Residential Solar Interconnections (Full Guide)

ecuip.com/solar-interconnection-guide

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Code Design SolarSeptember 25, 2020
By Ryan Gittens
With so many service equipment configurations and local rules, interconnecting your solar PV system to the existing electrical system can be quite confusing. An improper connection can potentially spell disaster as equipment can be overloaded – don't count on inspectors catching the mistake!

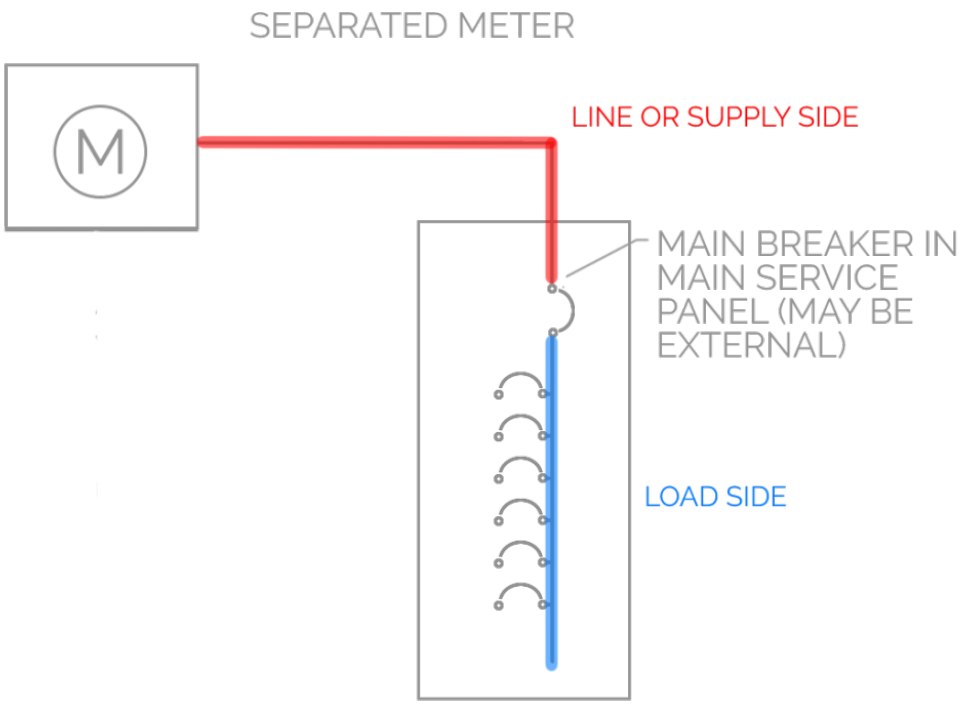
This post is to help clear things up so you know what is permitted by code and you can choose the best option depending on your particular situation. Unfortunately being up to code is sometimes not enough as the local jurisdiction and/or utility will have the final say so it's up to you to make sure it's allowed.

Jump to Relevant Section:

Configurations

Separated Meter

In this configuration, the meter is physically separated from the main breaker which exposes conductors on the line side that can be accessed.

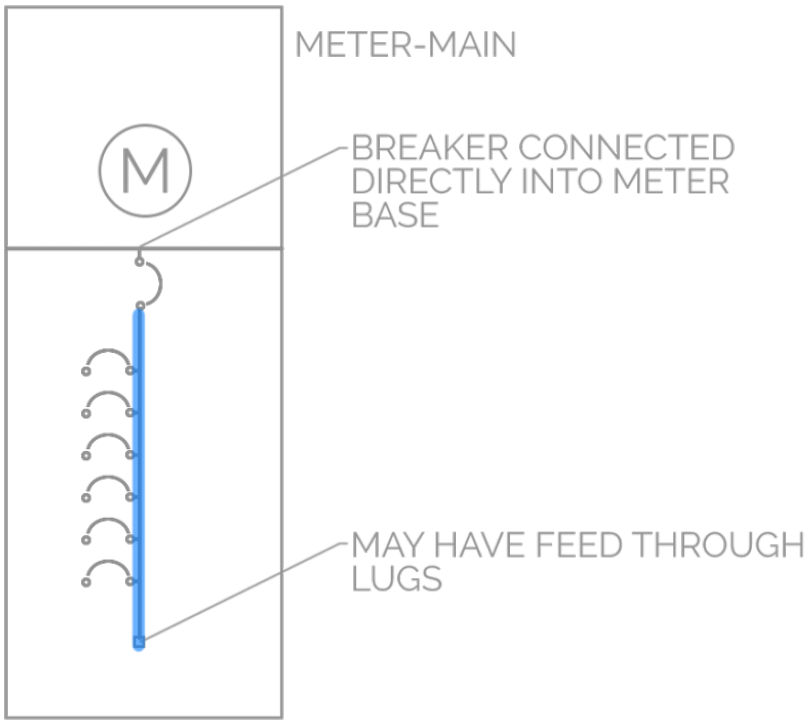


Separated Meter Interconnection Options:

	Easiest		**Hardest**
	Options		
Configuration	Line Tap	Backfeed Breaker (Opposite End)	Downsize main & backfeed breaker
20% panel rating >= 125% total inverter output	x	x	
20% panel rating < 125% total inverter output	x		x

Meter Main Combo – No Feed Through Panel

Meter-main combos have a main breaker directly connected into the meter base. This set-up has no accessible line side conductors.



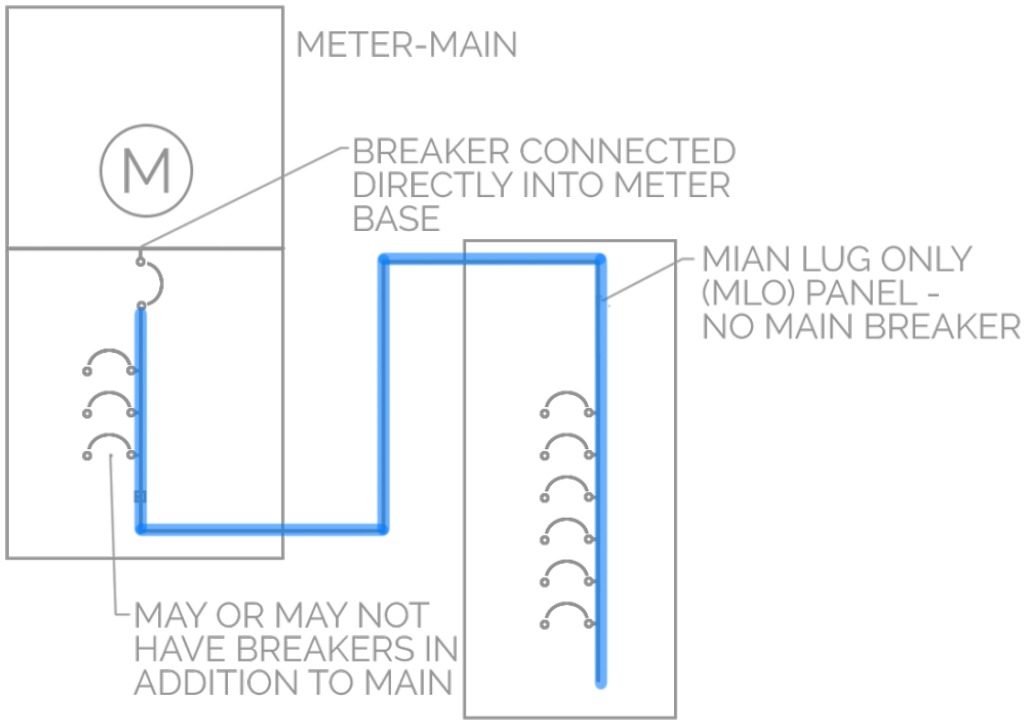
Separated Meter Interconnection Options:

	Easiest	Hardest
	Options	
Configuration	Backfeed Breaker (Opposite End)	Downsize main & backfeed breaker
20% panel rating >= 125% total inverter output	x	
20% panel rating < 125% total inverter output		x

Meter Main Combo – Feed Through MLO Panel

In some meter-main configurations, the feed through lugs go to a main lug only (MLO) panel which makes things interesting.

The lack of overcurrent protection from the feed through lugs to the feed through panel means that this effectively extends the busbar into the feed through panel so that the end of the busbar is the end of the MLO panel. Therefore, the 120% rule does not apply if a breaker is added to the end of the meter-main busbar. The 120% rule would only apply if the breaker is connected to the end of the feed through panel busbar.



Separated Meter Interconnection Options:

	Easiest		**Hardest**
	Options		
Configuration	Backfeed Breaker (Opposite End)	Downsize main & Load Tap	Downsize main & backfeed breaker
Meter-main panel: 20% panel rating >= 125% total inverter output		x	x[1]
Meter-main panel: 20% panel rating < 125% total inverter output		x	x[1]
Feed through panel: 20% panel rating >= 125% total inverter output	x		
Feed through panel: 20% panel rating < 125% total inverter output			x[2]

