PowerXL™

DG1 Variable Frequency Drives
Starting, Stopping and Operation

Level 2	1 – Fundamental – No previous experience necessary 2 – Basic – Basic knowledge recommended 3 – Advanced – Reasonable knowledge required 4 – Expert – Good experience recommended

Powering Business Worldwide

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Contents

Danger! - Dangerous electrical voltage!

- Disconnect the power supply of the device.
- Ensure that devices cannot be accidentally restarted.
- Verify isolation from the supply.
- Cover or enclose any adjacent live components.
- Follow the engineering instructions (AWA/IL) for the device concerned.
- Only suitably qualified personnel in accordance with EN 50110-1/-2 (VDE 0105 Part 100) may work on this device/system.
- Before installation and before touching the device ensure that you are free of electrostatic charge.
- The functional earth (FE, PES) must be connected to the protective earth (PE) or the potential equalization. The system installer is responsible for implementing this connection.
- Connecting cables and signal lines should be installed so that inductive or capacitive interference does not impair the automatic control functions.
- Suitable safety hardware and software measures should be implemented for the I/O interface so that an open circuit on the signal side does not result in undefined states.
- Deviations of the mains voltage from the rated value must not exceed the tolerance limits given in the specification, otherwise this may cause malfunction and/or dangerous operation.
- Emergency stop devices complying with IEC/EN 60204-1 must be effective in all operating modes. Unlatching of the emergency-stop devices must not cause a restart.
- Devices that are designed for mounting in housings or control cabinets must only be operated and controlled after they have been properly installed and with the housing closed.
- Wherever faults may cause injury or material damage, external measures must be implemented to ensure a safe operating state in the event of a fault or malfunction (e.g. by means of separate limit switches, mechanical interlocks etc.).
- Frequency inverters may have hot surfaces during and immediately after operation.
- Removal of the required covers, improper installation or incorrect operation of motor or frequency inverter may destroy the device and may lead to serious injury or damage.
- The applicable national safety regulations and accident prevention recommendations must be applied to all work carried on live frequency inverters.
- The electrical installation must be carried out in accordance with the relevant electrical regulations (e. g. with regard to cable cross sections, fuses, PE).
- Transport, installation, commissioning and maintenance work must be carried out only by qualified personnel (IEC 60364, HD 384 and national occupational safety regulations).
- Installations containing frequency inverters must be provided with additional monitoring and protective devices in accordance with the applicable safety regulations. Modifications to the frequency inverters using the operating software are permitted.
- All covers and doors must be kept closed during operation.
- To reduce the hazards for people or equipment, the user must include in the machine design measures that restrict the consequences of a malfunction or failure of the frequency inverter (increased motor speed or sudden standstill of motor). These measures include: – Other independent devices for monitoring safety related variables (speed, travel, end positions etc.).
- Electrical or non-electrical system-wide measures (electrical or mechanical interlocks).

Never touch live parts or cable connections of the frequency inverter after it has been disconnected from the power supply. Due to the charge in the capacitors, these parts may still be alive after disconnection. Consider appropriate warning signs.

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1 General

Depending on the application, demands on speed controlled systems can be much different. The spectrum reaches from a soft start up to cyclic operation in some seconds, from a spin start, where the motor is turning already at the time of starting up to dynamic braking, to mention only a few aspects.

At default, variable frequency drives of the series **PowerXL™ DG1** are configured to cover a plurality of applications. Additional adaptation can be achieved by changing parameter values.

This Application Note describes

- the different possibilities at starting and stopping
- the respective control commands
- the different ways of setpoint setting
- the setting of the relevant parameters
- the behavior in case of a fault
- measures to prevent unintended trips

Further information is available in the following application notes:

- AP040128EN Configuration of the analog I/Os
- AP040132EN Configuration of the digital I/Os

Note: When the expression “setpoint” or “reference” is used inside this document, it is generally related to speed.

2 Configurable protective functions

There are multiple protective functions. They can be configured separately, which enables an adaptation to the application. This adaptation is only possible when the device is disabled (No active START signal).

In the so called „Fire Mode“ some protective functions are disabled, to enable an operation of the variable frequency drive, even with active warning and fault messages. See application note AP040065EN “Smoke Mode and Fire Mode”.

Configurable protective functions have multiple choices:

- No Action
  - The fault message will be ignored.
- Warning
  - The variable frequency drive keeps on running.
  - A warning message is displayed on the keypad.
  - A relay contact closes respectively a digital output is activated, when they are configured accordingly (P5.1 … P5.6 = 5: Warning)
  - A warning can be reset (see 7.3.4) immediately after elimination of the cause or disappears automatically after about 5 s.
- Fault
  - The drive stops according to the setting of P7.10 “Stop Mode” (see chapter 8.1).
    - Note: With P7.10 = “1: Ramp” the fault message appears directly when the fault occurs and not only when standstill is reached.
  - A fault message is displayed on the keypad
  - A relay contact respectively a digital output switches, when they are configured accordingly.
    - P5.1 … P5.6 = 3: Fault
      - Fault → relay contact closes respectively a digital output is activated
    - P5.1 … P5.6 = 4: Fault Invert
      - Fault → relay contact opens respectively a digital output is deactivated
  - The fault has to be reset (see 7.3.4).
- Fault, Coast
  - The drive coasts, not depending on the setting of P7.10 “Stop Mode” (see chapter 8.1).
  - A fault message is displayed on the keypad
  - A relay contact respectively a digital output switches, when they are configured accordingly.
    - P5.1 … P5.6 = 3: Fault
      - Fault → relay contact closes respectively a digital output is activated
    - P5.1 … P5.6 = 4: Fault Invert
      - Fault → relay contact opens respectively a digital output is deactivated
  - The fault has to be reset (see 7.3.4).

2.1 Behavior at power-on

P9.20 „Line Start Lockout“

This parameter determines the behavior of the device, when it will be supplied (terminals L1/L2/L3) and a START signal is active at the same time. It is distinguished, if the selected operating mode (Local / Remote, see chapter 6.2) is the same, compared to the one before the latest disconnection or if it has changed.

P9-20	Operating mode is the same	Operating mode has changed
0	Drive starts	Rising edge of the START signal required
1	Rising edge of the START signal required	Rising edge of the START signal required
2	Drive starts	Drive starts
3	Rising edge of the START signal required	Drive starts

Parameter	Name	Range	Default
P9.20	Line Start Lockout	0: Disabled, No Change 1: Enable, No Change 2: Disabled, Changed 3: Enable, Changed	2: Disabled, Changed

2.2 STO

P9.56: STO Fault Response

The behavior of the device depending on the setting of P9.56 is described in chapter 2. It has to be noted in this case, that the device trips in any case, when the connection between the terminals STO+ and STO- is missing, even when “P9.56 = 1: Warning” is selected. The signalling is then done according to the setting “Warning” and not to “Fault”. A reset is not required. To restart a rising edge of the START signal is necessary.

Parameter	Name	Range	Default
P9.56	STO Fault Response (Fault Code 66)	0: No Action 1: Warning 2: Fault	2: Fault

2.3 Automatic restart after a fault

In case of a fault the variable frequency drive must be reset (see chapter 7.3.4). In case of the following fault messages an automatic restart is possible:

- Undervoltage (P9.27)
- Overvoltage (P9.28)
- Overcurrent (P9.29)
- 4mA fault (P9.30)
- Motor Temp Fault (P9.31)
- External Fault (P9.32)
- Underload (P9.33)

The parameter in brackets determine the number of attempts to restart, before the variable frequency drive must be reset manually after the root cause of the fault is eliminated.

Note: Please make sure, that no danger occurs when restarting automatically!

P9.24 „AR Wait Time“
Time after the occurrence of a fault, that has to expire, before an automatic restart is possible.

P9.25 „AR Trail Time“
Time after the Wait Time, in which an automatic restart has to be performed. When a restart is not done during the AR Trail Time, the drive switches into fault mode. No further restart will be performed and the drive must be reset manually after the root cause of the fault is eliminated (see chapter 7.3.4).

P9.26 „AR Start Function“
This parameter determines, if an automatic restart is performed with a ramp or as a flying start. Details see chapter 6.5 “Start mode”.

Parameter	Name	Range	Default
P9.24	AR Wait Time	1,00 … 300 s	1 s
P9.25	AR Trail Time	0 … 600 s	30 s
P9.26	AR Start Function	0: Flying Start 1: Ramp	0: Flying Start

2.4 Power part supervision

2.4.1 Supply side

The behavior of the device depending on the settings of P9.4 and P9.5 is described in chapter 2.

Parameter	Name	Range	Default
P9.4	Input Phase Fault (Fault Code 10)	0: No Action 1: Warning 2: Fault 3: Fault, Coast	2: Fault
P9.5	Uvolt Fault Response (Fault Code 9)	0: No Action 1: Warning 2: Fault 3: Fault, Coast	2: Fault

2.4.2 DC link

The setting of P9.27 and P9.28 determine the number of attempts of an automatic restart after an undervoltage (P9.27) respectively an overvoltage in the DC link. With the setting „0“ the drive trips and a fault message is displayed. See also chapter 2.3 “Automatic restart after a fault”.

Parameter	Name	Range	Default
P9.27	Undervoltage Attempts	0 … 10	1
P9.28	OverVoltage attempts	0 … 10	1

2.4.3 Motor circuit

P9.6 „Output Phase Fault“
Determination of the drive’s reaction to an asymmetric load (> 5 %) at the output. The behavior of the device depending on the settings is described in chapter 2.

P9.7 “Ground Fault”
Determination of the drive’s reaction in case of a ground fault. The tripping threshold is set with P9.44. Independently from this setting the variable frequency drive is protected against high leakage currents to ground by the overcurrent protection. The behavior of the device depending on the settings is described in chapter 2.

P9.44 „Ground Fault Limit“
Threshold of the ground fault protection.

Parameter	Name	Range	Default
P9.6	Output Phase Fault (Fault Code 63)	0: No Action 1: Warning 2: Fault 3: Fault, Coast	2: Fault
P9.7	Ground Fault (Fault Code 3)	0: No Action 1: Warning 2: Fault 3: Fault, Coast	2: Fault
P9.44	Ground Fault Limit	0 … 30 %	15 %

2.5 Motor protection

The devices of the series DG1 have multiple possibilities to protect the connected motor against overload.

- the internal I^2t calculator
- stall protection (blocking protection)
- a thermistor connection
- an extension module to connect PT100 resistors

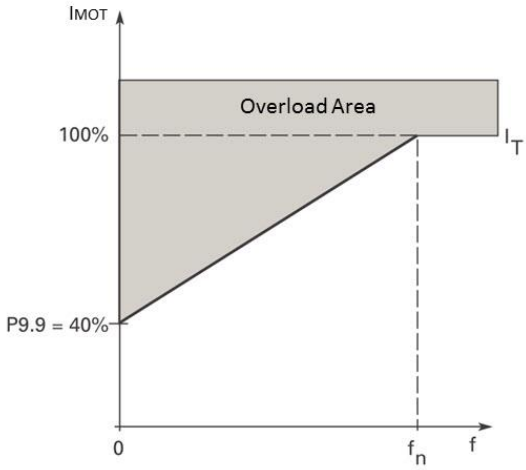
2.5.1 Internal I^2t calculator

P9.8 „Motor Thermal Protection“

Determination of the drive’s reaction in case of a calculated over temperature inside the motor. The calculation is based on the set motor data and the monitoring values during run. The behavior of the device depending on the settings is described in chapter 2.

P9.9 „Motor Thermal F0 Current“

Beside the losses inside the motor, their dissipation to the outside is responsible for the motor temperature. In many cases the standard induction motor is cooled by a fan on the motor’s shaft, whose cooling power is reduced at lower speeds. Therefore the motor can only be operated permanently in the lower speed range, when the load is reduced. To ensure motor protection also in this range, the tripping curve of the motor protection can be adopted accordingly. P9.9 determines the value at standstill. From here the tripping curve continues linearly up to the rated frequency of the motor, where the tripping curve is defined by P1.5 “Motor Nom Current”. The default setting is a typical value. It is recommended to contact the motor manufacturer and to change the value of P9.9 in case it is required by the application.



P9.10 „Motor Thermal Time“

The thermal time constant of the motor has to be set. This is the time in which the motor has reached 63 % of its maximum temperature. It depends on the motor size and is bigger for large motors than for small ones. Furthermore it can vary depending on the motor manufacturer at the same motor size.

Tripping class acc. to IEC/EN 60947-4-1	P9.10
Class 5	2 s
Class 10	5 s
Class 15	8 s
Class 20	11 s
Class 30	16 s
Class 40	22 s

If the tripping class according to IEC/EN 60947-4-1 of a protective device for this motor is known, the setting of P9.10 can be done according to the adjacent table.

When the drive is in stop mode, the time constant is increased by a factor of three. This takes into account, that the motor is only cooled by convection, because the fan is not effective in this case.

Parameter	Name	Range	Default
P9.8	Motor Thermal Protection (Fault Code 16)	0: No Action 1: Warning 2: Fault 3: Fault, Coast	2: Fault
P9.9	Motor Thermal F0 Current	0 … 150 % Motor Nom Current (P1.5)	40 %
P9.10	Motor Thermal Time	1 … 200 s	45 s

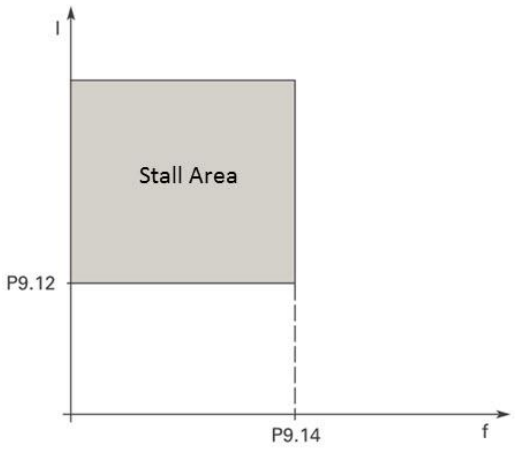
2.5.2 Stall protection (Blocking protection)

P9.11 „Stall Protection“

The stall protection is an overcurrent protection, which shall protect the motor in cases similar to a blockage of the rotor. The tripping criteria can be set with P9.12 “Stall Current Limit”, P9.13 “Stall Time Limit” and P9.14 “Stall Frequency Limit”. P9.11 determines the drive’s reaction when the stall protection trips. The behavior of the device depending on the settings is described in chapter 2.

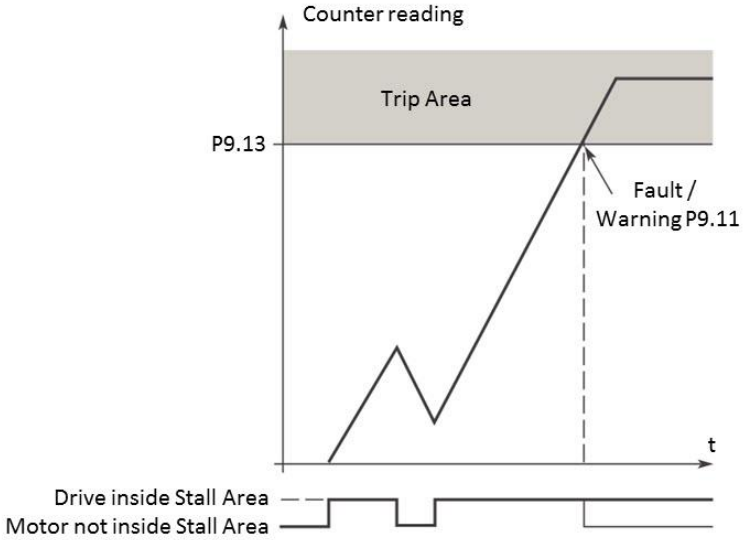
P9.12 „Stall Current Limit“

Determination of the stall area. The motor current must exceed the value set with P9.12 „Stall Current Limit“ to activate the stall protection. When the setting of parameter P1.5 “Motor Nom Current” is changed, the value of P9.12 is reset to the default one.



P9.13 „Stall Time Limit“

P9.13 defines the maximum time, for which a motor is allowed to operate inside the stall area before the stall protection trips. It can be set between 1.0 and 120.0 s. An internal counter increases its reading during an operation inside the stall area and reduces it during an operation outside this area. When the counter has reached the reading defined with P9.13, the drive behaves as defined with P9.11.



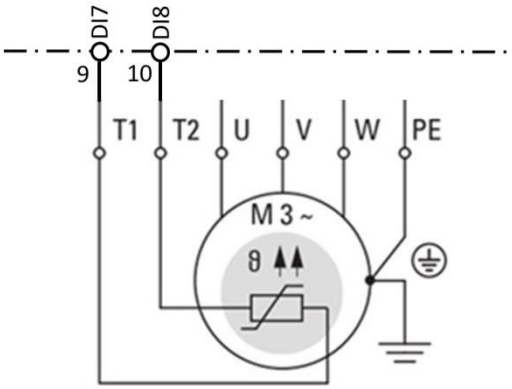
P9.14 „Stall Frequency Limit“

To activate the message „motor stalled“ the output frequency must be below the threshold defined with P9.14 and the current must be above the value of P9.12.

Parameter	Name	Range	Default
P9.11	Stall Protection (Fault Code 15)	0: No Action 1: Warning 2: Fault 3: Fault, Coast	0: No Action
P9.12	Stall Current Limit	0.1 … 2 • Motor Nom Current (P1.5)	f (I_e)
P9.13	Stall Time Limit	1.0 … 120.0 s	15.0 s
P9.14	Stall Frequency Limit	1 Hz … f-max (P1.2)	25 Hz

2.5.3 Thermistor

Thermistors inside the motor can be connected to devices of the series DG1 for temperature monitoring. They are connected to the terminals 9 and 10 (DigIN: 7 and DigIN: 8), when P3.4 “Thermistor Input Select” is set to “1: Thermistor Input”. Furthermore a thermistor can also be connected to the extension module DXG-EXT-3DI3DO1T.



ATTENTION: Variable frequency drives of the series DG1 are designed according IEC / EN 61800-5-1, which requires double isolation between mains circuits and circuits with low voltage. Inside the drive power part and control part are separated accordingly. In case temperature sensors inside the motor are connected to DG1, the sensors have to be double isolated against the motor windings, not to weaken the overall insulation system!

P3.4 „Thermistor Input Select“
The setting of P3.4 determines, if the digital inputs DigIN: 7 and DigIN: 8 are used as digital inputs or for the connection of a thermistor.

- P3.4 = 0: Digital Input
- P3.4 = 1: Thermistor Input

P9.19 „Thermistor Fault Response“
P9.19 determines the drive’s reaction in case the resistance of a thermistor, connected to the control board or at the extension module DXG-EXT-3DI3DO1T is out of range (> 4.7 kΩ or short-circuited). The behavior of the device depending on the settings is described in chapter 2.

P9.31 „Motor Temp Fault Attempts“
The setting of P9.31 determines the number of attempts of an automatic restart after a thermistor fault. With the setting „0“ the drive trips and a fault message is displayed. See also chapter 2.3 “Automatic restart after a fault”.

Parameter	Name	Range	Default
P3.4	Thermistor Input Select	0: Digital Input 1: Thermistor Input	0: Digital Input
P9.19	Thermistor Fault Response (Fault Code 29)	0: No Action 1: Warning 2: Fault 3: Fault, Coast	2: Fault
P9.31	Motor Temp Fault Attempts	0 … 10	1

2.5.4 PT100

P9.35 „PT100 Fault Response“

P9.35 determines the drive’s reaction in case the resistance of the PT100 sensors, connected to the extension module DXG-EXT-THER1, are out of range. The behavior of the device depending on the settings is described in chapter 2.

Parameter	Name	Range	Default
P9.35	PT100 Fault Response (Fault Code 56)	0: No Action 1: Warning 2: Fault 3: Fault, Coast	2: Fault

2.6 Underload protection

P9.15 „Underload Protection“

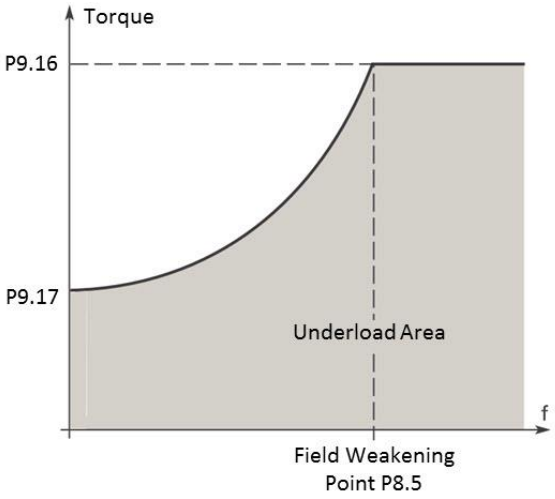
The underload protection protects the machine in case of a too low torque, e.g. when a V-belt is broken. The tripping criteria are set with the parameters P9.16 “Underload Fnom Torque”, P9.17 “Underload F0 Torque” and P9.18 “Underload Time Limit”. P9.15 determines the drive’s reaction in case of an underload trip. The behavior of the device depending on the settings is described in chapter 2.

P9.16 „Underload Fnom Torque“

This parameter determines the minimum torque in the field weakening area (above the value of P8.5 “Field Weakening Point”). When the setting of parameter P1.5 “Motor Nom Current” is changed, the value of P9.16 is reset to the default one.

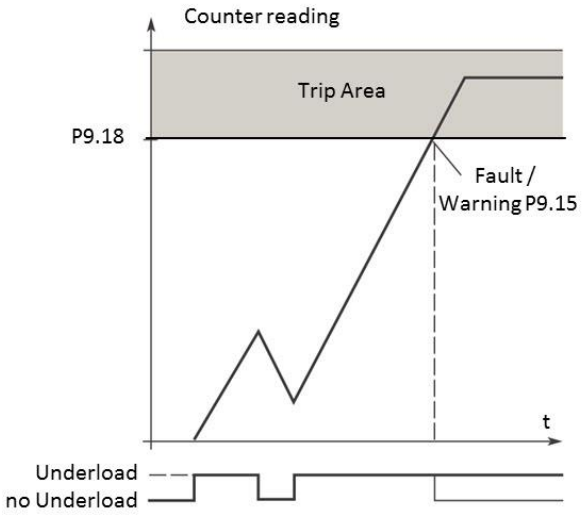
P9.17 „Underload F0 Torque“

This parameter determines the minimum torque at standstill. When the setting of parameter P1.5 “Motor Nom Current” is changed, the value of P9.17 is reset to the default one.



P9.18 „Underload Time Limit“

This is the maximum time, during which the motor can work in the underload area before the underload protection trips. It can be set between 2.0 and 600.0 s. An internal counter increases its reading during an operation inside the underload area and reduces it during an operation outside this area. When the counter has reached the reading defined with P9.18, the drive behaves as defined with P9.15.



P9.33 „Underload Attempts“

The setting of P9.33 determines the number of attempts of an automatic restart after a motor underload fault. With the setting „0“ the drive trips and a fault message is displayed. See also chapter 2.3 “Automatic restart after a fault”.

Parameter	Name	Range	Default
P9.15	Underload Protection (Fault Code 17)	0: No Action 1: Warning 2: Fault 3: Fault, Coast	0: No Action
P9.16	Underload Fnom Torque	10 … 150 % M_N of the motor	50 % M_N
P9.17	Underload F0 Torque	5 … 150 % M_N of the motor	10 % M_N
P9.18	Underload Time Limit	2 … 600 s	20 s
P9.33	Underload Attempts	0 … 10	1

2.7 Live zero fault (4…20 mA)

This fault message appears in case of a rupture of the wire for the analog setpoint signal. It is used, when the parameters P2.2.2 “AI1 Signal Range” respectively AI2.3.2 “AI2 Signal Range” are set to “1: 20-100%/4-20mA/2-10V/-6…+10V”. See also application note AP040129EN “Configuration of the analog I/Os”.

The signal at the analog input must be below 4 mA for 5 s respectively below 0.5 mA for 0.5 s before the live zero fault becomes active. For voltage signals at the analog input the values apply accordingly.

