

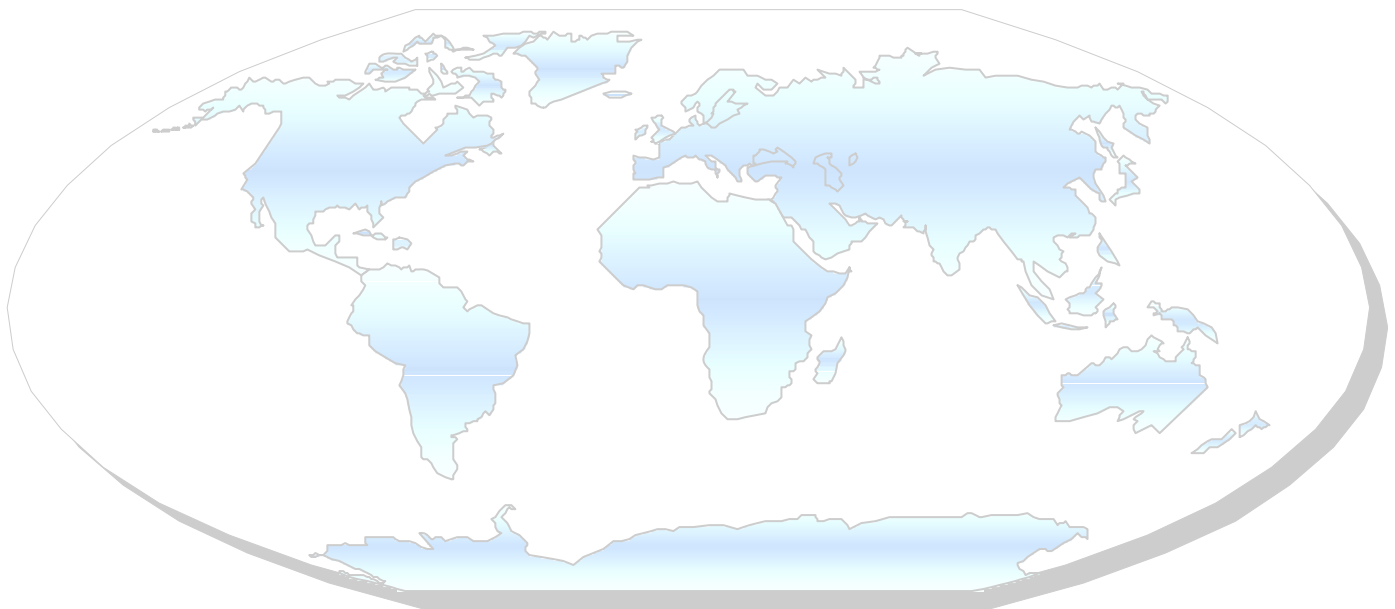
**DELPHI**

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# **Electrical Specification for Industrial Machinery**

(ADDENDUM TO IEC 60204-1: FIFTH EDITION, 2005-10)

**Global Common**



**DA 2004**

**Version 5.0**

**May 2009**

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## Foreword

This Electrical Specification for Industrial Machinery is issued by Delphi. The intent is to provide Delphi plants with safe, well designed, reliable, and productive electrical control systems for industrial machinery, which consistently produce high quality products.

This specification is designed as an addendum to “IEC 60204-1 Safety of machinery – Electrical equipment of machines – Part 1: General requirements Fifth edition 2005-10”. For clarity, the chapter headings and hence the overall format of IEC 60204-1 have been adopted, even if no additions or changes have been made. All item numbers containing technical content, have been identified as to the type of change made from IEC 60204-1. The following convention was used:

**ADD:** Requirement is completely new per this addendum. Paragraph number does not exist in IEC 60204-1.

**MODIFY:** The requirement has been modified significantly from IEC 60204-1.

**APPEND:** Additional requirements have been added. All existing requirements in IEC 60204-1 still apply.

**CLARIFY:** Informational text (*italic*) has been added to assist the user in understanding the requirement.

This specification was developed by Delphi Steering and modified by the Delphi Controls Engineering COE for Delphi Corporation. The mission was to develop a Delphi specification based on a globally accepted standard to:

- enhance safety.
- simplify and clarify the specifications in order for machinery and equipment builders to comply at minimum cost.
- encourage the common implementation across all plants.
- improve equipment reliability and maintainability.
- incorporate common divisional and plant specifications into this specification to reduce their size and complexity.
- support lean manufacturing equipment.
- support design-in safety practices.

This specification is not intended to inhibit new technology in any manner; consequently, Delphi would expect and encourage all industrial equipment builders to call to attention any situation which, in their opinion, inhibits the application of new technology. This approach allows any new technology proposal to be evaluated on the merits of its application.

Top priority is given to the enhancement of safety in the operation and maintenance of industrial equipment in conjunction with compliance with Country, State, Provincial, and/or municipal regulations and safety codes, including international consensus standards and qualified testing laboratories standards.

While Delphi believes that the specifications described in this booklet provide a sound basis for safe electrical control systems for industrial machinery, they are intended only for use within Delphi operations. The specifications were developed based solely on the equipment, operations, processes and facilities of Delphi. These specifications should not be relied on for use at non-Delphi operations and Delphi specifically disclaims any liability should these specifications be used for equipment, operations, processes, and facilities outside their intended purpose.

This specification applies to the purchase of new equipment and major equipment rebuilds. It should not be implied that any existing equipment is required to be retrofitted in order to comply with this specification.

## 1 Scope

### 1.1 ADD: Purpose

This specification is to be used for the purchase of equipment for manufacturing at all Delphi plant sites globally.

### 1.2 ADD: Standards

This equipment and devices on this equipment shall conform to international common industry standards such as IEC and ISO.

### 1.3 ADD: Modifications and additions

Equipment designed specifically for our requirements including modifications and additions to standard equipment shall also conform to these standards.

### 1.4 ADD: Mandatory requirements

Mandatory requirements of this specification are indicated by the use of "shall". Explanatory material is in *italics*.

### 1.5 ADD: Deviations

Deviations from this standard shall require advanced written approval of the Delphi controls engineer and the purchasing engineer (engineer in-charge). Any waivers granted shall apply only to the order in question and shall not be considered permanent.

### 1.6 ADD: Conflicts

The industrial equipment builder shall call to attention of the Delphi controls engineer any situation of a conflict between this standard and any other applicable code/regulation.

## 2 Normative references

### 2.1 ADD: Additional normative references

2.1.1 NFPA 70: National Electrical Code (NEC)

2.1.2 DA-2001, Delphi Specification for the Application of Safety Circuits, rev 2.1 3/03

2.1.3 DA-2006, Delphi Design-In Health and Safety Specification, rev 2.1 01SE06

2.1.4 DEG, Delphi's Design-In Ergonomics Guideline, SE05

2.1.5 Refer to purchasing division equipment purchase specifications, including drawings & manuals, HMI and PLC design guidelines.

