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R8C/2D Group

LED Table Lighting Application on Renesas Starter Kit

Introduction

This application note is to describe how to use the Renesas Starter Kit for R8C/2D to implement LED lighting with PFM (Pulse Frequency Modulation) controlling LED current. It is also controlled by key input, sound and CDS (Cadmium-Sulfide) sensor. The brightness can be adjusted smoothly by key, and be turned on/off by sound from a clap or button. With CDS sensing, it can automatically adjust lighting to constant luminance depending on lighting altitude. The board converts 12V DC to constant current for LED with PFM output of MCU; the MCU could share other tasks such as sound sensing, key control, CDS sensing etc.

Target Device

The target device is R8C/2D series.

Contents

1. The Configuration of the System

The configuration of the system is shown in Figure 1. R8C/2D generates the PFM output signal according to the A/D sense signals are generated after the PFM signals dimming the LED lamps brightness. CDS (Cadmium-Sulfide) sensor, MIC and Key provide different dimming condition to affect LED on/off and dimming.

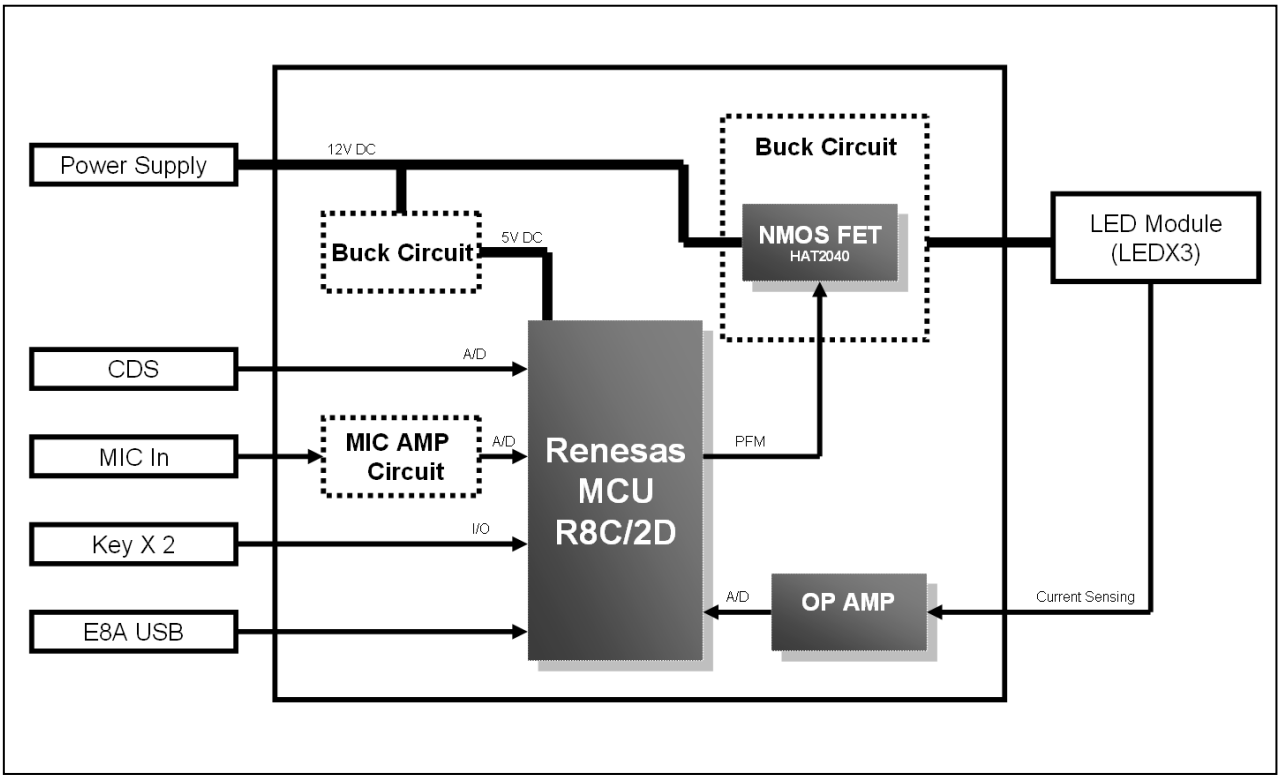

Figure 1 the configuration of the system

The block diagram above displays the LED table lighting function with Renesas R8C series MCU. It uses 3 ADCs to detect voltage and current. Auto dimming is base on CDS (Cadmium-Sulfide) sensing the lighting variation, then ADC captures the changes of A/D and sending value back to MCU to control PFM output. Sound control according to Miniature Condenser Microphone to receive sound and transfer voltage signal to ADC of MCU to on/ off LED module. Current sensing is supplied by amplifier, and the amplifier can get the current signal from LED Module. This function can help to provide feedback of the current status of LED to compensation current requirement of PFM control. Key functions are operated by I/O pin. The main purpose is to created power on/off key and manual dimming. Power supply is from 12V DC adapter and down to 5V DC to supply the MCU. Another one goes through DC-DC buck circuit to 9V DC and controlled current by PFM signal for brightness dimming. For this total solution is applicable for home lighting such as LED table lighting.

