All You Need to Know About DC Troubleshooting

August 2021

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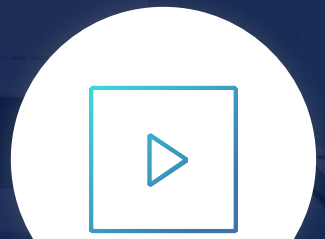
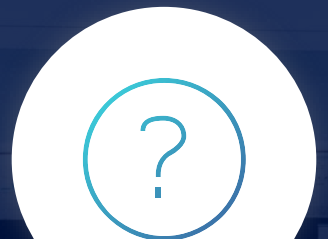
Before We Begin



We will send you the recording



Submit your questions anytime. We'll answer them throughout the session

Please complete the survey at the end

Presenters

Brent Heber

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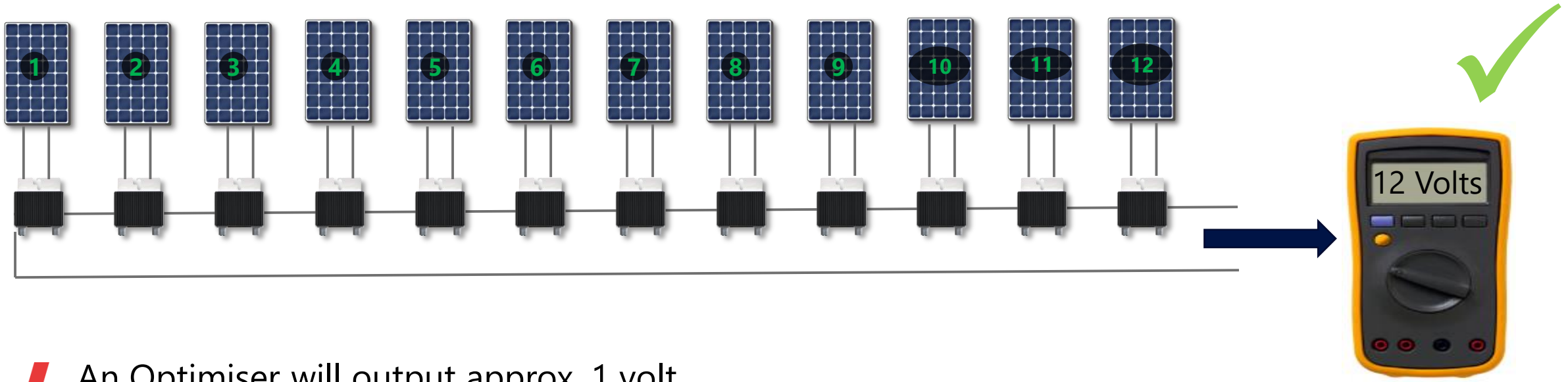
Agenda

- String Testing Scenarios
- Power Optimisers Installation Tips
- Ground Faults Examples
- Summary
- Survey

String Testing Scenarios

String Testing - Voltage



- An Optimiser will output approx. 1 volt.
- A range of 0.9 to 1.2 is acceptable.
- For this presentation assume 1 volt.
- Above string is connected perfectly. What is the expected Voltage?

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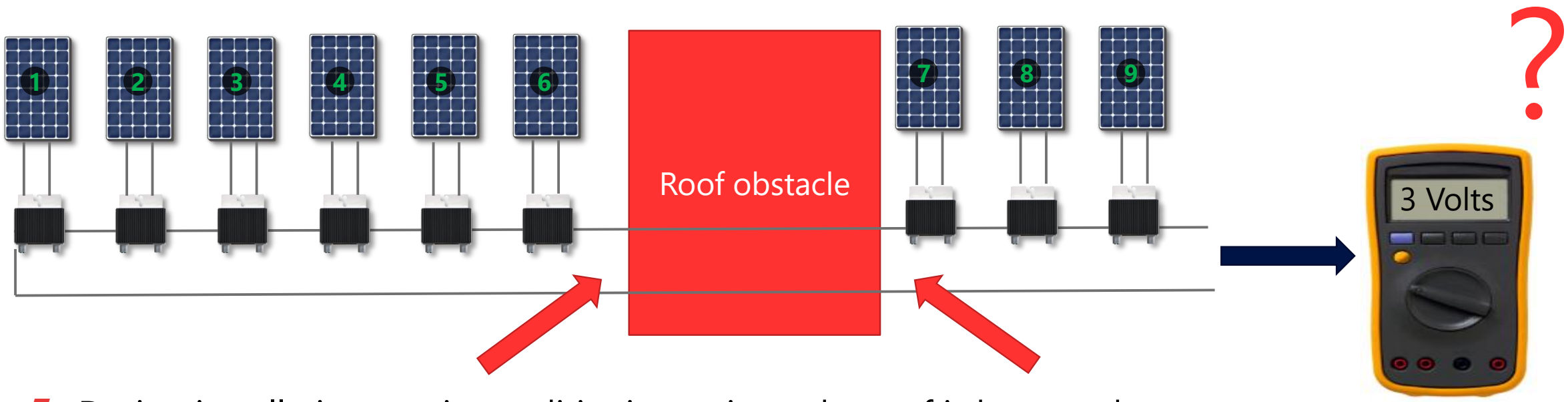
String Testing - Voltage



- During installation an air-conditioning unit on the roof is bypassed.
- Extension leads were used with hand made genuine MC4.
- The rest of the string is connected . The voltage at the end of the string is 3 Volts.
- What is the problem?

Reverse polarity in one of the two red arrows

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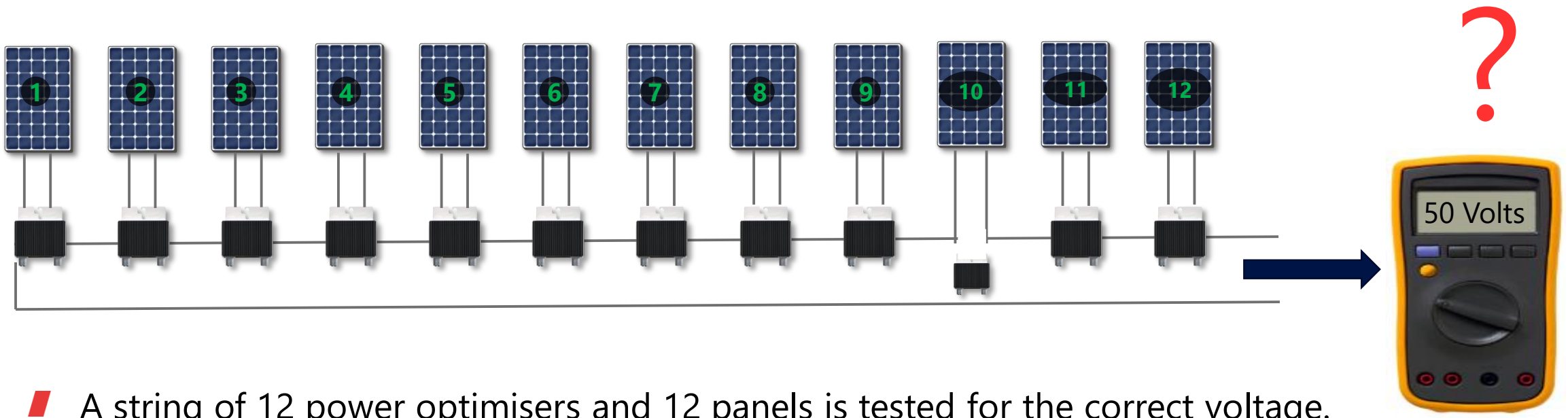
String Testing - Voltage



- A string of 12 power optimisers and 12 panels is tested for the correct voltage.
- The installer discovered that the string voltage is approx. 50 volts?
- What is the problem?

Optimiser number 10 is bypassed, and panel is plugged in the string instead.

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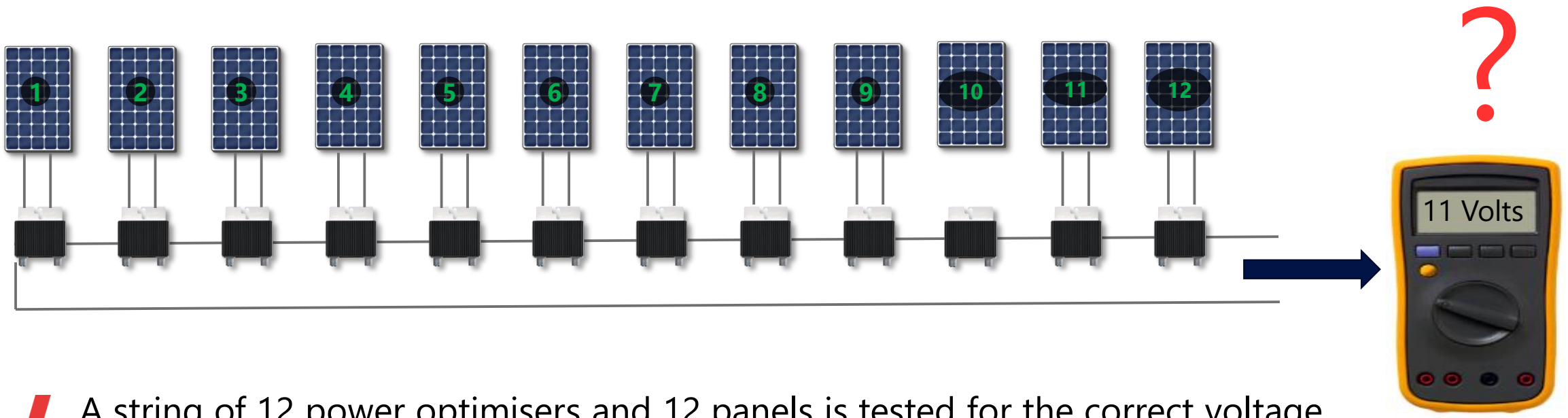
String Testing - Voltage



- A string of 12 power optimisers and 12 panels is tested for the correct voltage.
- The installer discovered that the string voltage is 11 volts?
- What is the problem?

