QCar 2

User Manual – Customizing QCar 2

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Caution

This equipment is designed to be used for educational and research purposes and is not intended for use by the public. The user is responsible for ensuring that the equipment will be used by technically qualified personnel only. **NOTE:** While the GPIO, ethernet and USB ports provides connections for external user devices, users are responsible for certifying any modifications or additions they make to the default configuration.

Caution

The Intel RealSense D435 RGB-D camera is classified as a Class 1 Laser Product under the IEC 60825-1, Edition 3 (2014) internationally and EN 60825-1:2014+A11:2021 in Europe. The camera complies with FDA performance standards for laser products except for conformance with IEC 60825-1 Ed. 3 as described in Laser Notice No. 56, dated May 8, 2019. The RPLIDAR A2M12 reaches Class I laser safety standard and complies with 21 CFR 1040.10 and 1040.11 except for deviations pursuant to Laser Notice No. 50, dated June 24, 2007.

Do not power on the product if any external damage is observed. Do not open or modify any portion of any laser product as it may cause the emissions to exceed Class 1. Invisible laser radiation when opened. Do not look directly at the transmitting laser through optical instruments such as a magnifying glass or microscope. Do not update laser product firmware unless instructed by Quanser.

Table of Contents

A. Overview

The QCar 2 has been designed as a research tool, aiming for maximum flexibility and customization. The following sections provide guidance on modifying QCar 2. For additional information or recommendations, users may contact tech@quanser.com.

B. Mechanical

Chassis

The QCar 2 chassis is built on a Traxxas (www.traxxas.com) platform. Their products are highly customizable, and you can find a variety of parts to modify the steering, suspension, tires, and other elements.

Bumpers

The foam bumpers were custom designed and extensively tested to minimize damage to the mechanical and electrical systems in the event of a collision running at the maximum rated speed (3m/s). If you make significant changes to the mass of the vehicle, it may be necessary to enhance the bumpers to provide the same level of protection.

The rear bumper can be removed by these two screws:

The front bumper can not be removed unless a big part of the QCar 2 is disassembled, please contact tech support (tech@quanser.com) if you need assistance with this.

Suspension

The QCar 2 suspension has been tuned for the default payload. Significant changes to the mass may require that you retune the suspension. If there is a large additional mass added, you should try changing the **spring pre-load spacer** (available from Traxxas or you can 3D print one):
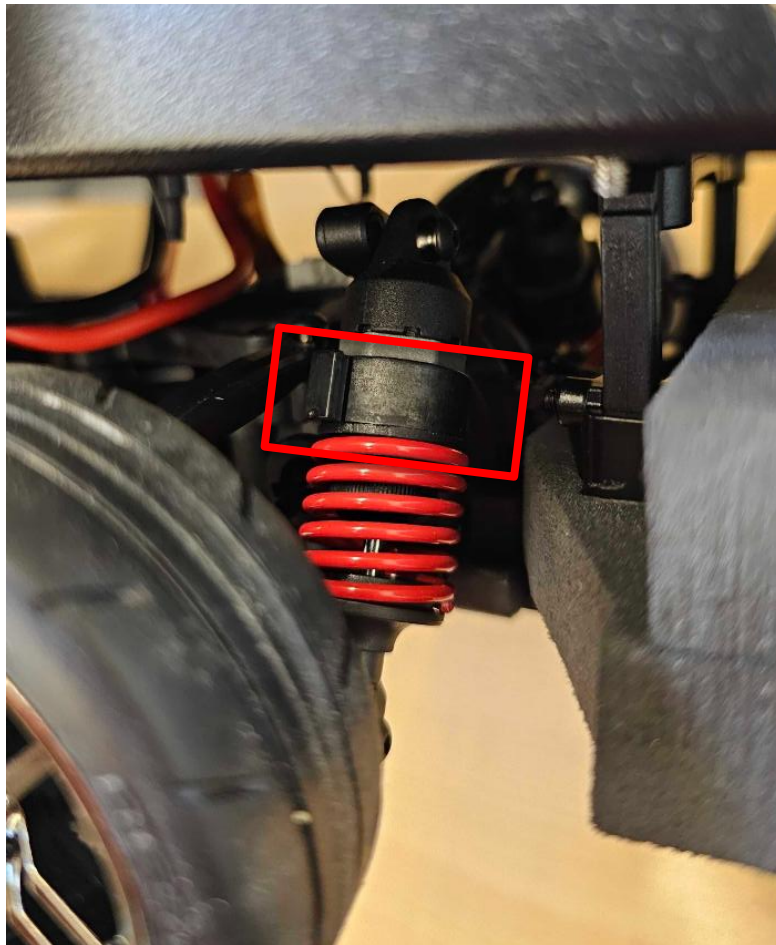
If the spacer does not provide enough additional force, the springs can be replaced. If that still does not provide enough force, the entire shock mechanism can be replaced with alternatives from Traxxas.

