

Assessing a Site for Installation of Consumption Monitoring

About the Enphase Envoy-S Metered

The Enphase Envoy-S Metered™ communications gateway enables performance monitoring and remote software and firmware updates of an Enphase Microinverter System. In addition, the Envoy-S Metered provides revenue-grade production data and allows for the monitoring of a site’s energy load, thus offering significant advantages over other PV system monitoring equipment. Users can access energy production and consumption data through Enphase Enlighten™ cloud based monitoring software.

To perform both revenue grade production and energy consumption monitoring, the Envoy-S Metered requires current transformers (CTs). This document provides guidance on assessing a site’s potential for monitoring and includes additional tips to help with CT installation. For assistance with revenue grade production monitoring, please refer to the [Enphase Envoy-S Installation and Operation Manual](#).

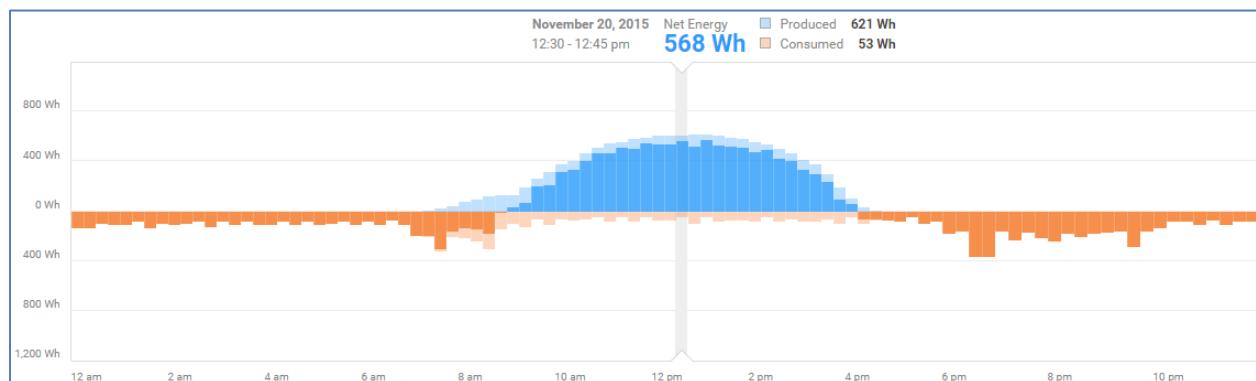
Enphase recommends that an installer or site assessor verify that the site can easily accommodate consumption CTs before approving consumption monitoring as part of the project.

The Envoy-S installs in most single-phase photovoltaic systems. For sites where consumption monitoring cannot be readily accommodated, this document provides a list of potential modifications to the service wiring to allow for consumption monitoring.

About Consumption Monitoring

Consumption monitoring is not required for a typical Enphase System installation, although consumption data is useful in helping a system owner better understand their energy usage related to their Enphase System production. Determining energy consumption is critical for homes that require zero export of Enphase System production to the grid or for potential customers of the Enphase AC Battery™.

Site energy consumption and production shown in MyEnlighten



- Dark Blue: Solar production exported to grid
- Dark Orange: Energy purchased from the utility
- Light Blue: Solar production consumed on site
- Light Orange: Consumption offset by solar

Consumption Current Transformers

Consumption monitoring requires installation of two consumption monitoring CTs on the main service conductors feeding the site. At some sites, the conductors or bussing feeding the main breaker of the service panel are not accessible or do not allow for adequate spacing.

Site Assessment Form

When considering consumption monitoring, first determine if the split-core consumption CTs can be readily installed around the service conductors or busbars. If the consumption CTs cannot be easily installed on the service panel, additional electrical wiring may be required to prepare the site.

To complete the site assessment form, an electrician may need to remove electrical enclosure covers. This must be performed by a competent individual. **Follow all safety and installation instructions in the [Enphase Envoy-S Installation and Operation Manual](#).** If the main electrical meter is installed in a separate enclosure from the main service panel, you can probably install consumption CTs without any additional electrical wiring.

Complete the form below appropriate to your installation.

