

Color Computer HIRES ADC Joystick Controller

By

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Color Computer HIRES ADC Joystick Controller

INTRODUCTION

This project was conceived in the mid 1980's before there was a High Resolution Joystick available from Radio Shack. It may still be useful not so much as a joystick controller, but maybe as a general purpose analog to digital converter for whatever the user desires to measure and display.

The HIRES ADC Joystick Controller provides for control of a cursor over the entire high resolution graphics screen (PMODE 4). This screen has a resolution of 256 x 192 pixels.

A Color Computer Joystick is an analog device, whose output varies from 0 to 5 volts. Actually, there are 3 outputs:

1. Horizontal Position
2. Vertical Position
3. Fire Button.

The button's output is 5 volts when open, and 0 volts when pressed.

An Analog to Digital converter is required to convert the joystick voltages to a digital value for the computer to read. The Color Computer contains a 6 bit Analog to Digital converter for the joystick ports. With 6 bits, the maximum value is only 64 (2^6), thus the joysticks have a resolution of only 64 pixels. This is much too low for precision control in PMODE 4.

For greater control, an 8 bit Analog to Digital converter is required. Eight bits allow for a maximum value of 256 (2^8), which is exactly the number of horizontal pixels in PMODE 4.

Color Computer HIRES ADC Joystick Controller

DETAILS

The Analog to Digital converter in this project is a National Semiconductor ADC0809. This chip features 8 multiplexed analog inputs which may be read one at a time. The analog inputs are configured as follows:

Input 1	Horizontal Positioning (X axis)
Input 2	Vertical Positioning (Y axis)
Input 3	Fire Button
Inputs 4-8	Not used, but could be used for a second stick or other analog signals.

Figure 1 is the schematic for the HIRES ADC Joystick Controller. The circuit can be built on a small breadboard or wire-wrapped on a perf board.

A plug in interface for breadboarding used to be available from GROUP Technology. Their board plugs into the ROM cartridge port. It has all of the computer's address, data and control lines brought out to breadboarding sockets which are clearly labeled. You can then run jumper wires from the sockets to your own breadboard. Their address used to be:

GROUP TECHNOLOGY, LTD
P.O. BOX 87
Check, VA 24072
703-651-3153

A company called Speech Systems used to carry a expansion board and case for the CoCo also.

I originally breadboarded the project using the Group Technology board. After testing, I wire-wrapped it on a small perf board. I then enclosed the board in an old game cartridge I didn't use anymore.

I cut off the game cartridge's circuit board and left the edge connector in the cartridge's housing. Then I soldered the necessary connections to the fingers of the edge card connector. Finally I mounted a 5-pin female DIN connector for the joystick to plug into on the side of the game cartridge. I wired the connections from the DIN connector to the perf board.

The end result is a cartridge that looks like a normal game cartridge. It can be plugged into the CoCo's expansion connector, my 4-Slot Expansion Interface, or the Tandy MPI.

Color Computer HIRES ADC Joystick Controller

PARTS LIST

The following is a parts list for the converter. Most of the parts can be purchased from electronics mail order houses such as DigiKey.

- 1 - National ADC0809 analog to digital converter
- 1 - 74LS00 Quad 2 Input NAND Gate
- 1 - 74LS02 quad 2 Input NOR Gate
- 2 - 1K 1/4 watt resistors
- 1 - 10K 1/4 watt resistor
- 1 - 680 pf disc cap
- 2 - .05 uf disc caps
- 1 - .1 uf disc cap
- 1 - 5-pin female DIN Connector
- 1 - CoCo game cartridge that you can sacrifice

SOFTWARE

A machine language driver is used to read and return the joystick position. The controller is setup as a memory mapped device, located at address's \$FF40-\$FF47, in the following manner:

<u>ADDRESS</u>	<u>INPUT</u>
\$FF40	Analog input #1 (horizontal)
\$FF41	Analog input #2 (vertical)
\$FF42	Analog input #3 (button)
\$FF43	Analog input #4 (not used)
\$FF44	Analog input #5 (not used)
\$FF45	Analog input #6 (not used)
\$FF46	Analog input #7 (not used)
\$FF47	Analog input #8 (not used)

The machine language driver is called by the BASIC 'USR' call. An argument must be supplied with the call, to tell the driver which input to read. By using the following statements from BASIC, you may read the X, Y, and fire button status:

- X = USR0(0) returns X location of joystick
- Y = USR0(1) returns Y location of joystick
- B = USR0(2) returns fire button status (255 or 0)

Color Computer HIRES ADC Joystick Controller

The following is a listing of the driver in 6809 assembler language:

START	BSR	\$B3ED	TRANSFER USR ARG. TO D REGISTER
	LDX	#\$FF40	GET ADC BASE ADDRESS
STA	B,X		START CONVERTER. B+X = INPUT TO CONVERT
	PSHS	X	SAVE X BEFORE USING IN DELAY LOOP
	LDX	#\$48	DELAY CONSTANT
DELAY	LEAX	-1,X	WAIT FOR CONVERSION
	BNE	DELAY	
	PULS	X	RESTORE X
	LDA	B,X	READ RESULT OF CONVERSION
	TFR	A,B	PLACE RESULT IN LSB OF D REGISTER
	CLRA		CLEAR MSB OF D REGISTER
	JMP	\$B4F4	RETURN D REGISTER TO BASIC
	END		

The driver works as follows:

The value supplied from the BASIC USR call gets transferred to the D register by calling the Integer Convert ROM routine at address \$B3ED. The B register then holds the value we passed. This gets added to the base address of the ADC0809 (\$FF40), to form the true address of the input to read.

By writing to the computed address the ADC0809 starts converting the input requested.

Then we delay for about 200 usec, while the ADC0809 calculates the value of the input. After the delay, we read the same address, thus putting the result in the A register.

Next we transfer the result to the B register (lower half of D), and clear the upper half of the D register.

Finally, we jump to the ROM routine at \$B4F4 to convert the D register to the variable in the USR call (X, Y, or B).

Color Computer HIRES ADC Joystick Controller

TESTING THE CONTROLLER

After double checking the breadboard for errors, connect the project to your COCO with the power off. Next, turn on your computer, then enter and RUN the following BASIC program. This program will list to the screen, the joystick position in X and Y and the status of the fire button. The driver program is relocatable. For users with 16K RAM, change the value of AD in line 60 to 16360 and change line 10 to CLEAR 200,16359.

```
10 CLEAR 200,32743
20 CLS:PRINT @33,"HIRES ADC JOYSTICK CONTROLLER"
30 PRINT @104,"TOM GUNNISON"
40 PRINT @389,"X=";:PRINT@404,"Y=";
50 PRINT @455,"FIRE BUTTON=";
60 AD=32744
70 FOR A=AD TO AD+23
80 READ D
90 POKE A,D
100 NEXT A
110 DEFUSR0=AD
120 X=USR(0):Y=USR(1):B=USR(2)
130 PRINT @391,X;:PRINT @406,Y;:PRINT@467,B
140 GOTO 120
150 DATA 189,179,237,142,255,64
160 DATA 167,133,16,142,0,54,49
170 DATA 63,38,252,166,133,31
180 DATA 137,79,126,180,244
```

Color Computer HIRES ADC Joystick Controller

As can be seen, this controller is fairly simple, but provides much more resolution over the CoCo's joystick ports. It can be used for precision control in a homebrew graphics program.

The controller can also be used for many other measurement tasks. The other inputs can be read, by using the same USR call, but change the argument to suit the input number you want to read. If you plan to use the controller with a disk system, you will need to use my 4-Slot Expansion Interface or a Tandy MultiPak Interface.

Comments or suggestions may be referred to:

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