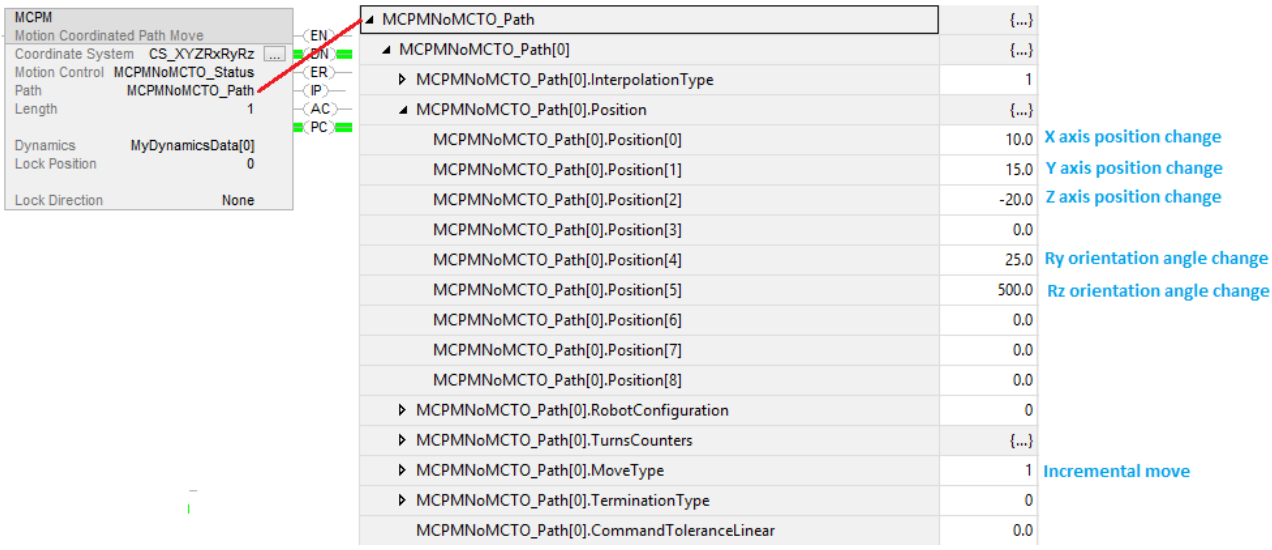
MCPM Move with transforms not enabled

This section looks at MCPM move on a Delta 5 axis robot with transforms not being enabled.
To see the difference between a MCPM move without transforms being enabled, we first look at MCPM move with the transforms being enabled.

The MCPM move in both cases (with and without Transforms) is an incremental move on all axes (except Rx axis), the image below shows the Path parameters of the move.



MCPM Move with transforms enabled

When the transforms are enabled in rung 0 of subroutine MCPM_With_MCTO, the position of the 6 axes (Cartesian coordinate system) shown below are initialized, they represent the Robot's EOA (End of Arm) position.

When MCPM instruction in rung 1 of same subroutine is executed and a trend is plotted of positions of all axes as they move to the path position (as seen in Figure 1 below) we can see that:

- X axis starts with initial X position of 31.00 of Robot, to final position of 41.00 (10 units move)
- Y axis starts with initial Y position of 0.00 of robot to final position of 15.00 (15 unit move)
- Z axis starts with initial Z position of -865.00 of robot to final position -885.00 (-20 unit move).
- Rx axis does not move
- Ry orientation axis starts with initial value of 0 deg to final orientation position of 25 deg (25 unit move)
- Rz orientation value can be seen initially trending from 0 to 179.999 degrees, then flipping down to -180 degrees and subsequently incrementing to 140 degrees. The total move is of 500: ((180 - 0) + (140 – (-180))) degree.

Note:
When Transforms are enabled (MCTO is programmed) Orientation axes are restricted to angles as shown below:

1. Rz is restricted between +/- 180^0 : i.e. when Rz crosses 179.99°, Rz flips to -180°
2. Ry is restricted between +/- 90^0
3. Rx is restricted between +/- 180^0

For Delta J1J2J3J4J5 geometry, Rx value can only be programmed with 0 or 180 degree value.