[1]120% rule does not apply

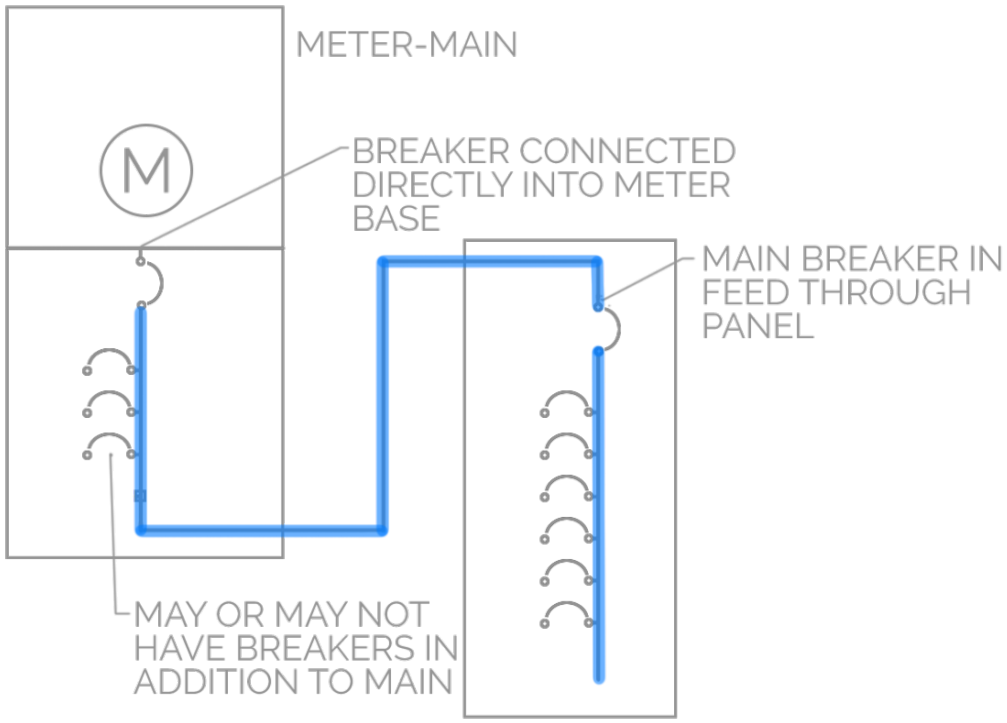
[2]Main breaker is located in meter-main panel

Meter Main Combo – Feed Through Panel w/ Main Breaker

In other meter-main configurations, the feed through lugs in the meter main may go to a main breaker panel.

The main breaker in the feed through panel protects the panel from any overload so it can be treated like a meter-main panel with no feed through panel and the 120% rule can be used for a breaker added to the end.

Alternatively, for a breaker connected to the feed through panel, the upstream panel (meter-main in this case) would need to be rated for the backfeed as well.



Separated Meter Interconnection Options:

		Easiest		Hardest
	Options			
Configuration	Load Tap	Backfeed Breaker (Opposite End)	Downsize main & Load Tap	Downsize main & backfeed breaker
Meter-main panel: 20% panel rating >= 125% total inverter output	x	x		

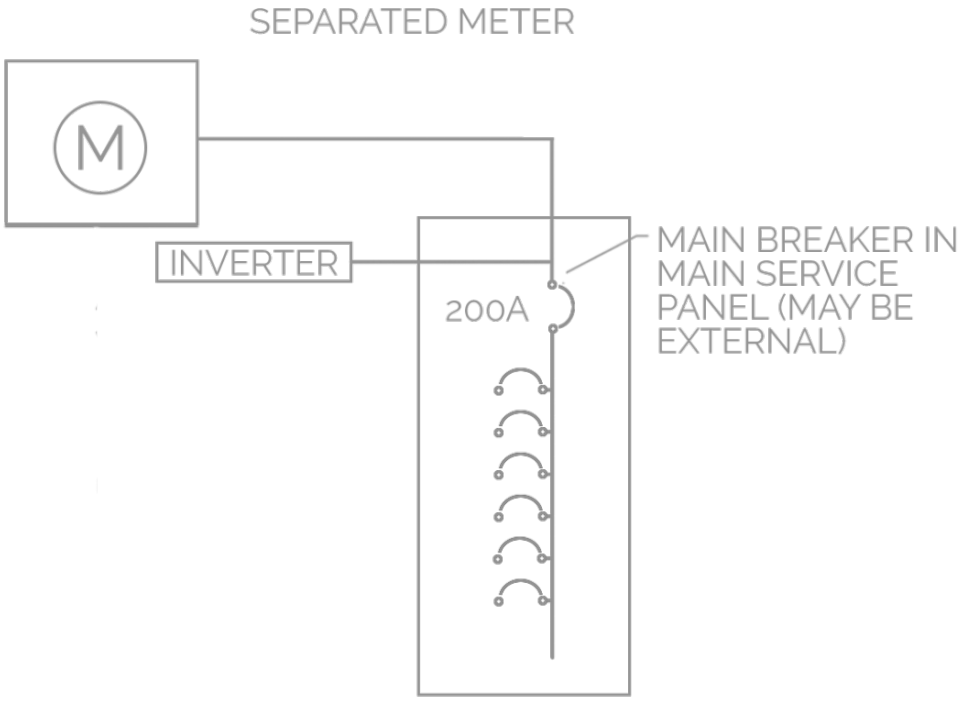
	Easiest		Hardest
Meter-main panel: 20% panel rating < 125% total inverter output		x	x
Feed through panel: 20% panel rating >= 125% total inverter output	x		
Feed through panel: 20% panel rating < 125% total inverter output			x

