Honeywell

Experion PKS

Site Planning Guide

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Release 431

Honeywell

Document	Release	Issue	Date
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Disclaimer

Contents

1 About This Document

This publication provides information needed to prepare facilities for the installation of your Experion system equipment before its delivery.

2 About this guide

This document contains planning information for the hardware components of an Experion system.

Revision	Date	Description
A	December 2013	Initial release of the document.

Related topics

"Intended audience" on page 12
"For more information" on page 13
"Purpose and scope of document" on page 15

2.1 Intended audience

This guide is intended for people who are responsible for planning the installation of the Experion control room. It is assumed that anyone planning the installation is familiar with the following:

- Local site requirements
- Agency compliance requirements
- Honeywell requirements

2.2 For more information

2.2.1 Honeywell user documents

The following table lists other Honeywell user documents that provide additional planning details for specific areas of the control system. These documents are referenced throughout this planning guide.

Document	Description
Experion Overview Guide	Provides brief descriptions of the functions and components that can be combined to personalize your Experion system. For site planning, helps you understand how the entire system works and identifies all the components to consider.
Experion Network and Security Planning Guide	Contains networking and security guidelines and best practices for an Experion system. For site planning, provides physical and environmental considerations for planning the physical location of your Experion system to enhance security.
FTE Implementation and Overview Guide	Provides an overview of Honeywell's Fault Tolerant Ethernet (FTE) and detailed network planning information. For site planning, helps you understand the Experion network levels and their requirements.
Experion Control Hardware Planning Guide	Provides detailed information about all aspects of the control hardware used in an Experion system. For site planning, contains planning information for cabling, wiring, power, and grounding of all control hardware.
Planning, Installation and Service for Honeywell computer platform	Contains installation information for the Honeywell Honeywell-based computer platforms that contains. For site planning, provides specifications and operating parameters for each computer platform.
Honeywell Icon Series Console Read me First	Contains important safety considerations for the Honeywell Icon series consoles. For site planning, contains special requirements for installing the Icon console.

2.2.2 Honeywell specification and technical documents

For Experion R310 release, the specification and technical documents for Experion components are listed in the following table.

Attention

You have to refer the applicable Specification and Technical data documents for each Experion release. That is, the Specification and Technical information is subject to change without notice and is superseded by information in applicable Experion product Specification and Technical data documents.

Document
EP03-200-rrr: Experion Server Specification
EP03-210-rrr: Experion Station Specification
EP03-300-rrr :CEE-based Experion Controllers and Network Capacities and Specifications
EP03-320-rrr :C300 Controller Hardware
EP03-350-rrr :CAB (Custom Algorithm Block)
EP03-400-rrr :CIOM-A

Document
EP03-410-rrr : Experion Rail I/O - Series A Specifications
EP03-420-rrr :RIOM-H
EP03-430-rrr :PMIO
EP03-440-rrr : Experion PKS - Platform - DeviceNet Interface
EP03-450-rrr :Profibus
EP03-460-rrr :HART Integration
EP03-470-rrr :FOUNDATION Fieldbus Integration
EP03-480-rrr :Field Device Manager
EP03-490-rrr :Experion Series C I/O
EP03-500-rrr :Fault Tolerant Ethernet
EP03-510-rrr :Experion Series C GI/IS IOTA
EP03-520-rrr :Experion Series C Platform

2.2.3 Other references

The following table lists other sources of information for Experion site planning. These external documents are reference throughout this document.

Document
ANSI/ISA S12.12 standard
Canadian Electrical Code (CEC)
European Committee for Electrotechnical Standardization (CENELEC)
Factory Mutual Research Corporation's Standard 3611
International Electrotechnical Commission (IEC)
ISA S12.12 Electrical Equipment for Use in Class 1, Division 2, Hazardous Locations
ISA S71.01 Environmental Conditions for Process Measurement and Control Systems: Temperature and Humidity
ISA S71.04 Environmental Conditions for Process Measurement and Control Systems: Airborne Contaminants
NFPA 493 Intrinsically Safe Apparatus for Use in Division 1 Hazardous Locations
NFPA 496 Purged and Pressurized Enclosures for Electrical Equipment
NFPA 497 Classification of Class I Hazardous Locations for Electrical Installations in Chemical Plants
NFPA 70 National Electrical Code
NFPA 75 Standards for Protection of Data Processing Equipment
Underwriters Laboratory (UL)
Building Industry Consulting Service International (BICSI) Telecommunications Distribution Methods Manual (TDMM)

2.3 Purpose and scope of document

This document defines the planning of the overall site control room and input/output area for the installation of a new Experion system. This document cannot cover all possible site planning situations, and is not intended to replace any other existing best practice or site requirement documents from other organizations.

The focus of the document is on the preparation of the site for the physical installation of the Experion hardware, and it includes the following types of subjects.

- Pre-installation considerations
- Placement and layout of control rooms and I/O areas
- Power and grounding requirements
- Environmental controls and requirements, including planning for a hazardous environment

3 Preparing to install an Experion System

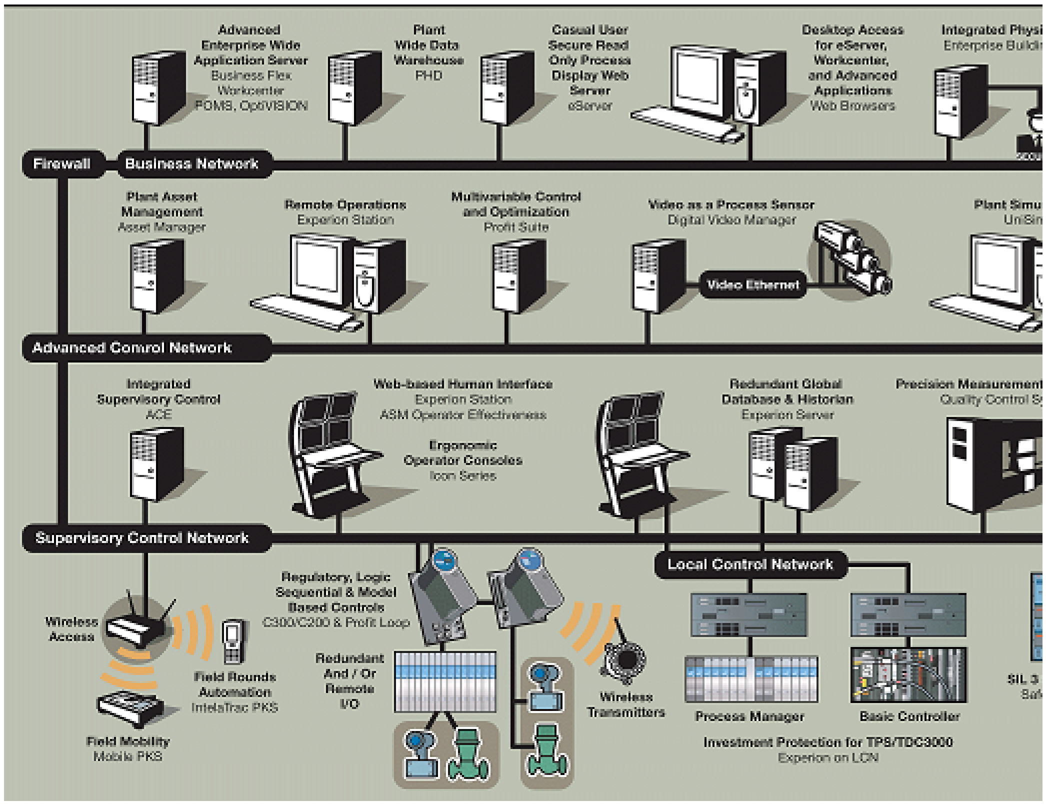
This section provides information that you should know or consider before you begin your site planning.

Related topics

"Experion system overview" on page 18
"Available Honeywell services and support" on page 20
"About the site survey" on page 21
"Gathering your site planning documentation" on page 22

3.1 Experion system overview

The following figure is a high level view of an Experion system. In preparing your site, you will need to consider the infrastructure requirements needed for each level of the system. See the documents listed in the ' “For more information” on page 13' section for additional information for specific Experion components.



3.1.1 Planning for the network levels

The following table describes the network levels of the Experion process control system and identifies the major components in each level. Each network level has different planning considerations.

Level	Network	Major components
Level 0	IO network	Control devices
Level 1	Local Control network	• Process control hardware • C300 Controller • Series C Fieldbus Interface Module • Control Firewall • FTEB • Level 1 switches
Level 2	Supervisory network	• Experion servers and consoles • Domain controller • Subsystem interfaces • Level 2 switches

Level	Network	Major components
Level 3	Application network	Applications that manage control devices but are not necessary for the control process itself.
Level 4	Business network	Applications that interface between business systems and the control system.

3.2 Available Honeywell services and support

Honeywell provides project services and other support in the areas listed in the following table.

Type of Honeywell service	Description
Field services	Construction, engineering, installation, loop check, calibration, commissioning, startup, and hot cutover.
Special testing	In addition to the standard system-level testing, a wide variety of special factory and field testing
Power-on support	Assistance during site preparation, unloading, installation, and power-up of the Experion System.
Outside purchase	Procurement services for other vendor's equipment that may be part of the total project.
Data configuration and programming services	A broad range of optional data services can be provided to create, modify, and maintain the operating system database or specific programs.
Application engineering	Studies can be provided for feasibility and economic analysis. System-design work involves the development of a functional process-control strategy to meet customer plant and process requirements.
Kickoff meetings	Special project kickoff meetings can be conducted at a Honeywell location or customer site to review project design, establish communications paths, and finalize project commercial and technical details

3.3 About the site survey

Prior to installing an Experion system, a thorough site survey should have been performed, which consists of the following activities:

- Reviewing the information submitted by the customer and compiling the any other existing information of the plant necessary for developing the project scope of work.
- Identifying defective or obsolete instrumentation.
- Establishing the state of installation and wiring.
- Reviewing existing control room and satellite house conditions.
- Reviewing plant design criteria and hazardous area protection methods.
- Reviewing existing documentation to assist in developing Honeywell scope of work and design basis.
- Identifying the interface requirements between instrumentation, electrical, piping, etc. will be identified.

3.4 Gathering your site planning documentation

This section contains lists of documents available from different sources that are useful for planning the installation of the Experion system.

Related topics

"Customer-provided documents" on page 22
"Honeywell-provided documents" on page 23

3.4.1 Customer-provided documents

The following table lists the types of documents that may have been provided to Honeywell by the customer during the initial design of the system.

✓	Document
	Plot plan and civil drawings
	Control room layout drawings, architectural drawings, etc.
	Power and grounding drawings
	Instrument symbology conventions (including electronic symbol libraries)
	Instrument index (if available)
	Loop numbering scheme
	Existing instrument loop diagrams, connection diagrams, schematics, etc.
	Data sheets and associated calibration data
	Drafting standards (including conventions used for: title blocks, layering, file naming, font type, font size, line weighting, etc.)
	Logic drawings or narratives
	Remote Instrument Enclosure (RIE) drawings (if applicable)
	Instrument installation details (instrument and electrical)
	Motor schematic drawings
	Instrument location plans
	Acceptable Manufacturers List (AML) including: Control valves, Panel mounted miniature instruments, Transmitters, Transducers, Pressure gauges, Temperature indicators, Bulk instruments (manifolds, tubing, wiring, etc.), Switches
	Electrical single lines [mainly for Uninterruptible Power Supply (UPS)]
	Power distribution schedules
	P&IDs and PFDs
	Existing connection diagrams (junction boxes, marshaling, etc.)
	Honeywell drawings of any third party systems which will interface with Honeywell equipment
	Existing panel and annunciator drawings
	Instrument and electrical underground, above ground plan drawings
	Customer standards
	Existing loop diagrams, connection diagrams, schematics, etc.
	Instrument specifications
	Process descriptions

✓	Document
	Safety memorandums and procedures

3.4.2 Honeywell-provided documents

The following table lists the types of documents that Honeywell generates during the initial design of the system.

✓	Document
	Functional Specification - DCS
	Functional Specification - SIS
	Functional Specification - RIE
	Functional Specification - PIN
	System Architectural Drawing
	RIE Layout Drawings
	Preliminary I/O list
	Scope of Work Document
	Control building layouts, RIE layout and materials of construction
	Control room layout drawing (including cabinet and console layout)
	Fiber Optic Plan Drawing and Scope document
	Completed project definition checklist
	Safety specifications
	PIN applications, architecture and topology

4 Site selection

This section provides criteria for selecting the optimal site for your Experion control system.

Related topics

"Site selection guidelines" on page 26
"Control room guidelines" on page 28
"Control room flooring" on page 29
"Environmental classes and specifications" on page 31

4.1 Site selection guidelines

The following table summarizes the major considerations for selecting a site for the Experion system. See the remaining sections in this section for detailed information on the guidelines provided.

	Guideline
Building and control room	
	Has the cost of insurance, which can be affected by the type of building construction used and by the location of the site relative to fire hazards and fire fighting facilities, been considered?
	What are the building codes for the area? These often require that your drawings be approved by a locally licensed architect and/or city engineer.
	Are there any zoning regulations that may affect site location, construction, use, and expansion?
	Is the floor of the control-room area structurally adequate to sustain the weight of the system components and any other loads that may be imposed upon it?
	Is the ceiling a minimum of 8 feet (2.44 meters) from the top of the raised floor to accommodate the Honeywell systems cabinets?
	Is there space for a UPS?
	Is space available to house air conditioning equipment such as compressors, air handling equipment, evaporators, condensers, and cooling tower equipment?
	Is there adequate space for efficient operation of the system-related work stations?
	Are support-function areas (office space, media storage, and equipment maintenance area) satisfactory?
	Can new equipment be added without causing radical changes to the current allocation of space?
	Is the lighting and power adequate for expansions?
Equipment installation and access	
	Are there any building modifications necessary before moving in the Experion equipment?
	Will the installation of the Experion System equipment and communications equipment disrupt any existing customer facilities and/or operations?
	Are the size and location of entrances and exits adequate for equipment delivery?
	Is there room to unload the delivery van?
	If the building (or facility) is more than one story tall, is the elevator accessible and is its capacity adequate?
	Is there year-around access where heavy flooding and/or snow are possibilities?
	Is there telephone access?
	Can the site be secured from unauthorized personnel?
Environment and safety	
	Is space available to house the heating and air-conditioning equipment (the compressor, air handlers, evaporators, condensers, and cooling-tower equipment), if needed?
	Is the site relatively free from process dust and explosive or corrosive fumes?
	Is the air-filtration system (air cleaner) adequate?
	Are there any sources of electrostatic or electromagnetic interference (EMI) in the proximity that may have an adverse effect on the system's operation?
	Is the lighting adequate? Proper natural and artificial lighting is essential for efficient and productive operation and to minimize operator fatigue?
	Do the control room surrounding walls and ceilings have any type of existing acoustical treatment to help reduce noise?
	Is the fire and smoke-detection system adequate?

✓	Guideline
	Is the fire extinguishing system adequate?
Power and electrical	
	Have you reviewed the National Electrical Code (NEC) requirements for the installation of power and signal cables? The national codes are contained in the National Electrical Code (NFPA 70) and the Standards for Protection of Data Processing Equipment (NFPA 75). In Europe, the European Committee for Electrotechnical Standardization (CENELEC) requirements must be adhered to.
	Is electrical power available and adequate? Are room electrical outlets sufficient as to type and location for any free-standing peripherals? Do electrical power and communications equipment provide for future expansion?
	Is there a separate room for the motor generator (MG)? These are not required when the customer is furnishing a UPS and batteries, or battery backup units are installed in the system.

4.2 Control room guidelines

The following table summarizes the major considerations for the Experion system control room. See the remaining sections in this section for detailed information on the guidelines provided.

✓	Guideline
Control room access	
	Consider the number and size of cabinets and consoles allowed.
	Aisles must have a minimum width of 1370 mm (54 inches) and allow access to all equipment, both front and rear.
	All doorways, stairwells, elevators, hallways, ramps and aisles must be of sufficient size to permit movement of equipment.
	Avoid routing foot traffic past electronic cabinets. The associated dirt, vibration, banging or pounding, and Electrostatic Discharge (ESD) causes unnecessary stress to the equipment.
Cabling and wiring	
	System cabinets are designed to allow cable entry from either the top or bottom.
	I/O areas that handle signals to a hazardous area should be located so that wire runs are kept to a minimum.
Floor design	
	Allow direct access to AC power wiring and cabling for both installation and maintenance.
	Provide for future expansion by verifying easy installation of new cables, grounds, and power wiring.
	Floor panels should be ESD protective, durable and practical.
	Flooring must support cabinets and consoles. See specification for weights.
	Cable ducts and troughs should provide electrical shielding for cables and wiring.
	Water must not be allowed to accumulate.
Equipment areas	
	The computer room may be separate from or part of the control room, or it may not be needed.
	Equipment room or I/O area: Consider installing I/O equipment in remote or satellite equipment rooms to take full advantage of the Experion architecture.

4.3 Control room flooring

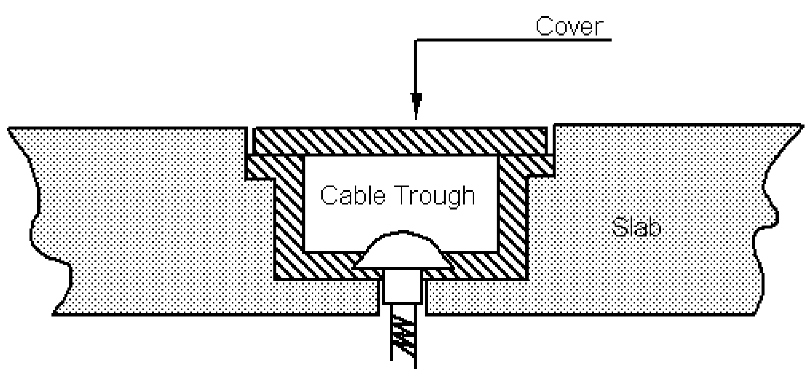
This section contains information about control room floors.

