-power in control

MULTI-LINE 2
DESCRIPTION OF OPTIONS



Option C2
Generator add-on protection package

- Description of option
- Functional description

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SW version:

1. Delimitation

1.1 Scope of option C2

This description of options covers the following products:

AGC-3	SW version 3.4x.x or later
AGC-4	SW version 4.0x.x or later
AGC 100 series	SW version 4.0x.x or later
AGC 200 series	SW version 3.66.x or later
APU 200 series	SW version 3.66.x or later
CGC 400	SW version 1.11.x or later
GPC-3/GPU-3 Hydro	SW version 3.06.0 or later
PPU-3/GPU-3	SW version 3.06.0 or later

2. General information

2.1 Warnings, legal information and safety

2.1.1 Warnings and notes

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

Warnings

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

Notes

Notes provide general information, which will be helpful for the reader to bear in mind.

2.1.2 Legal information and disclaimer

DEIF takes no responsibility for installation or operation of the generator set. If there is any doubt about how to install or operate the engine/generator controlled by the Multi-line 2 unit, the company responsible for the installation or the operation of the set must be contacted.

The Multi-line 2 unit is not to be opened by unauthorised personnel. If opened anyway, the warranty will be lost.

Disclaimer

DEIF A/S reserves the right to change any of the contents of this document without prior notice.

The English version of this document always contains the most recent and up-to-date information about the product. DEIF does not take responsibility for the accuracy of translations, and translations might not be updated at the same time as the English document. If there is a discrepancy, the English version prevails.

2.1.3 Safety issues

Installing and operating the Multi-line 2 unit may imply 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.

2.1.4 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.

2.1.5 Factory settings

The Multi-line 2 unit is delivered from factory with certain factory settings. These are based on average values and are not necessarily the correct settings for matching the engine/generator set in question. Precautions must be taken to check the settings before running the engine/generator set.

3. Description of option

3.1 Option C2

Option C2 is a software option and therefore not related to any hardware apart from the standard-installed hardware.

3.2 ANSI numbers

Protection	**ANSI no.**
Negative sequence current	46
Negative sequence voltage	47
Zero sequence current	$51I_0$
Zero sequence voltage	$59U_0$
Power-dependent reactive power	40
Inverse time over-current	51

4. Functional description

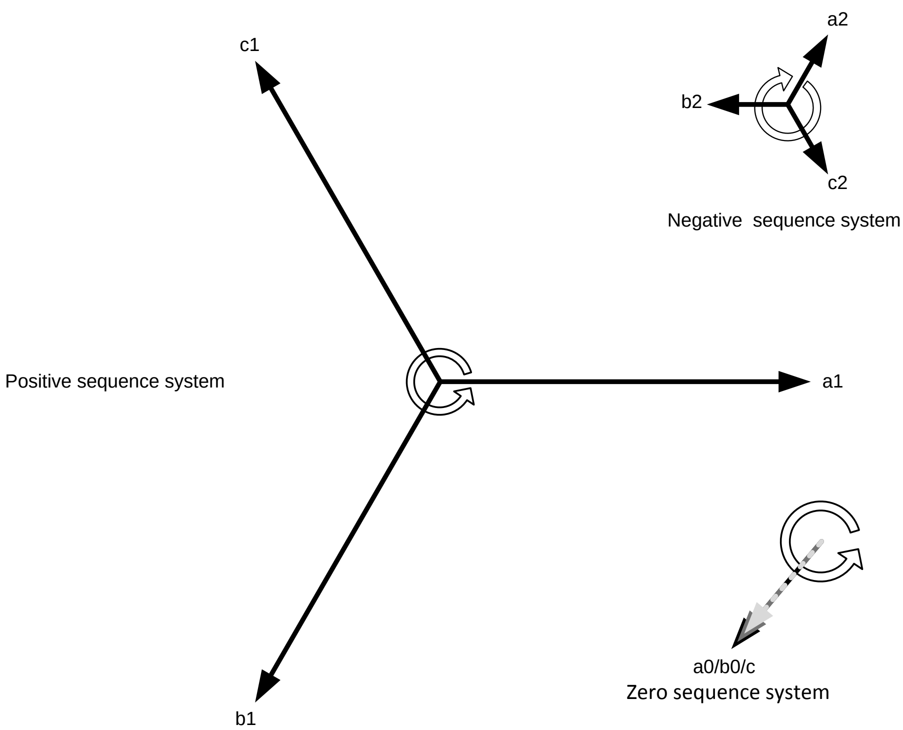
4.1 Positive, negative and zero sequences

4.1.1 Voltage vector system

The measurements of the generator currents and voltages are split up in three theoretical systems:

- The positive sequence system with a positive direction of rotation.
- The negative sequence system with a negative direction of rotation.
- The zero sequence system with a positive direction of rotation.

