

PROGRAMMABLE CONTROLLER REQUIREMENTS AND APPLICATION

1. GENERAL:

1.1 PURPOSE AND SCOPE:

This Standard describes the requirements for programmable controllers (PLCs), hardware, software, and applications, intended for general use throughout Ford Motor Company that will promote:

- (1) Safety to personnel.
- (2) Uninterrupted production.
- (3) Long life of equipment.
- (4) Ease and low cost of maintenance.

1.1.1 Sections 1 thru 7 of this Standard pertains mainly to PLC hardware and software manufacturers.

1.1.2 Sections 8 thru 11 of this Standard pertains mainly to the application and use of the PLC hardware and software.

1.2 MANDATORY AND PREFERRED ITEMS:

Mandatory requirements of this Standard are characterized by the use of the word "shall". Preferred items are characterized by the use of the word "should".

1.3 DEVIATIONS:

Deviations from this Standard shall have the approval of the requisitioning activity in writing. Any waivers granted shall apply only to the order in question and shall not be considered as permanent.

1.4 NOTE: *** Indicates the following item referenced on the attached w-EL3 Option Sheet.

1.5 REQUIREMENTS:

1.5.1 Current or voltage transients or electromagnetic effects SHALL NOT cause spurious operation or affect the normal operation of the PLC. The PLC shall meet or exceed the requirements of ANSI/IEEE C37.90.1 and NEMA ICS 1-109.6. Internal protection circuitry shall fail to a safe condition.

1.5.2 The PLC shall operate properly in a temperature range of 0 to 40 degrees C (32 to 104 degrees F) measured inside the NEMA 12/IP54 enclosure in which the PLC system will be mounted. It shall be capable of operating continuously at 40 degrees C without additional ventilation or active cooling systems.

1.5.3 The PLC shall operate properly in a humidity range of 5% to 95% (non-condensing) per IEC 1131-2, Sec. 2.1.1.3, Table 2, severity level RH-2.

- 1.5.4 Fasteners used in maintenance operations (example: module replacement) shall be captive type.
- 1.5.5 Plug-in modules shall be mechanically secured in place. The assembled system shall be designed to withstand vibration testing of 5-10Hz at 0.2-inch displacement (peak to peak) and 10-200Hz at 1 g and endurance testing (sweep test) of 10-200Hz for ninety minutes per axis and a dwell at resonance frequencies (10 minutes per resonance) per MIL Standard 810 and IEC 60068-2-6.
- 1.5.6 Where the PLC uses similar modules with unlike functions; the modules shall be mechanically keyed to prohibit insertion in incorrect positions or electrically interlocked to prevent operation in an incorrect position.

2. REFERENCE STANDARDS:

- 2.1 Whenever a specific Standard is referenced, it shall be the latest revision, unless otherwise specified.
- 2.2 This Standard includes and supplements the requirements of NEMA IA2.1 through IA 2.4 "Programmable Controllers", IEC 61131-1 through IEC 61131-4 "Programmable Controllers", and as applicable, requirements in:
- ANSI/IEEE C37.90.1 "Standard Surge Withstand Capability (SWC) Tests for Protective Relays and Relay Systems"
 - ANSI B11.19 - "Performance Criteria for the Design, Construction, Care, and Operation of Safeguarding When Referenced by the Other B11 Machine Tool Safety Standards"
 - ANSI B11.20 - "Machine Tools - Manufacturing Systems/Cells - Safety Requirements for Construction, Care, and Use"
 - ICS 1-109.6 - "Electrical Noise Tests (Showering Arc)"
 - MIL Standard 810 - "Environmental Engineering Considerations and Laboratory Tests"
 - IEC 60068-2-6 - "Environmental Testing - Test Fc and Guidance: Vibration (Sinusoidal)"
 - IEC 60204-1 - "Safety of Machinery - Electrical Equipment of Machines - Part 1: General Requirements"
 - EN 954 - "Safety of Machinery - Safety Related Parts of Control Systems - General Principles for Design"
 - UL 1277 - "Electrical Power and Control Tray Cables with Optional Optical-Fibre Members"
 - SAE HS-1738 - "SAE Electrical Standard for Industrial Machinery - Supplement to NFPA 79"
 - Ford Manufacturing Standard EX1 - "Electrical Standards for Mass Production Equipment"
 - Ford Manufacturing Standard U-EX001 - "Safety of Machinery - Electrical Equipment of Machines"

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3. CENTRAL PROCESSING UNIT (CPU):

3.1 In the event of a power failure, the CPU shall be capable of retaining the status or accumulated values in its memory associated with arithmetic operations, data files, latching states and timing functions. Non-volatile memory systems are preferred. Where batteries are used for memory retention, refer to Clause 3.8.

