DEIF

-power in control

CE

DESCRIPTION OF OPTIONS

Genset Controller, GC-1F
Option B3, Automatic Mains Failure (AMF) and Automatic Transfer Switch control (ATS)

- Description of option
- Functional description
- Parameter list

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This description includes the following versions:

GC-1F	SW version 1.2x.x
GC-1F/2	SW version 2.0x.x or later

Table of contents

1. Warnings, legal information and safety

Legal information and disclaimer

DEIF takes no responsibility for installation or operation of the genset. If there is any doubt about how to install or operate the engine/generator 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.

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.

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.

Factory settings

The unit is delivered with certain factory settings. Given the fact that these settings are based on average values, they are not necessarily the correct settings for matching the individual engine/generator. Thus precautions must be taken to check the settings before running the engine.

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.

Warnings

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 option B3

This document describes the functionality of AC voltage measurement and functions contained in option B3.

ANSI numbers

Function	ANSI no.
3-phase AC voltage measurement, 50 to 480 V AC, 50/60 Hz	-
3-phase over- and under-voltage failure	27/59
3-phase over- and under-frequency failure	81
3-phase voltage unbalance	60
3-phase – phase rotation sequence	47

Automatic Mains Failure (AMF)

Option B3 is a software and hardware option, which means that the front foil will have to be changed. The basic GC-1F genset controller unit can be equipped with option B3. With option B3, the GC-1F will function as a real emergency power system controller. The mains (busbar) is supervised, and if a fault (voltage/frequency/unbalanced) is detected, a disconnection signal will be sent to the mains breaker. At the same time the start sequence for the generator is initiated. When the generator voltage is within the limits, a signal will be transmitted to close the generator breaker. When the mains returns and the mains OK timer has expired, the generator breaker will open and the mains breaker is closed.

Automatic Transfer Switch (ATS)

The basic GC-1F genset controller unit can be equipped with option B3. With option B3, the GC-1F will be able to operate several different ATS mechanisms with AMF logic. There are two different ATS types:

- Generator – Mains
- Mains Source 1 – Mains Source 2 or Normal Source – Emergency Source. In this document, it will be called “Source – Source”

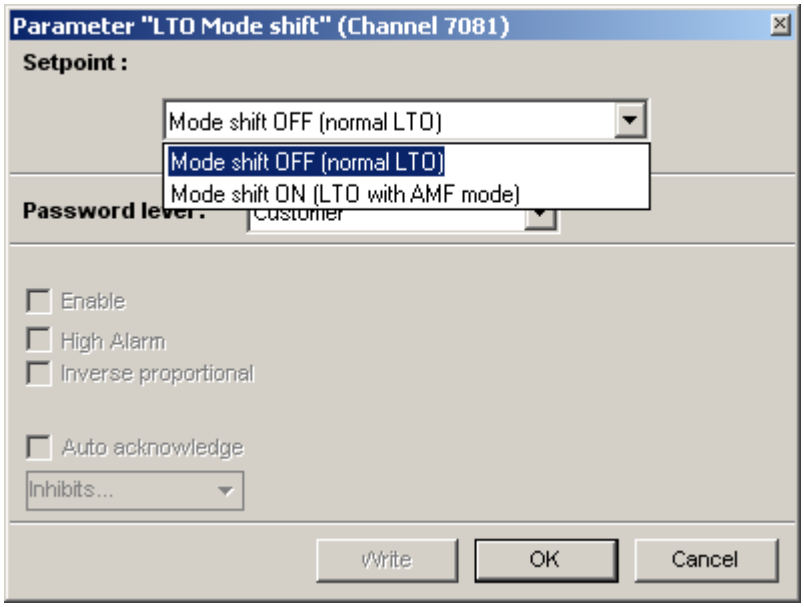
Generator – Mains
This ATS type will be able to operate the mechanism of an ATS with control signals, defined by the input/output settings. The ATS will use AMF logic for the operation. The ATS controller will be able to control and protect the genset like in normal mains failure situations.

It will also be possible just to give a start signal, “Start genset”, to a genset. In this mode, the control and protection of the genset is done by the genset controller, with the GC-1F/2 ATS controller operating the ATS.

Source – Source
This type of ATS control will operate the mechanism of an ATS with control signals as defined by the input/output settings. The AMF handling is available between two mains or utility sources. Similar parameters as Generator – Mains are used, but with parameter names better suited to fit the Source – Source application. The GC-1F/2 ATS controller will not be able to control a genset directly, for example managing the start sequence with prepare and crank, but it will be able to give a start signal, “Start genset”, for both sources. Priority selection of the sources will be possible by settings or done by M-Logic.

Load Take Over (LTO)

The purpose of the LTO mode is to allow the controller to transfer the load to the genset regardless of the mains status. This could be used with command timer functions. There are two LTO modes, mode shift with normal LTO and LTO with AMF.



Mode shift OFF (normal LTO)
If a mains failure event occurs, the controller will not automatically shift mode from LTO to AMF, thus the genset will not start. In this mode, the GC-1F will only start and take over the load when the unit is started in auto mode via digital input: “Auto start/stop”, regardless of the mains status. If a mains failure event occurs when a stop signal is given, the genset will continue to stop and open GB. The MB will remain open until the mains voltage is normal again, then it will close the MB. If a mains failure event occurs while the genset is not running in this mode, the genset will not react to the mains failure.

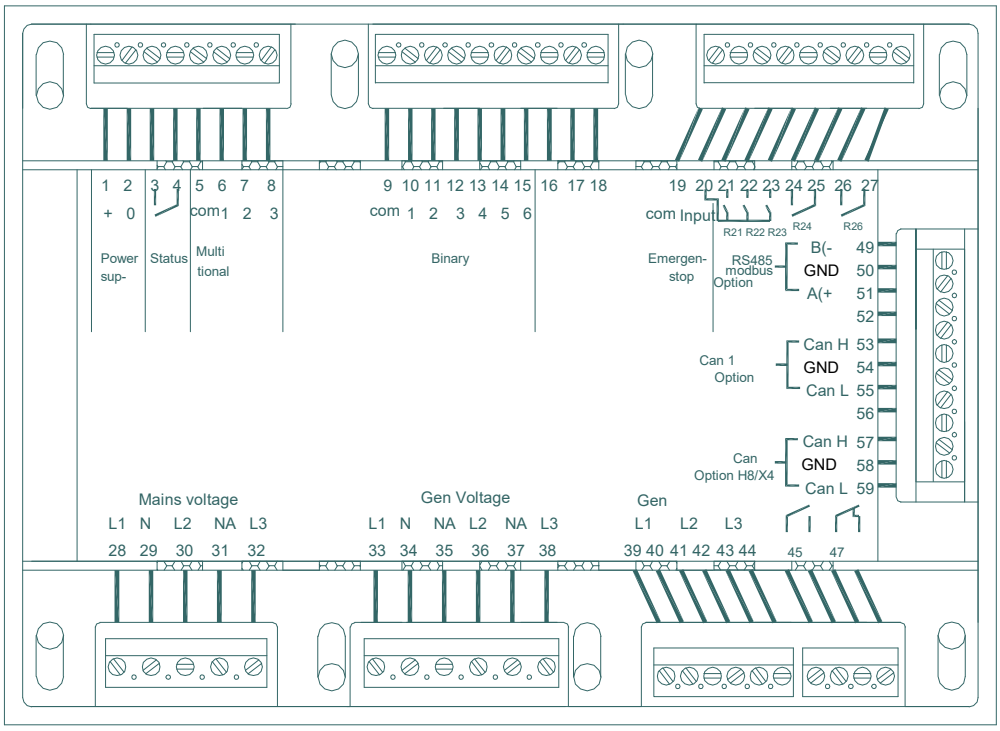
Mode shift ON (LTO with AMF mode)
If a mains failure occurs when a stop genset signal is active, the genset will shift mode to AMF and run the AMF sequence. This will keep the genset running and GB closed until the mains voltage is normal again. When mains is normal, it will shift mode back to LTO. If a mains failure occurs while the genset is stopped (not running), the genset will react to the mains failure and start up like in a normal mains failure situation. The genset will stop again when the mains has been restored.

Start/stop of the genset in auto mode requires configuration of “auto start/stop” digital input.

3. Hardware

Terminals

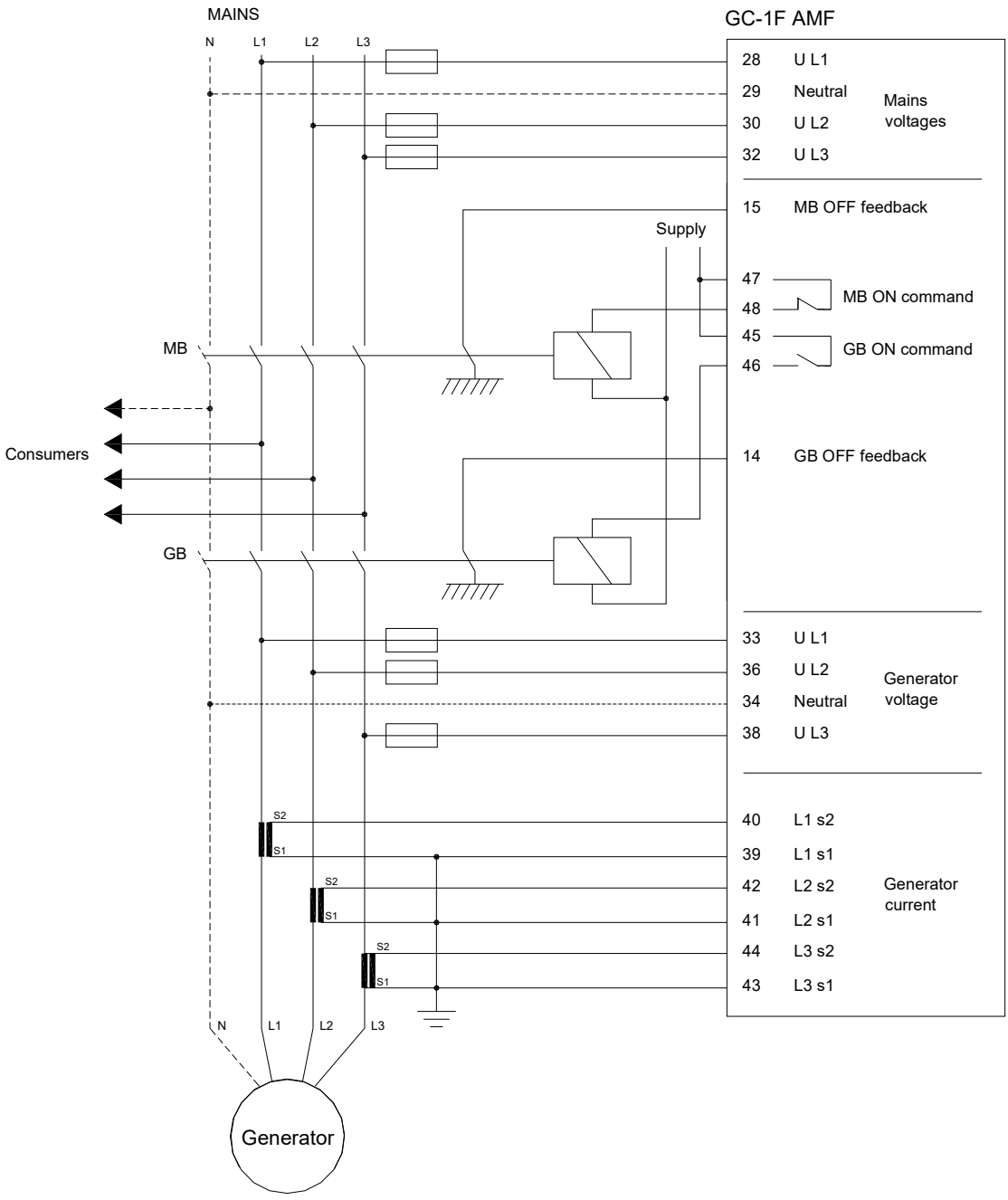
The AC voltage inputs are placed on terminals 28-32. The mains breaker control relay output is placed on terminals 47 and 48.



