16 Channel Sound Effects Unit
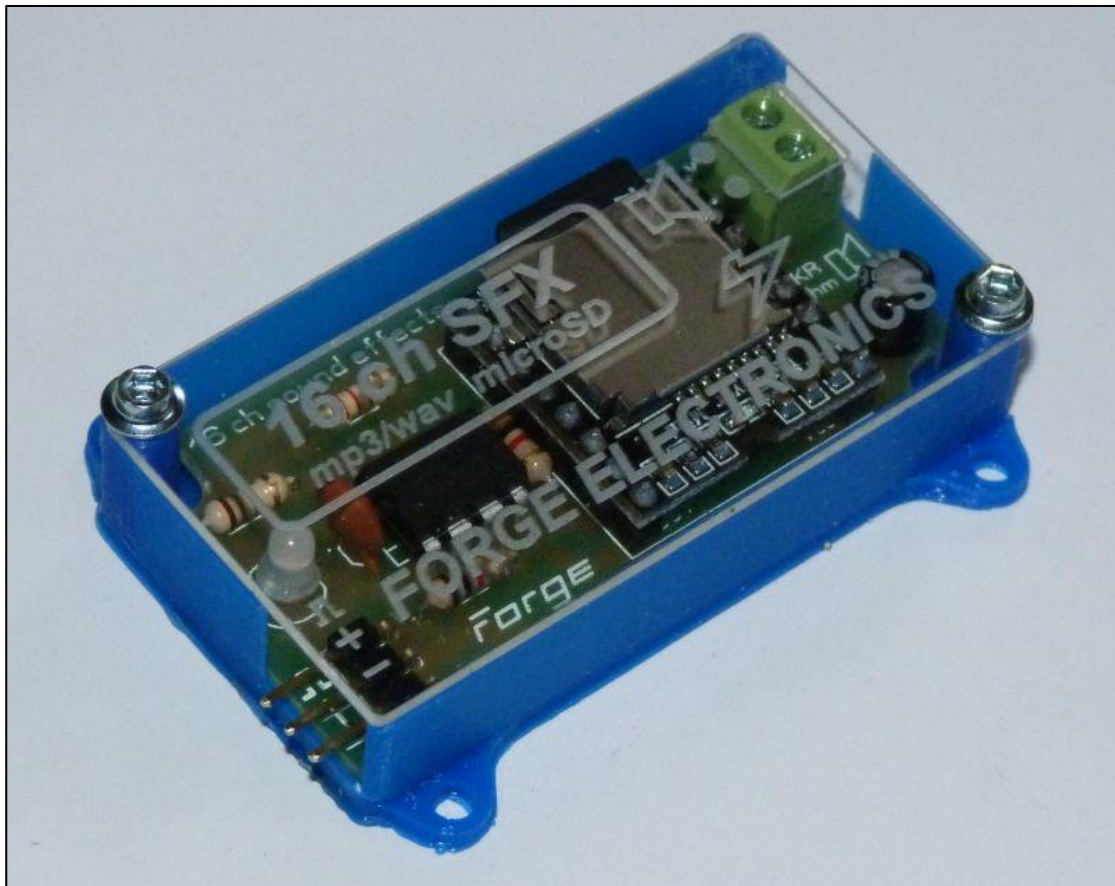
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Overview

This unit was designed to replay up to sixteen different recorded sound effects on radio controlled model boats, but will doubtless find application in other radio control projects. So far it has been used to great effect in several battleships to create various types of gunfire, sound horns and klaxons, make ASDIC 'pings', sound 'General Quarters', make aircraft and helicopter fly-bys etc. All the hard work is done by a commercially available embedded mp3 player module (the "DFPlayer Mini" seen in the picture above) and the unit's micro-controller chip simply serves to decode a spare (proportional) radio control channel used to trigger the sixteen sound tracks. A radio controlled volume control has been implemented using a seventeenth channel.