### 2.2 ADD: Local standards

All equipment shall comply with the latest versions of any applicable federal, state, provincial, and local standards for the plant site

*CLARIFY: The industrial equipment supplier is responsible for obtaining copies of all national and international standards referenced in the specification as needed. Delphi standards are available at [www.delphisuppliers.com](http://www.delphisuppliers.com) or upon request.*

## 3 Definitions

**ADD:** the following terms and definitions:

**3.58 GFCI:** Abbreviation for Ground-Fault Circuit-Interrupter. A device which will de-energize a circuit when it senses a difference in the amount of electricity passing through the device and returning through the device, or a "leak" of current from the circuit, typically when it detects a grounding problem which has caused an unsafe flow of current to ground. These devices commonly are built into outlet-socket or the circuit breaker feeding the outlet-socket.

Other industrial terms equivalent to GFCI include "Residual Current" or "Earth Link" such as:

- Residual current device (RCD)
- Residual current protective device (RCPD)
  
- Residual current circuit breaker (RCCB)
- Earth link circuit breaker (ELCB)

**3.59 in cycle:** The control function that makes a machine capable of producing automatic motion. This is not just an indication, but the command that enables automatic motion for the duration of the cycle.

**3.60 IP:** An IEC ingress protection rating system.

**3.61 PES:** Programmable electronic system, such as a PLC or CNC controller.

**3.62 PLC:** Programmable logic controller.

**3.63 TN-C / TN-S:** Acronyms for the type of electrical supply system at a facility.

The first letter (T or I) refers to the connection between earth and the power supply:

- T is direct connection point to earth
- I is no connection point to earth (isolated)

The second letter (T or N) refers to the connection between earth and the electrical device (machine):

- T is direct connection to earth (ground rod) independent of any other earth connection
- N is connection to earth via supply conductors

The third letter (C or S) refers to the connections to PE(earth) and Neutral:

- C is one common supply wire connected to both PE and Neutral
- S is two separate supply wires; a separate PE and Neutral

## 4 General requirements

### 4.2.2 Electrical equipment in compliance with the IEC 60439 series

*CLARIFY:* Safety requirements identified by a risk assessment, and subsequent circuit performance requirements, are detailed in DA-2006 Delphi Corporation Design-In Health & Safety Specification and DA-2001 Delphi Corporation Specification for the Application of Safety Circuits.

## 4.3 Electrical supply

### 4.4.5 Phase-to-ground connection

**ADD:** Equipment shall not be connected from a phase to ground (PE) of the three phase electrical supply.

*CLARIFY:* On TN-S 5-wire systems it is acceptable to connect from the phase to neutral.

## 4.4 Physical environment and operating conditions

### 4.4.3 Ambient air temperature

*CLARIFY:* Control enclosure heat dissipation calculations shall be based on an ambient air temperature of 40 degrees C.

## 5 Incoming supply conductor terminations and devices for disconnecting and switching off

### 5.1 Incoming supply conductor terminations

*CLARIFY:* Not all Delphi facilities have the same available utility connections, specific utility information is available from the purchasing division.

### 5.3 Supply disconnecting (isolating) device

#### 5.3.2 Type

**ADD to e):** A plug/socket combination shall not be used in wet locations. A plug/socket combination shall have a minimum degree of protection of NEMA 3R or IP54. A plug/socket combination shall have a retaining means.

#### 5.3.3 Requirements

**5.3.3 APPEND:** For the US, the permanent means of being locked in the off (isolated) position only, independent of door position, shall be external to the enclosure.

#### 5.3.5 Excepted circuits

**ADD:** Such circuits shall be provided with their own disconnecting device meeting all of the following:

- lockable only in the OFF position
- mounted adjacent to the enclosure, or within the main enclosure adjacent to the main disconnect

### 5.4 Devices for switching off for prevention of unexpected start-up.

*CLARIFY:* The DA-2006 Delphi Corporation Design-In Health & Safety Specification documents requirements for

determining when power removal is required, and appropriate circuit performance level for the application.

## 6 Protection against electric shock

### 6.2 Protection against direct contact

#### 6.2.2 Protection by enclosure

**MODIFY:** All device located inside enclosures and other live parts on the inside of doors shall be protected against direct contact to at least IP2X.

**MODIFY:** Opening an enclosure shall be possible only under either condition a) or b). Condition c) and NOTE 3 are not permitted.

#### 6.2.5 Protection by barriers

**MODIFY:** Any barrier provided within a control enclosure shall protect against direct contact to at least IP2X.

#### 6.2.6 Protection by placing out of reach or protection by obstacles

*CLARIFY:* Since all control devices (controlgear) are to be placed within easy access and maintainability, this clause is not applicable.

## 7 Protection of equipment

### 7.1 General

*CLARIFY:* Protection of equipment includes but is not limited to considerations for available fault current, voltage ratings, withstand ratings, and current limiting characteristics.

### 7.2 Overcurrent protection

#### 7.2.1 General

**ADD:** The equipment's overcurrent protective devices and power distribution devices shall be suitable for use on circuits capable of delivering 65,000 amperes symmetrical (rms), 50/60 hertz of short circuit current.

*Note:* For custom-designed systems the most cost-advantageous solution is to use Class-J fuses in the main disconnect. For commodity CNC machinery the industrial equipment supplier should consider one of the following two common solutions:

- either add a self-enclosed disconnect with Class-J fuses ahead of the CNC system, or
- if a three-phase transformer is provided ahead of the CNC system, verify that the system is suitable for (can withstand) the available short circuit current from the transformer.

## 7.2.5 Socket outlets and their associated conductors

**APPEND:** Overcurrent protection for convenience socket outlets (those not intended for maintenance equipment) shall not exceed 15 amperes for 120 volt applications, and 7.5 amperes for 230 volt applications.

## 7.2.6 Lighting circuits

**APPEND:** Overcurrent devices for lighting circuits shall not exceed 15 amperes for 120 volt applications, and 7.5 amperes for 230 volt applications.

## 7.2.7 Transformers

**APPEND:** Transformers shall be protected against overcurrent in accordance with the manufacturer's instructions, or with short circuit protective devices (SCPD) in accordance with Table 7.2.7 as follows:

Overcurrent Protection Provided in the:	Primary Current (amperes)	Maximum Primary SCPD	Maximum Secondary SCPD
Primary Only	< 2	300%	-
	< 9	167%	-
	≥ 9	125%	-
Primary and Secondary	< 9	250%	167%
	≥ 9	250%	125%

**Table 7.2.7**

## 7.2.9 Overcurrent protective devices

**CLARIFY:** Clause 16.4 requires that the short-circuit rating (SCR) of the equipment be marked on the nameplate attached to the enclosure. NFPA 70 includes this same requirement; calling it the short-circuit current rating or SCCR.

**ADD:** The SCR for the main enclosure shall be shown on the prints (either on the circuit diagrams, or a depiction of the nametag).

## 7.2.11 ADD: Resistance heating branch-circuit overcurrent protection

If the branch circuit supplies a single nonmotor-operated load rated at 16.7 amperes or more, the overcurrent device rating shall not exceed 150 percent of the load rating.

Equipment employing resistance-type heating elements rated at more than 48 amperes shall have the heating elements subdivided. Each subdivided load shall not exceed 48 amperes and shall be protected at not more than 60 amperes.

