ENGINEERING TOMORROW

Application Paper

VLT® AutomationDrive for **marine winch** applications

This Application Paper is meant to be a guideline for using Danfoss VLT® AutomationDrive in winch applications. The idea is to describe what to take into consideration for winch applications, and also to be an easy guideline for commissioning.

Application description

Winches are used onboard all ships for various operations. Typical use is heave-up and let-out equipment, for example a ship's anchor, fishing trawls or hauling in mooring lines when securing the ship to a pier. Winches come in a broad variety of designs and sizes whether it is for towing or tugging, anchor handling for positioning of oil rig anchors, sub sea operations or oceanographic research. However the main elements such as the drum, brakes, clutch, gear and electrical motor have many similarities across the different designs.

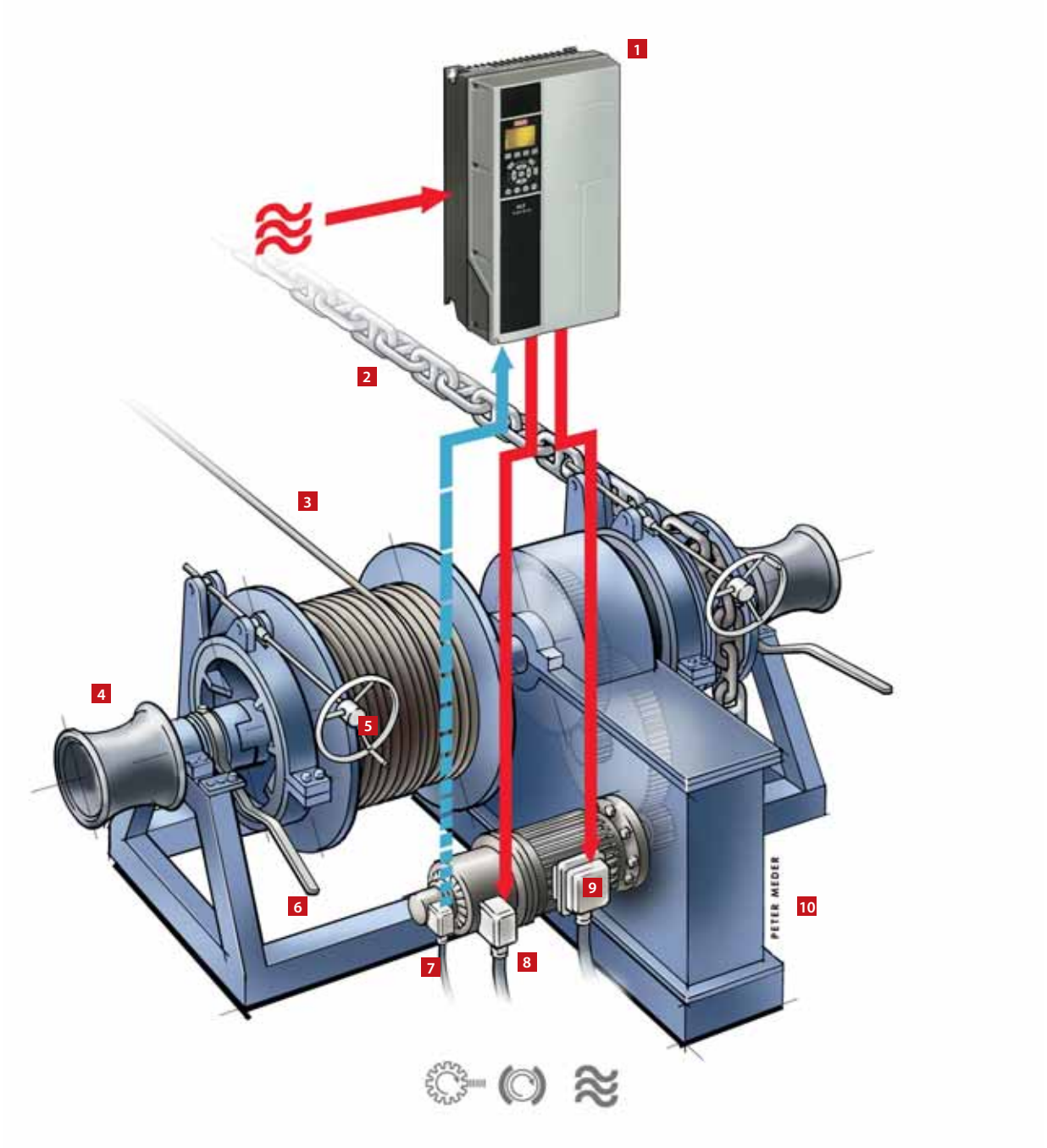
Increased environmental awareness is becoming more and more decisive for the type of equipment ship owners are choosing for their vessels. A result of this is the increased demand for electrical driven winches.

Most manufacturers of winches offer both hydraulic and electric alternatives. Electric driven winches provide several advantages such as; substantial energy saving (up to 30%), no risk of hydraulic oil leaks, no piping, low operation noise and reduced maintenance cost. Excellent speed and tension control and advanced mechanical brake control that ease mechanical stress on both gear and brakes are other benefits.

This application note describes the five most common motor configurations; single motor with and without encoder, single/ dual drives and dual motors with and without encoder, examples including installation diagram, all needed parameters and typical settings.

Winch – main elements

Here shown by the example of a combination winch.



1 Frequency converter
2 Anchor chain
3 Wire
4 Pulley
5 Manual holding brake
6 Clutch
7 Encoder
8 Electromechanical brake
9 Motor
10 Gear box

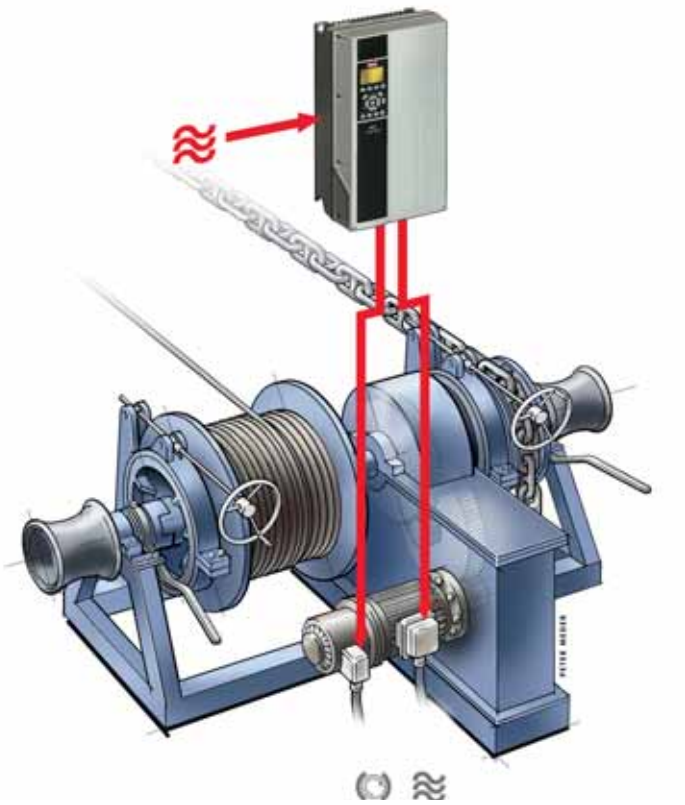
Single motor without feedback

Typical applications:

- Anchor windlass
- Capstan winches
- Tugger winches
- Fishing equipment winches
- Mooring winches

Parameter set-up and wiring:

see appendix 1.1 and 1.2



Strength

VVC+	Flux sensorless
Easy commissioning	Robust - no encoder
Robust - no encoder	High torque at low speed
Motor performance is normally OK with motor nameplate information	Handles shock load better than VVC+
Can work with less accurate advanced motor data (factory settings)	Starting torque higher than VVC+ mode
No adjustment of speed PID controller needed	
Better regulation in the over synchronous range	Embedded mechanical brake handling
Embedded mechanical brake handling	
Embedded tension control feature allows rendering with calculated or feedback torque	
Intertia compensated torque readout	
Speed monitoring with load catch	
Parameter setup see appendix 1.1	*Parameter setup see appendix 1.2*

Weaknesses

VVC+	Flux open loop control
Torque control does not work	
Cannot handle shock load as well as flux control	
Cannot be used in application where rendering is expected *	
Holding torque at low RPM is unsecure	More accurate advanced motor data necessary than VVC+ (AMA values)
Start delay needed to magnetize the motor and open the brake relay	Speed PID adjustment might be needed
Limited torque control range	
Torque cannot shift from motoric to generatoric mode during running	
Starting torque is dependent on motor temperature (weather condition)	

** Rendering is a winch feature for vessel applications such as mooring or subsea trenching. The winch is configured so that the winch rope will pull from the winch drum in the event that any external load becomes too great for the rated winch capacity thus preventing the winch from damage.*

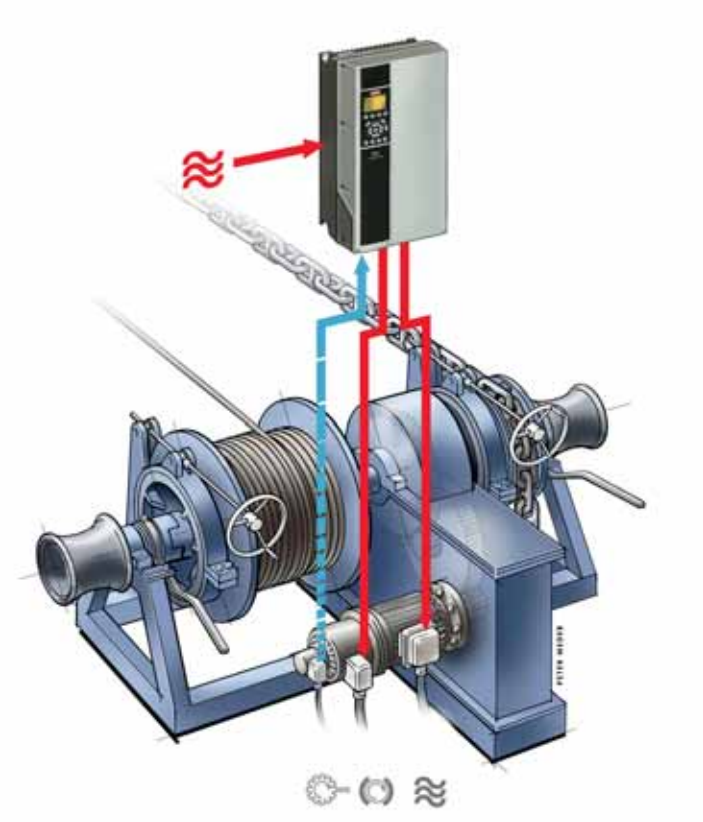
Single motor with feedback

Typical applications:

- Offshore winches - active heave compensation
- Mooring winches - compensation for high/low tidal water or loading/unloading
- Mooring winches with tension sensors

Parameter set-up and wiring:

see appendix 2.1 and 2.2



Strength

Flux with motor feedback
Full holding torque at 0 RPM
Fast speed response (after temporary torque overload)
Accurate torque control
Possible to move from one quadrant to another thru 0 RPM
Possible to use tracking error function = supervision of speed
Better control of the electromechanical brake function
Embedded tension control feature allows rendering with calculated or feedback torque
Intertia compensated torque readout
Speed monitoring with load catch
Parameter setup see appendix 2.2

Weaknesses

Flux vector closed loop control
More accurate advance motor data necessary (AMA values)
Speed PID adjustment might be needed
Lack of voltage in the field weakening range

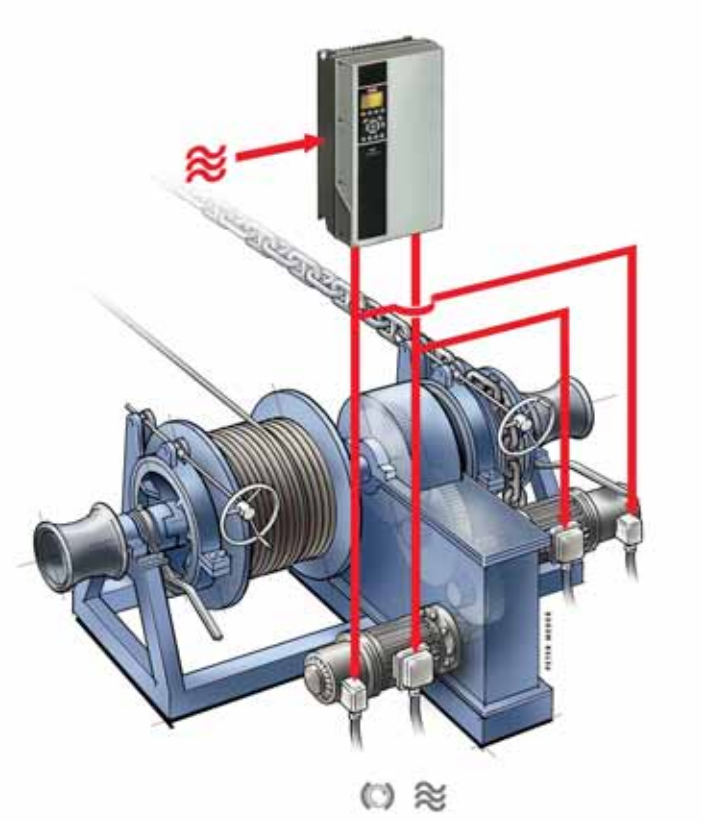
Multiple motors and single drive without feedback

Typical applications:

- Anchor windlass
- Capstan winches
- Tugger winches
- Fishing equipment winches
- Mooring winches