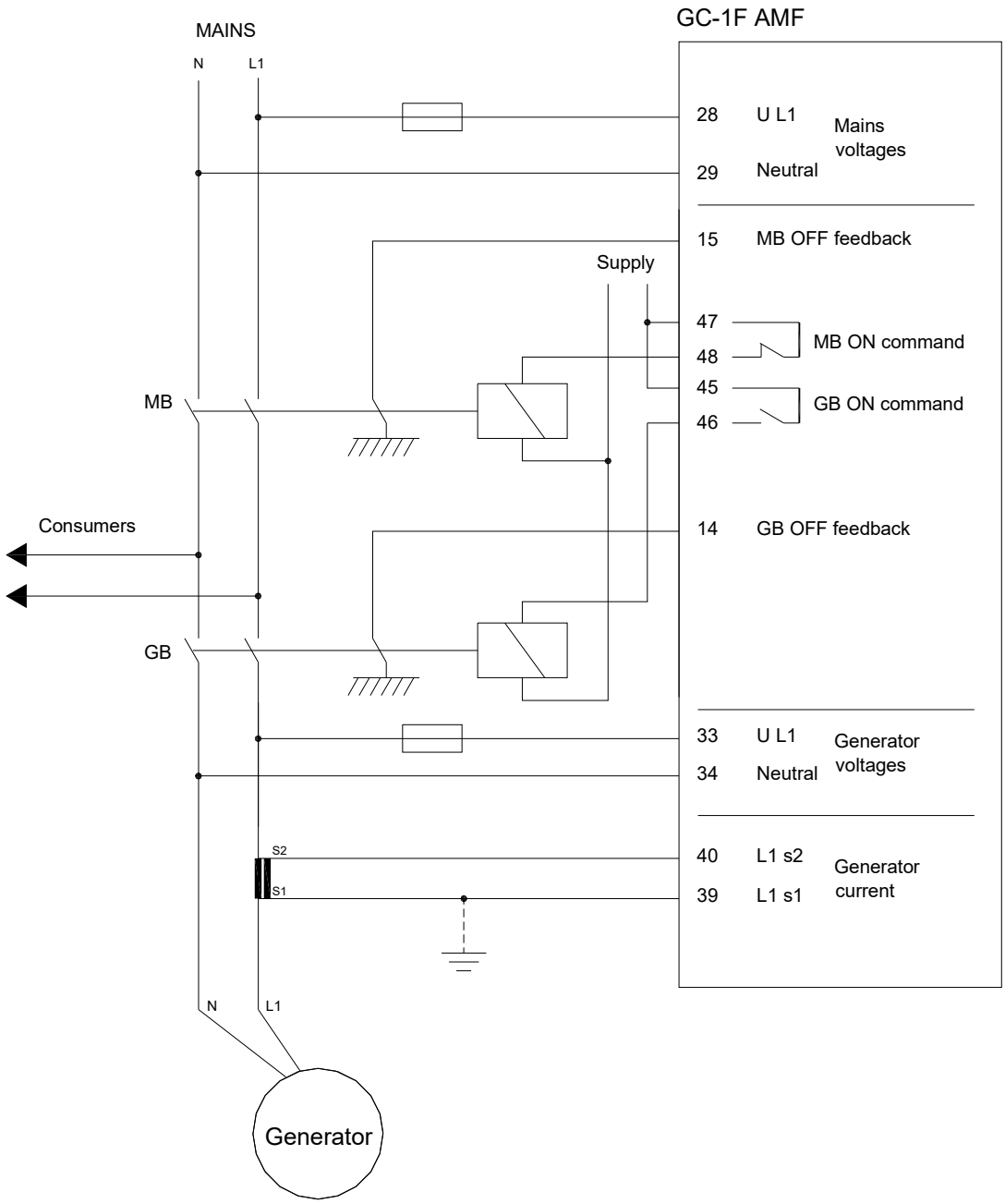
Unit rear view

AMF control		
28	Mains L1 voltage	Voltage range 50 to 480 V AC Ph-Ph value
29	Mains neutral voltage	
30	Mains L2 voltage	
31	Do not connect	
32	Mains L3 voltage	
47-48	Mains breaker control relay	Function NC (normally closed). Configurable

