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Document Revision

Version	Date	Description of changes
Rev1.0	2020-01-02	First release for ALM-04-MRTU

ALM-04-MRTU User's Manual

Table of Contents

1. Introduction

The ALM-04-MRTU controller have RS-485 connection with Modbus RTU protocol support. The controller makes an easy way to incorporate RS-485 connectivity into monitoring and control systems. Which makes perfect integration to monitoring in SCADA software, HMI Modbus & Utility.
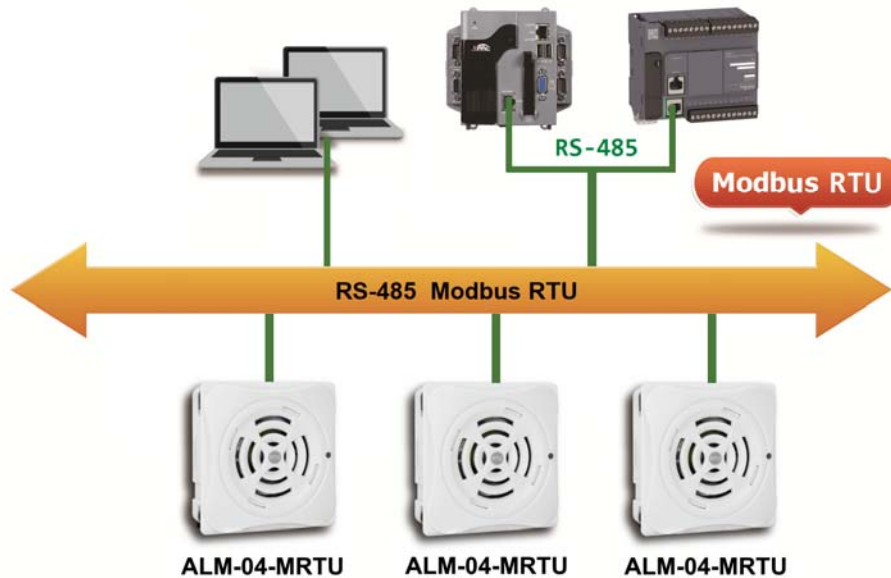

Figure 1-1: Application architecture for the ALM-04-MRTU

1.1   Features
- RS-485 Interface
- Modbus RTU protocol
- Photo couple input, Relay output
- Wide operating temperature range
- Wide power supply range
- MP3 Audio, external Line Out
- Digital Volume control
- Support up to 64 audio files
- 8 Alarm mode support
- 4 Single channel or 15 Binary channel support

1.1.1   Features Description

Modbus RTU protocols

The Modbus RTU function on the ALM-04-MRTU can be used to provide data monitoring from HMI/SCADA software built with Modbus RTU driver. All the RS-485 & Modbus RTU configuration are store in MicroSD(T-Flash), it can be created by PC Utility.

Built-in MP3 Audio decoder & Audio Output

The Alarm sound using MP3(MPEG1-Audio Layer III) audio, it support most of MP3 format(Sample Rate 24/44.1(prefer)/48 KHz, Bitrate 32 64 96 128(prefer) 160 192 Kbit/s), include an 3W audio power amplifier & 1KΩ Impedance Line Out can send the alarm sound to external PA(Power Amplifier) system.

Support 4 channel trigger input with 8 alarm mode & Output

Include 4 channel Photo couple input & 8 kinds of alarm trigger mode, it also can be triggering an extend device using external Relay Output. All modes & MP3 audio files can be created or config by PC Editor.

1.2   Specifications

Table 1-1: System Specifications

Communication	
Interface	RS-485
Parity, Data bit, Stop bit	None/Odd/Even, 8, 1/2
Baud Rate	300 ~ 115200 bps
Protocol	Modbus RTU
Watchdog	Yes, 1.8s
LED Indicators	
Power/Status	One 2 colors LED, Blue for System status, Red for Alarm status.
Protection	
ESD (IEC 61000-4-2)	±8 kV Air for Random Point
EFT (IEC 61000-4-4)	±2 kV for Power
Waterproof(IEC 60529)	IP54 (Panel Mount Upright Position)
Power Requirements	
Input Voltage Range	9 ~ 28 VDC with Reverse Protection (Vin to GND)
Power Consumption	0.48 W Standby.
Mechanism	
Dimensions(WxLxH)	72 mm x 72mm x 22 mm
Installation	Panel Mount/Wall Mount/DIN-Rail Mounting
Environment	
Operating Temperature	-20℃ ~ +75℃
Storage Temperature	-30℃ ~ +85℃
Humidity	10% ~ 85% RH, Non-condensing

Table 1-2: I/O Specification

Digital Input	
Channels	4
Input Type	Dry Contact: Sink
Dry Contact Level	Off Voltage Level: Open On Voltage Level: Close to GND
Photo-Isolation	3750 VDC
Input Condition	Pulse Width must > 150mSec or more
Digital Output	
Channels	1
Output Type	Form A
Contact Rating (Resistive Load)	DC50V/100mA

Table 1-3: Audio Specification

Audio	
Sound Pressure Level	99dB@1KHz/1meter
Volume Control	Digital Volume Control
Number of Playback	64(Max)
Audio File Format	MPEG1-Audio Layer III (MP3)
Sample Rate	24/44.1(prefer)/48 KHz
Bit Rate	32 64 96 128(prefer) 160 192 kbit/s
Audio Startup Time	< 150ms
Audio Output	3W(Max)
Line Out Impedance	1KΩ

Table 1-4: Storage Specification

Storage	
Audio Files Locate	Micro SD(T-Flash) up to 32GB, bundle 4GB
File System	Fat16/32
File Transfer	PC Editor Utility, Copy to Micro SD

2. Hardware

2.1 Outward Appearance

ALM-04-MRTU contains I/O connectors, Micro SD, Reset to Default and LEDs.
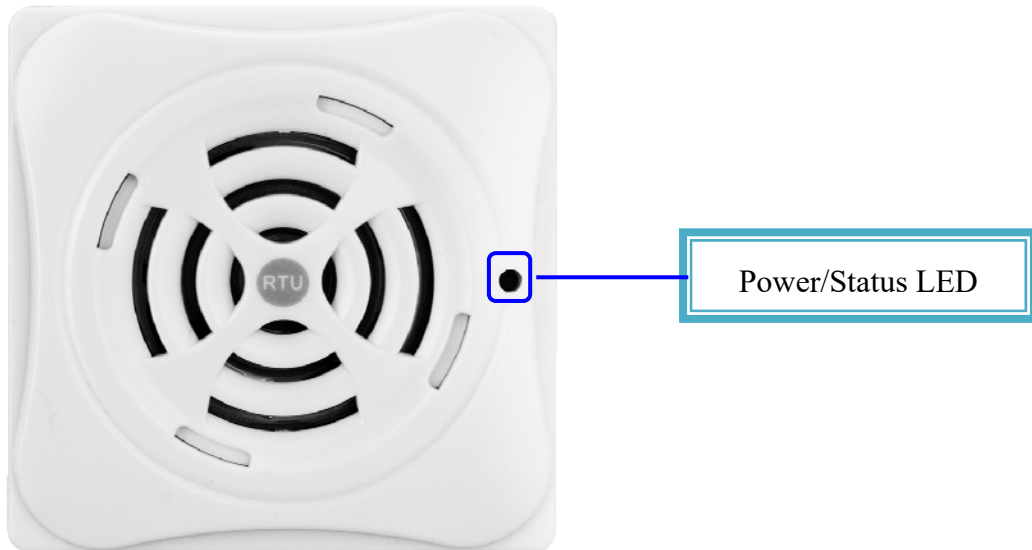

