The Ni-Wumpf
System 1 / 80 Sound Board
Manual

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Revision B

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Overview

When we started working on the hardware for the Gottlieb System 1 sound board, it was driven by the same restoration challenges that we faced in 1995: lack of serviceable components. In 2019, I was struggling with an Ice Fever game that had basically the same sound hardware that the System 1 Totem game had - albeit hacked up. So like all of us, I found that the only way to get a sound board for the game was to cobble up used parts, hopefully working, off of eBay. It is usually at this time that I ask myself; how hard could it be to figure out what these GTB guys did in 1979 that couldn't be done far easier with newer hardware?!?

...really hard. Over the next 4 years of tinkering, I figured out how they coded sound waveforms using a basic sine wave to create notes; attack/defeat tones, etc. to build our first *System 1* sound board. ...but then came the System 80 architecture - after all, if you are going to design a sound board for 7 or so games, you might as well tackle the next generation board as well. It can't be that much different...

...right. Stacatto sound sampling from the very firmware itself that has nothing to do with sine waves proved increasingly obvious that I would have to use the original GTB code to build into the firmware. Ugly. So I shelved the project for another hiatus. Again.

Until it came time to think seriously about tackling the System 80B ***CPU*** challenge. And while that is a story for another time, it caused me to consider both projects' overlap. What we really needed was to whip up a firmware emulator for a 6502 CPU, and three 6532s for that project, and when that seems logical, I realized; it would be far easier to work through a design with a limited architecture of say: a 6503 and a single 6530 than the more complex one of the CPU. Say... a nice Gottlieb sound board.

So, five 6532 prototypes and 4 separate sound board prototypes later, we bring you ***the new GTB system 1 / system 80 sound board!***

But it is waaaay more than that. By early 2025 we had a replacement sound board that is plug and play compatible across all three GTB platforms that this board was once used in. And is DIP switch selectable for any of the 28 games supported. By June we had it playing WAV files separately, and by October, we had it integrated with the Ni-Wumpf CPUs to communicate on a simple protocol from the CPU to the sound board including what switch it should play a sound for.

...going a little fast there I think. Basically, the board is capable of reproducing the original GTB sounds for 28 games that use this card. *And* it can also be installed on another 5 system 1 games that use that simple tone card to give them actual sounds! *And*... it can be completely customized to play sounds specific to the switch / target being activated. Similar to new games. Eh... that'll take a while to sink in too if I don't try to drive it home. For Gottlieb System 1 games there are 3 sounds to your game, plus the game over, coin up, and tilt sounds. On the System 80 games there are *15* sounds, adding in sounds for game start, accumulator 1, 2, and 3, replay, bonus, slam and theme sounds.

However, with a switch matrix that can provide up to 50 switches on the playfield, you could decide to play *50 different sounds specific to that playfield*!

All right. Example. So... on Countdown, there are 5 drop targets for the 4 different banks. Right now each drop target plays the same two sounds; "beep" for the non-lit target; "boop" for the lit target. Now however, I can give you eight different scoring tunes, two for each bank (500 / 5000 points), plus the normal 10 point rebound sounds, the 100 point sounds for the bumper, and the 1000 point sounds for the inlanes, etc. We'll get into it more later.

Basically, like our replacement CPUs, it will seriously breath new life into older games.

But here is the best part - *you can incorporate any sound you want onto your pinball game*. Your nephew's shouts on the upper right target bank, your sister's admonitions to "quiet down" on the upper left, sounds of glasses breaking on the lower left drop targets... You get the idea. And again, we'll get into that later.

Service

This board is designed using surface mount components throughout - it is a bitch to service. Normally, we don't do that - the parts are just too small to see, and like the original Gottlieb sound boards, *it is possible to incorrectly install this board using the wrong edge connector*. There is one for the System 1 game, and another for the System 80 games. They're identical. So the first, and most critical warning sign for users of this board is this:

DO NOT INSTALL THIS BOARD WITHOUT DOUBLE CHECKING WHAT EDGE CONNECTOR IS USED FOR YOUR GAME!



Figure 1 - Ni-Wumpf replacement sound board installation – System 1 vs System 80

You will fry the board and void the warranty, and we will not replace it. It is easy to know when a power problem fries the board - there is no; "oh it came that way" excuse. The CPU is hot, and the voltage regulator too. The next most critical warning sign for this (and any board) is:

DO NOT INSTALL THIS BOARD WITH THE POWER ON TO THE GAME.

This will 100% fry the board. Immediately. I've done it 8 times while testing cards in the test fixture dozens of times a day. Same caveat here; no excuses, we know when you've been drinking and opening the hood on your pinball game.

Design

Hardware

The core of the sound board is again; the ARM core processor. Inputs to the board go though bullet-proof discrete components that, while being surface mount, should not get hurt by damaged driver boards. The only output is to the speaker through the harness connecter. Basically, there is not a lot of external circuitry that can damage the board except to install it incorrectly or with the power on. The amplifier is a 20W class A amplifier – plenty of power.

Software

The board has two modes of operation; Gottlieb compatibility mode, and WAV file player. In the first mode, the board switches execution to hardware emulation of the original chips that were installed on the sound board; the 6503, and the 6530 chips. With some background in acoustics we started in 2019 to create a sound board that played the original GTB sounds as they were designed. Working lazily, by 2021 we'd achieved a system that was capable of playing the sounds encoded on the ROMs for these games, however, the updates to the encoding scheme made for the System 80 games, and later the boards with the daughter cards made that design too difficult to pursue. We picked up the project again in 2023 with a whole new direction; use the GTB firmware directly by emulating the chips on the board, and were surprised to find out that it worked.

Firmware Update

Software updates are managed via the micro-SD card with new/improved firmware downloaded to the SD card on your computer (you'd need some kind of microSD card reader/writer dongle) at the root directory. After the SD card is re-inserted into the sound board, and the game powered up again, it will look to the SD card for a specific filename (SndU535SPIupdate.bin), and overwrite all of the code on the board with the new release before deleting the update file on the SD card. Normally, updates will be released and available with a date / revision filename that is different than what is identified above. It will be necessary to copy that file to the SD card, and rename it to this specific filename. Update takes only a few moments, and the board will then reboot. However, if the board is operating in Ni-Wumpf sound mode, the game itself will then have to be rebooted again to, once again, sync the CPU with the sound board.

