

Brake Torque Control on FCA RU Platforms

This document illustrates the differences between the **CMD_TORQUE** and **CMD_TORQUE_RQ** brake control modes. Both control modes allow the user to request a brake torque value, but **CMD_TORQUE** relies solely on an open-loop lookup table to convert brake torque commands to pedal position commands, whereas **CMD_TORQUE_RQ** actively closes the loop on the torque request signal transmitted by the vehicle. Dataspeed recommends using **CMD_TORQUE_RQ** instead of **CMD_TORQUE** in all cases for reasons that are illustrated below.

Users can command brake torque directly by selecting the **CMD_TORQUE** mode (**CMD_TYPE** = **CMD_TORQUE**), and setting **PCMD_TORQUE** to the desired brake torque level. The logic in the ADAS Kit then internally maps this commanded brake torque to a commanded brake-pedal position (**PCMD_PEDAL**), as shown in Figure 1. This mapping, however, solely uses an open-loop lookup table to make this conversion. (See Figure 2).

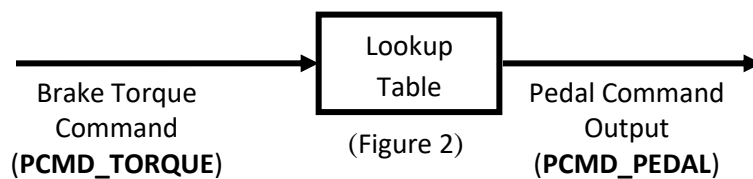


Figure 1. Open-loop brake torque mode.

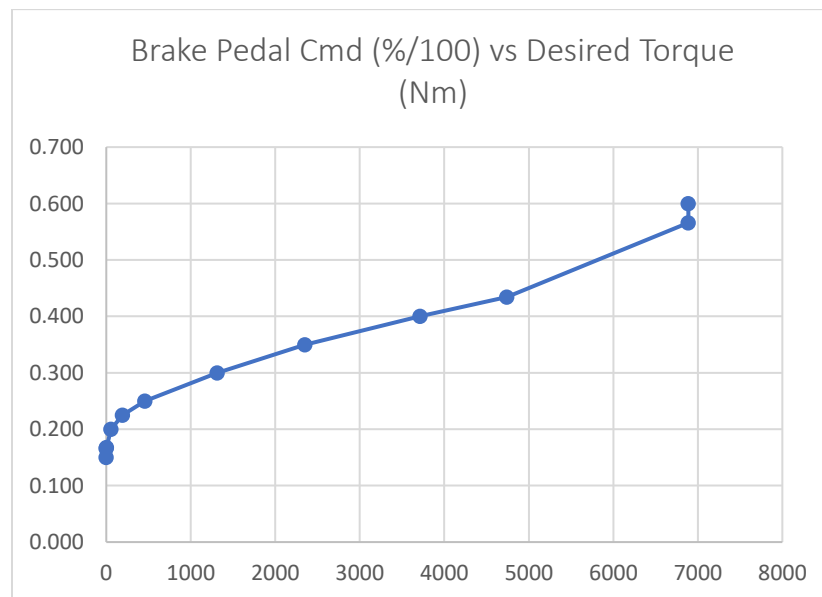


Figure 2. Open-loop lookup table that maps desired braking torque to brake pedal position.

Poor Accuracy and Consistency in Open-Loop

Figure 3 shows an example of open-loop brake torque control behavior for the **CMD_TORQUE** mode. The blue line is the user's drive-by-wire brake command, and the red line is the brake torque request reported by the vehicle.

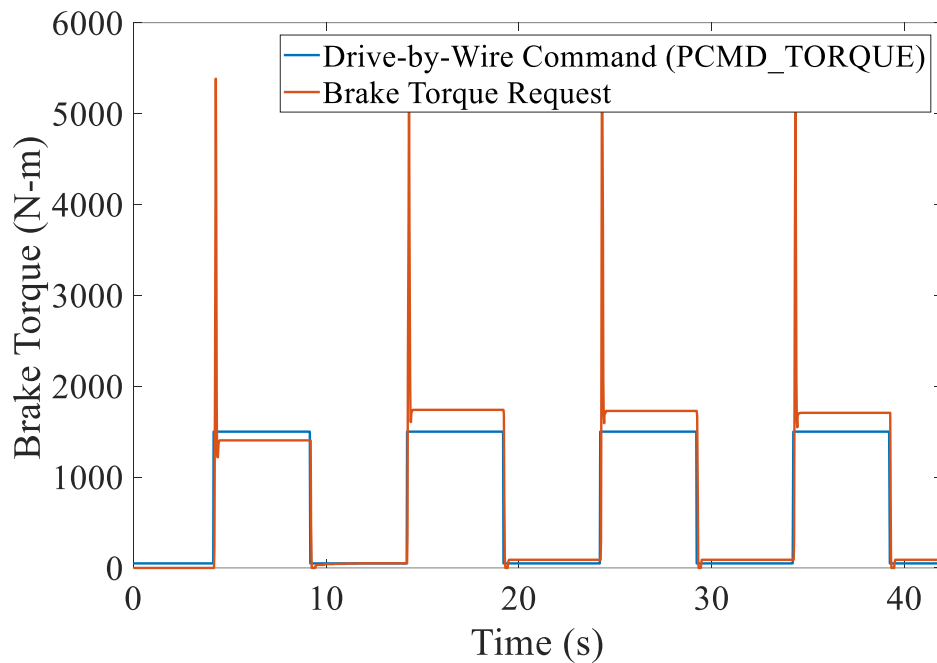


Figure 3. Inaccurate and inconsistent output in open-loop brake mode.

