UM2257
User manual

Getting started with the STEVAL-BLUEMIC-1 evaluation board, ultra-low power wireless microphone based on SPBTLE-1S module

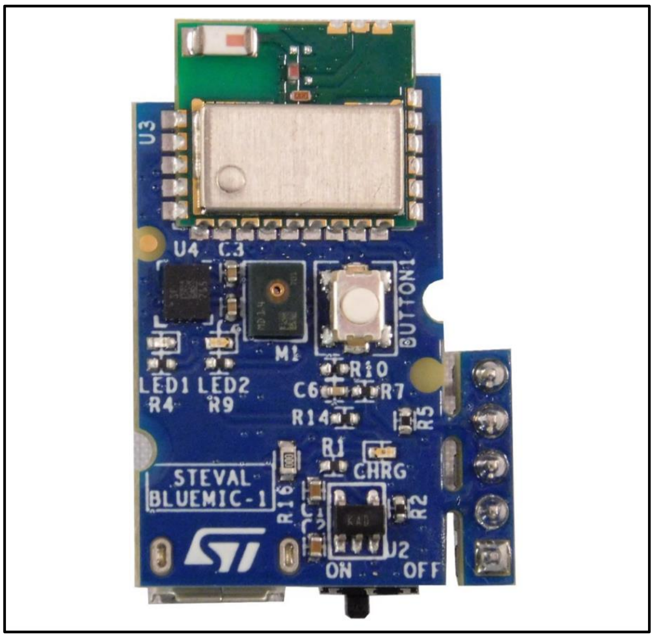
Introduction

The STEVAL-BLUEMIC-1 evaluation board mounts the SPBTLE-1S Bluetooth® SMART application processor compliant with BT specification v4.2. It supports multiple simultaneous roles and can act as a Bluetooth Smart master and slave device at the same time.

This BLE wireless battery powered solution also embeds digital MEMS microphone MP34DT04-C1 and 3D accelerometer + 3D gyroscope, which render this evaluation board suitable for a wide range of advanced smart application.

The evaluation board comes with a complete SW development kit that includes the Bluetooth low energy stack, all the needed drivers for audio and inertial data acquisition, and button and LED management. A ready-to-use BlueVoice library is included as middleware and a sample application is provided to get you started with voice streaming over BLE to an Android or iOS device, running the ST BlueMS apps.

Figure 1: STEVAL-BLUEMIC-1 evaluation board



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1.1 Hardware description

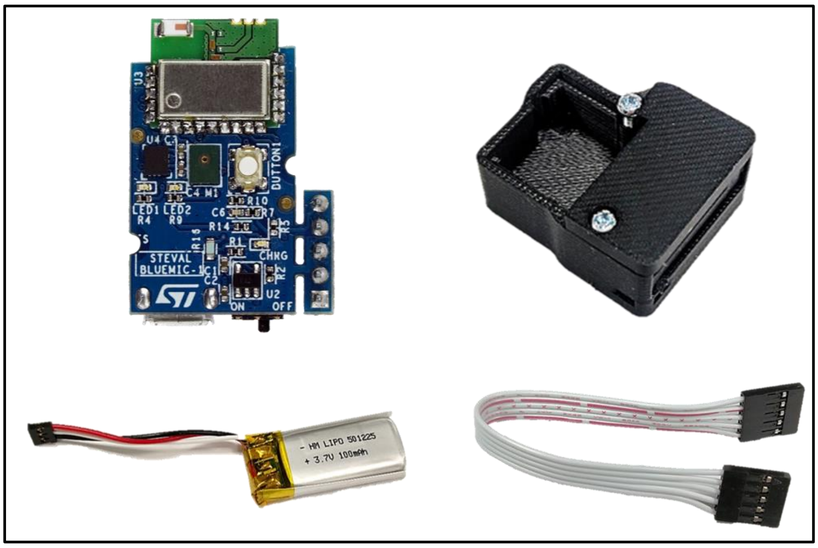
1.1.1 Features

- Bluetooth® SMART small form factor board based on the SPBTLE-1S module, Bluetooth v4.2 compliant
- On-board SPBTLE-1S module, based on BlueNRG-1, Bluetooth low energy application processor system on chip embedding an high performance:
  - ultra-low power ARM® Cortex®-M0 32-bit core architecture
  - Programmable embedded 160 KB Flash
  - 24 KB embedded RAM with data retention
- On-board MP34DT04-C1 digital MEMS microphone
- On-board LSM6DSL: MEMS 3D accelerometer (±2 / ±4 / ±8 / ±16 g) + 3D gyroscope (±125 / ±245 / ±500 / ±1000 / ±2000 dps)
- Voltage supply: 1V8 or 3V3
- Battery or USB powered
- On-board STBC08 linear Li-Ion battery charger
- SWD connector
- Included in the development kit package:
  - STEVAL-BLUEMIC-1
  - Plastic box for housing STEVAL-BLUEMIC-1
  - 100 mAh Li-Ion battery
  - SWD programming cable
- SW development kit for audio and inertial MEMS data streaming over BLE
- ST BlueMS: Android and iOS demo App available in the respective stores

1.1.2 Evaluation kit

The STEVAL-BLUEMIC-1 evaluation kit helps you to start prototyping a very low power solution to stream audio and inertial data over BLE, exploiting the single-mode system-on-chip BlueNRG-1.

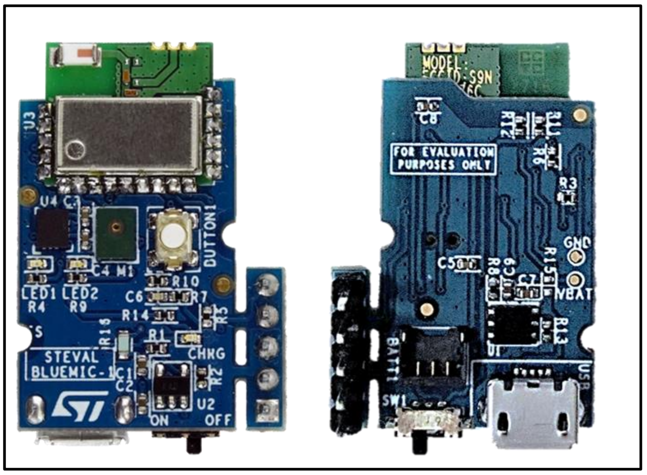
Figure 2: STEVAL-BLUEMIC-1 evaluation kit



The evaluation kit contains:

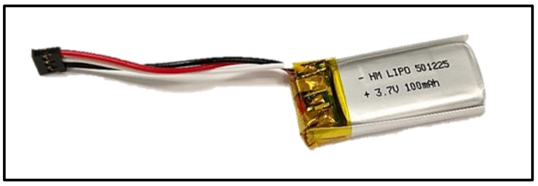
- an STEVAL-BLUEMIC-1 evaluation board

Figure 3: STEVAL-BLUEMIC-1 evaluation board: top and bottom



- a 100 mAh LiPO battery to be connected to the evaluation board as power supply

Figure 4: Battery

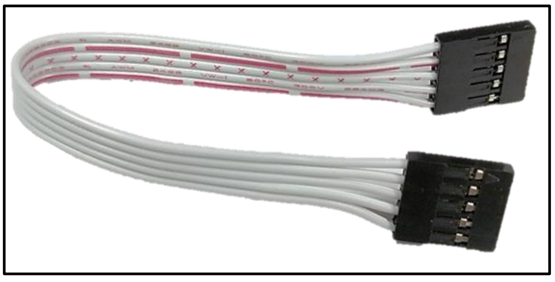


- a plastic case to house the evaluation board connected to the battery

Figure 5: Plastic case

- an ST-LINK SWD programming cable to program the evaluation board connected to ST-LINK

Figure 6: SWD cable



1.1.3 Evaluation board

The STEVAL-BLUEMIC-1 evaluation board is a highly integrated reference design that enables a fast prototyping of very low power solutions for audio and inertial streaming.

Figure 7: STEVAL-BLUEMIC-1 evaluation board hardware architecture

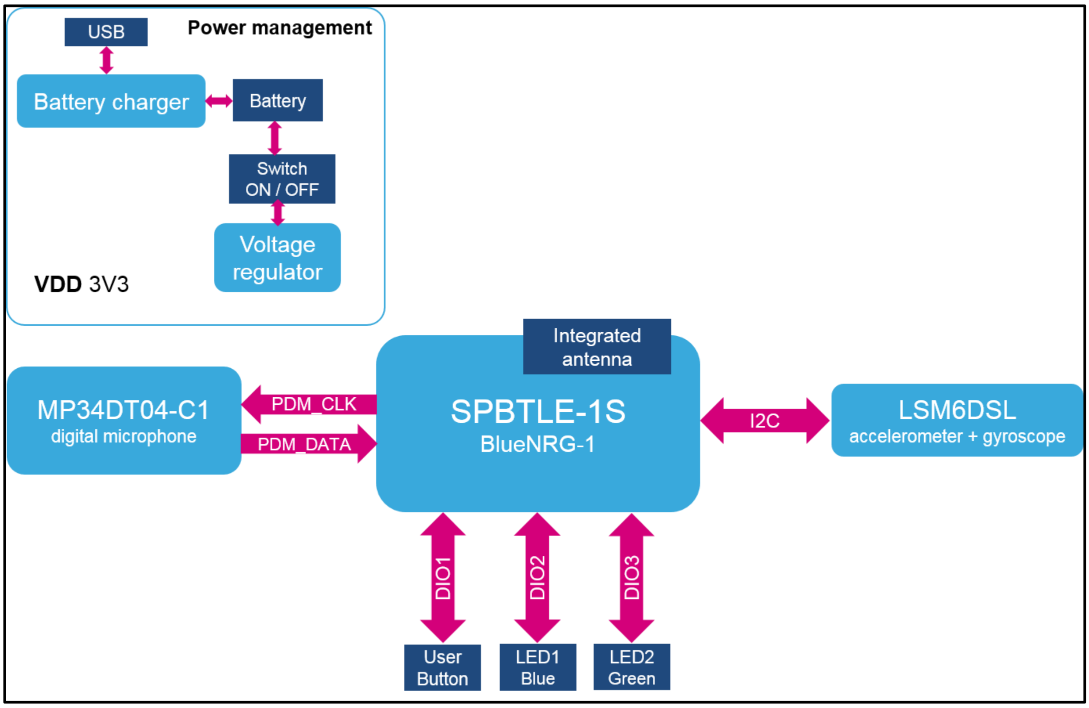


Figure 8: STEVAL-BLUEMIC-1 evaluation board main components

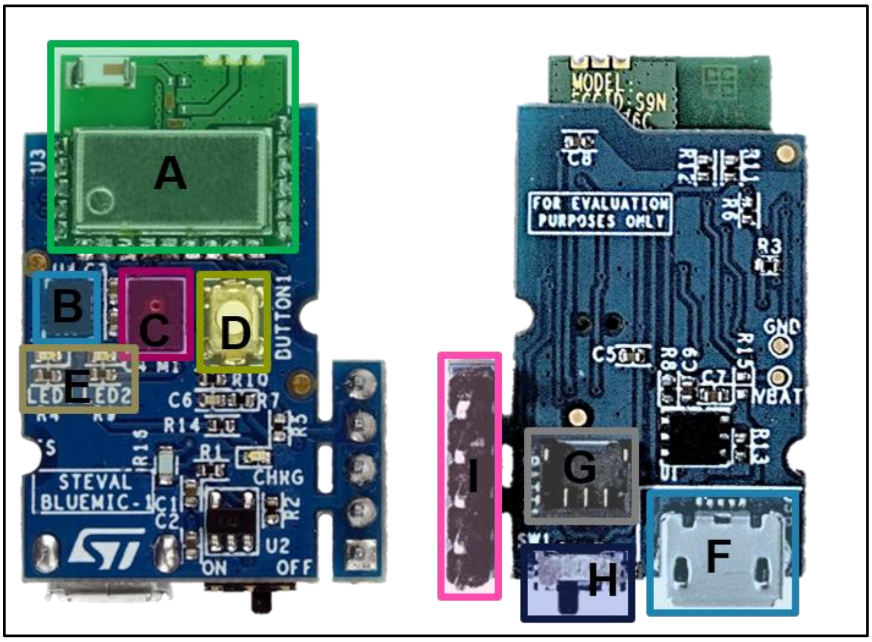


Table 1: STEVAL-BLUEMIC-1 evaluation board main component details

Reference	Device	Description
A	SPBTLE-1S	Bluetooth Low Energy application processor compliant with BT specification v4.2, based on BlueNRG-1 system-on-chip
B	LSM6DSL	iNEMO inertial module: low-power 3D accelerometer and 3D gyroscope
C	MP34DT04-C1	MEMS audio sensor digital microphone
D	Button	User button
E	LED	A blue LED and a green LED for visual feedback
F	USB	Micro USB connector for power supply and battery charging
G	Battery connector	Connector to plug the LiPO battery contained in the kit
H	Switch	ON-OFF switch to power the board
I	SWD connector	5-pin SWD connector for programming and debugging

