

Meteor 2021

An update to one of Stern's most popular
machines.

This rewrite of Stern's Meteor is accomplished by plugging a daughter card into the J5 connector of the MPU. The SB-300 already connects to J5, so the board built will mirror J5 up so the SB-300 can still be plugged in.

This board supports a switch that will allow the operator to boot to the original Meteor code and use the M6800 to run the machine. However, in the other position, the switch will halt the M6800 and allow the Arduino to boot and take over gameplay.

At the time of this writing, sounds are implemented on a Wav Trigger card, controlled by the Arduino. Future revisions may allow for the SB-300 to be used instead, but the Wav Trigger allows for a much more rich audio experience.

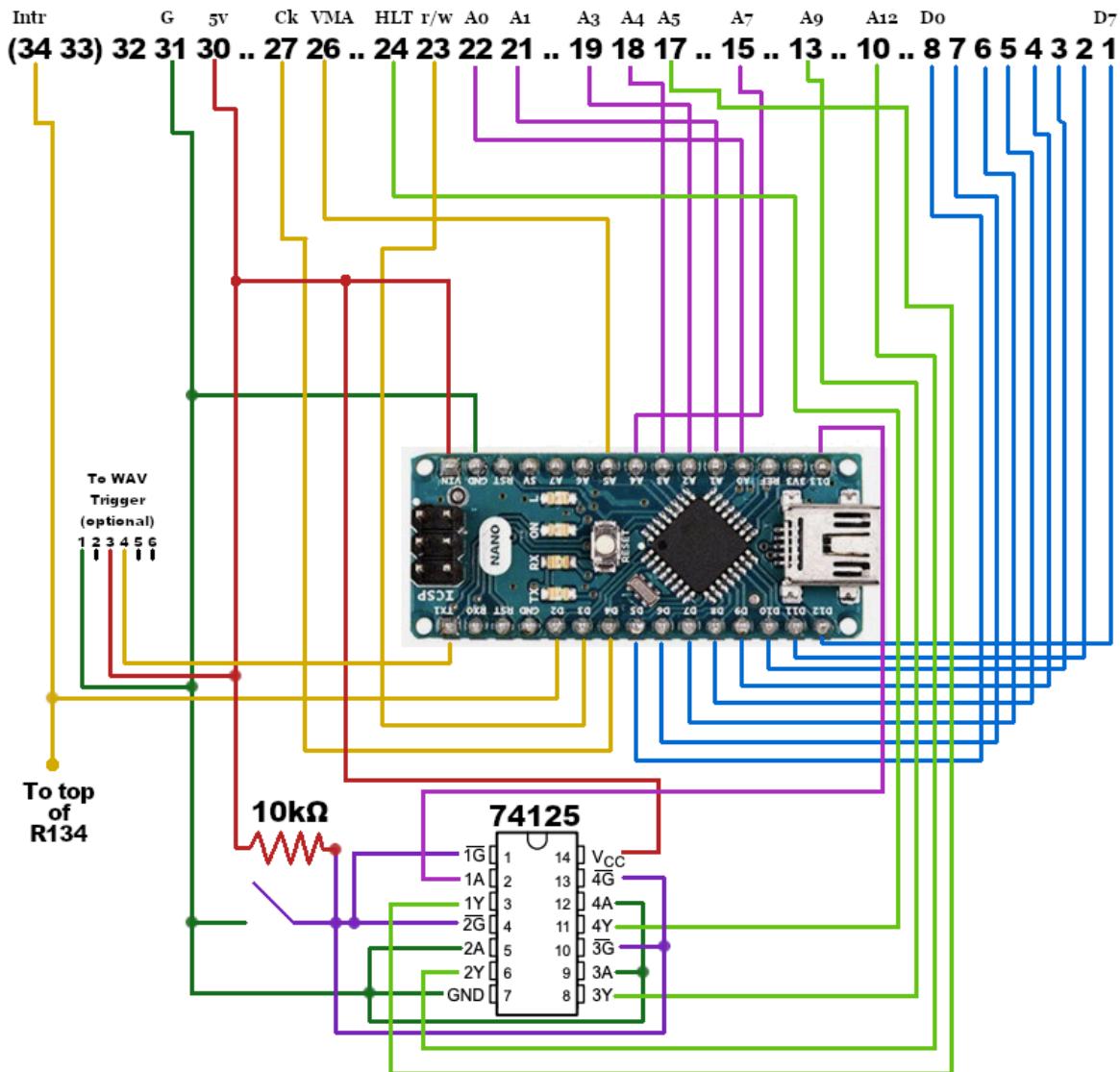
A Wav Trigger can be purchased from spark fun or Amazon. The currently supported model is the WIG-13660.

Creating the Arduino Controller Daughter Board

This code update is implemented by wiring an Arduino Nano into J5 on the MPU. (This board has been tested on Bally AS-2518-17, Stern MPU100, AS-2518-35, Stern MPU200, and Alltek Ultimate MPU Bally/Stern Replacement Board).

The diagram below shows how to create a board that will “dual boot” into either the new code or the original pinball machine code. If you don’t care about the old code, you can eliminate the use of a switch or the 74125 chip, and simply hardwire J5:pin 10, 12, and 24 to ground. Without the 74125, don’t wire the Arduino Pin D13 to pin J5:pin 17. With the 74125 buffer, the switch can be connected with two wires and can be several feet from this board (so it can be mounted behind the coin door).

