Honeywell

Users Manual

·

Application Manual

Excel VRL

CX/CXL/CXS

Constant and variable torque
Variable Speed Drives
for induction motors
1 Hp to 1100 Hp

Subject to changes without notice.

USERS MANUAL AND APPLICATION MANUAL

These two manuals provide the general information on how to use frequency converters and how to apply, if required, Application Package.

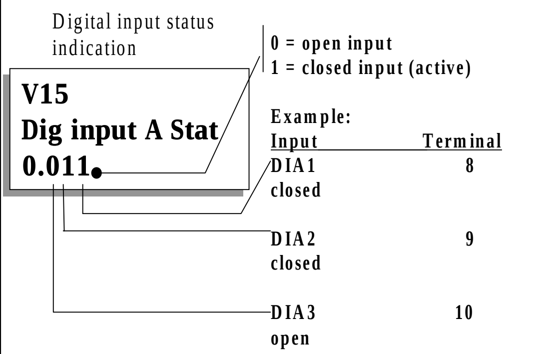
CX/CXL/CXS Users manual provides the information necessary to install, start-up and operate CX/CXL/CXS frequency converters. It is recommended that this manual is read thoroughly before powering up the frequency converter for the first time.

If a different I/O configuration or different operational functions is required, see chapter 12 from the Users manual, Application package, for a more suitable application. For more detailed information read the attached Application Package -application manual.

If problems are experienced, please contact your local Honeywell distributor. Honeywell is not responsible for the use of the frequency converter differently from what is noted in these instructions.

Monitoring values (MON)		
Num.	Data name	Unit
n 1	Output frequency	Hz
n 2	Motor speed	rpm
n 3	Motor current	A
n 4	Motor torque	%
n 5	Motor power	%
n 6	Motor voltage	V
n 7	DC-link voltage	V
n 8	Temperature	°C
n 9	Operating day counter	DD.dd
n 10	Operating hours, "trip counter"	HH.hh
n 11	MWh-hours	MWh
n 12	MWh-hours, "trip counter"	MWh
n 13	Voltage/analogue input	V
n 14	Current/analogue input	mA
n 15	Digital input stat.,group A	See
n 16	Digital input stat.,group B	figure
n 17	Digital and relay output status	below
n 18	Control program	
n 19	Unit nominal power	kW
n 20	Motor temperature rise	%
	Only in PI-controller	
n 20	PI-controller reference	%
n 21	PI-controller actual value	%
n 22	PI-controller error value	%
n 23	PI-controller output	Hz
n 24	Motor temperature rise	%

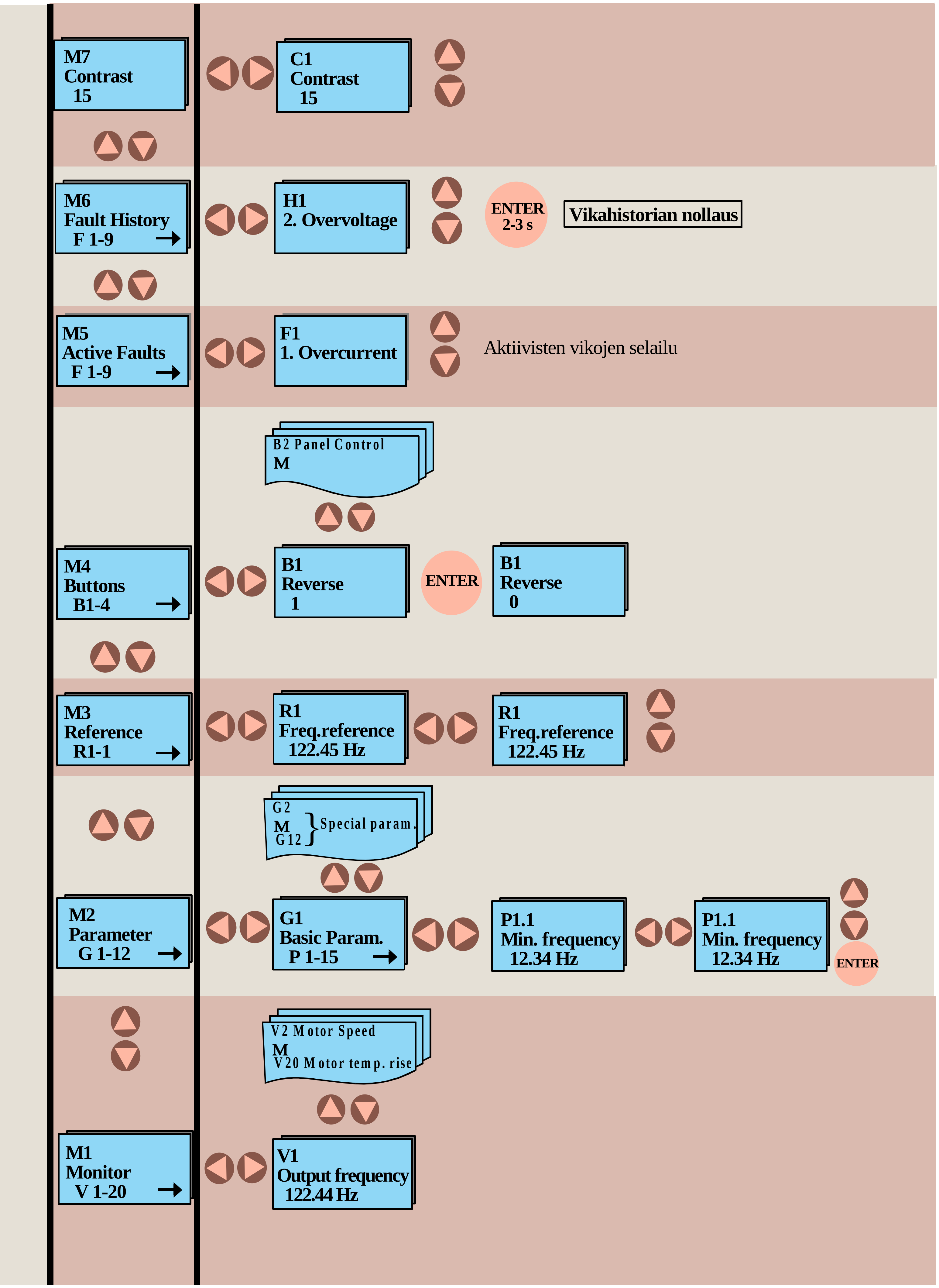
1.) DD=full days, dd=desimal part of a day
2.) HH=full hours, hh=desimal part of an hour



Faults and warnings	
Code	Fault
F 1	Overcurrent
F 2	Overvoltage
F 3	Earth fault
F 4	Inverter fault
F 5	Charging switch
F 9	Under voltage
F 10	Input line supervision
F 11	Output phase supervision
F 12	Brake chopper supervision
F 13	Vacon under temperature
F 14	Vacon over temperature
F 15	Motor stalled
F 16	Motor over temperature
F 17	Motor underload
F 18	Analogue input hardware fault
F 19	Option board identification
F 20	10 V voltage reference
F 21	24 V supply
F 22	EEPROM
F 23	checksum fault
F 24	
F 25	Microprocessor watchdog
F 26	Panel communication error
F 29	Thermistor protection
F 36	Analogue input I_{in} 4-20 mA <4 mA
F 41	External fault
	Warnings
A 15	Motor stalled
A 16	Motor over temperature
A 17	Motor underload
A 24	The values in the Fault history, MWh-counters or operating day/ hour counters might have been changed in the previous mains interrupt
A 28	Change of application has failed
A 30	Unbalance current fault
A 45	Vacon overtemp. warning
A 46	Reference warning, analogue input I_{in}+ <4 mA
A 47	External warning

Programmable push-buttons (BTNS) **ENTER-button**

Button	Button number	Function name	Feedback information 0	1	
b 1	Reverse	Changes the direction of motor rotation. Active only if the panel is the active control source	Direction command forward	Direction command backward	Feedback information flashes as long as direction is different from the command
b 2	Active control source	Selects the active control source between the panel and I/O terminals	Control via I/O terminals	Control from the Control Panel	
b 3	Clear trip operating hour counter	Clears the trip operating when pressed	No clearing	Clearing accepted	
b 4	Clear trip MWh counter	Clears the MWh trip counter when pressed	No clearing	Clearing accepted	


M7 Contrast 15
C1 Contrast 15
M6 Fault History F 1-9
H1 2. Overvoltage
ENTER 2-3 s
Vikahistorian nollaus
M5 Active Faults F 1-9
F1 1. Overcurrent
Aktiivisten vikojen selailu
B2 Panel Control
M
M4 Buttons B1-4
B1 Reverse 1
ENTER
B1 Reverse 0
M3 Reference R1-1
R1 Freq.reference 122.45 Hz
R1 Freq.reference 122.45 Hz
G2
M
G12
Special param.
M2 Parameter G 1-12
G1 Basic Param. P 1-15
P1.1 Min. frequency 12.34 Hz
P1.1 Min. frequency 12.34 Hz
ENTER
V2 Motor Speed
M
V20 Motor temp. rise
M1 Monitor V 1-20
V1 Output frequency 122.44 Hz

CONTENTS

CX/CXL/CXS USERS MANUAL

CX/CXL/CXS -APPLICATION MANUAL

HOW TO USE THIS MANUAL

This manual provides you with the information necessary to install, start-up and operate a CX/CXL/CXS drive. We recommend that you read this manual carefully.

At least the following 10 steps of the *Quick Start Guide* must be done during installation and startup.

If any problem occurs, please call the telephone number listed on the back of this manual for assistance.

Quick Start Guide

1. Check the equipment received compared to what you have ordered, see chapter 3.
2. Before doing any start-up actions carefully read the safety instructions in chapter 1.
3. Before mechanical installation, check the minimum clearances around the unit and verify that ambient conditions will meet the requirements of chapter 5.2. and table 4.3-1a.
4. Check the size of the motor cable, the utility cable and the fuses. Verify the tightness of the cable connections. Review chapters 6.1.1, 6.1.2 and 6.1.2.
5. Follow the installation instructions, see chapter 6.1.4.
6. Control cable sizes and grounding system are explained in chapter 6.2. The signal configuration for the Basic application is in chapter 10.2.

   Remember to connect the common terminals (CMA and CMB. See figure 10.2.1) of the digital input groups.
7. For instructions on how to use the control panel see chapter 7.
8. The basic application has only 10 parameters in addition to the motor rating plate data, the parameter and application package lock. All of these have default values. To ensure proper operation verify the nameplate data of both the motor and CX/CXL/CXS:

   - nominal voltage of the motor
   - nominal frequency of the motor
   - nominal speed of the motor
   - nominal current of the motor
   - supply voltage

   Parameters are explained in chapter 10.4.
9. Follow the start-up instructions, see chapter 8.
10. Your CX/CXL/CXS is now ready for use.

If a different I/O configuration or different operational functions from the basic configuration are required, see chapter 12, Application package for a more suitable configuration. For a more detailed description, see the separate application manual.

Honeywell is not responsible for the use of the frequency converter differently than noted in these instructions.

Honeywell

Users Manual

Excel VRL

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Constant and variable torque
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EXCEL VRL CX/CXL/CXS USERS MANUAL CONTENTS

1

1 SAFETY

ONLY A QUALIFIED ELECTRICIAN CAN CARRY OUT THE ELECTRICAL INSTALLATION

1.1 Warnings

1	Internal components and circuit boards (except the isolated I/O terminals) are at utility potential when the CX/CXL/CXS is connected to the line. This voltage is extremely dangerous and may cause death or severe injury if you come in contact with it.
2	When the CX/CXL/CXS is connected to the utility, the motor connections U(T1), V(T2), W(T3) and DC-link / brake resistor connections -,+ are live even if the motor is not running.
3	The control I/O terminals are isolated from the line potential but the relay outputs and other I/O:s (if jumper X4 is in OFF position see figure 6.2.2-1) may have dangerous external voltages connected even if the power is disconnected from the CX/CXL/CXS.
4	The CX/CXL/CXS has a large capacitive leakage current.
5	An upstream disconnect/protection device is to be used as noted in the National Electric Code (NEC).
6	Only spare parts obtained from a Honeywell authorized distributor can be used.

1.2 Safety instructions

1	The CX/CXL/CXS is meant only for fixed installation. Do not make any connections or measurements when the CX/CXL/CXS is connected to the utility.
2	After disconnecting the utility, wait until the unit cooling fan stops and the indicators on the control panel are extinguished (if no keypad is present, check the indicators in the cover). Wait 5 more minutes before doing any work on the CX/CXL/CXS connections. Do not open the cover before this time has run out.
3	Do not make any voltage withstand or megger tests on any part of the CX/CXL/CXS.
4	Disconnect the motor cables from the CX/CXL/CXS before meggering the motor cables.
5	Do not touch the IC-circuits on the circuit boards. Static voltage discharge may destroy the components.
6	Before connecting to the utility make sure that the cover of the CX/CXL/CXS is closed
7	Make sure that nothing but a three-phase motor is connected to the motor terminal, with the exception of factory recommended filters.

1.3 Grounding and ground fault protection

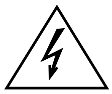
The CX/CXL/CXS must always be grounded with a grounding conductor connected to the grounding terminal ⏚.

The CX/CXL/CXS's ground fault protection protects only the CX/CXL/CXS if a ground fault occurs in the motor or in the motor cable.

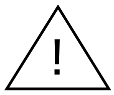
Due to the high leakage current fault current protective devices do not necessarily operate correctly with drives. When using this type of device its function should be tested in the actual installation.

Warning Symbols

For your own safety, please pay special attention to the instructions marked with these warning symbols:

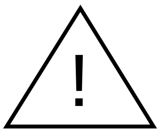


= **Dangerous voltage**



= **General warning**

1.4 Running the motor

	1	Before running the motor, make sure that the motor is mounted properly.
	2	Maximum motor speed (frequency) should never be set to exceed the motor's and driven machine's capability.
	3	Before reversing the rotation of the motor shaft, make sure that this can be done safely.

2

2 DIRECTIVES

2.1 CE-label

The CE-label on the product guarantees the free movement of the product in the EU-area. According to the EU-rules this guarantees that the product is manufactured in accordance with different directives relating to the product.

CX/CXL/CXSs are equipped with the CE-label in accordance with the Low Voltage Directive (LVD) and the EMC directive.

2.2 EMC-directive

2.2.1 General

The EMC directive (Electro Magnetic Compatibility) states that the electrical equipment must not disturb the environment and must be immune to other Electro Magnetic Disturbances in the environment.

A Technical Construction File (TCF) exists which demonstrates that the CX/CXL/CXS drives fulfill the requirements of the EMC directive. A Technical Construction File has been used as a statement of conformity with the EMC directive as it is not possible to test all combinations of installation.

2.2.2 Technical criteria

The design intent was to develop a family of drives, which is user friendly and cost effective, while fulfilling the customer needs. EMC compliance was a major consideration from the outset of the design.

The CX/CXL/CXS series is targeted at the world market. To ensure maximum flexibility, yet meet the EMC needs of different regions, all drives meet the highest immunity levels, while emission levels are left to the user's choice.

The code "N" CX/CXL/CXS inverters are designed for use outside the EU or for use within the EU where the end user take personal responsibility for EMC compliance.

2.2.3 EMC-levels

The EXCEL VRL frequency converters do not fulfil any EMC emission requirements without an optional RFI-filter, either buit-in or separate. For EMC purposes, the frequency converters are divided into three different levels. All the products have the same functions and control electronics, but their EMC properties vary as follows:

CX -level N:

The frequency converters (level N) do not fulfill any EMC emmission demands without a separate RFI-filter. With an external RFI-filter, the product fulfill the EMC emmissions demands in the heavy industrial environment (EN50081-2).

CXL, CXS -level I:

The frequency converters (level I) fulfill the EMC emmissions requirements in the heavy industrial environment (EN50081-2).

CXL, CXS -level C:

The frequency converters (level C) fulfill the EMC emmission requirements in the commercial, residential and light industrial environment (50081-1,-2, widest range of use)

All products (level N, I, C) fulfill all EMC immunity requirements (EN50082-1,-2 and EN61800-3).

2.2.4 Manufacturer's Declarations of Conformity

Following are copies of the Manufacturer's Declarations of Conformity, which show conformity with the directives for drives with different EMC levels.

2.3 UL-label

The EXCEL VRL frequency converters are UL-listed according to the standards, based on the needed voltage and power range. For more information contact you local Honeywell distributor. More information of cable selection and installation can be found from chapter 6.1.4.1.

EU DECLARATION OF CONFORMITY

We

Manufacturer's Name: Vaasa Control

Manufacturer's Address: P.O. BOX 25
Runsorintie 7
FIN-65381 VAASA
Finland

hereby declares that the product:

Product name: CX Frequency converter
CXL Frequency converter
CXS Frequency converter

Model number CX**........**
CXL**........**
CXS**........**

has been designed and manufactured in accordance with the following standards:

Safety: EN 50178 (1995) and relevant parts of EN60950 (1992), Am 1 (1993), Am 2 (1993), Am 3 (1995), EN60204-1(1996)

EMC: EN50082-2 (1995), EN61800-3

and conforms to the relevant safety provisions of the Low Voltage Directive (73/23/EEC) as amended by the Directive (93/68/EEC) and EMC Directive 89/336/EEC.

It is ensured through internal measures and quality control that product conforms at all times to the requirements of the current Directive and the relevant standards.

Vaasa 12.05.1997

Veijo Karppinen

Managing Director

The last two digits of the year the CE marking was affixed 97

EU DECLARATION OF CONFORMITY

We

Manufacturer's Name: Vaasa Control

Manufacturer's Address: P.O. BOX 25
Runsorintie 5
FIN-65381 VAASA
Finland

hereby declares that the product:

Product name: CX Frequency converter

Model number CX**......**N**.** + **.**RFI**...**

has been designed and manufactured in accordance with the following standards:

Safety: EN 50178 (1995) and relevant parts of EN60950 (1992), Am 1 (1993), Am 2 (1993), Am 3 (1995), EN60204-1 (1996)

EMC: EN50081-2 (1993), EN50082-2 (1995), EN61800-3 (1996)

Technical construction file
Prepared by: Vaasa Control Oy
Function: Manufacturer
Date: 03.05.1996
TCF no.: RP00012

Competent body
Name: FIMKO LTD
Address: P.O. Box 30 (Särkiniementie 3)
FIN-00211 Helsinki
Country: Finland

and conforms to the relevant safety provisions of the Low Voltage Directive (73/23/EEC) as amended by the Directive (93/68/EEC) and EMC Directive 89/336/EEC.

It is ensured through internal measures and quality control that product conforms at all times to the requirements of the current Directive and the relevant standards.

Vaasa 12.05.1997

Veijo Karppinen

Managing Director

The last two digits of the year the CE marking was affixed 97

EU DECLARATION OF CONFORMITY

We

Manufacturer's Name: Vaasa Control

Manufacturer's Address: P.O. BOX 25
Runsorintie 5
FIN-65381 VAASA
Finland

hereby declares that the product:

Product name: CXL Frequency converter

Model number CXL**......**I**.**

has been designed and manufactured in accordance with the following standards:

Safety: EN 50178 (1995) and relevant parts of EN60950 (1992), Am 1 (1993), Am 2 (1993), Am 3 (1995), EN60204-1 (1996)

EMC: EN50081-2 (1993), EN50082-2 (1995), EN61800-3 (1996)

Technical construction file

Prepared by:	Vaasa Control Oy
Function:	Manufacturer
Date:	03.05.1996
TCF no.:	RP00013

Competent body

Name:	FIMKO LTD
Address:	P.O. Box 30 (Särkiniementie 3) FIN-00211 Helsinki
Country:	Finland

and conforms to the relevant safety provisions of the Low Voltage Directive (73/23/EEC) as amended by the Directive (93/68/EEC) and EMC Directive 89/336/EEC.

It is ensured through internal measures and quality control that product conforms at all times to the requirements of the current Directive and the relevant standards.

Vaasa 12.05.1997

Veijo Karppinen

Managing Director

The last two digits of the year the CE marking was affixed 97

EU DECLARATION OF CONFORMITY

We

Manufacturer's Name: Vaasa Control

Manufacturer's Address: P.O. BOX 25
Runsorintie 5
FIN-65381 VAASA
Finland

hereby declares that the product:

Product name: CXL Frequency converter

Model number CXL**......**C**.**

has been designed and manufactured in accordance with the following standards:

Safety: EN 50178 (1995) and relevant parts of EN60950
(1992), Am 1 (1993), Am 2 (1993), Am 3 (1995), EN60204-1 (1996)

EMC: EN50081-1,-2 (1993), EN50082-1,-2 (1995), EN61800-3 (1996)

Technical construction file
Prepared by: Vaasa Control Oy
Function: Manufacturer
Date: 03.05.1996
TCF no.: RP00014

Competent body
Name: FIMKO LTD
Address: P.O. Box 30 (Särkiniementie 3)
FIN-00211 Helsinki
Country: Finland

and conforms to the relevant safety provisions of the Low Voltage Directive (73/23/EEC) as amended by the Directive (93/68/EEC) and EMC Directive 89/336/EEC.

It is ensured through internal measures and quality control that product conforms at all times to the requirements of the current Directive and the relevant standards.

Vaasa 12.05.1997

Veijo Karppinen

Managing Director

The last two digits of the year the CE marking was affixed 97

EU DECLARATION OF CONFORMITY

We

Manufacturer's Name: Vaasa Control

Manufacturer's Address: P.O. BOX 25
Runsorintie 5
FIN-65381 VAASA
Finland

hereby declares that the product:

Product name: CXS Frequency converter

Model number CXS**......I.**

has been designed and manufactured in accordance with the following standards:

Safety: EN 50178 (1995) and relevant parts of EN60950
(1992), Am 1 (1993), Am 2 (1993), Am 3 (1995), EN60204-1 (1996)

EMC: EN50081-2 (1993), EN50082-2 (1995), EN61800-3 (1996)

Technical construction file

Prepared by:	Vaasa Control Oy
Function:	Manufacturer
Date:	03.05.1996
TCF no.:	RP00015

Competent body

Name:	FIMKO LTD
Address:	P.O. Box 30 (Särkiniementie 3) FIN-00211 Helsinki
Country:	Finland

and conforms to the relevant safety provisions of the Low Voltage Directive (73/23/EEC) as amended by the Directive (93/68/EEC) and EMC Directive 89/336/EEC.

It is ensured through internal measures and quality control that product conforms at all times to the requirements of the current Directive and the relevant standards.

Vaasa 14.11.1997

Veijo Karppinen

Managing Director

The last two digits of the year the CE marking was affixed 97

EU DECLARATION OF CONFORMITY

We

Manufacturer's Name: Vaasa Control

Manufacturer's Address: P.O. BOX 25
Runsorintie 5
FIN-65381 VAASA
Finland

hereby declares that the product:

Product name: CXS Frequency converter

Model number CXS**......**C**.**

has been designed and manufactured in accordance with the following standards:

Safety: EN 50178 (1995) and relevant parts of EN60950 (1992), Am 1 (1993), Am 2 (1993), Am 3 (1995), EN60204-1 (1996)

EMC: EN50081-1,-2 (1993), EN50082-1,-2 (1995), EN61800-3 (1996)

Technical construction file

Prepared by:	Vaasa Control Oy
Function:	Manufacturer
Date:	03.05.1996
TCF no.:	RP00016

Competent body

Name:	FIMKO LTD
Address:	P.O. Box 30 (Särkiniementie 3) FIN-00211 Helsinki
Country:	Finland

and conforms to the relevant safety provisions of the Low Voltage Directive (73/23/EEC) as amended by the Directive (93/68/EEC) and EMC Directive 89/336/EEC.

It is ensured through internal measures and quality control that product conforms at all times to the requirements of the current Directive and the relevant standards.

Vaasa 14.11.1997

Veijo Karppinen

Managing Director

The last two digits of the year the CE marking was affixed 97

3 RECEIVING

This CX/CXL/CXS drive has been subjected to demanding factory tests before shipment. After unpacking, check that the device does not show any signs of damage and that the CX/CXL/CXS is as ordered (refer to the type designation code in figure 3-1).

In the event of damage, please contact and file a claim with the carrier involved immediately.

If the received equipment is not the same as ordered, please contact your distributor immediately.

Note! Do not destroy the packing. The template printed on the protective cardboard can be used for marking the mounting points of the CX/CXL/CXS on the wall.

3.1 Type designation code

CX(x) 0750HP V 3 4 A 2 N 0

CX(x)	Product Series	= CX, CXL, CXS
0750HP	e.g. * ●	0015 HP = 1.5 Hp 0015 = 1.5 kW 0750 HP = 75 Hp 0750 = 75 kW 9000 HP = 900 Hp 9000 = 900 kW 10000 HP = 1000 Hp 10000 = 1000 kW
V	Voltage	
3	Phase 1 or 3	
4	Voltage ● (3-phase)	2 = 230V 4 = 380V 5 = 480V 6 = 600V
A	Panel	A = 7-segment LED Display B = Graphic (LCD) Display G = Alphanumerical Display C = without local control panel D = special equipped (switches, etc.)
2	IP	0 = chassis (IP00) 2 = Series CX/CXL: protected chassis (IP20), Serie CXS:compact NEMA 1 (IP20) 5 = NEMA 12 (IP54) 7 = NEMA 1 (IP21)
N	RFI	C, I, N (no internal Filter)
0	Brake	1 = built in brake 0 = no brake

* in pump and fan applications (variable torque) the nominal power of the unit is one size larger (see section 4.2)

●480 V units are rated in Hp, 380 V units are rated in kW

Figure 3-1 Type designation code.

3.2 Storing

If the CX/CXL/CXS must be stored before installation and startup, check that the ambient conditions in the storage area are acceptable (temperature -40°C—+60°C; (-40°F - + 140°F), relative humidity <95%, no condensation allowed).

3.3 Warranty

This equipment is covered by the Honeywell standard drive warranty policy.

Honeywell distributors may have a different warranty period, which is specified in their sales terms and conditions and warranty terms.

If any questions arise concerning the warranty, please contact your distributor.

4 TECHNICAL DATA

4.1 General

Figure 4-1 shows a block diagram of the CX/CXL/CXS drive.

The three phase *AC-Choke* with the DC-link capacitor forms an LC filter which together with the *Diode Bridge* produce the DC voltage for the IGBT *Inverter Bridge* block. The AC-Choke smooths the HF-disturbances from the utility to the drive and HF-disturbances caused by the drive to the utility. It also improves the waveform of the input current to the drive.

The IGBT bridge produces a symmetrical three phase pulse width modulated AC voltage to the motor. The power drawn from the supply is almost entirely active power.

The Motor and Application Control block is based on microprocessor software. The microprocessor controls the motor according to measured signals, parameter value settings and commands from the *Control I/O* block and the *Control Panel*. The Motor and Application Control block gives commands to the *Motor Control ASIC* which calculates the IGBT switching positions. *Gate Drivers* amplify these signals for driving the IGBT inverter bridge.

The Control Panel is a link between the user and the drive. With the panel the user can set parameter values, read status data and give control commands. The panel is removable and can be mounted externally and connected via a cable to the drive.

The Control I/O block is isolated from line potential and is connected to ground via a 1 MΩ resistor and 4.7 nF capacitor. If needed, the Control I/O block can be grounded without a resistor by changing the position of the jumper X4 (GND ON/OFF) on the control board.

The basic Control interface and parameters (Basic application) make the inverter easy to operate. If a more versatile interface or parameter settings are needed, an optional application can be selected with one parameter from a Application package. The application package manual describes these in more detail.

An optional *Brake Chopper* can be mounted in the unit at the factory. Optional I/O-expander boards are also available.

Input and Output EMC-filters are not required for the functionality of the drive, they are only required for compliance with the EU EMC-directive.

4

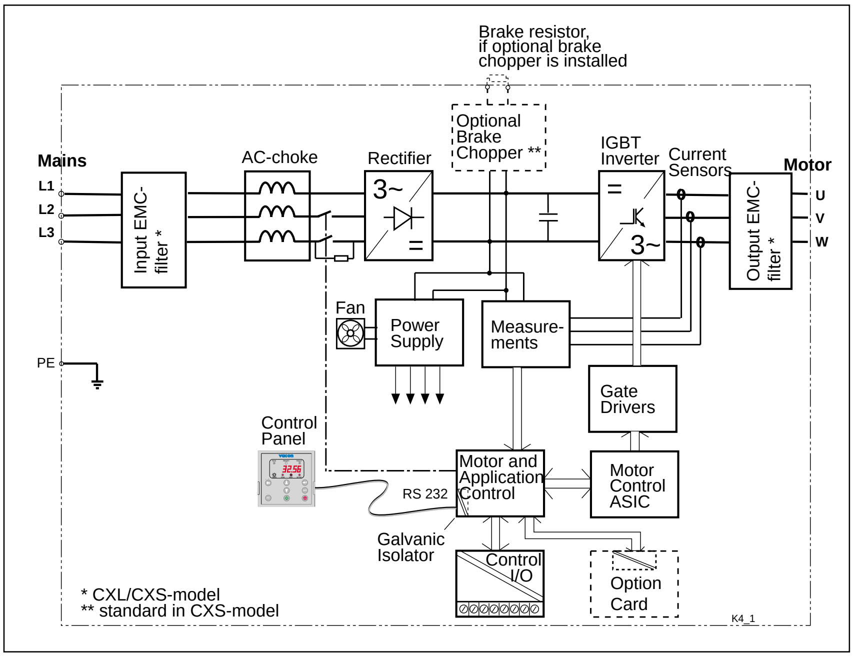


Figure 4-1 CX/CXL/CXS block diagram.

4.2 Power ratings

440 - 500Vac, +10% / -15%, 50/60 Hz, 3 ~ Input **Series CX (standard/protected chassis)**

Catalog Number	Rated Horsepower and output current				Frame Size / Enclosure Style	Dimensions W x H x D (inches)	Weight (lbs)
	Constant Torque		Variable Torque				
	Hp	Ict *	Hp	Ivt **			
CX 0030 HP V 3 5	3	5	-	-	M4 / Protected	4.7 x 11.4 x 8.5	15.4
CX 0040 HP V 3 5	-	-	5	8			
CX 0050 HP V 3 5	5	8	7.5	11			
CX 0075 HP V 3 5	7.5	11	10	15			
CX 0100 HP V 3 5	10	15	15	21	M5 / Protected	6.2 x 15.9 x 9.4	33.1
CX 0150 HP V 3 5	15	21	20	27			
CX 0200 HP V 3 5	20	27	25	32			
CX 0250 HP V 3 5	25	34	30	40	M6 / Protected	8.7 x 20.7 x 11.4	77.2
CX 0300 HP V 3 5	30	40	40	52			
CX 0400 HP V 3 5	40	52	50	65			
CX 0500 HP V 3 5	50	65	60	77			
CX 0600 HP V 3 5	60	77	75	96			
CX 0750 HP V 3 5	75	96	100	125	M7 / Chassis ***	9.8 x 31.5 x 12.4	133
CX 1000 HP V 3 5	100	125	125	160			
CX 1250 HP V 3 5	125	160	150	180			
CX 1500 HP V 3 5	150	180	-	-	M8 / Chassis ***	19.5 x 35.0 x 13.9	309
CX 1750 HP V 3 5	-	-	200	260			
CX 2000 HP V 3 5	200	260	250	320			
CX 2500 HP V 3 5	250	320	300	400	M9 / Chassis ***	27.6 x 39.4 x 15.4	485
CX 3000 HP V 3 5	300	400	400	460			
CX 4000 HP V 3 5	400	480	500	600	M10 / Chassis ***	38.9 x 39.4 x 15.4	684
CX 5000 HP V 3 5	500	600	600	672			
CX 6000 HP V 3 5	600	700	700	880	M11 / Chassis	55.1 x 39.4 x 15.4	948
CX 7000 HP V 3 5	700	880	800	1020	M12 / Chassis	77.9 x 39.4 x 15.4	1212
CX 8000 HP V 3 5	800	1020	900	1070			
CX 9000 HP V 3 5	900	1070	1000	1200			
CX 10000 HP V 3 5	1000	1200	-	-			
CX 11000 HP V 3 5	1100	1300	-	-			

* Ict = rated input and output current (constant torque load, max 50C ambient)

** Ivt = rated input and output current (variable torque load, max 40C ambient)

*** Protected Enclosure with Optional Cover

380 - 440Vac, +10% / -15%, 50/60 Hz, 3 ~ Input   Series CX (standard/protected chassis)

Catalog Number	Rated Kilowatts and output current				Frame Size / Enclosure Style	Dimensions W x H x D (inches)	Weight (lbs)
	Constant Torque		Variable Torque				
	kW	Ict *	kW	Ivt **			
CX 0022 V 3 4	2.2	6.5	3	8	M4 / Protected	4.7 x 11.4 x 8.5	15.4
CX 0030 V 3 4	3	8	4	10			
CX 0040 V 3 4	4	10	5.5	13			
CX 0055 V 3 4	5.5	13	7.5	18			
CX 0075 V 3 4	7.5	18	11	24	M5 / Protected	6.2 x 15.9 x 9.4	33.1
CX 0110 V 3 4	11	24	15	32			
CX 0150 V 3 4	15	32	18.5	42			
CX 0185 V 3 4	18.5	42	22	48	M6 / Protected	8.7 x 20.7 x 11.4	77.2
CX 0220 V 3 4	22	48	30	60			
CX 0300 V 3 4	30	60	37	75			
CX 0370 V 3 4	37	75	45	90			
CX 0450 V 3 4	45	90	55	110			
CX 0550 V 3 4	55	110	75	150	M7 / Chassis ***	9.8 x 31.5 x 12.4	133
CX 0750 V 3 4	75	150	90	180			
CX 0900 V 3 4	90	180	110	210			
CX 1100 V 3 4	110	210	132	270	M8 / Chassis ***	19.5 x 35.0 x 13.9	309
CX 1320 V 3 4	132	270	160	325			
CX 1600 V 3 4	160	325	200	410			
CX 2000 V 3 4	200	410	250	510	M9 / Chassis ***	27.6 x 39.4 x 15.4	485
CX 2500 V 3 4	250	510	315	580			
CX 3150 V 3 4	315	600	400	750	M10 / Chassis ***	38.9 x 39.4 x 15.4	684
CX 4000 V 3 4	400	750	500	840			
CX 5000 V 3 4	500	840	630	1050	M11 / Chassis	55.1 x 39.4 x 15.4	948
CX 6300 V 3 4	630	1050	710	1160	M12 / Chassis	77.9 x 39.4 x 15.4	1212
CX 7100 V 3 4	710	1270	800	1330			
CX 8000 V 3 4	800	1330	900	1480			
CX 9000 V 3 4	900	1480	-	-			
CX 10000 V 3 4	1000	1600	-	-			

* Ict = continuous rated input and output current (constant torque load, max 50C ambient)

** Ivt = continuous rated input and output current (variable torque load, max 40C ambient)

*** Protected Enclosure with Option

4

440 - 500Vac, +10% / -15%, 50/60 Hz, 3 ~ Input **Series CXL (NEMA 1)**

Catalog Number	Rated Horsepower and output current				Frame Size / Enclosure Style	Dimensions W x H x D (inches)	Weight (lbs)
	Constant Torque		Variable Torque				
	Hp	Ict *	Hp	Ivt **			
CXL 0030HP V 3 5	3	5	-	-	M4 / NEMA 1	4.7 x 15.4 x 8.5	17.6
CXL 0040HP V 3 5	-	-	5	8			
CXL 0050HP V 3 5	5	8	7.5	11			
CXL 0075HP V 3 5	7.5	11	10	15			
CXL 0100HP V 3 5	10	15	15	21	M5 / NEMA 1	6.2 x 20.3 x 9.4	35.3
CXL 0150HP V 3 5	15	21	20	27			
CXL 0200HP V 3 5	20	27	25	32			
CXL 0250HP V 3 5	25	34	30	40	M6 / NEMA 1	8.7 x 25.6 x 11.4	83.8
CXL 0300HP V 3 5	30	40	40	52			
CXL 0400HP V 3 5	40	52	50	65			
CXL 0500HP V 3 5	50	65	60	77			
CXL 0600HP V 3 5	60	77	75	96			
CXL 0750HP V 3 5	75	96	100	125	M7 / NEMA 1	14.7 x 39.4 x 13.0	221
CXL 1000HP V 3 5	100	125	125	160			
CXL 1250HP V 3 5	125	160	150	180			
CXL 1500HP V 3 5	150	180	-	-	M8 / NEMA 1	19.5 x 47.6 x 13.9	309
CXL 1750HP V 3 5	-	-	200	260			
CXL 2000HP V 3 5	200	260	250	320			
CXL 2500HP V 3 5	250	320	300	400	M9 / NEMA 1	27.6 x 56.1 x 15.4	574
CXL 3000HP V 3 5	300	400	400	460			
CXL 4000HP V 3 5	400	480	500	600	Contact Factory		
CXL 5000HP V 3 5	500	600	600	672			

380 - 440Vac, +10% / -15%, 50/60 Hz, 3 ~ Input **Series CXL (NEMA 1)**

Catalog Number	Rated Kilowatts and output current				Frame Size / Enclosure Style	Dimensions W x H x D (inches)	Weight (lbs)
	Constant Torque		Variable Torque				
	kW	Ict *	kW	Ivt **			
CXL 0022 V 3 4	2.2	6.5	3	8	M4 / NEMA 1	4.7 x 15.4 x 8.5	17.6
CXL 0030 V 3 4	3	8	4	10			
CXL 0040 V 3 4	4	10	5.5	13			
CXL 0055 V 3 4	5.5	13	7.5	18			
CXL 0075 V 3 4	7.5	18	11	24	M5 / NEMA 1	6.2 x 20.3 x 9.4	35.3
CXL 0110 V 3 4	11	24	15	32			
CXL 0150 V 3 4	15	32	18.5	42			
CXL 0185 V 3 4	18.5	42	22	48	M6 / NEMA 1	8.7 x 25.6 x 11.4	84
CXL 0220 V 3 4	22	48	30	60			
CXL 0300 V 3 4	30	60	37	75			
CXL 0370 V 3 4	37	75	45	90			
CXL 0450 V 3 4	45	90	55	110			
CXL 0550 V 3 4	55	110	75	150	M7 / NEMA 1	14.7 x 39.4 x 13.0	221
CXL 0750 V 3 4	75	150	90	180			
CXL 0900 V 3 4	90	180	110	210			
CXL 1100 V 3 4	110	210	132	270	M8 / NEMA 1	19.5 x 47.6 x 13.9	309
CXL 1320 V 3 4	132	270	160	325			
CXL 1600 V 3 4	160	325	200	410			
CXL 2000 V 3 4	200	410	250	510	M9 / NEMA 1	27.6 x 56.1 x 15.4	574
CXL 2500 V 3 4	250	510	315	580			
CXL 3150 V 3 4	315	600	400	750	Contact Factory		
CXL 4000 V 3 4	400	750	500	840			

* Ict = continuous rated input and output current (constant torque load, max 50C ambient)

** Ivt = continuous rated input and output current (variable torque load, max 40C ambient)

440 - 500Vac, +10% / -15%, 50/60 Hz, 3 ~ Input					**Series CXL (NEMA 12)**		
Catalog Number	Rated Horsepower and output current				Frame Size / Enclosure Style	Dimensions W x H x D (inches)	Weight (lbs)
	Constant Torque		Variable Torque				
	Hp	Ict *	Hp	Ivt **			
CXL 0030HP V 3 5	3	5	-	-	M4 / NEMA 12	4.7 x 15.4 x 8.5	17.6
CXL 0040HP V 3 5	-	-	5	8			
CXL 0050HP V 3 5	5	8	7.5	11			
CXL 0075HP V 3 5	7.5	11	10	15			
CXL 0100HP V 3 5	10	15	15	21	M5 / NEMA 12	6.2 x 20.3 x 9.4	35.3
CXL 0150HP V 3 5	15	21	20	27			
CXL 0200HP V 3 5	20	27	25	32			
CXL 0250HP V 3 5	25	34	30	40	M6 / NEMA 12	8.7 x 25.6 x 11.4	83.8
CXL 0300HP V 3 5	30	40	40	52			
CXL 0400HP V 3 5	40	52	50	65			
CXL 0500HP V 3 5	50	65	60	77			
CXL 0600HP V 3 5	60	77	75	96			
CXL 0750HP V 3 5	75	96	100	125	M7 / NEMA 12	14.7 x 39.4 x 13.0	221
CXL 1000HP V 3 5	100	125	125	160			
CXL 1250HP V 3 5	125	160	150	180			
CXL 1500HP V 3 5	150	180	-	-	M8 / NEMA 12	19.5 x 47.6 x 13.9	309
CXL 1750HP V 3 5	-	-	200	260			
CXL 2000HP V 3 5	200	260	250	320			
CXL 2500HP V 3 5	250	320	300	400	M9 / NEMA 12	27.6 x 56.1 x 15.4	574
CXL 3000HP V 3 5	300	400	400	460			
CXL 4000HP V 3 5	400	480	500	600	Contact Factory		
CXL 5000HP V 3 5	500	600	600	672			

380 - 440Vac, +10% / -15%, 50/60 Hz, 3 ~ Input					**Series CXL (NEMA 12)**		
Catalog Number	Rated Kilowatts and output current				Frame Size / Enclosure Style	Dimensions W x H x D (inches)	Weight (lbs)
	Constant Torque		Variable Torque				
	kW	Ict *	kW	Ivt **			
CXL 0022 V 3 4	2.2	6.5	3	8	M4 / NEMA 12	4.7 x 15.4 x 8.5	17.6
CXL 0030 V 3 4	3	8	4	10			
CXL 0040 V 3 4	4	10	5.5	13			
CXL 0055 V 3 4	5.5	13	7.5	18			
CXL 0075 V 3 4	7.5	18	11	24	M5 / NEMA 12	6.2 x 20.3 x 9.4	35.3
CXL 0110 V 3 4	11	24	15	32			
CXL 0150 V 3 4	15	32	18.5	42			
CXL 0185 V 3 4	18.5	42	22	48	M6 / NEMA 12	8.7 x 25.6 x 11.4	84
CXL 0220 V 3 4	22	48	30	60			
CXL 0300 V 3 4	30	60	37	75			
CXL 0370 V 3 4	37	75	45	90			
CXL 0450 V 3 4	45	90	55	110			
CXL 0550 V 3 4	55	110	75	150	M7 / NEMA 12	14.7 x 39.4 x 13.0	221
CXL 0750 V 3 4	75	150	90	180			
CXL 0900 V 3 4	90	180	110	210			
CXL 1100 V 3 4	110	210	132	270	M8 / NEMA 12	19.5 x 47.6 x 13.9	309
CXL 1320 V 3 4	132	270	160	325			
CXL 1600 V 3 4	160	325	200	410			
CXL 2000 V 3 4	200	410	250	510	M9 / NEMA 12	27.6 x 56.1 x 15.4	574
CXL 2500 V 3 4	250	510	315	580			
CXL 3150 V 3 4	315	600	400	750	Contact Factory		
CXL 4000 V 3 4	400	750	500	840			

* Ict = continuous rated input and output current (constant torque load, max 50C ambient)

** Ivt = continuous rated input and output current (variable torque load, max 40C ambient)

4

525 - 600Vac, +10% / -15%, 50/60 Hz, 3 ~ Input	Series CX (standard/protected chassis)						
Catalog Number	Rated Horsepower and output current				Frame Size / Enclosure Style	Dimensions W x H x D (inches)	Weight (lbs)
	Constant Torque		Variable Torque				
	Hp	Ict *	Hp	Ivt **			
CX 0020HP V 3 6	2	3.5	3	4.5	M5 / Protected	6.2 x 17.3 x 10.4	33.1
CX 0030HP V 3 6	3	4.5	-	-			
CX 0040HP V 3 6	-	-	5	7.5			
CX 0050HP V 3 6	5	7.5	7.5	10			
CX 0075HP V 3 6	7.5	10	10	14			
CX 0100HP V 3 6	10	14	15	19			
CX 0150HP V 3 6	15	19	20	23			
CX 0200HP V 3 6	20	23	25	26			
CX 0250HP V 3 6	25	26	30	35			
CX 0300HP V 3 6	30	35	40	42	M6 / Protected	8.7 x 24.3 x 11.4	83.8
CX 0400HP V 3 6	40	42	50	52			
CX 0500HP V 3 6	50	52	60	62			
CX 0600HP V 3 6	60	62	75	85			
CX 0750HP V 3 6	75	85	100	100			
CX 1000HP V 3 6	100	100	125	122	M8 / Chassis ***	19.5 x 35.0 x 13.9	300
CX 1250HP V 3 6	125	122	150	145			
CX 1500HP V 3 6	150	145	-	-			
CX 1750HP V 3 6	-	-	200	222	M9 / Chassis ***	27.6 x 39.4 x 15.4	466
CX 2000HP V 3 6	200	222	250	287			
CX 2500HP V 3 6	250	287	300	325	M10 / Chassis***	38.9 x 39.4 x 15.4	602
CX 3000HP V 3 6	300	325	400	390			
CX 4000HP V 3 6	400	400	500	490	M11 / Chassis	55.1 x 39.4 x 15.4	948
CX 5000HP V 3 6	500	490	600	620	M12 / Chassis	77.9 x 39.4 x 15.4	1213
CX 6000HP V 3 6	600	620	700	700			
CX 7000HP V 3 6	700	700	-	-			
CX 8000HP V 3 6	800	780	-	-			

* Ict = rated input and output current (constant torque load, max 50C ambient)
** Ivt = rated input and output current (variable torque load, max 40C ambient)
*** Protected Enclosure with Option

4

440 - 500Vac, +10% / -15%, 50/60 Hz, 3 ~ Input Series CXS (compact NEMA 1)

Catalog Number	Rated Horsepower and output current				Frame Size / Enclosure Style	Dimensions W x H x D (inches)	Weight (lbs)
	Constant Torque		Variable Torque				
	Hp	Ict *	Hp	Ivt **			
CXS 0010HP V 3 5	1	2.5	1.5	3	M3 / Compact NEMA 1	4.7 x 12.0 x 5.9	9.9
CXS 0015HP V 3 5	1.5	3	2	3.5			
CXS 0020HP V 3 5	2	3.5	3	5			
CXS 0030HP V 3 5	3	5	-	-			
CXS 0040HP V 3 5	-	-	5	8			
CXS 0050HP V 3 5	5	8	7.5	11	M4B / Compact NEMA 1	5.3 x 15.4 x 8.1	15.4
CXS 0075HP V 3 5	7.5	11	10	15			
CXS 0100HP V 3 5	10	15	15	21			
CXS 0150HP V 3 5	15	21	20	27			
CXS 0200HP V 3 5	20	27	25	34	M5B / Compact NEMA 1	7.3 x 22.8 x 8.5	33.1
CXS 0250HP V 3 5	25	34	30	40			
CXS 0300HP V 3 5	30	40	40	52			

380 - 440Vac, +10% / -15%, 50/60 Hz, 3 ~ Input Series CXS (compact NEMA 1)

Catalog Number	Rated Kilowatts and output current				Frame Size / Enclosure Style	Dimensions W x H x D (inches)	Weight (lbs)
	Constant Torque		Variable Torque				
	kW	Ict *	kW	Ivt **			
CXS 0007 V 3 4	0.75	2.5	1.1	3.5	M3 / Compact NEMA 1	4.7 x 12.0 x 5.9	9.9
CXS 0011 V 3 4	1.1	3.5	1.5	4.5			
CXS 0015 V 3 4	1.5	4.5	2.2	6.5			
CXS 0022 V 3 4	2.2	6.5	3	8			
CXS 0030 V 3 4	3	8	4	10			
CXS 0040 V 3 4	4	10	5.5	13	M4B / Compact NEMA 1	5.3 x 15.4 x 8.1	15.4
CXS 0055 V 3 4	5.5	13	7.5	18			
CXS 0075 V 3 4	7.5	18	11	24			
CXS 0110 V 3 4	11	24	15	32			
CXS 0150 V 3 4	15	32	18.5	42	M5B / Compact NEMA 1	7.3 x 22.8 x 8.5	33.1
CXS 0185 V 3 4	18.5	42	22	48			
CXS 0220 V 3 4	22	48	30	60			

* Ict = continuous rated input and output current (constant torque load, max 50C ambient)

** Ivt = continuous rated input and output current (variable torque load, max 40C ambient)

200-240 Vac. +10% / -15%. 50/60 Hz. 3 ~ Input					Series CXS (compact NEMA 1)		
Catalog Number	Rated Horsepower and output current				Frame Size / Enclosure Style	Dimensions W x H x D (inches)	Weight (lbs)
	Constant Torque		Variable Torque				
	Hp	Ict *	Hp	Ivt **			
CXS 0007HP V 3 2	0.75	3.6	1	4.7	M3 / Compact NEMA 1	4.7 x 12.0 x 5.9	9.9
CXS 0010HP V 3 2	1	4.7	1.5	5.6			
CXS 0015HP V 3 2	1.5	5.6	2	7			
CXS 0020HP V 3 2	2	7	3	10			
CXS 0030HP V 3 2	3	10	-	-	M4B / Compact NEMA 1	5.3 x 15.4 x 8.1	15.4
CXS 0040HP V 3 2	-	-	5	16			
CXS 0050HP V 3 2	5	16	7.5	22			
CXS 0075HP V 3 2	7.5	22	10	30			
CXS 0100HP V 3 2	10	30	15	43	M5B / Compact NEMA 1	7.3 x 22.8 x 8.5	33.1
CXS 0150HP V 3 2	15	43	20	57			
CXS 0200HP V 3 2	20	57	25	70			

200-240 Vac, +10% / -15%. 50/60 Hz. 3 ~ Input					Series CX (standard/protected chassis)		
Catalog Number	Rated Horsepower and output current				Frame Size / Enclosure Style	Dimensions W x H x D (inches)	Weight (lbs)
	Constant Torque		Variable Torque				
	Hp	Ict *	Hp	Ivt **			
CX 0020HP V 3 2	2	7	3	10	M4 / Protected	4.7 x 11.4 x 8.5	15.4
CX 0030HP V 3 2	3	10	-	-			
CX 0040HP V 3 2	-	-	5	16	M5 / Protected	6.2 x 15.9 x 9.4	33.1
CX 0050HP V 3 2	5	16	7.5	22			
CX 0075HP V 3 2	7.5	22	10	30			
CX 0100HP V 3 2	10	30	15	43			
CX 0150HP V 3 2	15	43	20	57	M6 / Protected	8.7 x 20.7 x 11.4	77.2
CX 0200HP V 3 2	20	57	25	70			
CX 0250HP V 3 2	25	70	30	83			
CX 0300HP V 3 2	30	83	40	113			
CX 0400HP V 3 2	40	113	50	139	M7 / Chassis***	9.8 x 31.5 x 12.4	135
CX 0500HP V 3 2	50	139	60	165			
CX 0600HP V 3 2	60	165	75	200			
CX 0750HP V 3 2	75	200	100	264	M8 / Chassis***	19.5 x 35 x 13.9	300

* Ict = continuous rated input and output current (constant torque load. max 50C ambient)

** Ivt = continuous rated input and output current (variable torque load. max 40C ambient)

*** Protected Enclosure with Option

4

200-240 Vac, +10% / -15%, 50/60 Hz, 3 ~ Input **Series CXL (NEMA 12)**

Catalog Number	Rated Horsepower and output current				Frame Size / Enclosure Style	Dimensions W x H x D (inches)	Weight (lbs)
	Constant Torque		Variable Torque				
	Hp	Ict *	Hp	Ivt **			
CXL 0020HP V 3 2	2	7	3	10	M4 / NEMA 12	4.7 x 15.4 x 8.5	17.6
CXL 0030HP V 3 2	3	10	-	-			
CXL 0040HP V 3 2	-	-	5	16	M5 / NEMA 12	6.2 x 20.3 x 9.4	35.3
CXL 0050HP V 3 2	5	16	7.5	22			
CXL 0075HP V 3 2	7.5	22	10	30			
CXL 0100HP V 3 2	10	30	15	43			
CXL 0150HP V 3 2	15	43	20	57	M6 / NEMA 12	8.7 x 25.6 x 11.4	84
CXL 0200HP V 3 2	20	57	25	70			
CXL 0250HP V 3 2	25	70	30	83			
CXL 0300HP V 3 2	30	83	40	113			
CXL 0400HP V 3 2	40	113	50	139	M7 / NEMA 12	14.7 x 39.4 x 13	180
CXL 0500HP V 3 2	50	139	60	165			
CXL 0600HP V 3 2	60	165	75	200			
CXL 0750HP V 3 2	75	200	100	264	M8 / NEMA 12	19.5 x 50.8 x 14	337

200-240 Vac, +10% / -15%, 50/60 Hz, 3 ~ Input **Series CXL (NEMA 1)**

Catalog Number	Rated Horsepower and output current				Frame Size / Enclosure Style	Dimensions W x H x D (inches)	Weight (lbs)
	Constant Torque		Variable Torque				
	Hp	Ict *	Hp	Ivt **			
CXL 0020HP V 3 2	2	7	3	10	M4 / NEMA 1	4.7 x 15.4 x 8.5	17.6
CXL 0030HP V 3 2	3	10	-	-			
CXL 0040HP V 3 2	-	-	5	16	M5 / NEMA 1	6.2 x 20.3 x 9.4	35.3
CXL 0050HP V 3 2	5	16	7.5	22			
CXL 0075HP V 3 2	7.5	22	10	30			
CXL 0100HP V 3 2	10	30	15	43			
CXL 0150HP V 3 2	15	43	20	57	M6 / NEMA 1	8.7 x 25.6 x 11.4	84
CXL 0200HP V 3 2	20	57	25	70			
CXL 0250HP V 3 2	25	70	30	83			
CXL 0300HP V 3 2	30	83	40	113			
CXL 0400HP V 3 2	40	113	50	139	M7 / NEMA 1	14.7 x 39.4 x 13	180
CXL 0500HP V 3 2	50	139	60	165			
CXL 0600HP V 3 2	60	165	75	200			
CXL 0750HP V 3 2	75	200	100	264	M8 / NEMA 1	19.5 x 50.8 x 14	337

* Ict = continuous rated input and output current (constant torque load, max 50C ambient)

** Ivt = continuous rated input and output current (variable torque load, max 40C ambient)

4

4.3 Specifications

Utility connection	Input voltage V_{in}	200-240V, 380—440V, 460—500V, 525—690V; -15%—+10%
	Input frequency	45—66 Hz
	Connection to the mains	once per minute or less (normally)
Motor Connection	Output voltage	0 — V_{in}
	Continuous output current	I_{CT}: ambient max +50°C, overload 1.5 x I_{CT} (1min/10 min) I_{VT}: ambient max +40°C, 1.1 x I_{CT} (1min/10 min)
	Starting torque	200%
	Starting current	2.5 x I_{CT}: 2 s every 20 s if output frequency <30 Hz and if the heatsink temperature <+60°C
	Output frequency	0—500 Hz
	Frequency resolution	0.01 Hz
Control characte-ristics	Control method	Frequency Control (V/Hz) Open Loop Sensorless Vector Control Closed Loop Vector Control
	Switching frequency	1—16 kHz (depending on horsepower rating)
	Frequency reference: Analog I/P	Resolution 12 bit, accuracy ±1%
	Frequency reference: Panel refer.	Resolution 0.01 Hz
	Field weakening point	30—500 Hz
	Acceleration time	0.1—3000 s
	Deceleration time	0.1—3000 s
	Braking torque	DC brake: 30%*T_N (without brake option)
Environ-mental limits	Ambient operating temperature	-10 (no frost)—+50°C at I_{CT}, (1.5 x I_{CT} max 1min/10min) -10 (no frost)—+40°C at I_{VT}, (1.1 x I_{CT} max 1min/10 min)
	Storage temperature	-40°C—+60°C
	Relative humidity	<95%, no condensation allowed
	Air quality - chemical vapors - mechanical particles	 IEC 721-3-3, unit in operation, class 3C2 IEC 721-3-3, unit in operation, class 3S2
	Altitude	Max 1000 m at continuous I_{CT} specification Over 1000 m reduce I_{CT} by 1% per each 100 m Absolute maximum altitude 3000 m
	Vibration (IEC 721-3-3)	Operation: max displacement amplitude 3 mm at 2—9 Hz, Max acceleration amplitude 0.5 G at 9—200 Hz
	Shock (IEC 68-2-27)	Operation: max 8 G, 11 ms Storage and shipping: max 15 G, 11 ms (in the package)
	Enclosure	Open and protected chassis (IP00 and IP20) Compact NEMA 1 (IP20) NEMA 1 (IP21) NEMA 12 (IP54)

Table 4.3-1 Specifications.

EMC	Noise immunity	Fulfils EN50082-1,-2 , EN61800-3
	Emissions	CX x x x x x x N x -series equipped with external RFI-Filter fulfils EN50081-2, EN61800-3 CXL x x x x x x I x -series fulfils EN50081-2, EN61800-3 CXL x x x x x x C x -series fulfils EN50081-1,-2, EN61800-3 CXS x x x x x x I x -series fulfils EN50081-2, EN61800-3 CXS x x x x x x C x -series fulfils EN50081-1,-2, EN61800-3
Safety		Fulfils EN50178, EN60204 -1,CE, UL, C-UL, FI, GOST R (check from the unit nameplate specified approvals for each unit)
Control connections	Analog voltage	0—+10 V, R_i = 200 kΩ, single ended (-10—+10V , joystick control), resolution12 bit, accur. ±1%
	Analog current	0 (4) — 20 mA, R_i = 250 Ω, differential
	Digital inputs (6)	Positive or negative logic
	Aux. voltage	+24 V ±20%, max 100 mA
	Pot. meter reference	+10 V -0% — +3%, max 10 mA
	Analog output	0 (4) — 20 mA, R_L <500 Ω, resolution 10 bit, accur. ±3%
	Digital output	Open collector output, 50 mA/48 V
	Relay outputs	Max switching voltage: 300 V DC, 250 V AC Max switching load: 8A / 24 V 0.4 A / 250 V DC 2 kVA / 250 V AC Max continuous load: 2 A rms
Protective functions	Overcurrent protection	Trip limit 4 x I_{CT}
	Overvoltage protection	Utility voltage: 220 V, 230 V, 240 V, 380 V, 400 V Trip limit: 1.47x V_n, 1.41x V_n, 1.35x V_n, 1.47x V_n, 1.40x V_n Utility voltage: 415 V, 440 V, 460 V, 480 V, 500 V Trip limit: 1.35x V_n ,1.27x V_n, 1.47x V_n, 1.41x V_n, 1.35x V_n Utility voltage: 525 V, 575 V, 600 V, 660 V, 690 V Trip limit: 1.77x V_n, 1.62x V_n, 1.55x V_n, 1.41x V_n, 1.35x V_n
	Undervoltage protection	Trip limit 0.65 x V_n
	Ground-fault protection	Protects the inverter from an ground-fault in the output (motor or motor cable)
	Utility supervision	Trip if any of the input phases is missing
	Motor phase supervision	Trip if any of the output phases is missing
	Unit over temperature protection	Yes
	Motor overload protection	Yes
	Stall protection	Yes
	Motor underload protection	Yes
	Short-circuit protection of +24V and +10V reference voltages	Yes

Table 4.3-1 Specifications.

5 INSTALLATION

5.1 Ambient conditions

The environmental limits mentioned in table 4.3-1 must not be exceeded.

5.2 Cooling

The specified space around the drive ensures proper cooling air circulation. See table 5.2-1 for dimensions. If multiple units are to be installed above each other, the dimensions must be b+c and air from the outlet of the lower unit must be directed away from the inlet of the upper unit.

With high switching frequencies and high ambient temperatures the maximum continuous output current has to be derated according to Table 5.2-3 and Figures 5.2-3 a-d.

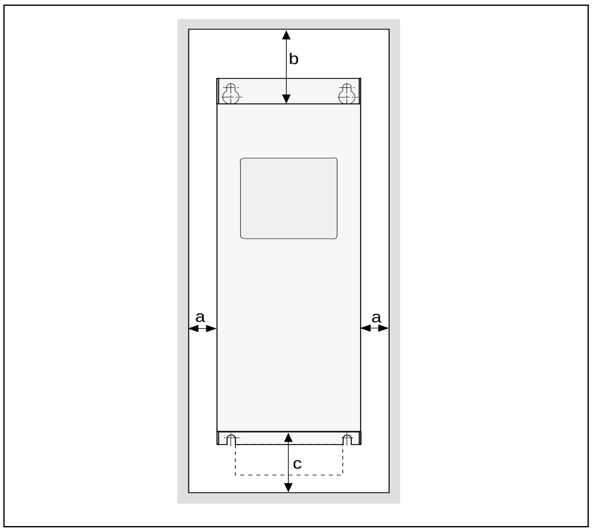


Figure 5.2-1 Installation space.

Frame Size / Enclosure Style	Dimensions (in)			
	a	a2	b	c
M3 / Compact NEMA 1	1	0.5	4	2
M4 / Protected & NEMA 12				
M4 / NEMA 1	1	1	4	2
M4B / M5B Compact NEMA 1	1	0.5	5	2.5
M5 / Protected & NEMA 12				
M5 / NEMA 1	1	1	5	2.5
M6 / Protected & NEMA 12	1.5	4	6.5	3.5
M6 / NEMA 1	1.5	1.5	6.5	3.5
M7 / Chassis* & NEMA 12	3 (1.5)**	3 (2.5)**	12	4
M7 / NEMA 1				
M8 / Chassis* & NEMA 12	10*** (3)**	3	12	
M8 / NEMA 1				
M9 / Chassis* & NEMA 12	8*** (3)**	3	12	
M9 / NEMA 1				
M10 / Chassis & NEMA 12	8*** (3)**	3	12	
M10 / NEMA 1				
M11 / Chassis & NEMA 12	Contact Factory			
M11 / NEMA 1				
M12 / Chassis & NEMA 12				
M12 / NEMA 1				

a2 - Distance from inverter to inverter in multiple inverter installations

* - Protected enclosure with optional cover.

** - Minimum allowable space - No space available for fan change.

*** - Space for fan change on sides of inverter.

Table 5.2 -1 Installation space dimensions.

Hp (KW)	Voltage / Enclosure	Required Airflow (CFM)
0.75 - 2	230 / Compact NEMA 1	42
2 - 3	230 / Protected & NEMA 1 / 12	
(0.75 - 5.5)	380 / Compact NEMA 1	
(2.2 - 7.5)	380 / Protected & NEMA 1/12	
1 - 7.5	480 / Compact NEMA 1	
3 - 10	480 / Protected & NEMA 1/12	
2 - 15	600 / Protected	
3 - 15	230 / Compact NEMA 1	100
5 - 10	230 / Protected & NEMA 1 / 12	
(7.5 - 18.5)	380 / Compact NEMA 1	
(11 - 30)	380 / Protected & NEMA 1/12	
10 - 25	480 / Compact NEMA 1	
15 - 40	480 / Protected & NEMA 1/12	
20 - 60	600 / Protected	
20	230 / Compact NEMA 1	218
15 - 30	230 / Protected & NEMA 1 / 12	
(22)	380 / Compact NEMA 1	
30	480 / Compact NEMA 1	
(37 - 45)	380 / Protected & NEMA 1/12	
50 - 60	480 / Protected & NEMA 1/12	
75	600 / Protected	
40 - 75	230 / Chassis* & NEMA 1 / 12	383
(55 - 90)	380 / Chassis* & NEMA 1/12	
75 - 125	480 / Chassis* & NEMA 1/12	
(110 - 160)	380 / Chassis* & NEMA 1/12	765
150 - 200	480 / Chassis* & NEMA 1/12	
100 - 150	600 / Chassis*	
(200 - 250)	380 / Chassis* & NEMA 1/12	1148
250 - 300	480 / Chassis* & NEMA 1/12	
175 - 200	600 / Chassis*	
(315 - 400)	380 / Chassis & NEMA 1/12	1736
400 - 500	480 / Chassis & NEMA 1/12	
250 - 300	600 / Chassis*	
(500)	380 / Chassis	2296
600	480 / Chassis	
400	600 / Chassis	
(630 - 1000)	380 / Chassis	3473
700 - 1100	480 / Chassis	
500 - 800	600 / Chassis	

* Protected enclosure with optional cover.

Table 5.2-2 Required cooling air.

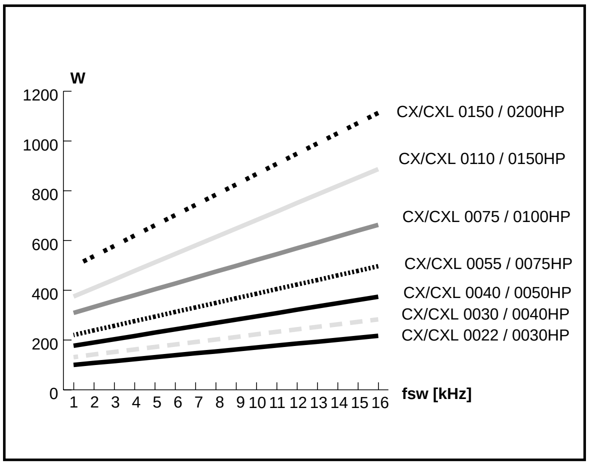


Figure 5.2-2a *2.2 - 15 kW, 3 - 20 hp*

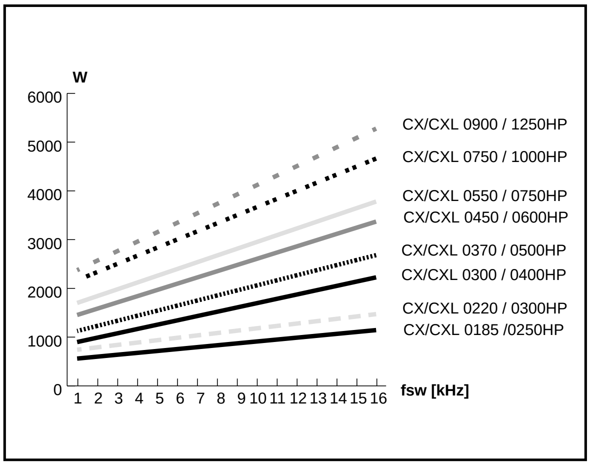


Figure 5.2-2b *18.5 - 90 kW, 25-125 HP*

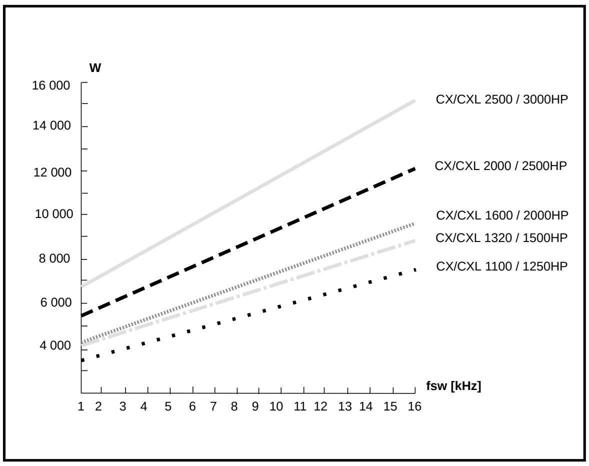


Figure 5.2-2c *110 - 250 kW, 150 - 300 HP*

Figures 5.2-2a—c Power dissipation as a function of the switching frequency for 400V (kW) and 500V (Hp) for standard enclosures (I_{VT},variable torque).

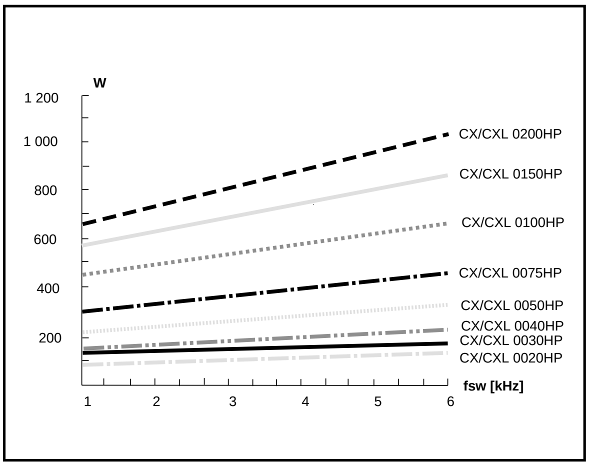


Figure 5.2-2d *2 - 20 HP*

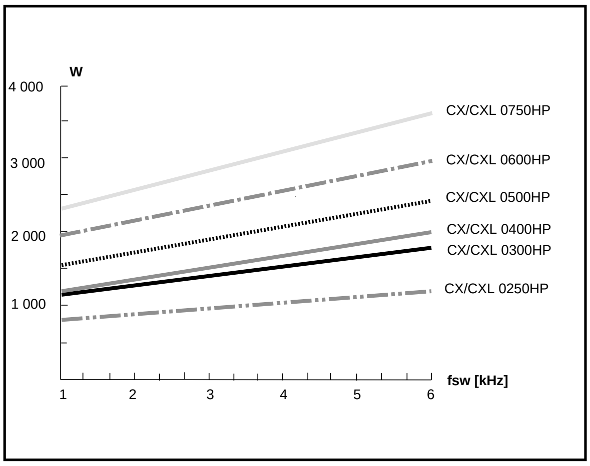


Figure 5.2-2e *25 - 75 HP*

Figures 5.2-2d—e: Power dissipation as a function of the switching frequency for 230V (Hp) for standard enclosures (I_{VT},variable torque).

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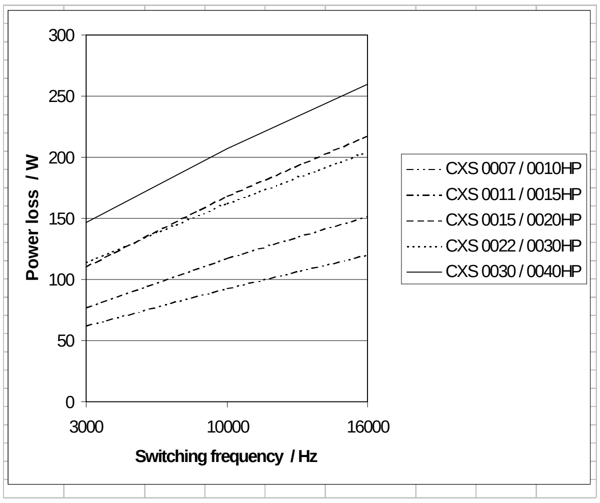


Figure 5.2-2f

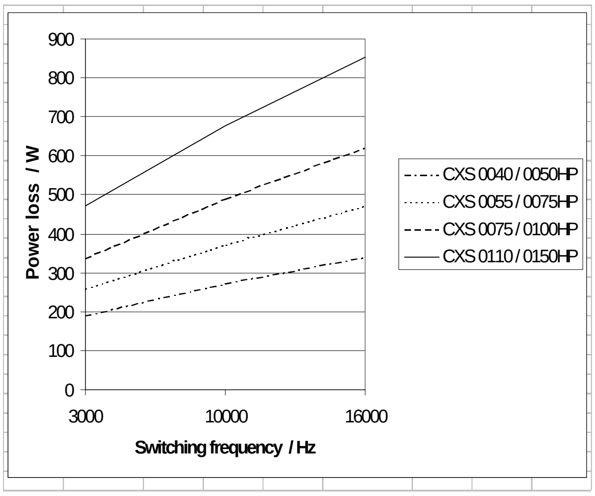


Figure 5.2-2g

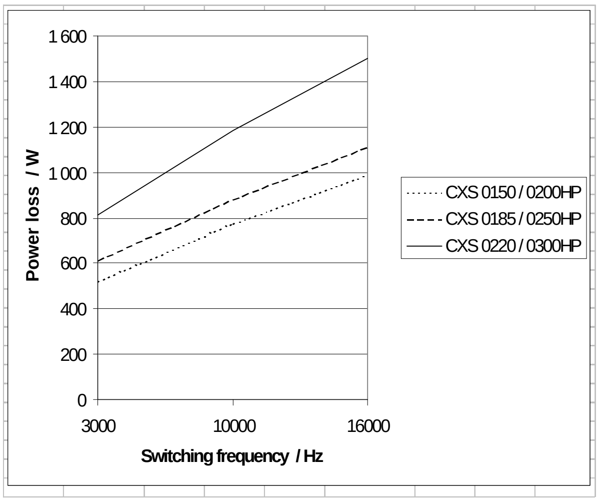


Figure 5.2-2h

Figures 5.2-2 f—h: Power dissipation as a function of the switching frequency for 400V and 500V (I_{VT}, variable torque), Compact Nema 1.

Type (HP)	Curve		
	3.6kHz	10kHz	16kHz
1-5	no derating	no derating	no derating
7.5	no derating	1	2
10	no derating	no derating	no derating
15	no derating	no derating	no derating
20	no derating	no derating	3
25	no derating	no derating	no derating
30	no derating	no derating	4
40	no derating	5	not allowed
50	no derating	6	not allowed
60	7	8	not allowed
75	no derating	9	not allowed
100	no derating	10	not allowed
125	11	12	not allowed
150	no derating	13	not allowed
175	no derating	14	not allowed
200	15	16	not allowed
250	no derating	17	not allowed
300	18	19	not allowed
400	*	*	*
500	*	*	*
600	*	*	*
700	*	*	*
800	*	*	*
900	*	*	*
1000	*	*	*
1100	*	*	*

Table 5.2-3 Constant output current derating curves for 400—500 V (I_{VT},variable torque).

* = Ask factory for details

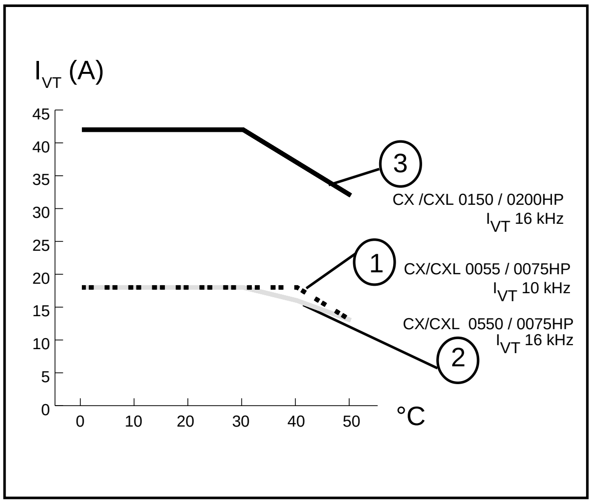


Figure 5.2.3 a

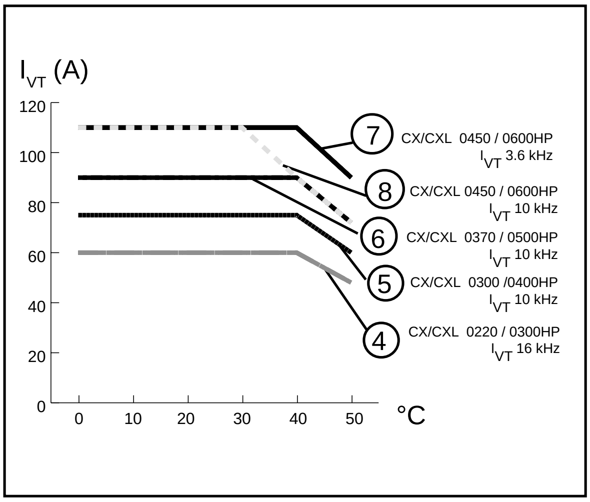


Figure 5.2.3 b

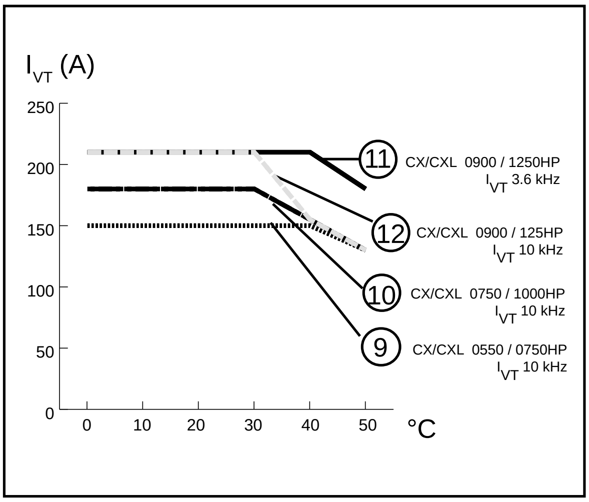


Figure 5.2.3 c

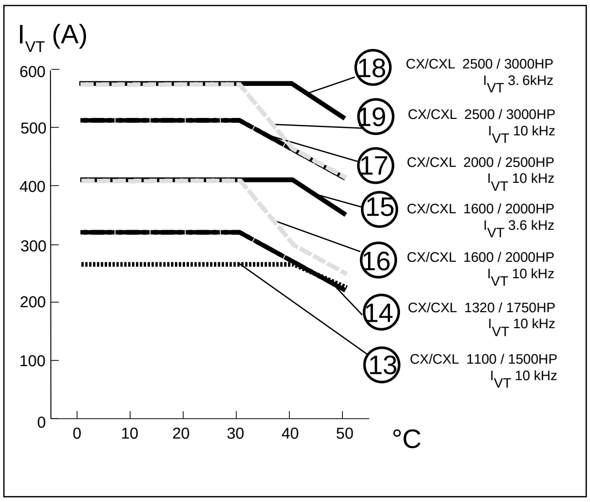


Figure 5.2-3 d

Figure 5.2-3a—d:Constant output current (I_{VT}) derating curves as a function of ambient temperature and switching frequency.

5

5

5.3 Mounting

The unit should be mounted in a vertical position on the wall or on the back plane of a cubicle. Follow the requirements for cooling, see table 5.2-1 and figure 5.2-1 for dimensions.

To ensure a safe installation, make sure that the mounting surface is relatively flat. Mounting holes can be marked on the wall using the template on the cover of the cardboard shipping package.

Mounting is done with four screws or bolts depending on the size of the unit, see tables 5.3-1 and 5.3-2, and figure 5.3-1 for dimensions. Units from 25 Hp to 500 Hp, have special lifting "eyes" which must be used, see figures 5.3-2 and 5.3-3.

The mounting instructions for units over 500 Hp are given in a separate manual. If further information is needed contact your Honeywell distributor.

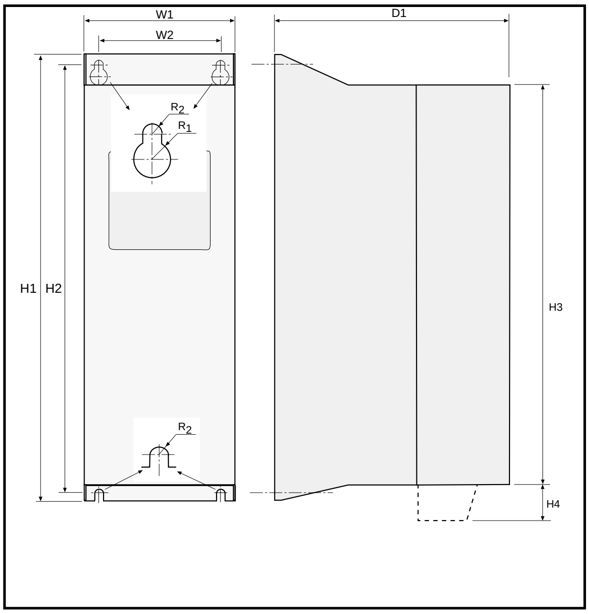


Figure 5.3-1 Mounting dimensions.

Frame	Enclosure	Voltage	Dimensions (inches)								
			W1	W2	H1	H2	H3	H4	D1	R1	R2
M3	Compact	230 / 380 / 480	4.7	3.7	13.5	13.1	12		5.9	0.28	0.14
M4B	NEMA 1	230 / 380 / 480	5.3	3.7	17	16.5	15.4		8.1	0.28	0.14
M5B	(CXS)	230 / 380 / 480	7.3	5.5	23.4	22.8	21.7		8.5	0.35	0.18
M4		230 / 380 / 480	4.7	3.7	16.7	16.2	15.4		8.5	0.28	0.14
M5		230 / 380 / 480	6.2	5	22.1	21.5	20.3		9.4	0.35	0.18
M6		230 / 380 / 480	8.7	7.1	27.6	26.9	25.6		11.4	0.35	0.18
M7	NEMA 1 / 12	230 / 380 / 480	14.7	13.6	41.3	40.6	39.4		13	0.35	0.18
M8	(CXL)	230 / 380 / 480	19.5	18	53.1	36.5	50.8		13.9	0.45	0.24
M9		380 / 480	27.6	26	57.9	40.2	56.1		15.4	0.45	0.24
M10		380 / 480	CONTACT FACTORY								
M4		230 / 380 / 480	4.7	3.7	12.7	12.3	11.4	1.6	8.5	0.28	0.14
M5		230 / 380 / 480	6.2	5	17.8	17.1	15.9	1.8	9.4	0.35	0.18
M5		600	6.2	5	19.1	18.5	17.3	1.8	10.4	0.35	0.18
M6		230 / 380 / 480	8.7	7.1	22.6	22	20.7	3.9	11.4	0.35	0.18
M6	Chassis /	600	8.7	7.1	26.3	25.6	24.3	3.9	11.4	0.35	0.18
M7	Protected	230 / 380 / 480	9.8	8.7	33.6	32.9	31.5		12.4	0.35	0.18
M8	(CX)	230 / 380 / 480 / 600	19.5	18	37.4	36.5	35		13.9	0.45	0.24
M9		380 / 480 / 600	27.6	26	41.1	40.2	39.4		15.4	0.45	0.24
M10		380 / 480 / 600	38.9	37.3	41.1	40.2	39.4		15.4	0.45	0.24
M11		380 / 480 / 600	CONTACT FACTORY								
M12		380 / 480 / 600									

Table 5.3-1 Dimensions for open chassis units.

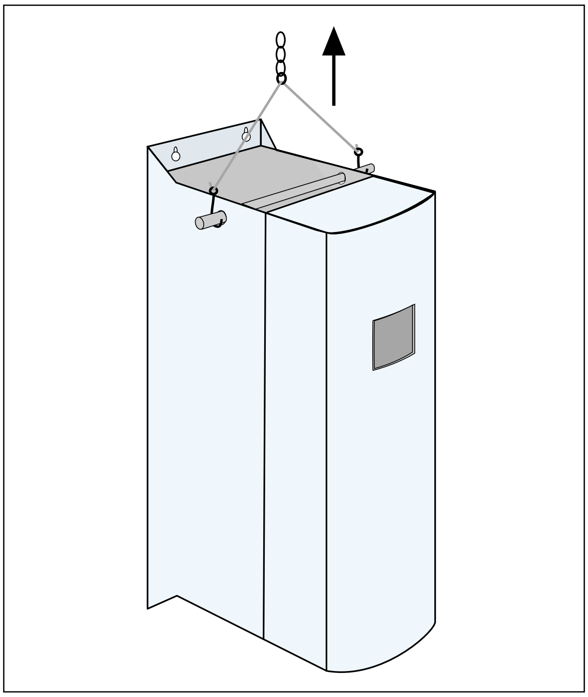
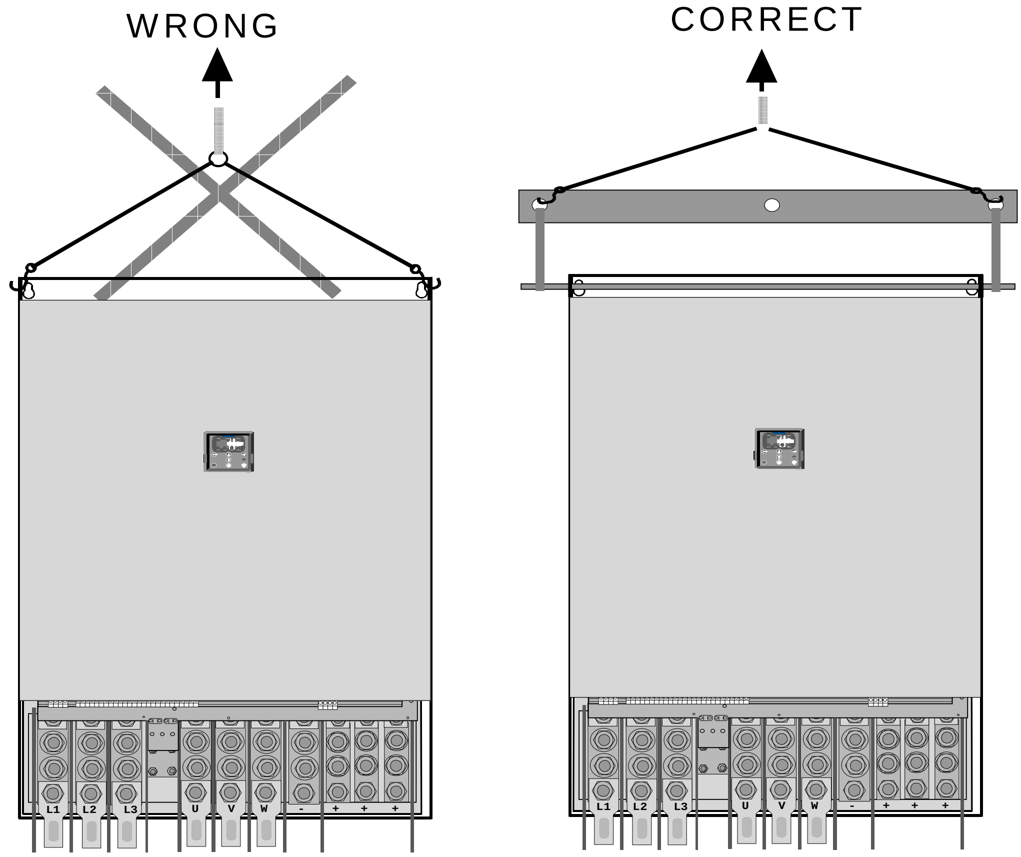


Figure 5.3-2 Lifting of 25—125 Hp units.



NOTE!
Unit sizes 150   500 Hp - do not lift without a rod through the lifting holes in the unit - see above.

M9NOSTO

6 WIRING

General wiring diagrams are shown in figures 6-1—6-3. The following chapters have more detailed instructions about wiring and cable connections.

The general wiring diagrams for M11 and M12 frame sizes are provided in a separate manual. If further information is required, contact your Honeywell distributor.

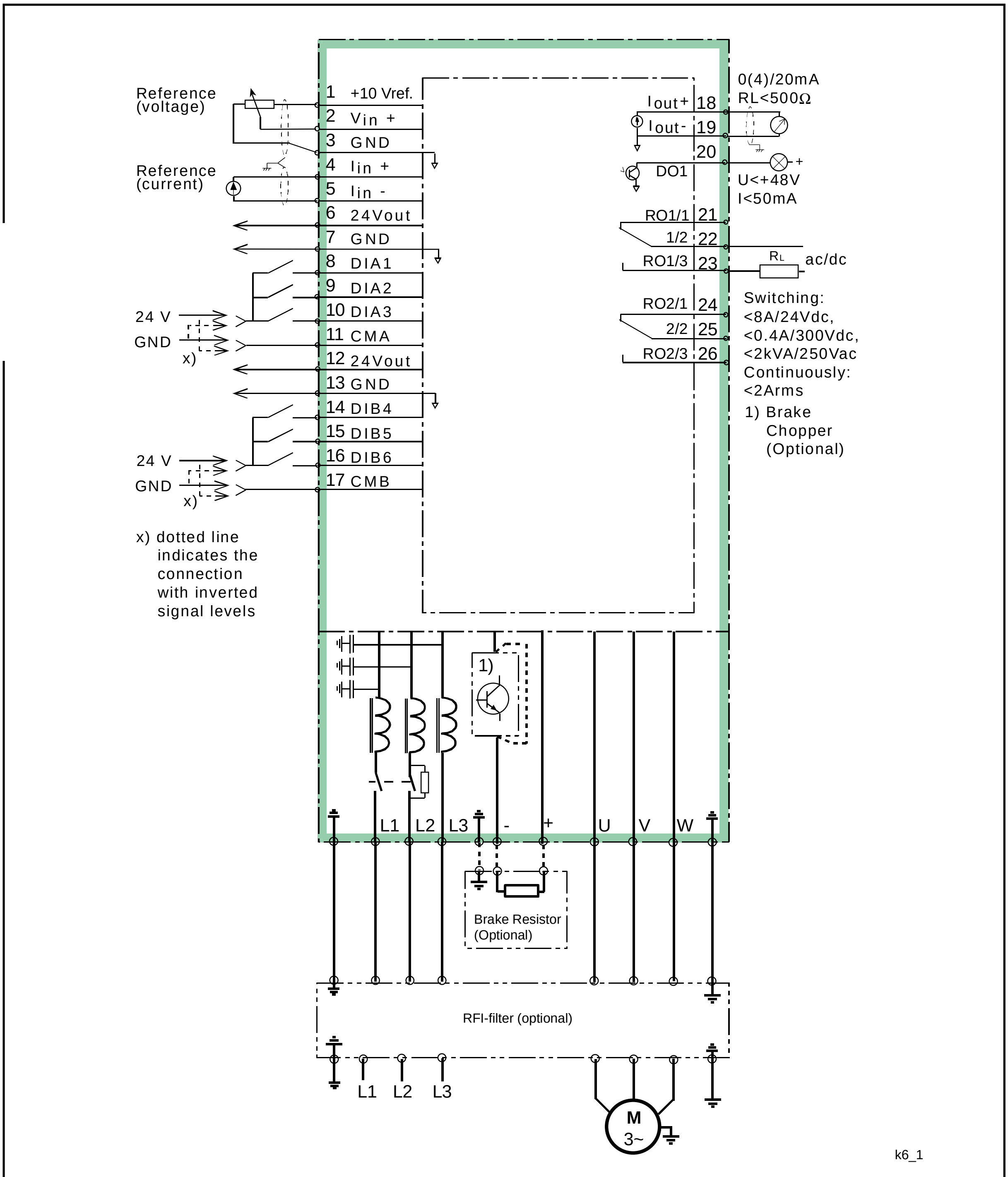


Figure 6-1 General wiring diagram, open/protected chassis units frame sizes M4—M6.

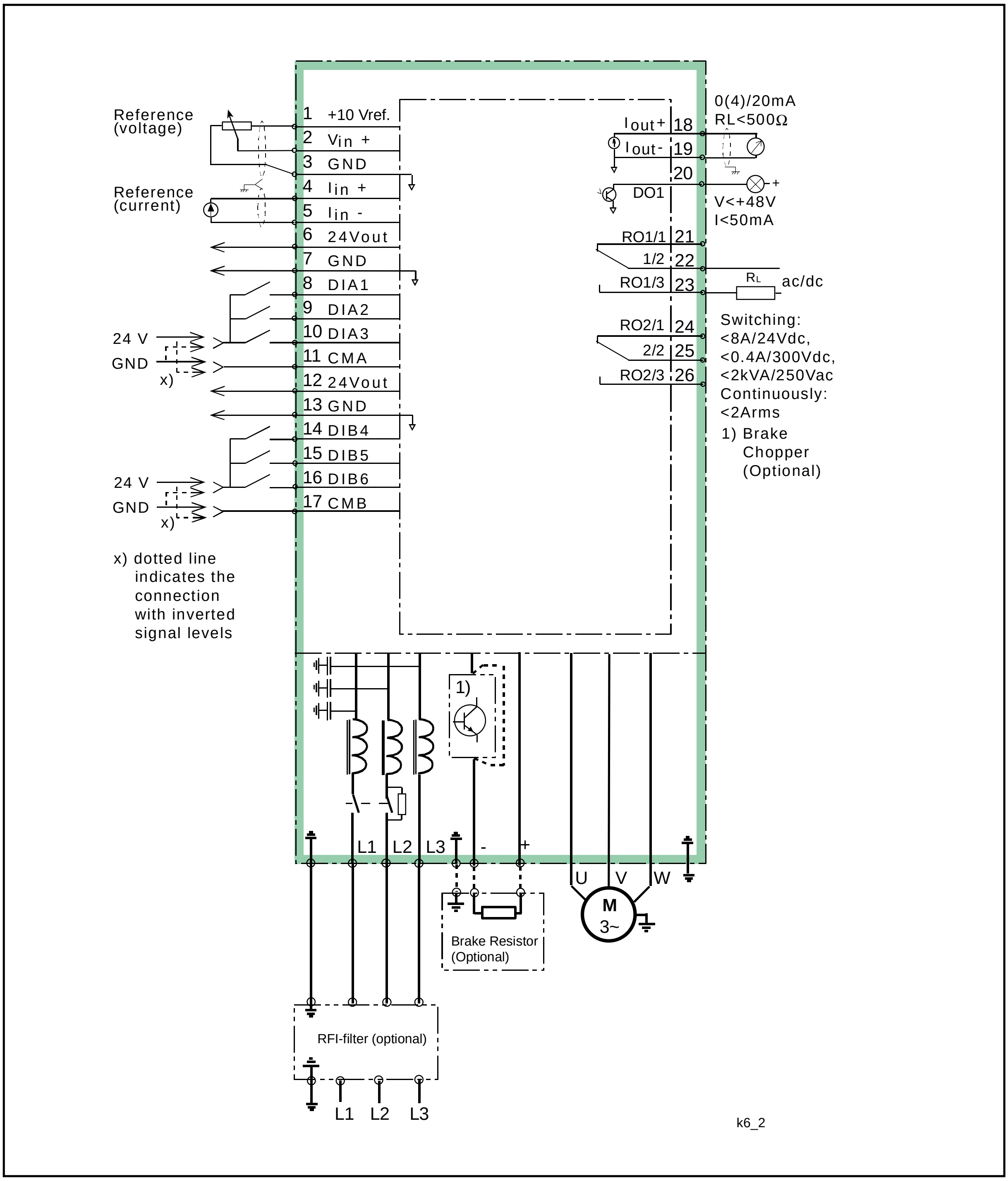


Figure 6-2 General wiring diagram, open/protected chassis frame size M7 and NEMA 1/12 units frame size > M8.

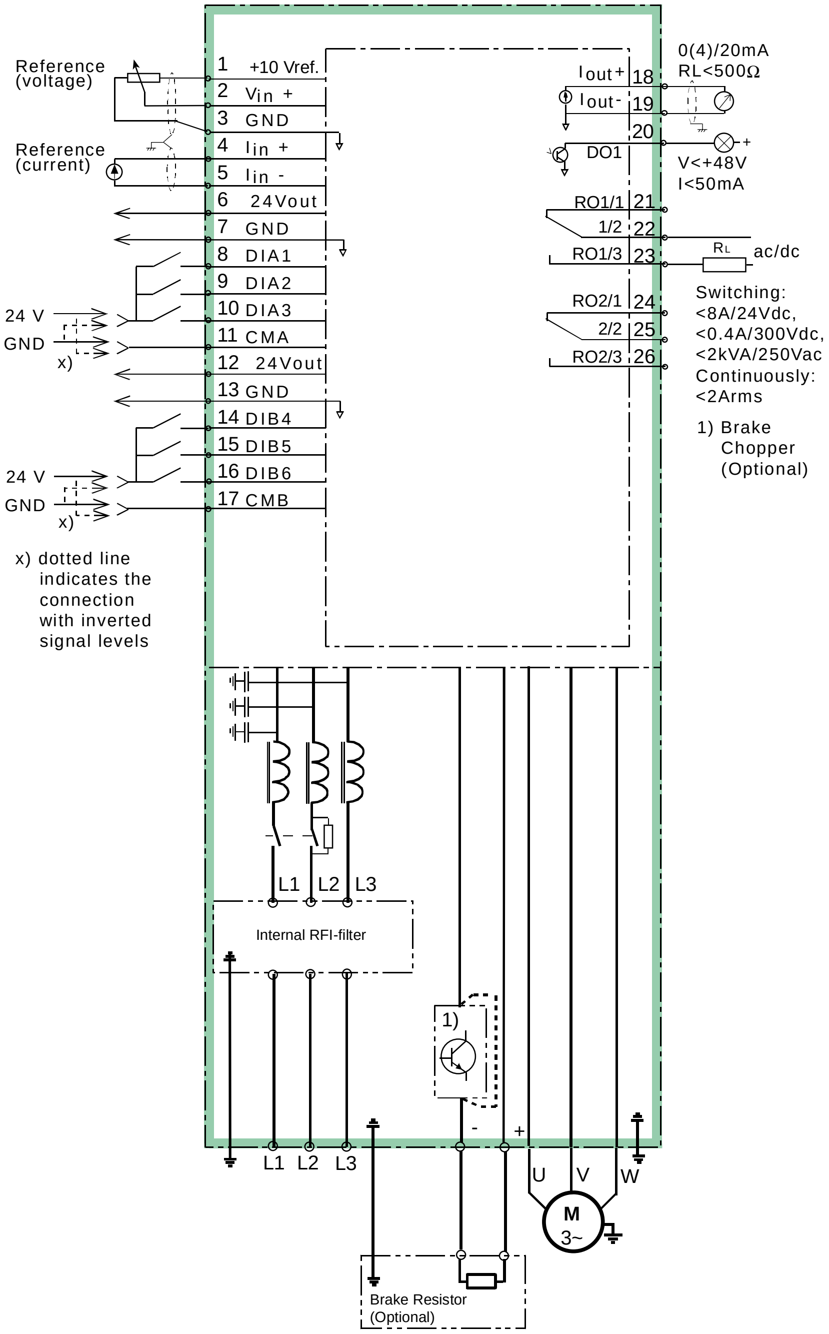


Figure 6-3 General wiring diagram, NEMA 1/12 units frame sizes M4 to M7 and compact NEMA 1 units.

6.1 Power connections

Use cables with a heat-resistance of +140°F (+60°C) or higher. The cable (and the fuses) have to be sized in accordance with the rated output current of the unit. Installation of the cable consistent with the UL Instructions is explained in chapter 6.1.4.1.

The minimum dimensions for the Cu-cables and corresponding fuses are given in the tables 6.1-2 — 6.1-5. The fuses have been selected so that they will also function as overload protection for the cables.

Consistent with the UL requirements, for maximum protection of the CX/CXL/CXS, UL recognized fuses type RK should be used.

If the motor temperature protection (I^2t) is used as overload protection the cables may be selected according to that. If 3 or more cables are used in parallel, on larger units, every cable must have its own overload protection.

These instructions cover the cases where one motor is connected with one cable to the drive.

Always pay attention to the local authority regulations and installation conditions.

6.1.1 Utility cable

Utility cables for the different EU EMC levels are defined in the table 6.1-1.

6.1.2 Motor cable

Motor cables for the different EU EMC levels are defined in the table 6.1-1.

6.1.3 Control cable

Control cables are specified in chapter 6.2.1.

Cable	level N	level I
Utility cable	1	1
Motor cable	2	2
Control cable	3	3

Table 6.1-1 Cable types for the different EMC levels.

1 = The power cable which is suitable for the installation, ampacity and voltage. Shielded cable is not required.

2 = The power cable contains a concentric protection wire, and is suitable for the ampacity and voltage.

3 = The control cable is a compact low-impedance shielded cable.

480V Hp	Ict	Fuse	Cu-cable LINE & MOTOR (Ground)	Ivt	Fuse	Cu-cable LINE & MOTOR (Ground)
1	2.5	10	16 (16)	3	10	16 (16)
1.5	3			3.5		
2	3.5			5		
3	5					
				8		
5	8			11	15	14 (14)
7.5	11	15	14 (14)	15	20	12 (12)
10	15	20	12 (12)	21	25	10 (10)
15	21	25	10 (10)	27	35	8 (8)
20	27	35	8 (8)	32	50	
25	34	50		40	50	
30	40	50		52	60	6 (6)
40	52	60	6 (6)	65	80	4 (6)
50	65	80	4 (6)	77	100	2 (6)
60	77	100	2 (6)	96	125	0 (4)
75	96	125	0 (4)	125	150	00 (2)
100	125	150	00 (2)	160	200	000 (0)
125	160	200	000 (0)	180	200	
150	180	200		260	300	350MCM (000)
200	260	300	350MCM (000)	320	400	2x [250MCM (00)]
250	320	400	2x [250MCM (00)]	400	500	2x [350MCM (000)]
300	400	500	2x [350MCM (000)]	460	600	2x [550MCM (250MCM)]
400	480			600		
500 - 1100	CONTACT FACTORY					

Table 6.1-2 Utility, motor cables and fuse recommendations according to output currents I_{CT} and I_{VT}, 500V range.

380V KW	Ict	Fuse	Cu-cable LINE & MOTOR (Ground)	Ivt	Fuse	Cu-cable LINE & MOTOR (Ground)
0.75	2.5	10	16 (16)	3.5	10	16 (16)
1.1	3.5			4.5		
1.5	4.5			6.5		
2.2	6.5			8		
3	8			10		
4	10			13	15	14 (14)
5.5	13	15	14 (14)	18	20	12 (12)
7.5	18	20	12 (12)	24	25	10 (10)
11	24	25	10 (10)	32	35	8 (8)
15	32	35	8 (8)	42	50	
18.5	42	50		48		
22	48			60	60	6 (6)
30	60	60	6 (6)	75	80	4 (6)
37	75	80	4 (6)	90	100	2 (6)
45	90	100	2 (6)	110	125	0 (4)
55	110	125	0 (4)	150	150	00 (2)
75	150	150	00 (2)	180	200	000 (0)
90	180	200	000 (0)	210	250	300MCM (00)
110	210	250	300MCM (00)	270	300	350MCM (000)
132	270	300	350MCM (000)	325	400	2x [250MCM (00)]
160	325	400	2x [250MCM (00)]	410	500	2x [350MCM (000)]
200	410	500	2x [350MCM (000)]	510	600	2x [500MCM (250 MCM)]
250	510	600	2x [500MCM (250 MCM)]	580	600	2x [500MCM (250 MCM)]
315 - 1000	CONTACT FACTORY					

Table 6.1-3 Utility, motor cables and fuse recommendations according to output currents I_{CT} and I_{VT}, 400V range

600V Hp	Ict	Fuse	Cu-cable LINE&MOTOR (Ground)	Ivt	Fuse	Cu-cable LINE&MOTOR (Ground)
7.5	10	10	16(16)	14	15	14(14)
10	14	15	14(14)	19	20	12(12)
15	19	20	12(12)	23	25	10(10)
20	23	25	10(10)	26	35	8(8)
25	26	35	8(8)	35	35	
30	35	35		42	50	
40	42	50		52	60	6(6)
50	52	60	6(6)	62	60	
60	62	60		85	100	2(6)
75	85	100	2(6)	100	100	
100	100	100		122	125	0(4)
125	122	125	0(4)	145	100	00(2)
150	145	150	00(2)			
175				222	250	300MCM(00)
200	222	250	300MCM(00)	287	300	350MCM(000)
250-800	CONTACT FACTORY					

Table 6.1-4 Utility, motor cables and fuse recommendations according to output currents I_{CT} and I_{VT}, 600V range.