P9.1 „4mA Input Fault“

P9.1 determines the drive’s reaction in case of a “AIN<4mA(4to20mA)” fault. The behavior of the device depending on the settings is described in chapter 2. In this case two additional types of warning message exist:

- P9.1 = 2: Warning: Previous Freq
  - When undercutting the minimum analog set point value, the drive continues to run with the speed it had previously. Warning messages as described in chapter 2.

- P9.1 = 3: Warning: Preset Freq
  - When undercutting the minimum analog set point value, the drive continues to run with the speed defined with P9.2. Warning messages as described in chapter 2.

P9.2 „4mA Fault Frequency“
Frequency in the range between 0.00 Hz and P1.2 „f-max“, with which the motor continues to run in case of an undercutting of the minimum analog value when P9.1 is set to “3: Warning: Preset Freq”.

P9.30 „4mA Fault Attempts““
The setting of P9.30 determines the number of attempts of an automatic restart after a 4mA fault. With the setting „0“ the drive trips and a fault message is displayed. See also chapter 2.3 “Automatic restart after a fault”.

Parameter	Name	Range	Default
P9.1	4mA Input Fault (Fault Code 50)	0: No Action 1: Warning 2: Warning: Previous Freq 3: Warning: Preset Freq 4: Fault 5: Fault, Coast	0: No Action
P9.2	4mA Fault Frequency	0.00 Hz … f-max (P1.2)	0.00 Hz
P9.30	4mA Fault Attempts	0 … 10	1

2.8 PID feedback fault

P9.51 „PID Feedback AI Loss Response“
P9.51 determines the drive’s reaction in case the analog feedback signal of a PID controller is below the value defined with P9.53. The behavior of the device depending on the settings is described in chapter 2. In this case two additional types of warning message exist:

- P9.51 = 3: Warning: Preset Freq
  - When undercutting the minimum analog set point value, the drive continues to run with the speed defined with P9.52. Warning messages as described in chapter 2.
- P9.51 = 4: Warning: Analog → Net
  - When undercutting the minimum analog set point value, the drive continues to run. The setpoint comes from the network in this case. Warning messages as described in chapter 2.

P9.52 „f@PID AFL“
Frequency in the range between 0.00 Hz and P1.2 „f-max“, with which the motor continues to run in case of an undercutting of the minimum analog value when P9.51 is set to “3: Warning: Preset Freq”.

P9.53 „PID Feedback AI Loss Pipe Fill Loss Level“
When the feedback value at the analog input undercuts the value of P9.53, the drive runs with a frequency defined with P9.52 (P9.51 = 3) respectively with the speed of the network (P9.51 = 4). After the time set with P9.54 the drive reacts according to the setting of P9.51.

P9.54 „PID Feedback AI Loss PreFreq Timeout“
Maximum time for which the drive runs with a preset frequency or a reference coming from the network, before a warning message is generated.

P9.55 „PID Feedback AI Loss Attempts“
The setting of P9.55 determines the number of attempts of an automatic restart after a PID Feedback AI Loss fault. With the setting „0“ the drive trips and a fault message is displayed. See also chapter 2.3 “Automatic restart after a fault”.

Parameter	Name	Range	Default
P9.51	PID Feedback AI Loss Response (PID1: Fault Code 98) (PID2: Fault Code 99)	0: No Action 1: Warning 2: Fault 3: Warning: Preset Freq 4: Warning Analog → Net	0: No Action
P9.52	PID Feedback AI Loss Pre Freq	0.00 Hz … f-max (P1.2)	0.00 Hz
P9.53	PID Feedback AI Loss Pipe Fill Loss Level	0 … 1000 (unit depending on the process variable)	0
P9.54	PID Feedback AI Loss Pre-Freq Timeout	0 … 6000 s	0 s
P9.55	PID Feedback AI Loss At-tempts	0 … 10	1

2.9 Communication / Network

P9.21 and P9.38 determine the drive’s reaction in case of communication problems with the connected network. In case of a COM fault the displayed message and fault code depend on the type of network. See also chapter 7.3.1.

The behavior of the device depending on the settings is described in chapter 2.

Parameter	Name	Range	Default
P9.21	Fieldbus Fault Response (Fault Codes 83 up to 88)	0: No Action 1: Warning 2: Fault 3: Fault, Coast 4: Warning, Coast	2: Fault
P9.38	IP Address Confliction Resp (Fault Code 18)	0: No Action 1: Warning 2: Fault 3: Fault, Coast	1: Warning

2.10 VFD hardware

P9.22 „OPTCard Fault Response“
P9.22 determines the drive’s reaction in case an extension module is not plugged in properly or is defective. The behavior of the device depending on the settings is described in chapter 2.

P9.29 „OverCurrent Attempts“
The setting of P9.29 determines the number of attempts of an automatic restart after an overcurrent trip. With the setting „0“ the drive trips and a fault message is displayed. See also chapter 2.3 “Automatic restart after a fault”.

P9.34 „RTC Fault“
P9.34 determines the drive’s reaction in case of a fault of the internal real time clock (RTC). The behavior of the device depending on the settings is described in chapter 2.

P9.36 „Replace Battery Fault Response“
P9.36 determines the drive’s reaction in case the battery of the real time clock (RTC) needs to be changed. The behavior of the device depending on the settings is described in chapter 2. Further information see application note AP040172EN “Real Time Clock and Use of the Timers”.

P9.37 „Replace Fan Fault Response“
P9.37 determines the drive’s reaction when the remaining life span of the internal fan is less than 2 months. The behavior of the device depending on the settings is described in chapter 2.

P9.45 „Keypad Comm Fault Response“
P9.45 determines the drive’s reaction when the connection between the keypad and the variable frequency drive is lost in case the keypad is selected as a source for the reference and/or START signal. The behavior of the device depending on the settings is described in chapter 2.

Parameter	Name	Range	Default
P9.22	OPTCard Fault Response (Fault Code 54)	0: No Action 1: Warning 2: Fault 3: Fault, Coast	2: Fault
P9.29	OverCurrent Attempts	0 … 3	1
P9.34	RTC Fault (Fault Code 55)	0: No Action 1: Warning 2: Fault 3: Fault, Coast	1: Warning
P9.36	Replace Battery Fault Response (Fault Code 64)	0: No Action 1: Warning 2: Fault 3: Fault, Coast	1: Warning
P9.37	Replace Fan Fault Response (Fault Code 65)	0: No Action 1: Warning 2: Fault 3: Fault, Coast	1: Warning
P9.45	Keypad Comm Fault Response (Fault Code 52)	0: No Action 1: Warning 2: Fault 3: Fault, Coast	2: Fault

2.11 Cold weather mode

The devices of the series DG1 are specified down to -10 °C. At lower temperatures there is a possibility to warm up the variable frequency drive with a current at low voltage and low frequency. Details see application note AP040058EN “Operating at low temperatures”.

P9.23 „Unit Under Temp Prot“
P9.23 determines the drive’s reaction when a too low temperature is detected. The behavior of the device depending on the settings is described in chapter 2.

P9.39 „Cold Weather Mode“
Activation of the cold weather mode.

P9.40 „Cold Weather Volt. Level“
Voltage, which drives the current when the cold weather mode is active.

P9.41 „Cold Weather Time Out“
If the temperature is still below -20 °C after the time defined with P9.41 “Cold Weather Time Out” the drive trips because of under temperature. After a Reset the procedure can be repeated to heat up the variable frequency drive furthermore.

Parameter	Name	Range	Default
P9.23	Unit Under Temp Prot (Fault Code 13)	0: No Action 1: Warning 2: Fault 3: Fault, Coast	2: Fault
P9.39	Cold Weather Mode	0: Disabled 1: Enabled	0: Disabled
P9.40	Cold Weather Volt. Level	0 … 20 % Motor Nom Voltage (P1.8)	2.0 %
P9.41	Cold Weather Time Out	0 … 10 min	3 min

2.12 Preheating the motor to prevent condensation

Depending on the environmental conditions on site it can come to condensate formation inside a motor when it is not in service. It is possible to drive a current across the motor to warm it up and to prevent this. This functionality must be enabled with parameter P9.46 “Preheat Mode”.

P9.46 „Preheat Mode“

- P9.46 = 0: Disabled
  - The preheat function is not available.
- P9.46 = 1: Enabled
  - When the temperature is inside the range defined with P9.48 “Preheat Enter Temp” and P9.49 “Preheat Quit Temp”, a voltage defined with P9.50 “Preheat Output Volt” is applied to the motor terminals. The motor warms up because of the current flow. When P9.49 is reached the current flow stops.

P9.47 „Preheat Control Source“
Definition of the temperature feedback source.

- P9.47 = 31: Drive Temperature
  - The temperature feedback value comes from the drive’s heatsink.
- P9.47 = 32…34 and 36…38: SlotA(B) PT100 Temp Channel x
  - The temperature feedback value comes from a PT100 resistor inside the motor, which is connected to an expansion module DXG-EXT-THER1.
- P9.47 = 35: SlotA Max PT100 Temp
  - The temperature feedback value is the highest one coming from PT100 resistors inside the motor, which are connected to an expansion module DXG-EXT-THER1 in Slot A.
- P9.47 = 39: SlotB Max PT100 Temp
  - The temperature feedback value is the highest one coming from PT100 resistors inside the motor, which are connected to an expansion module DXG-EXT-THER1 in Slot B.
- P9.47 = 40: SlotA and SlotB Max PT100 Temp
  - The temperature feedback value is the highest one coming from PT100 resistors inside the motor, which are connected to an expansion module DXG-EXT-THER1.

Parameter	Name	Range	Default
P9.46	Preheat Mode	0: Disabled 1: Enabled	0: Disabled
P9.47	Preheat Control Source	0: DigIN:NormallyOpen 1: DigIN:NormallyClose 2: DigIN 1 3: DigIN 2 4: DigIN 3 5: DigIN 4 6: DigIN 5 7: DigIN 6 8: DigIN 7 9: DigIN 8 10: DigIN: A: IO1: 1 (on DXG-EXT-3DI3DO1T) 11: DigIN: A: IO1: 2 (on DXG-EXT-3DI3DO1T) 12: DigIN: A: IO1: 3 (on DXG-EXT-3DI3DO1T) 13: DigIN: A: IO5: 1 (on DXG-EXT-6DI) 14: DigIN: A: IO5: 2 (on DXG-EXT-6DI) 15: DigIN: A: IO5: 3 (on DXG-EXT-6DI) 16: DigIN: A: IO5: 4 (on DXG-EXT-6DI) 17: DigIN: A: IO5: 5 (on DXG-EXT-6DI) 18: DigIN: A: IO5: 6 (on DXG-EXT-6DI) 19: DigIN: B: IO1: 1 (on DXG-EXT-3DI3DO1T) 20: DigIN: B: IO1: 2 (on DXG-EXT-3DI3DO1T) 21: DigIN: B: IO1: 3 (on DXG-EXT-3DI3DO1T) 22: DigIN: B: IO5: 1 (on DXG-EXT-6DI) 23: DigIN: B: IO5: 2 (on DXG-EXT-6DI) 24: DigIN: B: IO5: 3 (on DXG-EXT-6DI) 25: DigIN: B: IO5: 4 (on DXG-EXT-6DI) 26: DigIN: B: IO5: 5 (on DXG-EXT-6DI) 27: DigIN: B: IO5: 6 (on DXG-EXT-6DI)	31: Drive Temperature

Parameter	Name	Range	Default
		28: Time Channel 1 29: Time Channel 2 30: Time Channel 3 31: Drive Temperature 32: SlotA PT100 Temp Channel 1 33: SlotA PT100 Temp Channel 2 34: SlotA PT100 Temp Channel 3 35: SlotA Max PT100 Temp 36: SlotB PT100 Temp Channel 1 37: SlotB PT100 Temp Channel 2 38: SlotB PT100 Temp Channel 3 39: SlotB Max PT100 Temp 40: SlotA and SlotB Max PT100 Temp	
P9.48	Preheat Enter Temp	0 … 19.9 °C	10 °C
P9.49	Preheat Quit Temp	20.0 … 40.0 °C	20 °C
P9.50	Preheat Output Volt	0.0 … 20.0 % Motor Nom Voltage (P1.8)	2.0 %

2.13 External fault

The command „External Fault“ is used to include external digital signals (potential-free contacts as well as static signals e.g. coming from a PLC) into the fault management of DG1. It can be configured to which source (e.g. digital inputs) the signals are connected and if a HIGH or a LOW signal is linked to a fault condition. Up to three signals “External Fault 1…3” can be connected to the device. The fault code is “51” in all cases, but it is possible to have different display texts (P3.52 … P3.54).

P3.6 „Ext. Fault 1 NO“
P3.48 „Ext. Fault 2 NO“
P3.50 „Ext. Fault 3 NO“
Determination of the source for the external fault signal.

- LOW → No Fault
- HIGH → Fault

P3.7 „Ext. Fault 1 NC“
P3.49 „Ext. Fault 2 NC“
P3.51 „Ext. Fault 3 NC“
Determination of the source for the external fault signal.

- LOW → Fault
- HIGH → No Fault

P3.52 „Ext. Fault 1 Text“
P3.53 „Ext. Fault 2 Text“
P3.54 „Ext. Fault 3 Text“
Selection of the text, which is displayed in case of a fault.

P9.3 „External Fault“

P9.3 determines the drive’s reaction when an external fault is detected. The behavior of the device depending on the settings is described in chapter 2. It is the same one for all external faults (External Fault 1…3).

P9.32 „External Fault Attempts“

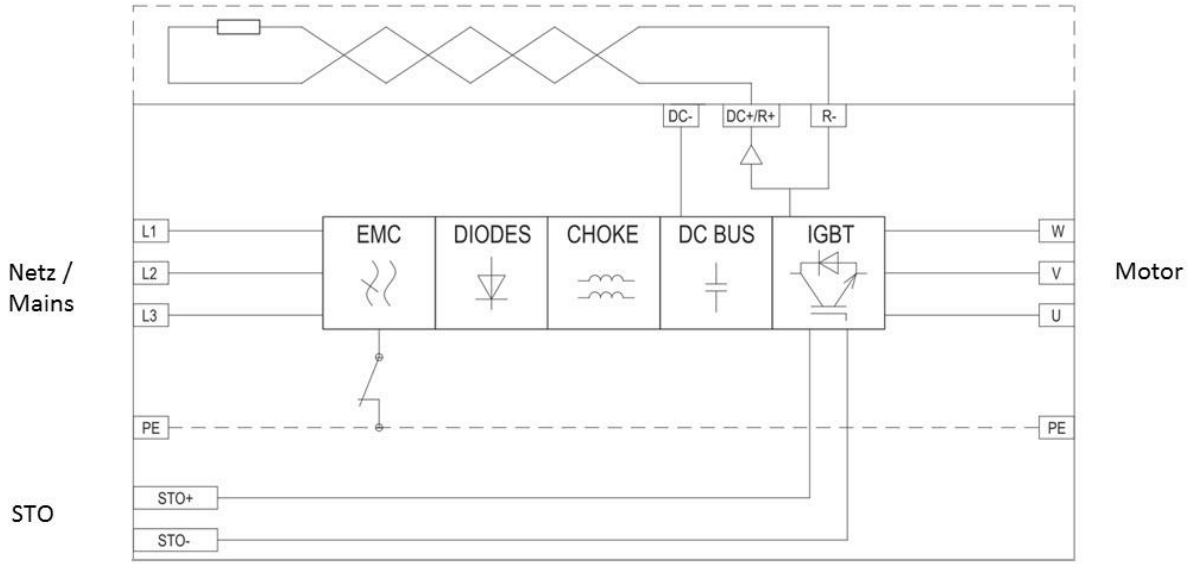
The setting of P9.32 determines the number of attempts of an automatic restart after an external fault. With the setting „0“ the drive trips and a fault message is displayed. See also chapter 2.3 “Automatic restart after a fault”.

Parameter	Name	Range	Default
P3.6	Ext. Fault 1 NO	0: DigIN:NormallyOpen 1: DigIN:NormallyClose 2: DigIN 1 3: DigIN 2 4: DigIN 3 5: DigIN 4 6: DigIN 5 7: DigIN 6 8: DigIN 7 9: DigIN 8 10: DigIN: A: IO1: 1 (on DXG-EXT-3DI3DO1T) 11: DigIN: A: IO1: 2 (on DXG-EXT-3DI3DO1T) 12: DigIN: A: IO1: 3 (on DXG-EXT-3DI3DO1T) 13: DigIN: A: IO5: 1 (on DXG-EXT-6DI) 14: DigIN: A: IO5: 2 (on DXG-EXT-6DI) 15: DigIN: A: IO5: 3 (on DXG-EXT-6DI) 16: DigIN: A: IO5: 4 (on DXG-EXT-6DI) 17: DigIN: A: IO5: 5 (on DXG-EXT-6DI) 18: DigIN: A: IO5: 6 (on DXG-EXT-6DI) 19: DigIN: B: IO1: 1 (on DXG-EXT-3DI3DO1T) 20: DigIN: B: IO1: 2 (on DXG-EXT-3DI3DO1T) 21: DigIN: B: IO1: 3 (on DXG-EXT-3DI3DO1T) 22: DigIN: B: IO5: 1 (on DXG-EXT-6DI) 23: DigIN: B: IO5: 2 (on DXG-EXT-6DI) 24: DigIN: B: IO5: 3 (on DXG-EXT-6DI) 25: DigIN: B: IO5: 4 (on DXG-EXT-6DI) 26: DigIN: B: IO5: 5 (on DXG-EXT-6DI) 27: DigIN: B: IO5: 6 (on DXG-EXT-6DI) 28: Time Channel 1 29: Time Channel 2 30: Time Channel 3 31: RO1 Function 32: RO2 Function 33: RO3 Function 34: Virtual RO1 Function 35: Virtual RO2 Function	4: DigIN3
P3.7	Ext. Fault 1 NC	see P3.6	1: NC
P3.48	Ext. Fault 2 NO	see P3.6	0: NO
P3.49	Ext. Fault 2 NC	see P3.6	1: NC
P3.50	Ext. Fault 3 NO	see P3.6	0: NO
P3.51	Ext. Fault 3 NC	see P3.6	1: NC

Parameter	Name	Range	Default
P3.52	Ext. Fault 1 Text	0: External Fault 1: Vibration Cut out 2: High Motor temp 3: Low Pressure 4: High Pressure 5: Low Water 6: Damper Interlock 7: Run Enable 8: Freeze Stat Trip 9: Smoke Detect 10: Seal Leakage 11: Rod Breakage	0: External Fault
P3.53	Ext. Fault 2 Text	see P3.52	1: Vibration Cut out
P3.54	Ext. Fault 3 Text	see P3.52	2: High Motor temp
P9.3	External Fault (Fault Code 51)	0: No Action 1: Warning 2: Fault 3: Fault, Coast	2: No Action
P9.32	External Fault Attempts	0 … 10	0

3 Power-on

Switching on the device means applying a voltage to the terminals L1, L2 and L3. The voltage rating depends on the device type.



When applying the supply voltage, the DC link capacitor will be charged. Current limiting elements are used to prevent an inrush peak of the current. After the charging, the elements are bypassed. They are not effective during operation. It has to be noted that the current limiting elements are not foreseen for a continuous duty. Therefore the number of starts per time is limited. Typical value: 1 charging per 60 s.

If the application requires a more frequent starting, the starting and stopping of the motor has to be done by the signals at the control terminals. The supply voltage remains at the terminals continuously and is only removed when the machine is switched off.

The choke in the DC link improves the current wave form on the mains side.

The devices contain the function „Safe Torque Off“ (STO) according IEC/EN 61800-5-2. To operate the variable frequency drive the terminals STO+ and STO- must be connected. Opening this connection leads to a coast of the motor. Torque cannot be produced any longer.

By default the devices have a right rotating field (cw) at the output terminals when direction FWD is selected. In case the motor has the wrong sense of rotation because of a wrong connection or because of mechanical reasons, the sense of the field at the output terminals can be changed by using parameter P7.29 “Change PhaseSequence Motor” without modifying motor connections.

P7.29 = 0: Change Disable → Right rotating field (cw) at terminals U-V-W
P7.29 = 1: Change Enable → Left rotating field (ccw) at terminals U-V-W

Parameter	Name	Range	Default
P7.29	Change PhaseSequence Motor	0: Change Disable 1: Change Enable	0: Change Disable

4 Speed limits and setpoint setting

4.1 Upper and lower speed limits

The speed range of the connected motor is determined by the parameters P1.1 „Min Frequency“ and P1.2 „Max Frequency“. The reference is linear between these two values.

Please note, that the value of P1.2 cannot be exceeded, even when multiple references are added up. The value of P1.1 cannot be undercut. This is true for both senses of rotation.

Parameter	Name	Range	Default
P1.1	Min Frequency	0.0 Hz … P1.2	0.0 Hz
P1.2	Max Frequency	P1.1 … 400 Hz	50.0 Hz

4.2 Sense of rotation

The sense of rotation can be selected in different ways:

- with digital commands at the terminals (FWD/REV)
- via the polarity of the reference (see application note AP040129EN “Configuration of the analog I/Os”)
- via fieldbus

4.2.1 Operating via terminals

The sense of rotation is selected with the signals FWD and REV. The setting of P3.1 “IO Terminal 1 Start Stop Logic” determines, how the signals have to be applied (see chapter 6.4).

- HIGH signal at FWD means right rotating field (cw)
- HIGH signal at REV means left rotating field (ccw)
- Are both signals present simultaneously, the motor turns into the direction of the signal, which was applied first.

4.2.2 Sense of rotation at pulse start / pulse stop

When P3.1 “IO Terminal 1 Start Stop Logic” is set to “3: Start Pulse - Stop Pulse” the sense of rotation is determined by the signal at the source defined with P3.5 “Reverse” (see also chapter 6.4).

- LOW → right rotating field (cw)
- HIGH → left rotating field (ccw)

Parameter	Name	Range	Default
P3.5	Reverse	0: DigIN:NormallyOpen ….. 35: Virtual RO2 Function See AP040132EN Configuration of the digital I/Os	0: NO

4.2.3 Operating via keypad

When the drive is switched ON and OFF with the keypad, the sense of rotation can be determined with parameter P7.4 “Keypad Direction”. There is a softkey for the reversal command, provided it is activated with P21.1.19.

P7.4 „Keypad Direction“

- P7.4 = 0: FWD → right rotating field (cw)
- P7.4 = 1: Reverse → left rotating field (ccw)

P21.1.19 „Reverse Softkey Hidden“

- P21.1.19 = 0: Disabled → Softkey not hidden
- P21.1.19 = 1: Enabled → Softkey hidden

Parameter	Name	Range	Default
P7.4	Keypad Direction	0: FWD 1: Reverse	0: FWD
P21.1.19	Reverse Softkey Hidden	0: Disabled 1: Enabled	0: Disabled

4.2.4 Blocking the reverse direction

The factory settings of the variable frequency drives DG1 enable an operation for both senses of rotation (FWD = cw, REV = ccw). The selection of the sense can be done via a digital signal, the polarity of the reference or via the fieldbus, depending on the application.

It is possible to block the reverse direction (ccw).

P1.16 „Reverse Enable“

- P1.16 = 0: Disabled
  - Only right rotating field at the terminals U, V and W is possible. When the reverse direction is selected at whatever source, the REV command is ignored and the drive is disabled. STP is displayed on the keypad.
- P1.16 = 1: Enabled
  - Both directions are possible.

Parameter	Name	Range	Default
P1.16	Reverse Enable	0: Disabled 1: Enabled	1: Enabled

4.3 Applying setpoint values

The actual frequency reference at the input of the ramp can be displayed with Parameter M2 “Freq Reference”.

4.3.1 Analog setpoint value

In many cases the reference value is applied as an analog signal. The device must be configured accordingly. The possible signal levels, their connection to the device as well as the possibilities for adaptation are comprehensively described in the application note AP040129EN “Configuration of the analog I/Os”.

4.3.2 Preset speeds

Preset speeds are setpoint values, which are defined once, e.g. during commissioning, and which are activated by a digital signal in case they are required. The devices of the series DG1 have up to 7 preset speeds Preset Speed 1 … Preset Speed 7), which can be selected independently.

