TECHNICAL BULLETIN

Voltage Rise Calculation
Date: 2/27/2020

Chilicon Power microinverters require a minimum design effort compared to conventional optimizer/string based systems. In addition to maximum branch sizing determination*, the only other calculation needed to ensure that all micros operate within code defined limits is that of voltage rise. However, as Chilicon Power uses #10 AWG wire in our cabling, voltage rise values are modest compared to competing microinverter systems.

Voltage Rise: *Any time a current flows through a device with internal resistance, Ohm's Law states that a voltage change will result. As each microinverter acts as a current source, the voltage along a chain will increase with the largest voltage present at the furthest microinverter on the circuit. Residential grids should supply 240V at the service panel, with the microinverters allowed to operate up to 264V (229V for 208V systems).*

The total voltage rise is the sum of the voltage rises from 1) the trunk cable individual subcircuits, 2) the subcircuit lines connecting to the subpanel, and 3) the line connecting the subpanel to the main service panel.

1) To calculate the expected voltage rise at the last microinverter, use the tables in this document to find the appropriate value of either voltage increase or percentage increase based on the number of microinverters in the circuit, the cable lengths deployed, and the grid voltage. If using a mixture of cable lengths, choosing the value associated with the longest length will give a worst case scenario for voltage rise. A rule of thumb is that the total voltage rise percentage to the main panel should not exceed 2%.

2) Next, calculate the voltage rise associated with the total length and wire size of the cabling from the subpanel to each of the subcircuits. Use the maximum potential current of each microinverter for this calculation. If the microinverter is current limited, use the current limited value.

V_{rise} = (Micros in branch x current per micro) x (resistance in Ω per unit length) x (length x2)
For #10 AWG THWN-2 CU resistance = .00129 Ω/ft (0.00423 Ω/m)

A number of programs are available to assist with this calculation such as:

https://www.calculator.net/voltage-drop-calculator.html

Chilicon Power. (310) 800-1396
15415 Sunset Blvd, Suite 102, Pacific Palisades, CA 90272

3) Calculate the voltage rise associated with the total length and wire size of the cabling from the subpanel to the main service panel using the approach outlined in Section 2. However, now use the total number of microinverters to calculate the total current.

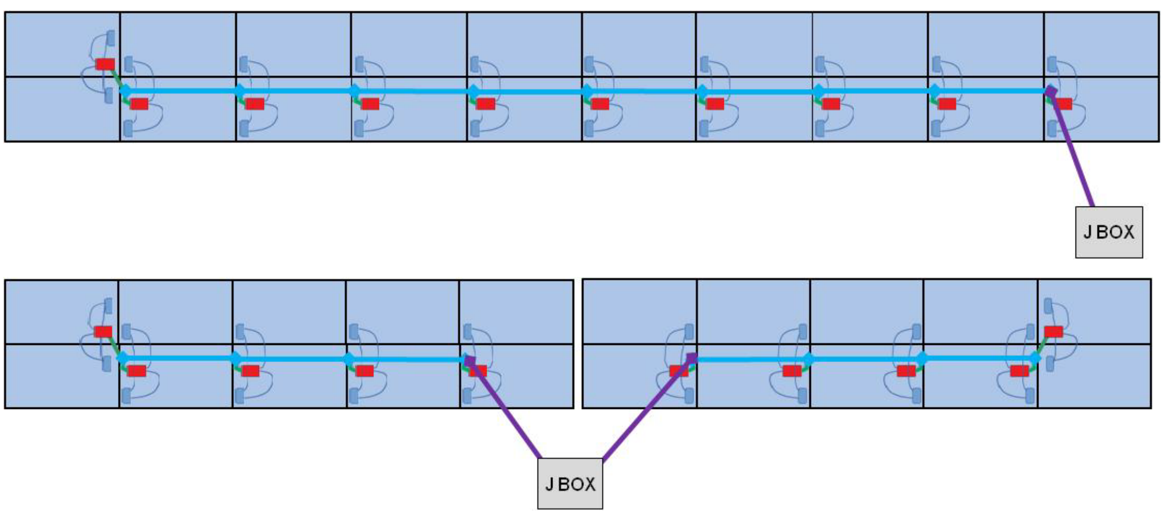
For percent voltage rise in Section 2 and 3, take the voltage calculated and simply divide by the service voltage, either 240 or 208V.