Power/Status LED

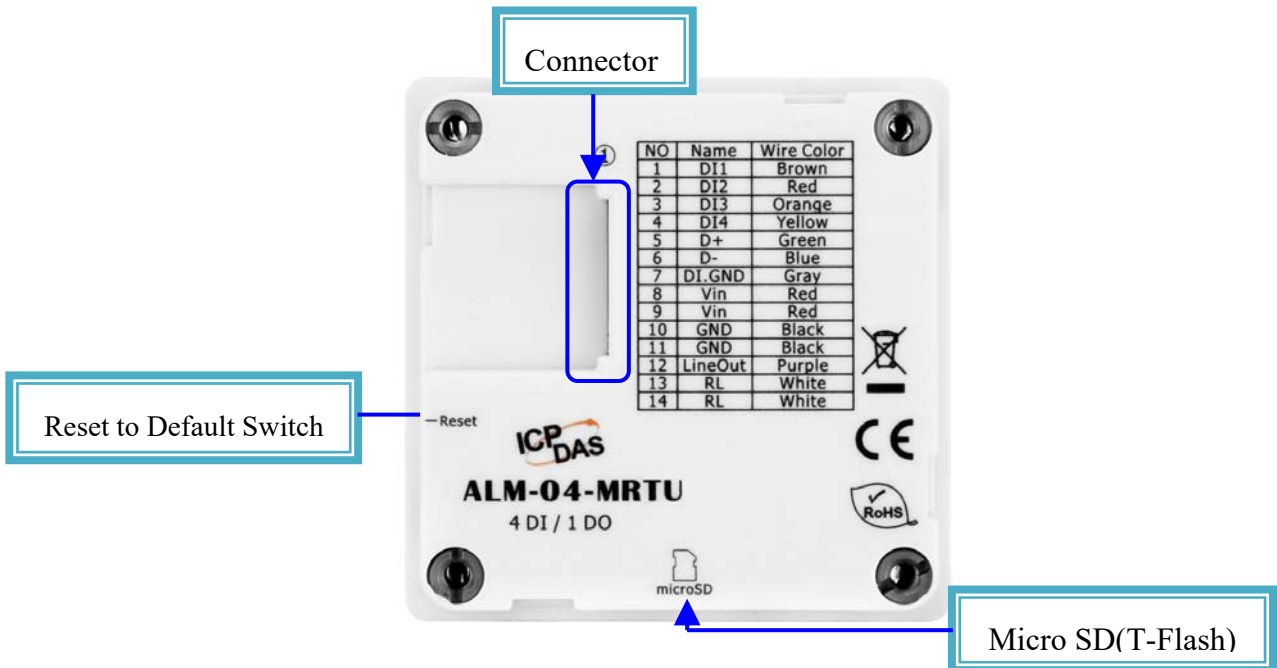Figure 2-1: Front Panel

Connector

Reset to Default Switch

Micro SD(T-Flash)

NO	Name	Wire Color
1	DI1	Brown
2	DI2	Red
3	DI3	Orange
4	DI4	Yellow
5	D+	Green
6	D-	Blue
7	DI.GND	Gray
8	Vin	Red
9	Vin	Red
10	GND	Black
11	GND	Black
12	LineOut	Purple
13	RL	White
14	RL	White

ALM-04-MRTU

4 DI / 1 DO

Figure 2-2: Back Panel

2.1.1 LED Indicator

Table 2-1: System Status Indicator

System Status Indicator		
LED	**Controller Status**	**LED Status**
PWR	Power On	Blue LED
	Alarm Status	Red LED

2.1.2 Connector Pin Define

Terminal NO	Pin Name	Wire Color
1	DI1	Brown
2	DI2	Red
3	DI3	Orange
4	DI4	Yellow
5	D+	Green
6	D-	Blue
7	DI.GND	Gray
8	Vin	Red
9	Vin	Red
10	GND	Black
11	GND	Black
12	Line Out	Purple
13	RL	White
14	RL	White

Figure 2-3: I/O Connector of ALM-04-MRTU

2.2 Reset to default

Press & hold the reset button on the bottom side over 6 Sec until the Red LED quick flash and release, the ALM-04-MRTU will restore to default setting, default Device ID is "1", RS-485 setting is "115200,N,8,1", Volume is "5".
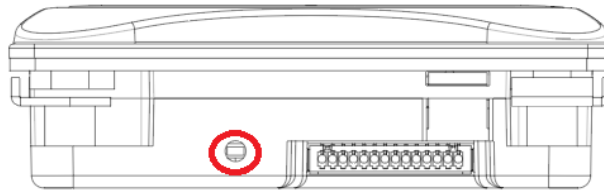
Figure 2-4: Reset button locate in the bottom side of ALM-04-MRTU

2.3 Dimensions

The diagrams below provide the dimensions of the ALM-04-MRTU to use in defining your enclosure specifications. All dimensions are in millimeters.
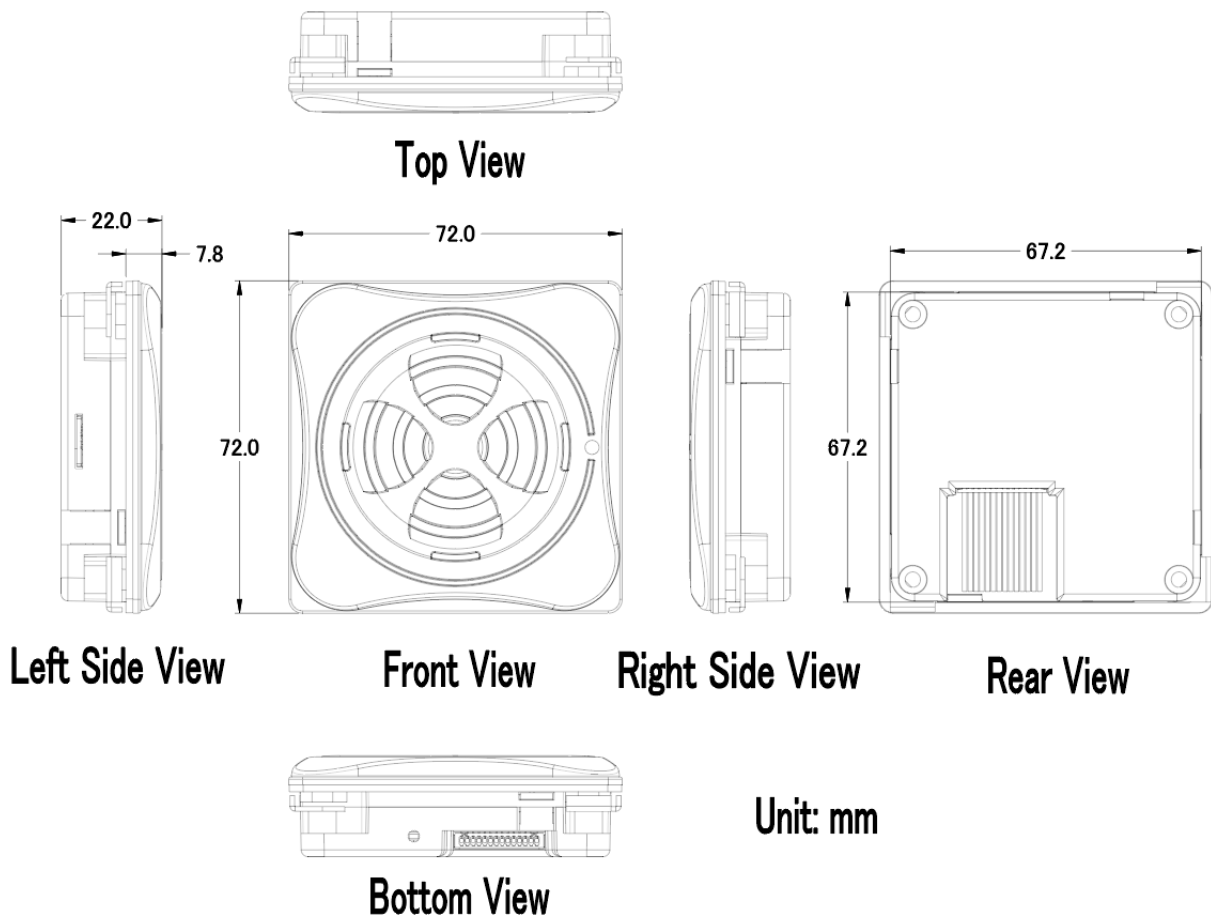

Figure 2-5: Dimension of the ALM-04-MRTU

2.4 Wire Connection

2.4.1 Wire connection define
The following describe the wire color & function

NO	Name	Wire Color
1	DI1	Brown
2	DI2	Red
3	DI3	Orange
4	DI4	Yellow
5	D+	Green
6	D-	Blue
7	DI.GND	Gray
8	Vin	Red
9	Vin	Red
10	GND	Black
11	GND	Black
12	LineOut	Purple
13	RL	White
14	RL	White

