TECHNICAL BRIEF

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Calculating AC Line Voltage Drop for M250 Microinverters with Engage Cables

Overview

This technical brief presents voltage rise guidelines for dedicated PV branch circuits and methods for calculating the AC line voltage drop (or voltage rise) with Enphase M250™ Microinverters and the Enphase Engage™ Cable.

The application of proper voltage rise calculations in your site plan will help to prevent nuisance voltage out-of-range trip issues due to high line voltage conditions. Less resistance in conductors also results in less heat at the terminals, less power loss, and improved performance of the PV system.

When designing circuits for electrical loads, these calculations are commonly called voltage drop (VDrop). But PV systems with inverters generate electricity instead of consume electricity, so voltage actually rises at the AC terminals of inverters. Therefore, this brief refers to these calculations as voltage rise (VRise).

Recommendations

To minimize voltage rise issues, Enphase recommends that you apply these guidelines when planning your system:

- The total VRise in the AC wiring should be less than 2% in all wire sections from the point of common coupling (PCC) to the last microinverter on each branch or sub-branch circuit as described in Voltage Rise by Wire Section on page 3. A good practice is to maintain less than 1% VRise in the Engage Cable.

- Center-feed the branch circuit to minimize voltage rise in a fully-populated branch. Since the VRise is nonlinear, reducing the number of microinverters in a branch circuit greatly reduces the voltage measured at the last microinverter in the branch. To center-feed a branch, divide the circuit into two sub-branch circuits protected by a single overcurrent protection device (OCPD). Find out more in Advantages of Center-Feeding the AC Branch Circuits.

- Use the correct wire size in each wire section. Using undersized conductors can result in nuisance tripping of the microinverter anti-islanding function when an AC voltage out-of-range condition occurs. What Contributes to Voltage Rise provides more information.

- Use the calculation methods in Calculating Total Voltage Rise for Single-Phase Installations and Calculating Total Voltage Rise for Three-Phase Installations to determine voltage rise values for your project.

Background

The IEEE 1547 standard requires that grid-tied or utility-interactive inverters cease power production if voltage measured at the inverter terminal exceeds +10% or -12% of nominal. Enphase Microinverters, like all utility-interactive inverters, sense voltage and frequency from the AC grid and cease exporting power when voltage or frequency from the grid is either too high or too low.

If the voltage measured is outside the limit, the Enphase Microinverter enters an AC Voltage Out-Of-Range (ACVOOR) condition and ceases to export power until this condition clears. Besides voltage

variations from the AC grid, voltage changes within system wiring can also contribute to VRise and could cause microinverters to sense an over-voltage condition and cease operation.

The Enphase Microinverter reference point for voltage measurement is at the microinverter AC output. Since the microinverter is located at the array, and the point of common coupling (PCC) is generally at the site load center, the distance from the microinverter AC output to the PCC could be substantial.

All components within system wiring contribute to resistance and must be considered when calculating the total VRise. The main factors that determine voltage rise in an Enphase Microinverter system are: 1) distance from the microinverters to the PCC, and 2) conductor size. What Contributes to Voltage Rise provides details.

Typically, you can quantify the voltage rise of three distinct wire sections and several wire terminations, as described in Voltage Rise by Wire Section. There is also some resistance associated with each OCPD (Over Current Protection Device), typically a circuit breaker.

What Contributes to Voltage Rise

Enphase M250 Microinverter systems are installed as dedicated branch circuits with each branch circuit protected by a 20A OCPD. Wire size, circuit current, circuit length, voltage margin, and utility voltage for each branch circuit must be considered when calculating VRise.

- Wire size: Wire sizing is important because improper wire size can result in nuisance tripping of the utility protective functions in the microinverter. Undersized conductors can cause the voltage measured at the microinverter to be outside of the IEEE limits, triggering an ACVOOR condition. This results in loss of energy harvest. Although the National Electric Code recommends that branch circuit conductors be sized for a maximum of 3% VRise (Article 210.19, FPN 4.), this value in practice is generally not low enough for a utility-interactive inverter.

  There is a tradeoff made between increased wire size and increased cost. You can often increase wire size by one AWG trade size with minimal cost impact. At some point, increasing the wire size necessitates increases in the conduit and/or terminal size and this also increases costs. However, these increases in wiring and conduit costs can be offset by the increase in energy production over the lifetime of the system.

- Circuit current: Circuit current varies depending on which "wire section" is being considered in the installation. Voltage Calculations by Wire Section describes a typical installation containing three the wire sections where current is considered. With Engage Cable, current increases with each inverter added to the circuit.