4.3.2.1 Setting the frequencies

The preset speeds are defined with the parameters P12.1 “Preset Speed 1” up to P12.7 “Preset Speed 7”. Each speed can be set between zero and the maximum frequency (P1.2). It has to be noted, that the minimum frequency (P1.1) will not be undercut, even when the value of a preset speed is lower.

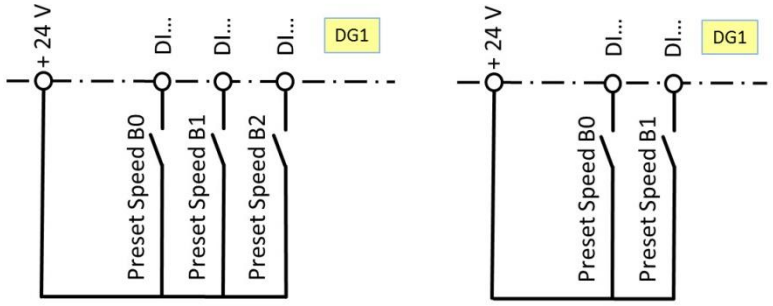
Example:
P1.1 „Min Frequency“ = 10 Hz
P12.1 „Preset Speed 1“ = 5 Hz
When preset speed 1 is selected the drive runs with 10 Hz.

Parameter	Name	Range	Default
P12.1	Preset Speed 1	0.00 Hz … P1.2 „Max Frequency“	5.00 Hz
P12.2	Preset Speed 2	0.00 Hz … P1.2 „Max Frequency“	10.00 Hz
P12.3	Preset Speed 3	0.00 Hz … P1.2 „Max Frequency“	15.00 Hz
P12.4	Preset Speed 4	0.00 Hz … P1.2 „Max Frequency“	20.00 Hz
P12.5	Preset Speed 5	0.00 Hz … P1.2 „Max Frequency“	25.00 Hz
P12.6	Preset Speed 6	0.00 Hz … P1.2 „Max Frequency“	30.00 Hz
P12.7	Preset Speed 7	0.00 Hz … P1.2 „Max Frequency“	35.00 Hz

The preset speeds are effective in both directions. The sense of rotation is defined according chapter 4.2.

4.3.2.2 Selecting the frequencies

The preset speeds can be selected via control signals at the terminals or via fieldbus. The selection is binary coded → for 7 preset speeds and the reference defined with Local / Remote, 3 bits are necessary (B0 … B2).



Picture above: Example for up to 7 (left) respectively up to 3 (right) preset speeds

	Preset Speed B2	Preset Speed B1	Preset Speed B0
Reference acc. Local / Remote	LOW	LOW	LOW
Preset Speed 1 (P12.1)	LOW	LOW	HIGH
Preset Speed 2 (P12.2)	LOW	HIGH	LOW
Preset Speed 3 (P12.3)	LOW	HIGH	HIGH
Preset Speed 4 (P12.4)	HIGH	LOW	LOW
Preset Speed 5 (P12.5)	HIGH	LOW	HIGH
Preset Speed 6 (P12.6)	HIGH	HIGH	LOW
Preset Speed 7 (P12.7)	HIGH	HIGH	HIGH

The assignment of control commands to terminals is done with the parameters P3.10 „Preset Speed B0“ up to P3.12 „Preset Speed B2“.

Parameter	Name	Range	Default
P3.10	Preset Speed B0	0: DigIN:NormallyOpen ….. 35: Virtual RO2 Function See AP040132EN Configuration of the digital I/Os	0: NO
P3.11	Preset Speed B1	0: DigIN:NormallyOpen ….. 35: Virtual RO2 Function See AP040132EN Configuration of the digital I/Os	0: NO
P3.12	Preset Speed B2	0: DigIN:NormallyOpen ….. 35: Virtual RO2 Function See AP040132EN Configuration of the digital I/Os	0: NO

4.3.3 Jogging

Jogging is frequently used during startup of a machine. In this case the machine runs with a frequency defined with P7.6 “Jog Reference”. Jogging can be performed in two different ways:

- with a HIGH-Signal at the source defined with P3.32 „Jog Enable“
  - LOW = No jogging
  - HIGH = Jogging
- With a softkey on the keypad, which has to be activated with P21.1.18 “Jog Softkey Hidden”
  - Press key JOG
  - Display: Enable Jog – Press OK
  - Press key OK
  - The machine runs in jogging mode.
  - Press key JOG
  - Display: Disable Jog – Press OK
  - Press key OK
  - Jogging mode will be disabled.

P21.1.18 „Jog Softkey Hidden“

- P21.1.18 = 0: Disabled → Softkey not hidden
- P21.1.18 = 1: Enabled → Softkey hidden

The Jogging mode takes priority over all other operating modes of the machine. Once the jogging signal is applied the drive runs to the speed defined with P7.6 „Jog Reference“. This reference must be in the range between the minimum frequency (P1.1) and the maximum frequency (P1.2).

The jogging command includes the start command. No other start signal is necessary. When jogging in both directions is required, the sense of rotation can be defined with the FWD and REV commands, see also chapter 6.4 “Configuring terminals for the start signal”.

When the keypad is used for jogging, the sense of rotation is defined by parameter P7.4 „Keypad Direction”.

Parameter	Name	Range	Default
P3.32	Jog Enable	0: DigIN:NormallyOpen ….. 35: Virtual RO2 Function See AP040132EN Configuration of the digital I/Os	0: NO
P7.6	Jog Reference	P1.1 „f-min“ … P1.2 „f-max“	0.00 Hz
P21.1.18	Jog Softkey Hidden	0: Disabled 1: Enabled	0: Disabled

4.3.4 Setpoint setting with the keypad

The frequency reference can be varied between P1.1 „Min Frequency“ and P1.2 „Max Frequency“ by using the buttons ▲ and ▼. It takes approximately 15 s to change from min to max frequency. It is the reference at the input of the ramp. This means:

- In case the ramp time is shorter than 15 s the drive accelerates/decelerates according to the adjustment of the reference.
- In case the ramp time is longer than 15 s the drive accelerates/decelerates according to the ramp times.
- The latest reference value is stored when the drive stops or is switched off. At the next start this value is effective. Acceleration and deceleration are performed according to the set ramp times. This also happens when the START signal is removed.

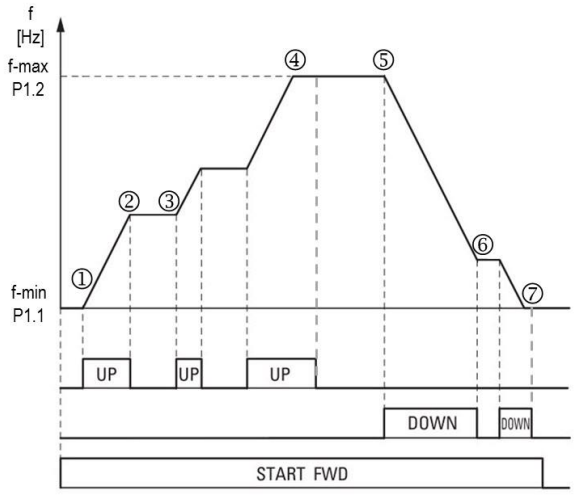
In addition to the setting of the reference with the arrow keys it is possible to set a reference value with parameter P7.3 “Keypad Reference”. When P7.3 is changed during operation, the drive ramps to this new speed without any further actuation of the buttons ▲ and ▼. This behavior can be used to start the drive with a defined speed reference and not with the one, which was effective before the latest stop.

Parameter	Name	Range	Default
P7.3	Keypad Reference	P1.1 „Min Frequency“ … P1.2 „Max Frequency“	0.00 Hz

4.3.5 Setpoint setting with digital commands (Motor pot)

The speed reference can also be changed with digital commands at the terminals. The command “Accel Pot Value” increases the reference, while “Decel Pot Value” reduces it. The advantage of the digital commands is the possibility to operate the machine from different places by paralleling the accel/decal contacts, which is sometimes required at expanded facilities.

The speed reference can be changed between P1.1 „Min Frequency“ and P1.2 „Max Frequency“.



① By applying the signal UP the output frequency is increased and the motor accelerates.
② The signal UP is removed. The motor keeps its speed.
③ The motor accelerates again, because the signal UP is applied.
④ When the maximum frequency (P1.2) is reached, the motor doesn’t accelerate any longer, even when the signal UP is applied.
⑤ The signal DOWN is applied. The motor decelerates.
⑥ The signal DOWN is removed. The motor keeps its speed.
⑦ When the minimum frequency (P1.1) is reached, the motor doesn’t decelerate any longer, even when the signal DOWN is applied.

P3.18 „Accel Pot Value“

This parameter determines the source, where the acceleration command is applied. When this command is active the speed reference will be increased with a rate set by P7.7 “Motor Pot Ramp Time”. The maximum value is P1.2 “Max Frequency”. If the acceleration and the deceleration commands are active simultaneously, acceleration has priority.

- P3.18 = LOW → Reference is not increased
- P3.18 = HIGH → Reference is increased

P3.19 „Decel Pot Value“

This parameter determines the source, where the deceleration command is applied. When this command is active the speed reference will be decreased with a rate set by P7.7 “Motor Pot Ramp Time”. The minimum value is P1.1 “Min Frequency”. If the acceleration and the deceleration commands are active simultaneously, acceleration has priority.

- P3.19 = LOW → Reference is not decreased
- P3.19 = HIGH → Reference is decreased

P7.7 „Motor Pot Ramp Time“

Change rate of the reference when the acceleration or deceleration command is applied. It determines the rate in Hz/s during a reference change. The ramp time is effective in addition. This means:

- In case the ramp time is shorter than the change rate when applying a digital signal, the drive follows the change rate during acceleration/deceleration.
- In case the ramp time is longer than the change rate when applying a digital signal, the drive follows the ramp time during acceleration/deceleration.
- In case the drive starts with the reference it had before the latest stop, the ramp is effective.

P7.8 „Motor Pot Ref Reset“

The speed reference at start is determined by P7.8 „Motor Pot Ref Reset“. It can be the reference value, which was effective before the latest stop as well as the “Min Frequency” (P1.1) after a reset of the reference value.

P7.8 = 0: No Reset

- No reset takes place. The drive starts with the reference, which was effective before the latest stop.

P7.8 = 1: Reset: Stop + Power Down

- At stop and/or at a removal of the supply voltage at the terminals L1/L2/L3 the reference is reset to „Min Frequency“ (P1.1).

P7.8 = 2: Reset: Power Down

- At a removal of the supply voltage at the terminals L1/L2/L3 the reference is reset to „Min Frequency“ (P1.1).
- After a stop no reset is performed. When the drive starts without removing the supply voltage at the terminals L1/L2/L3 before, it ramps to the speed, which was effective before the latest stop.

P3.20 „Reset Pot Zero“

A HIGH signal at the source specified here leads to a reset of the motor pot reference to “Min Frequency” (P1.1). A reset is possible during run and in this case the motor ramps from the actual frequency to “Min frequency”.

Parameter	Name	Range	Default
P3.18	Accel Pot Value	0: DigIN:NormallyOpen ….. 35: Virtual RO2 Function See AP040132EN Configuration of the digital I/Os	0: NO
P3.19	Decel Pot Value	0: DigIN:NormallyOpen ….. 35: Virtual RO2 Function See AP040132EN Configuration of the digital I/Os	0: NO
P3.20	Reset Pot Zero	0: DigIN:NormallyOpen ….. 35: Virtual RO2 Function See AP040132EN Configuration of the digital I/Os	0: NO

Parameter	Name	Range	Default
P7.7	Motor Pot Ramp Time	0.1 … 2000 Hz/s	10 Hz/s
P7.8	Motor Pot Ref Reset	0: No Reset 1: Reset: Stop + Power Down 2: Reset: Power Down	0: No Reset

4.4 Skip frequencies to prevent mechanical resonances

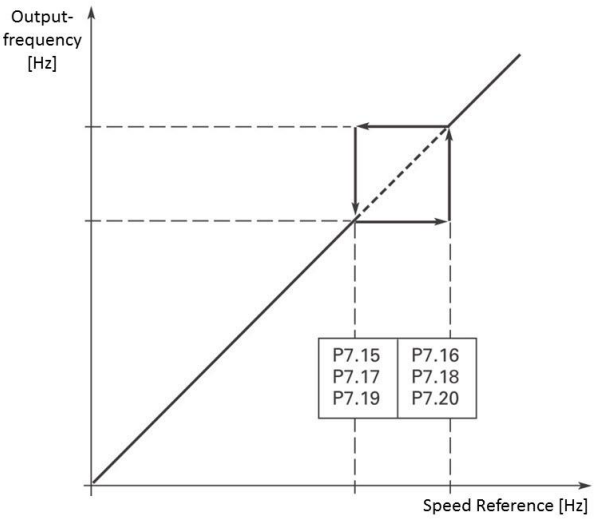
In some applications an operation of the motor in a certain frequency band leads to mechanical resonances, which can end up in a destruction of machine parts. The devices of the series **PowerXL™ DG1** have the possibility to skip up to three frequency bands for steady operation to avoid this effect.

Fading out frequencies is possible with all kind of reference signals, not depending on where they come from, e.g. analog input, fixed frequency, output of a PID controller, digital reference … , whatever is selected

Note: The high limit must be set before the low one. When deleting skip frequencies, the low limit must be deleted first.

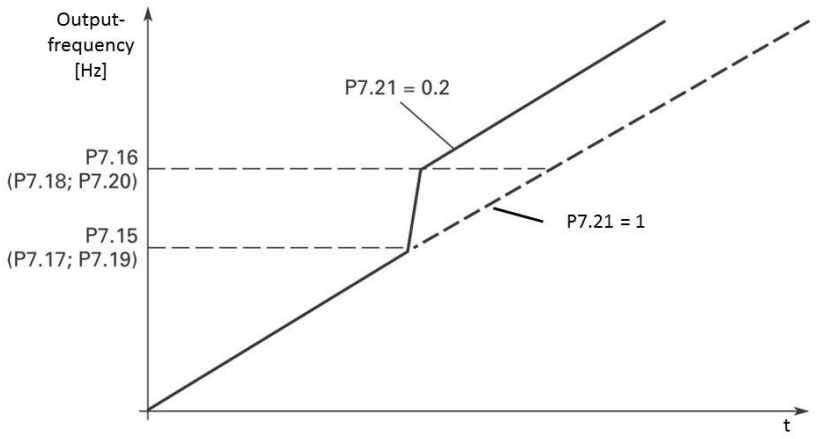
Skip Range	Low Limit	High Limit
F1	P7.15 „Skip F1 Low Limit“	P7.16 „Skip F1 High Limit“
F2	P7.17 „Skip F2 Low Limit“	P7.18 „Skip F2 High Limit“
F3	P7.19 „Skip F3 Low Limit“	P7.20 „Skip F3 High Limit“

Example:
A motor runs up to 50 Hz. In the range between 15 Hz and 25 Hz mechanical resonances can occur. Therefore the motor may not run inside this range steadily.
Low limit: P7.15 = 15 Hz
High limit: P7.16 = 25 Hz



How it works:
The reference is below the disabled range. → Drive runs with the set frequency. → Increase of reference into the disabled range → Motor accelerates and remains at the lower limit (in this example: 15 Hz). → Increase of reference above the disabled range → Motor accelerates to the new speed. → Motor operates above the disabled range according to the reference. → Reduction of reference into the disabled area → Motor decelerates and remains at the upper limit (in this example: 25 Hz). → Reduction of reference below the disabled area → Motor decelerates to the new speed.

P7.21 „Skip Range Ramp Factor“
When crossing the prohibited range the drive uses the ramp set with P1.03 / P1.04 by default. There is also a possibility to cross this area faster or slower. Parameter P7.21 is a factor, with which the ramp time is multiplied when the speed is inside the prohibited range.



Example:
A motor operates in the frequency range between 0 Hz and 50 Hz. The ramp time is 100 s. The range between 15 and 25 Hz is prohibited. Normally it is crossed in 20 s (100 s / 50 Hz • (25 Hz – 15 Hz) = 20s). When it shall be crossed in 2 s, P7.21 must be set to 0.1.

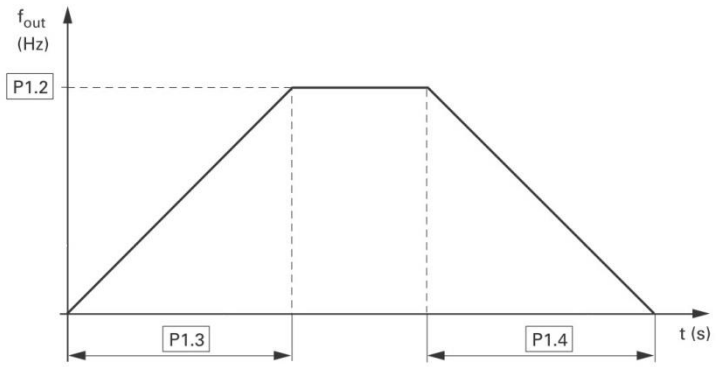
Parameter	Name	Range	Default
P7.15	Skip F1 Low Limit	0 Hz … P7.16 „Skip F1 High Limit“	0.00 Hz
P7.16	Skip F1 High Limit	P7.15 „Skip F1 Low Limit “ … P1.2 „Max Frequency“	0.00 Hz
P7.17	Skip F2 Low Limit	0 Hz … P7.18 „ Skip F2 High Limit “	0.00 Hz
P7.18	Skip F2 High Limit	P7.17 „Skip F2 Low Limit “ … P1.2 „Max Frequency“	0.00 Hz
P7.19	Skip F3 Low Limit	0 Hz … P7.20 „ Skip F3 High Limit “	0.00 Hz
P7.20	Skip F3 High Limit	P7.19 „Skip F3 Low Limit “ … P1.2 „Max Frequency“	0.00 Hz
P7.21	Skip Range Ramp Factor	0.1 … 10.0	1.0

5 The ramps

There are two ramps (ramp 1 and ramp 2), which can be set independently. A changeover between the ramps is done by using a digital signal. By default the ramps have a linear shape, which can be changed to an s-shape.

5.1 Linear Ramps

The time settings refer to a linear acceleration from standstill to the „Max Frequency“ (P1.2).



Ramp 1	acceleration	→	P1.3 „Accel Time 1“
	deceleration	→	P1.4 „Decel Time1“
Ramp 2	acceleration	→	P7.13 „Accel Time 2“
	deceleration	→	P7.14 „Decel Time 2“

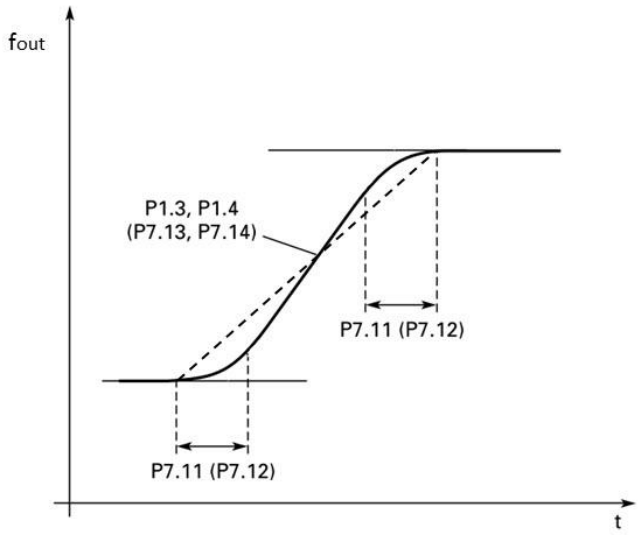
The selection between the ramps is described in chapter 5.3.

When the deceleration time is set too short, this leads to an energy feedback from the machine into the DC link and a trip of the variable frequency drive because of overvoltage. In this case, the value of the deceleration ramp must be increased or a brake resistor has to be used.

Parameter	Name	Range	Default
P1.3	Accel Time 1	0.1 … 3000 s	3 s
P1.4	Decel Time 1	0.1 … 3000 s	3 s
P7.13	Accel Time 2	0.1 … 3000 s	10 s
P7.14	Decel Time 2	0.1 … 3000 s	10 s

5.2 S-shaped ramps

Beginning and end of the ramps can be scattered with P7.11 (time constant for ramp 1) and with P7.12 (time constant for ramp 2). The setting 0.0 results in a linear ramp, higher ones in an s-shape of the ramp. Acceleration and deceleration times are set with P1.3 and P1.4 for ramp 1 and with P7.13 and P7.14 for ramp 2 according chapter 5.1.



Parameter	Name	Range	Default
P7.11	Ramp 1 Shape	0.1 … 10.0 s	0.0s
P7.12	Ramp 2 Shape	0.1 … 10.0 s	0.0s

5.3 Selecting the ramps

With factory settings, ramp 1 is active. Ramp 2 can be selected with a HIGH signal at the source defined with P3.15 „Accel/Decel Time Set".

The changeover between the ramps can also be performed depending on speed / frequency. The changeover threshold is defined with P7.28 "2nd Stage Ramp Frequency". See also chapter 5.3.1.

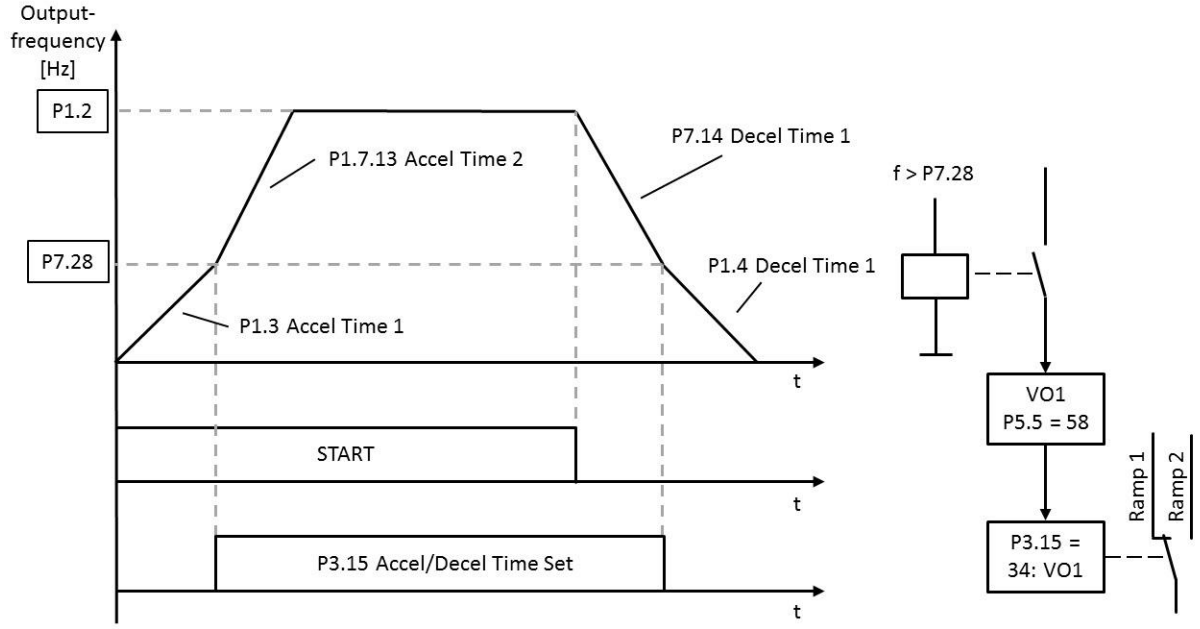
P3.15 „Accel/Decel Time Set"
Selection of the source for a changeover between the ramps.
LOW → Ramp 1
HIGH → Ramp 2

P7.28 „2nd Stage Ramp Frequency"
Determination of the frequency, above which the contact of an output relay closes or a virtual relay has HIGH signal, as far as selected (58: 2nd Stage Ramp Frequency Active). This signal is linked to P3.15 to changeover between the ramps. Below this frequency ramp 1 is active, above it ramp 2. See also chapter 5.3.1.

Parameter	Name	Range	Default
P3.15	Accel/Decel Time Set	0: DigIN:NormallyOpen ….. 35: Virtual RO2 Function See AP040132EN Configuration of the digital I/Os	0: NO
P7.28	2nd Stage Ramp Frequency	0.00 … 60.00 Hz	30.00 Hz

5.3.1 Example: Speed dependent ramp selection

A machine operates between 0 and 50 Hz. It shall accelerate from standstill to 20 Hz within 4 s, from 20 Hz to 50 Hz within 3 s. Speed reduction shall be slower: from 50 Hz to 20 Hz within 30 s and from 20 Hz to standstill within 10 s. The configuration shall be done in a way, that no relay output is required.



