

PointGuard LoadHub
Generator and Grid Mechanical Interlock
Technical Paper

Comply with UL67



Design Reference Standards	3
UL67, Section 6.6.10	3
UL67, Section 28.1	4
Grid & Generator Relay Operation Mode	5
Operation Mode Example 1: Generator Relay Close	6
Operation Mode Example 2: Generator Relay Open	6
Grid & Generator Interlock Mechanics	7
Interlock Logic electrical Circuit Diagram of Grid and Generator Ports	7
Normal Working Conditions	9
Normal Condition 1	9
Normal Condition 2	10
Normal Condition 3	11
Normal Condition 4	12
Normal Condition 5, 6, 7 & 8	13
Summary for normal working condition 1,2,3,4,5,6,7,8	15
Abnormal Working Conditions.....	15
Abnormal Condition 1	15
Abnormal Condition 2, 3, 4	16
Abnormal Condition 5	17
Abnormal Condition 6, 7, 8	18
Summary for abnormal working condition 5,6,7,8	19
Conclusion.....	20
Annex	21
UL Certification Letter issued to LoadHub	21

Design Reference Standards

PointGuard LoadHub complies to UL67 with a mechanical (hardware) interlock design.

The applied clauses are:

UL 67 Section 6.6.10 The operating mechanism in a panelboard used as transfer equipment in accordance with Article 702 of the National Electrical Code, ANSI/NFPA 70, shall be interlocked to prevent simultaneous connection to both the normal and alternate sources of supply. The interlock shall be installed as part of the panelboard assembly in the factory or provisions made for its field installation.

UL 67 Section 28.1 Exception No.1 Circuit breakers or switches provided with a mechanical interlock that prevents the normal and alternate supply circuit breakers or switches from being in motion simultaneously are not required to be tested in accordance with UL 1008.

UL67, Section 6.6.10

6.6.10 The operating mechanism in a panelboard used as transfer equipment in accordance with Article 702 of the National Electrical Code, ANSI/NFPA 70, shall be interlocked to prevent simultaneous connection to both the normal and alternate sources of supply. The interlock shall be installed as part of the panelboard assembly in the factory or provisions made for its field installation. The panelboard or field installed kit shall be marked in accordance with 34.12.18 or 34.12.19.

6.6.11 Panelboards intended for interconnection with one or more electric power production sources operating in parallel with a primary source(s) of electricity, in accordance with Article 705 of the National Electrical Code, NFPA 70, shall be permitted to have provisions for connection(s) as noted in (a) and (b). See 34.16 for marking requirements.

a) Supply Side Connection – Panelboards intended for use in applications where the non-primary sources are connected on the supply side of the service disconnecting means, see 6.2.1(g), shall comply with the following:

- 1) The sum of the continuous current output ratings of all supply side overcurrent devices connected to power production sources shall not exceed the rating of the panelboard unless protected by a Power Control System (PCS) complying with 6.6.12.
- 2) If connections are provided to interconnect power production sources, those connections shall accommodate conductors no smaller than 6 AWG copper or 4 AWG aluminum.

b) Load Side Connection – Panelboards for use in applications where the non-primary sources are connected on the load side of the service disconnecting means shall comply with the following:

- 1) Shall be permitted to have one or more load side disconnects for the interconnection of parallel power sources.
- 2) The total rating of all overcurrent devices supplying the panelboard shall not exceed the rating of the panelboard when protected by a Power Control System (PCS) complying with 6.6.12

Exception: The total rating of all overcurrent devices supplying the panelboard may exceed the rating of the panelboard by up to 120% of the rating of the panelboard if the overcurrent device(s) intended for use with interconnected parallel power sources are positioned at the opposite end

*UL from the main input, or if the connections are at either end of a center-fed panelboard. OTHER
PRODUCTION OR DISTRIBUTION WITHOUT PERMISSION FROM UL INC.*

UL67, Section 28.1

28 Test Requirements for Panelboards Used as Transfer Equipment

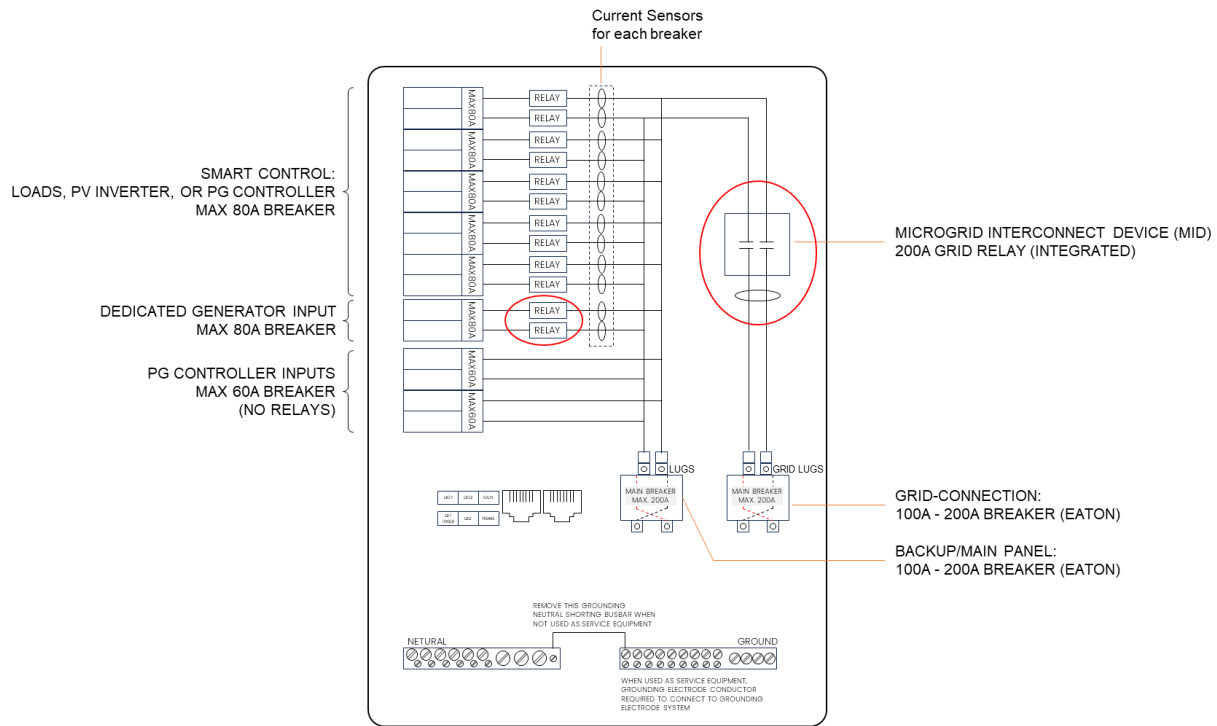
28.1 A panelboard that is intended for use in accordance with Article 702 of the National Electrical Code, ANSI/NFPA 70, along with its circuit breakers or switches and interlock, shall be tested in accordance with the Standard for Transfer Switch Equipment, UL 1008. See [6.6.9](#) and [6.6.10](#) for construction requirements, [34.12.18](#) and [34.12.19](#) for marking requirements.

