



BMA32-783 Voice Chip User Manual

V1.2

Product model: BMA32-783 Package: SOP16

Scope: Chip-level design, debug, and mass-production bring-up (external SPI Flash solution).

1 Product Overview

BMA32-783 targets local announcement, alarm, number reading, and simple combined playback scenarios that need larger voice capacity. The chip stores MP3 files on an external SPI Flash. When connected to a PC, the Flash enumerates as a standard USB mass-storage disk so content can be copied and updated directly—no dedicated programming fixture is required.

Control is primarily via a full-duplex UART. A TEST pin is also provided: grounding it plays the next track in sequence for quick audition. On the output side, choose either “built-in PWM speaker drive” or “DAC to an external amplifier,” selected by the hardware wiring of pin 1. The minimal peripheral system typically needs only two 105 (1 μ F) decoupling capacitors.

1.1 Feature Summary

- Supports external SPI Flash up to about 128 Mbit (16 MB). Common modules ship with about 4 MB; the chip auto-detects capacity.
- Enumerates as a standard USB disk on a PC; generally no special driver is needed. MP3 files can be rewritten repeatedly.
- UART defaults to 9600 bps; baud rate can be changed by command and is retained through power-off.



- Volume has 30 steps; supports single-track / playlist loop, combined sequential playback, and other common controls.
- PWM can directly drive about an 8 Ω / 0.5 W speaker; alternatively use DAC with an external amp (hardware either/or).
- Supply about 3.3 V–5.2 V (commonly recommended near 4.2–4.6 V).
- Decode format is primarily MP3; common sample rates 8–32 kHz, also often 44.1/48 kHz (subject to firmware capability).
- Highly compatible with the BMA32-780 UART protocol; differences are mainly storage medium, pinout, and how the output path is selected.

1.2 Key Specifications

Item	Specification
Audio container	MP3 (Layer III)
Recommended sample rates	8 / 11.025 / 12 / 16 / 22.05 / 24 / 32 kHz (also 44.1 / 48 kHz)
User storage	External SPI Flash, up to ~128 Mbit; modules commonly ~4 MB
USB	USB 2.0 Full Speed, virtual disk
UART	TTL UART, default 9600 8N1
Operating voltage	3.3 V–5.2 V (commonly ~4.2 V recommended; ~5 V system suggested with external amp)
Static / standby current	About 5–10 mA order (depends on state)
Playback current	From about tens of mA; direct-drive speaker peaks can reach ~200 mA (measure in practice)
PWM drive	~0.5 W class; 8 Ω speaker recommended
Operating temperature	About –40 °C to +85 °C (engineering reference)
ESD reference	Contact ~4 kV / air ~8 kV (reference)
Package	SOP16

1.3 Main Differences from BMA32-780

Comparison	BMA32-780	BMA32-783
Voice storage	On-chip user area ~320 KB	External SPI Flash, up to ~128 Mbit
Pins 1–3	IO1 / IO2 / IO3 trigger	SPI: CS-DAT / DO-CMD / SCK-CLK
Pin 6	IO4 trigger	TEST: ground to play next track
PWM/DAC select	config.txt field	Pin 1 to GND via 1 k Ω = DAC; floating = PWM
4-channel IO one-	Supported	Not supported (UART-centric)



to-one play		
Operating voltage	~2.5 V~5.2 V	~3.3 V~5.2 V
μA-level sleep	Configurable	This model focuses on always-on UART control

2 Pins and Package

The figure below shows the SOP16 top-view pin names. The notch side is the pin-1 orientation reference.

