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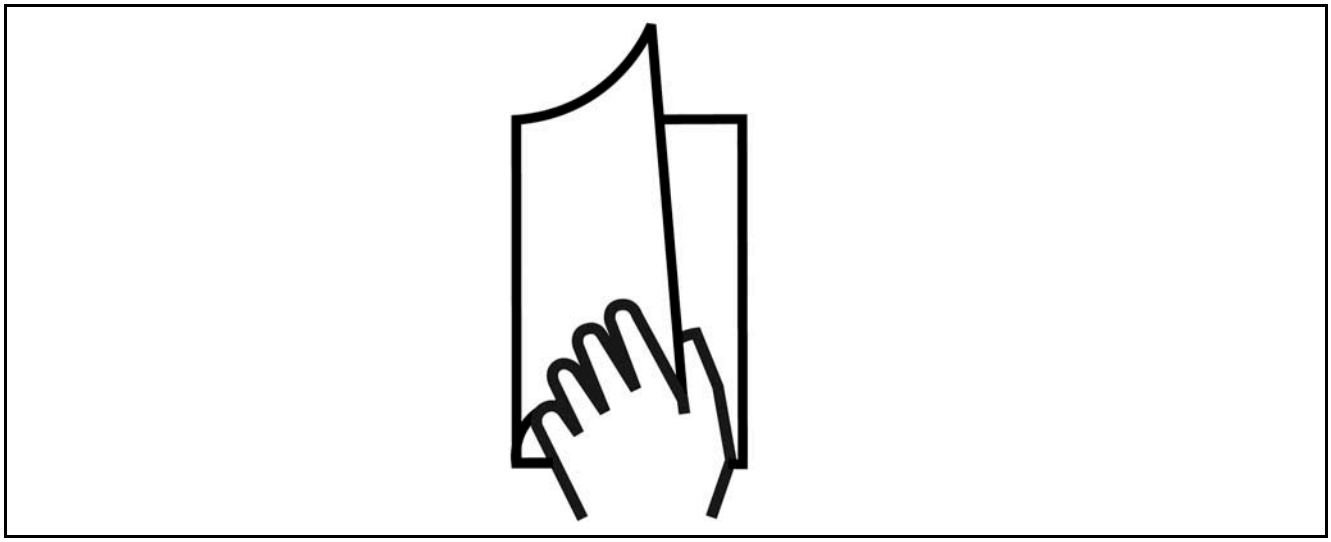

□ **How to Read this Design Guide**
This Design Guide will introduce all aspects of your FC 300.

Available literature for FC 300

- The VLT® AutomationDrive FC 300 Instruction Manual MG.33.AX.YY provides the necessary information for getting the drive up and running.
- The VLT® AutomationDrive FC 300 Design Guide MG.33.BX.YY entails all technical information about the drive and customer design and applications.
- The VLT® AutomationDrive FC 300 Profibus Instruction Manual MG.33.CX.YY provides the information required for controlling, monitoring, and programming the drive via a Profibus serial communication bus.
- The VLT® AutomationDrive FC 300 DeviceNet Instruction Manual MG.33.DX.YY provides the information required for controlling, monitoring, and programming the drive via a DeviceNet serial communication bus.

X = Revision number
YY = Language code

Danfoss Drives technical literature is also available online at www.danfoss.com/BusinessAreas/DrivesSolutions/Documentations/Technical+Documentation.

□ **Approvals**

How to Read this Design Guide

□ Symbols

Symbols used in this Design Guide.

NOTE
Indicates something to be noted by the reader.

Indicates a general warning.

Indicates a high-voltage warning.

* Indicates default setting

□ Abbreviations

Alternating current	AC
American wire gauge	AWG
Ampere/AMP	A
Automatic Motor Adaptation	AMA
Current limit	I_{LIM}
Degrees Celsius	°C
Direct current	DC
Drive Dependent	D-TYPE
Electro Magnetic Compellability	EMC
Electronic Thermal Relay	ETR
Adjustable Frequency Drive	AFD
Gram	g
Hertz	Hz
Kilohertz	kHz
Local Control Panel	LCP
Meter	m
Milli Henry Inductance	mH
Milliampere	mA
Millisecond, Second	ms, s
Minute	min
Motion Control Tool	MCT
Motor Type Dependent	M-TYPE
Nanofarad	nF
Newton meter	Nm
Nominal motor current	$I_{M,N}$
Nominal motor frequency	$f_{M,N}$
Nominal motor power	$P_{M,N}$
Nominal motor voltage	$U_{M,N}$
Parameter	par.
Protective Extra Low Voltage	PELV
Printed Circuit Board	PCB
Rated Inverter Output Current	I_{INV}
Revolutions per minute	RPM
Second	s
Torque limit	T_{LIM}
Volt	V

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How to Read this Design Guide

□ Definitions

Drive:

D-TYPE
Size and type of the connected drive (dependencies).

$I_{VLT,MAX}$
The maximum output current.

$I_{VLT,N}$
The rated output current supplied by the adjustable frequency drive.

$U_{VLT,\ MAX}$
The maximum output voltage.

Input:

Control command
You can start and stop the connected motor by means of LCP and the digital inputs.
Functions are divided into two groups.

Functions in group 1 have higher priority than functions in group 2.

Group 1	Reset, Coasting stop, Reset and Coasting stop, Quick-stop, DC braking, Stop and the "Off" key.
Group 2	Start, Pulse start, Reverse, Start reverse, Jog and Freeze output

Motor:

f_{JOG}
The motor frequency when the jog function is activated (via digital terminals).

f_M
The motor frequency.

f_{MAX}
The maximum motor frequency.

f_{MIN}
The minimum motor frequency.

$f_{M,N}$
The rated motor frequency (nameplate data).

I_M
The motor current.

$I_{M,N}$
The rated motor current (nameplate data).

M-TYPE
Size and type of the connected motor (dependencies).

$n_{M,N}$
The rated motor speed (nameplate data).

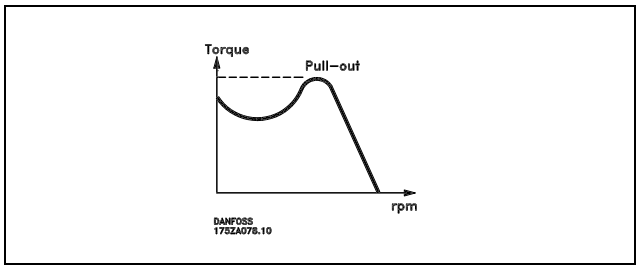
$P_{M,N}$
The rated motor power (nameplate data).

$T_{M,N}$
The rated torque (motor).

U_M
The instantaneous motor voltage.

$U_{M,N}$
The rated motor voltage (nameplate data).

Break-away torque



η_{VLT}
The efficiency of the adjustable frequency drive is defined as the ratio between the power output and the power input.

Start-disable command
A stop command belonging to the group 1 control commands - see this group.

Stop command
See Control commands.

References:
Analog Reference
A signal transmitted to the analog inputs 53 or 54, can be voltage or current.
Binary Reference
A signal transmitted to the serial communication port.
Preset Reference
A defined preset reference to be set from -100% to +100% of the reference range. Selection of eight preset references via the digital terminals.

Pulse Reference
A pulse frequency signal transmitted to the digital inputs (terminal 29 or 33).

Ref_{MAX}
Determines the relationship between the reference input at 100% full scale value (typically 10 V, 20mA) and the resulting reference. The maximum reference value set in par. 3-03.

How to Read this Design Guide

Ref_{MIN}
Determines the relationship between the reference input at 0% value (typically 0V, 0mA, 4mA) and the resulting reference. The minimum reference value set in par. 3-02.

Miscellaneous:

Analog Inputs
The analog inputs are used for controlling various functions of the adjustable frequency drive.
There are two types of analog inputs:
Current input, 0-20 mA and 4-20 mA
Voltage input, 0-10 V DC (FC 301)
Voltage input, -10 - +10 V DC (FC 302).

Analog Outputs
The analog outputs can supply a signal of 0-20 mA, 4-20 mA, or a digital signal.

Automatic Motor Adaptation, AMA
AMA algorithm determines the electrical parameters for the connected motor at standstill.

Brake Resistor
The brake resistor is a module capable of absorbing the braking energy generated in regenerative braking. This regenerative braking energy increases the intermediate circuit voltage and a brake chopper ensures that the energy is transmitted to the brake resistor.

CT Characteristics
Constant torque characteristics used for all applications such as conveyor belts, displacement pumps, and cranes.

Digital Inputs
The digital inputs can be used for controlling various functions of the adjustable frequency drive.

Digital Outputs
The drive features two solid state outputs that can supply a 24 V DC (max. 40 mA) signal.

DSP
Digital Signal Processor.

Relay Outputs:
The FC 301 drive features one programmable Relay Output.
The FC 302 drive features two programmable Relay Outputs.

ETR
Electronic Thermal Relay is a thermal load calculation based on present load and time.
Its purpose is to estimate the motor temperature.

Hiperface®
Hiperface® is a registered trademark of Stegmann.

Initializing
If initializing is carried out (par. 14-22), the adjustable frequency drive returns to the default setting.

Intermittent Duty Cycle
An intermittent duty rating refers to a sequence of duty cycles. Each cycle consists of an on-load and an off-load period. The operation can be either periodic duty or non-periodic duty.

LCP
The Local Control Panel (LCP) makes up a complete interface for control and programming of the FC 300 Series. The control panel is detachable and can be installed up to 9.8 ft (3 meters) from the adjustable frequency drive, i.e. in a front panel by means of the installation kit option.

lsb
Least significant bit.

MCM
Short for Mille Circular Mil, an American measuring unit for cable cross-section.
1 MCM ≡ 0.00079 in.^{2} (0.5067 mm^2).

msb
Most significant bit.

Online/Offline Parameters
Changes to online parameters are activated immediately after the data value is changed. Changes to offline parameters are not activated until you enter [OK] on the LCP.

Process PID
The PID regulator maintains the desired speed, pressure, temperature, etc. by adjusting the output frequency to match the varying load.

Pulse Input/Incremental Encoder
An external, digital pulse transmitter used for feeding back information on motor speed. The encoder is used in applications where great accuracy in speed control is required.

RCD
Residual Current Device.

Set-up
You can save parameter settings in four set-ups. Change between the four parameter set-ups and edit one set-up while another set-up is active.

SFAVM
Switching pattern called S tator F lux oriented A synchronous V ector M odulation (par. 14-00).

Slip Compensation
The adjustable frequency drive compensates for the motor slip by giving the frequency a supplement that follows the measured motor load keeping the motor speed almost constant..

Smart Logic Control (SLC)
The SLC is a sequence of user-defined actions executed when the associated user-defined events are evaluated as true by the SLC.

Thermistor:
A temperature-dependent resistor placed where the temperature is to be monitored (adjustable frequency drive or motor).

Trip
A state entered in fault situations, e.g. if the adjustable frequency drive is subject to an over-temperature or when the adjustable frequency drive is protecting the motor, process, or mechanism. Restart is prevented until the cause of the fault has disappeared and the trip state is cancelled by activating reset or, in some cases, by being programmed to reset automatically. Trip may not be used for personal safety.

How to Read this Design Guide

Trip-Locked
A state entered in fault situations when the adjustable frequency drive is protecting itself and requiring physical intervention, e.g. if the adjustable frequency drive is subject to a short circuit on the output. A locked trip can only be cancelled by cutting off AC line, removing the cause of the fault, and reconnecting the adjustable frequency drive. Restart is prevented until the trip state is cancelled by activating reset or, in some cases, by being programmed to reset automatically. Trip may not be used for personal safety.

VT Characteristics
Variable torque characteristics used for pumps and fans.

VVC^{plus}
Compared with standard voltage/frequency ratio control, Voltage Vector Control (VVC^{plus}) improves the dynamics and the stability, both when the speed reference is changed and in relation to the load torque.

60° AVM
Switching pattern called 60° A synchronous V ector M odulation (par. 14-00).

□ **Power Factor**
The power factor is the relation between I_1 and I_{RMS}.

$$\text{Power factor} = \frac{\sqrt{3} \text{ x U x I1xcos}\varphi}{\sqrt{3} \text{ x U x } I_{RMS}}$$

The power factor for 3-phase control:

$$= \frac{I_1 \text{ x cos } \varphi 1}{I_{RMS}} = \frac{I_1}{I_{RMS}} \text{ since cos}\varphi_1 = 1$$

The power factor indicates to what extent the adjustable frequency drive imposes a load on the mains supply.
The lower the power factor, the higher the I_{RMS} for the same HP/kW performance.

$$I_{RMS} = \sqrt{I_1^2 + I_5^2 + I_7^2 + .. + I_n^2}$$

In addition, a high power factor indicates that the different harmonic currents are low.
The FC 300 adjustable frequency drives' built-in DC coils produce a high power factor, which minimizes the imposed load on the mains supply.

How to Read this Design Guide

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Introduction to FC 300

Equipment containing electrical components may not be disposed together with domestic waste.
It must be collected separately as electrical and electronic waste according to local and currently valid legislation.

Caution

The FC 300 AutomationDrive DC link capacitors remain charged after power has been disconnected. To avoid an electrical shock hazard, disconnect the FC 300 from the power supply before carrying out maintenance. Wait at least as long as follows before servicing the adjustable frequency drive:

FC 300:	0.34 – 10 HP [0.25 – 7.5 kW]	4 minutes
FC 300:	14.75 – 29.5 HP [11 – 22 kW]	15 minutes

Be aware that there may be high voltage on the DC link even when the LEDs are turned off.

FC 300
Design Guide
Software version: 3.5x

This Design Guide can be used for all FC 300 adjustable frequency drives (AFD) with software version 3.5x.
The software version number can be seen from parameter 15-43.

□ CE Conformity and Labeling

What is CE Conformity and Labeling?

The purpose of CE labeling is to avoid technical trade obstacles within EFTA and the EU. The EU has introduced the CE label as a simple way of showing whether a product complies with the relevant EU directives. The CE label says nothing about the specifications or quality of the product. Adjustable frequency drives are regulated by three EU directives:

The machinery directive (98/37/EEC)

All machines with critical moving parts are covered by the machinery directive of January 1, 1995. Since an adjustable frequency drive is largely electrical, it does not fall under the machinery directive. However, if an adjustable frequency drive is supplied for use in a machine, we provide information on safety aspects relating to the adjustable frequency drive. We do this by means of a manufacturer's declaration.

The low-voltage directive (73/23/EEC)

Adjustable frequency drives must be CE-labeled in accordance with the low-voltage directive of January 1, 1997. The directive applies to all electrical equipment and appliances used in the 50 - 1000 V AC and the 75 - 1500 V DC voltage ranges. Danfoss CE-labels in accordance with the directive and issues a declaration of conformity upon request.

The EMC directive (89/336/EEC)

EMC is short for electromagnetic compatibility. The presence of electromagnetic compatibility means that the mutual interference between different components/appliances does not affect the way the appliances work. The EMC directive came into effect January 1, 1996. Danfoss CE-labels in accordance with the directive and issues a declaration of conformity upon request. To carry out EMC-correct installation, see the instructions in this Design Guide. In addition, we specify which standards our products comply with. We offer the filters presented in the specifications and provide other types of assistance to ensure the optimum EMC result.

The adjustable frequency drive is most often used by professionals of the trade as a complex component forming part of a larger appliance, system or installation. It must be noted that the responsibility for the final EMC properties of the appliance, system, or installation lies with the installer.

□ What Is Covered

The EU "Guidelines on the Application of Council Directive 89/336/EEC" outline three typical situations of using an adjustable frequency drive. See following for EMC coverage and CE labeling.

1. The adjustable frequency drive is sold directly to the end consumer. The adjustable frequency drive is for example sold to a DIY market. The end consumer is a layman. He installs the adjustable frequency

drive himself for use with a hobby machine, a kitchen appliance, etc. For such applications, the adjustable frequency drive must be CE-labeled in accordance with the EMC directive.

2. The adjustable frequency drive is sold for installation in a plant. The plant is built up by professionals of the trade. It could be a production plant or a heating/ventilation plant designed and installed by professionals of the trade. Neither the adjustable frequency drive nor the finished plant must be CE-labeled under the EMC directive. However, the unit must comply with the basic EMC requirements of the directive. This is ensured by using components, appliances, and systems that are CE-labeled under the EMC directive.
3. The adjustable frequency drive is sold as part of a complete system. The system is being marketed as complete and could be e.g. an air conditioning system. The complete system must be CE-labeled in accordance with the EMC directive. The manufacturer can ensure CE labeling under the EMC directive either by using CE-labeled components or by testing the EMC of the system. If it chooses to use only CE-labeled components, it does not have to test the entire system.

□ Danfoss VLT Adjustable Frequency Drive and CE Labeling

CE labeling is a positive feature when used for its original purpose, i.e. to facilitate trade within the EU and EFTA.

However, CE labeling may cover many different specifications. Thus, you must check what a given CE label specifically covers.

The covered specifications can be very different and a CE label may therefore give the installer a false sense of security when using an adjustable frequency drive as a component in a system or an appliance.

Danfoss CE labels the adjustable frequency drives in accordance with the low-voltage directive. This means that if the adjustable frequency drive is installed correctly, we guarantee compliance with the low-voltage directive. Danfoss issues a declaration of conformity that confirms our CE labeling in accordance with the low-voltage directive.

The CE label also applies to the EMC directive provided that the instructions for EMC-correct installation and filtering are followed. On this basis, a declaration of conformity in accordance with the EMC directive is issued.

The Design Guide offers detailed instructions for installation to ensure EMC-correct installation. Furthermore, Danfoss specifies which our different products comply with.

Danfoss gladly provides other types of assistance that can help you obtain the best EMC result.

□ Compliance with EMC Directive 89/336/EEC

As mentioned, the adjustable frequency drive is mostly used by professionals of the trade as a complex component forming part of a larger appliance, system, or installation. It must be noted that the responsibility for the final EMC properties of the appliance, system, or installation lies with the installer. As an aid to the installer, Danfoss has prepared EMC installation guidelines for the Power Drive System. The standards and test levels stated for Power Drive Systems are complied with, provided that the EMC-correct instructions for installation are followed, see section *Electrical Installation*.

□ Air Humidity

The adjustable frequency drive has been designed to meet the IEC/EN 60068-2-3 standard, EN 50178 pkt. 9.4.2.2 at 122 °F (50°C).

□ Aggressive Environments

An adjustable frequency drive contains a large number of mechanical and electronic components. All are to some extent vulnerable to environmental effects.

The adjustable frequency drive should not be installed in environments with airborne liquids, particles, or gases capable of affecting and damaging the electronic components. Failure to take the necessary protective measures increases the risk of stoppages, thus reducing the life of the adjustable frequency drive.

Liquids can be carried through the air and condense in the adjustable frequency drive and may cause corrosion of components and metal parts. Steam, oil, and salt water may cause corrosion of components and metal parts. In such environments, use equipment with enclosure rating IP 55. As an extra protection, coated printed circuit boards can be ordered as an option.

Airborne Particles such as dust may cause mechanical, electrical, or thermal failure in the adjustable frequency drive. A typical indicator of excessive levels of airborne particles is dust particles around the adjustable frequency drive fan. In very dusty environments, use equipment with enclosure rating IP 55 or a cabinet for IP 00/IP 20/TYPE 1 equipment.

In environments with high temperatures and humidity, corrosive gases such as sulfur, nitrogen, and chlorine compounds will cause chemical processes on the adjustable frequency drive components.

Such chemical reactions will rapidly affect and damage the electronic components. In such environments, mount the equipment in a cabinet with fresh air ventilation, keeping aggressive gases away from the adjustable frequency drive.
An extra protection in such areas is a coating of the printed circuit boards, which can be ordered as an option.

NOTE
Mounting adjustable frequency drives in aggressive environments increases the risk of stoppages and considerably reduces the life of the drive.

Before installing the adjustable frequency drive, check the ambient air for liquids, particles, and gases. This is done by observing existing installations in this environment. Typical indicators of harmful airborne liquids are water or oil on metal parts, or corrosion of metal parts.

Excessive dust particle levels are often found on installation cabinets and existing electrical installations. One indicator of aggressive airborne gases is blackening of copper rails and cable ends on existing installations.

□ Vibration and Shock

The adjustable frequency drive has been tested according to a procedure based on the shown standards:

IEC/EN 60068-2-6:	Vibration (sinusoidal) - 1970
IEC/EN 60068-2-64:	Vibration, broad-band random

The adjustable frequency drive complies with requirements that exist for units mounted on the walls and floors of production premises, as well as in panels bolted to walls or floors.

□ Control Principle

An adjustable frequency drive rectifies AC voltage from line into DC voltage, after which this DC voltage is converted into an AC current with a variable amplitude and frequency.

Introduction to FC 300

The motor is supplied with variable voltage / current and frequency, which enables infinitely variable speed control of three-phased, standard AC motors and permanent magnet synchronous motors.

FC 300 Controls

The adjustable frequency drive is capable of controlling either the speed or the torque on the motor shaft. Setting par. 1-00 determines the type of control.

Speed control:

There are two types of speed control:

- Speed open loop control which does not require any feedback (sensorless).
- Speed closed-loop control in the form of PID control that requires speed feedback to an input. Properly optimized speed closed-loop control will have higher accuracy than speed open loop control.

Selects which input to use as speed PID feedback in par. 7-00.

Torque control (FC 302 only):

Torque control is part of the motor control and correct settings of motor parameters are very important. The accuracy and settling time of the torque control are determined from *Flux w motor feedb* (par. 1-01 *Motor Control Principle*).

- Flux sensorless offers superior performance in all four quadrants at motor frequencies above 10 Hz.
- Flux with encoder feedback offers superior performance in all four quadrants and at all motor speeds.

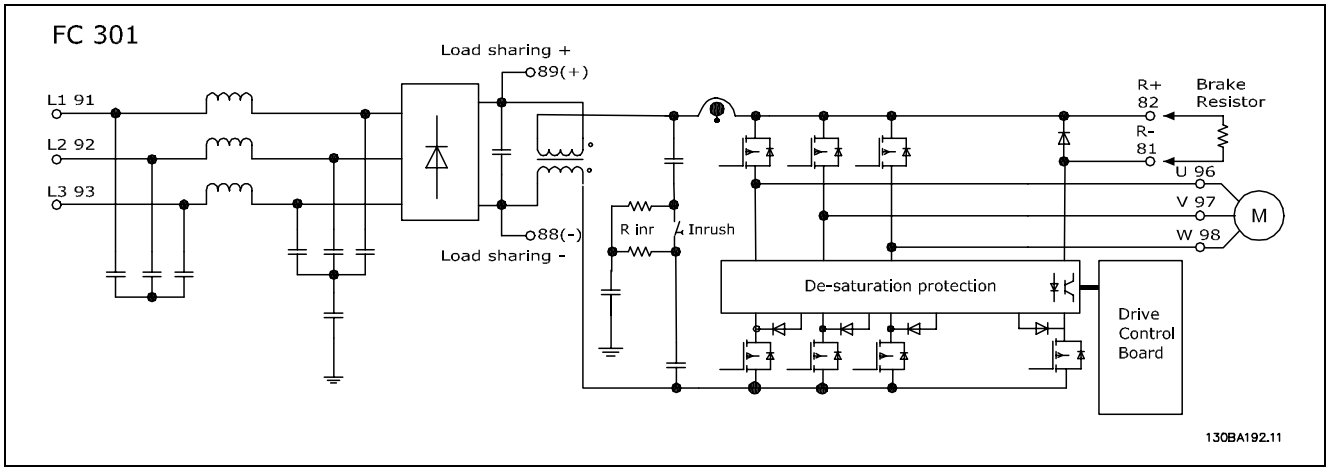
Speed / torque reference:

The reference to these controls can either be a single reference or the sum of various references including relatively scaled references. The handling of references is explained in detail later in this section.

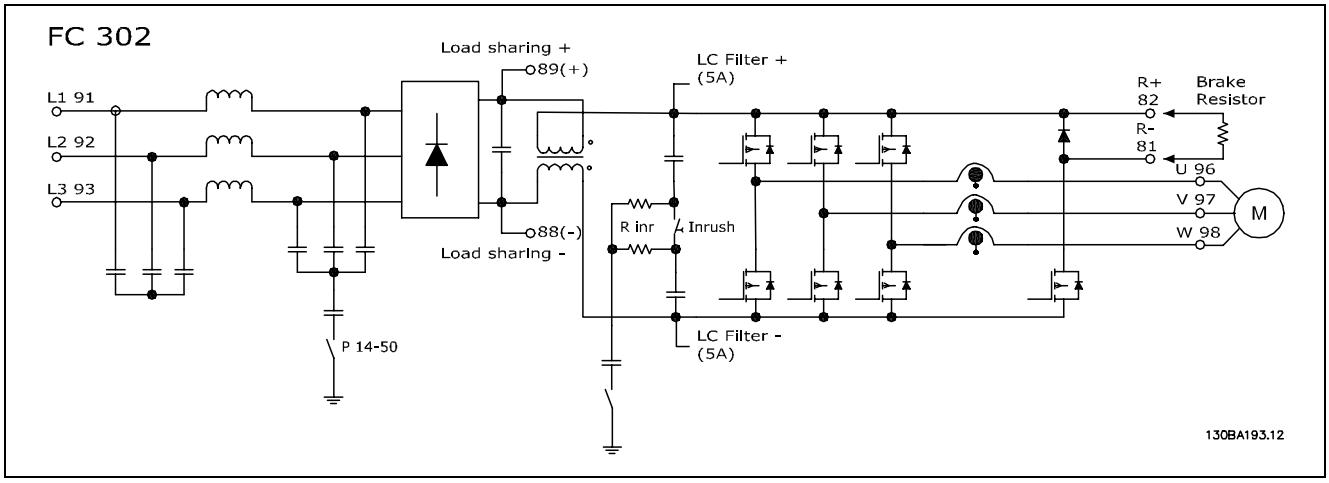
Introduction to FC 300

□ FC 301 vs. FC 302 Control Principle

The FC 301 is a general-purpose adjustable frequency drive for variable speed applications. The control principle is based on voltage vector control (VVC^{plus}).
The FC 301 can handle asynchronous motors only.
The current sensing principle in the FC 301 is based on current measurement in the DC link or motor phase. The ground fault protection on the motor side is solved by a de-saturation circuit in the IGBTs connected to the control board.
Short circuit behavior in the FC 301 depends on the current transducer with positive DC link and the desaturation protection with feedback from the 3 lower IGBTs and the brake.



The FC 302 is a high-performance adjustable frequency drive for demanding applications. The adjustable frequency drive can handle various kinds of motor control principles such as U/f special motor mode, VVCplus or flux vector motor control.
The FC 302 is able to handle permanent magnet synchronous motors (brushless servo motors) as well as normal squirrel-cage asynchronous motors.
Short circuit behavior on the FC 302 depends on the 3 current transducers in the motor phases and the desaturation protection with feedback from the brake.



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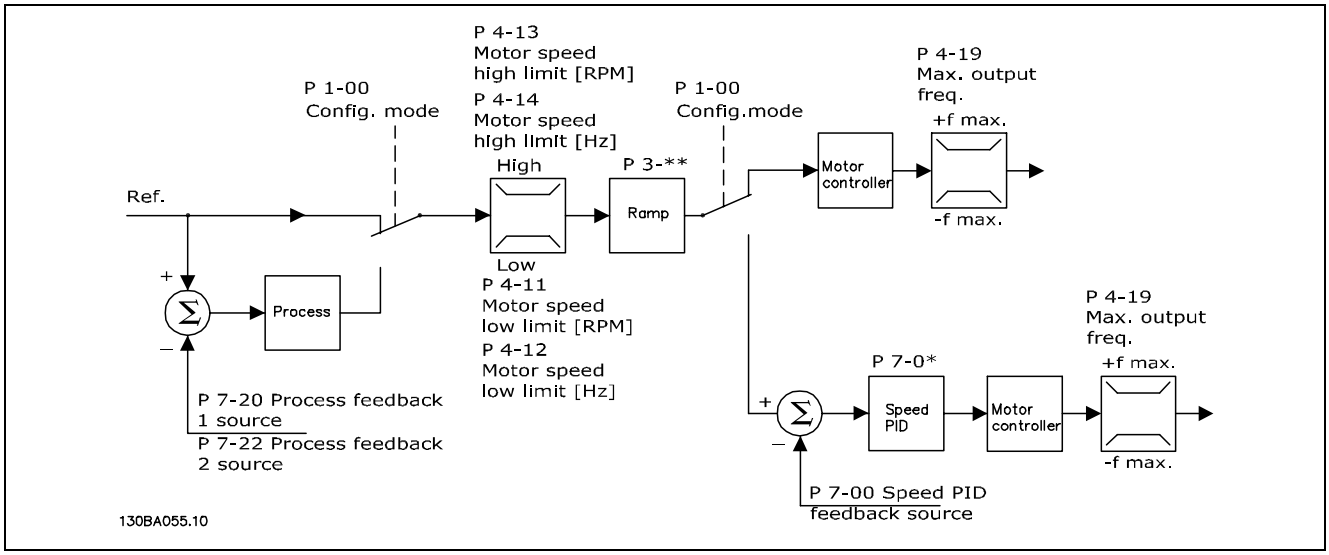
□ Control Structure in VVC^{plus}

Control structure in VVC^{plus} open-loop and closed-loop configurations:



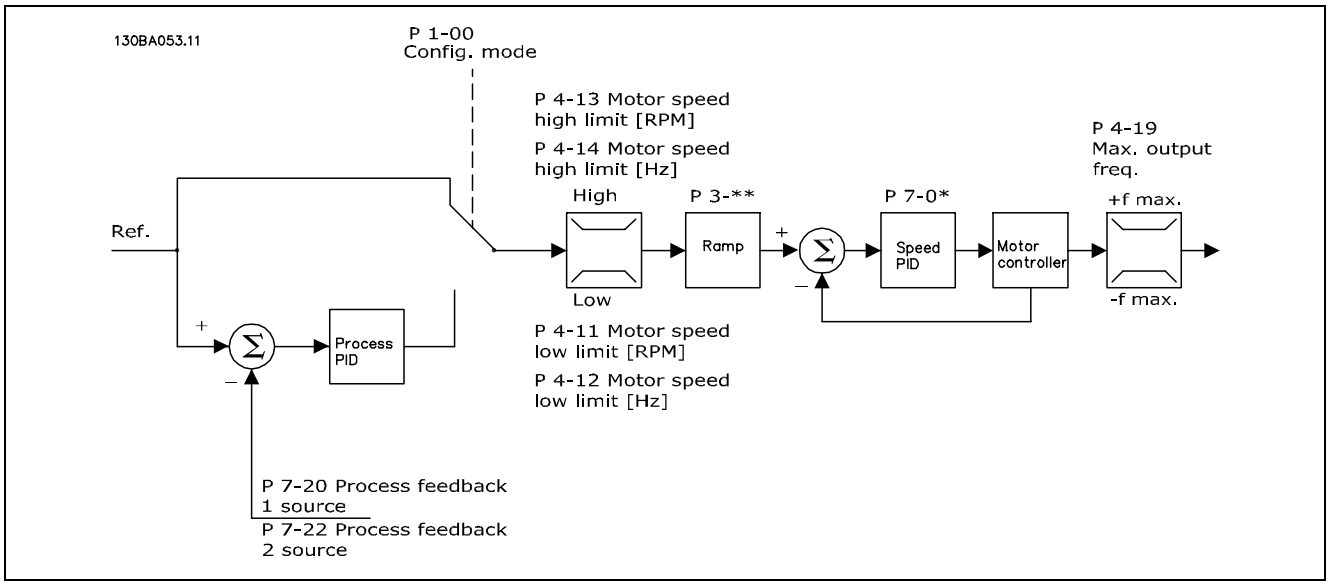
In the configuration shown in the illustration above, par. 1-01 *Motor Control Principle* is set to "VVC^{plus} [1]" and par. 1-00 is set to "Speed open-loop [0]". The resulting reference from the reference handling system is received and fed through the ramp limitation and speed limitation before being sent to the motor control. The output of the motor control is then limited by the maximum frequency limit.

If par. 1-00 is set to "Speed closed-loop [1]" the resulting reference will be passed from the ramp limitation and speed limitation into a speed PID control. The speed PID control parameters are located in the par. group 7-0*. The resulting reference from the speed PID control is sent to the motor control limited by the frequency limit.

Select "Process [3]" in par. 1-00 to use the process PID control for closed-loop control of, e.g., speed or pressure in the controlled application. The process PID parameters are located in par. group 7-2* and 7-3*.

□ Control Structure in Flux Sensorless (FC 302 only)

Control structure in flux sensorless open-loop and closed-loop configurations.



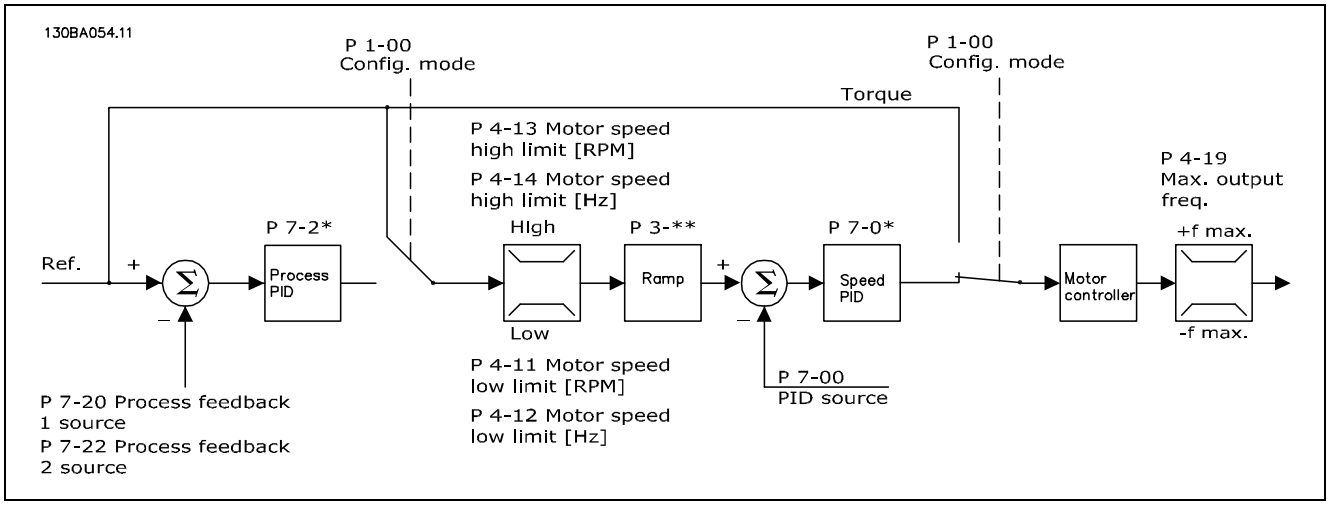
In the configuration shown, par. 1-01 *Motor Control Principle* is set to "Flux sensorless [2]" and par. 1-00 is set to "Speed open-loop [0]". The resulting reference from the reference handling system is fed through the ramp and speed limitations as determined by the parameter settings indicated.

An estimated speed feedback is generated to the speed PID to control the output frequency. The speed PID must be set with its P, I, and D parameters (par. group 7-0*).

Select "Process [3]" in par. 1-00 to use the process PID control for closed-loop control of, i.e., speed or pressure in the controlled application. The process PID parameters are found in par. group 7-2* and 7-3*.

□ **Control Structure in Flux with Motor Feedback**

Control structure in Flux with motor feedback configuration (only available in FC 302):



In the shown configuration, par. 1-01 *Motor Control Principle* is set to "Flux w encoder feedb [3]" and par. 1-00 is set to "Speed closed loop [1]".

The motor control in this configuration relies on a feedback signal from an encoder mounted directly on the motor (set in par. 1-02 *Motor Shaft Encoder Source*).

Select "Speed closed-loop [1]" in par. 1-00 to use the resulting reference as an input for the Speed PID control. The Speed PID control parameters are located in par. group 7-0*.

Select "Torque [2]" in par. 1-00 to use the resulting reference directly as a torque reference. Torque control can only be selected in the *Flux with motor feedback* (par. 1-01 *Motor Control Principle*) configuration. When this mode has been selected, the reference will use the Nm unit. It requires no torque feedback, since the actual torque is calculated on the basis of the current measurement of the adjustable frequency drive.

Select "Process [3]" in par. 1-00 to use the process PID control for closed-loop control of e.g. speed or a process variable in the controlled application.

□ **Internal Current Control in VVC+ Mode**

The adjustable frequency drive features an integral current limit control which is activated when the motor current, and thus the torque, is higher than the torque limits set in par. 4-16, 4-17 and 4-18.
When the adjustable frequency drive is at the current limit during motor operation or regenerative operation, the adjustable frequency drive will try to get below the preset torque limits as quickly as possible without losing control of the motor.

□ **Local (Hand On) and Remote (Auto On) Control**

The adjustable frequency drive can be operated manually via the local control panel (LCP) or remotely via analog and digital inputs and serial bus.
If allowed in par. 0-40, 0-41, 0-42, and 0-43, it is possible to start and stop the adjustable frequency drive via the LCP using the [Hand ON] and [Off] keys. Alarms can be reset via the [RESET] key.
After pressing the [Hand On] key, the adjustable frequency drive goes into Hand mode and follows (as default) the local reference that can be set using the arrow key on the LCP.

After pressing the [Auto On] key, the adjustable frequency drive goes into Auto mode and follows (as default) the remote reference. In this mode, it is possible to control the adjustable frequency drive via the digital inputs and various serial interfaces (RS-485, USB, or an optional serial communication bus). See more about starting, stopping, changing ramps and parameter set-ups, etc. in par. group 5-1* (digital inputs) or par. group 8-5* (serial communication).

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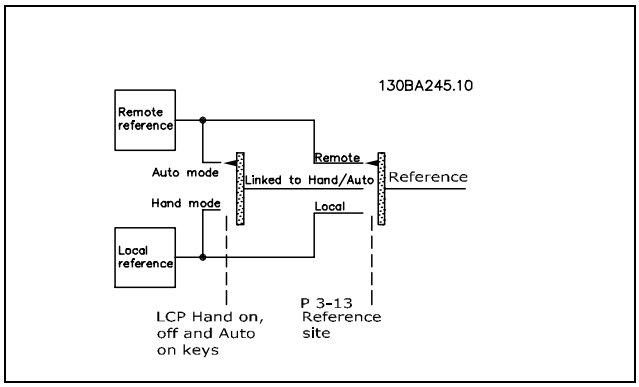
Active Reference and Configuration Mode

The active reference can be either the local reference or the remote reference.

In par. 3-13 *Reference Site* the local reference can be permanently selected by selecting *Local* [2]. To permanently select the remote reference, select *Remote* [1]. By selecting *Linked to Hand/Auto* [0] (default), the reference site will depend on which mode is active. (Hand Mode or Auto Mode).



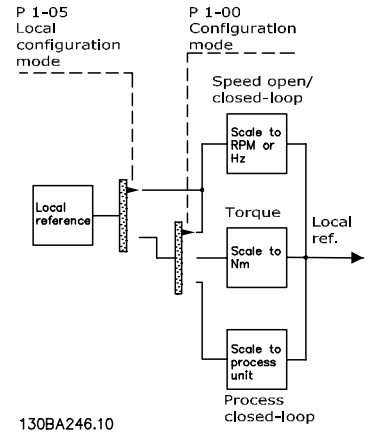
Hand Off Auto LCP Keys	Reference Site Par. 3-13	Active Reference
Hand	Linked to Hand / Auto	Local
Hand -> Off	Linked to Hand / Auto	Local
Auto	Linked to Hand / Auto	Remote
Auto -> Off	Linked to Hand / Auto	Remote
All keys	Local	Local
All keys	Remote	Remote

The table shows under which conditions either the local reference or the remote reference is active. One of them is always active, but both cannot be active at the same time.

Par. 1-00 *Configuration Mode* determines what kind of application control principle (i.e., speed, torque or process control) is used when the remote reference is active (see table above for the conditions).

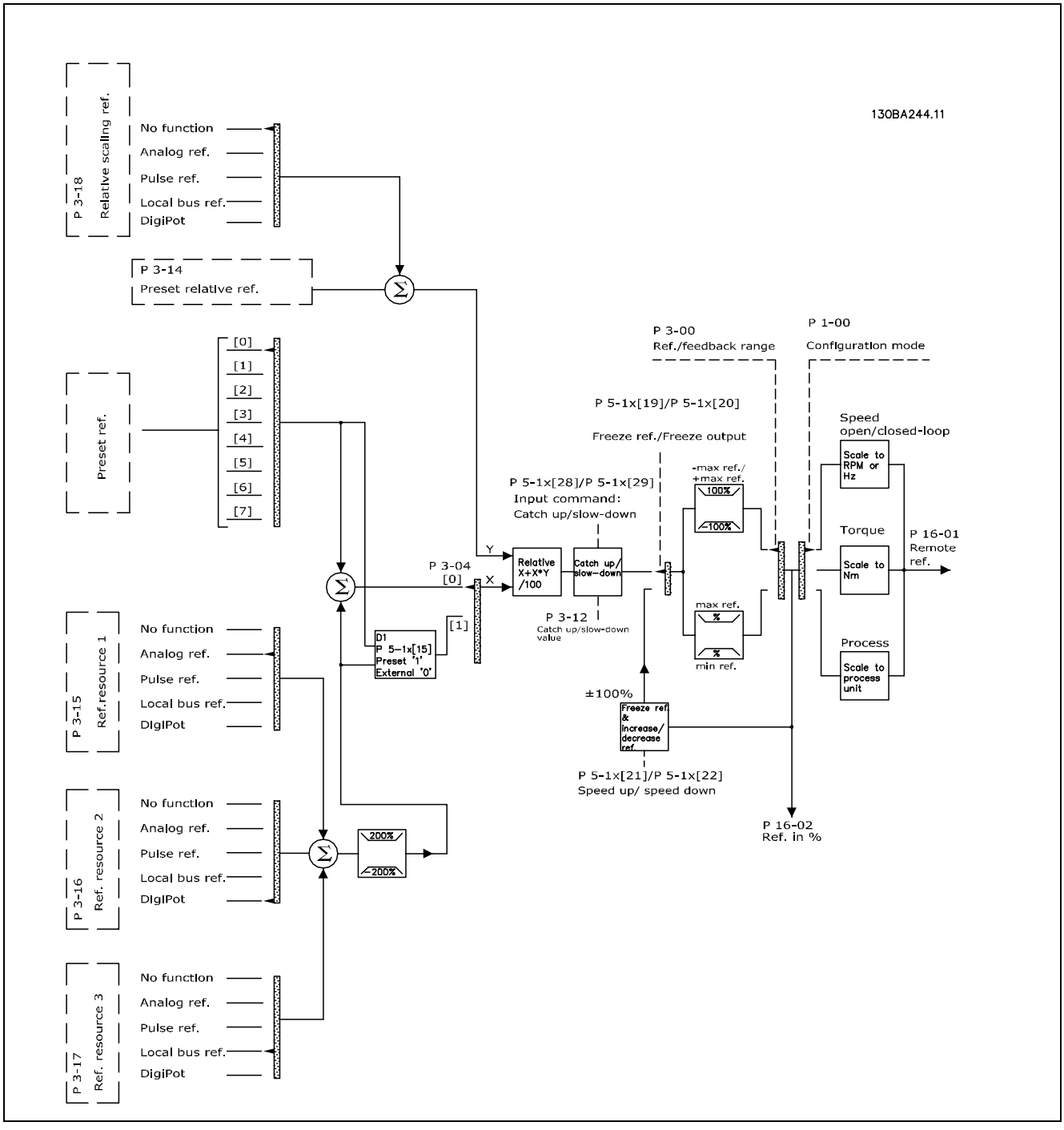
Par. 1-05 *Local Mode Configuration* determines the kind of application control principle that is used when the local reference is made activate.

Reference Handling
Local Reference



Remote Reference

The reference handling system for calculating the remote reference is shown in the illustration below.



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The remote reference is calculated once every scan interval and initially consists of two parts:

1. X (the external reference) : A sum (see par. 3-04) of up to four externally selected references, comprising any combination (determined by the setting of par. 3-15, 3-16 and 3-17) of a fixed preset reference (par. 3-10), variable analog references, variable digital pulse references, and various serial bus references in whatever unit adjustable frequency drives are controlled ([Hz], [RPM], [Nm] etc.).
2. Y- (the relative reference): A sum of one fixed preset reference (par. 3-14) and one variable analog reference (par. 3-18) in [%].

The two parts are combined in the following calculation: Remote reference = X + X * Y / 100%.
The *catch-up / slow-down* function and the *freeze reference* function can both be activated by digital inputs on the adjustable frequency drive. They are described in par. group 5-1*.
The scaling of analog references is described in par. groups 6-1* and 6-2*, and the scaling of digital pulse references is described in par. group 5-5*.
Reference limits and ranges are set in par. group 3-0*.

References and feedback can be scaled in physical units (i.e. RPM, Hz, °C) or simply in % relating to the values of par. 3-02 *Minimum Reference* and par. 3-03 *Maximum Reference*.

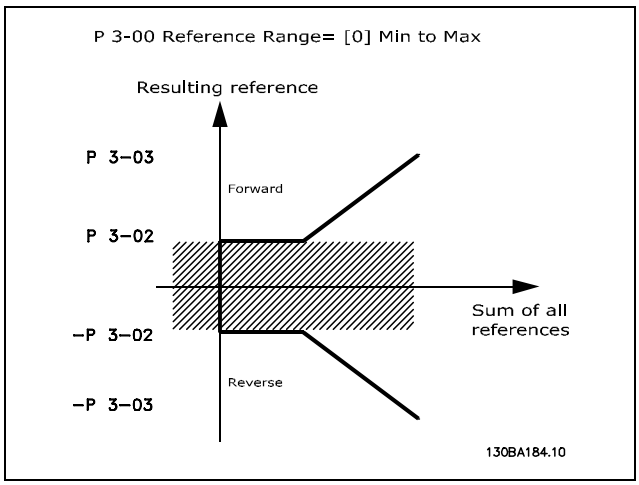
In this case, all analog and pulse inputs are scaled according to the following rules:

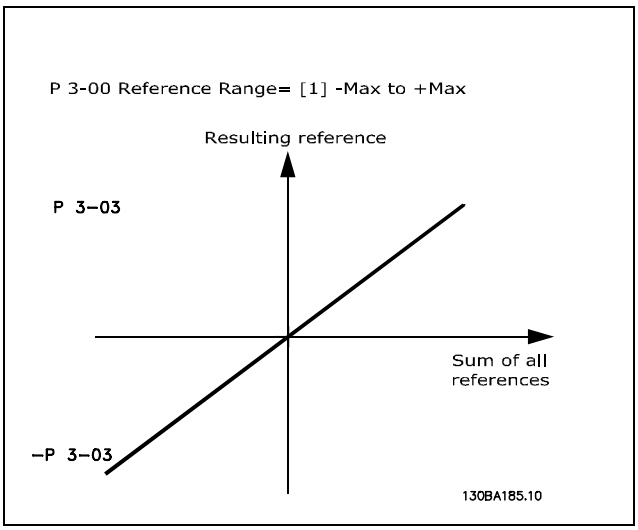
- When par. 3-00 *Reference Range* is [0] Min - Max, 0% reference equals 0 [unit], where unit can be any unit e.g. rpm, m/s, bar etc., 100% reference equals the Max (abs (par. 3-03 *Maximum Reference*), abs (par. 3-02 *Minimum Reference*)).
- When par. 3-00 *Reference Range*: [1] -Max - +Max, 0% reference equals 0 [unit], -100% reference equals -Max Reference, 100% reference equals Max Reference.

Bus references are scaled according to the following rules:

- When par. 3-00 *Reference Range* is [0] Min - Max. To obtain max resolution on the bus reference, the scaling on the bus is: 0% reference equals Min Reference and 100% reference equals Max reference.
- When par. 3-00 *Reference Range*: [1] -Max - +Max, -100% reference equals -Max Reference, 100% reference equals Max Reference.

Par. 3-00 *Reference Range*, 3-02 *Minimum Reference* and 3-03 *Maximum Reference* together define the allowed range of the sum of all references. The sum of all references is clamped when necessary. The relation between the resulting reference (after clamping) and the sum of all references is shown below.





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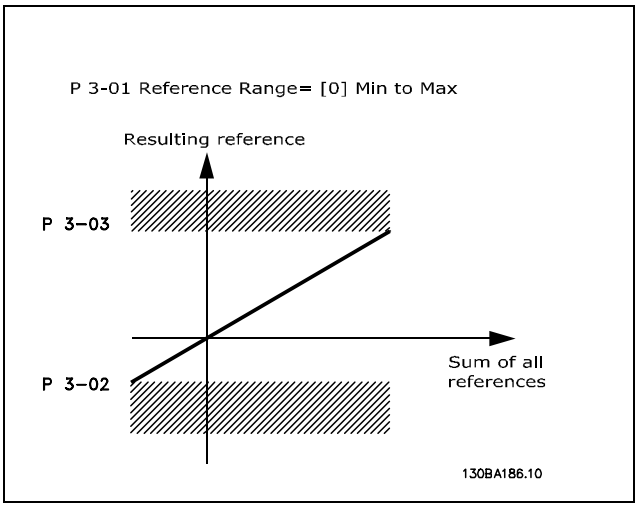
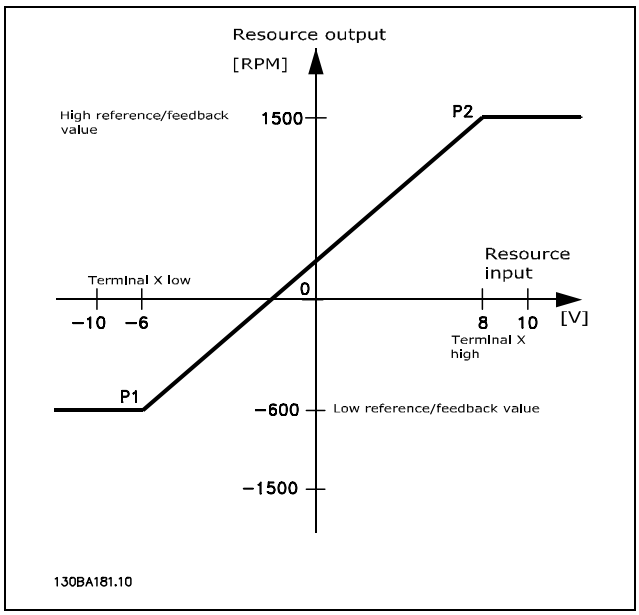
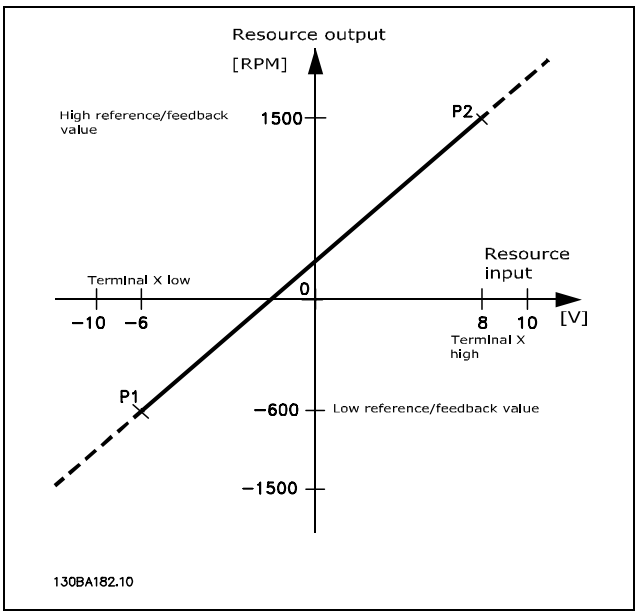
The value of par. 3-02 *Minimum Reference* can not be set to less than 0, unless par. 1-00 *Configuration Mode* is set to [3] Process. In this case, the subsequent relations between the resulting reference (after clamping) and the sum of all references are as shown to the right.



References and feedback are scaled from analog and pulse inputs in the same way. The only difference is that a reference above or below the specified minimum and maximum "endpoints" (P1 and P2 in the graph below) are clamped whereas a feedback above or below is not.





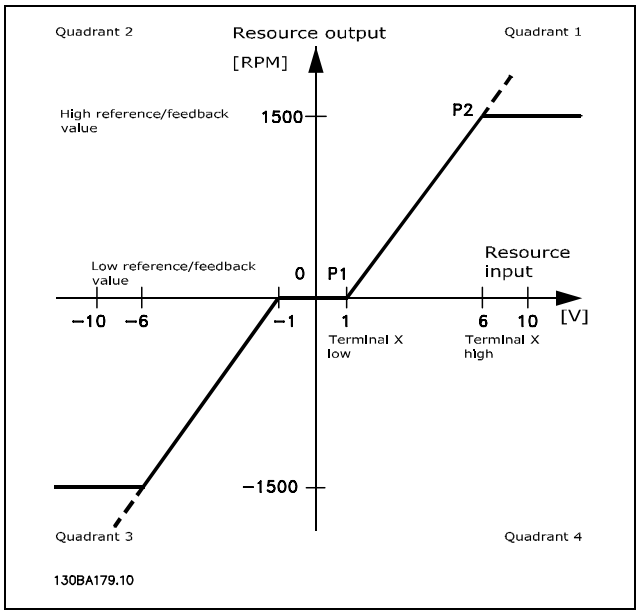
The endpoints P1 and P2 are defined by the following parameters, depending on which analog or pulse input is used

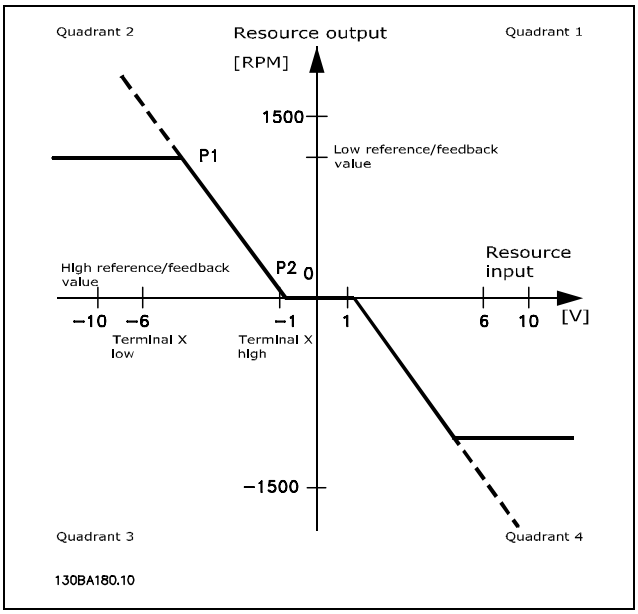
	Analog 53 S201=OFF	Analog 53 S201=ON	Analog 54 S202=OFF	Analog 54 S202=ON	Pulse Input 29	Pulse Input 33
P1 = (Minimum input value, Minimum reference value)						
Minimum reference value	Par. 6-14	Par. 6-14	Par. 6-24	Par. 6-24	Par. 5-52	Par. 5-57
Minimum input value	Par. 6-10 [V]	Par. 6-12 [mA]	Par. 6-20 [V]	Par. 6-22 [mA]	Par. 5-50 [Hz]	Par. 5-55 [Hz]
P2 = (Maximum input value, Maximum reference value)						
Maximum reference value	Par. 6-15	Par. 6-15	Par. 6-25	Par. 6-25	Par. 5-53	Par. 5-58
Maximum input value	Par. 6-11 [V]	Par. 6-13 [mA]	Par. 6-21 [V]	Par. 6-23 [mA]	Par. 5-51 [Hz]	Par. 5-56 [Hz]

In some cases, the reference (in rare cases also the feedback) should have a Dead Band around zero (i.e. to make sure the machine is stopped when the reference is "near zero"). To make the dead band active and to set the amount of dead band, the following settings must be done:

- Either Minimum Reference Value (see table above for relevant parameter) or Maximum Reference Value must be zero. In other words; Either P1 or P2 must be on the X-axis in the graph below.
- And both points defining the scaling graph are in the same quadrant.

The size of the Dead Band is defined by either P1 or P2 as shown in the graph below.

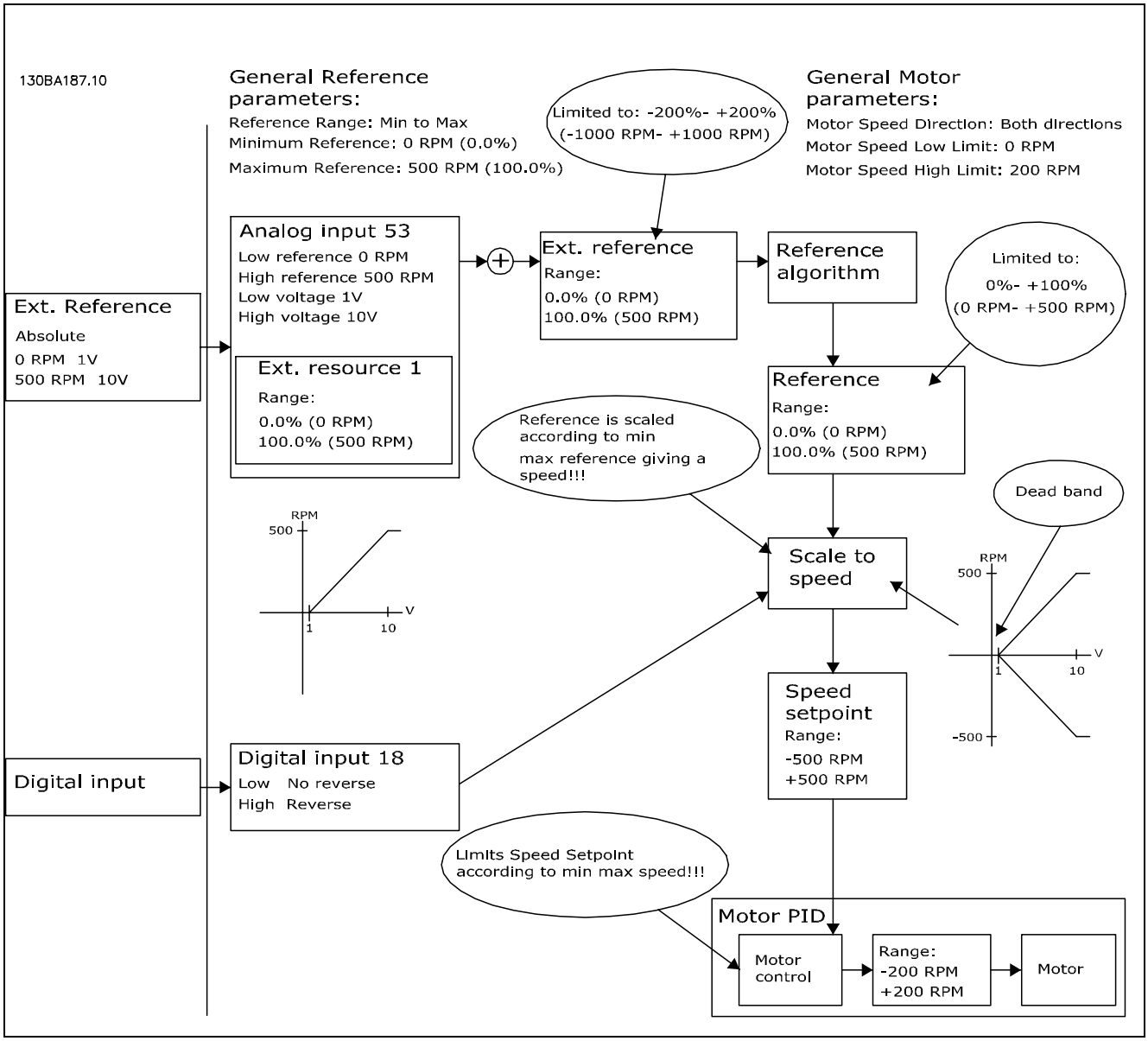




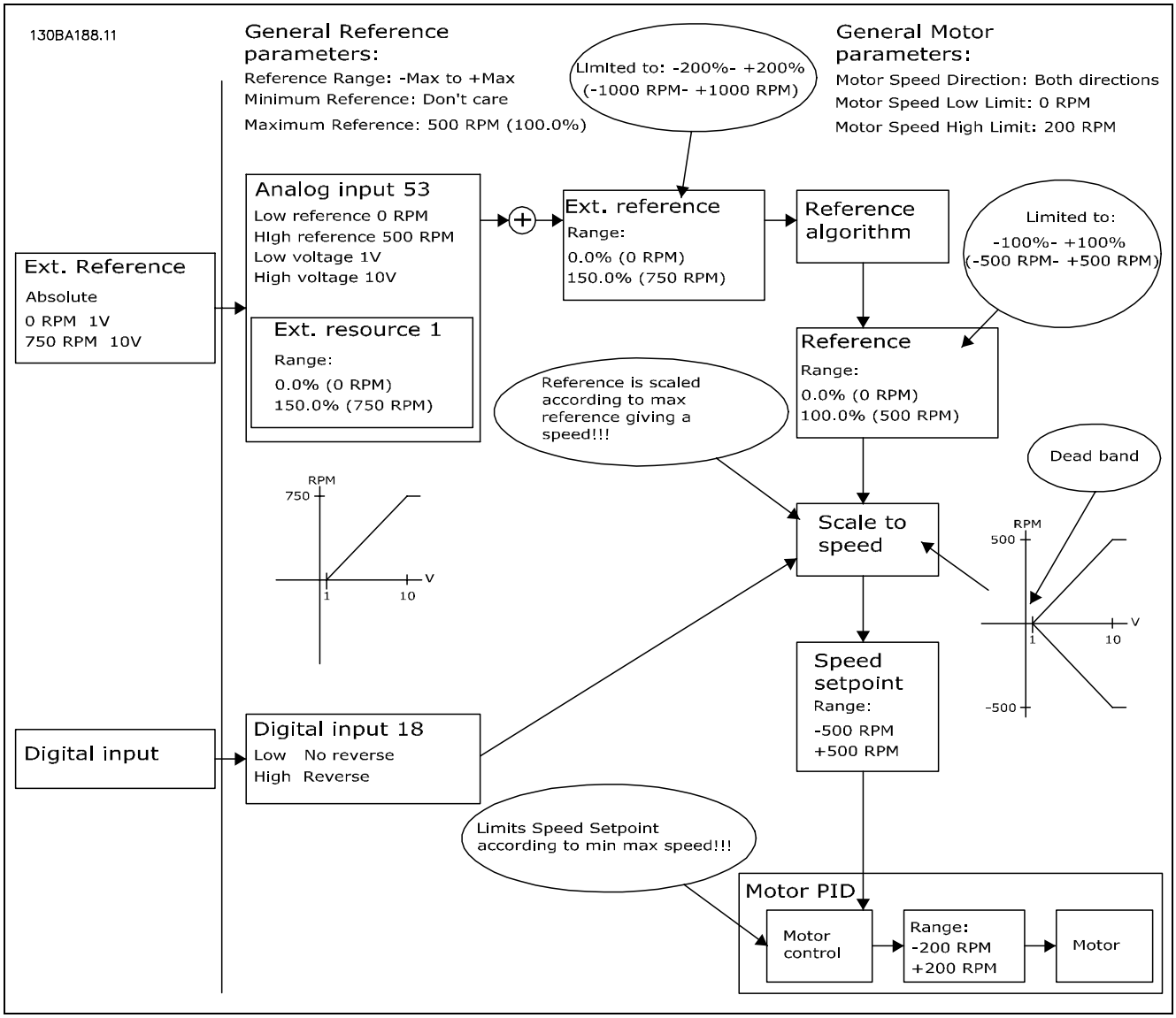
Thus a reference endpoint of P1 = (0 V, 0 RPM) will not result in any dead band, but a reference endpoint of e.g. P1 = (1V, 0 RPM) will result in a -1V to +1V dead band in this case provided that the end point P2 is placed in either Quadrant 1 or Quadrant 4.

Case 1: Positive Reference with Dead band, Digital input to trigger reverse

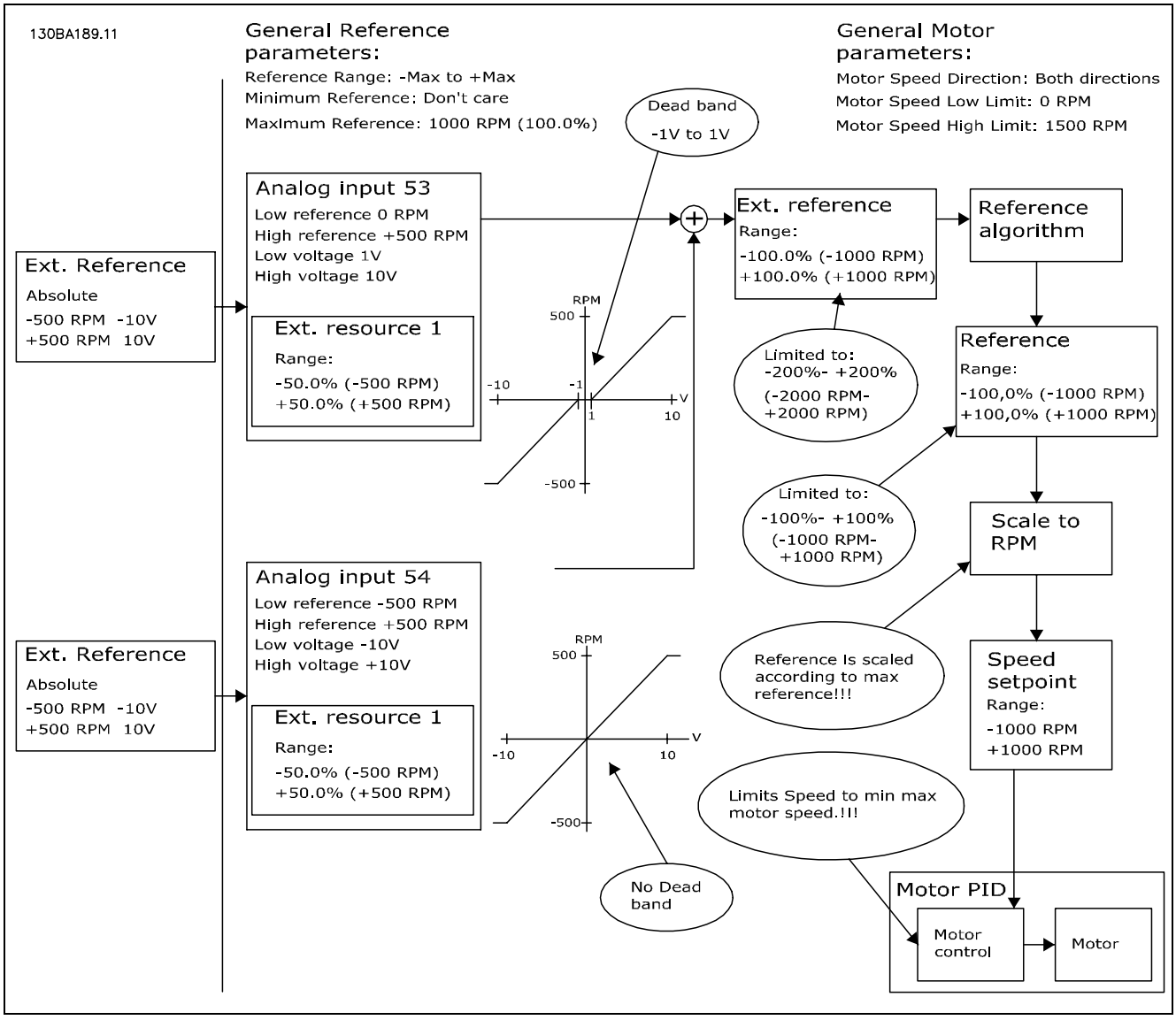
This Case shows how Reference input with limits inside Min - Max limits clamps.



Case 2: Positive Reference with Dead band, Digital input to trigger reverse. Clamping rules.
This Case shows how Reference input with limits outside -Max - +Max limits clamps to the inputs low and high limits before addition to External reference. And how the External reference is clamped to -Max - +Max by the Reference algorithm.



Case 3: Negative to positive reference with dead band, Sign determines the direction, -Max - +Max



□ **Speed PID Control**

The table shows the control configurations where the Speed Control is active.

Par. 1-00 Configuration Mode	Par. 1-01 Motor Control Principle			
	U/f	VVCplus	Flux sensorless	Flux w motor feedb
[0] Speed open loop	Not Active	Not Active	ACTIVE	N.A.
[1] Speed closed-loop	N.A.	**ACTIVE**	N.A.	ACTIVE
[2] Torque	N.A.	N.A.	N.A.	Not Active
[3] Process open-loop		Not Active	**ACTIVE**	**ACTIVE**

Note: "N.A." means that the specific mode is not available at all. "Not Active" means that the specific mode is available but the Speed Control is not active in that mode.

Note: The Speed Control PID will work under the default parameter setting, but tuning the parameters is highly recommended to optimize the motor control performance. The two Flux motor control principles are specially dependent on proper tuning to yield their full potential.

The following parameters are relevant for the Speed Control:

Parameter	Description of function
Feedback Par. 7-00	Select from which input the Speed PID should get its feedback.
Speed PID Proportional Gain Par. 7-02	The higher the value, the quicker the control. However, too high a value may lead to oscillations.
Speed PID Integral Time Par. 7-03	Eliminates steady state speed error. Lower value means quick reaction. However, too low a value may lead to oscillations.
Speed PID Differentiation Time Par. 7-04	Provides a gain proportional to the rate of change of the feedback. A setting of zero disables the differentiator.
Speed PID Diff. Gain Limit Par. 7-05	If there are quick changes in reference or feedback in a given application - which means that the error changes swiftly - the differentiator may soon become too dominant. This is because it reacts to changes in the error. The quicker the error changes, the stronger the differentiator gain is. The differentiator gain can thus be limited to allow setting of the reasonable differentiation time for slow changes and a suitably quick gain for quick changes.
Speed PID Lowpass Filter Time Par. 7-06	A low-pass filter that dampens oscillations on the feedback signal and improves steady state performance. However, too large a filter time will deteriorate the dynamic performance of the Speed PID control. Practical settings of Par 7-06 taken from the number of pulses per revolution on from encoder (PPR):

Encoder PPR	**Par. 7-06**
512	10 ms
1024	5 ms
2048	2 ms
4096	1 ms

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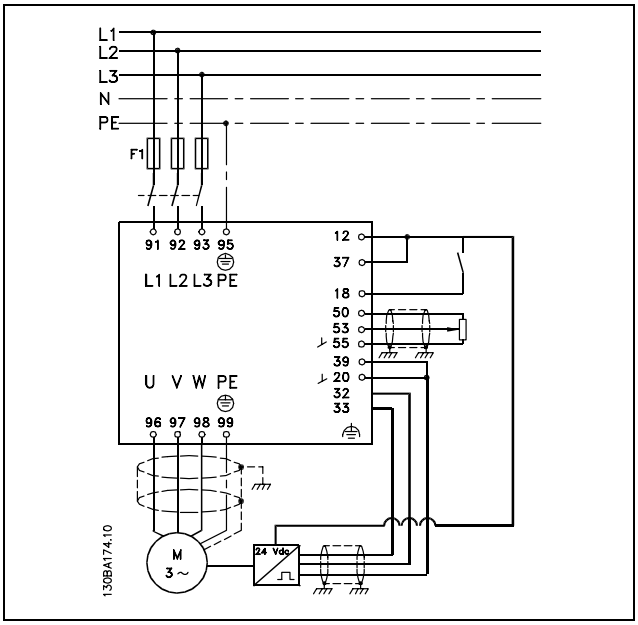
Below is given an example of how to program the Speed Control:

In this case, the Speed PID Control is used to maintain a constant motor speed regardless of the changing load on the motor.

The required motor speed is set via a potentiometer connected to terminal 53. The speed range is 0 - 1500, corresponding to 0 - 10V over the potentiometer.

Starting and stopping is controlled by a switch connected to terminal 18.

The Speed PID monitors the actual RPM of the motor by using a 24V (HTL) incremental encoder as feedback. The feedback sensor is an encoder (1024 pulses per revolution) connected to terminals 32 and 33.



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In the parameter list below, it is assumed that all other parameters and switches remain at their default setting.

The following must be programmed in the order shown - see explanation of settings in the section "How to Program."

Function	Par. no.	Setting
1) Make sure the motor runs properly. Do the following:		
Set the motor parameters using nameplate data	1-2*	As specified by motor nameplate
Have the VLT make an Automatic Motor Adaptation	1-29	[1] Enable complete AMA
2) Check that the motor is running and the encoder is attached properly. Do the following:		
Press the "Hand On" LCP key. Check that the motor is running and note in which direction it is turning (henceforth referred to as the "positive direction").		Set a positive reference.
Go to par. 16-20. Turn the motor slowly in the positive direction. It must be turned so slowly (only a few RPM) that it can be determined if the value in par. 16-20 is increasing or decreasing.	16-20	N.A. (read-only parameter) Note: An increasing value overflows at 65535 and starts again at 0.
If par. 16-20 is decreasing, then change the encoder direction in par. 5-71.	5-71	[1] Counter clockwise (if par. 16-20 is decreasing)
3) Make sure the drive limits are set to safe values		
Set acceptable limits for the references.	3-02 3-03	0 RPM (default) 1500 RPM (default)
Check that the ramp settings are within drive capabilities and allowed application operating specifications.	3-41 3-42	default setting default setting
Set acceptable limits for the motor speed and frequency.	4-11 4-13 4-19	0 RPM (default) 1500 RPM (default) 60 Hz (default 132 Hz)
Press the "Hand On" LCP key. Check that the motor runs and note in which direction it is turning.		Set a positive reference.
If the motor was turning in the wrong direction, remove the motor plug and switch two of the motor phases.		
4) Configure the Speed Control and select the Motor Control principle		
Activation of Speed Control	1-00	[1] Speed closed-loop
Selection of Motor Control Principle	1-01	[3] Flux w motor feedb
5) Configure and scale the reference to the Speed Control		
Set up Analog Input 53 as a reference resource	3-15	Not necessary (default)
Scale Analog Input 53 0 RPM (0 V) to 1500 RPM (10V)	6-1*	Not necessary (default)
6) Configure the 24V HTL encoder signal as feedback for the Motor Control and the Speed Control		
Set up digital input 32 and 33 as encoder inputs	5-14 5-15	[0] No operation (default)
Choose terminal 32/33 as motor feedback	1-02	Not necessary (default)
Choose terminal 32/33 as Speed PID feedback	7-00	Not necessary (default)
7) Tune the Speed Control PID parameters		
Use the tuning guidelines when relevant or tune manually	7-0*	See the guidelines below
8) Finished!		
Save the parameter settings to the LCP for safekeeping	0-50	[1] All to LCP

□ **Tuning guidelines**

The following tuning guidelines are relevant when using one of the Flux motor control principles in applications where the load is mainly inertial (with a low amount of friction).

The value of par. 7-02 Speed PID Proportional Gain is dependent on the combined inertia of the motor and load, and the selected bandwidth can be calculated using the following formula:

$$Par.7\text{-}02 = \frac{Total\ inertia\ [kgm^2]\ x\ Par.1-25}{Par.\ 1-20\ x\ 9550} x Bandwidth\,[rad/s]$$

Note: Par. 1-20 is the motor power in [kW] (i.e. enter '4' kW instead of '4000' W in the formula). A practical value for the Bandwidth is 20 rad/s. Check the result of the par. 7-02 calculation against the following formula (not required if you are using a high resolution feedback such as a SinCos feedback):

$$Par.7\text{-}02_{MAXIMUM} = \frac{0.01\ x\ 4\ x\ Encoder\ Resolution\ x\ par.\ 7-06}{2 * \pi} x MaxTorqueRipple\,[\%]$$

A good start value for par. 7-06 *Speed PID Lowpass Filter Time* is 5 ms (lower encoder resolution calls for a higher filter value). Typically a Max Torque Ripple of 3 % is acceptable. For incremental encoders, the Encoder Resolution is found in either par. 5-70 (24V HTL on standard drive) or par. 17-11 (5V TTL on MCB102 Option).

Generally the practical maximum limit of par. 7-02 is determined by the encoder resolution and the feedback filter time but other factors in the application might limit par. 7-02 *Speed PIDProportional Gain* to a lower value.

To minimize overshoot, par. 7-03 *Speed PIDIntegral Time* could be set to approx. 2.5 s (varies with the application).

Par. 7-04 *Speed PID Differentiation Time* should be set to 0 until everything else is tuned. If necessary, finish the tuning by experimenting with small increments of this setting.

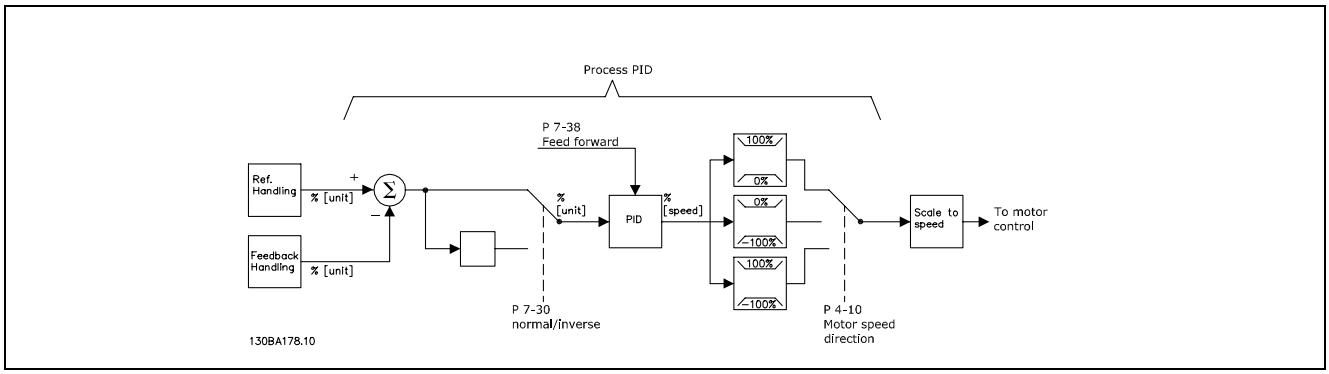
□ **Process PID Control**

The Process PID Control can be used to control application parameters that can be measured by a sensor (i.e. pressure, temperature, flow) and affected by the connected motor through a pump, fan or otherwise.

The table shows the control configurations where Process Control is possible. When a Flux Vector motor control principle is used, take care also to tune the Speed Control PID parameters. Refer to the section about the Control Structure to see where the Speed Control is active.

Par. 1-00 Configuration Mode	Par. 1-01 Motor Control Principle			
	U/f	VVCplus	Flux sensorless	Flux w motor feedb
[3] Process	N.A.	Process	Process & Speed	Process & Speed

Note: The Process Control PID will work under the default parameter setting, but tuning the parameters is highly recommended to optimize the application control performance. The two Flux motor control principles are specially dependent on proper Speed Control PID tuning (prior to tuning the Process Control PID) to yield their full potential.



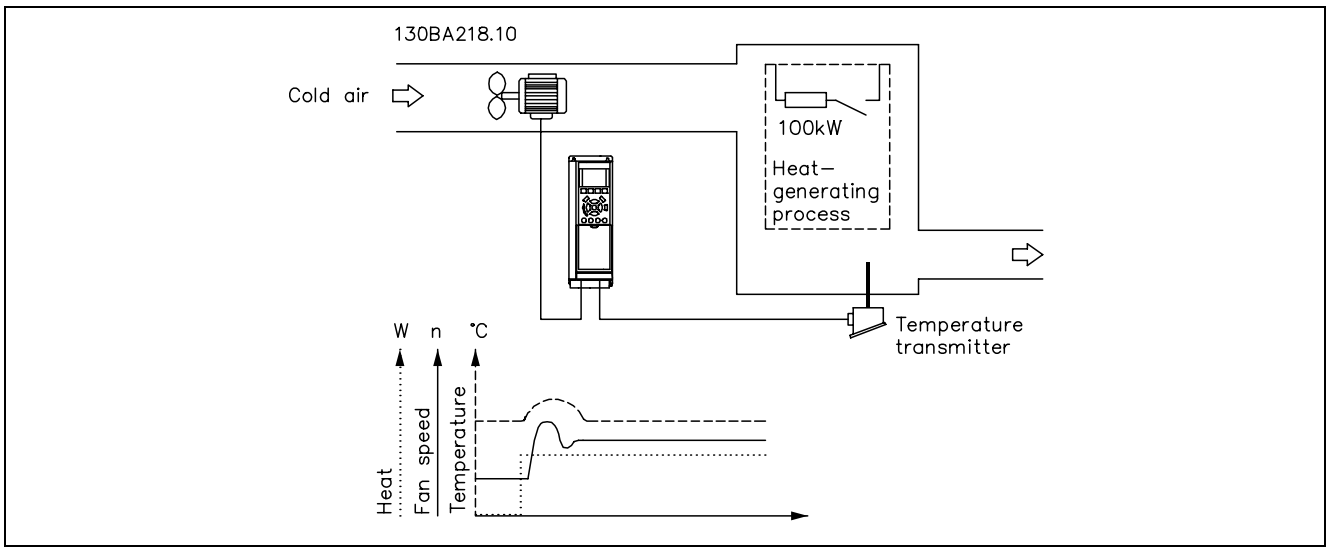
Process PID Control diagram

The following parameters are relevant for Process Control

Parameter	Description of function
Process CL Feedback 1 Resource Par. 7-20	Select from which resource (i.e. analog or pulse input) the Process PID should get its feedback
Process CL Feedback 2 Resource Par. 7-22	Optional: Determine if (and from where) the Process PID should get an additional feedback signal. If an additional feedback source is selected, the two feedback signals will be added together before being used in the Process PID Control.
Process PID Normal/inverse Control Par. 7-30	Under [0] Normal operation, the process control will respond with an increase of the motor speed if the feedback is getting lower than the reference. In the same situation, but under [1] Inverse operation, the process control will respond with a decreasing motor speed instead.
Process PID Anti Windup Par. 7-31	The anti-windup function ensures that when either a frequency limit or a torque limit is reached, the integrator will be set to a gain that corresponds to the actual frequency. This avoids integrating on an error that cannot in any case be compensated for by means of a speed change. This function can be disabled by selecting [0] "Off".
Process PID Controller Start Value Par. 7-32	In some applications, reaching the required speed/set point can take a very long time. In such applications it might be an advantage to set a fixed motor speed from the frequency converter before the process control is activated. This is done by setting a Process PID Start Value (speed) in par. 7-32.
Process PID Proportional Gain Par. 7-33	The higher the value, the quicker the control. However, too large a value may lead to oscillations.
Process PID Integral Time Par. 7-34	Eliminates steady state speed error. Lower value means quick reaction. However, too small a value may lead to oscillations.
Process PID Differentiation Time Par. 7-35	Provides a gain proportional to the rate of change of the feedback. A setting of zero disables the differentiator.
Process PID Differentiator Gain Limit Par. 7-36	If there are quick changes in reference or feedback in a given application - which means that the error changes swiftly - the differentiator may soon become too dominant. This is because it reacts to changes in the error. The quicker the error changes, the stronger the differentiator gain is. The differentiator gain can thus be limited to allow setting of the reasonable differentiation time for slow changes.
Process PID Feed Forward Factor Par. 7-38	In applications where there is a good (and approximately linear) correlation between the process reference and the motor speed necessary for obtaining that reference, the Feed Forward Factor can be used to achieve better dynamic performance of the Process PID Control.
Par. 5-54 (Pulse Filter Time Constant #29), Par. 5-59 (Pulse Filter Time Constant #33), Par. 6-16 (Terminal 53 Filter Time Constant), Par. 6-26 (Terminal 54 Filter Time Constant)	If there are oscillations of the current/voltage feedback signal, these can be dampened by means of a low-pass filter. This time constant represents the speed limit of the ripples occurring on the feedback signal. Example: If the low-pass filter has been set to 0.1s, the limit speed will be 10 RAD/sec. (the reciprocal of 0.1 s), corresponding to (10/(2 x π)) = 1.6 Hz. This means that all currents/voltages that vary by more than 1.6 oscillations per second will be damped by the filter. The control will only be carried out on a feedback signal that varies by a frequency (speed) of less than 1.6 Hz. The low-pass filter improves steady state performance but selecting a too large filter time will deteriorate the dynamic performance of the Process PID Control.

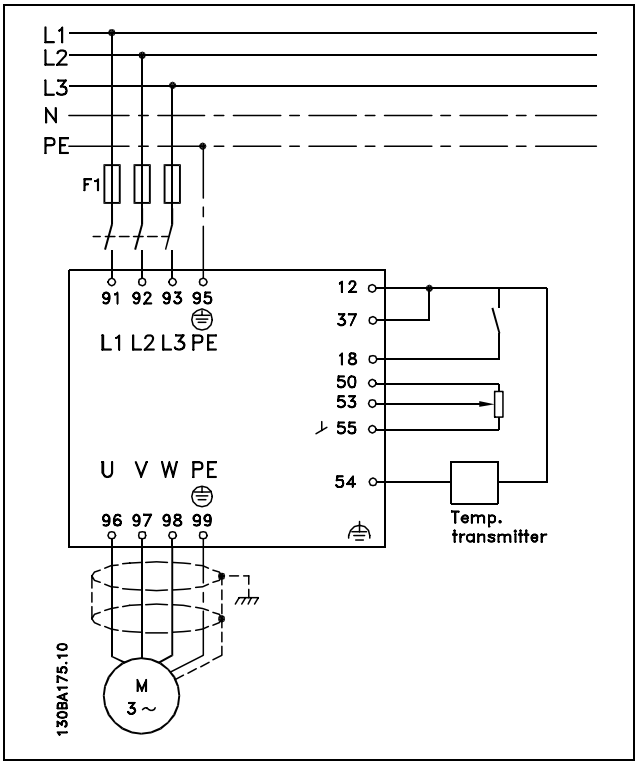
Introduction to FC 300

The following is an example of Process PID Control used in a ventilation system:



In a ventilation system, the temperature is to be settable from 23 - 95°F (- 5 - 35°C) with a potentiometer of 0-10 Volt. The set temperature must be kept constant, for which purpose the Process Control is to be used.

The control is of the inverse type, which means that when the temperature increases, the ventilation speed is increased as well, so as to generate more air. When the temperature drops, the speed is reduced. The transmitter used is a temperature sensor with a working range of 14 -104°F (-10-40°C), 4-20 mA. Min. / Max. speed 300 / 1500 RPM.



NOTE
The example shows a two-wire transmitter.

1. Start/Stop via switch connected to terminal 18.
2. Temperature reference via potentiometer (23 - 95°F (-5 - 35°C), 0-10 VDC) connected to terminal 53.
3. Temperature feedback via transmitter (14 -104°F (-10-40°C), 4-20 mA) connected to terminal 54. Switch S202 set to ON (current input).

Function	Par. no.	Setting
1) Make sure the motor runs properly. Do the following:		
Set the motor parameters using nameplate data	1-2*	As specified by motor nameplate
Have the adjustable frequency drive do an automatic motor adaptation.	1-29	[1] Enable complete AMA
2) Check that the motor is running in the right direction.		
Press the "Hand On" LCP key. Check that the motor is running and note in which direction it is turning.		Set a positive reference.
If the motor was turning in the wrong direction, remove the motor plug and switch two of the motor phases.		
3) Make sure the adjustable frequency drive limits are set to safe values		
Check that the ramp settings are within capabilities of the adjustable frequency drive and allowed application operating specifications.	3-41 3-42	60 sec. 60 sec. Depends on motor/load size! Also active in Hand mode.
Prohibit the motor from reversing if necessary	4-10	[0] Clockwise
Set acceptable limits for the motor speed and frequency	4-11 4-13 4-19	300 RPM 1500 RPM (default) 60 Hz (default 132 Hz)
4) Configure the reference to the process control.		
Allow for an "asymmetrical" reference range by selecting the "Min - Max" reference range.	3-00	[0] Min - Max
Select the appropriate reference unit.	3-01	[55]°F [[13] °C]
Set acceptable limits for the sum of all references.	3-02 3-03	23°F [-5°C] 95°F [35°C]
Set up Analog Input 53 as a reference resource	3-15	Not necessary (default)
5) Scale the analog inputs used for reference and feedback.		
Scale the Analog Input 1 (terminal 53) that is used for the temperature reference via potentiometer (23° - 95°F [-5° - 35°C], 0-10 VDC).	6-10 6-11 6-14 6-15	0 VDC 10 VDC 23°F [-5°C] 95°F [35°C]
Scale the Analog Input 2 (terminal 54) that is used for the temperature feedback via transmitter (14°-104°F [-10° - 40°C], 4-20 mA).	6-22 6-23 6-24 6-25 6-26	4 mA 20 mA 14°F [-10°C] 104°F [40°C] 50 ms - 100 ms
6) Configure the feedback to the process control.		
Set up Analog Input 54 as a feedback resource	7-20	[2] Analog input 54
7) Tune the process control PID parameters.		
Select inverse control.	7-30	[1] Inverse
Use the tuning guidelines when relevant or tune manually.	7-3*	See the guidelines below
8) Finished!		
Save the parameter settings to the LCP for safekeeping.	0-50	[1] All to LCP

Optimization of the process regulator

The basic settings have now been made; all that needs to be done is to optimize the proportional gain, the integration time, and the differentiation time (par. 7-33, 7-34, 7-35). In most processes, this can be done by following the guidelines given below.

1. Start the motor
2. Set par. 7-33 (*Proportional Gain*) to 0.3 and increase it until the feedback signal again begins to vary continuously. Then reduce the value until the feedback signal has stabilized. Now lower the proportional gain by 40-60%.
3. Set par. 7-34 (Integral Time) to 20 sec. and reduce the value until the feedback signal again begins to vary continuously. Increase the integration time until the feedback signal stabilizes, followed by an increase of 15-50%.
4. Only use par. 7-35 for very fast-acting systems (differentiation time). The typical value is four times the set integral time. The differentiator should only be used when the setting of the proportional gain and the integral time has been fully optimized. Make sure that oscillations in the feedback signal are sufficiently damped by the low-pass filter on the feedback signal.

NOTE
If necessary, start/stop can be activated a number of times in order to provoke a variation of the feedback signal.

□ **Ziegler Nichols Tuning Method**

In order to tune the PID controls of the adjustable frequency drive, several tuning methods can be used. One approach is to use a technique which was developed in the 1950s but which has stood the test of time and is still used today. This method is known as the Ziegler Nichols tuning.

NOTE
The method described must not be used on applications that could be damaged by the oscillations created by marginally stable control settings.

The criteria for adjusting the parameters are based on evaluating the system at the limit of stability rather than on taking a step response. We increase the proportional gain *(K_u)* until we observe continuous oscillations *(P_u)* (as measured on the feedback), that is, until the system becomes marginally stable. The corresponding gain (called the ultimate gain) and the period of oscillation (also called the ultimate period) are determined as shown in Figure 1.

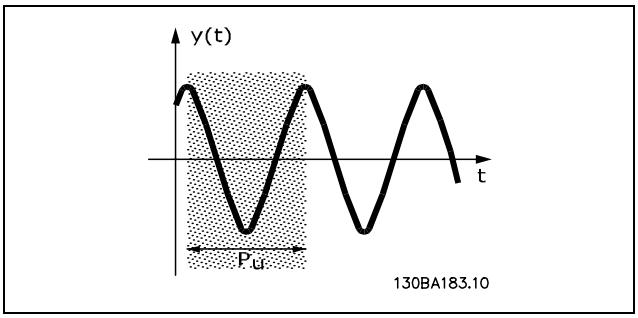


Figure 1: Marginally stable system

P_u should be measured when the amplitude of oscillation is quite small. Then we "back off" from this gain again, as shown in Table 1.

K_u is the gain at which the oscillation is obtained.

Type of Control	Proportional Gain	Integral Time	Differentiation Time
PI-control	0.45 * K_u	0.833 * P_u	-
PID tight control	0.6 * K_u	0.5 * P_u	0.125 * P_u
PID some overshoot	0.33 * K_u	0.5 * P_u	0.33 * P_u

Table 1: Ziegler Nichols tuning for regulator, based on a stability boundary.

Experience has shown that the control setting according to the Ziegler Nichols rule provides a good closed-loop response for many systems. The process operator can perform final tuning of the control iteratively to yield satisfactory control.

Step-by-step:

Step 1: Select only Proportional Control, meaning that the Integral time is selected to the maximum value, while the differentiation time is selected to zero.

Step 2: Increase the value of the proportional gain until the point of instability is reached (sustained oscillations) and the critical value of gain, K_u, is reached.