Exception No. 1: Circuit breakers or switches, provided with a mechanical means to prevent the load switching from the normal source of supply to the alternate source of supply in one continuous motion, are not required to be tested in accordance with UL 1008.

Exception No. 2: Circuit breakers or switches provided with a mechanical interlock that prevents the normal and alternate supply circuit breakers or switches from being in motion simultaneously are not required to be tested in accordance with UL 1008.

Grid & Generator Relay Operation Mode

PointGuard LoadHub Diagram

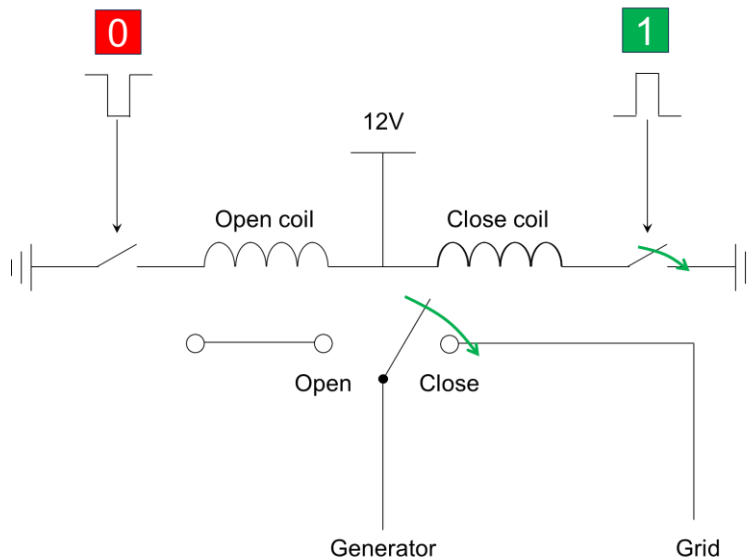


There are two-type of relays in the PG LoadHub:

1. Generator Relay
2. Grid Relay (MID, Microgrid interconnect Device)

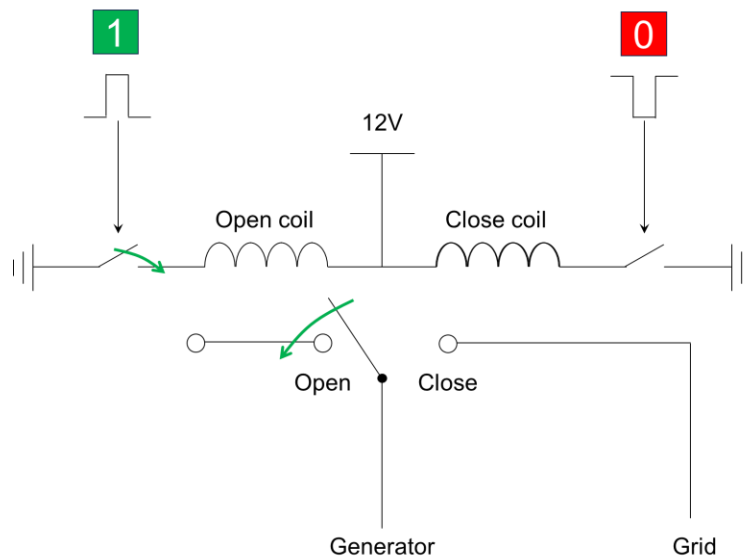
They are all **Latching Relay**. A latching relay is a type of relay that maintains its contact position without continuous power application.

Operation Mode Example 1: Generator Relay Close



A pulse signal sent to the close coil, the relay will close and maintain this contact position

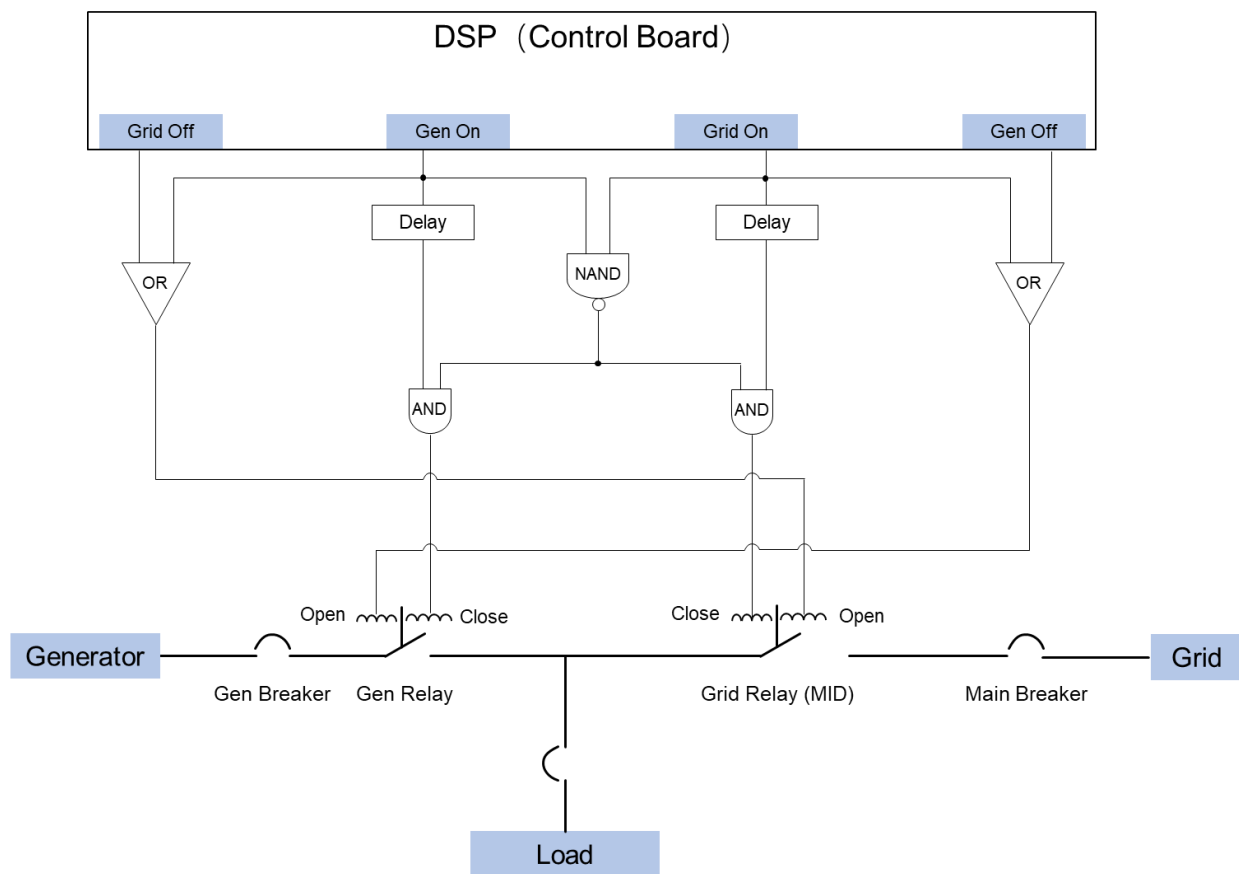
Operation Mode Example 2: Generator Relay Open