1.1.4 Schematic diagrams

Figure 9: Power and SPBTLE-1S module

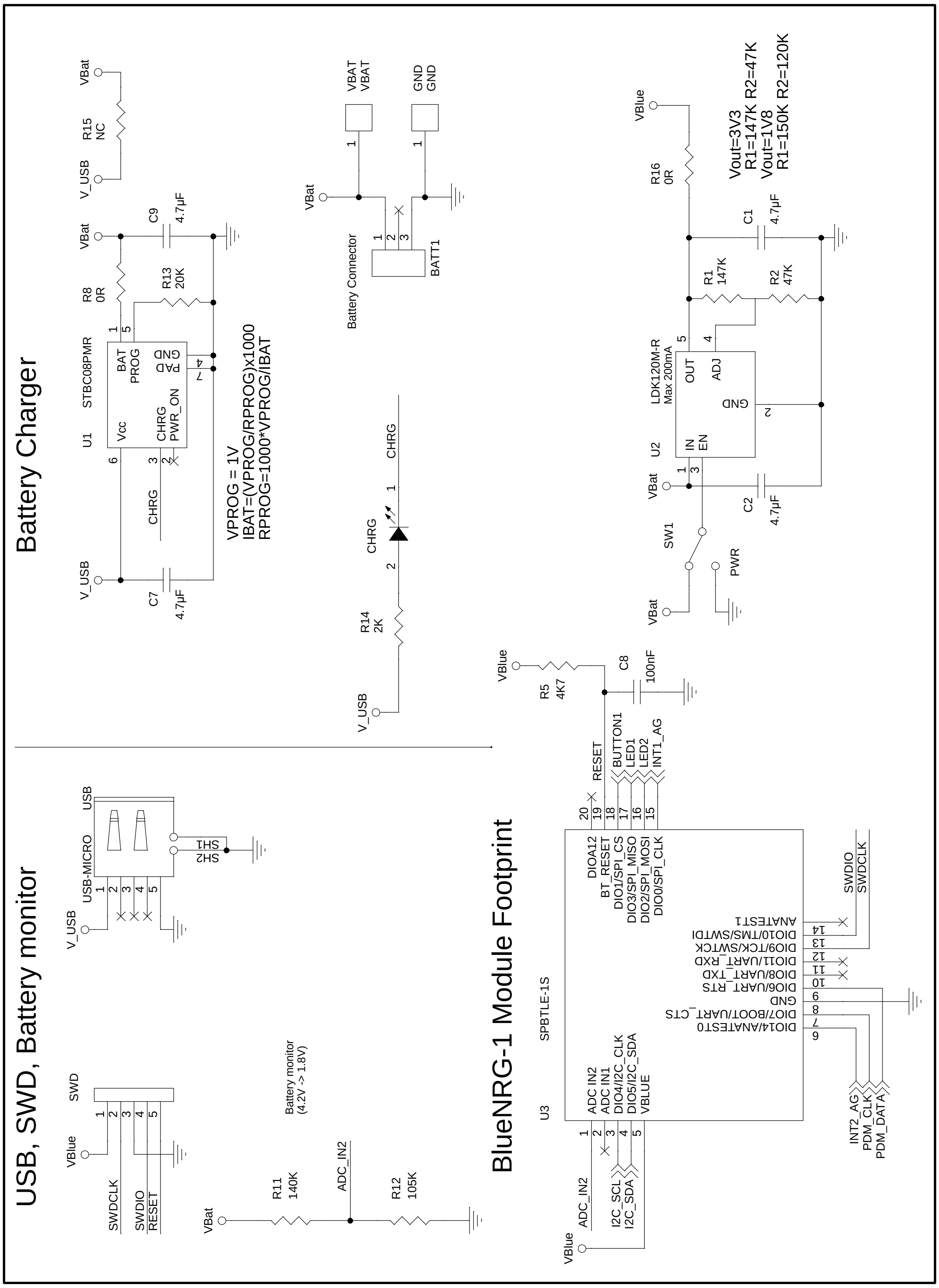
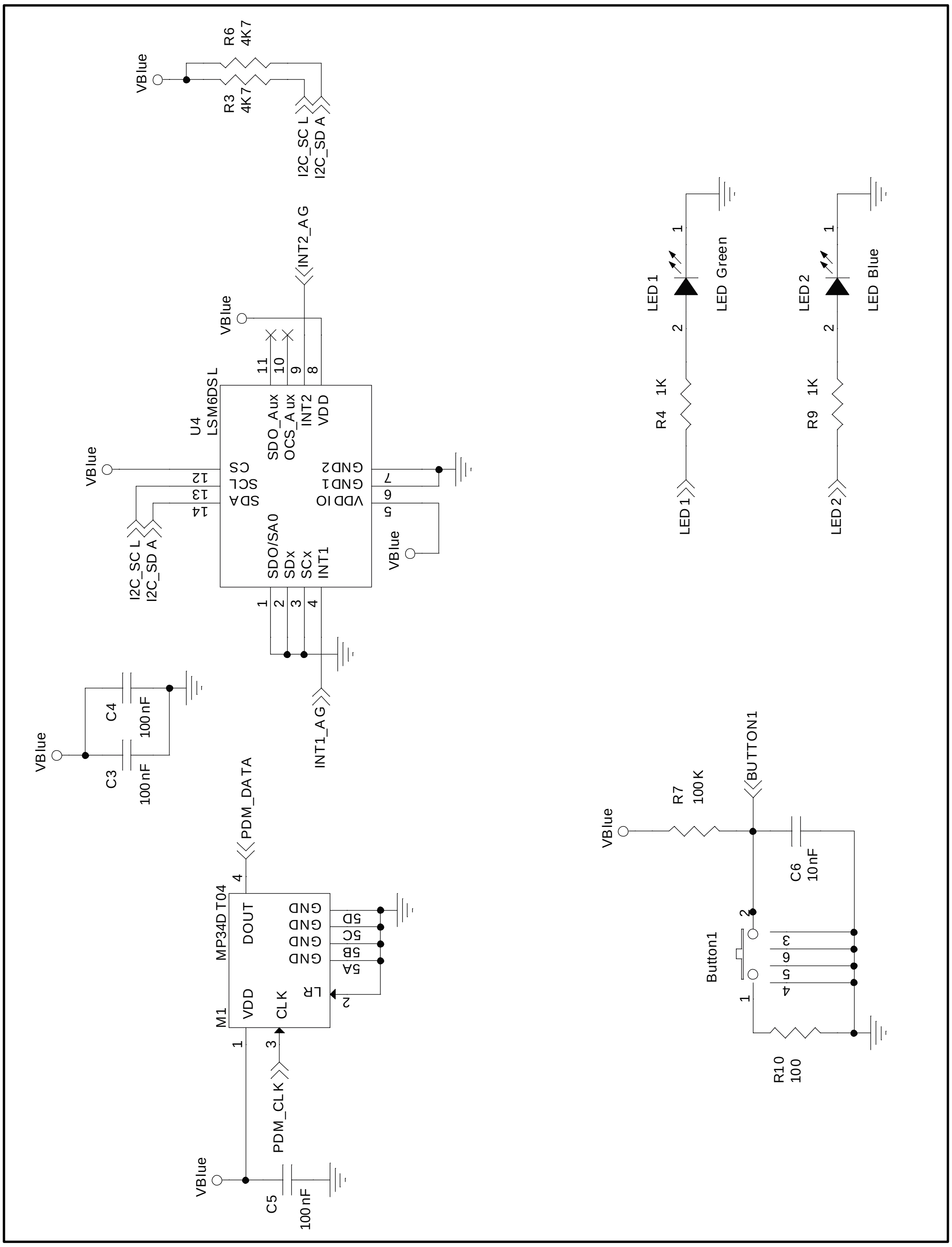


Figure 10: MEMS, button and LEDs



1.2 Software description

1.2.1 Overview

The STSW-BLUEMIC-1 is an evaluation software package that allows development of smart and innovative solution using the SPBTLE-1S module.

The software package includes the entire Bluetooth® low energy stack and protocols, complaint with the STSW-BLUENRG1-DK. It also contains a Board Support Package that offers a complete set of APIs for digital MEMS microphone, 3-axis accelerometer and gyroscope, button and LED management.

The latter is based on BlueNRG-1, a very low power Bluetooth low energy single mode system-on-chip embedding a high performance, ultra-low power 32-bit ARM® Cortex®-M0, with 160 kB of Flash memory and 24 kB of RAM.

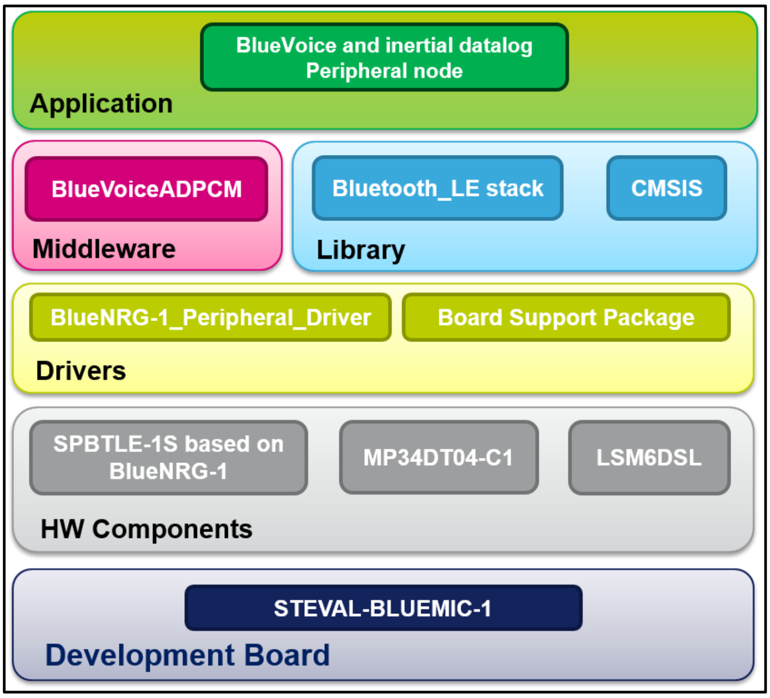
The BlueVoiceADPCM_BNRG1 binary library (available as middleware) provides a vendor specific profile for voice streaming over Bluetooth® low energy; it includes all APIs needed for audio compression using the ITU-T G.726 ADPCM standard, packetization and streaming.

The STSW-BLUEMIC-1 allows an STEVAL-BLUEMIC-1 evaluation board to act as a peripheral in a point-to-point connection with a mobile device running the ST BlueMS app, available for Android™ and iOS™. In this configuration, the evaluation board streams the audio acquired from the on-board digital MEMS microphone (MP34DT04-C1) or motion data acquired from the 3-axis accelerometer and gyroscope (LSM6DSL).

1.2.2 Architecture

The STSW-BLUEMIC-1 software is organized in different layers.

Figure 11: STSW-BLUEMIC-1 software architecture



The application layer manages the complete software chain from the audio and inertial data acquisition to the streaming.

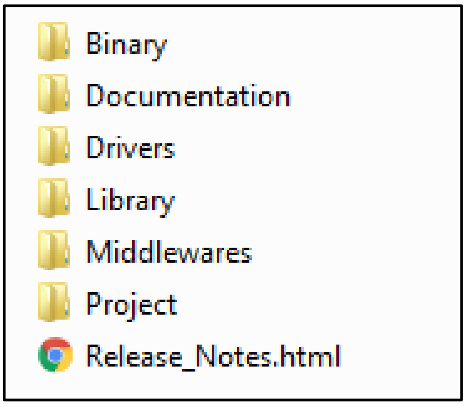
A complete set of drivers is available to interact with the on-board sensors and to manage the BlueNRG-1 peripheral.

A middleware layer, between the application and the hardware abstraction layer, includes:

- the Bluetooth® Low Energy stack library that allows communication between the central and the peripheral device;
- the BlueVoiceADPCM_BNRG1 library that provides all the APIs needed to implement a voice-over-Bluetooth® Low Energy profile.

1.2.3 Folder structure

Figure 12: STSW-BLUEMIC-1 folder structure



The following folders are included in the software package:

- **Binary**: contains ready-to-use firmware binary to be flashed on the STEVAL-BLUEMIC-1 evaluation board
- **Documentation**: contains a compiled HTML file generated from the source code detailing the software components and APIs
- **Drivers**: contains the board specific drivers including the on-board components
- **Library**: contains the Bluetooth low energy stack binary library, the CMSIS vendor-independent hardware abstraction layer for the ARM®Cortex®-M processor series, and BlueNRG-1 peripheral drivers
- **Middlewares**: contains the BlueVoice over BlueNRG-1 library
- **Projects**: contains demo applications for voice transmission over Bluetooth Low Energy. The projects support IAR Embedded Workbench for ARM, RealView Microcontroller Development Kit (MDK-ARM) and Atollic-True Studio for ARM development environments

1.2.4 APIs

Fully detailed user-API function and parameter descriptions are compiled in an HTML file located in the software **Documentation** folder.

