

Q&A

VRC 2020-2021: Change Up

Tagged: R22



Welcome to the official VEX Robotics Competition Question & Answer system, where all registered teams have the opportunity to ask for official rules interpretations and clarifications. This Q&A system is the only source for official VRC Change Up rules clarifications, and the clarifications made here from the Game Design Committee (GDC) are considered as official and binding as the written [Game Manual](#) itself.

Please review the [Q&A Usage Guidelines](#) before posting. This system is only intended for specific VRC Change Up rules questions.

- For event, registration, or other competition support questions, please contact your [REC Foundation Regional Support Manager](#).
 - For VEX technical support, contact support@vex.com or sales@vex.com.
- For game questions, suggestions, or concerns outside of specific and official rules questions, contact GDC@vex.com.

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820: Hot Swap Motors

20-Jul-2021

R22

Can a motor be rigged to be hot swapped?

This is done by taking out the cover screws from the motor cover. The cover is mounted to the robot in the traditional way with mounting screws. The motor case is then fastened to the cover with either zip ties or rubber bands. This allows a participant to quickly be able to replace a malfunctioning motor during competition.

Answered by Game Design Committee

Please review the [Q&A Usage Guidelines](#) before posting, specifically point 3, "Quote the applicable rule from the latest version of the manual in your question".

Rule R22 reads as follows, with a portion bolded for emphasis:

<R21> No modifications to electronic components are allowed. Motors (including the internal PTC or Smart Motor firmware), microcontrollers (including V5 Robot Brain firmware), extension cords, sensors, controllers, battery packs, reservoirs, solenoids, pneumatic cylinders, and any other electrical component or pneumatics component of the VEX platform may NOT be altered from their original state in ANY way.

[...]

c. Teams may make the following modifications to the V5 Smart Motor's user-serviceable features. No other modifications are permitted.

i. Changing or replacing the gear cartridge with other official replacement cartridges.

ii. Replacing the V5 Smart Motor Cap (276-6780).

iii. Replacing the threaded mounting inserts (276-6781).

Provided that no modifications are made other than replacing the V5 Smart Motor Cap, this would be legal.

708: <VUR6> Clarification

7-Dec-2020

R6 R7 R8 R10 R12 R20 R22 VUR2 VUR3 VUR5 VUR6 VUR8

In this previous ruling, it was determined that <VUR5> takes priority over <VUR6>:

<https://events.vex.com/VEXU/2020-2021/QA/674>

However, this is contradictory to every other instance of past rulings regarding <VUR6> and the wording of <VUR6> in the game manual.

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For example, consider a typical custom sensor such as the pixy camera:

<https://www.robotshop.com/en/charmed-labs-pixy-2-cmucam5-image-sensor.html>

This sensor violates <R6>, <R7>, <R8>, <R10>, <R12>, <R20>, <R22>, as well as <VUR3> and <VUR8>.

VUR3 restricts the materials allowed, but this sensor violates the allowed materials.

VUR8 restricts the screw sizes allowed, but this sensor may have smaller screws than the allowed limit.

As another example, consider a vex IQ sensor: <https://www.vexrobotics.com/228-3014.html>

This sensor would violate <R6>, <R7>, <R8>, <R10>, <R12>, <R20>, <R22>, as well as <VUR3> and <VUR2b>.

<VUR2b> restricts teams from using any vex IQ electronics, which would include this sensor.

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Because <VUR6> specifically states "There is no restriction on sensors and other additional electronics that Robots may use for sensing and processing" it has been understood by most VexU teams that <VUR6> takes priority over all the other rules in the game manual. Logically this would also mean <VUR6> would take priority over <VUR5>.

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Several other Q/As over the years have verified this as correct as the wording on <VUR6> has not significantly changed since these rulings:

<https://www.vexforum.com/t/answered-vexu-speakers-as-part-of-custom-sensor/42312>

<https://www.vexforum.com/t/answered-vex-u-old-college-q-a-updates/23810>

<https://www.vexforum.com/t/answered-custom-sensor-housing/19582/2>

These three Q/As verify that <VUR6> would take priority over <VUR3> and <VUR8> as well as all the regular game manual rules mentioned above.