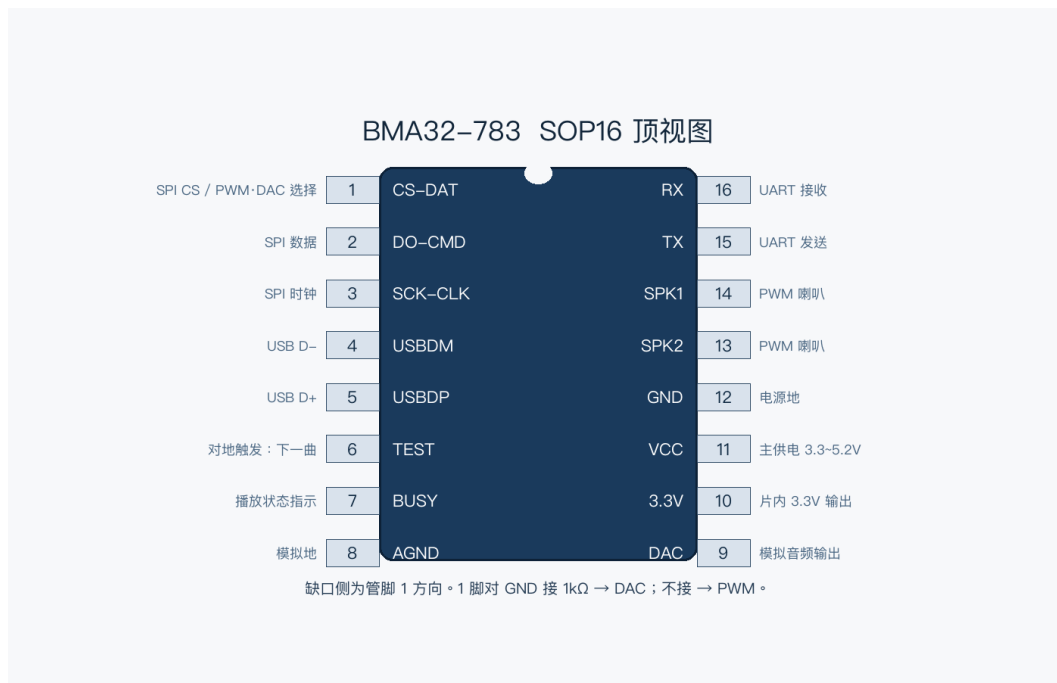


Figure 2-1 Pin function overview (BMA32-783)

No.	Name	Description
1	CS-DAT	SPI chip select; also PWM/DAC select (to GND via 1 kΩ = DAC; floating = PWM)
2	DO-CMD	SPI data
3	SCK-CLK	SPI clock
4	USBDM	USB D-
5	USBDP	USB D+
6	TEST	Test input: ground to trigger; each press plays the next track
7	BUSY	Busy signal: low while playing, high when idle
8	AGND	Analog ground



9	DAC	Analog audio out for external amp (mutually exclusive with PWM)
10	3.3V	On-chip 3.3 V output, max ~100 mA
11	VCC	Main supply input (3.3 V–5.2 V; best ~4.2 V)
12	GND	Digital / power ground
13	SPK2	PWM speaker terminal
14	SPK1	PWM speaker terminal (pair with SPK2; no polarity)
15	TX	UART transmit, connect to MCU RX
16	RX	UART receive, connect to MCU TX

Package outline matches a common narrow-body SOP16.

