





		Help	
DCS800 DC Drives		Basic Crane Drive features, part 2 G567e Part 3	
	eLearning		
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Welcome to the crane software features training module part 2 for the DCS800, ABB DC drives.

If you need help navigating this module, please click the Help button in the top right-hand corner. To view the presenter notes as text, please click the Notes button in the bottom right corner.

Objectives

After completing this module, you will know

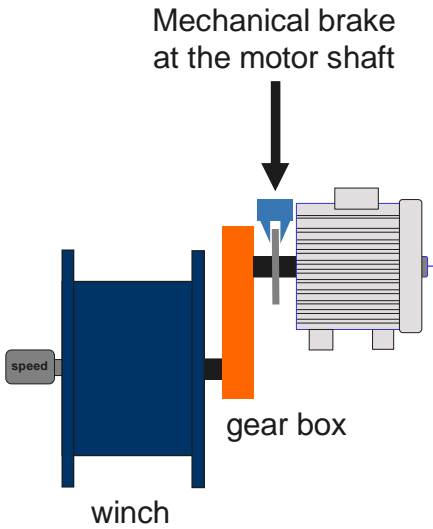
- Principle functionality of the brake logic
- Special brake functions for crane drives
- Snag load option
- Power optimization
- Reference Handler
- Master-Follower configuration
- Shared Motion Motor 2
- Fault and alarm messages for cranes



After completing this module, you will be familiar with:

- The main functionality of the brake logic,
- Special brake functions for crane drives,
- Snag Load option,
- Power optimization,
- Reference Handler,
- Master Follower,
- Shared Motion Motor 2 and
- Fault and alarm messages for cranes

Brake Logic



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- Brake logic can be used to control a mechanical brake
- The internal logic is designed to meet requirements of holding brakes
 - Carriage drives
 - Winder
 - Crane systems
- Crane logic influences directly the following firmware parts
 - Current Controller
 - Speed Controller
 - Speed Ramp

ABB

The “Brake logic,” used to control a mechanical brake, is an implemented software function inside the DCS800. The output of this logic is a control bit, which can be used to control the contactor of a mechanical brake.

The internal logic is designed to meet the requirements of holding brakes.

These can be:

- Carriage drives,
- Winders or
- Crane systems

The Crane logic directly affects the following firmware parts :

- Current controller,
- Speed controller and
- Speed ramp

Principle approach to lift a mechanical brake

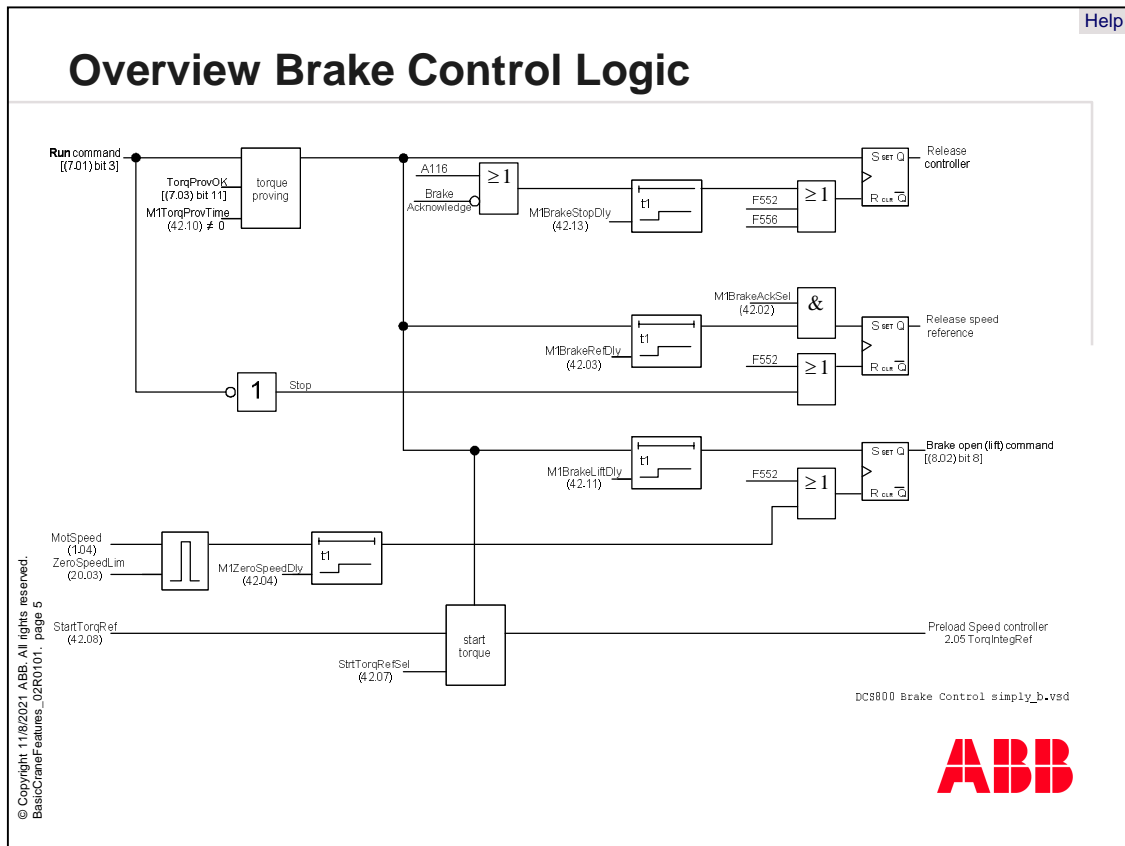
- Brake has two possible states (Lift / Open or Apply / Close)
- Brake is closed and motor torque not present
- Enable drive and the motor can produce torque
- Mechanical brake is lifting
- Normal operation of the drive system
- Motor speed is decreasing until zero speed level
- Mechanical brake is closing
- Motor torque can be switched-off
- Attention:
It is strictly forbidden to lift the mechanical brake without active motor torque.



The main approach to lifting a mechanical brake from the physical point of view is described on this slide.