<i>Separate Meter and Service Panel</i>	<i>YES</i>	<i>NO</i>
Is the utility meter installed in an enclosure separate from the main electrical service panel?		
Do both of the conductors in the main service panel have at least 2.0 inches of accessible length?		
If conductors are present, are they smaller than 350MCM THWN, 350MCM XHHW, or 4/0 RHW? If busbars are present, are they thinner than 0.75 inches?		
Is there adequate space (0.75 inches) around each conductor/busbar to install the consumption CTs?		
If you answered yes to all four questions above, the CTs can be readily installed without rewiring the service equipment.		



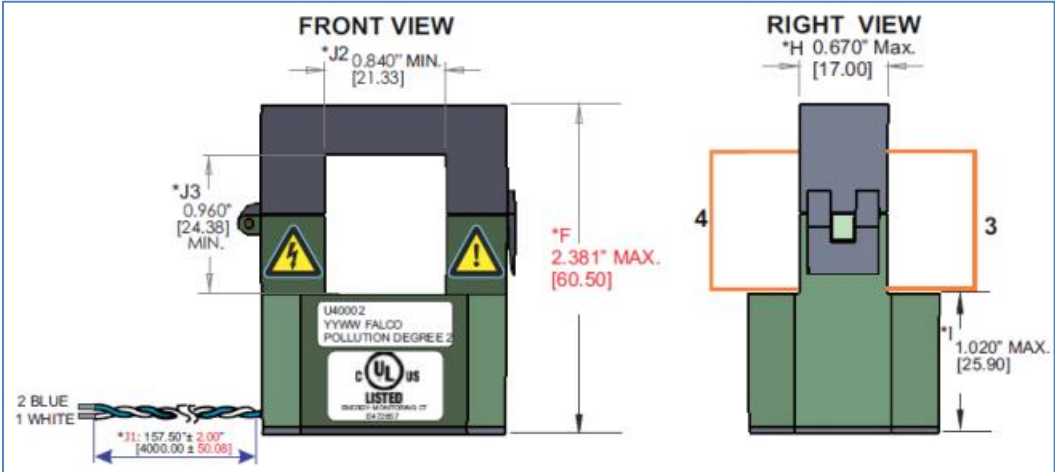
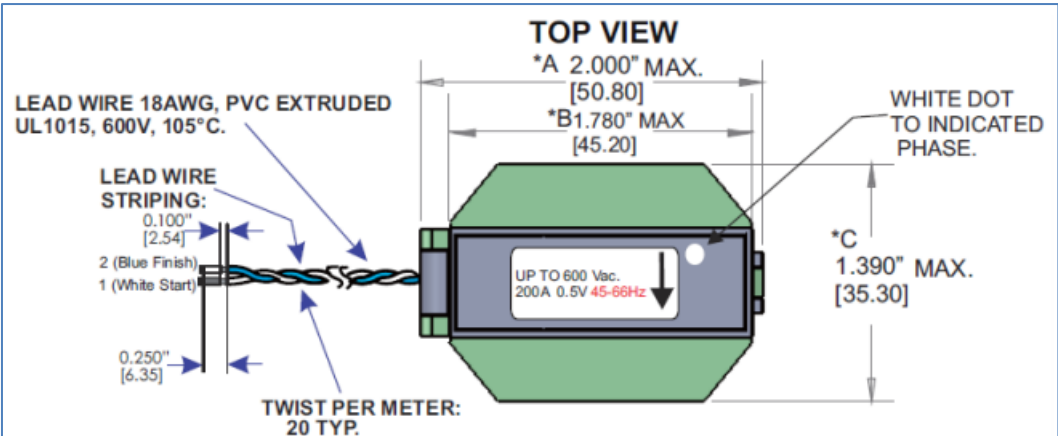
<i>Combined Meter/Main Service Panel</i>	<i>YES</i>	<i>NO</i>
Is the utility meter installed in a combined meter or main service panel?		
Do both of the conductors/busbar in the main service panel have at least 2.0 inches of accessible length?		
If conductors are present, are they smaller than 350MCM THWN, 350MCM XHHW, or 4/0 RHW? If busbars are present, are they thinner than 0.75 inches?		
Is there adequate space (0.75 inches) around each conductor/busbar to install the consumption CTs?		
If you answered yes to all four questions above, the CTs can be readily installed without rewiring the service equipment		



If the service conductors or busbars are not readily accessible for the split core consumption CT installation, this document provides additional tips and best practices that allow for easy installation of the CTs.

