ENGINEERING TOMORROW

Application Note

VLT® AutomationDrive for **marine winch** applications

This Application note 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 comes 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.

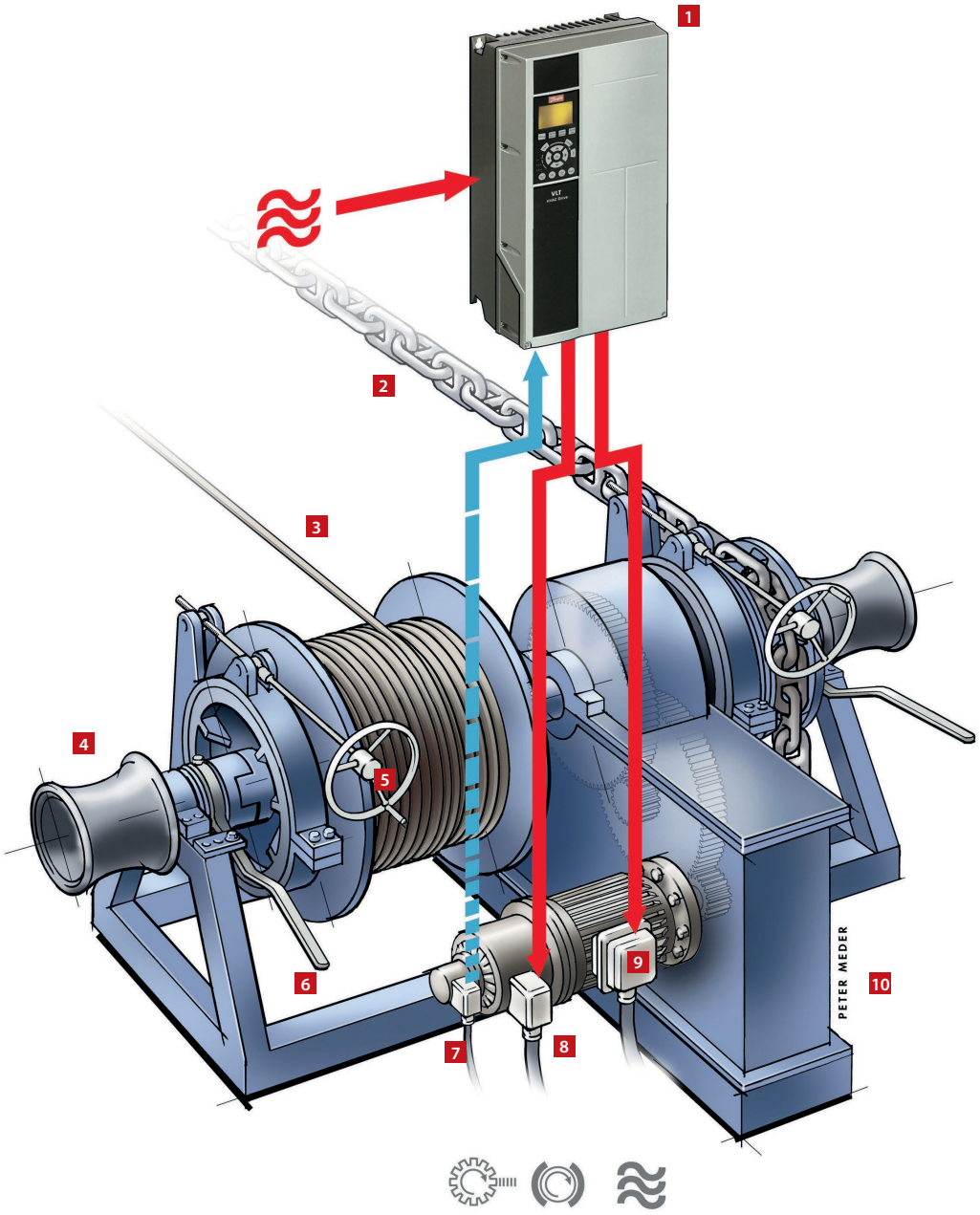
Increased environmental awareness is becoming more and more decisive for the type of equipment ship owners are choosing for their vessels. A result of this is the increased demand for electrical driven winches.

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

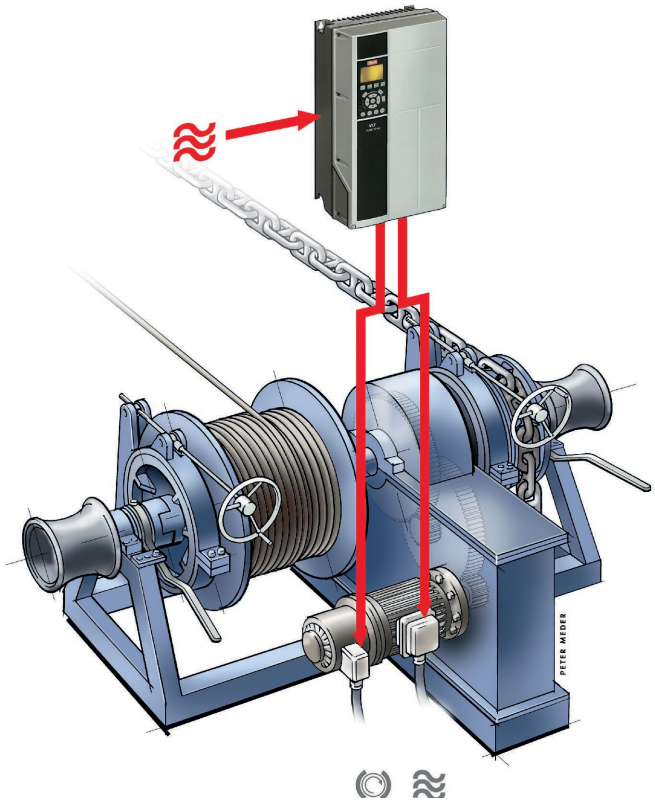
Single motor without encoder

Typical applications:

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

Parameter setup and wiring:

see appendix 1.1 and 1.2



Strength

VVC+ open loop control	Flux vector open loop control
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)	Possible higher starting torque than VVC+ mode
No adjustment of speed PID controller	Less dependent of motor temperature (weather conditions)
Better regulation in the over synchronous range	Less parameter settings for control of the electromechanical brake
Less parameter settings for control of the electromechanical brake	
Parameter setup see appendix 1.1	*Parameter setup see appendix 1.2*

Weaknessess

VVC+ open loop control	Flux vector open loop control
Torque control does not work	
Cannot handle shock load as well as flux control	Can not be used in applications where rendering is expected.
Cannot be used in application where rendering is expected	It needs either complete AMA or equivalent motor diagram parameters
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 necessary
Limited torque control range	Possible current and speed jump at change-over frequency
Torque cannot shift from motoric to generatoric mode during running	No torque mode control available
Starting torque is dependent on motor temperature (weather condition)	Lack of voltage in the over synchronous range

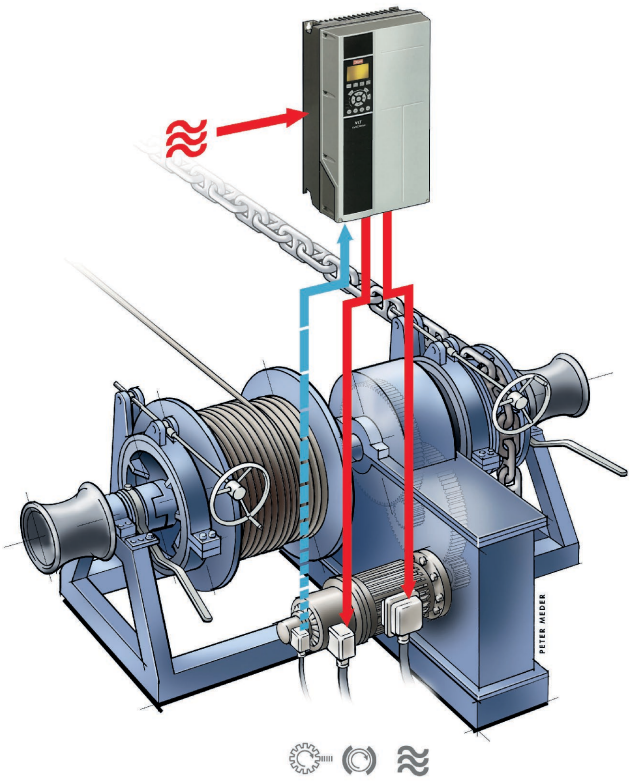
Single motor with encoder

Typical applications:

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

Parameter setup and wiring:

see appendix 1.1 and 1.2



Strength

VVC+ closed loop control	Flux vector closed loop control
Better performance at low speed than open loop	Full holding torque at 0 RPM
Tracking control can increase the safety	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
Parameter setup see appendix 2.1	*Parameter setup see appendix 2.2*

Weaknessess

VVC+ closed loop control	Flux vector closed loop control
Tuning of PID controller	More accurate advance motor data necessary (AMA values)
Can not be used where rendering* is expected	Speed PID adjustment necessary
	Possible current and speed jump at change over frequency
	Lack of voltage in the over synchronous range
	More parameter settings for the mechanical brake

