HOW TO:
Trouble shoot

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1. Required Equipment:

A. Fluke AMP clamp 376FC and/or Extech 380942 or equivilant to test current

B. Amprobe HD110C to test voltage. (must have current calibration)

C. Wire cutters / wire strippers

D. NEW MC4 components, both male/female, plastic and metal

E. Proper crimping tool

F. Jumper with MC4 ends for testing sets of panels (review site for length)

IIIEI

2. Safety Requirements for trouble shooting:

A. Before starting testing, review the following items:

1. Drawings
    a. Become familiar with all areas to be tested. Review rows, panel configuration and strings feeding into CBX.

    b. At this point, inverters are "hot" and site is producing.

2. Current Test
    a. This will require "clamping" around leads (home runs) as they enter into CBX and testing current will site is functioning.

    b. Testing will be performed by authorized employees only.

3. Voltage Test
    a. This will require testing of voltage produced by panels after conditions are set where current IS NOT being produced.

    b. Verify the connection to inverter is open and any chance of "back feed" is eliminated.

    c. Testing will be performed by authorized employees only.
4. Job Hazard Analysis (J.H.A.)
    a. Ensure voltage and current exposures are listed on JHA.

    b. Have all required PPE.

    c. Get JHA reviewed by E Light's Director of Safety and Loss Prevention.

    d. Create a step by step site specific procedure on how task will be accomplished.

        i. This document is not site specific and is only a general procedure on how to perform DC current (DCI) testing.

        ii. Get procedure reviewed by E Light's Director of Safety and Loss Prevention.

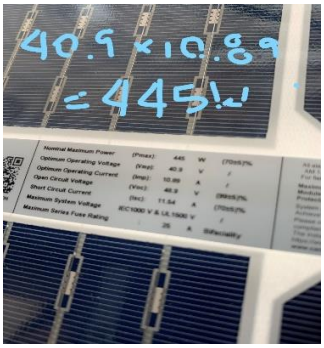
NOTE: Trouble shooting begins with checking current readings while system is "HOT". Voltage readings will be done **AFTER** CBX (combiner box) or DSC (disconnect switch) has been turned OFF and no current is running. Troubleshooters need to be aware of any voltage that may be feeding the area being checked to avoid any "back feed" from other strings connected to same CBX/DSC!

IF COMBINER BOX ACCES IS REQUIRED, wear appropriate PPE for ARC FLASH rating of CBX. DO NOT allow contact between adjacent bus bars. Follow all LOCK OUT –TAG OUT procedures.

A thorough understanding of the site specific wire management is necessary to safely understand where the problem might be found.

Recap of ohms law as it applies to Power is helpful, along with an understanding of series and parallel circuits.

P=EI, where Power (watts) is equal to Voltage (volts) x Current (amps)



this panel produces 445 watts with a voltage of 40.9 volts and 10.89 amps

Panels connected in series adds the voltage. Strings wired in parallel adds the current.

3. Troubleshooting:

A. Begin with rows at a single CBX/DSC and walk the suspected rows with an amp clamp. By beginning on the west end and heading east, this will typically read the rows in consecutive order. Be aware of how many banks (or strings) of panels are to the north and/or south of each row and the number of panels in each string. (The current can be calculated using the label on back of panel and noting the series and parallel configuration of the array)

Example: 1 set/bank of 28 panels in series puts out about **10 AMPS** with good sunshine (anything above 400 watts) **2 sets** in parallel put out 20 AMPS, **3 sets** in parallel will produce 30 AMPS

1. When 0 current is found, TURN OFF CBX or DISCONNECT! **"Kill the box**" to eliminate a source of power that may back feed from inverter.

2. Disconnect the home runs connections feeding the CBX/DSC that may be associated with the area your working. This will eliminate other sources of voltage that could be fed back to you via the bus bars in the box. When you "**POP the DROPS",** the positive and negative leads that connect to the CBX or IPC/BLA, it is now even safer by isolating this row from others associated with that CBX/DSC. (the other rows on won't "bite ya").

B. Check voltage

Example: (28 panels in series x 46volts = 1288 volts +-)

1. If voltage is good on the row, but not getting to CBX or DSC;

a. If the system is using **disconnect boxes** then a BLA is present that ties the boxes together. Chances are the IPC was never torqued to specs and not making a good connection. It will be necessary to open the "rat trap" and tighten the bolt with a 17mm deep socket. (NOTE: Ensure all other rows associated with this BLA are disconnected so you don't get bit! Double check readings with multimeter and appropriate PPE)

b. Otherwise the harness isn't making connection with the IPC whip and ALL the MC4s should be inspected starting with both ends of the home runs. Sometimes the internal parts of the MC4 are too deep or damaged by too much stress pulling the wire. A simple "tug test" at each MC4 connection can check this.

c. With **combiner box**, a simple missed connection inside the CBX may be the culprit. Wearing appropriate PPE, a simple "tug test" where the leads connect to at both internal positive and negative connections will check this.

2. If voltage has a low reading or zero:

a. Ensure CBX or DISCONNECT is off or **"Kill the box**" to eliminate power that may back feed from inverter so it's safe to test voltage.

b. In this case, a MC4 might be the problem or wire management is incorrect and it may be necessary to walk the entire row behind panels inspecting all connections. Sometimes the internal parts of the MC4 are too deep or damaged by too much stress pulling the wire. A simple "tug test" at each MC4 connection can check this.

CAUTION! In the event of direct short among panels, current will be flowing and care must be taken in disconnecting that area along with proper PPE. In the case of a "super circuit", an arc will be caused by opening a live circuit. Consideration should given to repairing it at night when irradiance will not cause panels to generate electricity.

c. The other possibility is a blown fuse and which can be checked by isolating the fuse and then checking continuity. (fuses do not always have obvious signs they are blown)

d. If connections seem secure it will be necessary to test all panels in row.

i. Test voltage form positive and negative leads from set of panels.

ii. "Sets" of panels can be tested to narrow down search.

EX. Break down a string of 30 panels into 3 sets of 10, making note of calculated voltage from label (10 panels at 50 volts each = 500 volts)

e. Once problem has been determined, correct with appropriate parts and tools

i. If panel is being replaced, ensure its specifications are similar to others in the row.

ii. Re assemble all connections, and re check voltage, then current after box is turned back on.

iii. Clean up area leaving it in "better condition" than when you arrived.

If all else fails, it's possible a ground fault or short may be hidden somewhere.

Contact commissioning manager.