230V Hp	Ict	Fuse	Cu-cable LINE& MOTOR	Ivt	Fuse	Cu-cable LINE&MOTOR (Ground)
0.75	3.6	10	16(16)	4.7	10	16(16)
1	4.7			5.6		
1.5	5.6			7		
2	7			10		
3	10			13	15	14(14)
		15	14(14)	16		
5	16			22	25	10(10)
7.5	22	25	10(10)	30	35	8(8)
10	30	35	8(8)	43	50	
15	43	50		57	60	6(6)
20	57	60	6(6)	70	80	4(6)
25	70	80	4(6)	83	100	2(6)
30	83	100	2(6)	113	125	0(4)
40	113	125	0(4)	139	150	00(2)
50	139	150	00(2)	165	200	000(0)
60	165	200	000(0)	200	200	
75	200	200		264	300	350MCM(000)

Table 6.1-5 Utility, motor cables and fuse recommendations according to output currents I_{CT} and I_{VT}, 230V range.

6

Frame	Hp (KW)	Voltage	CABLE (AWG / MCM) Main	Ground
M3	All	230 / 380 / 480	14	14
M4	All	230 / 380 / 480	10	10
M4B	All	230 / 380 / 480	6	6
M5	All	230 / 380 / 480 / 600		
M5B	10 - 20	230	2	00
	(15 - 22)	380		
	20 - 30	480		
M6	15 - 30	230		
	(18.5 - 22)	380		
	25 - 30	480		
	30 - 50	600		
	(30 - 45)	380	0 Cu, 00 Al	00
	40 - 60	480		
	60 - 75	600		
M7	40 - 75	230		
	(55 - 90)	380	350 MCM	000
	100 - 150	480		
M8	(110 - 160)	380	2x350 MCM Cu 2x500 MCM Al	2x500 MCM
	150 - 200	480		
	100 - 150	600		
M9	(200 - 250)	380	2x600 MCM	2x500 MCM
	250 - 300	480		
	200	600		
M10	(315 - 400)	380	4x500 MCM *	2x500 MCM
	400 - 500	480		
	250 - 300	600		
M11	(500)	380	CONTACT FACTORY	
	600	480		
	400	600		
M12	(630 - 1000)	380		
	700 - 1100	480		
	500 - 800	600		
* NEMA 1 / 12 maximum 3 parallel connected cables can be used				

Table 6.1-6 Maximum cable sizes of the power terminals.

6.1.4 Installation instructions

6

1

If an CX open chassis unit is to be installed outside a control cabinet or a separate cubicle a protective IP20 cover should be installed to cover the cable connections, see figure 6.1.4-3. The protective cover may not be needed if the unit is mounted inside a control cabinet or a separate cubicle.

All open chassis CX units should always be mounted inside a control cabinet, or a separate cubicle.

2

Locate the motor cable away from the other cables:

- Avoid long parallel runs with other cables.
- If the motor cable runs in parallel with the other cables, the minimum distances given in table 6.1.4-3 between the motor cable and control cables should be followed.
- These minimum distances apply also between the motor cable and signal cables of other systems.
- **The maximum length of a motor cable can be 600ft (180 m) (except for ratings 1.5 Hp and below max. length is 160 ft (50 m) and 2 Hp max. length 330 ft (100 m).** The power cables should cross other cables at an angle of 90 degrees. An output dv/dt filter option is required for motor cable lengths exceeding 33ft (10m) for drives 2 Hp and below and 100ft (33m) for drives 3Hp and larger

Distance between cables ft (m)	Motor cable length ft (m)
1 (0.3)	≤165 (50)
3.3 (1)	≤600 (180)

Table 6.1.4-3 Minimum cable distances.

3

See chapter 6.1.5 for cable insulation checks.

4

Connecting cables:

- Motor and utility cables should be stripped according to the figure 6.1.4-2 and table 6.1.4-2.
- Open the cover of the CX/CXL according to figure 6.1.4-3.
- Remove sufficient plugs from the cable cover (open chassis) cable cover or from the bottom of the NEMA 1/12 units.
- Pass cables through the holes in the cable cover.
- Connect the utility, motor and control cables to the correct terminals See figures 6.1.4-3—16. CX + external RFI-filter: (See RFI-filter option manual). The installation instructions for M11 and M12 frames are explained in the separate manual for M11/M12 units. Contact your Honeywell distributor for more information. Cable installation consitent with UL-instructions is explained in chapter 6.1.4.1.
- Check that control cable wires do not make contact with electrical components in the device.
- Connect optional brake resistor cable (if required).
- Ensure that the ground cable is connected to the ⏚-terminal of the frequency converter and motor.
- For open panel units, 150—500 Hp, connect the isolator plates of the protective cover and terminals according to figure 6.1.4-11.

- If a shielded power cable is used, connect its shield to the ground terminals of the drive, motor and supply panel.
- Mount the cable cover (open chassis units) and the unit cover.
- Ensure that the control cables and internal wiring are not trapped between the cover and the body of the unit.

5

NOTE:

The connection of the transformer inside the unit in frame sizes M7—M12 has to be changed if other than the default supply voltage of the drive is used. Contact your Honeywell distributor if more information is needed.

Voltage Code	Default Supply Voltage
2	230V
4	380V
5	480V
6	600V

6.1.4.1 Cable selection and installation for the UL listing

For the installation and cable connections the following must be noted. Use only with copper wire temperature rating of at least 140/ 167°F.

Units are suitable for use on a circuit capable of delivering not more than the fault RMS symmetrical amperes mentioned in the table 6.1.4.1-1, 480V maximum.

In addition to the connecting information the tightening torques of the terminals are defined in the table 6.1.4.1-2.

FRAME	Voltage	Maximum RMS symmetrical amperes on connecting circuitry
M4 / M5	380 / 480	5 000
M6 / M7		10 000
M8 / M9		18 000

Table 6.1.4.1-1 Maximum symmetrical supply current.

FRAME	Hp (KW)	Voltage	Tightening torque (in-lbs)
M4	All	380 / 480	7
M5	All		20
M6	(18.5 - 22)	380	35
M6	25 - 30	480	35
M6	(30 - 45)	380	44
M6	40 - 60	480	44
M7	All	380 / 480	130
M8	All		610*
M9	All		610*

* The isolated standoff of the busbar does not withstand the listed tightening torque. Use a wrench to apply counter torque when tightening.

Table 6.1.4.1-2 Tightening torque.

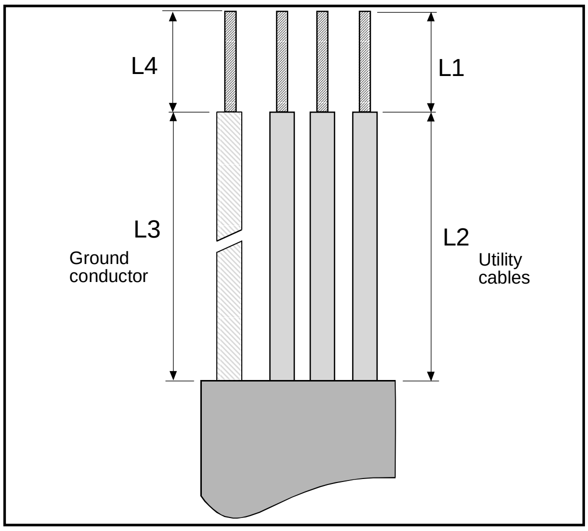


Figure 6.1.4-1 Stripping motor and utility cables.

Frame	Hp (KW)	Voltage	Stripping Lengths (in			
			s1	s2	s3	s4
M3	All	230 / 380 / 480	0.47	2.2	2.2	0.47
M4	All	230 / 380 / 480	0.24	1.4	2.4	0.6
M4B	All	230 / 380 / 480	0.35	1.6	4	0.6
M5	All	230 / 380 / 480 / 600				
M5B	10 - 20	230	0.6	1.6	4	0.6
	(15 - 22)	380				
	20 - 30	480				
M6	15 - 30	230				
	(18.5 - 22)	380				
	25 - 30	480				
	30 - 50	600				
	(30 - 45)	380	1	1.6	4	0.6
	40 - 60	480				
	60 - 75	600				
M7	40 - 75	230	2			1
	(55 - 90)	380				
	100 - 150	480				
M8	(110 - 160)	380	CONTACT FACTORY			
	150 - 200	480				
	100 - 150	600				
M9	(200 - 250)	380				
	250 - 300	480				
	200	600				
M10	(315 - 400)	380				
	400 - 500	480				
	250 - 300	600				
M11	(500)	380				
	600	480				
	400	600				
M12	(630 - 1000)	380				
	700 - 1100	480				
	500 - 800	600				
* NEMA 1 / 12 maximum 3 parallel connected cables can be used						

Table 6.1.4-2 Stripping lengths of the cables (in).
*Compact NEMA 1 * Contact factory*

① Loosen screws (2 pcs)
② Pull cover bottom outwards
③ Push cover upwards

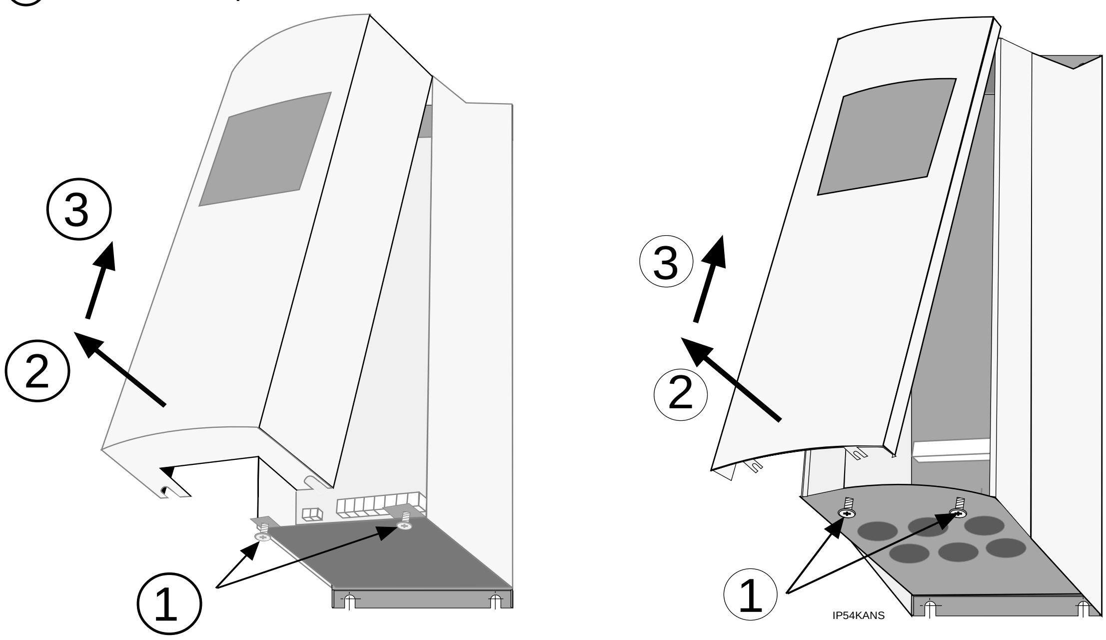


Figure 6.1.4-2 Opening the cover of the CX/CXL.

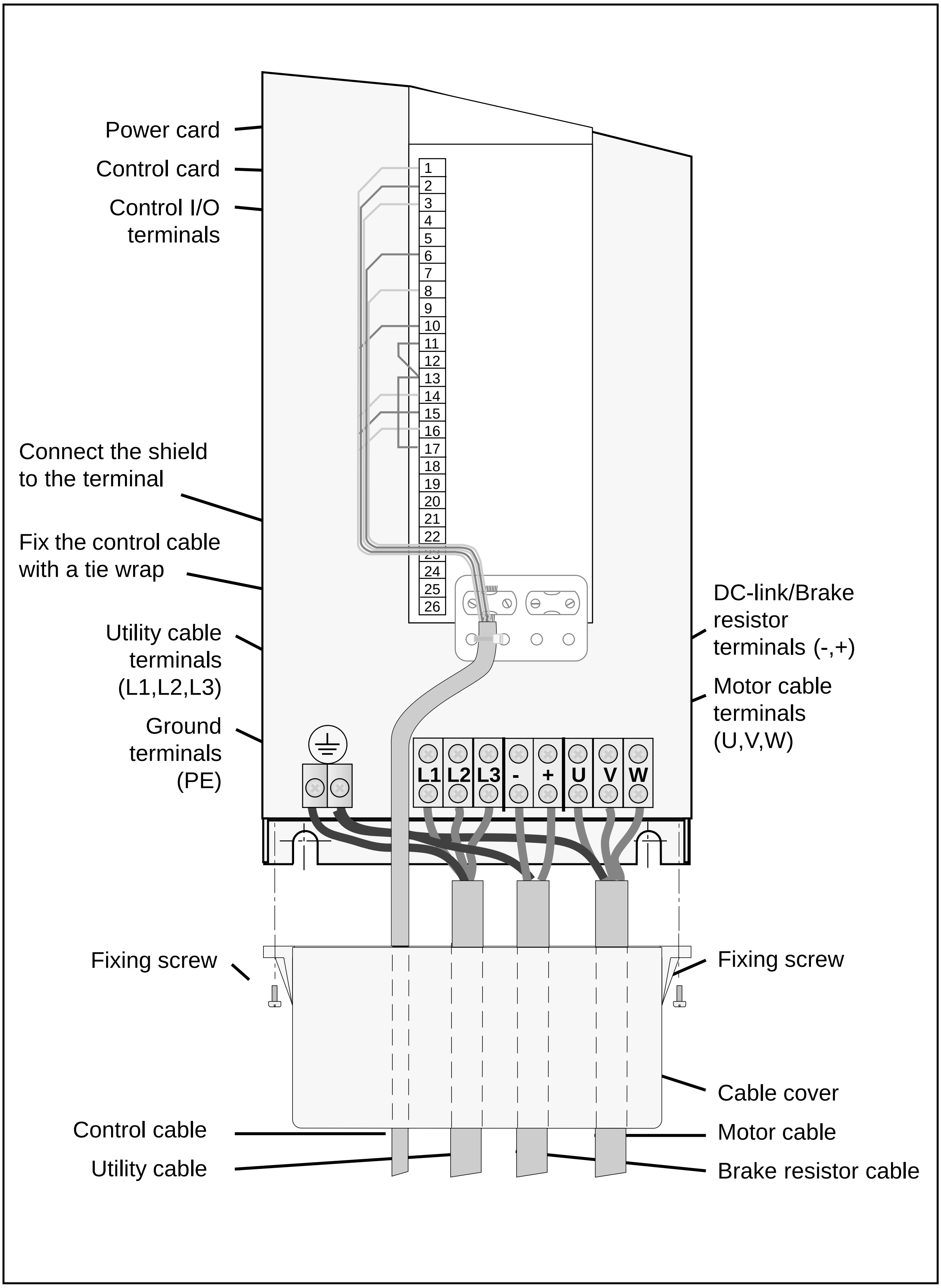


Figure 6.1.4-3 Cable assembly for open chassis: CX 0030-0200HP V 3 4/5 and CX 0020-0100HP V 3 2.

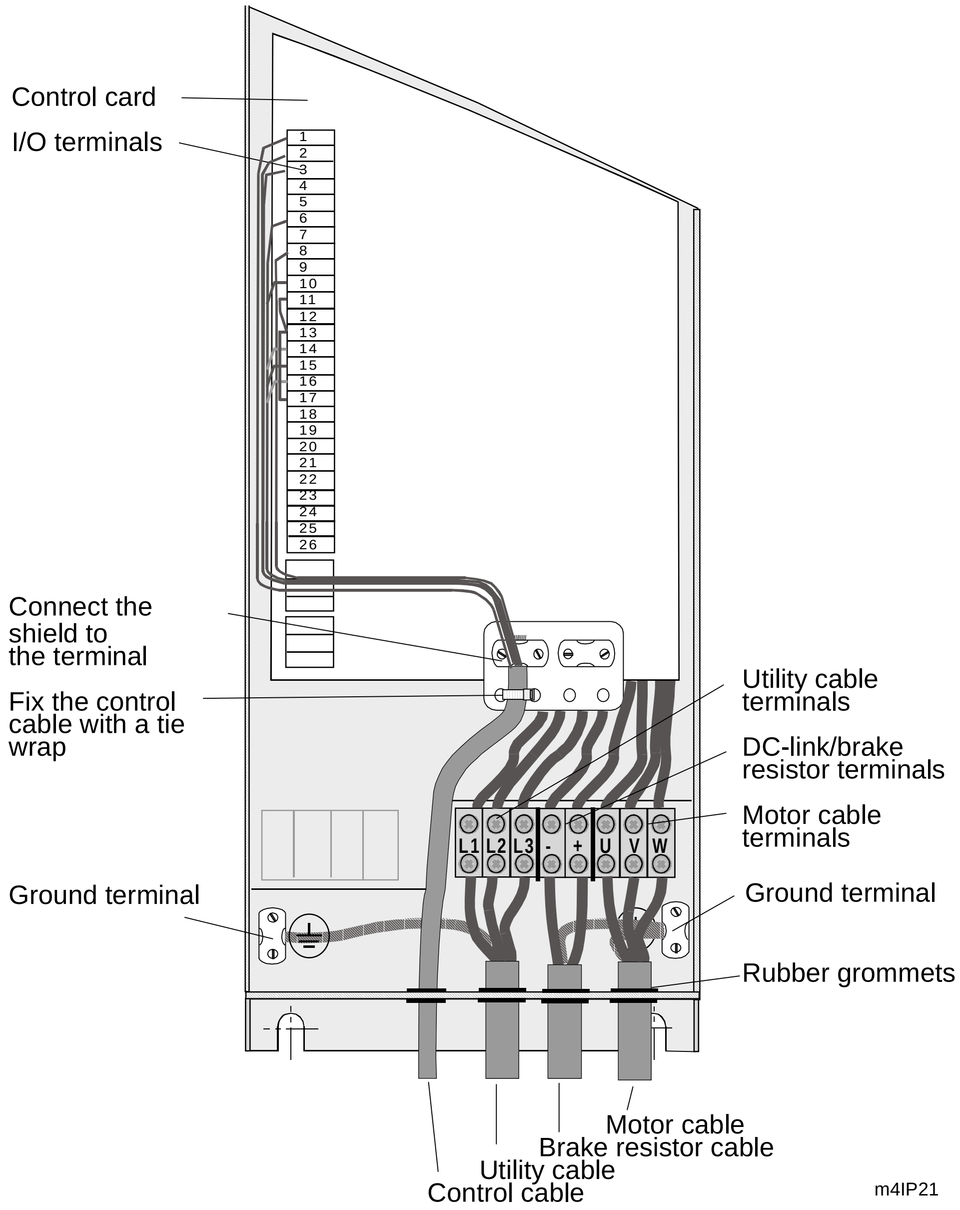


Figure 6.1.4-4 Cable assembly for NEMA 1: CXL 0030-0075HP V 3 4/5 and CXL 0020-0040HP V 3 2.

6

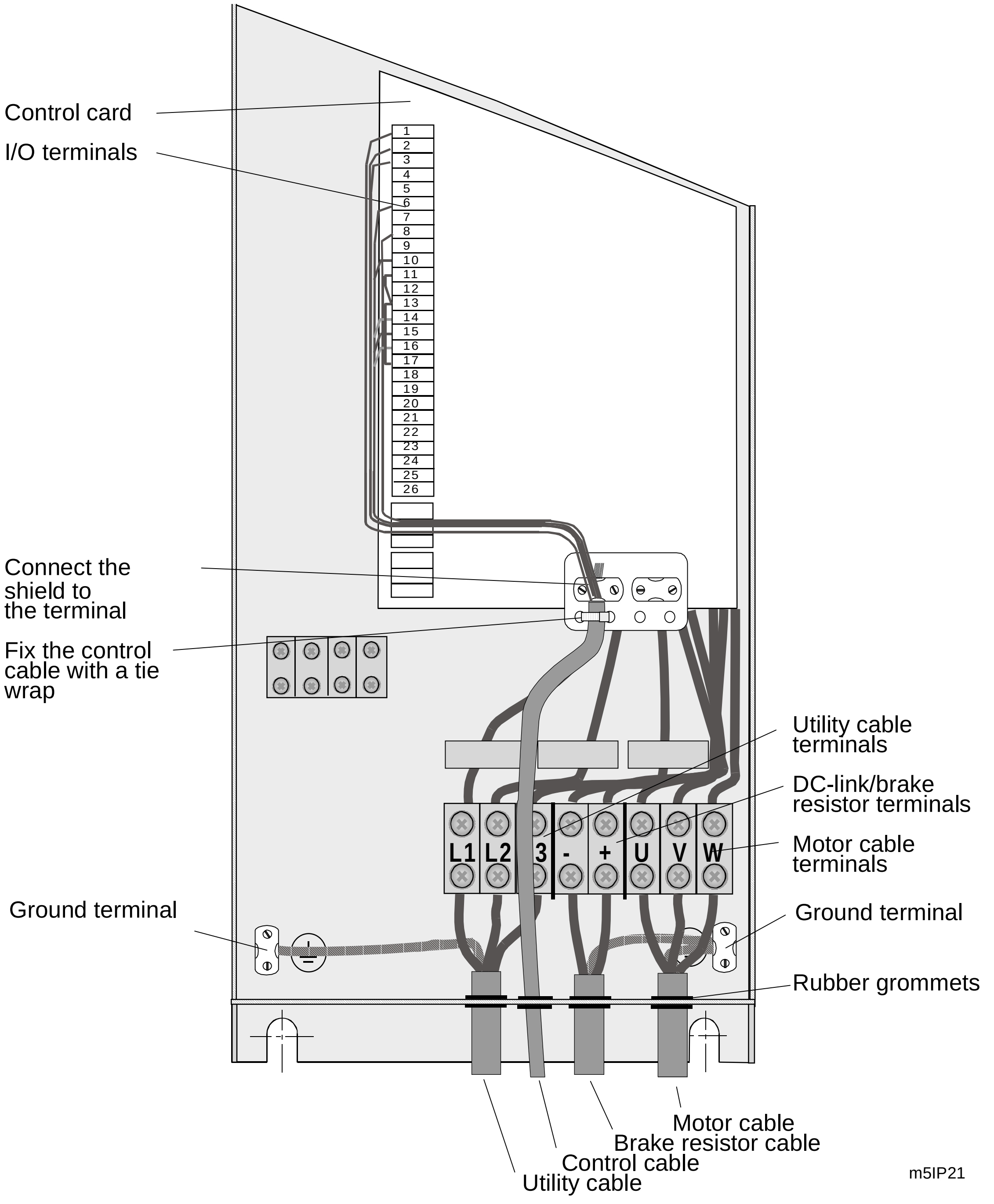


Figure 6.1.4-5 Cable assembly for NEMA 1: CXL 0100-0200HP V 3 4/5 and CXL 0050-0100HP V 3 2.

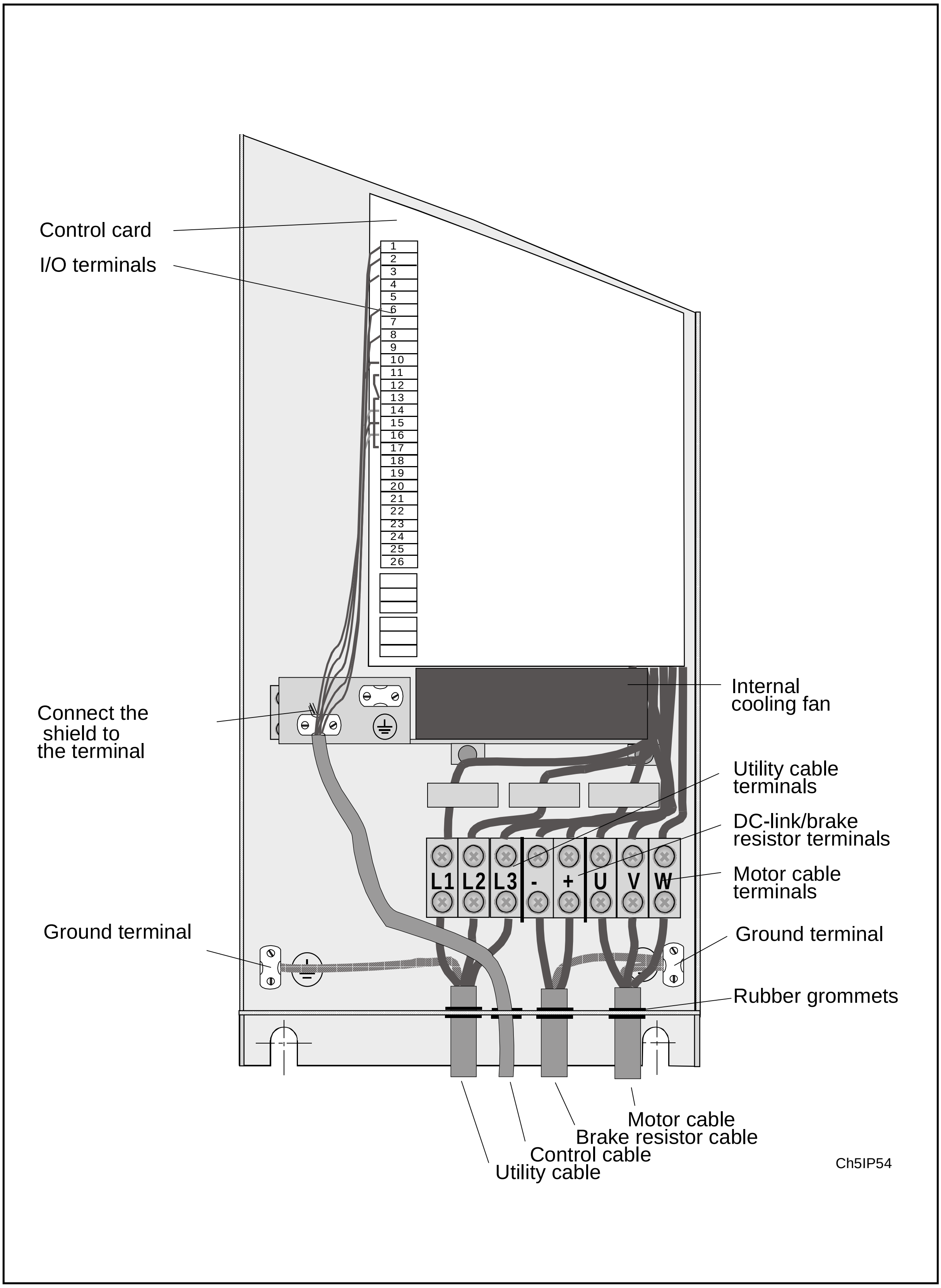


Figure 6.1.4-6 Cable assembly for NEMA 12: CXL 0100-0200HP V 3 4/5 and CXL 0050-0100HP V 3 2.

6

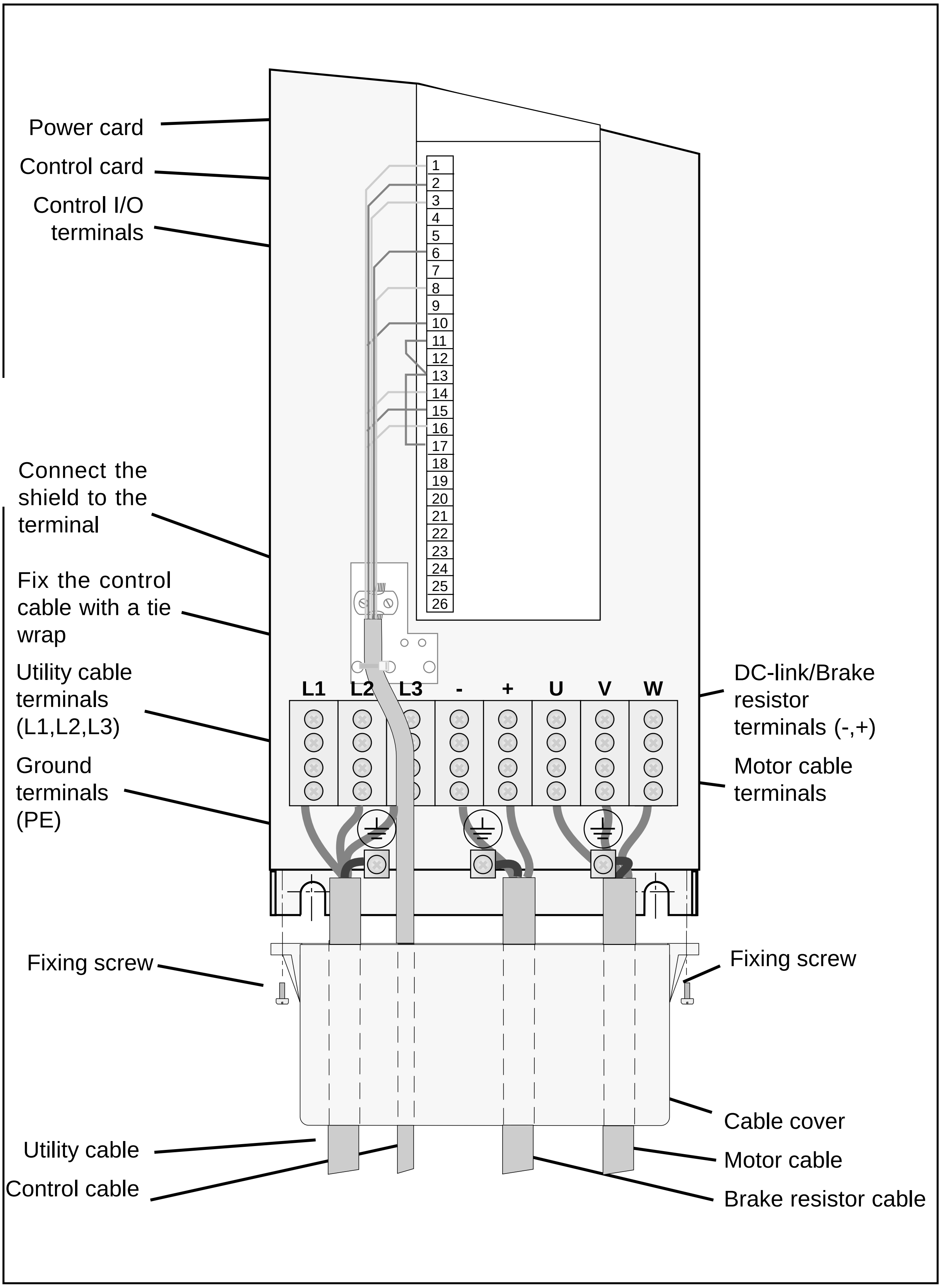


Figure 6.1.4-7 Cable assembly for open chassis: CX 0250-0600HP V 3 4/5 and CX 0150-0300HP V 3 2.

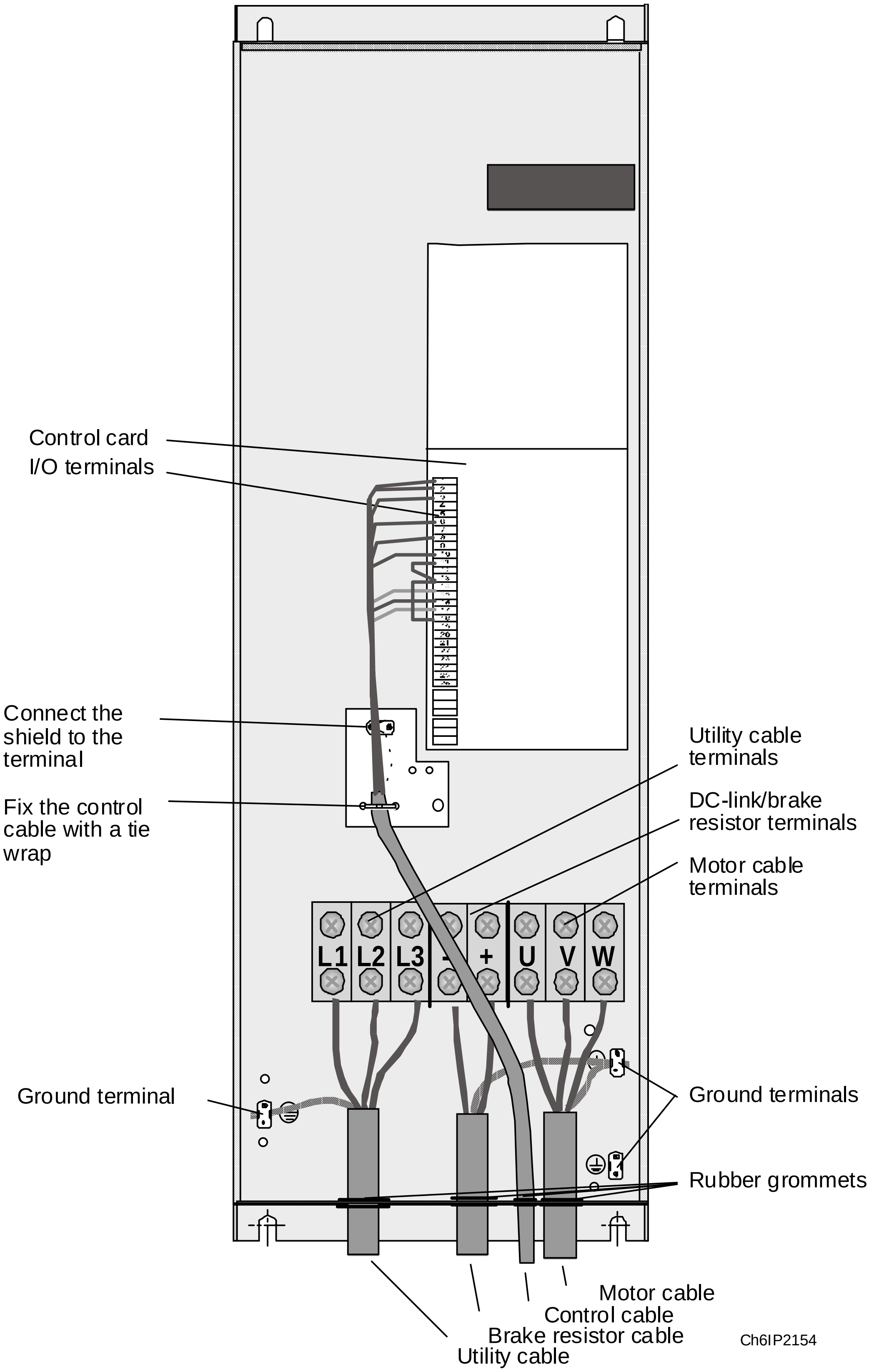


Figure 6.1.4-8 Cable assembly for NEMA 1: CXL 0250-0600HP V 3 4/5 and CXL 0150-0300HP V 3 2.

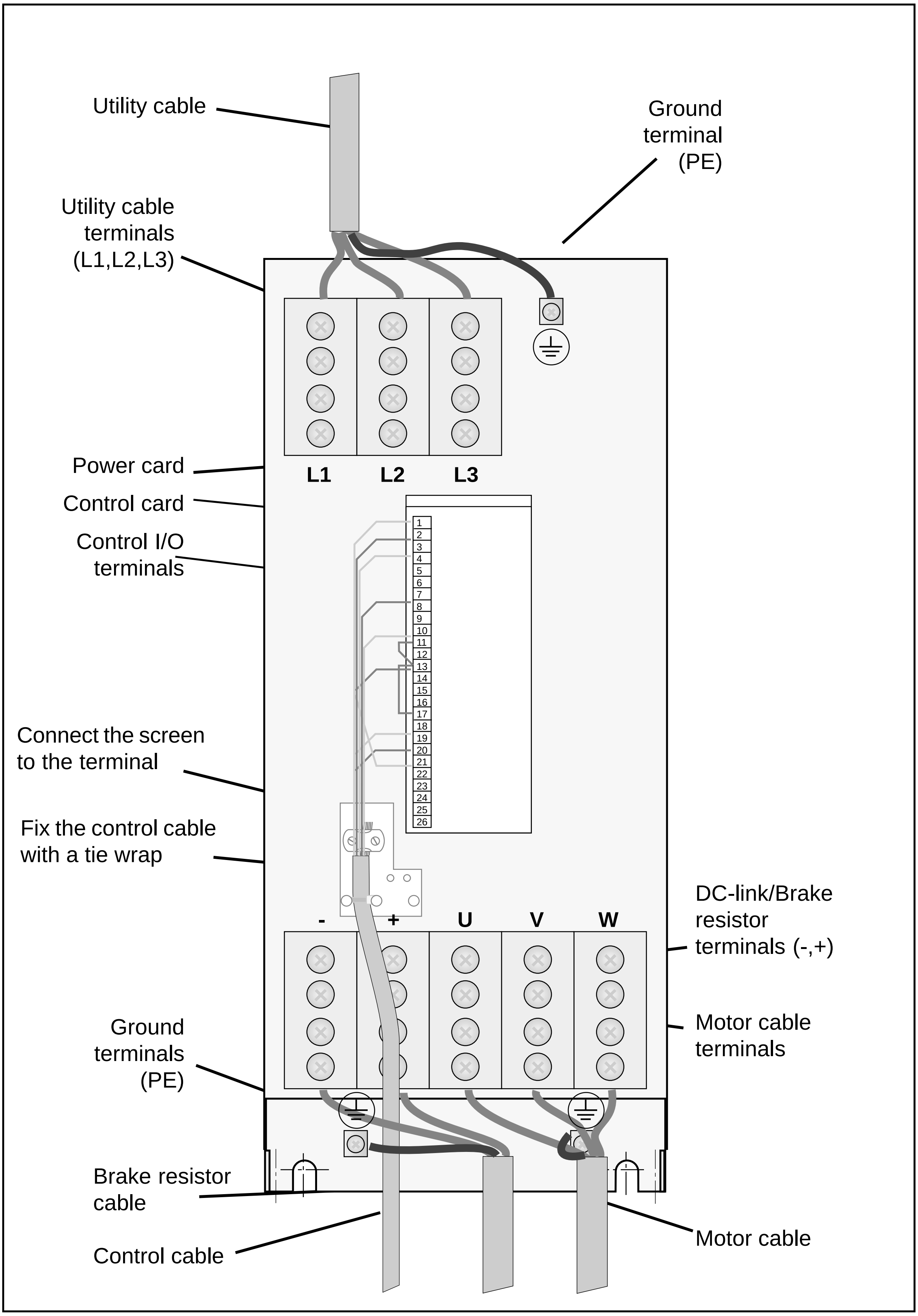


Figure 6.1.4-9 Cable assembly for open chassis: CX 0750-1250HP V 3 4/5 and CX 0400-0600HP V 3 2.

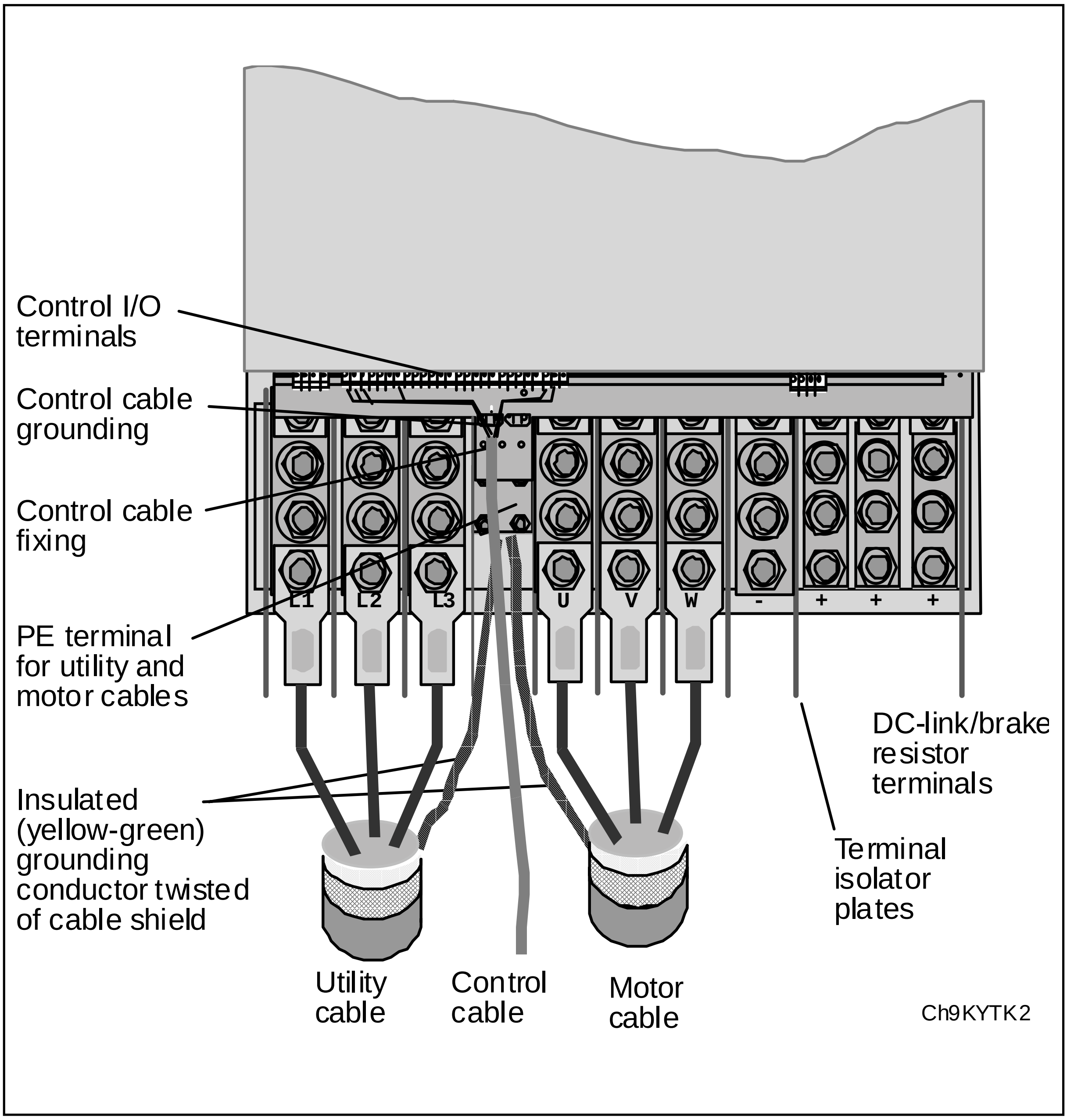
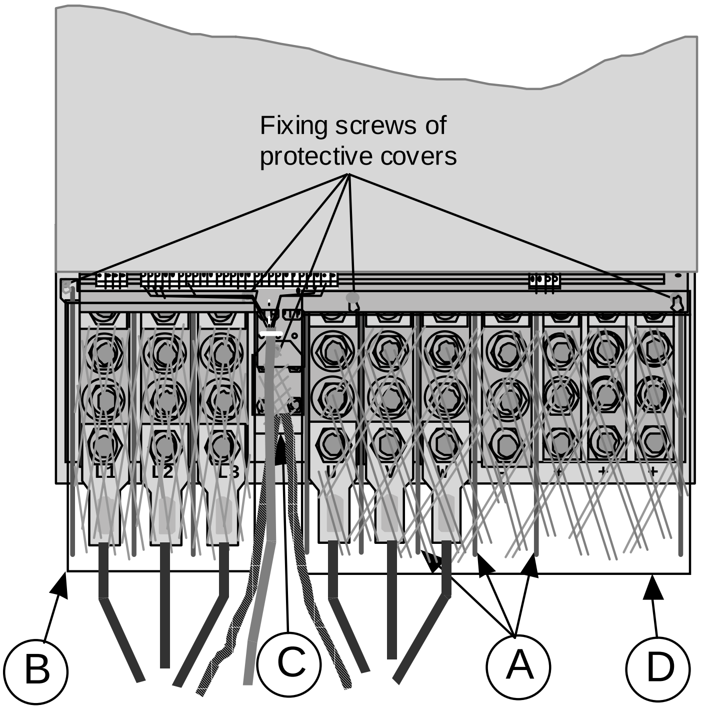
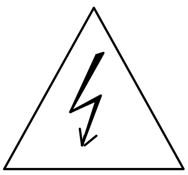


Figure 6.1.4-10 Cable assembly for open chassis: CX 1500-5000HP V 3 4/5, CX 1250-4000HP V 3 6 and CX 0750HP V 3 2; for NEMA 1: CXL 1500-5000HP V 3 4/5 and CXL 0750HP V 3 2.

6





After connecting the cables but before switching on the utility supply, ensure:

1. Insert all 10 terminal isolator plates (A) in the slots between the terminals, see figure below
2. Insert and fix three plastic protective covers (B, C, and D) over the

Fixing the terminal isolation plates:

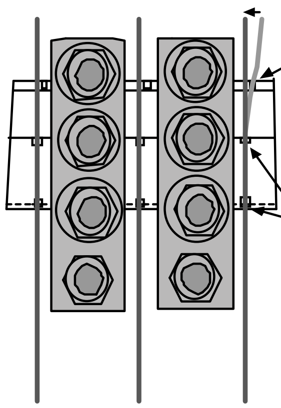


Figure 6.1.4-11 Cable cover and terminal assembly for open chassis: CX 1500-5000HP V 3 4/5, CX 1250-4000HP V 3 6 and CX 0750HP V 3 2; for NEMA 1: CXL 1500-5000HP V 3 4/5 and CXL 0750HP V 3 2.

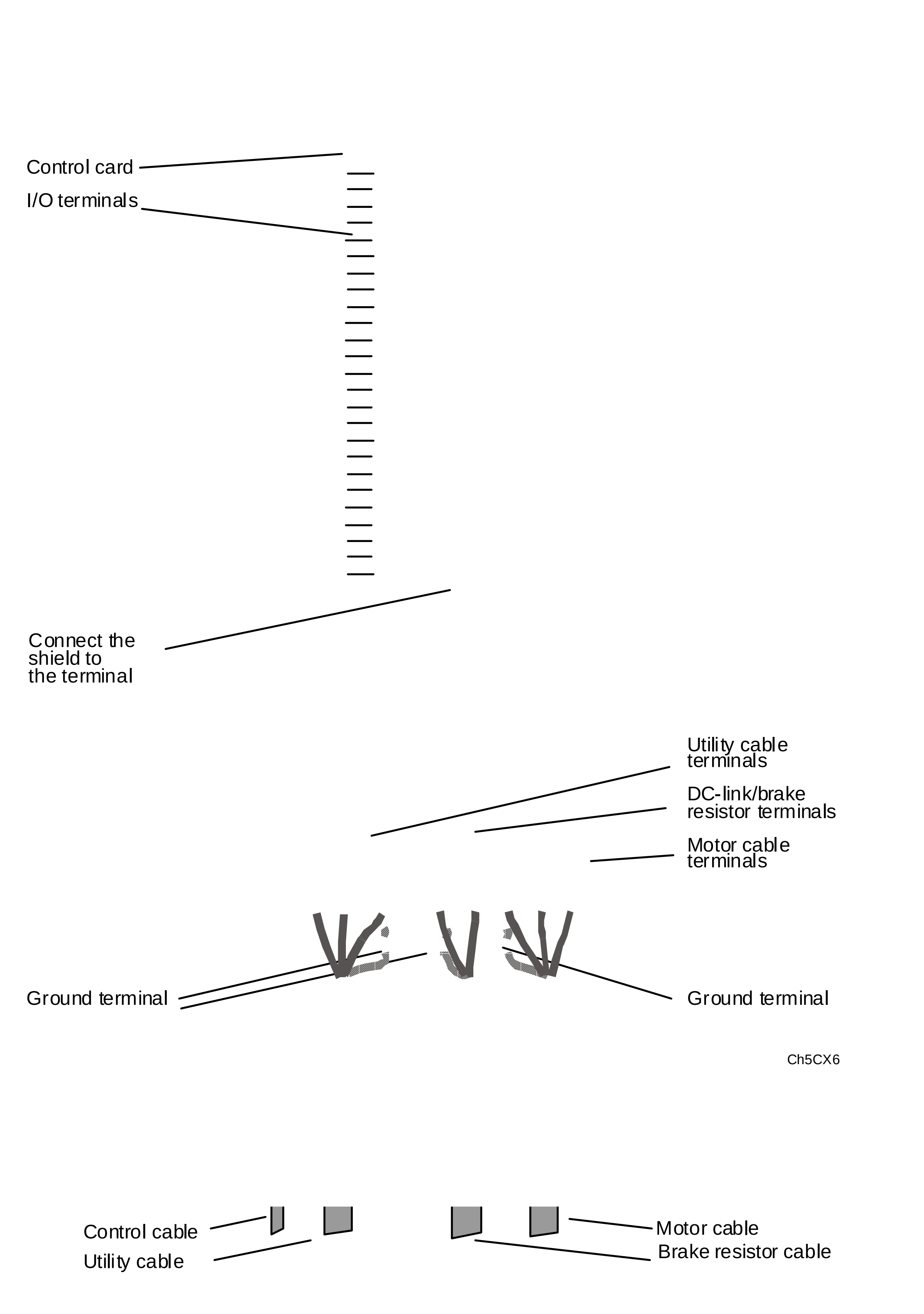


Figure 6.1.4-12 Cable assembly for open chassis: CX 0100-0300HP V 3 6.

6

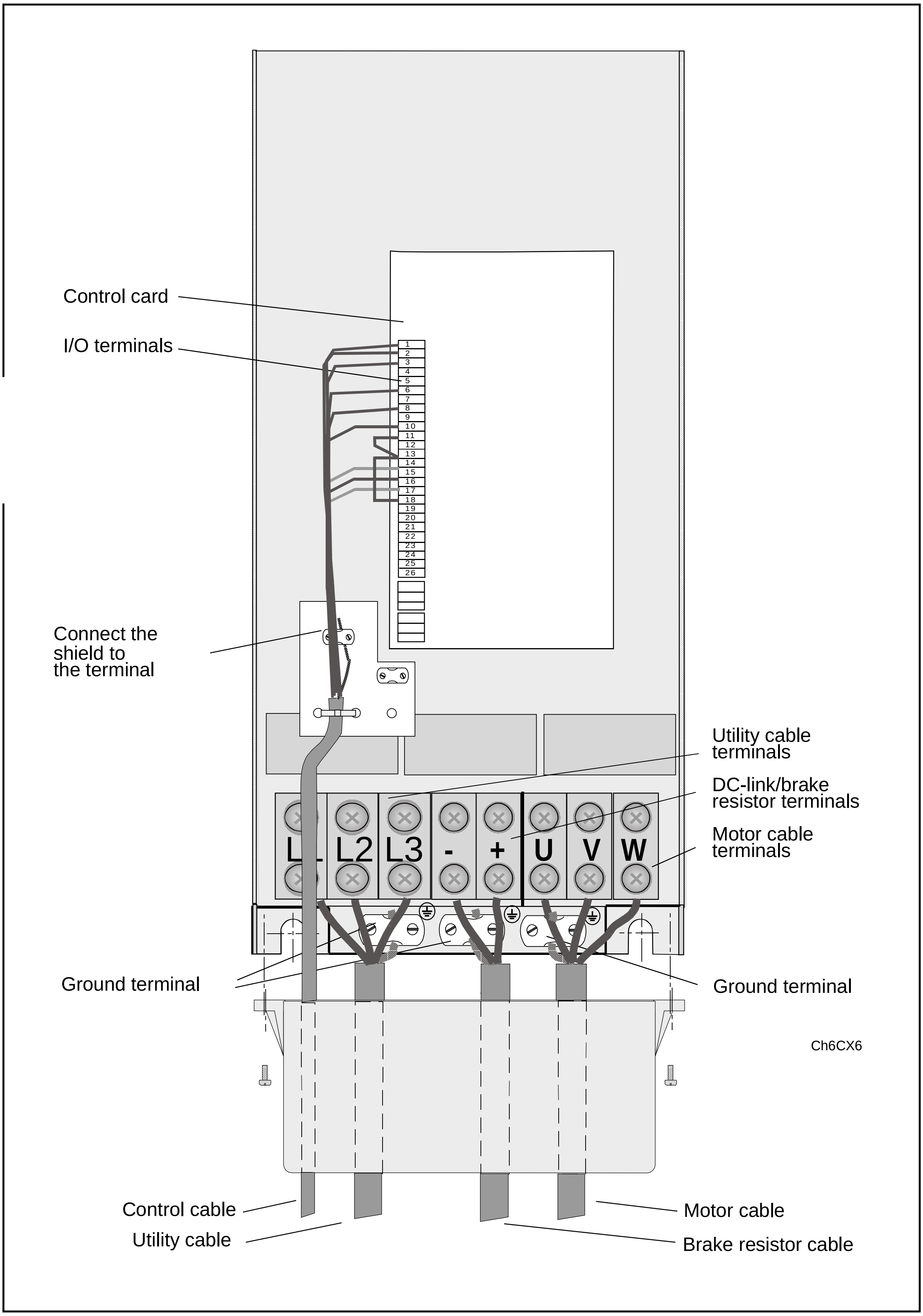


Figure 6.1.4-13 Cable assembly for open chassis: CX 0400-1000HP V 3 6.

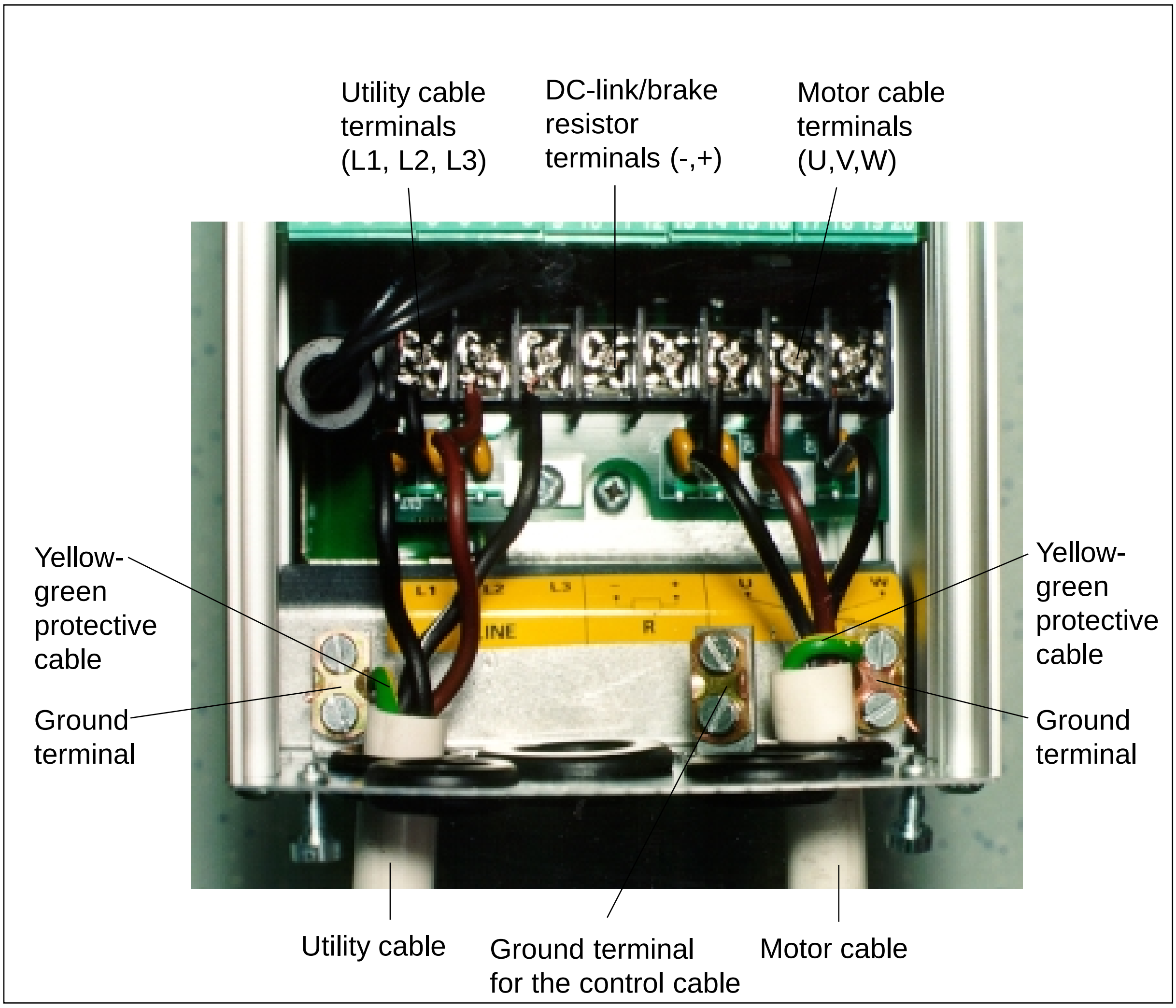


Figure 6.1.4-14 Cable assembly compact NEMA 1: CXS 0010-0030HP V 3 5.

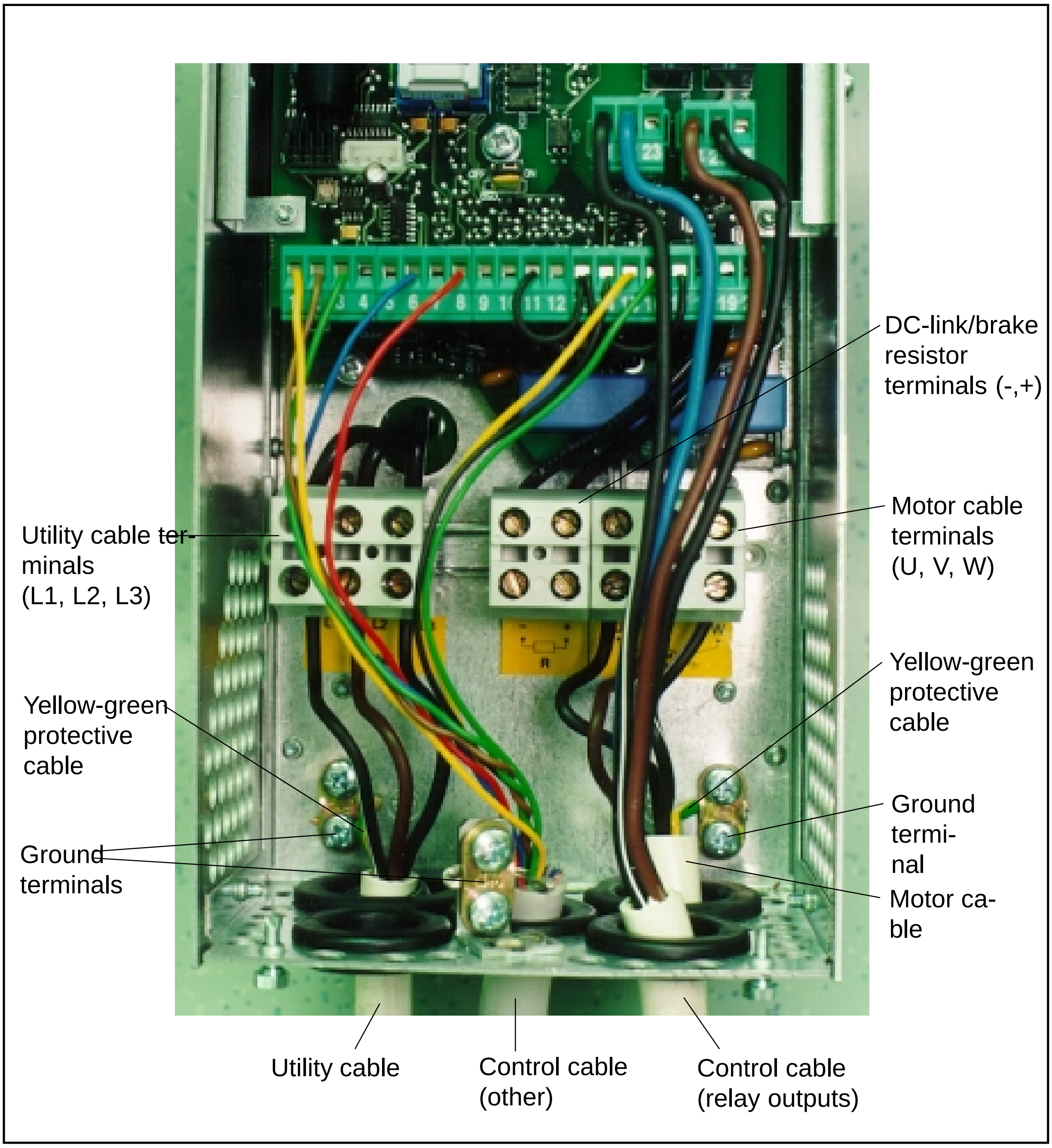


Figure 6.1.4-15 Cable assembly for compact NEMA1: CXS 0050-0150HP V 3 5.

6.1.5 Cable and motor insulation checks

1 Motor cable insulation checks

Disconnect the motor cable from the terminals U, V and W of the CX/CXL/CXS unit and from motor.

Measure the insulation resistance of the motor cable between each phase conductor and between each phase conductor and the protective ground conductor.
The insulation resistance must be >1MΩ.

2 Utility cable insulation checks

Disconnect the utility cable from terminals L1, L2 and L3 of the CX/CXL/XS unit and from the utlity.

Measure the insulation resistance of the utility cable between each phase conductor and between each phase conductor and the protective ground conductor.
The insulation resistance must be >1MΩ.

3 Motor insulation checks

Disconnect the motor cable from the motor and open any bridging connections in the motor connection box.

Measure insulation resistance of each motor winding. The measurement voltage has to be at least equal to the utility voltage but not exceeding 1000V.
The insulation resistance must be >1MΩ.

6.2 Control connections

Basic connection diagram is shown in the figure 6.2-1.

The functionality of the terminals for the Basic application is explained in chapter 10.2. If one of the alternative applications is selected, check the application manual for the functionality of the terminals for that application.

6.2.1 Control cables

The control cables should be minimum of #20 gauge shielded multicore cables, see table 6.1-1. The maximum wire size rating of the terminals is # 14.

6.2.2 Galvanic isolation barriers

The control connections are isolated from the utility potential and the I/O ground is connected to the frame of the CX/CXL/CXS via a 1 MΩ resistor and 4.7 nF capacitor. The control I/O ground can also be connected directly to the frame, by changing the position of the jumper X4 to ON-position, see figure 6.2.2-1.

Digital inputs and relay outputs are isolated from the I/O ground.

Terminal		Function	Specification
1	$+10V_{ref}$	Reference voltage output	Burden max 10 mA *
2	$V_{in}+$	Analog signal input	Signal range -10 V— +10 V DC
3	GND	I/O ground	
4	$I_{in}+$	Analog signal (+input)	Signal range 0(4)—20 mA
5	$I_{in}-$	Analog signal (-input)	
6	24V out	24V supply voltage	±20%, load max. 100 mA
7	GND	I/O ground	
8	DIA1	Digital input 1	R_i = min. 5 kΩ
9	DIA2	Digital input 2	
10	DIA3	Digital input 3	
11	CMA	Common for DIA1—DIA3	Must be connected to GND or 24V of I/O- terminal or to external 24V or GND
12	24V out	24V supply voltage	Same as # 6
13	GND	I/O ground	Same as # 7
14	DIB4	Digital input 4	R_i = min. 5 kΩ
15	DIB5	Digital input 5	
16	DIB6	Digital input 6	
17	CMB	Common for DIB4 — DIB6	Must be connected to GND or 24V of I/O- terminal or to external 24V or GND
18	$I_{out}+$	Analog signal (+output)	Signal range 0(4)—20 mA,
19	$I_{out}-$	Analog ground (-output)	R_L max. 500 Ω
20	DO1	Open collector output	Transistor output, max. V_{in} = 48 VDC max. current 50 mA
21	RO1/1	Relay output 1	Max. switch. voltage 250 VAC, 300 VDC
22	RO1/2		Max switch. current 8 A / 24 VDC,
23	RO1/3		0.4 A / 250 VDC
24	RO2/1	Relay output 2	Max. switch. power <2 kVA / 250 VAC
25	RO2/2		Max. cont. current <2 A rms
26	RO2/3		

Figure 6.2-1 Control I/O-terminal signals.

* If the potentiometer reference is used, potentiometer R = 1—10 kΩ

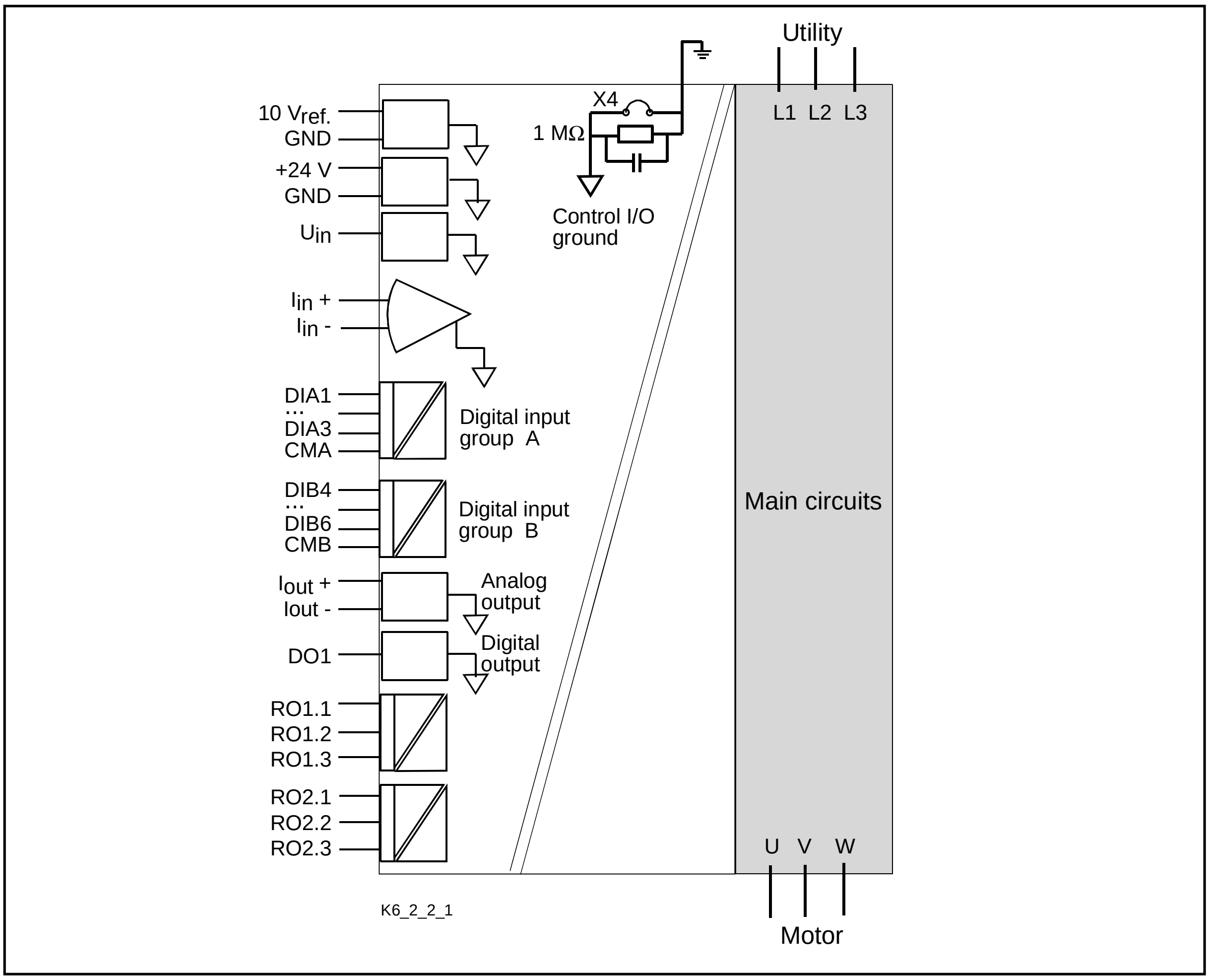


Figure 6.2.2-1 Isolation barriers.

6.2.3 Digital input function inversion

The active signal level of the digital input logic depends on how the common input (CMA, CMB) of the input group is connected. The connection can be either to +24 V or to ground. See figure 6.2.3-1.

The +24V or ground for the digital inputs and common terminals (CMA, CMB) can be either external or internal (terminals 6 and 12 of the drive).

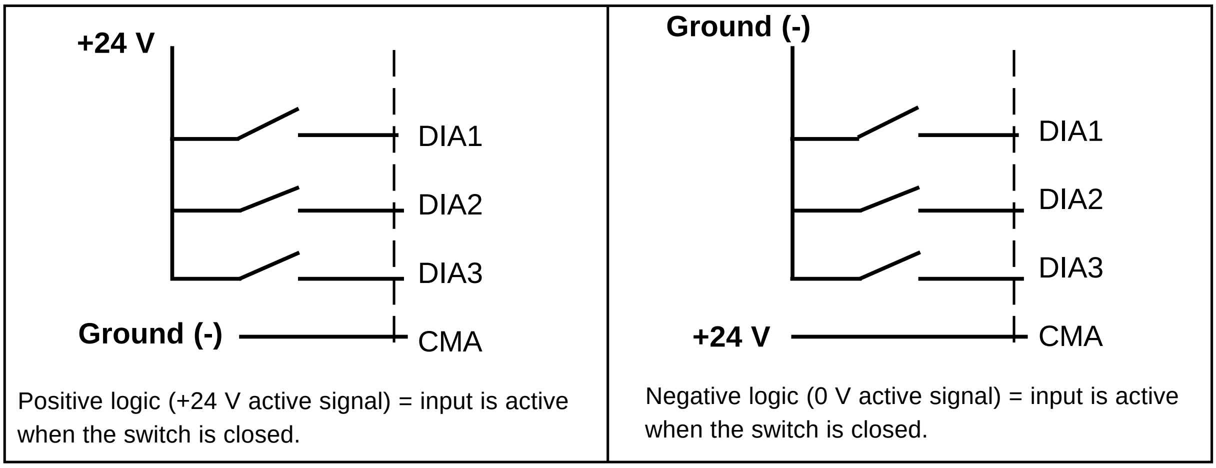


Figure 6.2.3-1 Positive/negative logic.

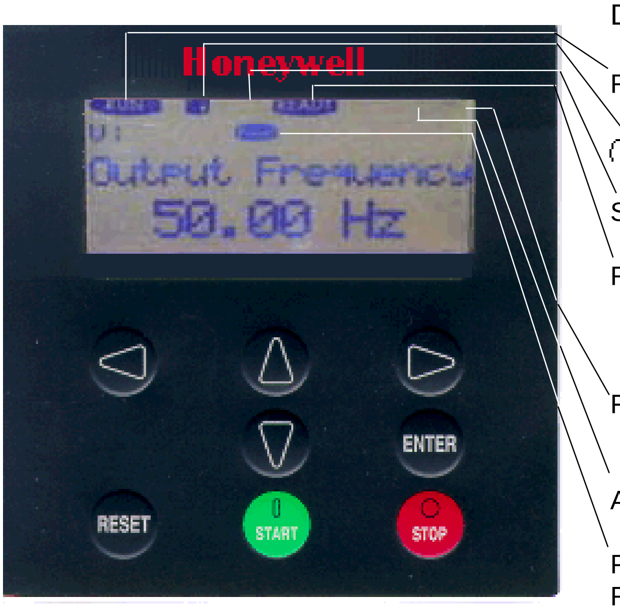
7. CONTROL PANEL

7.1 Introduction

The control panel of the CX/CXL/CXS drive features an alphanumeric Display with five indicators for the Run status (RUN, READY, FAULT, ↺ ↻, STOP) and two indicators for the control source. The panel embodies three indicator lines for the menu/submenu descriptions and the value/amount of the submenus. The eight push buttons on the panel are used for panel programming and monitoring.

The panel is detachable and isolated from the input line potential.

The display examples in this chapter present the text and numeric lines of the Alphanumeric Display only. The drive status indicators are not included in the examples.



DRIVE STATUS INDICATORS

RUN	=	lights when motor is running
↺ ↻	=	shows the selected rotation
STOP	=	lights when motor is not running
READY	=	lights when input voltage is supplied and the unit is ready for use
FAULT	=	lights when a fault in frequency drive occurs
ALARM	=	lights when a warning is given
Panel/ Remote	=	Shows the active control source

Figure 7-1 Control panel with LED display.


= *Menu button (left)*
Move forwards in the menu


= *Menu button (right)*
Move backwards in the menu


= *Browser button (up)*
Move in the main menu and between pages inside the same submenu.
Change value.


= *Browser button (down)*
Move in the main menu and between pages inside the same submenu.
Change value.

= *Enter button*
Acknowledgement of changed value.
Fault history reset.
Function as programmable button.

= *Reset button*
Fault resetting

= *Start button*
Starts the motor if the panel is the active control source

= *Stop button*
Stops the motor if the panel is the active control source

7.2 Panel operation

The panel is arranged in menus and submenus. The menus are used for the display of measurement and control signals, parameter settings, reference values, fault displays, contrast and the programmable buttons.

The desired submenu can also be entered from the main menu by using the menu buttons when the letter M and the number of the menu in question are visible on the first line of the display. See the CX/CXL/CXS User's Manual and the Application Manual for the specific parameters available for the CX/CXL/CXS setup needed.

The arrow (⟶) in the lower right corner indicates a further submenu.

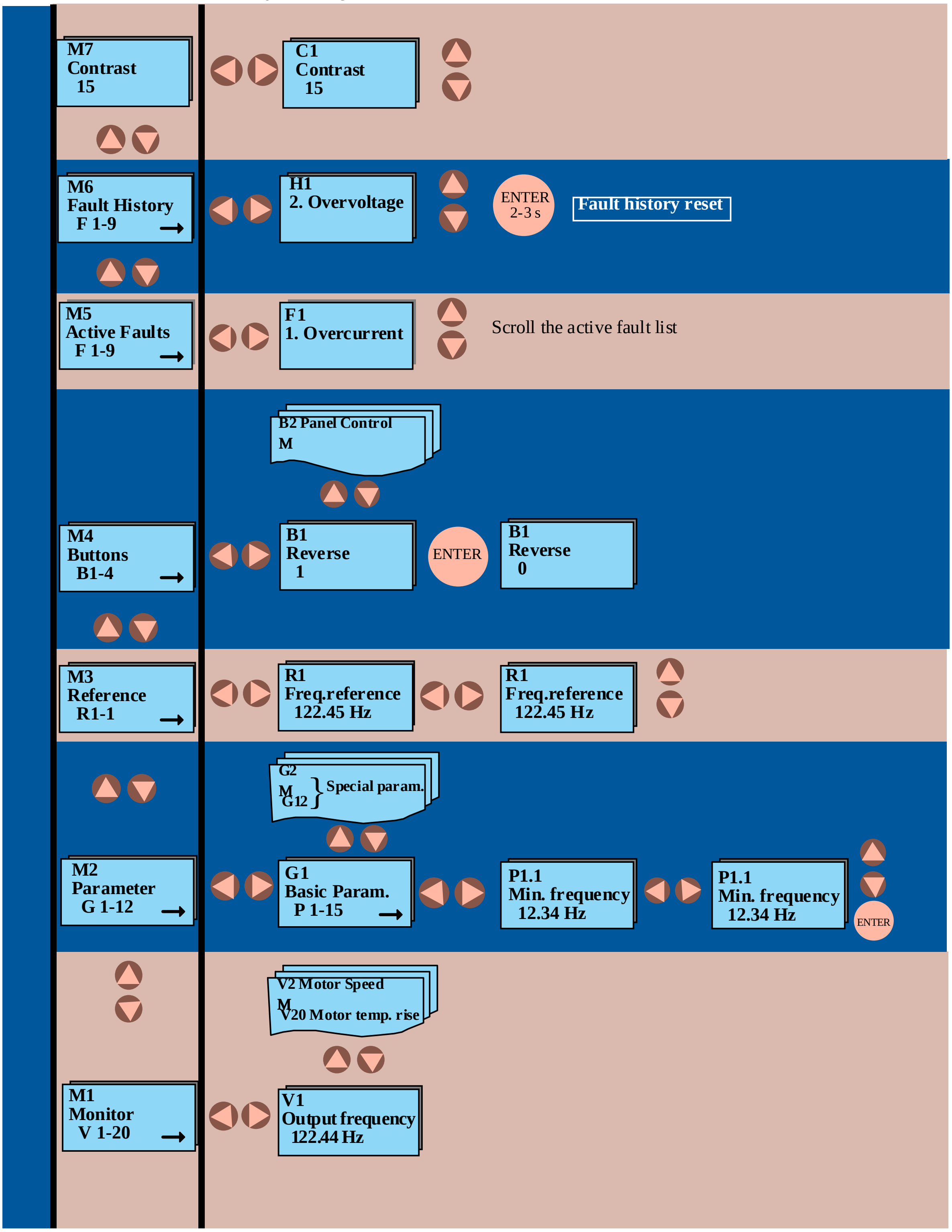


Figure 7-2 Panel operation.

7.3 Monitoring menu

The monitoring menu can be entered from the main menu when the symbol **M1** is visible on the first line of the Alpha-numeric display. How to browse through the monitored values is presented in Figure 7-3. All monitored signals are listed in Table 7-1. The values are updated once every 0.5 seconds. This menu is meant only for signal checking. The values cannot be altered here. See 7.4 Parameter group menu.

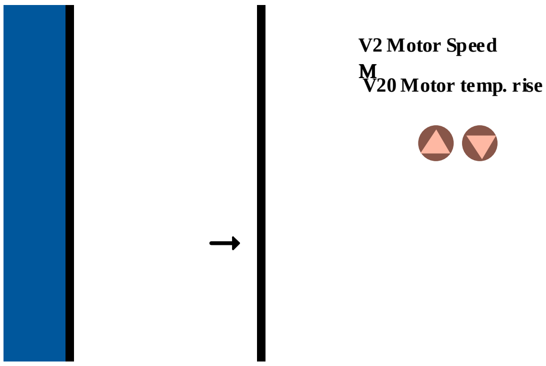


Figure 7-3 Monitoring menu.

Number	Signal name	Unit	Description
V1	Output frequency	Hz	Frequency to the motor
V2	Motor speed	rpm	Calculated motor speed
V3	Motor current	A	Measured motor current
V4	Motor torque	%	Calculated actual torque/nominal torque of the unit
V5	Motor power	%	Calculated actual power/nominal power of the unit
V6	Motor voltage	V	Calculated motor voltage
V7	DC-link voltage	V	Measured DC-link voltage
V8	Temperature	”C	Heat sink temperature
V9	Operating day counter	DD.dd	Operating days[1], not resettable
V10	Operating hours, trip counter	HH.hh	Operating hours[2], can be reset with programmable button #3
V11	MW hours counter	MWh	Total MWh, not resettable
V12	MW hours, trip counter	MWh	Resettable with programmable button #4
V13	Voltage/analog input	V	Voltage of terminal U_{in}+ (term. #2)
V14	Current/analog input	mA	Current of terminals I_{in}+ and I_{in}- (term. #4, #5)
V15	Digital input status, gr. A		See Figure 7-6
V16	Digital input status, gr. B		See Figure 7-6
V17	Digital and relay output status		See Figure 7-6
V18	Control program		Version number of the control software
V19	Unit nominal power	kW	The rated power size of the unit
V20	Motor temperature rise	%	100% = nominal motor temperature has been reached

Table 7-1 Monitored signals.

[1]DD = full days, dd = decimal part of day
[2]HH = full hours, hh = decimal part of hour

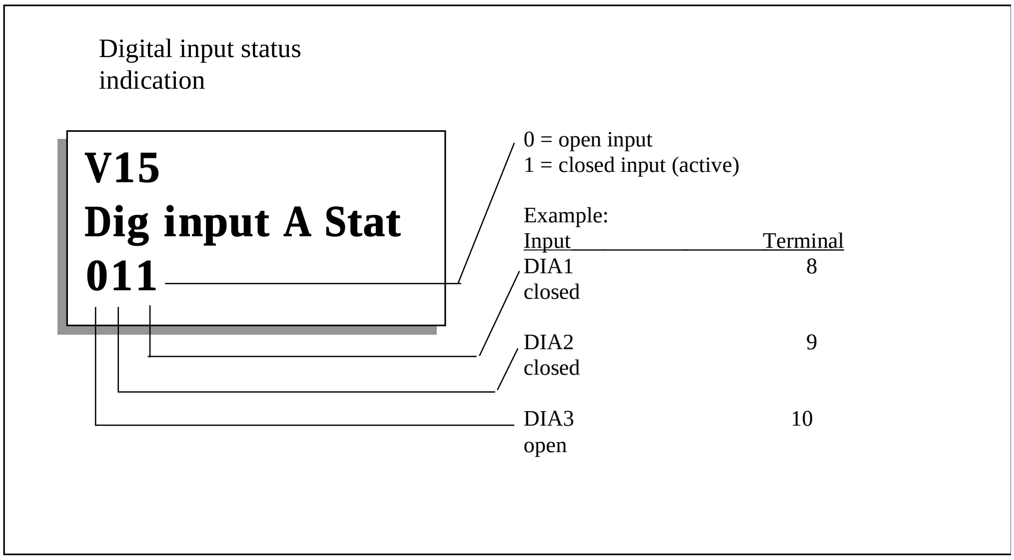


Figure 7-4 Digital inputs, Group A status.

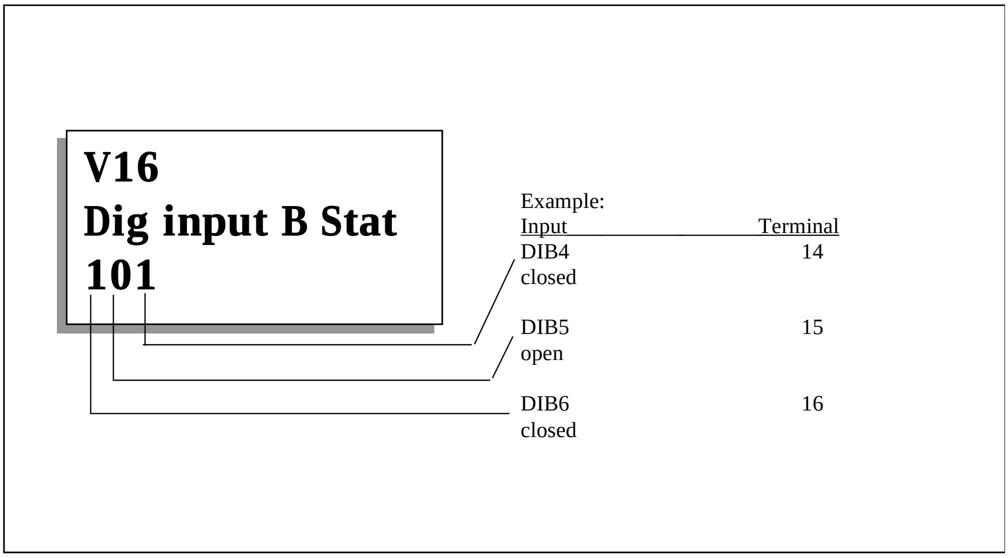


Figure 7-5 Digital inputs, Group B status.

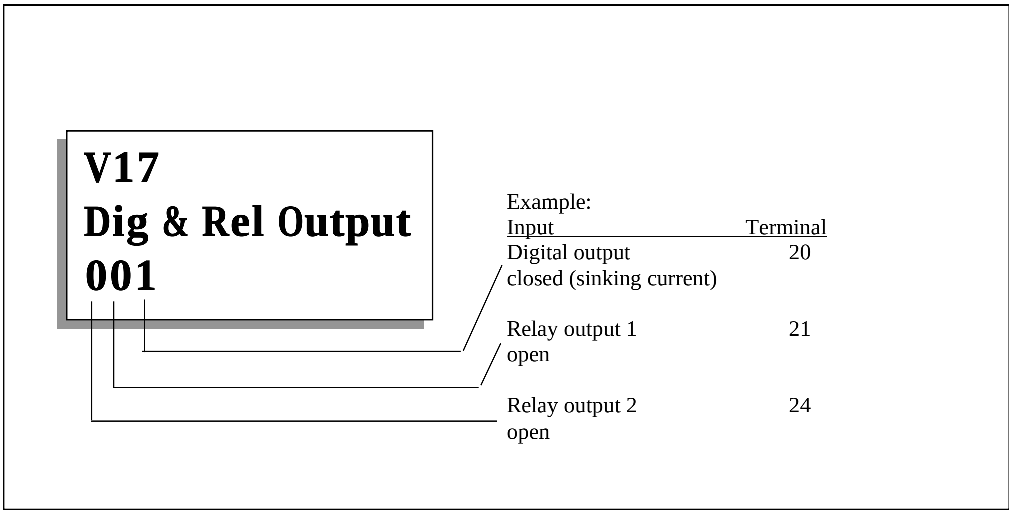


Figure 7-6 Output signal status.

7.4 Parameter group menu

The parameter group menu can be entered from the main menu when the symbol **M2** is visible on the first line of the Alpha-numeric display. Parameter values are changed in the parameter menu as shown in Figure 7-6:

Push the menu button once to move into the parameter group menu (G) and twice to enter the desired parameter menu. Locate the parameter you want to change by using the browser buttons. Push the menu button once again to enter the edit menu. Once you are in the edit menu, the symbol of the parameter starts to blink. Set the desired new value with the browser buttons and confirm the change by pushing the Enter button. Consequently, the blinking stops and the new value is visible in the value field. The value will not change unless the Enter button is pushed. You can go back by pressing the menu button .

Several parameters are locked, i.e. uneditable, when the drive is in RUN status. If you try to change the value of such a parameter, the text **locked** will appear on the display.

You can return to the main menu anytime by pressing the Menu button for 2-3 seconds.

The basic application embodies only those parameters necessary for operating the device. The parameter group 0 is accessible only by opening the Application package lock. See Chapter 11 of the CX/CXL/CXS User's Manual.

Other applications include more parameter groups.

Once in the last parameter of a parameter group, you can move directly to the first parameter of that group by pressing the browser button .

7

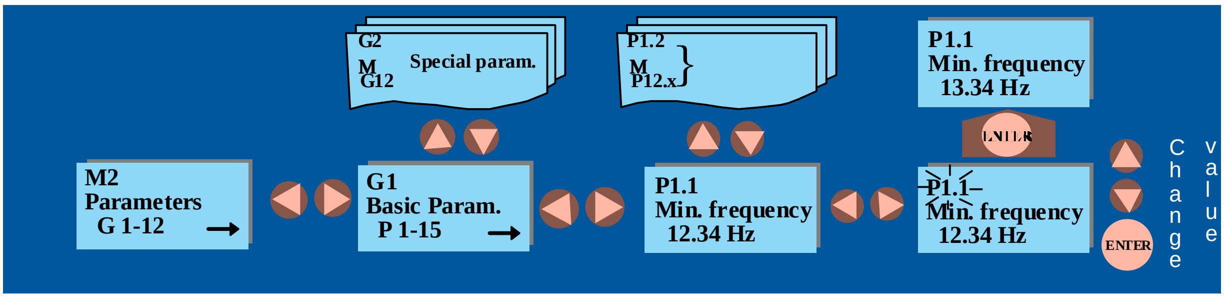


Figure 7-7 Parameter value change procedure

7.5 Reference menu

The reference menu can be entered from the main menu when the symbol **M3** is visible on the first line of the Alpha-numeric panel.

If the control panel is the active control source, the frequency reference can be changed by changing the value on the display with the browser buttons (for the selection of the active control source, see Chapter 7.6 Programmable push-button menu). See *Figure 7-8*.

Press the menu button  once and the symbol **R1** starts to blink. Now, you are able to alter the frequency reference value with the browser buttons. Pressing the Enter button  is not necessary. Motor speed changes as soon as the frequency reference changes or the load inertia allows the motor to accelerate or decelerate.

In some applications, there might be several references. In this case, pressing the menu button  once brings you to the menu where you can choose (with the browser buttons) the reference you wish to change. Another push on the button takes you to the editing mode.

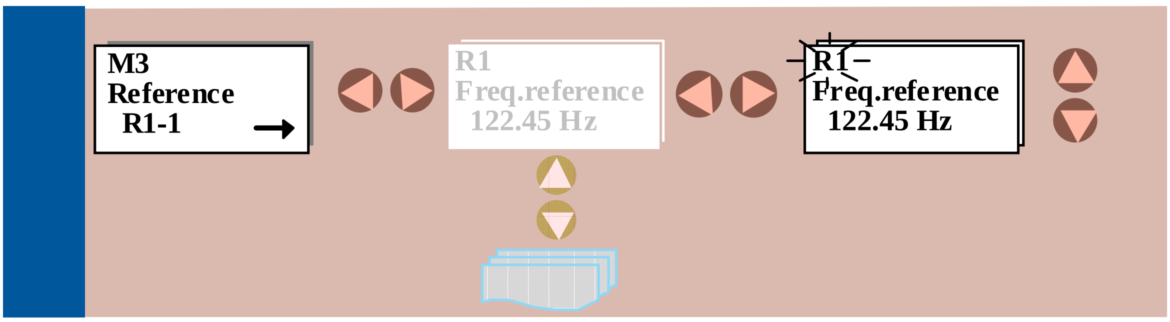


Figure 7-8 Reference setting on the control panel.

7.6 Programmable push-button menu

The programmable push-button menu can be entered from the main menu when the symbol **M4** is visible on the first line of the Alpha-numeric display. In this menu, there are four functions for the Enter button. Each button has two positions: On and Off. The functions are available in this menu only. In the other menus, the button is used for its original purpose. The status of the controlled function is shown through a feedback signal.

Enter the edit menu with the menu button . To change the button value, push the Enter button for a couple of seconds When you do this, the Enter symbol (↵) on the display inverts and the feedback value (On/Off) changes. The Enter symbol remains inverted as long as the Enter button is pushed down. See Figure 7-9.

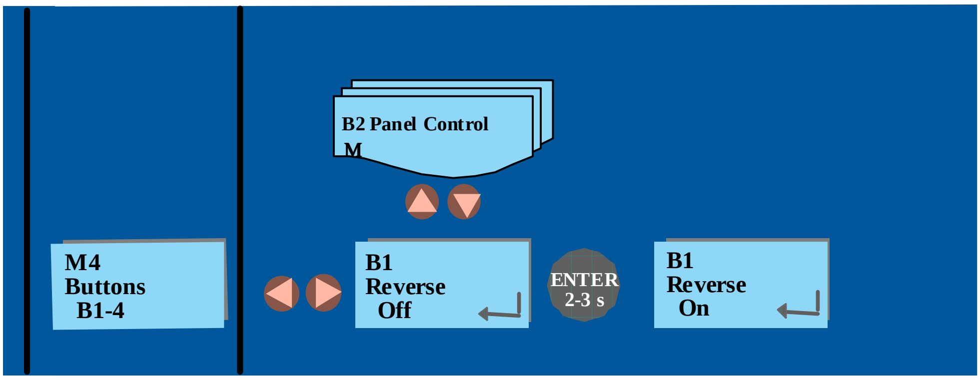


Figure 7-9 Programmable push-button.

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Button number	Button description	Function	Feedback information		
			0	1	Note
B1	Reverse	Changes the rotation direction of the motor. Available only when the control panel is the active control source	Forwards	Backwards	Feedback information flashes as long as the command is carried out.
B2	Active control source	Selection between I/O terminals and control panel	Control via I/O terminals	Control from the panel	
B3	Operating hours, trip counter; Reset	Resets the operating hours trip counter when pushed	No resetting	Reset of the operating hours trip counter	
B4	MWh counter, reset	Resets the MWh trip counter when pushed	No resetting	Reset of the MWh trip counter	

Table 7-2 Programmable push-button descriptions.

7.7 Active faults menu

The active faults menu can be entered from the main menu when the symbol **M5** is visible on the first line of the Alpha-numeric display as shown in Figure 7-10.

When a fault brings the frequency converter to a stop, the fault code (F#) and the description of the fault are displayed. If there are several faults at the same time, the list of active faults can be browsed with the browser buttons.

The display can be cleared with the Reset button and the read-out will return to the same display it had before the fault trip.

The fault remains active until it is cleared with Reset button or with a reset signal from the I/O terminal.

Note! Remove external Start signal before resetting the fault to prevent unintended restart of the drive.

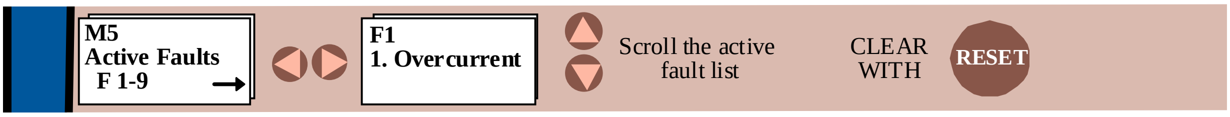

Figure 7-10 Active faults menu.

Fault codes	Fault	Possible cause	Checking
F1	Overcurrent	The frequency converter has measured too high a current (>4*In) in the motor output: - sudden heavy load increase - short circuit in the motor cables - unsuitable motor	Check loading Check motor size Check cables
F2	Overvoltage	The voltage of the internal DC-link of the frequency converter has exceeded the nominal voltage by 35% - deceleration time is too fast - high overvoltage spikes at utility	Adjust the deceleration time
F3	Ground fault	Current measurement detected that the sum of the motor phase current is not zero - insulation failure in the motor or the cables	Check the motor cables
F4	Inverter fault	The frequency converter has detected faulty operation in the gate drivers or IGBT bridge - interference fault - component failure	Reset the fault and restart again. If the fault occurs again contact your Honeywell affiliate.
F5	Charging switch	Charging switch open when START command active - interference fault - component failure	Reset the fault and restart again. If the fault occurs again contact your Honeywell affiliate.
F9	Undervoltage	DC-bus voltage has gone below 65% of the nominal voltage - most common reason is failure of the utility supply - internal failure of the frequency converter can also cause an undervoltage trip	In case of temporary supply voltage break, reset the fault and start again. Check utility input. If utility supply is correct and internal failure has occurred. Contact your Honeywell affiliate.
F10	Input line supervision	Input line phase is missing	Check the utility connection
F11	Output phase supervision	Current measurement has detected that there is no current in one motor phase	Check motor cables
F12	Brake chopper supervision	- brake resistor not installed - brake resistor broken - brake chopper broken	Check brake resistor - If resistor is OK the chopper is broken. Contact your Honeywell affiliate.
F13	Drive undertemperature	Temperature of heat sink below -10”C	

Table 7-3 Fault codes (cont.).

Fault codes	Fault	Possible cause	Checking
F14	Drive overtemperature	Temperature of heat sink over 75”C	- Check the cooling air flow - Check that the heat sink is not dirty - Check ambient temperature - Check that the switching frequency is not too high compared with ambient temperature and motor load
F15	Motor stalled	The motor stall protection has tripped	- Check the motor
F16	Motor overtemperature	The frequency converter motor temperature model has detected motor overheat - motor is overloaded	Decrease motor load. Check the temperature model parameters if the motor was not overheated
F17	Motor underload	The motor underload protection has tripped	
F18	Analog input hardware fault	Component failure on control board	Contact your Honeywell affiliate.
F19	Option board identification	Reading of the option board has failed	Check the installation - If installation is correct, contact your Honeywell affiliate.
F20	10 V voltage reference	+10 V reference shorted on control board or option board	Check the cabling from +10 V reference voltage
F21	24 V supply	+24 V supply shorted on control board or option board	Check the cabling from +24 V reference voltage
F22 F23	EEPROM checksum fault	Parameter restoring error - interference fault - component failure	When the fault is reset the frequency drive will automatically load parameter default settings. Check all parameter settings after reset. If the fault occurs again contact your Honeywell affiliate.
F25	Microprocessor watchdog	- interference fault - component failure	Reset the fault and restart. If the fault occurs again contact your Honeywell affiliate.
F26	Panel communication error	The connection between panel and the frequency converter is not working	Check the panel cable
F29	Thermistor protection	Thermistor input of the I/O expander board has detected increase of the motor temperature	- Check motor cooling and loading - Check thermistor connection (If thermistor input of the I/O expander board is not in use, it has to be short circuited)
F36	Analog input I_{in} < 4mA (signal range selected 4-20 mA)	The current in the analog input I_{in} is below 4 mA - signal source has failed - control cable is broken	Check the current loop circuitry
F41	External fault	Fault is detected in external fault digital input	Check the external fault circuit or device

Table 7-3 Fault codes.

7.8 Fault history menu

The fault history menu can be entered from the main menu when the symbol **M6** is displayed on the first line of the Alpha-numeric panel.

The memory of the frequency converter can store the maximum of 9 faults in the order of appearance. The latest fault has the number 1, the second latest number 2 etc. If there are 9 uncleared faults in the memory, the next fault will erase the oldest from the memory.

Pressing the Enter button for about 2…3 seconds resets the fault history. Then, the symbol F# will change for 0.

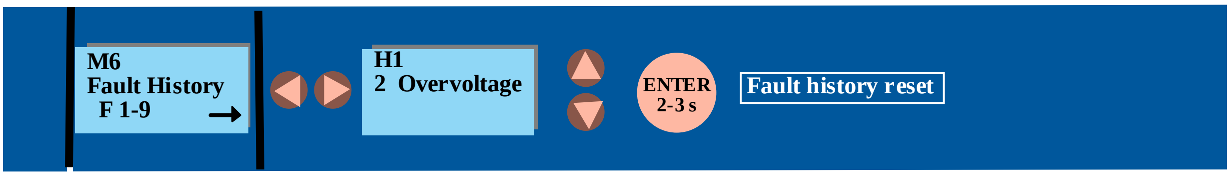

Figure 7-11 Fault history menu.

7.9 Contrast menu

The contrast menu can be entered from the main menu when the symbol **M7** is visible on the first line of the Alpha-numeric display.

Use the menu button (right) to enter the edit menu. You are in the edit menu when the symbol **C** starts to blink. Then change the contrast to the desired level using the browser buttons. The changes take effect immediately.

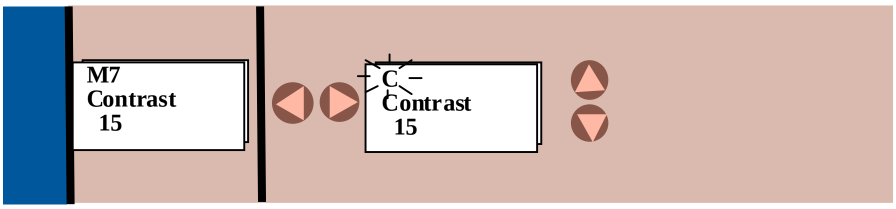

Figure 7-12 Contrast setting.

7.10 Active warning display

When a warning occurs, a text with a symbol **A#** appears on the display. Warning codes are explained in Table 7-3.

The display does not have to be cleared in any special way.

The warning on the display does not disable the normal functions of the push buttons.

Code	Warning	Checking
A15	Motor stalled (Motor stall protection)	Check motor
A16	Motor overtemperature (Motor thermal protection)	Decrease motor loading
A17	Motor underload (Warning can be activated in Application manual applications)	Check motor loading
A24	The values in the Fault History, MWh counters or operating day/hour counters might have been changed in the previous mains interruption	No actions necessary. Take a critical attitude to these values.
A28	The change of application has failed.	Choose the application again and push the Enter button.
A30	Unbalance current fault; the load of the segments is not equal.	Contact your Honeywell affiliate.
A45	The frequency converter overtemperature warning; Temperature >70"C	Check the cooling air flow and the ambient temperature.
A46	Reference warning; the current of input I_{in+} <4 mA (Warning can be activated in Application manual applications	Check the current loop circuitry.
A47	External warning; (Warning can be activated in Application manual applications)	Check the external fault circuit or device.

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Table 7-4 Warning codes.

7.11 Controlling the motor from the front panel

The CX/CXL/CXS can be controlled from either the I/O terminals or the control panel. The active control source can be changed with the programmable push button b2 (see chapter 7.6). The motor can be started, stopped and the direction of rotation can be changed from the active control source.

7.11.1 Control source change from I/O terminals to the front panel

After changing the control source the motor is stopped. The direction of rotation remains the same as with I/O control.
If the Start button is pushed at the same time as the programmable push button B2, the Run state, direction of rotation and reference value will be copied from the I/O terminals to the front panel.

7.11.2 Control source change from panel to I/O

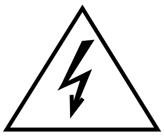
After changing the control source, the I/O terminals determine the run state, direction of rotation and reference value.

If motor potentiometer is used in the application, the panel reference value can be copied for a value of motor potentiometer reference by pushing the start button at the same time as the programmable push button B2. Motor potentiometer function mode must be "resetting at stop state" (Local/Remote Application: param. 1**.** 5 =4, Multi-purpose Application : param. 1**.** 5 = 9).

8 STARTUP

8.1 Safety precautions

Before startup, observe the following warnings and instructions:

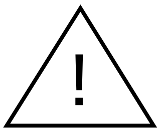


1 Internal components and circuit boards (except the isolated I/O terminals) are at line potential when the CX/CXL/CXS drive is connected to the utility. This voltage is extremely dangerous and may cause death or severe injury if you come in contact with it.

2 When the CX/CXL/CXS drive is connected to the utility, the motor connections U, V, W and DC-link / brake resistor connections -,+ are live even if the motor is not running.

3 Do not make any connections when the CX/CXL/CXS drive is connected to the utility line.

4 After disconnecting the utility, wait until the cooling fan on the unit stops and the indicators in the panel are turned off (if no panel check the indicators on the cover). Wait at least 5 minutes before doing any work on the CX/CXL/CXS drive connections. Do not open cover before this time has run out.



5 The control I/O terminals are isolated from the utility potential but the relay outputs and other I/O:s (if jumper X4 is in OFF position see fig. 6.2.2-1) may have dangerous external voltages connected even if the power is off from the CX/CXL/CXS drive.

6 Before connecting the utility make sure that the cover of the CX/CXL/CXS drive is closed.

8.2 Sequence of operation

1 Read and follow the safety precautions

2 After installation ensure that the:

- Drive and motor are connected to ground.
- Utility and motor cables are in accordance with the installation and connection instructions (chapter 6.1).
- Control cables are located as far as possible from the power cables (table 6.1.3-1), shields of the control cables are connected to the protective ground and wires do not have contact with any electrical components in the CX/CXL/CXS.
- The common input of digital input groups is connected to +24 V or ground of the I/O-terminal or external supply (See 6.2.3)

3 Check the quantity and quality of the cooling air (chapters 5.1 and 5.2).

4 Check that moisture has not condensed inside the CX/CXL/CXS drive.

5 Check that all Start/Stop switches connected to the I/O terminals are in the **Stop** state.

6 Connect the CX/CXL/CXS to the utility and switch the power ON.

7 Ensure the parameters of the Group 1 match the application.

Set the following parameters to match the motor nameplate:

- nominal voltage of the motor
- nominal frequency of the motor
- nominal speed of the motor
- nominal current of the motor
- supply voltage

See values from the nameplate of the motor.