Exception: A single sheath-type heating element requiring more than 48 amperes shall be protected at not more than 125 percent of the load where the element is integral with and enclosed within the machine housing.

## 7.3.2 Overload protection

### 7.3.2.1 ADD: Sizing overloads

Where overload protection is provided they shall be set at no greater than 115% of motor full-load amperage.

### 7.3.2.2 ADD: Reset of overloads

Resetting of the overload device shall not restart the motor.

### 7.3.2.3 ADD: Motor starter interlock and logic

When Programmable Electronic Systems are used to control motors, a normally open auxiliary contact from the motor starter shall be wired as an input. In the logic this input in series with a contact from the motor starter's output coil shall be used to seal in the motor starter's output coil.

*Note: This interlock is required such that resetting of the overload device does not restart the motor.*

## 8 Equipotential bonding

### 8.2 Protective bonding circuit

#### 8.2.2 Protective conductors

**8.2.2.1 ADD:** Conductor type  
Copper conductors are required.

**8.2.2.2 ADD:** Conductor cross-sectional area

The minimal cross-sectional area of all protective conductors shall be in accordance with IEC 60204-1 Table 1 (see 5.2).

#### 8.2.3 Continuity of the protective bonding circuit

**APPEND:** The continuity of the ground circuit between enclosures and/or field devices shall be ensured by effective connections through conductors only (machine mechanics are not permitted as the grounding path). Equipment grounding conductors shall be terminated in each electrical enclosure on a common ground bar bonded to the subplate.

*Note: Connection between the external protective conductor PE terminal and the main enclosure's common ground bar through the steel subplate is not considered effective, but instead must be through a conductor.*

#### 8.2.3.1 Manufacturer's recommendations

Where specified by the manufacturer, components and subassemblies shall be effectively bonded to the equipment grounding (protective bonding) circuit in accordance with the manufacturer's recommendations.

### 8.3 Functional bonding

**APPEND:** Single-phase AC circuits and DC circuits shall be grounded (connected to the protective bonding circuit).



## 9 Control circuits and control functions

### 9.1 Control circuits

#### 9.1.2 Control circuit voltages

Control voltage shall be 24 vdc grounded.

### 9.2 Control functions

#### 9.2.2 Stop functions

Cycle stop circuits shall

- be provided on continuous cycle machines,
- be stop category 2,
- stop the machine at its normal home position.

#### 9.2.3 Operating modes

##### 9.2.3.1 ADD: Manual operation

For manual operation, operator devices shall be provided to perform individual functions. Manual functions shall not operate during automatic mode. The design should minimize interlocks in manual mode to allow maximum freedom of operation without damage or hazard.

*Note: These requirements apply to axis motion as well as fluid power motions.*

*Note: Operator devices include but are not limited to: pushbuttons, momentary selector switches, operator interface keys or keypads, manual pulse generators.*

*Note: Direct mechanical operation of a solenoid valve is not considered the operator device.*

*Note: A single-step manual function (stepping through the machine sequence) is allowed, but not as a replacement to the individual manual functions required above.*

##### 9.2.3.2 ADD: Multiple operator control station(s) equipment

On multiple operator control station machinery, each operator station shall be provided a means for selecting and indicating the mode at that station.

#### 9.2.4 Suspension of safeguards

**9.2.4 MODIFY:** Cableless controls shall not be implemented for suspension of safeguards.

**9.2.4.1 ADD:** When two-hand control is used to bypass a safeguard (such as a light curtain or interlocked guarding) the two-hand control shall be implemented at a minimum Type 3.

**9.2.4.2 ADD:** When an enabling device (such as a live-man switch) is used to bypass a safeguard the enabling device circuit performance level shall be consistent with the safeguard circuit being bypassed.

#### 9.2.5 Operation

#### 9.2.5.1 General

**CLARIFY: Multiple Start Locations.** Where the start function is part of the machine's safety circuit, the start function's circuit performance shall meet the requirements of DA-2006 Delphi Corporation Design-In Health & Safety Specification and DA-2001 Delphi Corporation Specification for the Application of Safety Circuits. Exceptions to IEC 60204-1 clause 9.2.5.2 are allowed as documented by the system's risk assessment.

#### 9.2.5.2 Start

**CLARIFY: Manual Control as Safeguards.** Circuit performance requirements for manual controls implemented as operator safeguarding are detailed in DA-2006 Delphi Corporation Design-In Health & Safety Specification and DA-2001 Delphi Corporation Specification for the Application of Safety Circuits.

#### 9.2.5.4 Emergency operations (emergency stop, emergency switching off)

##### 9.2.5.4.2 Emergency stop

**APPEND:** Emergency stop circuits for systems which require an emergency stop pushbutton shall conform to all of the following:

- a) The emergency stop pushbutton shall be connected directly to a hardwired relay.
- b) The relay shall perform the required emergency stop function.
- c) The relay shall be reset (started) by a contact from the Master Start pushbutton, an Emergency Stop reset pushbutton, or a PLC contact output with logic initiated by an HMI reset button. The relay shall not be reset by pulling-out or twist-release of the emergency stop pushbutton. The relay shall not reset on application of power.

#### 9.2.5.5 Monitoring of command actions

##### 9.2.5.5 APPEND: Position and movement sensors

Proper sequencing, movements, and positioning of equipment and parts in process shall be sensed with position and movement sensors. Where monitoring the tooling position is not critical to the part processing or part quality; proximity style integral cylinder sensors are permitted. Sensing of time or pressure in lieu of position and movement requires Delphi controls engineer approval prior to the issuance of the machinery purchase order.

*Note: Position sensors should be limited to only what is needed. Some processes do not require a position sensor on each end of a motion. As an example, an auto-eject may not need a sensor because if the motion does not occur the operator can observe it.*

## 9.2.6 Other control functions

### 9.2.6.5 ADD: Cycle overtime feature

A cycle overtime feature shall be supplied on single cycle and continuous cycle equipment. The cycle overtime timer(s) shall be timing whenever the equipment is in cycle. When a cycle overtime occurs, auto cycle shall be deactivated (but not auto mode) and a cycle overtime fault shall be indicated. The cycle overtime fault shall be an immediate stop fault.

### 9.2.6.6 ADD: Control Functions – Diagnostics and Fault Logic

Delphi's functional control requirements for machine diagnostics and fault logic are detailed in the purchasing division specifications for Programmable Controller logic and Human Machine Interface applications.

### 9.2.7 Cableless control

Use of cableless control requires Delphi controls engineer approval prior to the issuance of the machinery purchase order.

## 9.4 Control functions in the event of failure

### 9.4.1 General requirements

*CLARIFY: Delphi's risk assessment requirements are detailed in DA-2006 Delphi Corporation Design-In Health & Safety Specification.*

### 9.4.4 ADD: Control systems incorporating software and firmware based controllers

Control systems incorporating software and firmware based controllers performing safety-related functions shall be self-monitoring and conform to all of the following:

- 1) in the event of any single failure, the failure shall:
  - a) not lead to the loss of the safety-related function
  - b) lead to the shutdown of the system in a safe state
  - c) prevent subsequent operation until the component failure has been corrected
  - d) prevent unintended startup of equipment upon correction of the failure
- 2) provide protection equivalent to that of control systems incorporating hardwired / hardware components
- 3) be designed in conformance with an approved standard that provides requirements for such systems

## 9.5 ADD: Programmable control devices

*Note: The following Clause 9.5's requirements are all additions unless otherwise indicated.*

### 9.5.1 Inputs and outputs

**9.5.1.1** Programmable controller inputs shall be sinking (+24 vdc applied to the appropriate input shall cause a false to true transition) and outputs shall be sourcing (+24 vdc shall be applied to the load when the output is active).