Interconnections

Line Side Tap

Governing Code(s): NEC 705.12(A), 705.31

A line side tap (or supply side tap) refers to a connection between the meter and main breaker. This is the preferred method of interconnection for solar installers as it is the most straight forward and requires the least amount of calculations. However, there are some jurisdictions or utilities that do not allow this method even though it's permitted by code.



Backfeed Breaker

Governing Code(s) (All Methods): 705.12(B)(2)(3), 705.12(B)(4)

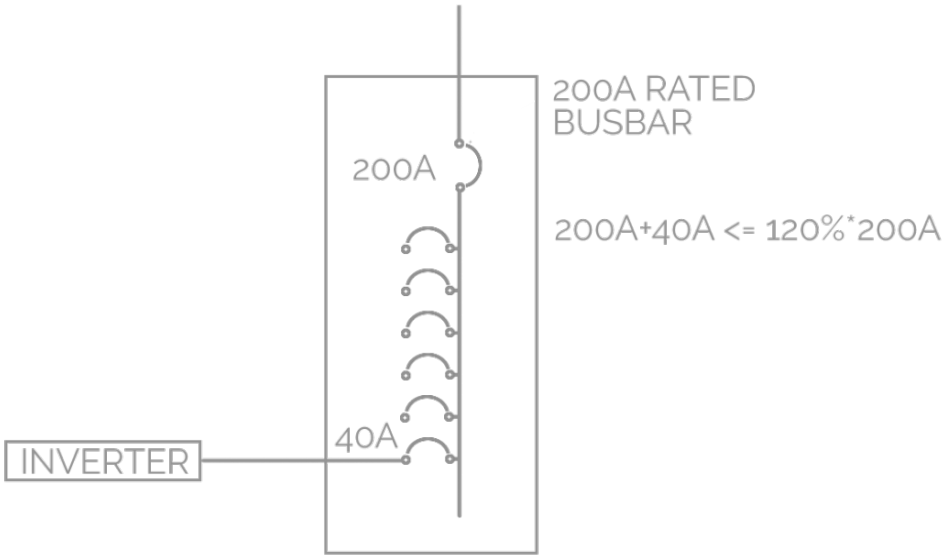
A backfeed breaker can be used to connect a solar PV system to the load-side of a service. There are several different ways this can be done per the NEC but the most common method for solar residential installs is by connecting it to the end of a busbar using the 120% rule (705.12(D)(2)(3)(B)).

Method 1: Backfeed breaker at end of busbar (120% rule)

Governing Code(s): 705.12(B)(2)(3)(b)

To comply with the 120% rule, the breaker must be connected to the end of the busbar (opposite end to the main breaker). This allows 120% of the busbar rating to be used for calculations. For example, a 200A busbar would be considered a 240A rating, in which case an inverter output up to 40A (125% of rated output current) can be added to the panel.

The reasoning behind this is that some current would be used by the loads between the two sources (utility and inverter) so the full potential potential current of the two sources are never combined.

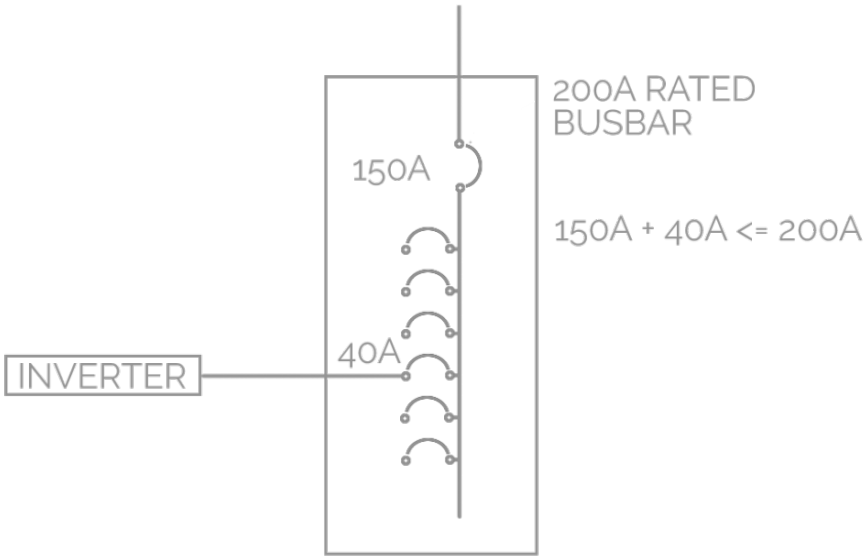


Method 2: Backfeed breaker at any location on busbar

Governing Code(s): 705.12(B)(2)(3)(a)

