

Ultrasonic Dog Chaser with Repelling Strobe Light and Extra Functions SLG47105

This application note describes how to create an ultrasonic dog chaser with powerful strobe light for an additional repelling effect using HVPAK. In addition, the device has a dog training mode and powerful flashlight functions.

The application note comes complete with design files which can be found in the Reference section.

No dogs were harmed in the making of this application note.

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1. Terms and Definitions

DC	Direct current
DFF	D Flip-Flop
HV	High voltage
OSC	Oscillator
VT	Voltage Transformer

2. References

For related documents and software, please visit:

<https://www.renesas.com/eu/en/products/programmable-mixed-signal-asic-ip-products/greenpak-programmable-mixed-signal-products/greenpak-high-voltage-programmable-mixed-signal-matrix>

Download our free GreenPAK Designer software [1] to open the .gp files [2] and view the proposed circuit design. Use the GreenPAK development tools [3] to freeze the design into your own customized IC in a matter of minutes. Renesas provides a complete library of application notes [4] featuring design examples as well as explanations of features and blocks within the Renesas IC.

[1] [GreenPAK Designer Software](#), Software Download and User Guide

[2] [AN-CM-345 Ultrasonic Dog Chaser with Repelling Strobe Light and Extra Functions.gp](#), GreenPAK Design File

[3] [GreenPAK Development Tools](#), GreenPAK Development Tools Webpage

[4] [GreenPAK Application Notes](#), GreenPAK Application Notes Webpage

[5] SLG47105 Datasheet

[6] [AN-CM-337 Monolithic Battery Charger](#), GreenPAK Design File

3. Introduction

The main goal of this application is to design a dog chaser using the SLG47105V. The system is designed using the HV macrocells and other internal and external components within the GreenPAK to control a piezo element and a 3 W LED.

The Dog Chaser has three modes: the Dog Repeller, the Dog Training, and the Flashlight. In the Dog Repeller mode, a powerful ultrasonic signal and strobe light disorient the dogs. In the Dog Training mode, the lower power ultrasonic signal is used, this signal makes dogs annoyed, but not disoriented. The Flashlight mode is just a powerful flashlight that can be useful when additional lighting is needed.

This Dog Chaser is a battery-powered device, so see also the [Monolithic Battery Charger Application Note](#) which describes how to configure SLG47105 as Battery Charger.

4. Construction and Operating Principle

4.1 Block Diagram and Circuit Design

The Block Diagram is shown in [Figure 1](#).

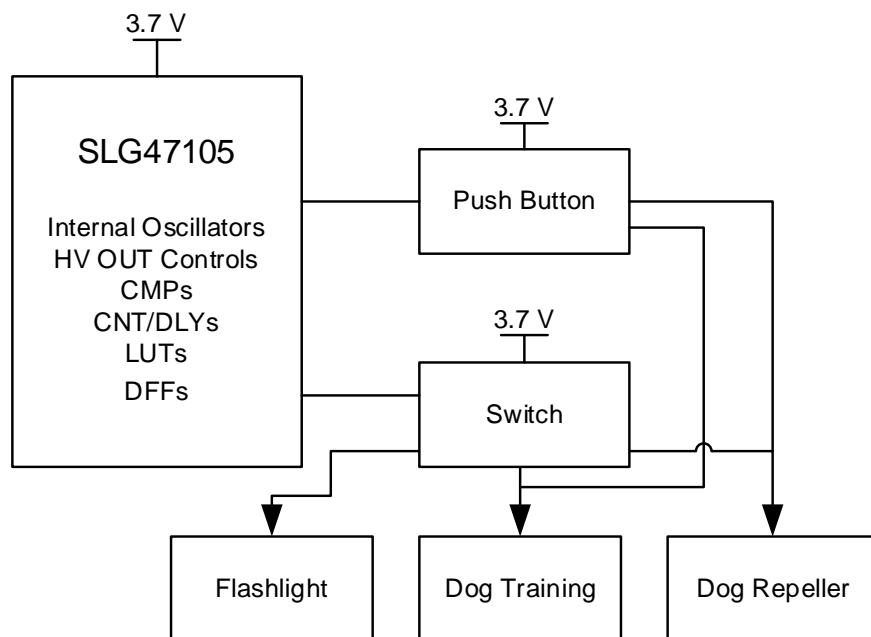


Figure 1 Block Diagram

As can be seen in [Figure 1](#), the Dog Chaser contains three modes, which are selected by a switch. Dog Repeller or Dog Training Mode is ON when the switch is in the appropriate position and the push button is pressed. To turn ON the Flashlight, there is no need to press the button, just switch to Flashlight Mode. The device is considered turned off when the switch is in the middle position (Dog Training Mode) and the push button is not pressed.

