DOWNLOAD PDF ELECTRICAL PANEL DESIGN BASICS

Chapter 1 : Electrical Control Panels for beginners â€¢ OEM Panels

Control panel design basics are www.nxgvision.com is always important, but so is an attractive appearance, simple operator controls and reliable operation. Simple panel designs are less expensive to produce and easier to operate and maintain.

For example, once the electrical designs are complete, they must be built by an electrician. Therefore, it is your responsibility to effectively communicate your design intentions to the electricians through drawings. Basic electrical design of a PLC panel â€" Wiring diagrams on photo: Modern industrial automation panel; credit: This article discusses the design issues in implementation that must be considered by the designer. The electrical design for each machine must include at least the following components. This power must be dropped down to a lower voltage level for the controls and DC power supplies. It is also common for a control cabinet to supply a higher voltage to other equipment, such as motors. Motor controller example An example of a wiring diagram for a motor controller is shown in Figure 1. Dashed lines indicate a single purchased component. The three phases are then connected to a power interrupter. Next, all three phases are supplied to a motor starter that contains three contacts, M, and three thermal overload relays breakers. The output of the motor starter goes to a three phase AC motor. Power is supplied by connecting a step down transformer to the control electronics by connecting to phases L2 and L3. The lower voltage is then used to supply power to the left and right rails of the ladder below. The neutral rail is also grounded. The logic consists of two push buttons: Start push button is normally open, so that if something fails the motor cannot be started. Stop push button is normally closed, so that if a wire or connection fails the system halts safely. The system controls the motor starter coil M, and uses a spare contact on the starter, M, to seal in the motor starter. The voltage for the step down transformer is connected between phases L2 and L3. The diagram also shows numbering for the wires in the device. This is essential for industrial control systems that may contain hundreds or thousands of wires. These numbering schemes are often particular to each facility, but there are tools to help make wire labels that will appear in the final controls cabinet. Figure 2 â€" A Physical Layout for the Control Cabinet Once the electrical design is complete, a layout for the controls cabinet is developed, as shown in Figure 2. The physical dimensions of the devices must be considered, and adequate space is needed to run wires between components. In the cabinet the AC power would enter at the terminal block, and be connected to the main breaker. It would then be connected to the contactors and overload relays that constitute the motor starter. Two of the phases are also connected to the transformer to power the logic. The start and stop buttons are at the left of the box note: The final layout in the cabinet might look like the one shown in Figure 1. When including a PLC in the ladder diagram still remains. But, it does tend to become more complex. Figure 5 below shows a schematic diagram for a PLC based motor control system, similar to the previous motor control example. This figure shows the E-stop wired to cutoff power to all of the devices in the circuit, including the PLC. All critical safety functions should be hardwired this way.

Chapter 2 : Electrical Control Panel Design basics â€¢ OEM Panels

Control panel design starts with the basics, and it's not just about selecting a cabinet and back panel to house your electrical control hardware. It's about creating a design to control a machine or process.

When you are constructing a house or redesigning your home and have to design the electric panel board there are many things that you have to take into consideration. The function of the main electrical panel is to distribute electric power to the various appliances in the house. This distribution is done with the aid of electrical circuits that emerge from the panel. Step 1-Understanding Components Electric panels can be customized and configured to meet the power requirement of the household. This is why there are different dimensions. Before designing an electrical panel board, it is good to know its components. The main panel distributes electricity to the household through branch circuits. These then go to the switches, appliances and other receptacles throughout your home. Step 2-Understanding the Circuits Two copper aluminum strips under the circuit breakers and the wiring panel are the power buses or hot buses that are connected to the incoming cable. Both the neutral and the wires for grounding are connected to their respective buses. These are present on either side of the power buses. The main breaker which controls all the power in the house is located on the upper part of the electric panel. Step 3-Considering Power Requirements An electric panel in a house provides or or amps. The individual circuits are then distributed from the main breaker by individual breakers which branches the power throughout the home. These individual breakers are designed depending upon the requirement of power. A light outlet circuit would need 15 amps and other appliances that need more power would usually be 60 to amps. Step 4-Designing the Panel When you are creating the design for your electric panel the following details should be incorporated into it. Location and dimension of the panel Load description, Amperage, Voltage required Phase and NEMA type Horsepower, cable size and conduit size Indication of the home run circuitry with a designated number Number of wires a conduit carries Type of insulation Step 5- Combining Location and Design If the panel is to be placed in an environment that you consider could be polluted, design it to keep contaminants out by applying positive air pressure. If it is to be placed in a dark area, design it to have an internal panel light mounted on it. On the other hand, design the panel to have a drain hose at the bottom of its enclosure if it is going to be installed in a place where water or other liquids may enter its enclosure. While it is wise to take into account all the power needs of the house, it would be wiser to future proof your home when designing an electric panel.