Figure 2-6: Wire color & function

2.4.2 Digital Input (DI) wiring

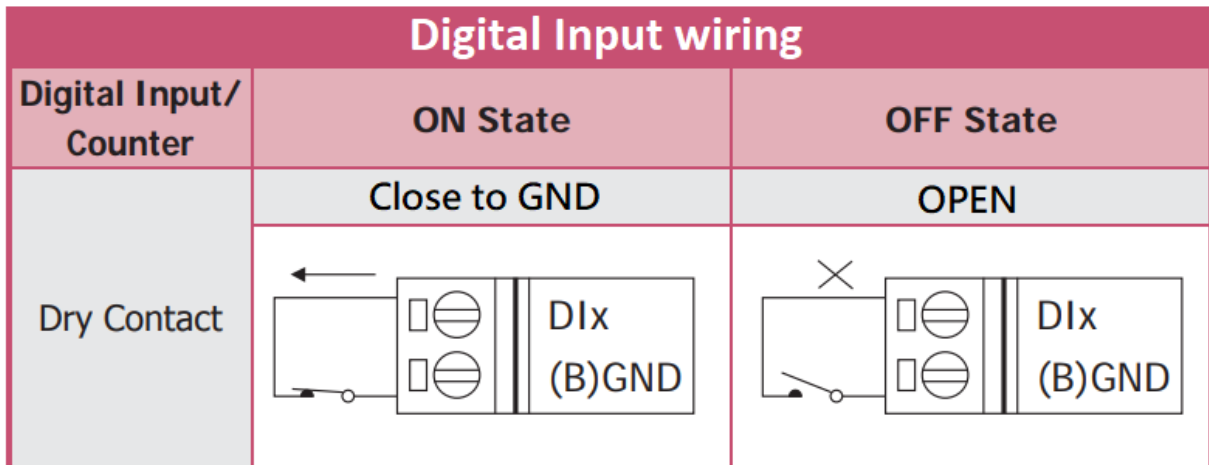| Digital Input wiring		
Digital Input/ Counter	ON State	OFF State
	Close to GND	OPEN
Dry Contact	DIx (B)GND	DIx (B)GND

Figure 2-7: DI Dry contact wiring
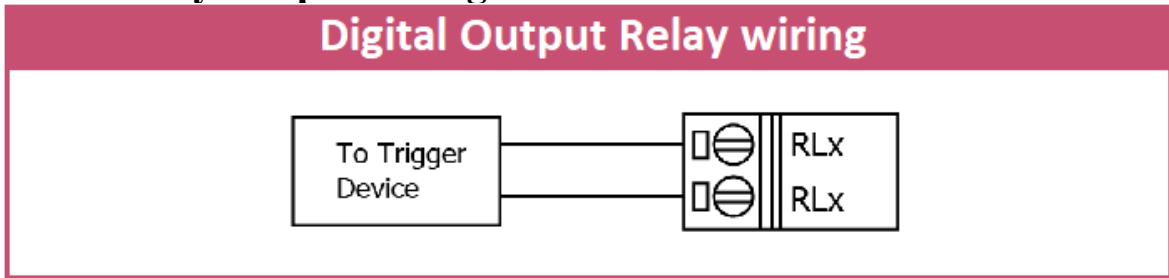
2.4.3 Relay Output wiring

Figure 2-8: Relay Output wiring
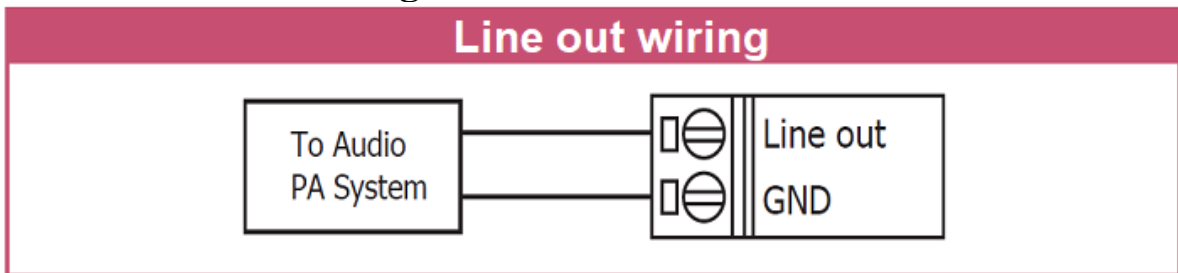
2.4.4 Line Out wiring

Figure 2-9: Line Out wiring
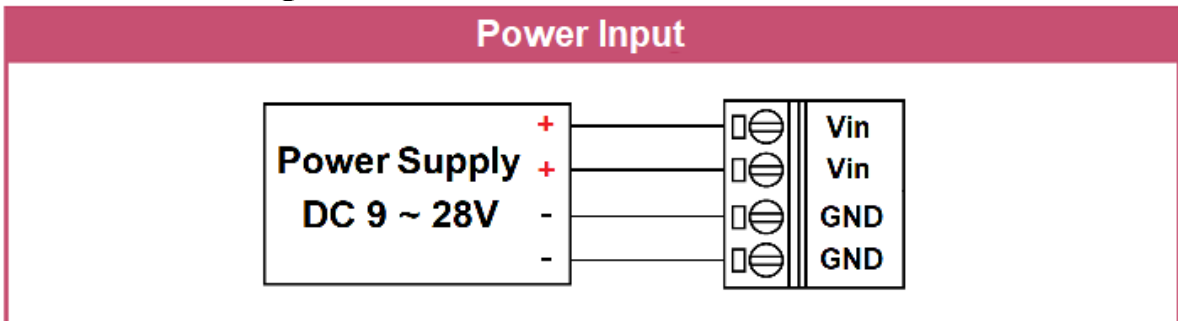
2.4.5 Power Input

Figure 2-10: Power Input

2.4.6 RS-485 Wiring

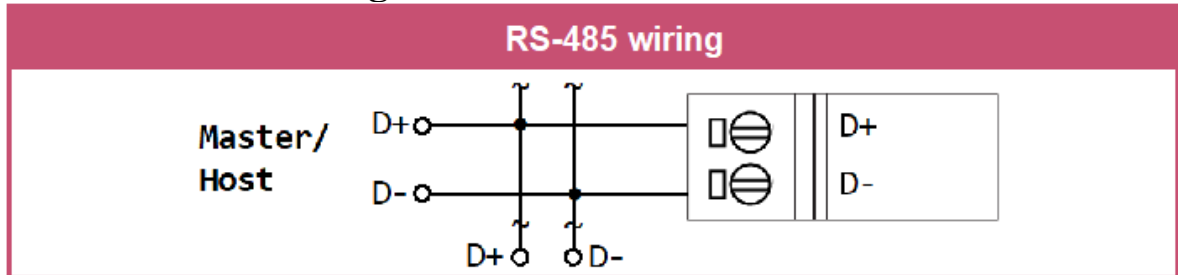
Figure 2-11: RS-485 Wiring

3. Software

The ALM04_Editor Utility provides the simple way to create or modify the MP3 Audio files & RS-485 Modbus RTU configuration. It is available on Windows application to configure the ALM-04-MRTU.

Utility Support Windows 7 (or later versions).