Both panel and power optimiser number 10 left unplugged

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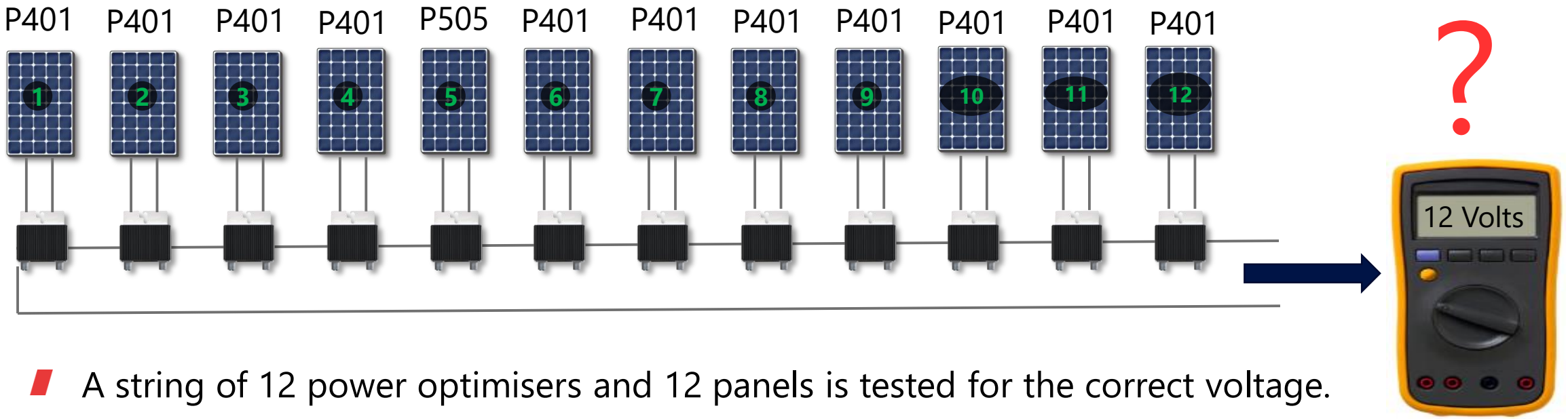
String Testing - Voltage



- A string of 12 power optimisers and 12 panels is tested for the correct voltage.
- The installer discovered that the string voltage is 12 volts? Happy days.
- Is there a problem with the above string?

It is not permitted to mix P401 and P505 in the same string.

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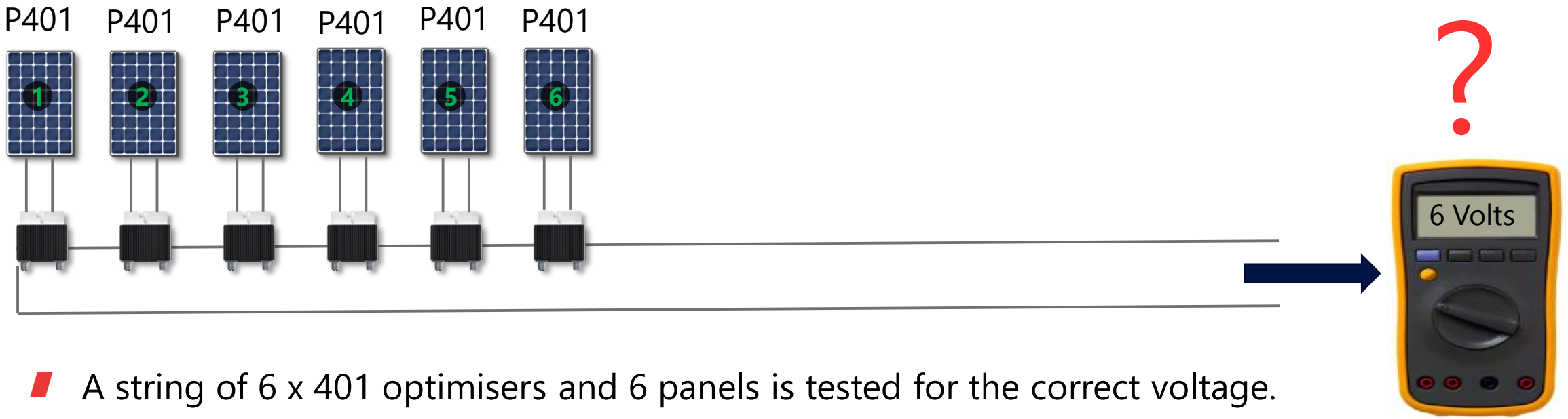
String Testing - Voltage



- A string of 6 x 401 optimisers and 6 panels is tested for the correct voltage.
- The installer discovered that the string voltage is 6 volts?
- The string is connected to a small inverter and paired.
- Is there a problem with the above?

The design is not valid. The minimum number of P401 optimisers allowed is 8.

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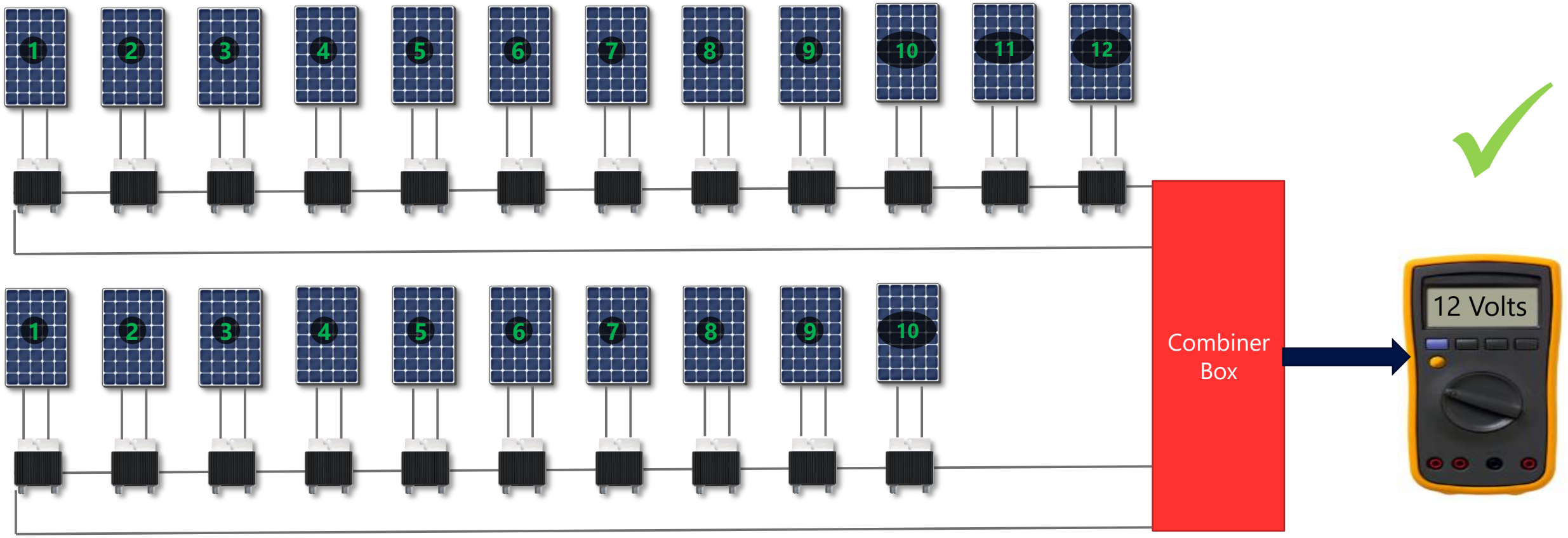
String Testing



- When combining a string of 12 volts and a string of 10 volts, what is the expected voltage after the combiner box?

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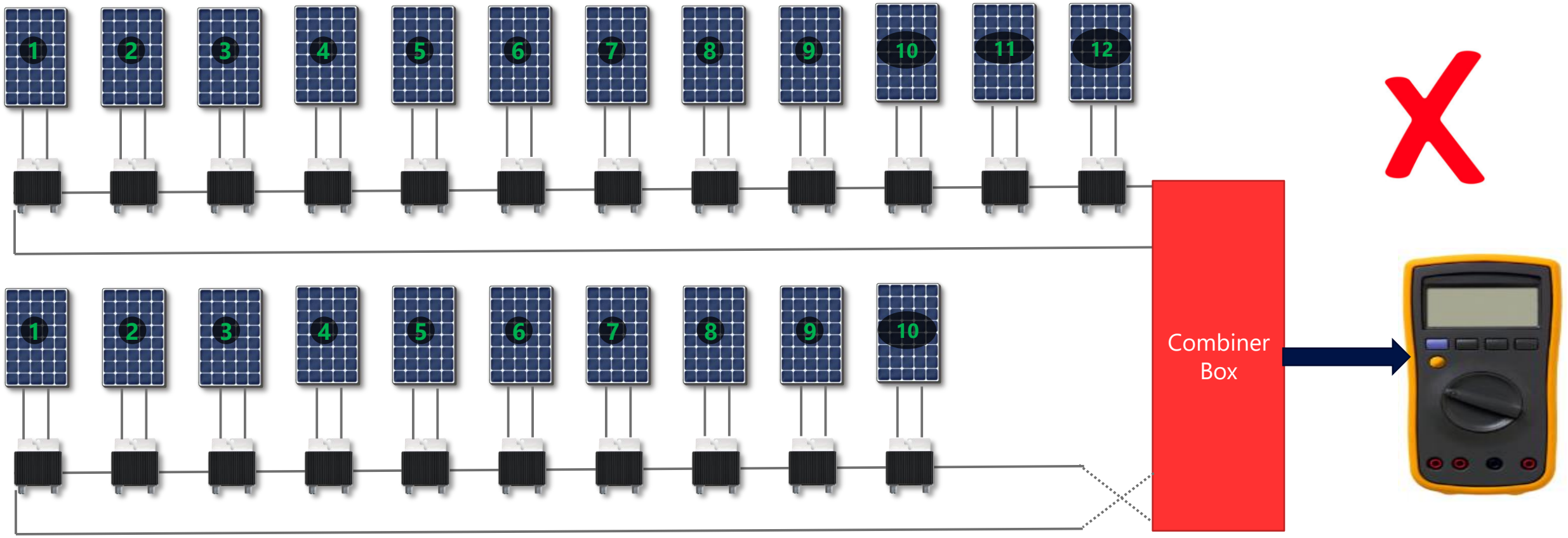
String Testing - Voltage



- Crucial mistake to combine one string in reverse polarity. Voltage may stabilize to a wrong value or fluctuate. Extra care required when combining strings. **Short circuit current test is a requirement.**