The (user added) sound files are stored on a microSD card (uses 1GB to 32GB cards formatted FAT16 or FAT32) and the player supports MP3 and WAV files with all of the most common sampling frequencies (kHz): 8 / 11.025 / 12 / 16 / 22.05 / 24 / 32 / 44.1 / 48. The output is monophonic, and stereo tracks are represented as such.

A microSD card populated with demonstration tracks is supplied with the unit, and users can thereafter replace them with their own tracks via a card reader on their computer (internal card slot or USB gizmo). There are a great many sound effect libraries on the web from which sounds may be downloaded, usually in WAV format, so a good sound editing package like Audacity (free!) is handy if it is desired to convert them to MP3 format. It can also be useful to clean up lead-in or trail-out artefacts etc. and set the relative volume levels of the tracks with respect to each other.

The user selects the desired track number by a corresponding number of 'jabs' of the joystick, the sounds being arranged in two banks of eight on opposite throws of the transmitter joystick. Although many thousand tracks can be stored on the microSD card, given the track selection method it was considered sensible to limit the access to just 16 tracks.

Selecting a track cancels any track currently playing and replaces it with the new one.

Provision has also been made for a track to interrupt the currently playing one and when the interrupting track has completed the original track resumes playing from the point it left off. This feature is limited to a single interrupting track. A typical use of this would be to have a background ambience track or an engine sound which can be interrupted by a horn (but don't expect the engine sound to vary in sympathy with the throttle – that's a different animal!)

The user may optionally have a 'wake up' track which is played when the unit is first powered up.

The mp3 module also contains a built in 3W amplifier and will drive an 8 ohm loud speaker, either the mini type supplied or a larger one provided by the user. A 20 step volume control is provided, accessed by 9 'jabs' of the joystick in the appropriate direction, the volume level finally set being stored in memory and re-asserted at power up.

Installation

The unit draws its power (including the speaker amplifier) from the receiver connection. Users should ensure this battery supply / system BEC is capable of supplying up to an additional 500mA or so to play sounds *over and above any other worst case supply loading.* Note that heavily loaded servos are capable drawing well over 1 amp so unpredictable results may occur if the 5v supply is inadequately rated.

Maximum supply voltage is 5.2v – systems with 6v BECs or 6v battery packs must NOT be used.
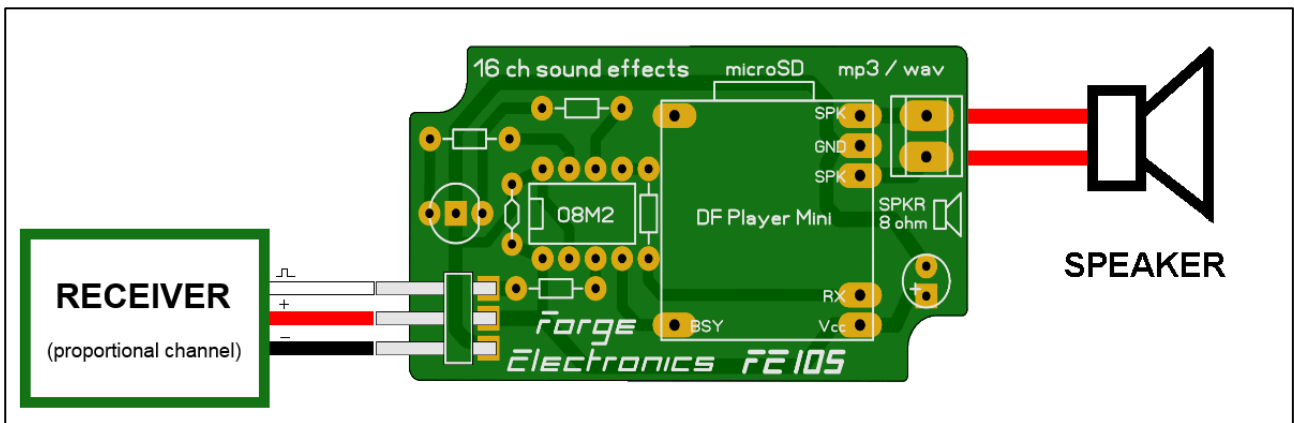
If the unit is plugged in the wrong way round to the receiver, no damage will result but the unit will give a continuous low frequency rhythmic pulsing sound from the speaker, accompanied by a flicker of the LED

Power Up

There is a ten second delay to allow the mp3 player to locate and read the files on the microSD card. The LED shows red and briefly occludes to count down the seconds. The LED then shows orange whilst the unit plays a 'wake-up' sound to signal that the system is operational. If the user chooses to omit the 'wake up' track the LED will show red for a second to indicate its attempt to find and play the missing track. The unit is then ready for use.