A pulse signal sent to the open coil, the relay will open and maintain this contact position

Grid & Generator Interlock Mechanics

Interlock Logic electrical Circuit Diagram of Grid and Generator Ports



The control board (DSP) has 4 command signals:

1. Grid On: Command with "1" pulse intended to close Grid relay
2. Grid Off: Command with "1" pulse intended to open Grid relay
3. Gen On: Command with "1" pulse intended to close Generator relay
4. Gen Off: Command with "1" pulse intended to open Generator relay

In normal control, all hardware and software are working correctly:

1. Grid On and Generator On will never be "1" at the same time
2. Grid On and Grid Off will never be "1" at the same time
3. Generator On and Generator Off will never be "1" at the same time

In abnormal control, hardware and software are working incorrectly:

1. Grid On and Generator On are "1" at the same time

2. Grid On and Grid Off are “1” at the same time
3. Generator On and Generator Off are “1” at the same time

Based on the above "Interlock Logic Electrical Circuit Diagram of Grid and Generator Ports" design, PointGuard ensures that under any possible command combination, the generator relay and grid relay will never close simultaneously.

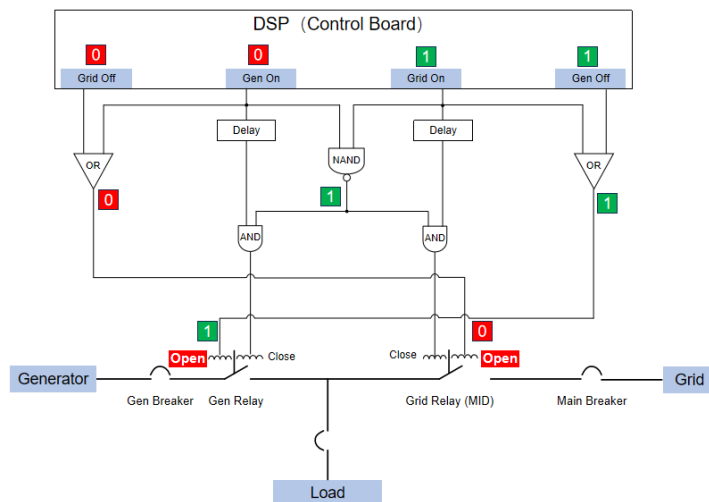
Working Condition	Grid On	Grid Off	Gen On	Gen Off	Gen Relay	Grid Relay
Normal	1	0	0	1	the generator relay and grid relay will never close simultaneously	
	1	0	0	0		
	0	1	1	0		
	0	0	1	0		
	0	1	0	0		
	0	0	0	1		
	0	1	0	1		
	0	0	0	0		
Abnormal	1	0	1	0		
	1	1	1	0		
	1	0	1	1		
	1	1	1	1		
	1	1	0	1		
	0	1	1	1		
	1	1	0	0		
	0	0	1	1		

Normal Working Conditions

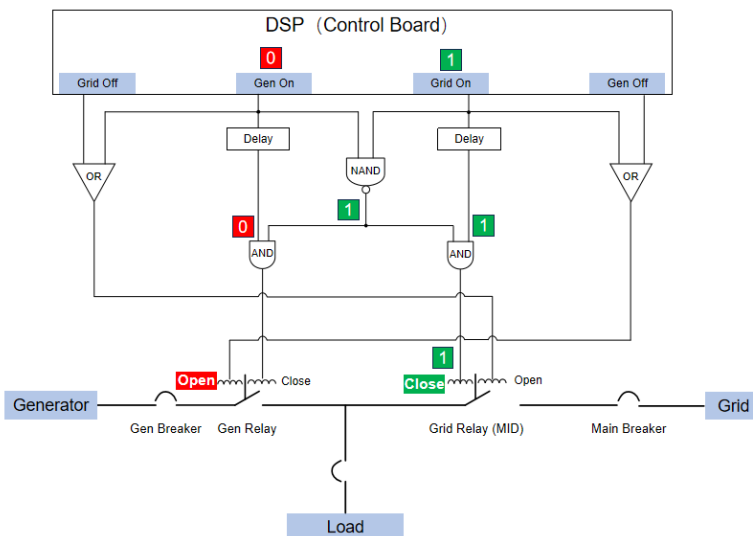
Normal Condition 1

Operation Condition	Grid On	Grid Off	Gen On	Gen Off	Gen Relay	Grid Relay
Normal 1	1	0	0	1		

Step 1: Grid On and Gen Off command will open the Gen Relay first (no signal delay)



Step 2: After 100ms delay, Grid relay will be close.