2. Hardware Specification

2.1 Implement LED table lighting application on Renesas Starter Kit for R8C/2D

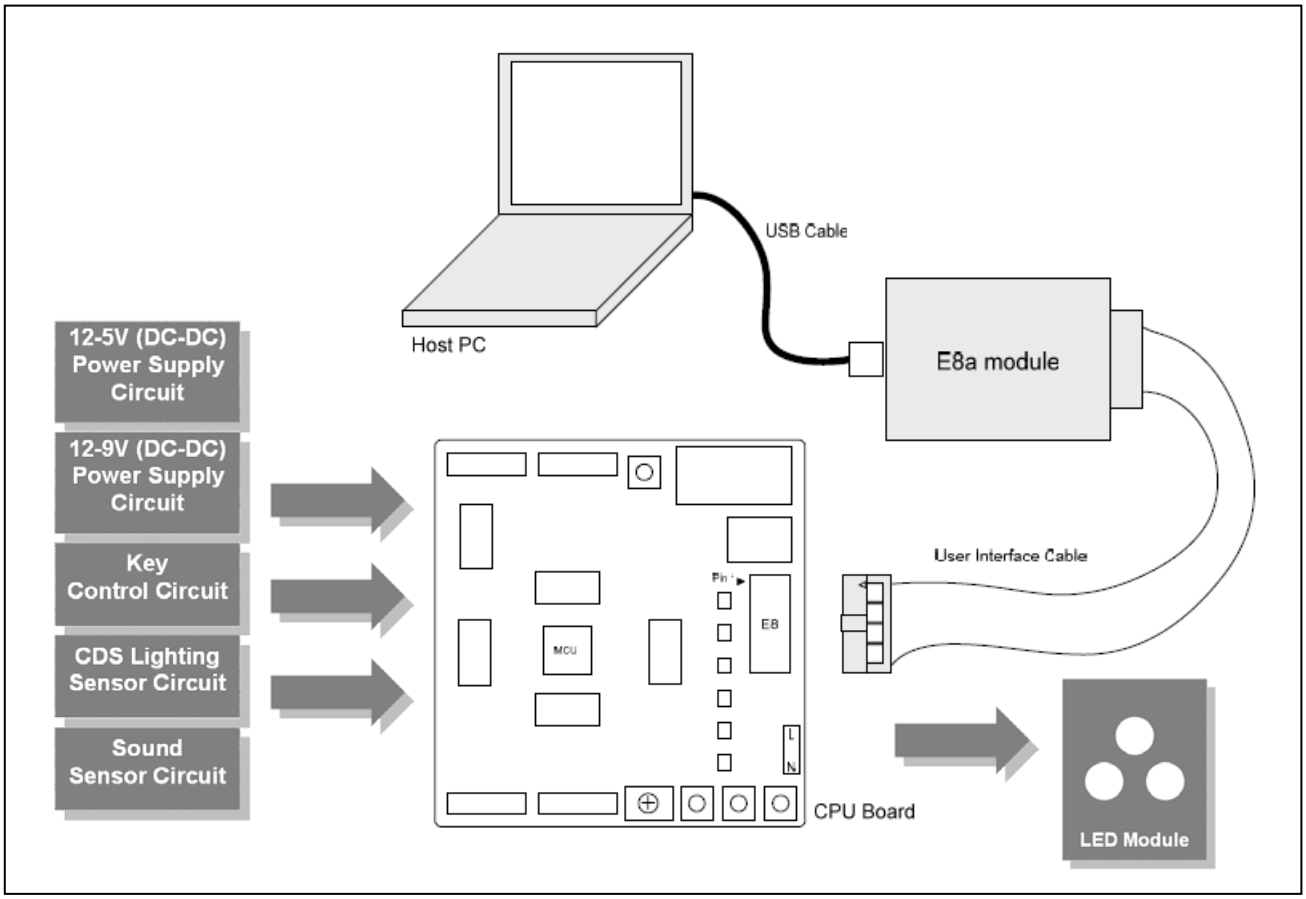

Figure 2 Implement LED table lighting application on RSK R8C/2D

RSK (Renesas Starter Kit) CPU board for R8C/2D is a useful platform which can implement LED table lighting conveniently. In Figure 2 illustrates the extra circuit block diagram for expansion on RSK. The detail schematics will be point out in next chapter “Reference Schematics”. The power supply of 12-5V DC-DC circuit block includes system 12V DC and the function of drop down 12V DC to 5V DC. The 5V DC is supplied to MCU operation. The second one is 12-9V power supply circuit. This buck circuit converts voltage from 12-9V DC, the power is provided to LED module, current control of LED Module is generated by PFM of MCU. Key control circuit connects to I/O pin of MCU for manual dimming. Another key function is connected with interrupt pin for power on/off control. CDS lighting sensor circuit contain CDS component which provides lighting- voltage conversion function. After ADC sensing the lighting- voltage is converted from CDS. MCU will adjust the PFM output for dimming automatically. Sound sensor includes MIC and amplifier circuit to capture the signal which is converted by sound to voltage. LED module has lamps current sensing circuit to feedback current status of lighting lamps. All of signal sensing, such as key (voltage detect), CDS (voltage detect), Sound (Voltage detect), LED module (current detect) are inputted to ADC of MCU thus according to these value to dim the brightness.