The circuit is powered by a Li-ion battery, so the VDD is between 3.0 V and 4.2 V. The LED intensity depends on voltage VDD, so the DC-DC Boost Converter is added to provide the constant necessary current to the LED.

The Full Circuit Schematic is shown in Figure 2.

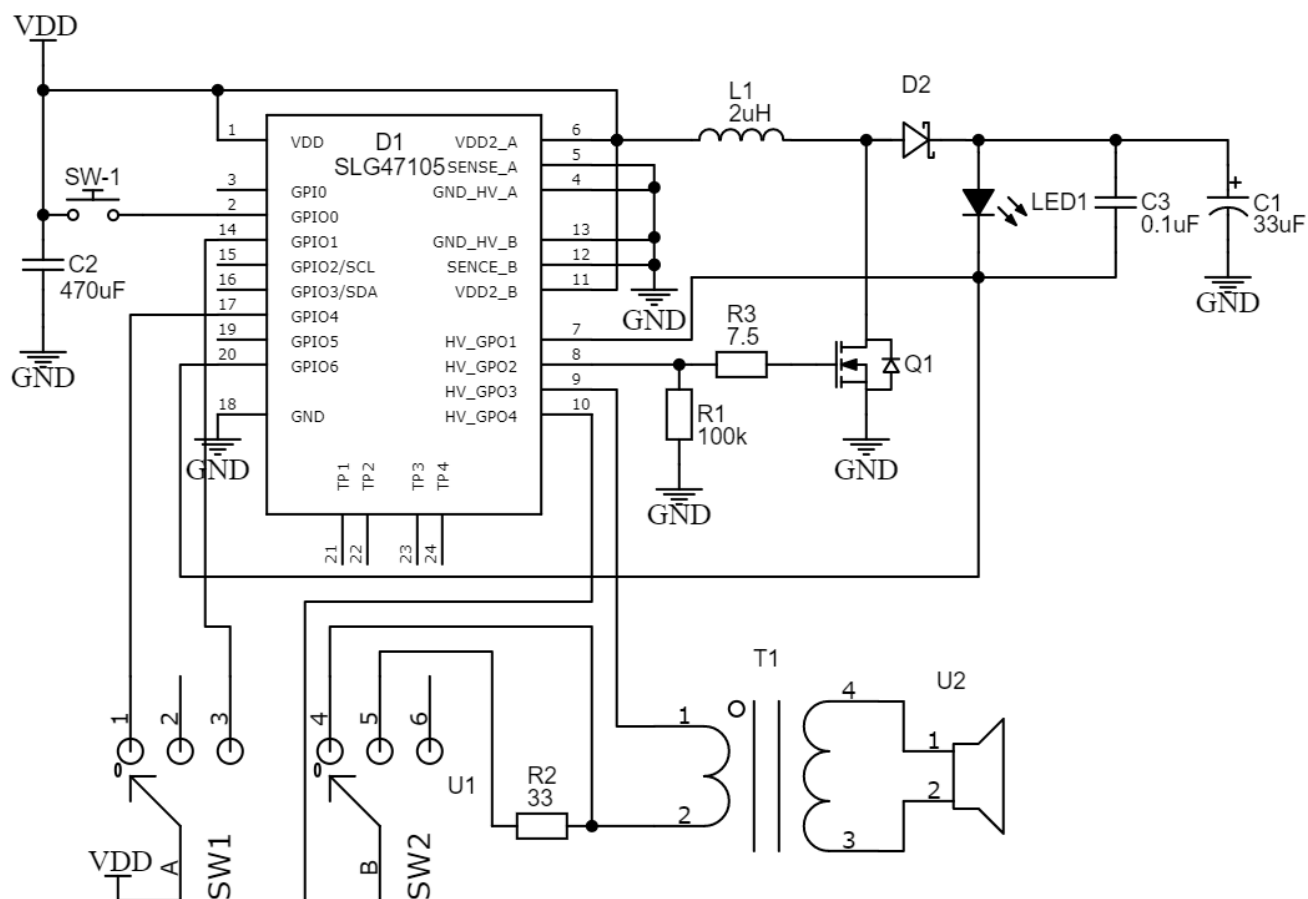


Figure 2 Full Circuit Schematic

The GreenPAK design is shown in Figure 3.