As a result of the generator's power production to the consumers, the positive sequence system represents the fault-free part of the voltages and currents. The negative sequence system, which rotates in the opposite direction of the generator, is used by the protections negative sequence current and negative sequence voltage to prevent the generator from overheating. The zero sequence system is used for detection of earth faults.



Description of the approach

Positive, negative and zero sequence values are calculated based on estimated phase current/phase voltage phasors. The RMS value of the phase quantity expresses the absolute value of the phasors, and an evaluation of zero crossings delivers expressions for the angles between the phasors.

4.1.2 Positive sequence

The voltages and currents in the positive sequence system are desirable, because they can be used by the consumers.

4.1.3 Negative sequence

A negative sequence current increases the risk of dangerous overheating in the generator, which could lead to general damage.

The negative sequence currents and voltages can occur for example in the event of single phase loads, unbalanced line short circuits and open conductors, unbalanced phase-phase or phase-neutral loads.

Especially the negative sequence currents can produce harmful overheating inside the generator. The reason is that these currents produce a magnetic field counter-rotating to the rotor. This field crosses the rotor at twice the rotor velocity, inducing double-frequency currents in the field system and in the rotor body.

4.1.4 Zero sequence

Zero sequence is used to detect an earth fault (earth current or neutral voltage). It is performed by measuring the vectorial displacement of the zero value (star point) for both current and voltage. The zero sequence measurement can therefore replace the more well-known methods, namely those using zero voltage measurement or summation transformers (zero sequence transformers).

Positive, negative and zero sequence is not available in the AGC 100 series.

4.2 Power-dependent reactive power

4.2.1 Steady state alternator reactive power capability curve

This curve indicates the possible reactive load at any given power load for the generator in question, for exporting and importing reactive power.

As the reactive power varies in a non-linear way with actual (power) load, the setting of trip values is made with a 12-point curve, six for lagging and six for leading reactive power. The unit carries out a linear regression between any two given points in order to find the trip point between the curve point settings.

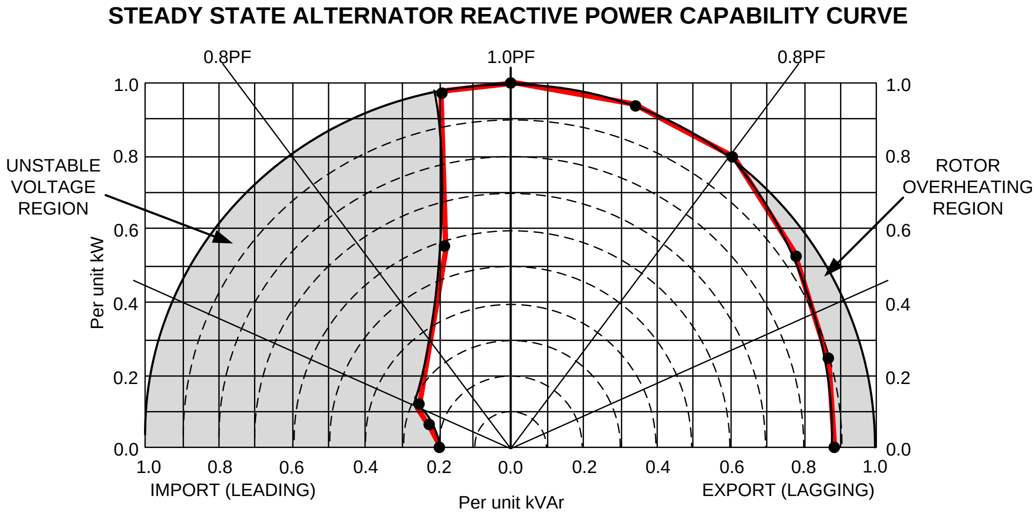
Each of the 12 points has a setting for real power (P) and a setting for the related reactive power (Q).

There are two separate reference settings (parameters) for apparent power, one for reactive power import and one for reactive power export. The intention of these two settings is that they should match the rated nominal apparent power of the genset. These two parameters only apply to this specific protection.

These two settings are not available in the AGC 100, AGC 200 and APU 200 series.

The relevant parameters for this protection are 1740-1790. For more detailed parameter information, refer to the respective product parameter list.

4.2.2 Setting curves



The settings of points 1-6, leading and lagging, should represent the generator manufacturer's recommended settings for var import (-Q)/export (+Q). Notice that the above curve is just an example, the actual values must be obtained from the generator manufacturer.

"Power-dependent reactive power" is NOT supported by the AGC 100 series and AGC-3.

It is imperative that the generator does not enter any of the grey areas. If it does, rotor overheating (export) or loss of synchronism (import) may occur.

