

ELECTRICAL INSPECTION BULLETIN

B-64-200

Solar Photovoltaic Installations



(Effective 2024-07-02)

Objective

To provide direction on the installation of Solar Photovoltaic Systems. This Bulletin supplements or clarifies the requirements set forth by the CSA C22.1:24 Canadian Electrical Code, Part 1 (26th Edition), Safety Standard for Electrical Installations. See additional notes at the end of this document.

Definitions

Micro Inverter - A solar micro-inverter, or simply microinverter, is a device used in photovoltaics, that converts direct current (DC) generated by a single or multiple solar modules to alternating current (AC).

String Inverter - A string inverter is connected to a series or “string” of solar panels and converts the power from Direct Current (DC) into Alternate Current (AC) electricity, for the solar system as a whole.

Optimizer - A power optimizer is a DC-to-DC converter technology developed to maximize the energy harvest from solar photovoltaic or wind turbine systems.

Maximum Circuit Loading (Diagram # 5/6/7)

CE Code Rule 64-100 requires that the maximum current of the inverter output circuit shall be the inverter continuous output current rating. Output circuits connected to these devices are to be sized based on this continuous output rating and are not to be based on input load calculations or battery banks if any (See Diagram # 2). Some inverters may have specifications listing sustained maximum output currents, and the higher of these numbers or the rated output shall be used.

In cases where the inverter output can be factory set or field programmed to limit the maximum continuous output, an exception to this rule will be allowed. These programmed settings shall be locked, or program protected in such a way that access to change these settings by unauthorized personnel or a homeowner is impossible. In these cases, a legible, permanent lamicoïd label, white letters on RED background shall be installed on or adjacent to the inverter and the main AC disconnect switch. Where micro-inverters are used, a label is only required on the main AC disconnect switch.

This label is to read as follows: “**Maximum Inverter Output Set at XX Amps - NOT TO BE EXCEEDED**”

Rodent Protection Requirements (Diagram # 5/6/7/8)

CE Code Rule 64-210 (5) requires protection against damage from rodents under some circumstances. This requirement shall only apply to DC string inverter systems. Micro-inverter installations shall not be required to have this additional rodent protection. In all cases, however, mechanical protection, if deemed necessary, shall still be required, e.g., for exposed RPVU type cabling.

In scenarios where rodent protection is required, use of rodent guard mesh sleeves approved for the purpose may be used for installation under the modules and along module racking only. Rodent guard mesh sleeves of any kind shall NOT be used as just mechanical protection or as a raceway system beyond the solar array boundary.

Wiring Methods

CE Code Rule 64-210 (2) & (3) indicate that type RPVU cables and manufacturer supplied module cabling greater than 30V shall be inaccessible to the public. This can be achieved by location of the array, complete fencing of the array or complete mesh/panel coverings to prevent hand contact. Other suitable methods may be acceptable with NSPI approval prior to installation.

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To Clarify these requirements:

- Achieved by location means on the roof of a dwelling or other building without permanent roof access. In cases where the building roof can only be accessed by authorized personnel for maintenance purposes, this is acceptable.
- Complete Fencing shall be a permanent, free standing chain link or wooden fence structure, minimum height 1.5m (5 ft) complete with locking gate access. Chicken wire or livestock fencing supported by push-in stakes or strapped to array structures is not acceptable (see Photo 2).
- Complete wire mesh / panel coverings shall be installed on the back of the array system fastened securely to the array racking using screws / washers (see Photo 1). This wire mesh covering shall be a metallic type, have openings 6mm x 6mm (1/4" x 1/4") maximum and installed in such a way to ensure no one can touch the RPVU type cabling or the connectors. This means all RPVU cabling shall be secured tightly and away from the wire mesh covering. In other words, the cabling shall not lay against the covering. **(Plastic meshing or coverings are not acceptable)**

Photo 1: Example of an acceptable installation:



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Photo 2: Example of unacceptable installation:



Equipment Bonding

CE Code Rule 64-222 requires that the bonding connection between the grounding conductor and exposed conductive surfaces of the renewable energy source or supply circuit equipment shall be made in such a manner that disconnection or removal of the equipment will not interfere with or interrupt bonding continuity.

In line with CE Code Rule 10-612, bond conductor sizes shall be minimum #6AWG copper or #4AWG aluminum in all cases when exposed. Exceptions to this requirement are as follows:

- The bond conductor within a factory assembled cable (i.e., Teck90 cable). The factory supplied bond conductor is acceptable.

Or

- The bond conductor runs within a complete conduit system with no exposure of the bond conductor. In this case the bond conductor shall be sized as per Table 16 requirements.

Bonding of the rack system - All bonding shall be installed as per the manufacturer's installation instructions and applicable code requirements. Where the racking system is used for bonding, it must be approved for use in Canada.

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Bonding of no-rack systems (rail-less): All bonding shall be installed as per the manufacturer's installation instructions and applicable code requirements. See potential scenarios for the bonding of rail-less systems at the end of this bulletin (Diagram # 1). Where the rail-less system is used for bonding, it must be approved for use in Canada. Certification Bodies or Special Inspection Bodies now use CSA 61730 / ORD 1703 when granting approval.

Rapid Shut-Down Requirements (Diagram # 4/9)

CE Code Rule 64-218 requires photovoltaic rapid shutdown to be provided for photovoltaic systems installed on or in buildings where the photovoltaic (DC) source or (DC) output circuit insulated conductors or cables on or in buildings are more than 1m from a photovoltaic array.

A device used to initiate photovoltaic rapid shutdown shall be readily accessible and located as follows. Note this requirement can be complied with in some cases by the disconnecting means referred to in the next section.

- For single dwelling units at the supply authority meter location. This also includes installations where photovoltaic modules are installed only on a detached garage or other outbuilding / ground mounted array.
- For other than single dwelling units, at the consumer's service equipment or supply authority meter location, and at a permanent access to a building roof where an array is installed within sight and within 9m of the array.

Disconnecting Means Requirements

Disconnecting means shall be provided as per CE Code Rules 64-060 and 84-022.

To facilitate these requirements, the following arrangements shall be made. These requirements shall be deemed as meeting both requirements of CE Code Rule 64-060 and 84-022. **Note: Other code rules that indicate the requirement for a disconnecting means to be installed for any other purpose are still required.**

For the purposes of this document the disconnecting means shall be located within 1m of the meter base or a ground mounted array. When located on a detached garage or other outbuilding without a meter base, they shall be located on the exterior of the building in a readily accessible location.

- For a single dwelling unit with photovoltaic installations on the roof of the dwelling unit only, a single AC disconnecting means shall be provided. The disconnecting means shall be located at the meter base location.
- For a single dwelling unit with photovoltaic installations on the roof of the dwelling unit as well as the roof of a detached garage or other outbuilding, an AC disconnecting means shall be provided both at the detached garage or other outbuilding and at the meter base location. Where photovoltaic installations are only mounted on the detached garage or other outbuilding, an AC disconnecting means shall be provided both at the detached garage or other outbuilding and at the meter base location.
- For a single dwelling unit with a photovoltaic ground mounted array, an AC disconnecting means shall be provided both at the ground mounted array and at the meter base location.
- For other than single dwelling units with photovoltaic installations on the roof such as stand-alone detached garages, other outbuildings and ground mounted arrays that are connected direct to the utility grid by means of a single utility service connection, an AC disconnecting means shall be provided at the meter base location. For a ground mounted array with the meter base remotely mounted, an AC disconnecting means shall be provided both at the ground mounted array and at the meter base location.

