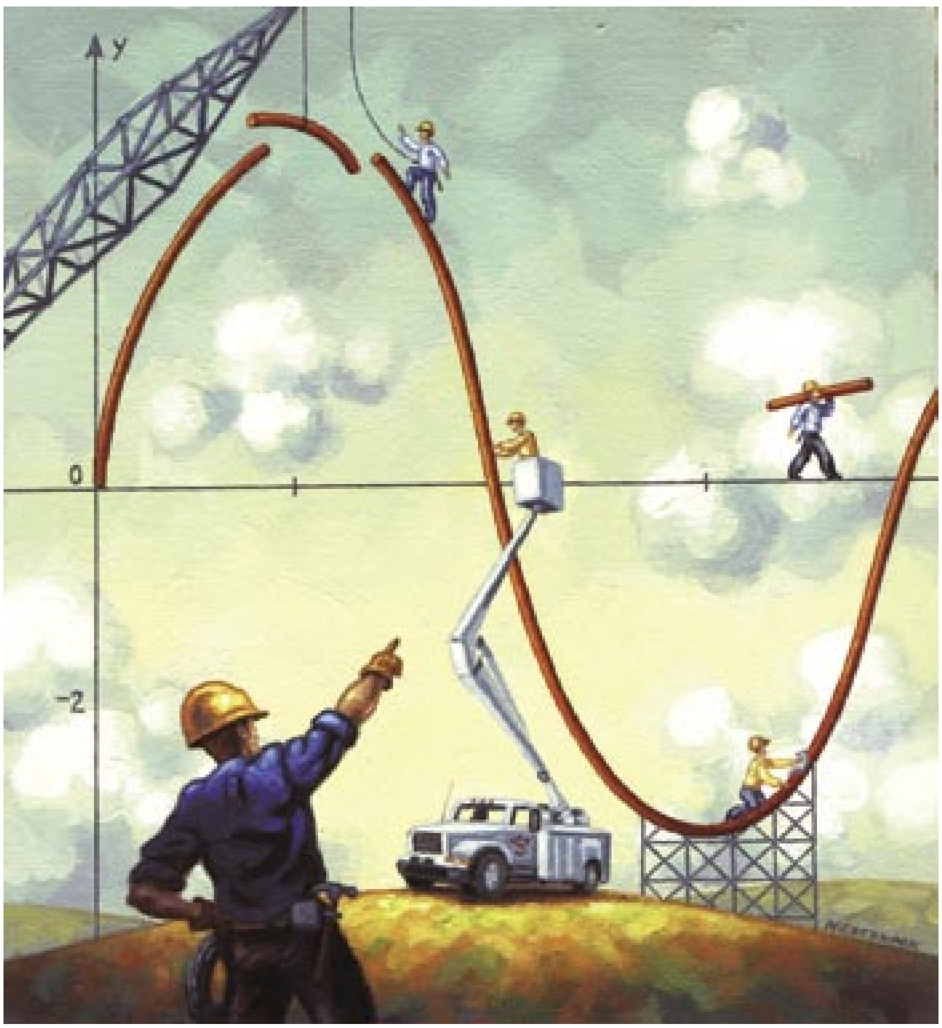
ELECTRICAL DESIGN LIBRARY

Create Electronics-Friendly Facilities



NECA

NATIONAL ELECTRICAL CONTRACTORS ASSOCIATION

Contents

Electrical Design Library (EDL) publications are prepared for architects, consulting engineers, and qualified electrical contractors, as well as owners, developers, investors, and their electrical construction specifying personnel. Issued periodically by the National Electrical Contractors Association (NECA), the publications provide factual explanations of the increasing variety of sophisticated electrical systems and the economics of their installation by professional electrical contractors. They are distributed by the Association's chapters, located in all sections of the United States.

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Introduction

Electronic devices are increasingly mission-critical to building tenants. Facility infrastructure deficiencies can interfere with operation of those devices.

You can address deficiencies during the design and construction phase, or you can wait until after the facility is occupied. The first choice is far less expensive than the second.

