

BY8001-16P MP3 Player Module

Marketed by: Shenzhen Balway Electronic Technology



1. Overview

The BY8001-16P is a compact, high quality MP3 module. The BY8001's master chip (SSOP24) supports decoding MP3 and WAV formats. The Module also has built-in TF card holder, and supports replacement audio content by an external USB stick using USB data cable. The module also has a built-in 3w power amplifier that can directly drive a single 3W speaker. This module was independently developed by Shenzhen Electronic Technology Ltd.

2. Product Characteristics

- Support MP3 and WAV high quality audio format files.
- 24 DAC Output dynamic range of 90dB and SNR in excess of 85dB.
- Supports 15 one-to-one voice trigger playback, 8 keypad trigger modes to choose from with 3 I/O hardware configurations making for wider variety of applications.
- Supports UART Asynchronous serial port control for play, pause, next track, amplifier volume levels, track selections, interruptions for advertising announcements, etc.
- Built-in volume, track, Spectrum Equalizer, power off saved memory functions.
- TF (Micro SD) card holder supports up to 32GB memory, removable TF card for changing audio content.

- Supports reading USB flash drives up to 32GB as a replacement for TF content via USB data cable.
- Onboard 3W power amplifier directly drives external mono speaker; customers may also add 2-channel power amplifier for stereo playback.
- Standard 2.54mm inline pin spacing, DIP16 compact package (not however breadboard friendly).

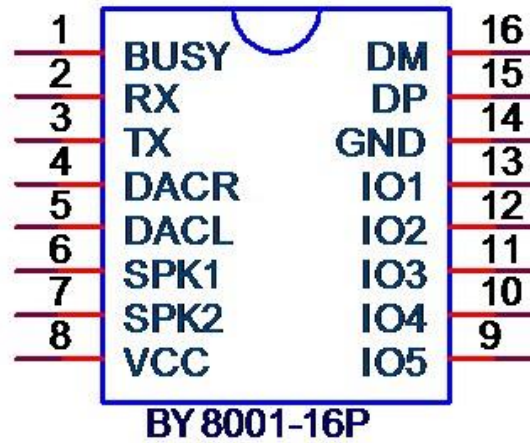
3. Applications

- The industrial control and field equipment
- Intelligent transportation equipment: Tollgate, parking, in-vehicle voice prompts
- Advertising: loudspeaker broadcasting
- Access control and time attendance with voice prompts/warnings
- Security industries, entry/exit voice prompts
- Advanced toys, game machine action sounds
- Medical electronics requiring device voice prompts
- Education and communication

4. Technical Specifications

Design Specification	Parameters
MP3 And WAV file formats	Supported sampling rates 8 - 48K and Bit rates 8 - 320Kbps audio files
UART Interface	Standard serial port, 3.3V, TTL-level, baud rate 9600
Input voltage	3.6V-5V (Typical 4.2V)
Quiescent current	16MA (in Standby mode)
Amplifier power	3W/4ohm or 2W/8ohm speaker (module's amplifier chip gets rather hot driving 4 ohm speaker over very short period, 8 ohm speaker is recommended)
Dimensions	22mm*21mm
Working temperature	-40°C - 70°C
Humidity	5% - 95%

5. Module Pin Mapping



Pin Number	Pin Name	Functional Description	Notes
1	BUSY	Playback output high, stopping for low	Busy signal
2	RX	UART Asynchronous serial data input	3.3V TTL level
3	TX	UART Asynchronous serial data output	3.3V TTL level
4	DACR	DAC Right channel output	External amplifier, headphone
5	DACL	DAC The left channel output	External amplifier, headphone
6	SPK1	External monaural speaker	3W/4 ω 2W/8 ω passive loudspeaker
7	SPK2	External monaural speaker	3W/4 ω 2W/8 ω passive loudspeaker
8	VCC	Positive power supply	3.6-5V
9	IO5	Input 5	Key/Button function trigger
10	IO4	Input 4	Key/Button function trigger

