user manual

SpeakUp

The SpeakUp is a speech recognition click™ board. You can set it up to recognize over 200 different voice commands and have the on-board MCU carry them out instantly.

MikroElektronika
DEVELOPMENT TOOLS | COMPILERS | BOOKS

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I want to express my thanks to you for being interested in our products and for having confidence in MikroElektronika.

The primary aim of our company is to design and produce high quality electronic products and to constantly improve the performance thereof in order to better suit your needs.

Nebojsa Matic
General Manager

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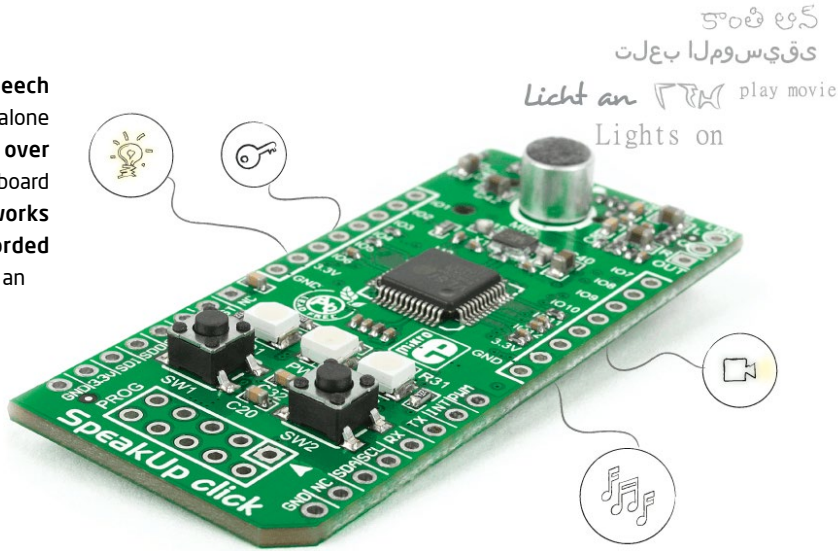
Table of Contents

1. Introduction 4
2. Applications 5
3. Package Contains 6
4, How to use it? 7
5. Tech Specs 8
6. Schematics 9
7. How It Works? 10
    SpeakUp Firwmware Algorithm 11
8. Configuration Through Software 12
    8.1. Typical Workflow 13
    8.2. Getting Started 14
    8.3. Creating a new project 15
    8.4. New Voice Command 16
    8.5. Configuring Project Settings 18
    8.6. Assigning An Action 20
    8.7. Uploading Project 22
    8.8. Exporting Constants 23
9. Direct Configuration 24
10. Recording Tips 25
11. Examples 26

1. Introduction

The **SpeakUp** is a speaker dependent **speech recognition click board** with standalone capabilities. You can **set it up to recognize over 200 voice commands** and have the onboard STM32F415RG MCU carry them out. It **works by matching sounds with pre-recorded commands**. Sound is received through an onboard microphone and then processed by a VS1053 IC with a built in stereo-audio codec. **The SpeakUp comes with a dedicated software tool for easy configuration.** The board is lined with 12 user programmable GPIOs for standalone functionality. It also carries a standard mikroBUS™ host socket.



Easy configuration

Over 200 commands

Ultra fast operation

Standalone mode

2. Applications

Wouldn't you rather issue verbal commands and have your machines comply, instead of pressing keys, pushing buttons and flipping switches all the time? There's a wide range of applications for the SpeakUp.

Command your lights, doors and home appliances.

Create voice commanded remotes for TVs or media centers.

Reduce complexity and cost of control interfaces.

When doing something with both hands and voice command is the only option.

3. Package Contains

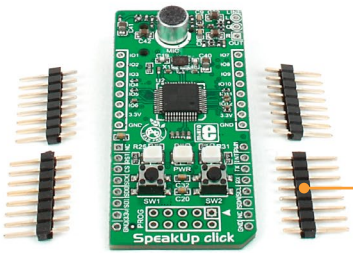
Package dimensions:
L 70mm, **W** 60mm, **H** 30mm

Package weight:
~40g

Box

User manual

Recycle Bin document

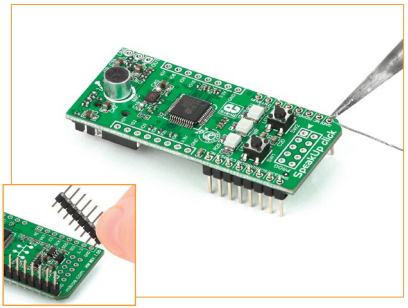


1x8 headers

SpeakUp click™ board

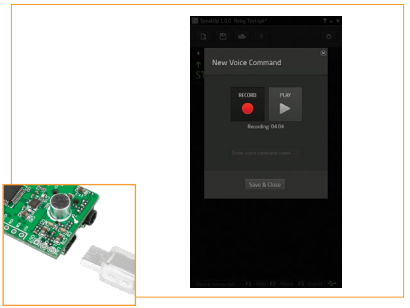
4. How To Use It?