Chapter 3 : Basic electrical design of a PLC panel (Wiring diagrams) | EEP

By taking a few extra steps in the selection, design, and installation of an industrial control panel, you can ensure it will have no failure time bombs ticking away. With a modest maintenance program, it will be nearly problem-free for its entire life.

These are power components. Below are the terms used to describe them with a description of each type. Circuit Breakers A circuit breaker is a manually operated electrical power switch that can detect short circuit and overload conditions and turn itself Off when one of these conditions is detected. Short circuit conditions are detected magnetically and overload conditions are detected thermally. Fused Disconnects A Fused Disconnect is the combination of a manual operated power switch and a fuse. A fuse is a thin metal wire in a sand packed paper wrapper. A fuse breaks the flow of electrical power by graceful self destruction. Soft Starters A Soft Starter is a simple solid state motor power controller. Instead of simply opening and closing the power circuit like a motor contactor, it ramps the motor voltage up or down to turn the motor on and off more smoothly to eliminate electrical surges and mechanical shock. A Soft Start SS is more expensive than a motor contactor, but provides the added benefit of reducing electrical and mechanical shocks associated with starting and stopping a motor. Instead of simply ramping the motor voltage up or down like a soft start to turn the motor on and off, a VFD controls the motor speed at all times. Electrical Control Components Control panels use electrical panel components to control the logical operating sequence of physical equipment. These are control components. Below are the terms used to describe the major control component types with a description of each. It has a coil that can be energized logical 1 and de-energized logical 0 by an electrical voltage V, 24VDC, etc. Timing Relays A Timing relay is the next simplest control device. They are control relays with built-in timers to control when their contacts change state, and are used to turn other devices contactors, pilot lights, etc. Below are the terms used to describe the major operator device types with a description of each. Pilot Devices Pilot devices are door mounted manually operated electrical switches or indicators. Digital Meters Digital Meters are door mounted digital display that allows an operator to monitor analog process variables Level, Pressure, Temperature, etc. Operator Interfaces Operator Interfaces are door mounted touchscreen computer displays that communicate with programmable logic controllers PLC. They can replace pilot devices and digital panel meters. Control Panel Builder Topics.

Chapter 4 : Books or Websites on Control Panel Design â€“ AutomationPrimer

Electrical control panel design basics further 4 way switch wiring diagram as well as typical ac power supply system scheme together with introduccion sistemas de deteccion de incendios together with g2r as well as emergency systems and nec further nec and optical fiber cable and raceway rules moreover loop wiring diagram ex les in addition.

