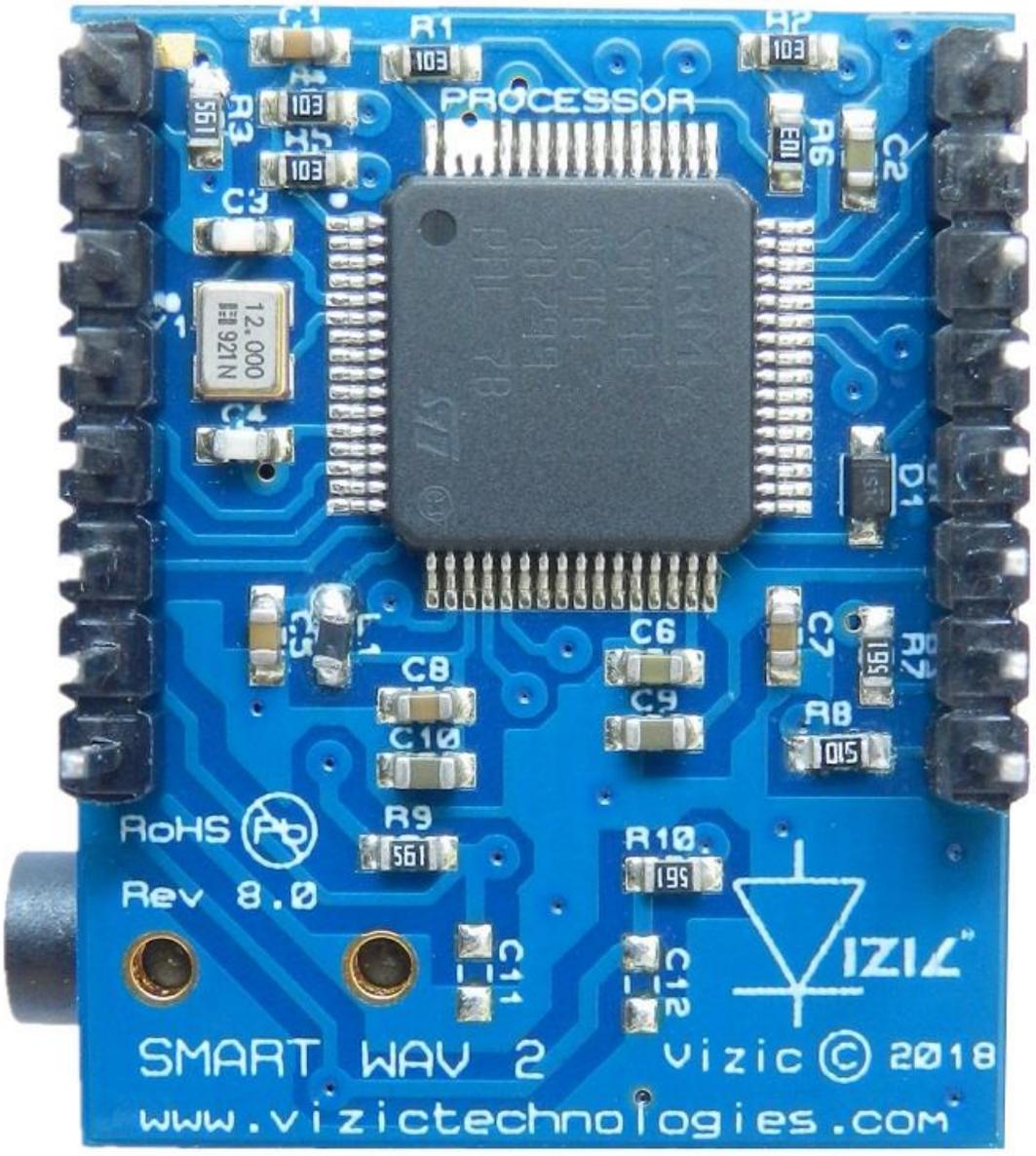


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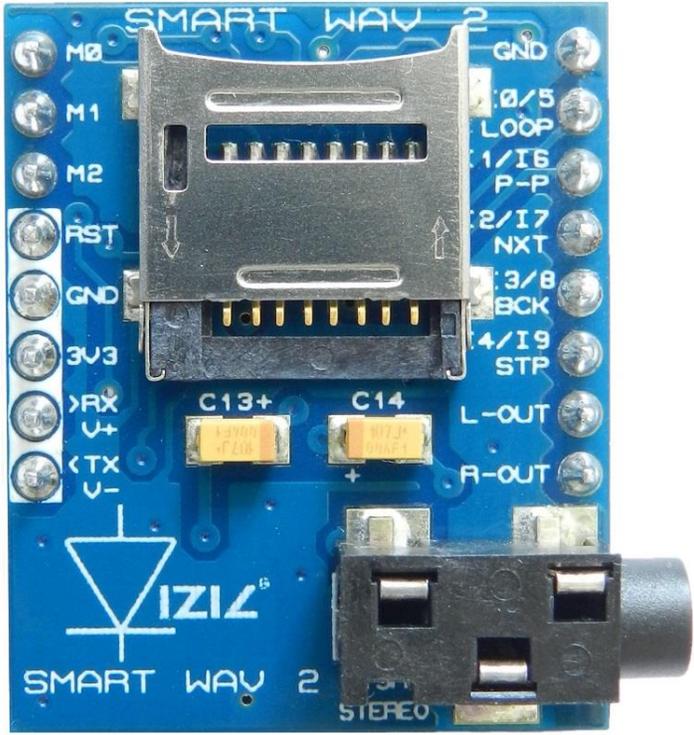
SMARTWAV 2

Datasheet----Rev 4.0

SmartWAV 2 – Intelligent Embedded Audio Processor



SmartWAV 2 Top View



SmartWAV 2 Direct phones connection: Pre-Amplified Outputs



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1- SmartWAV 2:

1.1- Introduction:



The SmartWAV 2 is an Intellectual Property smart high-end audio processor running on a state-of-the-art ARM Cortex M4 chip. The processor is mounted on a development board for easy and fast development.

SmartWAV 2 is polyphonic: can play up to 14 channels with high quality stereo sound from a microSD card with universal **FAT/FAT32** format. The processor supports **8/16bit, 8Khz-48Khz, mono/stereo, WAVE (.WAV)** files with CD Quality.

The main goal of the SmartWAV 2 it's to bring a very easy way to add polyphonic CD high quality stereo audio to any application or project without the user having experience in handling, mixing or decoding audio, neither managing FAT32 file formatting.

SmartWAV 2 is not a programmable device, no IDEs, programmers, nor debuggers are needed, it is a fully featured end device ready to plug and play in Slave mode, MIDI or Stand-Alone modes.

1.2- Features:

- Pre-amplified dual channel stereo out with 8/16bit, stereo/mono, and up to 48khz sampling rate, CD quality.
- Up to 14 channel polyphonic playback / auto mixing.
- Integrated digital volume control with 1/100 steps.
- Eight modes of operation, including Slave and Stand-Alone modes (M0, M1 and M2 Input pins for mode selection).
- MIDI mode compliant with channel selection.
- On board stereo 3.5mm plug for headphones, or line out.
- Easy 5 pin interface to any host device: **VCC, TX, RX, GND, RESET.** For standard serial mode.
- On-board uSD/uSDHC memory card socket with FAT/FAT32 support up to 32GB for storing thousands of tracks/audio **WAVE** files. No need of special/rare file formatting.
- Special data-logging FAT file create, open, read, write, delete, etc. functions with Long File Names and folder nesting / management support.
- 57600bps standard default baud rate speed for standard serial mode, 8 bits, no parity, 1 stop bit.
- 5V and 3V3 I/O compatible.
- 3V3 power supply, ultra-low current consumption.
- Sleep & Stand-by modes.

1.3- Typical Applications:

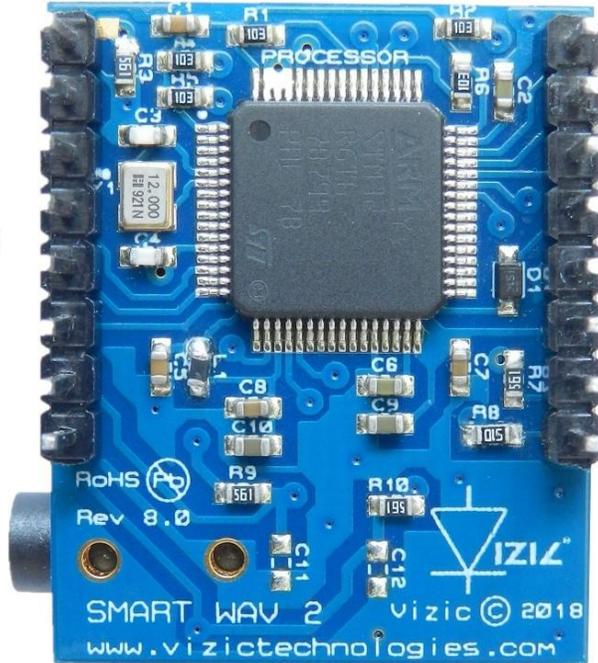
- Embedded polyphonic audio/sound systems.
- All voice annunciator systems.
- Audio channel mixers.
- Battery powered audio systems.
- Automotive, parking, GPS navigation systems.
- Robotics, industrial control.
- MIDI systems.
- Traffic facilities: Toll gates, parking lots.
- Home automation and domestic appliances.
- Elevator, Security, Access-Control, Warning devices.
- Toys, learning tools, talking books, gaming sound.
- Mp3 like full function simple systems.
- Drum machines.

2- SmartWAV 2 System Explained:

Main Processor

Stand-Alone Modes Inputs

Stereo Audio Outputs



Mode Selection Inputs

Serial Interface Inputs

MicroSD Card Socket

Mode Selection Inputs

Serial Interface Inputs



Stand-Alone Modes Inputs

Stereo Audio Outputs

3.5mm Stereo Output

SmartWAV 2 processor internally is a sophisticated multi-task system, it processes individual .wav tracks mounted on each of the 14 channels, mixing those with a master sample rate and a master gain control, this process is automatically.

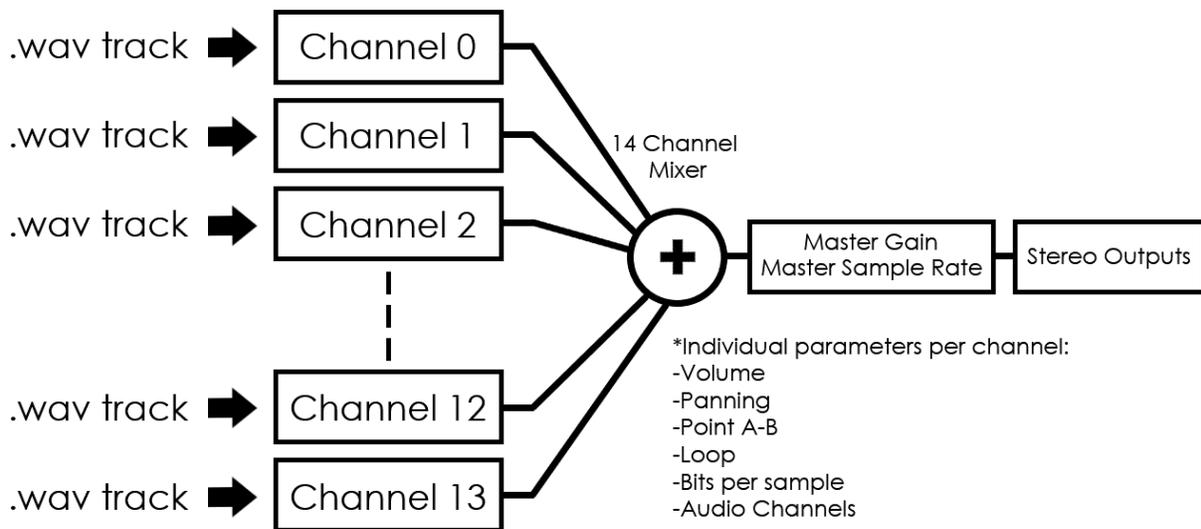
The master sample rate is how the processor outputs audio samples; this parameter is global for all 14 channels.

