals. The MCU can then determine whether to store the return signals or to take appropriate alarm action.

The HT45F2020 includes an integrated Shunt Regulator and a 10-bit multi-function timer to provide timing, pulse, PWM and complementary outputs. This can manage the sound and light driving in the sound and light alarm system. Also provided is a software voice development platform, which not only reduces the need for additional external components but also allows for more flexible and rapid product development.
Hardware Description

Since the networked encoded sound and light alarm is a slave, if it is not controlled by a master device, it will not be able to execute its required function. Therefore, this application example uses an electronic encoder to act as a master to communicate with the slave networked sound and light alarm. In this way the master can setup the control requirements. The following shows the two hardware sections.

Fig. 3. Networked sound and light alarm circuit diagram

Fig. 1. Encoder Circuit Diagram
Introduction to Power Bus Communication Principles

The communication method used by most products in fire protection products is power bus communication transmission. It has the following communication features:

1. Power is supplied via the bus without requiring additional power connections
2. Strong anti-interference ability.
3. Long communication distances of 1000m~1500m
4. Non-polarity wiring using a bridge circuit at the slave end
5. Flexible wiring

In the data transmission mode, the master terminal uses voltage signal modulation for the slave terminal to send commands, and the slave terminal uses current modulation for the master terminal return message. This provides reliable communication for multi-point slaves over long distances thus avoiding complicated wiring systems.

This application provides a simple master-slave transceiver format as shown.

![Slave reception logic level determination](image1)

**Fig. 2. Slave reception logic level determination**

The master will adjust the voltage level using the two lines of the power bus communication. The slave will measure the length of the positive and negative half cycles to determine the logic level. When the time in six time constants is less than 3 time constants then the logic level is deemed to be 1, and when it is greater than 3 time constants it is deemed to be 0.

![Master reception logic level determination](image2)

**Fig. 3. Master reception logic level determination**

When the slave returns a current modulated return code, the master will adjust the voltage to the VM voltage, and then check using a circuit detector to see whether the slave has returned a current. The logic level is determined during the current reading.
interval. If the voltage remains at the VM voltage for a period of time then this is deemed to be a logic 1, otherwise it will be deemed to be 0 when the voltage during the reading range is lower than VM for a period of time.

### Introduction to the Application Communication Protocol

The master terminal encoding format is a 4 Bit Command + 8-bit Address + 4-Bit Checksum. The checksum calculation method is to add the instruction to the address and then take the lower four bits. For example, if the instruction is 0000 and the address is 0x55 (01010101) then the checksum would be 0101. The slave terminal sends back a 4-bit Yes/No code. If the slave terminal determines that the code is correct, it will reply with a Yes to the host by sending 1010. Any non-1010 bit combination will be taken as a No. The delay time is set to be 6ms due to the maximum EEPROM write time of 6ms.

The following describes the application communication protocol of each function.

![Diagram 1](image1)

**Fig. 4. Writing the address to the slave terminal**

![Diagram 2](image2)

**Fig. 5. Reading the address from the slave terminal**

![Diagram 3](image3)

**Fig. 6. Multicast Alarm/Unicast Alarm**

![Diagram 4](image4)

**Fig. 7. Read Slave Terminal ADC Value**
Software Description

Networked encoder sound and light alarm S/W flow chart

- Main Program
Networked coded sound and light alarm program description

When the MCU is powered on, all the program registers are initialised, and the data memory is cleared. The system then waits for communication from the master. When the master sends a falling edge signal, the program will enter the interrupt. After entering the interrupt, the program will first examine the receive/return flag. If the flag indicates a receive code, it will enter the receive data flow. As either a rising edge or falling edge will trigger the interrupt, examining the flag can determine which one it is. When a falling edge triggers the interrupt, the timer is started. When a rising edge triggers the interrupt, the timed value is stored in the data through indirect addressing. In the memory, when the count is stored as 16-bit data, it indicates that the code is completed and it will enter the decoding process. First is checked if that the time from the first falling edge to reception of the 16-bit data is greater than 100ms. If it does exceed 100ms, then the data will be discarded and await the next code. Otherwise it will enter the decoding stage. Firstly the data previously stored indirectly will be retrieved, to determine whether it is exceeds...
240μs. If it does exceed 240μs, then it will be deemed to be logic 0, otherwise it will be read as 1. The value read will be stored as the variable, and the variable will be decoded by calculation and the master requested instruction will be executed. After the execution has completed, a return code will be activated after which it will await a falling edge signal from the master. Each falling edge returns 1 bit of data and a total of 16 bits of current modulated return codes are returned.