- Circuit length: There is often little choice in circuit length, but center-feeding the dedicated branch circuit significantly reduces voltage rise within the branch, as described in Advantages of Center-Feeding the AC Branch Circuits.

- Voltage margin: If service voltage is chronically high, the utility will sometimes perform a tap change on the distribution transformer. This can provide a percent or two of additional voltage margin. Also, if your system interconnection voltage is not 240 V single-phase or 208Y/120 V three-phase and you need to use transformers, the transformers may provide voltage taps to adjust the voltage by some percentage within your AC PV electrical system.

- Utility voltage: The utility strives to maintain voltage at the PCC within +/- 5% of nominal. The protective functions of the microinverters are set to +10%/-12% by default. The high voltage end of the tolerance is of most concern because the inverters are a SOURCE and not a LOAD. If the utility is consistently 5% high, that leaves less than 5% for all wiring and interconnection losses and inverter measurement accuracy. If you are concerned about the utility's voltage, you may request that your utility place a data logger at the PCC and make a record of the voltages available to you at the site.

Voltage Rise by Wire Section

A typical installation as shown in the illustration has three wire sections where you must consider voltage rise:

Section	Description
1.	Enphase Engage Cable. Internal voltage rise within the Engage Cables from the microinverter to the array-mounted AC junction box. You can find VRise values for M250s in Internal VRise Values of Engage Cables with M250 Microinverters on page 5.
2.	AC branch circuits to the dedicated OCPD. Voltage rise from the array-mounted AC junction box, along the AC branch circuits, to the load center containing the dedicated microinverter OCPDs (circuit breakers). The tables in Conductor Lengths for Wire Sections on page 4 list maximum distances that maintain a 1% voltage drop for this wire section.
3.	Microinverter subpanel to the PCC. Voltage rise from the load center to the PCC. The tables in Conductor Lengths for Wire Sections on page 4 list maximum distances that maintain a 1% voltage drop for this wire section.

Calculate each component individually and verify that the total voltage rise is less than 2%. Calculating Total Voltage Rise lists formulas to determine voltage rise. Additional losses exist at the terminals, connectors, and in circuit breakers; however, if you design for a 2% total voltage rise, these other factors may be ignored.

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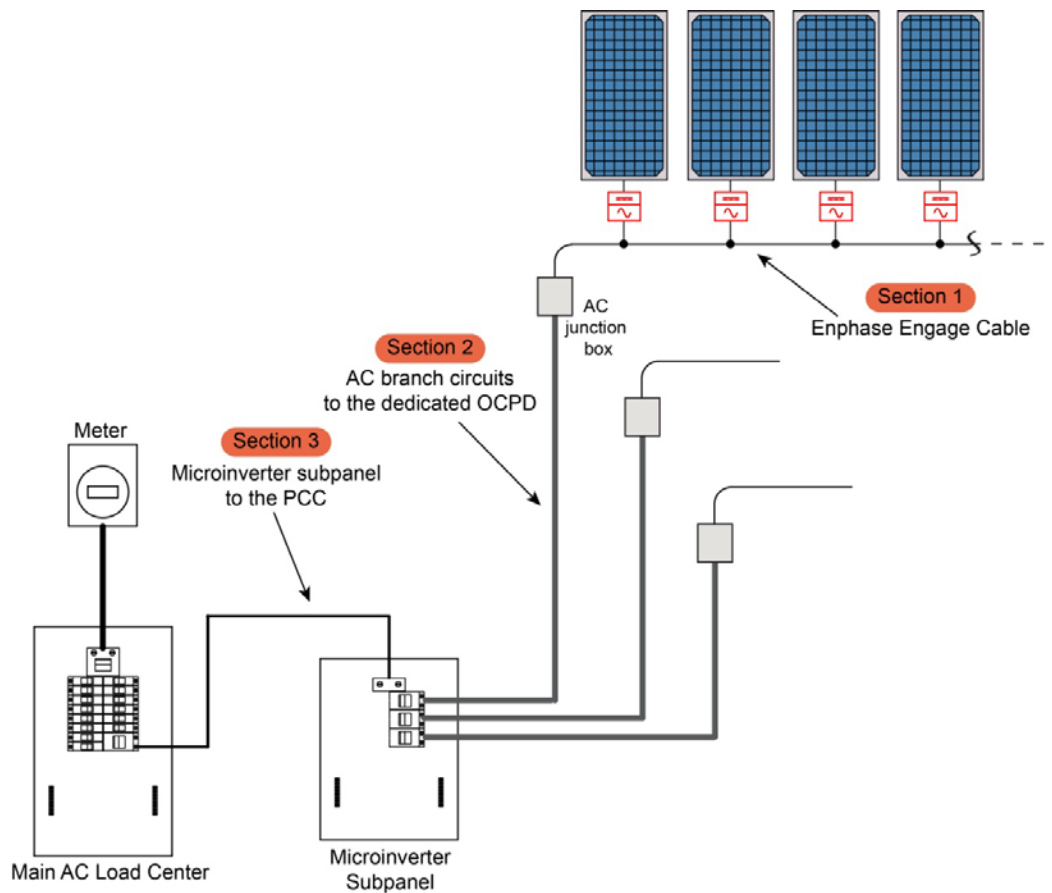
Conductor Lengths for Wire Sections