2.2 Timer RF and PFM Control

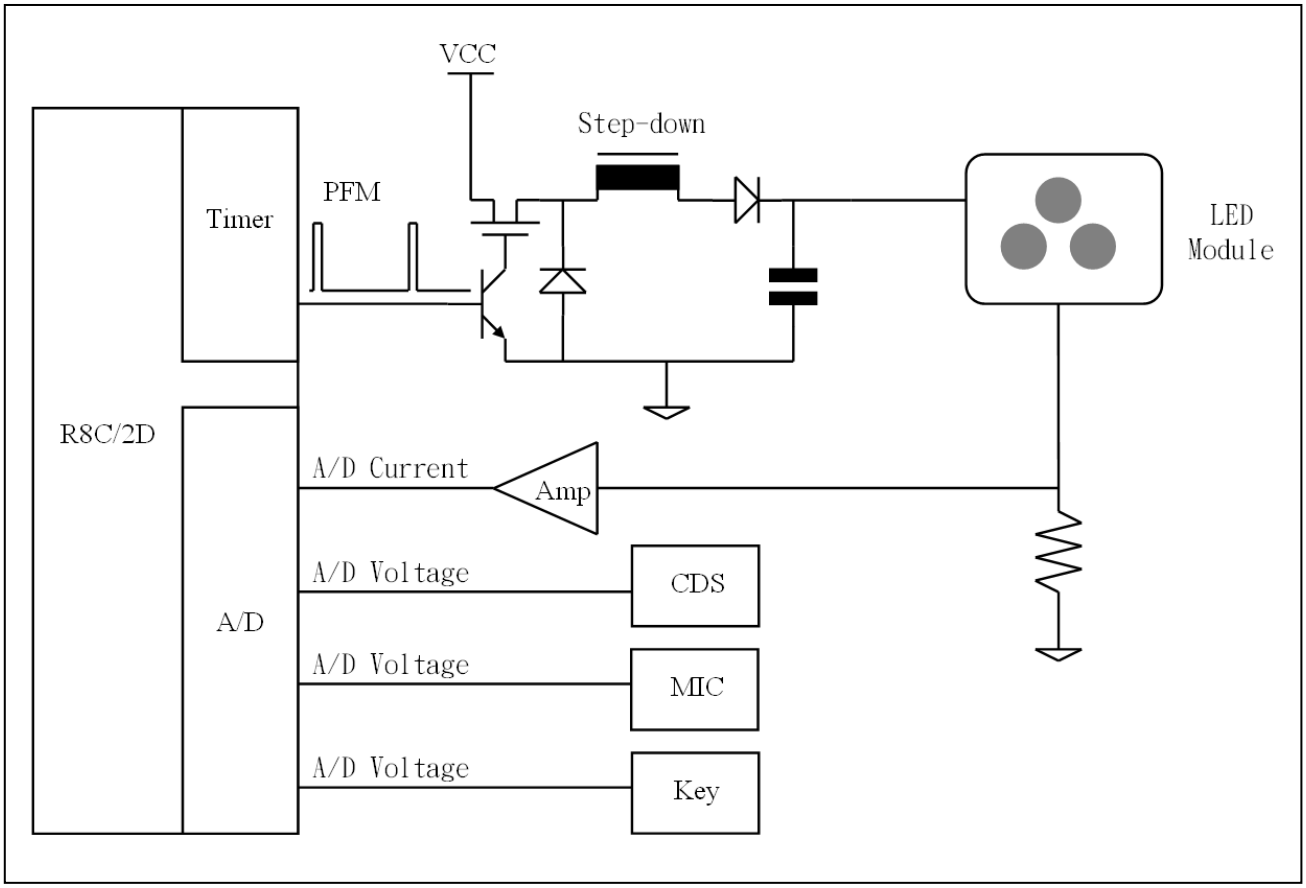

Figure 3 R8C/2D Timer RF out PFM Circuit

Figure 3 shows basic PFM and buck connection circuit. Figure 4 indicates PFM off, voltage keeps on high level and LED turn off. The output period of waveform is increase when dimming decrease and decrease when dimming increase. Timer RF of R8C/2D setting to PFM output mode. All of sensing signals capture by ADC then MCU change period for dimming.

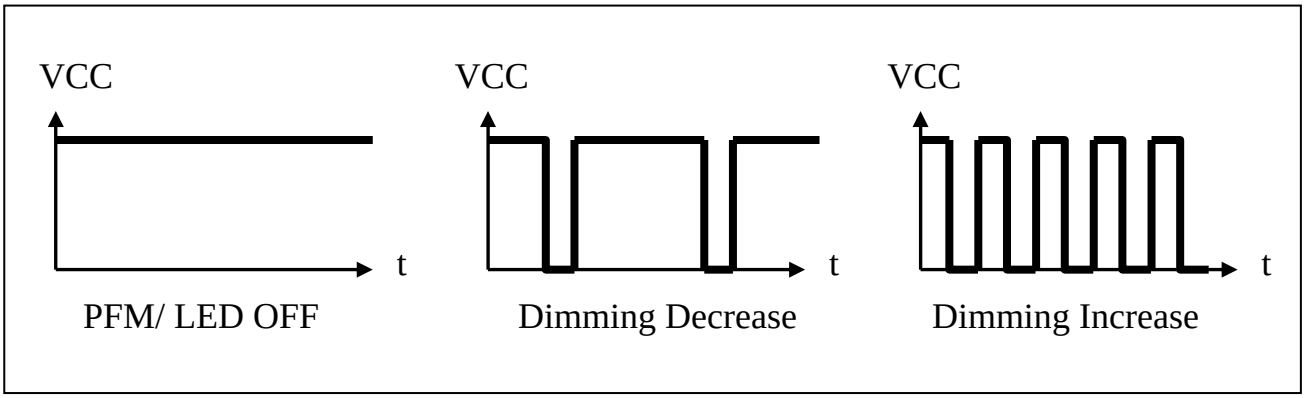

Figure 4 PFM Dimming Signals

2.3 Pin Usage on Renesas Starter Kit for R8C/2D

- **Pin Usage on R8C/2D**

Pin No.	Pin Label	Function
42	TRFO00	Using Timer RF for PFM output
79	P3_7	I/O pin for key input (manual dimming)
44	INT0n	Interrupt pin for key input (power on/ off)
57	AN8	Analog to Digital Converter for MIC in voltage detection
56	AN9	Analog to Digital Converter for LED current detection (PFM control for dimming)
55	AN10	Analog to Digital Converter for CDS in voltage detection

Table 1 Pin Usage on R8C/2D

- **Pin reference connect point on Renesas Starter Kit for R8C/2D**

Usage Pin Label	Connector on RSK R8C/2D	Pin No. in Connector of RSK
TRFO00	RSK R8C/2D CPU Board: J3	Pin 2
P3_7	RSK R8C/2D CPU Board: JA2	Pin 11
INT0n	RSK R8C/2D CPU Board: JA2	Pin 7
AN8	RSK R8C/2D CPU Board: JA5	Pin 9
AN9	RSK R8C/2D CPU Board: JA5	Pin 10
AN10	RSK R8C/2D CPU Board: JA5	Pin 11

