

1.7MHz/24V/20W Humidifier Reference Design

D/N: WAS-1995EN

Introduction

The Holtek 1.7MHz/24V/20W humidifier solution uses the BS45F3833, which is an ultrasonic atomizer dedicated MCU and with its large range of internal functions has a high level of functional integration. This solution uses a capacitance water detection method to provide water-shortage protection, ensuring safe and reliable operation. The integrated frequency tracking function ensures consistency in the overall product power and atomizer output during the production process. The solution also provides a mist output adjustment function, making it possible for users to select their required humidity level.

In order to assist users with their rapid solution design, Holtek provides product development suggestions and technical support. All relevant technical documents can be obtained from the “Reference Design Downloads” link.

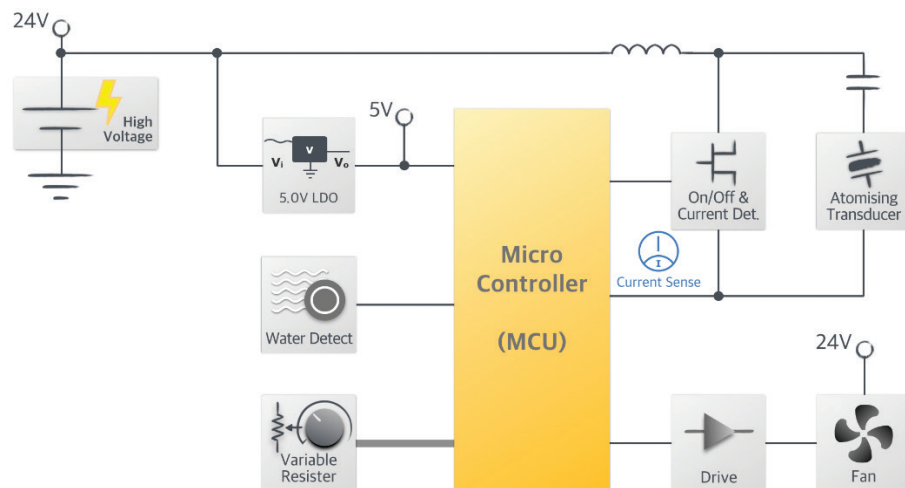


Figure 1

Applications

Home humidifiers, office humidifiers and hotel fragrance diffusers.

Solution Features

1. High accuracy frequency adjustment: Includes a dedicated 9-bit adjustable PTMOSC oscillator.

The BS45F3833 PTM dedicated oscillator is a fully integrated RC oscillator requiring no additional external components. This internal RC oscillator has a basic frequency of 12MHz which can be finely-adjusted by changing the FADJ[8:0] field value. The greater the value of the FADJ[8:0] field the lower the frequency of the PTMOSC oscillator outputs. For a 1.7MHz PTM PWM output, the average fine-adjustment resolution by using the internal 9-bit FADJ registers is 1.4kHz.

2. Capacitance water detection function: Can be used to implement water shortage detection using a Holtek-provided library file.

As Holtek provides a dedicated water detection library, then when using the internal algorithm, it is only necessary to set up the required software water detection parameters to implement a water detection function. For more details, refer to the related library instruction document provided by Holtek.

3. PTP direct driving of MOS transistors: The PTP pin output current can be up to 150mA.

The PTP output has the capability of driving a MOS transistor, which eliminates the need for external driving components. Additionally, the PTP pin has four slew rate levels which are selected using the SLEWC0 register.

Functional Description

The 1.7MHz/24V/20W humidifier provides a perfume atomization function by using a high frequency oscillation to break up liquid water into a fine mist. The difference between traditional self-driving oscillation solutions and this one is that this solution uses a PWM signal to directly drive a MOS transistor which in turn drives the atomization film oscillation resulting in higher atomization efficiency. As this solution results in reduced heat dissipation problems, the external MOS transistor heat sink can be reduced. This solution includes functions for atomizer driving, frequency tracking, capacitance water detection as well as the potentiometer controlled mist output adjustment function. The following figures show the product overall appearance (Figure.2), the PCB top view (Figure 3) and bottom view (Figure 4).



