

BLE Voice Remote Control

ABSTRACT

This application report describes the voice over RF protocol used for Maxscend Bluetooth Low energy (BLE) remote control solutions.

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1. Introduction

The MXD BLE Smart Remote Control is a complete HW and SW reference design for Bluetooth® Low Energy enabled remote control which will be used in smart TV, set-top boxes(STB) and projectors. It offers the best RF performance with ultra-low power consumption and the competitive cost.

The reference design based on Maxscend high RF performance and cost-effective Bluetooth Low Energy device MXD2670. It based an ARM cortex-m0+/ m33 core with 512K on-chip flash memory, a 16-bit Audio ADC support connect to an analog microphone or I2S/PDM connect to digital microphone directly.

All necessary firmware and host software are provided to implement a full design at both ends of the application. The firmware runs on the MXD2670, Host software support Android.

The design also contains schematics and layout files for the remote control in addition to a software example demonstrating human interface design(HID) functionality and voice sample and compress functionality.

1.1 Main Feature

- Complete Bluetooth Low Energy advanced remote control reference design
- Open source for firmware on MXD26xx
- 17 metal dome buttons matrix
- Low cost analog microphone inputs for voice/audio
- ADPCM (4:1) Audio CODEC support
- IR LED with NEC encode and decode software
- Modular design of HW and SW
- Stable HID profile compatible with android and IOS
- Host-side software demo for android

1.2 Applications

- Connected TV
- Set-Top-Box
- Media Centers
- Computers
- Gaming Platforms

1.3 KIT Content

- 1 Complete product example remote control
- 2 AAA batteries

1.4 Abbreviations and Acronyms

Table 1.1 Abbreviations and Acronyms

BLE	Bluetooth Low Energy
FA	Frequency Agility
PDM	Plus Density Modulation
RCU	Remote Control Unit
RF	Radio Frequency
IR	Infrared Radio

2. Solution

2.1 Solutions

The MXD BLE Smart Remote Control development kit is a complete development kit that requires no knowledge of embedded software to get start testing with the kit. All design file including hardware and software are open for download.

2.1.1 Block Diagram

There are multiple devices available for the RCU reference design and Figure 2.1 shows the components used in the BLE Smart Remote Controller.

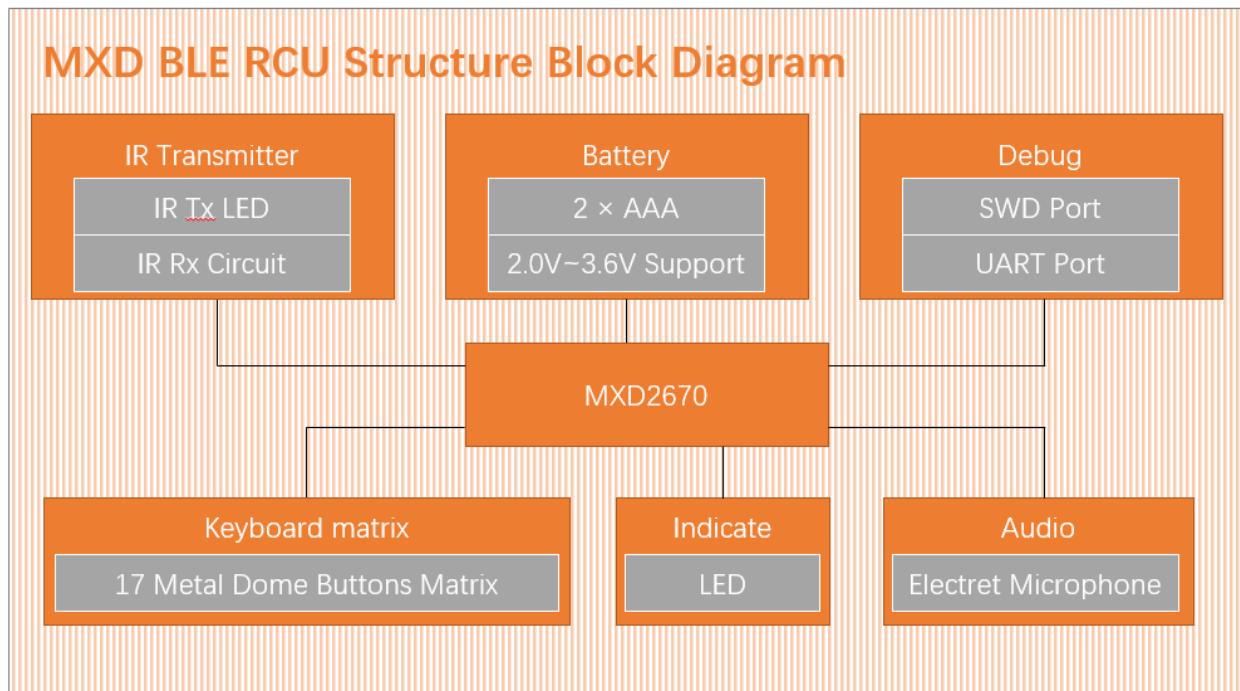


Figure 2.1 RCU Block Diagram

2.1.2 MXD2670 Function Block Diagram

The MXD2670 device is a SOC MCU targeting Bluetooth Low Energy voice remote control applications. The on-chip 16-bit audio ADC and I2S/PDM interface make it very easy to connect to analog and digital microphone directly.