Frank, Thanks for the informative site and your passion for teaching. I have found a lot of useful information on here. I wanted to ask you if you could possibly refer me to some books, sites, or anything for that matter, on designing electrical schematics for control panels. I am asking for subject material like sizing wire, breakers, fuses etc. The ULA is great material, but it can be too confusing. Doug asked for some elaboration on the panel design process and had also wondered if there were any books or websites on panel design. I did some research back then and was unable to find any actual books, but I did find several websites that discussed the subject. One site that covered the same question was this topic on plctalk. The original topic was started in but there are comments all the way up to Another site where I found some good info was at ecmweb. As far as sizing goes, my book also has some tables in it that I extracted from a handheld sizing calculator I got from Square D about 20 years ago. It was of great help when sizing wire and breakers for transformers and motors as well as showing the ampacity of conductors. These kinds of tables are in many manufacturer catalogs also and are presented in a better format than in the National Electric Code NEC. I also usually post topics like this on Linked In forums; sometimes people know of good books or websites and may make a suggestion. If someone knows of a good site or book I will forward the information or update this post. It took me over two thousand hours to write my book. People are usually so busy earning money for what they do that the last thing they want to do is take their job home with them. An exception would be teachers and professors, but as far as I know there are no teachers or professors that know the details of panel design. Most of the engineers I know who are experienced designers have no interest in writing. It really is a tremendous amount of work, and I would have to do it through McGraw-Hill since I signed a contract. There is also a lot of research and documentation required by major publishers which takes a lot of time. For those who have any book or website suggestions please post a comment here or on Linked In and I will ensure this post gets updated.

Chapter 5 : Guide to Design of Industrial Control Panels | EEP

Learn the basics of electrical panel wiring; it's a good first step to understanding your home's electrical system and is essential to performing safe repairs and upgrades. Types of Panels It's important to note that not all electrical panel wiring uses breakers, although that's been the standard for over 50 years.

Doug asked me to cover a little more on the panel design process. I am using the above picture because it contains a variety of different kinds of components in the same enclosure. Many larger enclosures allow the designer to separate similar components i. The first step in laying out an enclosure is to complete the electrical design schematics. It also allows the designer to determine how many terminal blocks and other power and signal distribution devices will be needed. Much of this process was discussed in a previous post. From the electrical schematics a Bill of Material BOM is generated listing all of the components in the system. It requires the designer to account for every component in the drawings, giving it a label and part number. It also looks at all of the junction points usually a dot joining at least two wires and assigns terminal blocks to them. For more information on CAD and wire numbering check out this post. Large components are easy; just put a number by the component and start a list of labeled components in a spreadsheet. Fuses and fuseblocks fall into this category. They are also easy to account for if a good single-line drawing of power distribution is created. These are more expensive than terminal blocks but save significantly on wiring time and space. Power distribution terminal blocks can be a little trickier to count. The same can be done for Neutral wires in AC circuits. Its a good idea to plan for a few extra points than are counted. After accounting for all of the components its time to locate them on an enclosure backplane. I generally start by placing the components in AutoCAD in a rectangle of some backplane dimension; i. At this point its a rough guess until all the components have been placed. Its a good idea to segregate devices of different voltages within the enclosure. Since the disconnect carries the highest voltage a distribution block is usually located close to it along with branch circuit fusing. The panel layout at the top of this post only has 24vdc and VAC devices in it, note that the VAC devices are all located on the left side. For some reason controllers often end up close to the upper left corner of the enclosure. There is no hard and fast rule for this , but if the power distribution is on the right and terminal blocks at the bottom this is often where it ends up. I generally try and locate all field termination points wiring arms, terminal blocks etc. This minimizes the amount of wiring inside of the cabinet which as can be seen below can be a considerable amount. If the wiring arms in the center area of this panel had been located vertically on the right side or at the bottom the wire would have been much more manageable. The red devices toward the bottom of this enclosure are guard and E-stop circuits. As safety systems have evolved over the past 20 years or so they have grown to take up more space. The guard switches, light curtains and E-stops are all brought in as field wiring and generally also require their own terminal blocks. After all of the components, terminal blocks and other devices have been placed in the rectangle items such as wiring duct wireway and DIN-rail can be placed. After all of the DIN-rail mounted and other components are located the wireway can be placed between the rows of components. I also generally place wireway all the way around the edges of the backplane. Some specifications require internal separators or even separate runs of wireway for different voltages. Mechanical designers usually want the enclosure to be as small as possible and ideally completely hidden from sight; tucked up under the machine somewhere. Electrical designers want enough room for a lounge chair and maybe a small TV. The result is usually somewhere in-between, mostly due to specification and space requirements. Since enclosures only come in specific sizes it is usually pretty easy to round up to the next size. Often similar systems can use one of these saved designs as a rough template, saving time and giving the designer a running start.