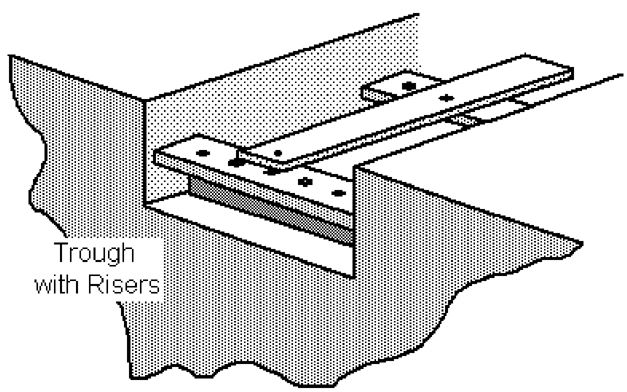
4.3.1 Types of floor construction

There are two types of floor construction in general use:

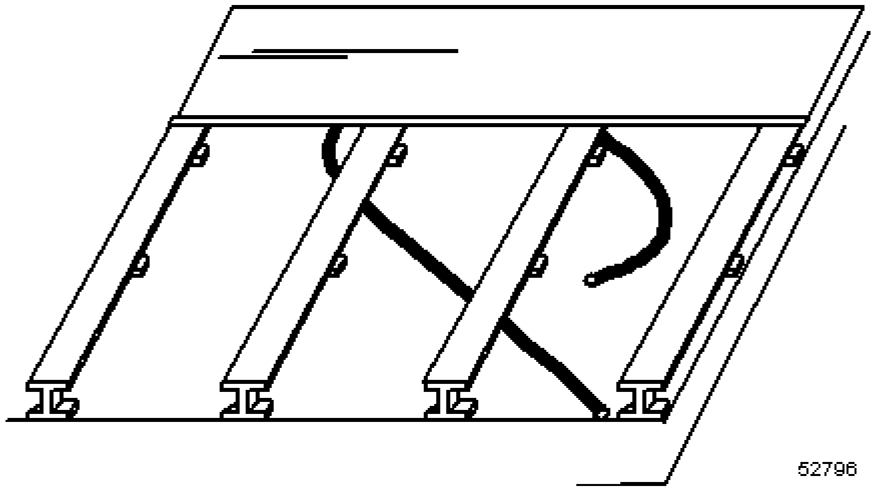
- Concrete floor with depressed cable troughs
- Raised floor (steel panels covered with ESD tile) on pedestal/raceway-type supports (stringers or screw jacks)

4.3.2 Example concrete floor with cable trough

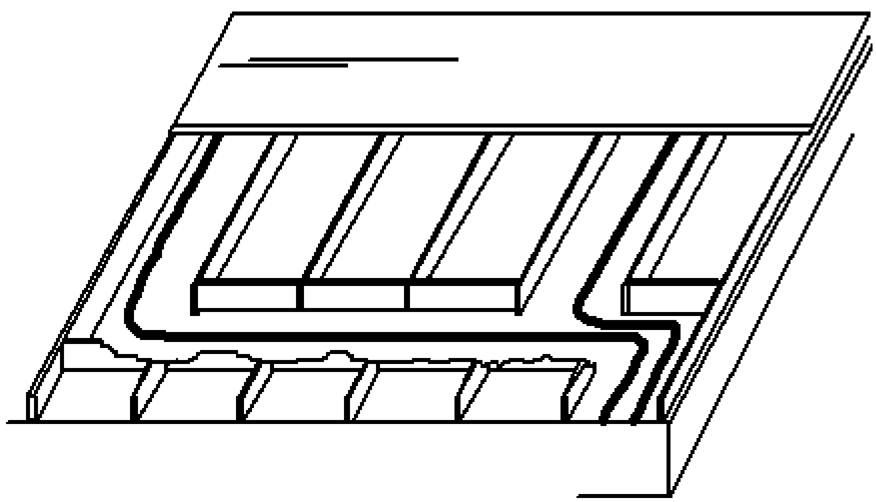




4.3.3 Example raised floor with stringers



4.3.4 Example raised floor with cable raceways



4.3.5 Advantages of raised flooring

A variety of floor coverings are acceptable with the following precautions:

- All floor coverings must meet local fire codes.
- Carpets must have antistatic construction that uses electrically conductive threads. This will reduce ESD damage to equipment. Periodic treatment of standard carpeting provides only temporary improvement.
- Tiled floor should never be waxed. The wax creates and retains static electricity. Any new floor should be treated with a wax stripper and then only washed.
- Concrete floors should be tiled or coated (sealed) to reduce dust generation and make cleaning easier.

4.4 Environmental classes and specifications

Experion equipment is for use in a controlled environment. Although the equipment will operate at 0-50°C (32-122°F), Honeywell recommends a normal environment of a nominal 25°C (77°F) with a relative humidity of 40-50% for maximum life and enhanced reliability. For details about the type of equipment qualified for each environmental class, see the ' “Equipment operating conditions” on page 35' section.

4.4.1 Environmental classes

Environmental specifications are grouped in the following four classes reflecting the allowable environmental ranges for the equipment.

Class	Description
Class A (general industrial)	For severe applications where dust, corrosive gases, wide temperature and humidity ranges, and general industrial conditions exist.
Class A1 (mild industrial)	For mild applications in an industrial atmosphere without corrosive gases with dust and wide temperature and humidity ranges.
Class A2	Same as A1 except for reduced operating temperature ranges.
Class C (office)	For applications generally within the comfort zone.

4.4.2 Environmental specifications by class

The following table lists the environmental specifications for each class. If the system contains equipment from different classes, use the most restrictive class unless the components are protected by a special enclosure or room that meets the higher class.

Category	Industrial Classes			Office Class
	A	A_1	A_2	C
Temperature (Note 1)				
Operating - external cabinet	0° to 50°C	0° to 60°C	5° to 40C	18° to 29°C
Operating - internal cabinet	0° to 70°C	0° to 70°C	5° to 60°C	18° to 44°C
Operational transient (0.25°C/Min. for 1 Hr. Max.)	\15°C	\15°C	\15°C	+11° -15°C
Storage/Shipment	-35° to 70°C	-35° to 70°C	-35° to 70°C	-35° to 70°C
Relative Humidity (R.H.) (Notes 2, 3)				
MAX. WET BULB	5 to 95% @ 32C	5 to 95% @ 32°C	5 to 95% @ 32°C	10 to 80%
Vibration (Note 4)				
Operating (14 to 150 Hz)	1.0 g	1.0 g	1.0 g	1.0 g
Shipping/Storage (14 to 150 Hz)	1.0 g	1.0 g	1.0 g	1.0 g
Shock (Note 4)				
Shipping/Storage	3.0 g	3.0 g	3.0 g	3.0 g
Altitude				
Operating - Maximum	7500 Ft.	7500 Ft	7500 Ft	7500 Ft.
Shipping/Storage - Maximum	35000 Ft.	35000 Ft.	35000 Ft.	35000 Ft.
Dust				

Category	Industrial Classes			Office Class
	A	A_1	A_2	C
Filters are effective down to:	10 Microns	10 Microns	10 Microns	10 Microns

Notes:

1. The specifications listed are 'Room Ambient' conditions except for 'Cabinet Internal Temperature,' which is the maximum temperature of cooling air that electronic components inside the cabinet will be exposed to.
2. The temperature and relative humidity should not be cycled such that moisture and condensation occurs on the equipment. The rate-of-change of relative humidity should be less than 6 per hour.
3. For Class C paper media, R.H. = 20 to 65%, temperature = 20 to 30°C.
4. The storage and shipping requirements are only for one year duration, provided the equipment is properly packaged and includes an adequate amount of desiccant (moisture removing agent).

5 Experion equipment operating conditions

This section summarizes the equipment operating guidelines for an Experion system to minimize equipment failure due to various atmospheric conditions.

Related topics

"Operating condition guidelines" on page 34
"Equipment operating conditions" on page 35
"Equipment noise levels" on page 36
"Estimating air conditioning loading" on page 38
"Ventilation and filtration" on page 39
"Corrosive materials" on page 40

5.1 Operating condition guidelines

The following table summarizes the major environmental considerations for planning the installation of an Experion system. See the remaining sections in this section for detailed information on the guidelines provided.

	Guidelines
Temperature and humidity	
	Maintain humidity levels between 40% and 60%.
	Control humidity fluctuations to less than 6% rate-of-change per hour.
	If millivolt and thermocouple circuits are used in the electronics area, limit the room temperature rate-of-change to 1°C/minute (1.8°F/minute) maximum to prevent the generation of thermal gradients at terminal blocks.
	Restrict drafts and air currents around FTAs where thermocouple wires connect
	During process upset or air conditioner breakdown, give priority to maintaining low relative humidity, minimizing air velocity, and preventing high concentrations of gaseous contaminants from reaching the equipment.
Ventilation	
	Maintain positive pressure in equipment rooms at approximately 0.1 inches of water.
	Diffuse air away from electronic equipment and towards doors and other entrances - do not duct air directly into cabinets.
	Plan an air distribution system that uses a minimum flow velocity and a minimum of makeup air.
	Use ducts to handle the air. Do not use the area under a raised floor as a plenum as the resulting vacuum/pressure under the floor draws air through cabinet cable cutouts and may cause problems.
	Choose an air distribution system that uses a minimum flow velocity and a minimum of makeup air.
	Route all air flow through a mechanical (non-electronic) dust filter.
Filtration	
	Use an air distribution system when atmospheric contaminants from process fumes, road dust, or cooking fumes are present.
	Minimize the quantity of particulates reaching equipment to less than 100 ug/m^3.
	Consider using a chemical purification system to provide acceptable air quality in an industrial environment.
	Choose the purification system based on its ability to filter out pollutants and to provide reactivity monitoring.
	Consider using air locks to minimize the ingress of untreated air.
	Ensure mechanical filters have an efficiency rating of not less than 20% after performing the Bureau of Standards discoloration test.
Anti-corrosion	
	Be aware of all corrosive compounds found at the site.
	If necessary, use a copper reactivity test to determine level of corrosion.
Operating practice	
	Do not defeat temperature and humidity controls by opening doors and windows to enhance comfort.
	Provide a means to close air inlets during periods of unusually high external pollutant levels.
	Place chemical purification systems on a strict analysis/replacement schedule.
	Keep the equipment doors closed at all times, except during times of actual human access.
	Restrict traffic through the equipment rooms.

5.2 Equipment operating conditions

The Experion system equipment must be located indoors and is suitable for continuous operation within its qualified environmental class. For a description of the classes and their specific operating conditions, see the ' “Environmental classes and specifications” on page 31' section.

Equipment type	Description
Experion Series C platform	Hardware components required to support, configure and operate the Experion Series C Control system installed in a Series C cabinet.
Server/workstations in cabinet	Honeywell qualified computer platforms for use with Experion installed in a Rittal-based equipment cabinet.
Server/workstations in console stations (Icon, Classic and Ergonomic)	Honeywell qualified computer platforms for use with Experion installed in control room furniture to serve as a workstation for process operators, process engineers and plant managers.

5.3 Equipment noise levels

The maximum acceptable noise level for any equipment installed in the control room is 55 dBA noise measured at a distance of 3 feet with a sound level meter using the 'A- weighted' sound level scale.

5.3.1 Temperature and humidity

Experion System equipment operates over a wide range of temperature and humidity. However, corrosive process materials, contaminants in the air and other environmental factors such as temperature and humidity may reduce the operating range of the equipment.

5.3.2 Optimal humidity

Maintaining the optimal relative humidity is an important factor in the prevention of corrosion failures. A few parts-per-billion of atmospheric contaminants combined with humidity in excess of 60% become very corrosive for electronic equipment. Low humidity (less than 40%), however, may cause ESD problems.

5.3.3 Effects of temperature changes

Temperature cycling and unnecessary air flow can cause equipment failures: temperature drops caused by the air-conditioning compressor cycling on may cause condensation of water soluble corrosives on the circuit boards; leakage of heated or cooled air may push electronic equipment to its temperature limit; temperature rate-of-change from heating and cooling may cause thermal gradients in millivolt circuits

5.3.4 Use of air conditioners to control humidity

When the facility's history of circuit board corrosion is not good, limit the maximum relative humidity to 60% at the boards. You can accomplish this by running the air conditioner continuously to keep the room dry and using heat to keep it comfortable. Commercial air dryers are also available.

Limit the temperature rate-of-change to 1°C/minute (1.8°F/minute) on actuation of the air conditioner, or use staged air conditioner compressors with the first having less than 1/4 of the capacity of the second.

5.3.5 Importance of dehumidification

The life of electronic circuits degrades in corrosive atmospheres with high humidity. Low concentrations of atmospheric sulfides and chlorides condense on the circuit boards (as dissolved electrolytes) each time the room temperature drops a degree or two. The corrosives accumulate with each temperature cycle below the dew point until circuit failure occurs. For example, indicated process variables may shift each time the air conditioner compressor turns on.

5.3.6 Use of humidification to control ESD and extend equipment life

An excessively dry room air causes personnel to generate high amounts of electrostatic discharge (ESD). The discharge causes Electromagnetic Interference (EMI), and excessive EMI can damage control electronics. The problem is particularly severe when personnel are required to wear flame-retardant clothing made from 100% synthetic fibers. Synthetics blended with cotton or stainless steel are not as susceptible to ESD.

Extra humidifier capacity allows frequent room air changes from doors opening. Use process steam or purchase a heating system with an evaporative humidifier. Avoid using faucet water directly in a spray or mist, which may inject dissolved solids into the air.

5.3.7 Temperature versus humidity

During process upset or air conditioner breakdown, give priority to maintaining low relative humidity, minimizing air velocity, and preventing high concentrations of gaseous contaminants from reaching the equipment. Raising the temperature lowers the humidity and does not cause significant short-term reliability problems.

5.4 Estimating air conditioning loading

The load on air conditioner units is caused by infiltration of heat from outside sources and from heat generated by equipment in the room. To determine the heat from equipment, assume that the full ac rms input to the power supplies is converted to heat using the calculation, *Power consumption = Voltage x Current x Power Factor*.

5.4.1 Preferable air conditioning units

An undersized air conditioner is preferred in wet climates because it will tend to run continuously and dry out the air. This minimizes corrosion. An oversized air conditioner is preferred in dry climates because it runs less often. This helps to minimize ESD problems by leaving moisture in the air.

5.5 Ventilation and filtration

Providing ventilation and filtration are important in the prevention of corrosion failures. Accumulation of particulates on equipment can form leakage paths between conductors, interfere with contacts and switches, or result in corrosion. Experion control rooms require air filtration of particles to a minimum of 19 microns. Honeywell recommends an air distribution system when atmospheric contaminants from process fumes, road dust, or cooking fumes are present.

5.5.1 Effects of poor ventilation and filtration

Use ducts to handle the air - do not use the area under a raised floor as a plenum. The resulting vacuum/pressure under the floor draws air through the equipment cable cutouts and may cause the following problems:

- Electronic circuits are continuously exposed to dirt, corrosives, and cooking fumes.
- The temperature drop caused by the air-conditioning compressor cycling on may cause condensation of water soluble corrosives on the circuit boards.
- Leakage of heated or cooled air may push electronic equipment to its temperature limit.
- Temperature rate-of-change from heating and cooling may cause thermal gradients in millivolt circuits.

5.5.2 Use of filters

Ensure mechanical filters have an efficiency rating of not less than 20% after performing the Bureau of Standards discoloration test. This test consists mainly of measuring the total cross-sectional area of dust particles removed from the filter. The filter should meet all local fire codes.

5.6 Corrosive materials

Atmospheric pollutants, such as corrosives, can cause premature failure of control electronics. Corrosives destroy the electronic components, while oils and dust cause connector contacts to lose continuity. This section provides information on corrosive and damaging atmospheres.

For a description of environmental classes and their specific operating conditions, see the ' “Environmental classes and specifications” on page 31' section. For equipment placement restrictions based on environmental class, see the ' “Equipment operating conditions” on page 35' section.

5.6.1 Most common corrosive compounds found in process control environments

Following are the most common and significant pollutants that cause corrosion in process control environments. See the rest of this section for details on these compounds.

- Inorganic chlorine compounds (chlorine, chlorine dioxide, hydrochloric acid)
- Active sulfurs (hydrogen sulfide, elemental sulfur, organics such as mercaptans)
- Sulfur oxides (SO_2, SO_3)

5.6.2 Inorganic chlorine compounds

Inorganic chlorine compounds (chlorine, chlorine dioxide, hydrochloric acid) are seldom absent in major installations and are a cause of atmospheric corrosion in the process industry. In the presence of moisture, they generate chloride ions that react with metals found in electronic components. The reactions can be significant even at chlorine levels in the low Parts-Per-Billion (PPB). While moderate reaction occurs at levels of 1 PPB, a few tenths of a PPB combined with very high humidity increases reaction well above the mild limit (Class G1) recommended for Experion equipment. Also, consider contaminants from secondary sources such as cooling towers or cleaning solvents, which often produce sufficient quantities (a few tenths PPB) to cause significant reactivity when combined with moisture and other gases.

5.6.3 Active sulfurs

Active sulfurs (hydrogen sulfide, elemental sulfur, and organics such as mercaptans) are a predominant cause of atmospheric corrosion in the process industry. In a mild (G1) environment, the concentration of active sulfurs is typically 2-3 PPB. The presence of moisture and a few tenths PPB of chlorides increases reactivity into the moderate (G2) class or above. Field studies show that reactions from mild (G1) to very harsh (GX) can be found with concentrations of H2S less than 20 PPB and CI less than 3 PPB, with the significant variable being the magnitude and rate of change of humidity.

5.6.4 Sulfur oxides (SO2, SO3)

Sulfur oxides (SO2, SO3) are generated as combustion products of sulfur-bearing fossil fuels, and from coking and nonferrous smelting operations. A few PPB of sulfur oxides can retard attack by other contaminants on reactive metals. At higher levels (>200 PPB), when dissolved in water to form acids, they can attack certain types of masonry, metals, elastomers, and plastics. Natural attenuation of sulfur oxides by permanent structures usually causes sulfur oxides to have little adverse effects indoors.

5.6.5 Other compounds

The effects of other compounds such as nitrogen oxides, ammonia, oxidants, and fluorides are either not precisely known or typically not present in sufficient quantities to warrant special precautions. If a problem with any special constituent is suspected, consult a corrosion specialist.

5.6.6 Dirt and oil

Dirt and airborne oils can also cause electronics to fail in the same way as corrosion does. The deposited material causes the electrical connectors in the equipment to lose their continuity. Cooking fumes has the same effect has dust.

5.6.7 Copper reactivity to determine level of corrosion

Measuring copper reactivity has been found to be more accurate and easier than measuring individual gas concentrations to determine the level of corrosion in the environment. To use this method, place a small copper strip, called a coupon, in the equipment enclosures and measure the corrosive-film thickness that develops on the surface over a known period of time. Use the results to predict the level of corrosion.

The following table describes the four classifications for copper reactivity based on angstroms/month established by ISA-571.04-1985.

Classification (ISA Class)	Angstroms/ Month	Effect
Mild (G1)	0 - 299	Corrosion is not a factor in determining equipment reliability.
Moderate (G2)	300 - 999	The effects of corrosion are measurable and may be a factor in determining equipment reliability.
Harsh (G3)	1000 - 1999	There is a high probability that corrosive attack will occur. This harsh level should prompt additional evaluation and result in environmental controls or specially designed and packaged equipment.
Severe (GX)	≥ 2000	Only specially designed and packaged equipment would be expected to survive. Specifications for equipment in this class are a matter of negotiation between user and supplier.

5.6.8 Intermittent effects of corrosion

Reactivity of 300 angstroms or greater each month may not result in immediate equipment failure, but problems may start intermittently from the formation of thin corrosion films on contacts or localized dendritic growth between printed wiring-board tracks. These problems often occur during brief periods of high humidity and may temporarily stop when humidity returns to a lower level. As reactivity approaches 1000 angstroms per month, intermittent failures become more frequent. Above 1000 angstroms per month equipment becomes unreliable.