11	IO3	Input 3	Key/Button function trigger
12	IO2	Input 2	Key/Button function trigger
13	IO1	Input 1	Key/Button function trigger
14	GND	Power common ground	System Ground
15	DP	USB Data cable	USB Flash Drive
16	DM	USB Data cable	USB Flash Drive

6. I/O Port Description

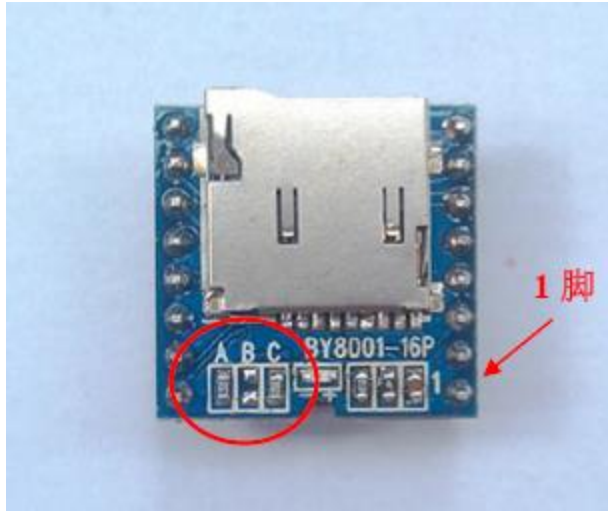
This module has five triggering I/O ports supporting up to 15 keys for triggering playback.

15 Keypad Press-to-Play Mapping:

I/O Pin	Function	I/O Pin	Function
IO1	Play track 1	IO1- IO5	Play track 9
IO2	Play track 2	IO2- IO3	Play track 10
IO3	Play track 3	IO2- IO4	Play track 11
IO4	Play track 4	IO2- IO5	Play track 12
IO5	Play track 5	IO3- IO4	Play track 13
IO1- IO2	Play track 6	IO3- IO5	Play track 14
IO1- IO3	Play track 7	IO4- IO5	Play track 15
IO1- IO4	Play track 8		

Keypad Control Modes, set by ABC solder pads on module PCB

Three I/O ports (A, B, C) can be set on front of module with PCB solder pads (labelled A, B, C) to ground by using 3.3K ohm 0402 SMD resistors. These provide a selection of up to eight different keystroke control modes, suitable for a wide variety of applications.



In the table below, '0' means grounding through a 3.3Kohm resistor, while '1' means open circuit. The module factory default setting is 010, but may be modified to suit customer's application. For serial control by MCU, recommended mode setting is '111'.

A	B	C	Keypad Triggered Playback Functions	
0	0	0	Play Once (play is only interrupted by another selection, but can't be stopped)	
0	0	1	Play/Stop	
0	1	0	Play Once (play is only interrupted by another selection, but can't be stopped)	
0	1	1	Play Once (play can't be manually interrupted or stopped)	
1	0	0	Play (press and hold), Stop (release) Note: MCU serial port control not supported by this mode.	
1	0	1	Play (press and hold), Stop (release) Note: MCU serial port control not supported by this mode.	
1	1	0	Standard MP3 mode	
			IO1	Play/Pause Track (short press), Stop Play (long press)
			IO2	Next Track (short press), Volume +(long press)

			IO3	Previous Track (short press), Volume- (long press)
			IO4	Volume +
			IO5	Volume-
1	1	1	Special function applications, Recommended mode for serial control by MCU	
			IO1	Play (short press), Repeat Play (press and hold through end of track)
			IO2	Next (short press), Volume+ (long press)
			IO3	Previous (short press), Volume- (long press)
			IO4	Replay/Restart (short press)
			IO5	Shuffle Play/Stop (Plays all tracks in random order)