**9.5.1.2** 10% spare I/O space shall be provided. This requirement extends to the I/O image table which shall have space reserved to accommodate these spare I/O requirements.

**9.5.1.3** An indication of the status of all digital inputs and outputs shall be provided.

### 9.5.2 Battery low indication

The battery low fault, when available from programmable equipment, shall be enunciated.

### 9.5.3 Programmable device power

Programmable controllers and human-machine interfaces shall be powered whenever the disconnect switch is on.

*Note: This typically means they are powered directly from the 24vdc power supply above any control circuits.*

### 9.5.4 Programming equipment

#### 9.5.4.1 Passwords

Passwords and/or access codes which disallow the user from altering the program are not permitted.

#### 9.5.4.2 Application program

Programming equipment shall provide the end user with the ability to enter, alter, view, upload and download the application program. In addition, the PES shall provide the ability to disable, change, and view all input and output status points as well as data at any memory address.

#### 9.5.4.3 Communication port

PES systems shall be designed such that one communication port is always available for use with the programming equipment. The port shall not require that any other systems interface be disconnected to use the programming equipment. For North American (USA and Mexico) facilities this programming port shall be provided at a readily accessible location on the exterior of the control enclosure.

#### 9.5.4.4 Receptacle

A minimum of one (1) receptacle for use by the programming equipment shall be provided, located adjacent to the programming port. The voltage and receptacle type shall be appropriate for the receiving plant.

### 9.5.5 Communication

All inter-device communications shall be ethernet based. An ethernet switch(es) shall be used to facilitate this communication. This switch shall have at least two spare ports, one for future plant network connections and one to satisfy the programming port requirement detailed above.

### 9.5.6 Part quality device interface

Part quality circuits shall protect against device malfunctions and shall give protection against qualifying reject parts as good. Inputs from part quality devices shall be a “Good Part” signal, not a “Reject Part” signal, in order to functionally check both the input and device each cycle. Proper operation of part quality devices shall be verified just prior to their use in classifying part status.

### 9.5.7 Part quality logic

Part quality logic shall be designed to prevent mis-qualifying a Reject Part as a Good Part. At a minimum the machine logic shall:

- 1) reset Good Part status upon removal of the part or, where no Part Present signal is provided, reset Good Part status upon change of mode.
- 2) reset Good Part status upon opening of an interlocked safety gate on automatic part-transfer systems where a part can be removed.  
*Note: Solenoid-locking interlock switches can minimize this occurrence.*
- 3) The PLC logic shall be written such that downloading the program to the PLC does not cause an incorrect part number to be run. The first scan of the program must reset all program (pn) selects to a null value and require part number verification by the operator via the system HMI
- 4) On PLC run/program/run transitions, including downloading programs, the program shall reset all part status in the machine shift register that cannot be validated as to quality because of machine timing or current position to a failed status. Only parts that are newly qualified as good as the system cycles may be called good.

### 9.5.8 Reject part manual unload

Machines which include hand-unload of parts require the following reject control sequence:

- 1) The machine shall drop out of cycle upon a Reject Part (optionally in some situations, as directed by the Delphi purchasing engineer, the machine shall continue to the end of the cycle).
- 2) The Reject Part shall remain clamped or, where no part clamp is provided at least one machine motion shall stay Advanced to prevent removal of the part.
- 3) The machine shall notify the operator of the Reject Part via the human-machine interface and / or an indicator light.
- 4) The operator must acknowledge the detection of the Reject Part. Once acknowledged, the machine shall unclamp or allow removal of the Reject Part.
- 5) The operator must remove the Reject Part from the fixture and place the part into a reject chute or bin.
- 6) The machine shall not be permitted to start the next cycle until the machine has verified the Reject Part has been placed into the reject chute or bin. The functionality of the reject chute sensor shall be

verified (such as logic requiring a transitioning from Off to On).

### 9.5.9 Solenoid valve control

PES logic circuits for hydraulic and pneumatic valves shall be designed to keep their solenoids energized until the opposite motion is initiated, as shown in Figure 9.5.9. This solenoid seal-in circuit shall be interrupted to prevent motion during power-up sequence.

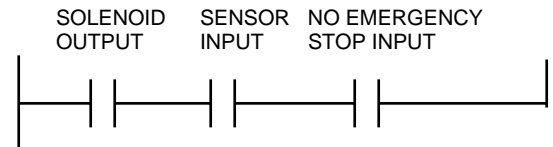


Figure 9.5.9

## 10 Operator interface and machine mounted control devices

### 10.1 General

**ADD:** Operator interface device identification tags shall be engraved with black characters on a white background. Machine mounted control device identification tags shall be provided as detailed in clause 16.3 of IEC 60204-1. The identification tag for actuators of emergency stop devices shall be engraved with black characters on a yellow background.

#### 10.1.1 General device requirements

##### 10.1.1.1 ADD: Non-permitted devices

The following devices shall not be used:

- Push selector switches for start-stop operation
- Time delay push-buttons, selectors, limit switches
- Drum type reversing switches
- Alternate acting push-buttons (requires advanced purchaser approval)
- Push/pull buttons for start-stop operations
- Lockable E-stop buttons
- Maintain position limit switches except for safety limit switches
- Latch relays for control of motion

#### 10.1.2 Location and mounting

**MODIFY:** Delphi ergonomic requirements for hand or foot-operated control devices are detailed in Delphi’s Design-In Ergonomics Guideline.

##### 10.1.2.1 Hand-operated control devices

**ADD:** All start pushbuttons shall be mounted above or to the left of their associated stop pushbuttons.

### 10.1.2.2 Foot-operated control devices

**ADD:** Foot-operated switches used for applications where accidental actuation could create a hazardous situation shall be protected to prevent accidental actuation by falling or moving objects and from unintended operation by accidental stepping onto the switch.

Exception: Foot-operated switches used for emergency stop shall not be of the covered or hooded type.

### 10.1.2.3 ADD: Arrangement of control station - Grouping of automatic and manual controls

Control pushbuttons, pilot lights, selector switches, panel meters, and human machine interface screens shall be arranged so the automatic controls are grouped and separately spaced from the manual controls. Manual controls shall be arranged in logical order in accordance with the sequence of machine operation.

## 10.2 Push-buttons

### 10.2.3 ADD: Type

Hardwired pushbutton actuators used to initiate a stop function shall be of the extended operator or mushroom-head type.