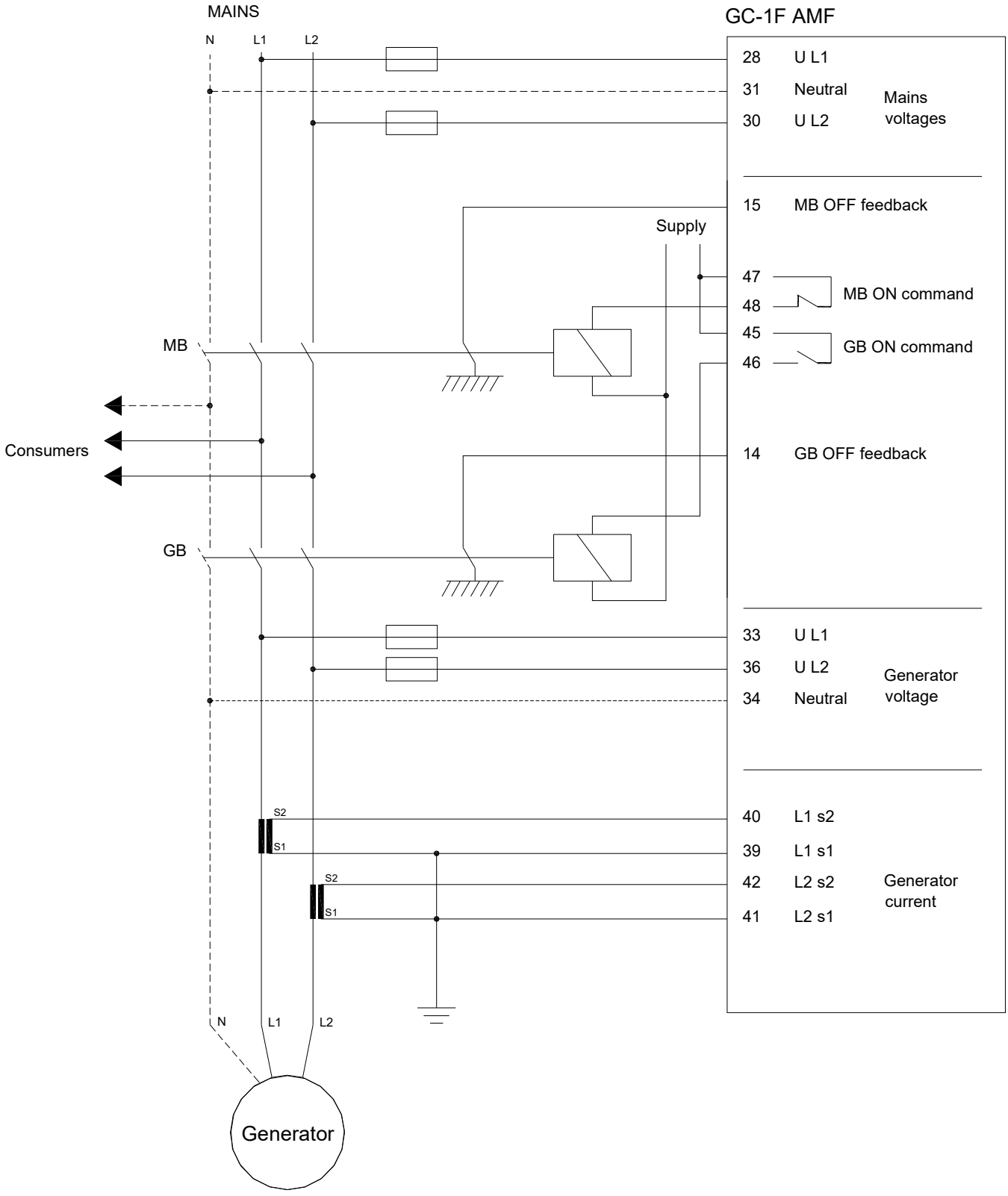
Wiring 3-phase



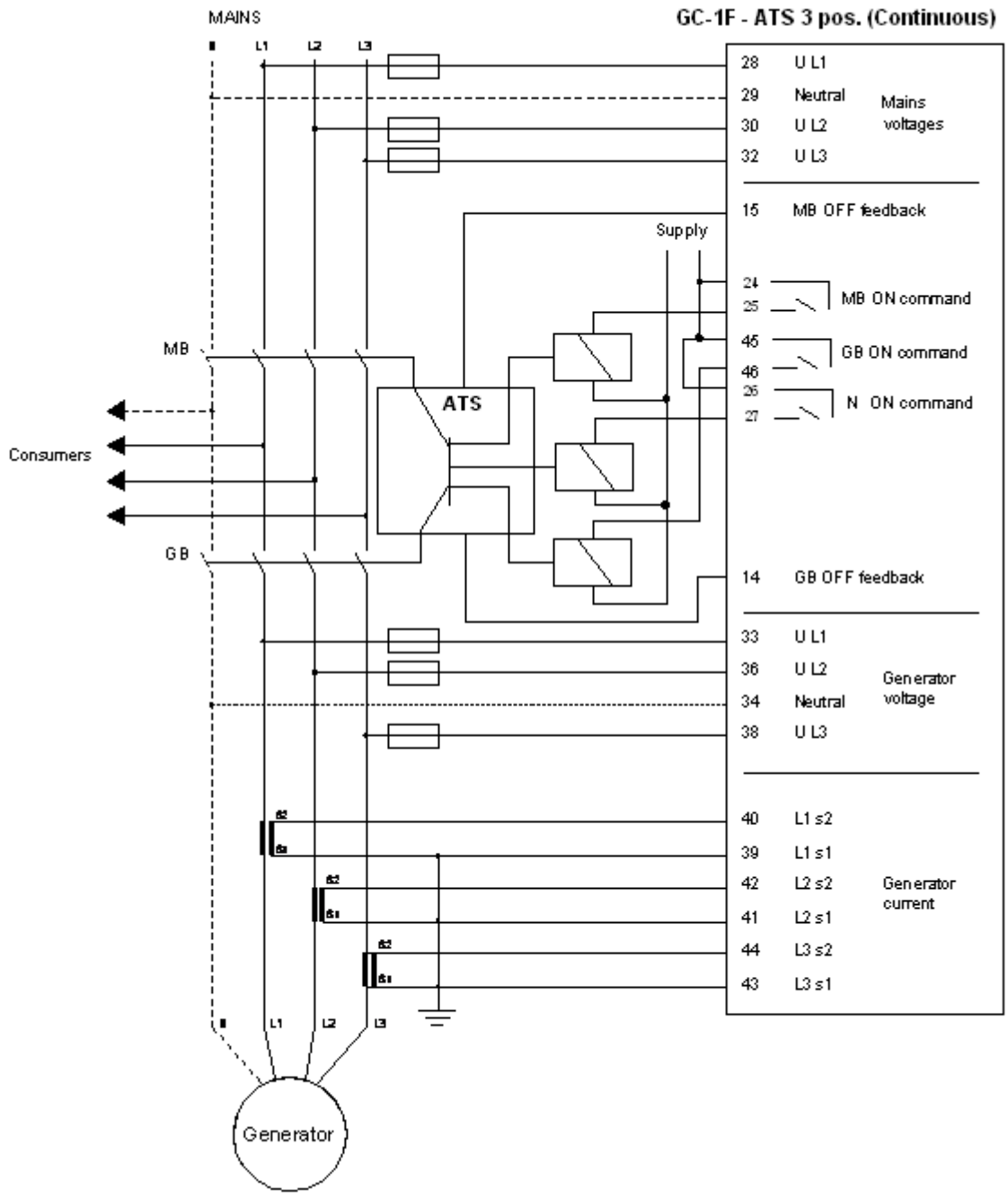
Wiring 1-phase



Wiring split-phase

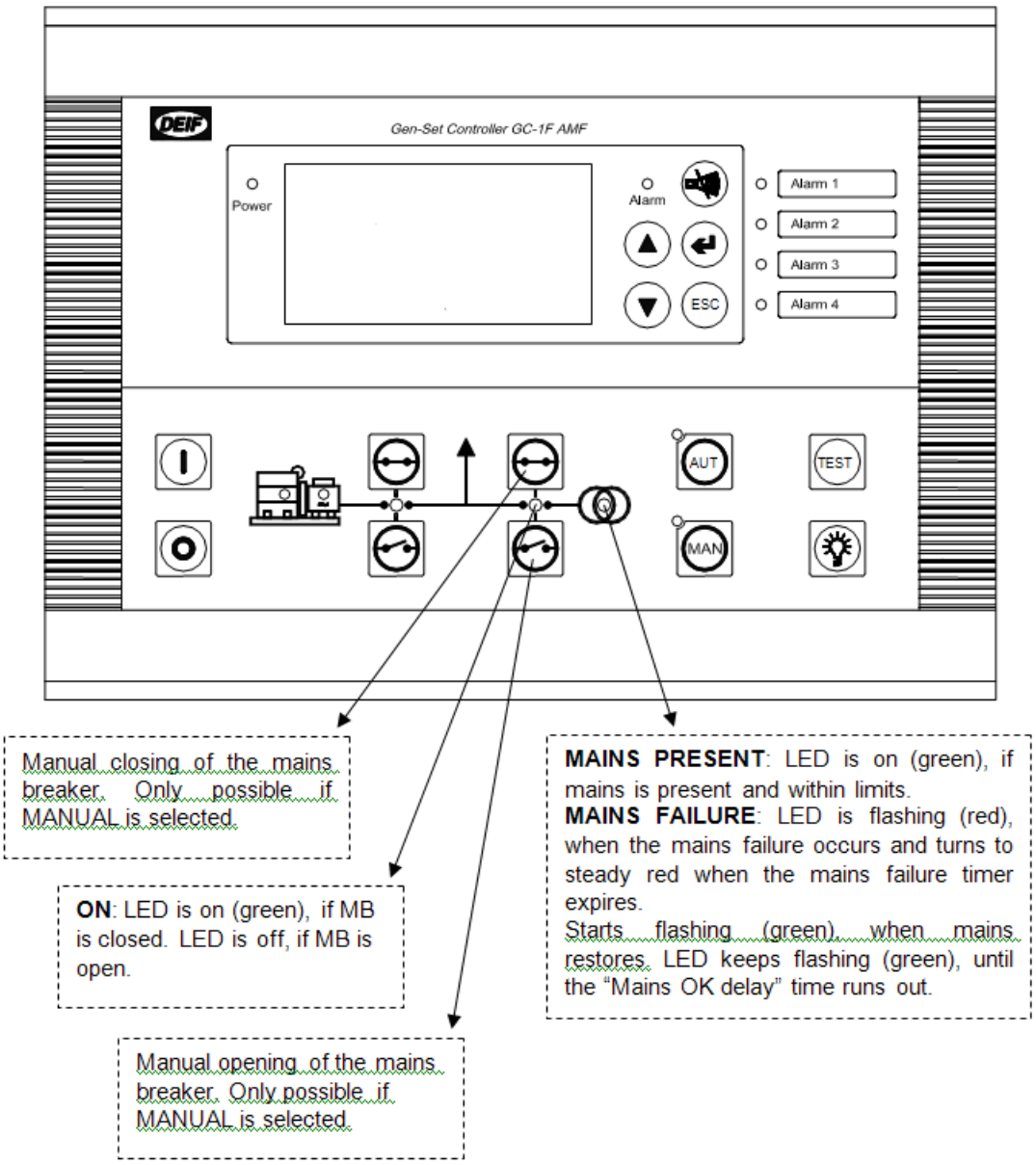


Wiring 3-phase 3-position ATS



Push-buttons and LEDs

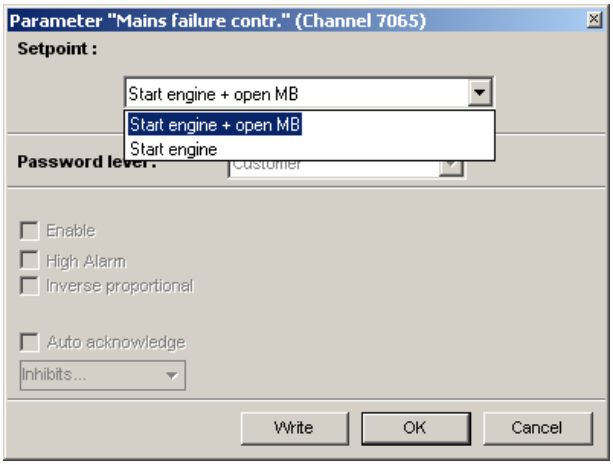
The display for option B3 includes two extra push-buttons and one LED.



For general information about the display push-buttons and LEDs, see the Installation Instructions and Reference Handbook.

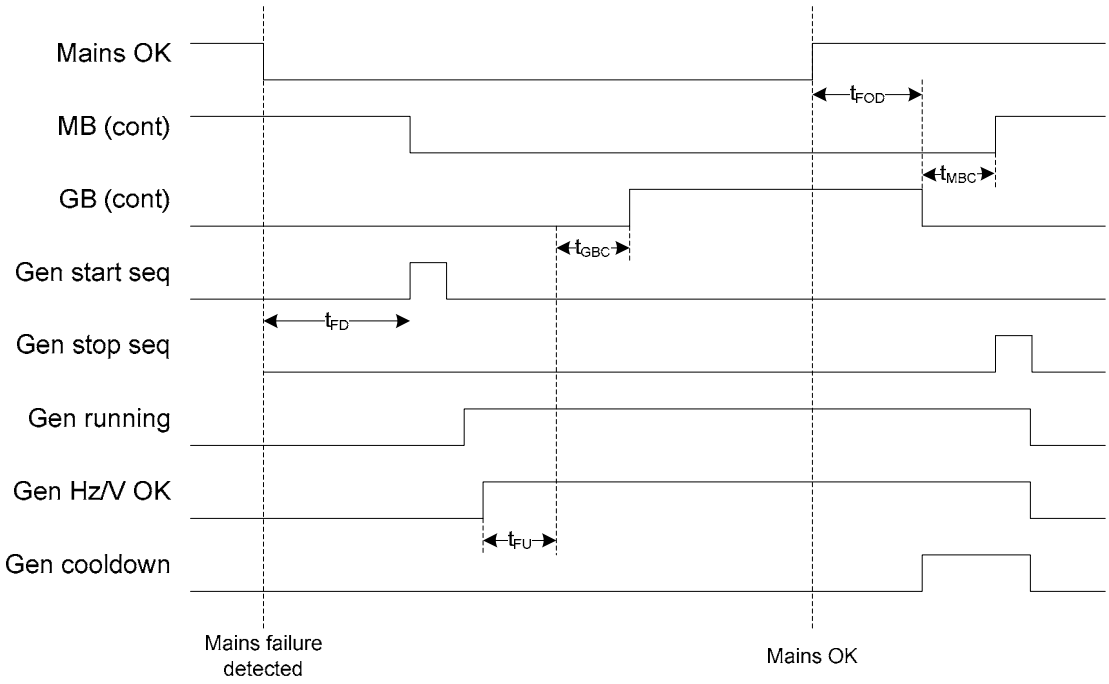
4. Functional descriptions

The following sequences will be shown in two conditions:

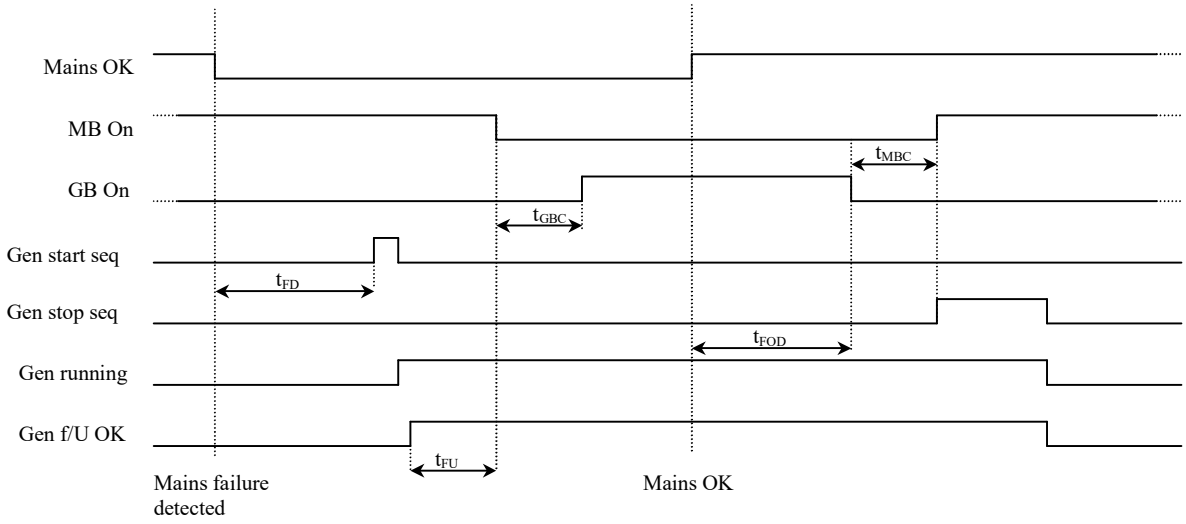


Mains fail timing sequence

Start engine + Open MB



Start engine



AMF/ATS failure logic

The following describes the normal failure situations handled by the GC-1F during a mains failure/OK sequence (refer to “Mains fail timing sequence” for details).

AMF/ATS logic will only activate in AUTO mode.

Mains failure, open MB

When a mains failure occurs, the MB is opened when either mains failure is detected (7065 Start eng. + open MB) or when GB is ready to take load (7065 Start eng.). If the MB cannot be opened, the GC-1F signals an MB open failure. The genset is kept running to have it ready when the MB failure has been fixed.

The fail class for MB open failure (2200):

1. Warning
    a. Alarm is activated
    b. GB is not closed, since MB cannot be opened
    c. Genset stays running
2. Trip of GB
    a. Alarm is activated
    b. Genset stays running
3. Trip and stop
    a. Alarm is activated
    b. Genset is stopped including cooldown
4. Shutdown
    a. Alarm is activated
    b. Genset is stopped without cooldown
5. Trip of MB
    a. Alarm is activated
    b. Genset stays running
6. Shutdown and manual mode
    a. Alarm is activated
    b. Genset is stopped without cooldown
    c. Controller changes running mode to MANUAL

Mains failure, closing GB

When the genset has been started and the MB is opened (no MB open failure), the GB must be closed. If this results in a GB close failure, the GB relay/pulse will be opened/given again and a GB close failure will be signalled. It is possible to change the fail class of the GB close failure to either “Trip and stop” or “Shutdown” to have the genset stopped when the GB cannot be closed.

The fail class for GB close failure (2170):

1. Warning
    a. Alarm is activated
    b. GB is tripped
    c. Genset stays running
2. Trip of GB
    a. Alarm is activated
    b. GB is tripped
    c. Genset stays running
3. Trip and stop
    a. Alarm is activated
    b. GB is tripped
    c. Genset is stopped including cooldown
4. Shutdown
    a. Alarm is activated
    b. GB is tripped
    c. Genset is stopped without cooldown
5. Trip of MB
    a. Alarm is activated
    b. GB is tripped
    c. MB trips (if closed) and load is dropped
    d. Genset stays running
6. Shutdown and manual mode
    a. Alarm is activated
    b. GB is tripped
    c. Genset is stopped without cooldown
    d. Controller changes running mode to MANUAL

Mains OK, Open GB

When mains returns, the GB must be opened and the MB can be closed. If the GB cannot be opened, a GB open failure is signalled and the GB relay/pulse is closed/given again.

The fail class for GB open failure (2160):

1. Warning
    a. Alarm is activated
    b. Genset stays running
2. Trip of GB
    a. Alarm is activated
    b. Genset stays running
3. Trip and stop
    a. Alarm is activated
    b. Genset is stopped including cooldown
4. Shutdown
    a. Alarm is activated
    b. Genset is stopped without cooldown
5. Trip of MB
    a. Alarm is activated
    b. Genset stays running
6. Shutdown and manual mode
    a. Alarm is activated

b. Genset is stopped without cooldown
c. Controller changes running mode to MANUAL

Mains OK, Close MB

When the GB has been opened, the genset starts its cooldown sequence and the MB is closed. If this results in an MB close failure, an MB close failure is signalled, and the MB relay/pulse is opened/given again. Furthermore, the GB is closed again, sourcing the load.

The fail class for MB close failure (2210):

1. Warning
    a. Alarm is activated
    b. If Gen V/Hz is OK, GB is closed
    c. Genset stays running
2. Trip of GB
    a. Alarm is activated
    b. GB trips. Load is dropped
3. Trip and stop
    a. Alarm is activated
    b. GB is tripped and the genset is stopped including cooldown
4. Shutdown
    a. Alarm is activated
    b. GB is tripped and the genset is stopped without cooldown
5. Trip of MB
    a. Alarm is activated
    b. MB trips and load is dropped
    c. If Gen V/Hz is OK, GB is closed. Genset stays running
6. Shutdown and manual mode
    a. Alarm is activated
    b. GB is tripped and the genset is stopped without cooldown
    c. Controller changes running mode to MANUAL

External trip of GB/CB1 or MB/CB2

If parameter 2240 (GB/CB1) or 2250 (MB/CB2) is activated, the GC-1F will monitor the breaker activity and act according to the configured fail class.

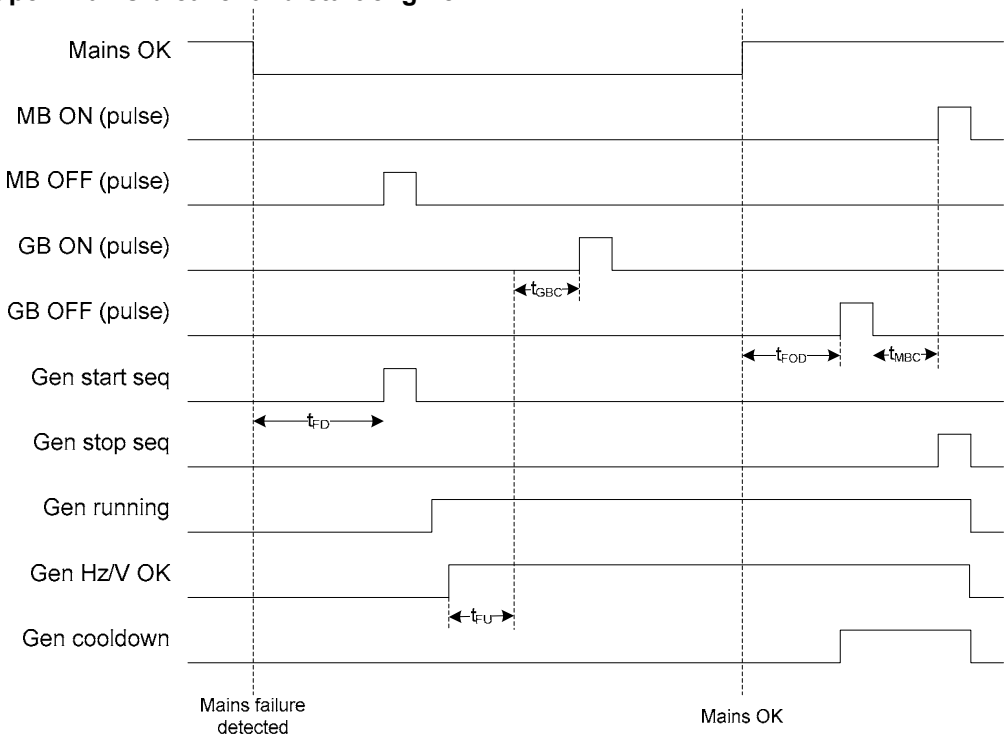
For example, if one of the breakers, CB1, is tripped by external events, the unit will report “CB1 Ext. tripped Unacknowledged” and the alarm LED will be turned ON.