Before using your click™ board on your target platform, make sure to solder 1x8 male headers to both left and right side of the board. Two 1x8 male headers are included with the board in the package.



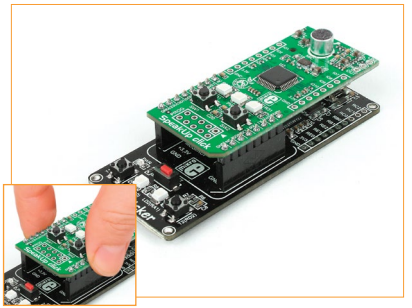
1. Prepare it

Turn the board upside down so that the bottom side is facing you upwards. Place shorter pins of the header into the appropriate soldering pads. Turn the board upward again. Make sure to align the headers so that they are perpendicular to the board, then solder the pins carefully.



2. Configure it

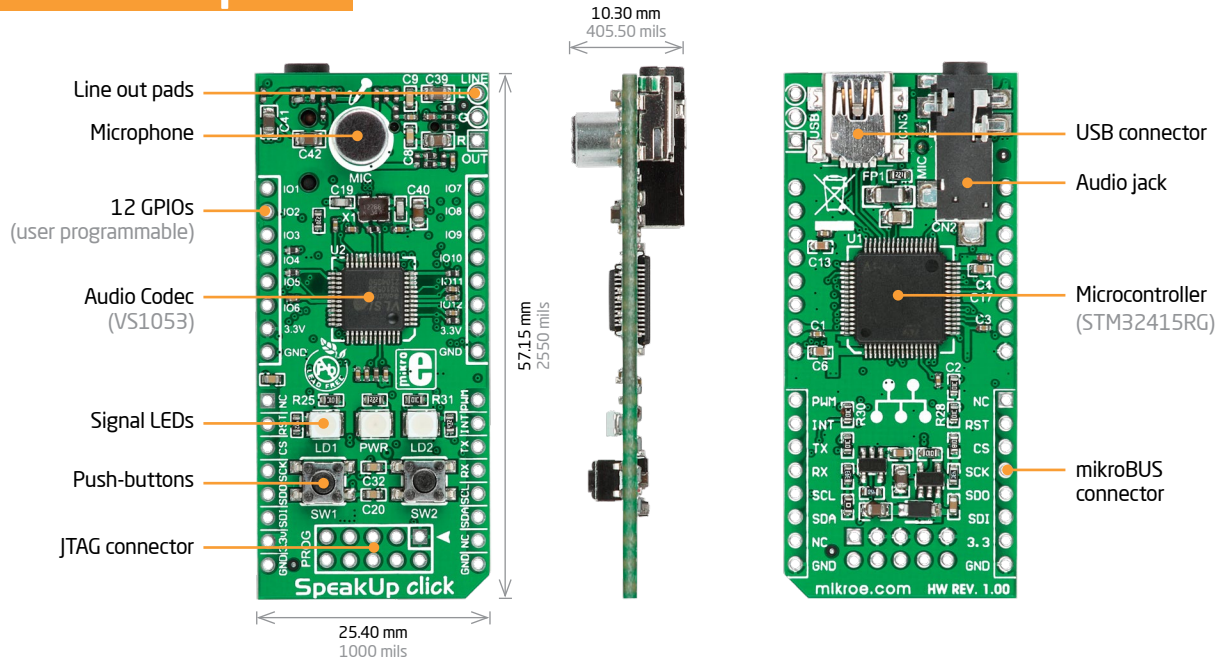
Now you need to train your SpeakUp to obey your commands. Plug in the board to your PC through USB cable. Configure it using the free software (see page 12). Alternatively you can configure the board directly using the on-board buttons (see page 24).