Finally, add the values calculated in Section 1 and 2 for each subcircuit. Take the largest value from this process and add to the value calculated in Section 3. The total voltage increase should be such that the final voltage should not exceed 264 V (229V for 208V) or 2%. Note: It is highly recommended that the installer first measure the voltage at the panel box to confirm its initial value.

Should a system design result in a voltage in excess of the maximum permitted, there are several approaches to remedy the situation:

1) Increase the wire gauge or shorten the distance to the service panel.

2) Center tap the connection to the microinverter subcircuits. This involves splitting the subcircuit into two sections and connecting to the *middle*. This will drop the voltage rise to less than half for that subcircuit.



3) For systems fed by a grid in excess of the standard voltage or for post-installation correction, it is possible to increase the operational voltage range of the Chilicon microinverters via the CP-100 gateway. Contact Chilicon Power for additional information on this procedure.

* Please refer to Technical Bulletin TBT4: *Power Limiting of Microinverters*

Voltage Rise for 240V Deployment

Microinverters	1.025 m Cable				1.7 m Cable				2.15 m Cable			
	2.4A		3.0A		2.4A		3.0A		2.4A		3.0A	
	V rise	%	V rise	%	V rise	%	V rise	%	V rise	%	V rise	%
1	0.02	0.01%	0.02	0.01%	0.03	0.01%	0.04	0.02%	0.04	0.02%	0.05	0.02%
2	0.06	0.03%	0.08	0.03%	0.11	0.04%	0.13	0.06%	0.13	0.06%	0.17	0.07%
3	0.12	0.05%	0.15	0.06%	0.21	0.09%	0.26	0.11%	0.27	0.11%	0.33	0.14%
4	0.21	0.09%	0.26	0.11%	0.35	0.14%	0.43	0.18%	0.44	0.18%	0.55	0.23%
5	0.32	0.13%	0.40	0.17%	0.53	0.22%	0.66	0.28%	0.67	0.28%	0.84	0.35%
6	0.45	0.19%	0.57	0.24%	0.74	0.31%	0.92	0.39%	0.94	0.39%	1.17	0.49%
7	0.60	0.25%	0.75	0.31%	1.00	0.42%	1.25	0.52%	1.26	0.52%	1.57	0.66%
8	0.77	0.32%	0.96	0.40%	1.27	0.53%	1.58	0.66%	1.60	0.67%	2.00	0.84%
9	0.97	0.40%			1.58	0.66%			2.00	0.84%		
10	1.18	0.49%			1.95	0.81%			2.46	1.03%		

15415 Sunset Blvd Suite 102,
Pacific Palisades, CA 90272

www.chiliconpower.com

(310) 800-1396

Chilicon Power

Voltage Rise for 208V Deployment

Microinverters	1.025 m Cable				1.7 m Cable				2.15 m Cable			
	2.66 A		3.43 A		2.66 A		3.43 A		2.66 A		3.43 A	
	V rise	%	V rise	%	V rise	%	V rise	%	V rise	%	V rise	%
1	0.02	0.01%	0.02	0.01%	0.03	0.01%	0.04	0.02%	0.04	0.02%	0.05	0.02%
2	0.07	0.03%	0.09	0.04%	0.12	0.05%	0.15	0.06%	0.15	0.06%	0.19	0.08%
3	0.13	0.06%	0.17	0.07%	0.23	0.10%	0.30	0.13%	0.30	0.12%	0.38	0.16%
4	0.23	0.10%	0.30	0.13%	0.38	0.16%	0.50	0.21%	0.49	0.20%	0.63	0.26%
5	0.35	0.15%	0.45	0.19%	0.59	0.24%	0.76	0.31%	0.74	0.31%	0.95	0.40%
6	0.50	0.21%	0.65	0.27%	0.82	0.34%	1.06	0.44%	1.04	0.43%	1.34	0.56%
7	0.67	0.28%	0.86	0.36%	1.10	0.46%	1.42	0.59%	1.40	0.58%	1.80	0.75%
8	0.85	0.36%			1.41	0.59%			1.78	0.74%		
9	1.07	0.45%			1.76	0.73%			2.22	0.93%		

15415 Sunset Blvd Suite 102,
Pacific Palisades, CA 90272

www.chiliconpower.com

(310) 800-1396