

CINEVECTRON

FPGA



Cinevector FPGA

Setup and Operations Manual

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Introduction

The Cinevectron FPGA preserves classic Cinematronics and Vectorbeam games by recreating the hardware needed to run these games in an original or replacement cabinet.

FPGA Multigame

Play all the original vector-based Cinematronics and Vectorbeam games in a single package. Games are presented in their original format, without emulation, with the original game logic implemented in an FPGA.

Plug & Play Design

This is a drop-in replacement for the original hardware, and is an ideal substitute for failing (or missing) boards that are expensive or difficult to repair.

Flexible Application

The Cinevectron FPGA can be operated in an original cabinet with the Cinematronics display, or in a more easily obtained Asteroids or Asteroids Deluxe cabinet running the Electrohome G05-801 / 802 or Wells Gardner 19V2000 monitors. It can also support color output and will drive the Wells Gardner 6100 monitor in a Space Duel cabinet.

Notice on limitation of liability

You MUST read this entire setup and operations manual before attempting to install and operate the Cinelectron FPGA kit. Do NOT attempt to install this kit if you do not have basic familiarity with arcade hardware and electronics theory. If, after reading this entire document, you still have questions about the use of this kit please contact us cinelectron@gmail.com.

While the Cinematronics FPGA and Adaptor boards have been thoroughly tested in many different cabinets and configurations, damage to the kit or the host cabinet can occur if the kit is improperly installed. The creators and distributors of this kit will not be held responsible for damages resulting from incorrect installation or operation.

Overview

What's Included

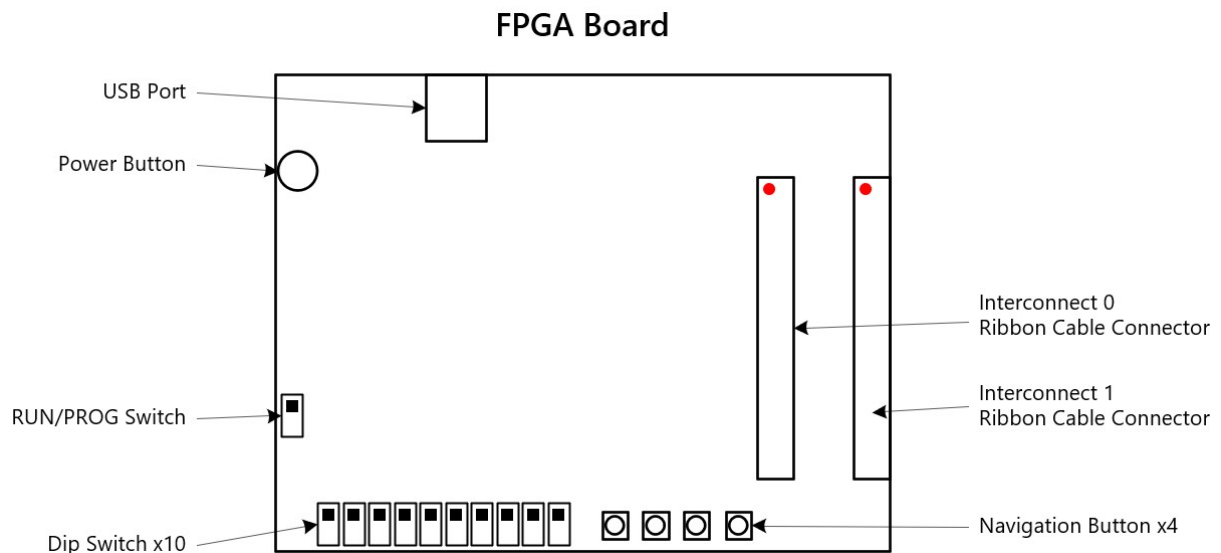
FPGA board: the execution environment for the original Cinematronics CCPU implemented in an FPGA. The FPGA board is an off-the-shelf DE0-CV board from Terasic that has been programmed with the FPGA code.

Interface board: provides the audio, display and control interfaces to the host cabinet. Also contains the CPU and Games ROMs.

Interconnect Ribbon Cables: 2 cables for connecting the FPGA board to the Interface board.

Polarity key: prevents the Interface board from being inserted the wrong way into the wire harness of an original Asteroids / Asteroids Deluxe cabinet

Diagrams



Power Button: Turns on the FGPA board. The board must be powered on during operation

RUN/PROG Switch: The switch must be set to RUN during operation. Set to PROG when updating the FPGA code

Dip Switch x10: Enable/disable features in the FPGA. See the section below on *Dip Switches*

Navigation Buttons x4:

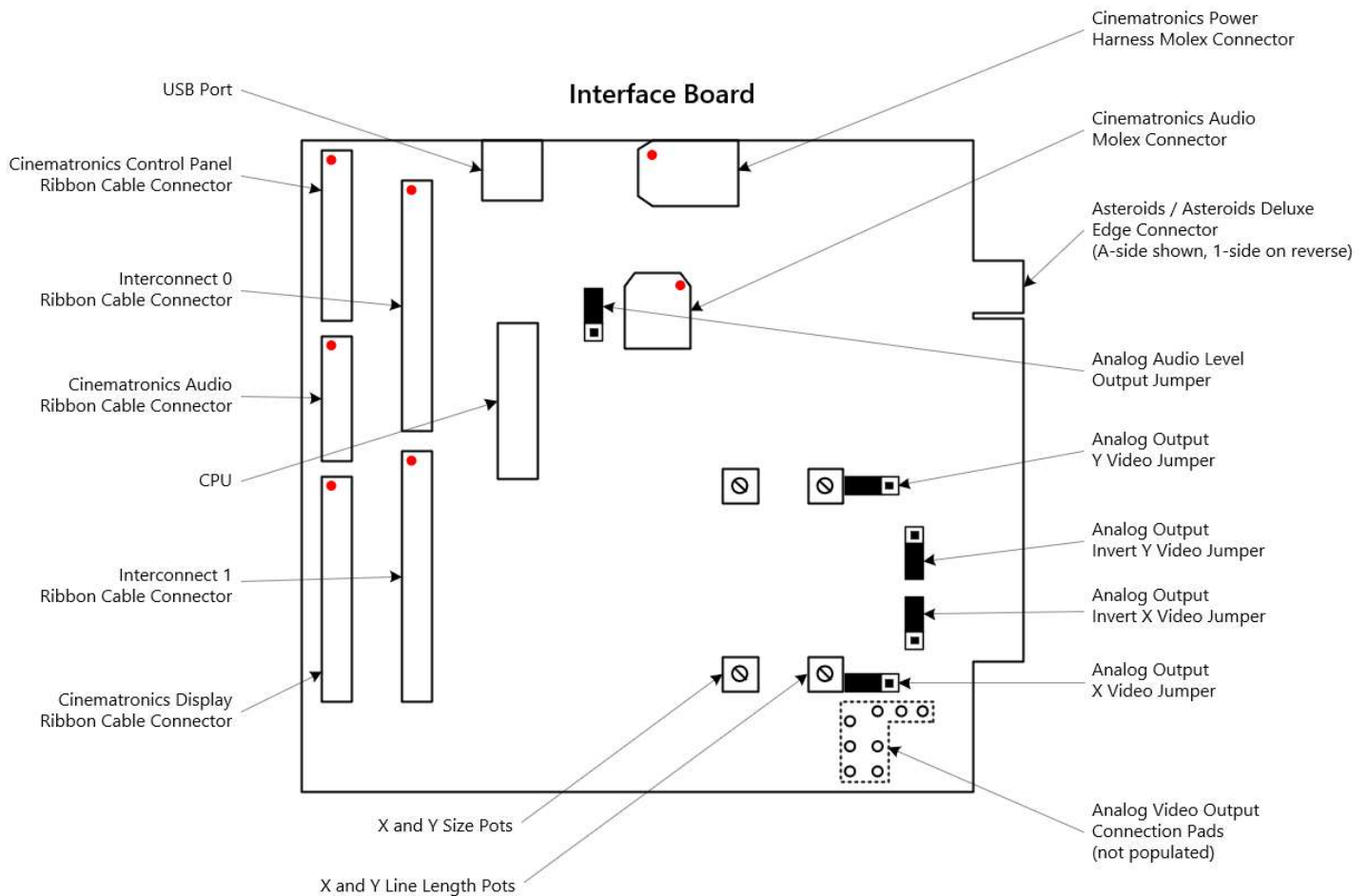
B1 + B3 = Enter Menu

B1 + B4 = Advance Game

USB Port: Used to load ROMs, and to update the Control Map

Interconnect 0 Ribbon Cable Connector: Connects the FPGA to the Interface board

Interconnect 1 Ribbon Cable Connector: Connects the FPGA to the Interface board



Red dot indicates pin 1 orientation

Cinematronics Control Panel Ribbon Cable Connector: Connects to the original Cinematronics / Vectorbeam control panel when running in a Cinematronics / Vectorbeam cabinet

Cinematronics Audio Ribbon Cable Connector: Connects the Interface board to an original Cinematronics / Vectorbeam Audio board. Not needed if you are using the onboard audio using one of the other available connectors. The interface board can be used with an original sound board, but will only support correct sound for the corresponding game (other games will output incorrect sounds)

Cinematronics Display Ribbon Cable Connector: Connects to the original Cinematronics / Vectorbeam monitor

Asteroids / Asteroids Deluxe Edge Connector: Connects the Interface board to an original Asteroids / Asteroids Deluxe cabinet harness

Analog Output Jumpers: Adjust the analog video output. See the section on *Jumpers* below

Analog Output Pots: Adjust the X and Y size and line length for analog output. See the section on *Pots* below

Installation

Requirements

Before installing this kit, you must make sure your host cabinet is fully functional. The FPGA will only work with a cabinet that is supplying the correct voltages and has a fully functional display.

Power supply requirements: Due to uncommon voltages required by the vector monitor, you can't just install a switching power supply to operate the kit. If you are planning to use the kit in a cabinet that is untested or in non-working condition, bringing up the original power supply and validating all voltages are in range is going to be your first step.

[Outerworld Arcade](#) has a page with useful info on servicing an original Cinematronics / Vectorbeam power supply.

Monitor requirements: <description>

Sound board requirements: If you are running the kit in an Asteroid or Asteroids Deluxe cabinet, make sure the AR board is functioning properly. If the power transistors are shorted, incorrect voltages on the 5V line could cause damage to the FPGA board

Installation instructions

The Interface board is extremely flexible and can support a variety of operational configurations. The most common setups are discussed below.

