



E-Learning, DC drives

DC Drives Motivation for Modernization G566e Part 1

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for a better world™ **ABB**

Welcome to the DC Drives e-learning module, motivation for modernizations.

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To view the presenter notes as text, please click the Notes button in the bottom right corner.

Overview

Training material for modernization

- Before starting this training course we want to give you an overview about all training modules
 - Module 1
 - Motivation for Modernization
 - Module 2
 - DC Drives Revamp Products
 - Module 3
 - Rebuild Kit Engineering
 - Module 4
 - Rebuild Kit Electrical Connection and Commissioning

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Before we start with this training module, we want to explain the different training modules of this course.

- Module 1 is about the motivations for modernization. There are different reasons, requirements and needs of the customer which have to be considered.
- Module 2 is about the ABB DC drives revamp products we have. It is mandatory to know the differences of all products to decide later about usability.
- Module 3 is about the DCS800 rebuild kit and the required engineering effort.
- Module 4 is about the electrical connection of the DCS800 rebuild kit and commissioning.

All modules together should give hints and suggestions on how to modernize with success!

Objectives

This training module covers:

- Different reasons for modernization
- Parts of the drive system which should be taken into consideration
- How to handle important hardware devices around the DC drive
- Hints for engineering required for all electrical parts

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Introduction



- Conditions, statements or wishes are listed and given by the machine's owner, as to why parts of the machine should be changed
- A typical drive configuration is used to list some hints which parts of a machine should be taken into consideration for a change
- Know ABB's terms and the product portfolio

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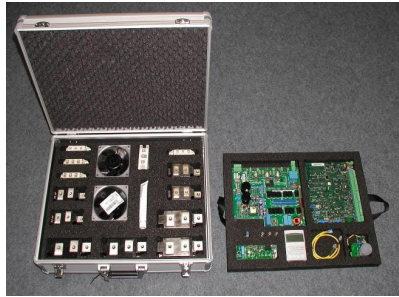
In this training module conditions, statements or wishes are listed and given by the machine's owner, as to why parts of the machine should be changed.

A typical drive configuration is used to list some hints which parts of a machine should be taken into consideration for a change.

Know ABB's terms and the product portfolio to decide about modernization solutions.

Reasons for a change

Argument 1: Spare parts



Argument

- “I want to make a change, because spare parts are no longer available”
- Spare parts are no longer available
- Delivery time for spare parts not available according to needs
- Commercial terms not according to expectation
- Spare parts may depend on each other
- Original manufacturer is no longer present on the market

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Let's start with an important argument: “I want to make a change, because spare parts are no longer available”.

- Spare parts are no longer available. The argument pertaining to the availability of spare parts is mentioned quite often and is directly related to the age of the existing equipment.
- Delivery time for spare parts not available according to needs.
- Commercial terms not according to expectations. Spare parts are quite costly compared to new products.
- Spare parts may depend on each other. This means some revisions do not work with each other and several parts have to be changed.
- The original manufacturer is no longer present on the market. It must be kept in mind, that solutions or components used in the past are no longer used today or may not be available at all.

Reasons for a change

Argument 2: Down time



Argument

- “I want to reduce the down time, the time to do the repair increase and the machine's availability decreases”
- What had caused the stand-still?
- Which tools are necessary to find the reason?
- Are the Tools being easy to handle or is the handling correct?
- Statistics available:
Which part failed how often?
- Preventive maintenance considered?

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Another argument is the down time. “I want to reduce the machine’s down time, as its repair time increases and its availability decreases over time.”

Important questions are:

- What had caused the stand-still?
- Which tools are necessary to find the reason?
- Are the tools easy to handle or is the handling correct? As a result, it may be helpful to improve the tools for fault tracing, diagnosis and/or monitoring.
- What about statistics? Which part failed and how often? It is important to find out which parts are sensitive and why.
- Has preventative maintenance been considered? ABB provides a maintenance schedule for each drive which gives information about necessary procedures.

