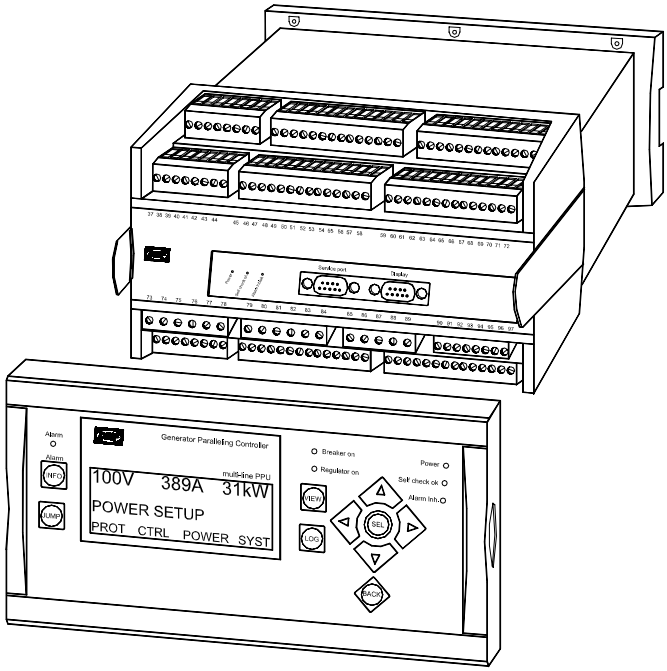
DEIF A/S

Description of options

Option A and B
Loss of mains protection package
Multi-line 2 - version 2

4189340266C
SW version 2.4X.X



- *Description of options*
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This paper relates to multi-line 2 ver. 2 PPU/GPU/GPC units with application software version 2.30.0 or later.

1. Warnings and legal information

Legal information and responsibility

DEIF takes no responsibility for installation or operation of the generator set. If there is any doubt about how to install or operate the generator set controlled by the unit, the company responsible for the installation or the operation of the set must be contacted.

The units are not to be opened by unauthorised personnel. If opened anyway, the warranty will be lost.

Electrostatic discharge awareness

Sufficient care must be taken to protect the terminals against static discharges during the installation. Once the unit is installed and connected, these precautions are no longer necessary.

Safety issues

Installing the unit implies work with dangerous currents and voltages. Therefore, the installation should only be carried out by authorised personnel who understand the risks involved in working with live electrical equipment.

Be aware of the hazardous live currents and voltages. Do not touch any AC measurement inputs as this could lead to injury or death.

Definitions

Throughout this document a number of notes and warnings will be presented. To ensure that these are noticed, they will be highlighted in order to separate them from the general text.

Notes

The notes provide general information which will be helpful for the reader to bear in mind.

Warning

The warnings indicate a potentially dangerous situation which could result in death, personal injury or damaged equipment, if certain guidelines are not followed.

2. Description of options

ANSI numbers

Protection	ANSI no.
Overvoltage	59
Undervoltage	27
Overfrequency	81
Underfrequency	81
Vector jump	78
df/dt (ROCOF)	7/78/81

A options

The A options are software options and therefore not related to any hardware apart from the standard-installed hardware. The A options are a mix of frequency, voltage, vector jump and df/dt protections as follows:

Option A1

- Over- and undervoltage, generator and busbar/mains
- Over- and underfrequency, generator and busbar/mains
- Vector jump
- df/dt (ROCOF)

Option A2

- Over- and undervoltage, generator and busbar/mains
- Over- and underfrequency, generator and busbar/mains
- df/dt (ROCOF)

Option A3

- Over- and undervoltage, generator and busbar/mains
- Over- and underfrequency, generator and busbar/mains
- Vector jump

B options

The B options are software options and therefore not related to any hardware apart from the standard-installed hardware. The B options are a mix of frequency and voltage protections as follows:

