Mitigating Transient Torque Spikes

while using the Cycle Synchronous Position mode

Application Note

1. Notices

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1.1. Copyrights and Trademarks

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3. Changelog

Version	Amendments	Date	Owner
1.0	Initial version	2026-07-28	fjamal

4. Overview

The drive is configured to run in CSP mode. The master sends incremental target position values on every task cycle. Occasional spikes in torque are exhibited, which could be observed as sudden noise while running.

The data plots from the master, e.g., OBLAC or TwinCAT, show spikes in 'Torque Demand Value' in some cycles. This is observed more frequently when DC sync is set up.

5. The Cause

Consider a master task, e.g., TwinCAT/CodeSys, that is running at 250Hz (PDO cycle every 4ms). The ACTILINK-S control input frequency is 1KHz by default, i.e., it reads new setpoints from the Object Dictionary every 1 ms, synchronized to SYNC0. If the master's PDO data arrives in the Object Dictionary at almost the same moment the drive reads it, even tiny timing variations, e.g., master jitter, decide whether a new setpoint is picked up in the current cycle or the next one. When it lands one cycle late, the drive holds the old setpoint for 1 ms and then catches up with an increased step, which the control loop turns into a torque spike.

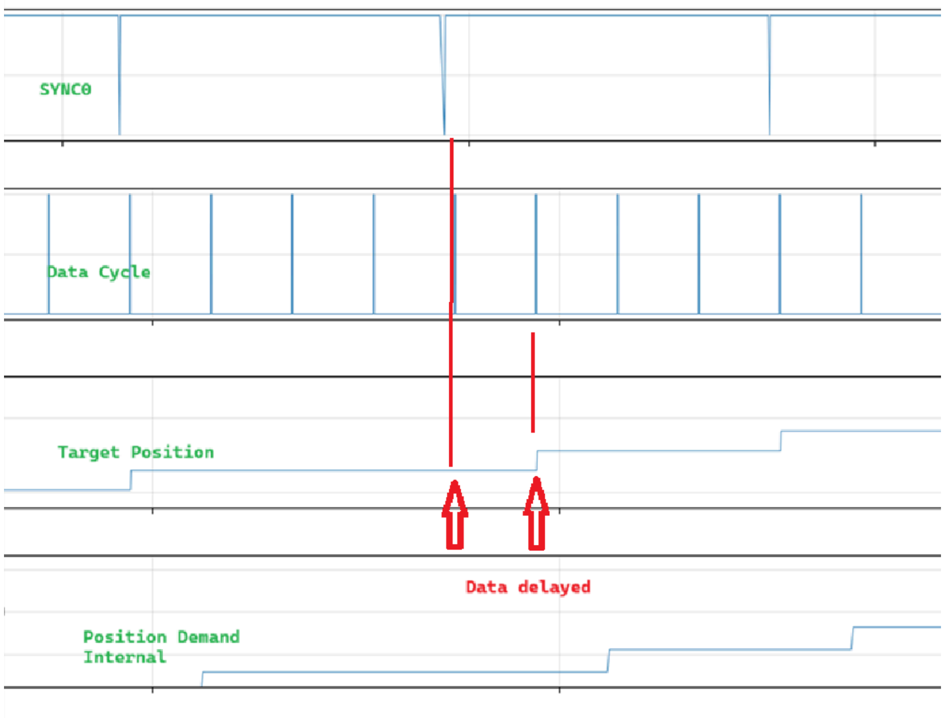


Figure 1 - Data cycle - Delayed data arrival

The delay could occur from various factors such as shift setting of master and also device, network setup and inconsistencies, master task cycle, and number of drives in the chain.

Additionally, the target position (profile) calculated by the master has an effect if the increment is not consistent with the data cycle.

This network trace is one such case that shows that the data frame arrives 1ms later than expected. Instead of 4ms, it arrives after 5ms.