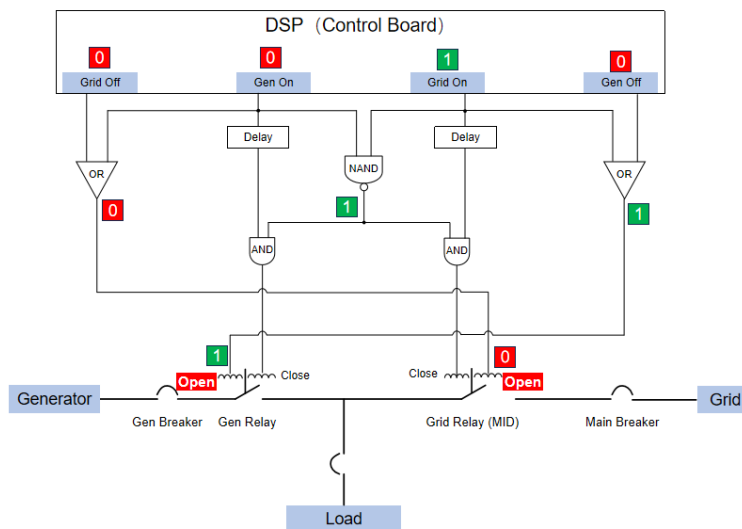


Operation Condition	Grid On	Grid Off	Gen On	Gen Off	Gen Relay	Grid Relay
Normal 1	1	0	0	1	Open	Close

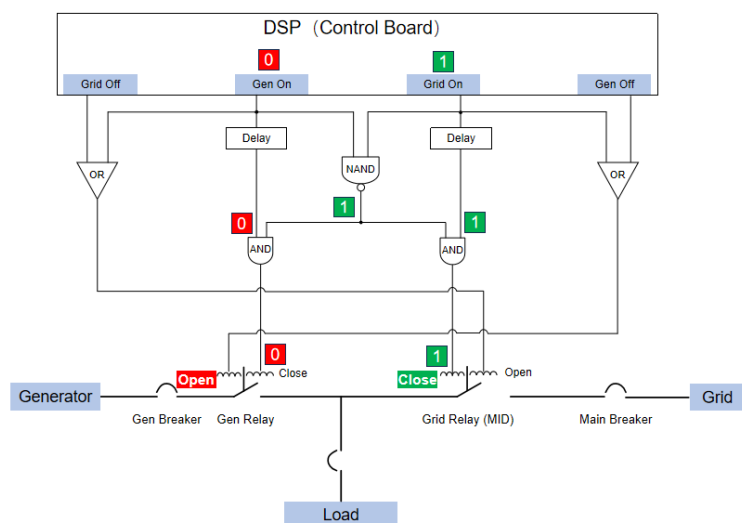
Normal Condition 2

Operation Condition	Grid On	Grid Off	Gen On	Gen Off	Gen Relay	Grid Relay
Normal 2	1	0	0	0		

Step 1: Grid On command will firstly open the Gen Relay first



Step 2: After around 0.1 seconds delay, the Grid Relay will be closed.

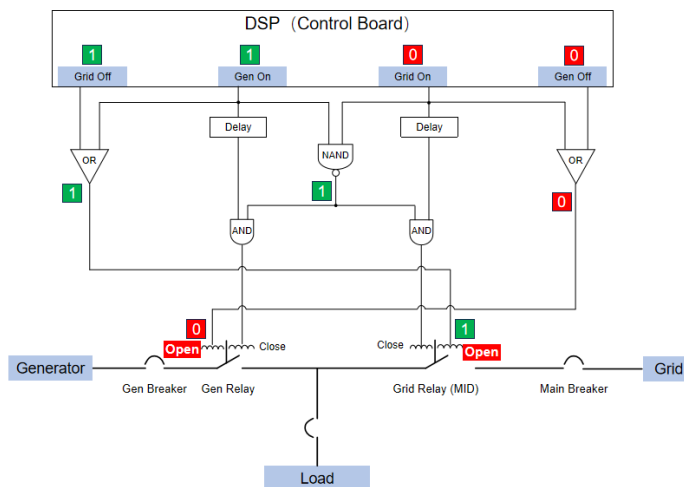


Operation Condition	Grid On	Grid Off	Gen On	Gen Off	Gen Relay	Grid Relay
Normal 2	1	0	0	0	Open	Close

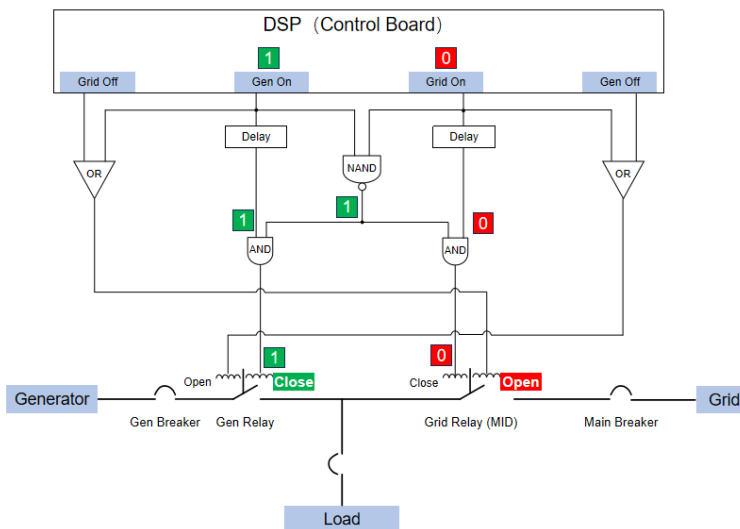
Normal Condition 3

Operation Condition	Grid On	Grid Off	Gen On	Gen Off	Gen Relay	Grid Relay
Normal 3	0	1	1	0		

Step 1: Gen On & Grid Off commands will open the Grid Relay first.



Step 2: After 100ms delay, the Gen Relay will be closed.

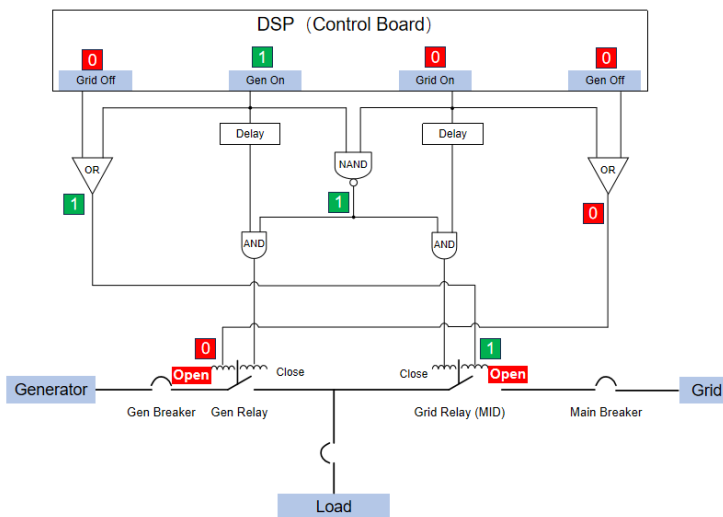


Operation Condition	Grid On	Grid Off	Gen On	Gen Off	Gen Relay	Grid Relay
Normal 3	0	1	1	0	Cose	Open