This method can be used only if the busbar has a higher rating than the main breaker. This can be achieved by downsizing the main breaker. In this case the sum of the sources (utility

and inverter) is less than the rating of the busbar so there is no possibility for overload.

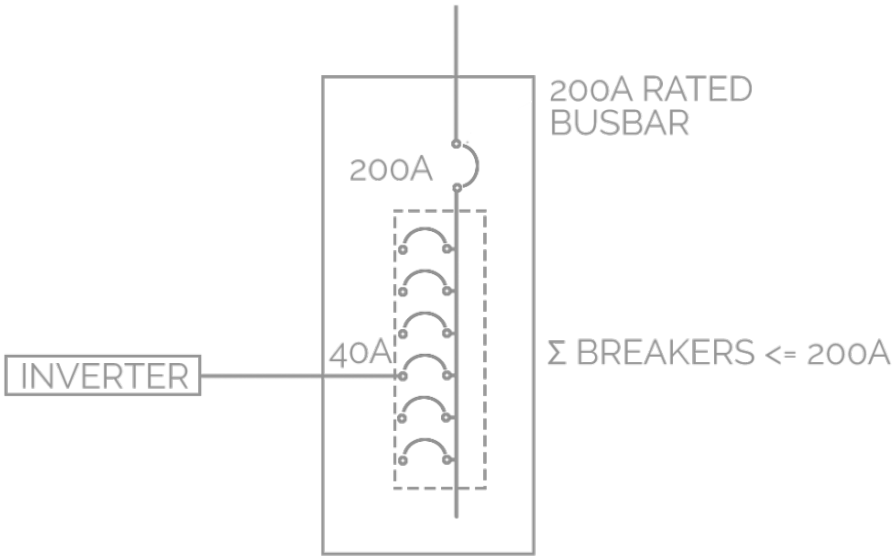


Method 3: Backfeed breaker at any location on busbar (Sum rule)

Governing Code(s): 705.12(B)(2)(3)(c)

For this method the sun of all breakers connected to the panel is less than the panel rating. The idea is that even if all breakers connected (both loads and sources) reach the maximum current there will not be potential for overload since the sum is less than or equal to the panel rating.

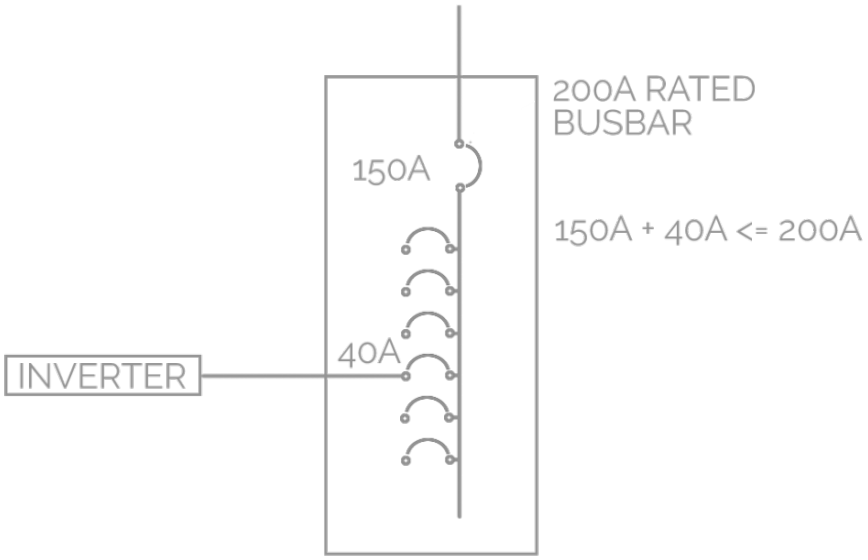
While this method is code compliant, it is not recommended as it assumes the sum of breakers will never exceed the panel rating. Even if the panel is not fully loaded at the time of install, it can be over loaded later if the homeowner adds more loads to the panel, at which point it has the potential to be overloaded and will no longer be code compliant.