Furthermore, the following Q/A shows that <VUR6> would also take priority over <VUR5>:

<https://www.vexforum.com/t/answered-vex-u-non-vex-servo-motors-for-a-custom-sensor/35538>

This allowed external non vex motors used solely for manipulating custom sensors.

If this were the case, it would agree with the wording of <VUR6>. There are numerous sensors and processing boards that rely on motors to operate.

For example, many full field lidar systems such as:

<https://www.robotshop.com/en/rplidar-a1m8-360-degree-laser-scanner-development-kit.html>

rely on an integrated motor to spin the lidar enabling it to map the field. VexU teams have legally used similar lidar systems in the past and may plan to do so again this season.

Another example would be the Nvidia Jetson Xavier NX listed below:

<https://www.nvidia.com/en-us/autonomous-machines/embedded-systems/jetson-xavier-nx/>

This processing board has a built-in fan on its heatsink that is critical to its function as a processing unit.

A third example is the pixy tilt and pan kit: <https://pixycam.com/pixy2-pan-tilt-kit/> (ruled legal in the above Q/A linked).

Without these integrated motors, none of these sensors or processing units could function as intended.

?

Therefore, which rules, if any, restrict the "no restriction" clause of <VUR6>?

Furthermore, if <VUR5> does not apply to <VUR6>, then was the previous ruling in QA#674 an error?

If <VUR5> is applicable, are 360-degree Lidar sensors and the Nvidia Jetson processing boards also illegal? If all VexU appendix rules also apply to <VUR6>, then does that mean that there are no legal VexU custom sensors?

Answered by Game Design Committee

If all VexU appendix rules also apply to <VUR6>, then does that mean that there are no legal VexU custom sensors?

Please see rule G3:

<G3> Use common sense. When reading and applying the various rules in this document, please remember that common sense always applies in the VEX Robotics Competition.

The intent of the answer in the linked Q&A was to prohibit using VUR6 as a loophole to install cooling fans on a Robot.

Sensors containing an internal motor which is integral to their operation, such as a LIDAR or pan-tilt Pixy, would be permissible. It would not be feasible for an inspector to take apart a LIDAR module to see if there is a motor inside of it. It is, however, feasible for an inspector to check if a fan is being used to cool a V5 Smart Motor.

To prevent confusion, we would advise Teams with external processors that require thermal protection to utilize a [passive heat sink](#) instead of an active cooling fan.

706: Optical Shaft Encoder Designation

6-Dec-2020

R22 R23

What is the legality of cutting a support hole off on a shaft encoder? Would this fall under R22 or R23? <R22> No modifications to electronic components are allowed. Motors (including the internal PTC or Smart Motor firmware), microcontrollers (including V5 Robot Brain firmware), extension cords, sensors, controllers, battery packs, reservoirs, solenoids, pneumatic cylinders, and any other electrical component or pneumatics component of the VEX platform may NOT be altered from their original state in ANY way.

<R23> Most modifications and repairs to non-electrical components are allowed. Physical modifications such as bending or cutting are permitted and may be done to legal VEX Robotics Competition metal structure or plastic components.

Answered by Game Design Committee

No, this would not be legal. A sensor is an electrical component, and cutting a hole in an electrical component would be a definitive violation of R22.

705: Legality of "Quick swap" Motors

2-Dec-2020

R22

Yesterday, <R22>-d was updated to

Teams may make the following modifications to the V5 Smart Motor. No other modifications are permitted. i. Changing or replacing the gear cartridge with other official replacement cartridges. ii. Replacing the V5 Smart Motor Cap (276-6780). iii. Replacing the threaded mounting inserts (276-6781).

