Computer Exercise 4
EL2520 Control Theory and Practice

Martin Isaksson
misakss@kth.se
920622-3373

Ioannis Tilaveridis
joannist@kth.se
930901-9215

Minimum phase case

Dynamic decoupling

The dynamic decoupling in exercise 3.2.1 is

$$W(s) = \begin{bmatrix} 1 & \dfrac{-0.01336\,(s+0.05645)}{(s+0.05645)\,(s+0.02572)} \\ \dfrac{-0.014759\,(s+0.05187)}{(s+0.05187)\,(s+0.0213)} & 1 \end{bmatrix}$$

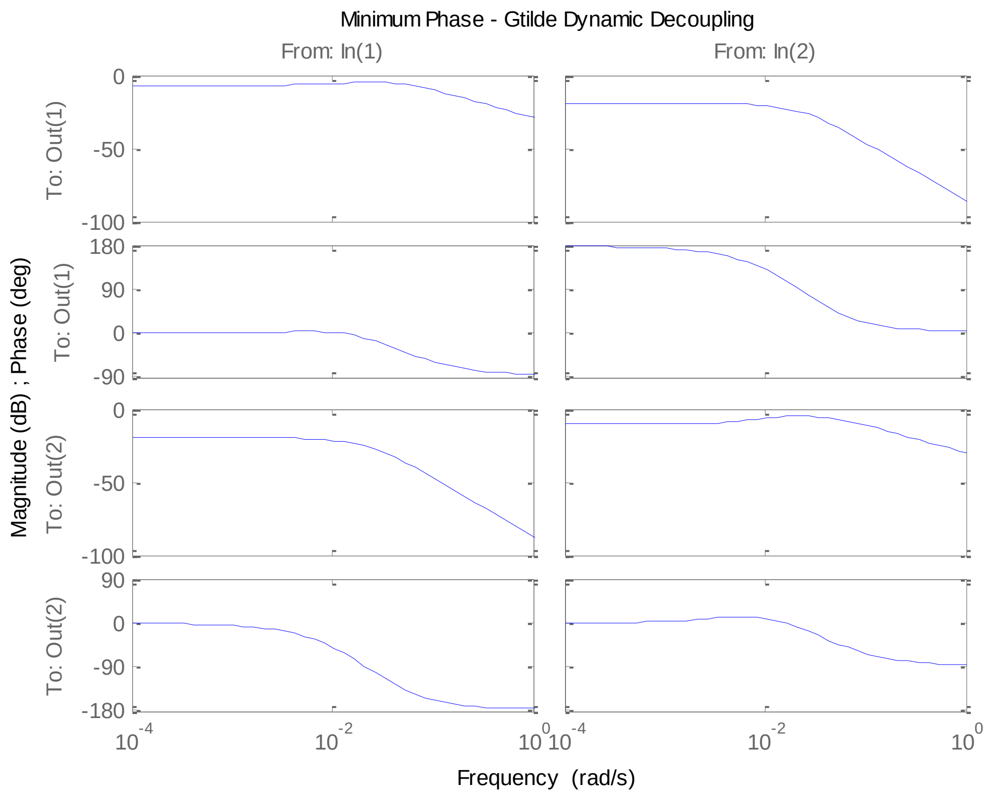