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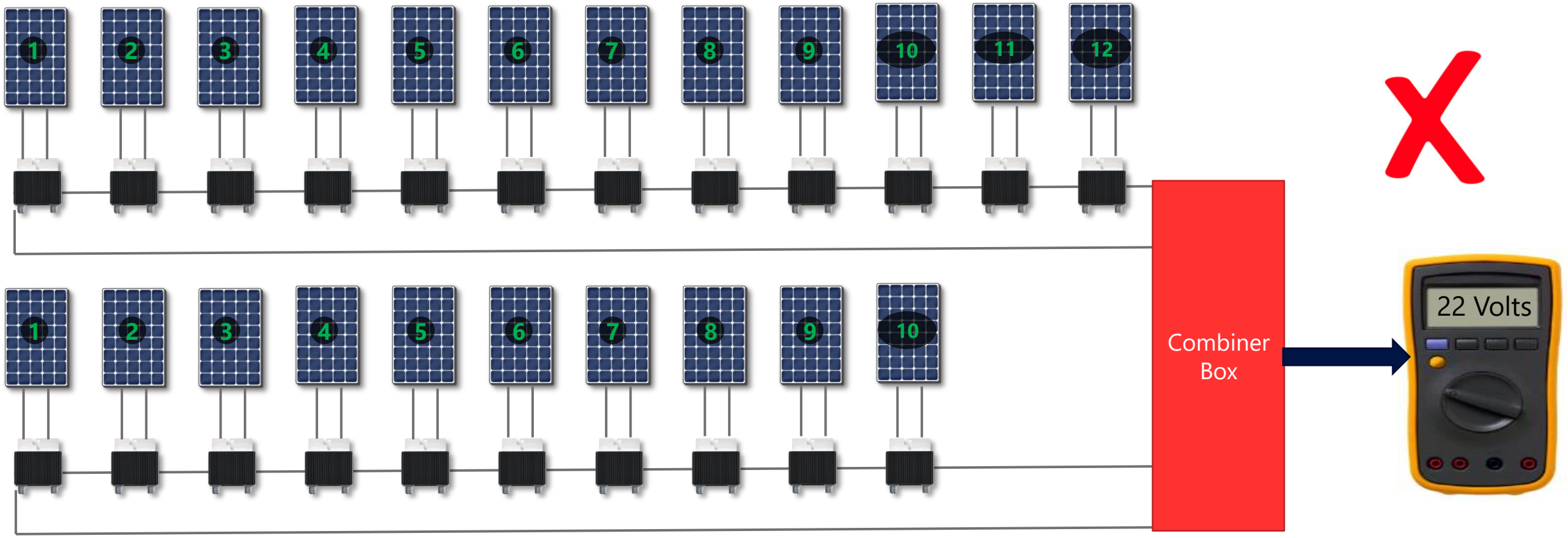
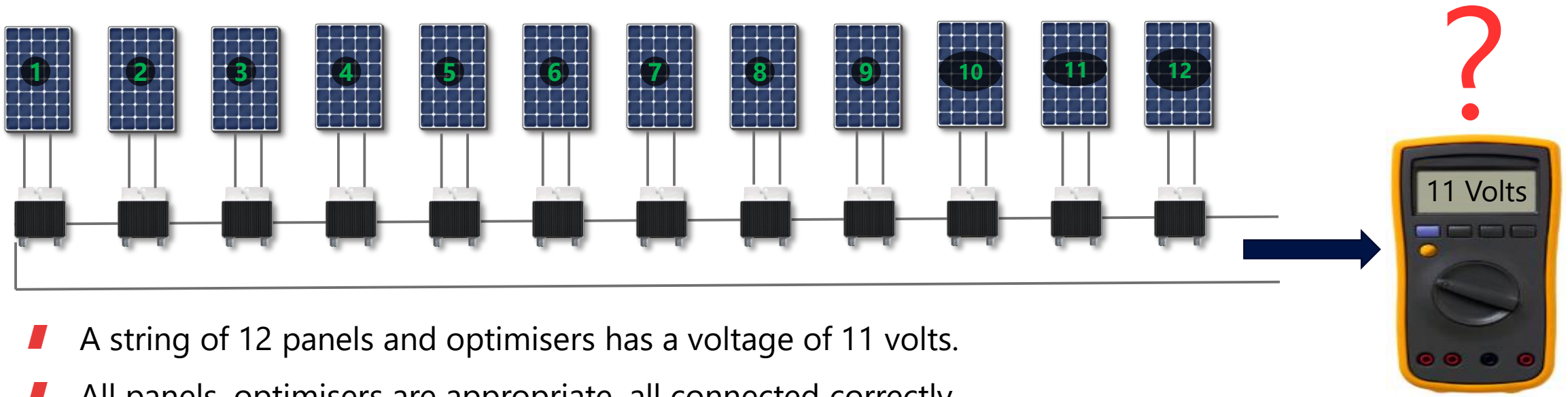
String Testing - Voltage



- What is the problem here?

The two strings are connected in series in the combiner box.

String Testing - Voltage



- A string of 12 panels and optimisers has a voltage of 11 volts.
- All panels, optimisers are appropriate, all connected correctly.
- Short Circuit and Insulation tests are all ok.
- What should I do next?

Since there is no fault; pair the system. Wait for the panels to report. Once reported determine which panel does not provide telemetries. Then debug it on the roof.

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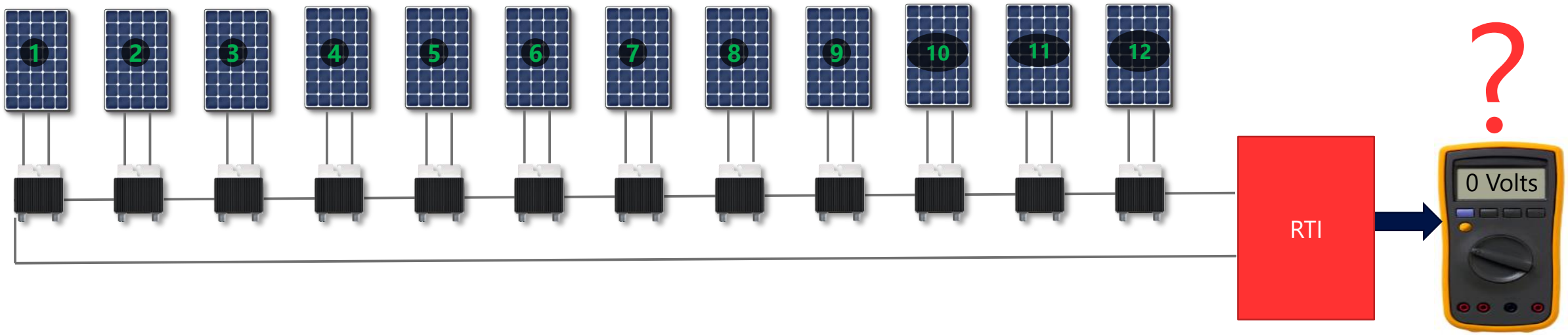
String Testing - Voltage



- A string of 12 panels and optimisers has a voltage of 0 volts when measured at the inverter.
- Can you think of a few reasons on why a string will measure 0 volts?

RTI left off.
Return lead unplugged.
A short between positive and negative.
Forward lead from optimiser to optimiser unplugged.
Reverse polarity on the 6th optimiser onwards resulting in 0 volts.

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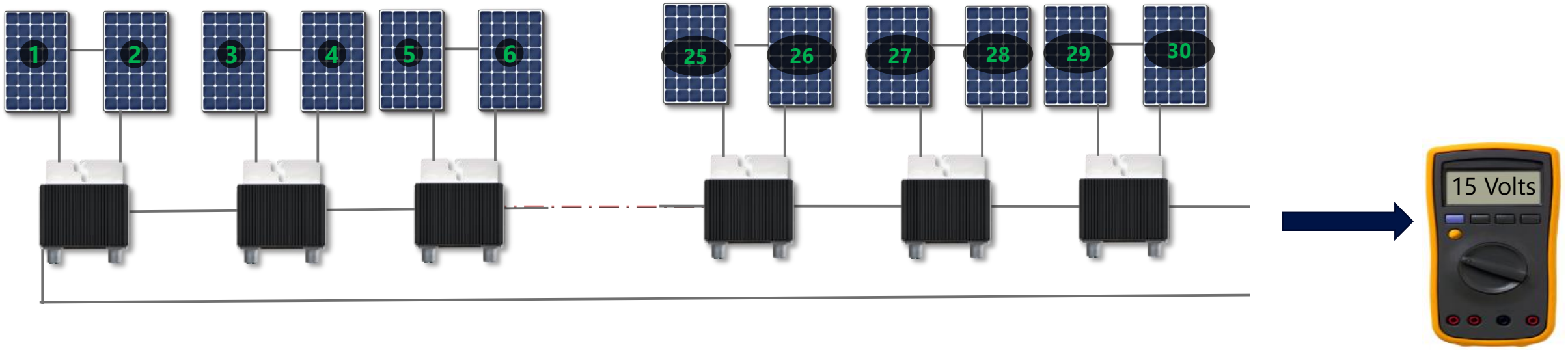
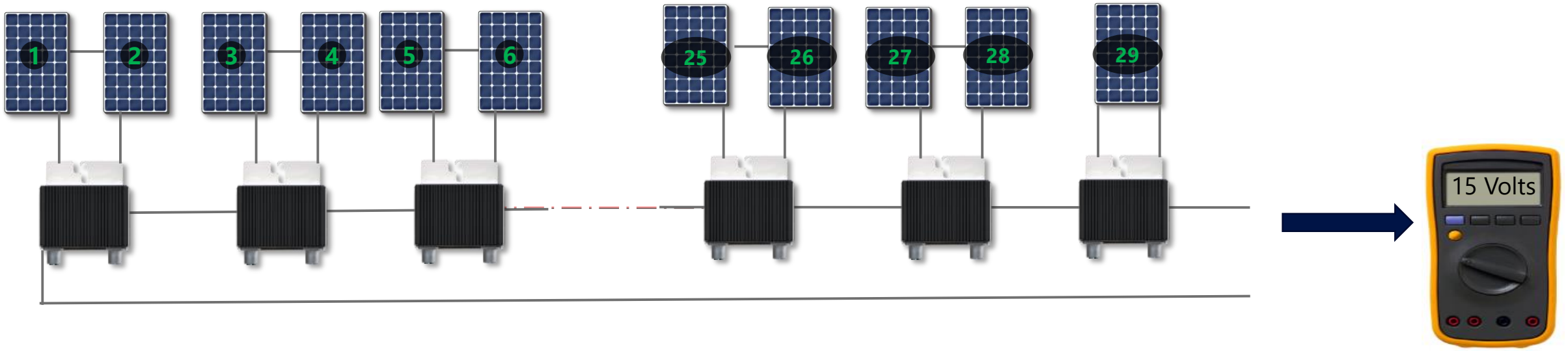
String Testing - Voltage



- Example of a string used in commercial inverters.
- Is it acceptable if I measure 17 volts?

Yes. That is approx. 1.2 volts per optimiser.