There is a common technique used by many VRC teams, known as quick swap, where the screws holding the cap onto the motor are removed and instead zip-ties are used to hold the motor together. While this doesn't affect matches, it greatly reduces the time required to troubleshoot a misbehaving motor, allowing students to spend more time on the engineering process. While this has [previously been considered legal, Quesiton 673](#) and the new changes to <R22>-d seem to prohibit any modifications to the motor other than replacing a cap, swapping the gear cartridge, or replacing the threaded inserts. Is quick swapping still permitted, and is it considered to be a modification?

Answered by Game Design Committee

The Q&A post that you linked states the following, with portions bolded for emphasis:

The intent of rule R22 is to state that "any modifications to motors are not permitted". The intent of points "c" and "d" exist to point out that certain parts of VEX motors were designed to be user-serviceable, and servicing those parts is legal.

The Q&A's linked above clarified that V5 Smart Motor Cap, **as a part that is intended to be user-serviceable**, is also included in this group.

Not installing the mounting screws that hold the V5 Smart Motor Cap in place would not be considered a "modification". It is more along the lines of "not fully replacing a user-serviceable part". Although partial reassembly is rarely advisable, this is not prohibited by the linked response or by R22d.

673: What parts of the motor and motor cartridge can VRC teams modify?

21-Oct-2020

R22

Attached is a labeled picture of all the components of a VEX V5 Smart Motor and its Gear Cartridge:



For *each* individual labeled part, is it legal for VRC Teams to do one or multiple of the following:

- Modify the part using legal modification techniques.
- Replace the part with a legally manufactured part.
- Remove the part.
- Use the part for other purposes outside of the motor (e.g. using the J type screws elsewhere in the robot construction).

I understand that the legality of modifying/replacing/removing/using elsewhere of some of these parts has previously been ruled upon in the following Q&As: <https://events.vex.com/VRC/2020-2021/QA/610>

<https://events.vex.com/VRC/2020-2021/QA/490>

<https://events.vex.com/VRC/2020-2021/QA/101>

However, my goal with this Q&A is to remove any ambiguity as to the legality of modifications made to V5 Smart Motors or the Motor Cartridge.

Answered by Game Design Committee

Please recall rule <G3> when looking for edge-case robot rule interpretations:

<G3> Use common sense. When reading and applying the various rules in this document, please remember that common sense always applies in the VEX Robotics Competition.

Rule <R22> states the following:

<R22> No modifications to electronic components are allowed. Motors (including the internal PTC or Smart Motor firmware), microcontrollers (including V5 Robot Brain firmware), extension cords, sensors, controllers, battery packs, reservoirs, solenoids, pneumatic cylinders, and any other electrical component or pneumatics component of the VEX platform may NOT be altered from their original state in ANY way.

[... clipped for brevity ...]

c. Teams may change or replace the gears in the “2-Wire 393” or “2-Wire 269” motors with the corresponding official VEX Replacement Gears.

d. Teams may change or replace the gear cartridge in the V5 Smart Motor with other official replacement gear cartridges.

The intent of rule R22 is to state that "any modifications to motors are not permitted". The intent of points "c" and "d" exist to point out that certain parts of VEX motors were designed to be user-serviceable, and servicing those parts is legal.

The Q&A's linked above clarified that V5 Smart Motor Cap, as a part that is intended to be user-serviceable, is also included in this group. Although this is the first question that has mentioned it, the threaded mounting inserts were also intended to be user-serviceable. These points will be added to R22 in a future game manual update.

Any further disassembly, modification, replacement, removal, or re-purposing of the V5 Smart Motor is neither an intended design of the motor, nor an intended design challenge in the VEX Robotics Competition, and would not be legal.

