

Application Note: Interconnection Guidelines for Yaskawa Solectria Solar Transformerless Inverters

XGI 1000:

XGI 1000-50/60-UL, XGI 1000-60/60-UL,
XGI 1000-60/65-UL, XGI 1000-65/65-UL

XGI 1500:

XGI 1500-125/125-UL, XGI 1500-125/150-UL,
XGI 1500-150/166-UL, XGI 1500-166/166-UL,
XGI 1500-175-480, XGI 1500-200/200-480,
XGI-225-600, XGI 1500 250/250-600

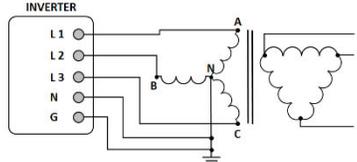
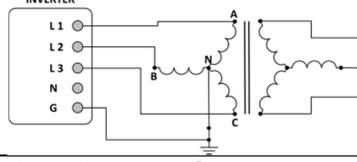
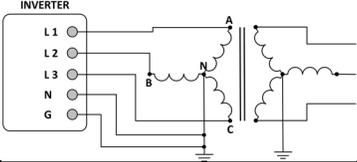
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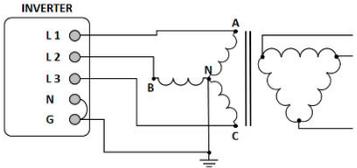
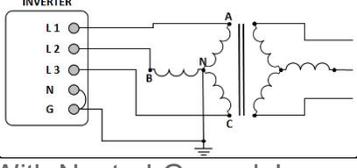
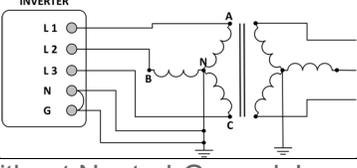
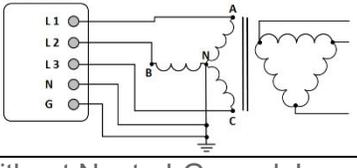
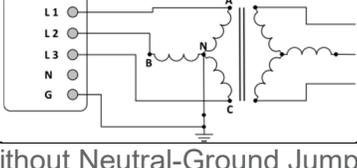
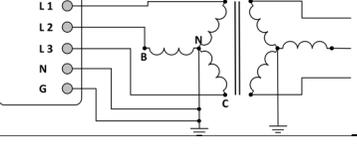
1. Interconnection Service Requirements

Yaskawa Solectria Solar’s XGI 1000 and XGI 1500 three-phase transformerless inverters require connection to a wye configured service with solidly grounded neutral. The neutral conductor is used by the XGI inverter for voltage sensing and does not carry current. Therefore, the size of the neutral conductor may be reduced to the same size (not smaller) as the EGC. Acceptable service configurations are depicted in the table below.

In the XGI 1500 a jumper between the neutral terminal of the inverter and ground inside the inverter wiring box is not necessary since the inverter internally bonds them together. In this configuration a physical neutral conductor from the transformer to ground is optional, but not required. Ultimate approval of such configuration lies with the authority having jurisdiction (AHJ). Please contact Yaskawa Solectria Solar should you have any questions.

Acceptable Service Configurations

| XGI 1500 Inverter-Side Transformer Winding | System Configuration | XGI 1500 Utility-Side Transformer Winding | XGI 1500 Inverter Compatibility |
|---|--|--|---------------------------------------|
| Grounded-WYE | Without Neutral-Ground Jumper  | Delta | Compatible |
| Grounded-WYE | Without Neutral-Ground Jumper  | WYE | Compatible |
| Grounded-WYE | Without Neutral-Ground Jumper  | Grounded-WYE | Compatible |

| XGI 1000 Inverter-Side Transformer Winding | System Configuration | XGI 1000 Utility-Side Transformer Winding | XGI 1000 Inverter Compatibility |
|---|--|--|---------------------------------------|
| Grounded-WYE | With Neutral-Ground Jumper  | Delta | Compatible |
| Grounded-WYE | With Neutral-Ground Jumper  | WYE | Compatible |
| Grounded-WYE | With Neutral-Ground Jumper  | Grounded-WYE | Compatible |
| Grounded-WYE | Without Neutral-Ground Jumper  | Delta | Compatible |
| Grounded-WYE | Without Neutral-Ground Jumper  | WYE | Compatible |
| Grounded-WYE | Without Neutral-Ground Jumper  | Grounded-WYE | Compatible |

Note: Any system configurations not shown in the tables above are NOT compatible with the XGI 1000 or XGI 1500 inverters, and an intermediary transformer must be used.