200A Consumption CT Dimensions

The split-core consumption CTs open and clamp around an existing conductor or busbar without rewiring. The CTs accommodate conductors up to 4/0 RHW, 350MCM THWN, 350MCM XHHW, or busbars up to 0.75 inches, which is adequate for 200A services.



Location of the Envoy-S Metered

To simplify the wiring of the consumption CTs, locate the AC Combiner Box and/or Envoy-S Metered at or near the main service panel.

If you are installing the Enphase AC Combiner Box, the Envoy-S Metered comes with the production CT and the Envoy-S prewired for power.

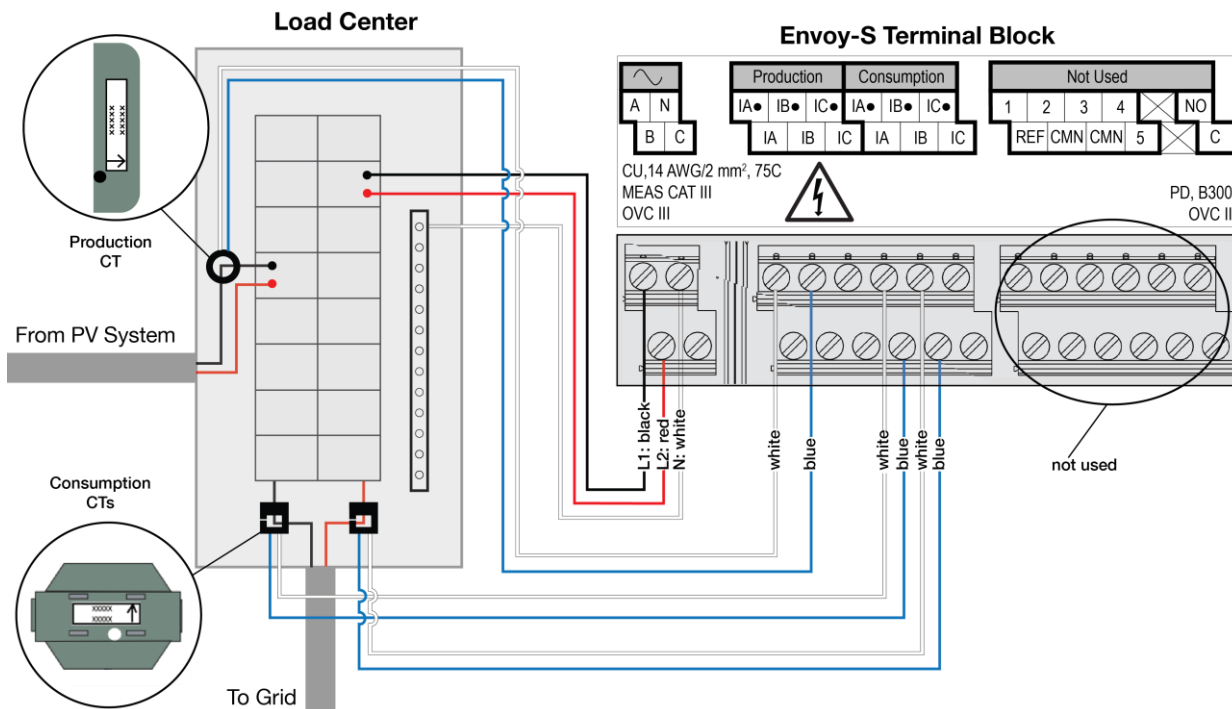


Installation of Consumption CTs

For consumption monitoring to work correctly, you must meet the following installation requirements:

- Attach the consumption CT installed on terminal IA (line 1) to the same line as power terminal A of the Envoy-S. Verify with a voltmeter.
- Make sure that the arrow on the consumption CT faces toward the loads.
- Wire the consumption CTs with the white wire installed on the upper row of wiring terminals and the blue wire installed on the lower row of wiring terminals.
- Do not use the Envoy-S terminal block on the right side.

NOTE: You must install the CT wired to terminal IA on the same line as the Envoy-S power terminal A.



Installing CTs in a simple scenario

When the conductors or busbars between the main service meter and service panel are accessible, complete the wiring as shown above as described in the [Enphase Envoy-S Installation and Operation Manual](#).

