



Frequently Asked Questions

SOFTWARE:

What end user software or utilities comes with the ByWire XGV™?

- ✓ The ByWire XGV comes with Demo Operator Control Unit (OCU) software that will allow users to control the vehicle for testing and calibration. Additionally, the ByWire XGV includes a web-based configuration utility that can be used to configure the ByWire XGV parameters, such as communication settings, control modes, and safety behavior. Finally, certain runtime parameters can be controlled through an integrated vehicle interface.

What interfaces does the software provide to communicate with the ByWire XGV?

- ✓ The ByWire XGV communicates using version 3.3 of the Joint Architecture for Unmanned Systems (JAUS) protocol over Ethernet. As such, the system is able to be controlled using the OCU packaged with the XGV, the TORC AutoNav™, or any other JAUS interoperable computing package or OCU. Several commercial and open-source implementations of the core JAUS specification exist for JAVA, C++, and .NET programming languages. The ByWire XGV uses several custom JAUS messages which are described in the XGV user's manual. The ByWire XGV is also backwards compatible with JAUS Version 3.2

What protocol does the ByWire XGV use internally to communicate message traffic?

- ✓ The ByWire XGV system modules communicate using proprietary messages sent over an independent CAN bus. The exception is the [SafeStop™](#) which interfaces to the XGV controller through a dedicated RS-232 serial link.

How is the XGV software tested?

- ✓ The ByWire XGV software is unit tested and regression tests are performed after any changes to the firmware. Any aspects of the software that are not suitable for unit testing are functionally tested. These tests were designed and are conducted by a team independent from the developers.

HARDWARE:

What systems are controlled by TORC actuators and which system are commanded electrically to the stock vehicle actuators?

- ✓ The only TORC added actuator is the brake actuator. This preserves the stock braking system which leaves ABS braking, stability control, and regenerative features untouched and ensures that manual braking can always be engaged. All other control is commanded electrically through the stock actuators.

Does TORC provide a rack to mount customer computing hardware?

- ✓ We've found that most customers have their own custom computer and hardware mounting and space requirements; therefore we do not include a rack with the ByWire XGV. Furthermore, all standard ByWire XGV components are already fully integrated into the vehicle and take up no more space than the stock components. All PowerHub™ components are designed to be used on a standard 19" rack. If a standard rack is used, a normal [PowerHub](#) installation will occupy 1-4 U depending on the desired configuration.

What is the procedure for updating the software on the components of the ByWire XGV system?

What about in-field reprogramming?

- ✓ The software on the main controller can be updated through the included web interface. There are provisions for updating the firmware on the individual control modules, however it is at TORC's discretion to send replacements, send an engineer to update the firmware, or send new firmware and instructions on the update procedure.

Does the end user have access to the main controller configuration and I/O?

- ✓ The main controller is intended for XGV use only. There is no provision for customer to use this controller. Doing so would jeopardize the integrity of the ByWire XGV.

POWER:

Is there a 48V power management option?

- ✓ A managed 48V power option is unavailable at this time. Up to 6kW of unmanaged power is available at 54V, which is well within the range of most 48v DC/DC convertors and components that take unregulated 48vdc.

Will a [PowerHub](#)™ supply uninterrupted power during a transition to shore power from vehicle power? How long can the vehicle be turned off until it needs to be connected to shore power?

- ✓ An option is available for purchase that will allow a PowerHub to keep onboard computers running for a short time when the vehicle is off and not connected to shore power. The expected run time is based on load: 28 minutes for 500w, 12 minutes at 1000w, and 4 minutes at 2000w.

What are the features of the [PowerHub Distribution Modules](#)?

- ✓ The PowerHub™ Distribution Modules provide a web and TCP control of eight power outputs. Each output supports current monitoring and configurable current limiting. In addition, each PowerHub supports remote input and output voltage monitoring, temperature monitoring, and over-voltage and reverse voltage protection.

Where is the [PowerHub](#) High Voltage DC/DC (400V to 48V) converter located?