Parameter set-up and wiring:

see appendix 3.1



Strength

U/f mode or VVC+ with open loop control
All motors in parallel connected to only one large frequency converter
Probably most economical solution for 2 motors
Multiple motors used due to limited space
Asynchronous motors with high slip provide natural load sharing capability
Share gear box load
Redundancy if one motor fail
Fairly simple set up and control (all motors are the same size = multiplying of motor current values)
U/f motor mode does not need advanced motor parameters
Embedded tension control feature allows rendering with calculated or feedback torque
Intertia compensated torque readout
Speed monitoring with load catch
Parameter setup see appendix 3.1

Weaknesses

U/f mode or VVC+ with open loop control
No redundancy if the frequency converter fails
Practical useful only for motors with fairly high slip = mainly smaller motors (motors with equal torque curves are available at small extra cost)
High efficiency motors with low slip do not provide good load sharing
No slip compensation in U/f mode

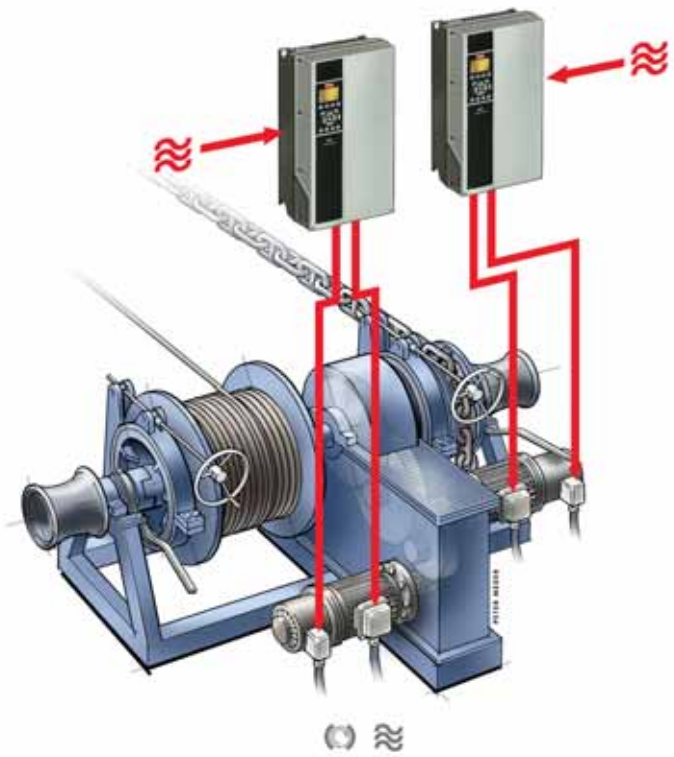
Multiple motors and multiple drives without feedback

Typical applications:

- Capstan winches
- Tugger winches
- Fishing equipment winches

Parameter set-up and wiring:

see appendix 4.1 and 4.2



Strength

VVC+ open loop control	Flux vector open loop control
Simple set up by using negative slip compensation	
Works even when one drive/motor fails	
One frequency converter for each motor	
Useful with limited space for one large motor	
Larger asynchronous motors with small slip can load share with negative slip compensation	
High efficient motors with small slip can work with negative slip compensation	
Redundancy if one motor/frequency converter fails	
Fairly simple set up and control in VVC+ or flux sensorless mode (common speed reference signal for both frequency converters).	
Parameter setup see appendix 4.1	*Parameter setup see appendix 4.2*

Weaknessess

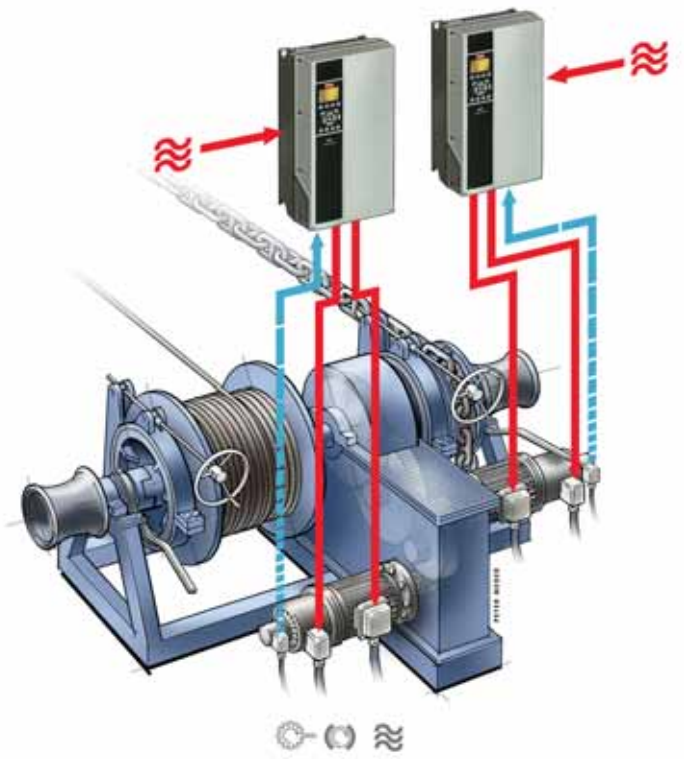
VVC+ open loop control	Flux vector open loop control
Can not be used where rendering is expected	
The motors have to be equal	
Speed is reduced with increasing load	
All motors must have the same power size (and torque curve).	
Start up and low RPM speed require careful parameter adjustment (possibility for regenerative mode if one system drives the other).	

Multiple motors and multiple drives with or without motor feedback (2)
Droop concept

Only to be run in flux vector mode closed loop and with software SW xxx or higher with droop

Typical applications:
- Offshore winches - active heave compensation
- Remote Operated Vehicle
- Anchor handling tug winch
- Deep sea winches

Parameter set-up and wiring:
see appendix 5.1



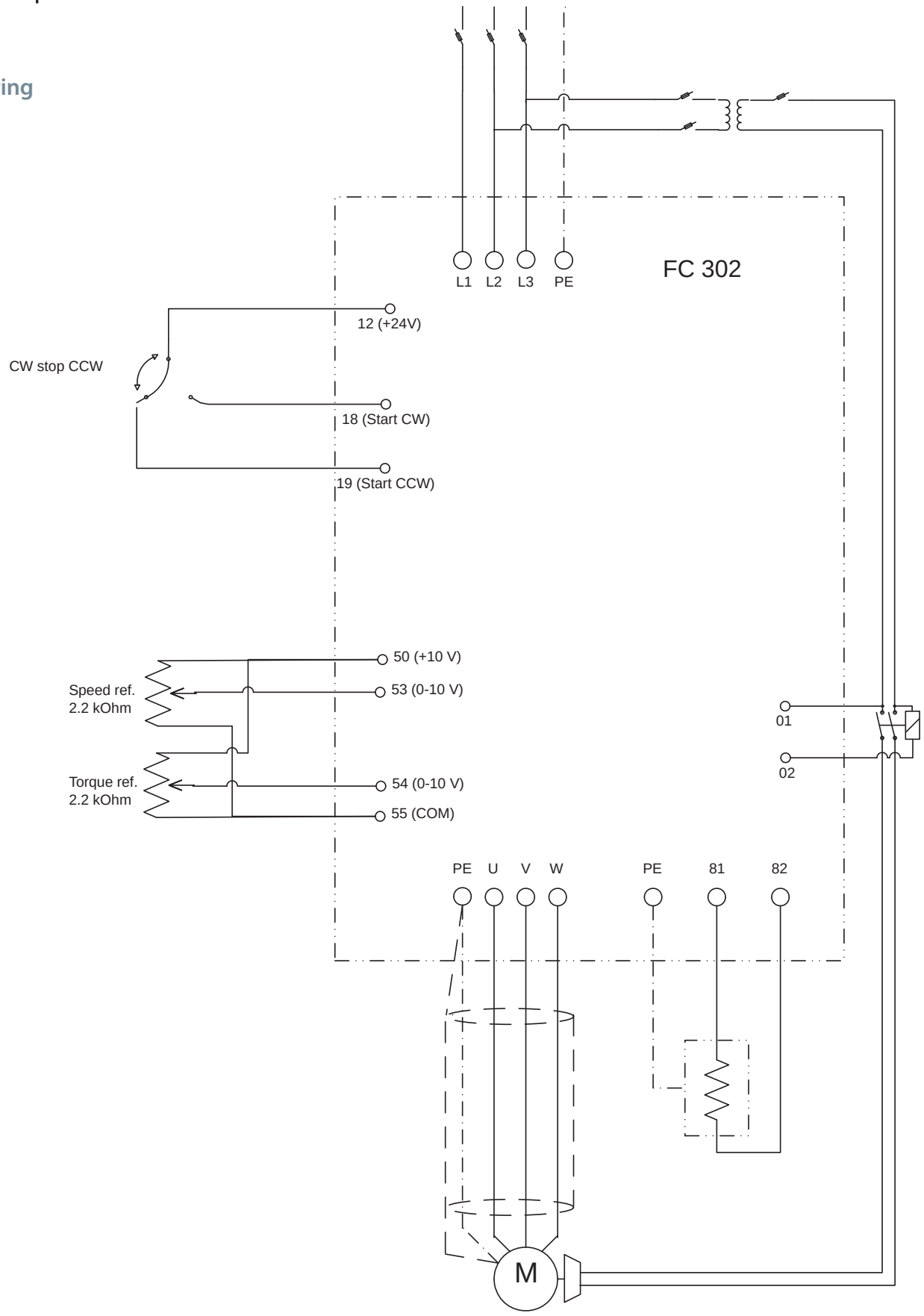
Strength

Flux vector closed loop control
Can be used in applications with rendering
Excellent electromechanical brake control
Normally the motors are equal in power size = equal load sharing with equal slip; but deviation can be compensated
Working in motoring as well as in regenerative mode
High torque available, also at 0 speed
Redundancy available, both electrical or mechanical, should one motor/frequency converter fail
Multiple drives will share the torque optimal
Easy programming, all drives have same programs
No communication needed between masters
Droop with speed trim possible
Embedded tension control feature allows rendering with calculated or feedback torque
Intertia compensated torque readout
Speed monitoring with load catch
Parameter setup see appendix 5.1

Appendix 1.1

Single motor without feedback VVC+ open loop control

Wiring



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Parameter set-up – Single motor without feedback VVC+ open loop control

Par. ID	Parameter name	Drive	Comment (* = factory settings)
1-00	Configuration Mode	Speed open loop	*
1-01	Motor Control Principle	VVC+	* (include V/A comp. and slip comp.)
1-03	Torque Characteristics	Constant torque	*
1-04	Overload Mode	High Torque	* (150-160% over current available)
1-06	Clockwise Direction	Normal	* (avoid using this parameter).
1-10	Motor Construction	Asynchron	* (no PM motor considered here)
1-20 1-26	Motor Data inserted	Motor size = Drive size	(150-160% over current available)
1-29	Automatic Motor Adaptation	Use complete AMA	For larger Drive use reduced AMA
1-30 1-37	Advanced motor data is calculated based on motor data	R1 = stator resistance Xh = main impedance.	R1 should also include cable resistance. Xh determine magnetizing current.
1-39	Motor Poles	Automatic calculated	Calculated based on par. 1-23 and 1-25. Never use synchron speed for par. 1-25.
1-50 1-52	Magnetizing current at low speed		* Use factory settings.
1-60 1-61	Low Speed and High Speed Compensation (V/A comp.)		* Use factory Settings.
1-62	Slip Compensation	100% = Constant speed in open loop.	* Use factory settings. But reduce % in case of unstable operation.
1-64	Resonance Dampening	100% = Normal damping.	Resonance damping is based on motor slip. Par.1-23 and par. 1-25. Unstable operation: increase or reduce parameter
1-71	Start Delay	0.1 – 1.5 second.	Time needed to magnetize the motor
1-72	Start Function	VVC+/flux clockwise	VVC+ can ramp up, but not provide motor torque before magnetized.
1-74	Start Speed	Use slip in RPM	After start delay time can the motor provide 100 % nominal torque.
1-80	Function at Stop	Coast	*
1-81	Min. Speed for Function at Stop	2-3 RPM	
1-90	Motor Thermal Protection	ETR warning 1	ETR does not require external sensors.
2-10	Brake Function	Resistor Brake.	Most application require a brake resistor. Large resistors can be water cooled.
2-11	Brake resistor	Use factory size.	Give 160% generatoric torque
2-12	Brake power limit	Use brake information.	Average value for the resistor.
2-13	Brake Power Monitoring.	Warning.	Use as indication for overheating.
2-15	Brake check	Warning.	Indication for brake failure.
2-18	Brake Check Condition	After Coast Situation	Additional brake check.
2-20	Release Brake Current	Use magnetizing current for the motor	When the actual current is above the set current within the start delay time, then mechanical brake relay change state.
2-21	Activate Brake Speed	Set RPM for closing	Determine physical closing time for the brake. Determine the ramp down time. Calculate the set RPM for closing the brake at 0 RPM.
2-23	Activate Brake Delay	0.1 – 0.5 second	Activate a holding torque, after the brake has closed. Taking care of time delay for worn brake lining.
Par. ID	Parameter name	Drive	Comment (* = factory settings)
3-40	Ramp 1 Type	Linear	* Other ramp types might be better, but can extend actual time.
3-41	Ramp 1. Ramp up time	As needed	Ramp time = time from 0 RPM to synchronous speed. Too short time may activate current /torque warning.
3-42	Ramp 1. Ramp down time	As needed	Ramp time = time from synchronous speed to 0 RPM. Too short time may activate current /torque warning.
4-10	Motor Speed Direction	Both directions	Winch normally need both directions
4-13	Motor Speed High Limit	As needed	Lower to max. needed (+ 2 x slip).
4-16	Torque Limit Motor Mode	160%	* (suggestion: 15% higher than current limit)
4-17	Torque Limit Generator Mode	160%	(suggestion: 15% higher than current limit)
4-18	Current limit	Max. %	% = Max. current for drive / nominal current for motor.
4-19	Max Output Frequency	As needed	Slightly higher than parameter 4-13.