6 Hazardous environments

This section discusses planning installation of the process control hardware in hazardous environments, and applies only to the process control hardware. Planning for the installation of servers and workstations is covered in the ' “Experion equipment operating conditions” on page 33' section.

Related topics

“Removal and insertion under power” on page 44
“Hazardous area guidelines” on page 45
“Hazardous area classifications” on page 46
“Process Control Equipment in hazardous areas” on page 48
“Equipment surface temperatures” on page 49

6.1 Removal and insertion under power

Many of Experion system's modules (that is, I/O Communications) are designed to permit removal and insertion under power (RIUP) without damaging the module or interrupting backplane communications. However, arching or sparking can occur anytime electrical connections are made or broken. For this reason, removal and insertion must *not* be performed in hazardous locations when the modules are under power.

WARNING

Experion's removal and insertion under power (RIUP) feature does not apply to installations that must conform to Division 2, Hazardous Location requirements. Unless the location is known to be non-hazardous, DO NOT do the following:

- Connect or disconnect cables;
- Connect or disconnect Removable Terminal Blocks (RTBs);
- Install or remove modules.

6.2 Hazardous area guidelines

The following table summarizes the major considerations for planning the installation of an Experion system in a hazardous area. See the remaining sections in this chapter for detailed information on the guidelines provided.

✓	Guidelines
Process control equipment placement	
	Determine the NEC or IEC classification and group of the site where the equipment will be installed.
	Be aware of any circumstances that would alter the NEC or IEC classification. See the ' “Interpretation of Division 2 rules” on page 46' section.
Division 1 and 2 wiring	
	Consult local electrical codes for wiring requirements.
	Consult the 'Electrical Equipment For Use In Class I, Division 2 Hazardous [Classified] Locations' section of the ANSI/ISA S12.12 standard for other requirements.
	Determine the maximum cable restrictions for each FTA. See the ' “Cable size and load parameter restrictions” on page 48' section.
	Enclose the electrical device and conductors throughout the Division 1 (Zone 0, 1) hazardous area in housings designed to contain the explosion.

6.2.1 NFPA documents

If you are in the USA, you can use the documents published by the National Fire Protection Agency (NFPA) to obtain information for selecting an appropriate location for equipment. See the NFPA publications listed in the ' “Other references” on page 14' section.

6.3 Hazardous area classifications

Certain processes deal with ignitable or explosive materials. Local electrical codes require that electrical devices that are located in or connected to such process areas have some type of control to prevent accidental ignition of the process material.

When planning the installation of process control equipment, consider the classifications for the process, the electrical installation and the material handling areas. The area in which the equipment is housed may not necessarily be classified the same as the material handling areas. For example, oil refiners use materials classified as Class 1, Groups B, C and D. You must plan the installation appropriately.

6.3.1 Hazardous location classifications

Hazardous areas are classified by the USA's National Electrical Code (NEC) and Switzerland's International Electrotechnical Commission (IEC). The following table lists hazardous materials classifications for both agencies.

NEC	IEC	Environment
Class I		Explosive gases or vapors are present.
Class II		Combustible dusts are present.
Class III		Ignitable fibers or flyings are present.
Division 0	Zone 0	A location where a hazardous concentration of gases or vapors exist approximately 10-100% of the time (subject to interpretation as above).
Division 1	Zone 1	A location where a hazardous concentration of gases or vapors exist approximately 1-10% of the time (subject to interpretation as above).
Division 2	Zone 2	A location where a hazardous concentration of gases or vapors exist approximately 0.1-1% of the time (subject to interpretation as above).
Non-hazardous	Non-hazardous	Hazardous vapors exist less than .1% of the time.

6.3.2 Hazardous group classifications

Flammable gases, vapors and ignitable dusts, fibers and flyings are classified into groups according to the energy required to ignite the most easily ignitable mixture within air. The following table lists the group classifications for hazardous materials:

NEC	IEC	Environment
Group A	Group IIC	A hazardous atmosphere containing acetylene or other similar gases or vapors.
Group B	Group IIC	A hazardous atmosphere containing hydrogen or other similar gases or vapors.
Group C	Group IIB	A hazardous atmosphere containing ethylene or other similar gases or vapors.
Group D	Group IIA	A hazardous atmosphere containing pentane or other similar gases or vapors.
Group E		A hazardous atmosphere containing metal dust, such as aluminum.
Group F		A hazardous atmosphere containing carbon black, coal, or coke dust.

6.3.3 Interpretation of Division 2 rules

The environment descriptions for NEC's Divisions and IEC's Zones are subject to interpretation. For example, an area with a hazardous atmosphere for 1 hour in 10,000 hours or 0.01% of the time would, according to the **Environment** description, be classified non-hazardous, and a safe location for electronic equipment. However, if the equipment has a hot component capable of causing ignition 100% of the time, explosion is imminent upon any process emission. Obviously, this is an unacceptable environment in which to install electronic equipment not approved for hazardous areas so the area should actually be considered Division 2/Zone 2 despite the description.

6.4 Process Control Equipment in hazardous areas

Experion Control hardware is CSA Certified and Factory Mutual (FM) Approved non-incendive Equipment for installation in Class I, Division 2, Group A, B, C and D Hazardous (Classified) Locations. Other devices, such as a Field Termination Assembly (FTAs) that contain unsealed relay contacts that may produce sparks, are not approved for hazardous areas. It is the user's responsibility to ensure all parts of the system, and any other equipment in the Division 2 area, are listed for installation in a Class I, Division 2 Hazardous (Classified) Location.

6.4.1 Division 2 (Zone 2) wiring

In general, field wiring in Division 2 hazardous locations must be according to local electrical codes. In some jurisdictions, however, non-incendive wires need not conform to the normal Division 2 wiring rules, but can use wiring methods suitable for ordinary locations. See the section, 'Electrical Equipment for Use in Class I, Division 2 Hazardous [Classified] Locations' in the *ANSI/ISA S12.12 Standard*.

6.4.2 Current limiting resistors on the approved FTAs

To avoid ignition of hazardous process materials, the non-incendive FTAs have resistors that limit the level of current on the conductors going to the process. The limiting prevents ignition by the opening, shorting, or grounding of the process circuits.

The value of the resistors was selected to assure worst case short circuit currents in a hazardous area of less than 150 milliamps for normal operating equipment. According to *NFPA publication 493, Intrinsically Safe Apparatus for Use in Division 1 Hazardous Location*s, 150 mA from a 24 VDC source is below the ignition threshold in a resistive circuit for gases in Groups A through D environments.

6.4.3 Cable size and load parameter restrictions

To ensure circuits are incapable of igniting a specific flammable atmosphere, the cable length and load parameters must be controlled. The *Experion Control Hardware Planning Guide* gives the maximum permissible values for qualified FTAs.

6.4.4 Division 1 (Zone 0, 1) wiring

In general, field wiring in Division 1 hazardous locations must be according to local electrical codes. When permitted by local electrical codes, explosion proofing conduit and housings can be an economical technique for connecting to Division 1 (Zone 0, 1).

6.4.5 About explosion proofing

Enclose the electrical device and conductors throughout the Division 1 (Zone 0, 1) hazardous area in housings designed to contain the explosion. This is the most common method of connecting electrical devices to a hazardous process.

6.4.6 About galvanically isolated FTAs

Field Termination Assemblies (FTAs) are available that accept plug-in Galvanic Isolation Modules. These FTAs are used for connecting input and output signals to field devices in Division 1 (Zone 0 and Zone 1) hazardous areas. The FTAs are compatible with the IOPs that support the companion standard FTAs. See the *Control Hardware Planning Guide* for a list of Galvanically Isolated FTAs and planning for their use.

6.5 Equipment surface temperatures

6.5.1 Surface temperature tests Class 1

When marking equipment as a result of temperature tests, Honeywell adheres to Factory Mutual Research Corporation's Standard 3611, which states:

The maximum temperature of an external or internal surface to which a surrounding specified flammable gas or vapor-in-air mixture has access shall be determined under normal operational conditions. Such measurements need not be made on the internal parts of sealed devices. Measurements shall be made at any convenient ambient temperature normally encountered in a laboratory, corrected linearly to 40°C (104°F).

6.5.2 Equipment maximum surface temperature codes

Equipment that attains temperatures higher than 100°C (212°F), based on a 40°C (104°F) ambient, shall be marked by the temperature code given in the following table and corrected linearly to a 40°C (104°F) ambient. Component surface temperature may exceed the marked rating if it can be demonstrated by testing that no hazard exists.

Degrees C	Degrees F	Temperature Code
450	842	T6 *
300	572	T2
280	536	T2
260	500	T2A
230	446	T2B
215	419	T2C
200	392	T2D
180	356	T3 *
165	329	T3A
160	320	T3B
135	275	T3C
120	248	T4 *
100	212	T4A
85	185	T5 *
Note: Temperature codes marked with an asterisk (*) are preferred and consistent with the temperature identification system specified by the International Electrotechnical Commission (IEC 79 Series Publications).		

7 Power requirements

This section summarizes the power requirements for an Experion system.

Related topics

“Power requirement guidelines” on page 52
“AC power requirements” on page 54
“AC power system design” on page 55
“Wires sizes according to voltage, current and length” on page 57
“AC primary power source” on page 59
“AC power distribution” on page 62
“About floating AC power” on page 63

7.1 Power requirement guidelines

The following table summarizes the power requirements of an Experion system. See the remaining sections in this chapter for detailed information on the guidelines provided.

✓	Guidelines
Compliance	
	All plant wiring (including power and signal cables) must be installed in accordance with the National Electrical Code (NEC), Canadian Electrical Code CEC), and all other local regulations.
	Power wiring must conform to the local electrical code. Use of a qualified contractor and approval by the local wiring inspector ensures compliance to this code.
	Power wiring and signal cables installed by Honeywell (an optional service) will conform to the NEC or CEC. Upon your request, Honeywell will institute optional changes that will conform to the code, as well as adhere to local regulations and requirements.
	Install all control hardware power wiring in accordance with the *Experion Control Hardware Installation Guide*.
Circuit and outlet capacities	
	Circuit capacity limits are governed by the NEC and CEC codes. Refer to these, and any other applicable local codes, to determine circuit capacities.
	Outlet capacity limits are governed by the NEC and CEC codes. Refer to these, and any other applicable local codes, to determine outlet capacities.
	Indicate the number and location of these outlets on your system layout drawing when designing your system. Outlets should be marked so that nothing, other than a system component, is plugged into them.
	Where multiple computer systems are installed, be sure to separate electrical power sources.
AC power system design	
	Design the power distribution system for no more than 5% power loss.
	Choose breaker size and wire size according to the lowest acceptable voltage.
	Each Experion cabinet must have its own dedicated breaker so that a single cabinet (or power strip in an equipment cabinet) can be shut off separately.
	When determining wire size, consider both the distance it must travel and the amps it must carry.
	When determining the size of the UPS, follow the steps in the ' “Determining the size of the UPS” on page 55' section.
Power Sources	
	If ac power is not securely referenced to local safety ground, the ac power for the Experion system equipment must be supplied by a dedicated power transformer located within 60 feet (18.3 meters) of the system distribution panel or dedicated branch circuits.
	Where multiple process control/computer systems are required, you must be careful to separate the electrical power requirements of each system.
	If your ac power is 3-phase with no neutral, see the ' “Three-phase power requirements” on page 59' section.
	Check the equipment specifications in the specification and technical manual to identify any frequency-sensitive devices.
	Each UPS must have its own power transfer switch.
	If there are non-Experion loads on the UPS, they must have separate transformers and distribution panels.
	If a Console station includes non-Experion devices, they must not be powered from the Experion dedicated transformer distribution box.
	Use surge protection devices, if necessary.
	All convenience outlets in the vicinity of this equipment must be grounded.

✓	Guidelines
AC Power Distribution Guidelines	
	Honeywell recommends metal conduits for all power cable runs.
	The metal conduit must be grounded at the power distribution box and at the system equipment power entry box.

7.2 AC power requirements

The Experion system must be supplied with ac power that is within certain limits, and the system electrical equipment must be properly grounded. System performance and safety is directly related to the quality of the power and grounding system supplied by the user. Honeywell provides that portion of the electrical power and grounding equipment contained within the system cabinets, consoles, and peripheral devices.

7.2.1 Analyze before planning

When planning the power system, carefully analyze the present requirements, together with future planned expansions and anticipate unplanned expansion. It is always easier and less expensive to initially install power systems to serve future needs, than to retrofit cabling trays, new distribution panels, etc., at a later date.

7.3 AC power system design

Strive to design the power distribution system for no more than 5% power loss.

- Transformer wire losses ≤ 3%
- Distribution system ≤ 2%

7.3.1 Circuit breakers

Breaker sizing and wire sizing should be according to the lowest acceptable voltage because the constant current outputs will draw more input current when the line voltage drops to the lowest acceptable voltage.

Attention

The typical RMS values do not include the increase in current caused by low voltages (102/204 Vac).

Each Experion cabinet must have its own dedicated breaker so that a single cabinet (or power strip in an equipment cabinet) can be shut off separately. Because each cabinet or power strip is limited to 15 amperes by the breaker in the cabinet, a larger breaker in the distribution box is not called for. The purpose of breakers in the distribution panel is to:

- Protect the power wiring from damage;
- Allow for complete shut off of power for service to the station or cabinet.

7.3.2 Distribution wiring

Use size 12 AWG (2.5 mm2) wire from the Operator Station or cabinet to the distribution panel if the distance from the distribution panel to the Station or cabinet is 75 feet (22 meters) or less and the total current in the cabinet is 10 amps or less.

If the distance is greater than 75 feet or if the current is greater than 10 amps, see the ' “Wires sizes according to voltage, current and length” on page 57' section.

For wire sizes larger than 12 AWG (2.5 mm2), you must reduce the wire size as it enters the Station, equipment cabinet, or controller cabinet because the power terminal will not accept wire larger than 12 AWG or 2.5 mm2).

7.3.3 Transformer sizing

When a transformer is used to directly supply ac power to the equipment (cabinets or computer-based systems) an Underwriter's Laboratory (UL) rated transformer with a K factor of 9 or better is recommended with 5% taps to provide an additional 5% output voltage on a contingency basis.

The resistance rating of the transformer should be 3% or better and the total impedance should be less than 5%. Low temperature-rise models or oversized units may be used to get the equivalent source resistance and to protect against additional temperature rise due to the harmonic eddy current content that is defined by the K = 9 rating. The 3% resistance is required to minimize the 'flat-top' voltage effect. The K factor-rated transformers are made by many vendors and have a premium cost factor of from 10% (for transformers in the 15 KVA range) to 100% (for 500 KVA). K = 9 transformers will have longer life.

7.3.4 Determining the size of the UPS

1. Add up the individual typical RMS currents for the Experion equipment chosen.
2. Multiply the total currents by 120 or 240 volts.
3. Check that the UPS equipment can handle a crest factor of at least 3.0.

Attention

These steps do not account for any overhead from other equipment or for possible expansions. These values are typical and do not include any margins.

7.3.5 Surge power protection

A good earth ground system minimizes the need for individual channel protection. However, if your facility is located in an area that has a history of severe lightning storms or if you have had a problem with lightning induced surges in the past with other instrumentation, you are probably aware of available surge protection devices. Properly sized surge protection devices incorporating solid state voltage limiters should be installed on power lines and all input/output wires associated with the system. You are responsible for evaluating your particular needs based on equipment location and the probability of a direct strike in the immediate area.

Use of convenience outlets

WARNING

All convenience outlets in the vicinity of this equipment must be grounded. The grounding conductors servicing these receptacles must be connected to earth ground at the service equipment, or at some other acceptable building earth ground (such as the building frame, in the case of a high-rise steel frame structure).

Supply separate and adequate convenience outlets in the Experion System area for items such as test equipment, vacuum cleaners, and floor buffers. To prevent noise interference from devices using these receptacles, convenience outlets must be on a circuit that has its transformer isolated from the circuits used for the system. One solution is to supply power for the components of the Experion System through an isolation transformer.

Honeywell regulators and power conditioner products

Honeywell offers a line of regulators and power conditioners suitable for any system configuration. Consult your Honeywell Account Manager for further information.

7.4 Wires sizes according to voltage, current and length

Use the tables in this section to determine the correct wire size to use.

7.4.1 Wire size based on current requirement for 120 vac

The following table identifies the correct copper wire size for 120 vac according to percentage voltage drop allowed, cable length, and load current.

1% (Voltage Drop)							2% (Voltage Drop)						
Amps	**Cable length (feet)**						**Cable length (feet)**						**KVA**
	25	**50**	**75**	**100**	**200**	**500**	**25**	**50**	**75**	**100**	**200**	**500**	
5	12	12	12	10	8	4	12	12	12	12	10	6	**0.6**
10	12	10	8	8	4	1	12	12	12	10	8	4	**1.2**
15	12	8	6	6	2	2/0	12	12	10	8	6	2	**1.8**
20	10	8	6	4	2	3/0	12	10	8	8	4	1	**2.4**
25	10	6	4	4	1	4/0	12	10	8	6	4	0	**3.0**
30	8	6	4	2	0	-	10	8	6	6	6	2/0	**3.6**
40	8	4	2	2	2/0	-	8	8	6	4	2	3/0	**4.8**
50	6	4	2	1	3/0	-	8	6	4	4	1	4/0	**6.0**
60	4	2	0	2/0	-	-	4	4	2	2	2/0	-	**7.2**
80	4	2	0	2/0	-	-	4	4	2	2	2/0	-	**9.6**
100	2	1	2/0	3/0	-	-	2	2	2	1	3/0	-	**12**
125	1	0	3/0	4/0	-	-	1	1	1	0	4/0		**15**

7.4.2 Wire size based on current requirement for 120 Vac (IEC)

The following table identifies the correct copper wire size for 120 Vac according to percentage voltage drop allowed, cable length, and load current.

2% Voltage Drop)						1% (Voltage Drop)				
Wire size	**Current in amps**				**Current in amps**					
(mm^2)	**5**	**10**	**15**	**20**	**30**	**5**	**10**	**15**	**20**	**30**
1.5	19	9.5	-	-	-	9.5	4.75	-	-	-
2.5	31.5	16	10.5	-	-	15.5	8	5.25	-	-
4	50	25	16.6	12.5	-	25	12.5	8.3	6.25	-
6	75	37.5	25	18.7	12.5	37.5	18.75	12.5	9.25	6.25
10	126	63	42	32	21	63	31.5	21	16	10.5
16	200	100	66	50	33.3	100	50	33	25	16.5

7.4.3 Wire size based on current requirement for 240 Vac (IEC)

The following tables identify the correct copper wire size for 240 Vac with a 2% voltage drop according to cable length, and load current.

2% (Voltage Drop)					
Wire size (mm^2)	**Current in amps**				
	5	**10**	**15**	**20**	**30**
1.5	38	19	-	-	-
2.5	63	32	21	-	-
4	100	50	33.3	25	-
6	150	75	50	37.5	25
10	252	126	84	63	42
16	400	200	133	100	66.6

7.5 AC primary power source

This section contains information for planning the AC primary power source.