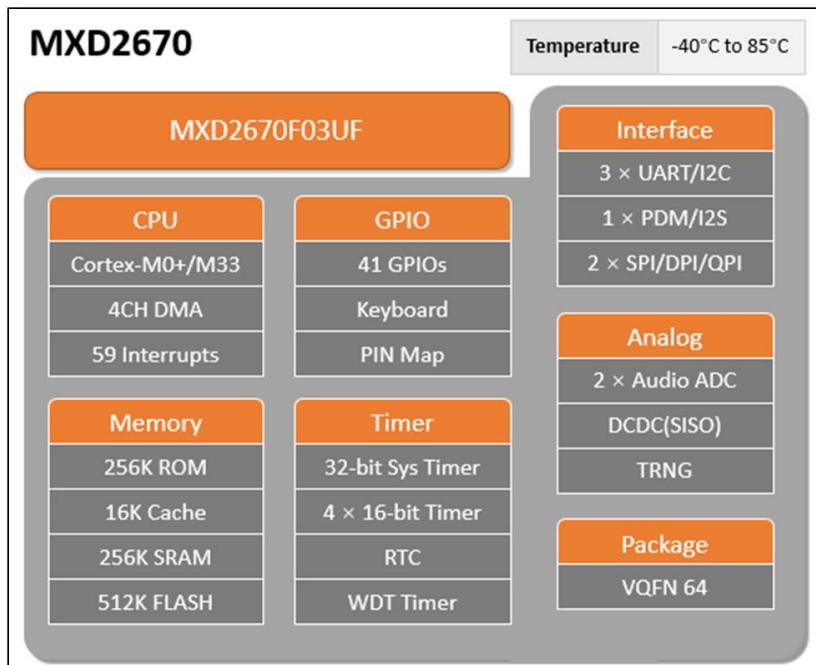


Figure 2.2 MXD2670 Functional Block Diagram

2.1.3 Functions

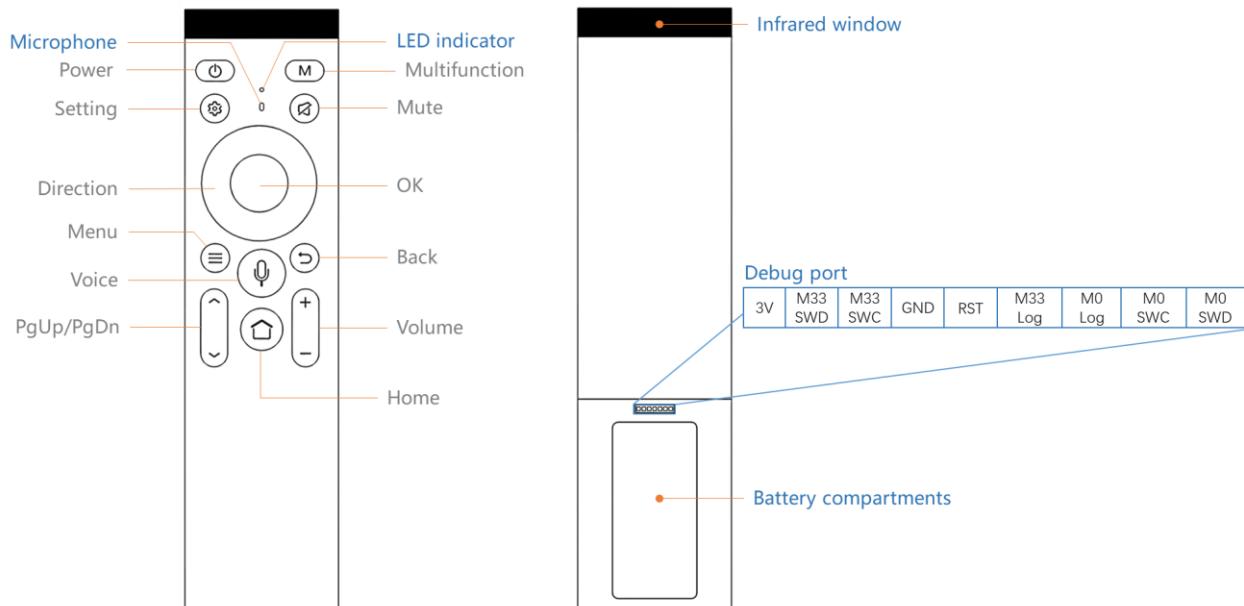


Figure 2.3 BLE Remote Control

3. System Design

3.1 Embedded Software

MXD BLE Smart Remote Control development kit including an embedded software, it implement on MXD2670 devices.

