

Subject: NES and TG16 controller Fun

Updated 9.30.08 – by **Duo-R**

This is an update to the original work by Joe LoCicero.

I originally made a NES to Duo conversion many years back. I had enough controllers, but recently my interest spiked on doing this hack again and updating the guide. It is a very simple mod, and just involves changing the internal circuitry. The original mod that I did converted a NES dog bone controller to Duo. The latest conversion project has been updated to work on the Sansui SSS and convert to Duo cable. The Sansui SSS was a very unique NES controller. First it was developed by Hudson, the same founders of the beloved PC Engine / TurboDuo. Looking at the controller you can see how similar it looks to a TurboDuo controller (making this an ideal controller to convert). Now many might be left wondering why bother doing this conversion.

- 1 - converting controllers is fun
- 2 - you can create something unique for your system
- 3 - in the Sansui example you are actually creating something better than the standard Duo controller

To explain the last point - the Sansui had an interesting feature for the NES, it featured a stereo headset jack that on the controller itself. It had a single RCA audio line that plugged into the NES AV

ports on the deck, and sent that single audio line and split into two lines for your "stereo" headphones. You could play and listen to the game tunes at your own comfort. Now that controller didn't feature true stereo, so now this is where we are making something better. We are going to yank the stereo mono line and replace with stereo. The audio will plug into the jack on the side of the Duo, and run the audio lines into a special cable we are using all the way to the controller ending at a stereo headset jack. So true stereo sound but in the spirit of the original concept.

Parts list for the Sansui SSS conversion project:

- * 74LS157 chip - source from futurlec.com or other online source
- * 74LS163 chip - source from futurlec.com only if you want to add turbo feature
- * 330 Ohm resistors X 4
- * Solder Iron
- * Desolder iron (not necessary but makes the mod easier)
- * 30+ gauge wire
- * mini jack plug - radio shack
- * pref board
- * 8 pin serial cable (monoprice.com.)
- * cable with 10 wires (hack DVI cable will do, try to find a junked one)

Now some information on how the NES controller works (quote from Joe):

"First, a brief summary of how the NES controller works. It has 5 pins -- ground, +5V, Clock, "Reset", and output. The NES supplies the clock and reset signals, while the controller sends the output signal back to the system. Every time the system wants to read the controller's state, it pulses Reset once, and the Clock 8 times. With each clock

pulse, a different button appears on the output line. These appear in this order: B, A, Select, Start, Up, Down, Left, Right.

The TG16 controller is more efficient, but requires more wires. It has 8 pins -- ground, +5V, Select, Reset, and 4 output lines. The TG supplies the select and reset signals, and the controller sends the 4 output lines back to the system. Every time the TG wants to read the controller's state, it pulses Reset once, and the select line once. When select is high, the 4 output lines contain Up, Down, Left, and Right. When select is low, the 4 output lines contain A, B, Select, and Start.

Despite the high degree of similarity between the two systems, it's just simpler to replace the circuitry inside the standard NES controller rather than add extra circuitry on the outside. We can simply replace the CD4021 chip inside the NES controller (a CMOS 8-bit parallel in, serial out shift

