# ADL A2D Thruster Interface installation

The ADL (Asteroids/Asteroids Deluxe/Lunar Lander) A2D (analog to digital) Thruster Interface is a small circuit board designed to plug into Braze Technology's Asteroids Multigame kit. Installation consists of the following steps:

1. Add the ten pin header to the Multigame kit (new kits may come with the header already installed)
2. Solder the three wire cable to the potentiometer of the Lunar Lander thruster control.
3. Plug all the pieces together.
4. Adjust the two trim pots on the interface board.

Step One: Add the ten pin header

The ten pin header allows the digital value from the thruster control to be read by the POKEY on the Multigame kit, and also serves as the attachment point for the interface. The header gets installed onto the Braze Technology kit, in the row of ten empty holes squeezed between the POKEY (CO12294) and the CPU (6502). It's the only space where it will fit. Insert it from the top of the circuit board, with the long ends of the pins sticking up. Solder the short ends of the pins where they come through on the underside of the board. They are only 0.1" apart so be careful and be sure no solder bridges across any pins or other pads.
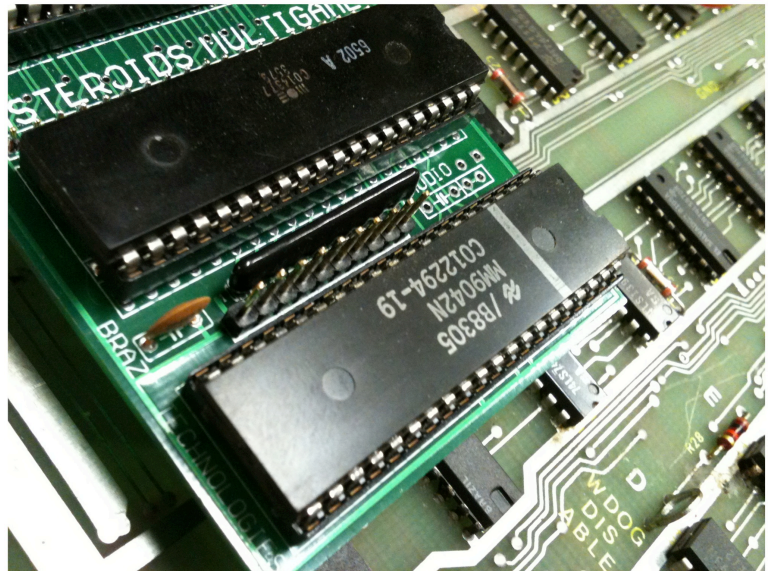
Step Two: Solder the cable to the thruster pot

The three wire cable supplies +5 volts to the potentiometer built into the thruster and returns a variable voltage based on the thruster's position. Strip about 3/16" of insulation off the end of the black wire, twist the strands together, and impart a shallow S shaped bend in the wire. This allows the wire to be fed from below, up through the hole in the terminal of the pot, and soldered in place. Black is ground and connects to the uppermost terminal of the pot. Repeat for the white wire which is soldered to the middle terminal, and the red wire which goes to the bottom.

Photo shows black wire done, white in place (note the bend through the hole), and red waiting to be done.
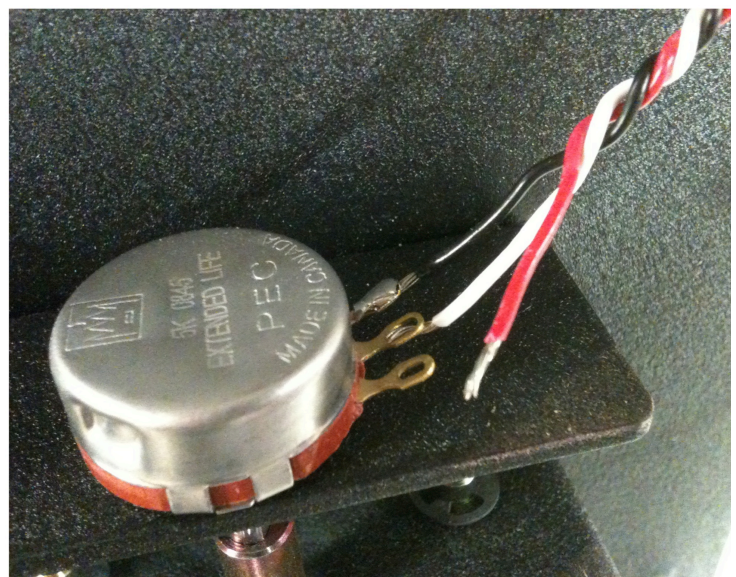
Step Three: Plug all the pieces together

Install the Braze Technology Multigame kit according to its instructions. Make sure it is working, and then enter setup to change the THRUST MODE to EXTERNAL DIGITAL in the Lunar Lander section. Save settings and exit, then turn off power to the game.

Next the three wire cable is plugged into the three pin header labeled P2 on the interface board. It's at the edge of the board between the capacitors and right next to the large chip. It's a tight fit due to the chip socket and though the connector isn't keyed the plug should fit only one way, with the wires matching the labels. If it's plugged in backwards you will have a Lunar Lander Brake instead of thruster but it won't damage anything.