Chapter 6 : AutoCAD Electrical Toolset | Electrical Design Software

Written by panel builders for panel builders "Industrial Control Panels for General Application and Industrial Control Panels for Industrial Machinery for the North American Market" is a guide written by panel builders for panel builders.

Electricity flows to your lights and appliances from the power company through your panel, its breakers, out on your circuits and back. Here is a schematic picture of all the major parts of your home electrical system. See my Is electricity mysterious? Your electrical utility company and its distribution system bring power over wires and through switches and transformers from the generating plant all the way to a point of connection at your home. Its built-in safety features can stop power in time, but other connections, broken lines, storms, imperfections, or mistakes can sometimes allow unusual voltages into your system, possibly damaging parts of it. The sensitivity of home electronic equipment to this has made us more aware of this possibility, so that our use of surge protectors has become common. But some surges are difficult to protect against and can be similar to lightning strikes in their effects. Your central breaker panel or fusebox directs electricity through your home as a number of separate circuits, each flowing "out" from its own circuit breaker or fuse on one wire and returning from whatever is using the electricity to another connection in the panel by means of another wire. The breaker or fuse will interrupt the current the flow if it ever starts to approach a dangerous level. This diagram compares a main panel as I have diagrammed it so far, with how a typical panel is arranged: There may be in the panel a distinct "main" breaker that can shut off power to most or all the circuits. These devices automatically turn power off, but connections at any one of these points -- at the meter, at the main breaker, inside the main breaker -- can fail or become unreliable, disrupting some or all the power in your home. A circuit is a path over which electric current can flow from and to an electric source. This concept could use some clarification. If it were always as simple as current from the source following only one possible path out to one light and back by one return path, then the operation or malfunction of a circuit would be easy to grasp. But it is not so simple. This diagram lets you trace the path of one circuit as it goes through your system: Taking this as the starting place of the electrical source, then, we will find that most circuits in a home are complex, involving sub-branches like those of a tree. By Code, a dedicated circuit is used for each of most large appliances like the electric range, electric water heater, air conditioner, or electric dryer; these as well as electric heaters will have two joined breakers in order to use volts rather than the volts used by most other items. A dedicated circuit of volts is usually provided for each dishwasher, disposal, gas or oil furnace, and clothes washer. Most other volt circuits tend to serve a number from 2 to 20 of lights and plug-in outlets. Circuits serving more than one outlet or light pass power on to successive locations by means of connections in the device itself or in the box the device is mounted in. So on any one circuit there are many places where electricity can fail to get through -- from the circuit breaker and its connections, through a number of connections at devices and boxes, through switches, and at the contacts of a receptacle where you plug something in. Troubleshooting electrical problems in your house will depend on a basic grasp of these matters. Sometimes the behavior of electricity in a home is explained by a comparison with plumbing. Water and what it does are less abstract. But the analogy is very limited. It is true that water pressure voltage through a certain size of pipe or showerhead resistance can result in a certain rate of flow current , and that a certain number of gallons kilowatt-hours will thereby be delivered. But what would a circuit mean -- in plumbing terms? Water pressure ends at the sink or out on the lawn beyond the sprinkler. The return of water back to a reservoir is very round-about. Electrical wiring is a tighter system, a more closed system. To understand the function that different wires in a circuit play, consider first our use of terms. Because a house is provided with alternating current, the terms "positive" and "negative" do not apply as they do to direct current in batteries and cars. Instead, the power company is providing electricity that will flow back and forth 60 times per second. The electricity flows through the transformer, on the one hand, and the operating household items, on the other hand, by way of the continuous wire paths between them. We call these isolated wires "hot" or "live" because anything even slightly connected to the earth like us! See this very good Portrayal of shocks by an engineer-type. The other half, in the case of a volt circuit, is the "neutral" wire. For a volt circuit, the other half is a hot wire from the other phase -- the other hot coming from the transformer. When they are turned on operating, running , the loads are part of the path of the current and are where the electricity is doing its intended work. Hot wires are distributed into your home from a number of circuit breakers or fuses in your panel. Hot wires are typically black, occasionally red or even white, and never green or bare. The earth-related neutral wires in your home are also distributed from your panel, but from one or two "neutral bars". Neutral wires are always supposed to be white. Contact with them should not normally shock you because they are connected to the earth much better we assume than you can be. But contact with a hot, even one that is white-colored, will tend to shock you. Even when they are switched off, we call these wires hot to remind ourselves that they will be, and to distinguish them from neutrals and grounds. Instead, it is there to connect to the metal parts of lights and appliances, so that a path is provided "to ground" if a hot wire should contact such parts; otherwise you or I could be the best available path. In this diagram see if you can picture the different paths taken by normal current and a short-to-ground: In other words, when a ground wire does carry current, it is taking care of an otherwise dangerous situation; in fact, it usually carries so much flow suddenly, that it causes the breaker of the circuit to trip, thereby also alerting us that a problem needs attention. By code, convention, and good reasons, only hot wires are supposed to be switched, never neutrals or grounds. This diagram shows how a household switch works: A switch is a device that continues the hotness of a hot wire on through to, say, a light or else discontinues that hotness. So the black or red wire between a switch and its light is not always actually hot; when it is not hot, its color is still valid, to remind us that it will sometimes be hot. There is a form of switching in which two or more switches can each control a light. These are commonly called three-way switches. They normally work by one switch continuing hotness to another on one or the other of two "traveler" wires that run between the switches; the final switch connects either the hot traveler or the unhot traveler on to the light, thus energizing the light or not. I give more Discussion and diagrams of 3-way switches. Other specialized switches include dimmers, motion sensors, photocells, timed switches, thermostats, and "smart home" X switches. You can get my tips about these at Automatic controls. Tour of a Circuit: This is where you will see a house wiring diagram, though not of a whole house. So that you can experience the ins and outs of a circuit in practice, take the Tour. Those who like puzzles will even find three troubleshooting challenges at the end of the tour. Then to compare this same circuit as it connects in electrical boxes with how its cables would be run in a particular set of rooms in a home, go to Circuit cabling. I recommend you view these files; you may recognize things in them that are like what you find in your own home. For the more advanced. Working with a more complex issue, you might want to beef up your education with this Tutorial about the connections in electrical boxes. And I have this page full of Connections Diagrams , which is to show most of the possible ways wires connect in outlet, light, and switch boxes. The problem is that there IS a mountain of information, but it is not all in one place nor easily accessible to a layman. At least, that is how it felt until I found your site. Finally here was a place which had all the information I was looking, and was presented in a nicely logical and easy to understand fashion. The diagram with the step by step reading helped me finally grasp the basics of home wiring.