Option B1

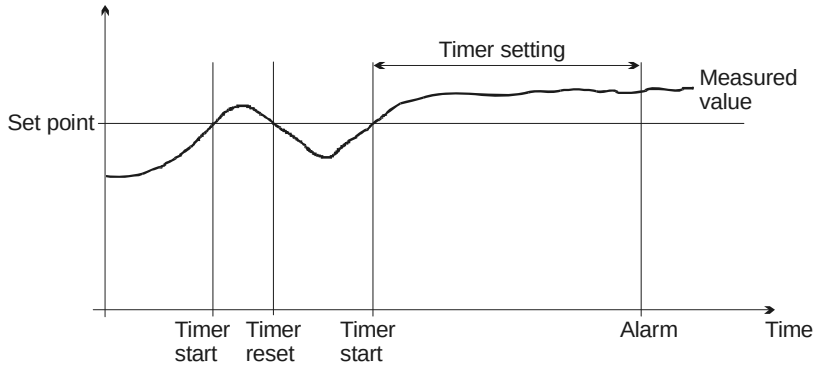
- Over- and undervoltage, generator and busbar/mains
- Over- and underfrequency, generator and busbar/mains

3. Functional descriptions

Voltage and frequency

Voltage and frequency is set in % of nominal generator value. The delay settings are all of the definite time type, meaning that a set point and time is selected.

If the function is e.g. overvoltage, then the timer will be activated if the set point is exceeded. If the voltage value falls below the set point value before the timer runs out, then the timer will be stopped and reset.

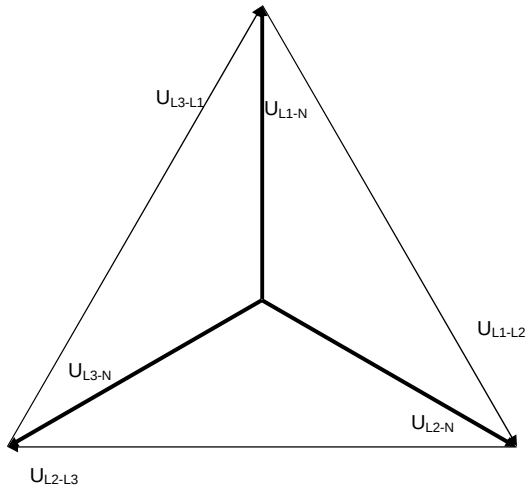


When the timer runs out, the output is activated. The total delay will be the delay setting + the reaction time.

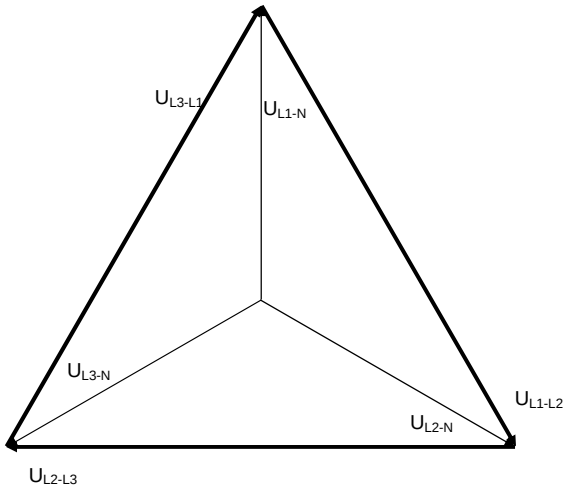
Phase-neutral voltage trip

If the voltage alarms are to work based on phase-neutral measurements, it is adjusted in menu 4960. Depending on the selections, either phase-phase voltages or phase-neutral voltages will be used for the alarm monitoring.

Phase-neutral



Phase-phase



As indicated in the vector diagram, there is a difference in voltage values at an error situation for the phase-neutral voltage and the phase-phase voltage.

The table shows the actual measurements at a 10% undervoltage situation in a 400/230 volts system.

	Phase-neutral	**Phase-phase**
Nominal voltage	**400/230**	**400/230**
Voltage, 10% error	380/**207**	**360**/185

It is clear that the alarm will occur at two different voltage levels even though the alarm set point is 10% in both cases.