Installing CTs in Eaton Service Panels / Solar Power Center

In many of the Eaton Service Panels and in the Eaton Solar Power Center panels, it may appear that the consumption CTs fit on one of the service entrance conductors, but not on both of the service entrance conductors or busbars. However, if you test the voltage across the main breaker, you will find that the line conductors are rotated inside the circuit breaker. This allows for the CTs to be installed so that one is on the conductor above and one is on the bussing below the main breaker.

You must place the breaker in the open position when attaching the CT to the busbar. It may help to loosen the bolt that holds the busbar when attaching the CT.

Install the CTs on the right conductor and right busbar in the Eaton Solar Power Centers.



Installing Multiple Conductors in a Single CT

In some situations, you may need to install multiple conductors within a single CT. This is acceptable as long as you ensure that the conductors terminate on the same line conductor, so the voltage at the terminals of the two conductors will be 0V between them.

There are some challenges to this approach.

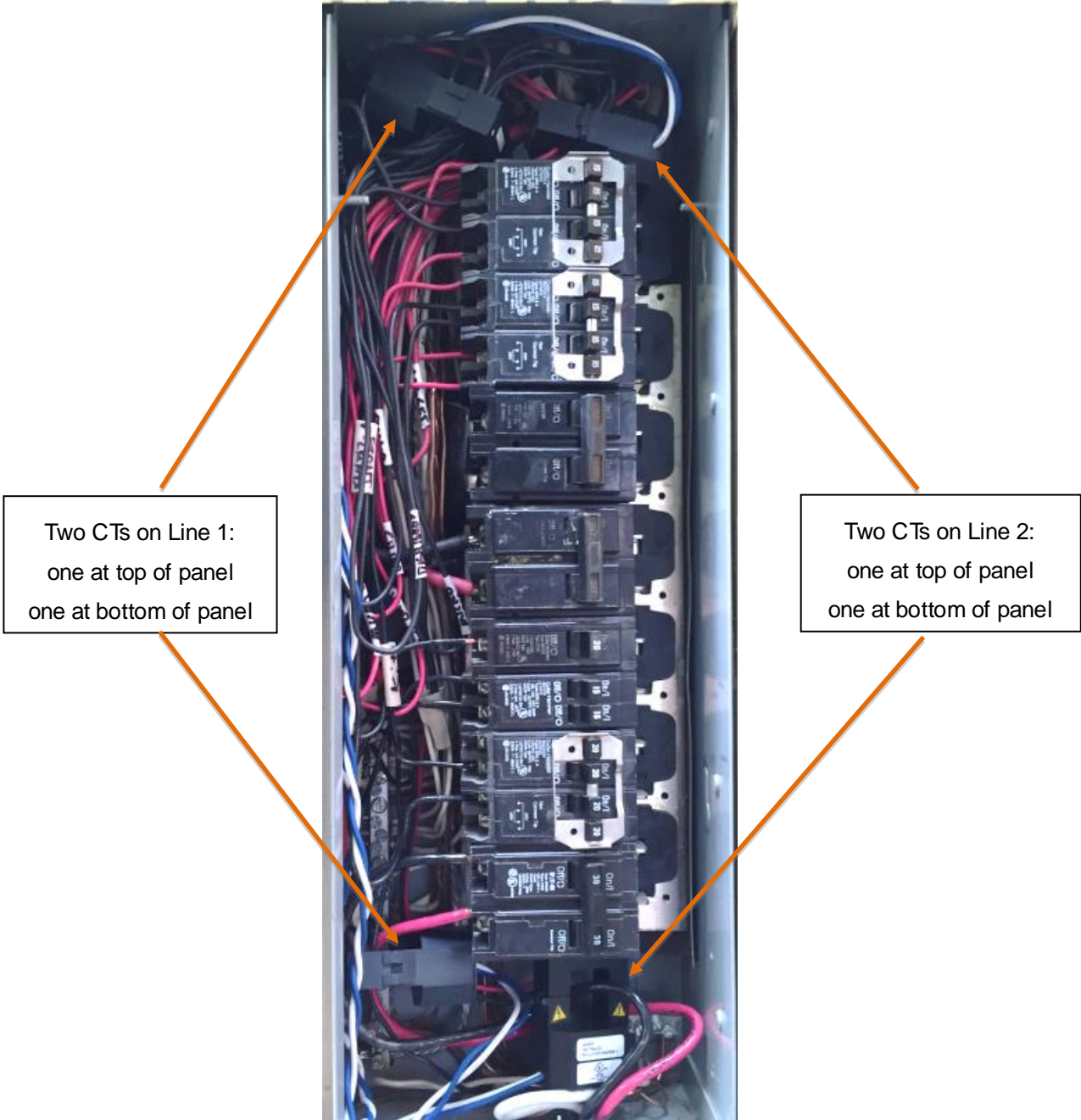
- It is easy to make a wiring error.
- The conductors must fit within the CT.
- All of the conductors on line 1 must be bundled and with the loads on the line 1 CT.
- All of the conductors on line 2 must be bundled and with the loads on the line 2 CT.
- This method may require extending some of the circuits.

