TEST-DOCUMENTATIONS

NIK5.3#5 IN-Kind – Project
Test Package for Linear Motion Technology

Author: Michael Klein
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Forschungszentrum Jülich GmbH
JCNS – Jülich Centre for Neutron Science
52425 Jülich
Germany

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Content

Test and Measurement Definition Report

Proposals from FZJ / JCNS

Analysis of the dynamic behavior and control quality

Herewith the dynamic driving profile of the linear motors could be investigated. Especially interesting could be the acceleration – and the force behavior. It would be possible to record the movement profile of the different linear motors that could be loaded with different loads / weights. The more load the motors should move, the more different the automatic controller action and transient response should look. It could be an option to test und control the control quality of the different linear motors.

In this test and measurement scope, basically all selected linear motors could be included and compared.

Performance and Stability

In this test and measurement scope, the performance and stability of the feedback systems and possibly of the linear motors could be investigated. Herewith different measurements or tests with the test items could be executed.

One possibility could be the analysis of the accuracy and repeatability of the different Feedback systems. The accuracy of the linear motor system is highly dependent on its feedback system and the mechanical guides and bearings. The mechanical guides and bearings, the linear motor system and the feedback system have to be well coordinated. Because of that it might be interesting to investigate which of the three selected feedback systems for commutation and positioning (note: Renishaw, AMO and NUMERIK JENA) with BiSS-C interface is the easiest one to integrate to the construction and the control level and which one is working in cooperation with the selected linear motors best and most accurate. This investigation is especially suitable for the selected feedback system for commutation and positioning in cooperation with the three phase linear motors (note: Tecnotion, HIWIN and LinMot).

Another possibility could be the comparison between the positioning measuring systems with BiSS-C or SSI Interface (note: Renishaw, AMO, NUMERIK JENA, Turck, TWK) and the ultra-precise displacement sensor IDS3010, manufactured by Attocube, which works on the interferometric measuring principle. In this connection, it could be an option to test and compare the long-term performance of the different feedback systems in comparison to the high-precision interferometer. For example, the accuracy or repeatability of the different feedback systems in continuous operation could be investigated in a given time “t”. Then it could be determined which system best matches the performance of the interferometer. The measured values recorded in the given time could be collected in parallel and forwarded to the control computer. There, the data could be collected and traced with external software in a waveform. Alternatively, it could be an option to start a long-term performance measurement in a given time “t” with both, the feedback systems for commutation and positioning (Renishaw, AMO, NUMERIK JENA) as well as the additional feedback systems just for positioning (Attocube, Turck, TWK, LVDT + Gantner Instruments). Afterwards both systems could be compared and analyzed (e.g. accuracy and repeatability). The measured values could be collected on the control computer and traced in a measuring curve as well.

Furthermore it could be possible to compare the performance between the iron-core linear motor, manufactured by HIWIN and the ironless linear motor, manufactured by Tecnotion. Here, the influence and impact of cogging on iron-core linear motors could be investigated in comparison to ironless motors. Cogging has negative effects on the synchronous run of the iron-core linear motors and thus on the positioning accuracy. Thus, it could be investigated whether one and the same feedback system in operation with an iron-core linear motor really influences the positioning accuracy compared to the operation with an ironless linear motor.

Temperature profile

Herewith the temperature dependency of all selected linear motors could be investigated. During continuous operation, temperature monitoring could be recorded over a given time “t”. Optionally the measured values could be collected and transferred to the control computer. With an external software it could be possible to trace the data in a waveform on the control computer. With the aid of these measured values, it can be evaluated how temperature-dependent the various linear motors are and whether it may be necessary to use external cooling (e.g. fan, water cooling).

In this test and measurement scope, basically all selected linear motors could be included and compared.

Force/current monitoring

In this test and measurement scope, a force-current characteristic curve of the selected linear motors could be recorded. In this connection a current measurement for each linear motor could be executed. Parallel a force measurement with a force sensor is necessary. Both measured data could be collected and diagramed in a coordinate system, which could then be compared with the theoretical ideal force-current curve. There is a direct proportional relationship between absorbed current and delivered force in linear motors. In fact, however, the power delivered by the motor depends on various parameters, such as mechanical friction, weight forces due to the mounting position or magnetic sources of error, such as cogging.