** 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.*

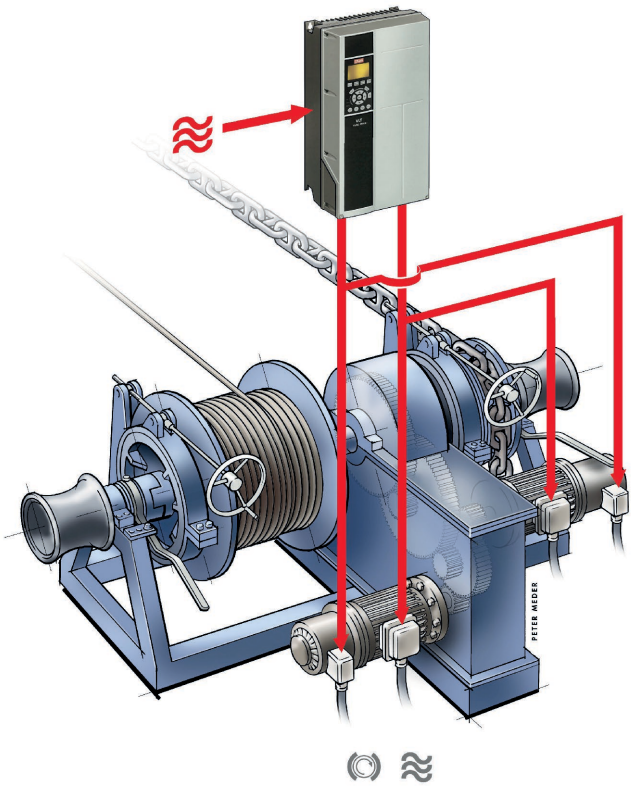
Dual motors and single drive without encoders

Typical applications:

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

Parameter setup and wiring:

see appendix 1.1 and 1.2



Strength

Special motor mode or VVC+ with open loop control
Both 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 (both motors are the same size = doubling of motor current values)
Special motor mode does not need advance motor parameters
Parameter setup see appendix 3.1

Weaknessess

Special motor 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 efficient motors with low slip do not provide good load sharing
Set up in special motor mode (or VVC+ mode)
Flux mode might be used; but is not recommended (AMA could be difficult)
No slip compensation in special motor mode

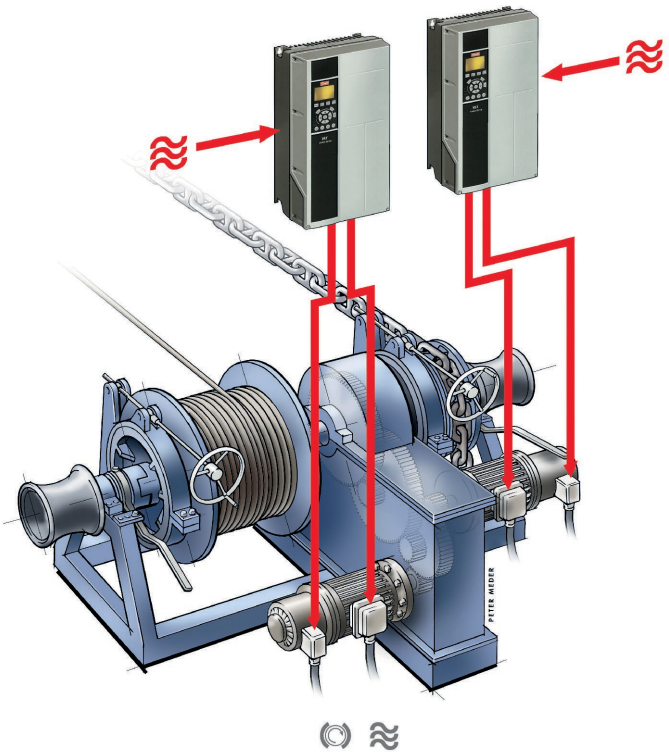
Dual motors and dual drives without encoders

Typical applications:

- Capstan winches
- Tugger winches
- Fishing equipment winches

Parameter setup 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).	

Dual motors and dual drives with encoders (1)
Master-follower load sharing concept

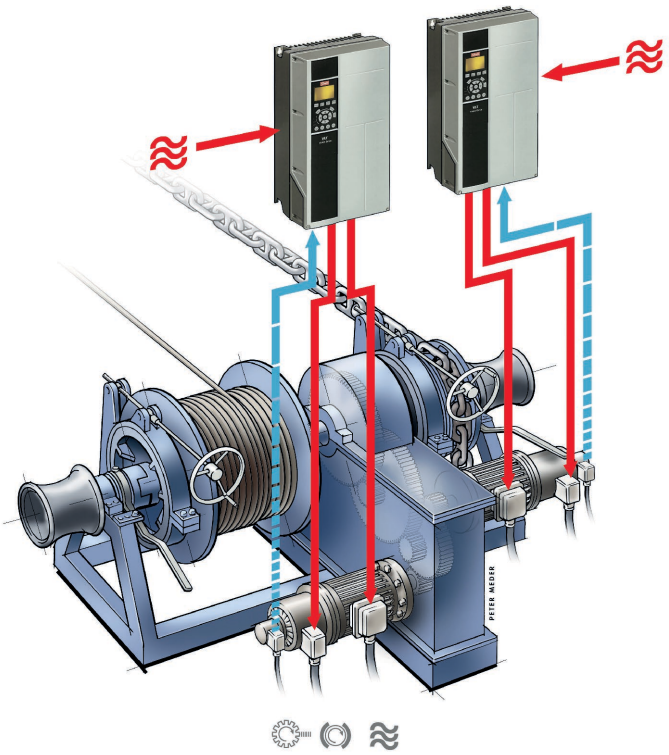
Only to be run in flux vector mode closed loop and a master follower set-up

Typical applications:

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

Parameter setup and wiring:

see appendix 5.1



Strength

Flux vector closed loop control
Can be used in applications with rendering
Tracking control can improve safety
Excellent electromechanical brake control
Normally used for larger motors in flux vector mode as master-slave configuration
Primary motor, called master, is in closed loop speed mode with torque output to slave
Other motor, called slave, is in torque mode with speed feedback to assist the master
Normally the 2 motors are equal in power size = equal load sharing; but the slave could be smaller = torque assistance for the master
Working in motoring as well as in regenerative mode
High torque available, also at 0 speed
High speed accuracy
Limited redundancy available, should one motor/frequency converter fail
More than one slave can be added to the system and load share with the master
Parameter setup see appendix 5.1

Weaknessess

Flux vector closed loop control
Fairly complicated parameter set up, especially if limited redundancy should be available
It is recommended to get motor equivalent diagram parameters from the motor manufacture
If the master drive fails the system fails
More complicated and sensitive hardware installation (encoders or resolvers)

Dual motors and dual drives with encoders (2)
Master-master load sharing concept

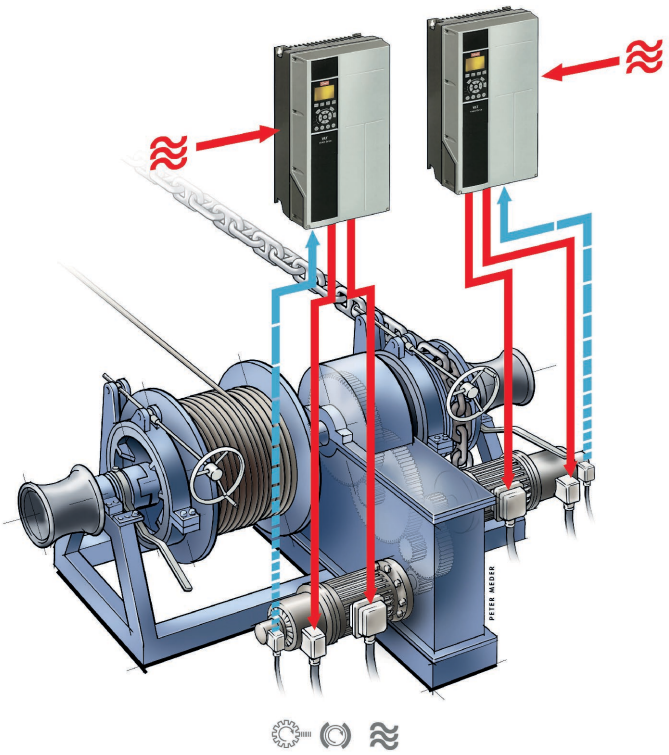
Only to be run in flux vector mode closed loop and with software 6.84 or higher

Typical applications:

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

Parameter setup and wiring:

see appendix 5.2



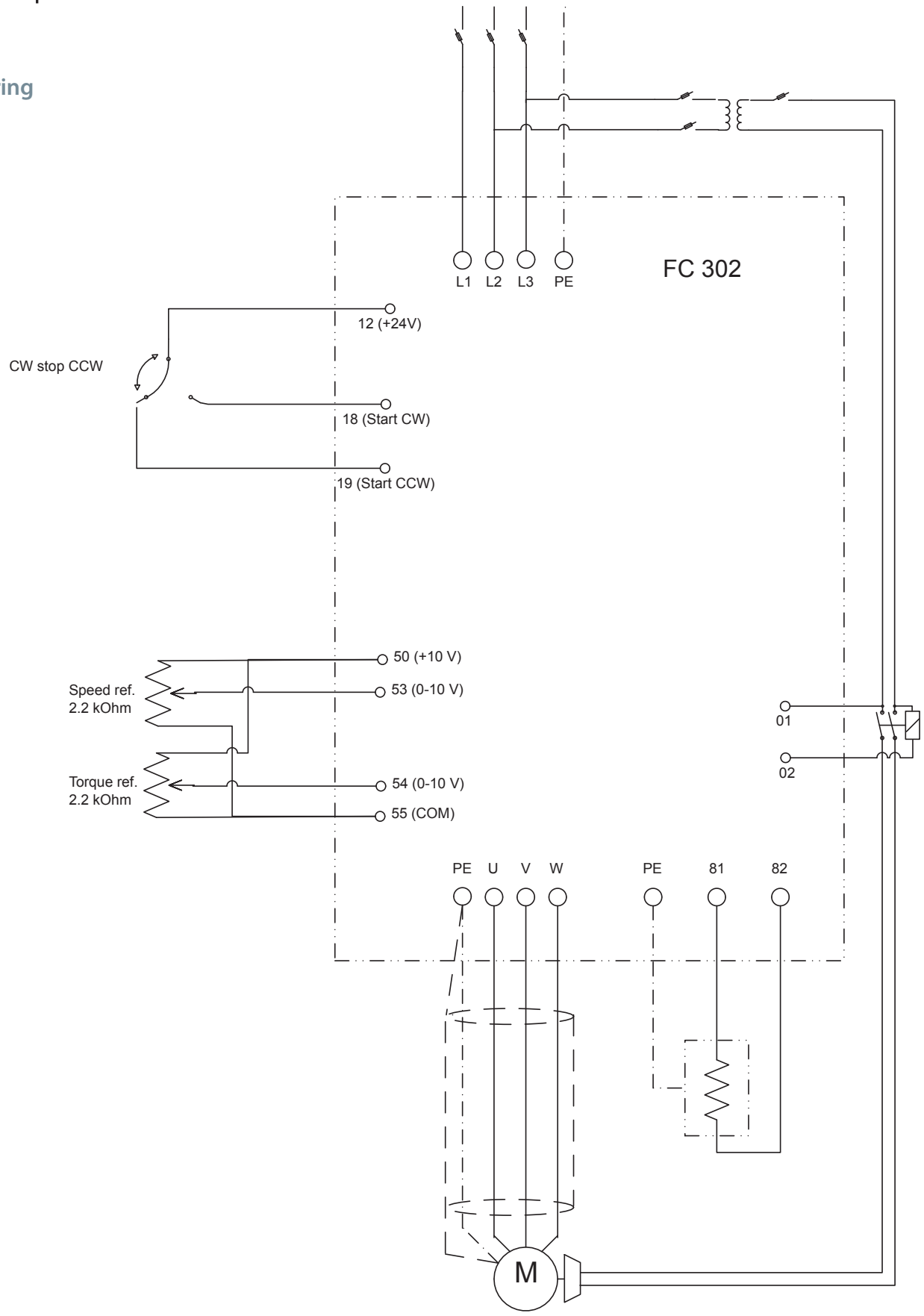
Strength

Flux vector closed loop control
Can be used in applications with rendering
Tracking control can improve safety
Excellent electromechanical brake control
Normally used for larger motors in flux vector mode as master-master configuration. but is also working very fine with small/medium motors
Normally the 2 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, should one motor/frequency converter fail
Multiple masters can load share
Easy programming, all masters have same programs
No communication needed between masters
Parameter setup see appendix 5.2

Appendix 1.1

Single motor without encoder VVC+ open loop control

Wiring



Parameter set-up

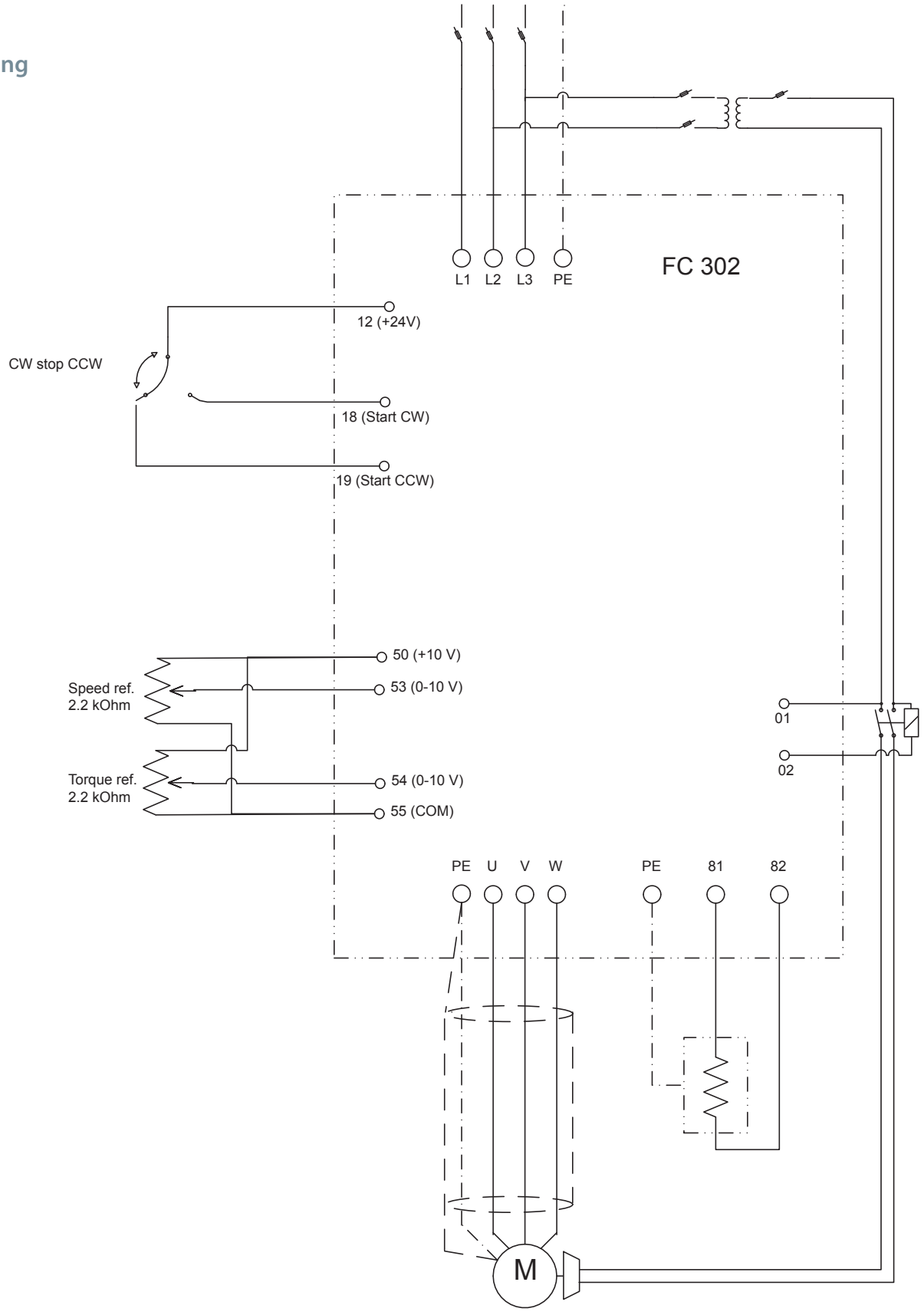
Par. ID	Parameter name	Drive	Comment (* = factory settings)
1-00	Configuration Mode	Speed open loop	*
1-01	Motor Control Principle	VVC+	* (include V/A comp. and slip comp.)
1-03	Torque Characteristics	Constant torque	*
1-04	Overload Mode	High Torque	* (150-160% over current available)
1-06	Clockwise 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 rest. Xh = main impedance.	R1 should also include cable rest. 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
1-67	Load Type	Passive Load	* Only work for flux sensorless mode.
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.
1-91	Motor External Fan	No	* Motor use own fan = speed dependent. Calculation for ETR.
1-93 1-99	External temperature sensors		If temperature sensors are embedded in the motor windings. Use this parameters to set up protection function
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.
3-00	Reference Range	-Min. -+Max.	* Use this setting;, if min. speed is 0 RPM
3-02	Minimum reference	As needed	Select in Par. 3-00: Min.-Max.
3-03	Maximum Reference	As needed	Actual limit see parameter in 4-xx.
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

Par. ID	Parameter name	Drive	Comment (* = factory settings)
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.
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.
5-02	Terminal 29 Mode	Output	If digital terminal should be used for output indication.
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.
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	
8-01 8-91	Internal bus control system.	No need to adjust.	When connection directly from PC to USB port overload could happen.
13-00 13-52	Smart Logic Controller	No need to adjust	Can be used for specific customer application.
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.
15-00 15-99	Drive information		Use as needed.
16-00 16-96	Data Read-outs		Use as needed.