8 Start-up test without the motor

Perform either test A or B:

A *Controls from the I/O terminals:*

- turn Start/Stop switch to ON position
- change the frequency reference
- check from the Monitoring page of the control panel that the output frequency follows the frequency reference
- turn Start/Stop switch to OFF position

B *Controls from the Control Panel:*

- change controls from the I/O terminals to the Control Panel with the programmable button B2, see chapter 7.6.
- push Start button 

- go to the Reference Page and change the frequency reference with the buttons  , see chapter 7.5
- go to the Monitoring Page and check that the output frequency follows the reference, see chapter 7.3.
- push Stop button 

9 If possible, make a start-up test with a motor which is not connected to the process.
If the inverter has to be tested on a motor connected to the process, ensure it is safe to be powered up. Inform all possible co-workers about the tests.

- switch the utility power OFF and wait until the CX/CXL/CXS has powered down according to chapter 8.1/ point 4
- connect the motor cable to the motor and the power terminals of the CX/CXL/CXS
- check that all start/stop switches connected to the I/O terminals are in the OFF state
- switch the utility power ON
- repeat test **A** or **B** of the test #8.

10 Connect the motor to the process (if the previous tests were done without the process)

- ensure it is safe to power up
- inform all possible co-workers about the tests.
- repeat test **A** or **B** of the test #8.

9 FAULT TRACING

When a fault trip occurs, the fault indicator is illuminated and the fault code and its description are displayed. The fault can be cleared with the Reset button or via an I/O terminal. The faults are stored to the fault history from where they can be viewed (see chapter 7.8). The fault codes are explained in table 9-1.

Fault codes	Fault	Possible cause	Checking
F1	Overcurrent	CX/CXL/CXS frequency converter has measured too high a current (>4*In) in the motor output: - sudden heavy load increase - short circuit in the motor cables unsuitable motor	Check load Check motor size Check cables
F2	Overvoltage	The voltage of the internal DC-link of the CX/CXL/CXS frequency converter has exceeded the nominal voltage by 35% - deceleration time is too fast - high overvoltage spikes at utility	Adjust the deceleration time
F3	Ground fault	Current measurement detected that the sum of the motor phase current is not zero - insulation failure in the motor or the cables	Check the motor cables
F4	Inverter fault	CX/CXL/CXS frequency converter has detected faulty operation in the gate drivers or IGBT bridge - interference fault - component failure	Reset the fault and restart again. If the fault occurs again contact your Honeywell affiliate.
F5	Charging switch	Charging switch open when START command active - interference fault - component failure	Reset the fault and restart again. If the fault occurs again contact your Honeywell affiliate.
F9	Undervoltage	DC-bus voltage has gone below 65% of the nominal voltage - most common reason is failure of the utility supply - internal failure of the CX/CXL/CXS frequency converter can also cause an undervoltage trip	In case of temporary supply voltage break, reset the fault and start again. Check utility input. If utility supply is correct an internal failure has occurred. Contact Honeywell affiliate.
F10	Input line supervision	Input line phase is missing	Check the utility connection
F11	Output phase supervision	Current measurement has detected that there is no current in one motor phase	Check motor cables
F12	Brake chopper supervision	- brake resistor not installed - brake resistor broken - brake chopper broken	Check brake resistor If resistor is OK the chopper is broken. Contact your Honeywell affiliate.
F13	FC undertemperature	Temperature of heat sink below -10”C	

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Fault codes	Fault	Possible cause	Checking
F14	FC overtemperature	Temperature of heatsink over 75◦ C For Compact NEMA 1 over 80◦ C	Check the cooling air flow Check that the heat sink is clean Check the ambient temperature Check that the switching frequency is not too high for the ambient temperature and load.
F15	Motor stalled	The motor stall protection has tripped	Check the motor
F16	Motor overtemperature	The CX/CXL/CXS motor temperature calculating model has calculated a motor overtemperature	Decrease motor load Check the temperature model parameters if the motor wasn t too hot.
F17	Motor underload	The motor underload protection has tripped	Check motor and possible belts etc.
F18	Analog input hardware fault	Component failure on the control card	Contact your Honeywell affiliate.
F19	Option board identification	Reading of the option board has failed	Check the installation of the board. If the installation is OK, contact your Honeywell affiliate.
F20	10 V voltage reference	+ 10 V reference shorted on the control card or on an option board	Check the wiring connected to the + 10 V reference
F21	24 V supply	+ 24 V supply shorted on the control card or on an option board	Check the wiring connected to the + 24 V reference
F22 F23	EEPROM checksum failure	Parameter restoring error interference component failure	On resetting this fault, the drive will automatically load the parameter default settings. Check all parameters before restarting the drive. If the fault occurs again, contact your Honeywell affiliate.
F25	Microprocessor watchdog	interference component failure	Reset the fault and restart. If the fault occurs again, contact your Honeywell distributor
F26	Panel communication error	The connection between the drive and the panel doesn t work	Check the panel cable and connectors. If the fault occurs again, contact your Honeywell affiliate.
F29	Thermistor protection	The thermistor input on the I/O boards has detected a motor temperature increase.	Check the motor load and cooling. Check the thermistor connection. If there are no thermistors, make sure the inputs are short-circuited.
F36	Analog input Im< 4 mA (signal range 4-20 mA selected)	The analog input current is below 4 mA signal source failed control cable broken.	Check the current loop circuitry
F41	External fault	An external fault has been detected at the digital input	Check the external fault source.

Table 9-1 Fault codes.

10 BASIC APPLICATION

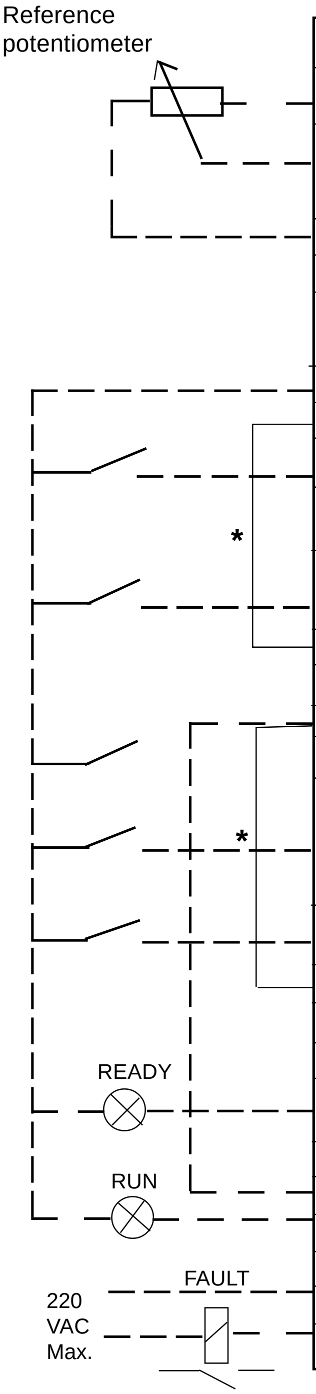
10.1 General

The Basic Application is the default setting as delivered from the factory. Control I/O signals of the Basic application are fixed (not programmable) and it only has parameter Group 1.

Parameters are explained in chapter 10.4. The function of motor thermal and stall protection in the Basic Application is explained in chapter 10.5.

*** NOTE! Remember to connect the CMA and CMB inputs.**

10.2 Control Connections



Terminal		Signal	Description
1	$+10V_{ref}$	Reference output	Voltage for a potentiometer, etc.
2	$V_{in}+$	Analog input, voltage range 0—10 V DC	Frequency reference activated if terminals 14 and 15 open and parameter 1.17 = 0 (default value)
3	GND	I/O ground	Ground for reference and controls
4	$I_{in}+$	Analog input, current range 0—20 mA	Frequency reference activated if terminals 14 and 15 closed, or open and parameter 1.17 = 1
5	$I_{in}-$		
6	+24V	Control voltage output	Voltage for switches, etc. max. 0.1 A
7	GND	I/O ground	Ground for reference and controls
8	DIA1	Start forward	Contact closed = start forward
9	DIA2	Start reverse	Contact closed = start reverse
10	DIA3	External fault input	Contact open = no fault Contact closed = fault
11	CMA	Common for DIA1—DIA3	Connect to GND or + 24V
12	+24V	Control voltage output	Voltage for switches, (same as #6)
13	GND	I/O ground	Ground for reference and controls
14	DIB4	Multi-step speed select 1	*DIB4* / *DIB5* / *Frequency ref.*
15	DIB5	Multi-step speed select 2	open / open / Ref. V_{in} (par.1.17=0) closed / open / Multi-step ref. 1 open / closed / Multi-step ref. 2 closed / closed / Ref. I_{in} (term. #4,5)
16	DIB6	Fault reset	Contact open = no action Contact closed = fault reset
17	CMB	Common for DIB4—DIB6	Connect to GND or + 24V
18	$I_{out}+$	Analog output 0—20 mA	0 - maximum frequency (par. 1. 2)
19	$I_{out}-$	Output frequency	R_L max 500 Ω
20	DO1	Digital output READY	activated = the CX/CXL/CXS is ready to operate
21	RO1	Relay output 1 RUN	Relay activated = CX/CXL/CXS is operating (motor is running)
22	RO1		
23	RO1		
24	RO2	Relay output 2 FAULT	Relay activated = fault trip has occured
25	RO2		
26	RO2		

Figure 1.2-1 Control connection example.

10.3 Control Signal Logic

Figure 10.3.-1 shows the logic of the I/O control signals and push buttons.

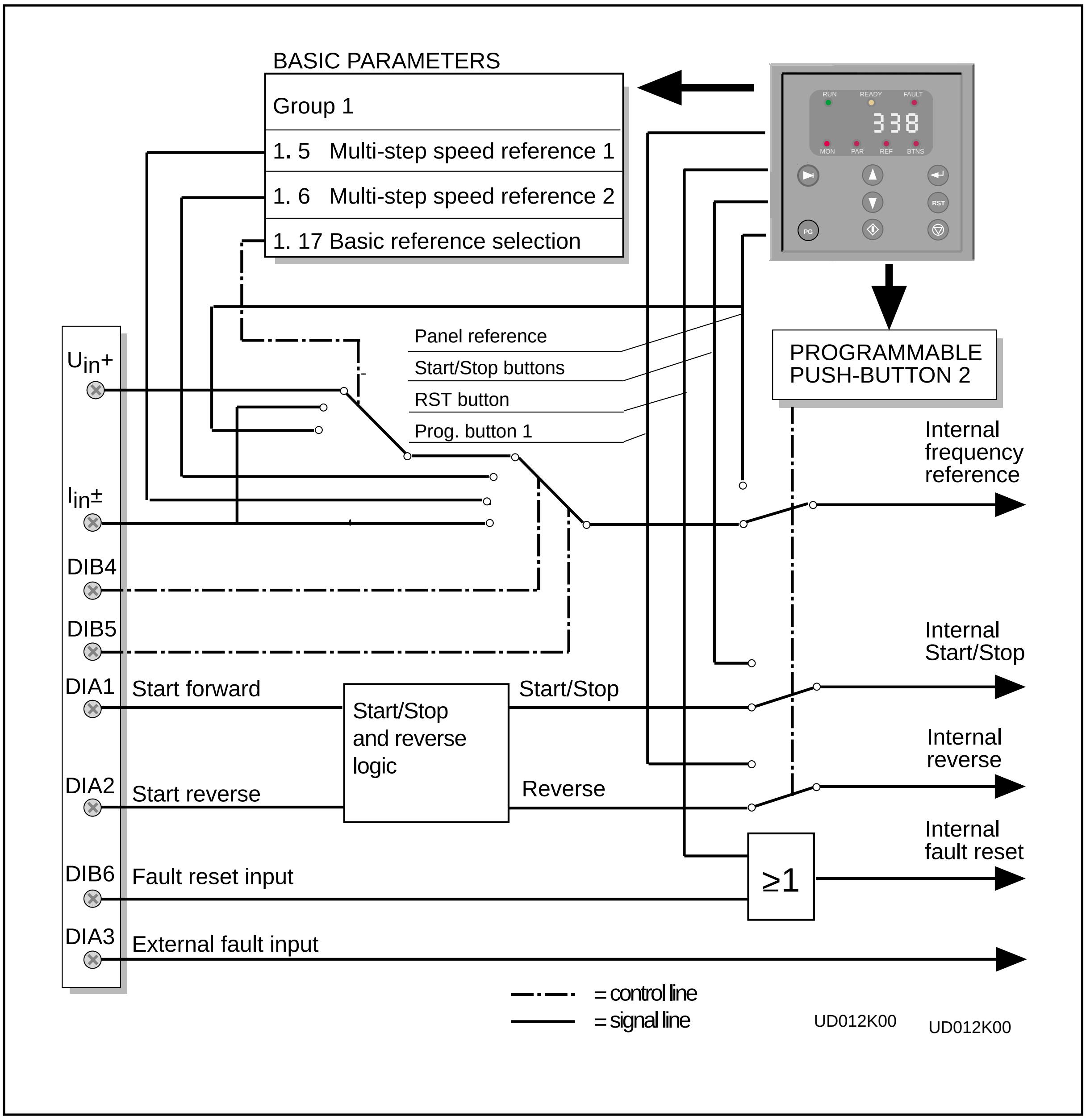


Figure 10.3-1 Control signal logic

If Start forward and Start reverse are both activated when the utility line is connected to the CX/CXL/CXS then Start forward will be selected for the direction.

If Start forward and Start reverse are both activated when the control source is changed from the panel to the I/O-terminals then Start forward will be selected for the direction.

If both directions are selected the first selected direction has higher priority than the second selected.

10.4 Parameters, Group 1

Num.	Parameter	Range	Step	Default	Customer	Description	Page
1. 1	Minimum frequency	0—f_{max}	1 Hz	0 Hz			76
1. 2	Maximum frequency	f_{min}-120/500 Hz	1 Hz	60 Hz		*	76
1. 3	Acceleration time	0.1—3000.0 s	0.1 s	3.0 s		Time from f_{min} (1. 1) to f_{max} (1. 2)	76
1. 4	Deceleration time	0.1—3000.0 s	0.1 s	3.0 s		Time from f_{max} (1. 2) to f_{min} (1. 1)	76
1. 5	Multi-step speed reference 1	f_{min} —f_{max} (1. 1) (1. 2)	0.1 Hz	10 Hz			76
1. 6	Multi-step speed reference 2	f_{min} —f_{max} (1. 1) (1. 2)	0.1 Hz	60 Hz			76
1. 7	Current limit	0.1—2.5 x I_{nCX}	0.1 A	1.5 x I_{nCX}		Output current limit [A] of the unit	76
1. 8	V/Hz ratio selection	0—1	1	0		0 = Linear 1 = Squared	76
1. 9	V/Hz optimization	0—1	1	0		0 = None 1 = Automatic torque boost	77
1. 10	Nominal voltage of the motor	180—690 V	1 V	230 V 380 V 480 V 600 V		CX/CXL/CXS V 3 2 CX/CXL/CXS V 3 4 CX/CXL/CXS V 3 5 CX V 3 6	77
1. 11	Nominal frequency of the motor	30—500 Hz	1 Hz	60 Hz		f_n from the nameplate of the motor	77
1. 12	Nominal speed of the motor	1—20000 rpm	1 rpm	1720 rpm **		n_n from the nameplate of the motor	77
1. 13	Nominal current of the motor	2.5 x I_{nCX}	0.1 A	I_{nCX}		I_n from the nameplate of the motor	77
1. 14	Supply voltage	208—240		230 V		CX/CXL/CXS V 3 2	78
		380—440		380 V		CX/CXL/CXS V 3 4	
		380—500		480 V		CX/CXL/CXS V 3 5	
		525—690		600 V		CX V 3 6	
1. 15	Application package lock	0—1	1	1		0 = package lock open Application is selected by parameter 0.1	78
1. 16	Parameter value lock	0—1	1	0		Disables parameter changes: 0 = changes enabled 1 = changes disabled	78
1. 17	Basic frequency reference selection	0—2	1	0		0 = analog input V_{in} 1 = analog input I_{in} 2 = reference from the panel	78
1. 18	Analog input I_{in} range	0—1	1	0		0 = 0—20 mA 1 = 4—20 mA	78

Table 10.4-1 Group 1 basic parameters

Note! = Parameter value can be changed only when the CX/CXL/CXS is stopped.

* If 1. 2 >motor synchr. speed, check suitability of motor and drive system.
** Default value for a four pole motor and a nominal size drive.

10.4.1 Descriptions

1. 1, 1. 2 Minimum/maximum frequency

Defines the frequency limits of the drive.

Default maximum value for parameters 1. 1 and 1. 2 is 120 Hz. By setting 1. 2 = 120 Hz in Stop state (RUN indicator not lit) and pressing the Enter key the maximum value of parameters 1. 1 and 1. 2 is changed to 500 Hz. At the same time the panel reference display resolution is changed from 0.01 Hz to 0.1 Hz. The max. value is changed from 500 Hz to 120 Hz when parameter 1. 2 is set to 119 Hz in Stop state and the Enter key is pressed.

1. 3, 1. 4 Acceleration time, deceleration time :

These limits correspond to the time required for the output frequency to accelerate from the set minimum frequency (par. 1. 1) to the set maximum frequency (par. 1. 2).

1. 5, 1. 6 Multi-step speed reference 1, Multi-step speed reference 2:

Parameter values are limited between minimum and maximum frequency.

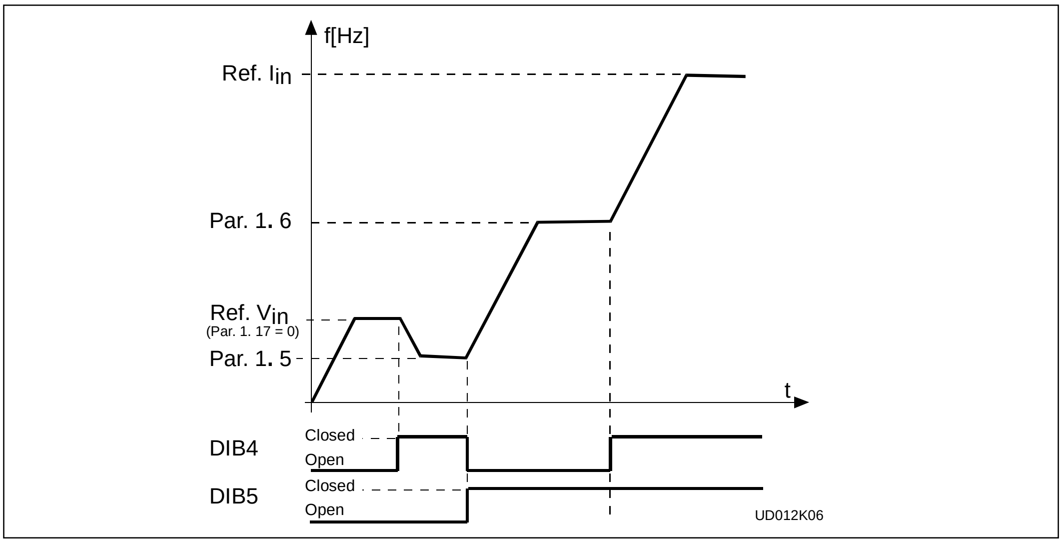


Figure 10.4.1-1 Example of Multi-step speed references.

10

1. 7 Current limit

This parameter determines the maximum motor current that the CX/CXL/CXS will provide short term.

1. 8 V/Hz ratio selection

Linear: **0** — The voltage of the motor changes linearly with the frequency from 0 Hz to the nominal frequency of the motor. The nominal voltage of the motor is supplied at this frequency. See figure 10.4.1-2.

Linear V/Hz ratio should be used in constant torque applications.

This default setting should be used if there is no special requirement for another setting.

Squared: **1** The voltage of the motor changes following a squared curve from 0 Hz to the nominal frequency of the motor. The Nominal voltage of the motor is supplied at this frequency. See figure 10.4.1-2.

The motor runs undermagnetized below the nominal frequency and it produces less torque and electromechanical noise.
A squared V/Hz ratio can be used in applications where the torque demand from the load is proportional to the square of the speed, e.g. in centrifugal fans and pumps.

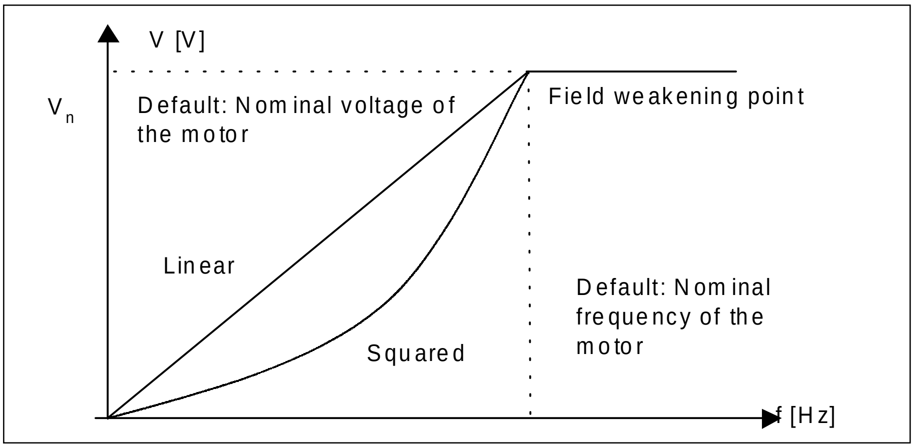


Figure 10.4.1-2 Linear and squared V/Hz curves.

1. 9 V/Hz optimization

Automatic torque boost: The voltage to the motor changes automatically which allows the motor to produce sufficient torque to start and run at low frequencies. The voltage increase depends on the motor type and horsepower.Automatic torque boost can be used in applications where starting torque due to starting friction is high, e.g. in conveyors.

NOTE! *In high torque - low speed applications - it is likely the motor will overheat. If the motor has to run for a prolonged time under these conditions, special attention must be paid to cooling the motor. Use external cooling for the motor if the operating temperature rise is too high.*

10

1. 10 Nominal voltage of the motor

Find the rated voltage V_n from the nameplate of the motor.

Note! If the nominal motor voltage is lower than the supply voltage, check that the insulation level of the motor is adequate.

1. 11 Nominal frequency of the motor

Find the value f_n from the nameplate of the motor.

1. 12 Nominal speed of the motor

Find the value n_n from the nameplate of the motor.

1. 13 Nominal current of the motor

Find the value I_n from the nameplate of the motor. The internal motor protection function uses this value as a reference value.

1. 14 Supply voltage

Set parameter value according to the nominal voltage of the supply. Values are predefined for CX/CXL/CXS V 3 2, CX/CXL/CXS V 3 4, CX/CXL/CXS V 3 5 and CX V 3 6, see table 10.4-1.

1. 15 Application package lock

The application package lock can be opened by setting the the value of the parameter 1.15 to 0. It will then be possible to enter the parameter group 0 from parameter 1.1 by pressing arrow down button (see figure 11-1). The number of the Application can be selected from the table 11-1 and it is selected by the value of parameter 0.1. After this, the new Application is in use and its parameters will be found in the Application manual.

1. 16 Parameter value lock

Defines access to the changes of the parameter values:

0 = parameter value changes enabled
1 = parameter value changes disabled

1. 17 Basic frequency reference selection

0 Analog voltage reference from terminals 2—3, e.g. a potentiometer
1 Analog current reference trom terminals 4—5, e.g. a transducer.
2 Panel reference is the reference set from the Reference Page (REF), see chapter 7.5.

1. 18 Analog input I_{in} range

Defines the minimum value of the Analog input I_{in} signal (terminals 4,5).

10

10.5 Motor protection functions in the Basic Application

10.5.1 Motor thermal protection

Motor thermal protection protects the motor from overheating. In the Basic application, Motor thermal protection uses constant settings and always causes a fault trip if the motor is overheated. To switch off the protection or to change the settings, see application manual.

Your CX/CXL/CXS is capable of supplying higher than nominal current to the motor. If the load requires this high current there is a risk that motor will be thermally overloaded. This is true especially at low frequencies, as the cooling effect and thermal capacity of the motor are reduced. The motor thermal protection is based on a calculated model which uses the output current of the drive to determine the load on the motor.

The thermal current I_T specifies the load current above which the motor is overloaded. See figure 10.5.1-1. If the motor current is above the curve, the motor temperature is increasing.

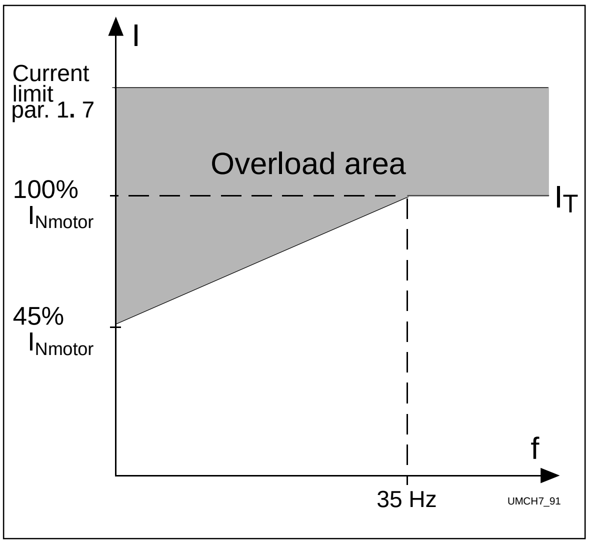


Figure 10.5.1-1 Motor thermal current I_T curve.

CAUTION! *The calculated model does not protect the motor if the airflow to the motor is reduced by an air intake grill that is blocked*

10.5.2 Motor Stall warning

In the Basic application, motor stall protection gives a warning of a short time overload of the motor e.g. a stalled shaft. The reaction time of this stall protection is shorter than the motor thermal protection time. The stall state is defined by Stall Current and Stall Frequency.

Both parameters have constant values. See figure 10.5.2-1. If the current is higher than the set limit and the output is lower than the set limit the stall state is true.If the stall state lasts longer than 15 s the stall warning is given on the display. To change th stall warning to a fault trip or to change the protection settings, see the application manual

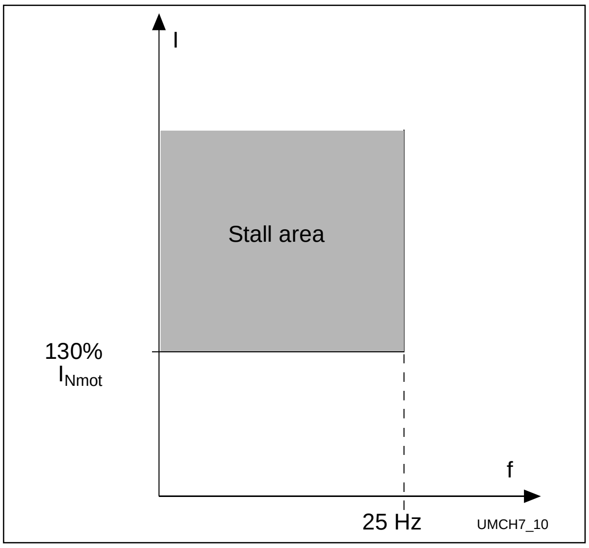


Figure 10.5.2-1 Stall state.

10

11 System parameter group 0

When the application package lock is open (par. 1.15 = 0) the system parameter group 0 can be accessed. Parameter group 0 can be entered from parameter 1.1 by the pressing arrow down button. The parameters of group 0 are shown in table 11-1.

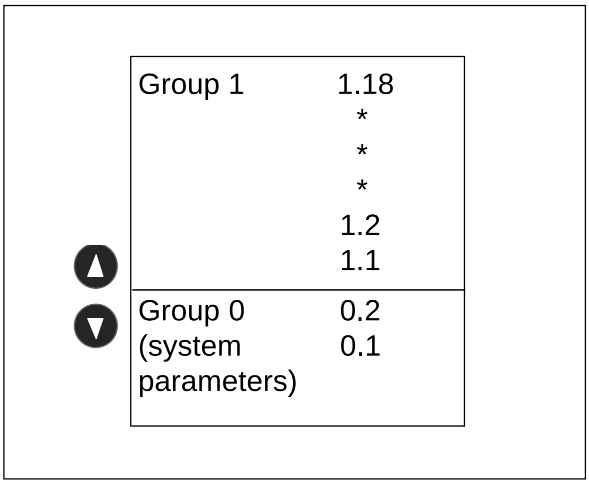


Figure 11-1 Group 0.

11.1 Parameter table

Number	Parameter	Range	Description	Page
0. 1	Application selection	1—7	1 = Basic Application 2 = Standard Application 3 = Local / Remote Control Application 4 = Multi-step Speed Application 5 = PI-control Application 6 = Multi-purpose Control Application 7 = Pump and fan control Application	80
0. 2	Parameter loading	0—5	0 = Loading ready / Select loading 1 = Load default settings 2 = Read up parameters to user's set 3 = Load down user's set parameters 4 = Read parameters up to the panel (possible only with the graphic panel) 5 = Load down parameters from the panel (possible only with graphic panel)	81
0. 3	Language selection	0—5	0 = English 1 = German 2 = Swedish 3 = Finnish 4 = Italian 5 = French	81

Table 11-1 System parameters, Group 0.

11.2 Parameter descriptions

0.1 Application selection

With this parameter the Application type can be selected. The default setting is the Basic Application. Applications are described in chapter 12.

0.2 Parameter loading

With this parameter it is possible to do different kinds of parameter load operations. After the operation is completed this parameter value changes automatically to 0 (loading ready).

0 Loading ready / Select loading

Loading operation has been completed and the drive is ready to operate.

1 Load default settings

By setting the value of parameter 0.2 to 1 and then pressing the Enter-button the parameter default values are used. The default values are based on the application selected with parameter 0.1.

2 Read up parameters to User's set

By setting the value of parameter 0.2 to 2 and then pressing Enter-button the parameter values are read up to the User's parameter value set. The parameter values can be later loaded by setting parameter 0.2 to 3 and pressing Enter button.

3 Load down user's set parameters

By setting the value of parameter 0.2 to 3 and then pressing Enter-button the parameter values are set according to the user's parameter set.

4 Read parameters up to the panel (possible only with the graphic panel).

5 Load down parameters from the panel (possible only with the graphic panel).

0.3 Language selection

This parameter selects the language of the text displayed on the operator's panel.

12 Application package

12.1 Application Selection

To use one of the Application package applications, first open the Application package lock (parameter 1.15). Group 0 then comes visible (see figure 11-1). Changing the value of parameter 0.1 changes the active application. See table 11-1.

Applications are presented in sections 12.2 - 12.7 and in more detail in the following, separate application manual.

12.2 Standard Application

The Standard Application has the same I/O signals and same Control logic as the Basic application.

Digital input DIA3 and all outputs are freely programmable.

Other additonal functions:

- Programmable Start/Stop and Reverse signal logic
- Reference scaling
- One frequency limit supervision
- Second set of ramps and choice of linear or S curve
- Programmable start and stop functions
- DC-braking at stop
- One prohibit frequency lockout range
- Programmable V/Hz curve and switching frequency
- Autorestart function
- Motor Thermal and Stall protection off / warning / fault programming

12.3 Local/Remote Application

Utilizing the Local/Remote Control Application the use of two different control and frequency reference sources is programmable. The active control source is selected with digital input DIB6. All outputs are freely programmable.

Other additonal functions:

- Programmable Start/stop and Reverse signal logic
- Analog input signal range selection
- Two frequency in band limit indications
- Torque in band limit indication
- Reference in band limit indication
- Second set of ramps and choice of linear or S curve
- DC-braking at start and stop
- Three prohibit frequency lockout ranges
- Programmable V/Hz curve and switching frequency
- Autorestart function
- Motor Thermal and Stall protection fully programmable
- Motor Underload protection
- Unused analog input functions

12.4 Multi-step Speed Application

The Multi-step Speed Control Application can be used where fixed speed references are required. 9 different speeds can be programmed: one basic speed, 7 multi-step speeds and one jogging speed. The speed steps are selected with digital signals DIB4, DIB5 and DIB6. If the jogging speed is used DIA3 can be programmed for jogging speed select

The basic speed reference can be either voltage or current signal via analog input terminals (2/3 or 4/5). All outputs are freely programmable.

Other additonal functions:

- Programmable Start/stop and Reverse signal logic
- Analog input signal range selection
- Two frequency in band limit indications
- Torque in band limit indication
- Reference in band limit indication
- Second set of ramps and choice of linear or S curve
- DC-braking at start and stop
- Three prohibit frequency lockout ranges
- Programmable V/Hz curve and switching frequency
- Autorestart function
- Motor Thermal and Stall protection fully programmable
- Motor Underload protection
- Unused analog input functions

12.5 PI-control Application

In the PI-control Application, there are two I/O-terminal control sources. Source A is a PI-controller and source B is a direct frequency reference. The control source is selected with the DIB6 input.

The PI-controller reference can be selected from the analog inputs, motor potentiometer, or panel reference. The actual value can be selected from the analog inputs or from a mathematical function acting on the analog inputs. The direct frequency reference can be used for control without the PI-controller. The frequency reference can be selected from the analog inputs or the panel reference.

All outputs are freely programmable.

Other additonal functions:

- Programmable Start/stop and Reverse signal logic
- Analog input signal range selection
- Two frequency in band limit indications
- Torque in band limit indication
- Reference in band limit indication
- Second set of ramps and choice of linear or S curve
- DC-braking at start and stop
- Three prohibit frequency lockout ranges
- Programmable V/Hz curve and switching frequency
- Autorestart function
- Motor Thermal and Stall protection fully programmable
- Motor Underload protection

12.6 Multi-purpose Control Application

In the Multi-purpose Control Application, the frequency reference can be selected from the analog inputs, joystick control, motor potentiometer, or a mathematical function of the analog inputs. Multi-step speeds and jog speed can also be selected if the digital inputs are programmed for these functions

Digital inputs DIA1 and DIA2 are reserved for Start/stop logic. Digital inputs DIA3 - DIB6 are programmable for multi-step speed select, jog speed select, motor potentiometer, external fault, ramp time select, ramp prohibit, fault reset and DC-brake command function. All outputs are freely programmable.

Other additonal functions:

- Programmable Start/stop and Reverse signal logic
- Analog input signal range selection
- Two frequency in band limit indications
- Torque in band limit indication
- Reference in band limit indication
- Second set of ramps and choice of linear or S-curve
- DC-braking at start and stop
- Three prohibit frequency lockout ranges
- Programmable V/Hz curve and switching frequency
- Autorestart function
- Motor Thermal and Stall protection fully programmable
- Motor Underload protection
- Free analog input functions

12.7 Pump and Fan Control Application

The Pump and Fan Control Application can be used to control one variable speed drive and 0-3 auxiliary drives. The PI-controller of the frequency converter controls the speed of the variable speed drive and gives control signals to Start and Stop auxiliary drives to control the total flow.

The application has two control sources on I/O terminal. Source A is Pump and fan control and source B is direct frequency reference. The control source is selected with DIB6 input.

All outputs are freely programmable.

Other additonal functions:

- Programmable Start/stop and reverse signal logic
- Analog input signal range selection
- Two frequency in band limit indications
- Torque in band limit indication
- Reference in band limit indication
- Second set of ramps and choice of linear or S curve
- DC-braking at start and stop
- Three prohibit frequency lockout ranges
- Programmable V/Hz curve and switching frequency
- Autorestart function
- Motor Thermal and Stall protection fully programmable
- Motor Underload protection

13 Options

13.1 External filters

Information of CX/CXL/CXS external input and output filters (RFI, dV/dT, and Sinusoidal-filters) can be found in their separate manuals.

13.2 Dynamic braking

Effective motor braking and short deceleration times are possible by using an external or internal braking chopper with an external brake resistor.

The internal braking chopper is assembled in the factory (available in certain models). It has the same continuous current specification as the unit itself.

Select the correct brake resistor to get the desired braking effect. More information can be found in the separate brake manual.

13.3 I/O- expander board

The available I/O can be increased by using the I/O- expander boards. I/O-expander boards can be installed in the option board position inside the open, protected, NEMA 1 and NEMA 12 models. For the Compact NEMA 1 model the board needs to be installed in a separate I/O-expander box.

More information can be found in the I/O-expander board manuals.

13.4 Communication

CX/CXL/CXS frequency converters can be connected to DeviceNet, Modbus RTU, Interbus-S, Profibus-DP and Lonworks systems by using the fieldbus option board.

The fieldbus board can be installed in the option board position inside the open, protected, NEMA 1 and NEMA 12 models. For the compact NEMA 1 model the board needs to be installed in a separate I/O-expander box.

More information can be found in the separate communication manuals.

13.6 Graphics control panel

The Graphics control panel can be used inplace of the standard 3 line LCD panel. It provides:

- parameters, monitored items etc. in text format
- 3 monitored items at the same time in display
- one monitored item can be shown in increased text size with a graph bar
- The selected parameter value is shown on a graph bar
- 3 monitored items can be shown on the graphical trend display
- the parameters of the frequency converter can be uploaded to the panel and then downloaded to another inverter.

More information can be found in the Graphics Panel manual.

13.7 FCDRIVE

FCDrive is the PC based tool for control and monitoring of the CX/CXL/CXS. With FCDrive:

- parameters can be loaded from the unit, changed, saved to a file or loaded back to the unit - parameters can be printed to paper or to a file
- references can be set
- the motor can be started and stopped
- signals can be examined in graphical form
- actual values can be displayed

The CX/CXL/CXS can be connected to a PC with a special RS232-cable.The same cable can be used for downloading specialized applications to the CX/CXL/CXS.

13.8 Operator panel door installation kit

An adapter kit is available to mount the operator display panel on an enclosure door.

13.9 Protected chassis cable cover for 75 - 125 HP open panel units

This optional cable cover provides a protected chassis capability equivalent to IP20.

Honeywell

Application Manual

Excel VRL

CX/CXL/CXS

Constant and variable torque
Variable Speed Drives
for induction motors
1 Hp to 1100 Hp

Subject to changes without notice

EXCEL VRL CX/CXL/CXS APPLICATION MANUAL

CONTENTS

A General

This manual provides you with the information needed to apply these applications.

Each application is described in its own chapter. Section B tells how to select the application.

B Application selection

If the Basic Application is in use, first open the application package lock (parameter 1.15 = 0) Group 0 appears. By changing the value of parameter 0.1 a different application can be selected. See table B-1.

To change from one application to another, simply change the value of parameter 0.1 to that of the application desired: see table B-1.

Number	Parameter	Range	Description
0. 1	Application	1 —7	1 = Basic Application 2 = Standard Application 3 = Local / Remote Control Application 4 = Multi-step Speed Application 5 = PI-control Application 6 = Multi-purpose Control Application 7 = Pump and Fan Control Application

Table B-1 Application selection parameters.

Besides the parameter group 1, the applications also have parameter groups 2 — 8 available (see figure B-1).

Parameters of the groups sequentially follow each other and changing from the last parameter of one group to the first parameter of the next group or vice versa is done simply by pushing the arrow up/arrow down buttons.

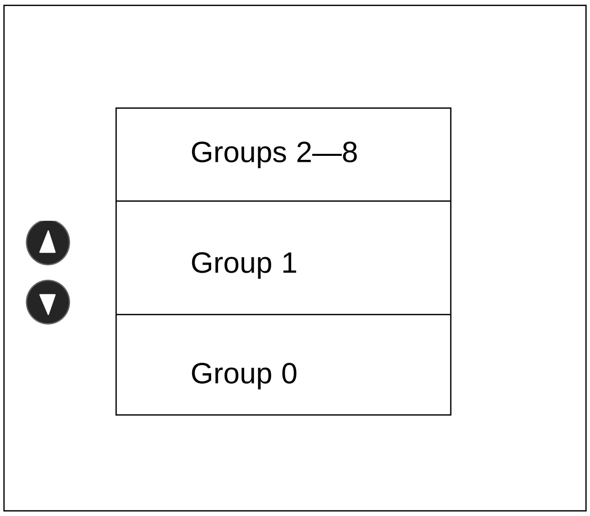


Figure B-1 Parameter Groups.

C Restoring default values of application parameters

Default values of the parameters of the applications 1 to 7 can be restored by selecting the same application again with parameter 0.1 or by setting the value of parameter 0.2 to 1. See User's manual chapter 12.

If parameter group 0 is not visible, make it visible as follows:

1. If parameter lock is set on, open the lock, parameter 1. 16, by setting the value of the parameter to 0.
2. If parameter conceal is set on, open the conceal parameter 1. 15, by setting the value of the parameter to 0.
   Group 0 becomes visible.

D Language selection

The language of the text shown on the operator's panel can be chosen with parameter 0. 3. See EXCEL VRL CX/CXL/ CXS User's Manual, chapter 11.

STANDARD CONTROL APPLICATION

(par. 0.1 = 2)

CONTENTS

1

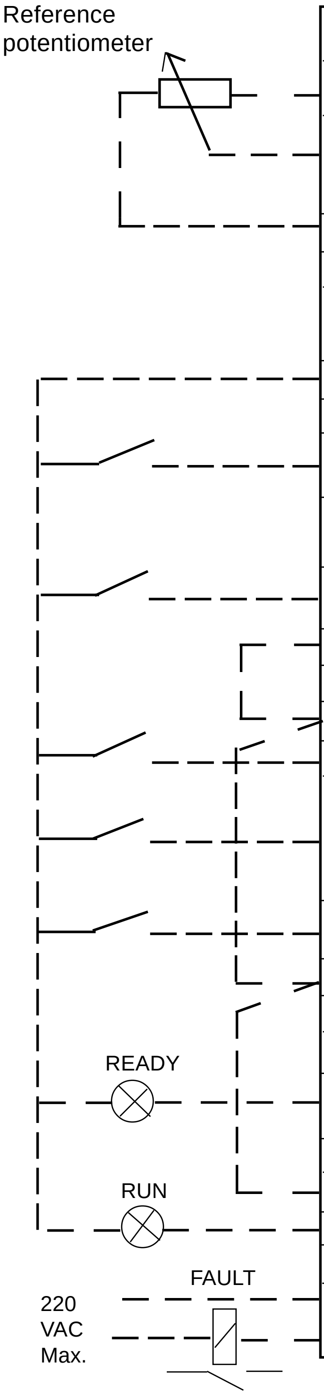
1 STANDARD APPLICATION

1.1 General

The Standard application has the same I/O signals and same Control logic as the Basic application. Digital input DIA3 and all outputs are programmable.

The Standard Application can be selected by setting the value of parameter 0. 1 to 2. Basic connections of inputs and outputs are shown in the figure 1.2-1. The control signal logic is shown in the figure 1.3-1. Programming of I/O terminals is explained in chapter 1.5.

1.2 Control I/O



Terminal		Signal	Description
1	$+10V_{ref}$	Reference output	Voltage for a potentiometer, etc.
2	$V_{in}+$	Analog input, voltage range 0—10 V DC	Frequency reference if activated if terminals 14 and 15 open and parameter 1.17 = 0 (default value)
3	GND	I/O ground	Ground for reference and controls
4	$I_{in}+$	Analog input, current range 0—20 mA	Frequency reference activated if terminals 14 and 15 closed, or open and parameter 1.17 = 1
5	$I_{in}-$		
6	+24V	Control voltage output	Voltage for switches, etc. max. 0.1 A
7	GND	I/O ground	Ground for reference and controls
8	DIA1	Start forward (Programmable)	Contact closed = start forward
9	DIA2	Start reverse (Programmable)	Contact closed = start reverse
10	DIA3	External fault input (Programmable)	Contact open = no fault Contact closed = fault
11	CMA	Common for DIA1—DIA3	Connect to GND or + 24V
12	+24V	Control voltage output	Voltage for switches, (same as #6)
13	GND	I/O ground	Ground for reference and controls
14	DIB4	Multi-step speed select 1	*DIB4* / *DIB5* / *Frequency ref.*
15	DIB5	Multi-step speed select 2	open / open / Ref. V_{in} (par.1.17=0) closed / open / Multi-step ref. 1 open / closed / Multi-step ref. 2 closed / closed / Ref. I_{in} (term. #4,5)
16	DIB6	Fault reset	Contact open = no action Contact closed = fault reset
17	CMB	Common for DIB4—DIB6	Connect to GND or + 24V
18	$I_{out}+$	Output frequency	Programmable (par. 3. 1)
19	$I_{out}-$	Analog output	Range 0—20 mA/R_L max. 500 Ω
20	DO1	Digital output READY	Programmable (par. 3. 6) Open collector, I≤50 mA, V≤48 VDC
21	RO1	Relay output 1 RUN	Programmable (par. 3. 7)
22	RO1		
23	RO1		
24	RO2	Relay output 2 FAULT	Programmable (par. 3. 8)
25	RO2		
26	RO2		

Figure 1.2-1 Default I/O configuration and connection example of the Standard Application.

1.3 Control signal logic

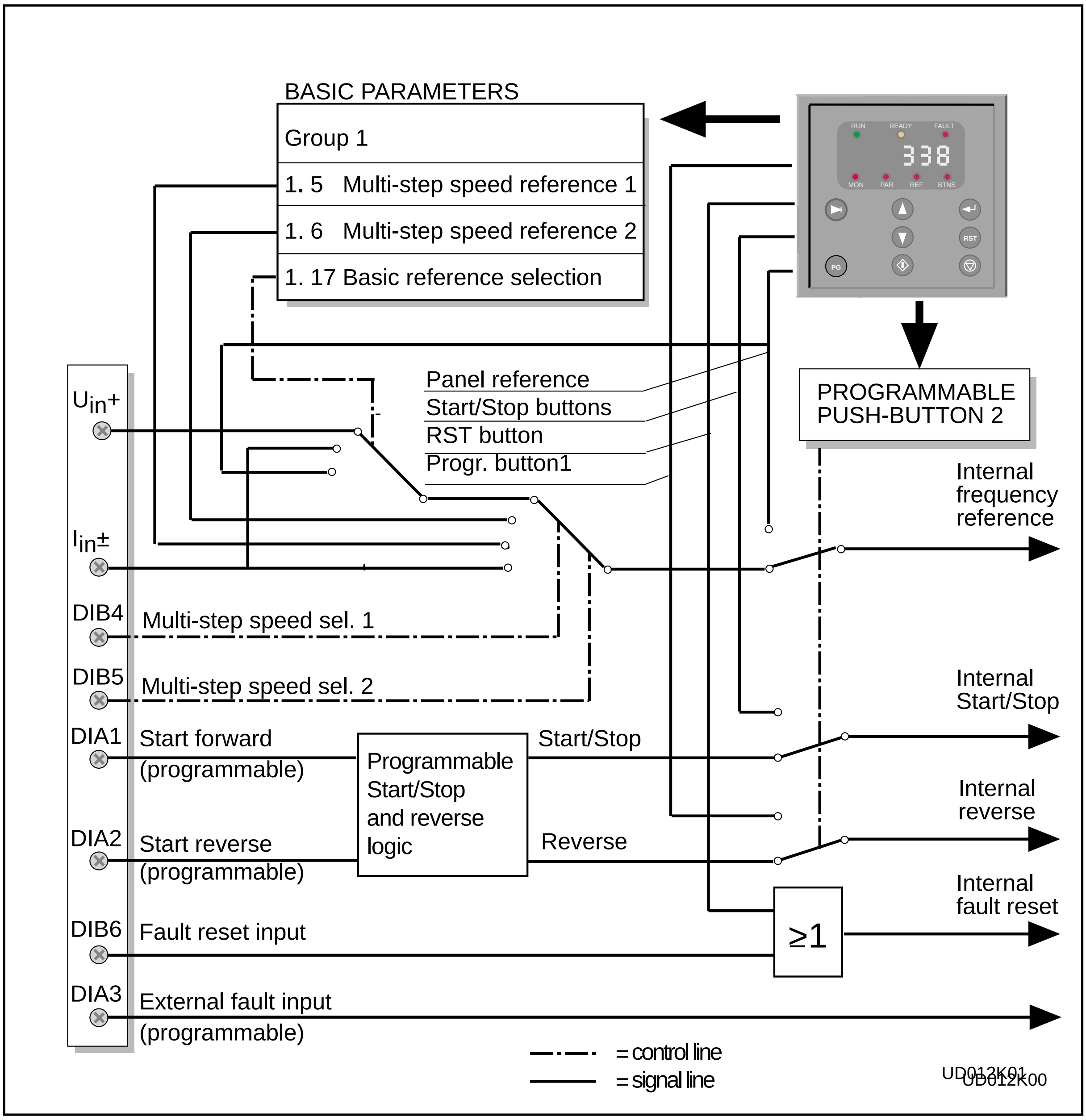


Figure 1.3-1 Control signal logic of the Standard Application.

1

1.4 PARAMETERS, GROUP 1

1.4.1 Parameter table

Code	Parameter	Range	Step	Default	Custom	Description	Page
1. 1	Minimum frequency	0—f_{max}	1 Hz	0 Hz			1-5
1. 2	Maximum frequency	f_{min}-120/500 Hz	1 Hz	60 Hz		*	1-5
1. 3	Acceleration time 1	0.1—3000.0 s	0.1 s	3,0 s		Time from f_{min} (1. 1) to f_{max} (1. 2)	1-5
1. 4	Deceleration time 1	0.1—3000.0 s	0.1 s	3.0 s		Time from f_{max} (1. 2) to f_{min} (1. 1)	1-5
1. 5	Multi-step speed reference 1	f_{min} —f_{max}	0.1 Hz	10.0 Hz			1-5
1. 6	Multi-step speed reference 2	f_{min} —f_{max}	0.1 Hz	60.0 Hz			1-5
1. 7	Current limit	0.1—2.5 x I_{nCX}	0.1 A	1.5 x I_{nCX}		Output current limit [A] of the unit	1-5
1. 8	V/Hz ratio selection	0—2	1	0		0 = Linear 1 = Squared 2 = Programmable V/Hz ratio	1-5
1. 9	V/Hz optimization	0 —1	1	0		0 = None 1 = Automatic torque boost	1-6
1. 10	Nominal voltage of the motor	180—690 V	1 V	230 V 380 V 480 V 575 V		CX/CXL/CXS V 3 2 CX/CXL/CXS V 3 4 CX/CXL/CXS V 3 5 CX V 3 6	1-7
1. 11	Nominal frequency of the motor	30—500 Hz	1 Hz	60 Hz		f_n from the nameplate of the motor	1-7
1. 12	Nominal speed of the motor	1—20000 rpm	1 rpm	1720 rpm **		n_n from the nameplate of the motor	1-7
1. 13	Nominal current of the motor	2.5 x I_{nCX}	0.1 A	I_{nCX}		I_n from the nameplate of the motor	1-7
1. 14	Supply voltage	208—240		230 V		CX/CXL/CXS V 3 2	1-7
		380—440		380 V		CX/CXL/CXS V 3 4	
		380—500		480 V		CX/CXL/CXS V 3 5	
		525—690		575 V		CX V 3 6	
1. 15	Parameter conceal	0—1	1	0		Visibility of the parameters: 0 = all parameter groups visible 1 = only group 1 is visible	1-7
1. 16	Parameter value lock	0—1	1	0		Disables parameter changes: 0 = changes enabled 1 = changes disabled	1-7
1. 17	Basic frequency reference selection	0—2	1	0		0 = analog input V_n 1 = analog input I_n 2 = reference from the panel	1-7

Table 1.4-1 Group 1 basic parameters.

Note! = Parameter value can be changed only when the drive is stopped.

* If 1. 2 > motor synchr. speed, check suitability for motor and drive system.
Selecting 120 Hz/500 Hz range see page 1-5.
** Default value for a four pole motor and a nominal size drive.

1.4.2 Description of Group 1 parameters

1. 1, 1. 2 Minimum/maximum frequency

Defines the frequency limits of the drive.

The default maximum value for parameters 1**.** 1 and 1**.** 2 is 120 Hz. By setting the value of the parameter 1**.** 2 to 120 Hz when the drive is stopped (RUN indicator not lit) parameters 1**.** 1 and 1**.** 2 are changed to 500 Hz. At the same time the resolution of the display panel is changed from 0.01 Hz to 0.1 Hz.

Changing the max. value from 500 Hz to 120 Hz in done by setting parameter 1**.** 2 to 119 Hz while the drive is stopped.

1. 3, 1. 4 Acceleration time1, deceleration time 1:

These limits correspond to the time required for the output frequency to accelerate from the set minimum frequency (par. 1**.** 1) to the set maximum frequency (par. 1**.** 2).

1. 5, 1. 6 Multi-step speed reference 1, Multi-step speed reference 2:

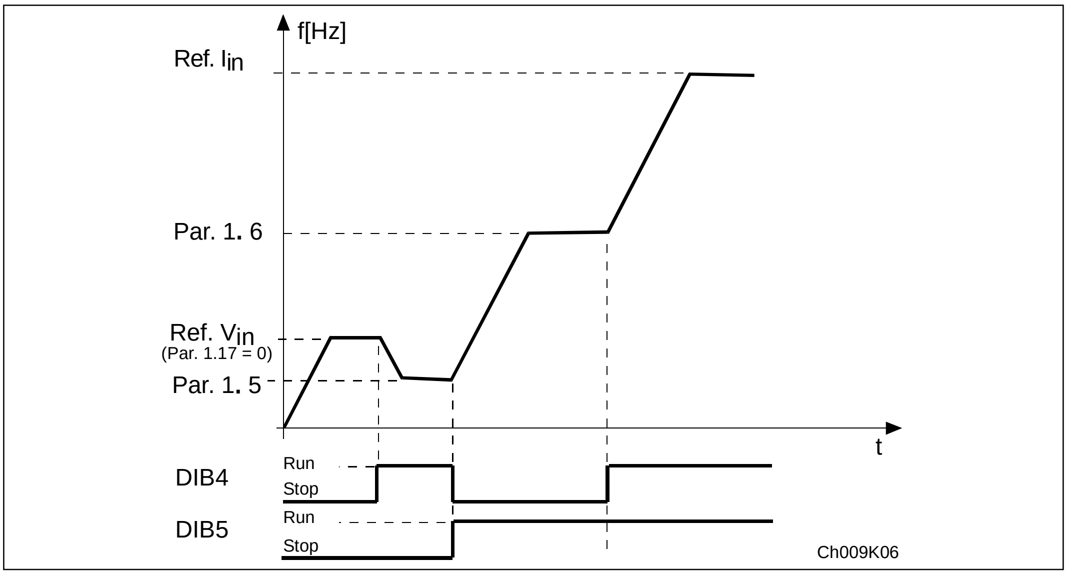


Figure 1.4-1 Example of Multi-step speed references.

Parameter values are automatically limited between minimum and maximum frequency (par 1**.** 1, 1**.** 2).

1. 7 Current limit

This parameter determines the maximum motor current that the CX/CXL/CXS will provide short term.

1. 8 V/Hz ratio selection

Linear: **0**

The voltage of the motor changes linearly with the frequency in the constant flux area from 0 Hz to the field weakening point (par. 6**.** 3) where a constant voltage (nominal value) is supplied to the motor. See figure 1.4-2.

A linear V/Hz ratio should be used in constant torque applications. **This default setting should be used if there is no special requirement for another setting.**

Squared: The voltage of the motor changes following a squared curve form with the frequency in the area from 0 Hz to the field weakening
1 point (par. 6. 3) where the nominal voltage is also supplied to the motor. See figure 1.4-2.

The motor runs undermagnetized below the field weakening point and produces less torque and electromechanical noise. A squared V/Hz ratio can be used in applications where the torque demand of the load is proportional to the square of the speed, e.g. in centrifugal fans and pumps.

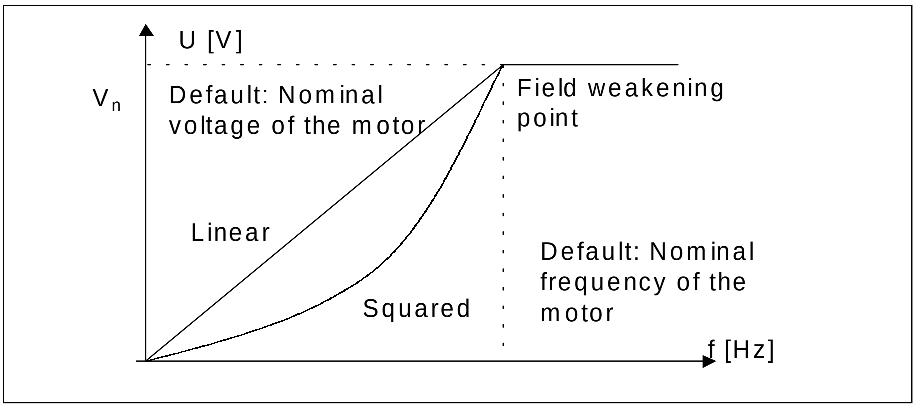


Figure 1.4-2 Linear and squared V/Hz curves.

Programm. V/Hz curve The V/Hz curve can be programmed with three different points. The parameters for programming are explained in chapter 1.5.2. A programmable V/Hz curve can be used if the standard settings
2 do not satisfy the needs of the application. See figure 1.4-3.

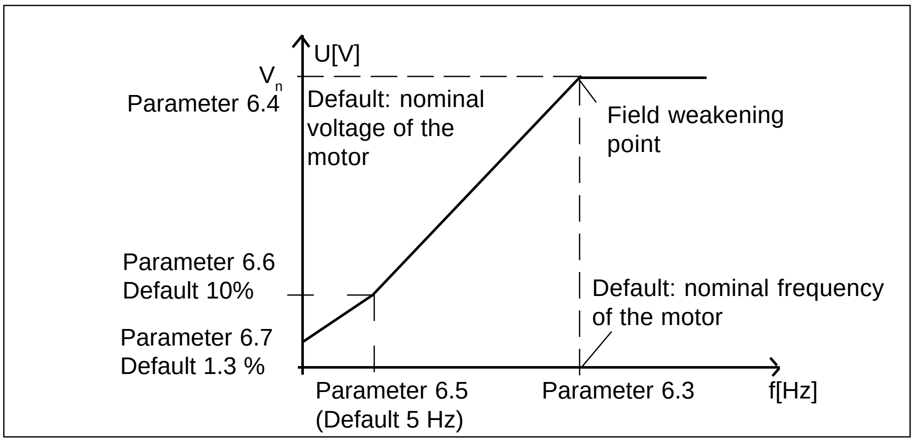


Figure 1.4-3 Programmable V/Hz curve.

1. 9 V/Hz optimization

Automatic torque The voltage to the motor changes automatically which allows the motor to produce enough torque to start and run at low frequencies. The boost voltage increase depends on the motor type and horsepower. Automatic torque boost can be used in applications where starting torque due to starting friction is high, e.g. in conveyors.

NOTE! *In high torque - low speed applications - it is likely that the motor will overheat.*
If the motor has to run for a prolonged time under these conditions, special attention must be paid to cooling the motor. Use external cooling for the motor if the operating temperature rise is too high.

1. 10 Nominal voltage of the motor

Find this value from the nameplate of the motor.
This parameter sets the voltage at the field weakening point, parameter 6**.** 4, to 100% x V_{nmotor}.

Note! If the nominal motor voltage is lower than the supply voltage, check that the insulation level of the motor is adequate.

1. 11 Nominal frequency of the motor

Find the nominal frequency f_n from the nameplate of the motor.
This parameter sets the field weakening point, parameter 6**.** 3, to the same value.

1. 12 Nominal speed of the motor

Find this value n_n from the nameplate of the motor.

1. 13 Nominal current of the motor

Find the value I_n from the nameplate of the motor.
The internal motor protection function uses this value as a reference value.

1. 14 Supply voltage

Set parameter value according to the nominal voltage of the supply.
Values are predefined for CX/CXL/CXS V 3 2, CX/CXL/CXS V 3 4, CX/CXL/CXS V 3 5 and CX V 3 6, see table 1.4-1.

1. 15 Parameter conceal

Defines which parameter groups are available:

0 = all groups are visible
1 = only group 1 is visible

1. 16 Parameter value lock

Permits access for changing the parameter values:

0 = parameter value changes enabled
1 = parameter value changes disabled

1. 17 Basic frequency reference selection

0 Analog voltage reference from terminals 2—3, e.g. a potentiometer
1 Analog current reference from terminals 4—5, e.g. a transducer.
2 Panel reference is the reference set from the Reference Page (REF), see chapter 7.5.

1.5 SPECIAL PARAMETERS, GROUPS 2—8

1.5.1 Parameter tables

Group 2, Input signal parameters

Code	Parameter	Range	Step	Default	Custom	Description		Page
						DIA1	DIA2	
2. 1	Start/Stop logic selection	0—3	1	0		0 = Start forward 1 = Start/Stop 2 = Start/Stop 3 = Start pulse	Start reverse Reverse Run enable Stop pulse	1-12
2. 2	DIA3 function (terminal 10)	0—5	1	1		0 = Not used 1 = Ext. fault, closing contact 2 = External fault, opening contact 3 = Run enable 4 = Acc./dec. time selection 5 = Reverse (if par. 2. 1 = 3)		1-13
2. 3	Reference offset for current input	0—1	1	0		0 = 0—20 mA 1 = 4—20 mA		1-13
2. 4	Reference scaling, minimum value	0—par. 2.5	1 Hz	0 Hz		Selects the frequency that corresponds to the minimum reference signal		1-13
2. 5	Reference scaling, maximum value	0—f_{max}	1 Hz	0 Hz		Selects the frequency that corresponds to the maximum reference signal 0 = Scaling off >0 = Maximum frequency value		1-13
2. 6	Reference invert	0—1	1	0		0 = No inversion 1 = Reference inverted		1-14
2. 7	Reference filter time	0.00 —10.00s	0.01s	0.10s		0 = No filtering		1-14

Group 3, Output and supervision parameters

Code	Parameter	Range	Step	Default	Custom	Description	Page
3. 1	Analog output function	0—7	1	1		0 = Not used Scale 100% 1 = O/P frequency (0—f_{max}) 2 = Motor speed (0—max. speed) 3 = O/P current (0—2.0xI_{nCX}) 4 = Motor torque (0—2xT_{nMot}) 5 = Motor power (0—2xP_{nMot}) 6 = Motor voltage (0—100%xV_{nMot}) 7 = DC-link volt. (0—1000 V)	1-15
3. 2	Analog output filter time	0.00—10.00 s	0.01s	1.00 s		0 = no filtering	1-15
3. 3	Analog output inversion	0—1	1	0		0 = Not inverted 1 = Inverted	1-15
3. 4	Analog output minimum	0—1	1	0		0 = 0 mA 1 = 4 mA	1-15
3. 5	Analog output scale	10—1000%	1%	100%			1-15

Note! = Parameter value can be changed only when the drive is stopped.

Group 3, Output and supervision parameters

Code	Parameter	Range	Step	Default	Custom	Description	Page
3. 6	Digital output function	0—14	1	1		0 = Not used 1 = Ready 2 = Run 3 = Fault 4 = Fault inverted 5 = CX overheat warning 6 = External fault or warning 7 = Reference fault or warning 8 = Warning 9 = Reversed 10 = Multi-step speed selected 11 = At speed 12 = Motor regulator activated 13 = Output frequency limit superv. 14 = Control from I/O-terminal	1-16
3. 7	Relay output 1 function	0—14	1	2		As parameter 3. 6	1-16
3. 8	Relay output 2 function	0—14	1	3		As parameter 3. 6	1-16
3. 9	Output freq. limit supervision function	0—2	1	0		0 = No 1 = Low limit 2 = High limit	1-16
3. 10	Output freq. limit supervision value	0.0—f_{max} (par. 1. 2)	0.1 Hz	0.0 Hz			1-16
3. 11	I/O-expander option board analog output function	0—7	1	3		As parameter 3. 1	1-15
3. 12	I/O-expander option board analog output scale	10—1000%	1%	100%		As parameter 3. 5	1-15

Group 4, Drive control parameters

Code	Parameter	Range	Step	Default	Custom	Description	Page
4. 1	Acc./Dec. ramp 1 shape	0.0—10.0 s	0.1 s	0.0 s		0 = Linear >0 = S-curve acc./dec. time	1-17
4. 2	Acc./Dec. ramp 2 shape	0.0—10.0 s	0.1 s	0.0 s		0 = Linear >0 = S-curve acc./dec. time	1-17
4. 3	Acceleration time 2	0.1—3000.0 s	0.1 s	10.0 s			1-17
4. 4	Deceleration time 2	0.1—3000.0 s	0.1 s	10.0 s			1-17
4. 5	Brake chopper	0—2	1	0		0 = Brake chopper not in use 1 = Brake chopper in use 2 = External brake chopper	1-17
4. 6	Start function	0—1	1	0		0 = Ramp 1 = Flying start	1-17
4. 7	Stop function	0—1	1	0		0 = Coasting 1 = Ramp	1-18
4. 8	DC-braking current	0.15—1.5 x I_{nCX} (A)	0.1 A	0.5 x I_{nCX}			1-18
4. 9	DC-braking time at Stop	0.00—250.00 s	0.01 s	0.00 s		0 = DC-brake is off	1-18

Note! = Parameter value can be changed only when the drive is stopped.

Group 5, Prohibit frequency parameters

Code	Parameter	Range	Step	Default	Custom	Description	Page
5. 1	Prohibit frequency range low limit	f_{min}—f_{max} par. 5. 2	0.1 Hz	0.0 Hz			1-19
5. 2	Prohibit frequency range high limit	f_{min}—f_{max} (1. 1) (1. 2)	0.1 Hz	0.0 Hz		0 = no prohibit frequency range (max limit = par. 1. 2)	1-19

Group 6, Motor control parameters

Code	Parameter	Range	Step	Default	Custom	Description	Page
6. 1	Motor control mode	0—1	1	0		0 = Frequency control 1 = Speed control	1-20
6. 2	Switching frequency	1.0—16.0 kHz	0.1	10/3.6 kHz		Dependant on Hp rating	1-20
6. 3	Field weakening point	30—500 Hz	1 Hz	Param. 1. 11			1-20
6. 4	Voltage at field weakening point	15—200% x V_{nmot}	1%	100%			1-20
6. 5	V/Hz curve mid point frequency	0.0—f_{max}	0.1 Hz	0.0 Hz			1-20
6. 6	V/Hz curve mid point voltage	0.00—100.00% x V_{nmot}	0.01%	0.00%			1-20
6. 7	Output voltage at zero frequency	0.00—100.0% x V_{nmot}	0.01%	0.00%			1-20
6. 8	Overvoltage controller	0—1	1	1		0 = Controller is off 1 = Controller is on	1-20
6. 9	Undervoltage controller	0—1	1	1		0 = Controller is off 1 = Controller is on	1-20

Note! = Parameter value can be changed only when the drive is stopped.

Group 7, Protections

Code	Parameter	Range	Step	Default	Custom	Description	Page
7. 1	Response to reference fault	0—3	1	0		0 = No action 1 = Warning 2 = Fault, stop according par. 4.7 3 = Fault, always coasting stop	1-21
7. 2	Response to external fault	0—3	1	2		0 = No action 1 = Warning 2 = Fault, stop according par. 4.7 3 = Fault, always coasting stop	1-21
7. 3	Phase supervision of the motor	0—2	2	2		0 = No action 2 = Fault	1-21
7. 4	Ground fault protection	0—2	2	2		0 = No action 2 = Fault	1-21
7. 5	Motor thermal protection	0—2	1	2		0 = No action 1 = Warning 2 = Fault	1-22
7. 6	Stall protection	0—2	1	1		0 = No action 1 = Warning 2 = Fault	1-22

Group 8, Autorestart parameters

Code	Parameter	Range	Step	Default	Custom	Description	Page
8. 1	Automatic restart: number of tries	0—10	1	0		0 = no action	1-23
8. 2	Automatic restart: multi-attempt max. trial time	1—6000 s	1 s	30 s			1-23
8. 3	Automatic restart: start function	0—1	1	0		0 = Ramp 1 = Flying start	1-24

Table 1.5-1 Special parameters, Groups 2—8.

1

1.5.2 Description of Group 2—8 parameters

2. 1 Start/Stop logic selection

0 DIA1: closed contact = start forward
DIA2: closed contact = start reverse,
See figure 1.5-1.

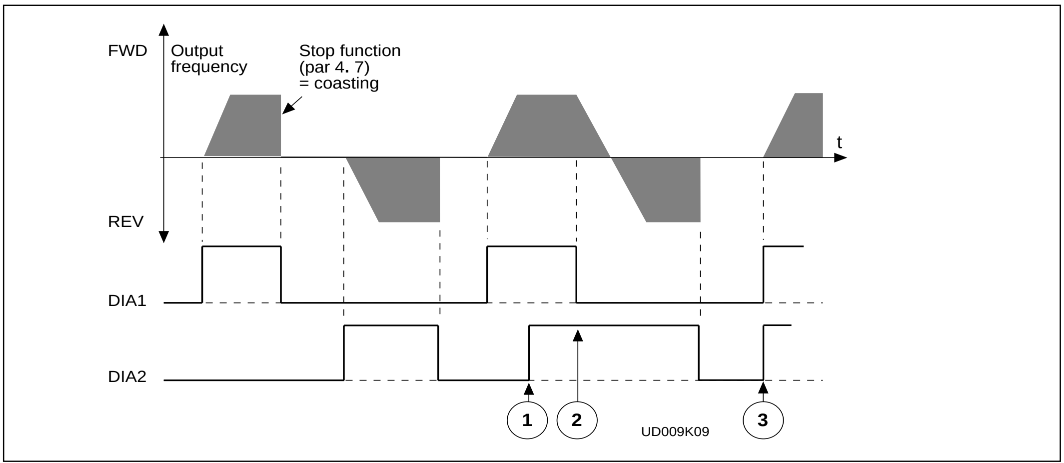


Figure 1.5-1 Start forward/Start reverse.

1. The first selected direction has the highest priority
2. When DIA1 contact opens, the direction of rotation starts to change
3. If Start forward (DIA1) and Start reverse (DIA2) signals are active simultaneously, the Start forward signal (DIA1) has priority.

1 DIA1: closed contact = start open contact = stop
DIA2: closed contact = reverse open contact = forward
See figure 1.5-2.

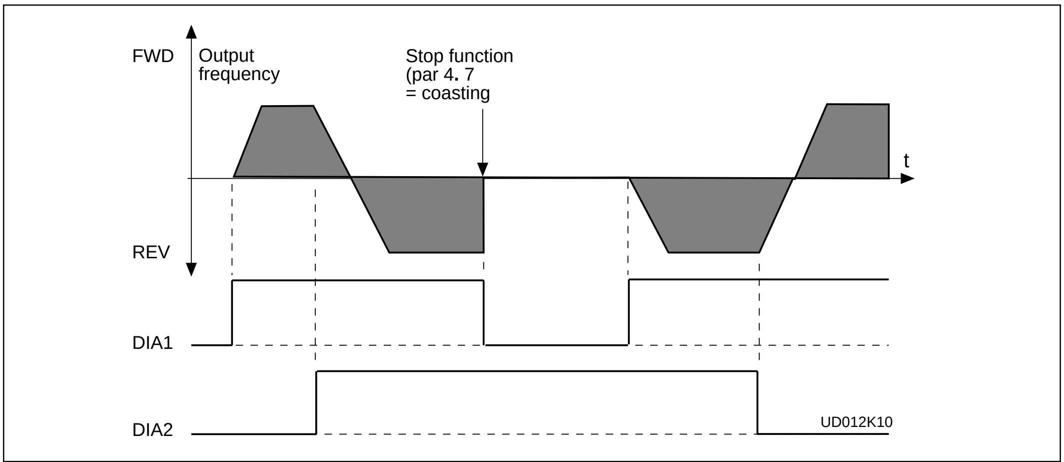


Figure 1.5-2 Start, Stop, reverse.

2: DIA1: closed contact = start open contact = stop
DIA2: closed contact = start enabled open contact = start disabled

3: 3-wire connection (pulse control):

DIA1: closed contact = start pulse
DIA2: closed contact = stop pulse
(DIA3 can be programmed for reverse command)
See figure 1.5-3.

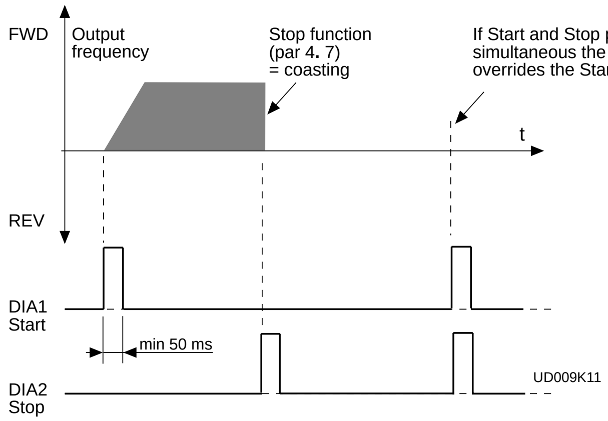


Figure 1.5-3 Start pulse/Stop pulse.

2. 2 DIA3 function

1: External fault, closing contact = Fault is shown and motor is stopped when the contact is closed.
2: External fault, opening contact = Fault is shown and motor is stopped when the contact is open.

3: Run enable contact open = Start of the motor disabled
contact closed = Start of the motor enabled

4: Acc. / Dec time select. contact open = Acceleration/Deceleration time 1 selected
contact closed = Acceleration/Deceleration time 2 selected

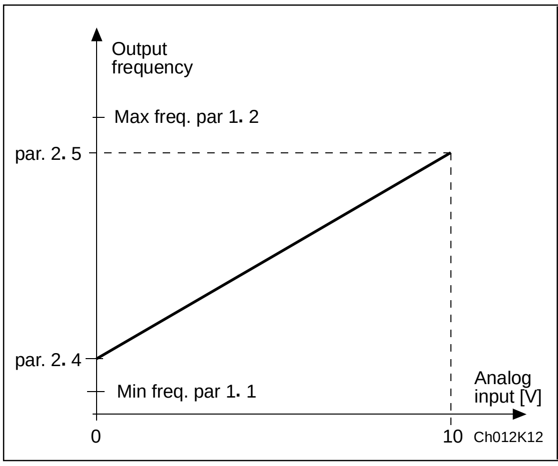
5: Reverse contact open = Forward
contact closed = Reverse
Can be used for reversing if parameter 2. 1 has value 3

2.3 Reference offset for current input

0: No offset
1: Offset 4 mA, provides supervision of zero level signal. The response to reference fault can be programmed with the parameter 7. 1.

2.4, 2.5 Reference scaling, minimum value/maximum value

Setting value limits: 0 ≤ par. 2. 4 ≤ par. 2. 5 ≤ par. 1. 2.
If parameter 2. 5 = 0 scaling is set off. See figures 1.5-4 and 1.5-5.



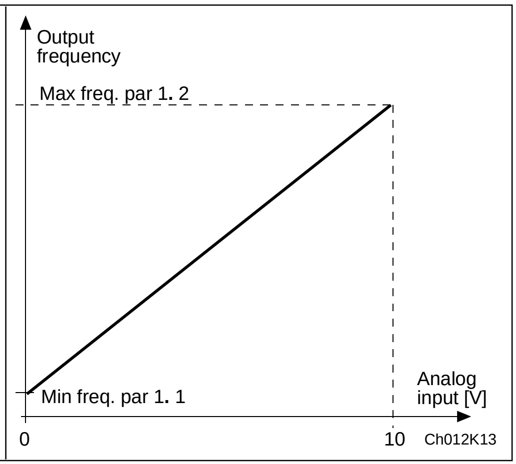


Figure 1.5-4 Reference scaling.

Figure 1.5-5 Reference scaling, parameter 2. 5 = 0.

2.6 Reference invert

Inverts reference signal:

max. ref. signal = min.set freq.
min. ref. signal = max. set freq.

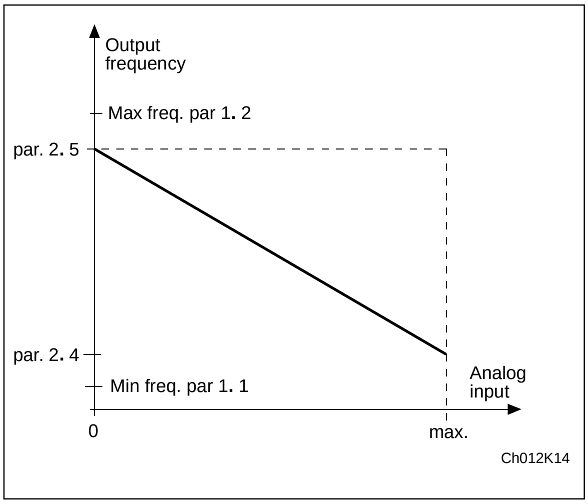


Figure 1.5-6 Reference invert.

2.7 Reference filter time

Filters out disturbances from the incoming reference signal. A long filtering time makes regulation response slower. See figure 1.5-7.

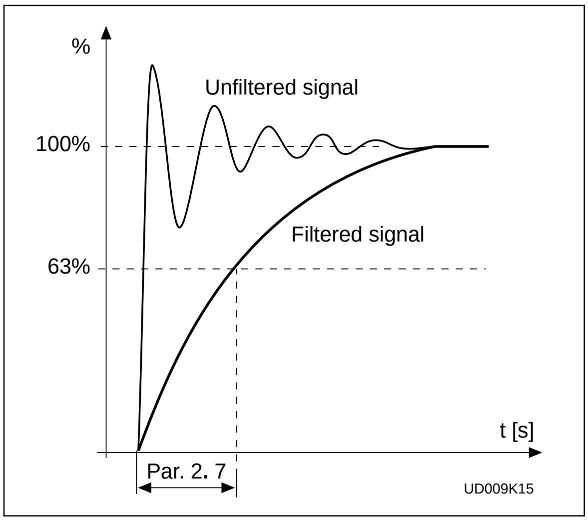


Figure 1.5-7 Reference filtering.

3. 1 Analog output function

See table "Group 3, output and supervision parameters" on the page 1-8.

3. 2 Analog output filter time

Filters the analog output signal. See figure 1.5-8.

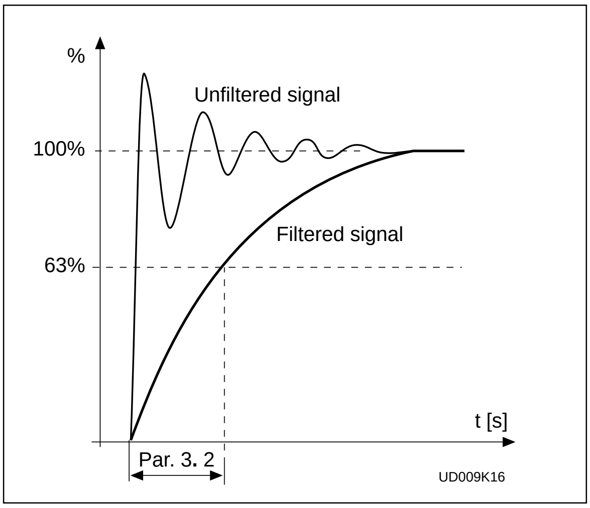


Figure 1.5-8 Analog output filtering.

3.3 Analog output invert

Inverts analog output signal:
max. output signal = minimum set value
min. output signal = maximum set value

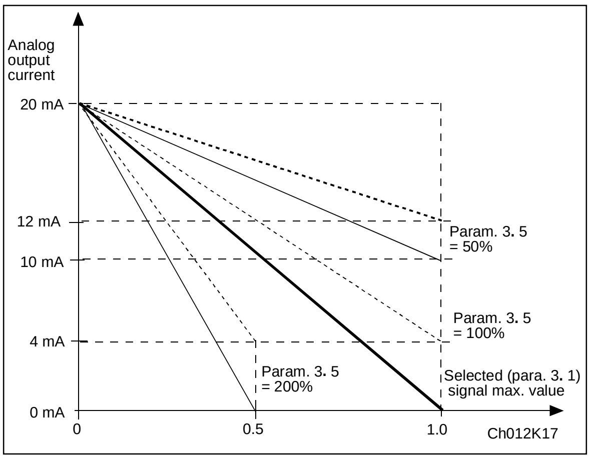


Figure 1.5-9 Analog output invert.

3. 4 Analog output minimum

Defines the signal minimum to be either 0 mA or 4 mA. See figure 1.5-10.

3. 5 Analog output scale

Scaling factor for analog output. See figure 1.5-10.

Signal	Max. value of the signal
Output frequency	Max. frequency (p. 1. 2)
Motor speed	Max. speed ($n_n x f_{max}/f_n$)
Output current	2 x I_{nCX}
Motor torque	2 x T_{nMot}
Motor power	2 x P_{nMot}
Motor voltage	100% x V_{nMot}
DC-link volt.	1000 V

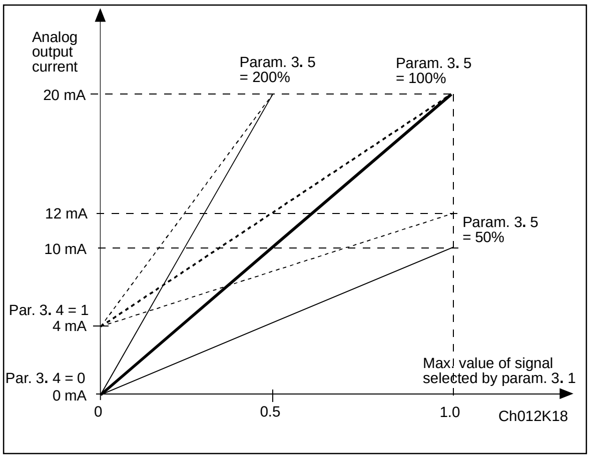


Figure 1.5-10 Analog output scale.

1

3. 6 Digital output function
3. 7 Relay output 1 function
3. 8 Relay output 2 function

Setting value	Signal content
0 = Not used	Out of operation
	Digital output DO1 sinks current and programmable relay (RO1, RO2) is activated when:
1 = Ready	The drive is ready to operate
2 = Run	The drive operates
3 = Fault	A fault trip has occurred
4 = Fault inverted	A fault trip has not occurred
5 = CX overheat warning	The heat-sink temperature exceeds +70°C
6 = External fault or warning	Fault or warning depending on parameter 7. 2
7 = Reference fault or warning	Fault or warning depending on parameter 7. 1 - if analog reference is 4—20 mA and signal is <4mA
8 = Warning	Always if a warning exists
9 = Reversed	The reverse command has been selected
10 = Multi-step speed selected	A multi-step speed has been selected
11 = At speed	The output frequency has reached the set reference
12 = Motor regulator activated	Overvoltage or overcurrent regulator was activated
13 = Output frequency supervision	The output frequency goes outside of the set supervision low limit/ high limit (par. 3. 9 and 3. 10)
14= Control from I/O terminals	Ext. control mode selected with progr. push-button #2

Table 1.5-2 Output signals via DO1 and output relays RO1 and RO2.

3. 9 Output frequency limit supervision function

0 = No supervision
1 = Low limit supervision
2 = High limit supervision

If the output frequency goes under/over the set limit (3. 10) this function generates a warning message via the digital output DO1 and via a relay output RO1 or RO2 depending on the settings of the parameters 3. 6—3. 8.

3. 10 Output frequency limit supervision value

The frequency value to be supervised by the parameter 3. 9.
See figure 1.5-11.

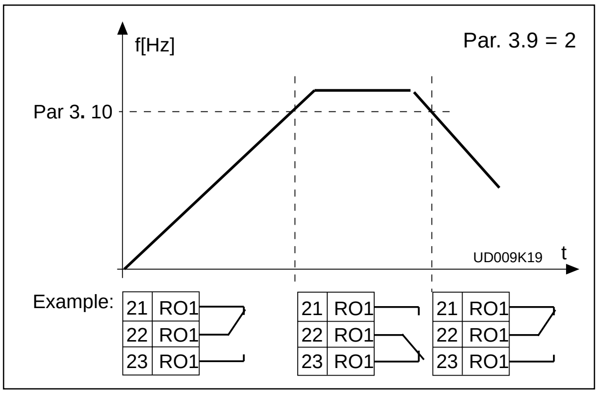


Figure 1.5-11 Output frequency supervision.

4. 1 Acc/Dec ramp 1 shape
4. 2 Acc/Dec ramp 2 shape

The acceleration and deceleration ramp shape can be programmed with these parameters.

Setting the value = 0 gives you a linear ramp shape. The output frequency immediately follows the input with a ramp time set by parameters 1. 3, 1. 4 (4. 3, 4. 4 for Acc/Dec. time 2).

Setting 0.1—10 seconds for 4. 1 (4. 2) causes an S-shaped ramp. The speed changes are smooth. Parameter 1. 3/ 1. 4 (4. 3/ 4. 4) determines the ramp time of the acceleration/deceleration in the middle of the curve. See figure 1.5-12.

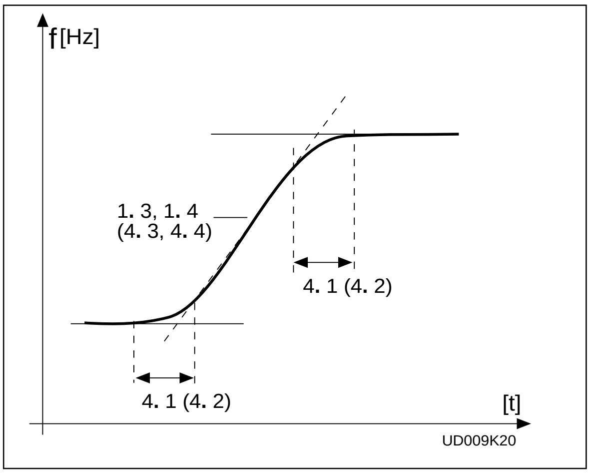


Figure 1.5-12 S-shaped acceleration/deceleration.

4. 3 Acceleration time 2
4. 4 Deceleration time 2

These values correspond to the time required for the output frequency to change from the set minimum frequency (par. 1. 1) to the set maximum frequency (par. 1. 2). With this parameter it is possibile to set two different acceleration/ deceleration times for one application. The active set can be selected with the programmable signal DIA3. See parameter 2. 2.

4. 5 Brake chopper

0 = No brake chopper
1 = Brake chopper and brake resistor installed
2 = External brake chopper

When the drive is decelerating the motor, the energy stored in the inertia of the motor and the load is fed into the external brake resistor. If the brake resistor is selected correctly the drive is able to decelerate the load with a torque equal to that of acceleration. See the separate Brake resistor installation manual.

4. 6 Start function

Ramp:

0 The drive starts from 0 Hz and accelerates to the set reference frequency within the set acceleration time. (Load inertia or starting friction may extend the acceleration times).

Flying start:

1 The drive starts into a running motor by first finding the speed the motor is running at. Searching starts from the maximum frequency down until the actual frequency reached. The output frequency then accelerates/decelerates to the set reference value at a rate determined by the acceleration/deceleration ramp parameters.

Use this mode if the motor may be coasting when the start command is given. With the flying start it is possible to ride through short utility voltage interruptions.

4. 7 Stop function

Coasting:

0 The motor coasts to an uncontrolled stop with the frequency converter off, after the Stop command is issued.

Ramp:

1 After the Stop command is issued, the speed of the motor is decelerated based on the deceleration ramp time parameter.
If the regenerated energy is high, it may be necessary to use an external braking resistor for faster deceleration.

4. 8 DC braking current

Defines the current injected into the motor during DC braking.

4. 9 DC braking time at stop

Determines whether DC braking is ON or OFF. It also determines the braking duration time of the DC-brake when the motor is stopping. The function of the DC-brake depends on the stop function, parameter 4**.** 7. See figure 1.5-13.

0 DC-brake is not used

>0 DC-brake is in use depending on the setup of the stop function (param. 4**.** 7). The time is set by the value of parameter 4**.** 9:

<u>Stop-function = 0 (coasting):</u>

After the stop command, the motor will coast to a stop with the frequency converter off.

With DC-injection, the motor can be electrically stopped in the shortest possible time, without using an optional external braking resistor.

The braking time is scaled according to the frequency when the DC- braking starts. If the frequency is $\geq$ nominal frequency of the motor (par. 1.11), the value of parameter 4.9 determines the braking time. When the frequency is $\leq$ 10% of the nominal, the braking time is 10% of the set value of parameter 4.9. See figure 1.5-13.

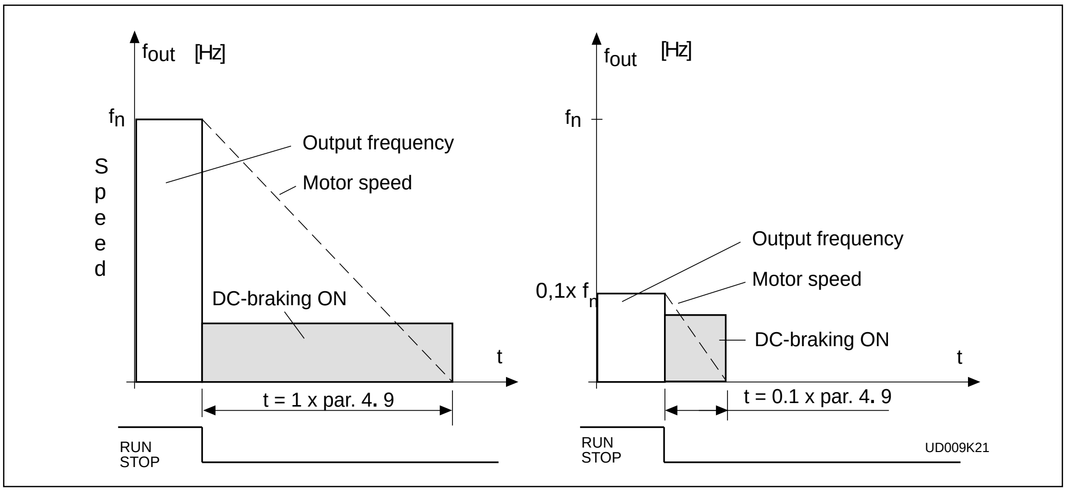


Figure 1.5-13 DC-braking time when stop = coasting.

Stop-function = 1 (ramp):

After a Stop command, the speed of the motor is reduced based on the deceleration ramp parameter. If no regeneration occurs due to load inertia DC-braking starts at a speed defined by parameter 4. 10.

The braking time is defined by par. 4. 9. If the load has a high inertia, use an external braking resistor for faster deceleration.

See figure 1.5-14.

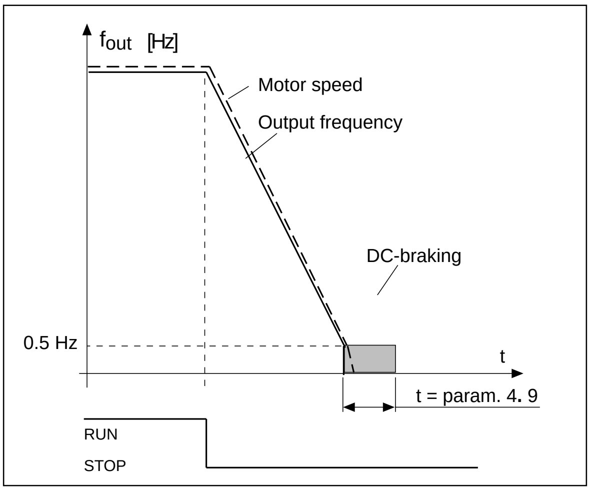


Figure 1.5-14 DC-braking time when stop function = ramp.

5. 1 Prohibit frequency area
5. 2 Low limit/High limit

In some systems it may be necessary to avoid certain frequencies because of mechanical resonance problems.

With these parameters it is possible to set limits for one "skip frequency" region between 0 Hz and 120 Hz/500 Hz. Accuracy of the setting is 0.1 Hz.

See figure 1.5-15.

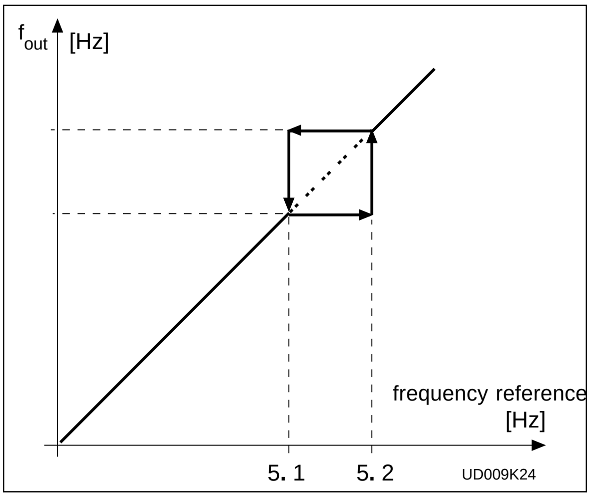


Figure 1.5-15 Example of prohibit frequency area setting.

6. 1 Motor control mode

0 = Frequency control: (V/Hz) — The I/O terminal and panel references are frequency references and the drive controls the output frequency (output freq. resolution 0.01 Hz)

1 = Speed control: (sensorless vector) — The I/O terminal and panel references are speed references and the drive controls the motor speed (control accuracy ± 0.5%).

6. 2 Switching frequency

Motor noise can be minimized by using a high switching frequency. Increasing the switching frequency reduces the current capacity of the CX/CXL/CXS.

Before changing the frequency from the factory default 10 kHz (3.6 kHz ≥40 Hp) check the drive derating in the curves shown in figures 5.2-2 and 5.2-3 in chapter 5.2 of the User's Manual.

6. 3 Field weakening point
6. 4 Voltage at the field weakening point

The field weakening point is the output frequency where the output voltage reaches the set maximum value (parameter 6**.** 4). Above that frequency the output voltage remains constant at the set maximum value. Below that frequency the output voltage depends on the setting of the V/Hz curve parameters 1**.** 8, 1**.** 9, 6**.** 5, 6**.** 6 and 6**.** 7. See figure 1.5-16.

When the parameters 1**.** 10 and 1**.** 11, nominal voltage and nominal frequency of the motor, are set, parameters 6**.** 3 and 6**.** 4 are also set automatically to the same values. If you need different values for the field weakening point and the maximum output voltage, change these parameters after setting parameters 1**.** 10 and 1**.** 11.

6. 5 V/Hz curve, middle point frequency

If the programmable V/Hz curve has been selected with parameter 1**.** 8, this parameter defines the middle frequency point of the curve. See figure 1.5-16.

6. 6 V/Hz curve, middle point voltage

If the programmable V/Hz curve has been selected with parameter 1**.** 8, this parameter defines the middle voltage point of the curve. See figure 1.5-16.

6. 7 Output voltage at zero frequency

If the programmable V/Hz curve has been selected with parameter 1**.** 8, this parameter defines the zero frequency voltage of the curve. See figure 1.5-16.

6. 8 Overvoltage controller
6. 9 Undervoltage controller

These parameters allow the over/undervoltage controllers to be switched ON or OFF. This may be useful in cases where the utility supply voltage varies more than -15%—+10% and the application requires a constant speed. If the controllers are ON, they will change the motor speed in over/undervoltage cases. Overvoltage = faster, undervoltage = slower.

Over/undervoltage trips may occur when the controllers are not used.

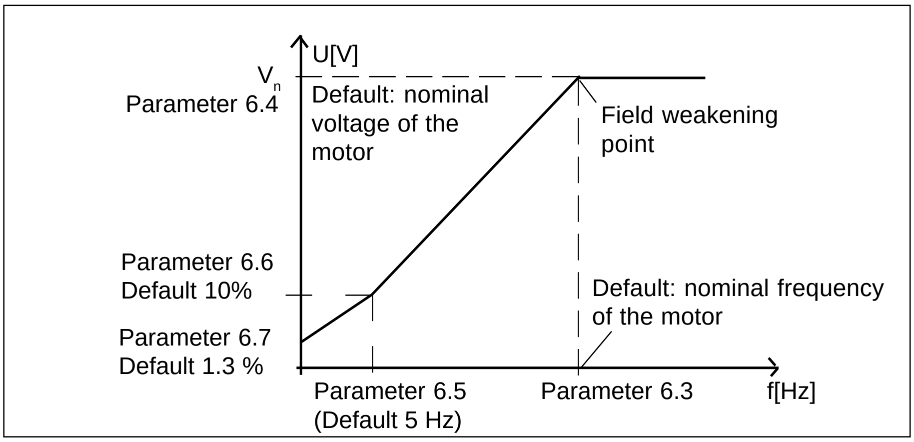


Figure 1.5-16 Programmable V/Hz curve.

7. 1 Response to reference faults

0 = No response
1 = Warning
2 = Fault, stop mode after fault detection according to parameter 4.7
3 = Fault, always coasting stop mode after fault detection

A warning or a fault action and message is generated if the 4—20 mA reference signal is used and the signal falls below 4 mA.
The information can also be programmed via digital output DO1 and via relay outputs RO1 and RO2.

7. 2 Response to external fault

0 = No response
1 = Warning
2 = Fault, stop mode after fault detection according to parameter 4.7
3 = Fault, always coasting stop mode after fault detection

A warning or a fault action and message is generated from the external fault signal in the digital input DIA3.

The information can also be programmed into digital output DO1 and into relay outputs RO1 and RO2.

7. 3 Phase supervision of the motor

0 = No action
2 = Fault

Phase supervision of the motor ensures that the motor phases have approximately equal current.

7. 4 Ground fault protection

0 = No action
2 = Fault

Ground fault protection ensures that the sum of motor phase currents is zero. The standard overcurrent protection is always present and protects the drive from ground faults with high current levels.

1

7.5 Motor thermal protection

Operation:
- 0 = Not in use
- 1 = Warning
- 2 = Trip

The motor thermal protection protects the motor from overheating. In the Standard application the thermal protection has fixed settings. In other applications it is possible to set the thermal protection parameters. A trip or a warning will give an indication on the display. If trip is selected, the drive will stop the motor and generate a fault.

Deactivating the protection by setting the parameter to 0 will reset the internal thermal model to 0% heating.

The CX/CXL/CXS drive is capable of providing higher than nominal current to the motor. If the load requires this high current there is a risk that motor will be thermally overloaded. This is true especially at low frequencies. With low frequencies the cooling effect of the motor fan is reduced and the capacity of the motor is reduced. Motor thermal protection is based on a calculated model and it uses the output current of the drive to determine the load on the motor.

The thermal current I_T specifies the load current above which the motor is overloaded. See figure 1.5-17. If the motor current is over the curve the motor temperature is increasing.

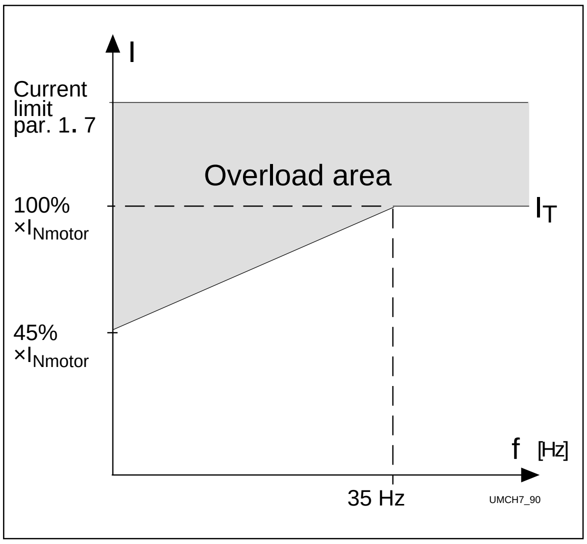


Figure 1.5-17 Motor thermal current I_T curve.

!	CAUTION!	*The calculated model does not protect the motor if the cooling of the motor is reduced either by blocking the airflow or due to dust or dirt.*

7. 6 Stall protection

Operation:
- 0 = Not in use
- 1 = Warning
- 2 = Trip function

The Motor Stall protection provides a warning or a fault based on a short time overload of the motor e.g. stalled shaft. The stall protection is faster than the motor thermal protection. The stall state is defined with Stall Current and Stall Frequency. In the Standard application they both have fixed values. See figure 1.5-18. If the current is higher than the set limit and output frequency is lower than the set limit the stall state is true. If the stall state lasts longer than 15 s a stall warning is given on the display panel. In the other applications it is possible to set the parameters of the Stall protection function. Tripping and warning will give a display indication. If tripping is set on, the drive will stop the motor and generate a fault.

Deactivating the stall protection by setting the parameter to 0 will reset the stall time counter to zero.

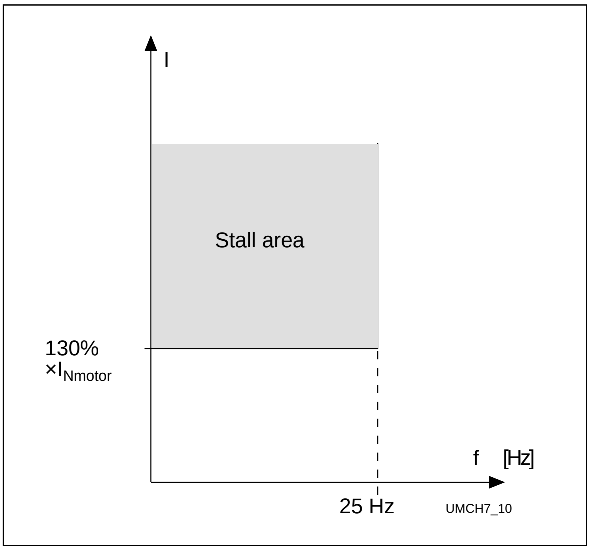


Figure 1.5-18 Stall state.

8. 1 Automatic restart: number of tries
8. 2 Automatic restart: trial time

The Automatic restart function will restart the drive after the following faults:

- overcurrent
- overvoltage
- undervoltage
- over/under temperature of the drive
- reference fault

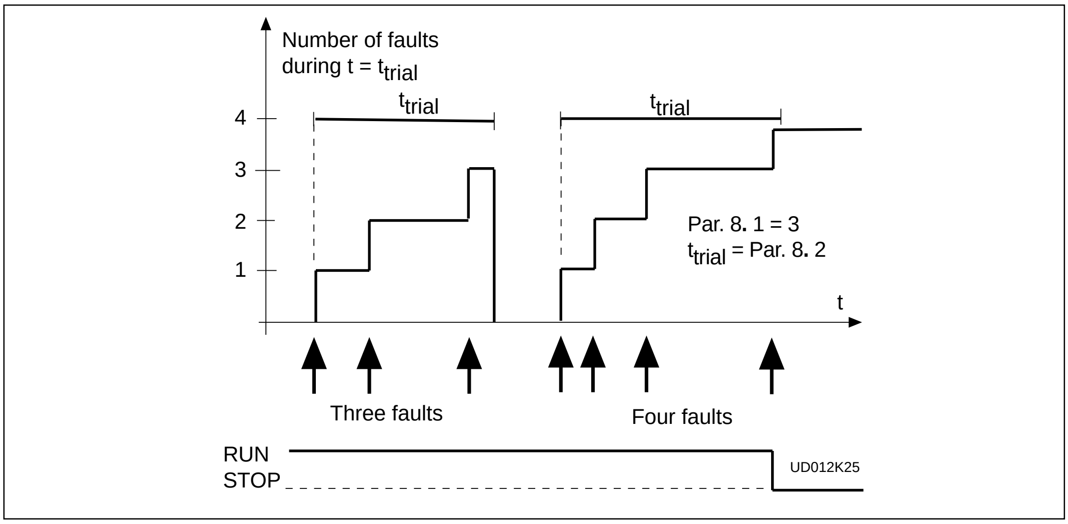


Figure 1.5-19 Automatic restart.