Step 3: Measure the period of oscillation to obtain the critical time constant, P_u.

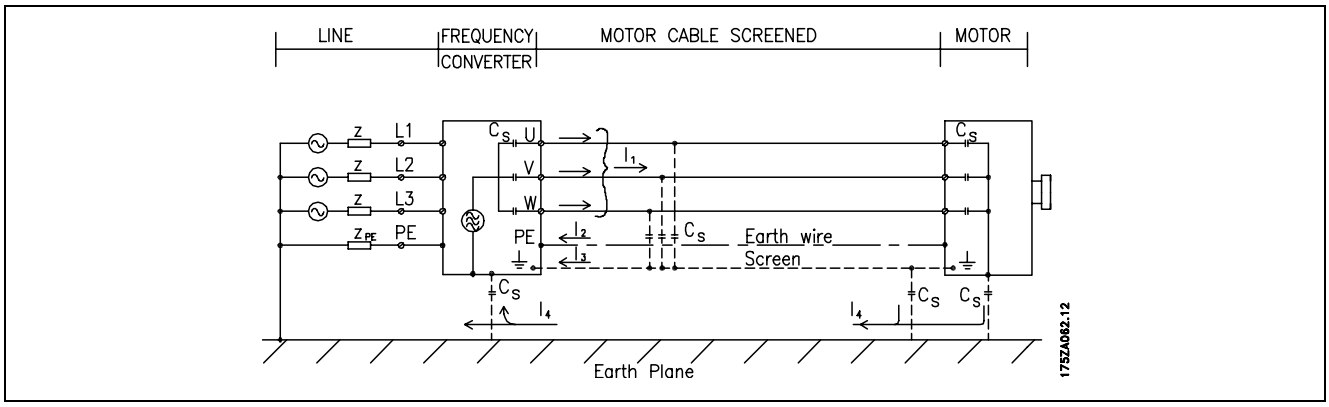
Step 4: Use the table above to calculate the necessary PID control parameters.

□ **General Aspects of EMC Emissions**

Electrical interference is usually conducted at frequencies in the range 150 kHz to 30 MHz. Airborne interference from the drive system in the range 30 MHz to 1 GHz is generated from the inverter, motor cable, and the motor.
As shown in the illustration below, capacitive currents in the motor cable coupled with a high dV/dt from the motor voltage generate leakage currents.
The use of a shielded motor cable increases the leakage current (see illustration below) because shielded cables have higher capacitance to ground than non-shielded cables. If the leakage current is not filtered, it will cause greater interference on the mains in the radio frequency range below approx. 5 MHz. Since the leakage current (I_1) is carried back to the unit through the shield (I_3), there will in principle only be a small electromagnetic field (I_4) from the shielded motor cable according to the below figure.

The shield reduces the radiated interference but increases the low-frequency interference on the mains. The motor cable shield must be connected to the adjustable frequency drive enclosure as well as on the motor enclosure. This is best done by using integrated shield clamps so as to avoid twisted shield ends (pigtails). These increase the shield impedance at higher frequencies, which reduces the shield effect and increases the leakage current (I_4).
If a shielded cable is used for Profibus, standard bus, relay, control cable, signal interface, and brake, the shield must be mounted on the enclosure at both ends. In some situations, however, it will be necessary to break the shield to avoid current loops.

Introduction to FC 300



If the shield is to be placed on a mounting plate for the adjustable frequency drive, the mounting plate must be made of metal, because the shield currents must be conveyed back to the unit. Moreover, ensure good electrical contact from the mounting plate through the mounting screws to the adjustable frequency drive chassis.

NOTE
When non-shielded cables are used, some emission requirements are not complied with, although the immunity requirements are observed.

In order to reduce the interference level from the entire system (unit + installation), make motor and brake cables as short as possible. Avoid placing cables with a sensitive signal level alongside motor and brake cables. Radio interference higher than 50 MHz (airborne) is especially generated by the control electronics.

EMC Test Results (Emission, Immunity)

The following test results have been obtained using a system with an adjustable frequency drive (with options if relevant), a shielded control cable, a control box with potentiometer, as well as a motor and motor cable.

FC 301/FC 302 200-240 V 380-500 V 600 V no filter	Conducted emission			Radiated emission	
	Industrial environment		Housing, trades and light industries	Industrial environment	Housing, trades and light industries
Setup	EN 55011 Class A2	EN 55011 Class A1	EN 55011 Class B	EN 55011 Class A1	EN 55011 Class B
FC 301/FC 302 H2					
0-3.7 kW 200-240 V	16 ft (5 m)	No	No	No	No
0-7.5 kW 380-500 V	16 ft (5 m)	No	No	No	No
FC 301 with integrated filter H1		164 ft (50 m)			
0-3.7 kW 200-240 V	246 (75 m)	164 ft (50 m)	33 ft (10 m)	Yes	No
0-7.5 kW 380-480 V	246 (75 m)		33 ft (10 m)	Yes	No
FC 302 with integrated filter H1		490 ft (150 m)			
0-3.7 kW 200-240 V	490 ft (150 m)	490 ft (150 m)	130 ft (40 m)	Yes	No
0-7.5 kW 380-500 V	490 ft (150 m)		130 ft (40 m)	Yes	No
FC 301 11-22 kW 380-500 V	82 ft (25 m)	No	No	No	No
FC 302 11-22 kW 380-500 V	82 ft (25 m)	No	No	No	No
FC 301 with integrated filter H1 11-22 kW 380-500 V	246 (75 m)	164 ft (50 m)	33 ft (10 m)	Yes	No
FC 302 with integrated filter H2 11-22 kW 380-500 V	490 ft (150 m)	490 ft (150 m)	130 ft (40 m)	Yes	No

Hx is without filter

□ Required Compliance Levels

Standard / environment	Housing, trades, and light industries		Industrial environment	
	Conducted	Radiated	Conducted	Radiated
IEC 61000-6-3 (generic)	Class B	Class B		
IEC 61000-6-4			Class A1	Class A1
EN 61800-3 (restricted)	Class A1	Class A1	Class A1	Class A1
EN 61800-3 (unrestricted)	Class B	Class B	Class A2	Class A2

EN 55011: Threshold values and measuring methods for radio interference from industrial, scientific and medical (ISM) high-frequency equipment.
Class A1: Equipment used in a public supply network. Restricted distribution.
Class A2: Equipment used in a public supply network.
Class B1: Equipment used in areas with a public supply network (residential, commerce, and light industries). Unrestricted distribution.

□ EMC Immunity

In order to document immunity against electrical interference from electrical phenomena, the following immunity tests have been made on a system consisting of an adjustable frequency drive (with options, if relevant), a shielded control cable, and a control box with potentiometer, motor cable, and motor.

The tests were performed in accordance with the following basic standards:

- **EN 61000-4-2 (IEC 61000-4-2): Electrostatic discharges (ESD)**
  Simulation of electrostatic discharges from human beings.
- **EN 61000-4-3 (IEC 61000-4-3): Incoming electromagnetic field radiation, amplitude modulated**
  Simulation of the effects of radar and radio communication equipment as well as mobile communications.
- **EN 61000-4-4 (IEC 61000-4-4): Electrical interference**
  Simulation of interference brought about by switching with a contactor, relays, or similar devices.
- **EN 61000-4-5 (IEC 61000-4-5): Surge transients**
  Simulation of transients brought about, e.g., by lightning that strikes near installations.
- **EN 61000-4-6 (IEC 61000-4-6): RF Common mode**
  Simulation of the effect from radio-transmitting equipment connected to connection cables.

See following EMC immunity form.

Immunity continued

FC 301/FC 302; 200-240 V, 380-500 V

Basic standard	Burst IEC 61000-4-4	Surge IEC 61000-4-5	ESD IEC 61000-4-2	Radiated electromagnetic field IEC 61000-4-3	RF common mode voltage IEC 61000-4-6
Acceptance criterion	B	B	B	A	A
Line	4 kV CM	2 kV/2 Ω DM 4 kV/12 Ω CM	—	—	10 V_{RMS}
Motor	4 kV CM	4 kV/2 Ω[1)]	—	—	10 V_{RMS}
Brake	4 kV CM	4 kV/2 Ω[1)]	—	—	10 V_{RMS}
Load sharing	4 kV CM	4 kV/2 Ω[1)]	—	—	10 V_{RMS}
Control wires	2 kV CM	2 kV/2 Ω[1)]	—	—	10 V_{RMS}
Standard bus	2 kV CM	2 kV/2 Ω[1)]	—	—	10 V_{RMS}
Relay wires	2 kV CM	2 kV/2 Ω[1)]	—	—	10 V_{RMS}
Application and serial communication options	2 kV CM	2 kV/2 Ω[1)]	—	—	10 V_{RMS}
LCP cable	2 kV CM	2 kV/2 Ω[1)]	—	—	10 V_{RMS}
External 24 V DC	2 kV CM	0.5 kV/2 Ω DM 1 kV/12 Ω CM	—	—	10 V_{RMS}
Enclosure	—	—	8 kV AD 6 kV CD	10 V/m	—

AD: Air Discharge

CD: Contact Discharge

CM: Common mode

DM: Differential mode

1. Injection on cable shield.

Introduction to FC 300

□ Galvanic Isolation (PELV)

PELV offers protection by way of extra low voltage. Protection against electric shock is ensured when the electrical supply is of the PELV type and the installation is made as described in local/national regulations on PELV supplies.

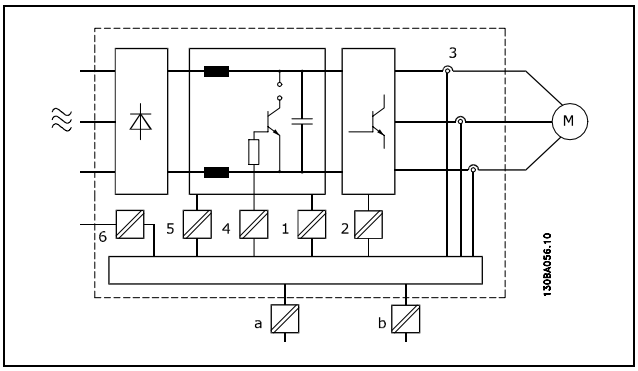
All control terminals and relay terminals 01-03/04-06 comply with PELV (Protective Extra Low Voltage) (Does not apply to 525-600 V units and at grounded Delta leg above 300 V).

Galvanic (ensured) isolation is obtained by fulfilling requirements for higher isolation and by providing the relevant creepage/clearance distances. These requirements are described in the EN 61800-5-1 standard.

The components that make up the electrical isolation, as described below, also comply with the requirements for higher isolation and the relevant test as described in EN 61800-5-1.
The PELV galvanic isolation can be shown in six locations (see illustration):

In order to maintain PELV all connections made to the control terminals must be PELV, e.g. thermistor must be reinforced/double insulated.

1. Power supply (SMPS) incl. signal isolation of U_{DC}, indicating the intermediate current voltage.
2. Gate drive that runs the IGBTs (trigger transformers/opto-couplers).
3. Current transducers.
4. Opto-coupler, brake module.
5. Internal inrush, RFI, and temperature measurement circuits.
6. Custom relays.



Galvanic isolation

The functional galvanic isolation (a and b on drawing) is for the 24 V backup option and for the RS-485 standard bus interface.

□ Ground Leakage Current

Warning:
Touching the electrical parts may be fatal - even after the equipment has been disconnected from line power.
Also make sure that other voltage inputs have been disconnected, such as load sharing (linkage of DC intermediate circuit), as well as the motor connection for kinetic backup.
Using VLT AutomationDrive FC 300: wait at least 15 minutes.
Shorter time is allowed only if indicated on the nameplate for the specific unit.

Leakage Current

The ground leakage current from the FC 300 exceeds 3.5 mA. To ensure that the ground cable has a good mechanical connection to the ground connection (terminal 95), the cable cross-section must be at least 3.9 in^2 [10 mm^2] or have 2 rated ground wires terminated separately.

Residual Current Device

This product can cause DC current in the protective conductor. Where a residual current device (RCD) is used for extra protection, only an RCD of Type B (time delayed) will be used on the supply side of this product. See also RCD Application Note MN.90.GX.02.

Protective grounding of the adjustable frequency drive and the use of RCDs must always follow national and local regulations.

□ Selection of Brake Resistor

To handle higher demands by generatoric braking, a brake resistor is necessary. Using a brake resistor ensures that the energy is absorbed in the brake resistor and not in the adjustable frequency drive.

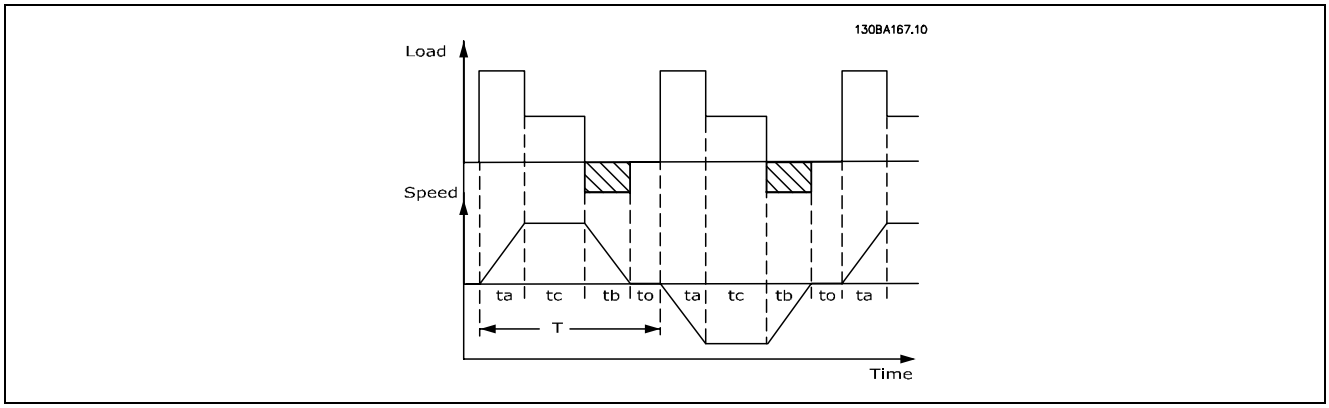
If the amount of kinetic energy transferred to the resistor in each braking period is not known; the average power can be calculated on the basis of the cycle time and braking time, also called intermitted duty cycle. The resistor intermittent duty cycle is an indication of the duty cycle at which the resistor is active. The below figure shows a typical braking cycle.

NOTE
Motor suppliers often use S5 when stating the permissible load which is an expression of intermittent duty cycle.

The intermittent duty cycle for the resistor is calculated as follows:

Duty cycle = t_b/T

T = cycle time in seconds
t_b is the braking time in seconds (of the cycle time)



Danfoss offers brake resistors with duty cycle of 5%, 10% and 40%. If a 10% duty cycle is applied, the brake resistors are able to absorb braking energy for 10% of the cycle time. The remaining 90% of the cycle time will be used for deflecting excess heat.

The max. permissible load on the brake resistor is stated as a peak power at a given intermittent duty cycle and can be calculated as:

$$P_{PEAK} = P_{MOTOR} \times M_{BR(\%)} \times \eta_{MOTOR} \times \eta_{VLT} \ [W]$$

The brake resistance is calculated as shown:

$$R_{br} = \frac{Udc^2}{P_{peak}} = [\Omega]$$

As can be seen, the brake resistance depends on the intermediate circuit voltage (UDC).
The FC 301 and FC 302 brake function is settled in 3 areas of the line supply:

Size	Brake active	Warning before cut out	Cut out (trip)
FC 301 / 302 3 x 200-240 V	390 V (UDC)	405 V	410 V
FC 301 3 x 380-480 V	778 V	810 V	820 V
FC 302 3 x 380-500 V	810 V	840 V	850 V
FC 302 3 x 525-600 V	943 V	965 V	975 V

NOTE
Check that the brake resistor can cope with a voltage of 410 V, 820 V, 850 V or 975 V - unless Danfoss brake resistors are used.

Danfoss recommends the brake resistance R_{REC}, i.e. one that guarantees that the adjustable frequency drive is able to brake at the highest braking torque (M_{br}) of 160%. The formula can be written as:

$$R_{rec} = \frac{Udc^2 \; x \; 100}{P_{motor} \; x \; M_{BR(\%)} \; x \; \eta_{vlt} \; x \; n_{motor}} = [\Omega]$$

η_{motor} is typically at 0.90 η_{VLT} is typically at 0.98

For the 200 V, 480 V, 500 V and 600 V adjustable frequency drives, R_{REC} at 160% braking torque is written as:

$$200\text{V}: \; \text{R}_{\text{REC}} = \frac{107780}{P_{MOTOR}} \quad [\Omega]$$

1. $480 \; V \; : \; R = \frac{375300}{P_{MOTOR}} \; [\Omega]$
2. $480 \; V \; : \; R = \frac{428914}{P_{MOTOR}} \; [\Omega]$

$$500 \text{ V}: \; \text{R}_{\text{REC}} = \frac{464923}{P_{MOTOR}} \quad [\Omega]$$

$$600 \text{ V}: \; \text{R}_{\text{REC}} = \frac{630137}{P_{MOTOR}} \quad [\Omega]$$

1. For FC 300 adjustable frequency drives ≤ 10 HP [7.5 kW] shaft output
2. For FC 300 adjustable frequency drives > 10 HP [7.5 kW] shaft output

NOTE
The resistor brake circuit resistance selected should not be higher than that recommended by Danfoss. If a brake resistor with a higher ohmic value is selected, the 160% braking torque may not be achieved because there is a risk that the adjustable frequency drive cuts out for safety reasons.

NOTE
If a short circuit in the brake transistor occurs, power dissipation in the brake resistor is only prevented by using a line switch or contactor to disconnect the AC line for the adjustable frequency drive. (The contactor can be controlled by the adjustable frequency drive).

□ **Control with Brake Function**

The brake is to limit the voltage in the intermediate circuit when the motor acts as a generator. This occurs, for example, when the load drives the motor and the power accumulates on the DC link. The brake is built up as a chopper circuit with the connection of an external brake resistor. Placing the brake resistor externally offers the following advantages:

- The brake resistor can be selected on the basis of the application in question.
- The braking energy can be dissipated outside the control panel, i.e., where the energy can be utilized.
- The electronics of the adjustable frequency drive will not overheat if the brake resistor is overloaded.

The brake is protected against short-circuiting of the brake resistor, and the brake transistor is monitored to ensure that short-circuiting of the transistor is detected. A relay/digital output can be used for protecting the brake resistor against overloading in connection with a fault in the adjustable frequency drive. In addition, the brake makes it possible to read out the momentary power and the mean power for the last 120 seconds. The brake can also monitor the power energizing and make sure it does not exceed a limit set in par. 2-12. In par. 2-13, select the function to carry out when the power transmitted to the brake resistor exceeds the limit set in par. 2-12.

NOTE

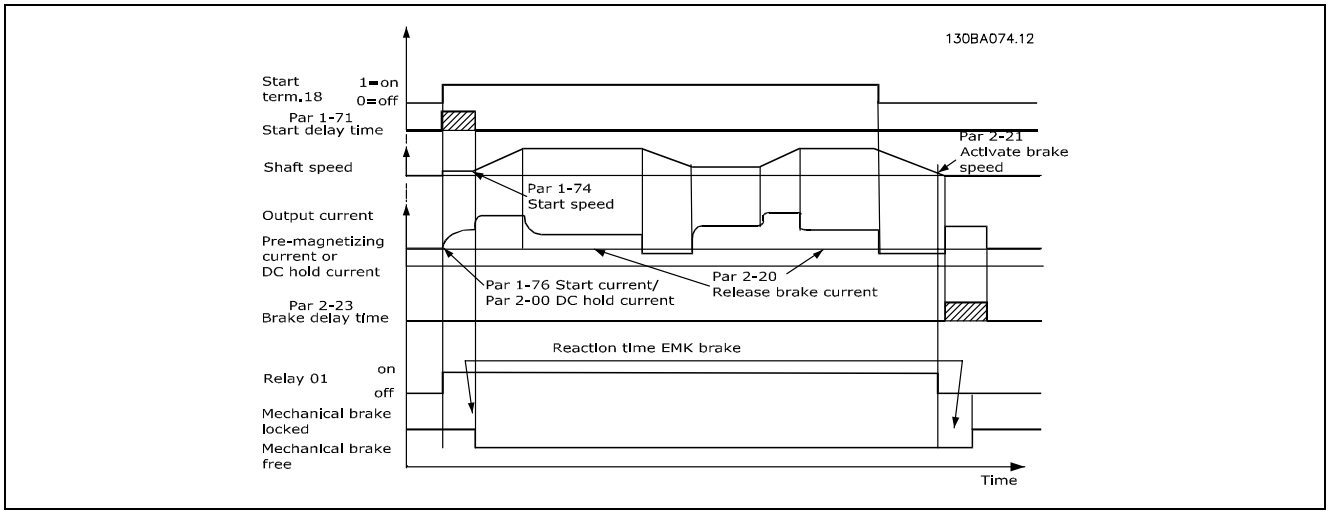
Monitoring the braking energy is not a safety function; a thermal switch is required for that purpose. The brake resistor circuit is not ground leakage protected.

Over-voltage control (OVC) (excluding the brake resistor) can be selected as an alternative brake function in par. 2-17. This function is active for all units. The function ensures that a trip can be avoided if the DC link voltage increases. This is done by increasing the output frequency to limit the voltage from the DC link. It is a very useful function, e.g., if the ramp-down time is too short since tripping the adjustable frequency drive is avoided. In this situation, the ramp-down time is extended.

□ Control of Mechanical Brake

For hoisting applications, it is necessary to be able to control an electro-magnetic brake. For controlling the brake, a relay output (relay1 or relay2) or a programmed digital output (terminal 27 or 29) is required. Normally, this output must be closed for as long as the adjustable frequency drive is unable to 'hold' the motor, e.g., because of load that is too large. In par. 5-40 (Array parameter), par. 5-30, or par. 5-31 (digital output 27 or 29), select *mechanical brake control* [32] for applications with an electro-magnetic brake.

When *mechanical brake control* [32] is selected, the mechanical brake relay stays closed during the start until the output current is above the level selected in par. 2-20 *Release Brake Current*. During stop, the mechanical brake will close when the speed is below the level selected in par. 2-21 *Activate Brake Speed [RPM]*. If the adjustable frequency drive is brought into an alarm condition, i.e., an overvoltage situation, the mechanical brake immediately cuts in. This is also the case during safe stop.



Step-by-step Description

In hoisting/lowering applications, it must be possible to control an electro-mechanical brake.

- To control the mechanical brake, any relay output or digital output (terminal 27 or 29) can be used; if necessary use a suitable magnetic contactor.
- Ensure that the output stays voltage-free as long as the adjustable frequency drive is unable to drive the motor, for example, due to the load being too heavy or due to the fact that the motor has not yet been dismounted.
- Select *Mechanical brake control* [32] in par. 5-4* (or in par. 5-3*) before connecting the mechanical brake.
- The brake is released when the motor current exceeds the preset value in par. 2-20.
- The brake is engaged when the output frequency is less than the frequency set in par. 2-21 or 2-22 and only if the adjustable frequency drive carries out a stop command.

NOTE
Check that the brake resistor is rated for 410 V (240 V units), 820 V (480 V units), 850 V (500 V units) or 975 V (600 V units) - unless Danfoss brake resistors are used.

NOTE
Do not touch the brake resistor since it can get very hot during/after braking.

NOTE
For vertical lifting or hoisting applications, it is strongly recommended to ensure that the load can be stopped in case of an emergency or a malfunction of a single part such as a contactor, etc. If the adjustable frequency drive is in alarm mode or in an overvoltage situation, the mechanical brake cuts in.

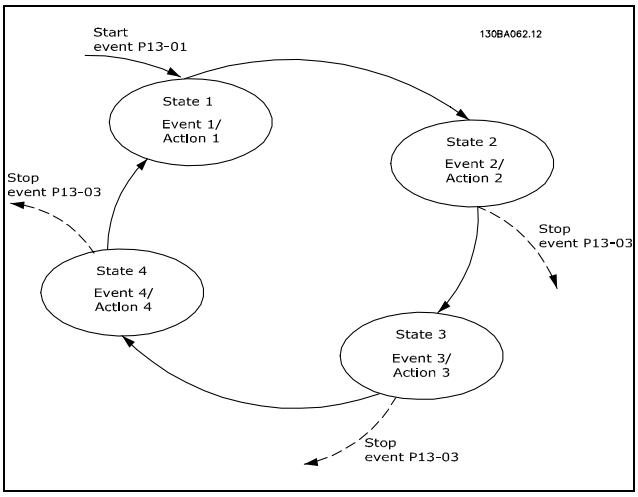
□ **Cabling**
EMC (twisted cables/shielding)
To reduce the electrical noise from the wires between the brake resistor and the adjustable frequency drive, the wires must be twisted.

For enhanced EMC performance, a metal shield can be used.

□ **Smart Logic Control**
Smart logic control (SLC) is essentially a sequence of user-defined actions (see par. 13-52) executed by the SLC when the associated user defined *event* (see par. 13-51) is evaluated as TRUE by the SLC. *Events* and *actions* are each numbered and are linked together in pairs. This means that when *event [1]* is fulfilled (attains the value TRUE), *action [1]* is executed. After this, the conditions of *event [2]* will be evaluated and if evaluated TRUE, *action [2]* will be executed and so on. Events and actions are placed in array parameters.

Only one *event* will be evaluated at any time. If an *event* is evaluated as FALSE, nothing happens (in the SLC) during the present scan interval and no other *events* will be evaluated. This means that when the SLC starts, it evaluates *event [1]* (and only *event [1]*) each scan interval. Only when *event [1]* is evaluated TRUE, the SLC executes *action [1]* and starts evaluating *event [2]*.

It is possible to program from 0 to 20 *events* and *actions*. When the last *event/action* has been executed, the sequence starts over again from *event [1] / action [1]*. The illustration shows an example with three *events/actions*:



□ Extreme Running Conditions

Short Circuit (Motor Phase – Phase)

The adjustable frequency drive is protected against short circuits by means of current measurement in each of the three motor phases or in the DC link. A short circuit between two output phases will cause an overcurrent in the inverter. The inverter will be turned off individually when the short circuit current exceeds the permitted value (Alarm 16 Trip Lock).
To protect the drive against a short circuit at the load sharing and brake outputs, please see the design guidelines.

Switching on the Output

Switching on the output between the motor and the adjustable frequency drive is fully permitted. You cannot damage the adjustable frequency drive in any way by switching on the output. However, fault messages may appear.

Motor-generated Overvoltage

The voltage in the intermediate circuit is increased when the motor acts as a generator. This occurs in the following cases:

1. The load drives the motor (at constant output frequency from the adjustable frequency drive), i.e. the load generates energy.
2. During deceleration ("ramp-down"), if the moment of inertia is high, the friction is low and the ramp-down time is too short for the energy to be dissipated as a loss in the adjustable frequency drive, the motor, and the installation.
3. Incorrect slip compensation setting may cause higher DC link voltage.

The control unit may attempt to correct the ramp if possible (par. 2-17 *Over-voltage Control*.
The inverter turns off to protect the transistors and the intermediate circuit capacitors when a certain voltage level is reached.
See par. 2-10 and par. 2-17 to select the method used for controlling the intermediate circuit voltage level.

Line Drop-out

During a line drop-out, the adjustable frequency drive keeps running until the intermediate circuit voltage drops below the minimum stop level, which is typically 15% below the adjustable frequency drive's lowest rated supply voltage.

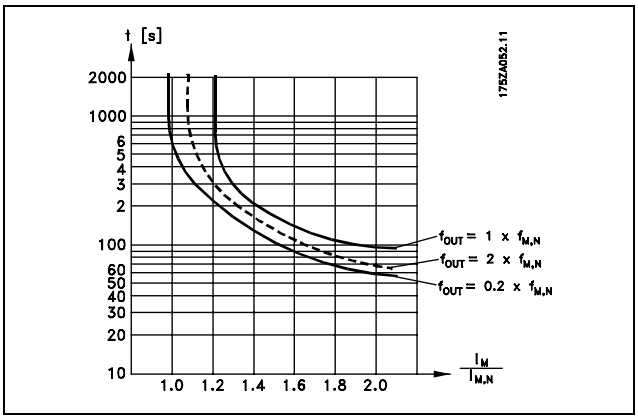
The line voltage before the drop-out and the motor load determine how long it takes for the inverter to coast.

Static Overload in VVC^{plus} mode

When the adjustable frequency drive is overloaded (the torque limit in par. 4-16/4-17 is reached), the control reduces the output frequency to reduce the load.
If the overload is excessive, a current may occur that makes the adjustable frequency drive cut out after approx. 5-10 s.

Operation within the torque limit is limited in time (0-60 s) in par. 14-25.

□ **Motor Thermal Protection**
The motor temperature is calculated on the basis of motor current, output frequency, and time or thermistor. See par. 1-90 in the chapter *How to Program*.



□ Safe Stop of FC 300

The adjustable frequency drive can perform the Safety Function "Uncontrolled Stopping by removal of power" (as defined by draft IEC 61800-5-2) or Stop Category 0 (as defined in EN 60204-1).
It is designed and approved suitable for the requirements of Safety Category 3 in EN 954-1. This functionality is called Safe Stop.
The Safe Stop function is activated by removing the voltage at Terminal 37 of the Safe Inverter. By connecting the Safe Inverter to external safety devices providing a safe delay, an installation for a safe Stop Category 1 can be obtained. The safe inverter can be used for asynchronous and synchronous motors.

Safe Stop activation (i.e. removal of 24 V DC voltage supply to terminal 37) does not provide electrical safety.

1. Activate the Safe Stop function by removing the 24 V DC voltage supply to the terminal 37.
2. After activation of Safe Stop, the adjustable frequency drive coasts (stops creating a rotational field in the motor). The resonse time is shorter than 10 ms for the complete performance range of FC 302. For FC 302 up to 7.5 kW it is even shorter than 5 ms.

The adjustable frequency drive is guaranteed not to restart creation of a rotational field by an internal fault (in accordance with Cat. 3 of EN 954-1).

After activation of Safe Stop, the FC 302 display will show the text "Safe Stop active". The associated help text says "Safe Stop has been activated. To resume normal operation, apply 24 V DC to terminal 37, then send Reset signal (via Bus, Digital I/O, or the [Reset] key)." This means that the Safe Stop has been activated, or that normal operation has not been resumed yet after a Safe Stop activation. NB: The requirements of EN 945-1 Category 3 are only fulfilled while 24 V DC supply to terminal 37 is removed or low.

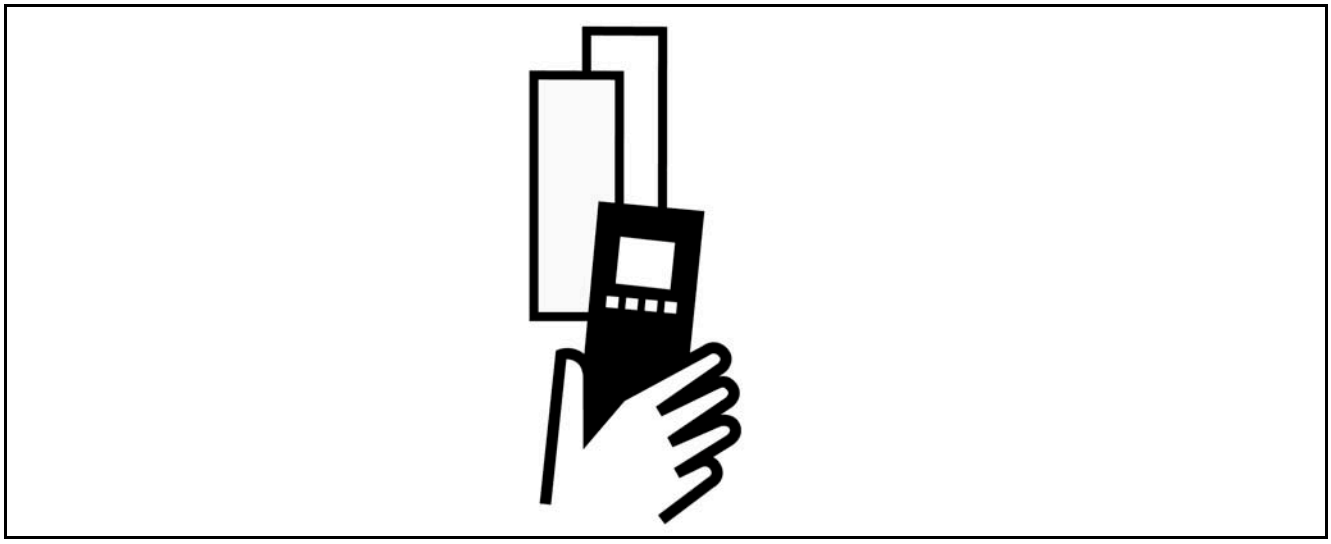
In order to resume operation after activation of Safe Stop, first 24 V DC voltage must be reapplied to terminal 37 (text "Safe Stop active" is still displayed), second a Reset signal must be created (via bus, Digital I/O, or [Reset] key on inverter).

NOTE
The Safe Stop function of FC 302 can be used for asynchronous and synchronous motors. It may happen that two faults occur in the adjustable frequency drive's power semiconductor. When using synchronous motors, this may cause a residual rotation. The rotation can be calculated to Angle=360/(Number of Poles). The application using synchronous motors must take this into consideration and ensure that this is not a safety-critical issue. This situation is not relevant for asynchronous motors.

NOTE
In order to use the Safe Stop functionality in conformance with the requirements of EN-954-1 Category 3, a number of conditions must be fulfilled by the installation of Safe Stop. Please see section *Safe Stop Installation* for further information.

NOTE
The adjustable frequency drive does not provide a safety-related protection against unintended or malicious voltage supply to terminal 37 and subsequent reset. Provide this protection via the interrupt device, at the application level, or at the organizational level.
For more information - see section *Safe Stop Installation*.

FC 300 Selection



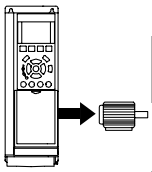
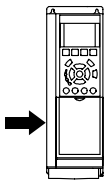
□ Electrical Data

□ Line Supply 3 x 200 - 240 VAC

FC 301/FC 302 Typical Shaft Output [kW]	0.25	0.37	0.55	0.75	1.1	1.5	2.2	3	3.7	4	5.5	7.5
Output current												
Continuous (3 x 200-240 V) [A]	1.8	2.4	3.5	4.6	6.6	7.5	10.6	12.5	16.7	-	-	-
Intermittent (3 x 200-240 V) [A]	2.9	3.8	5.6	7.4	10.6	12.0	17.0	20.0	26.7	-	-	-
Continuous KVA (208 V AC) [KVA]	0.65	0.86	1.26	1.66	2.38	2.70	3.82	4.50	6.00	-	-	-
Max. cable size (line, motor, brake) [AWG] [2] [mm²]	24 - 10 AWG 0.0079-0.1575 in [0.2-4 mm]²									-	-	-
Max. input current												
Continuous (3 x 200-240 V) [A]	1.6	2.2	3.2	4.1	5.9	6.8	9.5	11.3	15.0	-	-	-
Intermittent (3 x 200-240 V) [A]	2.6	3.5	5.1	6.6	9.4	10.9	15.2	18.1	24.0	-	-	-
Max. pre-fuses[1] [A]	10	10	10	10	20	20	20	32	32	-	-	-
Environment												
Estimated power loss at rated max. load [W] [4]	21	29	42	54	63	82	116	155	185	-	-	-
Enclosure IP 20												
Weight, enclosure IP 20 [kg]	4.7	4.7	4.8	4.8	4.9	4.9	4.9	6.6	6.6	-	-	-
Efficiency [4]	0.94	0.94	0.95	0.95	0.96	0.96	0.96	0.96	0.96	-	-	-

FC 300 Selection

□ Line Supply 3 x 380 - 500 VAC (FC 302)
3 x 380 - 480 VAC (FC 301)

FC 301/FC 302 Typical Shaft Output [kW]		0,25	0.37	0.55	0.75	1.1	1.5	2.2	3	3.7	4	5.5	7.5
Output current													
	Continuous (3 x 380-440 V) [A]	-	1.3	1.8	2.4	3	4.1	5.6	7.2	-	10	13	16
	Intermittent (3 x 380-440 V) [A]	-	2.1	2.9	3.8	4.8	6.6	9.0	11.5	-	16	20.8	25.6
	Continuous (3 x 440-500 V) [A]	-	1.2	1.6	2.1	2.7	3.4	4.8	6.3	-	8.2	11	14.5
	Intermittent (3 x 440-500 V) [A]	-	1.9	2.6	3.4	4.3	5.4	7.7	10.1	-	13.1	17.6	23.2
	Continuous KVA (400 V AC) [KVA]	-	0.9	1.3	1.7	2.1	2.8	3.9	5.0	-	6.9	9.0	11.0
	Continuous KVA (460 V AC) [KVA]	-	0.9	1.3	1.7	2.4	2.7	3.8	5.0	-	6.5	8.8	11.6
	Max. cable size (line, motor, brake) [AWG] [2] [mm²]	-	24 - 10 AWG 0.0079-0.1575 in [0.2-4 mm]²							-	24 - 10 AWG 0.0079-0.1575 in [0.2-4 mm]²		
Max. input current													
	Continuous (3 x 380-440 V) [A]	-	1.2	1.6	2.2	2.7	3.7	5.0	6.5	-	9.0	11.7	14.4
	Intermittent (3 x 380-440 V) [A]	-	1.9	2.6	3.5	4.3	5.9	8.0	10.4	-	14.4	18.7	23.0
	Continuous (3 x 440-500 V) [A]	-	1.0	1.4	1.9	2.7	3.1	4.3	5.7	-	7.4	9.9	13.0
	Intermittent (3 x 440-500 V) [A]	-	1.6	2.2	3.0	4.3	5.0	6.9	9.1	-	11.8	15.8	20.8
	Max. pre-fuses[1][A]	-	10	10	10	10	10	20	20	-	20	32	32
	Environment												
	Estimated power loss at rated max. load [W] [4]	-	35	42	46	58	62	88	116	-	124	187	255
	Enclosure IP 20												
	Weight, enclosure IP 20 [kg]	-	4.7	4.7	4.8	4.8	4.9	4.9	4.9	-	4.9	6.6	6.6
	Efficiency [4]	-	0.93	0.95	0.96	0.96	0.97	0.97	0.97	-	0.97	0.97	0.97

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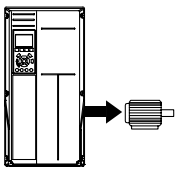
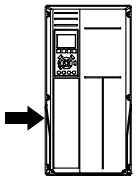
FC 300 Selection

Line Supply 3 x 380 - 500 VAC

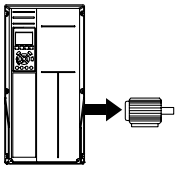
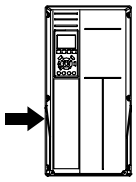
High Overload 160% for 1 minute

FC 302 Typical Shaft Output [kW]		11	15	18.5	22
Output current					
	Continuous (3 x 380-440 V) [A]	24	32	37.5	44
	Intermittent (3 x 380-440 V) [A]	38.4	51.2	60	70.4
	Continuous (3 x 440-500 V) [A]	21	27	34	40
	Intermittent (3 x 440-500 V) [A]	33.6	43.2	54.4	64
	Continuous KVA (400 V AC) [KVA]	16.6	22.2	26	30.5
Max. input current					
	Continuous (3 x 380-440 V) [A]	22	30	35	42
	Intermittent (3 x 380-440 V) [A]	35.2	48	56	67.2
	Continuous (3 x 440-500 V) [A]	20	25	32	38
	Intermittent (3 x 440-500 V) [A]	32	40	51.2	60.8
	Max. cable size [mm^2 / AWG] [2)]	16/6	16/6	35/2	35/2
	Max. pre-fuses [A] [1]	63	63	63	80
	Estimated power loss at rated max. load [W] [4)]	272	382	454	513
	Enclosure IP 21, IP 55				
	Weight, enclosure IP 21, IP 55 [kg]	23	23	28	28
	Efficiency[4)]	0.98	0.98	0.98	0.98

FC 300 Selection

Line Supply 3 x 380 - 500 V AC

Normal Overload 110% for 1 minute

FC 302 Typical Shaft Output [kW]		15	18.5	22	30
Output current					
	Continuous (3 x 380-440 V) [A]	32	37.5	44	61
	Intermittent (3 x 380-440 V) [A]	35.2	41.3	48.4	67.1
	Continuous (3 x 440-500 V) [A]	27	34	40	52
	Intermittent (3 x 440-500 V) [A]	29.7	37.4	44	57.2
	Continuous kVA (400 V AC) [kVA]	22.2	26	30.5	42.3
	Continuous kVA (460 V AC) [kVA]	21.5	27.1	31.9	41.4
Max. input current					
	Continuous (3 x 380-440 V) [A]	30	35	42	58
	Intermittent (3 x 380-440 V) [A]	33	38.5	46.2	63.8
	Continuous (3 x 440-500 V) [A]	25	32	38	49
	Intermittent (3 x 440-500 V) [A]	27.5	35.2	41.8	53.9
	Max. cable size [mm^2 / AWG] [2)]	16/6	16/6	35/2	35/2
	Max. pre-fuses [A] [1]	63	63	63	80
	Estimated power loss at rated max. load [W] [4)]	382	454	513	721
	Enclosure IP 21, IP 55				
	Weight, enclosure IP 21, IP 55 [kg]	23	23	28	28
	Efficiency[4)]	0.98	0.98	0.98	0.98

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□ **Line Supply 3 x 525 - 600 VAC (FC 302 only)**

FC 302 Typical Shaft Output [kW]	0.25	0.37	0.55	0.75	1.1	1.5	2.2	3	3.7	4	5.5	7.5
Output current												
Continuous (3 x 525-550 V) [A]	-	-	-	1.8	2.6	2.9	4.1	5.2	-	6.4	9.5	11.5
Intermittent (3 x 525-550 V) [A]	-	-	-	2.9	4.2	4.6	6.6	8.3	-	10.2	15.2	18.4
Continuous (3 x 525-600 V) [A]	-	-	-	1.7	2.4	2.7	3.9	4.9	-	6.1	9.0	11.0
Intermittent (3 x 525-600 V) [A]	-	-	-	2.7	3.8	4.3	6.2	7.8	-	9.8	14.4	17.6
Continuous kVA (525 V AC) [kVA]	-	-	-	1.7	2.5	2.8	3.9	5.0	-	6.1	9.0	11.0
Continuous kVA (575 V AC) [kVA]	-	-	-	1.7	2.4	2.7	3.9	4.9	-	6.1	9.0	11.0
Max. cable size (line, motor, brake) [AWG] 2) [mm²]	-	-	-	24 - 10 AWG 0.0079-0.1575 in [0.2-4 mm]²					-	24 - 10 AWG 0.0079-0.1575 in [0.2-4 mm]²		
Max. input current												
Continuous (3 x 525-600 V) [A]	-	-	-	1.7	2.4	2.7	4.1	5.2	-	5.8	8.6	10.4
Intermittent (3 x 525-600 V) [A]	-	-	-	2.7	3.8	4.3	6.6	8.3	-	9.3	13.8	16.6
Max. pre-fuses1) [A]	-	-	-	10	10	10	20	20	-	20	32	32
Environment												
Estimated power loss at rated max. load [W] 4)	-	-	-	35	50	65	92	122	-	145	195	261
Enclosure IP 20												
Weight, enclosure IP 20 [kg]	-	-	-	6.5	6.5	6.5	6.5	6.5	-	6.5	6.6	6.6
Efficiency 4)	-	-	-	0.97	0.97	0.97	0.97	0.97	-	0.97	0.97	0.97

1) For type of fuse, see section *Fuses.*
2) American Wire Gauge.
3) Measured using 16.4 ft. [5 m] shielded motor cables at rated load and rated frequency.
4) The typical power loss is at nominal load conditions and expected to be within +/-15% (tolerance relates to variety in voltage and cable conditions).
Values are based on a typical motor efficiency (eff2/eff3 border line). Less efficient motors will also add to the power loss in the adjustable frequency drive and vice versa.
If the switching frequency is raised from nominal, the power losses may rise significantly.
LCP and typical control card power consumption values are included. Further options and customer load may add up to 30 W to the losses. (Though typical, only 4 W extra for a fully loaded control card, or options for slot A or slot B, each).
Although measurements are made with state of the art equipment, some measurement inaccuracy must be allowed for (+/-5%).

□ General Specifications

Protection and Features:

- Electronic thermal motor protection against overload.
- Temperature monitoring of the heatsink ensures that the adjustable frequency drive trips if the temperature reaches 203°F ± 9°F [95 °C ± 5°C]. An overload temperature cannot be reset until the temperature of the heatsink is below 158°C ± 9°C [70°C ± 5°C] (Guideline - these temperatures may vary for different power sizes, enclosures, etc.).
- The adjustable frequency drive is protected against short circuits on motor terminals U, V, W.
- If a line phase is missing, the adjustable frequency drive trips or issues a warning (depending on the load).
- Monitoring of the intermediate circuit voltage ensures that the adjustable frequency drive trips if the intermediate circuit voltage is too low or too high.
- The adjustable frequency drive is protected against ground faults on motor terminals U, V, W.

Mains supply (L1, L2, L3):

Supply voltage ..... 200-240 V ±10%
Supply voltage ..... FC 301: 380-480 V / FC 302: 380-500 V ±10%
Supply voltage ..... FC 302: 525-600 V ±10%
Supply frequency ..... 50/60 Hz
Max. imbalance temporary between mains phases ..... 3.0 % of rated supply voltage
True Power Factor (λ) ..... 0.90 nominal at rated load
Displacement Power Factor (cos φ) near unity ..... (> 0.98)
Switching on input supply L1, L2, L3 ..... 2 times/min.
Environment according to EN60664-1 ..... overvoltage category III/pollution degree 2
The unit is suitable for use on a circuit capable of delivering not more than 100,000 RMS symmetrical Amperes, 240/500/600 V maximum.

Motor output (U, V, W):

Output voltage ..... 0 - 100% of supply voltage
Output frequency ..... FC 301: 0.2 - 1000 Hz / FC 302: 0 - 1000 Hz
Switching on output ..... Unlimited
Ramp times ..... 0.01 - 3600 sec.

Torque characteristics:

Starting torque (Constant torque) ..... 160% for 1 min.*
Starting torque ..... 180% up to 0.5 sec.*
Overload torque (Constant torque) ..... 160% for 1 min.*
**Percentage relates to FC 300's nominal torque.*

Cable lengths and cross -sections:

Max. motor cable length, shielded/armored ..... FC 301: 150 ft (50 m) / FC 302: 500 ft (150 m)
Max. motor cable length, non-shielded/unarmored ..... FC 301: 250 ft (75 m) / FC 302: 1000 ft (300 m)
Max. cross-section to motor, mains, load sharing and brake (see section Electrical Data in the FC 300 Design Guide MG.33.BX.YY for more information), (0.34 HP - 10 HP / 0.25 kW - 7.5 kW) ..... 0.006 in.^{2} (4 mm^2) / 10 AWG
Maximum cross-section to control wires, rigid wire .....
0.002 in.^{2} (1.5 mm^2)/16 AWG (2 x 0.001 in.^{2} (2 x 0.75 mm^2))
Maximum cross-section to control cables, flexible cable ..... 0.0015 in.^{2} (1 mm^2)/18 AWG
Maximum cross-section to control cables, cable with enclosed core ..... 0.0008 in.^{2} (0.5 mm^2)/20 AWG

FC 300 Selection

Minimum cross-section to control wires ..... 0.0004 in.^{2} (0.25 mm^2)

Digital inputs:

Programmable digital inputs	FC 301: 4 (5) / FC 302: 4 (6)
Terminal number	18, 19, 27 [1], 29 [4], 32, 33,
Logic	PNP or NPN
Voltage level	0 - 24 V DC
Voltage level, logic'0' PNP	< 5 V DC
Voltage level, logic'1' PNP	> 10 V DC
Voltage level, logic '0' NPN [2]	> 19 V DC
Voltage level, logic '1' NPN [2]	< 14 V DC
Maximum voltage on input	28 V DC
Input resistance, R_i	approx. 4 kΩ

Safe stop Terminal 37[4]:
Terminal 37 is fixed PNP logic

Voltage level	0 - 24 V DC
Voltage level, logic'0' PNP	< 4 V DC
Voltage level, logic'1' PNP	>20 V DC
Nominal input current at 24 V	50 mA rms
Nominal input current at 20 V	60 mA rms
Input capacitance	400 nF

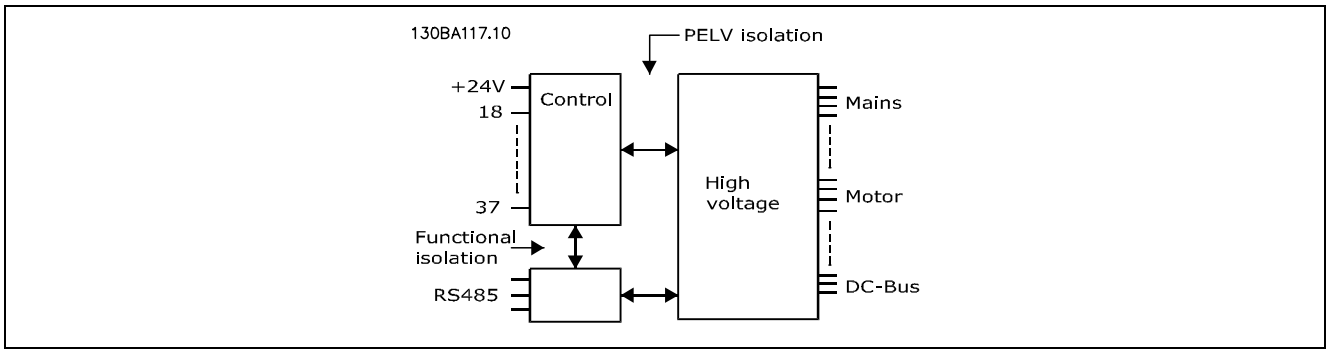
All digital inputs are galvanically isolated from the supply voltage (PELV) and other high-voltage terminals.
1) Terminals 27 and 29 can also be programmed as output.
2) Except safe stop input Terminal 37.
3) Terminal 37 is only available in the FC 302. It can only be used as safe stop input. Terminal 37 is suitable for category 3 installations according to EN 954-1 (safe stop according to category 0 EN 60204-1) as required by the EU Machinery Directive 98/37/EC. Terminal 37 and the Safe Stop function are designed in conformance with EN 60204-1, EN 50178, EN 61800-2, EN 61800-3, and EN 954-1. For correct and safe use of the Safe Stop function, follow the related information and instructions in the Design Guide.
4) FC 302 only.

FC 300 Selection

Analog inputs:

Number of analog inputs	2
Terminal number	53, 54
Modes	Voltage or current
Mode select	Switch S201 and switch S202
Voltage mode	Switch S201/switch S202 = OFF (U)
Voltage level	FC 301: 0 to + 10 / FC 302: -10 to +10 V (scalable)
Input resistance, R_i	approx. 10 kΩ
Max. voltage	± 20 V
Current mode	Switch S201/switch S202 = ON (I)
Current level	0/4 to 20 mA (scalable)
Input resistance, R_i	approx. 200 Ω
Max. current	30 mA
Resolution for analog inputs	10 bit (+ sign)
Accuracy of analog inputs	Max. error 0.5% of full scale
Bandwidth	FC 301: 20 Hz / FC 302: 100 Hz

The analog inputs are galvanically isolated from the supply voltage (PELV) and other high-voltage terminals.



Pulse/encoder inputs:

Programmable pulse/encoder inputs	2/1
Terminal number pulse/encoder	29, 33[1] / 18, 32, 33[2]
Max. frequency at terminal 18, 29, 32, 33	110 kHz (push-pull driven)
Max. frequency at terminal 18, 29, 32, 33	5 kHz (open collector)
Min. frequency at terminal 18, 29, 32, 33	4 Hz
Voltage level	see section on Digital input
Maximum voltage on input	28 V DC
Input resistance, R_i	approx. 4 kΩ
Pulse input accuracy (0.1 - 1 kHz)	Max. error: 0.1% of full scale
Encoder input accuracy (1 - 110 kHz)	Max. error: 0.05% of full scale

The pulse and encoder inputs (terminals 18, 29, 32, 33) are galvanically isolated from the supply voltage (PELV) and other high-voltage terminals.

1) Pulse inputs are 29 and 33

2) Encoder inputs: 32 = A, and 33 = B

MG.33.B6.22 - VLT is a registered Danfoss trademark

FC 300 Selection

Analog output:

Number of programmable analog outputs	1
Terminal number	42
Current range at analog output	0/4 - 20 mA
Max. load to common at analog output	500 Ω
Accuracy on analog output	Max. error: 0.5% of full scale
Resolution on analog output	12 bit

The analog output is galvonically isolated from the supply voltage (PELV) and other high-voltage terminals.

Control card, RS-485 serial communication:

Terminal number	68 (P,TX+, RX+), 69 (N,TX-, RX-)
Terminal number 61	Common for terminals 68 and 69

The RS-485 serial communication circuit is functionally separated from other central circuits and galvanically isolated from the supplier voltage (PELV).

Digital output:

Programmable digital/pulse outputs	2
Terminal number	27, 29 [1)]
Voltage level at digital/frequency output	0 - 24 V
Max. output current (sink or source)	40 mA
Max. load at frequency output	1 kΩ
Max. capacitive load at frequency output	10 nF
Minimum output frequency at frequency output	0 Hz
Maximum output frequency at frequency output	32 kHz
Accuracy of frequency output	Max. error: 0.1% of full scale
Resolution of output frequency	12 bit

1) Terminal 27 and 29 can also be programmed as input.

The digital output is galvanically isolated from the supply voltage (PELV) and other high-voltage terminals.

Control card, 24 V DC output:

Terminal number	12, 13
Max. load	FC 301: 130 mA / FC 302: 200 mA

The 24 V DC supply is galvonically isolated from the supply voltage (PELV), but has the same potential as the analog and digital inputs and outputs.

Relay outputs:

Programmable relay outputs	FC 301: 1 / FC 302: 2
Relay 01 Terminal number	1-3 (break), 1-2 (make)
Max. terminal load (AC-1)[1)] on 1-3 (NC), 1-2 (NO) (Resistive load)	240 V AC, 2 A
Max. terminal load (AC-15)[1)] (Inductive load @ cosφ 0.4)	240 V AC, 0.2 A
Max. terminal load (DC-1)[1)] on 1-2 (NO), 1-3 (NC) (Resistive load)	60 V DC, 1A
Max. terminal load (DC-13)[1)] (Inductive load)	24 V DC, 0.1A
Relay 02 (FC 302 only) Terminal number	4-6 (break), 4-5 (make)
Max. terminal load (AC-1)[1)] on 4-5 (NO) (Resistive load)	400 V AC, 2 A
Max. terminal load (AC-15)[1)] on 4-5 (NO) (Inductive load @ cosφ 0.4)	240 V AC, 0.2 A
Max. terminal load (DC-1)[1)] on 4-5 (NO) (Resistive load)	80 V DC, 2 A
Max. terminal load (DC-13)[1)] on 4-5 (NO) (Inductive load)	24 V DC, 0.1A
Max. terminal load (AC-1)[1)] on 4-6 (NC) (Resistive load)	240 V AC, 2 A
Max. terminal load (AC-15)[1)] on 4-6 (NC) (Inductive load @ cosφ 0.4)	240 V AC, 0.2A
Max. terminal load (DC-1)[1)] on 4-6 (NC) (Resistive load)	50 V DC, 2 A

Max. terminal load (DC-13)[1)] on 4-6 (NC) (Inductive load) ..... 24 V DC, 0.1 A
Min. terminal load on 1-3 (NC), 1-2 (NO), 4-6 (NC), 4-5 (NO) ..... 24 V DC 10 mA, 24 V AC 20 mA
Environment according to EN 60664-1 ..... overvoltage category III/pollution degree 2
1) IEC 60947 part 4 and 5
The relay contacts are galvanically isolated from the rest of the circuit by reinforced isolation (PELV).

Control card, 10 V DC output:

Terminal number 50
Output voltage ..... 10.5 V ±0.5 V
Max. load ..... 15 mA
The 10 V DC supply is galvonically isolated from the supply voltage (PELV) and other high-voltage terminals.

Control characteristics:

Resolution of output frequency at 0 - 1000 Hz ..... 0.013 Hz
Repeat accuracy of *Precise start/stop* (terminals 18, 19) ..... FC 301: ≤ ± 1ms / FC 302: ≤ ± 0.1 msec
System response time (terminals 18, 19, 27, 29, 32, 33) ..... FC 301: ≤ 10 ms / FC 302: ≤ 2 ms
Speed control range (open loop) ..... 1:100 of synchronous speed
Speed control range (closed loop) ..... 1:1000 of synchronous speed
Speed accuracy (open loop) ..... 30 - 4000 rpm: Max. error of ±8 rpm
Speed accuracy (closed loop) ..... 0 - 6000 rpm: Max. error of ±0.15 rpm
All control characteristics are based on a 4-pole asynchronous motor

Surroundings:

Enclosure ≤ 10 HP [7.5 kW] ..... IP 20, IP 55
Enclosure ≥ 14.75 HP [11 kW] ..... IP 21, IP 55
Enclosure kit available ≤ 10 HP [7.5 kW] ..... IP 21/TYPE 1/IP 4X top
Vibration test ..... 0.03 oz [1.0 g]
Max. relative humidity ..... 5% - 95%(IEC 721-3-3; Class 3K3 (non-condensing) during operation
Aggressive environment (IEC 721-3-3), uncoated ..... class 3C2
Aggressive environment (IEC 721-3-3), coated ..... class 3C3
Ambient temperature ..... Max. 122°F [50°C] (24-hour average maximum 113°F [45°C])
Derating for high ambient temperature, see section on special conditions
Minimum ambient temperature during full-scale operation ..... 32°F [0°C]
Minimum ambient temperature at reduced performance ..... 14°F [-10°C]
Temperature during storage/transport ..... -13° - +149/158°F [-25° - +65/70°C]
Maximum altitude above sea level ..... 3281 ft. [1000 m]
Derating for high altitude, see section on special conditions.
EMC standards, Emission ..... EN 61800-3, EN 61000-6-3/4, EN 55011
EMC standards, Immunity ..... EN 61800-3, EN 61000-6-1/2, EN 61000-4-2, EN 61000-4-3, EN 61000-4-4, EN 61000-4-5, EN 61000-4-6
See section on special conditions

Control card performance:

Scan interval ..... FC 301: 5 ms / FC 302: 1 ms

FC 300 Selection

Control card, USB serial communication:

USB standard ..... 1.1 (Full speed)
USB plug ..... USB type B "device" plug
Connection to PC is carried out via a standard host/device USB cable.
The USB connection is galvanically isolated from the supply voltage (PELV) and other high-voltage terminals.
The USB connection is not galvanically isolated from protection ground. Only use an isolated laptop as a PC connection to the USB connector on the FC 300 drive.

□ Efficiency

Efficiency of FC 300 Series (η_{VLT})

The load on the adjustable frequency drive has little effect on its efficiency. In general, the efficiency is the same at the rated motor frequency $f_{M,N}$, even if the motor supplies 100% of the rated shaft torque or only 75%, i.e., in case of part loads.

This also means that the efficiency of the adjustable frequency drive does not change even if other U/f characteristics are chosen.
However, the U/f characteristics influence the efficiency of the motor.

The efficiency declines a little when the switching frequency is set to a value of above 5 kHz. The efficiency will also be slightly reduced if the line voltage is 500 V, or if the motor cable is longer than 98.43 ft. [30 m].

Efficiency of the motor (η_{MOTOR})

The efficiency of a motor connected to the adjustable frequency drive depends on magnetizing level. In general, the efficiency is just as good as with line operation. The efficiency of the motor depends on the type of motor.

In the range of 75-100% of the rated torque, the efficiency of the motor is practically constant, both when it is controlled by the adjustable frequency drive and when it runs directly on line power.

In small motors, the influence from the U/f characteristic on efficiency is marginal. However, in motors from 14.75 HP [11 kW] and up, the advantages are significant.

In general, the switching frequency does not affect the efficiency of small motors. Motors from 14.75 HP [11 kW] and up have their efficiency improved (1-2%). This is because the sine shape of the motor current is almost perfect at high switching frequency.

Efficiency of the system (η_{SYSTEM})

To calculate the system efficiency, the FC 300 Series efficiency (η_{VLT}) is multiplied by the efficiency of the motor (η_{MOTOR}):

$\eta_{SYSTEM}) = \eta_{VLT} \times \eta_{MOTOR}$

Calculate the efficiency of the system at different loads based on the graph above.

FC 300 Selection

□ Acoustic Noise

The acoustic noise from the adjustable frequency drive comes from three sources:

1. DC intermediate circuit coils.
2. Integral fan.
3. RFI filter choke.

The typical values measured at a distance of 3.3 ft (1 m) from the unit:

FC 301/ FC 302	
PK25-P7K5: 200-240 V, 380-500 V, 525-600V	IP20/IP21/IP4Xtop/Type 1 (NEMA 1)
Reduced fan speed	51 dB(A)
Full fan speed	60 dB(A)

□ Peak Voltage on Motor

When a transistor in the inverter bridge switches, the voltage across the motor increases by a dV/dt ratio depending on:

- the motor cable (type, cross-section, length shielded or non-shielded)
- inductance

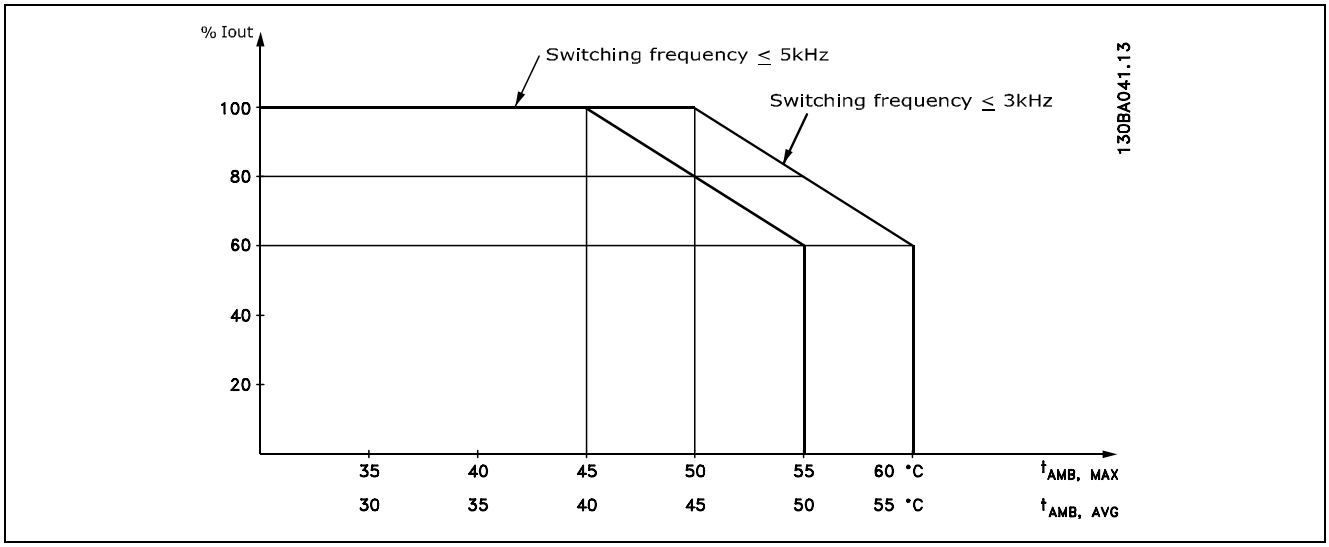
The natural induction causes an overshot U_{PEAK} in the motor voltage before it stabilizes itself at a level depending on the voltage in the intermediate circuit. The rise time and the peak voltage U_{PEAK} affect the service life of the motor. If the peak voltage is too high, especially motors without phase coil insulation are affected. If the motor cable is short (a few meters), the rise time and peak voltage are lower.
If the motor cable is long (328 ft / 100 m), the rise time and peak voltage increase.

If very small motors are used without phase coil insulation, connect an LC filter to the adjustable frequency drive.

□ Special Conditions

□ Derating for Ambient Temperature - data valid for ≤ 10 HP [7.5 kW]

The ambient temperature ($T_{AMB,MAX}$) is the maximum temperature allowed. The average ($T_{AMB,AVG}$) measured over 24 hours must be at least 9°F [5ºC] lower.
If the adjustable frequency drive is operated at temperatures above 122ºF [50 ºC], the continuous output current should be decreased according to the following diagram:



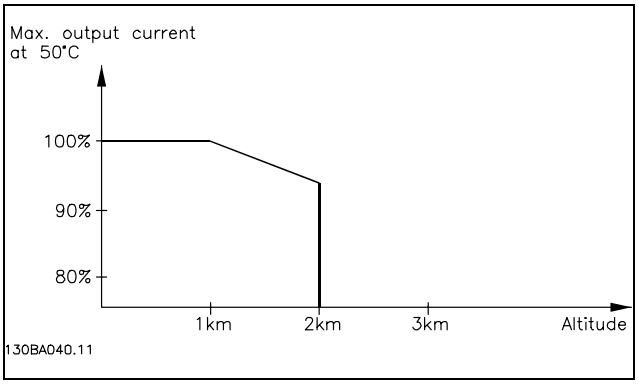
□ Derating for Low Air Pressure

In case of low air pressure, the air cooling capability is decreased.

Below an altitude of 3280 ft. [1000 m], no derating is necessary.

Above 3280 ft. [1000 m], the ambient temperature (T_{AMB}) or max. output current ($I_{VLT,MAX}$) should be derated in accordance with the shown diagram:

1. Derating of output current versus altitude at T_{AMB} = max. 122°F [50°C]
2. Derating of max. T_{AMB} versus altitude at 100% output current.



□ Derating for Running at Low Speed

When a motor is connected to an adjustable frequency drive, it is necessary to check that the cooling of the motor is adequate.
At low RPM values, the motor fan is not able to supply the required volume of air for cooling. This problem occurs when the load torque is constant (e.g. a conveyor belt) across the regulating range. The reduced

ventilation available determines the size of the torque that can be permitted under a continuous load. If the motor is to run continuously at an RPM value lower than half the rated value, the motor must be supplied with additional air for cooling (or use a motor designed for this type of operation). Instead of such extra cooling, the load level of the motor can be reduced e.g. by choosing a larger motor. However, the design of the adjustable frequency drive sets a limit to the motor size.

□ **Derating for Installing Long Motor Cables or Cables with Larger Cross-Section**

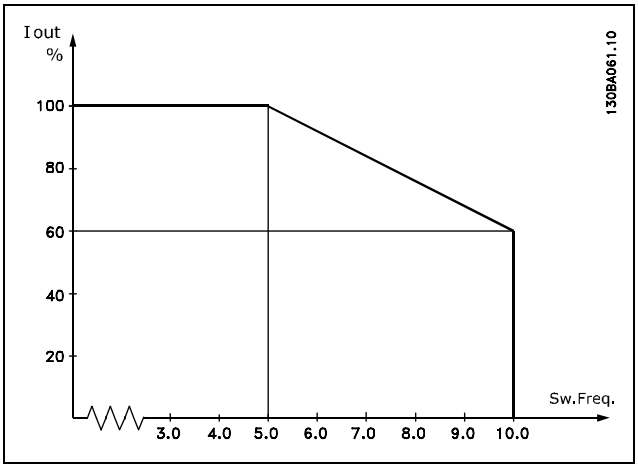
The max. cable length for FC 301 is 492 ft. [150 m] non-shielded cable and 164 ft. [50 m] shielded cable, respective for FC 302 is 984 ft. [300 m] non-shielded and 492 ft. [150 m] shielded cable.

The adjustable frequency drive has been tested using 984 ft. [300 m] non-shielded cable and 492 ft. [150 m] shielded cable.

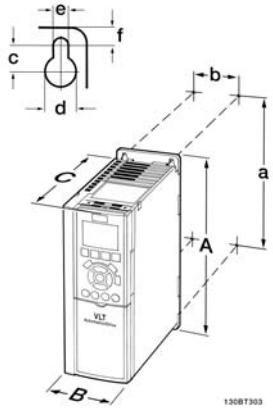
The adjustable frequency drive has been designed to work using a motor cable with a rated cross-section. If a cable with a larger cross-section is used, reduce the output current by 5% for every step the cross-section is increased.
(Increased cable cross-section leads to increased capacity to ground, and thus an increased ground leakage current).

□ **Temperature-Dependent Switch Frequency**

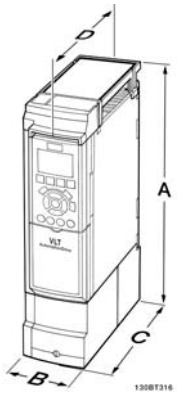
This function ensures the highest possible switch frequency without causing a thermal overload of the adjustable frequency drive. The internal temperature indicates whether the switch frequency can be based on the load, the ambient temperature, the supply voltage, or the cable length.
The switch frequency is set in par. 14-01.



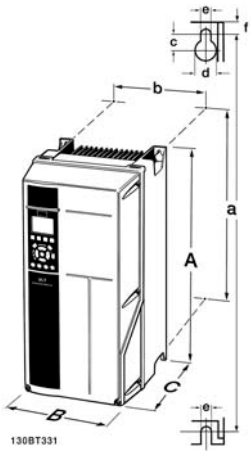
□ Mechanical Dimension



FC 300 IP 20 - see table for mechanical dimensions
A2 + A3 (IP 20)



Mechanical dimensions of the IP 21/IP 4x/ TYPE 1 enclosure kit (≤ 10 HP (7.5 kW))
A2 + A3 (IP 21)



Mechanical dimensions of the IP 21/IP 4x/ TYPE 1/IP 55/TYPE 12 (14.75-29.5 HP [11-22 kW])
A5 + B1 + B2

FC 300 Selection

Mechanical dimensions								
		Frame size A2 0.034-2.95 HP [0.25-2.2 kW] (200-240 V) 0.5-5.36 HP [0.37-4.0 kW] (380-500 V)		Frame size A3 4-5 HP [3.0-3.7 kW] (200-240 V) 7.37-10 HP [5.5-7.5 kW] (380-500 V) 1-10 HP [0.75-7.5 kW] (550-600 V)		Frame size A5 0.033-5 HP [0.25-3.7 kW] (200-500 V) 0.5-10 HP [0.37-7.5 kW] (380-500 V)	Frame size B1 14.75-20 HP [11-15 kW] (380-500 V)	Frame size B2 24.8-29.5 HP [18.5-22 kW] (380-500 V)
		IP20	IP21/Type 1	IP20	IP21/Type 1	IP55	IP21	IP21
Height								
Height of back plate	A	10.55 in [268 mm]	14.76 in [375 mm]	10.55 in [268 mm]	14.76 in [375 mm]	16.54 in [420 mm]	18.9 in [480 mm]	25.6 in [650 mm]
Distance between mounting holes	a	10.12 in [257 mm]	13.78 in [350 mm]	10.12 in [257 mm]	13.78 in [350 mm]	15.83 in [402 mm]	17.87 in [454 mm]	24.57 in [624 mm]
Width								
Width of back plate	B	3.54 in [90 mm]	3.54 in [90 mm]	5.12 in [130 mm]	5.12 in [130 mm]	9.53 in [242 mm]	9.53 in [242 mm]	9.53 in [242 mm]
Distance between mounting holes	b	2.76 in [70 mm]	2.76 in [70 mm]	4.33 in [110 mm]	4.33 in [110 mm]	8.46 in [215 mm]	8.27 in [210 mm]	8.27 in [210 mm]
Depth								
Depth without option A/B	C	8.07 in [205 mm]	8.07 in [205 mm]	8.07 in [205 mm]	8.07 in [205 mm]	7.68 in [195 mm]	10.24 in [260 mm]	10.24 in [260 mm]
With option A/B	C	8.66 in [220 mm]	8.66 in [220 mm]	8.66 in [220 mm]	8.66 in [220 mm]	7.68 in [195 mm]	10.24 in [260 mm]	10.24 in [260 mm]
Without option A/B	D		8.15 in [207 mm]		8.15 in [207 mm]			
With option A/B	D		8.74 in [222 mm]		8.74 in [222 mm]			
Screw holes								
	c	0.32 in [8.0 mm]	0.32 in [8.0 mm]	0.32 in [8.0 mm]	0.32 in [8.0 mm]	0.33 in [8.25 mm]	0.47 in [12 mm]	0.47 in [12 mm]
	d	ø0.43 in [11 mm]	ø0.43 in [11 mm]	ø0.43 in [11 mm]	ø0.43 in [11 mm]	ø0.47 in [12 mm]	ø0.75 in [19 mm]	ø0.75 in [19 mm]
	e	ø0.22 in [5.5 mm]	ø0.22 in [5.5 mm]	ø0.22 in [5.5 mm]	ø0.22 in [5.5 mm]	ø0.26 in (6.5 mm)	ø0.35 in [9 mm]	ø0.35 in [9 mm]
	f	0.35 in [9 mm]	0.35 in [9 mm]	0.35 in [9 mm]	0.35 in [9 mm]	0.35 in [9 mm]	0.35 in [9 mm]	0.35 in [9 mm]
Max weight		10.8 lb [4.9 kg]	11.68 lbs [5.3 kg]	14.55 lbs [6.6 kg]	15.43 lbs [7.0 kg]		50.7 lbs [23 kg]	59.51 lbs [27 kg]

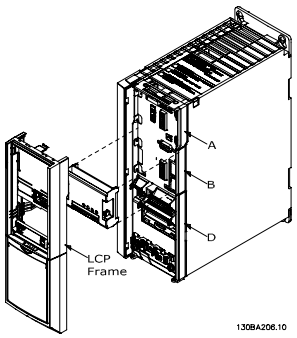
□ Options and Accessories

Danfoss offers a wide range of options and accessories for VLT AutomationDrive FC 300 Series.

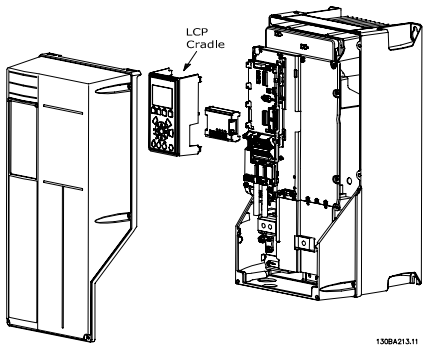
□ **Mounting Option Modules in Slot B**

The power to the adjustable frequency drive must be disconnected.

- Remove the LCP (Local Control Panel), the terminal cover, and the LCP frame from the adjustable frequency drive.
- Insert the MCB10x option card into slot B.
- Connect the control cables and fasten the cables with the enclosed cable strips.
  * Remove the knock out in the extended LCP frame, so that the option will fit under the extended LCP frame.
- Fit the extended LCP frame and terminal cover.
- Fit the LCP or blind cover in the extended LCP frame.
- Connect power to the adjustable frequency drive.
- Set up the input/output functions in the corresponding parameters, as mentioned in the section *General Technical Data*.



0.34 - 10 HP [0.25 - 7.5 kW] IP 20



0.34 - 10 HP [0.25 - 7.5 kW] IP 55
and
14.75 - 29.5 HP [11 - 22 kW] IP 21

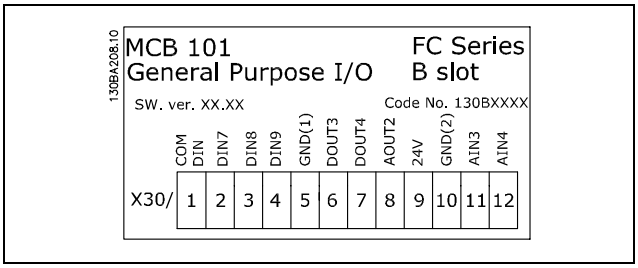
FC 300 Selection

□ **General Purpose Input Output Module MCB 101**

The MCB 101 is used for extension of digital and analog inputs and outputs of the FC 301 and FC 302 AutomationDrive.

Contents: The MCB 101 must be inserted in slot B in the AutomationDrive.

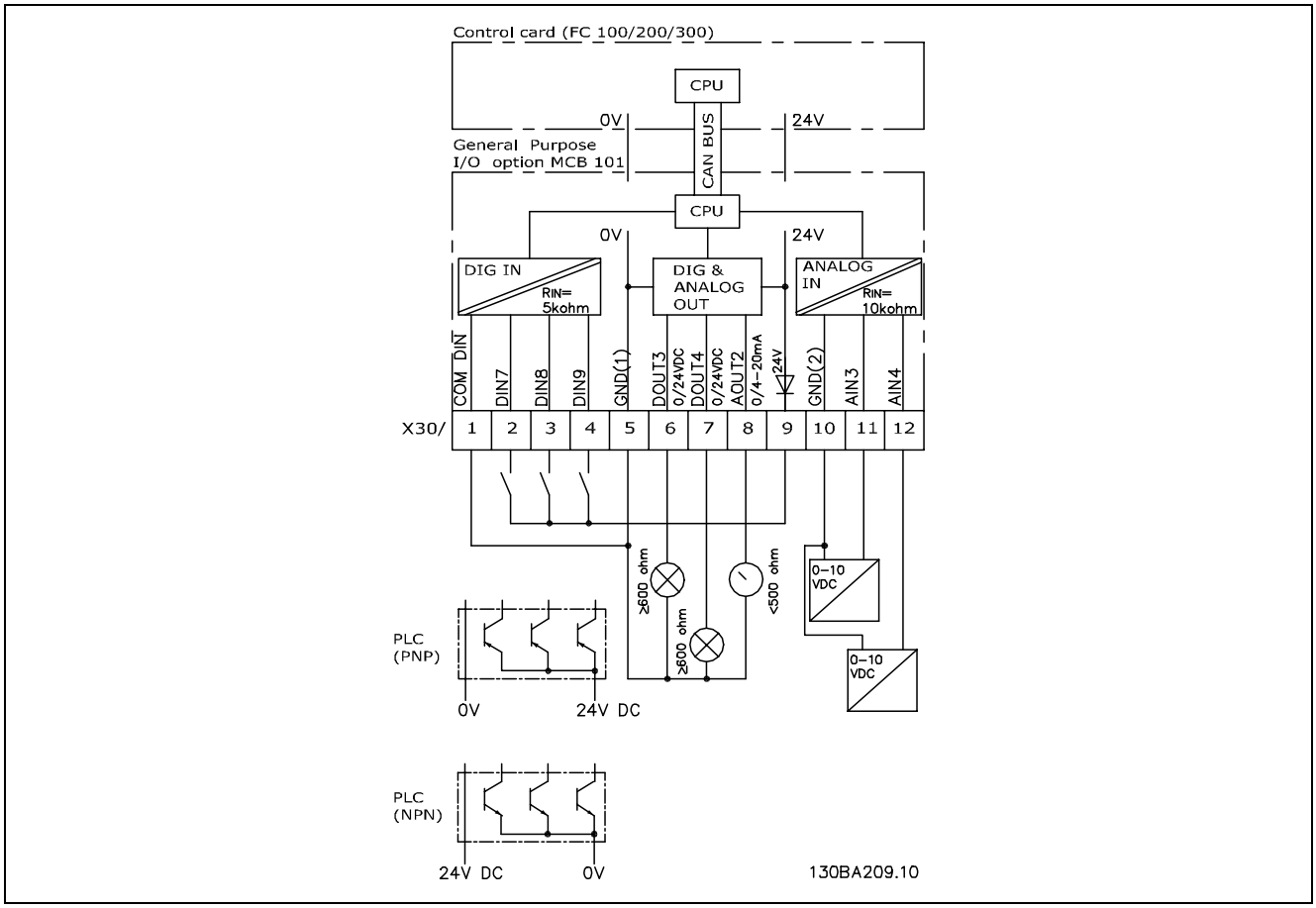
- MCB 101 option module
- Extended fixture for LCP
- Terminal cover



□ **Galvanic Isolation in the MCB 101**

Digital/analog inputs are galvanically isolated from other inputs/outputs on the MCB 101 and in the control card of the drive. Digital/analog outputs in the MCB 101 are galvanically isolated from other inputs/outputs on the MCB 101, but not from the ones on the control card of the drive.

If digital inputs 7, 8 or 9 are to be switched using the internal 24 V power supply (terminal 9), the connection between terminal 1 and 5 illustrated in the drawing has to be established.



Principle Diagram

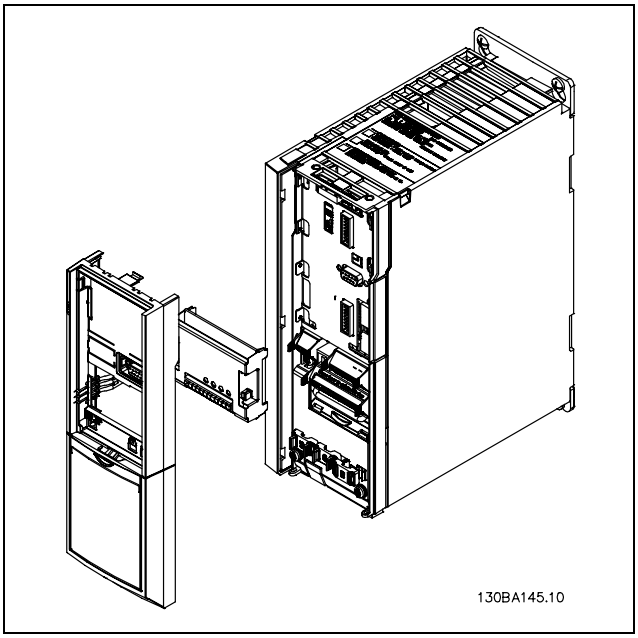
□ **Digital inputs - Terminal X30/1-4**

Parameters for set-up: 5-16, 5-17 and 5-18

Number of digital inputs	Voltage level	Voltage levels	Input impedance	Max. load
3	0-24 V DC	PNP type: Common = 0 V Logic "0": Input < 5 V DC Logic "0": Input > 10 V DC NPN type: Common = 24 V Logic "0": Input > 19 V DC Logic "0": Input < 14 V DC	Approx. 5 k ohm	± 28 V continuous ± 37 V in minimum 10 sec.

□ **Encoder Option MCB 102**

The encoder module is used for interfacing feedback from motor or process. Parameter settings in group 17-xx



Used for:
- VVC plus closed-loop
- Flux Vector Speed control
- Flux Vector Torque control
- Permanent magnet motor with SinCos feedback (Hiperface®)

Incremental encoder: 5 V TTL type
SinCos Encoder: Stegmann/SICK (Hiperface®)

Selection of parameters in par. 17-1* and par. 1-02
When the encoder option kit is ordered separately, the kit includes:
- Encoder module MCB 102
- Enlarged LCP fixture and enlarged terminal cover

The encoder option does not support FC 302 adjustable frequency drives manufactured before week 50/2004.
Min. software version: 2.03 (par. 15-43)

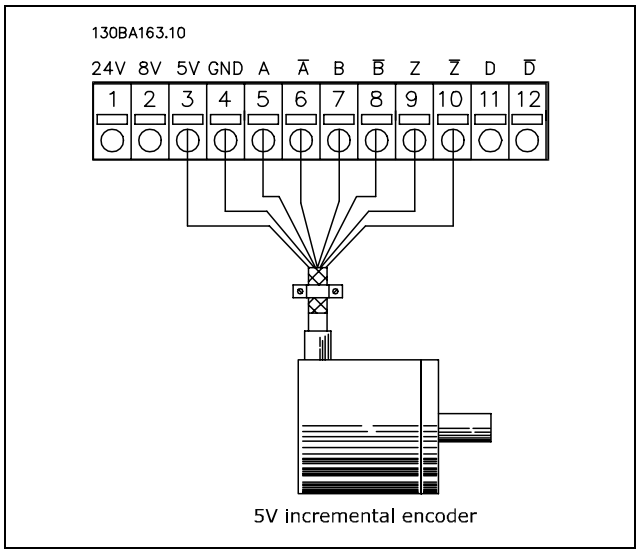
Installation of MCB 102:

- The power to the adjustable frequency drive must be disconnected.
- Remove the LCP, the terminal cover, and the cradle from the FC 30x.
- Fit the MCB 102 option in slot B.
- Connect the control cables and fasten the cables by the clamp to chassis.
- Fit the enlarged LCP fixture and enlarged terminal cover.
- Replace the LCP.
- Connect the power to the adjustable frequency drive.
- Select the encoder functions in par. 17-*.
- See also description in chapter *Introduction to FC 300*, section *Speed PID Control*

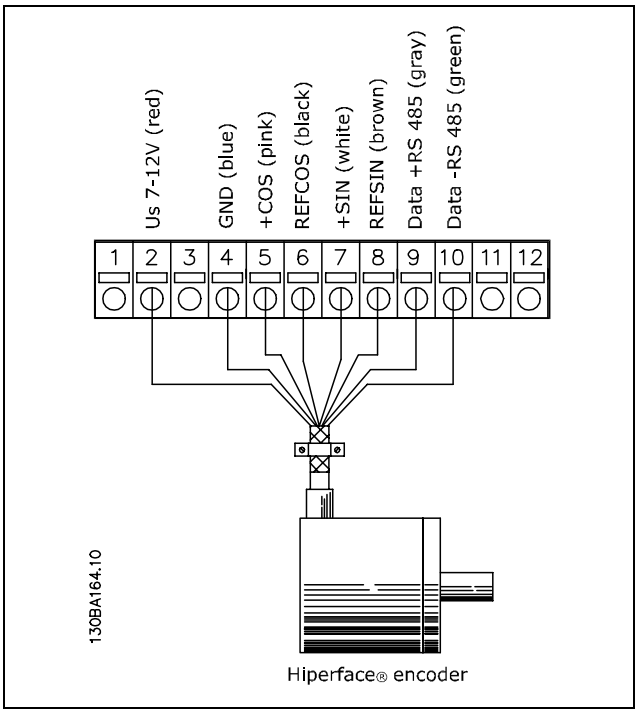
FC 300 Selection

Connector Designation X31	Incremental Encoder	SinCos Encoder Hiperface	SinCos Encoder EnDat	Description
1	NC			24 V Output
2	NC	8 Vcc		8 V Output
3	5 VCC		5 Vcc	5 V Output
4	GND		GND	GND
5	A input	+COS	+COS	A input
6	A inv input	REFCOS	REFCOS	A inv input
7	B input	+SIN	+SIN	B input
8	B inv input	REFSIN	REFSIN	B inv input
9	Z input	+Data RS485	Clock out	Z input OR +Data RS485
10	Z inv input	-Data RS485	Clock in	Z input OR -Data RS485
11	NC	NC	Data+	Future use
12	NC	NC	Data-	Future use

Max. 5V on X31.5-12



5V incremental encoder



Hiperface® encoder

FC 300 Selection

□ Resolver Option MCB 103

MCB 103 Resolver option is used for interfacing resolver motor feedback to the FC 300 AutomationDrive. Resolvers are used basically as motor feedback devices for permanent magnet brushless synchronous motors. When the resolver option is ordered separately, the kit includes:

- Resolver option MCB 103
- Enlarged LCP fixture and enlarged terminal cover

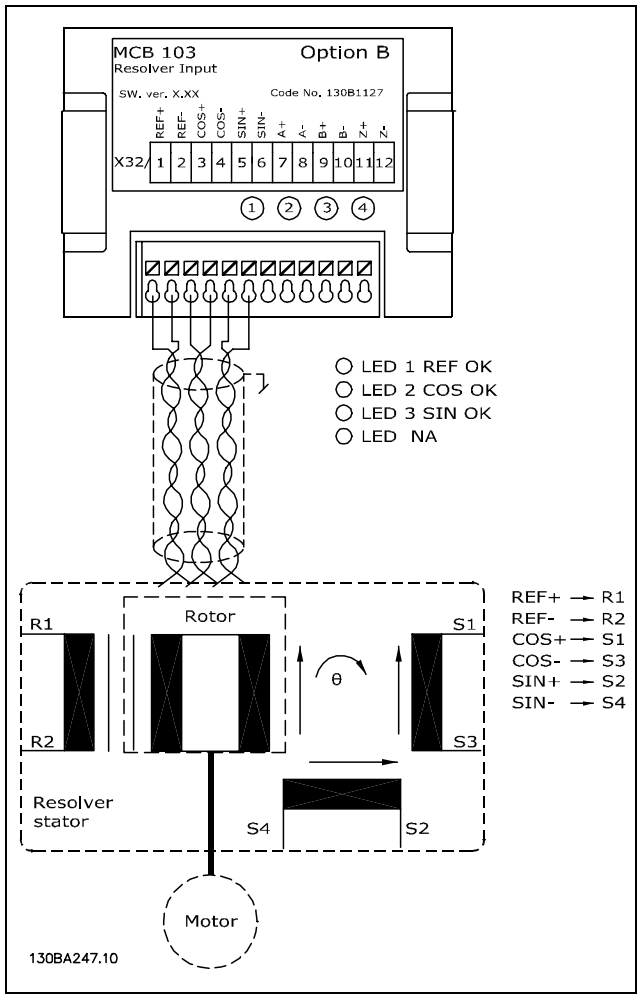
Selection of parameters: 17-5x resolver interface.

The resolver interface must support one resolver with the following specifications:

Resolver specifications:

The MCB 103 resolver option supports various resolver types.

Number of poles on resolver	Par. 17-50: 2 or 4 *2
Resolver input voltage	Par. 17-51: 2.0 – 8.0 V *7.0 V
Carrier frequency (ref. voltage)	Par. 17-52: 2.5 – 15 kHz *10.0 kHz
Transformation ratio	Par. 17-53: 0.1 – 1.1 *0.5
Primary voltage	2-8 Vrms
Primary frequency	2 kHz - 15 kHz
Primary current	Max. 50 mArms
Secondary input voltage	Max 8 Vrms
Resolution	10 bit @ max input amplitude
Secondary load	App. 10 kΩ
Cable length	Up to 490 ft [150 m] *Note: Cables MUST be shielded and separated from the motor cables.*



LED indicators

LED 1 is on when the reference signal is OK to resolver
LED 2 is on when cosine signal is OK from resolver
LED 3 is on when sinus signal is OK from resolver

The LEDs are active when par. 17-61 is set to *Warning* or *Trip*.

FC 300 Selection

Set-up example

In this example, a permanent magnet (PM) motor is used with resolver as speed feedback.
A PM motor must usually operate in flux mode.

Wiring:

The max cable length is 490 ft [150 m] when a twisted-pair cable is used.

NOTE

The resolver cable shielding must be correctly connected to the de-coupling plate and connected to the chassis (ground) on the motor side.

NOTE

Always use shielded motor cables and brake chopper cables.

Adjust the following parameters:		
Par. 1-00	Configuration Mode	Speed closed-loop [1]
Par. 1-01	Motor Control Principle	Flux with feedback [3]
Par. 1-10	Motor Construction	PM, non-salient SPM [1]
Par. 1-24	Motor Current	Nameplate
Par. 1-25	Motor Nominal Speed	Nameplate
Par. 1-26	Motor Cont. Rated Torque	Nameplate
AMA is not possible on PM motors		
Par. 1-30	Stator Resistance	Motor data sheet
Par. 1-37	d-axis inductance (Ld)	Motor data sheet (mH)
Par. 1-39	Motor Poles	Motor data sheet
Par. 1-40	Back EMF at 1000 RPM	Motor data sheet
Par. 1-41	Motor Angle Offset	Motor data sheet (Usually zero)
Par. 17-50	Poles	Resolver data sheet
Par. 17-51	Input Voltage	Resolver data sheet
Par. 17-52	Input Frequency	Resolver data sheet
Par. 17-53	Transformation Ratio	Resolver data sheet
Par. 17-60	Feedback Direction	
Par. 17-61	Feedback Signal Monitoring	Hardware check of resolver connections

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□ **Relay Option MCB 105**

The MCB 105 option includes 3 pieces of SPDT contacts and must be fitted into option slot B.

