

Dataspeed Drive-by-Wire Kit FAQ

September 21st, 2021

Polaris RZR Platform

Drive-By-Wire

Brakes

- **What is the report and expected control frequency?**
50 Hz report, 50 Hz command expected, 10 Hz timeout. Commands >100Hz will be down-sampled.
- **What is the command delay?**
Maximum delay incurred from the drive-by-wire system forwarding to the brake motor is 4ms (250Hz).
- **What is the interface? Units? Resolution?**
Torque in Nm with integer resolution. A motor is used to pull the brake pedal.
- **What is the criteria for the DRIVER bit?**
x>50Nm for 20ms
- **What is the criteria for the OVERRIDE bit?**
x>500Nm for 250ms, and the values can be changed via the DbwConfig GUI
- **Can I press the brake without overriding the system?**
Yes. Set the IGNORE bit in the command message. There is an option to disallow the IGNORE bit via the DbwConfig GUI.
- **Can the drive-by-wire achieve full brake deceleration?**
Yes.
- **Can the brake lights be controlled separately?**
No.

Throttle

- **What is the report and expected control frequency?**
50 Hz report, 50 Hz command expected, 10 Hz timeout. Interface to vehicle is analog, so >50Hz command is supported.

- **What is the command delay?**
Command messages are forwarded to the vehicle as soon as they are received to minimize delay. The vehicle's response time is the same as a physical pedal press. Commands are ramp limited to 0.2 per 20ms to prevent faults.
- **What is the interface? Units? Resolution?**
Pedal position (%). 12 bit resolution.
- **What is the criteria for the DRIVER bit?**
 $x > 0.25$ for 20ms
- **What is the criteria for the OVERRIDE bit?**
 $x > 0.30$ for 100ms, and the values can be changed via the DbwConfig GUI
- **Can I press the throttle without overriding the system?**
Yes. Set the IGNORE bit in the command message. There is an option to disallow the IGNORE bit via the DbwConfig GUI.

Steering

- **What is the report and expected control frequency?**
100 Hz report, 50 Hz command, 10 Hz timeout. Commands $> 250\text{Hz}$ will be down-sampled.
- **What is the command delay?**
Maximum delay incurred from the drive-by-wire system forwarding to the steering motor is 4ms (250Hz)
- **What is the interface? Units? Resolution?**
Steering wheel angle and maximum angular rate: full range ($\pm 440^\circ$), tenth of a degree resolution, maximum $1000^\circ/\text{s}$. Steering wheel torque: maximum 60 Nm, 1/128 Nm resolution.
- **What is the relationship between steering wheel angle and road angle?**
13:1
- **What is the steering wheel torque threshold for an override?**
8.0 Nm filtered torque, and the value can be changed via the DbwConfig GUI
- **Are there any restrictions on engaging the steering wheel?**
No.
- **Do any of the steering parameters or restrictions change with vehicle speed?**
Yes, lateral acceleration limit and angular acceleration limit parameters limit steering wheel angle and angular rate based on vehicle speed. These values can be changed via the DbwConfig GUI.

- **Is there a DRIVER bit to indicate activity on the steering wheel? (similar to the brake and throttle)**
No.
- **Can I control torque instead of position?**
Yes. Use extra caution when controlling steering wheel torque directly instead of angle. The vehicle lateral and angular acceleration limit parameters do not apply in this control mode.
- **Can I control the horn?**
No. Status is also not available.

Gear/Transmission

- **What is the report and expected control frequency?**
20 Hz report, control on-event
- **What is the interface?**
Gear position (park/reverse/neutral/low/high)
- **Are there any gear shift limitations?**
 - Gear shift commands will not be executed when there is an active driver override on brake/throttle/steering

Misc

- **What other vehicle sensors can I access?**
 - Vehicle speed is included in the steering report. (100 Hz)
 - 6-axis IMU (accel/gyro) from the Dataspeed module (100 Hz)
- **Is there an E-Stop button?**
There is an E-Stop button that removes power from all of the drive-by-wire hardware, see the wiring diagram. This will NOT stop the vehicle. Taking control with the steering wheel or brake pedal is a much smoother transition.
- **How do I access the drive-by-wire CAN network to send commands?**
If using ROS, a USB-CAN tool is provided and works with the ROS driver. Otherwise, there are CAN/power taps under the dash. See the wiring diagram.