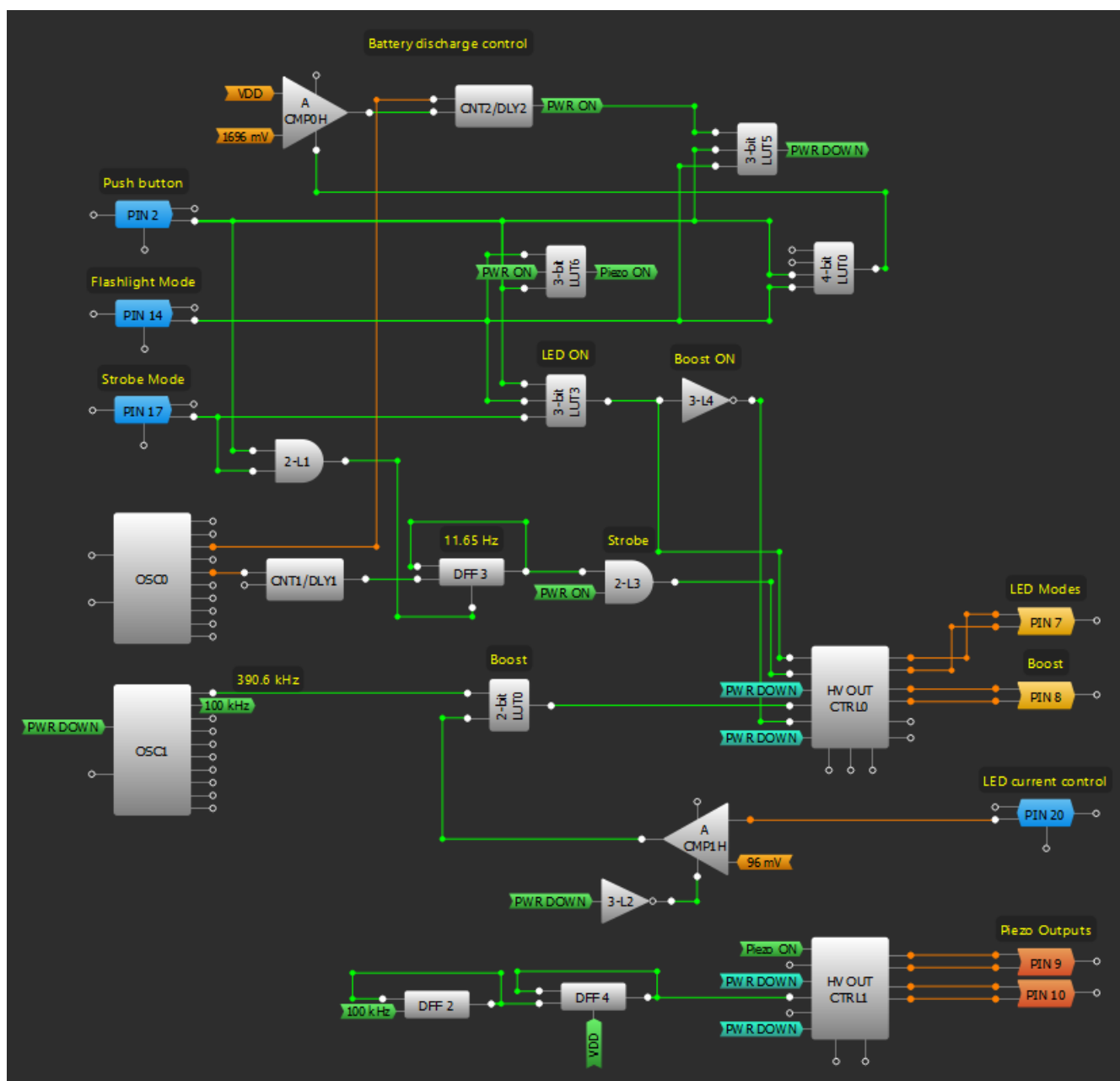


Figure 3 GreenPAK Design

The 390.6 kHz signal with a 50% duty cycle is created by OSC1 and goes to the 2-bit LUT0, which controls the Booster circuit through the HV PIN 8. When the maximum LED current of 700 mA is reached, the ACMP1 sets the 2-bit LUT0 to 0 and pulls down the HV PIN 8 keeping the current through the LED at the same level. It should be noted, that the external MOSFET must be selected with the lowest possible gate threshold voltage high enough current. For example IRL3303. The results of Boost can be found in [Figure 4](#) and [Figure 5](#). The HV PIN 8 is represented in blue and the ACMP1 is in green.