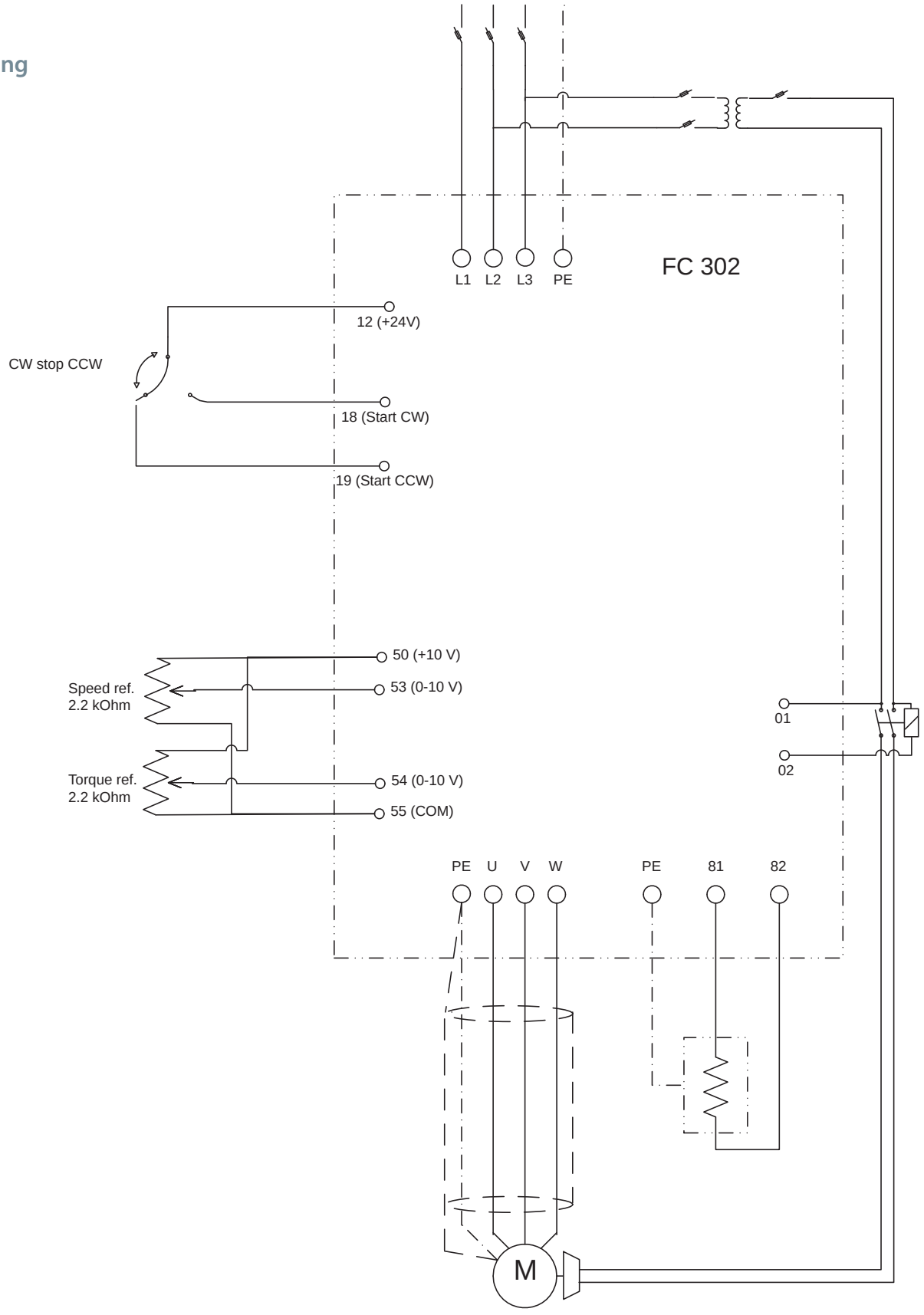
Parameter set-up – Single motor without feedback VVC+ open loop control

Par. ID	Parameter name	Drive	Comment (* = factory settings)
5-11	Terminal 19 Digital Input	Start reversing	Digital input normally provided by joystick with only one direction signal.
5-40	Function Relay	Mechanical brake ctrl.	Relay 1 is normally used for this function. Take care of contact burning.
5-41	On Delay, Relay	0.0 – 1.4 second	If the magnetizing time of the motor is longer than the release time of the brake.
5-42	Off Delay, Relay	0.0 second	* Normally not used.
6-00	Live Zero Timeout Time	1 second	Use where 4-20 mA signal is present.
6-01	Live Zero Timeout Function	Stop and trip.	Function if reference is lost.
14-00	Switching pattern	SFAVM	* Normally best choice regarding performance and acoustic noise.
14-01	Switching Frequency		* Switching frequency higher than factory settings might decrease thermal performance for the drive.
14-03	Overmodulation		* give higher voltage for VVC+ in over synchronous range.
14-10	Mains Failure	Ctrl. ramp down	This setting is best choice, but might not work for VVC+.
14-11	Mains Voltage at Mains Fault.	As needed	Set to 10% below min. mains level.
14-12	Function at Mains Imbalance	Warning.	Factory setting is trip. A generator supply might activate this trip too often.
14-24	Trip Delay at Current Limit	As needed	Running too long in current limit indicate something is overloaded.
14-25	Trip Delay at Torque Limit	As needed	Running too long in torque limit indicate something is overloaded.
14-26	Trip Delay at Inverter Fault	0 second	Too high voltage = brake faulty.
14-50	RFI Filter	Off	Factory setting is ON. For IT grids use OFF. For TN grids use ON.
14-90	Fault Level	Off	* Should not be used ; but fault condition can be changed.

Appendix 1.2

Single motor without feedback Flux vector open loop control

Wiring



Parameter set-up – Single motor without feedback Flux vector open loop control

Par. ID	Parameter name	Drive	Comment (* = factory settings)
1-00	Configuration Mode	Speed open loop	*
1-01	Motor Control Principle	Flux sensorless	* (include slip comp.)
1-03	Torque Characteristics	Constant torque	*
1-04	Overload Mode	High Torque	* (150-160% over current available)
1-06	Clockwise Direction	Normal	* (avoid using this parameter).
1-10	Motor Construction	Asynchron	* (no PM motor considered here)
1-20 1-26	Motor Data inserted	Motor size = Drive size	(150-160% over current available)
1-29	Automatic Motor Adaptation	Use complete AMA	For larger Drive use reduced AMA
1-30 1-37	Advanced motor data is calculated based on motor data	R1 = stator resistance Xh = main impedance	R1 should also include cable resistance Xh determine magnetizing current
1-39	Motor Poles	Automatic calculated	Calculated based on par. 1-23 and 1-25. Never use synchron speed for par. 1-25.
1-53	Model Shift Frequency		* Use factory settings, or about 15% of nominal frequency.
1-54	Voltage reduction in Field- weakening	0 Volt	* Use factory Settings. Can be increased if voltage is missing in over synchronous range.
1-62	Slip Compensation	!00% = Constant speed in open loop.	* use factory settings. But reduce % in case of unstable operation.
1-64	Resonance Dampening	100% = Normal damping.	Resonance damping is based on motor slip. Par.1-23 and par. 1-25. Unstable operation: increase or reduce parameter
1-66	Min. Current at Low Speed	100%	* 100% = low current is = nominal current. Change if needed.
1-67	Load Type	Active Load	Enhance the performance at low RPM.
1-71	Start Delay	0.1 – 2.0 second.	Time to indicate that current is present for the motor and above parameter 2-20
1-72	Start Function	VVC+/flux clockwise	Will calculate right current for output frequency.
1-74	Start Speed	Use slip in RPM	Can provide 100 % torque by star
1-80	Function at Stop	Coast	*
1-81	Min. Speed for Function at Stop	2-3 RPM	
1-90	Motor Thermal Protection	ETR warning 1	ETR does not require external sensors.
2-10	Brake Function	Resistor Brake.	Most application require a brake resistor. Large resistors can be water cooled.
2-11	Brake resistor	Use factory size.	Give 160% generatoric torque
2-12	Brake power limit	Use brake information.	Average value for the resistor.
2-13	Brake Power Monitoring.	Warning.	Use as indication for overheating.
2-15	Brake check	Warning.	Indication for brake failure.
2-18	Brake Check Condition	After Coast Situation	Additional brake check.
2-20	Release Brake Current	Use magnetizing current for the motor	When the actual current is above the set current within the start delay time, then mechanical brake relay change state.
2-21	Activate Brake Speed	Set RPM for closing	Determine physical closing time for the brake. Determine the ramp down time. Calculate the set RPM for closing the brake at 0 RPM.
2-23	Activate Brake Delay	0.1 – 0.5 second	Activate a holding torque, after the brake has closed. Taking care of time delay for worn brake lining.
3-40	Ramp 1 Type	Linear	* Other ramp types might be better, but can extend actual time.
3-41	Ramp 1. Ramp up time	As needed	Ramp time = time from 0 RPM to synchronous speed. Too short time may activate current /torque warning.
3-42	Ramp 1. Ramp down time	As needed	Ramp time = time from synchronous speed to 0 RPM. Too short time may activate current /torque warning.
4-10	Motor Speed Direction	Both directions	Winch normally need both directions
4-13	Motor Speed High Limit	As needed	Lower to max. needed (+ 2 x slip).
4-16	Torque Limit Motor Mode	160%	* (suggestion: 15% higher than current limit)
4-17	Torque Limit Generator Mode	160%	(suggestion: 15% higher than current limit)
4-18	Current limit	Max. %	% = Max. current for drive / nominal current for motor.
4-19	Max Output Frequency	As needed	Slightly higher than parameter 4-13.
5-11	Terminal 19 Digital Input	Start reversing	Digital input normally provided by joystick with only one direction signal.

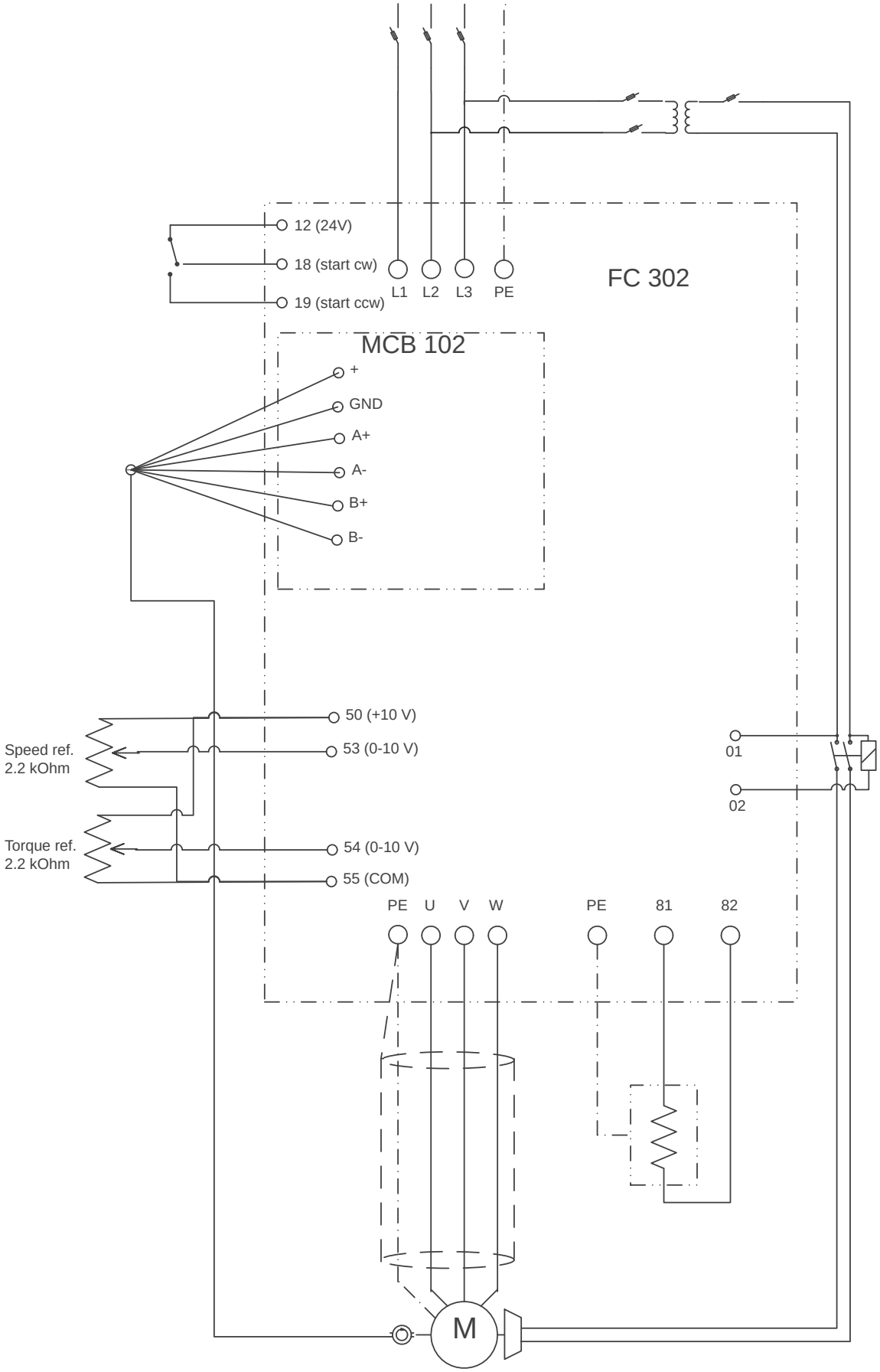
Parameter set-up – Single motor without feedback Flux vector open loop control