1.2.5 BlueMic1 application

The BlueMic1 application has been designed and built on the Bluetooth low energy architecture.

1.2.5.1 BlueMic1 profile description

The BlueMic1 application deploys a connection-based communication paradigm by providing a permanent point-to-point link between two devices, one acting as peripheral and one as central (Generic Access Profile or GAP).

The STEVAL-BLUEMIC-1 evaluation board acts as a peripheral device supporting a single connection and low complexity. This device only requires a controller that supports the slave role.

The central module can be an Android™ and iOS™ device running the ST BlueMS app (v3.0.0 or higher) or a FP-AUD-BVLINK1 receiver node.

The central and peripheral role assignment reflects the asymmetric design concept of Bluetooth Low Energy, where the device with a lower energy source works less: a slave cannot initiate complex procedures, whereas a master manages communication timing, adaptive frequency hopping, encryption setup, etc. A portable device provided with a coin-size battery is usually suitable as slave device.

Data sent through a Bluetooth Low Energy connection is organized through an additional protocol layer, the Generic Attribute Profile (GATT). It provides standard profiles to ensure interoperability between devices from different vendors that implement features like Proximity Profile, Glucose Profile and Health Thermometer Profile. The Bluetooth specification also lets you add custom profiles.

GATT defines client and server roles for interacting devices independent of the GAP master/central and slave/peripheral roles:

- **Client** performs service discovery about the presence and nature of server attributes; it sends requests to a server and accepts responses and server-initiated updates.
- **Server** accepts requests, commands and confirmations from a client and sends responses and server-initiated updates; it arranges and stores data according to the attribute (ATT) protocol.

In a mono-directional audio streaming asymmetric system, the device with voice data is the one with a microphone and is therefore considered the server. The client device sends requests to the server and accepts server-initiated updates containing audio data.

Audio data transmission is based on periodic server-to-client notifications which do not require a request or response from the receiving device. Server-initiated updates are sent as asynchronous notification packets which include the handle of a characteristic along with its current value.

According to the Bluetooth specification, the peripheral enters advertising mode at start-up and sends advertisement packets at relatively long intervals. The central unit enters discovery mode and sends a connection request on reception of an advertisement packet from a slave device. After connection, notifications carrying audio data are periodically sent from the server to the client.

1.2.5.2 BlueMic1 service

The Attribute Protocol (ATT) is used by GATT as a transport protocol for exchanging data between devices. The smallest entities defined by ATT (named attributes) are addressable pieces of information that may contain user data or meta-information on the attribute architecture, stored in the server and exchanged between client and server.

GATT server attributes are organized as a sequence of services, each one starting with a service declaration attribute marking its beginning. Each service groups one or more characteristics and each characteristic can include zero or more descriptors.

Since audio streaming is not part of the predefined set of profiles, the STSW-BLUEMIC-1 application defines a vendor-specific service named **BlueMic1 Service** based on an **Audio** characteristic to expose actual compressed audio data and a **Sync** characteristic to expose collateral information to implement a synchronization mechanism and an inertial characteristic to expose 3-axis accelerometer and gyroscope raw data.

Table 2: BlueMic1 UUID summary table

UUID name	UUID
bluemic1_service_uuid	00000000-0001-11e1-9ab4-0002a5d5c51b
audio_adpcm_char_uuid	08000000-0001-11e1-ac36-0002a5d5c51b
audio_adpcm_sync_char_uuid	40000000-0001-11e1-ac36-0002a5d5c51b
acc_gyr_char_uuid	00E00000-0001-11e1-ac36-0002a5d5c51b

Given the service hierarchical architecture, further characteristics may be added to the BlueMic1 service, such as configuration of parameters like volume, enabling/disabling of processing algorithms, etc.

1.2.6 Audio processing

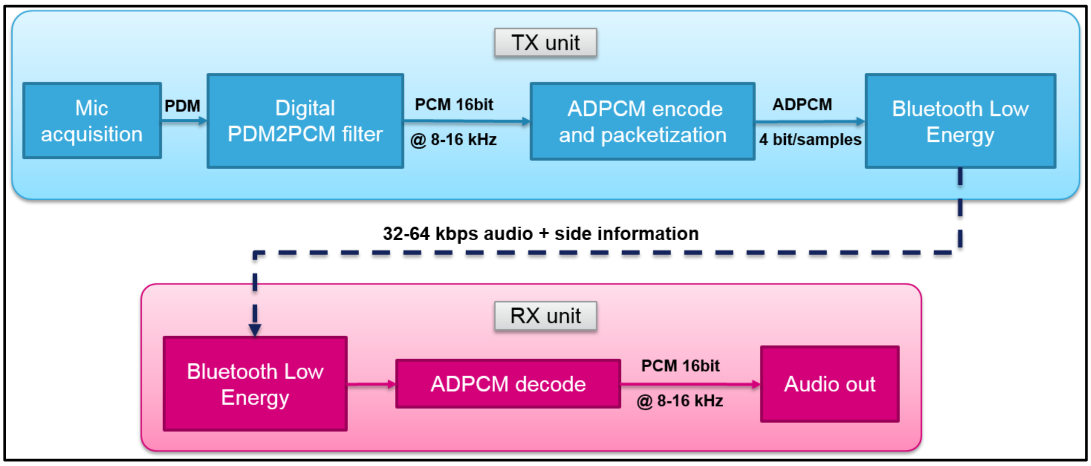
The audio processing component of the STSW-BLUEMIC-1 application is designed to achieve an audio sampling frequency of 8 or 16 kHz at the receiver side, with a trade-off between audio quality and bandwidth occupation for voice signals. The audio signal transmitted is compressed via ADPCM (adaptive differential pulse code modulation) to fit in the available data rate while minimizing radio transmission time and power consumption.

The figure below shows the speech processing chain in a complete communication system with Tx and Rx.

On the Tx side, the library receives an audio signal which is typically acquired by a digital MEMS microphone as a 1-bit PDM signal and converted by a PDM to PCM conversion filter, integrated in the ADC peripheral of the BlueNRG-1 SoC, into 16-bit PCM samples at 8 or 16 kHz.

The library can be provided with 1, 2, 5 or 10 ms of audio data. When the compressed output buffer is ready, a flag is set and audio data is streamed via Bluetooth Low Energy together with collateral ADPCM information. The resulting communication bandwidth is 32 kbps (with 8 kHz audio sampling frequency) or 64 kbps (with 16 kHz audio sampling frequency) of audio data plus 300 bps of collateral information.

Figure 13: STSW-BLUEMIC-1 audio processing chain



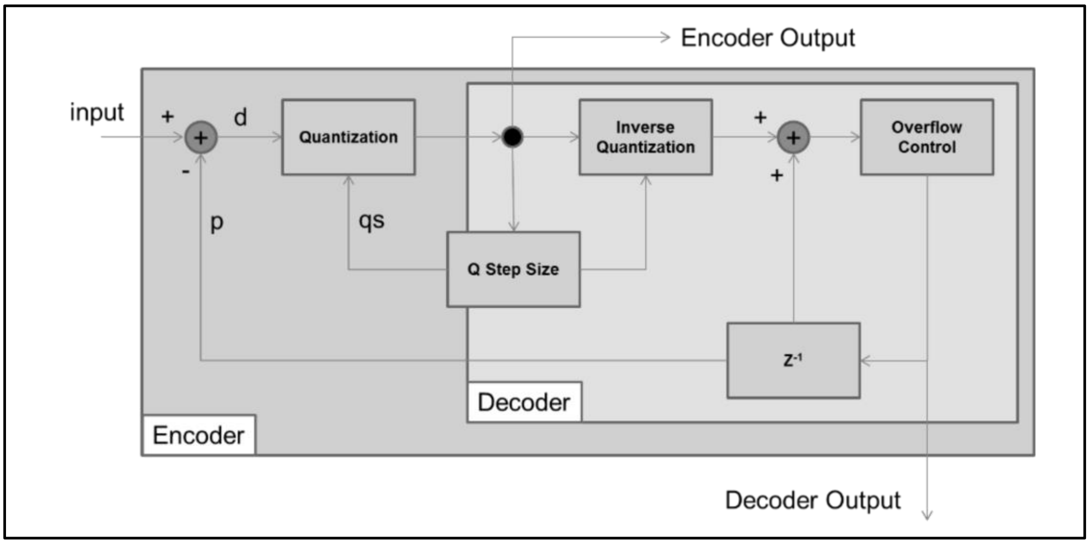
1.2.7 ADPCM compression

The ITU-T G.726 adaptive differential pulse code modulation (ADPCM) standard is applied to save bandwidth. This audio algorithm for lossy waveform coding predicts the current signal value from previous values, and transmits the difference between the real and the predicted value, quantized with an adaptive quantization step.

The ADPCM algorithm used in this application compresses digital voice signals encoded as:

- Audio format: PCM
- Audio sample size: 16 bits
- Channels: 1 (mono)
- Audio sample rate: 8-16 kHz

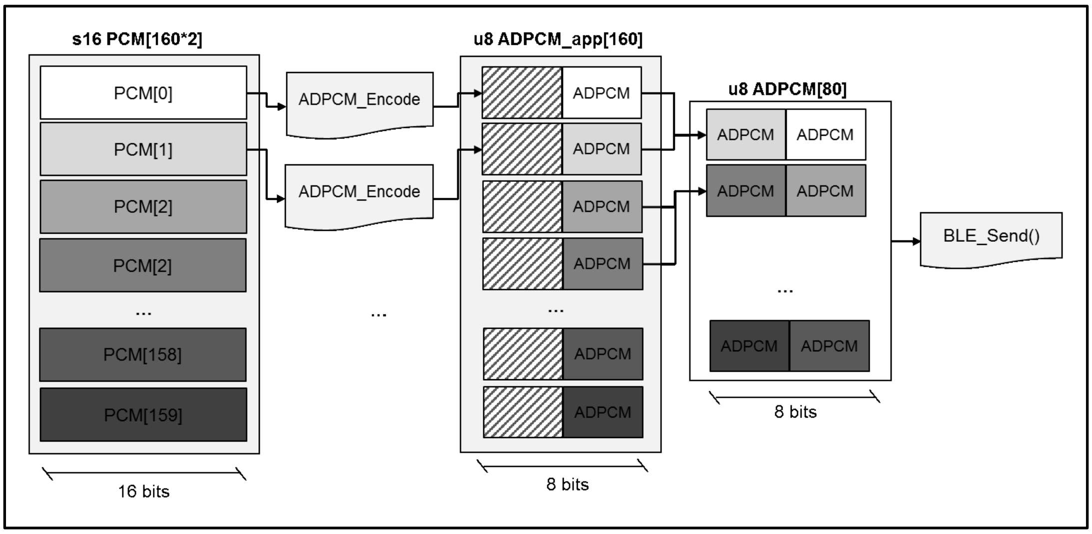
Figure 14: ADPCM encode-decode schema



BlueVoiceADPCM implements a modified version of the compression algorithm with improved communication robustness through an additional low data rate channel with collateral information added to the ADPCM quantized values; slightly increasing the overall bit-rate to an average 64.3 Kbps.

The internal buffering required by ADPCM compression is shown in the figure below. 16-bit input PCM samples are encoded in 8-bit temporary samples with 4-bit actual data (u8 ADPCM_app buffer) and then encapsulated in 8-bit samples containing information of two PCM samples (u8 ADPCM buffer).

Figure 15: ADPCM packet mechanism



ADCPM decoding on the Rx side is performed in a symmetric fashion.