String Testing - Voltage



- The same type of commercial optimiser is used.
- Is this a valid design?

Yes. The string is above the minimum number of optimisers and panels.
The minimum is 14 optimisers and 27 panels for commercial optimisers.

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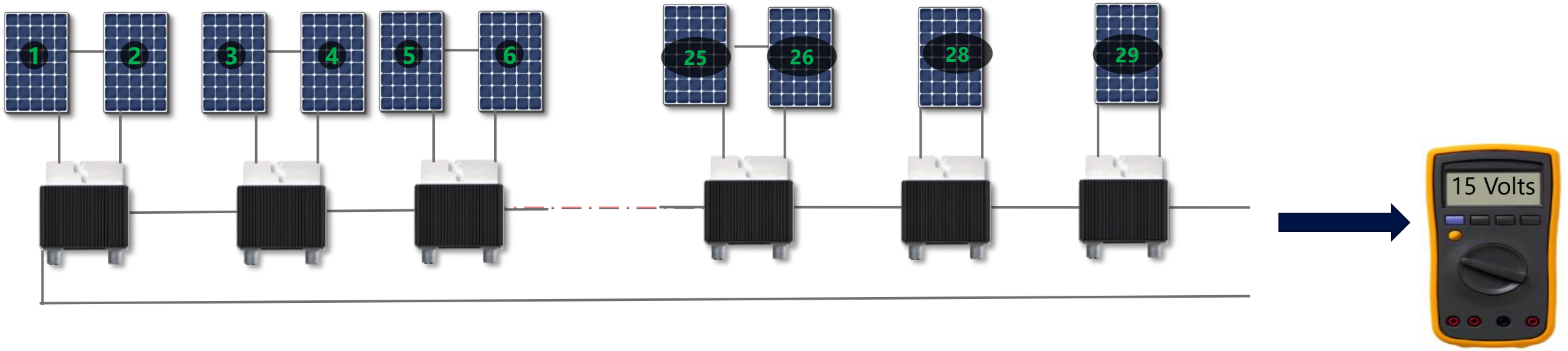
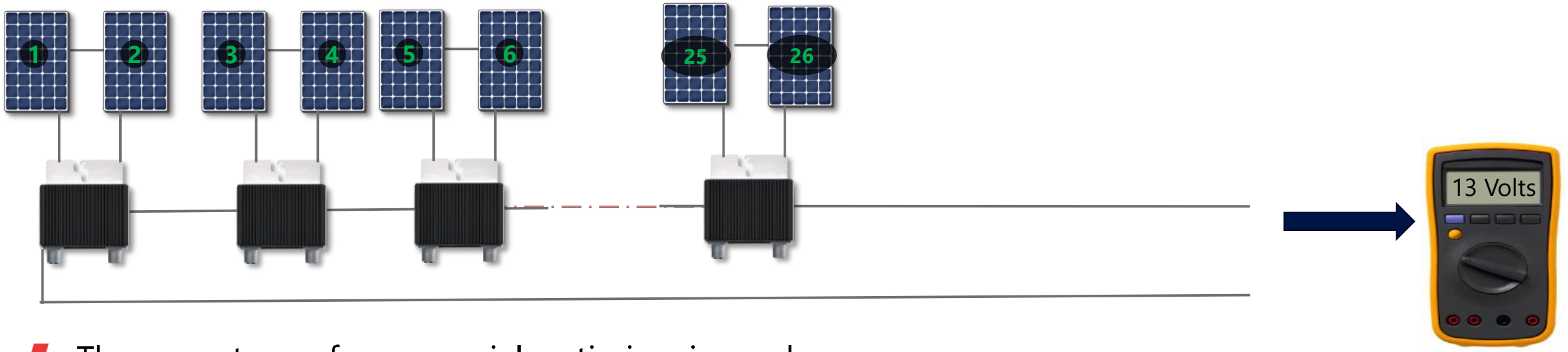
String Testing - Voltage



- The same type of commercial optimiser is used.
- Is this a valid design?

No. You can only use a commercial optimiser with one panel ONCE in the same string.

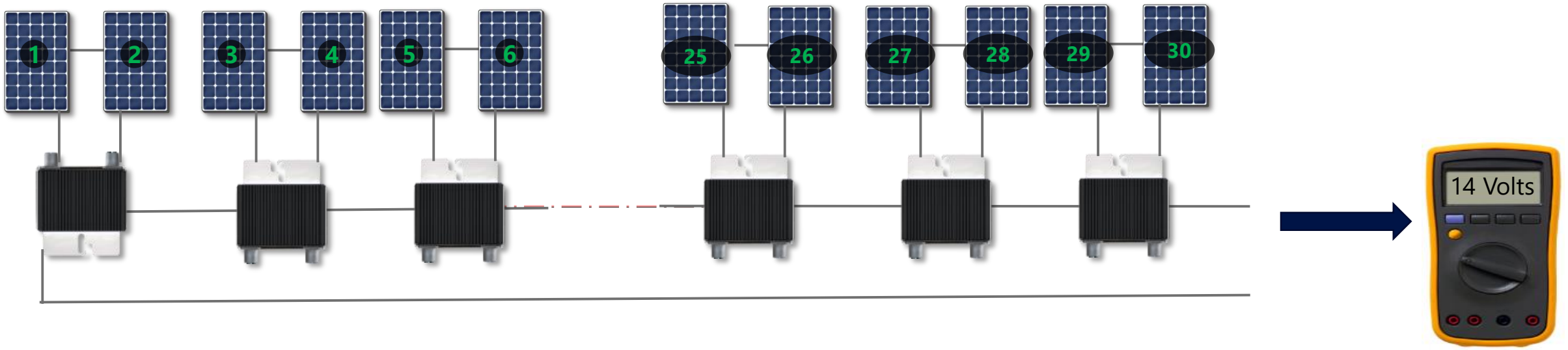
String Testing - Voltage



- The same type of commercial optimiser is used.
- Is this a valid design?

No. The minimum number of panels required in a commercial string is 27 and 14 optimisers.

String Testing - Voltage



- This commercial installation uses panels with short leads and split junction box.
- The engineer designed the system with1.3 meter long input lead optimisers.
- Can you think of a possible reason on why one optimiser is not reporting?

It is possible that the long input of the optimiser got confused with the output leads. Example demonstrated in the first optimiser.

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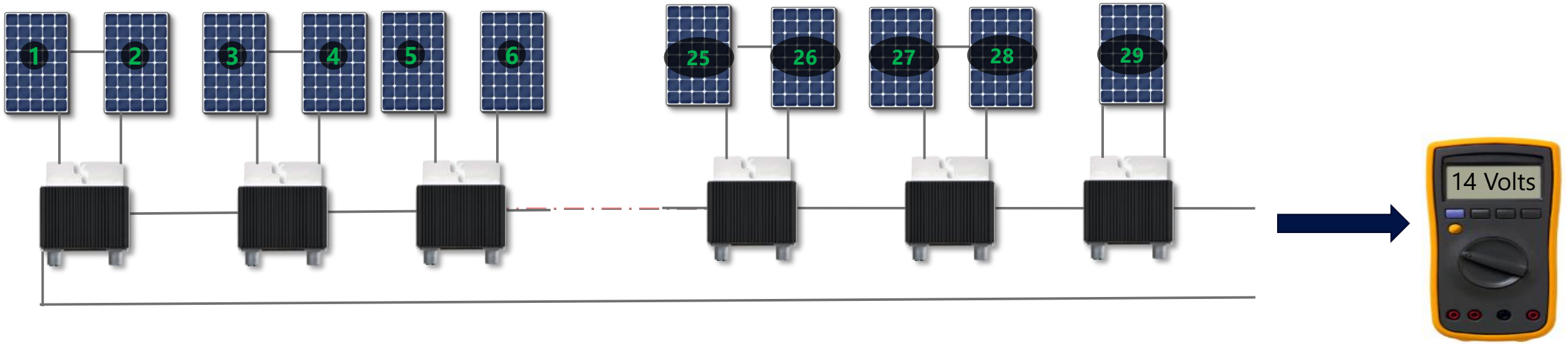
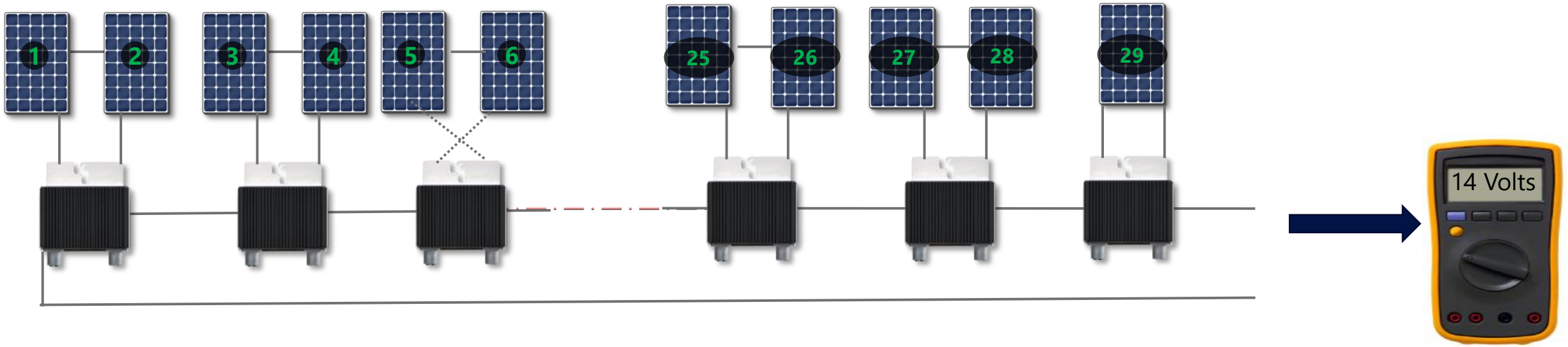
String Testing - Voltage



- One optimiser is not reporting.
- Can you think of a possible reason?

The panel to panel link is broken. Example demonstrated on panels 5 and 6.

