

CII MODULAR ELECTRICAL IN PATIENT CARE AREAS

1. THE ISSUE

Because of the differing types and quantities of electrical equipment located within a patient care area, i.e. electrical motorized beds, patient monitoring equipment, nurses call systems, lamps, and certain types of telemetry devices, electrical life support systems, and other electro-medical devices, all of which at one time or another may come in contact with the patient, the National Electrical Code, (NEC) has defined very stringent safety regulations with respect to the installation of electrical wiring within a patient care area. Article 517.2 of the N.E.C. defines a *patient care area* as, "Any portion of a health care facility wherein patients are intended to be examined or treated." Patient Care areas are further categorized as either Critical Care Areas or General Care Areas. These sub categories are set by the governing/administrative body of the facility, but in either case are treated identically by the NEC. In order to classify more precisely the boundaries of the Patient Care Area, the NEC has defined what it has determined to be the Patient Vicinity as, "In an area in which patients are normally cared for, the patient vicinity is the space with surfaces likely to be contacted by the patient or an attendant who can touch the patient. Typically in a patient room, this encloses a space within the room not less than 1.8 m (6 ft) beyond the perimeter of the bed in its nominal location, and extending vertically not less than 2.3 m (7 1/2 ft) above the floor. Generally speaking, the electrical services run to and through this Patient Vicinity is the issue at hand. The following text taken from the 2002 NEC Manual explains rather clearly the need for the additional precautions required when designing and installing electrical services for Patient Care Areas.

"In a health care facility, it is difficult to prevent the occurrence of a conductive or capacitive, (static electrical arc) path from the patient's body to some grounded object, because that path may be established accidentally or through instrumentation directly connected to the patient. Other electrically conductive surfaces that may make an additional contact with the patient, or instruments that may be connected to the patient, then become possible sources of electric currents that can traverse the patient's body. The hazard is increased as more apparatus is associated with the patient, and, therefore, more intensive precautions are needed. Control of electric shock hazard requires the limitation of electric current that might flow in an electric circuit involving the patient's body by raising the resistance of the conductive circuit that includes the patient, or by insulating exposed surfaces that might become energized, in addition to

reducing the potential difference that can appear between exposed conductive surfaces in the patient vicinity, or by combinations of these methods. A special problem is presented by the patient with an externalized direct conductive path to the heart muscle. The patient may be electrocuted at current levels so low that additional protection in the design of appliances, insulation of the catheter, and control of medical practice is required.”

Of the three methods listed in the preceding paragraph to control electric shock hazard to a patient, reducing the potential difference, which is to say reducing the electrical voltage, that can appear between exposed conductive surfaces in the patient vicinity is the focus of the NEC as it pertains to designing and installing electrical service in Patient Care Areas. Adherence to the NEC thus ensures minimal electrical voltage that can appear between exposed conductive surfaces in the patient vicinity by requiring that the conduit or raceway carrying branch circuits for use in Patient Care Areas must itself qualify as an equipment grounding return path.

In the CII standard wiring system design, every whip contains at least one equipment grounding conductor that ultimately terminates to the safety ground bus bar in the circuit panel board. For safety purposes, this equipment grounding conductor ties into, and thus provides a return ground path for all exposed metal parts of the CII wiring system. Although the superflex conduit of the CII PowerMate cables is thus “grounded”, in the eyes of the NEC and UL, it is not in itself an equipment grounding return path. Because the conduit is not a direct equipment grounding return path, there exists the potential for small levels of voltage, and therefore current, to be present on the superflex conduit, and any conductive surface in contact with it. As explained in the paragraphs above, the presence of even the smallest levels of voltage on exposed conductive surfaces can prove to be dangerous in the patient care environment. Beyond this, having the conduit qualify as its own equipment ground return path provides an additional layer of safety by means of the “belt & suspenders” or designed redundancy approach to safety design.

2. THE CII SOLUTION

The Chapter and Verse of the National Electrical Code that must be satisfied in order to meet the requirements for wiring within a Patient Care Area is NEC Art. 517.13(A), Grounding of Receptacles and Fixed Electric Equipment in Patient Care Areas.