3. Use it

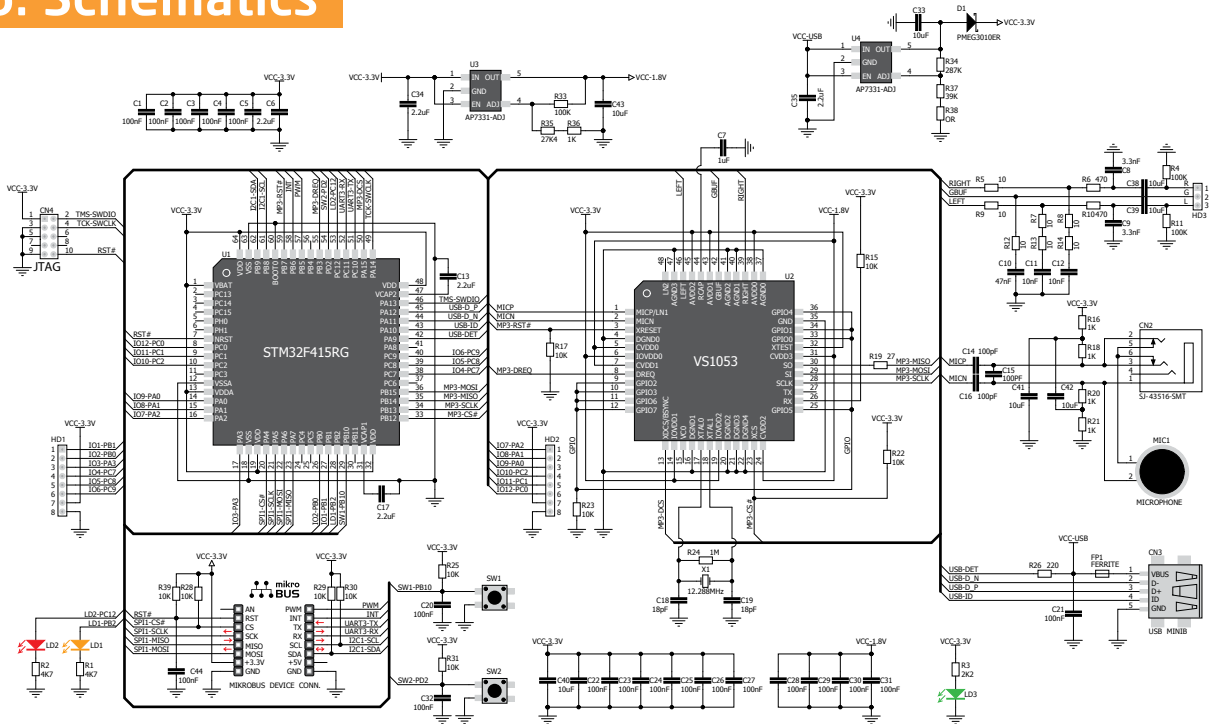
The SpeakUp now understands your commands. Connect relays, motors or other electronic actuators directly to SpeakUp's GPIO pins. Alternatively plug the SpeakUp into any board or shield carrying a mikroBUS™ socket. You can now control your devices with your voice.

5. Tech Specs



Along with its key components, the SpeakUp packs other useful bits like two buttons for recording or deleting voice commands manually, while three signal LEDs give recognition feedback and indicate power.

6. Schematics



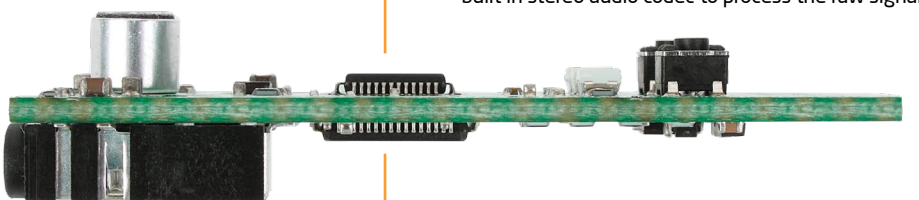
7. How It Works?

What gives the SpeakUp its speech recognition capabilities is the firmware we developed for the on-board MCU. It's based on the DTW algorithm, which makes it decisive, it turns your talk into action almost instantly.

Input:

Sound is received through an on-board microphone. There's also a 3.5mm jack for connecting an external microphone.

Between the mic and the MCU sits a VS1053 IC with a built in stereo audio codec to process the raw signal.



Output:

After the processed sound has been forwarded to the STM32F415RG MCU that interprets the voice command, there are two output options which can be utilized at the same time or separately:

STANDALONE MODE:
On-board MCU directly controls external devices using 12 user programmable GPIOs

CLICK™ MODE:
Sends index of the matched voice command to a selectable interface: USB or UART.

SpeakUp Firmware Algorithm

The main goal of a speech recognition system is to substitute a human listener, although it is very difficult for an artificial system to achieve the flexibility offered by human ear and human brain. The work principle of speech recognition systems is roughly based on the comparison of input data to prerecorded patterns. These patterns can be arranged in the form of phoneme or word. By this comparison, the pattern to which the input data is most similar is accepted as the symbolic representation of the data. It is very difficult to compare raw speech signals directly. Because the intensity of speech signals can vary significantly, a preprocessing on the signals is necessary. This preprocessing is called Feature Extraction.

First, short time feature vectors are obtained from the input speech data, and then these vectors are compared to the patterns classified prior to comparison. The feature vectors extracted from speech signal are required to best represent the speech data, to be in size that can be processed efficiently, and to have distinct characteristics.

The SpeakUp Firmware uses **Dynamic Time Warping (DTW)** algorithm - word-based, isolated word, speaker dependent and template matching algorithm :

- In the **word based** speech recognition the smallest recognition unit is a word
- In the **isolated word** recognition, words that are uttered with short pauses are recognized,
- **Speaker dependent** reference patterns are constructed for a single speaker,
- **Template matching** algorithm is a form of pattern recognition. It represents speech data as sets of feature/parameter vectors called templates. Each word or phrase in an application is stored as a separate template. The input speech is then compared with stored templates and the stored template most closely matching the incoming speech pattern is identified as the input word or phrase.