Finally, plug the interface into the Multigame kit by way of the ten pin header installed in step one. The orientation of the text on the interface should match the direction of the text on the Multigame, which will put the larger (ADC0804) chip over the POKEY. Also be sure all ten pins enter the connector on the bottom of the interface. If the interface is offset or flipped, it could damage the chip.
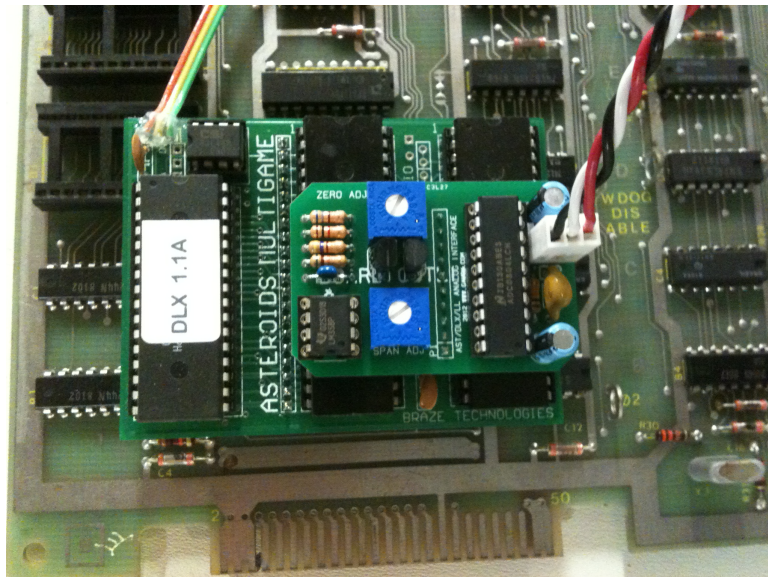
Step Four: Adjustment

The interface has two trim potentiometers (blue squares with the white circular dial). One is SPAN ADJ which sets how wide a range of digital values the interface will produce – think of it as the volume control of your car stereo. The other is ZERO ADJ which controls the offset of the values – think of it as the fader control that moves the sound forward or back in your car. They are adjusted using a small flat blade screwdriver.

Power up the game and enter self-test. Move the thruster control and verify the game is reading the thruster position by watching the THRUST hex numbers on the right side of the screen change. To set the proper range, release the handle to its lowest position and then adjust the ZERO ADJ (upper trim pot) to produce an initial reading of about 70. The value does not have to be exact

Now move the thruster to max and adjust the SPAN ADJ (lower trim pot) to obtain a reading of AA. Release the thruster, and note that low reading has changed because the adjustments are interdependent. Fine tune the ZERO ADJ to a reading of 68. Repeat until you get 68 on the low side and AA on the high side.

Exit self-test and have a go. Without rotating, watch your fuel – it should not be decreasing. Slowly throttle up and note when you fuel first starts going down (the numbers will start to decrease well before any change of engine sound or sign of thruster 'flame'). If it seems you've had to move the handle too far before it begins to thrust, increase the ZERO ADJ up to 70 or so. In hex that's 68-69-6A-6B-6C-6D-6E-6F-70. For the ultimate in touchy throttle response you can adjust it while the game is playing – turn it up until you see the fuel numbers start to decrease even with the handle at its lowest point, then back it off until it stops changing.

Troubleshooting:

Full throttle on startup
This is normal, actually, and is how the original dedicated Lunar Lander game operated. Because of variations in manufacturing tolerances, component values and voltage levels, the game hardware calibrates to the thruster by tracking the lowest and highest values it gets during gameplay. As stated by Howard Delman himself:

If you power up a Lunar Lander and start a game without having touched the thruster first, you'll find that the ship gives full thrust. This is because until the thruster is operated, the software really is lost as to its position. In fact, you can trick the software by only ever operating the thruster over a very small range.

Thruster sounds even with no throttle
"Fuel pumps." No, I don't know but that's true for the original game as well.

Don't see the hex number on the self-test screen
Make sure you have set the THRUST MODE to EXTERNAL DIGITAL in the Multigame setup menu.

Thrust hex value stuck at FF
Make sure the three wire cable is fully seated and not offset by a pin.

Can't make sense of the trim pot adjustments
It is tricky since they affect each other and the values are in hexadecimal. That's base 16 which means instead of counting from 0 to 9 and then expanding to use digits in the tens' place, you count up from 0 to 15 before you exhaust the ones' place. The extra numerals are represented by A through F.

Start over by centering the SPAN ADJ pot and then turning the ZERO ADJ to read a hex value evenly divisible by 16 (ie, 40 or 50 or 60). Add four to the sixteens' place and eight to the ones' place. So if you started at 50, you'd add four to the five, and add eight to the zero to get 98. If you started at 60 you'd add four to the six and get A, and eight to the zero to get A8. Move the thruster handle to max and adjust the SPAN ADJ to get the value you just calculated. Release and now adjust ZERO ADJ up to 68. You should now have a range very close to 68 to AA.

Hex value ones' place flickers
Nothing to worry about, this is due to the sensitivity of the analog to digital converter, and the small range of motion in the thruster pot. It just means the voltage coming in is right on the border between two digital values. If it really bothers you, the trim pots can be tweaked if you have the patience, but they are pretty sensitive – they were chosen to provide a balance between available range and fine resolution.

If it varies a lot it could mean it's time to rebuild your Audio/Regulator board or replace the 'big blue' cap in the Atari power brick.

What about the THRUST RATE setting?
The ratio selected is for button thrust only – it does not apply to external thrust input.

Other
Please check for updates at www.gauck.com/arcade or contact me at douglasgb@mac.com

dec	hex
1	01
2	02
3	03
4	04
5	05
6	06
7	07
8	08
9	09
10	0A
11	0B
12	0C
13	0D
14	0E
15	0F
16	10
17	11
18	12
19	13
20	14
21	15
22	16
23	17
24	18
25	19
26	1A
27	1B
28	1C
29	1D
30	1E
31	1F
32	20
33	21
34	22