The embedded software realize voice sample, compress and transmit via BLE protocol. Also, it implement infrared encode and decode function.

The CPU scan a 17 keys matrix, when one key pressed it will run the interrupt program to emit the infrared signal or record the voice. It support short press operation or long press operation at some keys.

A standard Human interface Design(HID) profile is realized to connect to smart devices, such as PC(windows), TV and smartphone(Android). The standard ASCII Key value will send to the devices when a key pressed.

When voice key is pressed, CPU will sample the voice by an analog microphone, the sample rate is support 16K and 32K. At the same time CPU running an ADPM(4:1) codec to compress the voice signal and then send to host by BLE protocol with a special voice transmit service.

4. Characters

4.1 Key Characters

Table 4.1 Power Consumption

Parameters	Description	Typical Value	Unit
Power Supply	2 x AAA	1.8~3.6	V
Current without BLE connection	Shut down mode @3.0v	< 3.0	uA
	Sleep mode @3.0v	<6.0	uA
Wake up time to BLE connected with Infrared emit	From shut down mode	<1200	mS
	From Sleep mode	< 700	mS
Wake up time to BLE connected without Infrared emit	From shut down mode	<800	mS
	From Sleep mode	< 300	mS
Wake up time without BLE Infrared emit	From shut down mode	<600	mS
	From Sleep mode	< 3	mS
Infrared current	20m	< 100	mA
Audio Sample Rate	16-bit	16K/32K	
Audio PGA		0-30	dBm

4.2 Power consumption

Table 4.2 Power Consumption

Firmware version	MXD267x_SDK_V0.10				
Status	Description	Min	Typical	Max	Unit
Infrared without BLE connect	Sleep mode	1.30	1.43	1.50	uA
	Short key press	-	29.4	-	mA
	Long key press	-	6.30	-	mA
BLE Connected Without infrared	Sleep mode(1.0S interval)	30.0	33.6	35.0	uA
	Short key press	1.80	1.82	2.33	mA
	Long key press	-	2.07	2.2	mA
	Short voice key press	-	4.73	-	mA
	Long voice key press	-	6.31	6.5	mA

This device complies with part 15 of the FCC rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

NOTE: The manufacturer is not responsible for any radio or TV interference caused by unauthorized modifications or changes to this equipment. Such modifications or changes could void the user's authority to operate the equipment.

NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.

- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

The device has been evaluated to meet general RF exposure requirement, The device can be used in portable exposure condition without restriction. Federal Communication Commission (FCC) Radiation Exposure Statement Power is so low that no RF exposure calculation is needed.

Federal Communication Commission (FCC) Radiation Exposure Statement

When using the product, maintain a distance of 20cm from the body to ensure compliance with RF exposure requirements.

This device is intended only for OEM integrators under the following conditions: 1. The antenna must be installed such that 20 cm is maintained between the antenna and users. 2. The transmitter module may not be co-located with any other transmitter or antenna. As long as the two conditions above are met, additional transmitter testing will not be required. However, the OEM integrator is still responsible for testing their end-product for any additional compliance requirements required for the installed module.

Important Note: In the event that these conditions cannot be met (for example certain laptop configurations or co-location with another transmitter), then the Federal Communications Commission of the U.S. Government (FCC) and the Canadian Government authorizations are no longer considered valid and the FCC ID cannot be used on the final product. In these circumstances, the OEM integrator shall be responsible for re-evaluating the end-product (including the transmitter) and obtaining a separate FCC authorization in the U.S. and Canada.

OEM Integrators - End Product Labeling Considerations: This transmitter module is authorized only for use in device where the antenna may be installed such that 20 cm may be maintained between the antenna and users. The final end product must be labeled in a visible area with the following: "Contains, FCC ID: 2BAM2-RCE70F01". The grantee's FCC ID can be used only when all FCC compliance requirements are met.

OEM Integrators - End Product Manual Provided to the End User: The OEM integrator shall not provide information to the end user regarding how to install or remove this RF module in end product user manual. The end user manual must include all required regulatory information and warnings as outlined in this document.

Appropriate measurements (e.g. 15 B compliance) and if applicable additional equipment authorizations (e.g. SDoC) of the host product to be addressed by the integrator/manufacturer.

This module is only FCC authorized for the specific rule parts 15.247, 15.407 listed on the grant, and the host product manufacturer is responsible for compliance to any other FCC rules that apply to the host product as being Part 15 Subpart B compliant.