VEX Online Challenges - Reverse Engineering Online Challenge

Reverse Engineering of the VRC Competition Switch

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Introduction:

The VRC competition switch is used to control (enable/disable) between driver control and autonomous control. The switch is designed for 4 controllers but the majority of the time this is not used. We are reverse-engineering the competition switch to make the device smaller for convenience and more reliable switches.



Method:

We start by removing the 4 Phillips screws on the competition switch, and carefully removing the PCB from the case.



We then expose the pins for the RJ45 connectors and the switches. We can label the pins with the following notation.



RJ45 Connector: Pin 1-4 Top Left to Right Pin 5-8 Bot Left to Right

Switch Connector: Pin 1-5 Left side Top to Bot Pin 6-10 Right side Top to Bot

Using a multimeter's logic mode, we can test the different pins and determine which ones are connected through the 4 different states on the competition switch. The logic mode produces a beeping noise when the pins of the multimeter have a connection. For instance, when we test pins 1 and 8 of the connector while the auton control switch is flipped to disabled, we get a beep. This signifies that pins 1 and 8 are connected on the PCB.



Reference Pin	Connector Pins	Driver/Auton Switch	En/Disable Switch
Connector Pin 1	3, 4, 7	1, 4, 5, 6, 9, 10	1, 3, 4, 5, 6, 8, 9, 10
Connector Pin 2			
Connector Pin 3	1, 4, 7	1, 4, 5, 6, 9, 10	1, 3, 4, 5, 6, 8, 9, 10
Connector Pin 4	1, 3, 7	1, 4, 5, 6, 9, 10	1, 3, 4, 5, 6, 8, 9, 10
Connector Pin 5			
Connector Pin 6			
Connector Pin 7	1, 3, 4	1, 4, 5, 6, 9, 10	1, 3, 4, 5, 6, 8, 9, 10
Connector Pin 8		2, 3, 7, 8	

Competition Disabled, Driver Control:

Competition Enabled, Driver Control:

Reference Pin	Connector Pins	Driver/Auton Switch	En/Disable Switch
Connector Pin 1	4, 7	1, 4, 5, 6, 9, 10	1, 4, 5, 6, 9, 10
Connector Pin 2			
Connector Pin 3			2, 3, 7, 8
Connector Pin 4	1, 7	1, 4, 5, 6, 9, 10	1, 4, 5, 6, 9, 10
Connector Pin 5			
Connector Pin 6			
Connector Pin 7	1, 4	1, 4, 5, 6, 9, 10	1, 4, 5, 6, 9, 10
Connector Pin 8		2, 3, 7, 8	

Competition Disabled, Auton:

Reference Pin	Connector Pins	Driver/Auton Switch	En/Disable Switch
Connector Pin 1	3, 4, 7, 8	1, 3, 4, 5, 6, 8, 9, 10	1, 3, 4, 5, 6, 8, 9, 10
Connector Pin 2			
Connector Pin 3	1, 4, 7, 8	1, 3, 4, 5, 6, 8, 9, 10	1, 3, 4, 5, 6, 8, 9, 10
Connector Pin 4	1, 3, 7, 8	1, 3, 4, 5, 6, 8, 9, 10	1, 3, 4, 5, 6, 8, 9, 10
Connector Pin 5			
Connector Pin 6			
Connector Pin 7	1, 3, 4, 8	1, 3, 4, 5, 6, 8, 9, 10	1, 3, 4, 5, 6, 8, 9, 10
Connector Pin 8	1, 3, 4, 7	1, 3, 4, 5, 6, 8, 9, 10	1, 3, 4, 5, 6, 8, 9, 10

Competition Enabled, Auton:

Reference Pin	Connector Pins	Driver/Auton Switch	En/Disable Switch
Connector Pin 1	4, 7, 8	1, 3, 4, 5, 6, 8, 9, 10	1, 4, 5, 6, 9, 10
Connector Pin 2			
Connector Pin 3			2, 3, 7, 8
Connector Pin 4	1, 7, 8	1, 3, 4, 5, 6, 8, 9, 10	1, 4, 5, 6, 9, 10
Connector Pin 5			
Connector Pin 6			
Connector Pin 7	1, 4, 8	1, 3, 4, 5, 6, 8, 9, 10	1, 4, 5, 6, 9, 10
Connector Pin 8	1, 4, 7	1, 3, 4, 5, 6, 8, 9, 10	1, 4, 5, 6, 9, 10

Now that we know the different connections, we can now determine what the switches do to the different states. We can simplify this process by drawing out the various connections.



Where Conn is the RJ45 Connecter, and Auton/Drive/Disable/Enable are labelled.

Enable/Disable Switch:

From the drawings and tables, we are able to see that the switch controls pins 2,3,7 and 8 on the switch, and they control whether or not they are connected to nothing, pin 3, or the other pins.

When we look at the different types of switches, we can see that this behaviour of changing pins 2/7 and 3/8 to different connectors most closely resembles a "double pole single throw" switch (DPST for short). This switch behaves with 2 inputs and 2 outputs (where pins 2/7 are one input, and pins 3/8 are the other). When the switch is in "disabled" pins 2/7 are connected to nothing while pins 3/8 are connected to the remaining other pins. When the switch is "enabled" the pins are all connected to pin 3 of the connector.



Auton/Driver Switch:

We can see that the driver/auton switch follows the same principle as the enable/disable switch. With a DPDT switch for the same pins.



Lessons Learned:

With this knowledge, we now know how the competition switch operates and can apply this knowledge to create our own custom PCB competition switch. Applying electrical engineering and debugging skills, this reverse-engineering provided us with strong fundamentals on how electronic circuits work, and how to analyze them.

Enuble/disuble	contrils pins
2,3,	7, 8 Connector pin 3
<u>Stete</u> Disuble	Output 2,7 Not connected 3,8 connected to all other pins
Enable	2,3,7,8 connected to pin 3 connector
Pn <u>2</u>	Oungle, Pril 3 Cristile Cristile Cristile
P.n. 7	Pin 8 Pin 2 Pur Com pin 3 Com pin 3
	PPST Switch
	P _{ins} 2,7 P _{ins} 3,8
	dan / in dy in pers Per pers
Oriver/ auton 2, 3, 5	Controls pins 7,8 Connector pin 8
<u>stute</u> Auton	Output 2,7 Not conneited 3,8 conneited to all other p;ns
Diver	2, 3, 7, 8 connected to pin 8 connector
Pin <u>2</u>	Com pix 8
Pin <u>7</u>	Pin 8 Pin 8 Pin 8
	DPST Switch
	Pm 2,7 Pm 3,8