Electrical Data:

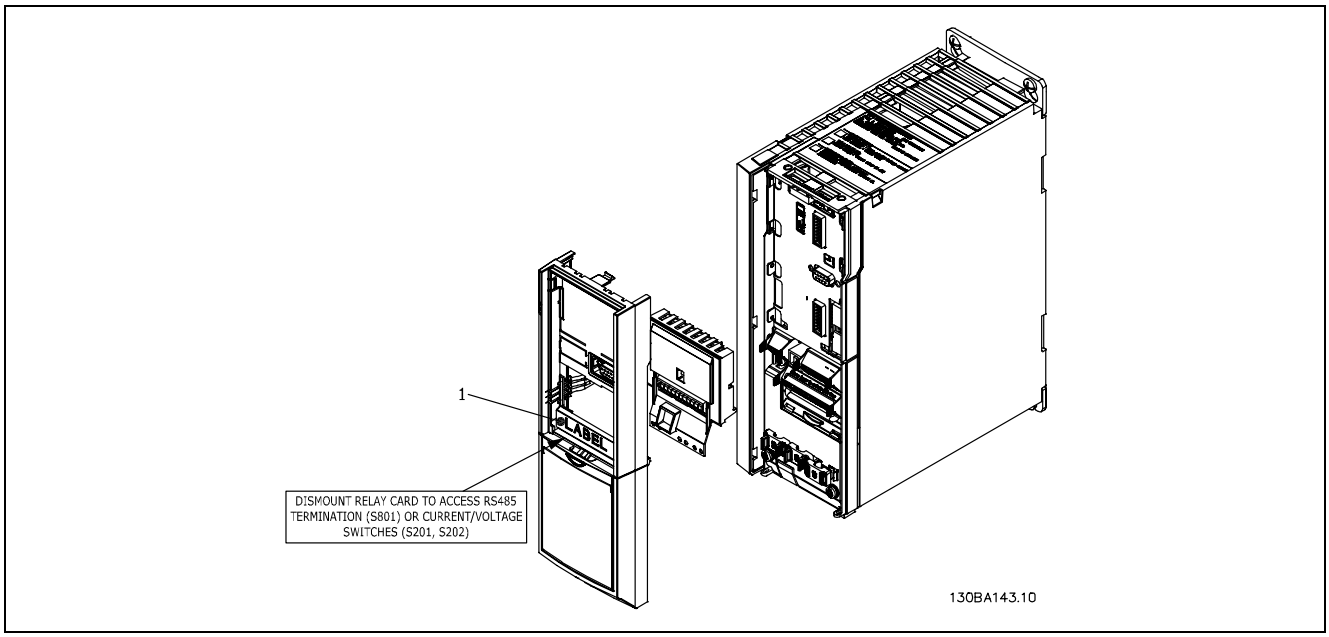
Max terminal load (AC-1) [1] (Resistive load) ..... 240 V AC 2A
Max terminal load (AC-15) [1] (Inductive load @ cosφ 0.4) ..... 240 V AC 0.2 A
Max terminal load (DC-1) [1] (Resistive load) ..... 24 V DC 1 A
Max terminal load (DC-13) [1] (Inductive load) ..... 24 V DC 0.1 A
Min terminal load (DC) ..... 5 V 10 mA
Max switching rate at rated load/min load ..... 6 min^{-1}/20 sec^{-1}
1) IEC 947 part 4 and 5

When the relay option kit is ordered separately, the kit includes:

- Relay Module MCB 105
- Enlarged LCP fixture and enlarged terminal cover
- Label for covering access to switches S201, S202, and S801
- Cable strips for fastening cables to relay module

The relay option does not support FC 302 adjustable frequency drives manufactured before week 50/2004.

Min. software version: 2.03 (par. 15-43).



IMPORTANT

1. The label MUST be placed on the LCP frame as shown (UL-approved).

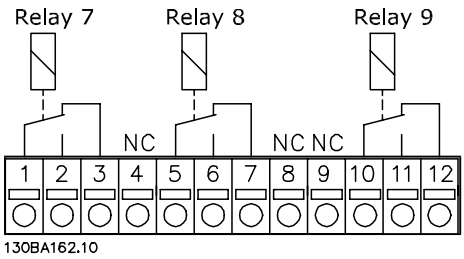
Warning Dual supply

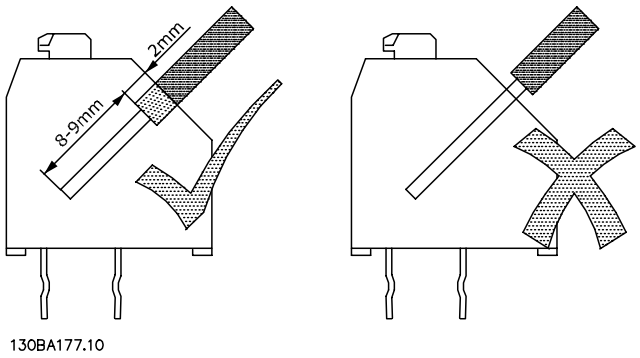
FC 300 Selection

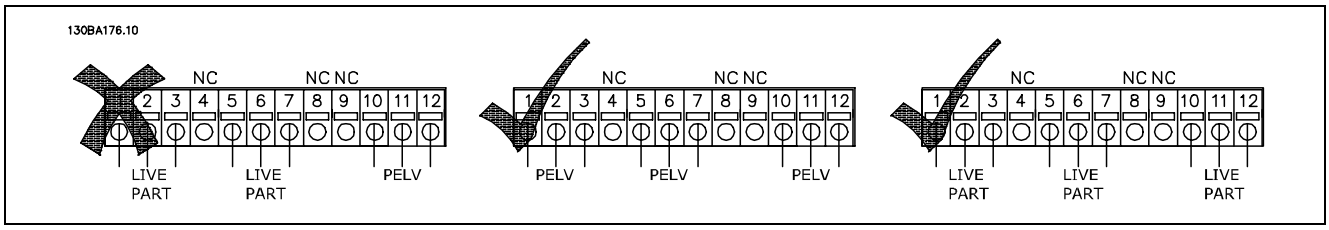
How to add the MCB 105 option:

- The power to the adjustable frequency drive must be disconnected.
- The power to the live part connections on relay terminals must be disconnected.
- Remove the LCP, the terminal cover, and the LCP fixture from the FC 30x.
- Fit the MCB 105 option in slot B.
- Connect the control cables and fasten the cables with the enclosed cable strips.
- Make sure the length of the stripped wire is correct (see the following drawing).
- Do not mix live parts (high voltage) with control signals (PELV).
- Fit the enlarged LCP fixture and enlarged terminal cover.
- Replace the LCP.
- Connect power to the adjustable frequency drive.
- Select the relay functions in par. 5-40 [6-8], 5-41 [6-8] and 5-42 [6-8].

NB (Array [6] is relay 7, array [7] is relay 8, and array [8] is relay 9)







Do not combine low voltage parts and PELV systems.

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FC 300 Selection

□ 24 V Back-Up Option (Option D)

External 24 V DC Supply

An external 24 V DC supply can be installed for low-voltage supply to the control card and any option card installed. This enables full operation of the LCP (including the parameter setting) without connection to line.

External 24 V DC supply specification:

Input voltage range	24 V DC +15 % (max. 37 V in 10 s)
Max. input current	2.2 A
Max cable length	246 ft (75 m)
Input capacitance load	< 10 uF
Power-up delay	< 0.6 s

The inputs are protected.

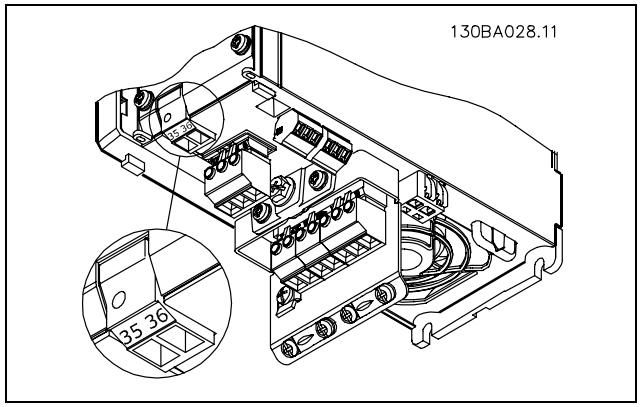
Terminal numbers:

Terminal 35: - external 24 V DC supply.
Terminal 36: + external 24 V DC supply.

Follow these steps:

1. Remove the LCP or Blind Cover
2. Remove the Terminal Cover
3. Remove the Cable Decoupling Plate and the plastic cover underneath
4. Insert the 24 V DC Back-up External Supply Option in the Option Slot
5. Mount the Cable Decoupling Plate
6. Attach the Terminal Cover and the LCP or Blind Cover.

When MCB 107, 24 V back-up option is supplying the control circuit, the internal 24 V supply is automatically disconnected.



Connection to 24 V backup supplier.

□ Brake Resistors

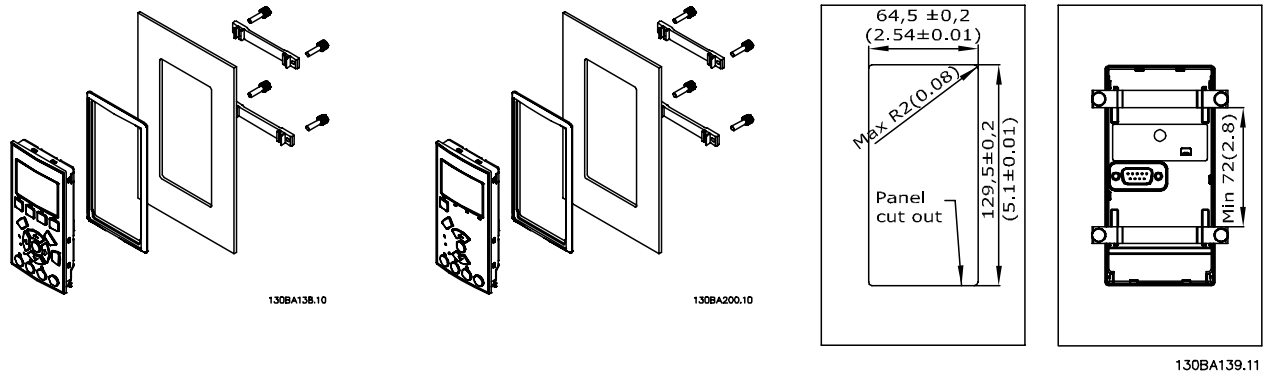
Brake resistors are used in applications where high dynamics are needed or a high inertia load has to be stopped. The brake resistor is used to remove the energy from the DC link in the adjustable frequency drive.

Code numbers for brake resistors: See section *How to Order*.

□ Remote mounting Kit for LCP

The Local Control Panel can be moved to the front of a cabinet by using the remote build-in kit. The enclosure is the IP 65. The fastening screws must be tightened with a torque of max. 1 Nm.

Technical data	
Enclosure:	IP 65 front
Max. cable length between VLT and unit:	9.8 ft (3 m)
Communication std:	RS-485



□ **IP 21/IP 4X/ TYPE 1 (NEMA 1) Enclosure Kit**

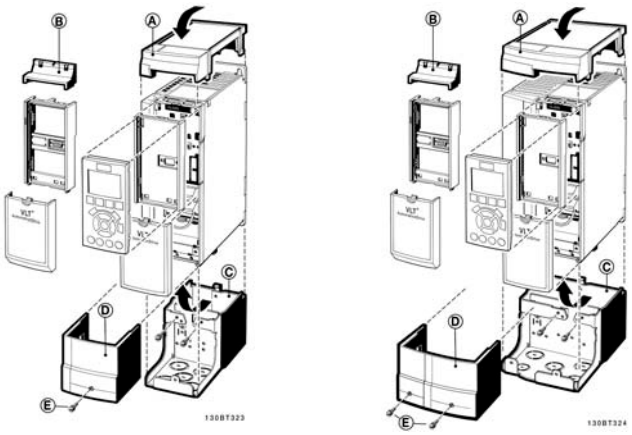
IP 20/IP 4X top/ TYPE 1 (NEMA 1) is an optional enclosure element available for IP 20 Compact units.
If the enclosure kit is used, an IP 20 unit is upgraded to comply with enclosure IP 21/ 4X top/TYPE 1 (NEMA 1).

The IP 4X top can be applied to all standard IP 20 FC 30X variants.

□ **IP 21/Type 1 Enclosure Kit**

A - Top cover
B - Brim
C - Base part
D - Base cover
E - Screw(s)

Place the top cover as shown. If an A or B option is used the brim must be fitted to cover the top inlet.
Place the base part C at the bottom of the drive and use the clamps from the accessory bag to correctly fasten the cables. Holes for cable glands:
Size A2: 2x PG16 (½") 3xPG21 (3/4")
Size A3: 3xPG16 (½") 3xPG21 (3/4")



□ **LC Filters**

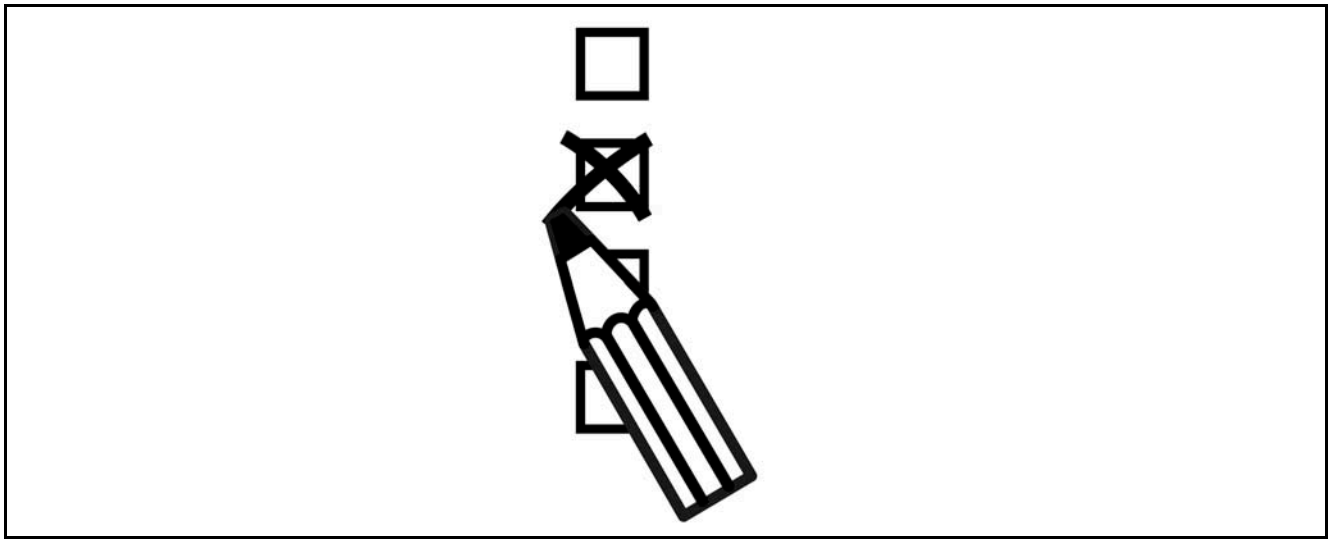
When a motor is controlled by an adjustable frequency drive, resonance noise will be heard from the motor. This noise, which is the result of the design of the motor, arises every time an inverter switch in the adjustable frequency drive is activated. The frequency of the resonance noise thus corresponds to the switching frequency of the adjustable frequency drive.

For the FC 300 Series, Danfoss can supply an LC filter to dampen the acoustic motor noise.

The filter reduces the ramp-up time of the voltage, the peak load voltage U_{PEAK} and the ripple current ΔI to the motor, which means that current and voltage become almost sinusoidal. The acoustic motor noise is thus reduced to a minimum.

The ripple current in the LC filter coils will also cause some noise. Solve the problem by integrating the filter in a cabinet or similar.

How to Order



□ **Drive Configurator**
It is possible to design an FC 300 adjustable frequency drive according to the application requirements by using the ordering number system.

For the FC 300 Series, you can order standard drives and drives with integral options by sending a type code string describing the product a to the local Danfoss sales office, i.e.:

FC-302PK75T5E20H1BGCXXXSXXXXA0BXCXXXXD0

The meaning of the characters in the string can be located in the pages containing the ordering numbers in the chapter *How to Select Your VLT*. In the example above, a Profibus DP V1 and a 24 V back-up option are included in the drive.

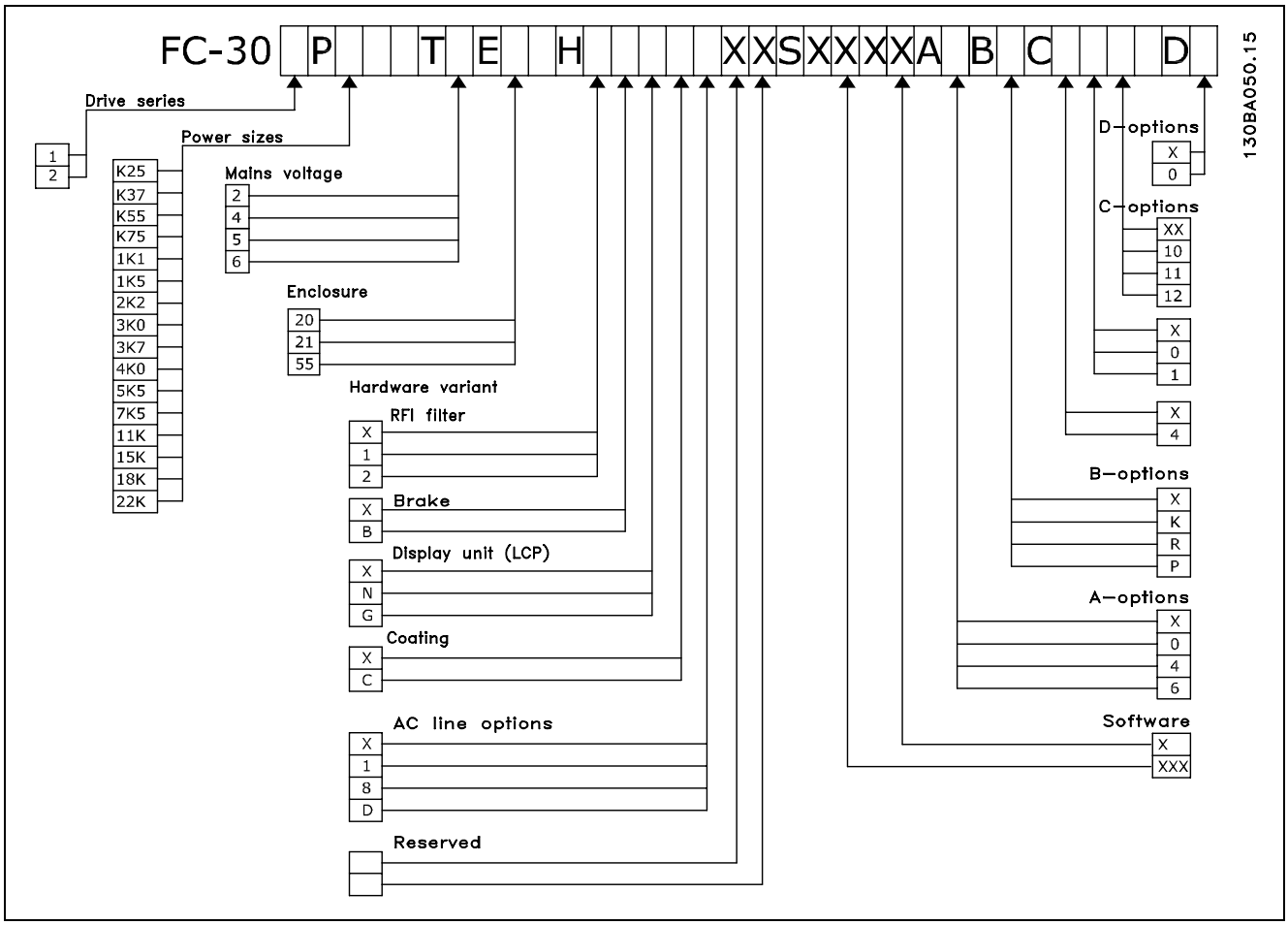
Ordering numbers for FC 300 standard variants can also be located in the chapter *How to Select Your VLT*.

Use the Internet-based drive configurator to configure the right drive for the right application and generate the type code string. The drive configurator will automatically generate an eight-digit sales number to be delivered to your local sales office.
Furthermore, you can establish a project list with several products and send it to a Danfoss sales representative.

The drive configurator can be found on the global Internet site: www.danfoss.com/drives.

How to Order

□ Ordering Form Type Code



1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39
FC-		0		P						T		E			H						X	X	S	X	X	X	X	A		B		C					D	

130BA052.13

	200-240V 3-phase	380-480V 3-phase	380-500V 3-phase	525-600V 3-phase	IP 20 / Chassis	IP 21/ Type 1	No RFI	RFI A1/B1	RFI (A2)	No brake chopper	Brake chopper	No LCP	Nu-meric LCP 101	Graphical LCP 102	Not coated PCB	Coated PCB	No AC line op-tion	Resv.	Resv.
Typecode	T2	T4	T5	T6	E20	E21	HX	H1	H2	X	B	X		G	X	C	X	X	X
Position	7-12	7-12	7-12	7-12	13-15	13-15	16-17	16-17	16-17	18	18	19	19	19	20	20	21	22	23
0.25kW/ 0.33HP	PK25				X	X		X	X	X	X	X	X	X	X	X	X	X	X
0.37kW/ 0.50HP	PK37	PK37	PK37		X	X		X	X	X	X	X	X	X	X	X	X	X	X
0.55kW/ 0.75HP	PK55	PK55	PK55		X	X		X	X	X	X	X	X	X	X	X	X	X	X
0.75kW/ 1.0HP	PK75	PK75	PK75		X	X		X	X	X	X	X	X	X	X	X	X	X	X
1.1kW/ 1.5HP	P1K1	P1K1	P1K1		X	X		X	X	X	X	X	X	X	X	X	X	X	X
1.5kW/ 2.0HP	P1K5	P1K5	P1K5		X	X		X	X	X	X	X	X	X	X	X	X	X	X
2.2kW/ 3.0HP	P2K2	P2K2	P2K2		X	X		X	X	X	X	X	X	X	X	X	X	X	X
3.0kW/ 4.0HP	P3K0	P3K0	P3K0		X	X		X	X	X	X	X	X	X	X	X	X	X	X
3.7kW/ 5.0HP	P3K7				X	X		X	X	X	X	X	X	X	X	X	X	X	X
4.0kW/ 5.5HP		P4K0	P4K0		X	X		X	X	X	X	X	X	X	X	X	X	X	X
5.5kW/ 7.5HP		P5K5	P5K5		X	X		X	X	X	X	X	X	X	X	X	X	X	X
7.5kW/ 10HP		P7K5	P7K5		X	X		X	X	X	X	X	X	X	X	X	X	X	X
0.75kW/ 1.0HP				PK75	X	X	X			X	X	X	X	X	X	X	X	X	X
1.1kW/ 1.5HP				P1K1	X	X	X			X	X	X	X	X	X	X	X	X	X
1.5kW/ 2.0HP				P1K5	X	X	X			X	X	X	X	X	X	X	X	X	X
2.2kW/ 3.0HP				P2K2	X	X	X			X	X	X	X	X	X	X	X	X	X
3.0kW/ 4.0HP				P3K0	X	X	X			X	X	X	X	X	X	X	X	X	X
4.0kW/ 5.5HP				P4K0	X	X	X			X	X	X	X	X	X	X	X	X	X
5.5kW/ 7.5HP				P5K5	X	X	X			X	X	X	X	X	X	X	X	X	X
7.5kW/ 10HP				P7K5	X	X	X			X	X	X	X	X	X	X	X	X	X

Pos 6 select:

1 = FC 301

2 = FC 302

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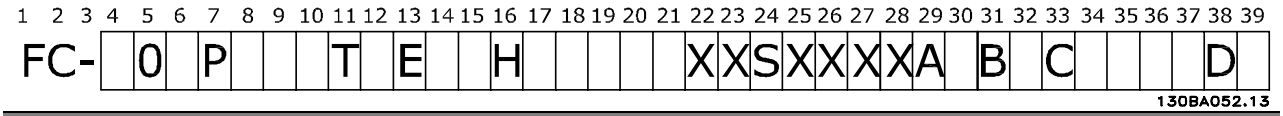
How to Order



Optional selections, 200-600 V		
Software:		Position: 24-27
SXXX	Latest release - standard software	
Languages:		Position: 28
X	Standard language pack	
A-options		Position: 29-30
AX	No options	
A0	Profibus DP V1	
A4	DeviceNet	
B-options		Position: 31-32
BX	No options	
B2	Encoder Option Module MCB 102	
B5	Relay Option Module MCB 105	
C1-options		Position: 33-34
CX	No options	
C2-options		Position: 35
X	No options	
C option software		Position: 36-37
XX	Standard software	
D-options		Position: 38-39
DX	No option	
D0	24V DC backup Option MCB 107	

□ Ordering Numbers

□ Ordering Numbers: Options and Accessories

Type	Description	Ordering no.	
Miscellaneous hardware			
DC link connector	Terminal block for DC link connection on frame size A2/A3	130B1064	
IP 21/4X top/TYPE 1 kit	Enclosure, frame size A2: IP 21/IP 4X Top/TYPE 1	130B1122	
IP 21/4X top/TYPE 1 kit	Enclosure, frame size A3: IP 21/IP 4X Top/TYPE 1	130B1123	
Profibus D-Sub 9	Connector kit for IP 20	130B1112	
Profibus top entry kit	Top entry kit for Profibus connection	130B0524[1)]	
Terminal blocks	Screw terminal blocks for replacing spring loaded terminals 1 x 10-pin, 1 x 6-pin and 1 x 3-pin connectors	130B1116	
LCP			
LCP 101	Numerical Local Control Panel (NLCP)	130B1124	
LCP 102	Graphical Local Control Panel (GLCP)	130B1107	
LCP cable	Separate LCP cable, 9.8 ft. [3 m]	175Z0929	
LCP kit	Panel mounting kit including graphical LCP, fasteners, 9.8 ft. [3 m] cable and gasket	130B1113	
LCP kit	Panel mounting kit including numerical LCP, fasteners and gasket	130B1114	
LCP kit	Panel mounting kit for all LCPs including fasteners, 9.8 ft. [3 m] cable and gasket	130B1117	
Options for Slot A Uncoated / Coated		**Uncoated**	**Coated**
MCA 101	Profibus option DP V0/V1	130B1100	130B1200
MCA 104	DeviceNet option	130B1102	130B1202
MCA 105	CANopen	130B1103	
Options for Slot B			
MCB 101	General purpose Input Output option	130B1125	
MCB 102	Encoder option	130B1115	
MCB 103	Resolver option	130B1127	130B1227
MCB 105	Relay option	130B1110	
MCB 108	Safety PLC interface (DC/DC drive)	130B1120	
Option for Slot D			
MCB 107	24 V DC back-up	130B1108	130B1208
External Options			
Ethernet IP	Ethernet master	175N2584	
Spare Parts			
Control board FC 302	Coated version		130B1109
Control board FC 301	Coated version		130B1126
Fan A2	Fan, frame size A2	130B1009	
Fan A3	Fan, frame size A3	130B1010	
Accessory bag B	Accessory bag, frame size A2	130B0509	
Accessory bag C	Accessory bag, frame size A3	130B0510	

1) Only IP 21 / > 14.75 HP [11 kW]

Options can be ordered as factory built-in options, see ordering information.
For information on serial communication bus and application option compatibility with older software versions, please contact your Danfoss supplier.

Ordering Numbers: Brake Resistors

AC line voltage 200-240 V	FC 301/302													
	Selected resistor													
	Standard IP 20									Aluminum-housed (flatpack) IP 65			Max. torque load[b]	
	Duty Cycle 10%						Duty Cycle 40%							
FC 301/ FC 302	P_{motor}	R_{min}	$R_{br,nom}$[c]	R_{rec}	$P_{br\ max}$	Order no.	R_{rec}	$P_{br\ max}$	Order no.	R_{rec} per item	Duty cycle	Order no.	FC 301	FC 302
	[kW]	[Ω]	[Ω]	[Ω]	[kW]	175Uxxxx	[Ω]	[kW]	175Uxxxx	[Ω]	%	175Uxxxx		
PK25	0.25	420	466.7	425	0.095	1841	425	0.430	1941	430 Ω/100 W	8	1002	145%	160%
PK37	0.37	284	315.3	310	0.250	1842	310	0.800	1942	310 Ω/200 W	16	0984	145%	160%
PK55	0.55	190	211.0	210	0.285	1843	210	1.350	1943	210 Ω/200 W	9	0987	145%	160%
PK75	0.75	139	154.0	145	0.065	1820	145	0.260	1920	150 Ω/100 W	14	1005	145%	160%
PK75	0.75	139	154.0	-	-	-	-	-	-	150 Ω/200 W	40	0989	145%	160%
P1K1	1.1	90	104.4	90	0.095	1821	90	0.430	1921	100 Ω/100 W	8	1006	145%	160%
P1K1	1.1	90	104.4	-	-	-	-	-	-	100 Ω/200 W	20	0991	145%	160%
P1K5	1.5	68	75.7	65	0.250	1822	65	0.800	1922	75 Ω/200 W	16	0992	145%	160%
P2K2	2.2	46	51.0	50	0.285	1823	50	1.00	1923	50 Ω/200 W	9	0993	145%	160%
P3K0	3	33	37.0	35	0.430	1824	35	1.35	1924	35 Ω/200 W	5.5	0994	145%	160%
P3K0	3	33	37.0	-	-	-	-	-	-	72 Ω/200 W	12	2X0992[a]	145%	160%
P3K7	3.7	25	29.6	25	0.800	1825	25	3.00	1925	27 Ω/200 W	4	0995	145%	160%

[a] Order two pieces, resistors must be connected in parallel.

[b] Max. load with the resistor in Danfoss standard program.

[c] $R_{br,nom}$ is the nominal (recommended) resistor value that ensures braking energy on the motor shaft of 137% / 145% / 160% for 1 minute.

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Ordering Numbers: Brake Resistors

AC line voltage 380-500 V / 380-480 V			FC 301/302											
			Selected resistor										Max. torque load[b]	
			Standard IP 20							Aluminum-housed (flatpack) IP 65				
			Duty Cycle 10%				Duty Cycle 40%							
FC 301/ FC 302	P_{motor}	R_{min}	$R_{br,nom}$[c]	R_{rec}	$P_{br\ max}$	Order no.	R_{rec}	$P_{br\ max}$	Order no.	R_{rec} per item	Duty cycle	Order no.	FC 301	FC 302
	[kW]	[Ω]	[Ω]	[Ω]	[kW]	175Uxxxx	[Ω]	[kW]	175Uxxxx	[Ω]	%	175Uxxxx		
PK37	0.37	620	1360.2	620	0.065	1840	830	0.450	1976	830 Ω/100 W	20	1000	137%	160%
PK55	0.55	620	915.0	620	0.065	1840	830	0.450	1976	830 Ω/100 W	20	1000	137%	160%
PK75	0.75	601	667.6	620	0.065	1840	620	0.260	1940	620 Ω/100 W	14	1001	137%	160%
PK75	0.75	601	667.6	-	-	-	-	-	-	620 Ω/200 W	40	0982	137%	160%
P1K1	1.1	408	452.8	425	0.095	1841	425	0.430	1941	430 Ω/100 W	8	1002	137%	160%
P1K1	1.1	408	452.8	-	-	-	-	-	-	430 Ω/200 W	20	0983	137%	160%
P1K5	1.5	297	330.4	310	0.250	1842	310	0.800	1942	310 Ω/200 W	16	0984	137%	160%
P2K2	2.2	200	222.6	210	0.285	1843	210	1.35	1943	210 Ω/200 W	9	0987	137%	160%
P3K0	3	145	161.4	150	0.430	1844	150	2.00	1944	150 Ω/200 W	5.5	0989	137%	160%
P3K0	3	145	161.4	-	-	-	-	-	-	300 Ω/200 W	12	2X0985[a]	137%	160%
P4K0	4	108	119.6	110	0.600	1845	110	2.40	1945	240 Ω/200 W	11	2X0986[a]	137%	160%
P5K5	5.5	77	86.0	80	0.850	1846	80	3.00	1946	160 Ω/200 W	6.5	2X0988[a]	137%	160%
P7K5	7.5	56	62.4	65	1.0	1847	65	4.50	1947	130 Ω/200 W	4	2X0990[a]	137%	160%
P11K	11	38	42.1	40	1.8	1848	40	5.00	1948	50 Ω/200 W	9	0993	137%	160%
P15K	15	27	30.5	30	2.8	1849	30	9.30	1949	35 Ω/200 W	5.5	0994	137%	160%
P15K	15	27	30.5	-	-	-	-	-	-	72 Ω/200 W	12	2X0992[a]	137%	160%
P18K	18.5	22	24.5	25	3.5	1850	25	12.70	1950	50 Ω/200 W	11	2X0993[a]	137%	160%
P22K	22	18	20.3	20	4.0	1851	20	13.00	1951	40 Ω/200 W	6.5	2X0996[a]	137%	160%

[a] Order two pieces, resistors must be connected in parallel.

[b] Max. load with the resistor in Danfoss standard program.

[c] $R_{br,nom}$ is the nominal (recommended) resistor value that ensures braking energy on the motor shaft of 137% / 145% / 160% for 1 minute.

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How to Order

□ Ordering Numbers: Harmonic Filters

Harmonic filters are used to reduce line harmonics.

- AHF 010: 10% current distortion
- AHF 005: 5% current distortion

380-415 V, 50 Hz				
$I_{AHF,N}$	Typical Motor Used [kW]	Danfoss ordering number		FC 301/FC 302
		AHF 005	AHF 010	
10 A	4, 5.5	175G6600	175G6622	P4K0, P5K5
19 A	7.5	175G6601	175G6623	P7K5
46 A	11	175G6602	175G6624	P11K
35 A	15, 18.5	175G6603	175G6625	P15K, P18K
43 A	22	175G6604	175G6626	P22K

440-480 V, 60 Hz				
$I_{AHF,N}$	Typical Motor Used [HP]	Danfoss ordering number		FC 301/FC 302
		AHF 005	AHF 010	
19 A	10, 15	175G6612	175G6634	P7K5
26 A	20	175G6613	175G6635	P15K
35 A	25, 30	175G6614	175G6636	P18K, P22K

500 V, 50 Hz				
$I_{AHF,N}$	Typical Motor Used [kW]	Danfoss ordering number		FC 301/FC 302
		AHF 005	AHF 010	
10 A	4, 5.5	175G6644	175G6656	P4K0, P5K5
19 A	7.5, 11	175G6645	175G6634	P7K5, P11K
26 A	15, 18.5	175G6646	175G6635	P15K, P18K
35 A	22	175G6647	175G6636	P22K

Matching the adjustable frequency drive and filter is pre-calculated based on 400 V/480 V and on a typical motor load (4-pole) and 160% torque.

□ Ordering Numbers: LC Filter Modules, 200-240 VAC

Mains supply 3 x 200-240 V					
FC 301/ FC 302	LC filter enclosure	Rated current at 200 V	Max. torque at CT/VT	Max. output frequency	Ordering no.
PK25 - P1K5	Bookstyle IP 20	7.8 A	160%	120 Hz	175Z0825
P2K2 - P3K7	Bookstyle IP 20	15.2 A	160%	120 Hz	175Z0826
PK25 - P3K7	Compact IP 20	15.2 A	160%	120 Hz	175Z0832

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How to Order

NOTE
When using LC filters, the switching frequency must be minimum 4.5 kHz (see par. 14-01).

□ **Ordering Numbers: LC Filter Modules, 380-500 VAC**

Mains supply 3 x 380 - 500 V					
FC 301/ FC 302	LC filter enclosure	Rated current at 400/500 V	Max. torque at CT/VT	Max. output frequency	Ordering no.
PK37-P3K0	Bookstyle IP 20	7.2 A / 6.3 A	160%	120 Hz	175Z0825
P4K0-P7K5	Bookstyle IP 20	16 A / 14.5 A	160%	120 Hz	175Z0826
PK37-P7K5	Compact IP 20	16 A / 14.5 A	160%	120 Hz	175Z0832

LC filters for FC 300, 525 - 600 V, please contact Danfoss.

NOTE
When using LC filters, the switching frequency must be minimum 4.5 kHz (see par. 14-01).

How to Order

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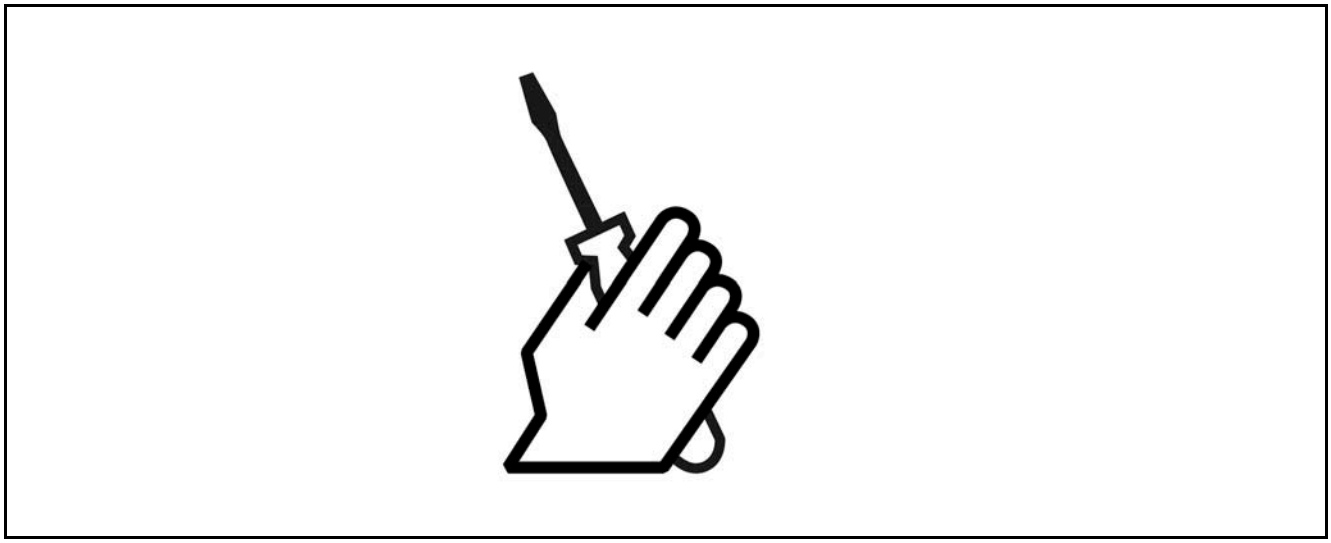
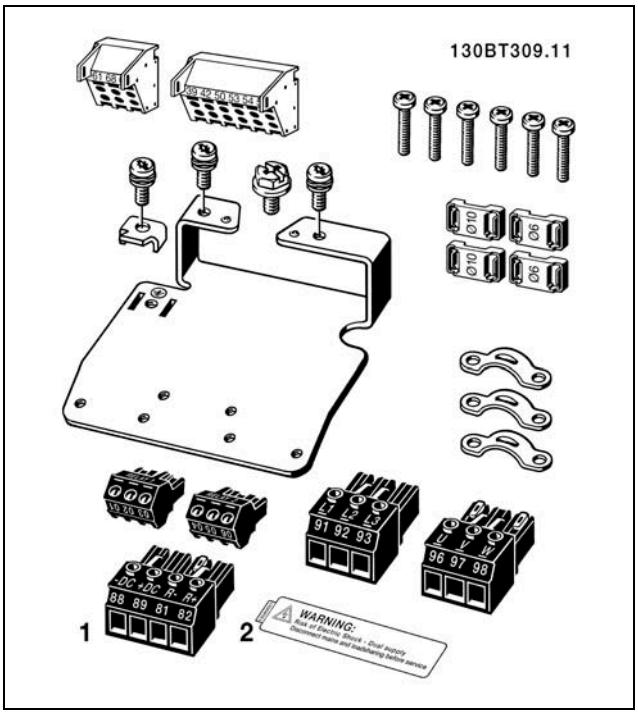
How to Install



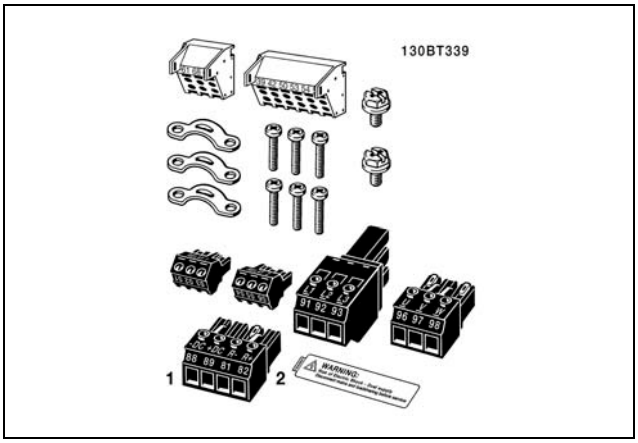
□ Mechanical Installation

□ **Accessory Bag ≤ 10 HP [7.5 kW]**
The following parts are included in the FC 300 Accessory Bag.



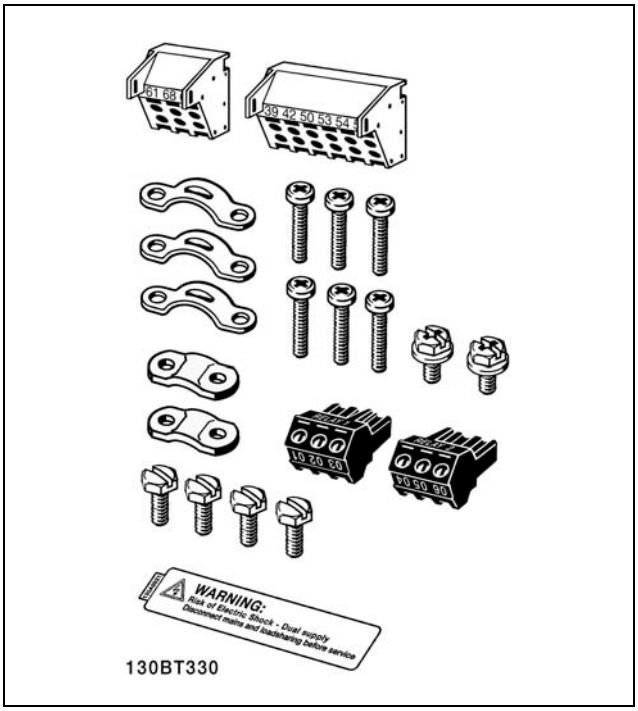
1 + 2 only available in units with brake chopper.
There is only one relay connector for the FC 301. (≤ 10 HP [7.5 kW])
For the DC link connection (load sharing), connector 1 can be ordered separately (order number 130B1064).

Accessory Bag ≤ 10 HP [7.5 kW], IP 55



1 + 2 only available in units with brake chopper.
There is only one relay connector for the FC 301.
(≤ 10 HP [7.5 kW], IP55)

Accessory Bag 14.75-29.5 HP [11-22 kW]



There is only one relay connector for the FC 301.
(14.75-29.5 HP [11-22 kW])

How to Install

□ Mechanical Mounting

1. Drill holes in accordance with the measurements given.
2. You must provide screws suitable for the surface on which you want to mount the FC 300. Retighten all four screws.

FC 300 IP20 allows side-by-side installation. Because of the need for cooling, there must be a minimum of 4 in (100 mm) free air passage above and below the FC 300.

How to Install

□ Safety Requirements of Mechanical Installation

Pay attention to the requirements that apply to integration and the field mounting kit. Follow the information in the list to avoid serious damage or injury, especially when installing large units.

The adjustable frequency drive is cooled by air circulation.
To protect the unit from overheating, it must be ensured that the ambient temperature *does not exceed the maximum temperature stated for the adjustable frequency drive* and that the 24-hour average temperature *is not exceeded*. Locate the maximum temperature and 24-hour average in the paragraph *Derating for Ambient Temperature*.
If the ambient temperature is in the range of 113° - 131°F [45°C - 55°C], derating of the adjustable frequency drive will become relevant, see *Derating for Ambient Temperature*.
The service life of the adjustable frequency drive is reduced if derating for ambient temperature is not taken into account.

□ Field Mounting

For field mounting, the IP 21/IP 4X top/TYPE 1 kits or IP 54/55 units (planned) are recommended.

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□ Electrical Installation

NOTE
Cables General
Always comply with national and local regulations on cable cross-sections.

Tightening-up Torque		
AFD size	Cable for:	Tightening-up torque
0.34-10 HP [0.25-7.5 kW]	Line, brake resistor, load sharing motor cable	0.5-0.6 Nm 1.8 Nm
14.75-10 HP [11-15 kW]	Line, brake resistor, load sharing motor cable	1.8 Nm
14.75-10 HP [11-15 kW]	Motor cable	1.8 Nm
	Relay	0.5-0.6 Nm
	Ground	2-3 Nm

□ Removal of Knockouts for Extra Cables

1. Remove the cable entry from the adjustable frequency drive (avoid foreign parts entering the adjustable frequency drive when removing knockouts).
2. The cable entry must be supported around the knockout you intend to remove.
3. The knockout can now be removed with a strong mandrel and a hammer.
4. Remove burrs from the hole.
5. Mount cable entry on adjustable frequency drive.

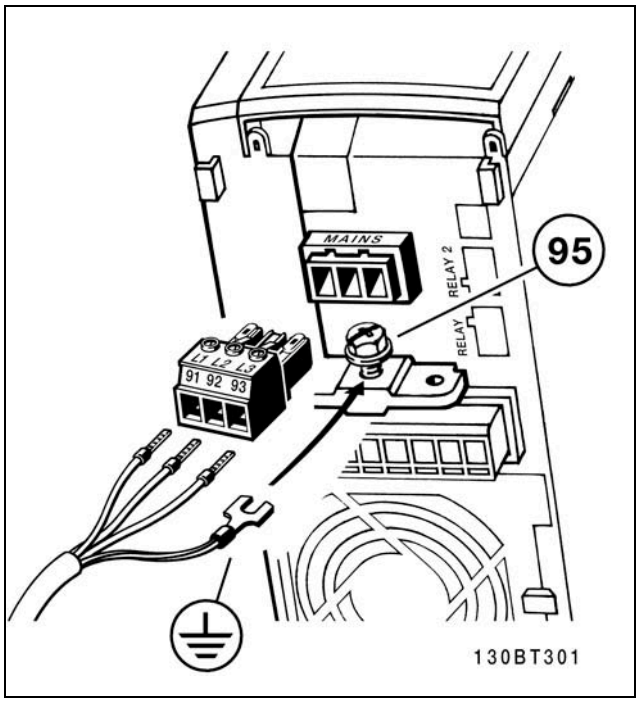
□ Connection to Line Supply and Grounding

NOTE
The plug connector for power can be removed.

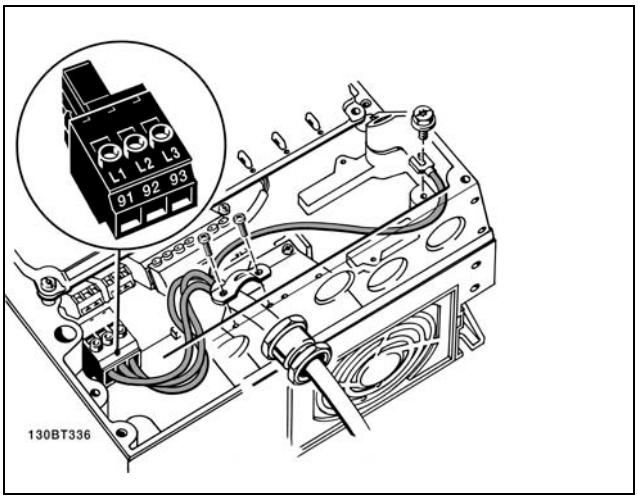
1. Make sure the FC 300 is properly grounded. Connect to ground connection (terminal 95). Use screw from the accessory bag.
2. Place plug connector 91, 92, 93 from the accessory bag onto the terminals labeled MAINS at the bottom of the FC 300.
3. Connect line wires to the line plug connector.

The ground connection cable cross-section must be at least 3.9 in^2 [10 mm^2] or have 2 rated line supply wires terminated separately according to EN 50178.

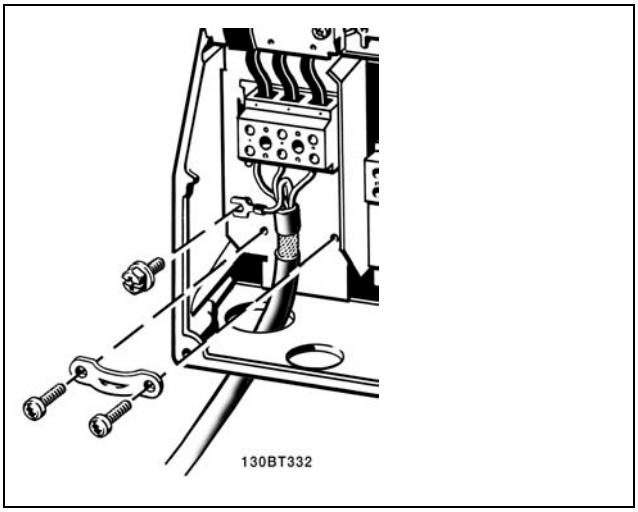
The line supply connection is fitted to the line supply switch if this is included.



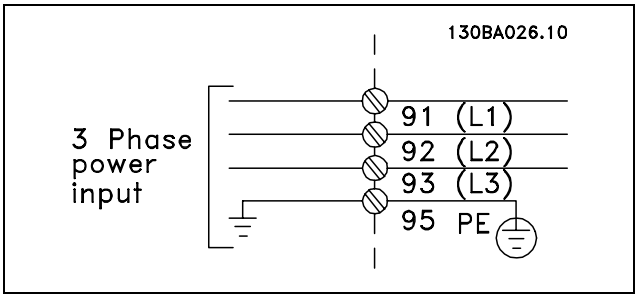
How to connect to the line supply and grounding (A2 and A3 enclosure).



How to connect to the line supply and grounding (A5 enclosure).



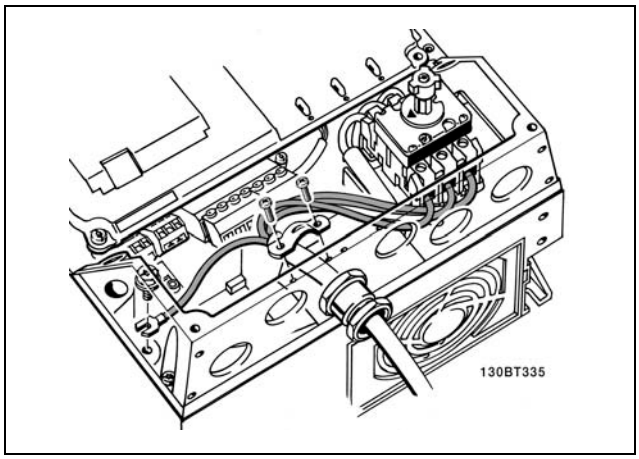
How to connect to the line supply and grounding (B1 and B2 enclosure).



Terminals for line supply and grounding.

NOTE
Check that AC line voltage corresponds to the line voltage of the FC 300 nameplate.

IT Line
Do not connect 400 V adjustable frequency drives with RFI filters to line supplies with a voltage between phase and ground of more than 440 V.
For IT lines and delta ground (grounded leg), line voltage may exceed 440 V between phase and ground.

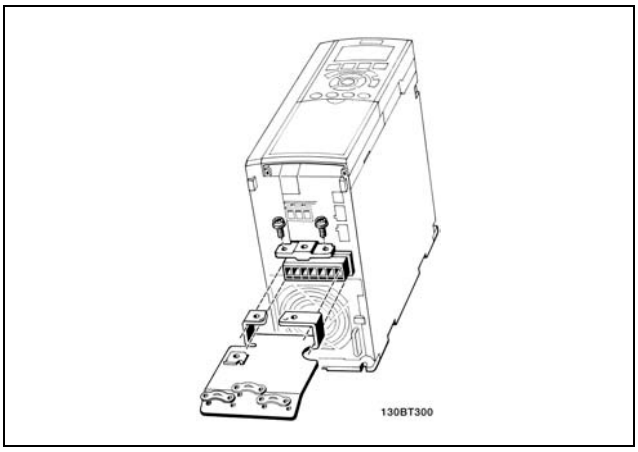


How to connect to the line supply and grounding with disconnector (A5 enclosure).

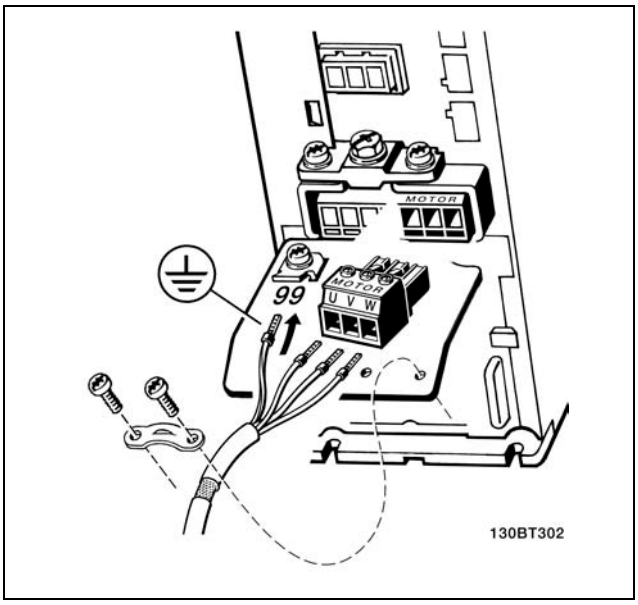
□ Motor Connection

NOTE
Motor cable must be shielded/armored. If an unshielded/unarmored cable is used, some EMC requirements are not complied with. For more information, see *EMC specifications*.

1. Fasten decoupling plate to the bottom of the FC 300 with screws and washers from the accessory bag.

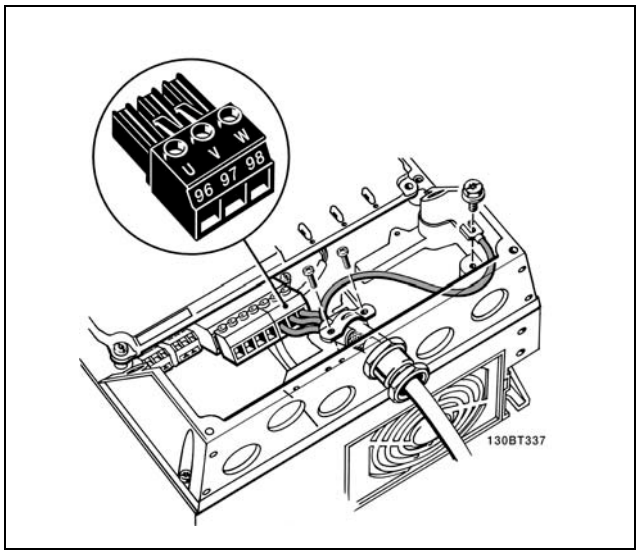


2. Attach motor cable to terminals 96 (U), 97 (V), 98 (W).
3. Connect to ground connection (terminal 99) on decoupling plate with screws from the accessory bag.
4. Insert terminals 96 (U), 97 (V), 98 (W) and motor cable to terminals labeled MOTOR.
5. Fasten shielded cable to decoupling plate with screws and washers from the accessory bag.

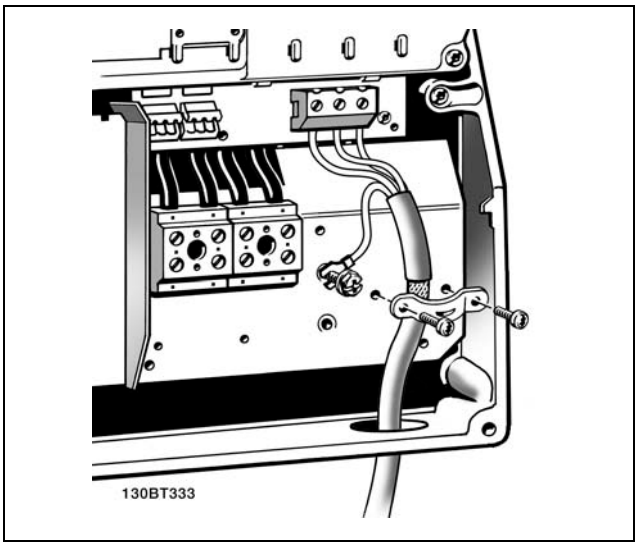


≤ 10 HP [7.5 kW] IP 20

How to Install

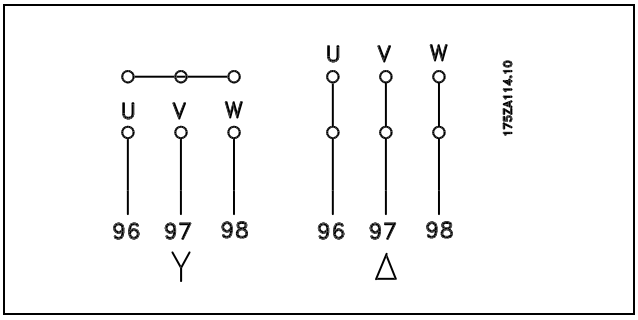


Motor connection ≤ 10 HP [7.5 kW] IP 55



14.75-29.5 HP [11-22 kW] IP 21

All types of three-phase asynchronous standard motors can be connected to the FC 300. Normally, small motors are star-connected (230/400 V, D/Y). Large motors are delta-connected (400/690 V, D/Y). Refer to the motor nameplate for correct connection mode and voltage.



NOTE
In motors without phase insulation paper or other insulation reinforcement suitable for operation with voltage supply (such as adjustable frequency drive, fit an LC filter on the output of the FC 300.

No.	96	97	98	
	U	V	W	Motor voltage 0-100% of AC line voltage. 3 wires out of motor
	U1 W2	V1 U2	W1 V2	6 wires out of motor, Delta-connected
	U1	V1	W1	6 wires out of motor, Star-connected U2, V2, W2 to be interconnected separately (optional terminal block)
No.	99			Ground connection
	PE			

□ Motor Cables

See section *General Specifications* for correct dimensioning of motor cable cross-section and length.

- Use a shielded/armored motor cable to comply with EMC emission specifications.
- Keep the motor cable as short as possible to reduce the noise level and leakage currents.
- Connect the motor cable shield to both the decoupling plate of the FC 300 and to the metal cabinet of the motor.
- Make the shield connections with the largest possible surface area (cable clamp). This is done by using the supplied installation devices in the FC 300.
- Avoid mounting with twisted shield ends (pigtails), which will spoil high frequency shielding effects.
- If it is necessary to split the shield to install a motor isolator or motor relay, the shield must be continued with the lowest possible HF impedance.

□ Electrical Installation of Motor Cables

Shielding of cables

Avoid installation with twisted shield ends (pigtails). They spoil the shielding effect at higher frequencies. If it is necessary to break the shield to install a motor isolator or motor contactor, the shield must be continued at the lowest possible HF impedance.

Cable length and cross-section

The adjustable frequency drive has been tested with a given length of cable and a given cross-section of that cable. If the cross-section is increased, the cable capacitance - and thus the leakage current - may increase, and the cable length must be reduced correspondingly.

Switching frequency

When adjustable frequency drives are used together with LC filters to reduce the acoustic noise from a motor, the switching frequency must be set according to the LC filter instruction in *Par. 14-01.*

Aluminum conductors

Aluminum conductors are not recommended. Terminals can accept aluminum conductors but the conductor surface must be clean and the oxidation must be removed and sealed by neutral acid-free grease before the conductor is connected.
Furthermore, the terminal screw must be retightened after two days due to the softness of the aluminum. It is crucial to keep the connection a gas-tight joint, otherwise the aluminum surface will oxidize again.

□ Fuses

Branch circuit protection:

In order to protect the installation against electrical and fire hazard, all branch circuits in an installation, switch gear, machines, etc., must be short-circuit and overcurrent-protected according to national/international regulations.

Short circuit protection:

The adjustable frequency drive must be protected against short-circuit to avoid electrical or fire hazard. Danfoss recommends using the fuses mentioned below to protect service personnel or other equipment in case of an internal failure in the drive. The adjustable frequency drive provides full short-circuit protection in case of a short-circuit on the motor output.

Overcurrent protection:

Provide overload protection to avoid fire hazard due to overheating of the cables in the installation. The adjustable frequency drive is equipped with internal overcurrent protection that can be used for upstream overload protection (UL applications excluded). See par. 4-18. Moreover, fuses or circuit breakers can be used to provide overcurrent protection in the installation. Overcurrent protection must always be provided according to national regulations.

Fuses must be designed for protection in a circuit capable of supplying a maximum of 100,000 A_{rms} (symmetrical), 500 V maximum.

Non-UL compliance

If UL/cUL is not to be complied with, we recommend using the following fuses, which will ensure compliance with EN50178:
In case of malfunction, not following the recommendation may result in unnecessary damage to the adjustable frequency drive.

FC 30X	Max. fuse size	Voltage	Type
K25-K75	10A[1)]	200-240 V	type gG
1K1-2K2	20A[1)]	200-240 V	type gG
3K0-3K7	32A[1)]	200-240 V	type gG
K37-1K5	10A[1)]	380-500 V	type gG
2K2-4K0	20A[1)]	380-500 V	type gG
5K5-7K5	32A[1)]	380-500 V	type gG
11K	63A[1)]	380-500 V	type gG
15K	63A[1)]	380-500 V	type gG
18K	63A[1)]	380-500 V	type gG
22K	80A[1)]	380-500 V	type gG

1) Max. fuses - see national/international regulations for selecting an applicable fuse size.

UL Compliance

200-240 V

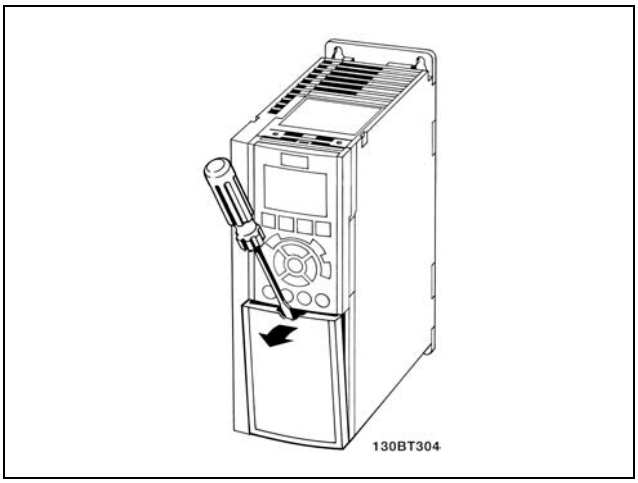
FC 30X	Bussmann	Bussmann	Bussmann	SIBA	Littel fuse	Ferraz-Shawmut	Ferraz-Shawmut
kW	Type RK1	Type J	Type T	Type RK1	Type RK1	Type CC	Type RK1
2-7.5	KTN-R10	JKS-10	JJN-10	5017906-010	KLN-R10	ATM-R10	A2K-10R
1.1-2.2	KTN-R20	JKS-20	JJN-20	5017906-020	KLN-R20	ATM-R20	A2K-20R
3.0-3.7	KTN-R30	JKS-30	JJN-30	5012406-032	KLN-R30	ATM-R30	A2K-30R

380-500 V, 525-600 V

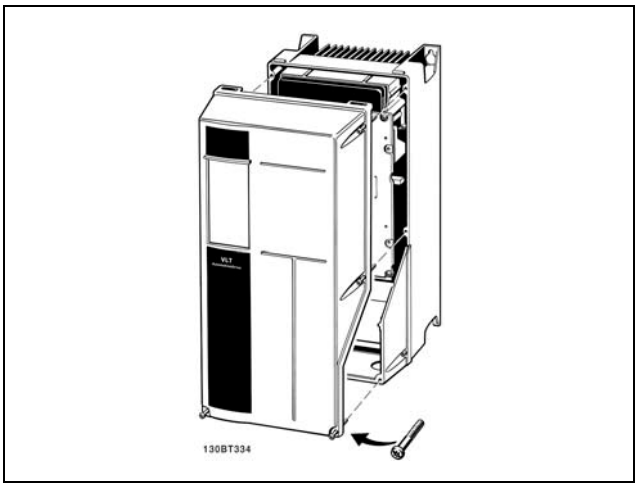
FC 30X	Bussmann	Bussmann	Bussmann	SIBA	Littel fuse	Ferraz-Shawmut	Ferraz-Shawmut
kW	Type RK1	Type J	Type T	Type RK1	Type RK1	Type CC	Type RK1
0.37-1.5	KTS-R10	JKS-10	JJS-10	5017906-010	KLS-R10	ATM-R10	A6K-10R
2.2-4.0	KTS-R20	JKS-20	JJS-20	5017906-020	KLS-R20	ATM-R20	A6K-20R
5.5-7.5	KTS-R30	JKS-30	JJS-30	5012406-032	KLS-R30	ATM-R30	A6K-30R
11.0	KTS-R40	JKS-40	JJS-40	5014006-040	KLS-R40		A6K-40R
15.0	KTS-R50	JKS-50	JJS-50	5014006-050	KLS-R50		A6K-50R
18.0	KTS-R60	JKS-60	JJS-60	5014006-063	KLS-R60		A6K-60R
22.0	KTS-R80	JKS-80	JJS-80	5014006-100	KLS-R80		A6K-80R

KTS fuses from Bussmann may substitute KTN for 240 V adjustable frequency drives.
FWH fuses from Bussmann may substitute FWX for 240 V adjustable frequency drives.
KLSR fuses from LITTEL FUSE may substitute KLNR fuses for 240 V adjustable frequency drives.
L50S fuses from LITTEL FUSE may substitute L50S fuses for 240 V adjustable frequency drives.
A6KR fuses from FERRAZ SHAWMUT may substitute A2KR for 240 V adjustable frequency drives.
A50X fuses from FERRAZ SHAWMUT may substitute A25X for 240 V adjustable frequency drives.

□ **Access to Control Terminals**
All terminals to the control cables are located underneath the terminal cover on the front of the adjustable frequency drive. Remove the terminal cover by means of a screwdriver (see illustration).



A1, A2 and A3 enclosures



A5, B1 and B2 enclosures

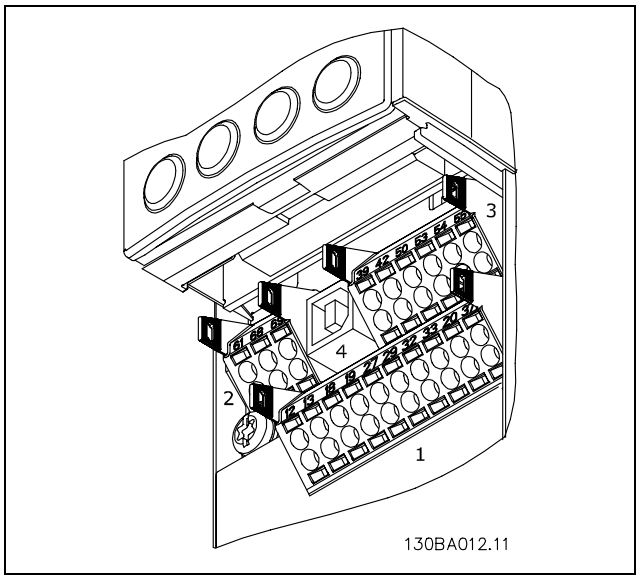
□ **Control Terminals (FC 301)**
Drawing reference numbers:

1. 8-pole plug, digital I/O.
2. 3-pole plug, RS485 bus.
3. 6-pole, analog I/O.
4. USB Connection.

Control Terminals (FC 302)

Drawing reference numbers:

1. 10-pole plug, digital I/O.
2. 3-pole plug, RS485 bus.
3. 6-pole, analog I/O.
4. USB Connection.

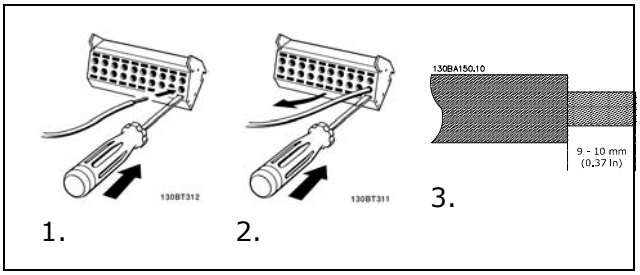


Control terminals (all enclosures)

□ **Electrical Installation, Control Terminals**

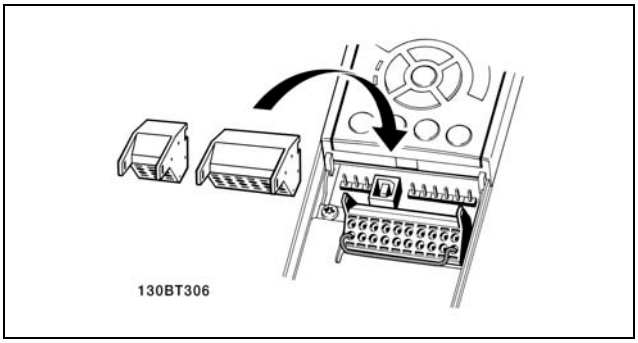
To mount the cable to the terminal:

1. Strip isolation of 0.34-0.39 in [9-10 mm]
2. Insert a screwdriver in the square hole.
3. Insert the cable in the adjacent circular hole.
4. Remove the screwdriver. The cable is now mounted to the terminal.

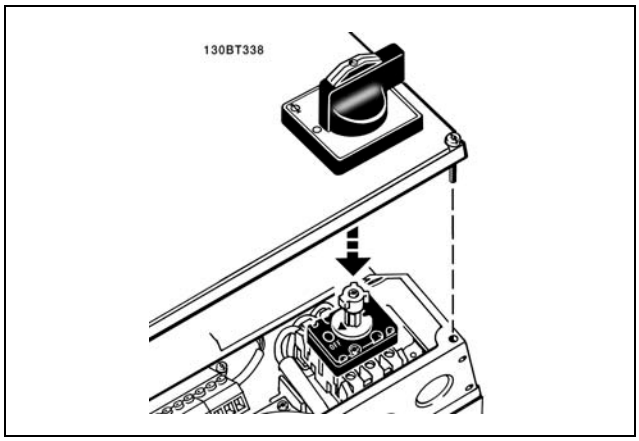


To remove the cable from the terminal:

1. Insert a screwdriver in the square hole.
2. Pull out the cable.



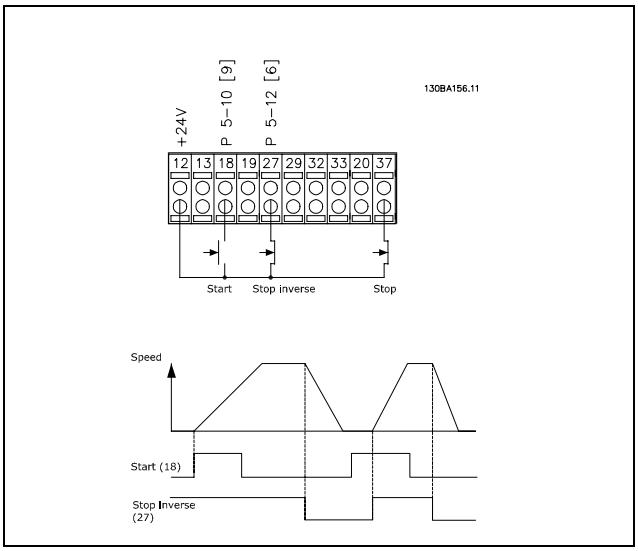
Assembling IP 55 / NEMA TYPE 12 (A5 housing) with line supply disconnector



□ Basic Wiring Example

1. Mount terminals from the accessory bag to the front of the FC 300.
2. Connect terminals 18, 27 and 37 (FC 302 only) to +24 V (terminal 12/13)

Default settings:
18 = start
27 = coast inverse
37 = safe stop inverse



□ Electrical Installation, Control Cables

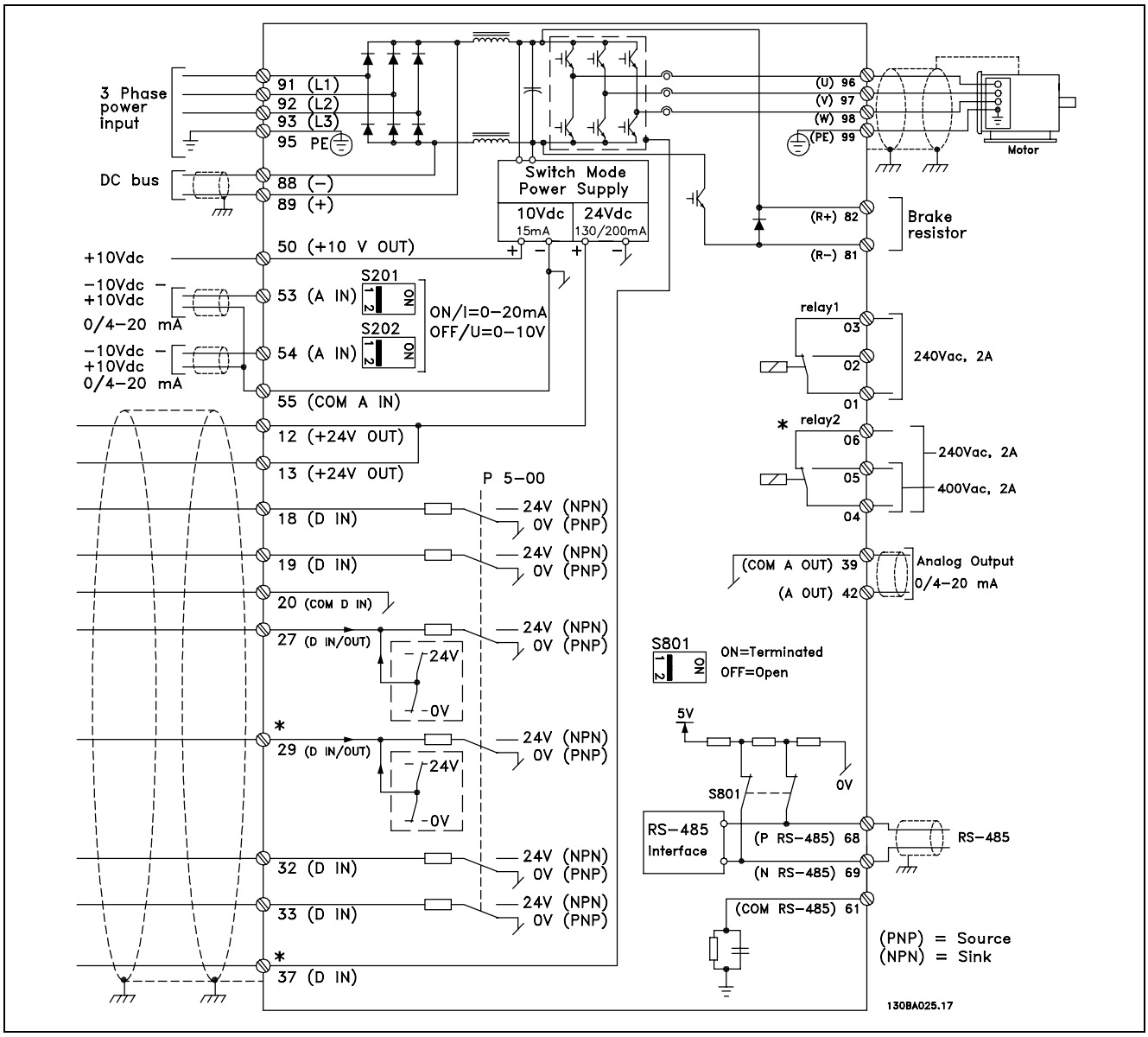


Diagram showing all electrical terminals.
Terminal 37 is not included in FC 301.
Terminal 37 is the input to be used for Safe Stop. For instructions on Safe Stop installation please refer to the section *Safe Stop Installation*.
* Terminal 29 and 37, relay 2 are not included in FC 301.

Very long control cables and analog signals may in rare cases, depending on installation, result in 50/60 Hz ground loops due to noise from mains supply cables.

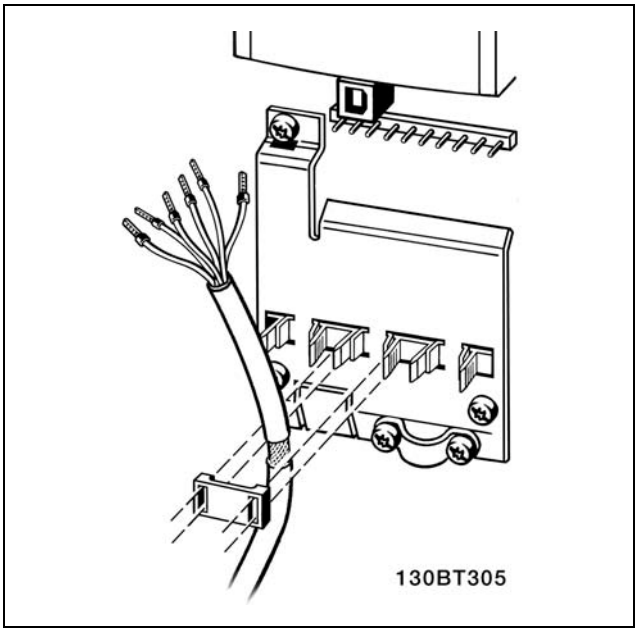
If this occurs, you may have to break the shield or insert a 100 nF capacitor between shield and chassis.

The digital and analog inputs and outputs must be connected separately to the FC 300 common inputs (terminal 20, 55, 39) to avoid ground currents from both groups affecting other groups. For example, switching on the digital input may disturb the analog input signal.

NOTE
Control cables must be shielded/armored.

1. Use a clamp from the accessory bag to connect the shield to the FC 300 grounding plate for control cables.

See section entitled *Grounding of Shielded/Armored Control Cables* for the correct termination of control cables.



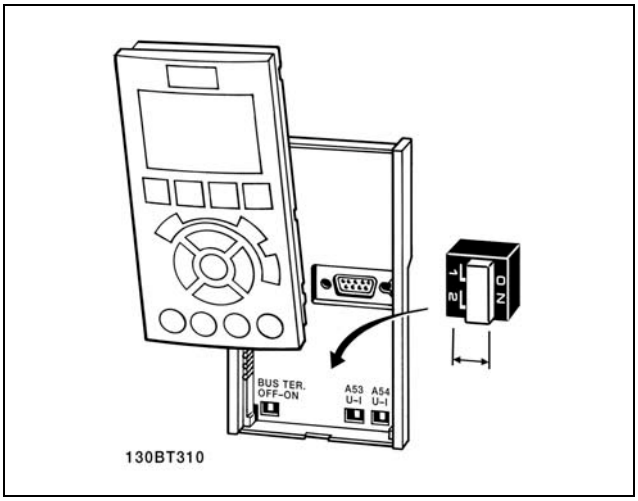
□ **Switches S201, S202, and S801**
Switches S201 (A53) and S202 (A54) are used to select a current (0-20 mA) or a voltage (-10 to 10 V) configuration of the analog input terminals 53 and 54 respectively.

Switch S801 (BUS TER.) can be used to enable termination on the RS-485 port (terminals 68 and 69).

See drawing *Diagram showing all electrical terminals* in section *Electrical Installation.*

Default setting:

S201 (A53) = OFF (voltage input)
S202 (A54) = OFF (voltage input)
S801 (Bus termination) = OFF

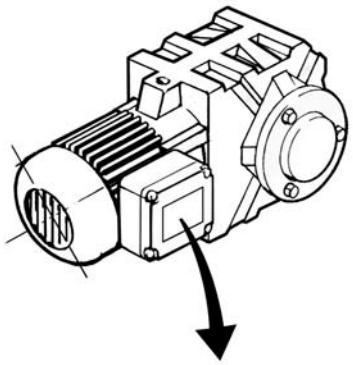


□ Final Set-Up and Test

To test the set-up and ensure that the adjustable frequency drive is running, follow these steps.

Step 1. Locate the motor nameplate.

NOTE
The motor is either star- (Y) or delta-connected (Δ). This information is located on the motor nameplate data.



BAUER D-73734 ESLINGEN				
3~ MOTOR NR. 1827421				2003
S/E005A9				
	1,5	kW		
n_2 31,5	/min.	400	Y	V
n_1 1400	/min.		50	Hz
cos φ 0,80			3,6	A
1,7L				
B IP 65		H1/1A		

130BT307

Step 2. Enter the motor nameplate data in this parameter list.
To access this list first press the [QUICK MENU] key, then select "Q2 Quick Setup".

1.	Motor Power [kW] or Motor Power [HP]	par. 1-20 par. 1-21
2.	Motor Voltage	par. 1-22
3.	Motor Frequency	par. 1-23
4.	Motor Current	par. 1-24
5.	Motor Nominal Speed	par. 1-25

Step 3. Activate the Automatic Motor Adaptation (AMA)
Performing an AMA will ensure optimum performance. The AMA measures the values from the motor model equivalent diagram.

1. Connect terminal 37 to terminal 12 (FC 302).
2. Connect terminal 27 to terminal 12 or set par. 5-12 to 'No function' (par. 5-12 [0])
3. Activate the AMA par. 1-29.
4. Choose between complete or reduced AMA. If an LC filter is mounted, run only the reduced AMA, or remove the LC filter during the AMA procedure.
5. Press the [OK] key. The display shows "Press [Hand on] to start".
6. Press the [Hand on] key. A progress bar indicates if the AMA is in progress.

Stop the AMA during operation.

1. Press the [OFF] key. The adjustable frequency drive enters into alarm mode and the display shows that the AMA was terminated by the user.

Successful AMA

1. The display shows "Press [OK] to finish AMA".
2. Press the [OK] key to exit the AMA state.

Unsuccessful AMA

1. The adjustable frequency drive enters into alarm mode. A description of the alarm can be found in the *Troubleshooting* section.
2. "Report Value" in the [Alarm Log] shows the last measuring sequence carried out by the AMA, before the adjustable frequency drive entered alarm mode. This number along with the description of the alarm will assist you in troubleshooting. If you contact Danfoss Service, make sure to mention number and alarm description.

NOTE
Unsuccessful AMA is often caused by incorrectly registered motor nameplate data or a difference between the motor power size and the FC 300 power size that is too large.

Step 4. Set speed limit and ramp time

Set up the desired limits for speed and ramp time.

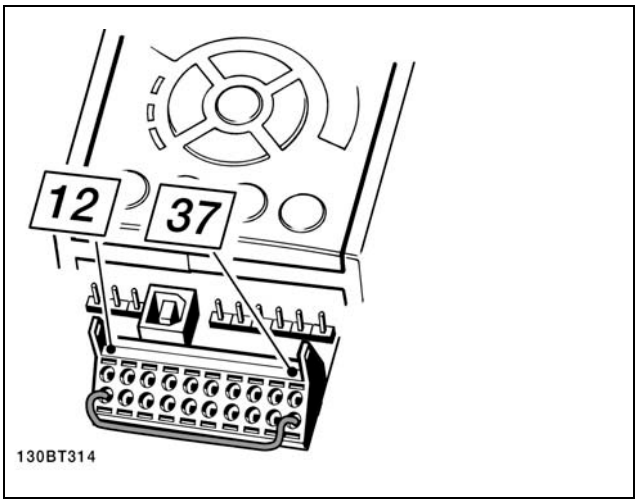
Minimum Reference	par. 3-02
Maximum Reference	par. 3-03

Motor Speed Low Limit	par. 4-11 or 4-12
Motor Speed High Limit	par. 4-13 or 4-14

Ramp-up Time 1 [s]	par. 3-41
Ramp-down Time 1 [s]	par. 3-42

□ **Safe Stop Installation (FC 302 only)**
To carry out an installation of a category 0 stop (EN60204) in conformance with safety category 3 (EN954-1), follow these instructions:

1. The bridge (jumper) between terminal 37 and 24 V DC of the FC 302 must be removed. Cutting or breaking the jumper is not sufficient. Remove it entirely to avoid short-circuiting. See jumper on illustration.
2. Connect terminal 37 to 24 V DC by a short circuit-protected cable. The 24 V DC voltage supply must be interruptible by an EN954-1 category 3 circuit interrupt device. If the interrupt device and the adjustable frequency drive are placed in the same installation panel, you can use a regular cable instead of a protected one.



Bridge jumper between terminal 37 and 24 VDC.

The illustration below shows a stopping category 0 (EN 60204-1) with safety cat. 3 (EN 954-1). The circuit interrupt is caused by an opening door contact. The illustration also shows how to connect a non-safety-related hardware coast.

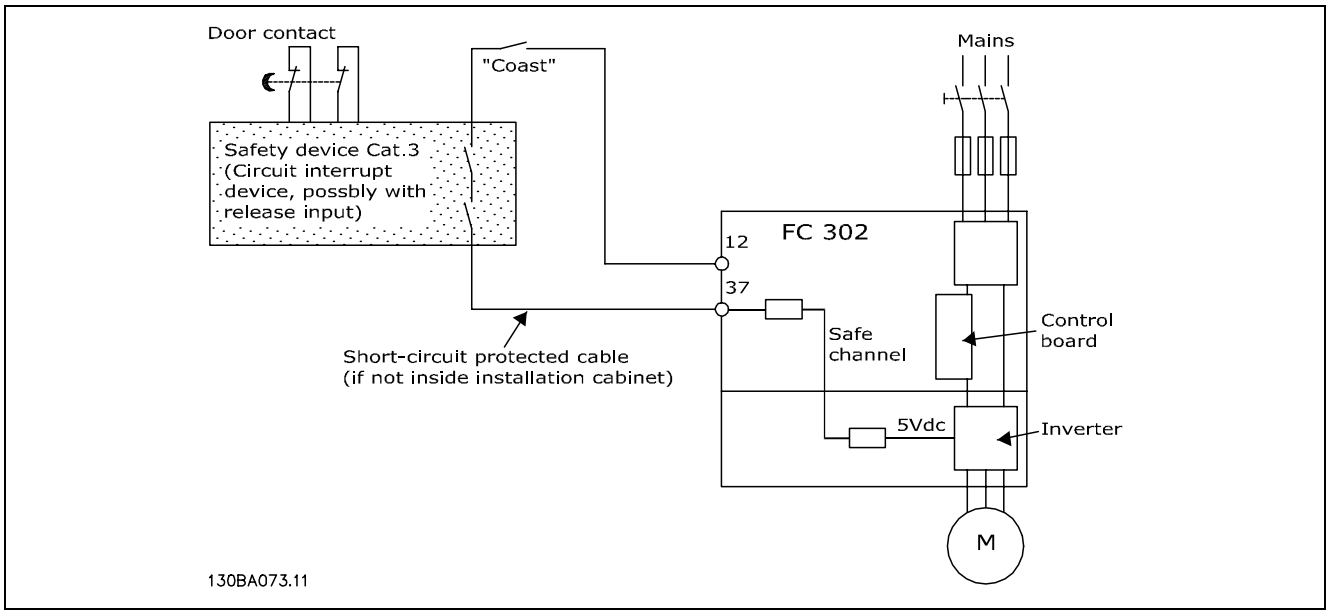


Illustration of the essential aspects of an installation to achieve a stopping category 0 (EN 60204-1) with safety cat. 3 (EN 954-1).

□ **Safe Stop Commissioning Test**

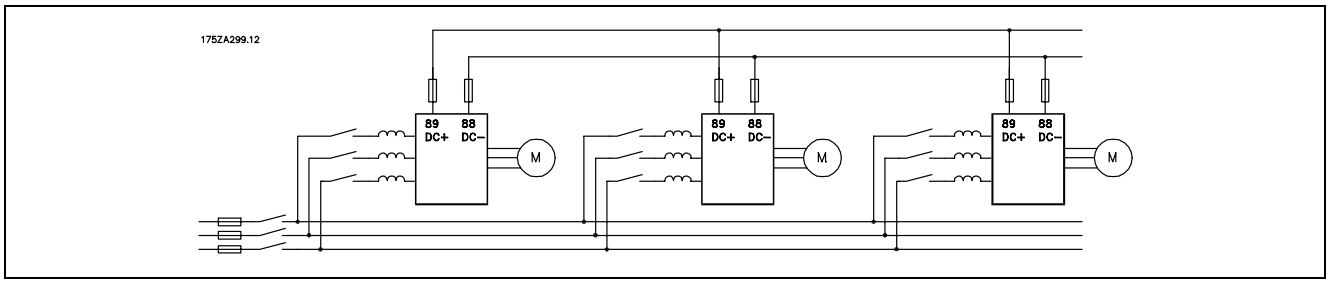
After installation and before first operation, perform a commissioning test of an installation or application making use of FC 300 Safe Stop.
Moreover, perform the test after each modification of the installation or application of which the FC 300 Safe Stop is part.
The commissioning test:

1. Remove the 24 V DC voltage supply to terminal 37 by the interrupt device while the motor is driven by the FC 302 (i.e. mains supply is not interrupted). The test step is passed if the motor reacts with a coast and the mechanical brake (if connected) is activated.
2. Then send Reset signal (via Bus, Digital I/O, or [Reset] key). The test step is passed if the motor remains in the Safe Stop state, and the mechanical brake (if connected) remains activated.
3. Then reapply 24 V DC to terminal 37. The test step is passed if the motor remains in the coasting state, and the mechanical brake (if connected) remains activated.
4. Then send Reset signal (via Bus, Digital I/O, or [Reset] key). The test step is passed if the motor becomes operational again.
5. The commissioning test is passed if all four test steps are passed.

□ Additional Connections

□ Load sharing

With load sharing you can connect several adjustable frequency drive's DC intermediate circuits if you extend the installation using extra fuses and AC coils (see illustration).



NOTE
Load sharing cables must be shielded/armoured. If an unshielded/unarmoured cable is used, some EMC requirements are not complied with.

Voltage levels of up to 975 V DC may occur between terminals 88 and 89.

No.	88	89	Loadsharing
	DC	DC +	

□ Installation of Load Sharing

The connection cable must be shielded and the max. length from the adjustable frequency drive to the DC bar is 81 ft. [25 m].

NOTE
Load sharing calls for extra equipment and safety considerations. For further information, see Load Sharing Instructions MI.50.NX.YY.

□ Brake Connection Option

The connection cable to the brake resistor must be shielded/armored.

No.	81	82	Brake resistor
	R-	R+	terminals

NOTE
Dynamic brake calls for extra equipment and safety considerations. For further information, see the Instruction *Brake Resistors for Horizontal Applications*, MI50SXYY.

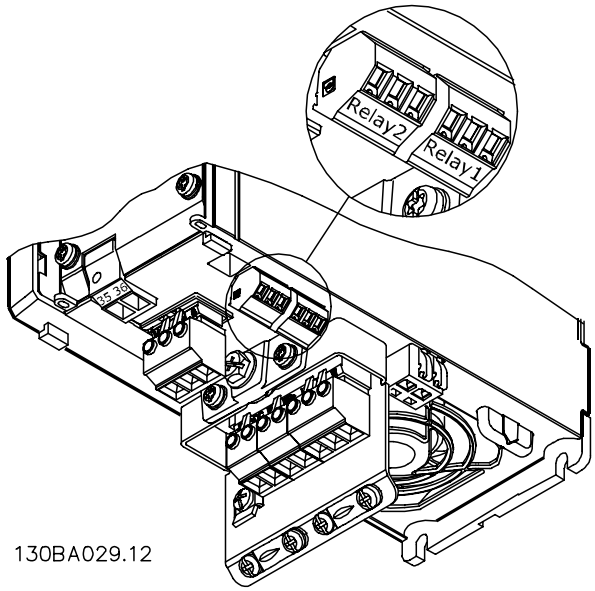
1. Use cable clamps to connect the shield to the metal cabinet of the adjustable frequency drive and to the decoupling plate of the brake resistor.
2. Dimension the cross-section of the brake cable to match the brake current.

NOTE
Voltages up to 975 V DC (@ 600 V AC) may occur between the terminals.

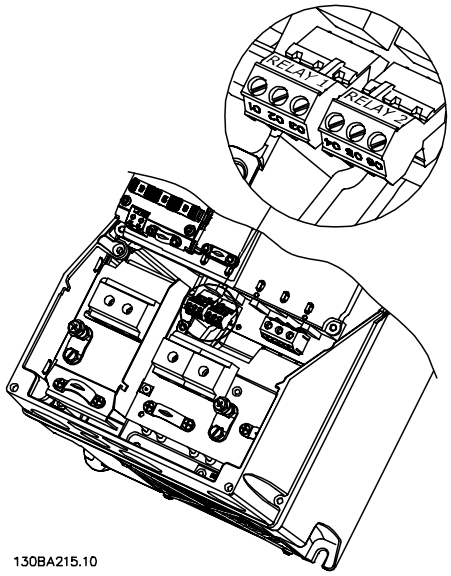
NOTE
If a short circuit in the brake IGBT occurs, prevent power dissipation in the brake resistor by using a line switch or contactor to disconnect the line power for the adjustable frequency drive. Only the adjustable frequency drive should control the contactor.

□ **Relay Connection**
To set relay output, see par. group 5-4* Relays.