1.2.8 Packetization

The Tx data rate for streaming data is obtained from:

- the connection interval
- the number of packets per connection interval and user data payload for each packet

The STSW-BLUEMIC-1 application implements:

- a constant bitrate allocated to audio data through the chosen ADPCM compression
- a small connection interval to minimize the overall audio latency

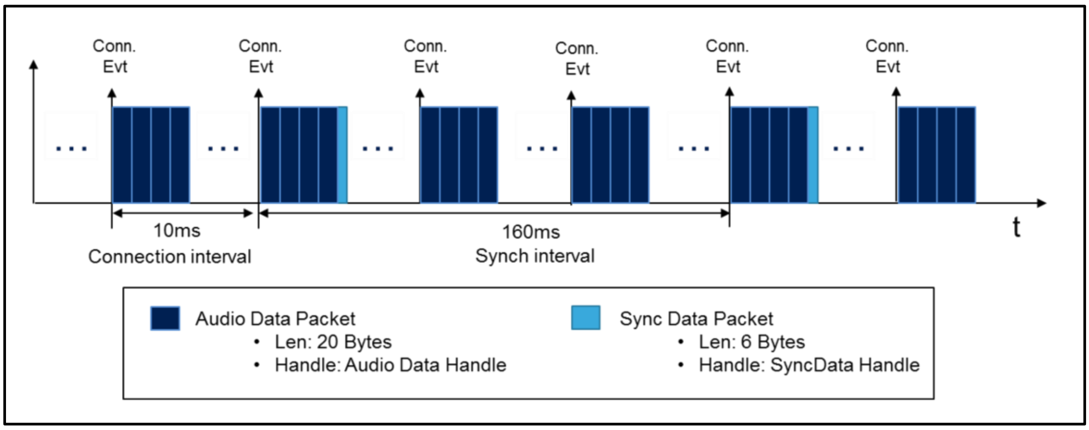
The following connection intervals are set for Android™ and iOS™ compliance:

- conn_min_int=10 ms
- conn_max_int=21.25 ms

If the streaming is performed between two ST modules, the selected connection interval is the minimum value (10 ms). The target 64 kbps constant data rate is achieved by sending 80 bytes of ADPCM data (640 bits) at each connection event. Consistent with maxPayload = 20 bytes per packet (160 bit), four packets (two if an audio sampling frequency of 8 kHz is set) of 20 bytes are sent per average connection event. In addition, ADPCM collateral information is sent at a lower frequency via an additional smaller packet sent at regular intervals.

The following figure shows a 16 kHz compressed audio streaming example, where four data packets of 20 bytes are sent at each connection interval of 10 ms, while ADPCM collateral information is sent as an additional packet once every 160 ms.

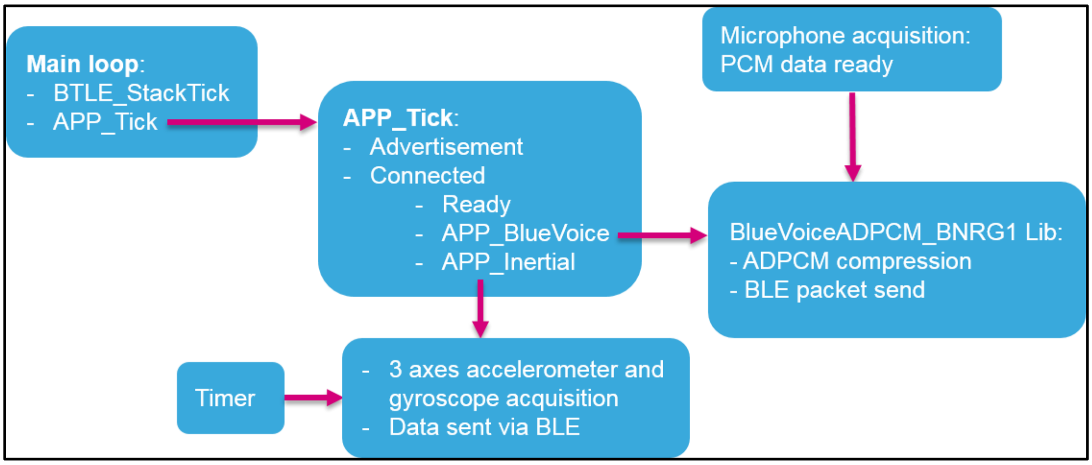
Figure 16: BLE packets for 16 Hz audio



1.2.9 STSW-BLUEMIC-1 application description

The STSW-BLUEMIC-1 software package is a complete example of audio and inertial data streaming over Bluetooth® Low Energy to an Android™ and iOS™ mobile device running the ST BlueMS app or to an STM32 platform.

Figure 17: STSW-BLUEMIC-1 software package architecture



The main loop continuously calls the `BTLE_StackTick` function needed for the RF management and the `APP_Tick` that contains all the functions implemented by the user.

As soon as the application starts, the `APP_STATUS_ADVERTISEMENT` state is set, BlueNRG-1 acts as a peripheral and sends advertisement messages until a central node requests a connection.

When the connection is estabilished, the app status is set to `APP_STATUS_CONNECTED` and two different demos can be activated from the ST BlueMS app running on the central node.

If BlueVoice is enabled (firmware status set to `APP_BLUEVOICE_ENABLED`) audio acquisition from the on-board digital microphone starts and drives the voice streaming. PCM samples are compressed and sent.

The audio streaming can be stopped or restarted by pressing the STEVAL-BLUEMIC-1 evaluation board button.

The user can switch to the inertial demo (firmware status set to `APP_INERTIAL_ENABLE`) via the BlueMS app.

A timer is set and every 30 ms raw data are acquired from the 3-axis accelerometer and gyroscope and sent to the mobile device together with a timestamp increased by one every 10 ms.

1.3 BlueVoiceADPCM_BNRG1 library software description

1.3.1 Initialization and configuration

To initialize the library call the `BluevoiceADPCM_BNRG1_Initialize` API. Then, configure the library on the basis of the audio acquisition implemented in the application.

A configuration structure must be filled by setting the audio sampling frequency (FR_8000 or FR_16000), the total number of channels given as the input to the library and which channel (between 1 and channel_tot) is used for the voice streaming:

```
BV_ADPCM_BNRG1_Config_t BV_ADPCM_BNRG1_Config;
BV_ADPCM_BNRG1_Config.sampling_frequency = FR_8000;
BV_ADPCM_BNRG1_Config.channel_in = 1;
BV_ADPCM_BNRG1_Config.channel_tot = 1;
BluevoiceADPCM_BNRG1_SetConfig(&BV_ADPCM_BNRG1_Config);
```

If the return value is `BV_ADPCM_BNRG1_SUCCESS`, the library has been correctly configured.

The BlueVoiceADPCM_BNRG1 library can be reset by recalling `BluevoiceADPCM_BNRG1_SetConfig`.

The library includes three callbacks that must be called when the corresponding BlueNRG event occurs:

- `BluevoiceADPCM_BNRG1_ConnectionComplete_CB` sets the connection handle when an EVT_LE_CONN_COMPLETE event occurs;
- `BluevoiceADPCM_BNRG1_DisconnectionComplete_CB` resets internal parameters when an EVT_DISCONN_COMPLETE event occurs;
- `BluevoiceADPCM_BNRG1_AttributeModified_CB` sets the working mode according to the enable notification received when an EVT_BLUE_GATT_ATTRIBUTE_MODIFIED event occurs.

A timeout has been included for correct management of the BlueVoice profile status; when the module is no longer streaming or receiving, the profile status switches to `BV_ADPCM_BNRG1_STATUS_READY` as soon as the timer expires. The timeout duration (in ms) is defined by `BV_ADPCM_BNRG1_TIMEOUT_STATUS`.

To increase this timer, call the `BluevoiceADPCM_BNRG1_IncTick` function every 1 ms from the SysTick_Handler.

1.3.2 Working mode setup

The library working mode can be configured as NOT_READY (initial setting), TRANSMITTER, RECEIVER or HALF-DUPLEX.

The service and characteristics for the BlueVoice profile can be created by calling the `BluevoiceADPCM_BNRG1_AddService` and `BluevoiceADPCM_BNRG1_AddChar` functions.

Both APIs require the UUIDs (chosen by the user) as parameters and they return the relevant handle.

The handle of the service must be passed to the `BluevoiceADPCM_AddChar` API.

Alternately, BlueVoice characteristics can be added to a pre-existing service created in your own application by calling `BluevoiceADPCM_BNRG1_AddChar` and passing the handle of that particular service as a parameter.

If both the functions return `BV_ADPCM_BNRG1_SUCCESS`, the library is set to TRANSMITTER mode and can stream audio over Bluetooth Low Energy.

You can also create the characteristics out of the library and pass the relevant handles using a structure of the type `BV_ADPCM_BNRG1_ProfileHandle_t` to the `BluevoiceADPCM_BNRG1_SetTxHandle` API. In the latter case, the following characteristics must be created:

- related to the compressed audio data
  ```
  aci_gatt_add_char(ServiceHandle,
          UUID_TYPE_128, CharAudioUUID, 20,
          CHAR_PROP_NOTIFY, ATTR_PERMISSION_NONE,
          GATT_DONT_NOTIFY_EVENTS, 16, 1,
          CharAudioHandle);
  ```
- to send collateral information for synchronization mechanism implementation
  ```
  aci_gatt_add_char(ServiceHandle,
          UUID_TYPE_128, CharAudioSyncUUID, 6,
          CHAR_PROP_NOTIFY, ATTR_PERMISSION_NONE,
          GATT_DONT_NOTIFY_EVENTS, 16, 1,
          CharAudioSyncHandle);
  ```

You can choose to not create the BlueVoice Service and the module is not able to transmit audio.

This node can still function as a RECEIVER; however, if the connected module exports the BlueVoice profile; you must set the handle of the BlueVoice service and characteristics exported by the transmitter module through the `BluevoiceADPCM_BNRG1_SetRxHandle` API and enable notifications on the other node by calling the `BluevoiceADPCM_BNRG1_EnableNotification` function.

If both the TRANSMITTER and RECEIVER procedures are performed, the module acts as transmitter and receiver and the working mode is set to HALF-DUPLEX, creating a half-duplex link over Bluetooth Low Energy.

1.3.3 Audio signal injection

The BlueVoiceADPCM_BNRG1 library receives audio PCM input samples.

The `BluevoiceADPCM_BNRG1_AudioIn` function accepts parameters from a PCM buffer, containing all the acquired audio channels (`channel_tot` according to the previous library configuration) and the number of PCM samples (for each channel) given as input. An amount of data equal to 1, 2, 5 or 10 ms is accepted, otherwise an `BV_ADPCM_BNRG1_PCM_SAMPLES_ERR` is returned.

The library compresses received PCM input samples; when 10 ms of audio is compressed, the `BluevoiceADPCM_BNRG1_AudioIn` API returns `BV_ADPCM_BNRG1_OUT_BUF_READY`.

1.3.4 Compressed audio streaming

On the transmitter side, the BlueVoiceADPCM_BNRG1 library gathers compressed data in an internal double buffer. For every 10 ms of audio, the `BluevoiceADPCM_BNRG1_AudioIn` function returns `BV_ADPCM_BNRG1_OUT_BUF_READY` to signal output data can be send via Bluetooth Low Energy by calling the `BluevoiceADPCM_BNRG1_SendData` API.

If the audio sampling frequency is set to 8 kHz, two 20-byte packets are sent every 10 ms (according to the connection interval); if the frequency is 16 kHz, four 20-byte packets are sent.

On the receiver side, compressed audio is received from a notification through a EVT_BLUE_GATT_NOTIFICATION event and passed to the `BluevoiceADPCM_BNRG1_ParseData` function that decompresses the data and returns a PCM buffer. This API is used to parse both audio and collateral information data.

2 System setup

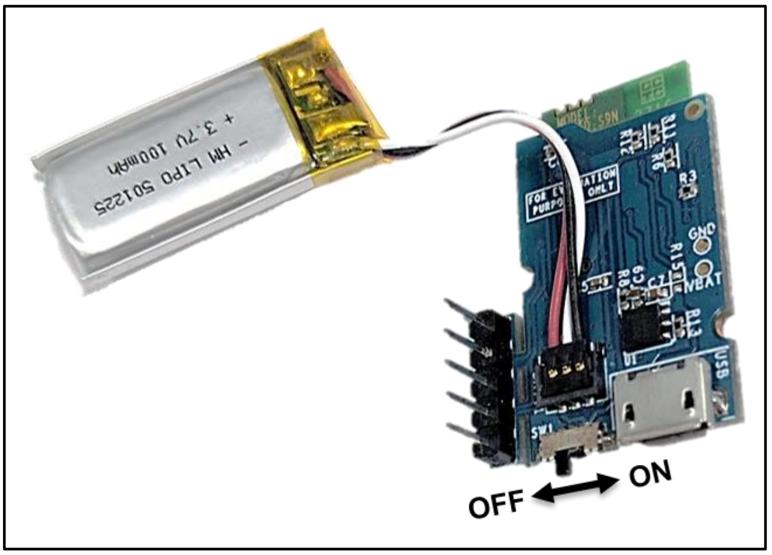
Two types of demos can be set up using an STEVAL-BLUEMIC-1 evaluation board:

1. unidirectional streaming of inertial data and audio at a sampling frequency of 8 kHz from the STEVAL-BLUEMIC-1 to an Android™ or iOS™ device running the ST BlueMS app (v3.0.0 or higher);
2. unidirectional audio streaming at a sampling frequency of 8 or 16 kHz from the STEVAL-BLUEMIC-1 to the receiver node of the FP-AUD-BVLINK1 application available on www.st.com.