Reasons for a change

Argument 3: Increase production



Argument

- “I want to increase the production, e.g., tons per hour, pieces per day, etc.”
- Decrease down-time / repair time
- Increase top speed of motor's
- Decrease cycle time by e.g., higher motor power
- Exchange further devices
- Less faulty parts
- Use hidden margin of the DC motor
- Change control configuration, e.g., paralleled motors to single supplied

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The argument “I want to increase production, for example tons per hour or pieces per day” quite often results in a change of key components in case the increase cannot be realized by decreasing standstill times, increasing the usage, etc.

- Very often an increase of the top speed or other physical values like current, torque, power, etc. is taken into consideration. Sometimes it seems to become very complicated and costly to turn this option into reality, but it is always worth examining the component's rated values.
- Decrease the cycle time by using higher motor power. In principle we are talking here about the same argument as before, but also in this case the name plate of the motor should be checked and compared to the needs.
- Sometimes it may become necessary to exchange or add a new supply, a supply transformer or even a motor. Such an action seems to be very costly at first glance. However, based on the final target and perhaps a possible rearrangement of components, even an enlargement of the whole installation using both types of drives, DC and AC, may be very cost efficient.
- Besides increasing physical values, the option to decrease standstill time, caused by faulty parts, or increase cycle time, needs to be verified as well.
- Often there is a hidden margin of the existing DC motor, which can be used in the future.
- Also a change of the control configuration may be necessary, for example paralleled motors changed to single supplied motors.

Reasons for a change

Argument 4: Production with higher quality



Argument

- "I want to produce my product with a much higher quality and higher accuracy"
- Less faulty products
- Lower tolerances (gear backlash, couplings, etc.)
- Better control (speed, torque variation, etc.)
- Material handling (storing, etc.)

The argument "better product quality required" is a very important one these days, because of various effects on the global market like being competitive, market price of the product, and so on. Secondly it is a need, which does not have to affect the electrical drive system only.

- Less faulty products mean mainly the manufacturing process itself. Of course, the drive system will influence this and should be adapted to the needs.
- Today's design of DC converters gives a higher performance which results in a higher accuracy for speed and current, but it is the overall configuration that determines if this improved performance can be reflected in the product. There is the electrical drive on one end and the machine with all its components on the other end, like speed feedback device, gear box, coupling, interaction with other parts of the production line and others.
- With today's converters, control is much better and additional control loops can be implemented to compensate for errors occurring somewhere in the machine. As long as the converter is engineered properly as a part of the whole system, the increased accuracy and performance is available to increase the product's quality.

Reasons for a change

Argument 5: Use latest technology



Argument

- “I want to supervise the complete production process and use the latest technology for that”
- Records about material flow
- Information about the machine's condition
- Data for preventive maintenance
- Data for fault tracing / repair
- Option for increased control performance

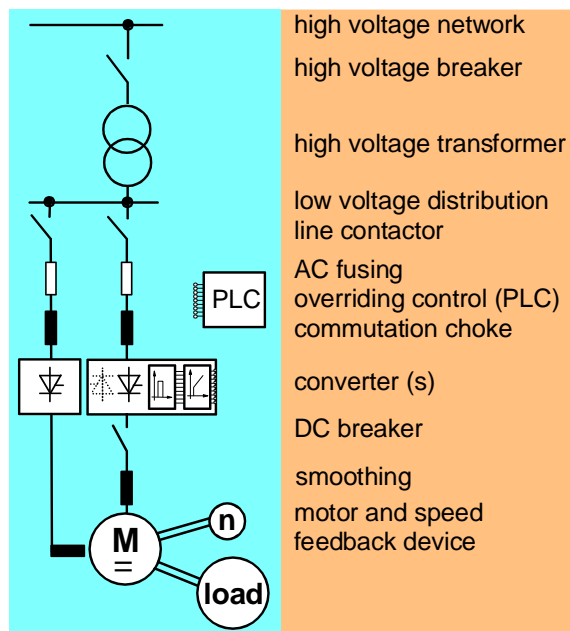
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Another argument can be: “I want to supervise the complete production process and use the latest technology for that”

- The argument “better factory automation based on the latest technology” is necessary to summarize a lot of smaller features which provide advantages for the management of the whole production process. This could perhaps start with the logistics of raw materials, the availability of the production line, the status of the actual product, including quality management, and end with the logistics for storing or shipment.
- The actions for this feature are not limited to just a single component. All the equipment may become affected by the change. Most likely a complete new PLC needs to be installed with as many components as possible linked to it either by a serial link or conventional I/O. When including e.g. level sensors for the oil at a gear box, preventative maintenance will be available as well.