Figure 1: Bode diagram of G(s) derived in exercise 3.2.1

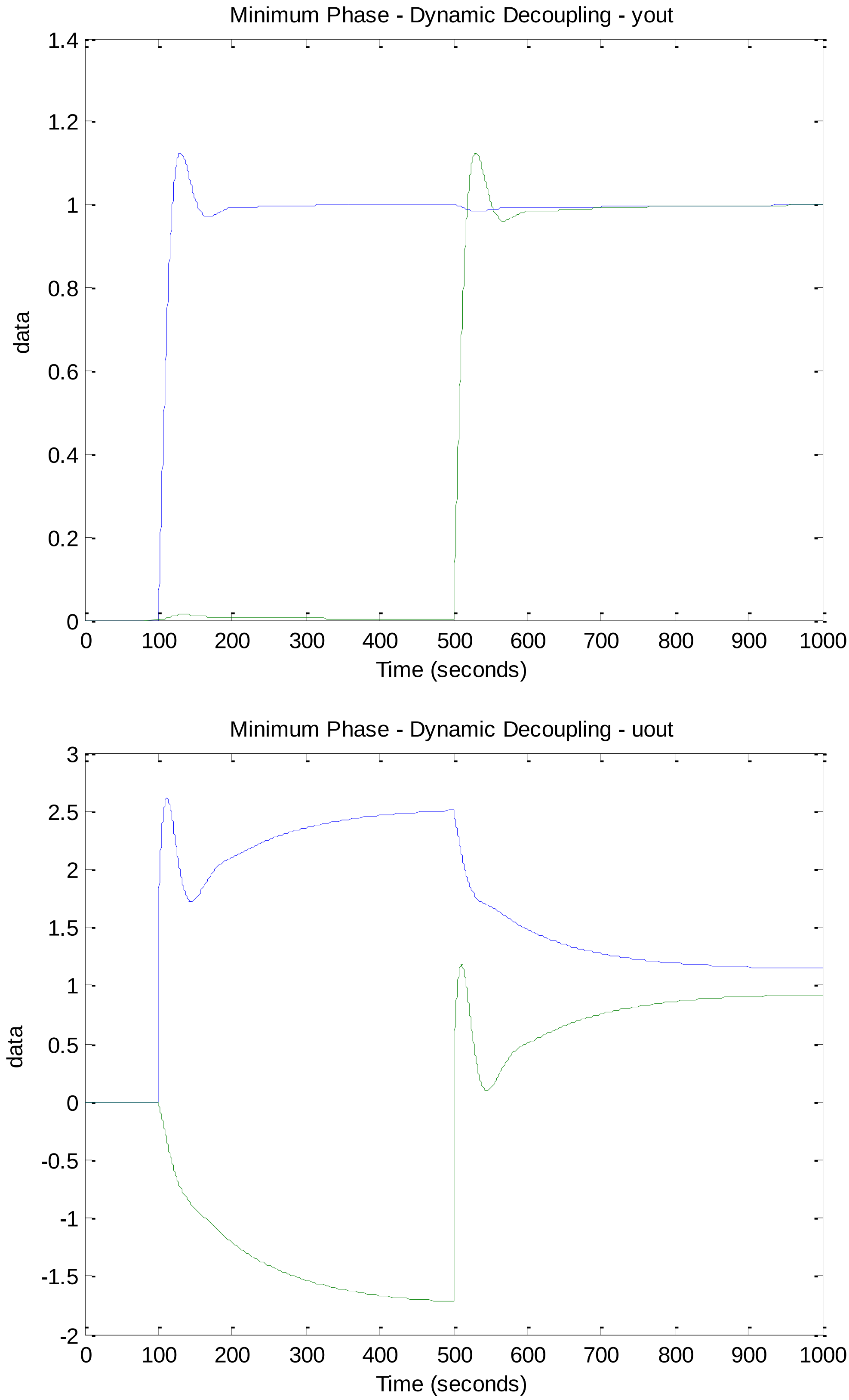


Figure 2: Simulink plots from exercise 3.2.4

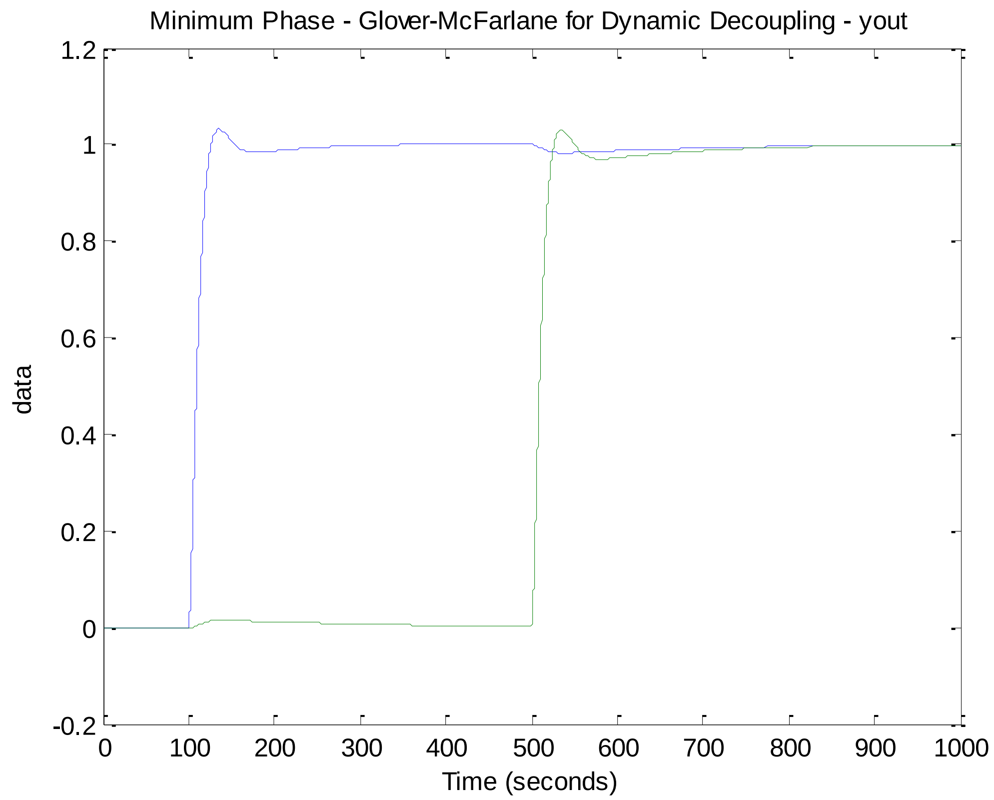
Is the controller good?

Well, it is almost decoupled (since one output only has a small deviation from their reference when the other changes, refer to Figure 2), but the overshoot is at almost 10%, which is a bit high. It can be regarded though as reasonably well-tuned.