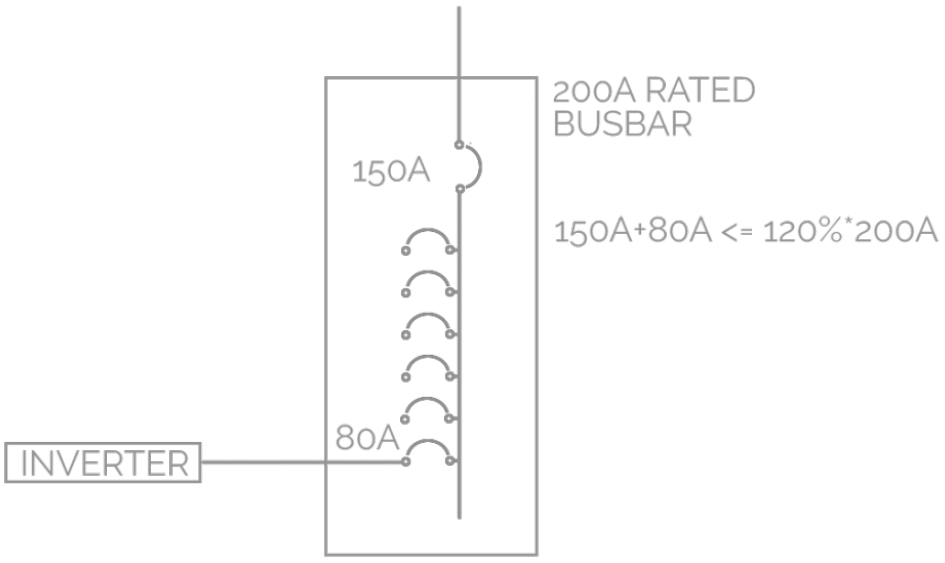
Downsize Main & Backfeed Breaker

Governing Code(s): 705.12(B)(2)(3)(a)

Downsizing the main breaker can “free up” capacity on the busbar. For example, a 200A rated bus with a 150A main breaker has 50A available capacity for another source to be connected. Therefore an inverter output to 50A (125% of rated output current) can be placed anywhere on the bus because the sum of both sources would be 200A. Since the bus is rated for 200A, there is no potential for overload.



Downsizing the main can be used in combination with the 120% rule to connect larger solar PV systems. In the example below, an 80A backfeed breaker is connected on the end of a 200A panel by downsizing the main to 150A. The maximum available capacity would be the difference in busbar and main breaker rating added to 20% of the busbar rating. I.e. 50A + 40A = 90A.



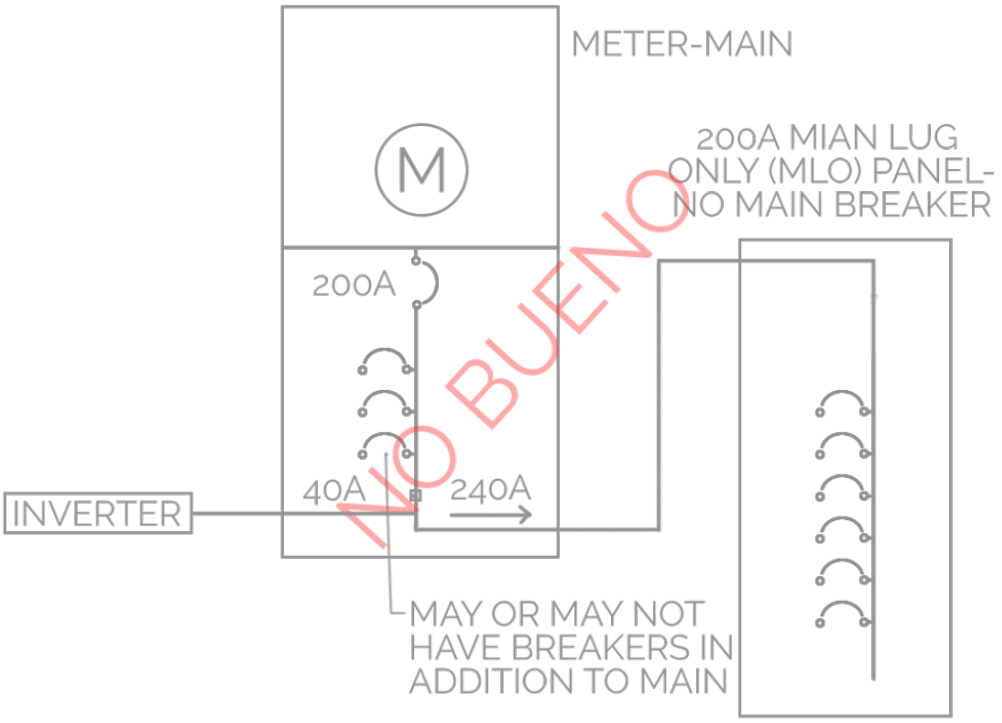
Load Tap

Governing Code(s): 705.12(B)(2)(1), 705.12(B)(2)(2)

Load taps are almost exclusively used on meter-main panels. The conductors going to the feed-through panel are easily accessible and the taps can be made in similar fashion to a line tap. The difference is that the connection is made after the main breaker so different rules apply.