P1.1 „Min Frequency“ P1.1 = 0 Hz
The operating range starts at 0 Hz.

P1.2 „Max Frequency“ P1.2 = 50 Hz
The upper limit of the operating range is 50 Hz.

P1.3 „Accel Time 1“ P1.3 = 10 s
The time to be set here is the one from 0 to “Max Frequency” (P1.2). 20 Hz shall be reached in 4 s.
P1.3 = 4 s • (50 Hz / 20Hz) = 10 s

P1.4 „Decel Time 1“ P1.4 = 25 s
The time to be set here is the one from “Max Frequency” (P1.2) to standstill. 20 Hz to standstill shall be done in 10 s.
P1.4 = 10 s • (50 Hz / 20Hz) = 25 s

P7.13 „Accel Time 2“ P7.13 = 5 s
The time to be set here is the one from 0 to “Max Frequency” (P1.2). Accelerating from 20 Hz to 50 Hz shall be done in 3 s.
P7.13 = 3 s • (50 Hz / (50 Hz – 20 Hz) = 5 s

P7.14 „Decel Time 2“	P7.14 = 50 s The time to be set here is the one from “Max Frequency” (P1.2) to standstill. Decelerating from 50 Hz to 20 Hz shall be done in 30 s. P7.14 = 30 s • (50 Hz / 30Hz) = 30 s
P7.28 „2nd Stage Ramp Frequency“	P7.28 = 20 Hz The changeover between the ramps shall be at 20 Hz.
P5.5 „Virtual RO1 Function“	P5.5 = 58: 2nd Stage Ramp Frequency Active The virtual relays behave like internal markers. The function of a marker is selected out of the function list. In this case the marker shall have HIGH signal in case the threshold set with P7.28 is exceeded.
P3.15 „Accel/Decel Time Set“	P3.15 = 34: Virtual RO1 Function The function assigned to virtual relay RO1 shall cause the changeover between the ramps.

5.4 Freezing ramps

The ramps are effective at each change of the speed reference. There is also a possibility to „freeze“ the ramp

P3.16 „Accel/Decel Prohibit“
Selection of the source to freeze the ramp.

- P3.16 = LOW
  - The ramp is active at each change of the speed reference value.
- P3.16 = HIGH
  - The speed reference at the ramp’s output is frozen. It is the one which was effective at the time when a HIGH signal was applied. Changes of the speed reference value e.g. at the analog input do not lead to a speed change. At removal of the HIGH signal the drive ramps to a speed corresponding to the reference value, which is applied at this point in time.

Parameter	Name	Range	Default
P3.16	Accel/Decel Prohibit	0: DigIN:NormallyOpen ….. 35: Virtual RO2 Function See AP040132EN Configuration of the digital I/Os	0: NO

6 Starting

At start the device must be supplied with voltage at the terminals L1 / L2 / L3 and no fault message may be active (see chapter 7.3ff).

6.1 Required enable signals

The variable frequency drives of the DG1 series require 4 enabling conditions, which must be fulfilled simultaneously, to start the drive:

- STO
- Emergency Stop
- Run Enable
- Start signal

6.1.1 STO

The terminals STO+ and STO- must be connected with a potential free contact. When the connection is missing, the modulation of the inverter is disabled. The connected motor cannot generate any torque. This complies to the stopping function “Safe Torque Off (STO)” according to the product standard for functional safety of power drive systems PDS-SR (IEC/EN 61800-5-2). Interrupting the link between the terminals STO+ and STO- during run leads to a coast of the motor. In case the connection between STO+ and STO- is missing the fault message “STO” is displayed and a relay contact opens, provided it is configured for fault signaling.

6.1.2 Emergency Stop

The parameter P3.42 „Emergency Stop“ determines the source, where the signal must be applied. By default, P3.42 is set to “1: DigIN:NormallyClose”. This means, that the emergency stop signal is applied permanently. Removing the signal leads to a coast of the motor and a fault message is displayed (“Emergency Stop”, fault code 6, see chapter 7.3.1).

Note: Resetting the fault is not necessary. As soon as the signal is reapplied, the fault message is reset automatically.

Parameter	Name	Range	Default
P3.42	Emergency Stop	0: DigIN:NormallyOpen ….. 35: Virtual RO2 Function See AP040132EN Configuration of the digital I/Os	1: NC

6.1.3 Run Enable

Parameter P3.9 „Run Enable“ determines the source, where the signal must be applied. By default, P3.42 is set to “1: DigIN:NormallyClose”. This means, that the emergency stop signal is applied permanently. This signal can be linked to conditions, when it is configured correspondingly. This makes for example sense in cases, where the START signal comes via fieldbus and where it shall be possible to remove the START signal by hardware and not only depending on the fieldbus. The behavior of the motor (coasting or ramping) in case of removing the Run Enable signal depends on the setting of parameter P7.10 “Stop Mode” (see chapter 8.1).

In case the start signal is applied already before the run enable signal, it doesn't lead to a start of the drive. The start signal must be removed (LOW) and reapplied (HIGH) to start the drive. Exception see 6.1.5 "Starting delay"

- HIGH → Run Enable active
- LOW → Run Enable not active

Parameter	Name	Range	Default
P3.9	Run Enable	0: DigIN:NormallyOpen ….. 35: Virtual RO2 Function See AP040132EN Configuration of the digital I/Os	1: NC

6.1.4 Start signal

Applying the START signal leads to an acceleration of the drive according to the setting with P7.9 "Start Mode" (see chapter 6.5). The behavior of the motor (coasting or ramping) in case of removing the START signal depends on the setting of parameter P7.10 "Stop Mode" (see chapter 8.1).

The variable frequency drives of the DG1 series have the possibility to receive the START signal from different sources (terminals, fieldbus, keypad …). For each control source a source for the reference signal can be defined (see drawing in chapter 6.2).

6.1.5 Starting delay

This function is used to delay the start of a speed controlled motor, to bring other system elements like dampers and valves into the right position respectively to activate a lubricant pump.

P18.1.8 „Damper Start":

- P18.1.8 = 0: Normal
  - The function is deactivated. The drive starts when the start signal is applied.
- P18.1.8 = 1: Interlock Start
  - To use this setting, a relay output (RO1, RO2 or RO3) has to be assigned to the function „35: Damper Control". In addition P3.9 „Run Enable" has to be assigned to a digital input. When a start signal is applied, the relay contact closes and opens for example a lock valve. The position of the lock valve is fed back by an auxiliary contact to the digital input, defined with P3.9. When the signal is present at the input, the drive starts.
- P18.1.8 = 2: Interlock Tout
  - This setting basically works like the one described with P18.1.8 = 1. In addition there is a time monitoring, whose duration is set with P18.1.9 "Damper Time Out". Is the feedback with the auxiliary contact not given within the time specified here, the drive trips and displays "Start-up prevent" and starting must be repeated.
- P18.1.8 = 3: Interlock Delay
  - This setting basically works like the one described with P18.1.8 = 1, but without a feedback by an auxiliary contact. The drive starts after expiration of the time defined with P18.1.10 "Damper Delay".

P18.1.9 „Damper Time Out“
This parameter is used when P18.1.8 is set to „2“. It defines the time in which the feedback signal of an auxiliary contact is expected. In case the time is exceeded, the drive trips and displays “Start-up prevent” (fault code 26).

P18.1.10 „Damper Delay“
This parameter is used when P18.1.8 is set to „3“. It defines the time after applying the start signal, at which the drive starts.

Parameter	Name	Range	Default
P5.2 or P5.3 or P5.4	RO1 Function RO2 Function RO3 Function	0: Not Used … 35: Damper Control … 60: Run BypassDrive	
P18.1.8	Damper Start	0: Normal 1: Interlock Start 2: Interlock Tout 3: Interlock Delay	0: Normal
P18.1.9	Damper Time Out	1 – 32500 s	5 s
P18.1.10	Damper Delay	1 – 32500 s	5 s

6.2 Modes „Local“ and „Remote“

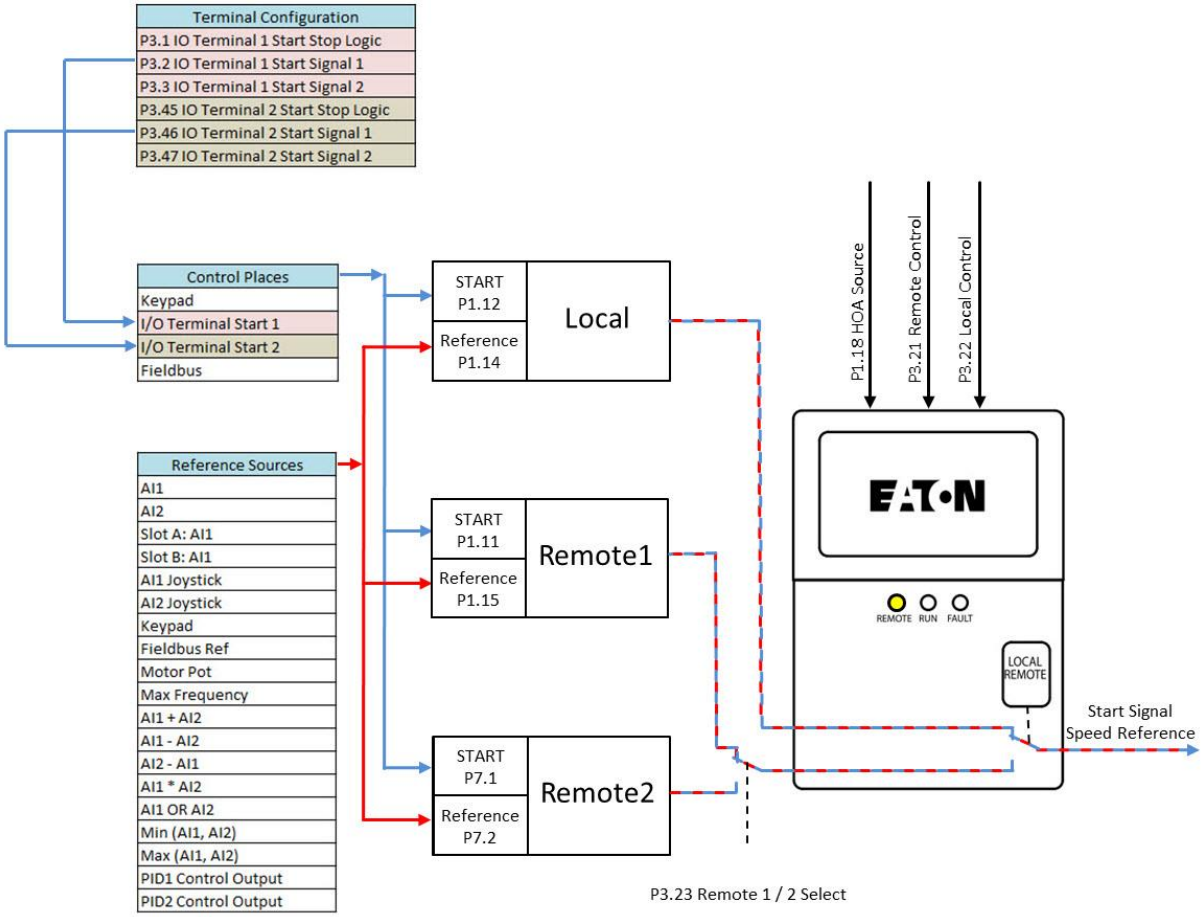
The variable frequency drives of the series **PowerXL™ DG1** have the operating modes

- Local
- Remote 1
- Remote 2

They differ in the sources for the START signal and for the speed reference (see drawing).

The devices can be used in a flexible way. Basically it comes back to the question, which source determines the START signal and which one the speed reference.

The drawing shows the basic structure.



A changeover between the operating modes is also possible during run. If a new START command is necessary after a changeover depends on the particular configuration.

The changeover is done by pushing the LOCAL REM button on the keypad.

- push button LOCAL REM
- You are asked, if you want to change to the other operating mode.
- If yes → push button OK
- In case the operating mode „Remote“ is active, the yellow LED REMOTE is shining.

Operating mode „Local“

- Selection of the source for the START signal with P1.12 “Local Control Place”
- Selection of the reference source with P1.14 „Local Reference“

Operating mode „Remote 1“

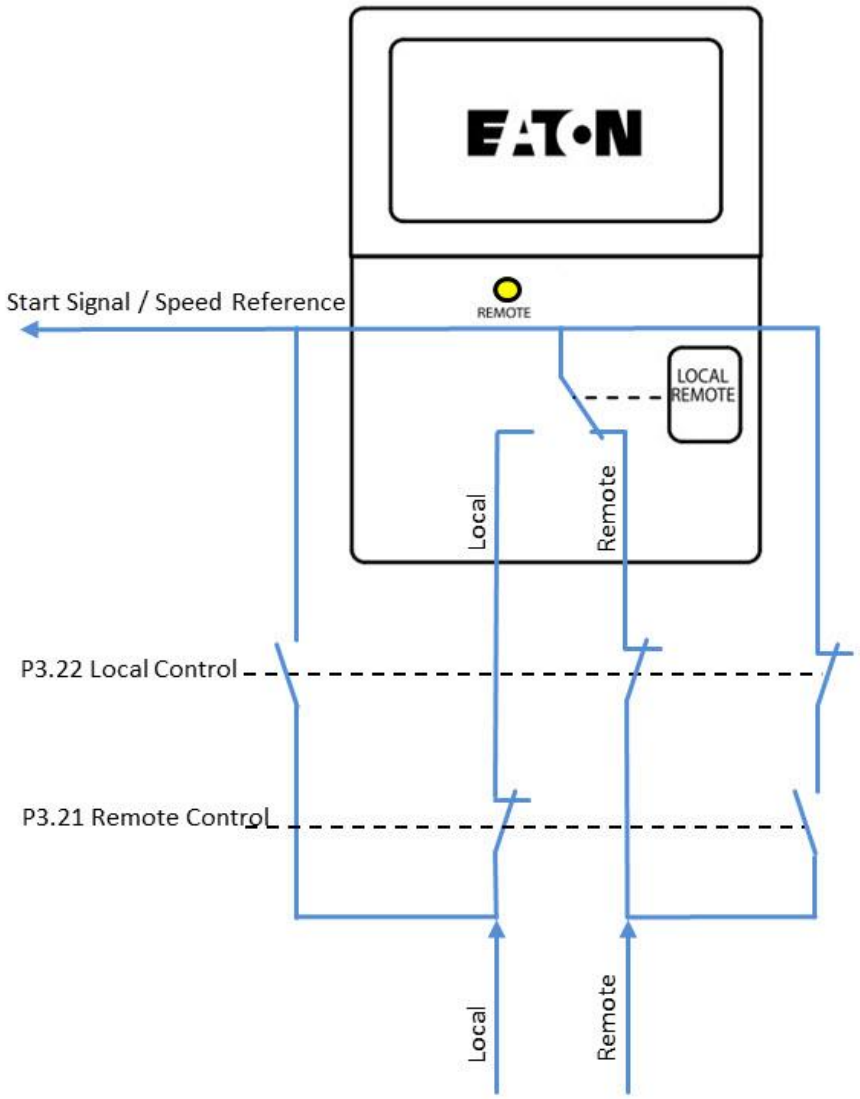
- Selection of the source for the START signal with P1.11 “Remote 1 Control Place”
- Selection of the reference source with P1.15 „Remote 1 Reference“

Operating mode „Remote 2“

- Selection of the source for the START signal with P7.1 “Remote 2 Control Place”
- Selection of the reference source with P7.2 „Remote 2 Reference“

P3.23 “Remote 1 / 2 Select” selects between “Remote 1” and “Remote 2”, where different sources for the START signal and the reference can be assigned to.

- P3.23 = LOW → Remote 1
- P3.23 = HIGH → Remote 2



There are two commands to force the operating modes “Local” and “Remote”. The dependencies at changeover are shown in the drawing above. If you select “Local” and “Remote” simultaneously, “Local” takes priority.

P3.21 „Remote Control“

Determination of the source for the operating mode „Remote“. When this signal is active, the drive changes into the operating mode „Remote“, not depending what was selected with the keypad before. This enables to changeover between the different operating modes without a use of the keypad. In this case, “Local” is selected with the keypad. When the command at the source selected with P3.21 is LOW, the drive runs in “Local”, when it becomes HIGH, it changes to “Remote”.

- P3.21 = LOW → Operating mode according to keypad setting
- P3.21 = HIGH → Operating mode „Remote“

P3.22 „Local Control“

Determination of the source for the operating mode „Local“. When this signal is active, the drive changes into the operating mode „Local“, not depending what was selected with the keypad before. This enables to changeover between the different operating modes without a use of the keypad. In this case, “Remote” is selected with the keypad. When the command at the source selected with P3.22 is LOW, the drive runs in “Remote”, when it becomes HIGH, it changes to “Local”.

- P3.22 = LOW → Operating mode according to keypad setting
- P3.22 = HIGH → Operating mode „Local“

P1.10 “Power Up Local Remote Select”

Determonation of the operating mode at power up (mains supply)

- P1.10 = 0: Hold last
  - At power up the drive starts with the operating mode, which was active before the latest disconnection.
- P1.10 = 1: Local Control
  - At power up always „Local Control“ is active.
- P1.10 = 2: Remote Control
  - At power up always „Remote Control“ is active.

Note: The parameters P3.21 “Remote Control” and P3.22 “Local Control” take priority over the setting of P1.10 “Power Up Local Remote Select”. In case a source defined with P3.21 or P3.22 has HIGH signal, it determines the operating mode and not the selection with P1.10.

Parameter	Name	Range	Default
P1.10	Power Up Local Remote Select	0: Hold Last 1: Local Control 2: Remote Control	0: Hold Last
P3.21	Remote Control	0: DigIN:NormallyOpen ….. 35: Virtual RO2 Function See AP040132EN Configuration of the digital I/Os	9: DigIN: 8
P3.22	Local Control	0: DigIN:NormallyOpen ….. 35: Virtual RO2 Function See AP040132EN Configuration of the digital I/Os	0: NO
P3.23	Remote 1 / 2 Select	0: DigIN:NormallyOpen ….. 35: Virtual RO2 Function See AP040132EN Configuration of the digital I/Os	0: NO

6.2.1 Hand / OFF / Auto (HOA)

In some applications, e.g. HVAC ones, it is usual to have a three position selector switch, which doesn't only changeover between the operating modes „Local“ and „Remote“, but has an OFF position in addition. Parameter P1.18 “HOA Source” determines the configuration of the variable frequency drive as far as operating modes are concerned.

In this context „Hand“ corresponds to the operating mode „Local“, „Auto“ corresponds to „Remote“..

P1.18 „HOA Source“

- P1.18 = 0: Disabled
  - Only a changeover between „Local“ and „Remote“ can take place. No OFF position.
- P1.18 = 1: IO Terminal
  - A HIGH signal at the source defined with P3.57 “HOA On/Off” must be present to operate the drive. In case this signal is missing, the drive cannot be started respectively ramps down to standstill. The operating modes can be selected as described in chapter 6.2.
- P1.18 = 2: Keypad
  - An additional position OFF exists when changeing over between the operating modes „Local“ and „Remote“ (Sequence: Local – Remote – OFF). When Off is selected, the drive cannot be started. In case OFF is selected during run, the drive ramps down to standstill. The operating modes can be selected as described in chapter 6.2.

Parameter	Name	Range	Default
P1.18	HOA Source	0: Disabled 1: IO Terminal 2: Keypad	0: Disabled
P3.57	HOA On/Off	0: DigIN:NormallyOpen ….. 35: Virtual RO2 Function See AP040132EN Configuration of the digital I/Os	1: NC

6.3 Sources for reference and start signal

The sources for the reference and the START signal can be freely configured. In case “I/O Terminal Start 1” respectively “I/O Terminal Start 2” is selected, the behavior at start depends on the terminal configuration. See chapter 6.4.

When the selected source for the START signal is „Keypad“ or “Fieldbus”, it is recommended to assign the Run Enable signal to a terminal and to use it as an additional possibility to stop the drive. See chapter 6.1.3.

Parameter	Name	Range	Default
P1.12	Local Control Place	0: Keypad 1: I/O Terminal Start 1 2: I/O Terminal Start 2 3: Fieldbus	0: Keypad
P1.14	Local Reference	0: AI 1 1: AI 2 2: Slot A: AI1 3: Slot B: AI1 4: AI1 Joystick 5: AI2 Joystick 6: Keypad 7: Fieldbus Ref 8: Motor Pot 9: Max Frequency 10: AI1 + AI2 11: AI1 – AI2 12: AI2 – AI1 13: AI1 · AI2 14: AI1 OR AI2 15: MIN (AI1, AI2) 16: MAX (AI1, AI2) 17: PID1 Control Output 18: PID2 Control Output See also AP040129DE Configuration of the analog I/Os	6: Keypad
P1.11	Remote 1 Control Place	0: I/O Terminal Start 1 1: Fieldbus 2: I/O Terminal Start 2 3: Keypad	0: I/O Terminal Start 1
P1.15	Remote 1 Reference	like P1.14	1: AI2
P7.1	Remote 2 Control Place	0: I/O Terminal Start 1 1: Fieldbus 2: I/O Terminal Start 2 3: Keypad	1: Fieldbus
P7.2	Remote 2 Reference	like P1.14	7: Fieldbus Ref

6.4 Configuring terminals for the start signal

Configuration of „I/O Terminal Start1“

- P3.1 „IO Terminal 1 Start Stop Logic“
- P3.2 „IO Terminal 1 Start Signal 1“
- P3.3 „IO Terminal 1 Start Signal 2“

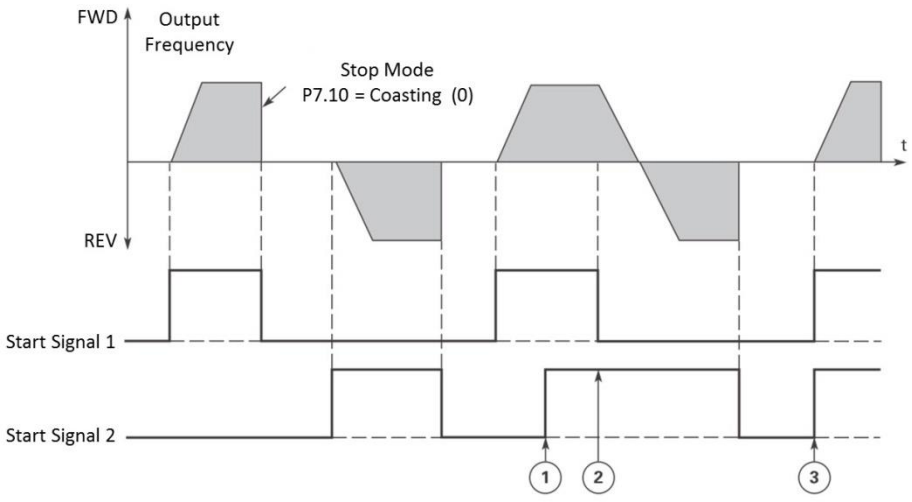
Configuration of „I/O Terminal Start2“

- P3.45 „IO Terminal 2 Start Stop Logic“
- P3.46 „IO Terminal 2 Start Signal 1“
- P3.47 „IO Terminal 2 Start Signal 2“

The Parameters P3.1 and P3.45 “IO Terminal Start Stop Logic” assign different functionalities to “IO Terminal Start Signal 1” and “IO Terminal Start Signal 2”.