Table 2 Reference connect point on RSK

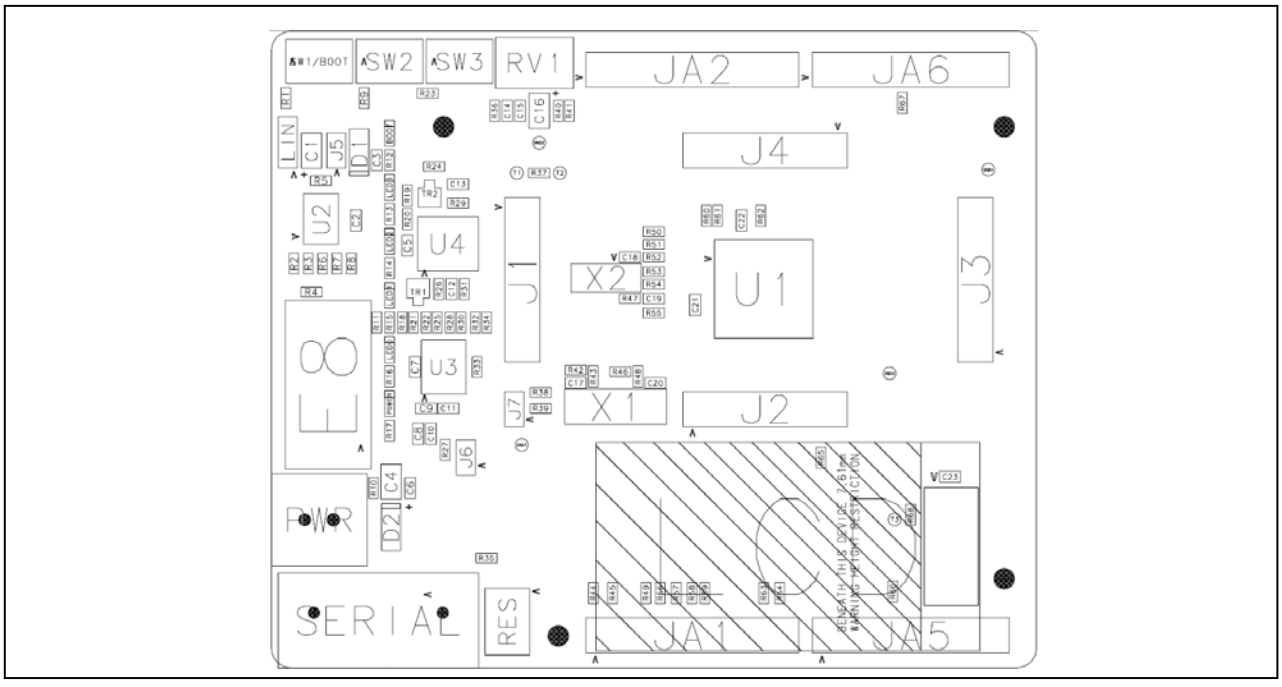

Figure 5 Connectors placement of Renesas Starter Kit CPU Board for R8C/2D

3. Reference Schematics

3.1 R8C/2D Control Schematics

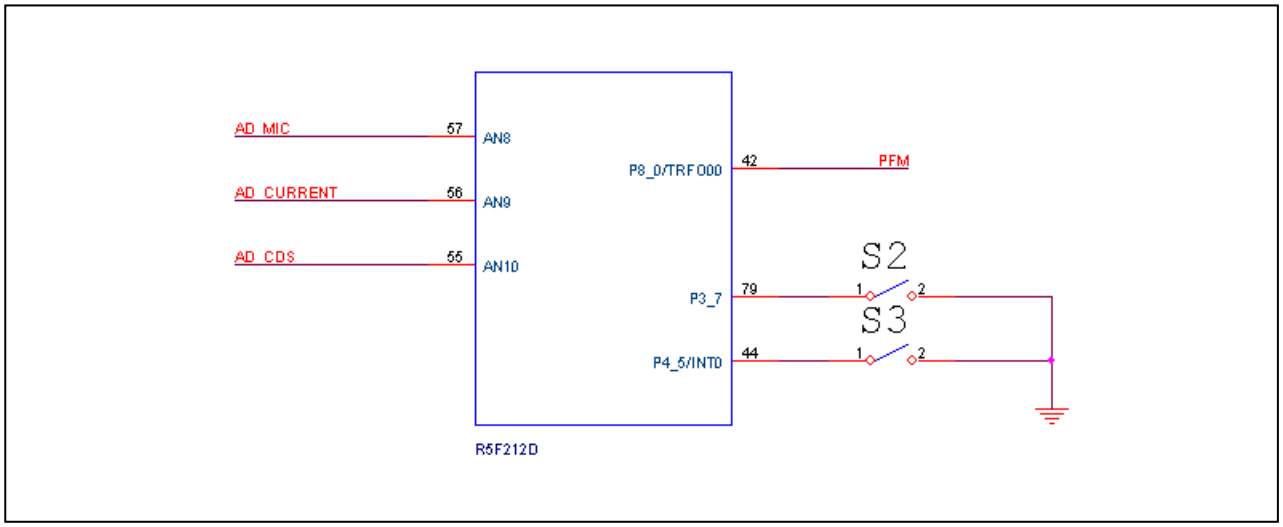

Figure 6 R8C/2D Control Schematics