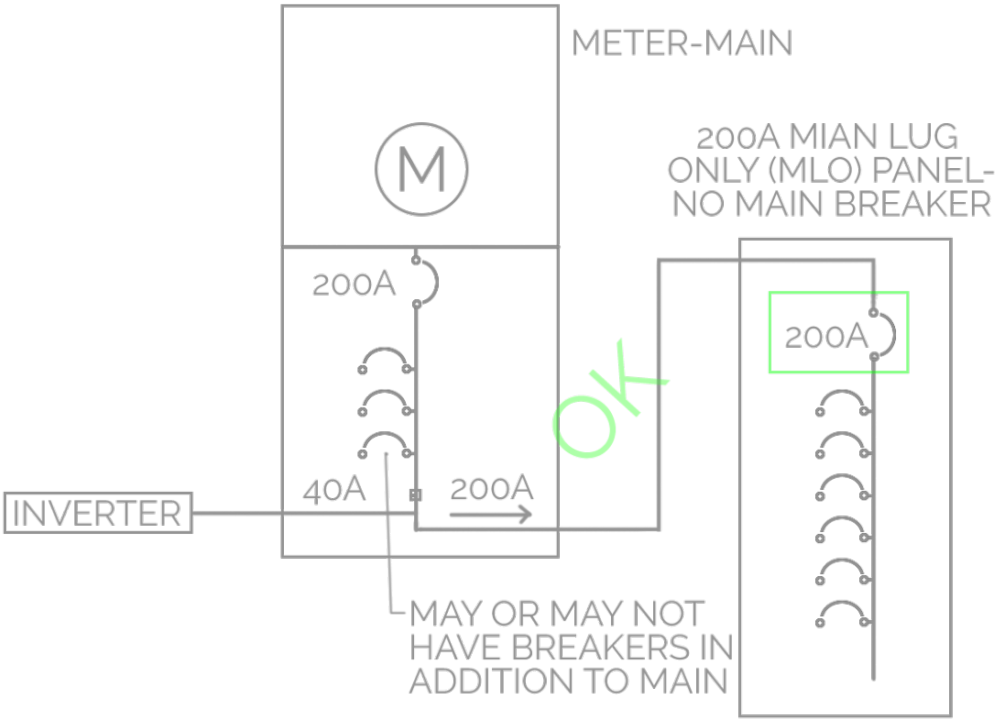
In a line tap, the only consideration is the size of the wires being tapped with no regard of what's downstream because the main breaker protects whatever is downstream at the rated current. However, in a load tap, the inverter output would be added to the potential utility current and the downstream equipment may not be protected or rated for the additional current.

For example, by connecting an inverter with a max output current of 40A using a load tap at the feed through conductors of a meter-main panel with a 200A main breaker exposes the wire and equipment downstream of that conductor to 200A + 40A = 240A. This causes a potential overload of the connected 200A panel.



The potential overload can be avoided either by adding a main breaker to the feed through panel per 705.12(B)(2)(1)(b) or downsizing the main breaker 705.12(B)(2)(1)(a).

When a main is added to the feed through panel, the meter-main panel can essentially be treated as if no feed through panel was connected. Tapping at the feed through conductors would be considered the end of the bus and the 120% rule can be applied.