**J5 of MPU100 or AS-2518-17 32 pins
(MPU200 / AS-2518-35 34 pins)**

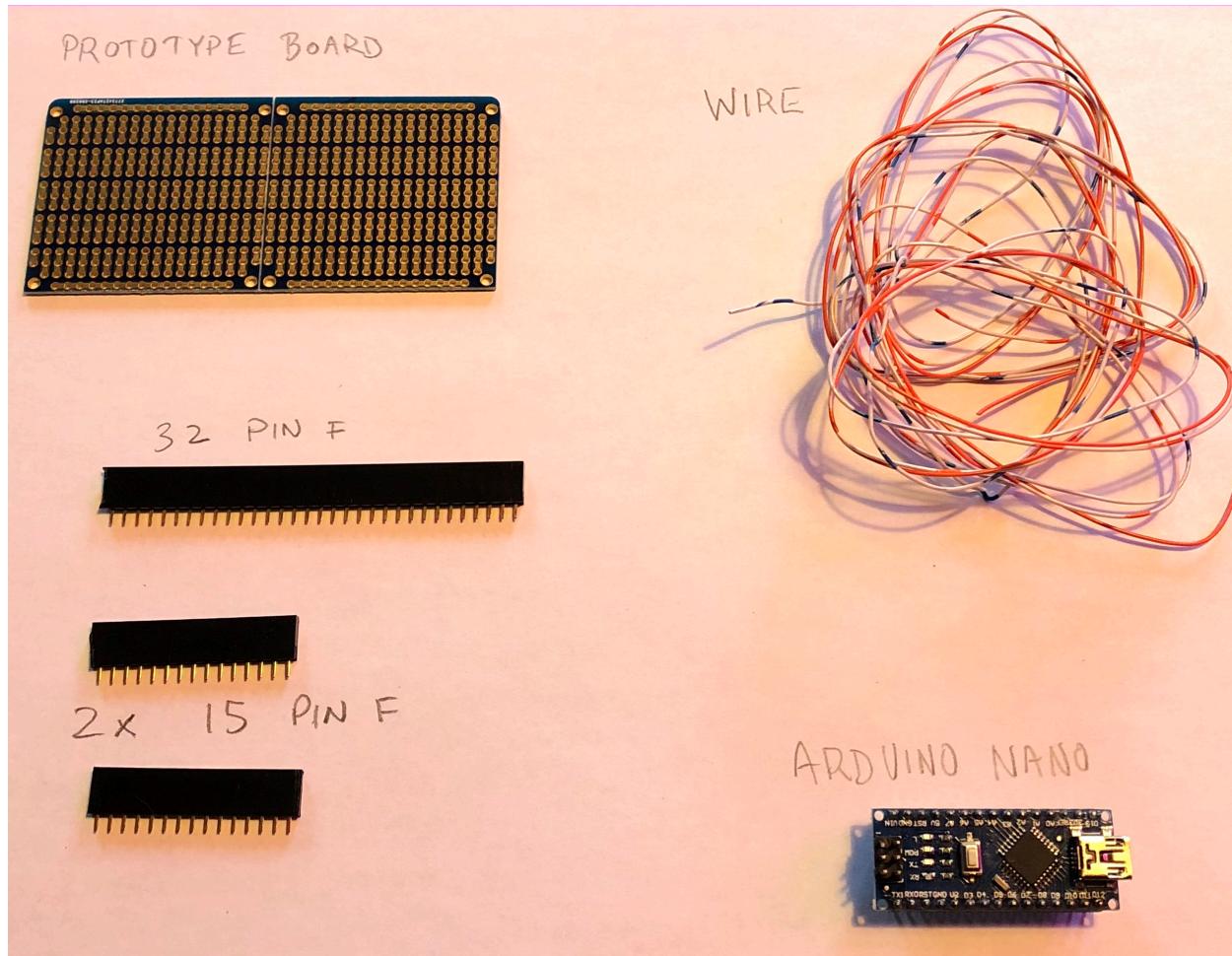


Connection Chart

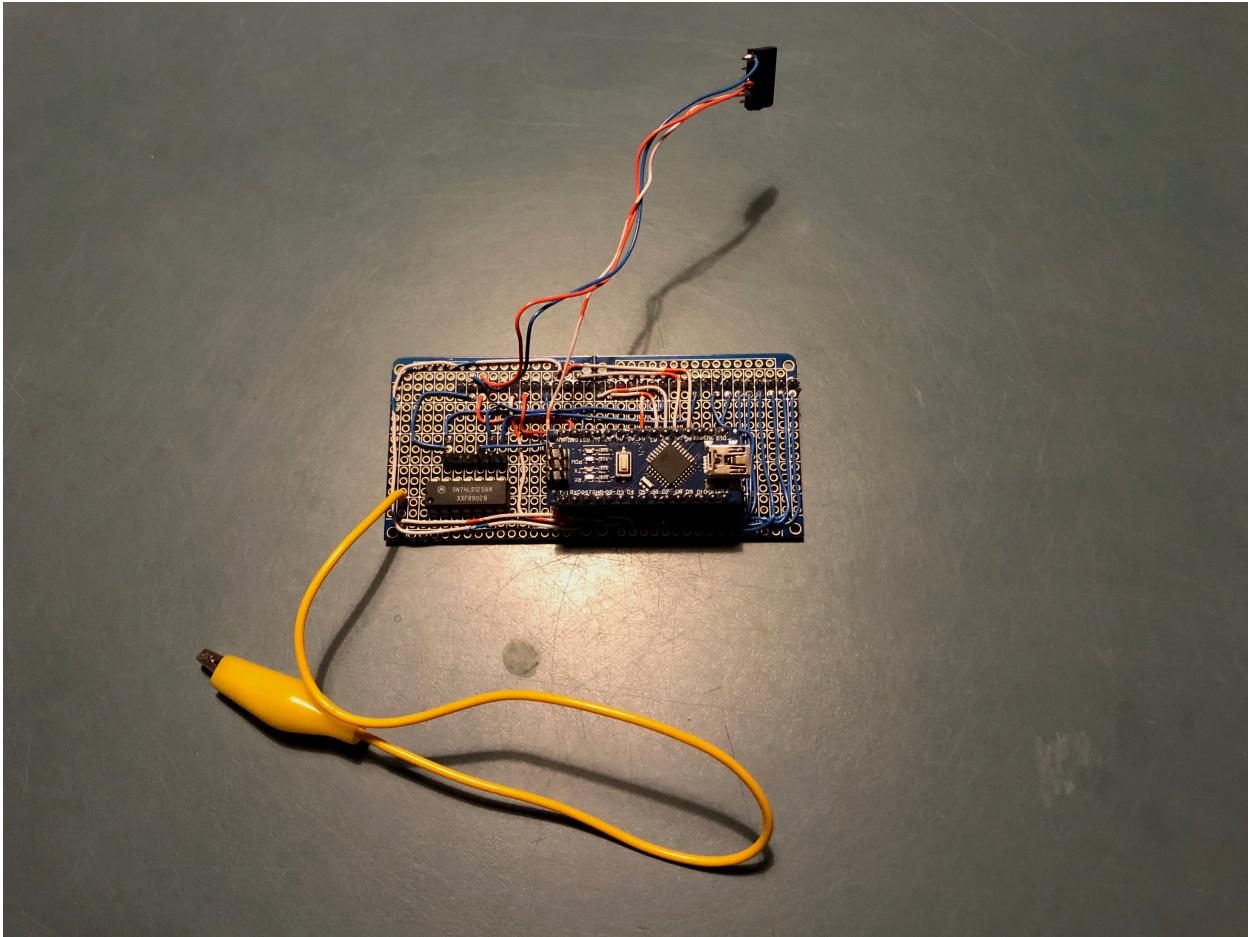
J5 Pin	Nano Pin
34 - IRQ	D2
31 - Ground	Nano GND
30 - 5V	Nano VIN
27 - Phi 2	D4
26 - VMA	A5
24 - HALT	74125 pin 11
23 - R/W	D3
22 - Ao	Ao
21 - A1	A1
19 - A3	A2
18 - A4	A3
17 - A5	74125 pin 3
15 - A7	A4
13 - A9	74125 pin 8
10 - A12	74125 pin 6
8 - Do	D5
7 - D1	D6
6 - D2	D7
5 - D3	D8
4 - D4	D9
3 - D5	D10
2 - D6	D11
1 - D7	D12
(Top of R134 - IRQ)	D2

NOTE: the MPU-200 and the Alltek have 34 pins on J5. For those two boards, the IRQ can be pulled directly from pin 34 of J5. With other MPUs, you'll need to run a jumper to the top of R134 (which is below U11).

Minimum Parts for custom Arduino interface board



Solder the connectors with wire jumpers as described above



On the back of this board, there is a 32-pin F header to plug onto J5.