## 10.3 Indicator lights and displays

### 10.3.1 General

**APPEND:** All hardwired indicator lights shall have a lamp test feature. The lamp test feature can be push-to-test or a separate test circuit

**ADD:** All indicator lights shall be 24vdc or less.

### 10.3.2 Colors

**CLARIFY:** *The color requirements for indicating towers on machines (stack lights) are included in the purchasing specification when required.*

**APPEND:** The POWER ON light shall be white.

## 10.6 Start Devices

**CLARIFY:** *To meet this specification mushroom-type and illuminated pushbutton actuators used to initiate a start require a ring-guard.*

## 10.7 Emergency stop devices and stop devices

### 10.7.1 Location of emergency stop devices

**APPEND:** All stop devices shall be continuously operable and readily accessible.

### 10.7.2 Types of emergency stop devices

**ADD:** Pushbutton-type devices for emergency stop shall be of the self-latching type, in compliance with IEC 60947-5-5.

### 10.7.3 Color of actuators

**CLARIFY:** *The background immediately around the pushbutton, such as the identification tag, shall be colored YELLOW.*

### 10.7.4 Local operation of the supply disconnecting device to effect emergency stop

**MODIFY:** The supply disconnect shall not serve the function of emergency stop.

### 10.7.5 ADD: Emergency stop indication

If four or more emergency stop devices are used, they shall be individually light annunciated.

## 10.8 Emergency switching off devices

**MODIFY:** Emergency switching off devices are not permitted.

## 10.9 Enabling control device

**CLARIFY:** *Where the enabling control device is part of the machine's safety circuit the requirements are detailed in DA-2006 Delphi Corporation Design-In Health & Safety Specification and DA-2001 Delphi Corporation Specification for the Application of Safety Circuits. Exceptions to IEC 60204-1 clause 10.9 are allowed as documented by the system's risk assessment.*

## 11 Controlgear: location, mounting and enclosures

### 11.2 Location and mounting

#### 11.2.1 Accessibility and maintenance

**CLARIFY:** *(Second paragraph) The Delphi ergonomic requirements as they apply to controlgear are detailed in the Delphi Design-In Ergonomics Guideline.*

**MODIFY:** (Third paragraph) Remote programming ports and receptacles are permitted to be mounted on doors or normally removable access covers of enclosures.

**MODIFY:** (Third paragraph) Supply disconnecting devices shall not be mounted on doors, nor on normally removable access covers of enclosures.

**CLARIFY:** *(Third paragraph) Disconnect handles can be mounted on the door, but the switch cannot be mounted on the door.*

**APPEND:** (Fourth paragraph) Plug-in devices and assemblies shall be mechanically secured.

**APPEND:** (Second and sixth paragraph) Terminal blocks shall be mounted to provide unobstructed access to terminals and conductors. Stackable, or multi-tier terminals are permitted, with a maximum of two (2) tiers. Terminals shall be mounted to a DIN rail, which is mounted to the subplate. Terminals shall be located between 0.2 m and 2.0 m above the servicing level.

**ADD:** Only devices for operator control, disconnects, indicating, measuring, cooling, remote programming ports and receptacles are permitted to be mounted through the side of the control enclosure.

**ADD:** All operator and setup controls shall be adjustable without opening the electrical enclosure.

### 11.2.2 Physical separation or grouping

**APPEND:** For cooling considerations, control devices shall be mounted per the manufacturer's recommended clearance (space).

### 11.2.3 Heating effects

**CLARIFY:** To minimize enclosure size and temperature rise, consideration should be given to mounting suitably enclosed heat producing devices, power factor correction capacitors and transformers outside of the control enclosure.

### 11.2.4 ADD: Mounting

**ADD:** All enclosure-mounted controlgear, including those in terminal boxes and operator stations, shall be mounted on a steel subplate unless otherwise explicitly permitted within IEC 60204-1 or this document.

**ADD:** Manufacturer's standard mounting details shall not be modified.

**ADD:** No devices shall be mounted behind the disconnecting means.

**ADD:** Threaded fasteners with machine threads shall be used to attach components to a subplate and shall provide sufficient thread engagement to maintain secure mounting.

**CLARIFY:** Steel subplate thickness shall provide engagement of at least 2 full threads.

### 11.3 Degrees of protection

**MODIFY:** All enclosures shall be a minimum of IP 54 or NEMA 12.

**CLARIFY:** To maintain this ingress protection rating of the enclosure(s) all raceways, heat exchange devices, and other devices connected to any enclosure require an equivalent rating. Externally mounted transformers do not require this rating but their connection method does need to maintain this rating.

**ADD:** Junction boxes shall not be mounted within any coolant spray area.

### 11.4 Enclosures, doors, and openings

**CLARIFY:** For control enclosure door interlocking requirements refer to IEC 60204-1 clause 6.2

#### 11.4.1 MODIFY: Door swing

All enclosure doors require an angle of opening of at least 95°. Enclosure doors shall have a minimum clearance of 150 mm (6 inches) above the servicing level.

#### 11.4.2 ADD: Spare space

A minimum of 10% spare usable subplate space is required in all electrical enclosures.

#### 11.4.3 ADD: Door hinges

All control enclosures which contain controlgear shall have vertical hinged doors. All operator interface and junction boxes greater than 400 cm<sup>2</sup> (60 inches<sup>2</sup>) shall have a hinge(s). Hinged doors shall be permanently affixed if control devices are mounted to the door.

### 11.5 Access to controlgear

**CLARIFY:** The access dimension in front of (from the front of) all control enclosures which contain controlgear shall be at least 1.0 m (39 inches). Where control enclosures which contain controlgear are present on both sides of an access way, this access dimension shall be at least 1.5 m (60 inches).

## 12 Conductors and cables

### 12.2 Conductors

**MODIFY:** Conductors shall be copper.

### 12.3 Insulation

**ADD:** The types of insulation shall:

- be rated for 75°C,
- be voltage rated per the application,
- (for cords and cables) have an environment rating at least equal to the control enclosure rating

**MODIFY:** The following insulation types are also allowed, and are preferred:

- MTW—Moisture-, Heat-, and Oil-Resistant Thermoplastic  
90°C (194°F) Dry Locations
- THHN—Heat-Resistant Thermoplastic  
90°C (194°F) Dry Locations
- THW—Moisture- and Heat-Resistant Thermoplastic  
75°C (167°F) Dry and Wet Locations
- THWN—Moisture- and Heat-Resistant Thermoplastic  
75°C (167°F) Dry and Wet Locations
- RHH—Thermoset  
90°C (194°F) Dry Locations
- RHW—Moisture-Resistant Thermoset  
75°C (167°F) Dry and Wet Locations
- RHW-2—Moisture-Resistant Thermoset  
90°C (194°F) Dry and Wet Locations
- XHHW—Moisture-Resistant Thermoset  
75°C (167°F) Dry and Wet Locations
- XHH2-2—Moisture-Resistant Thermoset  
90°C (194°F) Dry and Wet Locations

## 12.4 Current-carrying capacity in normal service

**MODIFY:** The maximum current carrying capacity for AWG conductors shall not exceed the values given in Table 310.16 of NFPA 70, *National Electrical Code*. Annex H contains current carrying capacities derived from Table 310.16 of NFPA 70.