- In principle, a mechanical brake has two possible states. Lift or open means the brake is not affecting anything. Apply or close means the brake is active and stops the turning shaft.
- If the drive is switched-off, the brake is closed because motor torque is not present.
- The next step is to activate the drive in a way that the motor can produce torque.
- The mechanical brake is lifting.
- Now the drive system is in normal operation mode.
- If the motor speed decreases until zero speed level, the normal operation mode is left.
- This means the mechanical brake is closing.
- If the brake is closed, motor torque can be switched-off.

Attention: It is strictly prohibited to lift the mechanical brake without active motor torque. In this case, the load could drive the mechanics by itself and compromise people or damage devices.



The picture shows a simplified overview of the drive logic in the DCS800. This functionality is embedded in the DCS800 firmware and can be switched-on if needed.

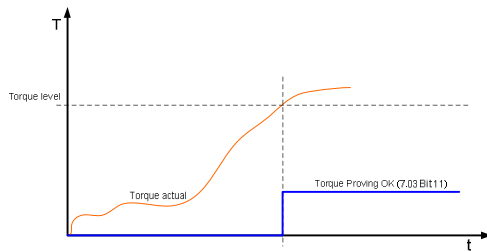
The complete functionality is connected to the drive logic.

The Output command of the brake logic has in principle three commands:

- Release speed reference / ramp,
- Release speed controller and
- Brake open command

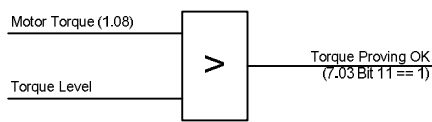
In the following slides, several parts of the brake logic will be described in more detail.

Torque Proving



Example:

Control Logic to set torque proving bit



Time for torque proving process is limited to 42.10
If Torque Proving OK is not confirmed within defined time,
fault F556 will be generated!

**Mechanical brake is closed
during torque proving process**

- Torque proving is used to check if the drive can produce torque
- The torque proving procedure must be implemented by an application program
- DCS800 provides only
 - Input to set torque reference
 - Torque proving time (42.10)
 - Torque proving ok bit
- Goal is to approve by setting of the torque proving ok bit (7.03 Bit 11)



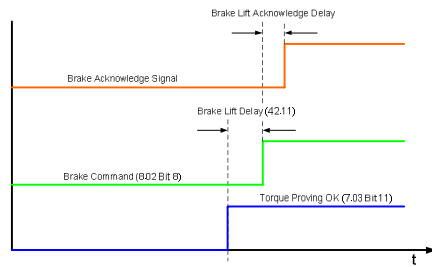
- Torque proving is used to check if the drive is able to produce torque. You have to set the torque proving bit via an application program to enable the brake logic. The DCC800 Crane application program includes torque proving functionality. The DCS800 itself does not include any torque proving functions.
- The torque proving procedure must be implemented by an application program. It is up to the programmer to define an approach for torque proving.
- The DCS800 only provides the following torque proving functions:
 - Input to set torque reference
 - Torque proving time
 - Torque proving OK bit
- The goal is to approve torque by setting the torque proving OK bit

The picture shows a very simple example of implementing a torque proving approach.

Torque proving works in the following way:

- A run command and a torque reference are set by separate torque inputs.
- The actual torque will be checked by an application program and the torque proving bit in auxiliary control word 2 must be set, if the test is completed successfully.
- The torque proving will be checked by torque proving time. If the torque proving is too long, a fault will be generated.
- Before the brake is opened, a start torque can be defined to avoid turning a motor in the wrong direction (dangerous for hanging loads).

Open mechanical brake



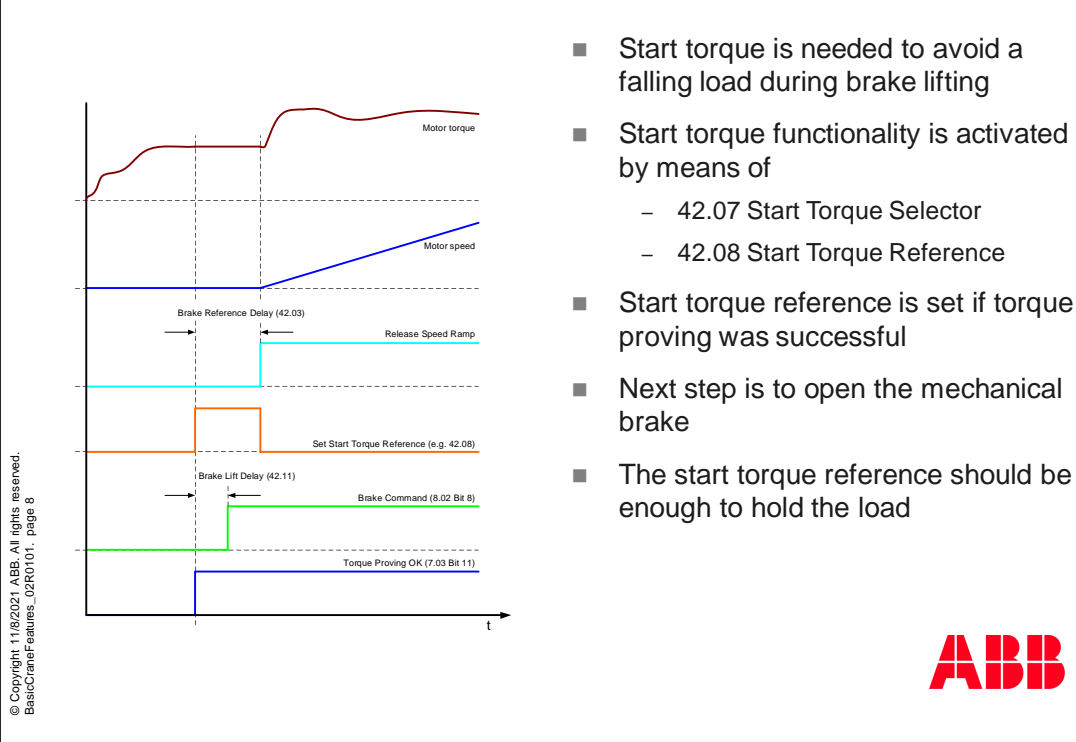
- If torque proving has been completed successful (7.04 Bit 11 = true), brake lifting process will start
- Brake is lifting after brake lift delay (42.11) has expired
- The brake lift acknowledge signal is the delayed signal coming from the brake which depends on the physical reaction time of the brake
- That means the following conditions are needed to lift the brake
 - Drive is in run command
 - Torque proving completed successfully



The open mechanism of the mechanical brake is the next step in the principal approach.

