

Load and Solar Circuit Control using IQ System Controller Auxiliary Contacts

Contents

- Load and Solar Circuit Control using IQ System Controller Auxiliary Contacts 1**
- Overview..... 2**
 - What are auxiliary contacts and how do they work? 2
- Auxiliary contact labelling in IQ System Controller..... 2**
- Auxiliary contact usage 3**
- Enabling Load Control on a site 3**
- Using the IQ Load Controller with IQ System Controller to enable Load control or PV shedding .3**
 - Using the IQ Load Controller for load shedding 4
 - Using the IQ Load Controller for PV shedding 5
- Using Load control in a Sunlight Backup system 6**
- Load control modes in the Enphase Installer App..... 6**
- Configuring Load Control via the Enphase Installer App 7**
 - Accessing Auxiliary contact configuration 7
 - Enable Load Control 7
 - Automatically shed solar circuit when off-grid..... 14
 - Validation of auxiliary contacts using Enphase Installer App 15
 - Troubleshooting steps..... 18
- Configuring Load Control via Enphase App..... 18**
- Installing a custom kit for Load/PV Shedding 23**
 - Using an external contactor with a 24 Vac coil 23
 - Using an external contactor with a 120Vac coil 26
- Validation and Troubleshooting Guidelines for setting up a custom Load Control kit 30**
- Appendix B: Controlling air conditioning unit using a thermostat. 33**
- Appendix C: Recommended maximum distance between IQ System Controller and IQ Load Controller..... 34**
- Appendix D: Additional reference BOM configurations 35**

Overview

This document provides installers and design engineers with the information required to plan and configure Smart Control (load and solar circuit control) using IQ System Controller Auxiliary contacts.

The Enphase Energy System (EES) must have sufficient power capability to sink all the power from the PV system during transitions to off-grid and must source power to support all loads in intentionally islanded (standalone) operation. This may not always be feasible. In such situations, auxiliary contacts in IQ System Controller can be used to disconnect (shed) excess solar or heavy loads.

In addition, low priority loads with high power requirements may deplete energy storage. Auxiliary contacts can be used to shed these large loads to help maintain energy in the storage system.

What are auxiliary contacts and how do they work?

The IQ System Controller has 5 relays rated for pilot duty at up to 24Vac/Vdc and 1A continuous current. One is dedicated for generator function while the others are available for general use. The contacts/terminals of the pilot relays are not energized by IQ System Controller i.e., they have no voltage on them and are “dry”. When these contacts are connected to a voltage source, they are “wetted”. In this document, we will be referring to these as auxiliary relays or contacts. The configuration of the relays is as follows:

1. Two Normally Open (NO)
2. Two Normally Closed (NC), and
3. One NO relay used for starting a generator (optional)

While the auxiliary contacts have NO and NC electrical configurations, the Enphase Installer App overrides this behavior when configuring the contacts. Once configured the contacts are closed when on-grid and open when off-grid. In special load control modes, the contacts may be closed when off-grid if battery charge exceeds a threshold or if a generator is running. **Due to this IQ System Controller can only be used with NO-type external definite purpose contactors or power relays to implement load control or solar circuit control as described in this tech brief.**

Note: Refer to the Generator support tech brief for documentation related to generator integration. This tech brief covers load and solar circuit shedding using auxiliary contacts.

Auxiliary contact labelling in IQ System Controller

The figure below illustrates the auxiliary contacts at the bottom of the IQ System Controller smart switch. It also shows the AC combiner, Generator and IQ Battery lugs.

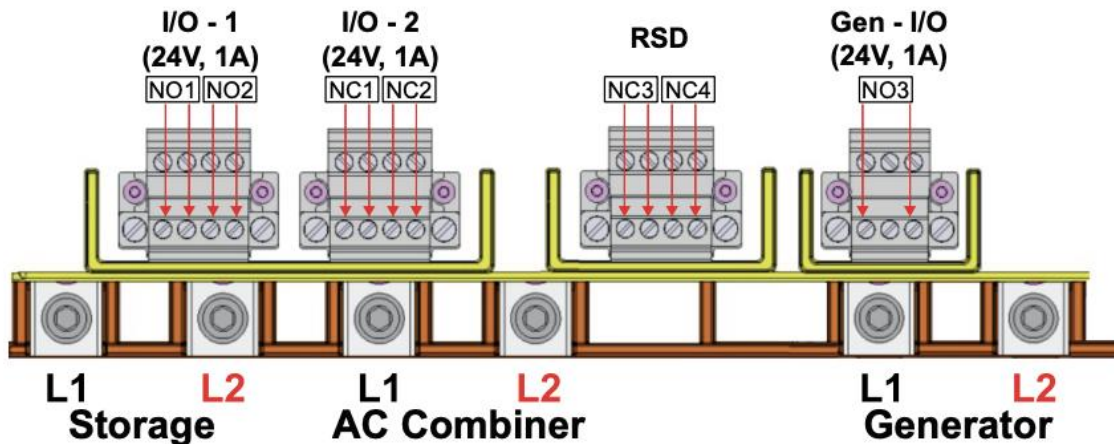


Figure 1 Auxiliary contact labelling and usage

Refer to the IQ System Controller QIG for installation instructions.

Note: Use 3/32inch /2 mm flathead screwdriver to work on auxiliary contact terminals.

Auxiliary contact usage

Enphase recommends using Normally Open auxiliary contacts for solar and Normally Closed auxiliary contacts for loads. The load/solar circuit behavior represented in this document requires that a Normally Open (NO) definite purpose external contactor be used. Enphase's software is tailored to work with these since these are the most readily available.

IQ System Controller's auxiliary contacts can be used with 2 different types of external contactors:

1. Normally Open external contactor with a 24 V ac coil
2. Normally Open external contactor with a 120 V ac coil (with an interposing power relay)

Note: The definite purpose external contactor may make a humming or buzzing sound when its coil is energized. This is normal and does not indicate issues with the equipment.

Enabling Load Control on a site

The auxiliary contacts, as described above, can be used for load shedding or PV shedding. Load shedding can be used to shed non-essential loads on a site during a grid outage to ensure that the essential loads are backed up for a longer time. Alternately, you may want to use the auxiliary contacts for PV shedding to maintain the Solar-To-Storage ratio in off-grid mode on sites with IQ6, IQ7, M215 or M250 microinverters.

In either case, you will require a general-purpose contactor, a power supply, and additional accessories to setup a site to use the load control feature. Enphase has launched a new product, the IQ Load Controller, which is a complete solution for using the IQ System Controller's load control feature. Installers are required to follow the simple and detailed instructions provided in the instructions guide with the product to complete the wiring to integrate the IQ Load Controller with the IQ System Controller in order to setup load control (or PV shedding) at a site.

Installers may also choose to setup a similar kit by themselves. Enphase has provided a list of recommended contactors, control transformers and other components to setup a self-assembled kit. You may skip to the ['Installing a custom kit for Load/PV Shedding'](#) section of the document to learn more.

Using the IQ Load Controller with IQ System Controller to enable Load control or PV shedding

Enphase's IQ Load Controller is a complete solution for using the IQ System Controller's load control feature. The Enphase IQ Load Controller, when used in conjunction with the IQ System Controller, enables control of up to two heavy loads running at 240Vac (or 4 120Vac loads) or shedding of up to two solar circuits when operating in an off-grid mode with the Enphase energy management system.

The IQ Load Controller is a UL listed, outdoor-rated, NRTL-certified NEMA type 4X enclosure with a DIN rail that contains two 40A contactors, a power supply, wires for control connections and other wiring accessories. Use the IQ Load Controller for controlling heavy, split-phase loads or for solar circuit shedding when solar power exceeds allowed solar to storage ratios. Heavy loads are those that exceed the power or surge capabilities of your energy management system. The IQ Load Controller supports control of 2 split-phase loads i.e., loads wired L1-L2 and running at 240V nominal AC voltage or 4 loads running at 120V nominal AC voltage.

IMPORTANT: The Enphase IQ Load Controller is an accessory for the IQ System Controller. The IQ System Controller is required to control loads or shed excess solar circuits using the IQ Load Controller.

Using the IQ Load Controller for load shedding

The Enphase IQ Load Controller, when used in conjunction with the IQ System Controller smart switch, enables control of up to 2 loads or shedding of up to two solar circuits when operating in an off-grid mode with the Enphase energy management system. To install the IQ Load Controller, read and follow all warnings and instructions mentioned in the QIG provide with the product. Safety warnings are listed on the back of the QIG. If you do not fully understand any of the concepts, terminology, or hazards outlined in the instructions, refer installation to a qualified electrician or installer. These instructions are not meant to be a complete explanation of a renewable energy system. All installations must comply with national and local electrical codes. Professional installation is recommended.

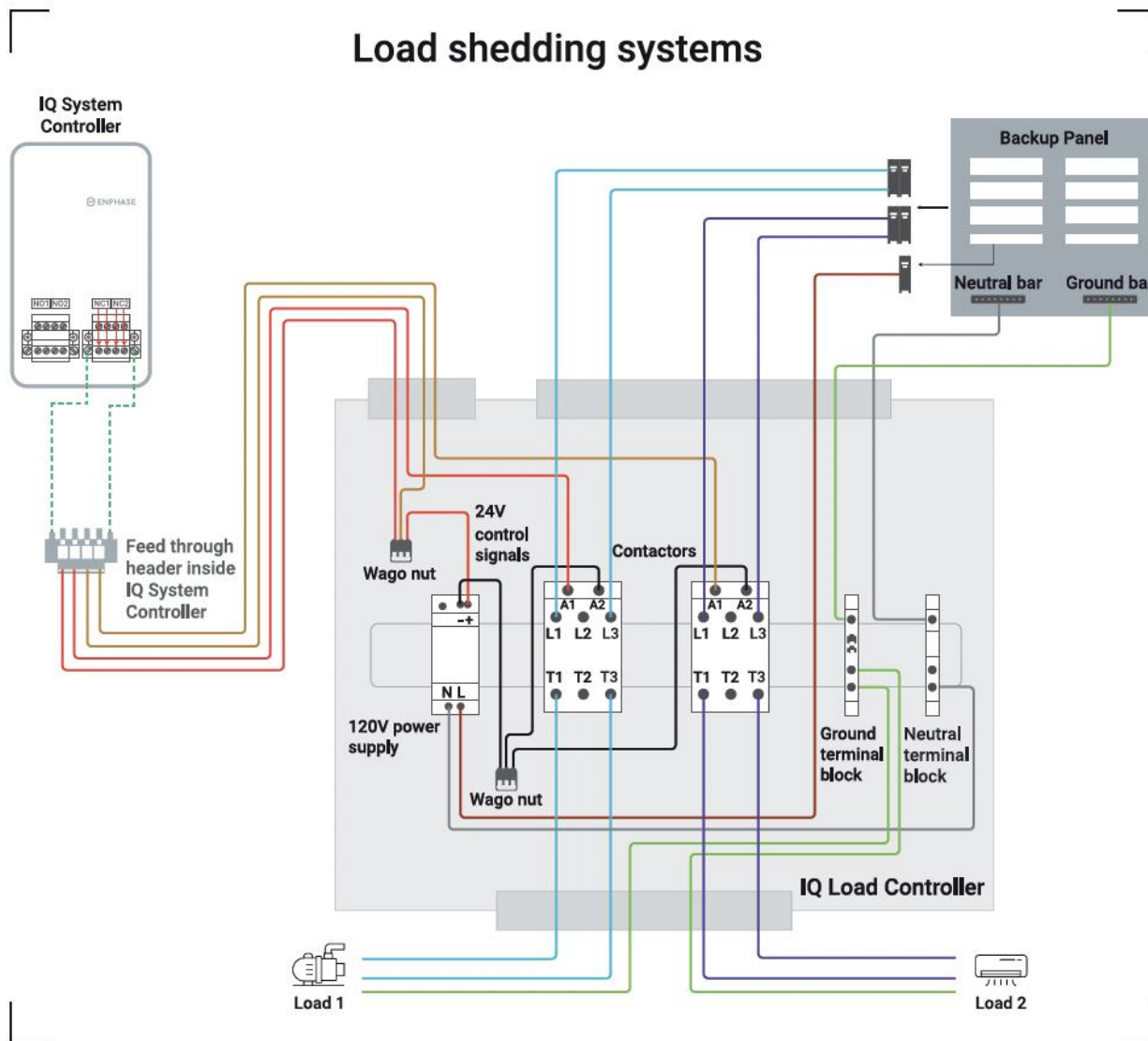


Figure 2: Load Shedding systems

As shown in the diagram above, the IQ Load Controller can be used for shedding loads of up to 36A running at 240Vac connected to a 45A breaker. It can also be used for shedding a 32A branch circuit connected to a 40A breaker. Follow all the instructions in the QIG provided with the product to setup load shedding on a site.

Note: The IQ Load Controller can also be used for shedding 4 loads running at 120Vac. If being used for such a use case it is important to ensure that the individual loads are connected on the outer poles of the contactors. Whenever possible, try to balance the current on the 2 poles of a contactor. To do this, connect the 2 loads with similar current requirements on the same contactor. This will prevent unequal wearing of the 2 poles of the contactors, thus ensuring a longer service life for the contactor.

Note: If there is a multi-wire branch circuit where 2 single phase circuits share a neutral, both current carrying conductors should be switched by a single contactor

Using the IQ Load Controller for PV shedding

The IQ Load Controller can be used for PV shedding as well. Note that this use case is only applicable for installations on sites with IQ6/IQ7 or M215, M250 microinverters. IQ8 installations do not require PV shedding.

The IQ6, IQ7 and M215, M250 PV installations with an IQ Battery require to maintain a Solar-To-Storage ratio when off-grid. By using an IQ Load Controller, you can install an additional 2 PV branches on a site, that function normally in an on-grid scenario but are shed when the system goes off-grid, thus preserving the Solar-To-Storage ratio. You can install up to 2 IQ Load Controllers on a site, thus having the provision to install up to 4 extra PV branch circuits for use in on-grid only mode.