Parameter 8. 1 determines how many automatic restarts can be made during the trial time set by the parameter 8. 2.

The count time starts from the first autorestart. If the number of restarts does not exceed the value of the parameter 8.1 during the trial time, the count is cleared after the trial time has elapsed. The next fault starts the counting again.

1

8. 3 Automatic restart, start function

The parameter defines the start mode:

0 = Start with ramp
1 = Flying start, see parameter 4. 6.

Notes:

LOCAL/REMOTE CONTROL APPLICATION
(par. 0.1 = 3)

2

CONTENTS

2

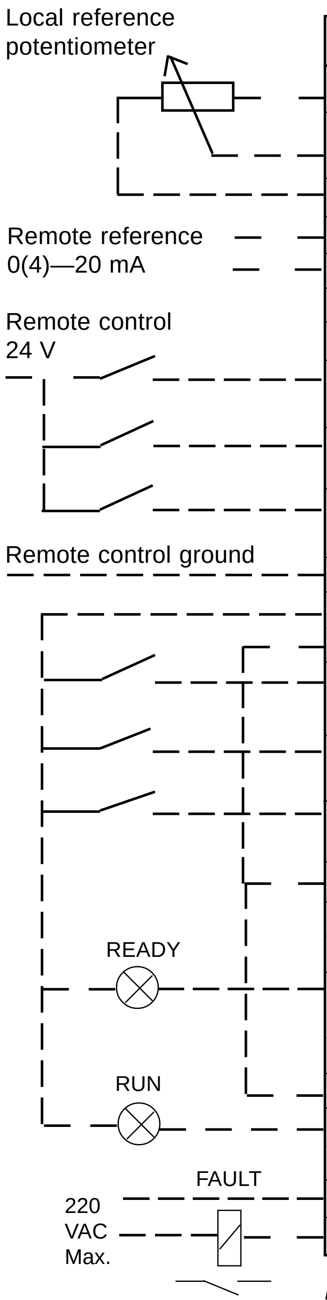
2.1 General

By utilizing the Local/Remote Control Application, the use of two different control and frequency reference sources is programmable. The active control source is selected with digital input DIB6.

The Local/Remote Control Application can be activated from the Group 0 by setting the value of parameter 0. 1 to 3.

Basic connections of inputs and outputs are shown in the figure 2.2-1. The control signal logic is shown in the figure 2.3-1. Programming of I/O terminals is explained in chapter 2.5, Special parameters.

2.2 Control I/O



Terminal		Signal	Description
1	$+10V_{ref}$	Reference output	Voltage for a potentiometer, etc.
2	$V_{in}+$	Analog input, voltage (programmable)	Source B frequency reference range 0—10 V DC
3	GND	I/O ground	Ground for reference and controls
4	$I_{in}+$	Analog input,	Source A frequency reference
5	$I_{in}-$	current (programmable)	range 0—20 mA
6	+24V	Control voltage output	Voltage for switches, etc. max. 0.1 A
7	GND	I/O ground	Ground for reference and controls
8	DIA1	Source A: Start forward (programmable)	Contact closed = start forward
9	DIA2	Source A: Start reverse (Programmable)	Contact closed = start reverse
10	DIA3	Fault reset (programmable)	Contact open = no action Contact closed = fault reset
11	CMA	Common for DIA1—DIA3	Connect to GND or + 24V
12	+24V	Control voltage output	Voltage for switches, (same as #6)
13	GND	I/O ground	Ground for reference and controls
14	DIB4	Source B: Start forward (programmable)	Contact closed = start forward
15	DIB5	Source B: Start reverse (programmable)	Contact closed = start reverse
16	DIB6	Source A/B selection	Contact open = source A is active Contact closed = source B is active
17	CMB	Common for DIB4—DIB6	Connect to GND or + 24V
18	$I_{out}+$	Output frequency	Programmable (par. 3. 1)
19	$I_{out}-$	Analog output	Range 0—20 mA/R_L max. 500 Ω
20	DO1	Digital output READY	Programmable (par. 3. 6) Open collector, I≤50 mA, V≤48 VDC
21	RO1	Relay output 1	Programmable (par. 3. 7)
22	RO1	RUN	
23	RO1		
24	RO2	Relay output 2	Programmable (par. 3. 8)
25	RO2	FAULT	
26	RO2		

Figure 2.2-1 Default I/O configuration and connection example of the Local/ Remote Control Application.

2.3 Control signal logic

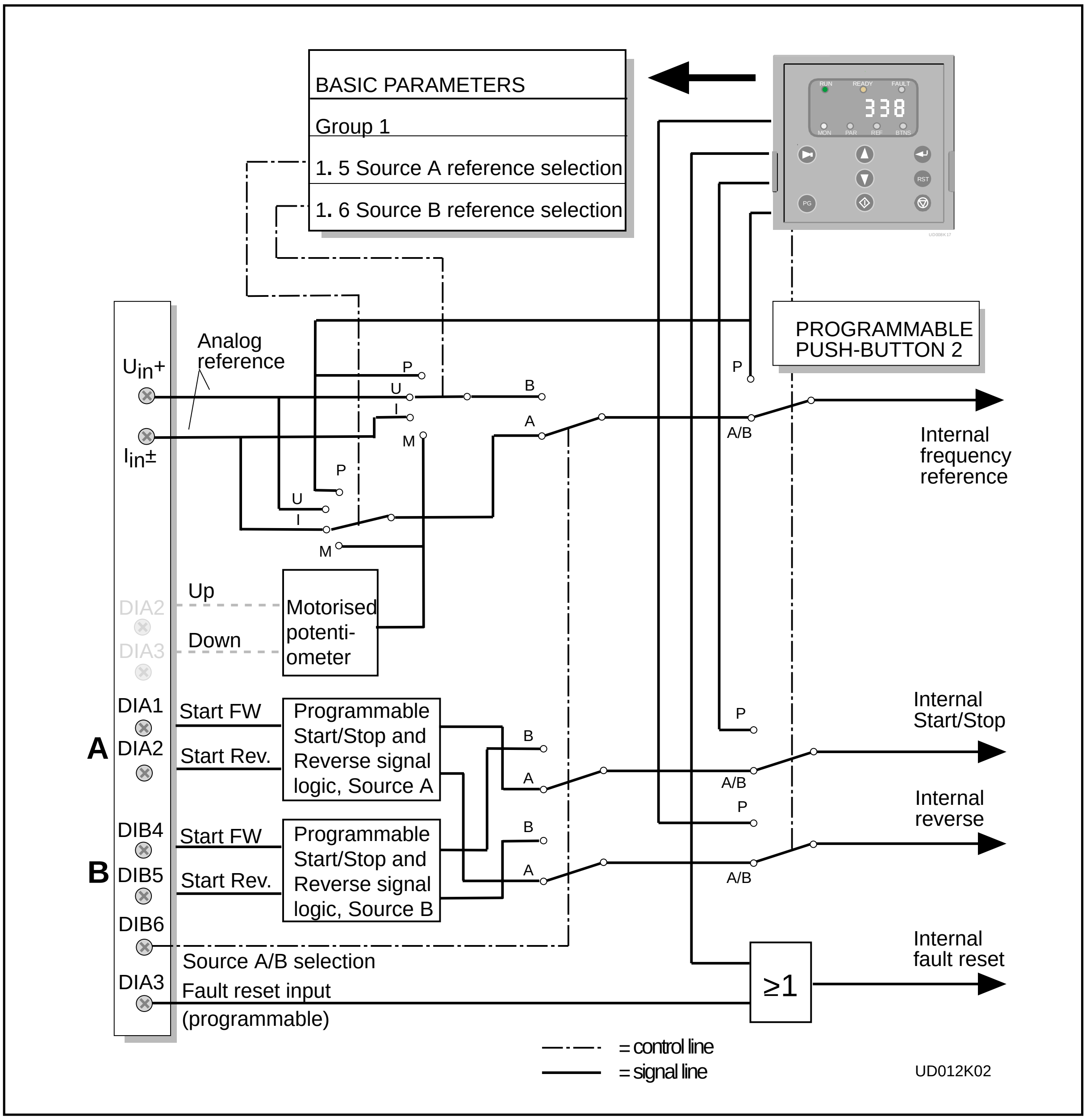


Figure 2.3-1 Control signal logic of the Local/Remote Control Application. Switch positions shown are based on the factory settings.

2

2.4 Basic parameters, Group 1

2.4.1 Parameter table

Code	Parameter	Range	Step	Default	Custom	Description	Page
1. 1	Minimum frequency	0—f_{max}	1 Hz	0 Hz			2-5
1. 2	Maximum frequency	f_{min}-120/500 Hz	1 Hz	60 Hz		*	2-5
1. 3	Acceleration time 1	0.1—3000.0 s	0.1 s	3.0 s		Time from f_{min} (1. 1) to f_{max} (1. 2)	2-5
1. 4	Deceleration time 1	0.1—3000.0 s	0.1 s	3.0 s		Time from f_{max} (1. 2) to f_{min} (1. 1)	2-5
1. 5	Source A: reference signal	0—4	1	1		0 = Anal. voltage input (term. 2) 1 = Anal. current input (term. 4) 2 = Set reference from the panel 3 = Signal from internal motor pot. 4 = Signal from internal motor pot. reset if CX is stopped	2-5
1. 6	Source B: reference signal	0—4	1	0		0 = Anal. voltage input (term. 2) 1 = Anal. current input (term. 4) 2 = Set reference from the panel 3 = Signal from internal motor pot. 4 = Signal from internal motor pot. reset if CX unit is stopped	2-5
1. 7	Current limit	0.1—2.5 x I_{nCX}	0.1	1.5 x I_{nCX}		Output current limit [A] of the unit	2-5
1. 8	V/Hz ratio selection	0—2	1	0		0 = Linear 1 = Squared 2 = Programmable V/Hz ratio	2-5
1. 9	V/Hz optimization	0—1	1	0		0 = None 1 = Automatic torque boost	2-7
1. 10	Nominal voltage of the motor	180—690 V	1 V	230 V 380 V 480 V 575 V		CX/CXL/CXS V 3 2 CX/CXL/CXS V 3 4 CX/CXL/CXS V 3 5 CX V 3 6	2-7
1. 11	Nominal frequency of the motor	30—500 Hz	1 Hz	60 Hz		f_n from the nameplate of the motor	2-7
1. 12	Nominal speed of the motor	1—20000 rpm	1 rpm	1720 rpm **		n_n from the nameplate of the motor	2-7
1. 13	Nominal current of the motor	2.5 x I_{nCX}	0.1 A	I_{nCX}		I_n from the nameplate of the motor	2-7
1. 14	Supply voltage	208—240		230 V		CX/CXL/CXS V 3 2	2-7
		380—440		400 V		CX/CXL/CXS V 3 4	
		380—500		500 V		CX/CXL/CXS V 3 5	
		525—690		690 V		CX V 3 6	
1. 15	Parameter conceal	0—1	1	0		Visibility of the parameters: 0 = All parameter groups visible 1 = Only group 1 is visible	2-7
1. 16	Parameter value lock	0—1	1	0		Disables parameter changes: 0 = Changes enabled 1 = Changes disabled	2-7

Table 2.4-1 Group 1 basic parameters.

Note! = Parameter value can be changed only when the drive is stopped.

* If 1. 2 > motor synchr. speed, check suitability for motor and drive system. Selecting 120 Hz/500 Hz range, see page 2-5.

** Default value for a four pole motor and a nominal size drive.

2.4.2 Description of Group 1 parameters

1. 1, 1. 2 Minimum / maximum frequency

Defines the frequency limits of the drive.

The default maximum value for parameters 1**.** 1 and 1**.** 2 is 120 Hz. By setting the value of parameter 1**.** 2 to 120 Hz when the drive is stopped (RUN indicator not lit) parameters 1**.** 1 and 1**.** 2 are changed to 500 Hz. At the same time the resolution of the panel reference is changed from 0.01 Hz to 0.1 Hz.

Changing the max. value from 500 Hz to 120 Hz is done by setting parameter 1**.** 2 to 119 Hz while the drive is stopped.

1. 3, 1. 4 Acceleration time1, deceleration time 1:

These limits correspond to the time required for the output frequency to accelerate from the set minimum frequency (par. 1**.** 1) to the set maximum frequency (par. 1**.** 2). Acceleration/deceleration times can be reduced with a free analog input signal, see parameters 2**.** 18 and 2**.** 19.

1. 5 Source A reference signal

0 Analog voltage reference from terminals 2—3, e.g. a potentiometer
1 Analog current reference trom terminals 4—5, e.g. a transducer.
2 Panel reference is the reference set from the Reference Page (REF),see chapter 7.5 in the User's Manual.
3 The reference value is controlled by digital input signals DIA2 and DIA3.
- switch in DIA2 closed = frequency reference increases
- switch in DIA3 closed = frequency reference decreases
The speed range for the reference change can be set with the parameter 2**.**3.
4 Same as setting 3 but the reference value is set to the minimum frequency (par. 2**.** 14 or par. 1. 1 if par 2. 15 = 0) each time the drive is stopped. When the value of parameter 1**.** 5 is set to 3 or 4, parameter 2**.** 1 is automatically set to 4 and parameter 2**.** 2 is automatically set to 10.

1. 6 Source B reference signal

See the values of the parameter 1**.** 5.

1. 7 Current limit

This parameter determines the maximum motor current that the CX/CXL/CXS will provide short term. Current limit can be set lower with a free analog input signal. See parameters 2**.** 18 and 2**.** 19.

1. 8 V/Hz ratio selection

Linear: **0** The voltage of the motor changes linearly with the frequency in the constant flux area from 0 Hz to the field weakening point (par. 6**.** 3) where a constant voltage (nominal value) is supplied to the motor. See figure 2.4-1.

A linear V/Hz ratio should be used in constant torque applications.

This default setting should be used if there is no special requirement for another setting.

Squared: The voltage of the motor changes following a squared curve form with the frequency in the area from 0 Hz to the field weakening

1 point (par. 6. 3) where the nominal maximum voltage is supplied to the motor. See figure 2.4-1.

The motor runs undermagnetized below the field weakening point and produces less torque and electromechanical noise. A squared V/Hz ratio can be used in applications where the torque demand of the load is proportional to the square of the speed, e.g. in centrifugal fans and pumps.

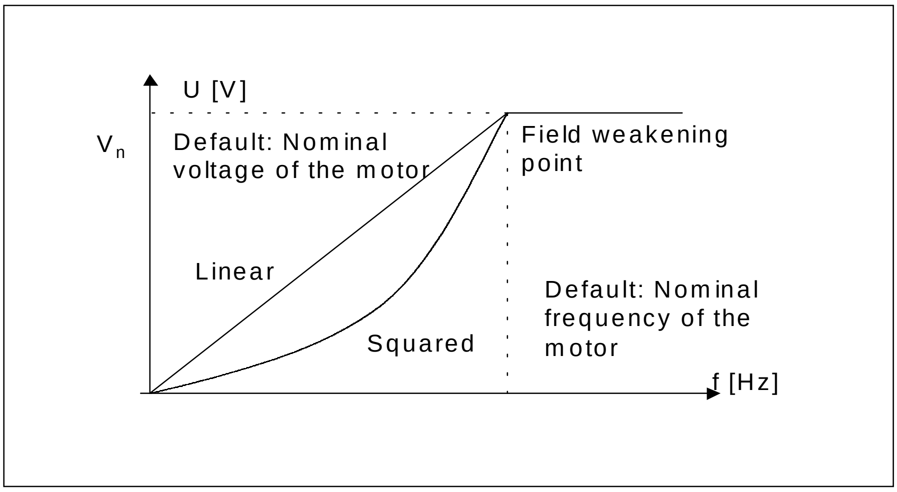


Figure 2.4-1 Linear and squared V/Hz curves.

Programm. V/Hz curve The V/Hz curve can be programmed with three different points. The parameters for programming are explained in chapter 2.5.2

2 Programmable V/Hz curve can be used if the standard settings do not satisfy the needs of the application. See figure 2.4-2.

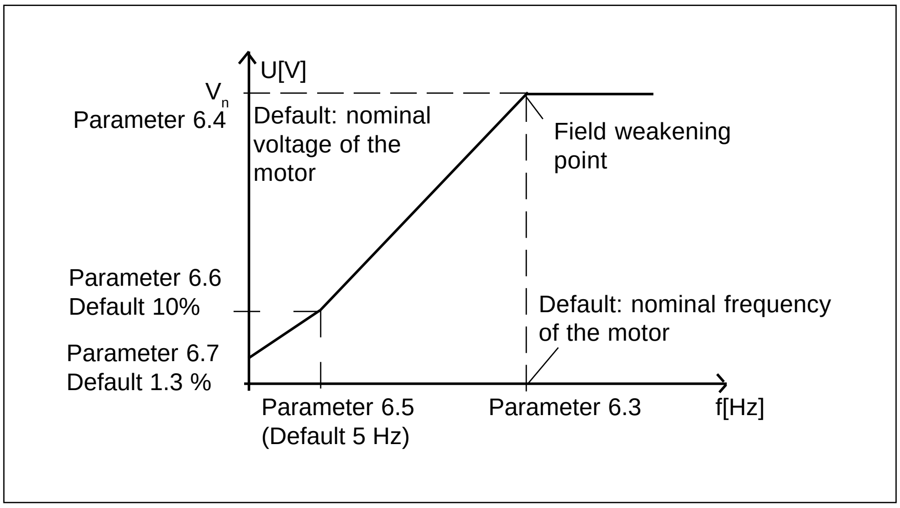


Figure 2.4-2 Programmable V/Hz curve.

1. 9 V/Hz optimization

Automatic torque boost: The voltage to the motor changes automatically which allows the motor to produce torque enough to start and run at low frequencies. The voltage increase depends on the motor type and horsepower.

Automatic torque boost can be used in applications where starting torque due to starting friction is high, e.g. in conveyors.

NOTE! *In high torque - low speed applications - it is likely the motor will overheat. If the motor has to run for a prolonged time under these conditions, special attention must be paid to cooling of the motor. Use external cooling for the motor if the temperature rise is too high.*

1. 10 Nominal voltage of the motor

Find this value V_n from the nameplate of the motor.
This parameter sets the voltage at the field weakening point, parameter 6**.** 4, to 100% x V_{nmotor}.

1. 11 Nominal frequency of the motor

Find the nominal frequency f_n from the nameplate of the motor.
This parameter sets the field weakening point, parameter 6**.** 3, to the same value.

1. 12 Nominal speed of the motor

Find this value n_n from the nameplate of the motor.

1. 13 Nominal current of the motor

Find the value I_n from the nameplate of the motor.
The internal motor protection function uses this value as a reference value.

1. 14 Supply voltage

Set parameter value according to the nominal voltage of the supply.
Values are pre-defined for CX/CXL/CXS V 3 2, CX/CXL/CXS V 3 4, CX/CXL/CXS V 3 5 and CX V 3 6. See table 2.4-1.

1. 15 Parameter conceal

Defines which parameter groups are available:

0 = all groups are visible
1 = only group 1 is visible

1. 16 Parameter value lock

Defines access for changing the parameter values:

0 = parameter value changes enabled
1 = parameter value changes disabled

If you have to adjust more of the functions of the Local/Remote Control Application, see chapter 2.5 to set up parameters of Groups 2—8.

2.5 Special parameters, Groups 2—8

2.5.1 Parameter tables, Group 2, Input signal parameters

Code	Parameter	Range	Step	Default	Custom	Description	Page
2. 1	Source A Start/Stop logic selection	0—4	1	0		DIA1 / DIA2 0 = Start forward / Start reverse 1 = Start/Stop / Reverse 2 = Start/Stop / Run enable 3 = Start pulse / Stop pulse 4 = Start forward / Motor pot. UP	2-15
2. 2	DIA3 function (terminal 10)	0—10	1	7		0 = Not used 1 = Ext. fault, closing contact 2 = External fault, opening contact 3 = Run enable 4 = Acc./dec. time selection 5 = Reverse (if par. 2. 1 = 3) 6 = Jog speed 7 = Fault reset 8 = Acc/dec. operation prohibit 9 = DC-braking command 10 = Motor potentiometer DOWN	2-16
2. 3	V_{in} signal range	0—1	1	0		0 = 0—10 V 1 = Custom setting range	2-17
2. 4	V_{in} custom setting min.	0.00—100.00%	0.01%	0.00%			2-17
2. 5	V_{in} custom setting max.	0.00—100.00%	0.01%	100.00%			2-17
2. 6	V_{in} signal inversion	0 — 1	1	0		0 = Not inverted 1 = Inverted	2-18
2. 7	V_{in} signal filter time	0.00 —10.00 s	0.01s	0.10s		0 = No filtering	2-18
2. 8	I_{in} signal range	0—2	1	0		0 = 0—20 mA 1 = 4—20 mA 2 = Custom setting range	2-19
2. 9	I_{in} custom setting minim.	0.00—100.00%	0.01%	0.00%			2-19
2. 10	I_{in} custom setting maxim.	0.00—100.00%	0.01%	100.00%			2-19
2. 11	I_{in} signal inversion	0—1	1	0		0 = Not inverted 1 = Inverted	2-19
2. 12	I_{in} signal filter time	0.01 —10.00 s	0.01s	0.10s		0 = No filtering	2-19
2. 13	Source B Start/Stop logic selection	0—3	1	0		DIB4 / DIB5 0 = Start forward / Start reverse 1 = Start/Stop / Reverse 2 = Start/Stop / Run enable 3 = Start pulse / Stop pulse	2-20
2. 14	Source A reference scaling minimum value	0—par. 2. 15	1 Hz	0 Hz		Sets the frequency corresponding to the min. reference signal	2-20
2. 15	Source A reference scaling maximum value	0—f_{max} (1. 2)	1 Hz	0 Hz		Sets the frequency corresponding to the max. reference signal 0 = Scaling off >0 = Scaled maximum value	2-20
2. 16	Source B reference scaling minimum value	0—par. 2. 17	1 Hz	0 Hz		Sets the frequency corresponding to the min. reference signal	2-20
2. 17	Source B reference scaling maximum value	0—f_{max} (1. 2)	1 Hz	0 Hz		Sets the frequency corresponding to the max. reference signal 0 = Scaling off >0 = Scaled maximum value	2-20

Note! = Parameter value can be changed only when the drive is stopped.

Code	Parameter	Range	Step	Default	Custom	Description	Page
2. 18	Free analog input, signal selection	0—2	1	0		0 = Not used 1 = V_{in} (analog voltage input) 2 = I_{in} (analog current input)	2-20
2. 19	Free analog input, function	0—4	1	0		0 = No function 1 = Reduces current limit (par. 1. 7) 2 = Reduces DC-braking current 3 = Reduces acc. and decel. times 4 = Reduces torque supervis. limit	2-20
2. 20	Motor potentiometer ramp time	0.1—2000.0 Hz/s	0.1 Hz/s	10.0 Hz/s			2-22

Group 3, Output and supervision parameters

Code	Parameter	Range	Step	Default	Custom	Description	Page
3. 1	Analog output function	0—7	1	1		0 = Not used Scale 100% 1 = O/P frequency (0—f_{max}) 2 = Motor speed (0—max. speed) 3 = O/P current (0—2.0 x I_{nCX}) 4 = Motor torque (0—2 x T_{nMot}) 5 = Motor power (0—2 x P_{nMot}) 6 = Motor voltage (0—100%xV_{nMot}) 7 = DC-link volt. (0—1000 V)	2-22
3. 2	Analog output filter time	0.00—10.00 s	0.01 s	100 s			2-22
3. 3	Analog output inversion	0—1	1	0		0 = Not inverted 1 = Inverted	2-22
3. 4	Analog output minimum	0—1	1	0		0 = 0 mA 1 = 4 mA	2-22
3. 5	Analog output scale	10—1000%	1%	100%			2-22
3. 6	Digital output function	0—21	1	1		0 = Not used 1 = Ready 2 = Run 3 = Fault 4 = Fault inverted 5 = CX overheat warning 6 = External fault or warning 7= Reference fault or warning 8 = Warning 9 = Reversed 10 = Jog speed selected 11 = At speed 12 = Motor regulator activated 13 = Output frequency limit superv. 1 14 = Output frequency limit superv. 2 15 = Torque limit supervision 16 = Reference limit supervision 17 = External brake control 18 = Control from I/O terminals 19 = Drive temperature limit supervision 20 = Unrequested rotation direction 21 = External brake control inverted	2-23

Note! = Parameter value can be changed only when the drive is stopped.

Code	Parameter	Range	Step	Default	Custom	Description	Page
3. 7	Relay output 1 function	0—21	1	2		As parameter 3. 6	2-23
3. 8	Relay output 2 function	0—21	1	3		As parameter 3. 6	2-23
3. 9	Output freq. limit 1 supervision function	0—2	1	0		0 = No 1 = Low limit 2 = High limit	2-24
3. 10	Output freq. limit 1 supervision value	0.0—f_{max} (par. 1. 2)	0.1 Hz	0.0 Hz			2-24
3. 11	Output freq. limit 2 supervision function	0—2	1	0		0 = No 1 = Low limit 2 = High limit	2-24
3. 12	Output freq. limit 2 supervision value	0.0—f_{max} (par. 1. 2)	0.1 Hz	0.0 Hz			2-24
3. 13	Torque limit supervision function	0—2	1	0		0 = No 1 = Low limit 2 = High limit	2-24
3. 14	Torque limit supervision value	0.0—200.0% x T_{nSV9}	0.1%	100.0%			2-24
3. 15	Active reference limit supervision	0—2	1	0		0 = No 1 = Low limit 2 = High limit	2-24
3. 16	Active reference limit supervision value	0.0—f_{max} (par. 1. 2)	0.1 Hz	0.0 Hz			2-24
3. 17	External brake OFF delay	0.0—100.0 s	0.1 s	0.5 s			2-25
3. 18	External brake ON delay	0.0—100.0 s	0.1 s	1.5 s			2-25
3. 19	Drive temperature limit supervision function	0—2	1	0		0 = No supervision 1 = Low limit 2 = High limit	2-25
3. 20	Drive temperature limit	-10—+75°C	1	+40°C			2-25
3. 21	I/O-expander board (opt.) analog output function	0—7	1	3		See parameter 3. 1	2-22
3. 22	I/O-expander board (opt.) analog output filter time	0.00—10.00 s	0.01 s	1.00 s		See parameter 3. 2	2-22
3. 23	I/O-expander board (opt.) analog output inversion	0—1	1	0		See parameter 3. 3	2-22
3. 24	I/O-expander board (opt.) analog output minimum	0—1	1	0		See parameter 3. 4	2-22
3. 25	I/O-expander board (opt.) analog output scale	10—1000%	1	100%		See parameter 3. 5	2-22

Note! = Parameter value can be changed only when the drive is stopped.

Group 4, Drive control parameters

Code	Parameter	Range	Step	Default	Custom	Description	Page
4. 1	Acc./Dec. ramp 1 shape	0.0—10.0 s	0.1 s	0.0 s		0 = Linear >0 = S-curve acc./dec. time	2-26
4. 2	Acc./Dec. ramp 2 shape	0.0—10.0 s	0.1 s	0.0 s		0 = Linear >0 = S-curve acc./dec. time	2-26
4. 3	Acceleration time 2	0.1—3000.0 s	0.1 s	10.0 s			2-26
4. 4	Deceleration time 2	0.1—3000.0 s	0.1 s	10.0 s			2-26
4. 5	Brake chopper	0—2	1	0		0 = Brake chopper not in use 1 = Brake chopper in use 2 = External brake chopper	2-26
4. 6	Start function	0—1	1	0		0 = Ramp 1 = Flying start	2-26
4. 7	Stop function	0—1	1	0		0 = Coasting 1 = Ramp	2-27
4. 8	DC-braking current	0.15—1.5 I_{nCX} (A)	0.1	0.5 x I_{nCX}			2-27
4. 9	DC-braking time at Stop	0.00—250.00 s	0.01 s	0.00 s		0 = DC-brake is off at Stop	2-27
4. 10	Turn on frequency of DC-brake during ramp Stop	0.1—10.0 Hz	0.1 Hz	1.5 Hz			2-28
4. 11	DC-brake time at Start	0.00—25.00 s	0.01 s	0.00 s		0 = DC-brake is off at Start	2-28
4. 12	Jog speed reference	f_{min} —f_{max}	0.1 Hz	10.0 Hz			2-29

Group 5, Prohibit frequency parameters

Code	Parameter	Range	Step	Default	Custom	Description	Page
5. 1	Prohibit frequency range 1 low limit	f_{min}—par. 5. 2	0.1 Hz	0.0 Hz			2-29
5. 2	Prohibit frequency range 1 high limit	f_{min}—f_{max} (1. 1) (1. 2)	0.1 Hz	0.0 Hz		0 = Prohibit range 1 is off	2-29
5. 3	Prohibit frequency range 2 low limit	f_{min}—par. 5. 4	0.1 Hz	0.0 Hz			2-29
5. 4	Prohibit frequency range 2 high limit	f_{min}—f_{max} (1. 1) (1. 2)	0.1 Hz	0.0 Hz		0 = Prohibit range 2 is off	2-29
5. 5	Prohibit frequency range 3 low limit	f_{min}—par. 5. 6	0.1 Hz	0.0 Hz			2-29
5. 6	Prohibit frequency range 3 high limit	f_{min}—f_{max} (1. 1) (1. 2)	0.1 Hz	0.0 Hz		0 = Prohibit range 3 is off	2-29

Note! = Parameter value can be changed only when the drive is stopped.

Group 6, Motor control parameters

Code	Parameter	Range	Step	Default	Custom	Description	Page
6. 1	Motor control mode	0—1	1	0		0 = Frequency control 1 = Speed control	2-29
6. 2	Switching frequency	1.0—16.0 kHz	0.1 kHz	10/3.6kHz		Depends on Hp rating	2-29
6. 3	Field weakening point	30—500 Hz	1 Hz	Param. 1. 11			2-29
6. 4	Voltage at field weakening point	15—200% x V_{nmot}	1%	100%			2-29
6. 5	V/Hz-curve mid point frequency	0.0—f_{max}	0.1 Hz	0.0 Hz			2-30
6. 6	V/Hz-curve mid point voltage	0.00—100.00 % x V_{nmot}	0.01%	0.00%			2-30
6. 7	Output voltage at zero frequency	0.00—100.00 % x V_{nmot}	0.01%	0.00%			2-30
6. 8	Overvoltage controller	0—1	1	1		0 = Controller is not operating 1 = Controller is operating	2-30
6. 9	Undervoltage controller	0—1	1	1		0 = Controller is not operating 1 = Controller is operating	2-30

Note! = Parameter value can be changed only when the drive is stopped.

Group 7, Protections

Code	Parameter	Range	Step	Default	Custom	Description	Page
7. 1	Response to reference fault	0—3	1	0		0 = No action 1 = Warning 2 = Fault, stop according to par. 4.7 3 = Fault, always coasting stop	2-30
7. 2	Response to external fault	0—3	1	0		0 = No action 1 = Warning 2 = Fault, stop according to par. 4.7 3 = Fault, always coasting stop	2-31
7. 3	Phase supervision of the motor	0—2	2	2		0 = No action 2 = Fault	2-31
7. 4	Ground fault protection	0—2	2	2		0 = No action 2 = Fault	2-31
7. 5	Motor thermal protection	0—2	1	2		0 = No action 1 = Warning 2 = Fault	2-32
7. 6	Motor thermal protection break point current	50.0—150.0% x I_{nMOTOR}	1.0%	100.0%			2-32
7. 7	Motor thermal protection zero frequency current	5.0—150.0% x I_{nMOTOR}	1.0%	45.0%			2-32
7. 8	Motor thermal protection time constant	0.5—300.0 minutes	0.5 min.	17.0 min.		Default value is set according to motor nominal current	2-33
7. 9	Motor thermal protection break point frequency	10—500 Hz	1 Hz	35 Hz			2-33
7. 10	Stall protection	0—2	1	1		0 = No action 1 = Warning 2 = Fault	2-34
7. 11	Stall current limit	5.0—200.0% x I_{nMOTOR}	1.0%	130.0%			2-34
7. 12	Stall time	2.0—120.0 s	1.0 s	15.0 s			2-34
7. 13	Maximum stall frequency	1—f_{max}	1 Hz	25 Hz			2-34
7. 14	Underload protection	0—2	1	0		0 = No action 1 = Warning 2 = Fault	2-35
7. 15	Underload prot., field weakening area load	10.0—150.0% x T_{nMOTOR}	1.0%	50.0%			2-35
7. 16	Underload protection, zero frequency load	5.0—150.0% x T_{nMOTOR}	1.0%	10.0%			2-35
7. 17	Underload time	2.0—600.0 s	1.0 s	20.0s			2-36

2

2

Group 8, Autorestart parameters

Code	Parameter	Range	Step	Default	Custom	Description	Page
8. 1	Automatic restart: number of tries	0—10	1	0		0 = Not in use	2-36
8. 2	Automatic restart: multi attempt maximum trial time	1—6000 s	1 s	30 s			2-36
8. 3	Automatic restart: start function	0—1	1	0		0 = Ramp 1 = Flying start	2-37
8. 4	Automatic restart of undervoltage	0—1	1	0		0 = No 1 = Yes	2-37
8. 5	Automatic restart of overvoltage	0—1	1	0		0 = No 1 = Yes	2-37
8. 6	Automatic restart of overcurrent	0—1	1	0		0 = No 1 = Yes	2-37
8. 7	Automatic restart of reference fault	0—1	1	0		0 = No 1 = Yes	2-37
8. 8	Automatic restart after over/undertemperature fault	0—1	1	0		0 = No 1 = Yes	2-37

Table 2.5-1 Special parameters, Groups 2—8.

2.5.2 Description of Groups 2—8 parameters

2. 1 Start/Stop logic selection

0: DIA1: closed contact = start forward
DIA2: closed contact = start reverse,
See figure 2.5-1.

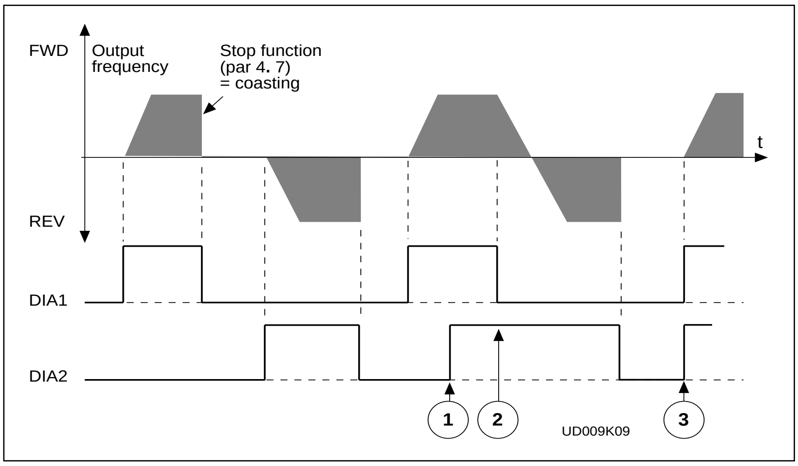


Figure 2.5-1 Start forward/Start reverse.

1. The first selected direction has the highest priority
2. When DIA1 contact opens, the direction of rotation starts to change
3. If Start forward (DIA1) and Start reverse (DIA2) signals are active simultaneously, the Start forward signal (DIA1) has priority.

1: DIA1: closed contact = start open contact = stop
DIA2: closed contact = reverse open contact = forward
See figure 2.5-2.

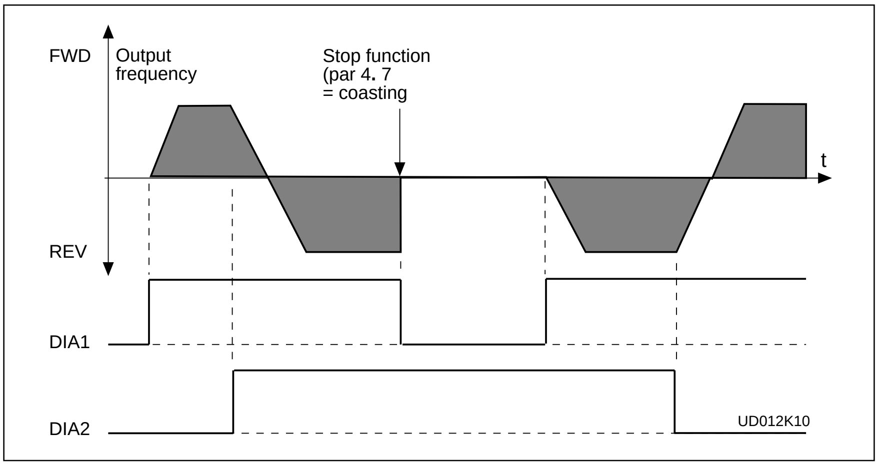


Figure 2.5-2 Start, Stop, reverse.

2: DIA1: closed contact = start — open contact = stop
DIA2: closed contact = start enabled — open contact = start disabled

3: 3-wire connection (pulse control):

DIA1: closed contact = start pulse
DIA2: closed contact = stop pulse
(DIA3 can be programmed for reverse command)
See figure 2.5-3.

4: DIA1: closed contact = start forward
DIA2: closed contact = reference increases (motor potentiometer reference, par. 2**.** 1 is automatically set to 4 if par. 1**.** 5 is set to 3 or 4).

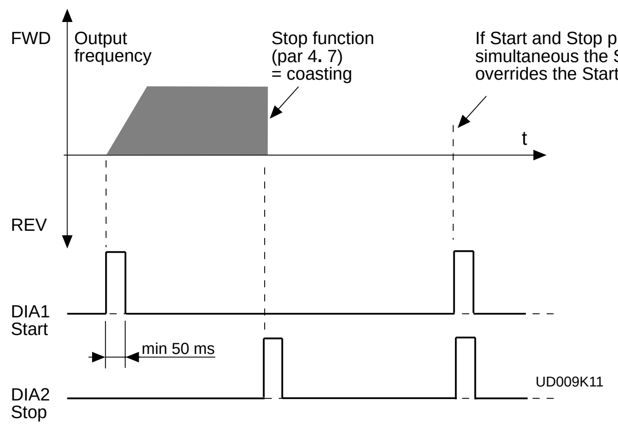


Figure 2.5-3 Start pulse /Stop pulse.

2. 2 DIA3 function

1:	External fault,	closing contact	= Fault is shown and motor is stopped when the contact is closed
2:	External fault,	opening contact	= Fault is shown and motor is stopped when the input is open
3:	Run enable	contact open	= Start of the motor disabled
		contact closed	= Start of the motor enabled
4:	Acc. / Dec time select.	contact open	= Acceleration/Deceleration time 1 selected
		contact closed	= Acceleration/Deceleration time 2 selected
5:	Reverse	contact open	= Forward — Can be used for reversing if parameter 2**.** 1 has value 3
		contact closed	= Reverse
6:	Jog freq.	contact closed	= Jog frequency selected for freq. refer.
7:	Fault reset	contact closed	= Resets all faults
8:	Acc./Dec. operation prohibited	contact closed	= Stops acceleration and deceleration until the contact is opened
9:	DC-braking command	contact closed	= In the stop mode, the DC-braking operates until the contact is opened, see figure 2.5-4. Dc-brake current is set with parameter 4**.** 8.
10:	Motor pot. meter down	contact closed	= Reference decreases until the contact is opened

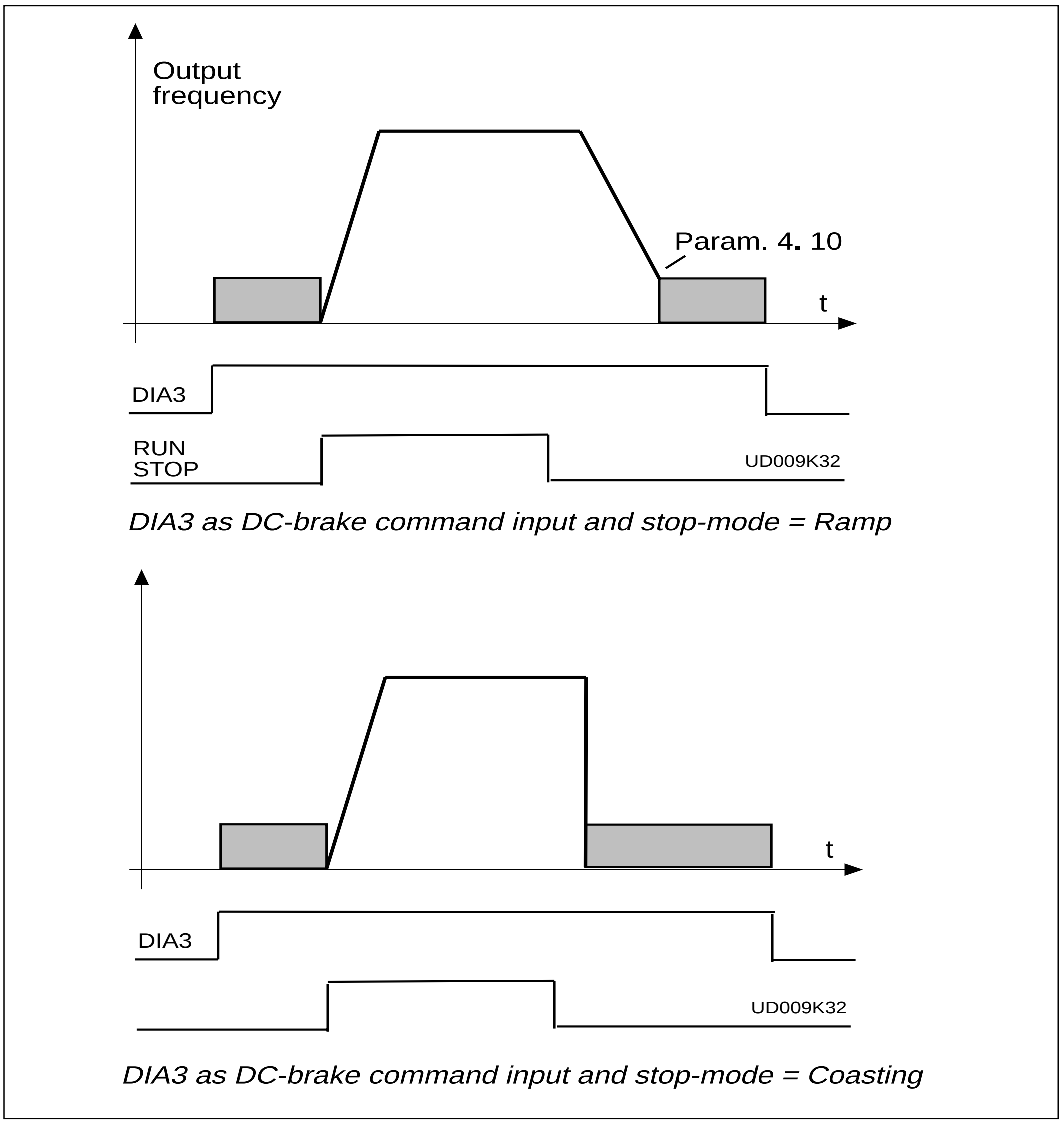


Figure 2.5-4 DIA3 as DC-brake command input: a) Stop-mode = Ramp, b) Stop-mode = Coasting.

2. 3 V_{in} signal range

0 = Signal range 0—10 V
1 = Custom setting range from custom minimum (par. 2. 4) to custom maximum (par. 2. 5)

2. 4 V_{in} custom setting minimum/maximum

2. 5 With these parameters you can set V_{in} for any input signal span within 0—10 V.

Minimum setting: Set the V_{in} signal to its minimum level, select parameter 2. 4, press the Enter button
Maximum setting: Set the V_{in} signal to its maximun level, select parameter 2. 5, press the Enter button

Note! The parameter values can only be set with this procedure (not with arrow up/arrow down buttons).

2

2. 6 V_{in} signal inversion

V_{in} is source B frequency reference, par. 1. 6 = 1 (default)

Parameter 2. 6 = 0, no inversion of analog V_{in} signal.

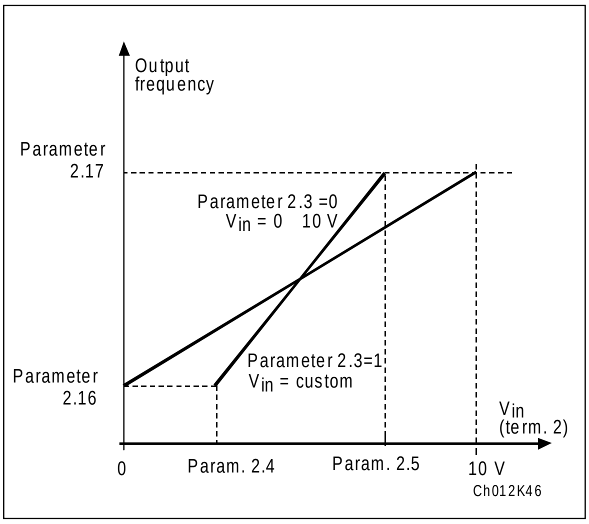


Figure 2.5-5 V_{in} no signal inversion.

Parameter 2. 6 = 1, inversion of analog V_{in} signal
max. V_{in} signal = minimum set speed
min. V_{in} signal = maximum set speed

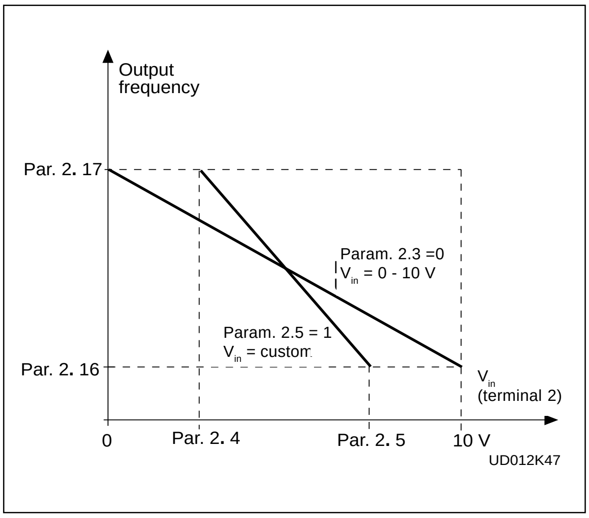


Figure 2.5-6 V_{in} signal inversion.

2. 7 V_{in} signal filter time

Filters out disturbances from the incoming analog V_{in} signal.
A long filtering time makes regulation response slower.
See figure 2.5-7.

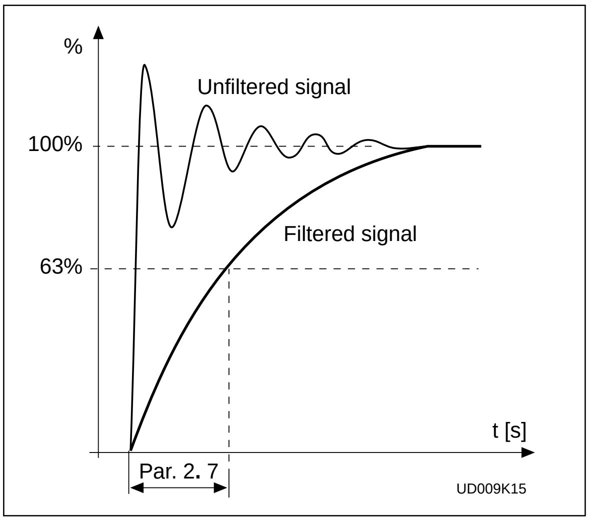


Figure 2.5-7 V_{in} signal filtering.

2. 8 Analog input I_{in} signal range

0 = 0—20 mA
1 = 4—20 mA
2 = Custom signal span

See figure 2.5-8.

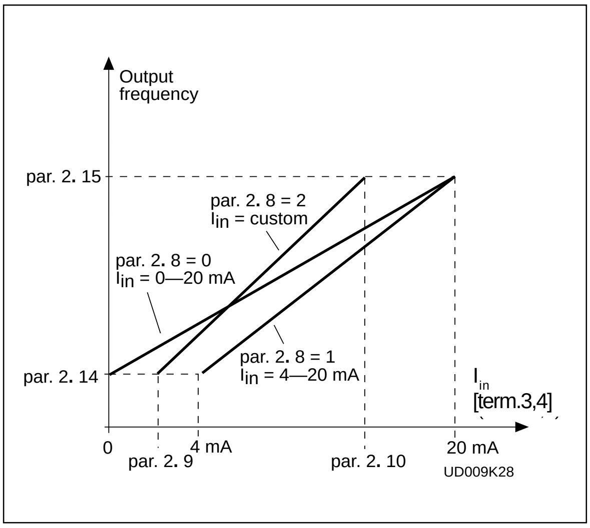


Figure 2.5-8 Analog input I_{in} scaling.

2. 9 Analog input I_{in} custom
2. 10 setting minimum/maximum

With these parameters you can scale the input current to correspond to a minimum and maximum frequency range. See figure 2.5-8.

Minimum setting:
Set the I_{in} signal to its minimum level, select parameter 2. 9, press the Enter button
Maximum setting:
Set the I_{in} signal to its maximun level, select parameter 2. 10, press the Enter button

Note! The parameter values can only be set with this procedure (not with arrow up/arrow down-buttons).

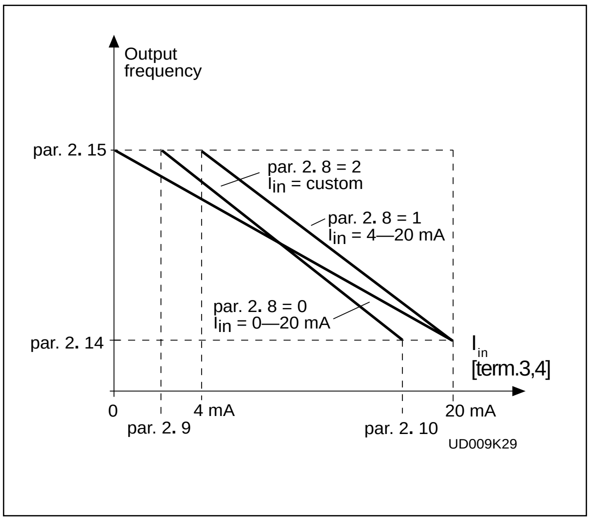


Figure 2.5-9 I_{in} signal inversion.

2. 11 Analog input I_{in} inversion

I_{in} is source A frequency reference, par. 1. 5 = 0 (default)

Parameter 2. 11 = 0, no inversion of I_{in} input
Parameter 2. 11 = 1, inversion of I_{in} input. See figure 2.5-9.

max. I_{in} signal = minimum set speed
min. I_{in} signal = maximum set speed

2. 12 Analog input I_{in} filter time

Filters out disturbances from the incoming analog I_{in} signal. A long filtering time makes regulation response slower.
See figure 2.5-10.

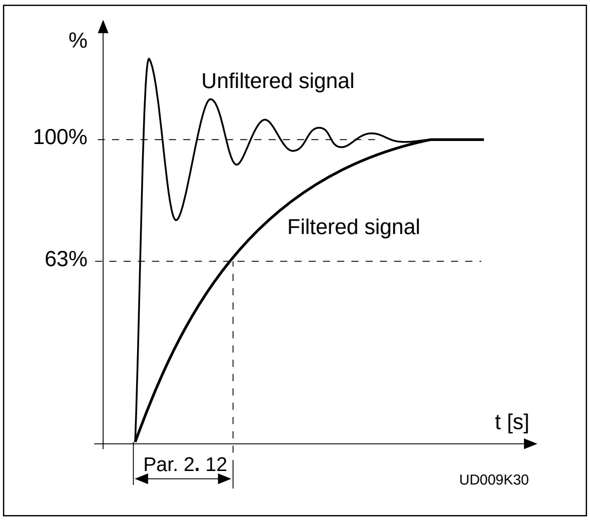


Figure 2.5-10 Analog input I_{in} filter time.

2. 13 Source B Start/Stop logic selection

See parameter 2**.** 1, settings 0—3.

2. 14, 2. 15 Source A reference scaling, minimum value/maximum value

Setting limits: 0 < par. 2**.** 14 < par. 2**.** 15 < par. 1**.** 2.
If par. 2**.** 15 = 0 scaling is set off. See figures 2.5-11 and 2.5-12.

(In figures voltage input Vin with signal range 0—10 V selected for source A reference)

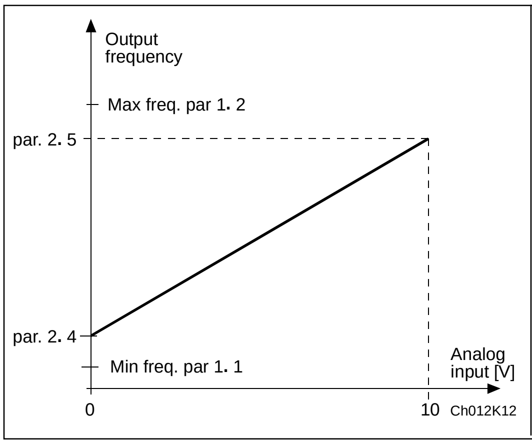


Figure 2.5-11 Reference scaling.

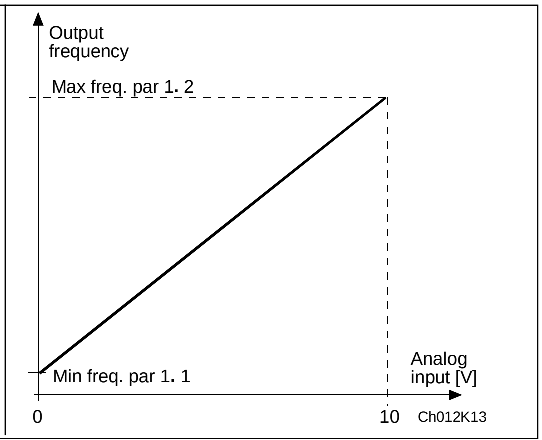


Figure 2.5-12 Reference scaling, par. 2. 15 = 0.

2. 16, 2. 17 Source B reference scaling, minimum value/maximum value

See parameters 2**.** 14 and 2**.** 15.

2. 18 Free analog input signal

Selection of input signal of a free analog input (an input not used for reference signal):
0 = Not in use
1 = Voltage signal V_{in}
2 = Current signal I_{in}

2. 19 Free analog input signal function

Use this parameter to select a function for a free analog input signal:

0 = Function is not used
1 = Reducing motor current limit (par. 1**.** 7)

This signal will adjust the maximum motor current between 0 and par. 1**.** 7 set max. limit. See figure 2.5-13.

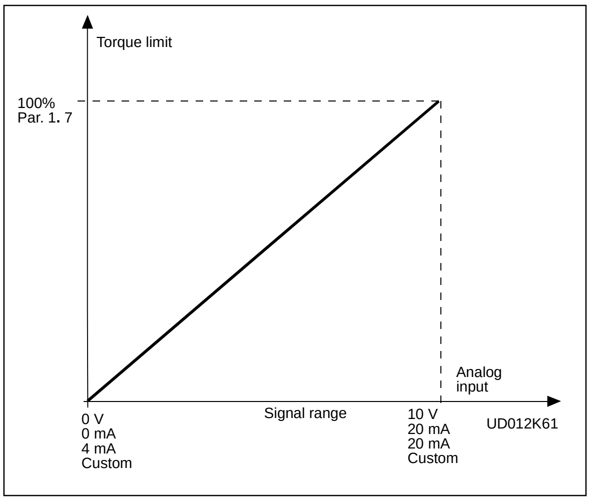


Figure 2.5-13 Scaling of max. motor current.

2 Reducing DC brake current.

DC braking current can be reduced with the free analog input signal between current 0.15 x I_{nSV9} and the current set by parameter 4. 8. See figure 2.5-14.

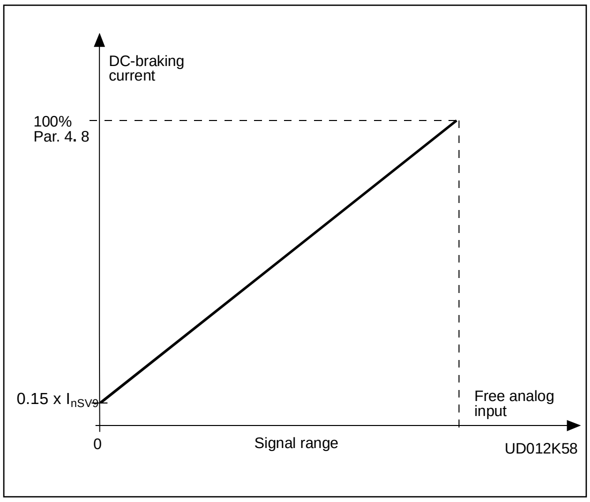


Figure 2.5-14 Reducing DC brake current.

3 Reducing acceleration and deceleration times.

Acceleration and deceleration times can be reduced with the free analog input signal according to the following formulas:

Reduced time = set acc./deceler. time (par. 1. 3, 1. 4; 4. 3, 4. 4) divided by the factor R from figure 2.5-15.

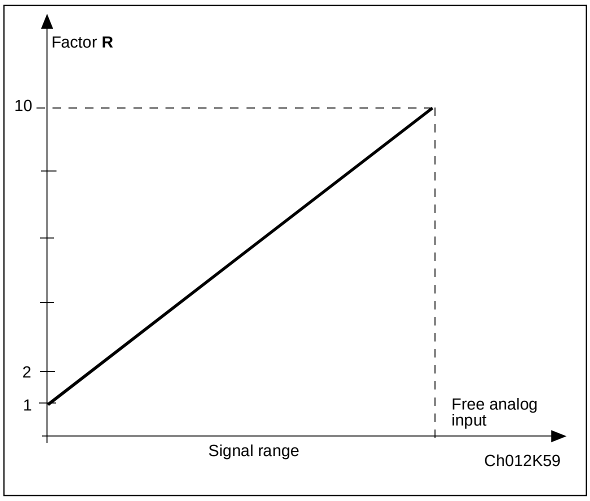


Figure 2.5-15 Reducing acceleration and deceleration times.

4 Reducing torque supervision limit.

Torque supervision limit can be reduced with a free analog input signal between 0 and the set supervision limit (par. 3. 14). See figure 2.5-16.

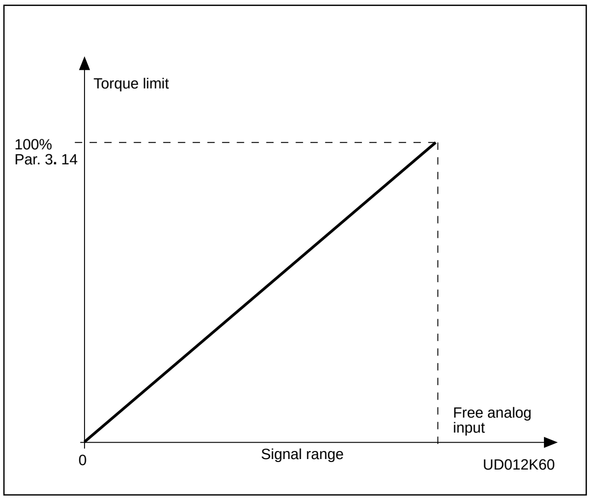


Figure 2.5-16 Reducing torque supervision limit.

2

2. 20 Motor potentiometer ramp time

Defines how fast the electronic motor potentiometer value changes.

3. 1 Analog output Content

See table on page 2-9.

3. 2 Analog output filter time

Filters the analog output signal. See figure 2.5-17.

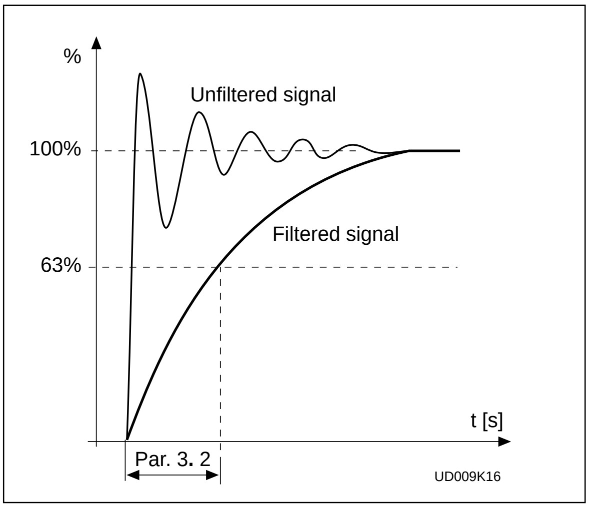


Figure 2.5-17 Analog output filtering.

3.3 Analog output invert

Inverts analog output signal:
max. output signal = minimum set value
min. output signal = maximum set value

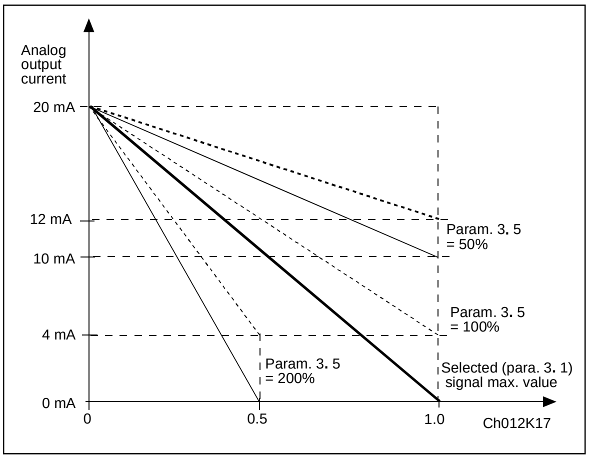


Figure 2.5-18 Analog output invert.

3. 4 Analog output minimum

Defines the signal minimum to be either 0 mA or 4 mA .
See figure 2.5-19.

3. 5 Analog output scale

Scaling factor for analog output.
See figure 2.5-19.

Signal	Max. value of the signal
Output frequency	Max. frequency (p. 1. 2)
Motor speed	Max. speed ($n_n x f_{max}/f_n$)
Output current	2 x I_{nCX}
Motor torque	2 x T_{nMot}
Motor power	2 x P_{nMot}
Motor voltage	100% x V_{nMot}
DC-link volt.	1000 V

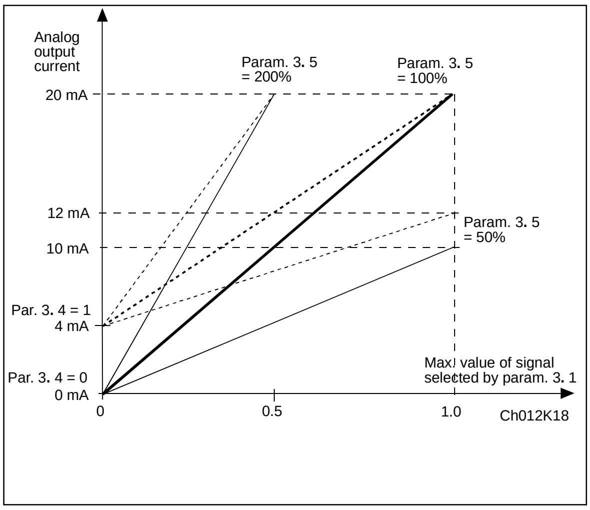


Figure 2.5-19 Analog output scale.

3. 6 Digital output function
3. 7 Relay output 1 function
3. 8 Relay output 2 function

Setting value	Signal content
0 = Not used	Out of operation
	<u>Digital output DO1 sinks current and programmable relay (RO1, RO2) is activated when:</u>
1 = Ready	The drive is ready to operate
2 = Run	The drive operates (motor is running)
3 = Fault	A fault trip has occurred
4 = Fault inverted	A fault trip <u>has not</u> occurred
5 = CX overheat warning	The heat-sink temperature exceeds +70°C
6 = External fault or warning	Fault or warning depending on parameter 7. 2
7 = Reference fault or warning	Fault or warning depending on parameter 7. 1 - if analog reference is 4—20 mA and signal is <4mA
8 = Warning	Always if a warning exists
9 = Reversed	The reverse command has been selected
10 = Jog speed	Jog speed has been selected with digital input
11 = At speed	The output frequency has reached the set reference
12 = Motor regulator activated	Overvoltage or overcurrent regulator was activated
13 = Output frequency supervision 1	The output frequency goes outside of the set supervision Low limit/ High limit (par. 3. 9 and 3. 10)
14 = Output frequency supervision 2	The output frequency goes outside of the set supervision Low limit/ High limit (par. 3. 11 and 3. 12)
15 = Torque limit supervision	The motor torque goes outside of the set supervision Low limit/ High limit (par. 3. 13 and 3. 14)
16 = Active reference limit supervision	Active reference goes outside of the set supervision Low limit/ High limit (par. 3. 15 and 3. 16)
17 = External brake control	External brake ON/OFF control with programmable delay (par 3. 17 and 3. 18)
18 = Control from I/O terminals	External control mode selected with prog. pushbutton #2
19 = Drive temperature limit supervision	Temperature on drive is outside the set supervision limits (par. 3. 19 and 3. 20)
20 = Unrequested rotation direction	Rotation direction of the motor shaft is different from the requested one
21= External brake control inverted	External brake ON/OFF control (par. 3.17 and 3.18), output active when brake control is OFF

Table 2.5-2 Output signals via DO1 and output relays RO1 and RO2.

2

3. 9 Output frequency limit 1, supervision function
3. 11 Output frequency limit 2, supervision function

0 = No supervision
1 = Low limit supervision
2 = High limit supervision

If the output frequency goes under/over the set limit (3. 10, 3. 12) this function generates a warning message via the digital output DO1 or via a relay output RO1 or RO2 depending on the settings of the parameters 3. 6—3. 8.

3. 10 Output frequency limit 1, supervision value
3. 12 Output frequency limit 2, supervision value

The frequency value to be supervised by the parameter 3. 9 (3. 11).
See figure 2.5-20.

3. 13 Torque limit , supervision function

0 = No supervision
1 = Low limit supervision
2 = High limit supervision

If the calculated torque value goes under/over the set limit (3.14) this function generates a warning message via the digital output DO1 or via a relay output RO1 or RO2 depending on the settings of the parameters 3. 6—3. 8.

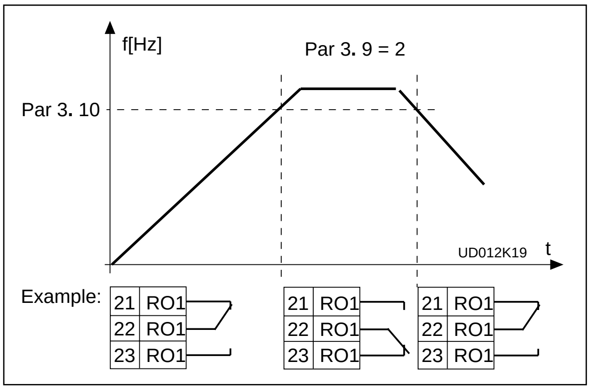


Figure 2.5-20 Output frequency supervision.

3. 14 Torque limit , supervision value

The calculated torque value to be supervised by the parameter 3. 13.
Torque supervision value can be reduced below the setpoint with a free analog input signal, see parameters 2. 18 and 2. 19.

3. 15 Reference limit , supervision function

0 = No supervision
1 = Low limit supervision
2 = High limit supervision

If the reference value goes under/over the set limit (3. 16) this function generates a warning message via the digital output DO1 or via a relay output RO1 or RO2 depending on the settings of the parameters 3. 6—3. 8. The supervised reference is the current active reference. It can be source A or B reference depending on DIB6 input or panel reference if panel is the active control source.

3. 16 Reference limit , supervision value

The frequency value to be supervised by the parameter 3. 15.

3. 17 External brake-off delay
3. 18 External brake-on delay

The function of the external brake can be delayed from the start and stop control signals with these parameters. See figure 2.5-21.

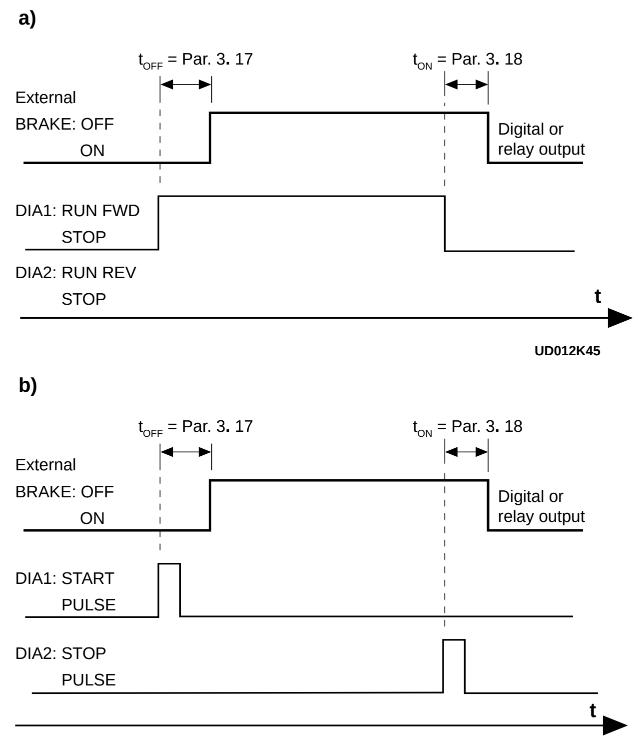


Figure 2.5-21 Ext. brake control: a) Start/Stop logic selection par 2. 1 = 0, 1 or 2
b) Start/Stop logic selection par 2. 1 = 3.

The brake control signal can be programmed via the digital output DO1 or via one of the relay outputs RO1 and RO2, see parameters 3. 6—3. 8.

3. 19 Drive temperature limit supervision

0 = No supervision
1 = Low limit supervision
2 = High limit supervision

If temperature of the unit goes under/over the set limit (par. 3. 20) this function generates a warning message via the digital output DO1 and via a relay output RO1 or RO2 depending on the settings of the parameters 3. 6—3. 8.

3. 20 Drive temperature supervision limit value

The set temperature value to be supervised with the parameter 3. 19.

2

4. 1 Acc/Dec ramp 1 shape
4. 2 Acc/Dec ramp 2 shape

The acceleration and deceleration ramp shape can be programmed with these parameters.

Setting the value = 0 gives you a linear ramp shape. The output frequency immediately follows the input with a ramp time set by parameters 1. 3, 1. 4 (4. 3, 4. 4 for Acc/Dec time 2).

Setting 0.1—10 seconds for 4. 1 (4. 2) causes an S-shaped ramp. The speed changes are smooth. Parameter 1. 3/ 1. 4 (4. 3/ 4. 4) determines the ramp time of the acceleration/deceleration in the middle of the curve. See figure 2.5-22.

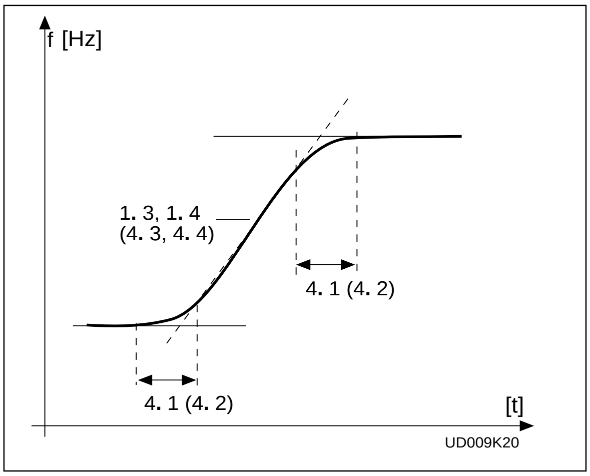


Figure 2.5-22 S-shaped acceleration/ deceleration.

4. 3 Acceleration time 2
4. 4 Deceleration time 2

These values correspond to the time required for the output frequency to accelerate from the set minimum frequency (par. 1. 1) to the set maximum frequency (par. 1. 2). With this parameter it is possible to set two different acceleration/deceleration times for one application. The active set can be selected with the programmable signal DIA3. See parameter 2. 2. Acceleration/deceleration times can be reduced with a free analog input signal. See parameters 2. 18 and 2. 19.

4. 5 Brake chopper

0 = No brake chopper
1 = Brake chopper and brake resistor installed
2 = External brake chopper

When the drive is decelerating the motor, the energy stored in the inertia of the motor and the load is fed into the external brake resistor. If the brake resistor is selected correctly the drive is able to decelerate the load with a torque equal to that of acceleration. See the separate Brake resistor installation manual.

4. 6 Start function

Ramp:

0 The drive starts from 0 Hz and accelerates to the set reference frequency within the set acceleration time. (Load inertia or starting friction may cause prolonged acceleration times).

Flying start:

1 The drive starts into a running motor by first finding the speed the motor is running at. Searching starts from the maximum frequency down until the actual frequency reached. The output frequency then accelerates/decelerates to the set reference value at a rate determined by the acceleration/deceleration ramp parameters.

Use this mode if the motor may be coasting when the start command is given. With the flying start it is possible to ride through short utility voltage interruptions.

4. 7 Stop function

Coasting:

0 The motor coasts to an uncontrolled stop with the CX/CXL/CXS off, after the Stop command.

Ramp:

1 After the Stop command, the speed of the motor is decelerated based on the deceleration ramp time parameter.

If the regenerated energy is high, it may be necessary to use an external braking resistor for faster deceleration.

4. 8 DC braking current

Defines the current injected into the motor during DC braking.
The DC braking current can be reduced from the setpoint with a external free analog input signal, see parameters 2**.** 18 and 2**.** 19.

4. 9 DC braking time at stop

Determines whether DC braking is ON or OFF. It also determines the braking duration time of the DC-brake when the motor is stopping. The function of the DC-brake depends on the stop function, parameter 4**.** 7. See figure 2.5-23.

0 DC-brake is not used

>0 DC-brake is in use and its function depends of the stop function, (parameter 4**.** 7), The time is set by the value of parameter 4**.** 9:

Stop-function = 0 (coasting):

After the stop command, the motor will coast to a stop with the SV9000 off.

With DC-injection, the motor can be electrically stopped in the shortest possible time, without using an optional external braking resistor.

The braking time is scaled according to the frequency when the DC- braking starts. If the frequency is $\geq$ nominal frequency of the motor (par. 1.11), the value of parameter 4.9 determines the braking time. When the frequency is $\leq$ 10% of the nominal, the braking time is 10% of the set value of parameter 4.9. See figure 2.5-13.

Stop-function = 1 (ramp):

After a Stop command, the speed of the motor is reduced based on the deceleration ramp parameter. If no regeneration occurs due to load inertia DC-braking starts at a speed defined by parameter 4. 10.

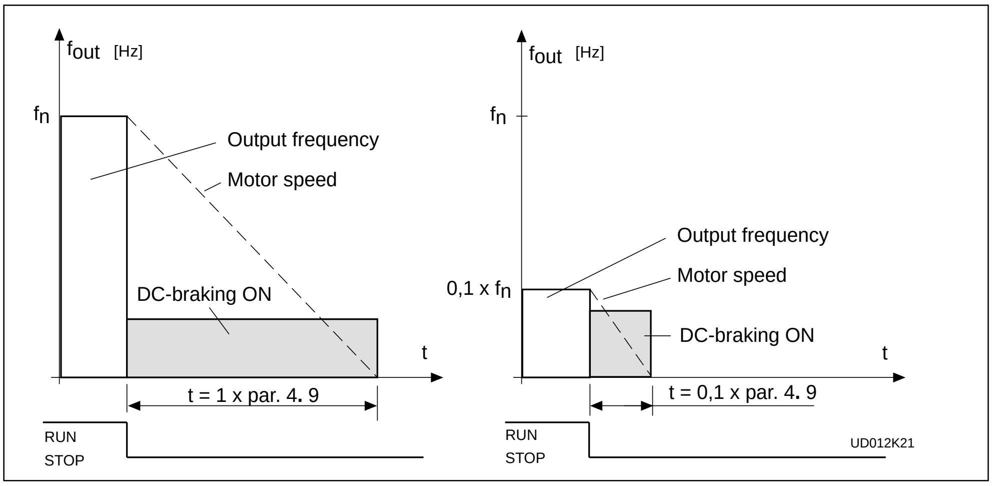


Figure 2.5-23 DC-braking time when par. 4. 7 = 0.

The braking time is defined by par. 4. 9. If the load has a high inertia, use an external braking resistor for faster deceleration.See figure 2.5-24.

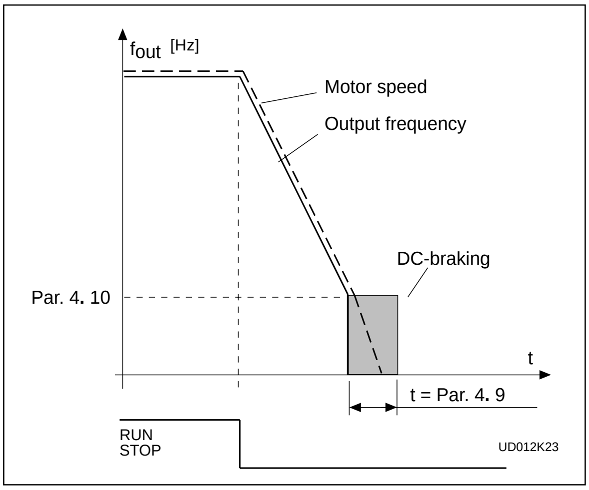


Figure 2.5-24 DC-braking time when par. 4. 7 = 1.

4. 10 Execute frequency of DC-brake during ramp Stop

See figure 2.5-24.

4. 11 DC-brake time at start

0 DC-brake is not used

>0 The DC-brake is activated by the start command given. This parameter defines the time before the brake is released. After the brake is released the output frequency increases according to the set start function parameter 4. 6 and the acceleration parameters (1. 3, 4. 1 or 4. 2, 4. 3). See figure 2.5-25.

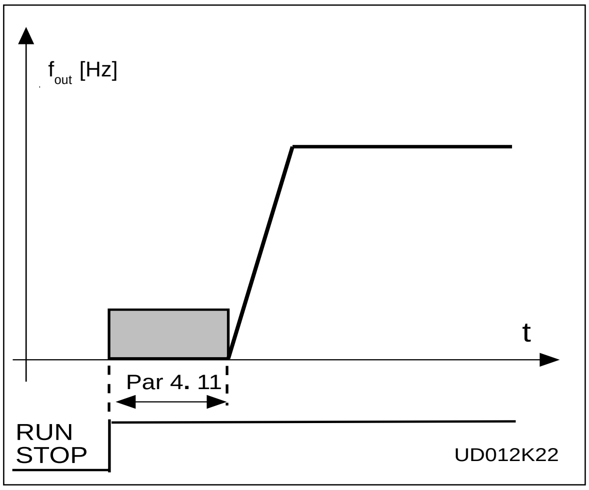


Figure 2.5-25 DC-braking time at start.

4. 12 Jog speed reference

This parameter value defines the jog speed if the DIA3 digital input is programmed for Jog and is selected. See parameter 2. 2.

5. 1- 5.6 Prohibit frequency area Low limit/High limit

In some systems it may be necessary to avoid certain frequencies because of mechanical resonance problems.

With these parameters it is possible to set limits for three "skip frequency" regions between 0 Hz and 500 Hz. The accuracy of thesetting is 0.1 Hz. See figure 2.5-6.

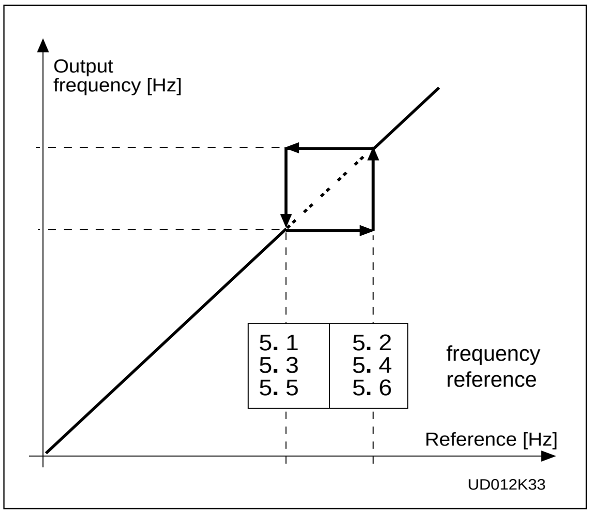


Figure 2.5-26 Example of prohibit frequency area setting.

6. 1 Motor control mode

0 = Frequency control: (V/Hz) — The I/O terminal and panel references are frequency references and the drive controls the output frequency (output freq. resolution 0.01 Hz)

1 = Speed control: (sensorless vector) — The I/O terminal and panel references are speed references and the drive controls the motor speed (control accuracy ± 0.5%).

6. 2 Switching frequency

Motor noise can be minimized by using a high switching frequency. Increasing the switching frequency reduces the current capacity of the CX/CXL/CXS.

Before changing the frequency from the factory default 10 kHz (3.6 kHz >40 Hp) check the drive derating in the curves shown in figures 5.2-2 and 5.2-3 in chapter 5.2 of the User's Manual.

6. 3 Field weakening point
6. 4 Voltage at the field weakening point

The field weakening point is the output frequency where the output voltage reaches the set maximum value (parameter 6. 4). Above that frequency the output voltage remains constant at the set maximum value. Below that frequency the output voltage depends on the setting of the V/Hz curve parameters 1. 8, 1. 9, 6. 5, 6. 6 and 6. 7. See figure 1.5-16.

When the parameters 1. 10 and 1. 11, nominal voltage and nominal frequency of the motor, are set, parameters 6. 3 and 6. 4 are also set automatically to the same values. If you need different values for the field weakening point and the maximum output voltage, change these parameters <u>after</u> setting parameters 1. 10 and 1. 11.

2

6. 5 V/Hz curve, middle point frequency

If the programmable V/Hz curve has been selected with parameter 1**.** 8, this parameter defines the middle frequency point of the curve. See figure 2.5-27.

6. 6 V/Hz curve, middle point voltage

If the programmable V/Hz curve has been selected with parameter 1**.** 8, this parameter defines the middle point voltage (% of motor nominal voltage) of the curve. See figure 2.5-27.

6. 7 Output voltage at zero frequency

If the programmable V/Hz curve has been selected with parameter 1**.** 8, this parameter defines the zero frequency voltage (% of motor nominal voltage) of the curve. See figure 2.5-27.

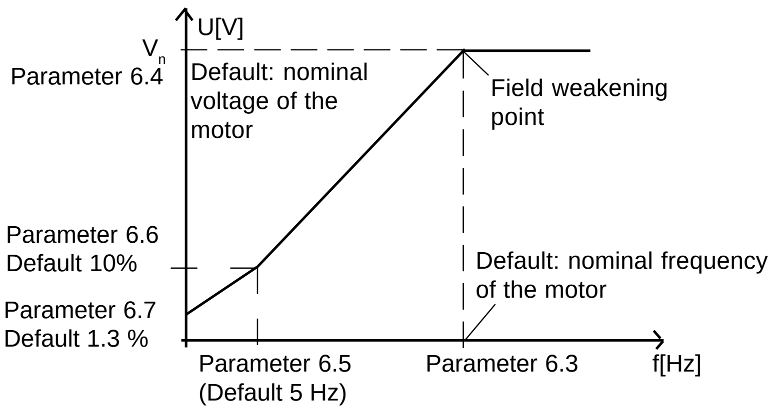


Figure 2.5-27 Programmable V/Hz curve.

6. 8 Overvoltage controller
6. 9 Undervoltage controller

These parameters allow the over/undervoltage controllers to be switched ON or OFF. This may be useful in cases where the utility supply voltage varies more than -15%—+10% and the application requires a constant speed. If the controllers are ON, they will change the motor speed in over/undervoltage cases. Overvoltage = faster, undervoltage = slower.

Over/undervoltage trips may occur when controllers are not used.

7. 1 Response to the reference fault

0 = No response
1 = Warning
2 = Fault, stop mode after fault according to parameter 4.7
3 = Fault, always coasting stop mode after fault detection

A warning or a fault action and message is generated if the 4—20 mA reference signal is used and the signal falls below 4 mA.
The information can also be programmed via digital output DO1 and via relay outputs RO1 and RO2.

7. 2 Response to external fault

0 = No response
1 = Warning
2 = Fault, stop mode after fault according to parameter 4.7
3 = Fault, always coasting stop mode after fault detection

A warning or a fault action and message is generated from the external fault signal on digital input DIA3.
The information can also be programmed into digital output DO1 and into relay outputs RO1 and RO2.

7. 3 Phase supervision of the motor

0 = No action
2 = Fault

Phase supervision of the motor ensures that the motor phases have approximately equal current.

7. 4 Ground fault protection

0 = No action
2 = Fault message

Ground fault protection ensures that the sum of the motor phase currents is zero. The standard overcurrent protection is always present and protects the frequency converter from ground faults with high current levels.

Parameters 7. 5—7. 9 Motor thermal protection

General

Motor thermal protection protects the motor from overheating. The CX/CXL/CXS drive is capable of supplying higher than nominal current to the motor. If the load requires this high current there is a risk that motor will be thermally overloaded. This is true especially at low frequencies. With low frequencies the cooling effect of the motor fan is reduced and the capacity of the motor is reduced. If the motor is equipped with a separately powered external fan, the load derating at low speed is small.

Motor thermal protection is based on a calculated model and it uses the output current of the drive to determine the load on the motor. When the motor is powered from the drive, the calculated model uses the heatsink temperature to determine the initial thermal stage for the motor. The calculated model assumes that the ambient temperature of the motor is 40°C.

Motor thermal protection can be adjusted by setting several parameters. The thermal current I_T specifies the load current above which the motor is overloaded. This current level is a function of the output frequency. The curve for I_T is set with parameters 7. 6, 7. 7 and 7. 9. Refer to the figure 2.5-28. The default values of these parameters are set from the motor nameplate data.

With the output current at I_T the thermal stage will reach the nominal value (100%). The thermal stage changes by the square of the current. With output current at 75% from I_T the thermal stage will reach 56% value and with output current at 120% from I_T the thermal stage would reach 144% value. The function will trip the drive (refer par. 7. 5) if the thermal stage will reach a value of 105%. The response time of the thermal stage is determined with the time constant parameter 7. 8. The larger the motor, the longer it takes to reach the final temperature.

The thermal stage of the motor can be monitored through the display. Refer to the table for monitoring items. (User's Manual, table 7.3-1).

CAUTION! *The calculated model does not protect the motor if the cooling of the motor is reduced either by blocking the airflow or due to dust or dirt.*

7. 5 Motor thermal protection

Operation:

0 = Not in use
1 = Warning
2 = Trip function

Tripping and warning will give a display indication with the same message code. If tripping is selected the drive will stop and activate the fault stage.

Deactivating the protection by setting this parameter to 0, will reset the thermal stage of the motor to 0%.

7. 6 Motor thermal protection, break point current

This current can be set between 50.0—150.0% x I_{nMotor}.
This parameter sets the value for thermal current at frequencies above the break point on the thermal current curve. Refer to the figure 2.5-28.

The value is set as a percentage of the motor nameplate nominal current , parameter 1**.** 13, not the drive's nominal output current.

The motor's nominal current is the current which the motor can withstand in direct online use without being overheated.

If parameter 1**.** 13 is adjusted, this parameter is automatically restored to the default value.

Setting this parameter (or parameter 1**.** 13) does not affect the maximum output current of the drive. Parameter 1**.** 7 alone determines the maximum output current of the drive.

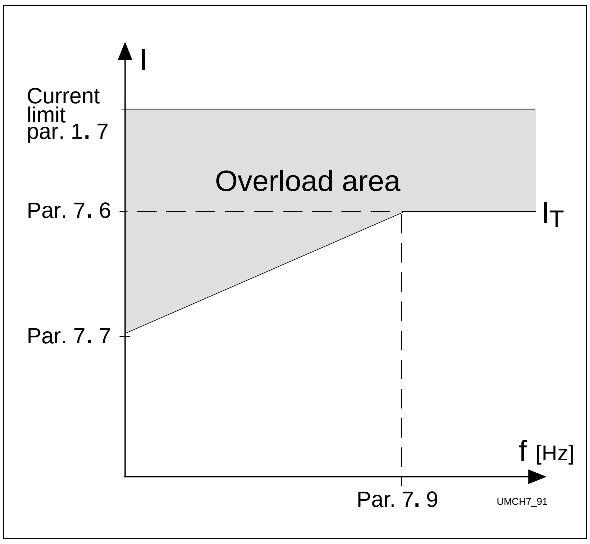


Figure 2.5-28 Motor thermal current, I_T curve.

7. 7 Motor thermal protection, zero frequency current

This current can be set between 10.0—150.0% x I_{nMotor}.
This parameter sets the value for thermal current at zero frequency. Refer to the figure 2.5-28.

The default value is set assuming that there is no external fan cooling the motor. If an external fan is used this parameter can be set to 90% (or higher).

The value is set as a percentage of the motor's nominal nameplate current, parameter 1. 13, not the drive's nominal output current. The motor's nominal current is the current which the motor can stand in direct on-line use without being overheated.

If you change parameter 1. 13, this parameter is automatically restored to the default value.

Setting this parameter (or parameter 1. 13) does not affect to the maximum output current of the drive. Parameter 1. 7 alone determines the maximum output current of the drive.

2

7. 8 Motor thermal protection, time constant

This time can be set between 0.5—300 minutes.
This is the thermal time constant of the motor. The larger the motor the greater the time constant. The time constant is defined as the time that it takes the calculated thermal stage to reach 63% of its final value.

The motor thermal time is specific to a motor design and it varies between different motor manufacturers.

The default value for the time constant is calculated based on the motor nameplate data from parameters 1. 12 and 1. 13. If either of these parameters is reset, then this parameter is set to default value.

If the motor's t_6 -time is known (given by the motor manufacturer) the time constant parameter could be set based on t_6 -time. As a rule of thumb, the motor thermal time constant in minutes equals to $2xt_6$ (t_6 in seconds is the time a motor can safely operate at six times the rated current). If the drive is stopped the time constant is internally increased to three times the set parameter value. Cooling in the stop stage is based on convection with an increased time constant

7. 9 Motor thermal protection, break point frequency

This frequency can be set between 10—500 Hz.
This is the frequency break point of the thermal current curve. With frequencies above this point the thermal capacity of the motor is assumed to be constant. Refer to the figure 2.5-28.

The default value is based on the motor's nameplate data, parameter 1. 11. It is 35 Hz for a 50 Hz motor and 42 Hz for a 60 Hz motor. More generally it is 70% of the frequency at the field weakening point (parameter 6. 3). Changing either parameter 1. 11 or 6. 3, will restore this parameter to its default value.

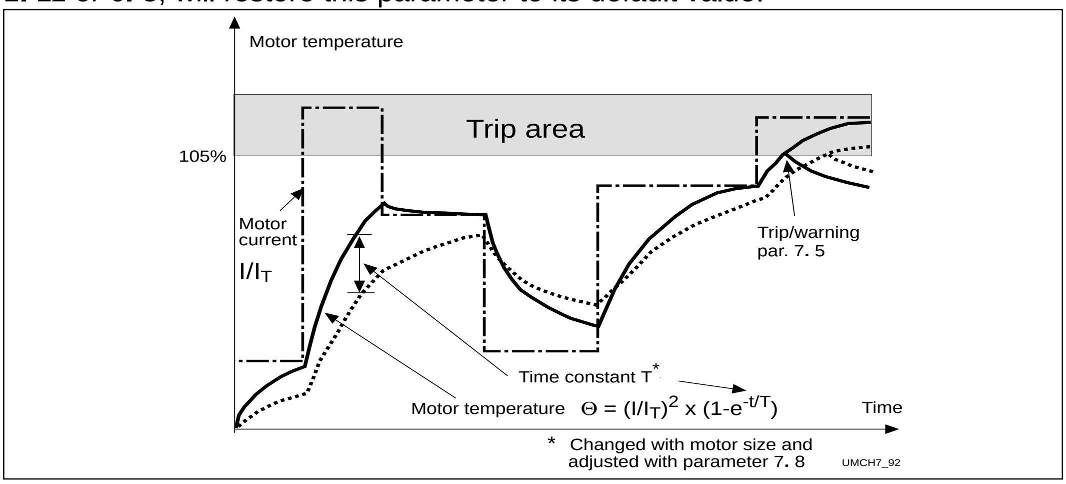


Figure 2.5-29 Calculating motor temperature.

2

Parameters 7. 10— 7. 13, Stall protection
General

Motor stall protection protects the motor from short time overload situations like a stalled shaft. The reaction time of stall protection can be set shorter than with motor thermal protection. The stall state is defined with two parameters, 7.11, Stall Current and 7.13., Stall Frequency. If the current is higher than the set limit and output frequency is lower than the set limit the stall state is true. There is no true detection of shaft rotation. Stall protection is a type of overcurrent protection.

7. 10 Stall protection

Operation:
- 0 = Not in use
- 1 = Warning
- 2 = Trip function

Tripping and warning will give a display indication with the same message code. If tripping is set on, the drive will stop and generate a fault. Deactivating the stall protection by setting the parameter to 0 will reset the stall time counter to zero.

7. 11 Stall current limit

The current can be set between 0.0—200% x I_{nMotor}.

In the stall stage the current has to be above this limit. Refer to figure 2.5-30. The value is set as a percentage of the motor name-plate nominal current, parameter 1**.** 13. If parameter 1**.** 13 is adjusted, this parameter is automatically restored to its default value.

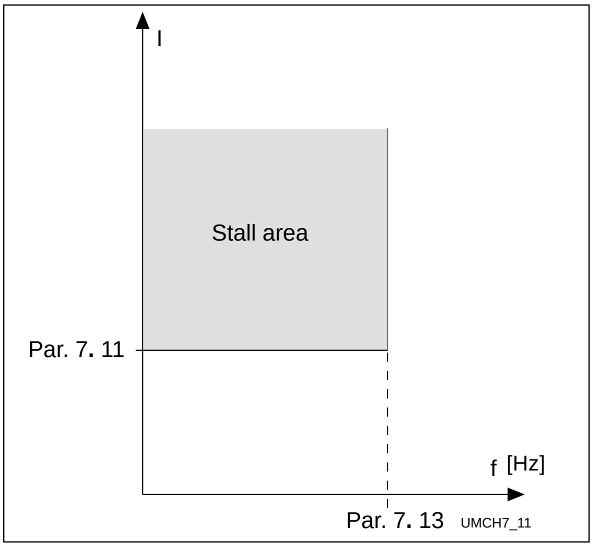


Figure 2.5-30 Setting the stall characteristics.

7. 12 Stall time

The time can be set between 2.0—120 s.
This is the maximum allowed time for a stall stage. There is an internal up/down counter to count the stall time. Refer to the figure 2.5-31. If the stall time counter value goes above this limit, this protection will cause a trip (refer to the parameter 7**.** 10).

7. 13 Maximum stall frequency

This frequency can be set between 1—f_{max} (param. 1**.** 2). In the stall state the ouput frequency has to be smaller than this limit. Refer to the figure 2.5-30.

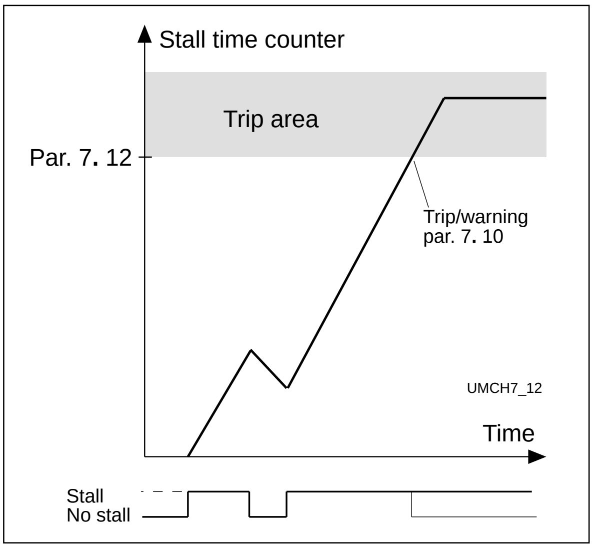


Figure 2.5-31 Counting the stall time.

Parameters 7. 14— 7. 17, Underload protection
General

The purpose of motor underload protection is to ensure there is load on the motor while the drive is running. If the motor load is reduced, there might be a problem in the process, e.g. broken belt or dry pump.

Motor underload protection can be adjusted by setting the underload curve with parameters 7**.** 15 and 7**.** 16. The underload curve is a squared curve set between zero frequency and the field weakening point. The protection is not active below 5Hz (the underload counter value is stopped). Refer to the figure 2.5-32.

The torque values for setting the underload curve are set with percentage values which refer to the nominal torque of the motor. The motor's nameplate data, parameter 1. 13, the motor's nominal current and the drive's nominal current I_{CT} are used to create the scaling ratio for the internal torque value. If other than a standard motor is used with the drive, the accuracy of the torque calculation is decreased.

7. 14 Underload protection

Operation:
- 0 = Not in use
- 1 = Warning message
- 2 = Fault message

Tripping and warning will give a display indication with the same message code. If tripping is set active the drive will stop and activate the fault stage.

Deactivating the protection, by setting this parameter to 0, will reset the underload time counter to zero.

7. 15 Underload protection, field weakening area load

The torque limit can be set between 20.0—150 % x T_{nMotor}.

This parameter is the value for the minimum allowed torque when the output frequency is above the field weakening point. Refer to the figure 2.5-32.
If parameter 1**.** 13 is adjusted, this parameter is automatically restored to its default value.

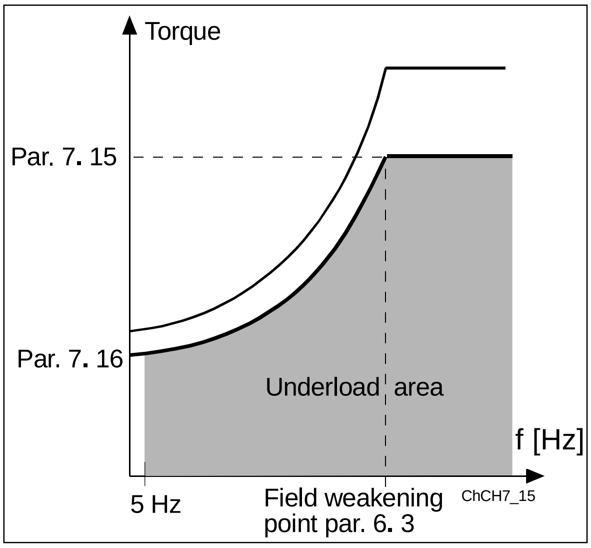


Figure 2.5-32 Setting of minimum load.

7. 16 Underload protection, zero frequency load

The torque limit can be set between 10.0—150 % x T_{nMotor}.

This parameter is the value for the minimum allowed torque with zero frequency. Refer to the figure 2.5-32. If parameter 1**.** 13 is adjusted, this parameter is automatically restored to its default value.

2

7. 17 Underload time

This time can be set between 2.0—600.0 s.

This is the maximum allowed time for an underload state. There is an internal up/down counter to accumulate the underload time. Refer to the figure 2.5-33.
If the underload counter value goes above this limit, the underload protection will cause a trip (refer to the parameter 7. 14).
If the drive is stopped the underload counter is reset to zero.

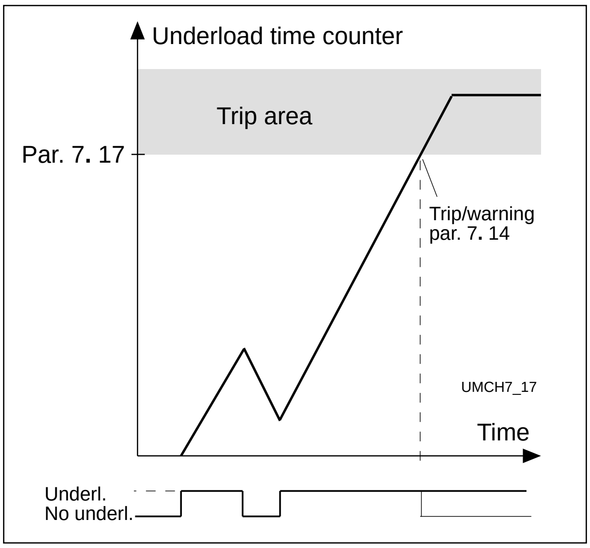


Figure 2.5-33 Counting the underload time.

8. 1 Automatic restart: number of tries
8. 2 Automatic restart: trial time

The Automatic restart function restarts the drive after the faults selected with parameters 8. 4—8. 8. The Start type for Automatic restart is selected with parameter 8. 3. See figure 2.5-34.

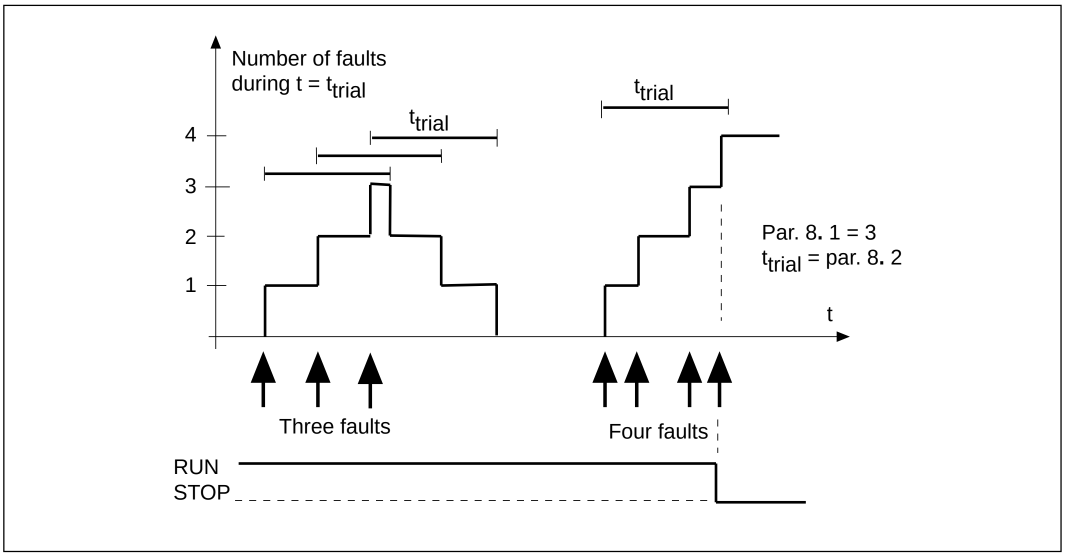


Figure 2.5-34 Automatic restart.

Parameter 8. 1 determines how many automatic restarts can be made during the trial time set by the parameter 8. 2.

The count time starts from the first autorestart. If the number of restarts does not exceed the value of parameter 8.1 during the trial time, the count is cleared after the trial time has elapsed. The next fault starts the counting again.

8. 3 Automatic restart, start function

The parameter defines the start mode:
0 = Start with ramp
1 = Flying start, see parameter 4. 6.