Initial setup (applies to all host cabinets)

1. Verify the power supply, display and sound board (if applicable) in the host cabinet are fully functional (see *Installation Requirements* section)
2. Connect the 2 Interconnect cables to the FPGA and Interface boards. Note correct cable orientation using pin 1 on the diagram which normally should correspond to the red band on the cables. Connect the header for Interconnect 0 on the FPGA board to the header for Interconnect 0 on the Interface board. Do the same for the Interconnect 1 headers
3. Ensure the FPGA board power button is ON (depressed), and the RUN/PROG switch is set to RUN

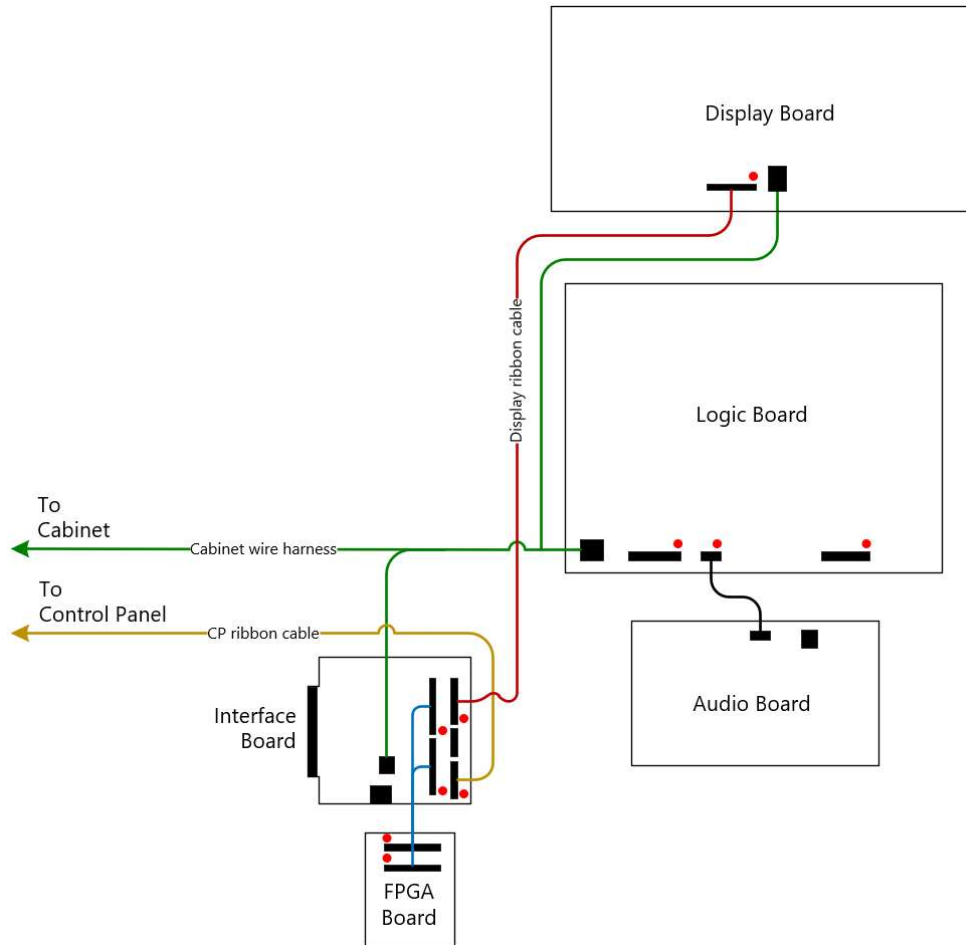
Installation in an original Cinematronics / Vectorbeam cabinet



NOTE

The kit has been tested and confirmed to work in later Cinematronics games. Refer to the Special Notes column of the ***Cinematronics / Vectorbeam Cabinet List*** in the Appendix for installation notes for each game. Do NOT install the kit into an older Cinematronics or Vectorbeam cabinet without referring to this section first. Older games will require a power and volume adaptor for correct installation.

Connectivity Diagram:



NOTE

The Interface board edge connector is energized when operating in Cinematronics / Vectorbeam cabinet. Be careful not to short the traces on the connector when operating the kit. You can use electrical tape or similar, non-conductive tape to protect the exposed edge during operation.

Installation Steps:

1. Set the dip switches on the FPGA board for use in a Cinematronics cabinet. See the **Setup and Adjustments** section on **Dip Switches**. The monitor type should be set to digital with Switch #9 = OFF. In most cases, the multi-level convert setting should be disabled with Switch #8 = OFF. If you are operating the kit using a monitor with the 16-level (in the case of Sundance) or 64-level daughterboard (found on an original Solar Quest or Sundance cabinet), then the multi-level convert setting must be enabled with Switch #8 = ON
2. Gain access to the back of the host cabinet. Remove the display and control panel ribbon cables from the connectors on the original Logic PCB. It is recommended to mark the pin 1 location on the cable with a black marker for reference. The audio ribbon cable does not need to be removed



NOTE

If you plan on operating the kit using the original audio board instead of the onboard audio, see the section below on **Using an original Cinematronics / Vectorbeam audio board**

3. Insert the display and control panel ribbon cables into the corresponding connectors on the Interface board, ensuring correct orientation referring to pin 1



NOTE

You **MUST** insert the display ribbon cable using the **SAME** orientation (pin 1 on the Interface board to pin 1 on the display board).

Installing the display ribbon cable incorrectly WILL damage your monitor.

4. Remove the 9-pin audio Molex connector from the original audio board and insert it into the corresponding header on the Interface board. The connector is keyed so it cannot be inserted in the wrong orientation



NOTE

The 12-pin power harness Molex connector **MUST** remain plugged into the original logic board, as this is the most effective way to ensure a proper return ground path. If the original logic board is not available (or you don't want to connect it), you can omit the power Molex so long as you provide a suitable return ground path from the monitor to the power supply. This can be done by attaching a 12-pin Molex with the grounds tied together to the original harness connector.

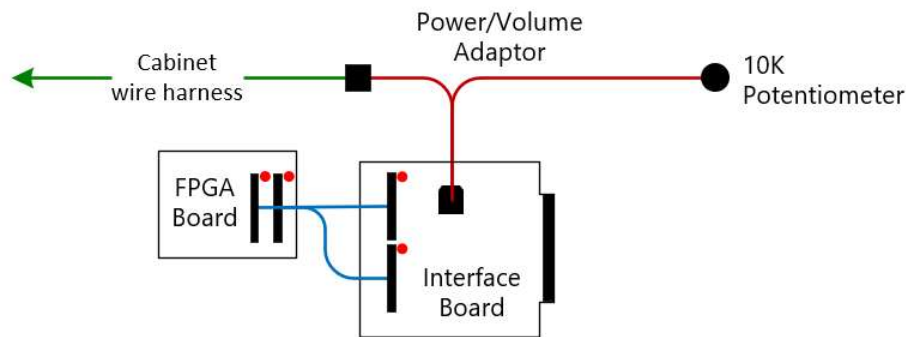
5. Double check all connections are correct. Then power on the cabinet
6. Install the correct control map file for your cabinet. See the **Maintenance** section on **Installing Control Map files**

Using an original Cinematronics / Vectorbeam audio board

<instructions are coming>

Adding a power / volume adaptor for use in an older Cinematronics / Vectorbeam cabinet

Connectivity Diagram:



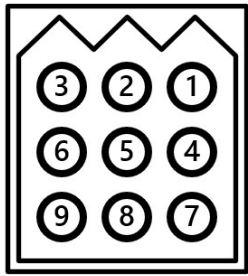
Early Cinematronics / Vectorbeam games (pre-Rip Off) had the volume control integrated on the audio board, instead of using a pot mounted remotely on the coin door. These cabinets will require a power/volume adaptor to be added when installing the kit, which includes a volume pot to be mounted for easy access by the operator. The following section details how to build and install the adaptor in your cabinet.

Tools and Materials Required:

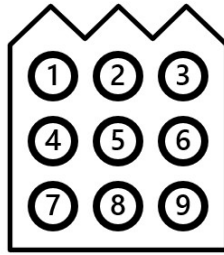
1. Molex 9-pin .093 audio connectors, male and female (Digikey part no. WM13078-ND, WM1329-ND)
2. Male and female pins, .093 (x8 ea.) (Digikey part no. WM1103-ND, WM1102-ND)
3. 10K ohm potentiometer (Digikey part no. CT3062-ND)
4. 18 and 16 AWG wire, various lengths (see table below)
5. Solder iron + solder
6. Wire crimp tool
7. Digital multimeter

Instructions:

1. Build up the wires between the cabinet harness and Interface board using crimped-on pins inserted into the connectors using the table below. The wires should be 6-8" length to ensure the original cabinet harness can reach the mounting location you have chosen for your kit, but you should confirm first to be sure
2. Add in the wires between the Interface board and the 10K pot, soldering the wires to the correct terminals on the pot. The wires should be about 18" length, but will ultimately depend upon where you chose to mount the volume pot
3. Confirm all wire to pin locations are correct according to the table before moving on
4. Disconnect the power connector from the monitor
5. Connect the adaptor to the cabinet harness. Do not plug the other end into the Interface board yet
6. Power up the cabinet
7. Check for +25V (approx.) between pin 7 (GND, black) and pin 4 (+25V, red)
8. Check for -25V (approx.) between pin 7 (GND, black) and pin 6 (-25V, blue)
9. Check for +5V between pin 7 (GND, black) and pin 9 (+5V, orange)
10. Verify there is no voltage between pin 7 (GND, black) and pins 1, 2, 3, 5, and 8
11. Power down the cabinet
12. Reconnect the monitor power connector
13. Mount the adaptor to the Interface board using the Audio molex header. Connect the other ribbon cables as documented in the previous section on installation in a Cinematronics/Vectorbeam cabinet



