EN

OL

CDB3000

Open-Loop Model

User Manual

Base unit CDB3000 BG3

Inverter drive system
750 W – 90 kW

LTi

User Manual – CDB3000, OL

Id.-Nr.: 1001.23B.1-00

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Applicable to inverter model CDB3000, OL
Applicable from firmware version: V310.25

Subject to technical change without notice.

The content of of the User Manual was compiled with the greatest care and attention, and based on the latest information available to us.
We should nevertheless point out that this document cannot always be updated in line with ongoing technical developments in our products.
Information and specifications may be subject to change at any time.

LTi

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1 About this User Manual

The development of standard devices for broadband application solutions regularly comes up against its limits in relation to specific applications or technologies. It is therefore necessary to provide the OL model for fan motors and drives as a special solution in a stand-alone variant for Güntner.

This OL model was derived from the c-line DRIVES CDB3000 series, and as such is based on a tried and proven system of drive controllers and an extensive package of accessories. As a result, the OL incorporates many familiar functions. At the same time, however, it also demands compromise in order to open up possibilities for new solutions. In terms of this model, that compromise means that the SCON, PCON and TCON modes are not available.

Note: The following sections detail only the special functions of the custom model, supplementing the standard documentation including the Operation Manual and Application Manual for the CDE/CDB3000.

Note: The OL model of the CDB3000 inverter module features a special control hardware and firmware.

The firmware supports sensorless operation both under open-loop control and under closed-loop control as a stator flux-oriented model of the asynchronous motor and the pole wheel-oriented model of a permanently excited synchronous motor.

The voltage and frequency of the V/f characteristic can be influenced by parameterisable controllers in order to optimise the current flow for efficient power-adapted operation. The various controllers thus produce a virtually fully controlled V/f characteristic.

With the sensorless mode for asynchronous motors, the motors can be operated dynamically with no encoder system. The underlying motor model is adapted by means of a drive identification and the motor can then be used in the application as an energy-saving, high-power component.

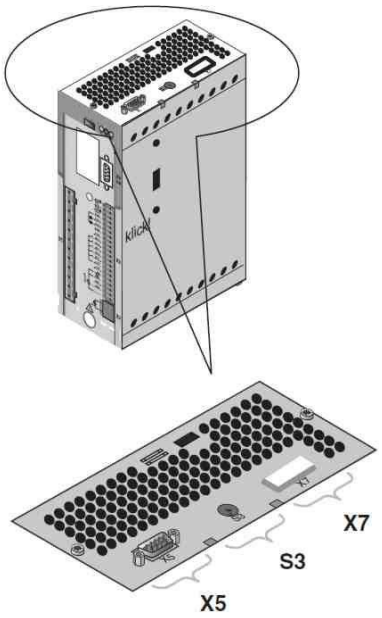
In the sensorless mode for permanently excited synchronous motors, a drive concept linked to the pole wheel is available for simplified loop-controlled operation with no encoder system. This enables synchronous motors with a high d/q ratio of inductance to be operated in a stable and dynamic way.

As standard the controller additionally features an integrated PLC and a process controller which can be used freely for any mode.

2 Constraints relative to the CDE/CDB3000 Operation Manual and Application Manual

Modified hardware:

- The encoder input has been removed. If an encoder connection is required, the standard CDB3000 should be used as a simple positioning specialist.



Designation:

X5 CANopen interface
S3 CANopen hardware address switch
X7 Blank cover

3 Modified software

The following operation modes are no longer supported in the CDB3000 OL drive controller:

- FOR (Field Oriented Regulation with encoder feedback)

  Speed Control SCON
  Positioning Control PCON
  Torque Control TCON

Settings resulting from these modes, such as driving set tables, encoder settings, speed and position controller parameter setting etc. are not supported. This must be considered when setting parameters to configure a drive solution. For drive solutions beyond the

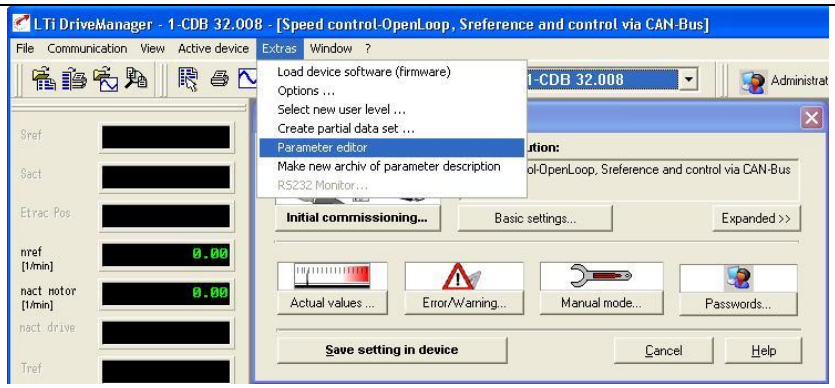
previously defined Güntner applications in relation to fan motors, the basic model of the positioning controller CDB3000 should be used.

Please note the following constraints and important information:

- Operator control by way of the graphical screens of the DRIVEMANAGER 3.x is severely restricted. The input and output and motor protection functions are primarily supported, by way of function selectors.

Note: For this reason, only the DRIVEMANAGER Parameter Editor should be used for drive controller parameter setting.

1.



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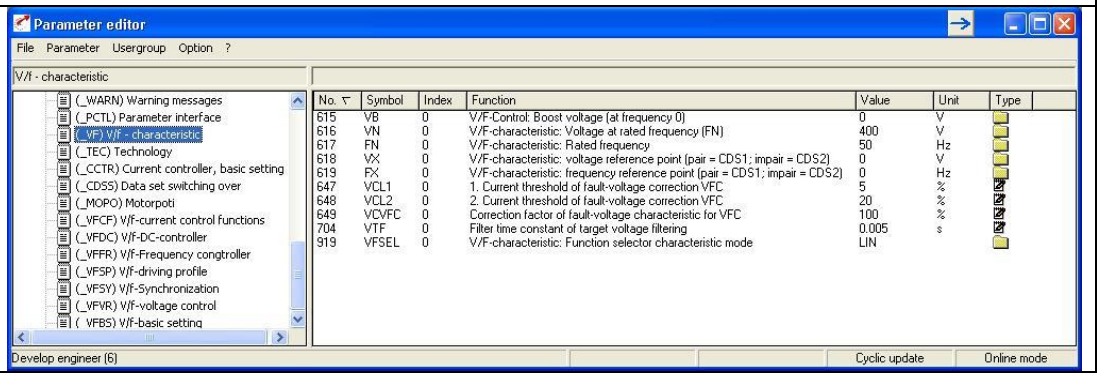
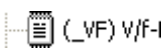


- To provide a more concise view, parameters have been bundled into subject areas. Settings required only for parameter setting in VFCON mode are identified in the subject areas by the prefix "V/f-…" or by the abbreviation "_VF…".