7.5.1 Use of power transformer

If ac power is not securely referenced to local safety ground, the ac power for the Experion system equipment must be supplied by a dedicated power transformer located within 60 feet (18.3 meters) of the system distribution panel or dedicated branch circuits. The term 'dedicated' means that the transformer secondary and panel breaker(s) are exclusively used to power the Experion System and for no other purpose. Various power line disturbances inherent in an industrial environment can adversely affect system performance.

Where multiple process control/computer systems are required, you must be careful to separate the electrical power requirements of each system.

The power transformer must accept single- or 3-phase 120/240/480 vac \10% (nominal power-line rating) at its primary and deliver 120/240 vac nominal at its secondary, and must operate in a frequency range of 47-62 Hz for 50 or 60 Hz. Local nominal power line voltage can vary; typical values include 110/220, 115/230, and 120/240 vac. Contact your local utility for actual values. The operating voltage range of the Experion System is 102-132 vac. Refer to the appropriate specification and technical manuals for the voltage range of each system device.

7.5.2 Three-phase power requirements

If your ac power is 3-phase with no neutral, you must consider all of the following:

- A dedicated transformer is required where the secondary must be a 4-wire system in a Y configuration.
- The secondary neutral must be wired in accordance with NEC Article 250-26, single-phase systems, or IEC standards. All other aspects of single-phase power and ground philosophies, as outlined in this manual, must be followed.
- A balanced load must be employed.
- Neutral returns are not to be daisy chained from device-to-device.
- See the ' “Wires sizes according to voltage, current and length” on page 57' section for wire sizing (the neutral wire must be two wire sizes larger because of the currents from the odd harmonics on the line).

7.5.3 Frequency variations

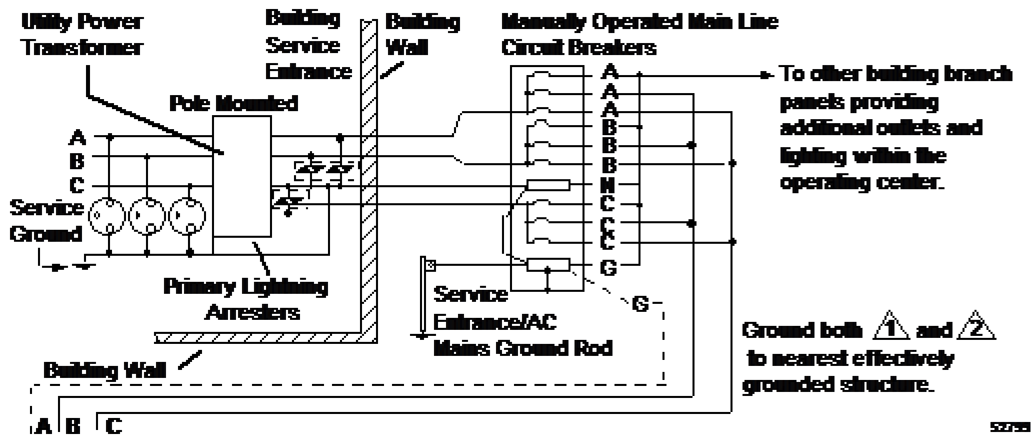
Frequency variations can be critical because some peripherals operate within 0.5 Hz of their nominal rating. Although power companies deliver ac power within fairly tight constraints (e.g., \ 0.5 Hz), a power outage or brownout may cause the more frequency-sensitive devices to reset.

Check the equipment specifications in the specification and technical manual to identify the frequency-sensitive devices. In addition, the input ac power to the system must not contain more than 6.0% Total Harmonic Distortion (THD), including the power transformer.

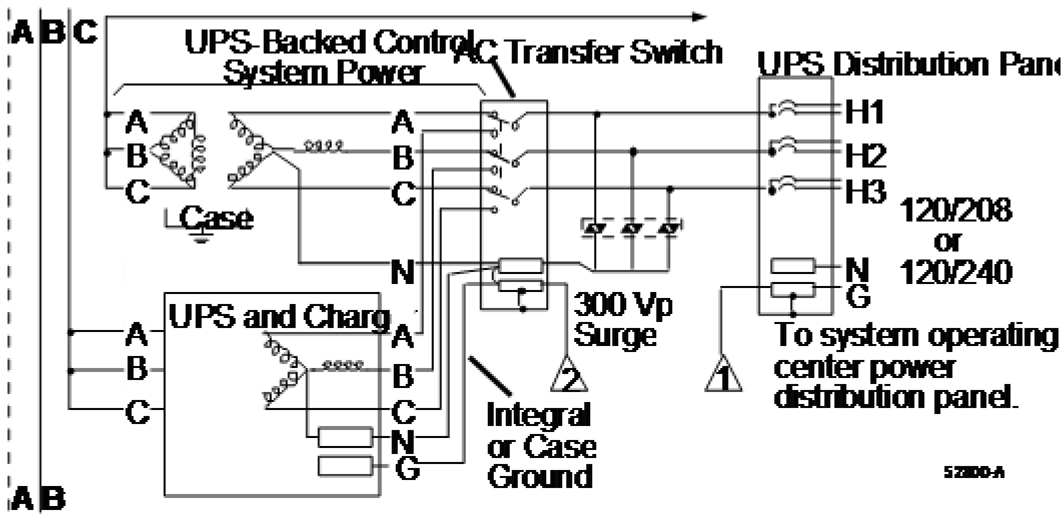
7.5.4 AC power entry, distribution system and UPS

The following three figures provide examples of a typical ac power entry, distribution system, and Uninterruptible Power Supply (UPS). The A, B, and C represent connections between the three figures creating one complete ac power system.

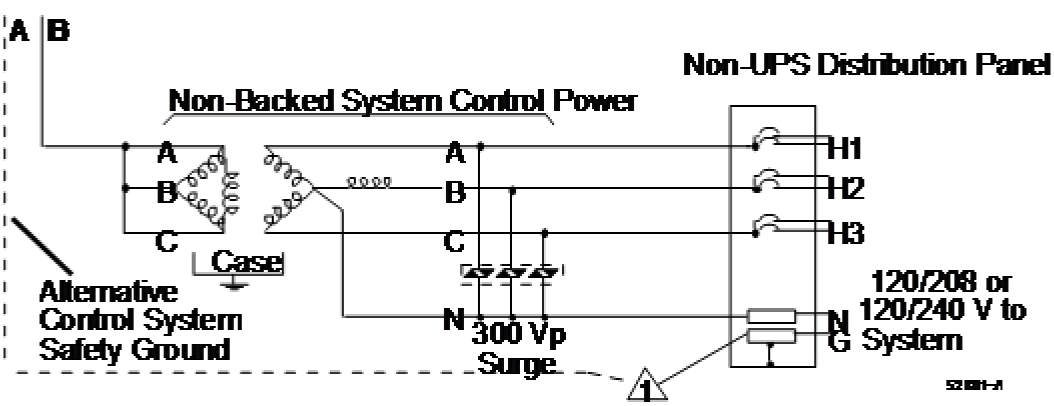
Typical three-phase power entry



Typical UPS distribution



Typical non-UPS power distribution



7.5.5 UPS as backup power

A UPS can provide primary power, with the local power providing backup power in case the primary power fails. Several UPSs can be used for redundant operation of critical console equipment. However, each UPS must have its own power transfer switch. Normally, the UPS is the primary feed and the local power is the backup feed.

For non-redundant multiple UPS installations, each UPS has its own power distribution box and switchover panel (if required). If there are non-Experion loads on the UPS, they require separate transformers and distribution panels.

If support equipment that is not Experion-related is included in a Console Station such as telephones, radios, chargers, programmable controllers, custom switch and annunciator panels, and related displays, the equipment must not be powered from the Experion-dedicated transformer distribution box.

7.6 AC power distribution

7.6.1 Conduit

Attention

- To avoid electrical noise problems in the system, observe the power cable(s) to signal cable(s) separation rules discussed in the controller planning manuals.
- Though the communication and field wirings can be routed through the cutouts provided at the top entry, do not route the cabinet AC power from the top entry. To maintain CE compliance, the AC power entries must always be routed from the bottom of the cabinet.

Metal conduits are highly recommended for all power cable runs. The conduit must be grounded at the power distribution box and at the system equipment power entry box. The case of the equipment power entry box and branch-circuit distribution panel must be grounded (bonded) to building steel.

The IEC allows cable trays for power cables when this is desirable.

All AC power wiring must be 3-conductor (hot, neutral, safety ground) with a fire-resistant jacket.

7.6.2 Distribution box sizing

The size or capacity of the system power distribution box or dedicated branch circuit(s) depends on the size of the system. The panel must contain a safety ground (equipment) bus bar to which the ground (green wire or yellow green) from the system cabinets, consoles, and device receptacles can be connected. The safety ground bus bar must then be connected to the ac safety ground rod through an insulated cable specified by local code requirements.

7.7 About floating AC power

Floating in-plant ac power systems are in use in several European countries. The reasoning behind such an arrangement is that a single earth fault does not cause power loss to any device connected to the power system. Earth fault detectors signal the presence of such a fault.

7.7.1 Risks

Attention

It is the user's responsibility to prevent excessive voltages. When a local UPS provides power and the entire power distribution is inside a single building, surge suppression by means of MOVs provides adequate protection.

Experience has shown that the floating power does not affect Experion operation. The risk is that if high voltages related to ground penetrate the power system, those high voltages can damage power supplies.

All connections to external power lines should be made through isolation transformers.

For best security, those transformers should have a grounded static screen between windings.

8 Grounding requirements

The implementation of correct grounding for Experion PKS is imperative to protect the system from excessive noise, static, lighting strikes, and voltage spikes. This section discusses required ground systems, their design, and their connections. Also see the ' “Grounding the copper cable plant” on page 103' section.

Related topics

8.1 Importance of grounding

WARNING

A broken or high resistance safety ground creates a potentially lethal situation, especially in equipment that incorporates line filters. The line filters include appreciable line-to-chassis capacitance. As a result, if the green or green/yellow ground wire is not intact, a person touching the equipment and ground can receive a serious and possibly fatal shock.

The grounding system must be installed in accordance with the National Electrical Code (NEC), Canadian Electrical Code (CEC), and any other applicable electrical codes (to include: IEEE-142; Lightning Protection Institute Installation Code LPI-175; NFPA-78 (ANSI); IEEE Std. 142-1972).

8.2 Grounding guidelines

The following table summarizes the grounding guidelines for an Experion system. See the remaining sections in this chapter for detailed information on the guidelines provided.

✓	Guidelines
General	
	Install grounding in accordance with the appropriate electrical code for the system.
	All earth-ground connections must be permanent and provide a continuous low impedance path to earth ground for induced noise currents and fault currents.
	For safe operation of your equipment, a high-integrity grounding system must be installed as part of the building's wiring system.
	Electrical outlets for workstations and any other higher-level computer connected to the ControlNet communications network must be on a separate AC circuit from its peripherals.
	If the existing installation does not have an equipment grounding conductor in the branch circuits, consult your Honeywell Account Manager. Consult local codes for ground wiring.
Female receptacles or connectors	
	An equipment ground wire must be enclosed with the circuit conductors (phase and neutral wires).
	The isolated ground wire must run directly from the outlet to the power source.
	The size of the ground conductor must be the same as, or larger, than the circuit conductors supplying the equipment.
	The ground conductor must be securely bonded to the building-ground electrode.
	Grounding provisions must be in accordance with the NEC, CEC, and any other local codes.

8.3 For additional information about grounding requirements

The following table lists sections from other Experion user documents that contain additional information about grounding requirements for Experion equipment.

Section	Description
Experion Control Hardware Planning Guide	
Series CSeries C Hardware Configuration > Series C Hardware Grounding Considerations	Grounding considerations for C300 Controllers
Site Selection and Planning > Planning for Power and Grounding	Grounding considerations and guidelines for controllers with PM I/O
Experion LIOM Planning and Installation Guide	
Honeywell Icon Series Console Planning, Installation and Service	
	Honeywell Icon console grounding
Experion ControlNet Installation Guide	
Introduction	
Experion Control Hardware Installation Guide	
Make ground connections	

8.4 Types of grounding

The following grounding systems are used for distributed control areas and are briefly described in this section. See also the 'Series C Hardware Configuration' section in the *Control Hardware Planning Guide* for specific grounding information about controller hardware.

- AC Safety Ground
- Lightning Ground
- Supplementary Ground
- Master Reference Ground

8.4.1 About Master reference ground in Experion

The Master Reference Ground (MRG) is not used with Experion systems, but it has been used in existing TPS installations including Process Manager I/O cabinets. There is no need to replace this ground, if it is present in an existing Process Manager I/O cabinet installation that is being adapted for use with an Experion Series C cabinet.

The MRG serves as the reference point for all signals. All common leads terminate at this point. Bus bars and wire shields are all connected to this ground. To maintain system reliability and electric integrity, the resistance to true earth should be less than five ohms for general purpose area installations. The master reference ground rods or grid are isolated from the safety and lightning ground rods to eliminate any noise at the signal reference point.

8.4.2 About supplementary ground

In accordance with NEC section 250.54, supplementary grounding electrodes can be used to connect to equipment grounding conductors. The supplementary ground can serve as the termination point for all common leads.

8.4.3 Using spark gap devices for more than one grounding system

Electrical codes do allow for both a safety ground and a master reference ground in the same building as long as there are devices that can connect the two grounds to safety in case of a lightning strike.

To connect two types of grounding systems, Honeywell recommends a 'spark gap' device. Spark gaps are preferred for grounds because of their very low voltage drop while conducting a surge. Suitable protectors can be purchased from local or national suppliers. Consult lightning specialists for proper model choice and correct installation.

8.5 Grounding consoles and cabinets

See also the installation manual for the specific console or cabinet.

8.5.1 Cabinet grounding

Each Experion cabinet and station is equipped with a Safety Ground Terminal. Honeywell recommends, and many codes require that, for personnel protection, each cabinet and station be connected to building steel or other designated safety ground before connecting ac power wiring.

Make sure that the safety wire (green or yellow green), if insulated, from the cabinet and station frame ground post is connected to the safety ground terminal block in the control room power panel, dedicated branch circuit power panel, or building steel.

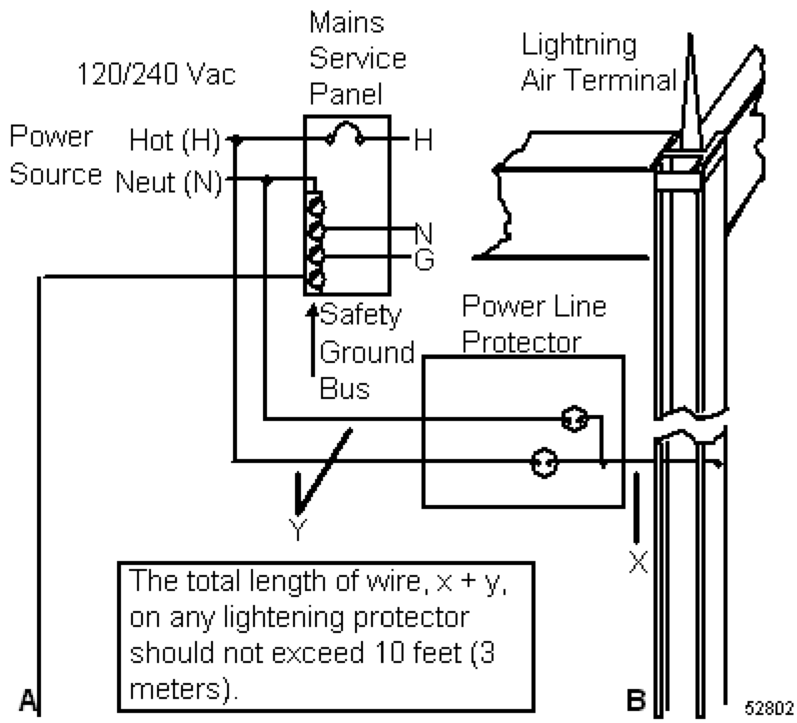
8.5.2 Grounding for PC based nodes

The ground connection is made through the third wire in the AC power cord.

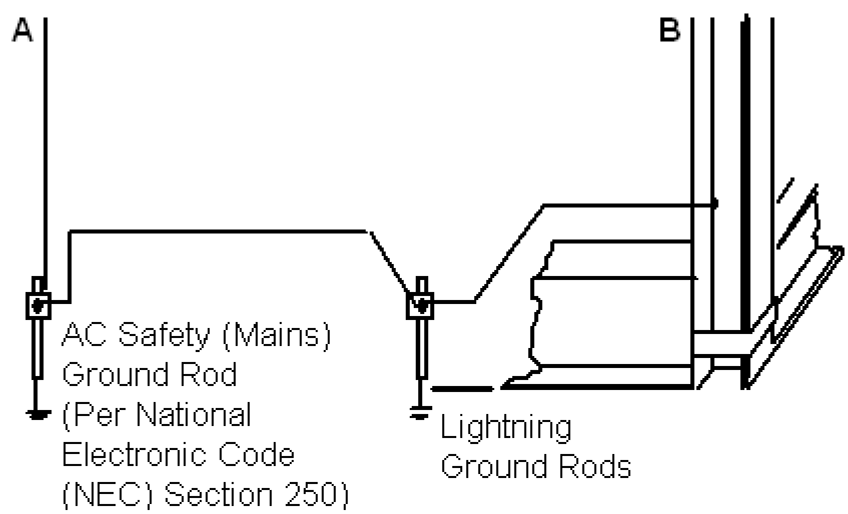
8.6 AC safety ground

AC safety ground interconnects all metallic structures and enclosures in an area minimizing the voltage that people can come into contact with. For each building power entry, an independent AC safety ground system with an electrode cable is preferred. The following two figures provide examples of an independent ground system.

8.6.1 Safety ground system - upper view



8.6.2 Safety ground system - lower view



8.6.3 Safety ground requirements

Safety grounding requires electrode systems that provide grounding resistances between 0.1 and 5.0 ohms. The required performance varies according to the following circumstances:

- When a facility has neither Zener barriers nor lightning problems, AC safety ground must only meet the minimum grounding requirements specified in the local electrical code. Usually, codes require a grounding resistance of 5.0 ohms maximum to true earth.
- When a facility uses Zener barriers for intrinsic safety, AC safety ground should be less than 0.1 ohms to true earth. See the ' “Lightning ground” on page 73' section.

8.6.4 IEC standards

Following are additional requirements according to IEC standards:

- Zener ground and equipment logic ground must be connected together.
- Zener ground and logic ground must have a resistance to safety ground of less than 1.0 ohm.

8.7 Lightning ground

Lightning ground safely disperses lightning charges that may be picked up by the facility metallic structure and electrical system to protect personnel, the process control equipment, and the building.

Lightning is intercepted by air terminals and/or the building's frame and conducted through a dedicated 5.2 mm (#4 AWG) wire to the lightning-ground rods or grid. Lightning ground is frequently integrated with AC safety ground as shown in the ' “Safety ground system - lower view” on page 71' section.