Appendix 1.2

Single motor without encoder Flux vector open loop control

Wiring



Parameter set-up

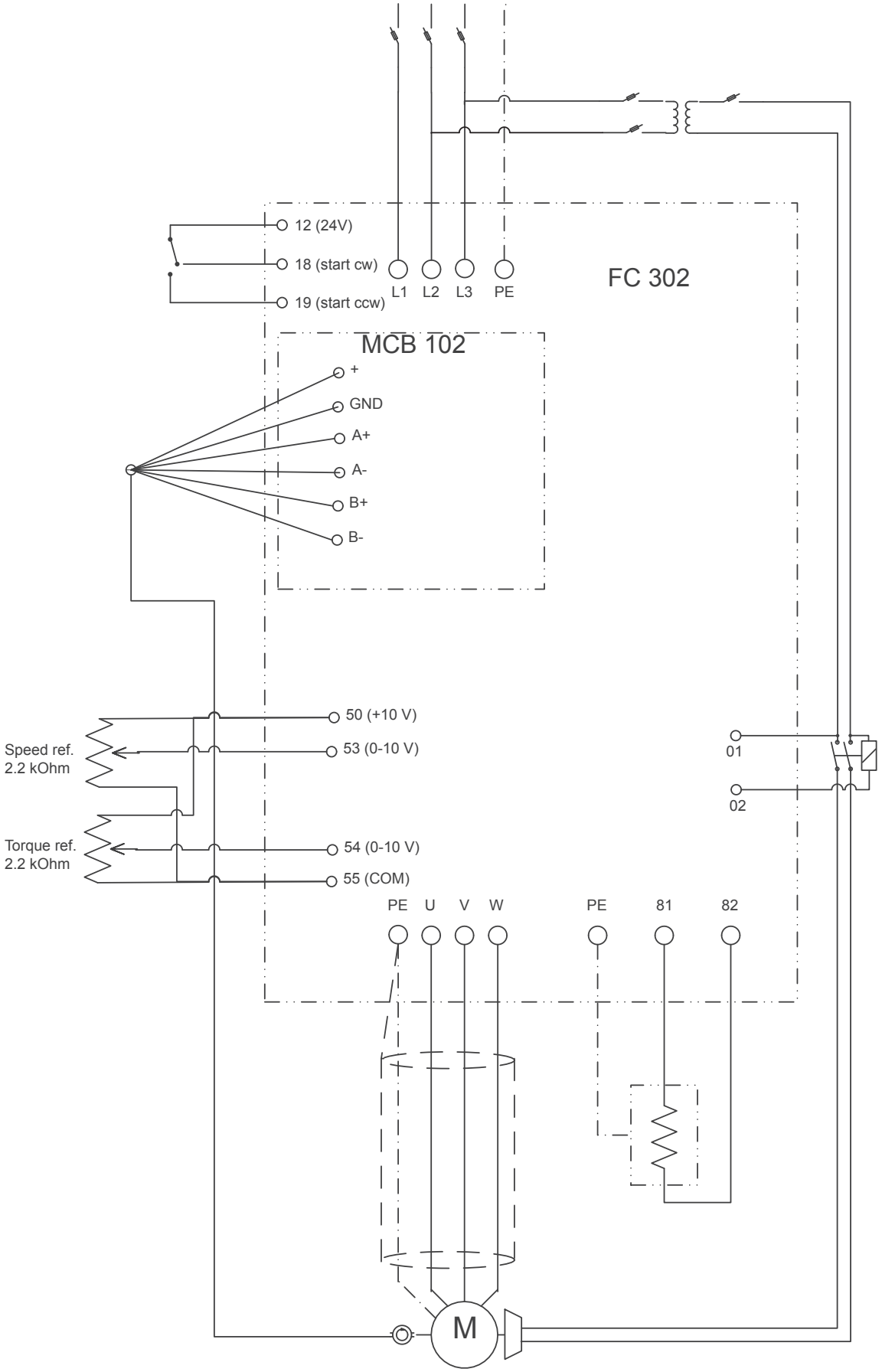
Par. ID	Parameter name	Drive	Comment (* = factory settings)
1-00	Configuration Mode	Speed open loop	*
1-01	Motor Control Principle	Flux sensorless	* (include slip comp.)
1-03	Torque Characteristics	Constant torque	*
1-04	Overload Mode	High Torque	* (150-160% over current available)
1-06	Clockwise Direction	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 rest. Xh = main impedance	R1 should also include cable rest. 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.
1-91	Motor External Fan	No	* Motor use own fan = speed dependent. Calculation for ETR.
1-93 1-99	External temperature sensors		If temperature sensors are embedded in the motor windings. Use this parameters to set up protection function
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.
3-00	Reference Range	-Min. -+Max.	* Use this setting;, if min. speed is 0 RPM
3-02	Minimum reference	As needed	Select in Par. 3-00: Min.-Max.
3-03	Maximum Reference	As needed	Actual limit see parameter in 4-xx.
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).

Par. ID	Parameter name	Drive	Comment (* = factory settings)
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.
4-30 4-39	Motor tracking error		N.B. Do not work for open loop application.
5-02	Terminal 29 Mode	Output	If digital terminal should be used for output indication.
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.
8-01 8-91	Internal bus control system.	No need to adjust.	When connection directly from PC to USB port overload could happen.
13-00 13-52	Smart Logic Controller	No need to adjust	Can be used for specific customer application.
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, 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.
15-00 15-99	Drive information		Use as needed.
16-00 16-96	Data Read-outs		Use as needed.

Appendix 2.1

Single motor with encoder VVC+ closed loop control

Wiring



Parameter set-up

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	*
1-04	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 rest. Xh = main impedance.	R1 should also include cable rest. 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.
1-91	Motor External Fan	No	* Motor use own fan = speed dependent. Calculation for ETR.
1-93 1-99	External temperature sensors		If temperature sensors are embedded in the motor windings. Use this parameters to set up protection function
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.
3-00	Reference Range	-Min. -+Max.	* Use this setting;, if min. speed is 0 RPM
3-02	Minimum reference	As needed	Select in Par. 3-00: Min.-Max.
3-03	Maximum Reference	As needed	Actual limit see parameter in 4-xx.
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.

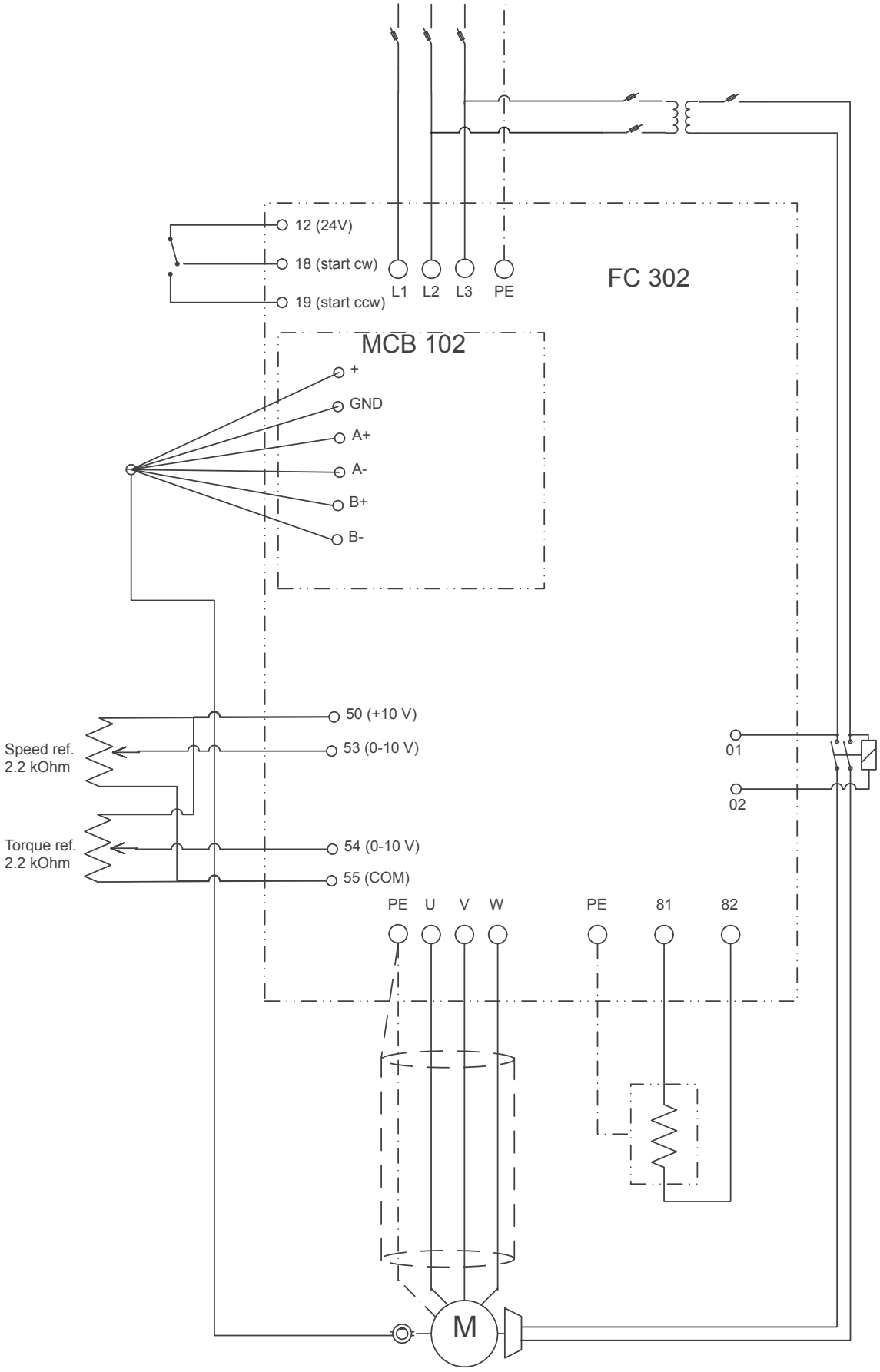
Par. ID	Parameter name	Drive	Comment (* = factory settings)
4-10	Motor Speed Direction	Both directions	Winch normally need both directions
4-11	Motor Speed Low Limit	0 RPM	* Normally no change needed.
4-13	Motor Speed High Limit	As needed	Lower to max. needed (+ 2 x slip).
4-16	Torque Limit Motor Mode	160%	* (suggestion: 15% higher than current limit). 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.
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.
5-02	Terminal 29 Mode	Output	If digital terminal 29 should be used for output indication.
5-11	Terminal 19 Digital Input	Start reversing	Digital input normally provided by joystick with only one direction signal.
5-14	Terminal 32 Digital Input	No operation	* In closed loop is no operation input for 24V encoder.
5-15	Terminal 33 Digital Input	No operation	* In closed loop is no operation input for 24V encoder.
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	24 V Encoder (or MCB 102 option).	* (Use 5 V encoder with MCB 102, especially with long cable lenghts). Here is shown, 24 V encoder with direct input to control card, but this system is more EMC sensitive.
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%).
8-01 8-91	Internal bus control system.	No need to adjust.	When connection directly from PC to USB port overload could happen.
13-00 13-52	Smart Logic Controller	No need to adjust	Can be used for specific customer application.

