

Exhaust Fan with Timer and Humidity Sensor

SLG46811

This application note describes how to use the SLG46811 to implement an exhaust fan with an off-delay timer and a sensor for humidity control. The application note comes complete with design files, which can be found in the References section.

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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>

Download our free GreenPAK Designer software [1] to open the .gp file [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 Electronics 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 Go Configure Software Hub](#), Software Download and User Guide, Renesas Electronics
- [2] [AN-CM-355 Exhaust Fan with Timer and Humidity Sensor.gp6](#), GreenPAK Design File, Renesas Electronics
- [3] [GreenPAK Development Tools](#), GreenPAK Development Tools Webpage, Renesas Electronics
- [4] [GreenPAK Application Notes](#), GreenPAK Application Notes Webpage, Renesas Electronics

1. Introduction

Exhaust ventilation fans allow a home to exhale, eliminating humidity, odors and airborne particulates from bathrooms, closets, mudrooms, laundry, workout space, and others. Ventilation fans improve indoor air quality by venting unwanted dirty, humid, and stale air outside quickly, which helps to control mold and mildew growth. For ease of use and automation, modern exhaust fans have built-in timers and humidity sensors.

For this application note, a typical exhaust fan was analyzed, and its functions were repeated on the SLG46811. The analyzed fan contains two ICs (a programmable timer and a quad operational amplifier) and more than 50 discrete components. The use of the SLG46811 allows reducing the number of components significantly and thus decreasing the device price.

Figure 1 shows a general schematic of the device based on the SLG46811.

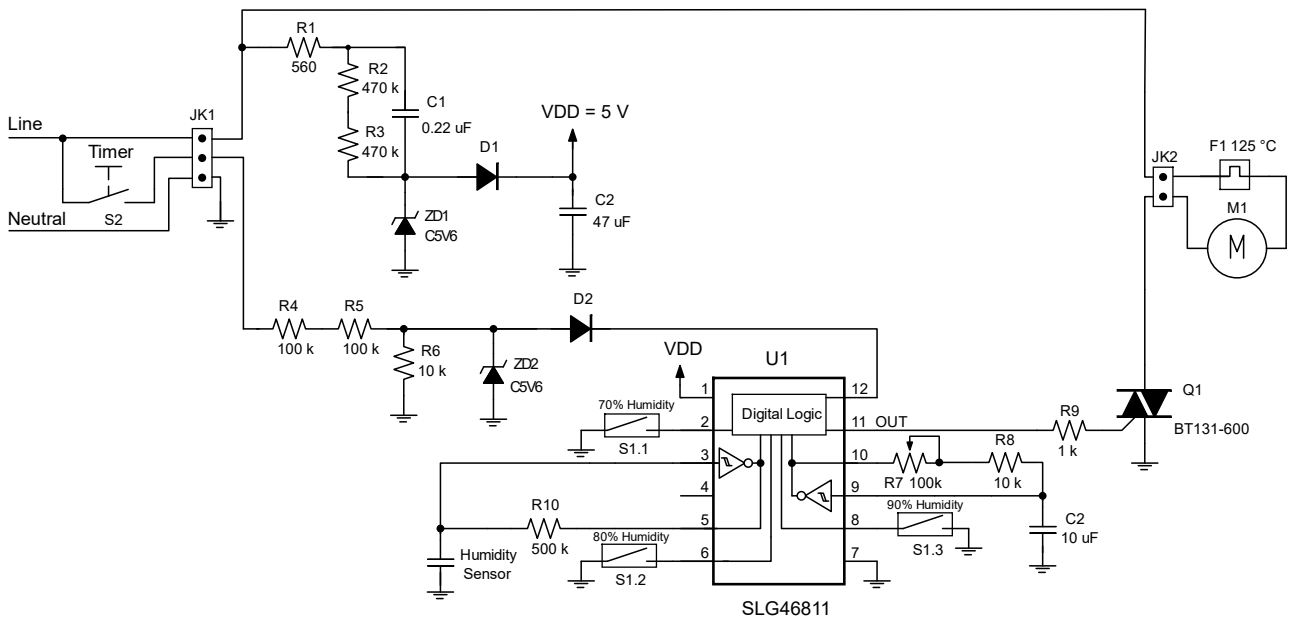


Figure 1. General Schematic of Exhaust Fan with Timer and Humidity Sensor Based on SLG46811

2. GreenPAK Design

Figure 2 shows an internal design of the exhaust fan in the GreenPAK Designer software.