The master gain control (master mixer volume) is a global parameter that affects all the 14 channels.

For each single channel: volume, panning, point A-B, loop, bits per sample and audio Channels(mono/stereo) parameters are handled independently:

The next diagram visually explains the system:

SmartWAV 2 Internal Multi-Task System:

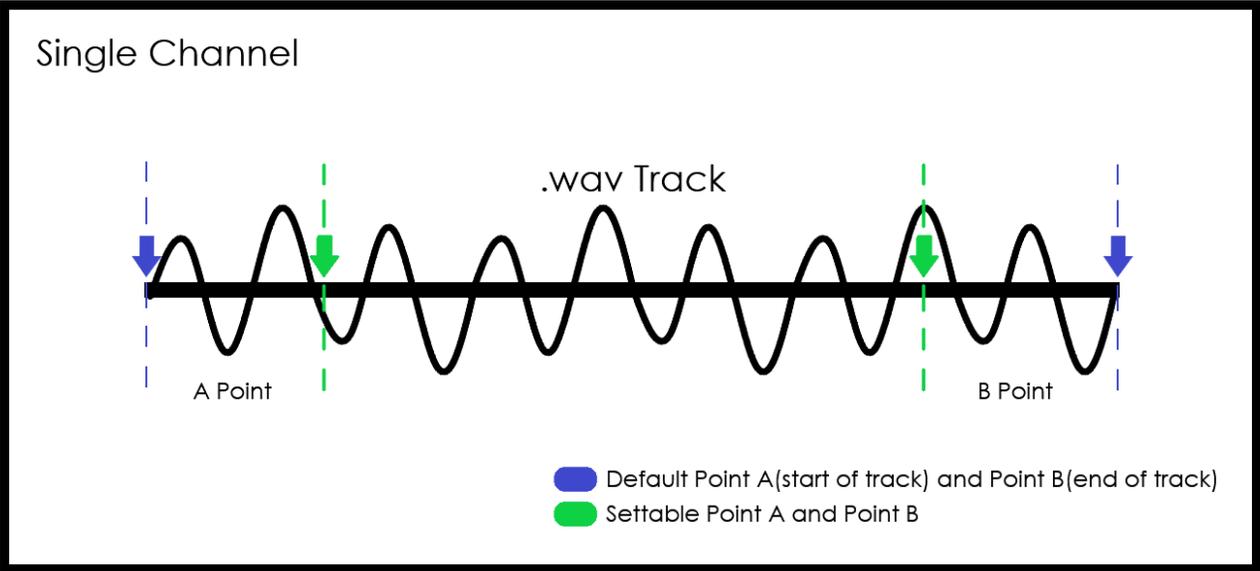


Point A and Point B are markers that the processor handles for each channel for rewind, loop and other functions. Each time a track is mounted, the points A and B are set at their defaults: A-Start of track and B-End of track (blue color).

User can later set and re-define those A and B points (green color) by the respective command.

The next diagram visually explains the above:

SmartWAV 2 Point A and Point B:



The bits per sample of each channel are internally obtained from the mounted .wav track, those are automatically handled by the system and user does not have to worry on how to handle those. If the user needs this parameters, those can be requested with the respective command.

The audio channels (1 for mono and 2 for stereo) are internally obtained from the mounted .wav track, those are automatically handled by the system and user does not have to worry on how to handle those. If the user needs this parameters, those can be requested with the respective command.

3- Operation Modes:

The module offers **8(eight)** modes of operation; selection between modes is by setting the external pins M0, M1 and M2, the next table details how mode is selected by tying the M0, M1 and M2 pins to VCC or GND:

SmartWAV 2 M0, M1, M2 Pin Mode Selection Table:

Mode	M2 Pin	M1 Pin	M0 Pin
M0: Standard Serial	GND	GND	GND
M1: Rewind Play (always)	GND	GND	VCC
M2: Rewind Play / Pause	GND	VCC	GND
M3: Rewind Play(hold) / Pause	GND	VCC	VCC
M4: MIDI Serial	VCC	GND	GND
M5: Play / Pause	VCC	GND	VCC
M6: Play(hold) / Pause	VCC	VCC	GND
M7: Music player	VCC	VCC	VCC

The next table explains how the smartWAV2 operates in each mode:

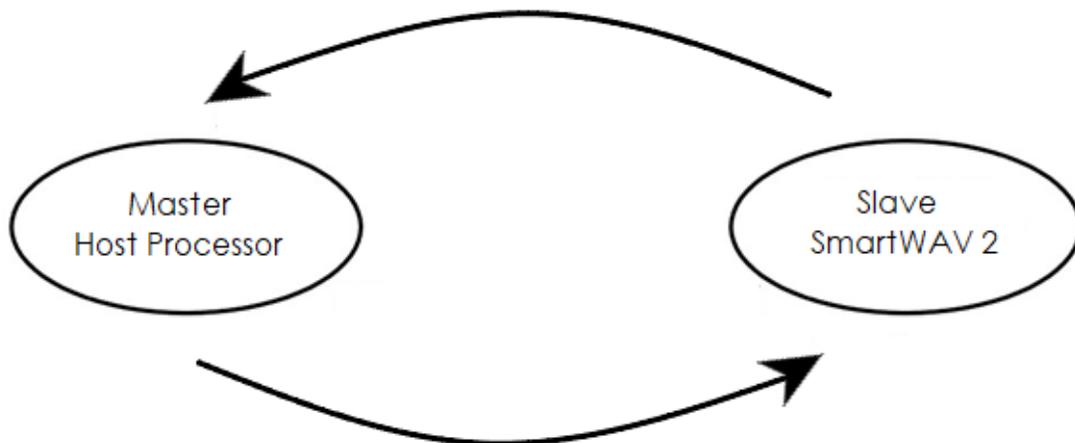
SmartWAV 2 Operation Modes Table:

Monophonic Stand-Alone Modes	Polyphonic Stand-Alone Modes	Polyphonic Slave Serial Modes
M7: Music player	M1: Rewind Play (always)	M0: Standard Serial
	M2: Rewind Play / Pause	M4: MIDI Serial
	M3: Rewind Play(hold) / Pause	
	M5: Play / Pause	
	M6: Play(hold) / Pause	

3.1- Polyphonic Slave Serial Mode 0 - Standard Serial: It is the most complete mode of operation of the system, it offers 14-channel polyphonic audio tracks triggered with a serial interface to any host micro-controller with a serial RX, TX port(UART/USART). Audio related functions (Refer to document **SmartWAV2-CommandSet.pdf**) are called using simple commands. The SmartWAV 2 allows users to develop their application using their favorite micro-controller or processor and software development tools using the provided libraries.

SmartWAV 2 processor doesn't need any configuration or programming on itself, it's a slave device that only receives orders, reducing and facilitating dramatically the code size, complexity and processing load on the main host controller (8051, PIC, ATMEL, FREESCALE, STMICRO, ARM, CORTEX), or any development platform (ARDUINO, RASPBERRY, FPGA MBED, etc.) or PC (USB-UART SX 2)).

-In Standard Serial mode (master-slave model), the master send commands to the slave and this replies with commands.



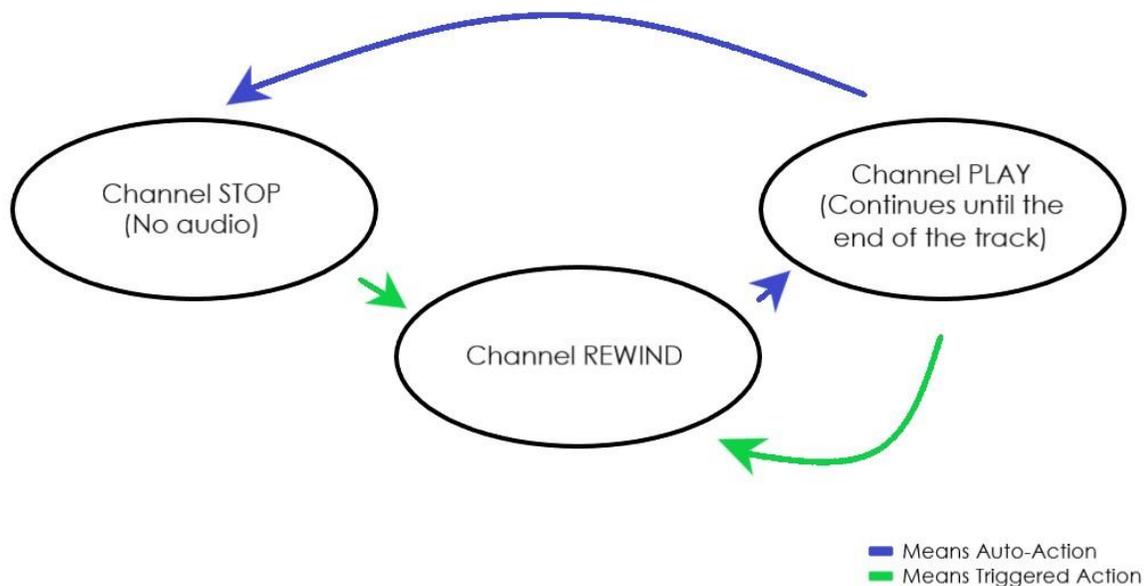
3.2- Polyphonic Stand-Alone Mode 1 - Rewind Play (always): In this mode a host controller is not required, SmartWAV 2 uses I0-I9 inputs to trigger up to 10-channel polyphonic audio tracks, those tracks are mounted on each channel at the power-on / initialization state of the processor, the track names (xxx.wav files) are obtained from the "tracks.txt" file (refer to section 3.9- The "Tracks.txt" File), be sure this file exists in the root path of the inserted microSD card together with the .wav files to be triggered.

The audio mixing is automatically handled by the system, but the way each individual input triggers the mounted tracks in this mode is the next:

-In Rewind Play (always) mode, each time an input channel is triggered: the track mounted rewinds and play, if during the playback a trigger is present: channel will rewind and play. If no trigger is present during playback: the channel will continue playing until the end of the track and stop.

Note: in the next diagram the green lines mean physical input triggered actions; purple lines mean automatic processor actions.

-Individual Channel Behaviour



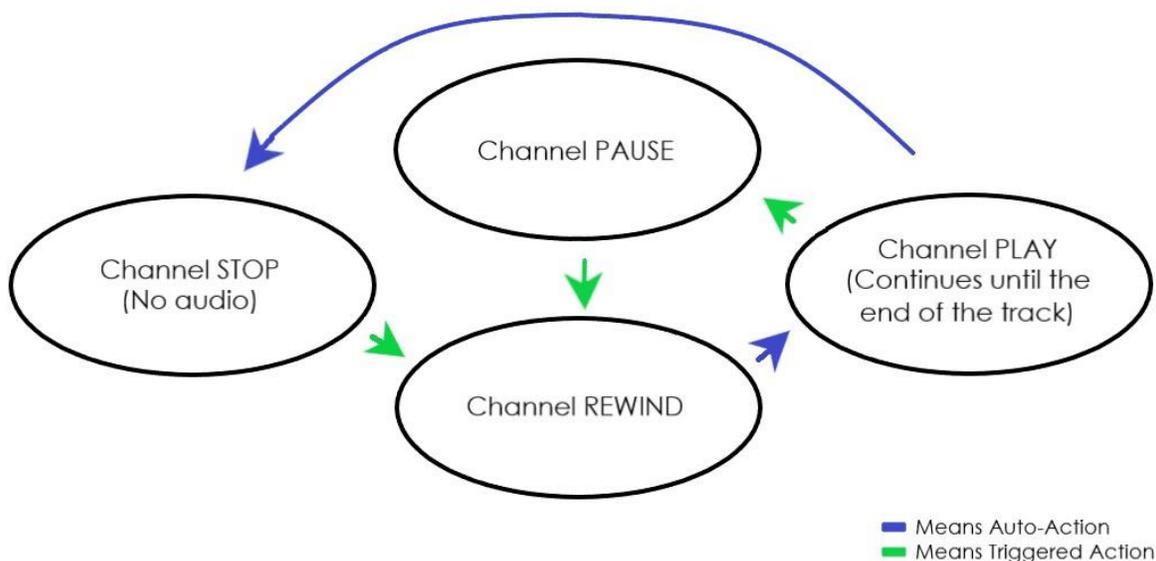
3.3- Polyphonic Stand-Alone Mode 2 - Rewind Play / Pause: In this mode a host controller is not required, SmartWAV 2 uses I0-I9 inputs to trigger up to 10-channel polyphonic audio tracks, those tracks are mounted on each channel at the power-on / initialization state of the processor, the track names (xxx.wav files) are obtained from the "tracks.txt" file (refer to section 3.9- The "Tracks.txt" File), be sure this file exists in the root path of the inserted microSD card together with the .wav files to be triggered.