2.1 Power supply

The main board power supply is the 100 mAh lithium-Ion polymer battery plugged to the connector on the PCB.

Figure 18: Battery connection and power switch



Use SW1 switch to power the STEVAL-BLUEMIC-1 evaluation board on or off.

The battery can be recharged via USB connected to a PC or any micro-USB battery charger. A red LED indicates the charging status:

- steady ON: the board is charging
- steady OFF: charge complete

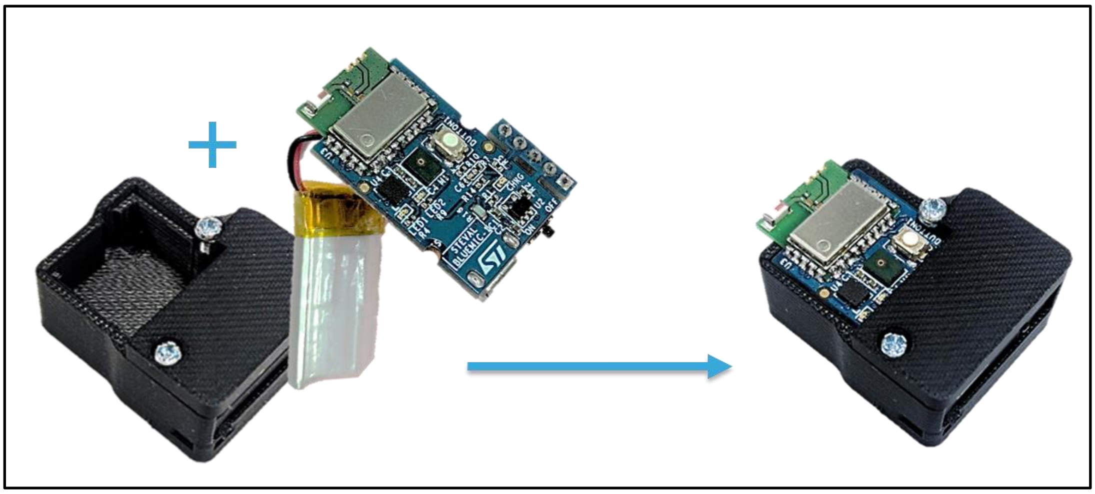
The on-board voltage regulator provides a 3.3 V power supply that can be changed to 1.8 V by replacing R1 and R2 according to the board schematic diagram (see *Section 1.1.4: "Schematic diagrams"*).

The STEVAL-BLUEMIC-1 can be powered using only the USB connector; the battery must be unplugged and the battery charger must be bypassed by removing R8 e by soldering the R15 0 Ohm resistor.

2.2 STEVAL-BLUEMIC-1 evaluation board assembly in form factor case

The STEVAL-BLUEMIC-1 evaluation board connected to the battery can be housed in the plastic box included in the evaluation kit as shown below.

Figure 19: STEVAL-BLUEMIC-1 evaluation board in plastic case



2.3 STEVAL-BLUEMIC-1 evaluation board programming interface

To program the board, connect an external ST-LINK to the SWD connector on the STEVAL-BLUEMIC-1 evaluation board; a 5-pin flat cable is provided in the evaluation kit.

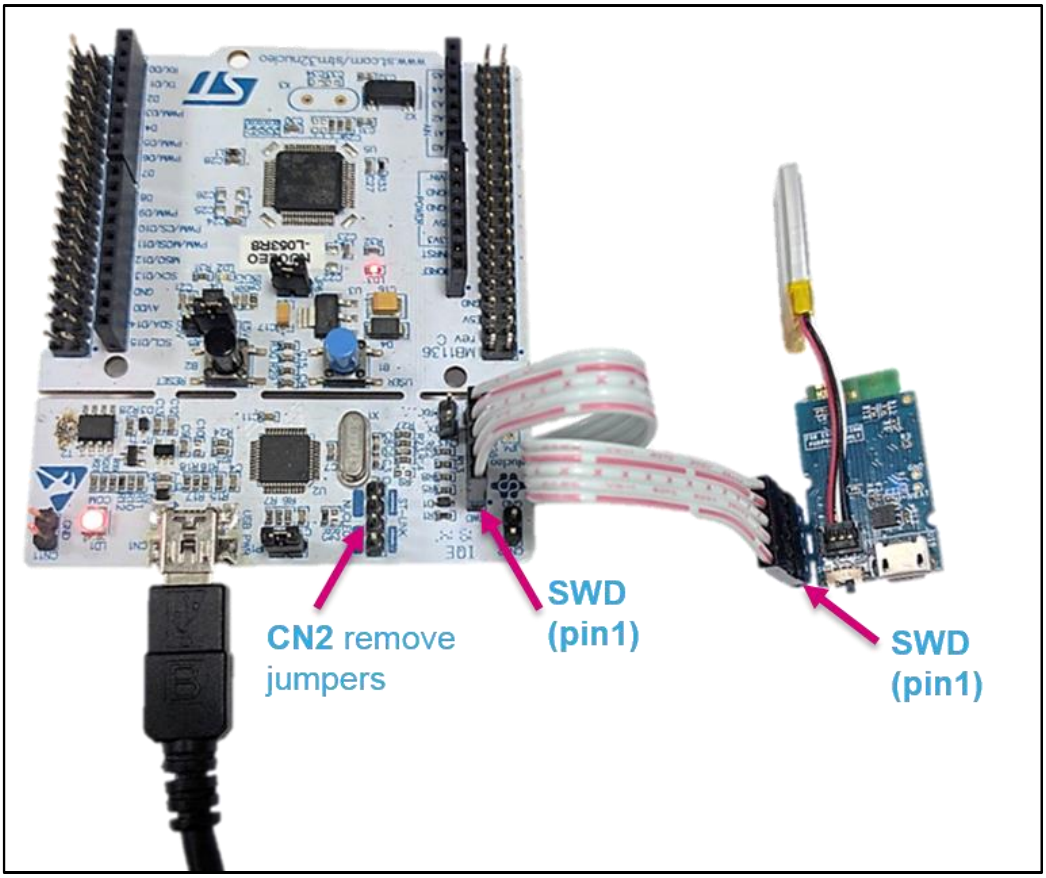
The easiest way to obtain an ST-LINK device is to get an STM32 Nucleo board, which bundles an ST-LINK V2.1 debugger and programmer.

1. Ensure that CN2 jumpers are OFF and connect your STM32 Nucleo board to the STEVAL-BLUEMIC-1 evaluation board via the cable provided, paying attention to the polarity of the connectors.

   Pin 1 is identified by:

   – a small dot on the PCB silkscreen on the STM32 Nucleo board
   – the square shape of the soldering pad on the STEVAL-BLUEMIC-1 evaluation board
2. Download from ST website the "BlueNRG-1 ST-LINK utility", a full-featured software interface to program the BlueNRG-1 microcontroller.
3. Follow the installation procedure
4. Program the STEVAL-BLUEMIC-1 evaluation board with the demo binary available in the software package.

Figure 20: STM32 Nucleo board and STEVAL-BLUEMIC-1 SWD connections with a 5-pin flat cable



2.4 STEVAL-BLUEMIC-1 evaluation board demos

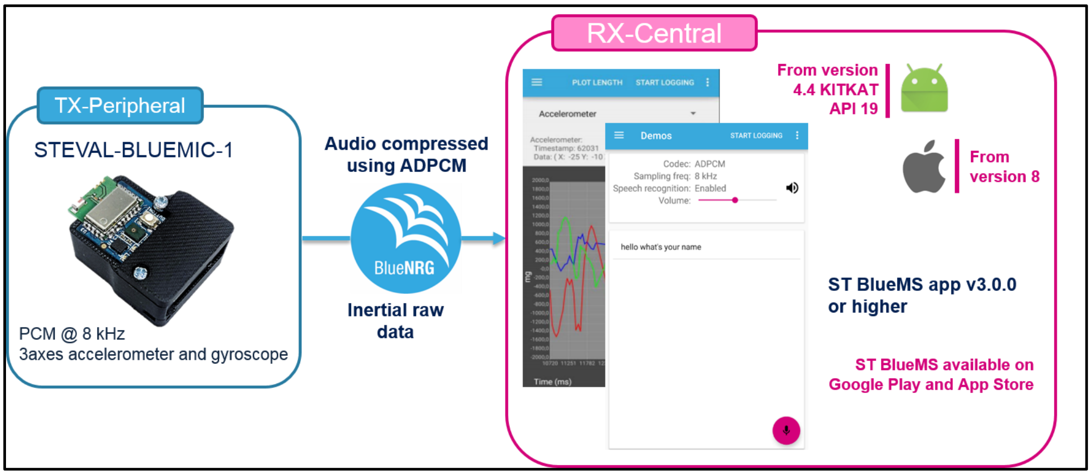
2.4.1 Streaming to a mobile device

One of the possible demos to be performed using a STEVAL-BLUEMIC-1 evaluation board is the unidirectional streaming from the board to an Android™ or iOS™ device running the ST BlueMS app (v3.0.0 or higher).

Set up the STEVAL-BLUEMIC-1 evaluation board as explained in the previous sections and program it with the relevant binary file (STSW-BLUEMIC1_8kHz.bin) included in the software package.

In this configuration, a point-to-point connection is created between the STEVAL-BLUEMIC-1 evaluation board acting as a peripheral and a mobile device acting as a central device: as soon as the two systems are connected, the evaluation board streams audio (acquired from the on-board microphone at 8 kHz of sampling frequency) or inertial raw data (acquired from the 3-axis accelerometer and gyroscope).

Figure 21: Voice streaming from the STEVAL-BLUEMIC-1 evaluation board to an Android™ or iOS™ mobile device

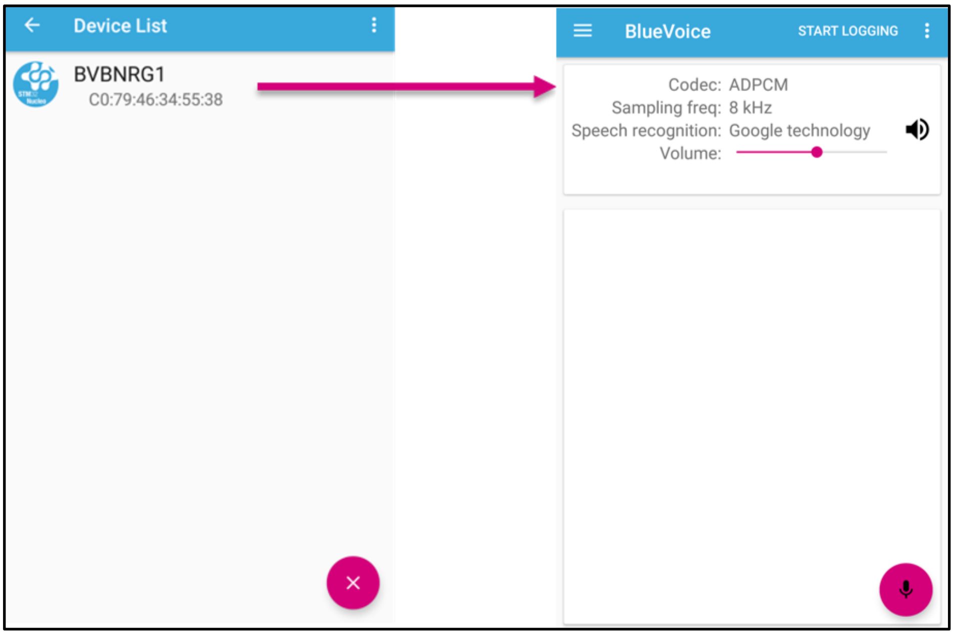


2.4.1.1 ST BlueMS app

To run this demo:

1. Turn the STEVAL-BLUEMIC-1 evaluation board on via SW1 switch
2. Open the ST BlueMS app on your smartphone or tablet.[a]
3. Start the scanning procedure when the app is ready
4. Wait until **BVBNRG1** appears in the device list
   If it does not appear, clear the device cache from the upper right corner menu.
5. When the scan finishes, select the device to be connect to.
   The application switches to the demo view and starts the connection procedure.

Figure 22: BlueMS (Android version) app device list



[a] Android app screenshots are used to show how the app works, but the procedure is the same for the iOS app.