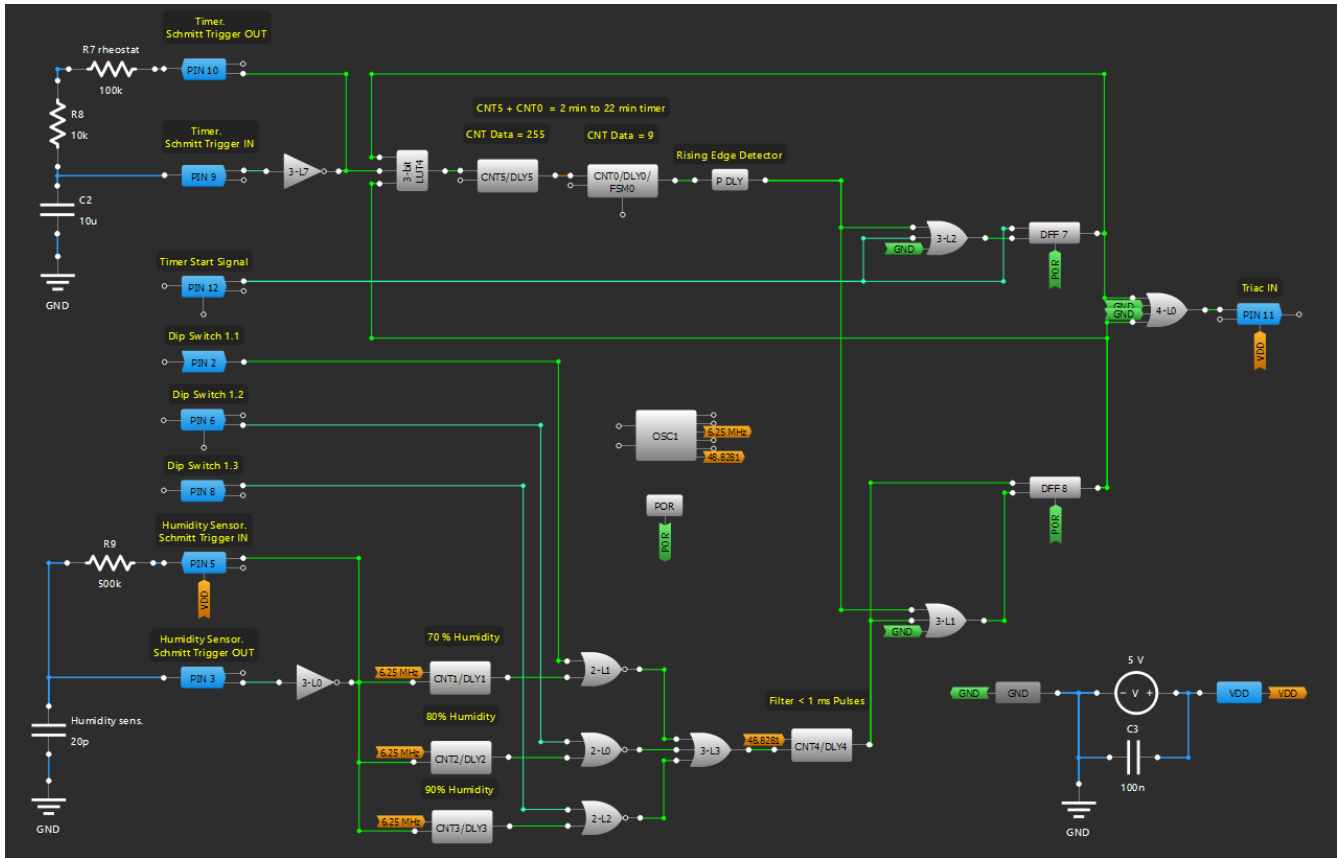


Figure 2. Exhaust Fan with Timer and Humidity Sensor GreenPAK Designer Schematic

2.1 Power Supply Circuit

The power supply circuit of the analyzed fan was used. This circuit was simplified by removing several components, since to power the SLG46811 only 5 V is required (see Figure 1), and the analyzed fan required two supply voltages of 10 V and 5 V.

The fan, in addition to the mains voltage, also needs a signal to start the timer. This signal uses the same mains voltage, which is supplied through a separate push button.

Resistors R1, R2, and R3 with Zener diode ZD1 and diode D1 form 5 V supply voltage for the SLG46811.

Furthermore, a circuit to transform the mains voltage for the timer to the voltage level applicable for the SLG46811 pins was used. Resistors R4, R5, and R6 are dropping resistors. Zener diode ZD2 limits the positive half-wave of the signal at 5.6 V and diode D2 clips the negative half-wave of the signal. The output of this circuit is a 5 V square wave signal with the frequency of the mains.