Wiring Methods. All branch circuits serving patient care areas shall be provided with a ground path for fault current by installation in a metal raceway system, or a cable armor or sheath assembly. The metal raceway system, or cable armor, or sheath assembly, shall itself qualify as an equipment grounding return path in accordance with 250.118. Type AC, Type MC, Type MI cables shall have an outer metal armor or sheath that is identified as an acceptable grounding return path.

Because this section of the code only allows for Type AC, MC, and MI cables whose outer metal armor or sheath is identified as an acceptable grounding return path, by their exclusion, Manufactured Wiring Systems, (the CII modular wiring system), have not been allowed as an acceptable method for wiring Patient Care Areas. Even if a Manufactured Wiring System were to be fabricated with an AC, MC, or MI cable whose outer metal armor or sheath is identified as an acceptable equipment ground return path, the Manufactured Wiring System would still not be in compliance with this section of the NEC by virtue of it not being specifically listed in this Article of the NEC as an acceptable wiring method.

The CII solution to this problem then became a three-step process. First, to design and build a Manufactured Wiring System that would satisfy the technical requirements of Art. 517.13 of the NEC. Second, submit this "Patient Care Area" Manufactured Wiring System to UL for listing and approval for use in Patient Care Areas. Third, based on UL certification, submit to the governing board of the National Electrical Code to revise Art. 517.13(A) to include Manufactured Wiring Systems approved for use in Patient care areas as an acceptable wiring method in Patient Care Areas.

Because Manufactured Wiring Systems have not been an approved method of wiring in a Patient Care Area, and CII was the first to apply to UL for such certification, UL had to establish a completely new set of testing procedures and performance criteria that would accurately assess the safety and performance of a Manufactured Wiring System intended for use in a Patient Care Area. Critical to the certification process would be the performance of the cables' outer metal armor or sheath as an acceptable equipment ground return path. This metal armor ground return path must not only extend the length of the cable, but must also span, without break, the plastic, non-conductive housings of the CII modular connectors that connect our PowerMate cables to Power Distribution Modules and Conversion Modules, as well as to StationLink terminal devices.

PRODUCT CONFIGURATION:

After a great deal of discussion with UL, it was determined that the only cable available that satisfies the grounding requirement of NEC Art. 517.13(A) is TYPE AC, Armor Clad Cable. In fact, when we submitted samples using other types of cable sheathing we thought appropriate, UL refused to even test these configurations. There are two design features of AC Cable that render it the cable of choice for this particular application. First, each of the insulated conductors is individually wrapped in a paper insulator, thus providing an extra insulating barrier, beyond that of the wire's plastic insulation. Secondly, AC cable is manufactured with a bare aluminum or copper conductor running the length of the cable within its armor sheath, being in constant intimate contact with its sheath. This feature again enhances AC Cable's performance as an approved equipment ground return path.

Although somewhat less flexible than MC Cable, and much less flexible than the standard CII PowerMate Cable, the primary drawback of having to use Type AC Cable is that at the present time, the maximum conductor count available in TYPE AC Cable is five, (5). This means that best case, in one cable run we would be able to supply 3 utility circuits. This is also a cable that we must purchase from an outside source; we are not equipped to produce our own Type AC Cable.

The final configuration we therefore submitted to UL for certification was a modular, five conductor, Type AC based cable, fitted with our standard 10-pin connectors. In order to ensure an unbroken equipment grounding return path via the AC Cable armor when one or more of our plastic 10-pin connectors is encountered throughout a cabling scheme, we incorporated bonding jumpers from the Type AC Cable armor, around the nonconductive plastic housing of our 10-pin connector, to the metal housing of the connected Power Distribution Module, Conversion Module, or StationLink device. (See Attached Drawing.)

3. THE ROAD TO APPROVAL

Because no Manufactured Wiring System had ever been evaluated for use in Patient Care Areas before, UL opened a special category of project for the evaluation they call a "New and Unusual". By virtue of what we were trying to accomplish, and the "New and Unusual" label applied to our project, extra scrutiny was given to the evaluation process from start to finish.