8.7.1 Lightning ground requirements

Lightning grounds must conform to applicable codes and design construction criteria.

Typically, a lightning-ground system consists of 10-foot (3-meter) ground rods bonded (connected) to vertical structural members every 100 feet (30 meters) along the building's perimeter. If possible, locate the rods near wet areas, and allow enough space for future access to existing rods or for expansion.

Normally, the ac safety ground (main) rod is connected to the lightning ground-rod system. A lightning-ground resistance of 0.1 ohms to true earth maximum is recommended.

NFPA No. 78 (ANSI), IEEE Std 142-1972, Code LP1-175, and other local codes. When a facility is subject to lightning, each lightning rod should be grounded at the base with a maximum resistance of 0.1 ohms to earth. A 100 kA lightning strike into a 0.1 ohm ground generates 10 kV. Experience has shown that 10 kV does not cause sparking inside of wiring trays or across terminal blocks.

8.7.2 Use of lightening arresters

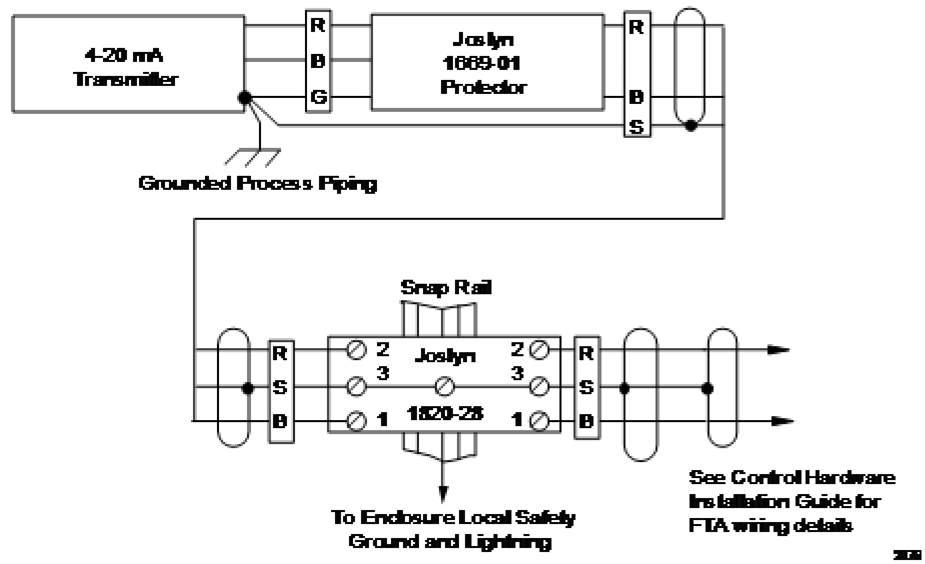
To help ensure the safety of all equipment and personnel, the primary transformers should be protected by lightning arresters. It is highly recommended that similar protection be provided at the service entrance to the building. Arresters reduce the possibilities that excessive voltage and currents caused by lightning strikes will seek an indeterminate, low-impedance path to ground, such as the system power circuits.

8.7.3 Use of spark-gap devices

There is always the possibility of arcing (flash) to an isolated ground 'systems' when lightning strikes. To prevent this, some electrical codes require all isolated ground systems to be connected to building steel through spark-gap devices. These spark-gap devices can be installed at any convenient location, usually where the ground wire leaves the building.

8.7.4 Twisted pair lightning protection

When a particular 4-20 mA/1-5 V twisted pair requires lightning protection, use the protection system shown in the following figure. Suitable protectors are available from Joslyn Electronic Systems in Goleta, California, telephone 805-968-3551. Use model 1669-01 at the transmitter and model 1820-28 in the electronics room.



About lightning grounds

Lightning grounds must conform to applicable codes such as NFPA No. 78 (ANSI),IEEE Std. 142-1972, Code LPI-175, and other local codes. A typical lightning ground system consists of 10-foot (3-meter) ground rods bonded (connected) to vertical structure members every 100 feet (30 meters) along the building perimeter.

The mains ground is usually bonded to the lightning ground. Master reference grounds must be isolated from all other grounds. Where ground wires are close in an enclosure, the possibility exists for arcing (flashover) between ground wires when lightning strikes.

To inhibit this hazardous arcing, some codes require all ground wires to be connected through spark gap devices at the building perimeter. The following example shows the master reference (common) ground and the low-level shield grounds connected to a building vertical steel frame structure that is also connected to the lightning ground rod.

Spark gap devices connect all ground wires to avoid an excess voltage difference that may be created by a lightning strike. We recommend 90 Volt, 150KA spark gaps for system grounds.

8.8 Grounding design

Use the following grounding design guidelines for your site:

- Measure the soil resistivity.
- Determine the best electrode configuration for the soil.
- Install and interconnect the electrodes.

8.8.1 Soil resistivity test

Soil resistivity can vary a great deal, depending upon the water table, chemical content of the soil, and geographical characteristics of the site. The only way to get electrical information about the soil at a given site is to drive electrodes down to the water table and measure resistance. The electrical measurement is done with a commercial tester. A single 3-meter (10-foot) electrode might have a contact resistance of, typically, 5 ohms to earth.

8.8.2 Deep grounding

Deep grounding minimizes both soil resistivity and seasonal variations. If variations are a potential problem, periodically measure and record the resistance of all ground systems to determine whether the resistance meets specifications.

8.8.3 Lightning ground design

When the ground is suitably large, no additional lightning protection is required because significant voltage cannot be induced by any kind of strike. If additional lightning protection, which can be expensive, is required the following approach considers both performance and cost:

- Ground the facility lightning antennas to an electrode system that has a contact resistance to the earth of 0.1 ohms or less.
- Install 150 kA protectors on the system power and grounds. If a strike occurs, it will be present here first.
- Install protection on circuit twisted pair wires only as damage occurs.

8.9 Electrodes and arrays

This section discusses the different types of electrodes and the methods for installing them.

8.9.1 Electrode material

The preferred electrode usually has the following characteristics.

- Stainless steel rod 1 inch (25 mm) in diameter in 8 to 10 foot (2 to 3 meter) lengths. Do not use copper.
- No protective platings or coatings on the rod, which may cause unhealthy fumes when the electrodes are welded.

8.9.2 Single driven electrode

The most economical electrode system consists of one long electrode driven into the water table with the rod sections welded together as it is driven in. A single rod going down 150 feet (45 meters) is common. Deep grounds are desirable because of their electrical stability with the changing seasons.

8.9.3 Electrode array

When soil conditions do not permit a single deep electrode, shorter electrodes can be used in arrays. The most efficient form of an array is created by placing the rods in a circle or in a straight line. The rod separation should equal the rod length. Therefore, 10-foot (3-meter) rods would be driven into the soil at 10-foot (3-meter) separations.

The relationship of separating rods at a distance equal to the rod length comes from each rod having a circle of influence out to a diameter equal to the rod length. Placing a rod inside of the circle of influence of another rod gains little in system grounding performance.

Ground rods can be placed in various arrays such as circles, triangles, squares, and straight lines. The straight line configuration is the most flexible because both ends are open for adding rods, if needed. On the other hand, filling in a circle or any other closed array improves performance very little, optimistically 2:1.

8.9.4 Array performance

You can estimate the performance of circular and in-line arrays using test results from a single isolated rod. For example, assume a test rod resistance of 10 ohms. To achieve 5 ohms of resistance, you may think that two rods in parallel would achieve this. Actually, to achieve 5 ohms of resistance from you would need four of the rods. When rods are separated at distances equal to their length, the circles of influence overlap such that each added rod has only a 50% independent circular contact with the soil.

8.9.5 Array connections

The rods are commonly connected together using cadmium welding and 11.8 mm (4/0 AWG) green insulated copper cable. Encase the ends of all rods and make all connections inside a reinforced concrete pipe with an 18 mm (3/4 inch) thick steel cover.

8.9.6 When driven rods cannot be used

When soil conditions or space do not allow the use of driven rods, a 4-inch (10 cm) or larger well can be drilled or pounded into the water table. Specify that drilling continues until two aquifers (rivers) are struck if reasonable for the area. The well requires a casing down to bed rock, or it may require casing for the full depth if there is no bed rock in the area. Casing can be perforated steel or plastic. Leave the top 30 feet (9 meters) solid and non-perforated to prevent surface water from draining into the well and contaminating the substrata aquifer.

8.9.7 Drilled electrode

For the well's grounding electrode, use a stainless steel rod centering it inside and extending it to the full depth of the well. Then fill the well with concrete mix, coke breeze, or other ashes. These materials slowly release ions that improve grounding over time. Do not use strong chemicals as they may cause water contamination.

The stainless steel rod must comply with the specification contained in IEC standards or NEC 250-83-C, paragraphs 1, 2, and 3.

9 Minimizing EMI and RFI

This section provides guidelines for reducing electro-magnetic interference (EMI) and radio frequency interference (RFI) within an Experion System. While these guidelines apply to most installations, certain electrically harsh environments may require additional precautions. These guidelines are not intended to supersede local electrical codes.

Related topics

"EMI and RFI guidelines" on page 80
"About EMI and RFI" on page 81
"Separation techniques" on page 82

9.1 EMI and RFI guidelines

The following table summarizes the guidelines for controlling EMI and RFI when installing or maintaining an Experion system. See the remaining sections in this chapter for detailed information on the guidelines provided.

✓	Guidelines
	Properly shield and ground the cables and equipment chassis.
	Route all cables away from potential interference sources.

9.2 About EMI and RFI

EMI and RFI can cause control system failures, such as a momentary shift in an indicated process variable or an unaccountable stop of a microprocessor. The effects of RFI and EMI can be reduced or eliminated by properly shielding and grounding the cables and equipment chassis, and by routing the cables away from potential interference sources.

9.2.1 Most common sources of EMI

EMI signals can be either steady-state or transient and are most commonly caused by:

- Electrical storms
- Power tools and appliances: residential, commercial, and industrial
- Electrical substations and transmission lines
- Large rotating electrical machinery
- Relays, contractors, or SCR circuits
- Business machines: computers
- Industrial: arc and induction furnace, heat sealer
- Arc lighting: fluorescent, mercury, sodium
- Microwave oven

9.2.2 Most common sources of RFI

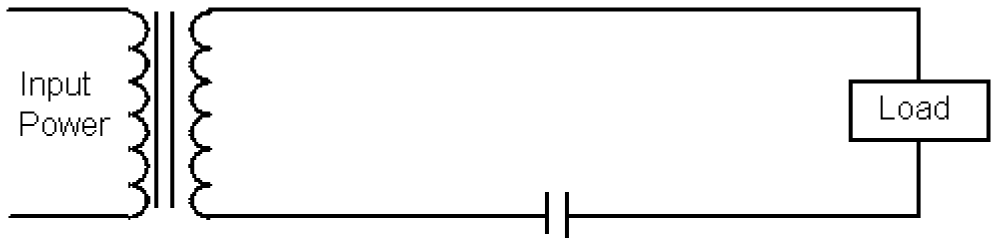
RFI is most commonly caused by the following:

- Broadcast stations: AM, FM, TV, also ship and air radio beacons
- Mobile 2-way radios: aircraft, ship, taxi, truck, police, and emergency
- Hand-held 2-way radios: Citizens Band, 440 MHz industrial and security

9.3 Separation techniques

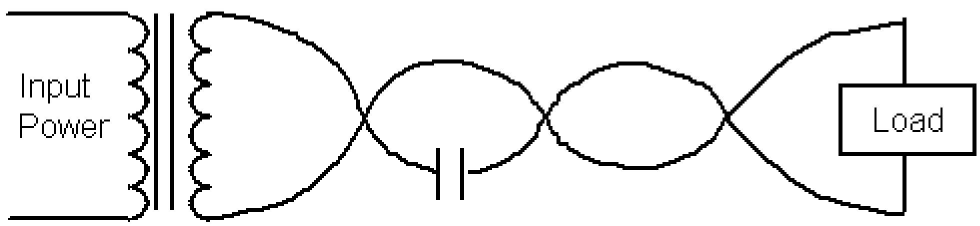
9.3.1 Open parallel power lines

When you directly switch the loads on open parallel power lines, install the coax cable at least 50 feet (15 m)/kV from the power lines.



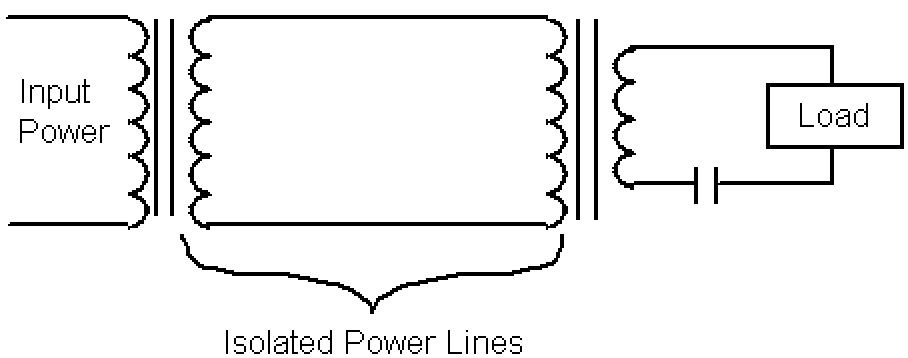
9.3.2 Open twisted power lines

When you directly switch the load on open twisted power lines (1 turn/1.5 meters or 5 feet), install the coax cable at least 10 feet (3 meter)/kV from the power lines.



9.3.3 Isolated open power lines

For open power lines with switched loads isolated by a step down transformer, use a separation of at least 1 foot (30 centimeter)/kV.



9.3.4 Enclosed power lines

With power lines enclosed in metal trays or conduit, eddy currents in the enclosure wall eliminate high frequency magnetic radiation. Keep a minimum separation distance of 1 foot (30 centimeters)/kV.

9.3.5 Right angle crossings

For right angle (90 + 5 degrees) crossing of the coax and the power line, reduce the separation distances to one-third (3:1), if the distance to the first bend of either cable is equal to or greater than specified for the previous examples.

9.3.6 Transformers and motors

Transformers and motors generate only a small amount of magnetic radiation. Large transformers frequently have short lengths of open wire on their high tension posts; however, the transformer inductance prevents the generation of a high-frequency magnetic field around them. When routing the coax past transformers and motors, keep a separation of at least 1 foot (30 centimeters)/kV.

9.3.7 Ground grid

Consider installing the coaxial cable in a bonded conduit or on a ground grid to reduce the separation distances of the previous examples to one-third (3:1).

- A ground grid is a 75 to 100 mm (3 to 4 inch) wire mesh made of 2.6 mm (No. 10 AWG) minimum, bare, galvanized steel wire, welded at each intersection.
- At power line crossings, the grid must be at least 4 feet (1.2 meters) wide and 75 feet (23 meters) long.
- The grid must be in direct contact with earth.
- If the grid is vinyl coated or is imbedded in concrete, it must be connected to earth ground at each end and each pull box.

10 Preventing ESD hazards

Electro static discharge (ESD), common in low humidity conditions, generates EMI that can cause control system problems. This section provides guidelines for preventing ESD.

Related topics

“ESD prevention guidelines” on page 86
“Preventing ESD” on page 87
“ESD categories and equipment errors” on page 88

10.1 ESD prevention guidelines

The following table summarizes the guidelines for preventing ESD when installing or maintaining an Experion system. See the remaining sections in this chapter for detailed information on the guidelines provided.

✓	Guidelines
Controlling the environment	
	Avoid cut-pile or other (fuzzy) fabric with exposed thread ends and any 00% synthetic covers such as vinyl.
	Periodically treat carpets with a commercially available antistatic spray.
	Make sure carpeting includes conductive strands to bleed the charge to the subfloor.
	Consider using antistatic casters on all rolling chairs.
	Do not allow the use of floor wax (it is an active source of charge and prevents dissipation of static to the subfloor).
Handling electronic components	
	Handle/transport boards to and from the job site in their protective bags.
	Before removing the boards from their protective bag or from a card slot, touch the hand to the chassis to discharge any static charge buildup.
	Handle circuit boards only by the edges.
	If you must touch the lands, connectors, or components wear a grounding strap, and stand on a grounded floor mat or touch a grounded surface before handling boards.
	Do not carry unprotected boards across carpeting.
	Ground all test equipment and handling equipment/tools (for example, screwdrivers or pliers) by touching the metal chassis with the tool before touching the boards or internal wiring on the enclosure or back panel.
	When shipping a suspected defective board, pack it in its protective bag before placing it in the shipping carton.
	Do not use standard bubble pack mailers and do not allow unprotected boards to come in contact with Styrofoam packing material.

10.2 Preventing ESD

10.2.1 Controlling humidity to prevent ESD

The most effective method of eliminating ESD in the operating environment is to control the temperature and relative humidity of the control room. See the ' “Temperature and humidity” on page 36' section.

10.2.2 Furniture and flooring

Selecting the right furniture coverings, the right floor coverings and controlling the type of clothing worn all can reduce the potential for ESD. See the ' “ESD prevention guidelines” on page 86' section for a list of specific actions to take.

10.2.3 ESD and types of clothing

Clothing is one of the most common contributors of ESD. Fire retardant polyamide uniforms may be required dress in certain facilities, but be this material is a source of ESD. It is not necessary for personnel wearing such clothing to touch grounded metal to draw ESD. The clothing itself causes an electrostatic discharge or sparks during walking or other movement. When fire retardant clothing is required, use fabric with woven-in stainless steel thread.

10.3 ESD categories and equipment errors

Experion process control equipment is designed under strict standards using test equipment that simulates electrostatic discharge. The discharge testing is in accordance with International Electrotechnical Commission (IEC) Standard 801-2 (1984). Testing is done at 15 kV with a 150 picofarad storage capacitor and a 150-ohm discharge resistor. This section discusses the categories of ESD and describes the types of equipment errors that can occur for each category.

10.3.1 Operational discharge

An operational discharge is a discharge applied to any surface of the enclosed equipment that can be touched by an operator.

Unacceptable equipment errors:

- A reset or halting of the normal operation of the device that requires manual restarting, software reloading, or manual reprogramming to regain normal operation.
- A deviation in an output of the device that exceeds the specified tolerances of the device's accuracy, or a deviation of a sufficient amount to cause failure, or create an abnormal or hazardous condition.
- A detected change at the inputs of the device that causes raised indications (for example, alarms), or causes outputs to permanently change to an abnormal value or to change long enough to cause improper control.
- Permanent damage to hardware or software that requires replacement to correct the failure.

Acceptable equipment errors:

- Display or indication flashes that are very short in duration (for example, 1 second or less) and return to normal without manual intervention.
- A display or indication change that is recoverable by actuating available apparatus (for example, keys, switches, or buttons) used during normal operation and readily accessible to the operator.