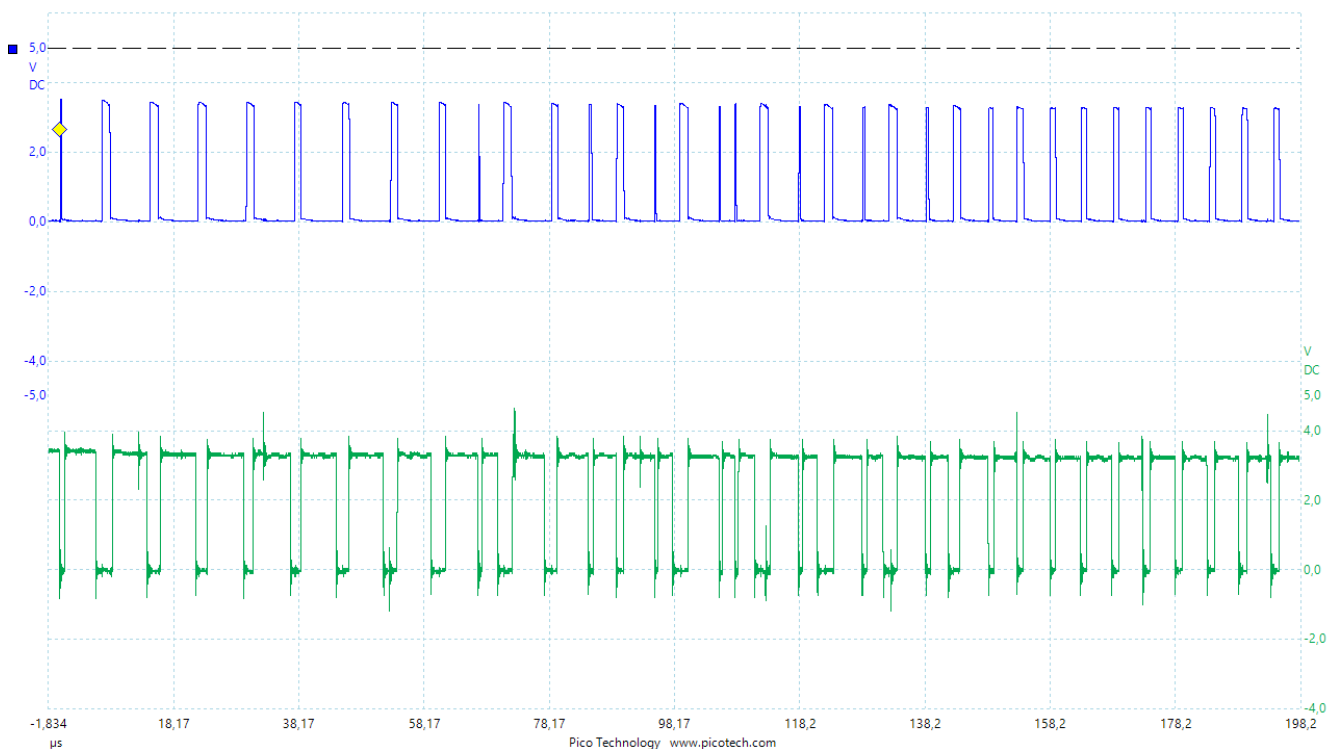


Figure 4 Boost Operation - 3.2 V

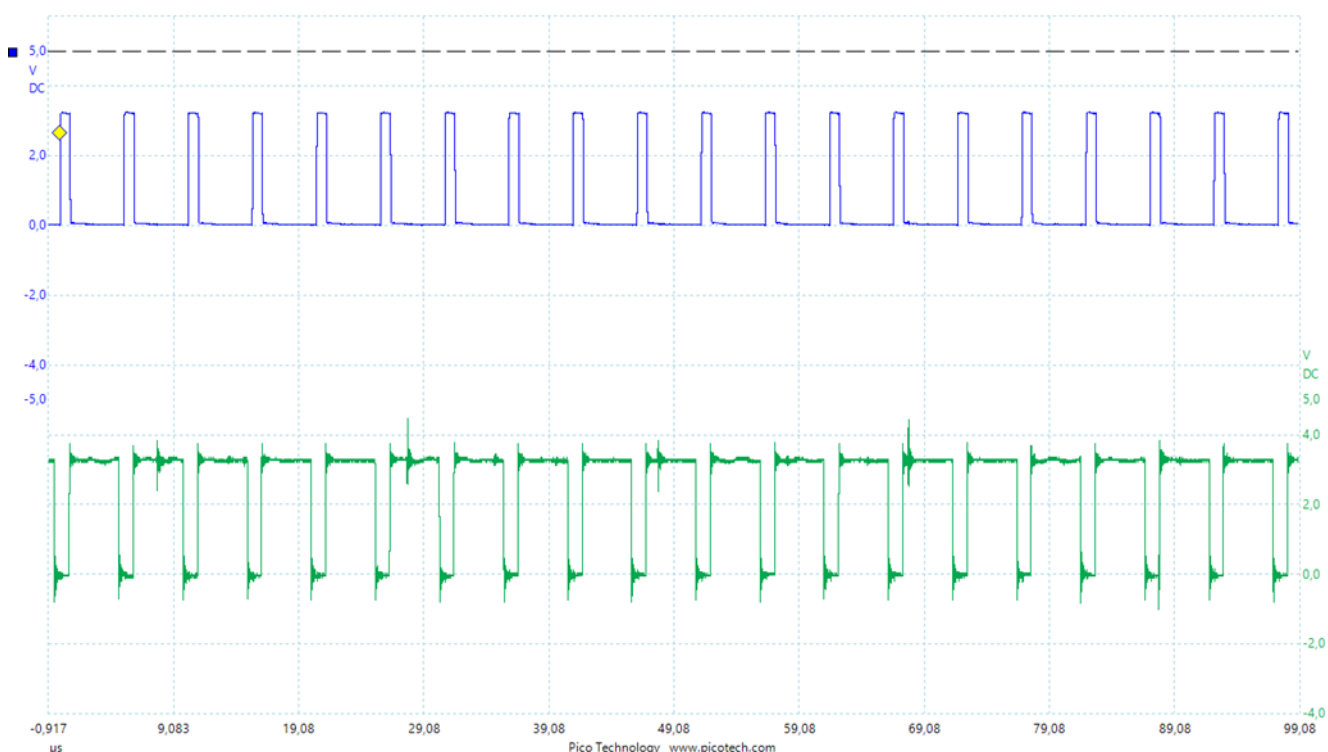


Figure 5 Boost Operation - 3.4 V

The necessary LED mode is selected by 3-bit LUT3 and DFF3. These signals go to HV PIN 7 of the HV OUT CTRL0 which is configured as a Half-Bridge and acts as a switch for the LED. So, the LED is ON when PIN 7 is LOW and vice versa. Also, the internal low-side MOSFET (PIN 7) is used as a current sensor. Its RDS On is about 150 mOhm which is perfect for our purpose.

4.2 Dog Repeller Mode

The Dog Repeller Mode includes two parts the Ultrasonic signal at full power and the LED strobe light.

The OSC1 generates the 100 kHz signal which goes through DFF2 and DFF4 and decreases to 25 kHz. Then this signal goes to PH input of HV OUT CTRL1, which is configured as Full Bridge. The Enable signal Piezo ON is generated by 3-bit LUT6 to be HIGH only when Dog Repelling Mode or Dog Training Mode is selected. To achieve the necessary amplitude the 4:40 voltage transformer is used. PIN 9 and PIN 10 are connected to the primary winding and the piezo element is connected to the secondary winding (see Figure 2). The resulting signal in the piezo element is a ~37 V amplitude ultrasound signal (Figure 6).