It is often possible to run all of the conductors in a service panel through a single set of consumption CTs.

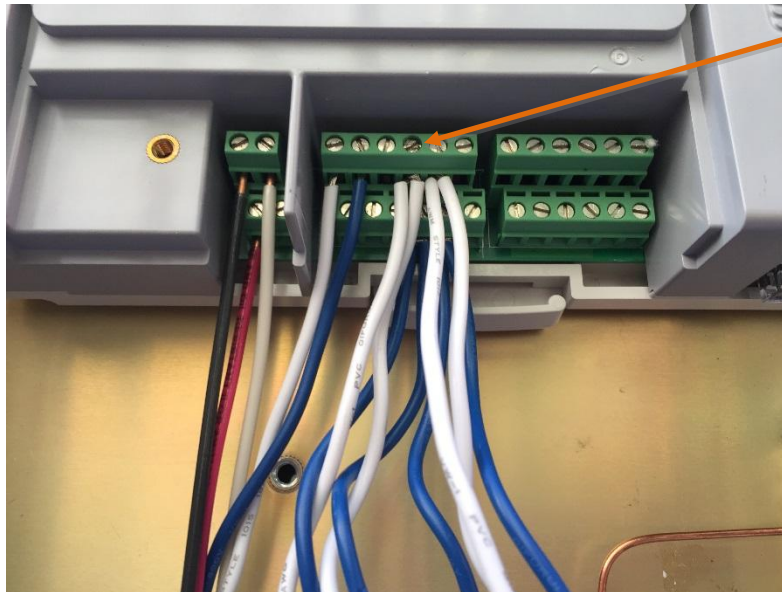


Installing Parallel Connected CTs for 400A Services and Crowded Service Panels

In many scenarios, it is difficult to install multiple conductors through a single CT, because some of the conductors may enter from the bottom of the service panel and others enter from the top of the service panel. Also, some service panels have 400A services that are provided by a set of two 200A conductors and parallel-connected 200A circuit breakers. In those scenarios, it is possible to use a set of parallel-connected consumption CTs to monitor the home's consumption. Do this by installing two consumption CTs on each line conductor and then parallel-connecting the output conductors at the Envoy-S CT wiring terminals or in a wire connector prior to landing in the Envoy-S terminals.



The terminals of the Envoy-S are rated for two #18 CT wires on a single terminal or one #14-#16 conductor.



Two #18 CT wires on a single terminal

Concerns around installing parallel consumption CTs:

- It is easy to make wiring errors
- It is critical to ensure that all of the conductors that pass through the line 1 CT terminate at circuit breakers on the black/line 1.
- Line 2 conductors must pass through the line 2 CT.
- The parallel CTs may not be used to monitor more than 600A of current
- A fill calculation should be made to ensure that no more than 60% of the CT's cross-sectional area is filled with conductors.
- If the solar circuit is not passed through the consumption CTs, the Envoy-S consumption metering setting must be set to Total rather than Net.
- As always, the safety standards spelled out in the National Electrical Code must be observed, particularly in regard to multi-wire branch circuits.