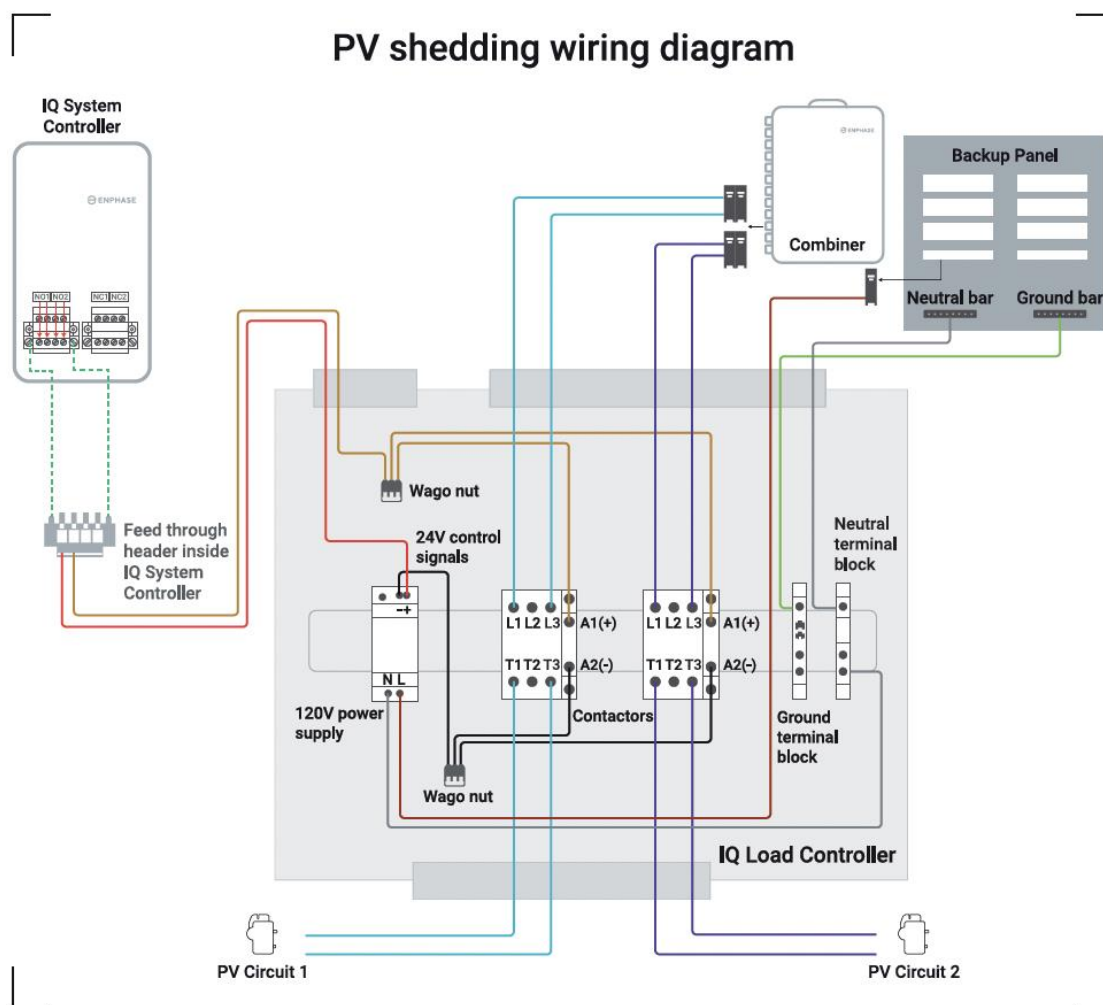


Figure 3: PV Shedding systems

The above PV shedding wiring diagram is placed along with the QIG inside the enclosure of the IQ Load Controller. If setting up PV shedding on a site, it would be useful to stick this label over the load shedding wiring diagram stuck on the inner door of the enclosure. Follow all the instructions in the QIG provided with the product to setup PV shedding on a site.

Using Load control in a Sunlight Backup system

A critical use case of the load control feature is for a Sunlight Backup system. This is a system with grid forming IQ8 microinverters on the roof, and an IQ System Controller but without a IQ battery on site. Such a system can remain powered during sunlight hours even in the absence of the grid. For optimal energy utilisation in such a system, Enphase recommends connecting the 4 most critical loads on the backup panel and controlled by 2 IQ Load Controllers (each IQ Load Controller controlling 2 loads). This provides the homeowner complete control over the 4 loads enabling the homeowner to shed one or more of these loads if required to ensure the other loads can remain powered for longer.

In sunlight backup mode, the system uses granular control of every load to try each load individually when it restarts post a collapse. Loads that repeatedly cause collapse are shed automatically after a few tries so that the homeowner gets the microgrid back with the loads that can be supported. The homeowner can manually reconnect the load when they believe power available has increased.

Load control modes in the Enphase Installer App

The Ensemble system can change the state of the auxiliary contact based on grid state, generator availability, and battery state of charge. This section describes the different control modes that are supported for solar and load circuits using auxiliary contacts.

The load control modes available are as follows:

- Basic Mode: Shed load when off-grid
- Scheduled Mode: When off-grid, shed loads at a certain time of the day.
- Advanced Mode: Shed load when off-grid based on battery state of charge or generator availability.
- Manual Mode: Keep the load permanently on or off irrespective of grid availability.

Load or solar circuits connected to IQ System Controller Auxiliary contacts can be configured to any of the modes above using the Enphase Installer App.

Note: Generator Mode available for systems with a standby generator. Generator support being released soon for Enphase Storage system.

Configuring Load Control via the Enphase Installer App

Accessing Auxiliary contact configuration

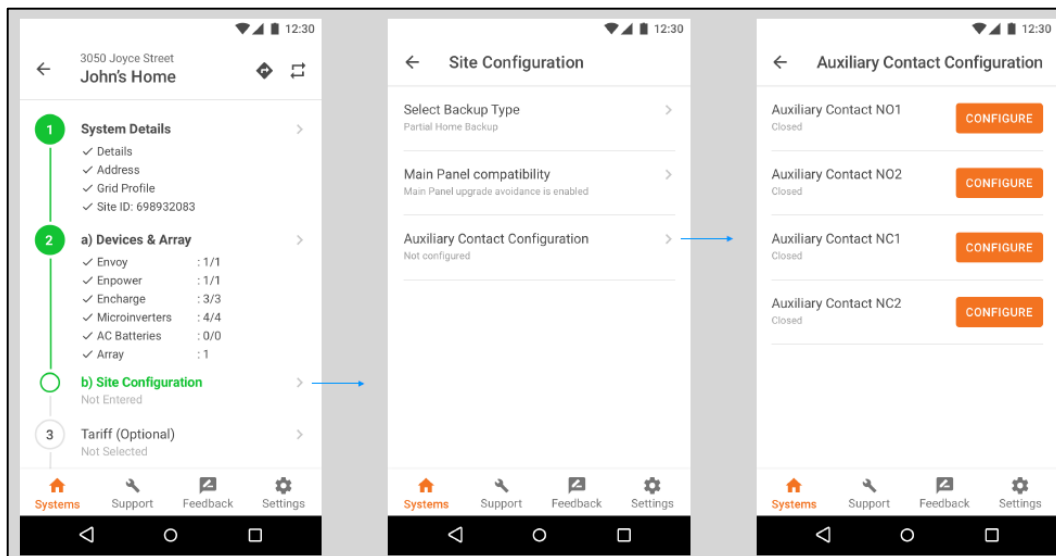


Figure 4: Accessing Enphase Installer App Auxiliary Contact Configuration

Press Site Configuration à Auxiliary Contact configuration

Enable Load Control

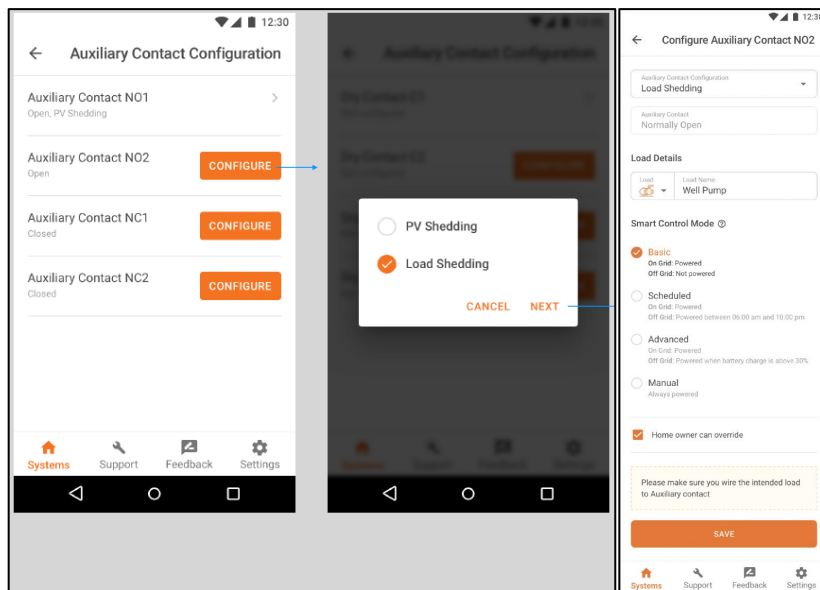


Figure 5: Configuring Load Circuit Control - Enable Load Control using Enphase Installer App

1. Press 'Configure'
2. Select option 'Load Shedding'
3. Press 'Next'

Basic Mode: Shed load when off-grid

IQ System Controller auxiliary contacts will shed the specific load circuits as soon as the system enters the off-grid mode. This is done to ensure that a stable microgrid is established. When the grid is back, the system will reconnect the load.

Mode	MID	Load circuit state
on-grid	Closed	Connected
off-grid	Open	Disconnected

Table 1: Basic mode - Shed load when off-grid

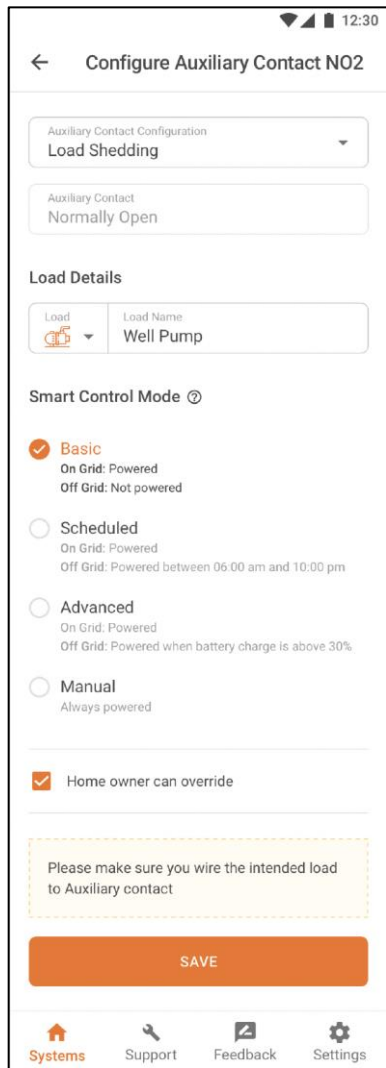


Figure 6: basic mode: Automatically shed load when off-grid using Enphase Installer App

1. Select radio button 'Basic'
2. Check 'Home owner can override' – this will let the home owner to access the settings from Enphase App Home Owner App
3. Press 'Save'

Scheduled Mode: When off-grid, shed loads at a certain time of the day

In this mode, installer is provided the ability to set a certain time interval of the day when the connected loads would be powered when system is off-grid. At other times, if system is off-grid, these loads remain powered off.

Note: If homeowner site does not have a battery installed, the allow time window to schedule load control is 9am to 4pm. For a site with battery, any time in 24 hours can be scheduled.

Mode	MID	Time of day	Load circuit state
on-grid	MID Closed	Any	Connected
off-grid	MID Open	Outside scheduled time	Disconnected
off-grid	MID Open	Within scheduled time	Connected

Table 2: Scheduled mode

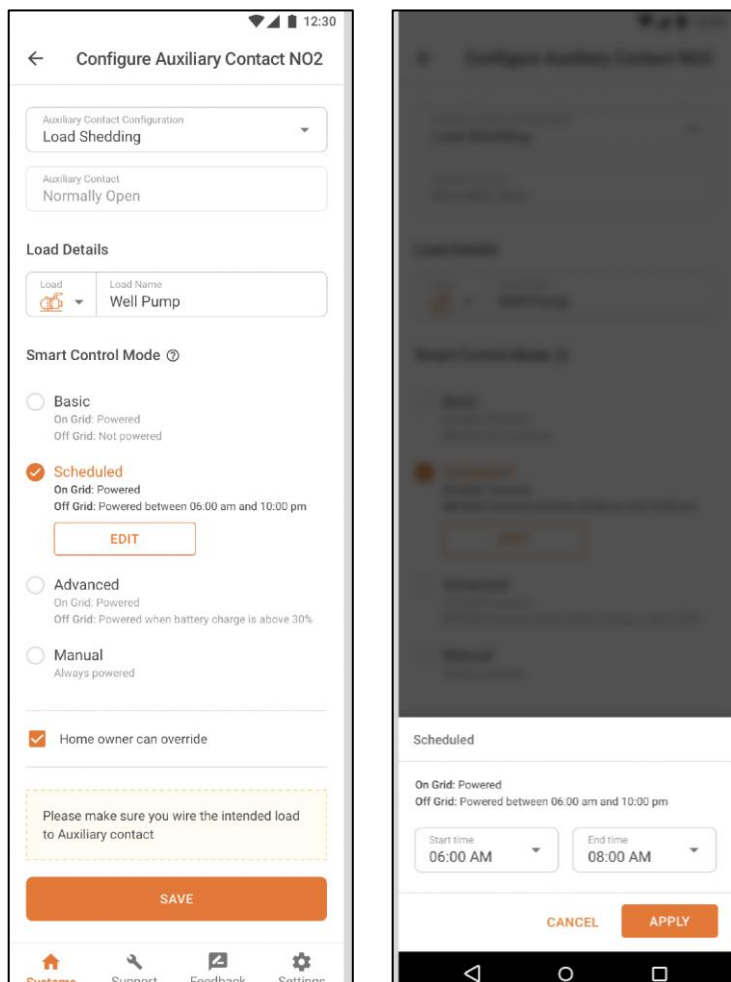


Figure 7 Scheduled mode: Automatically control load when off-grid at certain times of the day using Enphase Installer App

1. Select radio button 'Scheduled'
2. Set Start Time and End time for the duration during which loads are to remain powered when off-grid and click 'Apply'

3. Check 'Home owner can override' – this will let the home owner to access the settings from Enphase App Home Owner App
4. Press 'Save'

Advanced Mode: Shed load when off-grid based on battery state of charge or generator availability

This is an advanced mode allowing greater control over loads to the homeowner. Advanced mode can be used to control loads based on either battery or generator.

Advanced mode with battery-based control: Shed loads when off-grid and battery below a configured State of Charge (SoC)

In this mode, homeowner has the provision to control load based on battery state of charge. Homeowners can configure the charge limit below which the load automatically gets shed.

IQ System Controller can disconnect specific load circuits when the aggregate SoC of all the batteries on the site reaches or goes below a user set value(X%). The system will reconnect the load circuit once the aggregate SoC of all the batteries on the site reaches or goes above user set value Y(X + buffer%). The load will remain online if the SoC is between X% and Y% during the grid transition and will be shed only when the SoC is less than the user set low limit (X%).

Mode	MID	SoC	Load circuit state
on-grid	MID Closed	SoC =any	Connected
off-grid	MID Open	SoC ≥ X%	Connected
off-grid	MID Open	SoC ≤ X%	Disconnected
off-grid	MID Open	X% < SoC < Y%	Connected ^[1] or Disconnected ^[2]
off-grid	MID Open	SoC ≥ Y%	Connected

1. The load will remain connected as the SoC reduces from Y% to X%. It will be disconnected once the SoC goes below X%.
2. The load will remain disconnected as the SoC recovers from X% to Y%. It will be reconnected once the SoC goes above Y%.