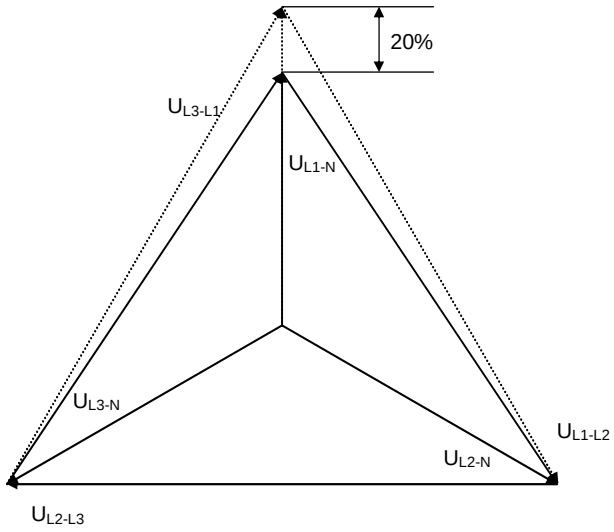
Example
The example below is from a 400V AC system. It shows that the phase-neutral voltage must change 20%, when the phase-phase voltage changes 40 volts (10%).

Example:
U_{NOM} = 400/230V AC

Error situation:
U_{L1L2} = 360V AC
U_{L3L1} = 360V AC

U_{L1-N} = 185V AC

ΔU_{PH-N} = 20%



Phase-neutral or phase-phase, both the generator protections and the busbar/mains protections use the selected voltage.

Vector jump and df/dt protections

The loss of mains protection package includes df/dt (Rate Of Change Of Frequency, ROCOF) and/or vector jump protection. The protections are used when the generator is paralleling with the mains.

Measurement

Both the df/dt and vector jump protections are based on 3 individual single phase measurements (individual monitoring of phases L1, L2 and L3). Therefore, the relay will trip if a df/dt and/or vector jump occurs in one of the 3 phases.

Principle

The vector jump and df/dt protections are intended for detection of a mains failure and subsequent opening of the mains breaker. The reasons are:

1) In case of mains failure the generator will run 'stand-alone' on the grid, attempting to supply power to all the consumers. Naturally, this is not possible because of the mains failure, and an overload/overcurrent situation is likely to be the end result, as the mains consumption normally exceeds the generator capacity.

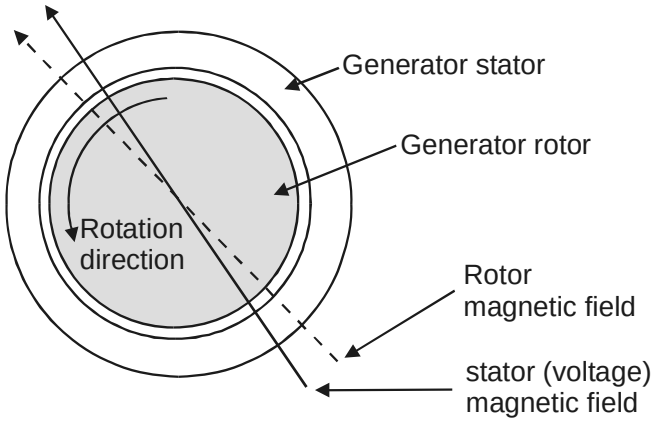
2) Mains transformer protection systems are constructed with a so-called 'fast re-closing' feature. This means that if a failure occurs (e.g. a short circuit), then the transformer protection system will open the transformer breaker. But after a while (the actual time period depends on the specific country (330 ms in Denmark)), the breaker will be re-closed to check whether it was a short-time failure, e.g. 2 overhead wires meeting shortly, a lightning strike, a branch falling down from a tree, etc. If the failure is still present, the breaker will be re-opened and remain there.

This re-closing combined with the high overload on the generator means that the generator and the mains will be paralleled again without synchronisation, an operation which will most likely damage the entire gen-set.

