

# Grounding schemes for various Inverters

This is a collection of grounding schemes for various inverters. It is information gathered from hands-on experience, manuals, discussions with manufacturing support groups and information from other forum members.

As I get information on additional inverters, I will update this resource. **If you have grounding information on these or any other inverters, please contact FilterGuy on the [DIY Solar Forum](#) for inclusion in this document.**

# A note about Inverter Grounding Similarities and Differences.

Unfortunately, different inverters can handle ground differently so there can be no simple statement on how they handle it.

## Similarities

Of the inverters I have looked at, the commonalities I have seen are:

- They all tie the AC-out Equipment Grounding Conductor to the case.
- Inverters that have an AC in (Such as inverter-Chargers) all tie the AC-in Equipment Grounding Conductor to the case.

**Warning:** The above are my observations of several different inverters and inverter brands. There is no guarantee all inverters will be the same.

## Differences

There are several critical differences between inverters.

- Some Inverters have a bond between AC Neutral and Ground. Some don't.
- Some inverters that have AC-in will dynamically switch on a N-G bond only when they are not getting AC-IN. Some don't.

Note: Some all-in-one inverter products have built in Ground-fault protection. Be sure to read the manual carefully because these units may already tie the DC circuit to the grounding system and an additional connection between the DC and Ground system may create problems.

It is important to find out how your specific inverter handles all of this in order to set the system up correctly. Unfortunately, the manuals and spec sheets for many inverters do not describe what the inverter does so it can be difficult to find out.

## **WARNING!!**

**This information is the best I have been able to put together through many sources and is accurate to the best of my knowledge. However, I can not guarantee the accuracy.**

If you find an inaccuracy, please contact Filterguy on the DIY solar forum.

## **WARNING!!**

**Some of the inverter models show 'bonding screws' that can be removed to disable the dynamic bonding of the inverter. These screws are not documented in the inverter manual and removing them may void warranties**

Links to document pages for specific inverters

[UL Listed inverters](#)

### Other inverters

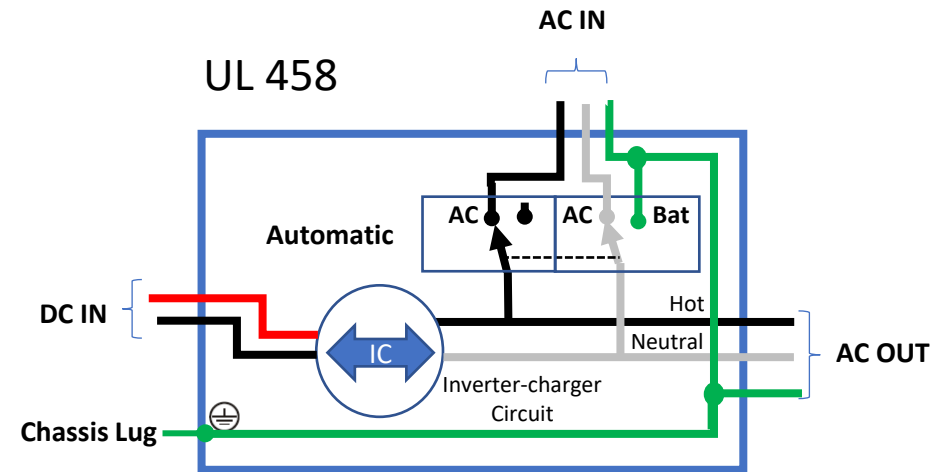
<a href="#"><u>Victron:</u></a>	<a href="#"><u>Multiplus</u></a>
<a href="#"><u>Cotec:</u></a>	<a href="#"><u>SD 2500 Hard-wired Inverter w/ transfer switch</u></a>
<a href="#"><u>Xantrex</u></a>	<a href="#"><u>PRO Series XM1000 w/ Transfer Switch</u></a>
<a href="#"><u>MPP Solar:</u></a>	<a href="#"><u>LV2424, LV6548</u></a>
<a href="#"><u>Aims:</u></a>	<a href="#"><u>Global LF Series Pure Sine Wave Inverter Charger</u></a>
<a href="#"><u>Giandle:</u></a>	<a href="#"><u>PS-4000QAR</u></a>
<a href="#"><u>Giandle:</u></a>	<a href="#"><u>PS-600DAR, PS100DAR, PS-1500QAR, PS-2000QAR, PS-3000QAR</u></a>
<a href="#"><u>Magnum:</u></a>	<a href="#"><u>MS-PAE Series</u></a>
<a href="#"><u>Renogy:</u></a>	<a href="#"><u>RNG-INVT-2000-12V-P2 (700w 1000w 2000w 3000w, 12V)</u></a>
<a href="#"><u>Victron:</u></a>	<a href="#"><u>Phoenix Inverter Smart</u></a>
<a href="#"><u>Xijia:</u></a>	<a href="#"><u>Model: 300W to 6000W, 12-48V</u></a>
<a href="#"><u>Must Power</u></a>	<a href="#"><u>Model: EP3000 Plus (European, 230V single phase, 6kW)</u></a>
<a href="#"><u>Growatt</u></a>	<a href="#"><u>SPF 3000TL LVM(24V &amp; 48V)</u></a>
<a href="#"><u>EG4</u></a>	<a href="#"><u>6000EX-48</u></a>
<a href="#"><u>MPP</u></a>	<a href="#"><u>6048</u></a>
<a href="#"><u>EG4</u></a>	<a href="#"><u>6500EX-48</u></a>

## UL listed inverters.

One place to get information about how an inverter handles ground internally are the UL listings it may have.

### UL 458 Inverter-Chargers

One of the more complicated aspects of inverter/chargers is what they do or don't do with the bond between neutral and ground. A UL 458 listed inverter-chargers have a neutral-to-ground switching relay the bonds neutral and ground when on battery power but removes the bond when on shore power. This is specifically aimed at mobile systems that are sometimes off-grid and sometimes plugged into the grid at docks, campgrounds or houses. (Note: UL 458 does not test the battery charging functionality)



**AC:** When powered from the AC-in, the inverter does not bond Neutral to ground  
**BAT:** When powered from the battery, the inverter does bond Neutral to ground and totally disconnects from the AC in.

### UL 1741

UL1741-listed inverters do not do bonding between Neutral and ground. They are intended to be used for systems where a permanent neutral-ground bond is done at the main breaker box. (Note: UL 1741 does test the battery charging functionality for safety.)

#### Warning:

Some inverters have configurations for how the Neutral-Ground bond happens and must be configured for the intended behavior. In fact some inverters have both UL 1741 and UL 458 listings.