P3.1 / P3.45 = 0: Forward - Reverse

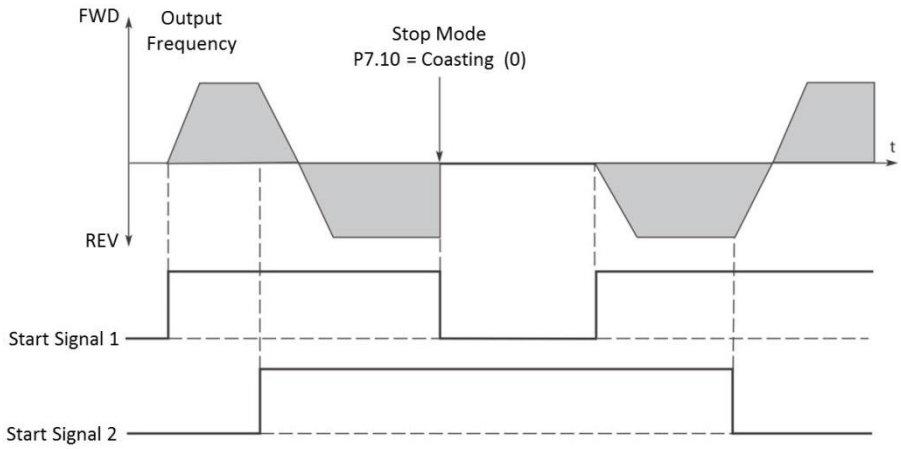
- P3.2 / P3.46 „IO Terminal Start Signal 1“
  - Start of the drive with right rotating field (FWD, cw)
- P3.3 / P3.47 „IO Terminal Start Signal 2“
  - Start of the drive with left rotating field (REV, ccw)
- HIGH = Enabled. The drive reacts to the voltage level. This means, when the HIGH signal is applied continuously, the drive starts as soon as mains voltage is applied (see chapter 2.1). Run Enable, Emergency Stop and STO must be HIGH at the same time (see chapter 6.1).
- When the HIGH signal is removed, the behavior of the motor (coasting or ramping) depends on the setting of parameter P7.10 “Stop Mode” (see chapter 8.1).



① The sense of rotation, which was selected first, takes priority.
② When Start Signal 1 is removed, the change of direction starts.
③ When Start Signal 1 and Start Signal 2 are applied simultaneously, Start Signal 1 takes priority.

P3.1 / P3.45 = 1: Start – Reverse

- P3.2 / P3.46 „IO Terminal Start Signal 1“
  - HIGH → Start of the drive
  - LOW → Stop of the drive
  - HIGH = Enabled. The drive reacts to the voltage level. This means, when the HIGH signal is applied continuously, the drive starts as soon as mains voltage is applied (see chapter 2.1). Run Enable, Emergency Stop and STO must be HIGH at the same time (see chapter 6.1).
  - When the HIGH signal is removed, the behavior of the motor (coasting or ramping) depends on the setting of parameter P7.10 “Stop Mode” (see chapter 8.1).
- P3.3 / P3.47 „IO Terminal Start Signal 2“
  - HIGH → Left rotating field (REV, ccw)
  - LOW → Right rotating field (FWD, cw)
- ATTENTION! In case REV is selected and a wire break happens, the drive will reverse! Alternative: Use combination with P3.1 / P3.45 = 0 (see above).

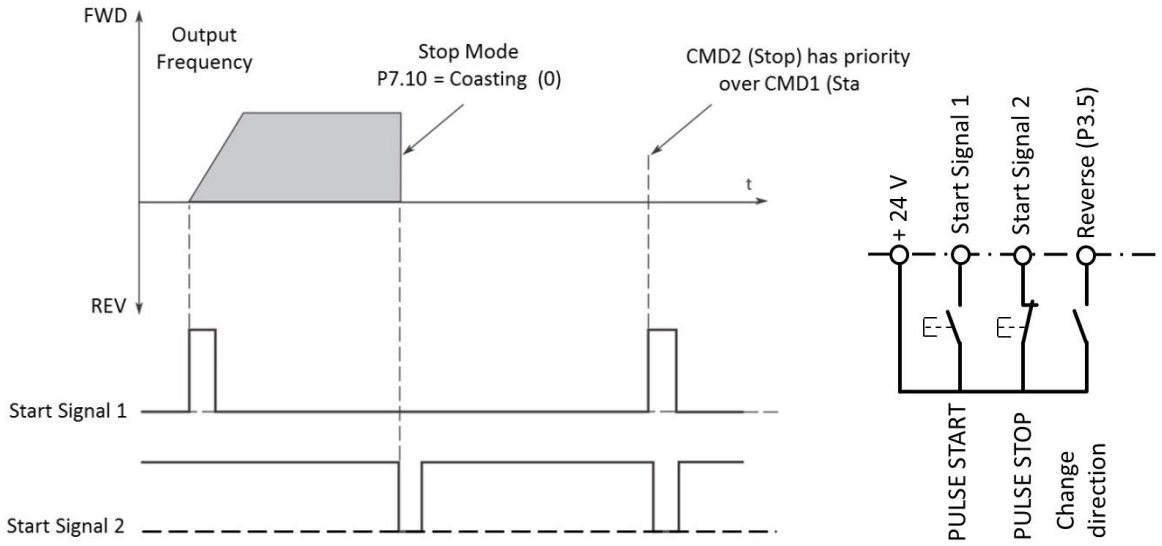


P3.1 / P3.45 = 2: Start - Enable

- To start the drive „IO Terminal Start Signal 1“ as well as „IO Terminal Start Signal 2“ are required.
  - The drive reacts to the voltage level. This means, when the HIGH signal is applied to both terminals continuously, the drive starts as soon as mains voltage is applied (see chapter 2.1). Run Enable, Emergency Stop and STO must be HIGH at the same time (see chapter 6.1).
  - When one or both HIGH signals are removed, the behavior of the motor (coasting or ramping) depends on the setting of parameter P7.10 “Stop Mode” (see chapter 8.1).
- P3.2 / P3.46 „IO Terminal Start Signal 1“
  - HIGH → Start of the drive (when IO Terminal Start Signal 2 = HIGH)
  - LOW → Stop of the drive
- P3.3 / P3.47 „IO Terminal Start Signal 2“
  - HIGH → Start of the drive (when IO Terminal Start Signal 1 = HIGH)
  - LOW → Stop of the drive

P3.1 / P3.45 = 3: Start Pulse – Stop Pulse

- P3.2 / P3.46 „IO Terminal Start Signal 1“
  - HIGH → Start of the drive
  - The drive is started with a pulse. During operation, no HIGH signal is required.
- P3.3 / P3.47 „IO Terminal Start Signal 2“
  - LOW → Stop of the drive
  - During run, the respective source must have HIGH signal. As soon as the signal turns to LOW, the drive stops.
  - When the HIGH signal is removed, the behavior of the motor (coasting or ramping) depends on the setting of parameter P7.10 “Stop Mode” (see chapter 8.1).
- When START and STOP signal are applied simultaneously, STOP takes the priority.
- This configuration behaves like a contactor control with locking. The START command is given with a pulse from LOW to HIGH (IO Terminal Start Signal 1). Condition is, that “IO Terminal Start Signal 2” is HIGH at the same time. As soon as “IO Terminal Start Signal 2” turns to LOW, the drive stops.



- Parameter P3.5 „Reverse“ determines the sense of rotation when P3.1 = 3
  - LOW → Right rotating field (FWD, cw)
  - HIGH → Left rotating field (REV, ccw)
- Starting with a rising edge:
  - In applications, where a rising edge of the START signal is required to start the drive, the configuration with P3.1 = 3 can also be used.
  - In this case „IO Terminal Start Signal 1“ and „IO Terminal Start Signal 2“ must be assigned to the same source.
  - With a change from LOW to HIGH the drive is started.
  - At removal of the HIGH signal it stops.
  - When the HIGH signal is applied continuously it does not lead to a start, when mains voltage is applied to the terminals. A rising edge of the START signal is required.

Parameter	Name	Range	Default
P3.1	IO Terminal 1 Start Stop Logic	0: Forward - Reverse 1: Start - Reverse 2: Start - Enable 3: Start Pulse – Stop Pulse	0: Forward - Reverse
P3.2	IO Terminal 1 Start Signal 1	0: DigIN:NormallyOpen ….. 35: Virtual RO2 Function See AP040132EN Configuration of the digital I/Os	2: DigIN: 1
P3.3	IO Terminal 1 Start Signal 2	like P3.2	3: DigIN: 2
P3.45	IO Terminal 2 Start Stop Logic	like P3.1	0: Forward - Reverse
P3.46	IO Terminal 2 Start Signal 1	like P3.2	2: DigIN: 1
P3.47	IO Terminal 2 Start Signal 2	like P3.2	3: DigIN: 2

6.5 Start mode

In some applications it can happen, that the motor turns already before switching on. One example are fans, which spin because of the chimney effect inside a wind tunnel. Another example are drive systems with high inertia, which didn't come to a stop after the latest switching off and which now have to be restarted. A direct switching of a variable frequency drive on a turning motor without additional measures can lead to an overcurrent trip. To prevent this DG1 has the flying start function which detects the actual speed of the spinning motor and controls the variable frequency drive accordingly.

The synchronization leads to a delay at start. Therefore it is disabled at default, not to have the delay, which is unwanted in some other applications. P7.9 "Start Mode" enables the flying start.

P7.9 „Start Mode"

- P7.9 = 0: Ramp
  - The motor starts with the preset ramp. No synchronization with a spinning motor will happen.
- P7.9 = 1: Flying Start
  - Flying Start is enabled. The synchronization procedure leads to a start delay.

Parameter	Name	Range	Default
P7.9	Start Mode	0: Ramp 1: Flying Start	0: Ramp

6.6 Frequency of starts

In some cases mechanical and electrical conditions at a machine require, to restart a machine only, when a certain time has elapsed since the latest start. The time can be set with Parameter P1.17 “Run Delay Time”.

The time defined here, is the time between two START signals and not the one between a STOP and the next START. It is effective on all sources (e.g. terminals, keypad, fieldbus …).

When a START signal is applied during the waiting time, it will be executed after the time has elapsed. This is also true for a pulse start (P3.1 = 3: Start Pulse – Stop Pulse).

Parameter	Name	Range	Default
P1.17	Run Delay Time	0 … 32500 s	0 s

7 Operation

7.1 Displaying operating data

7.1.1 Monitor parameters M…

Operating data of the variable frequency drive can be displayed with the keypad or with the configuration software InControl. The monitoring values start with M (Monitor), e.g. “M4” for the motor current.

Number	Name	Description
M1	Output Frequency	Frequency in Hz at the output of the drive With P8.1 „Motor Control Mode“ = “0: Freq Control” this value should be proportional to the frequency reference. With P8.1 „Motor Control Mode“ = “1: Speed Control” load dependent deviations can be found because of the slip of induction motors.
M2	Frequency Reference	Frequency reference at the input of the ramp in Hz
M3	Motor Speed	Calculated speed of the connected motor in rpm. The calculation is based on the entered motor data.
M4	Motor Current	Measured motor current in A
M5	Motor Torque	Calculated torque of the motor in percent, based on the entered motor data and the actual current draw. (100 % = Motor rated torque)
M6	Motor Power	Calculated power of the motor in percent, based on the entered motor data and the actual values of voltage and motor current (100 % = Motor rated power)
M7	Motor Voltage	Measured output voltage of the variable frequency drive in V
M8	DC Link Voltage	Measured DC Link voltage of the variable frequency drive in V
M9	Unit Temperature	Measured drive heat sink temperature in °C
M10	Motor Temperature	Calculated motor temperature in percent. The value is based on the entered motor data and the motor status information noted on power up.
M11	Torque Reference	Torque reference in percent with P8.1 „Motor Control Mode“ = “6: Open Loop Torque Control” (100 % = Motor rated torque)
M12	Analog Input 1	Measured value at analog input AI1. This can be a voltage or a current value, depending on the configuration of the input.
M13	Analog Input 2	Measured value at analog input AI2. This can be a voltage or a current value, depending on the configuration of the input.
M14	Analog Output 1	Measured value at analog output AO1. This can be a voltage or a current value, depending on the configuration of the output.
M15	Analog Output 2	Measured value at analog output AO2. This can be a voltage or a current value, depending on the configuration of the output.

Number	Name	Description
M16	DI1, DI2, DI3	Status of the digital inputs DI1, DI2, DI3 On = HIGH signal at the respective input Off = LOW signal at the respective input
M17	DI4, DI5, DI6	Status of the digital inputs DI4, DI5, DI6 On = HIGH signal at the respective input Off = LOW signal at the respective input
M18	DI7, DI8	Status of the digital inputs DI7, DI8 On = HIGH signal at the respective input Off = LOW signal at the respective input
M19	DO1, Virtual RO1, Virtual RO2	Status of the digital output DO1 and the virtual relays VO1 and VO2 On = the output is activated Off = the output is deactivated
M20	RO1, RO2, RO3	Status of the output relays RO1, RO2, RO3 On = relay contact closed Off = relay contact open
M21	TC1, TC2, TC3	Status of the Timer Channels TC1, TC2, TC3 Off = Timer Channel not active On = Timer Channel active
M22	Interval1	Status of Interval 1 0: Inactive 1: Active
M23	Interval2	Status of Interval 2 0: Inactive 1: Active
M24	Interval3	Status of Interval 3 0: Inactive 1: Active
M25	Interval4	Status of Interval 4 0: Inactive 1: Active
M26	Interval5	Status of Interval 5 0: Inactive 1: Active
M27	Timer1	When the timer is active, the remaining time until the output switches back to LOW is displayed in seconds.
M28	Timer2	When the timer is active, the remaining time until the output switches back to LOW is displayed in seconds.
M29	Timer3	When the timer is active, the remaining time until the output switches back to LOW is displayed in seconds.
M30	PID1 Set Point	PID1 reference value level
M31	PID1 Feedback	PID1 actual feedback value level
M32	PID1 Error Value	PID1 difference between set point and feedback value levels
M33	PID1 Output	Output signal of PID1 in percent. This value includes a possible feed forward signal.

Number	Name	Description
M34	PID1 Status	Status of PID1 0: Stopped → PID1 is not enabled (Signal at the source defined with P3.13 „PID1 Control Enable“ is LOW). 1: Running → PID1 is enabled (Signal at the source defined with P3.13 „PID1 Control Enable“ is HIGH). 2: Sleep Mode → PID1 is in sleep mode
M35	PID2 Set Point	PID2 reference value level
M36	PID2 Feedback	PID2 actual feedback value level
M37	PID2 Error Value	PID2 difference between set point and feedback value levels
M38	PID2 Output	Output signal of PID2 in percent. This value includes a possible feed forward signal.
M39	PID2 Status	Status of PID2 0: Stopped → PID2 is not enabled (Signal at the source defined with P3.14 „PID2 Control Enable“ is LOW). 1: Running → PID2 is enabled (Signal at the source defined with P3.14 „PID2 Control Enable“ is HIGH). 2: Sleep Mode → PID2 is in sleep mode
M40	Running Motors	Number of active single speed motors in a multi pump system with one speed controlled motor and multiple single speed ones. (P18.1.1 = 1)
M41	PT100 Temperature	Highest temperature of PT100 resistors, which are connected to an extension module DXG-EXT-THER1
M42	Latest Fault Code	Code of the latest fault (see chapter 7.3)
M43	RTC Battery Status	Status of the battery for the real time clock: • 0: Not installed → No battery inside the drive or the battery connector is unplugged. • 1: Installed → The battery is connected and in proper condition. • 2: Change Battery → The charging status of the battery is too low. The battery must be exchanged. • 3: Over Voltage → The voltage level of the battery is too high, e.g. because of using a wrong type of battery. The replacement battery must be of the same type as the original one: Supplier: Eaton, Type: DXG-ACC-RTBATT Article No. 730-32039-00P
M44	Instant Motor Power	Measured motor power draw in kW
M45	Energy Savings	Typical energy savings when using a variable frequency drive DG1 compared with a motor starter on the basis of the entered motor data.

Number	Name	Description
M46	Control Board DIDO Status	Status of the digital I/Os in digital format. To get the status of the single I/Os, the number must be converted into a binary (word) one. Bit 0 = DIN1 Status (Terminal 20) Bit 1 = DIN2 Status (Terminal 21) Bit 2 = DIN3 Status (Terminal 22) Bit 3 = DIN4 Status (Terminal 23) Bit 4 = DIN5 Status (Terminal 7) Bit 5 = DIN6 Status (Terminal 8) Bit 6 = DIN7 Status (Terminal 9) Bit 7 = DIN8 Status (Terminal 10) Bit 8 = DO1 Status (Terminal 14) Bit 9 = RO1 Status (Terminals 28 / 29) Bit 10 = RO2 Status (Terminals 32 / 34) Bit 11 = RO3 Status (Terminals 27 / 31) Bit 12 = Expansion module Slot A (1 = Module existing) Bit 13 = Expansion module Slot B (1 = Module existing) Bit 14 and 15 are not used .
M47	SlotA DIDO Status	Status of the digital I/Os on an expansion module in Slot A in digital format. To get the status of the single I/Os, the number must be converted into a binary (word) one. Depending on the module used, the different bits are used. Bit 0 = DIN1 Status Bit 1 = DIN2 Status Bit 2 = DIN3 Status Bit 3 = DO1 Status Bit 4 = DO2 Status Bit 5 = DO3 Status Bit 6 = RO1 Status Bit 7 = RO2 Status Bit 8 = RO3 Status Bit 9 = DIN1 Status (AC input on DXG-EXT-6DI) Bit 10 = DIN2 Status (AC input on DXG-EXT-6DI) Bit 11 = DIN3 Status (AC input on DXG-EXT-6DI) Bit 12 = DIN4 Status (AC input on DXG-EXT-6DI) Bit 13 = DIN5 Status AC input on DXG-EXT-6DI) Bit 14 = DIN6 Status (AC input on DXG-EXT-6DI) Bit 15 is not used.
M48	SlotB DIDO Status	Status of the digital I/Os on an expansion module in Slot B in digital format. To get the status of the single I/Os, the number must be converted into a binary (word) one. Depending on the module used, the different bits are used. Coding of the Bits like M47.

Number	Name	Description
M49	Application Status Word	The application status word contains information about the status of the drive. To get the single information, the number must be converted into a binary (word) one. Bit 0 = READY • no fault message AND • no START signal applied Bit 1 = RUN • no fault message • START signal applied OR • START signal removed. Drive is still ramping down. Bit 2 = Fault Active fault message, which has not been reset yet. Bit 3 = Fieldbus reference active Bit 4 = Drive stopping. START signal was removed, drive is still ramping down. Bit 5 = Reverse. Bit = 1, when left rotating field is at the output Bit 6 = Warning respectively fault, which is configured for an automatic restart. Bit 7 = Zero Speed. Bit 7 is also active in case the drive is enabled, but 0 Hz at the output. Bit 8 = Terminal control Bit 9 = Keypad control Bit 10 = Fieldbus control Bit 11 = DC Braking. The bit is active as long as current is injected into the motor. Bit 12 = Run Enable. The Bit is active when the source, defined with P3.9, has HIGH signal. Bit 13 = The drive is enabled and stops (0 Hz at the output). Bit 14 = External brake control. Bit = 1, when the relay contact for controlling an external brake is closed. Bit 15 = Bypass Mode
M50	Standard Status Word	Bits 0 to 7 of the standard status word are displayed. The content can have different meanings, which are determined with the parameters P20.1.9 up to P20.1.16. To get the single information, the number must be converted into a binary (word) one. Bit 0 = P20.1.9 (Default: 1 = READY) Bit 1 = P20.1.10 (Default: 1 = RUN) Bit 2 = P20.1.11 (Default: 1 = Fault) Bit 3 = P20.1.12 (Default: 1 = Fault invert) Bit 4 = P20.1.13 (Default: 1 = Warning) Bit 5 = P20.1.14 (Default: 1 = REV selected) Bit 6 = P20.1.15 (Default: 1 = at speed) Bit 7 = P20.1.16 (Deafult: 1 = Zero frequency)
M51	Output	Output frequency in a processing unit selected with P21.1.20. Minimum and maximum display values are determined by P21.1.21 and P21.1.22 (see chapter 7.1.3).

Number	Name	Description
M52	Reference	Speed reference in a processing unit selected with P21.1.20. Minimum and maximum display values are determined by P21.1.21 and P21.1.22 (see chapter 7.1.3).
M53	Total MWh Count	Amount of energy since the date of manufacture, which was supplied by the drive's output (energy consumption of the motor)
M54	Total Power Day Count	Time since the date of manufacture for which the variable frequency drive way supplied with voltage, displayed in number of days.
M55	Total Power hr Count	Time since the date of manufacture for which the variable frequency drive way supplied with voltage, displayed in number of hours.
M56	Trip MWh Count	Amount of energy since the latest reset with P21.4.7, which was supplied by the drive's output (energy consumption of the motor)
M57	Trip Power Day Count	Time since the latest reset with P21.4.10 for which the variable frequency drive way supplied with voltage, displayed in number of days.
M58	Trip Power Hr Count	Time since the latest reset with P21.4.10 for which the variable frequency drive way supplied with voltage, displayed in number of hours.

7.1.2 Operating time and energy consumption

In menu 21.4 information about the operating time of the drive and its energy consumption is available. One distinguishes between values since the first power-on of the drive, which cannot be reset, and others, which can be reset.

Counter for the energy consumption:

- P21.4.3 „Total MWh Count“
  - energy consumption in MWh since the date of manufacture. Not resettable
- P21.4.6 „Trip MWh Count“
  - energy consumption since the latest reset with P21.4.7
- P21.4.7 „Clear Trip MWh Count“
  - resets the content of P21.4.6 to zero

Counter for the operating time

- P21.4.4 „Total Power Day Count“
  - Operating time (voltage at the terminals L1 / L2 / L3) in days since the date of manufacture. Not resettable
- P21.4.5 „Total Power Hr Count“
  - Operating time (voltage at the terminals L1 / L2 / L3) in hours since the date of manufacture. Not resettable
- P21.4.8 „Trip Power Day Count“
  - Operating time (voltage at the terminals L1 / L2 / L3) in days since the latest reset with P21.4.10

- P21.4.9 „Trip Power Hr Count“
  - Operating time (voltage at the terminals L1 / L2 / L3) in hours since the latest reset with P21.4.10
- P21.4.10 „Clear Trip Power Count”
  - Resets the content of P21.4.8 and P21.4.9 to zero

Parameter	Name	Range	Default
P21.4.3	Total MWh Count		Read only
P21.4.4	Total Power Day Count		Read only
P21.4.5	Total Power Hr Count		Read only
P21.4.6	Trip MWh Count		Read only
P21.4.7	Clear Trip MWh Count	0: Not Reset 1: Reset	0: Not Reset
P21.4.8	Trip Power Day Count		Read only
P21.4.9	Trip Power Hr Count		Read only
P21.4.10	Clear Trip Power Count	0: Not Reset 1: Reset	0: Not Reset

7.1.2.1 Counter reset with the keypad

- Select P21.4.7 respectively P21.4.10 and press OK
- „Not Reset“ is displayed
- Press ▶ and afterwards ▼
- Display: „Reset“
- Acknowledge with OK. The display changes back to „Not Reset“ automatically

7.1.2.2 Counter reset with the software Power Xpert inControl

- Select P21.4.7 respectively P21.4.10
- Parameter value „Not Reset“ is shown
- Select „Reset“
- The counter is reset and the value changes back to „Not Reset” automatically.

7.1.3 Displaying the speed in processing units

With the monitor parameters M51 „Output“ and M52 „Reference“ output frequency respectively speed can be displayed in processing units. The processing units as well as the minimum and maximum values are determined by P21.1.20 up to P21.1.22.

P21.1.20 „Output Display Unit“
This parameter determines the processsing unit, which is used with M51 „Output“ and M52 „Reference“.

P21.1.21 „Output Display Unit Min“
This parameter determines, which numerical value is shown at the minimum frequency set with P1.1.

P21.1.22 „Output Display Unit Max“
This parameter determines, which numerical value is shown at the maximum frequency set with P1.2.

Parameter	Name	Range	Default
P21.1.20	Output Display Unit	0: % 1: 1/min 2: rpm 3: ppm 4: pps 5: l/s 6: l/min 7: l/h 8: kg/s 9: kg/min 10: kg/h 11: m3/s 12: m3/min 13: m3/h 14: m/s 15: mbar 16: bar 17: pa 18: kPa 19: mVS 20: kW 21: deg C 22: GPM 23: gal/s 24: gal/min 25: gal/h 26: lb/s 27: lb/min 28: lb/h 29: CFM 30: ft3/s 31: ft3/min 32: ft3/h 33: ft/s 34: in wg 35: ft wg 36: PSI 37: lb/in2 38: HP 39: deg F 40: PA 41: WC 42: HG 43: ft 44: m 45: Hz 46: Strokes/min	45: Hz
P21.1.21	Output Display Unit Min	-60000 … P21.1.22	0
P21.1.22	Output Display Unit Max	P21.1.21 … 60000	50

7.2 Behavior at mains loss

In case of a temporary mains loss it is possible, to feed the DC link not from the mains side, but from the motor. Output voltage and output frequency are lowered and the connected motor works as generator. If this functionality is required, it must be enabled with P7.22 “Power Loss Function”.