2.2 Off-Delay Timer

Pins 9 and 10, 3-bit LUT7 (an inverter), capacitor C2, rheostat R7, and resistor R8 form a Schmitt trigger oscillator. Depending on the position of R7's wiper, the total resistance of R7 and R8 changes from 10 kΩ to 110 kΩ, and accordingly, the frequency also changes by a factor of 11. This allows the digital counter to set desired timer's off-delay time in the range from 2 to 22 minutes by setting a corresponding counter data.

When the user presses a wall push button S2 (or pulls a pull cord switch), a series of pulses go to the DFF7 input D and the same pulses go through the 3-bit LUT2 (OR gate) to the CLK input. The first pulse causes a High-level signal on the DFF output and thus passes the Schmitt trigger oscillator's square wave signal to the CNT5 CLK input and provides the High-level signal on the 4-bit LUT0 output to start the fan (see Figure 3). The CNT5 and the CNT1 are chained together to get the desired counter time data to 2295. When the counter ends counting, a High-level voltage appears on its output. After passing through the Rising Edge Detector and the OR gate, this

signal will be on the CLK input of the DFF7. The DFF output goes LOW on the triggering edge of the pulse and the counter stops counting.

Because the output voltage level of the CNT0 remains HIGH until the next pulse on its clock input, the Rising Edge Detector makes the signal level LOW on the DFF's CLK input after the counter has counted till the end and the DFF output then goes LOW. Without the Rising Edge Detector, the next time after the button is pressed, it will be impossible to ensure a rising edge signal for the DFF7.

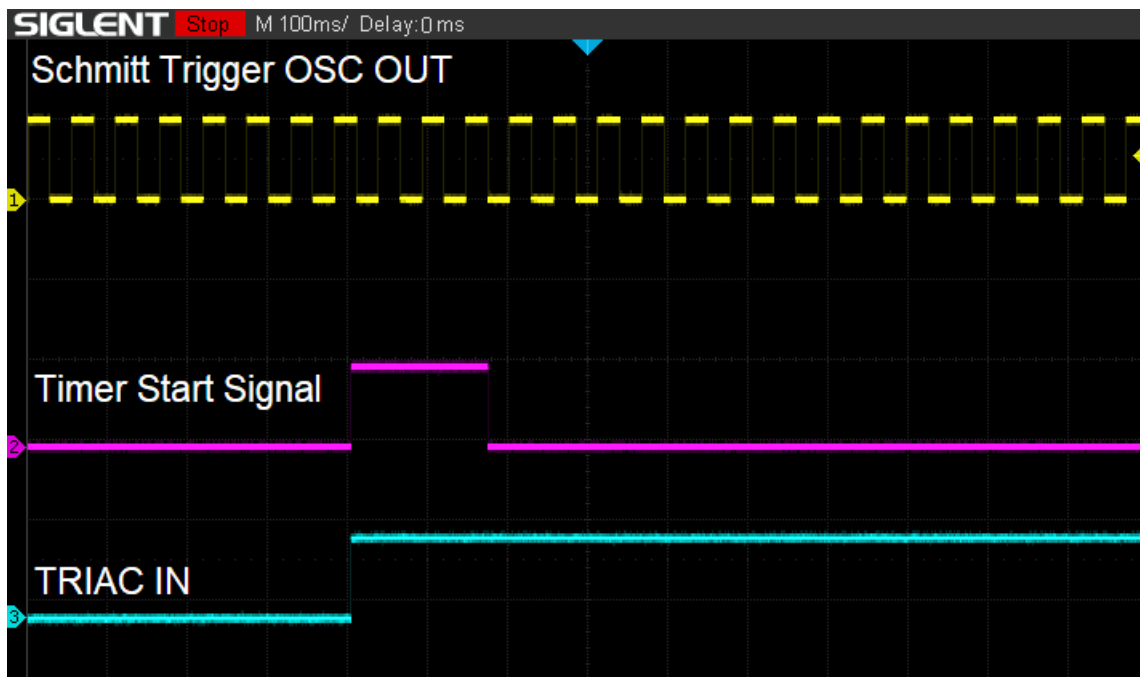


Figure 3. Waveforms for Off-Delay Timer Part

2.3 Humidity Sensor

Pins 5 and 3, 3-bit LUT0 (an inverter), a humidity sensor, and resistor R9 form the second Schmitt trigger oscillator. The frequency of the oscillator depends on air humidity. In this project, a capacitive humidity sensor was used. Its frequency decreases with increasing humidity. CNT/DLY0, CNT/DLY1, and CNT/DLY2 were used as Frequency Detectors for three different frequencies 42 kHz, 35 kHz, and 28 kHz, respectively. Thus, they are configured to detect three different humidity levels (70%, 80%, and 90%). The user can use the DIP switch to set the desired humidity level at which the fan will start. Please note that the Frequency Detectors thresholds should be set for a particular sensor individually.