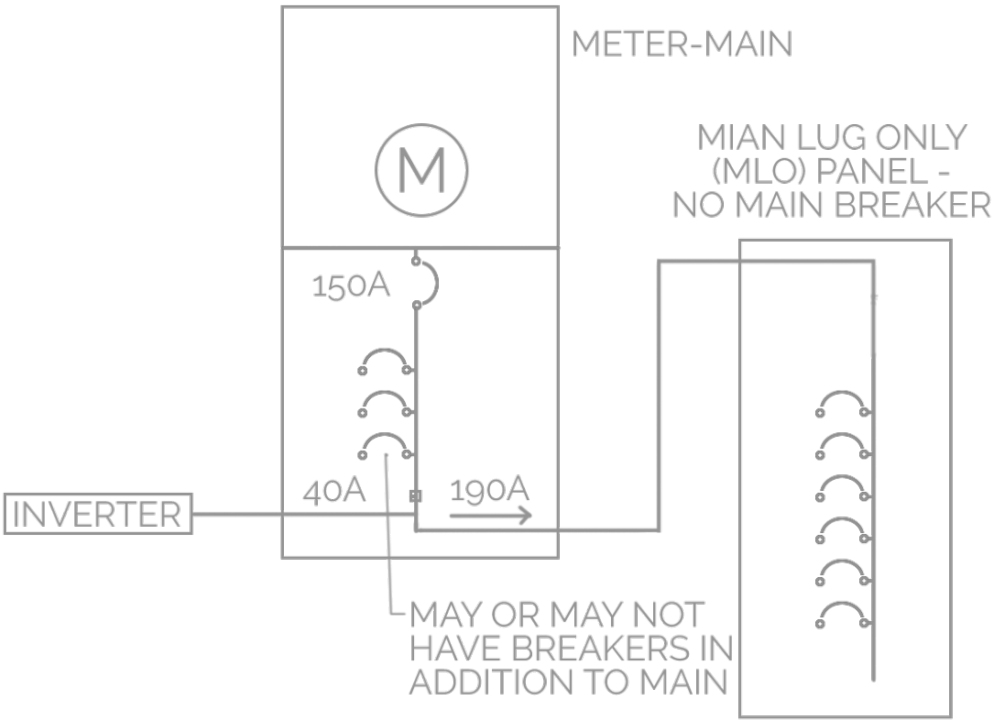


Downsize Main & Load Tap

Governing Code(s): 705.12(B)(2)(1)(a)

One way of safely making a load tap is by downsizing the main breaker to limit the potential current to the equipment downstream.

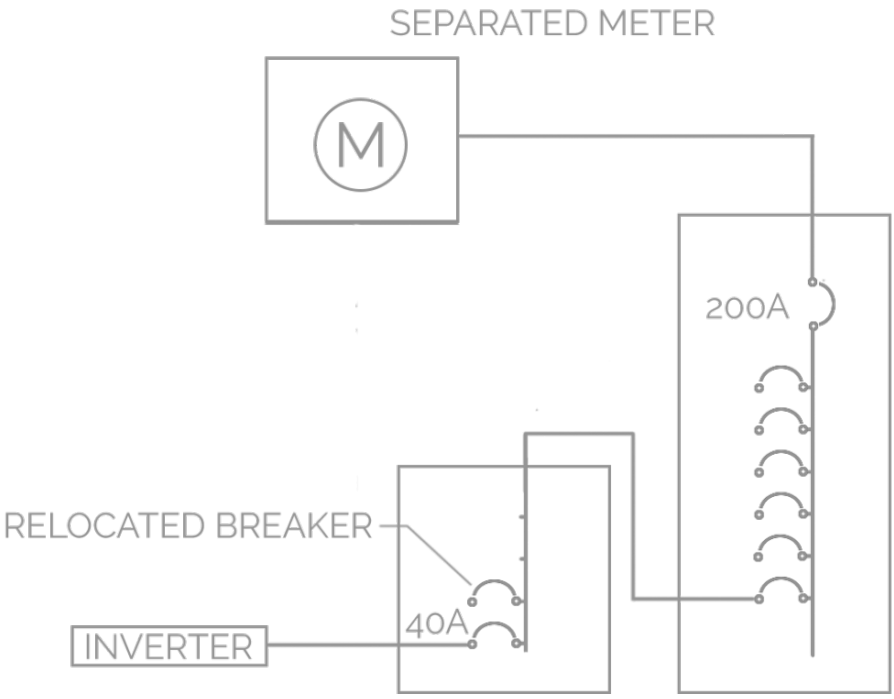
Using the same example as above, if a 200A rated meter-main panel has a downsized 150A main breaker, an inverter with max output of 40A (125% of rated output current) can be connected using a load tap with no issues. This is because the maximum potential current would be 40A + 150A = 190A. Since the equipment is rated for 200A there is no potential for overload.



No Available Breaker Space

When the backfeed breaker option is available but there is no breaker space a sub panel can be added. This would be useful when the jurisdiction does not allow line or load taps.

To add a subpanel, a breaker at the end of the busbar would be removed and a new breaker would be added to feed the subpanel. The load removed to make space for the new breaker would be relocated to the new subpanel along with the backfeed breaker used to interconnect the PV system. In this situation, the sum rule can be used to limit the size of subpanel needed.



Conclusion

There you have it – Solar Interconnections 101. As you can see interconnecting a Solar PV system may not be as straightforward as you might think. With many different service configurations things can certainly get involved.

I hope this article helped make things clear for you. Our goal is help you avoid making costly mistakes on your solar installs so please let me know in the comments if you have other questions about solar interconnections.

120% Rule, Interconnection

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