3.2 12V and 5V DC Power Supply

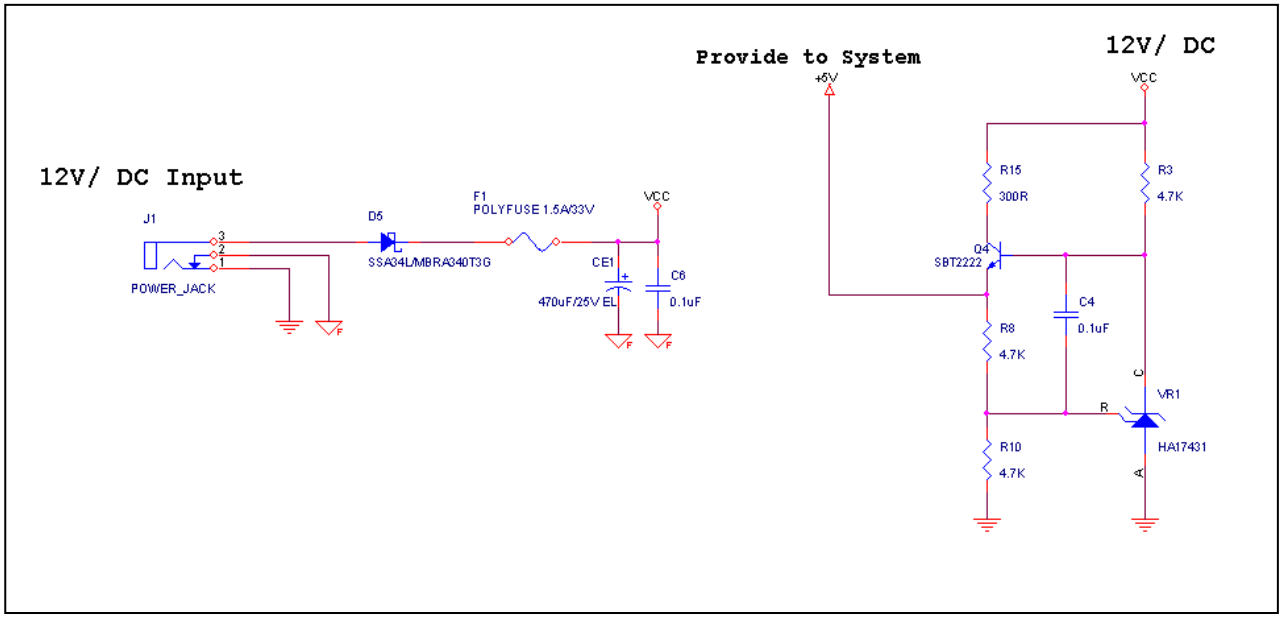

Figure 7 System Power Supply

3.3 LED Power Supply and PFM Control

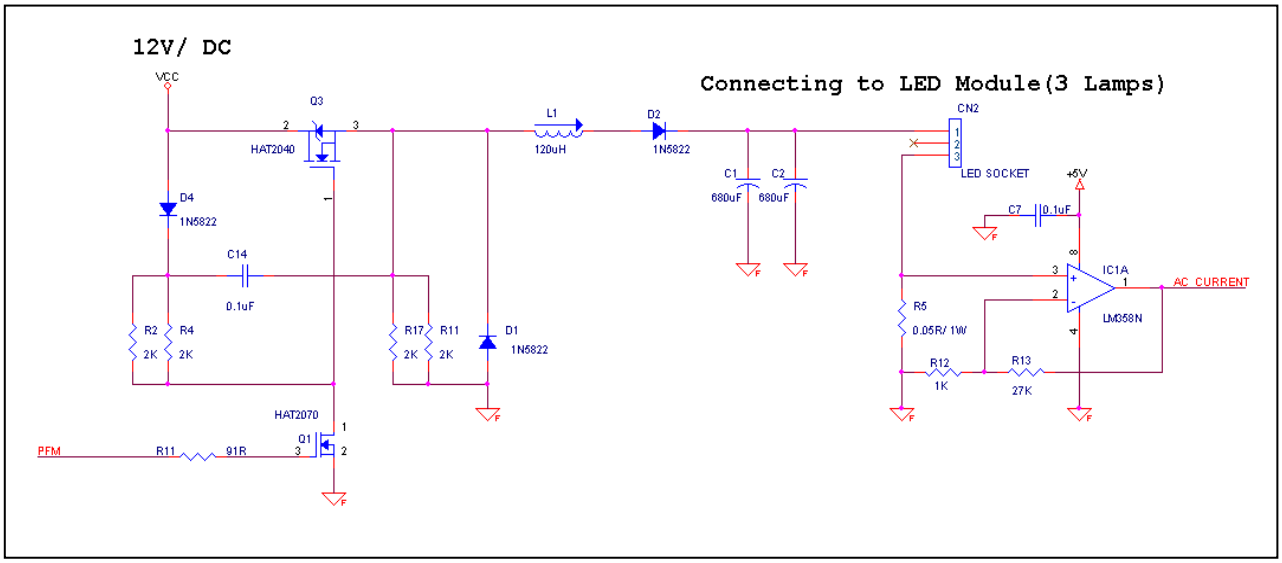

Figure 8 PFM Control Circuit

3.4 Sound Sensor Control

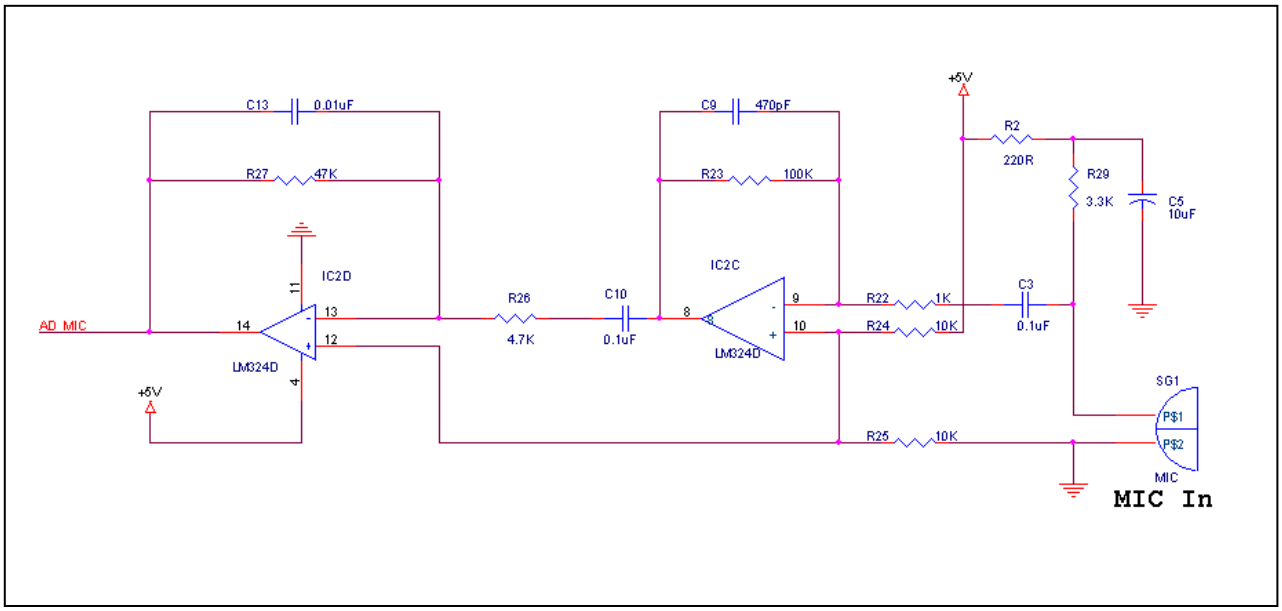