8. 4 Automatic restart after undervoltage

0 = No automatic restart after undervoltage fault
1 = Automatic restart after undervoltage fault condition returns to the normal condition (DC-link voltage returns to the normal level)

8. 5 Automatic restart after overvoltage

0 = No automatic restart after overvoltage fault
1 = Automatic restart after overvoltage fault condition returns to the normal condition (DC-link voltage returns to the normal level)

8. 6 Automatic restart after overcurrent

0 = No automatic restart after overcurrent fault
1 = Automatic restart after overcurrent faults

8. 7 Automatic restart after reference fault

0 = No automatic restart after reference fault
1 = Automatic restart after analog current reference signal (4—20 mA) returns to the normal level (≥4 mA)

8. 8 Automatic restart after over-/undertemperature fault

0 = No automatic restart after temperature fault
1 = Automatic restart after heatsink temperature has returned to its normal level between -10°C—+75°C.

Notes:

MULTI-STEP SPEED CONTROL APPLICATION

(par. 0.1 = 4)

CONTENTS

3

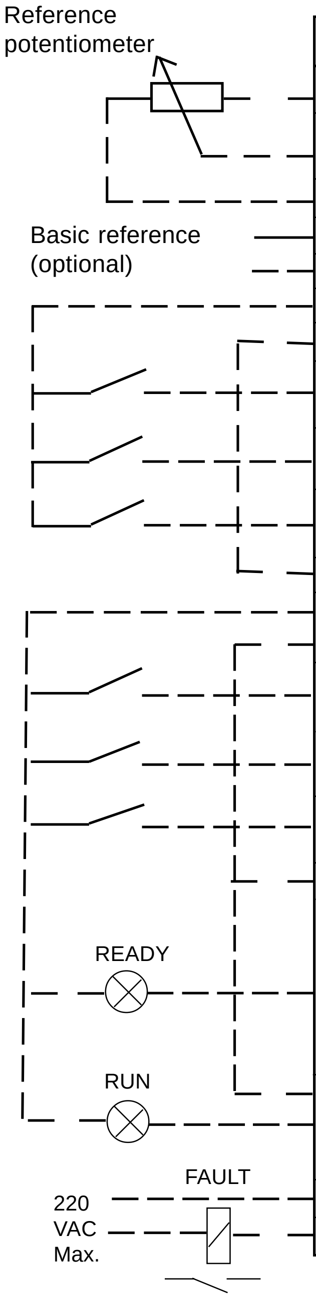
3.1 GENERAL

The Multi-step Speed Control Application can be used in applications where fixed speeds are needed. in total 9 different speeds can be programmed: one basic speed, 7 multi-step speeds and one jog speed. The speed steps are selected with digital signals DIB4, DIB5 and DIB6. If jog speed is used, DIA3 can be programmed from fault reset to jog speed select.

The basic speed reference can be either a voltage or a current signal via analog input terminals (2/3 or 4/5). The other analog input can be programmed for other purposes

All outputs are freely programmable.

3.2 CONTROL I/O



Terminal		Signal	Description
1	$+10V_{ref}$	Reference output	Voltage for a potentiometer, etc.
2	$V_{in}+$	Input for reference voltage	Basic reference (programmable), range 0—10 V DC
3	GND	I/O ground	Ground for reference and controls
4	$I_{in}+$	Input for reference current	Basic reference (programmable),
5	$I_{in}-$		range 0—20 mA
6	+24V	Control voltage output	Voltage for switches, etc. max. 0.1 A
7	GND	Control voltage ground	Ground for reference and controls
8	DIA1	Start forward (Programmable)	Contact closed = start forward
9	DIA2	Start reverse (Programmable)	Contact closed = start reverse
10	DIA3	Fault reset (Programmable)	Contact open = no action Contact closed = fault reset
11	CMA	Common for DIA1—DIA3	Connect to GND or + 24V
12	+24V	Control voltage output	Voltage for switches, (same as #6)
13	GND	I/O ground	Ground for reference and controls
14	DIB4	Multi-step speed select 1	sel 1 sel 2 sel 3 0 0 0 basic speed
15	DIB5	Multi-step speed select 2	1 0 0 speed 1 0 1 0 speed 2
16	DIB6	Multi-step speed select 3	- - - - - - 1 1 1 speed 7
17	CMB	Common for DIB4—DIB6	Connect to GND or + 24V
18	$I_{out}+$	Analog output	Programmable (par. 3. 1)
19	$I_{out}-$	Output frequency	Range 0—20 mA/R_L max. 500 Ω
20	DO1	Digital output READY	Programmable (par. 3. 6) Open collector, I≤50 mA, V≤48 VDC
21	RO1	Relay output 1	Programmable (par. 3. 7)
22	RO1	RUN	
23	RO1		
24	RO2	Relay output 2	Programmable (par. 3. 8)
25	RO2	FAULT	
26	RO2		

Figure 3.2-1 Default I/O configuration and connection example of the Multi-step speed Control Application.

3.3 Control signal logic

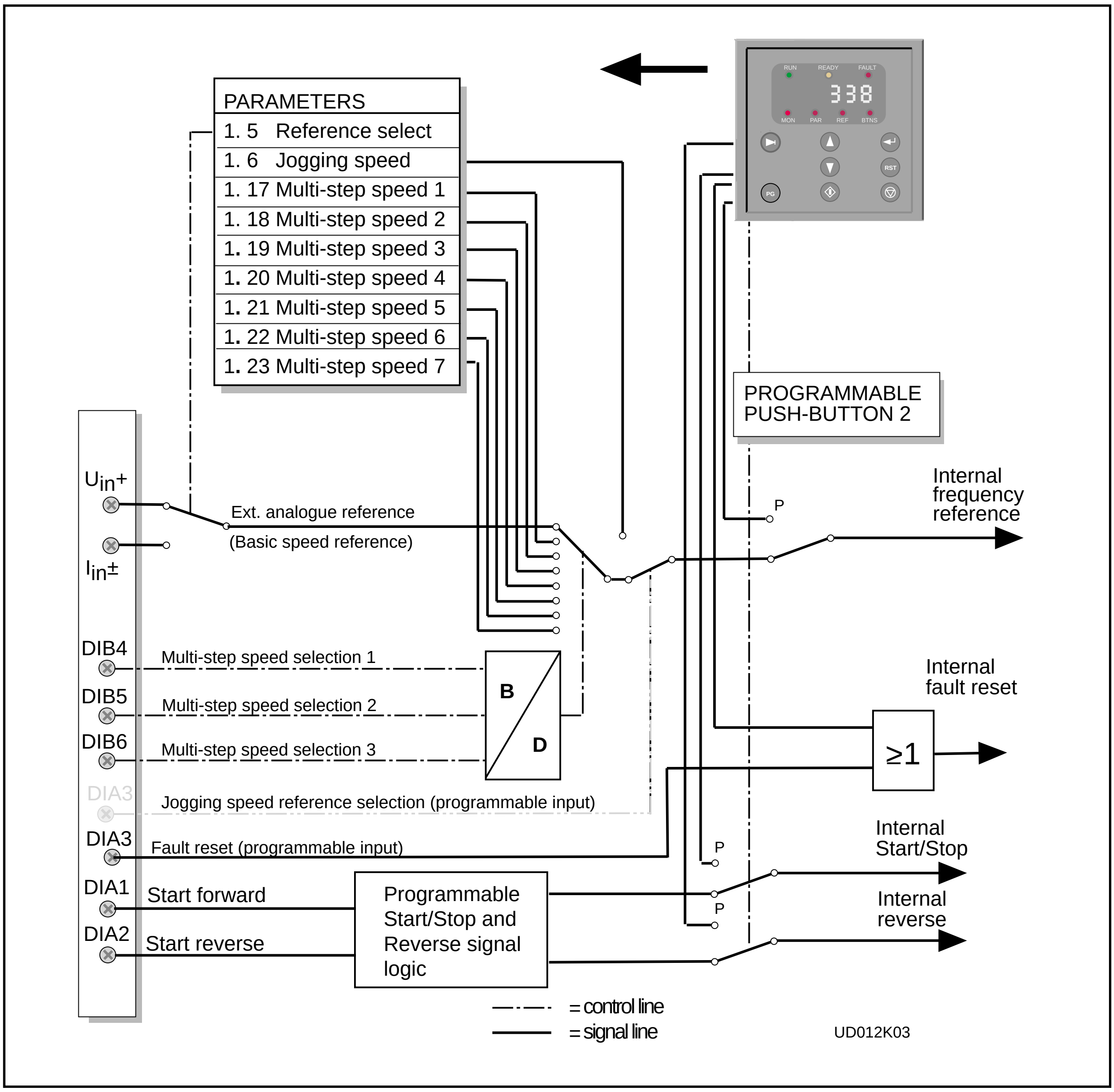


Figure 3.3-1 Control signal logic of the Multi-step Speed Control Application.
Switch positions shown are based on the factory settings.

3.4 Basic parameters, Group 1

Code	Parameter	Range	Step	Default	Custom	Description	Page
1. 1	Minimum frequency	0—f_{max}	1 Hz	0 Hz			3-5
1. 2	Maximum frequency	f_{min}-120/500Hz	1 Hz	60 Hz		*	3-5
1. 3	Acceleration time 1	0.1—3000.0 s	0.1 s	3.0 s		Time from f_{min} (1. 1) to f_{max} (1. 2)	3-5
1. 4	Deceleration time 1	0.1—3000.0 s	0.1 s	3.0 s		Time from f_{max} (1. 2) to f_{min} (1. 1)	3-5
1. 5	Basic reference selection	0—1	1	0		0 = Analog voltage input (term.2) 1 = Analog current input (term.4)	3-5
1. 6	Jog speed reference	f_{min} —f_{max} (1. 1) (1. 2)	0.1 Hz	5.0 Hz			3-5
1. 7	Current limit	0.1—2.5 xI_{nCX}	0.1A	1.5 x I_{nCX}		Output current limit [A] of the unit	3-5
1. 8	V/Hz ratio selection	0—2	1	0		0 = Linear 1 = Squared 2 = Programmable V/Hz ratio	3-6
1. 9	V/Hz optimisation	0—1	1	0		0 = None 1 = Automatic torque boost	3-7
1. 10	Nominal voltage of the motor	180—690 V	1 V	230 V 380 V 480 V 575 V		CX/CXL/CXS V 3 2 CX/CXL/CXS V 3 4 CX/CXL/CXS V 3 5 CX V 3 6	3-7
1. 11	Nominal frequency of the motor	30—500 Hz	1 Hz	60 Hz		f_n from the nameplate of the motor	3-7
1. 12	Nominal speed of the motor	1—20000 rpm	1 rpm	1720 rpm **		n_n from the nameplate of the motor	3-7
1. 13	Nominal current of the motor	2.5 x I_{nCX}	0,1 A	I_{nCX}		I_n from the nameplate of the motor	3-7
1. 14	Supply voltage	208—240		230 V		CX/CXL/CXS V 3 2	3-7
		380—440		380 V		CX/CXL/CXS V 3 4	
		380—500		480 V		CX/CXL/CXS V 3 5	
		525—690		575 V		CX V 3 6	
1. 15	Parameter conceal	0—1	1	0		Visibility of the parameters: 0 = all parameter groups visible 1 = only group 1 is visible	3-7
1. 16	Parameter value lock	0—1	1	0		Disables parameter changes: 0 = changes enabled 1 = changes disabled	3-7

Note! = Parameter value can be changed only when the frequency converter is stopped.

* If 1. 2 > motor synchr. speed, check suitability for motor and drive system
Selecting 120/500 Hz range see page 3-5.

** Default value for a four pole motor and a nominal size drive.

Code	Parameter	Range	Step	Default	Custom	Description	Page
1. 17	Multi-step speed reference 1	f_{min}—f_{max} (1. 1) (1. 2)	0.1 Hz	10.0 Hz			3-7
1. 18	Multi-step speed reference 2	f_{min}—f_{max} (1. 1) (1. 2)	0.1 Hz	15.0 Hz			3-7
1. 19	Multi-step speed reference 3	f_{min}—f_{max} (1. 1) (1. 2)	0.1 Hz	20.0 Hz			3-7
1. 20	Multi-step speed reference 4	f_{min}—f_{max} (1. 1) (1. 2)	0.1 Hz	25.0 Hz			3-7
1. 21	Multi-step speed reference 5	f_{min}—f_{max} (1. 1) (1. 2)	0.1 Hz	30.0 Hz			3-7
1. 22	Multi-step speed reference 6	f_{min}—f_{max} (1. 1) (1. 2)	0.1 Hz	40.0 Hz			3-7
1. 23	Multi-step speed reference 7	f_{min}—f_{max} (1. 1) (1. 2)	0.1 Hz	50.0 Hz			3-7

Table 3.4-1 Group 1 basic parameters.

3

3.4.2 Description of Group 1 parameters

1. 1, 1. 2 Minimum/maximum frequency

Defines the frequency limits of the drive.

The default maximum value for parameters 1. 1 and 1. 2 is 120 Hz. By setting 1. 2 = 120 Hz in the when the drive is stopped (RUN indicator not lit) parameters 1. 1 and 1. 2 are changed to 500 Hz. At the same time the resolution of the panel reference is changed from 0.01 Hz to 0.1 Hz.
Changing the max. value from 500 Hz to 120 Hz is done by setting parameter 1. 2 to 119 Hz while the drive is stopped.

1. 3, 1. 4 Acceleration time 1, deceleration time 1:

These limits correspond to the time required for the output frequency to accelerate from the set minimum frequency (par. 1. 1) to the set maximum frequency (par. 1. 2). Acceleration/deceleration times can be reduced with a free analog input signal, see parameters 2. 18 and 2. 19.

1. 5 Basic reference selection

0: Analog voltage reference from terminals 2—3, e.g. a potentiometer
1: Analog current reference trom terminals 4—5, e.g. a transducer

1. 6 Jog speed refrence

The value of this parameter defines the jog speed selected with the DIA3 digital input which if it is programmed for Jog speed. See parameter 2. 2.

Parameter value is automatically limited between minimum and maximum frequency (par 1. 1, 1. 2)

1. 7 Current limit

This parameter determines the maximum motor current that the CX/CXL/CXS will provide short term. Current limit can be set lower with a free analog input signal, see parameters 2. 18 and 2. 19.

1. 8 V/Hz ratio selection

Linear: The voltage of the motor changes linearly with the frequency in the constant flux area from 0 Hz to the field weakening point
0 (par. 6**.** 3) where a constant voltage (nominal vaue) is supplied to the motor. See figure 3.4-1.

A linear V/Hz ratio should be used in constant torque applications

This default setting should be used if there is no special requirement for another setting.

Squared: The voltage of the motor changes following a squared curve form with the frequency in the area from 0 Hz to the field weakening
1 point (par. 6**.** 3), where the nominal voltage is supplied to the motor. See figure 3.4-1.

The motor runs undermagnetized below the field weakening point and produces less torque and electromechanical noise. A squared V/Hz ratio can be used in applications where the torque demand of the load is proportional to the square of the speed, e.g. in centrifugal fans and pumps.

3

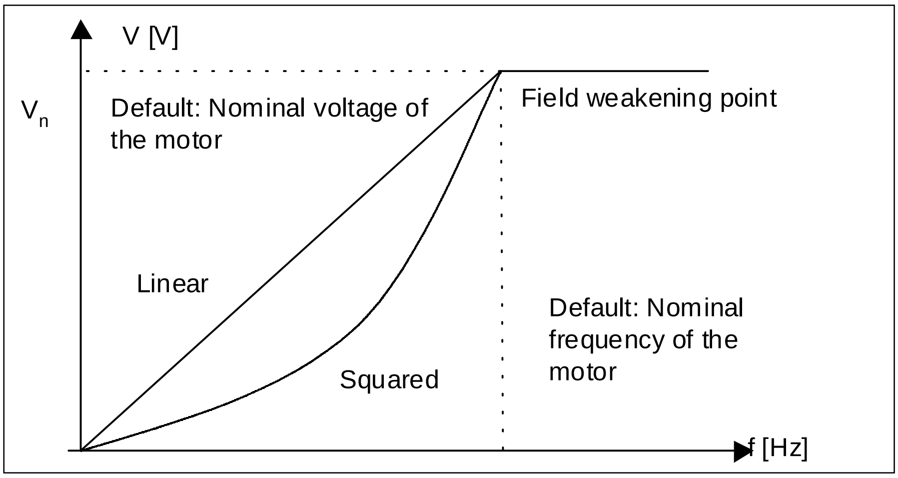


Figure 3.4-1 Linear and squared V/Hz curves.

Programm. V/Hz curve **2** The V/Hz curve can be programmed with three different points. The parameters for programming are explained in chapter 3.5.2. A programmable V/Hz curve can be used if the standard settings do not satisfy the needs of the application See figure 3.4-2.

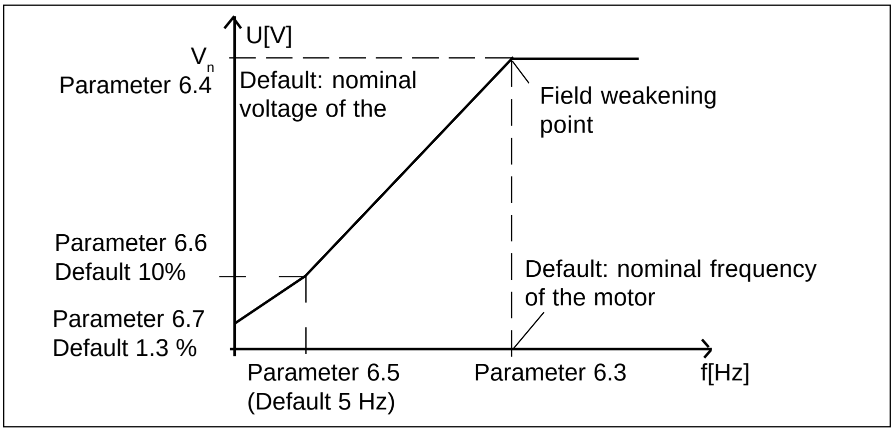


Figure 3.4-2 Programmable V/Hz curve.

1. 9 V/Hz optimization

Automatic torque boost — The voltage to the motor changes automatically which allows the motor to produce enough torque to start and run at low frequencies. The voltage increase depends on the motor type and horsepower. Automatic torque boost can be used in applications where starting torque due to starting friction is high, e.g. in conveyors.

NOTE! *In high torque - low speed applications - it is likely the motor will overheat.*

If the motor has to run for a prolonged time under these conditions, special attention must be paid to cooling the motor. Use external cooling for the motor if the temperature rise is too high.

1. 10 Nominal voltage of the motor

Find this value V_n from the nameplate of the motor.
This parameter sets the voltage at the field weakening point, parameter 6**.** 4, to 100% x V_{nmotor}.

1. 11 Nominal frequency of the motor

Find then nominal frequency f_n from the nameplate of the motor.
This parameter sets the field weakening point, parameter 6**.** 3, to the same value.

1. 12 Nominal speed of the motor

Find this value n_n from the nameplate of the motor.

1. 13 Nominal current of the motor

Find the value I_n from the nameplate of the motor.
The internal motor protection function uses this value as a reference value.

1. 14 Supply voltage

Set parameter value according to the nominal voltage of the supply.
Values are pre-defined for CX/CXL/CXS V 3 2, CX/CXL/CXS V 3 4, CX/CXL/CXS V 3 5 and CX V 3 6. See table 3.4-1.

1. 15 Parameter conceal

Defines which parameter groups are available:

0 = all parameter groups are visible
1 = only group 1 is visible

1. 16 Parameter value lock

Defines access to the changes of the parameter values:

0 = parameter value changes enabled
1 = parameter value changes disabled

1. 17 - 1. 23 Multi-step speed reference 1—7

These parameter values define the Multi-step speeds selected with the DIA4, DIB5 and DIB6 digital inputs .

These values are automatically limited between minimum and maximum frequency (par. 1. 1, 1. 2).

Speed reference	Multi-step speed select 1 DIB4	Multi-step speed select 2 DIB5	Multi-step speed select 3 DIB6
Par. 1. 6	0	0	0
Par. 1. 17	1	0	0
Par. 1. 18	0	1	0
Par. 1. 19	1	1	0
Par. 1. 20	0	0	1
Par. 1. 21	1	0	1
Par. 1. 22	0	1	1
Par. 1. 23	1	1	1

Table 3.4-2 Selection of multi-step speed reference 1—7.

3.5 Special parameters, Groups 2—8

3.5.1 Parameter tables

Input signal parameters, Group 2

Code	Parameter	Range	Step	Default	Custom	Description	Page
2. 1	Start/Stop logic selection	0—3	1	0		DIA1 / DIA2 0 = Start forward / Start reverse 1 = Start/Stop / Reverse 2 = Start/Stop / Run enable 3 = Start pulse / Stop pulse	3-15
2. 2	DIA3 function (terminal 10)	0—9	1	7		0 = Not used 1 = Ext. fault, closing contact 2 = External fault, opening contact 3 = Run enable 4 = Acc./Dec. time selection 5 = Reverse (if par. 2. 1 = 3) 6 = Jog speed 7 = Fault reset 8 = Acc./Dec. operation prohibit 9 = DC-braking command	3-16
2. 3	V_{in} signal range	0—1	1	0		0 = 0 —10 V 1 = Custom setting range	3-17
2. 4	V_{in} custom setting min.	0.00-100.00%	0.01%	0.00%			3-17
2. 5	V_{in} custom setting max.	0.00-100.00%	0.01%	100.00%			3-17
2. 6	V_{in} signal inversion	0—1	1	0		0 = Not inverted 1 = Inverted	3-18
2. 7	V_{in} signal filter time	0.00 —10.0 s	0.01s	0.10 s		0 = No filtering	3-18
2. 8	I_{in} signal range	0—2	1	0		0 = 0—20 mA 1 = 4—20 mA 2 = Custom setting range	3-19
2. 9	I_{in} custom setting minim.	0.00-100.00%	0.01%	0.00%			3-19
2. 10	I_{in} custom setting maxim.	0.00-100.00%	0.01%	100.00%			3-19
2. 11	I_{in} signal inversion	0—1	1	0		0 = Not inverted 1 = Inverted	3-19
2. 12	I_{in} signal filter time	0.01—10.00s	0.01s	0.10 s		0 = No filtering	3-19
2. 13	Reference scaling minimum value	0— par. 2. 14	1 Hz	0 Hz		Selects the frequency that corresponds to the min. reference signal	3-20
2. 14	Reference scaling maximum value	0— f_{max} (1. 2)	1 Hz	0 Hz		Selects the frequency that corresponds to the max. reference signal 0 = Scaling off >0 = Scaled maximum value	3-20
2. 15	Free analog input, signal selection	0—2	1	0		0 = Not use 1 = V_{in} (analog voltage input) 2 = I_{in} (analog current input)	3-20
2. 16	Free analog input, function	0—4	1	0		0 = No function 1 = Reduces current limit (par. 1.7) 2 = Reduces DC-braking current 3 = Reduces acc. and decel. times 4 = Reduces torque supervision limit	3-20

Note! = Parameter value can be changed only when the drive is stopped.

Group 3, Output and supervision parameters

Code	Parameter	Range	Step	Default	Custom	Description	Page
3. 1	Analog output function	0—7	1	1		0 = Not used Scale 100% 1 = O/P frequency (0—f_{max}) 2 = Motor speed (0—max. speed) 3 = O/P current (0—2.0 x I_{nCX}) 4 = Motor torque (0—2 x T_{nMot}) 5 = Motor power (0—2 x P_{nMot}) 6 = Motor voltage (0—100%xV_{nMot}) 7 = DC-link volt. (0—1000 V)	3-22
3. 2	Analog output filter time	0.00—10.00 s	0.01 s	1.00 s			3-22
3. 3	Analog output inversion	0—1	1	0		0 = Not inverted 1 = Inverted	3-22
3. 4	Analog output minimum	0—1	1	0		0 = 0 mA 1 = 4 mA	3-22
3. 5	Analog output scale	10—1000%	1%	100%			3-22
3. 6	Digital output function	0—21	1	1		0 = Not used 1 = Ready 2 = Run 3 = Fault 4 = Fault inverted 5 = CX overheat warning 6 = External fault or warning 7 = Reference fault or warning 8 = Warning 9 = Reversed 10 = Jog speed selected 11 = At speed 12 = Motor regulator activated 13 = Output frequency limit superv. 1 14 = Output frequency limit superv. 2 15 = Torque limit supervision 16 = Reference limit supervision 17 = External brake control 18 = Control from I/O-terminals 19 = Drive temperature limit supervision 20 = Unrequested rotation direction 21 = External brake control inverted	3-23
3. 7	Relay output 1 function	0—21	1	2		As parameter 3. 6	3-23
3. 8	Relay output 2 function	0—21	1	3		As parameter 3. 6	3-23
3. 9	Output freq. limit 1 supervision function	0—2	1	0		0 = No 1 = Low limit 2 = High limit	3-23
3. 10	Output freq. limit 1 supervision value	0.0—f_{max} (par. 1. 2)	0.1 Hz	0.0 Hz			3-23

Note! = Parameter value can be changed only when the drive is stopped.

Code	Parameter	Range	Step	Default	Custom	Description	Page
3. 11	Output freq. limit 2 supervision function	0—2	1	0		0 = No 1 = Low limit 2 = High limit	3-23
3. 12	Output freq. limit 2 supervision value	0.0—f_{max} (par. 1. 2)	0.1 Hz	0.0 Hz			3-23
3. 13	Torque limit supervision function	0—2	1	0		0 = No 1 = Low limit 2 = High limit	3-24
3. 14	Torque limit supervision value	0.0—200.0 % xT_{nCX}	0.1%	100.0%			3-24
3. 15	Reference limit supervision function	0—2	1	0		0 = No 1 = Low limit 2 = High limit	3-24
3. 16	Reference limit supervision value	0.0—f_{max} (par. 1. 2)	0.1 Hz	0.0 Hz			3-24
3. 17	Extern. brake Off-delay	0.0—100.0 s	0.1 s	0.5 s			3-24
3. 18	Extern. brake On-delay	0.0—100.0 s	0.1 s	1.5 s			3-24
3. 19	Drive temperature limit supervision	0—2	1	0		0 = No 1 = Low limit 2 = High limit	3-25
3. 20	Drive temperature limit value	-10—+75°C	1	40°C			3-25
3. 21	I/O-expander board (opt.) analog output function	0—7	1	3		See parameter 3. 1	3-22
3. 22	I/O-expander board (opt.) analog output filter time	0.00—10.00 s	0.01 s	1.00 s		See parameter 3. 2	3-22
3. 23	I/O-expander board (opt.) analog output inversion	0—1	1	0		See parameter 3. 3	3-22
3. 24	I/O-expander board (opt.) analog output minimum	0—1	1	0		See parameter 3. 4	3-22
3. 25	I/O-expander board (opt.) analog output scale	10—1000%	1	100%		See parameter 3. 5	3-22

Group 4, Drive control parameters

Code	Parameter	Range	Step	Default	Custom	Description	Page
4. 1	Acc./Dec. ramp 1 shape	0.0—10.0 s	0.1 s	0.0 s		0 = Linear >0 = S-curve acc./dec. time	3-25
4. 2	Acc./Dec. ramp 2 shape	0.0—10.0 s	0.1 s	0.0 s		0 = Linear >0 = S-curve acc./dec. time	3-25
4. 3	Acceleration time 2	0.1—3000.0s	0.1 s	10.0 s			3-25
4. 4	Deceleration time 2	0.1—3000.0s	0.1 s	10.0 s			3-25
4. 5	Brake chopper	0—2	1	0		0 = Brake chopper not in use 1 = Brake chopper in use 2 = External brake chopper	3-26
4. 6	Start function	0—1	1	0		0 = Ramp 1 = Flying start	3-26

Note! = Parameter value can be changed only when the drive is stopped.

Code	Parameter	Range	Step	Default	Custom	Description	Page
4. 7	Stop function	0—1	1	0		0 = Coasting 1 = Ramp	3-26
4. 8	DC-braking current	0.15—1.5 x I_{nCX} (A)	0.1 A	0.5xI_{nCX}			3-26
4. 9	DC-braking time at Stop	0.00-250.00s	0.01 s	0.00 s		0 = DC-brake is off at Stop	3-26
4. 10	Turn on frequency of DC brake during ramp Stop	0.1—10.0 Hz	0.1 Hz	1.5 Hz			3-28
4. 11	DC-brake time at Start	0.00—25.00s	0.01 s	0.00 s		0 = DC-brake is off at Start	3-28

Group 5, Prohibit frequency parameters

Code	Parameter	Range	Step	Default	Custom	Description	Page
5. 1	Prohibit frequency range 1 low limit	f_{min}— par. 5. 2	0.1 Hz	0.0 Hz			3-28
5. 2	Prohibit frequency range 1 high limit	f_{min}—f_{max} (1. 1) (1. 2)	0.1 Hz	0.0 Hz		0 = Prohibit range 1 is off	3-28
5. 3	Prohibit frequency range 2 low limit	f_{min}— par. 5. 4	0.1 Hz	0.0 Hz			3-28
5. 4	Prohibit frequency range 2 high limit	f_{min}—f_{max} (1. 1) (1. 2)	0.1 Hz	0.0 Hz		0 = Prohibit range 2 is off	3-28
5. 5	Prohibit frequency range 3 low limit	f_{min}— par. 5. 6	0.1 Hz	0.0 Hz			3-28
5. 6	Prohibit frequency range 3 high limit	f_{min}—f_{max} (1. 1) (1. 2)	0.1 Hz	0.0 Hz		0 = Prohibit range 3 is of	3-28

Group 6, Motor control parameters

Code	Parameter	Range	Step	Default	Custom	Description	Page
6. 1	Motor control mode	0—1	1	0		0 = Frequency control 1 = Speed control	3-29
6. 2	Switching frequency	1.0—16.0 kHz	0.1 kHz	10/3.6 kHz		Dependant on Hp rating	3-29
6. 3	Field weakening point	30—500 Hz	1 Hz	Param. 1. 11			3-29
6. 4	Voltage at field weakening point	15—200% x V_{nmot}	1%	100%			3-29
6. 5	V/Hz curve, midpoint frequency	0.0—f_{max}	0.1 Hz	0.0 Hz			3-29
6. 6	V/Hz-curve, midpoint voltage	0.00—100.00% x V_{nmot}	0.01%	0.00%			3-29
6. 7	Output voltage at zero frequency	0.00—100.00% x V_{nmot}	0.01%	0.00%			3-29
6. 8	Overvoltage controller	0—1	1	1		0 = Controller is turned off 1 = Controller is operating	3-30
6. 9	Undervoltage controller	0—1	1	1		0 = Controller is turned off 1 = Controller is operating	3-30

Note! = Parameter value can be changed only when the drive is stopped.

Group 7, Protections

Code	Parameter	Range	Step	Default	Custom	Description	Page
7. 1	Response to reference fault	0—3	1	0		0 = No action 1 = Warning 2 = Fault, stop according to par. 4.7 3 = Fault, always coasting stop	3-30
7. 2	Response to external fault	0—3	1	2		0 = No action 1 = Warning 2 = Fault, stop according to par. 4.7 3 = Fault, always coasting stop	3-30
7. 3	Phase supervision of the motor	0—2	2	2		0 = No action 2 = Fault	3-30
7. 4	Ground fault protection	0—2	2	2		0 = No action 2 = Fault	3-31
7. 5	Motor thermal protection	0—2	1	2		0 = No action 1 = Warning 2 = Fault	3-31
7. 6	Motor thermal protection break point current	50.0—150.0 % x I_{nMOTOR}	1.0 %	100.0%			3-32
7. 7	Motor thermal protection zero frequency current	5.0—150.0% x I_{nMOTOR}	1.0 %	45.0%			3-32
7. 8	Motor thermal protection time constant	0.5—300.0 minutes	0.5 min.	17.0 min.		Default value is set according to motor nominal current	3-33
7. 9	Motor thermal protection break point frequency	10—500 Hz	1 Hz	35 Hz			3-33
7. 10	Stall protection	0—2	1	1		0 = No action 1 = Warning 2 = Fault	3-34
7. 11	Stall current limit	5.0—200.0% x I_{nMOTOR}	1.0%	130.0%			3-34
7. 12	Stall time	2.0—120.0 s	1.0 s	15.0 s			3-34
7. 13	Maximum stall frequency	1—f_{max}	1 Hz	25 Hz			3-34
7. 14	Underload protection	0—2	1	0		0 = No action 1 = Warning 2 = Fault	3-35
7. 15	Underload prot., field weakening area load	10.0—150.0 % x T_{nMOTOR}	1.0%	50.0%			3-35
7. 16	Underload protection, zero frequency load	5.0—150.0% x T_{nMOTOR}	1.0%	10.0%			3-35
7. 17	Underload time	2.0—600.0 s	1.0 s	20.0s			3-36

3

Group 8, Autorestart parameters

Code	Parameter	Range	Step	Default	Custom	Description	Page
8. 1	Automatic restart: number of tries	0—10	1	0		0 = not in use	3-36
8. 2	Automatic restart: multi attempt maximum trial time	1—6000 s	1 s	30 s			3-36
8. 3	Automatic restart: start function	0—1	1	0		0 = Ramp 1 = Flying start	3-37
8. 4	Automatic restart after undervoltage trip	0—1	1	0		0 = No 1 = Yes	3-37
8. 5	Automatic restart after overvoltage trip	0—1	1	0		0 = No 1 = Yes	3-37
8. 6	Automatic restart after overcurrent trip	0—1	1	0		0 = No 1 = Yes	3-37
8. 7	Automatic restart after reference fault trip	0—1	1	0		0 = No 1 = Yes	3-37
8. 8	Automatic restart after over/undertemperature fault trip	0—1	1	0		0 = No 1 = Yes	3-37

Table 3.5-1 Special parameters, Groups 2—8.

3.5.2 Description of Groups 2—8 parameters

2. 1 Start/Stop logic selection

0: DIA1: closed contact = start forward
DIA2: closed contact = start reverse,
See figure 3.5-1.

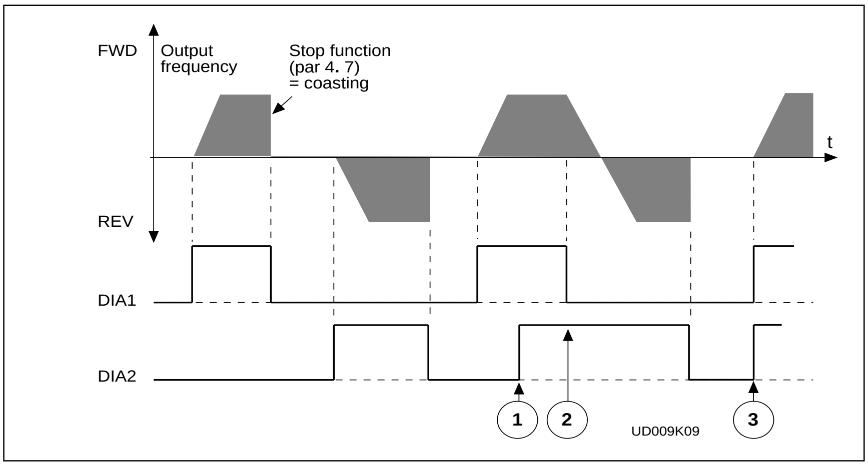


Figure 3.5-1 Start forward/Start reverse.

1. The first selected direction has the highest priority
2. When DIA1 contact opens, the direction of rotation starts to change
3. If Start forward (DIA1) and start reverse (DIA2) signals are active simultaneously, the start forward signal (DIA1) has priority.

1: DIA1: closed contact = start open contact = stop
DIA2: closed contact = reverse open contact = forward
See figure 3.5-2.

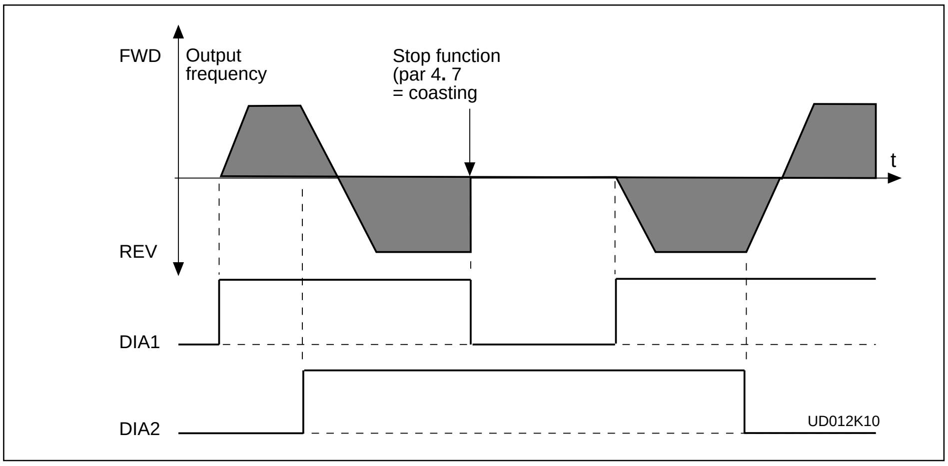


Figure 3.5-2 Start, Stop, reverse.

2: DIA1: closed contact = start open contact = stop
DIA2: closed contact = start enabled open contact = start disabled

3: 3-wire connection

DIA1: closed contact = start pulse
DIA2: closed contact = stop pulse
(DIA3 can be programmed for reverse command)
See figure 3.5-3.

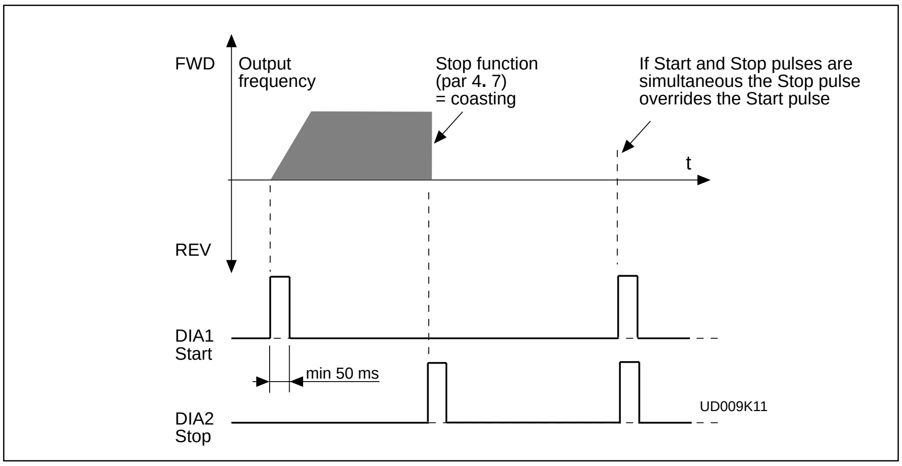


Figure 3.5-3 Start pulse /Stop pulse.

2. 2 **DIA3 function**

1: External fault, closing contact = Fault is shown and motor is stopped when the contact is closed
2: External fault, opening contact = Fault is shown and motor is stopped when the input is open

3: Run enable contact open = Start of the motor disabled
contact closed = Start of the motor enabled

4: Acc. / Dec time select. contact open = Acceleration/Deceleration time 1 selected
contact closed = Acceleration/Deceleration time 2 selected

5: Reverse contact open = Forward | Can be used for reversing if
contact closed = Reverse | parameter 2**.** 1 has value 3

6: Jog speed contact closed = Jog speed selected for freq. refer.

7: Fault reset contact closed = Resets all faults

8: Acc./Dec. operation prohibited
contact closed = Stops acceleration or deceleration until the contact is opened

9: DC-braking command
contact closed = In Stop mode, the DC-braking operates until the contact is opened, see figure 3.5-4. DC-brake current is set with parameter 4**.** 8.

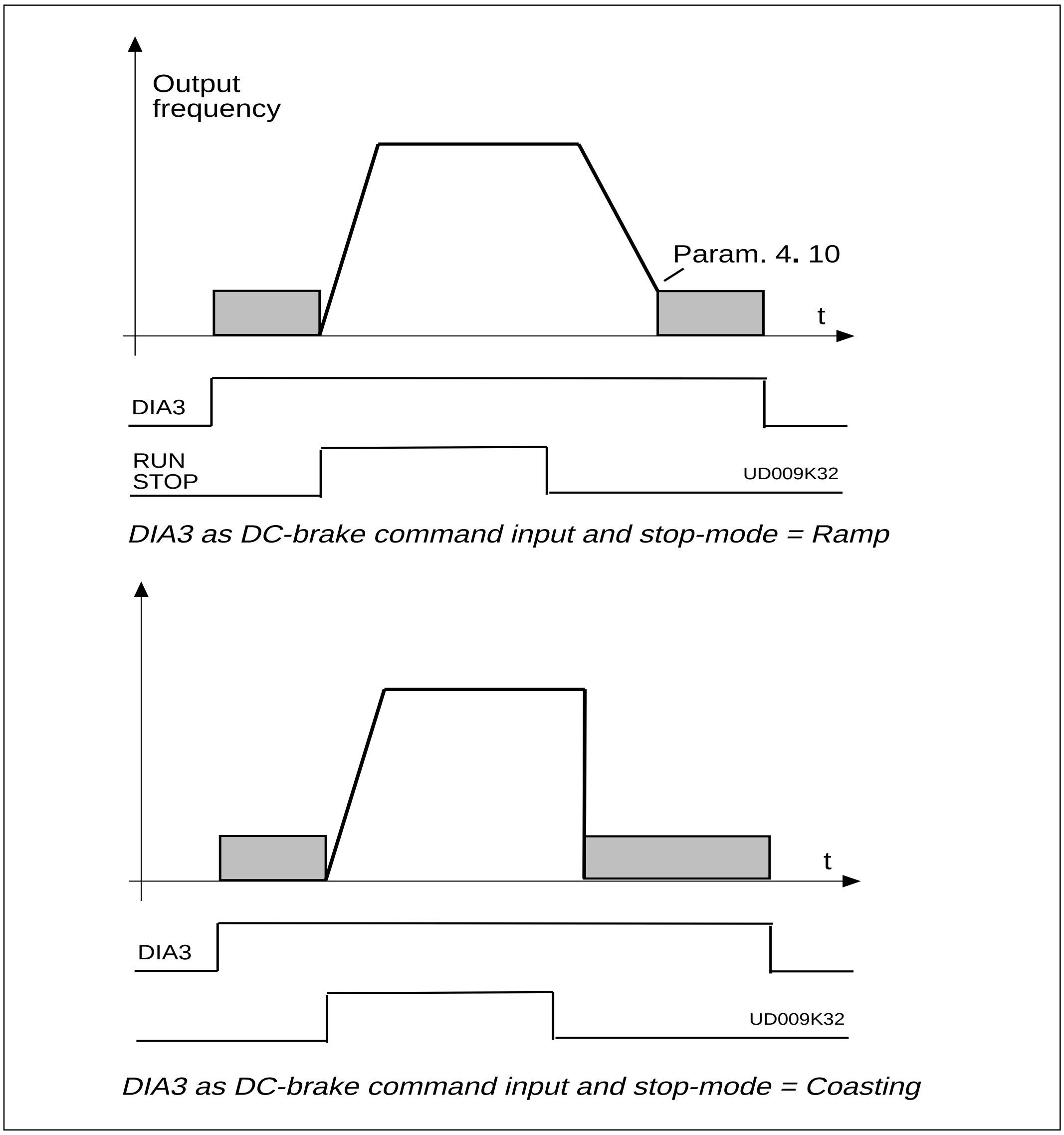


Figure 3.5-4 DIA3 as DC-brake command input: a) Stop mode = Ramp,
b) Stop mode = Coasting.

2. 3 V_{in} signal range

0 = Signal range 0—10 V
1 = Custom setting range from custom minimum (par. 2. 4) to custom maximum (par. 2. 5)

2. 4 V_{in} custom setting minimum/maximum

2. 5 These parameters set V_{in} for any input signal span within 0—10 V.

Minimum setting: Set the V_{in} signal to its minimum level, select parameter 2.4, press the Enter button
Maximum setting: Set the V_{in} signal to its maximum level, select parameter 2.5, press the Enter button

Note! The parameter values can only be set with this procedure (not with arrow up/arrow down buttons).

2. 6 V_{in} signal inversion

V_{in} is source B frequency reference, par. 1. 6 = 1 (default)

Parameter 2. 6 = 0, no inversion of analog V_{in} signal.

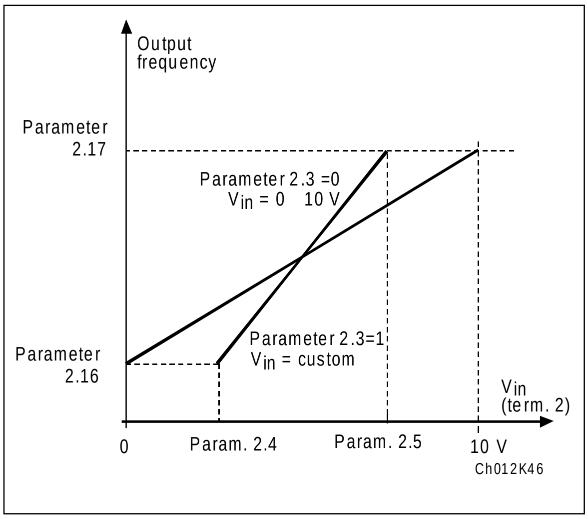


Figure 3.5-5 V_{in} no signal inversion.

Parameter 2. 6 = 1, inversion of analog V_{in} signal
max. V_{in} signal = minimum set speed
min. V_{in} signal = maximum set speed

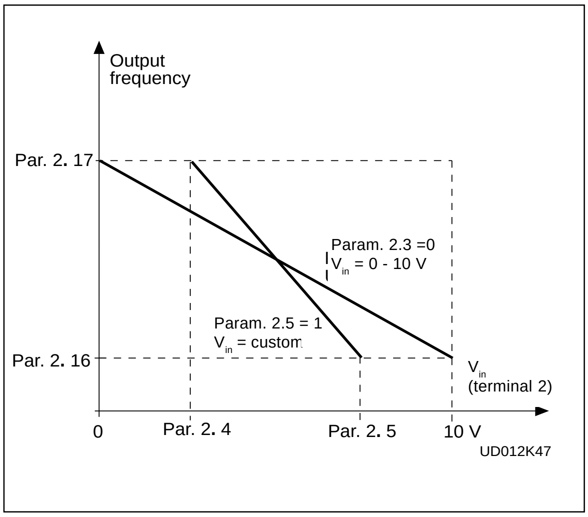


Figure 3.5-6 V_{in} signal inversion.

2. 7 V_{in} signal filter time

Filters out disturbances from the incoming analog V_{in} signal.
A long filtering time makes regulation response slower.
See figure 3.5-7.

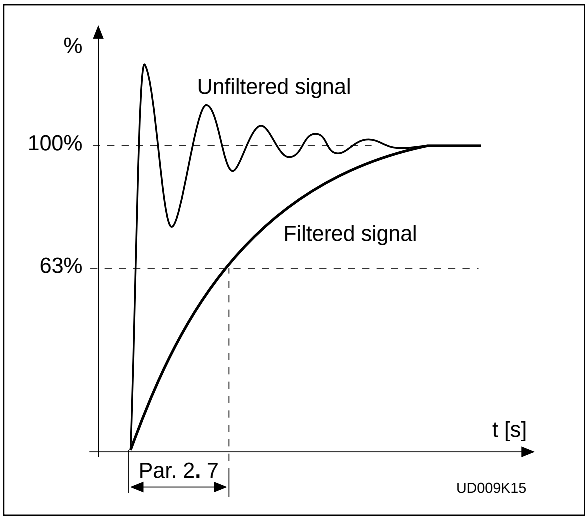


Figure 3.5-7 V_{in} signal filtering.

3

2. 8 Analog input I_{in} signal range

0 = 0—20 mA
1 = 4—20 mA
2 = Custom signal span

See figure 3.5-8.

2. 9 Analog input I_{in} custom
2. 10 setting minimum/maximum

With these parameters you can scale the input current to correspond to a minimum and maximum frequency range. See figure 3.5-8.

Minimum setting:
Set the I_{in} signal to its minimum level, select parameter 2. 9, press the Enter button
Maximum setting:
Set the I_{in} signal to its maximum level, select parameter 2. 10, press the Enter button

Note! The parameter values can only be set with this procedure (not with arrow up/arrow down-buttons).

2. 11 Analog input I_{in} inversion

I_{in} is source A frequency reference, par. 1. 5 = 0 (default)

Parameter 2. 11 = 0, no inversion of I_{in} input

Parameter 2. 11 = 1, inversion of I_{in} input, see figure 3.5-9.

max. I_{in} signal = minimum set speed
min. I_{in} signal = maximum set speed

2. 12 Analog input I_{in} filter time

Filters out disturbances from the incoming analog I_{in} signal. A long filtering time makes regulation response slower. See figure 3.5-10.

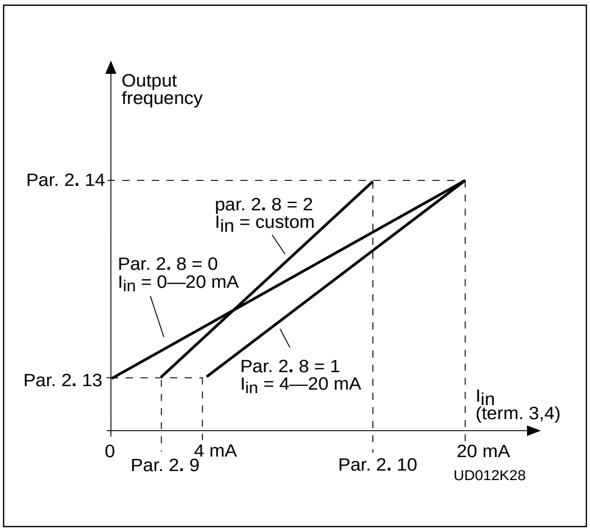


Figure 3.5-8 Analog input I_{in} scaling.

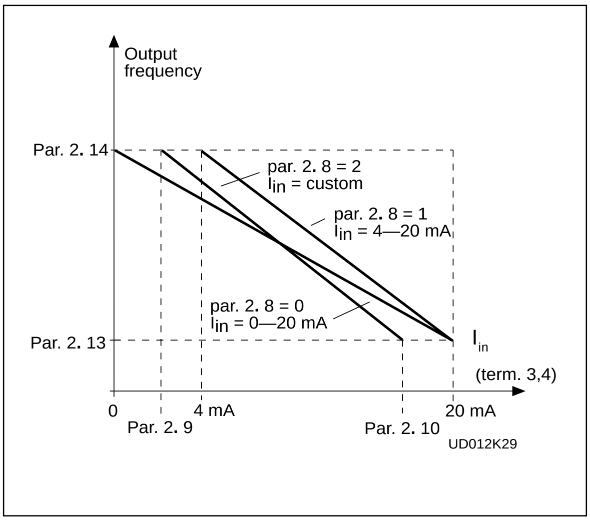


Figure 3.5-9 I_{in} signal inversion.

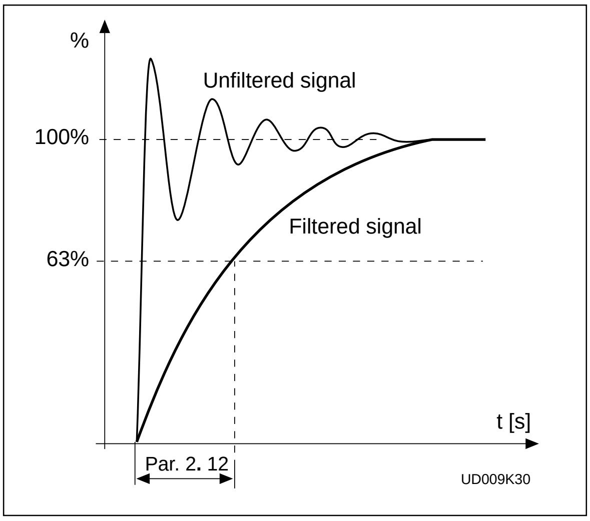


Figure 3.5-10 Analog input I_{in} filter time.

3

2. 13, 2. 14 Reference scaling, minimum value/maximum value

Scales the basic reference.

Setting limits: par. 1**.** 1 <par. 2**.** 13<par. 2**.** 14 <par. 1**.** 2.
If par. 2**.** 14 = 0 scaling is set off. See figures 3.5-11 and 3.5-12.

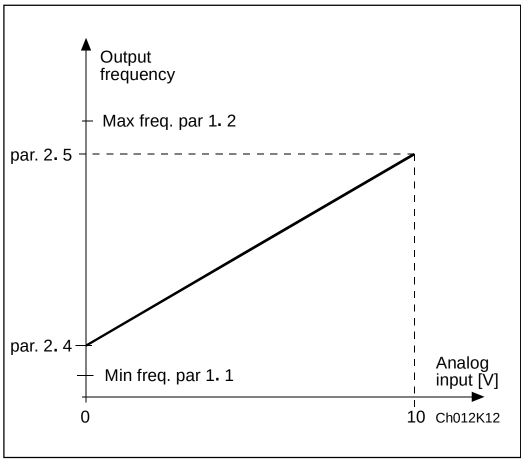


Figure 3.5-11 Reference scaling.

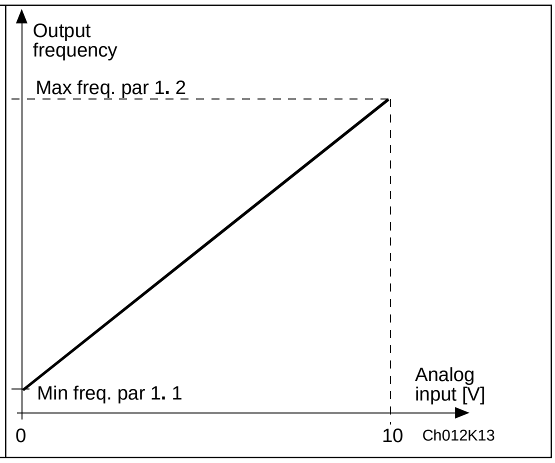


Figure 3.5-12 Reference scaling, par. 2. 14 = 0.

2. 18 Free analog input signal

Selection of input signal of free analog input (an input not used for reference signal):

0 = Not in use
1 = Voltage signal V_{in}
2 = Current signal I_{in}

2. 19 Free analog input signal function

Use this parameter to select a function for a free analog input signal:

0 = Function is not used

1 = Reducing motor current limit (par. 1**.** 7)

This signal will adjust the maximum motor current between 0 and with parameter 1**.** 7 set max. limit. See figure 3.5-13.

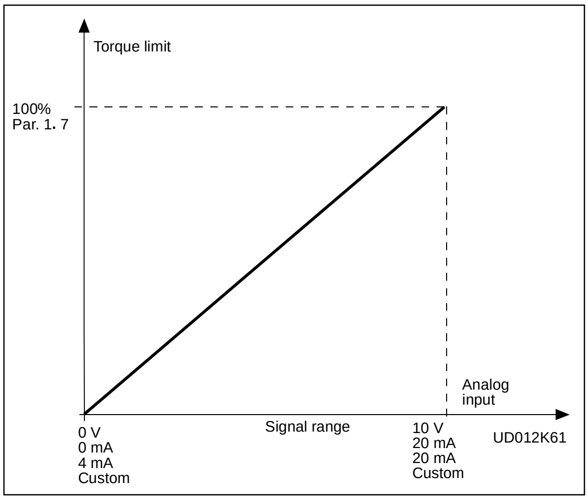


Figure 3.5-13 Reducing of max. motor current.

2 Reducing DC brake current.

DC braking current can be reduced with the free analog input signal between current 0.15 x I_{nSV9} and current set by the parameter 4**.** 8. See figure 3.5-14.

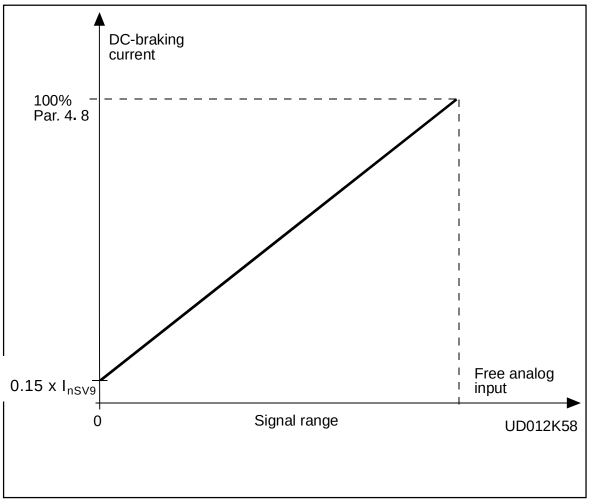


Figure 2.5-14 Reducing DC brake current.

3 Reducing acceleration and deceleration times.

Acceleration/deceleration times can be reduced with a free analog input signal according to the following formulas:

Reduced time = set acc./ deceler. time (par. 1**.** 3, 1**.** 4; 4**.** 3, 4**.** 4) divided by the factor R from the figure 3.5-15.

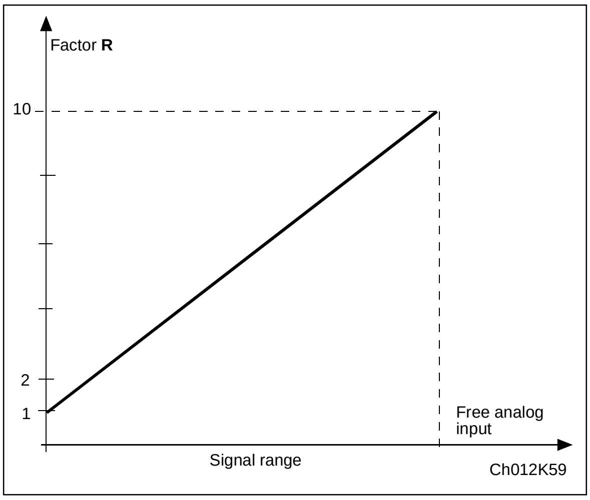


Figure 3.5-15 Reducing acceleration and deceleration times.

4 Reducing torque supervision limit.

Torque supervision limit can be reduced with a free analog input signal between 0 and set supervision limit (par. 3**.** 14), see figure 3.5-16.

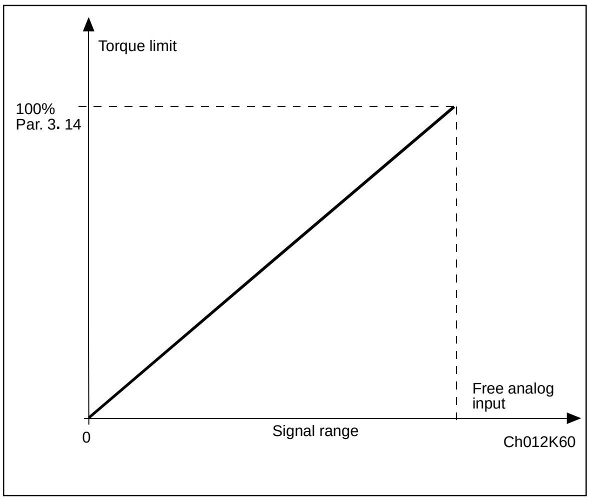


Figure 3.5-16 Reducing torque supervision limit.

3. 1 Analog output function

See table on page 3-9.

3. 2 Analog output filter time

Filters the analog output signal. See figure 3.5-17.

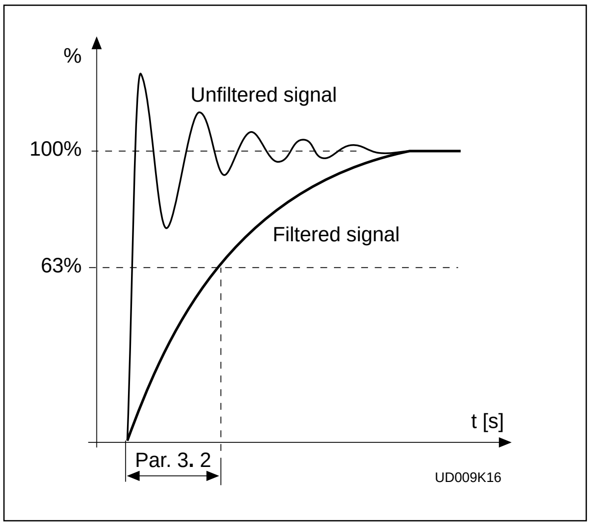


Figure 3.5-17 Analog output filtering.

3.3 Analog output invert

Inverts analog output signal:
max. output signal = minimum set value
min. output signal = maximum set value

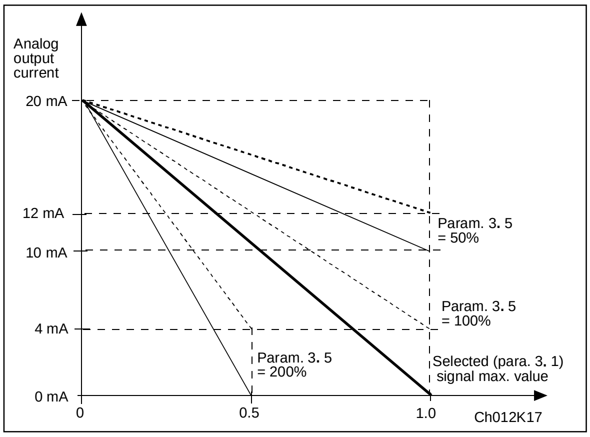


Figure 3.5-18 Analog output invert.

3. 4 Analog output minimum

Defines the signal minimum to be either 0 mA or 4 mA (living zero). See figure 3.5-19.

3. 5 Analog output scale

Scaling factor for analog output. See figure 3.5-19.

Signal	Max. value of the signal
Output frequency	Max. frequency (p. 1. 2)
Output current	2 x I_{nCX}
Motor speed	Max. speed ($n_n x f_{max}/f_n$)
Motor torque	2 x T_{nMot}
Motor power	2 x P_{nMot}
Motor voltage	100% x V_{nMot}
DC-link volt.	1000 V

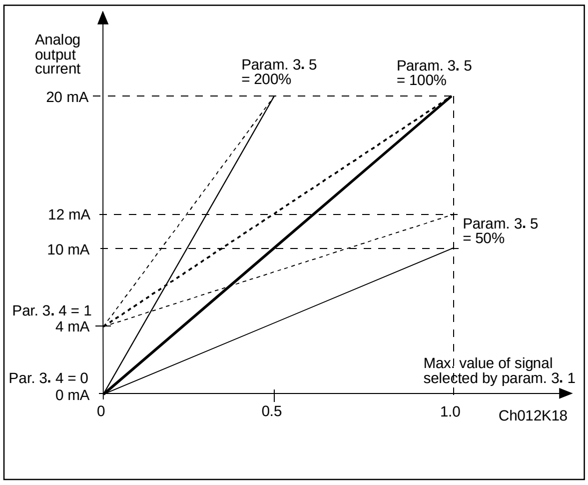


Figure 3.5-19 Analog output scale.

3. 6 Digital output function
3. 7 Relay output 1 function
3. 8 Relay output 2 function

Setting value	Signal content
0 = Not used	Out of operation
	Digital output DO1 sinks current and programmable relay (RO1, RO2) is activated when:
1 = Ready	The drive is ready to operate
2 = Run	The drive operates (motor is running)
3 = Fault	A fault trip has occurred
4 = Fault inverted	A fault trip has not occurred
5 = CX overheat warning	The heat-sink temperature exceeds +70°C
6 = External fault or warning	Fault or warning depending on parameter 7. 2
7 = Reference fault or warning	Fault or warning depending on parameter 7. 1 - if analog reference is 4—20 mA and signal is <4mA
8 = Warning	Always if a warning exists
9 = Reversed	The reverse command has been selected
10 = Jog speed selected	The Jog speed has been selected with digital input
11 = At speed	The output frequency has reached the set reference
12 = Motor regulator activated	Overvoltage or overcurrent regulator was activated
13 = Output frequency supervision 1	The output frequency goes outside of the set supervision Low limit/ High limit (par. 3. 9 and 3. 10)
14= Output frequency supervision 2	The output frequency goes outside of the set supervision Low limit/ High limit (par. 3. 11 and 3. 12)
15= Torque limit supervision	The motor torque goes outside of the set supervision Low limit/ High limit (par. 3. 13 and 3. 14)
16= Active reference limit supervision	Active reference goes outside of the set supervision Low limit/ High limit (par. 3. 15 and 3. 16)
17 = External brake control	External brake ON/OFF control with programmable delay (par 3. 17 and 3. 18)
18 = Control from I/O terminals	External control mode selected with prog. push-button#2
19 = Drive	Temperature on drive goes outside the set supervision limits (par. 3. 19 and 3. 20)
20 = Unrequested rotation direction	Rotation direction of the motor shaft is different from the requested one
21= External brake control inverted	External brake ON/OFF control (par 3.17 and 3.18), output active when brake control is OFF

Table 3.5-2 Output signals via DO1 and output relays RO1 and RO2.

3. 9 Output frequency limit 1, supervision function
3. 11 Output frequency limit 2, supervision function

0 = No supervision
1 = Low limit supervision
2 = High limit supervision

If the output frequency goes under/over the set limit (3. 10, 3. 12) this function generates a warning message via the digital output DO1 or via a relay output RO1 or RO2 depending on the settings of the parameters 3. 6—3. 8.

3. 10 Output frequency limit 1, supervision value
3. 12 Output frequency limit 2, supervision value

The frequency value to be supervised by the parameter 3. 9 (3. 11).
See figure 3.5-20.

3

3. 13 Torque limit , supervision function

0 = No supervision
1 = Low limit supervision
2 = High limit supervision

If the calculated torque value goes under/over the set limit (3. 14) this function generates a warning message via the digital output DO1 or via a relay output RO1 or RO2 depending on the settings of the parameters 3. 6—3. 8.

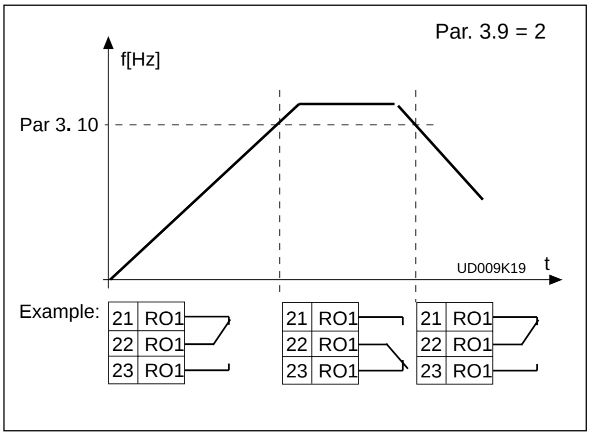


Figure 3.5-20 Output frequency supervision.

3. 14 Torque limit , supervision value

The calculated torque value to be supervised by the parameter 3.13. Torque supervision value can be reduced below the setpoint with al free analog input signal, see parameters 2.18 and 2.19.

3. 15 Reference limit , supervision function

0 = No supervision
1 = Low limit supervision
2 = High limit supervision

If reference value goes under/over the set limit (3. 16) this function generates a warning message via the digital output DO1 and via a relay output RO1 or RO2 depending on the settings of the parameters 3. 6—3. 8. The supervised reference is the current active reference. It can be source A or B reference depending on DIB6 input or panel reference if panel is the active control source.

3. 16 Reference limit , supervision value

The frequency value to be supervised by the parameter 3. 15.

3. 17 External brake-off delay

3. 18 External brake-on delay

The function of the external brake can be delayed from the start and stop control signals with these parameters. See figure 3.5-21.

The brake control signal can be programmed via the digital output DO1 or via one of the relay outputs RO1 and RO2, see parameters 3. 6—3. 8.

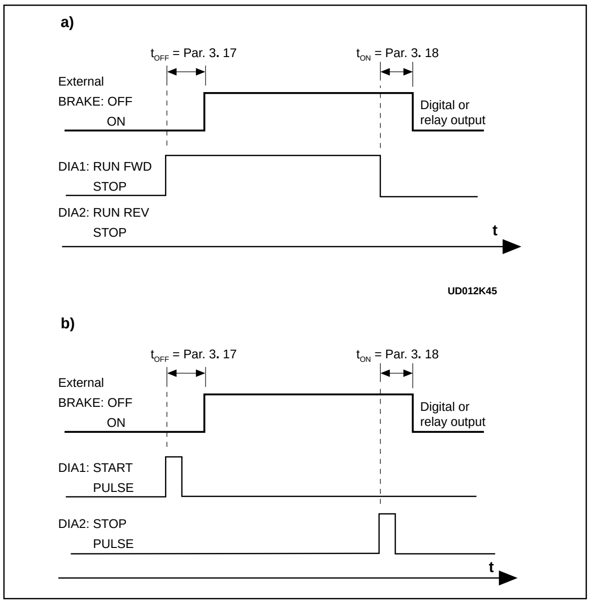


Figure 3.5-21 External brake control:
a) Start/Stop logic selection par. 2. 1 = 0, 1 or 2
b) Start/Stop logic selection par. 2. 1 = 3.

3. 19 Drive temperature limit supervision

0 = No supervision
1 = Low limit supervision
2 = High limit supervision

If the temperature of the unit goes under/over the set limit (3. 20) this function generates a warning message via the digital output DO1 or via a relay output RO1 or RO2 depending on the settings of the parameters 3. 6—3. 8.

3. 20 Drive temperature limit value

The temperature value to be supervised by the parameter 3. 19.

4. 1 Acc/Dec ramp 1 shape
4. 2 Acc/Dec ramp 2 shape

The acceleration and deceleration ramp shape can be programmed with these parameters.

Setting the value = 0 gives you a linear ramp shape. The output frequency immediately follows the input with a ramp time set by parameters 1. 3,1. 4 (4. 3, 4. 4 for Acc/Dec time 2).

Setting 0.1—10 seconds for 4. 1 (4. 2) causes an S-shaped ramp. The speed changes are smooth. Parameter 1. 3/ 1. 4 (4. 3/ 4. 4) determines the ramp time of the acceleration/deceleration in the middle of the curve. See figure 3.5-22.

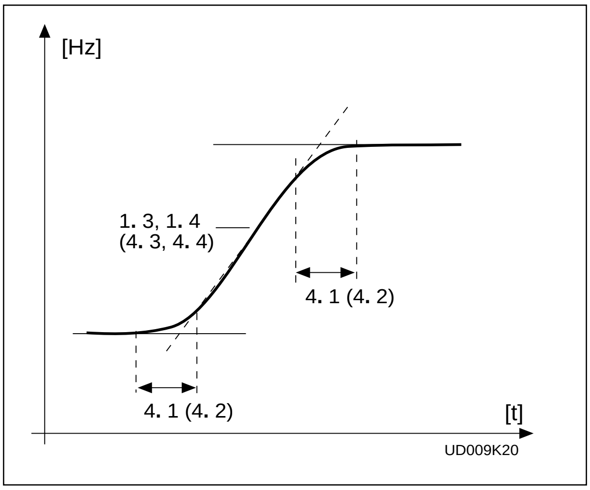


Figure 3.5-22 S-shaped acceleration/ deceleration.

4. 3 Acceleration time 2

4. 4 Deceleration time 2

These values correspond to the time required for output frequency to accelerate from the set minimum frequency (par. 1. 1) to the set maximum frequency (par. 1. 2). With this parameter it is possibile to set two different acceleration/ deceleration times for one application. The active set can be selected with the programmable signal DIA3. See parameter 2. 2.
Acceleration/deceleration times can be reduced with a free analog input signal. See parameters 2. 18 and 2. 19.

4. 5 Brake chopper

0 = No brake chopper
1 = Brake chopper and brake resistor installed
2 = External brake chopper

When the drive is decelerating the motor, the energy stored in the inertia of the motor and the load is fed into the external brake resistor. If the brake resistor is selected correctly the drive is able to decelerate the load with a torque equal to that of acceleration. See the separate Brake resistor installation manual.

4. 6 Start function

Ramp:

0 The drive starts from 0 Hz and accelerates to the set reference frequency within the set acceleration time. (Load inertia or starting friction may cause prolonged acceleration times).

Flying start:

1 The drive starts into a running motor by first finding the speed the motor is running at. Searching starts from the maximum frequency down until the actual frequency reached. The output frequency then accelerates/decelerates to the set reference value at a rate determined by the acceleration/deceleration ramp parameters.

Use this mode if the motor may be coasting when the start command is given. With the flying start it is possible to ride through short utility voltage interruptions.

4. 7 Stop function

Coasting:

0 The motor coasts to an uncontrolled stop with the CX/CXL/CXS off, after the Stop command.

Ramp:

1 After the Stop command, the speed of the motor is decelerated according to the deceleration ramp time parameter.
If the regenerated energy is high it may be necessary to use an external braking resistor for faster deceleration.

4. 8 DC braking current

Determines whether DC braking is ON or OFF. It also determines the braking duration time of the DC-brake when the motor is stopping. The function of the DC-brake depends on the stop function, parameter 4. 7. See figure 3.5-23.

0 DC-brake is not used

>0 DC-brake is in use depending on the setup of the stop function (param. 4. 7). The time is set by the value of parameter 4. 9:

3

<u>Stop-function = 0 (coasting):</u>

After the stop command, the motor will coast to a stop with the CX/CXL/CXS off.

With DC-injection, the motor can be electrically stopped in the shortest possible time, without using an optional external braking resistor.

The braking time is scaled according to the frequency when the DC- braking starts. If the frequency is ≥ nominal frequency of the motor (par. 1.11), the value of parameter 4.9 determines the braking time. When the frequency is ≤ 10% of the nominal, the braking time is 10% of the set value of parameter 4.9.

<u>Stop-function = 1 (ramp):</u>

After a Stop command, the speed of the motor is reduced based on the deceleration ramp parameter. If no regeneration occurs due to load inertia DC-braking starts at a speed defined by parameter 4. 10.

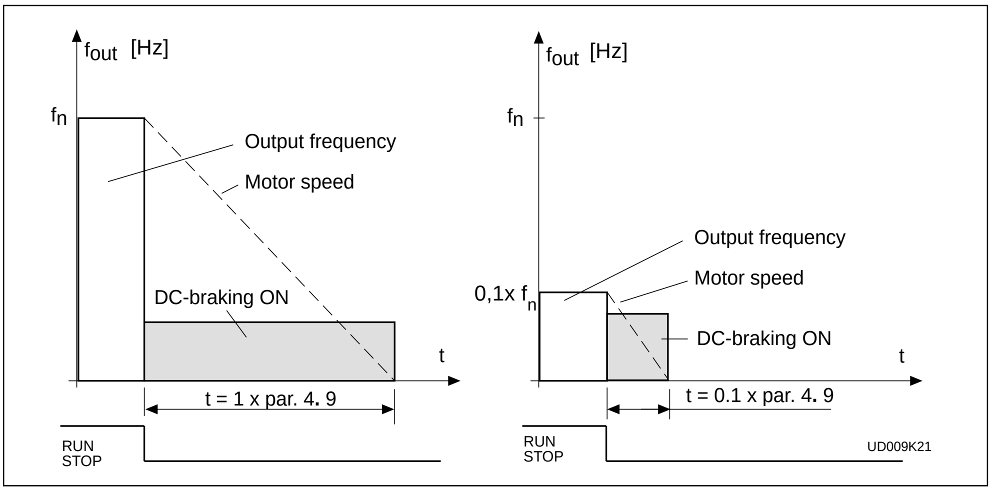


Figure 3.5-23 DC-braking time when stop = coasting.

The braking time is defined with parameter 4.9.

If high inertia exists it is recommended to use an external braking resistor for faster deceleration. See figure 3.5-24.

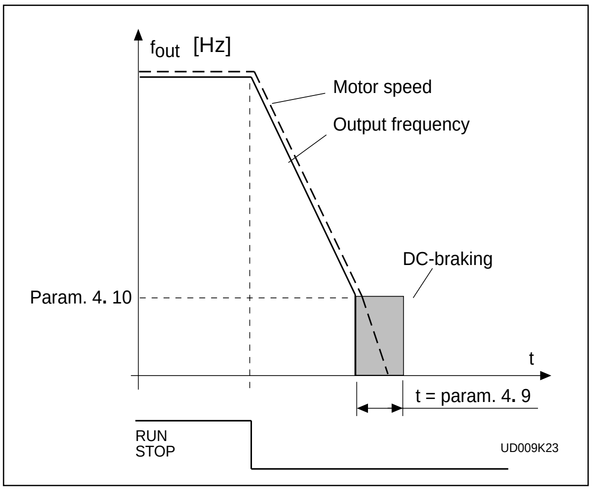


Figure 3.5-24 DC-braking time when stop function = ramp.

4. 10 Execute frequency of DC-brake during ramp Stop

See figure 3.5-24.

4. 11 DC-brake time at start

0 DC-brake is not used

>0 DC-brake is active when the start command is given. This parameter defines the time before the brake is released. After the brake is released, the output frequency increases according to the set start function parameter 4. 6 and the acceleration parameters (1.3, 4.1 or 4.2, 4.3). See figure 3.5-25.

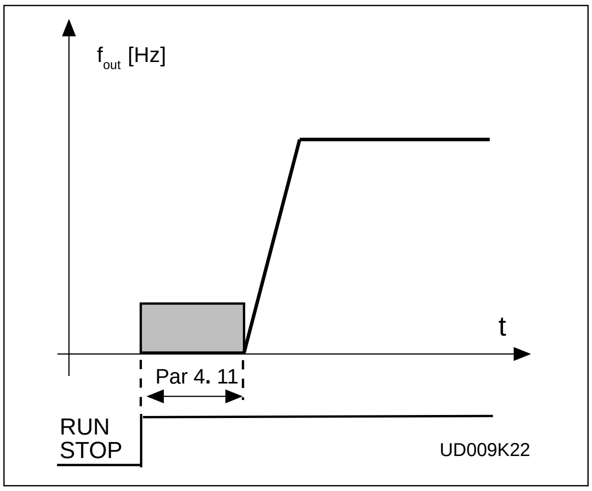


Figure 3.5-25 DC-braking time at start.

3

5. 1- 5.6 Prohibit frequency area Low limit/High limit

In some systems it may be necessary to avoid certain frequencies because of mechanical resonance problems.

With these parameters it is possible to set limits for three "skip frequency" regions between 0 Hz and 500 Hz. The accuracy of the setting is 0.1 Hz. See figure 3.5-26.

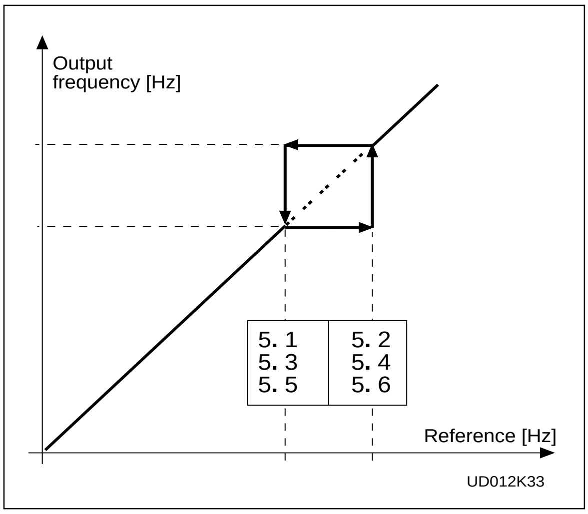


Figure 3.5-26 Example of prohibit frequency area setting.

6. 1 Motor control mode

0 = Frequency control: (V/Hz) — The I/O terminal and panel references are frequency references and the drive controls the output frequency (output freq. resolution 0.01 Hz)

1 = Speed control: (sensorless vector) — The I/O terminal and panel references are speed references and the drive controls the motor speed (control accuracy ± 0.5%).

6. 2 Switching frequency

Motor noise can be minimized by using a high switching frequency. Increasing the switching frequency reduces the current capacity of the CX/CXL/CXS.

Before changing the frequency from the factory default 10 kHz (3.6 kHz >40 Hp) check the drive derating in the curves shown in figures 5.2-2 and 5.2-3 in chapter 5.2 of the User's Manual.

6. 3 Field weakening point
6. 4 Voltage at the field weakening point

The field weakening point is the output frequency where the output voltage reaches the set maximum value. Above that frequency the output voltage remains at the set maximum value.
Below that frequency output voltage depends on the setting of the V/Hz curve parameters 1. 8, 1. 9, 6. 5, 6. 6 and 6. 7. See figure 3.5-27.

When the parameters 1. 10 and 1. 11, nominal voltage and nominal frequency of the motor are set, parameters 6. 3 and 6. 4 are also set automatically to the corresponding values. If you need different values for the field weakening point and the maximum output voltage, change these parameters after setting parameters 1. 10 and 1. 11.

6. 5 V/Hz curve, middle point frequency

If the programmable V/Hz curve has been selected with parameter 1. 8, this parameter defines the middle frequency point of the curve. See figure 3.5-27.

6. 6 V/Hz curve, middle point voltage

If the programmable V/Hz curve has been selected with parameter 1. 8, this parameter defines the middle point voltage (% of motor nominal voltage) of the curve. See figure 3.5-27.

6. 7 Output voltage at zero frequency

If the programmable V/Hz curve has been selected with parameter 1. 8, this parameter defines the zero frequency voltage of the curve. See figure 3.5-27.

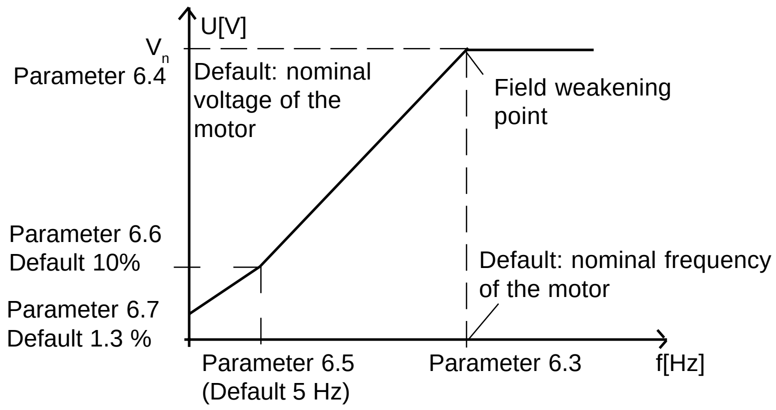


Figure 3.5-27 Programmable V/Hz curve.

3

6. 8 Overvoltage controller
6. 9 Undervoltage controller

These parameters allow the over/undervoltage controllers to be switched ON or OFF. This may be useful in cases where the utility supply voltage varies more than -15%—+10% and the application requires a constant speed. If the controllers are ON, they will change the motor speed in over/undervoltage cases. Overvoltage = faster, undervoltage = slower.

Over/undervoltage trips may occur when controllers are not used.

7. 1 Response to the reference fault

0 = No response
1 = Warning
2 = Fault, stop mode after fault according to parameter 4.7
3 = Fault, always coasting stop mode after fault

A warning or a fault action and message is generated if the 4—20 mA reference signal is used and the signal falls below 4 mA. The information can also be programmed via digital output DO1 and via relay outputs RO1 and RO2.

7. 2 Response to external fault

0 = No response
1 = Warning
2 = Fault, stop mode after fault according to parameter 4.7
3 = Fault, stop mode after fault always by coasting

A warning or a fault action and message is generated from the external fault signal in the digital input DIA3. The information can also be programmed into digital output DO1 and into relay outputs RO1 and RO2.

7. 3 Phase supervision of the motor

0 = No action
2 = Fault

Phase supervision of the motor ensures that the motor phases have approximately equal current.

7. 4 Ground fault protection

0 = No action
2 = Fault

Ground fault protection ensures that the sum of the motor phase currents is zero. The standard overcurrent protection is always working and protects the frequency converter from ground faults with high current levels.

Parameters 7. 5—7. 9 Motor thermal protection

General

Motor thermal protection is to protect the motor from overheating. The CX/CXL/CXS drive is capable of supplying higher than nominal current to the motor. If the load requires this high current there is a risk that motor will be thermally overloaded. This is true especially at low frequencies. With low frequencies the cooling effect of the motor fan is reduced and the capacity of the motor is reduced. If the motor is equipped with a separately powered external fan, the load derating at low speed is small.

Motor thermal protection is based on a calculated model and it uses the output current of the drive to determine the load on the motor. When the motor is powered from the drive, the calculated model uses the heatsink temperature to determine the initial thermal stage for the motor. The calculated model assumes that the ambient temperature of the motor is 40°C.

Motor thermal protection can be adjusted by setting several parameters. The thermal current I_T specifies the load current above which the motor is overloaded. This current limit is a function of the output frequency. The curve for I_T is set with parameters 7**.** 6, 7**.** 7 and 7**.** 9, refer to the figure 3.5-28. The default values of these parameters are set from the motor nameplate data.

With the output current at I_T the thermal stage will reach the nominal value (100%). The thermal stage changes by the square of the current. With output current at 75% from I_T the thermal stage will reach 56% value and with output current at 120% from I_T the thermal stage would reach 144% value. The function will trip the drive (refer par. 7**.** 5) if the thermal stage will reach a value of 105%. The response time of the thermal stage is determined with the time constant parameter 7**.** 8. The larger the motor, the longer it takes to reach the final temperature.

The thermal stage of the motor can be monitored through the display. Refer to the table for monitoring items. (User's Manual, table 7.3-1).

! CAUTION! *The calculated model does not protect the motor if the cooling of the motor is reduced either by blocking the airflow or due to dust or dirt.*

7. 5 Motor thermal protection

Operation:
- 0 = Not in use
- 1 = Warning
- 2 = Trip function

Tripping and warning will give a display indication with the same message code. If tripping is selected, the drive will stop and activate the fault stage.

Deactivating the stall protection by setting the parameter to 0 will reset the stall time counter to zero.

7. 6 Motor thermal protection, break point current

The current can be set between 50.0—150.0% x I_{nMotor}.
This parameter sets the value for thermal current at frequencies above the break point on the thermal current curve. Refer to the figure 3.5-28.

The value is set as a percentage of the motor nameplate nominal current, parameter 1. 13, not the drive's nominal output current.

The motor's nominal current is the current which the motor can withstand in direct on-line use without being overheated.

If parameter 1. 13 is adjusted, this parameter is automatically restored to the default value.

Setting this parameter (or parameter 1. 13) does not affect the maximum output current of the drive. Parameter 1. 7 alone determines the maximum output current of the drive.

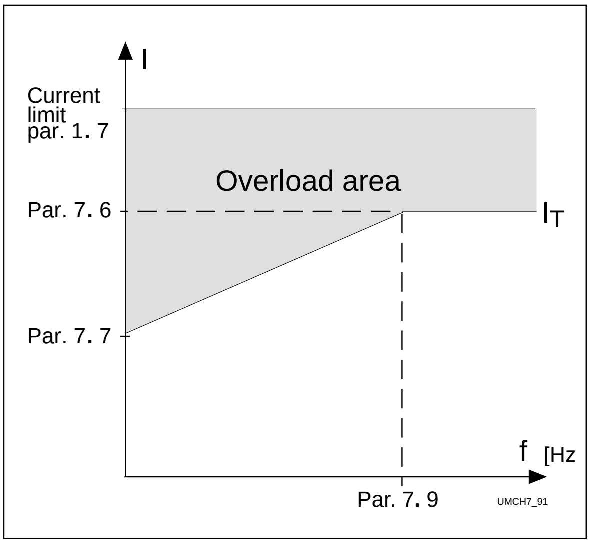


Figure 3.5-28 Motor thermal current I_T curve.

7. 7 Motor thermal protection, zero frequency current

The current can be set between 10.0—150.0% x I_{nMotor}.
This parameter sets the value for thermal current at zero frequency. Refer to figure 3.5-28.

The default value is set assuming that there is no external fan cooling the motor. If an external fan is used this parameter can be set to 90% (or higher).

The value is set as a percentage of the motor's nameplate nominal current, parameter 1. 13, not the drive's nominal output current. The motor's nominal current is the current which the motor can stand in direct on-line use without being overheated.If you change parameter 1. 13, this parameter is automatically restored to the default value.

Setting this parameter (or parameter 1. 13) does not affect to the maximum output current of the drive. Parameter 1. 7 alone determines the maximum output current of the drive.

7. 8 Motor thermal protection, time constant

This time can be set between 0.5—300 minutes. This is the thermal time constant of the motor. The larger the motor the greater the time constant. The time constant is defined as the time that it takes the calculated thermal stage to reach 63% of its final value.

The motor thermal time is specific to a motor design and it varies between different motor manufacturers.

The default value for the time constant is calculated based on the motor nameplate data from parameters 1**.**12 and 1**.**13. If either of these parameters is reset, then this parameter is set to default value.

If the motor's t_6 -time is known (given by the motor manufacturer) the time constant parameter could be set based on t_6 -time. As a rule of thumb, the motor thermal time constant in minutes equals to 2xt_6 (t_6 in seconds is the time a motor can safely operate at six times the rated current). If the drive is stopped the time constant is internally increased to three times the set parameter value. Cooling in the stop stage is based on convection with an increased time constant.

7. 9 Motor thermal protection, break point frequency

The frequency can be set between 10—500 Hz. This is the frequency break point of the thermal current curve. With frequencies above this point, the thermal capacity of the motor is assumed to be constant. Refer to the figure 3.5-28.

The default value is based on the motor's nameplate data, parameter 1**.** 11. It is 35 Hz for a 50 Hz motor and 42 Hz for a 60 Hz motor. More generally it is 70% of the frequency at the field weakening point (parameter 6**.** 3). Changing either parameter 1**.** 11 or 6**.** 3 will restore this parameter to its default value.

7. 10 Stall protection

Operation:

- 0 = Not in use
- 1 = Warning
- 2 = Trip function

Tripping and warning will give a display indication with the same message code. If tripping is set on, the drive will stop and activate the fault stage. Setting the parameter to 0 will deactivate the protection and will reset the stall time counter to zero.

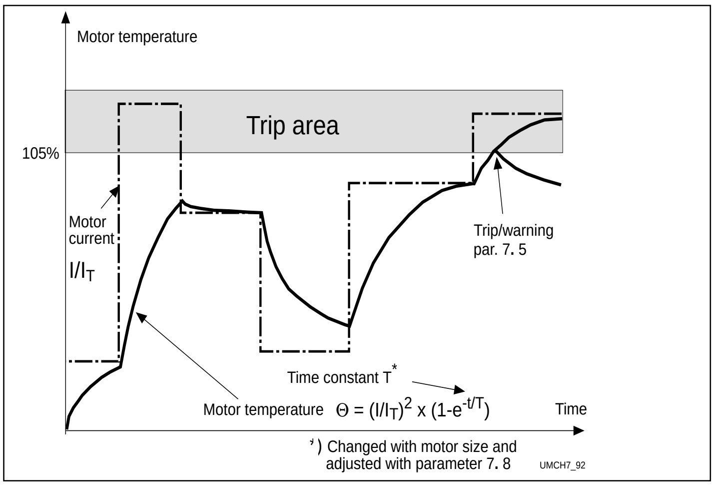


Figure 3.5-29 Calculating motor temperature.

Parameters 7. 10— 7. 13, Stall protection General

Motor stall protection protects the motor from short time overload situations like a stalled shaft. The reaction time of stall protection can be set shorter than with motor thermal protection. The stall state is defined with two parameters, 7.11. Stall Current and 7.13. Stall Frequency. If the current is higher than the set limit and output frequency is lower than the set limit the stall state is true. There is actually no real indication of the shaft rotation. Stall protection is a type of overcurrent protection.

7. 11 Stall current limit

The current can be set between 0.0—200% x I_{nMotor}.

In the stall stage the current has to be above this limit. Refer to the figure 3.5-30. The value is set as a percentage of the motor's nameplate nominal current, parameter 1. 13. If parameter 1. 13 is adjusted, this parameter is automatically restored to its default value.

7. 12 Stall time

The time can be set between 2.0—120 s. This is the maximum allowed time for a stall stage. There is an internal up/down counter to count the stall time. Refer to figure 3.5-31. If the stall time counter value goes above this limit the protection will cause a trip (refer to the parameter 7. 10).

7. 13 Maximum stall frequency

The frequency can be set between 1—f_{max} (parameter 1. 2).
In the stall state, the output frequency has to be smaller than this limit. Refer to the figure 3.5-30.

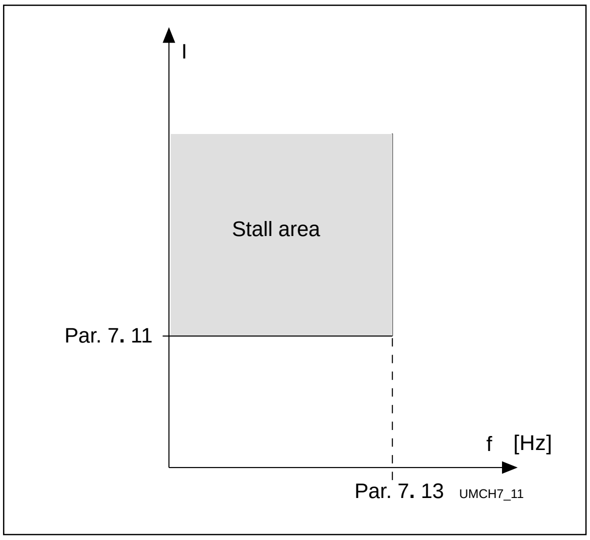


Figure 3.5-30 Setting the stall characteristics.

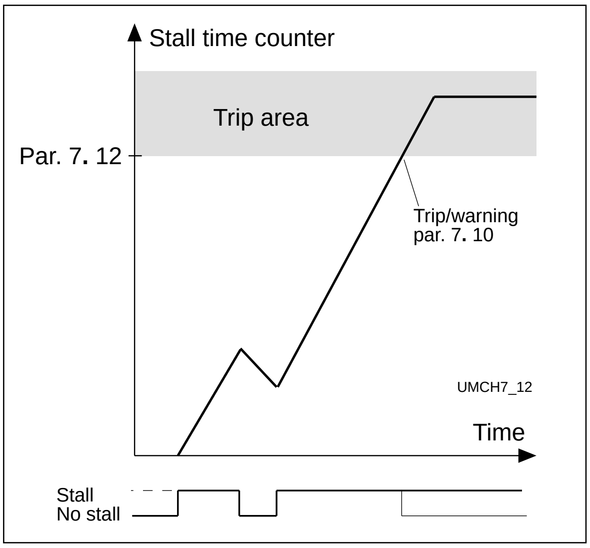


Figure 3.5-31 Counting the stall time.

Parameters 7. 14— 7. 17, Underload protection, General

The purpose of motor underload protection is to ensure that there is load on the motor while the drive is running. If the motor load is reduced, there might be a problem in the process, e.g. broken belt or dry pump.

Motor underload protection can be adjusted by setting the underload curve with parameters 7. 15 and 7. 16. The underload curve is a squared curve set between zero frequency and the field weakening point. The protection is not active below 5Hz (the underload counter value is stopped). Refer to figure 3.5-32.

The torque values for setting the underload curve are set with percentage values which refer to the nominal torque of the motor. The motor's nameplate data, parameter 1. 13, the motor's nominal current and drive's nominal current I_{CT} are used to find the scaling ratio for the internal torque value. If other than a standard motor is used with the drive, the accuracy of the torque calculation is decreased.

7. 14 Underload protection

Operation:

0 = Not in use
1 = Warning
2 = Fault

Tripping and warning will give a display indication with the same message code. If tripping is set active the drive will stop and activate the fault stage.

Deactivating the protection, by setting this parameter to 0, will reset the underload time counter to zero.

7. 15 Underload protection, field weakening area load

The torque limit can be set between 20.0—150 % x T_{nMotor}.

This parameter is the value for the minimum allowed torque when the output frequency is above the field weakening point. Refer to the figure 3.5-32. If parameter 1. 13 is adjusted, this parameter is automatically restored to its default value.

7. 16 Underload protection, zero frequency load

The torque limit can be set between 10.0—150 % x T_{nMotor}.

This parameter is the value for the minimum allowed torque with zero frequency. Refer to the figure 3.5-32. If parameter 1. 13 is adjusted this parameter is automatically restored to its default value.

7. 17 Underload time

This time can be set between 2.0—600.0 s.

This is the maximum allowed time for an underload state. There is an internal up/ down counter to accumulate the underload time. Refer to the figure 3.5-33. If the underload counter value goes above this limit, the protection will cause a trip (refer to the parameter 7. 14). If the drive is stopped, the underload counter is reset to zero.

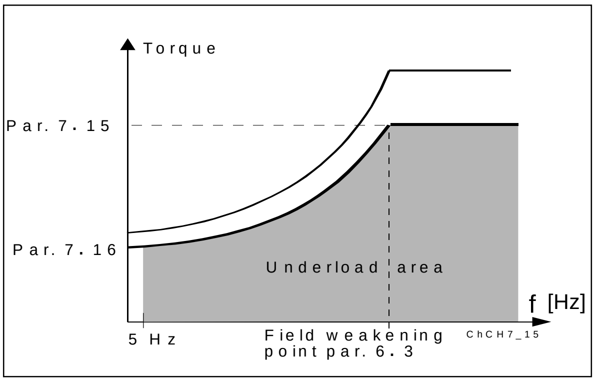


Figure 3.5-32 Setting of minimum load.

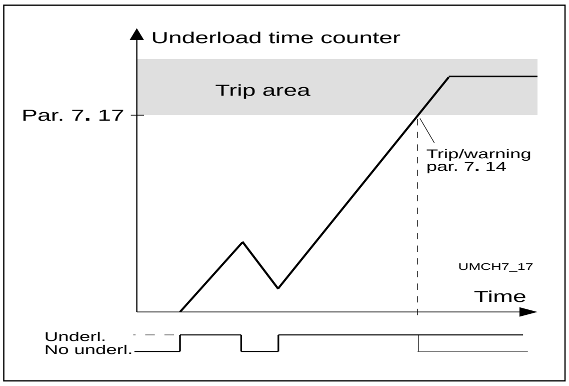


Figure 3.5-33 Counting the underload time.

8. 1 Automatic restart: number of tries

8. 2 Automatic restart: trial time

The Automatic restart function restarts the drive after the faults selected with parameters 8. 4 - 8. 8. The Start function for Automatic restart is selected with parameter 8. 3. See figure 3.5-34.

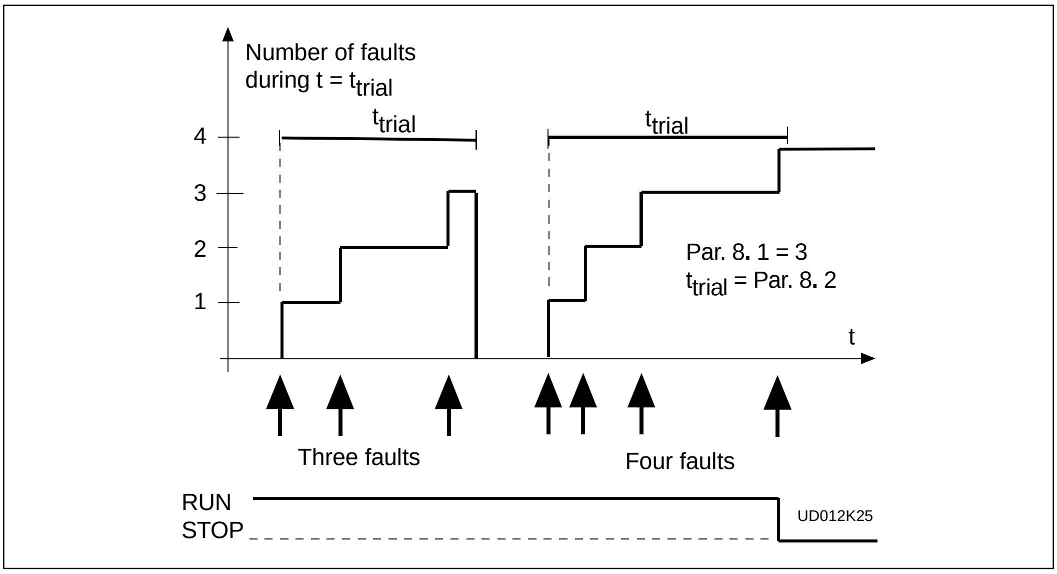


Figure 3.5-34 Automatic restart.

Parameter 8.1 determines how many automatic restarts can be made during the trial time set by the parameter 8.2.

The time counting starts from the first autorestart. If the number of restarts does not exceed the value of the parameter 8. 1 during the trial time, the count is cleared after the trial time has elapsed. The next fault starts the counting again.

8. 3 Automatic restart, start function

The parameter defines the start mode:
- 0 = Start with ramp
- 1 = Flying start, see parameter 4. 6.

8. 4 Automatic restart after undervoltage trip

- 0 = No automatic restart after undervoltage fault
- 1 = Automatic restart after undervoltage fault condition returns to the normal condition (DC-link voltage returns to the normal level)

8. 5 Automatic restart after overvoltage trip

- 0 = No automatic restart after overvoltage fault
- 1 = Automatic restart after overvoltage fault condition returns to the normal condition (DC-link voltage returns to the normal level)

8. 6 Automatic restart after overcurrent trip

- 0 = No automatic restart after overcurrent fault
- 1 = Automatic restart after overcurrent faults

3

8. 7 Automatic restart after reference fault trip

0 = No automatic restart after reference fault
1 = Automatic restart after analog current reference signal (4—20 mA) returns to the normal level ($\geq$4 mA)

8. 8 Automatic restart after over-/undertemperature fault trip

0 = No automatic restart after temperature fault
1 = Automatic restart after heatsink temperature has returned to its normal level between -10°C—+75°C.

Notes:

Notes:

PI-CONTROL APPLICATION
(par. 0.1 = 5)

CONTENTS

4.1 General

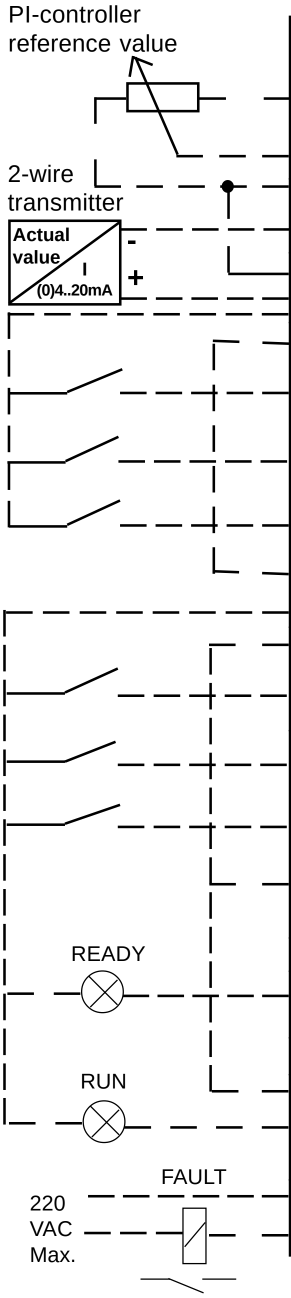
In PI-control application there are two I/O-terminal control sources. Source A is the PI-controller and source B is the direct frequency reference. The control source is selected with DIB6 input.

