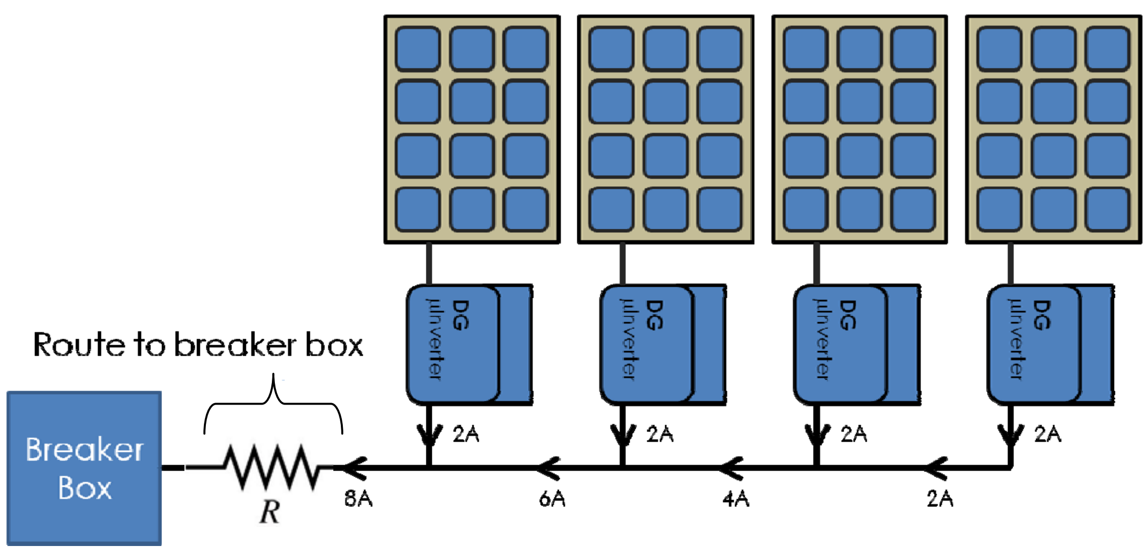
MICRO INVERTERS VOLTAGE RISE CALCULATIONS

Line Voltage Rise

When micro inverters are strung together on an (end fed) AC branch, each segment carries more current as you get closer to the breaker.

Voltage (V)= Current (I) x Resistance (R)···each segment of the AC branch has a finite resistance R. As a result, there is a voltage rise from the breaker to the last inverter on the branch.



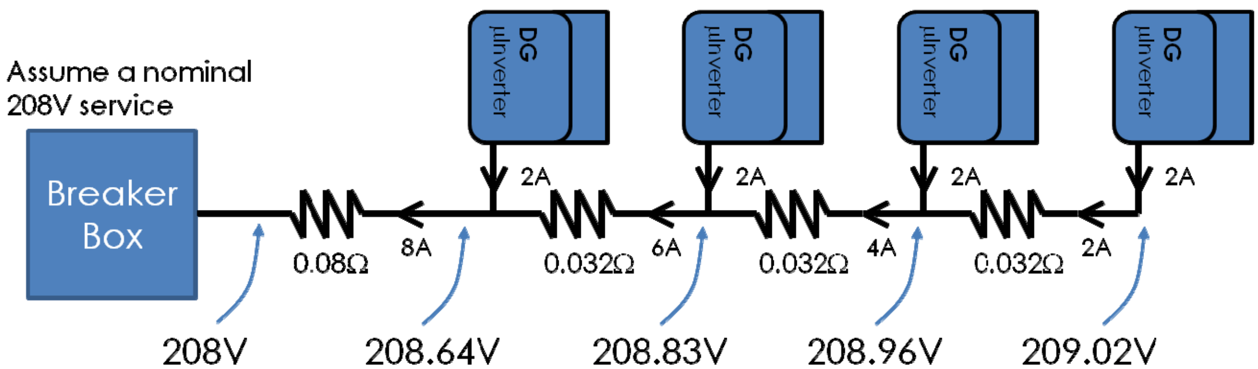
Direct Grid Technologies, LLC
131 Heartland Blvd.
Edgewood, NY 11717
P: 631.242.1900
F: 631.242.1901
E:info@directgrid.com

MICRO INVERTERS VOLTAGE RISE CALCULATIONS (cont.)

Example of Voltage Rise Calculation

Assume the Following:

- MIcro inverters are placed 4 meters apart.
- The common route from the breaker to the first inverter (trunk route) is 10 meters long.
- Each micro inverter can provide a max of 2A.



Why are all these resistances double 0.004 /m*length?
Answer: Because there are 2 lines to an AC connection, each with a resistance.

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Why Should You Care About Voltage Rise?