Installation

The board will install in place where the original GTB sound board was once mounted, however, because of its reduced size, it will only utilize 2 of the original 4 mounting posts that the old board used. You will note that the mounting holes on the board are sized to fit the two different posts for the System 1 and System 80 games – the former using a wood screw through the hole in the board, through a stand-off, and into the side of the cabinet. The latter using a nylon post that pops through the hole in the board, and is loosely attached as it was on the original board. In both cases, you must save the mounting hardware to re-use with this board. For the System 80 games, carefully squeeze the prongs on the stand-off to pull it off the board, and re-insert it on the new board. You can find a great tool to aid in board removal from Steve Young. When replacing the tone card in the original System 1 games, use the mounting holes on the System 80 to attach the board to the cabinet, and attach the connector to the bottom of the board.



Figure 1 - Ni-Wumpf replacement sound board installation – System 1

Installation of the sound board in the System 80 games differs from that of the System 1 games - the system 80 games have an external volume control at the front of the cabinet and no control on the sound board itself, while the System 1 sound board has that knob built into the sound board. System 1 game volume is controlled at the sound board, while system 80 game volume is controlled by the volume control in the cabinet, for that reason the volume on the Ni-Wumpf sound board must be turned up to the maximum level when installed in a System 80 game.

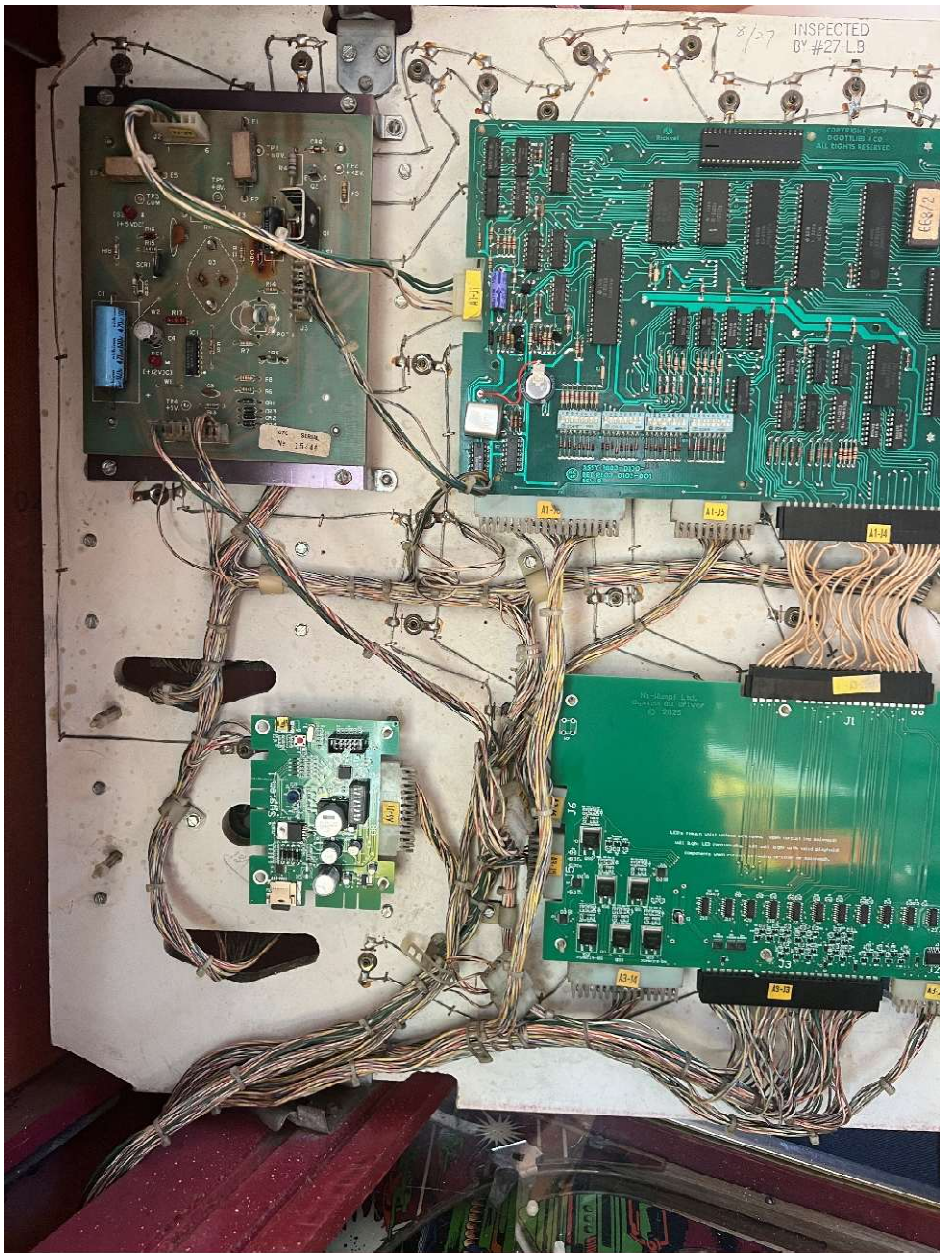


Figure 2 - Ni-Wumpf replacement sound board installation – System 80

DIP Switch Settings

The board has a DIP switch with 8 toggles numbered from top (near the CPU) to bottom (near the SD card) 1 – 8. At the time if this writing 'off' is to the left, 'on' is to the right as illustrated on the DIP.

- The first 5 switches are used to set the game that the board is to be installed in
- the 6th switch enables the attract mode for all sound types
- the 7th will depend on switch setting 8; when the board is configured to run in compatibility mode, this selects the type of sound played (for System 1 games, and this is described as sound / tones in the original manual). When configured to play Ni-Wumpf sounds, this selects game configuration of those tone card games (Close Encounters – Pinball Pool).

- the 8th switches the board from Gottlieb emulation mode to Ni-Wumpf sound theme mode.