8. Configuration Through Software

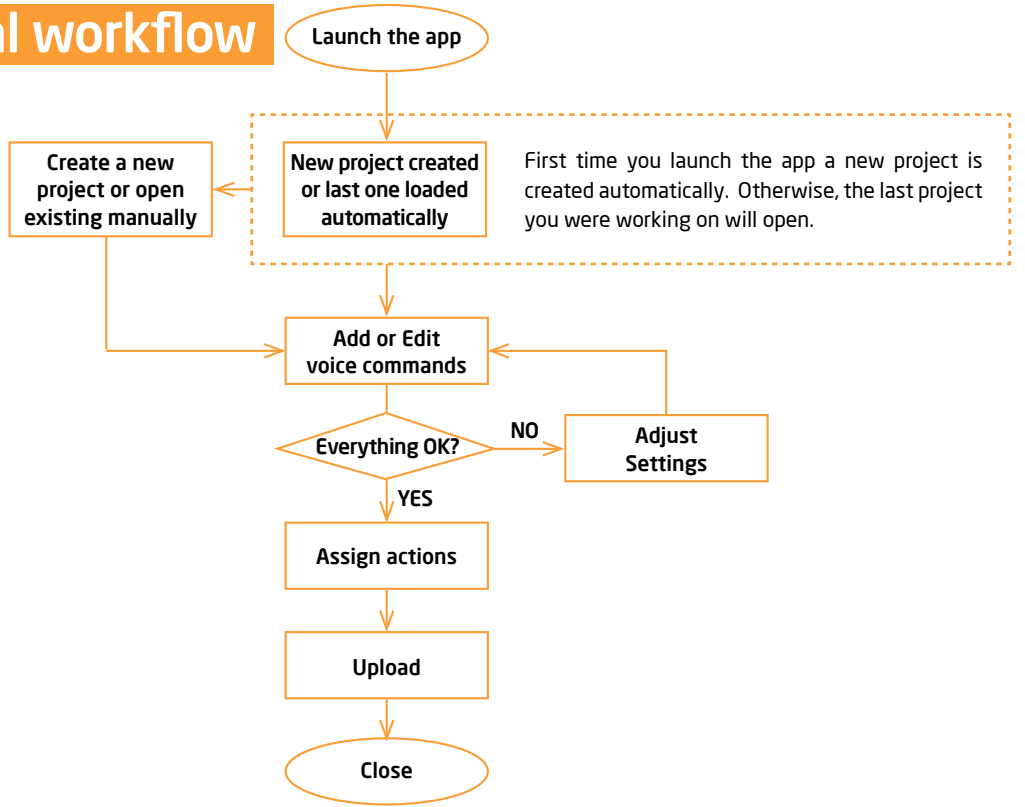
The SpeakUp software configuration tool is a free PC application for configuring the SpeakUp click board. With it, you can configure the board to recognize over 200 different voice commands and have the on-board MCU carry them out instantly. You can download the software from the following link:

http://www.mikroe.com/downloads/get/2077/speakup_app.zip

The software is designed with ease of use and simplicity in mind. The UI is based on tabs and drop-down menus requiring no programming skills to use.

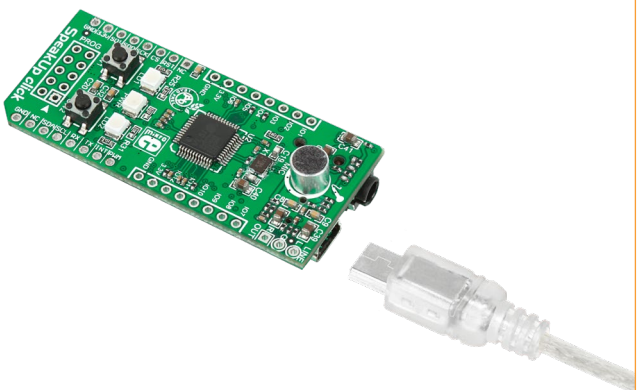
Still, it has all the essential features and options that give you full control of the set-up process.

8.1. Typical workflow



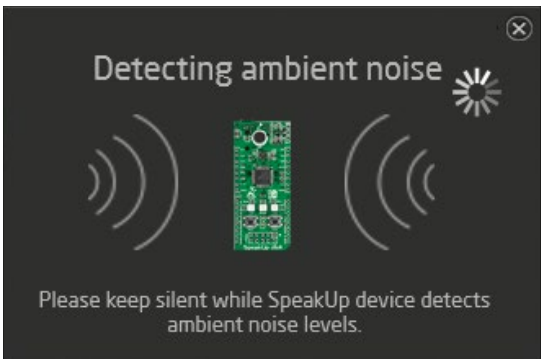
8.2. Getting Started

Connect the SpeakUp click board to the computer via the USB cable. It will be recognized as a USB Human Interface Device (HID) in the Device Manager of the Control Panel.