SOP16: plastic small outline package; 16 leads; body width 3.9 mm

SOT109-1

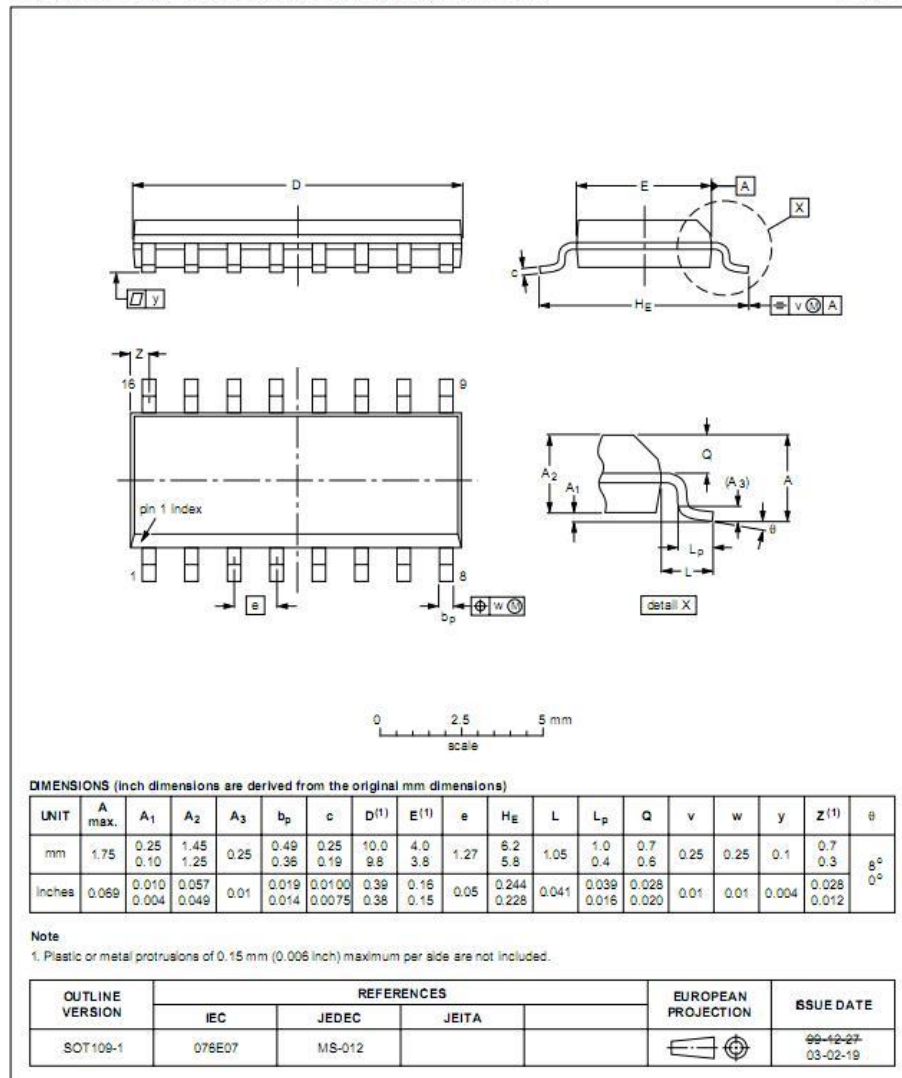


Figure 2-2 SOP16 outline dimensions reference (SOT109-1 / MS-012)



3 Audio Content Update (USB / SPI Flash)

After connecting USBDM/USBDP with power and ground to a PC, the system enumerates the external SPI Flash as a removable disk. Copy MP3 files to that disk to update announcement content. Visible capacity varies with the Flash part (e.g., W25Q128 commonly shows about 16 MB).



Figure 3-1 Virtual disk appears after USB connection (capacity depends on Flash)

音频文件命名规则

001开机.mp3	可点播：索引 001
002报警.mp3	可点播：索引 002
100金额.mp3	可点播：索引 100 (命令数据 0x64)
开机.mp3	无三位前缀 → 找不到
track1.mp3	无三位前缀 → 找不到

Figure 3-2 Example file list on the disk



3.1 File Naming Rules (Important)

- Use MP3 only.
- Filenames must start with a three-digit number: 001–999; descriptive text may follow, e.g. 001poweron.mp3.
- The chip recognizes only the numeric prefix index; files without a three-digit prefix cannot be selected for playback.
- Chinese or other characters after the prefix do not need to be removed.
- Total size of all files must not exceed available Flash space.
- Recommended: organize files locally on the PC, format the virtual disk, then copy all files in one go.



Figure 3-3 File naming and index illustration

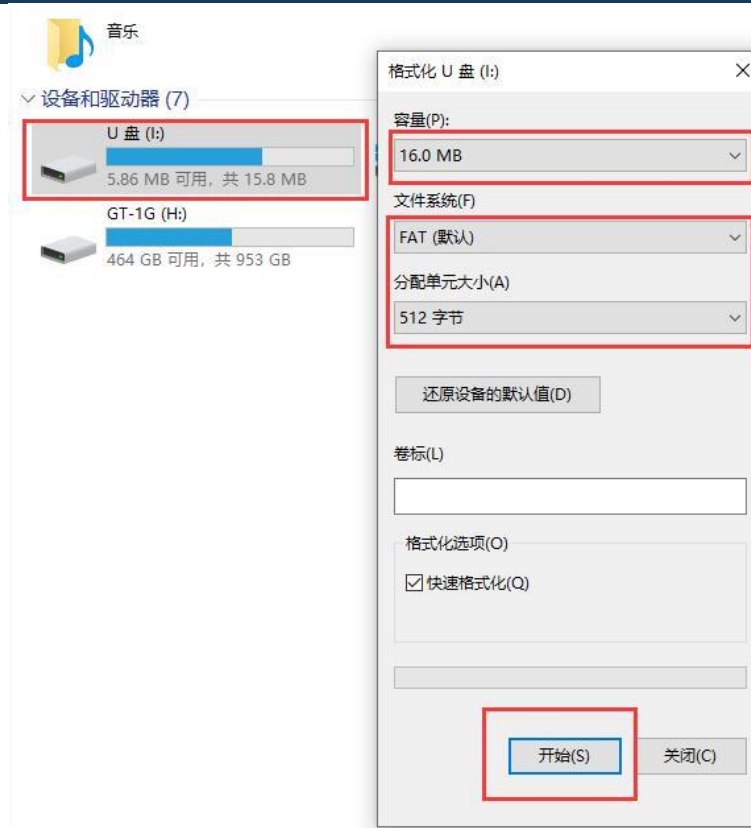


Figure 3-4 Virtual disk format illustration

For debug audition, ground TEST (pin 6) via a button: each press plays the next track, useful to quickly confirm audio was written successfully.