Table 3: Load control based on ESS State of Charge (SoC)

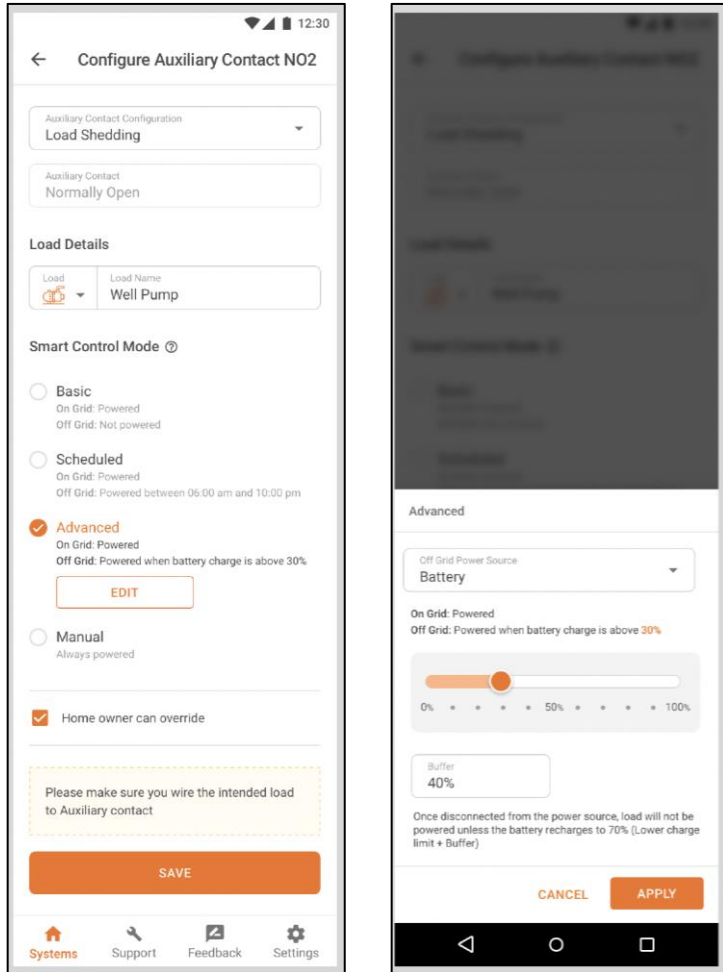


Figure 8: Battery Mode: Load control based on ESS State of Charge (SoC) via Enphase Installer App

1. Select 'Advanced'
2. Select 'Battery' as the 'Off Grid power Source'
3. Select the required SoC limit using the sliding range selector
4. Select the Buffer value.
5. Check 'Homeowner can override' – this will let the homeowner to access the settings from Enphase App Homeowner App
6. Press 'Save'

Advanced mode with Generator based control: Shed load when off-grid and restore when generator is connected

Note: Generator Mode available for systems with a standby generator. Generator support being released soon for Enphase Storage system.

IQ System Controller auxiliary contacts will shed the specific load circuits as soon as the system enters the off-grid mode and then reconnects specific load circuits to the microgrid after the generator is connected to the microgrid.

Mode	MID	GID	Load circuit state
on-grid	Closed	Open	Connected
off-grid	Open	Open	Disconnected
off-grid	Open	Closed	Connected

Table 4: Automatically shed load when off-grid and restore when generator is connected

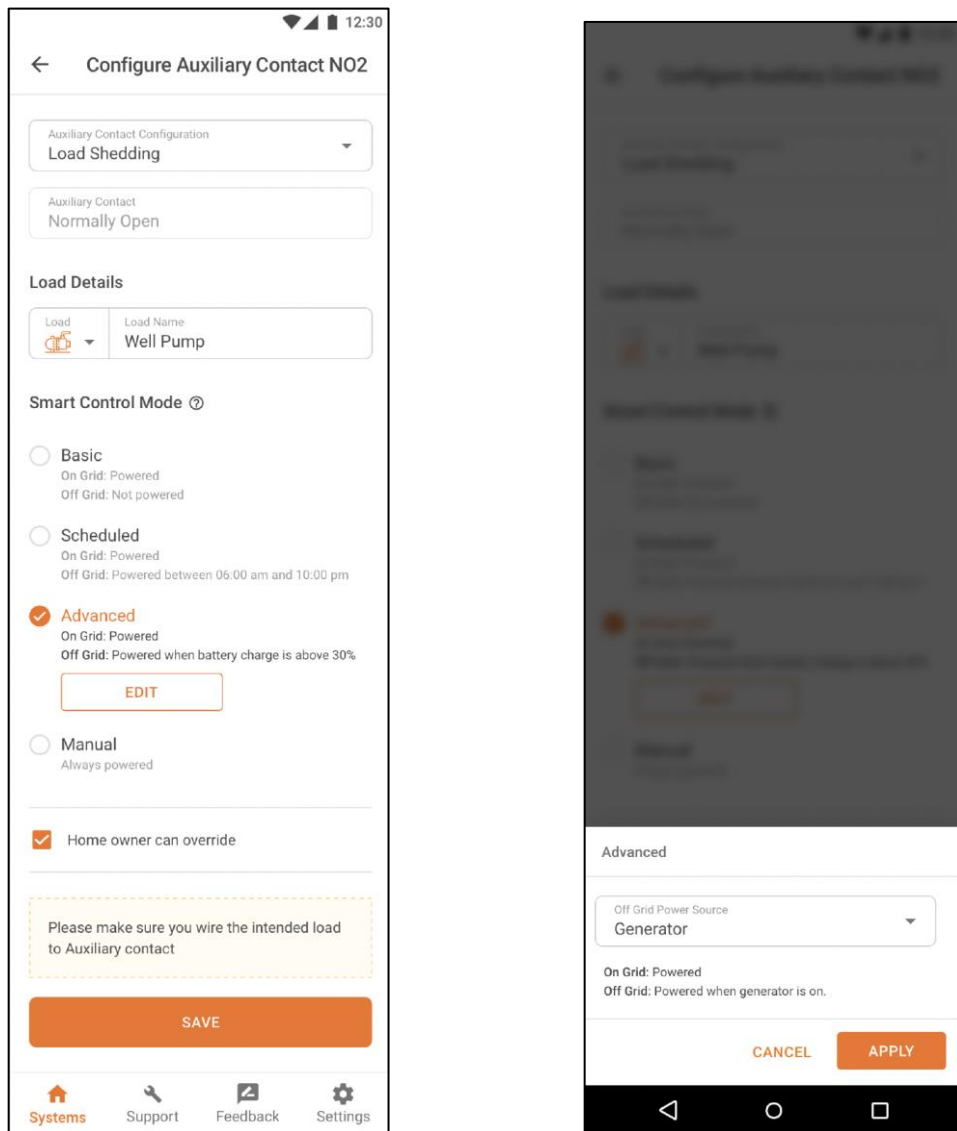


Figure 9: Generator Mode: Shed load when off-grid and restore when generator is connected

1. In 'Advanced' Mode, Select 'Generator' under 'Off Grid Power Source'
2. Check 'Home owner can override' – this will let the home owner to access the settings from Enphase App Home Owner App
3. Press 'Save'

Manual Mode: Keep the load permanently on or off irrespective of grid availability.

In this mode, loads retain their defined state permanently irrespective of the presence of the grid. A load that is selected to be powered on remains on and a load that is selected to be powered off remains off.

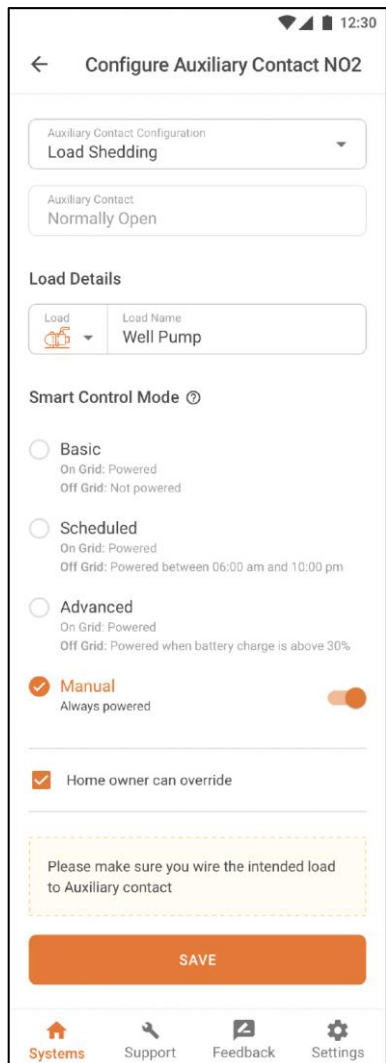


Figure 10: Manual mode

1. Select 'Manual' mode
2. Select whether to keep the load always powered or always switched off.
3. Check 'Homeowner can override' – this will let the homeowner to access the settings from Enphase App Homeowner App
4. Press 'Save'

Automatically shed solar circuit when off-grid

IQ System Controller auxiliary contacts will shed specific PV circuits from the microgrid to ensure that the solar to storage continuous power ratio is maintained at a safe level.

Mode	MID	PV circuit state
on-grid	MID Closed	Connected
off-grid	MID Open	Disconnected

Table 5: Automatically shed PV circuit when off-grid

Automatically shed PV circuit when off-grid

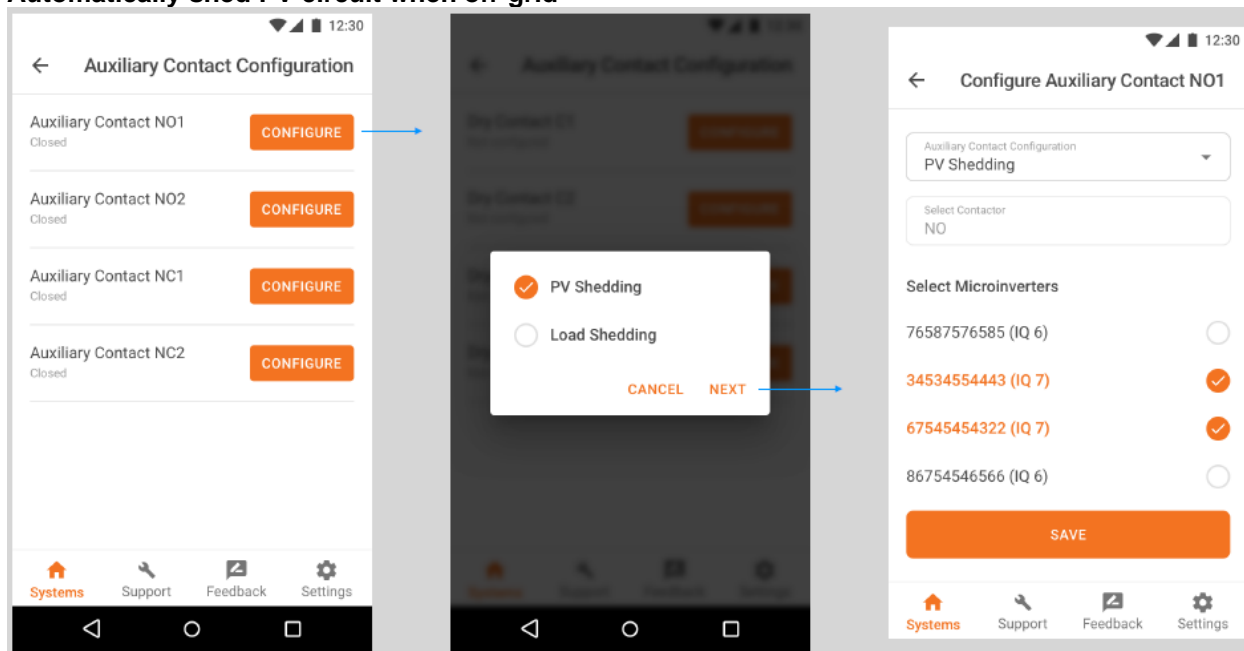


Figure 11: Automatically shed PV circuit when off-grid - Enable PV shedding

1. Click 'Configure' button
2. Check 'PV Shedding' to configure the Auxiliary contact for PV Shedding
3. Select the microinverter serial numbers in the PV branch circuit and click 'Save'

Disable PV shedding

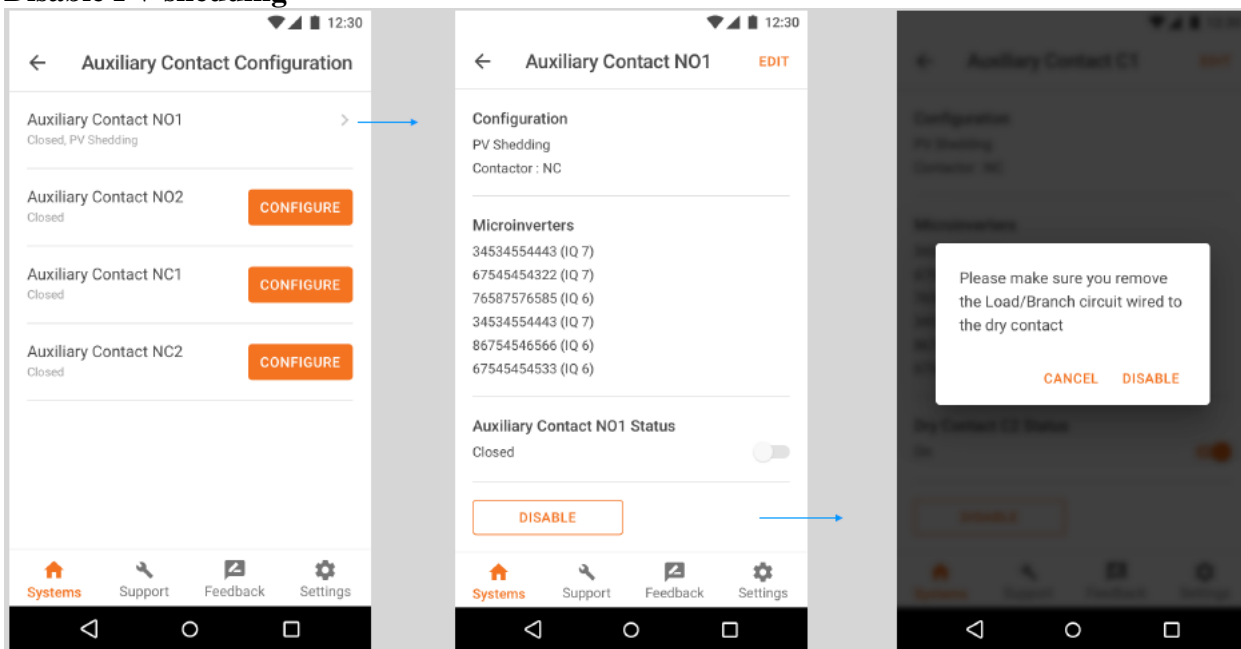


Figure 12: Automatically shed PV circuit when off-grid - Disable PV shedding

1. Select the relevant Auxiliary Contact
2. Click 'Disable' button on the bottom of the screen
3. Confirm 'Disable' option in the pop up