The audio mixing is automatically handled by the system, but the way each individual input triggers the mounted tracks in this mode is the next:

-In Rewind Play / Pause mode, if an input channel is triggered during the channel is stopped or paused: the track mounted rewinds and play, if during the playback a trigger is present: the channel will be paused. If no trigger is present during playback: the channel will continue playing until the end of the track and stop. In short, this mode works as a toggle-play state.

Note: in the next diagram the green lines mean physical input triggered actions; purple lines mean automatic processor actions.

-Individual Channel Behaviour



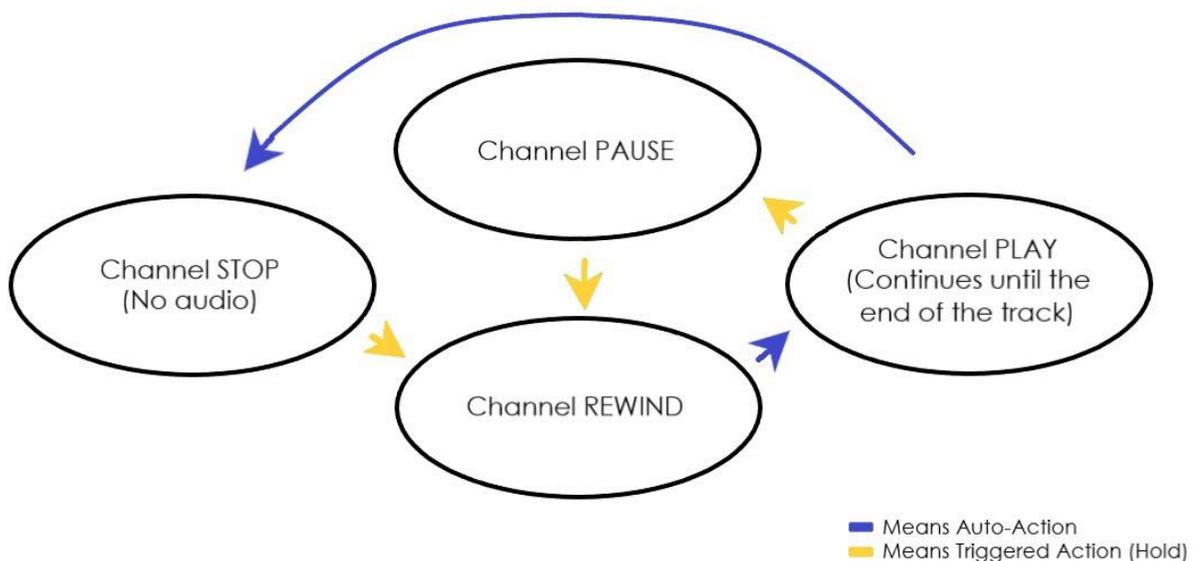
3.4- Polyphonic Stand-Alone Mode 3 - Rewind Play(hold) / Pause: In this mode a host controller is not required, SmartWAV 2 uses I0-I9 inputs to trigger up to 10-channel polyphonic audio tracks, those tracks are mounted on each channel at the power-on / initialization state of the processor, the track names (xxx.wav files) are obtained from the “tracks.txt” file (refer to section 3.9- The “Tracks.txt” File), be sure this file exists in the root path of the inserted microSD card together with the .wav files to be triggered.

The audio mixing is automatically handled by the system, but the way each individual input triggers the mounted tracks in this mode is the next:

-In Rewind Play(hold) / Pause mode, if an input channel is triggered during the channel is stopped or paused: the track mounted rewinds and play while the trigger is hold, if during the playback the input trigger is released: the channel will be paused. If no trigger is released during playback: the channel will continue playing until the end of the track and stop. In short, this mode works as a while-hold-play state.

Note: in the next diagram the yellow lines mean physical input triggered and hold actions; purple lines mean automatic processor actions.

-Individual Channel Behaviour

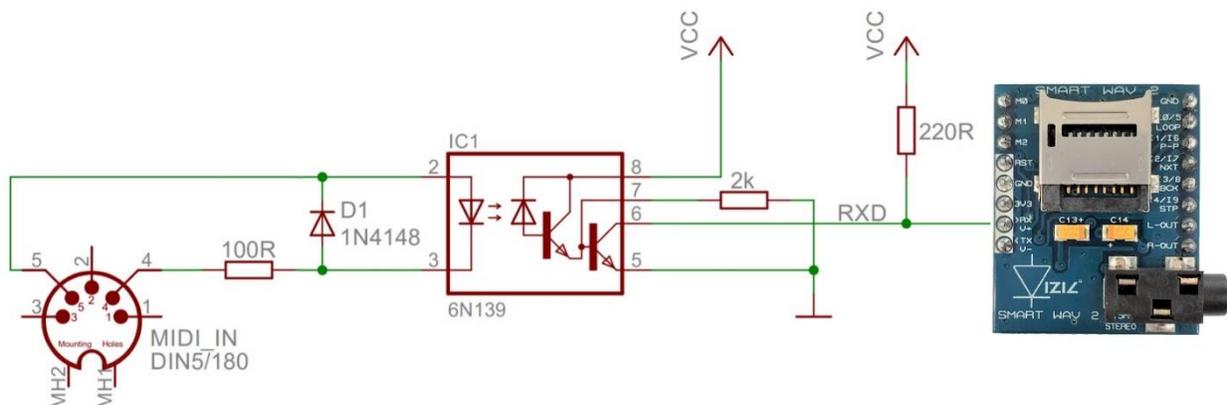


3.5- Polyphonic Slave Serial Mode 4 - Midi Serial: In this mode the SmartWAV2 can be controlled by standard musical instrument digital interface(midi) commands, this mode offers 14-channel polyphonic audio tracks that can be triggered by a midi host. Audio related functions (Refer to document **SmartWAV2-MIDI.pdf**) are controlled by receiving simple midi commands.

Midi channel selection is via the I0-I3 input pins, this allow a logical binary selection of channel 0(0000b) to 15(1111b), however inside the processor this is handled as channel: $n+1$, resulting in a 1 to 16 channel selection. The STP pin acts as a midi omni-channel enable/disable pin, when enabled it overrides the I0-I3 pins channel selection.

To receive midi commands the SmartWAV 2 uses it RX pin (midi in), midi protocol works on a standard serial protocol (31250bps, 8bit, 1stop, no parity), however the hardware interface of a standard serial TTL USART/UART device is different from the hardware interface of midi(opto-isolated), in order to connect a midi out device to SmartWAV 2 RX pin(midi in), a midi to serial TTL(0V-3.3V) converter is required:

Midi to Serial TTL converter.



The midi(opto-isolated) to TTL(0V-3.3V) converter is a simple circuit just to convert the electrical signals of the serial protocol.

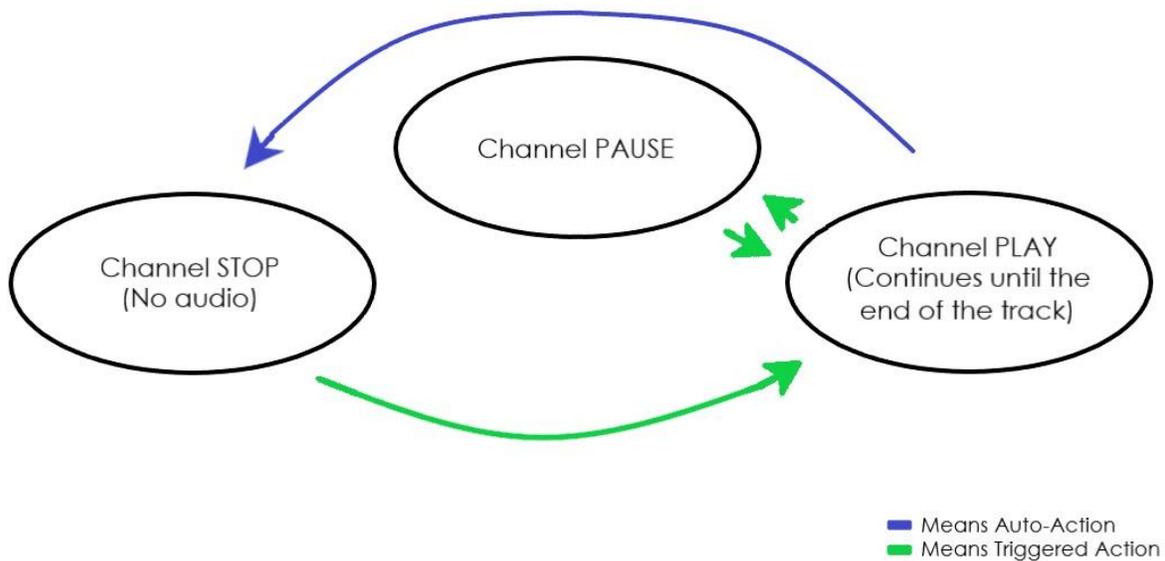
3.6- Polyphonic Stand-Alone Mode 5 - Play / Pause: In this mode a host controller is not required, SmartWAV 2 uses I0-I9 inputs to trigger up to 10-channel polyphonic audio tracks, those tracks are mounted on each channel at the power-on / initialization state of the processor, the track names (xxx.wav files) are obtained from the “tracks.txt” file (refer to section 3.9- The “Tracks.txt” File), be sure this file exists in the root path of the inserted microSD card together with the .wav files to be triggered.

The audio mixing is automatically handled by the system, but the way each individual input triggers the mounted tracks in this mode is the next:

-In Play / Pause mode, if an input channel is triggered during the channel is stopped or paused: the track mounted plays, if during the playback a trigger is present: the channel will be paused, if a trigger is present again: channel will continue playing from the current paused position and so on. If no trigger is present during playback: the channel will continue playing until the end of the track and stop. In short, this mode works as a toggle-play state.

Note: in the next diagram the green lines mean physical input triggered actions; purple lines mean automatic processor actions.