Drive configuration



- To run any type of load using a DC drive, some of the components shown on the left are necessary in every case
- Nevertheless every part can be taken into consideration for a change

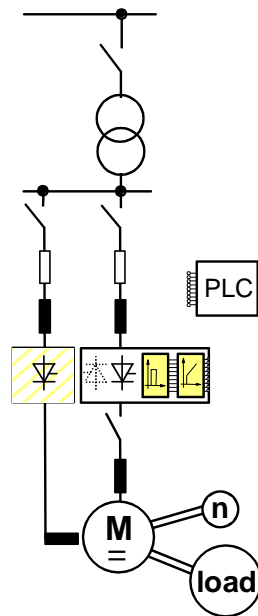
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Normally, every part of any installation can be questioned and taken into consideration for a change. This will result in a terribly long list with a lot of difficulties for evaluation. The next points just list options for a few selected components within a production line, which are worth observing in more detail from the electrical point of view only.

Parts taken into consideration (1)

New electronics



New electronics for the DC converter's power part

- All electronics located close to the power part are regarded as a part of the existing converter
- What are the control loops existing in that hardware?
- Which functions (monitoring, protection, etc) were available?
- Does the new solution cover all loops and functions
- Looks easy to do, cost effective, but needs high engineering skills

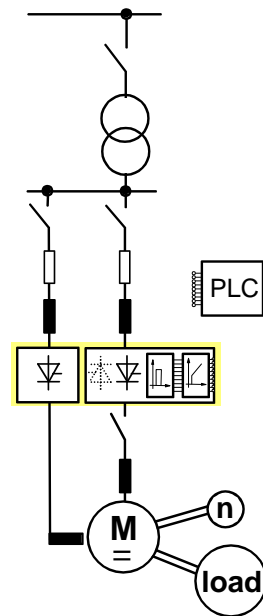
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The idea of new electronics for the existing DC converter's power part sometimes comes up, because of the impression it provides a fast, easy and cheap solution. When looking more into the details, a lot of hardware around needs to be reused and checked as well, if it is still in good condition. Additional questions arise too, such as spare parts for reused components or others previously mentioned. This option needs engineering similar to designing a brand new converter. Nevertheless when doing the engineering carefully, this option gives access to the power stack and to the PLC system as well. This automatically provides access to monitoring or diagnosis functions. In addition, improvements for the motor control as mentioned above are possible.

Parts taken into consideration (2)

New converter



New converter

- The converter with everything within its frame like power part, fan, electronic boards including interface to the installation and the frame itself is regarded
- Existing engineering is the basis to start with
- New converter is function tested, most likely with field supply and with warranty
- Gives access to new functions

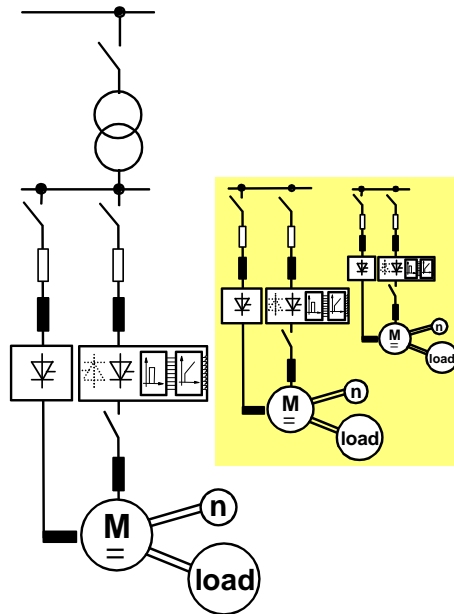
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The new converter option gives very similar results as the one before, but fewer risks, because the number of reused parts is much lower. The engineering efforts are slightly minimized, because standard solutions can be used to start with. Depending on the existing hardware to be changed, it is perhaps a more straight forward solution than the one before. When comparing the previous option and the current one, all engineering efforts have to be compared with each other as well as all the efforts necessary to do the installation and commissioning.