This section lists the maximum conductor lengths from the AC junction box back to the main service panel for maintaining a 1% voltage rise.

External Branch (Home Run) Wiring Maximum Distance to Maintain
1% V_{Rise} for 240 VAC Single-Phase

	Microinverters per Branch for 240 VAC Single-Phase															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
AWG	Maximum One-Way Wire Length (in Feet) to Maintain 1% VRISE															
#12	585	293	195	146	117	98	84	73	65	59	53	49	45	42	39	37
#10	930	465	310	233	186	155	133	116	103	93	85	78	72	66	62	58
#8	1483	742	494	371	297	247	212	185	165	148	135	124	114	106	99	93
#6	2353	1176	784	588	471	392	336	294	261	235	214	196	181	168	157	147
#4	3738	1869	1246	935	748	623	534	467	415	374	340	312	288	267	249	234

External Branch (Home Run) Wiring Maximum Distance to Maintain
1% V_{Rise} for 208 VAC Three-Phase

	Microinverters per Branch for 208 VAC Three-Phase							
	3	6	9	12	15	18	21	24
AWG	Maximum One-Way Wire Length (in Feet) to Maintain 1% VRISE							
#12	293	147	98	73	59	49	42	37
#10	501	250	167	125	100	83	72	63
#8	770	385	257	193	154	128	110	96
#6	1226	613	409	307	245	204	175	153
#4	1938	969	646	485	388	323	277	242

Use these tables to determine maximum conductor lengths for the wire sections in your installation.

Engage Cable and Internal Voltage Rise

The Engage Cable is a continuous length of 12 AWG stranded copper, outdoor-rated cable, with integrated connectors for M250 Microinverters.

The following table lists the Engage Cable types available for your project.

Voltage type and conductor count	Connector spacing	PV module orientation
240 VAC, 4 conductor	1.025 m (40")	Portrait
240 VAC, 4 conductor	1.7 m (67")	Landscape
208 VAC, three-phase, 5 conductor	1.025 m (40")	Portrait
208 VAC, three-phase, 5 conductor	1.7 m (67")	Landscape

Regardless of the application, Enphase recommends that the total percentage of voltage rise in the AC wiring be less than 2%, with (an inclusive) less than 1% voltage rise in the Engage Cable. Although Engage Cable is optimized for minimal VRise, it is still important to calculate total VRise for the entire system from the array to the PCC.

Internal VRise of Engage Cables with M250 Microinverters

The following tables provide VRise values for the available Engage cable types. Use these values and the examples in Calculating Total Voltage Rise for Single-Phase Installations and Calculating Total Voltage Rise for Three-Phase Installations to help calculate total VRise for your project.

The maximum number allowed on a 240 VAC branch circuit protected by a 20 A OCPD is 16 M250 microinverters. Refer to the *Enphase M250 Microinverter Installation and Operation Manual* for details.

M250 VRise for 240 VAC, 4 Wire, 1.0m Portrait Engage Cables
Center-Fed & End-Fed

Microinverters per Sub-Branch (Center-Fed) or per Branch (End-Fed) in Portrait															
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
VRise 0.01	0.04	0.08	0.14	0.21	0.30	0.40	0.51	0.64	0.78	0.93	1.10	1.29	1.48	1.69	1.92
% 0.01	0.02	0.04	0.06	0.09	0.12	0.16	0.21	0.26	0.32	0.39	0.46	0.54	0.62	0.71	0.80
Current 1.00	2.00	3.00	4.00	5.00	6.00	7.00	8.00	9.00	10.00	11.00	12.00	13.00	14.00	15.00	16.00