For most facilities, implementing basic electronics-friendly measures is adequate. But, this carries two caveats:

1. You must understand what those measures are and how to economically implement them.
2. You must know when those measures are insufficient and how to economically implement—and upsell to the project sponsors—the correct additional measures and features.

Implementing additional measures will raise the final cost of construction, so it's essential to perform a correct assessment of "who the customer is." Only then can a designer move to the next step: correctly assessing which electronics-friendly measures are appropriate.

This EDL helps the designer ensure a new facility will adequately accommodate electronic loads for its intended purpose, at a reasonable cost. Critical facilities (e.g., data centers, glass plants, hospitals) require additional measures.

Definitions

Knowing the definitions of some key words can reduce the chances of facility infrastructure deficiencies and other problems. Here are a few:

- **Bonding.** The permanent joining of metallic parts to form an electrically conductive path that ensures electrical continuity and the capacity to safely conduct any current likely to be imposed. Refer to National Electrical Code (NEC) Article 100.
- **Electronics.** For the purposes of this EDL: Devices that operate on the load side of a 5V power supply. These include the integrated circuits of programmable logic controllers (PLCs), computers, networks, photocopiers, and telephone systems.
- **Fault protection.** The opening of a circuit by a circuit breaker when a circuit experiences a predetermined level of overcurrent.
- **Grounding.** A conducting connection, whether intentional or accidental, between an electrical circuit or equipment and the earth (or to some conducting body that serves in place of the earth). Refer to NEC Article 100.
- **Raceway vs. conduit.** A raceway is an enclosed channel of metal or nonmetallic materials designed expressly for holding wires, cables, or busbar. Refer to NEC Article 100. A conduit is a specific type of raceway—many other types exist (see NEC Articles 320 – 390). For raceway installation considerations, see NECA 1000-NEIS Specification System.

Sources of Electronics Problems

Infrastructure-related electronics problems are usually the result of bonding omissions and errors related to grounding and bonding, layout, and wiring.

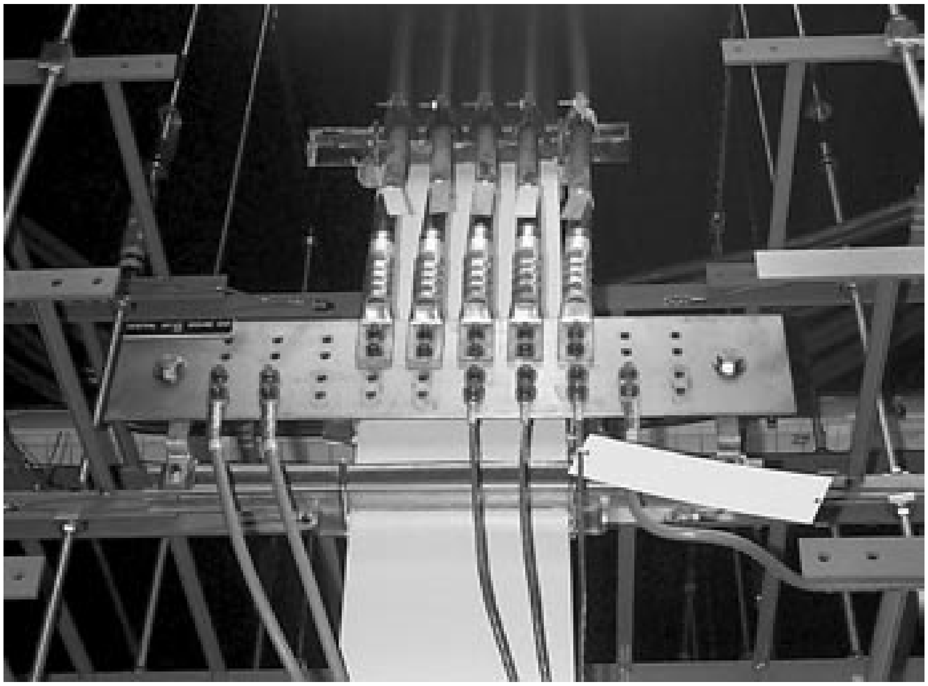
1. Bonding omissions—Electricity needs a way to get back to the source. If you don't deliberately provide a low-impedance path, electricity will find its own way back. First, it will build up a charge. Then it will either flashover or leak current through metal objects.