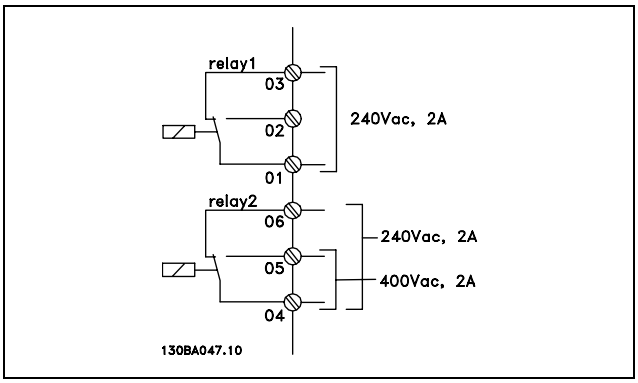
No.		
	01 - 02	make (normally open)
	01 - 03	break (normally closed)
	04 - 05	make (normally open)
	04 - 06	break (normally closed)



Terminals for relay connection (≤ 10 HP [7.5 kW]) (A1, A2 and A3 enclosures).



Terminals for relay connection (14.75-29.5 HP [11-22 kW])
(A5, B1 and B2 enclosures).



□ **Relay Output**

Relay 1

- Terminal 01: common
- Terminal 02: normal open 240 V AC
- Terminal 03: normal closed 240 V AC

Relay 2 (FC 302 only)

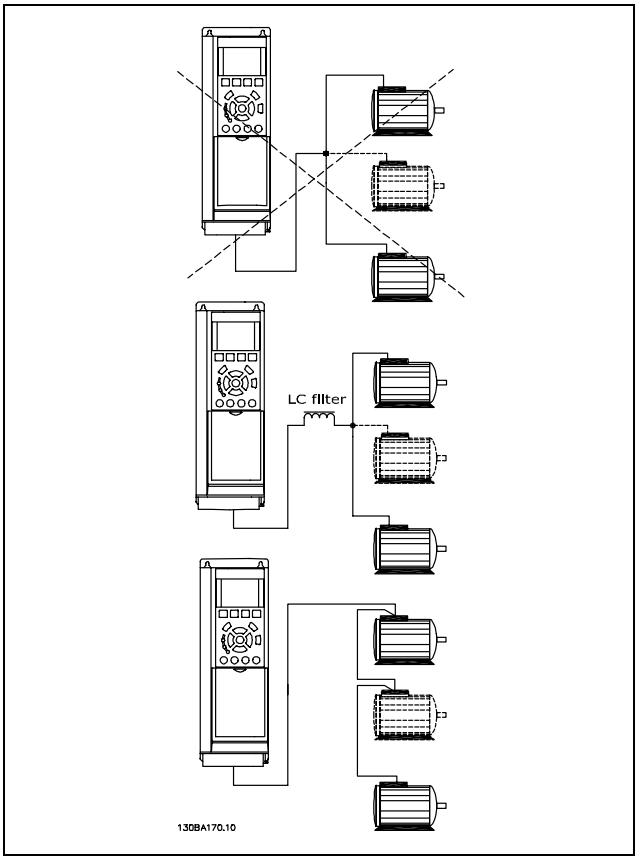
- Terminal 04: common
- Terminal 05: normal open 400 V AC
- Terminal 06: normal closed 240 V AC

Relay 1 and relay 2 are programmed in par. 5-40, 5-41, and 5-42.

Additional relay outputs by using option module MCB 105.

□ **Parallel Connection of Motors**

The adjustable frequency drive can control several parallel-connected motors. The total current consumption of the motors must not exceed the rated output current I_{INV} for the adjustable frequency drive.
This is only recommended when U/f is selected in par. 1-01.



NOTE
When motors are connected in parallel, par. 1-29 *Automatic Motor Adaptation (AMA)* cannot be used, and par. 1-01 *Motor Control Principle* must be set to *Special motor characteristics (U/f)*.

Problems may arise at start and at low RPM values if motor sizes are widely different because, for small motors, the relatively high ohmic resistance in the stator calls for a higher voltage at start and at low RPM values.

How to Install

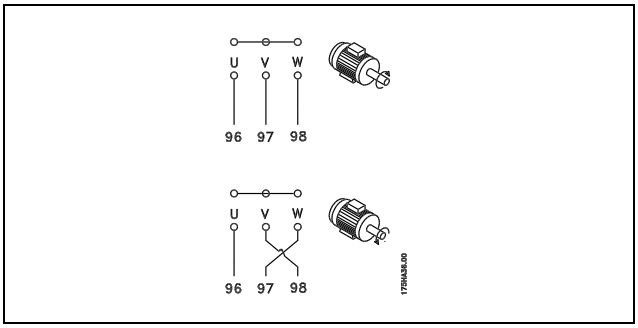
The electronic thermal relay (ETR) of the adjustable frequency drive cannot be used as motor protection for an individual motor in systems with parallel-connected motors. Provide further motor protection by, e.g., thermistors in each motor or individual thermal relays. (Circuit breakers are not suitable as protection).

□ Direction of Motor Rotation

The default setting is clockwise rotation with the adjustable frequency drive output connected as follows.

Terminal 96 connected to U-phase
Terminal 97 connected to V-phase
Terminal 98 connected to W-phase

The direction of motor rotation is changed by switching two motor phases.



□ Installation of Brake Cable

(Only for adjustable frequency drives ordered with brake chopper option).

The connection cable to the brake resistor must be shielded.

1. Connect the shield by means of cable clamps to the conductive back plate on the adjustable frequency drive and to the metal cabinet of the brake resistor.
2. Size the brake cable cross-section to match the brake torque.

No.	Function
81, 82	Brake resistor terminals

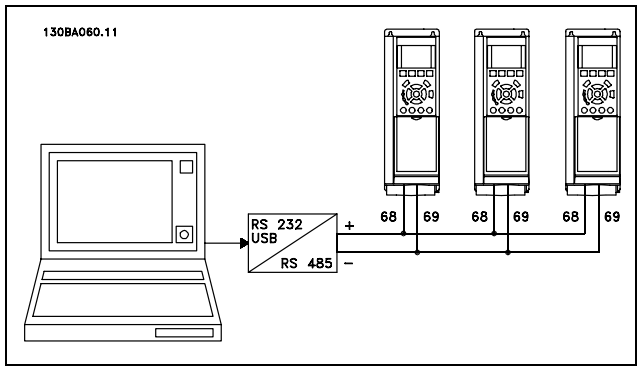
See Brake instructions, MI.90.FX.YY and MI.50.SX.YY for more information about safe installation.

NOTE
Voltages up to 960 V DC, depending on the supply voltage, may occur on the terminals.

□ **RS 485 Bus Connection**

One or more adjustable frequency drives can be connected to a control (or master) using the RS485 standardized interface. Terminal 68 is connected to the P signal (TX+, RX+), while terminal 69 is connected to the N signal (TX-, RX-).

If more than one adjustable frequency drive is connected to a master, use parallel connections.



In order to avoid potential equalizing currents in the shield, ground the cable shield via terminal 61, which is connected to the frame via an RC link.

Bus termination

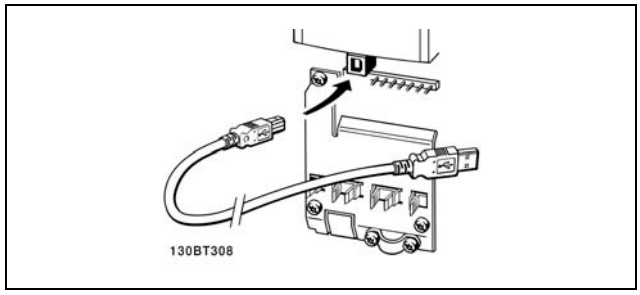
The RS485 bus must be terminated by a resistor network at both ends. For this purpose, set switch S801 on the control card to "ON".
For more information, see the paragraph *Switches S201, S202, and S801*.

NOTE

Communication protocol must be set to FC MC par. 8-30.

□ **How to Connect a PC to the FC 300**

To control the adjustable frequency drive from a PC, install the MCT 10 Setup Software.
The PC is connected via a standard (host/device) USB cable, or via the RS-485 interface as shown in the section *Bus Connection* in the chapter *How to Program*.



USB connection.

□ **The FC 300 Software Dialog**
Data storage in PC via MCT 10 Set-Up Software:

1. Connect a PC to the unit via USB com port
2. MCT 10 Set-up Software
3. Choose "Read from drive"
4. Choose "Save as"

All parameters are now stored.

Data transfer from PC to drive via MCT 10 Set-Up Software:

1. Connect a PC to the unit via USB com port
2. MCT 10 Set-up Software
3. Choose "Open" - stored files will be shown
4. Open the appropriate file
5. Choose "Write to drive"

All parameters are now transferred to the drive.

A separate manual for MCT 10 Set-up Software is available.

□ **High Voltage Test**

Carry out a high voltage test by short circuiting terminals U, V, W, L_1, L_2 and L_3. Energize by max. 2.15 kV DC for one second between this short circuit and the chassis.

NOTE
When running high voltage tests of the entire installation, interrupt the mains and motor connection if the leakage currents are too high.

□ **Safety Ground Connection**

The adjustable frequency drive has a high leakage current and must be grounded appropriately for safety reasons according to EN 50178.

The ground leakage current from the adjustable frequency drive exceeds 3.5 mA. To ensure a good mechanical connection from the ground cable to the ground connection (terminal 95), the cable cross-section must be at least 0.39 in2 [10 mm2] or 2 rated ground wires terminated separately.

□ **Electrical Installation - EMC Precautions**

The following is a guideline to good engineering practice when installing adjustable frequency drives. Follow these guidelines to comply with EN 61800-3 *First environment*. If the installation is in EN 61800-3 *Second environment,* i.e. industrial networks, or in an installation with its own transformer, deviation from these guidelines is allowed but not recommended. See also paragraphs *CE Labeling*, *General Aspects of EMC Emission* and *EMC Test Results*.

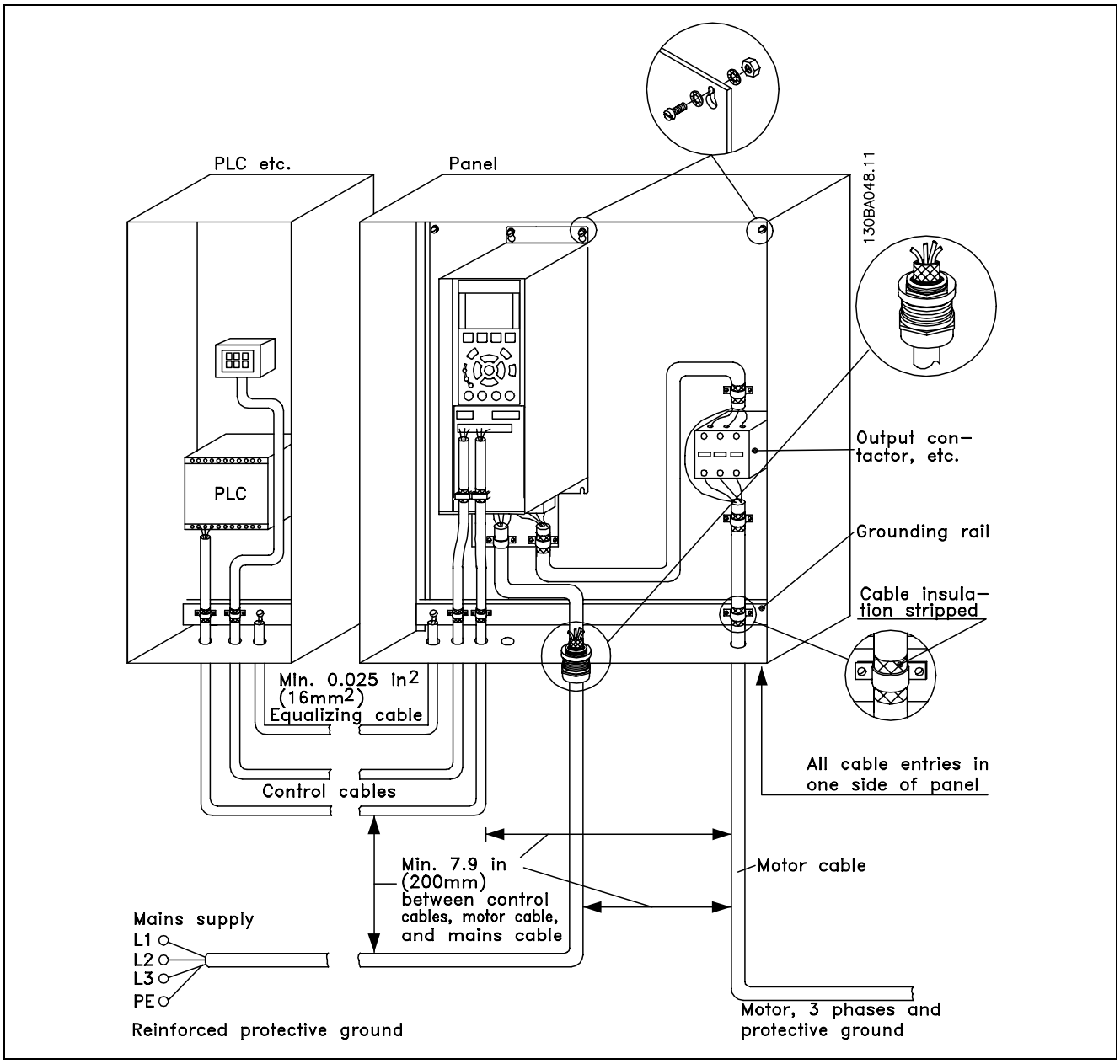
Good engineering practice to ensure EMC-correct electrical installation:

- Use only braided shielded/armored motor cables and braided shielded/armored control cables. The shield should provide a minimum coverage of 80%. The shield material must be metal, not limited to but typically copper, aluminum, steel or lead. There are no special requirements for the mains cable.
- Installations using rigid metal conduits are not required to use shielded cable, but the motor cable must be installed in conduit separate from the control and mains cables. Full connection of the conduit from the drive to the motor is required. The EMC performance of flexible conduits varies considerably and information from the manufacturer must be obtained.
- Connect the shield/armor/conduit to ground at both ends for motor cables as well as for control cables. In some cases, it is not possible to connect the shield in both ends. If so, connect the shield at the adjustable frequency drive. See also *Grounding of Braided Shielded/Armored Control Cables*.
- Avoid terminating the shield/armor with twisted ends (pigtails). It increases the high frequency impedance of the shield, which reduces its effectiveness at high frequencies. Use low-impedance cable clamps or EMC cable glands instead.
- Avoid using non-shielded/unarmored motor or control cables inside cabinets housing the drive(s), whenever this can be avoided.

Leave the shield as close to the connectors as possible.

The illustration shows an example of an EMC-correct electrical installation of an IP 20 adjustable frequency drive. The adjustable frequency drive is fitted in an installation cabinet with an output contactor and connected to a PLC, which is installed in a separate cabinet. Other ways of performing the installation may yield just as good EMC performance, provided the above guidelines for engineering practice are followed.

If the installation is not carried out according to the guidelines and if non-shielded cables and control wires are used, some emission requirements are not complied with, although the immunity requirements are fulfilled. See the paragraph *EMC test results*.



EMC-correct electrical installation of an IP20 adjustable frequency drive.

□ **Use of EMC-Correct Cables**

Danfoss recommends braided shielded/armored cables to optimize EMC immunity of the control cables and the EMC emission from the motor cables.

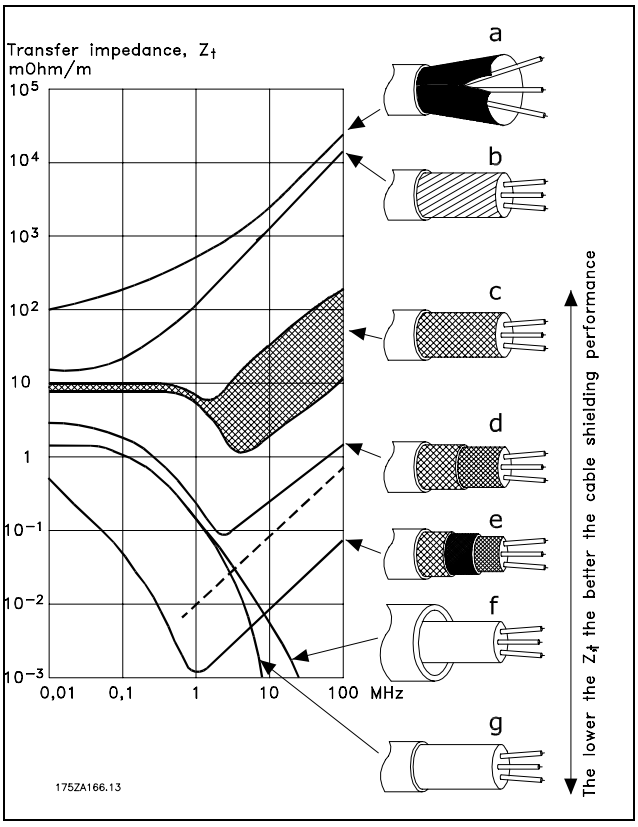
The ability of a cable to reduce the incoming and outgoing radiation of electric noise depends on the transfer impedance (Z_T). The shield of a cable is normally designed to reduce the transfer of electric noise; however, a shield with a lower transfer impedance (Z_T) value is more effective than a shield with a higher transfer impedance (Z_T).

Transfer impedance (Z_T) is rarely stated by cable manufacturers but it is often possible to estimate transfer impedance (Z_T) by assessing the physical design of the cable.

Transfer impedance (Z_T) can be assessed on the basis of the following factors:

- The conductibility of the shield material.
- The contact resistance between the individual shield conductors.
- The shield coverage, i.e. the physical area of the cable covered by the shield - often stated as a percentage value.
- Shield type, i.e. braided or twisted pattern.

a. Aluminum-clad with copper wire.
b. Twisted copper wire or armored steel wire cable.
c. Single-layer braided copper wire with varying percentage shield coverage.
   This is the typical Danfoss reference cable.
d. Double-layer braided copper wire.
e. Twin layer of braided copper wire with a magnetic, shielded/armored intermediate layer.
f. Cable that runs in copper tube or steel tube.
g. Lead cable with 0.043 in. (1.1 mm) wall thickness.



□ Grounding of Shielded/Armored Control Cables

Generally speaking, control cables must be braided shielded/armored and the shield must be connected by means of a cable clamp at both ends to the metal cabinet of the unit.

The drawing below indicates how correct grounding is carried out and what to do if in doubt.

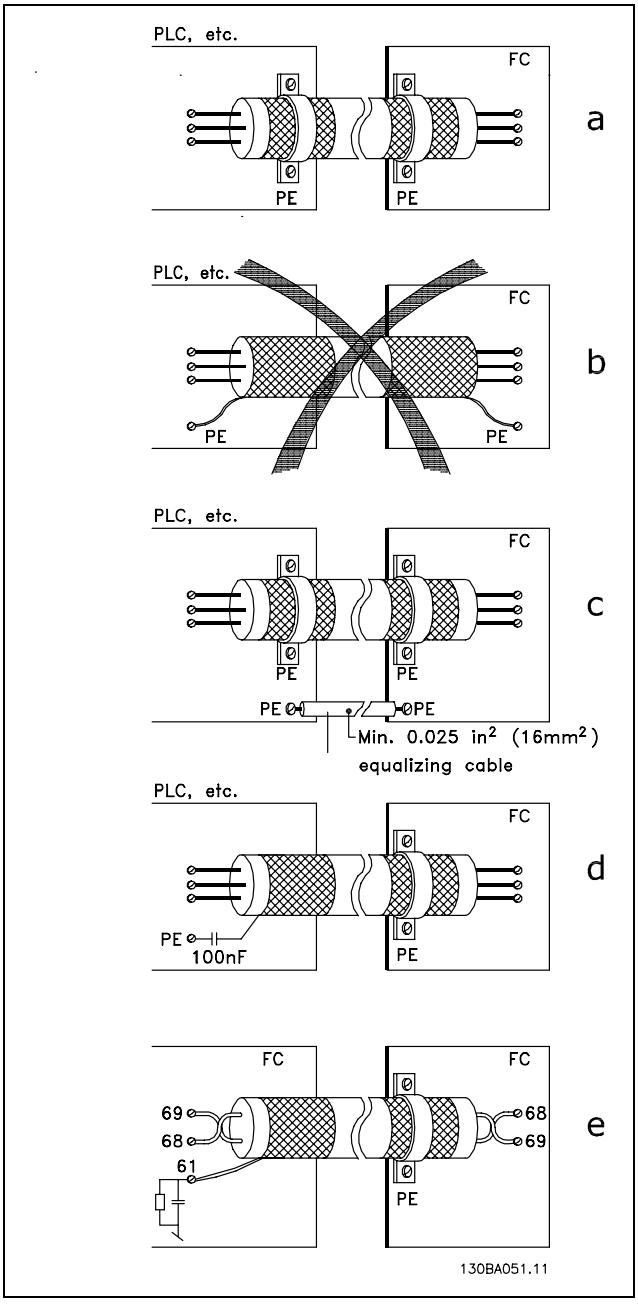
a. **Correct grounding**
Control cables and cables for serial communication must be fitted with cable clamps at both ends to ensure the best possible electrical contact.

b. **Wrong grounding**
Do not use twisted cable ends (pigtails). They increase the shield impedance at high frequencies.

c. **Protection with respect to ground potential between PLC and VLT**
If the ground potential between the adjustable frequency drive and the PLC (etc.) is different, electric noise may occur that will disturb the entire system. Solve this problem by fitting an equalizing cable, next to the control cable. Minimum cable cross-section: 0.025 in. ^{2} (16 mm ^{2}).

d. **For 50/60 Hz ground loops**
If very long control cables are used, 50/60 Hz ground loops may occur. Solve this problem by connecting one end of the shield to ground via a 100nF capacitor (keeping leads short).

e. **Cables for serial communication**
Eliminate low-frequency noise currents between two adjustable frequency drives by connecting one end of the shield to terminal 61. This terminal is connected to ground via an internal RC link. Use twisted-pair cables to reduce the differential mode interference between the conductors.

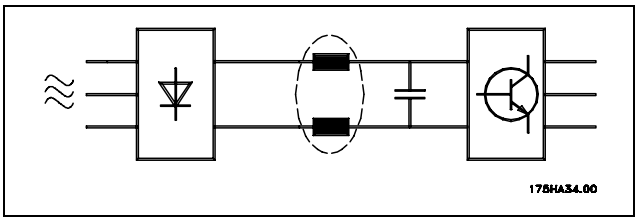


□ **Mains Supply Interference/Harmonics**

An adjustable frequency drive takes up a non-sinusoidal current from mains, which increases the input current I_{RMS}. A non-sinusoidal current is transformed by means of a Fourier analysis and split up into sine wave currents with different frequencies, i.e. different harmonic currents I_N with 50 Hz as the basic frequency:

Harmonic currents	I_1	I_5	I_7
Hz	50 Hz	250 Hz	350 Hz

The harmonics do not affect the power consumption directly but increase the heat losses in the installation (transformer, cables). Consequently, in plants with a high percentage of rectifier load, maintain harmonic currents at a low level to avoid overload of the transformer and high temperature in the cables.



NOTE

Some of the harmonic currents might disturb communication equipment connected to the same transformer or cause resonance in connection with power-factor correction batteries.

Harmonic currents compared to the RMS input current:

	Input current
I_{RMS}	1.0
I_1	0.9
I_5	0.4
I_7	0.2
I_{11-49}	< 0.1

To ensure low harmonic currents, the adjustable frequency drive is equipped with intermediate circuit coils as standard. This normally reduces the input current I_{RMS} by 40%.

The voltage distortion on the mains supply depends on the size of the harmonic currents multiplied by the mains impedance for the frequency in question. The total voltage distortion THD is calculated on the basis of the individual voltage harmonics using this formula:

$$THD\% = \sqrt{U_5^2 + U_7^2 + \ldots + U_N^2} \quad \left(U_N \% of\ U\right)$$

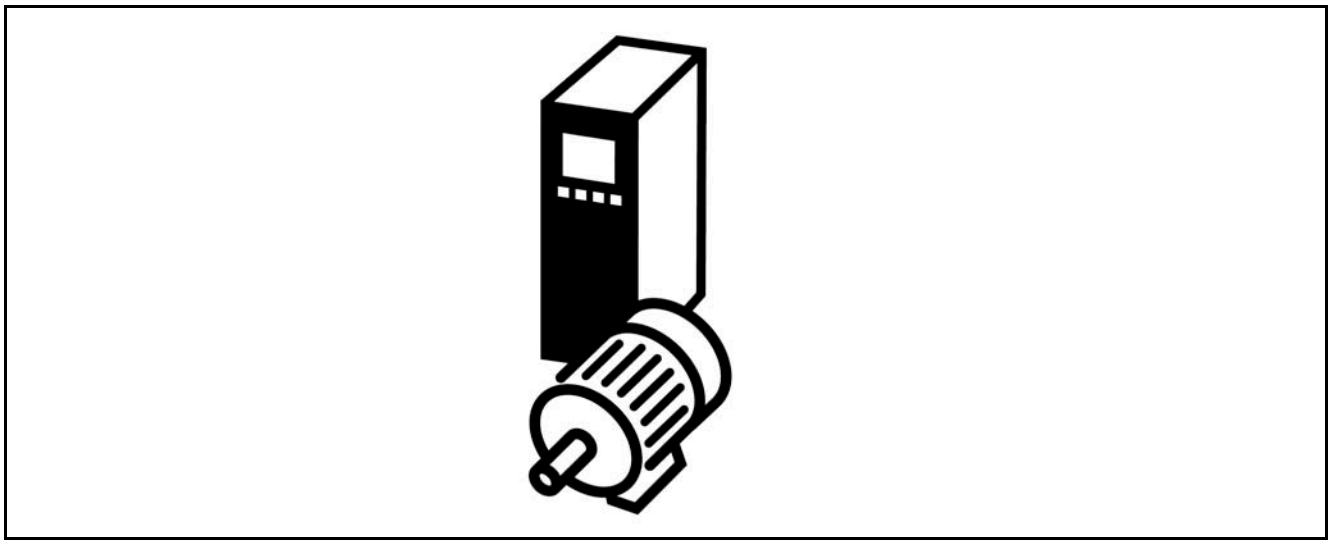
□ **Residual Current Device**

You can use RCD relays, multiple protective grounding or grounding as extra protection, provided that local safety regulations are complied with.

If a ground fault appears, a DC content may develop in the faulty current.

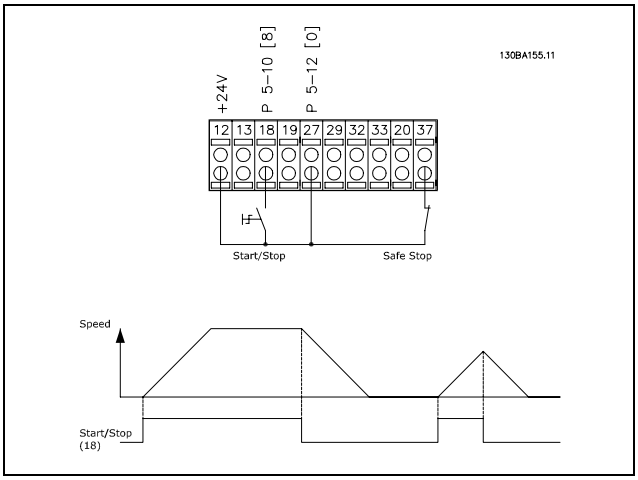
If RCD relays are used, you must observe local regulations. Relays must be suitable for protection of 3-phase equipment with a bridge rectifier and for a brief discharge on power-up; see section *Ground Leakage Current* for further information.

Application Examples



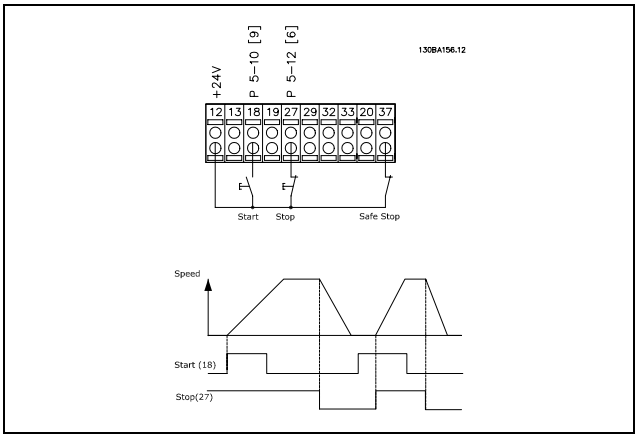
□ **Start/Stop**
Terminal 18 = start/stop par. 5-10 [8] *Start*
Terminal 27 = No operation par. 5-12 [0] *No operation* (Default *coast inverse*
Terminal 37 = Safe stop (FC 302 only)

Par. 5-10 *Digital Input* = *Start* (default)
Par. 5-12 *Digital Input* = *coast inverse* (default)



□ **Pulse start/stop**
Terminal 18 = start stop/ par. 5-10 [9] *Latched start*
Terminal 27= Stop par. 5-12 [6] *Stop inverse*
Terminal 37 = Safe stop (FC 302 only)

Par. 5 *Digital input* = *Latched start*
Par. 5 *Digital input* = *Stop inverse*

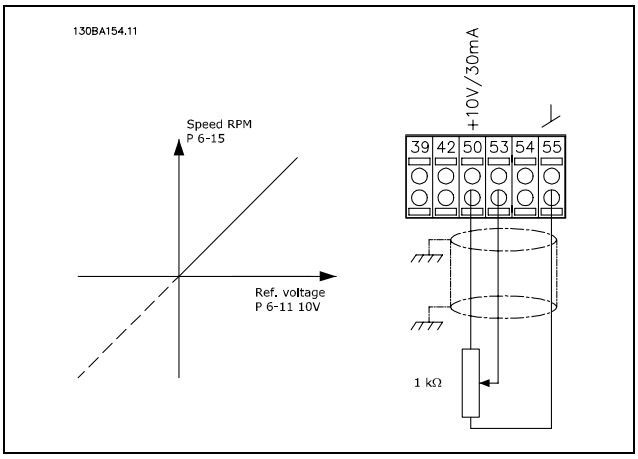


Application Examples

□ Potentiometer Reference

Voltage reference via a potentiometer.

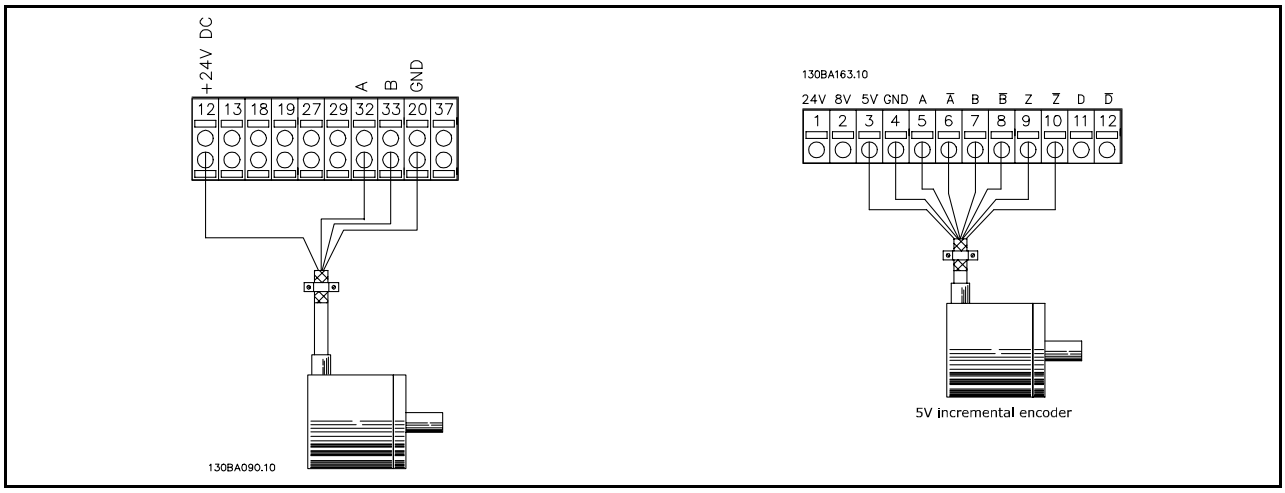
Par. 3-15 *Reference Resource 1* [1]
= Analog Input 53
Par. 6-10 *Terminal 53, Low Voltage* = 0 Volt
Par. 6-11 *Terminal 53, High Voltage* = 10 Volt
Par. 6-14 *Terminal 53, Low Ref./Feedb. Value Value* = 0 RPM
Par. 6-15 *Terminal 53, High Ref./Feedb. Value Value* = 1,500 RPM
Switch S201 = OFF (U)



□ Encoder Connection

The purpose of this guideline is to ease the set-up of encoder connection to the FC 302. Before setting up the encoder, the basic settings for a closed-loop speed control system will be shown.

Encoder Connection to FC 302



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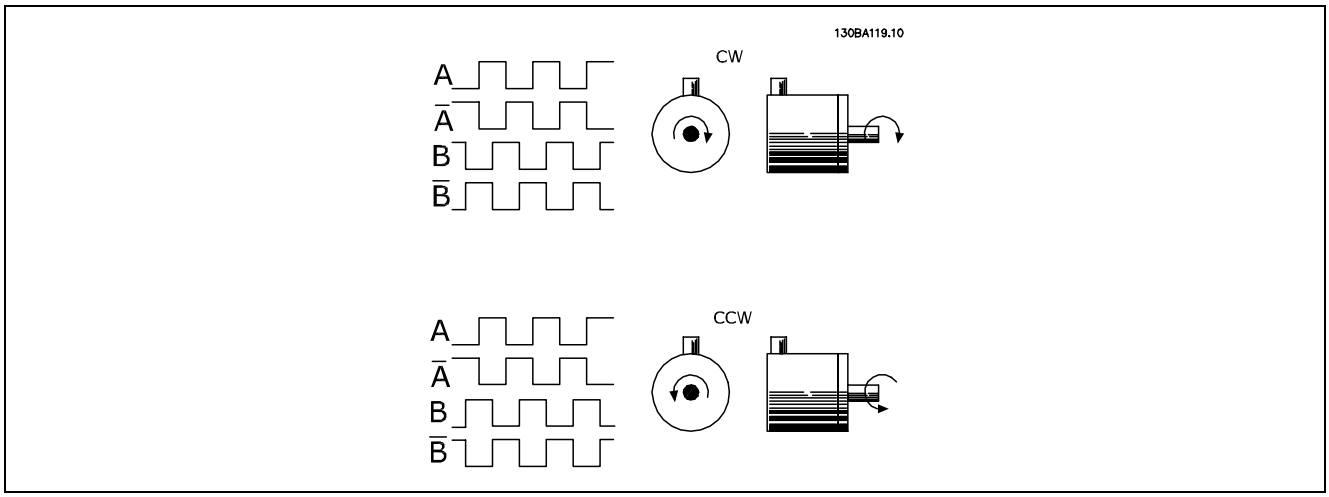
Application Examples

□ Encoder Direction

The direction of encoder is determined by which order the pulses are entering the drive.
A Clockwise direction means channel A is 90 electrical degrees before channel B.
A Counter Clockwise direction means channel B is 90 electrical degrees before A.
The direction is determined by looking into the shaft end.

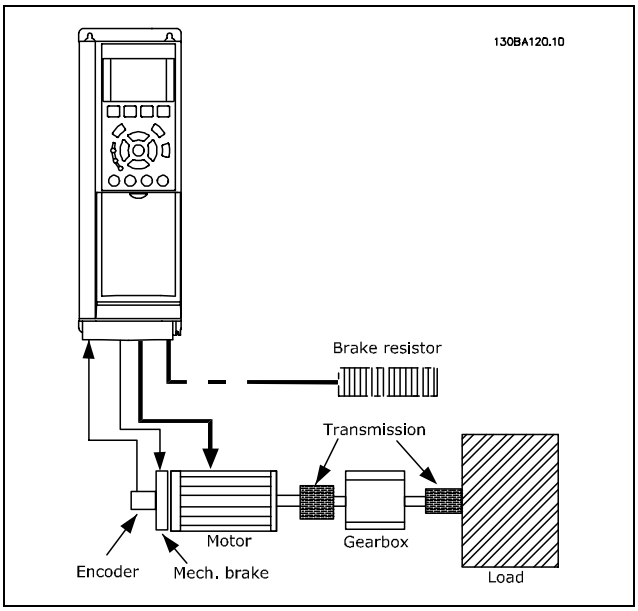


Application Examples

□ Closed Loop Drive System

A drive system consist usually of more elements as:

- Motor
- Add
  (Gearbox)
  (Mechanical Brake)
- FC 302 AutomationDrive
- Encoder as feedback system
- Brake resistor for dynamic braking
- Transmission
- Load



Basic Set-up for FC 302 Closed Loop Speed Control

Applications demanding mechanical brake control will usually need a brake resistor.

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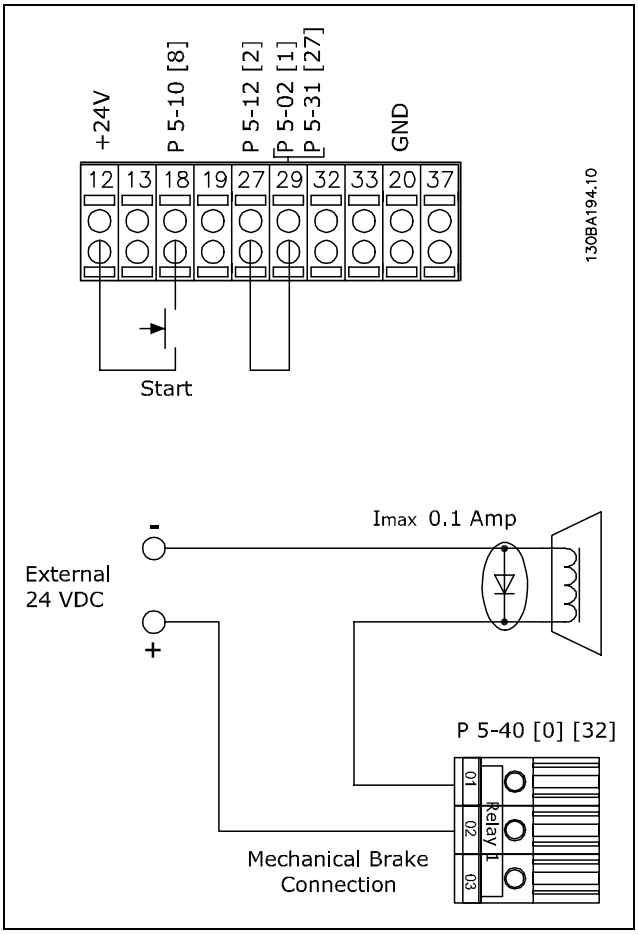
Application Examples

□ Programming of Torque Limit and Stop

In applications with an external electromechanical brake, such as hoisting applications, it is possible to stop the adjustable frequency drive via a "standard" stop command and simultaneously activate the external electromechanical brake.
The example given below illustrates the programming of adjustable frequency drive connections.
The external brake can be connected to relay 1 or 2, see paragraph *Control of Mechanical Brake*.
Program terminal 27 to Coast inverse [2] or Coast and reset inv. [3], and program terminal 29 to Terminal mode 29 Output [1] and Torque limit stop [27].

Description:
If a stop command is active via terminal 18 and the adjustable frequency drive is not at the torque limit, the motor ramps down to 0 Hz.
If the adjustable frequency drive is at the torque limit and a stop command is activated, terminal 29 Output (programmed to Torque limit stop [27]) is activated. The signal to terminal 27 l changes from "logic 1" to "logic 0", and the motor starts to coast, thereby ensuring that the hoist stops even if the adjustable frequency drive itself cannot handle the required torque (i.e. due to excessive overload).

- Start/stop via terminal 18
  Par. 5-10 Start [8]
- Quickstop via terminal 27
  Par. 5-12 Coast inverse [2]
- Terminal 29 Output
  Par. 5-02 Terminal 29 Mode Output [1]
  Par. 5-31 Torque limit stop [27]
- Relay output [0] (Relay 1)
  Par. 5-40 Mech. Brake Control [32]



Application Examples

□ Automatic Motor Adaptation (AMA)

AMA is an algorithm to measure the electrical motor parameters on a motor at standstill. This means that AMA itself does not supply any torque.
AMA is useful when commissioning systems and optimizing the adjustment of the adjustable frequency drive to the applied motor. This feature is particularly used where the default setting does not apply to the connected motor.
Par. 1-29 allows a choice of complete AMA with determination of all electrical motor parameters or reduced AMA with determination of the stator resistance Rs only.
The duration of a total AMA varies from a few minutes on small motors to more than 15 minutes on large motors.

Limitations and preconditions:

- For the AMA to determine the motor parameters optimally, enter the correct motor nameplate data in par. 1-20 to 1-26.
- For the best adjustment of the adjustable frequency drive, carry out an AMA on a cold motor. Repeated AMA runs may lead to a heating of the motor, which results in an increase of the stator resistance, Rs. Normally, this is not critical.
- An AMA can only be carried out if the rated motor current is minimum 35% of the rated output current of the adjustable frequency drive. An AMA can be carried out on up to one oversize motor.
- It is possible to carry out a reduced AMA test with an LC filter installed. Avoid carrying out a complete AMA with an LC filter. If an overall setting is required, remove the LC filter while running a total AMA. After completion of the AMA, reinsert the LC filter.
- If motors are coupled in parallel, use only a reduced AMA if any.
- Avoid running a complete AMA when using synchronous motors. If synchronous motors are applied, run a reduced AMA and manually set the extended motor data. The AMA function does not apply to permanent magnet motors.
- The adjustable frequency drive does not produce motor torque during an AMA. During an AMA, it is imperative that the application does not force the motor shaft to run, which is known to happen, e.g., with windmilling in ventilation systems. This disturbs the AMA function.

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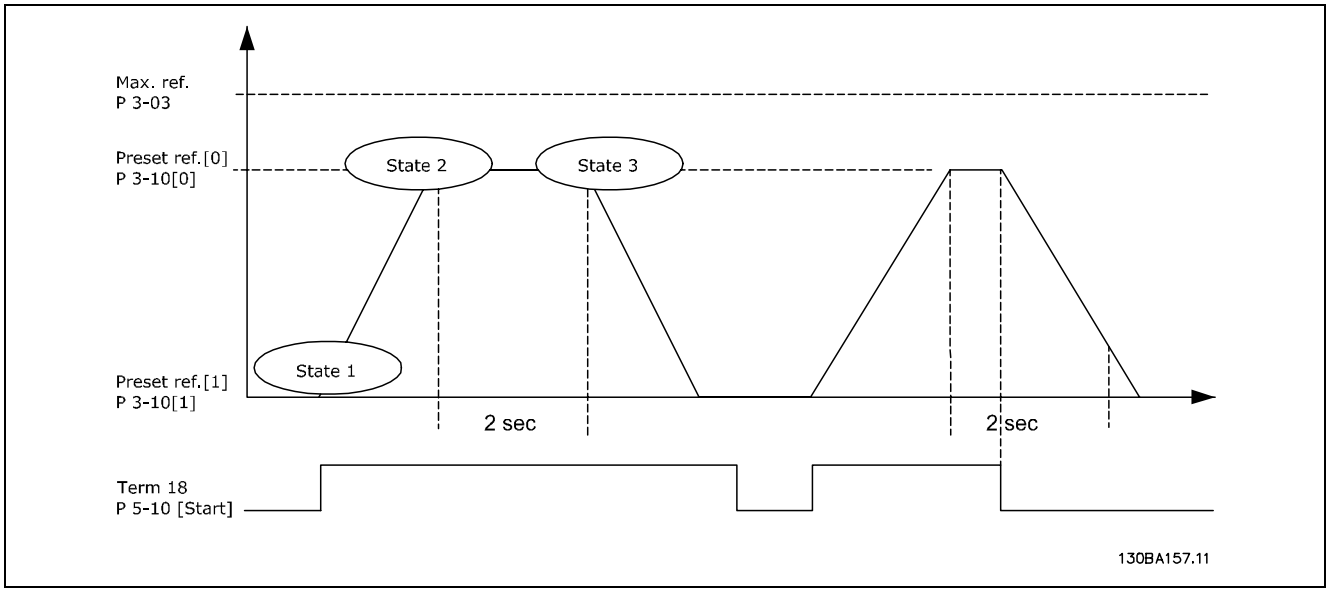
Application Examples

□ Smart Logic Control Programming

A new useful feature in the FC 302 is the Smart Logic Control (SLC).
In applications where a PLC generates a simple sequence, the SLC may take over elementary tasks from the main control.
SLC is designed to act from event sent to or generated in the FC 302. The adjustable frequency drive will then perform the pre-programmed action.

□ SLC Application Example

One sequence 1:
Start – ramp-up – run at reference speed 2 sec – ramp-down and hold shaft until stop.



Set the ramping times in par. 3-41 and 3-42 to the desired times.

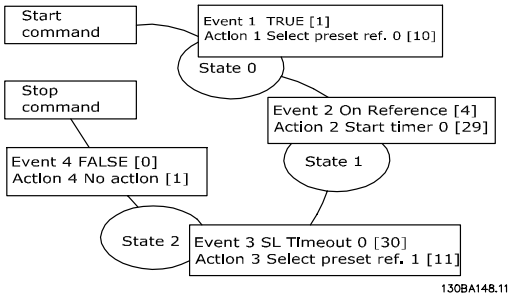
$$t_{ramp} = \frac{t_{acc} * n_{norm}[par.1-25]}{\▵ref[RPM]}$$

Set term 27 to *No Operation* (par. 5-12)
Set Preset reference 0 to first preset speed (par. 3-10 [0]) in percentage of Max Reference speed (par. 3-03). Ex.: 60%
Set preset reference 1 to second preset speed (par. 3-10 [1]) Ex.: 0% (zero).
Set the timer 0 for constant running speed in par. 13-20 [0]. Ex.: 2 sec.

Set Event 1 in par. 13-51 [1] to *True* [1]
Set Event 2 in par. 13-51 [2] to *On Reference* [4]
Set Event 3 in par. 13-51 [3] to *Timeout 0* [30]
Set Event 4 in par. 13-51 [1] to *False* [0]

Set Action 1 in par. 13-52 [1] to *Select preset 0* [10]
Set Action 2 in par. 13-52 [2] to *Start Timer 0* [29]
Set Action 3 in par. 13-52 [3] to *Select preset 1* [11]
Set Action 4 in par. 13-52 [4] to *No Action* [1]

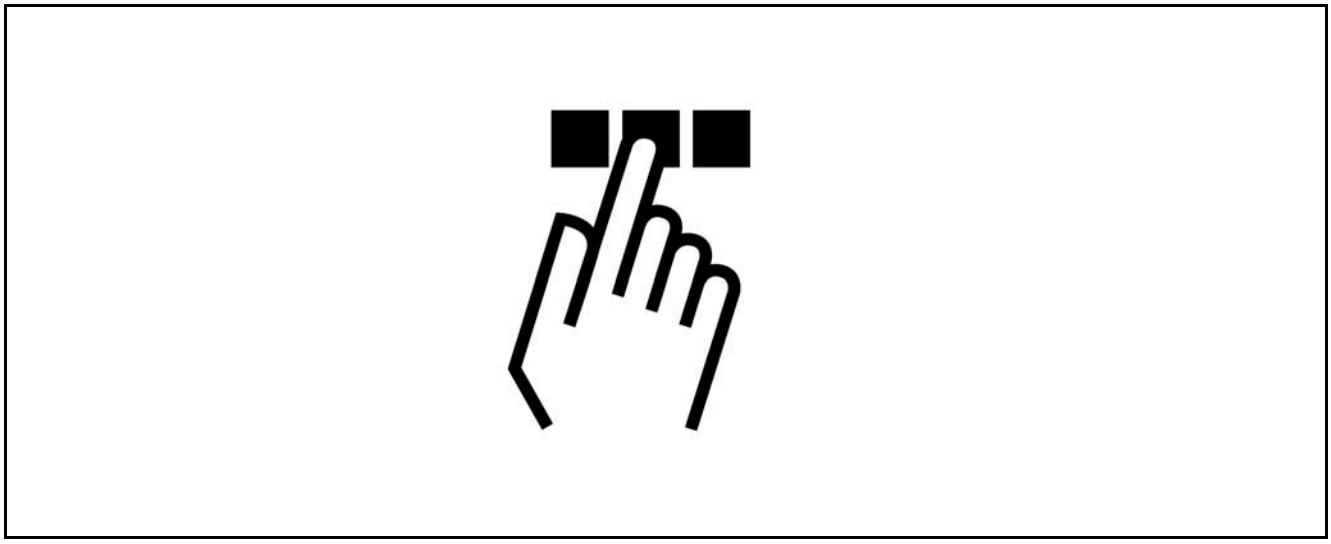
Application Examples



Set the Smart Logic Control in par. 13-00 to ON.

Start / stop command is applied on terminal 18. If stop signal is applied, the adjustable frequency drive will ramp down and go into free mode.

How to Program



The Graphical and Numerical FC 300 Local

How to Program on the Graphical Local Control Panel

The following instructions are valid for the graphical LCP (LCP 102):

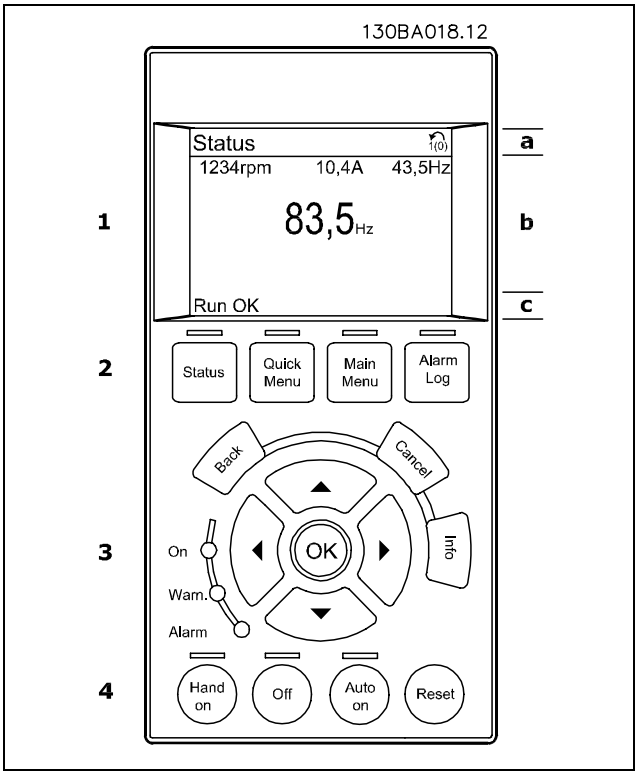
The control panel is divided into four functional groups:

1. Graphical display with Status lines.
2. Menu keys and LEDs - changing parameters and switching between display functions.
3. Navigation keys and LEDs.
4. Operation keys and LEDs.

All data is displayed in a graphical LCP display, which can show up to five items of operating data while displaying [Status].

Display lines:

a. **Status line:** Status messages displaying icons and graphic.
b. **Line 1-2:** Operator data lines displaying data defined or chosen by the user. By pressing the [Status] key, up to one extra line can be added.
c. **Status line:** Status messages displaying text.



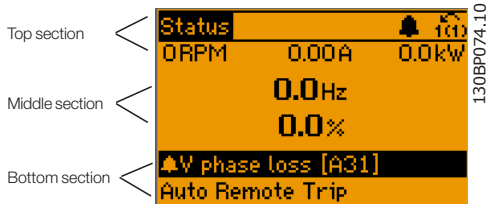
How to Program

The LCD display has back lighting and a total of 6 alpha-numeric lines. The display lines show the direction of rotation (arrow), the chosen Set-up as well as the programming Set-up. The display is divided into 3 sections:

Top section shows up to 2 measurements in normal operating status.

The top line in the **Middle section** shows up to 5 measurements with related units, regardless of status (except in the case of alarm/warning).

Bottom section always shows the state of the adjustable frequency drive in Status mode.



The Active Set-up (selected as the Active Set-up in par. 0-10) is shown. When programming another Set-up other than the Active Set-up, the number of the programmed Set-up appears to the right.

Display Contrast Adjustment

Press [status] and [▲] for darker display
Press [status] and [▼] for brighter display

Most FC 300 parameter set-ups can be changed immediately via the control panel, unless a password has been created via par. 0-60 *Main Menu Password* or via par. 0-65 *Quick Menu Password*.

LEDs:

If certain threshold values are exceeded, the alarm and/or warning LED light(s) up. A status and alarm text appear on the control panel.
The on LED is activated when the adjustable frequency drive receives line voltage or via a DC bus terminal or 24 V external supply. At the same time, the back light is on.

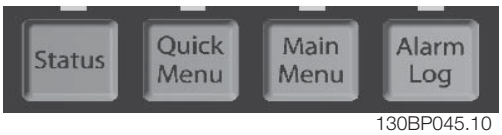
- Green LED/On: Control section is working.
- Yellow LED/Warn.: Indicates a warning.
- Flashing Red LED/Alarm: Indicates an alarm.

130BP040.10

How to Program

LCP keys

The control keys are divided into functions. The keys below the display and LEDS are used for parameter Set-up, including choice of display indication during normal operation.



[Status] indicates the status of the adjustable frequency drive and/or the motor. You can choose between 3 different readouts by pressing the [Status] key:
5 line readouts, 4 line readouts or Smart Logic Control.
Use **[Status]** for selecting the mode of display or for changing back to Display mode from either the Quick Menu mode, the Main Menu mode or Alarm mode. Also use the [Status] key to toggle single or double readout mode.

[Quick Menus] allows quick access to different Quick Menus such as:

- My personal menu
- Quick setup
- Changes made
- Loggings

Use **[Quick Menus]** for programming the parameters belonging to the Quick Menu. It is possible to switch directly between Quick Menu mode and Main Menu mode.

[Main Menu] is used for programming all parameters.
It is possible to switch directly between Main Menu mode and Quick Menu mode.
Parameter shortcut can be carried out by pressing down the **[Main Menu]** key for 3 seconds.
The parameter shortcut allows direct access to any parameter.

[Alarm log] displays an Alarm list of the five latest alarms (numbered A1-A5). To obtain additional details about an alarm, use the arrow keys to maneuver to the alarm number and press [OK]. You will now receive information about the condition of your adjustable frequency drive right before entering the alarm mode.

[Back] takes you to the previous step or layer in the navigation structure.

[Cancel] annuls your last change or command as long as the display has not been changed.

[Info] supplies information about a command, parameter, or function in any display window. [Info] provides detailed information whenever help is needed.
Exit info mode by pressing either [Info], [Back], or [Cancel].

Navigation Keys
The four navigation arrows are used to navigate between the different choices available in **[Quick Menus]**, **[Main Menu]** and **[Alarm log]**. Use the keys to move the cursor.

[OK] is used for choosing a parameter marked by the cursor and for enabling the change of a parameter.

Local Control Keys for local control are found at the bottom of the control panel.

[Hand on] enables control of the adjustable frequency drive via the LCP. [Hand on] also starts the motor, and it is now possible to enter the motor speed data by means of the arrow keys. The key can be selected as Enabled [1] or Disabled [0] via par. *0-40 [Hand on] key on LCP.*
External stop signals activated by means of control signals or a serial bus will override a "start" command via the LCP.
The following control signals will still be active when [Hand on] is activated:

- [Hand on] - [Off] - [Auto on]
- Reset
- Coasting stop inverse
- Reverse
- Set-up select lsb - Set-up select msb
- Stop command from serial communication
- Quick stop
- DC brake

[Off] stops the connected motor. The key can be selected as Enabled [1] or Disabled [0] via par. *0-41 [Off] key on LCP.* If no external stop function is selected and the [Off] key is inactive, the motor can be stopped by disconnecting the voltage.

[Auto on] enables the adjustable frequency drive to be controlled via the control terminals and/or serial communication. When a start signal is applied on the control terminals and/or the bus, the adjustable frequency drive will start. The key can be selected as Enabled [1] or Disabled [0] via par. *0-42 [Auto on] key on LCP.*

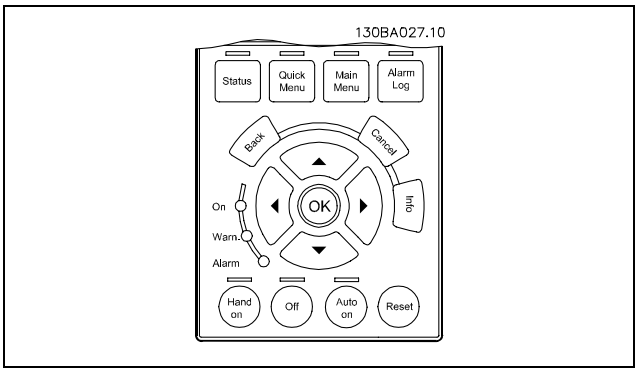
NOTE
An active HAND-OFF-AUTO signal via the digital inputs has higher priority than the control keys [Hand on] - [Auto on].

[Reset] is used for resetting the adjustable frequency drive after an alarm (trip). It can be selected as *Enabled* [1] or *Disabled* [0] via par. 0-43 *Reset Keys on LCP*.

The parameter shortcut can be carried out by holding down the [Main Menu] key for 3 seconds. The parameter shortcut allows direct access to any parameter.

□ Quick Transfer of Parameter Settings

Once the set-up of a drive is complete, we recommend that you store the data in the LCP or on a PC via the MCT 10 Set-up Software Tool.



Data storage in LCP:

1. Go to par. 0-50 *LCP Copy*
2. Press the [OK] key.
3. Select "All to LCP"
4. Press the [OK] key.

All the parameter settings are now being stored in the LCP as indicated by the progress bar. When 100% is reached, press [OK].

NOTE
Stop the motor before performing this operation.

You can now connect the LCP to another adjustable frequency drive and copy the parameter settings to this adjustable frequency drive as well.

Data transfer from LCP to drive:

1. Go to par. 0-50 *LCP Copy*
2. Press the [OK] key.
3. Select "All from LCP"
4. Press the [OK] key.

The parameter settings stored in the LCP are now transferred to the drive indicated by the progress bar. When 100% is reached, press [OK].

NOTE
Stop the motor before performing this operation.

Display Mode

In normal operation, up to 5 different operating variables can be indicated continuously in the middle section: 1.1, 1.2, and 1.3 as well as 2 and 3.

Display Mode - Selection of Read-Outs

You can toggle between three status readout screens by pressing the [Status] key.
Operating variables with different formatting are shown in each status screen - see below.

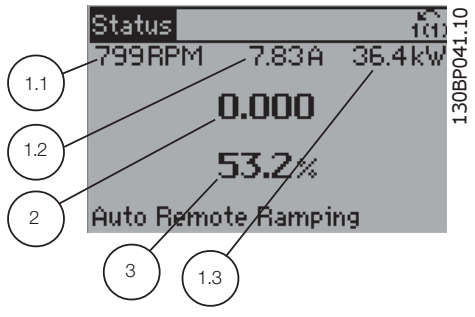
The table shows the measurements you can link to each of the operating variables. Define the links via par. 0-20, 0-21, 0-22, 0-23, and 0-24.

Each readout parameter selected in par. 0-20 to par. 0-24 has its own scale and digits after a possible decimal point. By larger numeric value of a parameter fewer digits are displayed after the decimal point.
Ex.: Current readout
5.25 A; 15.2 A 105 A.

Operating variable:	Unit:
Par. 16-00 Control Word	hex
Par. 16-01 Reference	[unit]
Par. 16-02 Reference	%
Par. 16-03 Status word	hex
Par. 16-04 Alarm word	hex
Par. 16-05 Warning word	hex
Par. 16-06 Extended status wordhex	[%]
Par. 16-10 Power	[kW]
Par. 16-11 Power	[HP]
Par. 16-12 Motor voltage	[V]
Par. 16-13 Frequency	[Hz]
Par. 16-14 Motor current	[A]
Par. 16-16 Torque	Nm
Par. 16-17 Speed	[RPM]
Par. 16-18 Motor thermal	%
Par. 16-20 Phase angle	
Par. 16-30 DC link voltage	V
Par. 16-32 Brake energy / s	kW
Par. 16-33 Brake energy / 2 min	kW
Par. 16-34 Heatsink temp.	C
Par. 16-35 Inverter thermal	%
Par. 16-36 InomVLT	A
Par. 16-37 ImaxVLT	A
Par. 16-38 SL controller state	
Par. 16-39 Control card temp.	C
Par. 16-50 External reference	
Par. 16-51 Pulse reference	
Par. 16-52 Feedback	[Unit]
Par. 16-60 Digital input	bin
Par. 16-61 Terminal 53 switch setting	V
Par. 16-62 Analog input 53	
Par. 16-63 Terminal 54 switch setting	V
Par. 16-64 Analog input 54	
Par. 16-65 Analog output 42	[mA]
Par. 16-66 Digital output	[bin]
Par. 16-67 Freq. input #29	[Hz]
Par. 16-68 Freq. input #33	[Hz]
Par. 16-69 Pulse output #27	[Hz]
Par. 16-70 Pulse output #29	[Hz]
Par. 16-80 Fieldbus CTW	hex
Par. 16-82 Fieldbus REF	hex
Par. 16-83 Fieldbus MAV	hex
Par. 16-84 Comm. option STW	hex
Par. 16-85 FC port CTW 1	hex
Par. 16-86 FC port REF 1	hex

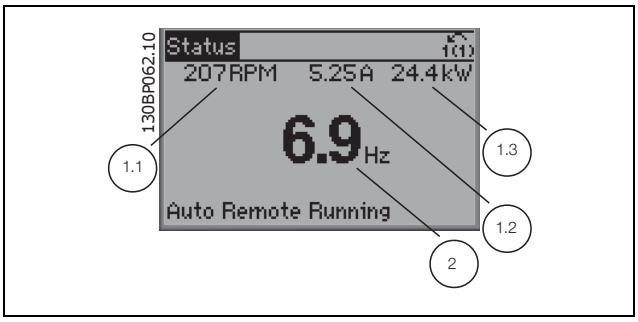
Status screen I:

This readout state is standard after start-up or initialization.
Use [INFO] to obtain information about the measurement links to the displayed operating variables /1.1, 1.2, 1.3, 2, and 3).
See the operating variables shown in the screen in this illustration.

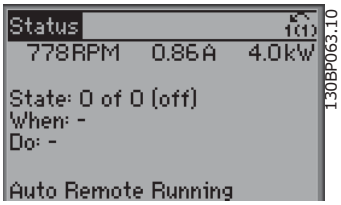


How to Program

Status screen II:
See the operating variables (1.1, 1.2, 1.3, and 2) shown in the screen in this illustration.
In the example, Speed, Motor current, Motor power and Frequency are selected as variables in the first and second.

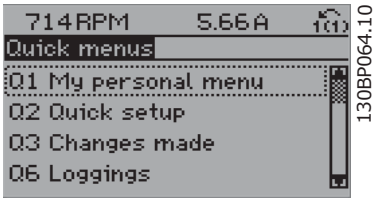


Status screen III:
This state displays the event and action of the Smart Logic Controller. For further information, see section *Smart Logic Controller*.



□ **Parameter Set-Up**
The FC 300 Series can be used for practically all assignments, which is why the number of parameters is quite large. The series offers a choice between two programming modes - a Main Menu and a Quick Menu mode. The former provides access to all parameters. The latter takes the user through a few parameters making it possible to start operating the adjustable frequency drive.
Regardless of the mode of programming, you can change a parameter both in the Main Menu mode and in the Quick Menu mode.

□ **Quick Menu Key Functions**
Pressing [Quick Menus] The list indicates the different areas contained in the Quick menu. Select *My personal menu* to display the chosen personal parameters. These parameters are selected in par. 0-25 *My Personal Menu*. Up to 20 different parameters can be added in this menu.



Select *Quick setup* to go through a limited number of parameters to get the motor running almost optimally. The default setting for the other parameters considers the desired control functions and the configuration of signal inputs/outputs (control terminals).

Parameters are selected by using the arrow keys. The parameters in the following table are accessible.

Parameter	Designation	Setting
0-01	Language	
1-20	Motor Power	[kW]
1-22	Motor Voltage	[V]
1-23	Motor Frequency	[Hz]
1-24	Motor Current	[A]
1-25	Motor Nominal Speed	[rpm]
5-12	Terminal 27 Digital Input	[0] No function*
3-02	Minimum Reference	[rpm]
3-03	Maximum Reference	[rpm]
3-41	Ramp 1 Ramp-up Time	[sec]
3-42	Ramp 1 Ramp-down Time	[sec]
3-13	Reference Site	
1-29	Automatic Motor Adaptation (AMA)	[1] Enable complete AMA

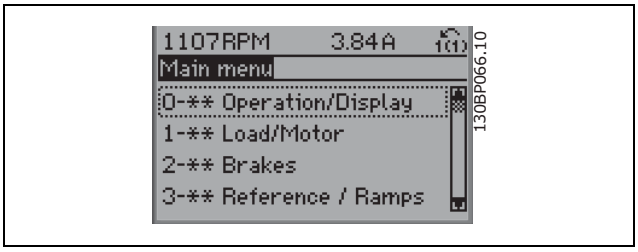
* If no connection in terminal 27 is selected, no connection to +24 V on terminal 27 necessary.

Select *Changes made* to get information about:

- the last 10 changes. Use the up/down navigation keys to scroll between the last 10 changed parameters.
- the changes made since default setting.

Select *Loggings* to get information about the display line readouts. The information is shown as graphs. Only display parameters selected in par. 0-20 and par. 0-24 can be viewed. It is possible to store up to 120 samples in the memory for later reference.

□ **Main Menu Mode**
Start the Main Menu mode by pressing the [Main Menu] key. The readout shown to the right appears on the display.
The middle and bottom sections on the display show a list of parameter groups which can be chosen by toggling the up and down buttons.



Each parameter has a name and number which remain the same regardless of the programming mode. In the Main Menu mode, the parameters are divided into groups. The first digit of the parameter number (from the left) indicates the parameter group number.

All parameters can be changed in the Main Menu. However, depending on the choice of configuration (par. 1-00), some parameters canl be "missing". E.g. open loop hides all the P.I.D. parameters, and other enabled options make more parameter groups visible.

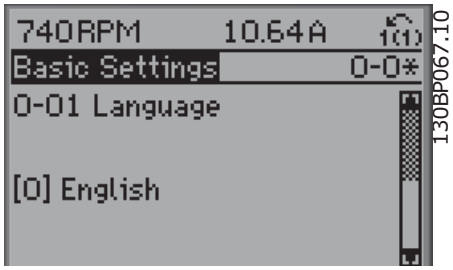
How to Program

Parameter Selection

In Main Menu mode, the parameters are divided into groups. You select a parameter group using the navigation keys.
The following parameter groups are accessible:

Group no.	Parameter group:
0	Operation/Display
1	Load/Motor
2	Brakes
3	References/Ramps
4	Limits/Warnings
5	Digital In/Out
6	Analog In/Out
7	Controls
8	Comm. and Options
9	Profibus
10	CAN ser. com. bus
11	Reserved Com. 1
12	Reserved Com. 2
13	Smart Logic
14	Special Functions
15	Drive Information
16	Data Readouts
17	Motor Feedb. Option

After selecting a parameter group, choose a parameter using the navigation keys.
The middle section on the display shows the parameter number and name as well as the selected parameter value.

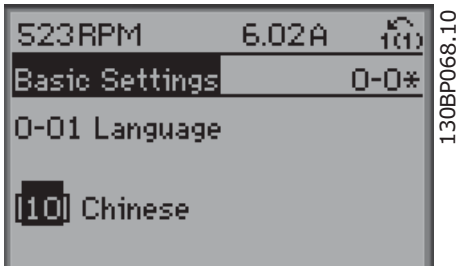


Changing Data

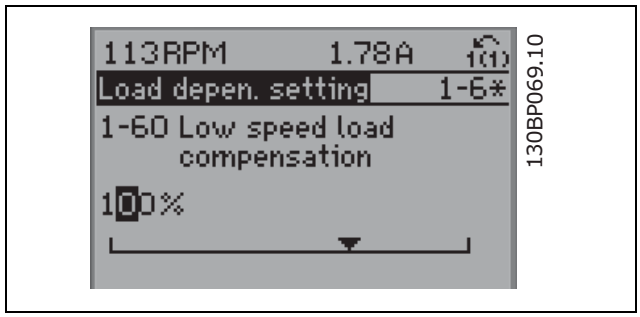
The procedure for changing data is the same whether you select a parameter in the Quick menu or the Main menu mode. Press [OK] to change the selected parameter.
The procedure for changing data depends on whether the selected parameter represents a numerical data value or a text value.

Changing a Text Value

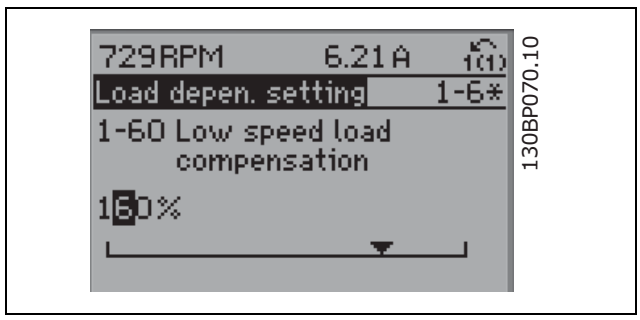
If the selected parameter is a text value, change the text value by means of the up/down navigation keys. The up key increases the value, and the down key decreases the value. Place the cursor on the value you want to save and press [OK].



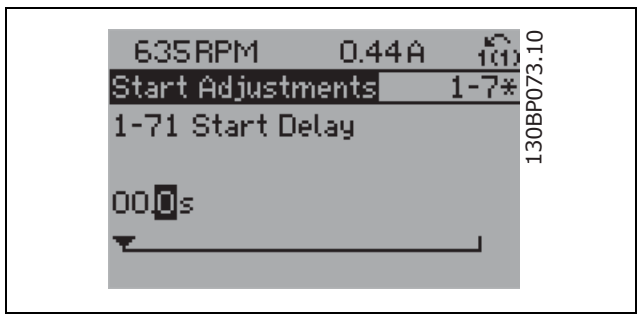
□ **Changing a Group of Numeric Data Values**
If the chosen parameter represents a numeric data value, change the chosen data value by means of the <> navigation keys as well as the up/down navigation keys. Use the <> navigation keys to move the cursor horizontally.



Use the up/down navigation keys to change the data value. The up key increases the data value, and the down key decreases the data value. Place the cursor on the value you want to save and press [OK].



□ **Infinitely Variable Change of Numeric Data Value**
If the chosen parameter represents a numeric data value, select a digit by means of the <> navigation keys.



Change the selected digit infinitely variably by means of the up/down navigation keys.
The chosen digit is indicated by the cursor. Place the cursor on the digit you want to save and press [OK].

□ **Changing of Data Value, Step-by-Step**
Certain parameters can be changed step-by-step or infinitely variably. This applies to *Motor Power* (par. 1-20), *Motor Voltage* (par. 1-22) and *Motor Frequency* (par. 1-23).
The parameters are changed both as a group of numeric data values and as numeric data values infinitely variably.

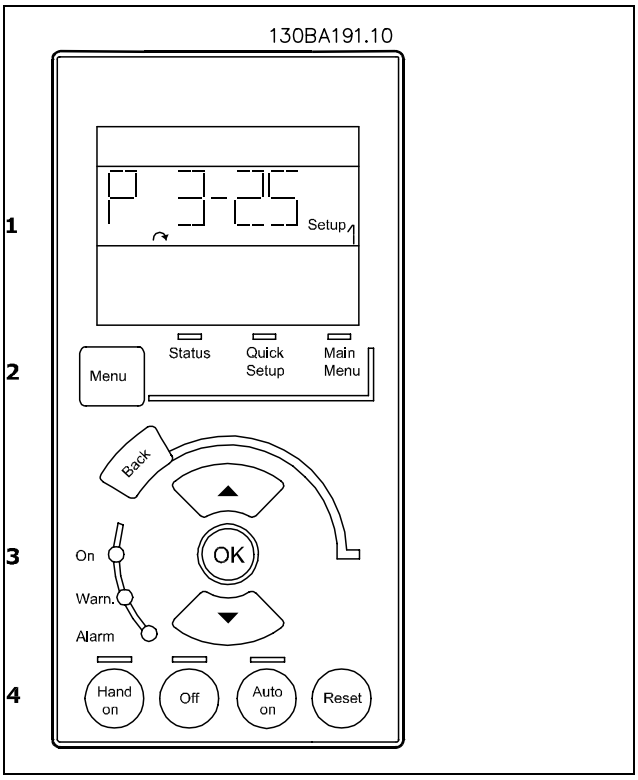
□ **Read-out and Programming of Indexed Parameters**
Parameters are indexed when placed in a rolling stack.
Par. 15-30 to 15-32 contain a fault log which can be read out. Choose a parameter, press [OK], and use the up/down navigation keys to scroll through the value log.

Use par. 3-10 as another example:
Choose the parameter, press [OK], and use the up/down navigation keys to scroll through the indexed values. To change the parameter value, select the indexed value and press [OK]. Change the value by using the up/down keys. Press [OK] to accept the new setting. Press [CANCEL] to abort. Press [Back] to leave the parameter.

How to Program on the Numerical Local Control Panel

The following instructions are valid for the Numerical LCP (LCP 101).
The control panel is divided into four functional groups:

1. Numerical display.
2. Menu keys and LEDs - changing parameters and switching between display functions.
3. Navigation keys and LEDs.
4. Operation keys and LEDs.



Display line:

Status line: Status messages displaying icons and numeric value.

LEDs:

- Green LED/On: Indicates if control section is on.
- Yellow LED/Wrn.: Indicates a warning.
- Flashing red LED/Alarm: Indicates an alarm.

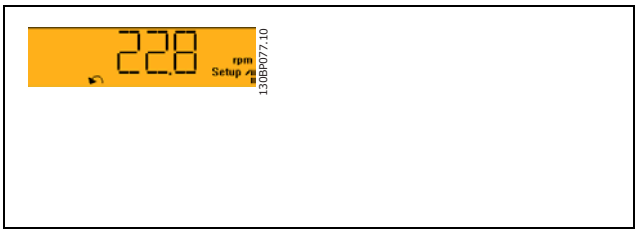
LCP keys

[Menu] Select one of the following modes:

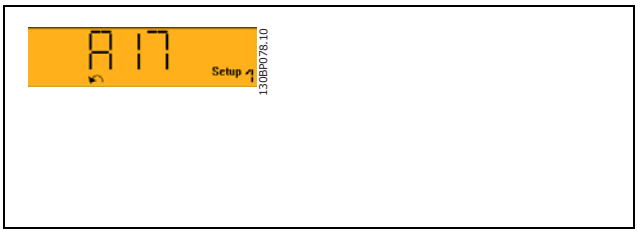
- Status
- Quick Setup
- Main Menu

How to Program

Status Mode: Displays the status of the adjustable frequency drive or motor.
If an alarm occurs, the NLCP automatically switches to status mode.
A number of alarms can be displayed.



NOTE
Parameter copy is not possible with LCP 101 numerical local control panel.



Par. No.	Parameter Description	Unit
1-20	Motor Power	kW
1-22	Motor Voltage	V
1-23	Motor Frequency	Hz
1-24	Motor Current	A
5-12	Terminal 27 Digital Input	[0] No function
3-02	Minimum Reference	rpm
3-03	Maximum Reference	rpm
3-41	Ramp 1 Ramp-up Time	sec
3-42	Ramp 1 Ramp-down Time	sec
3-13	Reference Site	
1-29	Automatic Motor Adaptation, AMA	[1] Enable complete AMA

Main Menu is used for programming all parameters.
The parameter values can be changed using the up/down arrows when the value is flashing.
Select the main menu by pressing the [Menu] key several times.
Select the parameter group [xx-__] and press [OK].
Select the parameter [__-xx] and press [OK].
If the parameter is an array parameter, select the array number and press [OK].
Select the desired data value and press [OK].

[Back] for stepping backwards.
Arrow [∧] [∨] keys are used for navigating between commands and within parameters.

□ Local Control Keys

Keys for local control are found at the bottom of the control panel.

130BP046.10

[Hand on] enables control of the adjustable frequency drive via the LCP. [Hand on] also starts the motor and it is now possible to enter the motor speed data by means of the arrow keys. The key can be selected as Enabled [1] or Disabled [0] via par. 0-40 *[Hand on] Key on LCP*.
External stop signals activated by means of control signals or a serial bus will override a "start" command via the LCP.
The following control signals will still be active when [Hand on] is activated:

- [Hand on] - [Off] - [Auto on]
- Reset
- Coasting stop inverse
- Reverse
- Set-up select lsb - Set-up select msb
- Stop command from serial communication
- Quick stop
- DC brake

[Off] stops the connected motor. The key can be selected as Enabled [1] or Disabled [0] via par. 0-41 *[Off] key on LCP*.
If no external stop function is selected and the [Off] key is inactive, the motor can be stopped by disconnecting the voltage.

[Auto on] enables the adjustable frequency drive to be controlled via the control terminals and/or serial communication. When a start signal is applied on the control terminals and/or the bus, the adjustable frequency drive will start. The key can be selected as Enabled [1] or Disabled [0] via par. 0-42 *[Auto on] Key on LCP*.

NOTE
An active HAND-OFF-AUTO signal via the digital inputs has higher priority than the control keys [Hand on] [Auto on].

[Reset] is used for resetting the adjustable frequency drive after an alarm (trip). It can be selected as Enabled [1] or Disabled [0] via par. 0-43 *Reset Key on LCP*.

□ Initialization to Default Settings

Initialize the adjustable frequency drive to default settings in two ways:

Recommended initialization (via par. 14-22)

1. Select par. 14-22
2. Press [OK]
3. Select "Initialisation"
4. Press [OK]
5. Cut off the mains supply and wait until the display turns off.
6. Reconnect the mains supply - the adjustable frequency drive is now reset.

Par. 14-22 initializes everything except:	
14-50	*RFI 1*
8-30	*Protocol*
8-31	*Address*
8-32	*Baud Rate*
8-35	*Minimum Response Delay*
8-36	*Max Response Delay*
8-37	*Max Inter-char Delay*
15-00 to 15-05	Operating data
15-20 to 15-22	Historic log
15-30 to 15-32	Fault log

Manual initialization

1. Disconnect from mains and wait until the display turns off.
2. Press [Status] - [Main Menu] - [OK] at the same time:
3. Reconnect mains supply while pressing the keys.
4. Release the keys after 5 s.
5. The adjustable frequency drive is now programmed according to default settings.

This parameter initializes everything except:	
15-00	*Operating Hours*
15-03	*Power-ups*
15-04	*Over temps*
15-05	*Over volts*

NOTE

When you carry out manual initialization, you also reset serial communication, RFI filter settings (par. 14-50) and fault log settings.

Parameter Selection

Parameters for FC 300 are grouped into various parameter groups to easily select the correct parameters for optimized operation of the adjustable frequency drive.
0-xx Operation and display parameters

- Basic settings, set-up handling
- Display and Local Control Panel parameters for choosing readouts, setting up selections, and copying functions

1-xx Load and motor parameters, including all load- and motor-related parameters

2-xx Brake parameters

- DC brake
- Dynamic brake (resistor brake)
- Mechanical brake
- Over-voltage control

3-xx References and ramping parameters includes DigiPot function

4-xx Limits and warnings; setting of limits and warning parameters

5-xx Digital inputs and outputs, including relay controls

6-xx Analog inputs and outputs

7-xx Controls; setting parameters for speed and process control

8-xx Communication and option parameters for setting of FC RS-485 and FC USB port parameters.

9-xx Profibus parameters

10-xx DeviceNet and CAN Fieldbus parameters

13-xx Smart Logic Control parameters

14-xx Special function parameters

15-xx Drive information parameters

16-xx Readout parameters

17-xx Encoder option parameters

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□ Parameters: Operation and Display

□ 0-0* Operation / Display

Parameters related to the fundamental functions of the adjustable frequency drive, function of the LCP buttons and configuration of the LCP display.

□ 0-0* Basic Settings

Parameter group for basic frequency converter settings.

0-01 Language

Option:

*	English UK (ENGLISH)	[0]
	German (DEUTSCH)	[1]
	French (FRANCAIS)	[2]
	Danish (DANSK)	[3]
	Spanish (ESPANOL)	[4]
	Italian (ITALIANO)	[5]
	Chinese (CHINESE)	[10]
	Finnish (FINNISH)	[20]
	English US (ENGLISH US)	[22]
	Greek (GREEK)	[27]
	Portuguese (PORTUGUESE)	[28]
	Slovenian (SLOVENIAN)	[36]
	Korean (KOREAN)	[39]
	Japanese (JAPANESE)	[40]
	Turkish (TURKISH)	[41]
	Traditional Chinese	[42]
	Bulgarian	[43]
	Serbian	[44]
	Romanian (ROMANIAN)	[45]
	Hungarian (HUNGARIAN)	[46]
	Czech	[47]
	Polish (POLISH)	[48]
	Russian	[49]
	Thai	[50]
	Bahasa Indonesian (BAHASA INDONESIAN)	[51]

Function:

Defines the language to be used in display.

The adjustable frequency drive can be delivered with 4 various language packages. English and German are included in all packages. English cannot be erased or manipulated.

Language package 1 consists of:
English, German, French, Danish, Spanish, Italian and Finnish.

Language package 2 consists of:
English, German, Chinese, Korean, Japanese, Thai and Bahasa Indonesian.

Language package 3 consists of:
English, German, Slovenian, Bulgarian, Serbian, Romanian, Hungarian, Czech and Russian.

Language package 4 consists of:
English, German, Spanish, English US, Greek, Brazilian Portuguese, Turkish and Polish.

0-02 Motor Speed Unit

Option:

*	RPM	[0]
	Hz	[1]

Function:

Select display of motor speed parameters (i.e. references, feedbacks and limits) in terms of shaft speed (RPM) or output frequency to the motor (Hz). This parameter cannot be adjusted while the motor is running.

0-03 Regional Settings

Option:

*	International	[0]
	US	[1]

Function:

Select *International* [0] to set par.1-20 *Motor Power* units to kW and the default value of par. 1-23*Motor Frequency* to 50 Hz. Select *US* [1] to set par.1-21 *Motor Power* units to HP and the default value of par. 1-23 *Motor Frequency* to 60 Hz. This parameter cannot be adjusted while the motor is running.

0-04 Operating State at Power-up (Hand)

Option:

	Resume	[0]
*	Forced stop, use saved reference	[1]
	Forced stop, reference = 0	[2]

Function:

Select theoperating mode upon reconnection of the frequency converter to mains voltage after power down in Hand (local) operation mode.

Select*Resume* [0] to restart the frequency converter maintaining the samelocal reference and the same start/stop settings (applied by [START/STOP]) as before the frequency converter was powered down.
Select Forced stop, use saved reference [1] to restart the frequency converter with a saved local reference, after mains voltage reappears and after pressing [START].
Select *Forced stop, set reference to 0* [2] to reset the local reference to 0 upon restarting the frequency converter.

□ 0-1* Set-Up Operations

Define and control the individual parameter set-ups.

0-10 Active Set-up

Option:

Factory setup	[0]
✱Set-up 1	[1]
Set-up 2	[2]
Set-up 3	[3]
Set-up 4	[4]
Multi set-up	[9]

Function:

Select the set-up to control the frequency converter functions.
Factory Set-up [0] cannot be changed. It contains the Danfoss data set, and can be used as a data source when returning the other set-ups to a known state.
Set-up 1 [1] to *Set-up 4* [4] are the four separate parameter set-ups within which all parameters can be programmed.
Select *Multi Set-up* [9] for remote selection of set-ups using digital inputs and the serial communication port. This option uses the settings from par. 0-12 This option linked to. Stop the frequency converter before making changes to open loop and closed loop functions.
Use par. 0-51 *Set-up copy* to copy a set-up to one or all other set-ups. Stop the frequency converter before switching between set-ups where parameters marked 'not changeable during operation' have different values. To avoid conflicting settings of the same parameter within two different set-ups, link the set-ups together using par. 0-12*This set-up linked to*. Parameters which are 'not changeable during operation' are marked FALSE in the parameter lists in the section *Parameter Lists*.

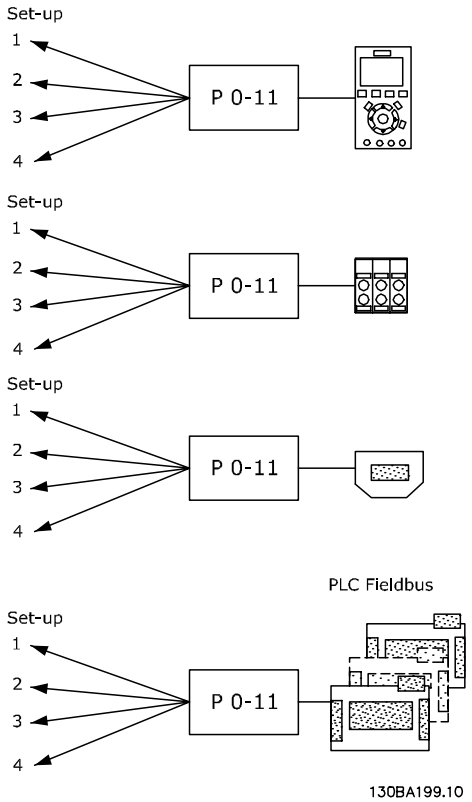
0-11 Edit Set-up

Option:

Factory setup	[0]
✱Set-up 1	[1]
Set-up 2	[2]
Set-up 3	[3]
Set-up 4	[4]
Active Set-up	[9]

Function:

Select the set-up to be edited (i.e. programmed) during operation; either the active set-up or one of the inactive set-ups.
Factory set-up [0] cannot be edited but it is useful as a data source to return the other set-ups to a known state. *Set-up 1* [1] to *Set-up 4* [4] can be edited freely during operation, independently of the active set-up. The *Active set-up* [9] can also be edited during operation. Edit the chosen set-up from a range of sources: LCP, FC RS485, FC USB or up to five fieldbus sites.



0-12 This Set-up Linked to

Option:

✱Setup 1	[1]

✱ default setting **( )** display text **[ ]** value for use in communication via serial communication port

Setup 2	[2]
Setup 3	[3]
Setup 4	[4]

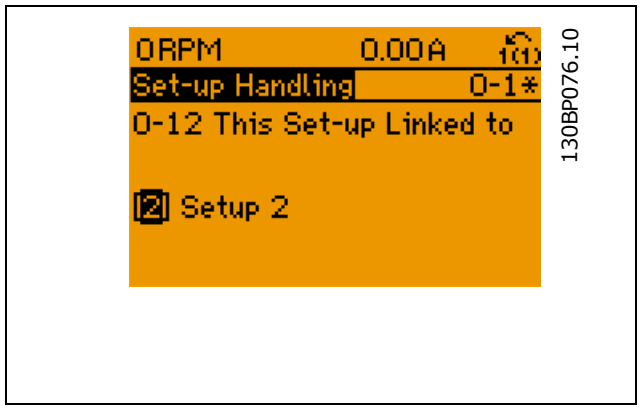
Function:

To enable conflict-free changes from one set-up to another during operation, link set-ups containing parameters which are not changeable during operation. The link will ensure synchronising of the 'not changeable during operation' parameter values when moving from one set-up to another during operation. 'Not changeable during operation' parameters can be identified by the label FALSE in the parameter lists in the section*Parameter Lists*.

The par. 0-12 link set-up feature is used by Multi set-up in par. 0-10 *Active Set-up*. Multi set-up is used to move from one set-up to another during operation (i.e. while the motor is running).
Example:
Use Multi set-up to shift from Set-up 1 to Set-up 2 whilst the motor is running. Programme in Set-up 1 first, then ensure that Set-up 1 and Set-up 2 are synchronised (or 'linked'). Synchronisation can be performed in two ways:
1. Change the edit set-up to *Set-up 2* [2] in par.0-11 *Edit Set-up* and set par. 0-12 *This Set-up Linked to* to *Set-up 1* [1]. This will start the linking (synchronising) process.

OR

2. While still in Set-up 1, copy Set-up 1 to Set-up 2. Then set par.0-12 to *Set-up 2* [2]. This will start the linking process.



After the link is complete, par. 0-13 *Readout: Linked Set-ups* will read {1,2} to indicate that all 'not changeable during operation' parameters on are now the same in Set-up 1 and Set-up 2. If there are changes to a 'not changeable during operation' parameter, e.g. par 1-30 *Stator Resistance (rs)*, in Set-up 2, they will also be changed automatically in Set-up 1. A switch between Set-up 1 and Set-up 2 during operation is now possible.

0-13 Readout: Linked Set-ups

Array [5]

Range:

0 - 255 N/A ✱0 N/A

Function:

View a list of all the set-ups linked by means of par. 0-12 *This Set-up Linked to*. The parameter has one index for each parameter set-up. Each set-up shows the set-up bitset to which it is linked. .

Example: Set-up 1 and Set-up 2 are linked

Index	LCP value
0	{0}
1	{1,2}
2	{1,2}
3	{3}
4	{4}

0-14 Readout: Edit Set-ups / Channel

Range:

0 - FFF.FFF.FFF *AAA.AAA.AAA

Function:

View the setting of par. 0-11 *Edit Set-up* for each of the four different communication channels. When the number is displayed in hex, as it is in the LCP, each number represents one channel.
Numbers 1-4 represent a set-up number; 'F' means factory setting; and 'A' means active set-up. The channels are, from right to left: LCP, FC-bus, USB, HPFB1.5.
Example: The number AAAAAA21h means that the FC bus selected Set-up 2 in par. 0-11, the LCP selected Set-up 1 and all others used the active set-up.

□ **0-2* LCP Display**

Define the display in the Graphical Logic Control Panel.