3.2 Recommended Flash Capacity Reference

The chip auto-detects capacity; select by application need. Common W25Q series reference:

type	size	package
W25Q80	1Mbyte	SOP8L[wide]
W25Q16	2Mbyte	SOP8L[wide]
W25Q32	4Mbyte	SOP8L[wide]
W25Q64	8Mbyte	SOP8L[wide]
W25Q128	16Mbyte	SOP8L[wide]

Figure 3-5 Common SPI Flash capacity reference



3.3 Mass-Production Programming Recommendations

Writing Flash over USB is slower than a dedicated programmer. For small batches / prototypes, USB copy is fine; for mass production recommend:

- Debug a sample board over USB and confirm audio is written to Flash.
- Remove that Flash as the master.
- Read the full image (bin) with an SPI Flash programmer.
- Have the supplier pre-program Flash at purchase, or program in volume on the production line.
- Example: W25Q32 (4 MB) with a dedicated programmer typically finishes in about ten-plus seconds (depends on tool).

4 Output Path and Operating Conventions

Unlike BMA32-780, BMA32-783 does not switch PWM/DAC via config.txt. The output path is set by pin-1 hardware wiring, and only one output may be active at a time.



Figure 4-1 PWM / DAC hardware selection illustration

Selection	Wiring	Active output	Notes
PWM	Pin 1 floating (no 1 k Ω)	SPK1 / SPK2	Direct-drive ~8 Ω / 0.5 W speaker
DAC	Pin 1 to GND via 1 k Ω	DAC	To external amp; SPK pins inactive

BUSY pin default: low during playback, high when idle. Can be used as amp enable or MCU status detect.



Default volume is generally the maximum step (30). For volume retained through power-off, use the UART “with memory” volume command; for temporary adjust use the non-memory command.

5 UART Control Interface

Hardware uses TTL levels. For debug, use USB-UART: cross-connect TX/RX and share ground with the chip. In production, the MCU drives UART directly. It is recommended to first verify with the companion serial debug tool that auto-generates command frames.

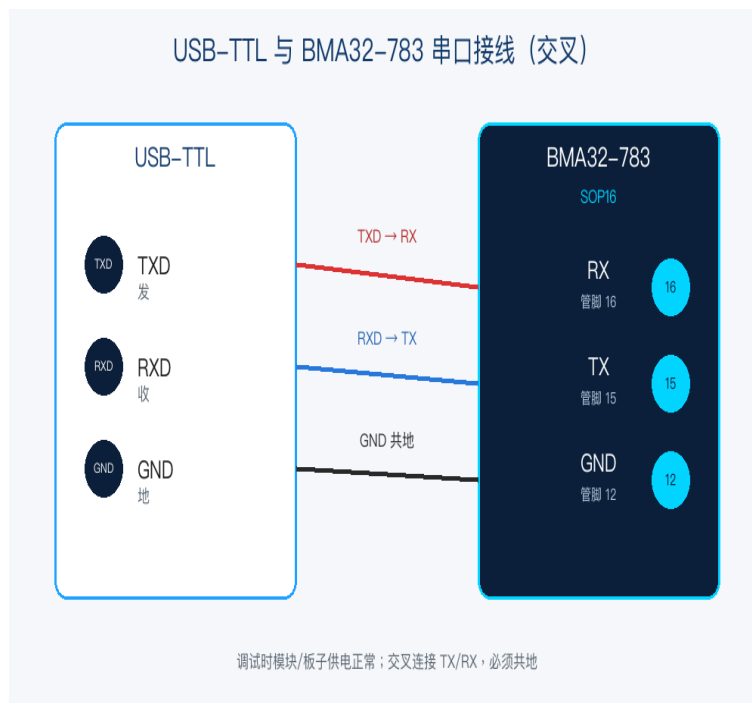


Figure 5-1 USB-TTL to chip wiring illustration



Figure 5-2 Serial debug tool UI illustration

5.1 Link Parameters and Timing

- Default 9600, 8 data bits, no parity, 1 stop bit; baud can be changed by command and retained through power-off.
- Power-on init time depends on file count—commonly ~700 ms; complex content may take ~1–1.5 s. Wait for the power-on reply before sending application commands.
- Internal UART processing cycle is about 10 ms; continuous commands should be spaced at least ~20 ms apart, or the previous frame may be overwritten.
- Response slows with very large track counts; general applications should stay within about a thousand tracks.