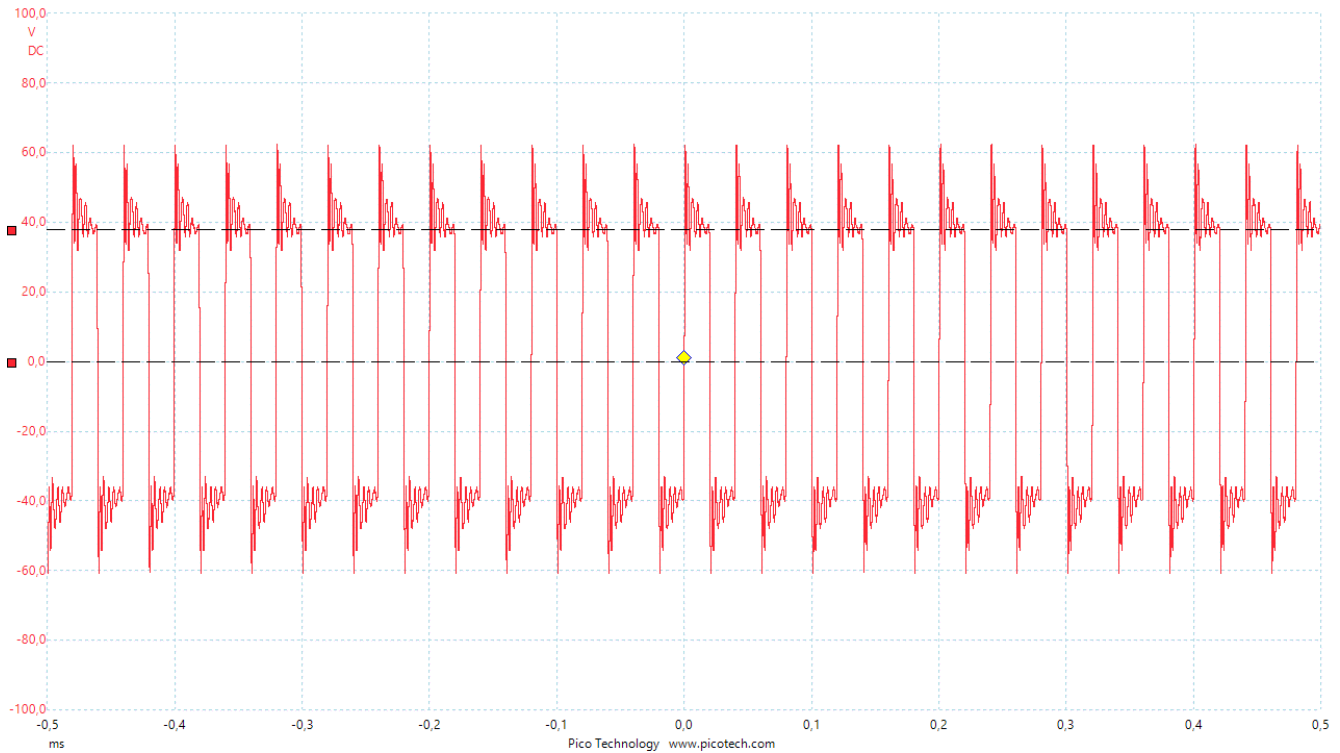


Figure 6 Piezo Output Signal in the Dog Repeller Mode

The LED strobe light is used to increase the dog's disorientation. In this case, the 3 W LED is connected to PIN 7 of HV OUT CTRL0 with an input of 11.65 Hz. The resulting LED signal is shown in Figure 7.