- If torque proving has been completed successfully, that means bit 11 in 7.04 is set to TRUE, the brake lifting process will start.
- The brake is lifting after brake lift delay, parameter 42.11, has expired. Then brake command, means bit 8 in parameter 8.02, is set to TRUE.
- The brake lift acknowledge signal is the delayed signal coming from the brake and depends on the physical reaction time of the brake.
- That means the following conditions must be met to lift the brake:
 - The drive is in Run command and
 - Torque proving completed successfully

Start torque



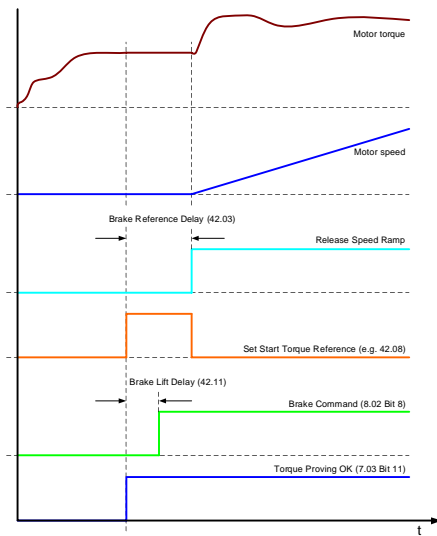
- Start torque is needed to avoid a falling load during brake lifting
- Start torque functionality is activated by means of
 - 42.07 Start Torque Selector
 - 42.08 Start Torque Reference
- Start torque reference is set if torque proving was successful
- Next step is to open the mechanical brake
- The start torque reference should be enough to hold the load



Start torque is another functionality, which is offered by the brake logic.

- Start torque is needed to avoid a falling load during brake lifting. Start torque means a preload of the integration part of a speed controller to minimize the control time during brake lifting.
- The start torque functionality is activated by parameter 42.07 Start Torque Selector and a forced reference, for example parameter 42.08 Start Torque Selector.
- The start torque reference is set, if torque proving has completed successfully
- The next step is to open the mechanical brake.
- The start torque reference should be enough to hold the load.
- This start torque value can be automatically latched before last stop.

Release speed ramp



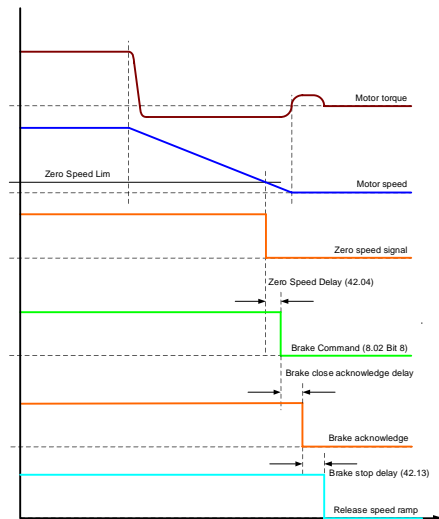
- If the start torque reference is set and the mechanical brake is lifted, motor produces torque
- With expired brake reference delay (42.03), speed ramp can be released
- Then the motor accelerate according to the speed reference
- Now a normal operation is possible



The next step is to release the speed ramp and enable the speed reference.

- If the start torque reference is set and the mechanical brake is lifted, the motor is able to produce torque.
- With expired brake reference delay, parameter 42.03, the speed ramp can be released.
- Then the motor accelerates according to the speed reference.
- Now normal operation is possible.

Close mechanical brake



- To close the mechanical brake, the zero-speed signal is important
- If the motor ramps down and the actual speed reaches zero-speed lim (20.03), the brake must close after zero speed delay (42.04)
- The controller stays alive until brake acknowledge is active and brake stop delay (42.13) has expired



Closing the mechanical brake is another approach which must be done in the opposite direction as was previously described.

- To close the mechanical brake, the zero-speed signal is required.
- The stop signal ramps the motor down and the actual speed reaches zero speed limit, parameter 20.03. Then the brake has to close after zero speed delay.
- The controller stays active until brake acknowledge is active and brake stop delay, parameter 42.13, has expired.

Failure scenarios

- Torque proving not successful
 - F556 TorqProvFault
 - Occurs if drive isn't able to produce torque
 - Brake lifting not possible
- Mechanical brake fault
 - F552 MechBrakeFault
 - Occurs if brake acknowledgement signal is not working properly
 - Brake closes immediately
- Brake long falling alarm
 - A116 BrakeLongFalling
 - Occurs if brake command is closed but brake acknowledge remains active
 - Indication of a wrong working mechanics or contactors



Failure scenarios are described on this slide.

- Torque proving not successful. This is fault F556, which occurs if the drive is not able to produce torque. Therefore, the mechanical brake cannot be lifted because it is dangerous.
- Mechanical brake fault is another brake logic fault. This is fault F552, which occurs if the brake acknowledgement signal is not working properly. The brake mechanism could also be damaged. If this is the case, the brake closes immediately.
- Brake long falling alarm is shown as alarm A116. It occurs if the brake command gives the closed command, but brake acknowledge remains TRUE. This can be an indication of faulty mechanics or contactors.

Torque Monitor

- Check that motor follows the speed reference
 - Motor direction
 - Change during acceleration and deceleration
- Torque monitoring must be activated with parameter 62.01
- Torque Fault will be generated if
 - $(P2.18 \text{ Speed Ref } 4 - P1.04 \text{ Motor Speed}) > P62.02 \text{ Speed Dev Lev}$ for a time longer than P62.03 Torque Fault TD
 - $P62.04 \text{ SpDerBlkLev} < \text{dn/dt } P1.04$
Note: Ramp time must be smaller than P62.04
- Example:
 - Ramp time is set to 5 seconds
 - P62.04 is set to 7,5 seconds
 - The drive will not trip if reaching torque limit during deceleration, as long as the actual deceleration time (100-0%) is below 7,5 seconds



Torque monitor is a safety functionality of the crane drive.