Par. ID	Parameter name	Drive	Comment (* = factory settings)
5-40	Function Relay	Mechanical brake ctrl.	Relay 1 is normally used for this function. Take care of contact burning.
5-41	On Delay, Relay	0.0 – 1.0 second	Adjust the brake to be open, when the drive start to ramp up.
5-42	Off Delay, Relay	0.0 second	* Normally not used.
6-00	Live Zero Timeout Time	1 second	Use where 4-20 mA signal is present.
6-01	Live Zero Timeout Function	Stop and trip.	Function if reference is lost.
6-15	Terminal 53 High ref/(feedback) Value	As needed	Reference for 20 mA or 10 Volt.
N.B.	Set control card switch for I or V	Current or voltage input	See settings in parameter 16-61.
7-02	Speed PID Proportional Gain	0.015	* Should be adjusted. Normally a higher gain is necessary; but take care of instability.
7-03	Speed PID Integral Time	200ms	* factory setting is normally O.K. ; but could be reduced for better dynamic operation. Take care of instability.
7-04	Speed PID Differentiation Time	Off	* Normally not used. If set, take care of instability above 1 ms.
14-00	Switching pattern	SFAVM	* Normally best choice regarding performance and acoustic noise.
14-01	Switching Frequency		* Switching frequency higher than factory settings might decrease thermal performance for the drive.
14-10	Mains Failure	Ctrl. ramp down	This setting is best choice
14-11	Mains Voltage at Mains Fault.	As needed	Set to 10% below min. mains level.
14-12	Function at Mains Imbalance	Warning.	Factory setting is trip. A generator supply might activate this trip too often.
14-24	Trip Delay at Current Limit	As needed	Running too long in current limit indicate something is overloaded.
14-25	Trip Delay at Torque Limit	As needed	Running too long in torque limit indicate something is overloaded.
14-26	Trip Delay at Inverter Fault	0 second	Too high voltage = brake faulty.
14-50	RFI Filter	Off	Factory setting is ON. For IT grids use OFF. For TN grids use ON
14-90	Fault Level	Off	* Should not be used ; but fault condition can be changed.

Appendix 2.1

Single motor with feedback VVC+ closed loop control

Wiring



Parameter set-up – Single motor with feedback VVC+ closed loop control

Par. ID	Parameter name	Drive	Comment (* = factory settings)
1-00	Configuration Mode	Speed closed loop	
1-01	Motor Control Principle	VVC+	* (include V/A comp.)
1-03	Torque Characteristics	Constant torque	*
1-02			
1-04	Overload Mode	High Torque	* (150-160% over current available)
1-06	Clockwise Direction	Normal	* (avoid using this parameter).
1-10	Motor Construction	Asynchron	* (no PM motor considered here)
1-20 1-26	Motor Data inserted	Motor size = Drive size	(150-160% over current available)
1-29	Automatic Motor Adaptation	Use complete AMA	For larger Drive use reduced AMA
1-30 1-37	Advanced motor data is calculated based on motor data	R1 = stator resistance Xh = main impedance.	R1 should also include cable restistance Xh determine magnetizing current.
1-39	Motor Poles	Automatic calculated	Calculated based on par. 1-23 and 1-25. Never use synchron speed for par. 1-25.
1-50 1-52	Magnetizing current at low speed		* Use factory settings.
1-60 1-61	Low Speed and High Speed Compensation (V/A comp.)		* Use factory Settings.
1-64	Resonance Dampening	100% = Normal damping.	Resonance damping is based on motor slip. Par.1-23 and par. 1-25. Unstable operation: increase or reduce parameter
1-71	Start Delay	0.1 – 1.5 second.	Time needed to magnetize the motor
1-72	Start Function	VVC+/flux clockwise	VVC+ can ramp up, but not provide motor torque before magnetized.
1-74	Start Speed	Use slip in RPM	After start delay time can the motor provide 100 % nominal torque.
1-80	Function at Stop	Coast	*
1-81	Min. Speed for Function at Stop	2-3 RPM	
1-90	Motor Thermal Protection	ETR warning 1	ETR does not require external sensors.
2-10	Brake Function	Resistor Brake.	Most application require a brake resistor. Large resistors can be water cooled.
2-11	Brake resistor	Use factory size.	Give 160% generatoric torque
2-12	Brake power limit	Use brake information.	Average value for the resistor.
2-13	Brake Power Monitoring.	Warning.	Use as indication for overheating.
2-15	Brake check	Warning.	Indication for brake failure.
2-18	Brake Check Condition	After Coast Situation	Additional brake check.
2-20	Release Brake Current	Use magnetizing current for the motor	When the actual current is above the set current within the start delay time, then the mechanical brake relay change state.t
2-21	Activate Brake Speed	Set RPM for closing	Determine physical closing time for the brake. Determine the ramp down time. Calculate the set RPM for closing the brake at 0 RPM.
2-23	Activate Brake Delay	0.1 – 0.5 second	Activate a holding torque, after the brake has closed. Taking care of time delay for worn brake lining.
3-40	Ramp 1 Type	Linear	* Other ramp types might be better, but can extend actual time.
3-41	Ramp 1. Ramp up time	As needed	Ramp time = time from 0 RPM to synchronous speed. Too short time may activate current /torque warning.
3-42	Ramp 1. Ramp up time	As needed	Ramp time = time from synchronous speed to 0 RPM. Too short time may activate current /torque warning.
4-10	Motor Speed Direction	Both directions	Winch normally need both directions
4-13	Motor Speed High Limit	As needed	Lower to max. needed (+ 2 x slip).
4-16	Torque Limit Motor Mode	160%	* (suggestion: 15% higher than current limit). Give true limit also in over synchronous range.
4-17	Torque Limit Generator Mode	160%	(Suggestion: 15% higher than current limit). Give true limit also in over synchronous range.

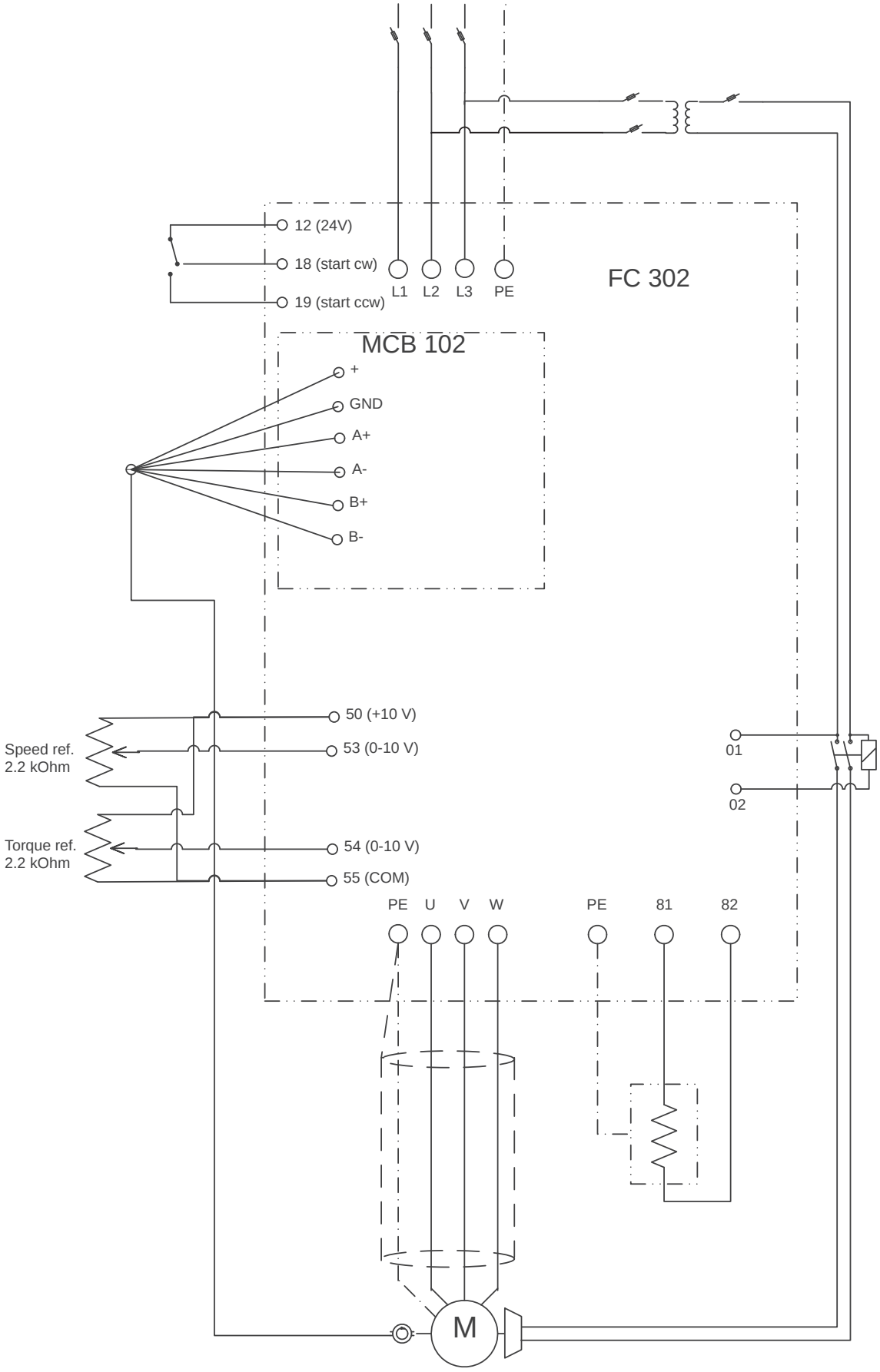
Parameter set-up – Single motor with feedback VVC+ closed loop control

Par. ID	Parameter name	Drive	Comment (* = factory settings)
4-18	Current limit	Max. %	% = Max. current for drive / nominal current for motor.
4-19	Max Output Frequency	As needed	Slightly higher than parameter 4-13.
4-30	Motor Feedback Loss function	Warning (switch to open loop)	Suggestion is Warning. Alternative setting is Switch to open loop, when output frequency = different from ref.
4-31	Motor Feedback Speed Error	300 RPM	* This window is motor dependent.
4-32	Motor feedback Loss Timeout	1 second	Factory setting of 0.05 second might be too fast.
4-34	Tracking Error Function	Warning.	
4-35	Tracking Error	100 RPM	Factory setting of 10 RPM is too small window.
4-36	Tracking Error Timeout	1 second	*
4-37	Tracking Error Ramping	100 RPM	* Might be increased to 200 RPM if too sensitive.
4-38	Tracking Error Ramping Timeout.	5 second	* Could be decreased to about 1 second for a faster detection.
5-11	Terminal 19 Digital Input	Start reversing	Digital input normally provided by joystick with only one direction signal.
5-40	Function Relay	Mechanical brake ctrl.	Relay 1 is normally used for this function. Take care of contact burning.
5-41	On Delay, Relay	0.0 – 1.4 second	If the magnetizing of the motor is longer than the opening of the brake.
5-42	Off Delay, Relay	0.0 second	* Normally not used.
5-70	Term 32/33 Pulses per revolution	1024	* Many encoders are with 1024 pulses, use factory settings, otherwise adjust.
5-71	Term 32/33 Encoder Direction.	Clockwise	* If over current or tracking error is present at start, then encoder direction most likely is wrong, change settings.
6-00	Live Zero Timeout Time	1 second	Use where 4-20 mA signal is present.
6-01	Live Zero Timeout Function	Stop and trip.	Function if reference is lost.
6-15	Terminal 53 High ref/(feedback) Value	As needed	Reference for 20 mA or 10 Volt.
N.B.	Set control card switch for I or V	Current or voltage input	See settings in parameter 16-61.
7-00	Speed PID Feedback Source	MCB 102 option	* Use 5 V encoder with MCB 102, especially with long cable lenghts
7-02	Speed PID Proportional Gain	0.015	* Can be increased. Take care of instability
7-03	Speed PID integral Time	8 ms	* Can be decreased for a faster response. Take care of instability.
7-04	Speed PID Differentiation Time	1 ms	Factory setting of 30ms is far too high. Use max. 1- 2 ms for faster response.
7-06	Speed PID Lowpass Filter Time	5 ms	Adjust to pulses per revolution of encoder. Higher pulses = lower ms.
7-08	Speed PID Feed Forward Factor	80%	Feed forward only working for VVC+, give a much faster response. Take care with too high settings, can lead to instability (avoid over 80%).
14-00	Switching pattern	SFAVM	* Normally best choice regarding performance and acoustic noise.
14-01	Switching Frequency		* Switching frequency higher than factory settings might decrease thermal performance for the drive.
14-03	Overmodulation		* give higher voltage for VVC+ in over synchronous range.
14-10	Mains Failure	Ctrl. ramp down	This setting is best choice, but might not work for VVC+.
14-11	Mains Voltage at Mains Fault.	As needed	Set to 10% below min. mains level.
14-12	Function at Mains Imbalance	Warning.	Factory setting is trip. A generator supply might activate this trip too often.
14-24	Trip Delay at Current Limit	As needed	Running too long in current limit indicate something is overloaded.
14-25	Trip Delay at Torque Limit	As needed	Running too long in torque limit indicate something is overloaded.
14-26	Trip Delay at Inverter Fault	0 second	Too high voltage = brake faulty.
14-50	RFI Filter	Off	Factory setting is ON, but this might increase the DC voltage especially in standby mode for IT mains. Use OFF.
14-55	Output filter	No filter	* Set parameter if output filter is used.
14-90	Fault Level	Off	* Should not be used ; but fault condition can be changed.