### Table 6 – Examples of current-carrying capacity

**CLARIFY:** Refer to Annex H for a chart comparing typical mm<sup>2</sup> and AWG conductor sizing.

## 13 Wiring practices

### 13.1 Connections and routing

#### 13.1.2 Conductor and cable runs

**13.1.2.1 MODIFY:** The existing 13.1.2 Exception is not allowed.

**13.1.2.2 ADD:** Exception: Crimp-on connectors may be used for devices which have integral leads (examples: motors and valves). Twist-on connectors (typically referred to as wire-nuts) are not allowed.

*Note: Examples of allowed connectors include crimp-on ring connectors and butt-splices typically used for wires #4 AWG and smaller, or split-bolts and box-lug ring connectors typically used for wires larger than #4 AWG.*

#### 13.1.3 Conductors of different circuits

##### 13.1.3.1 Conductors supplied from separate disconnects.

**ADD:** Where the equipment has two or more sources of power or two or more independent disconnecting means, power wiring from each disconnecting means shall be run in separate raceway and shall not terminate in or pass through common junction boxes.

##### 13.1.3.2 Electromagnetic interference

**ADD:** To minimize electromagnetic interference, electronic devices and associated wiring shall be segregated from the electromagnetic control and power wiring.

*Some methods to minimize electromagnetic interference are:*

- *Field wiring for electronic devices could be contained in a separate metallic raceway from potential sources of interference.*
- *Conductors from AC circuits should not be run in parallel with conductors from DC circuits, and should cross at 90° angles.*
- *Sensitive devices could be located in separate panel enclosures.*

### 13.1.5 ADD: Support for flexible cables and cords

Cables and cords shall be supported by the equipment or system structure as follows:

- in such a manner that the cable/cord will not be damaged by normal equipment use.
- every 300 mm (~12 in.) when suspended in a non-vertical run
- not attached to removable guarding.
- such that bends in cables/cords do not cause undue stress.

### 13.2 Identification of conductors

#### 13.2.1 General requirements

**MODIFY:** Conductors shall be identified by number or alphanumeric. Conductor identification by color alone is not permitted. Exception: The protective conductor is permitted to be identified as Green-and-Yellow as detailed in IEC 60204-1 clause 13.2.2.

**CLARIFY:** Identification of the light-blue neutral conductor shall include the alpha character N as a minimum.

**CLARIFY:** Industry standard cables such as serial communication cables are not required to have individual conductors identified where the cable is identified by number, alphanumeric, or a combination of color and numbers or alphanumeric.

#### 13.2.4 Identification by color

**13.2.4.1 ADD: Color-coded insulation required.** Insulated conductors shall be color-coded. The color-coding recommendations of this clause shall be followed. In addition the following colors shall be used:

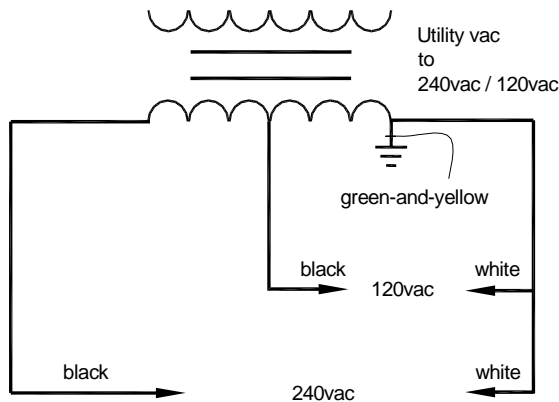
- WHITE: a.c. grounded conductor (current carrying ground)
- BLUE: d.c. grounded conductor (current carrying ground). Exception: Any combination of blue and white is permitted for the d.c. grounded conductor. The color shall be used consistent throughout the equipment.

Exception: Color-coding is not required for multi-conductor cables or cords.

**13.2.4.2 CLARIFY:** *Color-coded insulation applications.* The following are typical Delphi applications for insulation color-coding as required by 13.2.4.1:

- **GREEN-AND-YELLOW:** protective conductor (referred to as PE, or ground)
- **LIGHT BLUE:** neutral conductor (or N) used for single phase 230vac from a 5-wire 400vac utility power(phase to N)
- **BLACK:** a.c. power circuits include three-phase utility and distribution circuits, 230vac or 120vac single phase receptacles, fans, instrumentation power, and a.c. drive output wiring to the motor
- **WHITE:** the grounded conductor (current carrying ground) for the above listed a.c. power circuits
- **BLACK:** d.c. drive output wiring to the motor
- **RED:** a.c. control circuits (Delphi does not use a.c. control circuits)
- **BLUE:** 24vdc control circuits including the grounded conductor (current carrying ground)
- **ORANGE:** excepted circuits as permitted in 5.3.5 such as control interlocks and lighting disconnect circuits

**13.2.4.3 ADD:** **Wire colors for multiple a.c. power voltage levels.** Where 240 vac and 120 vac single phase are both present in an enclosure they shall be supplied either from separate transformers or from the single-phase secondary of a multi-tap transformer as shown in Figure 13.2.4.3.



**FIGURE 13.2.4.3 Wire Color Identification**

### 13.3 Wiring inside enclosures

**13.3.1 MODIFY:** **Nonmetallic/nonflammable ducts.** Nonmetallic/nonflammable ducts (wiring channels) are required in enclosures, they shall be mounted on the subplate(s), with a maximum 50% fill.

**13.3.2 CLARIFY:** *Wiring that extends beyond the enclosure.* PES I/O termination points are considered terminal blocks for control wiring that extends beyond the enclosure.

### 13.4 Wiring outside enclosures

**13.4.5 Plug/socket combinations**  
**MODIFY Exception c) to read as follows:** (additions are underlined) Plug/socket combinations intended to be connected or disconnected during load conditions shall have sufficient load-breaking capacity. Where the plug/socket combination is rated at 30 A, or greater, or applied at a voltage greater than 300 V, it shall be interlocked with a switching device so that the connection and disconnection is possible only when the switching device is in the OFF position. A switch-rated plug/socket combination (such as load-make / load-break, or disconnect-rated combination) meets these requirements.

### 13.4.7 Additional conductors

**ADD:** Spare conductors shall be provided for all junction boxes, pull boxes, and raceways directly connected to the main enclosure. Spare conductors shall be of sufficient length to reach the extreme points of the enclosure unless terminated. Spare conductors shall be uniquely labeled such as "SP1", "SP2". The number of spares for each junction box or pull box shall be 5% of the total conductors used or a minimum of two, whichever is greater. Spare conductors in any multiconductor cable shall not be cut off.

### 13.5 Ducts, connection boxes and other boxes

#### 13.5.1 General requirements

**CLARIFY:** *Ducts, rigid and flexible conduit, fittings, and connection boxes shall maintain the degree of protection (the NEMA or IP rating) consistent with the enclosure requirements from clause 11.*

#### 13.5.3 Rigid metal conduit and fittings

**13.5.3.1 ADD:** Electrical Metallic Tubing is not permitted.

**13.5.3.2 CLARIFY:** *Selection of fitting type should also be considered when determining the effective internal diameter (percentage fill) of conduit.*

## 14 Electric motors and associated equipment

### 14.2 MODIFY: Motor Enclosures

The degree of protection shall be at least IP54, or TEFC, for all motors.