Par. ID	Parameter name	Drive	Comment (* = factory settings)
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.
15-00 15-99	Drive information		Use as needed.
16-00 16-96	Data Read-outs		Use as needed.

Appendix 2.2

Single motor with encoder Flux vector closed loop control

Wiring



Parameter set-up

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 rest Xh = main impedance	R1 should also include cable rest 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 Rel.	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.
1-91	Motor External Fan	No	* Motor use own fan = cooling is speed dependent. Calculation for ETR.
1-93 1-99	External temperature sensors		If temperature sensors are embedded in the motor windings. Use this parameters to set up protection function
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.	* Use this setting;, if min. speed is 0 RPM
3-02	Minimum reference	As needed	Select in Par. 3-00: Min.-Max.
3-03	Maximum Reference	As needed	Actual limit see parameter in 4-xx.
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.

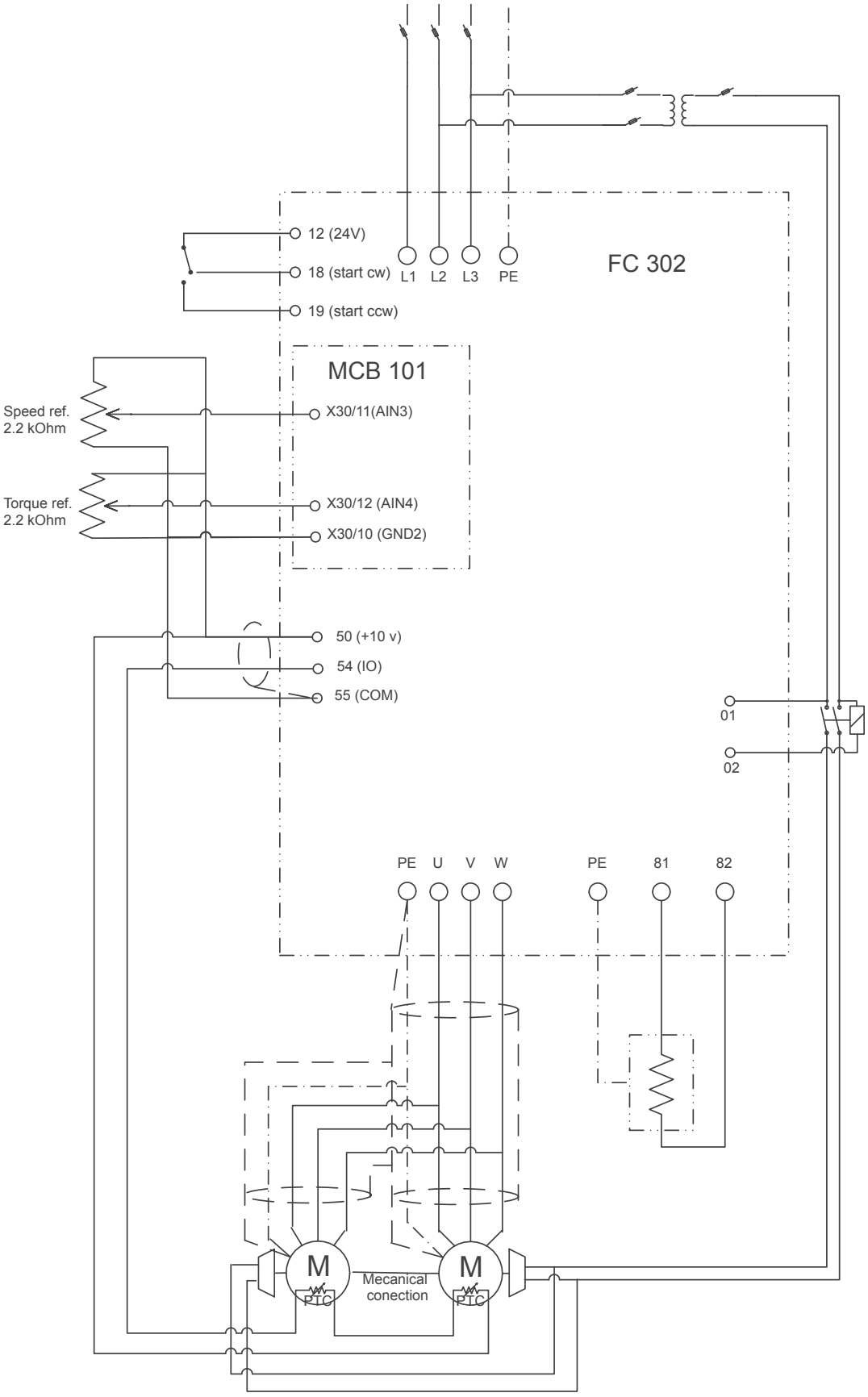
Par. ID	Parameter name	Drive	Comment (* = factory settings)
4-10	Motor Speed Direction	Both directions	Winch normally need both directions
4-11	Motor speed Low Limit	0 RPM	* Normally no change needed.
4-13	Motor Speed High Limit	As needed	Lower to max. needed (+ 2 x slip).
4-16	Torque Limit Motor Mode	160%	* (suggestion: 15% higher than current limit). Goes down with field weakening curve, when parameter 1-03 is set for constant power.
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.
5-02	Terminal 29 Mode	Output	If digital terminal 29 should be used for output indication.
5-11	Terminal 19 Digital Input	Start reversing	Digital input normally provided by joystick with only one direction signal.
5-14	Terminal 32 Digital Input	No operation	*
5-15	Terminal 33 Digital Input	No operation	*
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.
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 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.
8-01 8-91	Internal bus control system.	No need to adjust	When connection directly from PC to USB port overload could happen.
13-00 13-52	Smart Logic Controller	No need to adjust	Can be used for specific customer application.
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

Par. ID	Parameter name	Drive	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.
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, 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.
15-00 15-99	Drive information		Use as needed.
16-00 16-96	Data Read-outs		Use as needed.
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

Dual motors and single drive without encoders Special motor mode and VVC+ with open loop control

Wiring



Parameter set-up

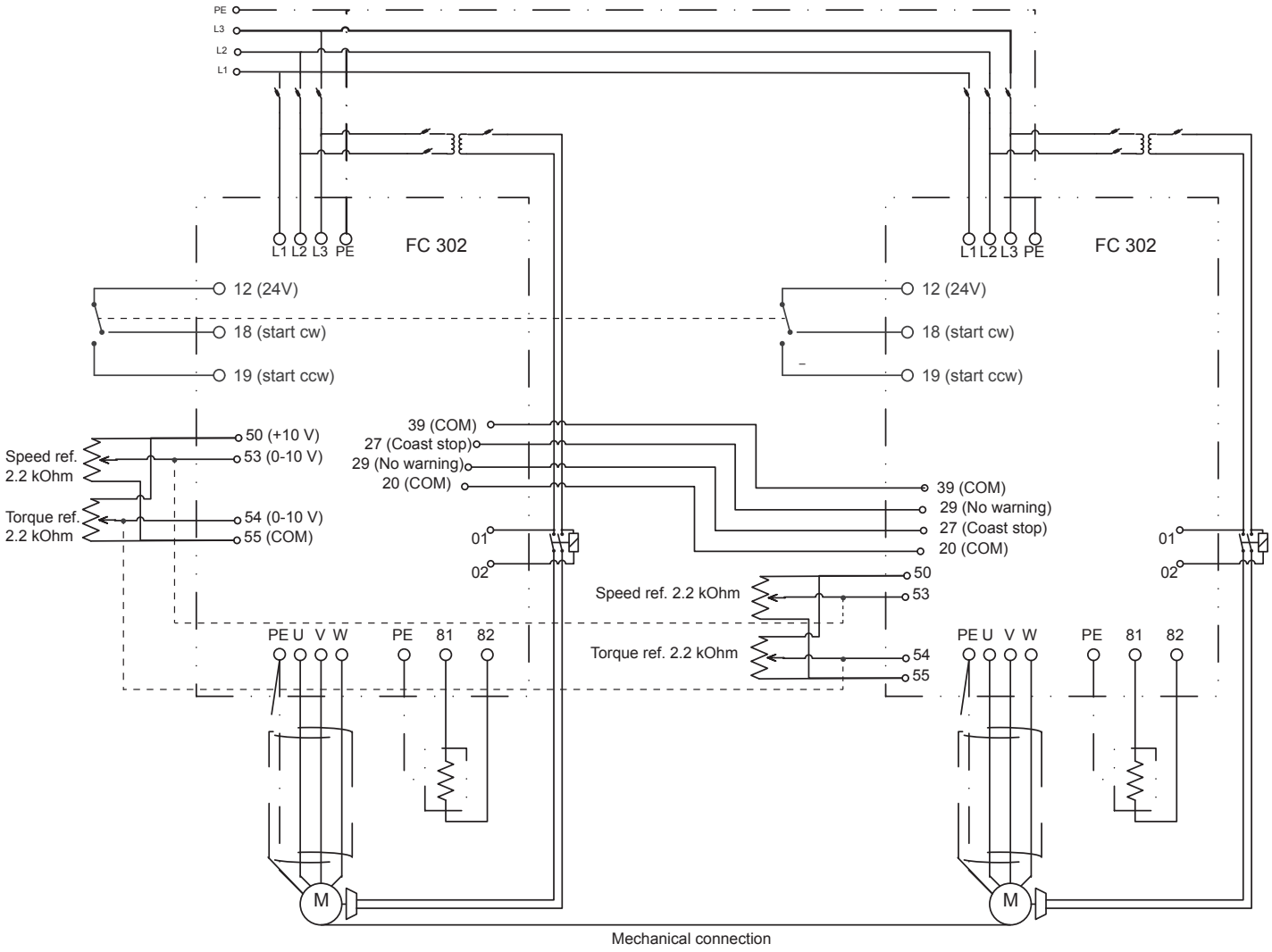
Par. ID	Description	Set-up	Comment
1-00	Configuration Mode	Speed open loop	*
1-01	Motor Control Principle	VVC+	* (include V/A comp. and slip comp.)
1-03	Torque Characteristics	Constant torque	*
1-04	Overload Mode	High Torque	* (150-160% over current available)
1-06	Clockwise Direction	Normal	* (avoid 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 rest. Xh = main impedance	R1 should also include cable rest. 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
1-67	Load Type	Passive Load	* Only work for flux sensorless mode.
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.
1-91	Motor External Fan	No	* Motor use own fan = speed dependent. Calculation for ETR.
1-93 1-99	External temperature sensors		If temperature sensors are embedded in the motor windings. Use this parameters to set up protection function
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.
3-00	Reference Range	-Min. -+Max.	* Use this setting;, if min. speed is 0 RPM
3-02	Minimum reference	As needed	Select in Par. 3-00: Min.-Max.
3-03	Maximum Reference	As needed	Actual limit see parameter in 4-xx.
3-40	Ramp 1 Type	Linear	* Other ramp types might be better, but can extend actual time.