Figure 2. Humidifier Overall Appearance

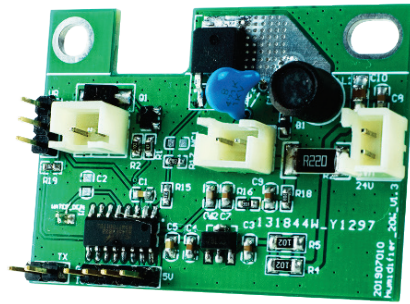


Figure 3. PCB Top View

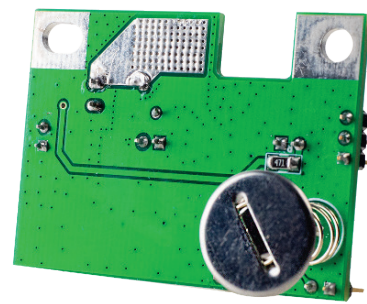


Figure 4. PCB Bottom View

Operating Principles

The 1.7MHz/24V/20W humidifier master board uses the BS45F3833 MCU for atomizer driving, frequency tracking and mist output control. The following shows the master board.

Hardware Description

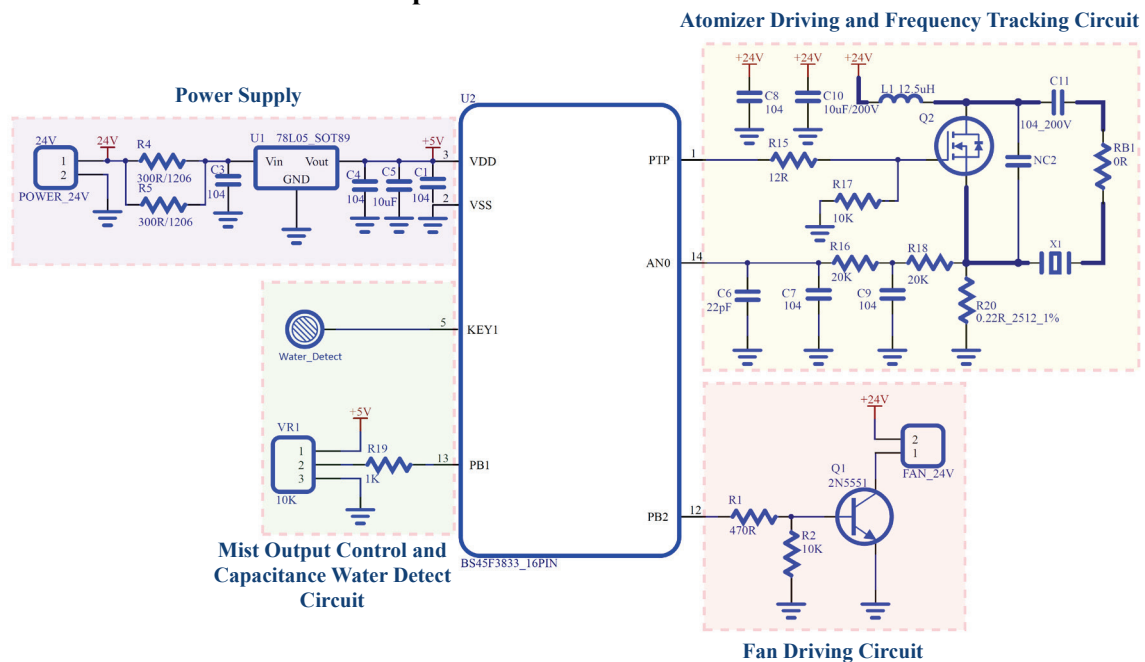


Figure 5

The 1.7MHz/24V/20W humidifier hardware circuit is divided into several parts which are power supply circuit, atomizer driving and frequency tracking circuit, fan driving circuit, potentiometer and capacitance water detect circuit.

- Atomizer Driving and Frequency Tracking Circuit

The atomizer driving circuit uses the PTP output PWM signal to drive the inductor boost which will then drive the atomization film which will oscillate for atomizing. The frequency tracking circuit uses a method whereby the PWM output frequency is adjusted from high to low and the current value is measured using the current sampling circuit. When the target current value is reached, the frequency is registered as the operating frequency.

● Mist Output Control and Capacitance Water Detect Circuit

This solution includes a potentiometer and a touch key for capacitance water detection. When using the Holtek software development kit, it is only necessary to connect a potentiometer to the MCU to implement the mist output level adjustment function.