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- For other than single dwelling units such as commercial buildings with photovoltaic installations on a roof, an AC disconnecting means shall be provided at the photovoltaic array on the roof, or at ground level if the roof is inaccessible, and at the meter base location. If a ground mounted array is used, an AC disconnecting means shall be installed at the ground mounted array and at the meter base location.

In situations where locating the disconnecting means in the identified locations is not practical due to meter base locations, accessibility issues or other circumstances, NSPI permission, or a DOL deviation, may be granted prior to installation to locate the AC disconnecting means in an alternate location within sight of the meter and accessible at ground level whenever possible. In this case, a permanent label shall be installed adjacent to the meter base or service equipment to indicate the actual location of the AC disconnecting means. When an alternate AC disconnecting means location has been approved, the alternate location and additional signage shall be identified clearly with their plans review submission.

For scenarios other than those identified above, contact NSPI prior to design and installation.

Alternate Solar PV Connections

Approved Dual Lug Meter Base:

Where a solar photovoltaic system is installed on the supply side of the service disconnecting means, according to CE Code Rule 64-112 (2), using a dual lug meter base, the disconnecting means shall be service entrance rated. The neutral conductor shall be installed and terminated at the disconnecting means.

A panelboard connected to a dual lug meter base used solely for connection to a solar PV installation shall be labelled as indicated below. Normal loads shall not be connected to this panelboard since this panelboard is not considered a load on the service and is not included in the load calculation for the installation. Connecting loads to a “solar only” panelboard may overload the service and introduce fire / shock hazards to the installation.

Bidirectional Disconnecting Means / Overcurrent Devices

Where a solar photovoltaic system is installed, the possibility of power flow in both directions exists. Breakers and disconnect switches falling into this category shall be approved for this purpose:

Breakers

According to CSA, Circuit breakers that are marked “Line” and “Load” have been evaluated for connection only in one direction. Circuit breakers without “Line” and “Load” have been evaluated for connection in both directions.

Disconnect Switches

All disconnect switches are bidirectional, even when marked line and load. This can be seen in the CE Code rules that stipulate warning notices for bidirectional use on switches marked line and load as well as the “Main Panel & All Disconnecting Means” warning label below.

Combination Solar / Back-up Generator installations

Photovoltaic systems are connected to the supply authority through interactive inverters that are equipped with anti-islanding protection in accordance with Rule 84-008. When generators are introduced to the customer’s power system, they may be mistaken for utility power and bypass the anti-islanding protection, bringing the solar system back online and connected to the utility while it is still deenergized. This may pose a shock hazard to utility personnel.

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Auto-Transfer Schemes (Diagram # 3)

In the case of an auto-transfer generator installation that is installed in conjunction with a solar application, a means of automatically isolating the solar system when the generator is activated shall be provided. This shall be achieved by means of auxiliary contacts or other manufacturer approved means.

Manual Transfer Schemes

In the case of a manual transfer generator installation that is installed in conjunction with a solar application, a legible permanent warning sign at the transfer switch location shall be provided as follows:

“**Caution: De-energize all Solar Systems before Starting Generator**”. White letters on red background (sized to suit).

Note: Transfer schemes that require the generator to be manually started (e.g., GenerLink installations) shall be considered as a manual scheme.

Off-Grid Installations

Although not connected to the Supply Authority (public utility), off-grid installations are still required to be permitted and inspected by the Inspection Authority as per Section 7 of the Electrical Installation & Inspection Act:

New or altered installation

- 7 (1) No electrical installation nor any alteration or addition to an electrical installation shall be made except in conformity with this Act and the regulations.
- (2) Where under this Act a duty is imposed upon a public utility to inspect an electrical installation or an alteration or addition to an electrical installation, the inspection shall be carried out by a person approved by the Fire Marshal for that purpose. R.S., c. 141, s. 7.

This includes compliance with the Canadian Electrical Code (CE Code), Part 1 for electrical installations and Appendix A for electrical equipment.

Diagrams & Labelling Requirements

CE Code rule 84-030 requires that a warning notice of an interconnected system and a permanent, legible single line diagram of the complete interconnected system shall be installed in a conspicuous location at the supply authority disconnecting means. For the purposes of this rule, the single line diagram shall only be required to be located inside at the main service panel and at any sub panels associated with the photovoltaic system. Laminated paper, aluminum plates, lamicoïd plates and/or other protective coverings shall be acceptable as long as they are securely fastened.

CE Code rules 64-060 to 64-222 require various types of labelling that pertain to photovoltaic installations. The following is a list of some, but not all of these minimum requirements and typical wording. Alternate similar wording or abbreviated wording is acceptable. Other labelling requirements not listed are still required where indicated by the Canadian Electrical Code C22.1.

All labels must be permanent lamicoïd engraved plates, legible, white lettering on RED background, sized per CE Code requirements. Where equipment size makes some labels impractical, reduced lettering sizes are acceptable as long as they are legible.

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Location: Main Panel / PV Breaker

“SOLAR INPUT - Do Not Relocate Breaker Position”

Location: Disconnecting Means (Roof DC Combiners / Ground DC Combiners)

“PHOTOVOLTAIC SYSTEM DC DISCONNECT”

Location: Main Panel Disconnect & Exterior Disconnecting Means

“PHOTOVOLTAIC SYSTEM AC DISCONNECT”

Location: Main Panel & Meter Base

“WARNING: Dual Supplies Utility Grid & Photovoltaic Power Source”

Location: Main Panel & All Disconnecting Means

“WARNING – ELECTRIC SHOCK HAZARD”

“Both Line and Load Sides May Be Energized in the Open Position”

Location: Exterior DC Disconnecting Means

“OPERATING VOLTAGE XXX VDC

OPERATING CURRENT XX A

MAX SYSTEM VOLTAGE XXX VDC

SHORT CIRCUIT CURRENT XX A”

Location: Exterior AC Disconnecting Means

“OPERATING VOLTAGE XXX VAC

OPERATING CURRENT XX A”

Location: Main Consumers Service Location & Exterior Disconnecting Means (may be the same exterior disconnects as noted above)

“WARNING – Photovoltaic System Equipped with Rapid Shutdown”

Location: Exterior DC Disconnecting Means, DC transition boxes

“WARNING – DC Conductors May Be Energized”

Location: Solar Panelboard connected to Dual Lug Meter Base

“WARNING: Panelboard connected to Solar PV Installation for Solar use only.”