Furthermore a load bearings test could be an option. Different loads could be fixed on the linear motors and then it could be investigated the consequences if the different loads have an impact on the acceleration or accuracy of the system. Can the linear motor still achieve the data for acceleration specified in the specifications?

In this test and measurement scope, basically all selected linear motors could be included and compared.

Disturbance reaction

It would be possible to investigate the disturbance behavior of the different test items. This applies primarily to the selected linear motors but also the feedback systems could be investigated in the disturbance behavior. What happens in the case of influence from outside?

For example, one option would be to test the behavior of the selected linear motors in the event of an emergency stop signal. Would the linear motor immediately stop and the fixed load experiences a strong jerk or would the motor continue in extreme cases until it reaches the limit stop? Also, the behavior of the selected feedback systems could be investigated in the event of a not stop signal.

Furthermore it could be possible to test the light sensitivity of the selected feedback systems. The lighting conditions can change at the place of installation. Sunlight from outside or power breakdowns, for example, may cause the lighting at the place of installation to vary. This could possibly affect the accuracy or repeatability of the feedback systems during operation, which could be investigated within this scope of the test.

Basically in this test and measurement scope, all selected linear motors and feedback systems could be included and compared.

Synchronously behavior

In this test and measurement scope, the synchronously behavior of the selected three-phases linear motors could be investigated. In this connection the selected feedback system for commutation and positioning (note: Renishaw, AMO, NUMERIK JENA) and the automatic controller action play a central role.

It could be possible to create a master / slave connection. Because of that, it is beneficial to use the selected linear motors (note: HIWIN, Tecnotion, LinMot) that will be powered and controlled via the dual channel servo drive, manufactured by Beckhoff. In that case, both channels of the servo drive and hereby two linear motors could be synchronized. A test example could be to create a requirement that the defined master – motor will reach the desired position “x” in a certain time “t”. The slave – motor could be configured in such a way that, for example, it moves

synchronously to the master motor, but reaches the desired position "x" only after twice the time "t" (2 x t). Also in this case it could be investigated whether the synchronously behavior would have an influence to the accuracy or repeatability of the feedback systems.

Environmental influences (optionally)

In these possible measurements or tests, the influence of environmental conditions on the different test items could be investigated. Especially for the utilization in neutron research, the selected products can be used in a variety of difficult environmental conditions such as high or low level radioactive radiation, vacuum or magnetic fields. For use in difficult conditions, most manufacturers cannot give any statements about the performance or possible limitations, as such areas of application are very rarely requested. Therefore, such tests could be useful, but unfortunately they are difficult to realize especially with the whole test bench.

A possibility could be to mount one of the selected motors and if necessary one of the selected feedback systems on a separate table and to expose the linear motor to a neutron instrument with radiation at the research neutron source FRM II in Garching near Munich, Germany. In that case it would be possible, for example to investigate the effects of the radiation environment for the selected test items for one day. Hereby different tests could be executed, for example the investigation of performance, automatic controller action, transient response, acceleration- and braking behavior for the selected linear motor or the accuracy and repeatability of the selected feedback system.

An additional possibility could be to investigate the above-mentioned tests for a linear motor and a feedback system at a research facility where an instrument with a magnet is available to observe the influence of magnetic fields on the test items.

Manageability

Herewith it could be possible to test and evaluate the manageability of the different test items. For example linear motors, and in particular the ironless motors, are designed to work very maintenance-friendly and wear-free. At the end of the test and measurement phase of this project, it could be possible to investigate if maintenance would be necessary or if wear on the motors, feedback systems or mechanical guides can be detected.

In this test and measurement scope, basically all selected linear motors could be included and compared.

Comprehensive cost analysis

In contrast to the previous, more technically designed tests, measurements and investigations, a comprehensive cost analysis would offer the opportunity to carry out an economic investigation as well. An evaluation could be created whether the costs for the different test items were justified on the basis of the carried out technical investigations (e.g. performance measurements). This could be useful for a final overall comparison and a final evaluation of the selected test items.

Another possibility could be, for example, to analyze the market whether costs of linear motors increase linearly or exponentially with the possible weight load of the motors.

Draw comparisons

Finally of the test and measurement phase of this project, an overall comparison of the various test items could be drawn. In addition to the acquisition costs, the results from the technical measurements and tests could also be introduced. The different selected linear motors and feedback systems could be compared and afterwards an evaluation can be created about which test items would make the most sense for the utilization in neutron research applications.

Commissioning Reports

Measurement Reports