M250 VRise for 240 VAC, 4 Wire, 1.7m Landscape Engage Cable
Center-Fed & End-Fed

Microinverters per Sub-Branch (Center-Fed) or per Branch (End-Fed) in Landscape															
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
VRise 0.02	0.07	0.14	0.23	0.35	0.49	0.66	0.84	1.05	1.29	1.54	1.83	2.13	2.46	2.81	3.18
% 0.01	0.03	0.06	0.10	0.15	0.20	0.27	0.35	0.44	0.54	0.64	0.76	0.89	1.02	1.17	1.33
Current 1.00	2.00	3.00	4.00	5.00	6.00	7.00	8.00	9.00	10.00	11.00	12.00	13.00	14.00	15.00	16.00

The maximum number allowed on a 208 VAC branch circuit protected by a 20 A OCPD is 24 M250 microinverters. Refer to the *Enphase M250 Microinverter Installation and Operation Manual* for details.

M250s VRise for 208 VAC, 5 Wire, 1.0m Portrait Engage Cable
**Center-Fed & End-Fed**

Microinverters per Sub-Branch (Center-Fed) or per Branch (End-Fed) in Portrait							
3	6	9	12	15	18	21	24
VRise 0.06	0.20	0.42	0.73	1.13	1.61	2.17	2.82
% 0.03	0.09	0.20	0.35	0.54	0.77	1.04	1.36
Current 2.00	4.00	6.00	7.99	9.99	11.99	13.99	15.99

M250 VRise for 208 VAC, 5 wire, 1.7m Landscape Engage Cable
Center-Fed & End-Fed

| Microinverters per Sub-Branch (Center-Fed) or per Branch (End-Fed) in Landscape							
3	6	9	12	15	18	21	24
VRise 0.09	0.33	0.70	1.22	1.87	2.67	3.60	4.68
% 0.04	0.16	0.34	0.58	0.90	1.28	1.73	2.25
Current 2.00	4.00	6.00	7.99	9.99	11.99	13.99	15.99

Determining VRise within a Microinverter Branch Circuit

VRise within the microinverter branch circuit can be easily determined. The following diagram represents a 240 VAC system with a fully populated end-fed branch circuit. It illustrates how voltage measured at an individual microinverter increases by position in the branch circuit. As the number of microinverters in a branch circuit increase, the voltage at each microinverter rises in a nonlinear manner.
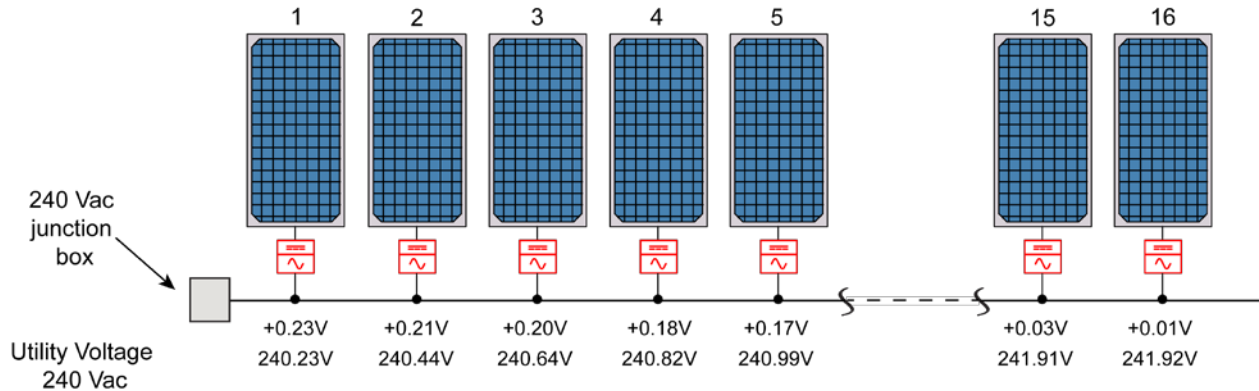
The top row of numbers is the incremental voltage rise from one microinverter to the next, and the bottom row is the cumulative line-to-line voltage overall.
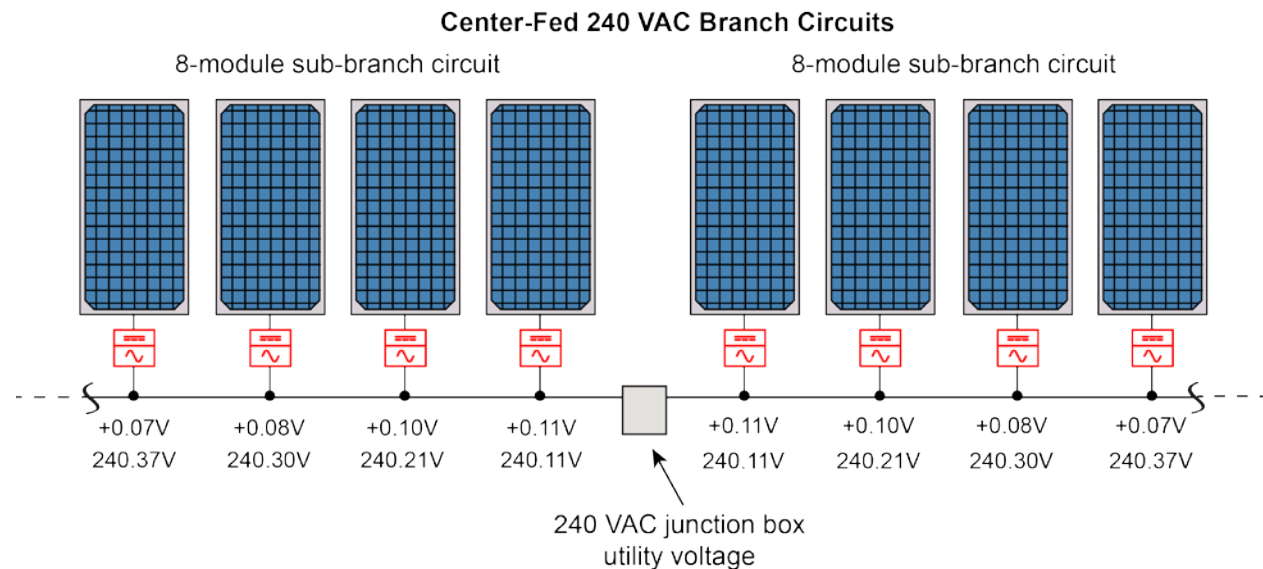
The following graph illustrates how the number of microinverters connected to a portrait-oriented Engage Cable causes a nonlinear voltage rise when operating at 240VAC.