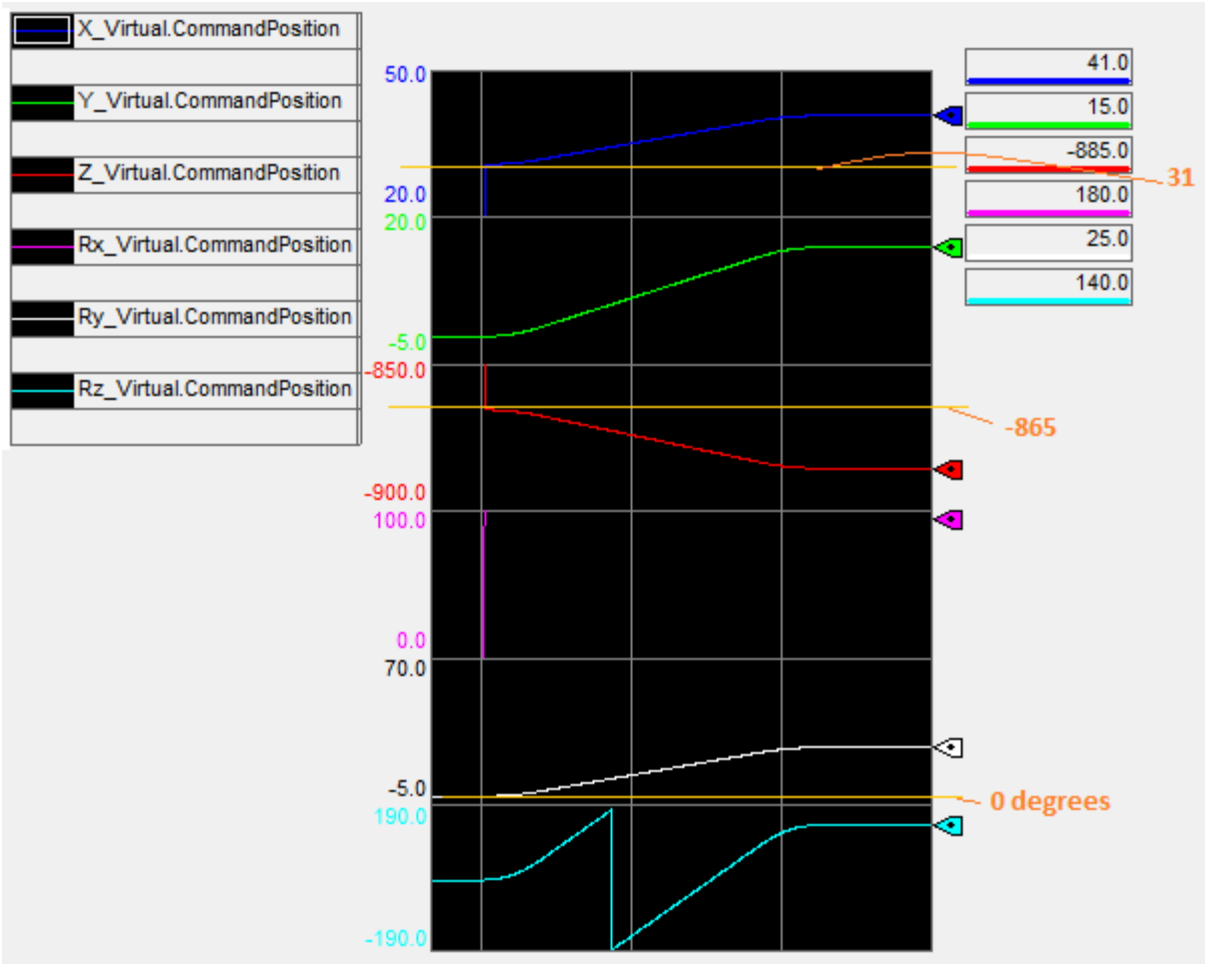


Figure 1 MCPM with Transforms enabled

MCPM Move with transforms disabled

In this case there is no Transforms enabled, as a result the initial position of all the 6 axes (Cartesian coordinate system) is 0.