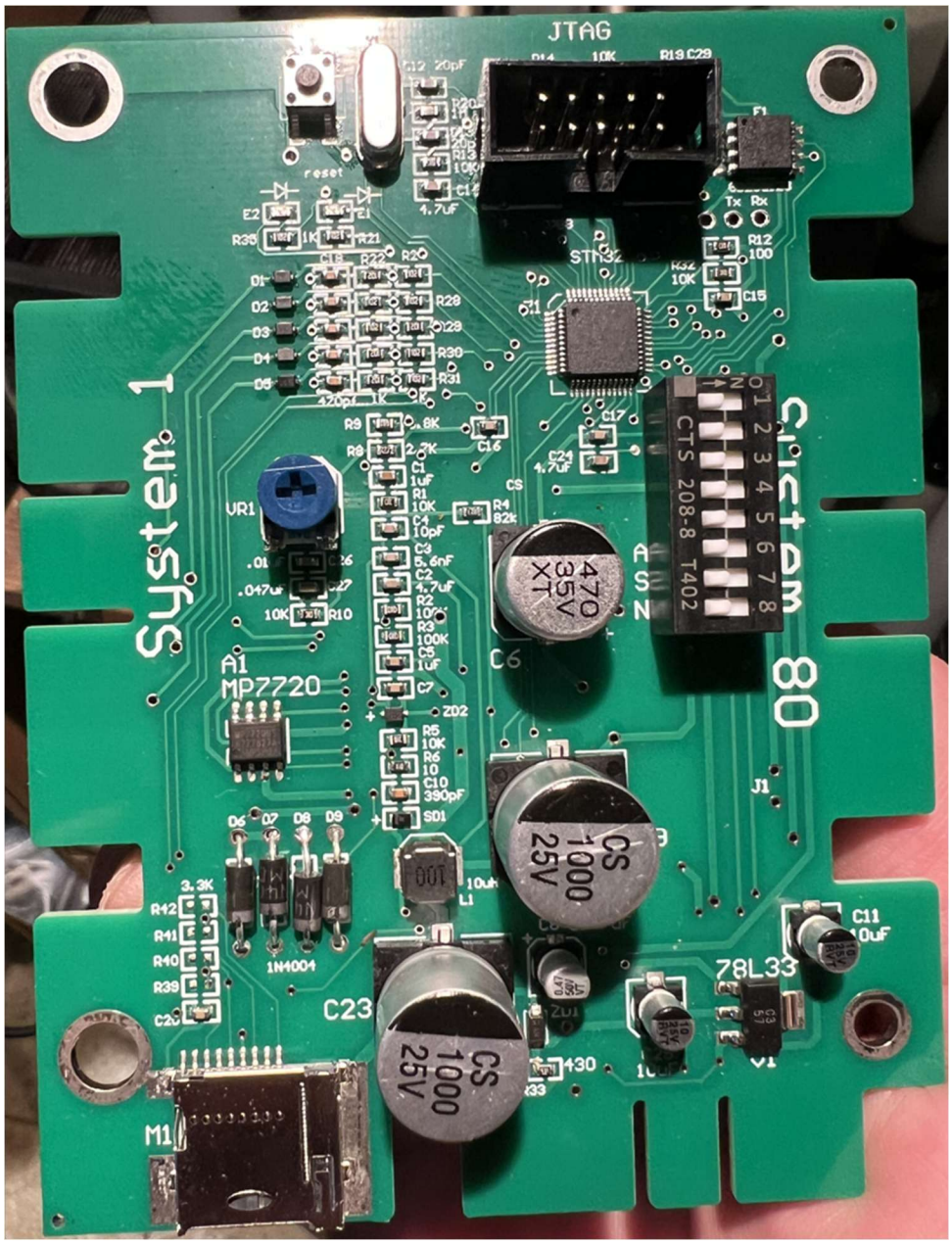


Figure 3 – the Ni-Wumpf Sound Board

Gottlieb Emulation Mode

When DIP switch 8 is off, the board acts as a direct replacement for the original Gottlieb sound board. After setting DIPs 1 – 5, it will play sounds as originally designed by Gottlieb for that game, including the functionality for the original 2 DIP switches on that board; attract, and tone/sound mode. It should be noted that when the board is used in the system 80 games, the tone/sound DIP switch is ignored, and that will be the case with our board as well. Attract mode is valid throughout the GTB games.

Games Supported

Below is shown the table listing the games supported on the board. They begin with the first GTB System 1 game to use this type of sound board, and end with the last System 80B game to use the modified version of the original board that had the daughter card mounted on top of it.

Name	No.	ROM	DIP8[1]	DIP1	DIP2	DIP3	DIP4	DIP5
System 1 games								
Totem	0	J	Off	Off	Off	Off	Off	Off
Hulk	1	K	Off	Off	Off	Off	Off	On
Genie	2	L	Off	Off	Off	Off	On	Off
Buck Rogers	3	N	Off	Off	Off	Off	On	On
Torch	4	P	Off	Off	Off	On	Off	Off
Roller Disco	5	R	Off	Off	Off	On	Off	On
Asteroid Annie	6	S	Off	Off	Off	On	On	Off
System80 games								
Panthera	7	652	Off	Off	On	On	On	On
Spiderman	8	653	Off	Off	On	Off	Off	Off
Circus	9	654	Off	Off	On	Off	Off	On
Counterforce	10	656	Off	Off	On	Off	On	Off
Star Race	11	657	Off	Off	On	Off	On	On
James Bond	12	658	Off	Off	On	On	Off	Off
Time Line	13	659	Off	Off	On	On	Off	On
Force II	14	661	Off	Off	On	On	On	Off
Pink Panther	15	664	Off	Off	On	On	On	On
Eclipse	16	671	Off	On	Off	Off	Off	Off
System80A games								
Amazon Hunt	17	684	Off	On	Off	Off	Off	On
Rack ‘Em Up	18	685	Off	On	Off	Off	On	Off
Ready Aim Fire	19	686	Off	On	Off	Off	On	On
Jack to Open	20	687	Off	On	Off	On	Off	Off
Touchdown	21	688	Off	On	Off	On	Off	On
Alien Star	22	689	Off	On	Off	On	On	Off
The Games	23	691	Off	On	Off	On	On	On
El Dorado	24	692	Off	On	On	Off	Off	Off
Ice Fever	26	695	Off	On	On	Off	Off	On
System80B games								
Bounty Hunter	25	694	Off	On	On	Off	On	Off
Chicago Cubs	27	696	Off	On	On	Off	On	On
Tag Team	28	698	Off	On	On	On	Off	Off

Table 1 – DIP – Game Selection

[1] Gottlieb emulation mode is ***on*** when DIP switch 8 is switched off

Ni-Wumpf Sound Mode

When DIP switch 8 is *on* however, the board acts as a sound board for custom sounds corresponding to all of the games tabulated above with the addition of seven System 1 tone board games. The table above is used to identify which WAV file sounds are to be used for those games, while the table below is used when the third connector at the bottom of the board is used to connect to the sound board.