Validation of auxiliary contacts using Enphase Installer App

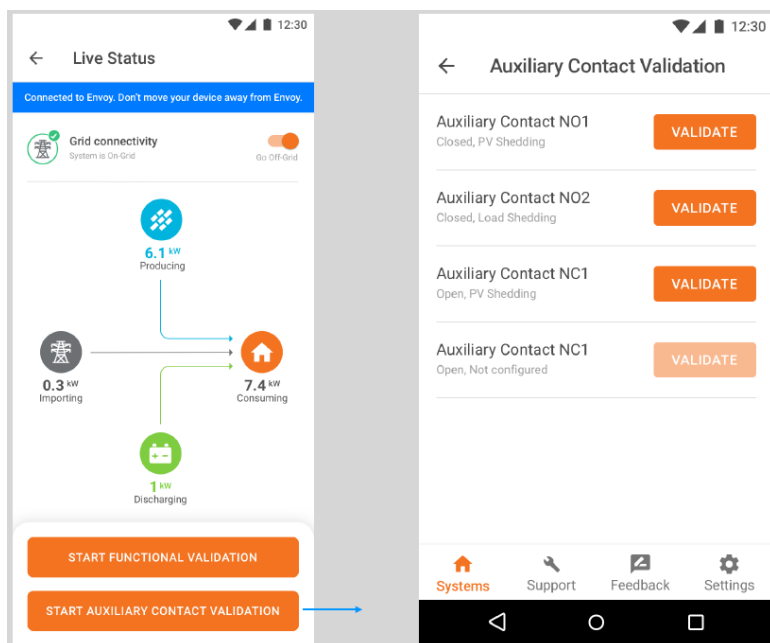


Figure 13: Validation of auxiliary contacts - 1

1. Click “Start Auxiliary Contact Validation”

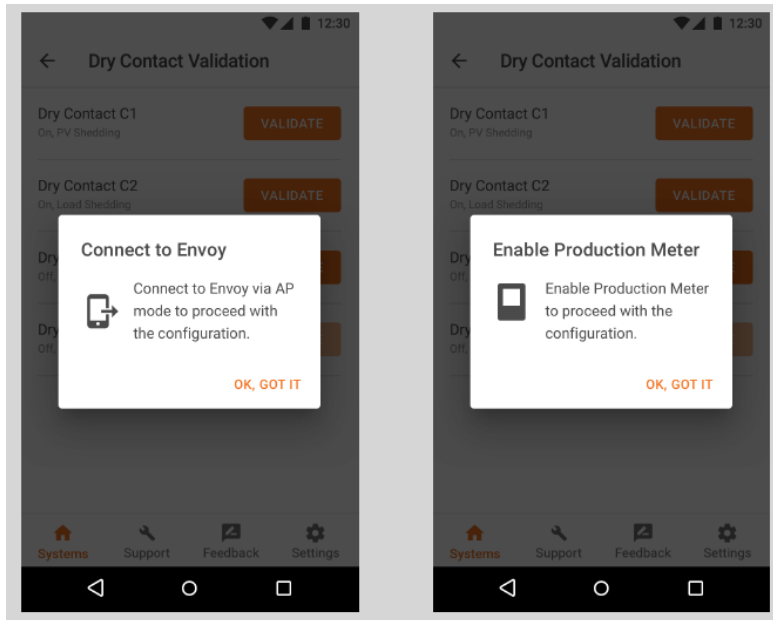


Figure 14: Validation of auxiliary contacts -2

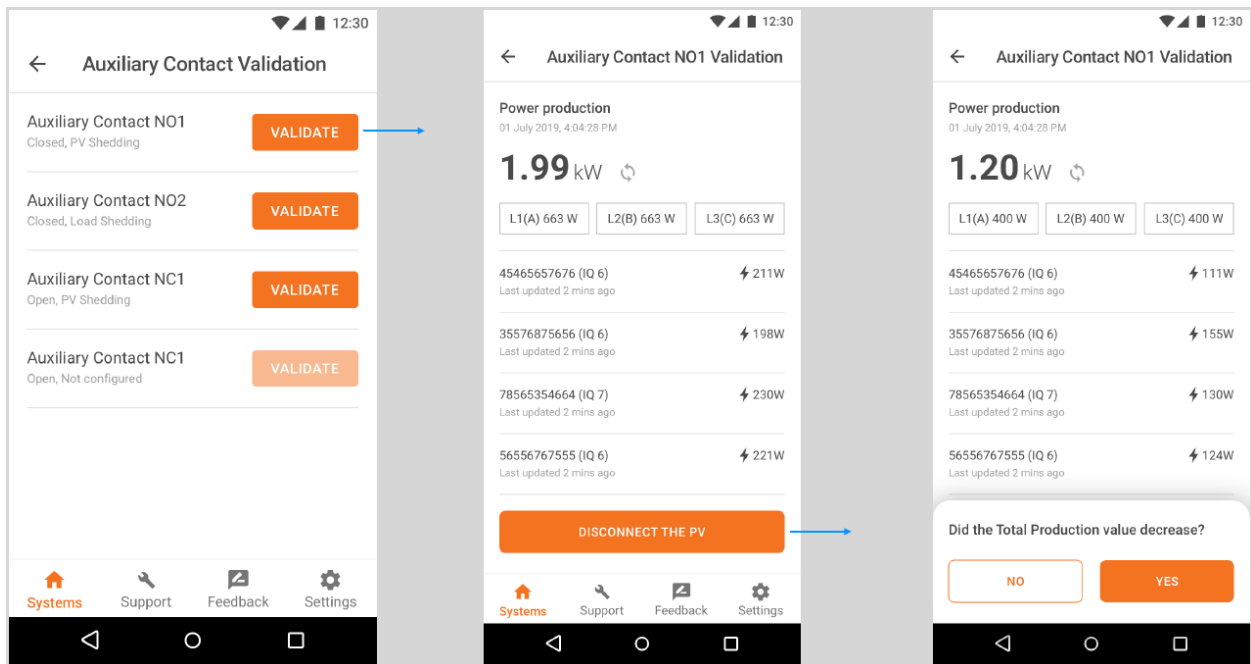


Figure 15: Validation of auxiliary contacts -3

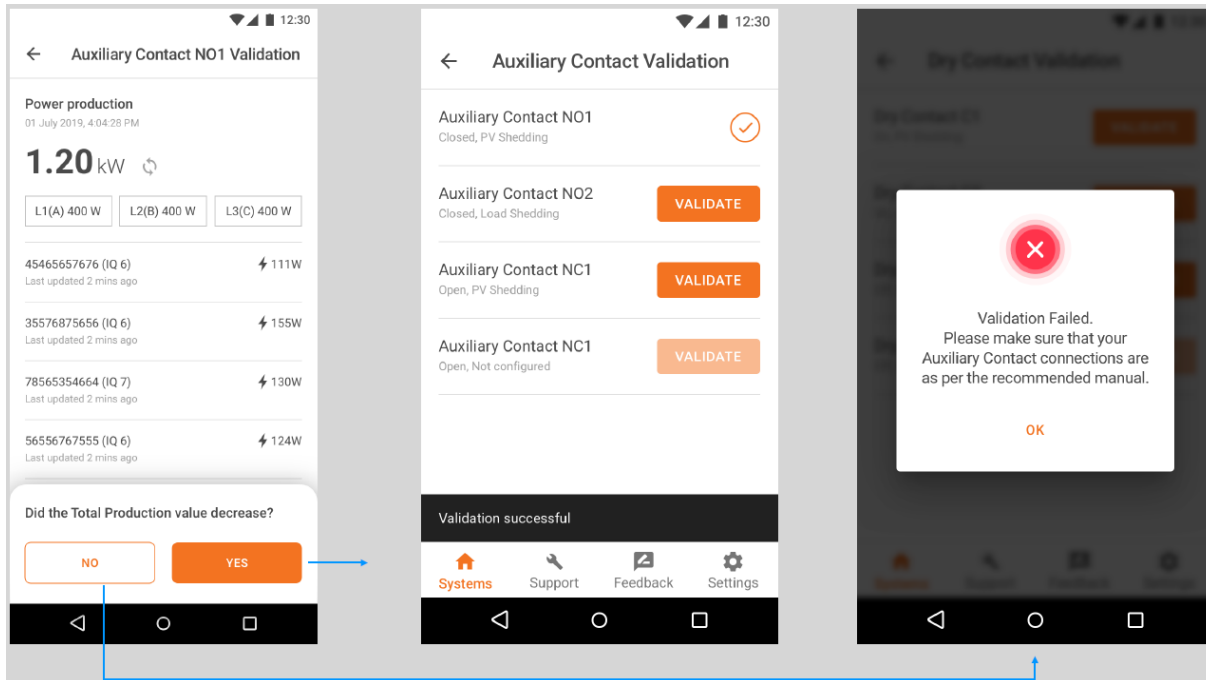


Figure 16: Validation of auxiliary contacts -4

1. Press “Validate”
2. Press “Disconnect the PV”
3. If the production value goes down press “Yes”
4. If production value goes down, validation is successful

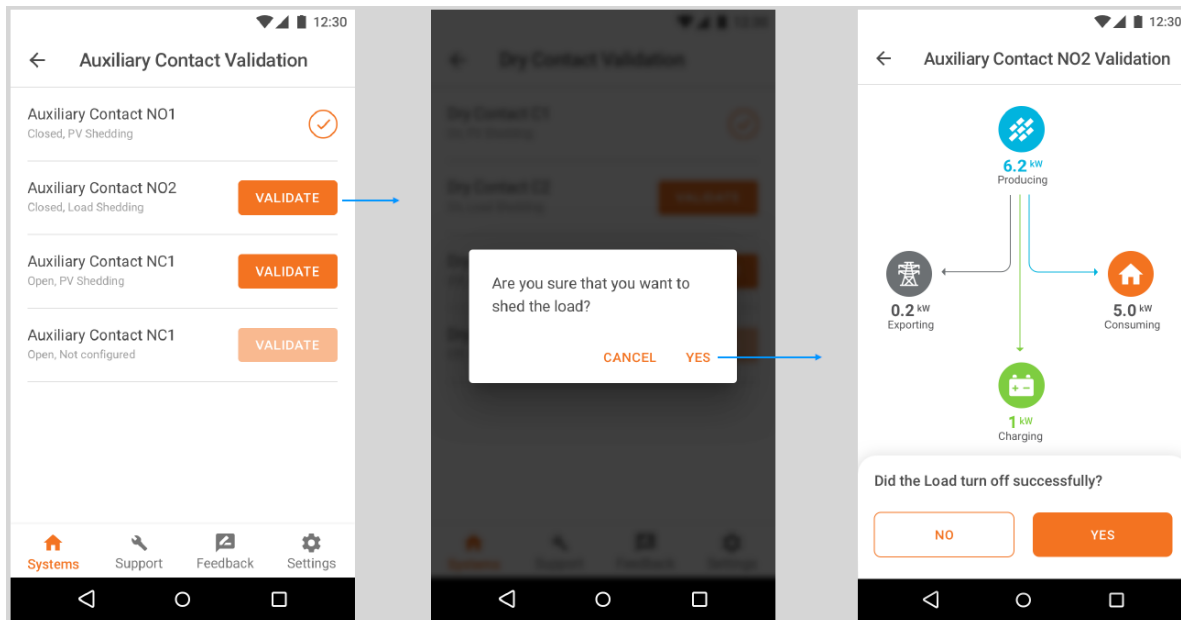


Figure 17: Validation of auxiliary contacts -5

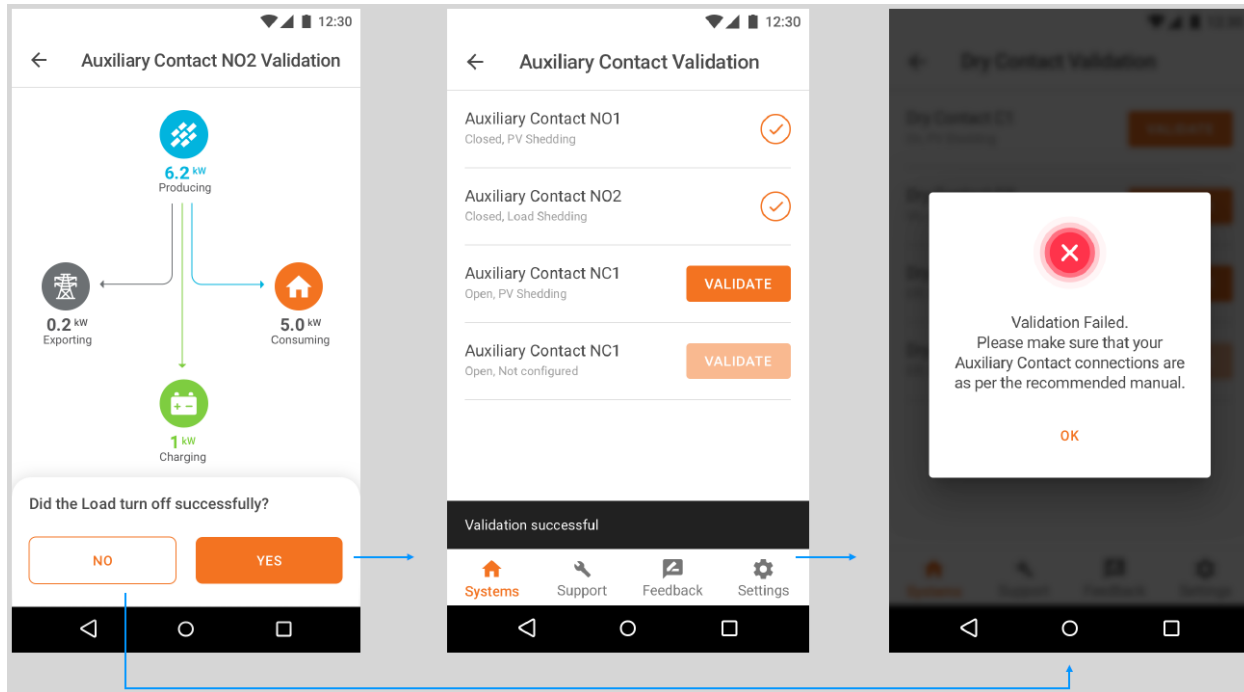


Figure 18: Validation of auxiliary contacts -6

1. Press “Validate”
2. Press “Disconnect load”
3. If the load is powered down validation is successful
4. If the load is not powered down the validation is not successful

Troubleshooting steps

Test	Expected Observation	Implication	Possible cause for deviation from expected observation
1. Open the breaker connected to the power supply input. 2. Use voltmeter to test the terminals of the contactor. 3. Close the load breaker.	The supply side of the contactor should have 240V, load side should have 0V.	Contactor has been correctly configured	Check L1, L2 line connections.
Close the breaker connected to the power supply input	You should see 240Vac on both sides. Armature pin is sucked in.	Load is successfully connected and operating.	Ensure power supply wiring is as described in the IQ Load Controller QIG

Table 6: Troubleshooting

Configuring Load Control via Enphase App

Installer needs to provide access so that Homeowner can configure load control. Homeowner cannot access PV circuit control configuration.

Basic Mode: Shed load when off-grid

In this mode, the load is switched off as soon as the system goes off-grid.