Parts taken into consideration (3)

Expansion of the equipment



Extension of the equipment

- Additional drives are necessary because of added sections or e.g. motors had been exchanged with bigger ones
- Just add new converters or cubicles as a supply
- Existing or spare parts (power parts, converters, etc) may be taken, rewired, reconfigured, etc. for higher power
- Utilize experience done with other projects

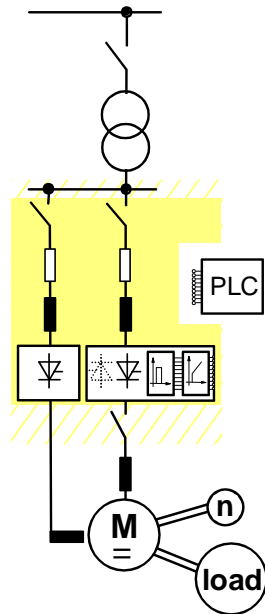
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Sometimes there is a simple solution for the extension of the equipment with an additional converter. One of these cases is present in case the power of a drive system needs to be increased. This can only be achieved by adding another converter. Nevertheless this does not have to end with horrible costs. It depends on some details, if several slightly different solutions are possible. When using a 4 quadrant system as an example, it may be one of these options to use the existing reverse bridge for the new forward current direction and have twice the available power and add a “small” new converter for the now missing reverse bridge. In case the motor needs that high power only in one quadrant, the new one can be comparatively small.

Parts taken into consideration (4)

New cabinet



New cabinet

- The complete drive system between DC motor and transformer will be replaced whereas the interface to the PLC needs to be pre-engineered
- Relatively low level of electrical engineering
- Mechanical engineering always necessary
- Numerous functions existing just for activation
- Perfect option for short “put-into-operation” time

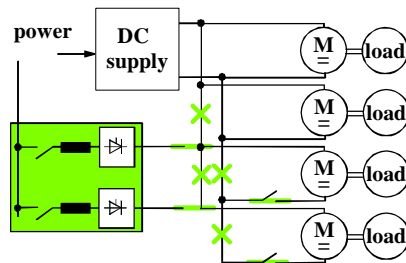
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The new cabinet from the control point of view will give very similar or identical results and options as the ones listed before. It is the installation time and the new power being available afterwards that makes the difference. This may be the fastest and safest way to exchange important components of a production line. From an economical point of view, all advantages / disadvantages need to be compared with each other before a final decision can be made.

Parts taken into consideration (5)

Change the configuration

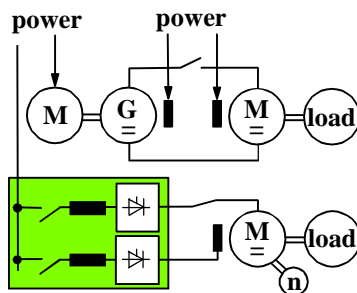


Change the configuration

- The existing wiring, e.g. of motors or their supply, will not provide the performance of today's solutions even with new controllers

Some examples

- MG Set → 6-pulse-converter or 12-pulse-converter and new transformer
- M3 / M6 configuration converted to B6 configuration
- Special DCS800 solution possible for roller table paralleled motors
- Field reversal replaced by 4-Q-drive



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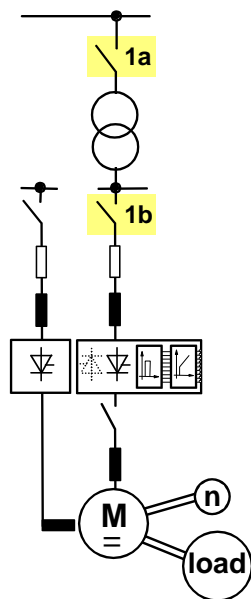
Changing the configuration needs the highest level of imagination, but, technically, mechanically and economically-speaking, this may end up with the most efficient ideas. Depending on the preconditions, e.g. mechanically or from the space point of view, a solution needs to be questioned, altered or perhaps rejected completely, when using a motor or generator as an example, the modification of the existing field control may look very nice and cost effective. The evaluation of that solution will show that the performance of the drive will not become dramatically better. Service and maintenance for the generator system (e.g. mechanically) will be identical and the main reason for a change may not be completely solved. Going to the other extreme and removing the generator and supplying the motor with a converter will raise other issues to be discussed like the supply for the converter (transformer, 6 or 12 pulse, etc.), converter configuration (number of pulses, parallel, serial, sequential, ripple current, harmonics, etc) and finally the costs, space, etc.