- Torque monitor checks that the motor follows the speed reference that means the motor direction. This prevents starting in wrong direction due to wind.
- Change during acceleration and deceleration in given time. This trips the drive at overload or mechanical fault. The supervision is blocked during normal acceleration and deceleration.

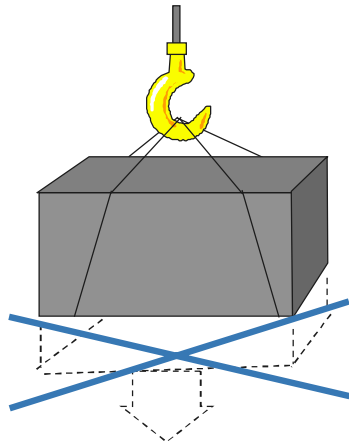
Torque monitoring must be activated with parameter 62.01.

- Torque fault will be generated, if the speed reference minus the motor speed is greater than the speed deviation level.
- Parameter 62.04 is smaller than the deviation of the motor speed.

Here is an example showing the functionality.

- In this case the ramp time is set to 5 seconds
- The trip level is set to 7.5 seconds
- Now the drive will not trip, if the torque limit is reached during deceleration, as long as the actual deceleration time is under 7.5 seconds.

Torque Memory



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- Minimizes the risk of load drop on hoist drives
 - Safe load handling without jerks
 - No risk of jamming between load and floor
- Software functionality
 - Enable torque memory with P42.07 Memory
 - Load torque is latched at stop command of the drive before brake closes
 - After release of the controllers the I-part of the speed controller will be loaded with value of torque memory



Torque memory is a function of the brake logic in the DCS800. Without torque memory the load on the crane could drop after the release of the mechanical brake, because the speed controller needs time to produce the needed torque reference.

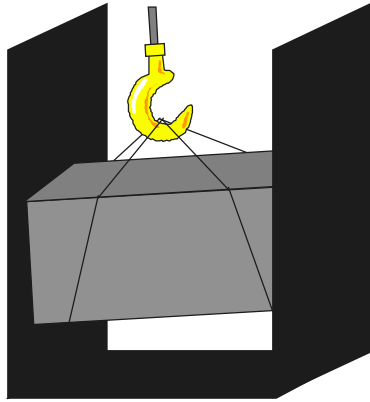
This special functionality called, “Torque Memory,” minimizes the risk of load drop on hoist drives when hoisting has begun.

- It offers safe load handling without any jerks and no risk of jamming between the load and the floor.

The software functionality is like the following:

- Enable torque memory by setting of parameter 42.07 to Memory.
- Then the load torque is latched at stop command of the drive before the brake closes.
- After release of the controllers, the I-part of the speed controller will be loaded with the value of the torque memory.
- This allows a fast reaction of the drive during motor start.

Snag Load



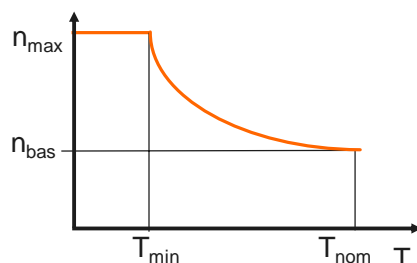
- The container could get stuck on the ship during hoisting
- This phenomena is called snag or snag-load
- If snag-load occurs the up-hoisting process must be stopped immediately
- An external snag-load detection activates the Fast Stop
- While snag-load is active only down-hoisting is possible



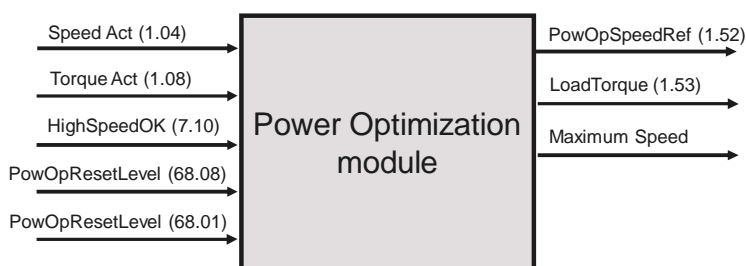
Snag Load is an important safety functionality for crane drives.

- One scenario could be that a container gets stuck on the ship during hoisting. This causes a larger load for the crane and stresses on the boom will constantly increase. This situation is dangerous for the workers present and the crane itself because the rope, parts of the crane or the ship could crack.
- This phenomenon is called snag or snag-load.
- If snag-load occurs, the up-hoisting process must be stopped immediately to avoid danger.
- Detection of snag-load is done by an external snag-load detector, which activates the Fast-Stop of the drive, if snag-load occurs.
- While snag-load is active, only down-hoisting can be used to discharge the crane.

Power Optimization (1)



- Ensures maximum hoist speed relative to the load
 - Lowest possible cycle time
 - Optimizes the crane capacity
- Autotuning calculates parameters



To ensure that the motor will always be able to produce sufficient torque for controlling the load in the field weakening range, the maximum allowed speed is calculated. This function is called power optimization. This means that for a heavy load, the maximum allowed speed is less than for a high load.