-Individual Channel Behaviour



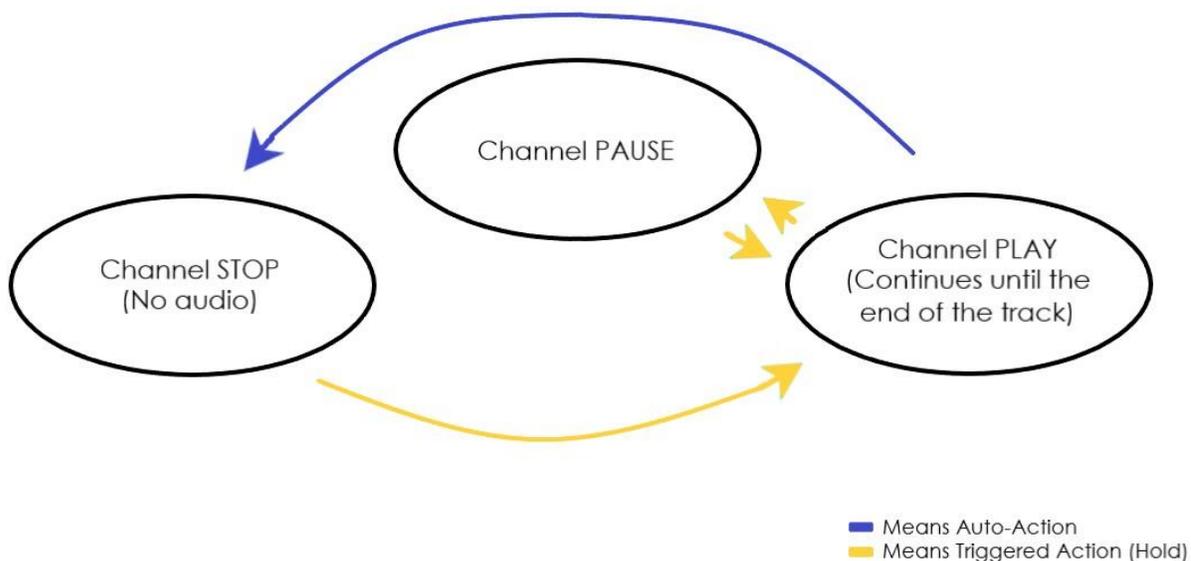
3.7- Polyphonic Stand-Alone Mode 6 - Play(hold) / Pause: In this mode a host controller is not required, SmartWAV 2 uses I0-I9 inputs to trigger up to 10-channel polyphonic audio tracks, those tracks are mounted on each channel at the power-on / initialization state of the processor, the track names (xxx.wav files) are obtained from the “tracks.txt” file, (refer to section 3.9- The “Tracks.txt” File), be sure this file exists in the root path of the inserted microSD card together with the .wav files.

The audio mixing is automatically handled by the system, but the way each individual input triggers the mounted tracks in this mode is the next:

-In Play(hold) / Pause mode, if an input channel is triggered during the channel is stopped or paused: the track mounted plays while the trigger is hold, if during the playback the input trigger is released: the channel will be paused, if a trigger is present again: channel will continue playing from the current paused position while the trigger is hold and so on. If no trigger is released during playback: the channel will continue playing until the end of the track and stop. In short, this mode works as a while-hold-play state.

Note: in the next diagram the yellow lines mean physical input triggered actions; purple lines mean automatic processor actions.

-Individual Channel Behaviour



3.8- Monophonic Stand-Alone Mode 7 - Music Player: This is the most common mode for most music playing related devices, in this mode a host controller is not required, SmartWAV 2 uses P/P(play/pause), NXT(next/fast forward(hold)), BCK(rewind, fast backward(hold)), STP(stop) and Loop inputs to trigger single monophonic audio tracks, this allow to create a complete mp3 like music playing device. Be sure that the .wav files to be triggered exist in the root path of the inserted microSD card.

Track management in this mode is divided in 3 working manners, the this is automatically selected at the power-on / initialization state of the processor based on the next:

-First: the processor looks for the file named "tracks.txt" (refer to section 3.9- The "Tracks.txt" File), if this file exists and can be read, the first track name "*.wav" file obtained from the tracks file will be mounted and ready to play. Consecutive mounted tracks will be obtained from this same "tracks.txt" file.

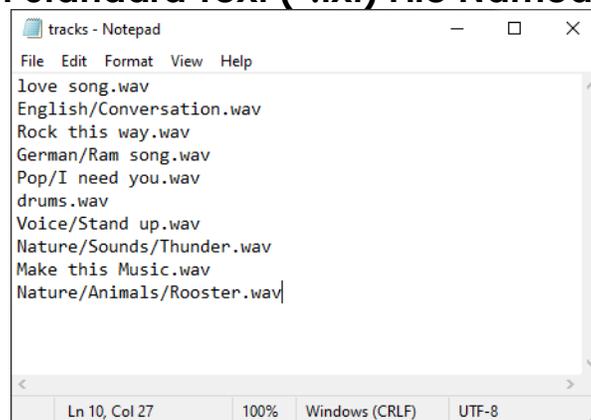
-Second: If the "tracks.txt" file doesn't exist, the processor then will look for the numbered file "0.wav" (zero.wav), if the track exists, it will be mounted and ready to play. Consecutive mounted tracks will be numbered files from "0.wav" (zero.wav) up to "999.wav" (nine hundred and ninety-nine.wav).

-Third: If the "tracks.txt" file doesn't exist, neither the numbered file "0.wav" (zero.wav) couldn't be found, then the processor will randomly look for "*.wav" files, the first found file will be mounted and ready to play. Consecutive tracks will be randomly "*.wav" files searched and mounted.

3.9- The “Tracks.txt” File: The next image shows an example of a standard “tracks.txt” file needed for the processor to correctly mount 1 to 10 tracks in the channels for **polyphonic modes 1, 2, 3, 5 and 6**, and to play single audio files in **monophonic mode 7 in the 1st working manner**.

This “tracks.txt” file must be placed in the microSD card root path together with the .wav files written in the contents of the .txt file.

Example of Standard Text (*.txt) File Named “tracks.txt”



```
tracks - Notepad
File Edit Format View Help
love song.wav
English/Conversation.wav
Rock this way.wav
German/Ram song.wav
Pop/I need you.wav
drums.wav
Voice/Stand up.wav
Nature/Sounds/Thunder.wav
Make this Music.wav
Nature/Animals/Rooster.wav
Ln 10, Col 27 100% Windows (CRLF) UTF-8
```

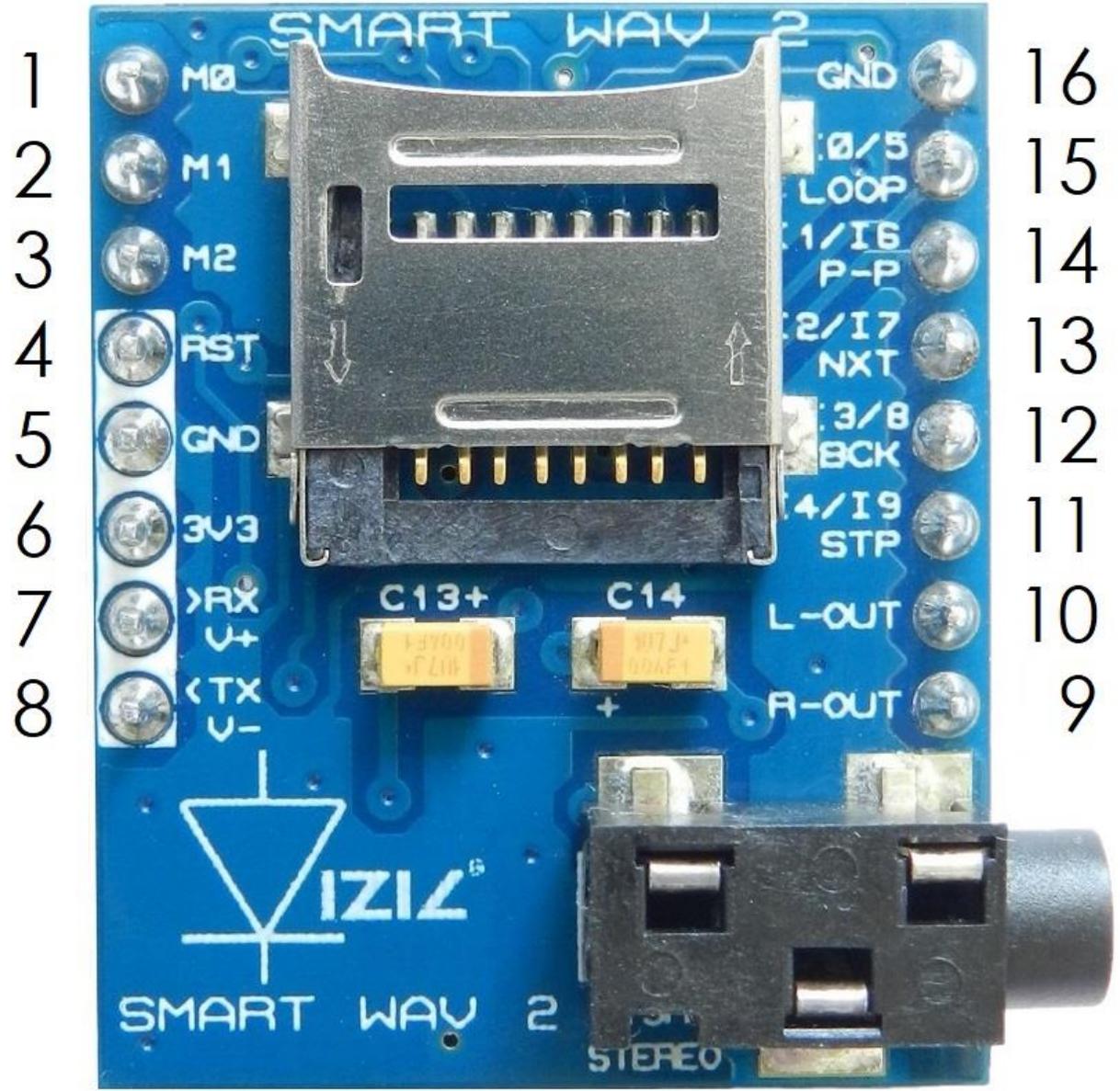
In **polyphonic modes 1, 2, 3, 5 and 6** the processor opens and read the contents of the “tracks.txt” file, and mounts each read .wav file/tracks (1 to 10) in their respective channels, then those are ready to be triggered with each one of the 10 physical inputs pins I0 - I9.

In **monophonic mode 7 1st working manner** the processor opens and read the contents of the first .wav file, mounts this and then it is ready to be triggered with the P/P (play/pause) input button.

** Please note that the '/' slash character can be used in the tracks.txt file contents to denote folder nesting, in the above image example, the Rooster.wav file is under Nature/Animals folder.*

** If no “tracks.txt” file is found or if the file read has no valid .wav files an audible message “No WAV tracks” will be triggered in the SmartWAV 2 audio outputs, this message could be avoided by programming a register in the Standard Serial Mode 0, refer to the **SmartWAV2-CommandSet.pdf** for more detailed information.*

4- SmartWAV 2 Pinout:



5- Polyphonic Slave Serial Mode 0 - Standard Serial:

5.1- Master-Slave Host Interface:

SmartWAV 2 in this mode acts as a slave peripheral device, providing a bidirectional serial interface to a master host controller via its UART(Universal Asynchronous Receiver - Transmitter), the required pins of Standard Serial Mode 0 are labeled with a white rectangle.

Any microcontroller or processor (AVR, PIC, mbed, raspberry PI, ARDUINO, beaglebone, 8051, MBED, FPGA, ARM, STM, etc) or PC(by serial interface RS232) as host, can communicate to the device over this serial interface at different bps speeds.

The serial protocol is universal and easy to implement:

Serial Data Format: 8 Bits, No Parity, 1 Stop Bit.

BaudRate: 57600 bps(default).

Serial data is true and not inverted.

5.2- Command Protocol Flow Control:

SmartWAV 2 processor is a slave device and all communication and events must be initiated first by the host (Refer to document **SmartWAV2-CommandSet.pdf**). Commands consist of a sequence of data bytes beginning with the command/function byte. When a command is sent from host to the processor, this executes the command and when the operation is completed it will always return a response*, the processor will also always send back a single acknowledge byte called the ACK (4Fhex, 'O' ascii), in the case of success, or NAK (46hex, 'F' ascii), in the case of failure or not recognized command.

** Commands having specific responses may send back varying numbers of bytes, depending upon the command and response. Processing and execution will take a certain amount of time, depending on the command type and the operation that has to be performed, but once the reply is sent, it means the processor has finished and its ready to receive more commands.*

5.3- Power-up, Reset and Serial Setup:

When the SmartWAV 2 device comes out of a power up or reset, a 50ms delay before sending any command must be met, this time let the processor to configure its internal state machines, do not attempt to communicate with the module before this period. Any command could be sent after this time.

The processor is configured to work at a standard default baud rate of **57600bps**. This baud rate speed can be changed from **9600bps** up to **256000bps** with the corresponding baud rate change command.