Ordinary protections will not identify a mains failure, before it is too late (300 ms). Therefore, the vector jump and/or df/dt protections are used. These will detect the mains failure and open the breaker before re-closing occurs.

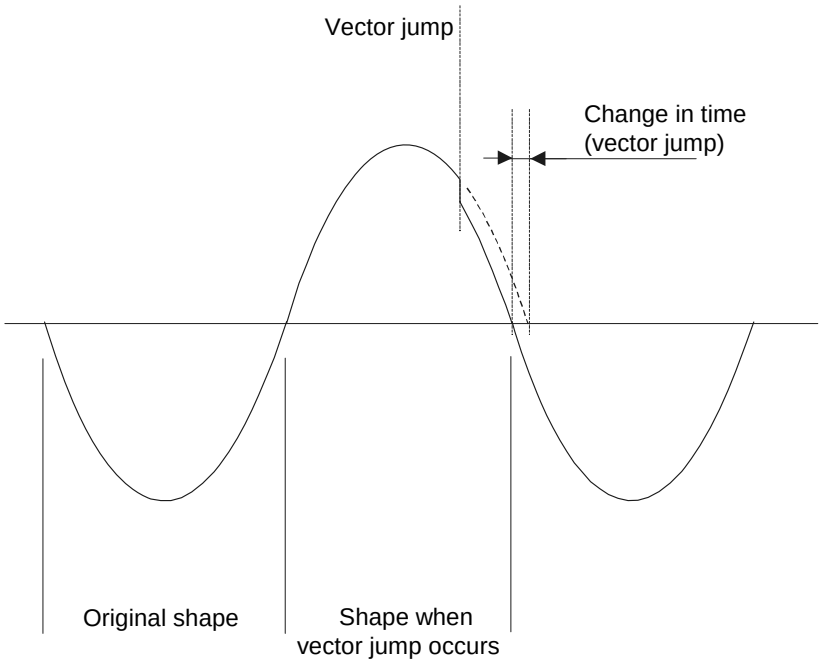
Vector jump

Vector jump is based on the fact that the stator magnetic field, and as a result, the 3-phase voltage from a generator, lack a little behind the rotor magnetic field (in time and position).



If a mains failure occurs, the time lack of the stator magnetic field (and the output voltage) will change (jump). This is called a vector jump.

Vector jump illustrated in a sine wave:

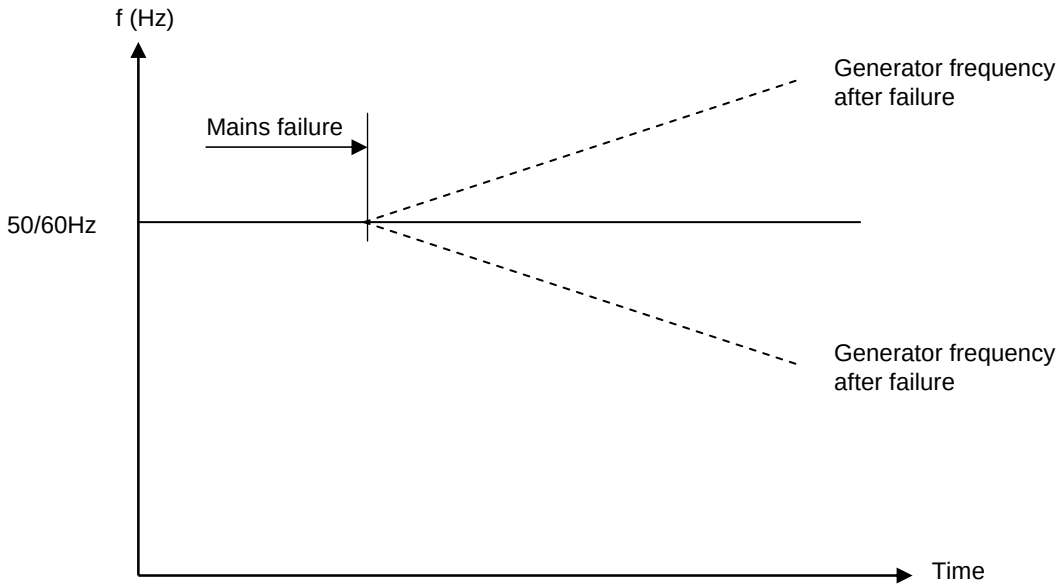


Again, comparing the half-sine curve time duration with the previous ones, a sudden change in time can be detected. This is the vector jump.