Here are some examples:

- An MG Set can be replaced by a 6-pulse-converter or a 12-pulse-configuration, sometimes combined with a new transformer.
- M3 and M6 configurations will be converted to B6 configurations.
- Special DCS800 solutions are available for roller table paralleled motors.
- Field reversal with a switch will be replaced by a 4-Quadrant-Drive.

Engineering

Dedicated transformer present



Dedicated transformer for the DC drive: (high voltage transformer present)

- Please check the following:
 - Recommend interlocking, sequencing and help for converter protection with switch 1b missing
 - With 1a and 1b present, close 1a first, then 1b delayed and vice versa
 - Depending on transformer ratio, take additional features into account, e.g. high voltage synchronization
- Note:
Any switching action at the transformer causes overvoltage in the DC drive!

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In many cases the dedicated converter transformer will be present. Reasons could be that the old one can be reused or is available due to some other reasons.

Typically, such high voltage transformers are connected to a medium voltage line and transform the voltage down to the converter's incoming voltage level. Normally, there are some switches at the primary and secondary side of the transformer which have to work in common with the DC drive system.

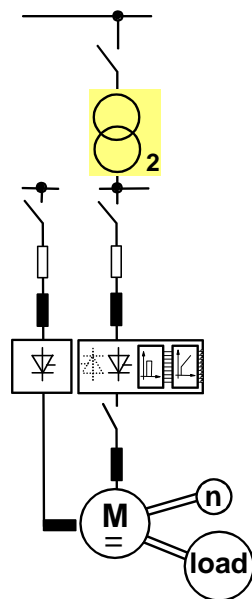
It is important to have the correct switching sequence of all the switches. Only this will help with converter protection if switch 1b is missing.

If switches 1a and 1b are present, close 1a first and, after a short delay, close 1b.

Depending on the transformer ratio, take additional features into account, for example external high-voltage synchronization.

Note: Any switching action at the transformer causes overvoltage in the DC drive!

Engineering Dedicated transformer



Dedicated transformer for the DC drive: (new high voltage transformer)

- Check the following:
 - Transformer data
 - Give comments on them
 - Recommend key data
 - Give additional converter data for economic transformer design

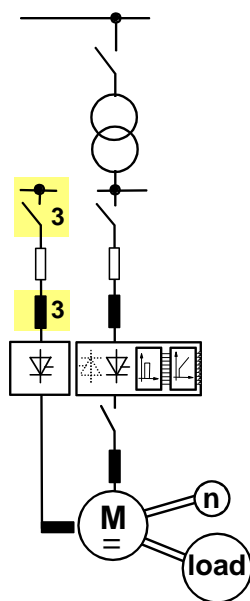
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If a new high-voltage transformer should be specified, some aspects have to be checked.

ABB DC Drives can help you to check the transformer data, give any comments on them, recommend key data or give additional converter data for economic transformer design.

Engineering Field Supply



Field supply strategy for the DC drive:

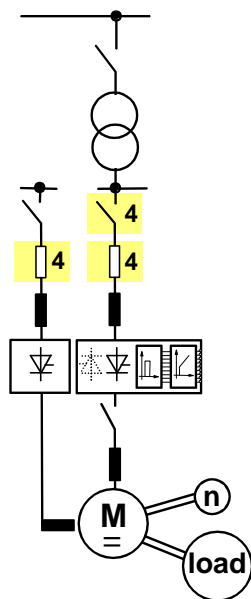
- Check the following:
 - List different circuits with pros and cons
 - Check existing solutions, analyze advantages and suggest solutions including parts to be used
 - If necessary, give design help for non-standard parts, e.g. matching transformer
 - Give configuration hints in case several motors are to be supplied

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In older DC drives, the field supply was often a separate unit. Nowadays this part is often integrated inside the armature converter. In the past many different field control circuits have been used and it is important to evaluate the pros and cons of those. The existing solution should also be checked to find out which parts can be reused for the new field exciter. If any adaptation transformer in the field circuit is necessary, they need to be designed to achieve optimal performance later. We can also give some configuration hints in case several motors are to be supplied.

