

Programmable Sound Generator

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30MAR2015



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Executive Summary:

The goal of the Smart Walker system is to maximize the user's independence and mobility without compromising safety. The system detects large changes in elevation indicating a sudden drop off and alerting the user with sufficient time to stop them from falling down and injuring themselves. With advancements in technology, devices such as microcontrollers are becoming smaller, faster, more energy efficient and cost-effective. These technologies are readily available to everyone and, as a consequence, are being used for many unique applications. One such application is to control the triggering of a programmable audio feedback circuit that will forewarn the user of any drop offs in their path. The following circuit was supplied to our team from our associate Stephen Blosser. Stephen and John Eulenberg are the original designers.

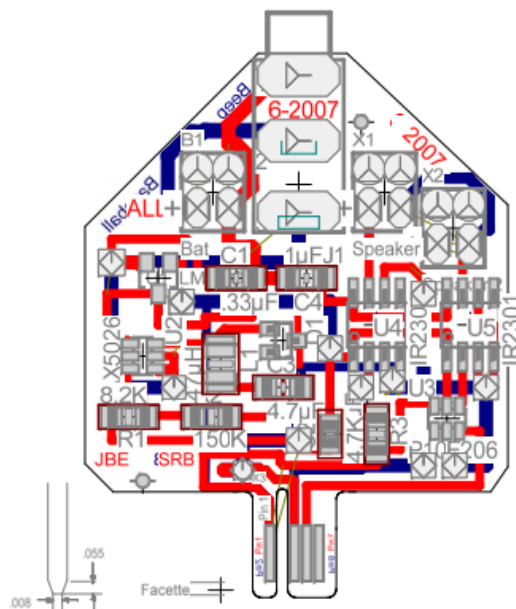


Figure 1: PCB Schematic of Programmable Sound Generator

How it Works:

The system as a whole is a smart walker module which mounts directly onto most walkers. The module will use sensors to detect ground elevation approximately four feet in front of the user. The sensors rely on sending a pulse out and measuring the time it takes to receive the reflected pulse. By knowing the speed of the initial pulse and the time it took the pulse to return allows for distance to be calculated. If a large increase in declination is detected for a certain number of consecutive measurements then the Parallax Propeller microcontroller will send a signal to the programmable sound generator circuit which will trigger the warning tones, notifying the user of any immediate drop offs so they can divert their course. The sound generator circuit is pictured below.