Cabinet Harness
9-pin connector, female

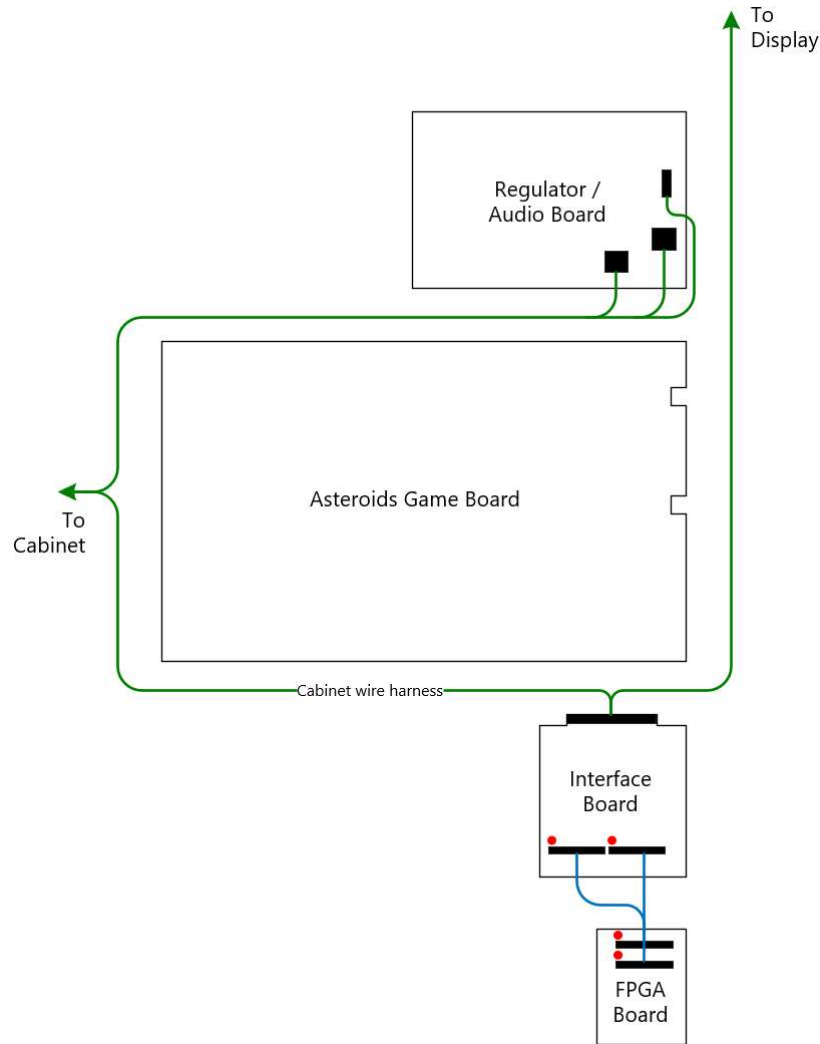


Interface Board
9-pin connector, male

Cabinet Harness (9-pin connector, female)		From / To		Interface Board (9-pin connector, male)		From / To		10K Potentiometer	
Pin		Color, AWG, Length	Function	Pin		Color, AWG, Length	Function	Pin	
1			(empty)	1	Male	Green, 18 ga, 18"	Audio Ground	1	
2	Male	Brown, 18 ga, 8"	Speaker	2	Female				
3			(empty)	3	Female	Black, 18 ga, 18"	Volume Wiper	2	
4	Male	Red, 16 ga, 8"	+25V	4	Female				
5	Male	Brown, 18 ga, 8"	Speaker	5	Female				
6	Male	Blue, 16 ga, 8"	-25V	6	Female				
7	Male	Black, 18 ga, 8"	Ground	7	Female				
8			(empty)	8	Female	Red, 18 ga, 18"	Audio Out	3	
9	Male	Orange, 18 ga, 8"	+5V	9	Female				

Installation in an original Asteroids / Asteroids Deluxe cabinet

Connectivity Diagram:



NOTE

Proper installation into an Asteroids Deluxe cabinet requires the AD Adaptor add-on to be used when connecting the Interface Board to the cabinet wire harness.

Contact cinelectron@gmail.com if you are interested in purchasing the AD Adaptor.

Installation Steps:

1. Set the jumpers on the Interface Board for use in an Asteroids cabinet. See the **Setup and Adjustments** section on **Jumpers**
2. Set the dip switches on the FPGA board for use in an Asteroids cabinet. See the **Setup and Adjustments** section on **Dip Switches**. The Monitor type setting should be set to analog with Switch #9 = ON
3. Gain access to the back of the host cabinet. Remove the Asteroids PCB from the wire harness edge connector



NOTE

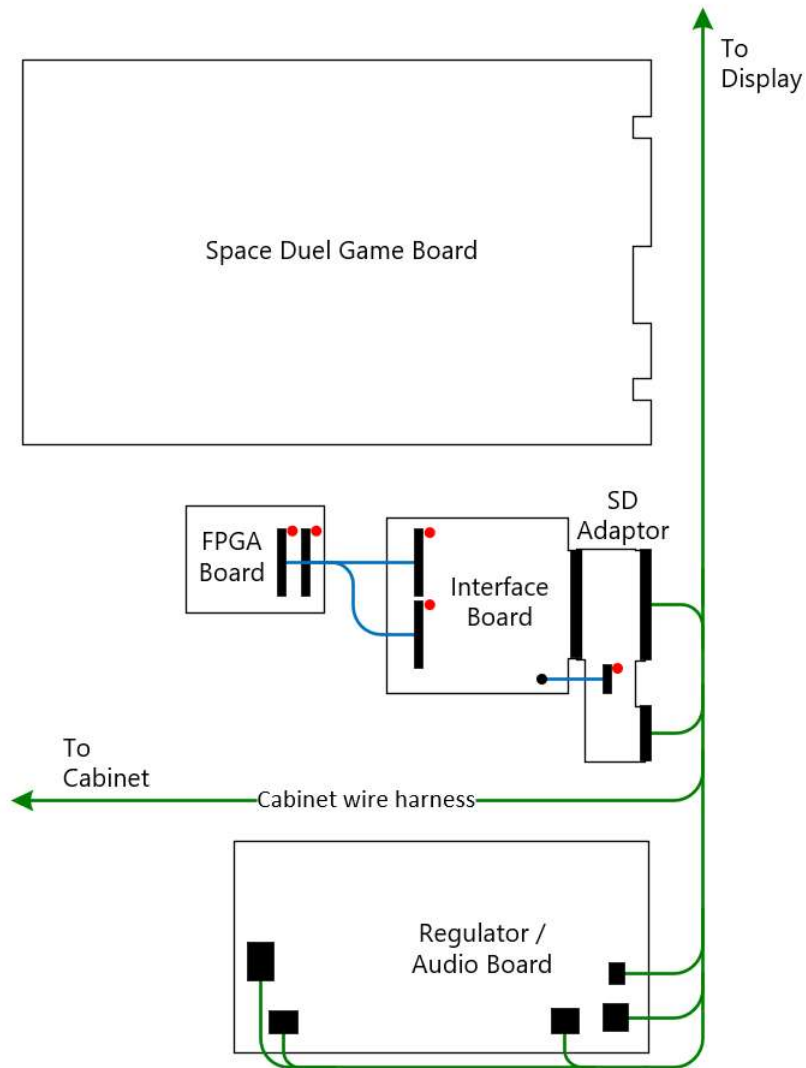
Before disconnecting the edge connector, take note of the original orientation. You MUST insert the Interface board using the SAME orientation (parts side to parts side, solder side to solder side). The Interface board is keyed in the same location as the original Asteroids board. If your cabinet harness doesn't have a key already installed, use the one we have provided to ensure you do not install the Interface board backwards.

Installing the Interface board backwards WILL damage the board.

4. Insert the Interface board edge connector into the cabinet wire harness edge connector, ensuring correct orientation
5. Double check all connections are correct. Then power on the cabinet
6. Install the Control Map file for Asteroids. See the **Maintenance** section on **Installing Control Map files**. Note that the Asteroids Control Map is preinstalled at time of shipment, so you shouldn't need to update it if this is your first time installing the kit

Installation in an original Space Duel cabinet

Connectivity Diagram:



NOTE

The simplest way to install the kit into a Space Duel cabinet is with the SD adaptor. This add-on includes a 7-pin video connector for the WG6100 display, a 26-pin ribbon cable for the controls, and the SD adaptor board for connecting the Interface board to the cabinet wire harness.

Contact cinelectron@gmail.com if you are interested in purchasing the SD adaptor.



NOTE

Before starting, be sure your FPGA Board has been updated to the latest version.

FPGA version 1.12 or later is required for proper functionality and to protect the WG6100 color display.

See the section on *Updating the FPGA* for instructions on how to do that.

SD Adaptor Installation:

1. Solder the wires from the 7-pin video connector to the unpopulated analog video output pads on the Interface board. The wires are pre-tinned and should be inserted into the through-hole via and soldered onto the pad from the solder side of the board. The following table shows the correct configuration:

Video Connector Pin	Wire Color	Interface Board Pad
Pin 1	Yellow	XOUT
Pin 2	White	YOUT
Pin 3	Black	XYRETurn
Pin 4	Red	RED
Pin 5	Green	GRN
Pin 6	Blue	BLU
Pin 7	Black	ZRETurn
N/A (leave unpopulated)		ZOUT

2. Insert the Interface board into the SD adaptor using its Asteroids/AD edge connector. The adaptor is not keyed so pay attention to the orientation. Note the cutaway in the Interface board edge connector should match the cutaway in the same location on the SD adaptor's edge connector
3. Mount the 7-pin video connector onto the header on the SD adaptor. Pin 1 on the header is the topmost when facing the part side with the edge connectors on the right (also denoted by the square pad on the solder side), and should connect to XOUT with the yellow wire
4. Insert the 2-pin ribbon cable into the control panel connector on the Interface board. The red wire on the ribbon cable should line up with pin 1 on the Interface board. The cable is keyed so can only be inserted correctly. Note the cable is routed around the underside of the Interface board.
5. Connect the interconnect cables between the Interface board as normal
6. Attach the ground wire between the FPGA board and the Interface board. The ground wire should be connected to pin 4 (the single female pin) on the power harness molex connector on the interface board. Attach the other end of the ground wire to the metal standoff on the FPGA board using the ring terminal wire connector. Test for continuity using a multimeter

Optional – Connect a Digital Spinner:

1. You can connect a digital spinner using the 4-pin header on the SD adaptor. Be sure to enable support for encoder processing on the FPGA (Switch #6 = ON). Connect the spinner as follows (Pin 1 is topmost):

Encoder Pin	Function
Pin 1	+5V
Pin 2	CHA
Pin 3	CHB
Pin 4	GND

Cabinet Installation Steps:

1. Set the jumpers on the Interface Board for use in a Space Duel cabinet. See the **Setup and Adjustments** section on **Jumpers**. The Analog Output X and Y Video Jumpers should be set for Color
2. Set the dip switches on the FPGA board for use in an Asteroids cabinet. See the **Setup and Adjustments** section on **Dip Switches**. The Monitor type setting should be set to analog with Switch #9 = ON
3. Gain access to the back of the host cabinet. Remove the Space Duel PCB from the wire harness edge connectors