3.1 ALM04 Editor Utility

The following is the main screens provided by ALM Utility, these utility tools can be thought as a useful tool for configuration and monitoring on the ALM-04-MRTU. It supplies several functions, such as Monitoring, Configuration, Connection, Wi-Fi setting and F/W upgrade, etc...
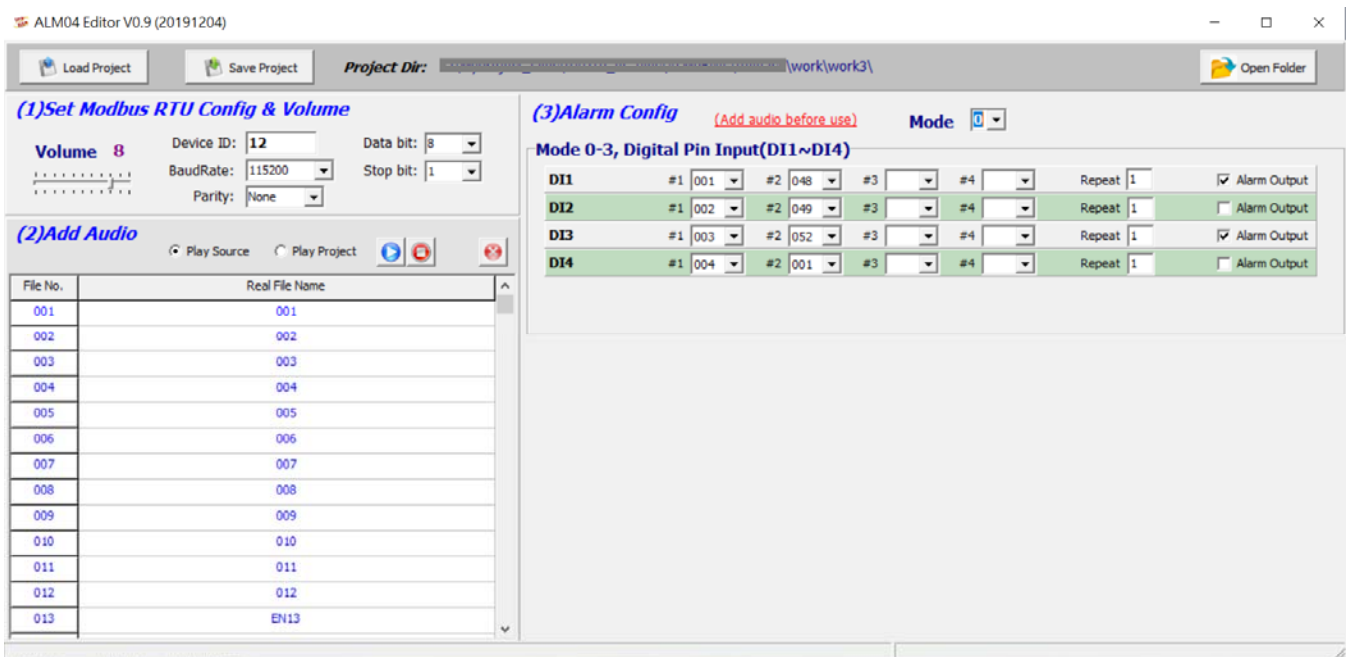
3.1.1 Main Screen

Figure 3-1: ALM04_Editor Utility main screen

3.1.2   Alarm Mode & Audio Editor

ALM-04-MRTU contain 8 kinds of alarm mode, **Mode 0 ~ 3** are DI1~DI4 in single independence channel trigger, in DIx channel priority, the priority of DI channel is DI4 > DI3 > DI2 > DI1.
Mode 4 ~ 7 are DI1~DI4 in Binary trigger, the priority of DI channel (DI4,DI3,DI2,DI1) in this mode is 1111b(0x0F)>…> 0001b(0x01).

Alarm Mode			
Mode	Channel Trigger Function	Mode	Binary Trigger Function
0	General Playback	4	General Playback
1	Trigger Input priority Playback	5	Trigger Input priority Playback
2	Hold Repeat Playback	6	Hold Repeat Playback
3	Memory Once Playback	7	Memory Once Playback

Max 4 MP3 files can be added for each Channel or Binary trigger alarm, it will playback from #1 to #4 for the trigger depend on the setting.
Relay output can set an extend alarm output to trigger another device.
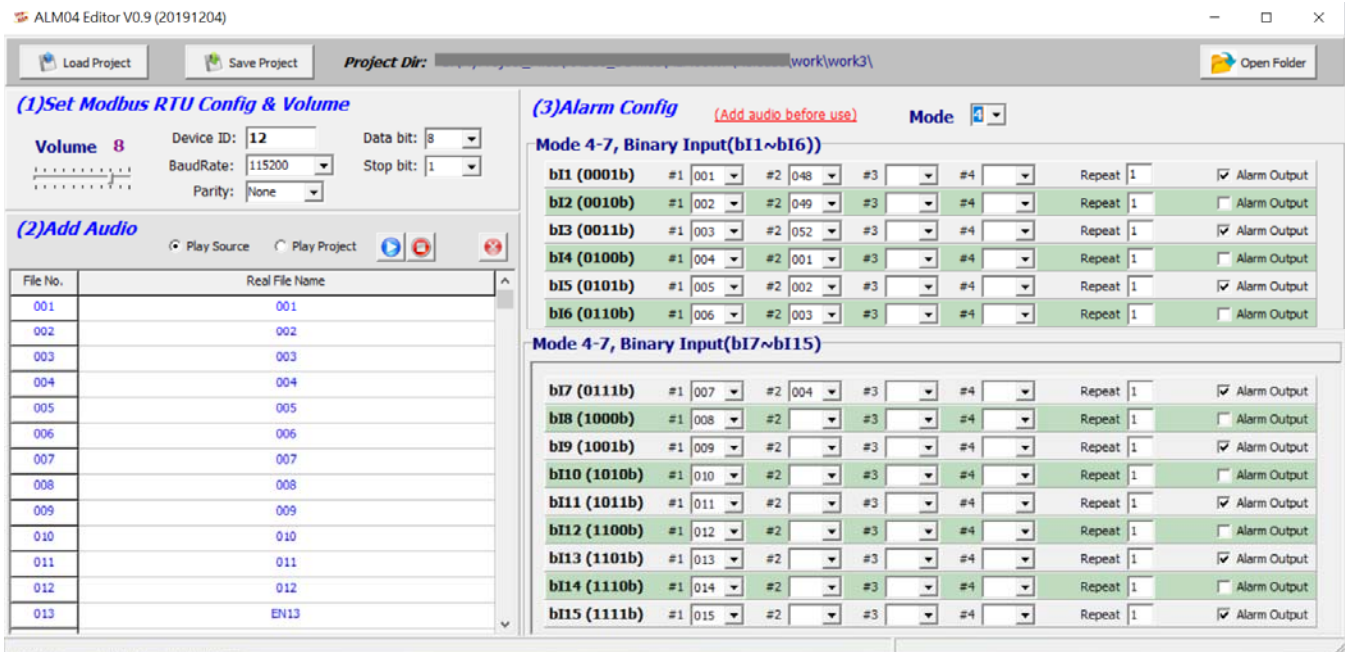All those setting can be done in PC Utility, show as below.

Figure 3-2**:** ALM-04-MRTU PC Utility Audio Editor page.

3.2 Start your Edit

First, load your project if the "**_Project Dir:_**" is not your target work job, or you need to start with a new project.

To Create a new project, use **Load Project** button, select the directory where you want to put and add the new directory name "newwork1", etc. show as below.
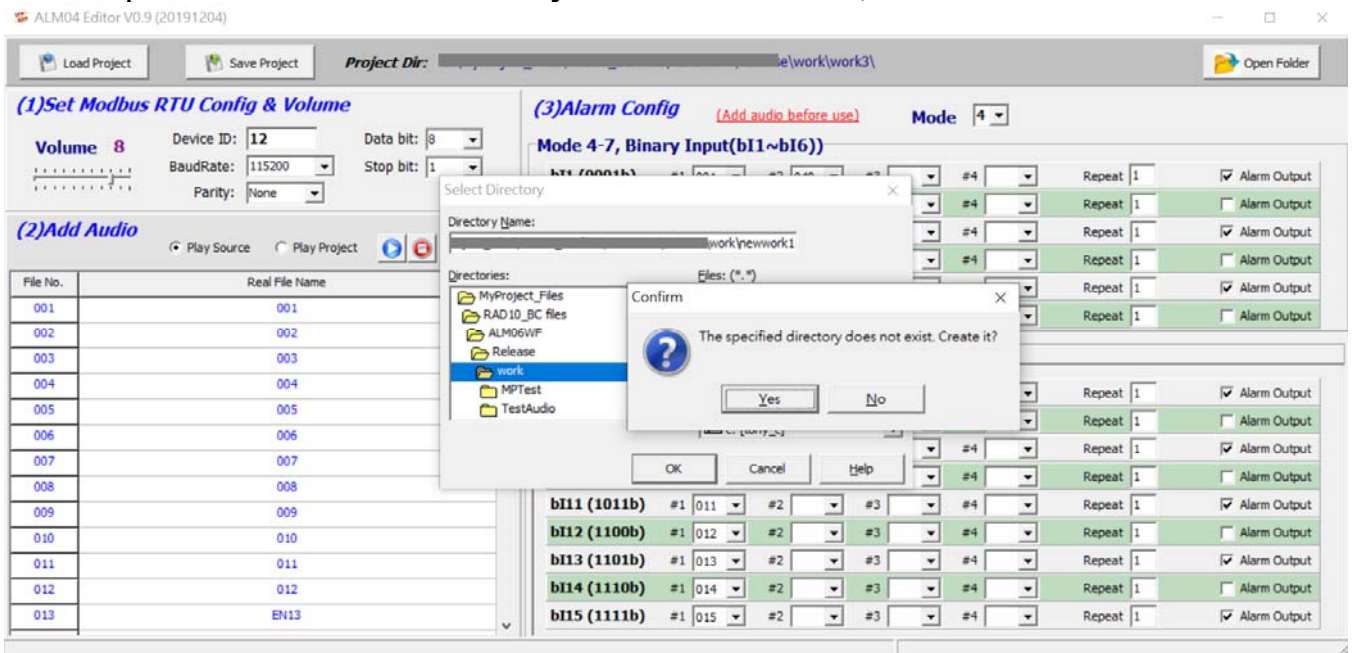

Figure 3-3**:** New a Project in Editor.