7. Serial Control Protocol

BY8001 Built-in standard UART Asynchronous serial interface, which belongs to the 3.3V TTL Level interface. Via MAX3232 chip converts RS232 levels. Communication data format is: baud rate: 9600, start bit: 1 bit; data bits: 8 bits and parity bit: none; stop bit: 1 bit. Using computer serial debugging assistant, you need to correctly set the serial port parameters:

Protocol command format

A MCU communicating with the BY8001 by serial protocol must send a string of command bytes (request) according to the following table:

Start Code	Length	Operation Code	Parameters	Check Code	End Code
7E	See below	See below	See below	See below	EF

All serial data is sent as a string of bytes, represented here as two-digit hexadecimal numbers, always beginning with Start Code (7E) and ending with an End Code (EF). **Length** byte refers to the number of subsequent bytes sent as hex codes (e.g., count of the Operation Code, plus any number of Parameters, plus the End Code". **Check Code** byte refers to the hex byte value derived as value calculated when XORing the string of Opcode with all associated Parameters. Customers can easily calculate the checksum value using any programmer's calculator that includes an XOR function.

For example, for Play instruction sent as hex: 7E 03 01 02 EF, Check Code 02 is calculated by formula: 03 XOR 01 = 02. If using the calculator program on the Windows PC, select HEX, and finally click to calculate 03 XOR 01 = 02.

Likewise, for the Play Track instruction, sent as hex: 7E 05 00 01 45 EF, the Check Code 45 is obtained by formula: 05 XOR 00 XOR 01 = 45.

Depending on the type of serial command request or the modules change in operating status, the module will respond/send a string of bytes as shown in the following table:

Ready Prompt (if preceding)	Return Codes (if any)	End Codes (if any)	Ready Prompt (if any, or if not preceded)
		0D 0A (CR, LF)	4F 4B ("OK")
	53 54 4F 50 ("STOP")		
4F 4B ("OK")			
	30 30 30 31 ("0001")	0D 0A (CR, LF)	4F 4B ("OK")

Startup (Power Restored) or Reset Return Codes

Return Codes	End Codes	Ready Prompt
45 50 50 52 4F 4D 20 4F 4E 4C 49 4E 45 6B 65 79 5F 41 42 43 48 3A 30 37 ("EEPROM ONLINEkey_ABC SWITCH:07")	0D 0A (CR, LF)	4F 4B ("OK")
4F 4B 4D 50 33 4E 4F 20 46 49 4C 45 4F 4B (with storage device inserted: "MP3NO FILE")		
4F 4B 4D 50 33 (without storage device inserted: "MP3")		

Note: 'NO FILE' reporting may be corrected with newer firmware version.

Storage Device Insertion Return Codes

Return Codes	End Codes	Ready Prompt
		4F 4B ("OK")

Storage Device Removal Return Codes

Return Codes	End Codes	Ready Prompt
53 54 4F 50 ("STOP")		

Data Error(s) Return Codes

Return Codes	End Codes	Ready Prompt
Not supported		

Serial Command Set

Execute commands:

Hex Command	Function	Function Hex Parameters
0x01	Play	None
0x02	Pause	None
0x03	Next track	None
0x04	Previous track	None
0x05	Increase volume setting (+1)	None
0x06	Decrease volume setting (-1)	None
0x07	Toggle standby/normal modes	None (when in Standby mode, 10mA current draw)

