Touch Automatic Soap Dispenser

D/N: WAS-20C3EN

Introduction

The automatic soap dispenser is a hand cleaning device usually installed in bathrooms. When users place their hands within its sensing range, it automatically dispenses some liquid soap or hand sanitizer. In a developed society, more attention is paid to hygiene and health, with automatic soap dispensers becoming increasingly popular. They can not only avoid secondary infections caused by hand contact, but can also automatically provide a measured amount of soap with each use, which will effectively reduce waste.

The Holtek touch automatic soap dispenser solution uses an infrared (IR) sensor with a BS45F3345 touch MCU to implement a touch control power on/off function along with an IR proximity sensing function. The BS45F3345 MCU includes a highly functionally integrated IR proximity sensing transceiver circuit, which integrates an IR AFE, a dual channel IR emitter driver circuit, a 4-Key Touch module and an H-Bridge driver.

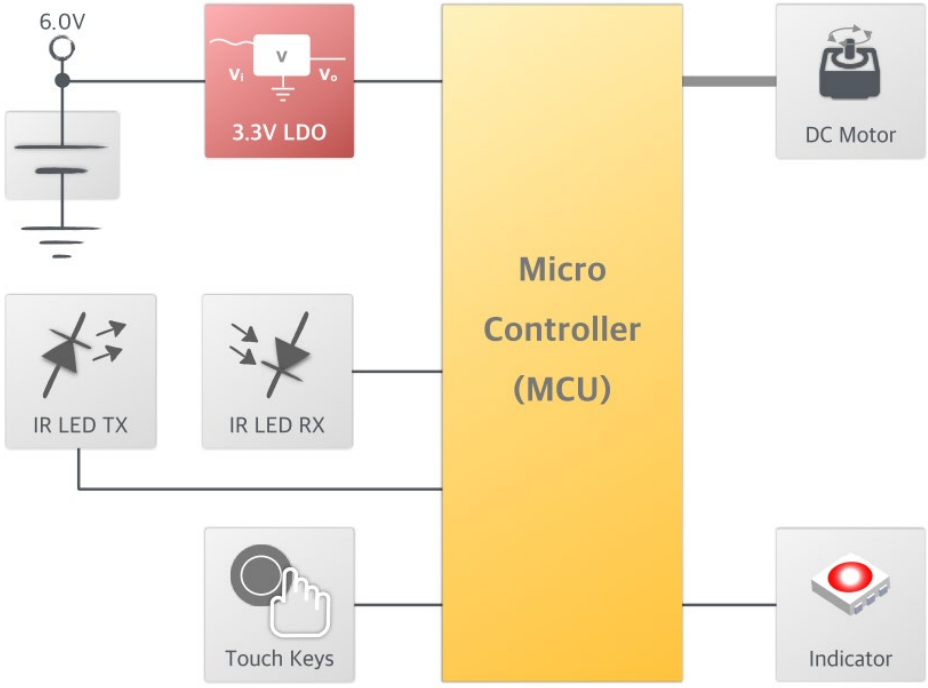

Figure 1. System Block Diagram

Application Areas

Automatic alcohol sprayer and automatic hand sanitizer.

Solution Features

1. Reduced components and low power consumption: contains a highly functionally integrated IR proximity sensing transceiver circuit

   The BS45F3345 has a sink current source generator for directly driving an IR LED. The sink current source generator can provide a constant current even though the IR LED port voltage (ISINK0) can be from 0.7V to 4.5V. Here the constant sink current range can be 1mA~192mA, which can be used to directly drive the IR LED. Using this device will save on the normally required discrete components required for the constant current generator.

   The BS45F3345 provides an IR AFE circuit that can be used for optical signal detection in IR applications. The circuit contains two fully integrated operational amplifiers. The optical signal can be detected and processed by the internal operational amplifiers. When used together with a timer and an A/D converter, this can implement automatic timing detection. The average current is about 15μA for every 0.5s detection.

2. Motor driver: highly integrated H-bridge driver

   The BS45F3345 has an integrated 1-channel H-bridge driver with a maximum motor peak current of 2.1A. Its two-wire input control pin structure is used to provide four control modes during the active cycles: Forward, Reverse, Brake and Standby modes. It can also control the H-bridge driver to enter and exit the sleep mode.

   A full range of protection functions are integrated including OCP, OSP and OTP to prevent the H-bridge driver from being damaged even if the motor stalls or experiences a short circuit in a critical operating environment. The H-bridge driver also includes separate power supplies for the control circuits and the motor power supply and also includes a current sensing pin to allow the system to measure the motor current using an external resistor.

Operating Principles

IR Proximity Sensing

The infrared sensing method in this solution adopts an active infrared sensing method.