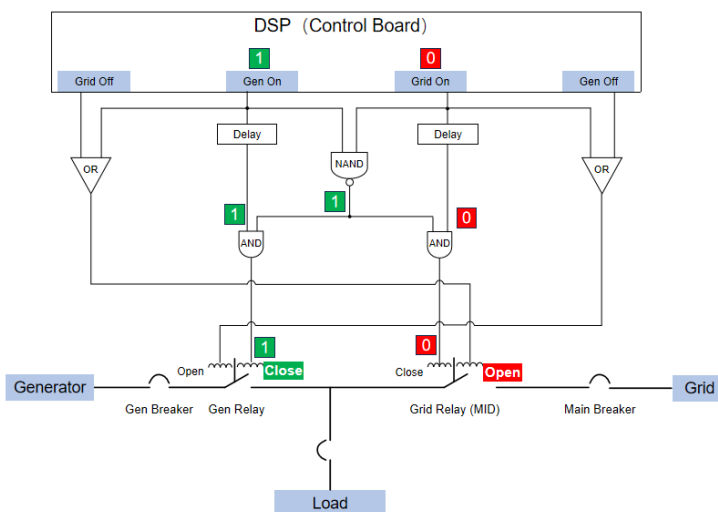
Normal Condition 4

Operation Condition	Grid On	Grid Off	Gen On	Gen Off	Gen Relay	Grid Relay
Normal 4	0	0	1	0		

Step 1: Gen On command will open the Grid Relay first.



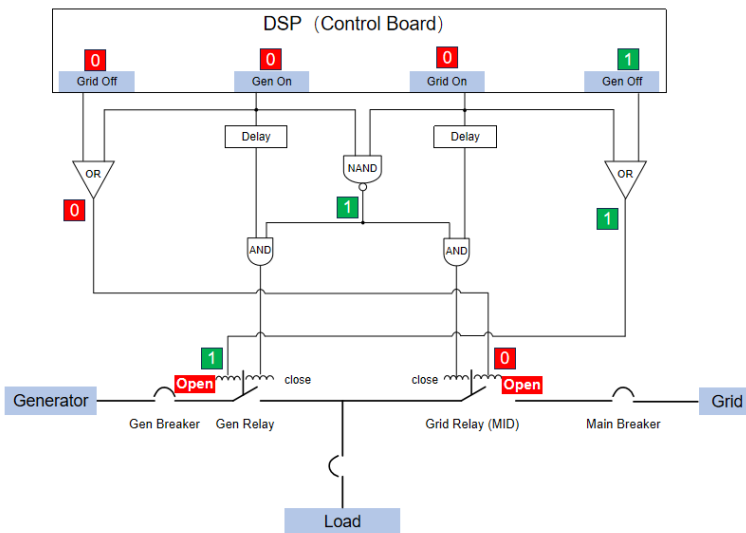
Step-2: After 100ms delay, the Gen Relay will be closed.



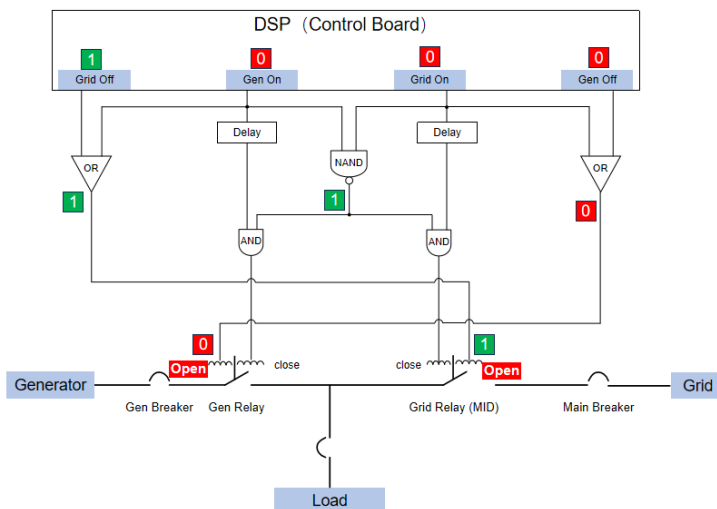
Operation Condition	Grid On	Grid Off	Gen On	Gen Off	Gen Relay	Grid Relay
Normal 4	0	0	1	0	Close	Open

Normal Condition 5, 6, 7 & 8

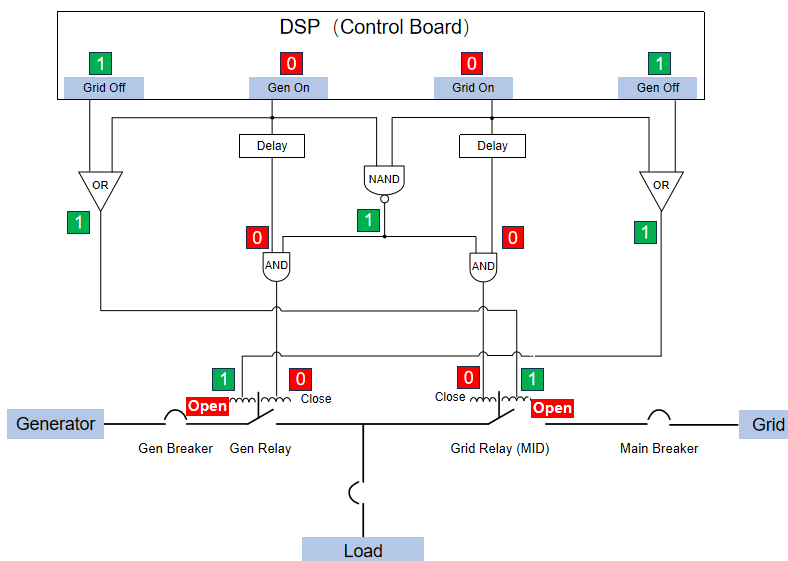
Operation Condition	Grid On	Grid Off	Gen On	Gen Off	Gen Relay	Grid Relay
Normal 5	0	0	0	1	Open	Open



Operation Condition	Grid On	Grid Off	Gen On	Gen Off	Gen Relay	Grid Relay
Normal 6	0	1	0	0	Open	Open