The vector jump setting is made in electrical degrees. The vector jump has no delay setting, since it reacts instantaneously. The delay will be the reaction time.

df/dt (ROCOF)

The df/dt function is based on the fact that the generator, if overloaded, will loose speed dramatically. Alternatively, it will speed up dramatically if a lot of load is dropped instantly.



So, a dramatic drop/increase of frequency over time is a mains failure. The df/dt setting is made in Hz/sec.

The delay is set in periods, i.e. if the setting is set to 6 per (factory setting), the time delay will be 120 ms (50Hz) or 100 ms (60Hz). The total delay will be the delay setting + reaction time.

Alarm inhibit

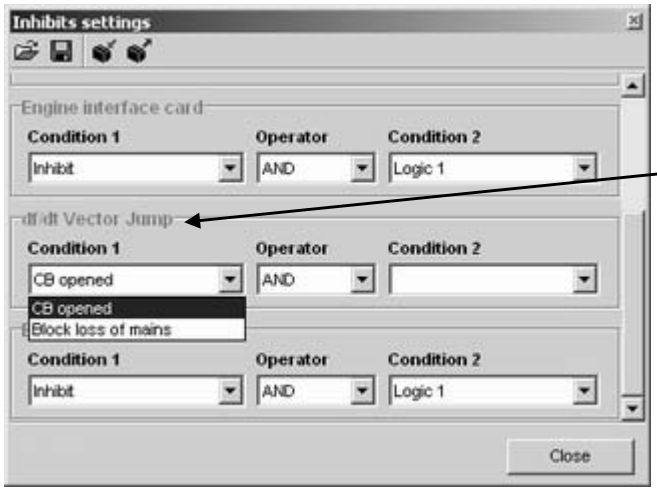
The alarms included in the option A and option B can all be inhibited in order to avoid nuisance alarms during controlled conditions such as start/stop of the gen-set and breaker operations.

For general information about the inhibit function, please refer to the Designer's Reference Handbook.

Inhibit of loss of mains protection

The df/dt and vector jump alarms can be inhibited in one of two possible methods:

	Inhibit by	Comment
Factory setting	Digital input no. 27	Terminal 23, 24, 26 can be used instead of terminal 27
User configurable setting	CB open	Configurable in the PC utility software. There is a 1 second time delay after the breaker closes until the alarm is activated!



Configure the inhibit function of the df/dt alarm and the vector jump alarm in this dialogue box.

When the choice "CB opened" is selected, the loss of mains alarms are inhibited when the breaker is open. When the choice "Block loss of mains" is selected, the loss of mains alarms are inhibited when the digital input is high. (factory selected digital input is terminal 27).

If the inhibit function is configured to follow the CB position, then there is a 1 second delay from the CB closes and until the loss of mains alarms are activated.

If the 1 second time delay of the breaker close signal cannot be accepted, then the block loss of mains input can be used. There is no time delay connected to this function.

The inhibit LED flashes when the loss of mains protections are inhibited.

Adjustments

Load jumps

Vector jump and df/dt protections are generally very reliable when used for parallel with mains generator protection against asynchronous reconnection of the generator to the mains after a mains failure.

Nevertheless, the protections may fail to react, if no or a very small load change takes place upon mains failure. This can happen when the generator is used in a peak lopping or Combined Heat and Power (CHP) system, where the power flow to the mains is very low.

In general, the system load change needed to activate the vector jump or the df/dt protections is in the range of 15-20% of the plant's rated power. Attempting to increase the sensitivity of the protection by lowering the set point value may result in false trips, because even the mains grid is not completely stable.