0x09	Reset module	None
0x0A	Fast forward	None
0x0B	Fast rewind	None
0x0E	Stop playback	None
0x31	Set volume level (0-30) (memory retained during power failure)	0x00-0x1E
0x32	Set equalizer profile	0x00-0x05 (Normal\Pop\Rock\Jazz\Classic\Bass) (Power failure memory)
0x33	Set loop playback mode (mode 4 disables loop playback)	0x00-0x04 (0/1/2/3/4 all/folder/single/random/disabled) (Power failure restores mode 4)
0x34	Folder switch	0x00 (Previous folder),0x0 1 (Next folder)
0x35	Switch device	0x00 (U Disk), 0x01 (TF card)
0x41	Play track by index number (1-65535) (Combination Play supports up to 10 track commands being sent in a row before first play starts)	0x0001 – 0xFFFF (Index is prescribed by FAT file system. Index order is generally in order that files were copied to flash drive, but not guaranteed. A FAT file sorter software program (such as “DriveSort” or “FAT32 Sorter”) should be used if specific file index order for playback is required.)
0x42	Track playback from specified folder	Eight-digit folder number (00-99), the lower eight bits for the song name (001-255)
0x43	Spot play insertion function (tracks 0-65535) (Interrupts current play to play another, then resume play) (TF device not supported)	0x0000 – 0xFFFF
0x44	Playback insertion from specific folder (TF device not supported)	Eight-digit folder number (00-99), the lower eight bits for the track number (000-256)

Query Commands:

Hex Command	Corresponding function	Returned parameters
0x10	Query the playback status	0x0000 (stopped), 0x0001 (playback), 0x0002 (paused/suspended), 0x0003 (Fast forward), 0x0004 (Rewind)
0x11	Query volume setting (0-30)	0x0000-0x001E
0x12	Query equalizer profile setting	0x0000-0x0005 (None\Pop\Rock\Jazz\Classic\Bass
0x13	Queries loop playback mode	0x0000-0x0004 (0/1/2/3/4 all/folder/single/random/disabled)
0x14	Query module firmware version number	0x0001 (version 1.0)
0x15	Query total number of track files on TF card (0 – 65535)	0x0000 – 0xFFFF
0x16	Query total number of track files on USB flash drive (0-65535)	0x0000 – 0xFFFF
0x18	Queries the current playback device	0x0000 (U Disk), 0x0001 (SD)
0x19	Query TF card 's current track (index position 1-65536)	0x0000 – 0xFFFF
0x1A	Query USB current track (index position 1-65536)	0x0000 – 0xFFFF
0x1C	Queries elapsed playback time in seconds (0-65535) of current track	0x0000 – 0xFFFF
0x1D	Queries total playback time in seconds of current track	0x0000 – 0xFFFF
0x1E	Querying current track file name (provides only FAT32 stored	0xYY 0xYY 0xYY 0xYY 0xYY 0xYY 0xYY 0xYY 0xZZ 0xZZ 0xZZ Note: YY's are hex upper case ASCII key codes of

	short file names (8 characters) which appear as abbreviated track title taken from FAT32 long file name (e.g., if naming with more than 8 characters)	characters taken from track title file name, followed by three ZZ hex ASCII key codes, identifying file format (“WAV” or “MP3”).
0x1F	Queries number of files in current playback folder (0-65535)	0x0000 – 0xFFFF

Note: BY8301-16P apparently uses the same instruction set as BY8001-16P. BY8301-16P has USB port for plug-in USB flash drive, no TF card slot, and different module pinout order, so not a drop in replacement for BY8001.

7.1 Execute and Query Commands Examples

7.1.1 Play

Start Code	Length	Operation Code	Check Code	End Code
7E	03	01	02	EF

This command sends an instruction to play the current track selection. This command also allows resuming playback if playback status is in a paused or stopped state.

7.1.2 Pause

Start Code	Length	Operation Code	Check Code	End Code
7E	03	02	01	EF

This command sends an instruction to pause track playback.

7.1.3 Next Track

Start Code	Length	Operation Code	Check Code	End Code
7E	03	03	00	EF

This command triggers playback of the next track. When the last track is the current selection, this command will trigger the first track selection to be played.

7.1.4 Previous Track

Start Code	Length	Operation Code	Check Code	End Code
7E	03	04	07	EF

This command triggers playback the previous track. When the first track is selected, this command will trigger the last selection to be played.

7.1.5 Increase Volume

Start Code	Length	Operation Code	Check Code	End Code
7E	03	05	06	EF

This command increases the volume setting by one.