Then, Follow the step number,
(1) Set Modbus RTU Config & Volume:
For default,
Volume level is **6**, range from 0(Mute)~10(Max).
For Modbus RTU Device ID is **1**.
For RS-485 (115200,N,8,1)
Baud Rate: **115200**
Parity: **None**
Data bit always be **8**
Stop bit: **1**
Modify those item for your system request.

(2) Add Audio: Double Click on which File No. you are going to add the audio file, max 64 files can be assigned.

     File No. play back, select **Play Source** (Audio file original location) or **Play Project** (Audio file in project), click **File No.** and press **Play** button to play, and **Stop** button to break playback.

Click **File No.** and press the **Delete** button to remove file name in list, show as below.
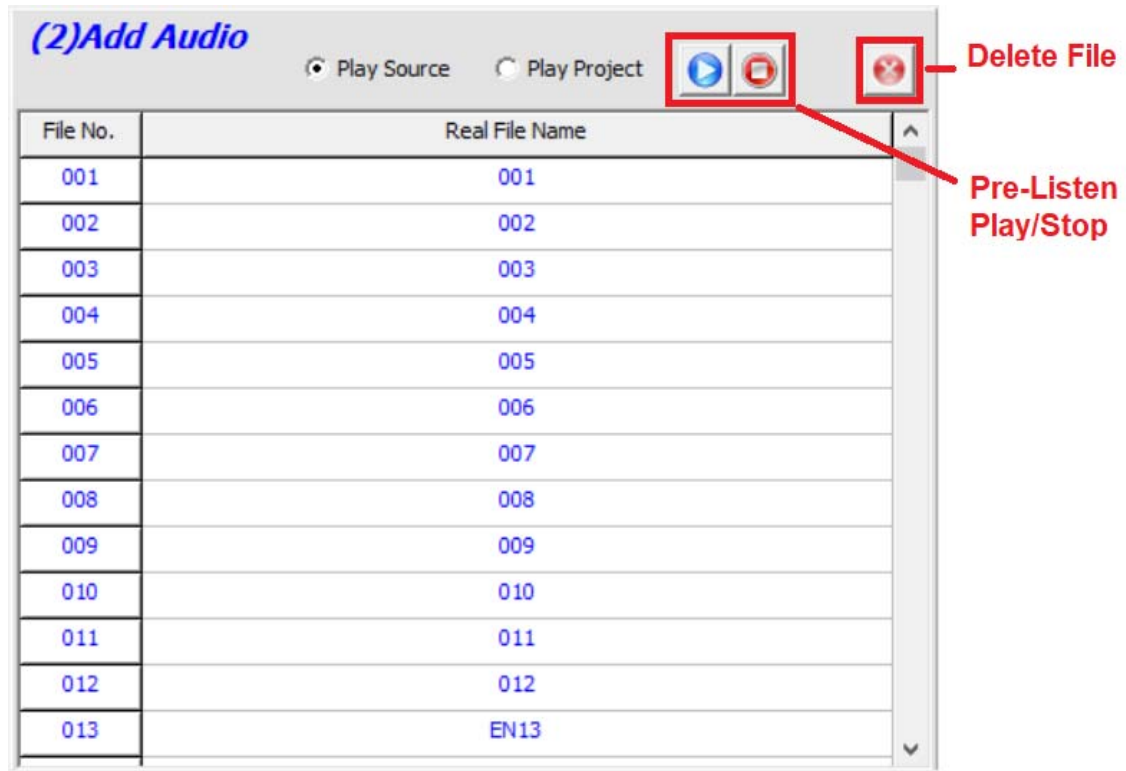

Figure 3-4: Play Back & Delete File.

(3) Alarm Config: Frist you need to select **Alarm Mode**, then you can assign audio File No. for each alarm channel from combo box, playback Repeat count & Alarm Output Relay.
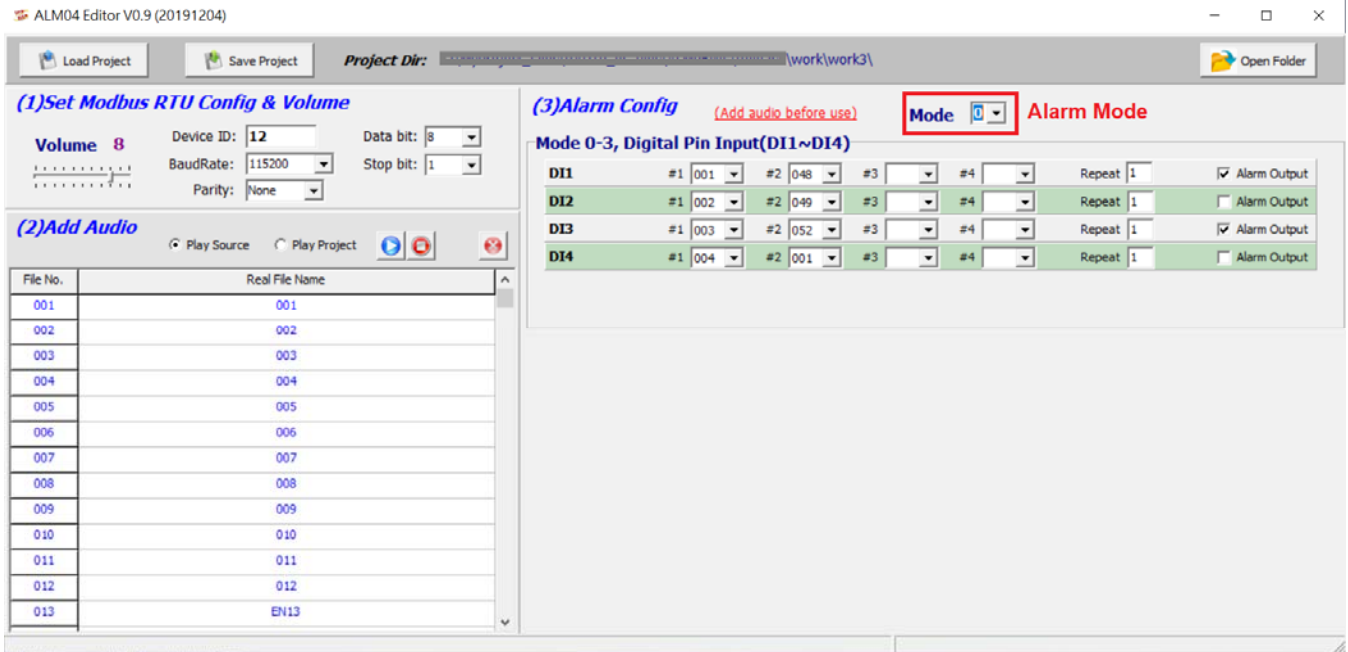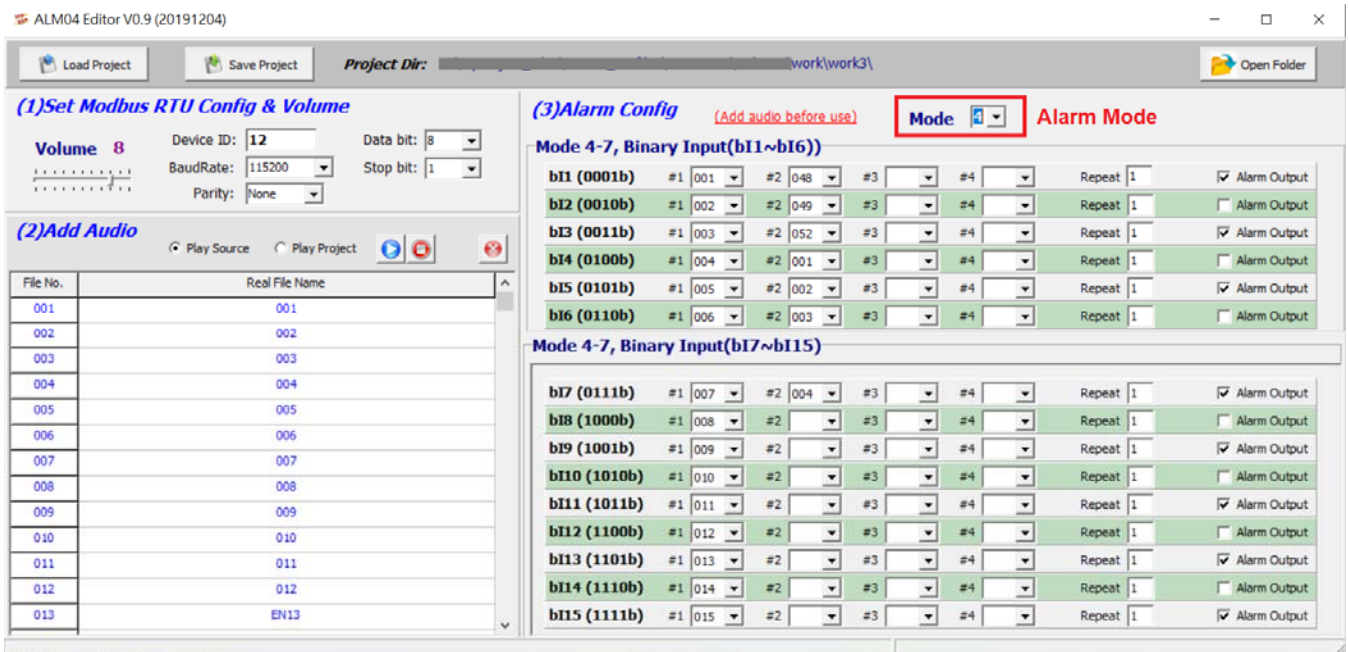