P7.22 „Power Loss Function“

- P7.22 = 0: Disabled
  - The drive trips in case of mains loss
- P7.22 = 1: Enabled
  - At mains loss the motor works as generator for a maximum time, which is defined by P7.23 „Power Loss Time“.

P7.23 „Power Loss Time“

- Maximum time, for which the connected motor works as a generator in case this functionality is enabled by P7.22 „Power Loss Function“. When the mains is not recovered in the time defined by P7.23 the unit trips.

Feeding back energy into the DC link starts at the voltages in the table below:

Rated voltage of the device	Regeneration starts at
230 V	157 V
480 V	303 V
575 V	427 V

Parameter	Name	Range	Default
P7.22	Power Loss Function	0: Disabled 1: Enabled	0
P7.23	Power Loss time	0,3 … 5 s	2 s

7.3 In case of a fault …

In the following chapters the behavior of the drive in case of a fault is described.

A general description how to handle the keypad is described inside the Application Manual MN040004EN.

7.3.1 Possible fault and warning messages, causes and remedy

In the table below not all code numbers are reserved. When a parameter number “P” is written in the column “Action”, the behavior of the drive in case of a fault is determined by the setting of this respective parameter (see chapter 2ff).

In some cases, removing the voltage and reapplying it afterwards is listed as a possible remedy. Between the removal and the reapplication a period of about 30 s should elapse to discharge the internal capacitors in between.

Code	Name	Action	Possible causes	Remedy
1	Over Current	Fault	• Too high current in the motor cable (> 4 • I_H). • Sudden heavy load increase • Short circuit in motor cables • Unsuitable or defective motor	• Check loading • Check motor • Check cables and connections • Make identification run • Increase ramp times
2	Over Voltage	Fault	The DC link voltage has exceeded its limits • Deceleration time set too short • Brake chopper is disabled • High over voltage spikes in supply • Start/stop sequence too fast	• Increase deceleration time (P1.4 / P7.14) • Use brake chopper with brake resistor • Activate overvoltage controller (P8.12) • Check input voltage
3	Earth Fault	P9.7	Current measurement has detected that the sum of motor phase current is not zero. • Insulation failure in cable or motor	• Check motor cables and motor
5	Charging Switch	Fault	The switch for bypassing the charging resistor is open, although a START signal was applied. Internal fault.	• Reset fault and restart. • Should the fault re-occur, contact the distributor or Eaton office next to you.
6	Emergency Stop	Fault	The emergency stop signal at the source defined with P3.42 is missing	• Set the signal at the respective source to HIGH respectively set P3.42 to "1: DigIN:NormallyClose" Note: In case of emergency stop no reset is necessary. As soon as the signal at the source defined with P3.42 turns to HIGH, no fault message is active!
7	Saturation Trip	Fault	• IGBT module is damaged • Short circuit in motor cable	• Check cable and connections • Reset fault and restart. • Should the fault re-occur, contact the distributor or Eaton office next to you.
9	UnderVoltage	P9.5	The DC link voltage is below the voltage limits. • Most probable cause: supply voltage too low • Defective input fuse • The switch for bypassing the charging resistor is open. **Note:** This fault is only active during run.	• In case of a temporary under voltage: reset fault and restart. • Check supply voltage. • In case the supply voltage is inside the specified range, the fault is probably an internal one. Contact the distributor or Eaton office next to you.
10	Input Phase Spv	P9.4	• Input phase missing • The voltage of the three supply phases is different.	• Check supply voltage • Check protective devices on the mains side • Check supply cable and connection at the terminals L1/L2/L3.

Code	Name	Action	Possible causes	Remedy
11	Output Phase Spv	Fault	No current in one output phase	• Check motor cable and its connection to the DG1 device and motor. • Check motor including links inside the terminal box
12	BrakeChopperSpv	Fault	• No brake resistor is installed, but the brake chopper is activated with P14.5 (P14.5 > 0) • The brake resistor is defective. • Faulty connection between brake resistor and DG1. • Brake chopper failure	• Disable brake chopper (P14.5 = „0: Disabled“) • Check cable and brake resistor
13	Drive UnderTemp	P9.23	The heatsink temperature is below -10 °C.	The device can be warmed up by activating the cold weather mode (P9.39). See application note AP040058EN “Operating at low temperatures”.
14	Drive OverTemp	Fault	The heatsink temperature is above 90 °C.	• Check the correct amount and flow of cooling air • The heatsink must be free from dust and fluff. • Check ambient temperature • Check setting of P8.10 „Switching Frequency“. Ambient temperature and motor load must be taken into account.
15	Motor Stalled	P9.11	Motor is stalled	• Check motor and load • Check settings of the V/f curve
16	Motor OverTemp	P9.8	The motor is too hot. This information is either based on the internal I^2t calculation or on a feedback from PT100 resistors inside the motor, which are connected to the extension module DXG-EXT-THER1.	• Check and eventually decrease motor load • When the load is not too high: check parameter setting for the motor model (P9.10 „Motor Thermal Time”) and probably increase it. • When DXG-EXT-THER1 is used: check ambient temperature of the motor and cooling (e.g. fan for forced cooling) for function and free air flow.
17	Motor Underload	P9.15	The motor torque is for a time > P9.18 lower than defined with P9.16 resp. P9.17.	• Check motor load • Check and eventually correct the settings for P9.16 … P9.18.
18	IP Address Conflict	P9.38	IP setting issue (P20.4.xxx)	• Check settings for IP address and verify no duplicates are on the network!
19	Power Board EEPROM Fault	Fault	EEPROM Fault on the power board	• Remove supply voltage and reapply it. • Try updating software • When the fault is still present: Contact the distributor or Eaton office next to you.

Code	Name	Action	Possible causes	Remedy
20	FRAM Fault	Fault	Data error in FRAM memory	• Remove supply voltage and reapply it. • Try updating software • When the fault is still present: Contact the distributor or Eaton office next to you.
21	Serial Flash Fault	Warning	Error in serial S-Flash memory	• Remove supply voltage and re-apply it. • Try updating software • When the fault is still present: Contact the distributor or Eaton office next to you.
25	MCU WatchDog Fault	Fault	Watchdog register overflow in MCU	• Remove supply voltage and re-apply it. • Try updating software • When the fault is still present: Contact the distributor or Eaton office next to you.
26	Start-up Prevent	Fault	Condition: starting delay P18.1.8 „Damper Start“ = „2: Interlock Tout” (see chapter 6.1.5). The fault message appears, when the time set with P18.1.9 „Damper Timer Out“ is elapsed and no feedback from an auxiliary contact was received.	• Check interlock conditions • Stop drive and re-apply START signal
29	Thermistor Fault	P9.19	The resistance of the thermistor connected to the control board or to the expansion module DXG-EXT-3DI3DO1T is out of range (> 4.7 kΩ or short circuit).	• Check ambient temperature of the motor and cooling (e.g. fan for forced cooling) for function and free air flow. • Check thermistor connection for wire break or short circuit
32	Fan Cooling	Fault	The fan is damaged or stalled	Check fan and wiring. The fan may not be blocked mechanically. 24 V must be present at the fan terminals.
36	Compatibility Fault	Fault	The control board doesn’t match with the power board	• Remove supply voltage and re-apply it. • Try updating software • When the fault is still present: Contact the distributor or Eaton office next to you.
37	Device Change	Warning	Power board or expansion card change	Reset the warning
38	Device added	Warning	Power board or expansion board added	Reset the warning. The device is ready for use. The old parameter settings will be used.
39	Device Removed	Fault	An expansion is removed from the slot or the connection to the power board is interrupted.	• Check connection with power board • Mount new expansion board

Code	Name	Action	Possible causes	Remedy
40	Device Unknown	Fault	Unknown expansion module or power board connected	• Remove suppy voltage and re-apply it • Check mounting of expansion modules in slot A and B including connectors • Try updating software • When the fault is still present: Contact the distributor or Eaton office next to you.
41	IGBT Temperature	Fault	IGBT temperature is too high	• Check device fan, heatsink and ambient temperature. • Check motor ratings. The rated power of the connected motor may be of max. one rating bigger than the one from the variable frequency drive • Possibly reduce switching frequency with P8.10.
50	AIN<4mA (4to20mA)	P9.1	The signal at the analog input is below 20 % (only when P2.2.2 and/or P2.3.2 =1)	• Check wire at the analog input for breakage or short circuit • Check settings of the DIP switch on the device. See also AP040129EN „Configuration of the analog I/Os”
51	External Fault (The displayed text may change depending on the settings of P3.52 up to P3.54. See chapter 2.13)	P9.3	The signal at the source for the external fault is missing. (Signal at the source defined with P3.6, P3.48, P3.50 is HIGH or the signal at the source defined with P3.7, P3.49, P3.51 is LOW)	• Check settings of parameters P3.6, P3.7, P3.48 up to P3.51 • Check, if the voltage at the digital inputs is inside the specified range • Check functionality and wiring of the external device, which generates the external fault signal
52	Keypad Communication Fault	P9.45	The connection between the keypad and the control board is lost (only when keypad is selected as the source for the START signal and/or reference. See also chapter 6.3).	Check connection between keypad and control board
54	OPT Card Fault	P9.22	Expansion board not plugged in properly or defective.	• Check, if the expansion board in slot A and/or B is plugged in properly. • Check option card status on the keypad respectively in the software inControl to get more detailed information (Menu B: Optional Boards). • When the fault cannot be identified and eliminated: Contact the distributor or Eaton office next to you.
55	Real time clock fault	P9.34	Internal fault of the real time clock (RTC)	• Remove supply voltage and re-apply it • When the fault is still present: Contact the distributor or Eaton office next to you.

Code	Name	Action	Possible causes	Remedy
56	PT100 Fault	P9.35	The value at the terminals for the PT100 resistors on the expansion module DXG-EXT-THER1 is out of range. • The temperature around the PT100 resistors is too high. • The PT100 resistor is short-circuited • The connection between PT100 and expansion module is interrupted.	• Check temperature around the PT100 resistors. Take mitigation measures in case it is too high (load too high? Cooling defective?) • Check connection between the PT100 resistor and the expansion board DXG-EXT-THER1
57	Motor ID Fault	Fault	The identification of the motor parameters with P8.14 could not be completed successfully.	• Check size of the connected motor. The rated power of the motor should not deviate more than one power class from the rated power of the variable frequency drive. • Repeat motor identification run • Check wiring of the power circuit (Terminals U/V/W)
58	Current Measure Fault	Fault	The current measurement is out of range.	• Remove supply voltage and re-apply it • When the fault is still present: Contact the distributor or Eaton office next to you.
59	Possible power wiring error detected	Fault	• The mains supply was accidentally connected to the output terminals. • The screws of the power terminals are not tightened properly.	Check and eventually correct power wiring.
60	Control Board OverTemp	Fault	The ambient temperature of the device, measured on the control board, is out of range (- 30 °C … +85 °C)	• Heat up control cabinet, when temperature is below -30 °C. • Check ventilation /cooling of the control cabinet and correct it, if needed. • When the real temperature is inside the specified range and an control board over temperature fault comes up, an internal fault is possible. • Remove the supply voltage in this case and re-apply it after 30 s. • When the fault is still present: Contact the distributor or Eaton office next to you.

Code	Name	Action	Possible causes	Remedy
61	Internal-ctrl Supply	Fault	The voltage between the terminals 12 (GND) and 13 (24 V) is either above 27 V or below 17 V.	Disconnect the wire from terminal 13 and check voltage. Is the voltage now inside the range from 17 V to 27 V, it can be a fault in the external wiring or an overload of the 24 V. In this case wiring and load must be checked and corrected accordingly. Is the voltage after the removal of the wire at terminal 13 still out of range, contact the distributor or Eaton office next to you.
62	Too Many Speed Search Starts	Fault	When P7.9 „Start Mode“ = “1: Flying Start“ is selected, the variable frequency drive tries to start a motor, which is spinning. For this, the variable frequency drive has to evaluate the actual speed based on multiple parameters. The fault message appears after 5 unsuccessful start trials. Most likely the cause are motor parameters, which are not set correctly.	• Check and eventually correct motor parameters • Check motor connection (Star / Delta)
63	Current unbalance	P9.6	Output current is unbalanced	• Check the voltage at the output and the wiring of the motor. • When the fault message still exists , contact the distributor or Eaton office next to you.
64	Replace Battery	P9.36	Too low voltage of the battery for the real time clock. See also application note AP040172EN „Real Time Clock and Timer“	Change battery (Eaton Type DXG-ACC-RTBATT, Article-No. 730-32039-00P)
65	Replace Fan	P9.37	Remaining fan life time is less than 2 months	• Check functionality of the fan • Clean out any contamination • When a spare fan is needed, contact the distributor or the Eaton office next to you.
66	Safety Torque Off	P9.56	The connection between the terminals STO+ and STO- was opened.	• Check the reason for the trip. • After elimination of the root cause for the trip (STO+ and STO- are now connected) the fault can be reset and the drive can be started.
67	Current Limit Control	Warning	The output current has reached the current limit value. The reason can be a mechanical overload to too short acceleration ramp times.	• Check, if the mechanical load is too high (load, are all bearings ok and is the mechanical brake lifted/released?). • When the warning appears during the acceleration phase, the ramp times should be increased (P1.3 „Accel Time 1“, P7.13 „Accel Time 2“).

Code	Name	Action	Possible causes	Remedy
68	Over voltage control	Warning	The DC link voltage is short below the threshold for “Over Voltage” (Fault Code 2), where the drive would trip. The warning offers the possibility to react before a trip.	• Check input voltage • Extend deceleration ramp (P1.4 / P7.14)
69	System Fault	Fault	Communication fault between the basic unit and the extension module DXG-EXT-THER1 (Thermistor)	• Remove supply voltage and re-apply it • When the fault is still present: Contact the distributor or Eaton office next to you.
70	System Fault	Fault	Fault in the parameter transfer between control board and the power board	• Remove supply voltage and re-apply it • When the fault is still present: Contact the distributor or Eaton office next to you.
71	System Fault	Fault	Communication error between control board and power board	• Remove supply voltage and re-apply it • When the fault is still present: Contact the distributor or Eaton office next to you.
72	Power Board EEPROM Fault	Fault	• Fault in the EEPROM of the power board • Memory lost in EEPROM when drive is initialized	• Remove supply voltage and re-apply it • Try updating software • When the fault is still present: Contact the distributor or Eaton office next to you.
73	FRAM Fault	Fault	FRAM Chip doesn’t work correctly	• Remove supply voltage and re-apply it • When the fault is still present: Contact the distributor or Eaton office next to you.
74	FRAM Fault	Fault	CRC check fault when accessing FRAM data	• Remove supply voltage and re-apply it • When the fault is still present: Contact the distributor or Eaton office next to you.
75	Power Board EEPROM Fault	Fault	EEPROM chip or I2c circuit broken	Contact the distributor or Eaton office next to you.
76	Power Board EEPROM Fault	Fault	CRC check fault when accessing EEPROM data	• Remove supply voltage and re-apply it • Restore factory settings (P21.1.3 = 1: Reload Defaults) • When the fault is still present: Contact the distributor or Eaton office next to you.
77	Serial Flash Fault	Warning	External serial flash chip is broken	• Remove supply voltage and re-apply it • When the fault is still present: Contact the distributor or Eaton office next to you.

Code	Name	Action	Possible causes	Remedy
82	BypassOverLoad	Fault	When using a bypass, the motor is protected with an external overload relay. A tripping of the overload relay can be included into the fault management of the device. During proper operation a LOW signal must be present at the source defined with P3.34 “Bypass Overload”. In case this signal changes to HIGH a fault message occurs.	• Check, if the mechanical load is too high (load, are all bearings ok and is the mechanical brake lifted/released?). • Check motor connections
83	FieldBus Fault	P9.21	Loss of communication with Modbus RTU. Reason can be a communication breakdown on the Modbus or wrong communication settings in Menu P20.3.xxx. (only when „Fieldbus“ is selected as the source for the reference and/or the START signal, see chapter 6.3).	• Check RS485 wiring • Check communication parameters in Menu P20.3.xx • Check Modbus master settings concerning communication data and address.
84	FieldBus Fault	P9.21	Loss of communication with Modbus TCP. Reason can be a communication breakdown on the Modbus or wrong communication settings in Menu P20.5.xxx. (only when „Fieldbus“ is selected as the source for the reference and/or the START signal, see chapter 6.3).	• Check Ethernet wiring • Check communication parameters in Menu P20.3.xx • Check Modbus master settings concerning communication data and address.
85	FieldBus Fault	P9.21	Loss of communication with BAC Net. Reason can be a communication breakdown on the BAC Net or wrong communication settings in Menu P20.3.xxx. (only when „Fieldbus“ is selected as the source for the reference and/or the START signal, see chapter 6.3).	• Check RS485 wiring • Check communication parameters in Menu P20.3.xx • Check BAC Net master settings concerning communication data and address.
86	FieldBus Fault	P9.21	Loss of communication with EtherNet/IP. Reason can be a communication breakdown on the EtherNet/IP or wrong communication settings in Menu P20.4.xxx. (only when „Fieldbus“ is selected as the source for the reference and/or the START signal, see chapter 6.3).	• Check Ethernet wiring • Check communication parameters in Menu P20.3.xx • Check EIP master settings concerning communication data and address.

Code	Name	Action	Possible causes	Remedy
87	FieldBus Fault	P9.21	Loss of communication with PROFIBUS in Slot A. Reason can be a communication break-down on the PROFIBUS or wrong communication settings in Menu P20.3.xxx. (only when „Fieldbus“ is selected as the source for the reference and/or the START signal, see chapter 6.3).	• Check PROFIBUS/CANOpen/ DeviceNet wiring • Check communication parameters in Menu P20.3.xx • Check EIP master settings concerning communication data and address.
88	FieldBus Fault	P9.21	Loss of communication with PROFIBUS in Slot B. Reason can be a communication break-down on the PROFIBUS or wrong communication settings in Menu P20.3.xxx. (only when „Fieldbus“ is selected as the source for the reference and/or the START signal, see chapter 6.3).	• Check PROFIBUS/CANOpen/ DeviceNet wiring • Check communication parameters in Menu P20.3.xx • Check EIP master settings concerning communication data and address.
89	Under Voltage	Fault	The DC link voltage is below its minimum value	Check input voltage (level, number of phases)
90	Drive UnderTemp	Warning/ Fault	• The cold weather mode is not activated and the temperature is below -10 °C. • The cold weather mode is activated and the temperature is below -30 °C. • The temperature is still below -20 °C after heating up the device. See also application note AP040058EN „Operating at low temperatures“.	• When the temperature is between -20 °C and -10 °C, start the motor in cold weather mode. • When the temperature is below -20 °C heat up the unit to temperatures above -20 °C and activate cold weather mode for a proper operation. • When temperature after the expiration of the “Cold Weather Time Out” (P9.41) still remains below -20 °C, increase the “Cold Weather Volt. Level” (P9.40).
91	Option Card Fault	Fault	External supply on the DeviceNet communication connector is not present.	Check voltage and wiring of power supply of the DeviceNet communication.
92	External Fault 2 (The displayed text may change depending on the settings of P3.53. See chapter 2.13)	P9.3	The signal at the source for the External Fault 2 is missing (The signal at the source defined with P3.48 is HIGH or the signal at the source defined with P3.49 is LOW).	• Check settings of parameters P3.48 and P3.49. • Check, if the voltage at the digital input is within the specified range. • Check functionality and wiring of the external device, which generates the external fault signal

Code	Name	Action	Possible causes	Remedy
93	Externer Fehler 3 (The displayed text may change depending on the settings of P3.54. See chapter 2.13)	P9.3	The signal at the source for the External Fault 3 is missing (The signal at the source defined with P3.50 is HIGH or the signal at the source defined with P3.51 is LOW).	• Check settings of parameters P3.50 and P3.51. • Check, if the voltage at the digital input is within the specified range. • Check functionality and wiring of the external device, which generates the external fault signal
94	Pump Lost	Warning	A drive, which is part of a multi pump system, has lost its communication with the master. See also Application Note AP040128 „DG1 in pump and fan applications“.	• Check Modbus connection at the RS485 interface • Check, if an interlock signal is present in case it is required.
95	Need Alternation	Warning	In a multi pump system with one speed controlled pump and several single speed ones an alternation of pumps is required (The time set with P18.4.4 is exceeded). See also Application Note AP040128 „DG1 in pump and fan applications“.	• Check run time of all pumps • An alternation can be achieved by switching off the pump system and a restart afterwards.
96	Parameter error	Warning	The value of a parameter is out of range and needs to be checked.	Check parameter changes to validate they are in the valid range of the drive settings.
97	Prime Loss	P18.6.5	In a multi pump application, where „Pipe Fill“ is used, the required pressure is not achieved in the specified time (P18.6.10 + P18.6.14). See also Application Note AP040128 „DG1 in pump and fan applications“.	• Check pump and pressure sensor • Check complete pump system for root causes. (valves, Leakage …).
98	PID1 Feedback AI Loss	P9.51	Analog feedback signal of PID1 lost	• Check settings of the analog input. The values can be checked in the monitor menu (see 7.1.1) • Check external sensors for proper operation.
99	PID2 Feedback AI Loss	P9.51	Analog feedback signal of PID2 lost	• Check settings of the analog input. The values can be checked in the monitor menu (see 7.1.1) • Check external sensors for proper operation.

7.3.2 The fault message

Note: In this chapter the expression „fault message“ is used as a general one. It also includes warning messages.

In case of a fault the device behaves as described in chapter 2ff. In addition the messages are displayed on the keypad and the configuration software Power Xpert inControl. The message helps to identify the fault and gives valuable hints.