5.4- Standard Serial Mode 0 Pinout:

Pin	Symbol	Function	Description
1	M0	INPUT	Digital input power ON/reset mode selection pin, the combination of M0, M1 and M2, determines the working mode of the processor. Internally pulled-down to ground via a 40K resistor.
2	M1	INPUT	Digital input power ON/reset mode selection pin, the combination of M0, M1 and M2, determines the working mode of the processor. Internally pulled-down to ground via a 40K resistor.
3	M2	INPUT	Digital input power ON/reset mode selection pin, the combination of M0, M1 and M2, determines the working mode of the processor. Internally pulled-down to ground via a 40K resistor.
4	RESET	INPUT	Digital input reset pin, an active low pulse greater than 100ns will reset the processor. Internally pulled-up to 3.3V via a 40K resistor. 5V tolerant input.

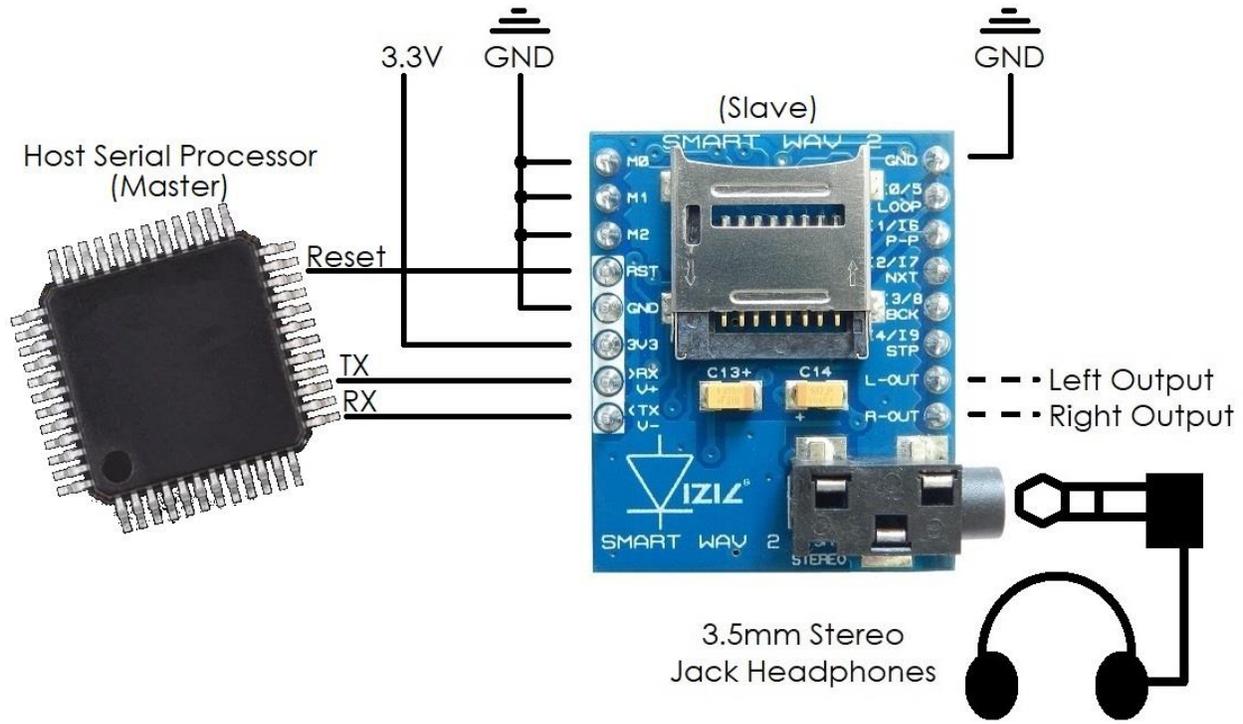
5	GROUND	POWER	Supply ground, be sure to have a well-grounded connection to avoid noise over the audio outputs.
6	3.3V	POWER	Main supply voltage: 2.7v-3.5v. Be sure to use a 10uF and 100nF coupling capacitors to GND as close as possible to avoid noise over the audio outputs.
7	Rx - V+	INPUT	Digital input pin RX (asynchronous serial receiver input pin). Internally pulled-up to 3.3V via a 40K resistor. 5V tolerant input.
8	TX - V-	OUT	Digital output pin TX (asynchronous serial transmitter output pin).
9	R-OUT	OUT	Pre-amplified right channel audio output pin. Connect this pin instead of the 3.5mm plug connector, those are internally connected. (*Do not use both plug and this pin at the same time).
10	L-OUT	OUT	Pre-amplified left channel audio output pin. Connect this pin instead of the 3.5mm plug connector, those are internally connected. (*Do not use both plug and this pin at the same time).
11	I4/I9 - STP	NC	Not used, leave unconnected.
12	I3/I8 - BCK	NC	Not used, leave unconnected.
13	I2/I7 - NXT	NC	Not used, leave unconnected.
14	I1/I6 - P/P	NC	Not used, leave unconnected.
15	I0/I5 - LOOP	NC	Not used, leave unconnected.

16	GND	POWER	Supply ground, be sure to have a well-grounded connection to avoid noise over the audio outputs.
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*NC means no connect.

5.5- Standard Serial Mode 0 Typical Connection:

*The SmartWAV 2 must always be powered with 2.7V-3.5V (Reset and RX pin are 5V tolerant).



*Note: use 3.5mm plug or the L-Out & R-Out output pins, but not both at the same time!

6- Polyphonic Stand-Alone Modes 1, 2, 3, 5 and 6:

6.1- Interface:

SmartWAV 2 could be connected as a Stand-Alone module without the need of an external host controller, in this fashion the processor can be triggered and controlled with external push buttons connected to the board inputs. The processor can be used as a battery powered system due to the ultra-low power consumption and the sleep/stand-by modes.

In Stand-Alone Modes, the SmartWAV 2 only recognize .wav files stored in the root path of the microSD card, all .wav files must be placed in this path.

6.2- Polyphonic Stand-Alone Modes 1, 2, 3, 5 and 6 Pinout:

Pin	Symbol	Function	Description
1	M0	INPUT	Digital input power ON/reset mode selection pin, the combination of M0, M1 and M2, determines the working mode of the processor. Internally pulled-down to ground via a 40K resistor.
2	M1	INPUT	Digital input power ON/reset mode selection pin, the combination of M0, M1 and M2, determines the working mode of the processor. Internally pulled-down to ground via a 40K resistor.
3	M2	INPUT	Digital input power ON/reset mode selection pin, the combination of M0, M1 and M2, determines the working mode of the processor. Internally pulled-down to ground via a 40K resistor.

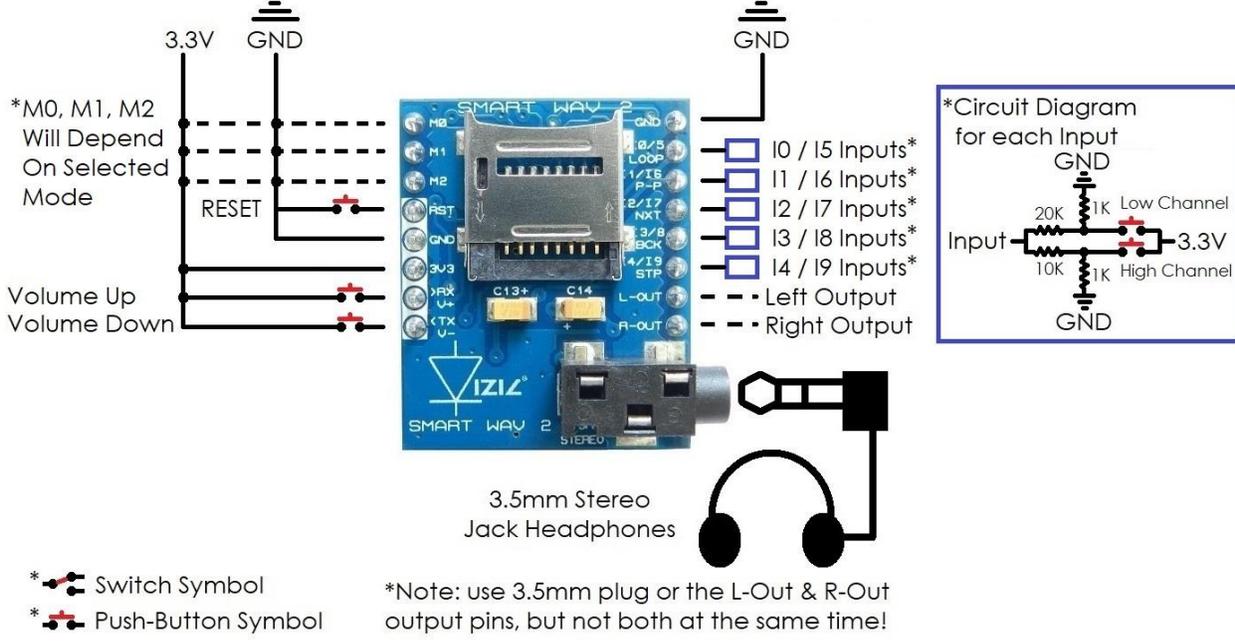
4	RESET	INPUT	Digital input reset pin, an active low pulse greater than 100ns will reset the processor. Internally pulled-up to 3.3V via a 40K resistor. 5V tolerant input.
5	GROUND	POWER	Supply ground, be sure to have a well-grounded connection to avoid noise over the audio outputs.
6	3.3V	POWER	Main supply voltage: 2.7v-3.5v. Be sure to use a 10uF and 100nF coupling capacitors to GND as close as possible to avoid noise over the audio outputs.
7	Rx - V+	INPUT	Digital input volume-up pin. Internally pulled-down via a 40K resistor.
8	TX - V-	INPUT	Digital input volume-down pin. Internally pulled-down via a 40K resistor.
9	R-OUT	OUT	Pre-amplified right channel audio output pin. Connect this pin instead of the 3.5mm plug connector, those are internally connected. (*Do not use both plug and this pin at the same time).
10	L-OUT	OUT	Pre-amplified left channel audio output pin. Connect this pin instead of the 3.5mm plug connector, those are internally connected. (*Do not use both plug and this pin at the same time).
11	I4/I9 - STP	INPUT	Analog input pin 14 and 19 Refer to analog input typical connections.
12	I3/I8 - BCK	INPUT	Analog input pin 13 and 18 Refer to analog input typical connections.
13	I2/I7 - NXT	INPUT	Analog input pin 12 and 17 Refer to analog input typical connections.

14	I1/I6 - P/P	INPUT	Analog input pin I1 and I6 Refer to analog input typical connections.
15	I0/I5 - LOOP	INPUT	Analog input pin I0 and I5 Refer to analog input typical connections.
16	GND	POWER	Supply ground, be sure to have a well-grounded connection to avoid noise over the audio outputs.

*NC means no connect.

6.3- Polyphonic Stand-Alone Modes 1, 2, 3, 5 and 6 Typical Connection:

*The SmartWAV 2 must always be powered with 2.7V-3.5V (Reset is 5V tolerant).



7- Polyphonic Slave Serial Mode 4 - MIDI Serial:

7.1- MIDI Host Interface:

SmartWAV 2 in this mode acts as a slave peripheral device, providing a unidirectional serial interface to a host MIDI controller via its UART(Universal Asynchronous Receiver).

Any MIDI compliant device can communicate with SmartWAV 2 using standard MIDI commands, note on, note off, program change, etc. (Refer to document **SmartWAV2-MIDI.pdf**). Midi channel selection is via the I0-I3 input pins, this allow a logical binary selection of channel 0(0000b) to 15(1111b), however inside the processor this is handled as channel: n+1, resulting in a 1 to 16 channel selection. The STP pin acts as a midi omni-channel enable/disable pin, when enabled it overrides the I0-I3 pins channel selection.

The serial protocol over MIDI is universal:

Serial Data Format: 8 Bits, No Parity, 1 Stop Bit.