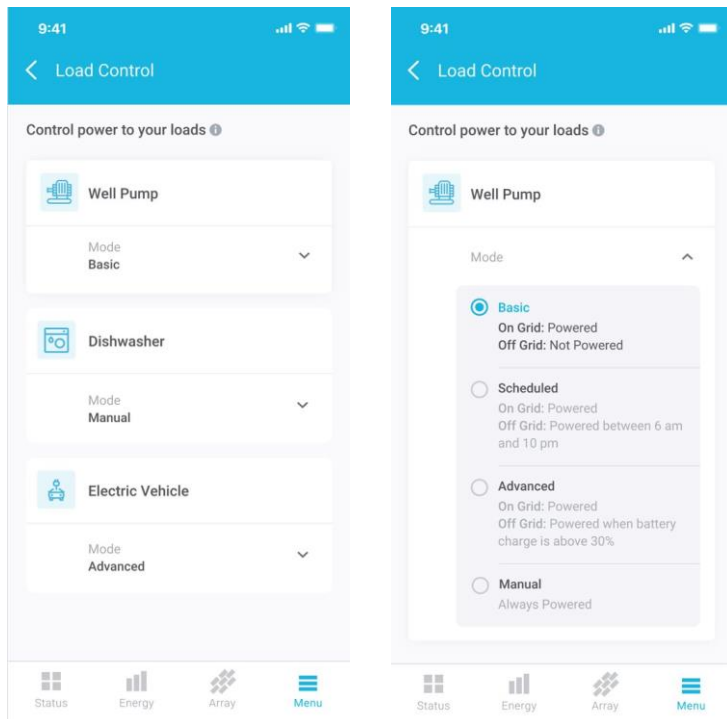


Figure 19: Basic Mode in Enphase App: Shed load when off-grid

1. Select radio button 'Basic Mode'
2. Press 'Apply'

Scheduled Mode: When off-grid, shed loads at a certain time of the day.

In this mode, homeowner is provided the ability to set a certain time interval of the day when the connected loads would be shed, if system is off-grid.

Note: If homeowner site does not have a battery installed, the allow time window to schedule load control is 9am to 4pm. For a site with battery, any time in 24 hours can be scheduled.

Load and Solar Circuit Control using IQ System Controller Auxiliary Contacts

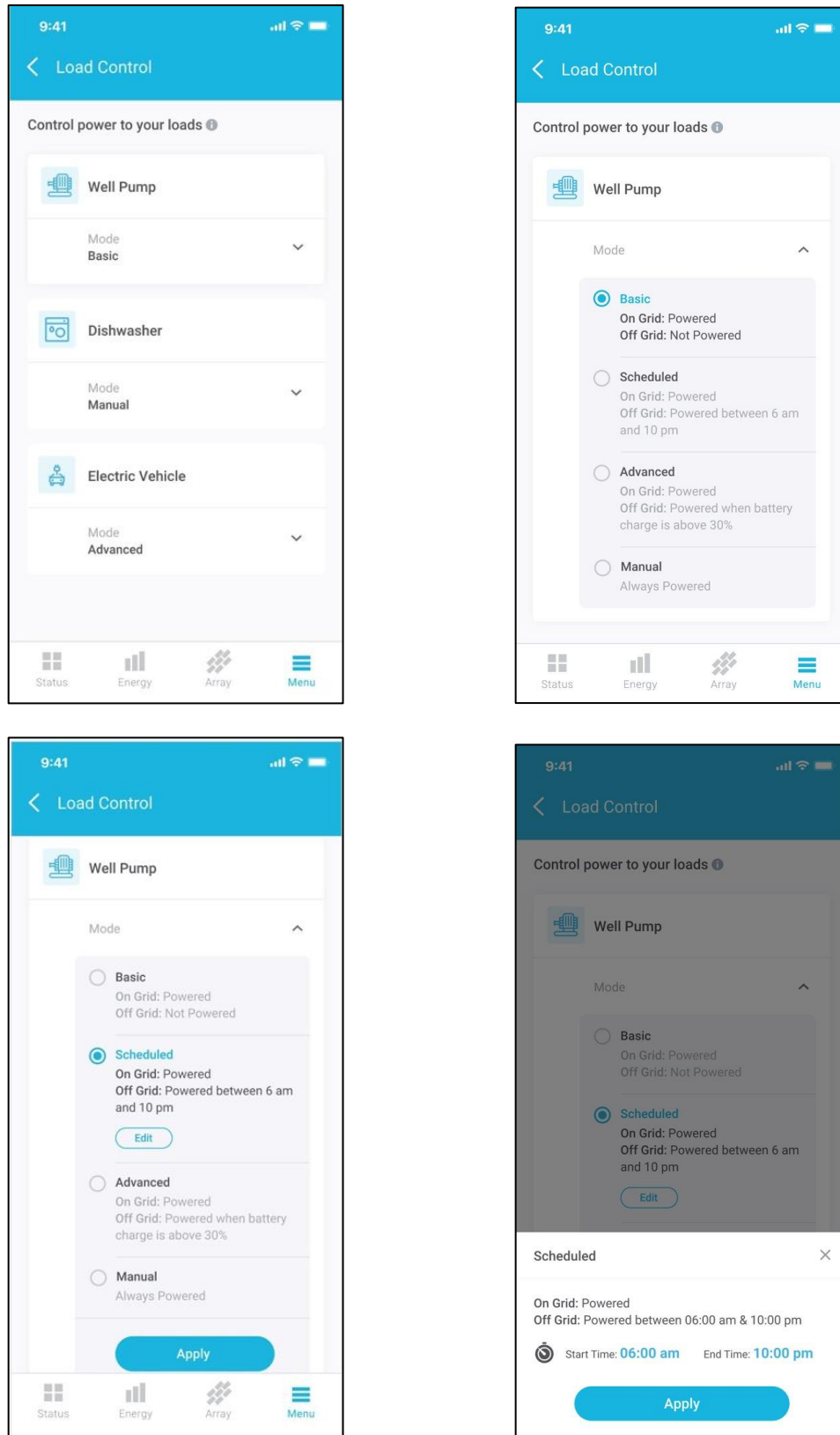


Figure 20: Scheduled Mode in Enphase App: Load control based on ESS State of Charge (SoC)

1. Select radio button 'Scheduled'
2. Select time of the day at which the load is to be shed.
3. Press 'Apply'

Advanced Mode: Shed load based on battery state of charge or generator power availability.

This is an advanced mode allowing greater control over loads to the homeowner. Advanced mode can be used to control loads based on either battery or generator.

Advanced mode with battery-based control

In this mode, homeowner has the provision to control load based on battery state of charge. Homeowners can configure the charge limit below which the load automatically gets shed.

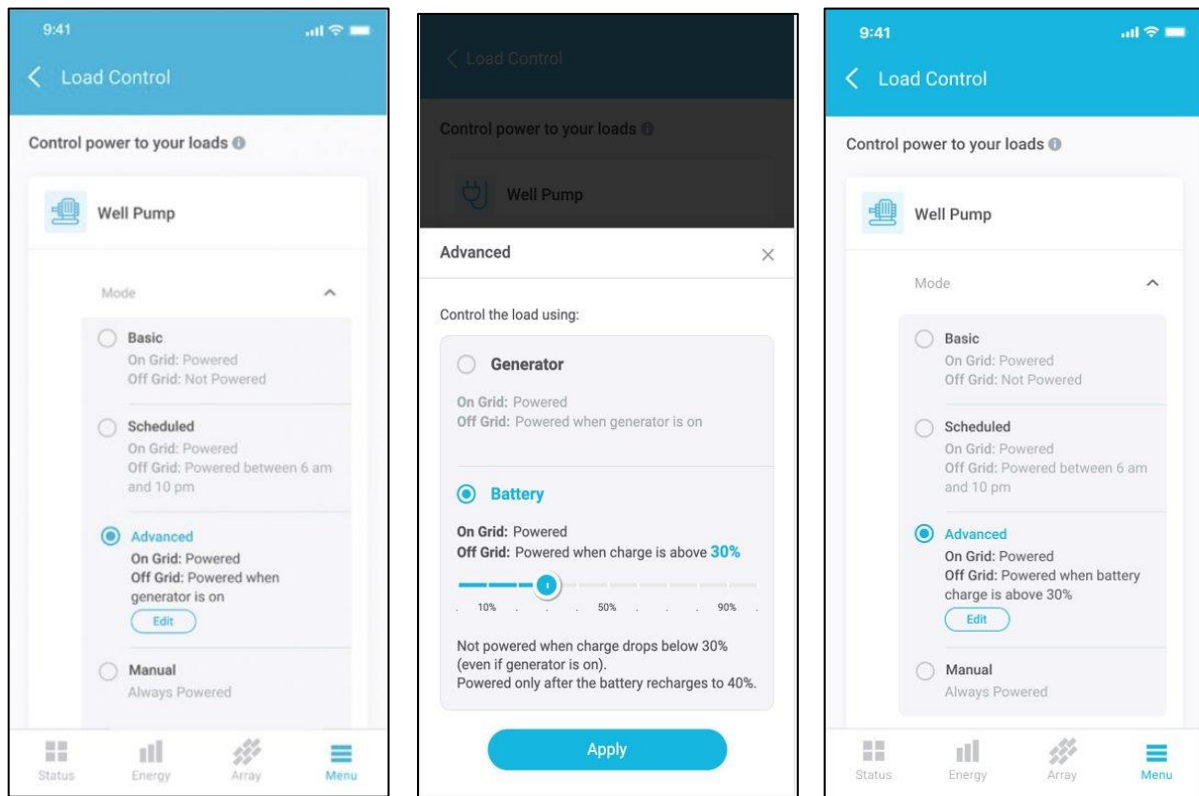


Figure 21: Battery Mode in Enphase App: Load control based on ESS State of Charge (SoC)

1. Select radio button 'Advanced'
2. Select radio button 'Battery'
3. Select the required SoC using the sliding range selector
4. Press 'Apply'

Advanced mode with generator-based control

In this mode, homeowner has the provision to control load based on generator availability. The load remains powered only when generator in the running in the off-grid mode.

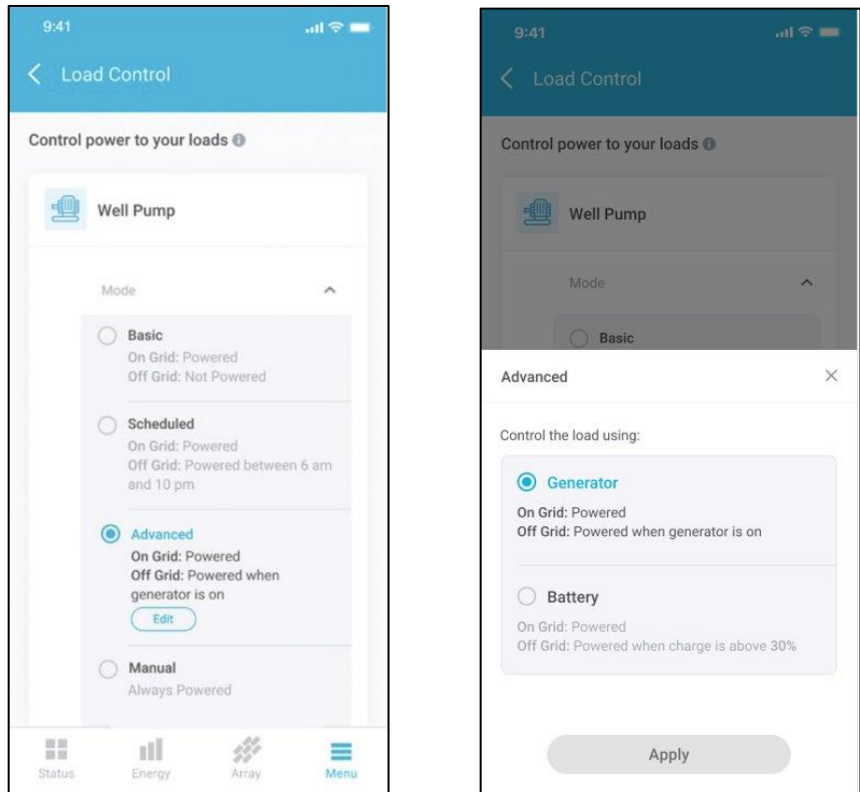


Figure 22: Generator Mode in Enphase App: Shed load when off-grid and restore when generator is connected

1. Select radio button 'Advanced'
2. Select radio button 'Generator'
3. Press 'Apply'

Manual Mode: Keep the load permanently on or off irrespective of grid availability.

In this mode, loads retain their defined state permanently irrespective of the presence of the grid. A load that is selected to be powered on remains on and a load that is selected to be powered off remains off.

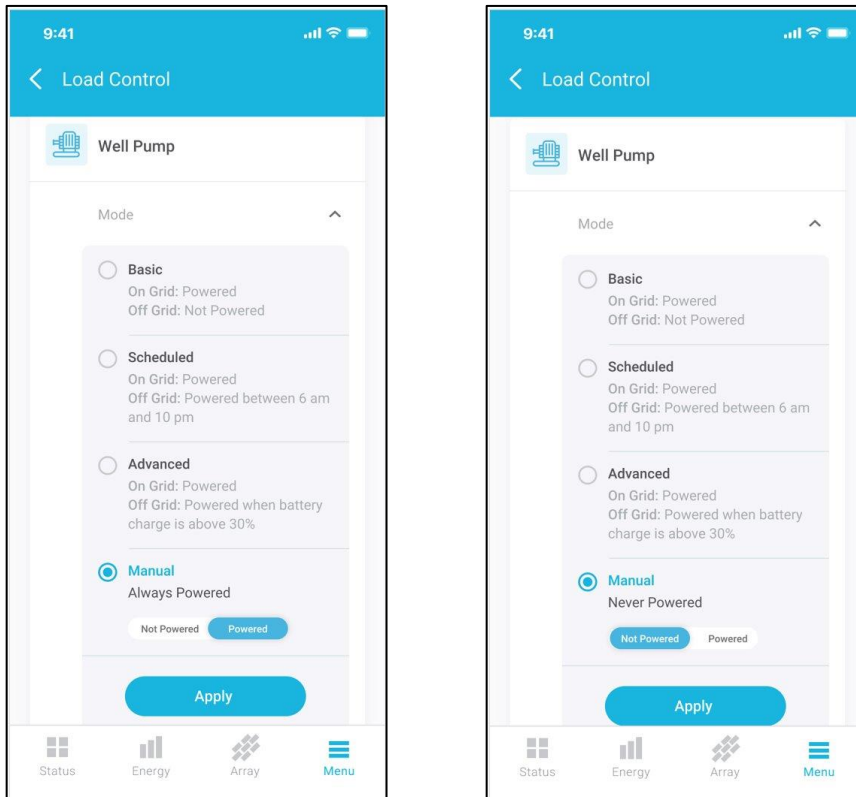


Figure 23: Manual Mode in Enphase App: Shed load when off-grid and restore when generator is connected

1. Select radio button 'Manual'
2. Toggle between the 2 options: 'Not Powered', 'Powered'
3. Press 'Apply'

Installing a custom kit for Load/PV Shedding

As mentioned earlier, The IQ Load Controller(EP-NA-LK02-040) can only be used for controlling dedicated loads of up to 36A connected on a 45A breaker or for controlling 32A branch circuits or PV circuits connected on a 40A breaker. The below section of the document provides details on setting up an installer self-assembled kit for controlling larger loads.

Note: The appendix contains reference BOM's for 20A, 30A and 40A circuits that can be used as an alternative to the IQ Load Controller.