Figure 9 MIC in Sensing Circuit

3.5 LED Power Supply and PFM Control

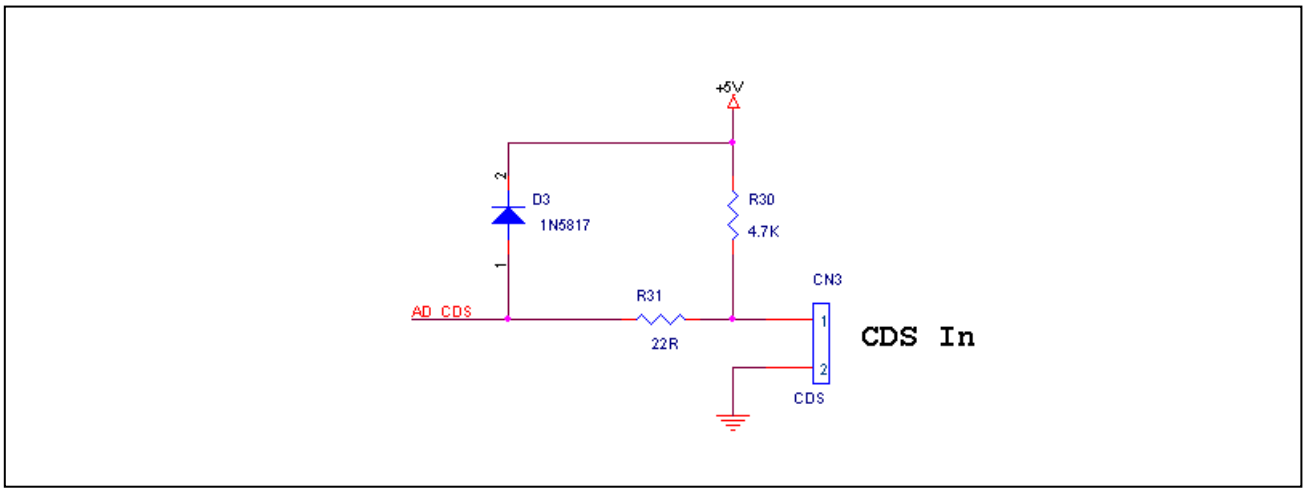

Figure 10 CDS Sensing Circuit

4 Program Flow Chart

■ **Program flow chart of main( ) : System main routine**

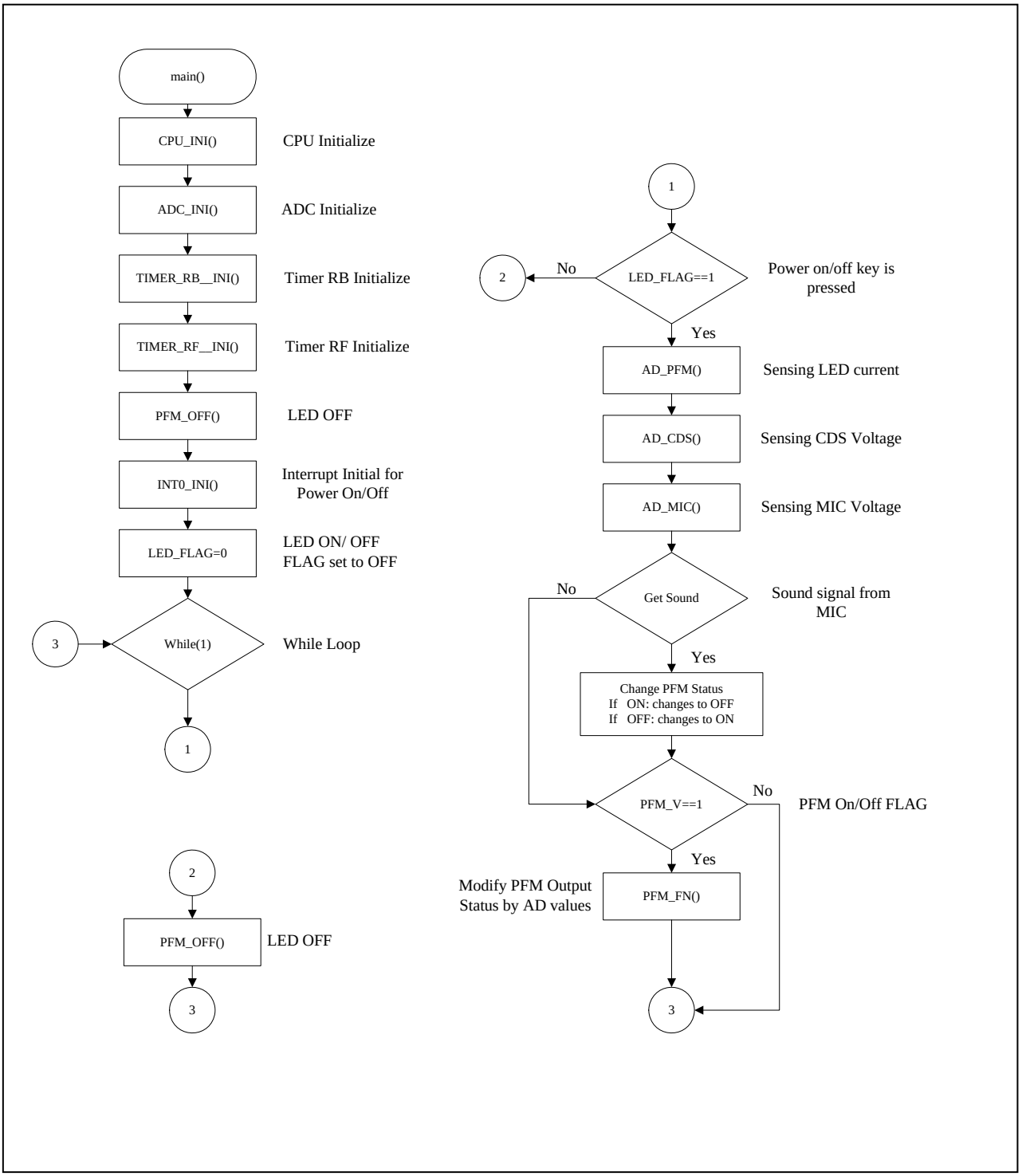

Figure 11 Program flow chart of main( )