Mechanical Breadboard

The top mechanical plate is designed to be easily drilled or cut to accommodate your own custom attachments or sensors. This can be made of virtually any material, but we recommend a plastic such as acrylic or polycarbonate, or a 3D printed plate to avoid the risk of any metal shards landing on the PCB or other electronics and causing damage.
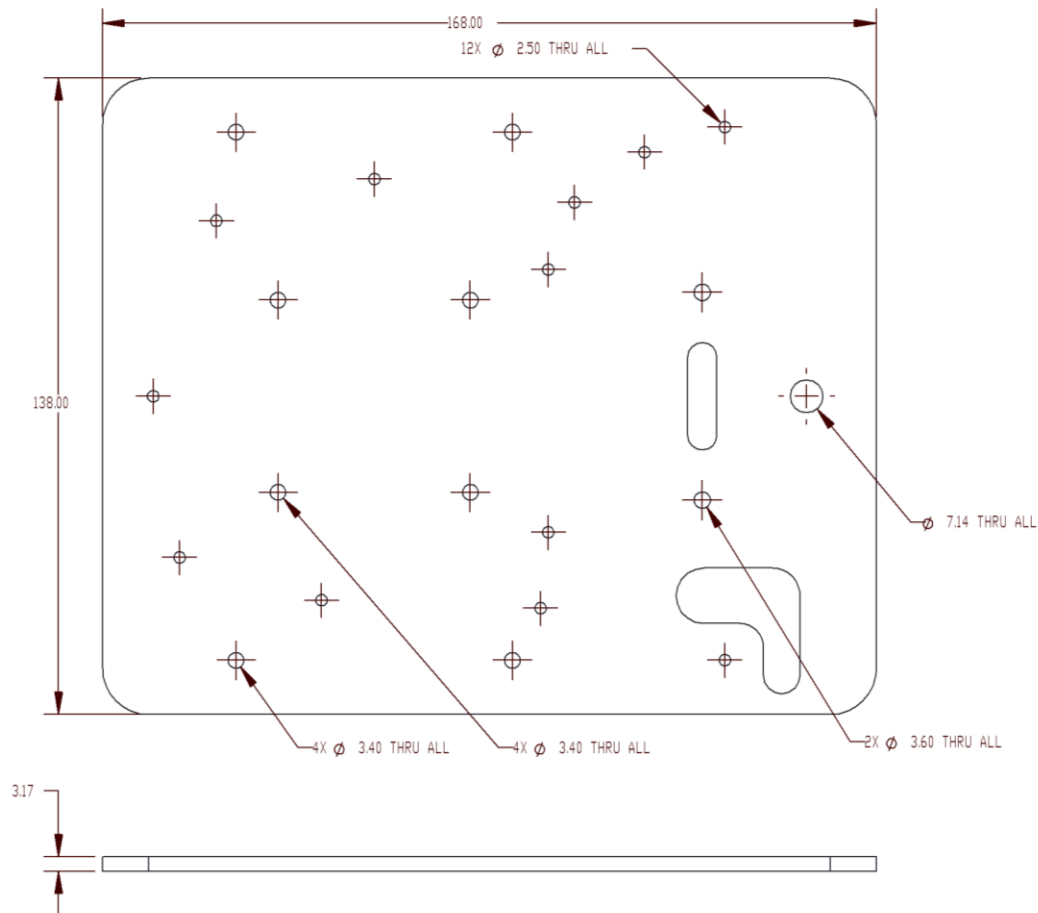
A DXF outline file (QCar 2 Mechanical Breadboard.dxf) is included in the **Supporting Documentation** folder for direct use with CNC or laser cutters, or it can be imported into a CAD program to modify.

Also, to avoid metal shards, we do not recommend drilling or cutting the metal frame. The use of an adhesive or clamping mechanism is preferred.

C. Electrical

The QCar 2 has extensive options for adding custom sensors and actuators for your research. Please see the pinouts in the User Manual - System Hardware. While some of the signals are 5V tolerant, most of the IO is 3.3V or 1.8V. Although 5V, 3.3V, and 1.8V are provided to power devices, it is the user's responsibility to use the appropriate level translator or divider circuits to adjust the input voltage to the appropriate level. Voltages more than the indicated signal voltages **will cause permanent damage** to the PCB. Likewise, the signal outputs are not strong enough to power most devices directly. If you wish to power motors, LED's or other devices using an IO pin, an amplifier or power switch must be used in between. Please also review the **Electrical Considerations** in the User Manual - System Hardware for limits on current consumption.

To access the GPIO or communication interfaces:

Programming Environment	APIs Available
MATLAB/SIMULINK	Simulink HIL/Stream blocks
Python	Python HIL/Stream Classes
C++	C++ HIL/Stream .h files

Table 1. QCar 2 IO access depending on software environment.

D. Software

IMPORTANT: Preinstalled Software

The QCar 2 documentation online includes a table of software that has been installed on the system, found in https://docs.quanser.com/quarc/documentation/qcar2.html#software. Refer to that table, as certain software should **not** be updated Do not update any software marked in red in the table found at that link. The software that should not be updated is also noted below.