Using an external contactor with a 24 Vac coil

24Vac low voltage is created with a control transformer protected with an OCPD such as an inline fuse. The 24Vac power supply should be connected to a definite purpose contactor via the auxiliary contact.

Load and Solar Circuit Control using IQ System Controller Auxiliary Contacts

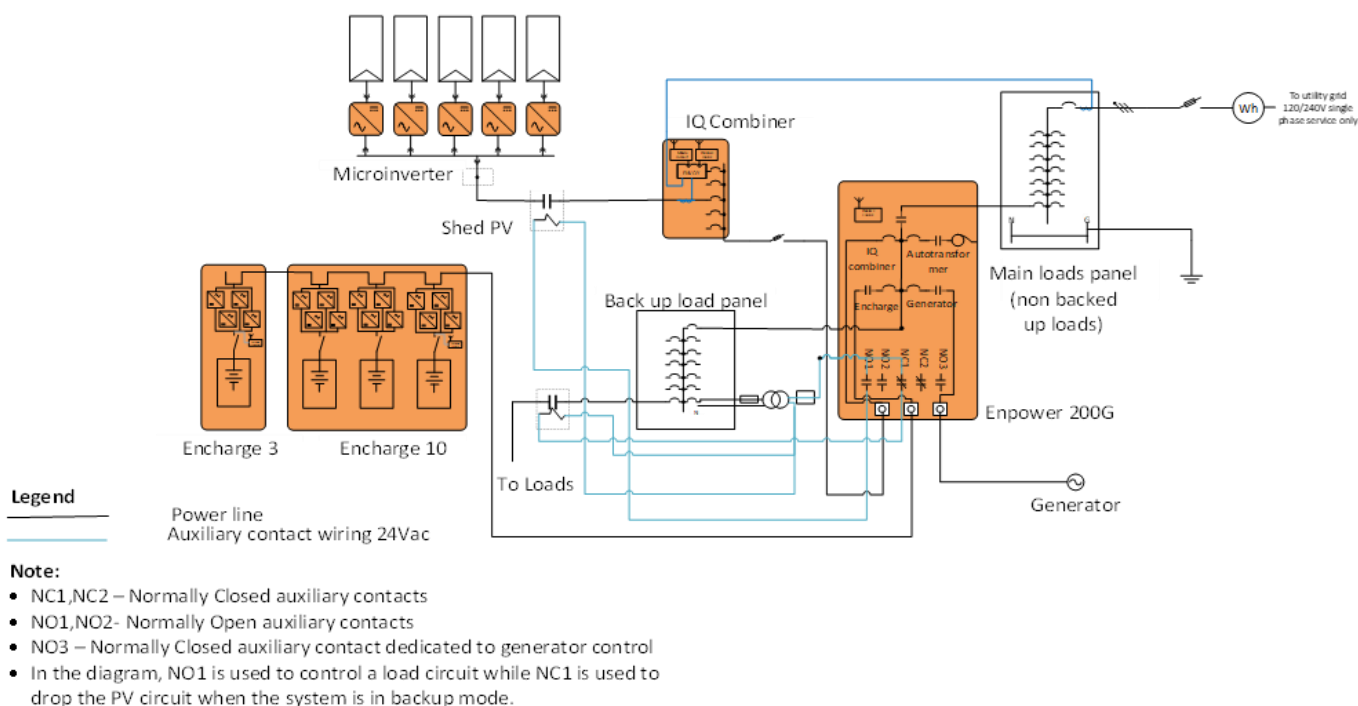


Figure 24: IQ System Controller Auxiliary contact wiring diagram

The line diagram represents both the Normally Opens auxiliary contacts configured for PV shedding and load shedding.

Refer Appendix A for detailed Single line diagram.

Supported Contactors and transformers

Definite purpose Contactors must meet or exceed the following parameters to work with IQ System Controller.

Parameter	Value
Continuous Current	< 1 A
Coil Voltage	24 V
Inrush VA	40 VA or rating of transformer being used
Opening time	≤ 30 ms

Table 7: Definite purpose contactor parameters

Note: Follow all guidelines by contactor manufacturer regarding installation. Ensure that the load connected does not exceed the contactor rating.

Supported contactors

Supplier	Part Number	Full Load Amperage (A)	Poles & NO/NC	Coil Voltage
Eaton	C25BNB220T	20	2 pole, NO	24 Vac
Cutler-Hammer	C25BNF240T	40	2 pole, NO	24 Vac
Protactor	PT-C240A	40	2 pole, NO	24 Vac
Packard	L45-038 C240A	40	2 pole NO	24Vac
Eaton	C25FNF260T	60	2 pole, NO	24 Vac

Square D	8910DP32V14	30	2 pole, NO	24 Vac
Square D	8910DPA63V14	60	3 pole, NO	24 Vac

Table 8: Supported contactors

Supported transformers (for power supply)

Supplier	Part Number	Secondary Voltage	Primary Voltage	VA Rating
Fiada	B07RDBS6NK	24 Vac	120/208/240Vac	40
Endurance Pro	EP4031OF	24 Vac	120/208/240Vac	40

Table 9: Supported Transformers for power supply

Recommended fuses and fuse holders

- 1A, Littelfuse 239 Series, 5×20 mm, Slo-Blo® Fuse in Series 150 fuse holder or equivalent
- Eaton BP-AGC-1-RP 250 V glass fuse in BP/HMK-RP fuse holder
- 3AG/AGC Screw Terminal Fuse holder

Reference bill of materials (BOM) for 60A load control

Reference BOM that can be used to design load shedding circuit of 60 A total load.

Item	Description	Quantity
Control transformer	Fiada B07RDBS6NK	1
Fuse Retainer	Littelfuse Universal Fuse Retainer Part No: 150145	1
Fuse	NTC 74-6SG1A-C 1 A 250V glass fuse	1
Contactator	Square D 8910DPA63V14 ¹ 60 A	1
Box	6X6 PVC box rated for outdoor use (NEMA 3R or better) (Carlon junction box, for example)	1
Quick Disconnects/Fast on Terminals/Receptacle lug (required for contactors without screw on terminals)	PIDG, Quick Disconnects, Receptacle, 22 – 18AWG Wire Size TE Internal #: 640911-1	2

Table 10: Reference BOM for a 60 A load control

¹ A 3-pole contactor is specified since the 2-pole 60A contactor from Square D i.e., 8910DPA62V14 has been discontinued.

Example Wiring: Heavy 240V Load Shedding for 1X Circuit

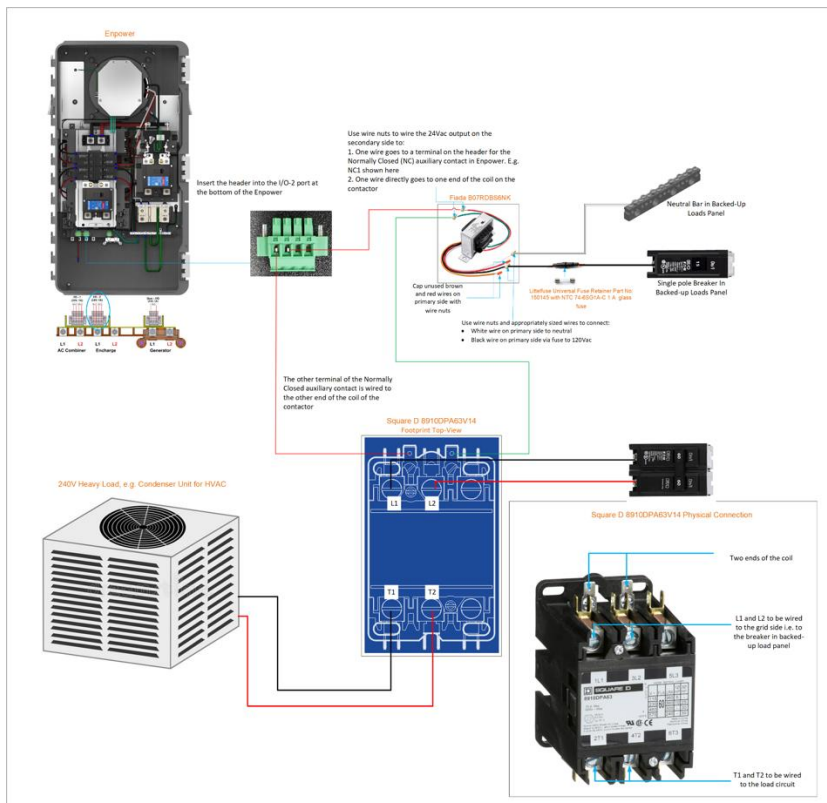


Figure 25: Example Wiring: Heavy 240V Load Shedding for 1X Circuit

Using an external contactor with a 120Vac coil

24 Vac coil based definite purpose contactors for large loads typically have holding currents that exceed IQ System Controller auxiliary contact rating of 1 A. In such cases an external contactor with a 120 Vac coil can be used with the bill of materials and wiring specified in this section. A 12 V DC power source is used to drive an interposing power relay and the auxiliary contacts in IQ System Controller controls the current to the coil of the power relay. The output of the power relay is used to control the 120 Vac coil of the external contactor.

Load and Solar Circuit Control using IQ System Controller Auxiliary Contacts

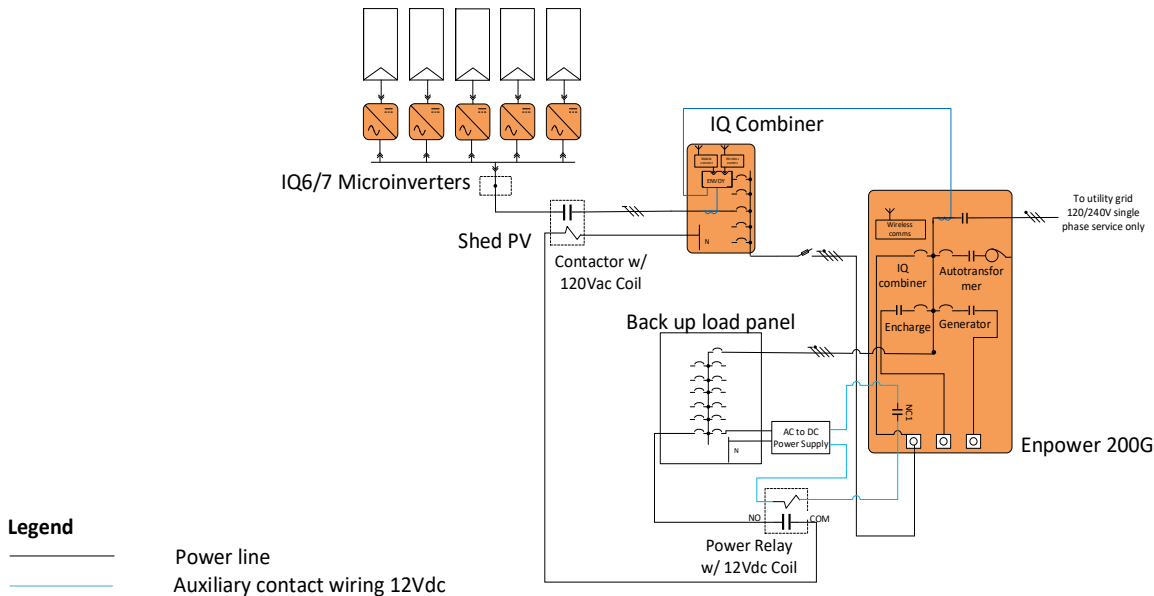


Figure 26: PV shedding using external contactor with 120 Vac coil

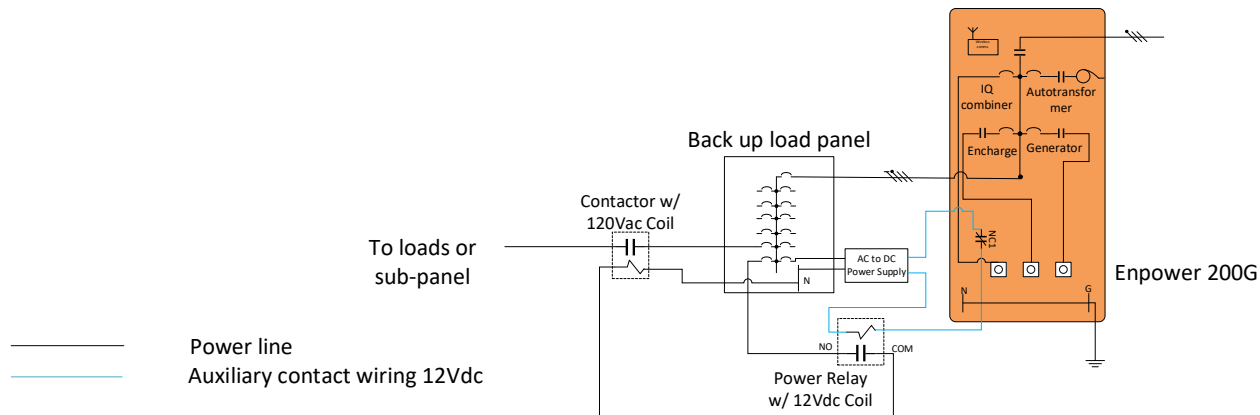


Figure 27: Load shedding using external contactor with 120 Vac coil

Reference BOM for 120 A load or PV shedding circuit

Item	Description	Quantity
DC power supply	12V 1A APV-12-12 Meanwell AC-DC Switching Power Supply	1
Power Relay	Schneider Electric Relays W9AS5D52-12	1
Contactors	120A Contactor C25HNE3120A Eaton / Cutler Hammer • 3 Pole • 110/120V Coil	1
Box	QILIPSU Hinged Cover Stainless Steel Latch Junction Box with Mounting Plate, ABS Plastic DIY Electrical Project Case IP67 Waterproof Dustproof Enclosure Grey (14.6"x10.6"x5.9")	1
Quick Disconnects/Fast on Terminals/Receptacle lug (required for contactors without screw on terminals)	PIDG, Quick Disconnects, Receptacle, 22 – 18AWG Wire Size TE Internal #: 640911-1	2