Figure 3-5**:** Alarm Config Mode0~3

Figure 3-6**:** Alarm Config Mode4~7

3.2.1 Make a Micro SD from project

Open project folder uses the **Open Folder** button, copy all the files inside this folder to the MicroSD root directory.
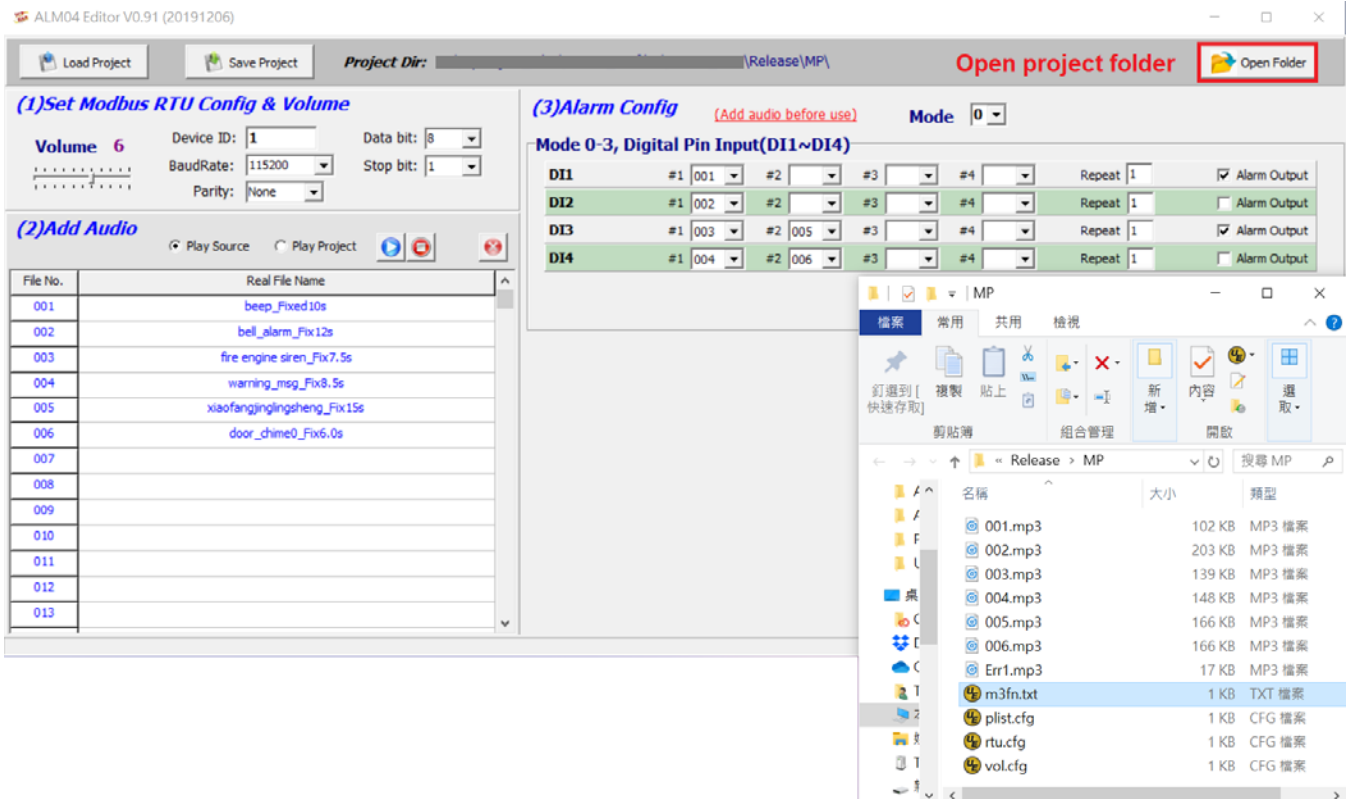

Figure 3-7**:** Open Project folder to copy

3.2.2 File content in SD Card

0xx.mp3 : File name start from 001.mp3~064.mp3 is MP3 audio file user can assign in editor.

m3fn.txt : Content MP3 file's long file name.

plist.cfg : Content the alarm index play rules, alarm mode, relay output enable, repeat count.

rtu.cfg : Content the Modbus RTU & RS-485 setting e.g. "1,115200,N,8,1",

The first "**1**" is for Modbus RTU Device ID.

"115200,N,8,1" is for RS-485,

Baud Rate: **115200**

Parity: **None**

Data bit always be **8**

Stop bit: **1**

vol.cfg : Content the volume setting e.g. "5", the volume level from 0(Mute) ~ 10(Max), this file will be delete after the device boot up & been read.

3.3 Alarm Mode Description

Mode 0: Channel Trigger-General Playback
- DI1 to DI4 playback in single independence trigger of 4 channels.
- A pulse input triggered the Playback. Playback repeat when the input is not release.
- When alarm in playback process, any input trigger will ignore.
- The highest DIx channel priority input will take place after the previous playback complete.
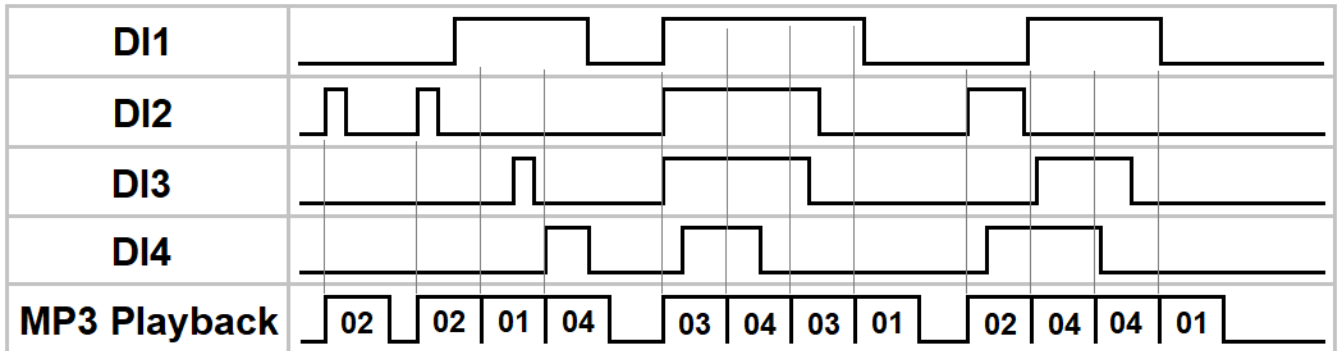