General subject areas have no special prefixing. Subject areas relating to sensor-controlled modes are prefixed by "SL-…".

- Only VFCON mode is supported. This mode includes a voltage/frequency characteristic which can be influenced by way of a large number of controllers. Consequently, the term "controlled V/f characteristic" is used in the following. VFCON mode is parameterized on the basis of the unit "Hz". No values are displayed in rpm, even if those units are displayed on the graphical DRIVEMANAGER screens.

- Power-related factory settings for simple presetting of the drive controller to run with typical motors in the 1:1 motor-controller configuration have been omitted. The basic configuration is dictated by the application data set "VSCC1: Speed control-OpenLoop, reference and open-loop control via CAN". The factory setting is loaded by the Güntner control via CAN.

- Changing of parameter values of the system status „parameterizing“ requires initiallation of controller (15-PLRDY=1). After this the controller is in the system status “switch lock“ resp. at set ENPO in status “ready to switch-on”.

- Factory setting and other application data sets can only be load at inactive output stage. Access to parameters at active output stage can be limited, provided that it deals not with a parameter which can be changed online.

- Device status can be interrogated via DriveCOM-state machine (403-STAT) or status word of device (410-BSTAT). For details see application manual CDB3000.

DriveCOM State	Value in 403-STAT
Start	0
NotReadyToSwitchOn	1
SwitchOnDisabled	2
ReadyToSwitchOn	3
SwitchedOn	4
OperationEnabled	5
QuickStop	6
FaultReactionActive	7
Fault	8

Bit, 410-BSTAT	Description
0:	Ready to switch-on
1:	Switched-on
2:	Technology released
3:	Error
4:	Voltage switched-on
5:	Quick-Stop
6:	Switch lock
7:	Warning
8:	De-Energized (Off)
9:	-
10:	Reference reached
11:	Reference limitation active
12:	Requirement "Safe stop"
13:	-
14:	Drive active
15:	Brake active

ATTENTION: At speeds above 16000 rpm the user unit Hz **must** be selected, as otherwise a number overflow may occur in the CPU.

4 UL approbation

UL approbation applies to the following units:

CDB 34.001 to CDB 34.032:	File no. E146022
CDB 34.044 to CDB 34.058:	File no. E163994

SCCR value: 5 kA

Reference to UL database

- UL file no. E146022
- UL file no. E163994

5 Safe Torque Off

All devices are available in the variant "Safe Torque Off", short form "SH" in the design code. The controller CDB3000, OL, SH support the safety function "STO" (Safe Torque Off), according to the requirements of EN 61800-5-2, EN ISO 13849-1 "PL e" and EN 61508 / EN 62061 "SIL 3".

The controller CDB3000, OL, SH has a separate input for the request "STO", a device to disable the restart lock as well as separate relay contact for the feedback. The I/Os with safety function cannot be used for other functions.

6 Power referred to max. rotating field frequency

Allocation of rotating field frequencies to power rating

Inverter type	Size	Power	Rotating field frequency
CDB34.001 to CDB34.032	BG1 ... BG5	0.375 ... 15 kW	0 ... 400 Hz
CDB34.045 to CDB34.072	BG6	22 ... 37 kW	0 ... 400 Hz

Note: Please note the power reduction dependent on power stage switching frequency.

7 New parameters in VFCON mode

Parameter No.	Parameter Abbreviation	Description	Online [1)]
019	***WTEST***	Activate wire test: On/Off (1 / 0)	
606	***CITF***	Apparent current actual value filter for current injections (magnetization,...)	✓
607	***HOSEL***	DC hold: Function selector OFF - switched off ON - active when f_act = 0 and (f_ref = 0 or start cancel))	
610	***APSEL***	Vibration damping: Function selector OFF - switched off ON - active (complete if greater than CISM+CISR)	
618	***VX***	V/F characteristic: Voltage interpolation points (even index = CDS1, odd index = CDS2)	✓
619	***FX***	V/F characteristic: Frequency interpolation points (even index = CDS1, odd index = CDS2) inactive if value = 0 or less than previous value	✓
663	***SDOPC***	Shutdown option code expanded: 2 = Shutdown via VFC (DC break)	
910	***MGSEL***	Magnetization: Function selector OFF - switched off ON - active	
911	***MAGCN***	Magnetization: Reference	✓
912	***MAGT***	Magnetization: Duration	✓
913	***DMGT***	Demagnetization time	✓
914	***DIST***	Shutdown time	✓
915	***BRSEL***	DC braking: Function selector OFF - switched off ON - active if SDOPC = 2 and start cancel	
916	***BRDCN***	DC braking: Reference	✓
917	***BRDCT***	DC braking: Duration	✓
918	***BRSLI***	DC braking: Initial frequency	✓
919	***VFSEL***	V/F characteristic: Selector LIN - Linear interpolation between 0 and FN LINSP - Linear interpolation with interpolation points	
920	***SYSEL***	Up-synchronization: Function selector OFF - switched off ON - active	✓
921	***SYCN***	Up-synchronization: Detection current	✓
922	***SYFM***	Up-synchronization: Detection frequency (maximum)	✓
923	***SYFR***	Up-synchronization: Detection frequency ramp	✓
925	***CDSPA***	Data set switchover: Switching parameter 0 - CDS1 1 - CDS2	✓
926	***CDSTI***	Data set switchover: Dwell time in DS	✓
927	***CDSCN***	Data set switchover: Current switch thresholds	✓
928	***SHYS***	Data set switchover: Hysteresis frequency (SLIM - SHYS)	✓

[1)] See table footnote

Parameter No.	Parameter Abbreviation	Description	Online [1)]
930	***IRSEL***	IxR load compensation: Function selector OFF - switched off ON - active (100% active if greater than CISM+CISR)	
931	***IXRKP***	IxR load compensation: Gain	✓
932	***IXRS***	IxR load compensation: Scaling factor	✓
933	***LFILT***	Filter inductance	

[1)] Parameter settings changeable online are activated by direct input. No new controller initialization is required. The drive does not have to be stopped or the power stage disabled for this. If changed values are to be permanently saved, they must be saved using the SAVE parameter.