Internal VRise for 240 VAC, 1.0 m Portrait Engage Cables and M250s
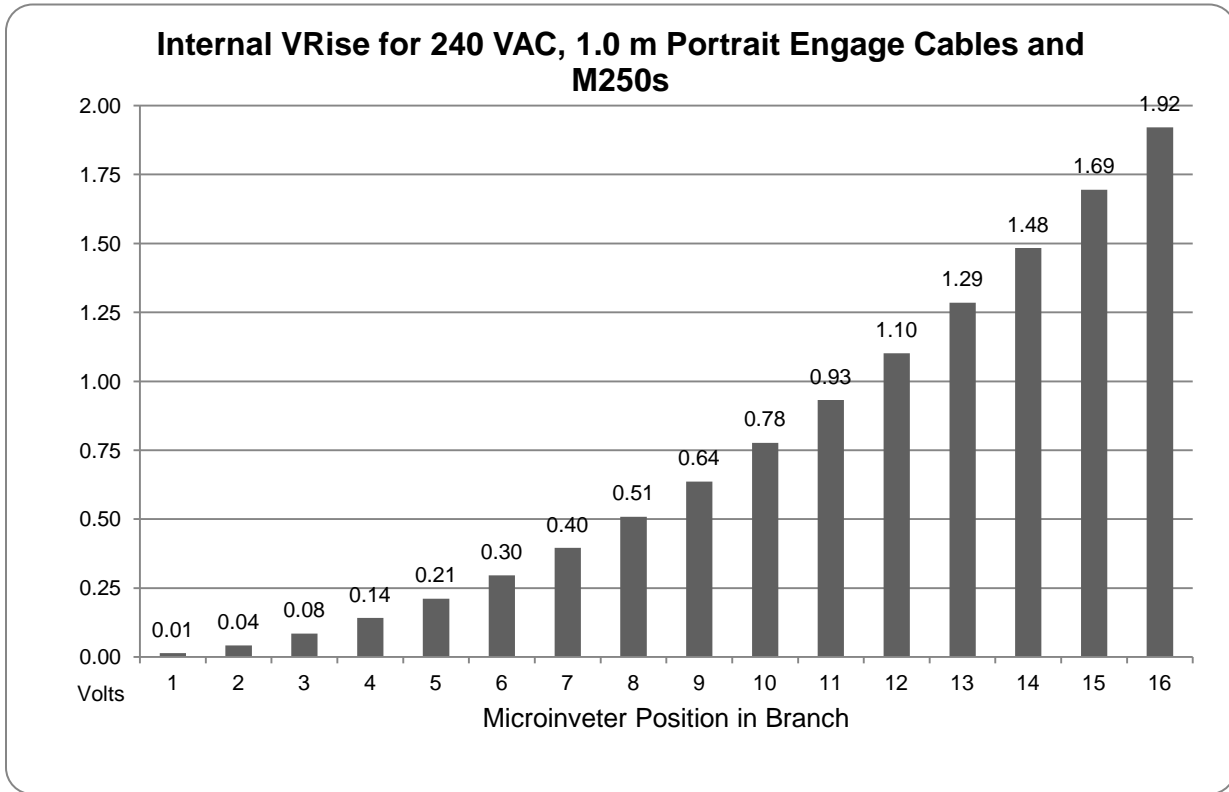
Advantages of Center-Feeding the AC Branch Circuits