Layout and Hardware Considerations

The PCB Layout top view and bottom view are shown in Figure 6 and Figure 7.

Note: 1. GND plane: Ensure that the GND area is large enough and that there is a complete ground layer to shield the signal.

2. The atomizer driving circuit area should be as small as possible. Ensure that high current traces are as thick as possible.

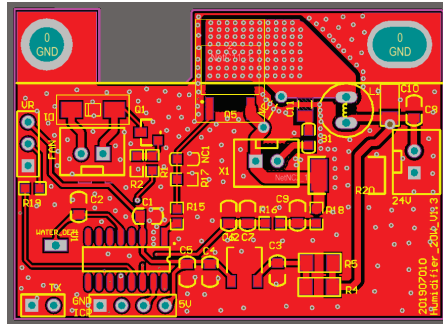


Figure 6. PCB Layout Top View

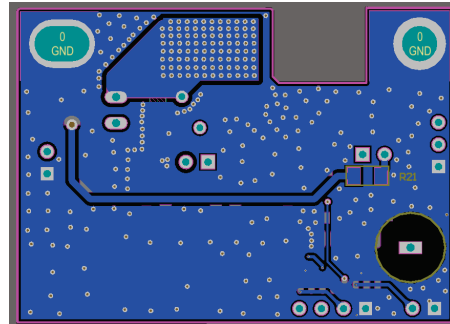


Figure 7. PCB Layout Bottom View

PCB BOM List

Bill of Materials					
Humidifier_1.7MHz_20W					
Source Data From: SCH_1.7MHz24V20W-Common-A01.SchDoc					
Project: Free Documents					
Variant: None					
Creation Date: 2020/4/30 PM 02:36:38					
Print Date: 43958 43958.39659					
Footprint	Comment	LibRef	Designator	Description	Quantity
XH-2P	2PIN	Header 2	24V	Header, 2-Pin	1
C0603	0.1uF	Cap	C1, C3, C4, C7, C8, C9	Capacitor	6
C0603	8pF	Cap	C2	Capacitor	1
C0603	10uF	Cap	C5	Capacitor	1
C0603	22pF	Cap	C6	Capacitor	1
C1206	10uF	Cap	C10	Capacitor	1
C1206	0.1uF_200V	Cap	C11	Capacitor	1
XH-2P	FAN_24V	Header 2	FAN	Header, 2-Pin	1
HDR1X4	ICP	Header 4	ICP	Header, 4-Pin	1
INDUCTOR	12.5uH	Inductor	L1	Inductor	1
C0603	100pF	Cap	NC1	Capacitor	1
AXIAL-0.3	470uF_200V	Cap	NC2	Capacitor	1
SOT-23	2N5551	NPN	Q1	NPN Bipolar Transistor	1
TO252-3	AOD4454	NMOS	Q2	N-Channel Power MOSFET	1
R0603	470R	Res	R1	Resistor	1
R0603	10K	Res	R2, R17	Resistor	2
R1206	300R	Res	R4, R5	Resistor	2
R0603	10R	Res	R15	Resistor	1
R0603	20K	Res	R16, R18	Resistor	2
R0603	1K	Res	R19	Resistor	1
R2512	0.22R_1%	Res	R20	Resistor	1
R1206	0R	Res	R21	Resistor	1
XH-2P	TX	Header 2	TX	Header, 2-Pin	1
NSOP 16	BS45F3833_16P	BS45F3833_16P	U1	MCU	1
SOT-89	78L05_SOT89	HT7350-1_SOT8	U2	LDO	1
HDR1X3	VR	Header 3	VR	Header, 3-Pin	1
Touch-Pad	Touch-Pad	Touch-Pad	WATER_DET1	Touch-Pad	1
XH-2P	ATO		X1	Crystal Oscillator	1
Approved					36
Notes					

Table 1

Software Description

System Flowchart

The solution program is developed based on the Holtek software development kit which has reserved entry for user function initialisation and user functions.

The system function includes the system setup initialisation and user function initialisation. The main function includes the frequency tracking function and user function.