8 Description of software functions in VFCON mode

8.1 Model PI current controller for function blocks

The following function blocks use the PI current controller of the subject area "(_CCTR) Current controller, basic setting":

- DC current controller before start
- DC current controller to brake / after hold
- Current limit value controller
- Constant current controller

PI current controller:

No.	Abbreviation	Description	Value range	Online
800	CCG	Current control: PI controller gain	0 … 500	✓
801	CCTLG	Current control: PI controller integral-action time	0.1 … 100	✓
802	CCTF	Current control: Current actual value filter, time constant	0 … 10	

The current actual value filter is programmable in the respective function block. Two filter variables are provided for this:

- 606-CITF for all DC current controllers and constant current controllers
- 630-CLTF for the current limit value controller

To set the current controller the typical controller variables are available as scope variables in the DRIVEMANAGER.

Scope variables for commissioning:

Scope variable	Abbreviation	Unit
Current actual value (filtered via CITF, peak)	i.phasorImp	A
Current reference (for DC current controller, peak)	i.phasorImpRef	A

Scope variable	Abbreviation	Unit
Current actual value (filtered via CLTF + 8ms, eff)	i.effClFilt	A
Current reference (for DC current controller, eff)	i.effClRef	A
Current actual value (unfiltered, peak)	i.phasor	A

8.2 DC current controller before start
(formerly: Magnetization)

A DC current is injected at 0 Hz output frequency. Depending on the actuation of the power stage valves, it forms a so-called "stationary space vector". The current rating is determined by way of the reference current. At the end of the DC current phase output of the rotating field begins.

The level of the reference current is oriented to the preset device rated current and is set with the motor identification to 50%.

Demagnetization time before DC braking
To avoid current spikes, an asynchronous motor must be demagnetized before connection of the DC current. To do so, the power stage is briefly disabled.

Reference activation threshold of the current controller
The current controller is active when at least one reference greater than 1.22% of the scaling current is preset and the function selector is set to MGSEL = ON. This reference threshold is necessary because the current measurement is subject to measurement noise and the controller cannot regulate to values less than the measurement noise.

Current controller shutdown condition
The link between the timer parameter and reference source produces the shutdown condition of the function.

- If the shutdown time is 0 s and the function selector is set to ≠ OFF, the shutdown condition is drawn solely from the reference source (reference value < 1.22% of the scaling current), meaning the timer is inactive.
- If the shutdown condition is set to a value less than 1.22% of the scaling current by setting the reference source before the timer expires, DC current application is ended.

Reference source:

- Reference parameter 911-MAGCN
- Analog input (online parameter) with setting DCMAG (field bus index: 47) for scaling of reference parameter 911-MAGCN

Parameters:

No.	Abbreviation	Description	Value range	FS	Online
910	MGSEL	Function selector	OFF/ON	OFF	
911	MAGCN	Reference	0 … 50%	0	✓
912	MAGT	Timer	0 … 800 s	0	✓
606	CITF	Current actual value filter	0 … 1 s	0	✓

No.	Abbreviation	Description	Value range	FS	Online
913	DMGT	Demagnetization time	0 … 800 s	0	✓

Scope variables for commissioning:

Scope variable	Abbreviation	Unit
Current actual value (peak)	i.phasorImp	A
Current reference value (peak)	i.phasorImpRef	A
Unfiltered apparent current (peak)	i.phasor	A
Filtered apparent current (peak)	i.phasorf	A

8.3 DC current controller for braking

If the "DC braking" function is set, when activated (start cancel and SDOPC set to "2") the space vector is held at the last angle and the preset current is injected. The current rating is determined by way of the reference current.

The level of the reference current is oriented to the preset device rated current and is set with the motor identification to 50%.

Demagnetization time before DC braking
To avoid current spikes, an asynchronous motor must be demagnetized before connection of the DC current. To do so, the power stage is briefly disabled.

Reference activation threshold of the current controller
The current controller is active when at least one reference greater than 1.22% of the scaling current is preset and the function selector is set to BRSEL = ON. This reference threshold is necessary because the current measurement is subject to measurement noise and the controller cannot regulate to values less than the measurement noise.

Initial frequency to activate DC braking
The initial frequency is the limit as from which DC braking is activated. Before that, after start cancel braking is applied with the preset deceleration ramp. The function is active when the initial frequency is greater than the standstill window 229-REF_S.

Current controller shutdown condition
The link between the timer parameter and reference source produces the shutdown condition of the function.

- If the shutdown time is 0 s and the function selector is set to ≠ OFF, the shutdown condition is drawn solely from the reference source (reference value < 1.22% of the scaling current), meaning the timer is inactive.
- If the shutdown condition is set to a value less than 1.22% of the scaling current by setting the reference source before the timer expires, DC current application is ended.

Reference source:

- Reference parameter 916-BRDCN
- Analog input (online parameter) with setting DCBR (field bus index: 49) for scaling of reference parameter 916-BRDCN

Parameters:

No.	Abbreviation	Description	Value range	FS	Online
915	BRSEL	Function selector	OFF/ON	OFF	
916	BRDCN	Reference	0 … 50 %	0	✓
917	BRDCT	Timer	0 … 800 s	0	✓
918	BRSLI	Initial frequency	0 … 1000 Hz	0	✓
606	CITF	Current actual value filter	0 … 1 s	0	✓
913	DMGT	Demagnetization time	0 … 800 s	0	✓

Scope variables for commissioning:

Scope variable	Abbreviation	Unit
Current actual value	i.phasorImp	A
Current reference	i.phasorImpRef	A
Unfiltered apparent current (peak)	i.phasor	A
Filtered apparent current (peak)	i.phasorf	A

8.4 DC current controller after hold
(formerly: DC hold)

If the "DC hold" function is set, when activated the space vector is held at the last angle and the preset current is injected. The current rating is determined by way of the reference current.

The level of the reference current is oriented to the preset device rated current and is set with the motor identification to 50%.

Reference activation threshold of the current controller
The current controller is active when at least one reference greater than 1.22% of the scaling current is preset and the function selector is set to HOSEL = ON. This reference threshold is necessary because the current measurement is subject to measurement noise and the controller cannot regulate to values less than the measurement noise.

Current controller standstill activation condition

Activation conditions in standstill window 229-REF_S**:**

- Reaching frequency actual value = 0 Hz and start cancel or
- Frequency reference = 0 Hz

Current controller shutdown condition
The link between the timer parameter and reference source produces the shutdown condition of the function.