Appendix 2.2

Single motor with feedback Flux vector closed loop control

Wiring



Parameter set-up – Single motor with feedback Flux vector closed loop control

Par. ID	Parameter name	Drive	Comment (* = factory settings)
1-00	Configuration Mode	Speed closed loop	
1-01	Motor Control Principle	Flux w/ motor feedback	
1-02	Flux Motor Feedback Source	MCB 102	TTL 5V encoder used for MCB 102
1-03	Torque Characteristics	Constant Power	Work only for flux closed loop.
1-04	Overload Mode	High Torque	* (150-160% over current available)
1-06	Clockwise Direction	Normal	* (avoid using this parameter).
1-10	Motor Construction	Asynchron	* (no PM motor considered here)
1-20 1-26	Motor Data inserted	Motor size = Drive size	(150-160% over current available)
1-29	Automatic Motor Adaptation	Use complete AMA	For larger Drive use reduced AMA
1-30 1-37	Advanced motor data is calculated based on motor data	R1 = stator resistance Xh = main impedance	R1 should also include cable resistance Xh determine magnetizing current
1-39	Motor Poles	Automatic calculated	Calculated based on par. 1-23 and 1-25 Never use synchron speed for par. 1-25
1-53	Model Shift Frequency		* Use factory setting. Otherwise use 15% of nominal motor frequency
1-54	Voltage reduction in Fieldweakening	0V	* Use factory setting. In case of warning 62 try to reduce the voltage.
1-71	Start Delay	0 second	* Disappear with settings in P1-72.
1-72	Start Function	Hoist Mech. Brake Relay	Special setting for flux closed loop.
1-76	Start Current	0.0 Amp.	*No use in flux closed loop.
1-80	Function at Stop	Coast	*
1-81	Min. Speed for Function at Stop	2-3 RPM	
1-90	Motor Thermal Protection	ETR warning 1	ETR does not require external sensors.
2-10	Brake Function	Resistor Brake	Most application requires a brake resistor. Large resistors can be water cooled.
2-11	Brake resistor	Use factory size.	Give 160% generatoric torque
2-12	Brake power limit	Use brake information.	Average value for the resistor.
2-13	Brake Power Monitoring.	Warning.	Use as indication for overheating.
2-15	Brake check	Warning.	Indication for brake failure.
2-18	Brake Check Condition	After Coast Situation	Additional brake check.
2-21	Activate Brake Speed	Set RPM for closing	Determine physical closing time for the brake. Determine the ramp down time. Calculate the set RPM for closing the brake at 0 RPM.
2-23	Activate Brake Delay	0.1 – 0.5 second	Activate a holding torque, after the brake has closed. Taking care of time delay for worn brake lining.
2-24	Stop Delay	0 second.	* delay time for closing the brake relay.
2-25	Brake Release Time	0.2 second	* Set as needed. Time for the brake to open. Time for increased proportional gain boost.
2-26	Torque Ref	70%	Set as needed. Torque applied against closed brake before brake release.
2-27	Torque Ramp Time	0.2 second	* Ramp time for parameter 2-26.
2-28	Gain boost Factor	2.00	Set as needed. Increased proportional gain during time for parameter 2-25.
3-40	Ramp 1 Type	Linear	* Other ramp types might be better, but can extend actual time.
3-41	Ramp 1. Ramp up time	As needed	Ramp time = time from 0 RPM to synchronous speed. Too short time may activate current /torque warning.
3-42	Ramp 1. Ramp down time	As needed	Ramp time = time from synchronous speed to 0 RPM. Too short time may activate current /torque warning.
4-10	Motor Speed Direction	Both directions	Winch normally need both directions
4-13	Motor Speed High Limit	As needed	Lower to max. needed (+ 2 x slip).
4-16	Torque Limit Motor Mode	160%	* (suggestion: 15% higher than current limit). Goes down with field weakening curve, when parameter 1-03 is set for constant power.

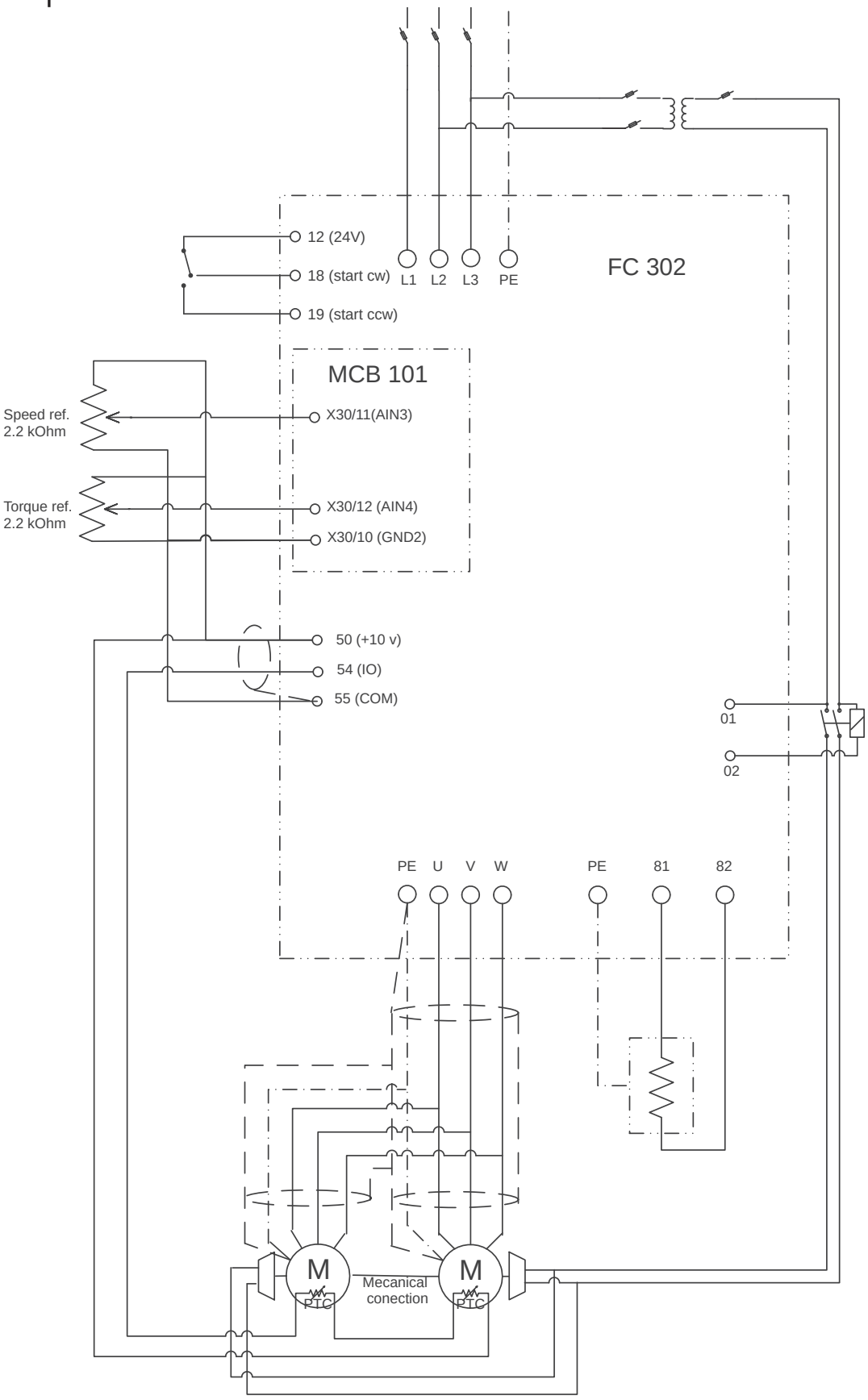
Parameter set-up – Single motor with feedback Flux vector closed loop control

Par. ID	Parameter name	Drive	Comment (* = factory settings)
4-17	Torque Limit Generator Mode	160%	(suggestion: 15% higher than current limit). Goes down with field weakening curve, when parameter 1-03 is set for constant power.
4-18	Current limit	Max. %	% = Max. current for drive / nominal current for motor.
4-19	Max Output Frequency	As needed	Slightly higher than parameter 4-13.
4-20	Torque Limit Factor Source	Analog in 54	Can be used to adjust parameter 4-16 and 4-17 by remote potentiometer.
4-30	Motor Feedback Loss function	Warning	Suggestion is Warning.
4-31	Motor Feedback Speed Error	300 RPM	* This window is motor dependent.
4-32	Motor feedback Loss Timeout	1 second	Factory setting of 0.05 second might be too fast.
4-34	Tracking Error Function	Warning	
4-35	Tracking Error	100 RPM	Factory setting of 10 RPM is too small window.
4-36	Tracking Error Timeout	1 second	*
4-37	Tracking Error Ramping	100 RPM	* Might be increased to 200 RPM if too sensitive.
4-38	Tracking Error Ramping Timeout.	5 second	* Could be decreased to about 1 second for a faster detection.
5-11	Terminal 19 Digital Input	Start reversing	Digital input normally provided by joystick with only one direction signal.
5-40	Function Relay	Mechanical brake ctrl.	Relay 1 is normally used for this function. Take care of contact burning.
5-41	On Delay, Relay	0.01 second	* Use parameter 2-25 if needed.
5-42	Off Delay, Relay	0.01 second	* Normally not used.
6-00	Live Zero Timeout Time	1 second	Use where 4-20 mA signal is present.
6-01	Live Zero Timeout Function	Stop and trip.	Function if reference is lost.
6-15	Terminal 53 High ref/(feedback) Value	As needed	Reference for 20 mA or 10 Volt.
N.B.	Set control card switch for I or V	Current or voltage input	See settings in parameter 16-61.
7-00	Speed PID Feedback Source	MCB 102 option.	* Use 5 V encoder with MCB 102, especially with long cable lengths.
7-02	Speed PID Proportional Gain	0.015	* Can be increased. Take care of instability
7-03	Speed PID integral Time	200 ms	* Can be decreased for a faster response. Take care of instability.
7-04	Speed PID Differentiation Time	1 ms	Use max. 1- 2 ms for faster response.
7-06	Speed PID Lowpass Filter Time	5 ms	Adjust to pulses per revolution of encoder. Higher pulses = lower ms.
14-00	Switching pattern	SFAVM	* Normally best choice regarding performance and acoustic noise.
14-01	Switching Frequency		* Switching frequency higher than factory settings might decrease thermal performance for the drive.
14-10	Mains Failure	Ctrl. ramp down	This setting is best choice, but might not work for VVC+.
14-11	Mains Voltage at Mains Fault	As needed	Set to 10% below min. mains level
14-12	Function at Mains Imbalance	Warning.	Factory setting is trip. A generator supply might activate this trip too often
14-24	Trip Delay at Current Limit	As needed	Running too long in current limit indicate something is overloaded.
14-25	Trip Delay at Torque Limit	As needed	Running too long in torque limit indicate something is overloaded.
14-26	Trip Delay at Inverter Fault	0 second	Too high voltage = brake faulty.
14-35	Stall Protection	Enable	*
14-50	RFI Filter	Off	Factory setting is ON. For IT grids use OFF. For TN grids use ON.
14-55	Output filter	No filter	* Set parameter if output filter is used.
14-90	Fault Level	Off	* Should not be used ; but fault condition can be changed.
17-10	Signal Type	RS 422 (5 V TTL)	* Factory setting for most used encoder.
17-11	Resolution (PPR)	1024	* Factory settings for most popular PPR. Change if needed.