Par. ID	Description	Set-up	Comment
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.
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.
5-02	Terminal 29 Mode	Output	If digital terminal should be used for output indication.
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	
8-01 8-91	Internal bus control system.	No need to adjust.	When connection directly from PC to USB port overload could happen.
13-00 13-52	Smart Logic Controller	No need to adjust	Can be used for specific customer application.
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, 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.
15-00 15-99	Drive information		Use as needed.
16-00 16-96	Data Read-outs		Use as needed.

Appendix 4.1

Dual motors and dual drives without encoders VVC+ open loop control

Wiring



Parameter set-up

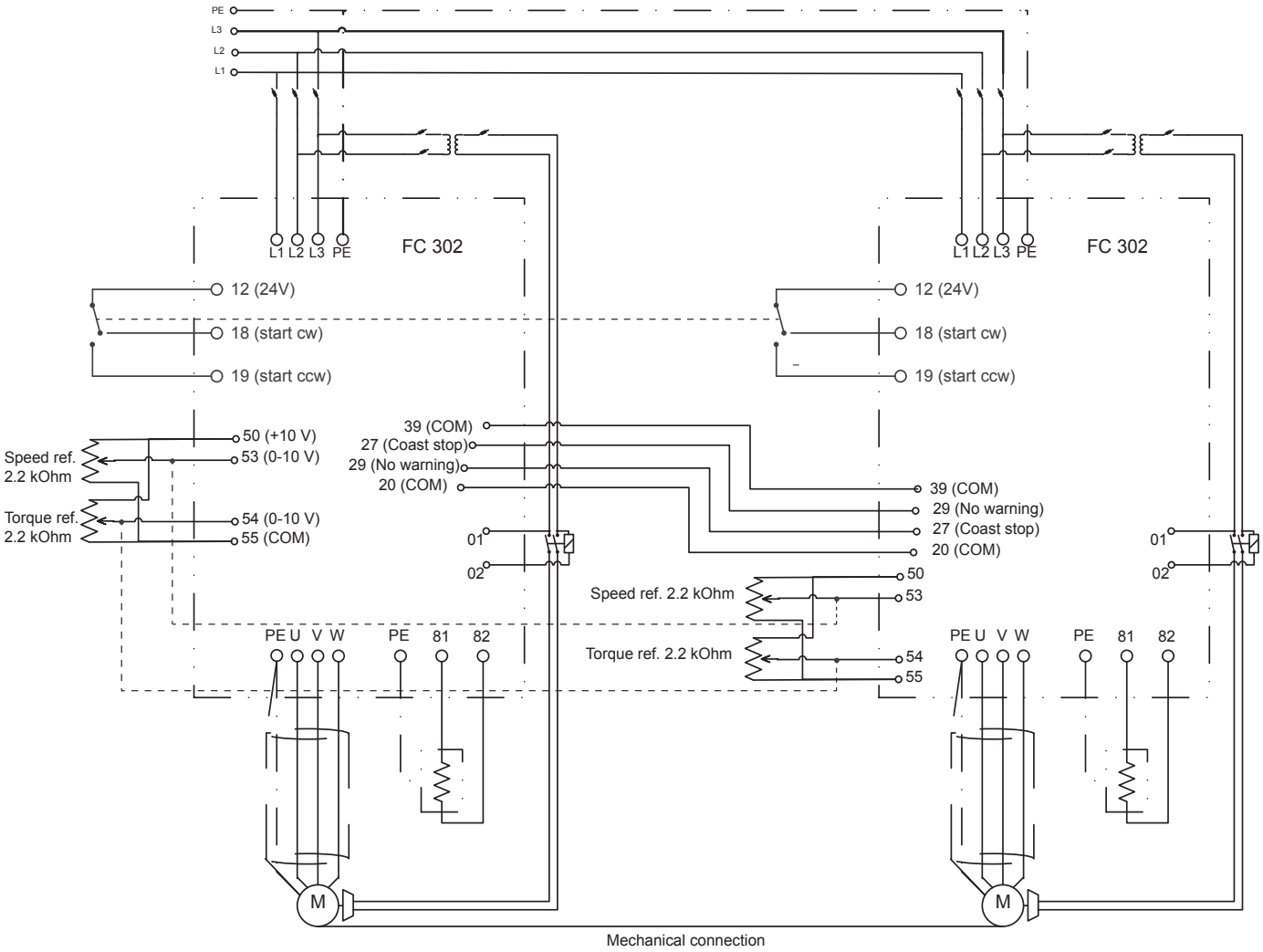
Par. ID	Description	Set-up	Comment
1-00	Configuration Mode	Speed open loop	*
1-01	Motor Control Principle	VVC+	* (include V/A comp. and slip comp.)
1-03	Torque Characteristics	Constant torque	*
1-04	Overload Mode	High Torque	* (150-160% over current available)
1-06	Clockwise Direction	Normal	* (avoid 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 rest. Xh = main impedance.	R1 should also include cable rest. 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
1-67	Load Type	Passive Load	* Only work for flux sensorless mode.
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.
1-91	Motor External Fan	No	* Motor use own fan = speed dependent. Calculation for ETR.
1-93 1-99	External temperature sensors		If temperature sensors are embedded in the motor windings. Use this parameters to set up protection function
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.
3-00	Reference Range	-Min. -+Max.	* Use this setting;, if min. speed is 0 RPM
3-02	Minimum reference	As needed	Select in Par. 3-00: Min.-Max.
3-03	Maximum Reference	As needed	Actual limit see parameter in 4-xx.
3-40	Ramp 1 Type	Linear	* Other ramp types might be better, but can extend actual time.

Par. ID	Description	Set-up	Comment
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.
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.
5-02	Terminal 29 Mode	Output	If digital terminal should be used for output indication.
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	
8-01 8-91	Internal bus control system.	No need to adjust.	When connection directly from PC to USB port overload could happen.
13-00 13-52	Smart Logic Controller	No need to adjust	Can be used for specific customer application.
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, 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.
15-00 15-99	Drive information		Use as needed.
16-00 16-96	Data Read-outs		Use as needed.

Appendix 4.2

Dual motors and dual drives without encoders Flux vector open loop control

Wiring



Parameter set-up

Par. ID	Description	Set-up	Comment
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 rest. Xh = main impedance.	R1 should also include cable rest. 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.
1-91	Motor External Fan	No	* Motor use own fan = speed dependent. Calculation for ETR.
1-93 1-99	External temperature sensors		If temperature sensors are embedded in the motor windings. Use this parameters to set up protection function
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.
3-00	Reference Range	-Min. -+Max.	* Use this setting;, if min. speed is 0 RPM
3-02	Minimum reference	As needed	Select in Par. 3-00: Min.-Max.
3-03	Maximum Reference	As needed	Actual limit see parameters in 4-xx.
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.

Par. ID	Description	Set-up	Comment
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.
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.
5-02	Terminal 29 Mode	Output	If digital terminal 29 should be used for output indication.
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.
8-01 8-91	Internal bus control system.	No need to adjust	When connection directly from PC to USB port overload could happen.
13-00 13-52	Smart Logic Controller	No need to adjust	Can be used for specific customer application.
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, 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.
15-00 15-99	Drive information		Use as needed.
16-00 16-96	Data Read-outs		Use as needed.

