Drive Dynamics Analysis, DDA: A powerful service for better performance of drive trains

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Summary

Based on more than 100 years of industrial process know-how and combined with the latest technology in mathematical simulation, ABB has developed a powerful service – Drive Dynamics Analysis, DDA to ensure better mechanical and electrical performance of drives in different industrial applications. The DDA Service package helps various industries identify the causes of poor dynamic performance of their drive trains, determine correct parameters for optimum drive performance and thereby improve productivity and quality.

What is DDA?

DDA, Drive Dynamics Analysis, is a service based on a software package developed by ABB. The service results in a report that contains detailed information on system performance, proposed controller tuning or recommendations for better mechanical solutions, depending on the specific customer's needs. The software package is based on ABB's know-how of drive system design and it
is used to analyze both the electrical and the mechanical performance of new and existing drive trains. By simulating the performance of different drive train solutions with DDA Service, ABB can provide customers with an accurate analysis of the complete drive train, thereby giving a better solution to optimize the performance of their drive systems.

The aim of the DDA Service is to identify possibilities and technical solutions to optimize and improve manufacturing processes that include drive trains. With the DDA Service, the current behavior of a drive system is documented, including the mechanical and electrical characteristics and their relationships with the process. In addition, the effect of introducing new mechanical or electrical components in the drive system may be analyzed.

The DDA results in a report that will give detailed information on:

- Mechanical characteristics like resonance frequency, amplitudes and damping in various parts of the mechanical components of the drive train.
- Electrical characteristics like torque dynamics and speed dynamics.
- Drive system characteristics like dynamic performance of combined electrical and mechanical systems, response times, maximum shaft torque and impact drop.
- Evaluation of improved performance through the introduction of advanced drive control algorithms. ABB has developed advanced algorithms for the demanding applications of drives in hot rolling mills and vehicle test rigs.

Fig. 1. Representation of shaft stiffness and inertias and calculation of all resonance frequencies.
Fig. 2. Representation of the resonance frequency and amplitude in each node of the drive train.

The report will also outline:

- The effects of retuning existing systems to provide a basis for improved performance and/or reduced wear and tear.
- The effects of replacing or modifying converters and/or mechanical parts.
- Proposed actions for improvement depending on the individual goals of the Service.

With ABB’s extensive know-how of different industrial applications of drive systems, DDA can be applied to any commercially available drive system.

**Why do we need DDA?**

In many industrial plants, such as rolling mills and paper machines, the **drive systems**, including the mechanical parts, constitute some of the most important process resources. It is very important that these drive systems are utilized optimally in order to achieve a high production in combination with a high quality with minimal maintenance costs.
In many cases the complete drive system, including the mechanical parts, is not properly designed, commissioned, tuned or maintained, which leads to visible symptoms such as:

- Poor drive dynamics
- Instability
- Torsional vibrations
- Wear and tear
- Increased maintenance requirements

In those cases where the drives perform adequately, there is still a potential for improvement, which is often largely ignored. DDA provides information on the status of the drive system and proposes possible ways to:

- Enhance the performance through redesigning and/or tuning of the drive system, thereby improving production yield and quality.
- Reduce maintenance requirements.
- Reduce plant downtime

Other important issues addressed by DDA are:

- Choosing an optimal revamp.
- Finding the root cause of mechanical breakdowns.

*Fig. 3. Industrial drive system.*
Fig. 4. Frequency response from motor torque and load torque, respectively, to all internal speeds and torques, as defined by the input data instructions.

**Benefits of DDA Service**

The DDA Report, the final result of DDA Service, will help the customer make the right decisions when optimizing the use of his drive system. The value of the benefits to the customer varies with the process and has to be calculated from plant to plant. However, the customer will generally gain the following benefits:

- **Increased productivity due to** minimizing of plant downtime, which occurs as a result of planned and unplanned maintenance that can cost kUS$10-100/h. A small reduction of the plant downtime after the improvement of a customer’s drive system proposed by DDA can give a very short payback time.

- **Better product quality** due to minimizing of product downgrade. Poor performance of a drive system will often be accompanied by downgraded production such as scrap that cannot be sold. The improved drive system will give higher material tolerances and thereby a better product quality.

- **Longer life cycle of drive systems due to** the retuning of the drive or the rebuilding/replacing of mechanical parts. Slow toque dynamics and weak shafts tend to shorten the life cycle of drive systems. DDA helps indicate weak points of the drive systems and their mechanical parts.
In general, the costs of performing the DDA Service are often substantially lower than the possible gains.

**Experience of DDA Service in different industries**

Around 100 drive trains for various applications have been analyzed using DDA. A few examples are briefly described below.

### Application in rolling mill drives

DDA has been applied in a tandem cold mill stand drive in South Korea. The major problem facing the customer was the poor dynamic performance of the drive. They could not meet their customers’ quality specifications. The drive train analysis indicated a weak shaft of the drive system and advanced drive controls were proposed to improve the drive performance. This DDA Service resulted in the inclusion of DDA at the design stage in subsequent ABB deliveries to the mill.

Another example was the application of DDA on a crop shear drive at a rolling mill in the U.S. The major symptom was coupling failure of the shear. In this case, the DDA Service performed by ABB included measurements, a drive train analysis and cutting torque simulations. The result showed the problem was caused by a low design cutting torque and large torsion overshoot. A new mechanical design was recommended to the customer.

### Application in paper mill drives

DDA has been applied on a Swedish paper machine. The customer had a problem with broken gears, broken foundations and about a 10% production bottleneck. With the help of DDA, ABB performed some measurements and a drive train analysis. The results showed that the main reason for these failures was that the mechanical parts in combination with traditional drive system controls could not take the higher speed. New drive system controls were proposed and installed for the active damping of the vibration.

### Applications in other industries

Since its launching, DDA has been applied in some other industries as well, such as fan drives for the cement industry and drive systems in the mining industry.

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