10.3.2 Maintenance discharges

A maintenance discharge is defined as any one of the following:

- A discharge applied to any surface of a subassembly housing (for example, chassis, card file, or mounting/ support rails/members) that is exposed when the device is withdrawn from its final housing, or when panels or doors are opened or removed.
- A discharge to a field/customer accessible termination (for example, screw terminals for field/customer wiring, or cable connections for field/customer termination).
- A discharge to a device that is used to interrupt power or preset/set/restart the unit. This includes mechanical adjusting devices that are used in field calibration, or test points that are made available for field calibration of the unit.

Direct discharges to printed circuit tracks or components other than field/customer calibration devices are not maintenance discharges.

Unacceptable equipment errors:

- The permanent damage to hardware or software media that requires replacement to correct the failure.
- The opening of fuses/breakers that are power protection devices.

Acceptable equipment errors:

- Resets or halting of the equipment that requires manual restarting, software reloading, or manual reprogramming to regain normal operation.

10.3.3 Troubleshooting/replacement discharges

A troubleshooting/replacement discharge is a discharge that is applied to any component/printed circuit disconnected or removed from the final assembly of a device and are not designated as field/customer accessible. Handling/unpacking of replacement parts/subassemblies is included in this category.

Any damage to the devices that occurs in the maintenance mode remains the responsibility of the maintenance personnel. Proper techniques require the use of grounding straps, correct handling, and a general knowledge of electrostatic discharge and its effects on devices if damage is to be prevented.

11 Safety planning

During construction, startup, and operation of the process control equipment, safety should be a prime consideration. This section discusses the major safety issues for planning, installing and operating your Experion system.

Related topics

"Safety guidelines" on page 92
"Fire control" on page 93
"Emergency lighting" on page 94

11.1 Safety guidelines

The following table summarizes the safety guidelines for an Experion system. See the remaining sections in this chapter for detailed information on the guidelines provided.

✓	Guidelines
Equipment	
	Verify that all vital control areas, service areas, and data storage areas are continually monitored.
	Periodically inspect all service piping located above raised ceilings and below raised flooring for damage.
	Use waterproofed electrical connections for any power connections below grade or underneath a raised floor.
	Verify all equipment cabinets and frames have a safety ground. Safety grounds are required to protect personnel.
Personnel	
	Provide emergency exits at all control areas. The number and size are determined by the size of the area.
	Verify all personnel are properly trained in safe shutdown procedures: shutting off electrical power in the proper method and sequence;, turning the battery switch off on each UPS; shutting down the air conditioning system;.
	Verify all personally are properly trained in emergency measures and processes: notifying the fire department clearly and promptly; operating fire extinguishing equipment, and prompt evacuation procedures.

11.2 Fire control

Providing a suitable gas flooding fire control system and hand-held extinguishers can prevent a fire from shutting down an operating control system.

11.2.1 Identifying equipment and its location

Honeywell recommends you consult the following to identify the type of fire control equipment needed and determine its location and usage:

- One of the Nationally Recognized Testing Laboratories (NRTLs) such as Factory Mutual Research (FM), Underwriters Laboratory (UL).
- Any local and national electrical codes such as the National Electrical Code (NEC), the Canadian Electrical Code (CEC), International Electrotechnical Commission (IEC), and the National Fire Prevention Agency (NFPA).

11.2.2 About carbon dioxide fire extinguishers

Fire extinguishers filled with liquid CO2 are suitable for electrical fires. They must be carefully used because CO2 replaces oxygen in the air and can be hazardous to personnel. If the nozzle is held close to printed electronic circuitry, the cold CO2 can cause damage by thermal shock.

11.3 Emergency lighting

Most electronics buildings are windowless for security. For safety during a power loss, provide some kind of emergency lighting, such as automatic recharge, wall-mounted lights.

12 Ethernet cabling

This section provides general guidelines for the network cabling of an Experion system. These guidelines only include cables specified for data communications use by TIA/EIA-568-B.2-1, ISO/IEC 11801 2nd Edition - 2000, and pending TIA/EIA-568-b.2-10.

Related topics

"Ethernet cabling guidelines" on page 96
"For additional information about Ethernet cabling" on page 98
"Ethernet cable topology" on page 99
"Selecting copper cables for the network" on page 100
"Terminating copper cables" on page 102
"Grounding the copper cable plant" on page 103
"Selecting fiber optic cables for the network" on page 105
"Routing fiber optic cables" on page 107
"Identifying network cables" on page 110
"Splicing and connecting fiber optic cables" on page 111
"Testing the network cables" on page 113

12.1 Ethernet cabling guidelines

The following table summarizes the Ethernet cabling guidelines for an Experion system. See the remaining sections in this chapter for detailed information on the guidelines provided.

✓	Guidelines
Planning steps	
	Determine physical installation and routing.
	Consider cable type, cable distance, and redundant cable run paths.
	Avoid installing cable through areas of high human traffic and high EMI/RFI.
	Determine the maximum cable lengths and the number of drops.
	Prepare a wiring list.
	Maintain a blueprint with location of wiring.
	Plan for expansion.
	Plan for diagnostics such as attachment spots for diagnostic tools (e.g. a protocol analyzer).
	Address separation issues for power, communications, and signal wiring/cabling.
General	
	Use copper cable only for intra building connectivity.
	Use fiber optic cable for inter building connectivity.
	If cable lengths over 33 feet (10 meters) are required, install a structured cable solution.
Intra building cables	
	Use, at a minimum, screened CAT 5e cable of ScTp or FTP construction. CAT 6 is more appropriate if future networks are likely.
	Use cables with stranded copper conductors for all patch and workstation cables.
	Use cables with solid copper conductors for all horizontal cables.
	Use 8 pin RJ45 style modular plugs and jacks for all connectors.
Inter building cables	
	For all fiber optic cabling, use either 62.5/125 \m MM or SM cable.
	Use ST or SC style connectors - these can be varied based on site requirements.
	Separate all fiber optic cables as much as possible.
FTE network cables	
	For FTE use, Honeywell recommends CMR rated cable, unless the local environment requires a plenum rated cable (a riser rated cable will cost less than a plenum rated cable and the jacket is more flexible and, in some cases, more durable).
	Use yellow cables for the A network tree and green cables for the B network tree.

✔	Guidelines
	For all patch cables, use those certified by the manufacturer that are available in yellow or green jackets or with color coded boots that go over the plugs.
	Use color coded jacks in both green and yellow and use one patch panel for all the green cables and another patch panel for all the yellow cables.
	If feasible, separate the yellow and green cables as much as possible.

12.2 For additional information about Ethernet cabling

The following table lists sections from other documents that contain additional information about cabling for an Experion system.

Section	Description
FTE Cabling Best Practices	
Copper cabling	
Fiber optic cabling	
Grounding	
Cable testing	
Experion Control Hardware Planning Guide	
Other standards	
IEEE 802.3 specification	Governs Ethernet networking, for cabling and interconnection detail information.
TIA/EIA-568-B.2 contains the requirements for patch cables up to CAT 5e	
TIA/EIA-568-B.2-1 contains the requirements for CAT 6 patch cables	
TIA/EIA-568-B.2-K.7	Additional requirements.
TIA/EIA-568-B.1-2 and NEC Article 250	
TIA/EIA 568	States that the UTP connecter for data use be an eight pin RJ 45 modular connection, which can be either a plug or a jack

12.3 Ethernet cable topology

The Experion Ethernet cabling uses a physical star topology with the switch as the center of the star and each workstation cabled back to it. The workstations can be connected to the switches using a structured or unstructured approach.

12.3.1 Structured cable plant

Honeywell recommends this method in all but the smallest of installations. A structured cable plant uses permanently installed termination devices on either end of a horizontal cable. Patch cables connect the workstation to the patch panel and to the switch. This method works especially well when:

- There are a high number of workstations in one area, or;
- The physical cable distance from the switch to the workstation exceeds 65.6 feet (
  20 meters), or;
- The workstations are separated from the switch by a physical wall.

12.3.2 Benefits of structured cable plant

A structured cable solution has more components, but it is more organized and reliable. At the switch end, all the terminations are contained in a patch panel, allowing the more flexible patch cords to be neatly routed from the patch panel to the switch ports. Since the outlet and the patch panels are appropriately labeled, identifying specific cable runs is easy. The horizontal cable is terminated at each end with insulated connections that can be tested. Since the cable is connected to a jack in a patch panel, face plate, or surface mount box, and does not move once installed, it should not experience any future problems. If there is a problem, it is usually the patch cable, which is simple and inexpensive to replace.

12.3.3 Unstructured cable plant

This method uses a long patch cable that has an RJ45 plug on each end to directly connect the switch port to the NIC in the workstation. This method can be used when:

- There are a small number of workstations in one area, and;
- The physical cable distance from the switch to the workstation is less than 15 feet (4.5 meters) in length.

Keep in mind that each FTE connected node has two cables connecting it to the network switch.

12.4 Selecting copper cables for the network

This section describes the characteristics of the copper patch cables and horizontal cables that can be used in the network.

12.4.1 Use of patch cables

TIA/EIA-568 defines patch cables as relatively short cables used to connect equipment to the horizontal cable plant or to be used for zone cabling. Zone cabling uses clustered jacks that are wired back to the telecommunications closet using horizontal cable. The jacks are then connected to the workstations using relatively long patch cables. When the area is reconfigured, the patch cable is replaced, but the horizontal cable is not disturbed. Honeywell supports using long patch cables for some installations if the cable meets the following requirements:

- Has a non plenum jacket for greater flexibility
- Matches the desired performance category and shielding type of the entire cable plant
- Has been assembled and tested at the factory. Field assembly is strongly advised against, as stated in TIA/EIA-568-B.1.10.2.4
- Has IDC RJ 45 plugs on each end uses stranded conductors for increased durability and flexibility
- Is of screened construction
- Has a yellow or green colored jacket or connector boot (a jacket or boot color other than yellow or green may be used for a non FTE device such as a printer)
- Is 33 feet (10 meters) or less in length

12.4.2 Cable plant performance standard

The overall performance of the cable plant is that of the lowest performing component. For example, a CAT 6 cable that has been terminated using CAT 5 jacks will only pass CAT 5 tests; a complete CAT 6 system that uses CAT 5 patch cables is actually only a CAT 5 system.

12.4.3 Copper data cable construction

TIA/EIA-568-B.2 states that copper data cable shall consist of 22 AWG to 24 AWG thermoplastic insulated solid conductors that are formed into four individually twisted-pairs and enclosed by a thermoplastic jacket, and have a nominal impedance of 100Ω .Although, the standards approve both screened and unshielded copper cable for data communications use, Honeywell recommends a screened cable for industrial networks. The screened types of cables as described in the following table have increased immunity against electromagnetic interference/radio frequency interference (EMI/RFI).

Type	Description
Screened Twisted Pair (ScTP)	The four pairs are covered with an overall fine wire screen.
Foil Twisted Pair (FTP)	The four pairs are covered with an overall metal foil shield.
Pairs in Metal Foil (PiMF)	Each of the four pairs is wrapped in a metal foil shield.
Double Shield Twisted Pair (SSTP) or Shielded Twisted Pair (STP)	Each of the four pairs is wrapped in a metal foil shield which are then wrapped in an overall foil metal shield.

12.4.4 Copper data cable transmission performance

Honeywell recommends a minimum of screened CAT 5e for industrial network installations or, if greater network performance is required, screened CAT 6 cable. Currently CAT 6 cable offers the highest electrical performance that is standards compliant. The maximum tested frequency determines what Category (CAT), or performance level a particular cable meets as described in the following table.

Type	Description
CAT 3 cable	Tested for the required parameters up to 16 MHz.
CAT 5 cable	Has been tested for the required parameters up to 100 MHz.
CAT 5e cable	Has been tested for the required parameters up to 100 MHz, but a number of the parameters are stricter than for CAT 5.
CAT 6 cable	Has been tested for the required parameters up to 250 MHz.

12.4.5 Copper cable jacket types

TIA/EIA standards do not address cable jacket construction other than how it affects color coding and the mechanical strength of the cable. The NEC classifies cables by flammability and the level of hazard the cables present if burned.

All Underwriters Laboratory listed cables approved for use by NEC have a classification label in which first two characters are CM (communications cable) and the third character defines where the cable can be used.

Type	Description
CMX	Communications cable suitable for residential use only.
CMG	General purpose communications cable not suitable for use in risers or plenums.
CMR	Communications cable suitable for use in a building riser or non plenum environment.
CMP	Communications cable suitable for use in a plenum environment where a ceiling or raised floor space is used by the air conditioning system as an air return plenum.

12.4.6 Copper cable bend radius and pulling tension

Cable manufacturers publish the minimum bend radius and pulling tension guidelines for cables. Follow the guidelines even when dressing patch cables in a cabinet because over bending a cable can distort the pairs and impede performance. If you use plastic tie-wraps to dress cables, do not over tighten and indent the cable jacket. Consider using Velcro tie-wraps to avoid this problem. Following are general guidelines for the load bend radius for copper patch and horizontal cables.

- ScTP patch cable: minimum no load bend radius of 2 inches (50mm)
- ScTP horizontal cable: minimum bend radius of 8 times the cable diameter

12.5 Terminating copper cables

TIA/EIA 568 states that the UTP connecter for data usage be an eight pin RJ 45 modular connection, which can be either a plug or a jack.

12.5.1 Termination plugs

If a long patch cable is used, it should have an RJ45 plug on both ends of the cable. Honeywell recommends you order a certified patch cable from a manufacturer that tests all patch cords and offers the cables in yellow or green jackets or with color coded boots that go over the plugs.

12.5.2 Termination jacks

The other method uses a jack terminated on either end of the horizontal cable. At the location of the network switches, install a patch panel or surface mounted box to house the jacks. At the location of the workstation, install a jack in a surface mounted box or a flush mounted wall plate. Use the patch cables to connect the jacks to the network switches and to the workstations. Honeywell recommends you order color coded jacks in both green and yellow and use one patch panel for all the green cables and another patch panel for all the yellow cables.

The recommended pin-out for terminating jacks is the 568B pin-out.

12.5.3 Other industrial connectors

Some cable manufacturers carry enhanced RJ45 plugs, jacks and patch cables specifically designed for use in industrial environments to protect against dust and water. The connectors are available in CAT 5e, CAT 6, and Fiber Optic versions with seals conforming to IP66/67.

Because the patch cables are designed for industrial environments, the cable jacket is stiff and not well suited to most control room environments. They are, however suited for connections in PLC or other control cabinets that may be left open to the elements. In less sever areas that require some protection, covered outlets can be used.

12.6 Grounding the copper cable plant

This section summarizes grounding procedures for the copper cable plant including the network switches. You can find additional information in TIA/EIA-568-B.1-2 and NEC Article 250.

12.6.1 About the TGB

Within each rack or telecommunications room, there should be a central grounding point, often called a telecommunications grounding bus bar or TGB. Equipment cabinets should be bonded to this bus bar using solid copper cable. The equipment in the cabinet are usually grounded through the ground prong on the power plug.

12.6.2 Remote network equipment cabinets

A remote network equipment cabinet is any cabinet that is separate from the main equipment cabinet and contains network equipment connected to the Experion network. Examples include a cabinet containing Level 2 FTE switches or a cabinet containing Honeywell's CF9. While it is within the standards to connect these cabinets using copper, unless it is certain that the remote cabinet will be on the same ground bus as the main cabinet, Fiber Optic cable is a better choice. In general, linking these cabinets using copper can be done safely if:

- The cabinets are in adjacent rooms;
- The cabinets are within 60 feet (18.2 meters) of each other;
- There are drawings or other firsthand knowledge that the two locations are on the same ground bus;
- The jack in the remote cabinet is housed in a non metallic surface mount box.

If there is any doubt that the two locations are not on the same ground bus, a ground wire should be installed along with the copper data cable to extend the TGB out to the remote location. Usually it costs less to link the two locations using Fiber Optic and gain EMI/RFI immunity than to have to extend the TGB.

12.6.3 Importance of using screened cable components

To realize the benefit of a screened cable system, use screened components throughout the installation, including cable, jacks, patch panels, and patch cables. See also the installation guidelines that come with each cable product.

12.6.4 Equipment room grounding

In the equipment room, bond the equipment cabinet to the equipment room ground, also known as the telecommunications grounding bar (TGB).

After the cabinet is properly grounded, ground the patch panel as follows:

- Attach a 6 AWG ground wire to the grounding lug on the patch panel and attaching the other end of the ground wire to the cabinet, or;
- Verify there is a bare metal connection between the mounting rails in the cabinet and the patch panel through the mounting screws.

Bond the shield of the cable either to the shield of the jack or to a common grounding point on the patch panel. When the jack is terminated at the outlet end, the shield will be bonded to the shield of that jack. This ensures a complete ground path from the work station outlet jack all the way back to the equipment room ground.

Verify only the end in the equipment room is bonded to the TGB, as grounding both ends of the channel may result in ground loops or a difference of potential from one end of the cable to the other. Additional ground paths may degrade the performance of the cable.

12.6.5 Importance of using the same grounding system

Short, intra-cabinet connections are assumed to be grounded to the equipment through the cable shield and the equipment chassis ground. It is not expected that equipment within the same cabinet or cabinet row would be on different ground potentials.

Verify the equipment room and the workstation location are on the same grounding system, and that there is no difference of potential between the two, which could result in equipment damage or personal injury. TIA/EIA-568-B.1-2-5.1-4.6 stresses that 'At the work area end of the horizontal cabling, the voltage measured between the screen and the ground wire of the electrical outlet used to provide power to the equipment shall not exceed 1.0 V rms and shall not exceed 1.0 V dc. The cause of any higher voltage should be removed before using the cable.'

12.7 Selecting fiber optic cables for the network

Selecting fiber optic cables is dependent on satisfying installation and environmental requirements without exceeded the maximum optical losses. Consider these factors when selecting fiber optic cable:

- Total fiber optic cable losses
- Cable requirements caused by the desired routing. Routing requirements can include direct burial, conduits, trays, raceways, plenums, etc.
- Construction code requirements

This section describes the different characteristics of fiber optic cables that can be used in the network.

12.7.1 Use of fiber optic patch cables

Fiber optic patch cables are used for connecting the fiber optic patch panel to a piece of equipment or for connecting different strands within a fiber optic patch panel. They are relatively light duty cables usually consisting of 2 fiber optic strands within a duplex PVC jacket with Kevlar yarn added for strength.

12.7.2 Fiber optic cable types

The following table describes the two types of fiber optic cable used for data communications.

Type	Description
Multi-mode (MM)	Light travels down multiple paths. Diameters include 62.5 \m and 50 \m. If legacy equipment requires MM, recommend a hybrid cable (SM and MM) be used.
Single mode (SM)	Light travels down a single path. Greater bandwidth and can be used for longer distances. Recommended for all new installations.

12.7.3 Fiber optic cable jacket types

Fiber optic cable jackets are available in different armoring configurations, depending on site environmental requirements. Always consider grounding requirements when using armored cable. The following table describes the three main categories of jackets used for fiber optic cable.