Name	No.	DIP8	DIP7[2]	DIP1	DIP2	DIP3	DIP4	DIP5
System 1 games								
Close Encounters	29	On	On	Off	Off	Off	Off	Off
Dragon	30	On	On	On	Off	Off	Off	Off
Charlies Angels	31	On	On	Off	On	Off	Off	Off
Solar Ride	32	On	On	On	On	Off	Off	Off
Count-Down	33	On	On	Off	Off	On	Off	Off
Pinball Pool	34	On	On	On	Off	On	Off	Off

Table 2 – DIP Settings for Tone Board Games

There are three remaining games that use dedicated chime units for sounds. Cleopatra, Sinbad, and Joker Poker. It is possible to create an adapter to plug into the chime unit harness, and wire the Ni-Wumpf sound board into the game with it, however, there is no speaker on these cabinets, and we did not want to produce the modifications to those games to support that at this time.

SD Card

The embedded Micro-SD card is necessary to not only host the sounds used by this board in both modes, Ni-Wumpf and legacy, but it also provides an easy mechanism to share files between a user's computer, and the sound card. It is formatted as a FATFS device, and by default, provides 1GB of storage. On it are the files and directories for Ni-Wumpf sounds, but more importantly, this is the media that provides the licensed Gottlieb binaries for the original sound cards used here on this board. Pretty much the same as the PROM for the original hardware, just a new format. Those files reside in the "GTB" directory, and will be loaded each time the board powers up and is configured to play the original Gottlieb sounds.

Gottlieb Sound Binary Licensing

The files in the GTB directory are licensed by Premier / Gottlieb, and are required for the operation of the board in this mode. There is an additional cost for this licensed firmware, and if the GTB directory does not exist on the SD card – this board has not been licensed for that code – please see Ni-Wumpf, or your distributor to purchase the licensed version of the SD card. Heads up - these files are encrypted to the Ni-Wumpf sound board and cannot be used for the original GTB hardware.

Playing Sounds

You probably could have skipped right to this section to figure out the answers to the burning question: how do I use this sound board to play a whole custom themed sound for my game?

[2] In Ni-Wumpf sound mode, DIP switch 7 is used to select emulation of the tone boards.

Or you might be looking for what really cool theme did Ni-Wumpf come up with for my game? Here is where the reality sets in: we didn't. We didn't custom create the sound themes for 36 separate games. Yet. We barely finished the ***hardware*** architecture to get this thing out to you. We did a middlin' attempt at the Totem theme as an example, (and Counterforce) but, a sound theme designer *really* needs to have the game he/she is working out sounds for in front of them to tweak those sounds. Still all is not lost. The board was targeted toward restoration of games that do not have a sound board at all, ***and*** we will be working on themes for games as we get to work with them. Plus! It was designed to be very easy to develop those themes in the field.

Pinball Sounds

But before all that, let's jump into the common-sense background of what sounds do during a game: pinball games are fast playing frenetic toys – that's what makes them fun. As such, timing is critical – especially if you want to *add* aurally to the energy of playing the game, rather than detract from it. As such, sounds are pretty short by nature. The original sounds were just bells/chimes. About a quarter of a second long with trailing harmonics. When playing these games, you will notice that most sounds are between 0.8 and 1.3 seconds long. That is pretty much the natural timing in games. Caveat #1 to remember then: the length of a sound clip is extremely important. You will also immediately realize while playing a game, that GTB sounds seem to create a new/cohesive sound out of repeatedly playing a single, shorter sound. Most 500 point sounds or 5000 point sounds are the result of 5 of the same overlapping sound requests with only the first 0.2 seconds heard before being interrupted to play that sound again. Caveat #2 to remember: a sound should focus on the first 0.2 seconds to be heard in a useful "cascading" sound. You'll notice this second rule quickly when you try to find a sound for scoring the bonus, which could be dozens of the same sound playing consecutively!

OK – so sounds have a basic timing to them, and they can be interrupted as soon as another request to play a sound comes in. Third caveat then: by default, sounds are interruptible. There is a way to override this default in one of two ways; the first – if a sound is being played, for example the bonus countdown sound, the sound can be flagged to override the default, and NOT interrupt itself. Any *other* sound request will interrupt that sound, but not the same sound. The example here is counting down the bonus. It is a sound that can be played from 1 to 29 times in succession. The sound theme *could* provide a good sound that seems to loop back on itself, but only plays a few times – like the tom-tom drums in the Totem example. Finally, a sound can be flagged to not be interruptible by any sound at all when it is begins playing – this is really useful when the player achieves a recognizable goal, and should be given time to hear the aural response. For example, the skill shot at the top of a game, if it starts playing, and the ball quickly hits a bumper, you just won't hear the skill shot award sound. Or a special award, this should be heard in its entirety whatever else happens on the playfield.

Gottlieb Pinball Sound Architecture

In the beginning there was light. But only a little. Gottlieb System 1 sound boards had only 7 sounds – a big improvement over the original 3 chimes! And it was pretty rough in the chime era, because back then, special sounds like game start, were crafted through playing a series of these 3 chimes. Chime tunes. So, when the sound board was developed, GTB sounds took a big jump in functionality. Now we had sounds for; 10 points, 100 pts., 1000 pts., game over, tilt, left coin chute, and right coin chute. Let's organize those. Gottlieb System 1 games had sounds that correspond to output signaling lines from the driver board for 3 sounds; 10, 100, and 1000 points; a sound from the tilt relay, and a sound from the game over relay in the following binary signals; bit 1 – sound 1, 1000 points (S1); bit 2 – S2, 100 points; bit 3 – S4, 10 points; bit 4 – tilt, and bit 5 – game over. Non-multiplexed. One bit set – one sound. Except in the case of the game over signal, where it was used to not only determine when to play the game over tune, but also to decide, when the game was in the game over state, if S1 or S3 were

activated, the sound board should play the left coin chute tune, or the right coin chute tune. Important if the coin chutes were set to a different credit configuration for each side.

System 80 Sounds

In just a few years, Gottlieb changed the signaling to their sound board. The hardware changed from 3 driver board signal lines and 2 relay lines, to 4 driver board signal lines that were no longer using transistors as output hardware! Why they kept the same wiring harness connector from one board to the second, I can only assume was because of cost – they had a lot of nylon shells left over from the System 1 games, and decided to use them for the System 80 games. *I cannot count how many sound boards were fried because of this decision*.