Appendix 3.1

Multiple motors and single drive without feedback – Special motor mode and VVC+ with open loop control

Wiring



Parameter set-up – Multiple motors and single drive without feedback
Special motor mode and VVC+ with open loop control control

Par. ID	Description	Set-up	Comment (* = factory settings)
1-00	Configuration Mode	Speed open loop	*
1-01	Motor Control Principle	VVC+	* (include V/A comp. and slip comp.)
1-03	Torque Characteristics	Constant torque	*
1-04	Overload Mode	High Torque	* (150-160% over current available)
1-06	Clockwise Direction	Normal	* (avoid using this parameter).
1-10	Motor Construction	Asynchron	* (no PM motor considered here)
1-20 1-26	Motor Data inserted	Motor size = Drive size	(150-160% over current available)
1-29	Automatic Motor Adaptation	Use complete AMA	For larger drive use reduced AMA
1-30 1-37	Advanced motor data is calculated based on motor data	R1 = stator restistance Xh = main impedance	R1 should also include cable resistance Xh determine magnetizing current.
1-39	Motor Poles	Automatic calculated	Calculated based on par. 1-23 and 1-25. Never use synchron speed for par. 1-25.
1-50 1-52	Magnetizing current at low speed		* Use factory settings.
1-60 1-61	Low Speed and High Speed Compensation (V/A comp.)		* Use factory Settings.
1-62	Slip Compensation	- 100%	The higher the motor slip is, the better is the natural load sharing. – 100% for large motors with low slip is normally enough; otherwise increase neg. %.
1-64	Resonance Dampening	100% = Normal damping.	Resonance damping is based on motor slip. Par.1-23 and par. 1-25. Unstable operation: increase or reduce parameter
1-71	Start Delay	0.1 – 1.5 second.	Time needed to magnetize the motor
1-72	Start Function	VVC+/flux clockwise	VVC+ can ramp up, but not provide motor torque before magnetized.
1-74	Start Speed	Use slip in RPM	After start delay time can the motor provide 100 % nominal torque.
1-80	Function at Stop	Coast	*
1-81	Min. Speed for Function at Stop	2-3 RPM	
1-90	Motor Thermal Protection	ETR warning 1	ETR does not require external sensors.
2-10	Brake Function	Resistor Brake.	Most application require a brake resistor. Large resistors can be water cooled.
2-11	Brake resistor	Use factory size.	Give 160% generatoric torque
2-12	Brake power limit	Use brake information.	Average value for the resistor.
2-13	Brake Power Monitoring.	Warning.	Use as indication for overheating.
2-15	Brake check	Warning.	Indication for brake failure.
2-18	Brake Check Condition	After Coast Situation	Additional brake check.
2-20	Release Brake Current	Use magnetizing current for the motor	When the actual current is above the set current within the start delay time, then mechanical brake relay change state.
2-21	Activate Brake Speed	Set RPM for closing	Determine physical closing time for the brake. Determine the ramp down time. Calculate the set RPM for closing the brake at 0 RPM.
2-23	Activate Brake Delay	0.1 – 0.5 second	Activate a holding torque, after the brake has closed. Taking care of time delay for worn brake lining.
3-40	Ramp 1 Type	Linear	* Other ramp types might be better, but can extend actual time.
3-41	Ramp 1. Ramp up time	As needed	Ramp time = time from 0 RPM to synchronous speed. Too short time may activate current /torque warning.
3-42	Ramp 1. Ramp down time	As needed	Ramp time = time from synchronous speed to 0 RPM. Too short time may activate current /torque warning.
4-10	Motor Speed Direction	Both directions	Winch normally need both directions
4-11	Motor speed Low Limit	0 RPM	* Normally no change needed.
4-13	Motor Speed High Limit	As needed	Lower to max. needed (+ 2 x slip).
4-16	Torque Limit Motor Mode	160%	* (suggestion: 15% higher than current limit)
4-17	Torque Limit Generator Mode	160%	(suggestion: 15% higher than current limit)

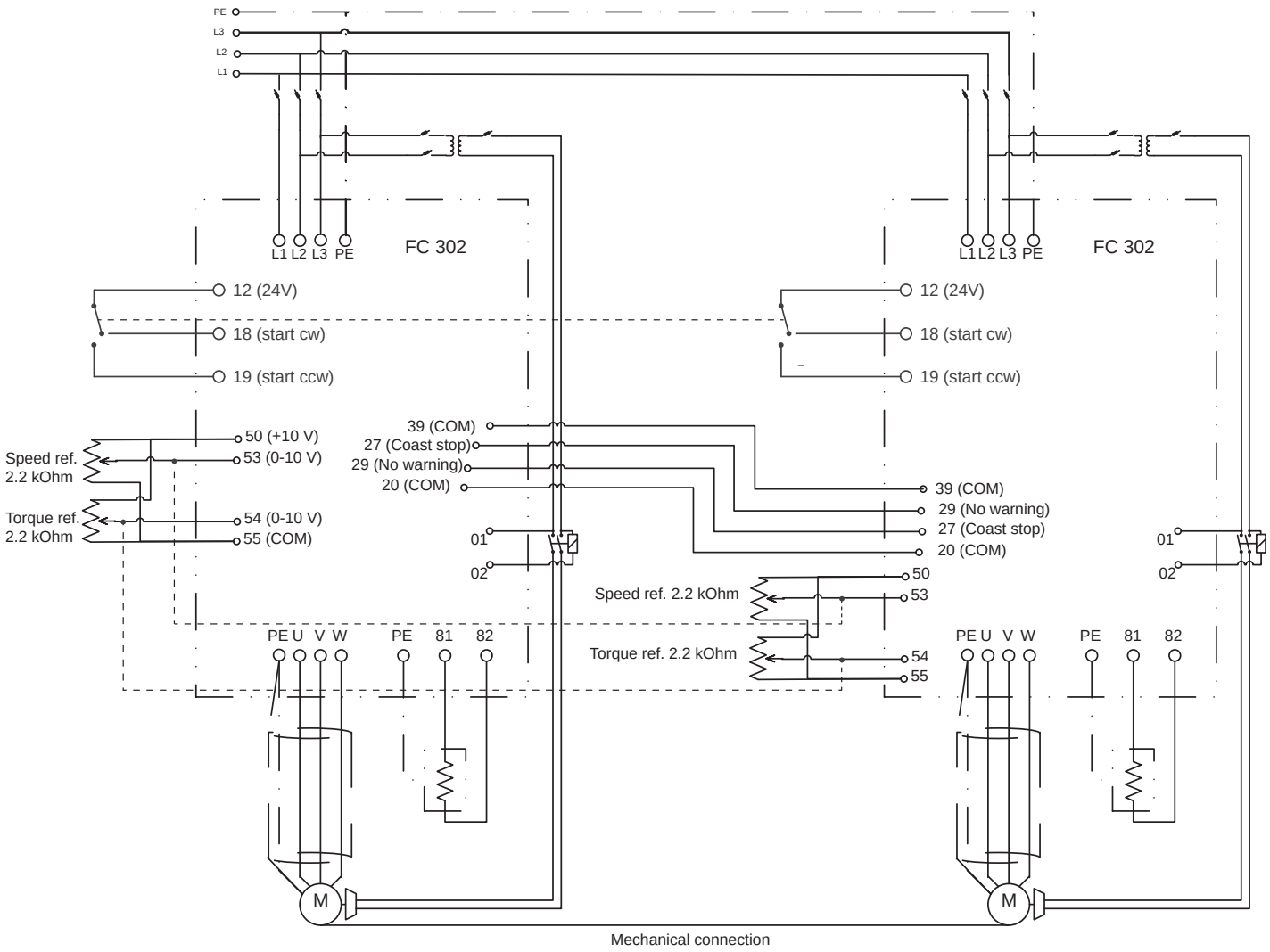
Parameter set-up – Multiple motors and single drive without feedback
Special motor mode and VVC+ with open loop control

Par. ID	Description	Set-up	Comment (* = factory settings)
4-18	Current limit	Max. %	% = Max. current for drive / nominal current for motor.
4-19	Max Output Frequency	As needed	Slightly higher than parameter 4-13.
5-11	Terminal 19 Digital Input	Start reversing	Digital input normally provided by joystick with only one direction signal.
5-40	Function Relay	Mechanical brake ctrl.	Relay 1 is normally used for this function. Take care of contact burning.
5-41	On Delay, Relay	0.0 – 1.4 second	If the magnetizing of the motor is longer than the opening of the brake.
5-42	Off Delay, Relay	0.0 second	* Normally not used.
6-00	Live Zero Timeout Time	1 second	Use where 4-20 mA signal is present.
6-01	Live Zero Timeout Function	Stop and trip.	Function if reference is lost.
6-15	Terminal 53 High ref/(feedback) Value	As needed	Reference for 20 mA or 10 Volt.
N.B.	Set control card switch for I or V	Current or voltage input	See settings in parameter 16-61.
7-00 7-57	PID controller for closed loop regulation.	Not used for VVC+ open loop	
14-00	Switching pattern	SFAVM	* Normally best choice regarding performance and acoustic noise.
14-01	Switching Frequency		* Switching frequency higher than factory settings might decrease thermal performance for the drive.
14-03	Overmodulation		* give higher voltage for VVC+ in over synchronous range.
14-10	Mains Failure	Controlled ramp down	This setting is best choice; but might not work for VVC+.
14-11	Mains Voltage at Mains Fault.	As needed	Set to 10% below min. mains level.
14-12	Function at Mains Imbalance	Warning.	Factory setting is trip. A generator supply might activate this trip too often.
14-24	Trip Delay at Current Limit	As needed	Running too long in current limit indicate something is overloaded.
14-25	Trip Delay at Torque Limit	As needed	Running too long in torque limit indicate something is overloaded.
14-26	Trip Delay at Inverter Fault	0 second	Too high voltage = brake faulty.
14-50	RFI Filter	Off	Factory setting is ON. For IT grids use OFF. For TN grids use ON.
14-90	Fault Level	Off	* Should not be used ; but fault condition can be changed.

Appendix 4.1

Multiple motors and multiple drives without feedback VVC+ open loop control

Wiring



Parameter set-up – Multiple motors and multiple drives without feedback
VVC+ open loop control

Par. ID	Description	Set-up	Comment (* = factory settings)
1-00	Configuration Mode	Speed open loop	*
1-01	Motor Control Principle	VVC+	* (include V/A comp. and slip comp.)
1-03	Torque Characteristics	Constant torque	*
1-04	Overload Mode	High Torque	* (150-160% over current available)
1-06	Clockwise Direction	Normal	* (avoid using this parameter).
1-10	Motor Construction	Asynchron	* (no PM motor considered here)
1-20 1-26	Motor Data inserted	Motor size = Drive size	(150-160% over current available)
1-29	Automatic Motor Adaptation	Use complete AMA	For larger drive use reduced AMA
1-30 1-37	Advanced motor data is calculated based on motor data	R1 = stator restistance Xh = main impedance.	R1 should also include cable resistance Xh determine magnetizing current.
1-39	Motor Poles	Automatic calculated	Calculated based on par. 1-23 and 1-25. Never use synchron speed for par. 1-25.
1-50 1-52	Magnetizing current at low speed		* Use factory settings.
1-60 1-61	Low Speed and High Speed Compensation (V/A comp.)		* Use factory Settings.
1-62	Slip Compensation	- 100%	The higher the motor slip is, the better is the natural load sharing. – 100% for large motors with low slip is normally enough; otherwise increase neg. %.
1-64	Resonance Dampening	100% = Normal damping.	Resonance damping is based on motor slip. Par.1-23 and par. 1-25. Unstable operation: increase or reduce parameter
1-71	Start Delay	0.1 – 1.5 second.	Time needed to magnetize the motor
1-72	Start Function	VVC+/flux clockwise	VVC+ can ramp up, but not provide motor torque before magnetized.
1-74	Start Speed	Use slip in RPM	After start delay time can the motor provide 100 % nominal torque.
1-80	Function at Stop	Coast	*
1-81	Min. Speed for Function at Stop	2-3 RPM	
1-90	Motor Thermal Protection	ETR warning 1	ETR does not require external sensors.
2-10	Brake Function	Resistor Brake.	Most application require a brake resistor. Large resistors can be water cooled.
2-11	Brake resistor	Use factory size.	Give 160% generatoric torque
2-12	Brake power limit	Use brake information.	Average value for the resistor.
2-13	Brake Power Monitoring.	Warning.	Use as indication for overheating.
2-15	Brake check	Warning.	Indication for brake failure.
2-18	Brake Check Condition	After Coast Situation	Additional brake check.
2-20	Release Brake Current	Use magnetizing current for the motor	When the actual current is above the set current within the start delay time, then mechanical brake relay change state.
2-21	Activate Brake Speed	Set RPM for closing	Determine physical closing time for the brake. Determine the ramp down time. Calculate the set RPM for closing the brake at 0 RPM.
2-23	Activate Brake Delay	0.1 – 0.5 second	Activate a holding torque, after the brake has closed. Taking care of time delay for worn brake lining.
3-40	Ramp 1 Type	Linear	* Other ramp types might be better, but can extend actual time.
3-41	Ramp 1. Ramp up time	As needed	Ramp time = time from 0 RPM to synchronous speed. Too short time may activate current /torque warning.
3-42	Ramp 1. Ramp down time	As needed	Ramp time = time from synchronous speed to 0 RPM. Too short time may activate current /torque warning.
4-10	Motor Speed Direction	Both directions	Winch normally need both directions
4-11	Motor speed Low Limit	0 RPM	* Normally no change needed.
4-13	Motor Speed High Limit	As needed	Lower to max. needed (+ 2 x slip).
4-16	Torque Limit Motor Mode	160%	* (suggestion: 15% higher than current limit)