When MCPM instruction in rung 0 of subroutine MCPM_NO_MCTO is executed and a trend is plotted (as shown in Figure 2 below), one can see that the initial positon of all axes is at 0, where as in the MCPM move with transforms enabled the initial position of each axes is different. We can see in the trend that:

- X axis starts with initial X position of 0.00 of Robot to final position of 10.00 (10 units move)
- Y axis starts with initial Y position of 0.00 of robot to final position of 15.00 (15 unit move)
- Z axis starts with initial Z position of 0.00 of robot to final position -20.00 (-20 unit move).
- Rx axis does not move
- Ry orientation axis starts with initial value of 0 deg to final orientation position of 25 deg (25 unit move)
- Rz orientation value can be seen trending from 0 degrees to 500 degrees and there are no flips happening (as seen compared to when transforms are enabled).

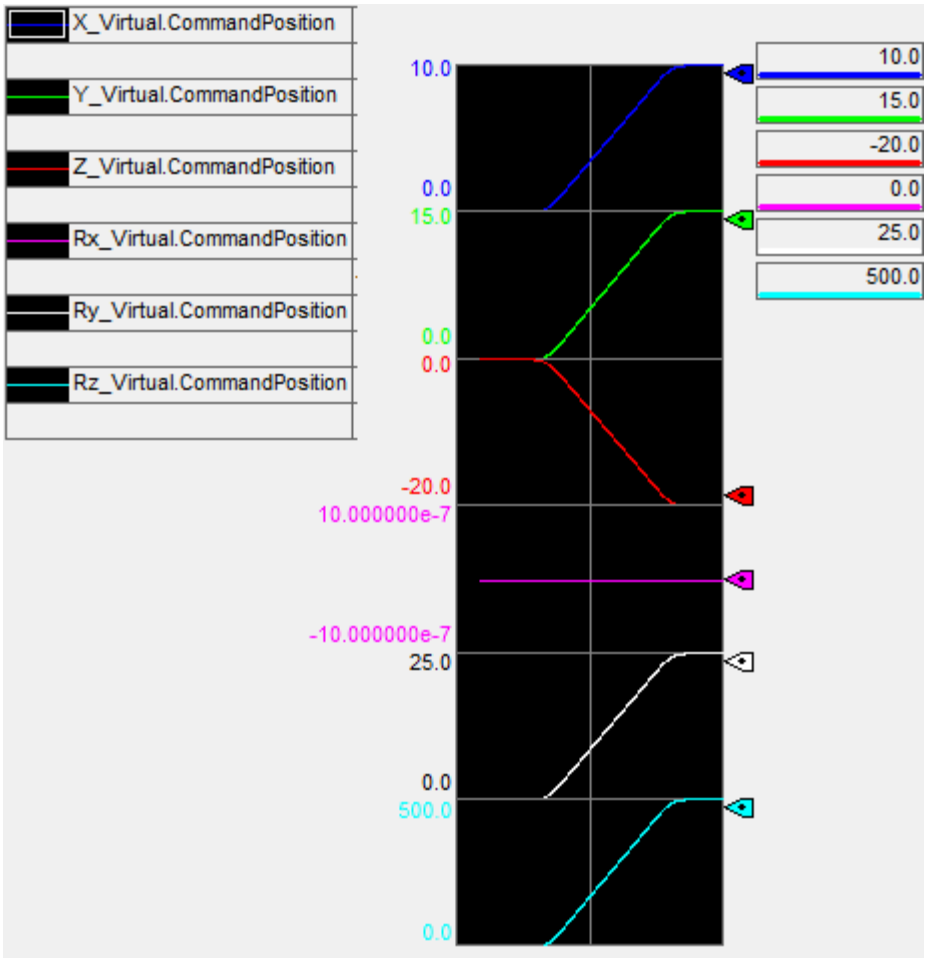


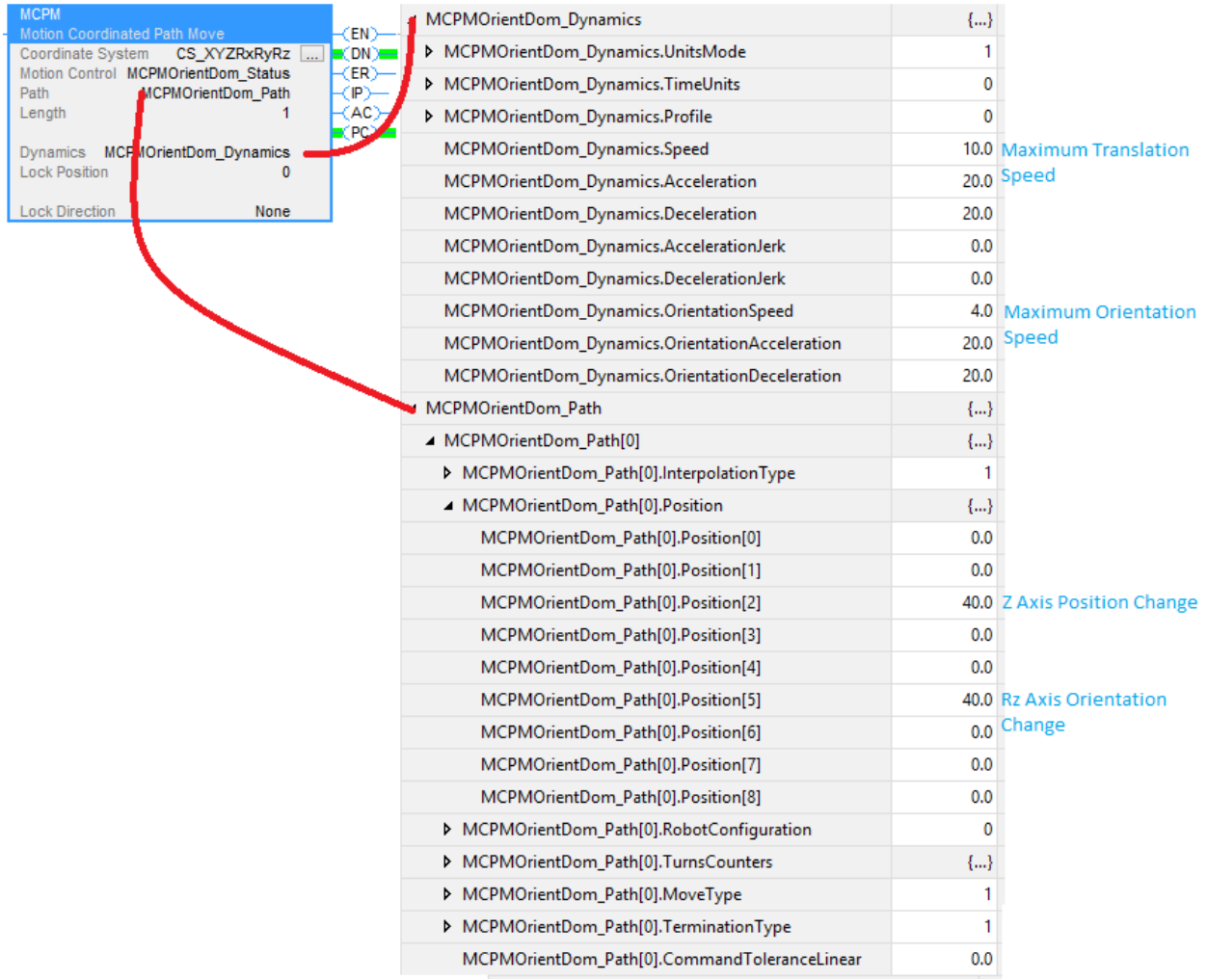
Figure 2: MCPM move without Transforms being enabled

Orientation Dominant MCPM Move

The section looks at Orientation dominant MCPM moves on a Delta 5 axis robot with transforms being enabled. The move is termed as orientation dominant as the max speed of Orientation axis influences the max speed achieved on the translation axes.

In the Example code the subroutine Orientation_Dominant_Move executes an incremental MCPM move on both Z axis and Rz axis of same units positions change but with different speeds. The image below shows the Path and dynamic parameters for the move.

- Z axis incremental move by 40 mm at programmed speed of 10 mm/sec.
- Rz incremental move of 40 degrees at programmed speed of 4 degrees/sec.



When MCPM instruction in rung 1 is executed and a trend is plotted of both speed and acceleration of Z and Rz axes, the trend shows that the programmed acceleration is achieved on both axes, but the max translation speed is not achieved, it gets capped at 4 mm/sec or 4 units/sec.

This happens because both the translation and orientation move have to finish at the same time but the orientation move will take approximately 10 seconds (approx.: 40/4 = 10 seconds), as a result the translation move speed gets capped to a smaller value: Orientation speed deciding the time it will take for translation move to complete, thus making it an orientation dominant move.