Example 1: Displaying an “External Fault” on the keypad

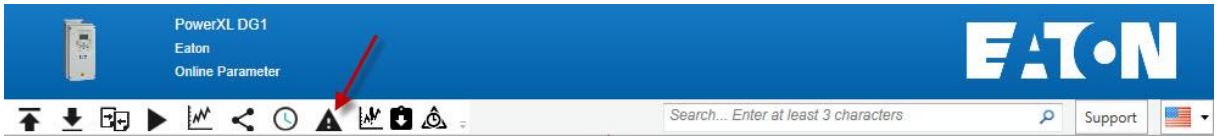
- An external fault is active.
- On the keypad appears „F1.1 Fault“ (Main Menu F: Fault → F1 Active Fault)
    - F**1**.x means, that the fault is still active and not reset yet.
    - F1.**1**: It is the first of possibly multiple faults, which are active at the same time.
- Below this the assigned text is displayed. In this case: External Fault
- In addition date and time of the fault occurrence are displayed in the format MMDDYY (date) and HH:MM:SS (time).
- Following information is available by pressing the softbutton Details:
    - The fault code of the message according to the column “Code” in the table in chapter 7.3.1 „Possible fault and warning messages, causes and remedy“. Here: 51
    - The type of message (fault or warning…)
    - The number of days since the first power-on

Example 2: Displaying the latest fault in the Monitor Parameter Menu (Chapter 7.1.1)

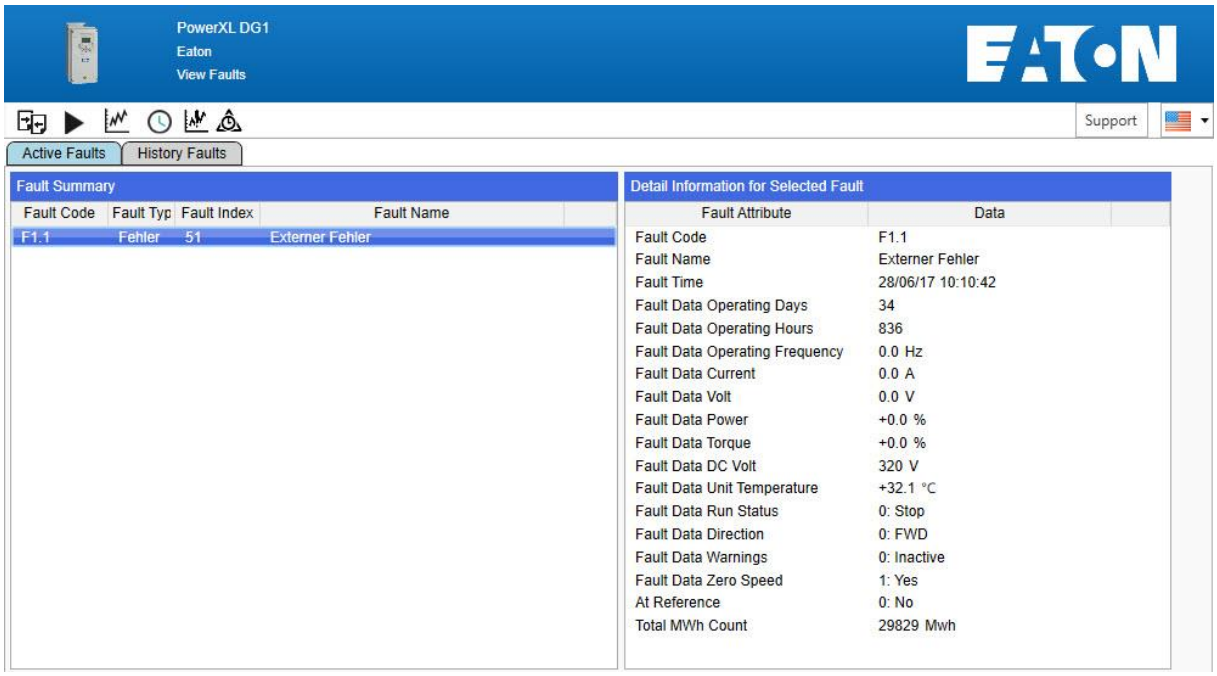
- M42 = 51 (= External Fault according to column „Code“ in the table in chapter 7.3.1)
    - Note: This is the latest fault, which occured. It is displayed here even when it was reset already.

Example 3: Message in the configuration software Power Xpert inControl in case of an actual fault „External Fault“

- The fault list is available by clicking on the triangle symbol.



- Additional information about the drive’s status at the point in time, at which the fault occurs, is available to draw conclusions of the possible cause.



7.3.3 Fault history

The fault history includes the 10 latest fault messages not depending on their status (active, reset …). F2.1 is the latest fault message

Example 1: Selection with the keypad

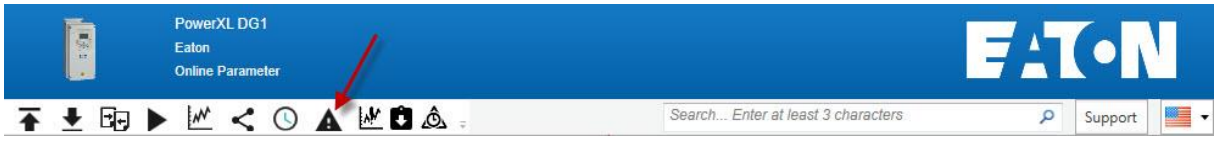
- Main Menu F → F2 History Fault
- The fault messages F2.1 up to F2.10 are displayed. These are the ten latest faults, which were recorded. F2.1 is the latest one, F2.10 the oldest one out of the 10 inside the fault history.
- Select fault message with ▲ and ▼. On the keypad e.g. „F2.3 Fault“ is displayed.
    - F**2**.x means, that this is not an actual fault, but one out of the fault history list.
    - F2.**3**: it is the third to last fault.
- Below the assigned text is displayed.
- In addition date and time of the fault occurrence are displayed in the format MMDDYY (date) and HH:MM:SS (time).
- Following information is available by pressing the softbutton Details:
    - The fault code of the message according to the column “Code” in the table in chapter 7.3.1 „Possible fault and warning messages, causes and remedy“. Here: 51
    - The type of message (fault or warning…)
    - The number of days since the first power-on

Example 2: Displaying the latest fault in the Monitor Parameter Menu (Chapter 7.1.1)

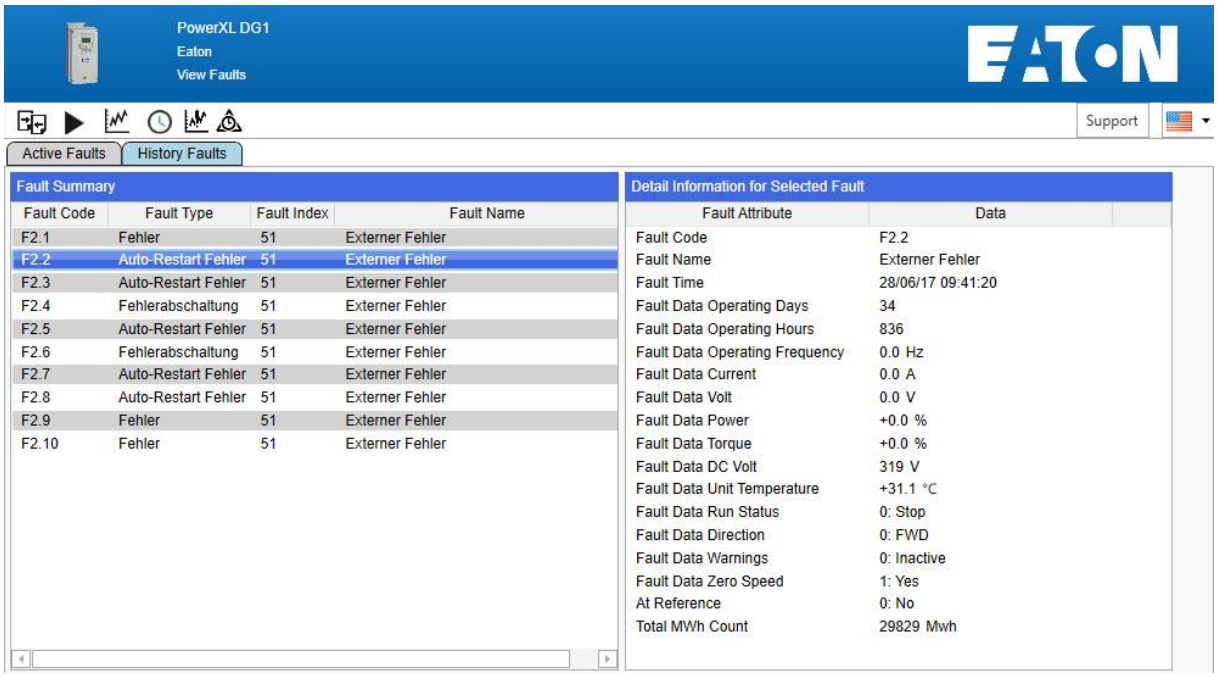
- M42 = 51 (= External Fault according to column „Code“ in the table in chapter 7.3.1)

Example 3: Fault history in the configuration software Power Xpert inControl

- The fault list is available by clicking on the triangle symbol.



- Additional information about the drive's status at the point in time, at which the fault occurs, is available to draw conclusions of the possible cause.



7.3.4 Reset fault and warning messages

In case warning and fault messages occur, they must be reset. Exceptions are those messages, which are configured for an automatic restart (see chapter 2.3 „Automatic restart after a fault“).

A reset can be done in different ways:

- With a rising edge (change from LOW to HIGH) of the signal at the source assigned to P3.8 „Fault Reset”.
- By pressing the button Back / Reset on the keypad for at least 2 s
- By removing and re-applying the mains voltage (terminals L1/L2/L3)
- By clicking on the button „Clear Faults“ below the error list in the configuration software
- With the control word, when the variable frequency drive is controlled via fieldbus (see respective fieldbus manual)
- In case of a warning the reset is done automatically after approximately 5 seconds,

The behavior of the drive after a reset command is determined by parameter P9.57 “Fault Reset Start”

P9.57 „Fault Reset Start“

- P9.57 = 0: Restart After Fault Reset
  - When a START command is still active after a reset, the drive restarts.
- P9.57 = 1: Start/Stop After Fault Reset
  - To start the drive after a fault reset a rising edge of the START command is required. The drive doesn't start even when the START command is applied as a constant HIGH signal.

Parameter	Name	Range	Default
P3.8	Fault Reset	0: DigIN:NormallyOpen 1: DigIN:NormallyClose 2: DigIN 1 3: DigIN 2 4: DigIN 3 5: DigIN 4 6: DigIN 5 7: DigIN 6 8: DigIN 7 9: DigIN 8 10: DigIN: A: IO1: 1 (on DXG-EXT-3DI3DO1T) 11: DigIN: A: IO1: 2 (on DXG-EXT-3DI3DO1T) 12: DigIN: A: IO1: 3 (on DXG-EXT-3DI3DO1T) 13: DigIN: A: IO5: 1 (on DXG-EXT-6DI) 14: DigIN: A: IO5: 2 (on DXG-EXT-6DI) 15: DigIN: A: IO5: 3 (on DXG-EXT-6DI) 16: DigIN: A: IO5: 4 (on DXG-EXT-6DI) 17: DigIN: A: IO5: 5 (on DXG-EXT-6DI) 18: DigIN: A: IO5: 6 (on DXG-EXT-6DI) 19: DigIN: B: IO1: 1 (on DXG-EXT-3DI3DO1T) 20: DigIN: B: IO1: 2 (on DXG-EXT-3DI3DO1T) 21: DigIN: B: IO1: 3 (on DXG-EXT-3DI3DO1T) 22: DigIN: B: IO5: 1 (on DXG-EXT-6DI) 23: DigIN: B: IO5: 2 (on DXG-EXT-6DI) 24: DigIN: B: IO5: 3 (on DXG-EXT-6DI) 25: DigIN: B: IO5: 4 (on DXG-EXT-6DI) 26: DigIN: B: IO5: 5 (on DXG-EXT-6DI) 27: DigIN: B: IO5: 6 (on DXG-EXT-6DI) 28: Time Channel 1 29: Time Channel 2 30: Time Channel 3 31: RO1 Function 32: RO2 Function 33: RO3 Function 34: Virtual RO1 Function 35: Virtual RO2 Function	5
P9.57	Fault Reset Start	0: Restart After Fault Reset 1: Start/Stop After Fault Reset	0

8 Stopping

There are multiple possibilities to stop a variable speed drive:

	Possible with DG1?	Accessories required
Switch off, drive coasts to standstill	YES	None
Ramp down to standstill	YES	None
Dynamic braking with brake resistor	YES	Brake resistor
DC braking	YES	None
AC flux braking	YES	None
Feedback energy to the mains	NO	-
Mechanical brake	YES	None. Control with DG1

The application determines, which possibility is selected. One may ask the question, why one re-signed the possibility to feedback energy to the mains. The answer is: because of energy efficiency. At a first glance, this sounds strange because dissipating energy as heat is surely less efficient than a feedback to the mains. But if you now realize that in most applications, where DG1 is used, the braking is done sporadically and a feedback unit with higher losses than a normal rectifier, like the one used in DG1, is active all the time, the statement becomes more feasible.

8.1 Ramping down or coasting (Stop Mode)

Parameter P7.10 „Stop Mode“ determines, if the motor coasts or if it ramps down when the START signal is removed. Condition is always, that a HIGH signal is present at the source defined with P3.42 „Emergency Stop“. If this signal is removed during run, the drive coasts, not depending on the setting of P7.10 „Stop Mode“.

P7.10 „Stop Mode“

- P7.10 = 0: Coasting
  - When the enable signal is removed, the output of the inverter is disabled and the motor coasts to stop. If the load can continue to rotate due to inertia and the drive may possibly be re-enabled whilst the motor is still rotating, the flying start function shall be enabled (see chapter 6.5 “Start Mode”).
- P7.10 = 1: Ramp
  - When the START signal is removed, the motor ramps to standstill with the active deceleration ramp (P1.4 “Decel Time 1” or P7.14 “Decel Time 2”, see chapter 5ff) and is disabled at stop.
  - ATTENTION: In a drive system the energy always flows from the subsystem with the higher frequency to the one with lower frequency. If the output frequency of the variable frequency drive is reduced too fast (deceleration ramp too short) and the motor still turns at a higher speed than the one corresponding to the output frequency of the inverter because of its inertia, the motor becomes a generator and feeds back energy into the DC link. This leads to an increase of the DC link voltage and possibly to a trip with the message “Over Voltage” (Fault Code 2). This can be prevented by a prolongation of the deceleration ramp time and, where this is not possible because of the application, by using a brake chopper (see: 8.2 “Dynamic braking with a brake chopper”) or by activating Flux braking (see 8.4 “Flux Braking”).

Parameter	Name	Range	Default
P3.42	Emergency Stop	0: DigIN:NormallyOpen 1: DigIN:NormallyClose 2: DigIN 1 3: DigIN 2 4: DigIN 3 5: DigIN 4 6: DigIN 5 7: DigIN 6 8: DigIN 7 9: DigIN 8 10: DigIN: A: IO1: 1 (on DXG-EXT-3DI3DO1T) 11: DigIN: A: IO1: 2 (on DXG-EXT-3DI3DO1T) 12: DigIN: A: IO1: 3 (on DXG-EXT-3DI3DO1T) 13: DigIN: A: IO5: 1 (on DXG-EXT-6DI) 14: DigIN: A: IO5: 2 (on DXG-EXT-6DI) 15: DigIN: A: IO5: 3 (on DXG-EXT-6DI) 16: DigIN: A: IO5: 4 (on DXG-EXT-6DI) 17: DigIN: A: IO5: 5 (on DXG-EXT-6DI) 18: DigIN: A: IO5: 6 (on DXG-EXT-6DI) 19: DigIN: B: IO1: 1 (on DXG-EXT-3DI3DO1T) 20: DigIN: B: IO1: 2 (on DXG-EXT-3DI3DO1T) 21: DigIN: B: IO1: 3 (on DXG-EXT-3DI3DO1T) 22: DigIN: B: IO5: 1 (on DXG-EXT-6DI) 23: DigIN: B: IO5: 2 (on DXG-EXT-6DI) 24: DigIN: B: IO5: 3 (on DXG-EXT-6DI) 25: DigIN: B: IO5: 4 (on DXG-EXT-6DI) 26: DigIN: B: IO5: 5 (on DXG-EXT-6DI) 27: DigIN: B: IO5: 6 (on DXG-EXT-6DI) 28: Time Channel 1 29: Time Channel 2 30: Time Channel 3 31: RO1 Function 32: RO2 Function 33: RO3 Function 34: Virtual RO1 Function 35: Virtual RO2 Function	1
P7.10	Stop Mode	0: Coasting 1: Ramp	1

8.2 Dynamic braking with a brake chopper

When a dynamic braking is required, it is necessary to choose DG1 devices with an internal brake chopper. They have a “B” inside the type code.

Example: DG1-xxxxxx**B**-xxxx

These devices have an internal brake chopper to control the external brake resistor. The assignment of the brake resistors to the singles devices in the tables below take the minimum resistance and the braking duty into account.

In some cases a single brake resistor is not sufficient and a combination of several resistors must be chosen. The tables below have to be read as follows:

- When only the type is mentioned, a single resistor has to be used.
- When a „P:“ is at the beginning, it is a combination of several resistors, which are connected in parallel. Example: P:4 x DX-BR006-5K1 are 4 resistors of the type DX-BR006-5K1, which are connected in parallel.
- When an „R:“ is at the beginning, it is a combination of several resistors, which are connected in series. Example: P:2 x DX-BR002-54K3 are 2 resistors of the type DX-BR002-54K3, which are connected in series.

Mains voltage class 3 x 230 V, IP21 (DG1-32….-..21..)

Device DG1	Resistor@10 % duty	Resistor@20 % duty	Resistor@40 % duty
DG1-323D7FB-C21C	DX-BR035-1K1	DX-BR040-3K1	DX-BR040-3K1
DG1-324D8FB-C21C	DX-BR035-1K1	DX-BR040-3K1	DX-BR040-3K1
DG1-326D6FB-C21C	DX-BR035-1K1	DX-BR040-3K1	DX-BR040-3K1
DG1-327D8FB-C21C	DX-BR035-1K1	DX-BR040-3K1	DX-BR040-3K1
DG1-32011FB-C21C	DX-BR035-1K1	DX-BR040-3K1	DX-BR040-3K1
DG1-32012FB-C21C	DX-BR022-1K4	DX-BR022-3K1	DX-BR022-5K1
DG1-32017FB-C21C	DX-BR022-1K4	DX-BR022-3K1	DX-BR022-5K1
DG1-32025FB-C21C	DX-BR022-1K4	DX-BR022-3K1	DX-BR022-5K1
DG1-32031FB-C21C	P:4 x DX-BR047-9K2	P:4 x DX-BR047-9K2	P:4 x DX-BR047-9K2
DG1-32048FB-C21C	P:4 x DX-BR047-9K2	P:4 x DX-BR047-9K2	P:4 x DX-BR047-9K2
DG1-32061FB-C21C	R:2 x DX-BR002-54K3	R:2 x DX-BR002-54K3	R:2 x DX-BR002-54K3
DG1-32075FB-C21C	R:2 x DX-BR002-54K3	R:2 x DX-BR002-54K3	R:2 x DX-BR002-54K3
DG1-32088FB-C21C	R:2 x DX-BR002-54K3	R:2 x DX-BR002-54K3	R:2 x DX-BR002-54K3
DG1-32114FB-C21C	P:4 x DX-BR006-5K1	DX-BR002-54K3	DX-BR002-54K3
DG1-32143FB-C21C	P:4 x DX-BR006-5K1	DX-BR002-54K3	DX-BR002-54K3
DG1-32170FB-C21C	P:4 x DX-BR006-5K1	DX-BR002-54K3	DX-BR002-54K3
DG1-32211FB-C21C	P:4 x DX-BR006-5K1	DX-BR002-54K3	DX-BR002-54K3
DG1-32248FB-C21C	P:4 x DX-BR006-5K1	DX-BR002-54K3	DX-BR002-54K3

Mains voltage class 3 x 230 V, IP54 (DG1-32….-..54..)

Device DG1	Resistor@10 % duty	Resistor@20 % duty	Resistor@40 % duty
DG1-323D7FB-C54C	DX-BR035-1K1	DX-BR040-3K1	DX-BR040-3K1
DG1-324D8FB-C54C	DX-BR035-1K1	DX-BR040-3K1	DX-BR040-3K1
DG1-326D6FB-C54C	DX-BR035-1K1	DX-BR040-3K1	DX-BR040-3K1
DG1-327D8FB-C54C	DX-BR035-1K1	DX-BR040-3K1	DX-BR040-3K1
DG1-32011FB-C54C	DX-BR035-1K1	DX-BR040-3K1	DX-BR040-3K1
DG1-32012FB-C54C	DX-BR022-1K4	DX-BR022-3K1	DX-BR022-5K1
DG1-32017FB-C54C	DX-BR022-1K4	DX-BR022-3K1	DX-BR022-5K1
DG1-32025FB-C54C	DX-BR022-1K4	DX-BR022-3K1	DX-BR022-5K1
DG1-32031FB-C54C	P:4 x DX-BR047-9K2	P:4 x DX-BR047-9K2	P:4 x DX-BR047-9K2
DG1-32048FB-C54C	P:4 x DX-BR047-9K2	P:4 x DX-BR047-9K2	P:4 x DX-BR047-9K2
DG1-32061FB-C54C	R:2 x DX-BR002-54K3	R:2 x DX-BR002-54K3	R:2 x DX-BR002-54K3
DG1-32075FB-C54C	R:2 x DX-BR002-54K3	R:2 x DX-BR002-54K3	R:2 x DX-BR002-54K3
DG1-32088FB-C54C	R:2 x DX-BR002-54K3	R:2 x DX-BR002-54K3	R:2 x DX-BR002-54K3
DG1-32114FB-C54C	P:4 x DX-BR006-5K1	DX-BR002-54K3	DX-BR002-54K3
DG1-32143FB-C54C	P:4 x DX-BR006-5K1	DX-BR002-54K3	DX-BR002-54K3
DG1-32170FB-C54C	P:4 x DX-BR006-5K1	DX-BR002-54K3	DX-BR002-54K3
DG1-32211FB-C54C	P:4 x DX-BR006-5K1	DX-BR002-54K3	DX-BR002-54K3
DG1-32248FB-C54C	P:4 x DX-BR006-5K1	DX-BR002-54K3	DX-BR002-54K3

Mains voltage class 3 x 400 V, IP21 (DG1-34….-..21..)

Device DG1	Resistor@10 % duty	Resistor@20 % duty	Resistor@40 % duty
DG1-342D2FB-C21C	DX-BR075-1K4	DX-BR075-5K1	DX-BR075-5K1
DG1-343D3FB-C21C	DX-BR075-1K4	DX-BR075-5K1	DX-BR075-5K1
DG1-344D3FB-C21C	DX-BR075-1K4	DX-BR075-5K1	DX-BR075-5K1
DG1-345D6FB-C21C	DX-BR075-1K4	DX-BR075-5K1	DX-BR075-5K1
DG1-347D6FB-C21C	DX-BR075-1K4	DX-BR075-5K1	DX-BR075-5K1
DG1-349D0FB-C21C	DX-BR075-1K4	DX-BR075-5K1	DX-BR075-5K1
DG1-34012FB-C21C	DX-BR047-3K1	DX-BR047-5K1	DX-BR047-9K2
DG1-34016FB-C21C	DX-BR047-3K1	DX-BR047-5K1	DX-BR047-9K2
DG1-34023FB-C21C	DX-BR047-3K1	DX-BR047-5K1	DX-BR047-9K2
DG1-34031FB-C21C	P:3 x DX-BR047-3K1	P:3 x DX-BR047-5K1	P:3 x DX-BR047-9K2
DG1-34038FB-C21C	P:3 x DX-BR047-3K1	P:3 x DX-BR047-5K1	P:3 x DX-BR047-9K2
DG1-34046FB-C21C	P:3 x DX-BR047-3K1	P:3 x DX-BR047-5K1	P:3 x DX-BR047-9K2
DG1-34061FB-C21C	P:3 x DX-BR022-5K1	P:3 x DX-BR022-9K2	R:4 x DX-BR002-54K3
DG1-34072FB-C21C	P:3 x DX-BR022-5K1	P:3 x DX-BR022-9K2	R:4 x DX-BR002-54K3
DG1-34087FB-C21C	P:3 x DX-BR022-5K1	P:3 x DX-BR022-9K2	R:4 x DX-BR002-54K3
DG1-34105FB-C21C	R:2 x DX-BR002-54K3	R:2 x DX-BR002-54K3	R:2 x DX-BR002-102K4
DG1-34140FB-C21C	R:2 x DX-BR002-54K3	R:2 x DX-BR002-54K3	R:2 x DX-BR002-102K4
DG1-34170FB-C21C	R:2 x DX-BR002-54K3	R:2 x DX-BR002-54K3	R:2 x DX-BR002-102K4
DG1-34205FB-C21C	R:2 x DX-BR002-54K3	R:2 x DX-BR002-54K3	R:2 x DX-BR002-102K4
DG1-34245FB-C21C	R:2 x DX-BR002-54K3	R:2 x DX-BR002-54K3	R:2 x DX-BR002-102K4

Mains voltage class 3 x 400 V, IP54 (DG1-34….-..54..)