The Engage Cable is both more efficient and less impacted by the effects of VRise than past Enphase cabling systems. This is particularly true of the Engage Cable with connectors spaced one meter apart for portrait applications. However, it is still important to calculate voltage rise for the entire system from the array to the PCC.

Since voltage rise is nonlinear, reducing the number of microinverters in the branch circuit greatly reduces the voltage measured at the last microinverter in the branch. One way to minimize this voltage rise is to center-feed the branch, that is, divide the circuit into two sub-branch circuits protected by a single OCPD. The following diagram illustrates the center-fed method.

Center-Fed 240 VAC Branch Circuits

8-module sub-branch circuit   8-module sub-branch circuit

| +0.07V | +0.08V | +0.10V | +0.11V | | +0.11V | +0.10V | +0.08V | +0.07V |
| 240.37V | 240.30V | 240.21V | 240.11V | | 240.11V | 240.21V | 240.30V | 240.37V |

240 VAC junction box
utility voltage

When a branch circuit feeds multiple roofs or sub-arrays, it is common to divide the sub-arrays into sub-branch circuits. It is acceptable to have different numbers of microinverters on each roof or sub-branch circuit. This is because the conductors from each Engage Cable on that branch circuit are paralleled within a junction box where all red conductors come together, all black conductors come together, etc.

A fully populated center-fed branch circuit has 16 M250 Microinverters, with a maximum of eight on the each of the two sub-branches. All microinverters meet in the same junction box. With center-feeding, you will measure a 0.51-volt increase at the last microinverter in the branch circuit rather than a 1.92-volt increase in an end-fed branch circuit.

Calculating Total Voltage Rise

Voltage Rise Formulas

All resistances of the system components are in series, and are cumulative. Since the same current is flowing through each resistance, the total VRise is simply the total current times the total resistance.

The VRise percentage for an Enphase Microinverter system is:

> % of Total VRise = % VRise Section 1 + % VRise Section 2 + % VRise Section 3

Where,

> % VRise Section 1 = % by number of microinverters in Internal VRise of Engage Cables with M250 Microinverters
>
> % VRise Section 2 = VRise Section 2 ÷ System Voltage (either 240 or 208)
>
> % VRise Section 3 = VRise Section 3 ÷ System Voltage (either 240 or 208)

VRise Formula for a 240 VAC, Single-Phase Installation

In a 240 VAC single-phase system, the total resistance is equal to two times the one-way resistance.

> VRise of Section = *(amps/inverter x number of inverters) x (Ω x 2-way wire length of Section 2 (or 3))*

Refer to the Sample Calculation for Single-Phase 240 VAC Installations on page 8 for an example.

VRise Formula for a 208 VAC, Three-Phase Installation

In a 208 VAC, three-phase system, use only the one-way wire length for resistance in the provided formula. While this calculation is not commonly used, it is a simple and accurate calculation of voltage rise in an Enphase Microinverter system.

VRise of Section = (watts/inverter x # of microinverter per subpanel) x (Ω/ft x 1-way wire length) ÷ 208 V

Refer to the Sample Calculation for Three-Phase 208 VAC Installations on page 10 for an example calculation.

Sample Calculation for Single-Phase 240 VAC Installations

As part of this analysis, we calculate VRise for a sample scenario of 48 M250 Microinverters in portrait orientation with three branch circuits, each with 16 M250 Microinverters. Each branch circuit is center-fed and separated into two sub-branch circuits, each with eight microinverters.

Section 1: M250 Internal VRise for 240 VAC Engage Cable

Refer to Engage Cable and Voltage Rise Values to find the Engage Cable VRise appropriate for your project.