0-20 Display Line 1.1 Small

None	[0]
Profibus Warning Word	[953]
Readout Transmit Error Counter	[1005]
Readout Receive Error Counter	[1006]
Readout Bus Off Counter	[1007]
Warning Parameter	[1013]
Running Hours	[1501]
kWh Counter	[1502]
Control Word	[1600]
Reference [Unit]	[1601]
Reference %	[1602]
Status Word	[1603]
Main Actual Value [%]	[1605]
Custom Readout	[1609]
Power [kW]	[1610]
Power [hp]	[1611]
Motor Voltage	[1612]
Frequency	[1613]
Motor Current	[1614]
Frequency [%]	[1615]
Torque	[1616]
* Speed [RPM]	[1617]
Motor Thermal	[1618]
KTY Sensor Temperature	[1619]
Motor Angle	[1620]
Phase Angle	[1621]
DC Link Voltage	[1630]
BrakeEnergy/s	[1632]
BrakeEnergy/2 min	[1633]
Heatsink Temp.	[1634]
Inverter Thermal	[1635]
Inv. Nom. Current	[1636]
Inv. Max. Current	[1637]
SL Control State	[1638]
Control Card Temp.	[1639]
External Reference	[1650]
Pulse Reference	[1651]
Feedback [Unit]	[1652]
DigiPot Reference	[1653]
Digital Input	[1660]
Terminal 53 Switch Setting	[1661]
Analog Input 53	[1662]
Terminal 54 Switch Setting	[1663]
Analog Input 54	[1664]
Analog Output 42 [mA]	[1665]
Digital Output [bin]	[1666]
Freq. Input #29 [Hz]	[1667]
Freq. Input #33 [Hz]	[1668]
Pulse Output #27 [Hz]	[1669]
Pulse Output #29 [Hz]	[1670]
Relay Output [bin]	[1671]
Counter A	[1672]
Counter B	[1673]
Ser. Com. Bus CTW 1	[1680]
Ser. com. bus REF 1	[1682]
Comm. Option STW	[1684]
FC Port CTW 1	[1685]
FC Port REF 1	[1686]
Alarm Word	[1690]
Alarm Word 2	[1691]
Warning Word	[1692]
Warning Word 2	[1693]
Ext. Status Word	[1694]
Ext. Status Word 2	[1695]
PCD 1 Write to MCO	[3401]
PCD 2 Write to MCO	[3402]
PCD 3 Write to MCO	[3403]
PCD 4 Write to MCO	[3404]
PCD 5 Write to MCO	[3405]
PCD 6 Write to MCO	[3406]
PCD 7 Write to MCO	[3407]
PCD 8 Write to MCO	[3408]
PCD 9 Write to MCO	[3409]
PCD 10 Write to MCO	[3410]
PCD 1 Read from MCO	[3421]
PCD 2 Read from MCO	[3422]
PCD 3 Read from MCO	[3423]
PCD 4 Read from MCO	[3424]
PCD 5 Read from MCO	[3425]
PCD 6 Read from MCO	[3426]
PCD 7 Read from MCO	[3427]
PCD 8 Read from MCO	[3428]
PCD 9 Read from MCO	[3429]
PCD 10 Read from MCO	[3430]
Digital Inputs	[3440]
Digital Outputs	[3441]
Actual Position	[3450]
Commanded Position	[3451]
Actual Master Position	[3452]

Slave Index Position	[3453]
Master Index Position	[3454]
Curve Position	[3455]
Track Error	[3456]
Synchronizing Error	[3457]
Actual Velocity	[3458]
Actual Master Velocity	[3459]
Synchronizing Status	[3460]
Axis Status	[3461]
Program Status	[3462]
Idle Time	[9913]
Paramdb Requests in Queue	[9914]
Analog input X30/11	[1675]
Analog input X30/12	[1676]
Analog output X30/8 mA	[1677]

Function:

Select a variable for display in line 1, left position.
None [0] No display value selected
Control Word [1600] Present control word
Reference [Unit] [1601] Total reference (sum of digital/analog/preset/bus/freeze ref./catch-up and slow-down) in selected unit.
Reference % [1602] Total reference (sum of digital/analog/preset/bus/freeze ref./catch-up and slow-down) in percent.
Status Word [binary] [1603] Present status word
Main actual value [1605] [Hex] One or more warnings in a Hex code
Power [kW] [1610] Actual power consumed by the motor in kW.
Power [hp] [1611] Actual power consumed by the motor in HP.
Motor Voltage [V] [1612] Voltage supplied to the motor.
Frequency [Hz] [1613] Motor frequency, i.e., the output frequency from the adjustable frequency drive in Hz.
Motor Current [A] [1614] Phase current of the motor measured as an effective value.
Frequency [%] [1615] Motor frequency, i.e., the output frequency from the adjustable frequency drive in percent.
Torque [%] [1616] Present motor load as a percentage of the rated motor torque.
**Speed [RPM]* [1617] Speed in RPM (revolutions per minute), i.e., the motor shaft speed in closed loop.
Motor thermal [1618] Thermal load on the motor, calculated by the ETR function.
DC Link Voltage [V] [1630] Intermediate circuit voltage in the adjustable frequency drive.
BrakeEnergy/s [1632] Present braking energy transferred to an external brake resistor. Stated as an instantaneous value.
BrakeEnergy/2 min [1633] Braking energy transferred to an external brake resistor. The mean power is calculated continuously for the latest 120 seconds.
Heatsink Temperature [°C] [1634] Present heatsink temperature of the adjustable frequency drive. The cut-out limit is 203 ± 9°F [95 ±5°C]; cutting back in occurs at 158 ± 9°F [70 ±5°C].
Inverter thermal [1635] Percentage load of the inverters.
Inv. Nom. Current [1636] Nominal current of the adjustable frequency drive.
Inv. Max. Current [1637] Maximum current of the adjustable frequency drive.
Condition control state [1638] State of the event executed by the control.
Control Card Temperature [1639] Temperature of the control card.
External Reference [1650] [%] Sum of the external reference as a percentage, i.e., the sum of analog/pulse/bus.
Pulse Reference [1651] [Hz] Frequency in Hz connected to the digital inputs (18, 19 or 32, 33).
Feedback [Unit] [1652] Reference value from programmed digital input(s).
Digital Input [1660] Signal states form the 6 digital terminals (18, 19, 27, 29, 32 and 33). Input 18 corresponds to the bit at the far left. Signal low = 0; Signal high = 1 Terminal 53 Switch Setting [1661] Setting of input terminal 54. Current = 0; Voltage = 1.
Analog Input 53 [1662] Actual value at input 53 either as a reference or protection value.
Terminal 54 Switch Setting [1663] Setting of input terminal 54. Current = 0; Voltage = 1.
Analog Input 54 [1664] Actual value at input 54 either as reference or protection value.
Analog Output 42 [mA] [1665] Actual value at output 42 in mA. Use par. 6-50 to select the value to be shown.
Digital output [bin] [1666] Binary value of all digital outputs.
Frequency input #29 [Hz] [1667] Actual value of the frequency applied at terminal 29 as an impulse input.
Frequency input #33 [Hz] [1668] Actual value of the frequency applied at terminal 33 as an impulse input.

Pulse output #27 [Hz] [1669] Actual value of impulses applied to terminal 27 in digital output mode.
Pulse output #29 [Hz] [1670] Actual value of impulses applied to terminal 29 in digital output mode.
Ser. com. bus control word1 signal [1680] Control word (CTW) received from the bus master.
Ser. com. bus speed set-point A signal [1682] Main reference value sent with control word from the bus master.
Communication Option Status Word [binary] [1684] Extended ser. communication bus option status word.
FC port control word1 signal [1685] Control word (CTW) received from the bus master.
FC port speed set-point A signal [1686] Status word (STW) sent to the bus master.
Alarm word [Hex] [1690] One or more alarms in a Hex code.
Alarm word 2 [Hex] [1691] One or more alarms in a Hex code.
Warning word [Hex] [1692] One or more warnings in a Hex code.
Warning word 2 [Hex] [1693] One or more warnings in a Hex code.
Ext. status word [Hex] [1694] One or more status conditions in a Hex code.
Ext. status word 2 [Hex] [1695] One or more status conditions in a Hex code.

0-21 Display Line 1.2 Small

Option:

✱Motor Current [A] [1614]

Options are the same as in par. 0-20.

Function:

Select a variable for display in line 1, middle position. The options are the same as those listed for par. 0-20 *Display Line 1.1 Small*.

0-22 Display Line 1.3 Small

✱Power [kW] [1610]

Function:

Select a variable for display in line 1, right position. The options are the same as those listed for par. 0-20 *Display Line 1.1 Small*.

0-23 Display Line 2 Large

✱Frequency [Hz] [1613]

Function:

Select a variable for display in line 2. The options are the same as those listed for par. 0-20 *Display Line 1.1 Small*.

0-24 Display Line 3 Large

Option:

✱Reference [%] [1602]

Options are the same as in par. 0-20.

Function:

Select a variable for display in line 3. The options are the same as those listed for par. 0-20 *Display Line 1.1 Small*.

0-25 My Personal Menu

Array [20]

Range:

0 - 9999

Function:

Define up to 20 parameters to include in the Q1 Personal Menu, accessible via the [Quick Menu] key on the LCP. The parameters will be displayed in the Q1 Personal Menu in the order they are programmed into this array parameter. Delete parameters by setting the value to '0000'.

□ 0-4* LCP Keypad

Enable and disable individual keys on the LCP keypad.

0-40 [Hand on] Key on LCP

Option:

Disabled [0]
✱Enabled [1]
Password [2]

Function:

Select *Disabled* [0] to avoid accidental start of the frequency converter in Hand mode. Select *Password* [2] to avoid unauthorised start in Hand mode. If par. 0-40 is included in the Quick Menu, then define the password in par. 0-65 *Quick Menu Password*.

0-41 [Off] Key on LCP

Option:

Disabled	[0]
✱ Enabled	[1]
Password	[2]

Function:

Press [Off] and select *Disabled* [0] to avoid accidental stop of the frequency converter. Press [Off] and select *Password* [2] to avoid unauthorised stop. If par. 0-41 is included in the Quick Menu, then define the password in par. 0-65 *Quick Menu Password*.

0-42 [Auto on] Key on LCP

Option:

Disabled	[0]
✱ Enabled	[1]
Password	[2]

Function:

Press [Auto on] and select *Disabled* [0] to avoid accidental start of the frequency converter in Auto mode. Press [Auto on] and select *Password* [2] to avoid unauthorised start in Auto mode. If par. 0-42 is included in the Quick Menu, then define the password in par. 0-65 *Quick Menu Password*.

0-43 [Reset] Key on LCP

Option:

Disabled	[0]
✱ Enabled	[1]
Password	[2]

Function:

Press [Reset] and select *Disabled* [0] to avoid accidental alarm reset. Press [Reset] and select *Password* [2] to avoid unauthorised resetting. If par. 0-43 is included in the Quick Menu, then define the password in par. 0-65 *Quick Menu Password*.

□ 0-5* Copy / Save

Copy parameter settings between set-ups and to/from the LCP.

0-50 LCP Copy

Option:

✱ No copy	[0]
Transfer to LCP all parameters	[1]
Transfer from LCP all parameters	[2]
Transfer from LCP size indep. parameters	[3]

Function:

Select *Transfer to LCP all parameters* [1] to copy all parameters in all set-ups from the frequency converter memory to the LCP memory.
Select *Transfer from LCP all parameters* [2] to copy all parameters in all set-ups from the LCP memory to the frequency converter memory.
Select *Transfer from LCP size indep. parameters* [3] to copy only the parameters that are independent of the motor size. The latter selection can be used to programme several drives with the same function without disturbing motor data which are already set. This parameter cannot be adjusted while the motor is running.

0-51 Set-up Copy

Option:

✱ No copy	[0]
Copy to set-up 1	[1]
Copy to set-up 2	[2]
Copy to set-up 3	[3]
Copy to set-up 4	[4]
Copy to all	[9]

Function:

Select *Copy to set-up 1* [1] to copy all parameters in the present edit set-up (defined in par. 0-11 *Edit Set-up*) to Set-up 1. Likewise, select the option corresponding to the other set-up(s). Select *Copy to all* [9] to copy the parameters in the present set-up over to each of the set-ups 1 to 4.

□ 0-6* Password

Define password access to menus.

0-60 Main Menu Password

Range:

0 - 9999 ✱ 100

Function:

Define the password for access to the Main Menu via the [Main Menu] key. If par. 0-61 *Access to*

Main Menu w/o Password is set to *Full access* [0], this parameter will be ignored.

0-61 Access to Main Menu w/o Password

Option:

*Full access	[0]
Read only	[1]
No access	[2]

Function:

Select *Full access* [0] to disable the password defined in par. 0-60 *Main Menu Password*. Select *Read only* [1] to prevent unauthorised editing of Main Menu parameters. Select *No access* [2] to prevent unauthorised viewing and editing of Main Menu parameters. If *Full access* [0] is selected then parameters 0-60, 0-65 and 0-66 will be ignored.

0-65 Quick Menu Password

Range:

0 - 9999	*200

Function:

Define the password for access to the Quick Menu via the [Quick Menu] key. If par. 0-66 *Access to Quick Menu w/o Password* is set to *Full access* [0], this parameter will be ignored.

0-66 Access to Quick Menu w/o Password

Option:

*Full access	[0]
Read only	[1]
No access	[2]

Function:

Select *Full access* [0] to disable the password defined in par. 0-65 *Quick Menu Password*. Select *Read only* [1] to prevent unauthorised editing of Quick Menu parameters. Select *No access* [2] to prevent unauthorised viewing and editing of Quick Menu parameters. If par. 0-61 *Access to Main Menu w/o Password* is set to *Full access* [0] then this parameter will be ignored.

□ Parameters: Load and Motor

□ 1-0* General Settings

Define whether the adjustable frequency drive operates in speed mode or torque mode; and whether the internal PID control should be active or not.

1-00 Configuration Mode

Option:

✱Speed open-loop	[0]
Speed closed-loop	[1]
Torque	[2]
Process	[3]

Function:

Select the application control principle to be used when a Remote Reference (via analog input) is active. A Remote Reference can only be active when par. 3-13 *Reference Site* is set to [0] or [1].
Speed open-loop [0]: Enables speed control (without feedback signal from motor) with automatic slip compensation for almost constant speed at varying loads.
Compensations are active but can be disabled in the Load/Motor par. group 1-0*.
Speed closed-loop [1]: Enables encoder feedback from motor. Obtain full holding torque at 0 RPM. For increased speed accuracy, provide a feedback signal and set the speed PID control.
Torque [2]: Connects the encoder speed feedback signal to the encoder input. Only possible with "Flux with motor feedback" option, par. 1-01 *Motor control principle*.
Process [3]: Enables the use of process control in the adjustable frequency drive. The process control parameters are set in par. groups 7-2* and 7-3*.
This parameter cannot be adjusted while the motor is running.

1-01 Motor Control Principle

Option:

U/f	[0]
✱VVC^{plus}	[1]
Flux sensorless (FC 302 only)	[2]
Flux w/ motor feedback(FC 302 only)	[3]

Function:

Select which motor control principle to employ.
Select *U/f* [0], a special motor mode, for parallel connected motors in special motor applications. When U/f is selected the characteristic of the control principle can be edited in par. 1-55 and 1-56.
Select *VVC^{plus}* [1] for a voltage vector control principle suitable for most applications. The main benefit of VVC^{plus} operation is that it uses a robust motor model.
Select *Flux sensorless* [2], i.e., flux vector control without encoder feedback, for simple installation and robustness against sudden load changes.
Select *Flux with encoder feedback* [3] for very high accuracy speed and torque control, suitable for the most demanding applications.

The best shaft performance is normally achieved using either of the two flux vector control modes *Flux sensorless* [2] and *Flux with encoder feedback* [3].
This parameter cannot be adjusted while the motor is running.

1-02 Flux Motor Feedback Source

Option:

✱24 V encoder	[1]
MCB 102	[2]
MCO 305	[3]

Function:

Select the interface at which to receive feedback from motor or process.
24V encoder [1] is an A and B channel encoder, which can be connected to the digital input terminals 32/33 only. Terminals 32/33 must be programmed to *no function*.
MCB 102 [2] is an encoder module option which can be configured in par. group 17-** *Parameters - Encoder Input*.
MCO 305 [3] is an option for positioning, synchronizing and programming.
This parameter cannot be adjusted while the motor is running.
This parameter appears in FC 302 only.

1-03 Torque Characteristics

Option:

✱Constant torque	[0]
Variable torque	[1]
Auto Energy Optim.	[2]

Function:

Select the torque characteristic required.
VT and AEO are both energy saving operations.
Constant torque [0]: The motor shaft output will provide constant torque under variable speed control.
Variable Torque [1]: The motor shaft output will provide variable torque under variable speed control.
Set the variable torque level in par. 14-40 *VT Level*.
Automatic Energy Optimizing function [2]:
This function automatically optimises energy consumption by minimising magnetisation and frequency via par. 14-41 *AEO Minimum Magnetisation* and par. 14-42 *Minimum AEO Frequency*.

1-04 Overload Mode

Option:

*High torque	[0]
Normal torque	[1]

Function:

High torque [0] allows up to 160% over torque.
Normal torque [1] is for oversized motors - allows up to 110% over torque.
This parameter cannot be adjusted while the motor is running.

1-05 Local Mode Configuration

Option:

Speed open-loop	[0]
Speed closed-loop	[1]
*As conf. mode P. 1-00	[2]

Function:

Select which application configuration mode (par. 1-00), i.e. application control principle, to use when a Local (LCP) Reference is active. A Local Reference can be active only when par. 3-13 *Reference Site* is set to [0] or [2]. By default the local reference is active in Hand Mode only.

□ 1-1* Motor selection

Parameter group for setting general motor data.
This parameter group cannot be adjusted while the motor is running.

1-10 Motor Construction

Option:

*Asynchronous	[0]
PM, non-salient SPM (FC 302 only)	[1]

Function:

Select the motor design type.
Select *Asynchronous* [0] for asynchronous motors.
Select *PM, non-salient SPM (FC 302 only)* [1] for permanent magnet (PM) motors.
Note that PM motors are divided into two groups, with either surface mounted (non-salient) or interior (salient) magnets.

Motor design can be either asynchronous or permanent magnet (PM) motor.

□ 1-2* Motor Data

Parameter group 1-2* comprises input data from the nameplate on the connected motor.
Parameters in parameter group 1-2* cannot be adjusted while the motor is running.

NOTE
Changing the value of these parameters affects the setting of other parameters.

1-20 Motor Power [kW]

Range:

0.5-10 HP [0.37-7.5 kW] [M-TYPE]

Function:

Enter the nominal motor power in kW according to the motor nameplate data. The default value corresponds to the nominal rated output of the unit.
This parameter cannot be adjusted while the motor is running.

1-21 Motor Power [HP]

Range:

0.5-10 HP [M-TYPE]

Function:

Enter the nominal motor power in HP according to the motor nameplate data. The default value corresponds to the nominal rated output of the unit.
This parameter cannot be adjusted while the motor is running.

1-22 Motor Voltage

Range:

200-600 V [M-TYPE]

Function:

Enter the nominal motor voltage according to the motor nameplate data. The default value

corresponds to the nominal rated output of the unit. This parameter cannot be adjusted while the motor is running.

1-23 Motor Frequency

Option:

*50 Hz (50 HZ)	[50]
60 Hz (60 HZ)	[60]

Min - Max motor frequency: 20 - 300 Hz

Function:

Select the motor frequency value from the motor nameplate data. Alternatively, set the value for motor frequency to be infinitely variable. If a value different from 50 Hz or 60 Hz is selected, it is necessary to adapt the load independent settings in par. 1-50 to 1-53. For 87 Hz operation with 230/400 V motors, set the nameplate data for 230 V/50 Hz. Adapt par. 4-13 *Motor Speed High Limit [RPM)* and par. 3-03 *Maximum Reference* to the 87 Hz application. This parameter cannot be adjusted while the motor is running.

NOTE
Changing the value in this parameter affects the setting of other parameters. Par. 1-23 cannot be changed while the motor is running.

NOTE
If a delta connection is used, select the rated motor frequency for the delta connection.

1-24 Motor Current

Range:

Motor type dependent.

Function:

Enter the nominal motor current value from the motor nameplate data. The data are used for calculating torque, motor protection, etc. This parameter cannot be adjusted while the motor is running.

1-25 Motor Nominal Speed

Range:

100 - 60000 RPM * RPM

Function:

Enter the nominal motor speed value from the motor nameplate data. The data are used for calculating motor compensations. This parameter cannot be adjusted while the motor is running.

1-26 Motor Cont. Rated Torque

Range:

1.0 - 10000.0 Nm *5.0 Nm

Function:

Enter the value from the motor nameplate data. The default value corresponds to the nominal rated output. This parameter is available when par. 1-10*Motor Design* is set to *PM, non salient SPM* [1], i.e. the parameter is valid for PM and non-salient SPM motors only.
This parameter cannot be adjusted while the motor is running.

1-29 Automatic Motor Adaptation (AMA)

Option:

*OFF	[0]
Enable complete AMA	[1]
Enable reduced AMA	[2]

Function:

The AMA function optimises dynamic motor performance by automatically optimising the advanced motor parameters (par. 1-30 to par. 1-35) while the motor is stationary.
Select the type of AMA. *Enable complete AMA* [1] performs AMA of the stator resistance R_S, the rotor resistance R_r, the stator leakage reactance x_1, the rotor leakage reactance X_2 and the main reactance X_h. Select this option if an LC filter is used between the drive and the motor.
FC 301: The Complete AMA does not include X_h measurement for FC 301. Instead, the X_h value is determined from the motor database. Par. 1-35 *Main Reactance (X^h)* may be adjusted to obtain optimal start performance.
Select *Reduced AMA* [2] performs a reduced AMA of the stator resistance R_s in the system only. Activate the AMA function by pressing [Hand on] after selecting [1] or [2]. See also the section *Automatic Motor Adaptation*. After a normal sequence, the display will read: "Press [OK] to finish AMA". After pressing the [OK] key the frequency converter is ready for operation.

Note:

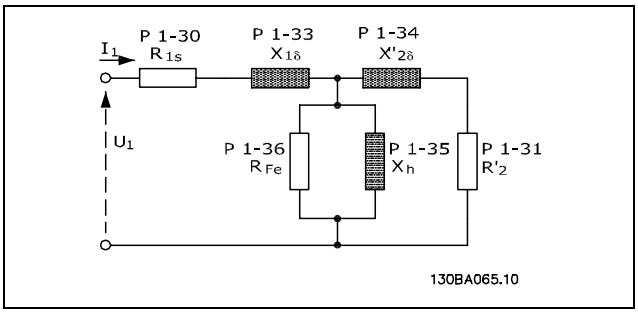
- For the best adaptation of the frequency converter, run AMA on a cold motor.
- AMA cannot be performed while the motor is running.
- AMA cannot be performed on permanent magnet motors.

NOTE
It is important to set motor par. 1-2* Motor Data correctly, since these form part of the AMA algorithm. An AMA must be performed to achieve optimum dynamic motor performance. It may take up to 10 min, depending on the power rating of the motor.

NOTE
Avoid generating external torque during AMA.

NOTE
If one of the settings in par. 1-2* Motor Data is changed, par. 1-30 to 1-39, the advanced motor parameters, will return to default setting. This parameter cannot be adjusted while the motor is running.

□ **1-3* Adv. Motor Data**
Parameters for advanced motor data. The motor data in par. 1-30 - par. 1-39 must match the relevant motor in order to run the motor optimally. The default settings are figures based on common motor parameter values from normal standard motors. If the motor parameters are not set correctly, a malfunction of the drive system may occur. If the motor data is not known, running an AMA (Automatic Motor Adaptation) is recommended. See the *Automatic Motor Adaptation* section. The AMA sequence will adjust all motor parameters except the moment of inertia of the rotor and the iron loss resistance (par. 1-36).
Parameters 1-3* and 1-4* cannot be adjusted while the motor is running.



Motor equivalent diagram for an asynchronous motor

1-30 Stator Resistance (Rs)

Option:

Ohm — Dependingonmotordata.

Function:

Set the stator resistance value. Enter the value from a motor data sheet or perform an AMA on a cold motor. This parameter cannot be adjusted while the motor is running.

1-31 Rotor Resistance (Rr)

Option:

Ohm — Dependingonmotordata.

Function:

Fine-tuning R_r will improve shaft performance. Set the rotor resistance value using one of these methods:

1. Run an AMA on a cold motor. The adjustable frequency drive will measure the value from the motor. All compensations are reset to 100%.
2. Enter the R_r value manually. Obtain the value from the motor supplier.
3. Use the R_r default setting. The adjustable frequency drive establishes the setting on the basis of the motor nameplate data.

This parameter cannot be adjusted while the motor is running.

1-33 Stator Leakage Reactance (X1)

Option:

Ohm — Dependingonmotordata.

Function:

Set the stator leakage reactance of the motor using one of these methods:

1. Run an AMA on a cold motor. The adjustable frequency drive will measure the value from the motor.
2. Enter the X_1 value manually. Obtain the value from the motor supplier.
3. Use the X_1 default setting. The adjustable frequency drive establishes the setting on the basis of the motor nameplate data.

This parameter cannot be adjusted while the motor is running.

1-34 Rotor Leakage Reactance (X2)

Option:

Ohm — Dependingonmotordata.

Function:

Set the rotor leakage reactance of the motor using one of these methods:

1. Run an AMA on a cold motor. The adjustable frequency drive will measure the value from the motor.
2. Enter the X_2 value manually. Obtain the value from the motor supplier.
3. Use the X_2 default setting. The adjustable frequency drive establishes the setting on the basis of the motor nameplate data.

This parameter cannot be adjusted while the motor is running.

1-35 Main Reactance (Xh)

Option:

Ohm — Dependingonmotordata.

Function:

Set the main reactance of the motor using one of these methods:

1. Run an AMA on a cold motor. The adjustable frequency drive will measure the value from the motor.
2. Enter the X_h value manually. Obtain the value from the motor supplier.
3. Use the X_h default setting. The adjustable frequency drive establishes the setting on the basis of the motor nameplate data.

This parameter cannot be adjusted while the motor is running.

1-36 Iron Loss Resistance (Rfe)

Range:

1 - 10.000 Ω — ✱M-TYPE

Function:

Enter the equivalent iron loss resistance (R_{Fe}) value to compensate for iron losses in the motor.
The R_{Fe} value cannot be found by performing an AMA.
The R_{Fe} value is especially important in torque control applications. If R_{Fe} is unknown, leave par. 1-36 on default setting.
This parameter cannot be adjusted while the motor is running.

1-37 d-axis Inductance (Ld)

Range:

0.0 - 1000.0 mH — ✱0.0 mH

Function:

Enter the value of the d-axis inductance. Obtain the value from the permanent magnet motor data sheet.
This parameter is only active when par. 1-10 *Motor Design* has the value *PM, non-salient SPM* [1] (Permanent Magnet Motor).
This parameter is available for FC 302 only.
This parameter cannot be adjusted while the motor is running.

1-39 Motor Poles

Option:

Depends on motor type
Value 2 - 100 poles — ✱4-pole motor

Function:

Enter the number of motor poles.

Poles	~n_n@ 50 Hz	~n_n@60 Hz
2	2700 - 2880	3250 - 3460
4	1350 - 1450	1625 - 1730
6	700 - 960	840 - 1153

The table shows the number of poles for normal speed ranges of various motor types. Define motors designed for other frequencies separately. The motor pole value is always an even number, because it refers to the total number of poles, not pairs of poles. The adjustable frequency drive creates the initial setting of par. 1-39 based on par. 1-23 *Motor Frequency* and par. 1-25 *Motor Nominal Speed*. This parameter cannot be adjusted while the motor is running.

□ **1-4* LCP Keypad**

Enable or disable the individual keys on the LCP panel.

1-40 Back EMF at 1000 RPM

Range:

10 - 1000 V ✱500 V

Function:

Set the nominal back EMF for the motor when running at 1000 RPM. This parameter is only active when par. 1-10 *Motor Design* is set to*PM motor* [1] (Permanent Magnet Motor).
This parameter is available for FC 302 only.
This parameter cannot be adjusted while the motor is running.

1-41 Motor Angle Offset

Range:

0 - 65535 N/A ✱0 N/A

Function:

Enter the correct offset angle between the PM motor and the index position (single-turn) of the attached encoder or resolver. The value range of 0 – 65535 corresponds to 0 - 2 * pi (radians). To obtain the offset angle value: After drive start-up apply DC-hold and enter the value of par. 16-20 *Motor Angle* into this parameter.
This parameter is only active when par. 1-10 *Motor Design* is set to *PM, non-salient SPM* [1] (Permanent Magnet Motor).
This parameter cannot be adjusted while the motor is running.

□ **1-5* Load Indep. Setting**

Parameters for setting the load-independent motor settings.

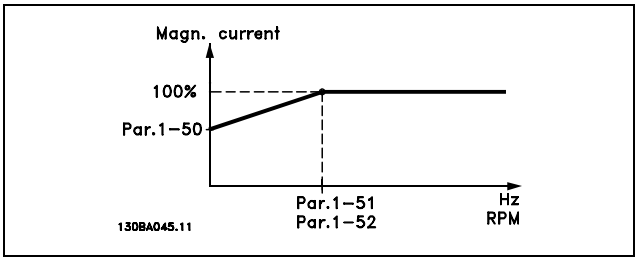
1-50 Motor Magnetization at Zero Speed

Range:

0 - 300 % ✱100%

Function:

Use this par. along with par. 1-51 *Min Speed Normal Magnetising [RPM]* to obtain a different thermal load on the motor when running at low speed.
Enter a value which is a percentage of the rated magnetizing current. If the setting is too low, the torque on the motor shaft may be reduced.



1-51 Min Speed Normal Magnetizing [RPM]

Range:

10 - 300 RPM ✱15 RPM

Function:

Set the required speed for normal magnetizing current. If the speed is set lower than the motor slip speed, par. 1-50 *Motor Magnetization at Zero Speed* and par. 1-51 are of no significance.
Use this par. along with par. 1-50. See drawing for par. 1-50.

1-52 Min Speed Normal Magnetizing [Hz]

Range:

0 - 10 Hz ✱0 Hz

Function:

Set the required frequency for normal magnetising current. If the frequency is set lower than the motor slip frequency, par. 1-50 *Motor Magnetisation at Zero Speed* and par. 1-51 *Min Speed Normal Magnetising [RPM]*. are inactive.
Use this par. along with par. 1-50. See drawing for par. 1-50.

1-53 Model Shift Frequency

Range:

4.0 - 50.0 Hz ✱6.7 Hz

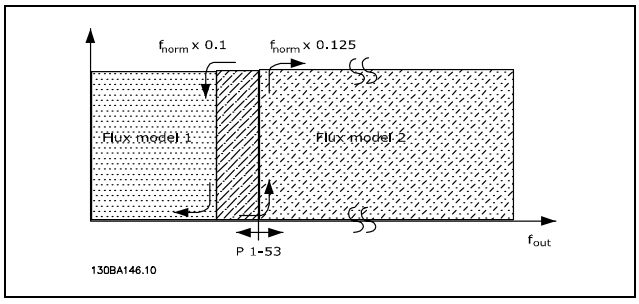
Function:

Flux Model shift

Enter the frequency value for shift between two models for determining motor speed. Choose the value based on settings in par. 1-00 *Configuration Mode* and par. 1-01 *Motor Control Principle*.
There are two options: shift between Flux model 1 and Flux model 2; or shift between Variable Current mode and Flux model 2. This parameter is available for FC 302 only.
This parameter cannot be adjusted while the motor is running.

Flux Model 1 – Flux model 2

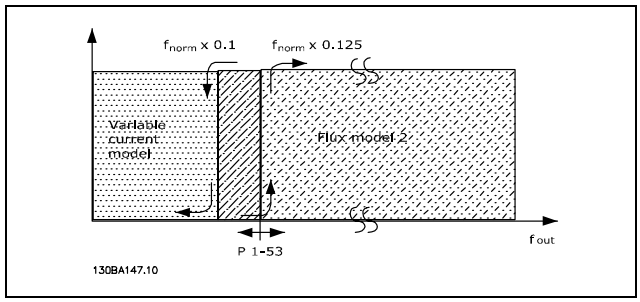
This model is used when par. 1-00 is set to *Speed closed loop* [1] or *Torque* [2] and par. 1-01 is set to *Flux w/motor feedback* [3]. With this parameter it is possible to make an adjustment of the shifting point where FC 302 changes between Flux model 1 and Flux model 2, which is useful in some sensitive speed and torque control applications.



Par. 1-00 = [1] Speed closed loop or [2] Torque and par. 1-01 = [3] Flux w/motor feedback

Variable Current - Flux model - Sensorless

This model is used when par. 1-00 is set to *Speed open loop* [0] and par. 1-01 is set to *Flux sensorless* [2].
In speed open loop in flux mode, the speed is determined from the current measurement. Below f_{norm} x 0.1, the drive runs on a Variable Current model. Above f_{norm} x 0.125 the frequency converter runs on a Flux model.



Par. 1-00 = [0] Speed open loop
Par. 1-01 = [2] Flux sensorless

1-55 U/f Characteristic - U

Range:

0.0 - max. motor voltage ✱Expression limit V

Function:

Enter the voltage at each frequency point to manually form a U/f-characteristic matching the motor.
The frequency points are defined in par. 1-56 *U/f Characteristic - F*.
This parameter is an array parameter [0-5] and is only accessible when par. 1-01 *Motor Control Principle* is set to *U/f* [0].

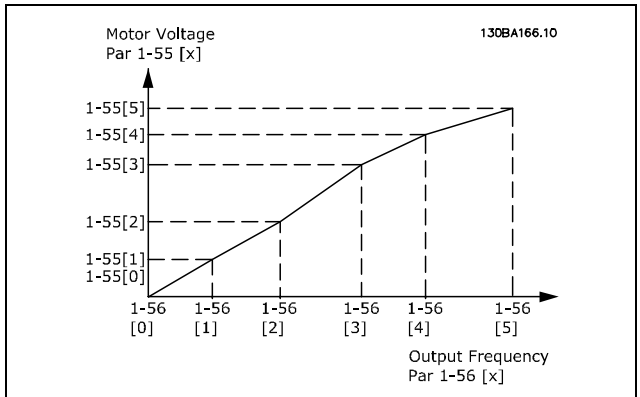
1-56 U/f Characteristic - F

Range:

0.0 - max. motor frequenc✱Expression limit Hz

Function:

Enter the frequency points to manually form a U/f-characteristic matching the motor.
The voltage at each point is defined in par. 1-55 *U/f Characteristic - U*.
This parameter is an array parameter [0-5] and is only accessible when par. 1-01 *Motor Control Principle* is set to *U/f* [0].



✱ default setting ( ) display text [ ] value for use in communication via serial communication port

□ 1-6* Load Depend. Setting

Parameters for adjusting the load-dependent motor settings.

1-60 Low Speed Load Compensation

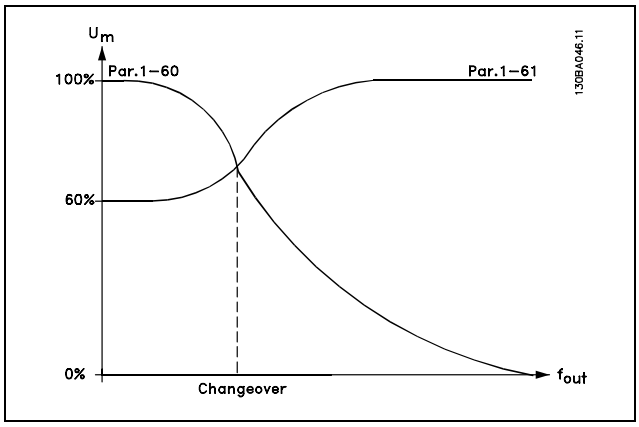
Range:

-300 - 300% ✱100%

Function:

Enter the % value to compensate voltage in relation to load when the motor is running at low speed and obtain the optimum U/f characteristic. The motor size determines the frequency range within which this parameter is active.

Motor size	Change over
0.25 kW - 7.5 kW	< 10 Hz



1-61 High Speed Load Compensation

Range:

-300 - 300% ✱100%

Function:

Enter the % value to compensate voltage in relation to load when the motor is running at high speed and obtain the optimum U/f characteristic. The motor size determines the frequency range within which this parameter is active.

Motor size	Change-over
0.25 kW - 7.5 kW	> 10 Hz

1-62 Slip Compensation

Range:

-500 - 500% ✱100%

Function:

Enter the % value for slip compensation, to compensate for tolerances in the value of $n_{M,N}$. Slip compensation is calculated automatically, i.e., on the basis of the rated motor speed $n_{M,N}$.
This function is not active when par. 1-00 *Configuration Mode* is set to *Speed closed-loop* [1] or *Torque* [2] torque control with speed feedback or when par. 1-01 *Motor Control Principle* is set to *U/f* [0] special motor mode.

1-63 Slip Compensation Time Constant

Range:

0.05 - 5.00 s ✱0.10s

Function:

Enter the slip compensation reaction speed. A high value results in slow reaction, and a low value results in quick reaction. If low-frequency resonance problems arise, use a longer time setting.

1-64 Resonance Dampening

Range:

0 - 500 % ✱100%

Function:

Enter the resonance dampening value. Set par. 1-64 and par. 1-65 *Resonance Dampening Time Constant* to help eliminate high-frequency resonance problems. To reduce resonance oscillation, increase the value of par. 1-64.

1-65 Resonance Dampening Time Constant

Range:

5 - 50 msec. ✱5 msec.

Function:

Set par. 1-64 *Resonance Dampening* and par. 1-65 to help eliminate high-frequency resonance problems. Enter the time constant that provides the best dampening.

1-66 Min. Current at Low Speed

Range:

0 - Variable Limit % ✱100%

Function:

Enter the minimum motor current at low speed, see par. 1-53 *Model Shift Frequency*. Increasing this current improves motor torque at low speed.
Par. 1-66 is enabled when par. 1-00 *Configuration Mode* = *Speed open-loop* [0] only. The drive runs with constant current through motor for speeds below 10 Hz.
For speeds above 10 Hz, the motor flux model in the drive controls the motor. Par. 4-16 *Torque Limit Motor Mode* and / or par. 4-17 *Torque Limit Generator Mode* automatically adjust par. 1-66. The parameter with the highest value adjusts par. 1-66. The current setting in par. 1-66 is composed of the torque generating current and the magnetizing current.
Example: Set par. 4-16 *Torque Limit for Motor Mode* to 100% and set par. 4-17 *Torque Limit for Generating Mode* to 60%. Par. 1-66 automatically adjusts to about 127%, depending on the motor size.
This parameter is available for the FC 302 only.

1-67 Load Type

Option:

✱Passive load	[0]
Active load	[1]

Function:

Select *passive load* [0] for conveyers, fan and pump applications. Select *active load* [1] for hoisting applications. When *active load* [1] is selected, set par. 1-66 Min. Current at low speed to a level which corresponds with maximum torque.
This parameter is available for the FC 302 only.

1-68 Minimum Inertia

Range:

0 - Variable Limit ✱Depending on motor data

Function:

Enter the minimum moment of inertia of the mechanical system. Par. 1-68 and par. 1-69 *Maximum Inertia* are used for pre-adjustment of the proportional gain in the speed control, see par. 7-02 *Speed PID Proportional Gain*.
This parameter is available for the FC 302 only.

1-69 Maximum Inertia

Range:

0 - Variable Limit ✱Depending on motor data

Function:

Enter the maximum moment of inertia of the mechanical system. Par. 1-68 *Minimum Inertia* and par. 1-69 are used for pre-adjustment of the proportional gain in the speed control, see par. 7-02 *Speed PID Proportional Gain*.
This parameter is available for the FC 302 only.

□ 1-7* Start Adjustments

Parameters for setting special motor start features.

1-71 Start Delay

Range:

0.0 - 10.0 s ✱0.0s

Function:

This parameter refers to the start function selected in par. 1-72 *Start Function*.
Enter the time delay required before commencing acceleration.

1-72 Start Function

Option:

DC hold/delay time	[0]
DC Brake/delay time	[1]
✱Coast/delay time	[2]
Start speed/ current clockwise operation	[3]
Horizontal operation	[4]
VVC^{plus}/Flux clockwise	[5]

Function:

Select the start function during start delay. This parameter is linked to par. 1-71 *Start Delay*.
Select *DC hold/delay time* [0] to energize the motor with a DC holding current (par. 2-00) during the start delay time.
Select *DC brake/delay time* [1] to energize the motor with a DC braking current (par. 2-01) during the start delay time.
Select *Coast/delay time* [2] to release the shaft coasted drive during the start delay time (inverter off).
[3] and [4] are only possible with VVC+.
Select *Start speed/current clockwise* [3] to connect the function described in par. 1-74

Start Speed (RPM) and par. 1-76 *Start Current* in the start delay time.
Regardless of the value applied by the reference signal, the output speed applies the setting of the start speed in par. 1-74 or par. 1-75 and the output current corresponds to the setting of the start current in par. 1-76 *Start Current*. This function is typically used in hoisting applications without counterweight and especially in applications with a cone motor, where the start is clockwise, followed by rotation in the reference direction. Select *Horizontal operation* [4] to obtain the function described in par. 1-74 and par. 1-76 during the start delay time. The motor rotates in the reference direction. If the reference signal equals zero (0), par. 1-74 *Start speed (RPM)* is ignored and the output speed equals zero (0). The output current corresponds to the setting of the start current in par. 1-76 *Start current*. Select *VVC+/Flux clockwise* [5] for the function described in par. 1-74 only (*Start speed in the start delay time*). The start current is calculated automatically. This function uses the start speed in the start delay time only. Regardless of the value set by the reference signal, the output speed equals the setting of the start speed in par. 1-74. *Start speed/current clockwise* [3] and *VVCplus/Flux clockwise* [5] are typically used in hoisting applications. *Start speed/current in reference direction* [4] is particularly used in applications with counterweight and horizontal movement.

1-73 Flying Start [RPM]

Option:

✱Off (DISABLED)	[0]
On (ENABLED)	[1]

Function:

This function makes it possible to catch a motor which is spinning freely due to a mains drop-out.

Select *Disable* [0] if this function is not required. Select *Enable* [1] to enable the frequency converter to "catch" and control a spinning motor.
When par. 1-73 is enabled par. 1-71 *Start Delay* and 1-72 *Start Function* have no function.

NOTE
This function is not recommended for hoisting applications.

1-74 Start Speed [RPM]

Range:

0 - 600 RPM	✱0 RPM

Function:

Set the motor start speed. After the start signal, the motor output speed leaps to the set value. This parameter can be used for hoist applications (cone rotor motors). Set the start function in par. 1-72 *Start Function* to [3], [4] or [5], and set a start delay time in par. 1-71 *Start Delay*. A reference signal must be present.

1-75 Start Speed [Hz]

Range:

0 - 500 Hz	✱0 Hz

Function:

Set the motor start speed. After the start signal the motor output speed leaps to the set value. This parameter can be used for hoist applications (cone rotor motors). Set the start function in par. 1-72 *Start Function* to [3], [4] or [5], and set a start delay time in par. 1-71 *Start Delay*. A reference signal must be present.

1-76 Start Current

Range:

0.00 - par. 1-24 A	✱0.00 A

Function:

Some motors, such as cone rotor motors, need extra current/starting speed (boost) to disengage the mechanical brake. Adjust par. 1-74 *Start Speed [RPM]* and par. 1-76 to get this boost. Set the required current value to disengage the mechanical brake. Set par. 1-72 *Start Function* to [3] or [4], and set a start delay time in par. 1-71 *Start Delay*. A reference signal must be present.

□ 1-8* Stop Adjustments

Parameters for setting special stop features for the motor.

1-80 Function at Stop

Option:

✱Coast	[0]
DC hold	[1]

Motor check	[2]
Pre-magnetizing	[3]
DC Voltage U0	[4]

Function:

Select the drive function after a stop command or after the speed is ramped down to the settings in par. 1-81 *Min Speed for Function at Stop [RPM]*.
Select *Coasting* [0] to leave the motor in free mode.
Select *DC hold* [1] to energize the motor with a DC holding current (see par. 2-00).
Select *Motor check* [2] to check if a motor is been connected.
Select *Pre-magnetizing* [3] to build up a magnetic field while the motor is stopped. The motor can now produce a quick torque build-up at start.

1-81 Min Speed for Function at Stop [RPM]

Range:

0 - 600 RPM	*1 RPM

Function:

Set the speed at which to activate par. 1-80 *Function at stop*.

1-82 Min Speed for Function at Stop [Hz]

Range:

0.0 - 500 Hz	*0.0 Hz

Function:

Set the output frequency at which to activate par. 1-80 *Function at stop*.

1-83 Precise Stop Function

Option:

*Precise ramp stop	[0]
Counter stop with reset	[1]
Counter stop without reset	[2]
Speed compensated stop	[3]
Speed compensated counter stop with reset	[4]
Speed compensated counter stop without reset	[5]

Function:

Select *Precise ramp stop* [0] to achieve high repetitive precision at the stopping point.
Select *Counter stop* (with or without reset) to run the adjustable frequency drive from receipt of a pulse start signal until the number of pulses programmed by the user in par. 1-84 *Precise Stop Counter Value* has been received at input terminal 29 or input terminal 33.
An internal stop signal will activate the normal ramp-down time (par. 3-42, 3-52, 3-62 or 3-72). The counter function is activated (starts timing) at the edge of the start signal (when it changes from stop to start).
Speed-compensated stop [3]: To stop at precisely the same point, regardless of the present speed, the stop signal is delayed internally when the present speed is lower than the maximum speed (set in par. 4-13).
Counter stop and Speed-compensated stop can be combined with or without reset.
Counter stop with reset [1]. After each precise stop, the number of pulses counted during ramp-down 0 rpm is reset.
Counter stop without reset [2]. The number of pulses counted during ramp-down to 0 rpm is deducted from the counter value in par. 1-84.
This parameter cannot be adjusted while the motor is running.

1-84 Precise Stop CounterValue

Range:

0 - 999999999	*100000

Function:

Enter the counter value to be used in the integrated precise stop function, par. 1-83.
The maximum permissible frequency at terminal 29 or 33 is 110 kHz.

1-85 Precise Stop Speed Compensation Delay

Range:

1-100 ms	*10 ms

Function:

Enter the delay time for sensors, PLCs, etc. for use in par. 1-83 *Precise Stop Function*.
In speed compensated stop mode, the delay time at different frequencies has a major influence on the stop function.

□ 1-9* Motor Temperature

Parameters for setting the temperature protection features for the motor.

1-90 Motor Thermal Protection

Option:

*No protection	[0]

Thermistor warning	[1]
Thermistor trip	[2]
ETR warning 1	[3]
ETR trip 1	[4]
ETR warning 2	[5]
ETR trip 2	[6]
ETR warning 3	[7]
ETR trip 3	[8]
ETR warning 4	[9]
ETR trip 4	[10]

Function:

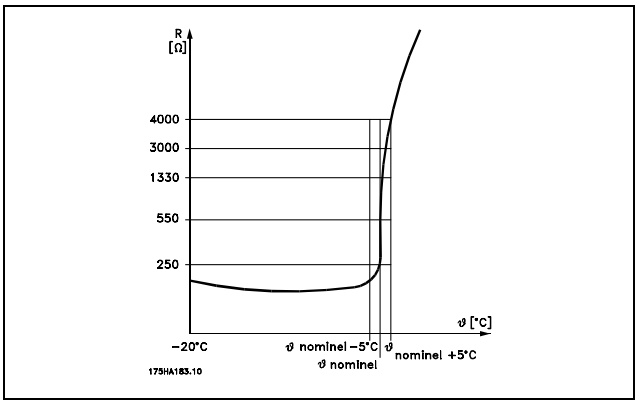
The frequency converter determines the motor temperature formotor protection in two different ways:

- Via a thermistor sensor connected to one of the analog or digital inputs (par. 1-93 *Thermistor Source*).
- Via calculation (ETR = Electronic Terminal Relay) of the thermal load, based on the actual load and time. The calculated thermal load is compared with the rated motor current $I_{M,N}$ and the rated motor frequency $f_{M,N}$. The calculations estimate the need for a lower load at lower speed due to less cooling from the fan incorporated in the motor.

Select *No protection* [0] for a continuously overloaded motor, when no warning or trip of drive is required.
Select *Thermistor warning* [1] to activate a warning when the connected thermistor in the motor reacts in the event of motor over-temperature.
Select *Thermistor trip* [2] to stop (trip) the frequency converter when the connected thermistor in the motor reacts in the event of motor over-temperature.

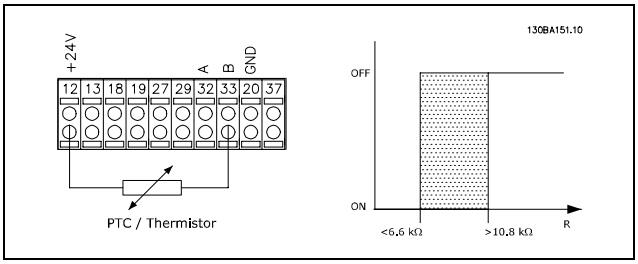
The thermistor cut-out value is > 3 kΩ.

Integrate a thermistor (PTC sensor) in the motor for winding protection.

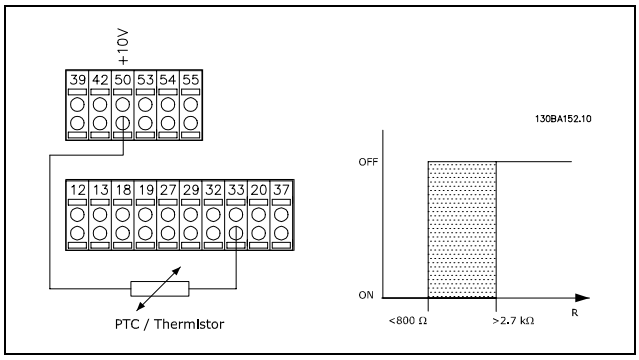


Motor protection can be implemented using a range of techniques: PTC sensor in motor windings; mechanical thermal switch (Klixon type); or Electronic Thermal Relay (ETR).
See parameter group 1-9* *Motor Temperature*.

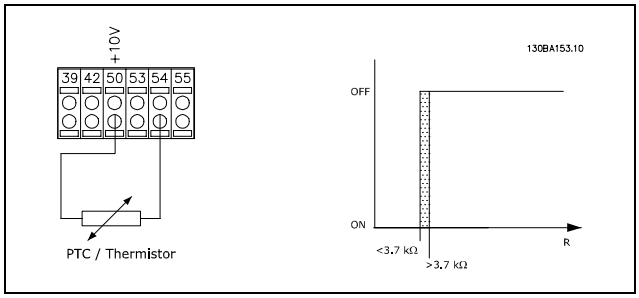
Using a digital input and 24 V as power supply:
Example: The frequency converter trips when the motor temperature is too high Parameter set-up:
Set Par. 1-90 *Motor Thermal Protection* to *Thermistor Trip* [2]
Set Par. 1-93 *Thermistor Source* to *Digital Input* [6]



Using a digital input and 10 V as power supply:
Example: The frequency converter trips when the motor temperature is too high.
Parameter set-up:
Set Par. 1-90 *Motor Thermal Protection* to *Thermistor Trip* [2]
Set Par. 1-93 *Thermistor Source* to *Digital Input* [6]



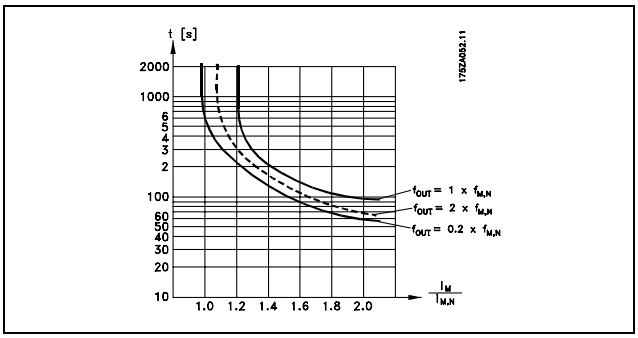
Using an analog input and 10 V as power supply:
Example: The frequency converter trips when the motor temperature is too high.
Parameter set-up:
Set Par. 1-90 *Motor Thermal Protection* to *Thermistor Trip* [2]
Set Par. 1-93 *Thermistor Source* to *Analog Input 54* [2]
Do not select a reference source.



Input Digital/analog	Supply Voltage Volt	Threshold Cut-out Values
Digital	24 V	< 6.6 kΩ - > 10.8 kΩ
Digital	10 V	< 800Ω - > 2.7 kΩ
Analog	10 V	< 3.0 kΩ - > 3.0 kΩ

NOTE
Check that the chosen supply voltage follows the specification of the used thermistor element.

Select *ETR Warning 1-4*, to activate a warning on the display when the motor is overloaded.
Select *ETR Trip 1-4* to trip the frequency converter when the motor is overloaded.
Programme a warning signal via one of the digital outputs. The signal appears in the event of a warning and if the frequency converter trips (thermal warning).
ETR (Electronic Terminal Relay) functions 1-4 will calculate the load when the set-up where they were selected is active. For example ETR starts calculating when setup 3 is selected. For the North American market: The ETR functions provide class 20 motor overload protection in accordance with NEC.

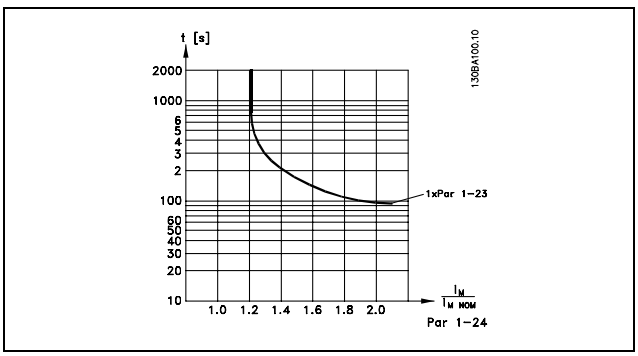


1-91 Motor External Fan

Option:

✱No	[0]
Yes	[1]

Function:
Select *No* [0] if no external fan is required, i.e. the motor is derated at low speed.
Select *Yes* [1] to apply an external motor fan (external ventilation), so no derating of the motor is required at low speed. The graph below is followed if the motor current is lower than nominal motor current (see par. 1-24). If the motor current exceeds nominal current, the operation time still decreases as if no fan were installed.



✱ default setting ( ) display text [ ] value for use in communication via serial communication port

This parameter cannot be adjusted while the motor is running.

1-93 Thermistor Source

Option:

* None	[0]
Analog input 53	[1]
Analog input 54	[2]
Digital input 18	[3]
Digital input 19	[4]
Digital input 32	[5]
Digital input 33	[6]

Function:

Select the input to which the thermistor (PTC sensor) should be connected. An analog input option [1] or [2] cannot be selected if the analog input is already in use as a reference source (selected in par. 3-15 *Reference Source* 1, 3-16 *Reference Source* 2 or 3-17 Reference Source 3).
This parameter cannot be adjusted while the motor is running.

□ Parameters: Brakes

□ 2-** Brakes

Parameter group for setting brake features in the adjustable frequency drive.

□ 2-0* DC Brakes

Parameter group for configuring the DC brake and DC hold functions.

2-00 DC Hold Current

Range:

0 - 100% ✱50%

Function:

Enter a value for holding current as a percentage of the rated motor current $I_{M,N}$ set in par. 1-24 Motor Current. 100% DC holding current corresponds to $I_{M,N}$.
This parameter holds the motor function (holding torque) or pre-heats the motor.
This parameter is active if *DC hold* is selected in par. 1-72 *Start Function* [0] or par. 1-80 *Function at Stop* [1].

NOTE
The maximum value depends on the rated motor current.
NOTE
Avoid 100% current for too long. It may damage the motor.

2-01 DC Brake Current

Range:

0 - 100% ✱50%

Function:

Enter a value for current as a percentage of the rated motor current $I_{M,N}$, see par. 1-24 *Motor Current*. 100% DC braking current corresponds to $I_{M,N}$. DC brake current is applied on a stop command, when the speed is lower than the limit set in par. 2-03 *DC Brake Cut In Speed*; when the DC Brake Inverse function is active; or via the serial communication port. The braking current is active during the time period set in par. 2-02 *DC Braking Time*.

NOTE
The maximum value depends on the rated motor current.
NOTE
Avoid 100 % current for too long. It may damage the motor.

2-02 DC Braking Time

Range:

0.0 - 60.0 s. ✱10.0s.

Function:

Set the duration of the DC braking current set in par. 2-01, once activated.

2-03 DC Brake Cut-In Speed

Range:

0 - par. 4-13 RPM ✱0RPM

Function:

Set the DC brake cut-in speed for activation of the DC braking current set in par. 2-01, upon a stop command.

□ 2-1* Brake Energy Funct.

Parameter group for selecting dynamic braking parameters.

2-10 Brake Function

Option:

✱Off	[0]
Resistor brake	[1]

Function:

Select *Off* [0] if no brake resistor is installed. Select *Resistor brake* [1] if a brake resistor is incorporated in the system, for dissipation of surplus brake energy as heat. Connecting a brake resistor allows a higher DC link voltage during braking (generating operation). The Resistor brake function is only active in frequency converters with an integral dynamic brake.

2-11 Brake Resistor (ohm)

Option:

Ohm Dependson unit size.

Function:

Set the brake resistor value in Ohms. This value is used for monitoring the power to the brake resistor in par. 2-13 *Brake Power Monitoring*. This

parameter is only active in frequency converters with an integral dynamic brake.

2-12 Braking Energy Limit (kW)

Range:

0.001 - Variable Limit kW ✱kW

Function:

Set the monitoring limit of the braking energy transmitted to the resistor.
The monitoring limit is a product of the maximum duty cycle (120 sec.) and the maximum power of the brake resistor at that duty cycle.
See the formula below.

For 200 - 240 V units: $P_{resistor} = \frac{390^2 * dutytime}{R * 120}$

For 380 - 480 V units $P_{resistor} = \frac{778^2 * dutytime}{R * 120}$

For 380 - 500 V units $P_{resistor} = \frac{810^2 * dutytime}{R * 120}$

For 575 - 600 V units $P_{resistor} = \frac{943^2 * dutytime}{R * 120}$

This parameter is only active in adjustable frequency drives with an integral dynamic brake.

2-13 Brake Power Monitoring

Option:

✱Off	[0]
Warning	[1]
Trip	[2]
Warning and Trip	[3]

Function:

This parameter is only active in frequency converters with an integral dynamic brake.
This parameter enables monitoring of the power to the brake resistor. The power is calculated on the basis of the resistance (par. 2-11 *Brake Resistor* (Ohm)), the DC link voltage, and the resistor duty time.
Select *Off* [0] if no brake power monitoring is required.
Select *Warning* [1] to activate a warning on the display when the power transmitted over 120 s exceeds 100% of the monitoring limit (par. 2-12 *Brake Power Limit (kW)*).
The warning disappears when the transmitted power falls below 80% of the monitoring limit.
Select *Trip* [2] to trip the frequency converter and display an alarm when the calculated power exceeds 100% of the monitoring limit.
Select *Warning and Trip* [3] to activate both of the above, including warning, trip and alarm.
If power monitoring is set to *Off* [0] or *Warning* [1], the brake function remains active, even if the monitoring limit is exceeded. This may lead to thermal overload of the resistor. It is also possible to generate a warning via a relay/digital outputs. The measuring accuracy of the power monitoring depends on the accuracy of the resistance of the resistor (better than ± 20%).

2-15 Brake Check

Option:

✱Off	[0]
Warning	[1]
Trip	[2]
Trip and Stop	[3]

Function:

Select type of test and monitoring function to check the connection to the brake resistor, or whether a brake resistor is present, and then display a warning or an alarm in the event of a fault. The brake resistor disconnection function is tested during power-up, and during braking. However the brake IGBT test is performed when there is no braking. A warning or trip disconnects the brake function.
The testing sequence is as follows:

1. The DC link ripple amplitude is measured for 300 ms without braking.
2. The DC link ripple amplitude is measured for 300 ms with the brake turned on.
3. If the DC link ripple amplitude while braking is lower than the DC link ripple amplitude before braking + 1 %. Brake check failed, return a warning or alarm.
4. If the DC link ripple amplitude while braking is higher than the DC link ripple amplitude before braking + 1 %. Brake check OK.

Select *Off* [0] to monitor the brake resistor and the brake IGBT for a short-circuit during operation. If a short-circuit occurs, a warning appears.

Select *Warning* [1] to monitor the brake resistor and brake IGBT for a short-circuit, and to run a test for brake resistor disconnection during power-up.
Select *Trip* [2], to monitor for a short-circuit or disconnection of the brake resistor, or a short-circuit of the brake IGBT. If a fault occurs the frequency converter cuts out while displaying an alarm (trip locked).
Select *Stop and Trip* [3] to monitor for a short-circuit or disconnection of the brake resistor, or a short-circuit of the brake IGBT. If a fault occurs the frequency converter ramps down to coast and then trips. A trip lock alarm is displayed.
Select *AC Brake* [4] to monitor for a short-circuit or disconnection of the brake resistor, or a short-circuit of the brake IGBT. If a fault occurs the frequency converter performs a controlled ramp down. This option is available for FC 302 only.

NOTE
NB!: Remove a warning arising in connection with *Off* [0] or *Warning* [1] by cycling the mains supply. The fault must be corrected first. For *Off* [0] or *Warning* [1], the frequency converter keeps running even if a fault is located.

This parameter is only active in frequency converters with an integral dynamic brake.

2-16 AC Brake Max. Current

Range:

0 - 200% ✱ 100%

Function:

Enter the maximum permissible current when using AC brake to avoid overheating motor windings. The AC brake function is available in Flux mode only (FC 302 only).

2-17 Over-voltage Control

Option:

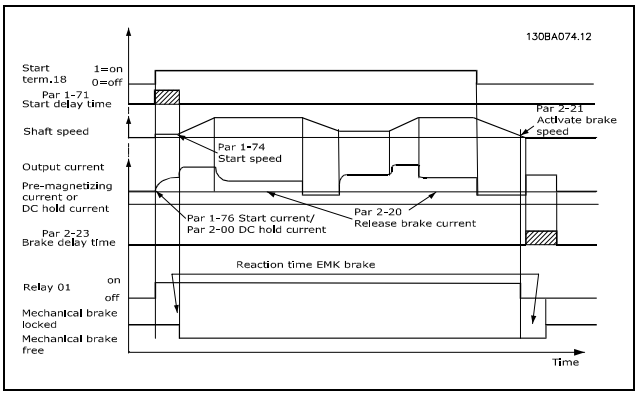
✱ Disabled	[0]
Enabled (not at stop)	[1]
Enabled	[2]

Function:

Over-voltage control (OVC) reduces the risk of the drive tripping due to an over voltage on the DC link caused by generative power from the load.
Select *Disabled* [0] if no OVC is required.
Select *Enabled* [2] to activate OVC.
Select *Enabled (not at stop)* [1] to activate OVC except when using a stop signal to stop the frequency converter.

□ 2-2* Mechanical Brake

Parameters for controlling operation of an electro-magnetic (mechanical) brake, typically required in hoisting applications.
To control a mechanical brake, a relay output (relay 01 or relay 02) or a programmed digital output (terminal 27 or 29) is required. Normally this output must be closed during periods when the drive is unable to 'hold' the motor, e.g. due to an excessive load. Select *Mechanical Brake Control* [32] for applications with an electro-magnetic brake in par. 5-40 *Function Relay*, par. 5-30 *Terminal 27 Digital Output*, or par. 5-31 *Terminal 29 Digital Output*. When selecting *Mechanical brake control* [32], the mechanical brake is closed from start up until the output current is above the level selected in par. 2-20 *Release Brake Current*. During stop, the mechanical brake activates when the speed falls below the level specified in par. 2-21 *Activate Brake Speed [RPM]*. If the frequency converter enters an alarm condition or an over-current or over-voltage situation, the mechanical brake immediately cuts in. This is also the case during safe stop.



2-20 Release Brake Current

Range:

0.00 - par. 16-37 A ✱ 0.00 A

✱ default setting ( ) display text [ ] value for use in communication via serial communication port

Function:

Set the motor current for release of the mechanical brake, when a start condition is present. The upper limit is specified in par. 16-37 *Inv. Max. Current*.

2-21 Activate Brake Speed [RPM]

Range:

0 - par. 4-53 RPM ✱0RPM

Function:

Set the motor speed for activation of the mechanical brake, when a stop condition is present. The upper speed limit is specified in par. 4-53 *Warning Speed High*.

2-22 Activate Brake Speed [Hz]

Range:

0 - Max. speed ✱0 Hz

Function:

Set the motor frequency for activation of the mechanical brake, when a stop condition is present.

2-23 Activate Brake Delay

Range:

0.0 - 5.0 s ✱0.0s

Function:

Enter the brake delay time of the coast after ramp-down time. The shaft is held at zero speed with full holding torque. Ensure that the mechanical brake has locked the load before the motor enters coast mode. See *Control of Mechanical Brake section*.

□ Parameters: Reference/Ramps

□ 3-** Reference Limits

Parameters for reference handling, defining limitations, and configuring the reaction of the adjustable frequency drive to changes.

□ 3-0* Reference Limits

Parameters for setting the reference unit, limits and ranges.

3-00 Reference Range

Option:

Min. - Max	[0]
✱-Max - +Max	[1]

Function:

Select the range of the reference signal and the feedback signal. Signal values can be positive only, or positive and negative. The minimum limit may have a negative value, unless *Speed closed loop* [1] control is selected in par. 1-00 *Configuration Mode*. Select *Min. - Max* [0] for positive values only. Select-Max - +Max [1] for both positive and negative values.

3-01 Reference/Feedback Unit

Option:

None	[0]
✱%	[1]
RPM	[2]
Nm	[4]
bar	[5]
Pa	[6]
PPM	[7]
CYCLE/min	[8]
PULSE/s	[9]
UNITS/s	[10]
UNITS/min	[11]
UNITS/h	[12]
°C	[13]
F	[14]
m^3/s	[15]
m^3/min	[16]
m^3/h	[17]
t/min	[23]
t/h	[24]
m	[25]
m/s	[26]
m/min	[27]
in wg	[29]
gal/s	[30]
gal/min	[31]
gal/h	[32]
lb/s	[36]
lb/min	[37]
lb/h	[38]
lb ft	[39]
ft/s	[40]
ft/min	[41]
l/s	[45]
l/min	[46]
l/h	[47]
kg/s	[50]
kg/min	[51]
kg/h	[52]
ft^3/s	[55]
ft^3/min	[56]
ft^3/h	[57]

Function:

Select the unit to be used in process PID control references and feedback.

3-02 Minimum Reference

Range:

-100000.000 - par. 3-03 ✱0.000 Unit

Function:

Enter the Minimum Reference. The Minimum Reference is the lowest value obtainable by summing all references.
Minimum Reference is active only when par. 3-00 *Reference Range* is set to *Min.- Max.* [0].
The Minimum Reference unit matches
- the choice of configuration in par 1-00 *Configuration Mode*: for *Speed closed loop* [1], RPM; for *Torque* [2], Nm.
- the unit selected in par. 3-01 *Reference/Feedback Unit*.

3-03 Maximum Reference

Range:

Par. 3-02 - 100000.000 ✱1500.000 Unit

Function:

Enter the maximum reference. The maximum reference is the highest value obtainable by summing all references. The maximum reference unit matches

- The choice of configuration in par. 1-00 *Configuration Mode*: for *Speed closed-loop* [1], RPM; for *Torque* [2], Nm.
- The unit selected in par. 3-01 *Reference/Feedback Unit*.

3-04 Reference Function

Option:

*Sum	[0]
External/Preset	[1]

Function:

Select *Sum* [0] to sum both external and preset reference sources.
Select *External/Preset* [1] to use either the preset or the external reference source.

□ **3-1* References**

Parameters for setting up the reference sources. Select the preset reference(s). *Select Preset ref. bit 0 / 1 / 2* [16], [17] or [18] for the corresponding digital inputs in parameter group 5.1* *Digital Inputs*.

3-10 Preset Reference

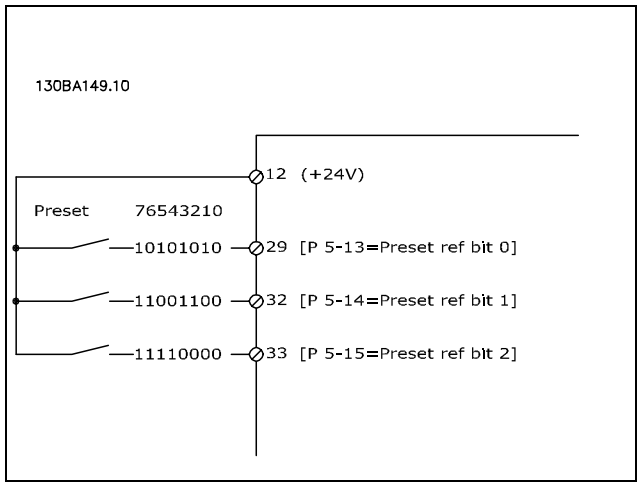
Array [8]

Range:

-100.00 - 100.00% *0.00%

Function:

Enter up to eight different preset references (0-7) in this parameter, using array programming. The preset reference is stated as a percentage of the value Ref_{MAX} (par. 3-03 *Maximum Reference*) or as a percentage of the other external references. If a Ref_{MIN} 0 (Par. 3-02 *Minimum Reference*) is programmed, the preset reference is calculated as a percentage of the full reference range, i.e., on the basis of the difference between Ref_{MAX} and Ref_{MIN}. Afterwards, the value is added to Ref_{MIN}. When using preset references, select Preset ref. bit 0 / 1 / 2 [16], [17] or [18] for the corresponding digital inputs in parameter group 5.1* Digital Inputs.



3-11 Jog Speed [Hz]

Range:

0.0 - par. 4-14 Hz *5 Hz

Function:

The jog speed is a fixed output speed at which the adjustable frequency drive is running when the jog function is activated.
See also par. 3-80.

3-12 Catch-up/slow-down value

Range:

0.00 - 100.00% *0.00%

Function:

Enter a percentage (relative) value to be either added to or deducted from the actual reference for catch-up or slow-down respectively. If *Catch-up* is selected via one of the digital inputs (par. 5-10 to par. 5-15), the percentage (relative) value is added to the total reference. If *Slow-down* is selected via one of the digital inputs (par. 5-10 to par. 5-15), the percentage (relative) value is deducted from the total reference. Obtain extended functionality with the DigiPot function. See parameter group 3-9* *Digital Potentiometer*.

3-13 Reference Site

Option:

*Linked to Hand / Auto	[0]
Remote	[1]
Local	[2]

Function:

Select which reference site to activate.

Select *Linked to Hand / Auto* [0] to use the local reference when in Hand mode; or the remote reference when in Auto mode.
Select *Remote* [1] to use the remote reference in both Hand mode and Auto mode.
Select *Local* [2] to use the local reference in both Hand mode and Auto mode.

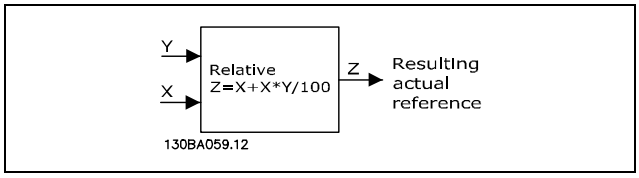
3-14 Preset Relative Reference

Range:

-100.00 - 100.00% ✱ 0.00%

Function:

Define a fixed value (in %) to be added to the variable value (defined in par. 3-18 *Relative Scaling Reference Source*). The sum of the fixed and variable values (labeled Y in the illustration below) is multiplied with the actual reference (labeled X in the illustration below). This product is then added to the actual reference (X+X*Y/100) to give the resulting actual reference.



3-15 Reference Resource 1

Option:

No function	[0]
✱ Analog input 53	[1]
Analog input 54	[2]
Frequency input 29	[7]
Frequency input 33	[8]
Local bus reference	[11]
Digital pot.meter	[20]

Function:

Select the reference input to be used for the first reference signal. Par. 3-15, 3-16 and 3-17 define up to three different reference signals. The sum of these reference signals defines the actual reference. This parameter cannot be adjusted while the motor is running.

3-16 Reference Resource 2

Option:

No function	[0]
Analog input 53	[1]
Analog input 54	[2]
Frequency input 29	[7]
Frequency input 33	[8]
Local bus reference	[11]
✱ Digital pot.meter	[20]

Function:

Select the reference input to be used for the second reference signal. Par. 3-15, 3-16 and 3-17 define up to three different reference signals. The sum of these reference signals defines the actual reference. This parameter cannot be adjusted while the motor is running.

3-17 Reference Resource 3

Option:

No function	[0]
Analog input 53	[1]
Analog input 54	[2]
Frequency input 29	[7]
Frequency input 33	[8]
✱ Local bus reference	[11]
Digital pot.meter	[20]

Function:

Select the reference input to be used for the third reference signal. Par. 3-15, 3-16 and 3-17 define up to three different reference signals. The sum of these reference signals defines the actual reference. This parameter cannot be adjusted while the motor is running.

3-18 Relative Scaling Reference Resource

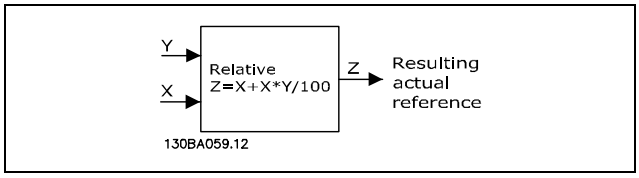
Option:

✱ No function	[0]
Analog input 53	[1]
Analog input 54	[2]
Frequency input 29	[7]
Frequency input 33	[8]
Local bus reference	[11]
Digital pot.meter	[20]

Function:

Select a variable value to be added to the fixed value (defined in par. 3-14*Preset Relative Reference*). The sum of the fixed and variable values (labelled Y in

the illustration below) is multiplied with the actual reference (labelled X in the illustration below). This product is then added to the actual reference (X+X*Y/100) to give the resultant actual reference.



This parameter cannot be adjusted while the motor is running.

3-19 Jog Speed [RPM]

Range:

0 - par. 4-13 RPM ✱150 RPM

Function:

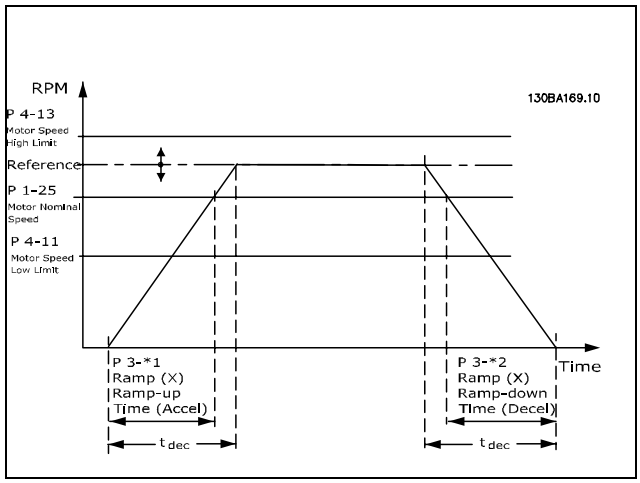
Enter a value for the jog speed n_{JOG}, which is a fixed output speed. The adjustable frequency drive runs at this speed when the jog function is activated. The maximum limit is defined in par. 4-13 *Motor Speed High Limit (Hz)*. See also par. 3-80.

□ **Ramps**

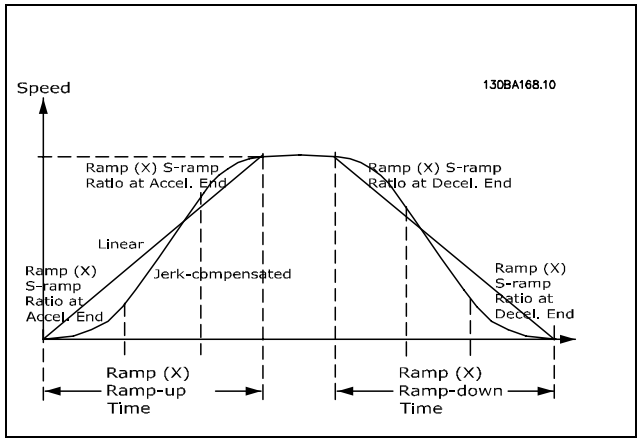
3-4* Ramp 1

For each of four ramps (par. 3-4*, 3-5*, 3-6* and 3-7*), configure the ramp parameters: ramp type, ramping times (duration of acceleration and deceleration) and level of jerk compensation for S ramps.

Start by setting the linear ramping times corresponding to the figures and formulas.



If S-ramps are selected, then set the level of non-linear jerk compensation required. Set jerk compensation by defining the proportion of ramp-up and ramp-down times where acceleration and deceleration are variable (i.e., increasing or decreasing). The S-ramp acceleration and deceleration settings are defined as a percentage of the actual ramp time.



3-40 Ramp 1 Type

Option:

✱Linear [0]
S-ramp [1]

Function:

Selects the desired ramp type, depending on requirements for acceleration/deceleration. A linear ramp will give constant acceleration during ramping. An S-ramp will give

non-linear acceleration, compensating for jerk in the application.

3-41 Ramp 1 Ramp-up Time

Range:

0.01 - 3600.00 s ✱ s

Function:

Enter the ramp-up time, i.e., the acceleration time from 0 RPM to the rated motor speed $n_{M,N}$ (par. 1-25). Choose a ramp-up time such that the output current does not exceed the current limit in par. 4-18 during ramping. The value 0.00 corresponds to 0.01 sec. in speed mode. See ramp-down time in par. 3-42.

$$Par.3-41 = \frac{t_{acc} * n_{norm}\ [par.1-25]}{\triangle ref\ [RPM]}\ [s]$$

3-42 Ramp 1 Ramp-down Time

Range:

0.01 - 3600.00 s ✱ s

Function:

Enter the ramp-down time, i.e., the deceleration time from the rated motor speed $n_{M,N}$ (par. 1-25) to 0 RPM. Choose a ramp-down time such that no over-voltage arises in the inverter due to regenerative operation of the motor, and such that the generated current does not exceed the current limit set in par. 4-18. The value 0.00 corresponds to 0.01 s in speed mode. See ramp-up time in par. 3-41.

$$Par.3-42 = \frac{t_{acc} * n_{norm}\ [par.1-25]}{\triangle ref\ [RPM]}\ [s]$$

3-45 Ramp 1 S-ramp Ratio at Accel. Start

Range:

1 - 99% ✱50%

Function:

Enter the proportion of the total ramp-up time (par. 3-41) in which the acceleration torque increases. The larger the percentage value, the greater the jerk compensation achieved, and thus the lower the torque jerks occurring in the application.

3-46 Ramp 1 S-ramp Ratio at Accel. End

Range:

1 - 99% ✱50%

Function:

Enter the proportion of the total ramp-up time (par. 3-41) in which the acceleration torque decreases. The larger the percentage value, the greater the jerk compensation achieved, and thus the lower the torque jerks in the application.

3-47 Ramp 1 S-ramp Ratio at Decel. Start

Range:

1 - 99% ✱50%

Function:

Enter the proportion of the total ramp-down time (par. 3-42) where the deceleration torque increases. The larger the percentage value, the greater the jerk compensation achieved, and thus the lower the torque jerks in the application.

3-48 Ramp 1 S-ramp Ratio at Decel. End

Range:

1 - 99% ✱50%

Function:

Enter the proportion of the total ramp-down time (par. 3-42) where the deceleration torque decreases. The larger the percentage value, the greater the jerk compensation achieved, and thus the lower the torque jerks in the application.

□ **3-5* Ramp 2**

Choosing ramp parameters, see 3-4*.

3-50 Ramp 2 Type

Option:

✱Linear	[0]
S-ramp	[1]

Function:

Select the ramp type, depending on requirements for acceleration/deceleration. A linear ramp will give constant acceleration during ramping. An S-ramp will give non-linear acceleration, compensating for jerk in the application.

NOTE
If S-ramp [1] is selected and the reference during ramping is changed, the ramp time may be prolonged in order to allow jerk free movement which may result in a longer start or stop way.
Additional adjustment of the S-ramp ratios or switching initiators may be necessary.

3-51 Ramp 2 Ramp-up Time

Range:
0.01 - 3600.00 s ✱s

Function:
Enter the ramp-up time, i.e., the acceleration time from 0 RPM to the rated motor speed $n_{M,N}$ (par. 1-25). Choose a ramp-up time such that the output current does not exceed the current limit in par. 4-18 during ramping. The value 0.00 corresponds to 0.01 sec. in speed mode. See ramp-down time in par. 3-52.

$$Par.3-51 = \frac{t_{acc} * n_{norm}\ [par.1-25]}{\triangle ref\ [RPM]}\ [sec]$$

3-52 Ramp 2 Ramp-down Time

Range:
0.01 - 3600.00 s. ✱s

Function:
Enter the ramp-down time, i.e. the deceleration time from the rated motor speed $n_{M,N}$ (par. 1-25) to 0 RPM. Choose a ramp-down time such that no over-voltage arises in the inverter due to regenerative operation of the motor, and such that the generated current does not exceed the current limit set in par. 4-18. The value 0.00 corresponds to 0.01 s in speed mode. See ramp-up time in par. 3-51.

$$Par.3-52 = \frac{t_{dec} * n_{norm}\ [par.1-25]}{\triangle ref\ [RPM]}\ [sec]$$

3-55 Ramp 2 S-ramp Ratio at Accel. Start

Range:
1 - 99% ✱50%

Function:
Enter the proportion of the total ramp-up time (par. 3-51) in which the acceleration torque increases. The larger the percentage value, the greater the jerk compensation achieved, and thus the lower the torque jerks in the application.

3-56 Ramp 2 S-ramp Ratio at Accel. End

Range:
1 - 99% ✱50%

Function:
Enter the proportion of the total ramp-up time (par. 3-51) in which the acceleration torque decreases. The larger the percentage value, the greater the jerk compensation achieved, and thus the lower the torque jerks in the application.

3-57 Ramp 2 S-ramp Ratio at Decel. Start

Range:
1 - 99% ✱50%

Function:
Enter the proportion of the total ramp-down time (par. 3-52) where the deceleration torque increases The larger the percentage value, the greater the jerk compensation achieved, and thus the lower the torque jerks in the application.

3-58 Ramp 2 S-ramp Ratio at Decel. End

Range:
1 - 99% ✱50%

Function:
Enter the proportion of the total ramp-down time (par. 3-52) where the deceleration torque decreases. The larger the percentage value, the greater the jerk compensation achieved, and thus the lower the torque jerks in the application.

□ 3-6* Ramp 3

Configure ramp parameters, see 3-4*.

3-60 Ramp 3 Type

Option:

✱Linear	[0]
S-ramp	[1]

Function:

Select the ramp type, depending on requirements for acceleration and deceleration. A linear ramp will give constant acceleration during ramping. An S-ramp will give non-linear acceleration, compensating for jerk in the application.

NOTE

If S-ramp [1] is selected and the reference during ramping is changed, the ramp time may be prolonged in order to allow jerk free movement which may result in a longer start or stop way. Additional adjustment of the S-ramp ratios or switching initiators may be necessary.

3-61 Ramp 3 Ramp up Time

Range:

0.01 - 3600.00 s ✱s

Function:

Enter the ramp-up time, i.e., the acceleration time from 0 RPM to the rated motor speed $n_{M,N}$ (par. 1-25). Choose a ramp-up time such that the output current does not exceed the current limit in par. 4-18 during ramping. The value 0.00 corresponds to 0.01 sec. in speed mode. See ramp-down time in par. 3-62.

3-62 Ramp 3 Ramp-down Time

Range:

0.01 - 3600.00 s ✱s

Function:

Enter the ramp-down time, i.e., the deceleration time from the rated motor speed nM,N (par. 1-25) to 0 RPM. Choose a ramp-down time such that no over-voltage arises in the inverter due to regenerative operation of the motor, and such that the generated current does not exceed the current limit set in par. 4-18. The value 0.00 corresponds to 0.01 s in speed mode. See ramp-up time in par. 3-61.

$$Par.3-62 = \frac{t_{dec} * n_{norm}\ [\,par.1-25\,]}{\triangle ref\ [RPM]}\ [sec]$$

3-65 Ramp 3 S-ramp Ratio at Accel. Start

Range:

1 - 99% ✱50%

Function:

Enter the proportion of the total ramp-up time (par. 3-61) in which the acceleration torque increases. The larger the percentage value, the greater the jerk compensation achieved, and thus the lower the torque jerks in the application.

3-66 Ramp 3 S-ramp Ratio at Accel. End

Range:

1 - 99% ✱50%

Function:

Enter the proportion of the total ramp-up time (par. 3-61) in which the acceleration torque decreases. The larger the percentage value, the greater the jerk compensation achieved, and thus the lower the torque jerks in the application.

3-67 Ramp 3 S-ramp Ratio at Decel. Start

Range:

1 - 99% ✱50%

Function:

Enter the proportion of the total ramp-down time (par. 3-62) where the deceleration torque increases. The larger the percentage value, the greater the jerk compensation achieved, and thus the lower the torque jerks in the application.

3-68 Ramp 3 S-ramp Ratio at Decel. End

Range:

1 - 99% ✱50%

Function:

Enter the proportion of the total ramp-down time (par. 3-62) where the deceleration torque decreases. The larger the percentage value, the

greater the jerk compensation achieved, and thus the lower the torque jerks in the application.

□ **3-7* Ramp 4**
Configure ramp parameters, see 3-4*.

3-70 Ramp 4 Type

Option:

*Linear	[0]
S-ramp	[1]

Function:
Select the ramp type, depending on requirements for acceleration and deceleration. A linear ramp will give constant acceleration during ramping. An S-ramp will give non-linear acceleration, compensating for jerk in the application.

NOTE
If S-ramp [1] is selected and the reference during ramping is changed, the ramp time may be prolonged in order to allow jerk free movement which may result in a longer start or stop way.
Additional adjustment of the S-ramp ratios or switching initiators may be necessary.

3-71 Ramp 4 Ramp-up Time

Range:
0.01 - 3600.00 s *s

Function:
Enter the ramp-up time, i.e., the acceleration time from 0 RPM to the rated motor speed $n_{M,N}$ (par. 1-25). Choose a ramp-up time such that the output current does not exceed the current limit in par. 4-18 during ramping. The value 0.00 corresponds to 0.01 sec. in speed mode. See ramp-down time in par. 3-72.

$$Par.3-71 = \frac{t_{acc} * n_{norm}\ [\,par.1-25\,]}{\triangle ref\ [RPM]}\ [sec]$$

3-72 Ramp 4 Ramp-down Time

Range:
0.01 - 3600.00 s *s

Function:
Enter the ramp-down time, i.e., the deceleration time from the rated motor speed $n_{M,N}$ (par. 1-25) to 0 RPM. Choose a ramp-down time such that no overvoltage arises in the inverter due to regenerative operation of the motor, and such that the generated current does not exceed the current limit set in par. 4-18. The value 0.00 corresponds to 0.01 s in speed mode. See ramp-up time in par. 3-71.

$$Par.3-72 = \frac{t_{dec} * n_{norm}\ [\,par.1-25\,]}{\triangle ref\ [RPM]}\ [sec]$$

3-75 Ramp 4 S-ramp Ratio at Accel. Start

Range:
1 - 99% *50%

Function:
Enter the proportion of the total ramp-up time (par. 3-71) in which the acceleration torque increases. The larger the percentage value, the greater the jerk compensation achieved, and thus the lower the torque jerks in the application.

3-76 Ramp 4 S-ramp Ratio at Accel. End

Range:
1 - 99% *50%

Function:
Enter the proportion of the total ramp-up time (par. 3-71) in which the acceleration torque decreases. The larger the percentage value, the greater the jerk compensation achieved, and thus the lower the torque jerks in the application.

3-77 Ramp 4 S-ramp Ratio at Decel. Start

Range:
1 - 99% *50%

Function:
Enter the proportion of the total ramp-down time (par. 3-72) where the deceleration torque increases. The larger the percentage value, the greater the jerk compensation achieved, and thus the lower the torque jerks in the application.

3-78 Ramp 4 S-ramp Ratio at Decel. End

Range:
1 - 99% *50%

Function:
Enter the proportion of the total ramp-down time (par. 3-72) where the deceleration torque decreases. The larger the percentage value, the

greater the jerk compensation achieved, and thus the lower the torque jerks in the application.

□ 3-8* Other Ramps

Configure parameters for special ramps, e.g., jog or quick stop.

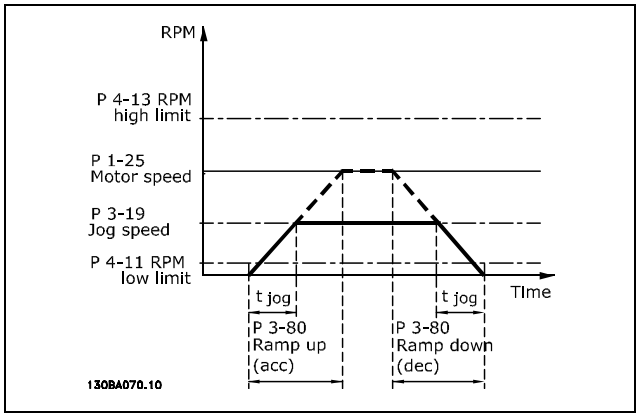
3-80 Jog Ramp Time

Range:

0.01 - 3600.00 s ✱s

Function:

Enter the jog ramp time, i.e. the acceleration/deceleration time between 0 RPM and the rated motor frequency $n_{M,N}$ (set in par. 1-25 *Motor Nominal Speed*). Ensure that the resultant output current required for the given jog ramp time does not exceed the current limit in par. 4-18. The jog ramp time starts upon activation of a jog signal via the control panel, a selected digital input, or the serial communication port.



$$Par.3-80 = \frac{t_{jog} * n_{norm}\ [\,par.1-25\,]}{\triangle\, jog\ \ speed\ [par.3-19]}\ [sec]$$

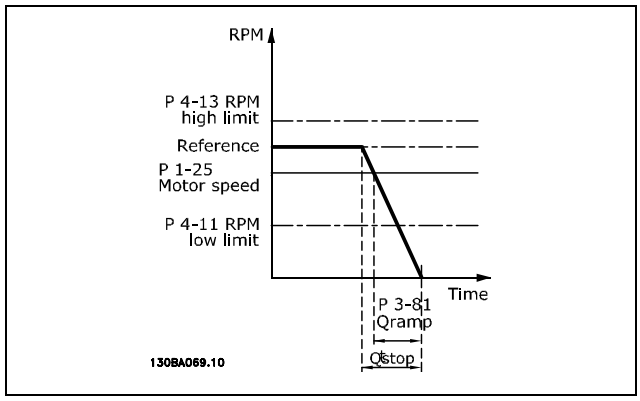
3-81 Quick Stop Ramp Time

Range:

0.01 - 3600.00 s ✱3 s

Function:

Enter the quick stop ramp-down time, i.e., the deceleration time from the rated motor speed to 0 RPM. Ensure that no resultant overvoltage will arise in the inverter due to regenerative operation of the motor required to achieve the given ramp-down time. Ensure also that the generated current required to achieve the given ramp-down time does not exceed the current limit (set in par. 4-18). Quick stop is activated by means of a signal on a selected digital input, or via the serial communication port.



$$Par.3-81 = \frac{t_{Qstop} * n_{norm}\ [\,par.1-25\,]}{\triangle\, jog\ \ ref\ [RPM]}\ [sec]$$

□ 3-9* Digital Pot.Meter

The digital potentiometer function allows the user to increase or decrease the actual reference by adjusting the set-up of the digital inputs using the functions INCREASE, DECREASE or CLEAR. To activate the function, at least one digital input must be set up to INCREASE or DECREASE.

3-90 Step Size

Range:

0.01 - 200.00% ✱0.10%

Function:

Enter the increment size required for INCREASE/DECREASE, as a percentage of the nominal speed set in par. 1-25. If INCREASE / DECREASE is activated the resulting reference will be increased / decreased by the amount set in this parameter.

3-91 Ramp Time

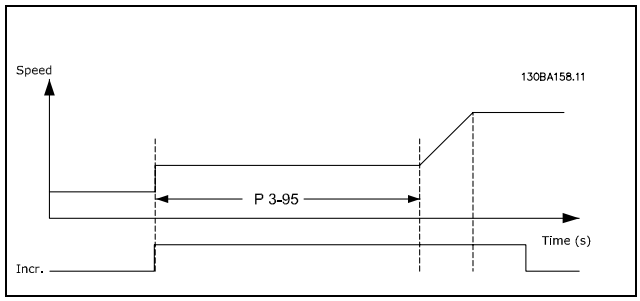
Range:

0.001 - 3600.00 s ✱1.00 s

Function:

Enter the ramp time, i.e., the time for adjustment of the reference from 0% to 100% of the specified

digital potentiometer function (INCREASE, DECREASE or CLEAR).
If INCREASE / DECREASE is activated for longer than the ramp delay period specified in par. 3-95, the actual reference will be ramped up / down according to this ramp time. The ramp time is defined as the time used to adjust the reference by the step size specified in par. 3-90 *Step Size*.



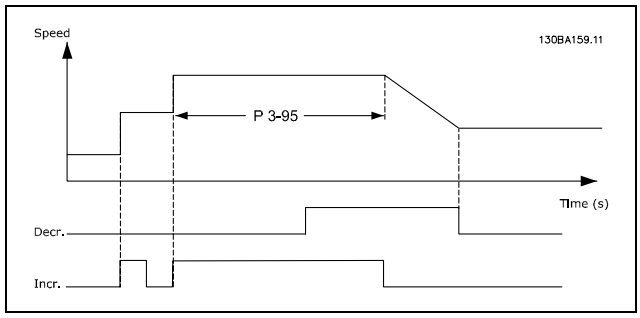
3-92 Power Restore

Option:

*Off	[0]
On	[1]

Function:

Select *Off* [0] to reset the Digital Potentiometer reference to 0% after power up.
Select *On* [1] to restore the most recent Digital Potentiometer reference at power up.



3-93 Maximum Limit

Range:

-200 - 200%	*100%

Function:

Set the maximum permissible value for the resultant reference. This is advisable if the digital potentiometer is used for fine tuning of the resulting reference.

3-94 Minimum Limit

Range:

-200 - 200 %	*-100%

Function:

Set the minimum permissible value for the resultant reference. This is advisable if the Digital Potentiometer is used for fine tuning of the resulting reference.

3-95 Ramp Delay

Range:

0.000 - 3600.00 s	*1.000s

Function:

Enter the delay required from activation of the digital potentiometer function until the frequency converter starts to ramp the reference. With a delay of 0 ms, the reference starts to ramp as soon as INCREASE / DECREASE is activated. See also par. 3-91 *Ramp Time*.

□ Parameters: Limits/Warnings

□ 4-** Motor Limits

Parameter group for configuring limits and warnings.

□ 4-1* Motor Limits

Define torque, current and speed limits for the motor, and the reaction of the frequency converter when the limits are exceeded.

A limit may generate a message on the display. A warning will always generate a message on the display or on the fieldbus. A monitoring function may initiate a warning or a trip, upon which the frequency converter will stop and generate an alarm message.