Distant mains breaker decoupling

If a mains failure occurs in a system where a generator is running as a peak lopping/automatic mains failure generator, and if the loss of mains protections are used to decouple a mains breaker, then care must be taken to prevent the generator breaker short circuit from tripping the generator breaker before the mains breaker is tripped.

This may happen, if the breaker opened at the mains failure is a distant one, because it will leave so many remaining consumers connected to the gen-set that they will appear to be a short circuit, when compared to the generator nominal current.

Compare the reaction + delay time of the vector jump/df/dt protection to the delay time of the generator breaker short circuit protection to determine whether this is a problem.

4. Parameter list

Parameter table description

The table consists of the following possible adjustments.

Set point: The alarm set point is adjusted in the set point menu. The setting is in Hz/sec.

Timer: The timer setting indicates the duration of the period between the alarm situation and the alarm occurrence.

Relay output A: A relay can be activated by the output A.

Relay output B: A relay can be activated by the output B.

Enable: The alarm can be activated or deactivated. ON means always activated, RUN means that the alarm has run status. This means it is activated when the running signal is present.

For further information about the structure of the parameter descriptions, please see the Designer's Reference Handbook.

Loss of mains protections (option A)

1350 df/dt (ROCOF)

No.	Setting		Min. setting	Max. setting	Factory setting
1351	df/dt (ROCOF)	Set point +/-	0.1 Hz/s	10.0 Hz/s	5.0 Hz/s
1352	df/dt (ROCOF)	Delay	1 per	20 per	6 per
1353	df/dt (ROCOF)	Relay output A	R0 (none)	R0 (none)	R0 (none)
1354	df/dt (ROCOF)	Relay output B	R0 (none)	R0 (none)	R0 (none)
1355	df/dt (ROCOF)	Enable	OFF	ON	OFF

This protection is included in option A1 and A2.

1360 Vector jump

No.	Setting		Min. setting	Max. setting	Factory setting
1361	Vector jump	Set point	0.0 deg.	90.0 deg.	10.0 deg.
1362	Vector jump	Relay output A	R0 (none)	R0 (none)	R0 (none)
1363	Vector jump	Relay output B	R0 (none)	R0 (none)	R0 (none)
1364	Vector jump	Enable	OFF	ON	OFF

The protection is included in option A1 and A3.

Voltage protections

4960 Voltage trip measurement

No.	Setting		Min. setting	Max. setting	Factory setting
4961	Voltage trip	Set point	Phase-phase	Phase-neutral	Phase-phase

The voltage protection functions are as default set to be based on phase-phase measurements, but can be selected to be phase-neutral based.

When phase-phase tripping is selected, the voltage alarms relate to the nominal voltage, menu 4014.

When phase-neutral tripping is selected, the voltage alarms relate to the nominal voltage (menu 4014) divided by √3.

1100 Generator high voltage 1 protection

No.	Setting		Min. setting	Max. setting	Factory setting
1101	Gen. high volt. 1	Set point	90.0%	120.0%	103.0%
1102	Gen. high volt. 1	Timer	0.1 s	100.0 s	10.0 s
1103	Gen. high volt. 1	Relay output A	R0 (none)	R0 (none)	R0 (none)
1104	Gen. high volt. 1	Relay output B	R0 (none)	R0 (none)	R0 (none)
1105	Gen. high volt. 1	Enable	OFF	ON	OFF

1110 Generator high voltage 2 protection

No.	Setting		Min. setting	Max. setting	Factory setting
1111	Gen. high volt. 2	Set point	90.0%	120.0%	105.0%
1112	Gen. high volt. 2	Timer	0.1 s	100.0 s	5.0 s
1113	Gen. high volt. 2	Relay output A	R0 (none)	R0 (none)	R0 (none)
1114	Gen. high volt. 2	Relay output B	R0 (none)	R0 (none)	R0 (none)
1115	Gen. high volt. 2	Enable	OFF	ON	OFF