- Per UL and VDE standards inverters have to shut off if the line voltage exceeds 10%
- For a 208V service, this would be around 228V above nominal.
- Assuming it could be within reason for the service at your site to run 5% high to start with. In such a scenario, there is only a 5% budget left for voltage rise (about 10V)
- Our previous example with only 4 inverters with 10AWG AC branch was well below 10V, but lets consider a larger AC branch with 16 inverters (below)

Example with 16 inverters in “end fed” AC Branch

General Formula for Rise in AC Branch:

$$V_{rise} = N * I_{\max} * R_{trunk} + \left(\frac{N^2 + N}{2} - 1 \right) * I_{\max} * R_{inv\,2inv}$$

For this Example: $I_{max} = 2A$, $R_{trunk} = 0.08\Omega$, $R_{inv2inv} = 0.032\Omega$, $N=16$

$$V_{rise} = 16 * 2 * 0.08 + \left(\frac{256 + 16}{2} - 1 \right) * 2 * 0.032 = 11.2V$$

At 11.2V, 16 four meter spaced inverters “end fed” with 10AWG would be an issue.

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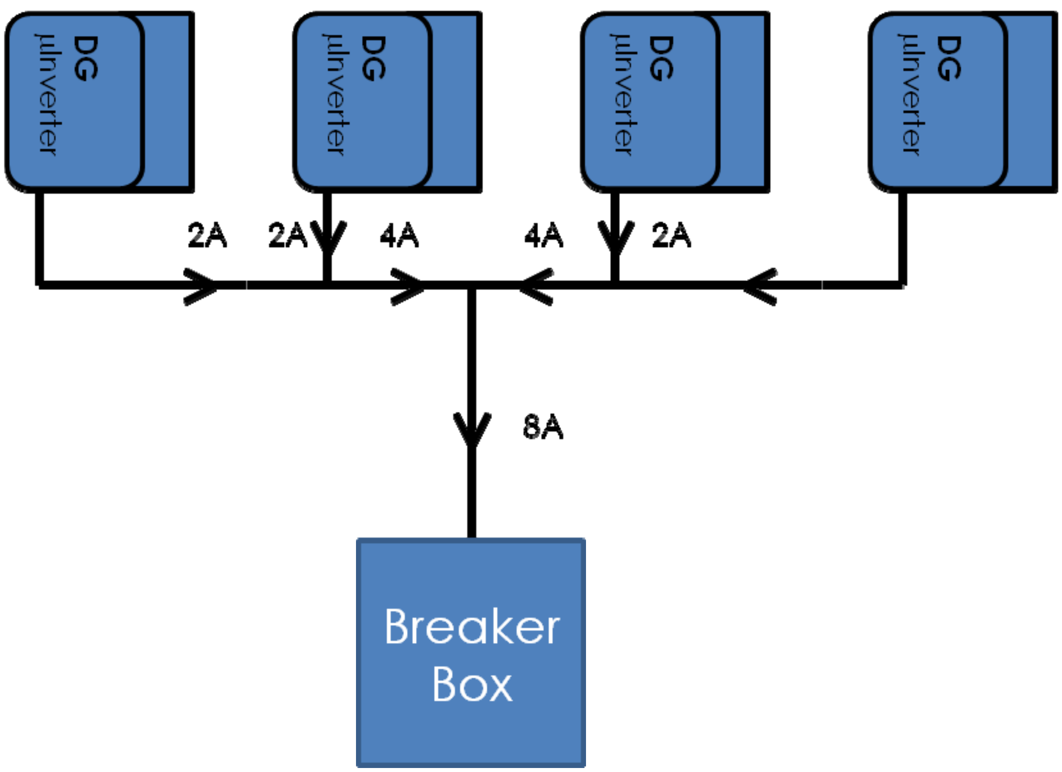
MICRO INVERTERS VOLTAGE RISE CALCULATIONS (cont.)

Center Fed AC Branch



- With a "center fed" AC Branch, both the currents and distances along the branch are cut in half. Therefore V_{rise} along the trunk is cut to ¼.
- The trunk feed from the Breaker Box to the AC branch remains the same.

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MICRO INVERTERS VOLTAGE RISE CALCULATIONS (cont.)

Vrise Formula with "Center Fed" AC Branch

For Center Fed AC Branches the Following Applies:

$$V_{rise} = N * I_{\max} * R_{trunk} + \left(\frac{N^2}{8} + \frac{N}{4} - 0.5 \right) * I_{\max} * R_{inv\,2\,inv}$$

For our same example: N=16, R_{trunk}=0.08Ω, $R_{inv2inv}$=.032Ω, Imax=2A

$$V_{rise} = 16 * 2 * 0.08 + \left(\frac{256}{8} + \frac{16}{4} - 0.5 \right) * 2 * .032 = 4.832V$$

Conclusion: Paying attention to Voltage rise across the AC connection is important to ensure all inverters remain on and producing power. When possible, use a center fed AC branch topology to mitigate voltage rise in the AC connection.

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