The first step in the process was to submit a number of conceptual drawings to UL for evaluation, illustrating how CII envisioned meeting the requirements of Art. 517.13(A) Once our concept was approved by Engineering Management within UL, UL then developed a series of tests and performance criteria that would accurately measure a modular Manufactured Wiring System's ability to perform up to the requirements of Art. 517.13. This again required Engineering Management approval.

Once the testing and evaluation criteria were approved, CII submitted a number of samples of varying configurations to UL. The samples submitted exceeded all of the performance criteria set by UL, which would ordinarily qualify a product for listing. But as this was a "New and Unusual", we were far from being listed. We still needed to secure Executive Approval from within UL, and then submit our proposed Patient Care wiring system to UL's "Council Report".

Executive Approval within UL required a comprehensive report be written, detailing the proposed use of our system, including product drawings and photographs. It also included a full write-up on the testing procedures and the performance of our product when tested to the newly developed UL performance standards. The report on the performance of our product was then presented by the evaluating engineer to a Director level, Senior V.P. within UL for final internal review. This senior level approval was granted with no modifications or qualification required.

Next in the process was the Council Report. The Council, in this instance is more or less an executive committee made up of the Senior and Chief Electrical Inspectors from across the country. The report that was just previously approved by a Director/Senior V.P. at UL was then sent to all the members of the Executive Council for their review. Every member of the council had 30 days to review the report and respond with either their approval or disapproval. UL would then take all Council member feedback into consideration, and then decide whether to approve our system for listing, or not.

Of all the Council members contacted, there were only four "non-positive" responses. Two of these non-positives were due to not fully understanding the concepts involved. Once clarified by the UL engineering staff, these two non-positives became positive responses. Of the two remaining non-positives, one did not want to trust the integrity of our entire system to a wire jumper shunting, or bypassing the plastic connectors of our whip heads; A chain is only as strong as its weakest link. This council member suggested we replace the jumper wire with a steel clam shell type design. The last non-positive response was from a

jurisdiction that does not allow any modular, quick-connect electrical distribution. Because ours is a modular system, this member had no use for it.