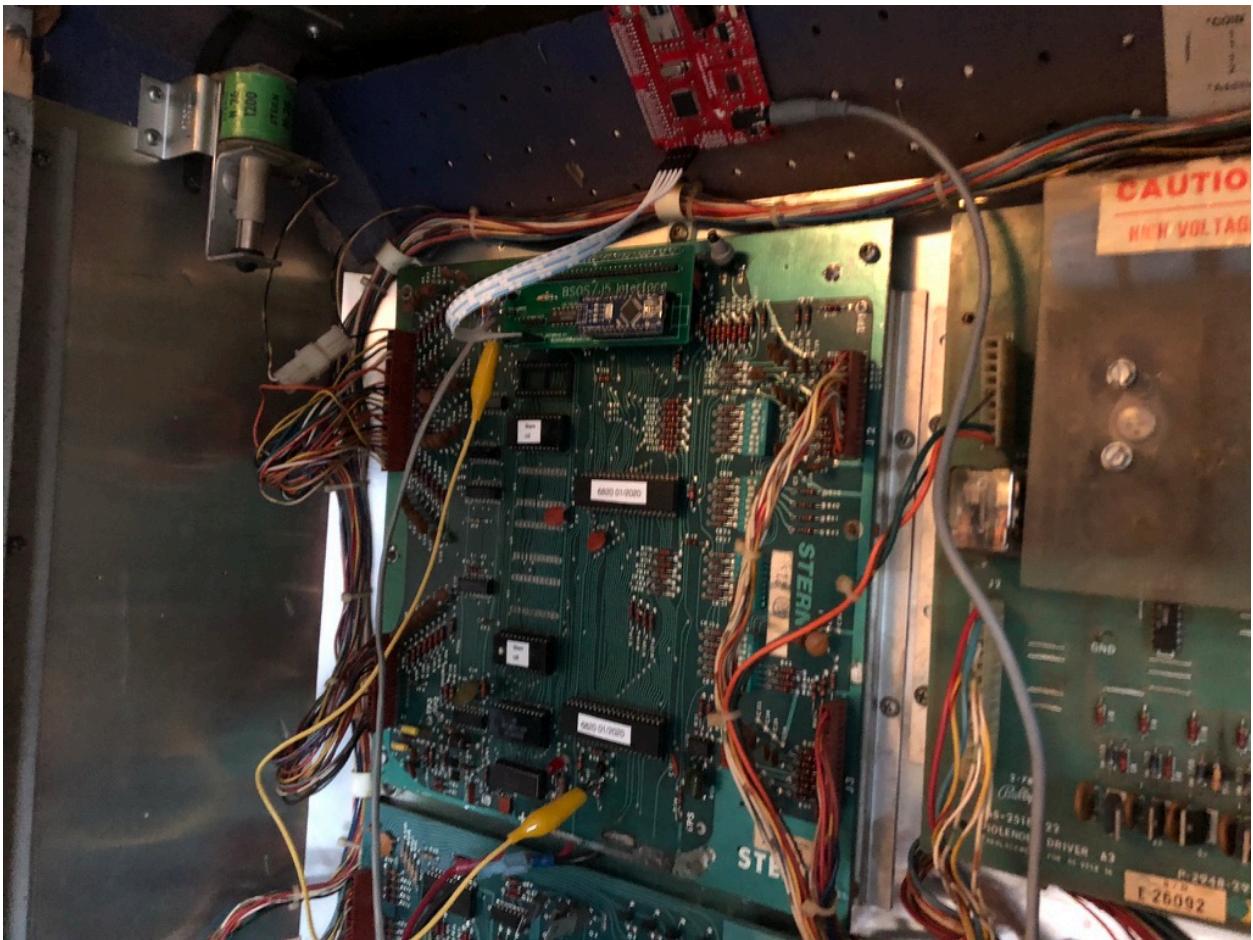
Next, program the Arduino with a computer & the software from:

<https://github.com/BallySternOS>

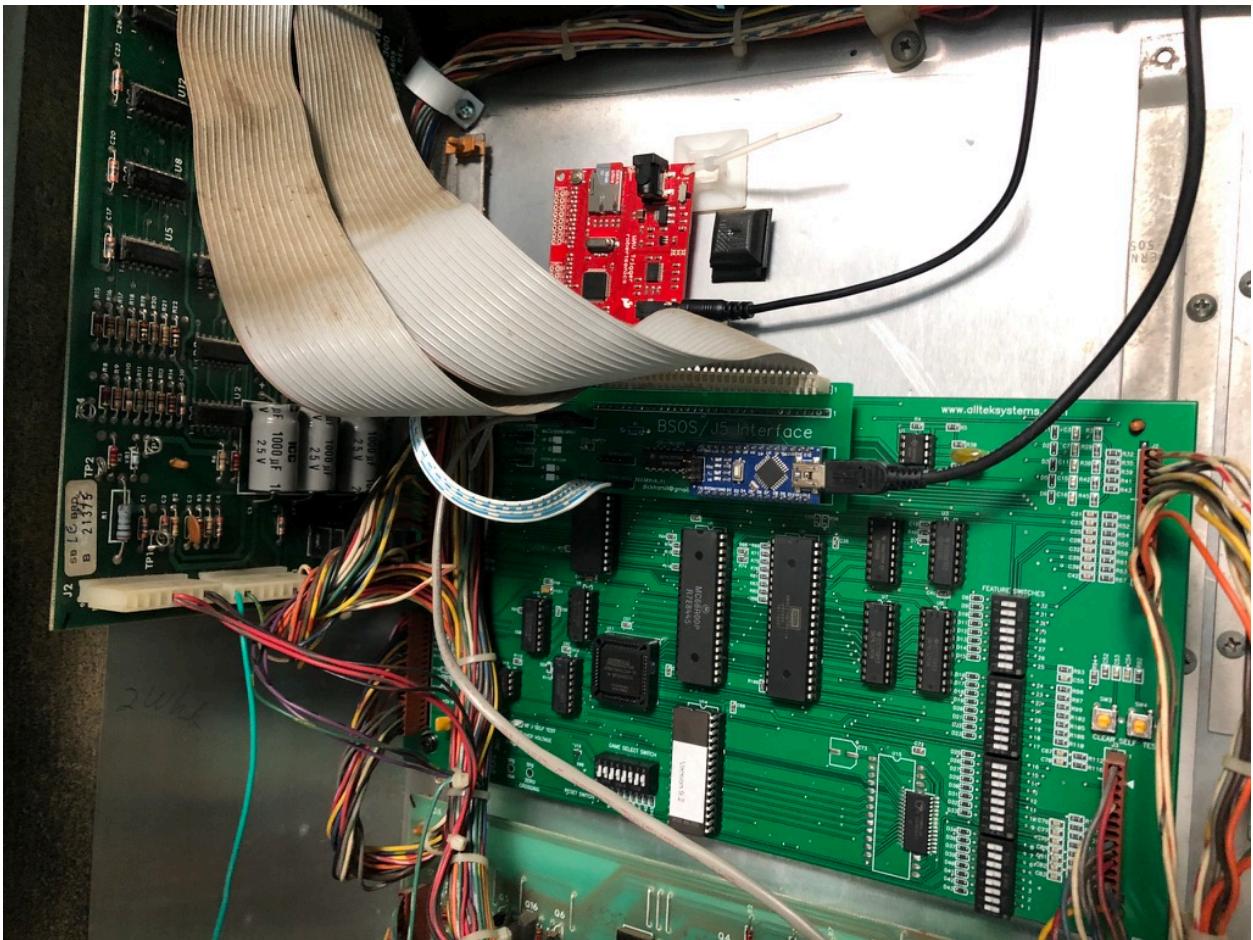
Plug the daughter card into J5. The IRQ line can be connected with an alligator clip to the top leg of R134