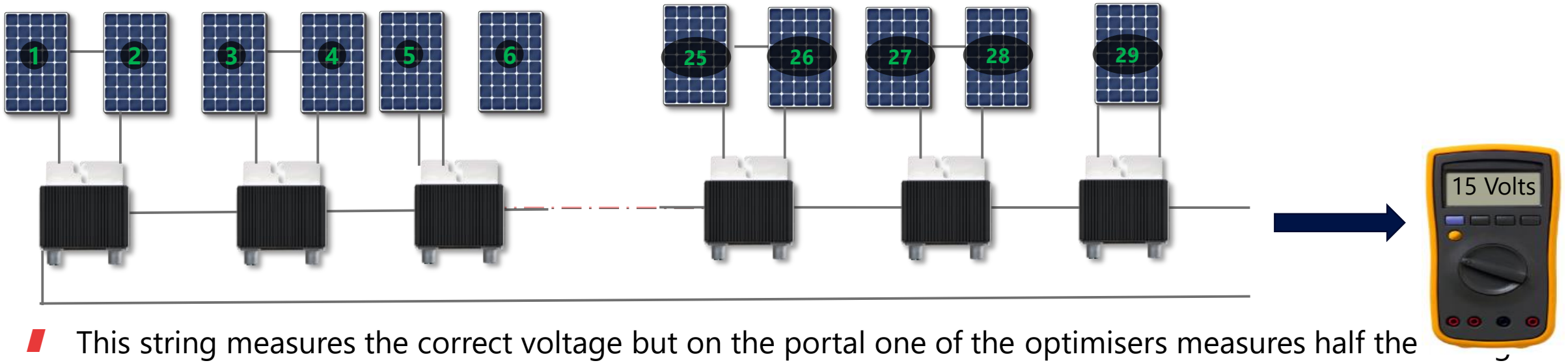
String Testing - Voltage



- This site has occasional hand made extension leads.
- Some of the panel are in a different row so the lead is used to couple them in the same optimiser.
- One optimiser is not reporting. Can you think of a possible reason?

Reverse polarity in the extension leads from optimiser to panel.

String Testing - Voltage



- This string measures the correct voltage but on the portal one of the optimisers measures half the and half the power.
- Can you think 3 reasons why this could be the case?

One panel left unplugged. Example panel 6.
One panel failed but allows voltage of adjacent panel through it.
Wrong mapping in the portal.

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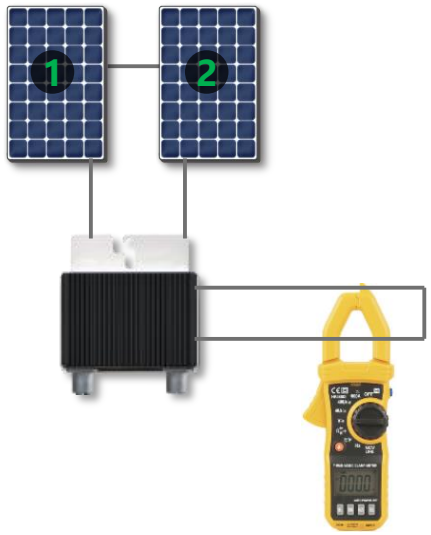
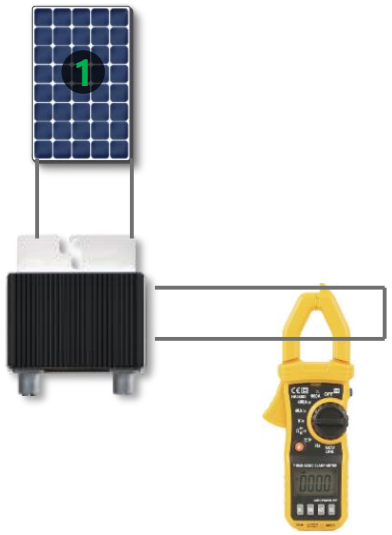
String Testing - Isc





- For a typical 2:1 expect a short circuit current of approx. 700 milliamps. This value can vary up to 1 amp and down to 400 milliamps based on meter accuracy and other factors.
- For a typical 1:1 expect 500 milliamps with a variance of 300 to 600 milliamps.
- For the purpose of this presentation, we will use 0.7 and 0.5 amps respectively.

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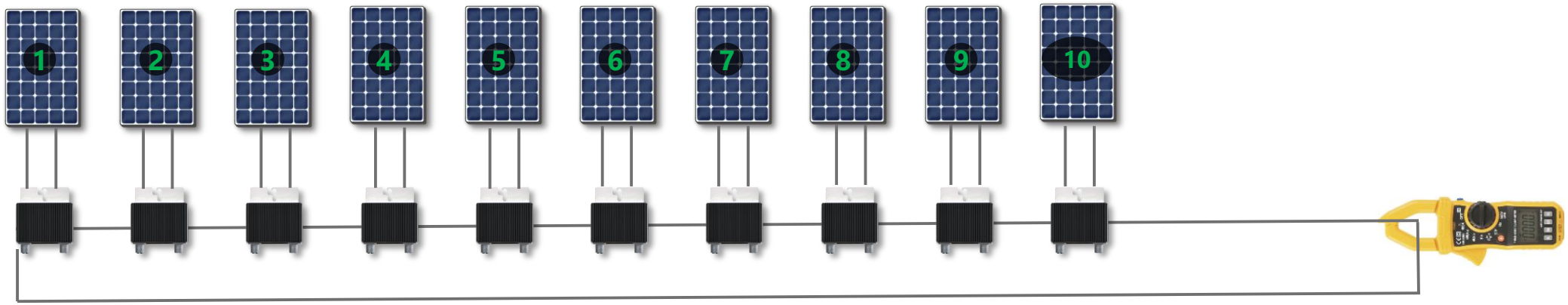
String Testing - Isc



- This string has 10 typical residential optimisers in series.
- The short circuit current of an optimiser is 500 milliamps.
- What Isc (short circuit current) do you expect for the whole string?

500 milliamps

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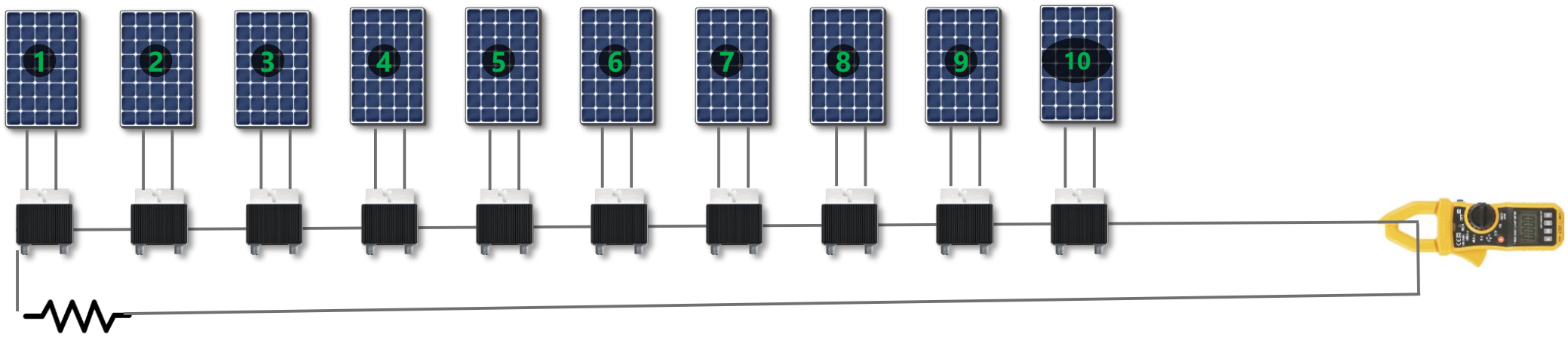
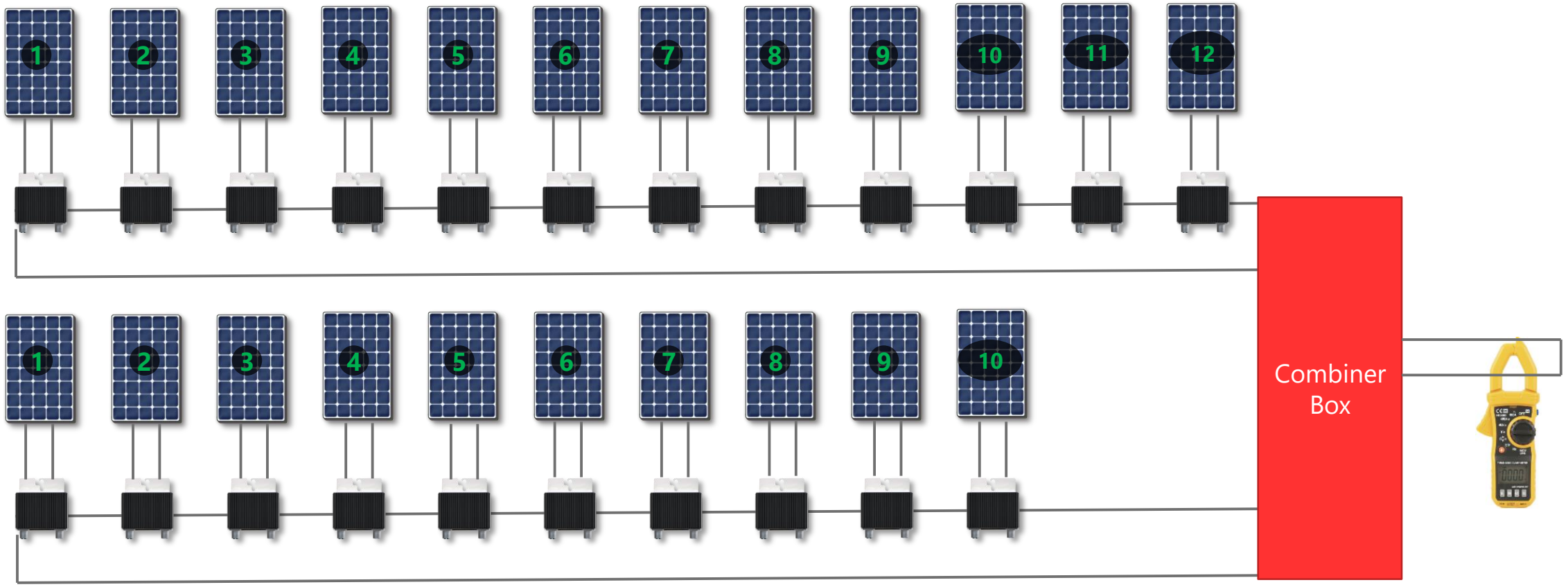
String Testing - Isc



- This string has 10 typical residential optimisers in series.
- The measured voltage is 10 volts.
- The measured Isc is 0. Why?
- Note the string also does not pair with the inverter.

Loose connection. Most commonly at the return lead of string.