Brand: **Victron**

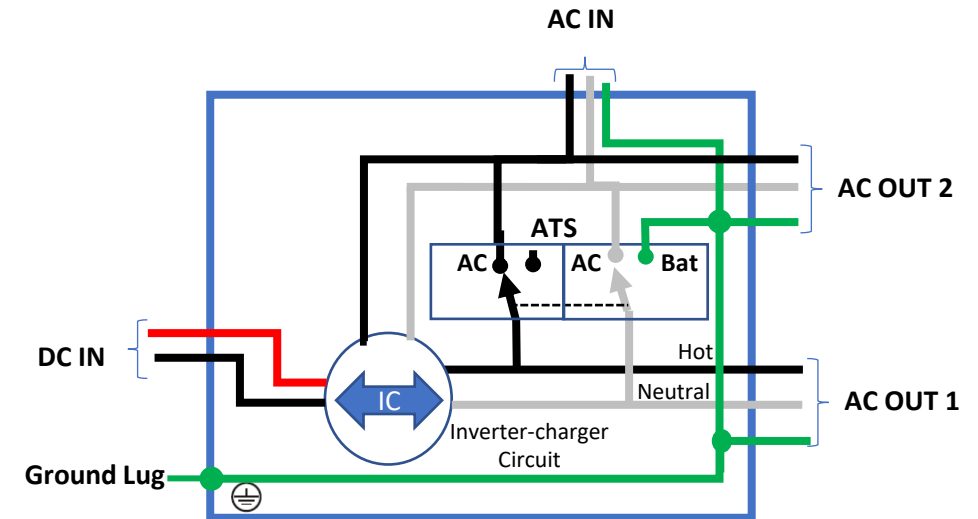
Model: **Multiplus line**

Description: Inverter-charger with various wattages and in/out voltages

Information provided by: FilterGuy

Source: Product Manual and reverse engineering.

Confidence: Very High



**AC:** When powered from the AC-in, the inverter does not bond Neutral to ground  
**BAT:** When powered from the battery, the inverter does bond Neutral to ground and totally disconnects from the AC in.

#### Notes:

- This unit would work well as a back-up power inverter with a hook up to a residential grid.
- If used with a generator, the generator should have a Neutral-Ground bond.

Brand: **Cotec**

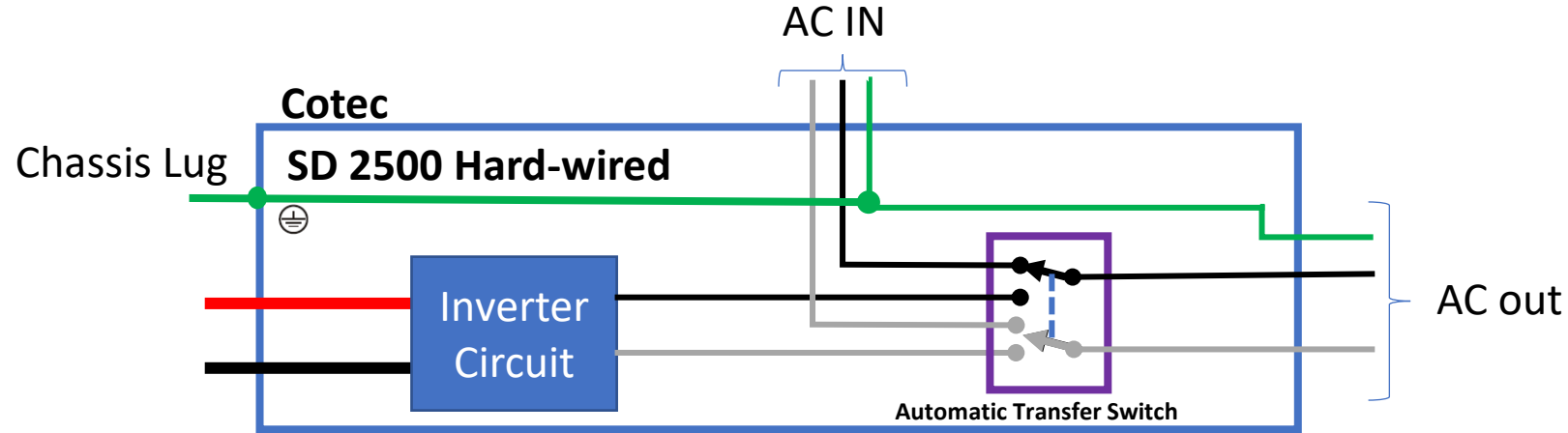
Model: **SD 2500 Hard-wired**

Description: 2500 W inverter with Transfer Switch

Information provided by: FilterGuy

Source: Product Manual and reverse engineering.

Confidence: Very High



#### Notes:

- This unit does **not** have a tie between neutral and ground.
- This unit ties Chassis ground, AC In ground and AC Out ground together.
- This unit does not tie DC Negative or Positive to ground.
- This unit would work well as a stand-alone source if the Neutral Ground bond is established after the AC Output.
- This unit would work well with a generator that does not have the Neutral-Ground bond but a Neutral-Ground bond is established after the inverter output.
- This unit would be problematic working with shore-power unless an external transfer switch is used.

Brand: **Xantrex**

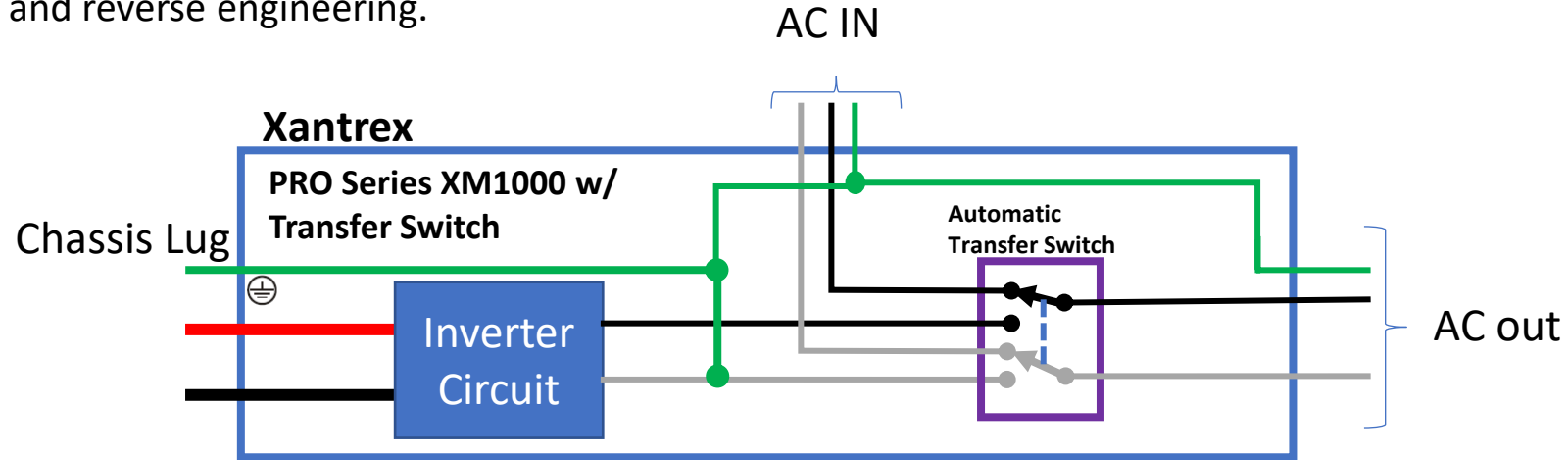
Model: **PRO Series XM1000 w/ Transfer Switch**

Description: 1000 W inverter with Transfer Switch

Information provided by: FilterGuy

Source: Product Manual and reverse engineering.

Confidence: Med High



From Xantrex Technical Support email:

**Xantrex Technical support:** “The unit is neutral - ground bonded except when it is given upstream AC power”.

**Filter Guy:** “Are all your inverters with AC-In like that?”

**Xantrex Technical support:** “Yes. It is an electrical code requirement. Devices without that feature are not compliant with the electrical code.”

Notes:

- This unit ties Chassis ground, AC In ground and AC Out ground together.
- This unit switches on a Neutral-Ground bond only when on Battery power
- This unit does not tie DC Negative or Positive to ground.
- This unit would work well with a generator that has the Neutral-Ground bond.