- If the shutdown time is 0 s and the function selector is set to ≠ OFF, the shutdown condition is drawn solely from the reference source (reference value < 1.22% of the scaling current), meaning the timer is inactive.
- If the shutdown condition is set to a value less than 1.22% of the scaling current by setting the reference source before the timer expires, DC current application is ended.

Reference source:

- Reference parameter 608-HODCN
- Analog input (online parameter) with setting DCHO (field bus index: 48) for scaling of reference parameter 608-HODCN

Parameters:

No.	Abbreviation	Description	Value range	FS	Online
607	HOSEL	Function selector	OFF/ON	OFF	
608	HODCN	Reference	0 … 50%	0	✓
609	HODCT	Timer	0 … 800 s	0	✓
606	CITF	Current actual value filter	0 … 1 s	0	✓

Scope variables for commissioning:

Scope variable	Abbreviation	Unit
Current actual value	i.phasorImp	A
Current reference	i.phasorImpRef	A
Unfiltered apparent current (peak)	i.phasor	A
Filtered apparent current (peak)	i.phasorf	A

8.5 Current limit value controller
(formerly: Current-controlled startup)

The current limit value controller is intended to prevent exceeding of a fixed current limit value. For this, the output frequency can be stopped or optionally reduced/increased.

Function selector:
- CCWFR: With frequency lowering in case of limit current being exceeded 632-CLCL
- CCWFS: Frequency ramp stop in case of limit current being exceeded 632-CLCL

Function selector set to CCWFR:
In the range from 75% limit current up to the current limit value (100%) the acceleration ramp is scaled from 100-0%. When the current limit value (100%) is reached, no more acceleration occurs. If the apparent current nevertheless exceeds the limit current, the frequency ramp is reduced. The ramp from the lowering ramp parameter above the limit current is scaled from 0…100%. The maximum ramp is reached at 125% limit current.

Function selector set to CCWFS:
In the range from 75% limit current up to the 125% limit current the acceleration ramp is scaled from 100 - 0%. When the 125% limit current is reached, no more acceleration occurs.

Initial frequency and lowering frequency
The initial speed and lowering frequency can be parameterized independently of each other.

Initial frequency > lowering frequency:	The function is activated when the initial frequency is reached; it also remains active when lowered down to the lowering frequency
Initial frequency < lowering frequency:	Only a slowing down to the constant frequency occurs between the initial frequency and lowering frequency, but no lowering.

Reference source:
- Reference parameter 608-HODCN
- Analog input (online parameter) with setting CLCL (field bus

index: 51) for scaling of reference parameter 632-CLCL

Static operation is reached when the output frequency is in the "Reference reached window" 230-REF_R.

Parameters:

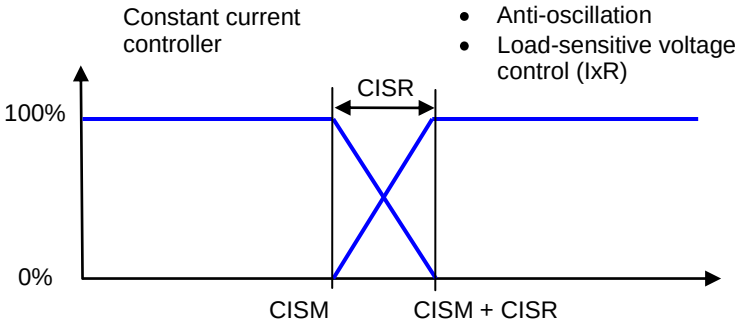
No.	Abbreviation	Description	Value range	FS	Online
630	CLTF	Current actual value filter	0 … 1 s	0,01	✓
631	CLSL	Function selector	OFF / CCWFR / CCWFS	OFF	
632	CLCL	Current limit value (apparent current)	0 … 180%	0	✓
634	CLSR	Initial frequency	0 … 500Hz	0	✓
635	CLRR	Lowering ramp	0 … 500Hz/s	30	✓
633		Minimum lowering frequency			

Scope variables for commissioning:

Scope variable	Abbreviation	Unit
Current control deviation		
Active deceleration ramp	rampDown	Hz/s
Active acceleration ramp	rampUp	Hz/s
Unfiltered apparent current (peak)	i.phasor	A
Filtered apparent current (peak)	i.phasorf	A

8.6 Function block action ranges

In a fixed frequency range the functions may overlap and thus restrict simultaneous working. This is determined by the limit frequency CISM and the transition range CISR.



Parameters:

No.	Abbreviation	Description	Value range	FS	Online
603	CISM	Limit speed	0 … 100%	8	✓
604	CISR	Transition range	0 … 100%	5	✓

8.7 Constant current controller (formerly: Current injection)

The constant current controller serves as a startup current controller and outputs a fixed defined torque by means of the constant current. It is executed as a PI controller. As from a parameterizable limit frequency the constant current controller is adjusted into the V/f characteristic. In the transition range 604-CISR the function is adjusted in and out in linear mode from 0…100%.

Function selector:

- ON: Acceleration and static operation
- ACC: Only startup acceleration
- ONCE: Once after start

Static operation is reached when the output frequency is in the "Reference reached window" 230-REF_R.

Reference source:

- Reference parameter 608-HODCN
- Analog input (online parameter) with setting CICI (field bus index: 50) for scaling of reference parameter 632-CICN/602-CICNR

Parameters:

No.	Abbreviation	Description	Value range	FS	Online
600	CISEL	Function selector	OFF / ON / ACC / ONCE	OFF	
601	CICN	Current reference	0 … 200%	100	✓
602	CICNR	Reduced current reference	0 … 100%	50	✓
603	CISM	Limit speed	0 … 100%	8	✓
604	CISR	Transition range	0 … 100%	5	✓
605	CITM	Timer for switchover	0 … 100s	20	✓
606	CITF	Current actual value filter	0 … 1s	0	✓

Scope variables for commissioning:

Scope variable	Abbreviation	Unit
Current actual value	i.phasorImp	A
Current reference	i.phasorImpRef	A
Current control deviation		A
Unfiltered apparent current (peak)	i.phasor	A
Filtered apparent current (peak)	i.phasorf	A

8.8 Anti-oscillation

The motor oscillation is counteracted by a small change to the output frequency dependent on the effective current. The counteraction of the controller is not signalled by a minus sign in the gain, meaning the value range is entered positively. The anti-oscillation is assigned the effective current as its reference.