Best practices for installing parallel CTs:

- If needed, rewire the service panel to make additional space for the consumption CTs
- Turn off the main breaker to reduce the risk of electrical shock. Remember to be cautious, as the line side of the main breaker will remain energized when the main breaker is off.
- To simplify the rewiring, flag each conductor passing through the line 2 CT with red tape.
- Be careful to ensure that all red conductors are landed on line 2.
- Ensure that the ungrounded conductors of all multi-wire branch circuits are wired to line conductors opposite from each other. This is critical because these circuits power 120V loads and use a shared neutral.
- Always run multi-wire branch circuits to a common-trip, 2-pole breaker. The neutral wire (grounded conductor) of a multi-wire branch circuit carries the unbalanced current of the two line conductors. If the red and black conductors of the multi-wire branch circuit are tied to the same line, then the neutral will carry the full current of both circuits and may result in damaged conductors and, potentially, a fire.
- Use a tie wrap to hold the line conductors together prior to installing the CT around them.

Calculating Whether Multiple Conductors Fit Within a CT

Use a conductor fill calculation to determine if a given number of conductors can be installed within a single CT. The NEC allows for a 60% fill calculation for conduit sections no longer than 24 inches. A 60% CT fill calculation provides a conservative basis for calculating the number of allowed conductors.

Enphase consumption CT – cross-sectional area				
Enphase consumption CT	100% Fill		60% fill (if multiple conductors)	
		520mm ²	0.806in ²	312mm ²

Dimensions of insulated conductors as specified in the NEC, Chapter 9, Table 5				
Size and Type of Conductor	Approximate Diameter		Approximate Area	
14 AWG THWN	2.819mm	0.111in	6.258mm ²	0.0097in ²
12 AWG THWN	3.302mm	0.130in	8.581mm ²	0.0133in ²
10 AWG THWN	4.166mm	0.164in	13.61mm ²	0.0211in ²
8 AWG THWN	5.486mm	0.216in	23.61mm ²	0.0366in ²
6 AWG THWN	6.452mm	0.254in	32.71mm ²	0.0507in ²
4 AWG THWN	8.230mm	0.324in	53.16mm ²	0.0824in ²
3 AWG THWN	8.941mm	0.352in	62.77mm ²	0.0973in ²
2 AWG THWN	9.754mm	0.384in	74.71mm ²	0.1158in ²
1 AWG THWN	11.33mm	0.446in	100.8mm ²	0.1562in ²
1/0 AWG THWN	12.34mm	0.486in	119.7mm ²	0.1855in ²
2/0 AWG THWN	13.51mm	0.523in	143.4mm ²	0.2223in ²
3/0 AWG THWN	14.83mm	0.584in	172.8mm ²	0.2679in ²
4/0 AWG THWN	16.31mm	0.642in	208.8mm ²	0.3237in ²
250 MCM THWN	18.06mm	0.711in	256.1mm ²	0.3970in ²
300 MCM THWN	19.46mm	0.766in	297.3mm ²	0.4608in ²
350 MCM THWN	20.75mm	0.817in	338.2mm ²	0.5242in ²

Based upon a 60% fill calculation, thirteen #8 THWN or thirty-six #12 THWN conductors can be installed within a single CT.

$$\frac{60\% \text{ of CT Cross – Sectional Area}}{\text{Area of Conductor}}$$

$$\frac{312\text{mm}^2}{8.581\text{mm}^2} = \text{Maximum } 36 - \#12 \text{ THWN conductors}$$

Example Calculations for a Service Panel

Suppose a service panel contains the following line conductors:

Circuit Description	Breaker Ampacity	Line Conductors	Conductor Type and Size	L1 – Black Conductor Area	L2 – Red Conductor Area
Electric heating	50	1 and 2	2 - #6 THWN	0.0507in ²	0.0507in ²
Oven	50	1 and 2	2 - #6 THWN	0.0507in ²	0.0507in ²
Stove top	40	1 and 2	2 - #8 THWN	0.0366in ²	0.0366in ²
Air conditioner	30	1 and 2	2 - #10 THWN	0.0211in ²	0.0211in ²
Electric dryer	30	1 and 2	2 - #10 THWN	0.0211in ²	0.0211in ²
Pool pump	30	1 and 2	2 - #10 THWN	0.0211in ²	0.0211in ²
Pool filter	30	1 and 2	2 - #10 THWN	0.0211in ²	0.0211in ²
Hot tub	40	1 and 2	2 - #8 THWN	0.0366in ²	0.0366in ²
Lights 1	20	1	1 - #12 THWN	0.0133in ²	
Lights 2	20	2	1 - #12 THWN		0.0133in ²
Lights 3	20	1	1 - #12 THWN	0.0133in ²	
Lights 4	20	2	1 - #12 THWN		0.0133in ²
Lights 5	20	1	1 - #12 THWN	0.0133in ²	
Lights 6	20	2	1 - #12 THWN		0.0133in ²
Receptacles 1	20	1	1 - #12 THWN	0.0133in ²	
Receptacles 2	20	2	1 - #12 THWN		0.0133in ²
Receptacles 3	20	1	1 - #12 THWN	0.0133in ²	
Receptacles 4	20	2	1 - #12 THWN		0.0133in ²
Receptacles 5	20	1	1 - #12 THWN	0.0133in ²	
Receptacles 6	20	2	1 - #12 THWN		0.0133in ²
Receptacles 7	20	1	1 - #12 THWN	0.0133in ²	
Receptacles 8	20	2	1 - #12 THWN		0.0133in ²
Total				0.3521in²	0.3521in²