2.4.1.2 BlueVoice page

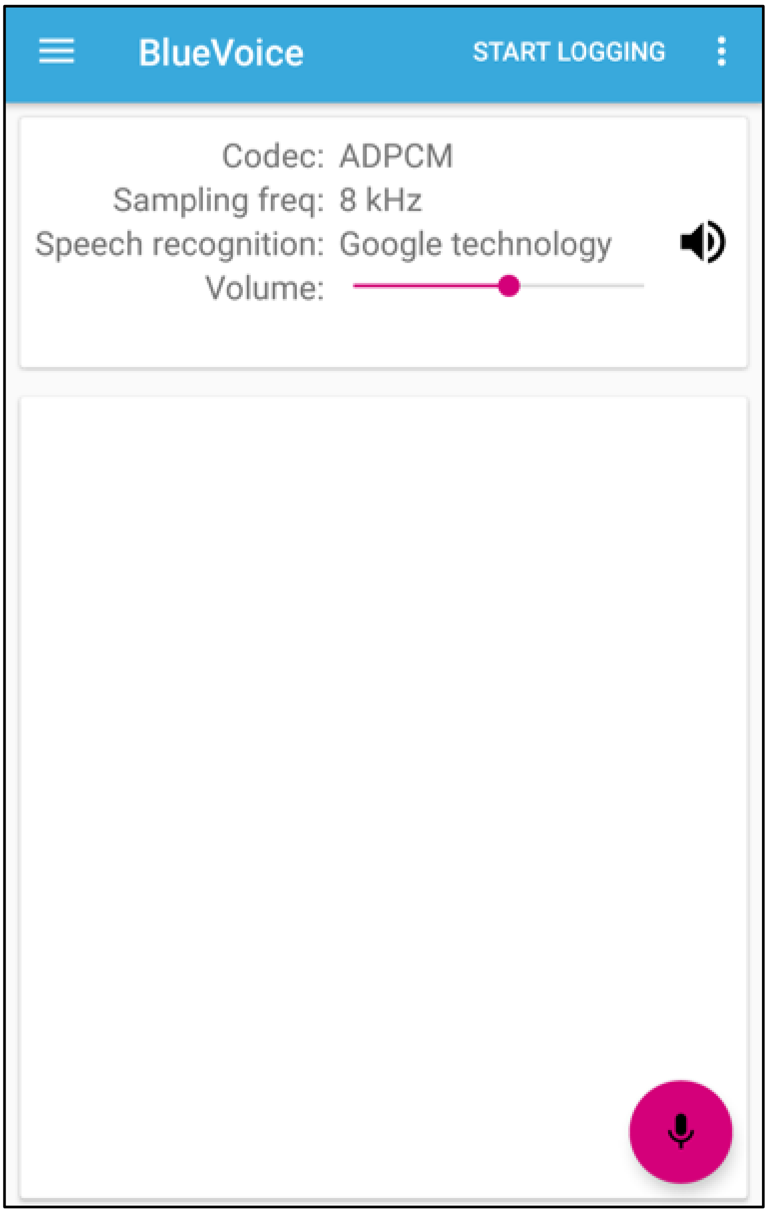
When the STEVAL-BLUEMIC-1 evaluation board is connected to a mobile device the on-board green LED turns on and the board starts streaming audio to the mobile device (in this phase the blue LED starts blinking fast).

In a different version of the evaluation board the color of the LED can be inverted.

You can stop and restart the streaming by pressing the button on the evaluation board.

The volume can be adjusted (via the slider on the BlueVoice page) or muted (by clicking on the speaker icon).

Figure 23: BlueMS (Android version) BlueVoice demo

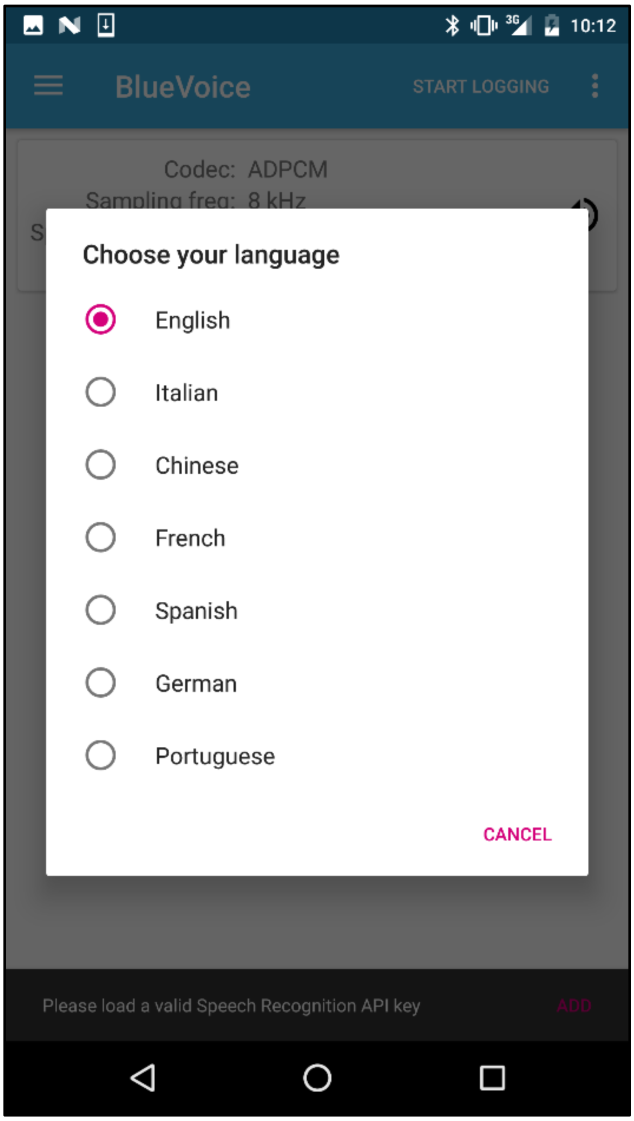


2.4.1.2.1 ASR language selection

Opening the ASR language menu, located in the demo main menu, the application displays a popup window that allows the ASR language selection.

According to the language selected, a specific ASR service is configured which determines the application behavior.

Figure 24: BlueMS (Android version) ASR language selection



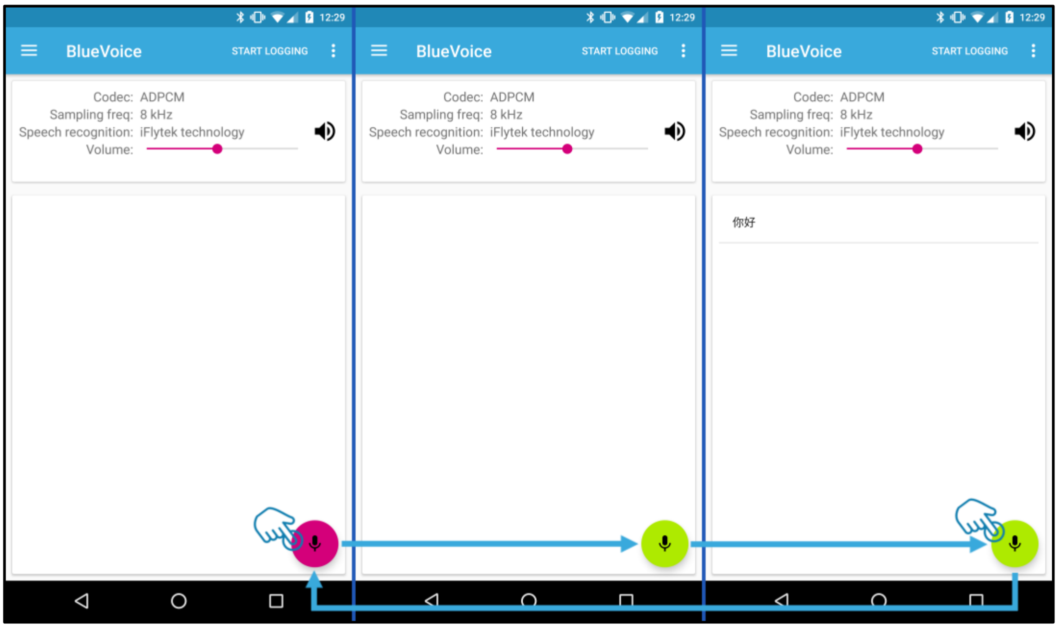
2.4.1.2.2 Chinese ASR: iFlyTek MSC service

When Chinese is selected, the ASR service provided by iFlyTek is enabled.

Pushing the button on the bottom right hand of the screen, it becomes green and the speech-to-text service starts.

The recognition is continuous and every sentence is recorded as shown below.

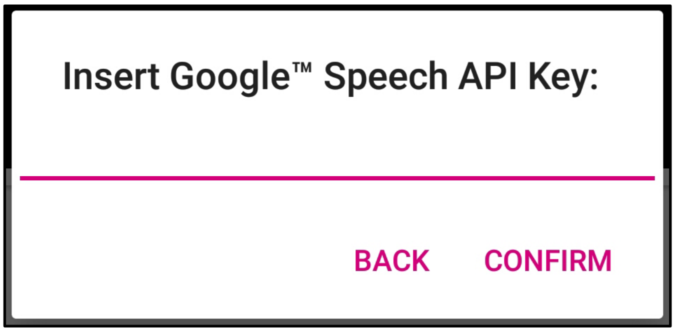
Figure 25: BlueMS (Android version) Chinese ASR, iFlytek technology



2.4.1.2.3 Alternative languages: Google Speech API

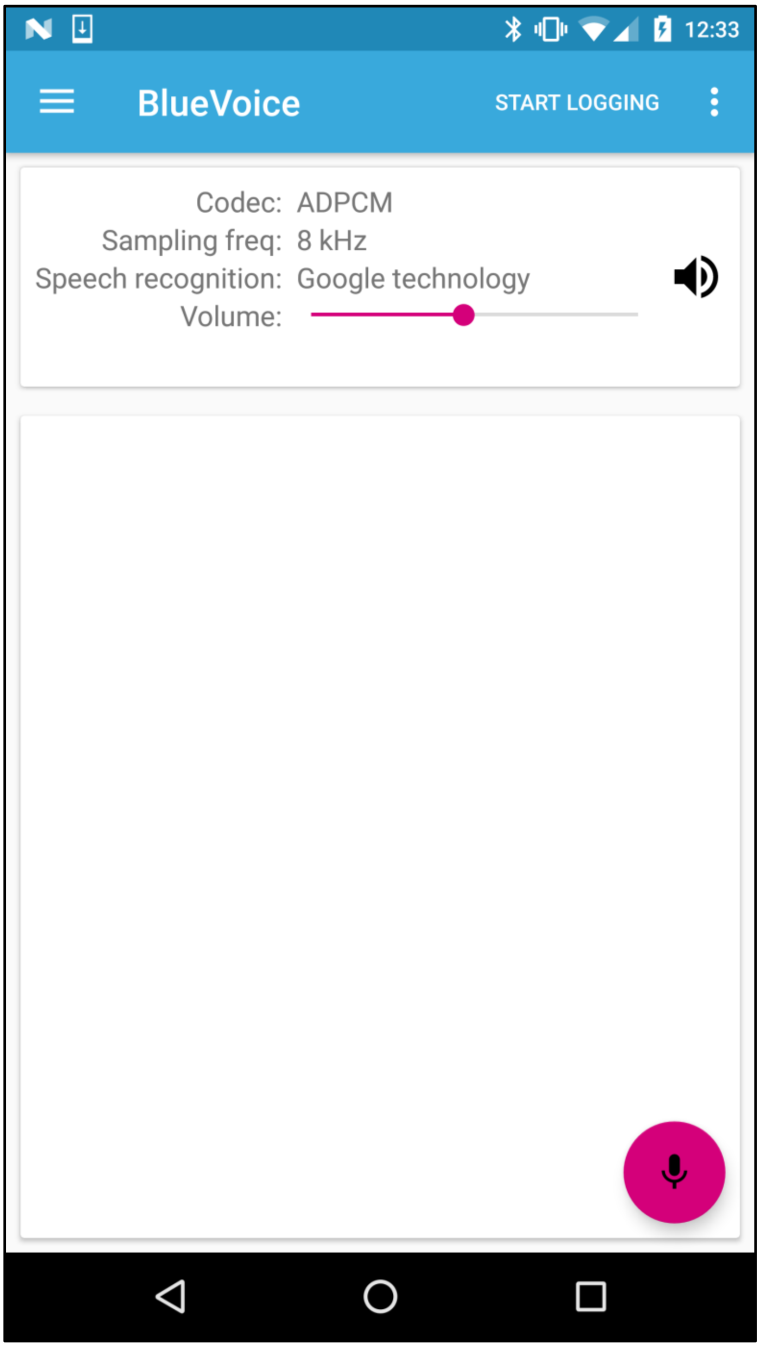
The ADD button allows the insertion of the key (see *Section 2.4.1.2.4: "Google speech ASR Key generation"*) to enable the ASR feature: a popup window prompts the insertion of a valid API key, followed by the ASR service activation key.