Safety

- The drive-by-wire modules have been through the DFMEA process with a tier 1 automotive supplier.
- All modules prioritize driver input over drive-by-wire CAN bus input.
- All modules disengage control after 100ms if a new command is not received.
- All modules pass through vehicle signals unmodified when unpowered or disabled.
- There is an E-Stop button that restores OEM functionality by removing power. See above.
- There is an optional watchdog counter capable of detecting fault conditions and applying a small amount of brakes to slowly bringing the vehicle to a stop.
- There is an optional external brake input that can be used to apply a constant braking value with a physical button. See the parameters document for more information.

Calibration

- **Steering Wheel Angle:** The user must provide the steering wheel angle calibration. Send a steering command CAN message with the CAL bit set and the desired value in the SCMD field. This value will update the SteeringCalOffset parameter and set the SteeringCal to true. The calibration is stored in flash, persists across firmware updates, and only needs to be done one time.
- **Brake Pedal Positions:** The drive-by-wire module automatically moves the brake pedal to record the correlation between brake pedal position and brake pressure. The process takes approximately one minute. This happens automatically when the vehicle speed is zero, the vehicle is in park, and the throttle pedal is not pressed. The calibration is stored in flash, persists across firmware updates, and only needs to be done one time. The calibration can be cleared to trigger a new calibration with the BrakeCalClear parameter. The parameter automatically clears itself when conditions are ready to calibrate (but the GUI may not update), do not clear it manually.
- **Shift Lever Positions:** The drive-by-wire module automatically moves the shift lever to observe and calibration the positions corresponding to specific gears. The process takes approximately one minute. This happens automatically when the vehicle speed is zero, the engine is off, and the throttle pedal is not pressed. The calibration is stored in flash, persists across firmware updates, and only needs to be done one time. The calibration can be cleared to trigger a new calibration with the ShiftCalClear parameter. The parameter automatically clears itself when conditions are ready to calibrate (but the GUI may not update), do not clear it manually.

Vehicle Parameters

- Steering ratio: 13:1
- Ackerman wheelbase: 90 inches

Power Distribution

- **How can I turn power distribution channels on and off?**
Touchscreen display in a cup holder mount, buttons inside the center console, startup/shutdown scripts, CAN message, Ethernet/LCM message
- **How can I configure the power distribution?**
Use PowerDistributionGUI.exe and its documentation.
- **What is the power rating?**
9-18 volts, 15 Amps per channel continuous, 180 Amps total continuous
- **Can I view the current of the 120V power inverter?**
No. The current consumption of the inverter is not available.
- **Can I connect a higher wattage power inverter instead of the 600W model?**
Yes. See the Power Distribution Panel datasheet for a list of supported part numbers.
- **What is the default mode change pin number?**
1234

Documentation

- Download the latest DriveByWire_Kit.zip release from <https://www.dataspeedinc.com/release-packages/>
 - Block diagram and wiring diagram PDFs
 - CAN bus documented in the Vector CAN DBC format: DataspeedByWire.dbc
 - Datasheets for each module (including CAN message definitions)
- ROS driver
https://bitbucket.org/DataspeedInc/dbw_polaris_ros

Updating

- Windows laptop and embedded modules

- Download the latest DriveByWire_Kit.zip release from <https://www.dataspeedinc.com/release-packages/>
- Check the CHANGELOGs to see which modules need to be updated.
- Update the firmware of required modules with DataspeedBootloader.exe by connecting to that module's USB cable. This process is documented in DataspeedBootloader.pdf.
- **Ubuntu Linux demo laptop**
 - ROS documentation can be found here: https://bitbucket.org/DataspeedInc/dbw_polaris_ros/src/master/ROS_SETUP.md
 - Run the 'One Line SDK Update' script at the link above.
 - The password for the provided laptop is 'password' (without quotes).