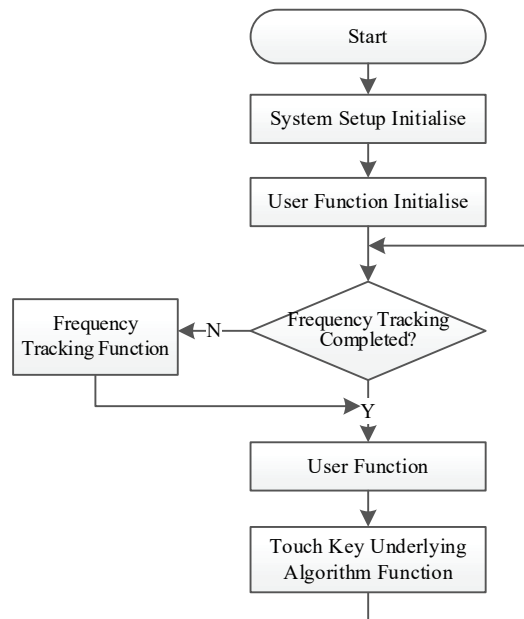


Figure 8

User Function Initialisation

After the power-on reset, the first program to execute is the system setup initialisation, which includes I/O initialisation, STM initialisation and variable initialisation.

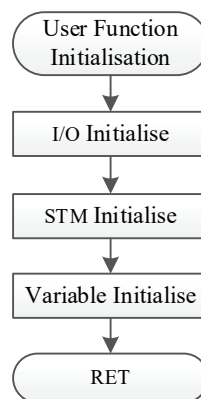


Figure 9

User Function

- Water Detect Scan: Scan and obtain the DATA_BUF[0] value, determine whether water runs out or not and turn off the atomizer function if there is no water.
- Mist Output Control: Control the mist output volume based on the obtained ADC signal of the mist control dial knob (potentiometer). The mist output control is implemented in a fast cyclical intermittent way.

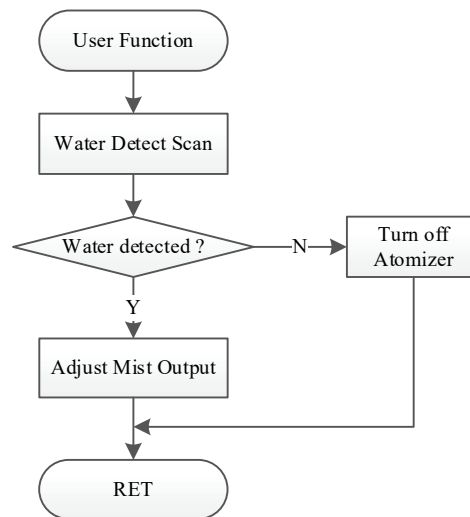


Figure 10

Operating Description

This product supports mist output control using the potentiometer VR and supports a capacitance water detection function. To implement a capacitance water detection operation, it is necessary to first calibrate under an empty water condition.

Water Empty Calibration

Erase all the EEPROM data during the programming process. When power is first applied to the product, ensure that there is no water in tank. For detailed explanations about the water empty calibration, refer to the related library instruction document provided by Holtek.

Atomizer Function Key – Touch Key

1. Press the key: The humidifier atomization will start.
2. Press the key again: The humidifier atomization stops.

Test Data

Test Items		Actual Tested Value	Notes
Power	Power Supply	3W	Total power that measured at adapter input terminal is 21W.
	Atomizer Power	17W	
	Fan Power	1W	
MOS Transistor Temperature		63°C	
Mist Output (Average)		250mL/H	
Conduction Disturbance (150kHz~30MHz)		PASS(4.5db μ V margin)	
Disturbance Power (30MHz~300MHz)		PASS(7dbpW margin)	
Radiation RE (30MHz~1GHz)		PASS(4db μ V/m margin)	

Table 2

Conclusion

This document has introduced the Holtek 1.7MHz/24V/20W humidifier reference design. The BS45F3833 provides a PWM signal output with a finely adjustable frequency and capacitance water detection function, making it suitable for atomizer product solutions. The PWM output, which has a finely adjusted period, can control the inductor boost to drive the atomizer high frequency oscillation. This in turn will break up the liquid water structure into a natural flowing mist. The capacitance water detection function provides a protection method that will prevent the atomizer burning out when water runs out.

Reference Material

Consult the BS45F3833 Datasheet.

For more information see the Holtek website www.holtek.com.

Version and Modification Information

Date	Author	Issue Release
2019.10.31	林齊昊	V1.00

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