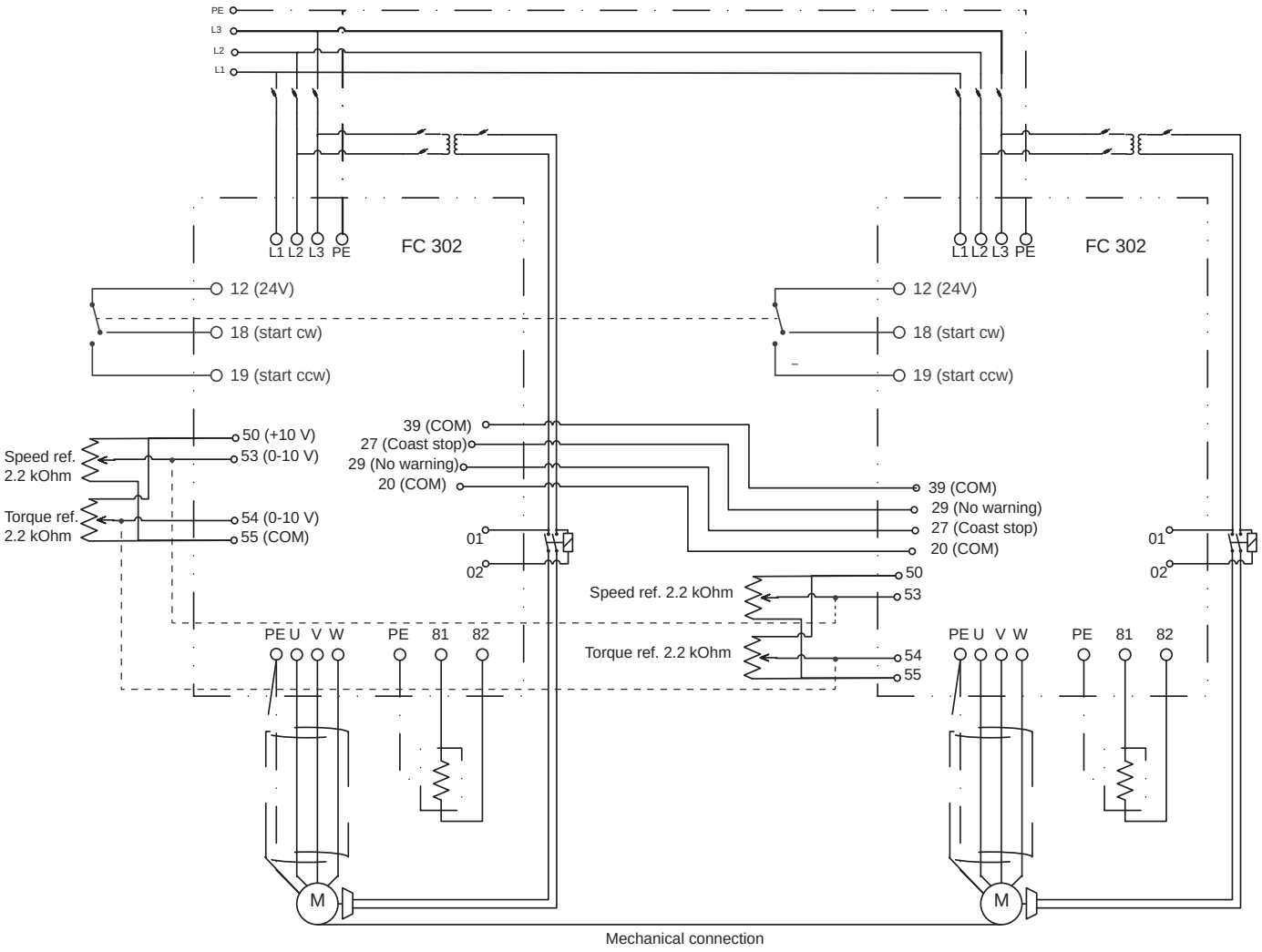
Parameter set-up – Multiple motors and multiple drives without feedback VVC+ open loop control

Par. ID	Description	Set-up	Comment (* = factory settings)
4-17	Torque Limit Generator Mode	160%	(suggestion: 15% higher than current limit)
4-18	Current limit	Max. %	% = Max. current for drive / nominal current for motor.
4-19	Max Output Frequency	As needed	Slightly higher than parameter 4-13.
4-30 4-39	Motor tracking error		N.B. Do not work for open loop application.
5-11	Terminal 19 Digital Input	Start reversing	Digital input normally provided by joystick with only one direction signal.
5-40	Function Relay	Mechanical brake ctrl.	Relay 1 is normally used for this function. Take care of contact burning.
5-41	On Delay, Relay	0.0 – 1.4 second	If the magnetizing of the motor is longer than the opening of the brake.
5-42	Off Delay, Relay	0.0 second	* Normally not used.
6-00	Live Zero Timeout Time	1 second	Use where 4-20 mA signal is present.
6-01	Live Zero Timeout Function	Stop and trip.	Function if reference is lost.
6-15	Terminal 53 High ref/(feedback) Value	As needed	Reference for 20 mA or 10 Volt.
N.B.	Set control card switch for I or V	Current or voltage input	See settings in parameter 16-61.
7-00 7-57	PID controller for closed loop regulation.	Not used for VVC+ open loop	
14-00	Switching pattern	SFAVM	* Normally best choice regarding performance and acoustic noise.
14-01	Switching Frequency		* Switching frequency higher than factory settings might decrease thermal performance for the drive.
14-03	Overmodulation		* give higher voltage for VVC+ in over synchronous range.
14-10	Mains Failure	Controlled ramp down	This setting is best choice; but might not work for VVC+.
14-11	Mains Voltage at Mains Fault.	As needed	Set to 10% below min. mains level.
14-12	Function at Mains Imbalance	Warning.	Factory setting is trip. A generator supply might activate this trip too often.
14-24	Trip Delay at Current Limit	As needed	Running too long in current limit indicate something is overloaded.
14-25	Trip Delay at Torque Limit	As needed	Running too long in torque limit indicate something is overloaded.
14-26	Trip Delay at Inverter Fault	0 second	Too high voltage = brake faulty.
14-50	RFI Filter	Off	Factory setting is ON. For IT grids use OFF. For TN grids use ON.
14-90	Fault Level	Off	* Should not be used ; but fault condition can be changed.

Appendix 4.2

Multiple motors and multiple drives without feedback
Flux vector open loop control

Wiring



Parameter set-up – Multiple motors and multiple drives without feedback
Flux vector open loop control

Par. ID	Description	Set-up	Comment (* = factory settings)
1-00	Configuration Mode	Speed open loop	*
1-01	Motor Control Principle	Flux sensorless	*
1-03	Torque Characteristics	Constant torque	*
1-04	Overload Mode	High Torque	* (150-160% over current available)
1-06	Clockwise Direction	Normal	* (avoid using this parameter).
1-10	Motor Construction	Asynchron	* (no PM motor considered here)
1-20 1-26	Motor Data inserted	Motor size = Drive size	(150-160% over current available)
1-29	Automatic Motor Adaptation	Use complete AMA	For larger Drive use reduced AMA
1-30 1-37	Advanced motor data is calculated based on motor data	R1 = stator resistance Xh = main impedance.	R1 should also include cable resistance Xh determine magnetizing current.
1-39	Motor Poles	Automatic calculated	Calculated based on par. 1-23 and 1-25. Never use synchron speed for par. 1-25.
1-53	Model Shift Frequency		* Use factory settings, or about 15% of nominal frequency.
1-54	Voltage reduction in Field- weakening	0 Volt	* Use factory Settings. Can be increased if voltage is missing in over synchronous range.
1-62	Slip Compensation	- 100%	The higher the motor slip is, the better is the natural load sharing. – 100% for large motors with low slip is normally enough; otherwise increase neg. %.
1-64	Resonance Dampening	100% = Normal damping.	Resonance damping is based on motor slip. Par.1-23 and par. 1-25. Unstable operation: increase or reduce parameter
1-66	Min. Current at Low Speed	100%	* 100% = low current is = nominal current. Change if needed.
1-67	Load Type	Active Load	Enhance the performance at low RPM.
1-71	Start Delay	0.1 – 0.2 second.	Time to indicate that current is present for the motor and above parameter 2-20
1-72	Start Function	VVC+/flux clockwise	Will calculate right current for output frequency.
1-74	Start Speed	Use slip in RPM	Can provide 100 % torque by start
1-80	Function at Stop	Coast	*
1-81	Min. Speed for Function at Stop	2-3 RPM	
1-90	Motor Thermal Protection	ETR warning 1	ETR does not require external sensors.
2-10	Brake Function	Resistor Brake.	Most application requires a brake resistor. Large resistors can be water cooled.
2-11	Brake resistor	Use factory size.	Give 160% generatoric torque
2-12	Brake power limit	Use brake information.	Average value for the resistor.
2-13	Brake Power Monitoring.	Warning.	Use as indication for overheating.
2-15	Brake check	Warning.	Indication for brake failure.
2-18	Brake Check Condition	After Coast Situation	Additional brake check.
2-20	Release Brake Current	Use magnetizing current for the motor	When the actual current is above the set current within the start delay time, then mechanical brake relay change state.
2-21	Activate Brake Speed	Set RPM for closing	Determine physical closing time for the brake. Determine the ramp down time. Calculate the set RPM for closing the brake at 0 RPM.
2-23	Activate Brake Delay	0.1 – 0.5 second	Activate a holding torque, after the brake has closed. Taking care of time delay for worn brake lining.
3-40	Ramp 1 Type	Linear	* Other ramp types might be better, but can extend actual time.
3-41	Ramp 1. Ramp up time	As needed	Ramp time = time from 0 RPM to synchronous speed. Too short time may activate current /torque warning.
3-42	Ramp 1. Ramp down time	As needed	Ramp time = time from synchronous speed to 0 RPM. Too short time may activate current /torque warning.
4-10	Motor Speed Direction	Both directions	Winch normally need both directions
4-11	Motor speed Low Limit	0 RPM	* Normally no change needed.
4-13	Motor Speed High Limit	As needed	Lower to max. needed (+ 2 x slip).
4-16	Torque Limit Motor Mode	160%	* (suggestion: 15% higher than current limit)
4-17	Torque Limit Generator Mode	160%	(suggestion: 15% higher than current limit)
4-18	Current limit	Max. %	% = Max. current for drive / nominal current for motor.

Parameter set-up – Multiple motors and multiple drives without feedback
Flux vector open loop control

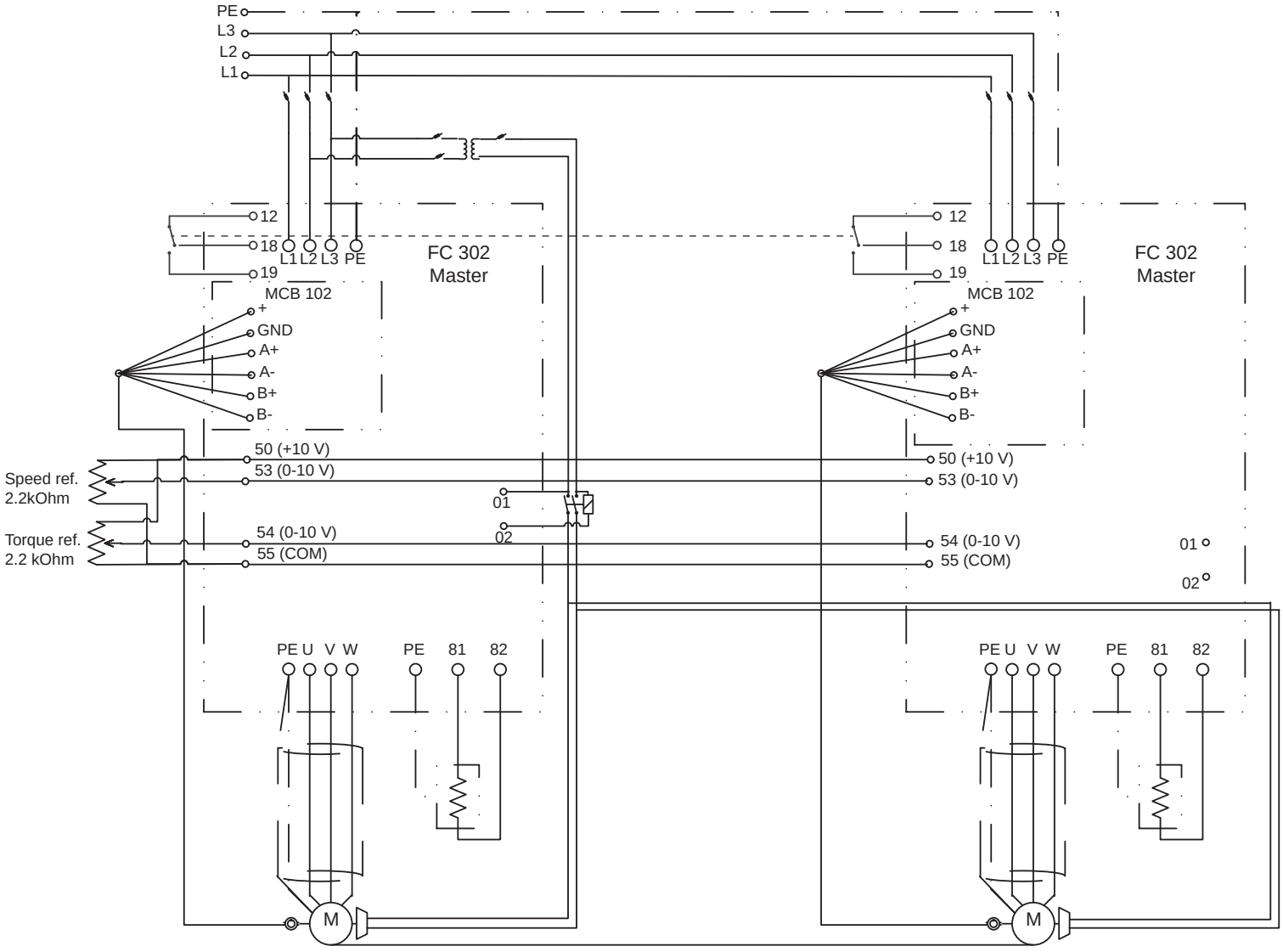
Par. ID	Description	Set-up	Comment (* = factory settings)
4-19	Max Output Frequency	As needed	Slightly higher than parameter 4-13.
5-11	Terminal 19 Digital Input	Start reversing	Digital input normally provided by joystick with only one direction signal.
5-40	Function Relay	Mechanical brake ctrl.	Relay 1 is normally used for this function. Take care of contact burning.
5-41	On Delay, Relay	0.0 – 1.0 second	Adjust the brake to be open, when the drive start to ramp up.
5-42	Off Delay, Relay	0.0 second	* Normally not used.
6-00	Live Zero Timeout Time	1 second	Use where 4-20 mA signal is present.
6-01	Live Zero Timeout Function	Stop and trip.	Function if reference is lost.
6-15	Terminal 53 High ref/(feedback) Value	As needed	Reference for 20 mA or 10 Volt.
N.B.	Set control card switch for I or V	Current or voltage input	See settings in parameter 16-61.
7-02	Speed PID Proportional Gain	0.015	* Should be adjusted. Normally is a higher gain necessary; but take care of instability.
7-03	Speed PID Integral Time	200ms	* factory setting is normally O.K. ; but could be reduced for better dynamic operation. Take care of instability.
7-04	Speed PID Differentiation Time	Off	* Normally not used. If set, take care of instability above 1 ms.
14-00	Switching pattern	SFAVM	* Normally best choice regarding performance and acoustic noise.
14-01	Switching Frequency		* Switching frequency higher than factory settings might decrease thermal performance for the drive.
14-10	Mains Failure	Ctrl. ramp down	This setting is best choice.
14-11	Mains Voltage at Mains Fault.	As needed	Set to 10% below min. mains level.
14-12	Function at Mains Imbalance	Warning.	Factory setting is trip. A generator supply might activate this trip too often.
14-24	Trip Delay at Current Limit	As needed	Running too long in current limit indicate something is overloaded.
14-25	Trip Delay at Torque Limit	As needed	Running too long in torque limit indicate something is overloaded.
14-26	Trip Delay at Inverter Fault	0 second	Too high voltage = brake faulty.
14-50	RFI Filter	Off	Factory setting is ON. For IT grids use OFF. For TN grids use ON
14-90	Fault Level	Off	* Should not be used ; but fault condition can be changed.