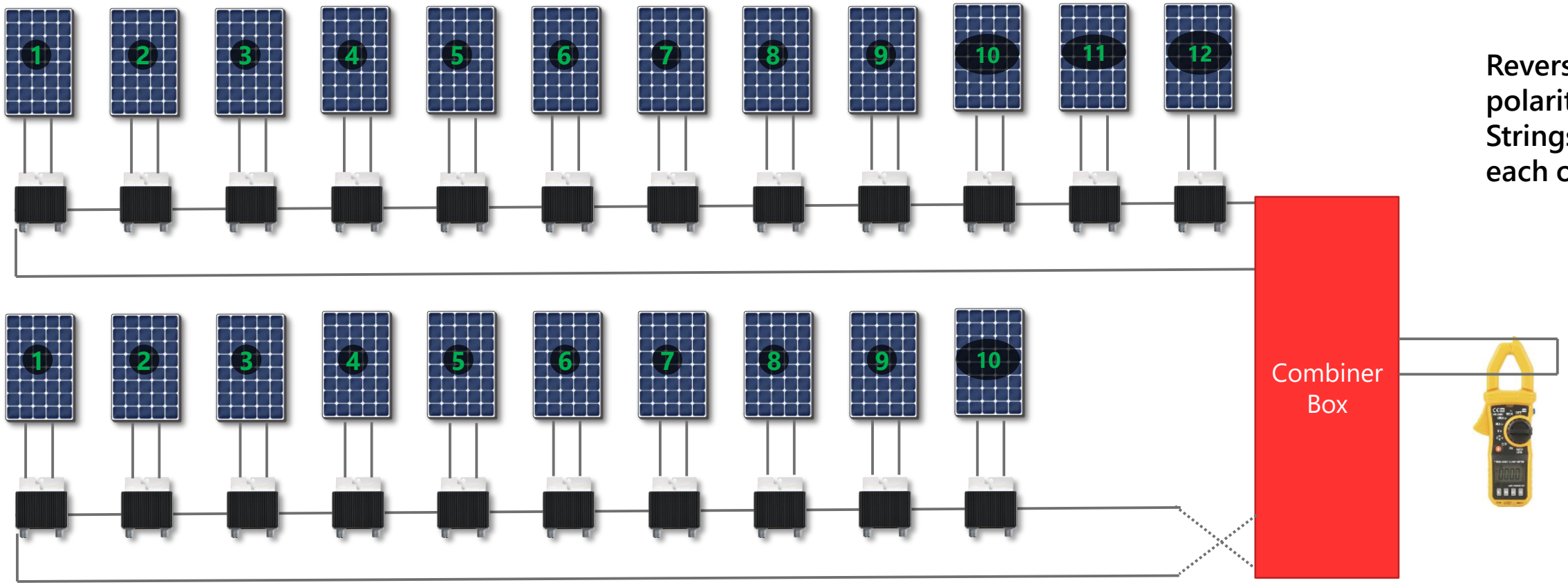
String Testing - Isc



- When combining a string of 12 volts and a string of 10 volts what is the expected Isc after the combiner box?

1 Amp. That is 0.5 amps per string.

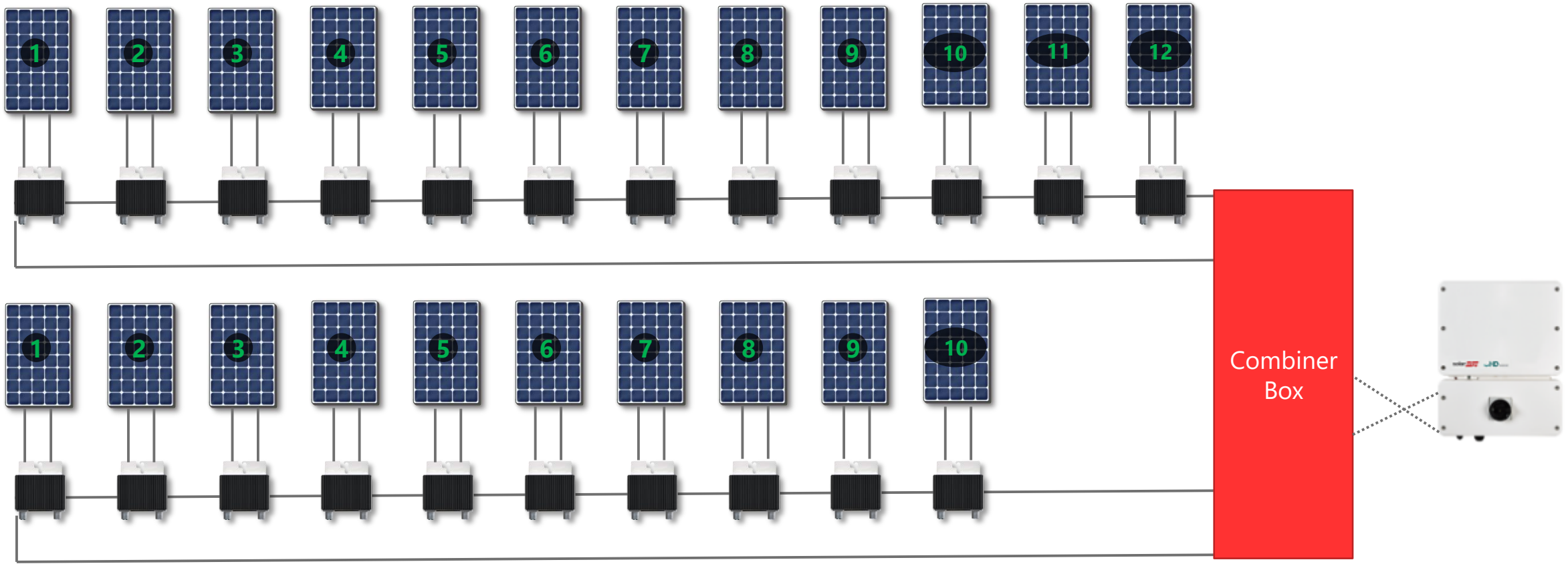
String Testing - Isc



Reverse polarity on S2. Strings cancel each other.

- In the above scenario the voltage is unstable. Isc results in 0 amps. What is the reason?

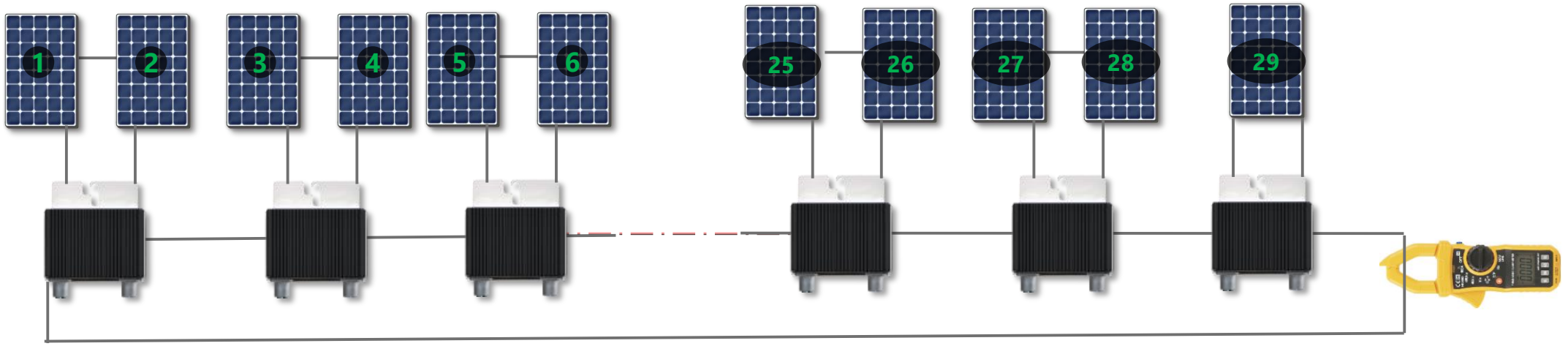
String Testing - Isc



- The voltage current and Insulation tests are ok. The inverter does not pair. Why?

Reverse polarity at the inverter terminals.

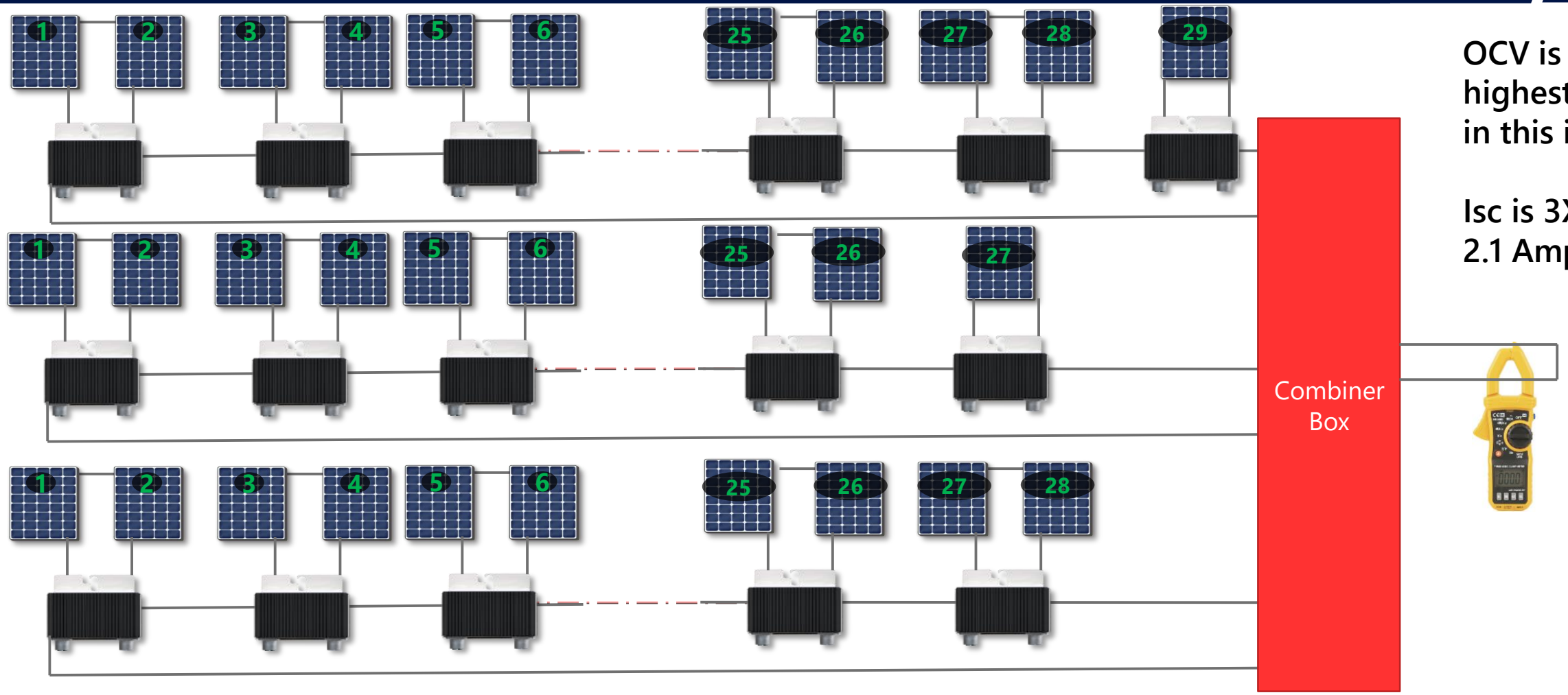
String Testing - Isc



- The same type of commercial optimiser is used.
- What is the expected Isc?