Brand: **MPP Solar**

Model: **LV2424, LV6548**

Description: ALL-in-one Inverter Charger

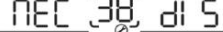
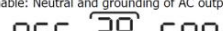
Information provided by: FilterGuy

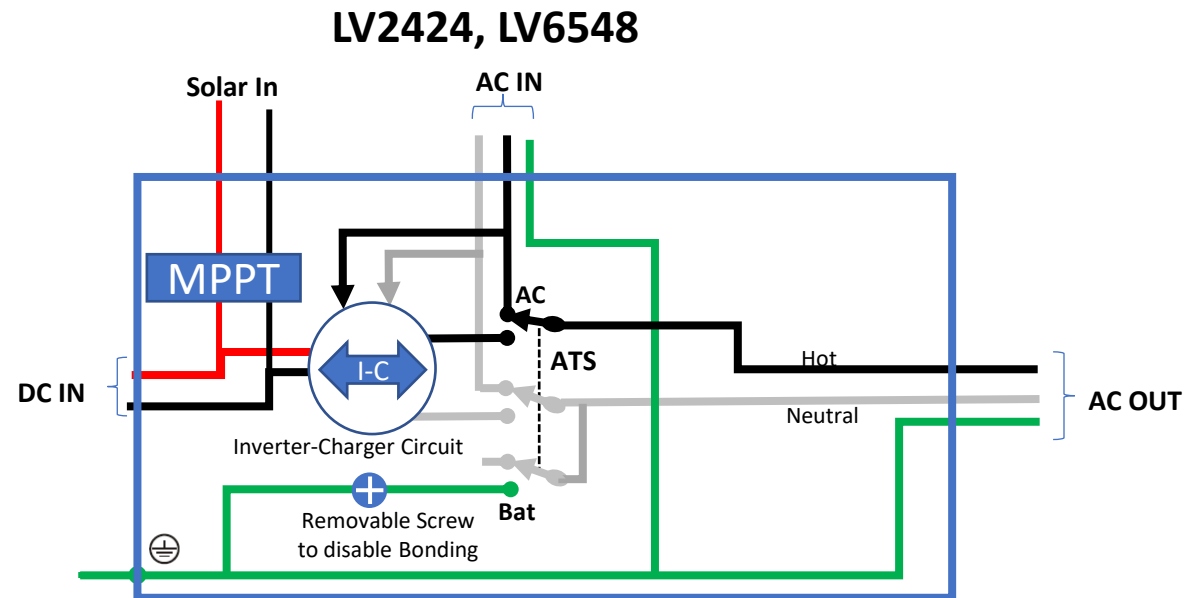
Source: Product Manual and Company Support

Confidence in information: Med-High

**The manual says:**

**11. GROUNDING INSTRUCTIONS** *This inverter/ charger should be connected to a permanent grounded wiring system. Be sure to comply with local requirements and regulation to install this inverter.*

38	Allow neutral and grounding of AC output is connected together: When enabled, inverter can deliver signal to trigger grounding box to short neutral and grounding	Disable: Neutral and grounding of AC output is disconnected. (Default)
		
		Enable: Neutral and grounding of AC output is connected.
		
This function is only available when the inverter is working with external grounding box. Only when the inverter is working in battery mode, it will trigger grounding box to connect neutral and grounding of AC output.		



**AC:** When powered from the AC-in, the inverter does not bond Neutral to ground

**BAT:** When powered from the battery, the inverter does bond Neutral to ground and totally disconnects from the AC in.

**NOTE:** At least the LV6548 has an internal screw that can be removed to disable the internal bonding relay.

**Emails From MPP Solar Support:**

**1) Is the AC-In ground, AC-out ground and Chassis ground all tied together?** *yes*

**2) Is there any bonding between the AC Neutral out and AC-Out Ground? If not, is there any problem if there is a Neutral-Ground bond in the circuit after the inverter?**  
*The output N-G is handled this way - when under line mode (AC bypass), N-G is open, but when under inverter mode, then N-G will short. There shouldn't be any problem to the inverter itself if you wish to N-G short manually, however we're told some countries (like Australia) require N-G to stay open when grid passes through so that's the reason it's designed this way.*

When asked about the configuration setting above, They said:

*Please ignore this setting as essentially it is the same as what I've described in the last message about how OUTPUT N-G is handled under different modes so it's already now done internally and this setting would have no use.*

*Thanks*

**Notes:**

- This unit would work well as a back-up power inverter with a hook up to a residential grid.
- If used with a generator, the generator should have a Neutral-Ground bond.
- **MPP solar support has specifically said to never connect the input and output neutrals.**

Brand: **Aims**

Model: **Global LF Series Pure Sine Wave Inverter Charger**

Description: Inverter Charger

Information provided by: FilterGuy

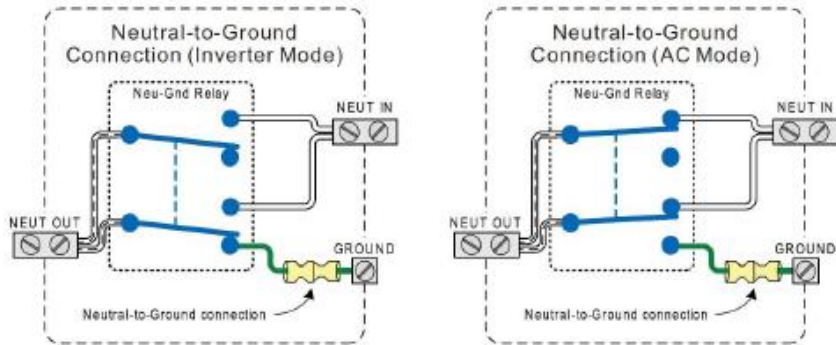
Source: Product Manual

Confidence in information: Med-High

### The manual says:

#### 3.5.1 Automatic Neutral-to-Ground Connection

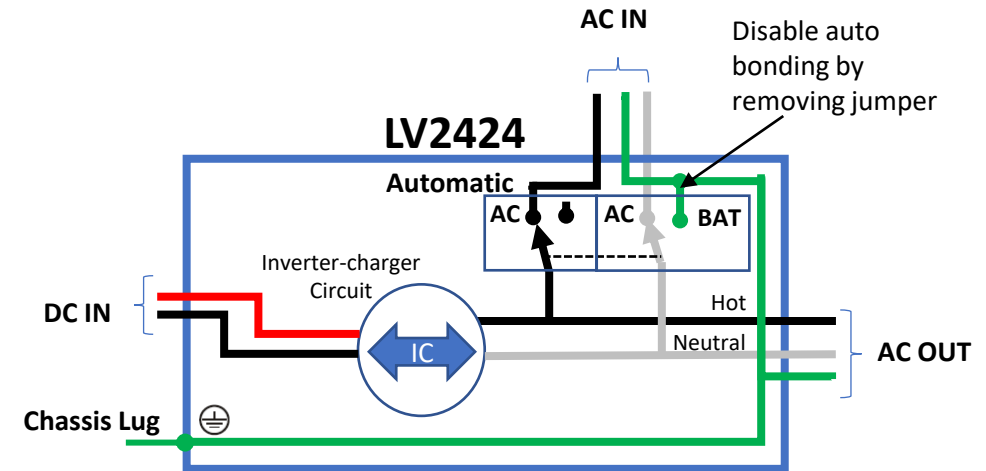
*All single phase 120Vac inverters are equipped with automatic neutral to ground switching. These inverters use an internal relay that automatically connects the AC neutral output to the vehicle/boat's safety ground (bonding it) in Inverter Mode and disconnects it ("un bonding" it) when they have connected to a qualified external AC source.*



*This design avoids two neutral to ground connections from existing at the same time, thereby preventing an electrical shock hazard between the vehicle/boat's neutral and the external AC source's neutral.*

### Notes:

- This unit would work well as a back-up power inverter with a hook up to a residential grid.
- If used with a generator, the generator should have a Neutral-Ground bond.