4-10 Motor Speed Direction

Option:

*Clockwise	[0]
Counter-clockwise	[1]
Both directions	[2]

Function:

Select the motor speed direction(s) required. Use this parameter to prevent unwanted reversing. When par. 1-00 *Configuration Mode* is set to *Process* [3], par. 4-10 is set to *Clockwise* [0] as default. The setting in par. 4-10 does not limit options for setting par. 4-13.

This parameter cannot be adjusted while the motor is running.

4-11 Motor Speed Low Limit [RPM]

Range:

0 - par. 4-13 RPM *0 RPM

Function:

Enter the minimum limit for motor speed. The motor speed low limit can be set to correspond to the manufacturer's recommended minimum motor speed. The motor speed low limit must not exceed the setting in par. 4-13 *Motor Speed High Limit [RPM]*.

4-12 Motor Speed Low Limit [Hz]

Range:

0 - par. 4-14 Hz *0 Hz

Function:

Enter the minimum limit for motor speed. The motor speed low limit can be set to correspond to the minimum output frequency of the motor shaft. The motor speed low limit must not exceed the setting in par. 4-14 *Motor Speed High Limit [Hz]*.

4-13 Motor Speed High Limit [RPM]

Range:

Par. 4-11 - Variable Limit RPM *3600. RPM

Function:

Enter the maximum limit for motor speed. The motor speed high limit can be set to correspond to the manufacturer's maximum rated motor speed. The motor speed high limit must exceed the setting in par. 4-11 *Motor Speed Low Limit [RPM]*.

NOTE

The output frequency value of the adjustable frequency drive must not exceed a value higher than 1/10 of the switching frequency.

4-14 Motor Speed High Limit [Hz]

Range:

Par. 4-12 - Variable limit Hz * 120 Hz

Function:

Enter the maximum limit for motor speed. The motor speed high limit can be set to correspond to the manufacturer's recommended maximum frequency of the motor shaft. The motor speed high limit must exceed the setting in par. 4-12 *Motor Speed Low Limit [Hz]*.

NOTE

The output frequency value of the adjustable frequency drive must not exceed a value higher than 1/10 of the switching frequency.

4-16 Torque Limit Motor Mode

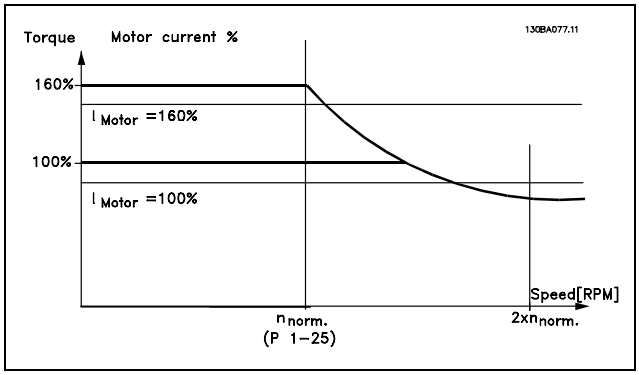
Range:

0.0 - Variable Limit % *160.0 %

Function:

Enter the maximum torque limit for motor operation. The torque limit is active in the speed range up to and including the rated motor speed set in par. 1-25 *Motor Nominal Speed*. To protect the motor from reaching the stalling torque, the default setting is 1.6 x the rated motor torque

(calculated value). See also par. 14-25 *Trip Delay at Torque Limit* for further details.
If a setting in par. 1-00 to par. 1-26 is changed, par. 4-16 is not automatically reset to the default setting.



If par. 4-16 is changed whilst par. 1-00 *Configuration Mode* is set to *Speed open-loop* [0], then par. 1-66 *Min Current at Low Speed* will automatically readjust.

4-17 Torque Limit Generator Mode

Range:

0.0 - Variable Limit % ✱160.0 %

Function:

Enter the maximum torque limit for generator mode operation. The torque limit is active in the speed range up to and including the rated motor speed (par. 1-25). See the illustration for par. 4-16 *Torque Limit Motor Mode*, and refer to par. 14-25 *Trip Delay at Torque Limit* for further details.
If a setting in par. 1-00 to par. 1-26 is changed, par. 4-17 is not automatically reset to the default settings.

4-18 Current Limit

Range:

0.0 - Variable Limit % ✱160.0 %

Function:

Enter the current limit for motor and generator operation. To protect the motor from reaching the stalling torque, the default setting is 1.6 x the rated motor torque (calculated value). If a setting in par. 1-00 to par. 1-26 is changed, par. 4-18 is not automatically reset to the default setting.

4-19 Max Output Frequency

Range:

0.0 - 1000.0 Hz ✱132.0 Hz

Function:

Enter the maximum output frequency value. Par. 4-19 specifies the absolute limit on the drive output frequency for improved safety in applications where accidental overspeeding must be avoided. This absolute limit applies to all configurations and is independent of the setting in par. 1-00. This parameter cannot be adjusted while the motor is running.

□ 4-3* Motor Feedback Monitoring

This parameter group includes settings for monitoring and handling of motor feedback devices such as encoders and resolvers.

4-30 Motor Feedback Loss Function

Option:

Disabled	[0]
Warning	[1]
✱Trip	[2]

Function:

Select the adjustable frequency drive reaction upon detecting a feedback fault, i.e., when the feedback signal differs from the output speed more than specified in par. 4-31 *Motor Feedback Speed Error* during the time set in par. 4-32 *Motor Feedback Loss Timeout*.
Select *Disabled* [0] if no action is required.
Select *Warning* [1] to issue a warning only. The adjustable frequency drive will continue operation.
Select *Trip* [2] to trip the adjustable frequency drive.

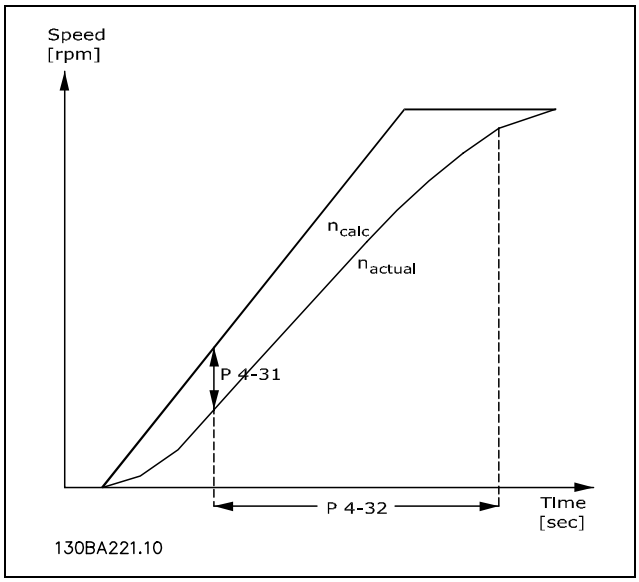
4-31 Motor Feedback Speed Error

Range:

1-600 RPM ✱300 RPM

Function:

Enter the maximum permissible tracking error between the calculated and the actual mechanical shaft output speed.



4-32 Motor Feedback Loss Timeout

Range:

0.00 - 60.00 sec. *0 sec.

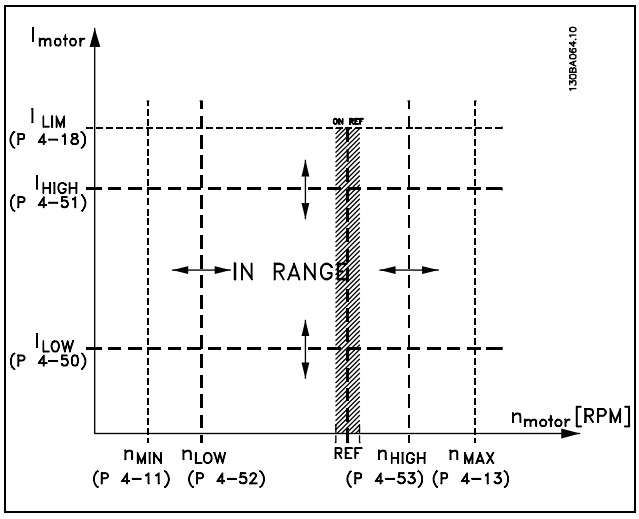
Function:

Enter the timeout period during which an error greater than the tracking error set in par. 4-31 *Motor Feedback Speed Error* is permissible.

□ **4-5* Adj. Warnings**

Define adjustable warning limits for current, speed, reference and feedback. Warnings are shown on the display, programmed output or serial bus.

Warnings are shown on display, programmed output or serial bus.



4-50 Warning Current Low

Range:

0.00 - par. 4-51 A *0.00A

Function:

Enter the I_{LOW} value. When the motor current falls below this limit (I_{LOW}), the display reads CURRENT LOW. The signal outputs can be programmed to produce a status signal on terminal 27 or 29 and on relay output 01 or 02. Refer to the drawing in this section.

4-51 Warning Current High

Range:

Par. 4-50 - par. 16-37 A *par. 16-37 A

Function:

Enter the I_{HIGH} value. When the motor current exceeds this limit (I_{HIGH}), the display reads CURRENT HIGH. The signal outputs can be programmed to produce a status signal on terminal 27 or 29 and on relay output 01 or 02. Refer to the drawing in this section.

4-52 Warning Speed Low

Range:

0 - par. 4-53 RPM *0RPM

Function:

Enter the n_{LOW} value. When the motor speed falls below this limit (n_{LOW}) the display reads SPEED LOW. The signal outputs can be programmed to produce a status signal on terminal 27 or 29 and on relay output 01 or 02. Programme the lower signal limit of the motor speed, n_{LOW}, within the normal working range of the frequency converter. Refer to the drawing in this section.

4-53 Warning Speed High

Range:

Par. 4-52 - par. 4-13 RPM * par. 4-13 RPM

Function:

Enter the n_{HIGH} value. When the motor speed exceeds this limit (n_{HIGH}), the display reads SPEED HIGH. The signal outputs can be programmed to produce a status signal on terminal 27 or 29 and on relay output 01 or 02. Programme the upper signal limit of the motor speed, n_{HIGH}, within the

normal working range of the frequency converter. Refer to the drawing in this section.

4-54 Warning Reference Low

Range:

-999999.999 - 999999.999 * -999999.999

Function:

Enter the lower reference limit. When the actual reference falls below this limit, the display indicates Ref Low. The signal outputs can be programmed to produce a status signal on terminal 27 or 29 and on relay output 01 or 02.

4-55 Warning Reference High

Range:

-999999.999 - 999999.999 * 999999.999

Function:

Enter the upper reference limit. When the actual reference exceeds this limit, the display reads Ref High. The signal outputs can be programmed to produce a status signal on terminal 27 or 29 and on relay output 01 or 02.

4-56 Warning Feedback Low

Range:

-999999.999 - 999999.999 * -999999.999

Function:

Enter the lower feedback limit. When the feedback falls below this limit, the display reads Feedb Low. The signal outputs can be programmed to produce a status signal on terminal 27 or 29 and on relay output 01 or 02.

4-57 Warning Feedback High

Range:

-999999.999 - 999999.999 * 999999.999

Function:

Enter the upper feedback limit. When the feedback exceeds this limit, the display reads Feedb High. The signal outputs can be programmed to produce a status signal on terminal 27 or 29 and on relay output 01 or 02.

4-58 Missing Motor Phase Function

Option:

Off [0]

*On [1]

Function:

Select *On*, to display an alarm in the event of a missing motor phase. Select *Off*, for no alarm in the event of a missing motor phase. However, if the motor runs on only two phases, it can be damaged by overheating. Retaining the *On* setting is therefore strongly recommended.
This parameter cannot be adjusted while the motor is running.

□ **4-6* Speed Bypass**

Define the Speed Bypass areas for the ramps. Some systems call for avoiding certain output frequencies or speeds, due to resonance problems in the system. A maximum of four frequency or speed ranges can be avoided.

4-60 Bypass Speed From [RPM]

Array [4]

Range:

0 - par. 4-13 RPM * 0 RPM

Function:

Some systems call for avoiding certain output speeds due to resonance problems in the system. Enter the lower limits of the speeds to be avoided.

4-61 Bypass Speed From [Hz]

Array [4]

Range:

0 - par. 4-14 Hz * 0 Hz

Function:

Some systems call for avoiding certain output speeds due to resonance problems in the system. Enter the lower limits of the speeds to be avoided.

4-62 Bypass Speed to [RPM]

Array [4]

Range:

0 - par. 4-13 RPM *0RPM

Function:

Some systems call for avoiding certain output speeds due to resonance problems in the system. Enter the upper limits of the speeds to be avoided.

4-63 Bypass Speed To [Hz]

Array [4]

Range:

0 - par. 4-14 Hz ✱ 0 Hz

Function:

Some systems call for avoiding certain output speeds due to resonance problems in the system. Enter the upper limits of the speeds to be avoided.

Parameters: Digital In/Out

5-** Digital In/Out

Parameter group for configuring the digital input and output.

5-0* Digital I/O Mode

Parameters for configuring the IO mode. NPN/PNP and setting up IO to input or output.

5-00 Digital I/O Mode

Option:

*PNP	[0]
NPN	[1]

Function:

Digital inputs and programmed digital outputs are pre-programmable for operation either in PNP or NPN systems.
Select *PNP* [0] systems for action on positive directional pulses (). PNP systems are pulled down to GND.
Select *NPN* [1] systems for action on negative directional pulses (). NPN systems are pulled up to + 24 V, internally in the frequency converter.
This parameter cannot be adjusted while the motor is running.

5-01 Terminal 27 Mode

Option:

*Input	[0]
Output	[1]

Function:

Select *Input* [0] to define terminal 27 as a digital input.
Select *Output* [1] to define terminal 27 as a digital output.
This parameter cannot be adjusted while the motor is running.

5-02 Terminal 29 Mode

Option:

*Input	[0]
Output	[1]

Function:

Select *Input* [0] to define terminal 29 as a digital input.
Select *Output* [1] to define terminal 29 as a digital output.
This parameter is available for the FC 302 only.
This parameter cannot be adjusted while the motor is running.

5-1* Digital Inputs

Parameters for configuring the input functions for the input terminals.
The digital inputs are used for selecting various functions in the frequency converter. All digital inputs can be set to the following functions:

Digital input function	Select	Terminal
No operation	[0]	All *term 32, 33
Reset	[1]	All
Coast inverse	[2]	All *term 27
Coast and reset inverse	[3]	All
Quick stop inverse	[4]	All
DC-brake inverse	[5]	All
Stop inverse	[6]	All
Start	[8]	All *term 8
Latched start	[9]	All
Reversing	[10]	All *term 19
Start reversing	[11]	All
Enable start forward	[12]	All
Enable start reverse	[13]	All
Jog	[14]	All *term 29
Preset reference on	[15]	All
Preset ref bit 0	[16]	All
Preset ref bit 1	[17]	All
Preset ref bit 2	[18]	All
Freeze reference	[19]	All
Freeze output	[20]	All
Speed up	[21]	All
Speed down	[22]	All
Set-up select bit 0	[23]	All
Set-up select bit 1	[24]	All
Precise stop inverse	[26]	18, 19
Precises start, stop	[27]	18, 19
Catch up	[28]	All
Slow down	[29]	All
Counter input	[30]	29, 33
Pulse input	[32]	29, 33
Ramp bit 0	[34]	All
Ramp bit 1	[35]	All
Mains failure inverse	[36]	All
Latched precise start	[40]	18, 19
Latched precise stop inverse	[41]	18, 19
DigiPot Increase	[55]	All
DigiPot Decrease	[56]	All
DigiPot Clear	[57]	All
Counter A (up)	[60]	29, 33
Counter A (down)	[61]	29, 33
Reset Counter A	[62]	All
Counter B (up)	[63]	29, 33
Counter B (down)	[64]	29, 33
Reset Counter B	[65]	All

All = Terminals 18, 19, 27, 29, 32, 33, X30/2, X30/3, X30/4. X30/ are the terminals on MCB 101. Terminal 29 is available in FC 302 only.

Functions dedicated to only one digital input are stated in the associated parameter.

All digital inputs can be programmed to these functions:

- **No operation [0]**: The frequency converter will not react to signals transmitted to the terminal.
- **Reset [1]**: Reset the frequency converter after a TRIP/ALARM. Not all alarms can be reset.
- **Coast inverse [2]** (Default Digital input 27): Coasting stop, inverted input (NC). The frequency converter leaves the motor in free mode. Logic '0' => coasting stop.
- **Coast and reset inverse [3]**: Reset and coasting stop Inverted input (NC). The frequency converter leaves the motor in free mode and resets the drive. Logic '0' => coasting stop and reset.
- **Quick stop inverse [4]**: Inverted input (NC). Generate a stop in accordance with the quick-stop ramp time set in par. 3-81. When the motor stops, the shaft is in free mode. Logic '0' => Quick-stop.
- **DC-brake inverse [5]**: Inverted input for DC braking (NC). Stops the motor by energizing it with a DC current for a certain time period. See par. 2-01 to par. 2-03. The function is only active when the value in par. 2-02 is different from 0. Logic '0' => DC braking.
- **Stop inverse [6]**:Stop Inverted function. Generate a stop function when the selected terminal goes from logical level '1' to '0'. The stop is performed according to the selected ramp time (par. 3-42, par. 3-52, par. 3-62, par. 3-72).

NOTE
When the frequency converter is at the torque limit and has received a stop command, it may not stop by itself. To ensure that the frequency converter stops, configure a digital output to *Torque limit & stop* [27] and connect this digital output to a digital input that is configured as coast.

- **Start [8]** (Default Digital input 18): Select start for a start/stop command. Logic '1' = start, logic '0' = stop.
- **Latched start [9]**: The motor starts, if a pulse is applied for min. 2 ms. The motor stops when Stop inverse is activated.
- **Reversing [10]**: (Default Digital input 19). Change the direction of motor shaft rotation. Select Logic '1' to reverse. The reversing signal only changes the direction of rotation. It does not activate the start function. Select both directions in par. 4-10 *Motor Speed Direction*. The function is not active in *Speed closed loop* [1] or *Torque* [2] control in par. 1-00 *Configuration Mode*.
- **Start reversing [11]**: Use for start/stop and for reversing on the same wire. Signals on start are not allowed at the same time.
- **Enable start forward [12]**: Use if the motor shaft must rotate clockwise at start.
- **Enable start reverse [13]**: Use if the motor shaft must rotate counter-clockwise at start.
- **Jog [14]** (Default Digital input 29): Use for shifting between external reference and preset reference. Select External/preset [2] in par. 2-14. Logic '0' = external references active; Logic '1' = one of the four references is active according to the table below.
- **Preset reference on [15]:** Use for shifting between external reference and preset reference. It is assumed that *External/preset* [1] has been selected in par. 3-04. Logic '0' = external reference active; logic '1' = one of the eight preset references is active.
- **Preset ref bit 0 [16]**: Preset ref. bit 0,1, and 2 enables a choice between one of the eight preset references according to the table below.
- **Preset ref bit 1 [17]**: Same as Preset ref bit 0 [16].
- **Preset ref bit 2 [18]**: Preset ref bit 2 [18]: Same as Preset ref bit 0 [16].

Present ref. bit	2	1	0
Preset ref. 0	0	0	0
Preset ref. 1	0	0	1
Preset ref. 2	0	1	0
Preset ref. 3	0	1	1
Preset ref. 4	1	0	0
Preset ref. 5	1	0	1
Preset ref. 6	1	1	0
Preset ref. 7	1	1	1

∗ default setting **( )** display text **[ ]** value for use in communication via serial communication port

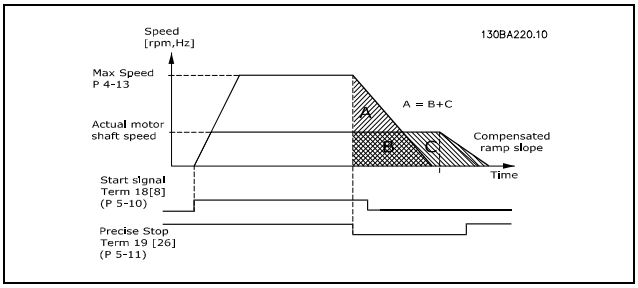
- **Freeze ref [19]**: Freeze the actual reference. The frozen reference is now the point of enable/condition for Speed up and Speed down to be used. If Speed up/down is used, the speed change always follows ramp 2 (par. 3-51 and 3-52) in the range 0 - par. 3-03 *Maximum Reference*.
- **Freeze output [20]**: Freeze the actual motor frequency (Hz). The frozen motor frequency is now the point of enable/condition for Speed up and Speed down to be used. If Speed up/down is used, the speed change always follows ramp 2 (par. 3-51 and 3-52) in the range 0 - par. 1-23 *Motor Frequency*.

NOTE
When Freeze output is active, the frequency converter cannot be stopped via a low 'start [13]' signal. Stop the frequency converter via a terminal programmed for Coasting inverse [2] or Coast and reset, inverse.

- **Speed up [21]**: Select Speed up and Speed down if digital control of the up/down speed is desired (motor potentiometer). Activate this function by selecting either Freeze reference or Freeze output. When Speed up is activated for less than 400 msec. the resulting reference will be increased by 0.1 %. If Speed up is activated for more than 400 msec. the resulting reference will ramp according to Ramp 2 in par. 3-41.

	Shut down	Catch up
Unchanged speed	0	0
Reduced by %-value	1	0
Increased by %-value	0	1
Reduced by %-value	1	1

- **Speed down [22]**: Same as Speed up [21].
- **Set-up select bit 0 [23]** : Select Set-up select bit 0 or Select Set-up select bit 1 to select one of the four set-ups. Set par. 0-10 *Active Set-up* to Multi Set-up.
- **Set-up select bit 1 [24]** (Default Digital input 32): Same as Set-up select bit 0 [23].
- **Precise stop inv. [26]**:Prolong the stop signal to give a precise stop independent of speed. Precise stop inverse function is available for terminals 18 or 19.
- **Precise start, stop [27]**: Use when Precise ramp stop [0] is selected in par 1-83 Precise stop function.



- **Catch up [28]**: Select Catch up/Slow down to increase or reduce the reference value set in par. 3-12.
- **Slow down [29]**: Same as Catch up [28].
- **Counter input [30]**: Select Counter input if you want to use the Precise stop function in par. 1-83 as Counter stop or speed compensated counter stop with or without reset. The counter value must be set in par. 1-84.
- **Pulse input [32]**: Select Pulse input when using a pulse sequence as either reference or feedback. Scaling is done in par. group 5-5*.
- **Ramp bit 0 [34]**
- **Ramp bit 1 [35]**
- **Mains failure inverse [36]**: Select to activate par. 14-10 *Mains Failure*. Mains failure inverse is active in the Logic .0. situation.
- **Latched Precise Stop inverse [41]**: Send a latched stop signal when the precise stop function is activated in par. 1-83 *Precise Stop Function*. See selection [26]. The Latched Precise stop inverse function is available for terminals 18 or 19.
- **DigiPot Increase [55]**: Use the input as an INCREASE signal to the Digital Potentiometer function described in parameter group 3-9*
- **DigiPot Decrease [56]**: Use the input as a DECREASE signal to the Digital Potentiometer function described in parameter group 3-9*
- **DigiPot Clear [57]**: Use the input to CLEAR the Digital Potentiometer reference described in parameter group 3-9*

- **Counter A [60]**: (Terminal 29 or 33 only) Input for increment counting in the SLC counter.
- **Counter A [61]**: (Terminal 29 or 33 only) Input for decrement counting in the SLC counter.
- **Reset Counter A [62]**: Input for reset of counter A.
- **Counter B [63]**: (Terminal 29 or 33 only) Input for increment counting in the SLC counter.
- **Counter B [64]**: (Terminal 29 or 33 only) Input for decrement counting in the SLC counter.
- **Reset Counter B [65]**: Input for reset of counter B.

5-10 Terminal 18 Digital Input

Function:

Select the function from the available digital input range.

5-11 Terminal 19 Digital Input

Function:

Select the function from the available digital input range.

5-12 Terminal 27 Digital Input

Function:

Select the function from the available digital input range.

5-13 Terminal 29 Digital Input

Option:

✱Jog	[14]
Counter A (up)	[60]
Counter A (down)	[61]
Counter B (up)	[63]
Counter B (down)	[64]

Function:

Select the function from the available digital input range and the additional options [60], [61], [63] and [64]. Counters are used in Smart Logic Control functions. This parameter is available for FC 302 only.

5-14 Terminal 32 Digital Input

Option:

✱No operation	[0]

Function:

Select the function from the available digital input range. Counters are used in Smart Logic Control functions.

5-15 Terminal 33 Digital Input

Option:

✱No operation	[0]
Counter A (up)	[60]
Counter A (down)	[61]
Counter B (up)	[63]
Counter B (down)	[64]

Function:

Select the function from the available digital input range and the additional options [60], [61], [63] and [64]. Counters are used in Smart Logic Control functions.

5-16 Terminal X30/3 Digital Input

Option:

*No operation [0]

Function:

This parameter is active when option module MCB 101 is installed in the adjustable frequency drive.

5-17 Terminal X30/4 Digital Input

Option:

*No operation [0]

Function:

This parameter is active when option module MCB 101 is installed in the adjustable frequency drive.

5-18 Terminal X30/4 Digital Input

Option:

*No operation [0]

Function:

This parameter is active when option module MCB 101 is installed in the adjustable frequency drive.

□ 5-3* Digital Outputs

5-30 Terminal 27 Digital Output

Function:

Select *Bus ctrl.* [45] to control the output via bus. The state of the output is set in par. 5-90. The output state is retained in the event of bus time-out.

Select *Bus ctrl. On at time-out* [46] to control the output via bus. The state of the output is set in par. 5-90. In the event of bus time-out the output state is set high (On).
Select *Bus ctrl. Off at time-out* [47] to control the output via bus. The state of the output is set in par. 5-90. In the event of bus time-out the output state is set low (Off).

5-31 Terminal 29 digital Output

Function:

Select *Bus ctrl.* [45] to control the output via bus. The state of the output is set in par. 5-90. The output state is retained in the event of bus time-out.
Select *Bus ctrl. On at time-out* [46] to control the output via bus. The state of the output is set in par. 5-90. In the event of bus time-out the output state is set high (On).
Select *Bus ctrl. Off at time-out* [47] to control the output via bus. The state of the output is set in par. 5-90. In the event of bus time-out the output state is set low (Off).

5-32 Terminal X30/6 Digital Output (MCB 101)

Option:

*No operation	[0]

Function:

This parameter is active when option module MCB 101 is mounted in the adjustable frequency drive.

5-33 Terminal X30/7 Digital Output (MCB 101)

Option:

*No operation	[0]

Function:

This parameter is active when option module MCB 101 is mounted in the adjustable frequency drive.

□ 5-4* Relays

Parameters for configuring the timing and the output functions for the relays.

5-40 Function Relay

Option:

Array	[8]
(Relay)	[0]
(Relay 2)	[1]
Relay 7	[6]
Relay 8	[7]
Relay 9	[8]
Control word bit 11	[36]
Control word bit 12	[37]

Relay 2 is included in FC 302 only. The par. 5-40 options are as for par. 5-30, including options 36 and 37.

Function:

Select options to define the function of the relays. Choose between available mechanical relays in an array function.
Example: par. 5-4* => 'OK' => Function Relay => 'OK' => [0] => 'OK' => select function Relay no. 1 has array no. [0]. Relay no. 2 has array no. [1].
When relay option MCB 105 is fitted in the drive, the following selection of relays will be available:
Relay 7 => Par. 5-40 [6]
Relay 8 => Par. 5-40 [7]
Relay 9 => Par. 5-40 [8]

Select the relay function options from the same list as for solid state output functions, see par. 5-3*, and the following:
Control word bit 11 [36]: Bit 11 in the control word controls relay 01. See section *Control Word According to FC Profile (CTW)*. This option is available in par. 5-40 only.
Control word bit 12 [37]: Bit 12 in the control word controls relay 02. See section *Control Word According to FC Profile (CTW)*.

5-41 On Delay, Relay

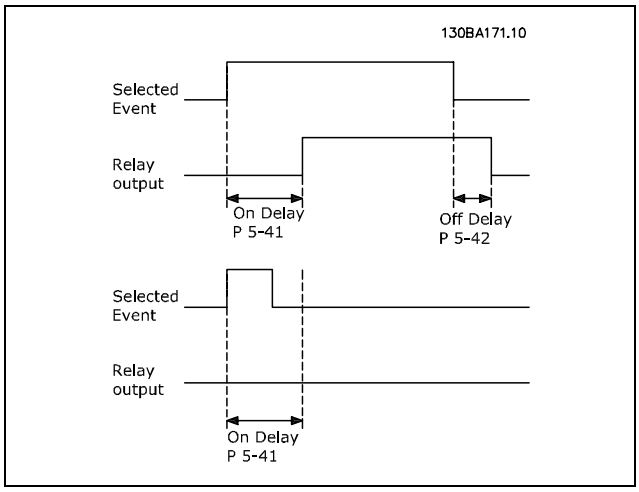
Array [8]	(Relay 1 [0], Relay 2 [1], Relay 7 [6], Relay 8 [7], Relay 9 [8])

Range:

0.01 - 600.00 s	*0.01s

Function:

Enter the delay of the relay cut-in time. Select one of available mechanical relays and MCO 105 in an array function. See par. 5-40.



5-42 Off Delay, Relay

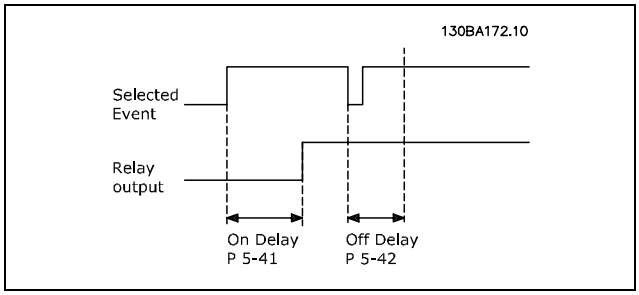
Array [8] (Relay 1 [0], Relay 2 [1], Relay 7 [6], Relay 8 [7], Relay 9 [8])

Range:

0.01 - 600.00 s. *0.01s

Function:

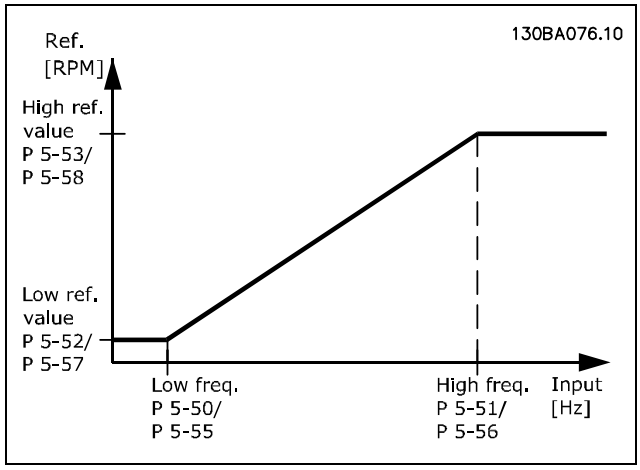
Enter the delay of the relay cut-out time. Select one of available mechanical relays and MCO 105 in an array function. See par. 5-40.



If the selected event condition changes before the on or off delay timer expires, the relay output is unaffected.

□ **5-5* Pulse Input**

The pulse input parameters are used to define an appropriate window for the impulse reference area by configuring the scaling and filter settings for the pulse inputs. Input terminals 29 or 33 act as frequency reference inputs. Set terminal 29 (par. 5-13) or terminal 33 (par. 5-15) to *Pulse input* [32]. If terminal 29 is used as an input, then set par. 5-01 to *Input* [0].



5-50 Term. 29 Low Frequency

Range:

100 - 110000 Hz *100Hz

Function:

Enter the low frequency limit corresponding to the low motor shaft speed (i.e. low reference value) in par. 5-52. Refer to the diagram in this section.
This parameter is available for FC 302 only.

5-51 Term. 29 High Frequency

Range:

0 - 110000 Hz *100Hz

Function:

Enter the high frequency limit corresponding to the high motor shaft speed (i.e. high reference value) in par. 5-53.
This parameter is available for FC 302 only.

5-52 Term. 29 Low Ref./Feedb. Value

Range:

-1000000.000 - par. 5-53 * 0.000

Function:

Enter the low reference value limit for the motor shaft speed [RPM]. This is also the lowest feedback value, see also par. 5-57. Set terminal 29 to digital output (par. 5-02 =*Output* [1] and par. 5-13 = applicable value).
This parameter is available for the FC 302 only.

5-53 Term. 29 High Ref./Feedb. Value

Range:

Par. 5-52 - 1000000.000 *1500.000

Function:

Enter the high reference value [RPM] for the motor shaft speed and the high feedback value, see also par. 5-58. Select terminal 29 as a digital output (par. 5-02 =*Output* [1] and par. 5-13 = applicable value). This parameter is available for the FC 302 only.

5-54 Pulse Filter Time Constant #29

Range:

1 - 1000 ms *100 ms

Function:

Enter the pulse filter time constant. The pulse filter dampens oscillations of the feedback signal, which is an advantage if there is a lot of noise in the system. A high time constant value results in better dampening but also increases the time delay through the filter. This parameter is available for the FC 302 only.
This parameter cannot be adjusted while the motor is running.

5-55 Term. 33 Low Frequency

Range:

0 - 110000 Hz *100Hz

Function:

Enter the low frequency corresponding to the low motor shaft speed (i.e. low reference value) in par. 5-57. Refer to the diagram in this section.

5-56 Term. 33 High Frequency

Range:

0 - 110000 Hz *100 Hz

Function:

Enter the high frequency corresponding to the high motor shaft speed (i.e. high reference value) in par. 5-58.

5-57 Term. 33 Low Ref./Feedb. Value

Range:

-100000.000 - par. 5-58) *0.000

Function:

Enter the low reference value [RPM] for the motor shaft speed. This is also the low feedback value, see also par.5-52.

5-58 Term. 33 High Ref./Feedb. Value

Range:

Par. 5-57 - 100000.000 *1500.000

Function:

Enter the high reference value [RPM] for the motor shaft speed. See also par. 5-53 *Term. 29 High Ref./Feedb. Value*.

5-59 Pulse Filter Time Constant #33

Range:

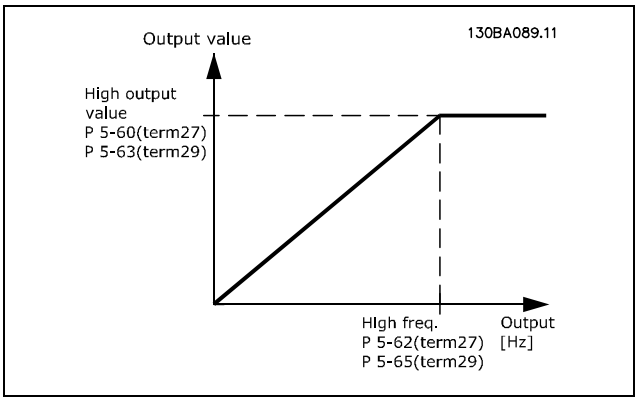
1 - 1000 ms * 100ms

Function:

Enter the pulse filter time constant. The low-pass filter reduces the influence on and dampens oscillations on the feedback signal from the control. This is an advantage, e.g. if there is a great amount on noise in the system. This parameter cannot be adjusted while the motor is running.

□ 5-6* Pulse Outputs

Parameters for configuring the scaling and output functions of pulse outputs. The pulse outputs are designated to terminals 27 or 29. Select terminal 27 output in par. 5-01 and terminal 29 output in par. 5-02.



Options for readout output variables:

*No operation	[0]
MCO controlled	[51]
Output frequency	[100]
Reference	[101]
Feedback	[102]
Motor current	[103]
Torque relative to limit	[104]
Torque relative to rated	[105]
Power	[106]
Speed	[107]
Torque	[108]

Function:

Parameters for configuring the scaling and output functions of pulse outputs. The pulse outputs are designated to terminals 27 or 29. Select terminal 27 output in par. 5-01 and terminal 29 output in par. 5-02.

5-60 Terminal 27 Pulse Output Variable

Option:

*No operation [0]

Function:

Select the variable for viewing on the terminal 27 display.
This parameter cannot be adjusted while the motor is running.

5-62 Pulse Output Maximum Frequency #27

Range:

0 - 32000 Hz *5000Hz

Function:

Set the maximum frequency for terminal 27, corresponding to the output variable selected in par. 5-60.
This parameter cannot be adjusted while the motor is running.

5-63 Terminal 29 Pulse Output Variable

Option:

*No operation [0]

Function:

Select the variable for viewing on the terminal 29 display. This parameter is available for the FC 302 only.
This parameter cannot be adjusted while the motor is running.

5-65 Pulse Output Maximum Frequency #29

Range:

0 - 32000 Hz *5000Hz

Function:

Set the maximum frequency for terminal 29 corresponding to the output variable set in par. 5-63. This parameter cannot be adjusted while the motor is running.

5-66 Terminal X30/6 Pulse Output Variable

Option:

*No operation [0]

Function:

Select the variable for read-out on terminal X30/6. This parameter cannot be adjusted while the motor is running.
This parameter is active when option module MCB 101 is installed in the adjustable frequency drive.

5-68 Pulse Output Maximum Frequency #X30/6

Option:

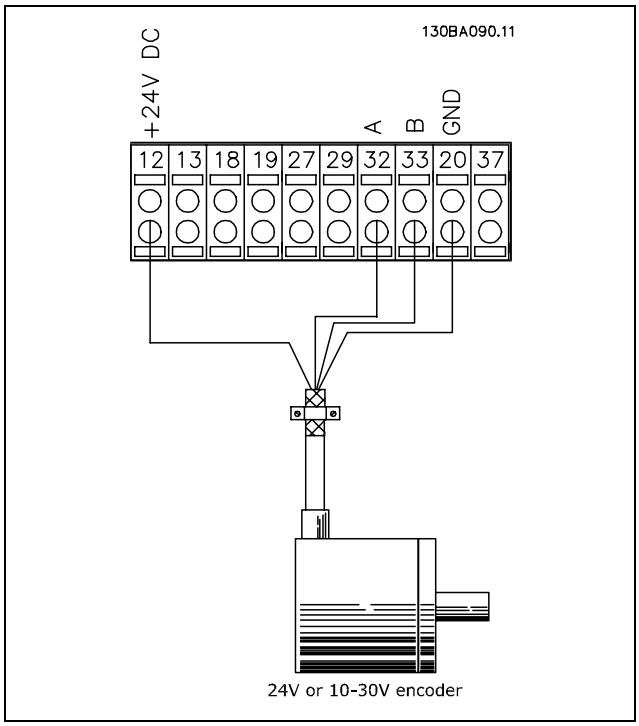
*No operation [0]

Function:

Select the maximum frequency on terminal X30/6 referring to the output variable in par. 5-66. This parameter cannot be adjusted while the motor is running.
This parameter is active when option module MCB 101 is mounted in the adjustable frequency drive.

□ 5-7* 24 V Encoder Input

Parameters for configuring the 24 V encoder. Connect the 24 V encoder to terminal 12 (24 V DC supply), terminal 32 (Channel A), terminal 33 (Channel B), and terminal 20 (GND). The digital inputs 32/33 are active for encoder inputs when *24 V encoder* is selected in par. 1-02 and par. 7-00. The encoder used is a dual channel (A and B) 24 V type. Max input frequency: 110 kHz.



5-70 Term 32/33 Pulses per Revolution

Range:

128 - 4096 PPR ✱1024 PPR

Function:

Set the encoder pulses per revolution on the motor shaft. Read the correct value from the encoder. This parameter cannot be adjusted while the motor is running.

5-71 Term 32/33 Encoder Direction

Option:

*Clockwise	[0]
Counterclockwise	[1]

Function:

Change the detected encoder rotation direction without changing the wiring to the encoder. Select *Clockwise* [0] to set channel A 90° (electrical degrees) behind channel B upon clockwise rotation of the encoder shaft. Select *Counter clockwise* [1] to set channel A 90° (electrical degrees) ahead of channel B upon clockwise rotation of the encoder shaft.
This parameter cannot be adjusted while the motor is running.

5-72 Term 32/33 Gear Numerator

Range:

1.0 - 60000 N/A ✱1N/A

Function:

Enter the numerator value for a gear ratio between encoder and drive shaft. The numerator corresponds to the encoder shaft and the denominator corresponds to the drive shaft. Use this parameter to set a multiplier on the encoder feedback to compensate a ratio of encoder turns to motor turns.
Example:
Speed on the encoder shaft = 1000 RPM and speed on the drive shaft is 3000 RPM:
Par. 5-72 = 1000 and par. 5-73 = 3000, or par. 5-72 = 1 and par. 5-73 = 3.
If the motor control principle is *Flux w motor feedback* [3] in par. 1-01, the gear ratio between motor and encoder must be 1: 1. (No gear).
This parameter cannot be adjusted while the motor is running.

5-73 Term 32/33 Gear Denominator

Range:

1.0 - 60000 N/A ✱1N/A

Function:

Enter the denominator value for a gear ratio between encoder and drive shaft. The numerator corresponds to the encoder shaft and the denominator corresponds to the drive shaft. See also par. 5-72.
This parameter cannot be adjusted while the motor is running.

□ 5-9* Bus Controlled

This parameter group selects digital and relay outputs via a serial communication bus setting.

5-90 Digital & Relay Bus Control

Range:

0 - FFFFFFFF

Function:

This parameter holds the state of the digital outputs and relays that is controlled by bus.
A logical '1' indicates that the output is high or active.

A logical '0' indicates that the output is low or inactive.

Bit 0	CC Digital Output Terminal 27
Bit 1	CC Digital Output Terminal 29
Bit 2	GPIO Digital Output Terminal X 30/6
Bit 3	GPIO Digital Output Terminal X 30/7
Bit 4	CC Relay 1 output terminal
Bit 5	CC Relay 2 output terminal
Bit 6	Option B Relay 1 output terminal
Bit 7	Option B Relay 2 output terminal
Bit 8	Option B Relay 3 output terminal
Bit 9-15	Reserved for future terminals
Bit 16	Option C Relay 1 output terminal
Bit 17	Option C Relay 2 output terminal
Bit 18	Option C Relay 3 output terminal
Bit 19	Option C Relay 4 output terminal
Bit 20	Option C Relay 5 output terminal
Bit 21	Option C Relay 6 output terminal
Bit 22	Option C Relay 7 output terminal
Bit 23	Option C Relay 8 output terminal
Bit 24-31	Reserved for future terminals

Parameters: Analog In/Out

6-** Analog In/Out

Parameter group for configuring the analog input and output.

6-0* Analog I/O Mode

Parameter group for setting up the analog I/O configuration.

FC 300 is equipped with 2 analog inputs: Terminal 53 and 54. The analog inputs on FC 302 can freely be allocated to either voltage (-10 V - +10 V) or current input (0/4 - 20 mA)

NOTE
Thermistors may be connected to either an analog or a digital input.

6-00 Live Zero Timeout Time

Range:

1 - 99 s ✱ 10s

Function:

Enter the Live Zero Time-out time period. Live Zero Time-out Time is active for analog inputs, i.e. terminal 53 or terminal 54, allocated to current and used as reference or feedback sources. If the reference signal value associated with the selected current input falls below 50% of the value set in par. 6-10, par. 6-12, par. 6-20 or par. 6-22 for a time period longer than the time set in par. 6-00, the function selected in par. 6-01 will be activated.

6-01 Live Zero Timeout Function

Option:

✱Off	[0]
Freeze Output	[1]
Stop	[2]
Jogging	[3]
Max. speed	[4]
Stop and trip	[5]

Function:

Select the timeout function. The function set in par. 6-01 will be activated if the input signal on terminal 53 or 54 is below 50% of the value in par. 6-10, par. 6-12, par. 6-20 or par. 6-22 for a time period defined in par. 6-00. If several timeouts occur simultaneously, the adjustable frequency drive prioritizes the timeout functions as follows:

1. Par. 6-01 *Live Zero Timeout Function*
2. Par. 5-74 *Encoder Loss Function*
3. Par. 8-04 *Control word Timeout Function*

The output frequency of the adjustable frequency drive can be:

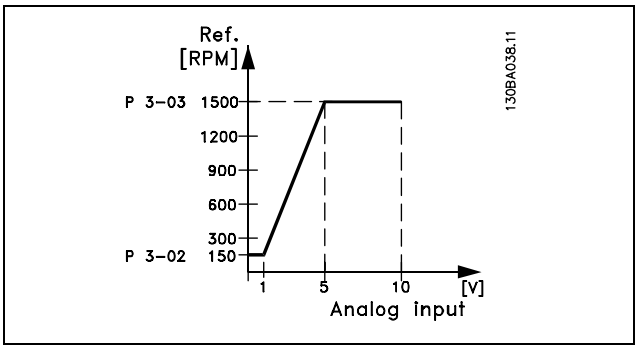
The output frequency of the adjustable frequency drive can be:

- [1] frozen at the present value
- [2] overruled to stop
- [3] overruled to jog speed
- [4] overruled to max. speed
- [5] overruled to stop with subsequent trip

This parameter cannot be adjusted while the motor is running.

6-1* Analog Input 1

Parameters for configuring the scaling and limits for analog input 1 (terminal 53).



6-10 Terminal 53 Low Voltage

Range:

-10.0 - par. 6-11 ✱ 0.07 V

Function:

Enter the low voltage value. This analog input scaling value should correspond to the minimum reference value, set in par. 3-02. See also the section *Reference Handling*.

6-11 Terminal 53 High Voltage

Range:

Par. 6-10 to 10.0 V ✱ 10.0V

Function:
Enter the high voltage value. This analog input scaling value should correspond to the maximum reference value, set in par. 3-03.

6-12 Terminal 53 Low Current

Range:
0.0 to par. 6-13 mA ✱0.14 mA

Function:
Enter the low current value. This reference signal should correspond to the minimum reference value, set in par. 3-02. The value must be set at >2 mA in order to activate the live zero timeout function in par. 6-01.

6-13 Terminal 53 High Current

Range:
Par. 6-12 to - 20.0 mA ✱ 20.0 mA

Function:
Enter the value of the reference signal that corresponds to the maximum reference value, set in par. 3-03.

6-14 Terminal 53 Low Ref./Feedb. Value

Range:
-1000000.000 to par. 6-15 ✱ 0.000 Unit

Function:
Enter the analog input scaling value that corresponds to the minimum reference feedback value set in par. 3-02.

6-15 Terminal 53 High Ref./Feedb. Value

Range:
Par. 6-14 to 1000000.000 ✱ 1500.000 Unit

Function:
Enter the analog input scaling value that corresponds to the maximum reference feedback value set in par. 3-03.

6-16 Terminal 53 Filter Time Constant

Range:
0.001 - 10.000 s ✱0.001s

Function:
Enter the time constant. This is a first-order digital low pass filter time constant for suppressing electrical noise in terminal 53. A high time constant value improves dampening but also increases the time delay through the filter.
This parameter cannot be adjusted while the motor is running.

□ **6-2* Analog Input 2**
Parameters for configuring the scaling and limits for analog input 2 (terminal 54).

6-20 Terminal 54 Low Voltage

Range:
-10.0 – par. 6-21 ✱0.07 V

Function:
Enter the low voltage value. This analog input scaling value should correspond to the minimum reference value, set in par. 3-02. See also the section *Reference Handling*.

6-21 Terminal 54 High Voltage

Range:
Par. 6-20 to 10.0 V ✱10.0V

Function:
Enter the high voltage value. This analog input scaling value should correspond to the maximum reference value, set in par. 3-03.

6-22 Terminal 54 Low Current

Range:
0.0 to par. 6-23 mA ✱0.14 mA

Function:
Enter the low current value. This reference signal should correspond to the minimum reference value, set in par. 3-02. The value must be set at >2 mA in order to activate the live zero timeout function in par. 6-01.

6-23 Terminal 54 High Current

Range:
Par. 6-22 to - 20.0 mA ✱20.0 mA

Function:
Enter the value of the reference signal that corresponds to the maximum reference value, set in par. 3-03.

6-24 Terminal 54 Low Ref./Feedb. Value

Range:
-1000000.000 to par. 6-25 ✱ 0.000 Unit

Function:
Enter the analog input scaling value that corresponds to the minimum reference feedback value set in par. 3-02.

6-25 Terminal 54 high ref./feedb. value

Range:
Par. 6-24 to 1000000.000 *1500.000 Unit

Function:
Enter the analog input scaling value that corresponds to the maximum reference feedback value set in par. 3-03.

6-26 Terminal 54 Filter Time Constant

Range:
0.001 - 10.000 s * 0.001s

Function:
Enter the time constant. This is a first-order digital low pass filter time constant for suppressing electrical noise in terminal 54. A high time constant value improves dampening but also increases the time delay through the filter.
This parameter cannot be adjusted while the motor is running.

□ **6-3* Analog Input 3 (MCB 101)**
Parameter group for configuring the scale and limits for analog input 3 (X30/11) placed on option module MCB 101.

6-30 Term. X30/11 Low Voltage

Range:
-10 - par. 6-31 * 0.07 V

Function:
Sets the analog input scaling value to correspond to the minimum reference value (set in par. 3-02).

6-31 Term. X30/11 High Voltage

Range:
Par. 6-31 to 10.0 V *10.0 V

Function:
Sets the analog input scaling value to correspond to the maximum reference value (set in par. 3-03).

6-34 Term. X30/11 Low Ref./Feedb. Value

Range:
1000000.000 to par. 6-35 *0.000 Unit

Function:
Sets the analog input scaling value to correspond to the minimum reference feedback value (set in par. 3-02).

6-35 Term. X30/11 High Ref./Feedb. Value

Range:
Par. 6-34 to 1000000.000 *1500.000 Unit

Function:
Sets the analog input scaling value to correspond to the maximum reference feedback value (set in par. 3-03).

6-36 Term. X30/11 Filter Time Constant

Range:
0.001 - 10.000 s *0.001 s

Function:
A 1st order digital low pass filter time constant for suppressing electrical noise on terminal X30/11. Par. 6-36 cannot be changed while the motor is running.

□ **6-4* Analog Input 4 (MCB 101)**
Parameter group for configuring the scale and limits for analog input 3 (X30/12) placed on option module MCB 101.

6-40 Term. X30/12 Low Voltage

Range:
-10.0 to par. 6-41 *0.7 V

Function:
Sets the analog input scaling value to correspond to the minimum reference value (set in par. 3-02).

6-41 Term. X30/12 High Voltage

Range:
Par. 6-41 to 10.0 V *10.0 V

Function:
Sets the analog input scaling value to correspond to the maximum reference value (set in par. 3-03).

6-44 Term. X30/12 Low Ref./Feedb. Value

Range:
-1000000.000 to par. 6-45 *0.000 Unit

Function:

Sets the analog input scaling value to correspond to the minimum reference feedback value (set in par. 3-02).

6-45 Term. X30/12 High Ref./Feedb. Value

Range:

Par. 6-44 to 1000000.000 *1500.000 Unit

Function:

Sets the analog input scaling value to correspond to the maximum reference feedback value (set in par. 3-03).

6-46 Term. X30/12 Filter Time Constant

Range:

0.001 - 10.000 s *0.001 s

Function:

A 1st order digital low pass filter time constant for suppressing electrical noise on terminal X30/12. Par. 6-46 cannot be changed while the motor is running.

□ 6-5* Analog Output 1 (MCB 101)

Parameters for configuring the scaling and limits for analog output 1, i.e. Terminal 42. Analog outputs are current outputs: 0/4 – 20 mA. Common terminal (terminal 39) is the same terminal and has the same electrical potential for analog common and digital common connection. Resolution on analog output is 12 bit.

6-50 Terminal 42 Output

Option:

No operation	[0]
Output frequency	[100]
Reference	[101]
Feedback	[102]
Motor current	[103]
Torque rel to lim	[104]
Torque rel to rated	[105]
Power	[106]
Speed	[107]
Torque	[108]
Output freq. 4-20mA	[130]
Reference 4-20mA	[131]
Feedback 4-20mA	[132]
Motor cur. 4-20mA	[133]
Torque % lim. 4-20mA	[134]
Torque % nom 4-20mA	[135]
Power 4-20mA	[136]
Speed 4-20mA	[137]
Torque 4-20mA	[138]
Bus ctrl. 0-20 mA	[139]
Bus ctrl. 4-20 mA	[140]
Bus ctrl. 0-20 mA, timeout	[141]
Bus ctrl. 4-20 mA, timeout	[142]

Function:

Select the function of Terminal 42 as an analog current output.

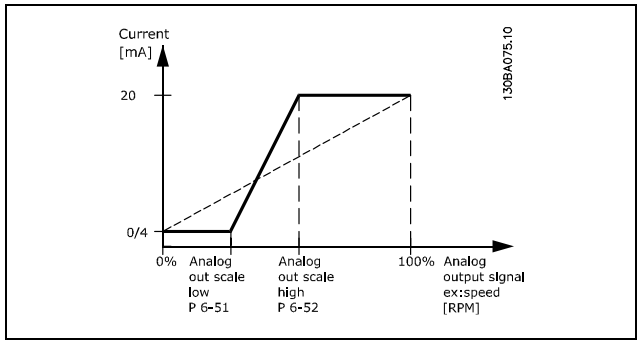
6-51 Terminal 42 Output Min Scale

Range:

0.00 – 200% *0%

Function:

Scale the minimum output of the selected analog signal at terminal 42, as a percentage of the maximum signal value. E.g., if 0 mA (or 0 Hz) is desired at 25% of the maximum output value, then program 25%. Scaling values up to 100% can never be higher than the corresponding setting in par. 6-52.



6-52 Terminal 42 Output Max Scale

Range:

000 – 200% *100%

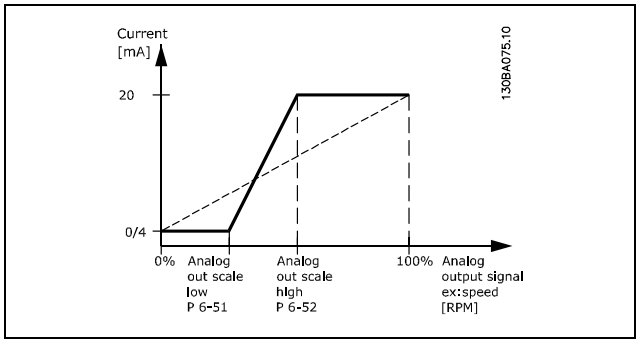
Function:

Scale the maximum output of the selected analog signal at terminal 42. Set the value to the maximum value of the current signal output. Scale the output to give a current lower than 20 mA at full scale; or 20 mA at an output below 100% of the maximum signal value. If 20 mA is the desired output current

at a value between 0 - 100% of the full-scale output, program the percentage value in the parameter, i.e., 50% = 20 mA. If a current between 4 and 20 mA is desired at maximum output (100%), calculate the percentage value as follows:

$$20\,mA/desired\,maximum\,current\;*\;100\%$$

$$i.e.\;\;10\,mA\;=\;\frac{20}{10}*100\;=\;200\%$$



6-53 Terminal 42 Output Bus Control

Range:

0.00 – 100.00% ✱0.00%

Function:

Holds the level of Output 42 if controlled by bus.

6-54 Terminal 42 Output Timeout Preset

Range:

0.00 – 100.00% ✱0.00%

Function:

Holds the preset level of Output 42.
In case of a bus timeout and a timeout function is selected in par. 6-50, the output will preset to this level.

□ **6-6* Analog Output 2 (MCB 101)**

Analog outputs are current outputs: 0/4 - 20 mA. Common terminal (terminal X30/7) is the same terminal and electrical potential for an analog common connection. Resolution on analog output is 12 bit.

6-60 Terminal X30/7 Output

Option:

No operation	[0]
MCO 0-20 mA	[52]
MCO 4-20 mA	[53]
Output frequency (0 . 1000 Hz), 0.20 mA	[100]
Output frequency (0 . 1000 Hz), 4.20 mA	
Reference (Ref min-max), 0.20 mA	[101]
Reference (Ref min-max), 4.20 mA	
Feedback (FB min-max) 0.20 mA	[102]
Feedback (FB min-max) 4.20 mA	
Motor current (0-Imax) 0.20 mA	[103]
Motor current (0-Imax) 4.20 mA	
Torque relative to limit 0-Tlim, 0.20 mA	[104]
Torque relative to limit 0-Tlim, 4.20 mA	
Torque relative to rated 0-Tnom, 0.20 mA	[105]
Torque relative to rated 0-Tnom, 4.20 mA	
Power (0-Pnom), 0.20 mA	[106]
Power (0-Pnom), 4.20 mA	
Speed (0-Speedmax), 0.20 mA	[107]
Speed (0-Speedmax), 4.20 mA	
Torque (+/-160% torque), 0-20 mA	[108]
Torque (+/-160% torque), 4-20 mA	
Output freq. 4-20 mA	[130]
Reference 4-20 mA	[131]
Feedback 4-20 mA	[132]
Motor cur. 4-20 mA	[133]
Torque % lim. 4-20 mA	[134]
Torque % nom 4-20 mA	[135]
Power 4-20 mA	[136]
Speed 4-20 mA	[137]
Torque 4-20 mA	[138]
Bus Ctrl 0-20 mA	[139]
Bus Ctrl 4-20 mA	[140]
Bus Ctrl 0-20 mA, Timeout	[141]
Bus Ctrl 4-20 mA, Timeout	[142]

6-61 Term. X30/8 Output Min Scale

Range:

0.00 - 200% ✱0%

Function:

Scales the minimum output of the selected analog signal on terminal X30/8. Scale the minimum value as a percentage of the maximum signal value, i.e., 0 mA (or 0 Hz) is desired at 25% of the maximum output value and 25% is programmed. The value

can never be higher than the corresponding setting in par. 6-62 if value is below 100%.
This parameter is active when option module MCB 101 is mounted in the adjustable frequency drive.

6-62 Term. X30/8 Output Max Scale

Range:

0.00 - 200% ✱100%

Function:

Scales the maximum output of the selected analog signal on terminal X30/8. Scale the value to the desired maximum value of the current signal output. Scale the output to give a lower current than 20 mA at full scale or 20 mA at an output below 100% of the maximum signal value. If 20 mA is the desired output current at a value between 0 - 100% of the full-scale output, program the percentage value in the parameter, i.e., 50% = 20 mA. If a current between 4 and 20 MA is desired at maximum output (100%), calculate the percentage value as follows:

$$20\ mA/desired\ maximum\ current\ *\ 100\%$$

$$i.e.\ 10\ mA\ =\ \frac{20}{10}\ *\ 100\ =\ 200\%$$

Parameters: Controllers

7-** Controllers

Parameter group for configuring application controls.

7-0* Speed PID Ctrl.

Parameters for configuring the speed PID control.

7-00 Speed PID Feedback Source

Option:

*Motor feedb. P1-02 (FC 302 only)	[0]
24V encoder	[1]
MCB 102	[2]
MCO 305	[3]

Function:

Select the encoder for closed loop feedback. The feedback may come from a different encoder (typically mounted on the application itself) than the motor mounted encoder feedback selected in par. 1-02.
This parameter cannot be adjusted while the motor is running.

NOTE
If separate encoders are used (FC 302 only) to ramp settings parameters in the following groups: 3-4*, 3-5*, 3-6*, 3-7* and 3-8* must be adjusted according to the gear ratio between the two encoders.

7-02 Speed PID ProportionalGain

Range:

0.000 - 1.000 * 0.015

Function:

Enter the speed controller proportional gain. The proportional gain amplifies the error (i.e., the deviation between the feedback signal and the set-point). This parameter is used with par. 1-00 *Speed open-loop* [0] and *Speed closed-loop* [1] control. Quick control is obtained at high amplification. However if the amplification is too great, the process may become unstable.

7-03 Speed PID Integral Time

Range:

2.0 - 20000.0 ms *8.0 ms

Function:

Enter the speed controller integral time, which determines the time the internal PID control takes to correct errors. The greater the error, the more quickly the gain increases. The integral time causes a delay of the signal and therefore a damping effect, and can be used to eliminate steady state speed error. Obtain quick control through a short integral time, though if the integral time is too short, the process becomes unstable. An excessively long integral time disables the integral action, leading to major deviations from the required reference, since the process regulator takes too long to regulate errors. This parameter is used with *Speed open-loop* [0] and *Speed closed-loop* [1] control, set in par. 1-00 *Configuration Mode*.

7-04 Speed PID Differentiation Time

Range:

0.0 - 200.0 ms *30.0 ms

Function:

Enter the speed controller differentiation time. The differentiator does not react to constant error. It provides gain proportional to the rate of change of the speed feedback. The quicker the error changes, the stronger the gain from the differentiator. The gain is proportional with the speed at which errors change. Setting this parameter to zero disables the differentiator. This parameter is used with par. 1-00 *Speed closed-loop* [1] control.

7-05 Speed PID Diff Gain Limit

Range:

1.000 - 20.000 *5.000

Function:

Set a limit for the gain provided by the differentiator. Since the differential gain increases at higher frequencies, limiting the gain may be useful. For example, set up a pure D-link at low frequencies and a constant D-link at higher frequencies. This parameter is used with par. 1-00 *Speed closed loop* [1] control.

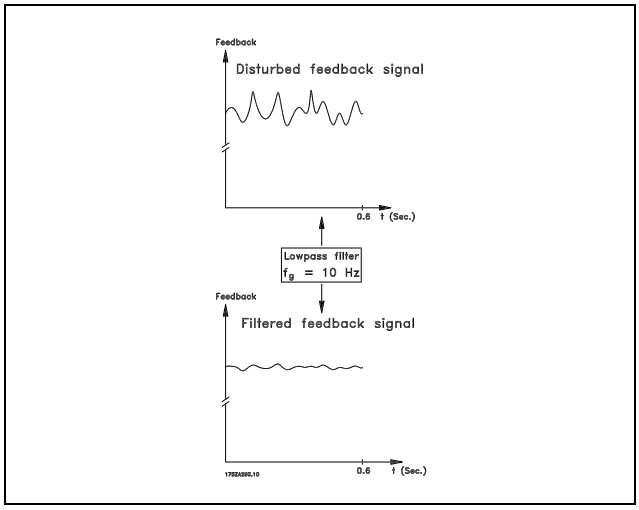
7-06 Speed PID Lowpass Filter Time

Range:

1.0 - 100.0 ms * 10.0ms

Function:

Set a time constant for the speed control low-pass filter. The low-pass filter improves steady-state performance and dampens oscillations on the feedback signal. This is an advantage if there is a great amount on noise in the system, see illustration below. For example, if a time constant (τ) of 100 ms is programmed, the cut-off frequency for the low-pass filter will be 1/0.1= 10 RAD/sec., corresponding to (10/2 x p) = 1.6 Hz. The PID regulator only regulates a feedback signal that varies by a frequency of less than 1.6 Hz. If the feedback signal varies by a higher frequency than 1.6 Hz, the PID regulator does not react.
Note that severe filtering can be detrimental to dynamic performance.
This parameter is used with par. 1-00 *Speed closed loop* [1] and *Torque* [2] control.



□ **7-2* Process Ctrl. Feedb.**

Select the feedback sources for the Process PID Control, and how this feedback should be handled.

7-20 Process CL Feedback 1 Resource

Option:

✱No function	[0]
Analog input 53	[1]
Analog input 54	[2]
Frequency input 29	[3]
Frequency input 33	[4]
Bus feedback 1	[5]
Bus feedback 2	[6]
Analog input X30/11	[7]
Analog input X30/12	[8]

Function:

The effective feedback signal is made up of the sum of up to two different input signals.
Select which frequency converter input should be treated as the source of the first of these signals.
The second input signal is defined in par. 7-22.

7-22 Process CL Feedback 2 Resource

Option:

✱No function	[0]
Analog input 53	[1]
Analog input 54	[2]
Frequency input 29	[3]
Frequency input 33	[4]
Bus feedback 1	[5]
Bus feedback 2	[6]
Analog input X30/11	[7]
Analog input X30/12	[8]

Function:

The effective feedback signal is made up of the sum of up to two different input signals. Select which frequency converter input should be treated as the source of the second of these signals. The first input signal is defined in par. 7-21.

□ **7-3* Process PID Ctrl.**

Parameters for configuring the Process PID control.

7-30 Process PID Normal/Inverse Control

Option:

✱Normal	[0]
Inverse	[1]

Function:

Select *Normal* [0] to set the process control to increase the output frequency.
Select *Inverse* [1] to set the process control to reduce the output frequency. Normal and inverse control are implemented by introducing a difference between the reference signal and the feedback signal.

7-31 Process PID Anti Windup

Option:

✱Off	[0]
On	[1]

✱ default setting **( )** display text **[ ]** value for use in communication via serial communication port

Function:

Select *Off* [0] to cease regulation of an error when the output frequency can no longer be adjusted. Select *On* [1] to continue regulation of an error even when the output frequency cannot be increased or decreased.

7-32 Process PID Start Speed

Range:

0 - 6000 RPM ✱0 RPM

Function:

Enter the motor speed to be attained as a start signal for commencement of PID control. When the power is switched on, the frequency converter will commence ramping and then operate under speed open loop control. Thereafter, when the Process PID start speed is reached, the frequency converter will change over to Process PID control.

7-33 Process PID Proportional Gain

Range:

0.00 - 10.00 N/A ✱0.01 N/A

Function:

Enter the PID proportional gain. The proportional gain multiplies the error between the set point and the feedback signal.

7-34 Process PID Integral Time

Range:

0.01 - 10000.00 ✱10000.00 s

Function:

Enter the PID integral time. The integrator provides an increasing gain at a constant error between the set point and the feedback signal. The integral time is the time needed by the integrator to reach the same gain as the proportional gain.

7-35 Process PID Differentiation Time

Range:

0.00 - 10.00 s ✱0.00 s

Function:

Enter the PID differentiation time. The differentiator does not react to a constant error, but provides a gain only when the error changes. The shorter the PID differentiation time, the stronger the gain from the differentiator.

7-36 Process PID Differentiation Gain Limit

Range:

1.0 - 50.0 N/A ✱5.0 N/A

Function:

Enter a limit for the differentiator gain (DG). If there is no limit, the DG will increase when there are fast changes. Limit the DG to obtain a pure differentiator gain at slow changes and a constant differentiator gain where fast changes occur.

7-38 Process PID Feed Forward Factor

Range:

0 - 500% ✱0%

Function:

Enter the PID feed forward (FF) factor. The FF factor sends a constant fraction of the reference signal to bypass the PID control, so the PID control only affects the remaining fraction of the control signal. Any change to this parameter will thus affect the motor speed. When the FF factor is activated it provides less overshoot, and high dynamics when changing the set point. Par. 7-38 is active when par. 1-00 *Configuration Mode* is set to [3] Process.

7-39 On Reference Bandwidth

Range:

0 - 200% ✱5%

Function:

Enter the On Reference bandwidth. When the PID Control Error (the difference between the reference and the feedback) is less than the set value of this parameter the On Reference status bit is high, i.e. =1.

□ Parameters: Communications and Options

□ 8-** Comm. and Options

Parameter group for configuring communications and options.

□ 8-0* General Settings

General settings for communications and options.

8-01 Control Site

Option:

✱Digital and ctrl. word [2]	[0]
Digital only	[1]
Control word only	[2]

Function:

Select *Digital and ctrl. word* [0] for control using both digital input and control word.
Select *Digital only* [1] for control using digital inputs only.
Select *Control word only* [2] for control using control word only.
The setting in this parameter overrules the settings in par. 8-50 to 8-56.

8-02 Control Word Source

Option:

✱FC RS-485	[0]
FC USB	[1]
Option A	[2]

Function:

Select the source of the control word: one of two serial interfaces or four installed options. During initial power-up, the frequency converter automatically sets this parameter to *Option A* [3] if it detects a valid fieldbus option installed in slot A. If the option is removed, the frequency converter detects a change in the configuration, sets par. 8-02 back to default setting *FC RS485*, and the frequency converter then trips. If an option is installed after initial power-up, the setting of par. 8-02 will not change but the drive will trip and display: Alarm 67 *Option Changed*.
This parameter cannot be adjusted while the motor is running.

8-03 Control Word Timeout Time

Range:

0.1 - 18000.0 s	✱1.0s

Function:

Enter the maximum time expected to pass between the reception of two consecutive telegrams. If this time is exceeded, it indicates that the serial communication has stopped. The function selected in par. 8-04 *Control Word Time-out Function* will then be carried out. The time-out counter is triggered by a valid control word. Acyclic DP V1 does not trigger the time-out counter.

8-04 Control Word Timeout Function

Option:

✱Off	[0]
Freeze Output	[1]
Stop	[2]
Jogging	[3]
Max. Speed	[4]
Stop and trip	[5]
Select set-up 1	[7]
Select set-up 2	[8]
Select set-up 3	[9]
Select set-up 4	[10]

Function:

Select the time-out function. The time-out function activates when the control word fails to be updated within the time period specified in par. 8-03 *Control Word Time-out Time*.

- *Off* [0]: Resume control via serial bus (Fieldbus or standard) using the most recent control word.
- *Freeze output* [1]: Freeze output frequency until communication resumes.
- *Stop* [2]: Stop with auto restart when communication resumes.
- *Jogging* [3]: Run the motor at JOG frequency until communication resumes.
- *Max. freq.* [4]: Run the motor at maximum frequency until communication resumes.
- *Stop and trip* [5]: Stop the motor, then reset the frequency converter in order to restart: via the fieldbus, via the reset button on the LCP or via a digital input.
- *Select set-up 1-4* [7] - [10]: This option changes the set-up upon reestablishment of communication following a control word time-out. If communication resumes causing the time-out situation to disappear, par. 8-05 *End-of-time-out Function* defines whether to resume the set-up used before the time-out or to retain the set-up endorsed by the time-out

function. Note the following configuration required in order to change the set-up after a time-out: Set Par. 0-10 *Active set-up to Multi set-up* [9], and select the relevant link in par. 0-12 *This Set-up Linked To*.

8-05 End-of-Timeout Function

Option:

*Hold set-up	[0]
Resume set-up	[1]

Function:

Select the action after receiving a valid control word following a time-out. This parameter is active only when par. 8-04 is set to *Set-up 1-4*.
Hold: The frequency converter retains the set-up selected in par. 8-04 and displays a warning, until par. 8-06 toggles. Then the frequency converter resumes its original set-up.
Resume: The frequency converter resumes the set-up active prior to the time-out.

8-06 Reset Control Word Timeout

Option:

*Do not reset	[0]
Do reset	[1]

Function:

Select *Do reset* [1] to return the frequency converter to the original set-up following a control word time-out. When the value is set to *Do reset* [1], the frequency converter performs the reset and then immediately reverts to the *Do not reset* [0] setting.
Select *Do not reset* [0] to retain the set-up specified in par. 8-04, *Select setup 1-4* following a control word time-out.
This parameter is active only when *Hold set-up* [0] has been selected in par. 8-05 *End-of-Time-out Function*.

8-07 Diagnosis Trigger

Option:

*Disable	[0]
Trigger on alarms	[1]
Trigger alarms/warn.	[2]

Function:

This parameter enables and controls the drive diagnosis function and permits expansion of the diagnosis data to 24 byte. It relates only to Profibus.

- *Disable* [0]: Do not send extended diagnosis data even if they appear in the adjustable frequency drive.
- *Trigger on alarms* [1]: Send extended diagnosis data when one or more alarms appear in alarm par. 16-90 or 9-53.
- *Trigger alarms/warn.*[2]: Send extended diagnosis data if one or more alarms or warnings appear in alarm par. 16-90, 9-53, or warning par. 16-92.

The content of the extended diagnosis frame is as follows:

Byte	Content	Description
0 - 5	Standard DP Diagnose Data	Standard DP Diagnose Data
6	PDU length xx	Header of extended diagnostic data
7	Status type = 0x81	Header of extended diagnostic data
8	Slot = 0	Header of extended diagnostic data
9	Status info = 0	Header of extended diagnostic data
10 - 13	VLT par. 16-92	VLT warning word
14 - 17	VLT par. 16-03	VLT status word
18 - 21	VLT par. 16-90	VLT alarm word
22 - 23	VLT par. 9-53	Communication warning word (Profibus)

Enabling diagnosis may cause increased bus traffic. Diagnosis functions are not supported by all serial communication bus types.

□ 8-1* Ctrl. Word Settings

Parameters for configuring the option control word profile.

8-10 Control Word Profile

Option:

*FC profile	[0]
PROFIdrive profile	[1]
ODVA	[5]
CANopen DSP 402	[7]

Function:

Select the interpretation of the control and status words corresponding to the installed serial communication bus. Only the selections valid

for the serial communication bus installed in slot A will be visible in the LCP display.
For guidelines for selecting *FC profile* [0] and *PROFIdrive profile* [1], please refer to the *Serial communication via RS 485 Interface* section in the *How to Program* chapter.
For additional guidelines in the selection of *PROFIdrive profile* [1], *ODVA* [5] and *CANopen DSP 402* [7], please refer to the Instruction Manual for the installed serial communication bus.

8-13 Configurable Status Word STW

Option:

Bit 12	[12]
Bit 13	[13]
Bit 14	[14]
Bit 15	[15]

Function:

This parameter enables configuration of bit 12 – 15 in the status word.
Profile Default [1]: The function on the bit corresponds to the profile default selected in par. 8-10.
Alarm 68 Only [2]: The bit is only set in case of an Alarm 68.
Trip except Alarm 68 [3]: The bit is set in case of a trip, except if the trip is executed by an Alarm 68.
T37 DI status [16]: The bit indicates the status of terminal 37.
"0" indicates T37 is low (safe stop)
"1" indicates T37 is high (normal)

□ **8-3* FC Port Settings**
Parameters for configuring the FC Port.

8-30 Protocol

Option:

✱FC	[0]
FC MC	[1]

Function:

Select the protocol for the FC (standard) port.

8-31 Address

Range:

1 - 126	✱1

Function:

Enter the address for the FC (standard) port.
Valid range: 1 - 126.

8-32 FC Port Baud Rate

Option:

2400 Baud	[0]
4800 Baud	[1]
✱9600 Baud	[2]
19200 Baud	[3]
38400 Baud	[4]
115200 Baud	[7]

Function:

Baud rate selection for the FC (standard) port.

8-35 Minimum Response Delay

Range:

1 - 500 ms	✱10ms

Function:

Specify the minimum delay time between receiving a request and transmitting a response. This is used for overcoming modem turnaround delays.

8-36 Max Response Delay

Range:

1 - 10000 ms	✱5000ms

Function:

Specify the maximum permissible delay time between transmitting a request and receiving a response. Exceeding this delay time will cause control word time-out.

8-37 Max Inter-Char Delay

Range:

0 - 30 ms	✱25ms

Function:

Specify the maximum permissible time interval between receipt of two bytes. This parameter activates time-out if transmission is interrupted. This parameter is active only when par. 8-30 is set to *FC MC* [1] protocol.

□ **8-5* Digital/Bus**
Parameters for configuring the control word Digital/Bus merging.

8-50 Coasting Select

Option:

Digital input	[0]
Bus	[1]

Logic AND	[2]
*Logic OR	[3]

Function:

Select control of the coasting function via the terminals (digital input) and/or via the bus.

NOTE
This parameter is active only when par. 8-01 *Control Site* is set to [0] *Digital and control word*.

8-51 Quick Stop Select

Option:

Digital input	[0]
Bus	[1]
Logic AND	[2]
*Logic OR	[3]

Function:

Select control of the Quick Stop function via the terminals (digital input) and/or via the bus.

NOTE
This parameter is active only when par. 8-01 *Control Site* is set to [0] *Digital and control word*.

8-52 DC Brake Select

Option:

Digital input	[0]
Bus	[1]
Logic AND	[2]
*Logic OR	[3]

Function:

Select control of the DC brake via the terminals (digital input) and/or via the fieldbus.

NOTE
This parameter is active only when par. 8-01 *Control Site* is set to [0] *Digital and control word*.

8-53 Start Select

Option:

Digital input	[0]
Bus	[1]
Logic AND	[2]
*Logic OR	[3]

Function:

Select control of the frequency converter start function via the terminals (digital input) and/or via the fieldbus.
Select *Bus* [1], to activate the Start command via the serial communication port or fieldbus option.
Select *Logic AND* [2] to activate the Start command via the fieldbus/serial communication port, AND additionally via one of the digital inputs.
Select *Logic OR* [3] to activate the Start command via the fieldbus/serial communication port OR via one of the digital inputs.

NOTE
This parameter is active only when par. 8-01 *Control Site* is set to [0] *Digital and control word*.

8-54 Reverse Select

Option:

Digital input	[0]
Bus	[1]
Logic AND	[2]
*Logic OR	[3]

Function:

Select control of the frequency converter reverse function via the terminals (digital input) and/or via the fieldbus.
Select *Bus* [1], to activate the Reverse command via the serial communication port or fieldbus option.
Select *Logic AND* [2] to activate the Reverse command via the fieldbus/serial communication port, AND additionally via one of the digital inputs.
Select *Logic OR* [3] to activate the Reverse command via the fieldbus/serial communication port OR via one of the digital inputs.

NOTE
This parameter is active only when par. 8-01 *Control Site* is set to [0] *Digital and control word*.

8-55 Set-up Select

Option:

Digital input	[0]
Bus	[1]
Logic AND	[2]
*Logic OR	[3]

Function:

Select control of the frequency converter set-up selection via the terminals (digital input) and/or via the fieldbus.
Select *Bus* [1], to activate the set-up selection via the serial communication port or fieldbus option.
Select *Logic AND* [2] to activate the set-up selection via the fieldbus/serial communication port, AND additionally via one of the digital inputs.
Select *Logic OR* [3] to activate the set-up selection via the fieldbus/serial communication port OR via one of the digital inputs.

NOTE
This parameter is active only when par. 8-01 *Control Site* is set to [0] *Digital and control word*.

8-56 Preset Reference Select

Option:

Digital input	[0]
Bus	[1]
Logic AND	[2]
✱Logic OR	[3]

Function:

Select control of the frequency converter Preset Reference selection via the terminals (digital input) and/or via the fieldbus.
Select *Bus* [1], to activate the Preset Reference selection via the serial communication port or fieldbus option.
Select *Logic AND* [2] to activate the Preset Reference selection via the fieldbus/serial communication port, AND additionally via one of the digital inputs.
Select *Logic OR* [3] to activate the Preset Reference selection via the fieldbus/serial communication port OR via one of the digital inputs.

NOTE
This parameter is active only when par. 8-01 *Control Site* is set to [0] *Digital and control word*.

□ **8-9* Bus Jog**
Parameters for configuring the Bus Jog.

8-90 Bus Jog 1 Speed

Range:

0 - par. 4-13 RPM ✱100RPM

Function:

Enter the jog speed. This is a fixed jog speed activated via the serial port or fieldbus option.

8-91 Bus Jog 2 Speed

Range:

0 - par. 4-13 RPM ✱200RPM

Function:

Enter the jog speed. This is a fixed jog speed activated via the serial port or fieldbus option.

Parameters: Profibus

9-** Profibus

Parameter group for all Profibus-specific parameters.

9-15 PCD Write Configuration

Array [10]

Option:

None
3-02 Minimum Reference
3-03 Maximum Reference
3-12 Catch Up/Slow Down Value
3-41 Ramp 1 Ramp Up Time
3-42 Ramp 1 Ramp Down Time
3-51 Ramp 2 Ramp Up Time
3-52 Ramp 2 Ramp Down Time
3-80 Jog Ramp Time
3-81 Quick Stop Ramp Time
4-11 Motor Speed Low Limit [RPM]
4-13 Motor Speed High Limit [RPM]
4-16 Torque Limit Motor Mode
4-17 Torque Limit Generator Mode
8-90 Bus Jog 1 Speed
8-91 Bus Jog 2 Speed
16-80 Fieldbus CTW 1
16-82 Fieldbus REF 1

Function:

Select the parameters to be assigned to PCD 3 to 10 of the telegrams. The number of available PCDs depends on the telegram type. The values in PCD 3 to 10 will then be written to the selected parameters as data values. Alternatively, specify a standard Profibus telegram in par. 9-22.

9-16 PCD Read Configuration

Array [10]

Option:

None
16-00 Control Word
16-01 Reference [Unit]
16-02 Reference %
16-03 Status Word
16-05 Main Actual Value [%]
16-10 Power [kW]
16-11 Power [hp]
16-12 Motor Voltage
16-13 Frequency
16-14 Motor Current
16-16 Torque
16-17 Speed [RPM]
16-18 Motor Thermal
16-19 KTY Sensor Temperature
16-20 Phase Angle
16-30 DC Link Voltage
16-32 Brake Energy / s
16-33 Brake Energy / 2 min
16-34 Heatsink Temp.
16-35 Inverter Thermal
16-38 SL Controller State
16-39 Controlcard Temp.
16-50 External Reference
16-51 Pulse Reference
16-52 Feedback [Unit]
16-53 Digi Pot Reference
16-60 Digital Input
16-61 Terminal 53 Switch Setting
16-62 Analog Input 53
16-63 Terminal 54 Switch Setting
16-64 Analog Input 54
16-65 Analog Output 42 [mA]
16-66 Digital Output [bin]
16-67 Freq. Input #29 [Hz]
16-68 Freq. Input #33 [Hz]
16-69 Pulse Output #27 [Hz]
16-70 Pulse Output #29 [Hz]
16-84 Comm Option STW [Binary]
16-85 FC port CTW 1 Signal
16-90 Alarm Word
16-91 Alarm Word 2
16-92 Warning Word
16-93 Warning Word 2
16-94 Extended Status Word
16-95 Extended Status Word 2

Function:

Select the parameters to be assigned to PCD 3 to 10 of the telegrams. The number of available PCDs depends on the telegram type. PCDs 3 to 10 contain the actual data values of the selected parameters. For standard Profibus telegrams, see par. 9-22.

9-18 Node Address

Range:

0 - 126 *126

Function:

Enter the station address in this parameter or alternatively in the hardware switch. In order to adjust the station address in par. 9-18, the hardware switch must be set to 126 or 127 (i.e. all switches set to 'on'). Otherwise this parameter will display the actual setting of the switch.

9-22 Telegram Selection

Option:

Standard telegram 1	[1]
PPO 1	[101]
PPO 2	[102]
PPO 3	[103]
PPO 4	[104]
PPO 5	[105]
PPO 6	[106]
PPO 7	[107]
*PPO 8	[108]

Function:

Select a standard Profibus telegram configuration for the frequency converter, as an alternative to using the freely configurable telegrams in par. 9-15 and 9-16.

9-23 Parameters for Signals

Array [1000]

Option:

None
3-02 Minimum Reference
3-03 Maximum Reference
3-12 Catch Up/Slow Down Value
3-41 Ramp 1 Ramp Up Time
3-42 Ramp 1 Ramp Down Time
3-51 Ramp 2 Ramp Up Time
3-52 Ramp 2 Ramp Down Time
3-80 Jog Ramp Time
3-81 Quick Stop Ramp Rime
4-11 Motor Speed Low Limit
4-13 Motor Speed High Limit
4-16 Torque Limit Motor Mode
4-17 Torque Limit Generator Mode
8-90 Bus Jog 1 Speed
8-91 Bus Jog 2 Speed
16-00 Control Word
16-01 Reference [Unit]
16-02 Reference %
16-03 Status Word
16-05 Main Actual Value [%]
16-10 Power [kW]
16-11 Power [hp]
16-12 Motor Voltage
16-13 Frequency
16-14 Motor Current
16-16 Torque
16-17 Speed [RPM]
16-18 Motor Thermal
16-19 KTY Sensor Temperature
16-20 Phase Angle
16-30 DC Link Voltage
16-32 Brake Energy / s
16-33 Brake Energy / 2 Min
16-34 Heatsink Temp.
16-35 Inverter Thermal
16-38 SL Controller State
16-39 Controlcard Temp.
16-50 External Reference
16-51 Pulse Reference
16-52 Feedback [Unit]
16-53 Digi Pot Reference
16-60 Digital Input
16-61 Terminal 53 Switch Setting
16-62 Analog Input 53
16-63 Terminal 53 Switch Setting
16-64 Analog Input 54
16-65 Analog Output 42 [mA]
16-66 Digital Output [bin]
16-67 Freq. Input #29 [Hz]
16-68 Freq. Input #33 [Hz]
16-69 Pulse Output #27 [Hz]
16-70 Pulse Output #29 [Hz]
16-80 Fieldbus CTW 1
16-82 Fieldbus REF 1
16-84 Comm Option STW
16-85 FC Port CTW 1
16-90 Alarm Word
16-91 Alarm Word 2
16-92 Warning Word
16-93 Warning Word 2
16-94 Extended Status Word
16-95 Extended Status Word 2

Function:

This parameter contains a list of signals available for selection in par. 9-15 and 9-16.

9-27 Parameter Edit

Option:

Disabled	[0]
*Enabled	[1]

Function:

Parameters can be edited via Profibus, the standard RS485 interface, or the LCP.
Select *Disabled* [0] to disable editing via Profibus.

9-28 Process Control

Option:

Disable	[0]
*Enable cyclic master	[1]

Function:

Process control (setting of Control Word, speed reference, and process data) is possible via either Profibus or standard fieldbus but not both simultaneously. Local control is always possible via the LCP. Control via process control is possible via either terminals or fieldbus depending on the settings in par. 8-50 to 8-56.
Select *Disable* [0] to disable process control via Profibus, and enable process control via standard fieldbus or Profibus Master class 2.
Select *Enable cyclic master* [1] to enable process control via Profibus Master Class 1, and disable process control via standard fieldbus or Profibus Master class 2.

9-53 Profibus Warning Word

Option:

Bit:	Meaning:
0	Connection with DP master is not
1	Timeout action active
2	FDL (Field-bus Data link Layer) is not ok
3	Clear data command received
4	Actual value is not updated
5	baud rate search
6	PROFIBUS ASIC is not transmitting
7	Initializing of PROFIBUS is not ok
8	drive is tripped
9	internal CAN error
10	wrong ID sent by PLC
11	Internal error occurred
12	not configured
13	clear command received
14	warning 34 active

Function:

This parameter displays Profibus communication warnings. Please refer to the Profibus Operating Instructions for further information.

9-63 Actual Baud Rate

Option:

Read-only	
9.6 kbit/s	[0]
19.2 kbit/s	[1]
93.75 kbit/s	[2]
187.5 kbit/s	[3]
500 kbit/s	[4]
1500 kbit/s	[6]
3000 kbit/s	[7]
6000 kbit/s	[8]
12000 kbit/s	[9]
31.25 kbit/s	[10]
45.45 kbit/s	[11]
No baud rate found	[255]

Function:

This parameter displays the actual Profibus baud rate. The Profibus Master automatically sets the baud rate.

9-65 Profile Number

Option:

Read only
0 - 0 * 0

Function:

This parameter contains the profile identification. Byte 1 contains the profile number and byte 2 the version number of the profile.

NOTE
This parameter is not visible via LCP.

9-70 Edit Set-up

Option:

Factory setup	[0]
* Setup 1	[1]
Setup 2	[2]
Setup 3	[3]
Setup 4	[4]
Active setup	[9]

Function:

Select the set-up to be edited.
Select *Set-up 1-4* [1]-[4] to edit a specific set-up.
Select *Active set-up* [9] to follow the active set-up selected in par. 0-10.
Select *Factory set-up* [0] for default data. This option can be used as a data source to return the other set-ups to a known state.
This parameter is unique to LCP and fieldbuses.
See also par. 0-11 *Edit set-up*.

9-71 Save Data Values

Option:

* Off	[0]
Store edit setup	[1]
Store all set-ups	[2]

Function:

Parameter values changed via Profibus are not automatically stored in non-volatile memory. Use this parameter to activate a function that stores parameter values in the EEPROM non-volatile memory, so changed parameter values will be retained at power-down.
Select *Off* [0] to deactivate the non-volatile storage function.
Select *Store edit setup* [1] to store all parameter values in the set-up selected in par. 9-70 in the non-volatile memory. The selection returns to Off [0] when all values have been stored.
Select *Store all set-ups* [2] to store all parameter values for all set-ups in the non-volatile memory. The selection returns to *Off* [0] when all parameter values have been stored.

9-72 Drive Reset

Option:

* No action	[0]
Power-on reset	[1]
Power-on reset prep	[2]
Comm. option reset	[3]

Function:

Select *Power-on reset* [1] to reset the frequency converter upon power-up, as for power-cycle.
Select *Comm. option reset* [3] to reset the Profibus option only, useful after changing certain settings in parameter group 9-**, e.g. par. 9-18.
When reset, the frequency converter disappears from the fieldbus, which may cause a communication error from the master.

9-80 Defined Parameters (1)

Array [1000]

Option:

No LCP access
Read-only
0 - 9999 * 0

Function:

This parameter displays a list of all the defined frequency converter parameters available for Profibus.

9-81 Defined Parameters (2)

Array [1000]

Option:

No LCP access
Read-only
0 - 9999 * 0

Function:
This parameter displays a list of all the defined frequency converter parameters available for Profibus.

9-82 Defined Parameters (3)

Array [1000]

Option:
No LCP access
Read-only
0 - 9999 *0

Function:
This parameter displays a list of all the defined frequency converter parameters available for Profibus.

9-83 Defined Parameters (4)

Array [1000]

Option:
No LCP access
Read-only
0 - 9999 *0

Function:
This parameter displays a list of all the defined frequency converter parameters available for Profibus.

9-90 Changed Parameters (1)

Array [1000]

Option:
No LCP access
Read-only
0 - 9999 *0

Function:
This parameter displays a list of all the frequency converter parameters deviating from default setting.

9-91 Changed Parameters (2)

Array [1000]

Option:
No LCP access
Read-only
0 - 9999 *0

Function:
This parameter displays a list of all the frequency converter parameters deviating from default setting.

9-92 Changed Parameters (3)

Array [1000]

Option:
No LCP access
Read-only
0 - 9999 *0

Function:
This parameter displays a list of all the frequency converter parameters deviating from default setting.

9-93 Changed Parameters (4)

Array [1000]

Option:
No LCP access
Read-only
0 - 9999 *0

Function:
This parameter displays a list of all the frequency converter parameters deviating from default setting.

□ Parameters: DeviceNet CAN Fieldbus

□ 10-** DeviceNet CAN Ser. Com. Bus

Parameter group for DeviceNet CAN serial communication bus parameters.

□ 10-0* Common Settings

Parameter group for configuring common settings for CAN fieldbus options.

10-00 CAN Protocol

Option:

CANopen	[0]
✱DeviceNet	[1]

Function:

View the active CAN protocol.

NOTE
The options depend on installed option.

10-01 Baud Rate Select

Option:

10 Kbps	[16]
20 Kbps	[17]
50 Kbps	[18]
100	[19]
✱125 Kbps	[20]
250 Kbps	[21]
500 Kbps	[22]

Function:

Select the fieldbus transmission speed. The selection must correspond to the transmission speed of the master and the other fieldbus nodes.

10-02 MAC ID

Option:

0 - 127 N/A	✱63 N/A

Function:

Selection of station address. Every station connected to the same DeviceNet network must have an unambiguous address.

10-05 Readout Transmit Error Counter

Range:

0 - 255	✱0

Function:

View the number of CAN control transmission errors since the last power-up.

10-06 Readout Receive Error Counter

Range:

0 - 255	✱0

Function:

View the number of CAN control receipt errors since the last power-up.

10-07 Readout Bus Off Counter

Range:

0 - 1000	✱0

Function:

View the number of Bus Off events since the last power-up.

□ 10-1* DeviceNet

Parameters specific to the DeviceNet fieldbus.

10-10 Process Data Type Selection

Option:

Instance 100/150	[0]
Instance 101/151	[1]
Instance 20/70	[2]
Instance 21/71	[3]

Function:

Select the instance (telegram) for data transmission. The instances available are dependent upon the setting of par. 8-10 *Control Word Profile*.
When par. 8-10 is set to [0] *FC profile*, par. 10-10 options [0] and [1] are available.
When par. 8-10 is set to [5] *ODVA*, par. 10-10 options [2] and [3] are available.
Instances 100/150 and 101/151 are Danfoss-specific. Instances 20/70 and 21/71 are ODVA-specific AC drive profiles.
For guidelines in telegram selection, please refer to the DeviceNet Instruction Manual.
Note that a change to this parameter will be executed immediately.

10-11 Process Data Config Write

Option:

✱0 None
16-80 Fieldbus CTW 1 (Fixed)

16-82 Fieldbus REF 1 (Fixed)
3-02 Minimum Reference
3-03 Maximum Reference
3-12 Catch up/slow-down value
3-41 Ramp 1 Ramp-up Time
3-42 Ramp 1 Ramp-down Time
3-51 Ramp 2 Ramp-up Time
3-52 Ramp 2 Ramp-down Time
3-80 Jog Ramp Time
3-81 Quick Stop Ramp Time
4-11 Motor Speed Low Limit (RPM)
4-13 Motor Speed High Limit (RPM)
4-16 Torque Limit Motor Mode
4-17 Torque Limit Generator Mode
8-90 Bus Jog 1 Speed
8-91 Bus Jog 2 Speed

Function:

Select the process write data for I/O Assembly Instances 101/151. Elements [2] and [3] of this array can be selected. Elements [0] and [1] of the array are fixed.