Type	Description
Outside plant cable	• Intended only for use outside buildings and is not a listed assembly by the NEC for use indoors. • Jacket is usually made of polyethylene (PE) and may include metallic armoring. • Per Article 770.113 an unlisted cable may penetrate a building a maximum of 50 feet (15 meters) before it is required to be terminated, spliced to a listed cable, or enclosed in conduit. • Most durable of the three jacket types.
Indoor/outdoor cable	• Indoor/Outdoor cabling has a type of jacket that is UL listed for indoor riser and outdoor use, but cannot be used in a plenum airspace. • Typically the cabling has a polyvinyl chloride (PVC) jacket with ultra-violet (UV) stabilizers, and includes some type of water blocking compound to enable it to be used outside. • Considered a medium duty cable and meets the requirements of NEC Article 770 as long as the building environment is classified as a riser and not a plenum.
Inside plant cable (includes plenum and riser versions)	• Inside plant cable can be a substantial assembly, but is not considered as rugged as an outside plant or indoor/outdoor cable. • An inside plant cable jacket is typically either PVC or Teflon, for plenum rated applications, and usually does not contain any water blocking mechanisms.

12.7.4 Fiber optic cable construction

The following table describes the two types of fiber optic cable construction used for data communications.

Construction	Description
Loose tube	Actual tubes within the cable that may contain up to 12 strands of fiber. Labor intensive to terminate because the strands must be inserted in a tight buffer tube to protect them and provide something for the connector strain relief to attach to.
Tight buffered	Each strand has its own jacket extruded over it in the manufacturing process. Easier to terminate. A central strength member is often manufactured into the cable made of fiberglass, nylon, or a metallic strand. Honeywell recommends you avoid the metallic strength members, because these make the cable an electrical conductor that must be properly grounded.

12.7.5 Air blown fiber optic cable

A completely separate technology is air blown fiber (ABF). ABF separates the conventional fiber optic cable into its two components: the outer jacket and the fiber optic strands. The outer jacket component is a tube that contains a number of smaller tubes within the outer jacket. The fiber optic strand component is actually a foam covered bundle of fiber optic strands. The fiber optic bundle is literally 'blown' along the tubes by either pressurized air or nitrogen.

The advantage of ABF is the ability to install a minimum number of fiber optic strands and then, at a later time, blow additional bundles in unoccupied tubes for either greater capacity or a different type of fiber.

The initial cost of this technology is comparable to conventional fiber, but additions or changes are much more cost effective if the initial tube layout was done correctly. Honeywell can help determine if this system is appropriate for your site.

12.7.6 Fiber optic connector types

There are a number of standards compliant connector types available. The following table summarizes the uses for each type within the horizontal cable plant.

Type	When to use
ST connectors	Older cable plants typically use.
SC connectors	Duplex SC connector recommended for new fiber optic installations (unless matching an existing type of connector is necessary).
LC connectors	Smaller connected used for very high density installations.

Electronics manufacturers often change the fiber optic interfaces on their equipment. It is advisable to choose a particular connector type and standardize on that type for your facility. A Honeywell cable design professional can assist with the decision. Once that decision has been made, patch cables are used to transition from the horizontal cable to the network equipment interface.

12.8 Routing fiber optic cables

Fiber optic cable is the specified media for all inter building connectivity. You can route Fiber optic cable underground (with direct burial cable), through the air (with outdoor aerial cable), or in cable and electrical wiring trays. Fiber optic cable is immune to interference from electromagnetic fields or transmissions. Fiber optic cable is safe to route through intrinsically safe areas with no danger of explosion. This section provides recommendations for fiber optic routing.

12.8.1 Fiber optic cable path design

Fault Tolerant Ethernet is built upon a traditional 802.3 CSMA/CD Ethernet architecture. This means that a Level 2 switch is directly connected to a Level 2 backbone switch through the cable plant. The goal of cable plant design is to route the fiber optic cable in a manner that allows for the greatest redundancy within the existing plant structure.

12.8.2 Separation of A network and B network

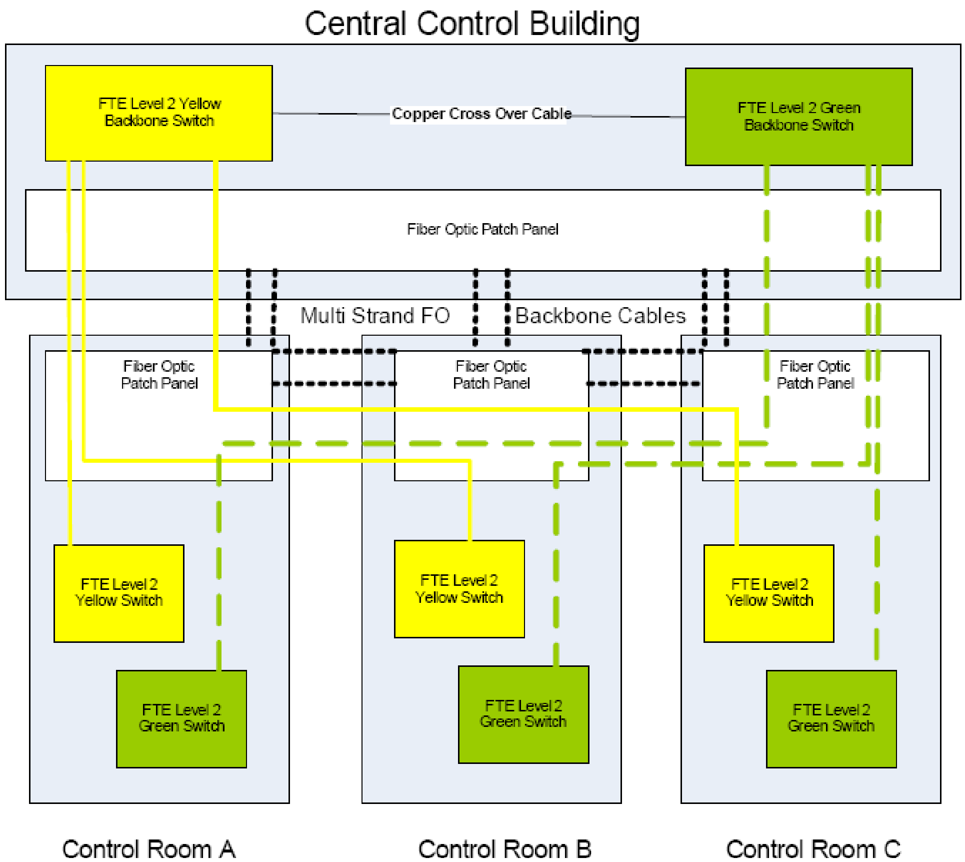
Route the A (yellow) and B (green) to the destination using different routes to avoid simultaneously damaging or cutting both cables. Assuming the plant infrastructure can support it, the optimal physical cable routing is to encompass as much of the facility as possible with additional cable runs bisecting the main route. In this design, known as a mesh, the fiber optic cable physically connects all the necessary facilities.

Attention

The maximum difference in the total length of the routed Link A and Link B cables must be less than half (½) the maximum length of the media used for the links on each of the branches of the FTE network. That is a 50 meter differential on a copper branch, a 1 km differential on a (multi-mode) fiber branch or a 7.5 km differential on a (single-mode) fiber branch.

12.8.3 Example of a mesh fiber optic cable path design

The following figure is an example of a mesh design. In the figure, all control rooms are connected by the black dotted lines representing physical cabling and there are additional cable runs from Control Room B to the Central Control Room. The yellow solid line and the green dashed line indicate the cable paths that are taken for FTE connectivity.



12.8.4 Benefits of mesh design

In the mesh design, the cables can be spliced or patched through at the various fiber patch panels. This design is very flexible as it allows any number of different routes for a control room switch to connect back to a backbone switch. The design allows for maximum FTE redundancy by allowing the yellow connection from a switch to go one direction and the green to go the other direction, as well as providing additional routes within the main route. If possible, the cable should enter and leave on opposite sides of a building.

If this design can be implemented, even if the yellow and green fibers cannot be physically separated, it would take multiple cable failures in different areas of the plant to isolate a control room.

There are few complications implementing this design using SM fiber. If using MM fiber, a detailed loss budget needs to be completed to account for cable loss due to distance as well as any loss incurred either by splices or patch cables.

12.8.5 Fiber optic cable distance limitations

Physical cable distance is critical to the cable routing design. Refer to the following table to determine distance for various cable types and interfaces. All distance data is dependent on the physical condition of the cable and connections.

Cable	Interface	MM Fiber optic distances
MM fiber optic	100 Mb interfaces	Can be as great as 2 km
MM 62.5/125 \m fiber optic *	LX/LH Gigabit interfaces	Should not exceed 550 meters

Cable	Interface	MM Fiber optic distances
MM 50/125 \m fiber optic	LX/LH Gigabit interfaces	Should not exceed 550 meters
SM fiber optic	LX/LH Gigabit interfaces	Can be as great as 10 kilometers without using high powered long distance interfaces
Note: *If cable length is less than 300 feet (100 meters) or more than 900 feet (300 meters), you must use a mode conditioning cable, which is a special cable assembly that precisely offsets the laser launch of the transmitter to mimic a multi mode launch.		

12.8.6 Fiber optic cable bend radius and pulling tension

Cable manufacturers publish the minimum bend radius and pulling tension guidelines for cables. Follow the guidelines at all times because over bending a cable can distort the pairs and impede performance. If you use plastic tie-wraps to dress cables, do not over tighten and indent the cable jacket. Consider using Velcro tie-wraps to avoid this problem. Following are general guidelines for the load bend radius for fiber optic cables.

- Outside plant fiber optic cable shall have a minimum pulling strength of 600 lbs/foot and have a minimum bend radius of 10 times the cable diameter at rest and 20 times the cable diameter under load.
- Air blown fiber optic cable has its own bend radius requirements related to the tube that the fiber bundles are installed in. Obtain the data from the manufacturer.

12.8.7 Direct burial hazards

You can bury heavy-duty cables directly in the ground. Use cable with a durable polyethylene jacket material and an inner layer of steel armor to provide some protection from the effects for the following conditions:

- Freezing water
- Heaving of rocks caused by the ground freezing
- Ground disruption because of construction
- Rodents

You can also choose to bury conduit or polyethylene pipe and run cable through it.

12.8.8 General fiber optic safety guidelines

When working around equipment with FO interfaces or FO patch panels, never look directly into an interface or port. Doing so may result in permanent eye damage. All unused fiber ports and interfaces should have their protective caps in place. Also, unless you are trained in the handling and installation of fiber, do not handle the actual fiber optic strands as these can break and become lodged in your skin.

12.9 Identifying network cables

This section contains guidelines for identifying the network cables.

12.9.1 Labeling all network cables

Before installing data cabling, establish a standard labeling convention for all network cables. TIA/EIA 606 recommends a scheme for labeling large cable plants, but for smaller systems, Honeywell recommends you establish a standard method and convention for labeling all network cables, patch panels and outlets.

12.9.2 Cable identification examples

Create the same label for both ends of the cable that, at a minimum, includes a unique cable identification number, indication of where both ends of the cable terminate, and an identifier for the FTE network tree. Consider also adding additional characters to indicate the type of cable or the number of strands. The following tables show cable examples.

Unique cable number	Location of termination point	Location of termination point	FTE network identifier
40-	*NCB-*	*SCB-*	*Y*
40^{th} cable	North Control Building	South Control Building	Indicates yellow connection
50-	*WCB-*	*ECB-*	*G*
50^{th} cable	West Control Building	East Control Building	Indicates green connection

12.10 Splicing and connecting fiber optic cables

12.10.1 Cabling design considerations

When planning a system installation, design the cabling to have the minimum number of splices. For example, convert outdoor cable to indoor cable when entering a cabinet where the bend radius of outdoor cable will not fit in the cabinet. Where this splicing must be made, sufficient cable length must be provided for a splice loop. Thirty to 45 centimeters (12 to 18 inches) on each cable end is the usual allowance for a service loop. Also, when entering the equipment cabinet, sufficient cable length must be allowed for breakout (stripping and fanning out) and termination of the individual fibers.

12.10.2 Cable splice protection

Completed splices cannot withstand tensile forces and must be housed in a strain relief assembly. Moisture entry into the splice can cause degradation of performance; therefore, the splice enclosure must be sealed, and if necessary, the splice encapsulated to minimize moisture entry.

12.10.3 Cable breakout

Breakout eliminates the outer sheath, leaving the more flexible individual fibers for routing within the cabinet. Tight buffer indoor cables provide strength members with each fiber, eliminating the need to use breakout kits to add strength members for each fiber.

12.10.4 Using a breakout kit

In outdoor loose-buffered, gel-filled cable designs, there is no strength member or protective jacket for the individual fibers. To terminate and use this type of cable requires the use of a breakout or fan-out kit. The kit provides strength members with flexible jackets that are placed over the fibers after the outer jacket is removed. These kits can be installed over fibers as much as 33 feet (10 meters) in length. The kit provides fiber protection for in-cabinet routing and termination.

12.10.5 Cables with connectors preinstalled

If the cable length is accurately determined and the cable does not have to be pulled through a conduit, cables can be ordered with connectors installed on the ends. This requires less field skill and installation time. ST-type connectors, can also be used as a means of splicing two cables; however, to minimize losses at or near maximum cable lengths, professional installation is required using fusion splices.

12.10.6 Vertical fiber migration consideration

Fiber in vertical installations does not break because of its own weight; however, for vertical runs of 49.2 feet (15 meters), and greater, excess fiber can migrate downward. The crowding of excess fiber at the bottom can cause an increase in attenuation.

You can reduce this downward migration of fiber in vertical runs by placing loops in the cable, approximately 1 to 1.5 feet (0.3 to 0.5 meter) in diameter, at the top, bottom, and at 50-foot (15-meter) intervals.

12.10.7 Securing network cables

Aerial Lashing methods are similar to those used for electrical cables. Most cables are compatible with helical lashing, clamping, or tied mounting.

You must firmly clamp cable in vertical trays, raceways, or shafts at frequent intervals to support cable weight evenly. Clamping intervals can be as short as 3.3 feet (1 meter) outdoors to prevent wind slapping and minimize ice loading, or as long as 49.2 feet (15 meters) in interior locations.

12.11 Testing the network cables

This section provides testing guidelines for installed network cabling. Testing applies only to a structured cable solution, as the test equipment is not designed to test short patch cables in the field. This is another reason that patch cables should not be field assembled and should be purchased from a manufacturer that does 100% testing of their cables.

12.11.1 For additional information about network cable testing

Refer to the following publications:

- Copper cabling: *TIA/EIA-568-B.1.11.2 and TIA/EIA-568-B.2-1 Annex B*
- Fiber optic cabling: *TIA/EIA-568-B.1.11.3, TIA-526-7 and TIA-526-14-A*

12.11.2 Multi-test equipment

TIA/EIA standards define the test parameters for installed data cabling and the performance requirements for the testers used. As a minimum, all installed horizontal or backbone cables should be tested with one of the new cable test devices designed for both copper and fiber testing. The device tests both fiber and copper using an 'Autotest' procedure for a number of standards based parameters and is sufficient for most installations including the following:

- Wire mapping: Verifies the cable is terminated properly at each end.
- Length: Verifies the cable does not exceed the maximum length per the standards.
- Near End Crosstalk (NEXT): Also verifies the cable has been installed and terminated properly so its manufactured electrical characteristics are able to cancel out crosstalk between adjacent cable pairs near the transmitting source.

12.11.3 Fiber optic cable test equipment

Longer outside plant fiber installations should also be verified with an Optical Time Domain Reflectometer (OTDR). The OTDR visually displays the installed cable as a wave form showing any 'events', or changes to the cable such as splices or kinks, and provides the more accurate length measurement compared to a multi test device.

12.11.4 Test results

Test results should be reviewed against the passing levels and provided to the cable plant owner upon completion of the testing and saved for future reference. Verify all appropriate information is included in the testing such as jack number and location in addition to pass or fail.

13 Control Hardware Cabling

The *Experion Control Hardware Planning Guide* contains detailed information for the control hardware cabling. This section summarizes the information found in those documents and provides a list of specific references for more information.

Related topics

"For additional information about control hardware cabling" on page 116
"Planning your control hardware cabling and wiring" on page 117

13.1 For additional information about control hardware cabling

The following table lists sections from other documents that contain additional information about cabling used for the control hardware in an Experion system.

Section	Description
Experion Control Hardware Planning Guide	
Series C Hardware Configuration > C300 Controller Memory Backup	Provides guidelines for cabling of the memory backup assembly.
Series CSeries C Hardware Configuration > Series C System Cabling	• Describes the color schemes used for the Series C system cabling • Identifies cables used with the Series C system including link, Ethernet, FTA, extension, and conditioner cables and provides guidelines for their use.
ControlNet Configuration > Planning your Physical Media	• States criteria for maintaining the Experion ControlNet cabling. • Provides criteria for selecting appropriate cable connectors.
ControlNet Configuration > Planning for your ControlNet Cable Connectors	Provides criteria for selecting appropriate cable connectors.

13.2 Planning your control hardware cabling and wiring

Wiring and cabling are typically placed inside wire-way hardware that confines the wiring/cabling to acceptable pathways inside the enclosure. This isolates different type wiring and cabling from each other, according to the National Electrical Code (NEC) and Canadian Electrical Code (CEC).

13.2.1 Typical wiring and cabling in an enclosure

Wiring and cabling in a typical enclosure generally consists of:

- Power and ground distribution
- FTE network and/or ControlNet cables
- Redundancy cable(s) (connecting Redundancy Modules in partner chassis)
- RTP-to-IOM cables
- Field-wiring entering the enclosure and connecting to RTPs or IOMs

13.2.2 Tasks for planning control hardware cabling

The following table lists the high level tasks for planning your control hardware cabling and wiring.

✓	Task
	Determine physical installation and routing.
	Consider cable type, cable distance, and redundant cable run paths.
	Avoid installing cable through areas of high human traffic and high EMI/RFI.
	Determine the maximum cable lengths and the number of drops.
	Prepare a wiring list.
	Maintain a blueprint with location of wiring.
	Plan for expansion.
	Plan for diagnostics such as attachment spots for diagnostic tools (e.g. a protocol analyzer).
	Address separation issues for power, communications, and signal wiring/cabling.

14 Experion equipment information

This section summarizes the technical specifications for Experion equipment.

Related topics

14.1 Equipment guidelines

The following table summarizes the major considerations for the Experion equipment. See the remaining sections in this section and the individual equipment installation manuals for detailed information on the guidelines provided.

✓	Guideline
Cabinets	
	Verify each cabinet has a space clearance of at least 91.5 centimeters (36.0 inches) around the enclosure to ensure proper heat dissipation.
	Do not place any items on top of the enclosure, or obstruct free air flow around the enclosure in any way.
	Follow all guidelines for the maximum nodes and their optimal placement within the cabinet.
Consoles	
	For Icon consoles, make sure you install the air dam and isolator foam that comes with the console according to the installation instructions.
	To reduce vibrations and ensure structural integrity, adjacent Icon Series consoles must be attached to one another at both the backpanel and the base.

14.2 Rittal cabinet

The Rittal cabinet is available in a single access and dual access configuration. This section contains specifications for the cabinet. See also the 'Model MU-C8SFR1/MU-C8DFR1 Cabinets' section in the Appendix of the *Control Hardware Planning Guide*.