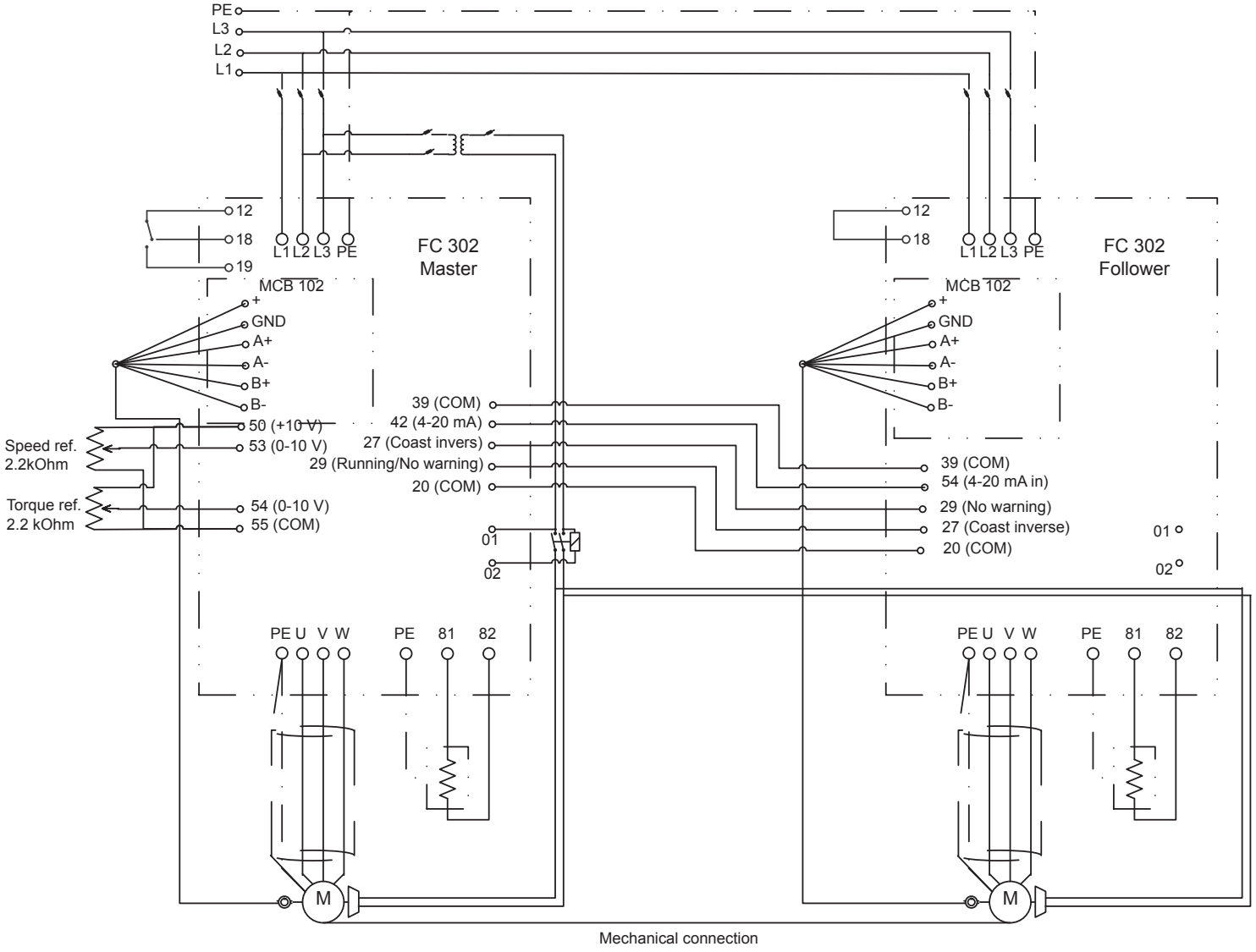
Appendix 5.1

Dual motors and dual drives with encoders (1) Flux vector closed loop controL

Master-follower 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

The below table shows only the parameters relevant for the master-slave setup of the two drives. It is assumed that correct motor parameters, feed back/encoder setup, speed reference to the master, brakes etc. etc. all are programmed correctly and in accordance with the actual application. Furthermore, such an application often requires certain safety issues to be considered, e.g. trip signals and communication with PLC, this is also not shown in the table.

Par. ID	Description	Master Drive	Slave Drive	Comment
1-00	Configuration Mode	Speed closed loop	Torque	
1-01	Motor Control Principle	Flux w/ motor feedback	Flux w/ motor feedback	
1-02	Flux Motor Feedback Source	MCB 102	MCB 102	TTL 5V encoder used for MCB 102
1-03	Torque Characteristics	Constant Power	Constant Power	Work only for flux closed loop.
1-04	Overload Mode	High Torque	High Torque	* (150-160% over current available)
1-06	Clockwise Direction	Normal	Normal	* (avoid using this parameter).
1-10	Motor Construction	Asynchron	Asynchron	* (no PM motor considered here)
1-20 1-26	Motor Data inserted	Motor size = Drive size	Motor size = Drive size	(150-160% over current available)
1-29	Automatic Motor Adaptation	Use complete AMA	Use complete AMA	For larger Drive use reduced AMA
1-30 1-37	Advanced motor data is calculated based on motor data	R1 = stator rest. Xh = main impedance.	R1 = stator rest. Xh = main impedance.	R1 should also include cable rest. Xh determine magnetizing current.
1-39	Motor Poles	Automatic calculated	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	0V	* Use factory setting. In case of warning 62 try to reduce the voltage.
1-71	Start Delay	0 second	0 second	* Disappear with settings in P1-72.
1-72	Start Function	Hoist Mech. Brake Rel.	(Hoist Mech. Brake Rel.)	Master drive should control mechanical brakes for both master as well as slave motor. Use same settings for slave as master. (Easy, if master goes down and slave must be master).
1-76	Start Current	0.0 Amp.	0.0 Amp.	* No use in flux closed loop.
1-80	Function at Stop	Coast	Coast	*
1-81	Min. Speed for Function at Stop	2-3 RPM	2-3 RPM	
1-90	Motor Thermal Protection	ETR warning 1	ETR warning 1	ETR does not require external sensors.
1-91	Motor External Fan	No	No	* Motor use own fan = cooling is speed dependent. Calculation for ETR.
1-93 1-99	External temperature sensors			If temperature sensors are embedded in the motor windings. Use this parameters to set up protection function
2-10	Brake Function	Resistor Brake.	Resistor Brake.	Most application requires a brake resistor. Large resistors can be water cooled.
2-11	Brake resistor	Use factory size.	Use factory size.	Give 160% generatoric torque
2-12	Brake power limit	Use brake information.	Use brake information.	Average value for the resistor.
2-13	Brake Power Monitoring.	Warning.	Warning.	Use as indication for overheating.
2-15	Brake check	Warning.	Warning.	Indication for brake failure.
2-18	Brake Check Condition	After Coast Situation	After Coast Situation	Additional brake check.
2-21	Activate Brake Speed	Set RPM for closing	(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	(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.	(0 second.)	* delay time for closing the brake relay.

Par. ID	Description	Master Drive	Slave Drive	Comment
2-25	Brake Release Time	0.2 second.	(0.2 second)	* Set as needed. Time for the brake to open. Time for increased proportional gain boost.
Par. ID	Description	Master Drive	Slave Drive	Comment
2-26	Torque Ref.	70%	0%	Set as needed. Torque applied against closed brake before brake release.
2-27	Torque Ramp Time	0.2 second	0 second	* Ramp time for parameter 2-26.
2-28	Gain boost Factor	2.00	2.00	Set as needed. Increased proportional gain during time for parameter 2-25.
3-00	Reference Range	Min. - +Max.	- Max - + Max.	Master: Speed reference. Slave: Torque reference.
3-02	Minimum reference	As needed	XX Nm	Master: Set min. speed ref. Slave: -(nominal motor torque x settings in par. 4-17).
3-03	Maximum Reference	As needed	XX Nm	Master: Set max. speed ref. Slave: nominal motor torque x settings in par. 4-16.
3-15	Reference Resource 1	Analog Input 53	Analog Input 54	Master: Speed ref. could be different than analog 53.
3-16 3-17	Resource 2 Resource 3	No function	No function	
3-40	Ramp 1 Type	Linear	Linear	* Other ramp types might be better, but can extend actual time.
3-41	Ramp 1. Ramp up time	As needed	Min.	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	Min.	Ramp time = time from synchronous speed to 0 RPM. Too short time may activate current /torque warning.
4-10	Motor Speed Direction	Both directions	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%	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%	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. %	% = Max. current for drive / nominal current for motor.
4-19	Max Output Frequency	As needed	As needed	Slightly higher than parameter 4-13.
4-20	Torque Limit Factor Source	Analog in 54	Analog in 54	Can be used to adjust parameter 4-16 and 4-17 by remote potentiometer.
4-30	Motor Feedback Loss function	Warning	Warning	Suggestion is Warning.
4-31	Motor Feedback Speed Error	300 RPM	300 RPM	* This window is motor dependent.
4-32.	Motor feedback Loss Timeout	1 second	1 second	Factory setting of 0.05 second might be too fast.
4-34	Tracking Error Function	Warning.	Warning.	
4-35	Tracking Error	100 RPM	100 RPM	Factory setting of 10 RPM is too small window.
4-36	Tracking Error Timeout	1 second	1 second	*
4-37	Tracking Error Ramping	100 RPM	100 RPM	* Might be increased to 200 RPM if too sensitive.
4-38	Tracking Error Ramping Timeout.	5 second	5 second	* Could be decreased to about 1 second for a faster detection.
5-02	Terminal 29 Mode	Running/ no warning	No warning	When digital terminal 29 is used as digital output
5-11	Terminal 19 Digital Input	Start reversing	Start	Digital input normally provided by joystick with only one direction signal.