**AC:** When powered from the AC-in, the inverter does not bond Neutral to ground  
**BAT:** When powered from the battery, the inverter does bond Neutral to ground and totally disconnects from the AC in.

Brand: **Aims**

Model: **Global LF Series Pure Sine Wave Inverter Charger**

Description: Inverter Charger

Information provided by: FilterGuy

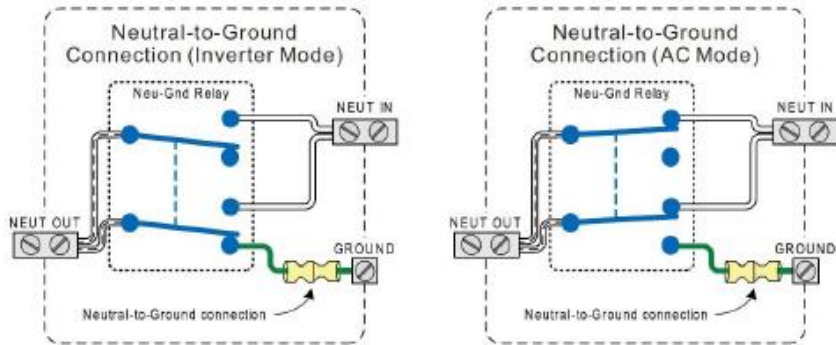
Source: Product Manual

Confidence in information: Med-High

### The manual says:

#### 3.5.1 Automatic Neutral-to-Ground Connection

*All single phase 120Vac inverters are equipped with automatic neutral to ground switching. These inverters use an internal relay that automatically connects the AC neutral output to the vehicle/boat's safety ground (bonding it) in Inverter Mode and disconnects it ("un bonding" it) when they have connected to a qualified external AC source.*



**AC:** When powered from the AC-in, the inverter does not bond Neutral to ground  
**BAT:** When powered from the battery, the inverter does bond Neutral to ground and totally disconnects from the AC in.

*This design avoids two neutral to ground connections from existing at the same time, thereby preventing an electrical shock hazard between the vehicle/boat's neutral and the external AC source's neutral.*

### Notes:

- This unit would work well as a back-up power inverter with a hook up to a residential grid.
- If used with a generator, the generator should have a Neutral-Ground bond.

Brand: **Giandle**

Model: **PS-4000QAR**

Description: Inverter

Information provided by: FilterGuy

Source: Manual

Confidence in information: **Med-Low**

### The manual says:

*The inverter is designed to use with the negative ground electrical system! Don't use it with positive ground electrical systems.*

#### 1) Grounding

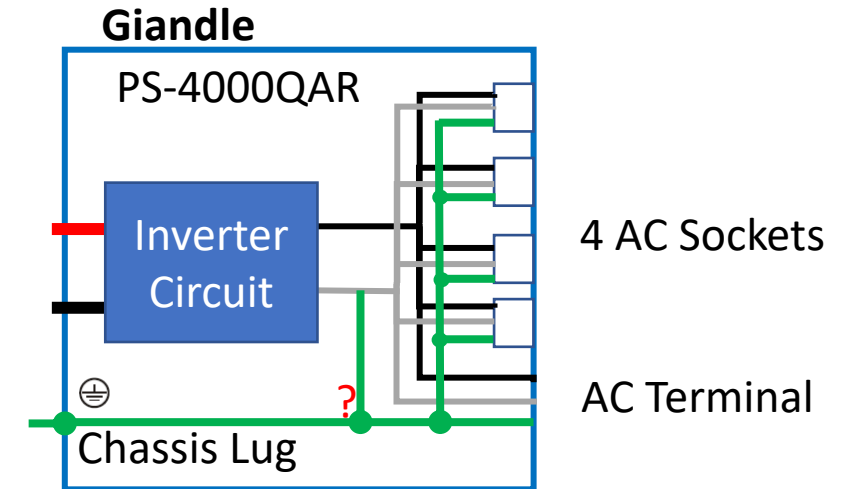
*The power inverter has a terminal on the rear panel marked "Grounding" or "⊖". This is used to connect the chassis of the power inverter to the ground. The ground terminal has already connected to the ground wire of AC output receptacle through the internal connecting wire.*

*The ground terminal must be connected to the ground wire, which will vary depending on where the power inverter is installed. In a vehicle, connect the ground terminal to the chassis of the vehicle. In a boat, connect it to the boat's grounding systems. In a fixed location, connect the ground terminal to earth. **Warnings:** To make sure the firmness of the connection. The ground wire must be 14AWG (2.08 mm<sup>2</sup>) or even larger.*

*Do not operate the power inverter without connecting to the ground. Electric shock may result.*

### An Email from Giandle Support says:

Our inverter is not floating ground. And please do not bond the AC Ground to the AC Neutral, there will be a security risk. Unless you use a GFCI socket.



Brand: **Giandle**

Model: **PS-600DAR, PS100DAR, PS-1500QAR, PS-2000QAR, PS-3000QAR**

Description: 600W, 1000W, 1500W, 2000W or 3000W Inverter (12 and 24V)

Information provided by: FilterGuy

Source: Manual & Tech support email.

Confidence in information: Med

### The manual says:

*The inverter is designed to use with the negative ground electrical system! Don't use it with positive ground electrical systems.*

#### 1) Grounding

*The power inverter has a terminal on the rear panel marked " Grounding "or "⊖". This is used to connect the chassis of the power inverter to the ground. The ground terminal has already connected to the ground wire of AC output receptacle through the internal connecting wire.*

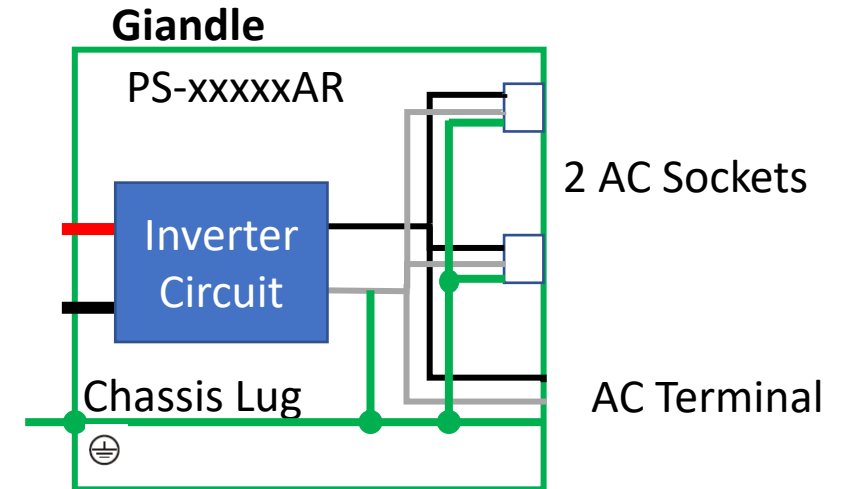
*The ground terminal must be connected to the ground wire, which will vary depending on where the power inverter is installed. In a vehicle, connect the ground terminal to the chassis of the vehicle. On the ship, connect the ground terminal to the ship grounding system; In a fixed position, connect the ground terminal to the earth.*