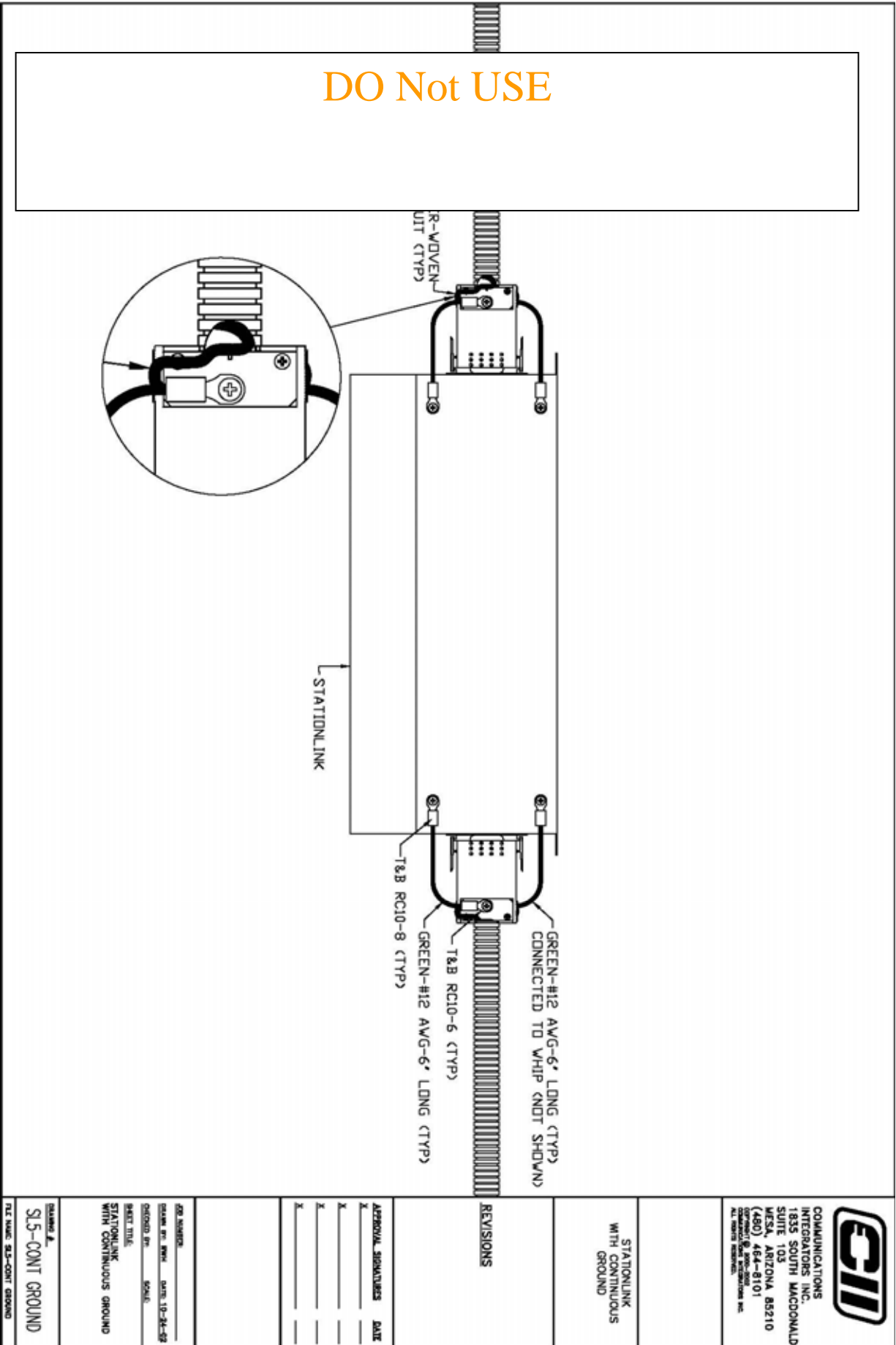
After final review of all council members' feedback, UL determined that they would list our system for use in Patient Care Areas, provided that we change the wire bypass/jumper to the clam shell design suggested in the Executive Council feedback. We have submitted drawings to UL showing the clam shell design we intend to use to replace the wire jumper, (see attached drawing). UL has approved the concept drawing and says that if thus submitted there should be no problem in the performance they are expecting from the clam shell whip head bypass.

UL's final requirement for listing will then be for CII to submit to UL our write-up that we will be submitting to the governing board of the National Electrical Code, presenting our proposed change to Art. 517.13(A), which will include Manufactured Wiring Systems approved for use in Patient Care Areas as an acceptable wiring method under this section of the NEC.

4. WHERE WE ARE TODAY

Within the last few months UL has restructured their engineering group, and I am no longer able to work with the same people on finalizing the approval. I am now working on coordinating this last piece of the approval process with UL's Customer Service group to have an engineer assigned to testing and evaluating our clam shell whip head bypass. As soon as I can get an engineer assigned we will submit the clam shell bypass and our proposed NEC change to Art. 517.13(A). I am expecting to have an engineer assigned within the next few weeks, with project final close-out within the next 4 to 6 weeks.

INITIAL DESIGN – GROUND STRAP WIRE



COMMUNICATIONS
 INTEGRATORS INC.
 1835 SOUTH MACDONALD
 SUITE 105
 MESA, ARIZONA 85210
 (480) 464-8101
 CII.COM
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STATION LINK
 WITH CONTINUOUS
 GROUND

REVISIONS

APPROVAL SIGNATURES	DATE
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FOR NUMBER _____