Table 11: Reference BOM for 120 A load or PV shedding circuit

Example wiring: Load shedding using definite purpose contactor with 120 Vac coil

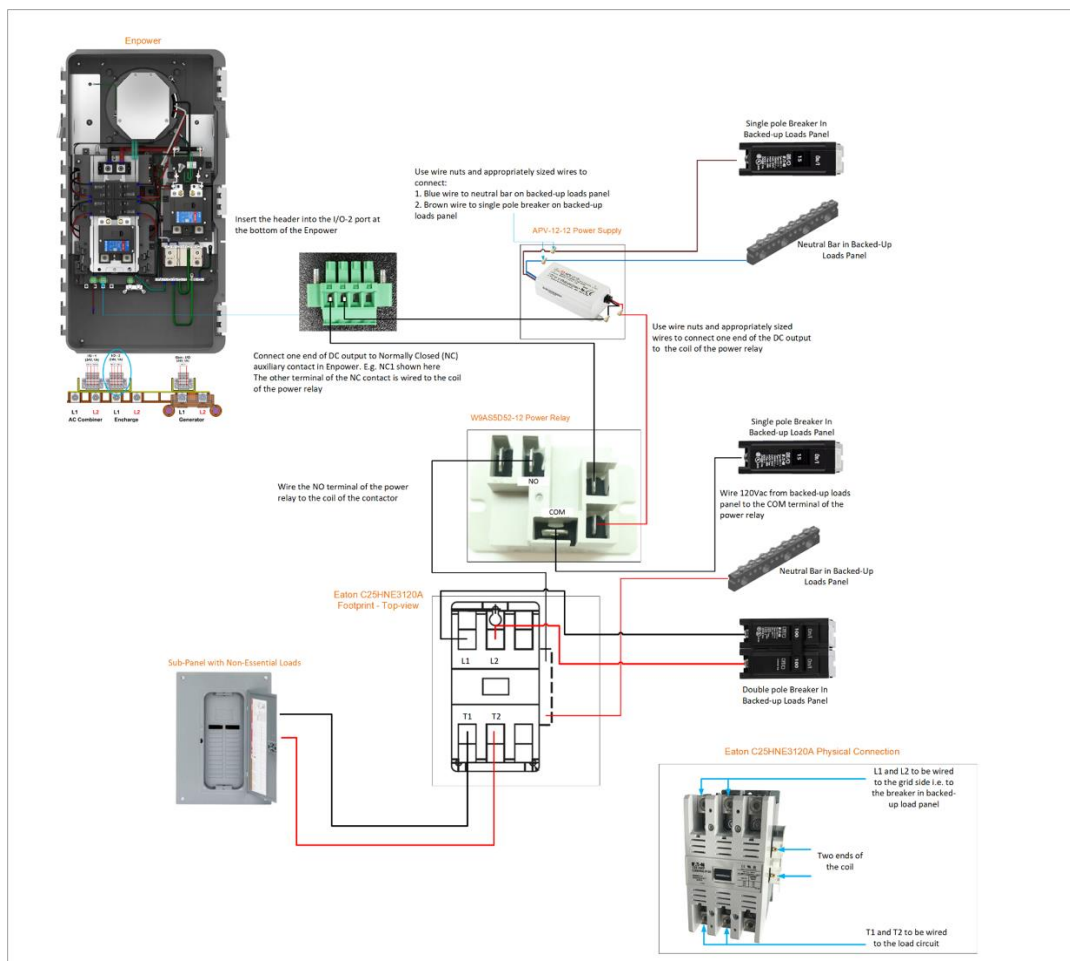


Figure 28: Example wiring: Load shedding using definite purpose contactor with 120 Vac coil

Example wiring: PV shedding using definite purpose contactor with 120 Vac coil

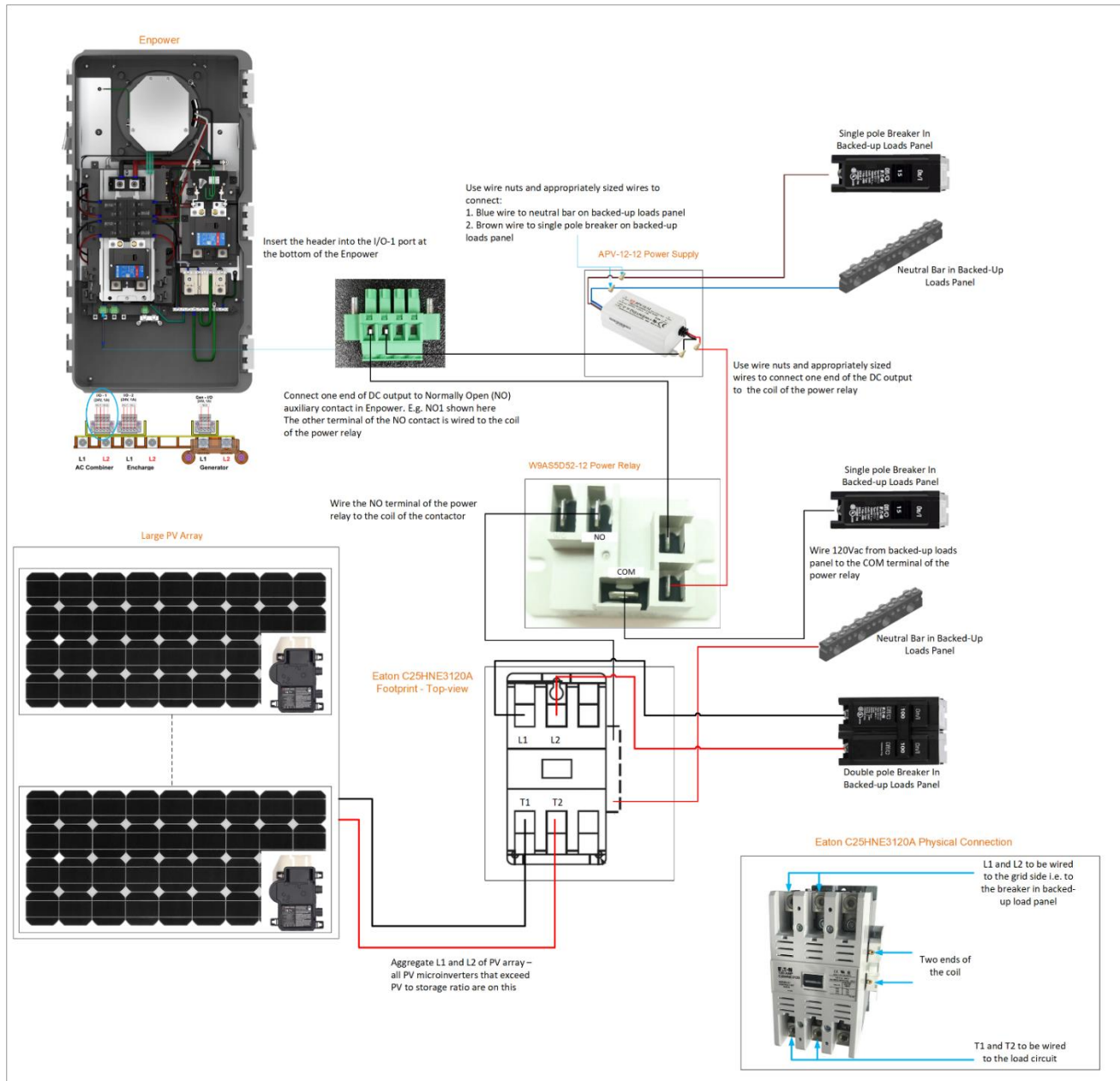


Figure 29 Example wiring: PV shedding using definite purpose contactor with 120 Vac coil

Please refer to [Appendix C](#) for more wiring configurations.

Validation and Troubleshooting Guidelines for setting up a custom Load Control kit

Install Validation

1. Ensure control transformer is wired correctly.
 - a. Confirm that there is 120 Vac to primary with appropriate fusing.
 - b. Confirm that there are no shorts on the secondary
 - c. Confirm that there are 24 Vac on the secondary.
 - d. **Important: never wire 120 Vac to the auxiliary contactors on IQ System Controller. The auxiliary contactor inputs on IQ System Controller must be 24 Vac or 12V DC.**
2. Prevent overloading of control transformer:
 - a) Secondary current must be less than 1 A and must be capable of delivering contactor inrush.
 - b) Overloading the control transformer will cause the control transformer to fail or the fuse on the primary side to blow. Always match the control transformer output to the inrush and steady state power drawn by the external contactor.
 - c) If you are not certain about the inrush and steady state power requirements of the external contactor, we recommend using one control transformer per external contactor.
 - d) If two or more external contactor control circuits are powered using a single control transformer, use a fuse on the secondary side of the control transformer as well the primary.
3. Ensure contactor coils are wired correctly:
 - a. Check the contactor specification and ensure that the wire the output of the control transformer output is wired to the appropriate contactor coil terminal.
 - b. The external contactor must close when energized. An on-grid contactor should have 24ac across its coils.
 - c. The Voltage across output terminals of the contactor must be the same as the input terminals.

Troubleshooting

Step	Symptom	Possible cause	Solution
1	Transformer is not powered. Diagnosed by measuring AC voltage on the secondary.	Tripped breaker or blown fuse. This can occur due to short on secondary such as the control wires landed on a single terminal of the contactor coil. This can also result in transformer is damage. When overloaded it is possible that transformer primary is damaged.	Ensure correct over current protection is installed on the primary and optionally secondary and replace transformer. Confirm there are no shorts and there is a circuit through all components.
2	Contactors are not powered. Diagnosed by measuring AC voltage on contactor coil and NO1/NO2 Auxiliary contact	NO1/ NO2 Auxiliary contact is not configured. As result there will be voltage drop across NO1/NO2	Ensure Auxiliary contacts are configured and provisioned in Enphase Installer App
3	Contactors are not powered. Diagnosed by measuring AC voltage on contactor coil.	Contactors aren't energized. Faulty wiring between auxiliary contact in IQ System Controller and definite purpose contactor.	Confirm 24V AC across aux contacts when terminal block is unplugged. Refer Figure 1 Auxiliary contact labelling and usage for identifying the auxiliary contact terminals in IQ System Controller.

Step	Symptom	Possible cause	Solution
			If you suspect miswiring or if the auxiliary contact is not working, check the continuity across the auxiliary contact terminals. When the system is on-grid, both NC and NO auxiliary contacts will be in closed position.
4	Contactors are under powered. Diagnosed by measuring AC voltage on contactor coil.	Contactors produce loud buzzing and there is no voltage on load side (not closed.) A quiet 60 Hz hum is expected, a loud buzzing indicates that the contactor may not be closing due to insufficient transformer size or excessive voltage drop	Confirm definite purpose contactor coil voltage is 24V. Increase wire size if a single contactor. Change to a single contactor per control transformer.
5	Contactors do not open when expected.	NC 1/ NC 2 Aux contact is not configured. Unplug the terminal block to ensure that the contactor opens.	Ensure Auxiliary contacts are configured and provisioned in Enphase Installer App

Table 12: Troubleshooting

Appendix A: Single Line Diagram

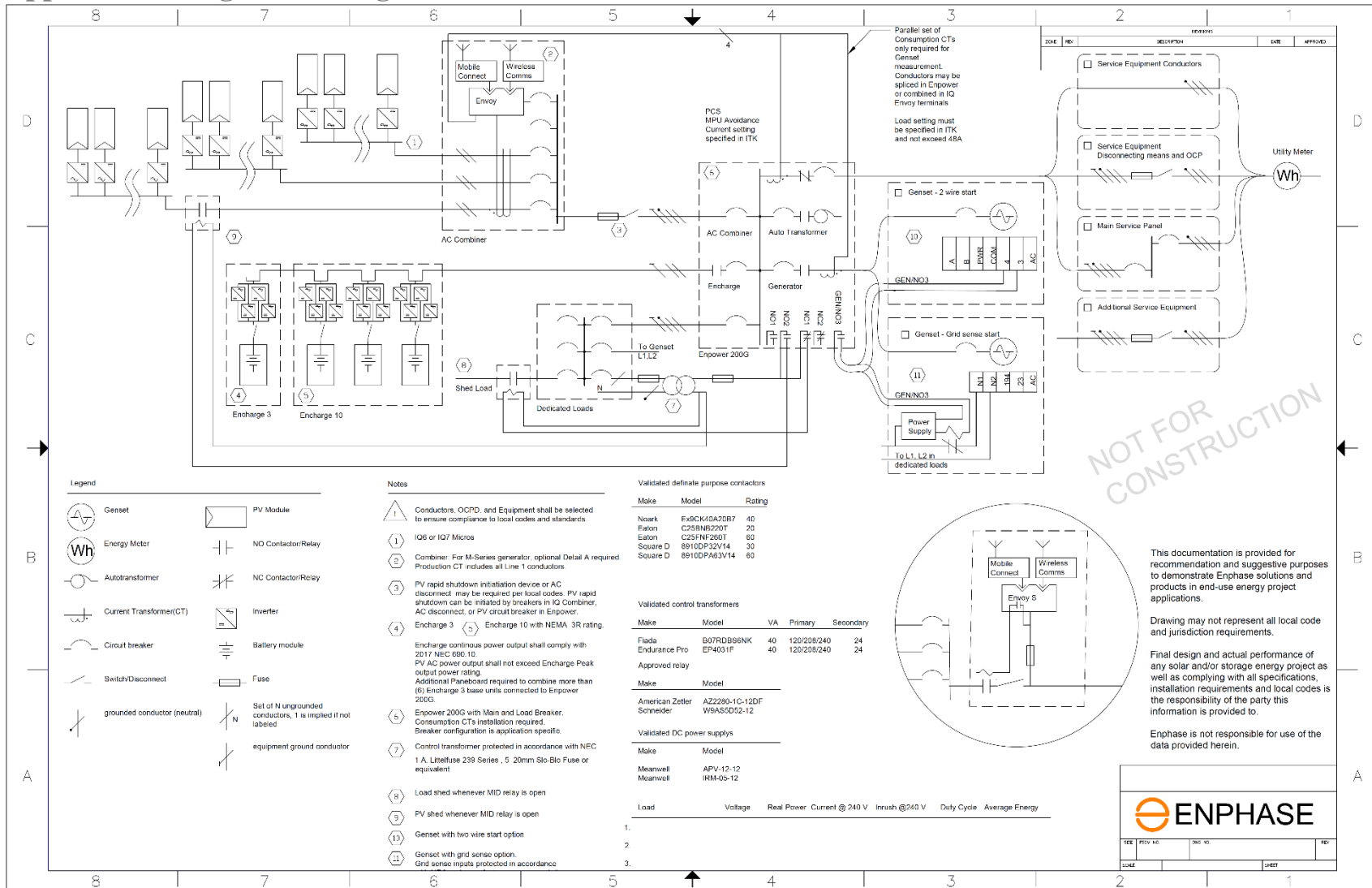


Figure 30 Detailed Single Line Diagram

Appendix B: Controlling air conditioning unit using a thermostat.

Auxiliary contact can be wired to intercept the control wire of a thermostat to an air conditioner

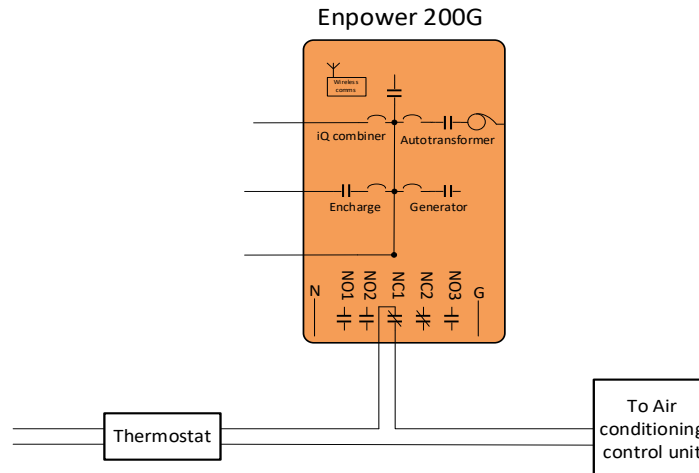


Figure 31: Using auxiliary contact for controlling air conditioning unit

Normally the air conditioning units are controlled by the thermostat. The air conditioner starts when it receives a signal from a thermostat. The signal from the thermostat usually goes into an air handler unit (typically indoors). The air handler unit in turn signals the condenser unit which is outdoors.