2. Paralleling Multiple Inverters

2.1 Maximum Numbers of Inverters in Parallel

Yaskawa Solectria Solar's XGI 1000 and XGI 1500 three-phase, transformerless inverters may be connected in parallel to one common point of connection in a single building block using up to the following number of inverters:

| Inverter Model | Allowed Parallel Qty. |
|--|------------------------------|
| XGI 1000-50/60-UL, XGI 1000-60/60-UL, XGI 1000-60/65-UL, XGI 1000-65/65-UL | 60 inverters per transformer |
| XGI 1500-125/125-UL, XGI 1500-125/150-UL XGI 1500-150/166-UL, XGI 1500-166/166-UL | 30 inverters per transformer |
| XGI 1500-175-480, XGI 1500-200/200-480, XGI-225-600, XGI 1500 250/250-600 | 30 inverters per transformer |

2.2 Direct Connection to Grid Service

The Yaskawa Solectria Solar XGI 1000 and XGI 1500 three phase transformerless inverters may be installed in parallel with AC output at a single point of connection creating a low voltage building block. The low voltage blocks may then be connected directly to a grid service without a step-up transformer if the inverter AC voltage matches the supply voltage. The requirements for this set-up are:

1. The grid's nominal voltage/frequency and variation range must follow U.S. grid standard/code.
2. The inverter AC voltage must match the supply voltage.
3. System voltage drop between the inverter's AC output and the grid connection point should not significantly affect the grid voltage at the inverter. If the system AC voltage drop is too high, the inverter will disconnect from the grid due to excessive voltage. The AC side wiring voltage drop should be limited to minimize power loss in the wires. **Therefore, Yaskawa Solectria Solar recommends the AC voltage drop be < 2% of Vnom (nominal AC voltage) at maximum power production.** The temperature rise in cables and the ambient temperature should be considered in the voltage drop calculation.

| Inverter Model | Nominal Voltage |
|---|-----------------|
| XGI 1000-50/60-UL, XGI 1000-60/60-UL, XGI 1000-60/65-UL, XGI 1000-65/65-UL, XGI 1500-175-480, XGI 1500-200/200-480 | 480/277 VAC |
| XGI 1500-125/125-UL, XGI 1500-125/150-UL, XGI 1500-150/166-UL, XGI 1500-166/166-UL, XGI-225-600, XGI 1500 250/250-600 | 600/347 VAC |

2.3 Connection via Transformer

The use of a transformer is acceptable if required to step-up/down nominal voltage and/or to comply with the above acceptable service configurations for Yaskawa Solectria Solar's XGI 1000 and XGI 1500 three-phase transformerless inverters.

If the connection to the grid is through a transformer, then the following additional requirements apply:

1. The transformer impedance must be no greater than 6%.
2. No oversizing of the transformer is required by Yaskawa Solectria Solar. However, the transformer VA rating must be at least the sum of the kVA ratings of all the inverters connected to it.
3. Additionally, it is suggested that the transformer be selected based on IEEE C57.159-2016 Guide on Transformers for Application in Distributed Photovoltaic (DPV) Power Generation Systems and IEEE C57.91-2011 Guide for Loading Mineral Oil Immersed Transformers. It is the responsibility of the system designer to determine the reliability of the transformer and other system parameters.

Example 1: 4.5 MW building block with XGI 1500-225 inverters set to default kVA of 225kVA

The XGI 1500-225 inverters have a standard, continuous, apparent output power rating of 225 kVA. If twenty (20) of these inverters are paralleled onto one winding of a transformer, the minimum rating of the transformer should be calculated by the following:

$$\begin{aligned} &(\# \text{ inverters}) \times (\text{inverter apparent power rating}) = \text{minimum apparent power rating of} \\ &\text{transformer} \\ &20 \times 225 \text{ kVA} = 4,500 \text{ kVA or } 4.5 \text{ MVA} \end{aligned}$$

A transformer with a **minimum** rating of 4.5 MVA may be used with (20) XGI 1500-225 inverters in the default standard mode and connected in parallel to a secondary winding or to the low voltage side of the transformer.

Example 2: 4.5 MW building block with XGI 1500-225 inverters, apparent power overhead mode (via password protected selection)

XGI 1500-225 inverters in apparent power overhead mode have a continuous apparent output power rating of 250 kVA. If twenty (20) of these inverters are paralleled onto one winding of a transformer, the minimum rating of the transformer should be calculated by the following:

$$\begin{aligned} &(\# \text{ inverters}) \times (\text{inverter apparent power rating}) = \text{minimum apparent power rating of} \\ &\text{transformer} \\ &20 \times 250 \text{ kVA} = 5,000 \text{ kVA or } 5 \text{ MVA} \end{aligned}$$

A transformer with a **minimum** rating of 5 MVA may be used with (20) XGI 1500-225 inverters in apparent power overhead mode connected in parallel to a secondary winding or to the low voltage side of this transformer.

Conclusion

System designs utilizing multiple inverters in parallel must follow the above recommendations. Additional requirements for installation of these inverters can be found in their respective Installation and Operation Manuals (<https://www.solectria.com/support/documentation/>). It is recommended that customers contact a Yaskawa Solectria Solar Application Engineer to review projects with complex AC system designs.

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