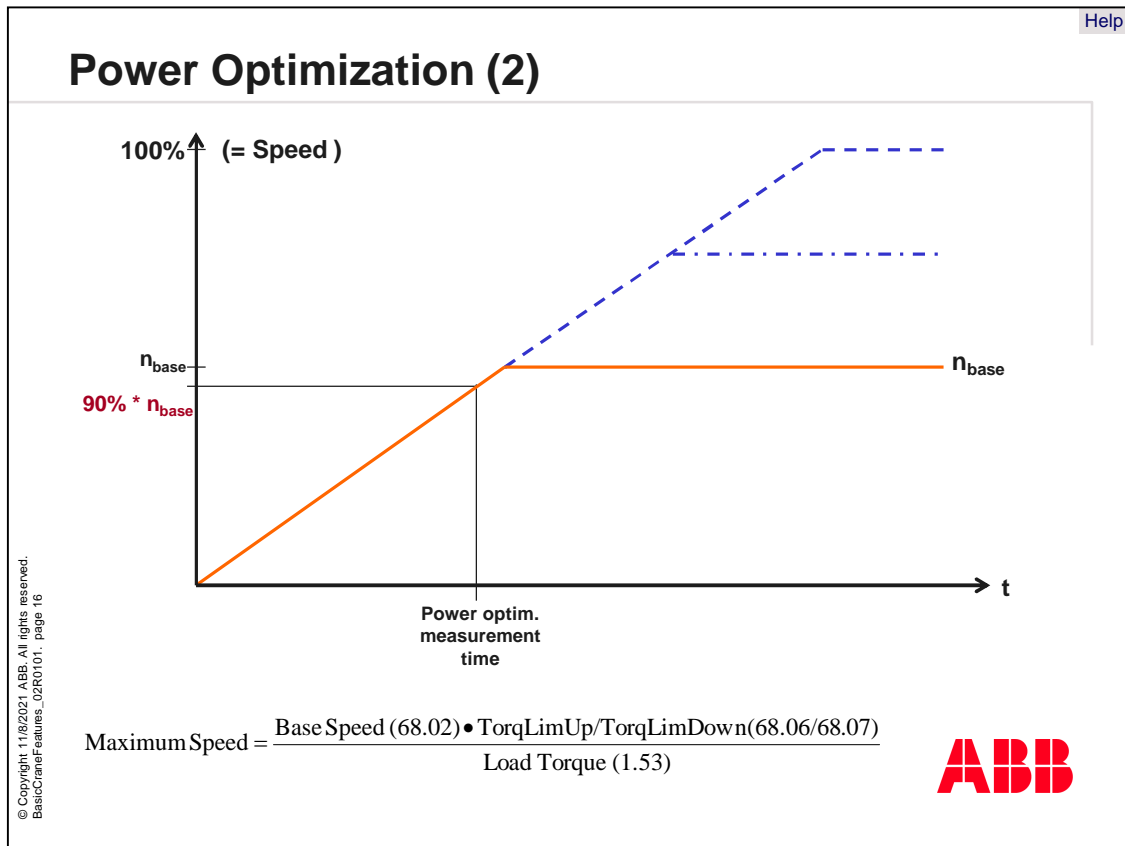
This is only used for hoisting drives, because a pulling load is needed. The speed reference in hoisting direction A must be positive.

Advantages of power optimization are:

- Lowest possible cycle time to load or unload, for example ships.
- An optimized crane capacity.

The DCC800 crane software offers a special autotuning function to calculate the important parameters for power optimization.

The load torque will be calculated inside the crane module. This is the torque, which is needed to hold the load.

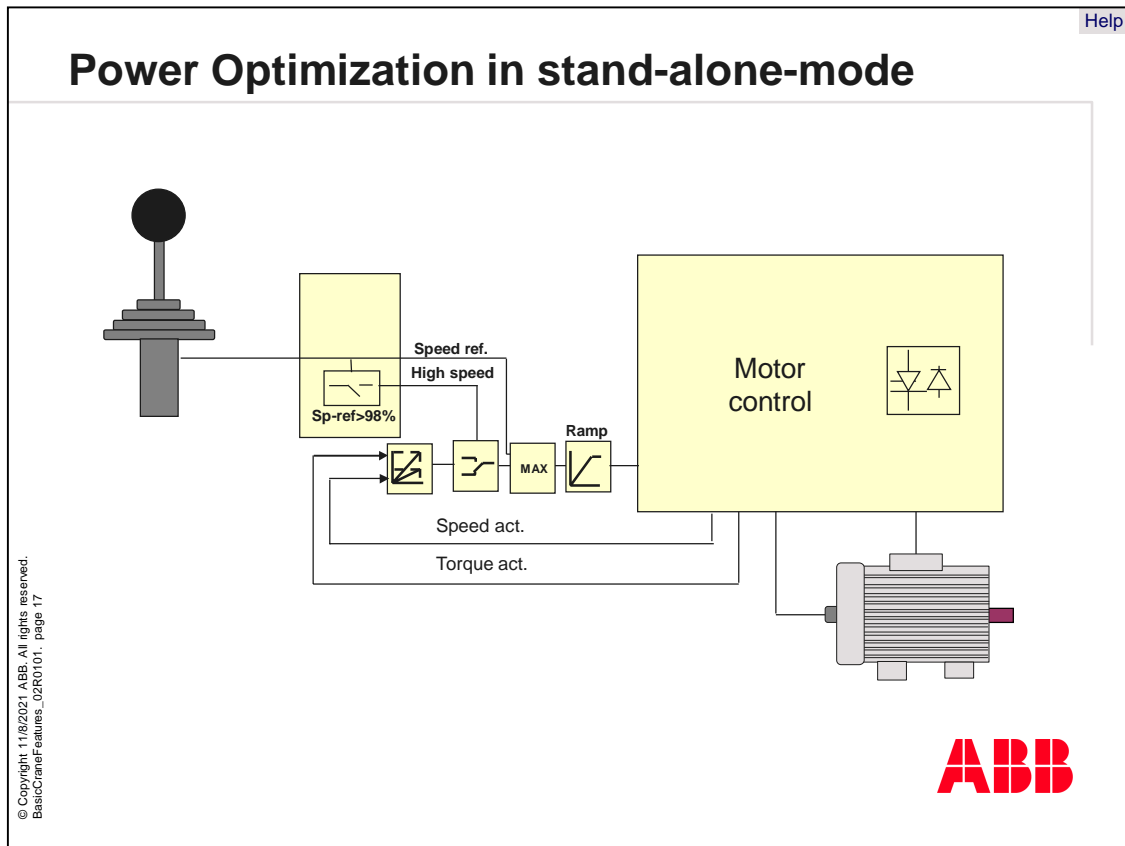


The picture shows the main working principle of power optimization.

- The motor accelerates from zero to base speed. During this time, the actual load torque will be measured inside the software.
- At the point of 90% base speed, the power optimization module starts calculating the maximum allowed speed.
- Then this module limits the maximum speed to the calculated point.

With this limitation, the motor is always able to produce enough torque for the load.