5.2 Frame Structure

A frame consists of start byte 0x7E, command code, length high/low bytes, optional data, and end byte 0xEF.

Field	Content
Header	0x7E
Command	CMD
Length	lenH, lenL



Payload	0–N bytes
Trailer	0xEF

Example: play track 1 → 7E 13 00 02 00 01 EF.

5.3 Control and Query Command Summary

CMD	Example frame	Function
0x11	7E 11 00 02 00 00 EF	Next track
0x12	7E 12 00 02 00 00 EF	Previous track
0x13	7E 13 00 02 00 08 EF	Select track (example: track 8)
0x14	7E 14 00 02 00 00 EF	Volume up
0x15	7E 15 00 02 00 00 EF	Volume down
0x16	7E 16 00 02 00 0A EF	Set volume (0–30)
0x18	7E 18 00 02 00 01 EF	Select track and single-track loop
0x0B	7E 0B 00 02 00 03 EF	Set baud rate
0x0C	7E 0C 00 02 00 00 EF	Software reset
0x1D	7E 1D 00 02 00 00 EF	Resume playback
0x1E	7E 1E 00 02 00 00 EF	Pause
0x21	7E 21 00 02 00 00 EF	Loop all
0x26	7E 26 00 02 00 00 EF	Stop
0x28	7E 28 00 02 00 01 EF	Random play
0x29	7E 29 00 02 00 00 EF	Enable loop on current track (must be playing)
0x31	7E 31 00 05 01 03 02 05 04 EF	Play list of indexes in sequence
0xD1	7E D1 00 02 00 00 EF	Restore factory-related settings
0x42	7E 42 00 02 00 00 EF	Query play status
0x43	7E 43 00 02 00 00 EF	Query volume
0x4A	7E 4A 00 02 00 00 EF	Query total file count
0x46	7E 46 00 02 00 00 EF	Query firmware / version info

5.4 Combined Sequential Playback (0x31)

When multiple short clips must be joined into one prompt (amount, temperature, time, etc.), send up to about 30 indexes in one command; the chip plays them in order. Payload is hexadecimal indexes, e.g. 0x64 corresponds to 100.mp3.

Example: play 001/003/002/005/004 → 7E 31 00 05 01 03 02 05 04 EF.



- Volume may be adjusted during the sequence, but next/previous mid-sequence is not recommended; send Stop to abort.
- Files must be in the root directory and named with three-digit numbers.
- If an index in the list does not exist, playback stops at that point.
- Use BUSY edges to detect when the whole list has finished.
- To reduce gaps between segments, trim leading/trailing silence from the source audio.

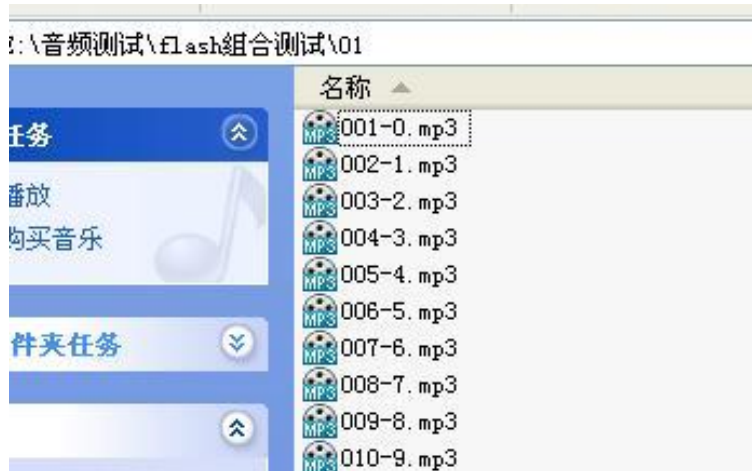


Figure 5-3 Root-directory numbered naming example

5.5 Chip Unsolicited Replies

The chip sends replies at key points so the host can track status:

- Power-on init success reply (init duration depends on file count; commonly ~700 ms).
- Command accept ACK: 7E 41 EF.
- Track end-of-play reply (commonly a 0x3D-class end frame; some firmwares may report an end form similar to the select-track command—confirm with target firmware). Example: after track 2, may reply something like 7E 3D 00 02 00 02 EF.
- Exception frame 0x40: 01 busy, 03 incomplete receive, 04 checksum-class error, 05 out of range, 06 missing file, etc.