0.7 Amps

String Testing - Isc

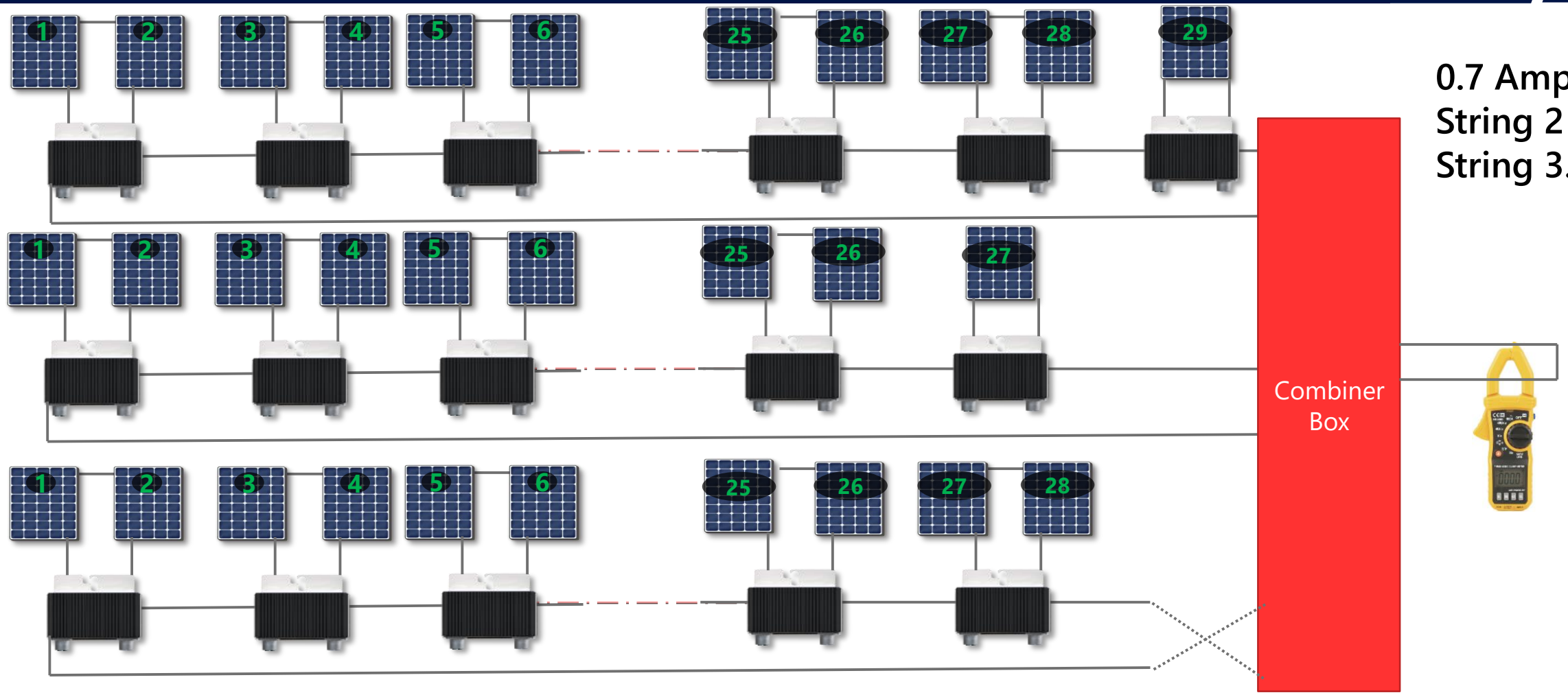


OCV is the highest. 15 volts in this instance.

Isc is 3X 0.7 = 2.1 Amps

- What is the combined Voltage and Isc after the combiner box?

String Testing - Isc



0.7 Amps.
String 2 cancels String 3.

- What is the combined Isc after the combiner box?

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Power Optimisers Installation Tips

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MC4 – Thin Profile PV Cable Compatibility

Possible indications of incompatible plug assemblies:

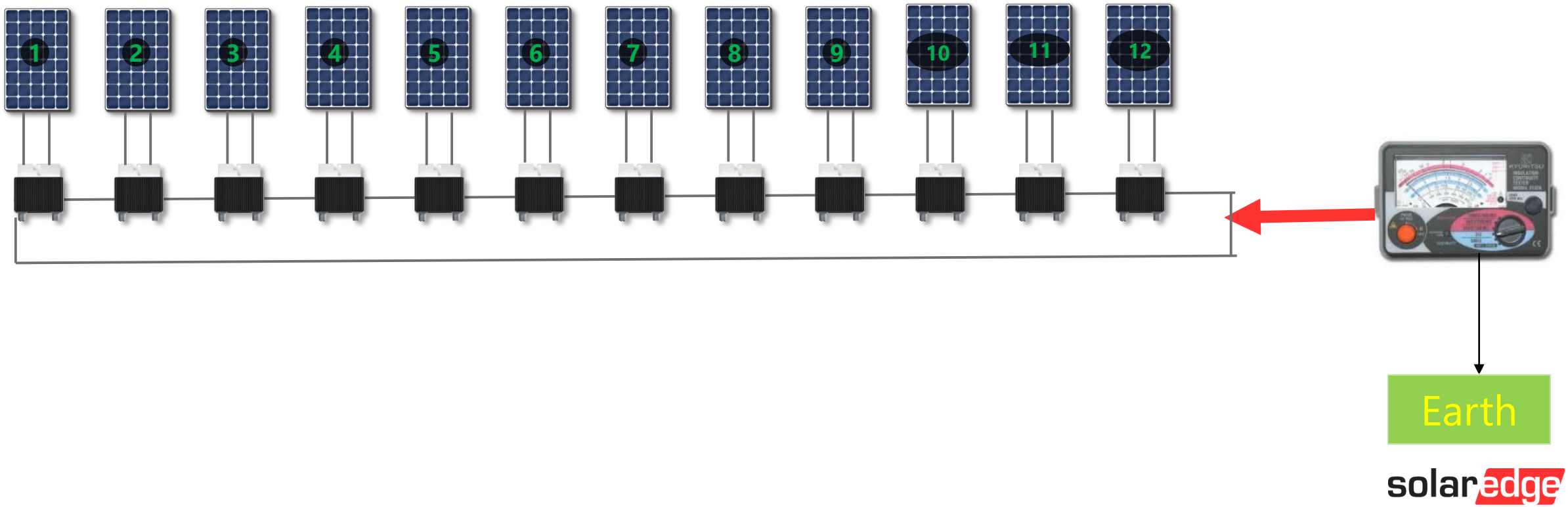
- Low insulation resistance and ground faults
- Plug spinning on the cable.
- Scorched or damaged plug assemblies due to arcing.
- Corrosion of internal components

Glands tightened:

Fitted to thin profile cable:

Connecting Optimisers – Insulation Verification

- When string **shorted** test at **500 Volts** from the common joint to Earth.
- A common value is above 100 Mohms.
- Compare the readings between strings. Check for consistency.



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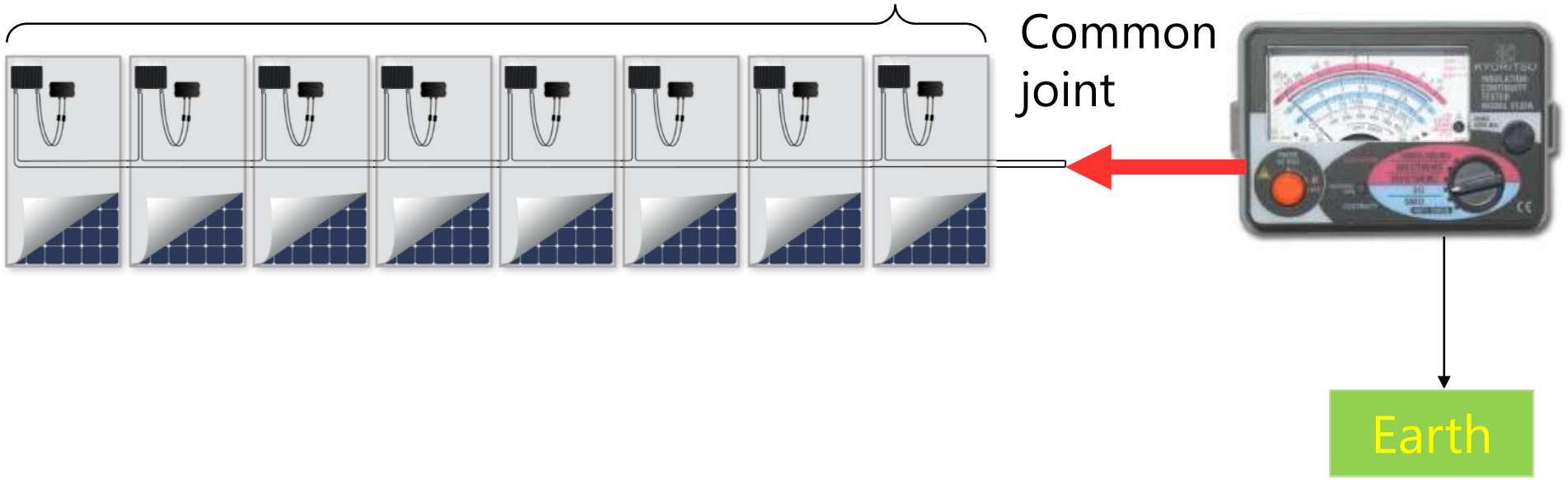
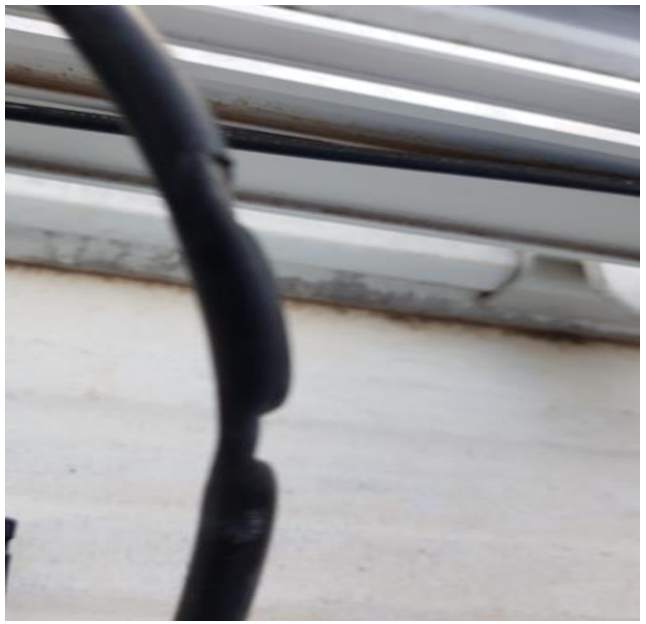
Question