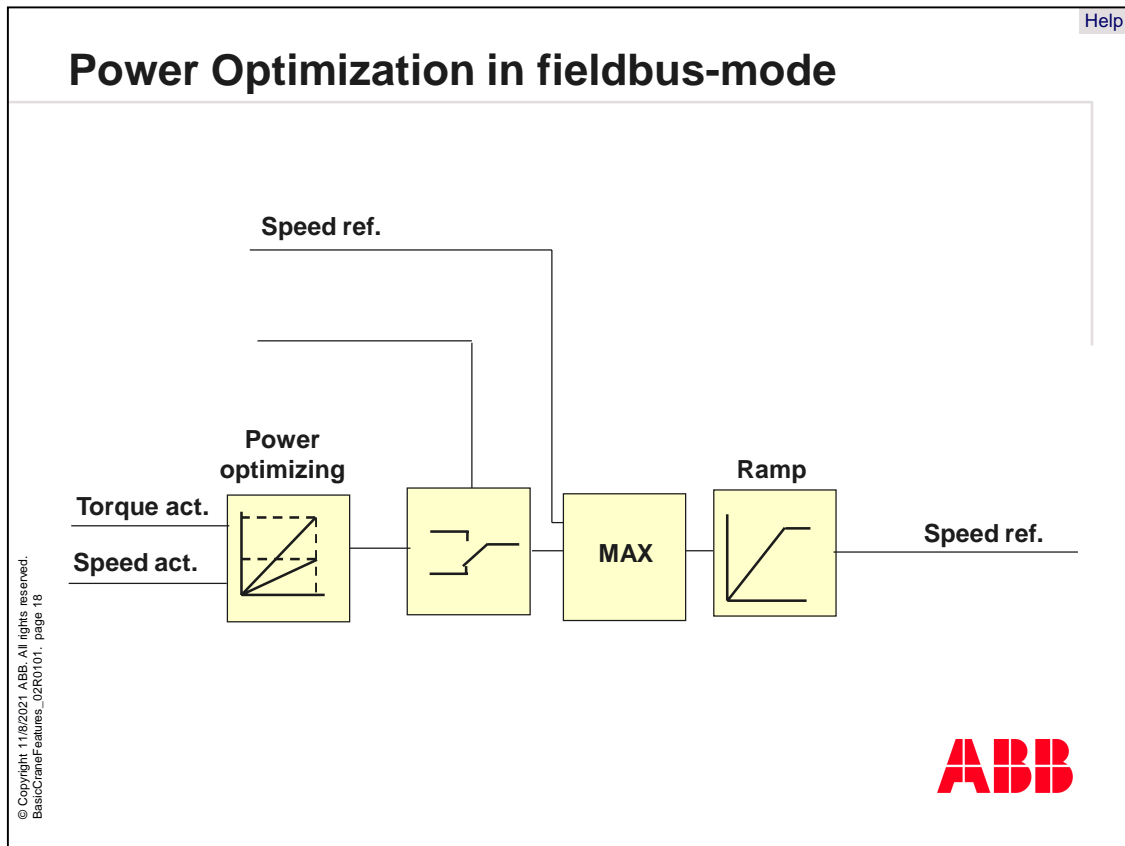
The maximum speed will be calculated by the formula shown.



In stand-alone mode, the speed reference is connected to analog input 1. If the speed reference value is greater than the high-speed level, parameter 64.03, the command High-Speed-OK will be given to allow motor speed greater base speed. If not, the maximum speed is limited to the base speed.

The power optimization module needs the actual speed and the actual torque of the drive to do calculations.

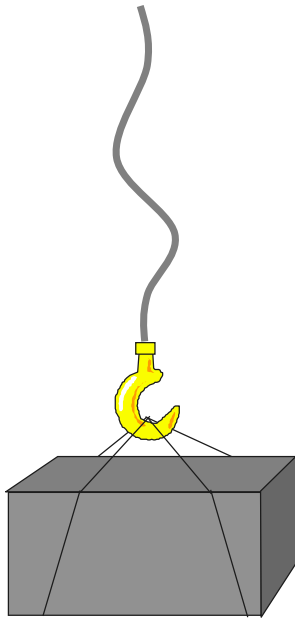
The speed reference directly affects the reference before the ramp generator. This value is limited according to the calculated maximum speed.



In fieldbus-mode, the power-optimization module receives a signal from the overriding control system called High-Speed-OK in fieldbus command word 7.10. This tells the power optimization module that the maximum speed is allowed.

Then the calculated maximum speed reference is used as input to the ramp unit and the motor will accelerate up to the corresponding speed.

Slack rope detection



- Slack rope situations can be detected if load torque drops below Slack Rope Torque Level (P68.10)
- To do this Load Torque Signal (P1.53) will be used
- If detected the following scenario occurs:
 - FBAuxStatusWord 8.16, bit 10
 - Drive is in Fast Stop 1 mode
- Fast Stop can be disabled by
 - FBAuxCommandWord 7.11, bit 7
 - SlackRopeTorqLev (P68.10) = -300%



Slack rope can also be detected by using the DCC800 crane software.

Slack rope situations can be detected if the load torque drops below the Slack-Rope-Torque-Level, parameter 68.10. To detect this, the Load-Torque-Signal, parameter 1.53, will be evaluated.

If slack rope has been detected, the following scenario will occur:

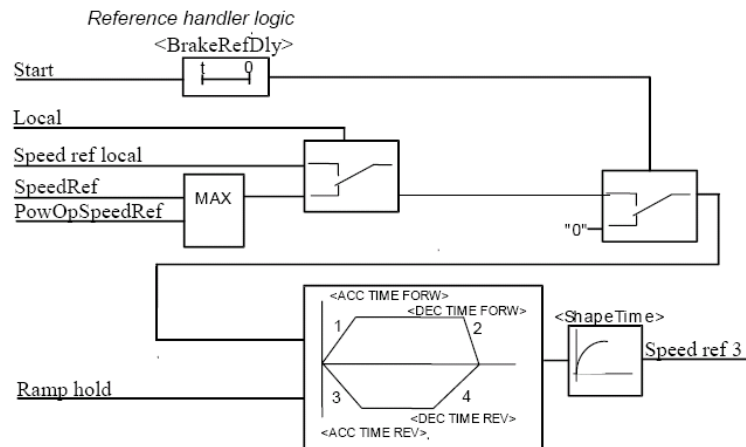
- Bit 10 in the fieldbus auxiliary command word, parameter 8.16, will be set and
- The drive stops in fast stop 1 mode.