The function requires configuration of breaker feedbacks.

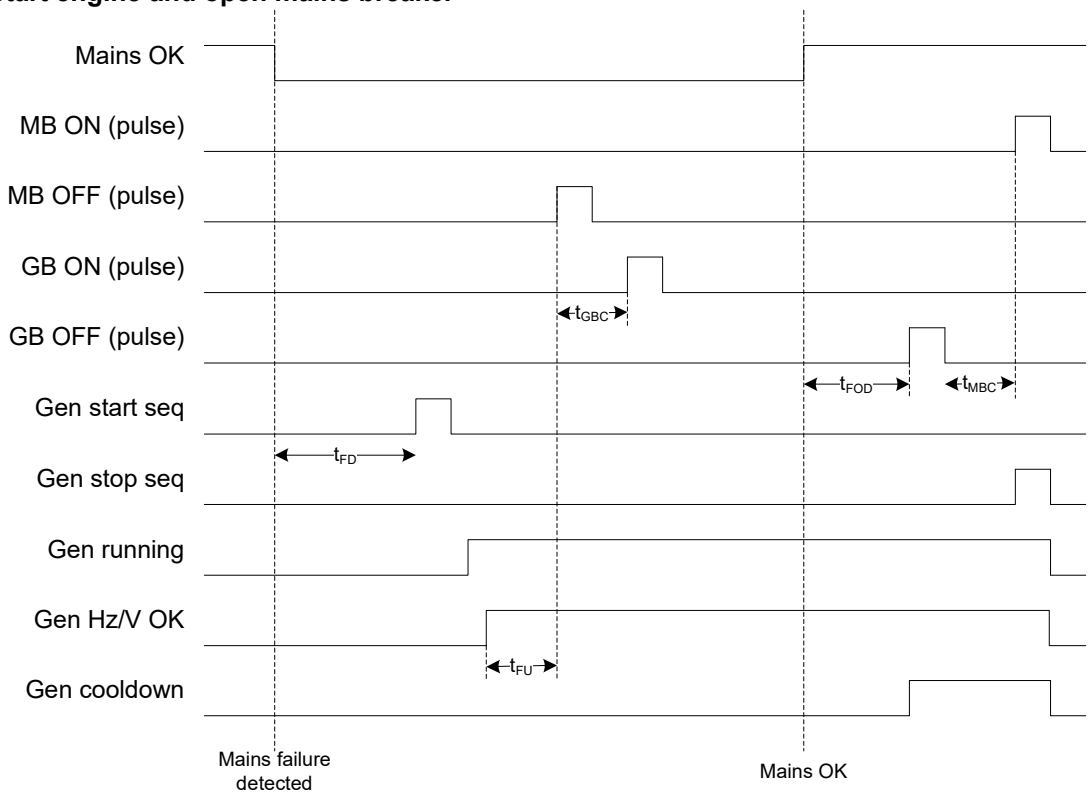
ATS timing sequences

2 standard, fast operating, stored energy circuit breakers (2CBFO)

Open mains breaker and start engine

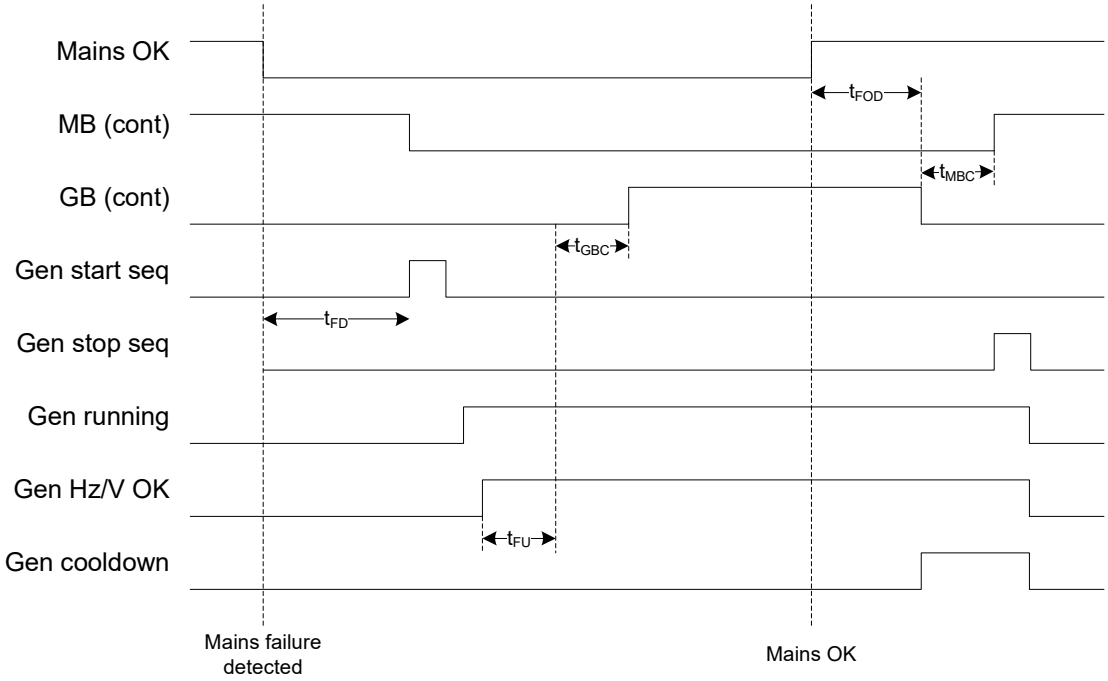


Start engine and open mains breaker

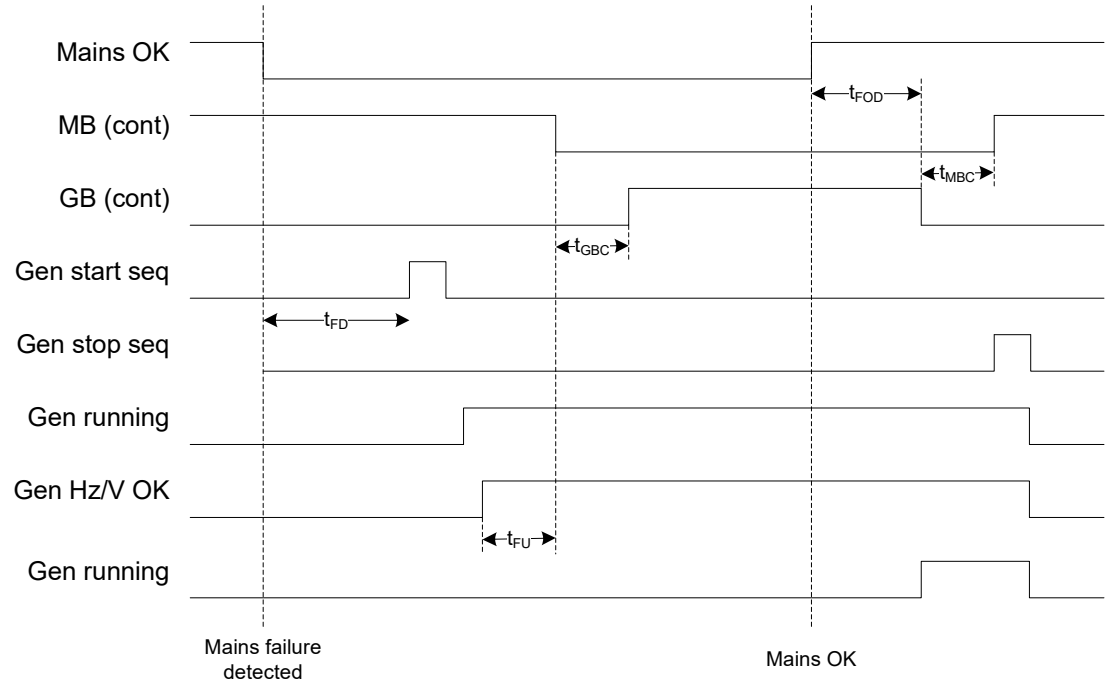


2 position electrically held, solenoid style ATS or 2 contactors electrically held, (2COEH)

Open mains breaker and start engine

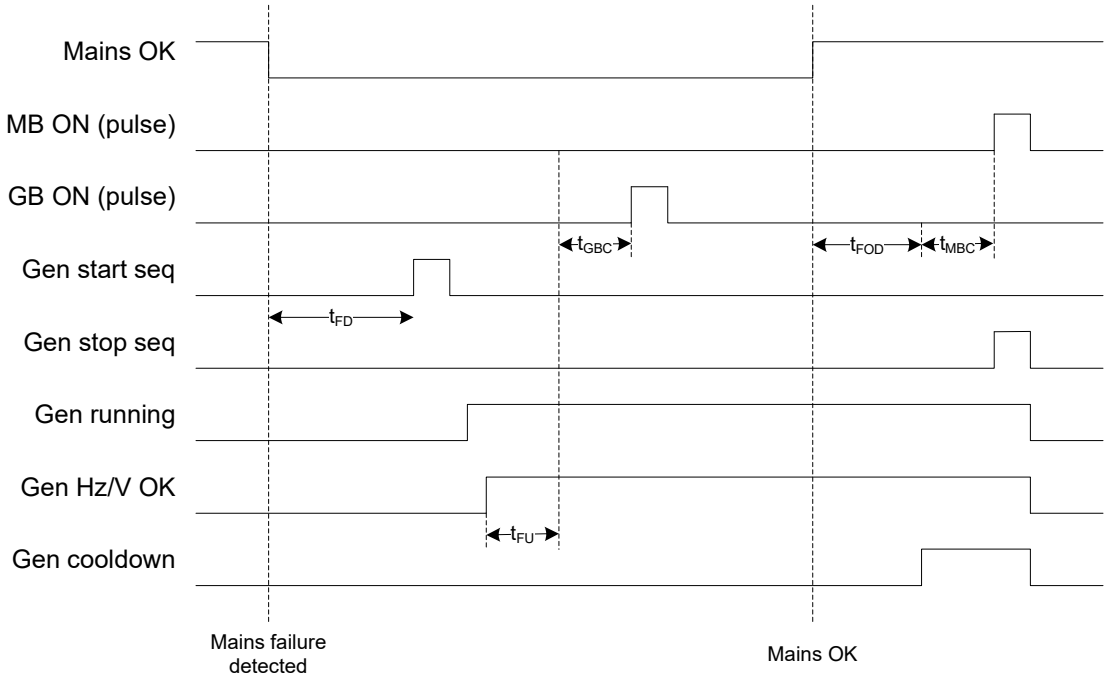


Start engine and open mains breaker

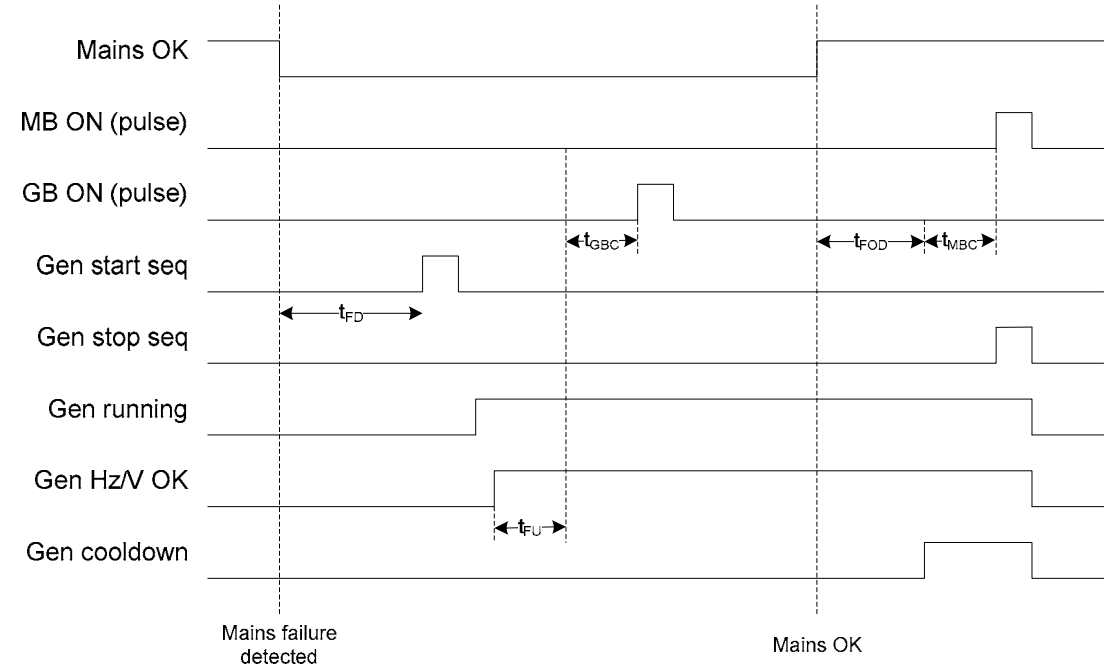


2 position mechanically held solenoid style ATS or 2 contactors, mechanically held (2COMH)