Before you turn on your machine for the first time, you should consider testing your implementation with your playfield fuse removed so you don't accidentally cause misfires to your solenoids. Correct output on the displays and lamps will indicate that you've wired everything right. Additionally, the project "MachineDiagnostics.ino" is a standalone file that will run the MPU through its paces and report back via the serial port on the Arduino.

Here's a custom PCB version of this board plugged into a MPU-100 (the yellow jumper wire connects the Arduino's D2 line to the top of R134).



A connection on an Alltek board doesn't require the jumper:



OPTIONAL - Audio

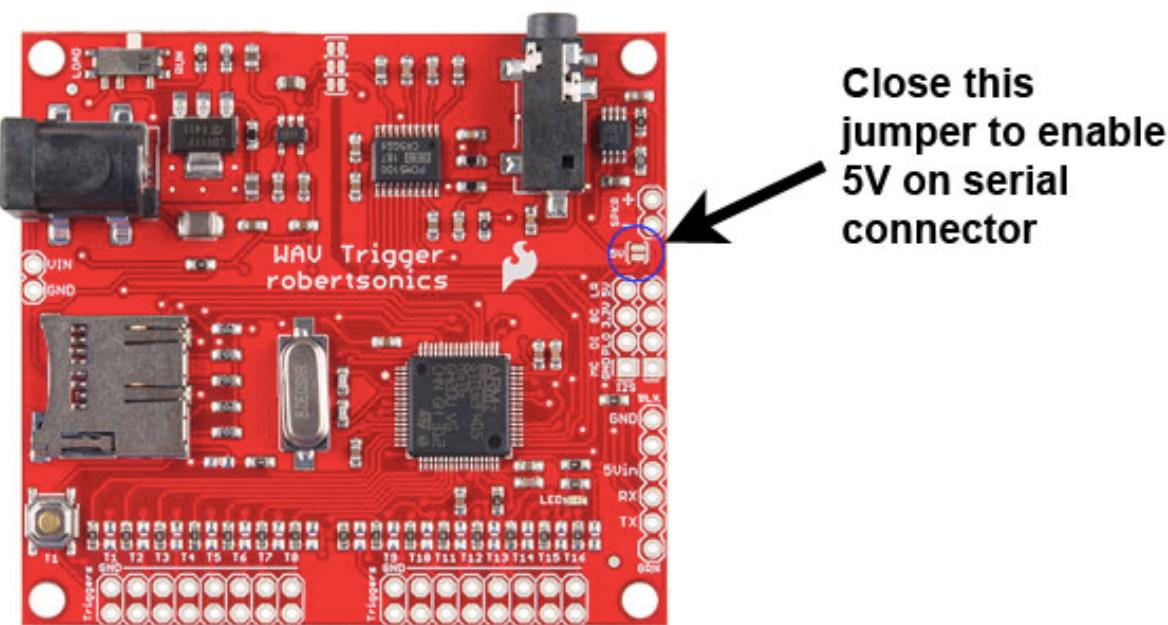
This software (may) also include support for a WAV Trigger board
<https://robertsonics.com/wav-trigger/>

To connect the Arduino to the WAV Trigger board, you'll need to make the following connections:

J5 Pin 31 (Ground) - WAV Trigger GND
J5 Pin 30 (5V) - WAV Trigger 5Vin
Arduino Pin Do (Tx1) - WAV Trigger Rx

In order to power the WAV Trigger from the serial port header, you'll have to solder a jumper on the solder pads.

<https://robertsonics.com/2015/04/25/arduino-serial-control-tutorial/>



The software required to talk to the Wav Trigger is built into the Arduino sketch in the files “SendOnlyWavTrigger.*”

Next, you'll put all the sound effects on a MicroSD card and plug it into the slot