An auxiliary contact can be used to intercept the “cool” wire from the thermostat to the air handler. The “cool” wire may also be called a “cool call” wire. Once this is done the IQ System Controller auxiliary contacts need to be configured to shed loads automatically in off-grid as outlined in sections above. When this is done:

- When the system is on-grid the auxiliary contact stays closed. This ensures that the thermostat’s signal goes to the air handler thereby ensuring the air handler and condenser operate as normal.
- When the system goes off-grid, the auxiliary contact opens, interrupting the control signal from thermostat to the air handling unit. Depending on the state of the condenser during the grid transition the following can happen:
 - If the condenser was running during grid transition, it will run for a cool down period, typically a few minutes. The IQ Batteries must be sized appropriately to support the steady state current requirement of the condenser, to ensure there is no microgrid collapse during the cooldown period.
 - If the condenser was not running during the grid transition, it will not start again during the off-grid mode.
- If the condenser is signaled to start at the same instant as the grid transition happens, the condenser may try to start. The surge current may collapse the microgrid unless the system has been designed to support the surge current. This is a very rare scenario, and the system recovers within a few seconds to form the microgrid again. Since the thermostat has been disconnected during the initial microgrid transition, the condenser will not start again in off-grid mode.

Note: IQ Battery must be sized appropriately to handle the power requirements of the external compressor.

Note: Use Normally Closed Auxiliary contact to wire the thermostat as the contact opens when the grid power goes off by default.

Appendix C: Recommended maximum distance between IQ System Controller and IQ Load Controller.

The System Controller sends a 24VDC signal from the aux contact to the load controller. The DC power source inside the load controller takes power from the back up panel (120V AC). There will be a voltage drop across both these cables in account of the inherent resistance of the cables. It is essential to ensure that the cable length selected is such that the voltage drop across both the lines (IQ System Controller-IQ Load controller and Back up Panel to IQ Load Controller) is within the limit of the contactor and the power source.

The technical data for the products used in the load controller are as below:

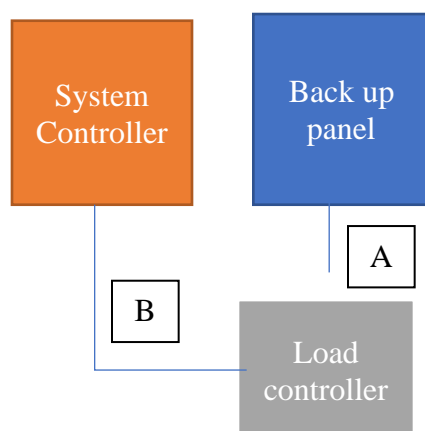
Devices on Backup panel-IQ Load Controller line

S.No	Parameter	Value
1	Voltage	120VAC
2	Max Current (in rush of power source)	25A
3	Min possible voltage for load center to operate	85VAC
4	Max permissible voltage drop	35VAC (120-85)
3	Wire Gauge used	18AWG
4	Resistance of wire gauge (average)	21 Ohm/1000 m

Devices on IQ System Controller-IQ Load Controller line

S.No	Parameter	Value
1	Voltage	24VDC
2	Max Current (in rush of contactor)	2 A
3	Min possible voltage for load center to operate	20.4 VDC
4	Max permissible voltage drop	3.6 VDC (24-20.4)
3	Wire Gauge used	18AWG
4	Resistance of wire gauge (average)	21 Ohm/1000 m

Based on the above values the recommended distance between the devices will be as follows



Max possible values for A and B are as follows

Sr.No	Component	Max. Distance (in ft)
1	A	100
2	B	135

This calculation is assuming that the wire resistance as mentioned in the tables above. With increased wire resistance the distance will reduce further. To compute for a different wire resistance please use the below formulae

$$\text{New Distance} = (\text{Old distance (A or B)} * \text{New resistance}) \div 21$$

What happens when the distance exceeds the recommendation?

- Contactors and power source don't get adequate voltage to startup. This leads to 'Chattering' of the contactor, which is a high frequency ON/OFF of contactors. This leads to damage to the contactor if this state prolongs for a long time.
- The system experiences the inrush current for a longer period of time, which can lead to potential damage to the IQ System Controller and to the cables if this state is allowed to persist for long.

Due to the above-mentioned reasons, it is highly recommended to mount the Load controller is installed within the distances recommended from the System Controller and Back up Panel.

Appendix D: Additional reference BOM configurations

1. 40A Load Shedding

Item	Description	Units Required	Purchase Link
Enclosure	Gratuity 15.7" *11.8" junction box	1	Link
Power Supply	Fiada (B07RDBS6NK) control transformer	1	Link
Definite Purpose Contactor	Packard(C240A) 24Vac 40A coil	1	Link
Fuse Holder	Parts Express(3AGAGC) Screw Terminal Fuse holder	1	Link
Fuse	Bussman (BP/AGC-1-RP) 1A 250V glass fuse	1	Link
Wiring	Gardner Bender(AMW-318) #18 Single Strand Wire	As required	Link

Table 13: 40A Load shedding BOM

Load and Solar Circuit Control using IQ System Controller Auxiliary Contacts



2. Reference BOM for 2 x 40A load/PV control

Component	Description	Part Number	Manufacturer	Quantity
Box	WH-22 Hinged Nema Outdoor Enclosure(13.74 x 9.82 x 5.88 in)	WH-22	Polycase	1
Box internal mounting plate	WH-22K Panel for WH-22 Enclosures(12.51 x 8.58 x 0.06 in)	WH-22K-01	Polycase	1
Contactors	2-pole NO 40A contactor (24Vac coil)	C25BNB240T	Eaton	2
Control Transformer	Edwards Signaling 599 120V/24V 40W Transformer	599	Edwards	1
Fuse	312/318 Series Lead-Free 3AG, Fast-Acting Fuse	BP-AGC-1-RP	Littelfuse	3
Fuse Holder	Littelfuse Fuse holder	03540801ZXGY	Littelfuse	3
Quick Disconnects	AIRIC Female Spade Connector 22-16 Gauge	B06XCWFTJ9	AIRIC	4
Fork connector	Terminal Spade 8-10 Stud 12-10 AWG Yellow	10-116	Gardner Bender	2
Fork connector	#22-#18 AWG (0.8 mm ²) Vinyl-Insulated Spade Terminals (4 to 6 Stud)	20-111	Gardner Bender	2

Load and Solar Circuit Control using IQ System Controller Auxiliary Contacts

Wing nut	Winggard Twist-On Wire Connector	13-086	Gardner Bender	3
Splicing connector	Wago Nut	221-413	Wago	3
Screws	Screws to hold components in place (Grabber #8 x 9/16 in. 14mm Waferhead Screw)	31ZV	Grabber	10
Feed Through Header	Pluggable Terminal Blocks 4 Pos 3.81mm pitch Plug 28-16 AWG Screw	1828362	Phoenix	2

Table 14: 40A load shedding BOM 2

3. Reference BOM for 2X circuits, up to 30A each
Reference BOM that can be used to design two solar or load shedding circuit of up to 30 A each.

Item	Description	Quantity
Control transformer	Fiada B07RDBS6NK	1
Fuse Retainer	2x Eaton BP/HMK-RP fuse holder	2
Fuse	2x Eaton BP-AGC-1-RP 250 V glass fuse	2
Contactator	2 X Square D 8910DP32V14 30A	2
Box	Gratary Junction Box, Hinged Cover Stainless Steel Clip, IP67 Waterproof Plastic Enclosure for Electrical Project Includes Mounting Plate and Wall Bracket (11.4"x7.5"x5.5")	1
Quick Disconnects/Fast on Terminals/Receptacle lug (required for contactors without screw-on terminals)	PIDG, Quick Disconnects, Receptacle, 22 – 18AWG Wire Size TE Internal #: 640911-1	As required

Table 15: Reference BOM for 2X circuits, up to 30A each

Example Wiring 2x Solar Circuits using 30A contactors for Excess Solar Shedding

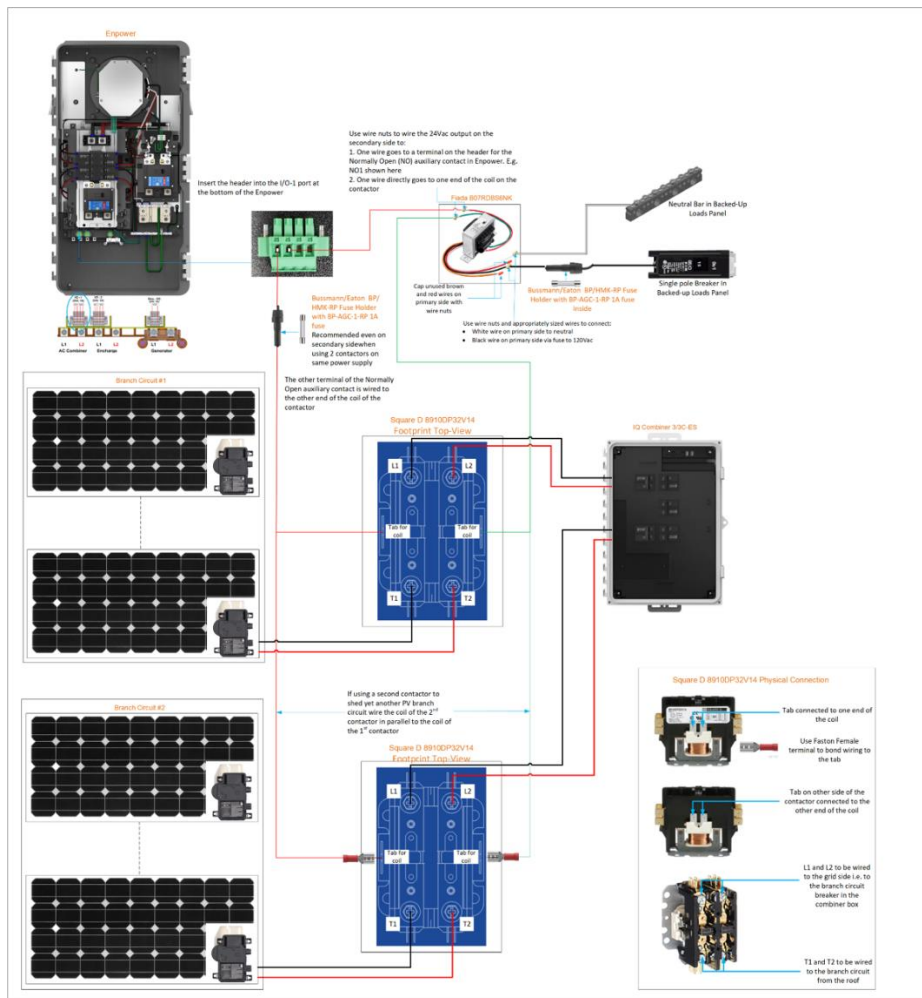


Figure 32: Example Wiring 2x Solar Circuits using 30A contactors for Excess Solar Shedding

4. Reference BOM for 20 A load or PV shedding circuit using a 20A contactor

Item	Description	Quantity
Control transformer	EP40310F 24V 40VA	1
Fuse Retainer	Bussmann BP/HMK-RP fuse holder	1
Fuse	NTC 74-6SG1A-C 1 A 250V glass fuse	1
Contactor	Eaton C25BNB220T 20A	1
Box	Gratory Junction Box, Hinged Cover Stainless Steel Clip IP67 Waterproof Plastic Enclosure for Electrical Project Includes Mounting Plate and Wall Bracket 290x190x140mm (11.4"x7.5"x5.5")	1
Quick Disconnects/Fast on Terminals/Receptacle lug (required for contactors without screw on terminals)	PIDG, Quick Disconnects, Receptacle, 22 – 18AWG Wire Size TE Internal #: 640911-1	2

Table 16: Reference BOM for 20 A load or PV shedding circuit using a 20A contactor

Example Wiring: Excess Solar Shedding for 1 Branch Circuit

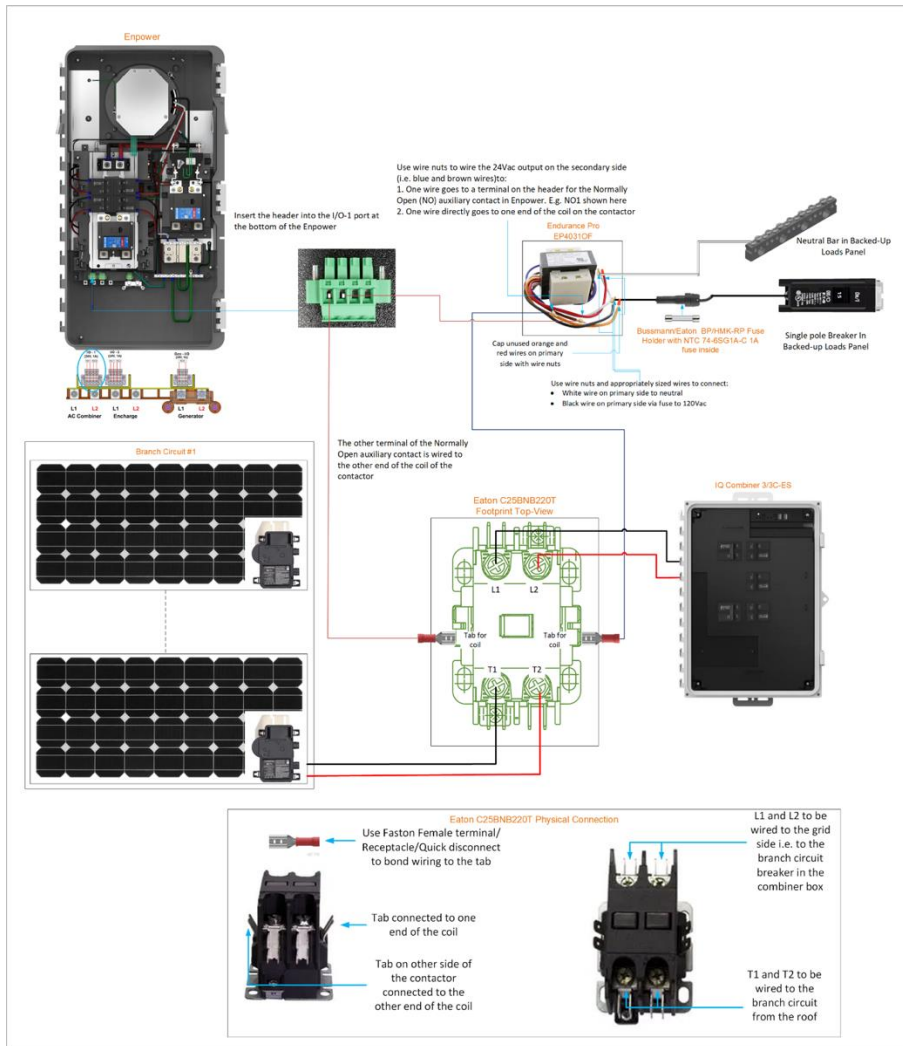


Figure 33: Example Wiring: Excess Solar Shedding for 1 Branch Circuit

Reference Wiring Image

Load and Solar Circuit Control using IQ System Controller Auxiliary Contacts