Are the output signals coupled?

Almost, since a change on one of them does affect the other but very little, as we can see on the simulation in Figure 2.

Glover-MacFarlane robust loop-shaping



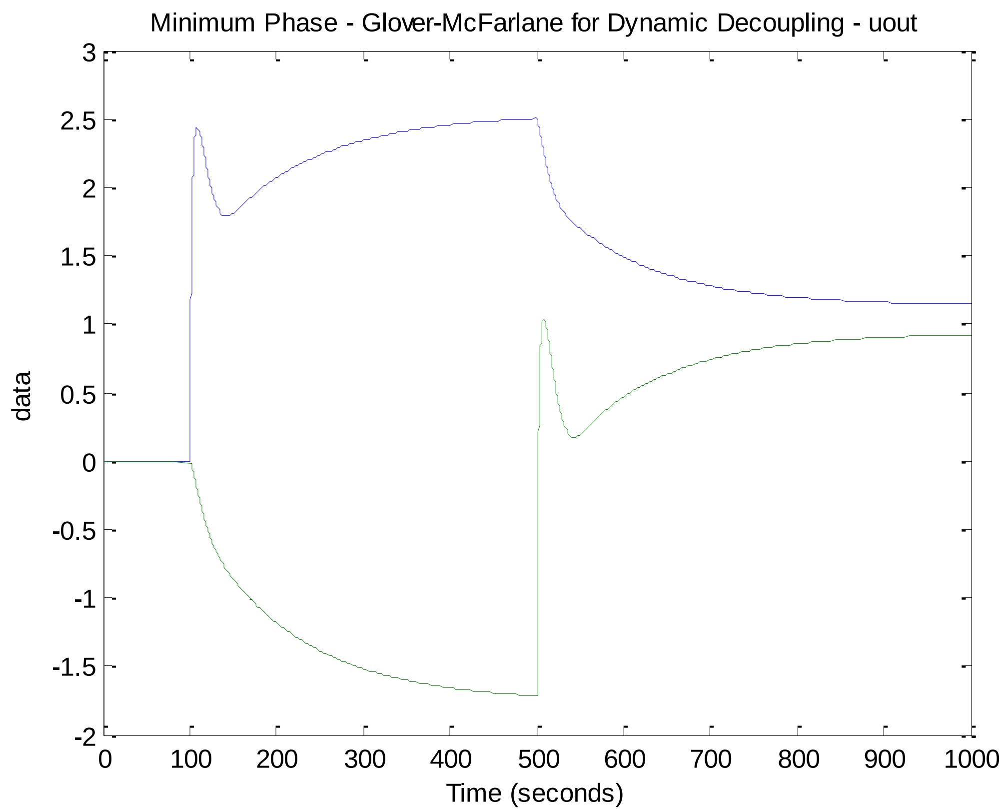


Figure 3: Simulink plots from exercise 3.3.4

What are the similarities and differences compared to the nominal design?