7.1.6 Decrease Volume

Start Code	Length	Operation Code	Check Code	End Code
7E	03	06	05	EF

This command decreases the volume setting by one.

7.1.7 Standby/Normal

Start Code	Length	Operation Code	Check Code	End Code
7E	03	07	04	EF

Ready Prompt	Return Codes	End Codes	Ready Prompt
4F 4B	49 44 4C 45		
	4D 50 33		4F 4B 4F 4B

When sending this command, the module switches to low power standby state and responds with “OKIDLE”. When sending this command again and module returns to normal power state and responds with “MP3OKOK”.

7.1.8 Reset Module

Start Code	Length	Operation Code	Check Code	End Code
7E	03	09	0A	EF

Ready Prompt	Return Codes	End Codes	Ready Prompt
4F 4B	45 50 50 52 4F 4D 20 4F 4E 4C 49 4E 45 6B 65 79 5F 41 42 43 48 3A 30 37	0D 0A	4F 4B
	4F 4B 4D 50 33 4E 4F 20 46 49 4C 45		4F 4B

Module is reset and sends reply:

“OKEEPROM ONLINEkey_SWITCH:07

“OKMP3NO FILEOK”

7.1.9 Fast Forward

Start Code	Length	Operation Code	Check Code	End Code
7E	03	0A	09	EF

Fast forwards the track playback for a short period.

7.1.10 Fast Rewind

Start Code	Length	Operation Code	Check Code	End Code
7E	03	0B	08	EF

Rewinds track playback for a short period.

7.1.11 Stop Playback

Start Code	Length	Operation Code	Check Code	End Code
7E	03	0E	0D	EF

This instruction stops playback.

7.1.12 Set Playback Volume

Start Code	Length	Operation Code	Parameters	Check Code	End Code
7E	04	31	19	2C	EF

This instruction sets the volume level to 25 in a range of 0-30. This instruction can be sent before, during, or after playback, and the setting is stored in memory for initialization when power is restored.

7.1.13 Set Equalizer Profile

Start Code	Length	Operation Code	Parameters	Check Code	End Code
7E	04	32	00	36	EF

This instruction sets the equalizer profile to “no spectrum filtering”.

7.1.14 Set Loop Mode

Start Code	Length	Operation Code	Parameters	Check Code	End Code
7E	04	33	02	35	EF

This command sets the loop mode to mode 2 (single track). The current track will replay over and over. To disable loop playback mode, set the loop mode to mode 4.

7.1.15 Folder switch

Start Code	Length	Operation Code	Parameters	Check Code	End Code
7E	04	34	01	31	EF

This command switches playback to next folder.

7.1.16 Switch Device

Start Code	Length	Operation Code	Parameters	Check Code	End Code
7E	04	35	01	30	EF

This command switches storage device to the TF Card Drive. Command allows for switching a playback device when there is more than one device installed.

7.1.17 Play Track By Index Number

Start Code	Length	Operation Code	Parameters		Check code	End code
			High Byte	Low Byte		
7E	05	41	00	01	45	EF

This command specifies playing track number 1.

Combination Play supports up to 10 tracks and is performed by sending a stream of multiple Play Specific Track commands. Example below plays tracks 1,2,3,4:

7E 05 41 00 01 45 EF 7E 05 41 00 02 46 EF 7E 05 41 00 03 47 EF 7E 05 41 00 04 40 EF

7.1.18 Track playback from specified folder

Start Code	Length	Operation Code	Folder Number	Track Number	Check Code	End Code
7E	05	42	00	02	45	EF

This command specifies playback of a track from a specified folder.

7.1.19 Spot Playback Insertion Function (TF device not supported)

Start Code	Length	Operation Code	Parameters		Check Code	End Code
			High Byte	Low Byte		
7E	05	43	00	03	45	EF

Module suspends current track playback, then plays the track specified. When insertion playback is finished, the current track playback is resumed. When play finished, then play pause track.