Internal VRise within 240 VAC, 4 wire, 1.0m portrait Engage Cables for M250s, center-fed:

Microinverters per Sub-Branch (Two Sub-Branches) in Portrait								
	1	2	3	4	5	6	7	8
VRise	0.01	0.04	0.08	0.14	0.21	0.30	0.40	0.51
%	0.01	0.02	0.04	0.06	0.09	0.12	0.16	0.21
Current	1.00	2.00	3.00	4.00	5.00	6.00	7.00	8.00

For a sub-branch circuit of eight M250s, the voltage rise on the 240 VAC Engage Cable is **0.21%.**

Section 2: Voltage Rise from the AC Junction Box to the Microinverter Subpanel

To calculate the voltage rise in this portion of the circuit, multiply the combined current of the microinverters in the branch by the total resistance of the wire run.

VRise = (amps/inverter × number of inverters) × (resistance in Ω/ft) × (2-way wire length)

The following example is for a fully populated branch circuit of 16 M250 Microinverters.

- M250 full load AC current = 1 amp

- Wire gauge for individual branch circuit = #10 AWG THWN-2 CU

- #10 AWG THWN-2 CU resistance = 0.00129/ft (from NEC 2008, Chapter 9, Table 8)

- Length of individual branch circuit = 40 feet, with two-way wire length = 80 feet

VRise   = (1 amp × 16) × (0.00129 Ω/ft) × (40 ft × 2)

       = 16.0 amps × 0.00129 Ω/ft × 80 ft

       = 1.65 volts

%VRise = 1.65 volts ÷ 240 volts = 0.69%

The voltage rise from the junction box to the microinverter subpanel is **0.69%**.

Section 3: Voltage Rise from the Microinverter Subpanel to the PCC

Determine the VRise in this portion of the circuit by multiplying the combined current of all the microinverters in the array by the total resistance of the wire run.

The following example is for three fully populated branch circuits of 16 M250 Microinverters each (48 total units).

VRise = (amps/inverter × number of inverters) × (resistance in Ω/ft) × (2-way wire length)

- Current of 16 M250s = 16 amps, for current of 3 branch circuits of 16 M250s = 48 amps

- Wire gauge for the microinverter subpanel feed = #4 AWG THWN-2 CU

- #4 AWG THWN-2 CU resistance = 0.000321/ft (from NEC Chapter 9, Table 8)

- Length of the microinverter subpanel feed = 80 feet, with 2-way wire length = 160 feet

VRise   = 48 amps × 0.000321 Ω/ft × (80 ft × 2)

       = 48 amps × 0.000321 Ω/ft × 160 ft = 2.47 volts

%VRise = 2.47 volts ÷ 240 volts = 1.03%

The voltage rise from the microinverter subpanel to the main service meter is **1.03%**.

Summary of Wire Section Calculations for Single-Phase 240 VAC Applications

With the utility operating at the upper limit of their allowable tolerance (+5%) and the microinverters having a measurement accuracy of 2.5%, we are left with a voltage rise budget of 5.4 volts (2.25%) for all wiring to the PCC. The calculated VRise for all three portions of the system must be 5.4 volts or less. For systems with very long branch circuit runs and/or very long runs from the PV load center to the PCC, it is best to make the VRise in the Engage Cable as small as possible. As we have already determined, 5.4 volts is equal to 2.25% of the nominal voltage. After accounting for additional losses within connections, terminals, circuit breakers, and unexpected increases in wire length, we recommend implementation of a total system voltage rise of less than 2%.

Section 1: Voltage rise in Engage Cable from the microinverters to the AC junction box = 0.21%

Section 2: Voltage rise from the AC junction box to the microinverter subpanel = 0.69%

Section 3: Voltage rise from the microinverter subpanel to the main service panel (PCC) = 1.03%

Total system voltage rise for all three wire sections = 1.93%

Sample Calculation for Three-Phase 208 VAC Installations

This example considers voltage rise calculations for a system using 72 M250 Microinverters with 208 VAC three-phase service. The system has three fully-populated branch circuits of 24 M250 Microinverters mounted in portrait orientation. For fully loaded branch circuits with 208 VAC, Enphase recommends that you center-feed the circuit to minimize voltage rise. The M250 Microinverter produces power on two legs, and the phases are balanced by the physical internal rotation of the phase cables inside the Engage Cable. A center-fed branch of 24 microinverters has 12 microinverters on one sub-branch circuit and 12 microinverters on the other.

Section 1: Internal VRise 208 VAC Engage Cable

Refer to Engage Cable and Internal Voltage Rise to find the Engage Cable VRise appropriate for your project.