The new controller is robustified compared to the initial decentralized controller. Comparing the graphs in Figures 2 & 3, we can see that the rise time & settling time are almost similar, but the overshoot now is much lower <5% than in the nominal case.

Non-minimum phase case

Dynamic decoupling

The dynamic decoupling in exercise 3.2.1 is

$$W(s) = \begin{bmatrix} \dfrac{-1.143\ (s+0.04692)\ (s+0.09089)}{(s+0.04692)\ (s+0.2)} & \dfrac{0.2}{(s+0.2)} \\ \dfrac{0.2}{(s+0.2)} & \dfrac{-1.615\ (s+0.05106)\ (s+0.08582)}{(s+0.05106)\ (s+0.2)} \end{bmatrix}$$

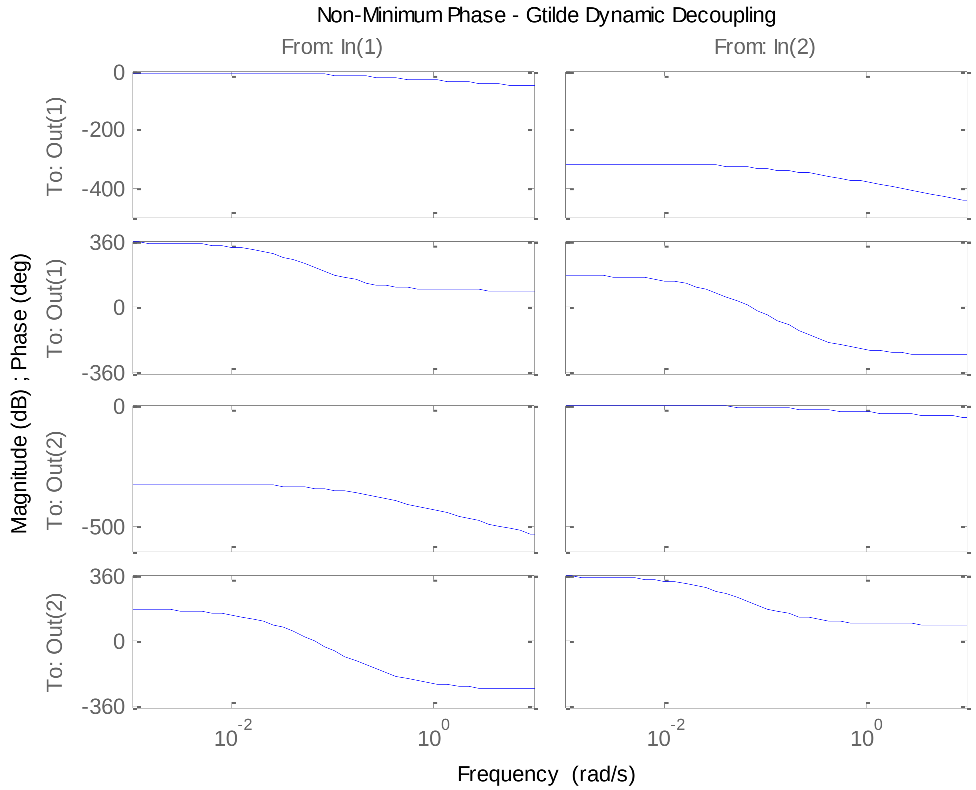