Once you connect the SpeakUp to your computer you're just a few clicks away from configuring it. The set-up process is dead simple. Launch the application, and it will lead you through the initial steps of recording and assigning commands.

Ambient Noise Detection



After the successful connection, the SpeakUp click™ board will perform ambient noise detection and calibrate itself. The process lasts about 10 seconds. It's done when the red signal LED turns off. After that the board is ready for recording voice commands. You can set custom calibration parameters for any subsequent usage in the **Project Settings** (see page 18).

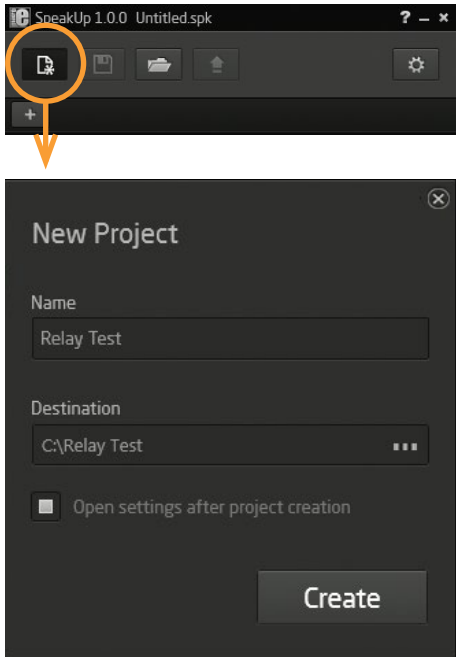
8.3. Creating A New Project

To create a new project, press the **Create New Project** button from the main toolbar of the SpeakUp software.

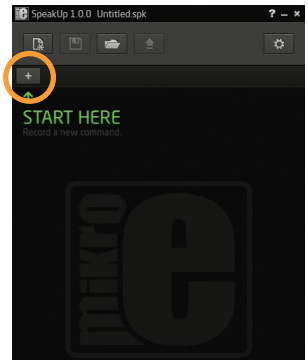
A new window will open, where you can enter your project's name and destination folder (if the destination folder doesn't exist, the software will prompt you to create it).

To finish project creation after inputting the required information, press the **Create** button.

Alternatively, you can choose to open the settings menu as soon as you create a project, by checking the appropriate box.

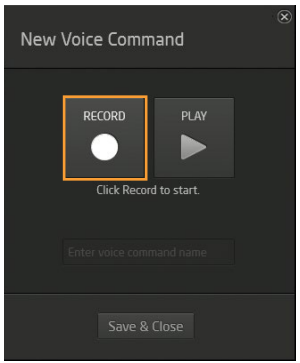


8.4. New Voice Command



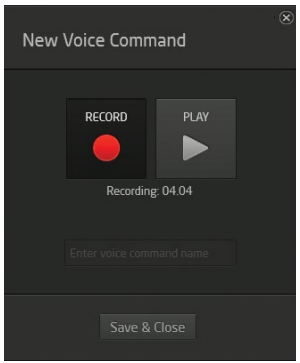
Add a voice command

To record a new voice command, press the **Add New Voice Command** button.



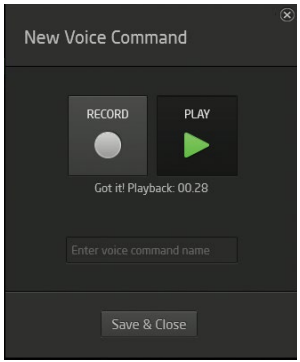
Record it

A New Voice Comand dialog window will appear. Press the **Record** button.



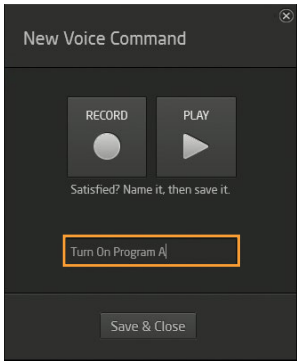
Stay within the time limit

The length of the recording is set in the **Project Settings** window (see page 18).



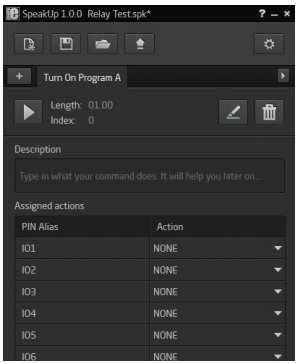
Hear it back

The recorded command will be played back automatically, so you can make sure it's OK.



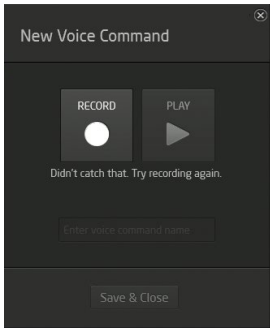
Name it and save it

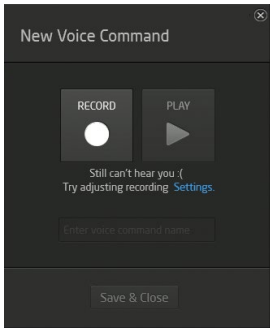
If you're satisfied with the recording, enter a name for your command and click the **Save & Close** button.