- The sum of the cross-sectional areas of these conductors could fit into a single set of consumption CTs.
- A consumption CT filled to 60% of the cross-sectional area can accommodate 0.484in² of conductors.
- The sum of these homes conductors is 0.3521in².

Retrofitting the Electrical Service for CT Installation

In the case where CTs cannot be installed on the existing service conductors, additional wiring may allow the installation of consumption CTs. One option is to request access to the utility's service conductors, and then connect the CTs in the utility side of the service panel.

Another option would be to work with the utility to relocate the main service meter in a separate enclosure from the main service panel. By relocating the main meter in a separate enclosure, the old utility side of the main service panel is accessible for wiring of the consumption CTs. If relocating the service meter, the old service meter base must be covered off with a service cover blank, and meter jumper bars must be installed in the old meter base.



Extending the Consumption CT Conductors

Consumption CT wires can be extended, but the production CT wires cannot be extended. Follow the recommendations in the [Enphase Envoy-S Installation and Operation Manual](#), which specifies the following conductor sizes and maximum wiring distances between the consumption CTs and the main service.

- 57.6 meters (189 feet) of 18AWG 7 strand Cu = 1.5Ω (3Ω - 2 way wire length)
- 91.7 meters (301 feet) of 16AWG 7 strand Cu = 1.5Ω (3Ω - 2 way wire length)
- 148.4 meters (478 feet) of 14AWG 7 strand Cu = 1.5Ω (3Ω - 2 way wire length)

When extending the consumption CTs, use CL3R type, 4 conductor cable, #14-4, #16-4, or #18-4 security cable. CL3R cable is readily available at many local hardware stores. CL3R meets the requirements for indoor and outdoor installations. Installation requirements are detailed in Article 725 for Power Limited Circuits and applications are detailed in Table 725.154 of the National Electrical Code.

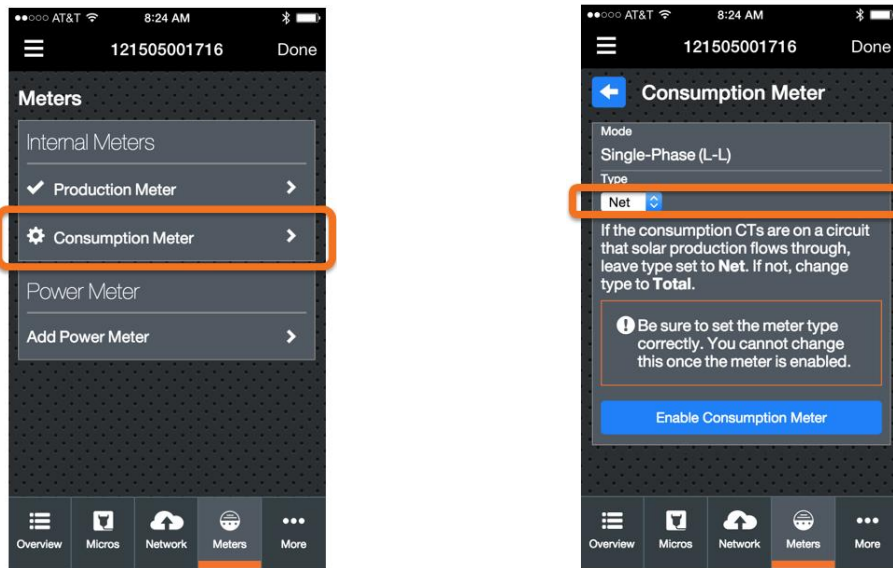


Net Consumption versus Total Consumption

To commission consumption monitoring with the Installer Toolkit mobile app, you must first push the top button on the Envoy-S, which places the Envoy into wireless access point mode (AP mode.) Once the Envoy is in AP Mode, you can connect your smartphone to its Wi-Fi network, through your phones Wi-Fi settings page. You can then open the Installer Toolkit app and connect to the Envoy-S.