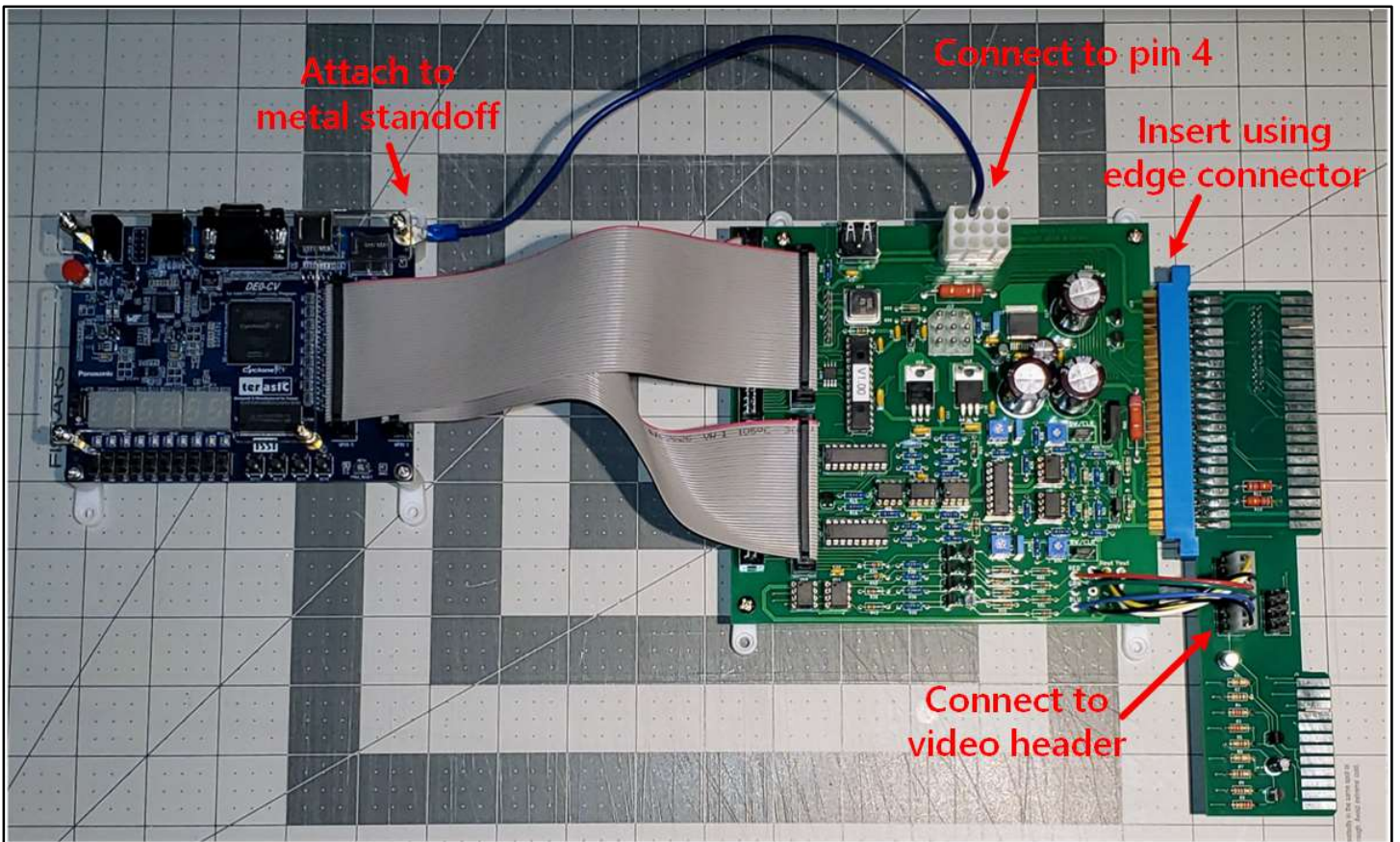
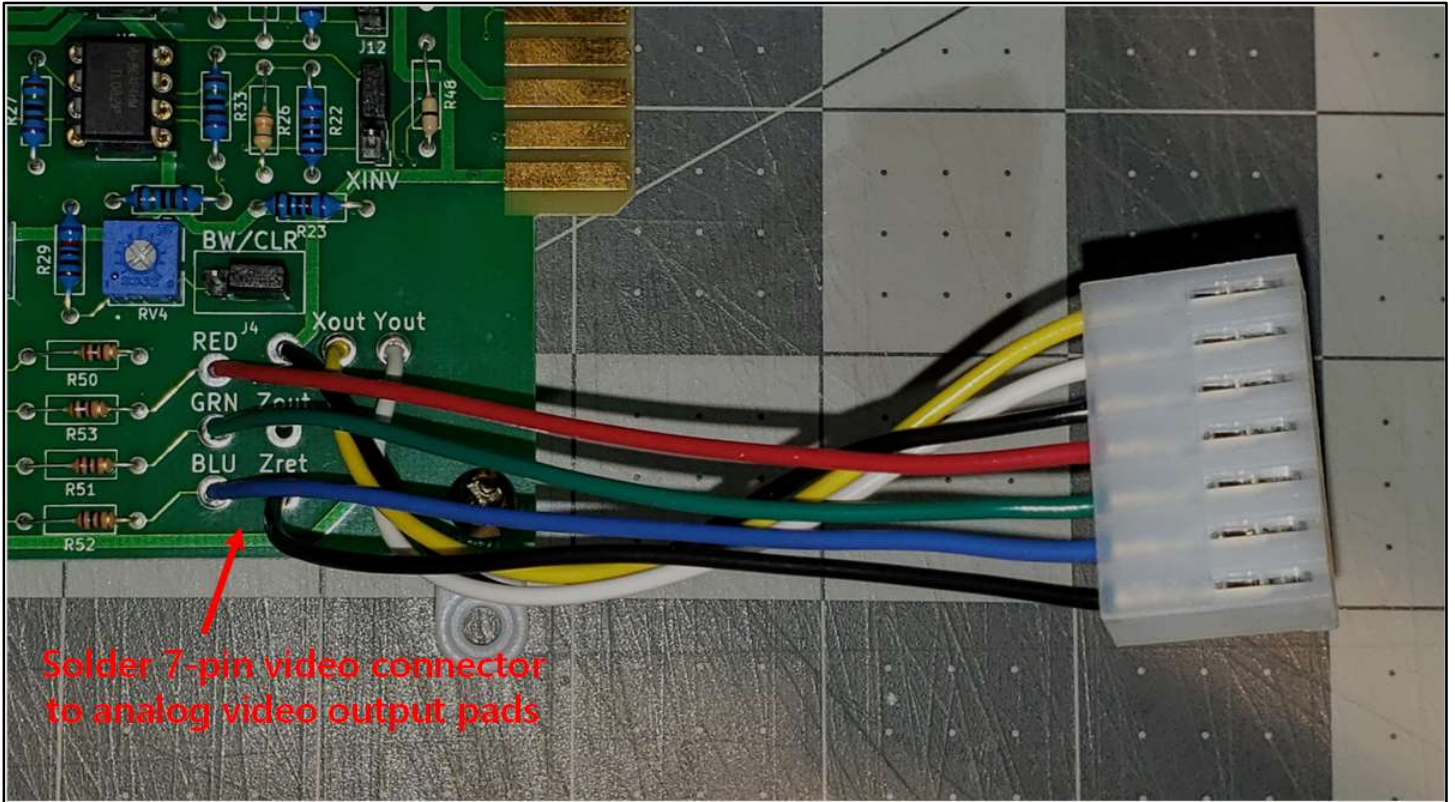
NOTE

Before disconnecting the edge connectors, take note of the original orientation. You MUST insert the SD adaptor board using the SAME orientation (parts side to parts side, solder side to solder side). The SD adaptor board is keyed in the same location as the original Space Duel board.

Installing the Interface board backwards WILL damage the board.

4. Insert both of the SD adaptor edge connectors into the cabinet wire harness edge connector, ensuring correct orientation
5. Double check all connections are correct. Then power on the cabinet
6. Install the Control Map file for Space Duel. See the **Maintenance** section on **Installing Control Map files** if you are unfamiliar with this process

Photos:



Setup and Adjustments

Dip Switches

Switch	Value	9	8	7	6	5	4	3	2	1	0
Monitor type	Analog	ON									
	Digital	OFF									
Multi-level convert	Enabled		ON								
	Disabled		OFF								
Menu lockout	Enabled			ON							
	Disabled			OFF							
Encoder processing	Enabled				ON						
	Disabled				OFF						
Hex display	Show unmapped I/Os									OFF	OFF
	Show mapped I/Os									OFF	ON
	Show CPU info									ON	

Up (towards the top of the board) is ON

Monitor type: sets the output format for the display. Use 'Analog' for Atari-style monitors like those used in Asteroids / Asteroids Deluxe. Use 'Digital' for Cinematronics / Vectorbeam monitors.

Multi-level convert: enable this when using a Cinematronics monitor with a multi-level daughterboard. This setting must be used when running the kit in an original Sundance or Solar Quest cabinet, as those monitors had the multi-level board installed. The setting must also be enabled when using a Cinematronics monitor with a color conversion daughterboard, as was present in an original Boxing Bugs or color War of the Worlds cabinet. Note the setting should be disabled if you are using the Analog Video Output Connection on the Interface board.

Menu lockout: allows the menus to be locked out from the control panel. The menus can still be brought up using the buttons on the FPGA board.

Encoder processing: enables support for digital spinner in the FPGA, instead of on an original sound board. The control map must support spinner input.

Menu lockout: enable this to prevent users from bringing up the menus from the control panel. Menu can still be accessed using the Navigation buttons on the FPGA board.

Hex display: determines what values are shown on the 7-segment display on the FPGA board.