*Warnings:*

- *To make sure the firmness of the connection. The ground wire must be 14AWG ( 2.08mm<sup>2</sup> ) or even larger.*
- *Do not operate the power inverter without connecting to ground. Electric shock hazard may result.*

### Email from Giandle Support:

*Yes, the grounding is bonded to the AC-out Neutral inside the inverter*



Brand: **Victron**

Model: **Phoenix Inverter Smart**

Description: 1600W – 1200W Inverter (12V, 24V & 48V)

Information provided by: FilterGuy

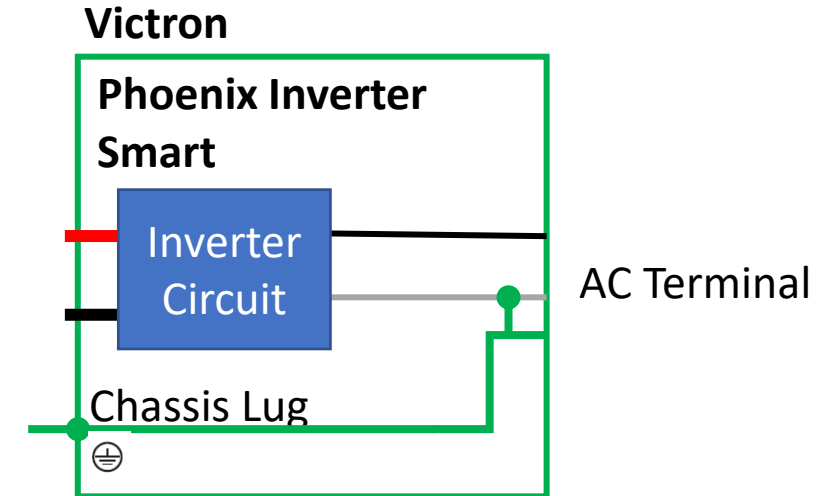
Source: Manual & Tech support email.

Confidence in information: high

**The manual says:**

The neutral wire of the AC output of this inverter is connected to the chassis (see appendix B for 1600VA/2000VA and appendix C for 3000VA/5000VA). This is to ensure proper functioning of a GFCI (or RCCB) to be installed in the AC output of the Inverter.

The chassis of the product must be connected to ground, to the frame (of a vehicle) or the ground plate or hull (of a boat).



Brand: **Magnum**

Model: MS-PAE Series

Description: Inverter-Charger

Information provided by: FilterGuy

Source: Manual & Discussion with tech support.

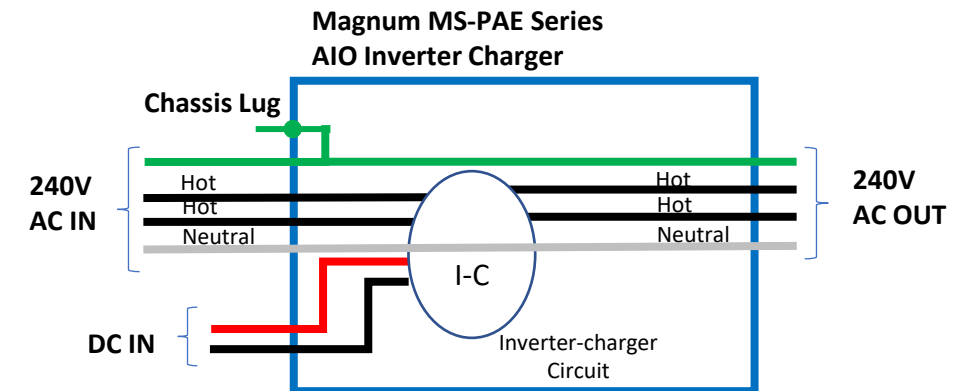
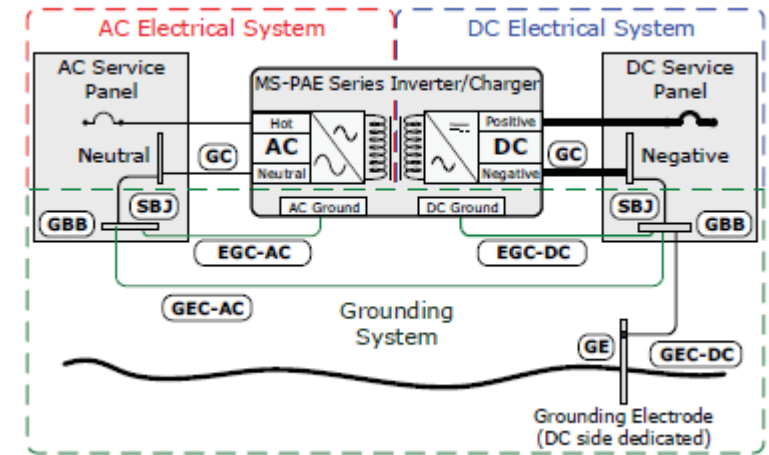
Confidence in information: High

### A few key points from the manual:

- \* The MS-PAE Series considers the Chassis Grounding Lug DC Ground
- \* The MS-PAE Series does NOT have an internal Ground-Neutral bond.
- \* The MS-PAE Series ties AC-in Ground to AC-out Ground
- \* The MS-PAE Series ties AC-in Ground to Chassis
- \* The MS-PAE Series ties AC-in neutral to AC-out neutral

### Notes.

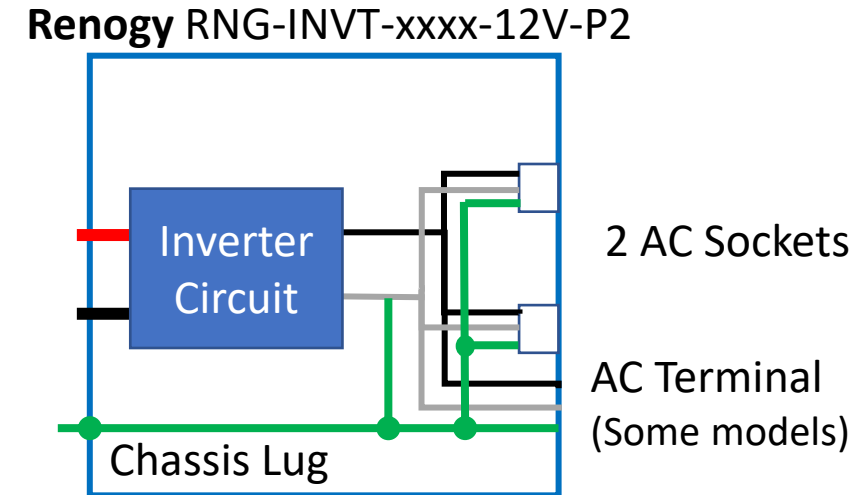
- The manual describes the internal grounding better than most other inverter manuals.
- This unit is designed for the North American market with 240 Split-phase. It would probably not be a good unit for installations outside the US.
- If installed in a mobile set-up, care must be taken to properly manage the Neutral-Ground Bond. (no bond when on shore power, but N-G bond when not on shore power)
- If used with a Generator, care must be taken to properly manage the Neutral-Ground Bond. (The easiest would be no bond in the generator and a permanent bond after the inverter.
- If followed, the instructions in the manual could have you create some ground loops. However, if the unit is used with the MP or MMP enclosure options the loops can remain inside the metal enclosures and may not cause an issue.
- The manual shows 3 options for setting up grounding electrodes. I recommend option 3 (shown here) for minimizing ground loops.