Python Packages:
- future
- h5py
- Keras-Preprocessing
- Mock
- Numpy
- Setuptools
- Six
- Tensorflow
- Torch
- torchvision

Debian Packages:
- librealsense2
- nvidia-jetpack

Linux Packages

The QCar 2 comes pre-installed with dozens of software packages and API's, many of which have been specifically optimized for the AGX Orin processor with the JetPack SDK (for a detailed list of JetPack features see https://developer.nvidia.com/embedded/jetpack for more information). These are in addition to the standard Ubuntu 20.04 LTS packages. Key additions include:

- Quanser's libraries
- CUDA (CUDA Toolkit)
- CUDA-X AI (cuDNN and TensorRT)
- OpenCV
- VisionWorks
- VPI
- NVIDIA Container Runtime (for Docker)
- Multimedia API's including gstreamer
- Deep Stream
- librealsense2 (including kernel patches to support the Intel RealSense family)

- Prerequisites for MATLAB GPU Coder (libsdl1.2-dev and v4l-utils)
- libfreenect
- ROS2 (dashing)
- ROS1 (melodic)
- ros1_bridge
- vision_opencv
- hector_slam

If you need a more recent version of a package **excluded from the no-update list** as defined in the previous section, the first thing to check is the **Software Updater**. Right click on the Software Updater and select Software Updater to view the list of updates available.
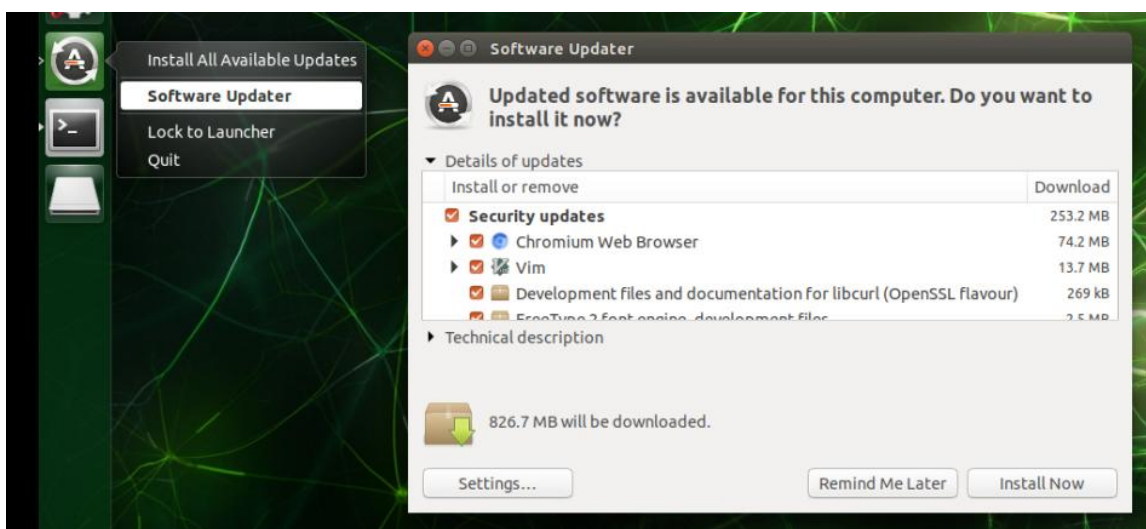
If you are following examples that require a specific version of JetPack that does not match components that are installed, please contact tech@quanser.com to help support you in the update if needed. The operating system and some kernel drivers have been customized and optimized specifically for the QCar 2 hardware. **Any software operation requiring the use of the recovery button should never be used except when directed by Quanser.** Directly re-flashing the QCar 2 with a new JetPack SDK will result in the QCar 2 being non-operational.

To view the complete list of packages installed, open a terminal window and type the following command:

```
apt list --installed | more
```

This will indicate which packages, and which version of each package is installed.

QUARC

The QUARC Target on the QCar 2 manages all the remote execution of compiled code from Simulink or other advanced toolchains from a remote PC. It also contains the most up-to-date drivers for QCar 2-specific hardware and APIs for C code. The QCar 2 ships with the most recently released version of QUARC at the time of manufacturing. In most cases, you can run a newer version of QUARC on your development PC than the target (the QCar 2). If an update is required, this will be advised in the QUARC and QCar 2 Content change logs.

If a new version of QUARC is available, connect your car to the internet (not the default router we ship since it usually is not connected to internet), and you should be able to see any available update it in the software updater as shown in the above picture. Select QUARC or Quanser's available updates and click **Install Now**.

Python

All the Python packages used in the examples come preinstalled on the QCar 2. These include:

- Python3 packages for TensorFlow (optimized for the QCar 2),
- Cffi
- Torch
- torchvision
- numpy
- cython

- opencv
- matplotlib
- pygame
- scikit-learn
- pyquaternion
- pytransform3d
- ultralytics

To view the complete list of Python packages, open a terminal window and type the following command:

```
python3 -m pip list
```

Refer to the preinstalled software section to see what packages available and which ones are should not be upgraded.

To update or install packages, make sure the QCar 2 is connected to the internet.

To update any other package, use:

```
python3 -m pip install <package_name> --upgrade
```

To install new packages, use:

```
python3 -m pip install <package_name>
```

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