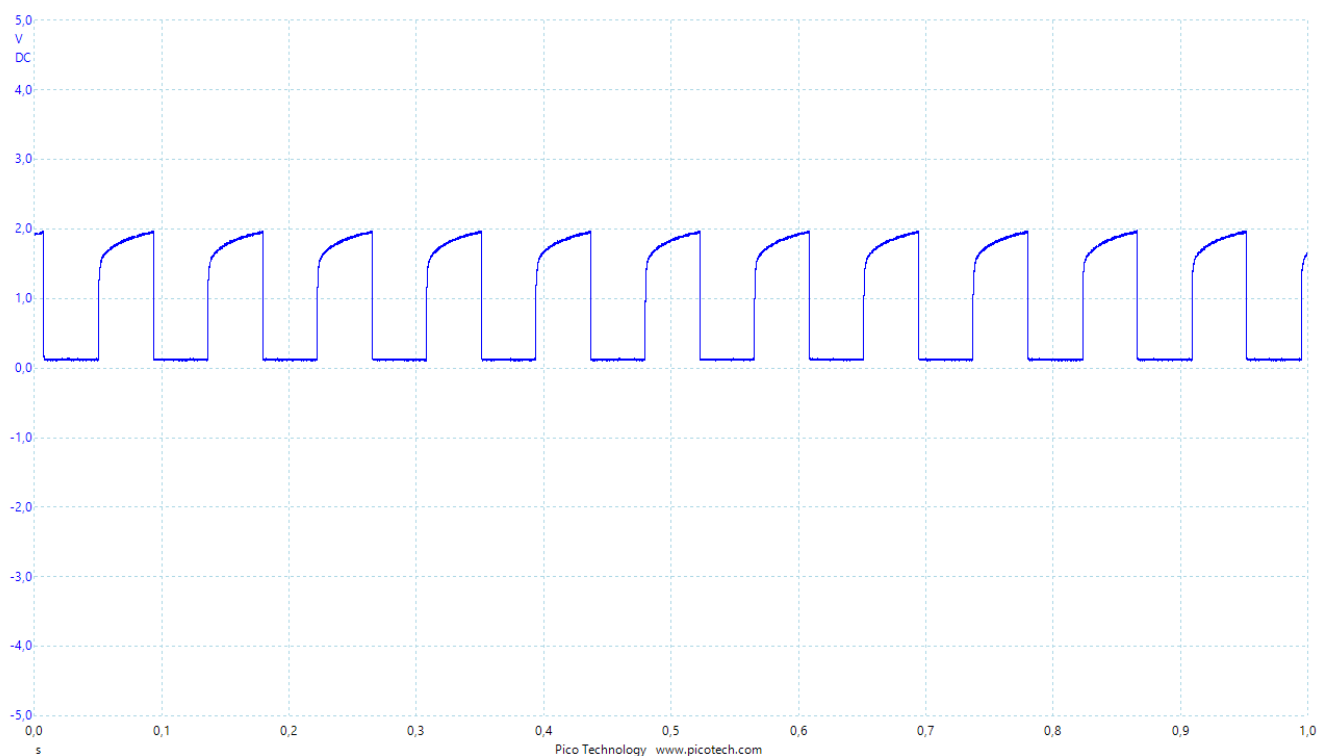


Figure 7 LED Signal Output in the Dog Repeller Mode

4.3 Dog Training Mode

The Dog Training Mode includes a 25 kHz signal with ~17 V amplitude when the battery is charged (4.1 V) and ~12 V when the battery is discharged (3.1 V). The additional 33 Ohm resistor is connected to PIN 9 of the primary winding of the voltage transformer and limits the current to ~80 mA to decrease the power of the piezo output signal (see Figure 9 and Figure 9).

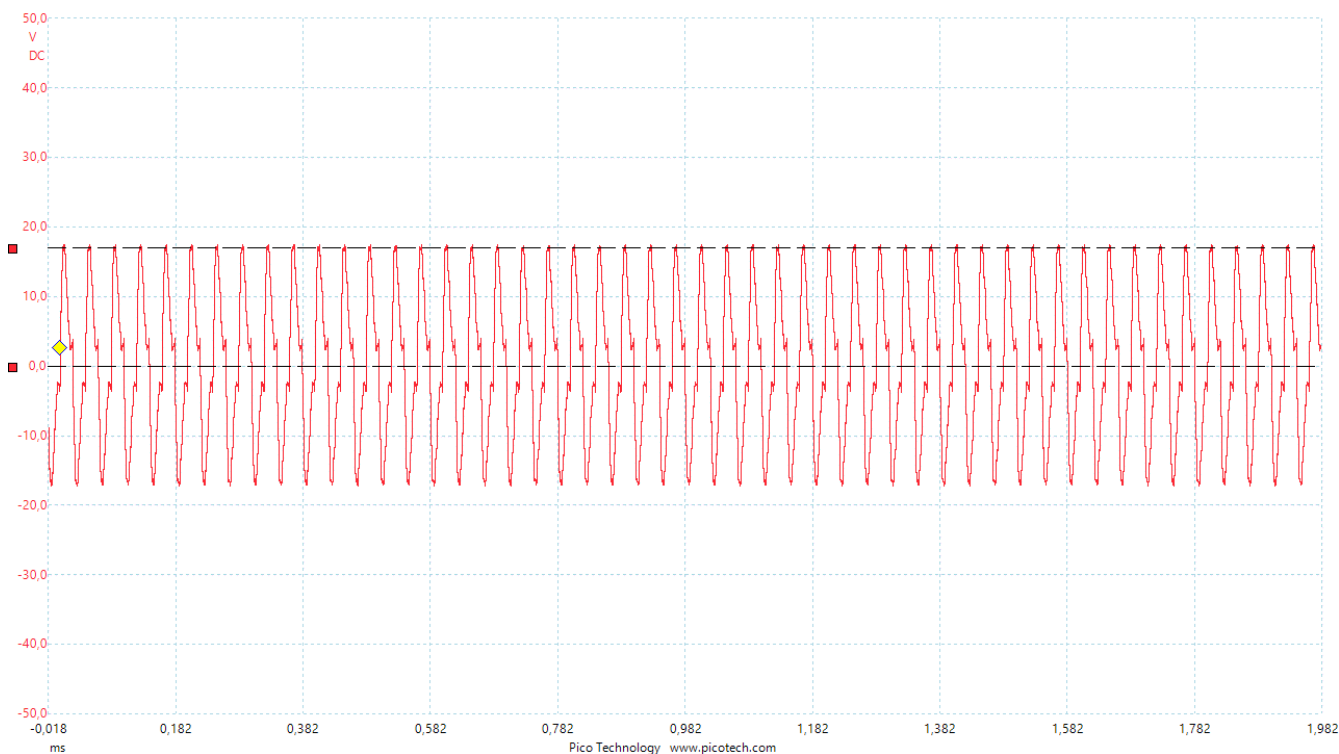


Figure 8 Piezo Output Signal in the Dog Training Mode (VDD - 4.1 V, amplitude - 17 V)