The four lines from the driver board were now at a TTL level, stable, and allowed the sound theme designer to select 15 different sounds to play. These sounds were now multiplexed, and eventually laid out according to the following binary assignments:

Sound Request	No.	S1	S2	S3	S4
GameOver	1	1	0	0	0
Start	2	0	1	0	0
Tilt	3	1	1	0	0
Replay	4	0	0	1	0
Credit	5	1	0	1	0
Acc1[3]	6	1	1	0	0
Acc2	7	1	1	1	0
Acc3	8	0	0	0	1
Special	9	1	0	0	1
Bonus	10	0	1	0	1
1000pts	11	1	1	0	1
100pts	12	0	0	1	1
10pts	13	1	0	1	1
Complete	14	1	1	0	1
Slam	15	1	1	1	1

Table 3 – Binary Sound Request Assignments

There are a whole slew of notes to add here, Ni-Wumpf adds sound '0' as the power-up sound that GTB does not use; the *Replay* sound is more appropriately used as the game start sound where the *Start* sound is most frequently used as an extra ball sound for Gottlieb games. The *Acc1, Acc2, Acc3* sounds are commonly used on those games when they have a "beat" to them – a higher urgency level in the game, as for Counterforce where the timer is running down, or James Bond. For earlier games they were used as a discrete sound for crossing a scoring magnitude. I.e. these games would play the 100-point sound 5 times for a target that scored 500 points, and when the subsequent player scoring went from xxx900 to xx1000, it would play the *Acc2* sound instead of the 100-point sound. A subtlety that many of us just didn't really register.

[3] This tune is labelled "Acc" because of the logic design of the System 80 CPU that provided the programmer 3 separate accumulators to use in coding the game. One would be the bonus, one might be a bank of drop targets, etc.

Ni-Wumpf Sound Logic

We are going to use that table above for both the System 1 and System 80 games as a default template for sounds on your pinball table when the board is used to play .WAV file sounds for each of the sound assignments above.

SD-Card Format

And here is how… On the Micro SD Card provided with the board, there will be all of the default sound files for each of these sounds listed above at the root directory, named "NiPwrUp.wav", "NiAttract.wav", and "NiGameOver.wav" thru "NiSlam.wav" respectively. There will also be a subdirectory for each game that supports this sound board (including those games that use tone cards). Once the DIP switch is set for the game that the board is to be installed into, the board will look into that subdirectory for files named according to the following filename construct; "XXXsound.wav", where XXX is derived from the following table:

Game Name	Prefix		Game Name	Prefix
Totem	TTM		Rack 'Em Up	RAK
Hulk	HLK		Ready Aim Fire	AIM
Genie	GNE		Jacks to Open	J2O
Buck Rogers	BUK		Alien Star	ALI
Torch	TOR		The Games	GMS
Roller Disco	ROD		Touchdown	TDO
Asteroid Annie	ANN		Eldorado	ELD
Spiderman	SPD		Ice Fever	ICE
Panthera	PAN		Chicago Cubs	CUB
Circus	CIR		Bounty Hunter	BNT
Counterforce	CRF		Tag Team	TAT
Star Race	STR		Close Encounters	CLE
James Bond	BON		Dragon	DRG
Time Line	TML		Charlies Angels	CHA
Force II	FOR		Solar Ride	SOL
Pink Panther	PIP		Countdown	CNT
Eclipse	ECL		Pinball Pool	PPL
Amazon Hunt	AMA			

Table 4 – Three Letter Filename Prefixes

In Ni-Wumpf sound mode, when the board is powered up, it will examine the root directory, ***and*** the game subdirectory for sounds to be used for the game. If no sound for one of the 16 sounds exists in the subdirectory for the game, the default sound will be used.

Sound Timing, Interruptions, Options and Filename Conventions

As described previously, sounds have a timing that may limit the sounds that are used for each of these sounds, and as indicated, there are overrides to those limitations. If a sound is determined to exceed the timeframe that works within the Gottlieb mode of repeatedly playing the same sound 'X' number of times for a single target scoring, that sound can be flagged to not interrupt by itself. For a bumper scoring 100 pt.s for a 5 ball game, or 300 pt.s for a 3 ball game the filename; "CNT100pts.wav" would be renamed to "CNT100pts**u**.wav" in the Countdown subdirectory to play a single sound. The 'u' appendix

to the filename indicates to the sound board that it should NOT start playing another 100 point sound if that sound is currently playing already. It should be noted that a 10 or 1000 point sound *would* interrupt the sequence and begin playing. Similarly, a sound name with a 'n' appendix will instruct the sound board to not allow *any* other sound to interrupt this one. Useful for extra ball, and skill shot scoring.

It should be noted that if there are two or more filenames of the same name with differing suffixes, only one of them will be loaded into memory with the following precedence; no suffix, the 'u' suffix, and finally, the 'n' suffix. The remaining files will be ignored.

Sound Options

Now, how many people *hate* hearing the same Attract sound repeatedly coming out of their pinball game when left alone for a period of time? I do. That is why each of these entries has the potential for 3 different sounds for the same entry. The specific sound played is selected randomly from one of the three different sound files. In the case of the attract mode here there could be; "NiAttract1.wav", "NiAttract2.wav", and "NiAttract3.wav". When the 5 minute attract timing is up, and the board decides to issue an attract sound, one of these three WAV files is played at random. The same goes for all of these sound entries. There can be three 10 point sounds, three tilt sounds, etc..

It ***is*** possible to mix these two suffixes together - but it's not a good idea. In this case, the filename might be formatted as; "Ni1000pts**1u**.wav", and the second sound might be "Ni1000pts2.wav". Ugly. Should work. Don't do it.

Ni-Wumpf CPUs with the Ni-Wumpf Sound Board

In addition to the sound modes described above where the sound board can play the original GTB sounds, or any user-derived sounds for each of these 16 default sounds, there is the option to completely customize the theme for your Gottlieb games *outside* of these constraints. It requires that the CPU be a Ni-Wumpf CPU to interface with the sound board in advanced mode. When in this mode, whenever a playfield switch is detected, *the switch number, and the sound scoring level* is sent to the sound board rather than just sound number 1 – 15. What this means is that *each switch can have a distinct sound* played. In the case where a switch has two different scoring levels, like a 3-ball / 5-ball score, that same switch can have two or more sounds associated with it corresponding to that scoring level.