- An inverter has 9 strings. 8 strings measure from 100 to 120 Mega ohms.
  - One string measures 10 Mega ohms.
  - They all belong to the same system and come down in the same cable tray.
  - Is there an issue with the installation???
- Answer: **Yes! Check the DC run back to the inverter or for a pinched cable.**

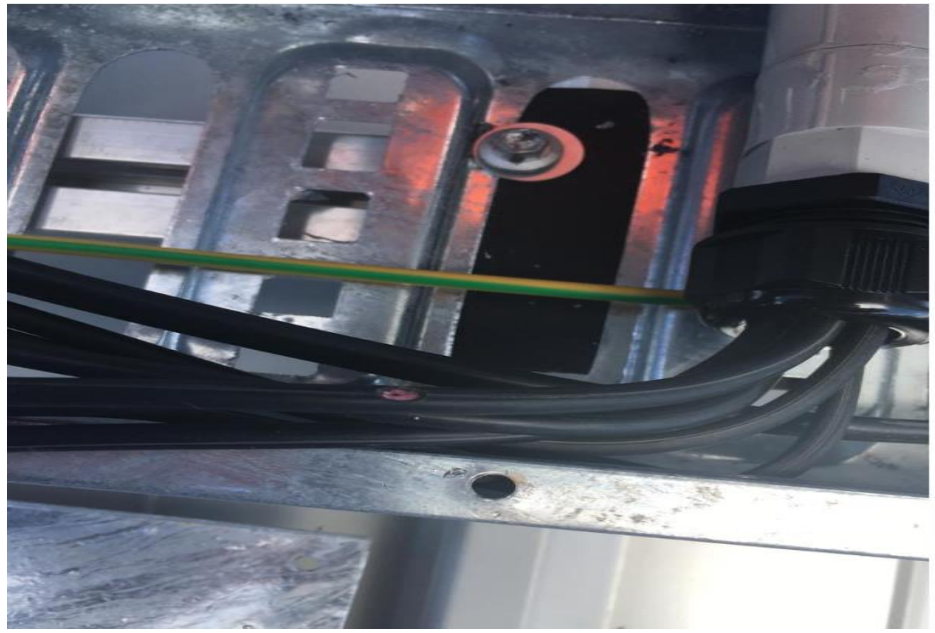


Ground Faults Examples

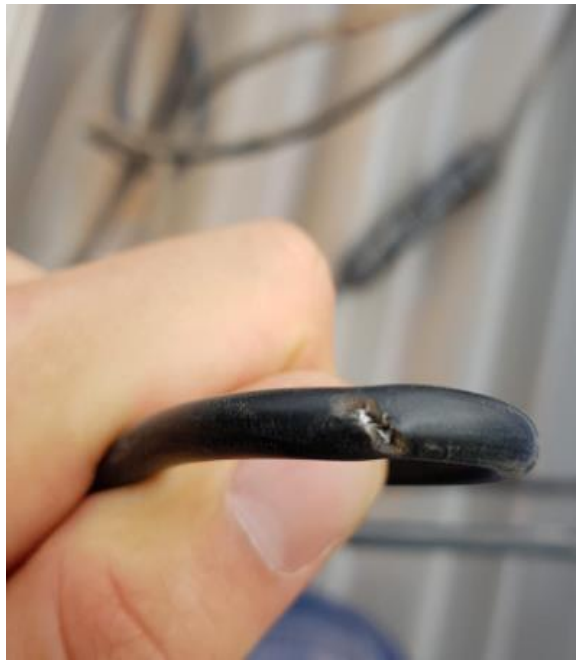
Examples of Ground Faults

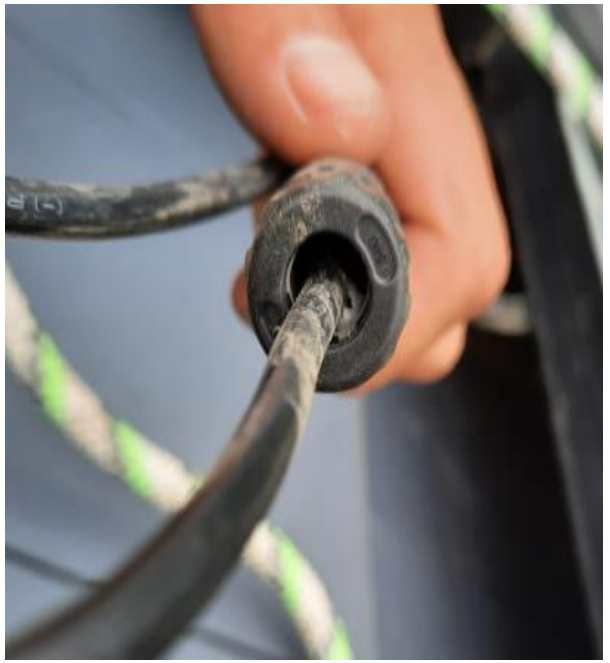


Examples of Ground Faults



Examples of Ground Faults

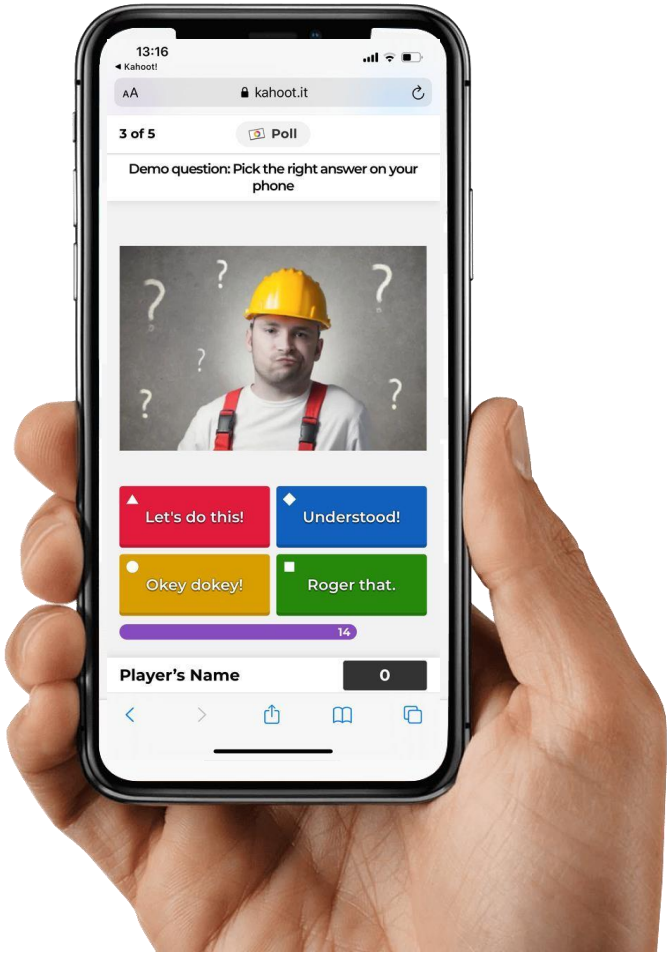





It’s Quiz Time!

It’s Quiz Time!

- Scan the QR code or go to **kahoot.it** using your phone and enter the quiz code
- Add your **full name** when prompted (not a nick name)
- The quiz questions will appear, select your answer - you have a limited time to answer
- Winners are nominated based on **accuracy** and **speed**
- We’ll nominate the winners and reward them with prizes



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Three Key Takeaways from This Webinar

1 **Have the right gear on hand!**
For success, make sure you have your current, voltage and insulation resistance tester on site

2 **If unsure, leave unplugged!**
Be confident of your DC cabling before connecting it to the inverter

3 **Respect the power optimiser!**
Mount and install optimisers as per documentation

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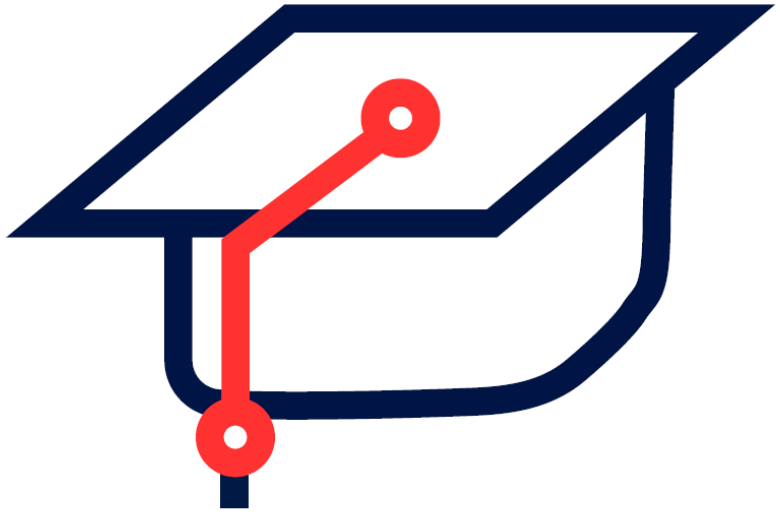
Want to Learn More?

Available training

- E-learning courses
- Webinars on demand
- Seminars



Questions & Survey

Thank You!

Cautionary Note Regarding Market Data & Industry Forecasts

This power point presentation contains market data and industry forecasts from certain third-party sources. This information is based on industry surveys and the preparer's expertise in the industry and there can be no assurance that any such market data is accurate or that any such industry forecasts will be achieved. Although we have not independently verified the accuracy of such market data and industry forecasts, we believe that the market data is reliable and that the industry forecasts are reasonable.

Version #: V.1.0