If no signal is detected from the receiver the unit repeatedly plays a brief "no signal" track followed by a two second pause, the LED showing orange in synchronism with the sound until signal is asserted. If the "no signal" track is omitted the LED will still briefly flash orange every two seconds until the signal is asserted.

Then, and at all future times, if not receiving user commands the LED shows dim red to indicate the unit is powered.

It is recommended that the 'wake-up' and 'no signal' tracks are retained to verify correct operation at power up as the LED indicator won't be visible once the unit is installed in a model.

Track Selection

This is accomplished by the user repeatedly 'jabbing' the joystick in the appropriate direction (and letting it return to centre position between jabs) - three times right for sound three right, five times left for sound five left etc. On the chosen jab the user continues to hold the joystick pressed to assert the sound. The LED shows green to give a visual indication of the jabs and holds. When the hold period elapses the sound is commanded to play and the LED shows orange. When the sound is heard to begin to play the joystick can be released and the LED reverts to the dim red "power on" indication. However, if the joystick is found to still be held when the sound has finished playing, the sound will be repeated - so for example, three short blasts of a horn could be accomplished this way. The interval between repeats may be adjusted by editing a length of trailing silence to the end of the mp3 file.

Users should arrange the sounds to be accessed in order of importance - for example a horn sound (when used for warning of imminent collision) should be activated by a single 'jab' rather than for example 7 'jabs'. Also consider assigning one easily accessed sound to be a short period of silence, the effect of which is to act as a 'cancel' command for any long duration sound (such as background ambience) that is currently playing.

The user may also set the volume level of the device during normal operation by giving nine 'jabs' and a 'hold' which selects a 17th track which ideally lasts for 30 seconds or more. All the time the 'hold' is maintained the volume gradually increases or decreases depending on the direction the joystick was operated. The joystick is released when the desired volume is attained and this setting is stored in EEPROM (the micro-controller's non-volatile memory) for subsequent recall next time the unit is powered up. The LED flickers rapidly whilst the volume is being adjusted, going solid when the maximum or minimum adjustment is reached.

Vacant Channels

If a vacant channel is selected (ie there is no corresponding file on the sound card), the LED briefly shows orange ('play' command sent) but when no sound results the LED shows bright red for the duration of the 'hold' to signify this situation.

MicroSD Card Handling

Note: the microSD card socket is a 'push to eject' style socket (so you must press the card inwards slightly to eject it). If you simply pull hard on the card without ejecting it you may cause physical damage to the socket and/or the MP3 module

MicroSD Card Files

These must be unprotected files - DRM 'copyright protected' files are not supported

Note: in the following examples, quote marks are shown for clarity – don't type them as part of file/directory names!

Files (be they MP3 or WAV) must be stored in a directory named "MP3" and file names must begin with a four digit number (using leading zeros) relating to the trigger channel

required. Users must employ numbers 0001 to 0016. The remainder of the filename can be any meaningful text (dots excluded). For example the following are valid filenames for channel 14:-   "0014.mp3", "0014TRACK.MP3" and "0014 - dive alarm.wav"

In addition
- if a file name beginning "0099" is present on the microSD card then at power-up that sound will play to signify that the unit is ready for use.
- a file name beginning "0098" should be assigned to a longish sound sample that is to be used for setting the volume (9 'jabs'). *If this file is not present the volume cannot be adjusted.*
- a file name beginning "0097" should be assigned to a short sound that indicates a "no signal" condition from the receiver.