Exception example	Meaning
7E 40 00 02 00 01 EF	Busy (common during power-on filesystem init)
7E 40 00 02 00 03 EF	Frame not fully received
7E 40 00 02 00 04 EF	Checksum-class error
7E 40 00 02 00 05 EF	Specified file out of range
7E 40 00 02 00 06 EF	Specified file not found



5.6 Common Commands in Detail

Select track (0x13): matches the filename numeric prefix. Play track 2: 7E 13 00 02 00 02 EF; for track 100 the data is 00 64. Selectable track range in practice often supports up to several thousand (too many slows lookup).

Volume (0x16): 7E 16 00 02 00 1E EF sets 30 without memory; 7E 16 00 02 01 0A EF sets 10 with memory (DH=1 means remember).

Single-track loop (0x18): e.g. 7E 18 00 02 00 01 EF loops track 1. During loop you can still pause / next-prev / adjust volume; exit via Stop or a new select-track.

Current-track loop (0x29): must be sent while playing. Enable 7E 29 00 02 00 00 EF; disable 7E 29 00 02 00 01 EF (after disable, stops when current segment ends).

Baud rate (0x0B) is saved after set; wait about 1 second, then reset (0x0C) or power-cycle before switching the host baud. To restore default baud, send the related factory-restore command.

Note: some references write the reset example as 0x1C / 7E 1C... and factory restore as 0xC1; this manual and the command table unify on 0x0C / 0xD1. Confirm by measurement on the target firmware before mass-production bring-up.

Baud rate	Command example
1200	7E 0B 00 02 00 00 EF
2400	7E 0B 00 02 00 01 EF
4800	7E 0B 00 02 00 02 EF
9600	7E 0B 00 02 00 03 EF
19200	7E 0B 00 02 00 04 EF
38400	7E 0B 00 02 00 05 EF
57600	7E 0B 00 02 00 06 EF
115200	7E 0B 00 02 00 07 EF
256000	7E 0B 00 02 00 08 EF

Query status (0x42): reply can distinguish play / pause / stop etc. (per firmware encoding). Query version (0x46): returns firmware version-related bytes.



6 Hardware and Design Notes

6.1 Levels and Interfaces

Parameter	Condition	Range (reference)
VIL	VDD=3.3 V	About -0.3 to $0.3 \times VDD$
VIH	VDD=3.3 V	About $0.7 \times VDD$ to $VDD+0.3$
VOL	VDD=3.3 V	Max about 0.33 V
VOH	VDD=3.3 V	Min about 2.7 V

- Design GPIO/UART for 3.3 V TTL; when connecting to a 5 V MCU, series $\sim 100 \Omega$ – $1 \text{ k}\Omega$ current limiting is recommended; watch for back-drive.
- In strong-interference environments consider opto-isolation, TVS, etc.; for long runs consider industrial isolation.
- Sample rates below 8 kHz may not decode; convert first.
- Direct-drive speaker: 8Ω / 0.5 W recommended; for more volume use an external amp (e.g. 8002 class).
- Keep SPI Flash traces short; pull WP/HOLD etc. to 3.3 V per Flash datasheet.

6.2 Power Recommendations

- Pins 10 and 11 must have 105 ($\sim 1 \mu\text{F}$) decoupling; do not omit.
- On a 5 V system with direct speaker drive, a diode can drop to about 4.2–4.6 V into VCC.
- 3.3 V systems work but direct-drive power is lower; ensure current headroom to avoid brown-out reset during playback.
- With an external amp, size amp supply per amp datasheet (commonly 5 V).

7 Typical Application Circuits

Two typical connections are shown below. PWM and DAC are either/or: pin 1 floating = PWM; pin 1 to GND via $1 \text{ k}\Omega$ = DAC. Keep the pin 10/11 decoupling capacitors.