Parameters:

No.	Abbreviation	Description	Value range	FS	Online
610	APSEL	Function selector	OFF/ON	OFF	
611	APGN	Gain	-500 … 500 Hz/A	0	✓
612	APTF	Current actual value filter	0.001 … 10s	0,02	✓
603	CISM	Limit speed	0 … 100%	8	✓
604	CISR	Transition range	0 … 100%	5	✓

In the transition range 604-CISR the function is adjusted in and out in linear mode from 0…100%.

The anti-oscillation acts by altering the frequency reference value of the loop control. The reference is influenced by a value proportional to the change in the effective current. Based on the effective current the periodic oscillation can be plotted.

Scope variables for commissioning:

Scope variable	Abbreviation	Unit
Frequency change	fApD	Hz
Filtered effective current (APTF)	iwAp	A

8.9 Load-sensitive voltage control (formerly: IxR load compensation)

Load-sensitive voltage control increases or reduces the output voltage dependent on the filtered apparent current. In this process, the output voltage can be increased up to the maximum adjustable output voltage in the basic setting range. The control process provides optimum load-sensitive adaptation of the output voltage.

Direction of action of the voltage control
Load-sensitive voltage control is active in the range f > MOFN*CISM. Dependent on the apparent current Is and the motor rated current MOCNM, the voltage is:

- increased by IXRKP * (Is – MOCNM) if Is > MOCNM
- reduced by IXRS * IXRKP * (Is – MOCNM) if Is < MOCNM

Scaling factor
The scaling factor for no-load lowering provides more voltage lowering for low-inductance motors, as generally the calculation is apparent current x stator resistance = correction factor. So the output voltage can be lowered under low current load to lower the voltage, thereby causing the motor to heat up less.

Correction factor
With the motor identification the output voltage correction factor is determined as

- IXRKP[0..1] = 2 x stator resistance R_S
- IXRS[0..1] = 100%

In the transition range 604-CISR the function is adjusted in and out in linear mode from 0…100%.

Parameters:

No.	Abbreviation	Description	Value range	FS	Online
930	IRSEL	Function selector	OFF/ON	OFF	
931	IXRKP	Gain CDS 0..1	0 … 100 V/A	0	✓
932	IXRS	Scaling factor for no-load lowering CDS 0..1	0 … 1000%	100	✓

Scope variables for commissioning:

Scope variable	Abbreviation	Unit
Voltage change	usd.IxR	V
Unfiltered apparent current (peak)	i.phasor	A
Filtered apparent current (peak, filtered)	i.phasorf	A

8.10 Characteristic data set switchover (CDS)

The characteristic data sets form a subset of the control parameters, correction factors, ramps, scaling parameters and V/f characteristic.
The characteristic data sets can be operated from various control locations. To switch the V/f characteristic voltage, the voltage is adjusted in by way of a PT1 element in the switchover phase. The characteristic data sets can be switched online.

Identification of characteristic data set-dependent parameters
Parameter names: The parameter's 5-digit code is suffixed by a 1 or 2
Field parameter: The index 0 contains the value of characteristic data set 1; index 1 contains the value of characteristic data set 2

Characteristic data set display:	0	Characteristic data set 1 (CDS1)
	1	Characteristic data set 2 (CDS2)

The default characteristic data set is CDS1.

Parameters:

No.	Abbreviation	Description	Value range	FS	Online
650	CDSAC	Display of current characteristic data set		1	✓
651	CDSSL	Function selector	see below	OFF	
652	SLIM	Limit frequency			✓
925	CDSPA	Switchover via parameter	0 … 1	0	✓
926	CDSTI	Dwell time in DS			✓
927	CDSCN	Current switch thresholds			✓
928	SHHY	Hysteresis frequency			✓
929	CDSTS	Settling time for CDS 2			✓

Data set switchover can be triggered by the following switching conditions.

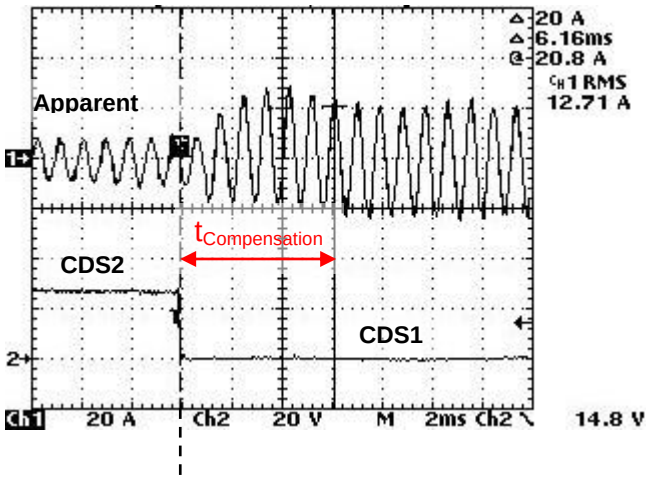
Parameter setting 651-CDSSL	Function
OFF (0)	No data set switchover
SLIM (1)	If fref > SLIM then CDS 2 If fref < SLIM – SHYS then CDS 1
TERM(2)	Switchover after digital input =1, function DSEL (23)
ROT (3)	CDS 1 for clockwise CDS 2 for anti-clockwise
SIO (4)	Not supported
CAN (5)	CDS = CAN control word bit 13
OPTN (6)	With connected option module CDS 2 ;-)
SLABS (7)	As SLIM, but uses amount of speed
PARAM (8)	CDS = CDSPA
ACCN (9)	If effective current < CDSCS[0] * CFPNM then CDS 2 If effective current > CDSCS[1] * CFPNM then CDS 1
APCN (10)	If current < CDSCS[0] * CFPNM then CDS 2 If current > CDSCS[1] * CFPNM then CDS 1
ACCN2 (11)	If effective current < CDSCS[0] * CFPNM then CDS 2 If effective current > I0 then CDS 1 I0 is scanned after switchover to CDS 2 and at end of

Parameter setting 651-CDSSL	Function
	settling time CDSTS.
APCN2 (12)	If current < CDSCS[0] * CFPNM then CDS 2 If current > I0 then CDS 1 I0 is scanned after switchover to CDS 2 and at end of settling time CDSTS.

With switchover via current threshold value a motor can be run at idle with reduced voltage and so with reduced current. This results in much less heat-up of the motor at idle.