As shown in figure below, when there is no object within the proximity sensing range, the IR receiver cannot capture the reflected infrared signal. Conversely, when an object is present within the detectable distance, the IR receiver will capture the reflected infrared signal.

The proximity reading is linearly proportional to the intensity of the captured infrared signal. The signal intensity value will be sampled by the ADC and then amplified by an internal amplifier. It can then be determined if it is a valid trigger signal or not.

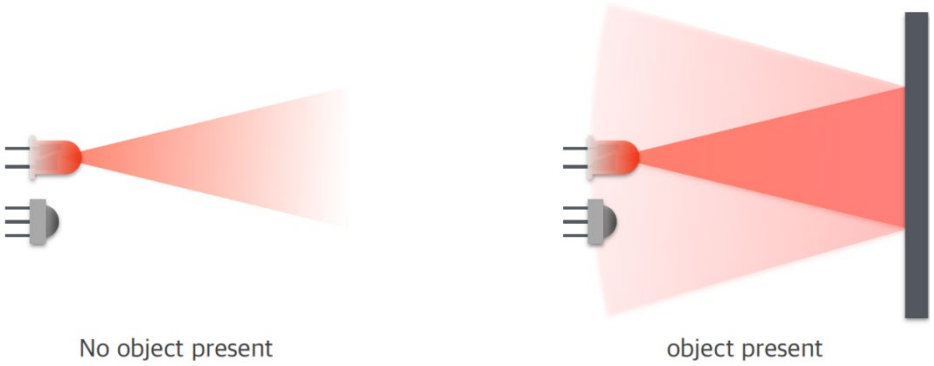

Figure 2

Functional Description

Solution Characteristics

- Operating voltage: DC 6V (1.5V×4)
- H-Bridge voltage: V_M = 7.5V (Max)
- Motor drive mode: PWM control
- Average standby current: 15μA – Typical – detects whether there is an object within the proximity area every 0.5s
- Sensing distance: up to 8 cm

Solution Functions

This solution includes both touch and proximity sensing functions. After powering on, pressing and holding the touch key for about 2 seconds will turn the device on. If a human hand is in close proximity to the soap outlet after power on, it will dispense an amount of soap. To turn off the device, press and hold the touch key for about 2 seconds again.

The product PCBA is shown in Figure 3.

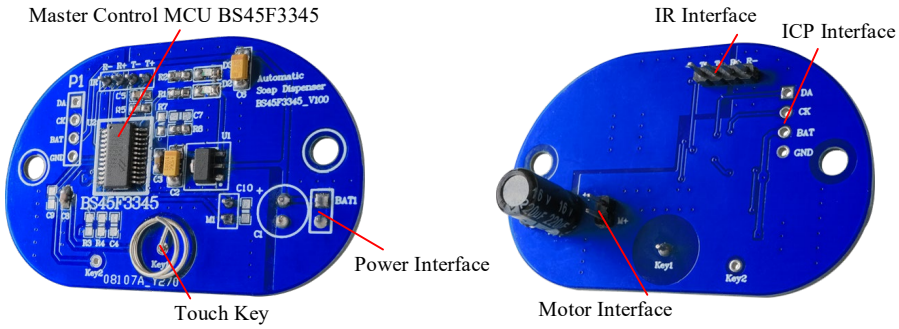

Figure 3. PCBA Physical Diagram

Solution Design Description

In this solution, the main controller MCU, the BS45F3345, provides 4K×16 ROM of program memory space, 17 bidirectional I/O lines and multiple timer modules. In addition, it has a UART universal serial interface module for data communication. For proximity sensing, it provides an IR AFE circuit, an internal constant sink current generator ISINK to implement IR proximity sensing.