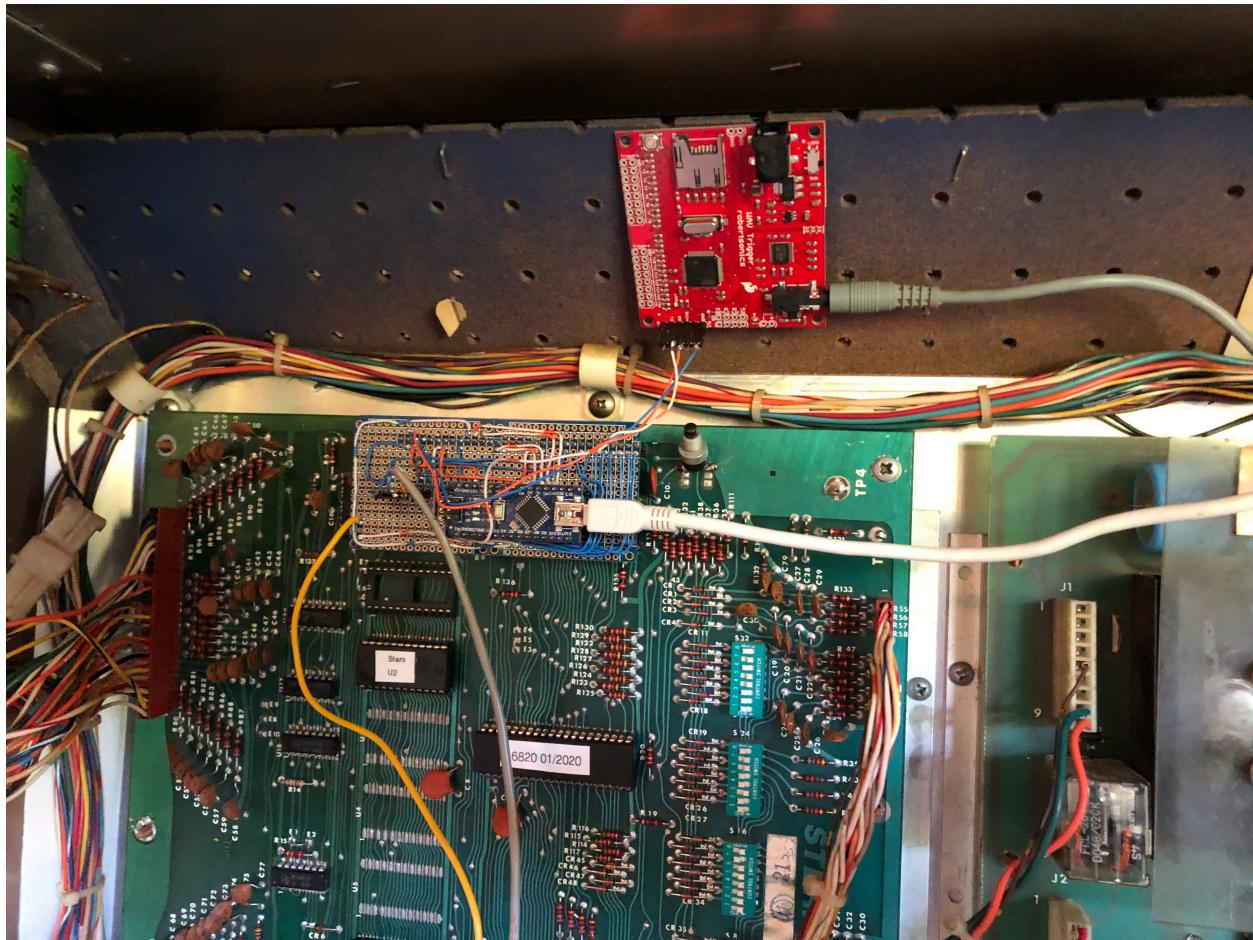
on the WAV Trigger.

To compile the sketch to use the Wav Trigger, you'll need to look in BSOS_Config.h. At the top of that file, you'll find lines that say:

```
#define USE_WAV_TRIGGER  
//#define USE_WAV_TRIGGER_1p3
```

If you've re-flashed your Wav Trigger for software rev 1.3 or greater, uncomment the second line (remove the "//") and comment the first line (add "//"). Otherwise, leave it as is. The current shipping software for the Wav Trigger is version 1.28.

Finally, plug in some sort of speakers into the 1/8" jack. Here's what my implementation looks like.



If you've built your daughter card

The code repository is located here: <https://github.com/BallySternOS>

You'll find instructions for downloading and building the software here:

<https://ballysternos.github.io/>

Meteor 2021 Test/Audit/Parameters

00:01 - Lamps
XX:XX - Displays
00:03 - Solenoids
00:04 - Switches
00:05 - Sound
01 - Award Score Level 1
02 - Award Score Level 2
03 - Award Score Level 3
04 - High Score to Date
05 - Current Credits
06 - Total plays (Audit)
07 - Total replays (Audit)
08 - Total times high score beaten (Audit)
09 - Chute #2 coins (Audit)
10 - Chute #1 coins (Audit)
11 - Chute #3 coins (Audit)
12 - Free play off/on (0, 1)
13 - Ball Save Num Seconds (0, 6, 11, 16, 21)
14 - Music Level (0, 1, 2, 3, [4, 5]) [if WAV Trigger is enabled in the build]
15 - Tournament Scoring (0-no, 1-yes)
16 - Tilt Warning (0, 1, 2)
17 - Award Score Override (0 - 7)
18 - Balls per game Override (3, 5)
19 - Scrolling Scores (0-no, 1-yes)
20 - Extra Ball Award (0 - 100,000) [only used for Tournament Scoring]
21 - Special Award (0 - 100,000) [only used for Tournament Scoring]
22 - Dim Level (2=50%, 3=33%)

**CHECK ALL VALUES YOUR
FIRST RUN -
THERE ARE NO DEFAULTS!**

**Activating the Slam Switch at any
time will reboot into Attract Mode.**

Lamps

Credits Display: **00** / Ball in Play Display: **01**

When first entered, all lamps will flash at 2Hz.

Pressing the Credit/Reset button will change the Player 1 score to 00 and the first lamp will flash. Repeated pressing of Credit/Reset button will cycle through all lamps (00-59) and then loop back around to 99, which will flash all lamps.