Open mains breaker and start engine

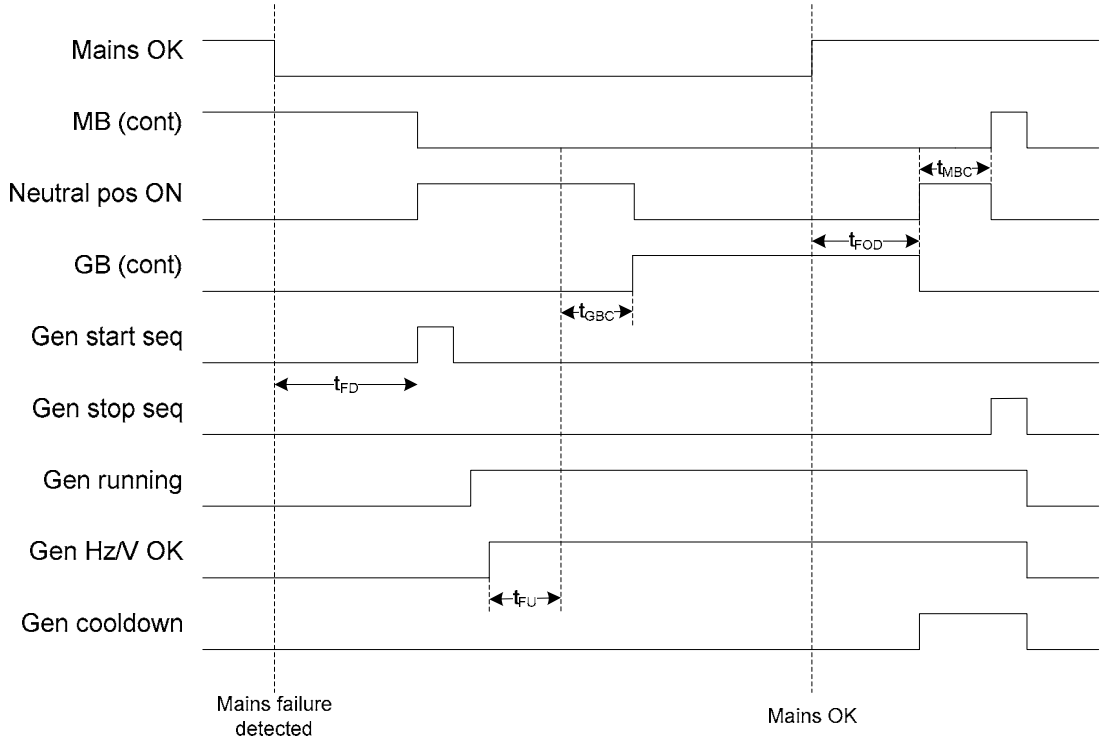


Start engine and open mains breaker

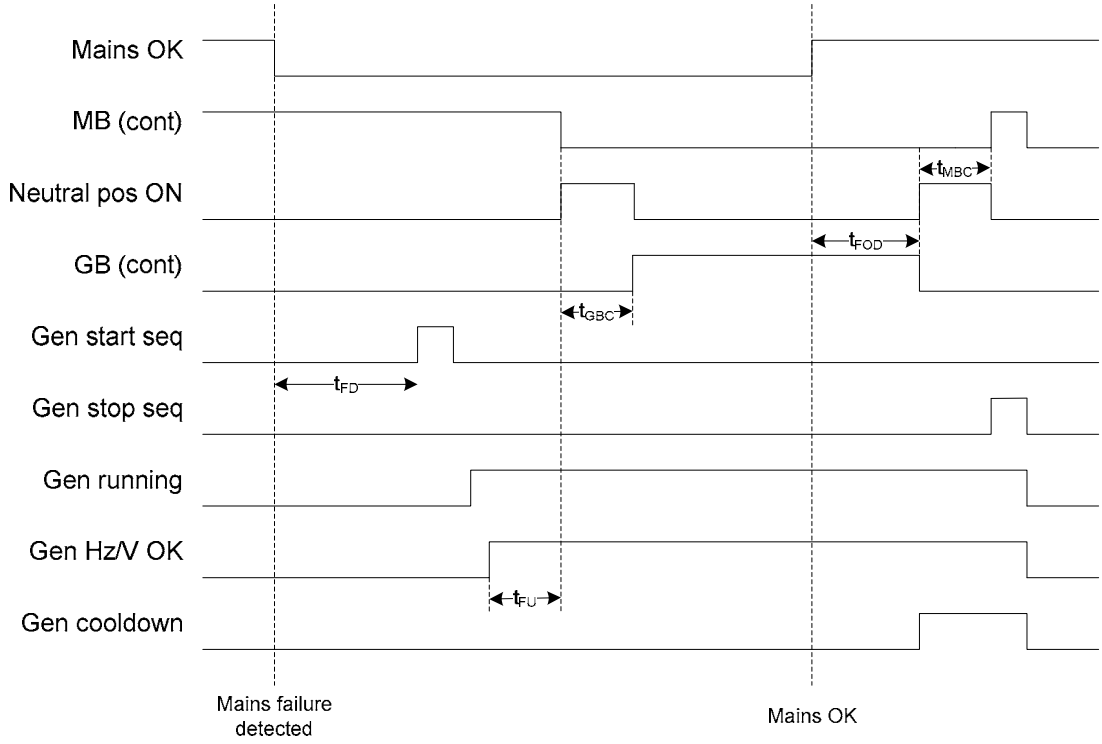


3 position electrically held solenoid style ATS or contactors (3COEH) – 2 outputs

Open mains breaker and start engine

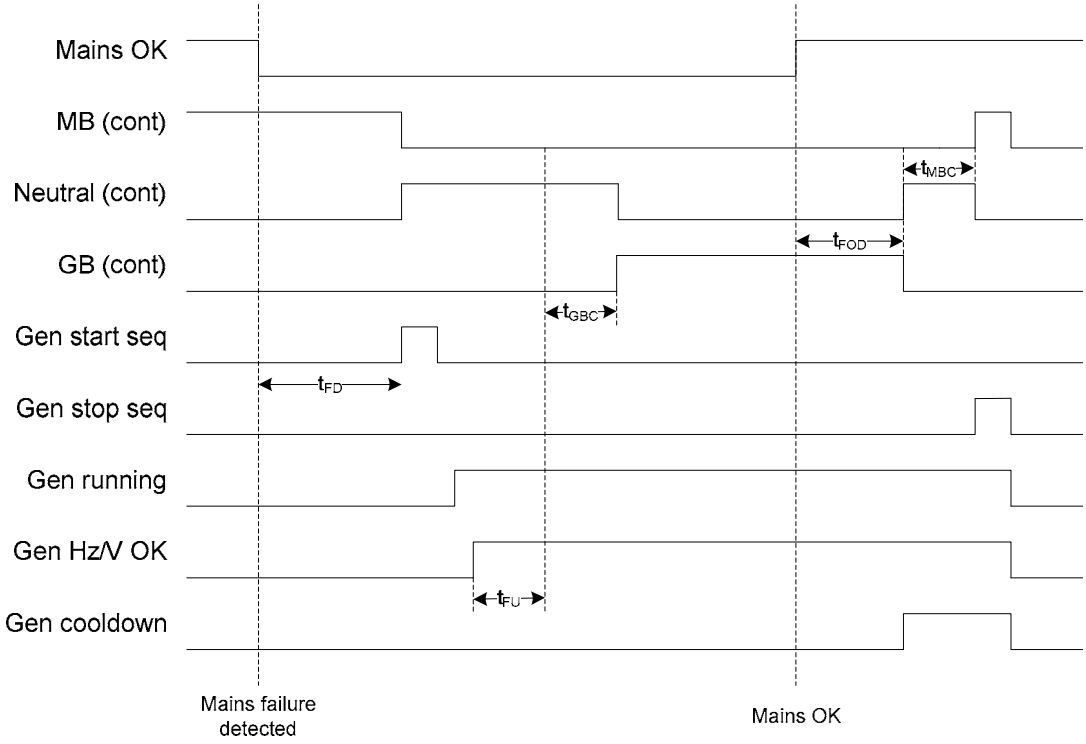


Start engine and open mains breaker

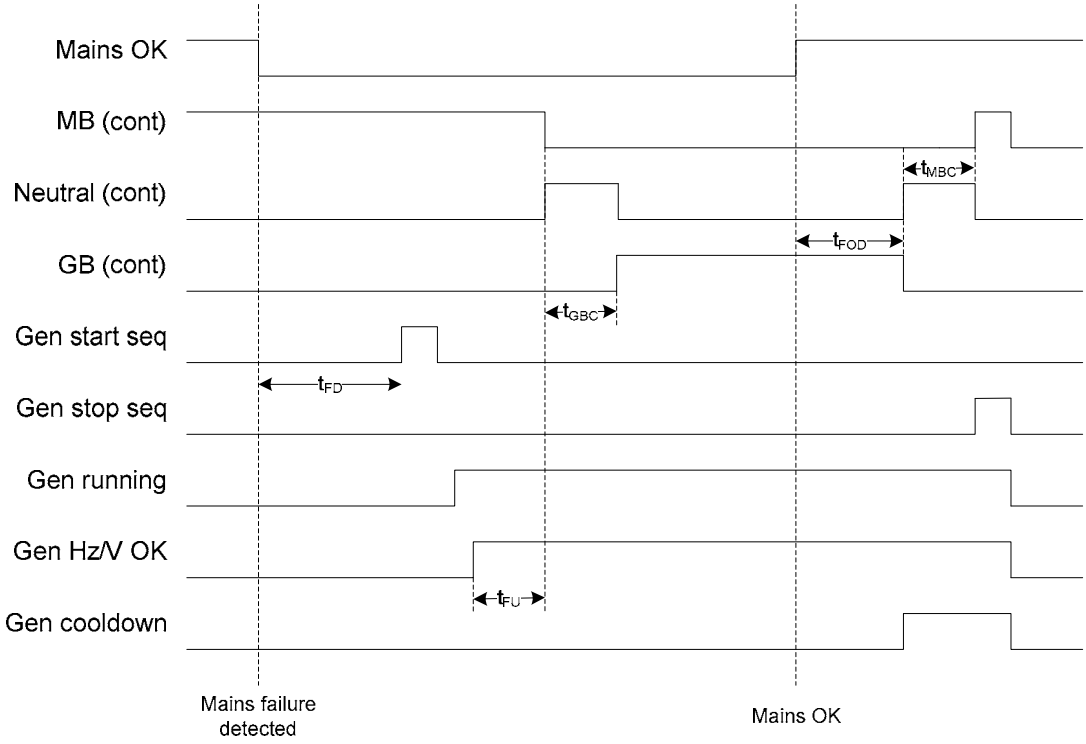


3 position electrically held solenoid style ATS or contactors (3COEH) – 3 outputs