Par. ID	Description	Master Drive	Slave Drive	Comment
5-12	Terminal 27 Digital Input	Stop inverse	Coast inverse*	
5-14	Terminal 32 Digital Input	No operation	No operation	*
5-15	Terminal 33 Digital Input	No operation	No operation	*
5-40	Function Relay	Mechanical brake ctrl.	(Mechanical brake ctrl.)	Relay 1 is normally used for this function. Take care of contact burning.
Par. ID	Description	Master Drive	Slave Drive	Comment
5-41	On Delay, Relay	0.01 second	0.01 second	* Use parameter 2-25 if needed.
5-42	Off Delay, Relay	0.01 second	0.01 second	* Normally not used.
6-00	Live Zero Timeout Time	1 second	1 second	Use where 4-20 mA signal is present.
6-01	Live Zero Timeout Function	Stop and trip.	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.
6-22	Terminal 54 Low Current		4 mA	Use 4 mA because super-vision of signal is possible.
6-23	Terminal 54 High Current		20 mA	*
6-24	Terminal 54 Low Ref/Feedb. Value		- XX Nm	- (Nominal motor torque x settings in par. 4-17) = Param. 3-03 with minus sign.
6-25	Terminal 54 High Ref/Feedb. value		XX Nm	Nominal motor torque x settings in par.4-16 = Par 3-03
6-50	Terminal 42 Output	[149] Torque % lim 4-20 mA		12 mA is 0 Nm from the master
N.B.	Set control card switch for I or V	Current or voltage input	Current or voltage input	See settings in parameter 16-61.
7-00	Speed PID Feedback Source	MCB 102 option.	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. Slave: not used.
7-03	Speed PID integral Time	200 ms		* Master: can be decreased for a faster response. Take care of instability. Slave: not used.
7-04	Speed PID Differentiation Time	1 ms		Master: Use max. 1- 2 ms for faster response. Slave: not used.
7-06	Speed PID Lowpass Filter Time	5 ms	5 ms	Adjust to pulses per revolution of encoder. Higher pulses = lower ms.
8-01 8-91	Internal bus control system.	No need to adjust.	No need to adjust.	When connection directly from PC to USB port overload could happen.
13-00 13-52	Smart Logic Controller	No need to adjust	No need to adjust	Can be used for specific customer application.
14-00	Switching pattern	SFAVM	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	Ctrl. ramp down	
14-11	Mains Voltage at Mains Fault.	As needed	As needed	Set to 10% below min. mains level.
14-12	Function at Mains Imbalance	Warning.	Warning.	Factory setting is trip. A generator supply might activate this trip too often.
14-24	Trip Delay at Current Limit	As needed	As needed	Running too long in current limit indicate something is overloaded. (Suggestion: 1 second).
14-25	Trip Delay at Torque Limit	As needed	As needed	Running too long in torque limit indicate something is overloaded. (Suggestion: 1 second).
14-26	Trip Delay at Inverter Fault	0 second	0 second	Too high voltage = brake faulty.
14-35	Stall Protection	Enable	Enable	*
14-50	RFI Filter	Off	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	No filter	* Set parameter if output filter is used.
14-90	Fault Level	Off	Off	* Should not be used ; but fault condition can be changed.

Par. ID	Description	Master Drive	Slave Drive	Comment
15-00 15-99	Drive information			Use as needed.
16-00 16-96	Data Read-outs			Use as needed.
Par. ID	Description	Master Drive	Slave Drive	Comment
17-10	Signal Type	RS 422 (5 V TTL).	RS 422 (5 V TTL).	* Factory setting for most used encoder.
17-11	Resolution (PPR)	1024	1024	* Factory settings for most popular PPR. Change if needed.
17-60	Feedback direction	Counter Clockwise	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	Warning	

Note:

The wiring with the analogue 4-20 mA torque reference signal from Master to Slave drive must be a screened cable with the screen connected to chassis on both ends. It is essential that the scaling of 4-20mA output on the Master drive corresponds to the scaling of the ana-logue reference input on the Slave drive. To handle that, be sure that p.4-16 and p.4-17 are set the same value. Master and Slave motor cannot share a single encoder. Each motor must be equipped with an encoder of its own. Let the Master drive control the electromechanical brakes for both motors.

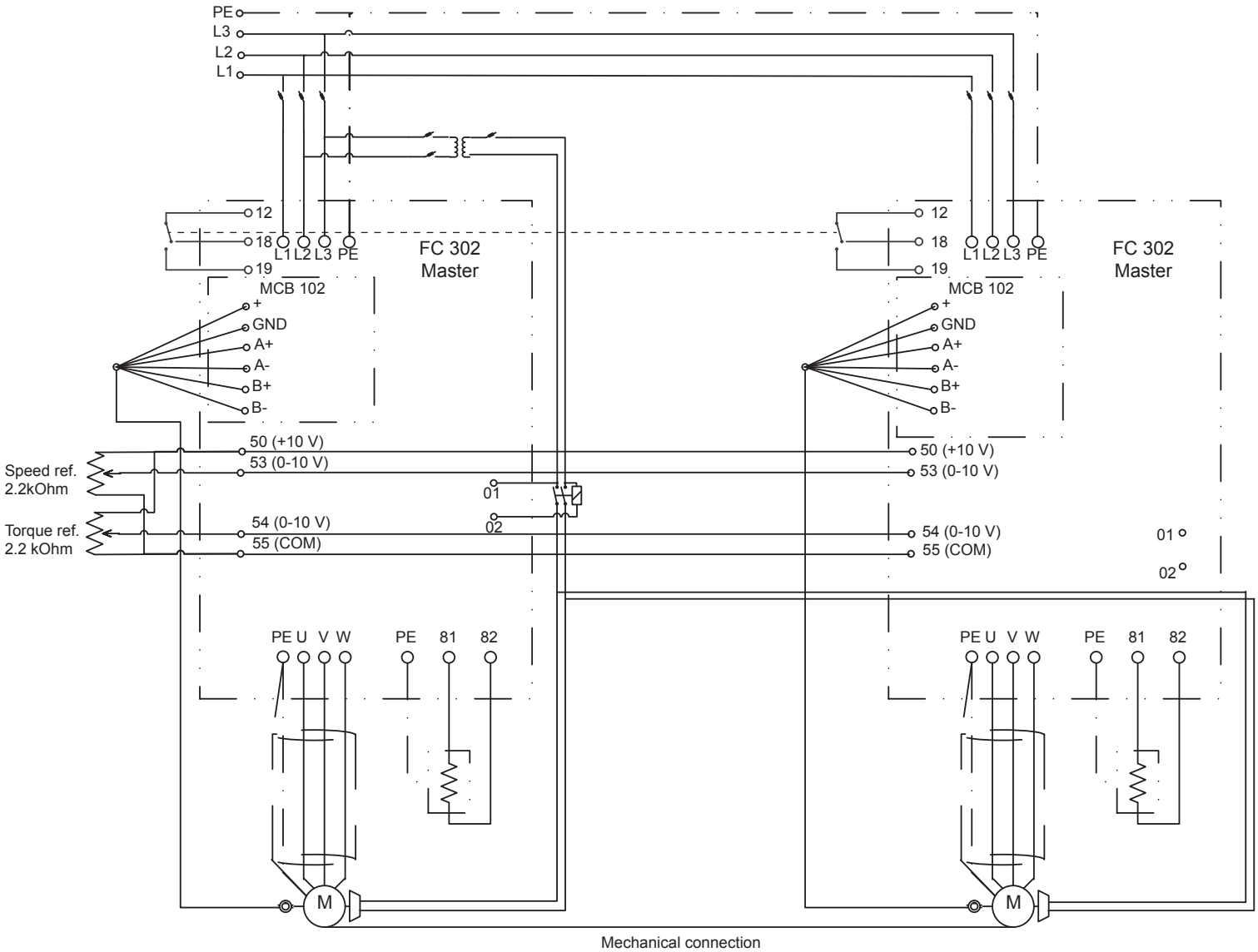
Appendix 5.2

Dual motors and dual drives with encoders (2) Flux vector closed loop control

Master-master 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

Par. ID	Description	Master Drive 1 Master Drive 2 etc.	Comment
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 rest. Xh = main impedance.	R1 should also include cable rest. 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.
1-71	Start Delay	0 second	* Disappear with settings in P1-72.
1-72	Start Function	Hoist Mech. Brake Rel.	
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	1 RPM	
1-90	Motor Thermal Protection	ETR warning 1	ETR does not require external sensors.
1-91	Motor External Fan	No	* Motor use own fan = cooling is speed dependent. Calculation for ETR.
1-93 1-99	External temperature sensors		If temperature sensors are embedded in the motor windings. Use this parameters to set up protection function
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. Slave: Torque reference.
3-02	Minimum reference	As needed	Master: Set min. speed ref. Slave: -(nominal motor torque x settings in par. 4-17).
3-03	Maximum Reference	As needed	Master: Set max. speed ref. Slave: 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.

Par. ID	Description	Master Drive 1 Master Drive 2 etc.	Comment
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	
5-14	Terminal 32 Digital Input	No operation	*
5-15	Terminal 33 Digital Input	No operation	*
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.
8-01 8-91	Internal bus control system.	No need to adjust.	When connection directly from PC to USB port overload could happen.
13-00 13-52	Smart Logic Controller	No need to adjust	Can be used for specific customer application.
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	

Par. ID	Description	Master Drive 1 Master Drive 2 etc.	Comment
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. (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, 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.
15-00 15-99	Drive information		Use as needed.
16-00 16-96	Data Read-outs		Use as needed.
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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The energy saved in the annual production of VLT® frequency converters is as much as that generated by a large power station each year. Improved process control optimises product quality and reduces waste and wear on the production lines.

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Danfoss VLT Drives is a global leader in the area of drive engineering and manufacture. In 1968 Danfoss introduced the world's first mass-produced frequency converters for three-phase motors, and since then has specialised in drive solutions. Today, VLT® stands for reliable technology, innovation and expertise for drive solutions within many different branches of industry.

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