- ✓ The high voltage converter is located in the vehicle cargo area behind the rear seats; it is designed to occupy 1 U of a standard 19" rackmount.

SAFETY:

What are the steps to go from autonomous/drive-by-wire to manual control?

- ✓ When the ByWire XGV is enabled, the shift selector is used to put the vehicle in and out of drive by wire mode. If the shift selector is in a position other than “neutral” the ByWire XGV is in manual override mode. As a precaution, the shifter must remain in “neutral” for 1.0 second before the computer will assume control. This feature allows the user to shift between gears without unintended computer intervention. This manual override feature is extremely useful for safe and efficient testing of control code. Note that any time the ByWire XGV system is active, an E-Stop disable event will apply the brakes and may shut off the engine. E-Stop disable events are not overridden by the manual override.

Can the ByWire XGV system be disabled, such as when transporting the vehicle?

- ✓ The ByWire XGV comes installed with a key switch located on the front console of the Escape that will completely disable the ByWire XGV system. In this mode the ByWire XGV will function as a normal vehicle and **will not respond to e-stop requests including e-stop disable.**

What states does the SafeStop, emergency stop system, have? What interfaces are available to know what state the e-stop system is in?

- ✓ The e-stop system itself has e-stop pause and e-stop disabled modes. Additionally, user software can command a special software pause state by sending a JAUS message to the XGV controller. The current e-stop mode can be queried through standard JAUS messages.

What happens when an E-stop pause or E-stop disable is commanded?

- ✓ E-stop pause will command the vehicle to stop at 4 m/s^2 while still accepting steering commands so that the vehicle will continue to drive a commanded path while coming to a controlled stop. Once stopped, the XGV will continue to apply brake to keep the vehicle stationary and will not accept speed control commands. An E-Stop disable will apply full brake (independently of the XGV Controller) and will return steering to manual mode, causing the steering wheel to auto-center.

What if there will always be a safety rider in the car and I don't want the brake to apply during an E-stop event?

- ✓ Along with the internal e-stop button there is an additional “emergency-manual-override” button that will (with no software in the loop) decouple the XGV actuators and return full control of the vehicle to the safety rider.

What happens when a door is opened in Drive-By-Wire mode?

- ✓ As a safety feature, if a door is opened in Drive-By-Wire mode, a software pause will automatically be commanded to the ByWire XGV.

What type of redundancies and cross checks are built into the system?

- ✓ Each module has the ability to command a software pause upon fault detection, including detecting a fault in another module. Additionally, the main controller monitors the health of each module and will command a

software pause in the event of a module fault. E-stop disable is handled in hardware, with no software in the loop; full brake will be applied and steering, throttle and shifting is returned to manual control. Finally, the brake system is designed such that the driver can always manually apply more braking than the system is commanding.

Are antilock brakes, traction control, or any other factory safety feature affected by ByWire XGV system?

- ✓ No. Antilock brakes, traction control, and other stock safety features still function normally.

MISCELLANEOUS:

How long does it take to install the ByWire XGV system on an Escape? Can it be done on site?

- ✓ The installation of the ByWire XGV takes about 2-5 days to complete, depending on options. The installation can be done on site.

Does the ByWire XGV have rollover prevention?

- ✓ No. The ByWire XGV will attempt to command the vehicle based on user input. It is up to the user to make sure that those commands are safe and reasonable.

What calibration/initialization procedures are necessary and how often do they have to be run?

- ✓ The ByWire XGV uses a stock steering wheel sensor to detect the steering angle. This sensor needs to be initialized each time the escape is started. If the ByWire XGV is enabled and the sensor has not been initialized, the system will prompt the user to perform initialization. The initialization only takes a few seconds and can either be done manually or automatically by the ByWire XGV. Further details are included in the user's manual.

Can I set the time on the ByWire XGV? How is this done?

- ✓ Yes, the end user can set the time on the ByWire XGV using a standard JAUS message. Once time is set, the ByWire XGV will continue to keep time even when off, although precise accuracy is not guaranteed due to normal clock drift. Time can be reset periodically if precise synchronization is needed.