In the above diagram, the positive power/reactive power flow direction is defined as the direction from the generator to the consumer, that is increasing export (lagging) is equal to increasing excitation.

4.3 Inverse time over-current

4.3.1 Formula and settings used

The inverse time over-current is based on IEC 60255 part 151.

The function used is **dependent time characteristic,** and the formula used is:

$$t(G) = TMS \left(\frac{k}{\left(\frac{G}{G_S}\right)^{\alpha} - 1} + C \right)$$

where

$t(G)$	is the theoretical operating time constant value of G in seconds
k, c, α	are the constants characterising the selected curve
G	is the measured value of the characteristic quantity
G_S	is the setting value
TMS	is the time multiplier setting

The constants k and c have a unit of seconds, α has no dimension.

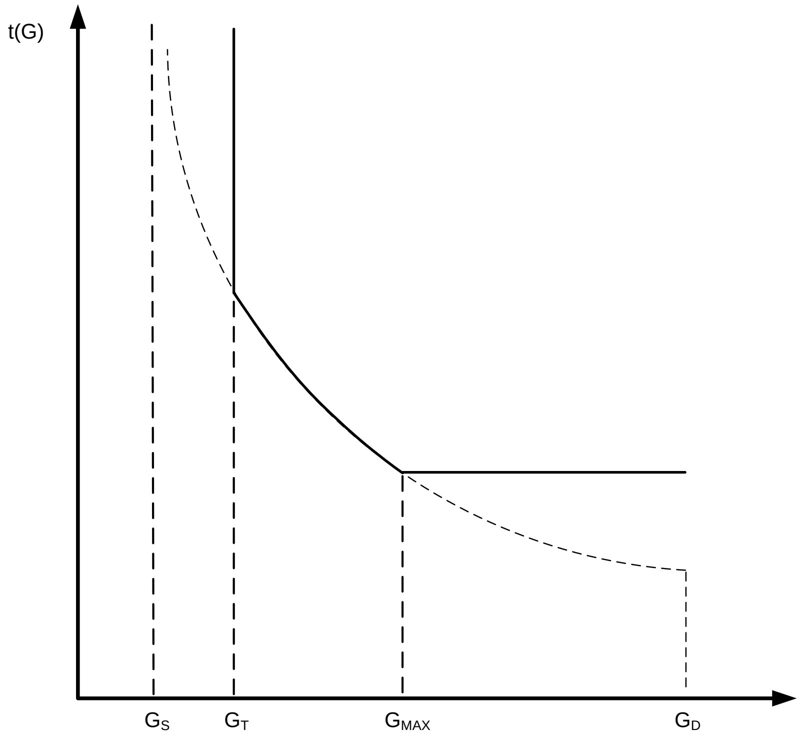
There is no intentional delay on reset. The function will reset when $G < G_S$.

"Inverse time over-current" is NOT supported by AGC-3.

"Inverse time over-current" is a standard feature in GPC-3/GPU-3/GPU-3 Hydro/PPU-3.

4.3.2 Curve shapes

Time characteristic:



$G_S = I_{nom}$ x LIM
$G_T = 1.1$ x G_S
G_{MAX} = Over-current factor x CT_P
$G_D = 20 * G_S$

Abbreviation explanation

G_T	Minimum trip current
G_{MAX}	Maximum trip current
I_{nom}	Nominal current setting
CT_P	Connected current transformer primary side value
G_D	The point where the alarm shifts from an inverse curve to a definite time characteristic
t_{MIN}	Minimum trip time that can be used for protection purpose. Only a calculation can show if this value will interfere with the intended trip curve

Product	Over-current factor	t_{MIN}
AGC-4	2.2	250 ms
AGC 100	3.5	400 ms
AGC 200	3.5	200 ms
CGC 400	2.0	250 ms
GPC/GPU Hydro	2.2	250 ms
PPU/GPU Hydro	2.2	250 ms

There is a choice between seven different curve shapes, of which six are predefined and one is user-definable:

IEC Inverse
IEC Very Inverse
IEC Extremely Inverse
IEEE Moderately Inverse
IEEE Very Inverse
IEEE Extremely Inverse
Custom

Common settings for all types:

Setting	Parameter no.	Factory setting value	Equals
LIM	1082	110 %	LIM = G_S/ I_{nom}
TMS	1083	1.0	Time multiplier setting

The following constants apply to the predefined curves:

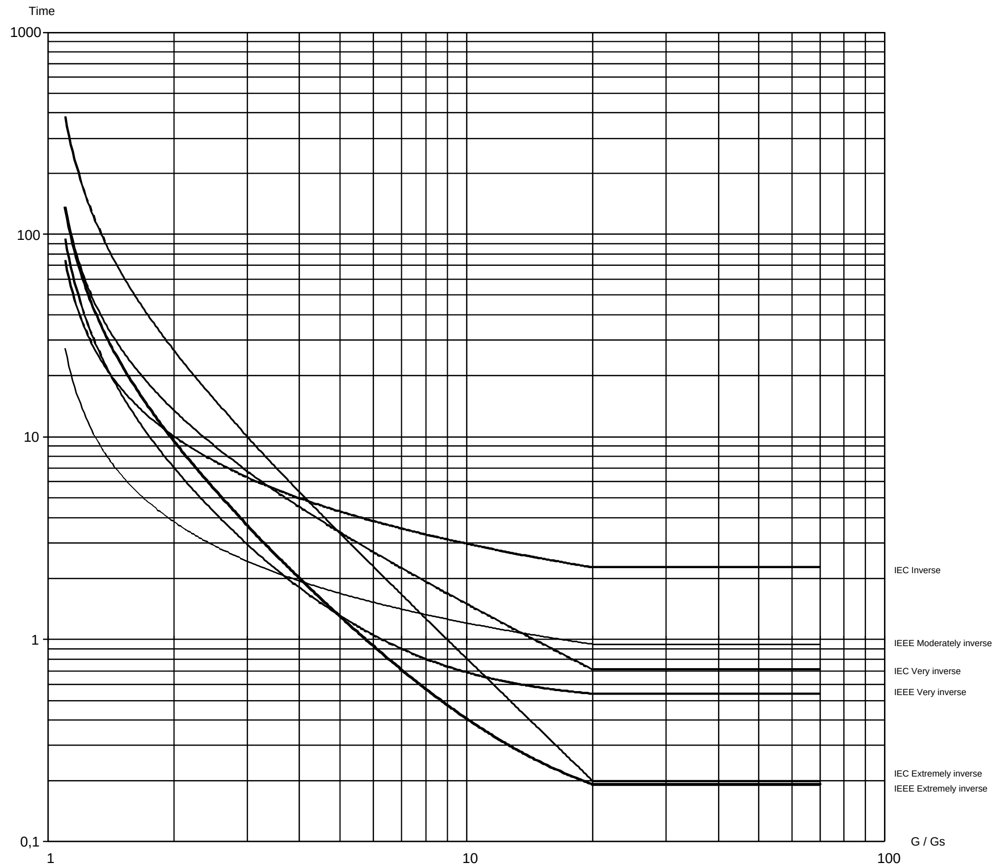
Curve type	k	c	α
IEC Inverse	0.14	0	0.02
IEC Very Inverse	13.5	0	1
IEC Extremely Inverse	80	0	2
IEEE Moderately Inverse	0.0515	0.1140	0.02
IEEE Very Inverse	19.61	0.491	2
IEEE Extremely Inverse	28.2	0.1217	2

For the custom curve, these constants can be defined by the user:

Setting	Parameter no.	Factory setting value	Equals
k	1084	0.140 s	k
c	1085	0.000 s	c
α	1086	0.020	α

For the actual setting ranges, see the separate parameter list document for the Multi-line unit in question.

4.3.3 Standard curves



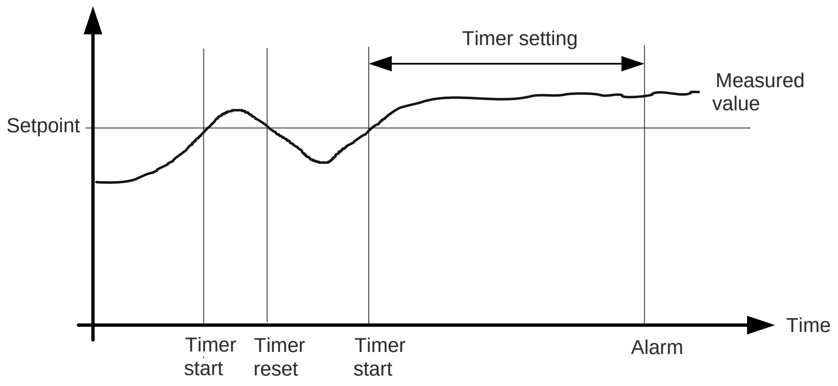
The curves are shown for TMS = 1.

5. Alarms

All settings are stated in percent of the nominal generator value.

The delay settings are (with a few exceptions, for example inverse time over-current) of the definite time type, that is a set point and time is selected.

If the function is for example over-voltage, 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, 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.

6. Parameters

6.1 Further information

The option C2 relates to the parameters 1080-1090, 1540-1590 and 1740-1790.

For further information, see the separate parameter list for the Multi-line unit in question:

AGC-3	Document number 4189340705
AGC-4	Document number 4189340688
AGC 100	Document number 4189340764
AGC 200	Document number 4189340605
GPC-3/GPU-3 Hydro	Document number 4189340580
PPU-3/GPU-3	Document number 4189340581