Engineering Protection



Protection on the AC side of the DC drive:

- Check the following:
 - Notes describing the background
 - Selection of semiconductor fuses
 - Fuses for the armature circuit
 - Fuses for the field circuit
 - Comments about the use of fuses versus breakers

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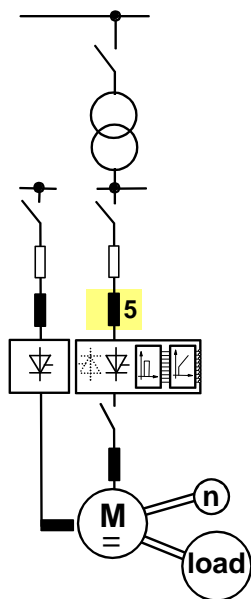
The protection of the DC drive is very important. On the AC side there are typically fuses or breakers to protect the DC drives system. Which one should be used depends on the power and the requirements.

It is important to know the background to decide correctly.

From the technical data of the drive, we know that small converters up to 1000 amps DC do not have fuses installed. They must be placed outside. All DC drives greater than 1000 amps DC have branching fuses integrated. In such cases, there is no need for a fuse before a converter's input to protect the drive. Fuses for the field circuit are required in the same way.

Only for high power applications are breakers used as main contactors and automatic fuses.

Engineering Disturbances



Line voltage disturbances:

- Check the following:
 - Suggest line choke based on circumstances
 - Give help to find suitable configuration taking technical needs and efforts into account
 - Recommend key data for non-standard conditions
 - Analyze and make comments for line voltage records

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In many discussions, line voltage disturbances are becoming more and more important because public network owners nowadays have more restrictions.

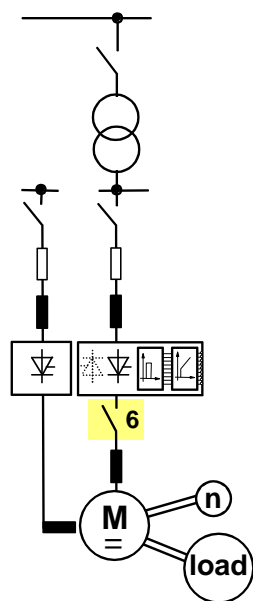
Therefore, it is advantageous to suggest a line choke based on the environmental circumstances. ABB provides 1% and 4% line chokes. Attention, sometimes old 0.25% chokes are used. Those have to be replaced!

We recommend key data for non-standard conditions like weak networks and so on.

Often it is necessary to analyze and make comments for line voltage records.

Engineering

Motor protection



Protection of the DC motor:

- Check the following:
 - Notes describing the background
 - Recommended DC breakers or fuses
 - Select breaker or fuse and do the mechanical and electrical design
 - Recommend interlocking and sequencing

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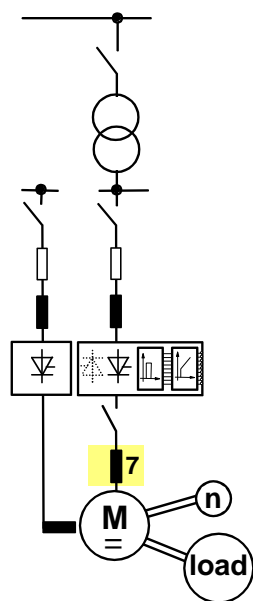
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Another issue is the protection of the DC motor. This especially comes into play, if it is a high-power application or an application which operates in regenerative mode.

Check the recommended breakers or fuses depending on the needs and requirements. If enclosed converters are ordered, the mechanical and electrical design must be done.

Do not forget the interlocking and sequencing of the breakers to avoid any problems later caused by overvoltage or shoot-through.