2. Grounding and bonding errors—Ground loops result from bonding errors. A ground rod driven into the soil with no bond to the main system is useless. An attempt to substitute grounding for bonding causes electronic components to fail prematurely and, sometimes, catastrophically.

3. Layout errors—These errors occur when equipment is not placed to avoid electrical interference and when structural members are not placed to accommodate wireless.

4. Wiring errors—These errors fall into two categories: National Electrical Code (NEC) Chapter 3 wiring errors and "other" wiring errors. You can expect any electrical contractor to comply with Chapter 3. You can't expect that compliance to be enough to prevent wiring-related problems in electronics. Work with your electrical contractor to identify additional requirements for the wiring system, depending on load types and locations.

Vague language in project specifications requiring contractors to "comply with all related codes and standards" will not prevent infrastructure-related electronics problems.



An electrical contractor will install a bonding bus like this one, as part of the bonding system. As you can see, this isn't a matter of driving a few ground rods. In fact, ground rods are not even part of this system.

- It passes the buck, resulting in an unproductive blame game when something goes wrong;
- Codes are for safety; they do not address issues of performance, reliability, or maintainability; and
- Standards often require design changes that are not in the budget and make assumptions that do not apply to your installation.

Always ensure that your project specifications provide details about which standards apply to your installation. Then ensure that your budget includes the costs of applying those standards.

Preventatives

When trying to prevent infrastructure-related electronics problems, the devil is in the details of bonding, grounding, layout, wiring, and items such as surge protection, backup power, and power quality monitoring.

Here is an array of bonding jumpers. NFPA 780, the Lightning Protection standard, requires bonding metallic objects on the roof to prevent flashovers. But if you limit this bonding to objects on the roof, you endanger electronics in the entire facility. Consult your electrical contractor before finalizing a project plan.

Bonding

For bonding, the primary rule is: bond all equipment. It would be simple, except that some equipment manuals require that equipment be unbonded and some customers require unbonded receptacles as a way of implementing an "isolated ground."

Isolated grounds usually create more problems than they solve. If you can't talk the customer out of requiring these, at least specify that they conform to the NEC and IEEE-142. Requirements in these standards differ from what equipment manufacturers typically imagine isolated grounds to be.

Equipment that isn't bonded is dangerous to itself, other equipment, and to people. Connecting equipment to bonding jumpers is pointless if you don't maintain the bonding path.

Several things can interfere with maintaining this path, unless you incur extra cost. Examples include fire-rated walls, nonmetallic conduit, electrometallic tubing, and mechanical isolation devices (e.g., rubber shock isolators). Have your electrical contractor review your plans to identify additional work and materials needed to maintain the bonding path.

Differences in potential (voltage) can exist between one system (e.g., electrical power) and another system (e.g., phone). This is why a properly "grounded" (bonded) network printer can present a lethal shock to someone who touches a network cabling connector.