10-12 Process Data Config Read

Option:

*None
16-03 Status Word (Fixed)
16-05 Main Actual Value [%] (Fixed)
16-00 Control Word
16-01 Reference [Unit]
16-02 Reference %
16-04 Main Actual Value [Unit]
16-91 Alarm Word 2
16-92 Warning Word
16-90 Alarm Word
16-93 Warning Word 2
16-94 Ext. Status Word
16-95 Ext. Status Word 2
16-10 Power [kW]
16-11 Power [hp]
16-12 Motor voltage
16-13 Frequency
16-14 Motor Current
16-16 Torque
16-17 Speed [RPM]
16-18 Motor Thermal
16-19 KTY Sensor Temperature
16-20 Phase Angle
16-30 DC Link Voltage
16-32 Brake Energy /s
16-33 Brake Energy /2 min
16-34 Heatsink Temp.
16-35 Inverter Thermal
16-38 SL Controller State
16-39 Control Card Temp.
16-50 External Reference
16-51 Pulse Reference
16-52 Feedback [Unit]
16-53 Digi Pot Reference
16-60 Digital Input
16-61 Terminal 53 Switch Setting
16-62 Analog Input 53
16-63 Terminal 54 Switch Setting
16-64 Analog Input 54
16-65 Analog Output 42 [mA]
16-66 Digital Output [bin]
16-67 Freq. Input #29 [Hz]
16-68 Freq. Input #33 [Hz]
16-69 Pulse Output #27 [Hz]
16-70 Pulse Output #29 [Hz]
16-84 Comm Option Status
16-85 FC Port CTW 1
16-09 Custom Readout

Function:

Select the process read data for I/O Assembly Instances 101/151. Elements [2] and [3] of this array can be selected. Elements [0] and [1] of the array are fixed.

10-13 Warning Parameter

Range:

0 - 63 *63

Function:

View a DeviceNet-specific Warning word. One bit is assigned to every warning. Please refer to the DeviceNet Operating Instructions (MG.33.DX.YY) for further information.

Bit:	Meaning:
0	Bus not active
1	Explicit connection timeout
2	I/O connection
3	Retry limit reached
4	Actual is not updated
5	CAN bus off
6	I/O send error
7	Initialization error
8	No bus supply
9	Bus off
10	Error passive
11	Error warning
12	Duplicate MAC ID Error
13	RX queue overrun
14	TX queue overrun
15	CAN overrun

10-14 Net Reference

Option:

Read-only from LCP.

*Off [0]
On [1]

Function:

Select the reference source in Instance 21/71 and 20/70.
Select *Off* [0] to enable reference via analog/digital inputs.
Select *On* [1] to enable reference via the fieldbus.

10-15 Net Control

Option:

Read-only from LCP.

*Off [0]
On [1]

Function:

Select the control source in Instance 21/71 and 20-70.
Select *Off* [0] to enable control via analog/digital inputs.
Select *On* [1] to enable control via the fieldbus.

□ 10-2* COS Filters

Parameters for configuring COS filter settings.

10-20 COS Filter 1

Range:

0 - FFFF *FFFF

Function:

Enter the value for COS Filter 1 to set up the filter mask for the Status Word. When operating in COS (Change-Of-State), this function filters out bits in the Status Word that should not be sent if they change.

10-21 COS Filter 2

Range:

0 - FFFF *FFFF

Function:

Enter the value for COS Filter 2, to set up the filter mask for the Main Actual Value. When operating in COS (Change-Of-State), this function filters out bits in the Main Actual Value that should not be sent if they change.

10-22 COS Filter 3

Range:

0 - FFFF *FFFF

Function:

Enter the value for COS Filter 3, to set up the filter mask for PCD 3. When operating in COS (Change-Of-State), this function filters out bits in PCD 3 that should not be sent if they change.

10-23 COS Filter 4

Range:

0 - 65535 *65535

Function:

Enter the value for COS Filter 4 to set up the filter mask for PCD 4. When operating in COS (Change-Of-State), this function filters out bits in PCD 4 that should not be sent if they change.

□ 10-3* Parameter Access

Parameter group providing access to indexed parameters and defining programming set-up.

10-30 Array Index

Range:

0 - 65536 *0

Function:

View array parameters. This parameter is valid only when a DeviceNet fieldbus is installed.

10-31 Store Data Values

Option:

*Off	[0]
Store edit setup	[1]
Store all setups	[2]

Function:

Parameter values changed via DeviceNet are not automatically stored in non-volatile memory. Use this parameter to activate a function that stores parameter values in the EEPROM non-volatile memory, so changed parameter values will be retained at power-down.
Select *Off* [0] to deactivate the non-volatile storage function.
Select *Store edit setup* [1] to store all parameter values from the active set-up in the non-volatile memory. The selection returns to Off [0] when all values have been stored.
Select *Store all set-ups* [2] to store all parameter values for all set-ups in the non-volatile memory. The selection returns to *Off* [0] when all parameter values have been stored.

10-32 Devicenet Revision

Range:

0 - 65535 N/A	*0 N/A

Function:

View the DeviceNet revision number. This parameter is used for EDS file creation.

10-33 Store Always

Option:

*Off	[0]
On	[1]

Function:

Select [0] to deactivate non-volatile storage of data.
Select [1] to store parameter data received via DeviceNet in EEPROM non-volatile memory as default.

10-39 Devicenet F Parameters

Array [1000]

Option:

No LCP access	
0 - 0	*0

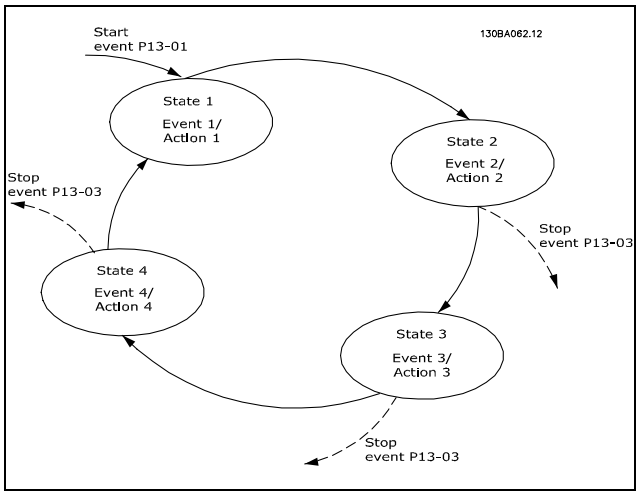
Function:

This parameter is used to configure the drive via Devicenet and build the EDS file.

□ Parameters: Smart Logic Control

□ 13-** Prog. Features

Smart logic control (SLC) is essentially a sequence of user-defined actions (see par. 13-52 [x]) executed by the SLC when the associated user-defined *event* (see par. 13-51 [x]) is evaluated as TRUE by the SLC. Events and *actions* are each numbered and linked together in pairs. This means that when *event* [0] is fulfilled (attains the value TRUE), *action* [0] is executed. After this, the conditions of *event* [1] will be evaluated and if evaluated TRUE, *action* [1] will be executed and so on. Only one *event* will be evaluated at any time. If an *event* is evaluated as FALSE, nothing happens (in the SLC) during the current scan interval and no other *events* will be evaluated. This means that when the SLC starts, it evaluates *event* [0] (and only *event* [0]) each scan interval. Only when *event* [0] is evaluated TRUE, will the SLC execute *action* [0] and start evaluating *event* [1]. It is possible to program from 1 to 20 *events* and *actions*. When the last *event* / *action* has been executed, the sequence starts over again from *event* [0] / *action* [0]. The illustration shows an example with three event / actions:



Starting and stopping the SLC:

Starting and stopping the SLC can be done by selecting On [1] or Off [0] in par. 13-00. The SLC always starts in state 0 (where it evaluates *event* [0]). The SLC starts when the start event (defined in par. 13-01 *Start Event*) is evaluated as TRUE (provided that *On* [1] is selected in par. 13-00). The SLC stops when the *Stop Event* (par. 13-02) is TRUE. Par. 13-03 resets all SLC parameters and start programming from scratch.

□ 13-0* SLC Settings

Use the SLC settings to activate, deactivate and reset the Smart Logic Control.

13-00 SL Controller Mode

Option:

✱Off	[0]
On	[1]

Function:

Select *On* [1] to enable smart logic control to start when a start command is present, e.g., via a digital input.
Select *Off* [0] to disable smart logic control.

13-01 Start Event

Option:

FALSE	[0]
TRUE	[1]
Running	[2]
In range	[3]
On reference	[4]
Torque limit	[5]
Current limit	[6]
Out of current range	[7]
Below I low	[8]
Above I high	[9]
Below speed low	[11]
Above speed high	[12]
Out of feedb. range	[13]
Below feedb. low	[14]
Above feedb. high	[15]
Thermal warning	[16]
Mains out of range	[17]
Reverse	[18]
Warning	[19]
Alarm (trip)	[20]
Alarm (trip lock)	[21]
Comparator 0	[22]
Comparator 1	[23]
Comparator 2	[24]
Comparator 3	[25]
Logic rule 0	[26]
Logic rule 1	[27]

✱ default setting **( )** display text **[ ]** value for use in communication via serial communication port

Logic rule 2	[28]
Logic rule 3	[29]
Digital input DI18	[33]
Digital input DI19	[34]
Digital input DI27	[35]
Digital input DI29 (FC 302 only)	[36]
Digital input DI32	[37]
Digital input DI33	[38]
Start command	[39]
Stop command	[40]

Function:

Select the boolean (TRUE or FALSE) input to activate Smart Logic Control.

**False* [0] (default setting) enters the fixed value of FALSE in the logic rule.

True [1] enters the fixed value TRUE in the logic rule.

Running [2] See parameter group 5-3* for further description.

In range [3] See parameter group 5-3* for further description.

On reference [4] See parameter group 5-3* for further description.

Torque limit [5] See parameter group 5-3* for further description.

Current limit [6] See parameter group 5-3* for further description.

Out of current range [7] See parameter group 5-3* for further description.

Below I low [8] See parameter group 5-3* for further description.

Above I high [9] See parameter group 5-3* for further description.

Below frequency low [11] See parameter group 5-3* for further description.

Above frequency high [12] See parameter group 5-3* for further description.

Thermal warning [16] See parameter group 5-3* for further description.

Mains voltage out of range [17] See parameter group 5-3* for further description.

Reversing [18] See parameter group 5-3* for further description.

Warning [19] See parameter group 5-3* for further description.

Alarm (trip) [20] See parameter group 5-3* for further description.

Alarm (trip lock) [21] See parameter group 5-3* for further description.

Comparator 0 [22] Use the result of comparator 0 in the logic rule.

Comparator 1 [23] Use the result of comparator 1 in the logic rule.

Comparator 2 [24] Use the result of comparator 2 in the logic rule.

Comparator 3 [25] Use the result of comparator 3 in the logic rule.

Logic rule 0 [26] Use the result of logic rule 0 in the logic rule.

Logic rule 1 [27] Use the result of logic rule 1 in the logic rule.

Logic rule 2 [28] Use the result of logic rule 2 in the logic rule.

Logic rule 3 [29] Use the result of logic rule 3 in the logic rule.

Digital input DI18 [33] Use the value of DI18 in the logic rule (High = TRUE).

Digital input DI19 [34] Use the value of DI19 in the logic rule (High = TRUE).

Digital input DI27 [35] Use the value of DI27 in the logic rule (High = TRUE).

Digital input DI29 [36] Use the value of DI29 in the logic rule (High = TRUE).

Digital input DI32 [37] Use the value of DI32 in the logic rule (High = TRUE).

Digital input DI33 [38] Use the value of DI33 in the logic rule (High = TRUE).

13-02 Stop Event

Option:

FALSE	[0]
TRUE	[1]
Running	[2]
In range	[3]
On reference	[4]
Torque limit	[5]
Current limit	[6]
Out of current range	[7]
Below I low	[8]
Above I high	[9]
Below speed low	[11]
Above speed high	[12]
Out of feedb. range	[13]
Below feedb. low	[14]
Above feedb. high	[15]
Thermal warning	[16]
Mains out of range	[17]

Reverse	[18]
Warning	[19]
Alarm (trip)	[20]
Alarm (trip lock)	[21]
Comparator 0	[22]
Comparator 1	[23]
Comparator 2	[24]
Comparator 3	[25]
Logic rule 0	[26]
Logic rule 1	[27]
Logic rule 2	[28]
Logic rule 3	[29]
SL Timeout 0	[30]
SL Timeout 1	[31]
SL Timeout 2	[32]
Digital input DI18	[33]
Digital input DI19	[34]
Digital input DI27	[35]
Digital input DI29 (FC 302 only)	[36]
Digital input DI32	[37]
Digital input DI33	[38]
Start command	[39]
Stop command	[40]

Function:

Select the boolean (TRUE or FALSE) input to activate Smart Logic Control.

**False* [0] (default setting) enters the fixed value of FALSE in the logic rule.

True [1] enters the fixed value TRUE in the logic rule.

Running [2] See parameter group 5-3* for further description.

In range [3] See parameter group 5-3* for further description.

On reference [4] See parameter group 5-3* for further description.

Torque limit [5] See parameter group 5-3* for further description.

Current limit [6] See parameter group 5-3* for further description.

Out of current range [7] See parameter group 5-3* for further description.

Below I low [8] See parameter group 5-3* for further description.

Above I high [9] See parameter group 5-3* for further description.

Below frequency low [11] See parameter group 5-3* for further description.

Above frequency high [12] See parameter group 5-3* for further description.

Thermal warning [16] See parameter group 5-3* for further description.

Mains voltage out of range [17] See parameter group 5-3* for further description.

Reversing [18] See parameter group 5-3* for further description.

Warning [19] See parameter group 5-3* for further description.

Alarm (trip) [20] See parameter group 5-3* for further description.

Alarm (trip lock) [21] See parameter group 5-3* for further description.

Comparator 0 [22] Use the result of comparator 0 in the logic rule.

Comparator 1 [23] Use the result of comparator 1 in the logic rule.

Comparator 2 [24] Use the result of comparator 2 in the logic rule.

Comparator 3 [25] Use the result of comparator 3 in the logic rule.

Logic rule 0 [26] Use the result of logic rule 0 in the logic rule.

Logic rule 1 [27] Use the result of logic rule 1 in the logic rule.

Logic rule 2 [28] Use the result of logic rule 2 in the logic rule.

Logic rule 3 [29] Use the result of logic rule 3 in the logic rule.

Digital input DI18 [33] Use the value of DI18 in the logic rule (High = TRUE).

Digital input DI19 [34] Use the value of DI19 in the logic rule (High = TRUE).

Digital input DI27 [35] Use the value of DI27 in the logic rule (High = TRUE).

Digital input DI29 [36] Use the value of DI29 in the logic rule (High = TRUE).

Digital input DI32 [37] Use the value of DI32 in the logic rule (High = TRUE).

Digital input DI33 [38] Use the value of DI33 in the logic rule (High = TRUE).

13-03 Reset SLC

Option:

*Do not reset SLC	[0]
Reset SLC	[1]

Function:

Select *Reset SLC* [1] to reset all group 13 parameters (13-*) to default settings.

Select **Do not reset SLC* [0] to retain the programmed settings in all group 13 parameters (13-*).

□ **13-1* Comparators**

Used for comparing continuous variables (i.e. output frequency, output current, analog input etc.) with a fixed preset value. Comparators are evaluated once in each scan interval. You can use the result (TRUE or FALSE) directly to define an event (see par. 13-51), or as Boolean input in a logic rule (see par. 13-40, 13-42, or 13-44). All parameters in this parameter group are array parameters with index 0-3. Select index 0 to program Comparator 0, index 1 to program Comparator 1, and so on.

13-10 Comparator Operand

Array [4]

Option:

✱ DISABLED	[0]
Reference	[1]
Feedback	[2]
Motor speed	[3]
Motor current	[4]
Motor torque	[5]
Motor power	[6]
Motor voltage	[7]
DC-link voltage	[8]
Motor thermal	[9]
VLT thermal	[10]
Heatsink temp.	[11]
Analog input AI53	[12]
Analog input AI54	[13]
Analog input AIFB10	[14]
Analog input AIS24V	[15]
Analog input AICCT	[17]
Pulse input FI29	[18]
Pulse input FI33	[19]
Alarm number	[20]
Counter A	[30]
Counter B	[31]

Function:

Select the variable to be monitored by the comparator.

**False* [0] (default setting) enters the fixed value of FALSE in the logic rule.

True [1]. enters the fixed value TRUE in the logic rule.

Running [2] See parameter group 5-3* for further description.

In range [3] See parameter group 5-3* for further description.

On reference [4] See parameter group 5-3* for further description.

Torque limit [5] See parameter group 5-3* for further description.

Current limit [6] See parameter group 5-3* for further description.

Out of current range [7] See parameter group 5-3* for further description.

Below I low [8] See parameter group 5-3* for further description.

Above I high [9] See parameter group 5-3* for further description.

Below frequency low [11] See parameter group 5-3* for further description.

Above frequency high [12] See parameter group 5-3* for further description.

Thermal warning [16] See parameter group 5-3* for further description.

Line voltage out of range [17] See parameter group 5-3* for further description.

Reversing [18] See parameter group 5-3* for further description.

Warning [19] See parameter group 5-3* for further description.

Alarm (trip) [20] See parameter group 5-3* for further description.

Alarm (trip lock) [21] See parameter group 5-3* for further description.

Comparator 0 [22] Use the result of comparator 0 in the logic rule.

Comparator 1 [23] Use the result of comparator 1 in the logic rule.

Comparator 2 [24] Use the result of comparator 2 in the logic rule.

Comparator 3 [25] Use the result of comparator 3 in the logic rule.

Logic rule 0 [26] Use the result of logic rule 0 in the logic rule.

Logic rule 1 [27] Use the result of logic rule 1 in the logic rule.

Logic rule 2 [28] Use the result of logic rule 2 in the logic rule.

Logic rule 3 [29] Use the result of logic rule 3 in the logic rule.

Digital input DI18 [33] Use the value of DI18 in the logic rule (High = TRUE).

Digital input DI19 [34] Use the value of DI19 in the logic rule (High = TRUE).
Digital input DI27 [35] Use the value of DI27 in the logic rule (High = TRUE).
Digital input DI29 [36] Use the value of DI29 in the logic rule (High = TRUE).
Digital input DI32 [37] Use the value of DI32 in the logic rule (High = TRUE).
Digital input DI33 [38] Use the value of DI33 in the logic rule (High = TRUE).

13-11 Comparator Operator

Array [4]

Option:

<	[0]
✱ ≈	[1]
>	[2]

Function:

Select the operator to be used in the comparison. Select < [0] for the result of the evaluation to be TRUE, when the variable selected in par. 13-10 is smaller than the fixed value in par. 13-12. The result will be FALSE, if the variable selected in par. 13-10 is greater than the fixed value in par. 13-12. Select > [2] for the inverse logic of option < [0]. Select ≈ [1] for the result of the evaluation to be TRUE, when the variable selected in par. 13-10 is approximately equal to the fixed value in par. 13-12.

13-12 Comparator Value

Array [4]

Range:

-100000.000 - 100000.000 ✱0.000

Function:

Enter the 'trigger level' for the variable that is monitored by this comparator. This is an array parameter containing comparator values 0 to 3.

□ 13-2* Timers

This parameter group consists of timer parameters. Use the result (TRUE or FALSE) from *timers* directly to define an *event* (see par. 13-51), or as boolean input in a *logic rule* (see par. 13-40, 13-42 or 13-44). A timer is only FALSE when started by an action (i.e. .Start timer 1 [29].) until the timer value entered in this parameter is elapsed. Then it becomes TRUE again.
All parameters in this parameter group are array parameters with index 0 to 2. Select index 0 to program Timer 0, select index 1 to program Timer 1, and so on.

13-20 SL Controller Timer

Array [3]

Range:

0.00 - 3600.00 s ✱0.00s

Function:

Enter the value to define the duration of the FALSE output from the programmed timer. A timer is only FALSE if it is started by an action (i.e. *Start timer 1* [29]) and until the given timer value has elapsed.

□ 13-4* Logic Rules

Combine up to three boolean inputs (TRUE / FALSE inputs) from timers, comparators, digital inputs, status bits and events using the logical operators AND, OR, and NOT. Select boolean inputs for the calculation in par. 13-40, 13-42, and 13-44. Define the operators used to logically combine the selected inputs in par. 13-41 and 13-43.

Priority of calculation

The results of par. 13-40, 13-41, and 13-42 are calculated first. The outcome (TRUE / FALSE) of this calculation is combined with the settings of par. 13-43 and 13-44, yielding the final result (TRUE / FALSE) of the logic rule.

13-40 Logic Rule Boolean 1

Array [4]

Option:

✱ False	[0]
True	[1]
Running	[2]
In range	[3]
On reference	[4]
Torque limit	[5]
Current limit	[6]
Out of current range	[7]
Below I low	[8]
Above I high	[9]

Out of speed range	[10]
Below speed low	[11]
Above speed high	[12]
Out of feedb. range	[13]
Below feedb. low	[14]
Above feedb. high	[15]
Thermal warning	[16]
Line voltage out of range	[17]
Reversing	[18]
Warning	[19]
Alarm (trip)	[20]
Alarm (trip lock)	[21]
Comparator 0	[22]
Comparator 1	[23]
Comparator 2	[24]
Comparator 3	[25]
Logic rule 0	[26]
Logic rule 1	[27]
Logic rule 2	[28]
Logic rule 3	[29]
Timeout 0	[30]
Timeout 1	[31]
Timeout 2	[32]
Digital input DI18	[33]
Digital input DI19	[34]
Digital input DI27	[35]
Digital input DI29	[36]
Digital input DI32	[37]
Digital input DI33	[38]
Start command	[39]
Drive stopped	[40]

Function:

Select the first Boolean (TRUE or FALSE) input for the selected logic rule.

**False* [0] (default setting) enters the fixed value of FALSE in the logic rule.

True [1] enters the fixed value TRUE in the logic rule.

Running [2] See parameter group 5-3* for further description.

In range [3] See parameter group 5-3* for further description.

On reference [4] See parameter group 5-3* for further description.

Torque limit [5] See parameter group 5-3* for further description.

Current limit [6] See parameter group 5-3* for further description.

Out of current range [7] See parameter group 5-3* for further description.

Below I low [8] See parameter group 5-3* for further description.

Above I high [9] See parameter group 5-3* for further description.

Out of speed range [10] See parameter group 5-3* for further description.

Below frequency low [11] See parameter group 5-3* for further description.

Above frequency high [12] See parameter group 5-3* for further description.

Out of feedback range [13] See parameter group 5-3* for further description.

Below feedback low [14] See parameter group 5-3* for further description.

Above feedback high [15] See parameter group 5-3* for further description.

Thermal warning [16] See parameter group 5-3* for further description.

Line voltage out of range [17] See parameter group 5-3* for further description.

Reversing [18] See parameter group 5-3* for further description.

Warning [19] See parameter group 5-3* for further description.

Alarm (trip) [20] See parameter group 5-3* for further description.

Alarm (trip lock) [21] See parameter group 5-3* for further description.

Comparator 0 [22] Use the result of comparator 0 in the logic rule.

Comparator 1 [23] Use the result of comparator 1 in the logic rule.

Comparator 2 [24] Use the result of comparator 2 in the logic rule.

Comparator 3 [25] Use the result of comparator 3 in the logic rule.

Logic rule 0 [26] Use the result of logic rule 0 in the logic rule.

Logic rule 1 [27] Use the result of logic rule 1 in the logic rule.

Logic rule 2 [28] Use the result of logic rule 2 in the logic rule.

Logic rule 3 [29] Use the result of logic rule 3 in the logic rule.

Timeout 0 [30] Use the result of timer 0 in the logic rule.

Timeout 1 [31] Use the result of timer 1 in the logic rule.

Timeout 2 [32] Use the result of timer 2 in the logic rule.
Digital input DI18 [33] Use the value of DI18 in the logic rule (High = TRUE).
Digital input DI19 [34] Use the value of DI19 in the logic rule (High = TRUE).
Digital input DI27 [35] Use the value of DI27 in the logic rule (High = TRUE).
Digital input DI29 [36] Use the value of DI29 in the logic rule (High = TRUE).
Digital input DI32 [37] Use the value of DI32 in the logic rule (High = TRUE).
Digital input DI33 [38] Use the value of DI33 in the logic rule (High = TRUE).

13-41 Logic Rule Operator 1

Array [4]

Option:

*Disabled	[0]
And	[1]
Or	[2]
And not	[3]
Or not	[4]
Not and	[5]
Not or	[6]
Not and not	[7]
Not or not	[8]

Function:

Select the first logical operator to use on the Boolean inputs from par. 13-40 and 13-42. [13 -XX] signifies the boolean input of par. 13-*. Select *DISABLED* [0] to ignore par. 13-42, 13-43, and 13-44.
AND [1] evaluates the expression [13-40] AND [13-42].
OR [2] evaluates the expression [13-40] OR [13-42].
AND NOT [3] evaluates the expression [13-40] AND NOT [13-42].
OR NOT [4] evaluates the expression [13-40] OR NOT [13-42].
NOT AND [5] evaluates the expression NOT [13-40] AND [13-42].
NOT OR [6] evaluates the expression NOT [13-40] OR [13-42].
NOT AND NOT [7] evaluates the expression NOT [13-40] AND NOT [13-42].
NOT OR NOT [8] evaluates the expression NOT [13-40] OR NOT [13-42].

13-42 Logic Rule Boolean 2

Array [4]

Option:

*False	[0]
True	[1]
Running	[2]
In range	[3]
On reference	[4]
Torque limit	[5]
Current limit	[6]
Out of current range	[7]
Below I low	[8]
Above I high	[9]
Out of speed range	[10]
Below speed low	[11]
Above speed high	[12]
Out of feedb. range	[13]
Below feedb. low	[14]
Above feedb. high	[15]
Thermal warning	[16]
Line voltage out of range	[17]
Reversing	[18]
Warning	[19]
Alarm (trip)	[20]
Alarm (trip lock)	[21]
Comparator 0	[22]
Comparator 1	[23]
Comparator 2	[24]
Comparator 3	[25]
Logic rule 0	[26]
Logic rule 1	[27]
Logic rule 2	[28]
Logic rule 3	[29]
Timeout 0	[30]
Timeout 1	[31]
Timeout 2	[32]
Digital input DI18	[33]
Digital input DI19	[34]
Digital input DI27	[35]
Digital input DI29	[36]
Digital input DI32	[37]
Digital input DI33	[38]
Start command	[39]
Drive stopped	[40]

Function:

Select the second Boolean (TRUE or FALSE) input for the selected logic rule. See par. 13-40 for further explanation.

13-43 Logic Rule Operator 2

Array [4]

Option:

*Disabled	[0]
And	[1]
Or	[2]
And not	[3]
Or not	[4]
Not and	[5]
Not or	[6]
Not and not	[7]
Not or not	[8]

Function:

Select the second logical operator to be used on the boolean input calculated in par. 13-40, 13-41, and 13-42, and the boolean input coming from par. 13-42.
[13-44] signifies the boolean input of par. 13-44.
[13-40/13-42] signifies the boolean input calculated in par. 13-40, 13-41, and 13-42.
DISABLED [0] (factory setting) . select this option to ignore par. 13-44.
AND [1] evaluates the expression [13-40/13-42] AND [13-44].
OR [2] evaluates the expression [13-40/13-42] OR [13-44].
AND NOT [3] evaluates the expression [13-40/13-42] AND NOT [13-44].
OR NOT [4] evaluates the expression [13-40/13-42] OR NOT [13-44].
NOT AND [5] evaluates the expression NOT [13-40/13-42] AND [13-44].
NOT OR [6] evaluates the expression NOT [13-40/13-42] OR [13-44].
NOT AND NOT [7] evaluates the expression NOT [13-40/13-42] and evaluates AND NOT [13-44].
NOT OR NOT [8] evaluates the expression NOT [13-40/13-42] OR NOT [13-44].

13-44 Logic Rule Boolean 3

Array [4]

Option:

*False	[0]
True	[1]
Running	[2]
In range	[3]
On reference	[4]
Torque limit	[5]
Current limit	[6]
Out of current range	[7]
Below I low	[8]
Above I high	[9]
Out of speed range	[10]
Below speed low	[11]
Above speed high	[12]
Out of feedb. range	[13]
Below feedb. low	[14]
Above feedb. high	[15]
Thermal warning	[16]
Line voltage out of range	[17]
Reversing	[18]
Warning	[19]
Alarm (trip)	[20]
Alarm (trip lock)	[21]
Comparator 0	[22]
Comparator 1	[23]
Comparator 2	[24]
Comparator 3	[25]
Logic rule 0	[26]
Logic rule 1	[27]
Logic rule 2	[28]
Logic rule 3	[29]
Timeout 0	[30]
Timeout 1	[31]
Timeout 2	[32]
Digital input DI18	[33]
Digital input DI19	[34]
Digital input DI27	[35]
Digital input DI29	[36]
Digital input DI32	[37]
Digital input DI33	[38]
Start command	[39]
Drive stopped	[40]

Function:

Select the third Boolean (TRUE or FALSE) input for the selected logic rule.

□ 13-5* States

Parameters for Programming the Smart Logic Controller.

13-51 SL Controller Event

Array [20]

Option:

*False	[0]
True	[1]
Running	[2]
In range	[3]
On reference	[4]
Torque limit	[5]
Current limit	[6]
Out of current range	[7]
Below I low	[8]
Above I high	[9]
Out of speed range	[10]
Below speed low	[11]
Above speed high	[12]
Out of feedb. range	[13]
Below feedb. low	[14]
Above feedb. high	[15]
Thermal warning	[16]
Line voltage out of range	[17]
Reversing	[18]
Warning	[19]
Alarm (trip)	[20]
Alarm (trip lock)	[21]
Comparator 0	[22]
Comparator 1	[23]
Comparator 2	[24]
Comparator 3	[25]
Logic rule 0	[26]
Logic rule 1	[27]
Logic rule 2	[28]
Logic rule 3	[29]
Timeout 0	[30]
Timeout 1	[31]
Timeout 2	[32]
Digital input DI18	[33]
Digital input DI19	[34]
Digital input DI27	[35]
Digital input DI29	[36]
Digital input DI32	[37]
Digital input DI33	[38]
Start command	[39]
Drive stopped	[40]

Function:

Select the boolean input (TRUE or FALSE) to define the smart logic controller event.

**False* [0] enters the fixed value FALSE in the event.

True [1] enters the fixed value TRUE in the event.

Running [2] See parameter group 5-3* for further description.

In range [3] See parameter group 5-3* for further description.

On reference [4] See parameter group 5-3* for further description.

Torque limit [5] See parameter group 5-3* for further description.

Current limit [6] See parameter group 5-3* for further description.

Out of current range [7] See parameter group 5-3* for further description.

Above I low [8] See parameter group 5-3* for further description.

Below I high [9] See parameter group 5-3* for further description.

Out of speed range [10] See parameter group 5-3* for further description.

Above frequency low [11] See parameter group 5-3* for further description.

Below frequency high [12] See parameter group 5-3* for further description.

Out of feedback range [13] See parameter group 5-3* for further description.

Below feedback low [14] See parameter group 5-3* for further description.

Above feedback high [15] See parameter group 5-3* for further description.

Thermal warning [16] See parameter group 5-3* for further description.

Line voltage out of range [17] See parameter group 5-3* for further description.

Reversing [18] See parameter group 5-3* for further description.

Warning [19] See parameter group 5-3* for further description.

Alarm (trip) [20] See parameter group 5-3* for further description.

Alarm (trip lock) [21] See parameter group 5-3* for further description.

Comparator 0 [22] Use the result of comparator 0 in the event.

Comparator 1 [23] Use the result of comparator 1 in the event.

Comparator 2 [24] Use the result of comparator 2 in the event.

Comparator 3 [25] Use the result of comparator 3 in the event.

Logic rule 0 [26] Use the result of logic rule 0 in the event.
Logic rule 1 [27] Use the result of logic rule 1 in the event.
Logic rule 2 [28] Use the result of logic rule 2 in the event.
Logic rule 3 [29] Use the result of logic rule 3 in the event.
Timeout 0 [30] Use the result of timer 0 in the event.
Timeout 1 [31] Use the result of timer 1 in the event.
Timeout 2 [32] Use the result of timer 2 in the event.
Digital input DI18 [33] Use the value of DI18 in the event (High = TRUE).
Digital input DI19 [34] Use the value of DI19 in the event (High = TRUE).
Digital input DI27 [35] Use the value of DI27 in the event (High = TRUE).
Digital input DI29 [36] Use the value of DI29 in the event (High = TRUE).
Digital input DI32 [37] Use the value of DI32 in the event (High = TRUE).
Digital input DI33 [38] Use the value of DI33 in the event (High = TRUE).
Start command [39] This event is TRUE if the adjustable frequency drive is started by any means (either via digital input, serial communication bus or other).
Drive stopped [40] This event is TRUE if the adjustable frequency drive is stopped or coasted by any means (either via digital input, ser. com. bus or other).

13-52 SL Controller Action

Array [20]

Option:

✱ Disabled	[0]
No action	[1]
Select set-up 0	[2]
Select set-up 1	[3]
Select set-up 2	[4]
Select set-up 3	[5]
Select preset ref. 0	[10]
Select preset ref. 1	[11]
Select preset ref. 2	[12]
Select preset ref. 3	[13]
Select preset ref. 4	[14]
Select preset ref. 5	[15]
Select preset ref. 6	[16]
Select preset ref. 7	[17]
Select ramp 1	[18]
Select ramp 2	[19]
Select ramp 3	[20]
Select ramp 4	[21]
Run	[22]
Run reverse	[23]
Stop	[24]
Qstop	[25]
Dcstop	[26]
Coast	[27]
Freeze output	[28]
Start timer 0	[29]
Start timer 1	[30]
Start timer 2	[31]
Set dig. out. A low	[32]
Set dig. out. B low	[33]
Set dig. out. C low	[34]
Set dig. out. D low	[35]
Set dig. out. E low	[36]
Set dig. out. F low	[37]
Set dig. out. A high	[38]
Set dig. out. B high	[39]
Set dig. out. C high	[40]
Set dig. out. D high	[41]
Set dig. out. E high	[42]
Set dig. out. F high	[43]
Reset Counter A	[60]
Reset Counter B	[61]

Function:

Select the action corresponding to the SLC event. Actions are executed when the corresponding event (defined in par. 13-51) is evaluated as true. The following actions are available for selection:
**DISABLED* [0]
No action [1]
Select set-up 1 [2] - changes the active set-up (par. 0-10) to '1'.
Select set-up 2 [3] - changes the active set-up (par. 0-10) to '2'.
Select set-up 3 [4] - changes the active set-up (par. 0-10) to '3'.
Select set-up 4 [5] - changes the active setup (par. 0-10) to '4'. If the set-up is changed, it will merge with other set-up commands coming from either the digital inputs or via a serial communication bus.
Select preset reference 0 [10] – selects preset reference 0.
Select preset reference 1 [11] – selects preset reference 1.

✱ default setting **( )** display text **[ ]** value for use in communication via serial communication port

Select preset reference 2 [12] – selects preset reference 2.
Select preset reference 3 [13] – selects preset reference 3.
Select preset reference 4 [14] – selects preset reference 4.
Select preset reference 5 [15] – selects preset reference 5.
Select preset reference 6 [16] – selects preset reference 6.
Select preset reference 7 [17] - selects preset reference 7. If the active preset reference is changed, it will merge with other preset reference commands coming from either the digital inputs or via a serial communication bus.
Select ramp 1 [18] - selects ramp 1.
Select ramp 2 [19] - selects ramp 2.
Select ramp 3 [20] - selects ramp 3.
Select ramp 4 [21] - selects ramp 4.
Run [22] - issues a start command to the adjustable frequency drive.
Run reverse [23] - issues a start reverse command to the adjustable frequency drive.
Stop [24] - issues a stop command to the adjustable frequency drive.
Qstop [25] - issues a quick stop command to the adjustable frequency drive.
Dcstop [26] - issues a DC stop command to the adjustable frequency drive.
Coast [27] - the adjustable frequency drive coasts immediately. All stop commands including the coast command stop the SLC.
Freeze output [28] - freezes the output frequency of the adjustable frequency drive.
Start timer 0 [29] - starts timer 0, see par. 13-20 for further description.
Start timer 1 [30] - starts timer 1, see par. 13-20 for further description.
Start timer 2 [31] - starts timer 2, see par. 13-20 for further description.
Set digital output A low [32] - any output with 'digital output 1' selected is low (off).
Set digital output B low [33] - any output with 'digital output 2' selected is low (off).
Set digital output C low [34] - any output with 'digital output 3' selected is low (off).
Set digital output D low [35] - any output with 'digital output 4' selected is low (off).
Set digital output E low [36] - any output with 'digital output 5' selected is low (off).
Set digital output F low [37] - any output with 'digital output 6' selected is low (off).
Set digital output A high [38] - any output with 'digital output 1' selected is high (closed).
Set digital output B high [39] - any output with 'digital output 2' selected is high (closed).
Set digital output C high [40] - any output with 'digital output 3' selected is high (closed).
Set digital output D high [41] - any output with 'digital output 4' selected is high (closed).
Set digital output E high [42] - any output with 'digital output 5' selected is high (closed).
Set digital output F high [43] - any output with 'digital output 6' selected is high (closed).
Reset Counter A [60] - resets Counter A to zero.
Reset Counter B [61] - resets Counter B to zero.

Parameters: Special Functions

14-** Special Functions

Parameter group for configuring special adjustable frequency drive functions.

14-0* Inverter Switching

Parameters for configuring the inverter switching.

14-00 Switching Pattern

Option:

60 AVM	[0]
✱SFAVM	[1]

Function:

Select the switching pattern: 60° AVM or SFAVM.

14-01 Switching Frequency

Option:

1.0 kHz	[0]
1.5 kHz	[1]
2.0 kHz	[2]
2.5 kHz	[3]
3.0 kHz	[4]
3.5 kHz	[5]
4.0 kHz	[6]
5.0 kHz	[7]
6.0 kHz	[8]
7.0 kHz	[9]
8.0 kHz	[10]
10.0 kHz	[11]
12.0 kHz	[12]
14.0 kHz	[13]
16.0 kHz	[14]

Function:

Select the inverter switching frequency. Changing the switching frequency can help to reduce acoustic noise from the motor.

NOTE

The output frequency value of the frequency converter must never exceed 1/10 of the switching frequency. When the motor is running, adjust the switching frequency in par. 4-11 until the motor is as noiseless as possible. See also par. 14-00 and the section *Derating*.

NOTE

Switching frequencies higher than 5.0 kHz lead to automatic derating of the maximum output of the frequency converter.

14-03 Overmodulation

Option:

Off	[0]
✱On	[1]

Function:

Select *On* [1] to connect the overmodulation function for the output voltage, to obtain an output voltage up to 15% greater than the line voltage.
Select *Off* [0] for no overmodulation of the output voltage, in order to avoid torque ripple on the motor shaft. This feature may be useful for applications such as grinding machines.

14-04 PWM Random

Option:

✱Off	[0]
On	[1]

Function:

Select *On* [1] to transform the acoustic motor switching noise from a clear ring tone into a less discernable 'white' noise. This is achieved by slightly and randomly altering the synchronism of the pulse width modulated output phases.
Select *Off* [0] for no change to the acoustic motor switching noise.

14-1* Line Supply On/Off

Parameters for configuring line failure monitoring and handling.

14-12 Function at Line Imbalance

Option:

✱Trip	[0]
Warning	[1]
Disabled	[2]

Function:

When a severe line imbalance is detected:
Select *Trip* [0] to trip the adjustable frequency drive;
Select *Warning* [1] to issue a warning; or
Select *Disabled* [2] for no action.

Operation under severe line imbalance conditions reduces the lifetime of the motor. Conditions are considered severe if the motor is operated continuously near nominal load (e.g., a pump or fan running near full speed).

□ **14-2* Trip Reset**

Parameters for configuring auto reset handling, special trip handling and control card self test or initialization.

14-20 Reset Mode

Option:

*Manual reset	[0]
Automatic reset x 1	[1]
Automatic reset x 2	[2]
Automatic reset x 3	[3]
Automatic reset x 4	[4]
Automatic reset x 5	[5]
Automatic reset x 6	[6]
Automatic reset x 7	[7]
Automatic reset x 8	[8]
Automatic reset x 9	[9]
Automatic reset x 10	[10]
Automatic reset x 15	[11]
Automatic reset x 20	[12]
Infinite Automatic Reset	[13]

Function:

Select the reset function after tripping. Once reset, the frequency converter can be restarted.
Select *Manual reset* [0], to perform a reset via [RESET] or via the digital inputs.
Select *Automatic reset x 1…x20* [1]-[12] to perform between one and twenty automatic resets after tripping.
Select *Infinite Automatic Reset* [13] for continuous resetting after tripping.

NOTE

If the specified number of AUTOMATIC RESETs is reached within 10 minutes, the frequency converter enters Manual reset [0] mode. After the Manual reset is performed, the setting of par. 14-20 reverts to the original selection. If the number of AUTOMATIC RESETs is not reached within 10 minutes, or when a Manual reset is performed, the internal AUTOMATIC RESET counter returns to zero.

The motor may start without warning.

14-21 Automatic Restart Time

Range:

0 - 600 s *10s

Function:

Enter the time interval from trip to start of the automatic reset function. This parameter is active when par. 14-20 is set to *Automatic reset* [1] - [13].

14-22 Operation Mode

Option:

*Normal operation	[0]
Control card test	[1]
Initialization	[2]

Function:

Use this parameter to specify normal operation; to perform tests; or to initialise all parameters except par. 15-03, 15-04 and 15-05. This function is active only when the power is cycled to the frequency converter.
Select *Normal operation* [0] for normal operation of the frequency converter with the motor in the selected application.
Select *Control card test* [1] to test the analog and digital inputs and outputs and the +10 V control voltage. The test requires a test connector with internal connections. Use the following procedure for the control card test:

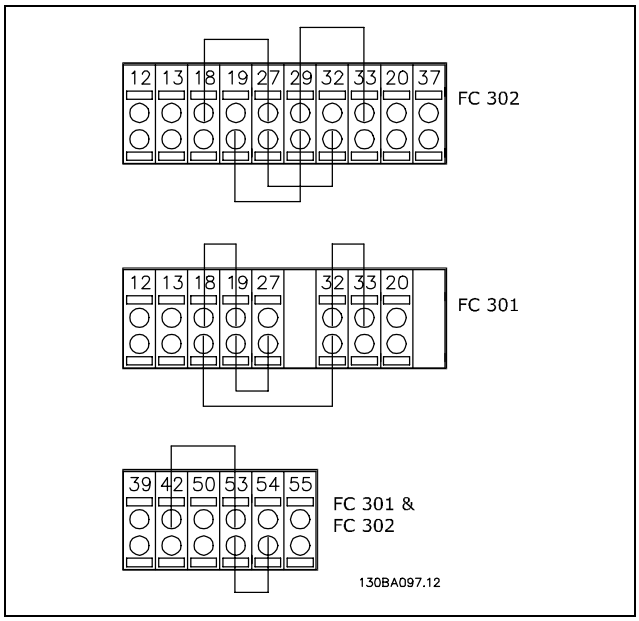
1. Select *Control card test* [1].
2. Disconnect the mains supply and wait for the light in the display to go out.
3. Set switches S201 (A53) and S202 (A54) = 'ON' / I.
4. Insert the test plug (see below).
5. Connect to mains supply.
6. Carry out various tests.
7. The results are displayed on the LCP and the frequency converter moves into an infinite loop.
8. Par. 14-22 is automatically set to Normal operation. Carry out a power cycle to start up in Normal operation after a control card test.

If the test is OK:

LCP read-out: Control Card OK.
Disconnect the mains supply and remove the test plug. The green LED on the Control Card will light up.

If the test fails:

LCP read-out: Control Card I/O failure.
Replace the frequency converter or Control card.
The red LED on the Control Card is turned on.
Test plugs (connect the following terminals to each other): 18 - 27 - 32; 19 - 29 - 33; 42 - 53 - 54



Select *Initialization* [2] to reset all parameter values to default settings, except for par. 15-03, 15-04, and 15-05. The frequency converter will reset during the next power-up.
Par. 14-22 will also revert to the default setting *Normal operation* [0].

14-25 Trip Delay at Torque Limit

Option:

0 - 60 s ✱ 60 s

Function:

Enter the torque limit trip delay in seconds. When the output torque reaches the torque limits (par. 4-16 and 4-17), a warning is triggered. When the torque limit warning has been continuously present for the period specified in this parameter, the adjustable frequency drive. Disable the trip delay by setting the parameter to 60 s = OFF. Thermal VLT monitoring will still remain active.

14-26 Trip Delay at Inverter Fault

Option:

0 - 30 s ✱ 5 s

Function:

When the adjustable frequency drive detects an overvoltage in the set time, tripping will be affected after the set time.

□ **14-3* Current Limit Control**

The FC 300 series features an integral current limit controller which is activated when the motor current, and thus the torque, is higher than the torque limits set in par. 4-16 and 4-17.
When the current limit is reached during motor operation or regenerative operation, the adjustable frequency drive will try to reduce torque below the preset torque limits as quickly as possible without losing control of the motor.
While the current control is active, the adjustable frequency drive can only be stopped by setting a digital input to *Coast inverse* [2] or *Coast and reset inv.* [3]. Any signal on terminals 18 to 33 will not be active until the adjustable frequency drive is no longer near the current limit.
By using a digital input set to *Coast inverse* [2] or *Coast and reset inv.* [3], the motor does not use the ramp-down time, since the drive is coasted. If a quick stop is necessary, use the mechanical brake control function along with an external electro-mechanical brake attached to the application.

14-30 Current Lim Cont, Proportional Gain

Option:

0 - 500% ✱100%

Function:

Enter the proportional gain value for the current limit controller. Selection of a high value makes the controller react faster. Too high a setting leads to controller instability.

14-31 Current Lim Contr, Integration Time

Option:

0.002 - 2.000 s ✱0.020 s

Function:

Controls the current limit controller integration time. Setting it to a lower value makes it react faster. A setting too low leads to controller instability.

□ 14-4* Energy Optimizing

Parameters for adjusting the energy optimization level in both Variable Torque (VT) and Automatic Energy Optimization (AEO) mode.

14-40 VT Level

Range:

40 - 90% ✱66%

Function:

Enter the level of motor magnetization at low speed. Selection of a low value reduces energy loss in the motor, but also reduces load capability.
This parameter cannot be adjusted while the motor is running.

14-41 AEO Minimum Magnetization

Range:

40 - 75% ✱40%

Function:

Enter the minimum allowable magnetisation for AEO. Selection of a low value reduces energy loss in the motor, but can also reduce resistance to sudden load changes.

14-42 Minimum AEO Frequency

Range:

5 - 40 Hz ✱10 Hz

Function:

Enter the minimum frequency at which the Automatic Energy Optimization (AEO) is to be active.

14-43 Motor Cos-Phi

Range:

0.40 - 0.95 N/A ✱0.66 N/A

Function:

The Cos(phi) setpoint is automatically set for optimum AEO performance. This parameter should normally not be altered. However in some situations it may be necessary to enter a new value to fine-tune.

□ 14-5* Environment

Set these parameters to *On* [1] to ensure the adjustable frequency drive complies with EMC standards. Select *Off* [0] only when the adjustable frequency drive is supplied from an isolated line source, i.e., IT line supply.

14-50 RFI 1

Option:

Off	[0]
✱On	[1]

Function:

Select *On* [1] to ensure the adjustable frequency drive complies with EMC standards.
Select *Off* [0] only when the adjustable frequency drive is supplied from an isolated line source, i.e., IT line. In this mode, the internal RFI capacities (filter capacitors) between chassis and the Line RFI Filter circuit are cut off to avoid damage to the intermediate circuit and to reduce the ground capacity currents (according to IEC 61800-3).
This parameter is available for the FC 302 only.

14-52 Fan Control

Option:

✱Auto	[0]
On 50%	[1]
On 75%	[2]
On 100%	[3]

Function:

Select the minimum speed of the internal fan.
Select *Auto* [0] to run the fan only when the internal temperature of the adjustable frequency drive is in the range 35 °C – approx. 55°C. The fan will run at low speed at 35C, and at full speed at approx. 55°C.

✱ default setting **( )** display text **[ ]** value for use in communication via serial communication port

Parameters: Drive Information

15-** Operating Data

Parameter group containing adjustable frequency drive information such as operating data, hardware configuration and software versions.

15-0* Operating Data

Parameter group containing operating data, e.g., operating hours, kWh counters, power-ups, etc.

15-00 Operating Hours

Range:

0 - 2147483647 h ✱0h

Function:

View how many hours the adjustable frequency drive has run. The value is saved when the frequency converter is turned off.

15-01 Running Hours

Range:

0 - 2147483647 h ✱ 0h

Function:

View how many hours the motor has run. Reset the counter in par. 15-07. The value is saved when the adjustable frequency drive is turned off.

15-02 kWh Counter

Range:

0 - 2147483647 kWh ✱ 0kWh

Function:

View the power consumption from mains in kWh as a mean value over one hour. Reset the counter in par. 15-06.

15-03 Power-ups

Range:

0 - 2147483647 ✱0

Function:

View the number of times the adjustable frequency drive has been powered up.

15-04 Over Temps

Range:

0 - 65535 ✱0

Function:

View the number of adjustable frequency drive temperature faults which have occurred.

15-05 Over Volts

Range:

0 - 65535 ✱0

Function:

View the number of adjustable frequency drive overvoltages which have occurred.

15-06 Reset kWh Counter

Option:

*Do not reset	[0]
Reset counter	[1]

Function:

Select *Reset* [1] and press [OK] to reset the kWh counter to zero (see par 15-02). This parameter cannot be selected via the serial port, RS 485. Select *Do not reset* [0] if no reset of the kWh counter is desired.

NOTE
The reset is carried out by pressing [OK].

15-07 Reset Running Hours Counter

Option:

✱Do not reset	[0]
Reset counter	[1]

Function:

Select *Reset* [1] and press [OK] to reset the Running Hours counter to zero (see par. 15-01). This parameter cannot be selected via the serial port, RS 485.
Select *Do not reset* [0] if no reset of the Running Hours counter is desired.

15-1* Data Log Settings

The Data Log enables continuous logging of up to 4 data sources (par. 15-10) at individual rates (par. 15-11). A trigger event (par. 15-12) and window (par. 15-14) are used to start and stop the logging conditionally.

15-10 Logging Source

Array [4]

Option:

None
16-00 Control Word
16-01 Reference [Unit]
16-02 Reference %
16-03 Status Word
16-10 Power [kW]
16-11 Power [hp]
16-12 Motor voltage
16-13 Frequency
16-14 Motor Current
16-16 Torque
16-17 Speed [RPM]
16-18 Motor Thermal
16-30 DC Link Voltage
16-32 Brake Energy /s
16-33 Brake Energy / 2 min
16-34 Heatsink Temp.
16-35 Inverter Thermal
16-50 External Reference
16-51 Pulse Reference
16-52 Feedback [Unit]
16-60 Digital Input
16-62 Analog Input 53
16-64 Analog Input 54
16-65 Analog Output 42 [mA]
16-66 Digital Output [bin]
16-90 Alarm Word
16-92 Warning Word
16-94 Ext. Status Word

Function:

Select which variables are to be logged.

15-11 Logging Interval

Range:

1 - 86400000 ms ✱1 ms

Function:

Enter the interval in milliseconds between each sampling of the variables to be logged.

15-12 Trigger Event

Option:

FALSE	[0]
TRUE	[1]
Running	[2]
In range	[3]
On reference	[4]
Torque limit	[5]
Current limit	[6]
Out of current range	[7]
Below I low	[8]
Above I high	[9]
Out of speed range	[10]
Below speed low	[11]
Above speed high	[12]
Out of feedb. range	[13]
Below feedb. low	[14]
Above feedb. high	[15]
Thermal warning	[16]
Mains out of range	[17]
Reverse	[18]
Warning	[19]
Alarm (trip)	[20]
Alarm (trip lock)	[21]
Comparator 0	[22]
Comparator 1	[23]
Comparator 2	[24]
Comparator 3	[25]
Logic rule 0	[26]
Logic rule 1	[27]
Logic rule 2	[28]
Logic rule 3	[29]
Digital input DI18	[33]
Digital input DI19	[34]
Digital input DI27	[35]
Digital input DI29	[36]
Digital input DI32	[37]
Digital input DI33	[38]

Function:

Select the trigger event. When the trigger event occurs, a window is applied to freeze the log. The log will then retain a specified percentage of samples before the occurrence of the trigger event (par. 15-14).

15-13 Logging Mode

Option:

✱Log always	[0]
Log once on trigger	[1]

Function:

Select *Log always* [0] for continuous logging. Select *Log once on trigger* [1] to conditionally start and stop logging using par. 15-12 and par.15-14.

15-14 Samples Before Trigger

Range:

0 - 100 N/A ✱50 N/A

Function:

Enter the percentage of all samples prior to a trigger event which are to be retained in the log. See also par. 15-12 and par. 15-13.

□ **15-2* Historic Log**

View up to 50 logged data items via the array parameters in this parameter group. For all parameters in the group, [0] is the most recent data and [49] the oldest data. Data is logged every time an *event* occurs (not to be confused with SLC events). *Events* in this context are defined as a change in one of the following areas:

1. Digital input
2. Digital outputs (not monitored in this SW release)
3. Warning word
4. Alarm word
5. Status word
6. Control word
7. Extended status word

Events are logged with value, and time stamp in msec. The time interval between two events depends on how often *events* occur (maximum once every scan time). Data logging is continuous but if an alarm occurs, the log is saved and the values can be viewed on the display. This feature is useful, for example when carrying out service following a trip. View the historic log contained in this parameter via the serial communication port or via the display.

15-20 Historic Log: Event

Array [50]

Range:

0 - 255 ✱0

Function:

View the event type of the logged events.

15-21 Historic Log: Value

Array [50]

Range:

0 - 2147483647 ✱ 0

Function:

View the value of the logged event. Interpret the event values according to this table:

Digital input	Decimal value. See par. 16-60 for description after converting to binary value.
Digital output (not monitored in this SW release)	Decimal value. See par. 16-66 for description after converting to binary value.
Warning word	Decimal value. See par. 16-92 for description.
Alarm word	Decimal value. See par. 16-90 for description.
Status word	Decimal value. See par. 16-03 for description after converting to binary value.
Control word	Decimal value. See par. 16-00 for description.
Extended status word	Decimal value. See par. 16-94 for description.

15-22 Historic Log: Time

Array [50]

Range:

0 - 2147483647 ✱0

Function:

View the time at which the logged event occurred. Time is measured in ms since frequency converter start.

□ **15-3* Fault Log**

Parameters in this group are array parameters, where up to 10 fault logs can be viewed. [0] is the most recent logged data, and [9] the oldest. Error codes, values, and time stamp can be viewed for all logged data.

15-30 Fault Log: Error Code

Array [10]

Range:

0 - 255 ✱ 0

Function:

View the error code and look up its meaning in the *Troubleshooting* chapter of the FC 300 Design Guide.

15-31 Fault Log: Value

Array [10]

Range:

-32767 - 32767 * 0

Function:

View an extra description of the error. This parameter is mostly used in combination with alarm 38 'internal fault'.

15-32 Fault Log: Time

Array [10]

Range:

0 - 2147483647 *0

Function:

View the time when the logged event occurred. Time is measured in seconds from adjustable frequency drive start-up.

□ **15-4* Drive Identification**

Parameters containing read only information about the hardware and software configuration of the adjustable frequency drive.

15-40 FC Type

Function:

View the FC type. The read-out is identical to the FC 300 Series power field of the type code definition, characters 1-6.

15-41 Power Section

Function:

View the FC type. The read-out is identical to the FC 300 Series power field of the type code definition, characters 7-10.

15-42 Voltage

Function:

View the FC type. The read-out is identical to the FC 300 Series power field of the type code definition, characters 11-12.

15-43 Software Version

Function:

View the combined SW version (or 'package version') consisting of power SW and control SW.

15-44 Ordered Typecode String

Function:

View the type code string used for re-ordering the adjustable frequency drive in its original configuration.

15-45 Actual Typecode String

Function:

View the actual type code string.

15-46 Adj Freq Dr Ordering No.

Function:

View the 8-digit ordering number used for re-ordering the adjustable frequency drive in its original configuration.

15-47 Power Card Ordering No.

Function:

View the power card ordering number.

15-48 LCP ID Num.

Function:

View the LCP ID number.

15-49 SW ID Control Card

Function:

View the control card software version number.

15-50 SW ID Power Card

Function:

View the power card software version number.

15-51 Adj Freq Dr Serial No.

Function:

View the adjustable frequency drive serial number.

15-53 Power Card Serial Number

Function:

View the power card serial number.

□ 15-6* Option Ident.

This read-only parameter group contains information about the hardware and software configuration of the options installed in slots A, B C0 and C1.

15-60 Option Mounted

Function:

View the installed option type.

15-61 Option SW Version

Function:

View the installed option software version.

15-62 Option Ordering No

Function:

Shows the ordering number for the installed options.

15-63 Option Serial No

Function:

View the installed option serial number.

15-70 Option in Slot A

Function:

View the type code string for the option installed in slot A, and a translation of the type code string. E.g., for type code string 'AX', the translation is 'No option'.

15-71 Slot A Option SW Version

Function:

View the software version for the option installed in slot A.

15-72 Option in Slot B

Function:

View the type code string for the option installed in slot B, and a translation of the type code string. E.g., for type code string 'BX', the translation is 'No option'.

15-73 Slot B Option SW Version

Function:

View the software version for the option installed in slot B.

15-74 Option in Slot C

Function:

View the type code string for the option installed in slot C, and a translation of the type code string. E.g. for type code string 'CXXXX' the translation is 'No option'.

15-75 Slot C Option SW Version

Function:

View the software version for the option installed in slot C.

□ 15-9* Parameter Info

Parameter lists

15-92 Defined Parameters

Array [1000]

Range:

0 - 9999 *0

Function:

View a list of all defined parameters in the frequency converter. The list ends with 0.

15-93 Modified Parameters

Array [1000]

Range:

0 - 9999 *0

Function:

View a list of the parameters that have been changed from their default setting. The list ends with 0. Changes may not be visible until up to 30 seconds after implementation.

15-99 Parameter Metadata

Array [23]

Option:

0 - 9999 *0

Function:

This parameter contains data used by the MCT10 software tool.

□ Parameters: Data Read-outs

□ 16-** Data Read-outs

Parameter group for data read-outs, e.g., current references, voltages, control, alarm, warning and status words.

□ 16-0* General Status

Parameters for reading the general status, e.g., the calculated reference, the active control word, status.

16-00 Control Word

Range:

0 - FFFF ✱0

Function:

View the control word sent from the adjustable frequency drive via the serial communication port in hex code.

16-01 Reference [Unit]

Range:

-999999.000 - 999999.000 ✱0.000

Function:

View the present reference value applied on impulse or analog basis in the unit resulting from the configuration selected in par. 1-00 (Hz, Nm or RPM).

16-02 Reference %

Range:

-200.0 - 200.0% ✱0.0%

Function:

View the total reference. The total reference is the sum of digital, analog, preset, bus, and freeze references, plus catch-up and slow-down.

16-03 Status Word

Range:

0 - FFFF ✱0

Function:

View the status word sent from the adjustable frequency drive via the serial communication port in hex code.

16-05 Main actual value [%]

Option:

0 - 0 N/A ✱N/A

Function:

Two-byte word sent with the Status word to the Bus Master reporting the main actual value. Please refer to the VLT® AutomationDrive FC 300 Profibus Instruction Manual MG.33.CX.YY for detailed description.

□ 16-1* Motor Status

Parameters for reading the motor status values.

16-10 Power [kW]

Range:

0.0 - 1000.0 kW ✱0.0kW

Function:

View the motor power in kW. The value shown is calculated on the basis of the actual motor voltage and motor current. The value is filtered, and therefore approx. 1.3 seconds may pass from when an input value changes to when the data read-out values change.

16-11 Power [hp]

Range:

0.00 - 1000.00 hp ✱0.00hp

Function:

View the motor power in hp. The value shown is calculated on the basis of the actual motor voltage and motor current. The value is filtered, and therefore approx. 1.3 seconds may pass from when an input value changes to when the data read-out values change.

16-12 Motor voltage

Range:

0.0 - 6000.0 V ✱0.0V

Function:

View the motor voltage, a calculated value used for controlling the motor.

16-13 Frequency

Range:

0.0 - 6500.0 Hz ✱0.0Hz

Function:

View the motor frequency, without resonance dampening.

16-14 Motor Current

Range:

0.00 - 0.00 A ✱0.00A

Function:

View the motor current measured as a mean value, IRMS. The value is filtered, and thus approx. 1.3 seconds may pass from when an input value changes to when the data read-out values change.

16-15 Frequency [%]

Range:

0.00 - 0.00 % ✱0.00%

Function:

View a two-byte word reporting the actual motor frequency (without resonance dampening) as a percentage (scale 0000-4000 Hex) of par. 4-19 *Max. Output Frequency*. Set par. 9-16 index 1 to send it with the Status Word instead of the MAV.

16-16 Torque

Range:

-3000.0 - 3000.0 Nm ✱0.0Nm

Function:

View the torque value with sign, applied to the motor shaft. Linearity is not exact between 160% motor current and torque in relation to the rated torque. Some motors supply more than 160% torque. Consequently, the min. value and the max. value will depend on the max. motor current as well as the motor used. The value is filtered, and thus approx. 1.3 seconds may pass from when an input changes value to when the data read-out values change.

16-17 Speed [RPM]

Range:

0 - 0 RPM ✱0 RPM

Function:

View the actual motor RPM. In open loop or closed loop process control the motor RPM is estimated. In speed closed loop modes the motor RPM is measured.

16-18 Motor Thermal

Range:

0 - 100% ✱0%

Function:

View the calculated thermal load on the motor. The cut-out limit is 100%. The basis for calculation is the ETR function selected in par. 1-90.

16-19 KTY Sensor Temperature

Range:

32° - xxx°F [0 - xxx°C] ✱32°F [0°C]

Function:

Returning the current temperature from the KTY sensor built into the motor.

16-20 Motor Angle

Range:

0 - 65535 ✱0

Function:

View the current encoder/resolver angle offset relative to the index position. The value range of 0-65535 corresponds to 0-2*pi (radians).

□ **16-3* Drive Status**

Parameters for reporting the status of the adjustable frequency drive.

16-30 DC Link Voltage

Range:

0 - 10000 V ✱0V

Function:

View a measured value. The value is filtered, and thus approx. 1.3 seconds may pass from when an input value changes to when the data read-out value changes.

16-32 Brake Energy /s

Range:

0.000 - 0.000 kW ✱0.000kW

Function:

View the brake power transmitted to an external brake resistor, stated as an instantaneous value.

16-33 Braking Energy /2 min

Range:

0.000 - 670510 HP [0.000 - 500.000 kW]

*0.000 HP [0.000 kW]

Function:

View the braking energy transmitted to an external brake resistor. The mean power is calculated on an average basis for the most recent 120 seconds.

16-34 Heatsink Temp.

Range:

0-491°F [0-255°C] *32°F [0°C]

Function:

View the adjustable frequency drive heatsink temperature. The cut-out limit is 203 ± 9°F [90 ± 5°C], and the motor cuts back in at 158 ± 9°F [60 ± 5°C].

16-35 Inverter Thermal

Range:

0 - 0 % *0 %

Function:

View the percentage load on the inverter.

16-36 Inv. Nom. Current

Range:

0.01 - 10000.00 A * A

Function:

View the inverter nominal current, which should match the nameplate data on the connected motor. The data are used for calculation of torque, motor protection, etc.

16-37 Inv. Max. Current

Range:

0.01 - 10000.00 A *A

Function:

View the inverter maximum current, which should match the nameplate data on the connected motor. The data are used for calculation of torque, motor protection, etc.

16-38 SL Controller State

Range:

0 - 0 *0

Function:

View the state of the event under execution by the SL controller.

16-39 Control Card Temp.

Range:

0-212°F [0-100°C] *32°F [0°C]

Function:

View the temperature on the control card, stated in °F [°C].

16-40 Logging Buffer Full

Option:

*No [0]

Yes [1]

Function:

View whether the logging buffer is full (see par. 15-1*). The logging buffer will never be full when par. 15-13 *Logging Mode* is set to *Log always* [0].

□ **16-5* Ref. & Feedb.**

Parameters for reporting the reference and feedback input.

16-50 External Reference

Range:

0.0 - 0.0 *0.0

Function:

View the total reference, the sum of digital, analog, preset, bus and freeze references, plus catch-up and slow-down.

16-51 Pulse Reference

Range:

0.0 - 0.0 *0.0

Function:

View the reference value from programmed digital input(s). The read-out can also reflect the impulses from an incremental encoder.

16-52 Feedback [Unit]

Range:

0.0 - 0.0 *0.0

Function:

View the feedback unit resulting from the selection of unit and scaling in par. 3-00, 3-01, 3-02 and 3-03.

16-53 Digi Pot Reference

Range:

0.0 - 0.0 *0.0

Function:

View the contribution of the Digital Potentiometer to the actual reference.

□ **16-6* Inputs and Outputs**

Parameters for reporting the digital and analog IO ports.

16-60 Digital Input

Range:

0 - 63 *0

Function:

View the signal states from the active digital inputs. Input 18 corresponds to the bit at the far left. '0' = no signal, '1' = connected signal.

Bit 0	Digital input term. 33
Bit 1	Digital input term. 32
Bit 2	Digital input term. 29
Bit 3	Digital input term. 27
Bit 4	Digital input term. 19
Bit 5	Digital input term. 18
Bit 6	Digital input term. 37
Bit 7	Digital input GP I/O term. X30/2
Bit 8	Digital input GP I/O term. X30/3
Bit 9	Digital input GP I/O term. X30/4
Bit 10-63	Reserved for future terminals

16-61 Terminal 53 Switch Setting

Option:

*Current [0]
Voltage [1]

Function:

View the setting of input terminal 53. Current = 0; Voltage = 1.

16-62 Analog Input 53

Range:

0.000 - 0.000 *0.000

Function:

View the actual value at input 53 either as a reference or a protection value.

16-63 Terminal 54 Switch Setting

Option:

*Current [0]
Voltage [1]

Function:

View the setting of input terminal 54. Current = 0; Voltage = 1.

16-64 Analog Input 54

Range:

0.000 - 0.000 *0.000

Function:

View the actual value at input 54 either as a reference or a protection value.

16-65 Analog Output 42 [mA]

Range:

0.000 - 0.000 *0.000

Function:

View the actual value at output 42 in mA. The value shown reflects the selection in par. 06-50.

16-66 Digital Output [bin]

Range:

0 - 3 *0

Function:

View the binary value of all digital outputs.

16-67 Freq. Input #29 [Hz]

Range:

0 - 0 *0

Function:

View the actual frequency rate on terminal 29. This parameter is available for FC 302 only.

16-68 Freq. Input #33 [Hz]

Range:

0 - 0 *0

Function:

View the actual value of the frequency applied at terminal 29 as an impulse input.

16-69 Pulse Output #27 [Hz]

Range:

0 - 0 *0

Function:

View the actual value of impulses applied to terminal 27 in digital output mode.

16-70 Pulse Output #29 [Hz]

Range:

0 - 0 *0

Function:

View the actual value of pulses to terminal 29 in digital output mode.
This parameter is available for the FC 302 only.

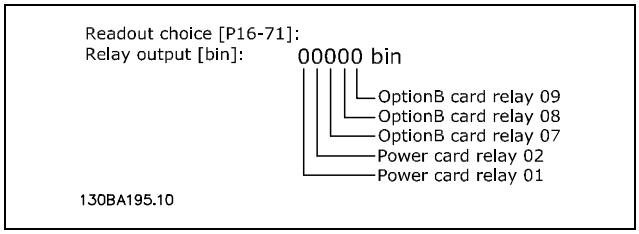
16-71 Relay Output [bin]

Range:

0 - 31 *0

Function:

View the settings of all relays.



16-72 Counter A

Range:

0 - 0 *0

Function:

View the present value of Counter A. Counters are useful as comparator operands, see par. 13-10. The value can be reset or changed either via digital inputs (parameter group 5-1*) or by using an SLC action (par. 13-52).

16-73 Counter B

Range:

0 - 0 *0

Function:

View the present value of Counter B. Counters are useful as comparator operands (par. 13-10). The value can be reset or changed either via digital inputs (parameter group 5-1*) or by using an SLC action (par. 13-52).

16-74 Precise Stop Counter

Range:

-2147483648 - 2147483648 *0

Function:

Returns the current counter value of precise counter (par. 1-84).

□ 16-8* Ser. Com. Bus & FC Port

Parameters for reporting the BUS references and control words.

16-80 Ser. Com. Bus CTW 1

Range:

0 - 65535 *0

Function:

View the two-byte control word (CTW) received from the bus master. Interpretation of the control word depends on the serial communication option installed and the control word profile selected in par. 8-10. For more information please, refer to the relevant serial communication bus manual.

16-82 Ser. com. bus REF 1

Function:

View the two-byte word sent with the control word form the bus master to set the reference value. For more information please, refer to the relevant serial communication bus manual.

16-84 Comm. Option STW

Range:

0 - 65535 *0

Function:

View the extended ser. com. bus option status word. For more information please, refer to the relevant serial communication bus manual.

16-85 FC Port CTW 1

Range:

0 - 65535 *0

Function:

View the two-byte control word (CTW) received from the bus master. Interpretation of the control word depends on the serial communication option installed and the control word profile selected in par. 8-10.

16-86 FC Port REF 1

Range:

0 - 0 *0

Function:

View the two-byte status word (STW) sent to the bus master. Interpretation of the status word depends on the serial communication bus option installed and the control word profile selected in par. 8-10.

□ **16-9* Diagnosis Read-Out**

Parameters displaying alarm, warning and extended status words.

16-90 Alarm Word

Range:

0 - FFFF *0

Function:

View the alarm word sent via the serial communication port in hex code.

16-92 Warning Word

Range:

0 - FFFF *0

Function:

View the warning word sent via the serial communication port in hex code.

16-94 Ext. Status Word

Range:

0 - FFFF *0

Function:

Returns the extended warning word sent via the serial communication port in hex code.

□ Parameters: EncoderInput

□ 17-** Motor Feedb. Option

Additional parameters to configure the Encoder (MCB102) or the Resolver (MCB103) Feedback Option.

□ 17-1* Inc. Enc. Interface

Parameters in this group configure the incremental interface of the MCB102 option. Note that both the incremental and absolute interfaces are active at the same time.

17-10 Signal Type

Option:

None	[0]
✱TTL (5V, RS422)	[1]
SinCos	[2]

Function:

Select the incremental type (A/B channel) of the encoder in use. Find the information on the encoder data sheet.
Select *None* [0] if the feedback sensor is an absolute encoder only.
This parameter cannot be adjusted while the motor is running.

17-11 Resolution (PPR)

Range:

10 - 10000 ✱1024

Function:

Enter the resolution of the incremental track, i.e. the number of pulses or periods per revolution.
This parameter cannot be adjusted while the motor is running.

□ 17-2* Abs. Enc. Interface

Parameters in this group configure the absolute interface of the MCB102 option. Note that both the incremental and absolute interfaces are active at the same time.

17-20 Protocol Selection

Option:

✱None	[0]
HIPERFACE	[1]
EnDat	[2]
SSI	[4]

Function:

Select *HIPERFACE* [1] if the encoder is absolute only.
Select *None* [0] if the feedback sensor is an incremental encoder only.
This parameter cannot be adjusted while the motor is running.

17-21 Resolution (Positions/Rev)

Option:

512	[512]
1024	[1024]
2048	[2048]
4096	[4096]
8192	[8192]
16384	[16384]
✱32768	[32768]

Function:

Select the resolution of the absolute encoder, i.e. the number of counts per revolution.
This parameter cannot be adjusted while the motor is running.

17-24 SSI Data Length

Range:

13 - 25 ✱13

Function:

Set the number of bits for the SSI telegram. Choose 13 bits for single-turn encoders and 25 bits for multi-turn encoder.

17-25 Clock Rate

Range:

100 - 260 kHz ✱260 kHz

Function:

Set the SSI clock rate. For long encoder cables, the clock rate must be reduced.

17-26 SSI Data Format

Option:

✱Gray Code	[0]
Binary Code	[1]

Function:

Set the data format of the SSI data. Choose between Gray or Binary format.

17-34 HIPERFACE Baud rate

Option:

600	[0]
1200	[1]
2400	[2]
4800	[3]
*9600	[4]
19200	[5]
38400	[6]

Function:

Select the baud rate of the attached encoder. This parameter cannot be adjusted while the motor is running.

□ 17-5* Resolver Interface

Parameter group 17-5* is used for setting parameters for the MCB 103 resolver option. Usually the resolver feedback is used as motor feedback from permanent magnet motors with par. 1-01 set to flux with motor feedback. Resolver parameters cannot be adjusted while the motor is running.

17-51 Resolver Input Voltage

Range:

4.0 - 8.0 V *7.0 V

Function:

Set the input voltage to the resolver. The voltage is stated as an RMS value.
The value is stated in the data sheet for resolvers.

17-50 Resolver Poles

Range:

2-4 *2

Function:

Set the number of poles on the resolver.
Most resolvers have 2 poles.
The value is stated in the data sheet for resolvers.

17-52 Resolver Input Frequency

Range:

2.0 - 15.0 kHz *10.0 kHz

Function:

Set the input frequency to the resolver.
The value is stated in the data sheet for resolvers.

17-53 Resolver Transformation Ratio

Range:

0.1 - 1.1 *0.5

Function:

Set the transformation ratio for the resolver.
The transformation ration is:

$$T_{ratio} = \frac{V_{Out}}{V_{In}}$$

The value is stated in the data sheet for resolvers.

17-59 Resolver Interface

Option:

*False	[0]
True	[1]

Function:

Activate the MCB 103 resolver option when the resolver parameters are selected.
To avoid damaging resolvers, par. 17-50 – par. 17-53 must be adjusted before activating this parameter.

□ 17-6* Monitoring and Application

This parameter group is used to select additional functions when the MCB 102 encoder option or MCB 103 resolver option is fitted into the option slot B as speed feedback.
Monitoring and application parameters cannot be adjusted while the motor is running.

17-60 Encoder Positive Direction

Option:

*Clockwise	[0]
Counterclockwise	[1]

Function:

Change the detected encoder rotation direction without changing the wiring to the encoder.
This parameter cannot be adjusted while the motor is running.

17-61 Encoder Signal Monitoring

Option:

Disabled	[0]
*Warning	[1]
Trip	[2]

Function:

Select which reaction the adjustable frequency drive should take if a fault encoder signal is detected.
The encoder function in par. 17-61 is an electrical check of the hardware circuit in the encoder system.

Parameter lists

Changes during operation
"TRUE" means that the parameter can be changed while the adjustable frequency drive is in operation and "FALSE" means that the it must be stopped before a change can be made.

4-Set-up
"All set-up": the parameter can be set individually in each of the four set-ups, i. e. one single parameter can have four different data values.
"1 set-up": data value will be the same in all set-ups.

Conversion index
This number refers to a conversion figure used when writing or reading by means of an adjustable frequency drive.

Conv. index	100	67	6	5	4	3	2	1	0	-1	-2	-3	-4	-5	-6
Conv. factor	1	1/60	1000000	100000	10000	1000	100	10	1	0.1	0.01	0.001	0.0001	0.00001	0.000001

Data type	**Description**	**Type**
2	Integer 8	Int8
3	Integer 16	Int16
4	Integer 32	Int32
5	Unsigned 8	Uint8
6	Unsigned 16	Uint16
7	Unsigned 32	Uint32
9	Visible String	VisStr
33	Normalized value 2 bytes	N2
35	Bit sequence of 16 Boolean variables	V2
54	Time difference w/o date	TimD

□ 0-** Operation/Display

Par. No. #	Parameter description	Default value	4-set-up	Change during operation	Conver-sion index	Type
0-0* Basic settings						
0-01	Language	[0] English	1 set-up	TRUE	-	Uint8
0-04	Operating state at Power-up (Hand)	[1] Forced stop, ref=old	All set-ups	TRUE	-	Uint8
0-1* Set-up handling						
0-10	Active set-up	[1] Setup 1	1 set-up	TRUE	-	Uint8
0-11	Edit set-up	[1] Setup 1	All set-ups	TRUE	-	Uint8
0-12	This set-up linked to	[1] Setup 1	All set-ups	FALSE	-	Uint8
0-13	Readout: Linked set-ups	0	All set-ups	FALSE	0	Uint16
0-14	Readout: Edit set-ups / channel	0	All set-ups	TRUE	0	Uint32
0-2* LCP Display						
0-20	Display line 1.1 small	[1617] Speed (RPM)	All set-ups	TRUE	-	Uint16
0-21	Display line 1.2 small	[1614] Motor current	All set-ups	TRUE	-	Uint16
0-22	Display line 1.3 small	[1610] Power (kW)	All set-ups	TRUE	-	Uint16
0-23	Display line 2 large	[1613] Frequency	All set-ups	TRUE	-	Uint16
0-24	Display line 3 large	[1602] Reference %	All set-ups	TRUE	-	Uint16
0-25	My personal menu	User depedent	1 set-up	TRUE	0	Uint16
0-4* LCP keypad						
0-40	[Hand on] key on LCP	[1] Enabled	All set-ups	TRUE	-	Uint8
0-41	[Off] key on LCP	[1] Enabled	All set-ups	TRUE	-	Uint8
0-42	[Auto on] key on LCP	[1] Enabled	All set-ups	TRUE	-	Uint8
0-43	[Reset] key on LCP	[1] Enabled	All set-ups	TRUE	-	Uint8
0-5* Copy/Save						
0-50	LCP copy	[0] No copy	All set-ups	FALSE	-	Uint8
0-51	Set-up copy	[0] No copy	All set-ups	FALSE	-	Uint8
0-6* Password						
0-60	Main menu password	100	1 set-up	TRUE	0	Uint16
0-61	Access to main menu w/o password	[0] Full access	1 set-up	TRUE	-	Uint8
0-64	Quick menu password	200	1 set-up	TRUE	0	Uint16
0-66	Access to quick menu w/o password	[0] Full access	1 set-up	TRUE	-	Uint8

□ 1-** Load/Motor

Par. No. #	Parameter description	Default value	4-set-up	Change during operation	Conver-sion index	Type
1-0* General settings						
1-00	Configuration mode	[0] Speed open loop	All set-ups	FALSE	-	Uint8
1-01	Motor control principle	[1] VVCplus	All set-ups	FALSE	-	Uint8
1-2* Motor data						
1-20	Motor power [HP]	Drive dependent	All set-ups	FALSE	1	Uint32
1-22	Motor voltage	Drive dependent	All set-ups	FALSE	0	Uint16
1-23	Motor frequency	Drive dependent	All set-ups	FALSE	0	Uint16
1-24	Motor current	Drive dependent	All set-ups	FALSE	-2	Uint16
1-25	Motor nominal speed	Drive dependent	All set-ups	FALSE	67	Uint16
1-29	Automatic motor adaptation(AMA)	[0] Off	All set-ups	FALSE	-	Uint8
1-3* Advanced motor data						
1-30	Stator resistance (Rs)	Motor dependent	All set-ups	FALSE	-4	Uint32
1-31	Rotor resistance (Rr)	Motor dependent	All set-ups	FALSE	-4	Uint32
1-33	Stator leakage reactance (X1)	Motor dependent	All set-ups	FALSE	-4	Uint32
1-34	Rotor leakage reactance (X2)	Motor dependent	All set-ups	FALSE	-4	Uint32
1-35	Main reactance (Xh)	Motor dependent	All set-ups	FALSE	-4	Uint32
1-36	Iron loss resistance (Rfe)	Motor dependent	All set-ups	FALSE	-3	Uint32
1-39	Motor poles	Motor dependent	All set-ups	FALSE	0	Uint8
1-5* Load indep. setting						
1-50	Motor magnetizing at zero speed	100 %	All set-ups	TRUE	0	Uint16
1-51	Min speed normal magnetizing [RPM]	1 RPM	All set-ups	TRUE	67	Uint8
1-6* Load depen. setting						
1-60	Low speed load compensation	100 %	All set-ups	TRUE	0	Int16
1-61	High speed load compensation	100 %	All set-ups	TRUE	0	Int16
1-62	Slip compensation	100 %	All set-ups	TRUE	0	Int16
1-63	Slip compensation time constant	0.10 s	All set-ups	TRUE	-2	Uint16
1-64	Resonance dampening	100 %	All set-ups	TRUE	0	Uint16
1-65	Resonance dampening time constant	5 ms	All set-ups	TRUE	-3	Uint8
1-66	Min. current at low speed	100 %	All set-ups	TRUE	0	Uint8
1-67	Load type	[0] Passive load	All set-ups	TRUE	-	Uint8
1-68	Minimum inertia	Drive dependent	All set-ups	FALSE	-4	Uint32
1-69	Maximum inertia	Drive dependent	All set-ups	FALSE	-4	Uint32
1-7* Start adjustments						
1-71	Start delay	0.0 s	All set-ups	TRUE	-1	Uint8
1-72	Start function	[2] Coast/delay time	All set-ups	TRUE	-	Uint8
1-74	Start speed [RPM]	0 RPM	All set-ups	TRUE	67	Uint16
1-76	Start current	0.00 A	All set-ups	TRUE	-2	Uint16
1-8* Stop adjustments						
1-80	Function at stop	[0] Coast	All set-ups	TRUE	-	Uint8
1-81	Min speed for function at stop [RPM]	0 RPM	All set-ups	TRUE	67	Uint16
1-9* Motor temperature						
1-90	Motor thermal protection	[0] No protection	All set-ups	TRUE	-	Uint8
1-91	Motor external fan	[0] No	All set-ups	TRUE	-	Uint16
1-93	Thermistor source	[0] None	All set-ups	FALSE	-	Uint8

□ 2-** Brakes

Par. No. #	Parameter description	Default value	4-set-up	Change during operation	Conver-sion index	Type
2-0* DC-brake						
2-00	DC hold current	50 %	All set-ups	TRUE	0	Uint8
2-01	DC brake current	50 %	All set-ups	TRUE	0	Uint16
2-02	DC braking time	10.0 s	All set-ups	TRUE	-1	Uint16
2-03	DC brake cut-in speed	0 RPM	All set-ups	TRUE	67	Uint16
2-1* Brake energy funct.						
2-10	Brake and over-voltage functions	[0] Off	All set-ups	TRUE	-	Uint8
2-11	Brake resistor (ohm)	Drive dependent	All set-ups	TRUE	0	Uint16
2-12	Brake power limit (kW)	Drive dependent	All set-ups	TRUE	0	Uint32
2-13	Brake power monitoring	[0] Off	All set-ups	TRUE	-	Uint8
2-15	Brake check	[0] Off	All set-ups	TRUE	-	Uint8
2-2* Mechanical brake						
2-20	Release brake current	0.00 A	All set-ups	TRUE	-2	Uint16
2-21	Activate brake speed [RPM]	0 RPM	All set-ups	TRUE	67	Uint16
2-23	Activate brake delay	0.0 s	All set-ups	TRUE	-1	Uint8

□ 3-** Reference / Ramps

Par. No. #	Parameter description	Default value	4-set-up	Change during operation	Conver-sion index	Type
3-0* Reference limits						
3-00	Reference range	[0] Min - Max	All set-ups	TRUE	-	Uint8
3-03	Maximum reference	1500.000 Unit	All set-ups	TRUE	-3	Int32
3-1* References						
3-10	Preset reference	0.00 %	All set-ups	TRUE	-2	Int16
3-12	Catch up/slow down value	0.00 %	All set-ups	TRUE	-2	Int16
3-13	Reference site	[0] Linked to Hand / Auto	All set-ups	FALSE	-	Uint8
3-14	Preset relative reference	0.00 %	All set-ups	TRUE	-2	Int32
3-15	Reference resource 1	[1] Analog input 53	All set-ups	FALSE	-	Uint8
3-16	Reference resource 2	[2] Analog input 54	All set-ups	FALSE	-	Uint8
3-17	Reference resource 3	[11] Local bus reference	All set-ups	FALSE	-	Uint8
3-18	Relative scaling reference resource	[0] No function	All set-ups	FALSE	-	Uint8
3-19	Jog speed	25 RPM	All set-ups	TRUE	67	Uint16
3-4* Ramp 1						
3-40	Ramp 1 type	[0] Linear	All set-ups	TRUE	-	Uint8
3-41	Ramp 1 ramp up time	Drive dependent	All set-ups	TRUE	-2	Uint32
3-42	Ramp 1 ramp down time	Drive dependent	All set-ups	TRUE	-2	Uint32
3-5* Ramp 2						
3-50	Ramp 2 type	[0] Linear	All set-ups	TRUE	-	Uint8
3-51	Ramp 2 ramp up time	Drive dependent	All set-ups	TRUE	-2	Uint32
3-52	Ramp 2 ramp down time	Drive dependent	All set-ups	TRUE	-2	Uint32
3-6* Ramp 3						
3-60	Ramp 3 type	[0] Linear	All set-ups	TRUE	-	Uint8
3-61	Ramp 3 ramp up time	Drive dependent	All set-ups	TRUE	-2	Uint32
3-62	Ramp 3 ramp down time	Drive dependent	All set-ups	TRUE	-2	Uint32
3-7* Ramp 4						
3-70	Ramp 4 type	[0] Linear	All set-ups	TRUE	-	Uint8
3-71	Ramp 4 ramp up time	Drive dependent	All set-ups	TRUE	-2	Uint32
3-72	Ramp 4 ramp down time	Drive dependent	All set-ups	TRUE	-2	Uint32
3-8* Other ramps						
3-80	Jog ramp time	Drive dependent	All set-ups	TRUE	-2	Uint32
3-81	Quick stop ramp time	Drive dependent	1 set-up	TRUE	-2	Uint32
3-9* Digital Pot.Meter						
3-90	Step Size	0.01 %	All set-ups	FALSE	-2	Uint16
3-91	Ramp Time	1.00 s	All set-ups	FALSE	-2	Uint32
3-92	Power Restore	[0] Off	All set-ups	FALSE	-	Uint8
3-93	Limit	100 %	All set-ups	FALSE	0	Uint16

□ 4-** Limits / Warnings

Par. No. #	Parameter description	Default value	4-set-up	Change during operation	Conver-sion index	Type
4-1* Motor limits						
4-10	Motor speed direction	[2] Both directions	All set-ups	FALSE	-	Uint8
4-11	Motor speed low limit [RPM]	0 RPM	All set-ups	TRUE	67	Uint16
4-13	Motor speed high limit [RPM]	3600 RPM	All set-ups	TRUE	67	Uint16
4-16	Torque limit motor mode	160.0 %	All set-ups	TRUE	-1	Uint16
4-17	Torque limit generator mode	160.0 %	All set-ups	TRUE	-1	Uint16
4-18	Current limit	160.0 %	All set-ups	TRUE	-1	Uint16
4-19	Max output frequency	132.0 Hz	All set-ups	FALSE	-1	Uint16
4-5* Adj. warnings						
4-50	Warning current low	0.00 A	All set-ups	TRUE	-2	Uint16
4-51	Warning current high	Par. 16-37	All set-ups	TRUE	-2	Uint16
4-52	Warning speed low	0 RPM	All set-ups	TRUE	67	Uint16
4-53	Warning speed high	Par. 4-13	All set-ups	TRUE	67	Uint16
4-58	Missing motor phase function	[0] Off	All set-ups	FALSE	-	Uint8
4-6* Speed bypass						
4-60	Bypass speed from [RPM]	0 RPM	All set-ups	TRUE	67	Uint16
4-62	Bypass speed to [RPM]	0 RPM	All set-ups	TRUE	67	Uint16

□ 5-** Digital In/Out

Par. No. #	Parameter description	Default value	4-set-up	Change during operation	Conver-sion index	Type
5-0* Digital IO mode						
5-00	Digital I/O mode	[0] PNP	All set-ups	FALSE	-	Uint8
5-01	Terminal 27 mode	[0] Input	All set-ups	FALSE	-	Uint8
5-02	Terminal 29 mode	[0] Input	All set-ups	FALSE	-	Uint8
5-1* Digital inputs						
5-10	Terminal 18 digital input	[8] Start	All set-ups	TRUE	-	Uint8
5-11	Terminal 19 digital input	[10] Reverse	All set-ups	TRUE	-	Uint8
5-12	Terminal 27 digital input	[2] Coast inverse	All set-ups	TRUE	-	Uint8
5-13	Terminal 29 digital input	[14] Jog	All set-ups	TRUE	-	Uint8
5-14	Terminal 32 digital input	[24] Set-up select bit 1	All set-ups	TRUE	-	Uint8
5-15	Terminal 33 digital input	[23] Set-up select bit 0	All set-ups	TRUE	-	Uint8
5-3* Digital outputs						
5-30	Terminal 27 digital output	[0] No operation	All set-ups	TRUE	-	Uint8
5-31	Terminal 29 digital output	[0] No operation	All set-ups	TRUE	-	Uint8
5-4* Relays						
5-40	Function relay	[0] No operation	All set-ups	TRUE	-	Uint8
5-41	On delay, relay	0.01 s	All set-ups	TRUE	-2	Uint16
5-42	Off delay, relay	0.01 s	All set-ups	TRUE	-2	Uint16
5-5* Pulse input						
5-50	Term. 29 low frequency	100 Hz	All set-ups	TRUE	0	Uint32
5-51	Term. 29 high frequency	100 Hz	All set-ups	TRUE	0	Uint32
5-52	Term. 29 low ref./feedb. value	0.000 Unit	All set-ups	TRUE	-3	Int32
5-53	Term. 29 high ref./feedb. value	1500.000 Unit	All set-ups	TRUE	-3	Int32
5-54	Pulse filter time constant #29	100 ms	All set-ups	FALSE	-3	Uint16
5-55	Term. 33 low frequency	100 Hz	All set-ups	TRUE	0	Uint32
5-56	Term. 33 high frequency	100 Hz	All set-ups	TRUE	0	Uint32
5-57	Term. 33 low ref./feedb. value	0.000 Unit	All set-ups	TRUE	-3	Int32
5-58	Term. 33 high ref./feedb. value	1500.000 Unit	All set-ups	TRUE	-3	Int32
5-59	Pulse filter time constant #33	100 ms	All set-ups	FALSE	-3	Uint16
5-6* Pulse output						
5-60	Terminal 27 pulse output variable	[0] No operation	All set-ups	FALSE	-	Uint8
5-62	Pulse output maximum frequency #27	5000 Hz	All set-ups	FALSE	0	Uint32
5-63	Terminal 29 pulse output variable	[0] No operation	All set-ups	FALSE	-	Uint8
5-65	Pulse output maximum frequency #29	5000 Hz	All set-ups	FALSE	0	Uint32
5-7* 24V encoder input						
5-70	Term 32/33 encoder resolution	1024	All set-ups	FALSE	0	Uint16
5-71	Term 32/33 encoder direction	[0] Clockwise	All set-ups	FALSE	-	Uint8

□ 6-** Analog In/Out

Par. No. #	Parameter description	Default value	4-set-up	Change during operation	Conver-sion index	Type
6-0* Analog IO mode						
6-00	Live zero Timeout Time	10 s	All set-ups	TRUE	0	Uint8
6-01	Live zero Timeout Function	[0] Off	All set-ups	TRUE	-	Uint8
6-1* Analog input 1						
6-10	Terminal 53 low voltage	0.07 V	All set-ups	TRUE	-2	Int16
6-11	Terminal 53 high voltage	10.00 V	All set-ups	TRUE	-2	Int16
6-12	Terminal 53 low current	0.14 mA	All set-ups	TRUE	-5	Int16
6-13	Terminal 53 high current	20.00 mA	All set-ups	TRUE	-5	Int16
6-14	Terminal 53 low ref./feedb. value	0.000 Unit	All set-ups	TRUE	-3	Int32
6-15	Terminal 53 high ref./feedb. value	1500.000 Unit	All set-ups	TRUE	-3	Int32
6-16	Terminal 53 filter time constant	0.001 s	All set-ups	FALSE	-3	Uint16
6-2* Analog input 2						
6-20	Terminal 54 low voltage	0.07 V	All set-ups	TRUE	-2	Int16
6-21	Terminal 54 high voltage	10.00 V	All set-ups	TRUE	-2	Int16
6-22	Terminal 54 low current	0.14 mA	All set-ups	TRUE	-5	Int16
6-23	Terminal 54 high current	20.00 mA	All set-ups	TRUE	-5	Int16
6-24	Terminal 54 low ref./feedb. value	0.000 Unit	All set-ups	TRUE	-3	Int32
6-25	Terminal 54 high ref./feedb. value	1500.000 Unit	All set-ups	TRUE	-3	Int32
6-26	Terminal 54 filter time constant	0.001 s	All set-ups	FALSE	-3	Uint16
6-5* Analog output 1						
6-50	Terminal 42 output	[0] No operation	All set-ups	TRUE	-	Uint8
6-51	Terminal 42 output min scale	0.00 %	All set-ups	TRUE	-2	Int16
6-52	Terminal 42 output max scale	100.00 %	All set-ups	TRUE	-2	Int16