Hardware Description

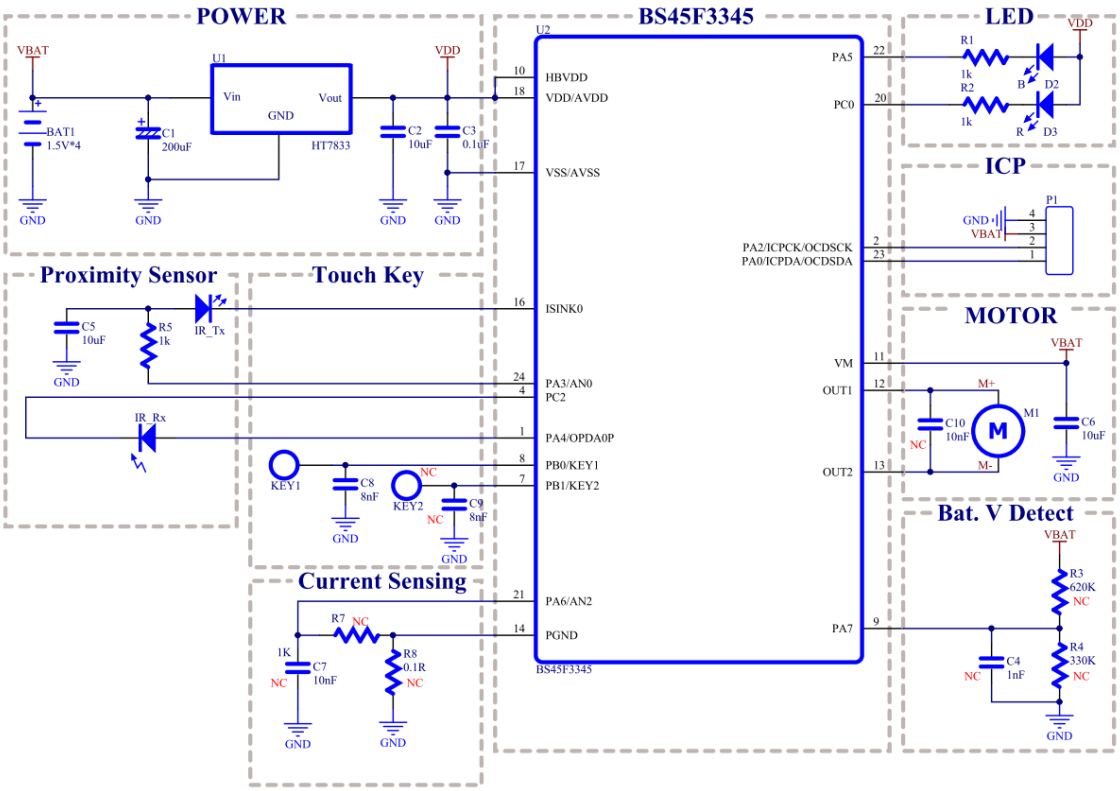

Figure 4. Touch Automatic Soap Dispenser Circuit Diagram

The upper left hand part of the circuit diagram contains the power circuit, which outputs a 3.3V voltage from an LDO for the MCU power and some back end application circuits. On the left side of the MCU is the IR emission and detection circuits and the touch key circuit. These circuits implement the IR proximity sensing function and the touch function. The device performs power on/off by a touch key. The upper right side circuit shows the LED driver circuit, which is used to indicate the application status. The circuit on the right side of the MCU shows the motor drive circuit. If the device is powered on, when an object approaches, the MCU will drive the motor and the LED will illuminate. The lower left and right side circuits are reserved for the OCP current detection circuit and the power supply voltage detection circuit.

Layout and Hardware Considerations

The PCB Layout top and bottom views are shown in Figure 5 and Figure 6.

Note: It is recommended that the motor current GND and the IR receiving circuit GND are separated by a 0Ω resistance to avoid interference.

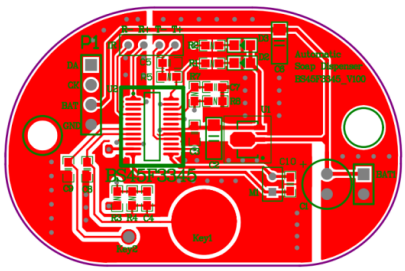

Figure 5

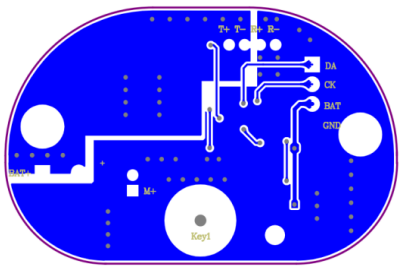

Figure 6

PCB BOM Table

Comment	Designator	Footprint	Quantity
1.5V*4	BAT1	HDR 1x2(2.54)	1
200uF	C1	CAP DIP 200uF/16V	1
10uF	C2, C6	C 1206	2
0.1uF	C3	C 0603	1
N.C.	C4, C7, C9, C10	C 0603	1
10uF	C5	C 0603	1
8nF	C8	C 0603	3
B	D2	LED_0805	1
R	D3	LED_0805	1
IR Connector	IR	HDR 1x4(2mm)_2	1
KEY	KEY1, KEY2	PAD - Test	2
Motor	M1	HDR 1X2 Pitch 2mm	1
ICP	P1	HDR_1x4_2.54mm	1
1k	R1, R2, R5	R 0603	4
N.C.	R3, R4, R7, R8	R 0603	1
HT7833	U1	SOT89-3	1
BS45F3345	U2	SSOP 24PIN 150MIL 0.635PITCH	1

Table 1

Software Description

The following table shows the software usage and resources.

