



Notes:

- (1) These diagrams are intended to be a means of identification for power source components, circuits, and connections.
- (2) The power source disconnect in these diagrams separates the power source from other systems.
- (3) Equipment disconnecting means not shown.
- (4) System grounding and equipment grounding are not shown.
- (5) Custom designs occur in each configuration, and some components are optional.

INFORMATIONAL NOTE FIGURE 705.1 Identification of Power Source Components in Common Configurations

Article 705 contains requirements for interconnecting power production sources that operate in parallel as distributed generation. It does not cover sources that are connected by a transfer switch that permits operation of a single source. The primary source is not required to be a utility source. The requirements of Article 705 are not dependent on the type of generating source employed. These installations are subject to the entire *NEC*[®], as detailed in 90.3.

705.5 Parallel Operation.

(A) Output Compatibility. Power production sources operating in parallel with a primary source of electricity or other power

production sources shall have compatible voltage, wave shape, and frequency ratings.

(B) Synchronous Generators. Synchronous generators operating in parallel with a primary power source shall be installed with the required synchronizing equipment.

Informational Note: See IEEE 1547, *Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces*, and UL 1741, *Standard for Inverters, Converters, Controllers and Interconnection System Equipment for Use with Distributed Energy Resources*, for utility interconnection.

Control of the power production source should include real power, reactive power, and harmonic content of the output. The output characteristics of a rotating generator are significantly different from those of a solid-state power source.

The parallel operation of generators is a complex balance of several variables that are design parameters and therefore beyond the scope of the *NEC*.

Some inverters, uninterruptible power supplies (UPS), or solid-state variable-speed drives may produce harmonic currents. (See Exhibit 705.1.) The multiples of the basic supply frequency (usually 60 hertz) can cause additional heating, which could require derating of generators, transformers, cables, and motors. Special generator voltage control systems are required to avoid erratic operation or destruction of control devices. Circuit breakers could require derating if the higher harmonics become significant.

In Exhibit 705.1 (middle), motors and transformers will be driven by harmonic-rich voltage and might require derating. In Exhibit 705.1 (bottom), the source generator could require derating, and special voltage control might be needed.

705.6 Equipment Approval. Interconnection and interactive equipment intended to connect to or operate in parallel with power production sources shall be listed for the required interactive function or be evaluated for the interactive function and have a field label applied, or both.

Informational Note No. 1: See UL 1741, *Standard for Inverters, Converters, Controllers and Interconnection System Equipment for Use with Distributed Energy Resources*, for evaluating interconnected equipment. Sources identified as stand-alone, interactive, or multimode are specifically identified and certified to operate in these operational modes. Stand-alone sources operate in island mode, interactive sources operate in interactive mode, and multimode sources operate in either island mode or interactive mode. Stand-alone sources are not evaluated for interactive capabilities.

Informational Note No. 2: An interactive function is common in equipment such as microgrid interconnect devices, power control systems, interactive inverters, synchronous engine generators, ac energy storage systems, and ac wind turbines.