Confidence in information: Med-High

- *Feature: Ground Fault Circuit Interruption*
- NEUTRAL and GROUND are bonded inside the inverter to comply with the National Electric Code (NEC) requirement that any AC source must have a neutral to ground connection.
- 4. Ground Terminal — For insulated safety ground wire.

- As a stand-alone unit, this system should not have an external Neutral-Ground bond.
- If used with another AC source, a transfer switch will be needed.
  - If the other AC source is shore power or a generator with a N-G bond, the transfer switch should switch both hot and Neutral
  - If the other AC source does not have a N-G bond, the transfer switch should only switch Hot. (Most portable generators in the US do not have a N-G bond)





Brand: Xijia

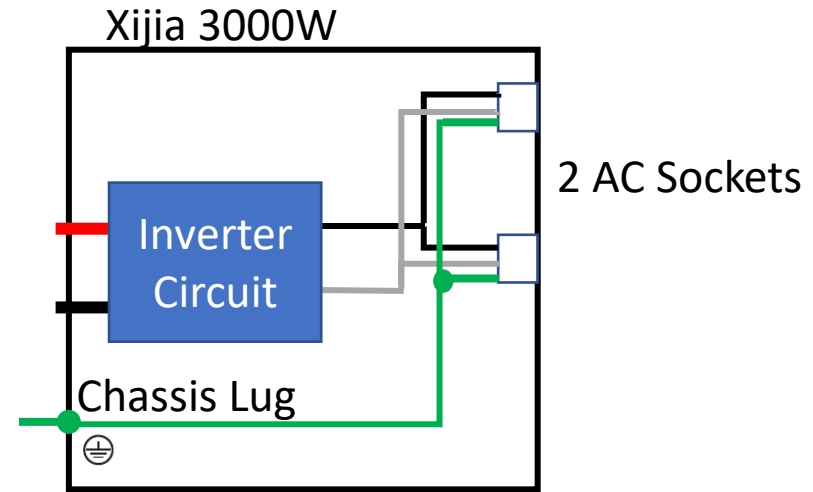
Model: 300W to 6000W, 12-48V

Description: 600W, 1000W, 1500W, 2000W or 3000W Inverter (12 and 24V)

Information provided by: **Off-Grid-Garage**

Source: Manual & hands on examination/testing

Confidence in information: Med-High



No internal Neutral-Ground Bond

Brand: **MUST Power**

Model: EP3000 Plus (European, 230V single phase, 6kW)

Source: UpNorthAndPersonal

Confidence: high

Are the two (or three) grounds tied together?

Yes

Is there a neutral-ground bond?

No


If there is an AC-IN, does it change the neutral-ground bond when getting power from the AC-in?

No - In Europe, it is generally not done - TT networks are actually growing due to RCDs being very good and readily available. It depends of course from country to country here...


Brand: **Growatt**  
Model: **Growatt SPF 3000TL LVM (24V & 48V)**  
Description: 3000 W inverter/charger with Transfer Switch  
Information provided by: FilterGuy  
Source: Product Manual, Youtube Videos & tech Support  
Confidence: Med High

The manual says:

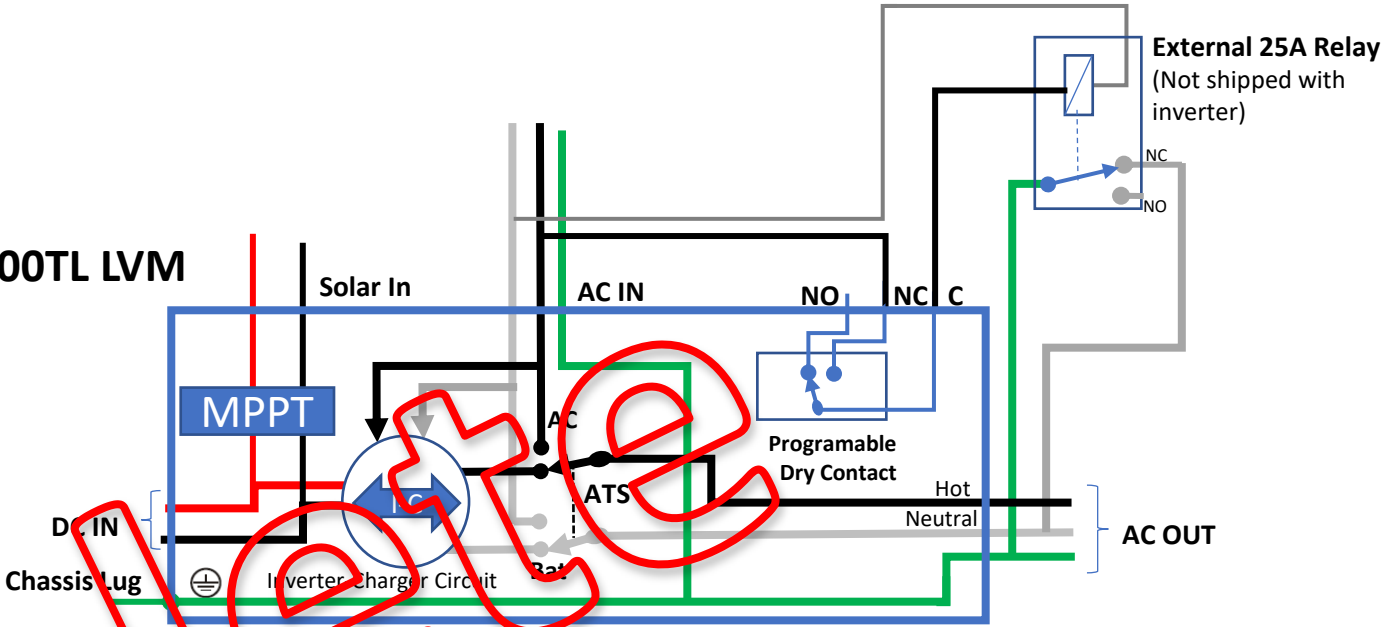
24	Allow neutral and grounding of AC output is connected together: When enabled, inverter can deliver signal to trigger grounding box to short neutral and grounding (for expansion)	Disable: Neutral and grounding of AC output is disconnected. (Default) <u>NEC</u>
		<u>d15</u> 24 <sub>ø</sub>
		Enable: Neutral and grounding of AC output is connected. <u>NEC</u>
		<u>ENA</u> 24 <sub>ø</sub>
This function is only available when the inverter is working with external grounding box. Only when the inverter is working in battery mode, it will trigger grounding box to connect neutral and grounding of AC output.		