BaudRate: 31250 bps(default).

Serial data is true and not inverted.

7.2- MIDI Serial Mode 4 Pinout:

Pin	Symbol	Function	Description
1	M0	INPUT	Digital input power ON/reset mode selection pin, the combination of M0, M1 and M2, determines the working mode of the processor. Internally pulled-down to ground via a 40K resistor.
2	M1	INPUT	Digital input power ON/reset mode selection pin, the combination of M0, M1 and M2, determines the working mode of the processor. Internally pulled-down to ground via a 40K resistor.

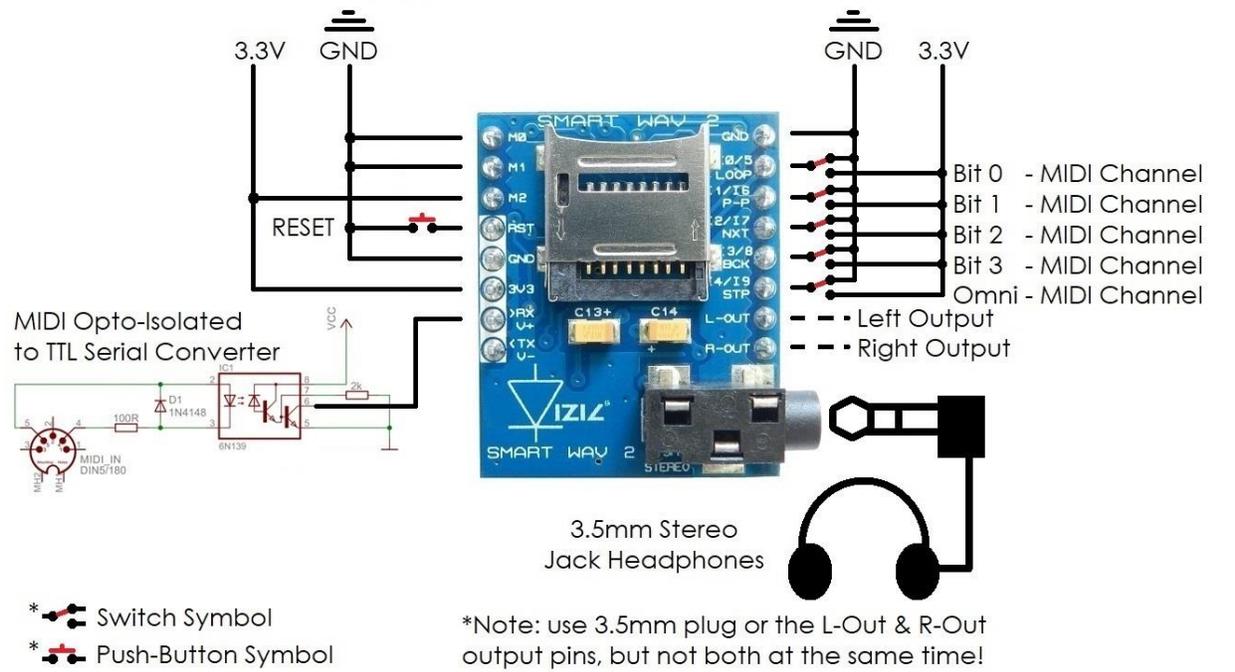
3	M2	INPUT	Digital input power ON/reset mode selection pin, the combination of M0, M1 and M2, determines the working mode of the processor. Internally pulled-down to ground via a 40K resistor.
4	RESET	INPUT	Digital input reset pin, an active low pulse greater than 100ns will reset the processor. Internally pulled-up to 3.3V via a 40K resistor. 5V tolerant input.
5	GROUND	POWER	Supply ground, be sure to have a well-grounded connection to avoid noise over the audio outputs.
6	3.3V	POWER	Main supply voltage: 2.7v-3.5v. Be sure to use a 10uF and 100nF coupling capacitors to GND as close as possible to avoid noise over the audio outputs.
7	Rx - V+	INPUT	Digital input pin MIDI IN. Refer to MIDI to TTL converter for connections. Internally pulled-up to 3.3V via a 40K resistor.
8	TX - V-	NC	Not used, leave unconnected.
9	R-OUT	OUT	Pre-amplified right channel audio output pin. Connect this pin instead of the 3.5mm plug connector, those are internally connected. (*Do not use both plug and this pin at the same time).
10	L-OUT	OUT	Pre-amplified left channel audio output pin. Connect this pin instead of the 3.5mm plug connector, those are internally connected. (*Do not use both plug and this pin at the same time).

11	I4/I9 - STP	INPUT	Digital input pin MIDI omni-channel enable/disable. Internally pulled-down to ground via a 40K resistor.
12	I3/I8 - BCK	INPUT	Digital input pin MIDI channel selection bit 3. Internally pulled-down to ground via a 40K resistor.
13	I2/I7 - NXT	INPUT	Digital input pin MIDI channel selection bit 2. Internally pulled-down to ground via a 40K resistor.
14	I1/I6 - P/P	INPUT	Digital input pin MIDI channel selection bit 1. Internally pulled-down to ground via a 40K resistor.
15	I0/I5 - LOOP	INPUT	Digital input pin MIDI channel selection bit 0. Internally pulled-down to ground via a 40K resistor.
16	GND	POWER	Supply ground, be sure to have a well-grounded connection to avoid noise over the audio outputs.

*NC means no connect.

7.3- MIDI Serial Mode 4 Typical Connection:

*The SmartWAV 2 must always be powered with 2.7V-3.5V (Reset is 5V tolerant).



8- Monophonic Stand-Alone Mode 7 - Music Player:

8.1- Interface:

SmartWAV 2 could be connected as a Stand-Alone module without the need of an external host controller, in this fashion the processor can be triggered and controlled with external push buttons connected to the board inputs. The processor can be used as a battery powered system due to the ultra-low power consumption and the sleep/stand-by modes.

In Stand-Alone Modes, the SmartWAV 2 only recognize .wav files stored in the root path of the microSD card, all .wav files must be placed in this path.

8.2- Monophonic Stand-Alone Mode 7 Music Player Pinout:

Pin	Symbol	Function	Description
1	M0	INPUT	Digital input power ON/reset mode selection pin, the combination of M0, M1 and M2, determines the working mode of the processor. Internally pulled-down to ground via a 40K resistor.
2	M1	INPUT	Digital input power ON/reset mode selection pin, the combination of M0, M1 and M2, determines the working mode of the processor. Internally pulled-down to ground via a 40K resistor.
3	M2	INPUT	Digital input power ON/reset mode selection pin, the combination of M0, M1 and M2, determines the working mode of the processor. Internally pulled-down to ground via a 40K resistor.

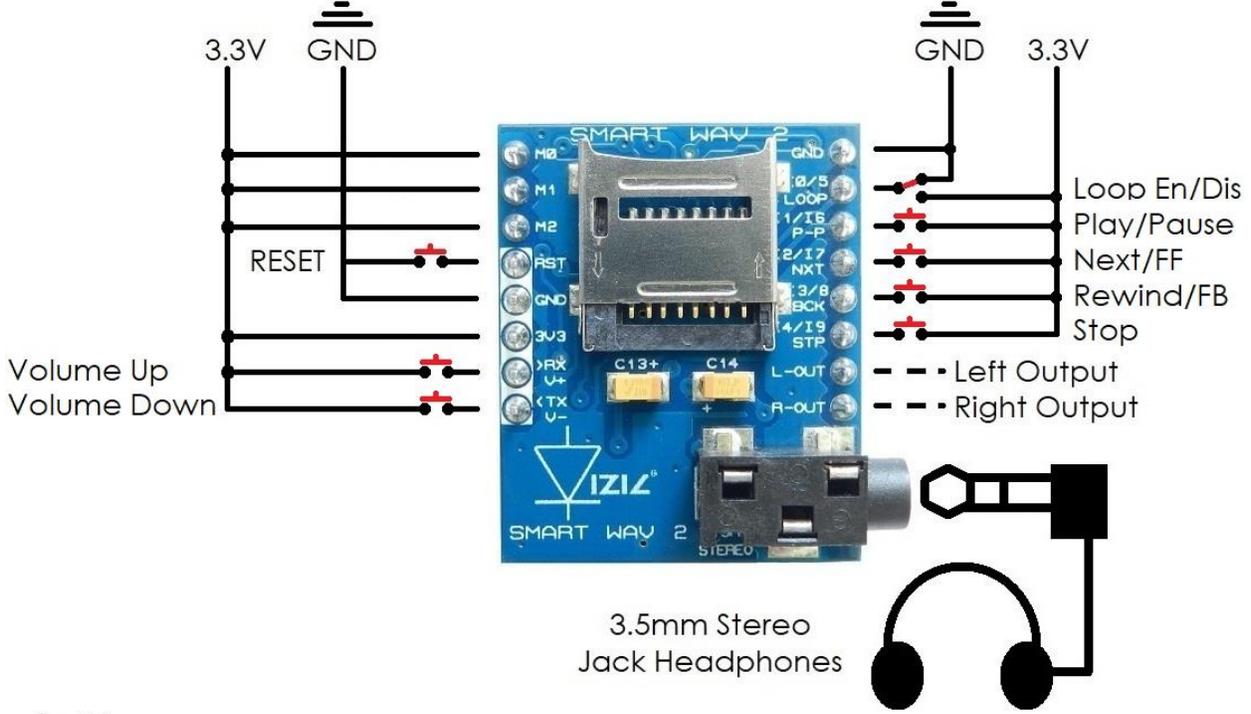
4	RESET	INPUT	Digital input reset pin, an active low pulse greater than 100ns will reset the processor. Internally pulled-up to 3.3V via a 40K resistor. 5V tolerant input.
5	GROUND	POWER	Supply ground, be sure to have a well-grounded connection to avoid noise over the audio outputs.
6	3.3V	POWER	Main supply voltage: 2.7v-3.5v. Be sure to use a 10uF and 100nF coupling capacitors to GND as close as possible to avoid noise over the audio outputs.
7	Rx - V+	INPUT	Digital input volume-up pin. Internally pulled-down via a 40K resistor.
8	TX - V-	INPUT	Digital input volume-down pin. Internally pulled-down via a 40K resistor.
9	R-OUT	OUT	Pre-amplified right channel audio output pin. Connect this pin instead of the 3.5mm plug connector, those are internally connected. (*Do not use both plug and this pin at the same time).
10	L-OUT	OUT	Pre-amplified left channel audio output pin. Connect this pin instead of the 3.5mm plug connector, those are internally connected. (*Do not use both plug and this pin at the same time).
11	I4/I9 - STP	INPUT	Digital input pin Stop Track. Internally pulled-down via a 40K resistor.
12	I3/I8 - BCK	INPUT	Digital input pin Rewind Track/Fast Backward. Internally pulled-down via a 40K resistor.

13	I2/I7 - NXT	INPUT	Digital input pin Next Track/Fast Forward(hold). Internally pulled-down via a 40K resistor.
14	I1/I6 - P/P	INPUT	Digital input pin Play/Pause Track. Internally pulled-down via a 40K resistor.
15	I0/I5 - LOOP	INPUT	Digital input pin Loop enable/disable. Internally pulled-down via a 40K resistor.
16	GND	POWER	Supply ground, be sure to have a well-grounded connection to avoid noise over the audio outputs.

*NC means no connect.

8.3- Monophonic Stand-Alone Mode 7 Music Player Typical Connection:

*The SmartWAV 2 must always be powered with 2.7V-3.5V (Reset is 5V tolerant).



- * Switch Symbol
- * Push-Button Symbol

*Note: use 3.5mm plug or the L-Out & R-Out output pins, but not both at the same time!

9- MicroSD File/Folder Organization - Standard Serial Mode 0:

The SmartWAV 2 is capable of managing and folders in this mode, so a complete library organized by artist/ album/ genre/ year/ etc. could be done inside the micro SD card. Also the processor could access nested folders for example: "D:/rock/punk/oldies/song.wav".