The PI-controller reference can be selected from an analog input, motorized (digital) potentiometer or panel reference. The actual value can be selected from the analog inputs or from mathematical functions of the analog inputs.

The direct frequency reference can be used for control without the PI-controller. The frequency reference can be selected from analog inputs or panel reference.

*** NOTE! Remember to connect CMA and CMB inputs.**

4.2 Control I/O



Terminal		Signal	Description
1	+10V$_{ref}$	Reference output	Voltage for a potentiometer, etc.
2	V$_{in}$+	Analog input, voltage (programmable)	PI-controller reference value range 0—10 V DC
3	GND	I/O ground	Ground for reference and controls
4	I$_{in}$+	Analog input,	PI-controller actual value
5	I$_{in}$-	current (programmable)	range 0—20 mA
6	+24V	Control voltage output	Voltage for switches, etc. max. 0.1 A
7	GND	Control voltage ground	Ground for reference and controls
8	DIA1	Start/Stop Source A (PI-controller)	Contact open = stop Contact closed = start
9	DIA2	External fault (programmable)	Contact open = no fault Contact closed = fault
10	DIA3	Fault reset (programmable)	Contact open = no action Contact closed = fault reset
11	CMA	Common for DIA1—DIA3	Connect to GND or + 24V
12	+24V	Control voltage output	Voltage for switches, (same as #6)
13	GND	I/O ground	Ground for reference and controls
14	DIB4	Start/Stop Source B (Direct freq. ref.)	Contact open = stop Contact closed = start
15	DIB5	Jog speed select (programmable)	Contact open = no action Contact closed = Jog speed
16	DIB6	Source A/B selection	Contact open = source A is active Contact closed = source B is active
17	CMB	Common for DIB4—DIB6	Connect to GND or + 24V
18	I$_{out}$+	Analog output	Programmable (par. 3. 1)
19	I$_{out}$-	Output frequency	Range 0—20 mA/R$_L$ max. 500 Ω
20	DO1	Digital output READY	Programmable (par. 3. 6) Open collector, I≤50 mA, V≤48 VDC
21	RO1	Relay output 1 RUN	Programmable (par. 3. 7)
22	RO1		
23	RO1		
24	RO2	Relay output 2 FAULT	Programmable (par. 3. 8)
25	RO2		
26	RO2		

Figure 4.2-1 Default I/O configuration and connection example of the PI-Control Application with 2-wire transmitter.

4.3 Control signal logic

The logic flow of the I/O-control signals and pushbutton signals from the panel is shown in figure 4.3-1.

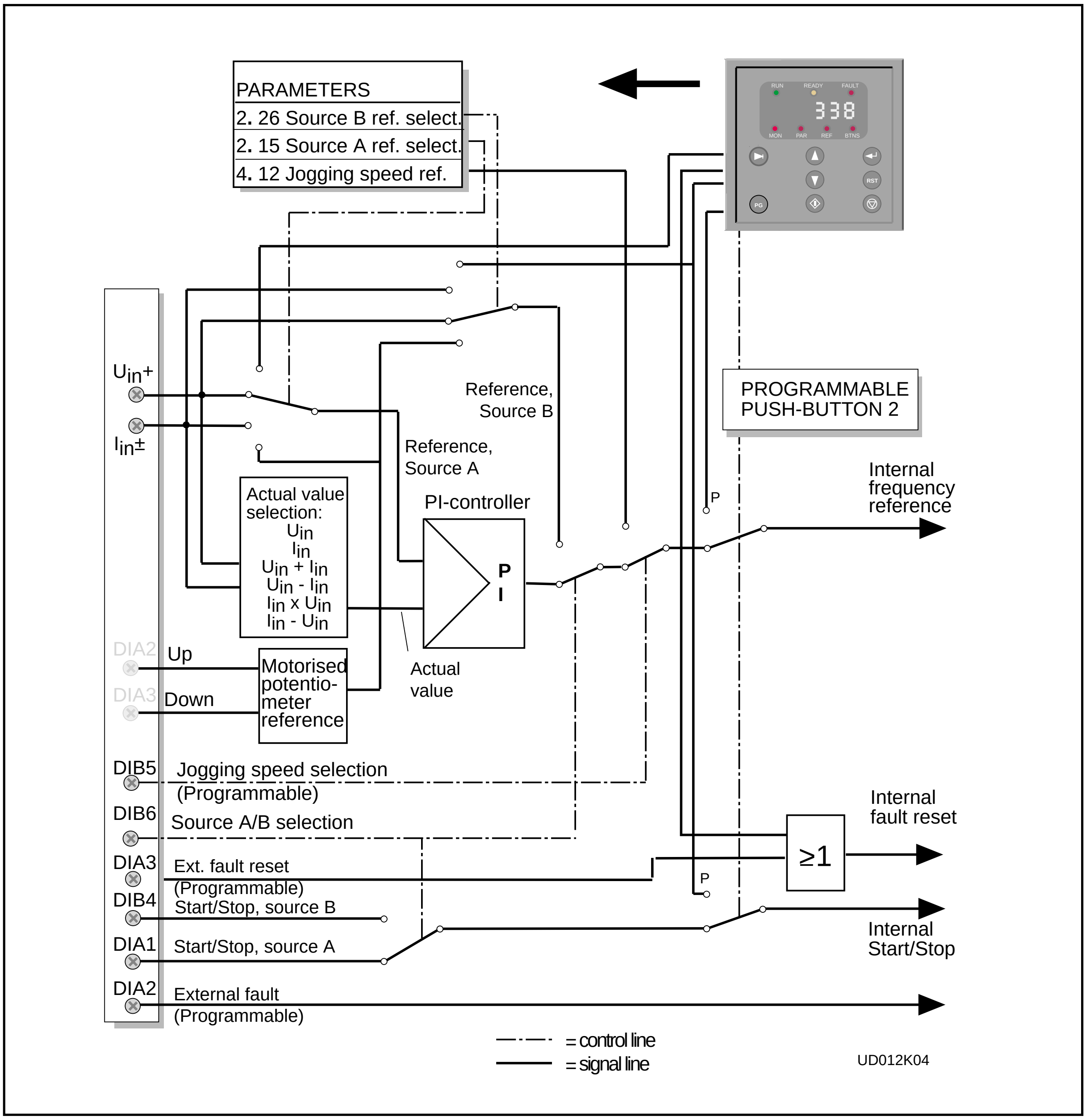


Figure 4.3-1 Control signal logic of the PI- Control Application.
Switch positions shown are based on the factory settings.

4

4.4 Basic parameters, Group 1

4.4.1 Parameter table, Group 1

Code	Parameter	Range	Step	Default	Custom	Description	Page
1. 1	Minimum frequency	0—f_{max}	1 Hz	0 Hz			4-5
1. 2	Maximum frequency	f_{min}-120/500 Hz	1 Hz	60 Hz		*	4-5
1. 3	Acceleration time 1	0.1—3000.0 s	0.1 s	1.0 s		Time from f_{min} (1. 1) to f_{max} (1. 2)	4-5
1. 4	Deceleration time 1	0.1—3000.0 s	0.1 s	1.0 s		Time from f_{max} (1. 2) to f_{min} (1. 1)	4-5
1. 5	PI-controller gain	1—1000%	1 %	100%			4-5
1. 6	PI-controller I-time	0.00—320.00 s	0.01s	10.00 s		0 = no Integral time in use	4-5
1. 7	Current limit	0.1—2.5 x I_{nCX}	0.1 A	1.5 x I_{nCX}		Output current limit [A] of the unit	4-5
1. 8	V/Hz ratio selection	0—2	1	0		0 = Linear 1 = Squared 2 = Programmable V/Hz ratio	4-5
1. 9	V/Hz optimization	0—1	1	0		0 = None 1 = Automatic torque boost	4-6
1. 10	Nominal voltage of the motor	180—690 V	1 V	230 V 380 V 480 V 575 V		CX/CXL/CXS V 3 2 CX/CXL/CXS V 3 4 CX/CXL/CXS V 3 5 CX V 3 6	4-7
1. 11	Nominal frequency of the motor	30—500 Hz	1 Hz	60 Hz		f_n from the nameplate of the motor	4-7
1. 12	Nominal speed of the motor	1—20000 rpm	1 rpm	1720 rpm **		n_n from the nameplate of the motor	4-7
1. 13	Nominal current of the motor	2.5 x I_{nCX}	0.1 A	I_{nCX}		I_n from the nameplate of the motor	4-7
1. 14	Supply voltage	208—240		230 V		CX/CXL/CXS V 3 2	4-7
		380—400		380 V		CX/CXL/CXS V 3 4	
		380—500		480 V		CX/CXL/CXS V 3 5	
		525—690		575 V		CX V 3 6	
1. 15	Parameter conceal	0—1	1	0		Visibility of the parameters: 0 = All parameter groups visible 1 = Only group 1 is visible	4-7
1. 16	Parameter value lock	0—1	1	0		Disables parameter changes: 0 = Changes enabled 1 = Changes disabled	4-7

Table 4.4-1 Group 1 basic parameters.

Note! = Parameter value can be changed only when the drive is stopped.

* If 1. 2 > motor synchr. speed, check suitability for motor and drive system.
Selecting 120 Hz/500 Hz range see page 4-5.

** Default value for a four pole motor and a nominal size drive.

4

4.4.2 Description of Group 1 parameters

1. 1, 1. 2 Minimum / maximum frequency

Defines frequency limits of the drive.

The default maximum value for parameters 1**.** 1 and 1**.** 2 is 120 Hz. By setting 1**.** 2 = 120 Hz when the drive is stopped (RUN indicator not lit) parameters 1**.** 1 and 1**.** 2 are changed to 500 Hz. At the same time the resolution of the panel is changed from 0.01 Hz to 0.1 Hz.
Changing the max. value from 500 Hz to 120 Hz is done by setting parameter 1**.**2 = 119 Hz while the drive is stopped.

1. 3, 1. 4 Acceleration time 1, deceleration time 1:

These limits correspond to the time required for the output frequency to accelerate from the set minimum frequency (par. 1**.** 1) to the set maximum frequency (par. 1**.** 2).

1. 5 PI-controller gain

This parameter defines the gain of the PI-controller.

If this parameter is set to 100%, a 10% change in error value causes the controller output to change by 1.0 Hz.

If the parameter value is set to 0, the PI-controller operates as an I-controller.

1. 6 PI-controller I-time

Defines the integration time of the PI-controller

1. 7 Current limit

This parameter determines the maximum motor current that the CX/CXL/CXS will provide short term.

1. 8 V/Hz ratio selection

Linear: **0** The voltage of the motor changes linearly with the frequency in the constant flux area from 0 Hz to the field weakening point (par. 6**.** 3) where a constant voltage (nominal value) is supplied to the motor. See figure 4.4-2.
A linear V/Hz ratio should be used in constant torque applications.

This default setting should be used if there is no special requirement for another setting.

Squared: **1** The voltage of the motor changes following a squared curve form with the frequency in the area from 0 Hz to the field weakening point (par. 6**.** 3) where the nominal voltage is supplied to the motor. See figure 4.4-2.

The motor runs undermagnetized below the field weakening point and produces less torque and electromechanical noise. A squared V/Hz ratio can be used in applications where the torque demand of the load is proportional to the square of the speed, e.g. in centrifugal fans and pumps.

4

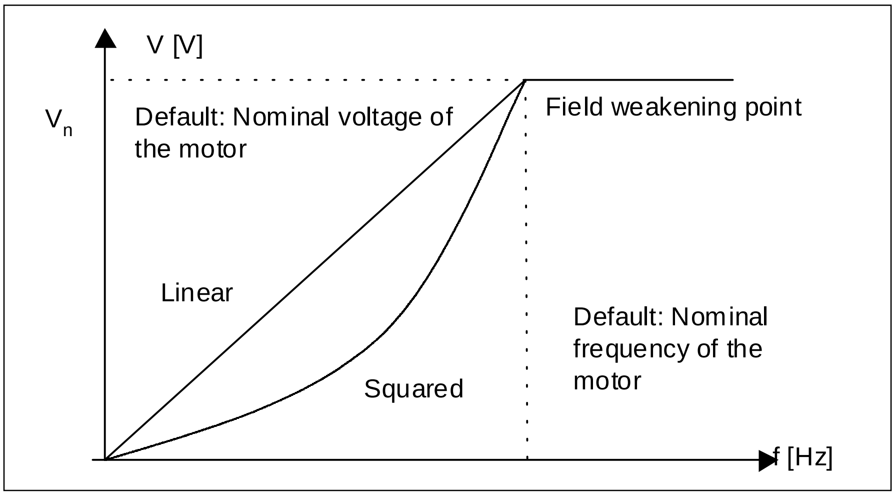


Figure 4.4-2 Linear and squared V/Hz curves.

Programm. V/Hz curve **2** The V/Hz curve can be programmed with three different points. The parameters for programming are explained in chapter 4.5.2. A programmable V/Hz curve can be used if the standard settings do not satisfy the needs of the application. See figure 4.4-3 .

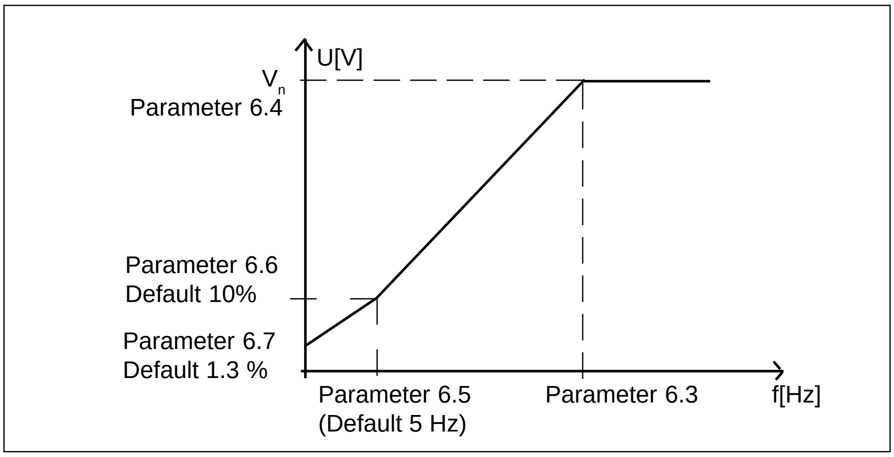


Figure 4.4-3 Programmable V/Hz curve.

1. 9 V/Hz optimization

Automatic torque boost — The voltage to the motor changes automatically which makes the motor produce enough torque to start and run at low frequencies. The voltage increase depends on the motor type and horsepower.

Automatic torque boost can be used in applications where starting torque due to starting friction is high, e.g. in conveyors.

NOTE! *In high torque - low speed applications - it is likely the motor will overheat.*
If the motor has to run for a prolonged time under these conditions, special attention must be paid to cooling the motor. Use external cooling for the motor if the temperature rise is too high.

4

1. 10 Nominal voltage of the motor

Find this value V_n from the nameplate of the motor.
This parameter sets the voltage at the field weakening point, parameter 6**.** 4, to 100% x $V_{n_{motor}}$.

1. 11 Nominal frequency of the motor

Find the nominal frequency f_n from the nameplate of the motor.
This parameter sets the frequency of the field weakening point, parameter 6**.** 3, to the same value.

1. 12 Nominal speed of the motor

Find this value n_n from the nameplate of the motor.

1. 13 Nominal current of the motor

Find the value I_n from the nameplate of the motor.
The internal motor protection function uses this value as a reference value.

1. 14 Supply voltage

Set parameter value according to the nominal voltage of the supply.
Values are pre-defined for CX/CXL/CXS V 3 2, CX/CXL/CXS V 3 4, CX/CXL/CXS V 3 5 and CX V 3 6. See table 4.4-1.

1. 15 Parameter conceal

Defines which parameter groups are available:

0 = all parametergroups are visible
1 = only group 1 is visible

1. 16 Parameter value lock

Defines access to the changes of the parameter values:

0 = parameter value changes enabled
1 = parameter value changes disabled

4

To adjust more of the functions of the PI-Control application, see chapter 4.5 to modify the parameters of Groups 2—8.

4.5 Special parameters, Groups 2—8

4.5.1 Parameter tables

Group 2, Input signal parameters

Code	Parameter	Range	Step	Default	Custom	Description	Page
2. 1	DIA2 function (terminal 9)	0—10	1	1		0 = Not used 1 = Ext. fault, closing contact 2 = External fault, opening contact 3 = Run enable 4 = Acceler./deceler. time selection 5 = Reverse 6 = Jog speed 7 = Fault reset 8 = Acc./dec. operation prohibit 9 = DC-braking command 10 = Motor (digital) pot. UP	4-15
2. 2	DIA3 function (terminal 10)	0—10	1	7		0 = Not used 1 = Ext. fault, closing contact 2 = External fault, opening contact 3 = Run enable 4 = Acc./dec. time selection 5 = Reverse 6 = Jog speed 7 = Fault reset 8 = Acc./dec. operation prohibit 9 = DC-braking command 10 = Motor (digital) pot. DOWN	4-16
2. 3	V_{in} signal range	0—1	1	0		0 = 0—10 V 1 = Custom setting range	4-16
2. 4	V_{in} custom setting min.	0.00-100.00%	0.01%	0.00%			4-16
2. 5	V_{in} custom setting max.	0.00-100.00%	0.01%	100.00%			4-16
2. 6	V_{in} signal inversion	0—1	1	0		0 = Not inverted 1 = Inverted	4-16
2. 7	V_{in} signal filter time	0.00 —10.00 s	0.01 s	0.10 s		0 = No filtering	4-17
2. 8	I_{in} signal range	0—2	1	0		0 = 0—20 mA 1 = 4—20 mA 2 = Custom setting range	4-17
2. 9	I_{in} custom setting min.	0.00-100.00%	0.01%	0.00%			4-17
2. 10	I_{in} custom setting max.	0.00-100.00%	0.01%	100.00%			4-17
2. 11	I_{in} signal inversion	0—1	1	0		0 = Not inverted 1 = Inverted	4-17
2. 12	I_{in} signal filter time	0.01 —10.00 s	0.01s	0.10 s		0 = No filtering	4-18
2. 13	DIB5 function (terminal 15)	0—9	1	6		0 = Not used 1 = Ext. fault, closing contact 2 = External fault, opening contact 3 = Run enable 4 = Acc./dec. time selection 5 = Reverse 6 = Jog speed 7 = Fault reset 8 = Acc./dec. operation prohibit 9 = DC-braking command	4-18

Note! = Parameter value can be changed only when the drive is stopped

Code	Parameter	Range	Step	Default	Custom	Description	Page
2. 14	Motor (digital) potentiometer ramp time	0.1—2000.0 Hz/s	0.1 Hz/s	10.0 Hz/s			4-18
2. 15	PI-controller reference signal (source A)	0—4	1	0		0 = Analog voltage input (term. 2) 1 = Analog current input (term. 4) 2= Set reference from the panel (reference r2) 3 = Signal from internal motor pot. 4 = Signal from internal motor pot. reset if CX/CXL/CXS is stopped	4-19
2. 16	PI-controller actual value selection	0—3	1	0		0 = Actual value 1 1 = Actual 1 + Actual 2 2 = Actual 1 - Actual 2 3 = Actual 1 * Actual 2	4-19
2. 17	Actual value 1 input	0—2	1	2		0 = No 1 = Voltage input 2 = Current input	4-19
2. 18	Actual value 2 input	0—2	1	0		0 = No 1 = Voltage input 2 = Current input	4-19
2. 19	Actual value 1 min scale	-320.00%—+320.00%	0.01%	0.00%		0 % = No minimum scaling	4-19
2. 20	Actual value 1 max scale	-320.00%—+320.00%	0.01%	100.0%		100 % = No maximum scaling	4-19
2. 21	Actual value 2 min scale	-320.00%—+320.00%	0.01%	0.00%		0 % = No minimum scaling	4-19
2. 22	Actual value 2 max scale	-320.00%—+320.00%	0.01%	100.0%		100 % = No maximum scaling	4-19
2. 23	Error value inversion	0—1	1	0		0 = No 1 = Yes	4-19
2. 24	PI-controller min. limit	f_{min}—f_{max} (1. 1) (1. 2)	0.1 Hz	0.0 Hz			4-20
2. 25	PI-controller max. limit	f_{min}—f_{max} (1. 1) (1. 2)	0.1 Hz	50.0 Hz			4-20
2. 26	Direct frequency reference, source B	0—4	1	0		0 = Analog voltage input (term. 2) 1 = Analog current input (term. 4) 2 = Set reference from the panel (reference r1) 3 = Signal from internal motor pot. 4 = Signal from internal motor pot. reset if CX/CXL/CXS stopped	4-20
2. 27	Source B reference scaling minimum value	0—par. 2. 28	1 Hz	0 Hz		Selects the frequency that corresponds to the min. reference signal	4-20
2. 28	Source B reference scaling maximum value	0—f_{max} (1. 2)	1 Hz	0 Hz		Selects the frequency that corresponds to the max. reference signal 0 = Scaling off >0 = Scaled maximum value	4-20

Note! = Parameter value can be changed only when the drive is stopped.

Group 3, Output and supervision parameters

Code	Parameter	Range	Step	Default	Custom	Description	Page
3. 1	Analog output function	0—7	1	1		0 = Not used Scale 100% 1 = O/P frequency ($0—f_{max}$) 2 = Motor speed (0—max. speed) 3 = O/P current ($0—2.0 \times I_{nCX}$) 4 = Motor torque ($0—2 \times T_{nMot}$) 5 = Motor power ($0—2 \times P_{nMot}$) 6 = Motor voltage ($0—100\% \times V_{nMot}$) 7 = DC-link volt. (0—1000 V)	4-21
3. 2	Analog output filter time	0.00—10.00 s	0.01s	1.00s			4-21
3. 3	Analog output inversion	0—1	1	0		0 = Not inverted 1 = Inverted	4-21
3. 4	Analog output minimum	0—1	1	0		0 = 0 mA 1 = 4 mA	4-21
3. 5	Analog output scale	10—1000%	1%	100%			4-21
3. 6	Digital output function	0—21	1	1		0 = Not used 1 = Ready 2 = Run 3 = Fault 4 = Fault inverted 5 = CX overheat warning 6 = External fault or warning 7 = Reference fault or warning 8 = Warning 9 = Reversed 10 = Jog speed selected 11 = At speed 12 = Motor regulator activated 13 = Output freq. limit superv. 1 14 = Output freq. limit superv. 2 15 = Torque limit supervision 16 = Reference limit supervision 17 = External brake control 18 = Control from I/O terminals 19 = Drive temperature limit supervision 20 = Unrequested rotation direction 21 = External brake control inverted	4-22
3. 7	Relay output 1 function	0—21	1	2		As parameter 3. 6	4-22
3. 8	Relay output 2 function	0—21	1	3		As parameter 3. 6	4-22
3. 9	Output freq. limit 1 supervision function	0—2	1	0		0 = No 1 = Low limit 2 = High limit	4-22
3. 10	Output freq. limit 1 supervision value	$0.0—f_{max}$ (par. 1. 2)	0.1 Hz	0.0 Hz			4-22

Note! = Parameter value can be changed only when the drive is stopped.

4

Code	Parameter	Range	Step	Default	Custom	Description	Page
3. 11	Output freq. limit 2 supervision function	0—2	1	0		0 = No 1 = Low limit 2 = High limit	4-22
3. 12	Output freq. limit 2 supervision value	0.0—f_{max} (par. 1. 2)	0.1 Hz	0.0 Hz			4-22
3. 13	Torque limit supervision function	0—2	1	0		0 = No 1 = Low limit 2 = High limit	4-23
3. 14	Torque limit supervision value	0.0—200.0% xT_{nSV9}	0.1%	100.0%			4-23
3. 15	Active reference limit supervision function	0—2	1	0		0 = No 1 = Low limit 2 = High limit	4-23
3. 16	Active reference limit supervision value	0.0—f_{max} (par. 1. 2)	0.1 Hz	0.0 Hz			4-23
3. 17	External brake off-delay	0.0—100.0 s	1	0.5 s			4-23
3. 18	External brake on-delay	0.0—100.0 s	1	1.5 s			4-23
3. 19	Drive temperature limit supervision	0—2	1	0		0 = No 1 = Low limit 2 = High limit	4-23
3. 20	Drive temperature limit	-10—+75°C	1	+40°C			4-23
3. 21	I/O-expander board (opt.) analog output function	0—7	1	3		See parameter 3. 1	4-21
3. 22	I/O-expander board (opt.) analog output filter time	0.00—10.00 s	0.01s	1.00s		See parameter 3. 2	4-21
3. 23	I/O-expander board (opt.) analog output inversion	0—1	1	0		See parameter 3. 3	4-21
3. 24	I/O-expander board (opt.) analog output minimum	0—1	1	0		See parameter 3. 4	4-21
3. 25	I/O-expander board (opt.) analog output scale	10—1000%	1	100%		See parameter 3. 5	4-21

Group 4, Drive control parameters

Code	Parameter	Range	Step	Default	Custom	Description	Page
4. 1	Acc./Dec. ramp 1 shape	0.0—10.0 s	0.1 s	0.0 s		0 = Linear >0 = S-curve acc./dec. time	4-24
4. 2	Acc./Dec. ramp 2 shape	0.0—10.0 s	0.1 s	0.0 s		0 = Linear >0 = S-curve acc./dec. time	4-24
4. 3	Acceleration time 2	0.1—3000.0 s	0.1 s	10.0 s			4-24
4. 4	Deceleration time 2	0.1—3000.0 s	0.1 s	10.0 s			4-24
4. 5	Brake chopper	0—2	1	0		0 = Brake chopper not in use 1 = Brake chopper in use 2 = External brake chopper	4-25
4. 6	Start function	0—1	1	0		0 = Ramp 1 = Flying start	4-25

Note! = Parameter value can be changed only when the drive is stopped.

Code	Parameter	Range	Step	Default	Custom	Description	Page
4. 7	Stop function	0—1	1	0		0 = Coasting 1 = Ramp	4-25
4. 8	DC-braking current	0.15—1.5 x I_{nCX} (A)	0.1 A	0.5 x I_{nCX}			4-25
4. 9	DC-braking time at Stop	0.00-250.00s	0.01 s	0.00 s		0 = DC-brake is off at Stop	4-25
4. 10	Turn on frequency of DC-brake at ramp Stop	0.1-10.0 Hz	0.1 Hz	1.5 Hz			4-26
4. 11	DC-brake time at Start	0.00—25.00s	0.01 s	0.00 s		0 = DC-brake is off at Start	4-27
4. 12	Jog speed reference	f_{min}—f_{max} (1. 1) (1. 2)	0.1 Hz	10.0 Hz			4-27

Group 5, Prohibit frequency parameters

Code	Parameter	Range	Step	Default	Custom	Description	Page
5. 1	Prohibit frequency range 1 low limit	f_{min}— par. 5. 2	0.1 Hz	0.0 Hz			4-27
5. 2	Prohibit frequency range 2 high limit	f_{min}—f_{max} (1. 1) (1. 2)	0.1 Hz	0.0 Hz		0 = no prohibit frequency range	4-27
5. 3	Prohibit frequency range 2 low limit	f_{min}— par. 5. 4	0.1 Hz	0.0 Hz			4-27
5. 4	Prohibit frequency range 2 high limit	f_{min}—f_{max} (1. 1) (1. 2)	0.1 Hz	0.0 Hz		0 = no prohibit frequency range	4-27
5. 5	Prohibit frequency range 3 low limit	f_{min}— par. 5. 6	0.1 Hz	0.0 Hz			4-27
5. 6	Prohibit frequency range 3 high limit	f_{min}—f_{max} (1. 1) (1. 2)	0.1 Hz	0.0 Hz		0 = no prohibit frequency range	4-27

Group 6, Motor control parameters

Code	Parameter	Range	Step	Default	Custom	Description	Page
6. 1	Motor control mode	0—1	1	0		0 = Frequency control 1 = Speed control	4-27
6. 2	Switching frequency	1.0-16.0 kHz	0.1 kHz	10/3.6kHz		Depends on Hp rating	4-27
6. 3	Field weakening point	30—500 Hz	1 Hz	Param. 1. 11			4-28
6. 4	Voltage at field weakening point	15—200% x V_{nmot}	1%	100%			4-28
6. 5	V/Hz-curve mid point frequency	0.0—f_{max}	0.1 Hz	0.0 Hz			4-28
6. 6	V/Hz-curve mid point voltage	0.00-100.00% x V_{nmot}	0.01%	0.00%			4-28
6. 7	Output voltage at zero frequency	0.00-100.00% x V_{nmot}	0.01%	0.00%			4-28
6. 8	Overvoltage controller	0—1	1	1		0 = Controller is not operating 1 = Controller is in operation	4-28
6. 9	Undervoltage controller	0—1	1	1		0 = Controller is not operating 1 = Controller is in operation	4-28

Note! **=** Parameter value can be changed only when the drive is stopped.

Group 7, Protections

Code	Parameter	Range	Step	Default	Custom	Description	Page
7. 1	Response to reference fault	0—3	1	0		0 = No action 1 = Warning 2 = Fault, stop according to par. 4.7 3 = Fault, always coasting stop	4-29
7. 2	Response to external fault	0—3	1	2		0 = No action 1 = Warning 2 = Fault, stop according to par. 4.7 3 = Fault, always coasting stop	4-29
7. 3	Phase supervision of the motor	0—2	2	2		0 = No action 2 = Fault	4-29
7. 4	Ground fault protection	0—2	2	2		0 = No action 2 = Fault	4-29
7. 5	Motor thermal protection	0—2	1	2		0 = No action 1 = Warning 2 = Fault	4-30
7. 6	Motor thermal protection break point current	50.0—150.0 % x I_{nMOTOR}	1.0 %	100.0%			4-30
7. 7	Motor thermal protection zero frequency current	5.0—150.0% x I_{nMOTOR}	1.0 %	45.0%			4-30
7. 8	Motor thermal protection time constant	0.5—300.0 minutes	0.5 min.	17.0 min.		Default value is set according to motor nominal current	4-31
7. 9	Motor thermal protection break point frequency	10—500 Hz	1 Hz	35 Hz			4-31
7. 10	Stall protection	0—2	1	1		0 = No action 1 = Warning 2 = Fault	4-32
7. 11	Stall current limit	5.0—200.0% x I_{nMOTOR}	1.0%	130.0%			4-32
7. 12	Stall time	2.0—120.0 s	1.0 s	15.0 s			4-33
7. 13	Maximum stall frequency	1—f_{max}	1 Hz	25 Hz			4-33
7. 14	Underload protection	0—2	1	0		0 = No action 1 = Warning 2 = Fault	4-33
7. 15	Underload prot., field weakening area load	10.0—150,.0 % x T_{nMOTOR}	1.0%	50.0%			4-34
7. 16	Underload protection, zero frequency load	5.0—150.0% x T_{nMOTOR}	1.0%	10.0%			4-34
7. 17	Underload time	2.0—600.0 s	1.0 s	20.0s			4-34

4

Group 8, Autorestart parameters

Code	Parameter	Range	Step	Default	Custom	Description	Page
8. 1	Automatic restart: number of tries	0—10	1	0		0 = not in use	4-34
8. 2	Automatic restart: multi attempt maximum trial time	1—6000 s	1 s	30 s			4-34
8. 3	Automatic restart: start function	0—1	1	0		0 = Ramp 1 = Flying start	4-35
8. 4	Automatic restart after undervoltage trip	0—1	1	0		0 = No 1 = Yes	4-35
8. 5	Automatic restart after overvoltage trip	0—1	1	0		0 = No 1 = Yes	4-35
8. 6	Automatic restart after overcurrent trip	0—1	1	0		0 = No 1 = Yes	4-35
8. 7	Automatic restart after reference fault trip	0—1	1	0		0 = No 1 = Yes	4-35
8. 8	Automatic restart after over/undertemperature fault trip	0—1	1	0		0 = No 1 = Yes	4-35

Table 4.5-1 Special parameters, Groups 2—8.

4.5.2 Description of Groups 2—8 parameters

2. 1 DIA2 function

1: External fault, closing contact = Fault is shown and motor is stopped when the input is active

2: External fault, opening contact = Fault is shown and motor is stopped when the input is not active

3: Run enable contact open = Start of the motor disabled
contact closed = Start of the motor enabled

4: Acc. / Dec time select. contact open = Acceleration/Deceleration time 1 selected
contact closed = Acceleration/Deceleration time 2 selected

5: Reverse contact open = Forward
contact closed = Reverse

If two or more inputs are programmed to reverse, only one of them is required to reverse

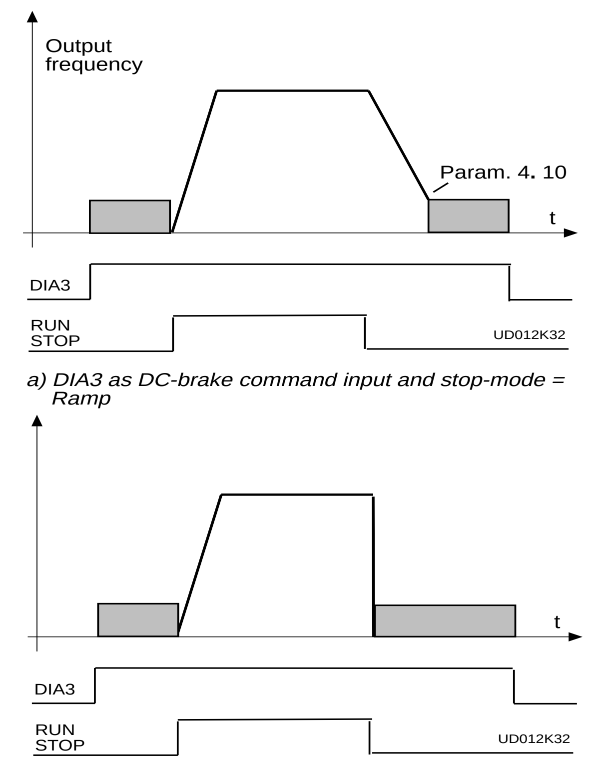
6: Jog speed contact closed = Jog speed selected for freqency reference.

7: Fault reset contact closed = Resets all faults

8: Acc./Dec. operation prohibited contact closed = Stops acceleration and deceleration until the contact is opened

9: DC-braking command contact closed = In the stop mode, the DC-braking operates until the contact is opened, see figure 4.5-1. DC-brake current is set with parameter 4. 8.

10: Motor(digital) pot. UP contact closed = Reference increases until the contact is opened



a) DIA3 as DC-brake command input and stop-mode = Ramp

b) DIA3 as DC-brake command input and stop-mode = Coasting

Figure 4.5-1 DIA3 as DC-brake command input:
a) Stop-mode = ramp,
b) Stop-mode = coasting

2. 2 DIA3 function

Selections are same as in 2.1 except :

10: Motor(digital) pot. DOWN — contact closed = Reference decreases until the contact is opened

2. 3 V_{in} signal range

0 = Signal range 0—10 V
1 = Custom setting range from custom minimum (par. 2. 4) to custom maximum (par. 2. 5)

2. 4 V_{in} custom setting minimum/maximum

2. 5 These parameters set V_{in} for any input signal span within 0—10 V.

Minimum setting: Set the V_{in} signal to its minimum level, select parameter 2. 4, press the Enter button
Maximum setting: Set the V_{in} signal to its maximum level, select parameter 2. 5, press the Enter button

Note! The parameter values can only be set with this procedure (not with arrow up/arrow down buttons)

2. 6 V_{in} signal inversion

Parameter 2. 6 = 0, no inversion of analog V_{in} signal.

Parameter 2. 6 = 1, inversion of analog V_{in} signal.

2. 7 **V_{in} signal filter time**

Filters out disturbances from the incoming analog V_{in} signal.
A long filtering time makes regulation response slower.
See figure 4.5-2.

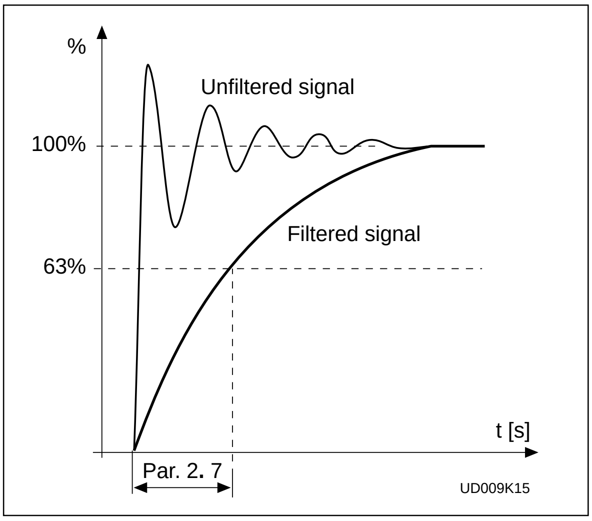


Figure 4.5-2 V_{in} signal filtering.

2. 8 **Analog input I_{in} signal range**

0 = 0—20 mA
1 = 4—20 mA
2 = Custom signal span

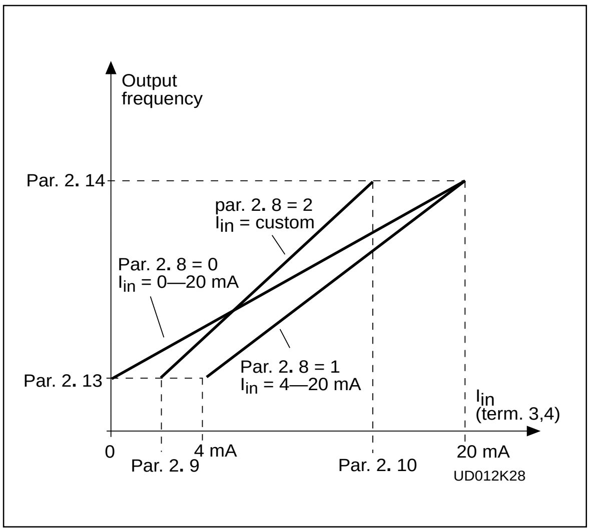


Figure 4.5-3 Analog input I_{in} scaling.

2. 9 **Analog input I_{in} custom**
2. 10 **setting minimum/maximum**

With these parameters you can scale the input current signal (I_{in}) signal range between 0—20 mA.

Minimum setting:
Set the I_{in} signal to its minimum level, select parameter 2. 9, press the Enter button
Maximum setting:
Set the I_{in} signal to its maximum level, select parameter 2. 10, press the Enter button

Note! The parameter values can only be set with this procedure (not with arrow up/arrow down buttons)

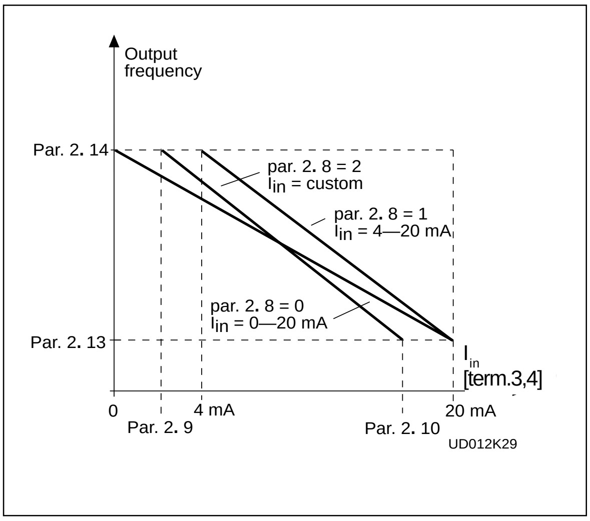


Figure 4.5-4 I_{in} signal inversion.

2. 11 **Analog input I_{in} inversion**

Parameter 2. 11 = 0, no inversion of I_{in} input.

Parameter 2. 11 = 1, inversion of I_{in} input.

4

2. 12 Analog input I_{in} filter time

Filters out disturbances from the incoming analog I_{in} signal. A long filtering time makes regulation response slower.
See figure 4.5-3.

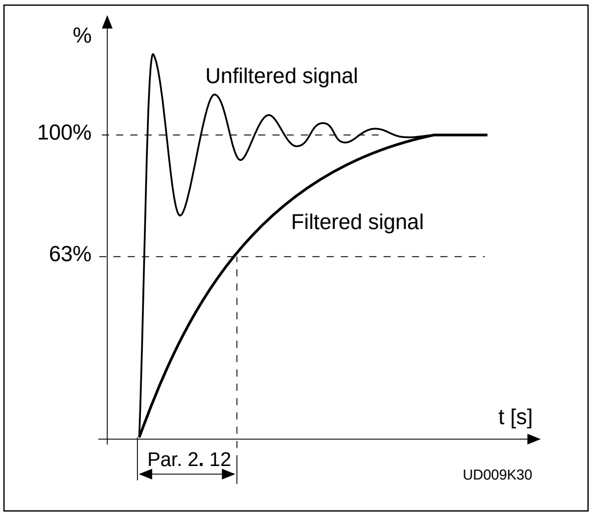


Figure 4.5-5 Analog input I_{in} filter time.

2. 13 DIA5 function

1:	External fault,	closing contact	= Fault is shown and motor is stopped when the input is active
2:	External fault,	opening contact	= Fault is shown and motor is stopped when the input is not active
3:	Run enable	contact open	= Start of the motor disabled
		contact closed	= Start of the motor enabled
4:	Acc. / Dec time select.	contact open	= Acceleration/Deceleration time 1 selected
		contact closed	= Acceleration/Deceleration time 2 selected
5:	Reverse	contact open	= Forward
		contact closed	= Reverse
6:	Jog speed	contact closed	= Jog speed selected for freqency reference
7:	Fault reset	contact closed	= Resets all faults
8:	Acc./Dec. operation prohibited	contact closed	= Stops acceleration and deceleration until the contact is opened
9:	DC-braking command	contact closed	= In the stop mode, the DC-braking operates until the contact is opened, see figure 4.5-1. DC-brake current is set with parameter 4. 8.

If two or more inputs are programmed to reverse, only one of them is required to reverse

2. 14 Motor potentiometer ramp time

Defines how fast the electronic motor (digital) potentiometer value changes.

2. 15 PI-controller reference signal

0 Analog voltage reference from terminals 2—3, e.g. a potentiometer
1 Analog current reference trom terminals 4—5, e.g. a transducer.
2 Panel reference is the reference set from the Reference Page (REF). Reference r2 is the PI-controller reference, see chapter 4.7.
3 Reference value is changed with digital input signals DIA2 and DIA3.
- switch in DIA2 closed = frequency reference increases
- switch in DIA3 closed = frequency reference decreases
Speed of the reference change can be set with the parameter 2**.** 3.
4 Same as setting 3 but the reference value is set to the minimum frequency (par. 1**.** 1) each time the drive is stopped. When the value of parameter 1**.** 5 is set to 3 or 4, the value of parameter 2**.** 1 is automatically set to 4 and value of the parameter 2**.** 2 is automatically set to 10.

2. 16 PI-controller actual value selection
2. 17 Actual value 1
2. 18 Actual value 2

These parameters select the PI-controller actual value.

2. 19 Actual value 1 minimum scale

Sets the minimum scaling point for Actual value 1. See figure 4.5-6.

2. 20 Actual value 1 maximum scale

Sets the maximum scaling point for Actual value 1. See figure 4.5-6.

2. 21 Actual value 2 minimum scale

Sets the minimum scaling point for Actual value 2. See figure 4.5-6.

2. 22 Actual value 2 maximum scale

Sets the maximum scaling point for Actual value 2. See figure 4.5-6.

2. 23 Error value inversion

This parameter allows you to invert the error value of the PI-controller (and thus the the operation of the PI-controller).

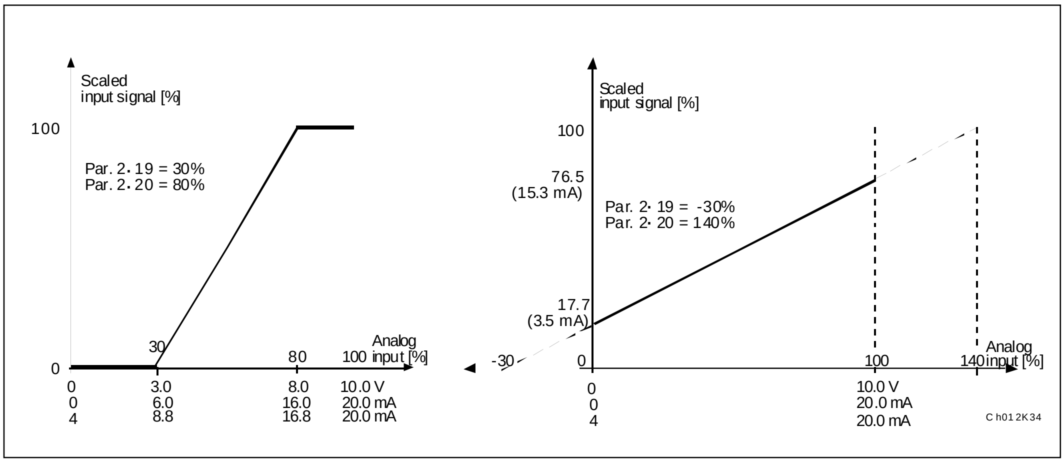


Figure 4.5-6 Examples of actual value scaling of PI-regulator.

2. 24 PI-controller minimum limit

2. 25 PI-controller maximum limit

These parameter set the minimum and maximum values of the PI-controller output.
Parameter value limits: par 1**.**1 <par. 2**.** 24 <par. 2**.** 2 5.

2. 26 Direct frequency reference. Place B

0 Analog voltage reference from terminals 2—3, e.g. a potentiometer

1 Analog current reference trom terminals 4—5, e.g. a transducer.

2 Panel reference is the reference set from the Reference Page (REF), Reference r1 is the Place B reference, see chapter 6.

3 Reference value is changed with digital input signals DIA2 and DIA3.
- switch in DIA2 closed = frequency reference increases
- switch in DIA3 closed = frequency reference decreases
Speed of the reference change can be set with the parameter 2**.** 3.

4 Same as setting 3, but the reference value is set to the minimum frequency (par. 1**.** 1) each time the drive is stopped. When the value of the parameter 1**.** 5 is set to 3 or 4, value of the parameter 2**.** 1 is automatically set to 4 and value of the parameter 2**.** 2 is automatically set to 10.

2. 27 Source B reference scaling, minimum value/maximum value

2. 28 Setting limits: 0 < par. 2**.** 27 < par. 2**.** 28 < par. 1**.** 2.
If par. 2**.** 28 = 0 scaling is set off.
See figures 4.5-7 and 4.5-8.

(In the figures below the voltage input V_{in} with signal range 0—10 V is selected for source B reference)

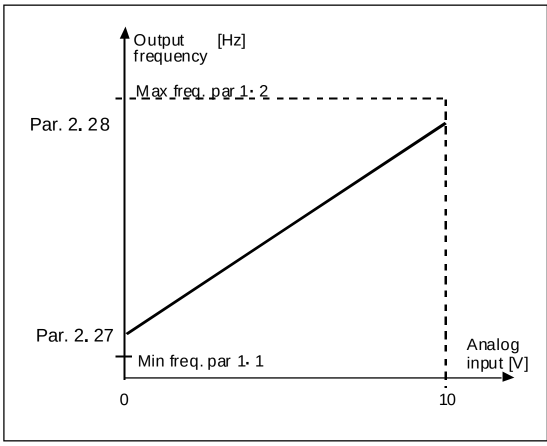


Figure 4.5-7 Reference scaling.

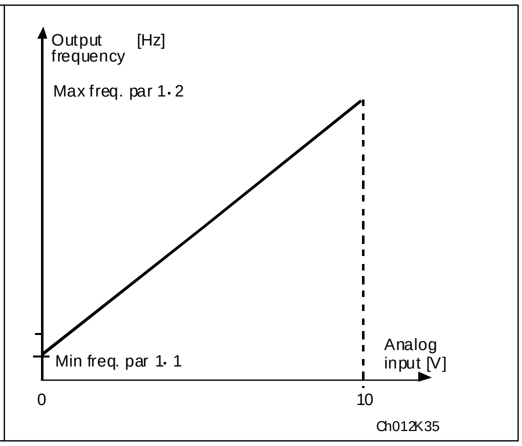


Figure 4.5-8 Reference scaling, par. 2. 28 = 0.

3. 1 **Analog output Content**

See table on page 4-10.

3. 2 **Analog output filter time**

Filters the analog output signal. See figure 4.5-9.

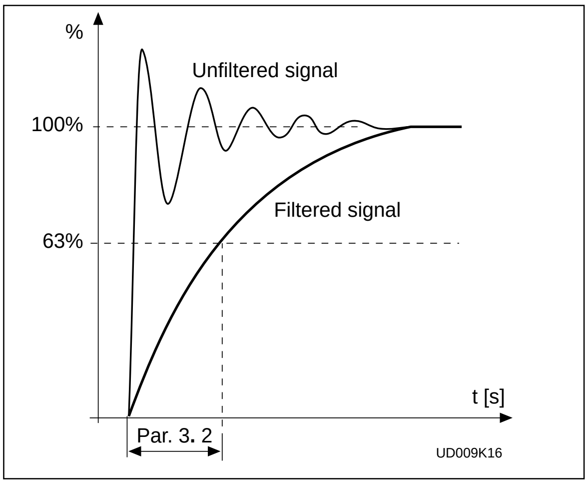


Figure 4.5-9 Analog output filtering.

3.3 **Analog output invert**

Inverts analog output signal:
max output signal = minimum set value
min output signal = maximum set value

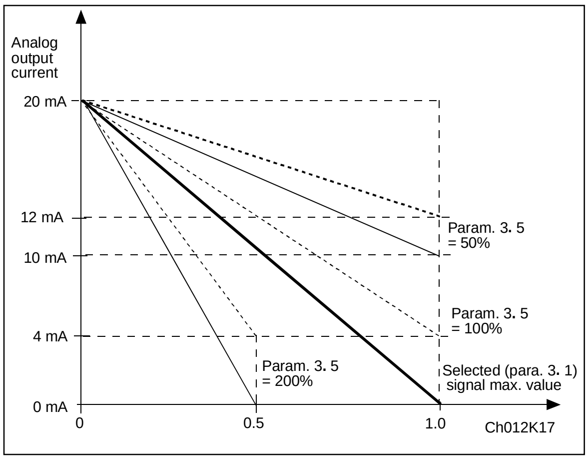


Figure 4.5-10 Analog output invert.

4

3. 4 **Analog output minimum**

Defines the signal minimum to be either 0 mA or 4 mA. See figure 4.5-9.

3. 5 **Analog output scale**

Scaling factor for analog output. See figure 4.5-11.

Signal	Max. value of the signal
Output frequency	Max. frequency (p. 1. 2)
Motor speed	Max. speed ($n_n x f_{max}/f_n$)
Output current	2 x I_{nCX}
Motor torque	2 x T_{nMot}
Motor power	2 x P_{nMot}
Motor voltage	100% x V_{nMot}
DC-link volt.	1000 V

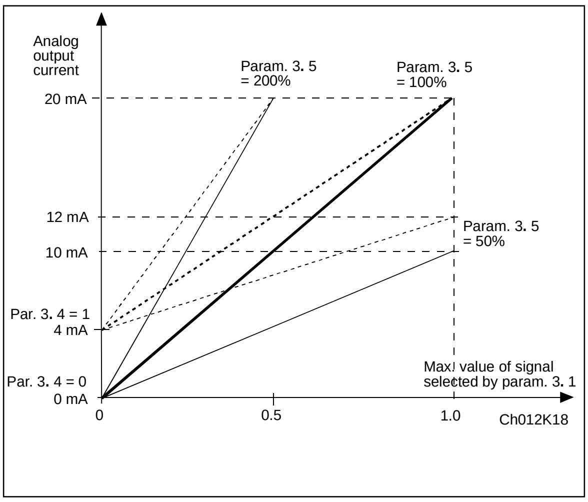


Figure 4.5-11 Analog output scale.

3. 6 Digital output function
3. 7 Relay output 1 function
3. 8 Relay output 2 function

Setting value	Signal content
0 = Not used	Out of operation
	Digital output DO1 sinks current and programmable relay (RO1, RO2) is activated when:
1 = Ready	The drive is ready to operate
2 = Run	The drive operates (motor is running)
3 = Fault	A fault trip has occurred
4 = Fault inverted	a fault trip has not occurred
5 = CX overheat warning	The heat-sink temperature exceeds +70°C
6 = External fault or warning	Fault or warning depending on parameter 7. 2
7 = Reference fault or warning	Fault or warning depending on parameter 7. 1 - if analog reference is 4—20 mA and signal is <4mA
8 = Warning	Always if a warning exists (see Table 7.10-1 in Users' manual
9 = Reversed	The reverse command has been selected
10 = Jog speed	Jog speed has been selected with digital input
11 = At speed	The output frequency has reached the set reference
12 = Motor regulator activated	Overvoltage or overcurrent regulator was activated
13 = Output frequency supervision 1	The output frequency goes outside of the set supervision Low limit/ High limit (par. 3. 9 and 3. 10)
14= Output frequency supervision 2	The output frequency goes outside of the set supervision Low limit/ High limit (par. 3. 11 and 3. 12)
15= Torque limit supervision	The motor torque goes outside of the set supervision Low limit/ High limit (par. 3. 13 and 3. 14)
16= Active reference limit supervision	Active reference goes outside of the set supervision Low limit/ High limit (par. 3. 15 and 3. 16)
17 = External brake control	External brake ON/OFF control with programmable delay (par 3. 17 and 3. 18)
18 = Control from I/O terminals	External control mode selected with progr. push-button #2
19 = Drive temperature limit supervision	Temperature on drive goes outside the set supervision limits (par. 3. 19 and 3. 20)
20 = Unrequested rotation direction	Rotation direction of the motor shaft is different from the requested one
21 = External brake control inverted	External brake ON/OFF control (par. 3.18 and 3.18) output active when brake control is OFF

Table 4.5-2 Output signals via DO1 and output relays RO1 and RO2.

3. 9 Output frequency limit 1, supervision function
3. 11 Output frequency limit 2, supervision function

0 = No supervision
1 = Low limit supervision
2 = High limit supervision

If the output frequency goes under/over the set limit (3. 10, 3. 12) this function generates a warning message via the digital output DO1 or via a relay output RO1 or RO2 depending on the settings of the parameters 3. 6—3. 8.

3. 10 Output frequency limit 1, supervision value
3. 12 Output frequency limit 2, supervision value

The frequency value to be supervised by the parameter 3. 9 (3. 11).

See figure 4.5-12.

3. 13 Torque limit , supervision function

0 = No supervision
1 = Low limit supervision
2 = High limit supervision

If the calculated torque value goes under/over the set limit (3**.** 14) this function generates a warning message via the digital output DO1 or via a relay output RO1 or RO2 depending on the settings of the parameters 3**.** 6—3**.** 8.

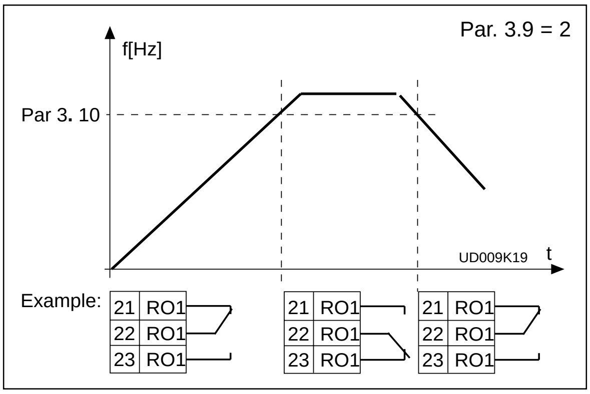


Figure 4.5-12 Output frequency supervision.

3. 14 Torque limit , supervision value

The calculated torque value to be supervised by the parameter 3**.** 13.

3. 15 Reference limit , supervision function

0 = No supervision
1 = Low limit supervision
2 = High limit supervision

If the reference value goes under/over the set limit (3**.** 16) this function generates a warning message via the digital output DO1 or via a relay output RO1 or RO2 depending on the settings of the parameters 3**.** 6—3**.** 8. The supervised reference is the current active reference. It can be source A or B reference depending on DIB6 input or panel reference if panel is the active control place.

3. 16 Reference limit , supervision value

The frequency value to be supervised by the parameter 3**.** 15.

3. 17 External brake-off delay
3. 18 External brake-on delay

The function of the external brake can be delayed from the start and stop control signals with these parameters. See figure 4.5-13.

The brake control signal can be programmed via the digital output DO1 or via one of the relay outputs RO1 and RO2, see parameters 3**.** 6—3**.** 8.

3. 19 Drive temperature limit supervision

0 = No supervision
1 = Low limit supervision
2 = High limit supervision

If the temperature of the drive goes under/over the set limit (3**.** 20) this function generates a warning message via the digital output DO1 or via a relay output RO1 or RO2 depending on the settings of the parameters 3**.** 6—3**.** 8.

3. 20 Drive temperature limit value

The temperature value to be supervised by parameter 3**.** 19.

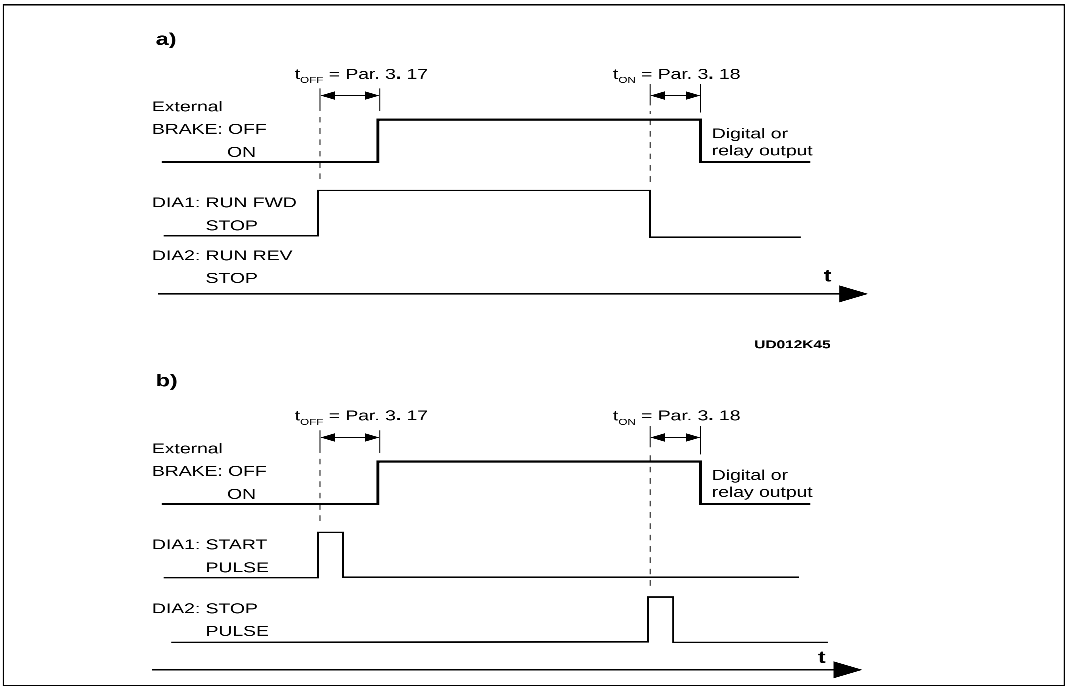


Figure 4.5-13 External brake control: a) Start/Stop logic selection par. 2. 1 = 0, 1 or 2
b)Start/Stop logic selection par. 2. 1 = 3.

4. 1 Acc/Dec ramp 1 shape
4. 2 Acc/Dec ramp 2 shape

The acceleration and deceleration ramp shape can be programmed with these parameters.

Setting the value = 0 gives you a linear ramp shape. The output frequency immediately follows the input with a ramp time set by parameters 1. 3, 1. 4 (4. 3, 4. 4 for Acc/Dec time 2).

Setting 0.1—10 seconds for 4. 1 (4. 2) causes an S-shaped ramp. The speed changes are smooth. Parameter 1. 3/ 1. 4 (4. 3/ 4. 4) determines the ramp time of the acceleration/deceleration in the middle of the curve.
See figure 4.5-14.

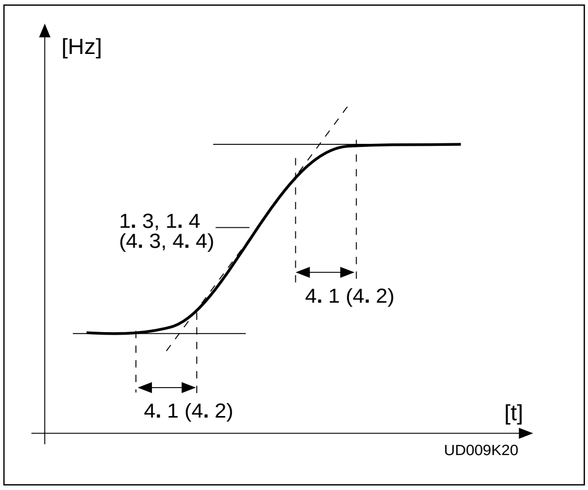


Figure 4.5-14 S-shaped acceleration/ deceleration.

4. 3 Acceleration time 2
4. 4 Deceleration time 2

These values correspond to the time required for the output frequency to accelerate from the set minimum frequency (par. 1. 1) to the set maximum frequency (par. 1. 2). With this parameter it is possibile to set two different acceleration/ deceleration times for one application. The active set can be selected with the programmable signal DIA3 of this application, see parameter 2. 2.

4. 5 Brake chopper

0 = No brake chopper
1 = Brake chopper and brake resistor installed
2 = External brake chopper

When the drive is decelerating the motor, the energy stored in the inertia of the motor and the load is fed into the external brake resistor. If the brake resistor is selected correctly the drive is able to decelerate the load with a torque equal to that of acceleration. See the separate Brake resistor installation manual.

4. 6 Start function

Ramp:

0 The drive starts from 0 Hz and accelerates to the set reference frequency within the set acceleration time. (Load inertia or starting friction may extend the acceleration times).

Flying start:

1 The drive starts into a running motor by first finding the speed the motor is running at. Searching starts from the maximum frequency down until the actual frequency reached. The output frequency then accelerates/decelerates to the set reference value at a rate determined by the acceleration/deceleration ramp parameters.

Use this mode if the motor may be coasting when the start command is given. With the flying start it is possible to ride through short utility voltage interruptions.

4. 7 Stop function

Coasting:

0 The motor coasts to an uncontrolled stop with the CX/CXL/CXS off, after the Stop command.

Ramp:

1 After the Stop command, the speed of the motor is decelerated according to the deceleration ramp time parameter.
If the regenerated energy is high it may be necessary to use an external braking resistor for faster deceleration.

4. 8 DC braking current

Defines the current injected into the motor during the DC braking.

4. 9 DC braking time at stop

Defines if braking is ON or OFF and the braking time of the DC-brake when the motor is stopping. The function of the DC-brake depends on the stop function, parameter 4**.** 7. See figure 4.5-15.

0 DC-brake is not used
>0 DC-brake is in use and its function depends on the Stop function, (param. 4**.** 7), and the time depends on the value of parameter 4**.** 9:

Stop-function = 0 (coasting):

After the stop command, the motor will coast to a stop with the CX/CXL/CXS off.

With DC-injection, the motor can be electrically stopped in the shortest possible time, without using an optional external braking resistor.

The braking time is scaled according to the frequency when the DC-braking starts. If the frequency is ≥nominal frequency of the motor (par. 1.11), setting value of parameter 4.9 determines the braking time. When the frequency is ≤10% of the nominal, the braking time is 10% of the set value of parameter 4.9.

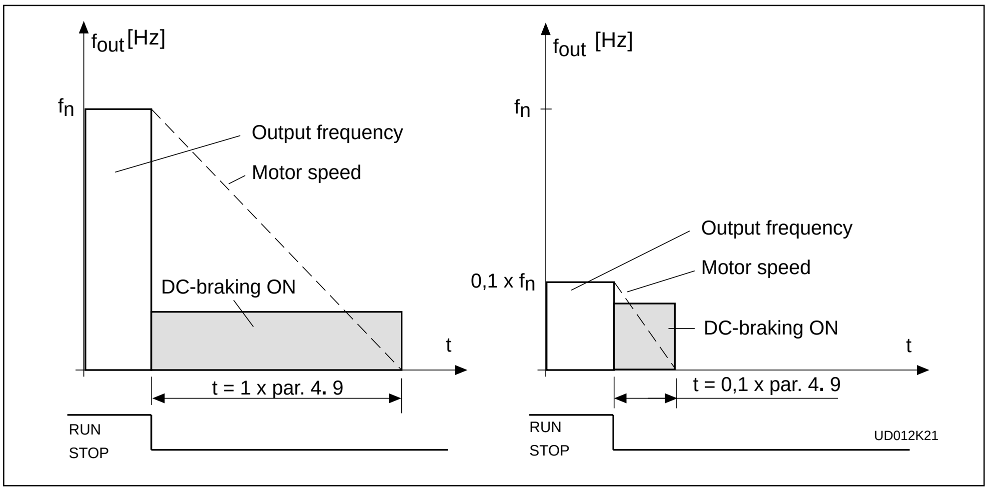


Figure 4.5-15 DC-braking time when par. 4. 7 = 0.

Stop-function = 1 (ramp):

After the stop command, the speed of the motor is reduced based on the deceleration ramp parameter, if no regeneration occurs due to load inertia, to a speed defined with parameter 4. 10 where the DC-braking starts.

The braking time is defined with parameter 4. 9.

If high inertia exists it is recommended to use an external braking resistor for faster deceleration. See figure 4.5-16.

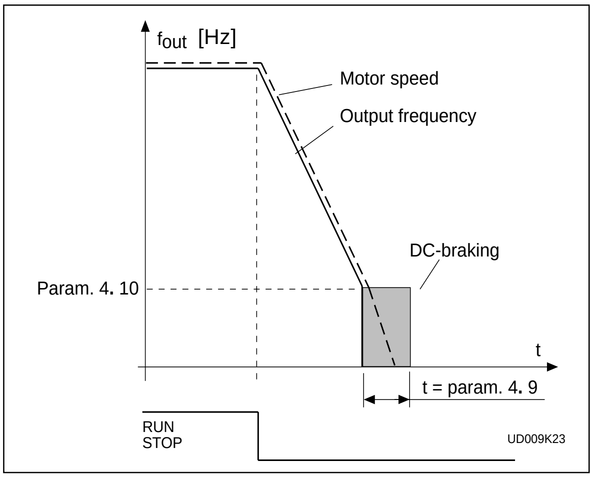


Figure 4.5-16 DC-braking time when par. 4. 7 = 1.

4. 10 Execute frequency of DC-brake during ramp Stop

See figure 4.5-16.

4. 11 DC-brake time at start

0 DC-brake is not used

>0 DC-brake is active when the start command is given. This parameter defines the time before the brake is released. After the brake is released the output frequency increases according to the set start function parameter 4. 6 and the acceleration parameters (1. 3, 4. 1 or 4. 2, 4. 3). See figure 4.5-17.

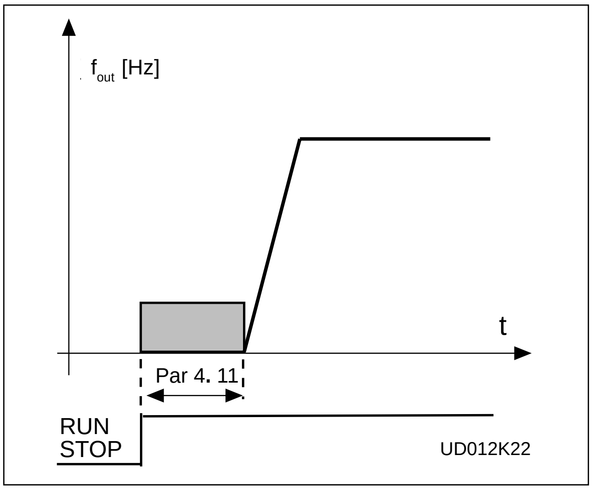


Figure 4.5-17 DC-braking time at start

4. 12 Jog speed reference

Parameter value defines the Jog speed selected with the digital input.

5. 1- 5.6 Prohibit frequency area, Low limit/High limit

In some systems it may be necessary to avoid certain frequencies because of mechanical resonance problems.

With these parameters it is possible to set limits for three "skip frequency" regions. The accuracy of the setting is 0.1 Hz.

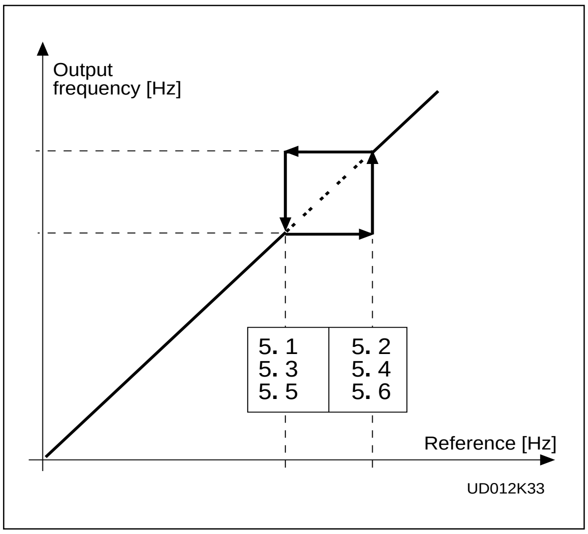


Figure 4.5-18 Example of prohibit frequency area setting

6. 1 Motor control mode

0 = Frequency control: (V/Hz)	The I/O terminal and panel references are frequency references and the drive controls the output frequency (output freq. resolution 0.01 Hz)
1 = Speed control: (sensorless vector)	The I/O terminal and panel references are speed references and the drive controls the motor speed (control accuracy ± 0.5%).

6. 2 Switching frequency

Motor noise can be minimized using a high switching frequency. Increasing the frequency reduces the capacity of the CX/CXL/CXS.
Before changing the frequency from the factory default 10 kHz (3.6 kHz >40 Hp) check the drive derating in the curves shown in figures 5.2-2 and 5.2-3 in chapter 5.2 of the User's Manual.

6. 3 Field weakening point
6. 4 Voltage at the field weakening point

The field weakening point is the output frequency where the output voltage reaches the set maximum value (par. 6. 4). Above that frequency the output voltage remains at the set maximum value.
Below that frequency output voltage depends on the setting of the V/Hz curve parameters 1. 8, 1. 9, 6. 5, 6. 6 and 6. 7. See figure 4.5-19.

When parameters 1. 10 and 1. 11, nominal voltage and nominal frequency of the motor are set, parameters 6. 3 and 6. 4 are also set automatically to the corresponding values. If you need different values for the field weakening point and the maximum output voltage, change these parameters after setting parameters 1. 10 and 1. 11.

6. 5 V/Hz curve, middle point frequency

If the programmable V/Hz curve has been selected with parameter 1. 8, this parameter defines the middle point frequency of the curve. See figure 4.5-19.

6. 6 V/Hz curve, middle point voltage

If the programmable V/Hz curve has been selected with parameter 1. 8, this parameter defines the middle point voltage (% of motor nominal voltage) of the curve. See figure 4.5-19.

6. 7 Output voltage at zero frequency

If the programmable V/Hz curve has been selected with parameter 1. 8 this parameter defines the zero frequency voltage of the curve. See figure 4.5-19.

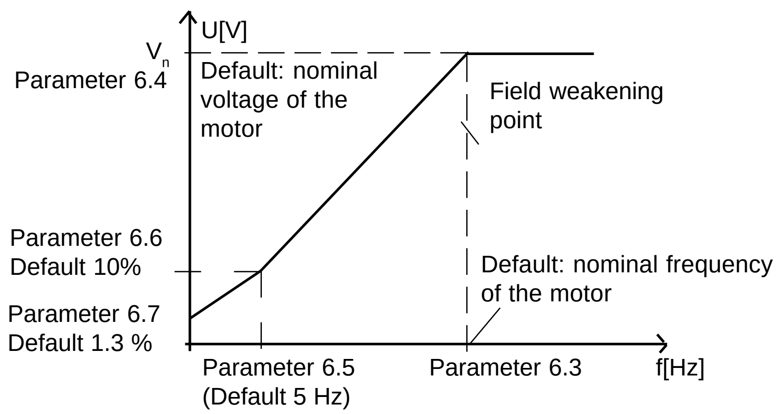


Figure 4.5-19 Programmable V/Hz curve.

6. 8 Overvoltage controller
6. 9 Undervoltage controller

These parameters allow the over/undervoltage controllers to be switched ON or OFF. This may be useful in cases where the utility supply voltage varies more than -15%—+10% and the application requires a constant speed. If the controllers are ON, they will change the motor speed in over/undervoltage cases. Overvoltage = faster, undervoltage = slower.

Over/undervoltage trips may occur when the controllers are not used.

7. 1 Response to the reference fault

0 = No response
1 = Warning
2 = Fault, stop mode after fault according to parameter 4.7
3 = Fault, always coasting stop mode after fault

A warning or a fault action and message is generated if the 4—20 mA reference signal is used and the signal falls below 4 mA. The information can also be programmed via digital output DO1 and via relay outputs RO1 and RO2.

7. 2 Response to external fault

0 = No response
1 = Warning
2 = Fault, stop mode after fault according to parameter 4.7
3 = Fault, always coasting stop mode after fault

A warning or a fault action and message is generated from the external fault signal in the digital input DIA3. The information can also be programmed into digital output DO1 and into relay outputs RO1 and RO2.

7. 3 Phase supervision of the motor

0 = No action
2 = Fault

Phase supervision of the motor ensures that the motor phases have approximately equal current.

7. 4 Ground fault protection

0 = No action
2 = Fault

Ground fault protection ensures that the sum of the motor phase currents is zero. The standard overcurrent protection is always working and protects the frequency converter from ground faults with high current levels.

Parameters 7. 5—7. 9 Motor thermal protection

General

Motor thermal protection is to protect the motor from overheating. The CX/CXL/CXS drive is capable of supplying higher than nominal current to the motor. If the load requires this high current there is a risk that the motor will be thermally overloaded. This is true especially at low frequencies. With low frequencies the cooling effect of the motor fan is reduced and the capacity of the motor is reduced. If the motor is equipped with an external fan, the load derating on low speed is small.

Motor thermal protection is based on a calculated model and it uses the output current of the drive to determine the load on the motor. When the power is turned on to the drive, the calculated model uses the heatsink temperature to determine the initial thermal stage for the motor. The calculated model assumes that the ambient temperature of the motor is 40°C.

Motor thermal protection can be adjusted by setting several parameters. The thermal current I_T specifies the load current above which the motor is overloaded. This current limit is a function of the output frequency. The curve for I_T is set with parameters 7**.** 6, 7**.** 7 and 7**.** 9, refer to the figure 4.5-20. The default values of these parameters are set from the motor nameplate data.

With the output current at I_T the thermal stage will reach the nominal value (100%). The thermal stage changes by the square of the current. With output current at 75% from I_T the thermal stage will reach 56% value and with output current at 120% from I_T the thermal stage would reach 144% value. The function will trip the drive (refer par. 7**.** 5) if the thermal stage will reach a value of 105%. The response time of the thermal stage is determined with the time constant parameter 7**.** 8. The larger the motor, the longer it takes to reach the final temperature.

The thermal stage of the motor can be monitored through the display. Refer to the table for monitoring items. (User's Manual, table 7.3-1).

⚠ CAUTION!	*The calculated model does not protect the motor if the cooling of the motor is reduced either by blocking the airflow or due to dust or dirt.*

7. 5 Motor thermal protection

Operation:
0 = Not in use
1 = Warning
2 = Trip function

Tripping and warning will give a display indication with the same message code. If tripping is selected , the drive will stop and activate the fault stage.

Deactivating the protection by setting this parameter to 0, will reset the thermal stage of the motor to 0%.

4

7. 6 Motor thermal protection, break point current

The current can be set between 50.0—150.0% x I_{nMotor}.
This parameter sets the value for thermal current at frequencies above the break point on the thermal current curve. Refer to the figure 4.5-20.

The value is set as a percentage of the motor nameplate nominal current, parameter 1**.** 13, not the drive's nominal output current.

The motor's nominal current is the current which the motor can withstand in direct on-line use without being overheated.

If parameter 1**.** 13 is adjusted, this parameter is automatically restored to the default value.

Setting this parameter (or parameter 1**.** 13) does not affect the maximum output current of the drive. Parameter 1**.** 7 alone determines the maximum output current of the drive.

7. 7 Motor thermal protection, zero frequency current

The current can be set between 10.0—150.0% x I_{nMotor}. This parameter sets the value for thermal current at zero frequency. Refer to the figure 4.5-20.

The default value is set assuming that there is no external fan cooling the motor. If an external fan is used this parameter can be set to 90% (or higher).

The value is set as a percentage value of the motor's nameplate nominal current, parameter 1. 13, not the drive's nominal output current. The motor's nominal current is the current which the motor can stand in direct on-line use without being overheated.

If you change the parameter 1. 13 this parameter is automatically restored to the default value.

Setting this parameter (or parameter 1. 13) does not affect to the maximum output current of the drive. Parameter 1. 7 alone determines the maximum output current of the drive.

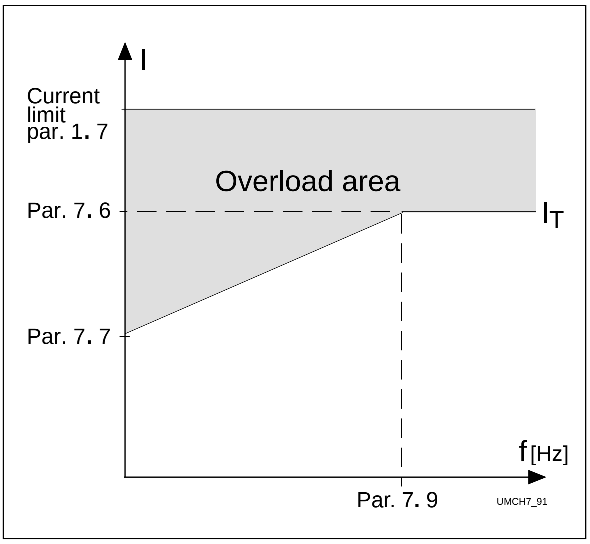


Figure 4.5-20 Motor thermal current I_T curve

7. 8 Motor thermal protection, time constant

This time can be set between 0.5—300 minutes.
This is the thermal time constant of the motor. The larger the motor the greater the time constant. The time constant is defined as the time that it takes the calculated thermal stage to reach 63% of its final value.

The motor thermal time is specific to a motor design and it varies between different motor manufacturers.

The default value for the time constant is calculated based on the motor nameplate data from parameters 1. 12 and 1. 13. If either of these parameters is reset, then this parameter is set to default value.

If the motor's t_6 -time is known (given by the motor manufacturer) the time constant parameter could be set based on t_6 -time. As a rule of thumb, the motor thermal time constant in minutes equals to 2xt_6 (t_6 in seconds is the time a motor can safely operate at six times the rated current). If the drive is stopped the time constant is internally increased to three times the set parameter value. The cooling in the stop stage is based on convection with an increased time constant.

7. 9 Motor thermal protection, break point frequency

This frequency can be set between 10—500 Hz.
This is the frequency break point of the thermal current curve. With frequencies above this point, the thermal capacity of the motor is assumed to be constant. Refer to figure 4.5-20.

The default value is based on the motor's nameplate data, parameter 1. 11. It is 35 Hz for a 50 Hz motor and 42 Hz for a 60 Hz motor. More generally it is 70% of the frequency at the field weakening point (parameter 6. 3). Changing either parameter 1. 11 or 6. 3 will restore this parameter to its default value.

4

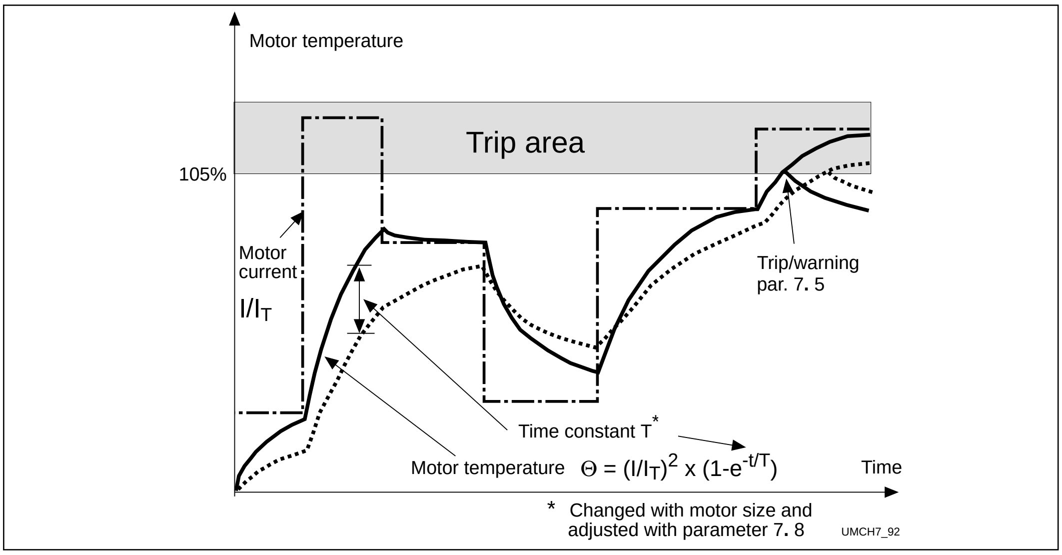


Figure 4.5-21 Calculating motor temperature.

Parameters 7. 10— 7. 13, Stall protection
General

Motor stall protection protects the motor from short time overload situations like a stalled shaft. The reaction time of stall protection can be set shorter than with motor thermal protection. The stall state is defined with two parameters, 7.11. Stall Current and 7.13. Stall Frequency. If the current is higher than the set limit and output frequency is lower than the set limit the stall state is true. There is no true detection of shaft rotation. Stall protection is a type of overcurrent protection.

4

7. 10 Stall protection

Operation:

0 = Not in use
1 = Warning
2 = Trip function

Tripping and warning will give a display indication with the same message code. If tripping is set on, the drive will stop and activate the fault stage. Setting the parameter to 0 will deactivate the protection and will reset the stall time counter to zero.

7. 11 Stall current limit

The current can be set between 0.0—200% x I_{nMotor}.

In the stall stage the current has to be above this limit. Refer to the figure 4.5-22. The value is set as a percentage of the motor's name-plate nominal current, parameter 1.13, motor's nominal current. If parameter 1.13 is adjusted, this parameter is automatically restored to its default value.

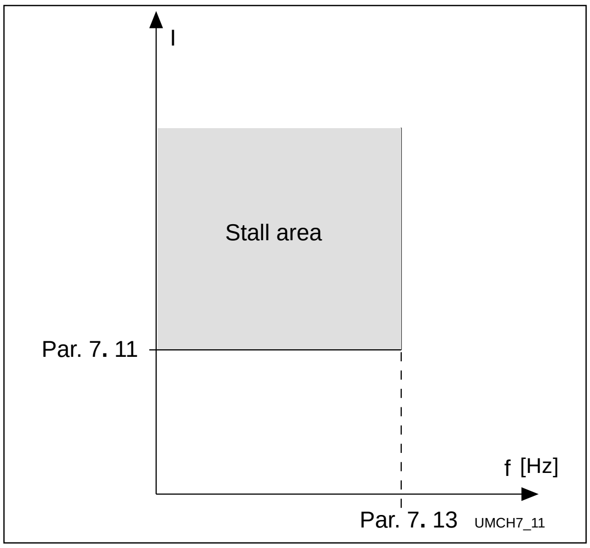


Figure 4.5-22 Setting the stall characteristics.

7. 12 Stall time

The time can be set between 2.0—120 s.
This is the maximum allowed time for a stall stage. There is an internal up/down counter to count the stall time. Refer to figure 4.5-23.
If the stall time counter value goes above this limit the protection will cause a trip (refer to parameter 7**.** 10).

7. 13 Maximum stall frequency

The frequency can be set between 1—f_{max} (par. 1**.** 2).
In the stall state, the output frequency has to be smaller than this limit. Refer to figure 4.5-22.

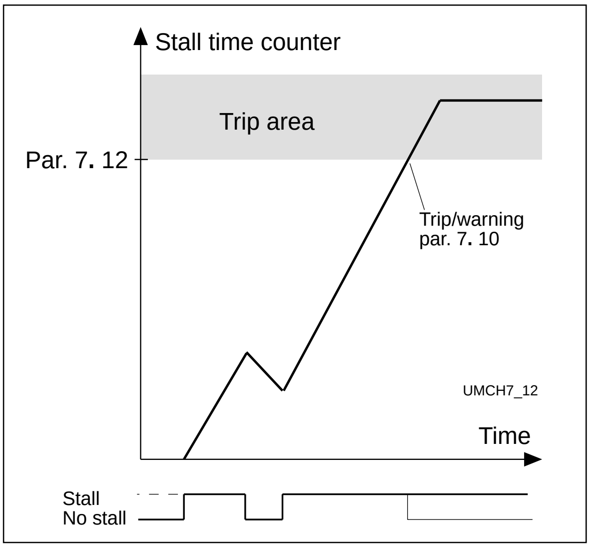


Figure 4.5-23 Counting the stall time.

Parameters 7. 14— 7. 17, Underload protection
General

The purpose of motor underload protection is to ensure that there is load on the motor while the drive is running. If the motor load is reduced, there might be a problem in the process, e.g. broken belt or dry pump.

Motor underload protection can be adjusted by setting the underload curve with parameters 7**.** 15 and 7**.** 16. The underload curve is a squared curve set between zero frequency and the field weakening point. The protection is not active below 5 Hz (the underload counter value is stopped). Refer to the figure 4.5-24.

The torque values for setting the underload curve are set with percentage values which refer to the nominal torque of the motor. The motor's nameplate data, parameter 1. 13, the motor's nominal current and the drive's nominal current I_{CT} are used to find the scaling ratio for the internal torque value. If other than a standard motor is used with the drive, the accuracy of the torque calculation is decreased.

7. 14 Underload protection

Operation:
- 0 = Not in use
- 1 = Warning
- 2 = Fault

Tripping and warning will give a display indication with the same message code. If tripping is set active the drive will stop and activate the fault stage.

Deactivating the protection, by setting this parameter to 0, will reset the underload time counter to zero.

4

7. 15 Underload protection, field weakening area load

Torque limit can be set between 20.0—150 % x T_{nMotor}.

This parameter is the value for the minimum allowed torque when the output frequency is above the field weakening point.
Refer to the figure 4.5-24.
If parameter 1. 13 is adjusted, this parameter is automatically restored to its default value.

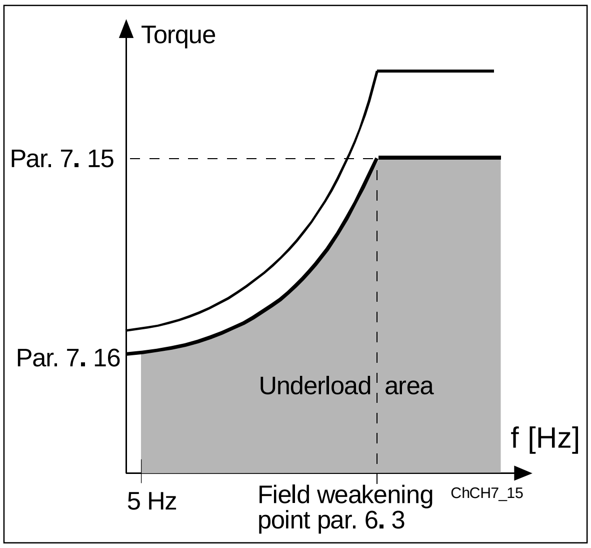


Figure 4.5-24 Setting of minimum load.

7. 16 Underload protection, zero frequency load

Torque limit can be set between 10.0—150 % x T_{nMotor}.

This parameter is the value for the minimum allowed torque with zero frequency. Refer to the figure 4.5-24. If parameter 1. 13 is adjusted this parameter is automatically restored to its default value.

7. 17 Underload time

This time can be set between 2.0—600.0 s.

This is the maximum allowed time for an underload state. There is an internal up/down counter to accumulate the underload time. Refer to the figure 4.5-25.
If the underload counter value goes above this limit, the protection will cause a trip (refer to the parameter 7. 14). If the drive is stopped, the underload counter is reset to zero.

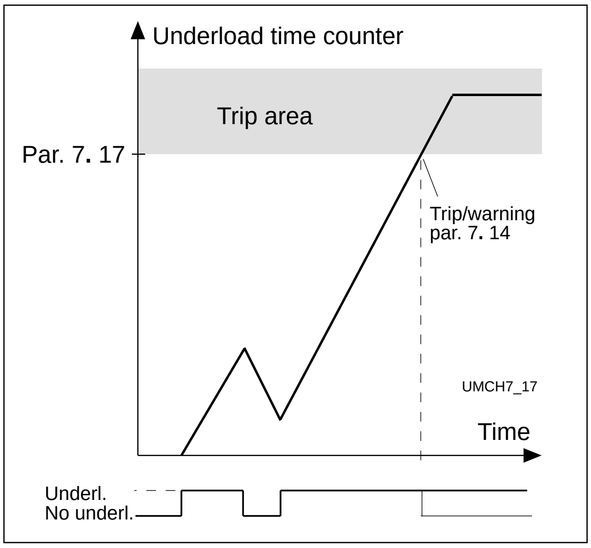


Figure 4.5-25 Counting the under-load time.

8. 1 Automatic restart: number of tries
8. 2 Automatic restart: trial time

The Automatic restart function restarts the drive after the faults selected with parameters 8. 4—8. 8. The Start function for Automatic restart is selected with parameter 8. 3. See figure 4.5-26.

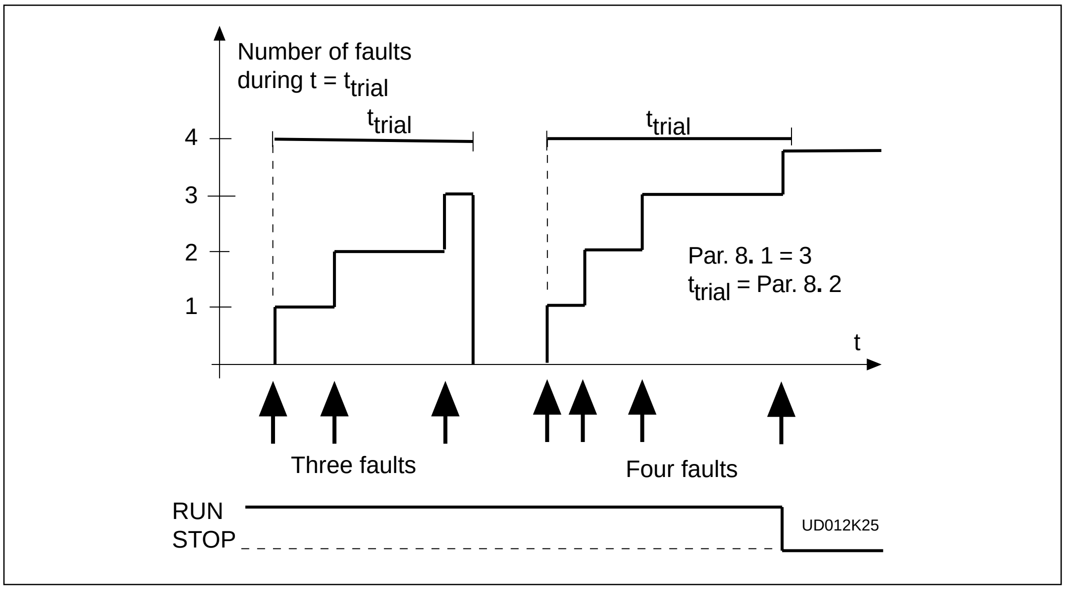


Figure 4.5-26 Automatic restart.

Parameter 8**.** 1 determines how many automatic restarts can be made during the trial time set by the parameter 8**.** 2.

The time counting starts from the first autorestart. If the number of restarts does not exceed the value of the parameter 8**.** 1 during the trial time, the counting is cleared after the trial time has elapsed. The next fault starts the counting again.

8. 3 Automatic restart, start function

The parameter defines the start mode:
0 = Start with ramp
1 = Flying start, see parameter 4**.** 6.

8. 4 Automatic restart after undervoltage trip

0 = No automatic restart after undervoltage trip
1 = Automatic restart after undervoltage fault condition returns to the normal condition (DC-link voltage returns to the normal level)

8. 5 Automatic restart after overvoltage trip

0 = No automatic restart after overvoltage trip
1 = Automatic restart after overvoltage fault condition returns to the normal condition (DC-link voltage returns to the normal level)

8. 6 Automatic restart after overcurrent trip

0 = No automatic restart after overcurrent trip
1 = Automatic restart after overcurrent faults

8. 7 Automatic restart after reference fault trip

0 = No automatic restart after reference fault trip
1 = Automatic restart after analog current reference signal (4—20 mA) returns to the normal level (≥4 mA)

8. 8 Automatic restart after over-/undertemperature fault trip

0 = No automatic restart after temperature fault trip
1 = Automatic restart after heatsink temperature has returned to its normal level between -10°C—+75°C.

4

4.6 Panel reference

The PI-control application has an extra reference (r2) for the PI-controller on the panel's reference page. See table 4.6-1.

Reference number	Reference name	Range	Step	Function
r 1	Frequency reference	f_{min}—f_{max}	0.01 Hz	Reference for panel control and I/O terminal Source B reference.
r 2	PI-controller reference	0—100%	0.1%	Reference for PI-controller

4.7 Monitoring data

The PI-control application has additional items for monitoring. See table 4.7-1

Number	Data name	Unit	Description
v 1	Output frequency	Hz	Frequency to the motor
v 2	Motor speed	rpm	Calculated motor speed
v 3	Motor current	A	Measured motor current
v 4	Motor torque	%	Calculated actual torque/nominal torque of the unit
v 5	Motor power	%	Calculated actual power/nominal power of the unit
v 6	Motor voltage	V	Calculated motor voltage
v 7	DC-link voltage	V	Measured DC-link voltage
v 8	Temperature	°C	Temperature of the heat sink
v 9	Operating day counter	DD.dd	Operating days [1], not resettable
v 10	Operating hours, "trip counter"	HH.hh	Operating hours [2], can be reset with programmable button #3
v 11	MW-hours	MWh	Total MW-hours, not resettable
v 12	MW-hours, "trip counter"	MWh	MW-hours, can be reset with programmable button #4
v 13	Voltage/analog input	V	Voltage at the terminal V_{in}+ (term. #2)
v 14	Current/analog input	mA	Current at terminals I_{in}+ and I_{in}- (term. #4, #5)
v 15	Digital input status, gr. A		
v 16	Digital input status, gr. B		
v 17	Digital and relay output status		
v 18	Control program		Version number of the control software
v 19	Unit nominal power	Hp	Shows the horsepower size of the unit
v 20	PI-controller reference	%	Percent of the maximum reference
v 21	PI-controller actual value	%	Percent of the maximum actual value
v 22	PI-controller error value	%	Percent of the maximum error value
v 23	PI-controller output	Hz	
v 24	Motor temperature rise	%	100%= temperature of motor has risen to nominal

[1] DD = full days, dd = decimal part of a day

[2] HH = full hours, hh = decimal part of an hour

Table 4.7-1 Monitored items.

4

Notes:

Notes:

MULTI-PURPOSE CONTROL APPLICATION
(par. 0.1 = 6)

CONTENTS

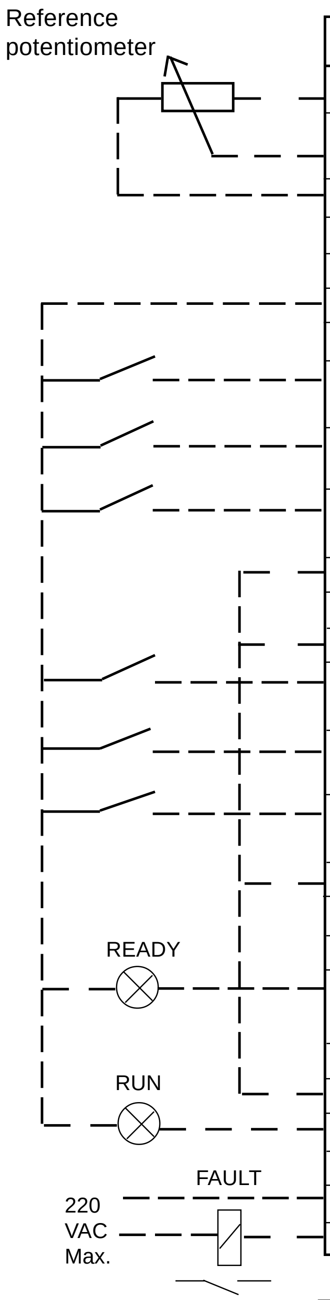
5 Multi-purpose Control Application

5.1 General

In the Multi-purpose control application the frequency reference can be selected from the analog inputs, the joystick control, the motorized (digital) potentiometer and a mathematical function of the analog inputs. Multi-step speeds and jog speed can also be selected if digital inputs are programmed for these functions.

Digital inputs DIA1 and DIA2 are reserved for Start/stop logic. Digital inputs DIA3—DIB6 are programmable for multi-step speed select, jog speed select, motorized (digital potentiometer, external fault, ramp time select, ramp prohibit, fault reset and DC-brake command function. All outputs are freely programmable.

5.2 Control I/O



Terminal		Signal	Description
1	$+10V_{ref}$	Reference output	Voltage for a potentiometer, etc.
2	$V_{in}+$	Analog input, voltage (programmable)	Frequency reference range 0—10 V DC
3	GND	I/O ground	Ground for reference and controls
4	$I_{in}+$	Analog input,	Default setting: not used
5	$I_{in}-$	current (programmable)	range 0—20 mA
6	+24V	Control voltage output	Voltage for switches, etc. max. 0.1 A
7	GND	I/O ground	Ground for reference and controls
8	DIA1	Start forward (programmable)	Contact closed = start forward
9	DIA2	Start reverse (Programmable)	Contact closed = start reverse
10	DIA3	Fault reset (programmable)	Contact open = no action Contact closed = fault reset
11	CMA	Common for DIA1—DIA3	Connect to GND or + 24V
12	+24V	Control voltage output	Voltage for switches, (same as #6)
13	GND	I/O ground	Ground for reference and controls
14	DIB4	Jog speed select (programmable)	Contact open = no action Contact closed = jog speed
15	DIB5	External fault (programmable)	Contact open = no fault Contact closed = fault
16	DIB6	Accel./deceler. time select (programmable)	Contact open = par. 1.3, 1.4 in use Contact closed = par. 4.3, 4.4 in use
17	CMB	Common for DIB4—DIB6	Connect to GND or + 24V
18	$I_{out}+$	Output frequency	Programmable (par. 3. 1)
19	$I_{out}-$	Analog output	Range 0—20 mA/R_L max. 500 Ω
20	DO1	Digital output READY	Programmable (par. 3. 6) Open collector, I≤50 mA, V≤48 VDC
21	RO1	Relay output 1	Programmable (par. 3. 7)
22	RO1	RUN	
23	RO1		
24	RO2	Relay output 2	Programmable (par. 3. 8)
25	RO2	FAULT	
26	RO2		

Figure 5.2-1 Default I/O configuration and connection example of the Multi-purpose Control Application.

5.3 Control signal logic

The logic flow of the I/O-control signals and pushbutton signals from the panel is shown in figure 5.3-1.

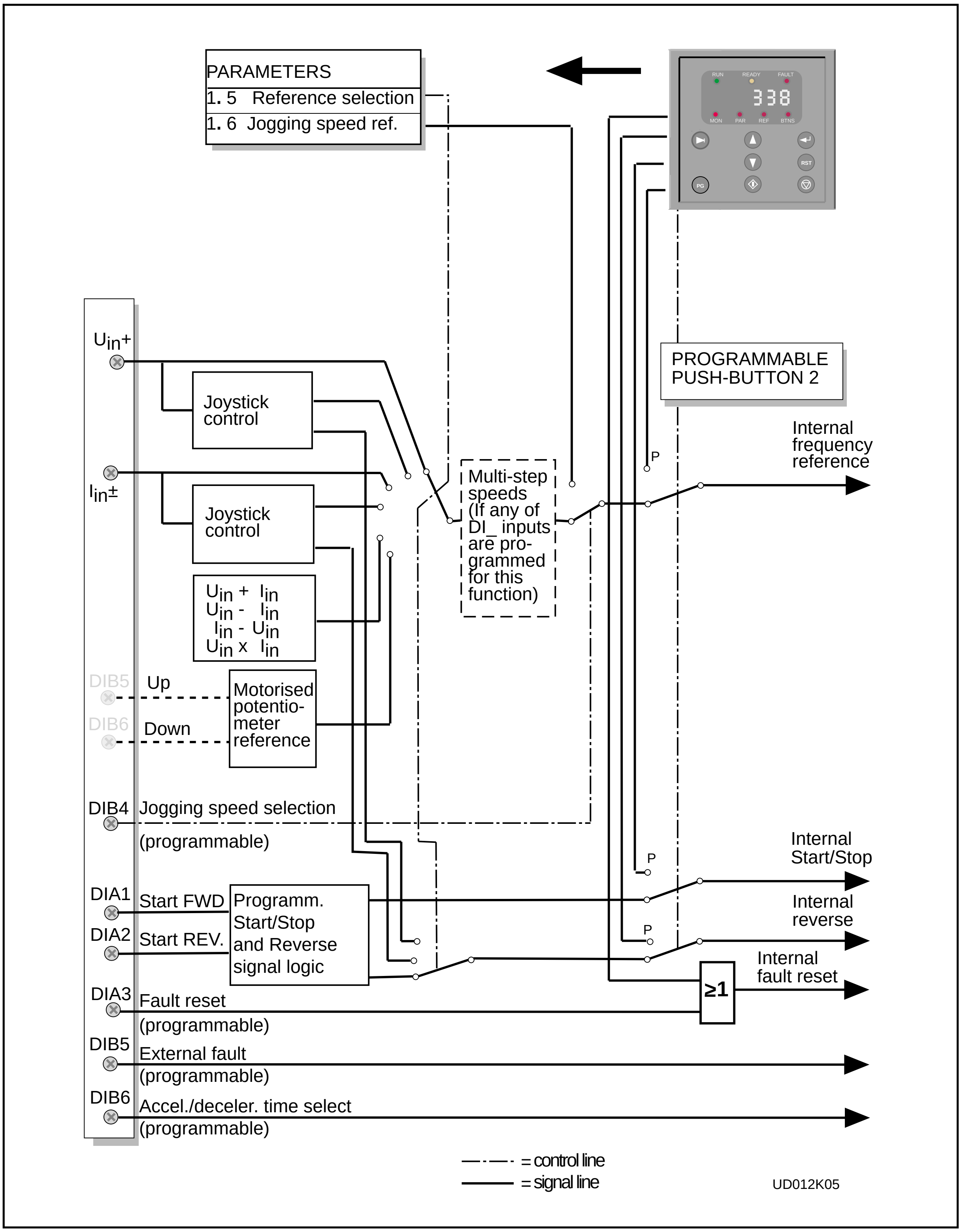


Figure 5.3-1 Control signal logic of the Multipurpose Control Application.
Switch positions shown are based on the factory settings.