Unit Status	Condition				Dry contact port: 	
					NC & C	NO & C
Power Off	Unit is off and no output is powered.				Close	Open
	Output is powered from Utility.				Close	Open
Power On	Output is powered from Battery or Solar.	Program 01 set as Utility	Battery voltage < Low DC warning voltage	Open	Close	Close
			Battery voltage > Setting value in Program 13 or battery charging reaches floating stage	Close	Open	Open
		Program 01 is set as SBU or Solar first	Battery voltage < Setting value in Program 12	Open	Close	Close
			Battery voltage > Setting value in Program 13 or battery charging reaches floating stage	Close	Open	Open

When program 24 is set as "enable":

Unit Status	Condition				Dry contact port: 	
					NC & C	NO & C
Power Off	Unit is off and no output is powered.				Close	Open
	Unit works in standby mode, line mode or fault mode				Close	Open
Power On	Unit works in battery mode or power saving mode				Open	Close

SPF 3000TL LVM



AC: When powered from the AC in, the inverter does not bond Neutral to ground  
BAT: When powered from the battery, the inverter does not bond Neutral to ground but does close the dry contact outputs. (Can be used for a N-G bond relay)

Notes

- The inverter does not have internal bonding of anything.
- There is a dry contact that can be programmed to trigger an external N-G ground relay. The relay contacts have to be rated for at least the current of the inverter which is 3000/120=25A.
- According to an email from Growatt Support, the dry contacts are rated for up to 3A at 250VAC. They also confirmed it can be used with the 48V battery voltages.
- Notice that in the circuit above, the relay is powered from the AC in. This minimizes power drain when not on grid power.

Warning:

When switching to Grid power from battery power there is a brief moment when the relay is closed \*and\* the unit is in line mode. This momentarily creates two N-G bonds that will pop any GFCI/RCD that is providing grid power to the inverter.

CONTINUED ON NEXT PAGE

Brand: **Growatt (UPDATED)**

Model: **Growatt SPF 3000TL LVM 24V & 48V (Old versions)**

Description: 3000 W inverter/charger with Transfer Switch

Information provided by: FilterGuy

Source: Product Manual, YouTube Videos & tech Support

Confidence: Med High

Growatt has updated the SPF 300TL LVM to do the dynamic bonding internally. The new models are:

- **SPF 3000 TL LVM-24P – model# SKSL00.0010200**

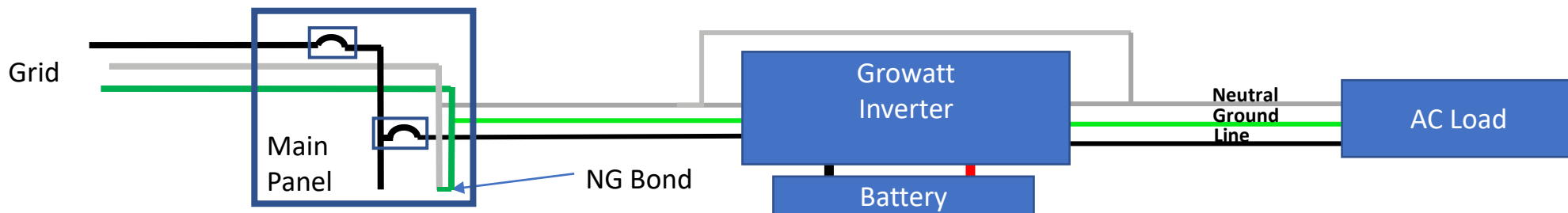
- **SPF 3000 TL LVM-48P – model# SKSL00.0010000**

When I get more info on the new models, I will add a new page for them.

**On the older models, Growatt no longer supports using the dry contact output and has removed Program 24 from the firmware. Instead, the grounding should be as described below. (Note that the neutral-in and neutral out are connected on the inverter.)**

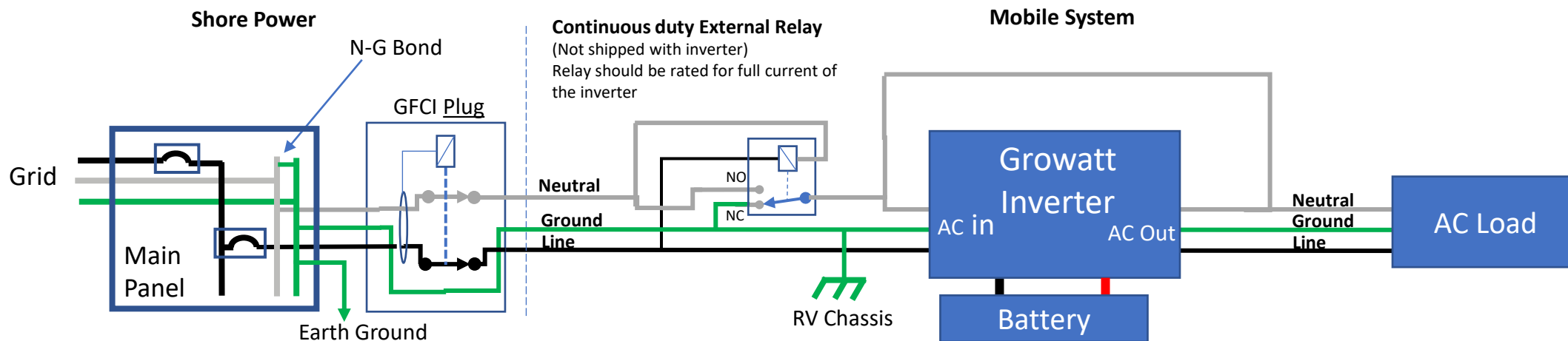
### STATIONARY SYSTEMS with no GFCI/RCD plug upstream of the inverter:

For stationary systems with no GFCI plugs upstream from the inverter, simply jumper the AC-IN Neutral and-AC OUT Neutral. This works for stationary systems because the inverter output circuits will always 'see' the N-G bond of the grid connection. (**Warning:** If there is a GFCI/RCD plug upstream from the inverter, it can isolate the system from the house NG-Bond by disconnecting the Neutral. In this case, the relay shown for the mobile system should be used. **NOTE:** GFCI breakers in breaker boxes do not disconnect neutral and therefore do not have this issue.)



### MOBILE SYSTEMS or Stationary systems with a GFCI/RCD plug upstream of the inverter that might disconnect Neutral:

There needs to be a way to do dynamic NG-Bond that does not trip a GFCI/RCD. The circuit shown below creates a bond when there is no shore power and connects Neutral when there is shore power. Note that the local bond is broken \*before\* the neutral from shore power is hooked up. This prevents a case of dual N-G bonds that might trip a GFCI.



Brand: **Growatt** (UPDATED)

Model: **Growatt SPF 3000TL LVM 24V & 48V** (New versions)

- SPF 3000 TL LVM-24P – model# SKSL00.0010200
- SPF 3000 TL LVM-48P – model# SKSL00.0010000

Description: 3000 W inverter/charger with Transfer Switch

Information provided by: FilterGuy

Source: Product Manual, YouTube Videos & tech Support

Confidence: TBD

Growatt has updated the SPF 300TL LVM to do the dynamic NG- bonding internally. The new models are:

- **SPF 3000 TL LVM-24P – model# SKSL00.0010200**
- **SPF 3000 TL LVM-48P – model# SKSL00.0010000**

When I get more info on the new models, I will update this page.