Open mains breaker and start engine

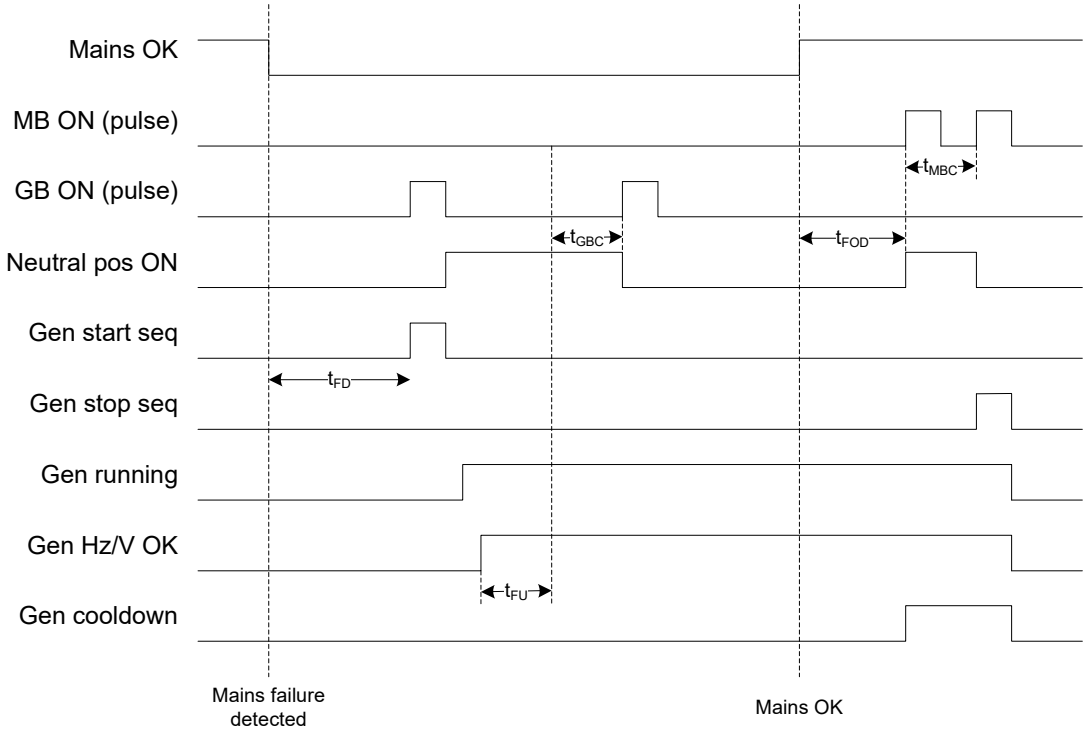


Start engine and open mains breaker

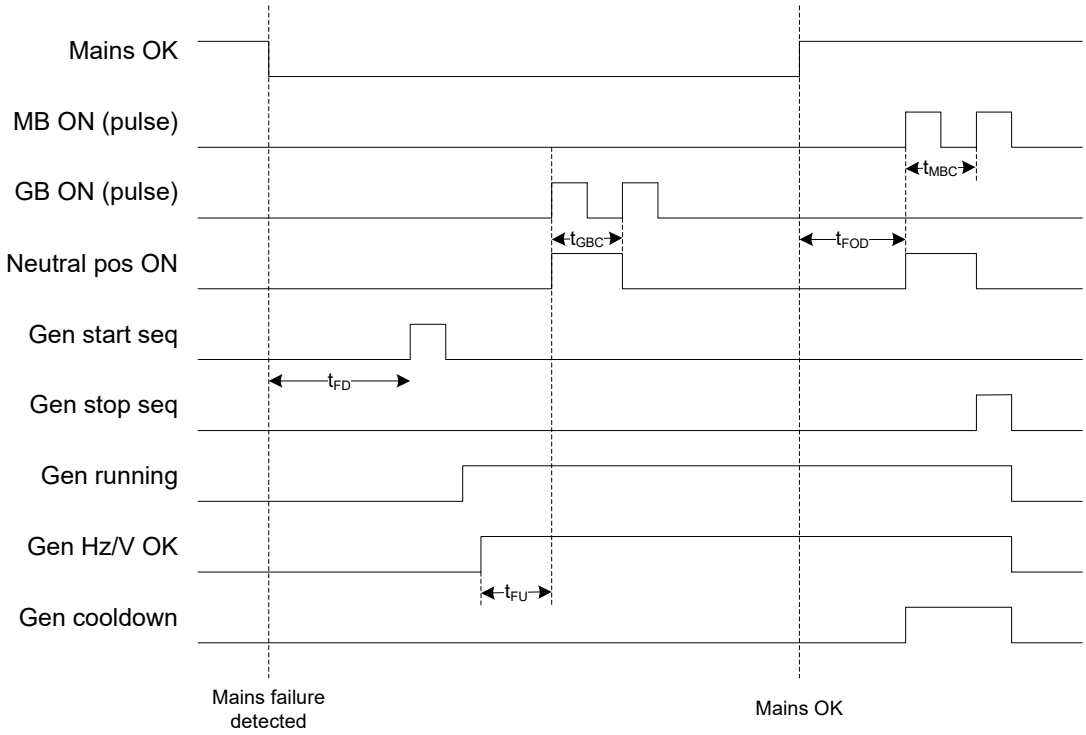


3 position mechanically held solenoid style ATS or contactors (3COMH) – 2 outputs

Open mains breaker and start engine

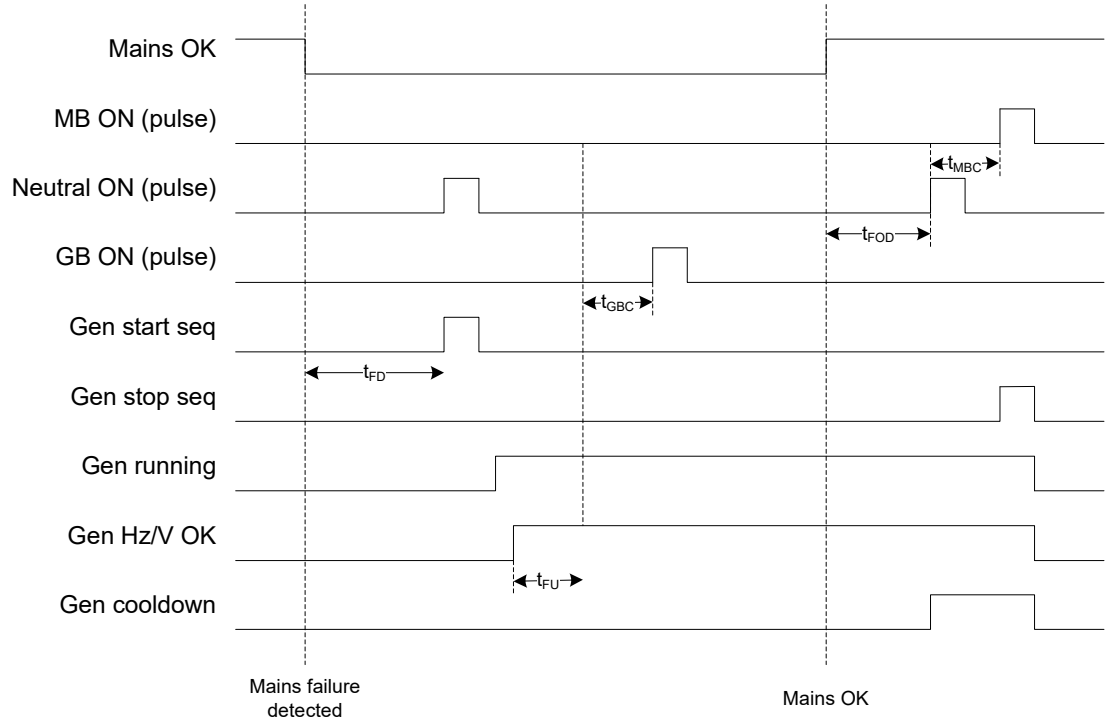


Start engine and open mains breaker

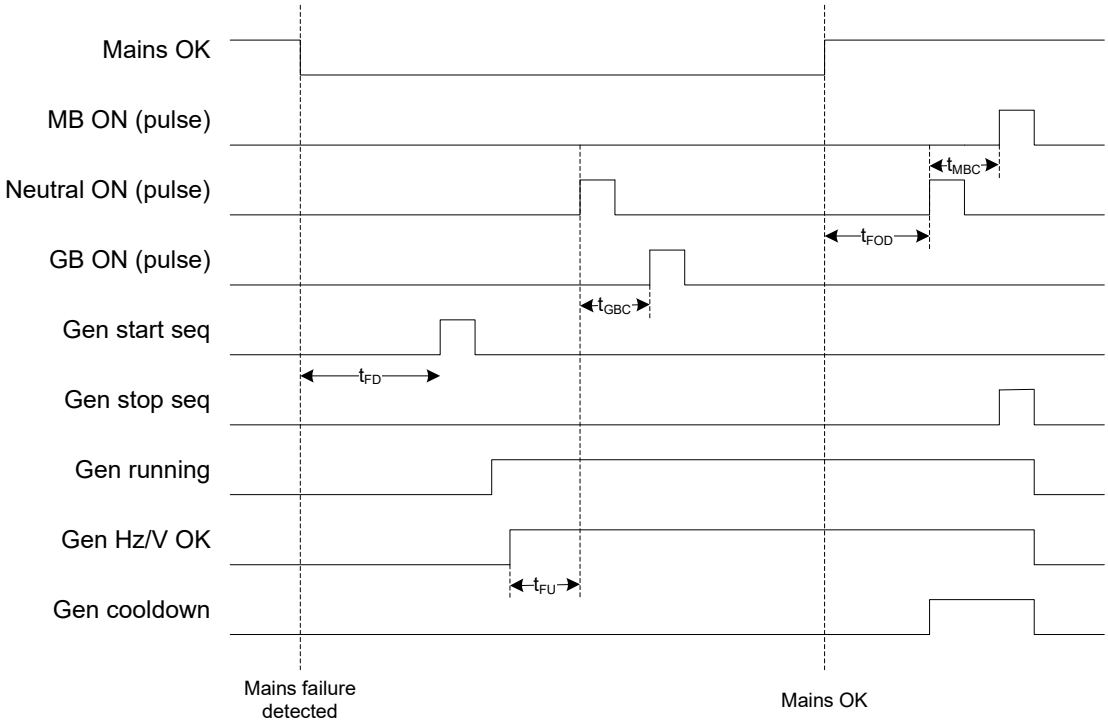


3 position mechanically held solenoid style ATS or contactors (3COMH) – 3 outputs

Open mains breaker and start engine



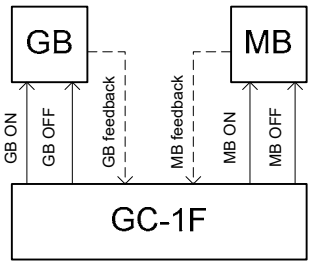
Start engine and open mains breaker



ATS configurations

2 × standard fast operating stored energy circuit breakers (2CBFO)

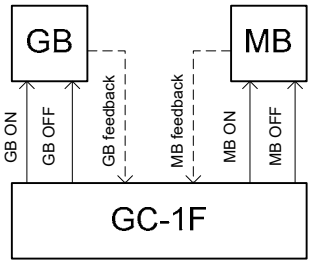
2CBFO needs one trip and one close contact for each breaker. Often they are mechanically and/or electrically interlocked so they cannot both be closed at the same time. Thus the controller will not send a close signal to the GB until an open signal from the MB has been received (when feedback signals are assigned).



Settings	Gen-Mains	Source-Source
Relay	GB ON (pulse)	CB1 ON (pulse)
Relay	GB OFF (pulse)	CB1 OFF (pulse)
Relay	MB ON (pulse)	CB2 ON (pulse)
Relay	MB OFF (pulse)	CB2 OFF (pulse)

2 position electrically held solenoid style ATS (2COEH)

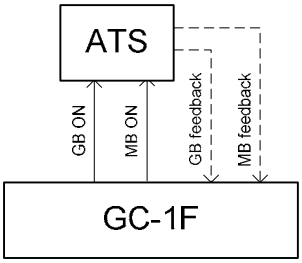
2COEH needs one continuous signal for each ATS position. When GB is closed (and MB is opened), it electrically holds the ATS in the Gen position. When MB is closed (and GB is opened), it electrically holds the ATS in the Mains position.



Settings	Gen-Mains	Source-Source
Relay	GB (cont)	CB1 (cont)
Relay	MB (cont)	CB2 (cont)

2 position mechanically held solenoid style ATS (2COMH)

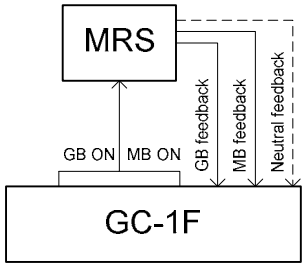
2COMH operates like a 2COEH, but with pulse signals instead of continuously held signals. There is no open signal, only close signals. Closing the ATS in Gen position will mechanically open mains and vice versa. The closing signals are pulses with a variable pulse length (adjustable in USW), or until a close feedback is detected.



Settings	Gen-Mains	Source-Source
Relay	GB ON (pulse)	CB1 ON (pulse)
Relay	MB ON (pulse)	CB2 ON (pulse)

Motorised rotary switch (MRS)

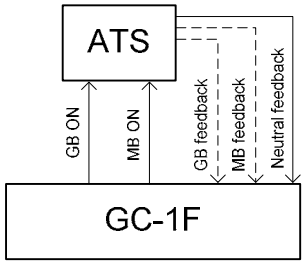
An MRS is controlled by only one signal input, controlling a motor that runs to change the ATS position. The motor only runs in one direction, and therefore feedback signals are needed to tell when the ATS is in the correct position. The GB ON and the MB ON pulse outputs must be connected in parallel to operate the motor run signal. When feedback signals are detected, the pulse outputs are opened and the motor is stopped in the position.



Settings	Gen-Mains	Source-Source
Relay	GB ON (pulse)	CB1 ON (pulse)
Relay	MB ON (pulse)	CB2 ON (pulse)
Input	GB position ON	CB1 position ON
Input	MB position ON	CB2 position ON

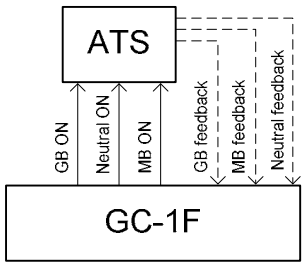
3 position mechanically held solenoid style ATS or contactors (3COMH)

3COMH can be operated with either two or three pulse outputs. For both setups, the ATS must go through neutral when moving from either Gen to Mains or from Mains to Gen (Gen -> Neutral -> Mains, Mains -> Neutral -> Gen).



Settings	Gen-Mains	Source-Source
Relay	GB ON (pulse)	CB1 ON (pulse)
Relay	MB ON (pulse)	CB2 ON (pulse)
Input	Neutral position ON	Neutral position ON

For the setup with two outputs, a neutral feedback must be configured as well. When the 3COMH must go from Mains to Gens, it will first send a GB ON pulse to go to neutral, and when neutral feedback is detected, a second GB ON pulse will be given to go to Gens.
When the 3COMH must go from Gen to Mains, it will first send an MB ON pulse to go to neutral, and when neutral feedback is detected, a second MB ON pulse will be given to go to mains.

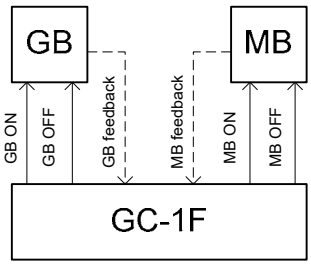


Settings	Gen-Mains	Source-Source
Relay	GB ON (pulse)	CB1 ON (pulse)
Relay	Neutral ON (pulse)	Neutral ON (pulse)
Relay	MB ON (pulse)	CB2 ON (pulse)

For a setup with three outputs, the neutral ON pulse will be given to move the ATS to neutral, GB ON pulse will be given to go to Gen, and an MB ON pulse will be given to go to mains.