Displays

Credits Display: **XX** / Ball in Play Display: **XX**

When this mode is entered, all displays will cycle through the digits (1-9), changing at 4Hz. Pressing the Credit/Reset button will move through the digits one at a time so they can be tested individually.

Solenoids

Credits Display: **00** / Ball in Play Display: **03**

When this mode is entered, the solenoids (0-14) will be energized one at a time and the solenoid number will be displayed in the Player 1 score box. Each solenoid will be energized for 3/120^{ths} of a second.

Pressing the Credit/Reset button will toggle the automatic advance of the solenoid number to energize the same solenoid multiple times in a row.

Switches

Credits Display: **00** / Ball in Play Display: **04**

When this mode is entered, the ID of the first closed switch will be shown in Player 1 score box. Further closed switches will be displayed in Player 2, 3, and 4 boxes. Displays will be blank if there are no closed switches to show.

Sound

FUTURE FEATURE: Credits Display: **00** / Ball in Play Display: **05**

In the future, this mode will test the sound features.

Award Score Levels

Credits Display: **01, 02, 03**

The game keeps three Award Score Levels. They are set using the Self Test switch (modes 1, 2, and 3). If an Award Score is set to zero, there is no award given. Otherwise, the award is controlled by the Award Score Override (Self Test mode 17). The current Award Score (1, 2, or 3) is shown in the Player 1 score box.

During game play, when an Award Score Level is crossed, the player receives the award (extra ball or credit). For tournament scoring mode (when available), the Award Score Levels will be ignored.

In these three setting modes (1, 2, and 3), the scores are changed with the Credit/Reset button. Pressing the button once increases the score by 1,000 points. Pressing and holding the Credit/Reset button will gradually increase the score. Double-clicking the Credit/Reset button will return the given score to zero.

The Award Score Override (Self Test mode 17) can be set to 0-7.

High Score to Date

Credits Display: **04**

When a player's score exceeds the High Score to Date, the new High Score is recorded and shown during the Attract Mode. The game will award 3 Credits when a high score is reached.

In this mode, the score can be changed with the Credit/Reset button. Pressing the button once increases the score by 1,000 points. Pressing and holding the Credit/Reset button will gradually increase the score. Double-clicking the Credit/Reset button will return the score to zero.

Credits

Credits Display: **05**

This mode allows the operator to see/change the number of credits currently on the machine. The number of credits will appear in the Player 1 score box.

Pressing the Credit/Reset button will increase the number of credits up to 20, and then cycle back around to 0.

Audits

Credits Display: **06, 07, 08, 09, 10, 11**

The audit features allow the operator to inspect/reset usage values of the machine.

Double-clicking the Credit/Reset button will reset any of the audit values back to zero.

06 - Total plays - total number of games that have been played since this value was reset.

07 - Total replays - total number of credits awarded since this value was reset.

08 - Total times high score was beaten - total number of times the high score has been beaten since this value was reset.

09 - Chute #2 coins

10 - Chute #1 coins

11 - Chute #3 coins

Free Play

Credits Display: **12**

Player 1 score display will show a “0” meaning Free Play is OFF, or a “1” meaning Free Play is ON. The 0 and 1 are toggled by pressing the Credit/Reset button. As soon as the value is toggled, it is written to memory and the machine can be reset into Free Play mode.

If off, the machine will require a positive credit count in order to start a game. Credits can be added through the coin chutes or through setting mode 5.

If Free Play is on, hitting the Credit/Reset button will start a game (if in Attract mode), add a player (if ball 1 is in play), or restart the game if ball 2 or more is in play.

Ball Save

Credits Display: **13**

The Ball Save timer is controlled through this mode. The Player 1 score display will read 0, 6, 16, or 21. Why those values? I don’t know. Write your own software if you want values that make sense to you. Or, change this software—it’s easy.

Pressing the Credit/Reset button cycles through the different values. Setting the Ball Save to “0” turns off the Ball Save feature.

Music Level

Credits Display: **14**

This value controls the amount of sound effects played in the game. Setting to “0” makes the sound effects minimal. A “1” gives some sound, and a “2” gives the full sound. A setting of “3” plays the sounds and background music. The current level is displayed in the Player 1 score box.

The Credit/Reset button cycles between “0”, “1”, “2”, and “3”.

Tournament Scoring

Credits Display: **15**

A value of “0” indicates that Tournament Scoring is off. With a value of “1”, Extra Balls and Credits will not be awarded. Instead, the player will get a point bonus (set by parameters 20 & 21). In Tournament Scoring, Award Scores will be deactivated. Pressing the Credit/Reset button toggles between these values.

Tilt Warning

Credits Display: **16**

This parameter can be set to 0, 1, or 2, and it represents the number of warnings the player gets before the machine Tilts. At “0”, the machine will tilt at the first hard nudge. A value of “2” will warn the player twice and tilt on the third hit. A tilt warning consists of a sound.

The Credit/Reset button cycles between “0”, “1”, and “2”.

Award Score Override

Credits Display: **17**

This setting lets the operator set extra ball or credit for each of the 3 award scores (set in modes 1, 2, and 3) individually.

The Credit/Reset button cycles through the values 0-7 and then jumps to 99. The award is based on the table below.