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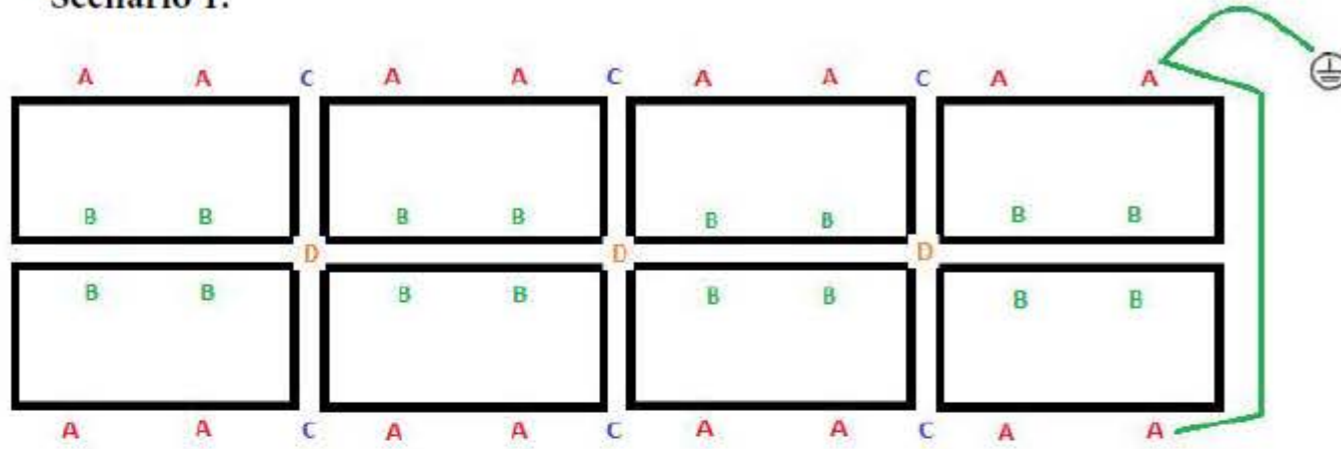
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Notes:

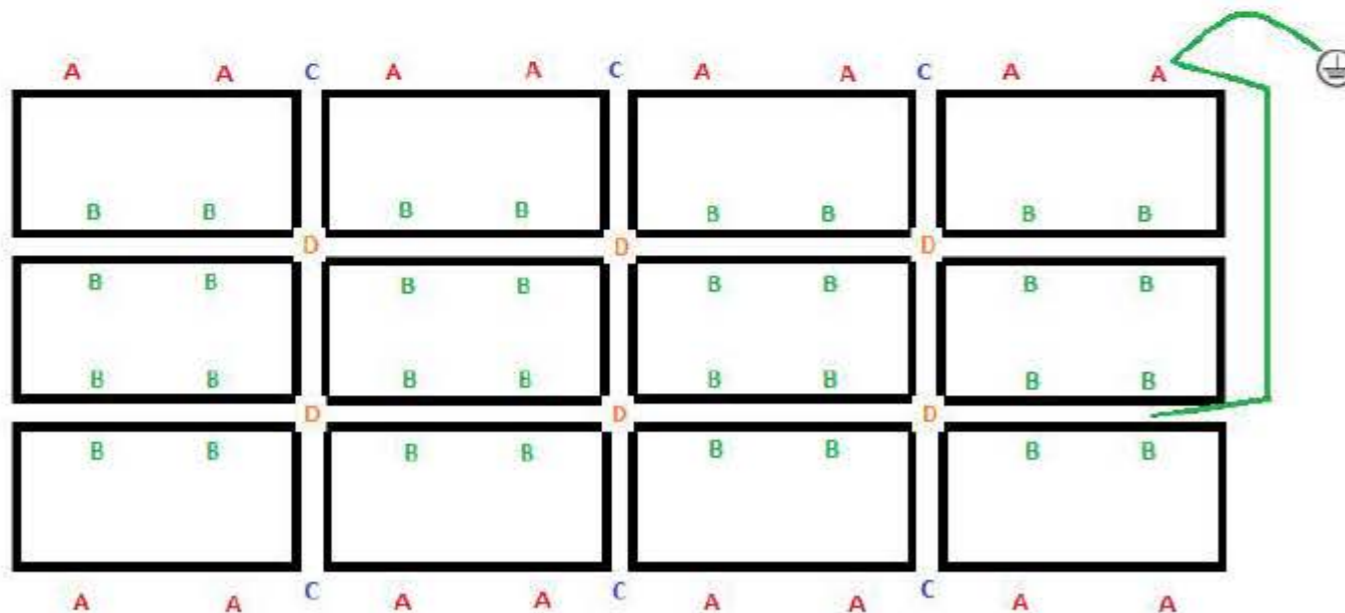
1. All solar photovoltaic installations, regardless of whether off-grid or utility interactive, shall have both a rough-in inspection and a final inspection. The rough-in inspection shall require as a minimum installation, all plug & play cabling, junction boxes on the roof, installation of micro-inverters or optimizers, and rack bonding as well as everything that will be covered up by the solar module installations or not visible at the time of final inspection. This may also include underground installations for ground mounted arrays, cabling inside buildings that will be covered, etc. (Exceptions to this requirement shall be approved by NSPI prior to equipment installations)
2. It is the installation contractor's responsibility to have a certified electrician on-site for inspections to arrange for safe access to roofs, panelboards, junction boxes or for questions related to their installations. If a contractor is unable to be on-site at the time of the inspection and an issue or clarity is required, this may delay acceptance of their inspection and rebooking will be required.
3. Disconnecting Means: Section 84, CE Code Rule 84-024 (1) c) indicates that contact operation is verifiable by direct visible means. This is only required for installations greater than 1000V.
4. All solar photovoltaic disconnect switches shall be kept de-energized until a bi-directional meter is installed, and the final inspection is complete. A short duration allowance will be accepted for testing purposes only. It is the contractor's responsibility to make sure these switches are turned off and the owner is informed not to energize until the bi-directional meter is installed. Any installations deemed as not meeting these requirements may be de-energized and sealed by NSPI at any time.
5. Reference NSPI Bulletin B-02-014 for submittal of electrical plans requirements. All single line diagrams submitted shall be legible and complete with all electrical equipment specifications, wire types & sizes, monitoring equipment, bonding, etc.
6. Disconnect switches and other arc producing devices, such as utility smart meters with integral disconnects, combiner panels, and inverters shall not be located within 1 meter of a natural gas relief vent or 3 meters of a propane gas relief vent.