1120 Generator low voltage 1 protection

No.	Setting		Min. setting	Max. setting	Factory setting
1121	Gen. low volt. 1	Set point	80.0%	100.0%	97.0%
1122	Gen. low volt. 1	Timer	0.1 s	100.0 s	10.0 s
1123	Gen. low volt. 1	Relay output A	R0 (none)	R0 (none)	R0 (none)
1124	Gen. low volt. 1	Relay output B	R0 (none)	R0 (none)	R0 (none)
1125	Gen. low volt. 1	Enable	OFF	ON	OFF

1130 Generator low voltage 2 protection

No.	Setting		Min. setting	Max. setting	Factory setting
1131	Gen. low volt. 2	Set point	50.0%	100.0%	95.0%
1132	Gen. low volt. 2	Timer	0.1 s	100.0 s	5.0 s
1133	Gen. low volt. 2	Relay output A	R0 (none)	R0 (none)	R0 (none)
1134	Gen. low volt. 2	Relay output B	R0 (none)	R0 (none)	R0 (none)
1135	Gen. low volt. 2	Enable	OFF	ON	OFF

1180 Busbar (mains) high voltage 1 protection

No.	Setting		Min. setting	Max. setting	Factory setting
1181	Bus high volt. 1	Set point	90.0%	120.0%	103.0%
1182	Bus high volt. 1	Delay	0.00 s	99.99 s	10.00 s
1183	Bus high volt. 1	Relay output A	R0 (none)	R0 (none)	R0 (none)
1184	Bus high volt. 1	Relay output B	R0 (none)	R0 (none)	R0 (none)
1185	Bus high volt. 1	Enable	OFF	ON	OFF

1190 Busbar (mains) high voltage 2 protection

No.	Setting		Min. setting	Max. setting	Factory setting
1191	Bus high volt. 2	Set point	90.0%	120.0%	105.0%
1192	Bus high volt. 2	Delay	0.00 s	99.99 s	5.00 s
1193	Bus high volt. 2	Relay output A	R0 (none)	R0 (none)	R0 (none)
1194	Bus high volt. 2	Relay output B	R0 (none)	R0 (none)	R0 (none)
1195	Bus high volt. 2	Enable	OFF	ON	OFF

1200 Busbar (mains) low voltage 1 protection

No.	Setting		Min. setting	Max. setting	Factory setting
1201	Bus low volt. 1	Set point	80.0%	100.0%	97.0%
1202	Bus low volt. 1	Delay	0.00 s	99.99 s	10.00 s
1203	Bus low volt. 1	Relay output A	R0 (none)	R0 (none)	R0 (none)
1204	Bus low volt. 1	Relay output B	R0 (none)	R0 (none)	R0 (none)
1205	Bus low volt. 1	Enable	OFF	ON	OFF

1210 Busbar (mains) low voltage 2 protection

No.	Setting		Min. setting	Max. setting	Factory setting
1211	Bus low volt. 2	Set point	50.0%	100.0%	95.0%
1212	Bus low volt. 2	Delay	0.00 s	99.99 s	5.00 s
1213	Bus low volt. 2	Relay output A	R0 (none)	R0 (none)	R0 (none)
1214	Bus low volt. 2	Relay output B	R0 (none)	R0 (none)	R0 (none)
1215	Bus low volt. 2	Enable	OFF	ON	OFF

Frequency protections (option A and B)

Frequency settings relate to the nominal frequency setting (setting 4011).