Award Score Override	Score 1	Score 2	Score 3
0	Extra ball	Extra ball	Extra ball
1	Credit	Extra ball	Extra ball
2	Extra ball	Credit	Extra ball
3	Credit	Credit	Extra ball
4	Extra ball	Extra ball	Credit
5	Credit	Extra ball	Credit
6	Extra ball	Credit	Credit
7	Credit	Credit	Credit

Balls Per Game Override

Credits Display: **18**

Balls per game (3 or 5).

Scrolling Scores

Credits Display: **19**

When the player's score exceeds 999,999, the scores will either wrap around to 0 or they will begin to scroll. A setting of "0" in this parameter will make the scores wrap to 0. A setting of "1" will allow the scores to scroll through the 6-digit displays.

Pressing the Credit/Reset button will toggle this value.

Extra Ball Award

Credits Display: **20**

The Extra Ball Award is only relevant in Tournament Scoring mode. If Tournament Scoring is activated, collecting the Wow! Targets will give this award instead of Shoot Again.

In this mode, the score is changed with the Credit/Reset button. Pressing the button once increases the score by 1,000 points. Pressing and holding the Credit/Reset button will gradually increase the score. Double-clicking the Credit/Reset button will return the given score to zero.

Special Award

Credits Display: **21**

The Special Award is only relevant in Tournament Scoring mode. If Tournament Scoring is activated, collecting the Special Targets will give this award instead of a credit.

In this mode, the score is changed with the Credit/Reset button. Pressing the button once increases the score by 1,000 points. Pressing and holding the Credit/Reset button will gradually increase the score. Double-clicking the Credit/Reset button will return the given score to zero.

Dim Level

Credits Display: **22**

The Dim Level adjustment allows the operator to choose the duty cycle of “dim” lights. At a level of 2, a dim bulb will be lit 50% of the time. At a level of 3, a dim bulb will be lit 33% of the time. With some bulbs, a noticeable flash will be present at a duty cycle of 33%. With other bulbs, a 50% duty cycle will appear nearly the same as a fully-lit lamp. This adjustment should be re-checked on new machines or if the bulbs are changed.

When in this mode, the bonus lamps will toggle between the dim value and the full-lit value (every second). This allows the operator to see the contrast between

the two.

Pressing the Credit/Reset button will toggle the dim level between 2 & 3.

DIP Switches

DIP Switches

This game currently ignores the DIP switches.

Coin Chutes

Right now, any of the coin chute switches will add 1 credit. A sound is played when a credit is added (controlled by Music Level).

This ignores the Credits/Coin DIP switches entirely.

Coin Lockout

If the number of credits is at the maximum value (40), then the coin lockout will be energized. Otherwise, it's not.

Credit Reset

Pressing the Credit/Reset button in Attract Mode will start a 1-player game if the machine is in Free Play or there is at least 1 credit. (Pressing the button again during ball 1 will add a player.)

Skill Shot

At the start of the ball, the rollovers and METEOR drop target lights will flash. Hitting either of those achieves a skill shot.

During the course of normal play, the rules of Meteor are similar to the original. Banks of 3 drop targets award bonus lights. Completing the METEOR drop targets advances the Bonus X, and the spinner value is controlled by how many METEOR targets are down.

When the METEOR targets are cleared, a Meteor Storm will begin. Meteors are represented by flashing lights descending on the bonus light array. A rocket can be armed by hitting one of the associated drop targets. For example, if a meteor is dropping in the first column, hitting one of the three 1 drop targets will arm a rocket in that sector.

There are three ways to fire a rocket:

- 1) Arming a rocket through the drop target and then hitting the Stand Up target to launch.
- 2) Hitting the dead bumper (only for 1 and 3) of the associated sector.
- 3) Clearing the drop target bank for the associated sector.

Note: methods 2) and 3) above are available for the first meteor storm. Following an Orpheus round, those methods are curtailed.

Once all meteors in the storm have been cleared, an Orpheus round begins. All METEOR targets are lowered and the player is warned of Orpheus incoming. Then, two or more targets are raised and are accompanied by a WOW light. The player is asked to drop only the lit target. If all Orpheus targets are cleared, Orpheus will be completed and the player will be awarded with a mode where all switches are worth a large award for a period of time. Then, regular play will resume.

If an unlit Orpheus target is hit, the player will enter the Orpheus Fragmented mode. During that mode, all raised drops have to be hit before they reset. Once that is accomplished, the player will be awarded with a brief switch reward.

During normal play (not Meteor Storm or Orpheus), spinner hits are count down towards 0 in the Credits display. Once the player reaches 0 spins left, they will engage in Super Spinner for a period of time. The spinner lights will flash and spins will be worth 4x value. This mode is timed, unless the user enters a Meteor storm while the spinner reward is running (then the timer is frozen).

At any time, if the player maxes out all three bonus columns, they will achieve the Max Bonus reward. For the rest of the ball, the bonus lights will flash to display this reward.

If the player achieves all four goals over the course of a game, they will enter the Wizard Mode. The four goals are:

- 1) Meteor Storm > Orpheus > Orpheus Fragmented & Completed
- 2) Meteor Storm > Orpheus > Completed
- 3) Super Spinner
- 4) Max Bonus

Upon completion of the four goals and resumption of regular play, Wizard Mode will begin. During the Wizard Mode period, all switches are worth a large value and clearing banks of 3 targets will award a Jackpot. Clearing the METEOR targets awards a Super Jackpot.