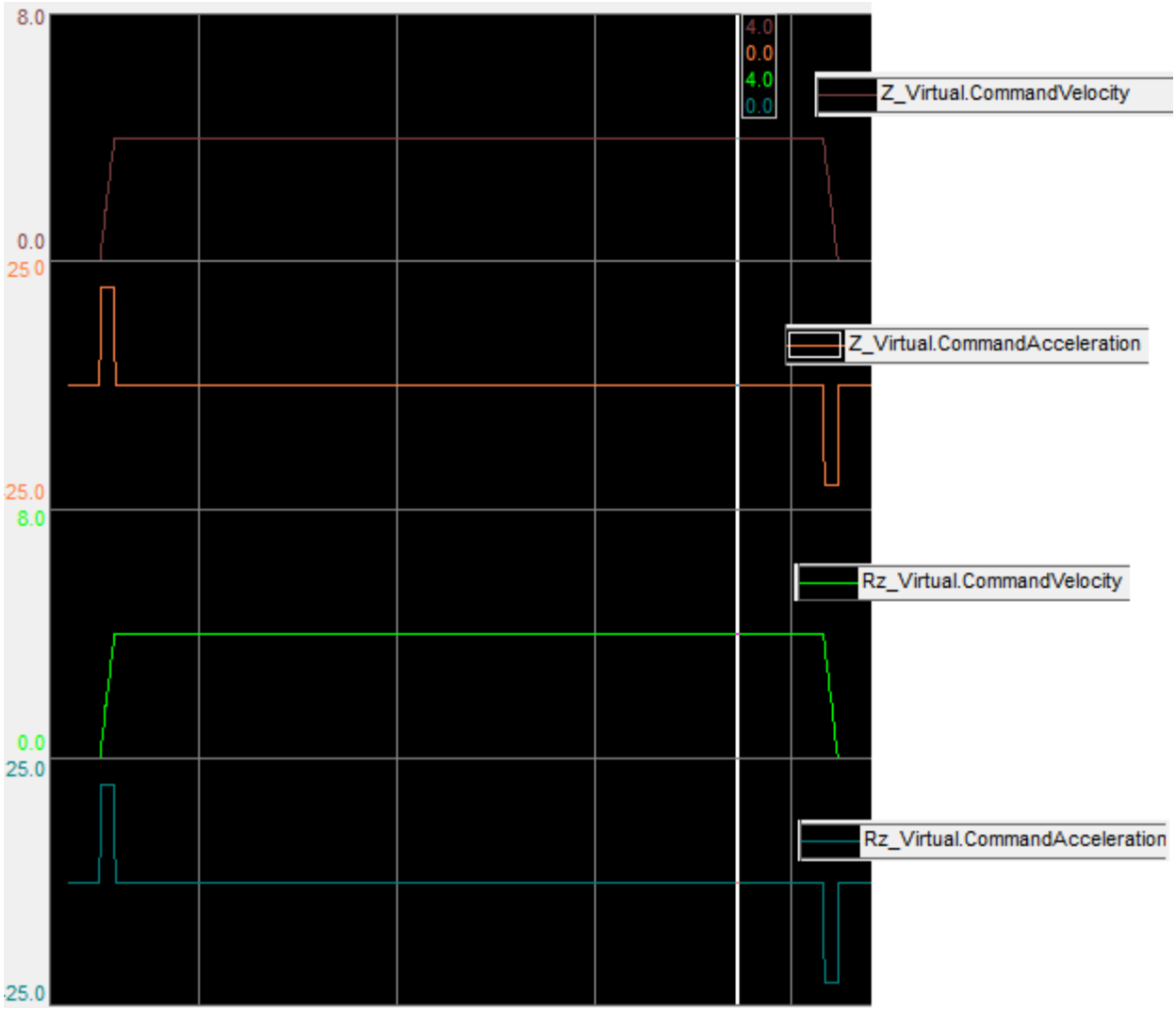


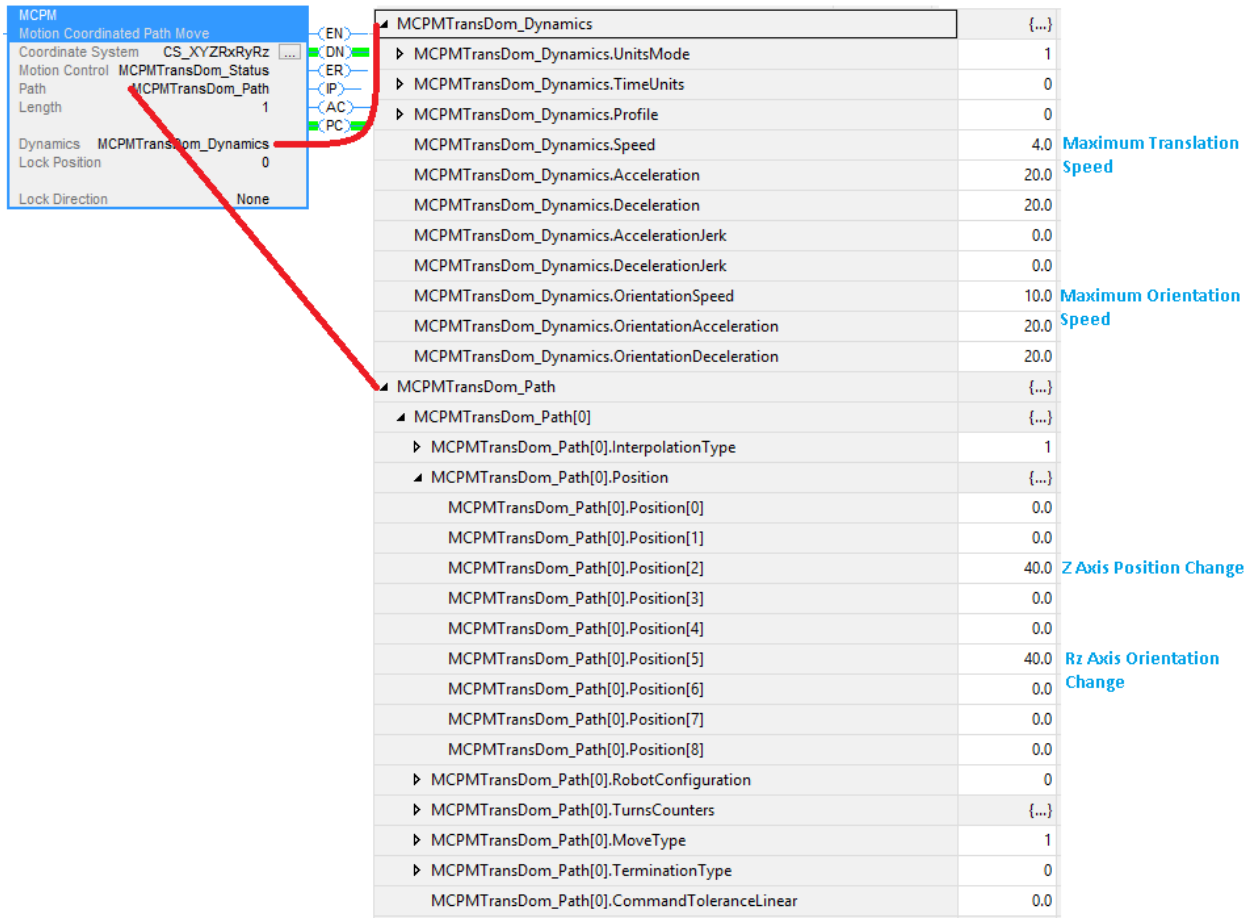
Figure 3: MCPM Orientation Dominant Move

Translation Dominant MCPM Move

The following examples looks at Translation dominant MCPM moves on a Delta 5 axis robot with transforms being enabled.

In the Example code the subroutine Translation_Dominant_Move executes an incremental MCPM move on both Z axis and Rz axis. The path move is programmed to move. The image below shows the Path and dynamic parameters for the move.

- Z axis incremental move by 40 mm at programmed speed of 4 mm/sec.
- Rz incremental move of 40 degrees at programmed speed of 10 degrees/sec.



When MCPM instruction in rung 1 is executed and a trend is plotted of both speed and acceleration of Z and Rz axes, the trend shows that the max acceleration is achieved but max orientation speed is not achieved, it gets capped at 4 deg/sec or 4 units/sec.