Diagram # 1: Rail-less Bonding

Scenario 1:



Scenario 2:



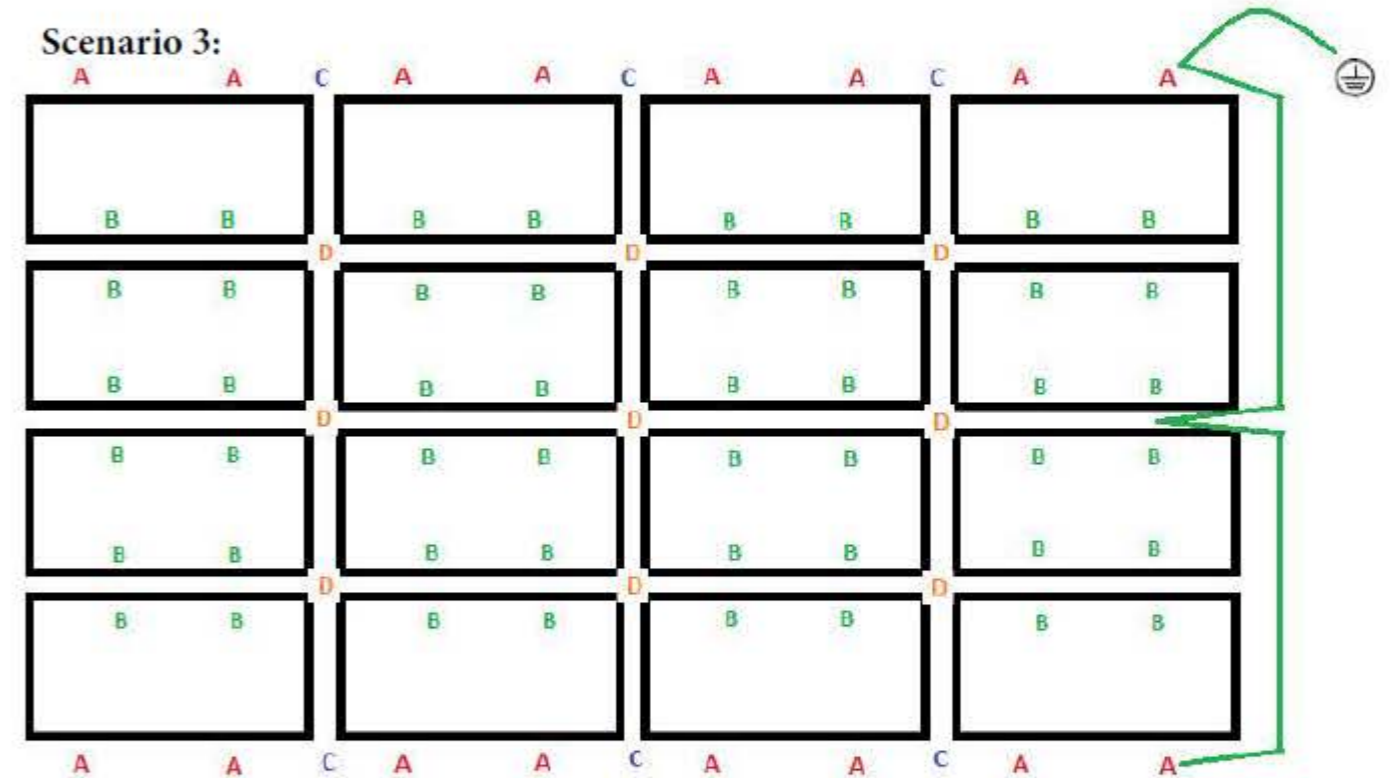
Required to be bonded at 50% or greater, of the end or mid clamps at the beginning of each row closest to the JB, and alternate clamps.

Example: 2-3 Rows - 2 points, 4-5 Rows - 3 points, etc.

For arrays with a single row, bonding must be done at one edge clamp at each panel.

Bond wire must be continuous. All End and Mid Floating Bond Splices are required for Canadian Installations. Panels must be mounted with the long side horizontal. Bonding must be done in this manner regardless of trim installed or not.

Scenario 3:



Legend:

- A - End Clamp
- B - Mid Clamp
- C - End Floating Bond Splice
- D - Mid Floating Bond Splice
- ⊕ - Bond Connection in JB

Diagram # 2: Sample Battery Storage with Inverter/Charger with Emergency load Panel