5

5.4 Basic parameters, Group 1
5.4.1 Parameter table

Code	Parameter	Range	Step	Default	Custom	Description	Page
1. 1	Minimum frequency	0— f_{max}	1 Hz	0 Hz			5-5
1. 2	Maximum frequency	f_{min}-120/500Hz	1 Hz	60 Hz	*		5-5
1. 3	Acceleration time 1	0.1—3000.0 s	0.1 s	3.0 s		Time from f_{min} (1. 1) to f_{max} (1. 2)	5-5
1. 4	Deceleration time 1	0.1—3000.0 s	0.1 s	3.0 s		Time from f_{max} (1. 2) to f_{min} (1. 1)	5-5
1. 5	Reference selection (stop icon)	0—9	1	0		0 = V_{in} 3 = V_{in} - I_{in} 1 = I_{in} 4 = I_{in} - V_{in} 2 = V_{in} + I_{in} 5 = V_{in} * I_{in} 6 = V_{in} joystick control 7 = I_{in} joystick control 8 = Signal from internal motor pot. 9 = Signal from internal motor pot. reset if CX/CXL/CXS is stopped	5-5
1. 6	Jog speed reference (stop icon)	f_{min} —f_{max} (1. 1) (1. 2)	0.1 Hz	5.0 Hz			5-6
1. 7	Current limit	0.1—2.5 x I_{nCX}	0.1 A	1.5 x I_{nCX}		Output current limit [A] of the unit	5-6
1. 8	V/Hz ratio selection (stop icon)	0—2	1	0		0 = Linear 1 = Squared 2 = Programmable V/Hz ratio	5-6
1. 9	V/Hz optimization (stop icon)	0—1	1	0		0 = None 1 = Automatic torque boost	5-8
1. 10	Nominal voltage of the motor (stop icon)	180—690 V	1 V	230 V 380 V 480 V 575 V		CX/CXL/CXS V 3 2 CX/CXL/CXS V 3 4 CX/CXL/CXS V 3 5 CX V 3 6	5-8
1. 11	Nominal frequency of the motor (stop icon)	30—500 Hz	1 Hz	60 Hz		f_n from the nameplate of the motor	5-8
1. 12	Nominal speed of the motor (stop icon)	1—20000 rpm	1 rpm	1720 rpm **		n_n from the nameplate of the motor	5-8
1. 13	Nominal current of the motor (stop icon)	2.5 x I_{nCX}	0.1 A	I_{nCX}		I_n from the nameplate of the motor	5-8
1. 14	Supply voltage (stop icon)	208—240		230 V		CX/CXL/CXS V 3 2	5-8
		380—440		380 V		CX/CXL/CXS V 3 4	
		380—500		480 V		CX/CXL/CXS V 3 5	
		525—690		575 V		CX V 3 6	
1. 15	Parameter conceal	0—1	1	0		Visibility of the parameters: 0 = All parameter groups visible 1 = Only group 1 is visible	5-8
1. 16	Parameter value lock	0—1	1	0		Disables parameter changes: 0 = Changes enabled 1 = Changes disabled	5-8

Note! (stop icon) = Parameter value can be changed only when the drive is stopped.

Table 5.4-1 Group 1 basic parameters.

* If 1. 2 >motor synchr. speed, check suitability for motor and drive system.
Selecting 120/500 Hz range see page 5-5.

** Default value for a four pole motor and a nominal size drive.

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5.4.2 Description of Group 1 parameters

1. 1, 1. 2 Minimum / maximum frequency

Defines frequency limits of the drive.
The default maximum value for parameters 1. 1 and 1. 2 is 120 Hz. By setting 1. 2 = 120 Hz when the drive is stopped (RUN indicator not lit) parameters 1. 1 and 1. 2 are changed to 500 Hz. At the same time the panel reference resolution is changed from 0.01 Hz to 0.1 Hz.
Changing the max. value from 500 Hz to 120 Hz is done by setting parameter 1. 2 = 119 Hz when the drive is stopped.

1. 3, 1. 4 Acceleration time 1, deceleration time 1:

These limits correspond to the time required for the output frequency to accelerate from the set minimum frequency (par. 1. 1) to the set maximum frequency (par. 1. 2).

1. 5 Reference selection

0 Analog voltage reference from terminals 2—3, e.g. a potentiometer
1 Analog current reference trom terminals 4—5, e.g. a transducer.
2 Reference is formed by adding the values of the analog inputs
3 Reference is formed by subtracting the voltage input (V_{in}) value from the current input (I_{in}) value.
4 Reference is formed by subtracting the current input (I_{in}) value from the voltage input (V_{in}) value.
5 Reference is formed by multiplying the values of the analog inputs
6 Joystick control from the voltage input (V_{in}).

Signal range	Max reverse speed	Direction change	Max forward speed
0—10 V	0 V	5 V	+10 V
Custom	Par. 2. 7 x 10V	In the middle of custom range	Par. 2. 8 x 10 V
-10 V—+10 V	-10 V	0 V	+10 V

Warning! Use only -10V—+10 V signal range. If a custom or 0—10 V signal range is used, the drive will run at the max. reverse speed if the reference signal is lost.

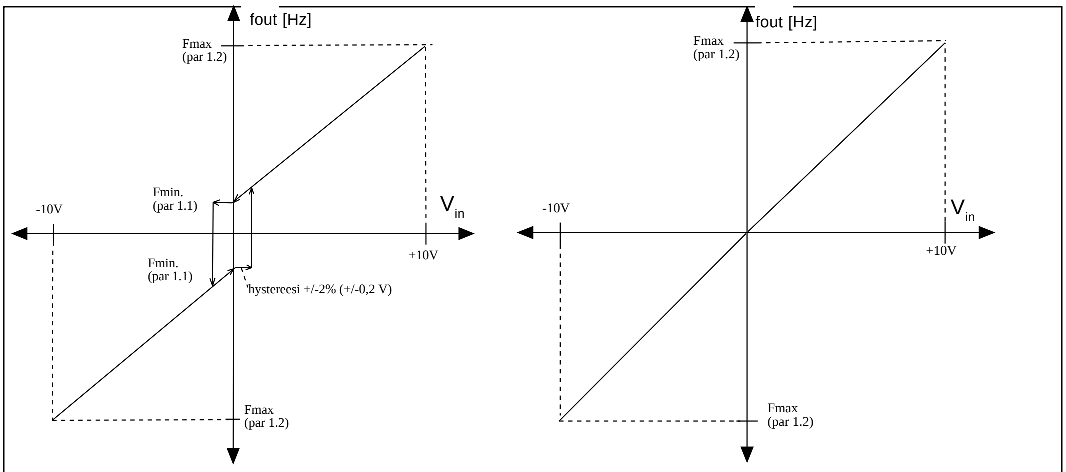
7 Joystick control from the current input (I_{in}).

Signal range	Max reverse speed	Direction change	Max forward speed
0—20 mA	0 mA	10 mA	20 mA
Custom	Par. 2. 13 x 20 mA	In the middle of custom range	Par. 2. 14 x 20 mA
4—20 mA	4 mA	12 mA	20 mA

Warning! Use only 4—20 mA signal range. If a custom or 0—20 mA signal range is used, the drive will run at the max. reverse speed if the control signal is lost. Set the reference fault (par. 7. 2) active when the 4—20 mA range is used, then the drive will stop with a reference fault if the reference signal is lost.

Note! When joystick control is used, the direction control is generated from the joystick reference signal. See figure 5.4-1.

Analog input scaling, parameters 2**.** 16—2**.** 19 are not used when joystick control is used.



If minimum frequency (par 1**.** 1) >0, hysteresis is ± 2% at reversing point.

If minimum frequency (par 1**.** 1) = 0, there is no hysteresis at reversing point.

Fig. 5.4-1 Joystick control Vin signal -10 V—+10 V.

8 Reference value is changed with digital input signals DIA4 and DIA5.
- switch in DIA3 closed = frequency reference increases
- switch in DIA4 closed = frequency reference decreases
Speed of the reference change can be set with the parameter 2**.** 20.

9 Same as setting 8 but the reference value is set to the minimum frequency (par. 1**.** 1) each time the SV9000 is stopped.
When the value of parameter 1**.** 5 is set to 8 or 9, the value of parameters 2**.** 4 and 2**.** 5 are automatically set to 11.

1. 6 Jog speed reference

Parameter value defines the jog speed selected with the digital input

1. 7 Current limit

This parameter determines the maximum motor current that the CX/CXL/CXS will provide short term.

1. 8 V/Hz ratio selection

Linear: **0** The voltage of the motor changes linearly with the frequency in the constant flux area from 0 Hz to the field weakening point (par. 6**.** 3) where a constant voltage (nominal value) is also supplied to the motor. See figure 5.4.-2. A linear V/Hz ratio should be used in constant torque applications.

This default setting should be used if there is no special requirement for another setting.

Squared:
1

The voltage of the motor changes following a squared curve form with the frequency in the area from 0 Hz to the field weakening point (par. 6. 3) where the nominal voltage is also supplied to the motor. See figure 5.4.-2.

The motor runs undermagnetized below the field weakening point and produces less torque and electromechanical noise. A squared V/Hz ratio can be used in applications where the torque demand of the load is proportional to the square of the speed, e.g. in centrifugal fans and pumps.

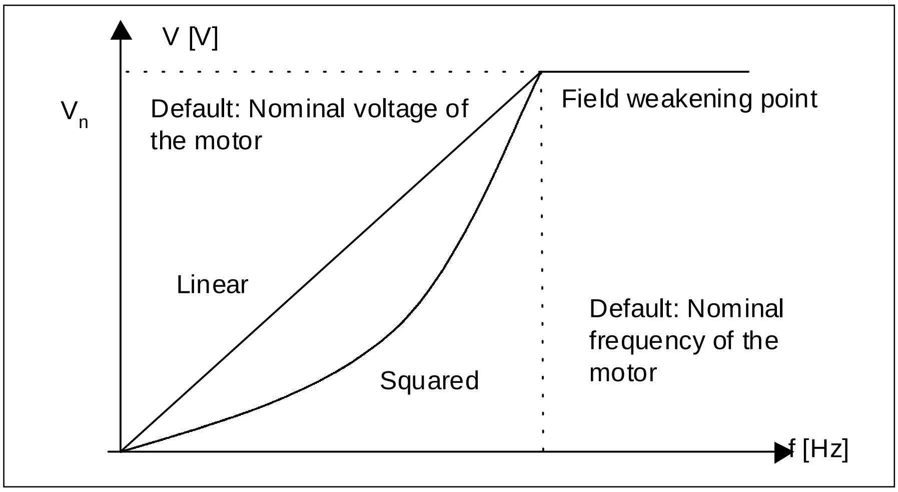


Figure 5.4.-2 Linear and squared V/Hz curves.

Programm. V/Hz curve
2

The V/Hz curve can be programmed with three different points. The parameters for programming are explained in chapter 1.5.2. A programmable V/Hz curve can be used if the standard settings do not satisfy the needs of the application. See figure 5.4.-3.

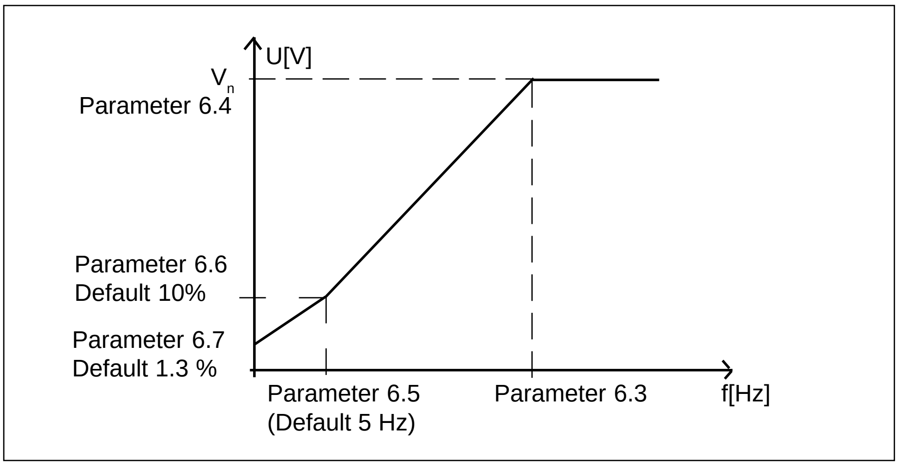


Figure 5.4-3 Programmable V/Hz curve.

5

1. 9 V/Hz optimization

Automatic torque boost

The voltage to the motor changes automatically which makes the motor produce sufficient torque to start and run at low frequencies. The voltage increase depends on the motor type and horsepower.

Automatic torque boost can be used in applications where starting torque due to starting friction is high, e.g. in conveyors.

NOTE!

In high torque - low speed applications - it is likely the motor will overheat.
If the motor has to run prolonged time under these conditions, special attention must be paid to cooling the motor. Use external cooling for the motor if the temperature rise is too high.

1. 10 Nominal voltage of the motor

Find this value V_n from the nameplate of the motor.
This parameter sets the voltage at the field weakening point, parameter 6**.** 4, to 100% x V_{nmotor}.

1. 11 Nominal frequency of the motor

Find the nominal frequency f_n from the nameplate of the motor.
This parameter sets the frequency of the field weakening point, parameter 6. 3, to the same value.

1. 12 Nominal speed of the motor

Find this value n_n from the nameplate of the motor.

1. 13 Nominal current of the motor

Find the value I_n from the nameplate of the motor.
The internal motor protection function uses this value as a reference value.

1. 14 Supply voltage

Set parameter value according to the nominal voltage of the supply.
Values are pre-defined for CX/CXL/CXS V 3 2, CX/CXL/CXS V 3 4, CX/CXL/CXS V 3 5 and CX V 3 6. See table 5.4-1.

1. 15 Parameter conceal

Defines which parameter groups are available:

0 = all parameter groups are visible
1 = only group 1 is visible

1. 16 Parameter value lock

Defines access to the changes of the parameter values:

0 = parameter value changes enabled
1 = parameter value changes disabled

To adjust more of the functions of the Multi-purpose application, see chapter 5.5 to modify the parameters of Groups 2—8.

5.5 Special parameters, Groups 2—8
5.5.1 Parameter tables

Group 2, Input signal parameters

Code	Parameter	Range	Step	Default	Custom	Description	Page
2. 1	Start/Stop logic selection	0—3	1	0		DIA1 / DIA2 0 = Start forward / Start reverse 1= Start/Stop / Reverse 2 = Start/Stop / Run enable 3 = Start pulse / Stop pulse	5-16
2. 2	DIA3 function (terminal 10)	0—9	1	7		0 = Not used 1 = Ext. fault, closing contact 2 = External fault, opening contact 3 = Run enable 4 = Acc./dec. time selection 5 = Reverse 6 = Jog speed 7 = Fault reset 8 = Acc./dec. operation prohibit 9 = DC-braking command	5-17
2. 3	DIB4 function (terminal 14)	0—10	1	6		0 = Not used 1 = Ext. fault, closing contact 2 = External fault, opening contact 3 = Run enable 4 = Acc./dec. time selection 5 = Reverse 6 = Jog speed 7 = Fault reset 8 = Acc./dec. operation prohibit 9 = DC-braking command 10 = Multi-Step speed select 1	5-18
2. 4	DIB5 function (terminal 15)	0—11	1	1		0 = Not used 1 = Ext. fault, closing contact 2 = External fault, opening contact 3 = Run enable 4 = Acc./dec. time selection 5 = Reverse 6 = Jog speed 7 = Fault reset 8 = Acc./dec. operation prohibit 9 = DC-braking command 10 = Multi-Step speed select 2 11 = Motorized pot. speed up	5-18
2. 5	DIB6 function (terminal 16)	0—11	1	4		0 = Not used 1 = Ext. fault, closing contact 2 = External fault, opening contact 3 = Run enable 4 = Acc./dec. time selection 5 = Reverse 6 = Jog speed 7 = Fault reset 8 = Acc./dec. operation prohibit 9 = DC-braking command 10 = Multi-Step speed select 3 11 = Motorized pot. speed down	5-18
2. 6	V_{in} signal range	0—2	1	0		0 = 0—10 V 1 = Custom setting range 2 = -10—+10 V (can be used only with Joystick control)	5-19

Note! = Parameter value can be changed only when the drive is stopped.

Code	Parameter	Range	Step	Default	Custom	Description	Page
2. 7	V_{in} custom setting min.	0.00-100.00%	0.01%	0.00%			5-19
2. 8	V_{in} custom setting max.	0.00-100.00%	0.01%	100.00%			5-19
2. 9	V_{in} signal inversion	0—1	1	0		0 = Not inverted 1 = Inverted	5-19
2. 10	V_{in} signal filter time	0.00—10.00 s	0.01 s	0.10 s		0 = No filtering	5-19
2. 11	I_{in} signal range	0—2	1	0		0 = 0—20 mA 1 = 4—20 mA 2 = Custom setting range	5-19
2. 12	I_{in} custom setting minim.	0.00-100.00%	0.01%	0.00%			5-20
2. 13	I_{in} custom setting maxim.	0.00-100.00%	0.01%	100.00%			5-20
2. 14	I_{in} signal inversion	0—1	1	0		0 = Not inverted 1 = Inverted	5-20
2. 15	I_{in} signal filter time	0.01 —10.00 s	0.01 s	0.10 s		0 = No filtering	5-20
2. 16	V_{in} minimum scaling	-320.00%— +320.00 %	0.01	0.00%		0% = no minimum scaling	5-20
2. 17	V_{in} maximum scaling	-320.00%— +320.00 %	0.01	100.00%		100% = no maximum scaling	5-20
2. 18	I_{in} minimum scaling	-320.00%— +320.00%	0.01	0.00% .		0% = no minimum scaling	5-20
2. 19	I_{in} maximum scaling	-320.00%— +320.00 %	0.01	100.00%		100% = no maximum scaling	5-20
2. 20	Free analog input, signal selection	0—2	1	0		0 = Not use 1 = V_{in} (analog voltage input) 2 = I_{in} (analog current input)	5-21
2. 21	Free analog input, function	0—4	1	0		0 = No function 1 = Reduces current limit (par. 1.7) 2 = Reduces DC-braking current 3 = Reduces acc. and decel. times 4 = Reduces torque supervis. limit	5-21
2. 22	Motorized digital potentiometer ramp time	0.1—2000.0 Hz/s	0.1 Hz/s	10.0 Hz/s			5-22

Group 3, Output and supervision parameters

Code	Parameter	Range	Step	Default	Custom	Description	Page
3. 1	Analog output function	0—7	1	1		0 = Not used Scale 100% 1 = O/P frequency (0—f_{max}) 2 = Motor speed (0—max. speed) 3 = O/P current (0—2.0 x I_{nCX}) 4 = Motor torque (0—2 x T_{nMot}) 5 = Motor power (0—2 x P_{nMot}) 6 = Motor voltage (0—100% x V_{nMot}) 7 = DC-link volt. (0—1000 V)	5-23
3. 2	Analog output filter time	0.00-10.00s	0.01 s	1.00 s			5-23
3. 3	Analog output inversion	0—1	1	0		0 = Not inverted 1 = Inverted	5-23
3. 4	Analog output minimum	0—1	1	0		0 = 0 mA 1 = 4 mA	5-23
3. 5	Analog output scale	10—1000%	1%	100%			5-23

Note! = Parameter value can be changed only when the drive is stopped.

Code	Parameter	Range	Step	Default	Custom	Description	Page
3. 6	Digital output function	0—21	1	1		0 = Not used 1 = Ready 2 = Run 3 = Fault 4 = Fault inverted 5 = CX overheat warning 6 = External fault or warning 7 = Reference fault or warning 8 = Warning 9 = Reversed 10 = Jog speed selected 11 = At speed 12 = Motor regulator activated 13 = Output freq. limit superv. 1 14 = Output freq. limit superv. 2 15 = Torque limit supervision 16 = Reference limit supervision 17 = External brake control 18 = Control from I/O terminals 19 = Drive temperature limit supervision 20 = Unrequested rotation direction 21 = External brake control inverted	5-24
3. 7	Relay output 1 function	0—21	1	2		As parameter 3. 6	5-24
3. 8	Relay output 2 function	0—21	1	3		As parameter 3. 6	5-24
3. 9	Output freq. limit 1 supervision function	0—2	1	0		0 = No 1 = Low limit 2 = High limit	5-24
3. 10	Output freq. limit 1 supervision value	0.0—f_{max} (par. 1. 2)	0.1 Hz	0.0 Hz			5-24
3. 11	Output freq. limit 2 supervision function	0—2	1	0		0 = No 1 = Low limit 2 = High limit	5-24
3. 12	Output freq. limit 2 supervision value	0.0—f_{max} (par. 1. 2)	0.1 Hz	0.0 Hz			5-24
3. 13	Torque limit supervision function	0—2	1	0		0 = No 1 = Low limit 2 = High limit	5-25
3. 14	Torque limit supervision value	-200.0—200.0% xT_{nCX}	0.1%	100.0%			5-25
3. 15	Reference limit supervision function	0—2	1	0		0 = No 1 = Low limit 2 = High limit	5-25
3. 16	Reference limit supervision value	0.0—f_{max} (par. 1. 2)	0.1 Hz	0.0 Hz			5-25
3. 17	Extern. brake Off-delay	0.0—100.0 s	0.1 s	0.5 s			5-25
3. 18	Extern. brake On-delay	0.0—100.0 s	0.1 s	1.5 s			5-25
3. 19	Drive temperature limit supervision function	0—2	1	0		0 = No 1 = Low limit 2 = High limit	5-25
3. 20	Drive temperature limit value	-10—+75°C	1°C	+40°C			5-25

Note! = Parameter value can be changed only when the drive is stopped.

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Code	Parameter	Range	Step	Default	Custom	Description	Page
3. 21	I/O-expander board (opt.) analog output content	0—7	1	3		See parameter 3. 1	5-23
3. 22	I/O-expander board (opt.) analog output filter time	0.00—10.00 s	0.01	1.00 s		See parameter 3. 2	5-23
3. 23	I/O-expander board (opt.) analog output inversion	0—1	1	0		See parameter 3. 3	5-23
3. 24	I/O-expander board (opt.) analog output minimum	0—1	1	0		See parameter 3. 4	5-23
3. 25	I/O-expander board (opt.) analog output scale	10—1000%	1	100%		See parameter 3. 5	5-23

Group 4, Drive control parameters

Code	Parameter	Range	Step	Default	Custom	Description	Page
4. 1	Acc./Dec. ramp 1 shape	0.0—10.0 s	0.1 s	0.0 s		0 = Linear >0 = S-curve acc./dec. time	5-26
4. 2	Acc./Dec. ramp 2 shape	0.0—10.0 s	0.1 s	0.0 s		0 = Linear >0 = S-curve acc./dec. time	5-26
4. 3	Acceleration time 2	0.1—3000.0 s	0.1 s	10.0 s			5-27
4. 4	Deceleration time 2	0.1—3000.0 s	0.1 s	10.0 s			5-27
4. 5	Brake chopper	0—2	1	0		0 = Brake chopper not in use 1 = Brake chopper in use 2 = External brake chopper	5-27
4. 6	Start function	0—1	1	0		0 = Ramp 1 = Flying start	5-27
4. 7	Stop function	0—1	1	0		0 = Coasting 1 = Ramp	5-27
4. 8	DC-braking current	0.15—1.5 x I_{nCX} (A)	0.1 A	0.5 x I_{nCX}			5-27
4. 9	DC-braking time at Stop	0.00-250.00s	0.01 s	0.00 s		0 = DC-brake is off at Stop	5-28
4. 10	Execute frequency of DC-brake during ramp Stop	0.1—10.0 Hz	0.1 Hz	1.5 Hz			5-29
4. 11	DC-brake time at Start	0.00-25.00 s	0.01 s	0.00 s		0 = DC-brake is off at Start	5-29
4. 12	Multi-step speed reference 1	f_{min}—f_{max} (1. 1) (1. 2)	0.1 Hz	10.0 Hz			5-29
4. 13	Multi-step speed reference 2	f_{min}—f_{max} (1. 1) (1. 2)	0.1 Hz	15.0 Hz			5-29
4. 14	Multi-step speed reference 3	f_{min}—f_{max} (1. 1) (1. 2)	0.1 Hz	20.0 Hz			5-29
4. 15	Multi-step speed reference 4	f_{min}—f_{max} (1. 1) (1. 2)	0.1 Hz	25.0 Hz			5-29
4. 16	Multi-step speed reference 5	f_{min}—f_{max} (1. 1) (1. 2)	0.1 Hz	30.0 Hz			5-29
4. 17	Multi-step speed reference 6	f_{min}—f_{max} (1. 1) (1. 2)	0.1 Hz	40.0 Hz			5-29
4. 18	Multi-step speed reference 7	f_{min}—f_{max} (1. 1) (1. 2)	0.1 Hz	50.0 Hz			5-29

Note! = Parameter value can be changed only when the drive is stopped.

Group 5, Prohibit frequency parameters

Code	Parameter	Range	Step	Default	Custom	Description	Page
5. 1	Prohibit frequency range 1 low limit	f_{min}—par. 5. 2	0.1 Hz	0.0 Hz			5-29
5. 2	Prohibit frequency range 1 high limit	f_{min}—f_{max} (1. 1) (1. 2)	0.1 Hz	0.0 Hz		0 = Prohibit range 1 is off	5-29
5. 3	Prohibit frequency range 2 low limit	f_{min}—par. 5. 4	0.1 Hz	0.0 Hz			5-29
5. 4	Prohibit frequency range 2 high limit	f_{min}—f_{max} (1. 1) (1. 2)	0.1 Hz	0.0 Hz		0 = Prohibit range 2 is off	5-29
5. 5	Prohibit frequency range 3 low limit	f_{min}—par. 5. 6	0.1 Hz	0.0 Hz			5-29
5. 6	Prohibit frequency range 3 high limit	f_{min}—f_{max} (1. 1) (1. 2)	0.1 Hz	0.0 Hz		0 = Prohibit range 3 is off	5-29

Group 6, Motor control parameters

Code	Parameter	Range	Step	Default	Custom	Description	Page
6. 1	Motor control mode	0—1	1	0		0 = Frequency control 1 = Speed control	5-29
6. 2	Switching frequency	1.0—16.0 kHz	0.1 kHz	10/3.6kHz		Depends on Hp rating	5-30
6. 3	Field weakening point	30—500 Hz	1 Hz	Param. 1. 11			5-30
6. 4	Voltage at field weakening point	15—200% x V_{nmot}	1%	100%			5-30
6. 5	V/Hz curve mid point frequency	0.0—f_{max}	0.1 Hz	0.0 Hz			5-30
6. 6	V/Hz curve mid point voltage	0.00—100.00% x V_{nmot}	0.01%	0.00 %			5-30
6. 7	Output voltage at zero frequency	0.00—100.00% x V_{nmot}	0.01%	0.00 %			5-30
6. 8	Overvoltage controller	0—1	1	1		0 = Controller is not operating 1 = Controller is operating	5-31
6. 9	Undervoltage controller	0—1	1	1		0 = Controller is not operating 1 = Controller is operating	5-31

Note! = Parameter value can be changed only when the drive is stopped.

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Group 7, Protections

Code	Parameter	Range	Step	Default	Custom	Description	Page
7. 1	Response to reference fault	0—2	1	0		0 = No action 1 = Warning 2 = Fault, stop according to par 4.7 3 = Fault, always coasting stop	5-31
7. 2	Response to external fault	0—2	1	2		0 = No action 1 = Warning 2 = Fault, stop according to par 4.7 3 = Fault, always coasting stop	5-31
7. 3	Phase supervision of the motor	0—2	2	2		0 = No action 2 = Fault	5-31
7. 4	Ground fault protection	0—2	2	2		0 = No action 2 = Fault	5-31
7. 5	Motor thermal protection	0—2	1	2		0 = No action 1 = Warning 2 = Fault	5-32
7. 6	Motor thermal protection break point current	50.0—150.0 % x I_{nMOTOR}	1.0 %	100.0%			5-32
7. 7	Motor thermal protection zero frequency current	5.0—150.0% x I_{nMOTOR}	1.0 %	45.0%			5-33
7. 8	Motor thermal protection time constant	0.5—300.0 minutes	0.5 min.	17.0 min.		Default value is set according to motor nominal current	5-33
7. 9	Motor thermal protection break point frequency	10—500 Hz	1 Hz	35 Hz			5-34
7. 10	Stall protection	0—2	1	1		0 = No action 1 = Warning 2 = Fault	5-34
7. 11	Stall current limit	5.0—200.0% x I_{nMOTOR}	1.0%	130.0%			5-35
7. 12	Stall time	2.0—120.0 s	1.0 s	15.0 s			5-35
7. 13	Maximum stall frequency	1—f_{max}	1 Hz	25 Hz			5-35
7. 14	Underload protection	0—2	1	0		0 = No action 1 = Warning 2 = Fault	5-36
7. 15	Underload prot., field weakening area load	10.0—150.0 % x T_{nMOTOR}	1.0%	50.0%			5-36
7. 16	Underload protection, zero frequency load	5.0—150.0% x T_{nMOTOR}	1.0%	10.0%			5-36
7. 17	Underload time	2.0—600.0 s	1.0 s	20.0s			5-36

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Group 8, Autorestart parameters

Code	Parameter	Range	Step	Default	Custom	Description	Page
8. 1	Automatic restart: number of tries	0—10	1	0		0 = not in use	5-37
8. 2	Automatic restart:multi attempt maximum trial time	1—6000 s	1 s	30 s			5-37
8. 3	Automatic restart: start function	0—1	1	0		0 = Ramp 1 = Flying start	5-38
8. 4	Automatic restart of undervoltage	0—1	1	0		0 = No 1 = Yes	5-38
8. 5	Automatic restart of overvoltage	0—1	1	0		0 = No 1 = Yes	5-38
8. 6	Automatic restart of overcurrent	0—1	1	0		0 = No 1 = Yes	5-38
8. 7	Automatic restart of reference fault	0—1	1	0		0 = No 1 = Yes	5-38
8. 8	Automatic restart after over/undertemperature fault	0—1	1	0		0 = No 1 = Yes	5-38

Table 5.5-1 Special parameters, Groups 2—8.

5.5.2 Description of Groups 2—8 parameters

2. 1 Start/Stop logic selection

0: DIA1: closed contact = start forward
DIA2: closed contact = start reverse,
See figure 5.5-1.

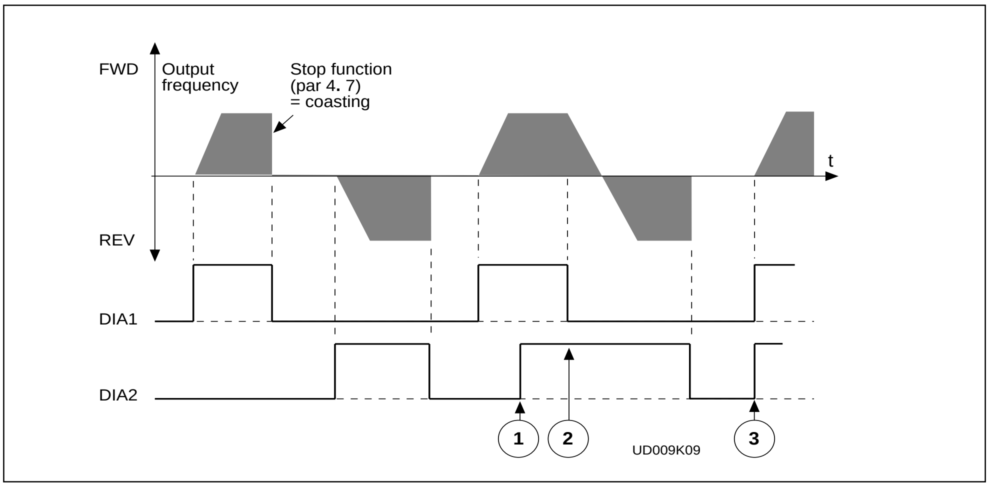

Figure 5.5-1 Start forward/Start reverse.

1. The first selected direction has the highest priority
2. When DIA1 contact opens, the direction of rotation starts to change
3. If Start forward (DIA1) and Start reverse (DIA2) signals are active simultaneously, the Start forward signal (DIA1) has priority.

1: DIA1: closed contact = start open contact = stop
DIA2: closed contact = reverse open contact = forward
See figure 5.5-2.

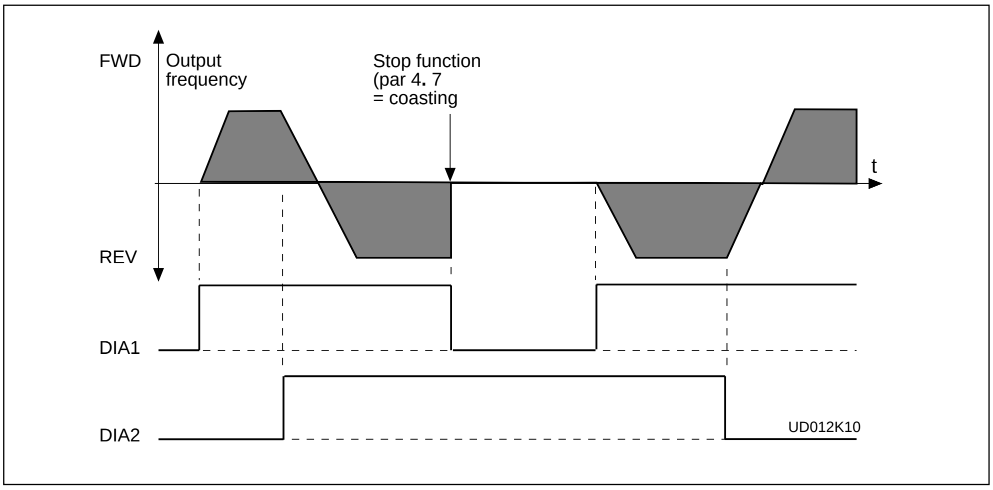

Figure 5.5-2 Start, Stop,reverse.

2: DIA1: closed contact = start open contact = stop
DIA2: closed contact = start enabled open contact = start disabled

3: 3-wire connection (pulse control):

DIA1: closed contact = start pulse
DIA2: closed contact = stop pulse
(DIA3 can be programmed for reverse command)
See figure 5.5-3.

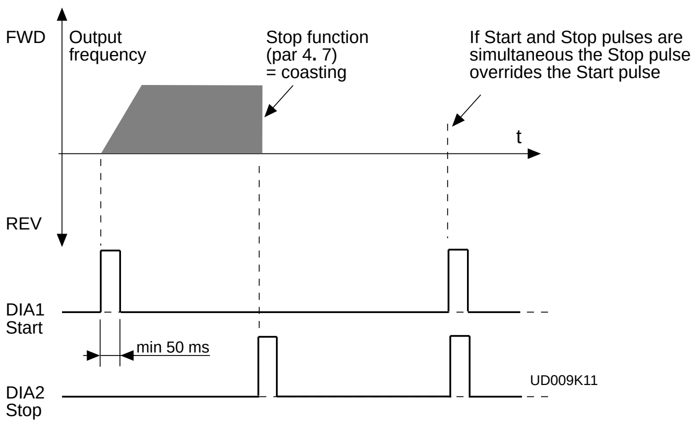

Figure 5.5-3 Start pulse /Stop pulse.

2. 2 **DIA3 function**

1:	External fault,	closing contact	= Fault is shown and motor is stopped when the input is active
2:	External fault,	opening contact	= Fault is shown and motor is stopped when the input is not active
3:	Run enable	contact open contact closed	= Start of the motor disabled = Start of the motor enabled
4:	Acc. / Dec time select.	contact open contact closed	= Acceleration/Deceleration time 1 selected = Acceleration/Deceleration time 2 selected
5:	Reverse	contact open contact closed	= Forward = Reverse — Can be used for reversing if parameter 2**.** 1 has value 3
6:	Jog speed.	contact closed	= Jog speed selected for freq. reference
7:	Fault reset	contact closed	= Resets all faults
8:	Acc./Dec. operation prohibited	contact closed	= Stops acceleration or deceleration until the contact is opened
9:	DC-braking command	contact closed	= In Stop mode, the DC-braking operates until the contact is opened, see figure 5.5-4. DC-brake current is set with parameter 4**.** 8.

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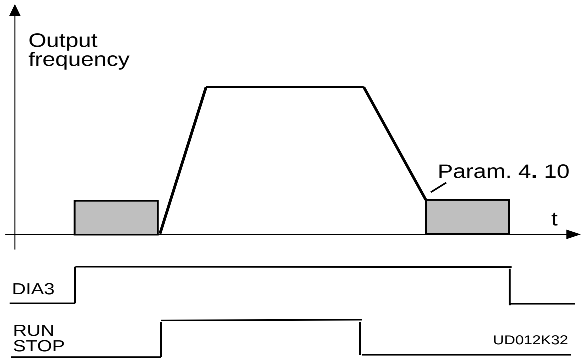
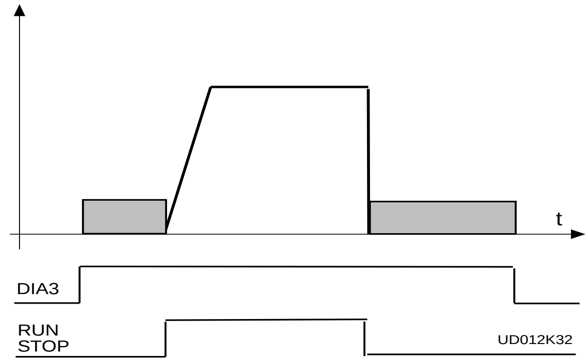


a) DIA3 as DC-brake command input and stop-mode = Ramp



b) DIA3 as DC-brake command input and stop-mode = Coasting

Figure 5.5-4 DIA3 as DC-brake command input: a) Stop-mode = Ramp, b) Stop-mode = Coasting.

2. 3 DIB4 function

Selections are same as in 2. 2 except :

10: Multi-Step speed select 1 — contact closed = Selection 1 active

2. 4 DIB5 function

Selections are same as in 2. 2 except :

10: Multi-Step speed select 2 — contact closed = Selection 2 active

11: Motor pot. UP — contact closed= Reference decreases until the contact is opened

2. 5 DIB6 function

Selections are same as in 2. 2 except :

10: Multi-Step speed select 3 — contact closed= Selection 3 active

11: Motor pot. DOWN — contact closed= Reference decreases until the contact is opened

2. 6 V_{in} signal range

0 = Signal range 0—+10 V
1 = Custom setting range from custom minimum (par. 2. 4) to custom maximum (par. 2. 5)
2 = Signal range -10—+10 V , can be used only with Joystick control

2. 7 V_{in} custom setting minimum/maximum

2. 8 With these parameters, V_{in} can be set for any input signal span within 0—10 V.

Minimum setting: Set the V_{in} signal to its minimum level, select parameter 2. 7, press the Enter button
Maximum setting: Set the V_{in} signal to its maximum level, select parameter 2. 8, press the Enter button

Note! These parameters can only be set with this procedure (not with arrow up/arrow down buttons)

2. 9 V_{in} signal inversion

Parameter 2. 9 = 0, no inversion of analog V_{in} signal.

Parameter 2. 9 = 1, inversion of analog V_{in} signal.

2. 10 V_{in} signal filter time

Filters out disturbances from the incoming analog V_{in} signal.
A long filtering time makes regulation response slower.
See figure 5.5-5.

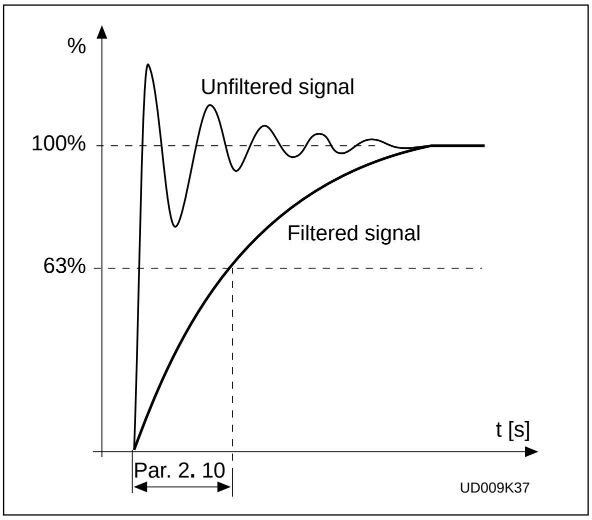


Figure 5.5-5 V_{in} signal filtering.

2. 11 Analog input I_{in} signal range

0 = 0—20 mA
1 = 4—20 mA
2 = Custom signal span

5

2. 12 2. 13 Analog input I_{in} custom setting minimum/maximum

With these parameters, the scaling of the input current signal (I_{in}) range can be set between 0—20 mA.

Minimum setting:
Set the I_{in} signal to its minimum level, select parameter 2. 12, press the Enter button
Maximum setting:
Set the I_{in} signal to its maximum level, select parameter 2. 13, press the Enter button

Note!These parameters can only be set with this procedure (not with arrow up/arrow down buttons)

2. 14 Analog input I_{in} inversion

Parameter 2. 14 = 0, no inversion of I_{in} input
Parameter 2. 14 = 1, inversion of I_{in} input.

2. 15 Analog input I_{in} filter time

Filters out disturbances from the incoming analog I_{in} signal.
A long filtering time makes regulation response slower.
See figure 5.5-6.

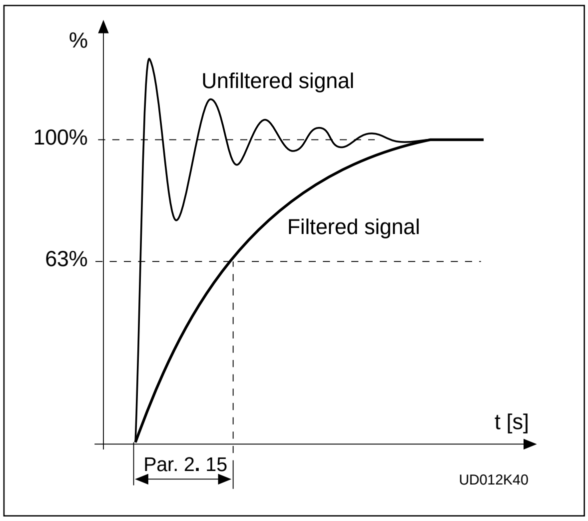


Figure 5.5-6 Analog input I_{in} filter time.

2. 16 V_{in} signal minimum scaling
Sets the minimum scaling point for V_{in} signal. See figure 5.5-7.

2. 17 V_{in} signal maximum scaling

Sets the maximum scaling point for V_{in} signal. See figure 5.5-7.

2. 18 I_{in} signal minimum scaling

Sets the minimum scaling point for I_{in} signal. See figure 5.5-7.

2. 19 I_{in} signal maximum scaling

Sets the maximum scaling point for I_{in} signal. See figure 5.5-7.

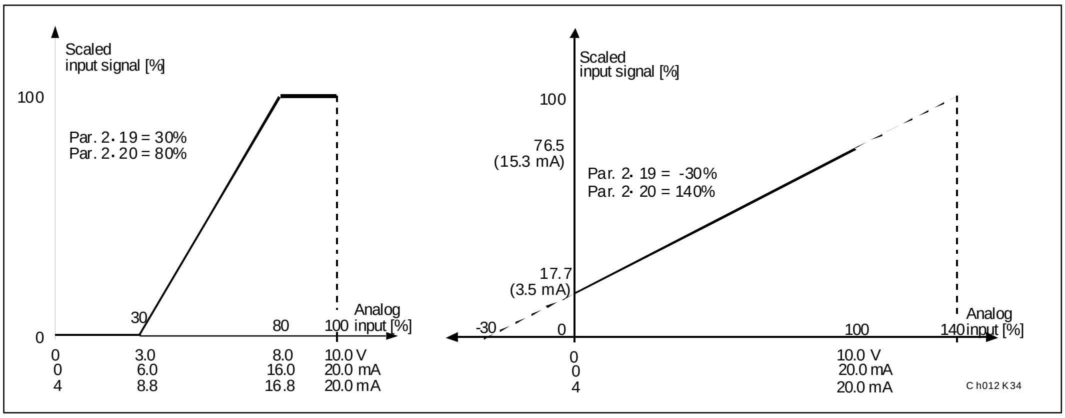


Figure 5.5-7 Examples of the scaling of V_{in} and I_{in} inputs .

2. 20 Free analog input signal

Selection of input signal of free analog input (an input not used for reference signal):

0 = Not in use
1 = Voltage signal V_{in}
2 = Current signal I_{in}

2. 21 Free analog input signal function

This parameter sets the function of the free analog input:

0 = Function is not used

1 = Reducing motor current limit (par. 1**.** 7)
This signal will adjust the maximum motor current between 0 and parameter 1**.** 7 set max. limit.
See figure 5.5-8.

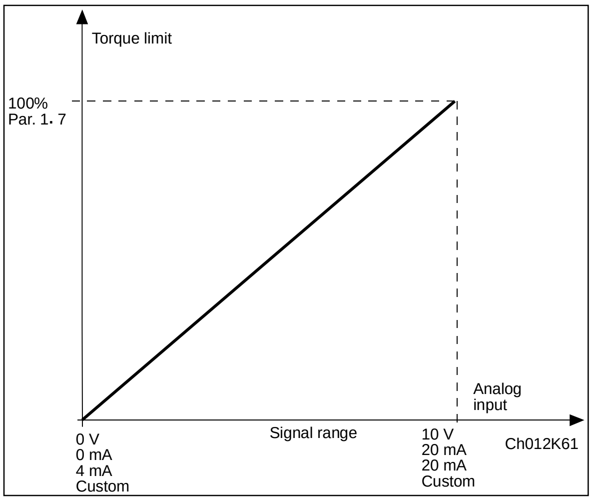


Figure 5.5-8 Reducing of max. motor current.

2 = Reducing DC brake current.

The DC braking current can be reduced, with the free analog input signal, between $0.15xI_{nCX}$ and current set by parameter 4**.** 8.
See figure 5.5-9.

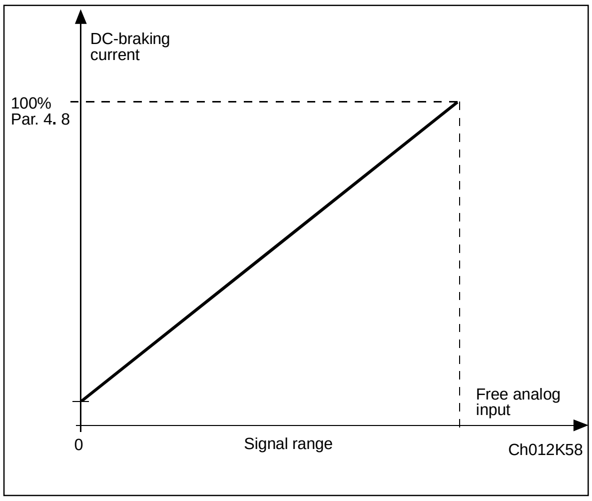


Figure 5.5-9 Reducing DC brake current.

3 Reducing acceleration and deceleration times.

The acceleration and deceleration times can be reduced with the free analog input signal, according to the following formula:

Reduced time = set acc./ decel time (par. 1**.** 3, 1**.** 4; 4**.** 3, 4**.** 4) divided by the factor R from figure 5.5-10.

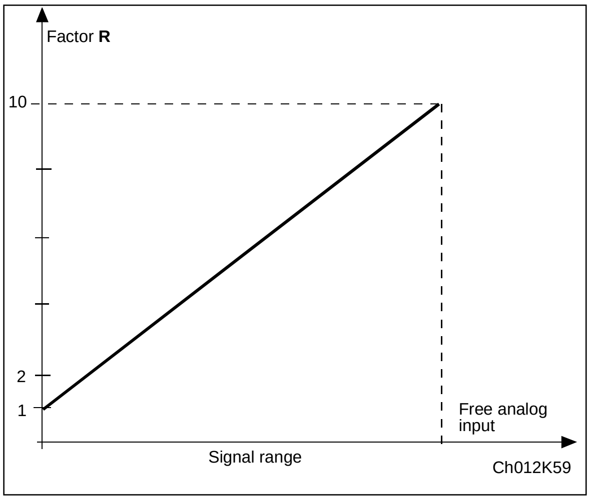


Figure 5.5-10 Reducing acceleration and deceleration times.

4 Reducing torque supervision limit.

The set torque supervision limit can be reduced with the free analog input signal between 0 and set supervision limit (par. 3**.** 14), see figure 5.5-11.

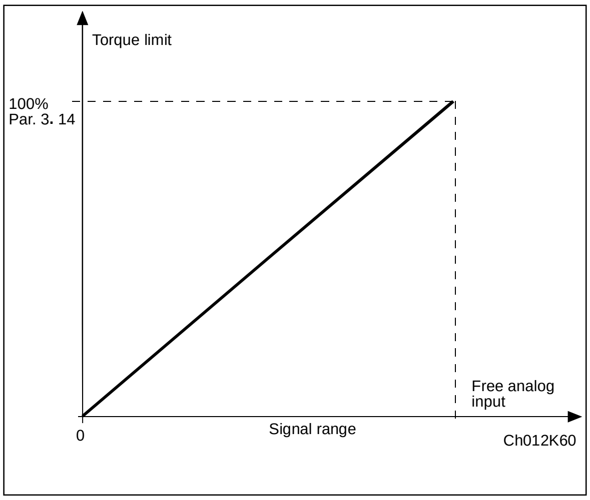


Figure 5.5-11 Reducing torque supervision limit.

2. 22 Motor potentiometer ramp time

Defines how fast the electronic motor (digital) potentiometer value changes.

5

3. 1 **Analog output function**

See table on page 5-10.

3. 2 **Analog output filter time**

Filters the analog output signal. See figure 5.5-12.

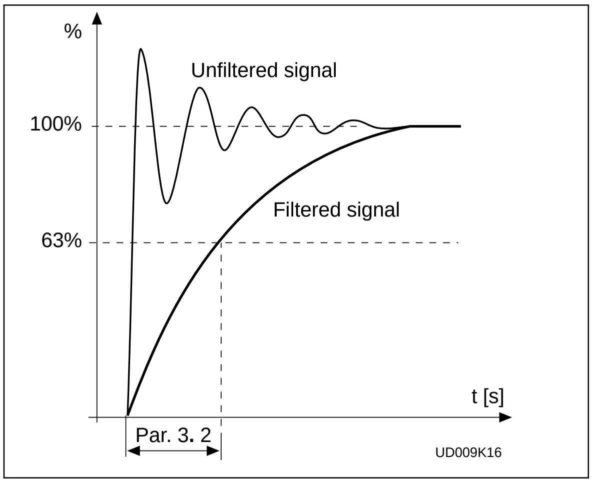


Figure 5.5-12 Analog output filtering.

3.3 **Analog output invert**

Inverts analog output signal:
max output signal = minimum set value
min output signal = maximum set value

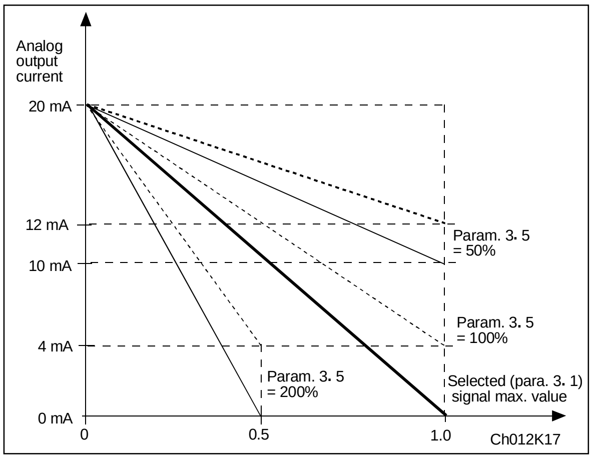


Figure 5.5-13 Analog output invert.

3. 4 **Analog output minimum**

Defines the signal minimum to be either 0 mA or 4 mA. See figure 5.5-14.

3. 5 **Analog output scale**

Scaling factor for analog output. See figure 5.5-14.

Signal	Max. value of the signal
Output frequency	Max. frequency (p. 1. 2)
Motor speed	Max. speed ($n_n x f_{max}/f_n$)
Output current	2 x I_{nCX}
Motor torque	2 x T_{nMot}
Motor power	2 x P_{nMot}
Motor voltage	100% x V_{nMot}
DC-link volt.	1000 V

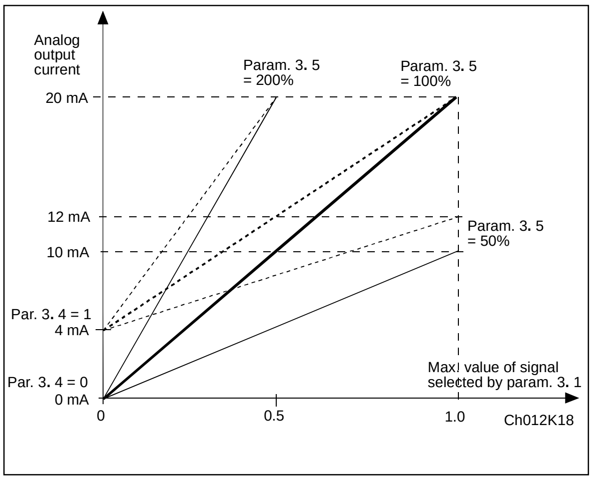


Figure 5.5-14 Analog output scale.

3. 6 Digital output function
3. 7 Relay output 1 function
3. 8 Relay output 2 function

Setting value	Signal content
0 = Not used	Out of operation
	Digital output DO1 sinks current and programmable relay (RO1, RO2) is activated when:
1 = Ready	The drive is ready to operate
2 = Run	The drive operates (motor is running)
3 = Fault	A fault trip has occurred
4 = Fault inverted	A fault trip has not occurred
5 = CX overheat warning	The heat-sink temperature exceeds +70°C
6 = External fault or warning	Fault or warning depending on parameter 7. 2
7 = Reference fault or warning	Fault or warning depending on parameter 7. 1 - if analog reference is 4—20 mA and signal is <4mA
8 = Warning	If a warning exists. See Table 7.10-1 in the Users' Manual
9 = Reversed	The reverse command has been selected
10 = Jog speed	Jog speed has been selected with digital input
11 = At speed	The output frequency has reached the set reference
12 = Motor regulator activated	Overvoltage or overcurrent regulator was activated
13 = Output frequency supervision 1	The output frequency goes outside of the set supervision Low limit/ High limit (par. 3. 9 and 3. 10)
14= Output frequency supervision 2	The output frequency goes outside of the set supervision Low limit/ High limit (par. 3. 11 and 3. 12)
15= Torque limit supervision	The motor torque goes outside of the set supervision Low limit/ High limit (par. 3. 13 and 3. 14)
16= Reference limit supervision	Reference goes outside of the set supervision Low limit/ High limit (par. 3. 15 and 3. 16)
17 = External brake control	External brake ON/OFF control with programmable delay (par 3. 17 and 3. 18)
18 = Control from I/O terminals	External control mode selected with prog. pushbutton #2
19 = Drive	Temperature on drive goes outside the set temperature supervision limits (par. 3. 19 and 3. 20)
20 = Unrequested rotation direction	Rotation direction of the motor shaft is different from the requested one
21 = External brake control inverted	External brake ON/OFF control (par. 3.17 and 3.18), output active when brake control is OFF

Table 5.5-2 Output signals via DO1 and output relays RO1 and RO2.

5

3. 9 Output frequency limit 1, supervision function
3. 11 Output frequency limit 2, supervision function

0 = No supervision
1 = Low limit supervision
2 = High limit supervision

If the output frequency goes under/over the set limit (3. 10, 3. 12) this function generates a warning message via the digital output DO1 or via a relay output RO1 or RO2 depending on the settings of the parameters 3. 6—3. 8.

3. 10 Output frequency limit 1, supervision value
3. 12 Output frequency limit 2, supervision value

The frequency value to be supervised by the parameter 3. 9 (3. 11).

See figure 5.5-15.

3. 13 Torque limit , supervision function

0 = No supervision
1 = Low limit supervision
2 = High limit supervision

If the calculated torque value goes under/over the set limit (3. 14) this function generates a warning message via the digital output DO1, via a relay output RO1 or RO2 depending on the settings of parameters 3. 6—3. 8.

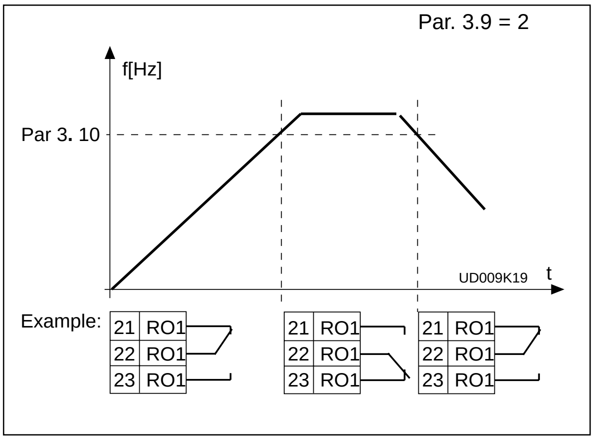


Figure 5.5-15 Output frequency supervision.

3. 14 Torque limit , supervision value

The calculated torque value to be supervised by the parameter 3. 13.

3. 15 Reference limit , supervision function

0 = No supervision
1 = Low limit supervision
2 = High limit supervision

If the reference value goes under/over the set limit (3. 16) this function generates a warning message via the digital output DO1 or via a relay output RO1 or RO2 depending on the settings of the parameters 3. 6—3. 8. The supervised reference is the current active reference. It can be source A or B reference depending on DIB6 input or the panel reference if panel is the active control source.

3. 16 Reference limit , supervision value

The frequency value to be supervised by the parameter 3. 15.

3. 17 External brake-off delay
3. 18 External brake-on delay

The function of the external brake can be delayed from the start and stop control signals with these parameters. See figure 5.5-16.

The brake control signal can be programmed via the digital output DO1 or via one of relay outputs RO1 and RO2, see parameters 3. 6—3. 8.

3. 19 Drive temperature limit supervision function

0 = No supervision
1 = Low limit supervision
2 = High limit supervision

If the temperature of the drive goes under/over the set limit (3. 20) this function generates a warning message via the digital output DO1 or via a relay output RO1 or RO2 depending on the settings of the parameters 3. 6—3. 8.

3. 20 Drive temperature limit value

The temperature value to be supervised by the parameter 3. 19.

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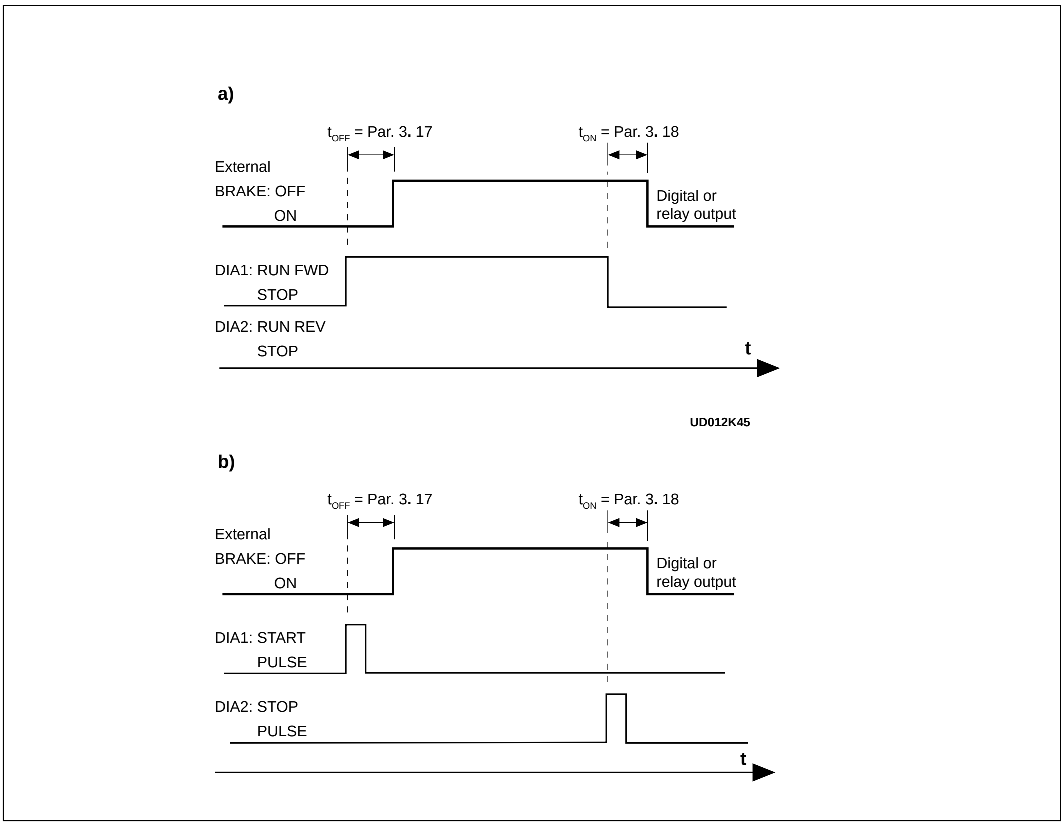


Figure 5.5-16 External brake control: a) Start/Stop logic selection par. 2. 1 = 0, 1 or 2
b)Start/Stop logic selection par. 2. 1 = 3.

4. 1 Acc/Dec ramp 1 shape
4. 2 Acc/Dec ramp 2 shape

The acceleration and deceleration ramp shape can be programmed with these parameters.

Setting the value = 0 gives you a linear ramp shape. The output frequency immediately follows the input with a ramp time set by parameters 1**.** 3, 1**.** 4 (4**.** 3, 4**.** 4 for Acc/Dec time 2).

Setting 0.1—10 seconds for 4**.** 1 (4**.** 2) causes an S-shaped ramp. The speed changes are smooth. Parameter 1**.** 3/ 1**.** 4 (4**.** 3/ 4**.** 4) determines the ramp time of the acceleration/deceleration in the middle of the curve.

See figure 5.5-17.

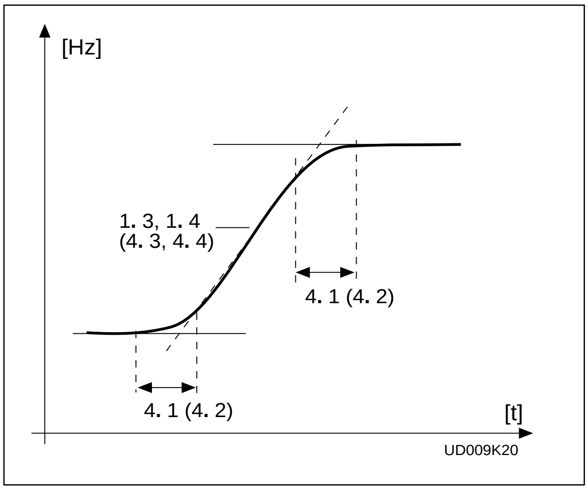


Figure 5.5-17 S-shaped acceleration/ deceleration.

4. 3 Acceleration time 2
4. 4 Deceleration time 2

These values correspond to the time required for the output frequency to accelerate from the set minimum frequency (par. 1**.** 1) to the set maximum frequency (par. 1**.** 2). With this parameter it is possibile to set two different acceleration/ deceleration times for one application. The active set can be selected with the programmable signal DIA3 of this application, see parameter 2**.** 2.
Acceleration/deceleration times can be reduced with a external free analog input signal, see parameters 2**.** 18 and 2**.** 19.

4. 5 Brake chopper

0 = No brake chopper
1 = Brake chopper and brake resistor installed
2 = External brake chopper

When the drive is decelerating the motor, the energy stored in the inertia of the motor and the load is fed into the external brake resistor. If the brake resistor is selected correctly the drive is able to decelerate the load with a torque equal to that of acceleration. See the separate Brake resistor installation manual.

4. 6 Start function

Ramp:

0 The drive starts from 0 Hz and accelerates to the set reference frequency within the set acceleration time. (Load inertia or starting friction may cause prolonged acceleration times).

Flying start:

1 The drive starts into a running motor by first finding the speed the motor is running at. Searching starts from the maximum frequency down until the actual frequency reached. The output frequency then accelerates/decelerates to the set reference value at a rate determined by the acceleration/deceleration ramp parameters.

Use this mode if the motor may be coasting when the start command is given. With the flying start it is possible to ride through short utility voltage interruptions

4. 7 Stop function

Coasting:
0 The motor coasts to an uncontrolled stop with the CX/CXL/CXS off, after the
Stop command.

Ramp:
1 After the Stop command, the speed of the motor is decelerated according to the deceleration ramp time parameter.
If the regenerated energy is high it may be necessary to use an external braking resistor for faster deceleration.

4. 8 DC braking current

Defines the current injected into the motor during DC braking.

4. 9 DC braking time at stop

Defines if braking is ON or OFF and braking time of the DC-brake when the motor is stopping. The function of the DC-brake depends on the stop function, parameter 4**.** 7. See figure 5.5-18.

0 DC-brake is not used

>0 DC-brake is in use and its function depends on the Stop function, (param. 4**.** 7), and the time depends on the value of parameter 4**.** 9:

Stop-function = 0 (coasting):

After the stop command, the motor will coast to a stop with the CX/CXL/CXS off.

With DC-injection, the motor can be electrically stopped in the shortest possible time, without using an optional external braking resistor.

The braking time is scaled according to the frequency when the DC-braking starts. If the frequency is ≥ nominal frequency of the motor (par. 1.11), setting value of parameter 4.9 determines the braking time. When the frequency is ≤ 10% of the nominal, the braking time is 10% of the set value of parameter 4.9.

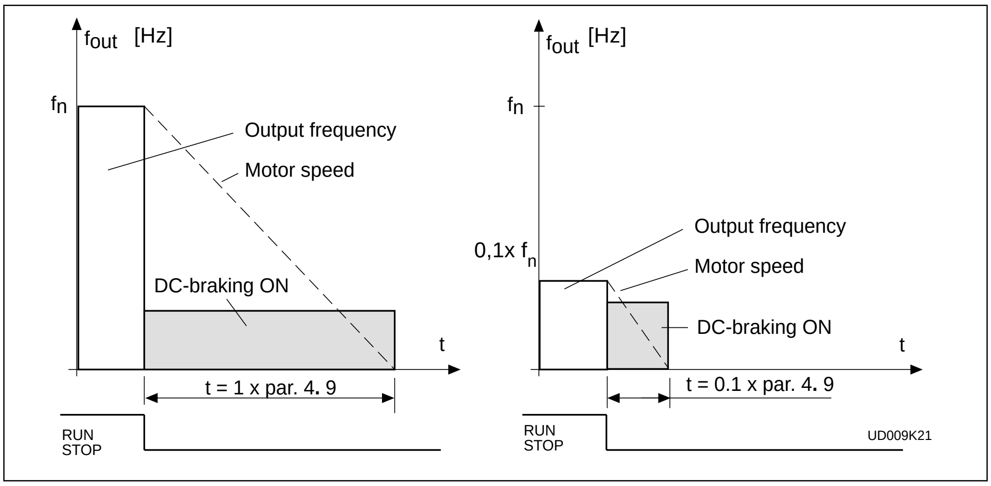


Figure 5.5-18 DC-braking time when stop = coasting.

Stop-function = 1 (ramp):

After the Stop command, the speed of the motor is reduced based on the deceleration parameter ramp parameter, if no regeneration occurs due to load inertia, to a speed defined with parameter 4**.** 10, where the DC-braking starts.

The braking time is defined with parameter 4**.** 9.

If high inertia exists, it is recommended to use an external braking resistor for faster deceleration. See figure 5.5-19.

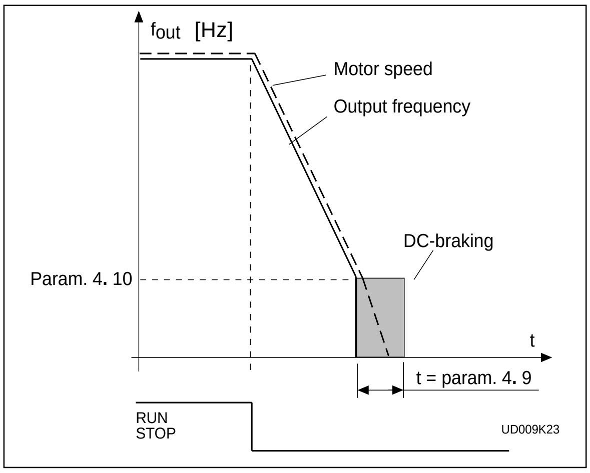


Figure 5.5-19 DC-braking time when stop function = ramp

4. 10 Execute frequency of DC-brake during ramp Stop

See figure 5.5-19.

4. 11 DC-brake time at start

0 DC-brake is not used
>0 DC-brake is active when the start command is given. This parameter defines the time before the brake is released. After the brake is released the output frequency increases according to the set start function parameter 4. 6 and the acceleration parameters (1. 3, 4. 1 or 4. 2, 4. 3). See figure 5.5-20.

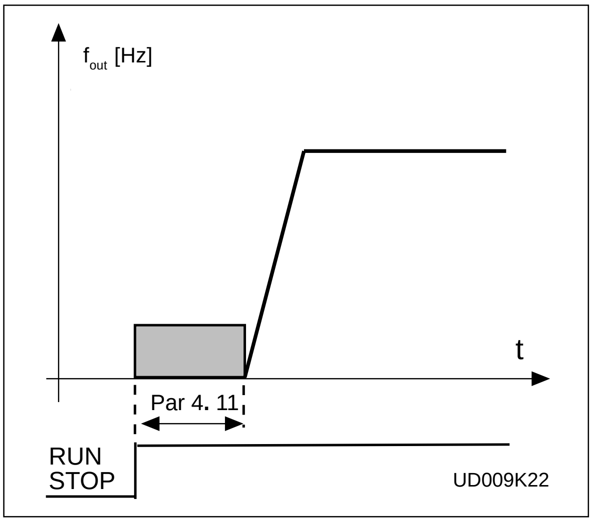


Figure 5.5-20 DC-braking at start.

4. 12 - 4. 18 Multi-Step speeds 1-7

These parameter values define the Multi-step speeds selected with the DIA4, DIB5 and DIB6 digital inputs. The selection of Multi-step speeds will occur similarly as described in the table 3.4-2 page 3-8.

5. 1- 5.6
Prohibit frequency area

Low limit/High limit

In some systems it may be necessary to avoid certain frequencies because of mechanical resonance problems.

With these parameters it is possible to set limits for three "skip frequency" regions. The accuracy of the setting is 0.1 Hz.

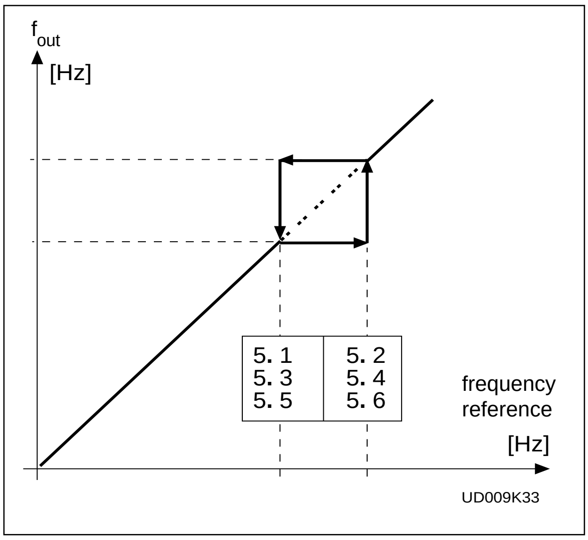


Figure 5.5-21 Example of prohibit frequency area setting.

6. 1 Motor control mode

0 = Frequency control: (V/Hz)	The I/O terminal and panel references are frequency references and the drive controls the output frequency (output frequency resolution = 0.01 Hz)
1 = Speed control: (sensorless vector)	The I/O terminal and panel references are speed references and the drive controls the motor speed (regulation accuracy ± 0.5%).

6. 2 Switching frequency

Motor noise can be minimized using a high switching frequency. Increasing the switching frequency reduces the capacity of the CX/CXL/CXS.

Before changing the frequency from the factory default 10 kHz (3.6 kHz $\geq$ 40 Hp), check the drive derating from the curves in figures 5.2-2 and 5.2-3 in the User's Manual.

6. 3 Field weakening point
6. 4 Voltage at the field weakening point

The field weakening point is the output frequency at which the output voltage reaches the set maximum value (par. 6**.** 4). Above this frequency the output voltage remains at the set maximum value.
Below that frequency the output voltage depends on the setting of the V/Hz curve parameters 1**.** 8, 1**.** 9, 6**.** 5, 6**.** 6 and 6**.** 7. See figure 5.5-22.

When the parameters 1**.** 10 and 1**.** 11, nominal voltage and nominal frequency of the motor are set, parameters 6**.** 3 and 6**.** 4 are also set automatically to the corresponding values. If you need different values for the field weakening point and the maximum output voltage, change these parameters after setting parameters 1**.** 10 and 1**.** 11.

6. 5 V/Hz curve, middle point frequency

If the programmable V/Hz curve has been selected with parameter 1**.** 8, this parameter defines the middle point frequency of the curve. See figure 5.5-22.

6. 6 V/Hz curve, middle point voltage

If the programmable V/Hz curve has been selected with parameter 1**.** 8 this parameter defines the middle point voltage of the curve. See figure 5.5-22.

6. 7 Output voltage at zero frequency

If the programmable V/Hz curve has been selected with parameter 1**.** 8 this parameter defines the zero frequency voltage of the curve. See figure 5.5-22.

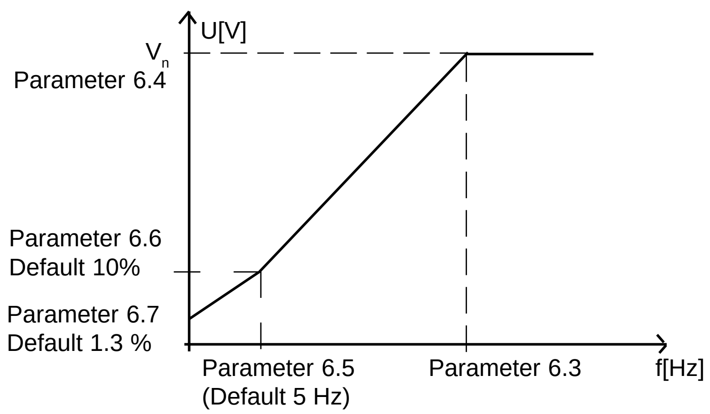


Figure 5.5-22 Programmable V/Hz curve.

5

6. 8 Overvoltage controller
6. 9 Undervoltage controller

These parameters allow the over/undervoltage controllers to be switched ON or OFF. This may be useful in cases where the utility supply voltage varies more than -15%—+10% and the application requires a constant speed. If the controllers are ON, they will change the motor speed in over/undervoltage cases. Overvoltage = faster, undervoltage = slower.

Over/undervoltage trips may occur when controllers are not used

7. 1 Response to the reference fault

0 = No response
1 = Warning
2 = Fault, stop mode after fault according to parameter 4.7
3 = Fault, always coasting stop mode after fault

A warning or a fault action and message is generated if 4—20 mA reference signal is used and the signal falls below 4 mA. The information can also be programmed via digital output DO1 and via relay outputs RO1 and RO2.

7. 2 Response to external fault

0 = No response
1 = Warning
2 = Fault, stop mode after fault according to parameter 4.7
3 = Fault, always coasting stop mode after fault

A warning or a fault action and message is generated from the external fault signal in the digital input DIA3. The information can also be programmed into digital output DO1 and into relay outputs RO1 and RO2.

7. 3 Phase supervision of the motor

0 = No action
2 = Fault

Phase supervision of the motor ensures that the motor phases have approximately equal current.

7. 4 Ground fault protection

0 = No action
2 = Fault

Ground fault protection ensures that the sum of the motor phase currents is zero. The standard overcurrent protection is always working and protects the frequency converter from ground faults with high current levels.

Parameters 7. 5—7. 9 Motor thermal protection

General

Motor thermal protection is to protect the motor from overheating. The CX/CXL/CXS drive is capable of supplying higher than nominal current to the motor. If the load requires this high current there is a risk that motor will be thermally overloaded. This is true especially at low frequencies. With low frequencies the cooling effect of the motor fan is reduced and the capacity of the motor is reduced. If the motor is equipped with an external fan the load reduction on low speed is small.

Motor thermal protection is based on a calculated model and it uses the output current of the drive to determine the load on the motor. When the power is turned on to the drive, the calculated model uses the heatsink temperature to determine the initial thermal stage for the motor. The caculated model assumes that the ambient temperature of the motor is 40°C.

Motor thermal protection can be adjusted by setting several parameters. The thermal current I_T specifies the load current above which the motor is overloaded. This current limit is a function of the output frequency. The curve for I_T is set with parameters 7**.** 6, 7**.** 7 and 7**.** 9, refer to the figure 5.5-23. The default values of these parameters are set from the motor nameplate data.

With the output current at I_T the thermal stage will reach the nominal value (100%). The thermal stage changes by the square of the current. With output current at 75% from I_T the thermal stage will reach 56% value and with output current at 120% from I_T the thermal stage would reach 144% value. The function will trip the device (refer par. 7**.** 5) if the thermal stage will reach a value of 105%. The response time of the thermal stage is determined with the time constant parameter 7**.** 8. The larger the motor the longer it takes to reach the final temperature.

The thermal stage of the motor can be monitored through the display. Refer to the table for monitoring items. (User's Manual, table 7.3-1).

! CAUTION! *The calculated model does not protect the motor if the cooling of the motor is reduced either by blocking the airflow or due to dust or dirt.*

7. 5 Motor thermal protection

Operation:
- 0 = Not in use
- 1 = Warning
- 2 = Trip function

Tripping and warning will give a display indication with the same message code. If tripping is selected the drive will stop and activate the fault stage.

Deactivating the protection by setting this parameter to 0, will reset the thermal stage of the motor to 0%.

7. 6 Motor thermal protection, break point current

The current can be set between 50.0—150.0% x I_{nMotor}.
This parameter sets the value for thermal current at frequencies above the break point on the thermal current curve. Refer to the figure 5.5-23.

The value is set in percentage of the motor nameplate data of the motor, parameter 1**.** 13, not the drive's nominal output current.

The motor's nominal current is the current which the motor can withstand in direct on-line use without being overheated.

If parameter 1**.** 13 is adjusted, this parameter is automatically restored to the default value.

Setting this parameter (or parameter 1**.** 13) does not affect the maximum output current of the drive. Parameter 1**.** 7 alone determines the maximum output current of the drive.

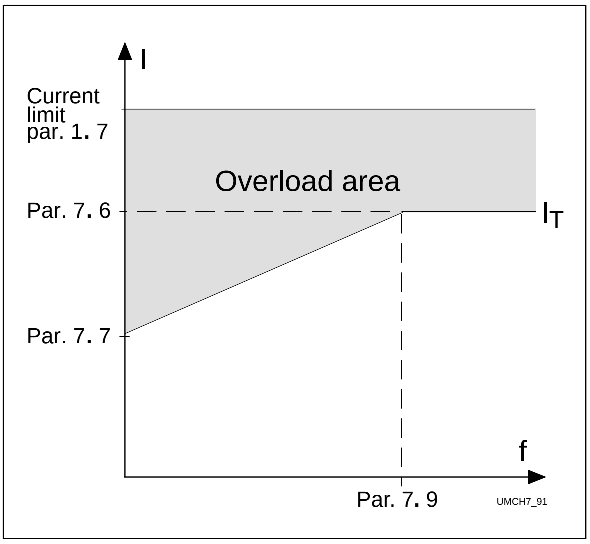


Figure 5.5-23 Motor thermal current I_T curve.

7. 7 Motor thermal protection, zero frequency current

The current can be set between 10.0—150.0% x I_{nMotor}. This parameter sets the value for thermal current at zero frequency. Refer to the figure 5.5-23.

The default value is set assuming that there is no external fan cooling the motor. If an external fan is used this parameter can be set to 90% (or higher).

The value is set as a percentage of the motor's nameplate nominal current, parameter 1. 13, not the drive's nominal output current. The motor's nominal current is the current which the motor can stand in direct on-line use without being overheated.

If you change the parameter 1. 13 this parameter is automatically restored to the default value.

Setting this parameter (or parameter 1. 13) does not affect to the maximum output current of the drive. Parameter 1. 7 alone determines the maximum output current of the drive.

7. 8 Motor thermal protection, time constant

This time can be set between 0.5—300 minutes.
This is the thermal time constant of the motor. The larger the motor the greater the time constant. The time constant is defined as the time that it takes the calculated thermal stage to reach 63% of its final value.

The motor thermal time is specific to a motor design and it varies between different motor manufacturers.

The default value for the time constant is calculated based on the motorname plate data from parameters 1. 12 and 1. 13. If either of these parameters is reset, then this parameter is set to its default value.

If the motor's t_6 -time is known (given by the motor manufacturer) the time constant parameter could be set based on t_6 -time. As a rule of thumb, the motor thermal time constant in minutes equals to 2xt_6 (t_6 in seconds is the time a motor can safely operate at six times the rated current). If the drive is in the stop stage the time constant is internally increased to three times the set parameter value. The cooling in the stop stage is based on convection with an increased time constant.

5

7. 9 Motor thermal protection, break point frequency

This frequency can be set between 10—500 Hz.
This is the frequency break point of thermal current curve. With frequencies above this point the thermal capacity of the motor is assumed to be constant. Refer to the figure 5.5-23.

The default value is based on motor's nameplate data, parameter 1**.** 11. It is 35 Hz for a 50 Hz motor and 42 Hz for a 60 Hz motor. More generally it is 70% of the frequency at the field weakening point (parameter 6**.** 3). Changing either parameter 1**.** 11 or 6**.** 3 will restore this parameter to its default value.

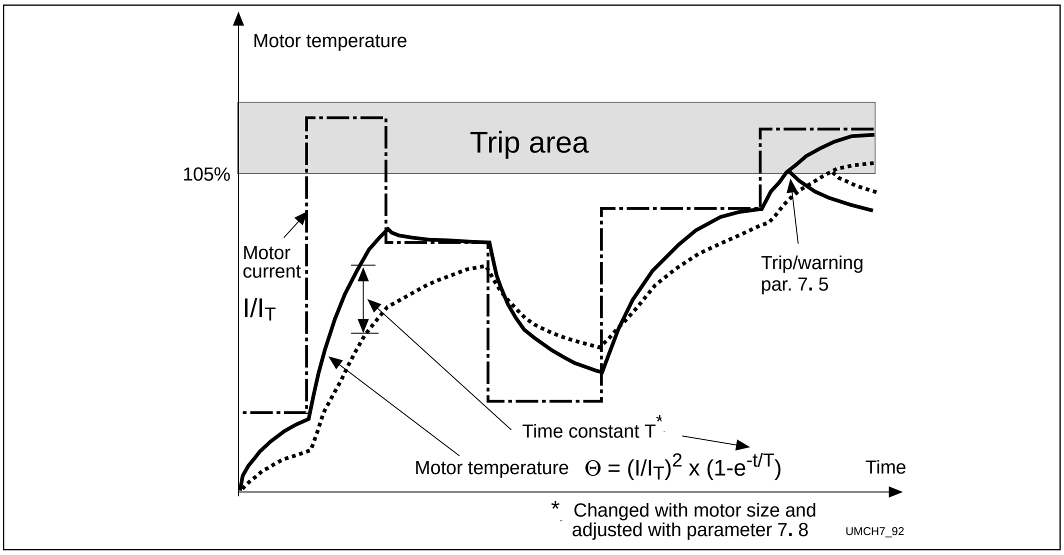


Figure 5.5-24 Calculating motor temperature.

Parameters 7. 10— 7. 13, Stall protection
General

Motor stall protection protects the motor from short time overload situations like a stalled shaft. The reaction time of stall protection can be set shorter than with motor thermal protection. The stall state is defined with two parameters, 7.11. Stall Current and 7.13. Stall Frequency. If the current is higher than the set limit and output frequency is lower than the set limit the stall state is true. There is no true detection of shaft rotation. Stall protection is a type of overcurrent protection.

7. 10 Stall protection

Operation:
- 0 = Not in use
- 1 = Warning
- 2 = Trip function

Tripping and warning will give a display indication with the same message code. If tripping is set on, the drive will stop and activate the fault stage.

Setting this parameter to 0 will deactivate the protection and will reset the stall time counter to zero.

5

7. 11 Stall current limit

The current can be set between 0.0—200% x I_{nMotor}.

In the stall stage the current has to be above this limit. Refer to the figure 5.5-25. The value is set as a percentage of the motor's name- plate nominal current, parameter 1**.** 13, motor's nominal current. If parameter 1**.**13 is adjusted, this parameter is automatically restored to its default value.

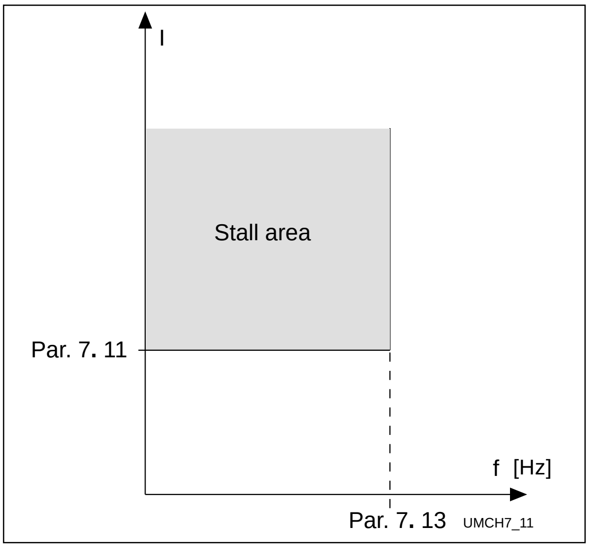


Figure 5.5-25 Setting the stall characteristics.

7. 12 Stall time

The time can be set between 2.0—120 s.
This is the maximum allowed time for a stall stage. There is an internal up/down counter to count the stall time. Refer to the figure 5.5-26.
If the stall time counter value goes above this limit the protection will cause a trip (refer to the parameter 7**.** 10).

7. 13 Maximum stall frequency

The frequency can be set between 1—f_{max} (par. 1**.** 2).
In the stall state, the ouput frequency has to be smaller than this limit. Refer to the figure 5.5-25.

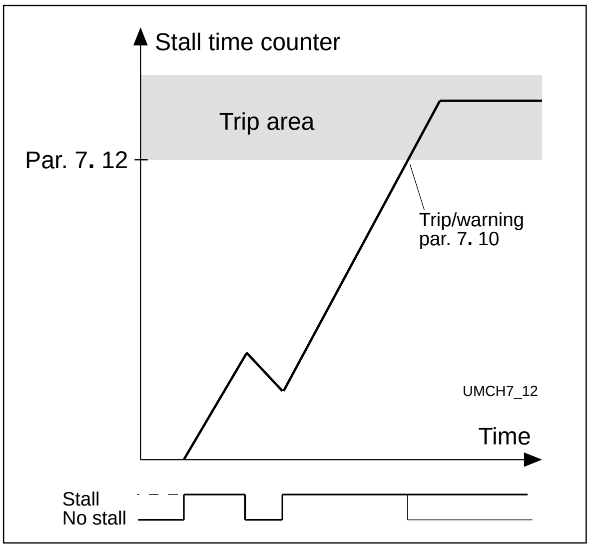


Figure 5.5-26 Counting the stall time.

Parameters 7. 14— 7. 17, Underload protection
General

The purpose of motor underload protection is to ensure that there is load on the motor while the drive is running. If the motor load is reduced, there might be a problem in the process, e.g. broken belt or dry pump.

Motor underload protection can be adjusted by setting the underload curve with parameters 7**.** 15 and 7**.** 16. The underload curve is a squared curve set between zero frequency and the field weakening point. The protection is not active below 5Hz (the underload counter value is stopped). Refer to the figure 5.5-27.

The torque values for setting the underload curve are set with percentage values which refer to the nominal torque of the motor. The motor's nameplate data, parameter 1. 13, the motor's nominal current and the drive's nominal current I_{CT} are used to find the scaling ratio for the internal torque value. If other than a standard motor is used with the drive, the accuracy of the torque calculation is decreased.

7. 14 Underload protection

Operation:

0 = Not in use
1 = Warning
2 = Fault

Tripping and warning will give a display indication with the same message code. If tripping is set active the drive will stop and activate the fault stage.

Deactivating the protection, by setting this parameter to 0, will reset the underload time counter to zero.

7. 15 Underload protection, field weakening area load

The torque limit can be set between 20.0—150 % x T_{nMotor}.

This parameter is the value for the minimum allowed torque when the output frequency is above the field weakening point.
Refer to the figure 4.5-22.
If parameter 1**.** 13 is adjusted, this parameter is automatically restored to its default value.

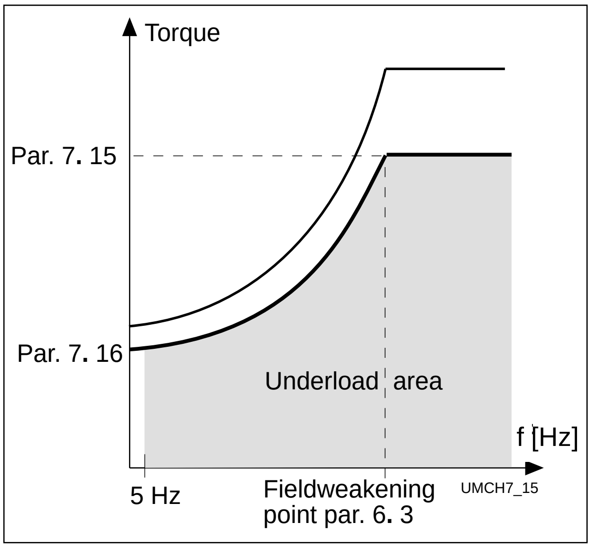


Figure 5.5-27 Setting of minimum load.

7. 16 Underload protection, zero frequency load

Torque limit can be set between 10.0—150 % x T_{nMotor}.

This parameter is the value for the minimum allowed torque with zero frequency. Refer to the figure 5.5-27. If parameter 1**.** 13 is adjusted, this parameter is automatically restored to its default value.

7. 17 Underload time

This time can be set between 2.0—600.0 s.

This is the maximum allowed time for an underload state. There is an internal up/down counter to accumulate the underload time. Refer to the figure 5.5-28.
If the underload counter value goes above this limit, the protection will cause a trip (refer to the parameter 7**.** 14). If the drive is stopped the underload counter is reset to zero.

5

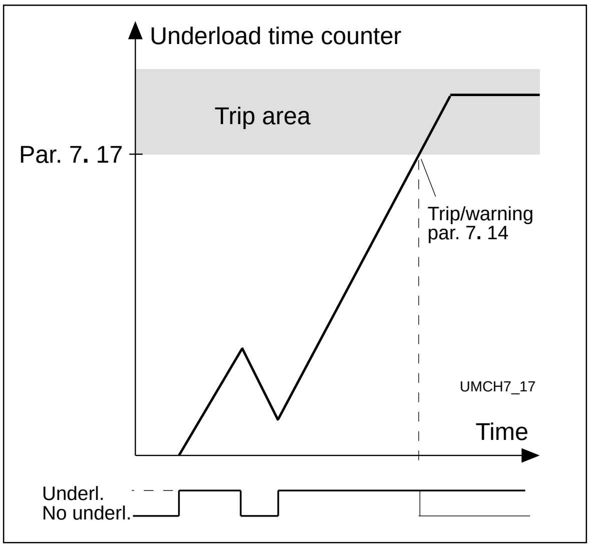


Figure 5.5-28 Counting the underload time.

8. 1 Automatic restart: number of tries
8. 2 Automatic restart: trial time

The Automatic restart function restarts the drive after the faults selected with parameters 8. 4—8. 8. The Start function for Automatic restart is selected with parameter 8. 3.

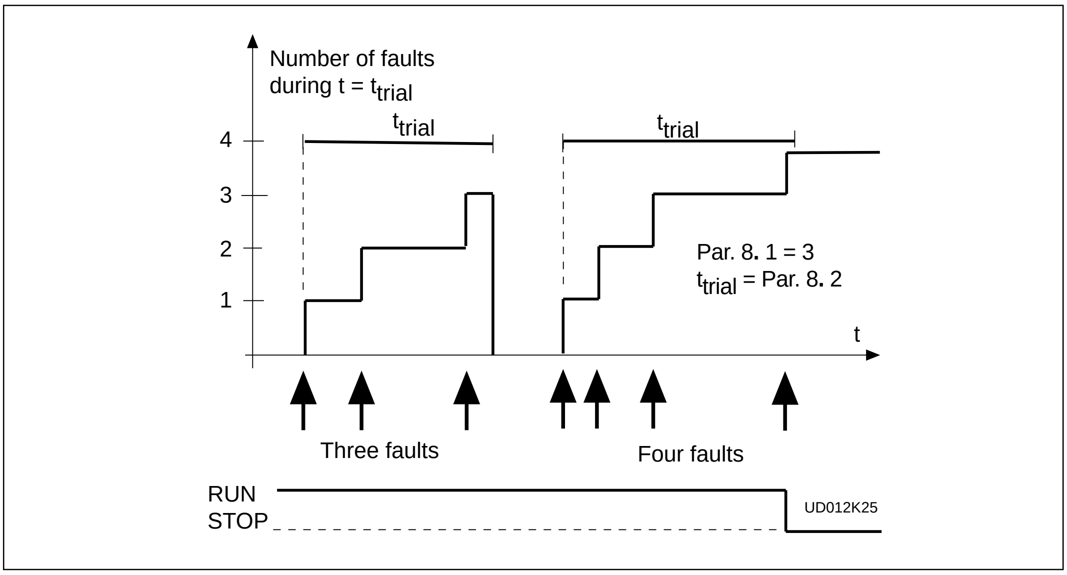


Figure 5.5-29 Automatic restart

Parameter 8. 1 determines how many automatic restarts can be made during the trial time set by the parameter 8. 2.

The time counting starts from the first autorestart. If the number of restarts does not exceed the value of the parameter 8. 1 during the trial time, the counting is cleared after the trial time has elapsed. The next fault starts the counting again.

5

8. 3 Automatic restart, start function

The parameter defines the start mode:
0 = Start with ramp
1 = Flying start, see parameter 4. 6.

8. 4 Automatic restart after undervoltage trip

0 = No automatic restart after undervoltage fault trip
1 = Automatic restart after undervoltage fault condition returns to the normal condition (DC-link voltage returns to the normal level)

8. 5 Automatic restart after overvoltage trip

0 = No automatic restart after overvoltage fault trip
1 = Automatic restart after overvoltage fault condition returns to the normal condition (DC-link voltage returns to the normal level)

8. 6 Automatic restart after overcurrent trip

0 = No automatic restart after overcurrent fault trip
1 = Automatic restart after overcurrent faults

8. 7 Automatic restart after reference fault trip

0 = No automatic restart after reference fault trip
1 = Automatic restart after analog current reference signal (4—20 mA) returns to the normal level (≥4 mA)

8. 8 Automatic restart after over-/undertemperature fault trip

0 = No automatic restart after temperature fault trip
1 = Automatic restart after heatsink temperature has returned to its normal level between -10°C—+75°C.

Notes:

Notes:

PUMP AND FAN CONTROL APPLICATION
(par. 0.1 = 7)

CONTENTS

6

6.1 General

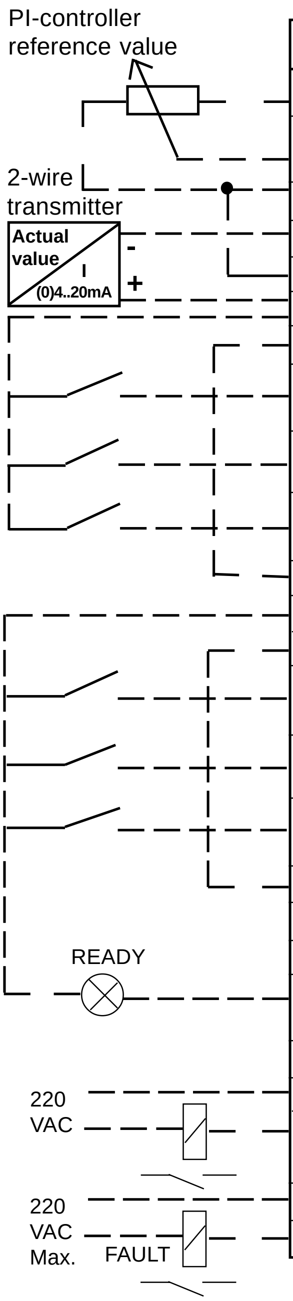
The pump and fan control appliation can be selected by setting the value of parameter 0.1 to 7.

The application can be used to control one variable speed drive and 0-3 auxiliary drives. The PI-controller of the CX/CXL/CXS controls the drive speed and provides control signals to Start and Stop one to three auxiliary drives to control the total flow.

The application has two control sources on the I/O terminals. Source A is Pump and fan control and source B is direct frequency reference. The control source is selected with DIB6 input.

*** NOTE! Remember to connect the CMA and CMB inputs.**

6.2 Control I/O



Terminal		Signal	Description
1	$+10V_{ref}$	Reference output	Voltage for a potentiometer, etc.
2	$V_{in}+$	Analog input, voltage (programmable)	PI-controller reference value range 0—10 V DC
3	GND	I/O ground	Ground for reference and controls
4	$I_{in}+$	Analog input,	PI-controller actual value
5	$I_{in}-$	current (programmable)	range 0—20 mA
6	+24V	Control voltage output	Voltage for switches, etc. max. 0.1 A
7	GND	Control voltage ground	Ground for reference and controls
8	DIA1	Start/Stop Source A (PI-controller)	Contact open = stop Contact closed = start
9	DIA2	External fault (programmable)	Contact open = no fault Contact closed = fault
10	DIA3	Fault reset (programmable)	Contact open = no action Contact closed = fault reset
11	CMA	Common for DIA1—DIA3	Connect to GND or + 24V
12	+24V	Control voltage output	Voltage for switches, (same as #6)
13	GND	I/O ground	Ground for reference and controls
14	DIB4	Start/Stop Source B (Direct freq. ref.)	Contact open = stop Contact closed = start
15	DIB5	Jog speed select (programmable)	Contact open = no action Contact closed = jog speed
16	DIB6	Source A/B selection	Contact open = source A is active Contact closed = source B is active
17	CMB	Common for DIB4—DIB6	Connect to GND or + 24V
18	$I_{out}+$	Analog output	Programmable (par. 3. 1)
19	$I_{out}-$	Output frequency	Range 0—20 mA/R_L max. 500 Ω
20	DO1	Digital output READY	Programmable (par. 3. 6) Open collector, I≤50 mA, V≤48 VDC
21	RO1	Relay output 1	Programmable (par. 3. 7)
22	RO1	Auxil. motor 1	
23	RO1	control	
24	RO2	Relay output 2	Programmable (par. 3. 8)
25	RO2	FAULT	
26	RO2		

Figure 6.2-1 Default I/O configuration and connection example of the Pump and Fan Control Application with 2-wire transmitter.

6.3 Control signal logic

The logic flow of the I/O-control signals and pushbutton signals from the panel is shown in figure 6.3-1.

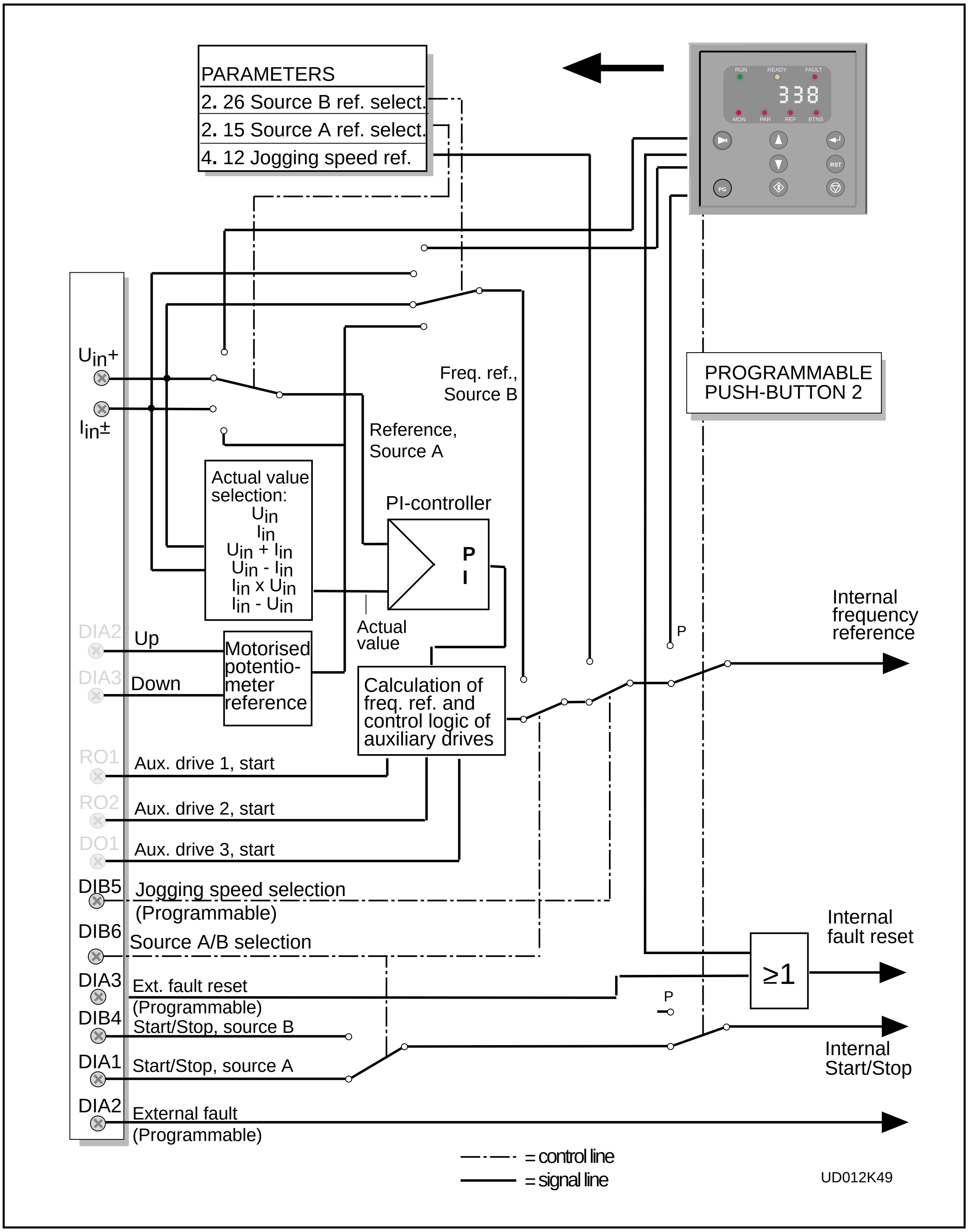


Figure 6.3-1 Control signal logic of the Pump and Fan control Application.
Switch positions shown are based on the factory settings.