1140 Generator high frequency 1 protection

No.	Setting		Min. setting	Max. setting	Factory setting
1141	Gen. high freq. 1	Set point	90.0%	120.0%	103.0%
1142	Gen. high freq. 1	Delay	0.2 s	100.0 s	10.0 s
1143	Gen. high freq. 1	Relay output A	R0 (none)	R0 (none)	R0 (none)
1144	Gen. high freq. 1	Relay output B	R0 (none)	R0 (none)	R0 (none)
1145	Gen. high freq. 1	Enable	OFF	ON	OFF

1150 Generator high frequency 2 protection

No.	Setting		Min. setting	Max. setting	Factory setting
1151	Gen. high freq. 2	Set point	90.0%	120.0%	105.0%
1152	Gen. high freq. 2	Delay	0.2 s	100.0 s	5.0 s
1153	Gen. high freq. 2	Relay output A	R0 (none)	R0 (none)	R0 (none)
1154	Gen. high freq. 2	Relay output B	R0 (none)	R0 (none)	R0 (none)
1155	Gen. high freq. 2	Enable	OFF	ON	OFF

1160 Generator low frequency 1 protection

No.	Setting		Min. setting	Max. setting	Factory setting
1161	Gen. low freq. 1	Set point	80.0%	100.0%	97.0%
1162	Gen. low freq. 1	Delay	0.2 s	100.0 s	10.0 s
1163	Gen. low freq. 1	Relay output A	R0 (none)	R0 (none)	R0 (none)
1164	Gen. low freq. 1	Relay output B	R0 (none)	R0 (none)	R0 (none)
1165	Gen. low freq. 1	Enable	OFF	ON	OFF

1170 Generator low frequency 2 protection

No.	Setting		Min. setting	Max. setting	Factory setting
1171	Gen. low freq. 2	Set point	80.0%	100.0%	95.0%
1172	Gen. low freq. 2	Delay	0.2 s	100.0 s	5.0 s
1173	Gen. low freq. 2	Relay output A	R0 (none)	R0 (none)	R0 (none)
1174	Gen. low freq. 2	Relay output B	R0 (none)	R0 (none)	R0 (none)
1175	Gen. low freq. 2	Enable	OFF	ON	OFF

1220 Busbar (mains) high frequency 1 protection

No.	Setting		Min. setting	Max. setting	Factory setting
1221	Bus high freq. 1	Set point	90.0%	120.0%	103.0%
1222	Bus high freq. 1	Delay	0.00 s	99.99 s	10.00 s
1223	Bus high freq. 1	Relay output A	R0 (none)	R0 (none)	R0 (none)
1224	Bus high freq. 1	Relay output B	R0 (none)	R0 (none)	R0 (none)
1225	Bus high freq. 1	Enable	OFF	ON	OFF

1230 Busbar (mains) high frequency 2 protection

No.	Setting		Min. setting	Max. setting	Factory setting
1231	Bus high freq. 2	Set point	90.0%	120.0%	105.0%
1232	Bus high freq. 2	Delay	0.00 s	99.99 s	5.00 s
1233	Bus high freq. 2	Relay output A	R0 (none)	R0 (none)	R0 (none)
1234	Bus high freq. 2	Relay output B	R0 (none)	R0 (none)	R0 (none)
1235	Bus high freq. 2	Enable	OFF	ON	OFF

1240 Busbar (mains) low frequency 1 protection

No.	Setting		Min. setting	Max. setting	Factory setting
1241	Bus low freq. 1	Set point	80.0%	100.0%	97.0%
1242	Bus low freq. 1	Delay	0.00 s	99.99 s	10.00 s
1243	Bus low freq. 1	Relay output A	R0 (none)	R0 (none)	R0 (none)
1244	Bus low freq. 1	Relay output B	R0 (none)	R0 (none)	R0 (none)
1245	Bus low freq. 1	Enable	OFF	ON	OFF

1250 Busbar (mains) low frequency 2 protection

No.	Setting		Min. setting	Max. setting	Factory setting
1251	Bus low freq. 2	Set point	80.0%	100.0%	95.0%
1252	Bus low freq. 2	Delay	0.00 s	99.99 s	5.00 s
1253	Bus low freq. 2	Relay output A	R0 (none)	R0 (none)	R0 (none)
1254	Bus low freq. 2	Relay output B	R0 (none)	R0 (none)	R0 (none)
1255	Bus low freq. 2	Enable	OFF	ON	OFF