Troubleshooting

- **The only CAN messages from the drive-by-wire system are Version (0x07F) and License (0x07E)**

The embedded firmware requires a valid license. See LicenseManager\DataspeedLM.exe to view and modify the license in the steer-by-wire module. Contact [Dataspeed](#) to receive your license.
- **Steering is not working and reporting a calibration fault.**

Steering has not been calibrated. To calibrate, send a steering command with the desired value and the 'CAL' bit set.
- **Braking is not working and reporting a calibration fault.**

Braking has not been calibrated. This is automatic, and takes approximately one minute to press the brakes all the way down. To calibrate, the vehicle speed must be zero, the shift selector must be in park, and the throttle pedal must not be pressed. Refrain from pressing the brake pedal while the system is calibrating. To reset the calibration, use DbwLogger.exe to set the BrakeCalClear parameter.
- **Brake control is erratic.**

Verify performance by sending slowly increasing brake values. If there is still erratic performance, the brake calibration could contain incorrect values. To reset the calibration, use DbwLogger.exe to set the BrakeCalClear parameter. To calibrate, the vehicle speed must be zero, the shift selector must be in park, and the throttle pedal must not be pressed. Refrain from pressing the brake pedal while the system is calibrating.
- **Shifting is not working and reporting a calibration fault.**

Shifting has not been calibrated. This is automatic, and takes approximately one minute to calibrate each gear position. To calibrate, the vehicle speed must be zero, the engine must be off, and the throttle pedal must not be pressed. To reset the calibration, use DbwLogger.exe to set the ShiftCalClear parameter.

- **Shift lever control is erratic.**

The shift lever calibration could contain incorrect values. To reset the calibration, use DbwLogger.exe to set the ShiftCalClear parameter. To calibrate, the vehicle speed must be zero, the engine must be off, and the throttle pedal must not be pressed.

- **My vehicle is not responding to commands and FLTWDC=1.**

These are the symptoms of a Watchdog Counter fault. To clear a watchdog counter event, press the OK button on the left side of the steering wheel or cycle power to the drive-by-wire system. If the Watchdog counter fault keeps triggering, set the COUNT field to zero in all command messages to disable this functionality.

- **My vehicle is making the override beeping noise continuously and engaging/disengaging control rapidly.**

Most commands are expected every 20ms and timeout after 100ms. This sets TMOU=1 and EN=0. If the timeout causes control to disengage, the audible warning is triggered. Verify that your software sends commands every 20ms using an external CAN tool. One common problem is for some other process on the computer sending the drive-by-wire commands to take all the processing power and delay other processes for longer than the 100ms timeout. Make sure that the vehicle control software is separate from perception and other processing that could take a large amount of resources, and try assigning a higher priority to the process running the control software.

- **My vehicle is not responding to commands or generating reports and the drive-by-wire power usage is 100mA or less.**

Check that the E-Stop button is not pressed. Some vehicles may have a red emergency stop button near the cup holders.

- **My vehicle is not responding to commands or generating reports and the drive-by-wire power usage is 900mA or greater.**

There may be a hardware or wiring problem. Contact Dataspeed to help debug the problem.

- **The thermocouple on the Power Distribution Panel is reporting wild values.**

There is a known hardware issue with the Power Distribution Panel thermocouple sensor where the value is prone to noise from nearby equipment such as the inverter remote cable. It is not recommended to trust the temperature reading from the thermocouple sensor.

- **Steering, braking, throttle, shifting, turn signals, or something else is not working.**

- Check that all subsystems have the latest firmware with DataspeedBootloader.exe and a USB cable using the laptop included with your vehicle. There may be unexpected issues if the firmware versions of each drive-by-wire modules do not match.
- Check the configurable parameters with DbwConfig.exe, and reset all values to default.
- Test with a known working interface: Run the ROS joystick demo on the laptop included with your vehicle and test the problem.
- If the issue still persists, contact [Dataspeed](#). Dataspeed may ask you to extract a recording of the problem from the USB cable of the GATEWAY module, which shows up as a read-only flash drive.