Attention

The Specification and Technical information is subject to change without notice and is superseded by information in applicable Experion product Specification and Technical data documents. Hence, for each Experion release, you are recommended to refer the applicable Specification and Technical data documents.

14.2.1 Technical data for Rittal cabinet

The following table provides technical information about Rittal cabinets. All dimensions are in centimeters (inches).

Measurement	Single access details	Dual access details
Height	200.00 (78.74)	200.00 (78.74)
Width	80.00 (31.49)	80.00 (31.49)
Depth	50.00 (19.69)	80.00 (31.49)

14.2.2 Environmental characteristics for Rittal cabinet

The following table provides operational specifications for temperature, humidity, EMC, ESD, EMI and vibration for the Rittal cabinet.

Consideration	Operational limits (Note 1)
Ambient temperature range	• External: 0°C to +50°C (Note 2) • Internal: 0°C to +60°C (Note 3)
Relative humidity (Note 3)	5% to 95% (non condensing) (Note 4)
Barometric pressure altitude	-300 to +3000 m
Corrosives	G3 Standard (ISA S71.04) - Denoted by 'CC-' model number
EMC	• Emissions: EN61326-1:1988, A-2: 2001 • Immunity: EN61326-1:1998, Amended 2: 2001 • Harmonics: EN61000-3-2 • Flicker: EN61000-3-3
EMI	15 V/M
ESD	15kV 20x once/5 seconds (Note 5)
Vibration	• Sinusoidal (5 to 10 Hz) 2.54mm/0.100in (Note 6) • Max (10 to 150 Hz) 0.5 g max. (0-Pk) • Transport: Random Vertical Shipping Axis 5 to 300 Hz 1.07 g (rms) (Note 7) • Longitudinal and Transverse 10 to 500 Hz

Consideration	Operational limits (Note 1)
Notes: 1. If Lithium Batteries are used, some Government regulations may prohibit air transport of batteries. 2. Rating applies to the external ambient temperature of the enclosure with doors closed. 3. Rating applies to the internal ambient temperature of the enclosure with the doors closed. 4. Maximum relative humidity specifications applies up to 40°C. Above 40°C, the RH specification is de-rated to 55% to maintain constant moisture content. 5. Measured with field strength meter near the surface of the electronics with doors open. This is a goal for the entire contents of the cabinet and may be a stretch for some items. 6. Applied to items that are likely to be in contact with discharge sources (that is. human body) during typical maintenance actions. 7. 10 Hz is approximate - exact crossover frequency determined by the intersection of the displacement and acceleration.	

14.2.3 Node installation requirements in the Rittal cabinet

Following is a summary of the node installation restrictions in the Rittal cabinet:

- Due to thermal constraints, Rittal TS8 cabinets can have the maximum number of nodes installed:
  - Rittal cabinet: 6 nodes maximum.
  - Rittal 1-meter deep cabinet: 9 nodes maximum.
- Due to safety and center-of-gravity considerations, servers must be mounted at the bottom of the cabinet.
- Redundant power entries are standard in the cabinet and the power load should be distributed evenly across the redundant power entries.
- All unused rack mount locations must have blank front panels and air duct baffles installed.

14.3 Series C cabinet

The Series C cabinet is available in a single access and dual access configuration. This section contains specifications for the cabinet. See also the following topics in the 'Series C Hardware Configuration' section of the *Control Hardware Planning Guide* for more information:

- 'Planning Your Series C Control System' > 'Series C cabinet layout examples'
- 'Selecting Series C Cabinet Hardware'
- 'Agency Approvals for Series C Cabinets'
- 'Series C cabinet safety ground connections'
- 'Series C cabinet typical power and ground connections'

Attention

The Specification and Technical information is subject to change without notice and is superseded by information in applicable Experion product Specification and Technical data documents. Hence, for each Experion release, you are recommended to refer the applicable Specification and Technical data documents.

14.3.1 Technical data for Experion Series C platform

The following table provides technical information about Series C cabinets. All dimensions are in centimeters (inches).

Measurement	Single access details	Dual access details
Height	200.00 (78.74)	200.00 (78.74)
Width	80.00 (31.49)	80.00 (31.49)
Depth	50.00 (19.69)	80.00 (31.49)

14.3.2 Environmental characteristics for Experion Series C platform

The following table provides operational specifications for temperature, humidity, EMC, ESD, EMI and vibration for the Experion Series C platform hardware.

Consideration	Operational limits (Note 1)
Ambient temperature range	• External: 0°C to +50°C (Note 2) • Internal: 0°C to +60°C (Note 3)
Relative humidity (Note 3)	5% to 95% (non condensing) (Note 4)
Barometric pressure altitude	-300 to +3000 m
Corrosives	G3 Standard (ISA S71.04) - Denoted by 'CC-' model number
EMC	• Emissions:EN61326-1:1988, A-2: 2001 • Immunity:EN61326-1:1998, Amended 2: 2001 • Harmonics: EN61000-3-2 • Flicker: EN61000-3-3
EMI	15 V/M
ESD	15kV 20x once/5 seconds (Note 5)

Consideration	Operational limits (Note 1)
Vibration	• Sinusoidal (5 to 10 Hz) 2.54mm/0.100in (Note 6) • Max (10 to 150 Hz) 0.5 g max. (0-Pk) • Transport: Random Vertical Shipping Axis 5 to 300 Hz 1.07 g (rms) (Note 7) • Longitudinal and Transverse 10 to 500 Hz

Notes:

1. If Lithium Batteries are used, some Government regulations may prohibit air transport of batteries.
2. Rating applies to the external ambient temperature of the enclosure with doors closed.
3. Rating applies to the internal ambient temperature of the enclosure with the doors closed.
4. Maximum relative humidity specifications applies up to 40°C. Above 40°C, the RH specification is de-rated to 55% to maintain constant moisture content.
5. Measured with field strength meter near the surface of the electronics with doors open. This is a goal for the entire contents of the cabinet and may be a stretch for some items.
6. Applied to items that are likely to be in contact with discharge sources (that is. human body) during typical maintenance actions.
7. 10 Hz is approximate - exact crossover frequency determined by the intersection of the displacement and acceleration.

14.4 Icon Series console

The Honeywell Icon Series is a suite of consoles and control room furniture designed for process operators, process engineers and plant managers in a control room environment. See also the *Honeywell Icon Series Console Planning, Installation and Service Guide*.

14.4.1 Special considerations for Icon series console

Honeywell Icon Consoles come with an air dam and isolator foam to control the air flow within the console's electronic enclosure. Make sure you follow the instructions in installation documents to install these properly.

14.4.2 Technical data for Icon series console

The following table provides technical information about the Icon console. All dimensions are in centimeters (inches).

Measurement	Dual console details	Quad console details
Maximum height	129.5 (50.98)	175.3 (69.02)
Maximum width	111.40 (43.86)	111.40 (43.86)
Maximum depth	92.7 (36.5)	92.7 (36.5)

14.4.3 Environmental characteristics for Icon series console

The following table provides operational specifications for temperature, humidity, EMC, ESD, EMI and vibration for the Icon series console. See also the *Planning, Installation and Service for Icon Series Console* for additional specifications.

Consideration	Operational limits (Note 1)
Ambient temperature range	+10°C to +35°C
Relative humidity	8% to 80% (non condensing)
Altitude	2,286 meters (7,500 feet)
Vibration	0.1 G at 3 to 200 Hz at 1 octave/min
Note: 1. Peripheral devices may have different specifications. Refer to manufacturer's specifications for each device.	

14.4.4 Complexing requirements for Icon series console

Icon Console furniture is complexed together using three complexing part types, each of which comes several options depending on the particular console configurations that are to be spliced together.

- A **Backpanel filler** is used to splice together two console backpanels.
- A **Complexing wedge** is used to splice together two console backpanels. The wedge has an enclosure that can be used to mount electrical equipment.
- A **Base splice plate** is used to splice together two console base units.

Adjacent Icon Series consoles must be attached to one another at two points: the backpanel using the correct backpanel filler and at the base using the correct splice plate. Attaching adjacent consoles at both these points ensures structural integrity by reducing vibrations. The backpanel fillers are required to:

- Provide full strength of the console structure;

- Block the visual gap between adjacent consoles reducing visual distraction for the operator, and;
- Optionally mount task lamps or custom equipment.

Where there are no adjacent back panels, the base splice plate is still required. The splice plates are required to:

- Properly align adjacent consoles and table units, and;
- Provide full strength of the console structure.

See also the 'Console Complexing' section of the *Honeywell Icon Series Console Planning, Installation and Service Guide.*

14.5 Classic consoles

The Classic Console features integrated flat panel displays, auxiliary modules with expanded room for additional nodes, and a two-tier configuration.

14.5.1 Environmental characteristics for Classic console

The following table provides operational specifications for temperature, humidity, EMC, ESD, EMI and vibration for the Classic console.

Consideration	Operational limits (Note 1)
Ambient temperature range	+5°C to +40°C
Relative humidity	20 to 80% (non condensing)
Vibration	0.012" P-P displ to 20 Hz, then 0.25g to 150 Hz; 60 min per axis, all 3 axes
Shock	10g, 10 msec half-sine pulse, 1 positive, 1 negative
Note: 1. Peripheral devices may have different specifications. Refer to manufacturer's specifications for each device.	

14.6 Z/EZ consoles

The Z/EZ console are ergonomic consoles with the following features:

The Z Console provides a narrow console base with integrated flat panel displays. It features an angled footrest, several Honeywell keyboard options, two PC node bays for local electronics mounting, and several auxiliary electronics offerings.

The EZ Console provides free-standing (desktop) displays with tilt and swivel capabilities for increased operator comfort and enhanced viewing. Below the monitors, the two consoles are identical, and both use the Z Console base.

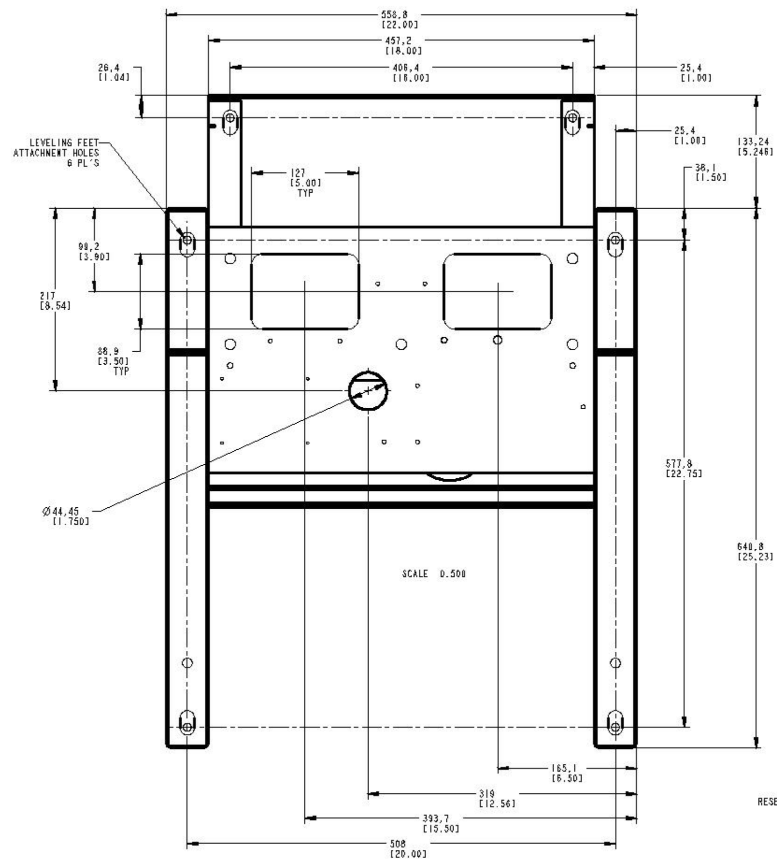
14.6.1 Environmental characteristics for Z/EZ consoles

The following table provides operational specifications for temperature, humidity, EMC, ESD, EMI and vibration for the Z/EZ consoles.

Consideration	Operational limits (Note 1)
Ambient temperature range	+5°C to +40°C
Relative humidity	20 to 80% (non condensing)
Vibration	0.012" P-P displ to 20 Hz, then 0.25g to 150 Hz; 60 min per axis, all 3 axes
Shock	10g, 10 msec half-sine pulse, 1 positive, 1 negative
Note: 1. Peripheral devices may have different specifications. Refer to manufacturer's specifications for each device.	

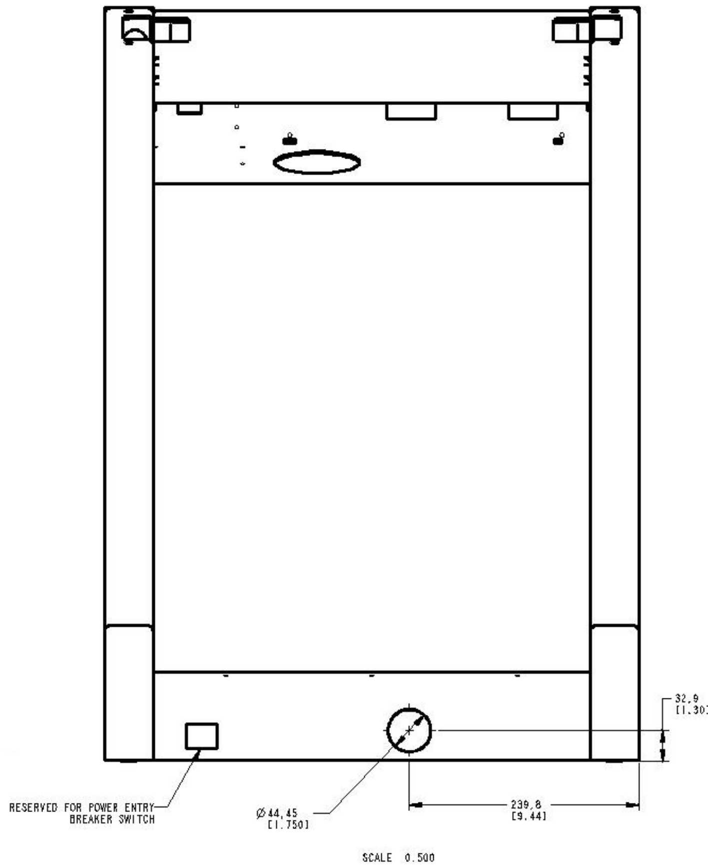
14.6.2 Z/EZ console bottom view

The measurements are in millimeters (inches).



14.6.3 Z/EZ console rear view

The measurements are in millimeters (inches).


32,9
[1.30]
RESERVED FOR POWER ENTRY
BREAKER SWITCH
Ø44,45
[1.750]
239,8
[9.44]
SCALE 0.500

14.7 About Honeywell computer platforms

Platforms sold by Honeywell are engineered for the process control mission of Experion systems to provide consistent, robust performance. Through an extensive qualification process, Honeywell defines specific peripheral devices, slot locations, and BIOS settings for best performance and reliability, sometimes even adding cooling fans for longer service. Honeywell platforms are then built to Honeywell specifications by the computer manufacturer.

Honeywell engineering has tested all the Honeywell workstations and servers with other Honeywell hardware and software and has qualified their use for specific configurations as identified in the Software Change Notice (SCN). These platforms are not standard Dell models and cannot be ordered independently from Dell. The Technical Assistance Center (TAC) is trained on and fully supports Honeywell platforms. Use of any other computer, including a similar Dell model, is considered a project special and its TAC support is limited according to the services policy.

15 Planning checklists

This section contains checklists that may be useful when planning for the installation of your Experion control system.

Related topics

"System power-on checklist" on page 134
"Equipment and documentation checklists" on page 135

15.1 System power-on checklist

✔ .	Action Item	Comments	Action by
	Check the temperatures and the humidity in the control room.		
	Check for obstruction of air flow.		
	Check correct operation of fans.		
	Check for earth faults (if earth leak detection is available).		
	Check for signal earthing, power earthing and frame earthing busbars in all the cabinets. Check the resistance for all the Busbars as per drawing.		
	Check the main incomer/UPS voltages in the PDB cabinet.		
	Check externally supplied AC voltages (from UPS). (List feeders with voltage levels.).		
	Check external AC supply is having phase, Neutral and ground three separate lines.		
	Check fuses in power distribution wiring.		
	Check all AC voltages inside the cabinets. (List feeders with voltage levels.)		
	Check fans for dust concentration.		
	Replace all dust filters if required.		
	Check the fasteners on the power distribution units.		
	Check all cable clamps.		
	Check all shield connections.		
	Check all earth/ground connections.		
	Test all communication links with external/ internal devices.		
	Check all the FTE as well as other Ethernet links.		
	Check the internal panel wiring, dressing, AC/DC wiring separation.		
	Check the entire panel I/O cabling.		
	Check the entire FTA cabling as per drawing. Check the tightness of the cabling.		
	Check power cabling in all the cabinets.		
	Check the control cabling.		
	Check the accessibility and the locations of all the items in the cabinets.		
	Check all the modules.		
	Check all the power supplies and their outputs. It should be 25vDC without load.		
	Check the ratings of all the MCB's as well as of MCCB's. in all the cabinets.		

15.2 Equipment and documentation checklists

Related topics

"Special equipment and tools" on page 135
"Honeywell documentation" on page 135
"Signature checklist" on page 136

15.2.1 Special equipment and tools

Verify the tools and equipment in the following checklist are available.

✔	Action Item	Comments	Action by
	Multimeters		
	Calibrators		
	Continuity testers, Meggers, etc.		
	Tool Kits which should include screwdriver sets, spanners, crimping tools, stripping tools, soldering gun, Anti Static wrist band, etc.		
	4-20mA Analog input Simulator		
	Digital Input Simulator		
	Termination tool kit for Fiber Optic Cabling		
	Sufficient fuses of all ratings required in system		
	Any other tools for system wiring		
	Allen keys for any particular system Wiring		
	No of Steel screws with minimum sizes and Appropriate screwdriver		

15.2.2 Honeywell documentation

Verify the documents in the following checklist are available and have been approved.

✔	Action Item	Comments	Action by
	System Architecture		
	Control Room Layout		
	System Cabinet Layout		
	Marshaling Cabinet Layout		
	Ground and Earthing Wiring Drawing		
	230 VAC Power Supply Wiring Drawing		
	24 VDC Power Supply Wiring Drawing		
	Hardware Design Manual		
	Software Design Manual		
	I/O Assignment		

✔	Action Item	Comments	Action by
	Networking drawing		
	Inter unit Cabling/Wiring drawing		
	Cabinet Layout drawings.		
	Field Cable Schedule		
	Loop Drawings, Termination details, etc.		
	Installation Guides / Manual of all bought-out material		
	Operation and Maintenance Manual of all bought-out material		

15.2.3 Signature checklist

Title	Signature
Project / Lead Engineer	
Project Manager	
Project Operations Head	
AMS Engineer	
AMS Project Manager	
AMS Operations Head	