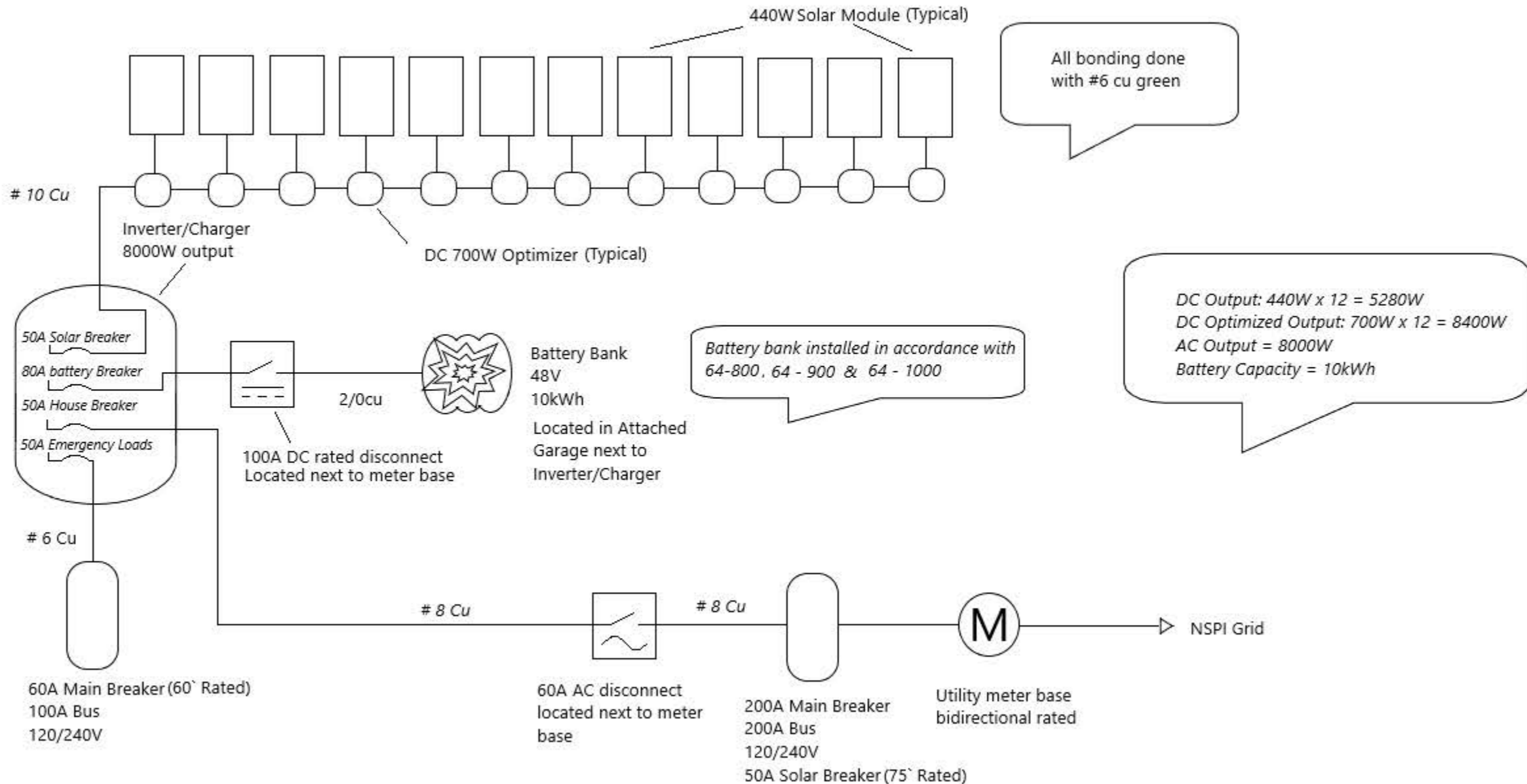


Diagram # 3: Generator & Solar Example

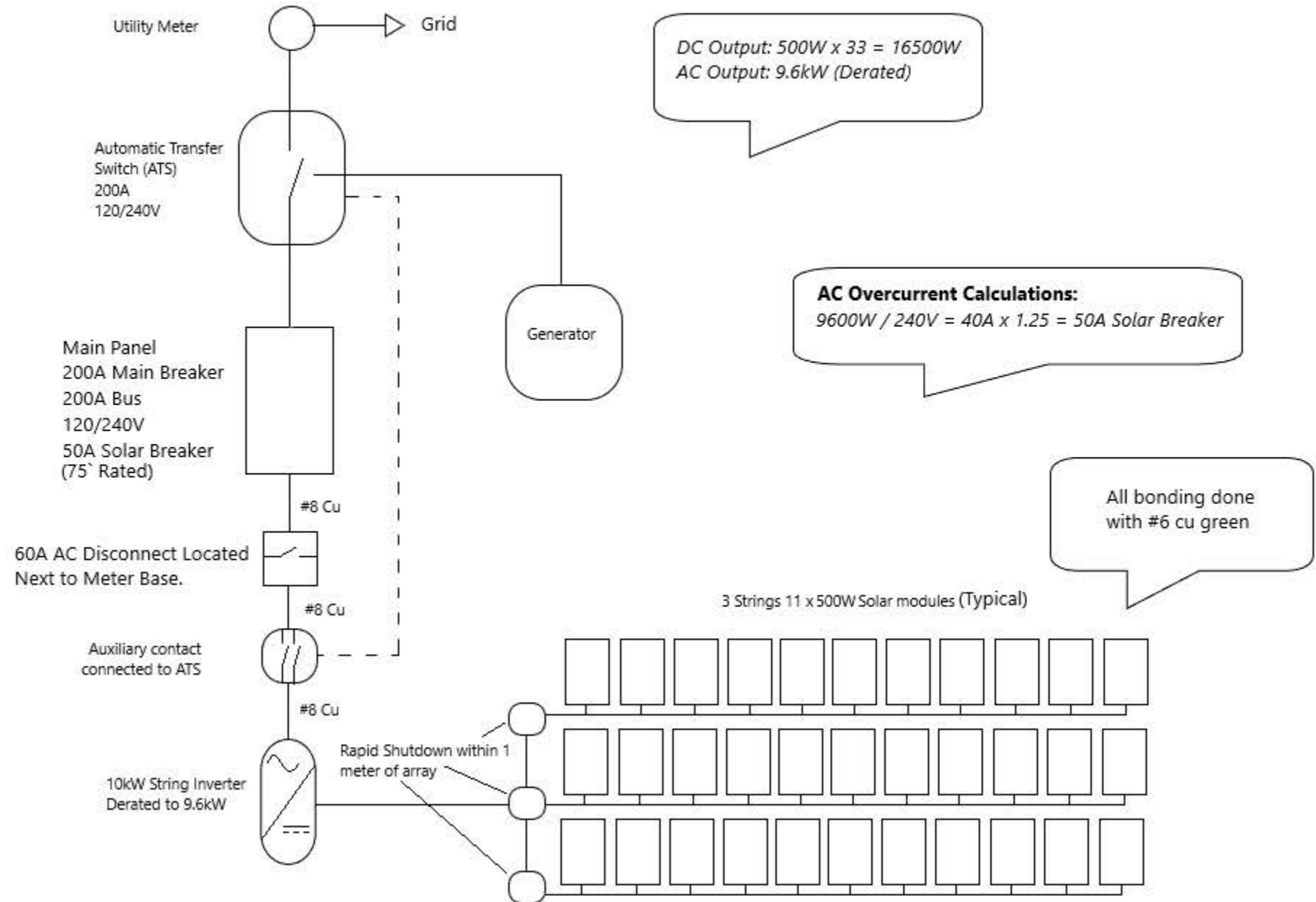


Diagram # 4: Ground Mount