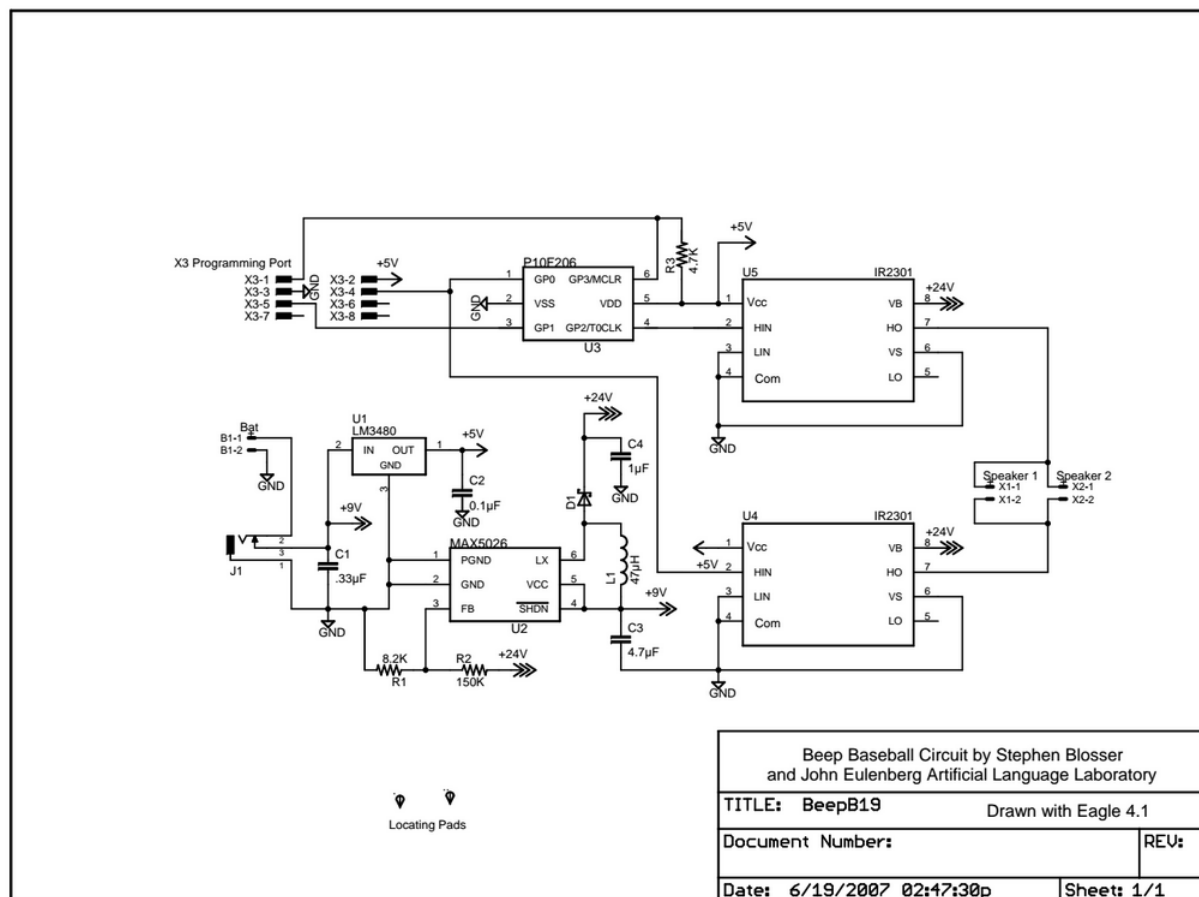


Figure 2: Beep Circuit by Stephen B. and John E.

DC-DC Converter:

The Maxim MAX5026 is a constant-frequency, pulse-width modulating, and low-noise boost converter. The circuit schematic is shown in Figure 2. It works well in low-voltage systems because often there are sub-circuits that need to be powered with high voltage locally to not affect other parts of the circuit are not rated for. This is necessary for the circuit design because the Parallax Propeller, the main system board, and all other components are supplied by a 5 V source however the piezo audio transducers need to be driven by 9 V at least. The MAX5026 outputs 30 V by default, to get the desired 9 V a voltage divider is implemented at the output with resistor values of 8.2 k Ω and 150 k Ω .

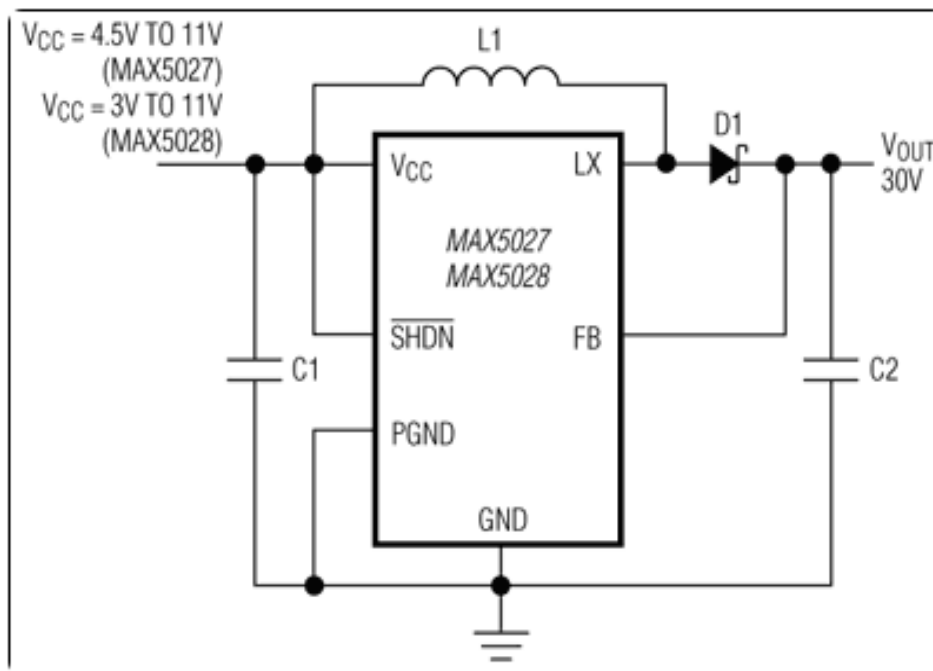


Figure 3: MAX5026 Schematic

Microcontroller and PWM:

The PIC10F206 is a flash-based 8-bit peripheral interface controller which supplies a PWM signal to drive the piezo sound transducers. This programmable logic device was chosen due to its small size, low power, high performance, and ease of use and I/O flexibility. The PIC10F206 is supported with a fully-featured macro assembler, software simulator, debugger, and C compiler. The PIC10F206 can produce a few different types of sounds such as a basic beep at 2 kHz, increasing the frequency from 1.5 kHz to 1.75 kHz to 2 kHz with no delay between each subsequent increase, likewise this same option is available with a delay between frequency patterns, or it can produce a constant tone at 2.25 kHz. There are also multiple resources available online that walk through how to program custom tones on the microcontroller. The PIC10F206 waits for the Parallax Propeller to signal when a drop off has been detected. Once this signal is received the PIC10F206 uses pulse width modulation (PWM) to drive two IR2301S power MOSFETs which each control a piezo audio transducer. Once the Propeller board no longer detects the drop off it sends a signal to the PIC10F206 which then terminates the driving signal to the MOSFET gates, silencing the speakers. Below is a schematic of the typical connection of the IR2301S power MOSFET.

Typical Connection

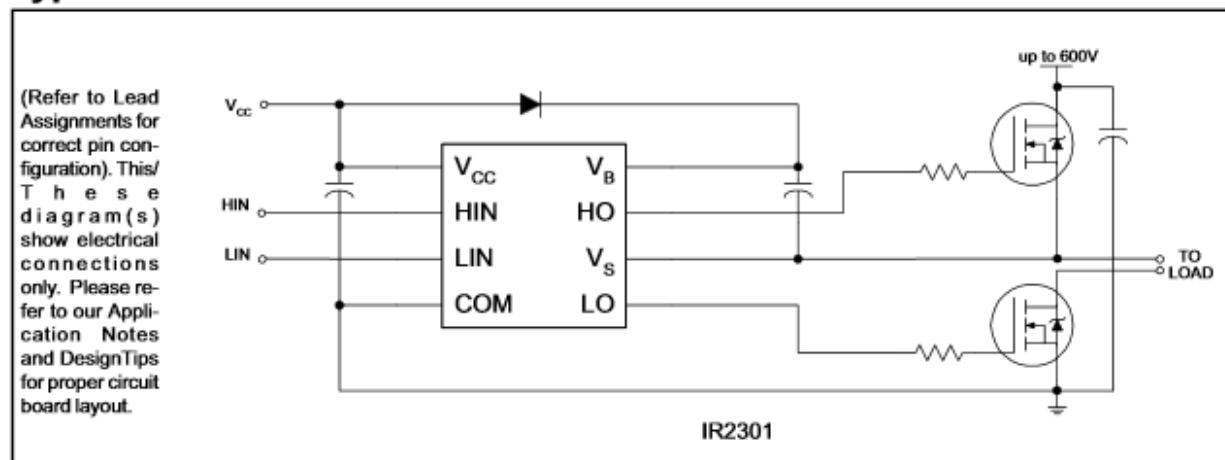


Figure 4: Typical Connection for IR2301S power MOSFET

Resources:

[1] National Semiconductor, "100 mA, SOT-23, Quasi Low-Dropout Linear Voltage Regulator," LM3480 datasheet, March 2005.

[2] Maxim Integrated, "500kHz, 36V Output, SOT23, PWM Step-Up DC-DC Converters," MAX5026 datasheet, March 2009.

[3] Microchip, "6-Pin, 8-bit Flash Microcontroller," PIC10F206 datasheet, 2004.

[4] International Rectifier, "High and Low Side Driver," IR2301(S) datasheet, September 2004.

[5] CUI Inc., "Piezo Audio Transducer," CEP-1114 datasheet, January 2007.

[6] Circuit documentation provided by the designer, Stephen Blosser.