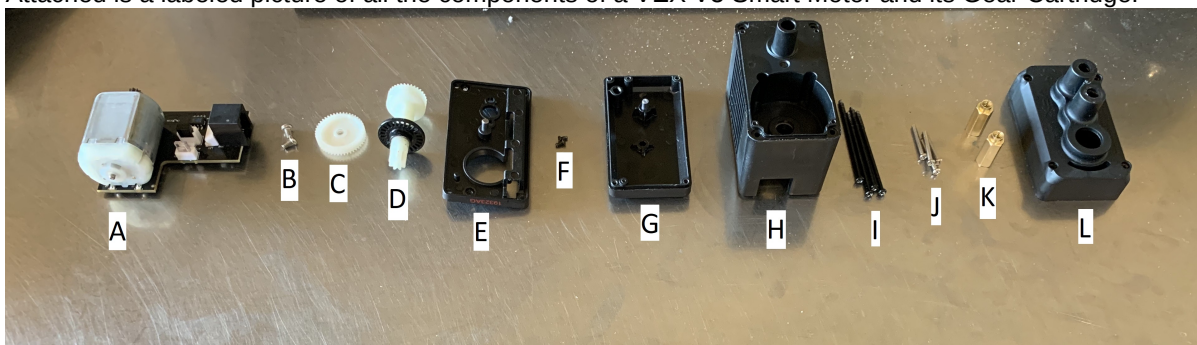
This post, alongside the upcoming game manual update, should be used as the definitive overarching response to any further V5 motor modification questions. Any further Q&A's on this subject will be answered by referring back to this response and/or quoting the game manual.

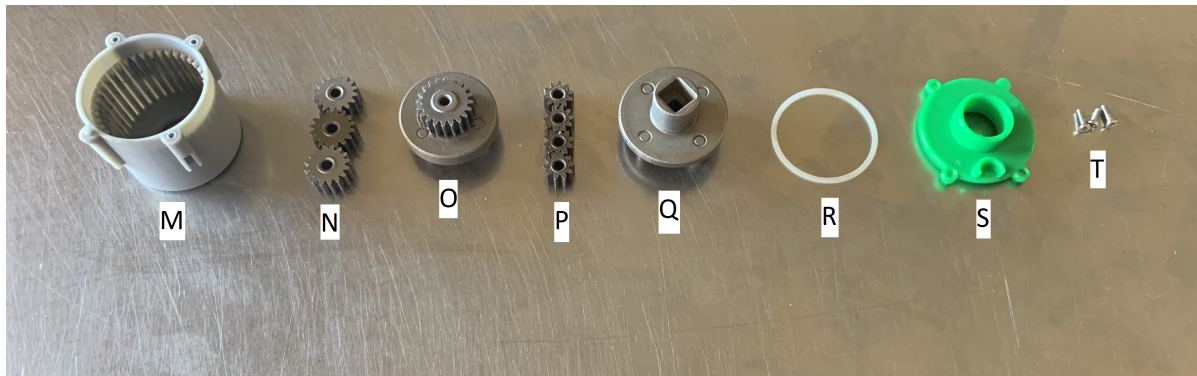
672: What parts of the motor and motor cartridge can VEXU teams modify?

21-Oct-2020

R22

Attached is a labeled picture of all the components of a VEX V5 Smart Motor and its Gear Cartridge:





For *each* individual labeled part, is it legal for VEXU Teams to do one or multiple of the following:

- Modify the part using legal modification techniques.
- Replace the part with a legally manufactured part.
- Remove the part.
- Use the part for other purposes outside of the motor (e.g. using the J type screws elsewhere in the robot construction).

I understand that the legality of modifying/replacing/removing/using elsewhere of some of these parts has previously been ruled upon in the following Q&As: <https://events.vex.com/VEXU/2020-2021/QA/611>

<https://events.vex.com/VEXU/2020-2021/QA/612>

<https://events.vex.com/VEXU/2020-2021/QA/650>

<https://events.vex.com/VEXU/2020-2021/QA/652>

However, my goal with this Q&A is to remove any ambiguity as to the legality of modifications made to V5 Smart Motors or the Motor Cartridge.

Answered by Game Design Committee

Please see the response in this similar Q&A post:

<https://events.vex.com/VRC/2020-2021/QA/673>

The same response provided there applies to this question as well. The only difference is that in VEX U, any part which is "user-serviceable" may be replaced, modified, or custom-fabricated within the rules set forth by VUR3.