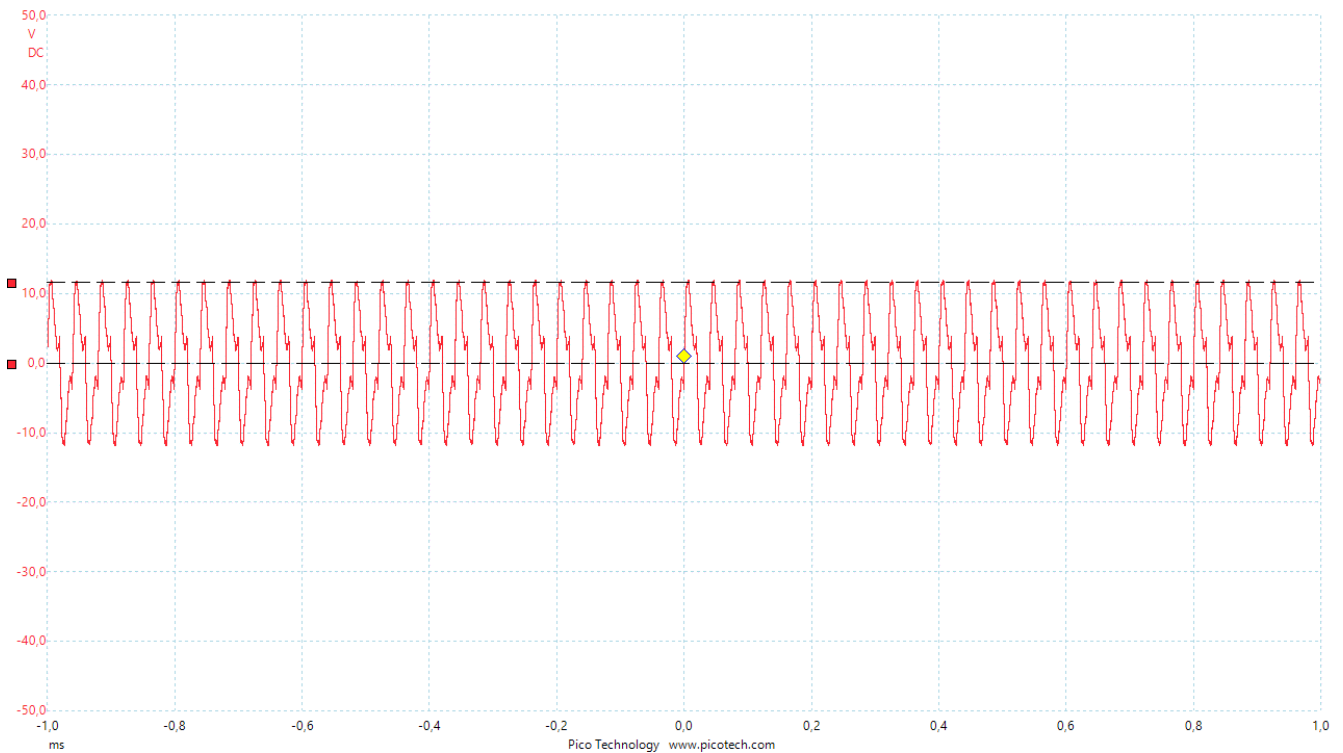


Figure 9 Piezo Output Signal in the Dog Training Mode (VDD – 3.1 V, amplitude - 12 V)

4.4 Flashlight

In the Flashlight Mode, the DFF3 sets the Enable signal OE0 of the HV OUT CNTR0 to HIGH, and the 3-bit LUT3 set the IN0 to LOW, so the output of PIN 7 is continuously LOW and the LED is continuously ON.

4.5 Battery Discharge

As the device is powered by a Li-ion battery, for example, an 18650 cell, there is a need to control the discharge level to prevent cell damage (assuming the battery does not have its own protection circuit). The comparator ACMP0 monitors the VDD level and if the voltage is less than 3072 mV the circuit is cut off. When the Dog Training Mode or Dog Repeller Mode is selected and the push button is not pressed, comparators ACMP0 and ACMP1, HV OUT CTRL0, HV OUT CTRL1, and OSC1 are in Sleep Mode thus consuming close to 0 current. The device is considered turned off when the switch is in the middle position and the push button is not pressed.

5. Conclusion

The application note describes how to configure the HV GreenPAK to create a Dog Chaser. The results prove that the circuit works as expected, and the HV GreenPAK is capable of acting as the control module for the piezo element and the powerful LED.

The Dog Chaser has three modes. The Dog Repeller Mode is powerful ultrasonic and strobe light signals that disorient the dog. The Dog Training Mode is a lower-power ultrasonic signal which helps to train the dog. And the last Mode is powerful Flashlight.

The GreenPAK's internal resources, including the HV, oscillators, logic, and GPIOs are easy to configure to implement the desired functionality for this design.

6. Revision History

Revision	Date	Description
1.00	Aug 31, 2022	Initial release.

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