You're done!

The recorded command will appear as a **new tab**. You can play it back, edit or delete it anytime.



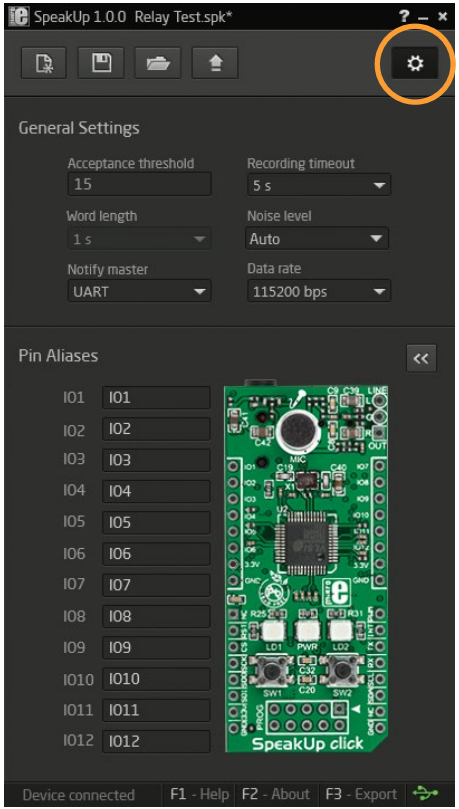


Troubleshoot

If the SpeakUp fails to detect a voice command, your surrounding might be too noisy. Try again by speaking a bit louder. If it still doesn't work, launch Settings and adjust the **Noise treshhold**.

8.5. Configuring Project Settings

To configure project settings, press the **Open Settings Window** button and the Settings window will open.



General Settings

In the General Settings you can configure the SpeakUp's functionality:

- **Acceptance threshold:** This is the parameter you should adjust to define how closely your delivery has to match your pre-recorded command. At lower values, you'll have to deliver the command precisely the way you recorded it. At higher values the matching doesn't have to be so precise, but this increases the probability that the SpeakUp will pick up irrelevant speech and interpret it as a command. You should be able to reach the sweet spot value through some trial & error.

- **Recording timeout:** Timeframe in which the SpeakUp click board expects recording input after the record button is being pressed. User can choose between 5, 10 and 15 seconds timeframes.

- **Word Length:** Length of the voice command being recorded, in seconds. Can be 1, 1.5 and 2 seconds.

- **Noise level:** Minimal sound volume level that can trigger a voice command recognition. Lower values require quieter pronunciation, resulting in higher noise/hiss sensitivity. On the contrary, higher level values require louder pronounciation and they are less sensitive to noise/hiss.

  We recommend that you keep auto detection enabled. That way the SpeakUp Click board will measure the noise level, and perform noise calibration automatically. Auto detection can last a bit longer, usually around 10 seconds. Sudden changes in sound levels will lengthen the time of calibration and will result in improper sound level values.

- **Notify master:** Notifies the master (MCU or PC) when the voice command is recognized by sending a 16-bit index number of voice command via chosen communication interface (UART or USB).

- **Data rate:** Sets the speed used for sending data to the master (MCU or PC).

Pin Aliases And Initial Pin States

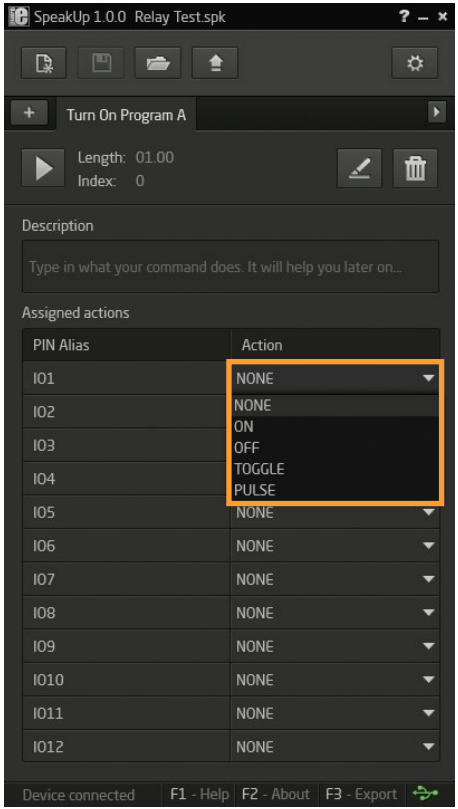
In this section, you can rename GPIO pins according to your needs and set their starting conditions. The new GPIO pin aliases will be applied in the main window too. Set the corresponding initial GPIO pin state in the **Initial Pin States** section. Condition can be either low (logical 0) or high (logical 1).