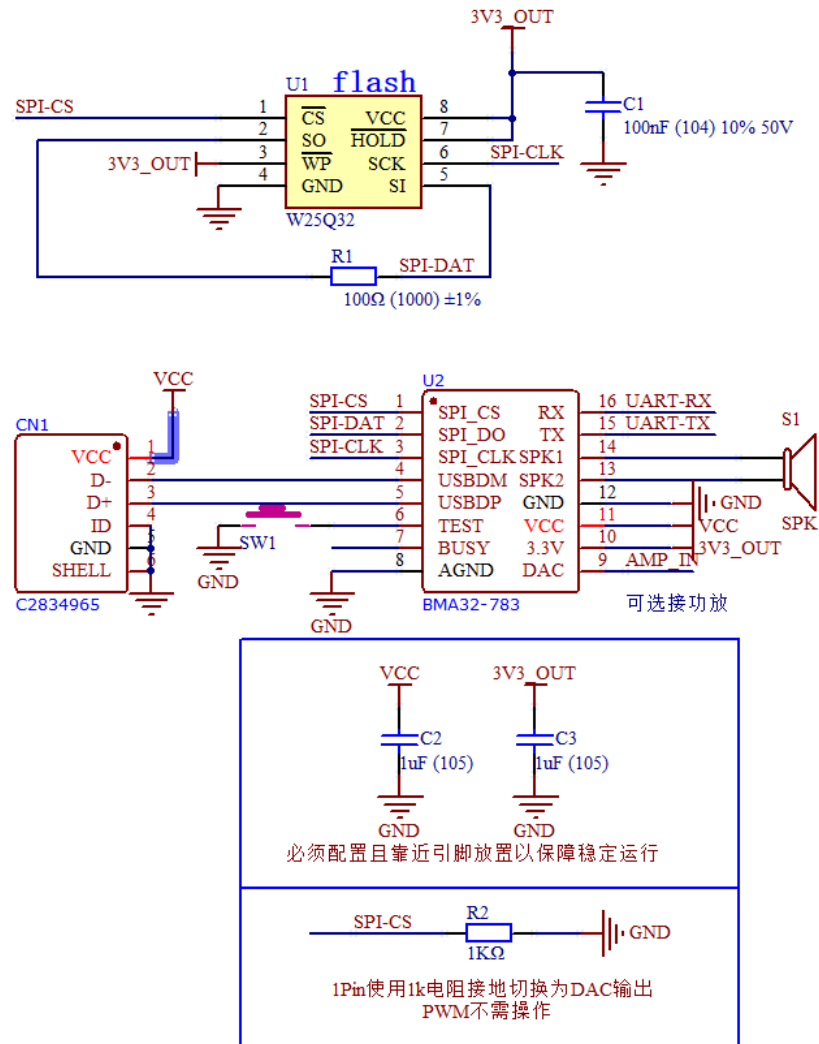


Figure 7-1 Reference schematic

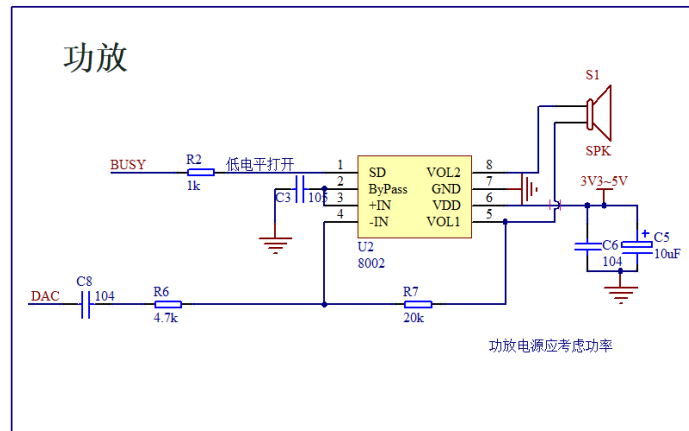


Figure 7-2 DAC with external amp reference schematic



Only one output is active at a time. Keep USB pads for production or after-sales voice updates.

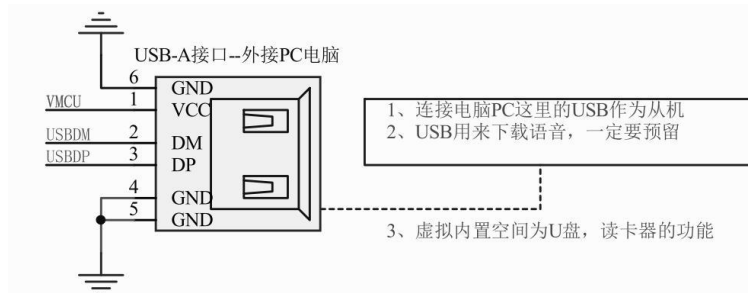


Figure 7-3 USB differential pin order: DM=D-, DP=D+

8 Debug and Troubleshooting

8.1 Power-On and Recognition

First confirm VCC is 3.3 V–5.2 V, pin 10/11 caps are present, and pin 10 has a stable ~3.3 V. USB must use a four-wire data cable; prefer a direct host port. When normal, Device Manager shows a mass-storage class device.