To achieve this, the nominal data of the V/f characteristic must be entered in CDS1 and the data of the reduced V/f characteristic in CDS2. The reduced V/f characteristic is determined dependent on the motor, and can typically be up to 2/3 of the nominal.

Example of a switchover with load jump with M_N from CDS2 to CDS1



Scope variables for commissioning:

Scope variable	Abbreviation	Unit
Active CDS	VFC_ActCDS	---

8.11 Up-synchronizing to an asynchronous motor

To determine the rotating field frequency, a parameterizable detection current with variable frequency is injected into the asynchronous motor.

Search mode sequence
The sequence starts from the minimum output frequency of the motor and the last preset motor direction, and the search frequency of the current space vector is increased in linear mode with the search frequency ramp. If the momentary rotating field frequency of the motor is not determined by when the maximum output frequency is reached, the search is performed in the opposite direction. If no synchronization point is detected there either, the start frequency 0Hz is applied.

Detection current setting
By adapting the detection current a smooth up-synchronization to the motor can be achieved.

Detection current too low:	The synchronization point cannot be determined. The frequency output starts at 0Hz.
Detection current too high:	The synchronization point can be determined, but the rotor accelerates or decelerates very perceptibly due to the high detection current. The up-synchronization is not jerk-free.

Demagnetization time before up-synchronization
If the synchronization point of the running-down motor is found, to demagnetize the motor the power stage is briefly disabled and then synchronized up to the motor with the detected output frequency. To avoid current spikes, an asynchronous motor must be demagnetized before up-synchronization.

Note: The function is not suitable for multi-motor operation. If multiple motors are to be rotated in the same direction at virtually identical frequency, the function can approximate the synchronization point. The detection current must be increased slightly. Jerk-free and safe transfer of the motors is not assured.

Parameters:

No.	Abbreviation	Description	Value range	FS	Online
920	SYSEL	Function selector	OFF/ON	OFF	✓
921	SYCN	Detection current	0 … 180 %	0	✓
922	SYFM	Detection frequency (maximum)	0 … 500Hz	0	✓
923	SYFR	Detection frequency ramp	0 … 1000 Hz/s	0	✓
913	DMGT	Demagnetization time	0 … 800 s	0	✓

8.12 Power failure bridging

With the power failure bridging function, the speed of a specific motor can be reduced in the event of a mains power failure. If the mains power is restored within a defined period of time, a restart can be executed.

There are three different power failure bridging modes.

RETRN: Longest possible DC link bridging with mains power restore detection and restart
NORET: Longest possible DC link bridging without mains power restore detection and restart
NOLIM: Fastest possible DC link braking without mains power restore detection, without restart

The voltage limits are set as follows:

PFON: The power failure detection limit is always composed of uzk_ok + parameter value. Uzk_ok is entered in the power stage data.
PFREF: In the states with the longest possible DC link bridging the voltage setpoint is composed of uzk_ok + parameter value.
In the state of fastest possible DC link braking the setpoint is calculated from the braking chopper threshold + parameter value. The braking chopper threshold ubc_ein is entered in the power stage data.

Parameters:

No.	Abbreviation	Description	Value range	FS	Online
340	PFSEL	Function selector	RETRN / NORET / NOLIM	OFF	
341	PFREF	Reference voltage	-200 … 200 V	0	✓
342	PFON	Inception voltage	0 … 200 V	0	✓

8.13 Dynamic DC link braking

With dynamic DC link braking, a braking action can be executed dependent on the DC link voltage. This is often required by motors to which high moments of inertia are connected. Braking at constant power is also implemented by this controller.

Parameters:

No.	Abbreviation	Description	Value range	FS	Online
936	PBSEL	Function selector	ON/OFF	OFF	✓
937	PBREF	Reference voltage	0 … 1000 V	600	✓
938	PG	DC link controller: Gain	0 … 1000	1	✓
939	PTLG	DC link controller: Integral-action time	1 … 2000 ms	20	✓

8.14 Motor choke compensation

The use of motor chokes and filters has a beneficial effect on the operational characteristics of the motor. Among other benefits, smooth running quality is improved and heat introduction due to harmonics in the motor is reduced. This extends the service life of the drive.

Function
Motor choke compensation increases the output voltage by the factor of the voltage drop at the choke, so that the momentum on the drive motor is retained. Compensation for the voltage drop at the motor choke thus improves the dynamics of the drive.

Limiting compensation
The voltage increase is limited by the maximum adjustable output voltage dependent on the DC link voltage.

Interaction of load-sensitive voltage control and motor choke compensation
By contrast to load-sensitive voltage control (I*R compensation), motor choke compensation is frequency-dependent. I*R compensation and motor choke compensation are added together.

Parameters:

No.	Name	Description	Value range	FS	Online
933	LFILT	Filter inductance	0..10H	0	

Scope variables for commissioning:

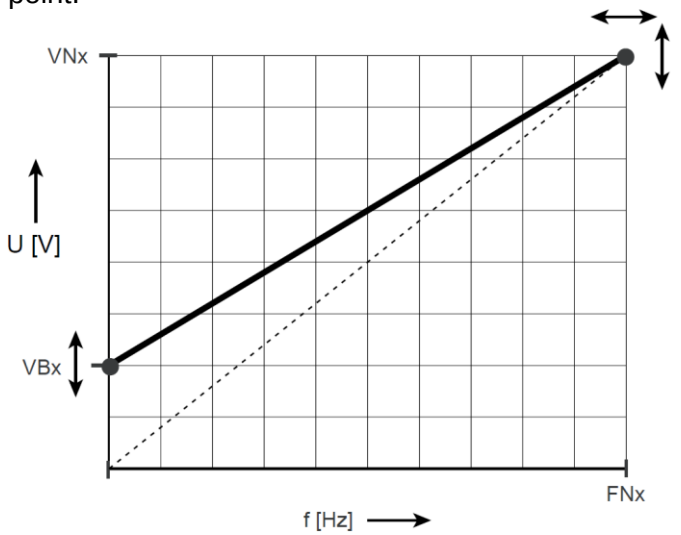
Scope variable	Abbreviation	Unit
Voltage change	usd.IxR	V
Unfiltered apparent current (peak)	i.phasor	A
Filtered apparent current (peak, filtered)	i.phasorf	A