In Stand-Alone Modes, the SmartWAV 2 only recognize .wav files stored in the root path of the microSD card, all .wav files must be placed in this path.

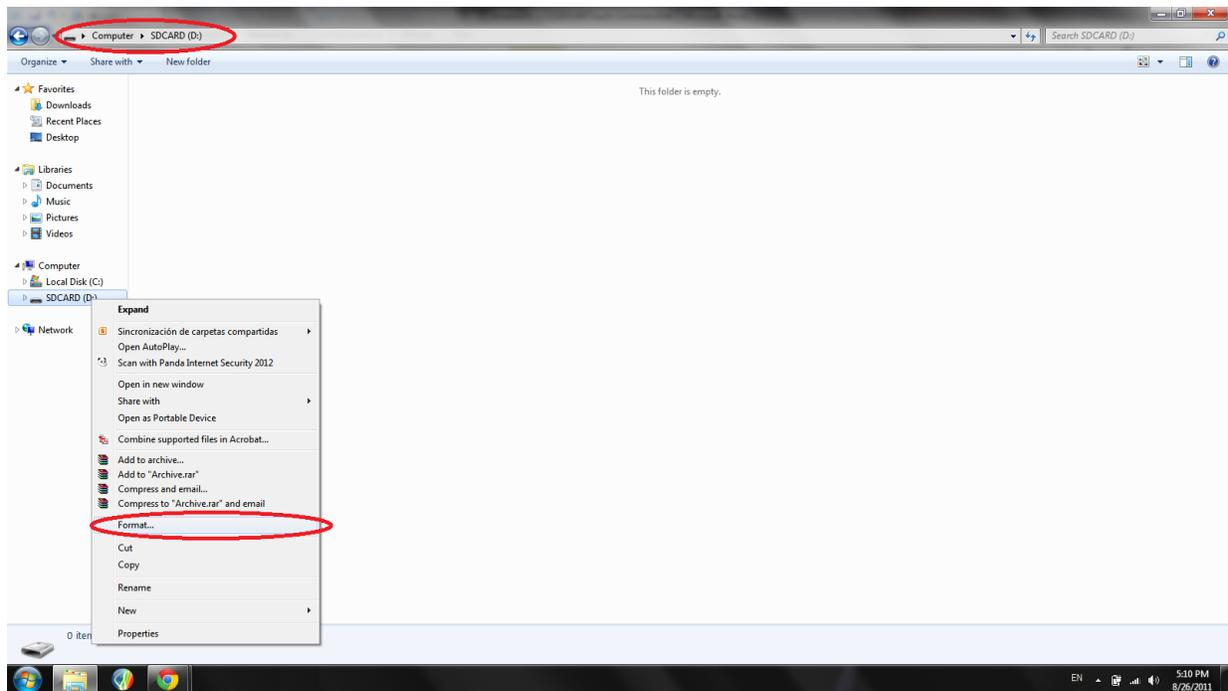
The next image gives some examples of files/folders organization/nesting that can be achieved and accessed, folder nesting is allowed:



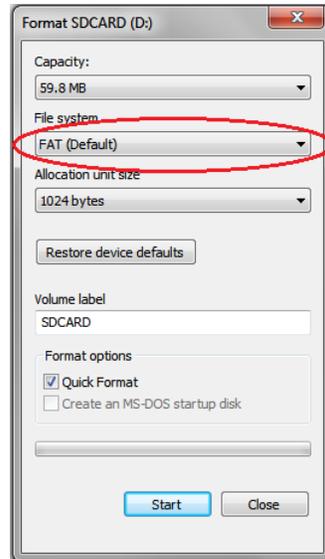
10- Formatting MicroSD Card:

It is recommended but not strictly necessarily to format the micro SD card for first use, in this section a format to new micro SD card to FAT format is explained.

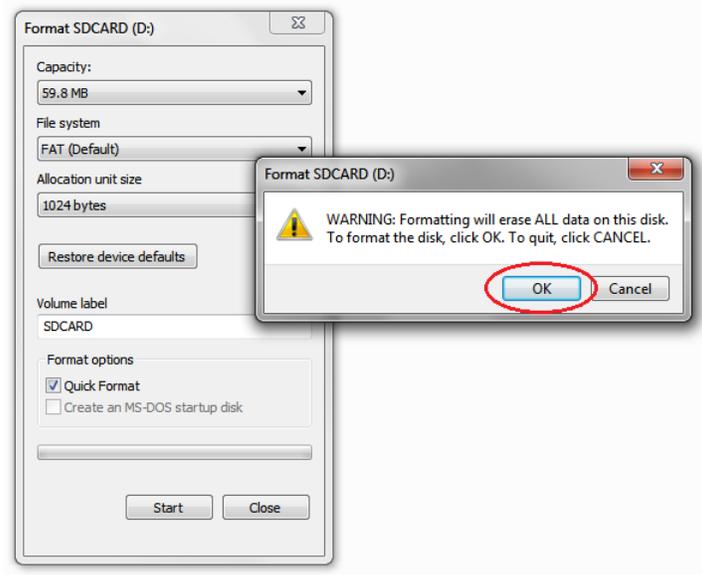
A.- Open a new windows explorer right click on the microSD card and a menu appears, select the “FORMAT...” and click on it. *(Note that formatting a micro SD card will erase all the contents of it).*



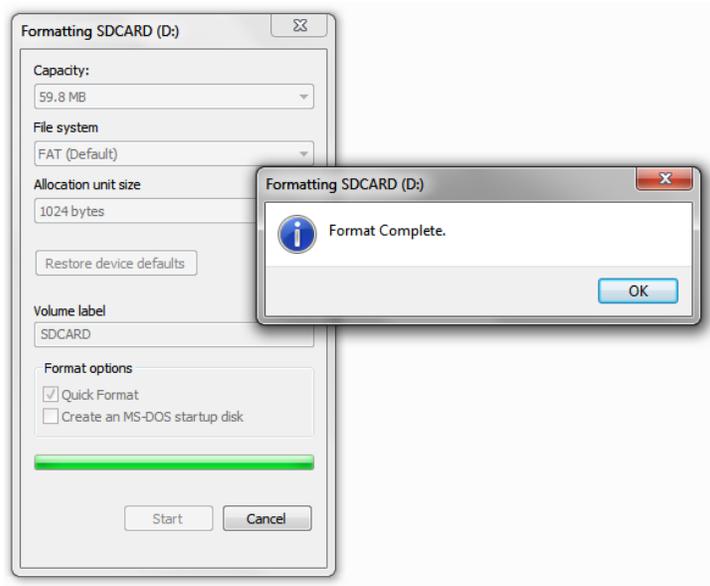
B.- A new window will pop-up, chose FAT/FAT32(default) on the File System menu, and click start.



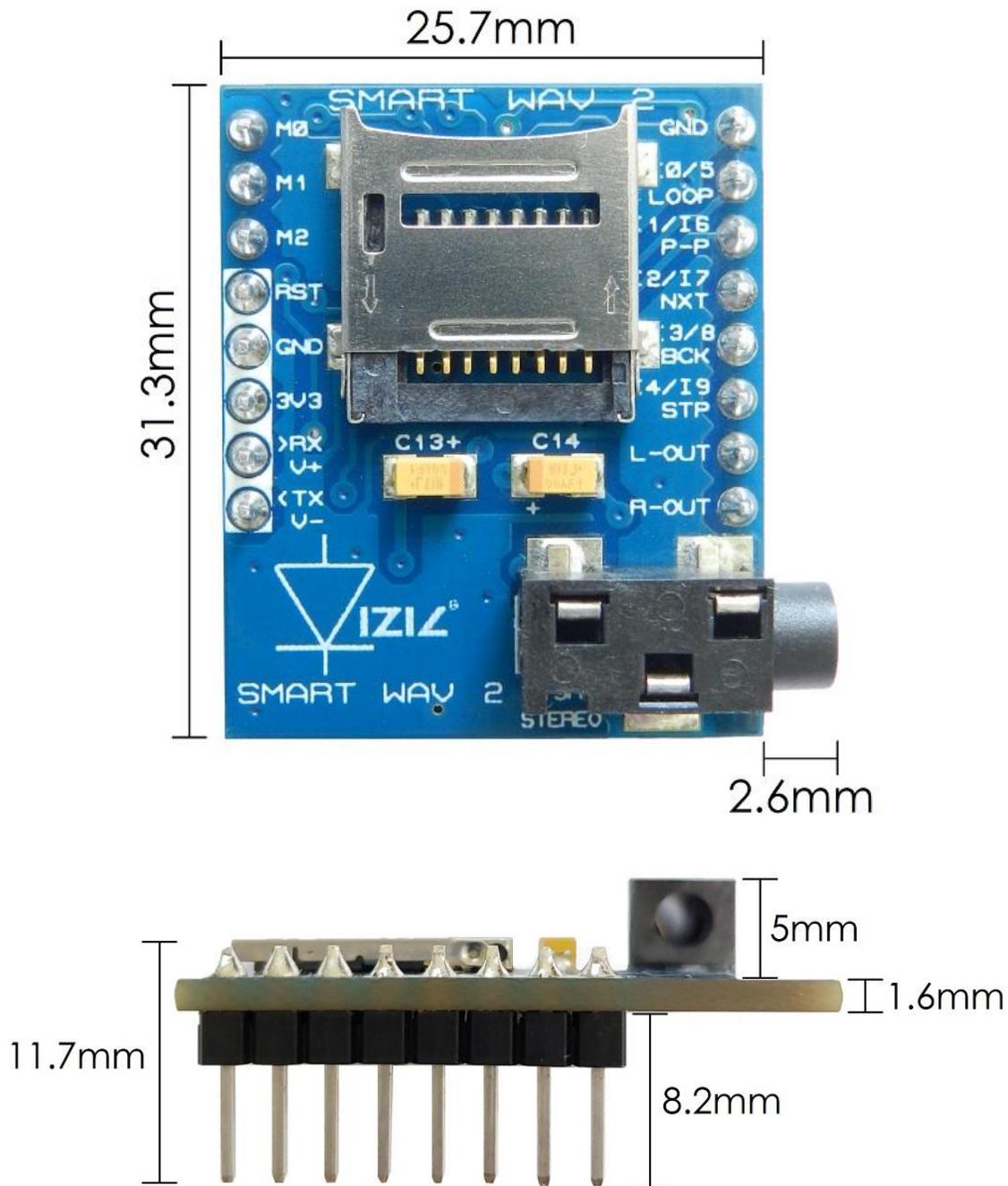
C.- Click OK on the new window and wait to the PC to perform the format.



D.- Now the microSD card is ready to load tracks and songs!



11- Mechanical Dimensions:



**All units are in mm.*

12- Specifications and Ratings:

Voltage characteristics

Symbol	Ratings	Min	Max	Unit
$V_{DD}-V_{SS}$	External main supply voltage	2.4	3.6	V
V_{IN}	Input voltage on five-volt tolerant pin ⁽¹⁾	$V_{SS}-0.3$	$V_{DD}+4$	
	Input voltage on any other pin	$V_{SS}-0.3$	4.0	

- V_{IN} maximum value must always be respected.

General operating conditions

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V_{IN}	Input voltage on RST and five-volt tolerant pins	$2\text{ V} \leq V_{DD} \leq 3.6\text{ V}$	-0.3	-	5.5	V
	Input voltage on normal pins	-	-0.3	-	$V_{DD}+0.3$	

Current characteristics

Symbol	Ratings	Max.	Unit
I_{VDD}	Total current into V_{DD} power lines (source) ⁽¹⁾	240	mA
I_{VSS}	Total current out of V_{SS} ground lines (sink) ⁽¹⁾	240	
I_{IO}	Output current sunk by any I/O and control pin	25	
	Output current source by any I/Os and control pin	25	
$I_{INJ(PIN)}^{(2)}$	Injected current on five-volt tolerant I/O ⁽³⁾	-5/+0	
	Injected current on any other pin ⁽⁴⁾	± 5	
$\Sigma I_{INJ(PIN)}^{(4)}$	Total injected current (sum of all I/O and control pins) ⁽⁵⁾	± 25	

- All main power (V_{DD}) and ground (V_{SS}) pins must always be connected to the external power supply, in the permitted range.
- Negative injection disturbs the analog performance of the device.
- Positive injection is not possible on these I/Os. A negative injection is induced by $V_{IN} < V_{SS}$. $I_{INJ(PIN)}$ must never be exceeded.
- A positive injection is induced by $V_{IN} > V_{DD}$ while a negative injection is induced by $V_{IN} < V_{SS}$. $I_{INJ(PIN)}$ must never be exceeded.
- When several inputs are submitted to a current injection, the maximum $\Sigma I_{INJ(PIN)}$ is the absolute sum of the positive and negative injected currents (instantaneous values).