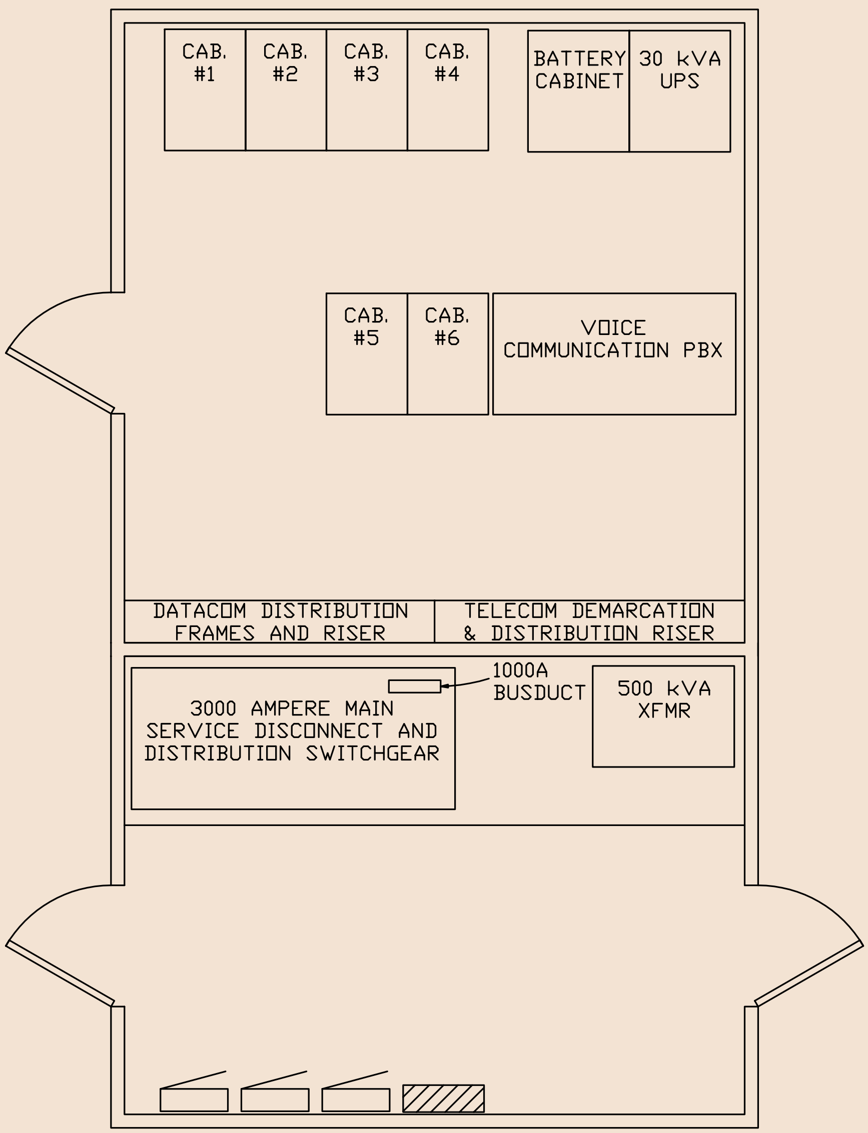
A simple fix is to run a bonding jumper between the two systems. Specify this in the design requirements—require bonding jumpers between all systems and between all metallic objects.

Once you establish a low-impedance bonding path and bond all equipment to it, you have a path that prevents most power quality problems. Additional bonding does not improve power quality. For example, sidewalks that connect locations where you walk keep your feet from getting muddy. Installing additional sidewalks doesn't make your feet cleaner.

Better Layout Improves Electronics Performance

Graphics on these pages represent poor facility layout (left) and better facility layout (right). Examine them to find ways to improve layout at your facility before changes become expensive or impossible.

1. **Poor layout:** Datacom distribution frames are on the common wall between electrical room and network room—increasing risk of inducing electrical noise on datacom wiring.
   Better layout: Datacom distribution frames are away from electrical room.
2. **Poor layout:** Telecom distribution frames are on the common wall between electrical room and network room—increasing risk of inducing electrical noise on datacom wiring. **Better layout:** Telecom distribution frame is away from electrical room.
3. In neither case is the telecom switch adjacent to strong electrical sources. However, magnetic fields from the UPS can induce noise on the switch.
4. **Poor layout:** UPS is in net-