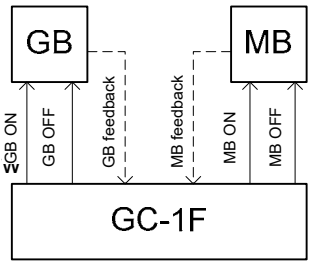
3 position electrically held solenoid style ATS or contactors (3COEH)

The 3COEH is operated like the 3COMH, but with continuous signals. Operation with either two or three outputs is supported. For both setups, the ATS must go through neutral when moving from either Gen to Mains or from Mains to Gen (Gen -> Neutral -> Mains, Mains -> Neutral -> Gen).



Settings	Gen-Mains	Source-Source
Relay	GB (cont)	CB1 (cont)
Relay	MB (cont)	CB2 (cont)
Input	Neutral position ON	Neutral position ON

For the setup with two outputs, a neutral feedback must be configured as well. When the 3COEH must go from Mains to Gens, it will first open both GB and MB to go to neutral, and when neutral feedback is detected, the GB relay is closed to go to Gens.
When the 3COEH must go from Gen to Mains, it will first open both MB and GB to go to neutral, and when neutral feedback is detected, the MB relay is closed to go to mains.



Settings	Gen-Mains	Source-Source
Relay	GB (cont)	CB1 (cont)
Relay	Neutral (cont)	Neutral (cont)
Relay	MB (cont)	CB2 (cont)

For a setup with three outputs, the neutral relay will be closed to move the ATS to neutral, GB relay will be closed to go to Gen and an MB relay will be closed to go to mains (only one relay closed at a time).

Timer explanation

Timer	Description
t_{FD}	Mains failure delay See 7063 and 7073
t_{FU}	Frequency/voltage OK See 6220
t_{FOD}	Mains failure OK delay See 7062 and 7072
t_{GBC}	GB ON delay See 6231
t_{MBC}	MB ON delay See 7082

ON and OFF sequences

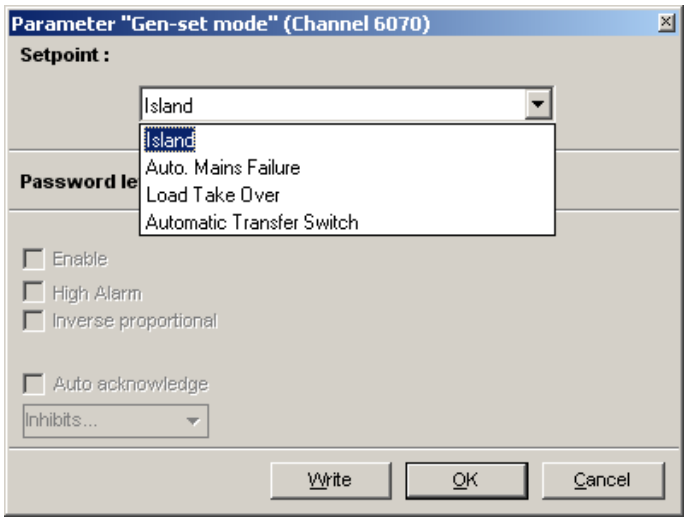
The condition(s) must be met before the operation can take place	
Operation	**Condition**
GB ON, direct closing	Running feedback Generator frequency/voltage OK MB open
Generator OK (ATS) input, direct closing	
MB ON, direct closing	Mains frequency/voltage OK GB open
Mains OK (ATS)	
GB OFF, direct opening	Shutdown Trip GB alarms
MB OFF, direct opening	Mains failure

Mains failure control (7065) set Start engine + open MB.
If the generator fails to start or the generator breaker fails to close and the mains is OK, the mains "ok u" and mains "ok f" timer must expire, before the mains breaker is closed.

Mains failure control (7065) set Start engine.
If the generator fails to start or the generator breaker fails to close, the mains breaker is closed.

Configuration

Genset mode



ATS type: Source – Source can only be selected by display, and it will only be possible when "ATS" is selected as Genset mode (parameter 6070).

Input functions (B3)

Input function	Comment
MB Pos on	Configurable
MB Pos off	Configurable
Neutral Pos on	Configurable
Remote MB open	Configurable
Remote MB close	Configurable
Remote neutral pos	Configurable
LTO mode	Configurable
AMF mode	Configurable
ATS mode	Configurable
Generator Ok (ATS)	Configurable
Mains OK (ATS)	Configurable
Bypass to generator (ATS)	Configurable
Bypass to mains (ATS)	Configurable
MB close inhibit	Configurable

Input function description

1. MB Pos on

When this input is activated, the GC-1F sees the generator breaker as closed. If the MB on/off feedbacks is high/high simultaneously, an MB position failure is displayed.

2. MB Pos off

When this input is activated, the GC-1F sees the generator breaker as open. If the MB on/off feedback is high/high simultaneously, an MB position failure is displayed.

3. Neutral Pos on
When this input is activated, the GC-1F sees the generator and mains breaker as open. If this input is used, no GB/MB off breaker signals can be used.

4. Remote MB open
This input will open the mains breaker, but will only work in Man mode

5. Remote MB close
This input will close the mains breaker, but will only work in Man mode

6. Remote neutral pos
This input will force the ATS in neutral position, but will only work in Man mode

7. LTO mode
This input will change mode to load take over (LTO)

8. AMF mode
This input will change mode to AMF

9. ATS mode
This input will change mode to ATS

10. Generator Ok (ATS)
This input will skip the generator AC measurement and start the Ok timer right away.

11. Mains OK (ATS)
This input will skip the mains AC measurement and start the Ok timer right away.

12. Bypass to generator (ATS)
This input will bypass the Hz/V OK timer and close the generator breaker.

13. Bypass to Mains (ATS)
This input will bypass the mains OK Hz/V timer and close the mains breaker.

14. MB close inhibit
This input will make an inhibit of closing the mains breaker.

Output functions (B3)

Output function	Factory setting
MB (continuous)	Relay 47
Neutral (continuous)	
MB ON (pulse)	
MB OFF (pulse)	
Neutral ON (pulse)	
Genset start (ATS)	
MB status	
Neutral status	
Mains OK	
Mains fail	

Relays 21/22/23 cannot be configured as MB.

Relay 47 is closed when de-energised, but works as all other relays when the GC-1F is powered up.

Output function description

1. MB (continuous)
MB relay contact will close continuously.

2. Neutral (continuous)
Neutral relay contact will close continuously.

3. MB ON (pulse)
MB relay contact will give an ON pulse signal (adjustable in 7084).

4. MB OFF (pulse)
MB relay contact will give an OFF pulse signal (adjustable in 7084).

5. Neutral ON (pulse)
Neutral relay contact will give an ON pulse signal (adjustable in 2310).

6. Genset start (ATS)
This function is used to give remote start/stop signal in cascade ATS applications.

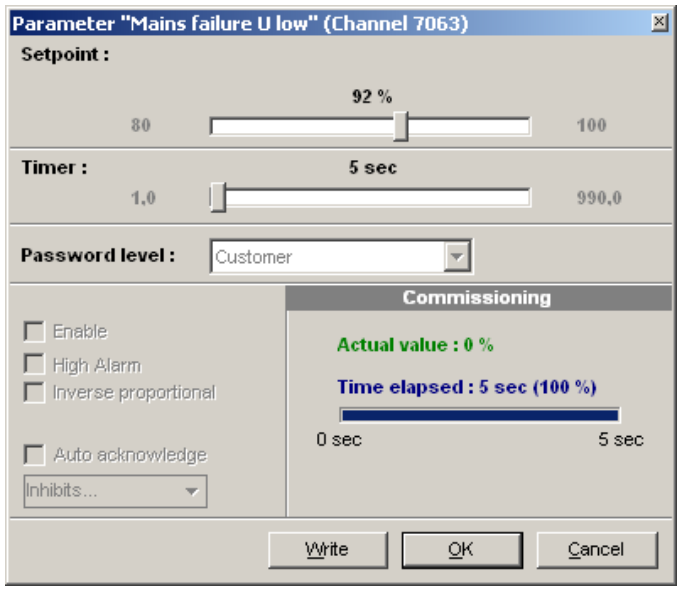
7. MB status
This output contact will close when the MB is closed.

8. Neutral status
This output contact will close when the ATS is in neutral position.

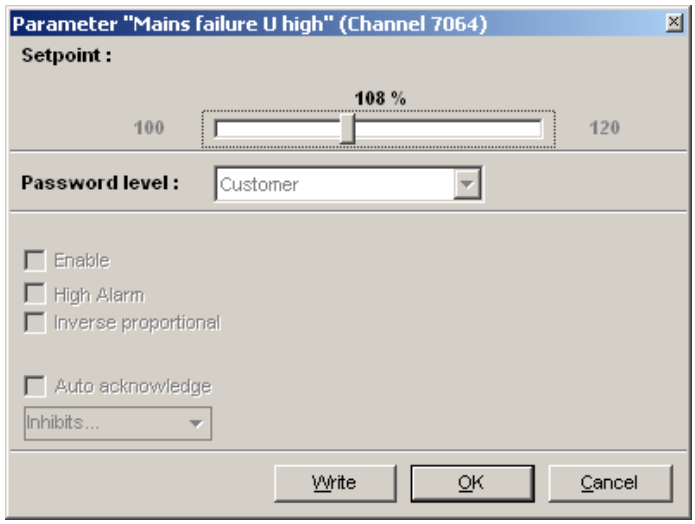
9. Mains OK
Output contact will close when no mains failure is present or the mains Ok timer is running.

10. Mains fail
Output contact will close when mains failure is present.

The example below shows the menu for setting the mains failure low voltage:

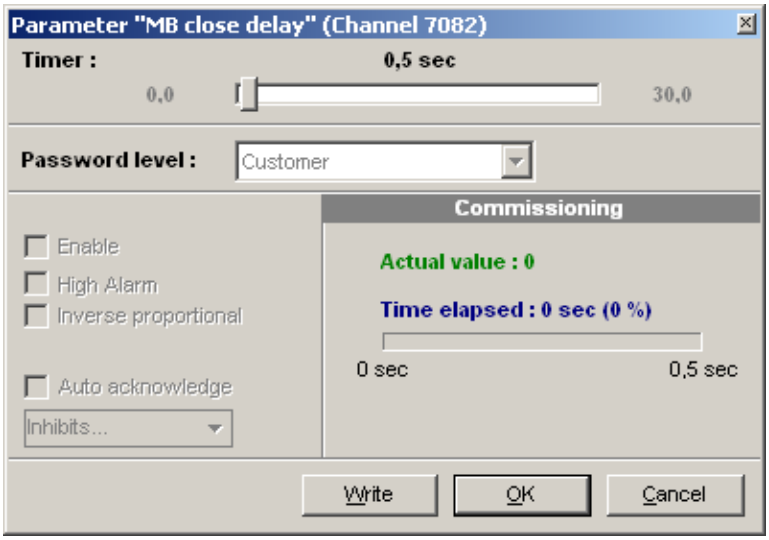


The example below shows the menu for setting the mains failure high voltage:

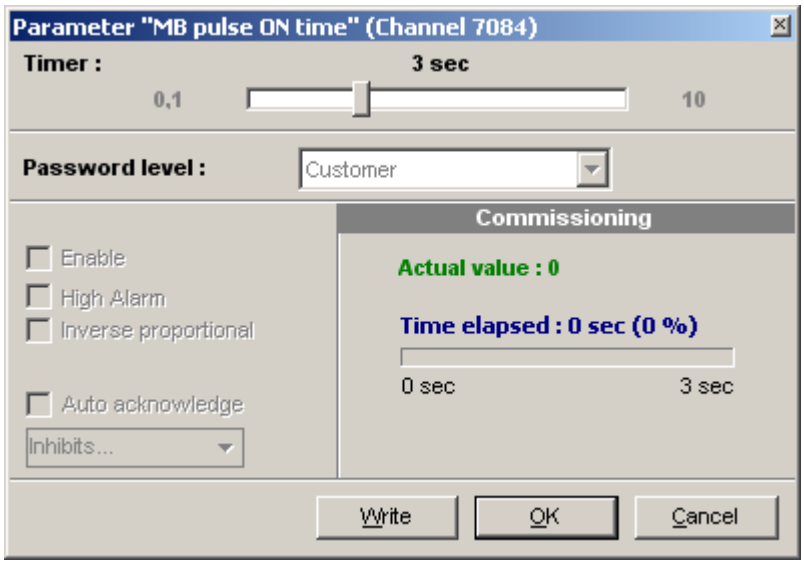


The timer for both low and high voltage set point is set in the menu for low voltage. The same principle is used for the setting of low and high frequency.

The example below shows the MB close delay timer. The delay set is the time between the transmission of the GB open signal to the transmission of the MB close signal.