Jumpers

Analog Audio Output Level Jumper:

Asteroids

Asteroids Deluxe

Analog Output Y Video Jumper:

Color

B&W

Analog Output X Video Jumper:

Color

B&W

Analog Output Invert Y Video Jumper:

Normal

Inverted

Analog Output Invert X Video Jumper

Normal

Inverted

Pots

Adjust the size and line length for analog output

X Line Length: adjust horizontal line length

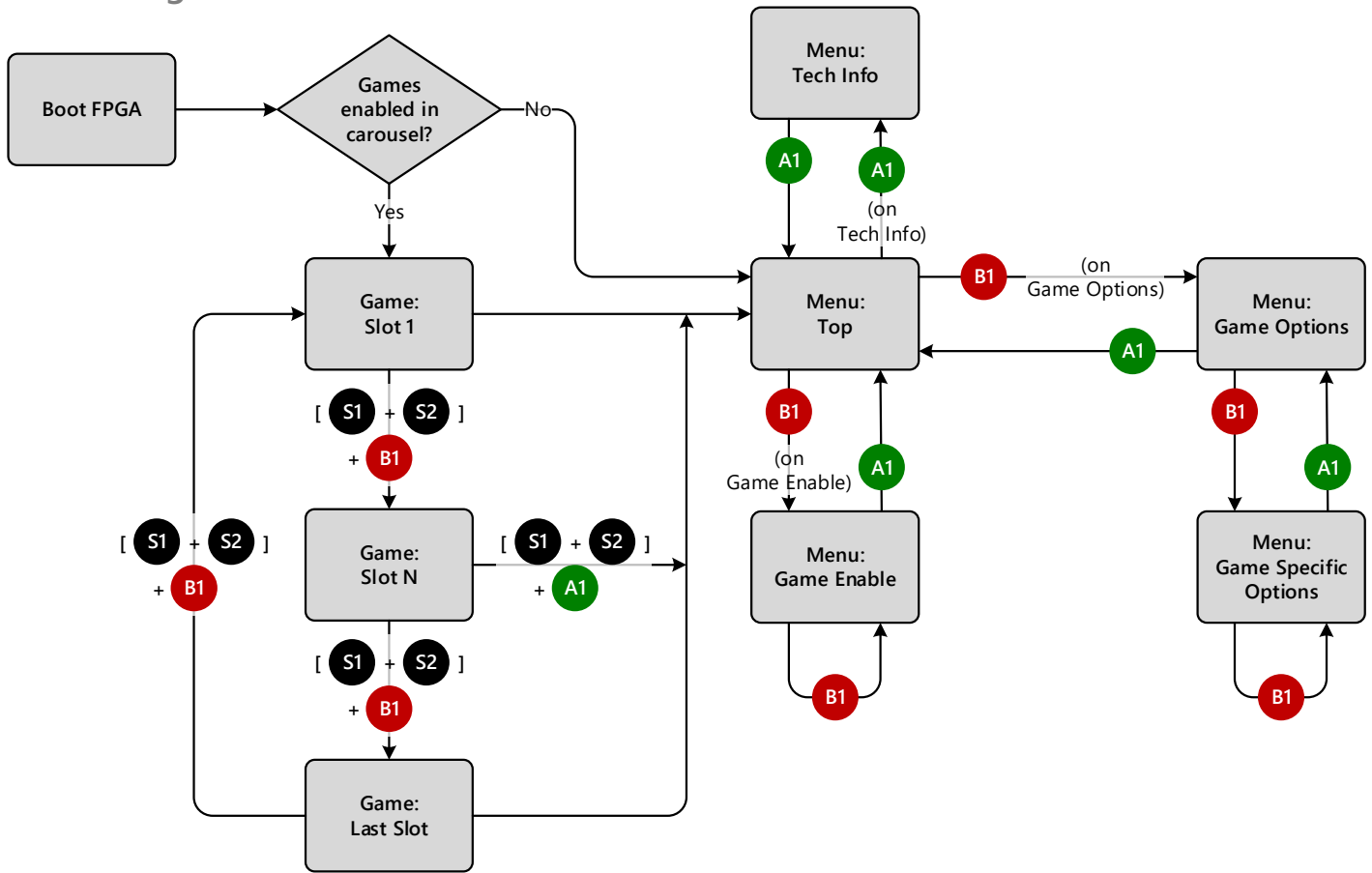
Y Line Length: adjust vertical line length

X Size: adjust horizontal output width

Y Size: adjust vertical output height

Operation

State Navigation



Settings

Forced Freeplay: When enabled, freeplay is turned on for all games. Some games had built in support for freeplay, which can be individually set in Game Options.

High Score Save: When enabled, high scores will survive a reboot. Note that resetting games options will wipe saved high scores.

Game Enable: Allows games to be added or removed from the game carousel.

Game Options: All primary and secondary game options can be modified for each game.

Control Mappings

The following controls schemes require installation of the corresponding Control Map file.

Space Wars (v7)			Game							
Pin	Control	I/O	Space Wars ¹	Star Hawk ¹	Speed Freak	Barrier	Sundance	Warrior ¹	Tail Gunner	Rip Off ¹
	P1 Left		P1 Left	P1 Left		P1 Left		P1 Left	Left	P1 Left
	P1 Right		P1 Right	P1 Right		P1 Right		P1 Right	Right	P1 Right
	P1 Forward		P1 Forward	P1 Down		P1 Down		P1 Down	Down	P1 Forward
	P1 Fire		P1 Fire	P1 Up		P1 Up		P1 Up	Up	P1 Fire
	P1 Hyperspace		P1 Hyperspace	P1 Fire				P1 Sword		
	P2 Left		P2 Left	P2 Left		P2 Left		P2 Left		P2 Left
	P2 Right		P2 Right	P2 Right		P2 Right		P2 Right		P2 Right
	P2 Forward		P2 Forward	P2 Down		P2 Down		P2 Down	Shield	P2 Forward
	P2 Fire		P2 Fire	P2 Up		P2 Up		P2 Up	Fire	P2 Fire
	P2 Hyperspace		P2 Hyperspace	P2 Fire				P2 Sword		
	Reset		Reset							
	N1		Start (Game 9)	P1 Start	Start	P1 Start	P1 Start	Start	Start	P1 Start
	N2		Start (Game 1)	P2 Start		P2 Start	P2 Start			P2 Start
	N0,3-9		N0,3-9							
(unmapped)				P1 Slow	Gas	A-E	P1 Hatches 1-9			
				P1 Med	Shift Down		P1 Nova			
				P1 Fast	Shift Up		P2 Hatches 1-9			
				P2 Slow	Steer A		P2 Nova			
				P2 Med	Steer B		2 Suns			
				P2 Fast			3 Suns			
							4 Suns			
						Grid/No Grids				

Space Wars continued			Game						
Pin	Control	I/O	Star Castle	Armor Attack ¹	Solar Quest	Boxing Bugs	War of the Worlds	Demon ¹	QB-3
	P1 Left		Left	P1 Left	Left		Left	P1 Left	Fire Left
	P1 Right		Right	P1 Right	Right		Right	P1 Right	Fire Right
	P1 Forward		Thrust	P1 Forward	Thrust	Glove	Shield	P1 Forward	Fire Down
	P1 Fire		Fire	P1 Fire	Fire	Cannon	Fire	P1 Fire	Fire Up
	P1 Hyperspace							P1 Panic	
	P2 Left			P2 Left				P2 Left	Move Left
	P2 Right			P2 Right				P2 Right	Move Right
	P2 Forward			P2 Forward				P2 Forward	Move Down
	P2 Fire			P2 Fire				P2 Fire	Move Up
	P2 Hyperspace							P2 Panic	
	Reset								
	N1		P1 Start	P1 Start	P1 Start / Hyperspace	P1 Start / Panic	P1 Start	P1 Start	P1 Start
	N2		P2 Start	P2 Start	P2 Start / Nuke	P2 Start / Panic	P2 Start	P2 Start	P2 Start
	N0,3-9								
(unmapped)									

Notes

1. P1 Controls always on the right side of control panel

Rip Off / Armor Attack (v10)			Game							
Pin	Control	I/O	Space Wars ¹	Star Hawk ¹	Speed Freak	Barrier	Sundance	Warrior ¹	Tail Gunner	Rip Off ¹
10	P1 Start	PI[1]	Start (Game 9)	P1 Start	Start	P1 Start	P1 Start	P1 Sword	Start	P1 Start
20	P1 Left	PI[12]	P1 Left	P1 Down	Shift Down ²	P1 Left		P1 Left	Left	P1 Left
22	P1 Right	PI[14]	P1 Right	P1 Up	Shift Up ²	P1 Right		P1 Right	Right	P1 Right
23	P1 Forward	PI[15]	P1 Forward			P1 Down		P1 Down	Down	P1 Forward
21	P1 Fire	PI[13]	P1 Fire			P1 Up		P1 Up	Up	P1 Fire
8	P2 Start	PI[3]	Start (Game 1)	P1 Fire	Gas	P2 Start	P2 Start	P2 Sword		P2 Start
11	P2 Left	PI[0]	P2 Left			P2 Left		P2 Left		P2 Left
9	P2 Right	PI[2]	P2 Right			P2 Right		P2 Right		P2 Right
15	P2 Forward	PI[4]	P2 Forward	P1 Left		P2 Down		P2 Down	Shield	P2 Forward
14	P2 Fire	PI[5]	P2 Fire	P1 Right		P2 Up		P2 Up	Fire	P2 Fire
12	(Encoder A)	PI[7]			Steer A ³					
18	(Encoder B)	PI[9]			Steer B ³					
(unmapped)			P1 Hyperspace	P1 Slow		A-E	P1 Hatches 1-9			
(unmapped)			P2 Hyperspace	P1 Med			P1 Nova			
(unmapped)			Reset	P1 Fast			P2 Hatches 1-9			
(unmapped)			N1-9	P2 Start			P2 Nova			
(unmapped)				P2 Left			2 Suns			
(unmapped)				P2 Right			3 Suns			
(unmapped)				P2 Down			4 Suns			
(unmapped)				P2 Up			Grid/No Grids			
(unmapped)				P2 Fire						
(unmapped)				P2 Slow						
(unmapped)				P2 Med						
(unmapped)				P2 Fast						

Rip Off / Armor Attack continued			Game						
Pin	Control	I/O	Star Castle	Armor Attack ¹	Solar Quest	Boxing Bugs	War of the Worlds	Demon ¹	QB-3
10	P1 Start	PI[1]	P1 Start	P1 Start	P1 Start / Hyperspace	P1 Start/Panic	P1 Start	P1 Start/Panic	P1 Start
20	P1 Left	PI[12]	Left	P1 Left	Left		Left	P1 Left	Fire Left
22	P1 Right	PI[14]	Right	P1 Right	Right		Right	P1 Right	Fire Right
23	P1 Forward	PI[15]	Thrust	P1 Forward	Thrust	Glove	Shield	P1 Forward	Fire Down
21	P1 Fire	PI[13]	Fire	P1 Fire	Fire	Cannon	Fire	P1 Fire	Fire Up
8	P2 Start	PI[3]	P2 Start	P2 Start	P2 Start / Nuke	P2 Start/Panic	P2 Start	P2 Start/Panic	P2 Start
11	P2 Left	PI[0]		P2 Left				P2 Left	Move Left
9	P2 Right	PI[2]		P2 Right				P2 Right	Move Right
15	P2 Forward	PI[4]		P2 Forward				P2 Forward	Move Down
14	P2 Fire	PI[5]		P2 Fire				P2 Fire	Move Up
12	(Encoder A)	PI[7]				Rotate A ³			
18	(Encoder B)	PI[9]				Rotate B ³			
(unmapped)									