Item	**BS45F3345**
V_{DD}	3.3V
Operating Frequency	8MHz
ROM	3101×16 used – 75% occupied
RAM	156×8 used – 81% occupied
WDT	128ms
Timer	Time base 0 – 256μs Time base 1 – 256μs
Other Peripherals	1. KEY1 – Touch key 2. OPAMP0 – Infrared signal input amplifier 3. ADC – Read the OPDA0O signal to determine the proximity sensing 4. H-bridge driver – Drive motor 5. Sink current source generator ISINK0 – provides constant current to the IR LED

Software Main Flow Description

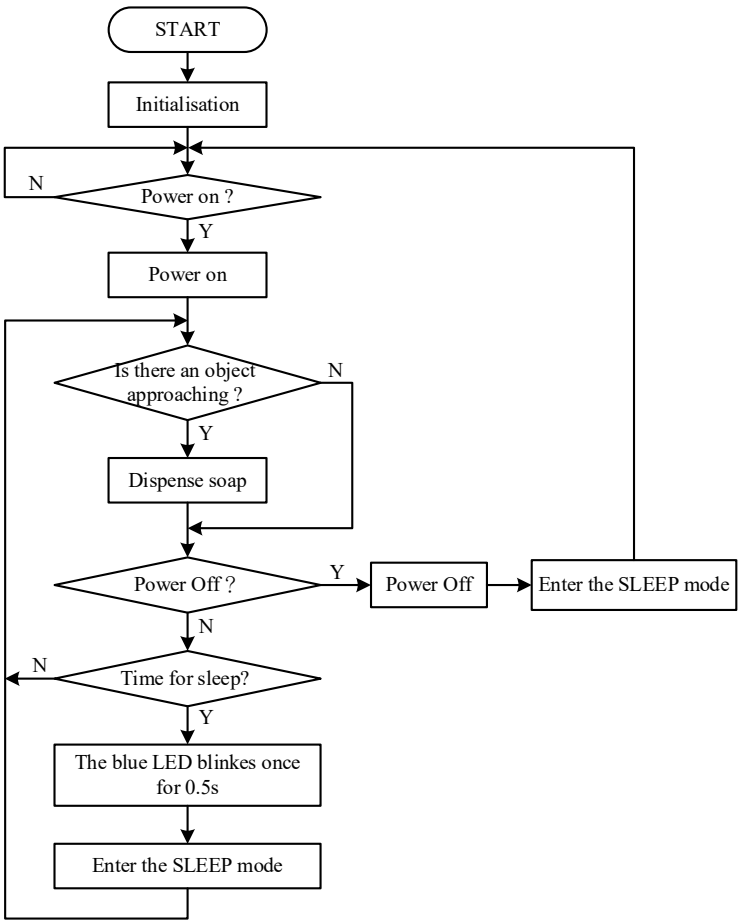

Figure 7

1. Initialisation: I/O setting, touch initialisation, infrared sensing initialisation (OPA calibration), WDT setting, etc.
2. Power on: After pressing and holding the touch key for about 2 seconds, the blue LED will illuminate for 1s and the device will be powered on.
3. Approaching object: The MCU will detect whether an object is at 512ms intervals. If the intensity of the infrared signal received by the IR receiver is greater than the threshold, it will determine that there is an approaching object.
4. Dispense soap: Activate the blue LED, switch on the motor driver and dispense soap for about 0.7s.
5. Power off: After pressing and holding the touch key for about 2 seconds, the red LED will illuminate for 1s and the device will power off.
6. Enter the SLEEP mode: After the sleep time overflows, the MCU enters the SLEEP mode, when the WDT overflows, the MCU will be woken up at 128ms intervals.

Test Data

Test Item	Test Condition	Actual Value
Average operating current	Powered by four 1.5V dry batteries, sensing the approaching hand, motor driver	228.6mA
Average standby current	Powered by four 1.5V dry batteries, standby after being powered on (detect every 0.5s)	15μA

Table 2

Solution Comparison

Item	Holtek Solution	Traditional Solution
Function	Touch detection, infrared sensing and motor driver are all highly functionally integrated	Uses a traditional switch with infrared sensing and motor driver being external
Program	Standby current:15μA	Standby current: more than 60μA
Cost	MCU contains integrated touch and infrared functional circuits requiring few external discrete components	The touch and infrared functions require two independent MCUs. Requires an extensive number of external discrete components

Conclusion

This solution has introduced the Holtek BS45F3345 for use in automatic soap dispenser solutions. The BS45F3345 provides an IR AFE circuit and a sink current source generator for proximity sensing products. It also provides 4-key touch I/Os, which enables proximity sensing products to have touch key functions based on general IR sensing.

Reference File

Refer to the BS45F3345 Datasheet.

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

Revision and Modification Information

Date	Author	Issue	Modification
2023.06.26	黃憲、張益倉	V1.00	First version

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