Figure 4: Bode diagram of G(s) derived in exercise 3.2.1

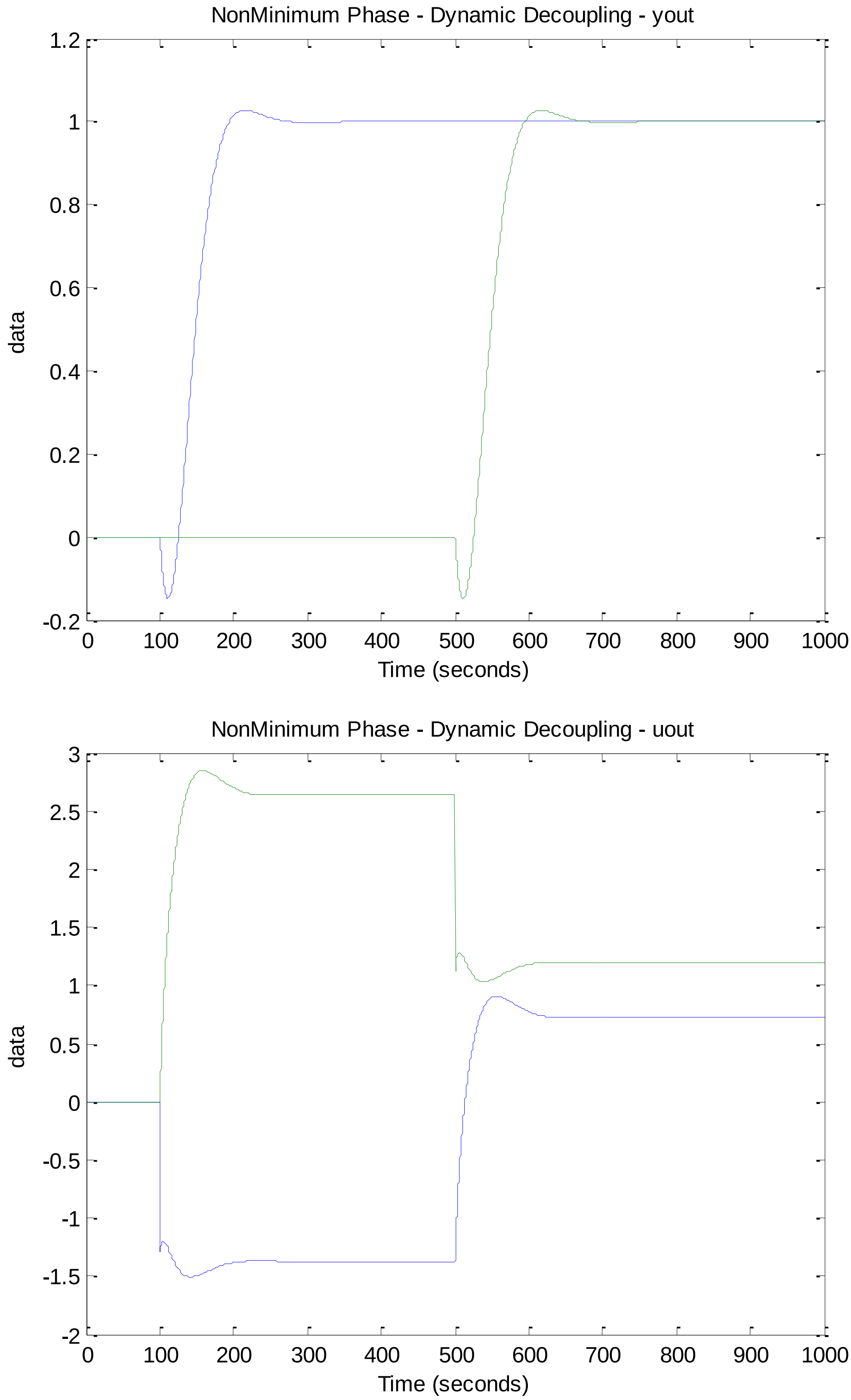


Figure 5: Simulink plots from exercise 3.2.4

Is the controller good?

The controller is very slow (almost 150 seconds to settle to its final reference value, refer to Figure 5). The overshoot though is very small (almost 5%), which is better than the minimum phase decoupled controller in Figure 2.

Are the output signals coupled?

No, they are not. Figure 5 shows clearly that the system is decoupled. A change in one of the outputs does not affect the other at all.