Device DG1	Resistor@10 % duty	Resistor@20 % duty	Resistor@40 % duty
DG1-342D2FB-C54C	DX-BR075-1K4	DX-BR075-5K1	DX-BR075-5K1
DG1-343D3FB-C54C	DX-BR075-1K4	DX-BR075-5K1	DX-BR075-5K1
DG1-344D3FB-C54C	DX-BR075-1K4	DX-BR075-5K1	DX-BR075-5K1
DG1-345D6FB-C54C	DX-BR075-1K4	DX-BR075-5K1	DX-BR075-5K1
DG1-347D6FB-C54C	DX-BR075-1K4	DX-BR075-5K1	DX-BR075-5K1
DG1-349D0FB-C54C	DX-BR075-1K4	DX-BR075-5K1	DX-BR075-5K1
DG1-34012FB-C54C	DX-BR047-3K1	DX-BR047-5K1	DX-BR047-9K2
DG1-34016FB-C54C	DX-BR047-3K1	DX-BR047-5K1	DX-BR047-9K2
DG1-34023FB-C54C	DX-BR047-3K1	DX-BR047-5K1	DX-BR047-9K2
DG1-34031FB-C54C	P:3 x DX-BR047-3K1	P:3 x DX-BR047-5K1	P:3 x DX-BR047-9K2
DG1-34038FB-C54C	P:3 x DX-BR047-3K1	P:3 x DX-BR047-5K1	P:3 x DX-BR047-9K2
DG1-34046FB-C54C	P:3 x DX-BR047-3K1	P:3 x DX-BR047-5K1	P:3 x DX-BR047-9K2
DG1-34061FB-C54C	P:3 x DX-BR022-5K1	P:3 x DX-BR022-9K2	R:4 x DX-BR002-54K3
DG1-34072FB-C54C	P:3 x DX-BR022-5K1	P:3 x DX-BR022-9K2	R:4 x DX-BR002-54K3
DG1-34087FB-C54C	P:3 x DX-BR022-5K1	P:3 x DX-BR022-9K2	R:4 x DX-BR002-54K3
DG1-34105FB-C54C	R:2 x DX-BR002-54K3	R:2 x DX-BR002-54K3	R:2 x DX-BR002-102K4
DG1-34140FB-C54C	R:2 x DX-BR002-54K3	R:2 x DX-BR002-54K3	R:2 x DX-BR002-102K4
DG1-34170FB-C54C	R:2 x DX-BR002-54K3	R:2 x DX-BR002-54K3	R:2 x DX-BR002-102K4
DG1-34205FB-C54C	R:2 x DX-BR002-54K3	R:2 x DX-BR002-54K3	R:2 x DX-BR002-102K4
DG1-34245FB-C54C	R:2 x DX-BR002-54K3	R:2 x DX-BR002-54K3	R:2 x DX-BR002-102K4

Mains voltage class 3 x 575 V, IP21 (DG1-35….-..21..)

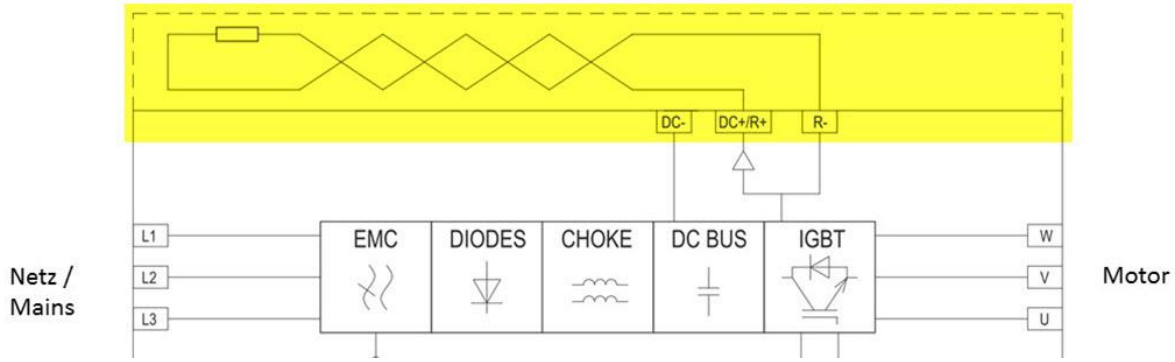
Device DG1	Resistor@10 % duty	Resistor@20 % duty	Resistor@40 % duty
DG1-353D3FB-C21C	DX-BR100-1K4	DX-BR100-6K2	DX-BR100-6K2
DG1-354D5FB-C21C	DX-BR100-1K4	DX-BR100-6K2	DX-BR100-6K2
DG1-357D5FB-C21C	DX-BR100-1K4	DX-BR100-6K2	DX-BR100-6K2
DG1-35010FB-C21C	DX-BR040-5K1	DX-BR047-9K2	P2R2: DX-BR047-9K2
DG1-35013FB-C21C	DX-BR040-5K1	DX-BR047-9K2	P2R2: DX-BR047-9K2
DG1-35018FB-C21C	DX-BR040-5K1	DX-BR047-9K2	P2R2: DX-BR047-9K2
DG1-35022FB-C21C	DX-BR022-9K2	P:2 x DX-BR047-9K2	P:4 x DX-BR100-6K2
DG1-35027FB-C21C	DX-BR022-9K2	P:2 x DX-BR047-9K2	P:4 x DX-BR100-6K2
DG1-35034FB-C21C	DX-BR022-9K2	P:2 x DX-BR047-9K2	P:4 x DX-BR100-6K2
DG1-35041FB-C21C	P:4 x DX-BR047-9K2	P:4 x DX-BR047-9K2	R:5 x DX-BR002-54K3
DG1-35052FB-C21C	P:4 x DX-BR047-9K2	P:4 x DX-BR047-9K2	R:5 x DX-BR002-54K3
DG1-35062FB-C21C	P:4 x DX-BR047-9K2	P:4 x DX-BR047-9K2	R:5 x DX-BR002-54K3
DG1-35080FB-C21C	P:3 x DX-BR022-9K2	R:4 x DX-BR002-54K3	R:4 x DX-BR002-102K4
DG1-35100FB-C21C	P:3 x DX-BR022-9K2	R:4 x DX-BR002-54K3	R:4 x DX-BR002-102K4
DG1-35125FB-C21C	P:3 x DX-BR022-9K2	R:4 x DX-BR002-54K3	R:4 x DX-BR002-102K4
DG1-35144FB-C21C	P:2 x DX-BR006-33K3	R:2 x DX-BR002-102K4	
DG1-35208FB-C21C	P:2 x DX-BR006-33K3	R:2 x DX-BR002-102K4	

Mains voltage class 3 x 575 V, IP54 (DG1-35….-..54..)

Device DG1	Resistor@10 % duty	Resistor@20 % duty	Resistor@40 % duty
DG1-353D3FB-C54C	DX-BR100-1K4	DX-BR100-6K2	DX-BR100-6K2
DG1-354D5FB-C54C	DX-BR100-1K4	DX-BR100-6K2	DX-BR100-6K2
DG1-357D5FB-C54C	DX-BR100-1K4	DX-BR100-6K2	DX-BR100-6K2
DG1-35010FB-C54C	DX-BR040-5K1	DX-BR047-9K2	P2R2: DX-BR047-9K2
DG1-35013FB-C54C	DX-BR040-5K1	DX-BR047-9K2	P2R2: DX-BR047-9K2
DG1-35018FB-C54C	DX-BR040-5K1	DX-BR047-9K2	P2R2: DX-BR047-9K2
DG1-35022FB-C54C	DX-BR022-9K2	P:2 x DX-BR047-9K2	P:4 x DX-BR100-6K2
DG1-35027FB-C54C	DX-BR022-9K2	P:2 x DX-BR047-9K2	P:4 x DX-BR100-6K2
DG1-35034FB-C54C	DX-BR022-9K2	P:2 x DX-BR047-9K2	P:4 x DX-BR100-6K2
DG1-35041FB-C54C	P:4 x DX-BR047-9K2	P:4 x DX-BR047-9K2	R:5 x DX-BR002-54K3
DG1-35052FB-C54C	P:4 x DX-BR047-9K2	P:4 x DX-BR047-9K2	R:5 x DX-BR002-54K3
DG1-35062FB-C54C	P:4 x DX-BR047-9K2	P:4 x DX-BR047-9K2	R:5 x DX-BR002-54K3
DG1-35080FB-C54C	P:3 x DX-BR022-9K2	R:4 x DX-BR002-54K3	R:4 x DX-BR002-102K4
DG1-35100FB-C54C	P:3 x DX-BR022-9K2	R:4 x DX-BR002-54K3	R:4 x DX-BR002-102K4
DG1-35125FB-C54C	P:3 x DX-BR022-9K2	R:4 x DX-BR002-54K3	R:4 x DX-BR002-102K4
DG1-35144FB-C54C	P:2 x DX-BR006-33K3	R:2 x DX-BR002-102K4	
DG1-35208FB-C54C	P:2 x DX-BR006-33K3	R:2 x DX-BR002-102K4	

In contradiction to a DC braking, the dynamic braking is not only active when stopping the drive, but also when the speed is reduced e.g. from 1000 rpm to 800 rpm. The activation of the brake chopper is done automatically, when the DC link voltage exceeds a certain threshold. When the DC link voltage decreases, the brake chopper is deactivated. The power of the connected resistor is determined by the duty of braking. The mechanical values for an exact calculation of a brake resistor are quite often not available and the designer uses values out of his experience in similar applications.

The brake resistor is connected to the terminals DC+/R+ and R-.



The brake chopper must be activated with parameter P14.5 “Brake Chopper Define”. Depending on the setting of P14.5 the brake resistor loop is supervised for a proper connection. In case of a fault the fault message “BrakeChopper Spv” (Fault Code 12) is displayed and the drive trips.

Possible causes:

- No brake resistor is installed, but the brake chopper is enabled (P14.5 >0).
- The brake resistor is defective.
- Faulty connection between the device and the brake resistor.
- Fault inside the brake chopper

P14.5 „Brake Chopper Define“

- P14.5 = 0: Disabled
  - The brake chopper is not activated. No braking is performed.
- P14.5 = 1: B(Run) T(Rdy)
  - The brake chopper is only active during run, but is supervised during run and in ready state (Device is supplied, but no START signal active).
- P14.5 = 2: External
  - An external brake chopper is used. No supervision.
- P14.5 = 3: B(Rdy) T(Rdy)
  - The brake chopper is active and supervised in run as well as in ready state (Device is supplied, but no START signal active).
- P14.5 = B(run) T(No)
  - The brake chopper is active during run. No supervision.

P21.3.1 „Brake Chopper“

This parameter shows (1:Yes), that a brake chopper is installed and the software is configured accoordingly. In normal cases no change by the use is required. At devices without brake chopper „0:No“ is displayed.

P21.3.2 „Brake Resistor Status“

Shows, if a brake resistor is installed and works properly (with P14.5 = 1…3)

Parameter	Name	Range	Default
P14.5	Brake Chopper Define	0: Disabled 1: B(Run) T(Rdy) 2: External 3: B(Rdy) T(Rdy) 4: B(run) T(No)	0
P21.3.1	Brake Chopper	0: No 1: Yes	
P21.3.2	Brake Resistor Status	0: No 1: Yes	

8.3 DC braking to standstill

A DC current is injected into the motor, which generates a braking torque. The rotating energy of the machine is converted into heat, dissipated by the motor. This means that a DC braking may not be performed quite often, not to overload the motor.

A DC braking cannot be used for a speed reduction e.g. from 1000 rpm to 800 rpm, but to a braking to standstill only. DC braking is also used to stop spinning motors before they are started, e.g. in fan applications where the motor spins because of the chimney effect inside the wind tunnel. This measure prevents over current trips at start.

DC braking must be enabled with a HIGH signal at the source defined with P3.26 „DC Brake Active".

P3.26 „DC Brake Active"

- LOW → DC braking disabled
- HIGH → DC braking enabled

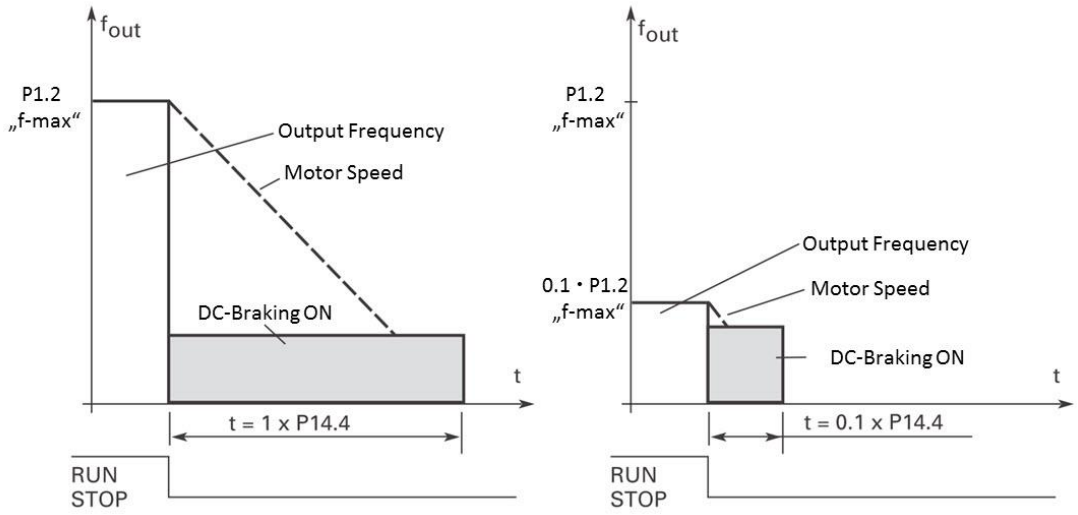
P14.1 „DC-Brake Current"
Current in Ampere, which is injected into the motor during DC braking.

P14.2 „Start DC-Brake Time"
P14.2 defines the DC braking time in cases, where DC braking shall be performed to stop a spinning motor before it starts. When the START signal is applied, the current defined with P14.1 is injected for the time defined here, before the motor ramps to the desired speed. With P14.2 = 0.00s, no DC braking is performed.

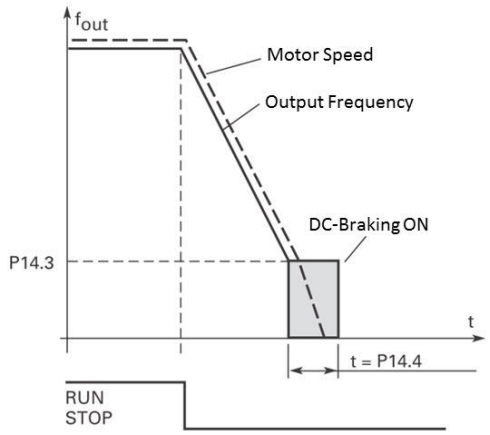
P14.3 „Stop DC-Brake Frequency"
When „Stop Mode" P7.10 = "1: Ramp" is selected, the drive initially ramps down according to the set deceleration ramp. When the frequency set with P14.3 is reached, DC braking starts. See also the drawing further below.

P14.4 „Stop DC-Brake Time"
This parameter defines the DC braking time at stop. The behavior of the drive depends on the setting of P7.10 "stop Mode". With P4.14 = 0.00s, no DC braking is performed.

- P7.10 „Stop Mode" = 0: Coasting
  - The DC braking starts as soon as the START signal is removed.
  - The braking time defined with P14.4 is related to the maximum frequency set with P1.2. The time changes proportional to the frequency at removal of the START signal. Is the START signal removed at a frequency of 10 % of the maximum frequency, the braking time is consequently 10 % of the setting with P14.4. See also the drawing further below.



- P7.10 „Stop-Mode“ = 1: Ramp
  - When the START signal is removed, the drive decelerates with the set ramp.
  - Reaching the frequency according to P14.3 „Stop DC-Brake Frequency“ the DC braking starts. The duration of the braking is defined with P14.4.



Parameter	Name	Range	Default
P3.26	DC Brake Active	0: DigIN:NormallyOpen 1: DigIN:NormallyClose 2: DigIN 1 3: DigIN 2 4: DigIN 3 5: DigIN 4 6: DigIN 5 7: DigIN 6 8: DigIN 7 9: DigIN 8 10: DigIN: A: IO1: 1 (on DXG-EXT-3DI3DO1T) 11: DigIN: A: IO1: 2 (on DXG-EXT-3DI3DO1T) 12: DigIN: A: IO1: 3 (on DXG-EXT-3DI3DO1T) 13: DigIN: A: IO5: 1 (on DXG-EXT-6DI) 14: DigIN: A: IO5: 2 (on DXG-EXT-6DI) 15: DigIN: A: IO5: 3 (on DXG-EXT-6DI) 16: DigIN: A: IO5: 4 (on DXG-EXT-6DI) 17: DigIN: A: IO5: 5 (on DXG-EXT-6DI) 18: DigIN: A: IO5: 6 (on DXG-EXT-6DI) 19: DigIN: B: IO1: 1 (on DXG-EXT-3DI3DO1T) 20: DigIN: B: IO1: 2 (on DXG-EXT-3DI3DO1T)	0

Parameter	Name	Range	Default
		21: DigIN: B: IO1: 3 (on DXG-EXT-3DI3DO1T) 22: DigIN: B: IO5: 1 (on DXG-EXT-6DI) 23: DigIN: B: IO5: 2 (on DXG-EXT-6DI) 24: DigIN: B: IO5: 3 (on DXG-EXT-6DI) 25: DigIN: B: IO5: 4 (on DXG-EXT-6DI) 26: DigIN: B: IO5: 5 (on DXG-EXT-6DI) 27: DigIN: B: IO5: 6 (on DXG-EXT-6DI) 28: Time Channel 1 29: Time Channel 2 30: Time Channel 3 31: RO1 Function 32: RO2 Function 33: RO3 Function 34: Virtual RO1 Function 35: Virtual RO2 Function	
P14.1	DC-Brake current	Depending on the drive's rating	f (I_e)
P14.2	Start DC-Brake Time	0.00 … 600.00 s	0.00 s
P14.3	Stop DC-Brake Frequency	0.10 … 10.00 Hz	1.50 Hz
P14.4	Stop DC-Brake Time	0.00 … 600.00 s	0.00 s

8.4 Flux braking

During flux braking the output frequency of the variable frequency drive is reduced, which results in an over excitation of the motor. The rotating energy of the machine is converted into heat, dissipated by the motor. This means that a DC braking may not be performed quite often, not to overload the motor. When flux braking is required, it has to be activated by setting P14.6 “Flux Brake” to “1: On”.

Flux braking is performed along the active deceleration ramp. It is an alternative to the DC braking and is predominantly used on motors up to 15 kW.

P14.6 „Flux Brake“

- P14.4 = 0: Off
  - No flux braking
- P14.4 = 1: On
  - Flux Braking is enabled

P14.7 „Flux Brake Current“
Current in Ampère, which is injected into the motor during flux braking

Parameter	Name	Range	Default
P14.6	Flux Brake	0: Off 1: On	0
P14.7	Flux Brake Current	Depending on the drive’s rating	f (I_e)

8.5 Control of a mechanical brake

In some applications the motor must be braked respectively secured mechanically to prevent dangerous situations. This is for example the case in hoist applications, where the weight of the load pulls downwards when the motor has no or not enough torque (variable frequency drive disabled, mains loss …). In the majority of cases a mechanical brake is not used to bring a motor to standstill, but to secure a motor, which has stopped already → holding brake.

Devices of the series DG1 have an internal logic to control the brake by using a digital output or a relay output. Multiple information (frequency, current, torque …) are used to control the brake at the right point in time. Would the brake of a hoist simultaneously be lifted when starting the variable frequency drive, the load would most likely sag because of the reaction time of the drive. When the brake is released when the motor has generated enough torque already, sagging is prevented.

8.5.1 Configuration of a digital output for brake control

Typically mechanical brakes work with spring pressure. This means, that the brake is activated by the spring force. To lift the brake, voltage must be applied to the coil of the brake. The magnetic field acts against the spring force and lifts the brake. This principle is advantageous, because in case of a wire break in the coil loop the brake is activated and secures a safe situation. There are some cases, in which the brake is activated by applying a voltage to the coil. The devices of the series DG1 support both principles. A respective selection has to be done when configuring the digital output DO1 respectively the relays RO1 … RO3.

P5.1 „DO1 Function“
P5.2 „RO1 Function“
P5.3 „RO2 Function“
P5.4 „RO3 Function“

- P5.1 or P5.2 or P5.3 or P5.4 = „18: Ext Brake Control“
  - The digital output is activated respectively the relay contact is closed, when the mechanical brake is active.
  - The digital output is deactivated respectively the relay contact is open, when the mechanical brake shall be lifted.
- P5.1 or P5.2 or P5.3 or P5.4 = „19: Ext Brake Inverted“
  - The digital output is activated respectively the relay contact is closed, when the mechanical brake shall be lifted.
  - The digital output is deactivated respectively the relay contact is open, when the mechanical brake is active.

8.5.2 Lifting the brake

To lift the mechanical brake (brake off) multiple conditions must be fulfilled simultaneously:

- The variable frequency drive must be in RUN state.
- When enabled:
  - The motor current (M4) must be higher than the value set with P5.40 „Motor Current 1 Superv Value“. To activate the supervision P5.39 „Motor Current 1 Supv“ must be set to „3: Brake-off Control”.
  - The motor current (M4) must be higher than the value set with P5.42 „Motor Current 2 Superv Value“. To activate the supervision P5.41 „Motor Current 2 Supv“ must be set to „3: Brake-off Control”.
  - The output frequency (M1) must be higher than the value set with P5.10 “Freq Limit 2 Supv Val”. To activate the supervision P5.9 “Freq Limit 2 Supv” must be set to “3: Brake-off Control”. Is the lifting and the braking activated at the same frequency, P5.9 “Freq Limit 2 Supv” must be set to “4: Brake-on/off Control”.
  - The torque (M5) must be higher than the value set with P5.12 “Torque Limit Supv Value”. To activate the supervision P5.11 “Torque Limit Supv” must be set to „3: Brake-off Control”.

8.5.3 Braking

To activate the mechanical brake (brake on) one or multiple of the following conditions must be fulfilled:

- The variable frequency drive is not in RUN state.
- The variable frequency drive is not in fire mode and a fault is active.
- When enabled:
  - A STOP command is given and the output frequency (M1) is below the value set with P5.8 „Freq Limit 1 Supv Val“. This applies to applications, where lifting and activation of the brake are done at different frequency levels (P5.9 “Freq Limit 2 Supv” set to “3: Brake-off Control”). P5.7 “Freq Limit 1 Supv” must be set to “3: Brake-on Control”.
  - A STOP command is given and the output frequency (M1) is below the value set with P5.10 „Freq Limit 2 Supv Val“. This applies to applications, where lifting and activation of the brake are done at the same frequency level (P5.9 “Freq Limit 2 Supv” set to “4: Brake-on/off Control”).

8.5.4 Time delay at brake control

The signal to lift and to activate the brake can be delayed. The delay time at lifting can be set with P5.15 “Ext Brake Off Delay” and the one for activation with P5.16 “Ext Brake On Delay”.

8.5.5 Parameters for controlling the mechanical brake

Parameter	Name	Range	Default
P5.1	DO1 Function	0: Not used ..... 18: Ext Brake Control 19: Ext Brake Inverted ..... 61: Bypass Overload	1
P5.2	RO1 Function	like P5.1	2
P5.3	RO2 Function	like P5.1	3
P5.4	RO3 Function	like P5.1	7
P5.7	Freq Limit 1 Supv	0: No Limit 1: Low Limit Superv 2: High Limit Superv 3: Brake-on Control	0
P5.8	Freq Limit 1 Supv Val	0.00 Hz … P1.2 „Max Frequency“	0.00 Hz
P5.9	Freq Limit 2 Supv	0: No Limit 1: Low Limit Superv 2: High Limit Superv 3: Brake-off Control 4: Brake on/off Control	0
P5.10	Freq Limit 2 Supv Val	0.00 Hz … P1.2 „Max Frequency“	0.00 Hz
P5.11	Torque Limit Supv	0: No Limit 1: Low Limit Superv 2: High Limit Superv 3: Brake-off Control	0
P5.12	Torque Limit Supv Val	-1000 % … +1000 % M_N	100.0 %
P5.15	Ext Brake Off Delay	0.00 … 100.00 s	0.5 s
P5.16	Ext Brake On Delay	0.00 … 100.00 s	1.5 s
P5.39	Motor Current 1 Supv	0: No Limit 1: Low Limit Superv 2: High Limit Superv 3: Brake-off Control	0
P5.40	Motor Current 1 Supv Val	0 … 200 % I_e	100 % I_e
P5.41	Motor Current 2 Supv	0: No Limit 1: Low Limit Superv 2: High Limit Superv 3: Brake-off Control	0
P5.42	Motor Current 2 Supv Val	0 … 200 % I_e	100 % I_e