Tracks 1 to 8 are assigned to one side of the joystick and respond accordingly with up to 8 'jabs'. Similarly tracks 9 to 16 are assigned to the other side of the joystick and respond accordingly with up to 8 'jabs'.

Interruption Track
The interrupting track (if used) must be stored in a directory named "ADVERT" and its filename must begin with "0001". It is accessed by a single "jab RIGHT" as above. It is expected that it will be the same file as stored as "0001" in the "MP3" directory such that the single "jab RIGHT" always gives a consistent sound.

File Name Extensions
Note that if users have the "hide known file extensions" option turned on in their file manager then typing in the following keystrokes to rename a file "0006 six inch gun.mp3" will actually result in a file named "0006 six inch gun.mp3.mp3" which will not play! In this case just type "0006 six inch gun" and the original mp3 file extension will be appended automatically.

Notes on MP3 and WAV File Formats
MP3 is a compression format, typically storing files in about a tenth of the space they would occupy on a CD or in an equivalent WAV file. But this comes at a price – apart from the extra computing power required to decompress the file 'on the fly', a short delay also precedes a file before it is played. This is because one element of the compression algorithm saves memory space by simply recording changes in the sound from one instant to the next rather than having to save the separate instants. That's fine whilst the piece is playing but at the beginning of a track the algorithm spends time creating the first instant of sound from non-existent previous instants of silence. For playing successive tracks from a music album this minor delay is of no consequence.

So this means that a sound doesn't occur immediately it is activated. Usually the delay is too short to be noticed, but if the track has a low sample rate then it may become noticeable. The higher the sample rate the shorter the delay so it's worth using the highest quality sample you can find (or converting lower sample rate files to higher rates). In the latter case the quality won't improve but the start delay will be reduced.

In contrast WAV files are not compressed and have no preceding silence. However, users should bear in mind that the 'DFPlayer Mini' module uses a disk operating system and file parameters have to be found and loaded from the microSD card before the file can be played so even with WAV files a short (file access) delay will occur before the sound is heard.

In practice it seems the file access time is the dominant delay and there is little to choose between MP3 and WAV files.

The above issues are mentioned because if the track interruption feature provided by the 'DFPlayer Mini' module is used, the two sounds aren't seamlessly joined together, so for example listeners would hear a momentary pause in the engine sound before the horn interrupted it followed by a further momentary pause before the engine sound resumed.

It is recommended that the user sticks to the mp3 file format if the track interruption feature is to be used as it has been observed that in the case of WAV files the interrupting track can repeatedly "stutter" before playing. This is an undocumented feature of the 'DFPlayer Mini'

File Selection Summary

The table below shows the filenames (including directory path) of the example tracks supplied on the microSD card and how they are accessed.

Track Played at Power Up	\MP3\0099 startup.mp3			
Jabs RIGHT	**Resultant Track Played**		**Jabs LEFT**	**Resultant Track Played**
1	\MP3\0001 horn mid.mp3		1	\MP3\0009 silence.mp3
2	\MP3\0002 horn multi.mp3		2	\MP3\0010 asdic.mp3
3	\MP3\0003 horn deep.mp3		3	\MP3\0011 whoop2.mp3
4	\MP3\0004 boatairhorn3.mp3		4	\MP3\0012 gun 3.mp3
5	\MP3\0005 foghorn.mp3		5	\MP3\0013 gun 9.mp3
6	\MP3\0006 bc ferry.mp3		6	\MP3\0014 helicopter.mp3
7	\MP3\0007 steam whistle.mp3		7	\MP3\0015 ww2 flyover.mp3
8	\MP3\0008 klaxon.mp3		8	\MP3\0016 narrowboat engine.mp3
9	\MP3\0098 volume setting track.mp3		9	\MP3\0098 volume setting track.mp3
	Volume UP			Volume DOWN

- note "jabs RIGHT/LEFT" etc may equally be "jabs LEFT/RIGHT" depending on the transmitter channel reversing switch
- similarly "jabs RIGHT/LEFT" may be "jabs UP/DOWN" depending on the RC channel assigned to track selection.

Sample Directory Listings of Supplied MicroSD Card