When commissioning consumption monitoring with the Installer Toolkit mobile app, select **Meters** and then select the type. Consider the following, when selecting the type:

- **Net** - If the solar production CT is installed on the load side of the consumption CTs, then you can leave the consumption meter set as Net.
- **Total** - If the solar array is line side connected or if the solar production CT is installed on a separate circuit from the consumption CTs, then select Total.



Monitoring with the Installer Toolkit Mobile App

The Installer Toolkit allows you to monitor and troubleshoot consumption monitoring once it has been configured. You can view production and consumption data from the Installer Toolkit Overview page, as long as the phone and Envoy-S are paired in AP Mode. This data is near real-time consumption data that updates every 60 seconds. A blue “updating” bar displays every 60 seconds on the upper edge of the screen, to indicate that production and consumption data is updating.

Once the system is installed, the system owner has access to the consumption data from Enphase MyEnlighten or from their Enlighten system page. The consumption monitoring is available to the system owner in both MyEnlighten and Enlighten Manager, but is not available to installers without permission from the system owners.

Troubleshooting

One method to validate that the consumption monitoring is installed correctly is to turn off the PV system and then validate that the consumption reported by the Installer Toolkit app is the same as what the main service meter is reporting. This requires that the smartphone is paired to the Envoy in AP Mode.

If the consumption monitoring does not match the main service meter data, take these steps.

- Confirm that the consumption meters are monitoring all circuits of the main service meter.
- Confirm that the consumption CT on line 1 is wired to the terminal IA (line 1) of the Envoy-S Metered. These are the fourth CT wiring terminals from the left.
- Confirm that the CT on line 2 is wired to the terminal IB (line 2.) These are the fifth CT wiring terminals from the left.
- Confirm that the service conductor (line 1) is the same conductor that is wired to Power Terminal A (line 1) of the Envoy-S Metered. Confirm this by testing the voltage between line 1 at the main service panel and Power Terminal A of the Envoy-S Metered. The voltage should be 0V between these terminals and 240V between Line 1 of the main service and Power Terminal B (line 2) of the Envoy-S Metered.
- Confirm that the consumption CTs are installed with the arrow facing toward the site loads.
- Confirm that the consumption CTs are installed with the white conductor on the top terminal and the blue conductor on the bottom terminal.
- If installing multiple conductors in a single CT, turn on the load breakers individually and confirm with the Installer Toolkit app that each circuit increases the load being reported. If the consumption monitoring is reporting a negative load, the line conductor and the CT are likely not aligned.

Viewing Sites with Consumption Monitoring

Actual Sites with Consumption Monitoring

Enphase allows access to actual sites that use consumption monitoring. You can view these using the demo login info provided below:

<https://enlighten.enphaseenergy.com/pv/systems/67?osv=1> (Eich Residence)

<https://enlighten.enphaseenergy.com/pv/systems/283776?osv=1> (Brown Residence)

You will be prompted to log in. Use the following email/password:

- email: demo@enphase.com
- password: Enlighten!

Select the Systems page to select one of the systems above. Once viewing the system, select the MyEnlighten button on the top right to view the homeowner view of consumption monitoring, or select the **Graph** tab in Enlighten Manager to view the Enlighten Manager view.

Gaining access to a sites consumption monitoring data

As an installer, if you want access to the consumption monitoring of a customer system, you can request it from the Enlighten system's **Devices** page by selecting the Consumption Meter.

There are two Enlighten Help topics on this. One for the installer and one for the homeowner:

- For Homeowners:
<http://www2.enphase.com/myenlighten-help/tip/how-do-i-give-access-to-my-consumption-data-to-other-users/>
- For Installers:
<http://www2.enphase.com/enlighten-help/tip/i-know-that-a-system-has-a-consumption-meter-installed-why-cant-i-see-the-data-in-enlighten/?m=mgr>.