QA Quality Assurance

Residential Supply-Side Interconnection

A supply-side connection offers some real advantages to the designer of a grid-connected photovoltaic system. In particular, the rated output current of a PV system using a supply-side connection may be as large as the ampacity of the service entrance conductors, which is usually considerably more than the permitted output current of a load-side connection. But this increased flexibility in system size often comes hand in hand with added complexity and cost because the installation requires adding a new service disconnect and service entrance conductors.

Many homes today are built with an all-in-one service entrance device that combines the utility meter, the main circuit breaker—which acts as the service disconnecting means—and a distribution panelboard or load center. Making a supply-side connection can be impossible in this case because tapping the internal conductors or busbars may void both the device's listing and the manufacturer's warranty.

With older construction, however, you occasionally encounter an all-in-one service entrance device in which a single main breaker does not protect the busbars between the utility meter and the circuit breakers. Backfeeding a PV breaker in this type of panel looks like a load-side connection, but it is actually a supply-side connection. Knowing the difference helps you design a safe *Code* compliant PV system, and it just might save you time and money during the installation.

Background

Article 690.64(A) of the *National Electrical Code* allows the point of connection to be made before the building's service disconnecting means. Typically this means tapping the service entrance conductors between the utility meter and the main circuit breaker, adding a fused disconnect and then connecting the output of the PV system to the new disconnect. Article 230 covers many of the requirements for these changes.

In the simplest case, there are only two service disconnecting means after the PV installation: the original main breaker or switch and the new fused disconnect for the PV system. Article 230.71 allows up to six disconnects per service. Frequently this is referred to as the *six-handle rule* and simply means that it should take no more than six movements of your hand to completely shut off all electrical service to the home. The six handles may be a combination of disconnect switches and circuit breakers, and they should all be grouped together with each clearly labeled as a service disconnect.

Other considerations may be important. Because the service entrance conductors do not have overcurrent protection at the point where they receive their supply, in a fault condition they would be subjected to the full brunt of the fault current available from the utility transformer. Wiring should follow established best practices, and it never CONTINUED ON PAGE 18

Figure 1 The sealed portion (lower left) of this all-in-one service entrance device houses the utility's service lateral, which comes in underground and feeds the meter portion of the device (lower right). The top portion of the device is the distribution panel.

Courtesy McCalmont Engineering (2)

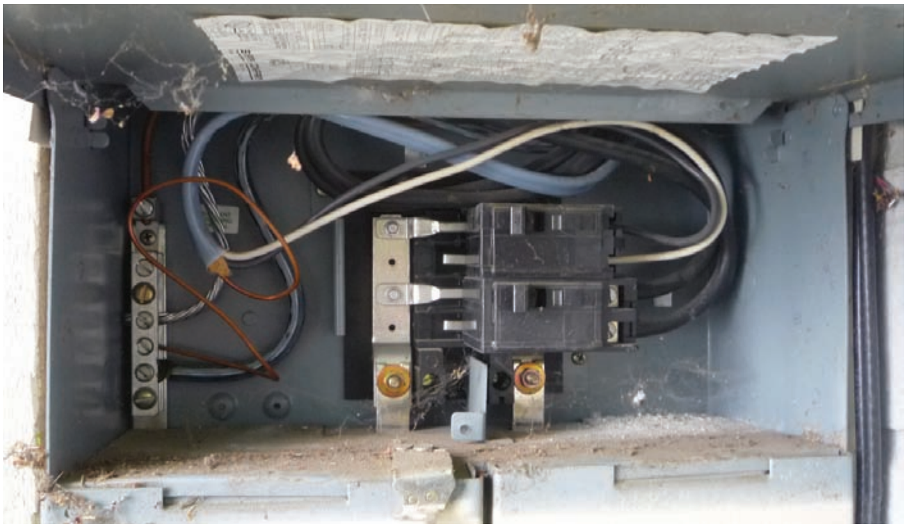
Figure 2 Opening the cover of the distribution panel reveals a stamped dead plate cover identifying any installed breakers as service disconnecting means.

hurts to check with the local AHJ to determine if there are any special requirements for the conductors.

A Simpler Supply Side

The photograph in Figure 1 (p. 16) shows a residential service entrance panel, and Figure 2 (p. 16) shows the same panel with the front cover open. At a glance it looks like a typical all-in-one device. The utility's service lateral comes underground through the sealed portion of the enclosure at the lower left, passes through the meter portion of the box at the lower right, then feeds the distribution panel at the top.

Looking more closely at the top section, you can see indications that there might be something different about this particular distribution panel. First, there are only two breakers: a 100 A breaker feeding a subpanel in the garage on the bottom and a 40 A breaker for the air conditioning above it. If the 100 A breaker were the main breaker, it would be unusual for there to be only one additional two-pole breaker in the entire panel. Second, to the left of the four blank breaker slots the words *Service Disconnect* are stamped into the steel dead front panel cover. This indicates that breakers in these slots will be connected directly to the service entrance conductors.



Courtesy McCalmont Engineering

Figure 3 After the dead plate cover is removed, it is evident that any breaker installed in this main distribution panel is fed directly from the service entrance conductors, which in this case are the panel busbars. Note that the white conductor landed on the 40 A HVAC breaker is allowed according to *NEC* 200.7(C)(1) as part of a cable assembly; however, this conductor should be permanently reidentified, with red tape or paint, wherever it is visible and accessible.

Figure 3 shows the top section of the all-in-one with the dead front panel removed. Now it is possible to see how the device is constructed. In particular, notice that the conductors from the meter socket come up through the bottom of the compartment and directly feed the busbars for all the breakers, not just the two already installed but also any additional breakers added to the left side. There is no single main breaker; in fact, *all* the breakers in this panel function as main breakers, or more correctly, service disconnecting means.

In this case, it is simple to add a new two-pole breaker in the enclosure, to the left of one of the existing breakers. Note that this looks exactly like the typical load-side connection, as it is a backfed breaker in an existing all-in-one enclosure. However, in this case you are actually making a supply-side connection because the busbars inside the all-in-one panel are the service entrance conductors. The new circuit breaker becomes a new service disconnecting means for the PV system, equivalent to the fused disconnect typically used. No new service entrance conductors are required, as the busbars already exist and need no modification to add an additional breaker. Finally, the all-in-one service entrance device shown is rated for 200 amps. With a load-side connection, the PV system would be limited to a 40 A breaker or less, using the 120% rule of Article 690.64(B)(2). Since this is a supply-side connection, however, the system can be significantly larger, up to the rating of the service.

When selecting a breaker for the PV system, you must match the interrupt rating to the available fault current from the utility transformer. In most cases matching the amps interrupting capacity of the existing breakers suffices, but a better approach is to ask the utility what the available fault current is for the location and then select a breaker with an appropriate interrupt rating.

As always, special conditions must be considered. Although the all-in-one device is rated for a 200 A service, it might restrict the size of each breaker to something less than the total rating. Carefully read the device label to ensure that the new breaker does not exceed the manufacturer's guidelines. In this case, there are only two breakers in the device prior to adding the PV breaker, but many times there will be more. If there are already six (or more!), some of the circuits need to be moved to a subpanel before a PV breaker can be added. Look out for tandem or quad breakers because each handle counts separately. Also remember that each breaker must be clearly labeled as a service disconnecting means.

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