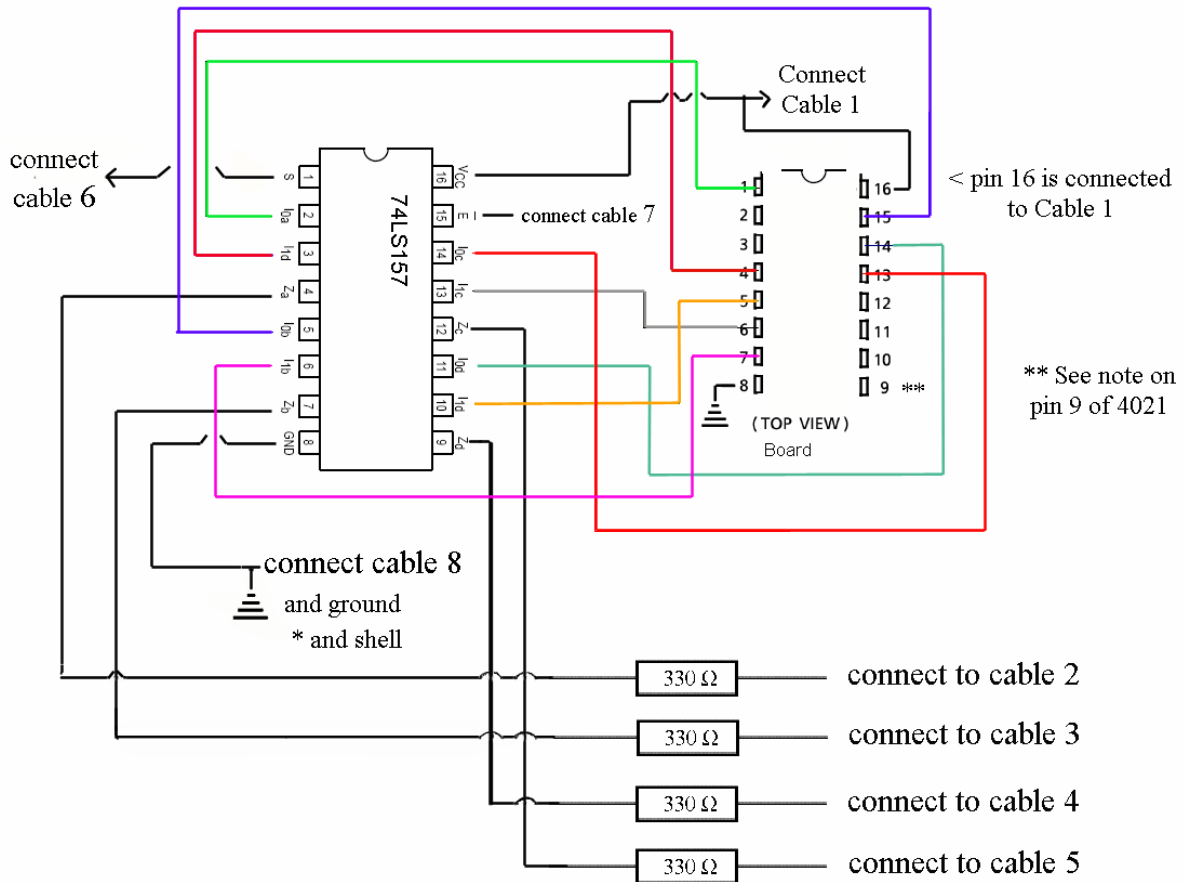
register) with a 74LS157 chip (a TTL quad 2:1 MUX chip). You can either unsolder the CD4021 chip (not too difficult with a soldering iron and a "solder sucker" or desoldering wick, all available at Radio Shack), or cut the chip off of the board with diagonal cutters. This second solution is a little messier, and doesn't leave nice holes for you in which you can solder new wires; I recommend the first. The new 74LS157 chip can't just be substituted -- you have to wire it differently. I've included a table below of the 74LS157 pins, and where they need to be connected:

74LS157 pin #	Function	Connect to	Pin #
1	Select	Cable	6
2	A input	CD4021	1
3	U input	CD4021	4
4	Output 1	Resistor to Cable	2
5	B input	CD4021	15
6	R input	CD4021	7
7	Output 2	Resistor to Cable	3
8	Ground	Cable	8 & Shell
	and	CD4021	8
9	Output 3	Resistor to Cable	4
10	D input	CD4021	5
11	Select inp.	CD4021	14
12	Output 4	Resistor to Cable	5
13	L input	CD4021	6
14	Start inp.	CD4021	13
15	Strobe	Cable	7
	and	CD4021	9 (**)
16	+5V	Cable	1
	and	CD4021	16

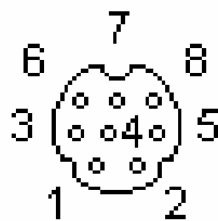
The connection marked (**) is only necessary if your controller has an auto-fire circuit on it. Otherwise, connect nothing to the old CD4021 pin 9. 'Shell' means the outside of the TG16 connector. Be sure to connect this to the shield on the cable -- that's the metal braid that surrounds the other wires. This will keep your system shielded, and in compliance with FCC regulations. ←Note – I am not so sure this one is correct. I am instead going to add the same circuitry found in the original duo controller for Turbo.