8.15 V/f characteristic with interpolation points

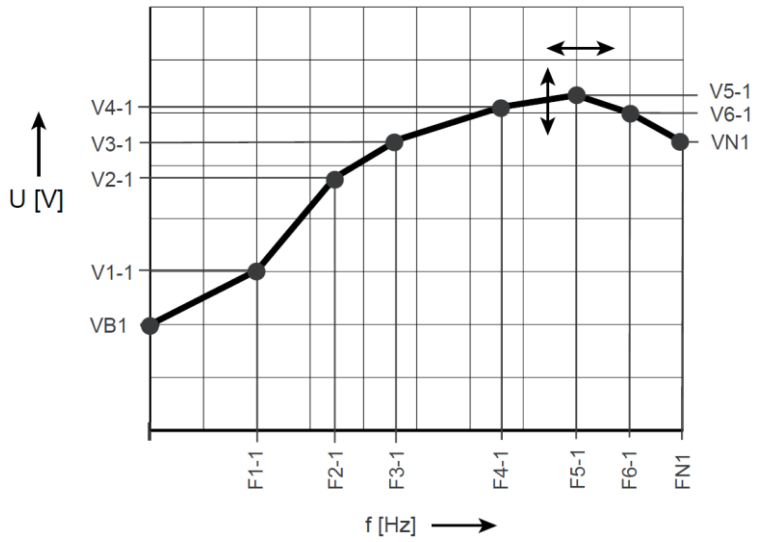
Using interpolation points enables a free voltage/frequency characteristic to be programmed.

For free parameter setting, the interpolation values are allocated automatically according to the frequency. Interpolation values with frequency 0 deactivate the V/f interpolation point.

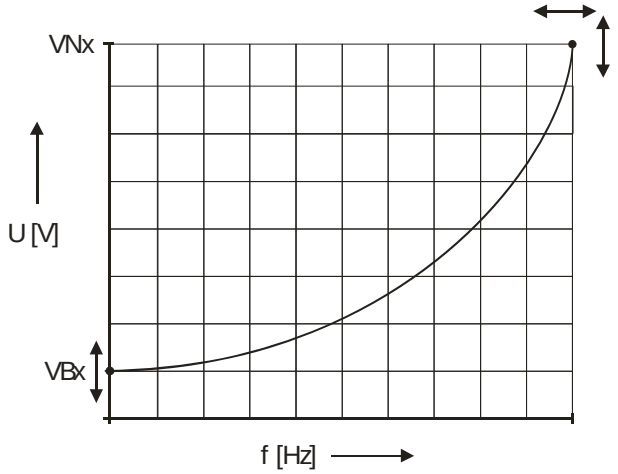
LIN: Linear V/f characteristic with boost voltage and nominal point.



LINSP: V/f characteristic with up to 6 free interpolation points between boost voltage and nominal point.



QUAD: Quadratic V/f characteristic with boost voltage and nominal point.



So any number of characteristics can be simulated:

- 50 Hz linear characteristic
- 60 Hz linear characteristic
- 87 Hz linear characteristic
- 50 Hz quadratic characteristic
- 60 Hz quadratic characteristic

Parameters:

No.	Name	Description	Value range	FS	Online
618	VX	Voltage interpolation points (even index = CDS1, odd index = CDS2)	0 …600	0	✓
619	FX	Frequency interpolation points (even index = CDS1, odd index = CDS2)	0 …500	0	✓
705	VFSEL	Selector	LIN/LINSP	LIN	✓

8.16 Filtering of the V/f characteristic voltage reference on CDS switchover

The voltage reference of the inverter is filtered with the filter time constant for voltage filtering "704-VTF". On switching characteristic data sets, this effects a 'smooth' transition between the V/f characteristics without overcurrent tripping due to transient currents.

Parameters:

No.	Name	Description	Value range	FS	Online
704	VTF	Filter time constant for voltage filtering	0 ... 1 s	0,005	✓

8.17 Automatic load-sensitive selection of power stage switching frequency

A high switching frequency of the inverter output voltage is a key factor in terms of the smooth running of a drive. As a general rule: Smooth running performance improves as the power stage switching frequency increases, as does the power stage's power loss.

The switching frequency can be automatically adjusted to the maximum permissible switching frequency of the power stage dependent on the apparent current. As the load increases, the switching frequency is reduced down to a minimum at which the maximum power is available at the power stage.

Operation with output filters
As a constraining measure for operation with output filters, a minimum switching frequency can be specified for automatic switching frequency switchover. This is necessary because operating output filters below the specified switching frequency causes damage to the filter.

Parameters:

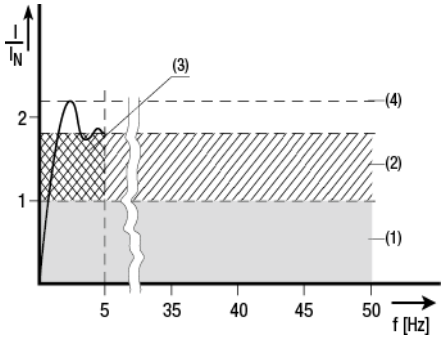
No.	Name	Description	Value range	FS	Online
688	PMSW	Setting of the switching frequency switchover	OFF / ON / 4kHz / 8kHz / 12kHz	ON	
689	PMFSA	Modulation: Momentary switching frequency of power stage	4kHz / 8kHz / 12kHz / 16 kHz	Display	
690	PMFS	Modulation: Switching frequency of power stage	4kHz / 8kHz / 12kHz / 16 kHz	8 kHz	

Parameter 688-PMSW defines the minimum switching frequency for automatic switching frequency switchover. With parameter 690-PMFS the preferred maximum switching frequency is defined when parameter 688-PMSW ≠ OFF.

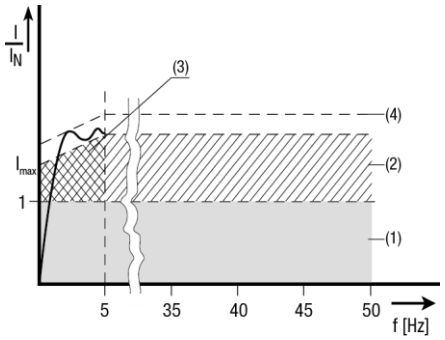
Parameter setting 688-PMSW	Function
OFF (0)	No automatic switching frequency switchover
ON (1)	Switchover via 12kHz and 8kHz to minimum 4 kHz
4KHZ (2)	Switchover via 12kHz and 8kHz to minimum 4 kHz
8KHZ (3)	Switchover via 12kHz to minimum 8 kHz
12KHZ (4)	Minimum switching frequency 12 kHz

Max. current limit value for automatic switching frequency switchover
The maximum permissible inverter output current and the peak current are dependent on the mains voltage, the motor cable length, the power stage switching frequency and the ambient temperature. The basis for protection of the power stage is provided by the protective mechanisms and limit values at switching frequency 8 kHz. Above 8 kHz the switching frequency is switched dependent on the power stage temperature. The current limit value of 8 kHz is defined as the maximum current at higher switching frequencies.