If needed fast stop can be disabled if

- Bit 7 in fieldbus auxiliary command word, parameter 7.11, is set or
- Slack Rope Torque Level, parameter 68.10, is set to -300%.

Reference Handler

- The function module includes
 - Setting of ramp times
 - Handling of speed references



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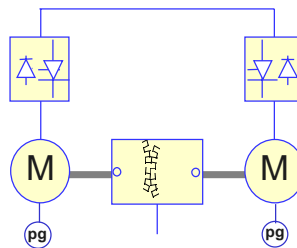
The reference handler is part of the crane application and handles the sequences for the correct reference values.

The function module includes:

- Setting of ramp times and
- Handling of speed references.

Master-Follower Mode

- Load sharing of two motor drives on the same shaft
 - For motions with requirements of too large torque for one motor or if redundancy is required
 - Also where two motors are coupled through a rigid crane structure
 - Broadcast mode (torque reference for followers) alternative also available, par. 72.11
 - Encoder feedback should be used in both Master & Follower



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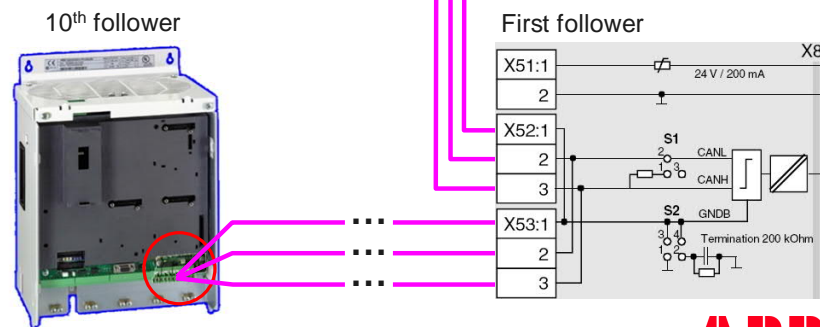
Master follower mode is used if two coupled motors should be used to drive a load. In a crane system this can be the hoist motor.

In principle, master-follower is a load sharing of two motor drives on the same shaft.

- For motions with requirements of excess amounts of torque for one motor or if redundancy is required.
- Also, for where two motors are coupled through a rigid crane structure
- Broadcast mode means that the torque reference from the master drive will be sent to all follower drives, which work in torque control mode. If parameter 72.11 is set to broadcast, some settings will be modified internally in group 94.
- Encoder feedback should be used in both Master & Follower drives
- Grabship unloaders typically have master-follower or connections between hold and close.

Shared Motion 2

- Communication via DCS-Link
- One master can control up to 10 followers
- Max. total length of the DCS-Link cable is 100 m



NOTE: Encoder feedback should be used with both Master and Follower(s)



Shared motion 2 is used for communication between several drives. It handles the following:

- Communication via a DCS-Link,
- One master can control up to 10 followers,
- Maximum total length of the DCS-Link cable is 100 meters.

Do not forget to set the correct cable termination jumpers on the DSL board.

Note: Encoder feedback should be used with both Master and Follower drives!

Shared Motion 2

- Shared Motion is used to control two different motors (called Motor 1 and Motor 2) with the same converter.
- For Motor 2, there is the possibility to set 53 individual parameters in parameter group 49 (43) and 80 (10) for second motor. They are used if parameter MacroChangeMode (16.05) = Motor1/2.
 - Armature current control
 - Speed control
 - Speed limits
 - Field circuit



The Shared Motion 2 group is used to control two different motors, called motor 1 and motor 2, with the same converter.

It can also be used for drive control of two independent field exciters, which are always active.

For motor 2, 53 individual parameters can be set in groups 49 and 80. They will be used if parameter Macro Change Mode, parameter 16.05, is set to Motor1/2.

This applies to

- Armature current control
- Speed control
- Speed limits and
- Field circuit

Crane specific alarm

Code seven segm. display	Text on LCD of control panel CDP 312 (or DRIVES WINDOW)	Definition / Possible source	Signal number (ALARM_WORD_1/2)		Remark
A310	JoystickWarn	<p>The drive is stopped and prevented from start. If Stand Alone Sel (Parameter 64.1) is True and control Type (Par 64.10) is JOYSTICK</p> <p>Conditions:</p> <ul style="list-style-type: none"> START DIR A= "12" and START DIR B="1" simultaneously SPEED REF is > 1 V or TORQUE REF is >1V and ZERO POS ="1" <p>Check:</p> <ul style="list-style-type: none"> Joystick and wiring to digital inputs 2,7,8 and analogue inputs 1 or 2. Setting of parameter 64.1 (Stand Alone Sel) if using fieldbus control 	9.09	bit 0	



There is only one crane specific alarm with the number A310. This alarm occurs if there is something wrong with the joystick.

- If this alarm occurs, the drive is stopped and prevented from starting.
- It is only activated if the crane works in stand-alone-mode by setting parameter 64.01 to TRUE and the control type, parameter 64.10, is set to "Joystick".
- Conditions for this alarm can be that direction A and B commands are given simultaneously or the speed and torque reference is greater than 1 volt if joystick is in zero position.
- In that case, please check the correct wiring of the digital inputs and the settings of the control type, parameter 64.10.
- If the alarm occurs, bit 0 in parameter 9.09 will be set.