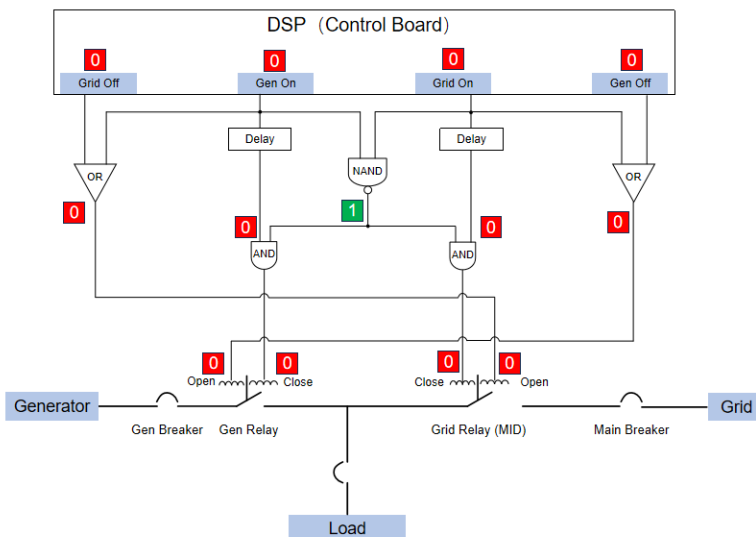


Operation Condition	Grid On	Grid Off	Gen On	Gen Off	Gen Relay	Grid Relay
Normal 7	0	1	0	1	Open	Open



If all DSP commands are “0”, it means the system staying as normal (No change).

Operation Condition	Grid On	Grid Off	Gen On	Gen Off	Gen Relay	Grid Relay
Normal 8	0	0	0	0	Open	Open



Summary for normal working condition 1,2,3,4,5,6,7,8

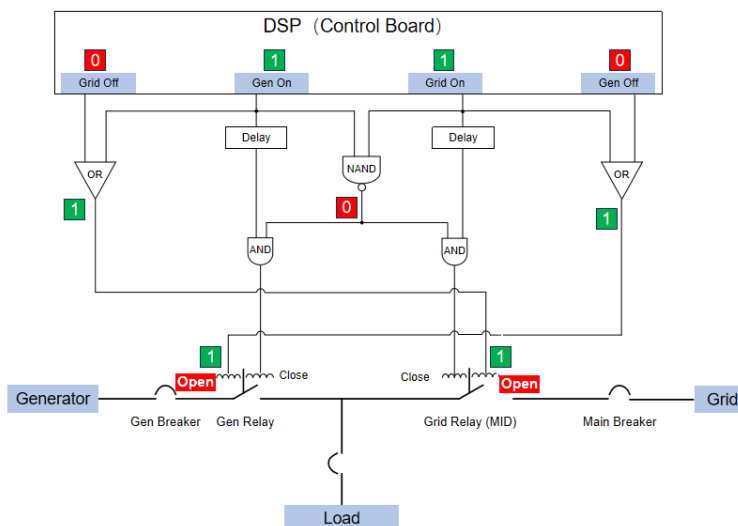
Operation Condition	Grid On	Grid Off	Gen On	Gen Off	Gen Relay	Grid Relay
Normal 1	1	0	0	1	Open	Close
Normal 2	1	0	0	0	Open	Close
Normal 3	0	1	1	0	Close	Open
Normal 4	0	0	1	0	Close	Open
Normal 5	0	1	0	0	Open	Open
Normal 6	0	0	0	1	Open	Open
Normal 7	0	1	0	1	Open	Open
Normal 8	0	0	0	0	Open	Open

Abnormal Working Conditions

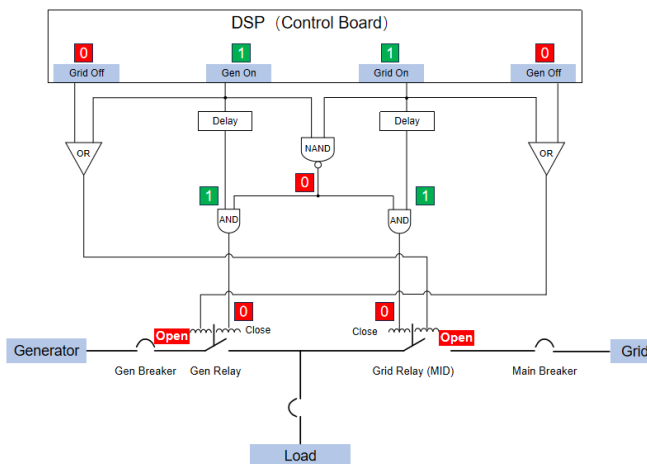
Abnormal Condition 1

Operation Condition	Grid On	Grid Off	Gen On	Gen Off	Gen Relay	Grid Relay
Abnormal 1	1	0	1	0		

Step 1: Gen On & Grid On simultaneously, these two commands will open both of generator relay and grid relay firstly.



Step 2: The NAND gate and the two AND gates will remain grid relay and generator relay at open with both “0” signal status.

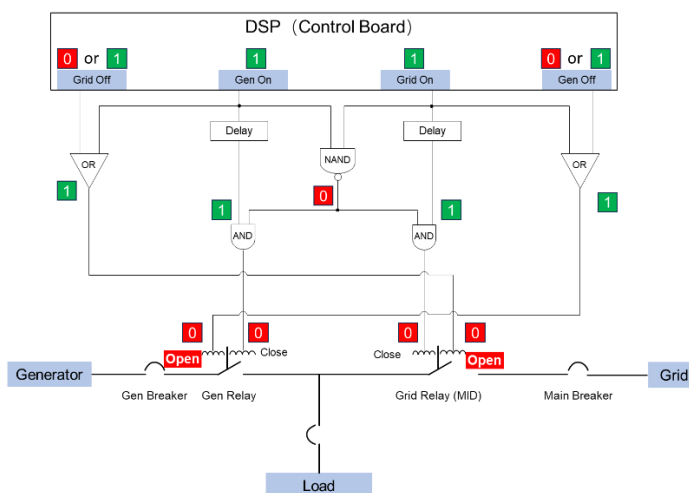


Operation Condition	Grid On	Grid Off	Gen On	Gen Off	Gen Relay	Grid Relay
Abnormal 1	1	0	1	0	Open	Open

Abnormal Condition 2, 3, 4

All the following conditions have the Gen On and Grid On simultaneously, so these working conditions have the same result as the abnormal condition 1.