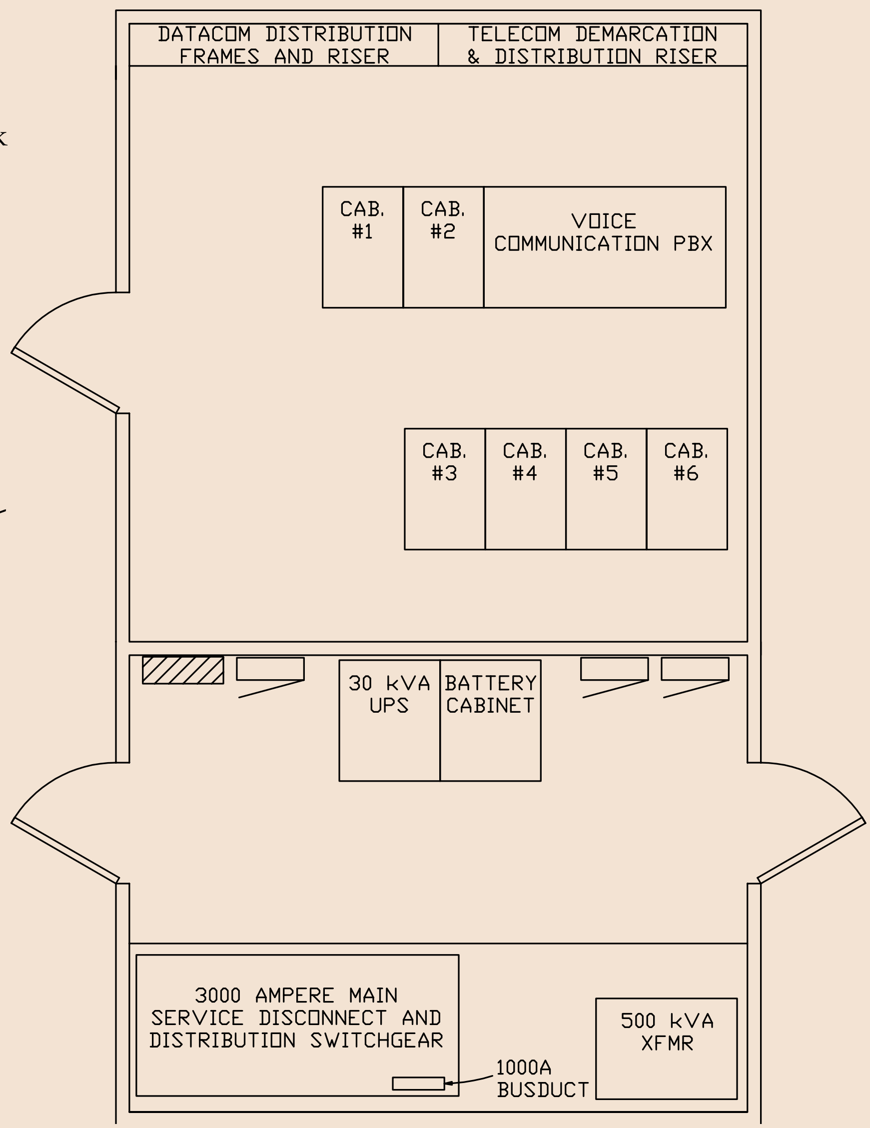


work room, placing equipment close to strong magnetic fields.
Better layout: UPS is in electrical room, away from network equipment.

5-7. **Poor layout:** 3000A switchgear, busduct riser, and large transformer are all positioned on the common wall between electrical room and network room.
Better layout: These items are away from the common wall.

8. **Poor layout:** Low power panelboards are on an outside wall.
Better layout: These are on the common wall. Use engineering judgment when locating panelboards on this wall. Magnetic fields generated by these panelboards are low and dissipate quickly. But the tyranny of numbers—e.g., many heavily loaded panelboards—can create problems.

9. This wall is intentionally left blank to create a buffer zone—improving the results of installing the panelboards and UPS in the electrical room as shown.



Grounding

Grounding serves two purposes. It allows circuit breakers to trip on fault current and provides a path for lightning. Consequently, grounding is not an issue for electronics per se. For lightning protection, refer to NFPA-780. For proper grounding, see these standards:

- NEC Article 250,
- Soares Book on Grounding, and
- IEEE-142.

Layout

It is tempting to place equipment closets, switchgear, and distribution transformers in locations that keep wiring costs to a bare minimum. Such a strategy may cause electrical noise problems the tenant can't possibly overcome. Properly placing equipment closets, switchgear, and distribution transformers plays a key role in reducing interference with electronics.

Consult your electrical contractor to determine a reasonable balance between saving wiring costs and reducing interference. For example, keep high-noise equipment away from sensitive equipment. Never position arc-welders next to the accounting office.