7.1.19 Insertion Playback Function from Specific Folder (TF device not supported)

Start Code	Length	Operation Code	Folder Number	Track Number	Check Code	End Code
7E	05	44	01	06	46	EF

Module suspends current track playback, then plays the folder and track specified. When insertion playback is finished, the current track playback is resumed.

7.1.20 Query Playback Status

Start Code	Length	Operation Code	Check Code	End Code
7E	03	10	13	EF

Return Codes	End Codes	Ready Prompt
30 30 30 30	0D 0A	4F 4B

Module returns playback status 'stopped' as ASCII key codes representative of characters "0000", followed by End Codes as ASCII carriage return (CR) and new line feed (LF), then Ready Prompt "OK".

7.1.21 Query Volume Setting

Start Code	Length	Operation Code	Check Code	End Code
7E	03	11	12	EF

Return Codes	End Codes	Ready Prompt
30 30 30 31	0D 0A	4F 4B

Module returns volume setting as an ASCII key codes representative of numeric characters "0001", followed by End Codes as ASCII carriage return (CR) and new line feed (LF), then Ready Prompt "OK".

7.1.22 Query Equalizer Profile Setting

Start Code	Length	Operation Code	Check Code	End Code
7E	03	12	11	EF

Return Codes	End Codes	Ready Prompt
30 30 30 30	0D 0A	4F 4B

Module returns ASCII key codes representative of numeric characters "0000" (Normal) followed by End Codes as ASCII carriage return (CR) and new line feed (LF), then Ready Prompt "OK". Equalizer set to "no spectrum filtering".

7.1.23 Query Loop Playback Mode Setting

Start Code	Length	Operation Code	Check Code	End Code
7E	03	13	10	EF

Return Codes	End Codes	Ready Prompt
30 30 30 34	0D 0A	4F 4B

Module returns ASCII key codes representative of characters "0004" (Loop Playback Disabled) followed by End Codes as ASCII carriage return (CR) and new line feed (LF), then Ready Prompt "OK".

7.1.24 Query Module Firmware Version Number

Start Code	Length	Operation Code	Check Code	End Code
7E	03	14	17	EF

Return Codes	End Codes	Ready Prompt
30 30 30 31	0D 0A	4F 4B

Module returns ASCII key codes representative of characters "0001" (i.e., firmware version 1.0) followed by End Codes as ASCII carriage return (CR) and new line feed (LF), then Ready Prompt "OK".

7.1.25 Query Number of Files on TF Card

Start Code	Length	Operation Code	Check Code	End Code
7E	03	15	16	EF

Return Codes	End Codes	Ready Prompt
30 30 37 65	0D 0A	4F 4B

Module returns count as a 4-byte hexadecimal number in ASCII characters “007e” (i.e., 126 files counted) followed by End Codes as ASCII carriage return (CR) and new line feed (LF), then Ready Prompt “OK”.

7.1.26 Query Number of Files on USB Flash drive

Start Code	Length	Operation Code	Check Code	End Code
7E	03	16	15	EF

Return Codes	End Codes	Ready Prompt
30 30 30 30	0D 0A	4F 4B

Module returns file count (if any) of USB Flash Drive as a 4-byte hexadecimal number in ASCII characters “0000” (i.e., 0 files counted) followed by End Codes as ASCII carriage return (CR) and new line feed (LF), then Ready Prompt “OK”.

7.1.27 Query Current Playback Device

Start Code	Length	Operation Code	Check Code	End Code
7E	03	18	1B	EF

Return Codes	End Codes	Ready Prompt
30 30 30 31	0D 0A	4F 4B

Module returns current playback device as a 4-byte hexadecimal number as ASCII characters “0001” (i.e., TF Card Drive) followed by End Codes as ASCII carriage return (CR) and new line feed (LF), then Ready Prompt “OK”.