9323	0.003938213	LCFCElectron_74:2e:…	Broadcast	ECAT	180	7 Cmds, SumLen 64, 'ARM
9325	0.004071370	LCFCElectron_74:2e:…	Broadcast	ECAT	180	7 Cmds, SumLen 64, 'ARM
9327	0.003991371	LCFCElectron_74:2e:…	Broadcast	ECAT	180	7 Cmds, SumLen 64, 'ARM
9329	0.004026208	LCFCElectron_74:2e:…	Broadcast	ECAT	180	7 Cmds, SumLen 64, 'ARM
9331	0.003916482	LCFCElectron_74:2e:…	Broadcast	ECAT	180	7 Cmds, SumLen 64, 'ARM
9333	0.004081660	LCFCElectron_74:2e:…	Broadcast	ECAT	180	7 Cmds, SumLen 64, 'ARM
9335	0.003934789	LCFCElectron_74:2e:…	Broadcast	ECAT	180	7 Cmds, SumLen 64, 'ARM
9337	0.005131285	LCFCElectron_74:2e:…	Broadcast	ECAT	180	7 Cmds, SumLen 64, 'ARM
9339	0.003927799	LCFCElectron_74:2e:…	Broadcast	ECAT	180	7 Cmds, SumLen 64, 'ARM
9341	0.004013355	LCFCElectron_74:2e:…	Broadcast	ECAT	180	7 Cmds, SumLen 64, 'ARM
9343	0.003935050	LCFCElectron_74:2e:…	Broadcast	ECAT	180	7 Cmds, SumLen 64, 'ARM
9345	0.004019458	LCFCElectron_74:2e:…	Broadcast	ECAT	180	7 Cmds, SumLen 64, 'ARM
9347	0.003972792	LCFCElectron_74:2e:…	Broadcast	ECAT	180	7 Cmds, SumLen 64, 'ARM
9349	0.003896308	LCFCElectron_74:2e:…	Broadcast	ECAT	180	7 Cmds, SumLen 64, 'ARM
9351	0.004018891	LCFCElectron_74:2e:…	Broadcast	ECAT	180	7 Cmds, SumLen 64, 'ARM
9353	0.003990720	LCFCElectron_74:2e:…	Broadcast	ECAT	180	7 Cmds, SumLen 64, 'ARM
9355	0.003955360	LCFCElectron_74:2e:…	Broadcast	ECAT	180	7 Cmds, SumLen 64, 'ARM

Figure 2 - Delayed network data frame

The graph below explains how the data is sampled internally and control parameters are calculated based on the sampled data. The position control loop with control input FIR filter is explained in Reference [1].

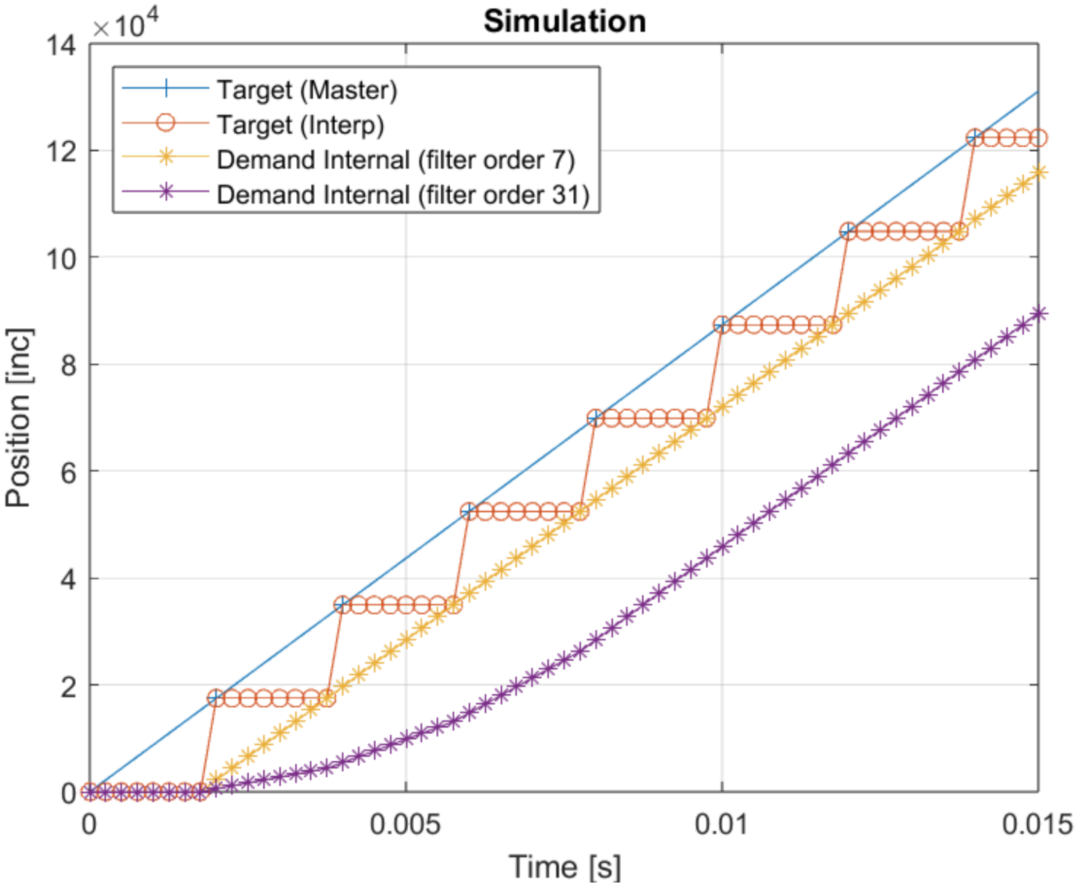
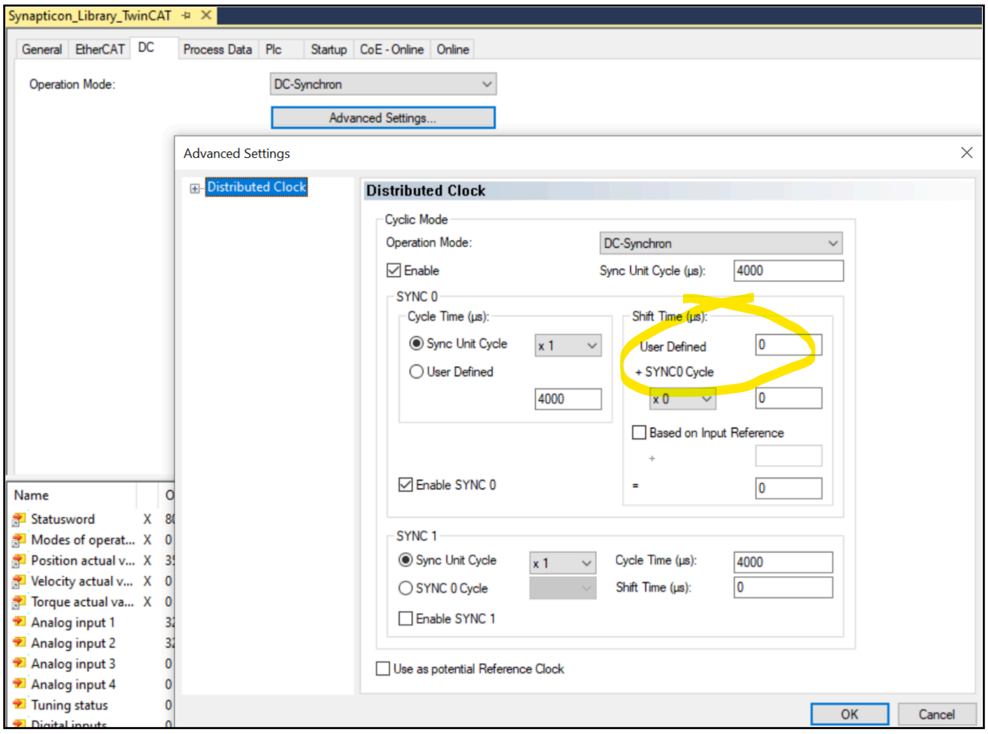