## 14.5 Criteria for motor selection

### 14.5.1 Inverter rated

**ADD:** All 3-phase electrical motors controlled by a drive, such as a variable frequency drive, shall be inverter rated.

## 14.7 ADD: Direction arrow

A direction arrow is required for all three phase motors. The arrow shall be adjacent to the motor and plainly visible.

## 14.8 ADD: Motor nameplate

A motor nameplate is required on all three phase motors. The nameplate shall include as a minimum:

- manufacturer's part number
- frame size
- rated frequency(s)
- rated voltage(s)
- full load amperage
- RPM
- horsepower or watts
- CE Mark (for Europe)

Special characteristics of AC motors shall be shown on a separate nameplate mounted adjacent to the conventional motor nameplate. Typical examples include special insulation, shaft length, torque, balance, lubrication, and mounting.

## 15 Accessories and lighting

**CLARIFY:** The requirements of clause 13.4.5 also apply to plug/socket combinations used for accessories and lighting.

### 15.1 Accessories

#### 15.1.1 Ground-fault circuit-interrupter (GFCI)

**ADD:** All socket-outlets shall be provided with GFCI or equivalent protection.

### 15.2 Local lighting of the machine and equipment

#### 15.2.2 Supply

**Modify:** The permitted sources for lighting circuits shall be the first, third, or fourth bullet from IEC 60204-1 15.2.2 clause. The Exception for this clause is not permitted. The fourth bullet shall be modified as follows: (additions are underlined):

- an isolation transformer connected to the line side of the supply disconnecting device, provided with a dedicated primary disconnecting means (see 5.3.5) and secondary overcurrent protection, and mounted within or adjacent to the control enclosure, and mounted adjacent to the supply disconnecting device (see also 13.1.3).

#### 15.2.3 Protection

**ADD:** Work lights operating at a voltage greater than 24vdc shall be provided with ground-fault protection (GFCI).

### 15.2.4 Fittings

**ADD:** Work lights exposed to coolants or other liquids shall be installed in liquid-tight fixtures that are protected from damage caused by chips, broken tools or similar items.

## 16 Marking, warning signs and reference designations

### 16.2 Warning signs

#### 16.2.1 Electric shock hazard

**ADD:** The warning sign shall be:

- provided adjacent to the main disconnect operating handle where the disconnect does not de-energize all conductors when the disconnect is in the open (off) position.
- attached to the control enclosure door for systems where the main disconnect is either an attachment plug or a remote mounted disconnect.

### 16.4 Marking of equipment

**CLARIFY:** The nameplate requires the equipment short-circuit rating (SCR or SCCR). The SCR calculations can take into account an available fault current of 65,000 amperes symmetrical (RMS), 50/60 hertz as detailed in item 7.2.1 of this document.

## 17 Technical documentation

### 17.2 Information to be provided

**ADD:** the following items to list b):

- 13) Panel and operator layouts;
- 14) Interdevice communication diagram(s);
- 15) Electronic schematics ( where appropriate);
- 16) Lubrication diagram (reference only when the equipment has a lubrication system);
- 17) Pneumatic diagram (reference only when the equipment has a pneumatic system);
- 18) Hydraulic diagram (reference only when the equipment has a hydraulic system);
- 19) Miscellaneous system diagrams such as coolant, water, steam, and test oil, (reference only when the equipment has such systems);
- 20) Program copy; one copy of the as-shipped program, stored on compact-disk (CD), suitable for direct machine loading with the manufacturer's standard peripheral equipment or with Delphi's specified support system.
- 21) Compiled code (for systems running compiled code); one copy of the source code stored on CD.

*Note: These program copy CDs and compiled code CDs shall either be placed in the main electrical enclosure or shipped to the Delphi purchasing engineer (engineer in charge).*



### 17.3 Requirements applicable to all documentation

**MODIFY:** Delphi's documentation requirements for machine (electrical, hydraulic, pneumatic, and miscellaneous system diagrams), tooling, and gauging drawings are detailed in the purchasing divisions specifications for drawings & manuals.

### 17.6 Circuit diagrams

#### 17.6.1 ADD: Device identification

Devices shall be identified by a number-letter combination using designations as shown:

Control Relay	207CR
Motor Starter	1014M
Limit Switch	735LS

#### 17.6.1.1 Device numbers

Device numbers for devices connected to a PLC must have the same number as the input or output. For systems with controller tag names the device number shall be the tag name. If a single device is connected to more than one input or output, that device shall be assigned a single number.

Non-PLC numbers may be assigned in sequential order or using the line reference number where the device is located on the drawing. When line reference numbers are used, similar devices on the same line require an additional identifier (example on line 605: 605\_1LS and 605\_2LS).

#### 17.6.1.2 Device function

The functional description for each device shall be shown adjacent to its symbol. Functional descriptions shall be in present or past tense. Motion terminology shall have the verb prior to the noun (Raise Press) and position or status terminology shall have the noun prior to the verb (Press Raised). Further examples are listed in Table 17.6.1 below.

*Note: Simple control device terms such as Extend Cylinder or Retract Cylinder do not describe the actual function of the tooling and therefore are not permitted. Vertical motions are typically described as Raised or Lowered, they are not Advanced or Retracted.*

Motion	Sensor
Lower Press	Press Lowered
Retract Shot Pin	Shot Pin Retracted
Advance Shuttle	Shuttle Advanced
Close Part Clamp	Part Clamp Closed
Open Part Clamp	Part Clamp Opened
Open Collet	Collet Opened
Expand Mandrel	Mandrel Expanded
Lower Front Tooling Slide	Front Tooling Slide Lowered
Rotate Tube to Punch Position	Tube Rotated to Punch Position

**Table 17.6.1**

#### 17.6.2 ADD: Cross-referencing

A cross-referencing scheme shall be used in conjunction with each relay, output device, limit switch, and pressure switch such that any contact associated with the device can be readily located on the diagram.

#### 17.6.3 Graphical symbols

**CLARIFY:** ANSI based graphical symbols are preferred for Delphi US, Mexico, and China facilities. IEC based graphical symbols are preferred for Delphi European facilities. Refer to Annex I of this document for cross-reference of ANSI to IEC based graphical symbols. Symbols shown in Annex I are permitted. Adherence to only one column, either the ANSI symbol or IEC Symbol column is recommended. Based on the annex, the vendor and the Delphi controls engineer should come to an understanding on which method to use.

#### 17.6.4 Characteristics relating to the function

**CLARIFY:** Functional characteristics which are not evident from the symbol are required per IEC 60204-1 clause 17.6. These characteristics include, but are not limited to:

- voltage, current (FLA), and short circuit rating (SCR or SCCR) for supply connections
- transformer voltages and KVA ratings
- motor data such as horsepower or kw, frame size, full load amperage, voltage, and speed
- fuse and circuit breaker sizes (by manufacture's number)
- wire sizes, identification, and color
- cable assembly identification number and conductor identification
- settings for user programmable devices (such as dip switches, jumpers, and rotary switches)
- settings for time, temperature, and pressure
- rack and slot locations of PES cards
- electrical values and ratings load resistors and potentiometers that are not detailed on the parts list and subplate layout(s)
- special documentation for unique devices

The information can be documented within the circuit diagrams adjacent to the device or on a chart near the circuits.