Brand: EG4

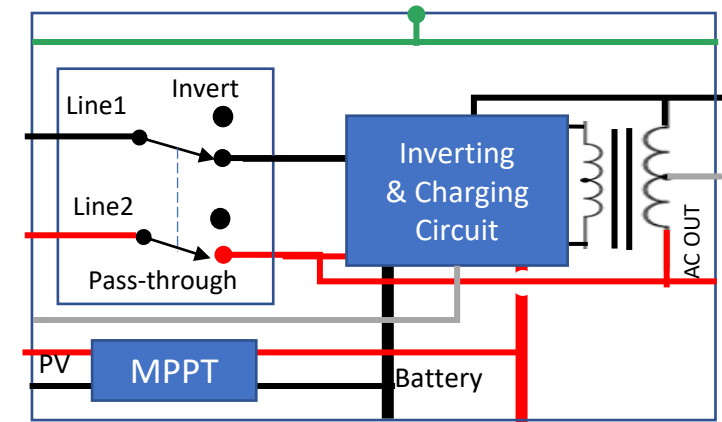
Model: 6000EX

Description: 48V low frequency inverter with Split phase output

Information provided by: **Filter-guy**

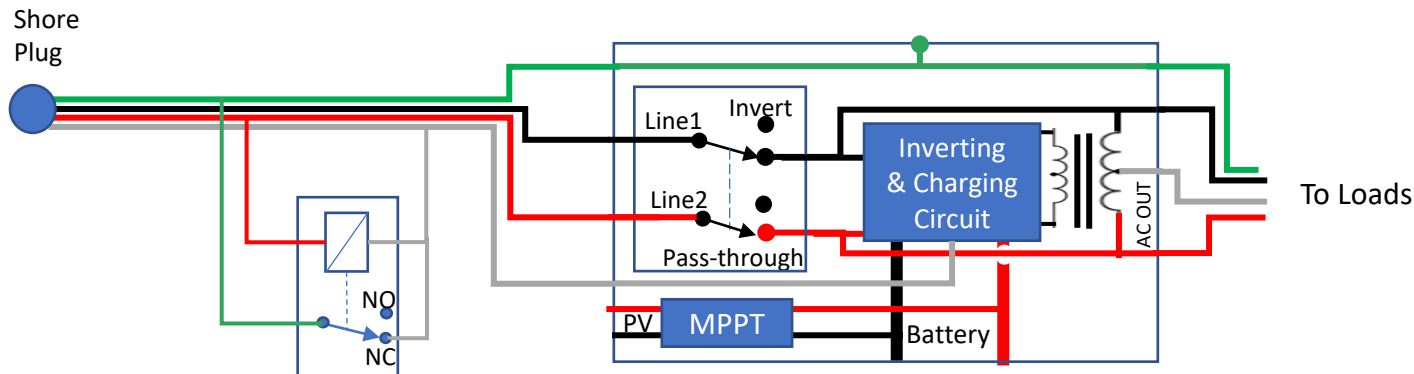
Source: examination/testing by various forum members

Confidence in information: Med-High



### Notes:

- There is no internal Neutral-Ground Bond
- The neutral out is derived by the output transformer in both pass-through and inverter mode.  
Note that the NEC requires the neutral of an auto-transformer be tied back to the neutral of the source (Grid) power. This would create a common neutral system where the Main Bonding Jumper is the only NG bond in the system. (I do not know if EG4 supports a common neutral layout)
- To properly set this up to use shore power in a mobile install, an external relay would be needed.



Brand: MPP

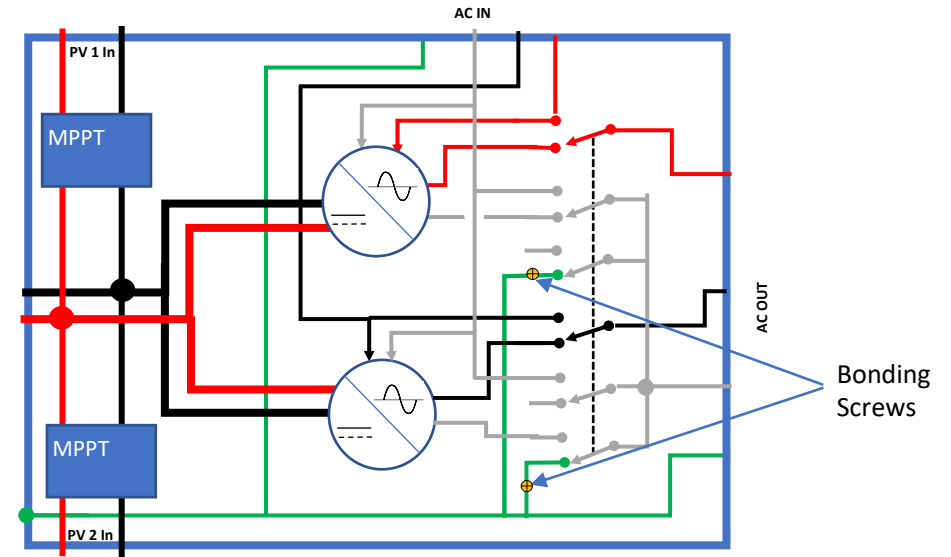
Model: 6048

Description: 48V High frequency inverter with Split phase output

Information provided by: **Filter-guy**

Source: examination/testing by various forum members

Confidence in information: Med-High



Notes:

- This is essentially two high frequency inverters packaged into one case.
- There are TWO bonding screws (One for each side of the split phase)

Brand: **EG4**

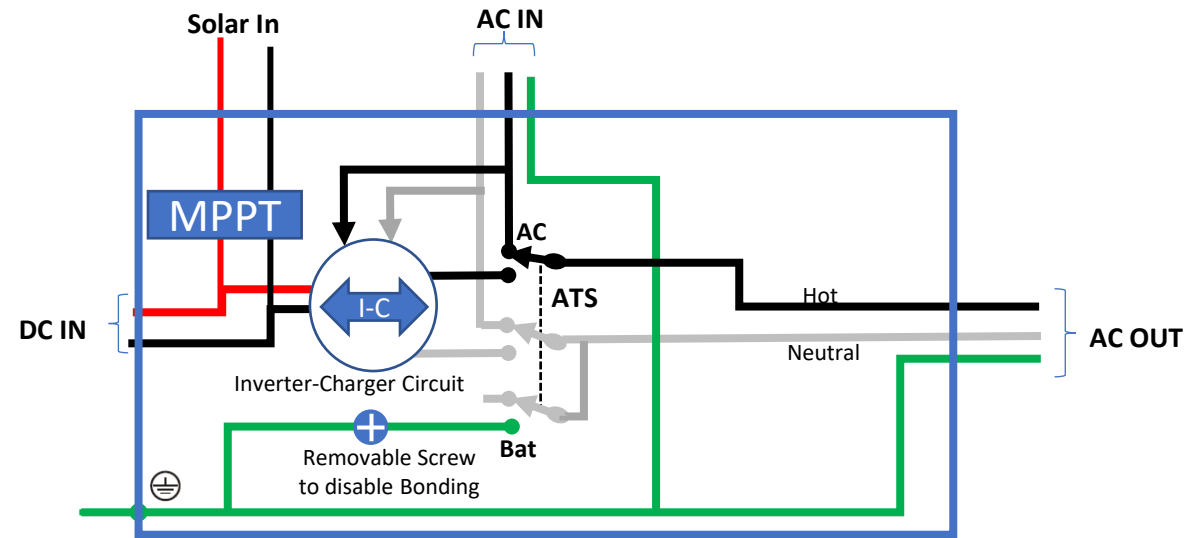
Model: **6500EX**

Description: ALL-in-one Inverter Charger

Information provided by: FilterGuy

Source: Product Manual and Company Support

Confidence in information: Med-High



**AC:** When powered from the AC-in, the inverter does not bond Neutral to ground

**BAT:** When powered from the battery, the inverter does bond Neutral to ground and totally disconnects from the AC in.

**NOTE:** At least the LV6548 has an internal screw that can be removed to disable the internal bonding relay.

#### Notes:

- This unit would work well as a back-up power inverter with a hook up to a residential grid.
- If used with a generator, the generator should have a Neutral-Ground bond.