Figure 26: BlueMS (Android version) popup API key window



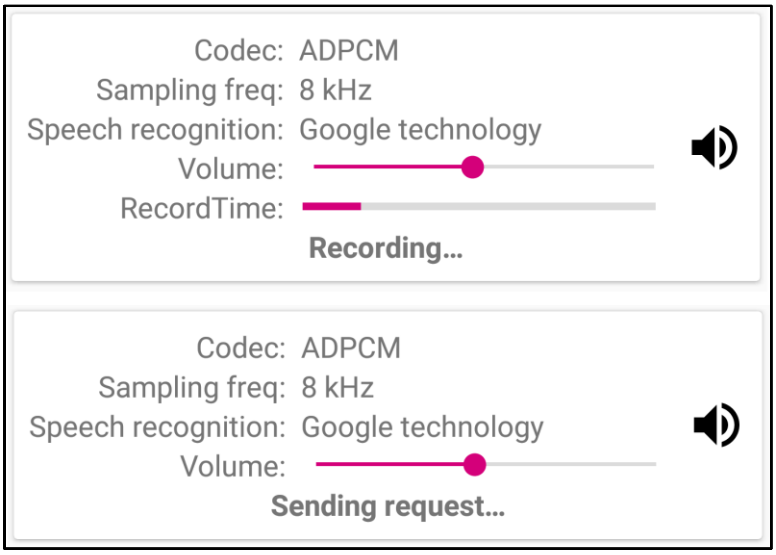
Once the key is correctly inserted, the start screen changes.

Figure 27: BlueMS (Android version) ASR service enabled



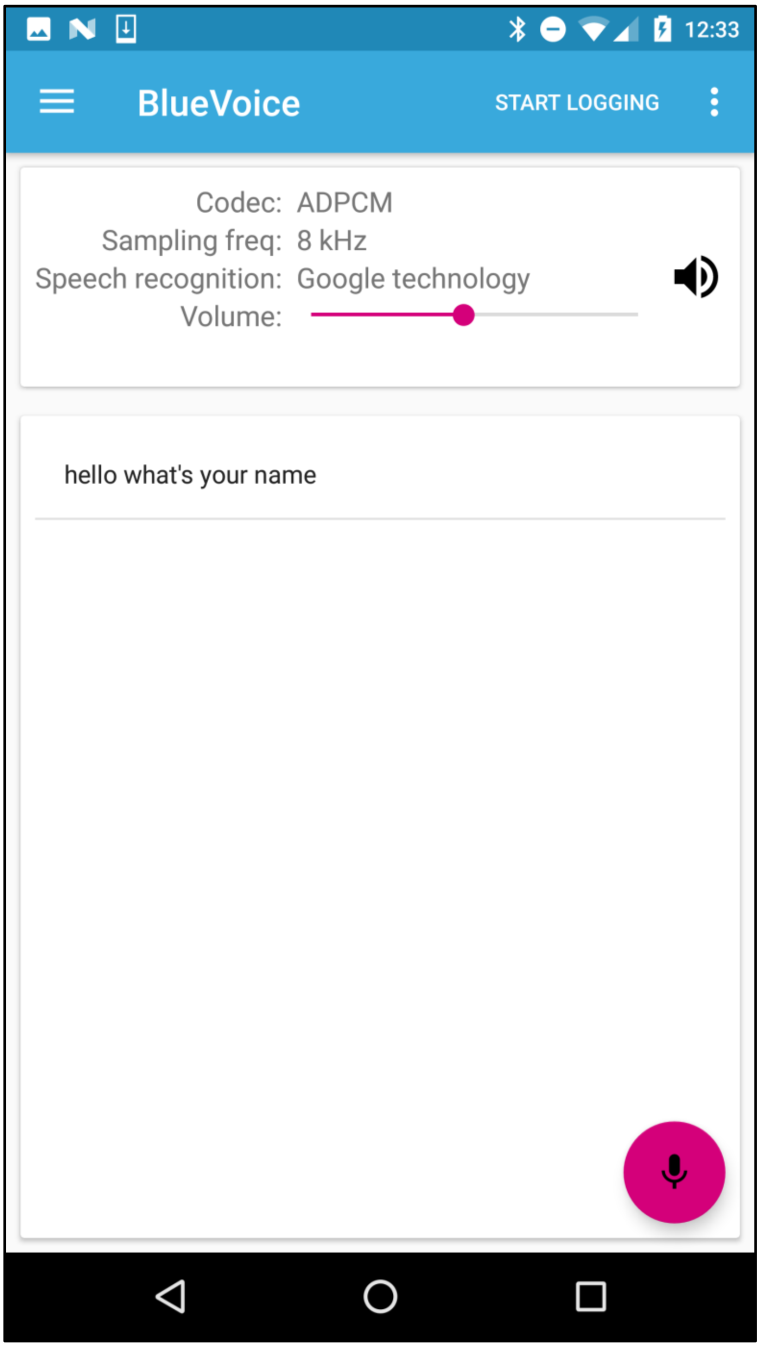
Hold the recording button to record your voice for subsequent recognition. While the button is pressed, a bar progressively indicates the elapsed recording time. When you release the button a “Sending request…” message appears.

Figure 28: BlueMS (Android version) voice recording



The speech recognized by the ASR service appears below the volume bar.

Figure 29: BlueMS (Android version) recognised voice text



If the recording cannot be recognized, a “Token not recognized’ message appears instead of the text.

2.4.1.2.4 Google speech ASR Key generation

The Google Speech APIs require a key to access the web-based service. You need a Google account to complete the procedure and access the service.

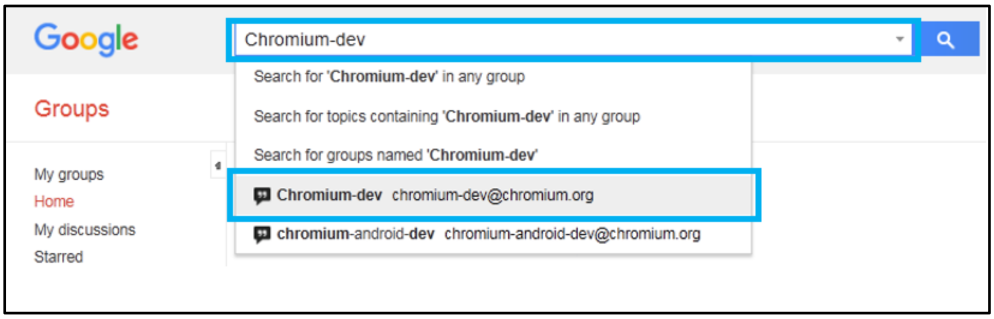
To generate a key:

1 Login with your own Google account.

2 Subscribe to Chromium-dev at *https://groups.google.com/a/chromium.org/forum/?fromgroups#!forum/chromium-dev*.

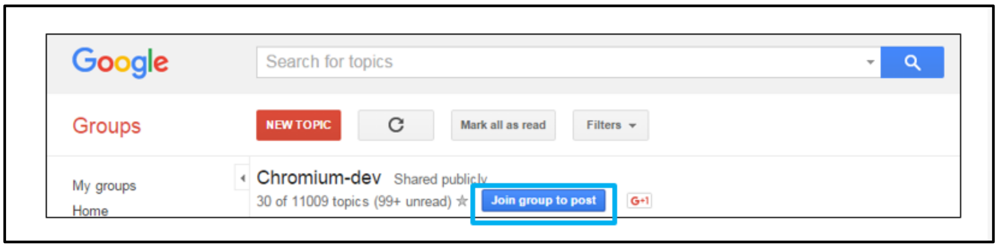
3 Write "Chromium-dev" in the search box, and select the appropriate group.

Figure 30: Google Chromium-dev: search group



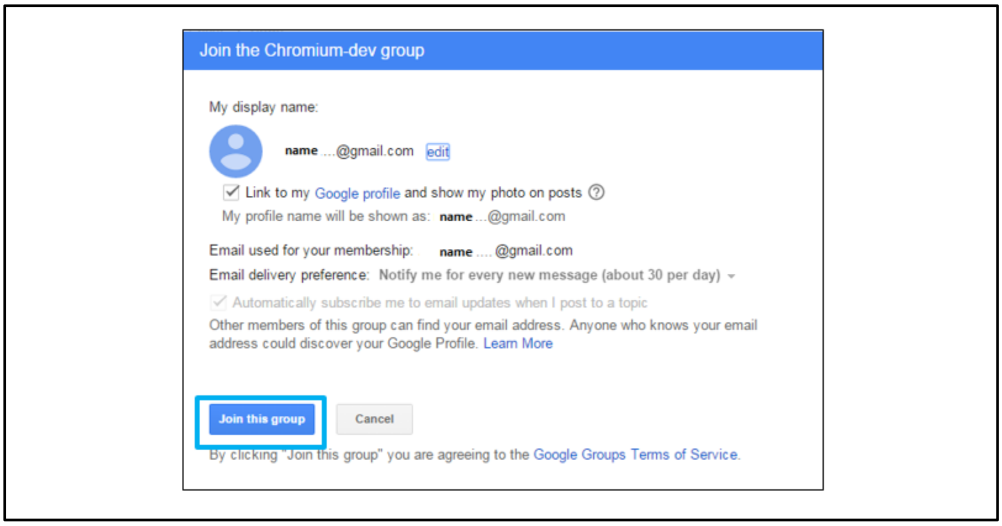
4 Click on "Join group to post" button

Figure 31: Google Chromium-dev: join group to post



5 Click on "Join this group" button to join the Chromium-dev group.

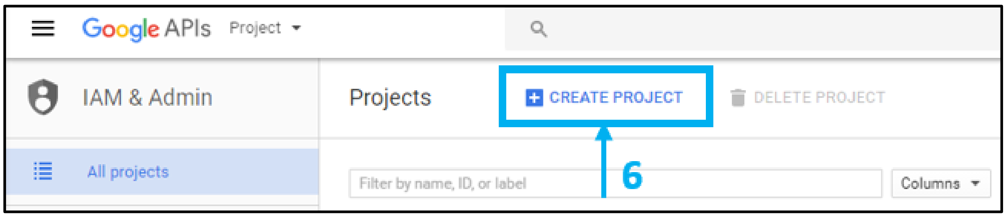
Figure 32: Google Chromium-dev: join the group



6 Go to *https://console.developers.google.com/project*

7 Click on "Create a project…"

Figure 33: Google Chromium-dev: create project



8 Choose the Project name.

9 Click on “Create” button.

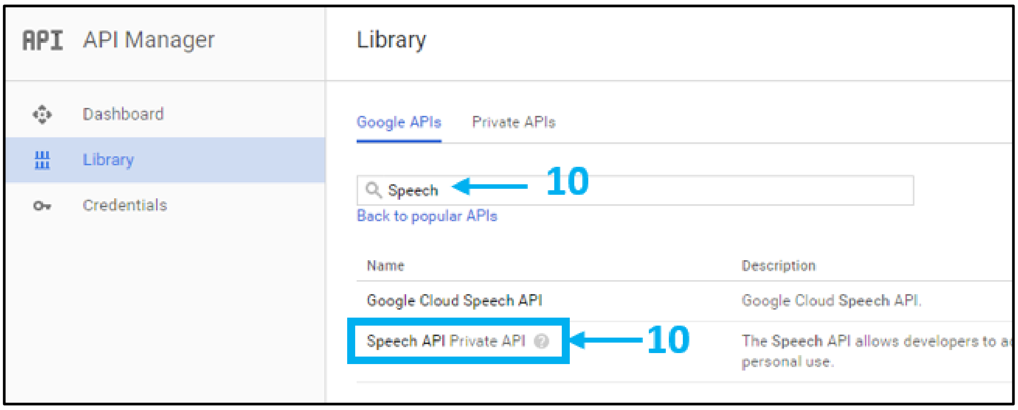
Figure 34: Google Developers Console: new project

10 Make sure you have selected the newly created project.

Figure 35: Google Developers Console: ASRProject

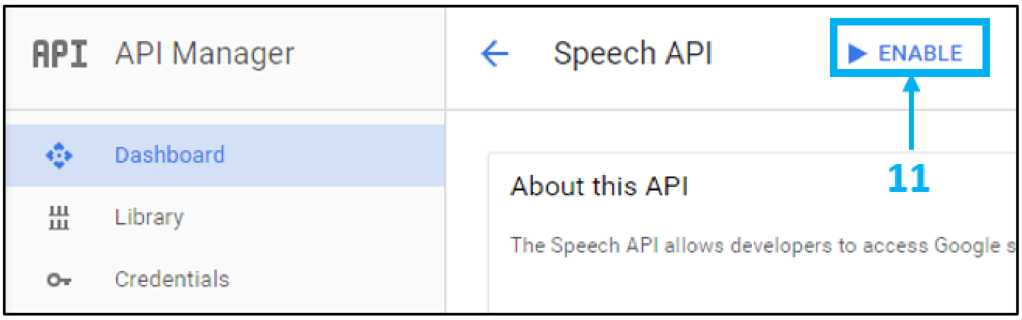
11 Write "Speech API" in the search box, and select correct result.