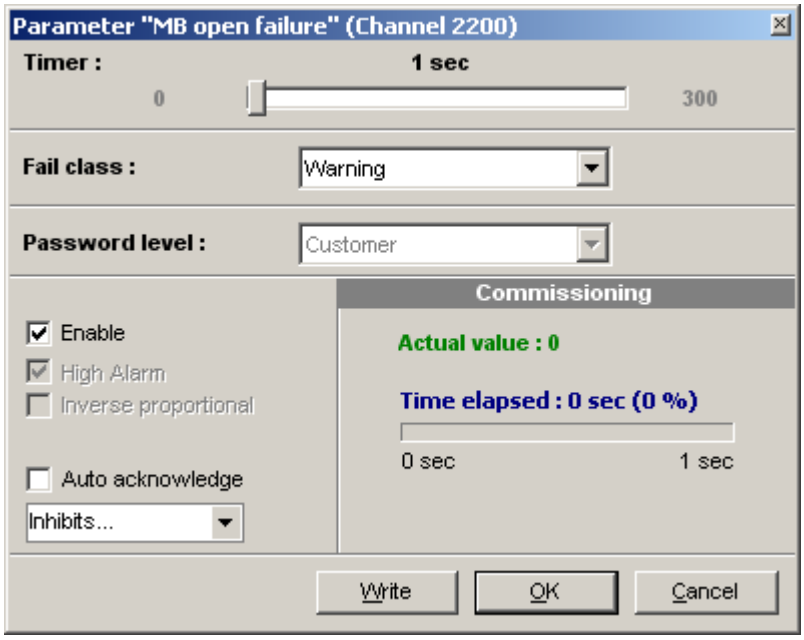
"MB pulse ON time" defines the MB relay out's pulse time.



"MB pulse ON time" will be interrupted if "MB ON" feedback is present or MB OFF signal is given in manual.

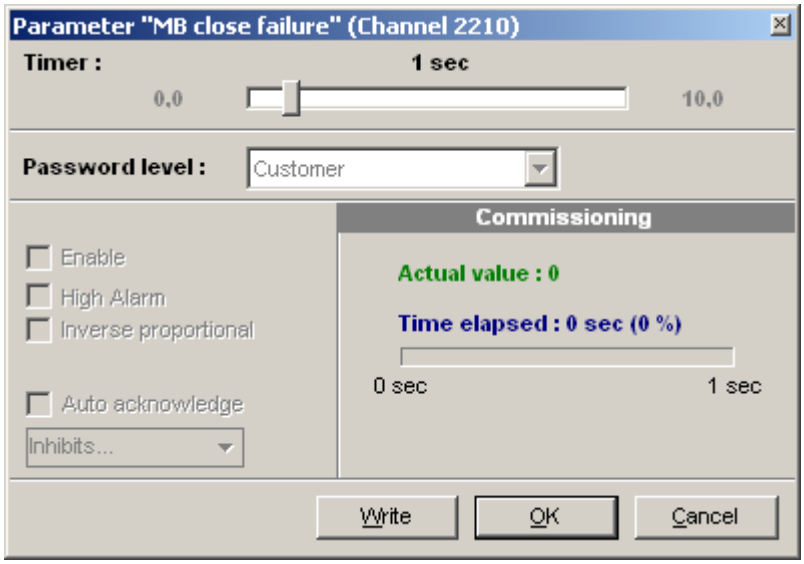
The example below shows the MB open failure timer. If the timer expires before the MB is open, the alarm will be activated. If no sign signals are used, the GC-1F will automatically assume that the breaker is opening.

The same principle is used for the GB.

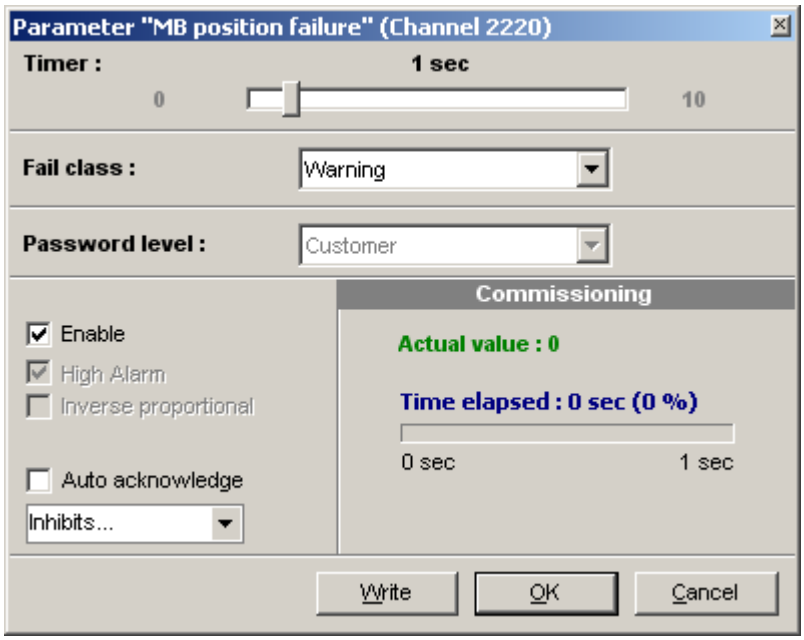


The example below shows the MB close failure timer. If the timer expires before the MB is closed, the alarm will be activated. If no sign signals are used, the GC-1F will automatically assume that the breaker is closing.

The same principle is used for the GB.

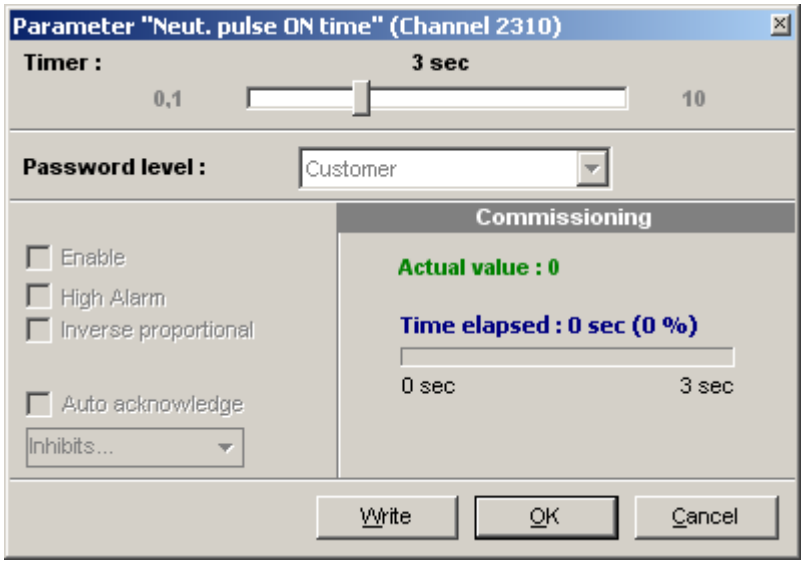


MB position failure:



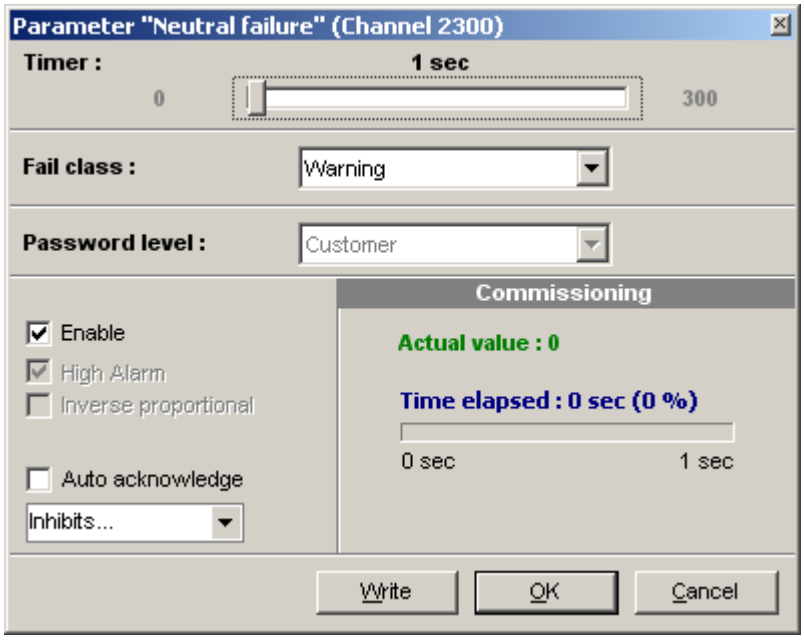
If “MB ON” and “MB OFF” inputs give the same feedback signals (High/High), an MB position failure will be present.

Neutral pulse ON time:



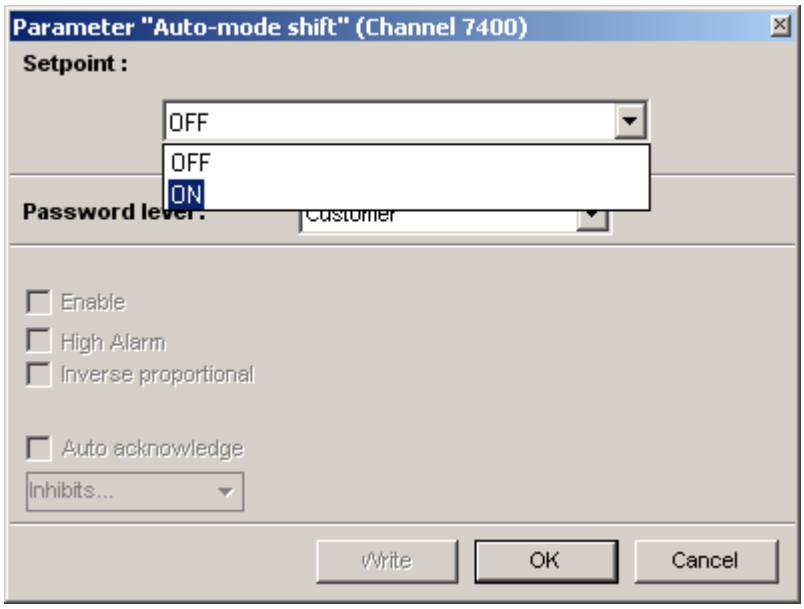
“Neut. pulse ON time” will be interrupted if “Neut. ON” feedback is present or “Open breaker” signal is given in manual.

Neutral failure:



This alarm is used for 3 pos. ATS switches where a neutral is used.

Auto-mode shift:



"Auto-mode shift" is used for alarms with fail class "Shutdown + man-mode" and the controller running in auto-mode. When alarms are acknowledged either by display or by "auto-acknowledge" setting, the mode will automatically switch to auto-mode.

"Auto-mode shift" parameter and the alarms with "auto-acknowledge" enabled will ensure the load of a source in case of periodic failures or unstable systems causing this shutdown.

ATS - Source – Source

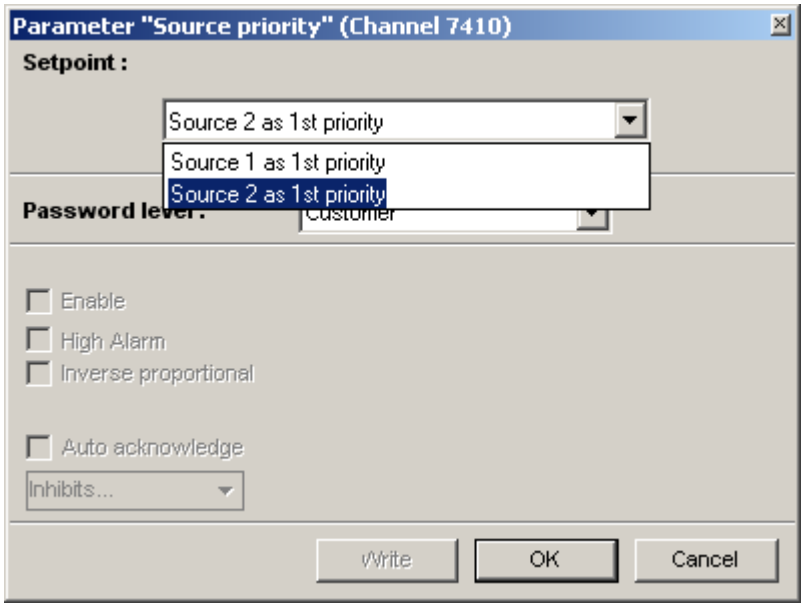
This variant is normally used to switch the load between two mains sources. One of the mains is working as emergency source for the other mains. In case of mains failure on the “first priority” mains, the second priority mains will take the load.

ATS type

Change of ATS type from, for example, “Gen – Mains” to “Source – Source” can **only** be done via display, when the genset mode 6070 = “Automatic Transfer Switch”.

Change of ATS type resets the unit and default parameters will be present.

Source priority



Parameter overview

The Source – Source ATS type uses the same parameters as Gen – Mains, but parameters for engine protection and control have been removed. In addition to this, the generator (Gen) and Mains (BB) parameters have changed names. The parameter numbers are kept the same, so it is easy to navigate.

Two new groups of protections; “Source 1”, “Source 2” and one new group called ATS logic. ATS logic has the same functionality and operates as the known AMF logic. “Priority 1” will always be operated as the “mains” like in normal emergency applications. “Source priority” makes it possible to choose first priority between Source 1 and Source 2.

Detailed information about standard functionality refers to “Installation Instructions and Reference Handbook”.

5. Parameter list

Related to this option are parameters 1620, 2160-2170, 2200-2210, 2240-2250, 6050-6070, 6104, 7060-7082 and 7110.

See the “Installation Instructions and Reference Handbook”, document number 4189340472.