■ **Program flow chart of into_int( ): Power on/ off control**

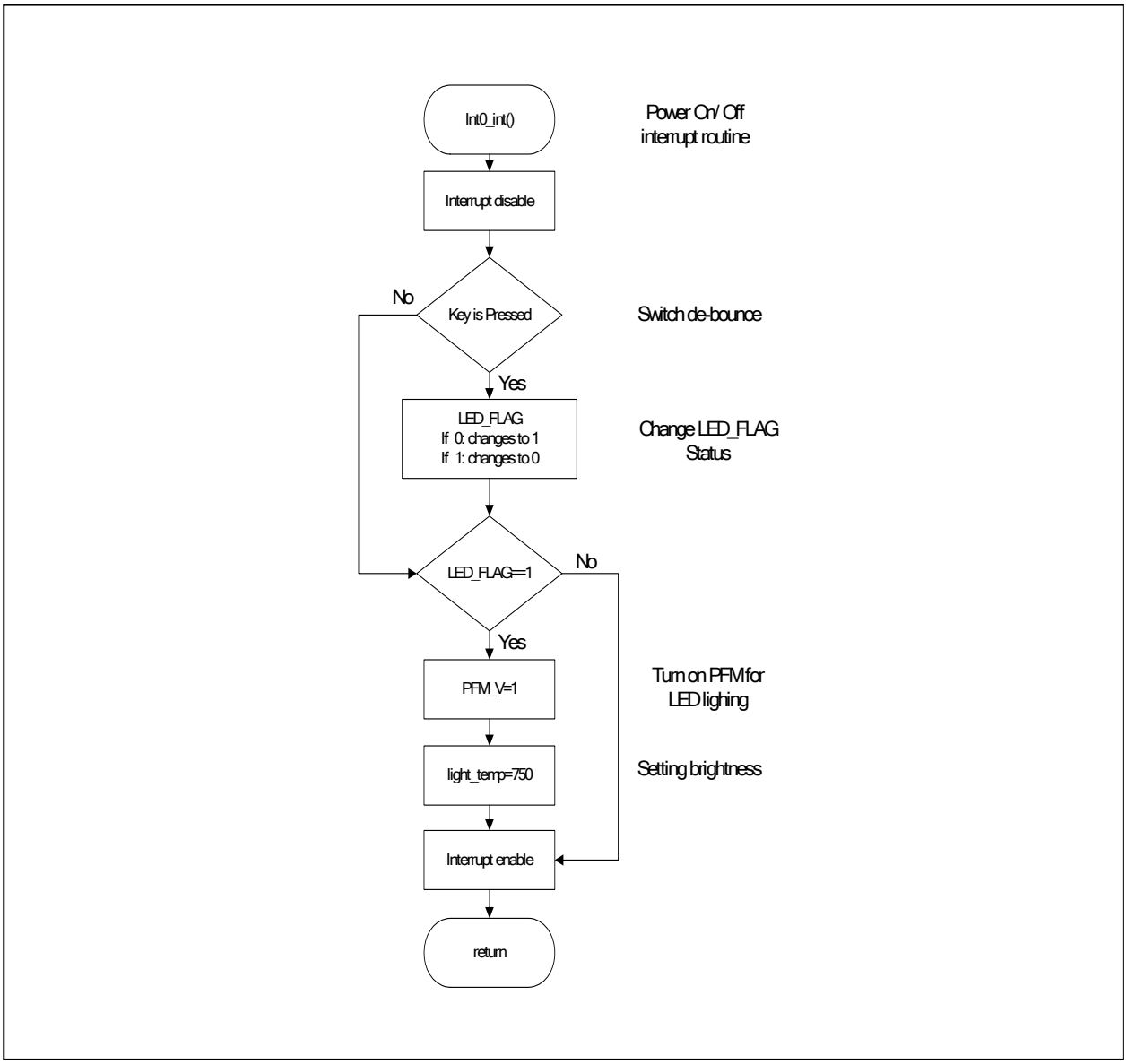

Figure 12 Program flow chart of int0_int( )