DATE: 10-24-09

DESIGNED BY: _____

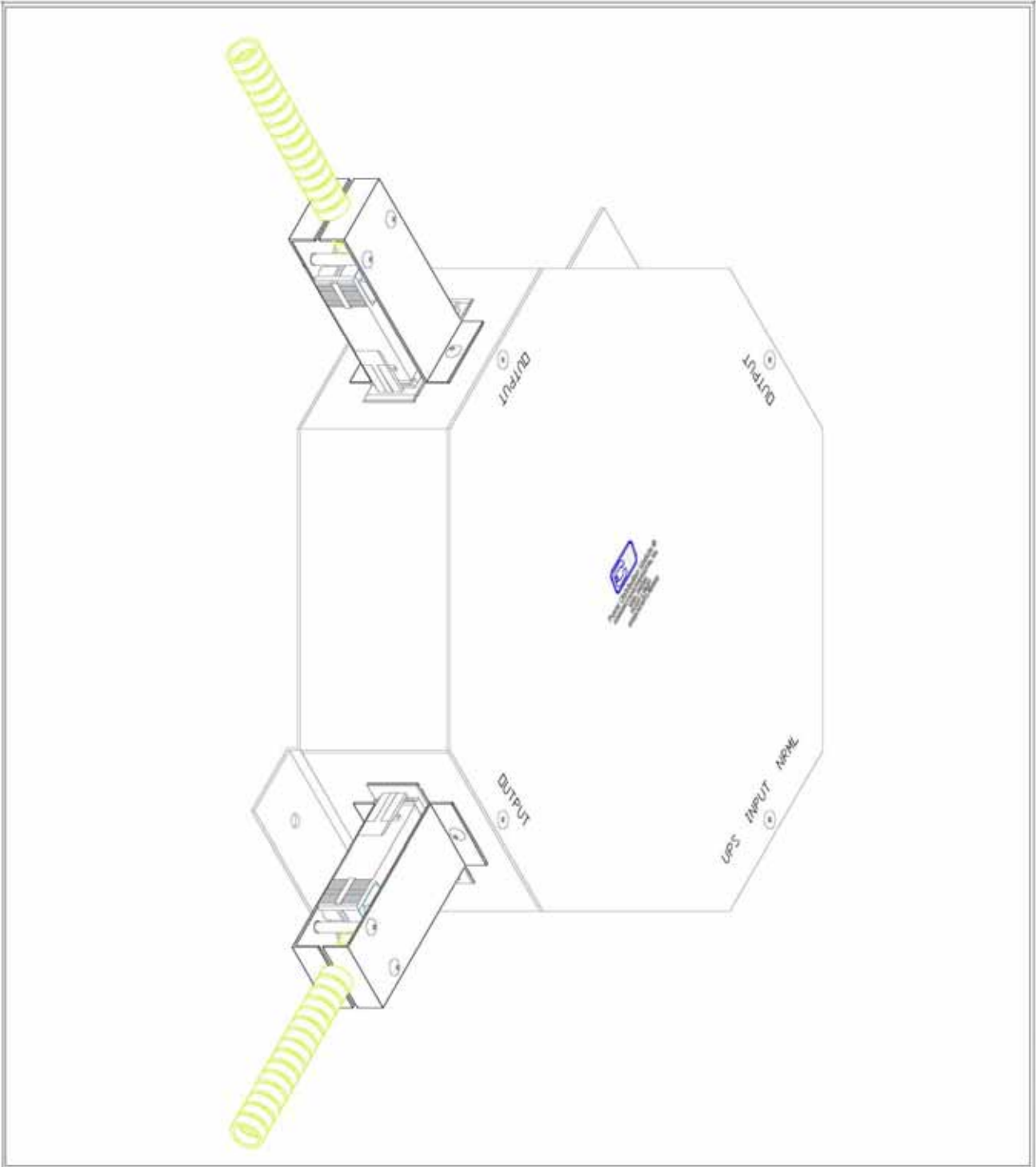
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SHEET TITLE:
 STATION LINK
 WITH CONTINUOUS GROUND

DRAWING BY:
 SLS-COINT GROUND

FILE NAME: SLS-COINT GROUND

MODIFIED DESIGN – WHIP HEAD CLAM SHELL



COMMUNICATIONS
INTEGRATORS INC.
1835 SOUTH MACDONALD
SUITE 103
MESA, ARIZONA 85210
(480) 404-8101
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DESIGNER: [Blank]
DATE: 10/04/24
CHECKED BY: [Blank]
SCALE: N/A
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