Notes

1. P1 Controls always on the right side of control panel
2. When using 2 Button Shift ROMs from Outerworld Arcade
3. Requires optical encoding enabled on the FPGA

Star Castle Upright (v7)			Game							
Pin	Control	I/O	Space Wars	Star Hawk	Speed Freak	Barrier	Sundance	Warrior	Tail Gunner	Rip Off
11	P1 Start	PI[0]	Start (Game 9)	P1 Start	Start	P1 Start	P1 Start	P1 Sword	Start	P1 Start
13	Left	PI[6]	P1 Left	P1 Left		P1 Left		P1 Left	Left	P1 Left
19	Right	PI[8]	P1 Right	P1 Right		P1 Right		P1 Right	Right	P1 Right
17	Thrust	PI[10]	P1 Forward	P1 Down	Gas	P1 Down		P1 Down	Down	P1 Forward
20	Fire	PI[12]	P1 Fire	P1 Up		P1 Up		P1 Up	Up	P1 Fire
9	P2 Start	PI[2]	Start (Game 1)	P1 Fire			P2 Start		Fire	
	(Encoder A)	PI[14]			Steer A ¹					
	(Encoder B)	PI[15]			Steer B ¹					
(unmapped)			P1 Hyperspace	P1 Slow	Shift Down	P2 Start	P1 Hatches 1-9	P2 Left	Shield	P2 Start
			P2 Left	P1 Med	Shift Up	P2 Left	P1 Nova	P2 Right		P2 Left
			P2 Right	P1 Fast		P2 Right	P2 Hatches 1-9	P2 Down		P2 Right
			P2 Forward	P2 Start		P2 Down	P2 Nova	P2 Up		P2 Forward
			P2 Fire	P2 Left		P2 Up	2 Suns	P2 Sword		P2 Fire
			P2 Hyperspace	P2 Right		A-E	3 Suns			
			Reset	P2 Down			4 Suns			
			N1-9	P2 Up			Grid/No Grids			
				P2 Fire						
				P2 Slow						
	P2 Med									
	P2 Fast									

Star Castle Upright continued			Game						
Pin	Control	I/O	Star Castle	Armor Attack	Solar Quest	Boxing Bugs	War of the Worlds	Demon	QB-3
11	P1 Start	PI[0]	P1 Start	P1 Start	P1 Start / Hyperspace	P1 Start/Panic	P1 Start	P1 Start/Panic	P1 Start
13	Left	PI[6]	Left	P1 Left	Left		Left	P1 Left	Fire Left
19	Right	PI[8]	Right	P1 Right	Right		Right	P1 Right	Fire Right
17	Thrust	PI[10]	Thrust	P1 Forward	Thrust	Glove	Shield	P1 Forward	Fire Down
20	Fire	PI[12]	Fire	P1 Fire	Fire	Cannon	Fire	P1 Fire	Fire Up
9	P2 Start	PI[2]	P2 Start		P2 Start / Nuke	P2 Start/Panic	P2 Start		P2 Start
	(Encoder A)	PI[14]				Rotate A ¹			
	(Encoder B)	PI[15]				Rotate B ¹			
(unmapped)				P2 Start				P2 Start/Panic	Move Left
				P2 Left				P2 Left	Move Right
				P2 Right				P2 Right	Move Down
				P2 Forward				P2 Forward	Move Up
				P2 Fire				P2 Fire	

Notes

1. Requires optical encoding enabled on the FPGA

Boxing Bugs (v4)			Game							
Pin	Control	I/O	Space Wars	Star Hawk	Speed Freak	Barrier	Sundance	Warrior	Tail Gunner	Rip Off
8	P1 Start/Panic (L)	PI[3]	Start (Game 9)	P1 Start	Start	P1 Start	P1 Start	Start	Start	P1 Start
14	Cannon (L)	PI[5]	P1 Left	P1 Left		P1 Left		P1 Left	Left	P1 Left
15	Glove (L)	PI[4]	P1 Right	P1 Right		P1 Right		P1 Right	Right	P1 Right
9	P2 Start/Panic (R)	PI[2]	Start (Game 1)	P1 Fire	Gas		P2 Start	P1 Sword	Fire	
10	Glove (R)	PI[1]	P1 Forward	P1 Down	Shift Down ¹	P1 Down		P1 Down	Down	P1 Forward
11	Cannon (R)	PI[0]	P1 Fire	P1 Up	Shift Up ¹	P1 Up		P1 Up	Up	P1 Fire
22	Encoder A	PI[14]			Steer A ²					
23	Encoder B	PI[15]			Steer B ²					
(unmapped)			P1 Hyperspace	P1 Slow		P2 Start	P1 Hatches 1-9	P2 Left	Shield	P2 Start
			P2 Left	P1 Med		P2 Left	P1 Nova	P2 Right		P2 Left
			P2 Right	P1 Fast		P2 Right	P2 Hatches 1-9	P2 Down		P2 Right
			P2 Forward	P2 Start		P2 Down	P2 Nova	P2 Up		P2 Forward
			P2 Fire	P2 Left		P2 Up	2 Suns	P2 Sword		P2 Fire
			P2 Hyperspace	P2 Right		A-E	3 Suns			
			Reset	P2 Down			4 Suns			
			N1-9	P2 Up			Grid/No Grids			
				P2 Fire						
				P2 Slow						

Boxing Bugs continued			Game						
Pin	Control	I/O	Star Castle	Armor Attack	Solar Quest	Boxing Bugs	War of the Worlds	Demon	QB-3
8	P1 Start/Panic (L)	PI[3]	P1 Start	P1 Start	P1 Start / Hyperspace	P1 Start/Panic	P1 Start	P1 Start	P1 Start
14	Cannon (L)	PI[5]	Left	P1 Left	Left	Cannon	Left	P1 Left	Move Left
15	Glove (L)	PI[4]	Right	P1 Right	Right	Glove	Right	P1 Right	Move Right
9	P2 Start/Panic (R)	PI[2]	P2 Start		P2 Start / Nuke	P2 Start/Panic	P2 Start	P1 Panic	P2 Start
10	Glove (R)	PI[1]	Thrust	P1 Forward	Thrust	Glove	Shield	P1 Forward	Move Down
11	Cannon (R)	PI[0]	Fire	P1 Fire	Fire	Cannon	Fire	P1 Fire	Move Up
22	Encoder A	PI[14]				Rotate A ²			
23	Encoder B	PI[15]				Rotate B ²			
(unmapped)				P2 Start				P2 Start	Fire Left
				P2 Left				P2 Left	Fire Right
				P2 Right				P2 Right	Fire Down
				P2 Forward				P2 Forward	Fire Up
				P2 Fire				P2 Fire	
								P2 Panic	

Notes

1. When using 2 Button Shift ROMs from Outerworld Arcade
2. Requires optical encoding enabled on the FPGA

Asteroids Upright (v1)			Game							
Pin	Control	I/O	Space Wars	Star Hawk	Speed Freak	Barrier	Sundance	Warrior	Tail Gunner	Rip Off
	P1 Start		Start (Game 9)	P1 Start	Start	P1 Start	P1 Start	Start	Start	P1 Start
	Left		P1 Left	P1 Left		P1 Left		P1 Left	Left	P1 Left
	Right		P1 Right	P1 Right		P1 Right		P1 Right	Right	P1 Right
	Thrust		P1 Forward	P1 Down		P1 Down		P1 Down	Down	P1 Forward
	Fire		P1 Fire	P1 Up		P1 Up		P1 Up	Up	P1 Fire
	Hyperspace / Shield		P1 Hyperspace	P1 Fire	Gas			P1 Sword	Fire	
	P2 Start		Start (Game 1)				P2 Start		Shield	
	(unmapped)		P1 Hyperspace	P1 Slow	Shift Down	P2 Start	P1 Hatches 1-9	P2 Left		P2 Start
			P2 Left	P1 Med	Sift Up	P2 Left	P1 Nova	P2 Right		P2 Left
			P2 Right	P1 Fast	Steer A	P2 Right	P2 Hatches 1-9	P2 Down		P2 Right
			P2 Forward	P2 Start	Steer B	P2 Down	P2 Nova	P2 Up		P2 Forward
			P2 Fire	P2 Left		P2 Up	2 Suns	P2 Sword		P2 Fire
			P2 Hyperspace	P2 Right		A-E	3 Suns			
			Reset	P2 Down			4 Suns			
			N1-9	P2 Up			Grid/No Grids			
				P2 Fire						
				P2 Slow						
			P2 Med							
			P2 Fast							

Asteroids Upright continued			Game						
Pin	Control	I/O	Star Castle	Armor Attack	Solar Quest	Boxing Bugs	War of the Worlds	Demon	QB-3
	P1 Start		P1 Start	P1 Start	P1 Start / Hyperspace	P1 Start/Panic	P1 Start	P1 Start	P1 Start
	Left		Left	P1 Left	Left		Left	P1 Left	Fire Left
	Right		Right	P1 Right	Right		Right	P1 Right	Fire Right
	Thrust		Thrust	P1 Forward	Thrust	Glove	Shield	P1 Forward	Fire Down
	Fire		Fire	P1 Fire	Fire	Cannon	Fire	P1 Fire	Fire Up
	Hyperspace / Shield							P1 Panic	
	P2 Start		P2 Start		P2 Start / Nuke	P2 Start/Panic	P2 Start		P2 Start
	(unmapped)			P2 Start		Rotate A		P2 Start/Panic	Move Left
				P2 Left		Rotate B		P2 Left	Move Right
				P2 Right				P2 Right	Move Down
				P2 Forward				P2 Forward	Move Up
				P2 Fire				P2 Fire	