[NES to Duo Hack Diagram](#) ← link to Diagram (hold CTRL and click)

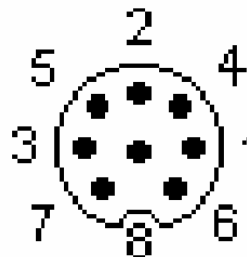
Converting NES controller to TurboDuo / PC Engine



Duo Connector



TG-16 Connector



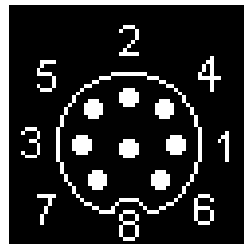
* Shell means the outside of the TG16 or Duo connector. Be sure to connect this to the shield on the cable, that's the metal braid that surrounds the other wires. This will keep your system shielded, and in compliance with FCC regulations

**Pin 9 where the 4021 board (marked **) is only necessary if your controller has an auto-fire circuit on it. Otherwise, connect nothing to the old CD4021 pin 9. If your controller has turbo-fire circuit, connect pin 9 of the 4021 board to cable 7 (it will also be joined with pin 15 on the 74LS157)

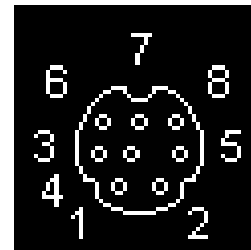
The "Resistor to Cable" means that you should connect that pin to one end of a 330 ohm resistor. You can see in the diagram what lines the resistors are placed in. The other end of the resistor should connect to a wire on the cable which connects to the specified pin.

Of course, to complete your controller, you have to replace the old Nintendo cable with a new 8-wire cable. The following are the pinouts for both the TG-16 and Duo style connector (obtained from Gamesx.com):

TG-16 style connector

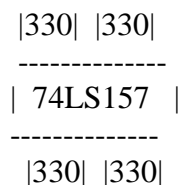


Duo style connector



You can purchase the 74LS157 from futuralec.com (or other online source). For the Duo connector, your source is going to be monoprice.com. TG connector, soldering and desoldering aids I have mentioned. I also recommend purchasing some of their "perfboard" -- brown circuit-board material that has 1/10"-spaced holes in it. You can mount the chip and resistors on this material, and it can be easily cut with diagonal cutters. (The Duo-style connector seems to only be available from mail-order electronics suppliers like Digi-Key and Jameco.) The chip will probably cost you about \$1.50. The perfboard will also be about that price, but should supply you with enough to modify 5 - 15 connectors. The resistors will cost you \$0.69 for 4 or so. While the soldering iron and desoldering aids will cost you about \$15-\$20, they are valuable tools for any individual. If anyone is really interested, I can get exact Radio Shack part numbers for everything I've mentioned.

If you use the perfboard, the easiest way to "lay out" the chip and 4 resistors on the board is like the diagram shown below:



Another way is to just putting the resistor between a wire, this will allow your prefboard to be smaller and less cluttered.

Make sure that you lay the chip and resistors as flat as possible on the perfboard so that it will all fit inside the controller. It'll be a tight fit! Additionally, since we're not using a chip socket, be VERY CAREFUL not to hold the soldering iron to the chip pin for too long. You can destroy the internal circuitry this way. A maximum of 5-7 seconds should always be observed.

If you stopped here, you would have a functional Duo controller, but without turbo feature. Now for some games this wouldn't cut it. But Bomberman or say Devil's Crash, this is going to work just fine. But what about Bonk or some of the shooters you say? Stay tuned because I am going to cover that:

Update coming soon – how to hook up a 74LS163 to make this controller think it is a fully functional Duo controller (with turbo features)....