Figure 3-8: ALM-04-MRTU Mode 0

Mode 1: Channel Trigger-Trigger Input priority Playback
- DI1 to DI4 playback in single independence trigger of 4 channels.
- When alarm in playback process, any trigger input will break & take place the previous playback.
- In this mode, it only playback once, even the input is not release.
- Only when multi trigger in same time the highest DIx channel priority will take place
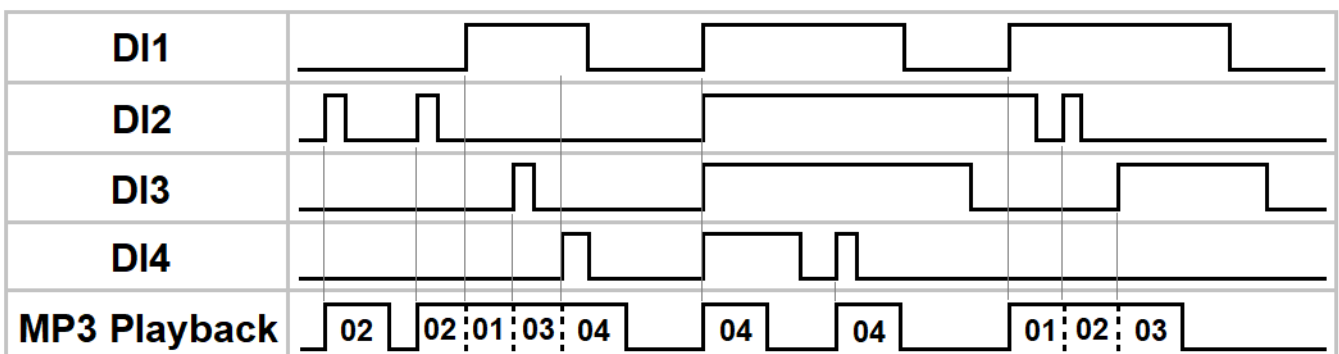

Figure 3-9: ALM-04-MRTU Mode 1

Mode 2: Channel Trigger- Hold Repeat Playback

- DI1 to DI4 playback in single independence trigger of 4 channels.
- When alarm in playback process, only higher DIx channel priority can break & take place the previous playback.
- Playback will repeat when input are not release & will stop immediately when input released.
- When multi trigger in same time the highest DIx channel priority will take place

Figure 3-10: ALM-04-MRTU Mode 2

Mode 3: Channel Trigger- Memory Once Playback

- DI1 to DI4 playback in single independence trigger of 4 channels.
- When alarm in playback process, any trigger input will memory once for next playback.
- In this mode, it only playback once, even the input is not release.
- When multi trigger in same time the highest DIx channel priority will take place

Figure 3-11: ALM-04-MRTU Mode 3

Mode 4: Binary Trigger-General Playback

- DI1 to DI4 are used as binary input, max 15 channels.
- A pulse input triggered the Playback. Playback repeat when the input is not release.
- When alarm in playback process, any input trigger will ignore.
- The highest binary channel priority input will take place after the previous playback complete, DI4 is the most highest channel.

Figure 3-12: ALM-04-MRTU Mode 4

Mode 5: Binary Trigger-Trigger Input priority Playback

- DI1 to DI4 are used as binary input, max 15 channels.
- When alarm in playback process, any trigger input will break & take place the previous playback.
- In this mode, it only playback once, even the input is not release.
- The priority depend on trigger input, only when multi trigger in same time the highest binary channel priority will take place, DI4 is the most highest channel.

.

Figure 3-13: ALM-04-MRTU Mode 5

Mode 6: Binary Trigger- Hold Repeat Playback
■ DI1 to DI4 are used as binary input, max 15 channels.
■ When alarm in playback process, only highest binary channel priority can break & take place the previous playback.
■ Playback will repeat when input are not release & will stop immediately when input released.
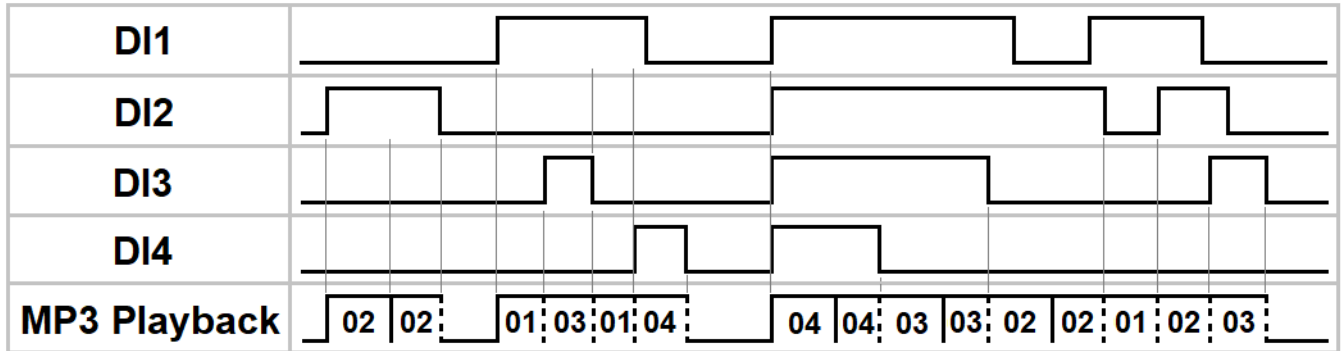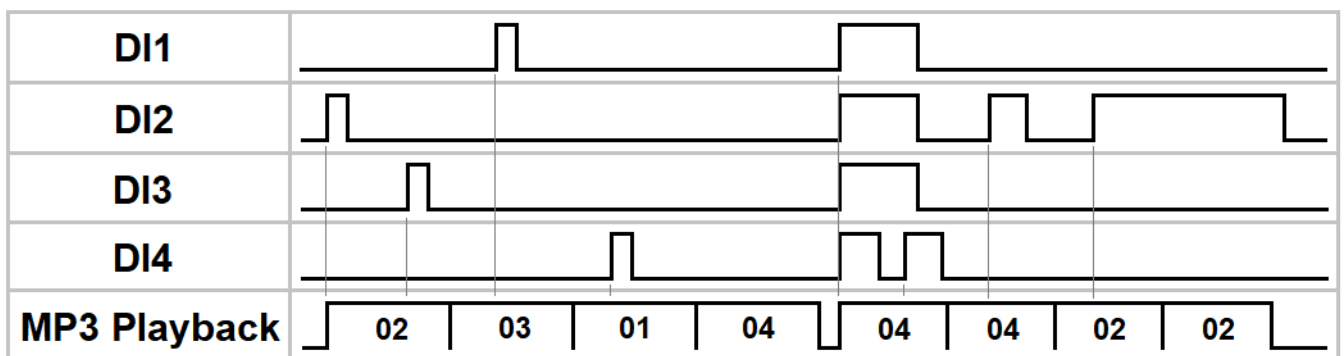■ When multi trigger in same time the highest binary channel priority will take place, DI4 is the most highest channel.
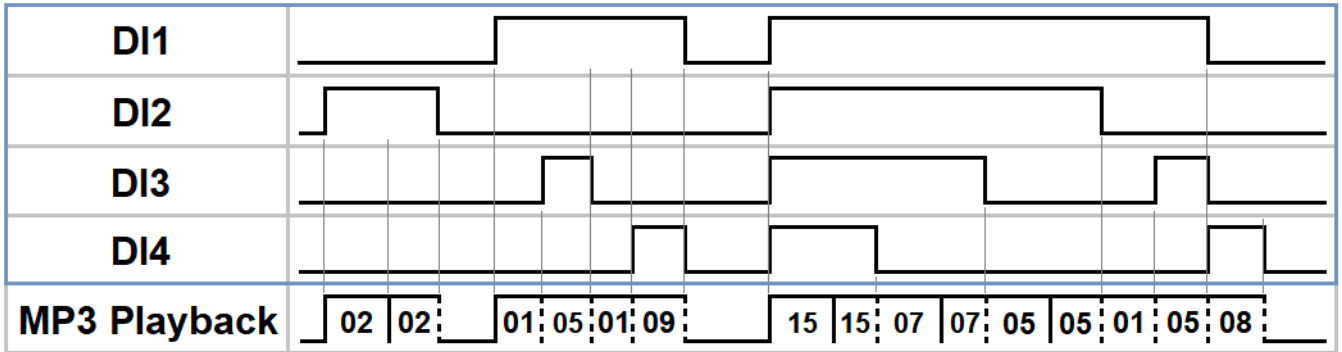
Figure 3-14: ALM-04-MRTU Mode 6