Figure 8-1 Host correctly recognizing the device



8.2 Virtual Disk Does Not Appear

- Check Flash soldering and SPI three-wire (CS/DO/SCK).
- Confirm it is not a charge-only two-wire cable; avoid poor-quality hubs when possible.
- After connecting to a PC, BUSY may show activity (often fast blink—confirm by measurement).
- If USB port voltage is pulled below about 4.2 V by the load, host enumeration may fail.
- If pin 10 voltage is abnormally high (e.g. clearly above ~3.7 V), the chip may already be damaged.

8.3 DAC Silent / Missing Word Onset

First confirm pin 1 is tied to GND via 1 k Ω , and amp supply, enable, and input caps are correct. If amp enable is driven by BUSY, enable delay can clip the start of speech—use always-on enable, reduce the time constant, or add ~100 ms silence at the start of the audio.

8.4 Quick Audition Bring-Up

- After power-up, ground TEST and confirm sequential sound.
- Observe BUSY: low with audio, high when idle.
- Then use USB-TTL + serial tool with select-track commands to verify communication.

8.5 No UART Response

Confirm crossed wiring: chip TX→host RX, chip RX→host TX, and shared ground. After power-on you should see the init reply; if there is no data at all, first use TEST audition to rule out supply/audio issues.

8.6 Audio Production

This chip is optimized for MP3. Uncompressed formats such as WAV are generally not default-supported. Export mono MP3 with common audio tools—e.g. start at 16 kHz / 16 kbps, then raise bitrate for listening quality.



Figure 8-2 Audio conversion illustration (1)

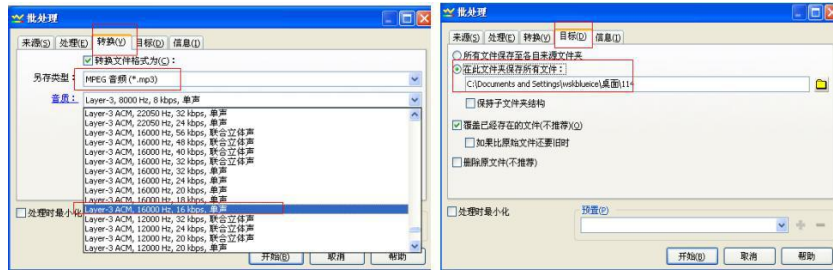


Figure 8-3 Audio conversion illustration (2)

8.7 Grounding

For typical consumer apps, AGND and GND may meet at a single point at the power entry. For noise-sensitive designs, keep analog ground return separate and away from fast digital edges and the SPI clock.

9 FAQ

Q1 What can the chip do?

A1 External SPI Flash enumerates as a USB disk for MP3 copy; UART controls select/volume/loop/combined play; choose PWM direct-drive or DAC external amp.

Q2 How to choose voltage, current, and speaker?

A2 Supply 3.3–5.2 V; standby about several mA to 10 mA; playback may reach ~100 mA class depending on speaker. Direct-drive 8 Ω / 0.5 W recommended; use external amp for louder output.

Q3 Fastest way to verify hardware?

A3 Confirm pin 10/11 have 105 caps and pin 10 ~3.3 V → USB disk appears → TEST to GND produces sound → then test UART.

Q4 How is copy order determined?



A4 By filename prefix index 001–999; organize locally then copy in one go.

Q5 Board soldered but no response?

A5 Check VCC range, pin 10/11 caps, pin 10 3.3 V, Flash soldering, and whether a USB device appears.

Q6 Can mass production avoid per-unit USB copy?

A6 Yes. Debug a master → programmer reads the image → batch pre-program Flash.

Q7 DAC has no sound?

A7 Confirm pin 1 is to GND via 1 k Ω ; PWM and DAC cannot be used together.

Q8 How to connect UART to a 5 V MCU?

A8 Chip I/O is 3.3 V TTL; with a 5 V MCU, series 100 Ω –1 k Ω current limiting is recommended.

Appendix A Quick Reference

Item	Convention
Model	BMA32-783 (SOP16)
Storage	External SPI Flash, up to ~128 Mbit
Control	UART primary; TEST pin for sequential audition
BUSY	Playing = low, idle = high
PWM	Pin 1 floating; SPK1/SPK2
DAC	Pin 1 to GND via 1 k Ω ; DAC pin
Filename	001–999 prefix + MP3
Default UART	9600 8N1, frame format 7E ... EF
Decoupling	105 caps on pins 10 / 11 required

Appendix B Revision History

Version	Notes
V1.0	Initial version
V1.1	UART replies and command details, mass-production flow, package dimensions, and FAQ
V1.2	Review fixes: replace wiring/debug-tool figures that contained old branding; redo file-naming illustration; improve schematic part marking; add note on reset/factory-command wording differences in reference materials