To enable this, the Ni-Wumpf CPU has to have revision 2.68 of the System 1 platform code, or 1.43 of the System 80 platform code. At the time of release, most CPUs already sold will have to be updated to this revision in order to take advantage of this mode. Please contact Ni-Wumpf with your current platform revision to determine if it can be upgraded remotely via the USB port, or returned for a firmware update[4]. The user would go into the "OPTIONS" self-test menu, to the end of that menu, and enable the "NiSnd Board" option. With the CPU configured, the sound board will recognize this advanced mode by flashing 3 times at power-up. If the board does ***not*** flash 3 times, it indicates that the hardware handshake has not happened.

Do not operate the game with the "NiSnd Board" option enabled when the sound board is configured for legacy sounds. You are not going to like the sounds coming out of it.

[4] There is never a cost for firmware update, other than the return shipping costs.

More Filename Conventions

With the game in advanced sound mode, when a switch is detected and sent to the sound board for processing, the sound board will look for a switch-specific sound to play for that switch at that point level. Failing that, one of the 10, 100, 1000 point game sounds will be played instead. The process to override this default sound sequence is to create a filename in the game subdirectory according to the following format: "GAMxxy.wav", where GAM is the three character game name prefix, 'xx' is the switch number, and 'y' is the scoring level 1 – 3 where 1 is for 10 points, 2 – 100, and 3 - 1000 points. In the Totem subdirectory, there is a filename; "TTM423.wav" for example - this is the sound to play for switch 42, the first varitarget increment. The request will be for 1000 points (but really multiples thereof). The CPU will send to the sound board these two protocol fields; 42 and 3, and the sound board will look up any entry for that switch entry at the 1000 point level and play that sound rather than the default 1000 point sound.

"One More Thing"

Looking at Counterforce however, where there are 7 drop targets, it might be cool to select a specific sound for an alien dying with these drop targets, rather than the default 1000 points. All good, but a waste of sound board memory if you wanted to store that same override sound 7 times. It is for this reason that we created ".lnk" files. These are text files in the subdirectory that are also read by the sound board at game processing to link one switch's sound to another switch sound entry. For example, also in the Totem subdirectory, there is a file "TTM523.lnk" that contains the text entry: "TTM423", it indicates to the sound board, that switch 52 should play the sound for switch 42. *Only an existing filename, and nothing else*, should be in this link file. Switch 52 is the second Totem varitarget increment, while "TTM513.wav" is the sound to play for maxing out the varitarget.

This is pretty much where we bring our older Gottlieb pinball machines from 50 years ago into the present-day pinball sound experience. Any game can now be configured to engage the user with game themed sounds. You just have to use your imagination…

How to Create Pinball Game Sounds

…and you need to know how to do so.

The sounds played by the Ni-Wumpf sound board are 8KHz monoaural Microsoft WAV file format encoded as 8-bit (unsigned) PCM data. And the best way to get started with using and creating these sound files is with the tool: Audacity. It is Open Source at: https://sourceforge.net/projects/audacity/# and is invaluable in creating / mastering these pinball sounds. Review how to capture sounds from your PC's sound card here: https://www.youtube.com/watch?v=UTnG7Ve3G0g. After configuring your computer to capture sound into Audacity, it is a matter of working on the timing of the sound, amplifying it to the maximum level possible, and exporting that material that you can save under one of the filenames described above for your game.

One important note: WAV files can only be 192kBytes or less, anything larger on the SD card will cause the sound card to hang trying to read it.

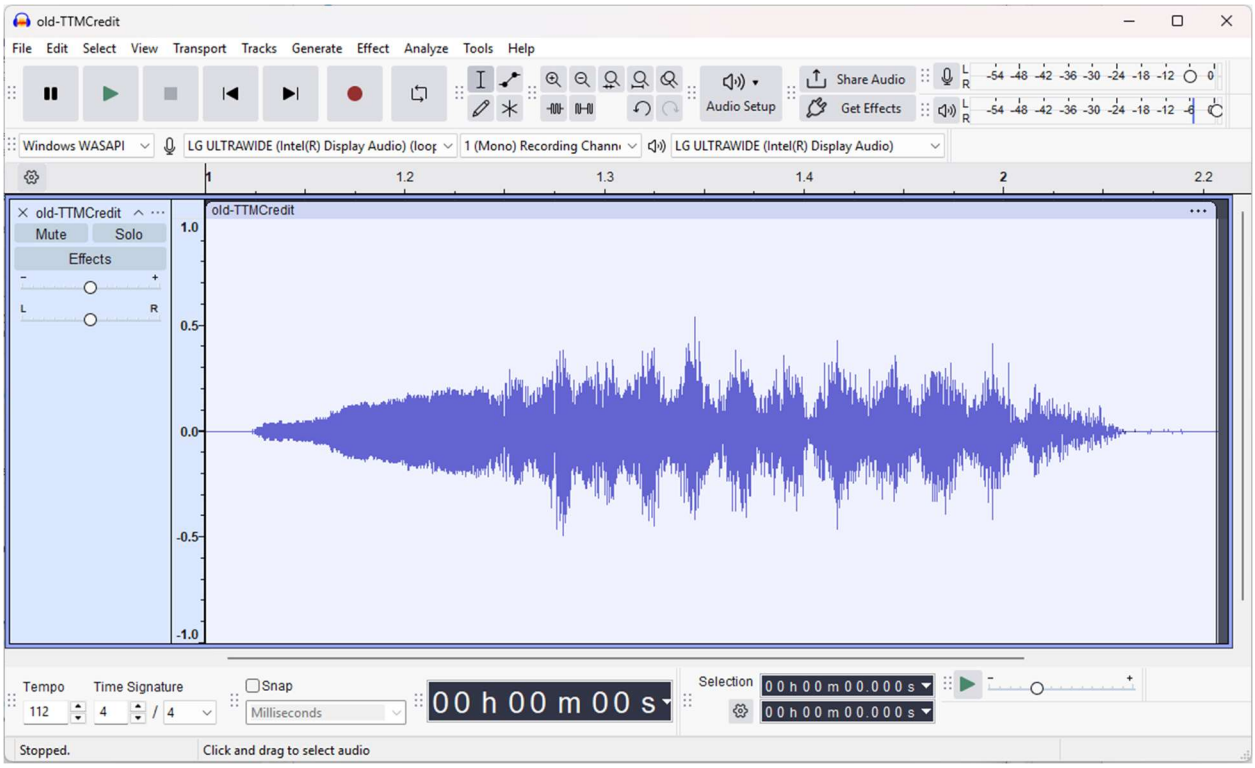


Figure 4 – the Audacity Sound Tool

LED Error Flashes

With the amount of configurations possible, and a removable file system, there are going to be chances for problems with the operation of the sound board. When this happens, the CPU normally flashes the error condition described below to identify the fault condition.