Typical and maximum current consumption

Symbol	Parameter	Typ	Max		Unit
		T _A = 25 °C	T _A = 85 °C	T _A = 105 °C	
I _{DD}	Supply current in Run mode	60	77	84	mA
	Supply current in Sleep mode	1.5	2	3	mA
	Supply current in Standby mode	2.2	9.8	19.2	μA

DAC characteristics

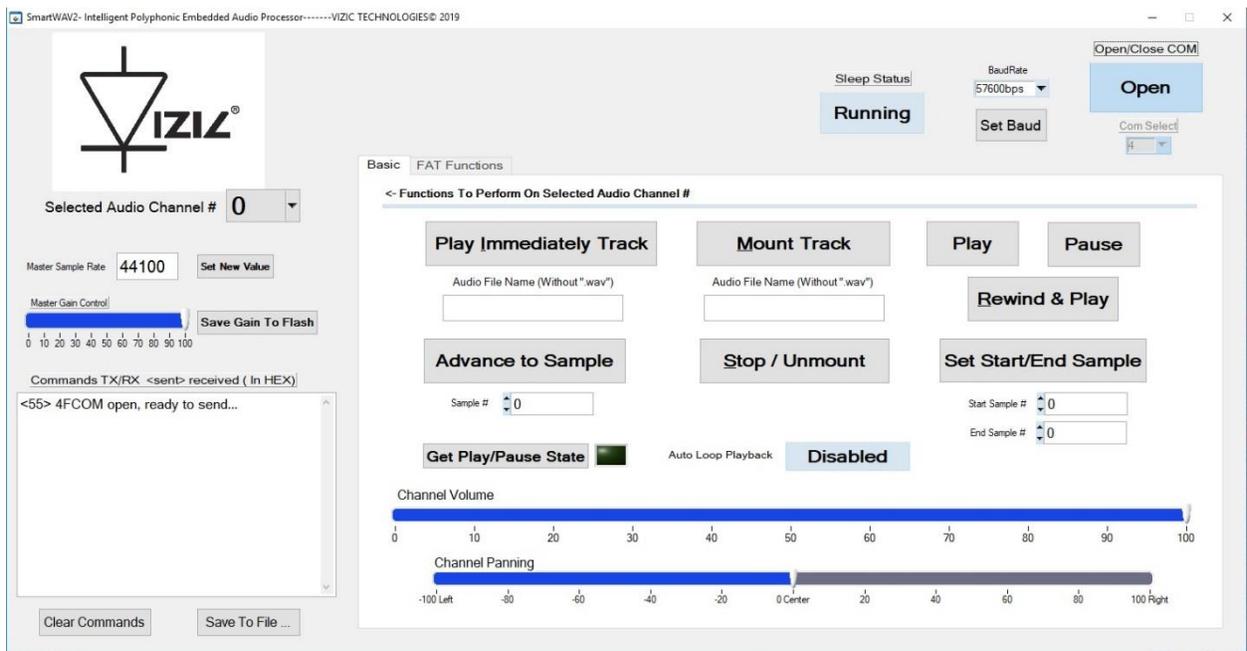
Symbol	Parameter	Min	Typ	Max	Unit
R _{LOAD}	Minimum resistive load	5	16	-	Ω

13- Development Software & Hardware Tools

In order to make easier the learning about how to communicate with the SmartWAV 2, free software could be downloaded and used in any PC. This software simulates almost all of the functions of the processor in Standard Serial Mode 0, this is achieved by connecting the hardware tool USB-UART SX Bridge to the SmartWAV 2 enabling real time audio processing, the required pins of Standard Serial Mode 0 are labeled with a white rectangle.

This software greatly reduces the time of learning the commands, and helps the user to understand how commands are created.

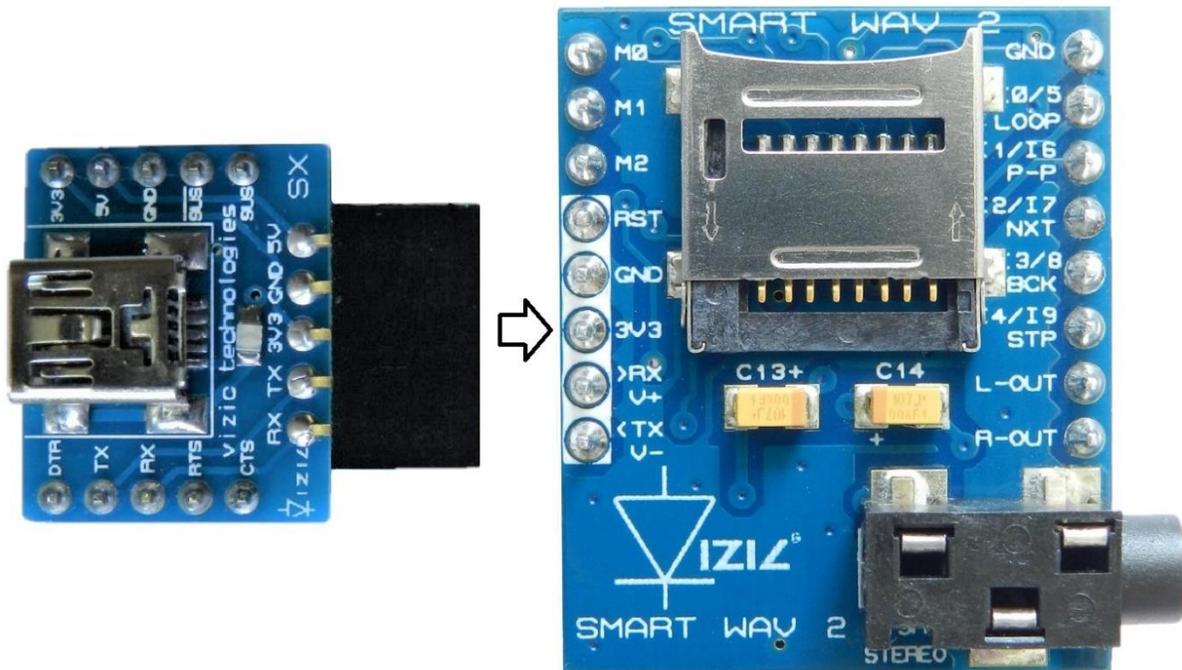
SmartWAV 2 PC Interface:



The USB-UART SX:

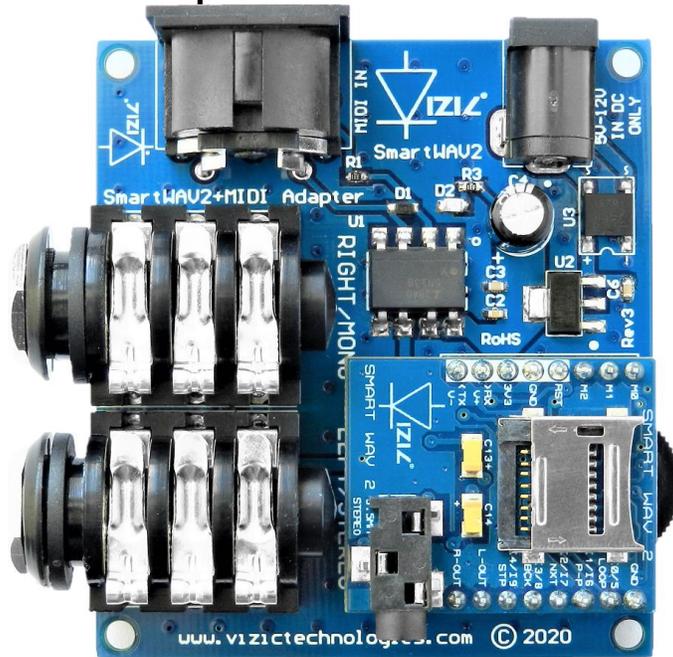


SmartWAV 2 connected to the USB-UART SX, the required pins of Standard Serial Mode 0 are labeled with a white rectangle:

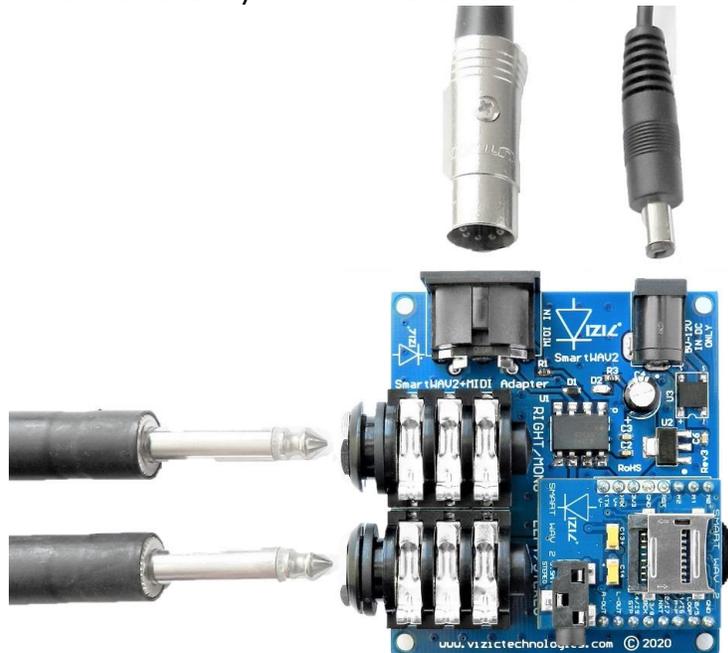


For detailed information about the USB-UART SX Bridge, please visit our web site.

The SmartWAV2+MIDI Adapter:



This special hardware/adapter provides all the required wiring, thus converting the SmartWAV2 into a professional MIDI system ready to plug and play (The SmartWAV2 is directly soldered to the adapter, therefore this hardware only allows to use SmartWAV2 in MIDI mode):



For detailed information about the SmartWAV2+MIDI Adapter, please visit our web site.

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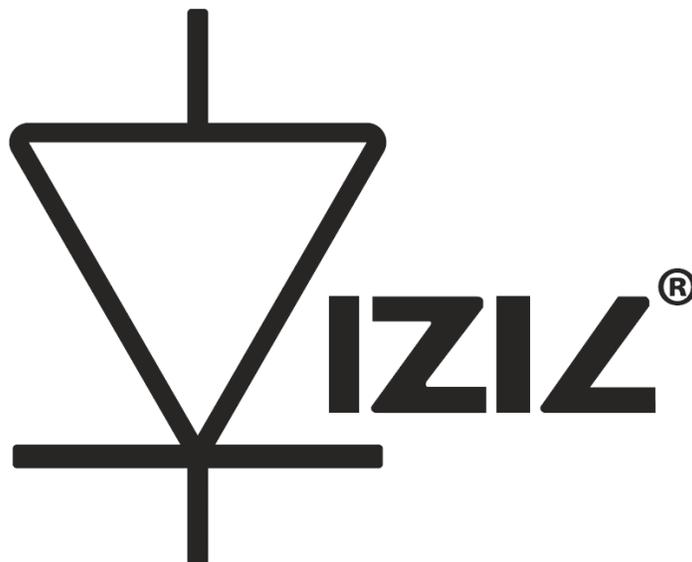
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