Internal VRise within 208 VAC, 5 wire, 1.0m portrait Engage Cables for M250s, center-fed

Microinverters per Sub-Branch (Two Balanced Sub-Branches) in Portrait				
	3	6	9	12
VRise	0.06	0.20	0.42	0.73
%	0.03	0.09	0.20	0.35
Current	2.00	4.00	6.00	7.99

The voltage rise for a branch circuit of 24 M250s center-fed, with two sub-branch circuits of 12 microinverters each in portrait is **0.35%**.

Section 2: VRise from the AC junction box to the Microinverter Subpanel

Determine the VRise in this portion of the circuit by multiplying the branch circuit output power in watts by the total resistance of the wire run divided by the voltage.

$$\text{VRise} = \frac{\text{(Watts/inverter)} \times \text{(number of inverters per branch circuit)} \times (\Omega/\text{ft}) \times \text{(1-way wire length)}}{208 \text{ volts}}$$

The following example is for a fully populated branch circuit of 24 M250 Microinverters.

- M250 rated AC output in watts = 240 watts
- Number of microinverters per branch circuit = 24
- Wire gauge for individual branch circuit = #10 AWG THWN-2 CU
- #10 AWG THWN-2 CU resistance = 0.00129 Ω/ft (from NEC Chapter 9, Table 8)
- Length of individual branch circuit = 40 feet

$$\text{VRise} = \frac{240 \text{ watts} \times 24 \times 0.00129 \ \Omega/\text{ft} \times 40 \text{ ft}}{208 \text{ volts}}$$

VRise = (5760 watts × 0.0516Ω) ÷ 208 volts

= 1.42 volts

%VRise = 1.42 volts ÷ 208 volts = 0.69%

The voltage rise from the junction box to the microinverter subpanel is **0.69%**.

Section 3: VRise from the Microinverter Subpanel to the Main Service Meter (PCC)

Determine the VRise in this portion of the circuit by multiplying the total microinverter subpanel output power in watts by the total resistance of the wire run divided by the voltage. The phases are balanced by the physical internal rotation of the phases inside the Engage Cable.

$$\text{VRise} = \frac{\text{(Watts/inverter)} \times \text{(number of inverters per microinverter subpanel)} \times (\Omega/\text{ft}) \times \text{(1-way wire length)}}{208 \text{ volts}}$$

The following calculations are for three fully populated branch circuits of 24 M250 Microinverters, with two sub-branch circuits of 12 microinverters each, in portrait, for a total of 72 microinverters.

- M250 rated AC output in watts = 240 watts
- Number of Microinverters per microinverter subpanel = 72
- Wire gauge for the microinverter subpanel feed = #2 AWG THWN-2 CU
- #2 AWG THWN-2 CU resistance = 0.000201 Ω/ft (from NEC Chapter 9, Table 8)
- Length of microinverter subpanel feed = 80 feet

$$\text{VRise} = \frac{240 \text{ watts} \times 72 \times 0.000201 \ \Omega/\text{ft} \times 80 \text{ ft}}{208 \text{ volts}}$$

= (17280 watts × 0.01608 Ω) ÷ 208 volts

= 1.34 volts

%VRise = 1.34 volts ÷ 208 volts = 0.64%

The voltage rise from the microinverter subpanel to the main service meter is **0.64%**.

Summary of Wire Section Calculations for Three-Phase 208 VAC Applications

With the utility operating at the upper limit of their allowable tolerance (+5%) and the microinverters having a measurement accuracy of 2.5%, the result is a voltage rise budget of 4.88 volts (2.25%) for all wiring to the PCC. The calculated VRise for all three portions of the system must be 4.88 volts or less. For systems with long branch circuit runs and/or long runs from the inverter subpanel to the main service panel or PCC, it is best to make the VRise in the Engage Cable as small as possible. However, after accounting for additional losses within connections, terminals, circuit breakers, and unexpected increases in wire length, Enphase recommends calculating a total system voltage rise of less than 2%.

Section 1: Voltage rise in Engage Cable from the microinverters to the AC junction box   = 0.35%

Section 2: Voltage rise from the AC junction box to the microinverter subpanel   = 0.69%

Section 3: Voltage rise from the microinverter subpanel to the main service meter (PCC)   = 0.64%

Total system voltage rise for all three wire sections   = 1.68%

In this example, we were able keep the VRise to less than 2% by center-feeding the circuit to create two sub-branch circuits at the array.

Conclusion

Center-feeding is a great way to decrease costs, improve production, and increase system reliability. Center-feeding each branch circuit in an Enphase Microinverter system is essential, both for optimal microinverter operation and to minimize wire costs for the installer. Follow the guidelines and calculations in this document to help to minimize voltage rise or voltage drop issues with your installation.