Where you locate HVAC ducts, pipes, elevators, and plenums will have a pronounced effect on how well the building accommodates wireless. Avoid creating a floor-to-ceiling "wall" of metal.

If your contract contains a wireless specification, consult a wireless expert during the design phase so you can create a "path" for wireless transmission. It's easy for a wireless installer to add devices to overcome the occasional dead zone, but it is not easy to accommodate a building that is riddled with wireless "holes" or whose structure greatly attenuates the signals throughout.

Wiring

Build a first line of defense by providing dedicated transformers, panels, and circuits for various load types (lighting, convenience receptacles, computers, production equipment, pumps and motors).

To prevent inductance of current from one system to another, separate the wiring. To do this cost-effectively, have your electrical contractor review floor plans and equipment locations and advise on the routing paths.

Raceways can significantly affect the environment for electronic equipment. Consult with an electrical contractor to determine the raceway types to use. Specify the appropriate NECA-NEIS raceway installation standards, such as NECA 101-2001, Standard for Installing Steel Conduit (Rigid, IMC, EMT).

Additional Considerations

Increasing project scope with additional measures to support electronics may actually increase revenues. Ensure that the following are covered:

- **Surge Protection.** Integrate with the electrical switchgear. For most applications, a two-tier approach is less expensive than—and provides better protection than—a single-unit system. A key factor is the number of panels that need to be protected.
- **Backup Power.** How much backup power and what kind of power will this facility need? If the facility will house a data-intensive operation, such as a server farm, backup power considerations—including additional ventilation—can be significant.
- **Power Quality Monitoring.** Integrating a power monitoring system into the switchgear adds to installation considerations. Work with the switchgear vendor and power monitor vendor for the best layout.

To reduce startup problems with the electrical infrastructure, refer to NECA 90-2004, Recommended Practice for Commissioning Building Electrical Systems (ANSI).

Conclusion

Review specifications carefully with your electrical contractor before completing any project work breakdown structure to avoid design holes and costly rework. This is critical to holding down project costs and still doing the job right.

Watch for vague requirements to support specific kinds of equipment, such as communications systems or production machinery. Support for this equipment may go beyond electronic issues and include special footings, additional cooling capacity, or other infrastructure requirements.

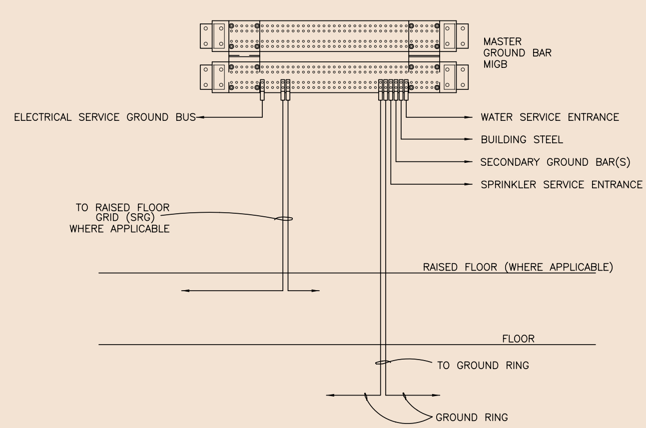
Take advantage of your electrical contractor's experience and expertise early in the design cycle, so you can identify requirements when it is least expensive to do so.

Some requirements vary by site location and facility use. Integrate these requirements into the project planning. Errors and omissions not corrected early in the project will manifest themselves in operational problems once the facility is occupied, which can easily result in huge remediation and settlement costs.

Grounding vs. Bonding

Grounding alone does little to protect electronics. It is bonding that protects electronics (and people). Unlike grounding, bonding puts equipment and systems at equipotential—thereby reducing the hazards of flashover, lethal shock, and corrosive leakage currents.

This detail shows the bonding of several systems, most of which will be in any facility, at a common point. This is only part of the total bonding work required to make a facility electronics-friendly. You will save money if you consult with your electrical contractor during the design phase to determine the scope of the bonding work to be done during construction.



1 GROUND BAR DETAIL
NONE

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