Crane specific fault messages (1)

Code seven segm. display	Text on LCD of control panel CDP 312 (or DRIVES WINDOW)	Definition/Action	Status signal (FAULT_WORD_1/2/3/4)		Remark
F610	TorqueFault	<p>If SPEED ERROR during constant speed is higher than <i>Speed Dev Lev (62.02)</i> for a time longer than <i>Torque Fault TD (62.03)</i>, the drive will trip for TorqueFault.</p> <p>Check:</p> <ul style="list-style-type: none"> • Ramp times • Torque and Current limit settings • Torque monitoring (Group 62) parameter settings • Motor and motor cables • Pulse encoder connections (A and B) 	9.05	bit 0	(1)
F611	MasterOscFit	<p>If "next edge" of the communication test bit is not received within a certain time (parameter 70.04), the drive will trip.</p> <p>Check:</p> <ul style="list-style-type: none"> • Fieldbus adapter and its connection to board SDCS-COM-8x channel 0. • PLC program connection of comm. test bit from input to output. • Fieldbus wiring. 	9.05	bit 1	(1)



There are also crane specific fault messages, which have to be explained on this slide:

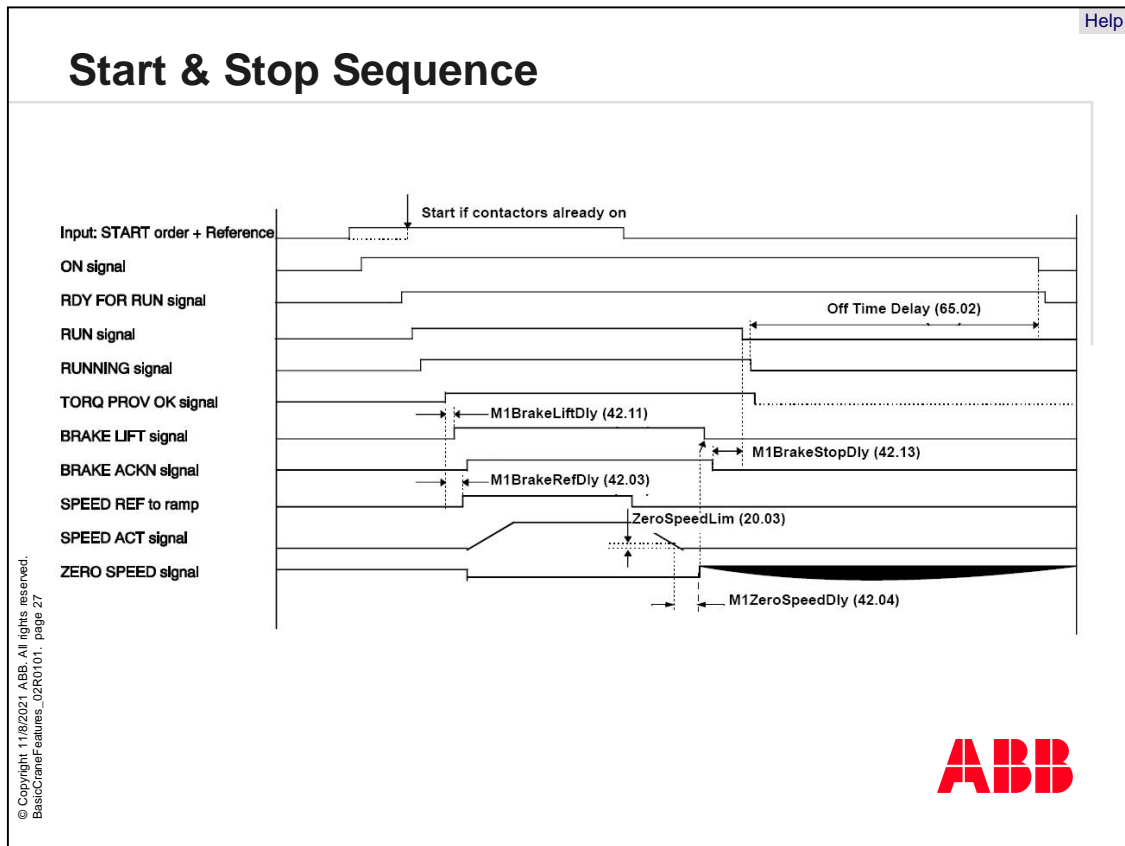
- F619 is the torque fault, which occurs if the speed error during constant speed is higher than speed the deviation level, parameter 62.02, longer than torque fault TD, parameter 62.03.
- This situation will trip the drive. Please check ramp times, torque and current limit settings, torque monitoring parameters in group 62, motor cabling and the pulse encoder connections.
- F611 is the communication monitor between the PLC and the drive which monitors the toggle bit.

Crane specific Fault messages (2)

F612	MFRunFault	Both Master and Follower drive receiving start-order, but only one of the drives is in "Running" state. Check: <ul style="list-style-type: none"> Setting of param. 72.9 M/F FAULT TD. M/F bus connections and fibres 	9.05	bit 2	
F613	TqProvFit	The torque proving could not be performed within the set torque proving time. Check: <ul style="list-style-type: none"> Setting of parameter 42.10, M1TorqueProvTime and 49.40, M2TorqueProvTime Check motor cables 	9.05	bit 3	
F614	FollowerFit	The follower drive has a fault. Check the follower unit.	9.05	bit 4	
F615	MFComFault		9.05	bit 5	



- F612 is the master follower run fault. That means both master and follower drives are receiving start-order, but only one of the drives is in “running” state.
- F613 is the torque proving fault. It occurs when torque proving could not be performed within the set torque proving time.
- F614 is the follower fault. This fault occurs if the follower drive has a fault.
- F615 is the master follower communication fault. It occurs when the communication between master and follower is not working properly.



The correct start and stop sequence are both very important for the complete crane system. Only if this sequence is fulfilled correctly will the crane drive function.

- The sequence starts with the ready-on command, which is active if the drive system is without fault.
- Then the ON signal can be given to switch-on main contactors.
- The next command is the Ready-Run signal, which comes from the drive logic if a mains voltage and correct frequency exist.
- The Run command will be given by the Start A or Start B command of the joystick.
- After that the torque proving starts and if the procedure is completed successfully the mechanical brake will start lifting.
- Then the speed reference for the ramp will be activated and the drive will start accelerating.
- The Stop sequence can be completed in reverse order.

Summary

Key points of this module

- Principle functionality of the brake logic
- Special brake functions for crane drives
- Snag load option
- Power optimization
- Reference Handler
- Master-Follower
- Shared Motion Motor 2
- Fault and alarm messages for cranes



Here are the key points of this module:

- Principle functionality of the brake logic,
- Special brake functions for crane drives,
- Snag load option,
- Power optimization,
- Reference Handler,
- Master-Follower,
- Shared motion motor 2 and
- Fault and alarm messages for cranes.



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