Chapter 7 : Control Panel Layout And Wiring Best Practices. | Harold On Controls

2 In volume 3, we provide knowhow on Control Panel Design, from Information on UL Certifications, to Differences in Terminals, Electrical Control CAD, Display Visibility, and Temperature Controller.

What are some good practices? What could be improved? Click to enlarge The quality of the wiring methods used in an industrial control panel can vary quite widely. This article summarizes what this author believes are some best practice when it comes to control panel layout and wiring. The goal is to produce a panel that is logically arranged and easy to maintain for the life of control panel. Use MTW type wire. Note any exceptions so these can be added to the drawings or design notes. U loop, as long as possible, facing down anchored on each side of the hinge with screws or bolts no adhesive. Place sleeve or spiral wrap over the wires running over the hinge between the anchor points. They get cut off when troubleshooting and are rarely replaced. A good wire management system should not require any wire ties. Make it a goal to use no wire ties except temporarily while wiring. Leave service loops as the wires leave or enter the device or terminal. Take all corners in a wiring duct as wide as possible. Run wires in horizontal and vertical lines. Run wires in horizontal and vertical lines, no diagonal runs. Wire in wire duct should be run so they do not cross each other excessively. Do not run wire over other devices, including the wireway. Elevate the duct and go under the duct with wires if needed. Place Pig tail loops between devices that are spaced such that it makes it easier to remove wiring if the pig tail is added. Unless specifically required strip off a generous amount of the jacket so that each conductor can be easily accessed for removal, testing, and replacement. Also remove the jacket as it exits a wire duct, keeping the twists where the cable otherwise creates unwanted wire congestion. Terminate all shields close to the signal wires. Consider using 2, 3, or even 4 high terminal blocks with jumper slots for signal wiring depending on the wiring needed. This allows busing the power supply voltages for a cleaner installation. Wires should exit the terminal straight. Do not bend the wire at the point of termination. Instead loop or bend wires on the insulation that do not go straight to the wireway. Use tubular, pressure plate type screw terminals that minimize wire distortions or damage when terminating. Position Terminals to allow visual inspection of the recessed connections. Elevate Control Terminals to allow wiring under the terminals if needed. Angle and elevate terminals mounted on the side panel for wiring ease and to allow visual inspection of wiring in the terminals. Wire all grounds to the incoming ground lug either directly or with a wire to the other ground bus bars. This is in addition to the ground established through the panel. Use 2 ground wires from opposite ends of the bus or chain of ground bars if the ground is isolated. Wire the ground on all doors and subpanels and the cabinet itself to a ground bar terminated at the main ground lug. Wire all equipment and chassis grounds to the ground bar s which is terminated at the main ground lug. For additional details on grounding and bonding see the Grounding And Bonding post dedicated to just this subject. Consider the routing of all of the wires and how the various voltages will be kept separated.

Chapter 8 : Handbook of Electrical Design Details, Second Edition

Electrical wiring diagrams of a PLC panel In an industrial setting a PLC is not simply "plugged into a wall socket". The electrical design for each machine must include at least the following components.

The panel receives power from the utility company and distributes it to the individual circuits that supply all of the fixtures, outlets and other devices in the home. The precursor to the breaker-type panel is the fuse panel, which uses disposable fuses instead of breakers to protect the circuits from shorts and overloads. To shut off the power to an individual circuit, you have to remove the fuse. A subpanel essentially is a small version of a main panel and may be installed when a main panel has no room left for adding circuits or to provide power and easy panel access to a house addition or new garage. The inner panel surrounding the switches conceals the guts of the electrical panel wiring. Three heavy-gauge service cables enter the panel from the electric meter. One of these is the neutral line, and it connects to the neutral bus bar â€" a metal strip with numerous screw terminals â€" inside the service panel. The two other lines are the hot lines. These connect to the two hot bus bars in the panel via a large "main" circuit breaker. Each hot line carries volts of power. A panel must also have a heavy grounding wire usually bare copper that connects to the neutral bus bar on one end and to a grounding rod driven into the ground on the other end. In houses with metal water pipes, there may also be a ground wire between the panel and a nearby cold-water pipe. All of the remaining cables going into the panel are the individual circuit cables from the house and subpanel, if you have one. The hot wire usually black or red from each cable connects to a circuit breaker, while the neutral wire usually white connects to the neutral bus bar. Circuit Breakers Circuit breakers are the primary safety devices in your electrical system and they are integral to electrical panel wiring. A breaker automatically "trips" and shuts off power to a circuit if it senses an overload, which can be caused by plugging in too many appliances on one circuit, or by a short. A short can result from things like loose wires, damaged insulation or a curious kid sticking a coat hanger into an outlet ouch. Breakers are rated for the power draw of each circuit. Standard breakers carry volts and either 15 or 20 amps amperes. High-voltage breakers carry volts and 30 or more amps. The amp rating is the number stamped on the end of each breaker switch lever. All panels should have an index label on the panel door listing the main devices on each circuit e. Electrical Safety Now that you know a little about electrical panel wiring, the most important rule to remember is: And before doing anything with the panel â€" including removing the inner cover â€" shut off the main breaker. This cuts the power to all of the household circuits at once. For electrical repair and upgrades that are beyond your comfort zone, hire a reliable, licensed electrician. Updated December 24,

Chapter 9 : Your Home Electrical System Explained

CHAPTER 1 Electrical Plan Design. 3. demand requirements of the facility based on the individual parts of the electrical distribution system (see Chapter 6).