Figure 36: Google Developers Console: select API



12 Enable the Speech API clicking on the blue button.

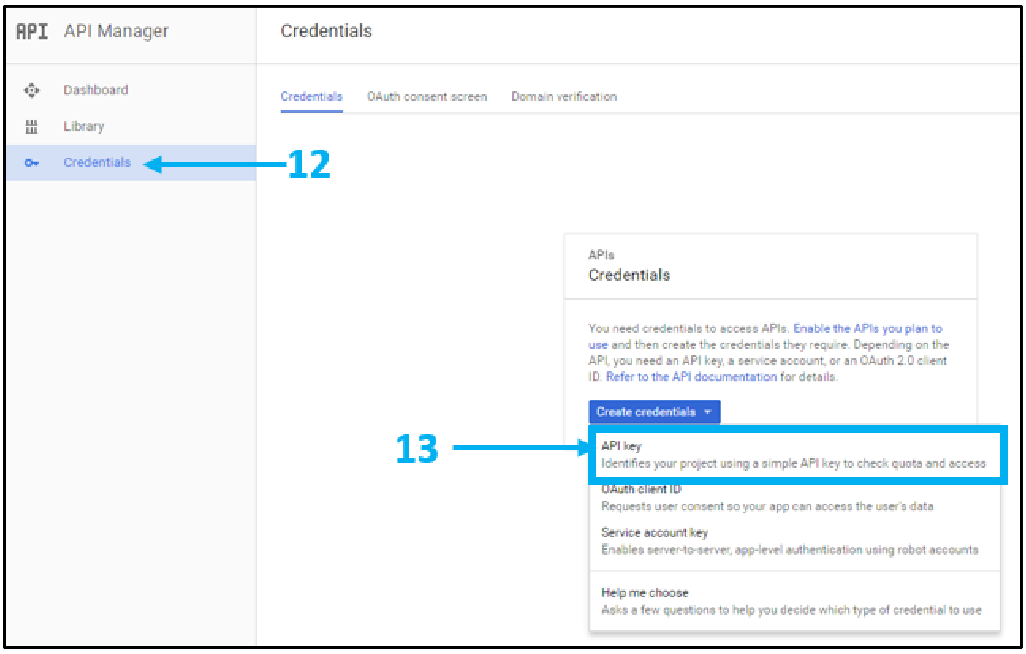
Figure 37: Google API Manager: enable API



13 Move from the “Dashboard” tab to “Credentials” tab.

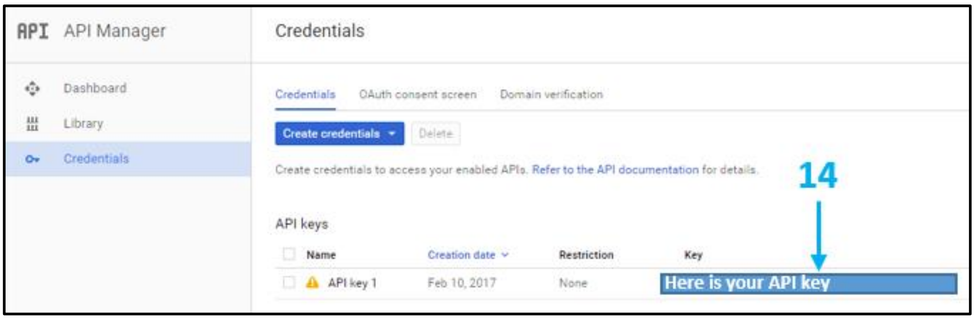
14 Open the “Create credentials” menu and select “API key”.

Figure 38: Google API Manager: create API key



15 Your API key is created. Click on Close to return to the Credentials section. Here you can see your API Key.

Figure 39: Google API Manager: Android API key



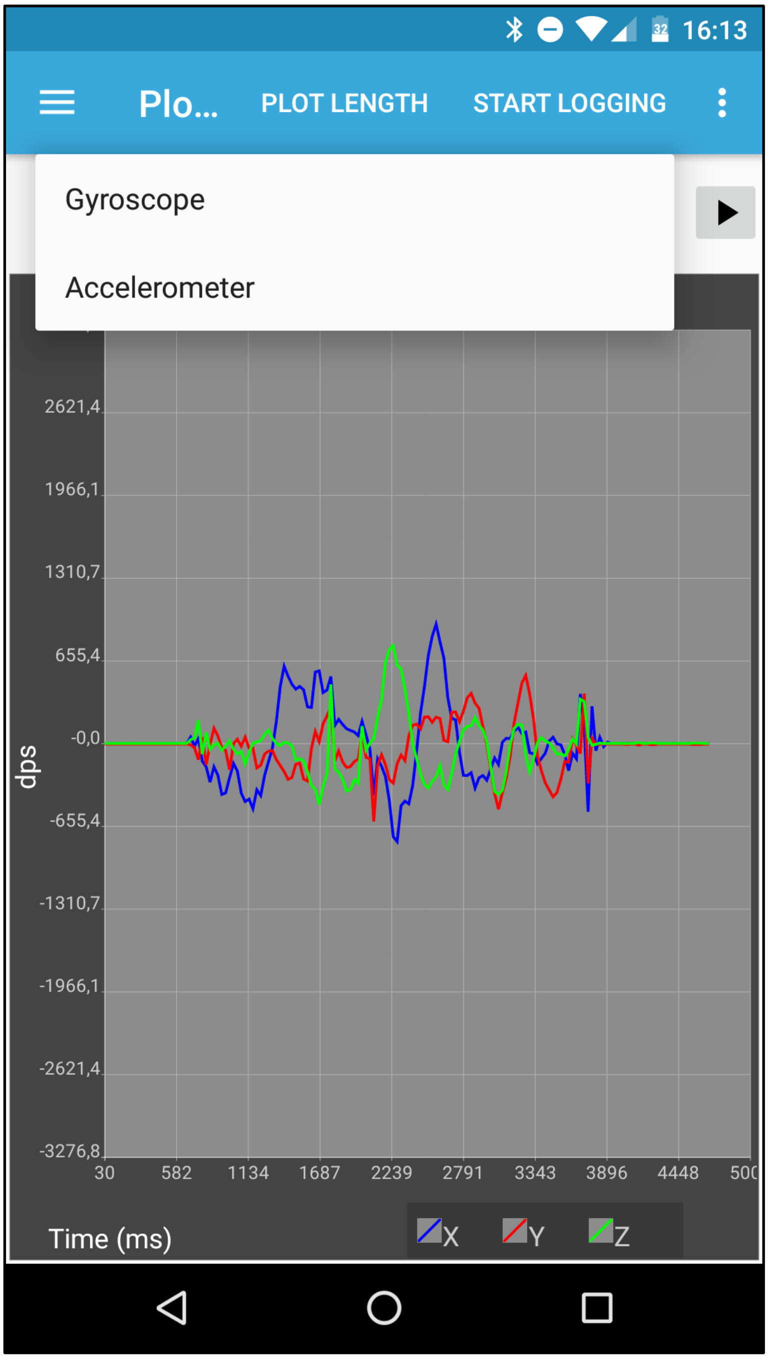
2.4.1.3 Inertial data plot page

The STEVAL-BLUEMIC-1 evaluation board also streams inertial data acquired from the on-board 3-axis accelerometer and gyroscope.

Swipe from the right to open a new page that allows a real-time plot of inertial raw data received from the evaluation board. Gyroscope or accelerometer can be selected from the menu on the top; the plot starts as soon as the "Play button" on the right is pressed.

By clicking on the Plot Length menu item, you can set the time scale in seconds to be displayed.

Figure 40: BlueMS (Android version) plot data page

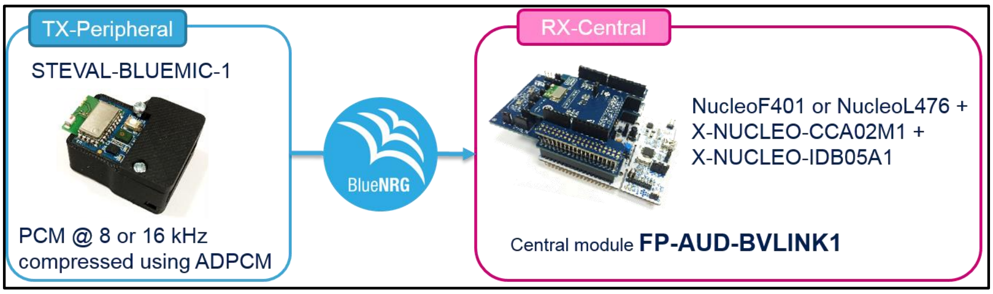


2.5 Streaming to an STM32 Nucleo board used as a receiver

Another possible demo to be performed using a STEVAL-BLUEMIC-1 evaluation board is the unidirectional voice streaming from the evaluation board to an STM32Nucleo stack running the FP-AUD-BVLINK1 central application.

The audio can be acquired at 8 or 16 kHz of sampling frequency: the transmitter and the receiver must be configured accordingly.[a]

Figure 41: Voice streaming from a STEVAL-BLUEMIC-1 evaluation board to an STM32 Nucleo board



1 Power the STEVAL-BLUEMIC-1 evaluation board on using the on-board switch SW1

2 Connect the receiver to a PC via the mini USB on the X-NUCLEO-CCA02M1 expansion board (the jumper JP5 on the STM32 Nucleo must be E5V).

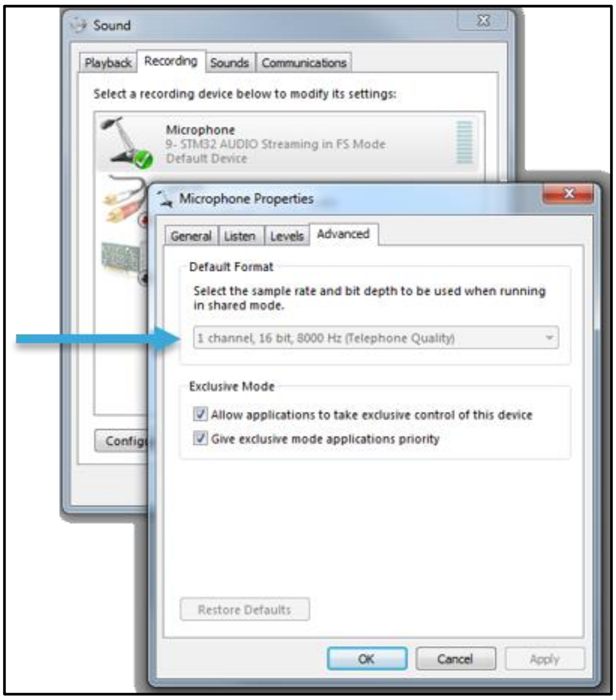
When the green LED on the STEVAL-BLUEMIC-1 evaluation board turns on, the connection is established and the voice streaming from the peripheral to central device starts.

In a different version of the evaluation board the color of the LED can be inverted.

3 As soon as the central unit is recognized as a standard USB microphone, select the correct option in Microphone Properties (8 or 16 kHz) as shown below.

[a] Refer to the relevant page on www.st.com to set up the central module to be used as a receiver.

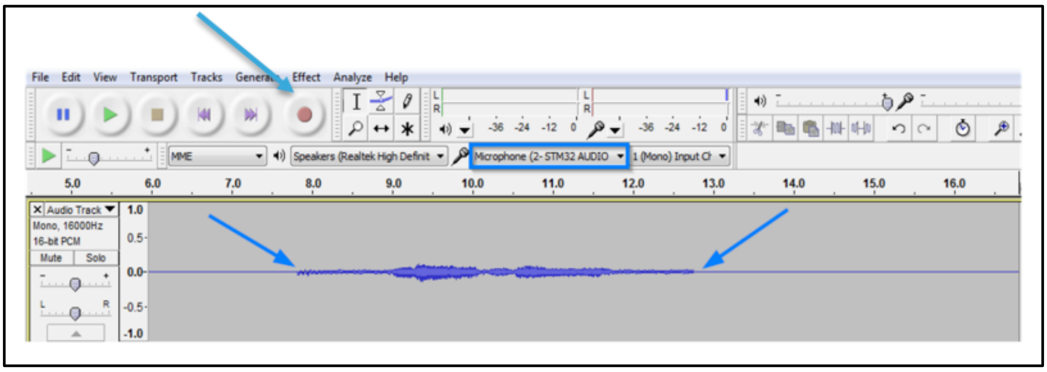
Figure 42: Receiver recognized as USB microphone



4 Use any freeware or commercial audio recording software to interface with the system, for example Audacity (*http://audacity.sourceforge.net/*).

5 Open it and press the Record button to record the audio streamed from the STEVAL-BLUEMIC-1 evaluation board.

Figure 43: Audacity recording voice streamed by the peripheral



6 Stop or restart the streaming by pressing the user button on the evaluation board.

3 Revision history

Table 3: Document revision history

Date	Version	Changes
17-Jul-2017	1	Initial release