8.6. Assigning An Action

When a new command is recorded, it is time to assign it an action. The action will be performed when the voice command is recognized. Also, a 16-bit index number of the voice command will be sent via chosen communication interface (UART or USB) .

There are five types of action that can be assigned :

- **NONE:** When this option is selected, no action will be performed on the corresponding GPIO pin upon voice command matching.
- **ON:** When this option is selected, a corresponding GPIO pin will be set to logical high state upon voice command matching.
- **OFF:** When this option is selected, a corresponding GPIO pin will be set to logical low state upon voice command matching.
- **TOGGLE:** When this option is selected, a corresponding GPIO pin state will be toggled upon voice command matching.
- **PULSE:** When this option is selected, a train of pulses will be sent to the corresponding GPIO pin upon voice command matching.

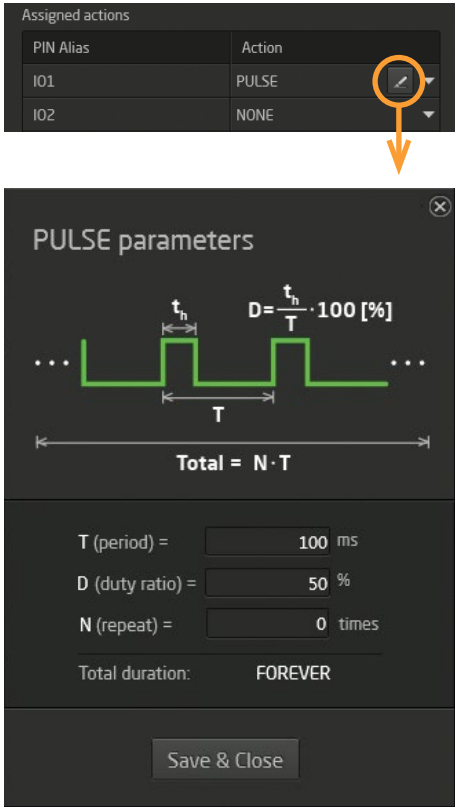


Pulse parameters

The pulse parameters can be set in the Pulse Parameters window (click on the Edit pulse parameters icon Edit pulse parameters to open it) :

- **A period (T)** is the time it takes for a signal to complete a single cycle (sum of the high state and low state time periods).
- **Duty ratio (D)** is the percentage of T in which a signal is active, i.e. ratio of the high state period and a complete period.
- **N** is the number of times the pulse is repeated.

Thus, a 60% duty cycle means the signal is ON 60% of the time period but OFF 40% of the time period.

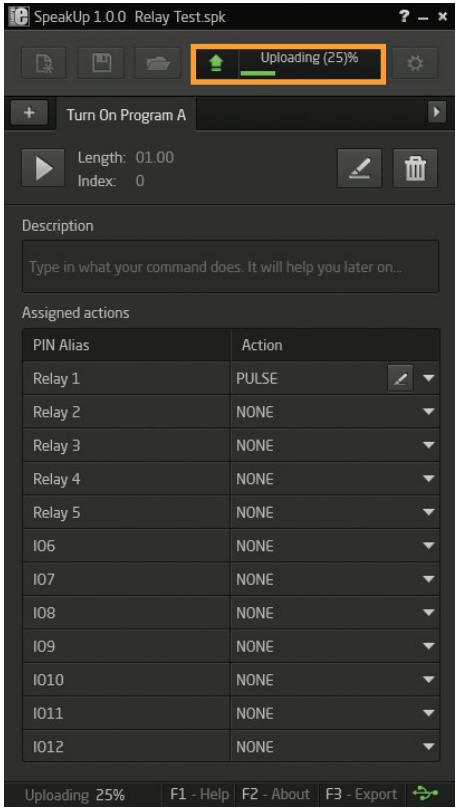


8.7. Uploading Project

When you're finished recording and configuring voice commands, it is time to upload the project to the SpeakUp click™ board. This is done via the **Upload Project** button.

You can monitor the upload process in the Toolbar.

After it's done, an appropriate message will be displayed in the Status Bar.



8.8. Exporting Constants

Each recorded voice command is given an index number which is sent to the host MCU. You can export voice command names and their indexes as constants. The exported document will be in the form of a source file (in any of the three languages), as shown below.