7.1.25 Query TF Card’s Current Track

Start Code	Length	Operation Code	Check Code	End Code
7E	03	19	1A	EF

Return Codes	End Codes	Ready Prompt
30 30 30 31	0D 0A	4F 4B

Module returns TF card current track as an index 4-byte hexadecimal number as ASCII characters “0001” (i.e., 1 index) followed by End Codes as ASCII carriage return (CR) and new line feed (LF), then Ready Prompt “OK”.

7.1.26 Query USB Flash Drive’s Current Track

Start Code	Length	Operation Code	Check Code	End Code
7E	03	1A	19	EF

Return Codes	End Codes	Ready Prompt
30 30 30 30	0D 0A	4F 4B

Module returns USB Flash Drive current track as an index 4-byte hexadecimal number as ASCII characters “0000” (i.e., 0 index) followed by End Codes as ASCII carriage return (CR) and new line feed (LF), then Ready Prompt “OK”.

7.1.27 Query Elapsed Playback Time

Start Code	Length	Operation Code	Check Code	End Code
7E	03	1C	1F	EF

Ready Prompt	Return Codes	End Codes
4F 4B	30 30 30 36	0D 0A

Module ready prompt “OK”, then elapsed time in seconds of current track playback as a 4-byte hexadecimal number as ASCII characters “0006” (i.e., 6 seconds) followed by End Codes as ASCII carriage return (CR) and new line feed (LF).

7.1.28 Query Total Playback Time of Current Track

Start Code	Length	Operation Code	Check Code	End Code
7E	03	1D	1E	EF

Ready Prompt	Return Codes	End Codes
4F 4B	30 30 33 63	0D 0A

Module returns ready prompt “OK”, then current track playback time in seconds as a 4-byte hexadecimal number as ASCII characters “003c” (i.e., 60 seconds) followed by End Codes as ASCII carriage return (CR) and new line feed (LF).

7.1.29 Query Current Track File Name

Start Code	Length	Operation Code	Check Code	End Code
7E	03	1E	1D	EF

Ready Prompt	Return Codes	End Codes
4F 4B	42 41 4C 41 4E 43 45 44 77 41 56	0D 0A
	42 41 4C 41 4E 43 45 44 77 41 56 (with fw 0001, “4F 4B” sometimes is placed at end)	0D 0A 4F 4B

Module returns “OK”, followed by eight characters of file named “BALANCED”, immediately followed by file format “WAV”, then End Codes 0D 0A (carriage return [CR] and new line feed [LF]).

7.1.25 Query Number of Files in Current Playback Folder

Start Code	Length	Operation Code	Check Code	End Code
7E	03	1F	1C	EF

Ready Prompt	Return Codes	End Codes
4F 4B	30 30 37 65	0D 0A

Module returns ready prompt, then count as a 4-byte hexadecimal number as ASCII characters “007e” (i.e., 126 files counted) followed by End Codes as ASCII carriage return (CR) and new line feed (LF).

7.2 Serial Communications Firmware 1.0 Errata

For modules with firmware version 0001, the following functions do not appear to respond to commands properly, return wrong reply data, or erroneous response:

cmd: 0x0A (fast forward) – no response

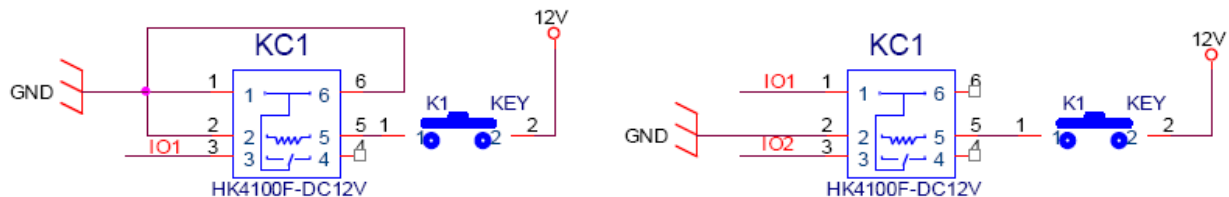
cmd: 0x0B (fast rewind) – no response

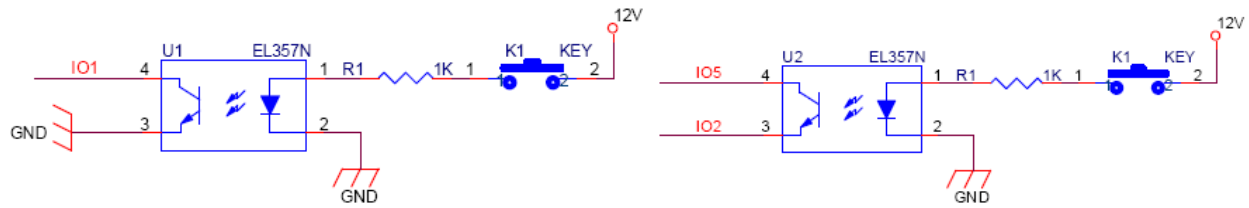
cmd: 0x19 (current track TF – returns “0” value instead of correct number

cmd: 0x34 (switch folder) – switches to next/previous folder, but starts playback when playback is stopped.

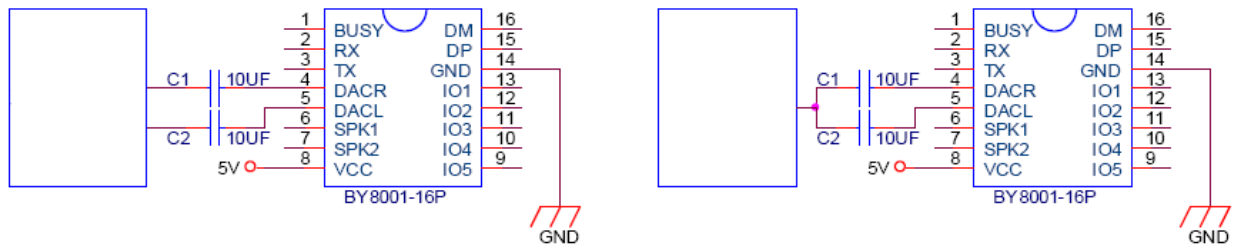
Cmd 0x41 (play track by index number) – Combination playlist playback is terminated if any subsequent commands sent before combination playback completes. In such case, only first track of combination playlist is played.

cmd 0x1F (number of tracks current folder) – returns “0” value instead of correct number.

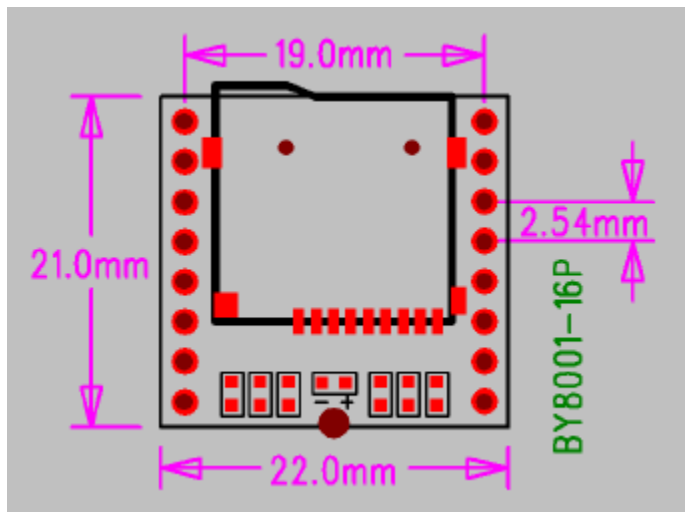




8.4 External Amplifier Application Wiring Diagram



9.0 Module PCB Layout



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