6

6.4 Basic parameters, Group 1

6.4.1 Parameter table, Group 1

Code	Parameter	Range	Step	Default	Custom	Description	Page
1. 1	Minimum frequency	0—f_{max}	1 Hz	0 Hz			6-5
1. 2	Maximum frequency	f_{min}-120/500 Hz	1 Hz	60 Hz		*	6-5
1. 3	Acceleration time 1	0.1—3000.0 s	0.1 s	1.0 s		Time from f_{min} (1. 1) to f_{max} (1. 2)	6-5
1. 4	Deceleration time 1	0.1—3000.0 s	0.1 s	1.0 s		Time from f_{max} (1. 2) to f_{min} (1. 1)	6-5
1. 5	PI-controllergain	1—1000%	1 %	100%			6-5
1. 6	PI-controller I-time	0.00—320.00 s	0.01s	10.00s		0= No Integral timein use	6-5
1. 7	Current limit	0.1—2.5 x I_{nCX}	0.1 A	1.5 x I_{nCX}		Output current limit [A] of the unit	6-5
1. 8	V/Hz ratio selection	0—2	1	0		0 = Linear 1 = Squared 2 = Programmable V/Hz ratio	6-5
1. 9	V/hz optimization	0—1	1	0		0 = None 1 = Automatic torque boost	6-6
1. 10	Nominal voltage of the motor	180—690 V	1 V	230 V 380 V 480 V 575 V		CX/CXL/CXS V 3 2 CX/CXL/CXS V 3 4 CX/CXL/CXS V 3 5 CX V 3 6	6-7
1. 11	Nominal frequency of the motor	30—500 Hz	1 Hz	60 Hz		f_n from the rating plate of the motor	6-7
1. 12	Nominal speed of the motor	1—20000 rpm	1 rpm	1720 rpm **		n_n from the rating plate of the motor	6-7
1. 13	Nominal current of the motor	2.5 x I_{nCX}	0.1 A	I_{nCX}		I_n from the rating plate of the motor	6-7
1. 14	Supply voltage	208—240		230 V		CX/CXL/CXS V 3 2	6-7
		380—440		380 V		CX/CXL/CXS V 3 4	
		380—500		480 V		CX/CXL/CXS V 3 5	
		525—690		575 V		CX V 3 6	
1. 15	Parameter conceal	0—1	1	0		Visibility of the parameters: 0 = All parametergroups visible 1 = Only group 1 is visible	6-7
1. 16	Parameter value lock	0—1	1	0		Disables parameter changes: 0 = Changes enabled 1 = Changes disabled	6-7

Table 6.4-1 Group 1 basic parameters.

Note! = Parameter value can be changed only when the drive is stopped.

* If 1. 2 > motor synchr. speed, check suitability for motor and drive system
Selecting 120 Hz/500 Hz range see page 6-5.

** Default value for a four pole motor and a nominal size drive.

6

6.4.2 Description of Group 1 parameters

1. 1, 1. 2 Minimum / maximum frequency

Defines frequency limits of the drive.

The default maximum value for parameters 1. 1 and 1. 2 is 120 Hz. By setting 1. 2 = 120 Hz when the drive is stopped (RUN indicator not lit) parameters 1. 1 and 1. 2 are changed to 500 Hz. At the same time the resolution of the panel reference is changed from 0.01 Hz to 0.1 Hz.
Changing the max. value from 500 Hz to 120 Hz is done by setting parameter 1. 2 = 119 Hz when the drive is stopped.

1. 3, 1. 4 Acceleration time 1, deceleration time 1:

These limits correspond to the time required for the output frequency to accelerate from the set minimum frequency (par. 1. 1) to the set maximum frequency (par. 1. 2).

1. 5 PI-controller gain

This parameter defines the gain of the PI-controller.

If this parameter is set to 100%, a 10% change in error value causes the controller output to change by 1.0 Hz.

If the parameter value is set to 0 the PI-controller operates as I-controller.

1. 6 PI-controller I-time

Defines the integration time of the PI-controller.

1. 7 Current limit

This parameter determines the maximum motor current what the CX/CXL/CXS will supply short term.

1. 8 V/Hz ratio selection

Linear: **0** — The voltage of the motor changes linearly with the frequency in the constant flux area from 0 Hz to the field weakening point (par. 6. 3) where a constant voltage (nominal value) is supplied to the motor. See figure 6.4-1.
Linear V/Hz ratio should be used in constant torque applications.

This default setting should be used if there is no special requirement for another setting.

Squared: **1** — The voltage of the motor changes following a squared curve form with the frequency in the area from 0 Hz to the field weakening point (par. 6. 3) where the nominal voltage is also supplied to the motor. See figure 6.4-1.

The motor runs undermagnetized below the field weakening point and produces less torque and electromechanical noise. A squared V/Hz ratio can be used in applications where the torque demand of the load is proportional to the square of the speed, e.g. in centrifugal fans and pumps.

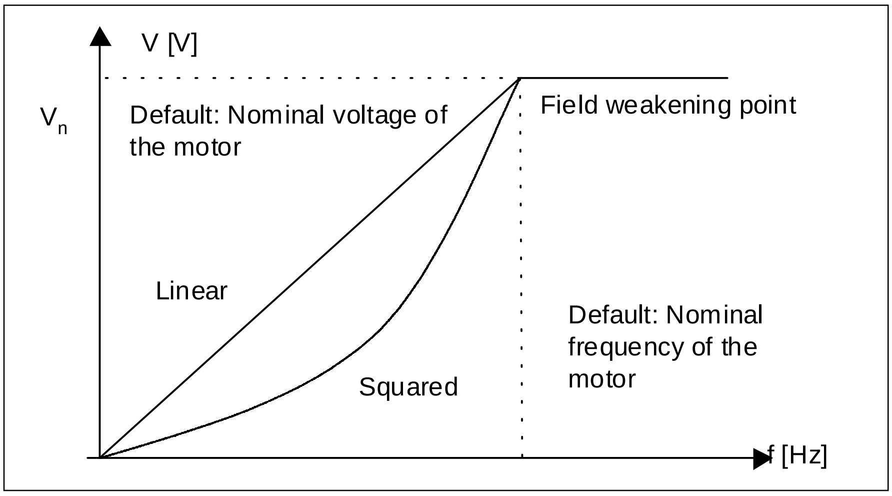


Figure 6.4-1 Linear and squared V/Hz curves.

Programm. V/Hz curve 2 The V/Hz curve can be programmed with three different points. The parameters for programming are explained in chapter 6.5.2. A programmable V/Hz curve can be used if the standard settings do not satisfy the needs of the application. See figure 6.4-2.

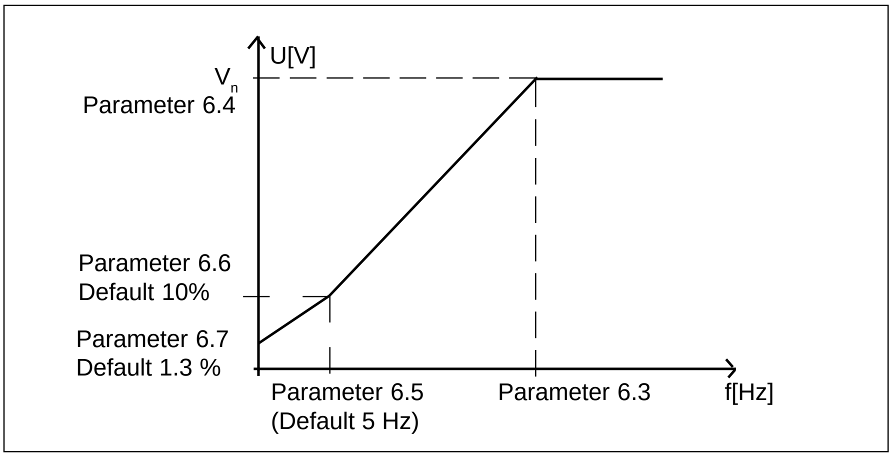


Figure 6.4-2 Programmable V/Hz curve.

1. 9 V/Hz optimization

Automatic torque boost — The voltage to the motor changes automatically which makes the motor to produce torque enough to start and run at low frequencies. The voltage increase depends on the motor type and horsepower.

Automatic torque boost can be used in applications where starting torque due to starting friction is high, e.g. in conveyors.

NOTE! *In high torque - low speed applications - it is likely the motor will overheat.*
If the motor has to run for a prolonged time under these conditions, special attention must be paid to cooling the motor. Use external cooling for the motor if the temperature tends to rise too high.

6

1. 10 Nominal voltage of the motor

Find this value V_n from the nameplate of the motor.
This parameter sets the voltage at the field weakening point, parameter 6. 4, to 100% x $V_{n_{motor}}$.

1. 11 Nominal frequency of the motor

Find the nominal frequency f_n from the nameplate of the motor.
This parameter sets the frequency at the field weakening point, parameter 6. 3, to the same value.

1. 12 Nominal speed of the motor

Find this value n_n from the nameplate of the motor.

1. 13 Nominal current of the motor

Find the value I_n from the nameplate of the motor.
The internal motor protection function uses this value as a reference value.

1. 14 Supply voltage

Set parameter value according to the nominal voltage of the supply.
Values are pre-defined for CX/CXL/CXS V 3 2, CX/CXL/CXS V 3 4, CX/CXL/CXS V 3 5 and CX V 3 6. See table 6.4-1.

1. 15 Parameter conceal

Defines which parameter groups are available:

0 = All parameter groups are visible
1 = Only group 1 is visible

1. 16 Parameter value lock

Defines access to the changes of the parameter values:

0 = Parameter value changes enabled
1 = Parameter value changes disabled

6.5 Special parameters, Groups 2—9

6.5.1 Parameter tables

Group 2, Input signal parameters

Code	Parameter	Range	Step	Default	Custom	Description	Page
2. 1	DIA2 function (terminal 9)	0—10	1	1		0 = Not used 1 = Ext. fault, closing contact 2 = External fault, opening contact 3 = Run enable 4 = Acceler./deceler. time selection 5 = Reverse 6 = Jog frequency 7 = Fault reset 8 = Acc./dec. operation prohibit 9 = DC-braking command 10 = Motor (digital) potent. UP	6-16
2. 2	DIA3 function (terminal 10)	0—10	1	7		0 = Not used 1 = Ext. fault, closing contact 2 = External fault, opening contact 3 = Run enable 4 = Acceler./deceler. time selection 5 = Reverse 6 = Jog frequency 7 = Fault reset 8 = Acc./dec. operation prohibit 9 = DC-braking command 10 = Motor (digital) potent. DOWN	6-17
2. 3	V_{in} signal range	0—1	1	0		0 = 0—10 V 1 = Custom setting range	6-17
2. 4	V_{in} custom setting min.	0.00-100.00%	0.01%	0.00%			6-17
2. 5	V_{in} custom setting max.	0.00-100.00%	0.01%	100.00%			6-17
2. 6	V_{in} signal inversion	0—1	1	0		0 = Not inverted 1 = Inverted	6-17
2. 7	V_{in} signal filter time	0.00—10.00 s	0.01s	1.00s		0 = No filtering	6-17
2. 8	I_{in} signal range	0—2	1	0		0 = 0—20 mA 1 = 4—20 mA 2 = Custom setting range	6-17
2. 9	I_{in} custom setting minim.	0.00-100.00%	0.01%	0.00%			6-18
2. 10	I_{in} custom setting maxim.	0.00-100.00%	0.01%	100.00%			6-18
2. 11	I_{in} signal inversion	0—1	1	0		0 = Not inverted 1 = Inverted	6-18
2. 12	I_{in} signal filter time	0.01—10.00s	0.01s	1.00 s		0 = No filtering	6-18
2. 13	DIB5 function (terminal 15)	0—9	1	6		0 = Not used 1 = Ext. fault, closing contact 2 = External fault, opening contact 3 = Run enable 4 = Acc./dec. time selection 5 = Reverse 6 = Jog speed 7 = Fault reset 8 = Acc./dec. operation prohibit 9 = DC-braking command	6-18

Note! = Parameter value can be changed only when the drive is stopped

Code	Parameter	Range	Step	Default	Custom	Description	Page
2. 14	Motor(digital) potentiometer ramp time	0.1—2000.0 Hz/s	0.1 Hz/s	10.0 Hz/s			6-19
2. 15	PI-controller reference signal (source A)	0—4	1	0		0 = Analog voltage input (term. 2) 1 = Analog current input (term. 4) 2 = Set reference from the panel (reference r2) 3 = Signal from internal motor pot. 4 = Signal from internal motor pot. reset if CX/CXLCXS unit is stopped	619
2. 16	PI-controller actual value selection	0—3	1	0		0 = Actual value1 1 = Actual 1 + Actual 2 2 = Actual 1 - Actual 2 3 = Actual 1 * Actual 2	6-19
2. 17	Actual value 1 input	0—2	1	2		0 = No 1 = Voltage input 2 = Current input	6-19
2. 18	Actual value 2 input	0—2	1	0		0 = No 1 = Voltage input 2 = Current input	6-19
2. 19	Actual value 1 min scale	-320.00%—+320.00%	0.01%	0.00%		0% = no minimum scaling	6-19
2. 20	Actual value 1 max scale	-320.00%—+320.00%	0.01%	100.00%		100% = no maximum scaling	6-19
2. 21	Actual value 2 min scale	-320.00%—+320.00%	0.01%	0.00%		0% = no minimum scaling	6-19
2. 22	Actual value 2 max scale	-320.00%—+320.00%	0.01%	100.00%		100% = no maximum scaling	6-19
2. 23	Error value inversion	0—1	1	0		0 = No 1 = Yes	6-20
2. 24	PI-controller reference value rise time	0.0—100.0 s	0.1 s	60.0 s		Time for reference value change from 0 % to 100 %	6-20
2. 25	PI-controller reference value fall time	0.0—100.0 s	0.1 s	60.0 s		Time for reference value change from 100 % to 0 %	6-20
2. 26	Direct frequency reference, source B	0—4	1	0		0 = Analog voltage input (term. 2) 1 = Analog current input (term. 4) 2 = Set reference from the panel (reference r1) 3 = Signal from internal motor pot. 4 = Signal from internal motor pot. reset if CX/CXL/CXS unit is stopped	6-20
2. 27	Source B reference scaling minimum value	0—par.2. 28	1 Hz	0 Hz		Selects the frequency that corresponds to the min. reference signal	6-20
2. 28	Source B reference scaling maximum value	0—f_{max}	1 Hz	0 Hz		Selects the frequency that corresponds to the max. reference signal 0 = Scaling off >0 = Scaled maximum value	6-20

Note! = Parameter value can be changed only when the drive is stopped

6

Group 3, Output and supervision parameters

Code	Parameter	Range	Step	Default	Custom	Description	Page
3. 1	Analog output function	0—15	1	1		0 = Not used Scale 100% 1 = O/P frequency(0—f_{max}) 2 = Motor speed (0—max. speed) 3 = O/P current (0—2.0 x I_{nCX}) 4 = Motor torque (0—2 x T_{nMot}) 5 = Motor power (0—2 x P_{nMot}) 6 = Motor voltage (0—100%xV_{nMot}) 7 = DC-link volt. (0—1000 V) 8—10 = Not in use 11 = PI-controller reference value 12 = PI-controller actual value 1 13 = PI-controller actual value 2 14 = PI-controller error value 15 = PI-controller output	6-21
3. 2	Analog output filter time	0.00—10.00 s	0.01s	1.00s			6-21
3. 3	Analog output inversion	0—1	1	0		0 = Not inverted 1 = Inverted	6-21
3. 4	Analog output minimum	0—1	1	0		0 = 0 mA 1 = 4 mA	6-21
3. 5	Analog output scale	10—1000%	1%	100%			6-21
3. 6	Digital output function	0—30	1	1		0 = Not used 1 = Ready 2 = Run 3 = Fault 4 = Fault inverted 5 = CX overheat warning 6 = External fault or warning 7 = Reference fault or warning 8 = Warning 9 = Reversed 10 = Jog speed selected 11 = At speed 12 = Motor regulator activated 13 = Output freq. limit superv. 1 14 = Output freq. limit superv. 2 15 = Torque limit supervision 16 = Reference limit supervision 17 = External brake control 18 = Control from I/O terminals 19 = Drive temperature limit supervision 20 = Unrequested rotation direction 21 = External brake control inverted 22—27 = Not in use 28 = Auxiliary drive 1 start 29 = Auxiliary drive 2 start 30 = Auxiliary drive 3 start	6-22
3. 7	Relay output 1 function	0—30	1	28		As parameter 3. 6	6-22
3. 8	Relay output 2 function	0—30	1	3		As parameter 3. 6	6-22
3. 9	Output freq. limit 1 supervision function	0—2	1	0		0 = No 1 = Low limit 2 = High limit	6-22
3. 10	Output freq. limit 1 supervision value	0.0—f_{max} (par. 1. 2)	0.1 Hz	0.0 Hz			6-22

Note! = Parameter value can be changed only when the drive is stopped.

Code	Parameter	Range	Step	Default	Custom	Description	Page
3. 11	Output freq. limit 2 supervision function	0—2	1	0		0 = No 1 = Low limit 2 = High limit	6-22
3. 12	Output freq. limit 2 supervision value	0.0—f_{max} (par. 1. 2)	0.1 Hz	0.0 Hz			6-22
3. 13	Torque limit supervision function	0—2	1	0		0 = No 1 = Low limit 2 = High limit	6-23
3. 14	Torque limit supervision value	0.0—200.0% xT_{nCX}	0.1%	100.0%			6-23
3. 15	Active reference limit supervision function	0—2	1	0		0 = No 1 = Low limit 2 = High limit	6-23
3. 16	Active reference limit supervision value	0.0—f_{max} (par. 1. 2)	0.1 Hz	0.0 Hz			6-23
3. 17	External brake off-delay	0.0—100.0 s	1	0.5 s			6-23
3. 18	External brake on-delay	0.0—100.0 s	1	1.5 s			6-23
3. 19	Drive temperature limit supervision function	0—2	1	0		0 = No 1 = Low limit 2 = High limit	6-23
3. 20	Drive temperature limit	-10—+75°C	1	+40°C			6-23
3. 21	I/O-expander board (opt.) analog output content	0—7	1	3		See parameter 3. 1	6-21
3. 22	I/O-expander board (opt.) analog output filter time	0.00—10.00 s	0.01	1.00 s		See parameter 3. 2	6-21
3. 23	I/O-expander board (opt.) analog output inversion	0—1	1	0		See parameter 3. 3	6-21
3. 24	I/O-expander board (opt.) analog output minimum	0—1	1	0		See parameter 3. 4	6-21
3. 25	I/O-expander board (opt.) analog output scale	10—1000%	1	100%		See parameter 3. 5	6-21

Group 4, Drive control parameters

Code	Parameter	Range	Step	Default	Custom	Description	Page
4. 1	Acc./dec. ramp 1 shape	0.0—10.0 s	0.1 s	0.0 s		0 = Linear >0 = S-curve acc./dec. time	6-24
4. 2	Acc./dec. ramp 2 shape	0.0—10.0 s	0.1 s	0.0 s		0 = Linear >0 = S-curve acc./dec. time	6-24
4. 3	Acceleration time 2	0.1—3000.0 s	0.1 s	10.0 s			6-25
4. 4	Deceleration time 2	0.1—3000.0 s	0.1 s	10.0 s			6-25
4. 5	Brake chopper	0—2	1	0		0 = Brake chopper not in use 1 = Brake chopper in use 2 = External brake chopper	6-25
4. 6	Start function	0—1	1	0		0 = Ramp 1 = Flying start	6-25
4. 7	Stop function	0—1	1	0		0 = Coasting 1 = Ramp	6-25

Note! = Parameter value can be changed only when the drive is stopped.

Code	Parameter	Range	Step	Default	Custom	Description	Page
4. 8	DC-braking current	0.15—1.5 x I_{nCX} (A)	0.1 A	0.5 x I_{nCX}			6-25
4. 9	DC-braking time at Stop	0.00-250.00 s	0.01 s	0.00 s		0 = DC-brake is off at Stop	6-25
4. 10	Turn on frequency of DC-brake during ramp Stop	0.1-10.0 Hz	0.1 Hz	1.5 Hz			6-27
4. 11	DC-brake time at Start	0.00-25.00 s	0.01 s	0.00 s		0 = DC-brake is off at Start	6-27
4. 12	Jog speed reference	f_{min} —f_{max} (1. 1) (1. 2)	0.1 Hz	10.0 Hz			6-27

Group 5, Prohibit frequency parameters

Code	Parameter	Range	Step	Default	Custom	Description	Page
5. 1	Prohibit frequency range 1 low limit	f_{min}— par. 5. 2	0.1 Hz	0.0 Hz			6-27
5. 2	Prohibit frequency range 2 high limit	f_{min}—f_{max} (1. 1) (1. 2)	0.1 Hz	0.0 Hz		0 = No prohibit frequency range	6-27
5. 3	Prohibit frequency range 2 low limit	f_{min}— par. 5. 4	0.1 Hz	0.0 Hz			6-27
5. 4	Prohibit frequency range 2 high limit	f_{min}—f_{max} (1. 1) (1. 2)	0.1 Hz	0.0 Hz		0 = No prohibit frequency range	6-27
5. 5	Prohibit frequency range 3 low limit	f_{min}— par. 5. 6	0.1 Hz	0.0 Hz			6-27
5. 6	Prohibit frequency range 3 high limit	f_{min}—f_{max} (1. 1) (1. 2)	0.1 Hz	0.0 Hz		0 = No prohibit frequency range	6-27

Group 6, Motor control parameters

Code	Parameter	Range	Step	Default	Custom	Description	Page
6. 1	Motor control mode	0—1	1	0		0 = Frequency control 1 = Speed control	6-27
6. 2	Switching frequency	1.0—16.0 kHz	0.1 kHz	10/3.6kHz		Depends on Hp rating	6-28
6. 3	Field weakening point	30—500 Hz	1 Hz	Param. 1. 11			6-28
6. 4	Voltage at field weakening point	15—200% x V_{nmot}	1%	100%			6-28
6. 5	V/Hz curve mid point frequency	0.0—f_{max}	0.1 Hz	0.0 Hz			6-28
6. 6	V/Hz curve mid point voltage	0.00—100.00% x V_{nmot}	0.01%	0.00%			6-28
6. 7	Output voltage at zero frequency	0.00—100.00% x V_{nmot}	0.01%	0.00%			6-28
6. 8	Overvoltage controller	0—1	1	1		0 = Controller is not operating 1 = Controller is in operation	6-29
6. 9	Undervoltage controller	0—1	1	1		0 = Controller is not operating 1 = Controller is in operation	6-29

6

Note! = Parameter value can be changed only when the drive is stopped.

Group 7, Protections

Code	Parameter	Range	Step	Default	Custom	Description	Page
7. 1	Response to reference fault	0—3	1	0		0 = No action 1 = Warning 2 = Fault, stop according to par 4.7 3 = Fault, always coasting stop	6-29
7. 2	Response to external fault	0—3	1	2		0 = No action 1 = Warning 2 = Fault, stop according to par 4.7 3 = Fault, always coasting stop	6-29
7. 3	Phase supervision of the motor	0—2	2	2		0 = No action 2 = Fault	6-29
7. 4	Ground protection	0—2	2	2		0 = No action 2 = Fault	6-29
7. 5	Motor thermal protection	0—2	1	2		0 = No action 1 = Warning 2 = Fault	6-30
7. 6	Motor thermal protection break point current	50.0—150.0 % x I_{nMOTOR}	1.0 %	100.0%			6-30
7. 7	Motor thermal protection zero frequency current	5.0—150.0% x I_{nMOTOR}	1.0 %	45.0%			6-31
7. 8	Motor thermal protection time constant	0.5—300.0 minutes	0.5 min.	17.0 min.		Default value is set according to motor nominal current	6-31
7. 9	Motor thermal protection break point frequency	10—500 Hz	1 Hz	35 Hz			6-32
7. 10	Stall protection	0—2	1	1		0 = No action 1 = Warning 2 = Fault	6-32
7. 11	Stall current limit	5.0—200.0% x I_{nMOTOR}	1.0%	130.0%			6-33
7. 12	Stall time	2.0—120.0 s	1.0 s	15.0 s			6-33
7. 13	Maximum stall frequency	1—f_{max}	1 Hz	25 Hz			6-33
7. 14	Underload protection	0—2	1	0		0 = No action 1 = Warning 2 = Fault	6-34
7. 15	Underload prot., field weakening area load	10.0—150.0 % x T_{nMOTOR}	1.0%	50.0%			6-34
7. 16	Underload protection, zero frequency load	5.0—150.0% x T_{nMOTOR}	1.0%	10.0%			6-34
7. 17	Underload time	2.0—600.0 s	1.0 s	20.0 s			6-34

Group 8, Autorestart parameters

Code	Parameter	Range	Step	Default	Custom	Description	Page
8. 1	Automatic restart: number of tries	0—10	1	0		0 = Not in use	6-35
8. 2	Automatic restart:multi attempt maximum trial time	1—6000 s	1 s	30 s			6-35
8. 3	Automatic restart: start function	0—1	1	0		0 = Ramp 1 = Flying start	6-36
8. 4	Automatic restart after undervoltage trip	0—1	1	0		0 = No 1 = Yes	6-36
8. 5	Automatic restart after overvoltage trip	0—1	1	0		0 = No 1 = Yes	6-36
8. 6	Automatic restart after overcurrent trip	0—1	1	0		0 = No 1 = Yes	6-36
8. 7	Automatic restart after reference fault trip	0—1	1	0		0 = No 1 = Yes	6-36
8. 8	Automatic restart after over/undertemperature fault trip	0—1	1	0		0 = No 1 = Yes	6-36

Group 9, Pump and fan control special parameters

Code	Parameter	Range	Stepl	Default	Custom	Description	Page
9. 1	Number of aux. drives	0—3	1	1			6-37
9. 2	Start frequency of auxiliary drive 1	I_{min}—I_{max}	0.1 Hz	51.0 Hz			6-37
9. 3	Stop frequency of auxiliary drive 1	I_{min}—I_{max}	0.1 Hz	25.0 Hz			6-37
9. 4	Start frequency of auxiliary drive 2	I_{min}—I_{max}	0.1 Hz	51.0 Hz			6-37
9. 5	Stop frequency of auxiliary drive 2	I_{min}—I_{max}	0.1 Hz	25.0 Hz			6-37
9. 6	Start frequency of auxiliary drive 3	I_{min}—I_{max}	0.1 Hz	51.0 Hz			6-37
9. 7	Stop frequency of auxiliary drive 3	I_{min}—I_{max}	0.1 Hz	25.0 Hz			6-37
9. 8							
9. 9							
9. 10	Start delay of the auxiliary drives	0.0—300.0 s	0.1 s	4.0 s			6-37
9. 11	Stop delay of the auxiliary drives	0.0—300.0 s	0.1 s	2.0 s			6-37
9. 12	Reference step after start of the 1 aux. drive	0.0—100.0 %	0.1 %	0.0 %		In % of actual value	6-38
9. 13	Reference step after start of the 2 aux. drive	0.0—100.0 %	0.1 %	0.0 %		In % of actual value	6-38
9. 14	Reference step after start of the 3 aux. drive	0.0—100.0 %	0.1 %	0.0 %		In % of actual value	6-38
9. 15	(Reserved)						
9. 16	Sleep level	0.0-120/500.0 Hz	0.1 Hz	0.0 Hz		Frequency below which the freq. of the speed controlled motor has go before starting the sleep delay counting (0.0 = not in use)	6-38
9. 17	Sleep delay	0.0—3000.0 s	0.1 s	30.0 s		Time that freq. has to be below par. 9.16 before stopping the CX/CXL/CXS	6-38
9. 18	Wake up level	0.0—100.0 %	0.1 %	0.0 %		Level of the actual value for restarting the CX/CXL/CXS	6-38
9. 19	Wake up function	0—1	1	0		0 =Wake up when falling below the wake up level 1 = Wake up when exeeding the wake up level	6-38
9. 20	PI-regulator bypass	0—1	1	0		1 = PI-regulator bypassed	6-39

Table 6.5-1 Special parameters, Groups 2—9.

6.5.2 Description of Groups 2—9 parameters

2. 1 DIA2 function

1: External fault, closing contact = Fault is shown and motor is stopped when the input is active

2: External fault, opening contact = Fault is shown and motor is stopped when the input is not active

3: Run enable contact open = Start of the motor disabled
contact closed = Start of the motor enabled

4: Acc. / Dec time select. contact open = Acceleration/Deceleration time 1 selected
contact closed = Acceleration/Deceleration time 2 selected

5: Reverse contact open = Forward
contact closed = Reverse
If two or more inputs are programmed to reverse only one of them is required for reverse

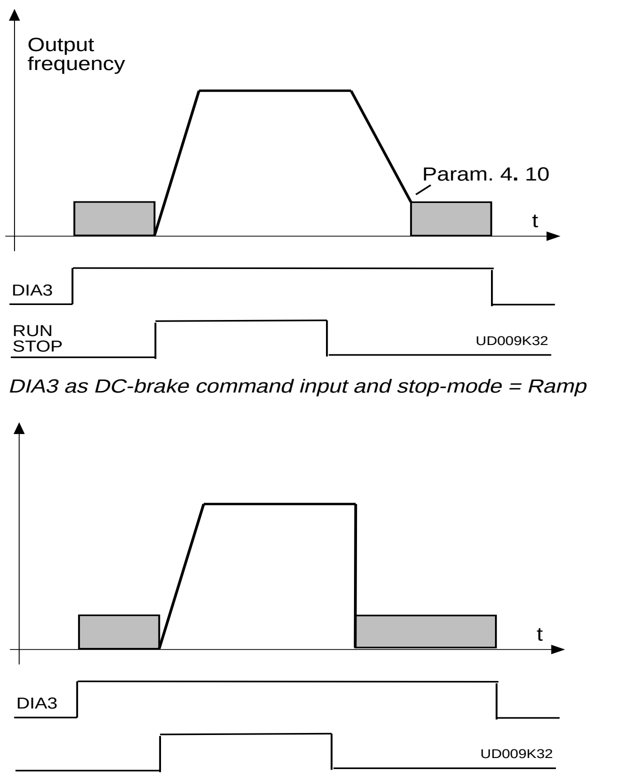
6: Jog freq. contact closed = Jog frequency selected for freq. refer.

7: Fault reset contact closed = Resets all faults

8: Acc./Dec. operation prohibited contact closed = Stops acceleration and deceleration until the contact is opened

9: DC-braking command contact closed = In the stop mode, the DC-braking operates until the contact is opened, see figure 6.5-1. DC-brake current is set with parameter 4. 8.

10: Motor (digital) pot. UP contact closed = Reference increases until the contact is opened



DIA3 as DC-brake command input and stop-mode = Ramp

DIA3 as DC-brake command input and stop-mode = Coasting

Figure 6.5-1 DIA3 as DC-brake command input:
a) Stop-mode = ramp,
b) Stop-mode = coasting

2. 2 DIA3 function

Selections are same as in 2. 1 except :

10: Motor (digital) pot. DOWN — contact closed = Reference decreases until the contact is opened

2. 3 V_{in} signal range

0 = Signal range 0—10 V
1 = Custom setting range from custom minimum (par. 2. 4) to custom maximum (par. 2. 5)

2. 4 V_{in} custom setting minimum/maximum

2. 5 These parameters set V_{in} for any input signal span within 0—10 V.

Minimum setting: Set the V_{in} signal to its minimum level, select parameter 2. 4, press the Enter button
Maximum setting: Set the V_{in} signal to its maximum level, select parameter 2. 5, press the Enter button

Note! The parameter values can only be set with this procedure (not with arrow up/arrow down buttons)

2. 6 V_{in} signal inversion

Parameter 2. 6 = 0, no inversion of analog V_{in} signal

Parameter 2. 6 = 1, inversion of analog V_{in} signal.

2. 7 V_{in} signal filter time

Filters out disturbances from the incoming analog V_{in} signal.
A long filtering time makes the regulation response slower.
See figure 6.5-2.

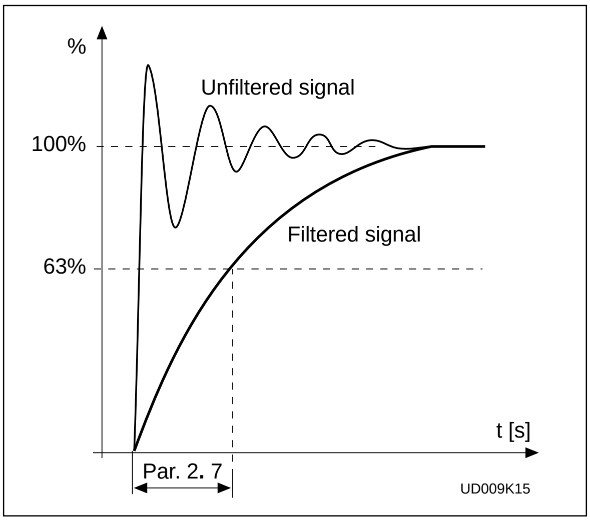


Figure 6.5-2 V_{in} signal filtering

2. 8 Analog input I_{in} signal range

0 = 0—20 mA
1 = 4—20 mA
2 = Custom signal span

6

2. 9 Analog input I_{in} custom setting
2. 10 minimum/maximum

With these parameters you can scale the input current signal (I_{in}) signal range between 0—20 mA.

Minimum setting: Set the I_{in} signal to its minimum level, select parameter 2. 9, press the Enter button
Maximum setting: Set the I_{in} signal to its maximum level, select parameter 2. 10, press the Enter button

Note! The parameter values can only be set with this procedure (not with the arrow up/ arrow down buttons)

2. 11 Analog input I_{in} inversion

Parameter 2. 11 = 0, no inversion of I_{in} input.
Parameter 2. 11 = 1, inversion of I_{in} input.

2. 12 Analog input I_{in} filter time

Filters out disturbances from the incoming analog I_{in} signal.
A long filtering time makes the regulation response slower.
See figure 6.5-3.

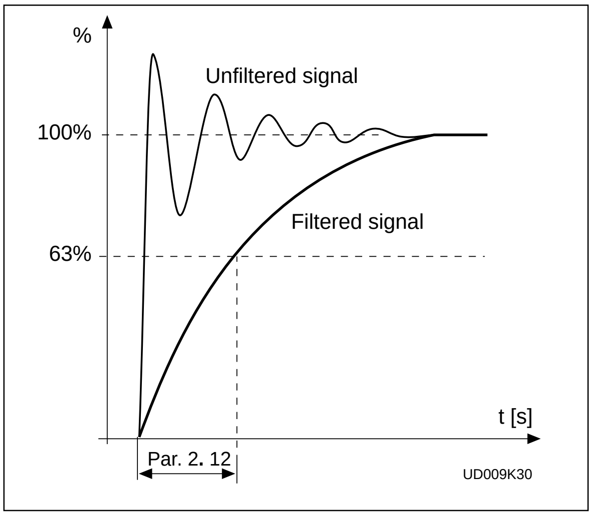


Figure 6.5-3 Analog input I_{in} filter time

2. 13 DIA5 function

1: External fault, closing contact = Fault is shown and motor is stopped when the input is active
2: External fault, opening contact = Fault is shown and motor is stopped when the input is not active

3: Run enable contact open = Start of the motor disabled
contact closed = Start of the motor enabled

4: Acc. / Dec time select. contact open = Acceleration/Deceleration time 1 selected
contact closed = Acceleration/Deceleration time 2 selected

5: Reverse contact open = Forward
contact closed = Reverse
If two or more inputs are programmed to reverse only one of them is required for reverse

6: Jog freq. contact closed = Jog frequency selected for freq. refer.

7: Fault reset contact closed = Resets all faults

8: Acc./Dec. operation prohibited contact closed = Stops acceleration and deceleration until the contact is opened

9: DC-braking command contact closed = In the stop mode, the DC-braking operates until the contact is opened, see figure 6.5-1. DC-brake current is set with parameter 4. 8.

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2. 14 Motor potentiometer ramp time

Defines how fast the electronic motor (digital) potentiometer value changes.

2. 15 PI-controller reference signal

0 Analog voltage reference from terminals 2—3, e.g. a potentiometer
1 Analog current reference trom terminals 4—5, e.g. a transducer.
2 Panel reference is the reference set from the Reference Page (REF). Reference r2 is the PI-controller reference, see chapter 6.
3 Reference value is changed with digital input signals DIA2 and DIA3.
- switch in DIA2 closed = frequency reference increases
- switch in DIA3 closed = frequency reference decreases
Speed of the reference change can be set with the parameter 2**.** 3.
4 Same as setting 3 but the reference value is set to the minimum frequency (par. 1**.** 1) each time the drive is stopped. When the value of parameter 1**.** 5 is set to 3 or 4, the value of parameter 2**.**1 is automatically set to 4 and the value of parameter 2**.** 2 is automatically set to 10.

2. 16 PI-controller actual value selection
2. 17 Actual value 1
2. 18 Actual value 2

These parameters select the PI-controller actual value.

2. 19 Actual value 1 minimum scale

Sets the minimum scaling point for Actual value 1. See figure 6.5-4.

2. 20 Actual value 1 maximum scale

Sets the maximum scaling point for Actual value 1. See figure 6.5-4.

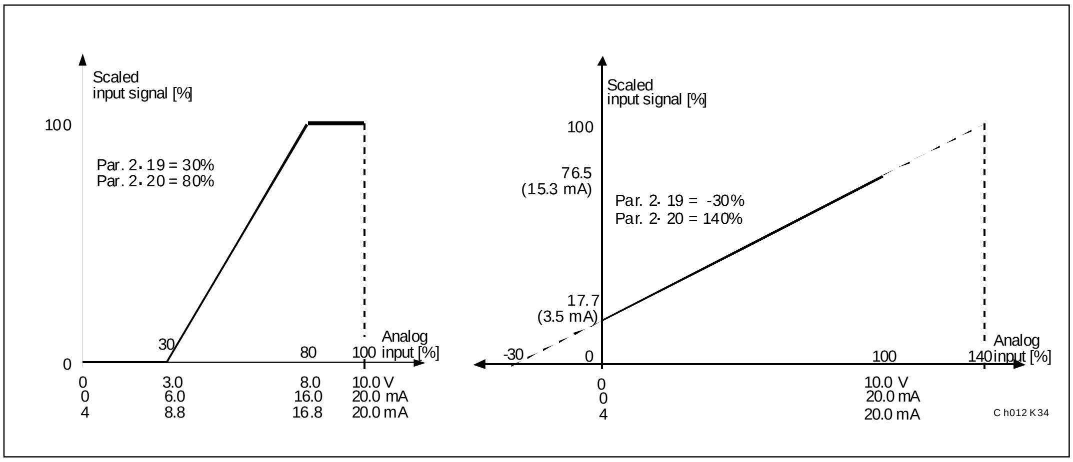

Figure 6.5-4 Examples about the scaling of actual value signal.

2. 21 Actual value 2 minimum scale

Sets the minimum scaling point for Actual value 2.

2. 22 Actual value 2 maximum scale

Sets the maximum scaling point for Actual value 2.

6

2. 23 Error value inversion

This parameter allows you to invert the error value of the PI-controller (and thus the the operation of the PI-controller).

2. 24 PI-controller minimum limit
2. 25 PI-controller maximum limit

These parameters set the minmum and maximum values of the PI-controller output.

Parameter value limits: par 1.1 <par. 2. 24 <par. 2. 25.

2. 26 Direct frequency reference, Place B

0 Analog voltage reference from terminals 2—3, e.g. a potentiometer
1 Analog current reference trom terminals 4—5, e.g. a transducer.
2 Panel reference is the reference set from the Reference Page (REF), Reference r1 is the Place B reference, see chapter 6.
3 Reference value is changed with digital input signals DIA2 and DIA3.
- switch in DIA2 closed = frequency reference increases
- switch in DIA3 closed = frequency reference decreases
Speed of the reference change can be set with the parameter 2. 3.
4 Same as setting 3 but the reference value is set to the minimum frequency (par. 1. 1) each time the drive is stopped.
When the value of parameter 1. 5 is set to 3 or 4, the value of parameter 2.1 is automatically set to 4 and the value of parameter 2. 2 is automatically set to 10.

2. 27 Place B reference scaling, minimum value/maximum value

2. 28 Setting limits: 0 < par. 2. 27 < par. 2. 28 < par. 1. 2.
If par. 2. 28 = 0 scaling is set off.
See figures 6.5-5 and 6.5-6.

(In the figures below the voltage input V_{in} with signal range 0—10 V is selected for source B reference)

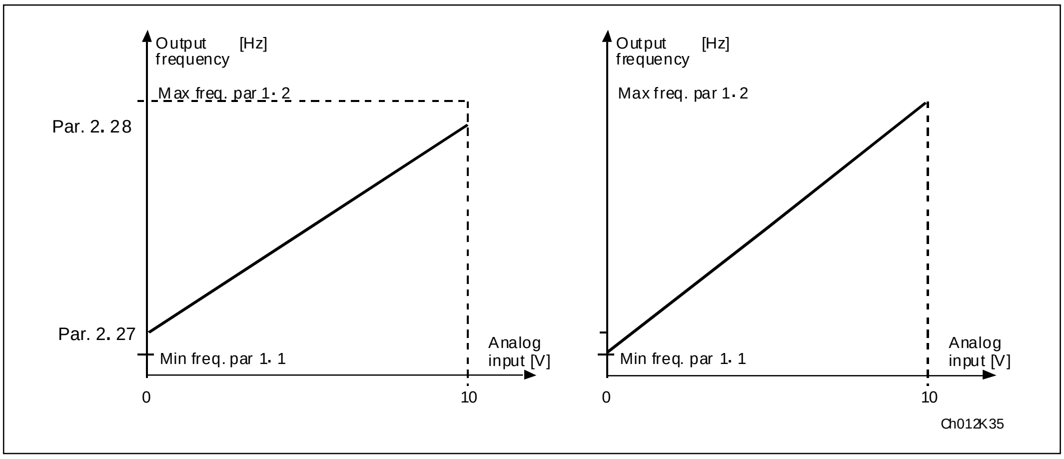

Figure 6.5-5 Reference scaling. *Figure 6.5-6 Reference scaling, par. 2. 15 = 0*

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3. 1 Analog output function

See table on page 6-10.

3. 2 Analog output filter time

Filters the analog output signal. See figure 6.5-7.

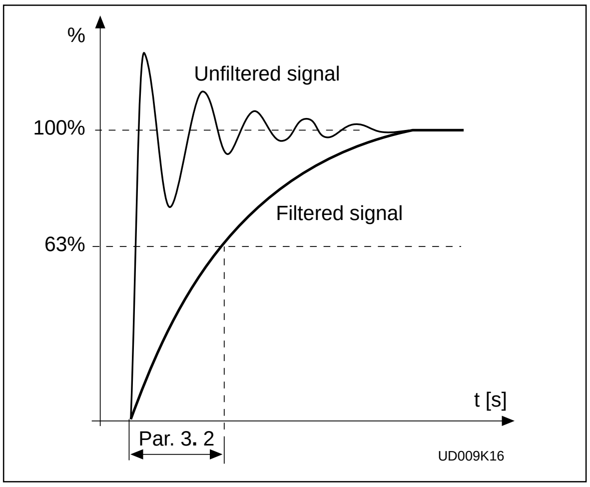

Figure 6.5-7 Analog output filtering.

3.3 Analog output invert

Inverts analog output signal:
max output signal = minimum set value
min output signal = maximum set value

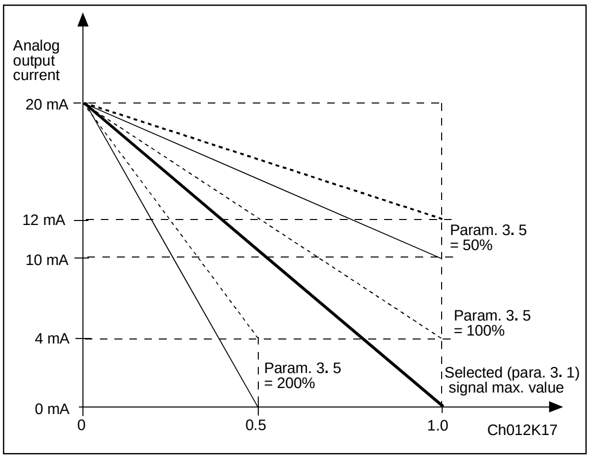

Figure 6.5-8 Analog output invert.

3. 4 Analog output minimum

Defines the signal minimum to be either 0 mA or 4 mA. See figure 6.5-9.

3. 5 Analog output scale

Scaling factor for analog output. See figure 6.5-9.

Signal	Max. value of the signal
Output freq.	Max. frequency (p. 1. 2)
Motor speed	Max. speed ($n_n x f_{max}/f_n$)
Output current	2 x I_{nCX}
Motor torque	2 x T_{nMot}
Motor power	2 x P_{nMot}
Motor voltage	100% x V_{nMot}
DC-link volt.	1000 V
PI-ref. value	100% x ref. value max.
PI-act. value1	100% x act. value max.
PI-act. value2	100% x act. value max.
PI-error value	100%x error value max.
PI-output	100% x output max.

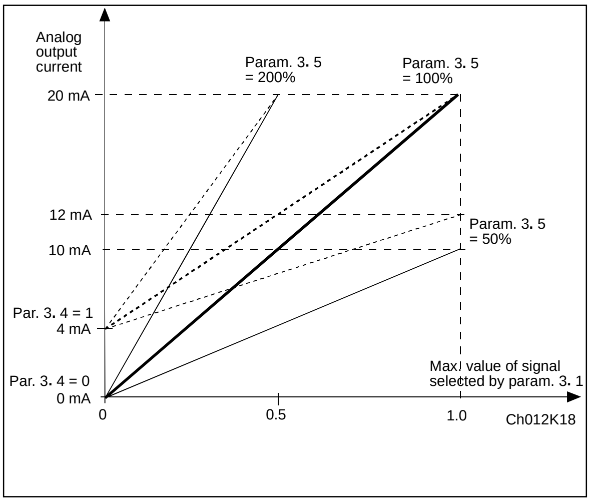

Figure 6.5-9 Analog output scale.

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3. 6 Digital output function
3. 7 Relay output 1 function
3. 8 Relay output 2 function

Setting value	Signal content
0 = Not used	Out of operation
	Digital output DO1 sinks current and programmable relay (RO1, RO2) is activated when:
1 = Ready	The drive is ready to operate
2 = Run	The drive operates (motor is running)
3 = Fault	A fault trip has occurred
4 = Fault inverted	A fault trip has not occurred
5 = CX overheat warning	The heat-sink temperature exceeds +70°C
6 = External fault or warning	Fault or warning depending on parameter 7. 2
7 = Reference fault or warning	Fault or warning depending on parameter 7. 1 - if analog reference is 4—20 mA and signal is <4mA
8 = Warning	If a warning exists. See Table 7.10-1 in User's Manual
9 = Reversed	The reverse command has been selected
10 = Multi-step or jog speed	Multi-step or jog speed has been selected by digital inp.
11 = At speed	The output frequency has reached the set reference
12 = Motor regulator activated	Overvoltage or overcurrent regulator was activated
13 = Output frequency supervision 1	The output frequency goes outside of the set supervision Low limit/ High limit (par. 3. 9 and par. 3. 10)
14= Output frequency supervision 2	The output frequency goes outside of the set supervision Low limit/ High limit (par. 3. 11 and par. 3. 12)
15= Torque limit supervision	The motor torque goes outside of the set supervision Low limit/ High limit (par. 3. 13 and par. 3. 14)
16= Active reference limit supervision	Active reference goes outside of the set supervision Low limit/ High limit (par. 3. 15 and par. 3. 16)
17 = External brake control	External brake ON/OFF control with programmable delay (par 3. 17 and 3. 18)
18 = Control from I/O terminals	External control mode selected with progr. pushbutton#2
19 = Drive temperature limit supervision	Temperature on drive goes outside the set supervision limits (par. 3. 19 and 3. 20)
20 = Unrequested rotation direction	Rotation direction of the motor shaft is different from the requested one
21 = External brake control inverted	External brake ON/OFF control (par. 3.17 and 3.18). Output active when brake control is ON
22—27 = Not in use	
28 = Auxiliary drive 1 start	Starts and stops auxiliary drive 1
29 = Auxiliary drive 2start	Starts and stops auxiliary drive 2
30 = Auxiliary drive 3 start	Starts and stops auxilary drive 3

Table 6.5-2 Output signals via DO1 and output relays RO1 and RO2.

3. 9 Output frequency limit 1, supervision function
3. 11 Output frequency limit 2, supervision function

0 = No supervision
1 = Low limit supervision
2 = High limit supervision

If the output frequency goes under/over the set limit (3. 10, 3. 12) this function generates a warning message via the digital output DO1 or via a relay output RO1 or RO2 depending on the settings of the parameters 3. 6—3. 8.

3. 10 Output frequency limit 1, supervision value
3. 12 Output frequency limit 2, supervision value

The frequency value to be supervised by the parameter 3. 9 (3. 11).
See figure 6.5-10.

6

3. 13 Torque limit , supervision function

0 = No supervision
1 = Low limit supervision
2 = High limit supervision

If the calculated torque value goes under/over the set limit (3. 14) this function generates a warning message via the digital output DO1 or via a relay output RO1 or RO2 depending on the settings of parameters 3. 6—3. 8.

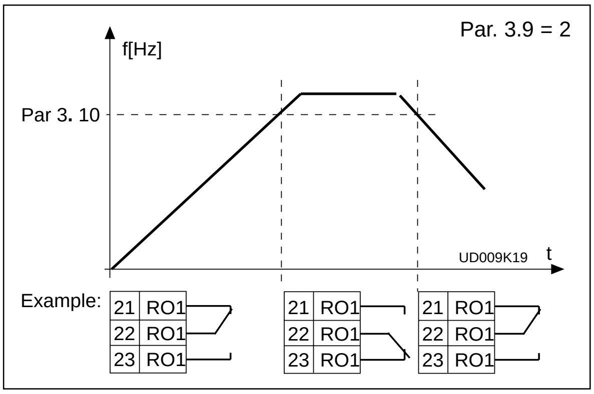

Figure 6.5-10 Output frequency supervision.

3. 14 Torque limit , supervision value

The calculated torque value to be supervised by parameter 3. 13.

3. 15 Active reference limit, supervision function

0 = No supervision
1 = Low limit supervision
2 = High limit supervision

If the reference value goes under/over the set limit (3. 16) this function generates a warning message via the digital output DO1 or via a relay output RO1 or RO2 depending on the settings of parameters 3. 6—3. 8. The supervised reference is the current active reference. It can be source A or B reference depending on DIB6 input or panel reference if the panel is the active control source.

3. 16 Active reference limit , supervision value

The frequency value to be supervised by the parameter 3. 15.

3. 17 External brake-off delay
3. 18 External brake-on delay

The function of the external brake can be delayed from the start and stop control signals with these parameters. See figure 6.5-11.

The brake control signal can be programmed via the digital output DO1 or via one of relay outputs RO1 and RO2, see parameters 3. 6—3. 8.

3. 19 Drive temperature limit supervision function

0 = No supervision
1 = Low limit supervision
2 = High limit supervision

If the temperature of the drive goes under/over the set limit (3. 20) this function generates a warning message via the digital output DO1 or via a relay output RO1 or RO2 depending on the settings of parameters 3. 6—3. 8.

3. 20 Drive temperature limit value

The temperature value to be supervised by parameter 3. 19.

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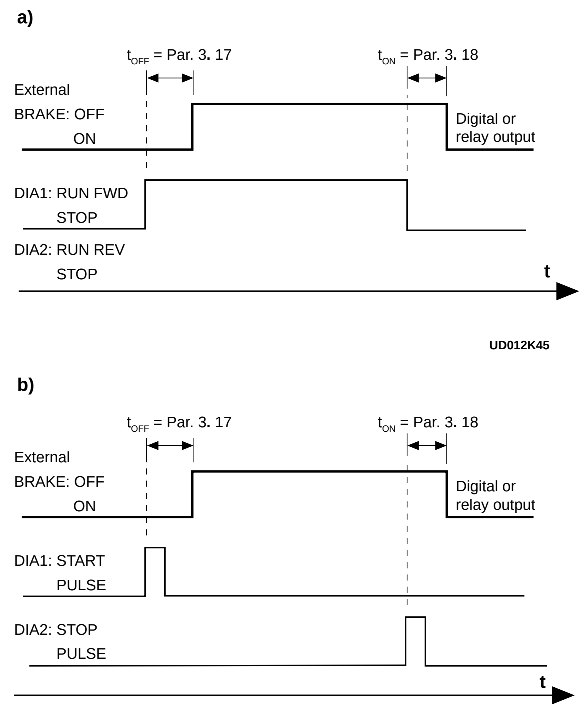

Figure 6.5-11 External brake control: a) Start/Stop logic selection par. 2. 1 = 0, 1 or 2
b)Start/Stop logic selection par. 2. 1 = 3.

4. 1 Acc/Dec ramp 1 shape
4. 2 Acc/Dec ramp 2 shape

The acceleration and deceleration ramp shape can be programmed with these parameters.

Setting the value = 0 gives you a linear ramp shape. The output frequency immediately follows the input with a ramp time set by parameters 1. 3, 1. 4 (4. 3, 4. 4 for Acc/Dec time 2).

Setting 0.1—10 seconds for 4. 1 (4. 2) causes an S-shaped ramp. The speed changes are smooth. Parameter 1. 3/ 1. 4 (4. 3/ 4. 4) determines the ramp time of the acceleration/deceleration in the middle of the curve. See figure See figure 6.5-12.

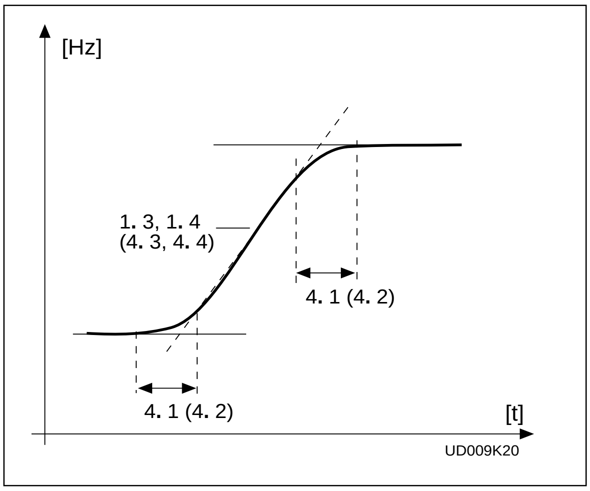

Figure 6.5-12 S-shaped acceleration/ deceleration.

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4. 3 Acceleration time 2

4. 4 Deceleration time 2

These values correspond to the time required for the output frequency to accelerate from the set minimum frequency (par. 1**.** 1) to the set maximum frequency (par. 1**.** 2). With this parameter it is possibile to set two different acceleration/ deceleration times for one application. The active set can be selected with programmable signal DIA3 of this application. See parameter 2**.** 2. Acceleration/ deceleration times can be reduced with a external free analog input signal. See parameters 2**.** 18 and 2**.** 19.

4. 5 Brake chopper

0 = No brake chopper
1 = Brake chopper and brake resistor installed
2 = External brake chopper

When the drive is decelerating the motor, the energy stored in the inertia of the motor and the load is fed into the external brake resistor. If the brake resistor is selected correctly the drive is able to decelerate the load with a torque equal to that of acceleration. See the separate Brake resistor installation manual.

4. 6 Start function

Ramp:

0 The drive starts from 0 Hz and accelerates to the set reference frequency within the set acceleration time. (Load inertia or starting friction may cause prolonged acceleration times).

Flying start:

1 The drive starts into a running motor by first finding the speed the motor is running at. Searching starts from the maximum frequency down until the actual frequency reached. The output frequency then accelerates/decelerates to the set reference value at a rate determined by the acceleration/deceleration ramp parameters.

Use this mode if the motor may be coasting when the start command is given. With the flying start it is possible to ride through short utility voltage interruptions.

4. 7 Stop function

Coasting:

0 The motor coasts to an uncontrolled stop with the CX/CXL/CXS off, after the Stop command.

Ramp:

1 After the Stop command, the speed of the motor is decelerated according to the deceleration ramp time parameter. If the regenerated energy is high it may be necessary to use an external braking resistor for faster deceleration.

4. 8 DC braking current

Defines the current injected into the motor during the DC braking.

4. 9 DC braking time at stop

4. 9 DC braking time at stop

Determines whether DC braking is ON or OFF. It also determines the braking duration time of the DC-brake when the motor is stopping. The function of the DC-brake depends on the stop function, parameter 4**.** 7. See figure 6.5-13.

0 DC-brake is not used

>0 DC-brake is in use depending on the setup of the stop function (param. 4**.** 7). The time is set by the value of parameter 4**.** 9:

Stop-function = 0 (coasting):

After the stop command, the motor will coast to a stop with the CX/CXL/CXS off.

With DC-injection, the motor can be electrically stopped in the shortest possible time, without using an optional external braking resistor.

The braking time is scaled according to the frequency when the DC- braking starts. If the frequency is ≥ nominal frequency of the motor (par. 1.11), the value of parameter 4.9 determines the braking time. When the frequency is ≤ 10% of the nominal, the braking time is 10% of the set value of parameter 4.9.

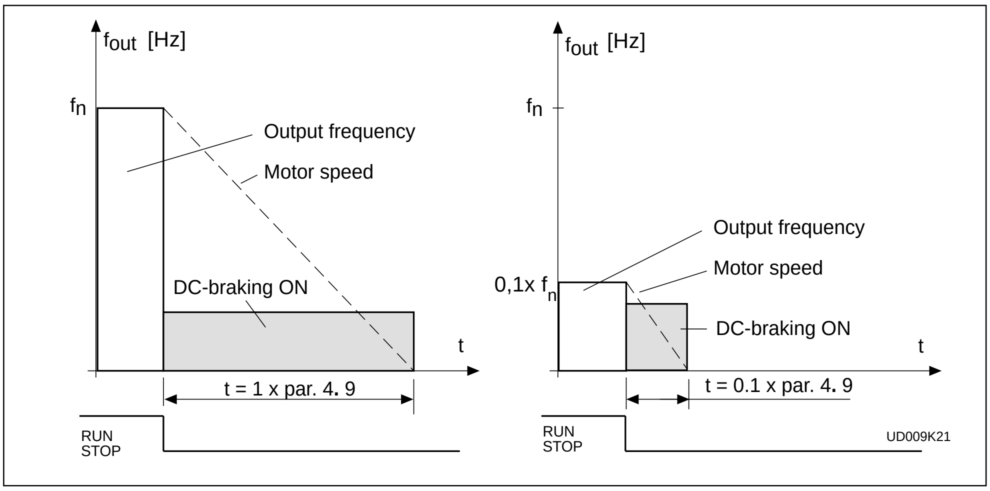

Figure 6.5-13 DC-braking time when par. 4. 7 = 0.

Stop-function = 1 (ramp):

After the Stop command, the speed of the motor is reduced baed on the deceleration ramp parameter, if no regeneration occurs due to load inertia, to a speed defined with by parameter 4**.** 10, where the DC-braking starts.

The braking time is defined with parameter 4**.** 9.

If high inertia exists, it is recommended to use an external braking resistor for faster deceleration. See figure 6.5-14.

4. 10 Execute frequency of DC-brake during ramp Stop

See figure 6.5-14.

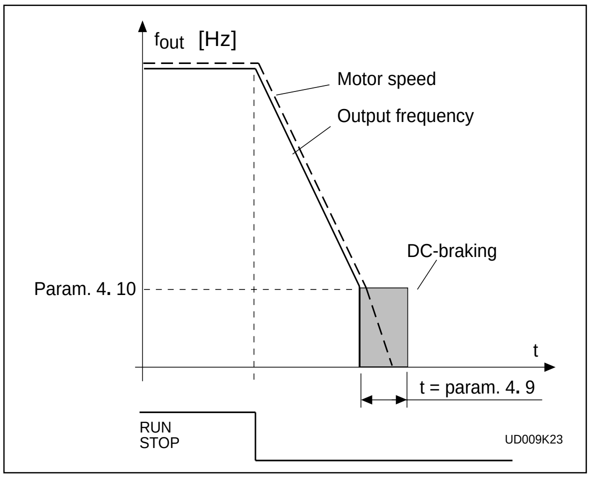

Figure 6.5-14 DC-braking time when par. 4. 7 = 1.

6

4. 11 DC-brake time at start

0 DC-brake is not used

>0 DC-brake is active when the start command is given. This parameter defines the time before the brake is released. After the brake is released the output frequency increases according to the set start function parameter 4. 6 and acceleration parameters (1. 3, 4. 1 or 4. 2, 4. 3), see figure 6.5-15.

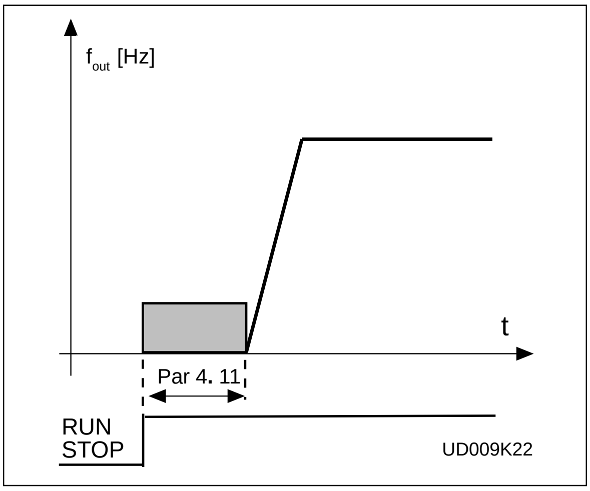

Figure 6.5-15 DC-braking time at start.

4. 12 Jog speed reference

Parameter value defines the jog speed selected with the digital input.

5. 1-5.6 Prohibit frequency area, Low limit/High limit

In some systems it may be necessary to avoid certain frequencies because of mechanical resonance problems.

With these parameters it is possible to set limits for three "skip frequency" regions. The accuracy of the setting is 0.1 Hz.

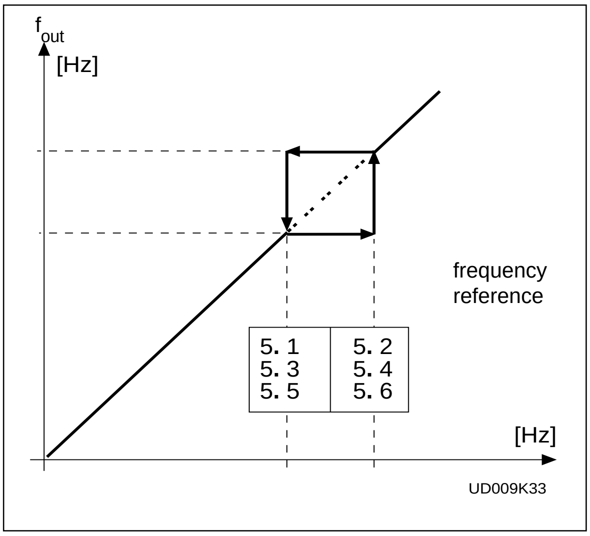

Figure 6.5-16 Example of prohibit frequency area setting.

6. 1 Motor control mode

0 = Frequency control: (V/Hz) — The I/O terminal and panel references are frequency references and the drive controls the output frequency (output freq. resolution 0.01 Hz)

1 = Speed control: (sensorless vector) — The I/O terminal and panel references are speed references and the drive controls the motor speed (control accuracy ± 0.5%).

6. 2 Switching frequency

Motor noise can be minimized by using a high switching frequency. Increasing the frequency reduces the capacity of the CX/CXL/CXS. Before changing the frequency from the factory default 10 kHz (3.6 kHz≥40Hp), check the drive derating from the curves in figure 5.2-2 and 5.2-3 of the User's Manual.

6. 3 Field weakening point

6. 4 Voltage at the field weakening point

The field weakening point is the output frequency where the output voltage reaches the set maximum value (par. 6**.** 4). Above that frequency the output voltage remains at the set maximum value.
Below that frequency output voltage depends on the setting of the V/Hz curve parameters 1**.** 8, 1**.** 9, 6**.** 5, 6**.** 6 and 6**.** 7. See figure 6.5-17.

When parameters 1**.** 10 and 1**.** 11, nominal voltage and nominal frequency of the motor are set, parameters 6**.** 3 and 6**.** 4 are also set automatically to the corresponding values. If different values for the field weakening point and the maximum output voltage are required, change these parameters <u>after</u> setting the parameters 1**.** 10 and 1**.** 11.

6. 5 V/Hz curve, middle point frequency

If the programmable V/Hz curve has been selected with parameter 1**.** 8 this parameter defines the middle point frequency of the curve. See figure 6.5-17.

6. 6 V/Hz curve, middle point voltage

If the programmable V/Hz curve has been selected with parameter 1**.** 8 this parameter defines the middle point voltage (% of motor nominal voltage) of the curve. See figure 6.5-17.

6. 7 Output voltage at zero frequency

If the programmable V/Hz curve has been selected with parameter 1**.** 8 this parameter defines the zero frequency voltage of the curve. See figure 6.5-17.

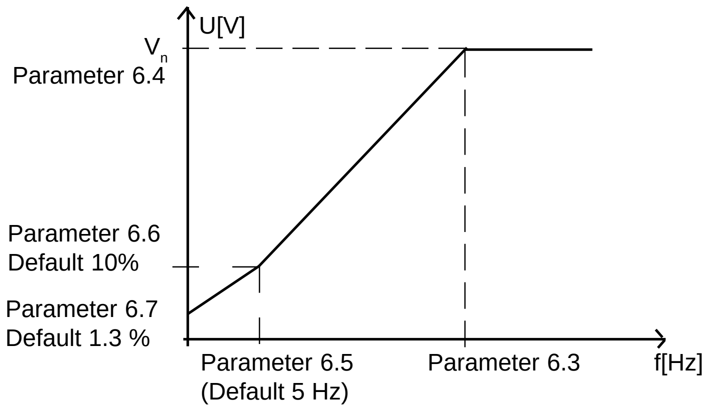

Figure 6.5-17 Programmable V/Hz curve.

6. 8 Overvoltage controller

6. 9 Undervoltage controller

These parameters allow the over/undervoltage controllers to be switched ON or OFF. This may be useful in cases where the utility supply voltage varies more than -15%—+10% and the application requires a constant speed. If the controllers are ON, they will change the motor speed in over/undervoltage cases. Overvoltage = faster, undervoltage = slower.

Over/undervoltage trips may occur when controllers are not used.

7. 1 Response to the reference fault

0 = No response
1 = Warning
2 = Fault, stop mode after fault according to parameter 4.7
3 = Fault, always coasting stop mode after fault

A warning or a fault action and message is generated if 4—20 mA reference signal is used and the signal falls below 4 mA. The information can also be programmed via digital output DO1 and via relay outputs RO1 and RO2.

7. 2 Response to external fault

0 = No response
1 = Warning
2 = Fault, stop mode after fault according to parameter 4.7
3 = Fault, always coasting stop mode after fault

A warning or a fault action and message is generated from the external fault signal in the digital input DIA3. The information can also be programmed into digital output DO1 and into relay outputs RO1 and RO2.

7. 3 Phase supervision of the motor

0 = No action
2 = Fault

Phase supervision of the motor ensures that the motor phases have approximately equal current.

7. 4 Ground fault protection

0 = No action
2 = Fault message

Ground fault protection ensures that the sum of the motor phase currents is zero. The overcurrent protection is always working and protects the drive from ground faults with high current levels.

Parameters 7. 5—7. 9 Motor thermal protection

General

Motor thermal protection is to protect the motor from overheating. The CX/CXL/CXS drive is capable of supplying higher than nominal current to the motor. If the load requires this high current, there is a risk that motor will be thermally overloaded. This is true especially at low frequencies. With low frequencies the cooling effect of the motor fan is reduced and the capacity of the motor is reduced. If the motor is equipped with an external fan, the load reduction on low speed is small.

Motor thermal protection is based on a calculated model and it uses the output current of the drive to determine the load on the motor. When the power is turned on to the drive, the calculated model uses the heatsink temperature to determine the initial thermal stage for the motor. The calculated model assumes that the ambient temperature of the motor is 40°C.

Motor thermal protection can be adjusted by setting several parameters. The thermal current I_T specifies the load current above which the motor is overloaded. This current limit is a function of the output frequency. The curve for I_T is set with parameters 7. 6, 7. 7 and 7. 9. Refer to the figure 6.5-18. The default values of these parameters are set from the motor nameplate data.

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With the output current at I_T the thermal stage will reach the nominal value (100%). The thermal stage changes by the square of the current. With output current at 75% from I_T the thermal stage will reach 56% value and with output current at 120% from I_T the thermal stage would reach 144% value. The function will trip the drive (refer par. 7**.** 5) if the thermal stage will reach a value of 105%. The response time of the thermal stage is determined with the time constant parameter 7**.** 8. The larger the motor the longer it takes to reach the final temperature.

The thermal stage of the motor can be monitored through the display. Refer to the table for monitoring items. (User's Manual, table 7.3-1).

!	CAUTION! *The calculated model does not protect the motor if the cooling of the motor is reduced either by blocking the airflow or due to dust or dirt.*

7. 5 Motor thermal protection

Operation:
- 0 = Not in use
- 1 = Warning
- 2 = Trip function

Tripping and warning will give a display indication with the same message code. If tripping is selected, the drive will stop and activate the fault stage.

Deactivating the protectionby setting this parameter to 0, will reset the thermal stage of the motor to 0%.

7. 6 Motor thermal protection, break point current

The current can be set between 50.0—150.0% x I_{nMotor}.
This parameter sets the value for thermal current at frequencies above the break point on the thermal current curve. Refer to the figure 6.5-18.

The value is set as a percentage of the motor nameplate nominal current, parameter 1**.** 13, nominal current of the motor, not the drive's nominal output current.

The motor's nominal current is the current which the motor can withstand in direct on-line use without being overheated.

If parameter 1**.** 13 is adjusted, this parameter is automatically restored to its default value.

Setting this parameter (or parameter 1**.** 13) does not affect the maximum output current of the drive. Parameter 1**.** 7 alone determines the maximum output current of the drive.

7. 7 Motor thermal protection, zero frequency current

The current can be set between 10.0—150.0% x I_{nMotor}. This parameter sets the value for thermal current at zero frequency. Refer to the figure 6.5-18.

The default value is set assuming that there is no external fan cooling the motor. If an external fan is used this parameter can be set to 90% (or higher).

The value is set as a percentage of the motor's nameplate nominal current, parameter 1**.** 13, not the drive's nominal output current. The motor's nominal current is the current which the motor can stand in direct on-line use without being overheated.

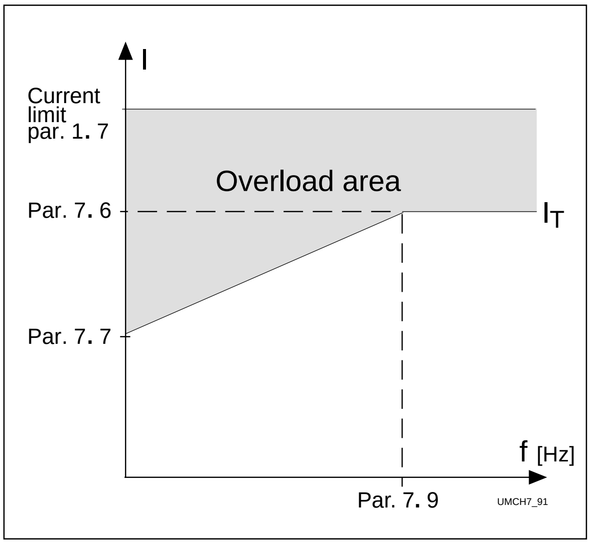

Figure 6.5-18 Motor thermal current I_T curve.

If you change parameter 1. 13, this parameter is automatically restored to the default value.

Setting this parameter (or parameter 1. 13) does not affect to the maximum output current of the drive. Parameter 1. 7 alone determines the maximum output current of the drive.

7. 8 Motor thermal protection, time constant

The time can be set between 0.5—300 minutes.This is the thermal time constant of the motor. The larger the motor the greater the time constant. The time constant is defined as the time it takes the calculated thermal stage to reach 63% of its final value.

The motor thermal time is specific to a motor design and it varies between different motor manufacturers.

The default value for the time constant is calculated based on the motor nameplate data from parameters 1. 12 and 1. 13. If either of these parameters is reset, then this parameter is set to its default value.

If the motor's t_6 -time is known (given by the motor manufacturer) the time constant parameter could be set based on t_6 -time. As a rule of thumb, the motor thermal time constant in minutes equals to $2xt_6$ (t_6 in seconds is the time a motor can safely operate at six times the rated current). If the drive is in stopped, the time constant is internally increased to three times the set parameter value. The cooling in the stop stage is based on convection with an increased time constant.

7. 9 Motor thermal protection, break point frequency

The frequency can be set between 10—500 Hz.This is the frequency break point of thermal current curve. With frequencies above this point the thermal capacity of the motor is assumed to be constant. Refer to the figure 6.5-18.

The default value is based on motor's nameplate data, parameter 1**.** 11. It is 35 Hz for a 50 Hz motor and 42 Hz for a 60 Hz motor. More generally it is 70% of the frequency at the field weakening point (parameter 6**.** 3). Changing either parameter 1**.** 11 or 6**.** 3 will restore this parameter to its default value.

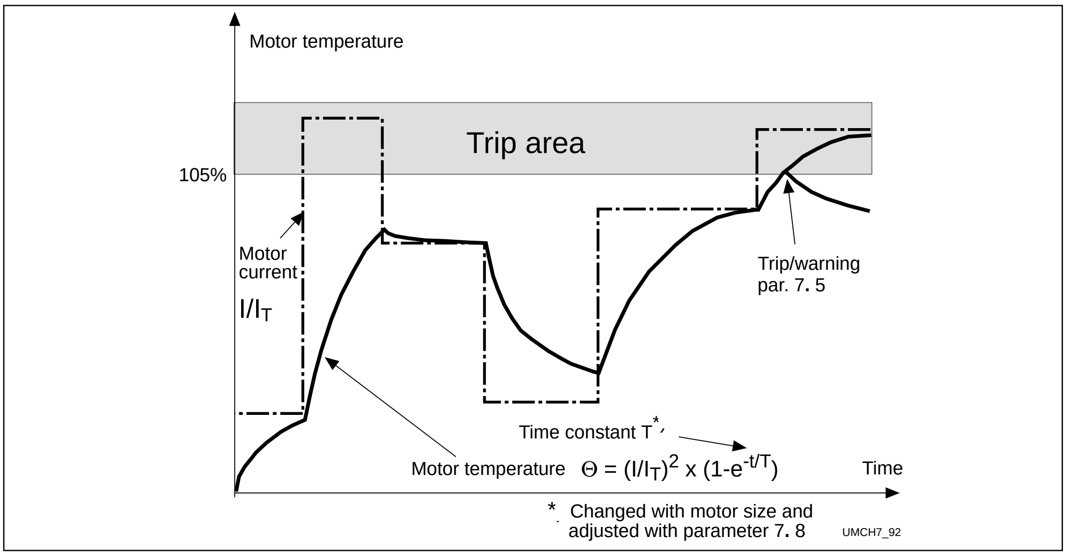

Figure 6.5-19 Calculating motor temperature

Parameters 7. 10— 7. 13, Stall protection
General

Motor stall protection protects the motor from short time overload situations like a stalled shaft. The reaction time of stall protection can be set shorter than with motor thermal protection. The stall state is defined with two parameters, 7.11. Stall Current and 7.13. Stall Frequency. If the current is higher than the set limit and output frequency is lower than the set limit, the stall state is true. There is actually no real indication of the shaft rotation. Stall protection is a type of overcurrent protection.

7. 10 Stall protection

Operation:

0 = Not in use
1 = Warning
2 = Trip function

Tripping and warning will give a display indication with the same message code. If tripping is set on, the drive will stop and activate the fault stage.

Setting this parameter to 0 will deactivate the protection and will reset the stall time counter to zero.

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7. 11 Stall current limit

The current can be set between 0.0—200% x I_{nMotor}.

In the stall stage the current has to be above this limit. Refer to the figure6.5-20. The value is set as a percentage of the motor's name-plate nominal current, parameter 1.13. If parameter 1.13 is adjusted, this parameter is automatically restored to its default value.

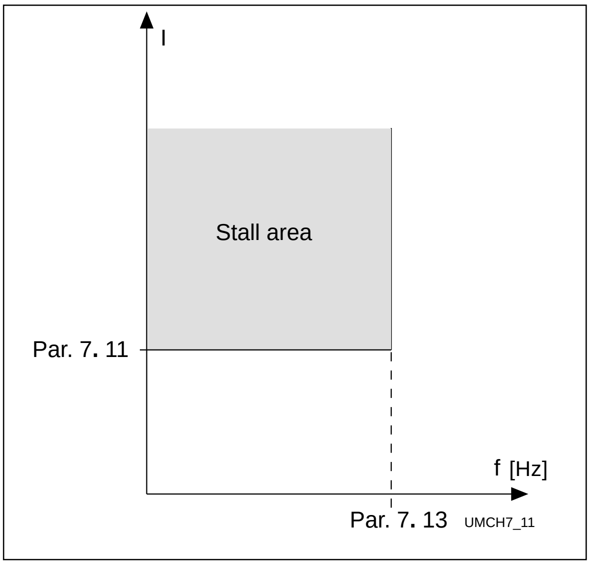

Figure 6.5-20 Setting the stall characteristics.

7. 12 Stall time

The time can be set between 2.0—120 s.
This is the maximum allowed time for a stall stage. There is an internal up/down counter to count the stall time. Refer to the figure 6.5-21.
If the stall time counter value goes above this limit the protection will cause a trip (refer to the parameter 7. 10).

7. 13 Maximum stall frequency

The frequency can be set between 1—f_{max} (par. 1. 2).
In the stall state, the output frequency has to be smaller than this limit. Refer to figure 6.5-20.

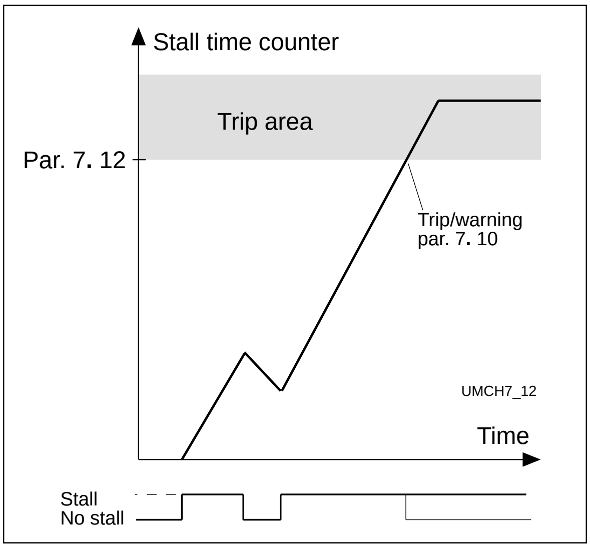

Figure 6.5-21 Counting the stall time.

Parameters 7. 14— 7. 17, Underload protection
General

The purpose of motor underload protection is to ensure that there is load on the motor while the drive is running. If the motor load is reduced, there might be a problem in the process, e.g. broken belt or dry pump.

Motor underload protection can be adjusted by setting the underload curve with parameters 7. 15 and 7. 16. The underload curve is a squared curve set between zero frequency and the field weakening point. The protection is not active below 5Hz (the underload counter value is stopped). Refer to figure 6.5-22.

The torque values for setting the underload curve are set with percentage values which refer to the nominal torque of the motor. The motor's nameplate data, parameter 1**.** 13, the motor's nominal current and the drive's nominal current I_{CT} are used to find the scaling ratio for the internal torque value. If other than standard motor is used with the drive, the accuracy of the torque calculation is decreased.

7. 14 Underload protection

Operation:
- 0 = Not in use
- 1 = Warning
- 2 = Fault

Tripping and warning will give a display indication with the same message code. If tripping is set active the drive will stop and activate the fault stage.

Deactivating the protection, by setting this parameter to 0, will reset the underload time counter to zero.

7. 15 Underload protection, field weakening area load

The torque limit can be set between 20.0—150 % x T_{nMotor}.

This parameter is the value for the minimum allowed torque when the output frequency is above the field weakening point.

Refer to the figure 6.5-22.
If parameter 1**.** 13 is adjusted, this parameter is automatically restored to its default value.

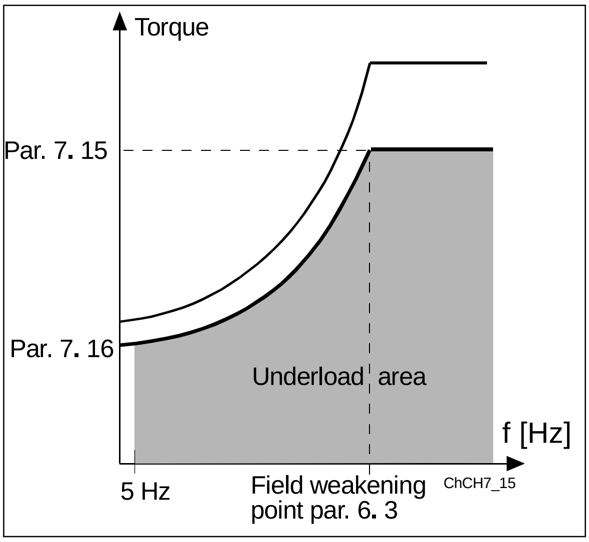

Figure 6.5-22 Setting of minimum load.

7. 16 Underload protection, zero frequency load

Torque limit can be set between 10.0—150 % x T_{nMotor}.

This parameter is the value for the minimum allowed torque with zero frequency. Refer to the figure 6.5-22. If parameter 1**.** 13 is adjusted, this parameter is automatically restored to its default value.

7. 17 Underload time

This time can be set between 2.0—600.0 s.

This is the maximum allowed time for an underload state. There is an internal up/down counter to accumulate the underload time. Refer to the figure 6.5-23.
If the underload counter value goes above this limit, the protection will cause a trip (refer to the parameter 7**.** 14). If the drive is stopped the underload counter is reset to zero.

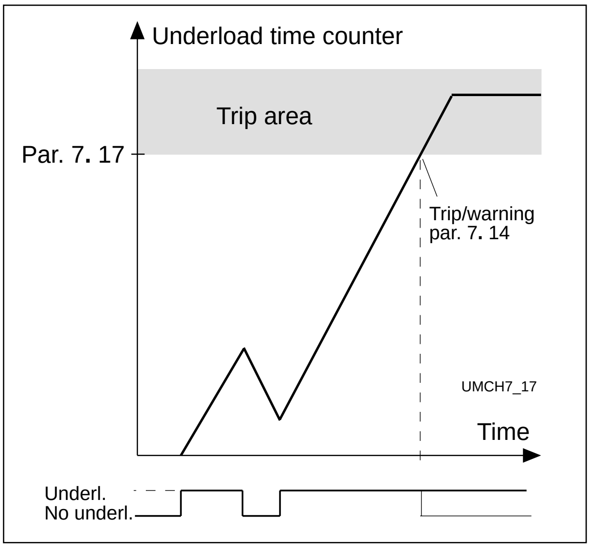

Figure 6.5-23 Counting the underload time.

8. 1 Automatic restart: number of tries
8. 2 Automatic restart: trial time

The Automatic restart function restarts the drive after the faults selected with parameters 8. 4—8. 8. The Start function for Automatic restart is selected with parameter 8. 3.

Parameter 8. 1 determines how many automatic restarts can be made during the trial time set by the parameter 8. 2.

The time counting starts from the first autorestart. If the number of restarts does not exceed the value of parameter 8.1 during the trial time, the counting is cleared after the trial time has elapsed. The next fault starts the counting again.
See figure 6.5-24.

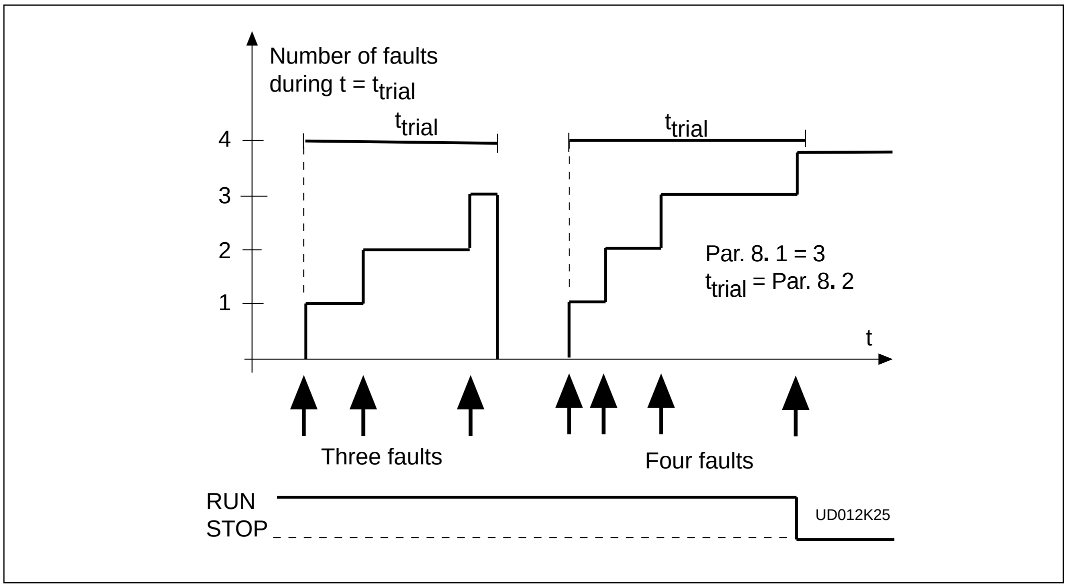

Figure 6.5-24 Automatic restart.

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8. 3 Automatic restart, start function

The parameter defines the start mode:
0 = Start with ramp
1 = Flying start, see parameter 4**.** 6.

8. 4 Automatic restart after undervoltage trip

0 = No automatic restart after undervoltage trip
1 = Automatic restart after undervoltage fault condition returns to the normal condition (DC-link voltage returns to the normal level)

8. 5 Automatic restart after overvoltage trip

0 = No automatic restart after overvoltage trip
1 = Automatic restart after overvoltage fault condition returns to the normal condition (DC-link voltage returns to the normal level)

8. 6 Automatic restart after overcurrent trip

0 = No automatic restart after overcurrent trip
1 = Automatic restart after overcurrent faults

8. 7 Automatic restart after reference fault trip

0 = No automatic restart after reference fault trip
1 = Automatic restart after analog current reference signal (4—20 mA) returns to the normal level (≥4 mA)

8. 8 Automatic restart after over/undertemperature fault trip

0 = No automatic restart after temperature fault trip
1 = Automatic restart after heatsink temperature has returned to its normal level between -10°C—+75°C.

9. 1 Number of auxiliary drives

With this parameter the number of auxiliary drives in use is defined. The signals to control the auxiliary drives on and off can be programmed to the relay outputs or to the digital output with parameters 3. 6 - 3. 8. The default setting is one auxiliary drive in use, pre-programmed to relay output RO1.

9. 2 Start frequency of auxiliary drive 1
9. 4 Start frequency of auxiliary drive 2
9. 6 Start frequency of auxiliary drive 3

The frequency of the CX/CXL/CXS must exceed by 1 Hz the limit defined with these parameters before the auxiliary drive is started. The 1 Hz provides hysteresis to avoid unnecessary starts and stops. See figure 6.5-25.

9. 3 Stop frequency of auxiliary drive 1
9. 5 Stop frequency of auxiliary drive 2
9. 7 Stop frequency of auxiliary drive 3

The frequency of the CX/CXL/CXS must fall 1Hz below the limit defined with these parameters before the auxiliary drive is stopped. The stop frequency limit also defines the frequency the drive drops to after starting the auxiliary drive. See figure 6.5-25.

9. 10 Start delay of auxiliary drives

Starting of the auxiliary drives is delayed based on the time setting of parameter 9. 10. This prevents unnecessary starts which could be caused by a flow reference request which is momentarily above the previous reference level. See figure 6.5-25.

9. 11 Stop delay of auxiliary drives

Stopping of the auxiliary drives is delayed based on the time setting of parameter 9. 10. This prevents unnecessary stops which could be caused by a flow reference request which is momentarily below the previous reference level. See figure 6.5-25.

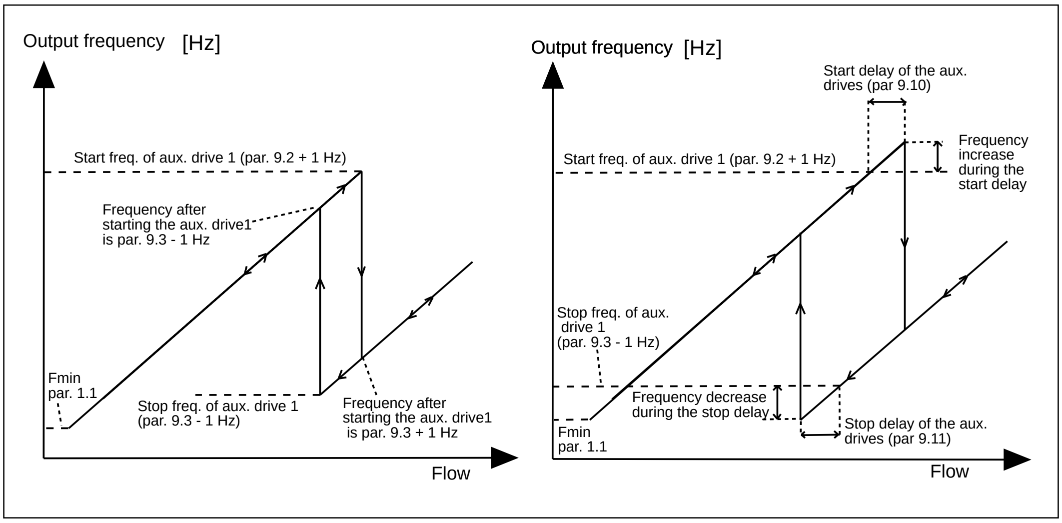

Figure 6.5-25 Example of the effect of parameters in variable speed and one auxiliary drive system.

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9. 12 Reference step after start of the auxiliary drive 1
9. 13 Reference step after start of the auxiliary drive 2
9. 14 Reference step after start of the auxiliary drive 3

A reference step will automatically be added to the reference value when the corresponding auxiliary drive is started. This allows compensation for the pressure loss in the piping caused by the increased flow. See figure 6.5-26.

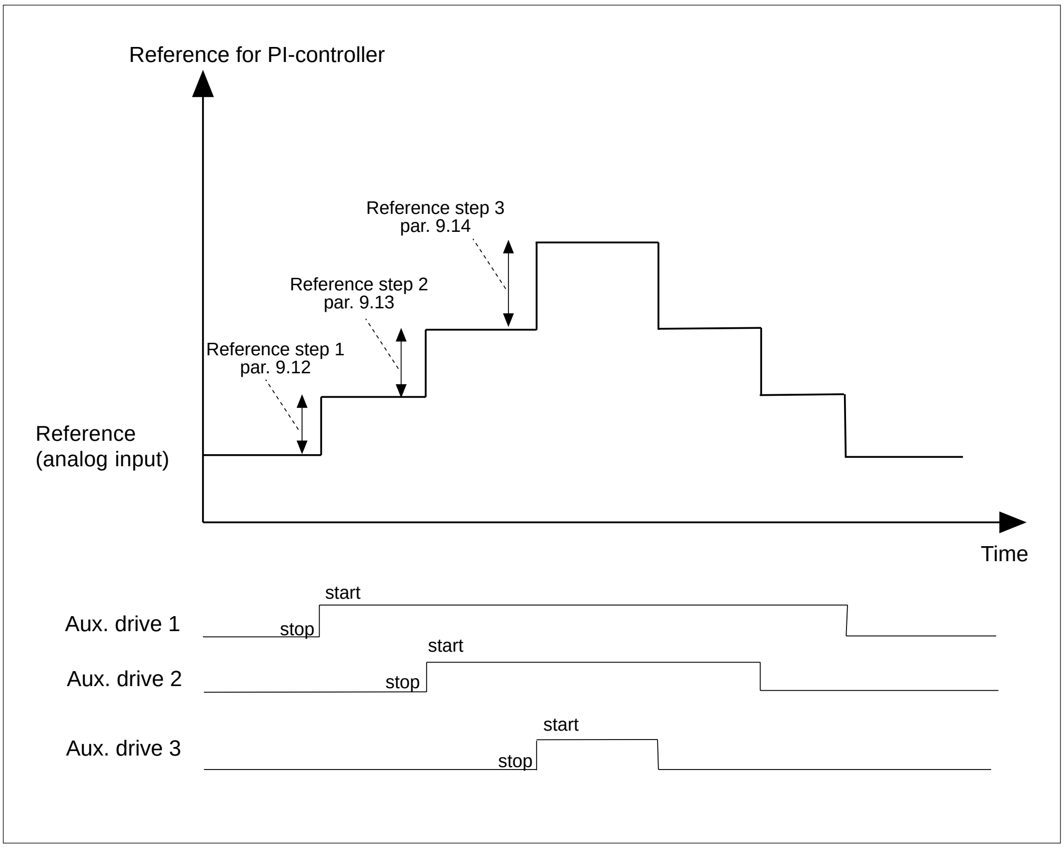

Figure 6.5-26 Reference steps after starting and stopping the auxiliary drives.

9. 16 Sleep level
9. 17 Sleep delay

Changing this parameter from a value of 0.0 Hz activates the sleep function where the drive is stopped automatically when the frequency is below the sleep level (par. 9.16) continuously over the sleep delay (9. 17) time. During the stop state the Pump and fan control logic is operating and will switch the drive to the Run state when the wake up level defined with parameters 9. 18 and 9. 19 is reached. See figure 6.5-27.

9. 18 Wake up level

The wake up level defines the percentage level below which the actual frequency must fall or which has to be exceeded before starting the drive from the sleep function. See figure 6.5-27.

9. 19 Wake up function

This parameter defines if the wake up occurs when the frequency either falls below or exceeds the wake up level (par. 9. 18).

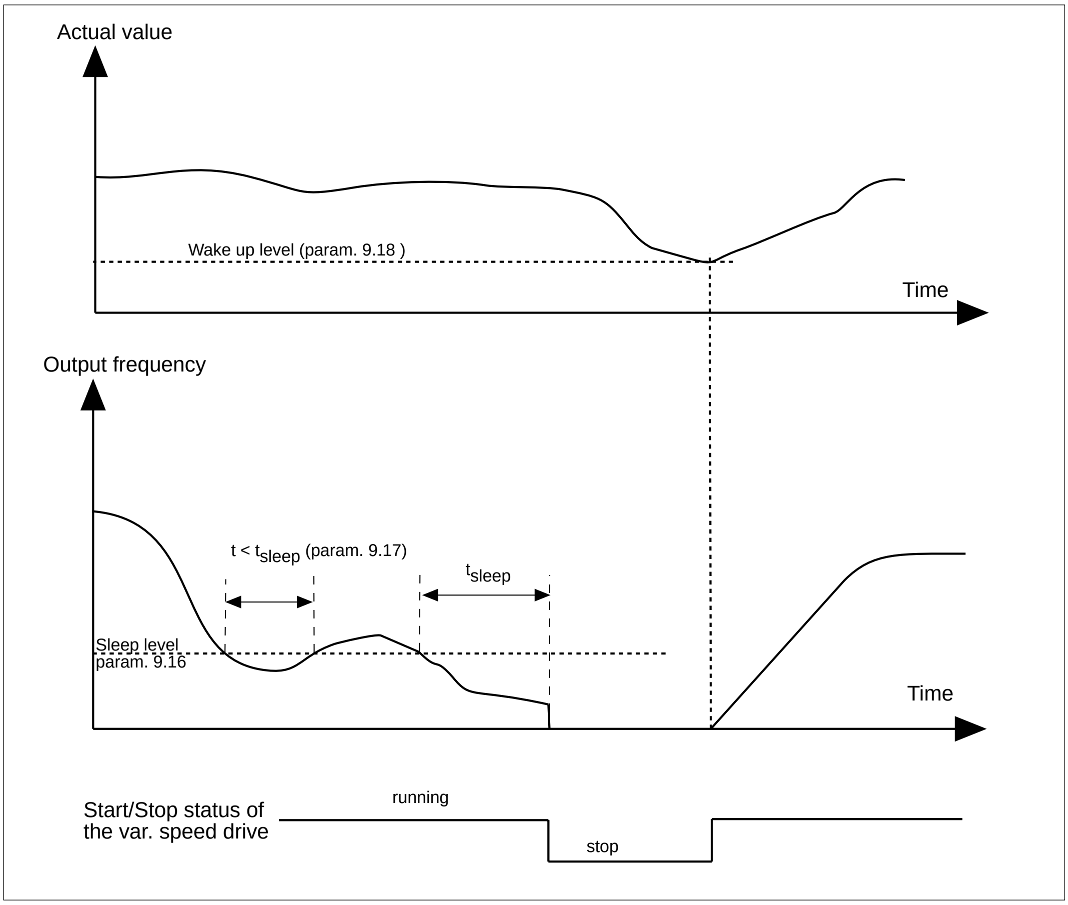

Figure 6.5-27 Example of the sleep function.

9. 20 PI-regulator bypass

With this parameter the PI-requlator can be programmed to be bypassed. Then the frequency of the drive is controlled by the frequency reference and the starting points of the auxiliary drives are also defined by this reference.

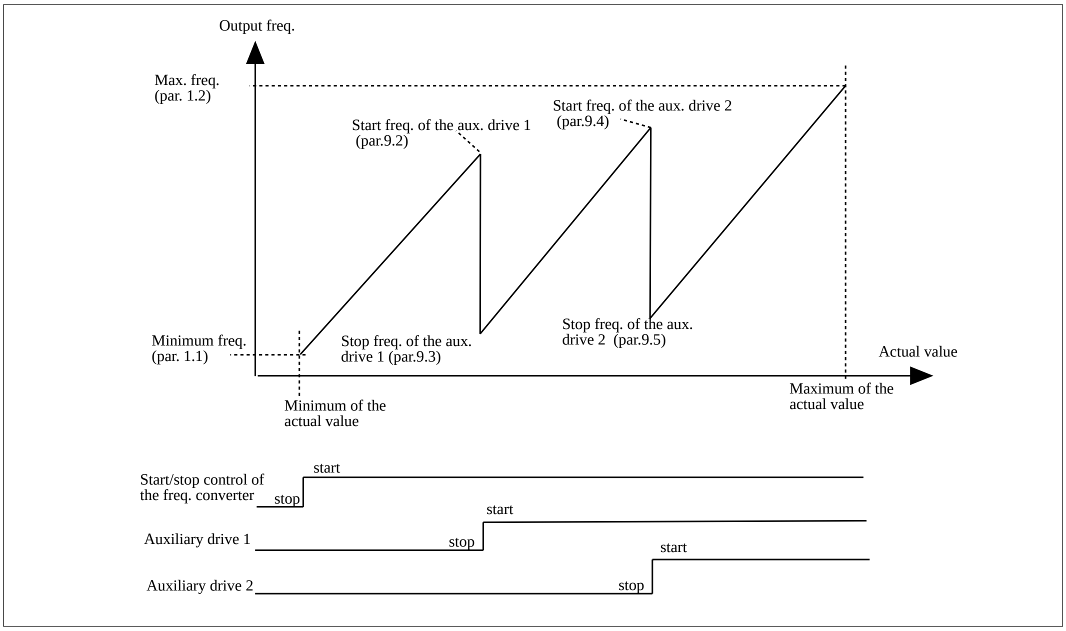

Figure 6.5-28 Example of the function of variable speed drive and two auxiliary drives when PI-requlator is bypassed with parameter 9. 20.

6

6.6 MONITORING DATA

The PI-control application has additional items for monitoring (n20 - n25). See table 6.6-1

Data number	Data name	Unit	Description
v 1	Output frequency	Hz	Frequency to the motor
v 2	Motor speed	rpm	Calculated motor speed
v 3	Motor current	A	Measured motor current
v 4	Motor torque	%	Calculated actual torque/nominal torque of the unit
v 5	Motor power	%	Calculated actual power/nominal power of the unit
v 6	Motor voltage	V	Calculated motor voltage
v 7	DC-link voltage	V	Measured DC-link voltage
v 8	Temperature	°C	Temperature of the heat sink
v 9	Operating day counter	DD.dd	Operating days [1], not resettable
v 10	Operating hours, "trip counter"	HH.hh	Operating hours [2], can be reset with programmable button #3
v 11	MW-hours	MWh	Total MW-hours, not resettable
v 12	MW-hours, "trip counter"	MWh	MW-hours, can be reset with programmable button #4
v 13	Voltage/analog input	V	Voltage of the terminal V_{in}+ (term. #2)
v 14	Current/analog input	mA	Current of terminals I_{in}+ and I_{in}- (term. #4, #5)
v 15	Digital input status, gr. A		
v 16	Digital input status, gr. B		
v 17	Digital and relay output status		
v 18	Control program		Version number of the control software
v 19	Unit nominal power	Hp	Shows the horsepower size of the unit
v 20	PI-controller reference	%	Percent of the maximum reference
v 21	PI-controller actual value	%	Percent of the maximum actual value
v 22	PI-controller error value	%	Percent of the maximum error value
v 23	PI-controller output	Hz	
v 24	Number of running auxiliary drives		
v 25	Motor temperature rise	%	100%= temperature of motor has risen to nominal

Table 6.6-1 Monitored items.

[1] DD = full days, dd = decimal part of a day

[2] HH = full hours, hh = decimal part of an hour

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6.7 Panel reference

The Pump and fan control application has an extra reference (r2) for PI-controller on the panel's reference page. See table 6.7-1.

Refrence number	Reference name	Range	Step	Function
r1	Frequency reference	f_{min}—f_{max}	0.01 Hz	Reference for panel control and I/O terminal Source B reference.
r2	PI-controller reference	0—100%	0.1%	Reference for PI-controller

Table 6.7-1 Panel reference.

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Remarks:

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