## 17.9 Parts list

**CLARIFY:** *The parts list shall be provided in the format detailed in the specification included by Delphi purchasing engineer related to General Drawings and Manuals.*

**CLARIFY:** *Special modifications of any part shall be clearly described in the parts list.*

**APPEND:** All items on the parts list shall include the original manufacturer's model number.

**ADD:** The parts list (the detail numbers) shall be cross-referenced to all layout drawings.

## 17.10 ADD: Logic and human machine interface (HMI) documentation

Delphi's documentation requirements are detailed in the purchasing division specifications for programmable devices, Programmable Controller logic format, and Human Machine Interface applications.

## 17.11 ADD: Interdevice communication diagram

An interdevice communication diagram (or system communication diagram) shall be included as part of the circuit diagrams. At a minimum the communication diagram shall include cabling schematics and device addresses such as IP addresses. IP addresses will be provided by the Delphi controls engineer.

## 17.12 ADD: Control approval

### 17.12.1 Approval of design

Approval of design documentation shall neither constitute a waiver of responsibility for proper operation of the equipment nor relieve the industrial equipment supplier of conformance to these standards or any other specifications that are part of the purchase order.

### 17.12.2 Approval milestones

The industrial equipment supplier shall provide documentation to the Delphi controls engineer according to the milestones listed below. After preliminary approval at each of these milestones, any modifications made by the equipment builder shall have advanced written approval of the Delphi controls engineer. 10 working days shall be allowed for each approval set submitted.

#### 17.12.2.1 Hardware

Prior to ordering parts, the hardware design shall be approved. Submittal shall include all hardware drawings and documentation, including, but not limited to, electrical schematics, fluid power schematics, I/O wiring schematics, power distribution schematics, electrical and fluid power parts lists, panel layouts, push-button layouts, calculations used for determining panel cooling requirements, and any other documentation that would be useful to the Delphi controls engineer in evaluating the design concept.

#### 17.12.2.2 Software

Prior to the first run-off visit, the logic/software shall be approved. One fully commented program for each programmable device on the equipment shall be submitted for approval.

### 17.12.2.3 Construction check

Prior to run-off, the construction of the control equipment shall be approved by the Delphi controls engineer(s). Construction approval includes but is not limited to the control enclosure, field wiring, and all fluid power construction.

### 17.12.2.4 Function check

Prior to run-off, the Delphi controls engineer may review the function of the control system. This function check would take place at the industrial equipment supplier's facility and would be completed on a run-off intent system, to verify that approved logic is installed in the equipment during the run-off.

### 17.12.2.5 Final Documentation

**CLARIFY:** *The final circuit documentation shall be entered into the Delphi drawings and document system as detailed by the Delphi purchasing engineer.*

## Annex H AWG / mm<sup>2</sup> current-carrying capacity chart (Informative)

(Derived from NFPA 70 Table 310.16 derated to 40°C, and IEC 60204-1 Table 6 already based on 40°C)

AWG		Ampacity	mm(2)	
@75C in raceway	@60C in enclosure		PVC Insulated - Single wire in raceway / enclosure	PVC Insulated - Multi-conductor cable in space
	24	1.6		
24		1.8		
	22	2.5		
22		2.6		
	20	4.1		
20		4.4		0.2
	18	5.7		
18		6.2		
		7.8		0.5
	16	8.2		
		8.6	0.75	
16		8.8		
		10.3	1	
		10.4		0.75
		12.4		1
		13.5	1.5	
14	14	15		
		16.1		1.5
		18.3	2.5	
12	12	20		
		22		2.5
		24	4	
	10	25		
10		31	6	4
	8	33		
		37		6
8		44	10	
	6	45		
		52		10
6	4	57		
		59	16	
	3	70		16
4		75		
		77	25	
	2	78		
3		88		25
	1	90		
		96	35	
2	0	102		
		110		35
1		115		
		117	50	
	2/0	120		
0		132		
		133		50
	3/0	135		
		149	70	
2/0		154		
	4/0	160		
		171		70
3/0	250	176		
		180	95	
4/0	300	200		
		210	120	95
	350	215		

**Annex I Selections from IEC 60617 / ANSI / IEE315 symbol tables (Informative)**

ANSI SYMBOL	ANSI CODE	IEC 617 SYMBOL	IEC CODE	DESCRIPTION
	CON		KM	CONTACTOR CONTACT OPEN
	CON		KM	CONTACTOR CONTACT CLOSED
	CR		KA	RELAY CONTACT OPEN
	CR		KA	RELAY CONTACT CLOSED
	TR		KT	TIMED CONTACT, N.O. - ON DELAY (TDE)
	TR		KT	TIMED CONTACT, N.C. - ON DELAY (TDE)
	TR		KT	TIMED CONTACT, N.C. - OFF DELAY (TDD)
	TR		KT	TIMED CONTACT, N.O. - OFF DELAY (TDD)
	SS		SA	SELECTOR SWITCH
	PB		SB	PUSHBUTTON N.O.
	PB		SB	PUSHBUTTON N.C.
	PB		SB	PUSHBUTTON MUSHROOM HEAD
	FL		SL	LIQUID LEVEL SWITCH
	FLS		SF	FLOW SWITCH
	PS		SP	PRESSURE SWITCH
	TS		ST	TEMPERATURE SWITCH
	LS		SQ	LIMIT SWITCH
	PRS		SQ	PROXIMITY SWITCH
	FTS		FTS	FOOT SWITCH
	LT		HL	INDICATING LIGHT
	PL		XS	PLUG AND SOCKET

## Selections from IEC 60617 / ANSI / IEE315 symbol tables

ANSI SYMBOL	ANSI CODE	IEC 617 SYMBOL	IEC CODE	DESCRIPTION
	CON		KM	CONTACTOR CONTACT OPEN
	CON		KM	CONTACTOR CONTACT CLOSED
	CR		KA	RELAY CONTACT OPEN
	CR		KA	RELAY CONTACT CLOSED
	TR		KT	TIMED CONTACT, N.O. - ON DELAY (TDE)
	TR		KT	TIMED CONTACT, N.C. - ON DELAY (TDE)
	TR		KT	TIMED CONTACT, N.C. - OFF DELAY (TDD)
	TR		KT	TIMED CONTACT, N.O. - OFF DELAY (TDD)
	SS		SA	SELECTOR SWITCH
	PB		SB	PUSHBUTTON N.O.
	PB		SB	PUSHBUTTON N.C.
	PB		SB	PUSHBUTTON MUSHROOM HEAD
	FL		SL	LIQUID LEVEL SWITCH
	FLS		SF	FLOW SWITCH
	PS		SP	PRESSURE SWITCH
	TS		ST	TEMPERATURE SWITCH
	LS		SQ	LIMIT SWITCH
	PRS		SQ	PROXIMITY SWITCH
	FTS		T	FOOT SWITCH
	LT		HL	INDICATING LIGHT
	PL		XS	PLUG AND SOCKET