□ 7-** Controllers

Par. No. #	Parameter description	Default value	4-set-up	Change during operation	Conver-sion index	Type
7-0* Speed PID ctrl.						
7-02	Speed PID proportional gain	0.015	All set-ups	TRUE	-3	Uint16
7-03	Speed PID Integral Time	Drive dependent	All set-ups	TRUE	-4	Uint32
7-04	Speed PID differentiation time	Drive dependent	All set-ups	TRUE	-4	Uint16
7-05	Speed PID diff. gain Limit	5.0	All set-ups	TRUE	-1	Uint16
7-06	Speed PID lowpass filter time	10.0 ms	All set-ups	TRUE	-4	Uint16

□ 8-** Comm. and options

Par. No. #	Parameter description	Default value	4-set-up	Change during operation	Conver-sion index	Type
8-0* General settings						
8-00	Enabled options	[1] All	All set-ups	FALSE	-	Uint8
8-01	Control site	[0] Digital and ctrl.word	All set-ups	TRUE	-	Uint8
8-02	Controlword source	[0] FC RS485	All set-ups	TRUE	-	Uint8
8-03	Controlword Timeout Time	1.0 s	1 set-up	TRUE	-1	Uint32
8-04	Controlword Timeout Function	[0] Off	1 set-up	FALSE	-	Uint8
8-05	End-of-timeout function	[1] Resume set-up	1 set-up	TRUE	-	Uint8
8-06	Reset Controlword Timeout	[0] Do not reset	All set-ups	TRUE	-	Uint8
8-07	Diagnosis trigger	[0] Disable	2 set-ups	FALSE	-	Uint8
8-1* Ctrl. word settings						
8-10	Control word profile	[0] FC profile	All set-ups	TRUE	-	Uint8
8-3* FC Port settings						
8-30	Protocol	[0] FC	1 set-up	FALSE	-	Uint8
8-31	Address	1	1 set-up	FALSE	0	Uint8
8-32	FC port baudrate	[2] 9600 Baud	1 set-up	FALSE	-	Uint8
8-35	Minimum response delay	10 ms	All set-ups	FALSE	-3	Uint16
8-36	Max response delay	5000 ms	1 set-up	FALSE	-3	Uint16
8-37	Max inter-char delay	25 ms	1 set-up	FALSE	-3	Uint16
8-5* Digital/Bus						
8-50	Coasting select	[3] Logic OR	All set-ups	TRUE	-	Uint8
8-51	Quick stop select	[3] Logic OR	All set-ups	TRUE	-	Uint8
8-52	DC Brake select	[3] Logic OR	All set-ups	TRUE	-	Uint8
8-53	Start select	[3] Logic OR	All set-ups	TRUE	-	Uint8
8-54	Reverse select	[3] Logic OR	All set-ups	TRUE	-	Uint8
8-55	Set-up select	[3] Logic OR	All set-ups	TRUE	-	Uint8
8-56	Preset reference select	[3] Logic OR	All set-ups	TRUE	-	Uint8
8-9* Bus jog						
8-90	Bus Jog 1 Speed	100 RPM	All set-ups	TRUE	67	Uint16
8-91	Bus Jog 2 Speed	200 RPM	All set-ups	TRUE	67	Uint16

□ 9-** Profibus

Par. No. #	Parameter description	Default value	4-set-up	Change during operation	Conver-sion index	Type
9-00	Setpoint	0	All setups	TRUE	0	Uint16
9-07	Actual Value	0	All setups	FALSE	0	Uint16
9-15	PCD write configuration	0	1 setup	TRUE	-	Uint16
9-16	PCD read configuration	0	1 setup	TRUE	-	Uint16
9-18	Node address	126	1 setup	TRUE	0	Uint8
9-22	Telegram selection	[1] Standard telegram 1	1 setup	TRUE	-	Uint8
9-23	Parameters for signals	0	All setups	TRUE	-	Uint16
9-27	Parameter edit	[1] Enabled	1 setup	FALSE	-	Uint16
9-28	Process control	[1] Enable cyclic master	1 setup	FALSE	-	Uint8
9-53	Profibus Warning Word	0	All setups	TRUE	0	V2
9-63	Actual baud rate	[255] No baud rate found	All setups	TRUE	-	Uint8
9-64	Device Identification	0	All setups	TRUE	0	Uint16
9-65	Profile number	0	All setups	TRUE	0	Uint8
9-67	Control word 1	0	All setups	TRUE	0	V2
9-68	Status word 1	0	All setups	TRUE	0	V2
9-71	Save Data Values	[0] Off	All setups	TRUE	-	Uint8
9-72	Drive Reset	[0] No action	1 setup	FALSE	-	Uint8
9-80	Defined parameters (1)	0	All setups	FALSE	0	Uint16
9-81	Defined parameters (2)	0	All setups	FALSE	0	Uint16
9-82	Defined parameters (3)	0	All setups	FALSE	0	Uint16
9-83	Defined parameters (4)	0	All setups	FALSE	0	Uint16
9-90	Changed parameters (1)	0	All setups	FALSE	0	Uint16
9-91	Changed parameters (2)	0	All setups	FALSE	0	Uint16
9-92	Changed parameters (3)	0	All setups	FALSE	0	Uint16
9-93	Changed parameters (4)	0	All setups	FALSE	0	Uint16

□ 10-** CAN fieldbus

Par. No. #	Parameter description	Default value	4-set-up	Change during operation	Conversion index	Type
10-0* Common settings						
10-00	CAN protocol	[1] Device Net	All set-ups	FALSE	-	Uint8
10-01	Baudrate select	[20] 125 Kbps	All set-ups	FALSE	-	Uint8
10-02	MAC ID	63	All set-ups	FALSE	0	Uint8
10-05	Readout Transmit Error Counter	0	All set-ups	TRUE	0	Uint8
10-06	Readout Receive Error Counter	0	All set-ups	TRUE	0	Uint8
10-07	Readout Bus Off Counter	0	All set-ups	TRUE	0	Uint16
10-1* DeviceNet						
10-10	Process data type selection	App. dependent	1 set-up	TRUE	-	Uint8
10-11	Process Data Config Write	0	All set-ups	FALSE	0	Uint8
10-12	Process Data Config Read	0	All set-ups	FALSE	0	Uint8
10-13	Warning Parameter	63	All set-ups	FALSE	0	Uint8
10-14	Net Reference	[0] Off	All set-ups	TRUE	-	Uint8
10-15	Net Control	[0] Off	All set-ups	TRUE	-	Uint8
10-2* COS filters						
10-20	COS Filter 1	65535	All set-ups	FALSE	0	Uint16
10-21	COS Filter 2	65535	All set-ups	FALSE	0	Uint16
10-22	COS Filter 3	65535	All set-ups	FALSE	0	Uint16
10-23	COS Filter 4	65535	All set-ups	FALSE	0	Uint16
10-3* Parameter access						
10-30	Parameter Data Types	[0] Errata 1	All set-ups	TRUE	-	Uint8
10-31	Array index	0	All set-ups	TRUE	0	Uint16
10-39	Devicenet F parameters	0	All set-ups	TRUE	0	Uint32

□ 13-** Smart logic control

Par. No. #	Parameter description	Default value	4-set-up	Change during operation	Conversion index	Type
13-1* Comparators						
13-10	Comparator Operand	[0] DISABLED	2 set-ups	FALSE	-	Uint8
13-11	Comparator Operator	[1] ≈	2 set-ups	FALSE	-	Uint8
13-12	Comparator Value	0.000	2 set-ups	FALSE	-3	Int32
13-2* Timers						
13-20	SL control timer	0.000 s	1 set-up	FALSE	-3	TimD
13-4* Logic rules						
13-40	Logic Rule Boolean 1	[0] False	2 set-ups	FALSE	-	Uint8
13-41	Logic Rule Operator 1	[0] DISABLED	2 set-ups	FALSE	-	Uint8
13-42	Logic Rule Boolean 2	[0] False	2 set-ups	FALSE	-	Uint8
13-43	Logic Rule Operator 2	[0] DISABLED	2 set-ups	FALSE	-	Uint8
13-44	Logic Rule Boolean 3	[0] False	2 set-ups	FALSE	-	Uint8
13-5* Smart logic ctrl.						
13-50	SL control mode	[0] Off	2 set-ups	FALSE	-	Uint8
13-51	SL control event	[0] False	2 set-ups	FALSE	-	Uint8
13-52	SL control action	[0] DISABLED	2 set-ups	FALSE	-	Uint8

□ 14-** Special functions

Par. No. #	Parameter description	Default value	4-set-up	Change during operation	Conver-sion index	Type
14-0* Inverter switching						
14-00	Switching Pattern	[1] SFAVM	All set-ups	FALSE	-	Uint8
14-01	Switching Frequency	[5] 5.0 kHz	All set-ups	FALSE	-	Uint8
14-03	Overmodulation	[0] Off	All set-ups	FALSE	-	Uint8
14-04	PWM random	[0] Off	All set-ups	FALSE	-	Uint8
14-1* Electrical power On/Off						
14-10	Electrical failure	[0] No function	All set-ups	FALSE	-	Uint8
14-11	Electrical Voltage at Electrical Fault	342 V	All set-ups	TRUE	0	Uint16
14-12	Function at Electrical Imbalance	[0] Trip	All set-ups	TRUE	-	Uint8
14-2* Trip reset						
14-20	Reset mode	[0] Manual reset	All set-ups	TRUE	-	Uint8
14-21	Automatic restart time	10 s	All set-ups	TRUE	0	Uint16
14-22	Operation mode	[0] Normal operation	All set-ups	TRUE	-	Uint8
14-25	Trip delay at torque limit	60 s = Off	All set-ups	FALSE	0	Uint8
14-29	Service code	0	All set-ups	FALSE	0	Int32
14-3* Current limit ctrl.						
14-30	Current lim cont, Proportional Gain	100 %	All set-ups	FALSE	0	Uint16
14-31	Current lim contr, Integration Time	0.020 s	All set-ups	FALSE	-3	Uint16
14-5* Environment						
14-50	RFI 1	[1] On	1 set-up	FALSE	-	Uint8

□ 15-** Drive information

Par. No. #	Parameter description	Default value	4-set-up	Change during operation	Conversion index	Type
15-0* Operating Data						
15-00	Operating hours	0 h	All set-ups	FALSE	74	Uint32
15-01	Running hours	0 h	All set-ups	FALSE	74	Uint32
15-02	kWh counter	0. kWh	All set-ups	FALSE	75	Uint32
15-03	Power up's	0	All set-ups	FALSE	0	Uint32
15-04	Over temp's	0	All set-ups	FALSE	0	Uint16
15-05	Over volt's	0	All set-ups	FALSE	0	Uint16
15-06	Reset of kWh counter	[0] Do not reset	All set-ups	FALSE	-	Uint8
15-07	Reset running hours counter	[0] Do not reset	All set-ups	FALSE	-	Uint8
15-2* Historic Log						
15-20	Historic log: Event	0	All set-ups	FALSE	0	Uint8
15-21	Historic log: Value	0	All set-ups	FALSE	0	Uint32
15-22	Historic log: Time	0 ms	All set-ups	FALSE	-3	Uint32
15-3* Fault Log						
15-30	Fault log: Error code	0	All set-ups	FALSE	0	Uint8
15-31	Fault log: Value	0	All set-ups	FALSE	0	Int16
15-32	Fault log: Time	0 s	All set-ups	FALSE	0	Uint32
15-4* Drive identification						
15-40	FC type	0	All set-ups	FALSE	0	VisStr[6]
15-41	Power section	0	All set-ups	FALSE	0	VisStr[20]
15-42	Voltage	0	All set-ups	FALSE	0	VisStr[20]
15-43	Software version	0	All set-ups	FALSE	0	VisStr[5]
15-44	Ordered typecode string	0	All set-ups	FALSE	0	VisStr[40]
15-45	Actual typecode string	0	All set-ups	FALSE	0	VisStr[40]
15-46	Drive ordering no	0	All set-ups	FALSE	0	VisStr[8]
15-47	Power card ordering no	0	All set-ups	FALSE	0	VisStr[8]
15-48	LCP Id no	0	All set-ups	FALSE	0	VisStr[20]
15-49	SW id control card	0	All set-ups	FALSE	0	VisStr[20]
15-50	SW id power card	0	All set-ups	FALSE	0	VisStr[20]
15-51	Drive serial number	0	All set-ups	FALSE	0	VisStr[10]
15-53	Power card serial number	0	All set-ups	FALSE	0	VisStr[19]
15-6* Option ident						
15-60	Option in slot A	0	All set-ups	FALSE	0	VisStr[30]
15-61	Slot A option SWversion	0	All set-ups	FALSE	0	VisStr[20]
15-62	Slot A ordering no	0	All set-ups	FALSE	0	VisStr[8]
15-63	Slot A option serial number	0	All set-ups	FALSE	0	VisStr[10]
15-65	Option in slot B	0	All set-ups	FALSE	0	VisStr[30]
15-66	Slot B option SWversion	0	All set-ups	FALSE	0	VisStr[20]
15-67	Slot B ordering no	0	All set-ups	FALSE	0	VisStr[8]
15-68	Slot B option serial number	0	All set-ups	FALSE	0	VisStr[10]
15-70	Option in slot C	0	All set-ups	FALSE	0	VisStr[30]
15-71	Slot C option SWversion	0	All set-ups	FALSE	0	VisStr[20]
15-72	Slot C ordering no	0	All set-ups	FALSE	0	VisStr[8]
15-73	Slot C option serial number	0	All set-ups	FALSE	0	VisStr[10]
15-75	Option in slot D	0	All set-ups	FALSE	0	VisStr[30]
15-9* Parameter info						
15-92	Defined parameters	0	All set-ups	FALSE	0	Uint16
15-93	Modified parameters	0	All set-ups	FALSE	0	Uint16
15-99	Parameter metadata	0	All set-ups	FALSE	0	Uint16

□ 16-** Data readouts

Par. No. #	Parameter description	Default value	4-set-up	Change during operation	Conver-sion index	Type
16-0* General status						
16-00	Control Word	0	All set-ups	FALSE	0	V2
16-01	Reference [Unit]	0.000 Unit	All set-ups	FALSE	-3	Int32
16-02	Reference %	0.0 %	All set-ups	FALSE	-1	Int16
16-03	Status word	0	All set-ups	FALSE	0	V2
16-05	Main actual value [%]	0	All set-ups	FALSE	0	N2
16-1* Motor status						
16-10	Power [kW]	0.0 kW	All set-ups	FALSE	2	Uint32
16-11	Power [hp]	0.00 hp	All set-ups	FALSE	-2	Uint32
16-12	Motor voltage	0.0 V	All set-ups	FALSE	-1	Uint16
16-13	Frequency	0.0 Hz	All set-ups	FALSE	-1	Uint16
16-14	Motor current	0.00 A	All set-ups	FALSE	-2	Uint32
16-16	Torque	0.0 Nm	All set-ups	FALSE	-1	Int16
16-17	Speed [RPM]	0 RPM	All set-ups	FALSE	67	Int32
16-18	Motor thermal	0 %	All set-ups	FALSE	0	Uint8
16-3* Drive status						
16-30	DC link Voltage	0 V	All set-ups	FALSE	0	Uint16
16-32	Brake energy /s	0.0 HP	All set-ups	FALSE	0	Uint32
16-33	Brake energy /2 min	0.0 HP	All set-ups	FALSE	0	Uint32
16-34	Heatsink temp.	0 °C	All set-ups	FALSE	100	Uint8
16-35	Inverter thermal	0 %	All set-ups	FALSE	0	Uint8
16-36	InomVLT	Drive dependent	All set-ups	FALSE	-2	Uint16
16-37	ImaxVLT	Drive dependent	All set-ups	FALSE	-2	Uint16
16-38	SL controller state	0	All set-ups	FALSE	0	Uint8
16-39	Controlcard temp.	0 °C	All set-ups	FALSE	100	Uint8
16-5* Ref. & feedb.						
16-50	External reference	0.0	All set-ups	FALSE	-1	Int16
16-51	Pulse reference	0.0	All set-ups	FALSE	-1	Uint32
16-52	Feedback [Unit]	0.000	All set-ups	FALSE	-3	Int32
16-6* Inputs & outputs						
16-60	Digital input	0	All set-ups	FALSE	0	Uint16
16-61	Terminal 53 switch setting	[0] Current	All set-ups	FALSE	-	Uint8
16-62	Analog input 53	0.000	All set-ups	FALSE	-3	Int32
16-63	Terminal 54 switch setting	[0] Current	All set-ups	FALSE	-	Uint8
16-64	Analog input 54	0.000	All set-ups	FALSE	-3	Int32
16-65	Analog output 42 [mA]	0.000	All set-ups	FALSE	-3	Int16
16-66	Digital output [bin]	0	All set-ups	FALSE	0	Int16
16-67	Freq. input #29 [Hz]	0	All set-ups	FALSE	0	Int32
16-68	Freq. input #33 [Hz]	0	All set-ups	FALSE	0	Int32
16-69	Pulse output #27 [Hz]	0	All set-ups	FALSE	0	Int32
16-70	Pulse output #29 [Hz]	0	All set-ups	FALSE	0	Int32
16-8* Fieldbus & FC port						
16-80	Fieldbus CTW 1	0	All set-ups	FALSE	0	V2
16-82	Fieldbus REF 1	0	All set-ups	FALSE	0	N2
16-84	Comm. option STW	0	All set-ups	FALSE	0	V2
16-85	FC port CTW 1	0	All set-ups	FALSE	0	V2
16-86	FC port REF 1	0	All set-ups	FALSE	0	N2
16-9* Diagnosis Readout						
16-90	Alarm word	0	All set-ups	FALSE	0	Uint32
16-92	Warning word	0	All-setups	FALSE	0	Uint32
16-94	Extended status word	0	All-setups	FALSE	0	Uint32

∗ default setting **( )** display text **[ ]** value for use in communication via serial communication port

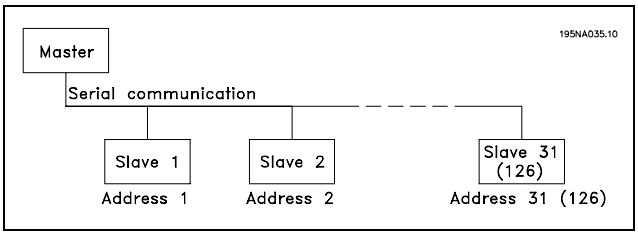
□ 17-** Motor Feedb.Option

Par. No. #	Parameter description	Default value	4-set-up	FC 302 only	Change during operation	Conversion index	Type
17-1* Inc. Enc. Interface							
17-10	Signal Type	[1] TTL (5V, RS422)	All set-ups		FALSE	-	Uint8
17-11	Resolution (PPR)	1024 N/A	All set-ups		FALSE	0	Uint16
17-2* Abs. Enc. Interface							
17-20	Protocol Selection	[0] None	All set-ups		FALSE	-	Uint8
17-21	Resolution (Positions/Rev)	[32768] 32768	All set-ups		FALSE	-	Uint16
17-34	HIPERFACE Baud rate	[4] 9600	All set-ups		FALSE	-	Uint8
17-6* Monitoring and App.							
17-60	Encoder Positive Direction	[0] Clockwise	All set-ups		FALSE	-	Uint8

□ Serial communication via RS 485 Interface

□ Protocols

Master-slave communication.



□ Telegram Traffic

Control and response telegrams

The master controls telegram traffic in a master-slave system. You can connect a maximum of 31 slaves to a master unless you use repeaters. If so, you can connect a maximum of 126 slaves to a master.

The master constantly sends telegrams addressed to the slaves and waits for their response telegrams. The slave response time is maximum 50 ms.

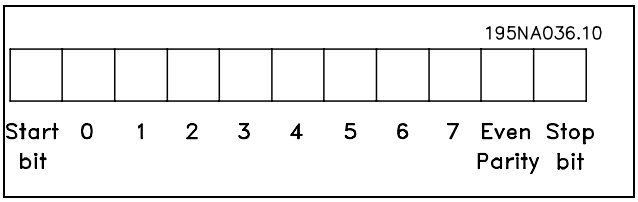
A slave can only send a response telegram if it has received an error-free telegram addressed to itself.

Broadcast

A master can send the same telegram simultaneously to all slaves connected to the bus. During this broadcast communication, the slave does not send any response telegrams to the master on whether the telegram is correctly received. Broadcast communication is set up in address format (ADR), see *Telegram structure*.

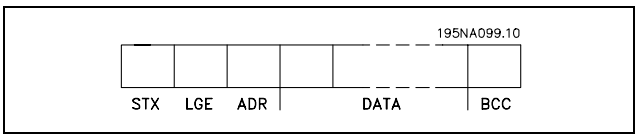
Content of a character (byte)

Each character transferred begins with a start bit. Then 8 data bits are transferred, corresponding to a byte. Each character is secured via a parity bit, which is set to "1" when it reaches parity (i.e. when there is an equal number of 1's in the 8 data bits and the parity bit in total). A character is completed by a stop bit, thus consisting of 11 bits in all.



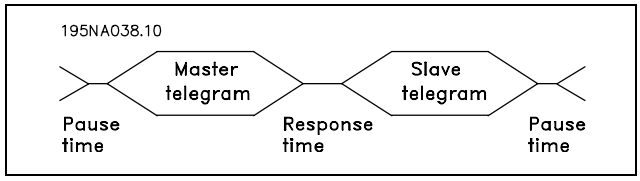
□ Telegram Structure

Each telegram begins with a start character (STX) = 02 Hex, followed by a byte denoting the telegram length (LGE) and a byte denoting the adjustable frequency drive address (ADR). A number of data bytes (variable, depending on the type of telegram) follow. The telegram is completed by a data control byte (BCC).



Telegram timing

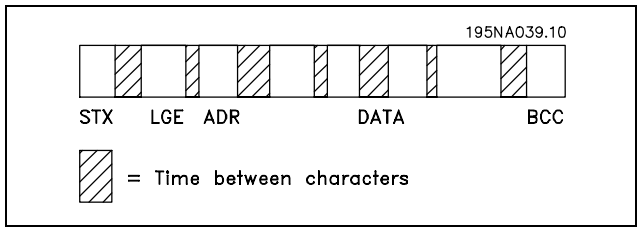
The communication speed between a master and a slave depends on the baud rate. The adjustable frequency drive's baud rate must be the same as the master's baud rate (selected in par. 8-32 *FC Port Baud Rate*).



After a response telegram from the slave, make sure there is a pause of at least 2 characters (22 bits) before the master sends a new telegram. At a baud rate of 9600 baud, make sure there is a pause of at least 2.3 ms. When the master has completed the telegram, the slave's response time to the master is maximum of 20 ms. There is a pause of at least 2 characters.

- Pause time, min: 2 characters
- Response time, min: 2 characters
- Response time, max: 20 ms

The time between the individual characters in a telegram may not exceed 2 characters, and the telegram must be completed within 1.5 x nominal telegram time. At a baud rate of 9600 baud and a telegram length of 16 bytes, the telegram is completed after 27.5 ms.



Telegram length (LGE)

The telegram length is the number of data bytes plus the address byte ADR and the data control byte BCC.

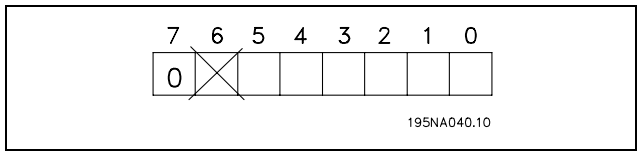
The length of telegrams with 4 data bytes is: LGE = 4 + 1 + 1 = 6 bytes
The length of telegrams with 12 data bytes is: LGE = 12 + 1 + 1 = 14 bytes
The length of telegrams containing texts is 10+n bytes. 10 represents the fixed characters, while the "n" is variable (depending on the length of the text).

Adjustable frequency drive address (ADR)

Two different address formats are used. The adjustable frequency drive's address range is either 1-31 or 1-126.

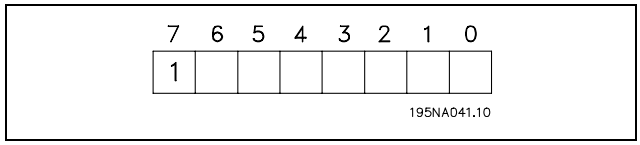
1. Address format 1-31

The byte for address range 1-31 has the shown profile:
Bit 7 = 0 (address format 1-31 active)
Bit 6 is not used
Bit 5 = 1: Broadcast, address bits (0-4) are not used
Bit 5 = 0: No Broadcast
Bit 0-4 = Adjustable frequency drive address 1-31



2. Address format 1-126

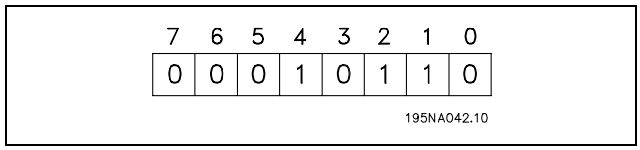
The byte for address range 1 - 126 has the shown profile:
Bit 7 = 1 (address format 1-126 active)
Bit 0-6 = Adjustable frequency drive address 1-126
Bit 0-6 = 0 Broadcast



The slave returns the address byte unchanged to the master in the response telegram.

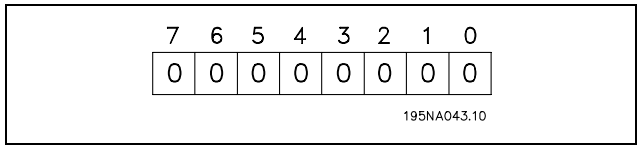
Example:

Writing to adjustable frequency drive address 22 (16H) with address format 1-31:



Data control byte (BCC)

The data control byte is explained in this example:
Before the first byte in the telegram is received, the Calculated CheckSum (BCS) is 0.



When the first byte (02H) is received:

BCS = BCC EXOR "first byte"
(EXOR = exclusive-or)

BCS	= 0 0 0 0 0 0 0 0 (00 H)
	EXOR
1. byte	= 0 0 0 0 0 0 1 0 (02H)
BCC	= 0 0 0 0 0 0 1 0 (02H)

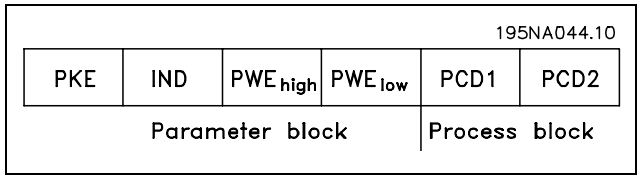
Each subsequent byte gates with BCS EXOR and produces a new BCC, e.g.:

BCS	= 0 0 0 0 0 0 1 0 (02H)
	EXOR
2nd byte	= 1 1 0 1 0 1 1 0 (D6H)
BCC	= 1 1 0 1 0 1 0 0 (D4H)

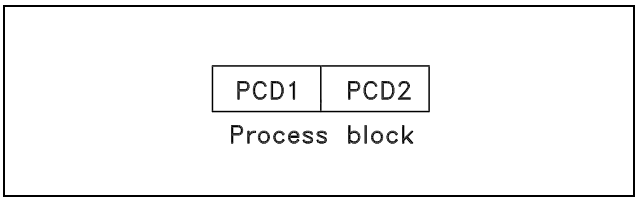
□ **Data Character (byte)**

The structure of data blocks depends on the type of telegram. There are three telegram types, and the type applies for both control telegrams (master=>slave) and response telegrams (slave=>master). The three types of telegram are:

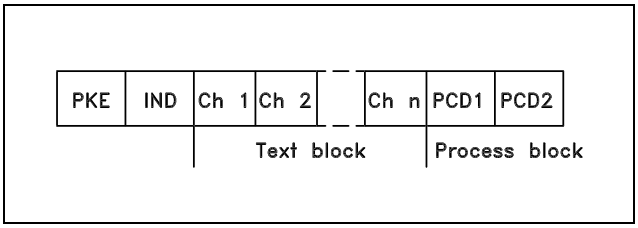
Parameter block: Used to transfer parameters between master and slave. The data block is made up of 12 bytes (6 words) and also contains the process block.



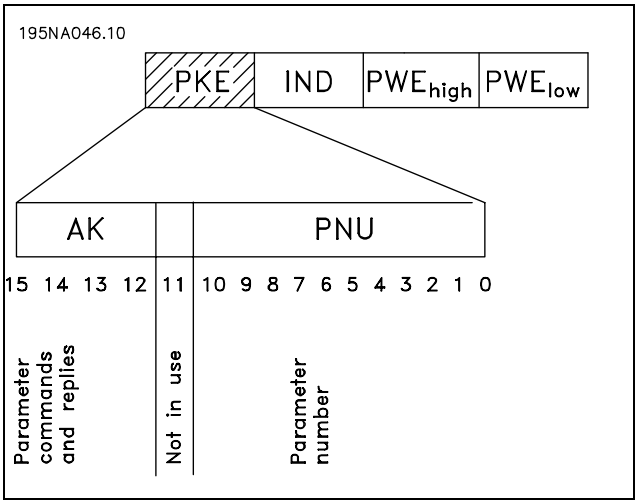
Process block: Made up of a data block of four bytes (2 words) and contains:
- Control word and reference value (from master to slave)
- Status word and present output frequency (from slave to master)



Text block is used to read or write texts via the data block.



Parameter commands and responses (AK)



Bits no. 12-15 transfers parameter commands from master to slave and returns processed slave responses to the master.

Parameter commands master=>slave				
Bit no.				Parameter command
15	14	13	12	
0	0	0	0	No command
0	0	0	1	Read parameter value
0	0	1	0	Write parameter value in RAM (word)
0	0	1	1	Write parameter value in RAM (double word)
1	1	0	1	Write parameter value in RAM and EEprom (double word)
1	1	1	0	Write parameter value in RAM and EEprom (word)
1	1	1	1	Read/write text

Response slave=>master				
Bit no.				Response
15	14	13	12	
0	0	0	0	No response
0	0	0	1	Parameter value transferred (word)
0	0	1	0	Parameter value transferred (double word)
0	1	1	1	Command cannot be performed
1	1	1	1	Text transferred

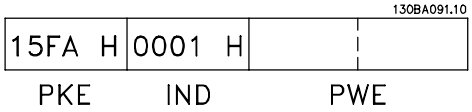
If the command cannot be performed, the slave sends this response: 0111 *Command cannot be performed* and issues the following fault report in the parameter value (PWE):

Response (0111)	Fault Report
0	The parameter number used does not exist
1	There is no write access to the defined parameter
2	Data value exceeds the parameter's limits
3	The sub index used does not exist
4	The parameter is not the array type
5	The data type does not match the defined parameter
17	Data change in the defined parameter is not possible in the adjustable frequency drive's present mode. Certain parameters can only be changed when the motor is turned off
130	There is no bus access to the defined parameter
131	Data change is not possible because factory Setup is selected

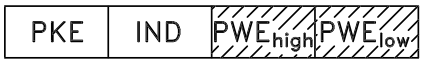
Parameter number (PNU)
Bits no. 0-10 transfers parameter numbers. The relevant parameter's function is defined in the parameter description in the chapter *How to Program*.

Index
Index is used together with the parameter number to read/write-access parameters with an index, e.g. par. 15-30 *Error code*. The index consists of 2 bytes - one lowbyte and one highbyte. Only the lowbyte is used as an index.

Example - Index:
The first error code (index [1]) in par. 15-30 *Error Code* must be read.
PKE = 15 FA Hex (read par. 15-30 *Error Code*.)
IND = 0001 Hex - Index no. 1.
The adjustable frequency drive responds in the parameter value block (PWE) with a fault code value from 1 - 99. See *Summary of Warnings and Alarms* to identify the fault code.



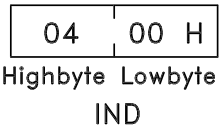
Parameter value (PWE)
The parameter value block consists of 2 words (4 bytes), and the value depends on the defined command (AK). If the master prompts for a parameter value, the PWE block does not contain a value.



If you want the master to change a parameter value (write), the new value is written in the PWE block and sent to the slave.
If the slave responds to a parameter request (read command), the present parameter value in the PWE block is transferred and returned to the master.
If a parameter contains not a numerical value but several data options, e.g. par. -001 *Language* where [0] corresponds to *English*, and [4] corresponds to *Danish*, select the data value by entering the value in the PWE block. See *Example - Selecting a data value*.

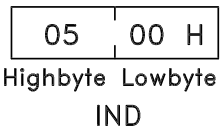
Via serial communication, it is only possible to read parameters that have data type 9 (text string). Par. 15-40 to 15-33 *Drive Identification* is data type 9. For example, you can read the unit size and mains voltage range in par. 15-40 *FC Type*.
When a text string is transferred (read), the length of the telegram is variable, and the texts are of different lengths. The telegram length is defined in the telegram's second byte, known as LGE.
To read a text via the PWE block, set the parameter command (AK) to "F" Hex.

The index character indicates if the command is read or write. In a read command, the index must have the shown format:



How to Program

Some adjustable frequency drives have parameters in which you can write a text. To write a text via the PWE block, set the parameter command (AK) to "F" Hex. For a write command, the text must have the shown format:



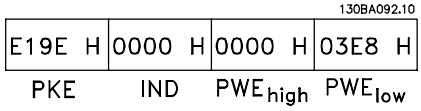
Data types supported by adjustable frequency drive:

Unsigned means that there is no operational sign in the telegram.

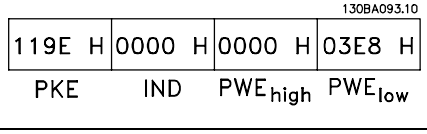
Data types	Description
3	Integer 16
4	Integer 32
5	Unsigned 8
6	Unsigned 16
7	Unsigned 32
9	Text string
10	Byte string
13	Time difference
33	Reserved
35	Bit sequence

Example - Write a parameter value:
Change par. 4-14 *Motor Speed High Limit* to 100 Hz. After a mains failure, recall the value to write it in EEPROM.

PKE = E19E Hex - Write for par. 4-14 *Motor Speed High Limit*
IND = 0000 Hex
PWE_{HIGH} = 0000 Hex
PWE_{LOW} = 03E8 Hex - Data value 1000, corresponding to 100 Hz, see conversion.

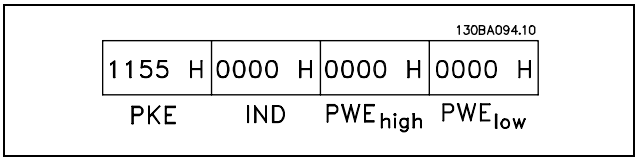


The response from the slave to the master will be:

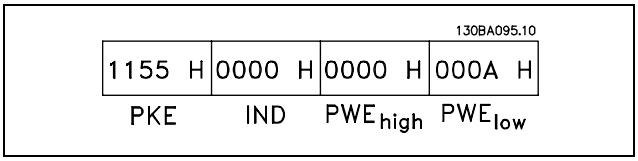


Example - Reading a parameter value:
Requires a value in par. 3-41 *Ramp 1 Up Time*.
The master sends the following request:

PKE = 1155 Hex - read par. 3-41 *Ramp 1 Up Time*
IND = 0000 Hex
PWE_{HIGH} = 0000 Hex
PWE_{LOW} = 0000 Hex



If the value in par. 3-41 *Ramp 1 Up Time* is 10 s, the response from the slave to the master is:

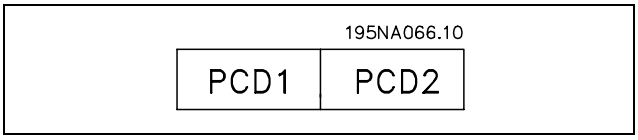


Conversion:
The various attributes of each parameter are displayed in section *Factory Settings*. A parameter value is only transferred as a whole number. Thus, use a conversion factor to transfer decimals.

Example:
Par. 4-12 *Motor Speed, Low Limit* has a conversion factor of 0.1. If you wish to preset the minimum frequency to 10 Hz, transfer the value 100. A conversion factor of 0.1 means that the value transferred is multiplied by 0.1. The value 100 is thus perceived as 10.0.

Conversion table	
Conversion index	Conversion factor
74	0.1
2	100
1	10
0	1
-1	0.1
-2	0.01
-3	0.001
-4	0.0001
-5	0.00001

□ **Process Words**
The block of process words is divided into two blocks of 16 bits, which always occur in the defined sequence.



	PCD 1	PCD 2
Control telegram (master=>slave)	Control word	Reference value
Control telegram (slave=>master)	Status word	Present outp. frequency

□ **Control Word According to FC Profile (CTW)**
To select the FC protocol in the control word, set par. 8-10 control word profile to FC protocol [0]. The control sends commands from a master (PLC or PC) to a slave (adj. frequency drive).

Master => slave				
1	2	3	.....	10
CTW	MRV	PCD	.....	PCD
		PCD read/write		

Explanation of the Control Bits

Bit	Bit value = 0	Bit value = 1
00	Reference value	external selection lsb
01	Reference value	external selection msb
02	DC brake	Ramp
03	Coasting	No coasting
04	Quick stop	Ramp
05	Freeze output	use ramp
06	Ramp stop	Start
07	No function	Reset
08	No function	Jog
09	Ramp 1	Ramp 2
10	Data not valid	Data valid
11	Relay 01 open	Relay 01 active
12	Relay 02 open (FC 302 only)	Relay 02 active (FC 302 only)
13	Parameter set-up	selection lsb
14	Parameter set-up	selection msb
15	No function	Reverse

Bits 00/01

Use bits 00 and 01 to choose between the four reference values, which are pre-programmed in par. 3-10 *Preset Reference* according to the shown table:

Programmed ref. value	Par.	Bit 01	Bit 00
1	3-10 [0]	0	0
2	3-10 [1]	0	1
3	3-10 [2]	1	0
4	3-10 [3]	1	1

NOTE
Make a selection in par. 8-56 *Preset Reference Select* to define how bit 00/01 gates with the corresponding function on the digital inputs.

Bit 02, DC brake:
Bit 02 = '0': DC braking and stop. Set braking current and duration in par. 2-01 *DC Brake Current* and 2-02 *DC Braking Time*. Bit 02 = '1' leads to ramping.

Bit 03, Coasting:
Bit 03 = '0': The adjustable frequency drive immediately "lets go" of the motor, (the output transistors are "shut off") and it coasts to a standstill. Bit 03 = '1': The adjustable frequency drive starts the motor if the other starting conditions are met.

NOTE
Make a selection in par. 8-50 *Coasting Select* to define how Bit 03 gates with the corresponding function on a digital input.

Bit 04, Quick stop:
Bit 04 = '0': Makes the motor speed ramp down to stop (set in par. 3-81 *Quick Stop Ramp Time*).

Bit 05, Freeze output frequency:
Bit 05 = '0': The present output frequency (in Hz) freezes. Change the frozen output frequency only by means of the digital inputs (par. 5-10 to 5-15) programmed to speed up and slow down.

NOTE
If freeze output is active, the adjustable frequency drive can only be stopped by the following:

- Bit 03 Coasting stop
- Bit 02 DC braking
- Digital input (par. 5-10 to 5-15) programmed to DC braking, coasting stop, or reset and coasting stop.

Bit 06, Ramp stop/start:
Bit 06 = '0': Causes a stop and makes the motor speed ramp down to stop via the selected ramp down par.
Bit 06 = '1': Permits the adjustable frequency drive to start the motor, if the other starting conditions are met.

NOTE
Make a selection in par. 8-53 *Start Select* to define how bit 06 ramp stop/start gates with the corresponding function on a digital input.

Bit 07, Reset: Bit 07 = '0': No reset. Bit 07 = '1': Resets a trip. Reset is activated on the leading edge of the signal, i.e., when changing from logic '0' to logic '1'.

Bit 08, Jog:
Bit 08 = '1': The output frequency is determined by par. 3-19 *Jog Speed*.

Bit 09, Selection of ramp 1/2:
Bit 09 = "0": Ramp 1 is active (par. 3-40 to 3-47). Bit 09 = "1": Ramp 2 (par. 3-50 to 3-57) is active.

Bit 10, Data not valid/Data valid:
Tell the adjustable frequency drive whether to use or ignore the control word. Bit 10 = '0': The control word is ignored. Bit 10 = '1': The control word is used. This function is relevant because the telegram always contains the control word, regardless of the telegram type. Thus, you can turn off the control word if you do not want to use it when updating or reading parameters.

Bit 11, Relay 01:
Bit 11 = "0": Relay not activated. Bit 11 = "1": Relay 01 activated provided that control word bit 11 is chosen in par. 5-40.

Bit 12, Relay 02 (FC 302 only):
Bit 12 = "0": Relay 2is not activated. Bit 12 = "1": Relay 02 is activated provided that control word bit 12 is chosen in par. 5-40.

Bit 13/14, Selection of set-up:

Use bits 13 and 14 to choose from the four menu set-ups according to the shown table. The function is only possible when Multi setup is selected in par. 0-10 *Active Set-Up*.

Set-up	Bit 14	Bit 13
1	0	0
2	0	1
3	1	0
4	1	1

NOTE
Make a selection in par. 8-55 *Set-up select* to define how bit 13/14 gates with the corresponding function on the digital inputs.

Bit 15 Reverse:
Bit 15 = '0': No reversing. Bit 15 = '1': Reversing. In the default setting, reversing is set to digital in par. 8-54 *Reversing Select*. Bit 15 causes reversing only when ser. communication, 'Logic or' or 'Logic and' is selected.

□ **Status Word According to FC Profile (STW)**
The status word informs the master (e.g., a PC) of the slave (adj. frequency drive) operation mode.

Slave => master				
1	2	3	.....	10
STW	MAV	PCD	.....	PCD
		PCD read/write		

Explanation of the Status Bits

Bit	Bit value = 0	Bit value = 1
00	Control not ready	Control ready
01	Drive not ready	Drive ready
02	Coasting	Enable
03	No error	Trip
04	Reserved	-
05	Reserved	-
06	No error	Triplock
07	No warning	Warning
08	Speed ≠ reference	Speed = reference
09	Local operation	Bus control
10	Out of frequency limit	Frequency limit OK
11	No operation	In operation
12	Drive OK	True if brake Warning/Failure
13	Voltage OK	Voltage exceeded
14	Torque OK	Torque exceeded
15	Timer OK	Timer exceeded

Bit 00, Control not ready/ready:
Bit 00 = '0': The adj. frequency drive trips. Bit 00 = '1': The adjustable frequency drive controls are ready but the power component does not necessarily receive any power supply (in case of external 24 V supply to controls).

Bit 01, Drive ready:
Bit 01 = '1': The adjustable frequency drive is ready for operation but the coasting command is active via the digital inputs or via serial communication.

Bit 02, Coasting stop:
Bit 02 = '0': The adjustable frequency drive releases the motor. Bit 02 = '1': The adjustable frequency drive starts the motor with a start command.

Bit 03, No error/trip:
Bit 03 ='0' : The adjustable frequency drive is not in fault mode. Bit 03 = '1': The adj. frequency drive trips. To re-establish operation, enter [Reset].

Bit 04, No error/error (no trip):
Bit 04 = '0': The adjustable frequency drive is not in fault mode. Bit 04 = "1": The adjustable frequency drive shows an error but does not trip.

Bit 05, Not used:
Bit 05 is not used in the status word.

Bit 06, No error / triplock:
Bit 06 = '0': The adjustable frequency drive is not in fault mode. Bit 06 = "1": The adjustable frequency drive is tripped and locked.

Bit 07, No warning/warning:
Bit 07 = '0': There are no warnings. Bit 07 = '1': A warning has been issued.

Bit 08, Speed≠ reference/speed = reference:
Bit 08 = '0': The motor is running but the present speed is different from the preset speed reference. It might, e.g., be the case when the speed ramps up/down during start/stop. Bit 08 = '1': The motor speed matches the preset speed reference.

Bit 09, Local operation/bus control:
Bit 09 = '0': [STOP/RESET] is activated on the control unit or local control in par. 3-13 *Reference Site* is selected. You cannot control the adjustable frequency drive via serial communication. Bit 09 = '1' It is possible to control the adjustable frequency drive via serial communication or the serial communication bus.

Bit 10, Out of frequency limit:
Bit 10 = '0': The output frequency has reached the value in par. 4-11 *Motor Speed Low Limit* or par. 4-13 *Motor Speed High Limit*. Bit 10 = "1": The output frequency is within the defined limits.

Bit 11, No operation/in operation:
Bit 11 = '0': The motor is not running. Bit 11 = '1': The adjustable frequency drive has a start signal or the output frequency is greater than 0 Hz.

Bit 12, Drive OK/stopped, autostart:
Bit 12 = '0': There is no temporary overtemperature on the inverter. Bit 12 = '1': The inverter stops because of overtemperature but the unit does not trip and will resume operation once the overtemperature stops.

Bit 13, Voltage OK/limit exceeded:
Bit 13 = '0': There are no voltage warnings. Bit 13 = '1': The DC voltage in the intermediate circuit of the adjustable frequency drive is too low or too high.

Bit 14, Torque OK/limit exceeded:
Bit 14 = '0': The motor current is lower than the torque limit selected in par. 4-18 *Current Limit*.
Bit 14 = '1': The torque limit in par. 4-18 *Current Limit* is exceeded.

Bit 15, Timer OK/limit exceeded:
Bit 15 = '0': The timers for motor thermal protection and VLT thermal protection are not exceeded 100%. Bit 15 = '1': One of the timers exceeds 100%.

□ Control Word according to PROFIdrive Profile (CTW)

The control word is used to send commands from a master (e.g., a PC) to a slave.

Master => slave				
1	2	3	.....	10
CTW	MRV	PCD	.....	PCD
		PCD read/write		

Explanation of the Control Bits

Bit	Bit value = 0	Bit value = 1
00	OFF 1	ON 1
01	OFF 2	ON 2
02	OFF 3	ON 3
03	Coasting	No coasting
04	Quick stop	Ramp
05	Hold frequency output.	Use ramp
06	Ramp stop	Start
07	No function	Reset
08	Jog 1 OFF	Jog 1 ON
09	Jog 2 OFF	Jog 2 ON
10	Data invalid	Data valid
11	No function	Slow-down
12	No function	Catch up
13	Parameter set-up 1	Selection lsb
14	Parameter set-up 2	Selection msb
15	No function	Reverse

Bit 00, OFF 1/ON 1:
Normal ramp stop uses the ramp times of the currently selected ramp. Bit 00 = "0": Stops and activates the output relay 1 or 2, if the output frequency is 0 Hz and if Relay 123 is selected in par. 5-40. Bit 00 = "1": The adjustable frequency drive starts if the other start conditions are met.

Bit 01, OFF 2/ON 2
Bit 01 = "0": Coasting stop and activation of the output relay 1 or 2 occurs if the output frequency is 0 Hz and if relay 123 is selected in par. 5-40. Bit 01 = "1": The adjustable frequency drive starts if the other start conditions are met.

Bit 02, OFF 3/ON 3
A quick stop uses the ramp time of par. 2-12. Bit 02 = "0": A quick stop and activation of the output relay 1 or 2 occurs if the output frequency is 0 Hz and if relay 123 is selected in par. 5-40. Bit 02 = "1": The adjustable frequency drive starts if the other start conditions are met.

Bit 03, Coasting/No coasting
Bit 03 = "0": Leads to a stop. Bit 03 = "1": The adjustable frequency drive starts if the other start conditions are met.

NOTE
The selection in par. 8-50 *Coasting Select* determines how bit 03 links with the corresponding function of the digital inputs.

Bit 04, Quick stop/Ramp
Quick stop uses the ramp time of par. 3-81. Bit 04 = "0": A quick stop occurs. Bit 04 = "1": The adjustable frequency drive starts if the other start conditions are met.

NOTE
The selection in par. 5-51 *Quick Stop Select* determines how bit 04 links with the corresponding function of the digital inputs.

Bit 05, Hold frequency output/Use ramp
Bit 05 = "0": Maintains the current output frequency even if the reference value is modified. Bit 05 = "1": The adjustable frequency drive performs its regulating function again. Operation occurs according to the respective reference value.

Bit 06, Ramp stop/Start
Normal ramp stop uses the selected ramp times of the current ramp. In addition, activation of the output relay 01 or 04 if the output frequency is 0 Hz if relay 123 is selected in par. 5-40. Bit 06 = "0": Leads to a stop. Bit 06 = "1": The adjustable frequency drive starts if the other start conditions are met.

NOTE
The selection in par. 8-53 determines how bit 06 links with the corresponding function of the digital inputs.

Bit 07, No function/Reset
Reset after switching off. Acknowledges event in fault buffer. Bit 07 = "0": No reset occurs. A reset occurs after switching off, when there is a slope change of bit 07 to "1".

Bit 08, Jog 1 OFF/ON
Activation of the pre-programmed speed in par. 8-90 *Bus Jog 1 Speed*. Jog 1 is only possible if bit 04 = "0" and bit 00 - 03 = "1".

Bit 09, Jog 2 OFF/ON
Activation of the pre-programmed speed in par. 8-91 *Bus Jog 2 Speed*. Jog 2 is only possible if bit 04 = "0" and bit 00 - 03 = "1". If both Jog 1 and Jog 2 are activated (bit 08 and 09 = "1"), Jog 3 is selected. Thus, the speed (set in par. 8-92) is used.

Bit 10, Data invalid/valid
Notifies the adjustable frequency drive if the process data channel (PCD) should respond to modifications by the master (bit 10 = 1) or not.

Bit 11, No function/Slow-down
Reduces the speed reference value by the amount given in par. 3-12 *Catch up/Slow-down Value*. Bit 11 = "0": The reference value is not modified. Bit 11 = "1": The reference value is reduced.

Bit 12, No function/Catch up
Increases the speed reference value by the amount given in par. 3-12 *Catch up/Slow-down Value*. Bit 12 = "0": The reference value is not modified. Bit 12 = "1": The reference value is increased. If both slowing down and accelerating are activated (bit 11 and 12 = "1"), slowing down has priority. Thus, the speed reference value is reduced.

Bits 13/14, Set-up selection

Choose between the four parameter set-ups via bits 13 and 14 according to the shown table: The function is only possible if you choose multi setup in par. 0-10. The selection in par. 8-55 *Set-up Select* determines how bits 13 and 14 links with the corresponding function of the digital inputs. When the motor is running, you can only change the set-up if it is linked.

Set-up	Bit 13	Bit 14
1	0	0
2	1	0
3	0	1
4	1	1

Bit 15, No function/Reverse

Reversion of the motor rotational direction. Bit 15 = "0": No reversion. Bit 15 = "1": Reversion. The reversion in the default setting in par. 8-54 *Reverse Select* is "Logic OR". Bit 15 causes a reversion only when "Bus", "Logic OR", or "Logic AND" is selected ("Logic AND" only in connection with terminal 9, however).

NOTE

Unless otherwise indicated, the control word bit links with the corresponding digital input function as a logic "OR".

□ Status Word According to PROFIdrive Profile (STW)

The Status word is used to notify a master (e.g. a PC) about the status of a slave.

Slave => master				
1	2	3	.....	10
STW	MAV	PCD	.....	PCD
		PCD read/write		

Explanation of the Status Bits

Bit	Bit value = 0	Bit value = 1
00	Control not ready	Control ready
01	Drive not ready	Drive ready
02	Coasting	Enable
03	No error	Trip
04	OFF 2	ON 2
05	OFF 3	ON 3
06	Start possible	Start not possible
07	No warning	Warning
08	Speed ≠ reference	Speed = reference
09	Local operation	Bus control
10	Out of frequency limit	Frequency limit
11	No operation	In operation
12	Drive OK	Stopped, autostart
13	Voltage OK	Voltage exceeded
14	Torque OK	Torque exceeded
15	Timer OK	Timer exceeded

Bit 00, Control not ready/ready
Bit 00 = "0": Bit 00, 01, or 02 of the Control word is "0" (OFF 1, OFF 2 or OFF 3) - or the adjustable frequency drive switches off (trips). Bit 00 = "1": The adjustable frequency drive control is ready but there is not necessarily a power supply (in the event of external 24 V supply of the control system).

Bit 01, VLT not ready/ready
Same significance as bit 00 but with power unit supply. The adjustable frequency drive is ready when it receives the necessary start signals.

Bit 02, Coasting/Enable
Bit 02 = "0": Bit 00, 01, or 02 of the Control word is "0" (OFF 1, OFF 2, or OFF 3 or coasting) - or the adjustable frequency drive switches off (trips). Bit 02 = "1": Bit 00, 01, or 02 of the Control word is "1" - the adjustable frequency drive does not trip.

Bit 03, No error/Trip
Bit 03 = "0": No error in the adjustable frequency drive. Bit 03 = "1": The adjustable frequency drive trips and requires. Press [Reset] to restart.

Bit 04, ON 2/OFF 2
Bit 04 = "0": Bit 01 of the Control word is "0". Bit 04 = "1": Bit 01 of the Control word is "1".

Bit 05, ON 3/OFF 3
Bit 05 = "0": Bit 02 of the Control word is "0". Bit 05 = "1": Bit 02 of the Control word is "1".

Bit 06, Start possible/Start not possible
Bit 06 is always "0" if you select FC Drive in par. 8-10. If you select PROFIdrive in par. 8-10, bit 06 is "1" after a switch-off acknowledgement, after activation of OFF2 or OFF3, and after switching on mains voltage. Start is not possible. The adjustable frequency drive is reset with bit 00 of the Control word set to "0" and bit 01, 02, and 10 set to "1".

Bit 07, No warning/Warning
Bit 07 = "0": No unusual situation. Bit 07 = "1": There is an unusual status in the adjustable frequency drive. For more information about warnings - see the *FC 300 Profibus Operating Instructions*.

Bit 08, Speed ≠ reference / Speed = reference:
Bit 08 = "0": The motor speed deviates from the set speed reference value. This occurs e.g. when the speed is changed during start/stop through ramp-up/down. Bit 08 = "1": The motor speed corresponds to the set speed reference value.

Bit 09, Local operation/Bus control
Bit 09 = "0": Indicates that the adjustable frequency drive is stopped via [Stop] or that Local is selected in par. 0-02. Bit 09 = "1": The adjustable frequency drive is controlled through the serial interface.

Bit 10, Out of frequency limit/Frequency limit OK
Bit 10 = "0": The output frequency is outside the limits set in par. 4-11 and par. 4-13 (Warnings: Motor speed low or high limit). Bit 10 = "1": The output frequency is within the indicated limits.

Bit 11, No operation/Operation
Bit 11 = "0": The motor is not running. Bit 11 = "1": A start signal is active or the output frequency is higher than 0 Hz.

Bit 12, Drive OK/Stopped, autostart
Bit 12 = "0": No temporary overloading of the inverter. Bit 12 = "1": The inverter stops due to overload. However, the adjustable frequency drive is not switched off (tripped) and will restart after the overloading stops.

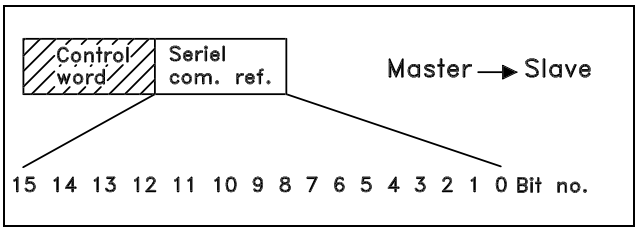
Bit 13, Voltage OK/Voltage exceeded
Bit 13 = "0": The adjustable frequency drive voltage limits are not exceeded. Bit 13 = "1": The direct voltage in the drive intermediate circuit is too low or too high.

Bit 14, Torque OK/Torque exceeded
Bit 14 = "0": The motor current is below the moment limit selected in par. 4-18. Bit 14 = "1": The torque limit selected in par. 4-18 is exceeded.

Bit 15, Timer OK/Timer exceeded
Bit 15 = "0": The timers for the thermal motor protection and adjustable frequency drive thermal protection have not exceeded 100%. Bit 15 = "1": One of the timers has exceeded 100%.

□ **Serial Communication Reference**

The serial communication reference is transferred to the adjustable frequency drive as a 16-bit word. The value is transferred in whole numbers 0 - ±32767 (±200%).
16384 (4000 Hex) corresponds to 100%.

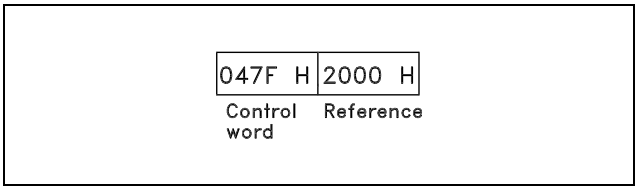


The serial communication reference has the following format: 0-16384 (4000 Hex) ≅ 0-100% (par. 3-02 *Minimum Ref.* to par. 3-03*Maximum Ref.*).

It is possible to change the direction of rotation via the serial reference. This is done by converting the binary reference value to 2' complement. See example.

Example - Control word and serial communication ref.:

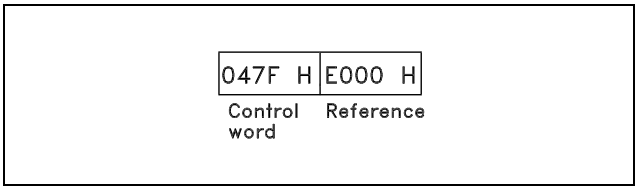
The adjustable frequency drive receives a start command and the reference is set to 50% (2000 Hex) of the reference range.
Control word = 047F Hex => Start command.
Reference = 2000 Hex => 50% reference.



The adjustable frequency drive receives a start command and the reference is set to -50% (-2000 Hex) of the reference range.
The reference value is first converted to 1' complement, and then 1 is added in binary fashion to obtain 2' complement:

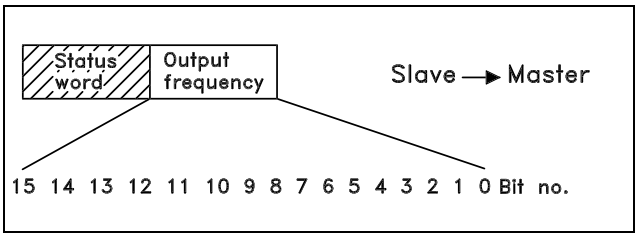
2000 Hex	0010 0000 0000 0000 0000
1' complement	1101 1111 1111 1111 1111
	+ 1
2' complement	1110 0000 0000 0000 0000

Control word = 047F Hex => Start command.
Reference = E000 Hex => -50% reference.



□ **Present Output Frequency**

The value of the adjustable frequency drive's present output frequency is transferred as a 16-bit word. The value is transferred as whole numbers 0 - ±32767 (±200%).
16384 (4000 Hex) corresponds to 100%.

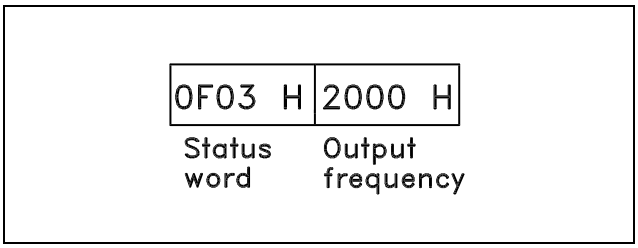


Output frequency has this format:
0-16384 (4000 Hex) ≅ 0-100% (Par. 4-12 *Motor Speed Low Limit* - par. 4-14 *Motor Speed High Limit*).

Example - Status word and current output frequency:

The adjustable frequency drive informs the master that the current output frequency is 50% of the output frequency range.
Par. 4-12*Motor speed low limit* = 0 Hz
Par. 4-14*Motor speed high limit* = 50 Hz

Status word = 0F03 Hex.
Output frequency= 2000 Hex => 50% of the frequency range, corresponding to 25 Hz.



□ **Example 1: For Controlling the Drive and Reading Parameters**

This telegram reads par. 16-14 *Motor Current*.

Telegram to the adjustable frequency drive:

stx	lge	adr	pke	ind	pwe, high	pwe, low	pcd 1	pcd 2	bcc
02	0E	01	6 4E	00 00	00 00	00 00	00 00	00 00	45

All numbers are in hex format.

The response from the adjustable frequency drive corresponds to the command above but *pwe,high* and *pwe,low* contain the actual value of par. 16-14 multiplied by 100. If the actual output current is 5.24 A, the value from the adjustable frequency drive is 524.

Response from the adjustable frequency drive:

stx	lge	adr	pke	ind	pwe, high	pwe, low	pcd 1	pcd 2	bcc
02	0E	01	6 4E	00 00	00 00	02 0C	06 07	00 00	4A

All numbers are in hex format.

Pcd 1 and *pcd 2* from example 2 can be used and added to the example. Thus, it is possible to control the drive and read the current at the same time.

□ **Example 2: Only for Controlling the Drive**

This telegram sets the control word to 047C Hex (Start command) with a speed reference of 2000 Hex (50%).

NOTE

Par. 8-10 is set to FC Profile.

Telegram to the adjustable frequency drive:
All numbers are in hex format.

stx	lge	adr	pcd 1	pcd 2	bcc
02	06	04	04 7C	20 00	58

The adjustable frequency drive supplies information about the drive status after receiving the command. By resending the command, the *pcd1* changes to a new status.

Response from the adjustable frequency drive:

All numbers are in hex format.

stx	lge	adr	pcd 1	pcd 2	bcc
02	06	04	06 07	00 00	01

□ **Read Parameter Description Elements**

Read the characteristics of a parameter (e.g. *Name, Default value, conversion,* etc.) with *Read Parameter Description Elements*.

The table shows the available parameter description elements:

Index	Description
1	Basic characteristics
2	No. of elements (array types)
4	Unit of measure
6	Name
7	Lower limit
8	Upper limit
20	Default value
21	Additional characteristics

In the following example, *Read Parameter Description Elements* is chosen on par. 0-01 *Language*, and the requested element is index 1 *Basic characteristics*.

Basis characteristics (index 1):
The Basic characteristics command is split up in two parts representing basic behavior and data type. The Basic characteristics return a 16-bit value to the master in PWE_{LOW}.
The basic behavior indicates whether e.g. text is available or the parameter is an array as single bit information in the high byte of PWE_{LOW}.
The data type part indicates if a parameter is signed 16, unsigned 32 in the low byte of PWE_{LOW}.

PWE high basic behavior:

Bit	Description
15	Active parameter
14	Array
13	Parameter value can only be reset
12	Parameter value different from factory setting
11	Text available
10	Additional text available
9	Read-only
8	Upper and lower limit not relevant
0-7	Data type

Active parameter is only active when communicating through Profibus.
Array means that the parameter is an array.
If bit 13 is true, the parameter can only be reset, not written to.
If bit 12 is true, the parameter value is different from the factory setting.
Bit 11 indicates that text is available.
Bit 10 indicates that additional text is available. E.g. par. 0-01, *Language*, contains text for index field 0, *English*, and for index field 1, *German*.
If bit 9 is true, the parameter value is read-only and cannot be changed.
If bit 8 is true, upper and lower limits of the parameter value are not relevant.

PWE$_{LOW}$ datatype

Dec.	Data type
3	Signed 16
4	Signed 32
5	Unsigned 8
6	Unsigned 16
7	Unsigned 32
9	Visible string
10	Byte string
13	Time difference
33	Reserved
35	Bit sequence

Example

In this example, the master reads the Basic characteristics of par. 0-01, *Language.* The following telegram must be sent to the adjustable frequency drive:

STX	LGE	ADR	PKE	IND	PWE$_{HIGH}$	PWE$_{LOW}$	PCD1	PCD2	BCC
02	0E	01	40 01	00 01	00 00	00 00	XX XX	XX XX	XX

STX = 02 Start byte
LGE = 0E Length of remaining telegram
ADR = Sends the adjustable frequency drive on Address 1, Danfoss format
PKE = 4001; 4 in the PKE field indicates a *Read Parameter Description* and 01 indicates par. 0-01, *Language*
IND = 0001; 1 indicates that *Basic characteristics* are required.

The response from the adjustable frequency drive is:

STX	LGE	ADR	PKE	IND	PWE$_{HIGH}$	PWE$_{LOW}$	PCD1	PCD2	BCC
02	0E	01	30 01	00 01	00 00	04 05	XX XX	XX XX	XX

STX= 02 Start byte
IND = 0001; 1 indicates that *Basic characteristics* are sent
PKE = 3001: 3 in the PKE field indicates *Parameter Description Element Transferred*, 01 indicates par. 0-01.
PWE$_{LOW}$ = 0405; 04 indicates that Basic behavior as bit 10 corresponds to *Additional text*. 05 is the data type which corresponds to *Unsigned 8*.

No of elements (index 2):

This function indicates the Number of elements (array) of a parameter. The answer to the master will be in PWE$_{LOW}$.

Conversion and Unit of measurement (index 4):
The Conversion and unit of measurement command indicates the conversion of a parameter and the unit of measurement. The answer to the master is in PWE_{LOW}. The conversion index is in the high byte of PWE_{LOW} and the unit index is in the low byte of PWE_{LOW}. Conversion index is signed 8 and unit index is unsigned 8, see the tables.

Conversion index	Conversion factor
0	1
1	10
2	100
3	1000
-1	0.1
-2	0.01
-3	0.001
67	1/60
74	3600
75	3600000
100	1

The unit index defines the "Unit of measure". The conversion index defines how the value should be scaled to get the basic representation of the "Unit of measure". Basic representation is where conversion index equals "0".

Example:
A parameter has a "unit index" of 9 and a "conversion index" of 2. The raw (integer) value read is 23. This means that we have a parameter of the unit "Power" and the raw value should be multiplied by 10 to the power of 2 and the unit is W. 23 x 10^2 = 2300 W

Unit index	Unit of measure	Designation	Conversion index
0	Dimensionless		0
4	Time	s	0
		h	74
8	Energy	J	0
		kWh	
9	Power	W	0
		kW	3
11	Speed	1/s	0
		1/min (RPM)	67
16	Torque	Nm	0
17	Temperature	K	0
		°C	100
21	Voltage	V	0
22	Current	A	0
24	Ratio	%	0
27	Relative change	%	0
28	Frequency	Hz	0
54	Time difference w/o date indication	ms	1*

*

Bit	8	7	6	5	4	3	2	1	
Byte 1	2^{31}	2^{30}	2^{29}	2^{28}	2^{27}	2^{26}	2^{25}	2^{24}	ms
Byte 2	2^{23}	2^{22}	2^{21}	2^{20}	2^{19}	2^{18}	2^{17}	2^{16}	
Byte 3	2^{15}	2^{14}	2^{13}	2^{12}	2^{11}	2^{10}	2^{9}	2^{8}	
Byte 4	2^{7}	2^{6}	2^{5}	2^{4}	2^{3}	2^{2}	2^{1}	2^{0}	

Name (index 6):
The Name returns a string value in ASCII format, containing the name of the parameter.

Example:
In this example, the master reads the name of par. 0-01, *Language*.

The following telegram must be sent to the adjustable frequency drive:

STX	LGE	ADR	PKE	IND	PWE_{HIGH}	PWE_{LOW}	PCD1	PCD2	BCC
02	0E	01	40 01	00 06	00 00	00 00	XX XX	XX XX	XX

STX = 02 Start byte
LGE = 0E Length of remaining telegram
ADR = Sends the adjustable frequency drive on Address 1, Danfoss format
PKE = 4001; 4 in the PKE field indicates a *Read Parameter Description* and 01 indicates par. 0-01, *Language*
IND = 0006; 6 indicates that *Names* is required.

The response from the adjustable frequency drive will be:

STX	LGE	ADR	PKE	IND	PVA	PCD1	PCD2	BCC
02	12	01	30 01	00 06	4C41 4E47 5541 4745	XXXX	XXXX	XX

PKE = 3001; 3 are the response for *Name* and 01 indicates the par. 0-01, *Language*
IND = 00 06; 06 indicates that *Name* is sent.
PVA = 4C 41 4E 47 55 41 47 45
L A N G U A G E

The parameter value channel is now set up to a visible string which returns an ASCII character for each letter in the parameter name.

Lower limit (index 7):
The Lower limit returns the minimum allowed value of a parameter. The data type of Lower limit is the same as for the parameter itself.

Upper limit (index 8):
The Upper limit returns the maximum allowed value of a parameter. The data type of Upper limit is the same as for the parameter itself.

Default value (index 20):
The Default value returns the default value of a parameter, which is the factory setting. The data type of Default value is the same as for the parameter itself.

Additional characteristics (index 21):
The command can be used for getting additional information on a parameter, e.g. *No bus Access, Power Unit dependency, etc.* The Additional characteristics returns an answer in PWE_{LOW}. If a bit is logic "1", the condition is true according to the table below:

Bit	Description
0	Special Default Value
1	Special Upper Limit
2	Special Lower Limit
7	LCP Access LSB
8	LCP Access MSB
9	NoBusAccess
10	Std Bus Read Only
11	Profibus Read Only
13	ChangeRunning
15	PowerUnitDependency

If one of bit 0 *Special Default Value*, bit 1 *Special Upper Limit* or bit 2 *Special Lower Limit* is true, the parameter has power unit-depending values.

Bit 7 and 8 indicate the attributes for the LCP access, see table.

Bit 8	Bit 7	Description
0	0	No access
0	1	Read-only
1	0	Read/write
1	1	Write with lock

Bit 9 indicates *No bus Access*.
Bits 10 and 11 indicate that this parameter can only be read over the bus.
If bit 13 is true, the parameter cannot be changed while running.
If bit 15 is true, the parameter depends on the power unit.

□ **Additional Text**

With this feature, it is possible to read additional text if bit 10, *Additional text available*, is true in Basic characteristics.

To read out additional text, the parameter command (PKE) must be set to F hex, see *Databytes*.

The index field is used for pointing out which element to read. Valid indexes are in the range of 1 through 254. The index must be calculated according to the following equation:
Index = Parameter value + 1 (see table below).

Value	Index	Text
0	1	English
1	2	Deutsch
2	3	Français
3	4	Dansk
4	5	Espanol
5	6	Italiano

Example:

In this example, the Master reads additional text in par. 0-01, *Language*. The telegram is set up to read data value [0] (*English*). You must send the following telegram to the adjustable frequency drive:

STX	LGE	ADR	PKE	IND	PWE_{HIGH}	PWE_{LOW}	PCD1	PCD2	BCC
02	0E	01	F0 01	00 01	00 00	00 00	XX XX	XX XX	XX

STX = 02 Start byte
LGE = 0E Length of the remaining telegram
ADR = Send the VLT adjustable frequency drive on Address 1, Danfoss format
PKE = F001; F in the PKE field indicates a *Read text* and 01 indicates par. 0-01, *Language*.
IND = 0001; 1 indicates that text to parameter value [0] is required

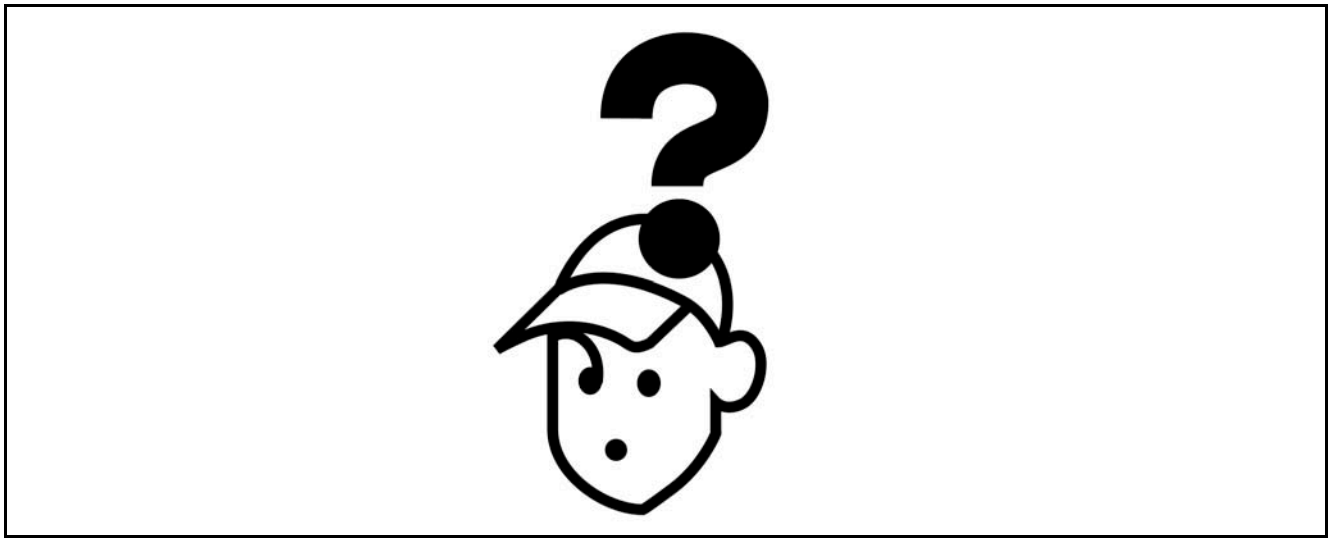
The response from the adjustable frequency drive is:

STX	LGE	ADR	PKE	IND	PVA	PCD1	PCD2	BCC
02	11	01	F0 01	00 01	454E 474C 4953 48	XX XX	XX XX	XX

PKE = F001; F is the response for *Text transfer* and 01 indicates par. 0-01, *Language*.
IND = 0001; 1 indicates that index [1] is sent
PVA = 45 4E 47 4C 49 53 48
E N G L I S H

The parameter value channel is now set up to a visible string, which returns an ASCII character for each letter in the index name.

Troubleshooting



□ Warnings/Alarm Messages

A warning or an alarm is signaled by the relevant LED on the front of the adjustable frequency drive and indicated by a code on the display. A warning remains active until its cause is no longer present. Under certain circumstances operation of the motor may still be continued. Warning messages may be critical, but are not necessarily so.

In the event of an alarm, the adjustable frequency drive will have tripped. Alarms must be reset to restart operation once their cause has been rectified. This may be done in three ways:

1. By using the [RESET] control button on the LCP control panel.
2. Via a digital input with the "Reset" function.
3. Via serial communication/optional bus.

NOTE
After a manual reset using the [RESET] button on the LCP, the [AUTO ON] button must be pressed to restart the motor.

If an alarm cannot be reset, the reason may be that its cause has not been rectified, or the alarm is trip-locked (see also table on following page).

Alarms that are trip-locked offer additional protection, meaning that the line supply must be switched off before the alarm can be reset. After being switched back on, the FC 100 is no longer blocked and may be reset as described above once the cause has been rectified.

Alarms that are not trip-locked can also be reset using the automatic reset function in parameters 14-20 (Warning: automatic wake-up is possible!)

If a warning and alarm is marked against a code in the table on the following page, this means that either a warning occurs before an alarm, or else that you can specify whether it is a warning or an alarm that is to be displayed for a given fault. This is possible, for instance, in parameters 1-90 *Motor Thermal Protection.* After an alarm or trip, the motor carries on coasting, and the alarm and warning flash on the FC 100. Once the problem has been rectified, only the alarm continues flashing.

Alarm/Warning code list

No.	Description	Warning	Alarm/Trip	Alarm/Trip Lock	Parameter Reference
1	10 V low	X			
2	Live zero error	(X)	(X)		6-01
3	No motor	(X)			1-80
4	Line phase loss	(X)	(X)	(X)	14-12
5	DC link voltage high	X			
6	DC link voltage low	X			
7	DC overvoltage	X	X		
8	DC undervoltage	X	X		
9	Inverter overloaded	X	X		
10	Motor ETR overtemperature	(X)	(X)		1-90
11	Motor thermistor overtemperature	(X)	(X)		1-90
12	Torque limit	X	X		
13	Overcurrent	X	X	X	
14	Ground fault	X	X	X	
15	Hardware mesh mash		X	X	
16	Short Circuit		X	X	
17	Control word timeout	(X)	(X)		8-04
25	Brake resistor short-circuited	X			
26	Brake resistor power limit	(X)	(X)		2-13
27	Brake chopper short-circuited	X	X		
28	Brake check	(X)	(X)		2-15
29	Power board overtemp	X	X	X	
30	Motor phase U missing	(X)	(X)	(X)	4-58
31	Motor phase V missing	(X)	(X)	(X)	4-58
32	Motor phase W missing	(X)	(X)	(X)	4-58
33	Soft-charge fault		X	X	
34	Serial communication fault	X	X		
38	Internal fault		X	X	
47	24 V supply low	X	X	X	
48	1.8 V supply low		X	X	
49	Speed limit	X			
50	AMA calibration failed		X		
51	AMA check U_{nom} and I_{nom}		X		
52	AMA low I_{nom}		X		
53	AMA motor too big		X		
54	AMA motor too small		X		
55	AMA parameter out of range		X		
56	AMA interrupted by user		X		
57	AMA timeout		X		
58	AMA internal fault	X	X		
59	Current limit	X			
62	Output Frequency at Maximum Limit	X			
63	Mechanical Brake Low		(X)		2-20
64	Voltage Limit	X			
65	Control Board Overtemperature	X	X	X	
66	Heatsink Temperature Low	X			
67	Option Configuration has Changed		X		
80	Drive Initialized to Default Value		X		
90	Encoder Loss	(X)	(X)		17-61

(X) Dependent on parameter

LED indication	
Warning	yellow
Alarm	flashing red
Trip-locked	yellow and red

Description of Alarm Word, Warning Word, and extended Status Word

Alarm Word Extended Status Word					
Bit	**Hex**	**Dec**	**AlarmWord**	**WarningWord**	**ExtendedStatusWord**
0	00000001	1	Brake Check	Brake Check	Ramping
1	00000002	2	Pwr. Card Temp	Pwr. Card Temp	AMA Running
2	00000004	4	Ground Fault	Ground Fault	Start CW/CCW
3	00000008	8	Ctrl.Card Temp	Ctrl.Card Temp	Slow-down
4	00000010	16	Ctrl. Word TO	Ctrl. Word TO	Catch up
5	00000020	32	Overcurrent	Overcurrent	Feedback High
6	00000040	64	Torque Limit	Torque Limit	Feedback Low
7	00000080	128	Thrmstr overld	Thrmstr overld	Output Current High
8	00000100	256	Motor ETR Over	Motor ETR Over	Output Current Low
9	00000200	512	Inverter Overld.	Inverter Overld.	Output Freq High
10	00000400	1024	DC undervolt	DC undervolt	Output Freq Low
11	00000800	2048	DC overvolt	DC overvolt	Brake Check OK
12	00001000	4096	Short Circuit	DC Voltage Low	Braking Max
13	00002000	8192	Soft-charge Fault	DC Voltage High	Braking
14	00004000	16384	Line ph. Loss	Line ph. Loss	Out of Speed Range
15	00008000	32768	AMA Not OK	No Motor	OVC Active
16	00010000	65536	Live Zero Error	Live Zero Error	
17	00020000	131072	Internal Fault	10 V Low	
18	00040000	262144	Brake Overload	Brake Overload	
19	00080000	524288	U phase Loss	Brake Resistor	
20	00100000	1048576	V phase Loss	Brake IGBT	
21	00200000	2097152	W phase Loss	Speed Limit	
22	00400000	4194304	Ser. com. bus fault	Ser. com. bus fault	
23	00800000	8388608	24 V Supply Low	24 V Supply Low	
24	01000000	16777216	Line Failure	Line Failure	
25	02000000	33554432	1.8 V Supply Low	Current Limit	
26	04000000	67108864	Brake Resistor	Low Temp	
27	08000000	134217728	Brake IGBT	Voltage Limit	
28	10000000	268435456	Option Change	Unused	
29	20000000	536870912	Drive Initialized	Unused	
31	80000000	2147483648	Mech. brake low	Extended Status Word	

The alarm words, warning words and extended status words can be read out via serial bus or optional ser. com. bus for diagnosis. See also par. 16-90, 16-92, and 16-94.

WARNING 1
10 V low:
The 10 V voltage from terminal 50 on the control card is below 10 V.
Remove some of the load from terminal 50, as the 10 V supply is overloaded. Max. 15 mA or minimum 590 Ω.

WARNING/ALARM 2
Live zero error:
The signal on terminal 53 or 54 is less than 50% of the value set in par. 6-10, 6-12, 6-20, or 6-22 respectively.

WARNING/ALARM 3
No motor:
No motor has been connected to the output of the adjustable frequency drive.

WARNING/ALARM 4
Mains phase loss:
A phase is missing on the supply side, or the line voltage imbalance is too high.
This message also appears in case of a fault in the input rectifier on the adjustable frequency drive.
Check the supply voltage and supply currents to the adjustable frequency drive.

WARNING 5
DC voltage high:
The intermediate circuit voltage (DC) is higher than the overvoltage limit of the control system. The adjustable frequency drive is still active.

WARNING 6
DC link voltage low
The intermediate circuit voltage (DC) is below the undervoltage limit of the control system. The adjustable frequency drive is still active.

WARNING/ALARM 7
DC overvoltage:
If the intermediate circuit voltage exceeds the limit, the adjustable frequency drive trips after a time.
Possible corrections:

Select **O**ver **V**oltage **C**ontrol function in par. 2-17
Connect a brake resistor
Extend the ramp time
Activate functions in par. 2-10
Increase par. 14-26

Selecting OVC function will extend the ramp times.

Alarm/warning limits:		
FC 102 Series	3 x 200-240 V AC [VDC]	3 x 380-500 V AC [VDC]
Undervoltage	185	373
Voltage warning low	205	410
Voltage warning high (w/o brake - w/brake)	390/405	810/840
Overvoltage	410	855

The voltages stated are the intermediate circuit voltage of the FC 100 with a tolerance of ± 5%. The corresponding line voltage is the intermediate circuit voltage (DC link) divided by 1.35.

WARNING/ALARM 8
DC undervoltage:
If the intermediate circuit voltage (DC) drops below the "voltage warning low" limit (see table above), the adjustable frequency drive checks if 24 V backup supply is connected.
If no 24 V backup supply is connected, the adjustable frequency drive trips after a given time depending on the unit.
To check whether the supply voltage matches the adjustable frequency drive, see the General Specifications.

WARNING/ALARM 9
Inverter overloaded:
The adjustable frequency drive is about to cut out because of an overload (too high current for too long). The counter for electronic, thermal inverter protection gives a warning at 98% and trips at 100%, while giving an alarm. You cannot reset the adjustable frequency drive until the counter is below 90%.
The fault is that the adjustable frequency drive is overloaded by more than nominal current for too long.

WARNING/ALARM 10
Motor ETR over:
According to the electronic thermal protection (ETR), the motor is too hot. You can choose whether the adjustable frequency drive should give a warning or an alarm when the counter reaches 100% in par. 1-90. The fault is that the motor is overloaded by more than nominal current for too long. Make sure that the motor par. 1-24 is set correctly.

WARNING/ALARM 11
Motor thermistor overtemp:
The thermistor or the thermistor connection is disconnected. You can choose whether the adjustable frequency drive should give a warning or an alarm in par. 1-90. Make sure the thermistor is connected correctly between terminal 53 or 54 (analog voltage input) and terminal 50 (+ 10 V supply), or between terminal 18 or 19 (digital input PNP only) and terminal 50. If a KTY sensor is used, check for correct connection between terminal 54 and 55.

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WARNING/ALARM 12
Torque limit:
The torque is higher than the value in par. 4-16 (in motor operation) or the torque is higher than the value in par. 4-17 (in regenerative operation).

WARNING/ALARM 13
Overcurrent:
The inverter peak current limit (approx. 200% of the rated current) is exceeded. The warning will last approx. 8-12 sec., then the adjustable frequency drive trips and issues an alarm. Turn off the adjustable frequency drive and check if the motor shaft can be turned and if the motor size matches the adjustable frequency drive.

ALARM 14
Ground fault:
There is a discharge from the output phases to ground, either in the cable between the adjustable frequency drive and the motor or in the motor itself. Turn off the adjustable frequency drive and remove the ground fault.

ALARM 15
Incomplete hardware:
An installed option is not compatible with the present control board (hardware or software).

ALARM 16
Short-circuit:
There is short-circuiting in the motor or on the motor terminals.
Turn off the adjustable frequency drive and remove the short-circuit.

WARNING/ALARM 17
Control word timeout:
There is no communication to the adjustable frequency drive.
The warning will only be activated when par. 8-04 is NOT set to *OFF*.
If par. 8-04 is set to *Stop* and *Trip*, a warning appears and the adjustable frequency drive ramps down to zero speed, while giving an alarm.
Par. 8-03 *Control Word Timeout Time* could possibly be increased.

WARNING 25
Brake resistor short-circuited:
The brake resistor is monitored during operation. If it short-circuits, the brake function is disconnected and the warning appears. The adjustable frequency drive still works, but without the brake function. Turn off the adjustable frequency drive and replace the brake resistor (see par. 2-15 *Brake Check*).

WARNING/ALARM 26
Brake resistor power limit:
The power transmitted to the brake resistor is calculated as a percentage, as a mean value over the last 120 s, on the basis of the resistance value of the brake resistor (par. 2-11) and the intermediate circuit voltage. The warning is active when the dissipated braking energy is higher than 90%. If *Trip* [2] has been selected in par. 2-13, the adjustable frequency drive cuts out and issues this alarm, when the dissipated braking energy is higher than 100%.

WARNING/ALARM 27
Brake chopper fault:
The brake transistor is monitored during operation and if it short-circuits, the brake function disconnects and the warning is issued. The adjustable frequency drive is still able to run, but since the brake transistor has short-circuited, substantial power is transmitted to the brake resistor, even if it is inactive.
Turn off the adjustable frequency drive and remove the brake resistor.

Warning: There is a risk of substantial power being transmitted to the brake resistor if the brake transistor is short-circuited.

ALARM/WARNING 28
Brake check failed:
Brake resistor fault: the brake resistor is not connected/working.

WARNING/ALARM 29
Drive overtemperature:
If the enclosure is IP 20 or IP 21/TYPE 1, the cut-out temperature of the heatsink is 203 ºF + 9 º [95 ºC + 5 ºC]. The temperature fault cannot be reset, until the temperature of the heatsink is below 158 ºF [70 ºC].
The fault could be:

- Ambient temperature too high
- Too long motor cable

ALARM 30
Motor phase U missing:
Motor phase U between the adjustable frequency drive and the motor is missing.
Turn off the adjustable frequency drive and check motor phase U.

ALARM 31
Motor phase V missing:
Motor phase V between the adjustable frequency drive and the motor is missing.
Turn off the adjustable frequency drive and check motor phase V.

ALARM 32
Motor phase W missing:
Motor phase W between the adjustable frequency drive and the motor is missing.
Turn off the adjustable frequency drive and check motor phase W.

ALARM 33
Soft-charge fault:
Too many power-ups have occurred within a short time period. See the chapter *General Specifications* for the allowed number of power-ups within one minute.

WARNING/ALARM 34
Serial communication fault:
The serial communication bus on the communication option card is not working.

ALARM 38
Internal fault:
Contact your Danfoss supplier.
Some typical alarm messages:
1299 - OptionSW in slot A is too old
1300 - OptionSW in slot B is too old
1301 - OptionSW in slot C0 is too old
1302 - OptionSW in slot C1 is too old
1315 - Option SW in slot A is not supported (not allowed)
1316 - Option SW in slot B is not supported (not allowed)
1317 - Option SW in slot C0 is not supported (not allowed)
1318 - Option SW in slot C1 is not supported (not allowed)
2315 - Missing SW version from power unit.

WARNING 47
24 V supply low:
The external 24 V DC backup power supply may be overloaded, otherwise contact your Danfoss supplier.

ALARM 48
1.8 V supply low:
Contact your Danfoss supplier.

WARNING 49
Speed limit:
The speed has been limited by range in par. 4-11 and par. 4-13.

ALARM 50
AMA calibration failed:
Contact your Danfoss supplier.

ALARM 51
AMA check Unom and Inom:
The setting of motor voltage, motor current, and motor power is presumably wrong.
Check the settings.

ALARM 52
AMA low Inom:
The motor current is too low. Check the settings.

ALARM 53
AMA motor too big:
The motor is too big for the AMA to be carried out.

ALARM 54
AMA motor too small:
The motor is too small for the AMA to be carried out.

ALARM 55
AMA par. out of range:
The par. values found from the motor are outside the acceptable range.

ALARM 56
AMA interrupted by user:
The AMA has been interrupted by the user.

ALARM 57
AMA timeout:
Try to start the AMA again a number of times, until the AMA is carried out. Please note that repeated runs may heat the motor to a level where the resistances Rs and Rr are increased. In most cases, however, this is not critical.

WARNING/ALARM 58
AMA internal fault:
Contact your Danfoss supplier.

WARNING 59
Current limit:
The current is higher than the value in par. 4-18.

WARNING 62
Output Frequency at Maximum Limit:
The output frequency is limited by the value set in par. 4-19

ALARM 63
Mechanical Brake Low:
The current motor current has not exceeded the "release brake" current within the "Start delay" time window.

WARNING 64
Voltage Limit:
The load and speed combination demands a motor voltage higher than the current DC link voltage.

WARNING/ALARM/TRIP 65
Control Card Overtemperature:
Control card overtemperature: The cut-out temperature of the control card is 176°F [80°C].

WARNING 66
Heatsink Temperature Low:
The heatsink temperature is measured as 32°F [0°C]. This could indicate that the temperature sensor is defective and thus the fan speed is increased to the maximum in case the power part or control card is very hot.

ALARM 67
Option Configuration has Changed:
One or more options has either been added or removed since the last power-down.

ALARM 70
Illegal Frequency Configuration:
Current combination of control board and power board is illegal.

ALARM 80
Drive Initialized to Default Value:
Parameter settings are initialized to the default setting after a manual (three-finger) reset or via par. 14-22.

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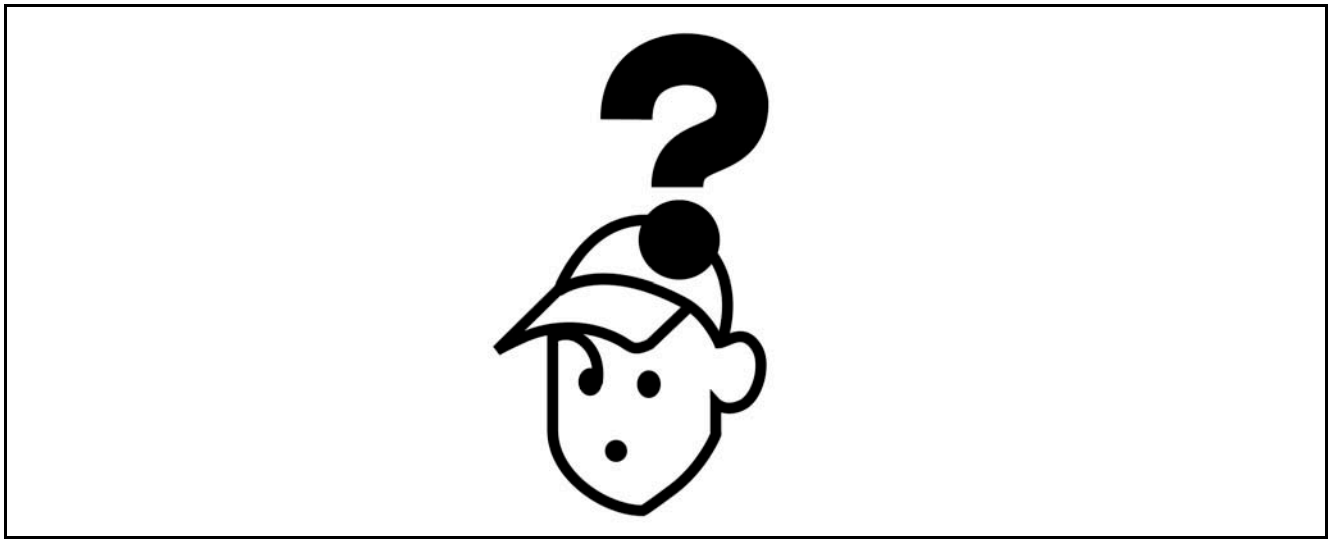

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