LED Indication	Error	Recovery
Continually flashing (E2)	There is no SD memory card, the contacts to the card are bad, or the SD card is bad.	Re-insert the SD card, and reset the CPU. Replace SD card.
Both LEDs flash once on startup flash upon start-up	No error.	This indicates normal power-on
E1 lights; E2 flashes once	SD card is not present, however Flash memory has a valid Ni-Wumpf sound theme already installed.	The board will use the pre-existing sound theme, but the SD card should be replaced
E1 lights, and E2 flashes 2x (repeats)	GTB directory not found on SD card, and board configured for legacy sound operation	Wrong SD card, mis-formatted SD card, or non-licensed version of the SD card.
E1 lights, and E2 flashes 3x (repeats)	GTB firmware files failed integrity (non-encrypted)	Wrong SD card, mis-formatted SD card, or non-licensed version of the SD card.

E1 lights, and E2 flashes 4x (repeats)	System 1 game selected in a System 80 game, or System 80 game selected in a System 1 game	Check DIP switch configuration setting for the game
E1 lights, and E2 flashes 5x (repeats)	Sound files created for the game are too large, and have overflowed FLASH memory constraints	Reduce total size of sound files for game (game specific + default sounds)
E1 lights, and E2 flashes 6x once	Existing flash memory is corrupt. Sound card will try to rebuild all indexes for game selected.	If error keeps happening, card may be damaged.

Table 5 – LED Error Conditions

Warranty

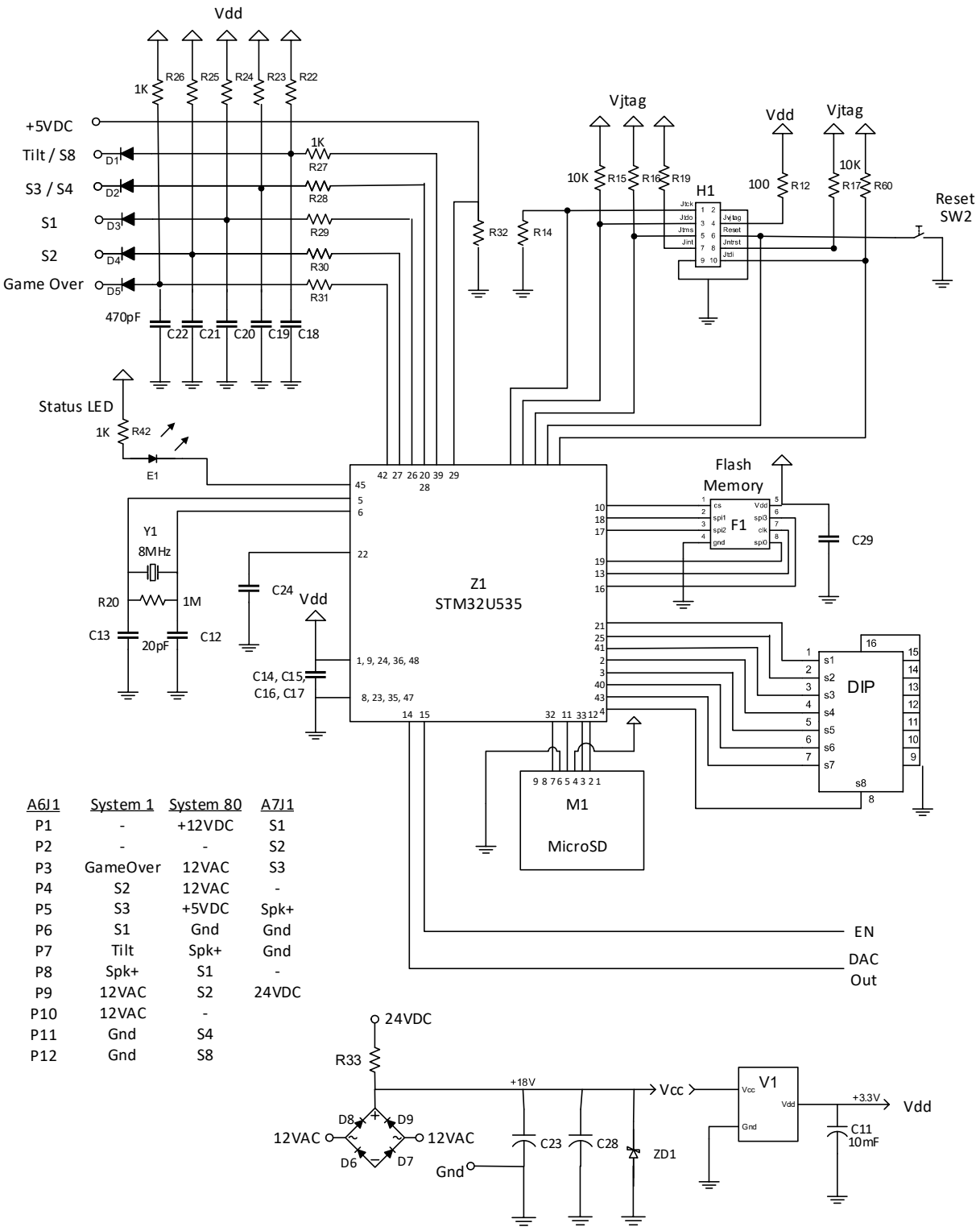
The ***Ni-Wumpf*** sound board is warranted against manufacturing defects and premature component failure, known as infant mortality, for up to 90 days after the date of it's purchase. For this reason, it may be prudent to keep a copy of the receipt for the board handy, in case the need should arrive to lend some credibility to your claims as to when it was actually purchased. In the unlikely event that a part should fail on the board within this time frame, simply package up the board, with a copy of your receipt, and return it to the factory address mentioned on our website, with some note of explanation as to why we are receiving this unexpected gift. Your CPU will be repaired or replaced and returned to you as quickly as possible.

Failure of the system within the warranty period due to abuse, incorrect installation, or faulty game components, is not covered by this warranty. The purpose of this warranty should be quite clear: we are willing to accept responsibility for manufacturing defects of the boards we are building, and feel that 90 days is a sufficient period to determine if such a defect may exist. We are not willing to accept the responsibility of those who may install this board into a game that may be broken enough to cause the board to fail.