Notes

Space Duel (v2)			Game							
Pin	Control	I/O	Space Wars ¹	Star Hawk ¹	Speed Freak	Barrier	Sundance	Warrior ¹	Tail Gunner	Rip Off ¹
10	Start	PI[1]	Start (Game 9)	P1 Start	Start	P1 Start	P1 Start	Start	Start	P1 Start
20	P1 Left	PI[12]	P1 Left	P1 Left		P1 Left		P1 Left	Left	P1 Left
22	P1 Right	PI[14]	P1 Right	P1 Right		P1 Right		P1 Right	Right	P1 Right
23	P1 Thrust	PI[15]	P1 Forward	P1 Down	Shift Down ²	P1 Down		P1 Down	Down	P1 Forward
21	P1 Fire	PI[13]	P1 Fire	P1 Up	Shift Up ²	P1 Up		P1 Up	Up	P1 Fire
19	P1 Shields	PI[8]	P1 Hyperspace	P1 Fire	Gas			P1 Sword	Fire	
8	Game Select	PI[3]	Start (Game 1)	P2 Start		P2 Start	P2 Start		Shields	P2 Start
11	P2 Left	PI[0]	P2 Left	P2 Left		P2 Left		P2 Left		P2 Left
9	P2 Right	PI[2]	P2 Right	P2 Right		P2 Right		P2 Right		P2 Right
15	P2 Thrust	PI[4]	P2 Forward	P2 Down		P2 Down		P2 Down		P2 Forward
14	P2 Fire	PI[5]	P2 Fire	P2 Up		P2 Up		P2 Sword		P2 Fire
13	P2 Shields	PI[6]	P2 Hyperspace	P2 Fire						
12	(Encoder A)	PI[7]			Steer A ³					
18	(Encoder B)	PI[9]			Steer B ³					
(unmapped)			Reset	P1 Slow		A-E	P1 Hatches 1-9			
			N1-9	P1 Med			P1 Nova			
				P1 Fast			P2 Hatches 1-9			
				P2 Slow			P2 Nova			
				P2 Med			2 Suns			
				P2 Fast			3 Suns			
							4 Suns			
							Grid/No Grids			

Space Duel continued			Game						
Pin	Control	I/O	Star Castle	Armor Attack ¹	Solar Quest	Boxing Bugs	War of the Worlds	Demon ¹	QB-3
10	Start	PI[1]	P1 Start	P1 Start	P1 Start / Hyperspace	P1 Start / Panic	P1 Start	P1 Start	P1 Start
20	P1 Left	PI[12]	Left	P1 Left	Left		Left	P1 Left	Fire Left
22	P1 Right	PI[14]	Right	P1 Right	Right		Right	P1 Right	Fire Right
23	P1 Thrust	PI[15]	Thrust	P1 Forward	Thrust	Glove	Shield	P1 Forward	Fire Down
21	P1 Fire	PI[13]	Fire	P1 Fire	Fire	Cannon	Fire	P1 Fire	Fire Up
19	P1 Shields	PI[8]						P1 Panic	
8	Game Select	PI[3]	P2 Start	P2 Start	P2 Start / Nuke	P2 Start / Panic	P2 Start	P2 Start	P2 Start
11	P2 Left	PI[0]		P2 Left				P2 Left	Move Left
9	P2 Right	PI[2]		P2 Right				P2 Right	Move Right
15	P2 Thrust	PI[4]		P2 Forward				P2 Forward	Move Down
14	P2 Fire	PI[5]		P2 Fire				P2 Fire	Move Up
13	P2 Shields	PI[6]						P2 Panic	
12	(Encoder A)	PI[7]				Rotate A ³			
18	(Encoder B)	PI[9]				Rotate B ³			
(unmapped)									

Notes

1. P1 Controls always on the right side of control panel
2. When using 2 Button Shift ROMs from Outerworld Arcade
3. Requires optical encoding enabled on the FPGA

Maintenance

Installing Control Map files

The Control Map file is stored in flash memory on the Interface board. Since only one Control Map file is active at any time, if you want to operate the kit in a new host cabinet you may need to update the Control Map file for the new cabinet.

The latest version of Control Map files can be downloaded from <http://cinelectron.com/downloads>

Update Control Map file

4. Format a USB drive: Windows format as FAT32, Macintosh format as MSDOS-FAT
5. Save the Control Map file for the host cabinet into the root folder of the USB drive. The file must be unzipped, and it must be titled ***control_map.bin***, case sensitive
6. Ensure everything is powered down (cabinet, FPGA and Interface boards)
7. Insert the USB drive into the USB port of the Interface board
8. Power on everything. The boards will boot up. Do NOT start a game yet. The copy process may not be successful if a game is playing
9. Wait 30 seconds
10. Power down everything. Remove the USB drive
11. Power up everything. Verify the new Control Map was successfully installed by starting a game (Control Map files cannot be confirmed in the Tech Info menu)

Installing Game and Menu ROMs

The interface board stores game ROMs in flash memory, which can be updated by the user via USB following the process below. A USB drive is required. The menu system is implemented as a set of game ROMs and can be updated by following the same process.

The latest version of Menu ROMs can be downloaded from <http://cinelectron.com/downloads>

Update game and menu ROMs

1. Format a USB drive: Windows format as FAT32, Macintosh format as MSDOS-FAT
2. Save the ROM files for the game you want to update into the root folder of the USB drive. The files must be unzipped, and they must EXACTLY match the expected ROM file names, case sensitive. See the ROM file list in the appendix for expected file names
3. Ensure everything is powered down (cabinet, FPGA and Interface boards)
4. Insert the USB drive into the USB port of the Interface board
5. Power on everything. The boards will boot up. Do NOT start a game yet. The copy process may not be successful if a game is playing
6. Wait 30 seconds
7. Power down everything. Remove the USB drive
8. Power up everything. Bring up the Tech Info menu to verify everything was successfully updated (game ROM versions cannot be confirmed in the Tech Info menu)

Updating the FPGA

The FPGA code can be updated using free tools provided by Intel. You will need a USB cable.

The latest version of FPGA code can be downloaded from <http://cinelectron.com/downloads>

Download/Install Quartus II v14.1

1. Go to the Intel FPGA Download Center at <http://fpgasoftware.intel.com>
2. Download the installer for version 14.1 Web Edition
 - a. Direct link at <http://fpgasoftware.intel.com/14.1/?edition=web>
 - b. Download Quartus II Software
 - c. Download Cyclone V device support and save to the same folder as Quartus II installer
 - d. You will need to create an account to download the files. It's free
3. Run Quartus Installer

Ensure USB Blaster driver is installed correctly

1. Attach the DE0 board to your PC with the USB cable, set SW10 on the board to PROG, and turn it on
2. On your PC, open Device Manager and check to see if USB-Blaster is banded out under Other devices. If so, the bundled driver installation failed
3. Right click on the USB-Blaster and choose Properties
4. Click Update Driver, then Browse my computer for driver software
5. Navigate to the Quartus install folder (generally C:\altera\14.1) and browse to {quartus}\drivers\usb-blaster. Click Next
6. If you get a security error, you may have to follow the workaround [here](#) to get around the fact that the driver is signed incorrectly and Windows is preventing you from installing it
7. After successfully installing the driver, you should see a message that "Windows has successfully updated your drivers", and the Altera USB-Blaster is listed as working properly under Universal Serial Bus controllers

Install Devices (only needed if you didn't download and install these with Quartus II install)

1. Launch Quartus II 14.1 Device Installer
2. Set the Download directory to where the Cyclone V QDZ file was downloaded to
3. Install the Cyclone V device support

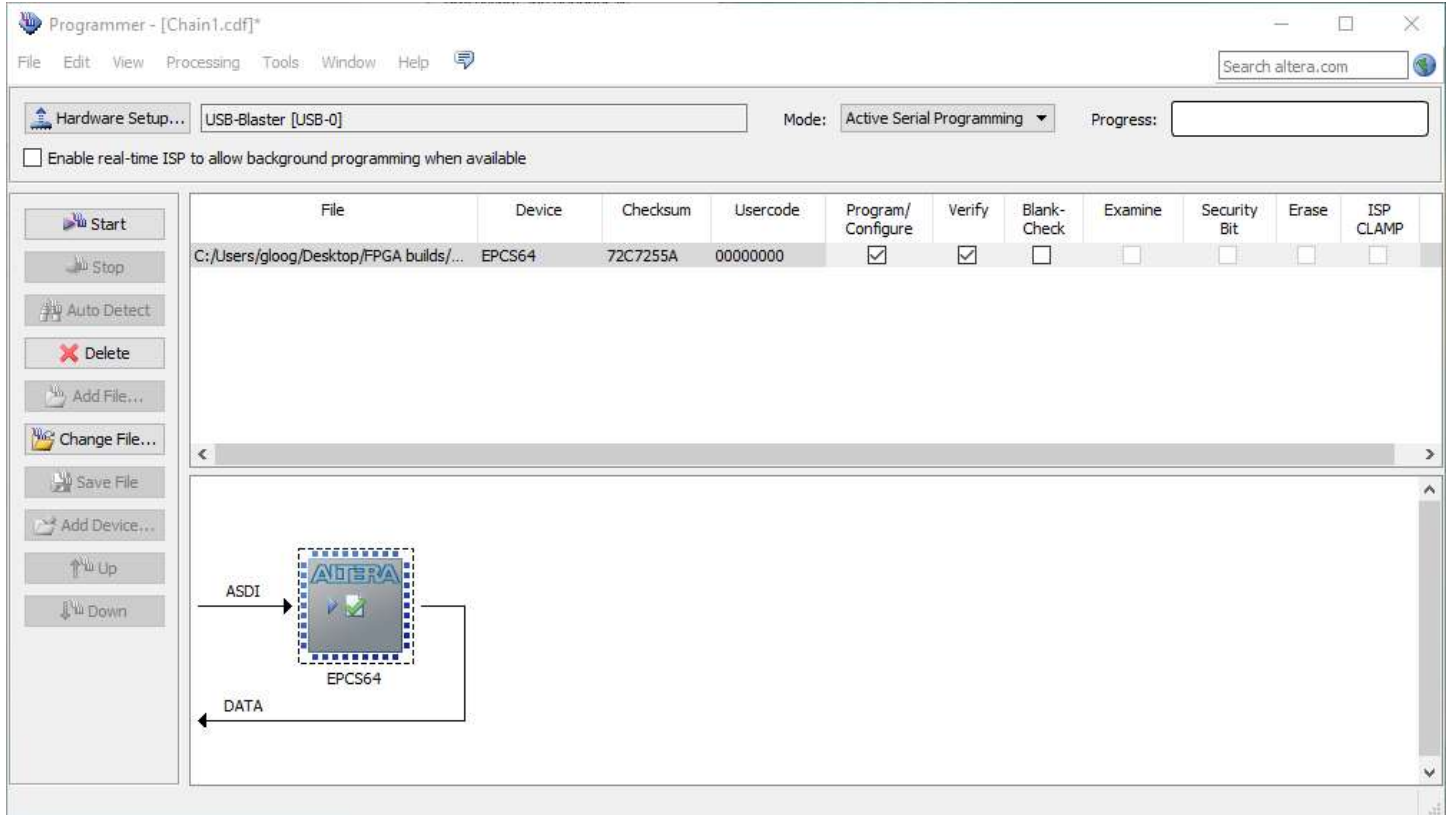
Setup Quartus Programmer

1. Launch Quartus
2. Attach the DE0 board to your PC with the USB cable, set SW10 on the board to PROG, and turn it on
3. Go to Tools > Programmer
4. Set the Mode to Active Serial Programming
5. Click Hardware Setup
6. USB-Blaster should be listed as an available hardware item. If not, ensure the USB Blaster driver is installed correctly
7. Select USB-Blaster in the currently selected hardware dropdown and click Close