This case will be vice versa of orientation dominant move, here again because both the translation and orientation move have to finish at the same time, but the translation move will take approximately 10 seconds to finish (approx.: 40/4 = 10 seconds), as a result the orientation move speed gets capped to a smaller value: translation speed deciding the time it will take for orientation move to complete, thus making it a translation dominant move.

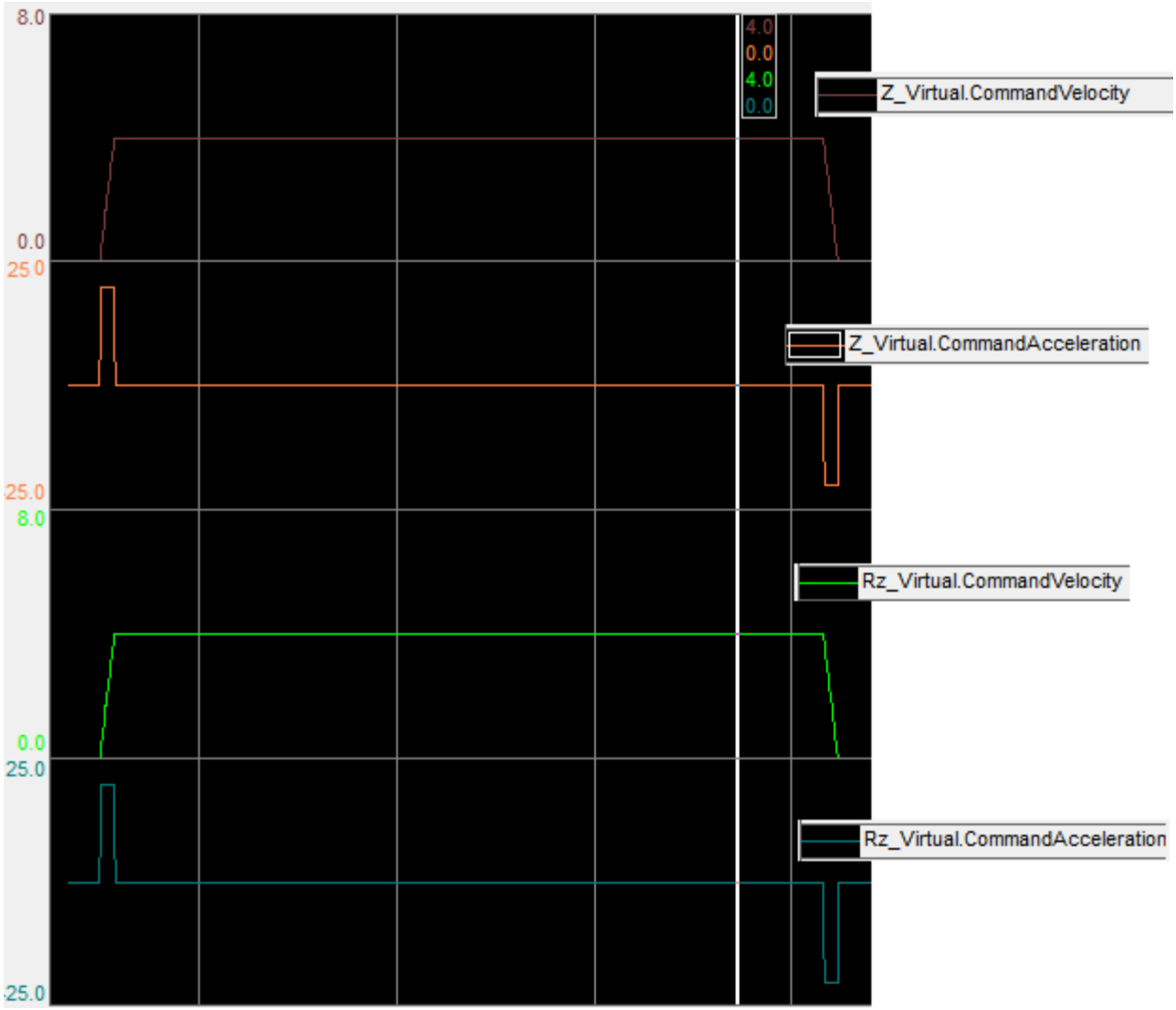


Figure 4: MCPM Translation Dominant Move