Mode 7: Binary Trigger- Memory Once Playback
■ DI1 to DI4 are used as binary input, max 15 channels.
■ When alarm in playback process, any trigger input will memory once for next playback.
■ In this mode, it only playback once, even the input is not release.
■ The highest binary channel priority input will take place after the previous playback complete, DI4 is the most highest channel.
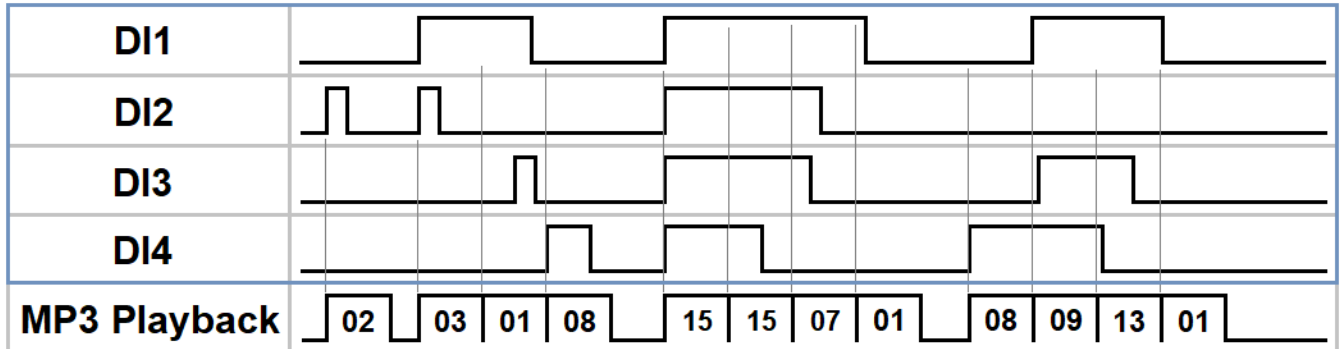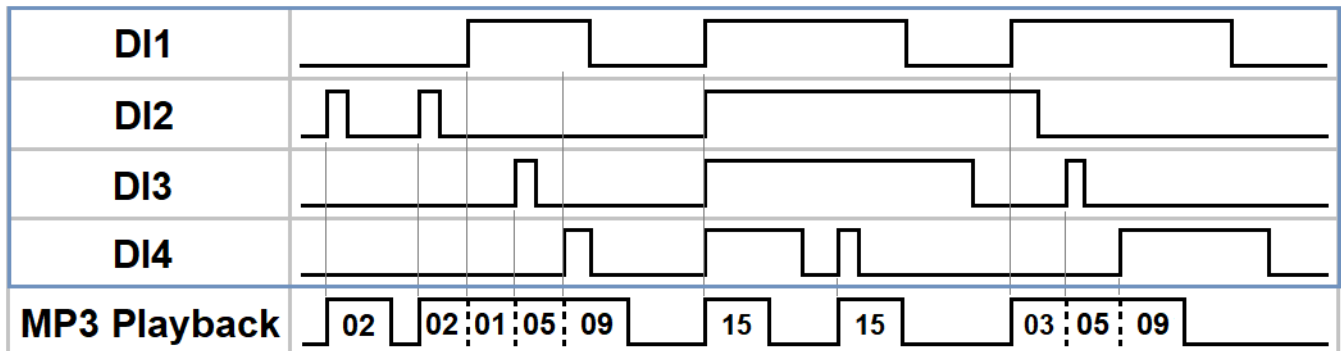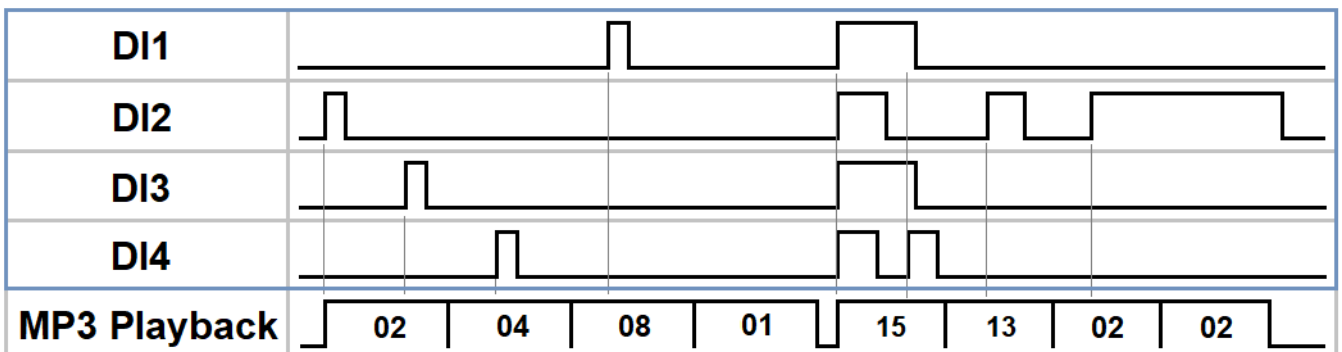

Figure 3-15: ALM-04-MRTU Mode 7

4. Modbus RTU Protocol

The Modbus protocol is developed by Modicon Inc., originally developed for Modicon controllers. Detailed information can be found at http://www.modicon.com/techpubs/toc7.html. You can also visit http://www.modbus.org to find more valuable information. ALM-04-MRTU modules support the Modbus RTU protocol. The communication Baud Rates range from 300bps to 115200bps. The following Modbus functions are supported.

4.1 Function Code

Function Code	Descriptions
01 (0x01)	Read Coils
02 (0x02)	Read discrete Inputs
03 (0x03)	Read multiple Output registers
05 (0x05)	Write Single Coil
06 (0x06)	Write single Output register

Table 4-1: Supports Function Codes of ALM-04-MRTU

If the function specified in the message is not supported, then the module responds as follows.

4.2 Error Response

Byte Index	Field Name	Byte count	Description
00	Address	1 Byte	1 to 247
01	Function code	1 Byte	Function code + 0x80
02	Exception code	1 Byte	01

Table 4-2: Error response of ALM-04-MRTU

If a CRC mismatch occurs, the module will not respond.

4.3 Data Encoding

Modbus uses a "big-endian" representation for address and data items. This means that when a numerical quantity larger than single byte is transmitted, the most significant byte (MSB, also called the high-order byte) is send first. The following sub-topics describe the different byte of encoding and show how the data is encoded as it is within the Modbus RTU packet.

4.3.1 Binary

A binary item is represented as a single bit within a data word. All binary is packed into 16-bits data words, which are accessed using function code 01 and 02. Therefore, a single register contains 16 bits of binary data, each having a specific meaning.

Value	1st	2nd
0xAA55 (1010101001010101)	0xAA (10101010)	0x55 (01010101)

Table 4-3: A single register contains 16 bits of binary data

4.3.2 16-bits Word(INT16)

A 16-bits word item is transmitted with the most significant byte first. Function code 03 and 04 read 16-bits items at a time; therefore, each of these data items will fit within one register that is read.

Value	1st	2nd
0x1234	0x12	0x34

Table 4-4: A 16-bits word item

4.4 ALM-04-MRTU Address Mapping

Modbus Address(MB Addr) Base: 0x00

Address	MB Addr	CH	Descriptions	Range(Byte)	Type
00001	0	1	Digital Output	0=OFF, 1=ON	R

∗ Length must always be 1.

Table 4-5: FC01 Read Coil address (0xxxx)

Address	MB Addr	CH	Descriptions	Range(Byte)	Type
10001~ 10004	0 ~ 3	1 ~ 4	Digital Input	0=OFF, 1=ON	R

Table 4-6: FC02 Read Discrete Inputs address (1xxxx)

Address	MB Addr	CH	Descriptions	Range(INT16)	Type
40001	0	-	Volume Level	0 ~ 10	R

∗ Length must always be 1.

Table 4-7: FC03 Read multiple Output registers address (4xxxx)

Address	MB Addr	CH	Descriptions	Range(Byte)	Type
00001	0	1	Relay Output	0x00=OFF, 0xFF=ON	W

∗ Length must always be 1.

Table 4-8: FC05 Write single Coil address (0xxxx)

Address	MB Addr	CH	Descriptions	Range(INT16)	Type
40001	0	-	Volume Level	0 ~ 10	W
40002	1	-	Play Back Alarm Index	0: Stop Playback 1~15: Alarm Index	W

Table 4-9: FC06 Write single Output registers address (4xxxx)

Technical Support

If you have problems about using the ALM-04-MRTU controller, please contact ICP DAS Product Support.

Email: service@icpdas.com