■ **Program flow chart of PFM_FN( ): PFM control for dimming- 1/2**

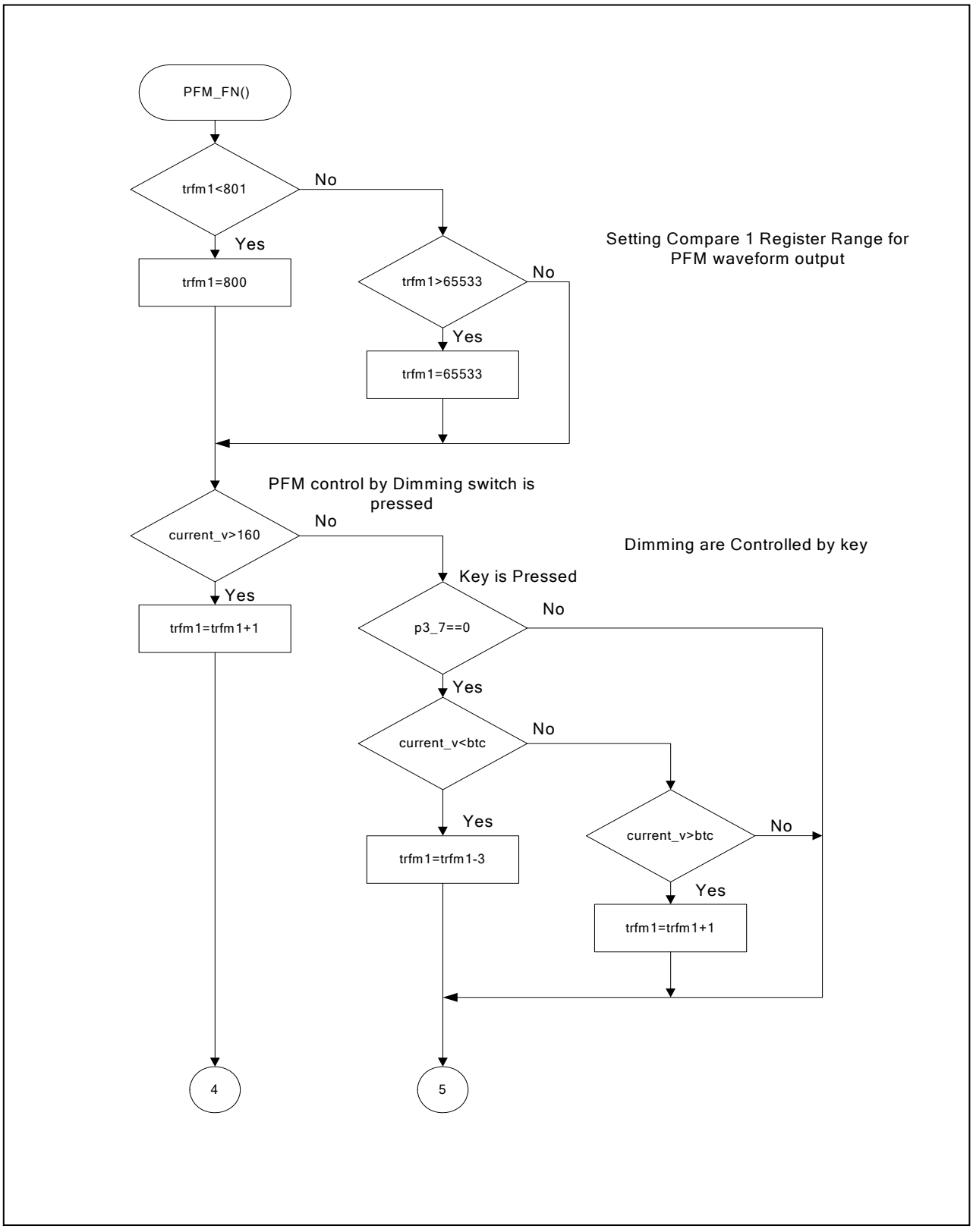

Figure 13 Program flow chart of PFM_FN( ) -1/2

■ **Program flow chart of PFM_FN( ): PFM control for dimming- 2/2**

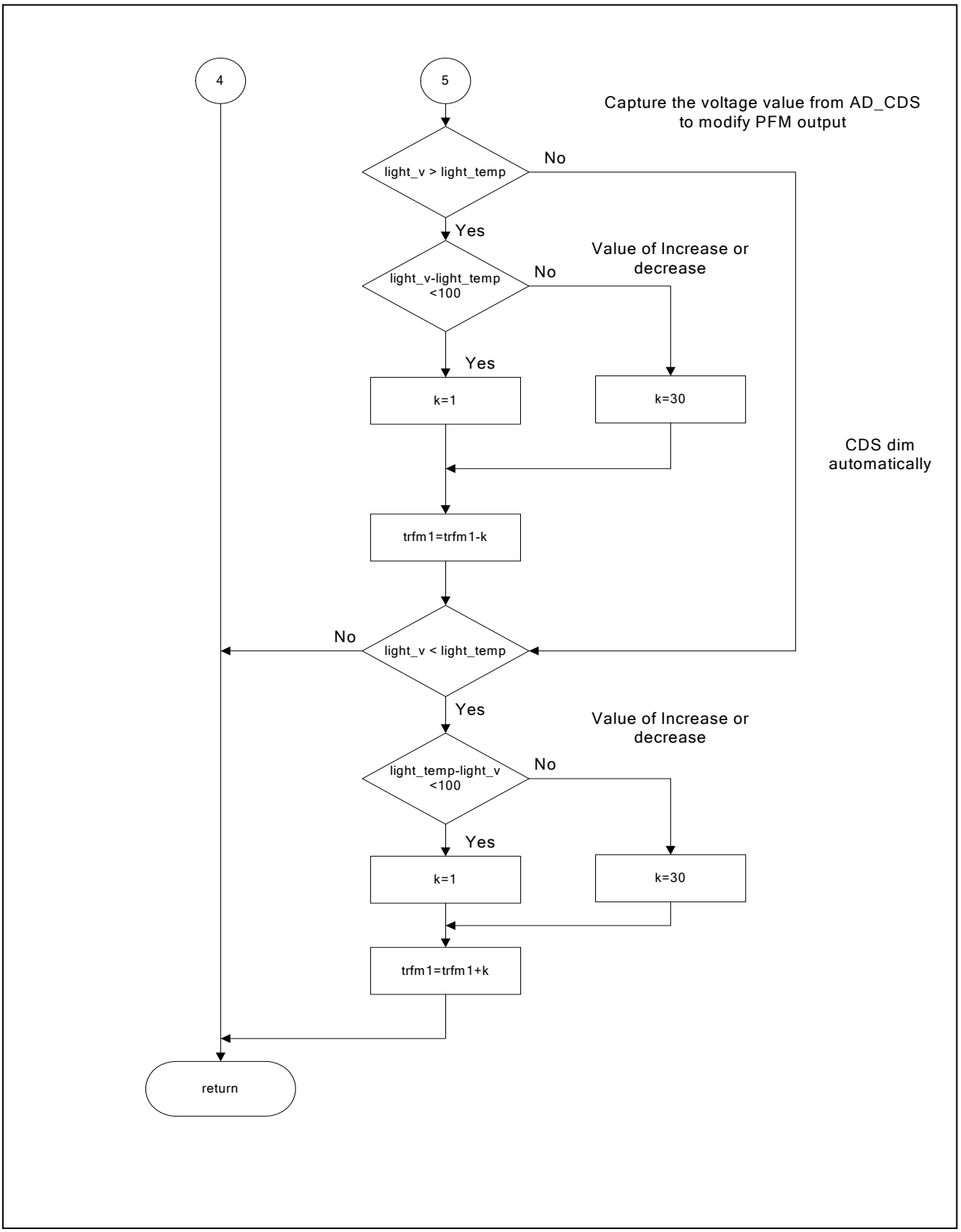

Figure 14 Program flow chart of PFM_FN ( ) -2/2

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Rev.	**Date**	**Page**	**Summary**
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