Micro Inverter System

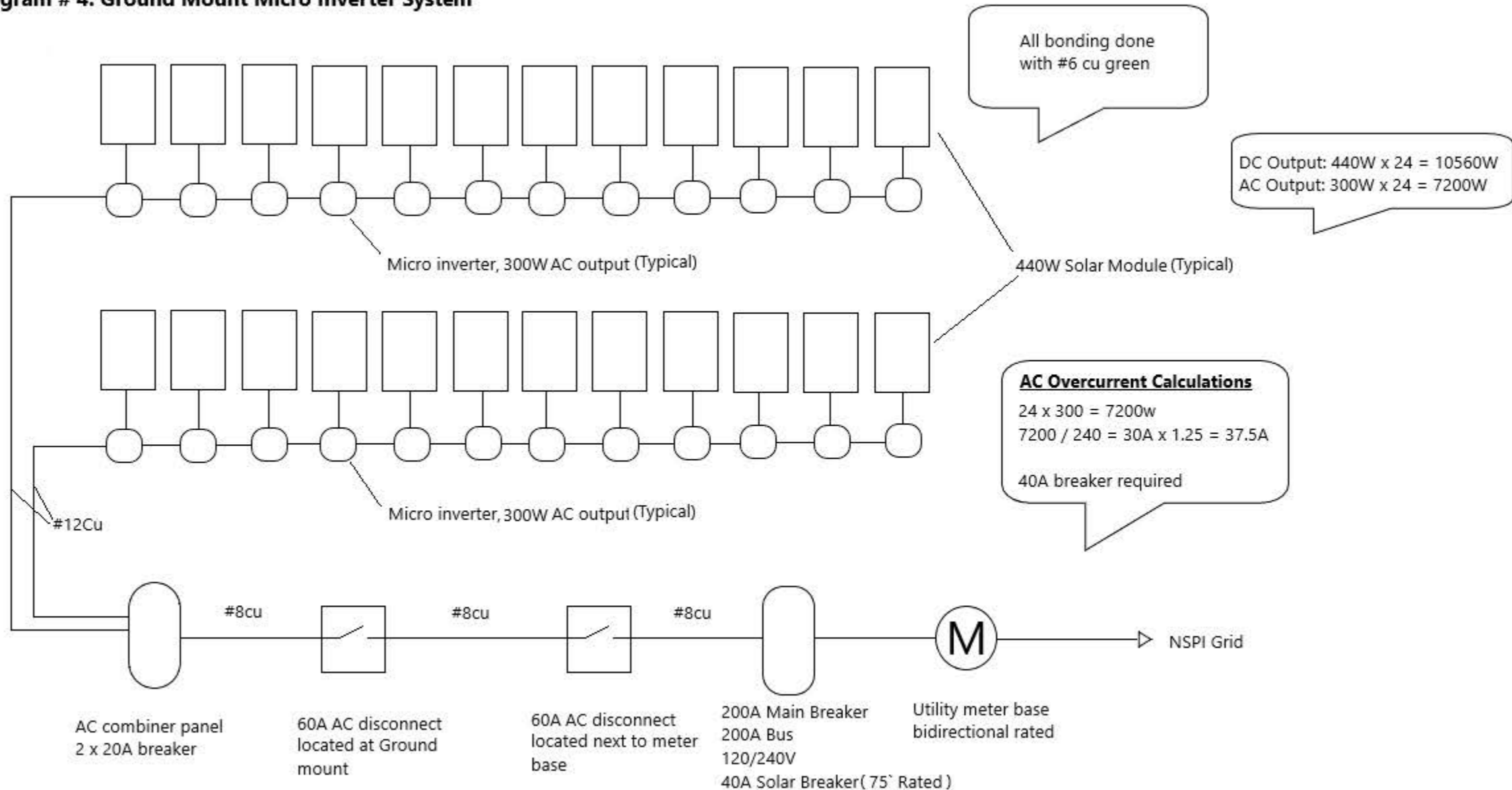
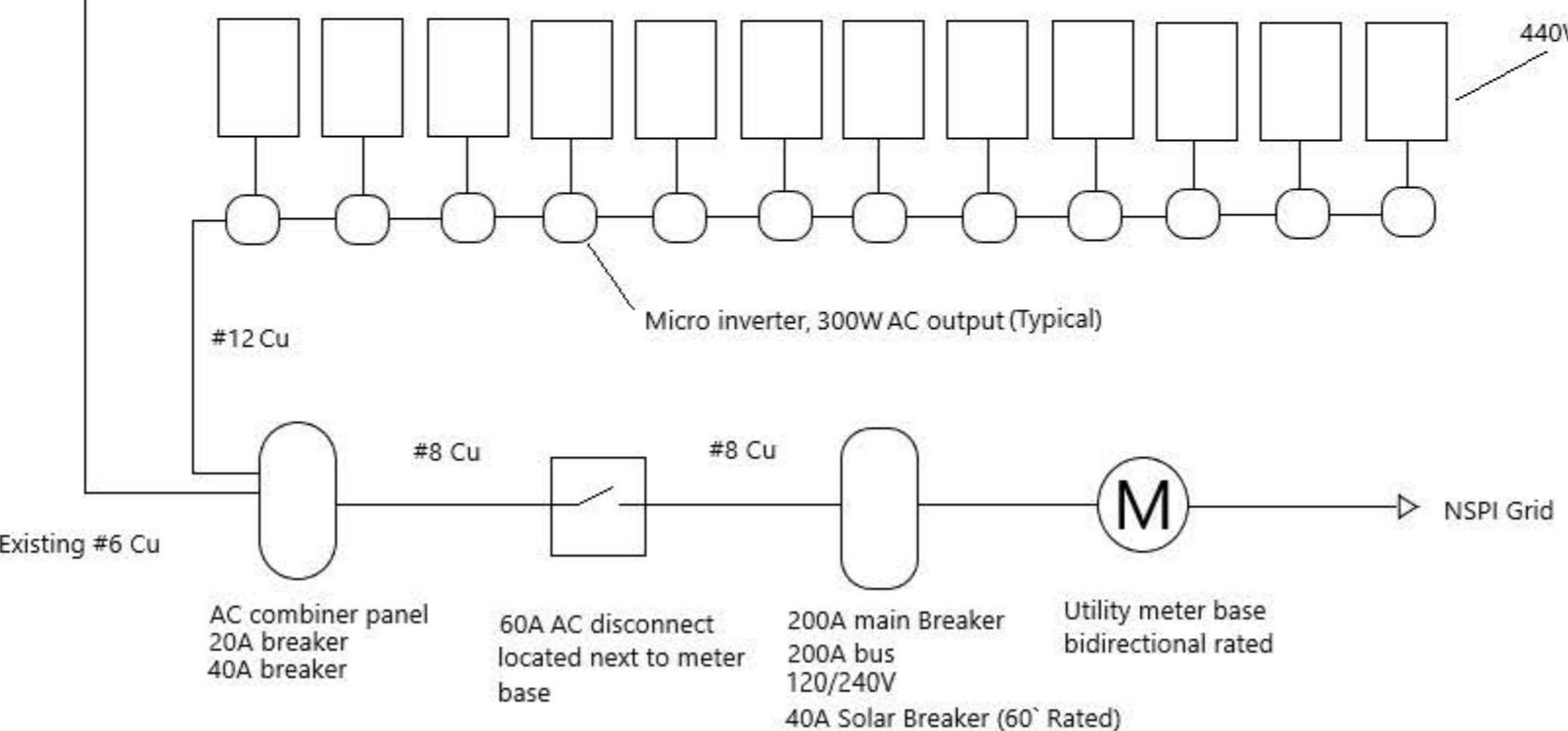
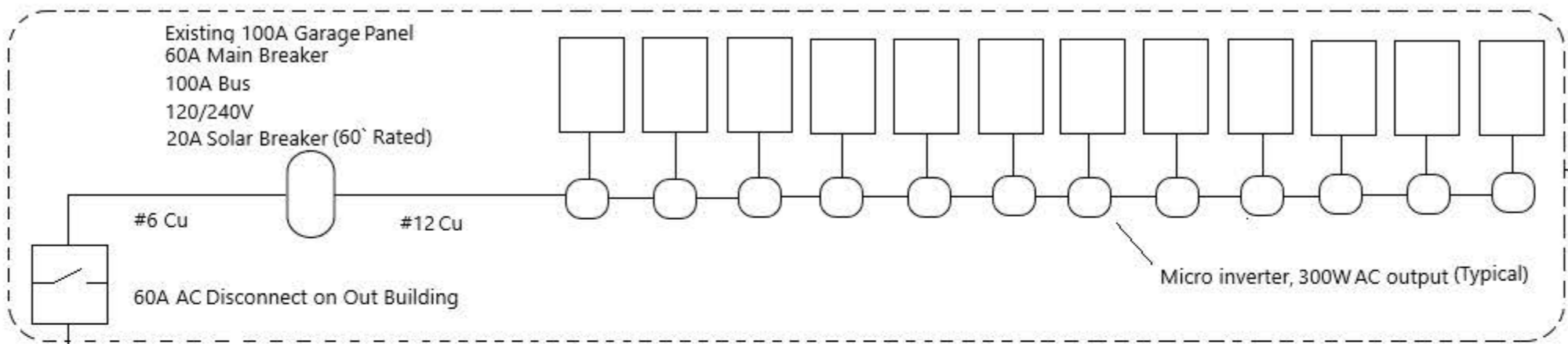