Engineering Harmonics



Matching network needs, DC motor characteristics and needs of the application:

- Harmonics in the electrical network
 - Recommend 12-pulse, e.g. parallel
 - Design the 12-pulse choke
 - Help for protection and interlocking
- Harmonics on the DC side
 - Suggest 12-pulse or smoothing choke
 - Get raw data then design the choke
 - Give help for DC-filter

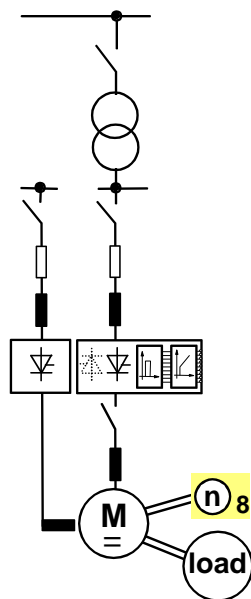
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Harmonics in electrical networks should be avoided or reduced. Therefore some points should be discussed:

- Harmonics in the electrical network can be reduced by 12-pulse-configurations.
- The design for the 12-pulse choke required for parallel configurations can be done by ABB DC drives. We also deliver the choke if necessary!
- Harmonics on the DC side can be reduced by 12-pulse or a smoothing choke.
- If DC-filters should also be used, some recommendations can be given by ABB DC drives.

Engineering Speed feedback



Matching a speed feedback device to the application:

- Check the following:
 - Analyze the necessary performance of the application
 - Give and explain the converter electronics possibilities
 - Discuss options to improve / reach the limits

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When modernizing a drive, a lot of different speed feedback versions exist which have to be connected to the new DC converter.

So it is useful to analyze the necessary performance of the application. This means all speed feedback devices have a tolerance which should be taken into account.

Also the options to connect the speed feedback devices are limited and should be checked in advance.

In some cases, an improvement in the speed feedback can be done, if a new device will be installed which provides better performance.

General info for revamps

- Short standstill time reduces the costs of the project
- Step-by-step solution could be interesting for customers
- Serial communication and interfaces often cause problems
- Extending power cables is often complicated and expensive
- Accuracy problems are often caused by mechanical or speed feedback problems
- Standard revamp solutions help to reduce stand-still time
- Discussions with the customer should be done in advance and be very detailed to avoid any surprises during the revamp
- If thyristor stacks should be reused, rebuild kits can be a cheap solution, but do not forget extra commissioning time!
- New drives typically require less space than the old ones

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Here is some general information for revamp projects which should assist you along the way:

- Short stand-still time reduces the costs of the project.
- A step-by-step solution could be advantageous for customers, because the investment and risk for small revamps are reduced.
- Serial communication and interfaces often cause problems. Sometimes they are no longer available.
- Extending power cables is often complicated and expensive.
- Accuracy problems are often caused by mechanical or speed feedback problems.
- Standard revamp solutions help to reduce stand-still time.
- Discussions with the customer should be done in advance and be very detailed to avoid any surprises during the revamp.
- If thyristor stacks should be reused, rebuild kits can be a cheap solution, but do not forget the extra commissioning time!
- New drives typically require less space than old ones.

Typical approach for bigger installations

- Check the lifecycle status of all parts
- Make a concept for short power-down time
- Critical parts should be prepared with pre-tests and should include a fallback strategy
- In the first step, only one or two drives should be changed
- Share the experience for further projects!
- Serial communication should always be pre-tested
- Check if upgrade packages are available
- Include engineering and commissioning partners at the beginning to pay attention to all requirements
- Mix products in a clever way ! (modules, panels, rebuild kits)
- Do not reuse field exciters!

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For modernizations of bigger installations, the following things should be done:

- Check the lifecycle status of all parts to get information about availability.
- Make a concept for short power-down time.
- Critical parts should be prepared with pre-tests and should include a fallback strategy.
- In the first step, only one or two drives should be changed.
- Share the experience for further projects!
- Serial communication should always be pre-tested to avoid problems on-site.
- Check if upgrade packages are available. This is always the easiest way!
- Include engineering and commissioning partners at the beginning to pay attention to all requirements.
- Mix products in a clever way!
- Do not reuse old field exciters!

Summary

Key points of this module are:

- Different reasons for a change
- Parts of the drive system which should be taken into consideration
- How to handle important hardware devices around the DC drive
- Hints for engineering required for all electrical parts

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Additional information

- DCS800 Technical Catalogue (3ADW000192)
- DCS800-R Rebuild Kits (3ADW000197)
- DCS800-R Upgrade Kits (3ADW000256)
- Questionnaire for rebuild projects

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