Appendix 5.1

Multiple motors and multiple drives with feedback (2)
Flux vector closed loop control
Speed droop load sharing concept

Wiring

The drawing shows the setup of two frequency converters, each driving a motor that are mechanically coupled on the same shaft, "Common shaft motors", either directly, or through a gear box.



Parameter set-up – Multiple motors and multiple drives with feedback (2)
Flux vector closed loop control

Par. ID	Description	Master Drive 1 Master Drive 2 etc.	Comment (* = factory settings)
1-00	Configuration Mode	Speed closed loop	Alternatively: Use speed open loop if there is no feedback. In that case ignore parameters 1-01; 1-02 and 17-XX
1-01	Motor Control Principle	Flux w/ motor feedback	
1-02	Flux Motor Feedback Source	MCB 102	TTL 5V encoder used for MCB 102
1-03	Torque Characteristics	Constant Power	Work sonly for flux closed loop.
1-04	Overload Mode	High Torque	* (150-160% over current available)
1-06	Clockwise Direction	Normal	* (avoid using this parameter).
1-10	Motor Construction	Asynchron	* (no PM motor considered here)
1-20 1-26	Motor Data inserted	Motor size = Drive size	(150-160% over current available)
1-29	Automatic Motor Adaptation	Use complete AMA	For larger Drive use reduced AMA
1-30 1-37	Advanced motor data is calculated based on motor data	R1 = stator resistance Xh = main impedance.	R1 should also include cable resistance Xh determine magnetizing current.
1-39	Motor Poles	Automatic calculated	Calculated based on par. 1-23 and 1-25. Never use synchron speed for par. 1-25.
1-53	Model Shift Frequency.		* Use factory setting. Otherwise use 15% of nominal motor frequency.
1-54	Voltage reduction in Fieldweakening.	0V	* Use factory setting. In case of warning 62 try to reduce the voltage.
1-62	Slip compensation	-100%	Only visible in software 6.84 and later for closed loop. Higher - settings give better load sharing, but less dynamic speed accuracy.
1-72	Start Function	Hoist Mech. Brake Relay	
1-80	Function at Stop	Coast	*
1-81	Min. Speed for Function at Stop	1 RPM	
1-90	Motor Thermal Protection	ETR warning 1	ETR does not require external sensors.
2-10	Brake Function	Resistor Brake.	Most application requires a brake resistor. Large resistors can be water cooled.
2-11	Brake resistor	Use factory size.	Give 160% generatoric torque
2-12	Brake power limit	Use brake information.	Average value for the resistor.
2-13	Brake Power Monitoring.	Warning.	Use as indication for overheating.
2-15	Brake check	Warning.	Indication for brake failure.
2-18	Brake Check Condition	After Coast Situation	Additional brake check.
2-21	Activate Brake Speed	Set RPM for closing	Determine physical closing time for the brake. Determine the ramp down time. Calculate the set RPM for closing the brake at 0 RPM.
2-23	Activate Brake Delay	0.1 – 0.5 second	Activate a holding torque, after the brake has closed. Taking care of time delay for worn brake lining.
2-24	Stop Delay	0 second.	* delay time for closing the brake relay.
2-25	Brake Release Time	0.2 second.	* Set as needed. Time for the brake to open. Time for increased proportional gain boost.
2-26	Torque Ref.	70%	Set as needed. Torque applied against closed brake before brake release.
2-27	Torque Ramp Time	0.2 second	* Ramp time for parameter 2-26.
2-28	Gain boost Factor	2.00	Set as needed. Increased proportional gain during time for parameter 2-25.
3-00	Reference Range	Min. - +Max.	Master: Speed reference. Follower: Torque reference.
3-02	Minimum reference	As needed	Master: Set min. speed ref. Follower: -(nominal motor torque x settings in par. 4-17).
3-03	Maximum Reference	As needed	Master: Set max. speed ref. Follower: nominal motor torque x settings in par. 4-16.
3-40	Ramp 1 Type	Linear	* Other ramp types might be better, but can extend actual time.
3-41	Ramp 1. Ramp up time	As needed	Ramp time = time from 0 RPM to synchronous speed. Too short time may activate current /torque warning.

Parameter set-up – Multiple motors and multiple drives with feedback (2)
Flux vector closed loop control

Par. ID	Description	Master Drive 1 Master Drive 2 etc.	Comment (* = factory settings)
3-42	Ramp 1. Ramp down time	As needed	Ramp time = time from synchronous speed to 0 RPM. Too short time may activate current /torque warning.
4-10	Motor Speed Direction	Both directions	Winch normally need both directions
4-11	Motor speed Low Limit	0 RPM	* Normally no change needed.
4-13	Motor Speed High Limit	As needed	Lower to max. needed (+ 2 x slip).
4-16	Torque Limit Motor Mode	160%	* (suggestion: 5% higher than current limit). Goes down with field weakening curve, when parameter 1-03 is set for constant power.
4-17	Torque Limit Generator Mode	160%	(suggestion: 5% higher than current limit). Goes down with field weakening curve, when parameter 1-03 is set for constant power.
4-18	Current limit	Max. %	% = Max. current for drive / nominal current for motor.
4-19	Max Output Frequency	As needed	Slightly higher than parameter 4-13.
4-20	Torque Limit Factor Source	Analog in 54	Can be used to adjust parameter 4-16 and 4-17 by remote potentiometer.
4-30	Motor Feedback Loss function	Warning	Suggestion is Warning.
4-31	Motor Feedback Speed Error	300 RPM	* This window is motor dependent.
4-32.	Motor feedback Loss Timeout	1 second	Factory setting of 0.05 second might be too fast.
4-34	Tracking Error Function	Warning.	
4-35	Tracking Error	100 RPM	Factory setting of 10 RPM is too small window.
4-36	Tracking Error Timeout	1 second	*
4-37	Tracking Error Ramping	100 RPM	* Might be increased to 200 RPM if too sensitive.
4-38	Tracking Error Ramping Timeout.	5 second	* Could be decreased to about 1 second for a faster detection.
5-02	Terminal 29 Mode	Running/ no warning	When digital terminal 29 is used as digital output
5-11	Terminal 19 Digital Input	Start reversing	Digital input normally provided by joystick with only one direction signal.
5-12	Terminal 27 Digital Input	Stop inverse	
5-40	Function Relay	Mechanical brake ctrl.	Relay 1 is normally used for this function. Take care of contact burning
5-41	On Delay, Relay	0.01 second	* Use parameter 2-25 if needed.
5-42	Off Delay, Relay	0.01 second	* Normally not used.
6-00	Live Zero Timeout Time	1 second	Use where 4-20 mA signal is present.
6-01	Live Zero Timeout Function	As needed	Function if reference is lost.
6-15	Terminal 53 High ref/ (feedback) Value		Reference for 20 mA or 10 Volt.
6-22	Terminal 54 Low Current		Use 4 mA because super-vision of signal is possible.
6-23	Terminal 54 High Current		*
6-24	Terminal 54 Low Ref/Feedb. Value		- (Nominal motor torque x settings in par. 4-17) = Param. 3-03 with minus sign.
6-25	Terminal 54 High Ref/Feedb. value		Nominal motor torque x settings in par.4-16 = Par 3-03
N.B.	Set control card switch for I or V	Current or voltage input	See settings in parameter 16-61.
7-00	Speed PID Feedback Source	MCB 102 option.	* Use 5 V encoder with MCB 102, especially with long cable lengths.
7-02	Speed PID Proportional Gain	0.015	* Master: can be increased. Take care of instability.
7-03	Speed PID integral Time	200 ms	* Master: can be decreased for a faster response. Take care of instability.
7-04	Speed PID Differentiation Time	1 ms	Master: Use max. 1- 2 ms for faster response.
7-06	Speed PID Lowpass Filter Time	5 ms	Adjust to pulses per revolution of encoder. Higher pulses = lower ms.
14-00	Switching pattern	SFAVM	* Normally best choice regarding performance and acoustic noise.
14-01	Switching Frequency		* Switching frequency higher than factory settings might decrease thermal performance for the drive.
14-10	Mains Failure	Ctrl. ramp down	
14-11	Mains Voltage at Mains Fault.	As needed	Set to 10% below min. mains level.

Parameter set-up – Multiple motors and multiple drives with feedback (2)
Flux vector closed loop control

Par. ID	Description	Master Drive 1 Master Drive 2 etc.	Comment (* = factory settings)
14-12	Function at Mains Imbalance	Warning.	Factory setting is trip. A generator supply might activate this trip too often.
14-24	Trip Delay at Current Limit	As needed	Running too long in current limit indicate something is overloaded. (Suggestion: 1 second).
14-25	Trip Delay at Torque Limit	As needed	Running too long in torque limit indicate something is overloaded. (Suggestion: 1 second).
14-26	Trip Delay at Inverter Fault	0 second	Too high voltage = brake faulty.
14-35	Stall Protection	Enable	*
14-50	RFI Filter	Off	Factory setting is ON. For IT grids use OFF. For TN grids use ON.
14-90	Fault Level	Off	* Should not be used ; but fault condition can be changed.
17-10	Signal Type	RS 422 (5 V TTL).	* Factory setting for most used encoder.
17-11	Resolution (PPR)	1024	* Factory settings for most popular PPR. Change if needed.
17-60	Feedback direction	Counter Clockwise	* If over current or tracking error is present at start, then encoder direction most likely is wrong, change settings.
17-61	Feedback Signal Monitoring	Warning	

Notes

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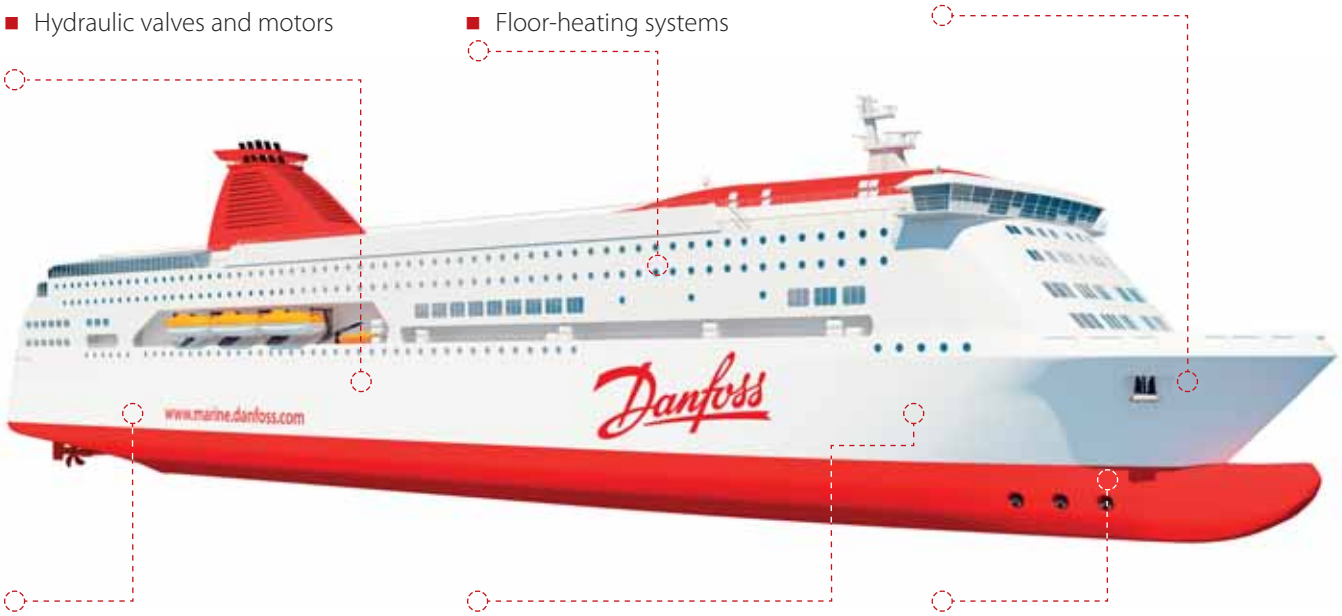

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