**Encoder Software Flowchart**

- **Main Code**

  ![Encoder Software Flowchart Diagram]
Corresponding Key Function and Display

- **Level=0**
  - LCM display
  - HOLTEK Encoder
  - 1.Write 2.Read

- **Level=1**
  - Key 1 or 2 is pressed?
    - Y: LCM display
    - N: Key 1 is pressed?
      - Y: Setup level=2
      - N: Enter key is pressed?
        - Y: Send instruction, address and checksum
        - N: Determine if return code is correct
          - Y: Update LCM 2nd row display with 3 digit address
          - N: Update LCM 2nd row display with updated return code value

- **Level=2**
  - Key 0~9 is pressed?
    - Y: Input mode?
      - Y: Send instruction, address and checksum
      - N: Determine if return code is correct
        - Y: Update LCM 2nd row display with 3 digit address
        - N: Update LCM 2nd row display with updated return code value

- **Setup level=0**
  - Return Key is pressed?
    - Y: Setup level=4
    - N: Initialise variables

- **Setup level=1**
  - Write Address: 000 (3 digits)
  - Setup instruction=0x00

- **Setup level=2**
  - Setup instruction=0x01

- **Setup level=3**
  - Setup level=2

- **Setup level=4**
  - Select 1 pressed?
    - Y: LCD display
    - N: Return Key is pressed?
      - Y: Setup level=0
      - N: Initialise variables

- **END**
Encoder Software Description

The encoder functions include encoder battery voltage detection, LCD display, power saving mode, key press sound, slave address assignment, reading the slave address, reading the slave ADC value and activating the slave alarm.

When the MCU is powered on and enters the main program, the registers will be initialised to detect whether the battery capacity is enough to provide communication and then start a 15 second count. If there is no key press within 15 seconds, the MCU power will be switched off and the power saving state entered. When a key press is detected, the corresponding key action and display subprogram are entered. The subprograms are divided into five levels, where level 2 is responsible for all key inputs, LCD display control and slave communication receiving/transmitting code. All are executed within level 2. All other levels are used to setup the corresponding function parameters after which it returns to level 2 for execution.
HT45F2020 Sound Generation Flow

Holtek has introduced the HT45F2020/HT45F2022 in response to the demand for custom sound effects for a range of products. With its multi-programming features, customers can program and create their own unique sound effects in response to their unique audio requirements. The MCU also has a range of functions and features to help generate custom audio effects. Holtek also provides a sound effect development platform, known as the Sound Effect Generator Wizard, which can be downloaded on the Holtek website. The platform contains 70 types of sound effects and according to the configuration options (load, output, drive, trigger) and recommended application circuits, can provide customer with a choice of programming selections. For operating flow details, the question mark icon, 7, on the bottom right side of the platform can be selected.

Operating Description

The function display of the networked coded sound and light alarm needs to be controlled and displayed via communication between the master and the slave. The following is displayed through the LCD screen to show how it should be operated.

Fig. 8. Function display (read/write address) writes address 085 to the slave and reads
Fig. 9. Function display (alarm) to make the slave address 085 alarm

Fig. 10. Function Display (read slave terminal A/D value) – slave terminal Bandgap = 1.2V, VDD=3.3V
Application Specification

<table>
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<th>Network encoder sound and light alarm specification</th>
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<tbody>
<tr>
<td>Operating Voltage</td>
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<tr>
<td>Signal main line: 16V~28V</td>
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<tr>
<td>Power main line: 20V~28V</td>
</tr>
<tr>
<td>Monitoring current</td>
</tr>
<tr>
<td>≤ 0.8mA</td>
</tr>
<tr>
<td>Alarm current</td>
</tr>
<tr>
<td>≤ 55mA</td>
</tr>
<tr>
<td>Operating environmental temperature</td>
</tr>
<tr>
<td>-10°C ~ +50°C</td>
</tr>
<tr>
<td>Flash frequency</td>
</tr>
<tr>
<td>1~2Hz</td>
</tr>
<tr>
<td>Sound level</td>
</tr>
<tr>
<td>≥ 85dB~120dB (in front 3m level) (A weighting)</td>
</tr>
<tr>
<td>Line system</td>
</tr>
<tr>
<td>Dual bus (4 lines)</td>
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Conclusion

The BA45FH0082 + HT45F2020 combination has provided a flexible development environment compared to traditional solutions by using a high level of functional integration. The BA45FH0082 includes integrated power line data transmission, using code and code return functions, eliminating many external components. The MCU has a low power consumption mode and will power down with a current ≤ 1μA. There is also an integrated LDO input voltage range of 7V~42V, reducing the need for an external LDO, as well as a fully integrated oscillator and an ADC.

The HT45F2020 includes an integrated Shunt Regulator which eliminates the need for external buck components. It has a software controlled fade-in function to meet the requirements for gradual volume change. The small package types are easy to integrate into space-limited products and a single device offers both sound and light functions. With reduced costs, complementary output buzzer driver, the need for an external transistor and inductor are eliminated. This combination of features, make it very suitable for home based products, and its software development platform greatly assists users with their product development.

Reference Material

Reference documents: BA45FH0082, HT45F2020 Datasheets.

For more information consult the Holtek website: www.holtek.com.

Version and Modification Information

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<th>Date</th>
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<th>Issue Release and Modification</th>
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