Glover-MacFarlane robust loop-shaping

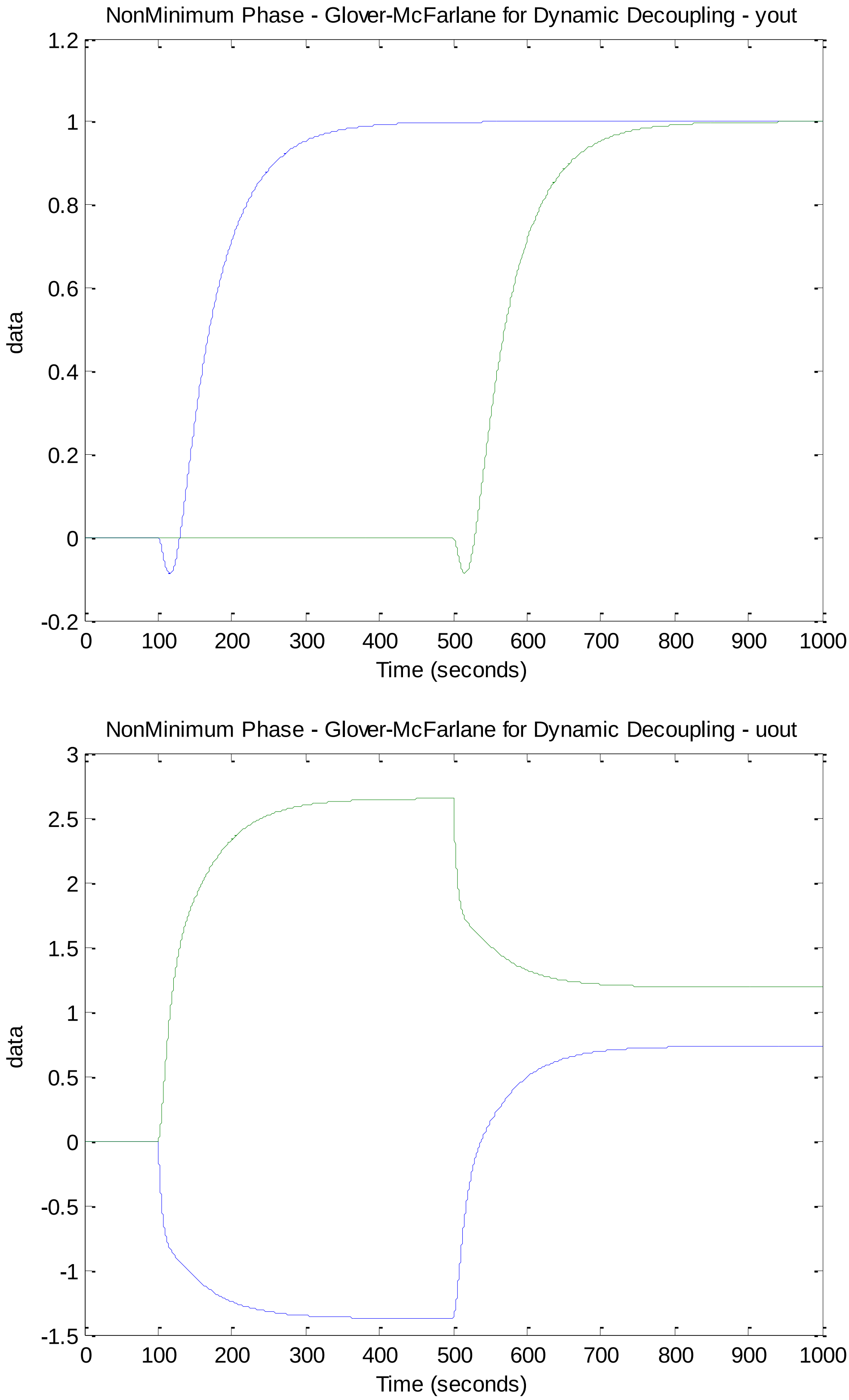


Figure 6: Simulink plots from exercise 3.3.4

What are the similarities and differences compared to the nominal design?

Comparing Figures 5 & 6, we see that the controller is very slow in both cases (around 150 seconds to reach its settling reference value), but compared to the nominal design, the overshoot is 0% on the Glover-McFarlane case. A robustified controller.