Figure 3 - Target demand

6. The Solution

1. Make sure the network is stable. Avoiding non-realtime (non-industrial) switches in the network might improve the data throughput.
2. Adjust the drift percentage and shift parameters in the master. This will improve the sync tolerance by reducing the jitter.
   For reference, refer to the images below from TwinCAT.



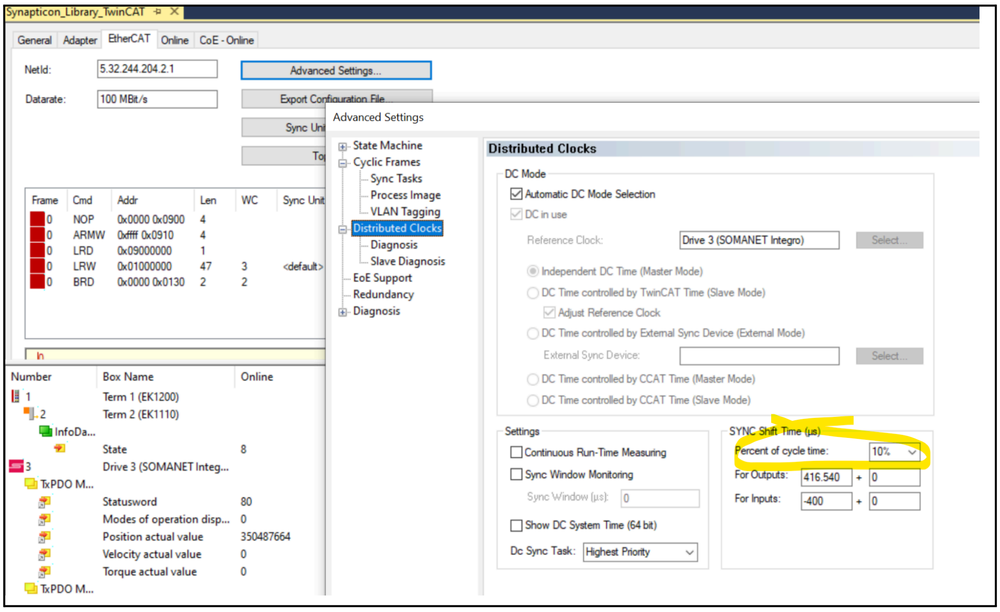


Figure 4 - Master DC setting in TwinCAT

3. Target setpoints issued by the master must not exhibit any jitter.
4. Tune properly to the expected step response based on the system. Tuning it for a sharp response tends to increase the occurrence of spikes.
5. Adjust the Input filter order. When the input FIR filter order is high, the input data would be smoother and the spikes are eliminated (0x2027 Control input FIR filter, 0x2015 Velocity feed forward)
6. Increasing the data read frequency (0x2500 Cyclic control input frequency) to 2KHz will increase the data read rate and smoothen the spikes.

7. References

[1] SoftwareReference 5.6 -> Motion Control -> Position Control Loops