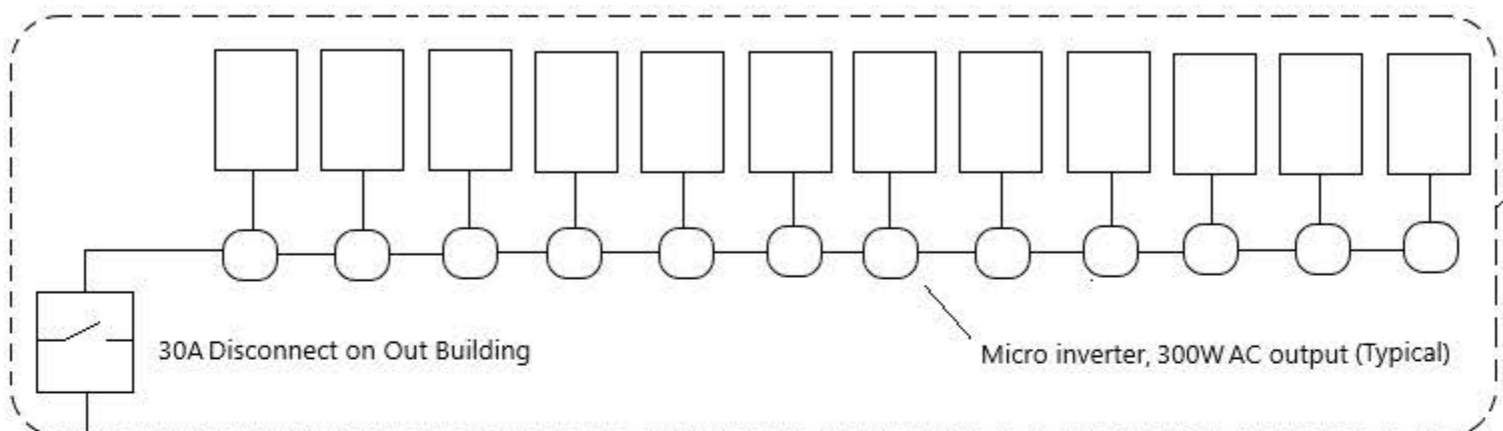
Diagram # 5: Micro Inverter System on Dwelling & Out Building with Existing feed



DC Output: $440W \times 24 = 10560W$
 AC Output: $300W \times 24 = 7200W$

AC overcurrent Calculations
 $24 \times 300 = 7200W$
 $7200 / 240 = 30A \times 1.25 = 37.5A$
 40A breaker required

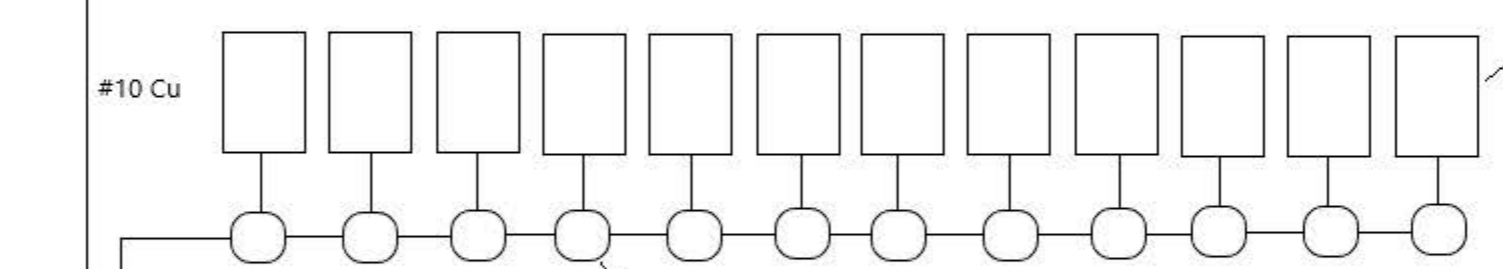
Diagram # 6: Micro Inverter System on Dwelling & out Building (New Feed)



Solar Located on Out building Approx. 50ft away from dwelling

All bonding done with #6 cu green

DC Output: $440W \times 24 = 10560W$
 AC Output: $300W \times 24 = 7200W$



AC overcurrent Calculations
 $24 \times 300W = 7200W$
 $7200 / 240 = 30A \times 1.25 = 37.5A$
 40A breaker required