As noted in one of the Q&A posts that you have linked:

The primary motor case, internal components, etc are still considered "electronics" under R23, and may not be modified.

610: The Extent of Motor Modification

15-May-2020

R22

What is considered modifying a motor? It has been previously ruled that removing the motor screws does not count, but does removing other parts count?

Similarly to a motor screw, the motor cap is a non-electronic part sold separately on the VEX website, so do you consider removing it from the motor a modification?

Furthermore, can they be modified? Can you cut a motor screw to be shorter or or add another hole in the motor cap for a screw?

Answered by Game Design Committee

Please see this similar Q&A post in the VEX U Q&A, which we believe answers your question. If it does not, please feel free to rephrase and re-submit.

<https://events.vex.com/VEXU/2020-2021/QA/611>

2858: 3d printed license plate holders

17-Oct-2025

R22

<R22> Rule R22 L states that no 3d printed parts can be used, even for license plates. Last year one of my teams used 3d printed license plates as well as 3d printed license plate holders since it was allowed. I just want to clarify if we are no longer allowed to do that. <R22>

Answered by Game Design Committee

Thanks for your question, Team 14521A.

<R19> and its clause L clearly address this: "The following types of mechanisms and components are NOT allowed:" ... "3D printed Robot parts for any purpose".

276: Rules moved from <R16> to <R22>

14-May-2019

R22

For the past few years, <R16> covered the rules on allowed modifications. This year, many but not all of those rules moved to <R22>. One rule that did not move was last year's <R16>g regarding the allowed use of Loctite or other threads locking solutions. Since this rule did not move to any other part of the document, does that mean that Loctite is no longer allowed? Or is this a possible oversight which will be added in a future revision?

Answered by Game Design Committee

Thank you for pointing this out. This was an error, and will be fixed in the June 14th Game Manual update. The use of Loctite for securing hardware, such as screws and nuts, is permitted.

1670: Legacy Pneumatic Parts

28-Sep-2023

R22

<R22>

Our teams will use the legacy pneumatic parts. One of the SMC parts has been replaced with a newer version. The part is on/off switch (hand/finger valve) is part number VHK3-04F-04F. The newer version works the same way except that it goes directly into the reservoir. Here's the link to SMC, <https://www.smc-pneumatics.com/VHK3A-04F-04F.html>. May we use the newer version with identical part number, VHK3-04F-04F?

Answered by Game Design Committee

Per the [Legal Pneumatics article](#) in the VEX Library, which is linked in rule [<R7>](#), VHK3A-04F-04F is a legal part for use.

The photo shown on the linked page is not VHK3A-04F-04F, as noted by the caption, "*Series image - for reference only*".

This goes a bit beyond the scope of VEX rules, but if you're curious... by clicking "Series Catalog" to the right of that page, you will be directed to [this PDF](#), which outlines SMC's part numbering scheme. The part in the photo appears to be something like VHK3A-**01S**-04F or VHK3A-**02S**-04F, which are not listed on the Legal Pneumatics list, and would therefore not be legal.

1003: R22 Threadlocker

10-Jan-2022

R22

Hi, In past seasons R22 had a subsection g which stated

Mechanical fasteners may be secured using Loctite or a similar thread-locking product. This may ONLY be used for securing hardware, such as screws and nuts.

However, this subsection is not present in the latest version of the Tipping Point Game Manual. This rule, or an equivalent, has been present in the game manual for a long time, so it seems odd to me that it would suddenly be removed. In Tower Takeover, a similar error was made, and was corrected: <https://events.vex.com/VRC/2019-2020/QA/276>

Is it legal to use Threadlocker such as Loctite for the sole purpose of securing hardware, such as screws and nuts?

Thank you.

Answered by Game Design Committee

Thank you for bringing this to our attention. This was an error, and will be fixed in a future Game Manual update. The use of Loctite for securing hardware, such as screws and nuts, is permitted.