Due to the slight instability of the oscillator's frequency, a HIGH level does not appear at the 3-bit LUT3 (OR gate) output immediately. At first, it will be turned off and on chaotically nearby a threshold level. A 1 ms CNT/DLY4 (in a delay mode) filters these unwanted spikes.

The High-level signal on the CNT/DLY4 output causes the High-level signal on the DFF8 output and thus passes the Schmitt trigger oscillator's square wave signal to the CNT5 CLK input and provides the High-level signal on the 4-bit LUT0 output to start the fan. When the counter ends counting, the Rising Edge Detector provides a pulse to the DFF8, and on its rising edge, the DFF8 output goes LOW if the humidity drops below the set threshold level or remains HIGH and starts the timer one more time.

Figure 4 shows waveforms for humidity control part.

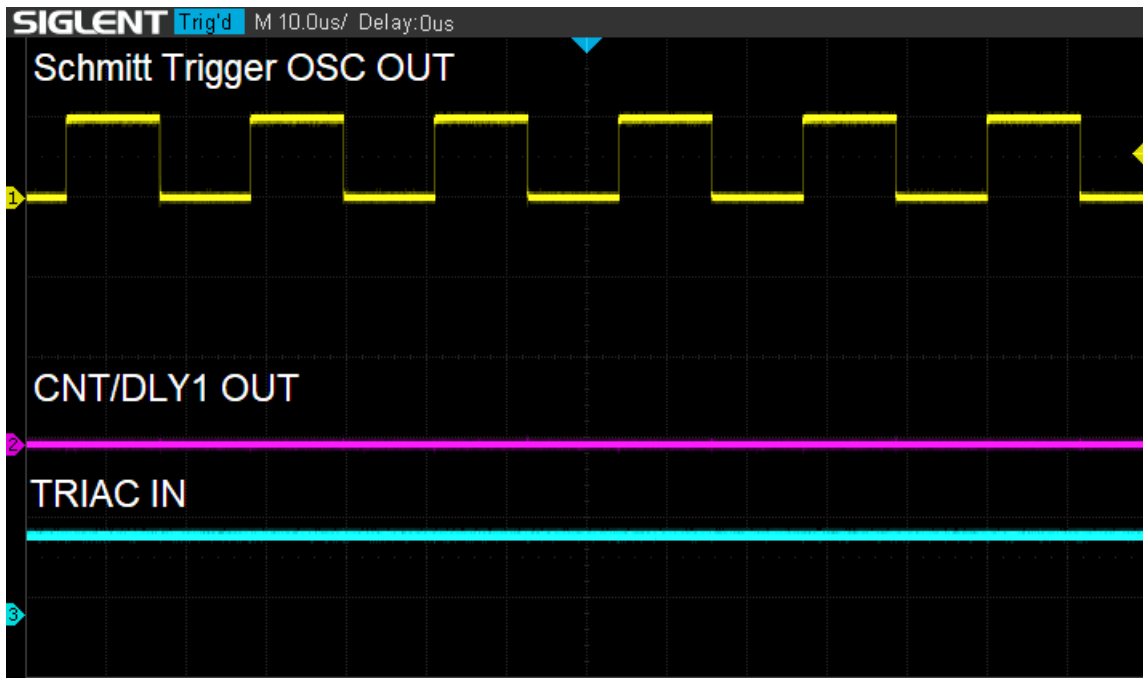


Figure 4. Waveforms for Humidity Control Part

2.4 Motor Control

Usually, in the exhaust fans, an asynchronous motor with a shaded-pole is used. To control the asynchronous motor, a triac with a gate trigger current equal to 3 mA was used. This triac is driven by the SLG46811. Resistor R9 limits the triac input current. To prevent the motor from overheating, a thermal fuse was used.

3. Simulation of the Project

The project can be simulated in the GreenPAK Designer Software Simulation Tool. All external components are available in the GreenPAK Designer, except for the humidity sensor, which can be easily replaced with a capacitor. [Figure 5](#) shows simulation waveforms for both Schmitt trigger oscillators.