(CMD_TYPE = CMD_TORQUE)

Because of the open-loop nature of this command mode, the accuracy of the resulting brake torque request is not guaranteed. This can be seen by this step input test, where brake torque request reaches different values in response to a consistent pedal command. The open-loop lookup table of the **CMD_TORQUE** command mode is thereby unable to achieve accurate brake torque control.

Improved Performance in Closed-Loop

The **CMD_TORQUE_RQ** command mode addresses the observed shortcomings of the open-loop **CMD_TORQUE** command mode. Figure 4 shows the results from running a similar test with **CMD_TYPE** set to **CMD_TORQUE_RQ**.

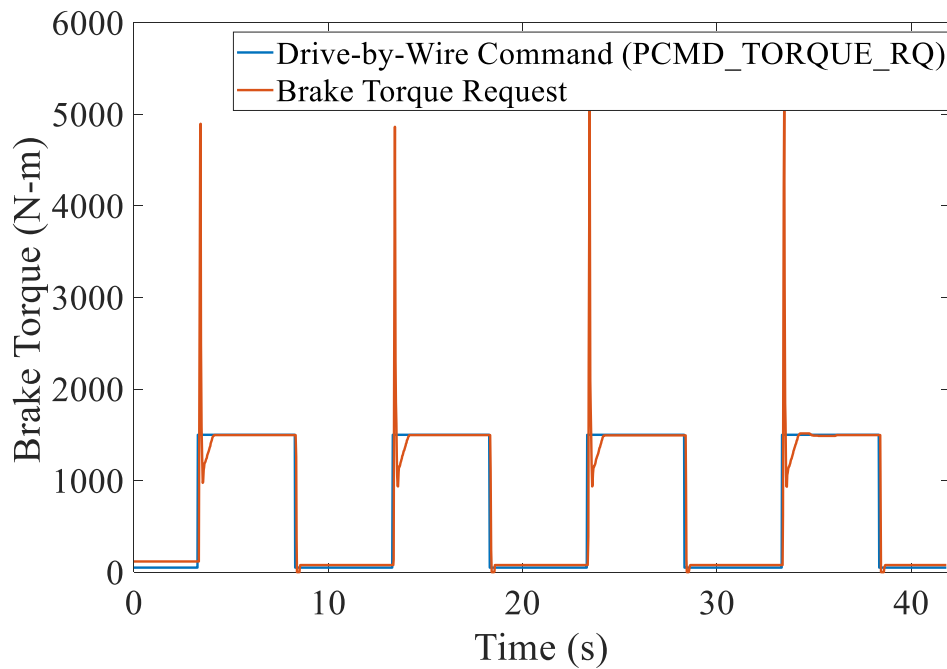


Figure 4. More accurate control in closed-loop brake torque mode.

(CMD_TYPE = CMD_TORQUE_RQ)

The architecture of the closed-loop brake controller behind the new **CMD_TORQUE_RQ** mode is illustrated in Figure 5. The same lookup table used in the **CMD_TORQUE** mode provides a feed-forward pedal position component that is added to the feedback component to produce the actual pedal position command sent to the vehicle. The feedback component is computed by applying PI control to the error signal defined as the difference between the user's brake torque command and the brake torque request as reported by the vehicle.

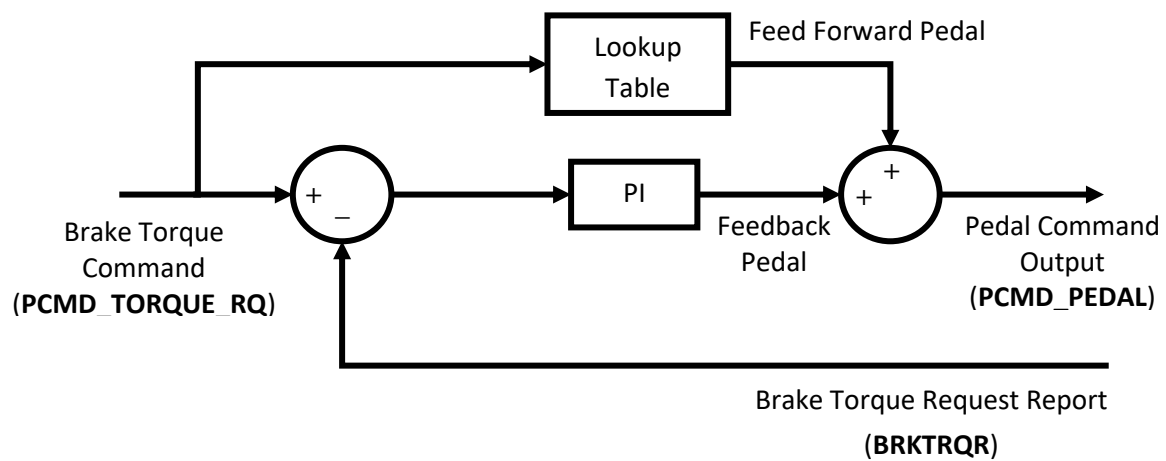


Figure 5. Closed-loop brake torque mode.

(CMD_MODE = CMD_TORQUE_RQ)