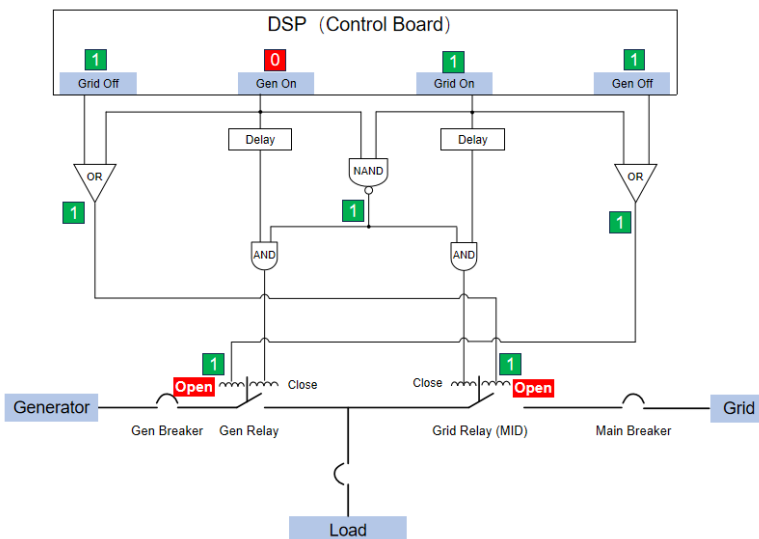
Operation Condition	Grid On	Grid Off	Gen On	Gen Off	Gen Relay	Grid Relay
Abnormal 1	1	0	1	0	Open	Open
Abnormal 2	1	1	1	0	Open	Open
Abnormal 3	1	0	1	1	Open	Open
Abnormal 4	1	1	1	1	Open	Open



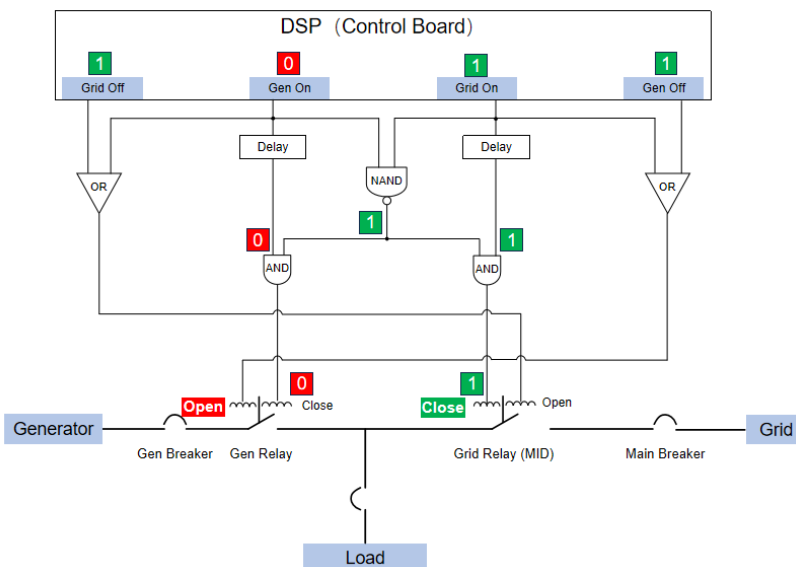
Abnormal Condition 5

Operation Condition	Grid On	Grid Off	Gen On	Gen Off	Gen Relay	Grid Relay
Abnormal 5	1	1	0	1		

Step 1: Gen Off & Grid Off will open both of generator relay and grid relay firstly.



Step 2: After Grid On delayed 100ms, the AND gate for grid relay will push grid relay close with “1” signal status. The Generator relay will remain open with “0” signal status.



Operation Condition	Grid On	Grid Off	Gen On	Gen Off	Gen Relay	Grid Relay
Abnormal 5	1	1	0	1	Open	Close

Abnormal Condition 6, 7, 8

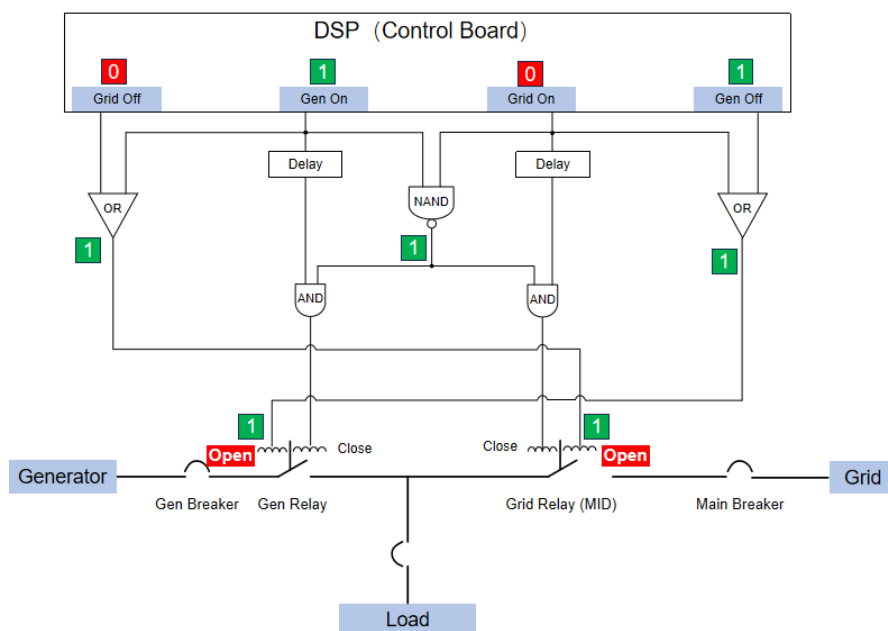
All the following conditions have the Gen On and Gen Off (or Grid On and Grid Off) simultaneously, so these working conditions have the same result as the abnormal condition 5.

Operation Condition	Grid On	Grid Off	Gen On	Gen Off	Gen Relay	Grid Relay
Abnormal 5	1	1	0	1		
Abnormal 6	0	1	1	1		
Abnormal 7	1	1	0	0		
Abnormal 8	0	0	1	1		

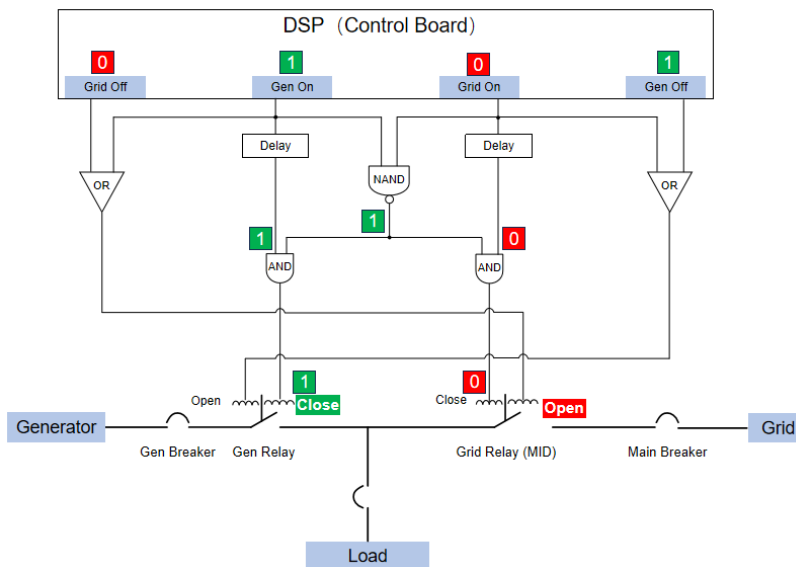
Example: Working condition abnormal 8

Operation Condition	Grid On	Grid Off	Gen On	Gen Off	Gen Relay	Grid Relay
Abnormal 8	0	0	1	1		

Step 1: Both grid relay and generator relay will open, because both two OR gates output will be “1” pulse.