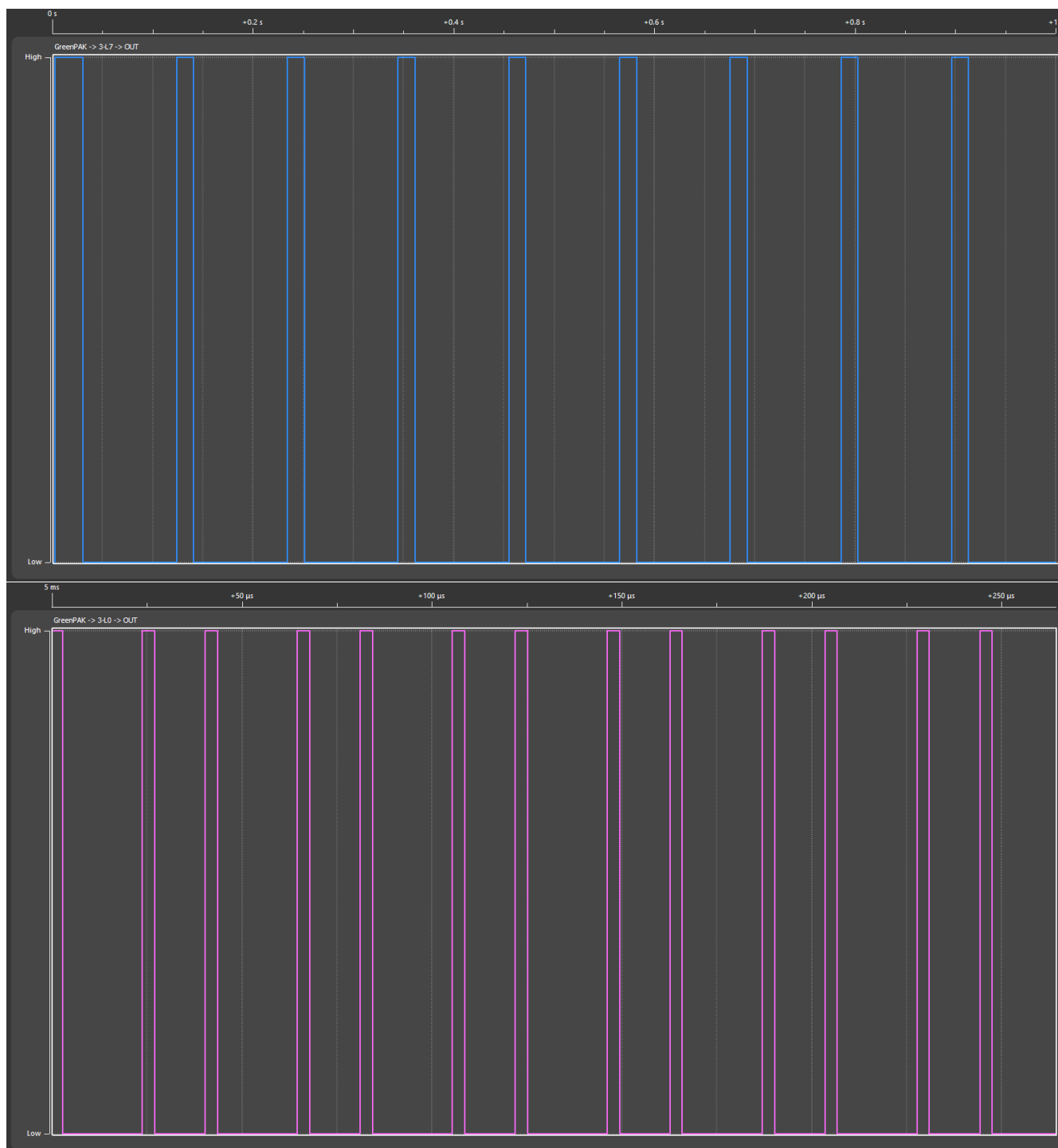


Figure 5. Simulation Waveforms Showing Work of Exhaust Fan’s Schmitt Trigger Oscillators

4. Conclusions

In this application note a typical cheap exhaust fan with an off-delay timer and a humidity sensor was analyzed. Its design was repeated on the SLG46811. The SLG46811 is one of the smallest and cheapest GreenPAK ICs. The use of the SLG46811 allows reducing of more than 30 components from PCB, including two ICs, and thus decreases the device price. Furthermore, removing all these components reduced power consumption.

5. Revision History

Revision	Date	Description
1.00	Dec 5, 2022	Initial release.

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