CDB34.001 to CDB34.032 (BG1 – BG5):



CDB34.044 to CDB34.168 (BG6 – BG7):



(1) Continuous operation
(2) Intermittent* > 5 Hz rotating field frequency
(**3**) Intermittent 0 to 5 Hz rotating field frequency
(4) Pulse mode

Note:

- $I_{eff} = \sqrt{\frac{1}{T} * \sum_{i=1}^{n} I_t^2 * t_i}$
- When the current space vector is stopped the maximum current is limited to 50% * $I_{N\ device}$.

Hysteresis for current limit value and power stage temperature on automatic switching frequency switchover

The current limit value and power stage temperature are assigned a hysteresis for switchover in order to avoid toggling between two switching frequencies.

Current limit value:	8 kHz:	CDB34001 – CDB34032	180 % * $I_{N\ device}$
		CDB34044 – CDB34143	150 % * $I_{N\ device}$
	12 kHz:	CDB34001 – CDB34143	110 % x $I_{N\ device}$
	16 kHz:	CDB34001 – CDB34143	100 % x $I_{N\ device}$
Power stage temperature (power section heat sink temperature):	2 Kelvin.		

Switching frequency switchover dependent on power section heat sink temperature

If the power stage temperature exceeds the defined limit value of the respective maximum temperature of the power stage module, the power stage is disabled as a protective measure with an error message E-OTI.

Switching frequency switchover	4 ⇨ E-OTI	8 ⇨ 4	12 ⇨ 8	16 ⇨ 12
If Temp greater than… switch down	T_{HSmax}	T_{HSmax} - 2K	T_{HSmax} - 2*2K	T_{HSmax} - 3*2K
Switching frequency switchover	E-OTI ⇨ 4	4 ⇨ 8	8 ⇨ 12	12 ⇨ 16
If Temp less than… switch up	T_{HSmax} - 3*2K	T_{HSmax} - 4*2K	T_{HSmax} - 5*2K	T_{HSmax} - 6*2K

HS Heat sink

8.18 Default frequency in case of field bus (CAN) error

In the event of an error in the CAN field bus a fixed parameterized frequency reference is used. A timeout can be set to limit the runtime of the fixed reference value. So that a CAN error is triggered in the event of a hardware fault, for example, a cyclic communication mode should be set. Please note that the following limit conditions are necessary.

1. The control system must be in “operational mode”. That means, the master control set the drive control via CAN-bus from mode BOOTUP in mode OPERATIONAL.
2. The drive control was started, for example with bit 0 = 1 in the status word
3. A cyclic monitoring via receive message must be parameterized. Set parameter 677-H22A5 = RXPDO monitoring and parameter 678-H22A6 in ms for the cyclic time. Alternativ is a cyclic SYNC-Telegramm to use.

If the parameter setting is 240-FOS00 = CAN during a communication error E-CAN the output OSD00 will be set to 1.

The monitoring of communication is active in all operational statuses, for example in quick stop, stop, reference value 0 Hz or ≠ 0 Hz. Please note this function because in standstill of motor the drive control starts the motor by a communication error.

Activating the function
The error reaction 540-R-CAN should be set to Warning. The frequency reference must be parameterized ≠ 0 Hz.

Timeout on fixed frequency in case of field bus error
The monitoring time 971-EMTMR = 0s disables shutdown of the drive. If a monitoring time parameter is set, the drive stops frequency output when the set time ends. This means time monitoring can be used similarly to a watchdog in the event of an error. Resetting an error does not automatically terminate operation at the fixed frequency with E-CAN. This requires a status change via "preoperational".

Parameters:

No.	Name	Description	Value range	FS	Online
546	EMSPD	Reference frequency in case of Bus-Off	0...200	0 (function disabled)	
547	EMTMR	Time for which the reference frequency is held	0..65535 s	0 (no monitoring)	✓

No.	Name	Description	Value range	FS	Online
540	R-CAN	Reaktion bei CAN Bus Ausfall	0...6	1 = WARN	

8.19 Extended error memory

Parameters:

No.	Name	Description	Value range	FS	Online
545	ERLOG	List of error parameters		0	

The following error types are logged in the field parameter ERLOG with detailed system values. The field parameter works as a loop memory. Error logging is not carried out simultaneously with power-off, and is not backed by a checksum.

- E_OC Index 0-9
- E_OV Index 10-19
- E_OLI Index 20-29
- E_OTI Index 30-39
- E_BRC Index 40-49

Parameter ERLOG:

Field parameter 950-ERLOG	Function
Index (0)	Reference frequency before ramps
Index (1)	Reference frequency after ramps
Index (2)	Device heat sink temperature
Index (3)	DC link voltage
Index (4)	Motor current (I_{RMS})
Index (5)	Device operating hours
Index (6)	SZUE system state
Index (7)	Error counter (incremented on each occurrence)
Index (8)	Error location
Index (9)	Error type
Further errors are appended as blocks of 10 values in the index until the loop memory is full.	

8.20 Error localization in case of external error E-EXT

An analog or digital input can be parameterized via the function selector to trigger an error message by setting E-EXT. If the input is set, an error message is triggered dependent on the programmed error reaction 524-R-EXT. The displayed error message contains the error type and location. The inputs are coded in the error location.

Error type - Error location	Input
E-EXT - 00	Digital standard input ISD00
E-EXT - 01	Digital standard input ISD01
E-EXT - 02	Digital standard input ISD02
E-EXT - 03	Digital standard input ISD03
E-EXT - 04	Digital input extension module ISE00
E-EXT - 05	Digital input extension module ISE01

Error type - Error location	Input
E-EXT - 06	Digital input extension module ISE02
E-EXT - 07	Digital input extension module ISE03
E-EXT - 08	Digital input extension module ISE04
E-EXT - 09	Digital input extension module ISE05
E-EXT - 10	Digital input expansion module ISE06
E-EXT - 11	Digital input extension module ISE07
E-EXT - 12	Analog standard input ISA00
E-EXT - 13	Analog standard input ISA02

Notes:

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