Returning Your Board for Repair

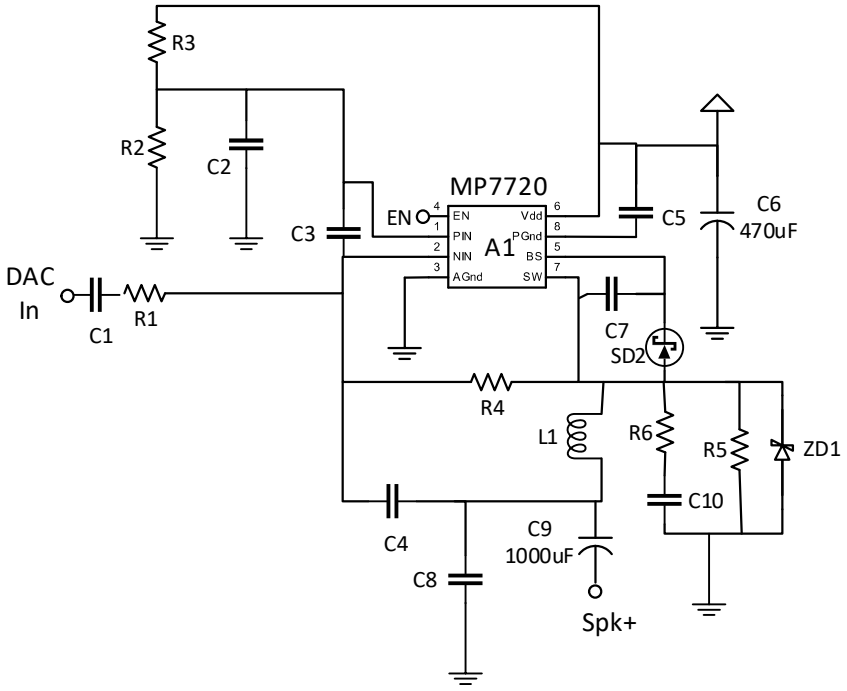
Despite the ominous warnings issued initially, we do service these boards. To determine the steps required to repair your CPU, it is best to gather the information necessary to get the board serviced, whether by yourself or the factory. First of all, be certain that the board is actually broken before calling it in for service, and the best way to ascertain this is to consult this manual in detail under the configuration and troubleshooting sections. Next, armed with the confidence that a smoking chip is indeed reason for repair, contact your distributor or refer to the website below to determine what steps to take next. If you intend to do the repair yourself, he will be the person with the parts necessary to replace the chips you deem necessary. He will also be the person with the knowledge of what repair costs the factory will be charging if you wind up sending it in for repair (and in the case that the company address should change, he will know what the current address for ***Ni-Wumpf*** will be).

Schematic supplement for the Ni-Wumpf System 80 replacement CPU



A6J1	System 1	System 80	A7J1
P1	-	+12VDC	S1
P2	-	-	S2
P3	GameOver	12VAC	S3
P4	S2	12VAC	-
P5	S3	+5VDC	Spk+
P6	S1	Gnd	Gnd
P7	Tilt	Spk+	Gnd
P8	Spk+	S1	-
P9	12VAC	S2	24VDC
P10	12VAC	-	
P11	Gnd	S4	
P12	Gnd	S8	

Schematics pg1 – Ni-Wumpf Sound Board CPU



Schematics pg2 – Ni-Wumpf Sound Board Amp

Designator	Qty	Description
R1,R5,R10,R13,R14,R15,R16, R17,R18,R19,R32	11	10K ohm,1%,100mW,0603
R21,R22,R23,R24,R25,R26, R27,R28,R29,R30,R31,R35	12	1K ohm,1%,100mW,0603
R39,R40,R41,R42	4	3.3K ohm,1%,100mW,0603
R2,R3	2	100K ohm,1%,100mW,0603
R37,R38	2	22 ohm,1%,100mW,0603
R12	1	100 ohm,1%,100mW,0603
R20	1	1M ohm,1%,100mW,0603
R8	1	2.7K ohm,1%,100mW,0603
R33	1	430 ohm,1%,100mW,0603
R34	1	1.5K ohm,1%,100mW,0603
R4	1	82K ohm,1%,100mW,0603
R6	1	10 ohm,1%,100mW,0603
R9	1	6.8K ohm,1%,100mW,0603
C7,C15,C16,C17,C25,C29	6	0.1uF,50V, 10%,X7R,0603
C18,C19,C20,C21,C22	5	470pF,50V,10%,X7R,0603
C2,C14,C24	3	4.7uF,50V,10%,X7R,0603
C1,C5	2	1uF,50V,10%,X7R,0603
C26	1	0.01uF,50V,10%,X7R,0603
C27	1	0.047uF,50V,10%,X7R,0603
C3	1	5.6nF,50V,10%,X7R,0603
C4	1	10pF,50V,10%,X7R,0603
C10	1	390pF,50V,10%,X7R,0603
C12,C13	2	20pF,50V,10%,X7R,0603
C11,C28	2	10uF,25V,20%, SMD Electrolytic Capacitor
C6	1	470uF,35V,20%, SMD Electrolytic Capacitor
C8	1	0.47uF,50V,20%, SMD Electrolytic Capacitor
C9,C23	2	1000uF,35V,20%, SMD Electrolytic Capacitor

D1,D2,D3,D4,D5	5	1SS404; 20V,300mA(DC),SOD-323 Schottky Diode
D6,D7,D8,D9	4	1N4004; 400V,30A,Diode
SD1	1	CDBU0130R; 30V,1.5A,Schottky Diode
ZD1	1	DDZ9705-7;18V,SOD-123 Zener Diode
ZD2	1	UDZVTE-176.2B; 6.2V,SOD-323 Zener Diode
E1, E2	2	LED red,2V,54mcd,0603
Y1	1	8MHz,20pF,HC-49/US
H1	1	USB,Mini USB-B,90°
Z1	1	STM32U535CET6,LQFP-48
V1	1	UA78M33,SOT89-3
A1	1	MP7720DS, Amplifier, SOIC-8
F1	1	GD25Q128, Flash Memory, SOP-8
L1	1	10uH inductor,20%, SMD
M1	1	MEM2075-00, MicroSD card connector
SW1	1	TL3305AF160QG,SPST Switch,SMD
VR1	1	3306F-1,25K Ohm potentiometer

Table 6 – Bill of Materials for the Ni-Wumpf Sound Board