Step 2: After 100ms delay, the AND gate for generator will output to “1” pulse, close the Generator Relay. The AND gate for grid will output to “0”, and remain open.



Operation Condition	Grid On	Grid Off	Gen On	Gen Off	Gen Relay	Grid Relay
Abnormal 8	0	0	1	1	Close	Open

Summary for abnormal working condition 5,6,7,8

Operation Condition	Grid On	Grid Off	Gen On	Gen Off	Gen Relay	Grid Relay
Abnormal 5	1	1	0	1	Open	Close
Abnormal 6	0	1	1	1	Close	Open
Abnormal 7	1	1	0	0	Open	Close
Abnormal 8	0	0	1	1	Close	Open

Conclusion

PointGuard LoadHub complies with UL67 and UL1008, the grid relay and generator relay designed with a mechanical (hardware) interlock, which ensures that under any possible command combination, the generator relay and grid relay will never close simultaneously.

Working Condition	Grid On	Grid Off	Gen On	Gen Off	Gen Relay	Grid Relay
Normal	1	0	0	1	Close	Open
	1	0	0	0	Close	Open
	0	1	1	0	Open	Close
	0	0	1	0	Open	Close
	0	1	0	0	Open	Open
	0	0	0	1	Open	Open
	0	1	0	1	Open	Open
	0	0	0	0	Open	Open
Abnormal	1	0	1	0	Open	Open
	1	1	1	0	Open	Open
	1	0	1	1	Open	Open
	1	1	1	1	Open	Open
	1	1	0	1	Open	Close
	0	1	1	1	Close	Open
	1	1	0	0	Open	Close
	0	0	1	1	Close	Open

Annex

UL Certification Letter issued to LoadHub

[1] CSA Description Report for **UL 67 Panelboards (Thirteenth Edition, Revision Dated May 15, 2018)**



Descriptive Report

MASTER CONTRACT: 303946
 REPORT: 80180395
 PROJECT: 80180395

Edition 1: March 26, 2024; Project 80180395 - Shanghai
 Prepared By: Rohana Yang
 Authorized By: Rohana Yang

Contents: Certificate of Compliance - Page 1 to 2
 Supplement to Certificate of Compliance - Page 1
 Description and Tests - Pages 1 to 16
 Annex A- Page 1
 Att1 Photos - Pages 1 to 5
 Att2 Construction - Pages 1 to 25
 Att3 Marking Label - Pages 1 to 5
 Att4 SCH and Layout - Pages 1 to 34
 Att5 Manual - Pages 1 to 37
 Att6 Magnetic Component- Pages 1 to 12
 Att7 Insulation Material Sheet- Pages 1 to 10
 Att8 FEMA report for Grid and Generator Transfer- Pages 1 to 28

PRODUCTS

CLASS 5311 09 - POWER SUPPLIES - Distributed Generation Power Systems Equipment
 CLASS 5311 89 - POWER SUPPLIES - Distributed Generation Power Systems Equipment - Certified to U.S. Standards

Microgrid Interconnect Device used as Pannel Board, PointGuard LoadHub, model PG LoadHub, permanently connected. Rating as following:

Model	PG LoadHub
Nominal Operating Voltage	120/240Vac Split Phase
Operating Voltage Range	104-155Vac /180-270Vac
Nominal Operating Frequency	60Hz
Operating Frequency Range	57-63Hz
Grid Max Continuous Current	200A
Backup Max Continuous Current	200A
Generator Max Continuous Current	64A
PG Home 1 Max Continuous Current	48A
PG Home 2 Max Continuous Current	48A
Smart Load 1 to 5	64A *5
Normal operation temperature range	-30°C - +55°C
Enclosure Rating Type	Type 3R
Short Circuit Current Rating	10kA when the main breaker installed.

The reader is responsible for any liability arising from actions taken in interpreting or applying the results presented in this report. This report shall not be reproduced except in full, without written approval from CSA Group Testing & Certification Inc. The results of this report only relate to those items tested.

1st Floor, Building 4, Qilai Industrial City, 889 Yiehan Road, Shanghai, 200233 China
 Telephone: (86)21.33688282 Fax: (86)21.33688122 www.csagroup.org

MASTER CONTRACT: 303946
 REPORT: 80180395
 PROJECT: 80180395

Page No: 2
 Date Issued: March 26, 2024

Note1: For the specified temperature range, Circuit breaker cannot be relied on to provide overload protection when installed below 0 degreeC. Separated Overload protection shall be provided as required CEC and NEC if ambient temperature is below 0 degreeC.

Note2: The Power Control System- Busbar protection function was evaluated with PG LoadHub and PointGuard Controller Series Inverter, the set point for the busbar protection function is non-adjustable and fixed at 160A. When the total current from all the sources (Grid, PG Home 1 and PG Home 2) exceeds the set point, the PointGuard Controller Inverter will shut down, and the remaining Grid Main Breaker will provide overcurrent protection for the Busbar.

Note3: Short circuit rating is assigned based on the lowest component short circuit rating when Eaton main breaker is not installed.

APPLICABLE REQUIREMENTS

- | | |
|-----------------------------------|--|
| CSA C22.2 No. 107.1-16
UL 1741 | - Power Conversion Equipment
- Inverters, Converters, Controllers and Interconnection System Equipment for Use With Distributed Energy Resources (Third Edition, Revision Dated May 19, 2023) |
| *UL1741 CRD
UL 67 | - Power Control Systems (PCS) (Dated March 08, 2019)
- Panelboards (Thirteenth Edition, Revision Dated May 15, 2018) |
| UL 869A | - Reference Standard for Service Equipment (Fourth Edition, Revision Dated November 10, 2006) |

*Note: The evaluated operating modes according to UL 1741 PCS CRD includes: Busbar Protection.