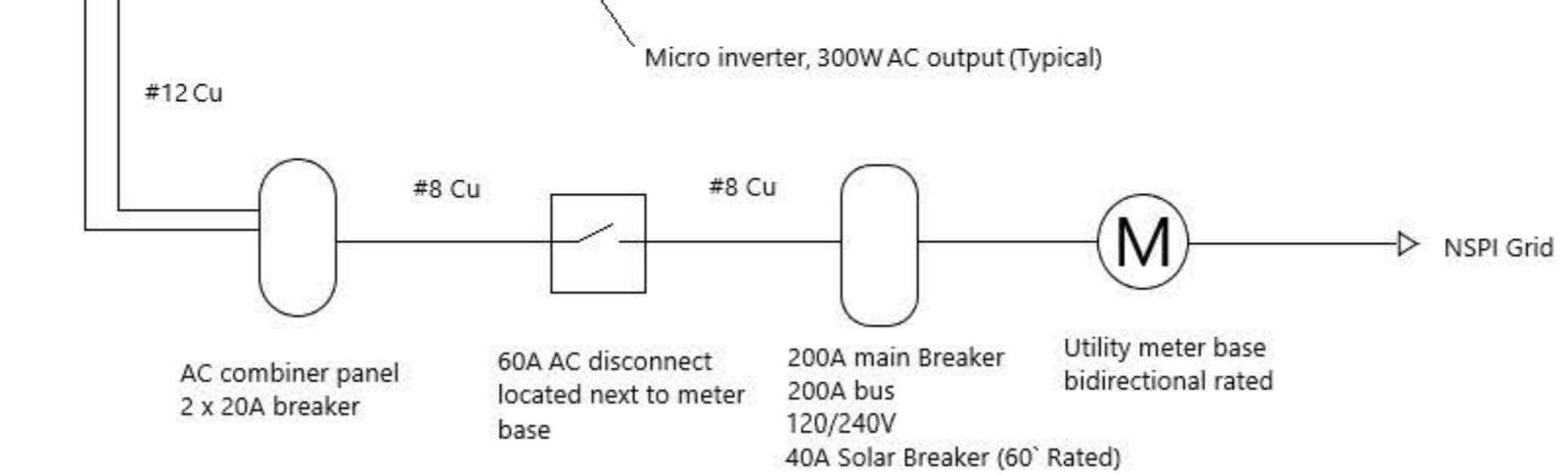


Diagram # 7: Micro Inverter Install

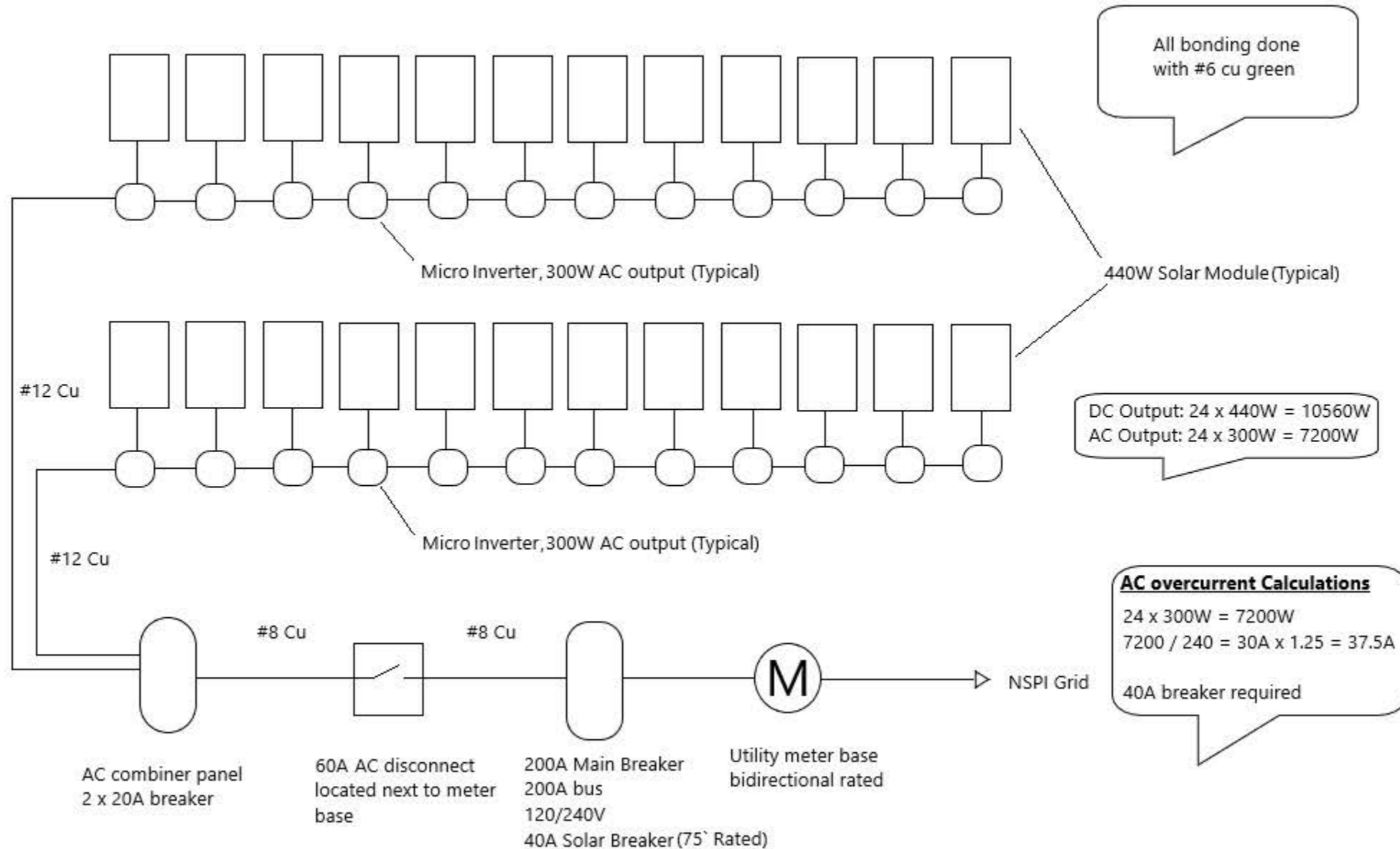


Diagram # 8: String Inverter with DC Optimizers

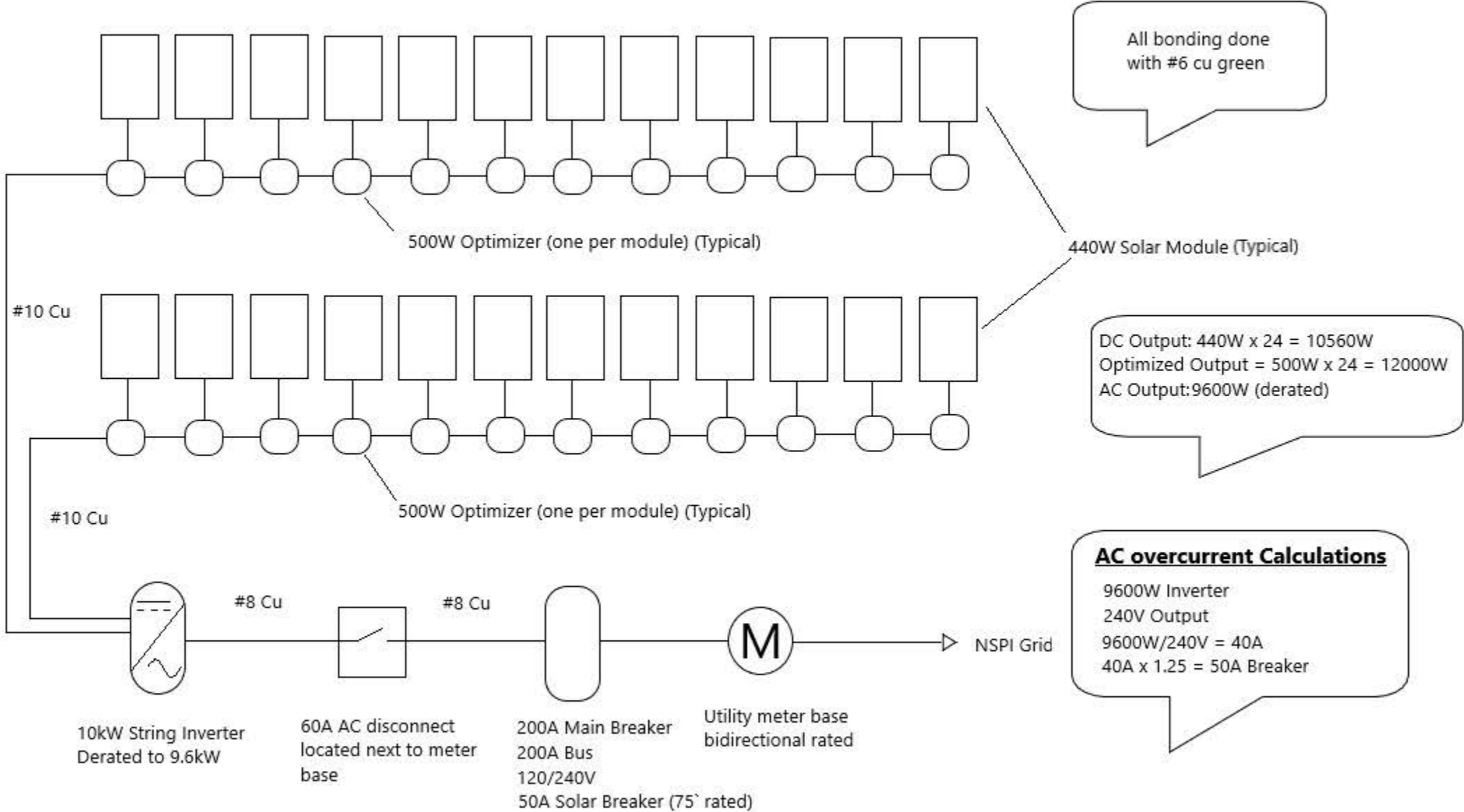


Diagram # 9: String Inverter with Rapid Shutdown