Program the FPGA

1. Attach the DE0 board to your PC with the USB cable, set SW10 on the board to PROG, and turn it on
2. In the Quartus Programmer window, click Add File
3. Browse to the location of the POF file, select it and click Open

4. Enable the checkboxes for Program
5. The Programmer window should look like this:



6. Click Start. The Progress bar will be green and the Messages window in the Quartus IDE should say "Programming device 1"
7. When the programmer is finished, the Progress bar will say "100% (Successful)". It's safe to close the Programmer window now
8. Power down the DE0 board and set SW10 on the board to RUN. Important: If you forget to do this, the DE0 board will not work in your arcade cabinet and you run the risk of blowing a fuse
9. You should now be able to reinstall the DE0 board and run the latest FPGA

Troubleshooting

Appendix

ROM List

No.	Base Game	Menu Variant	Description	ROM names
1	Space Wars	SPACE WARS	Cinematronics version	spacewar.u7 spacewar.r7
2	Starhawk	STARHAWK	Original version	starhawk.u7 starhawk.r7
3	Speed Freak	SPEED FREAK	Original version	speedfrk.t7 speedfrk.u7 speedfrk.p7 speedfrk.r7
4	Barrier	BARRIER	Original version	BARRIER.U7 BARRIER.R7
5		BARRIER – HORIZONTAL	Supports horizontal monitor	barrierh.t7 barrierh.p7
6	Sundance	SUNDANCE	Original version	sundance.t7 sundance.u7 sundance.p7 sundance.r7
7	Warrior	WARRIOR	Original version	warrior.t7 warrior.u7 warrior.p7 warrior.r7
8	Tail Gunner	TAIL GUNNER	Original version	TAILGUNR.T7 TAILGUNR.U7 TAILGUNR.P7 TAILGUNR.R7
9	Rip Off	RIP OFF	Original version	ripoff.t7 ripoff.u7 ripoff.p7 ripoff.r7
10	Star Castle	STAR CASTLE	Version 3	starcas3.t7 starcas3.u7 starcas3.p7 starcas3.r7
11		SC – EASY	Version 1	starcas.t7 starcas.u7 starcas.p7 starcas.r7
12		SC – COCKTAIL	Supports screen flipping	starcasc.t7 starcasc.u7 starcasc.p7 starcasc.r7
13		SC – COLOR	Supports color	starcast.t7 starcast.u7

				starcast.p7 starcast.r7
14	Armor Attack	ARMOR ATTACK	Original version	ar414le.t6 ar414ue.u6 ar414lo.p6 ar414uo.r6
15		AA – ROCK-OLA	Rock-Ola license	ARMORR.T7 ARMORR.U7 ARMORR.P7 ARMORR.R7
16	Solar Quest	SOLAR QUEST	Original version	solar.t7 solar.u7 solar.p7 solar.r7
17		SQ – NO MIRROR	Supports non-mirrored cabinet	solar6.t7 solar6.u7 solar6.p7 solar6.r7
18	Boxing Bugs	BOXING BUGS	Original version	BOXNBUGS.U1A BOXNBUGS.U2A BOXNBUGS.U3A BOXNBUGS.U4A BOXNBUGS.U1B BOXNBUGS.U2B BOXNBUGS.U3B BOXNBUGS.U4B
19	War of the Worlds	WAR OF THE WORLDS	Original version, supports color	wotw.t7 wotw.u7 wotw.p7 wotw.r7
20	Demon	DEMON	Original version	demon.7t demon.7u demon.7p demon.7r
21	QB-3	QB-3	Original version	qb3_le_t7.bin qb3_lo_p7.bin qb3_ue_u7.bin qb3_uo_r7.bin
22	Ping	PING		ping.t7 ping.p7
23	Menus	N/A		menu.t7 menu.u7 menu.p7 menu.r7

Filenames are case sensitive

Cinematronics / Vectorbeam Cabinet List

Name	Date	Manufacturer	Display Characteristics			Gameplay Characteristics		Special Notes
			Orient.	CRT	Overlay	Players	Controls	
Space Wars	Oct 1977	Cinematronics	Hori	B&W	None	2 simultaneous	Buttons: Left, Right, Thrust, Fire, Hyperspace, 9-digit keypad	- Requires power / volume adapter
Space War	1977	Vectorbeam	Hori	B&W	None	2 simultaneous	Buttons: Left, Right, Thrust, Fire, Hyperspace, 9-digit keypad	- Clone of Space Wars - Requires power / volume adapter
Star Hawk	Mar 1979	Cinematronics	Hori	B&W	None	1 or 2 simultaneous	Joystick (x2) Buttons: Slow, Med, Fast	- Requires power / volume adapter
Speed Freak	Mar 1979	Vectorbeam	Hori	B&W	None	1	Steering wheel Gearshift (4 pos) Pedal	- Requires power / volume adapter - Requires original sound board for encoder processing and cabinet wiring - Not a candidate for multigame
Barrier	1978	Vectorbeam	Vert	B&W	Yes, single color tone (blue)	1 or 2 alternating	Buttons: Up, Down, Left, Right (x2),	- Requires power / volume adapter
Scramble	Nov 1978	Vectorbeam	Hori	B&W	None			
Sundance	Oct 1979	Cinematronics	Vert	B&W	Yes, single color tone (amber)	1 or 2 simultaneous	Buttons: 9-digit keypad (x2), Nova (x2), 2x3 keypad	- Requires power / volume adapter - Uses 16-level daughterboard - Requires original control panel due to unique control functions - Not a candidate for multigame
Warrior	Oct 1979	Vectorbeam	Hori	B&W	None, but used interior diorama	2 simultaneous	Joystick (x2) Buttons: Sword	- Requires power / volume adapter - Mirrored display - Not a candidate for multigame
Tail Gunner	Nov 1979	Cinematronics	Hori	B&W	Yes, single color tone (cyan)	1	Joystick (analog) Buttons: Fire, Shield	- Requires power / volume adapter - Requires original sound board when using the analog joystick
Rip Off	Apr 1980	Cinematronics	Hori	B&W	None	2 simultaneous	Buttons: Left, Right, Forward, Fire (x2)	
Star Castle	Nov 1980	Cinematronics	Hori	B&W	Yes, color separation	1 or 2 alternating	Buttons: Left, Right, Thrust, Fire	
Armor Attack	June 1981	Cinematronics	Hori	B&W	Yes, playfield	1 or 2 simultaneous	Buttons: Left, Right, Forward, Fire (x2)	
Solar Quest	Nov 1981	Cinematronics	Hori	B&W	Yes, color separation	1 or 2 alternating	Buttons: Left, Right, Thrust, Fire, Hyperspace, Nuke	- Mirrored display - Uses 64-level daughterboard - Not a candidate for multigame
Boxing Bugs	Apr 1982	Cinematronics	Hori	Color	None	1 or 2 alternating	Spinner	- Supports color output

							Buttons: Glove, Cannon, Panic (x2)	- Requires original sound board when not using the FPGA for encoder processing
War of the Worlds	1982	Cinematronics	Hori	B&W	Yes, color separation	1 or 2 alternating	Buttons: Left, Right, Thrust, Fire	- Supports color output
Demon	1982	Rock-Ola	Hori	B&W	Yes, playfield and color separation	1 or 2 simultaneous	Buttons: Left, Right, Forward, Fire, Panic (x2)	- Prototype only
QB-3	1982	Rock-Ola	Hori	Color	None	1 or 2 alternating	Left Stick (move), Right Stick (fire)	- Prototype only

Interface Board Pinout

Component Side	Edge connector		Solder Side
GND	A	1	GND
+5V	B	2	+5V
	C	3	
Coin Counter Left (NC)	D	4	Coin Counter Center (N/C)
Audio 2	E	5	Audio 1
Coin Counter Right (N/C)	F	6	P2 LED (N/C)
	H	7	PLAYER2
PLAYER1	J	8	P1 LED (N/C)
Diagnostic Step (N/C)	K	9	Slam Switch (N/C)
Self Test (N/C)	L	10	Primary Input [14] (Hyperspace)
Z Out	M	11	Z GND
Primary Input [0] (P1 Start)	N	12	Coin Switch Center (N.O.) (COIN)
Primary Input [2] (P2 Start)	P	13	Coin Switch Left (N.O.) (COIN)
Coin Switch Right (N.O.) (COIN)	R	14	Primary Input [10] (Thrust)
Primary Input [8] (Right)	S	15	Primary Input [6] (Left)
Primary Input [12] (Fire)	T	16	
X GND	U	17	X Out
Y GND	V	18	Y Out
	W	19	
36 VAC	X	20	36 VAC
+5V	Y	21	+Sense
GND	Z	22	-Sense

J3 (Control Panel)			
(NC)	1	2	+5V (for Sundance CP)
Secondary Input [0]	3	4	Secondary Input [3]
Secondary Input [2]	5	6	Secondary Input [1]
Secondary Input [6]	7	8	Primary Input [3]
Primary Input [2] (P2 Start)	9	10	Primary Input [1]
Primary Input [0] (P1 Start)	11	12	Primary Input [7]
Primary Input [6] (Left)	13	14	Primary Input [5]
Primary Input [4]	15	16	Primary Input [11]
Primary Input [10] (Thrust)	17	18	Primary Input [9]
Primary Input [8] (Right)	19	20	Primary Input [12] (Fire)
Primary Input [13]	21	22	Primary Input [14] (Hyperspace)
Primary Input [15]	23	24	Coin Switch (N.C.) (N/C)
Coin Switch (N.O.)	25	26	Switch GND

Video pads

Red Video	RED
Green Video	GRN
Blue Video	BLU
X Out	Xout
Y Out	Yout
X and Y GND	XYret
Z Out	Zout
Z GND	Zret

Primary and Secondary inputs shown with default controls using Asteroids/AD control mapping. Actual controls depend on the mapping file used.

'N/C' indicates not connected.