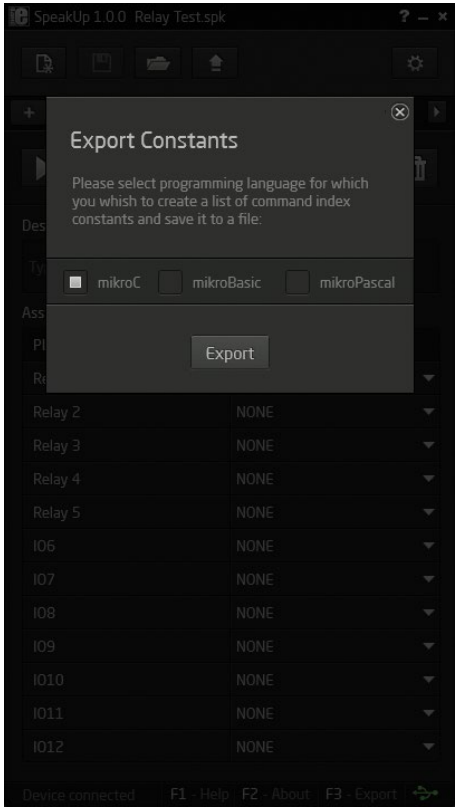
mikroC | mikroBasic | mikroPascal

```
/*
  This file is generated by SpeakUp Software.
  It containts voice commands constants.
  Creation date: 4/3/2014  Creation time: 11:20:09 AM
  Name: Turn ON Program A  Index: 0  Length: 0.0 s
  Description: Turns on Program A
*/

const VCMD_TURN_ON_PROGRAM_A = 0;

/*
  Name: Turn ON program B  Index: 1  Length: 0.0 s
  Description: Turns on Program A
*/

const VCMD_TURN_ON_PROGRAM_B = 1;
```



9. Direct Configuration

You can perform some basic configuration directly on the SpeakUp without using the software. Different combinations of button presses will allow you to record, re-record or erase commands. You'll get feedback from the on-board LEDs. However you won't be able to assign specific actions with this method.

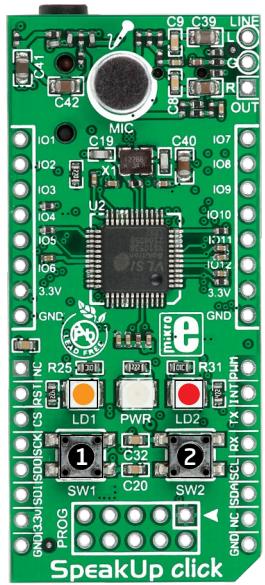
On-board push-buttons

Use push-buttons to operate the board:

❶ **Push-button 1** - To record your voice command, press and hold the button while speaking. You must stay within the time limit for each command (default settings: 1 second). You can also record multiple commands at once by pronouncing them one by one while keeping the button pressed. Just make sure to wait for the red LED to flash between pronouncing subsequent commands. Proceed in this way for as many commands as you need. Each command will be assigned a unique index.

❷ **Push-button 2** - If you press it for more than 2 seconds, all recorded voice commands will be erased.

❶ ❷ **If both push-buttons** are pressed for more than 2 seconds, the SpeakUp click board will reset.



On-board LEDs

Two indicator LEDs provide the following signals:

Amber LED - the board is ready for recording or listening.

Red LED - the board is perfoming an operation.

When the voice command is recognized, both LEDs are lit for a half a second.

Standalone mode default settings:

Acceptance Threshold: 15
Recording Timeout: 5s
Word Length: 1s
Noise Level: Auto
Notify Master: USB

10. Recording Tips

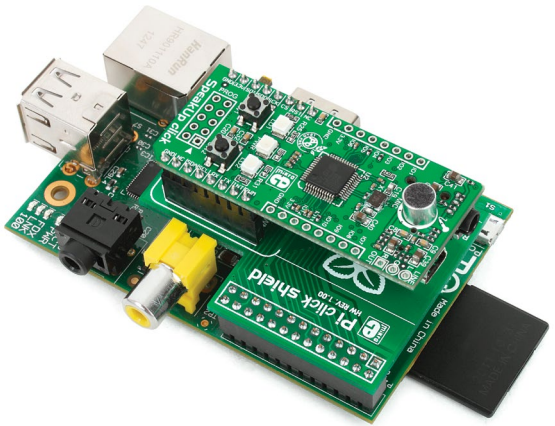
Here are some general recording Tips :

- For better recording results, it is necessary to provide conditions with lowest amounts of ambient noise and speaker distance from the microphone in the range from 10 to 20cm.
- If there are problems with the voice command detection, please record it several times due to the pronounciation diversity.
- It is **mandatory** to play back the recorded voice command in order to hear if some ambient noise was recorded also.
- Because of this, it is recommended that the SpeakUp click™ board is placed on a surface that doesn't transfer mechanical vibrations.
- **This is a speaker dependent system.** If there are more users, each person should record voice commands separately, due to the pronounciation diversity.
- Number of voice commands that can be recorded depend on their lengths, typically more than 200 for the voice command length of 1 second.
- Please keep in mind that the recording is performed by the SpeakUp click™ board, not the computer, so there is no need to connect an external microphone to the computer.

11. Examples

SpeakUp has a world of applications. It's up to your imagination to come up with the coolest ideas. Here's a hint or two:

Use SpeakUp on top of the Pi click Shield to command XBMC Home Media Center on Raspberry Pi®. It's a great a replacement for a mouse and a keyboard.



Replace your lamp switch with a SpeakUp click and a relay. Tell your light to turn ON or OFF if your hands are busy doing something important.

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