3.2 PLC FUNCTIONS:

3.2.1 The CPU shall offer a minimum function menu consisting of ladder programming including:

- a) Basic Relay
- b) "Latching" or "Retentive" Relay
- c) Retentive Timing
- d) Non-retentive Timing
- e) Incremental Counting

3.2.2 The logic line shall accept a minimum of seven (7) elements in series and a minimum of four (4) in parallel.

3.2.3 Program saving to a remote device shall default to include the entire control program memory.

3.2.4 Programming instructions for the smallest controllers shall be a subset of the largest for full upward compatibility.

3.3 The PLC shall not increment/decrement counters nor otherwise cause false movement or change in retained data when the power is turned on or off.

3.4 The PLC shall have Self-Diagnostic routines to insure the safe and reliable operation of the entire system. Upon fault detection, output devices shall be capable of being individually de-energized or held in last state (necessary in PID or analog control).

3.5 Status lights on the CPU shall verify normal operation. Typical lights are: AC and DC power, processor running, parity error, memory fault, memory support battery low, processor fault, power supply fault, and I/O fault.

3.6 Error Detection and Fault Isolation (EDFI) shall be integral and shall localize faults to the lowest modular (plug-in) level.

3.7 Program accessible status bits shall be available to provide local fault annunciation via lights

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3.8 BATTERIES:

- 3.8.1 Where a battery is required to retain the PLC memory, an internal bit or output, operating as part of the CPU, shall be available to indicate that the memory battery is low.
- 3.8.2 Where a battery is required to retain PLC memory, it shall be replaceable without loss of memory (with power on). The battery shall maintain processor memory for a minimum of 90 days with no power on. The battery shall be a readily available, long life type.
- 3.9 A selector switch shall be furnished to allow programming or editing only in the program or program/run position.
- 3.10 Removal of any processor module shall shut down the PLC system.

4. PROGRAMMING AND DATA ACCESS:

- 4.1 Programming devices shall provide indication of the logic state of each element comprising a rung or network of logic.
- 4.2 The PLC shall permit loading, recording, and verifying PLC programs with the main programming device.
- 4.3 ***When specified, systems using remote I/O shall permit monitoring and programming from all I/O locations with the main programming device. Interlocking shall not allow more than one programming device to communicate with the CPU at one time for program changes.

5. INPUT/OUTPUT (I/O):

- 5.1 I/O modules shall have a status indicating light to indicate CPU communication status.
- 5.2 I/O modules shall have a means for fast and easy card removal without disconnecting the field wiring.
- 5.3 I/O terminals shall accommodate at least two #16 AWG (1.0 mm²) Type MTW, 19 strand conductor. Neither the head nor the point of the terminal screw shall bear directly on the conductor strands. Screws shall be captive to the terminal base.
- 5.4 White marking space shall be provided adjacent to each I/O terminal to list at least six characters. This space shall not be on the I/O module.

- 5.5 Inputs and outputs shall be electrically isolated from the controller logic circuitry and from other inputs and outputs. Optical isolation is preferred.
- 5.6 Input and output modules shall be 24 VDC, unless otherwise specified by the requisitioning activity. 120 VAC outputs may be used if needed for direct control of higher current devices. Analog to digital (A to D) inputs and outputs (D to A) shall be rated to comply with the system requirements.
- 5.6.1 Sinking input modules and sourcing output modules shall be used for 24 VDC to prevent false actuation from ground faults. Sourcing input modules and sinking output modules SHALL NOT be used.
- 5.6.2 I/O's shall be provided with an integral power supply to provide I/O logic and special function reference voltages.
- 5.7 120 VAC 50/60 Hz inputs shall not turn on and shall turn off with 2.2 mA RMS or less of current and shall conduct at least 6 mA RMS in the on state.
- 5.8 Each 120 VAC output point shall be rated not less than 2 Amps continuous and shall be protected by an individual overload device. A visual fault indication shall be provided. Fuses shall be replaceable without soldering and should be accessible without the need to remove covers attached with threaded fasteners.
- 5.9 I/O modules should not be damaged by removal from, or insertion into, a PLC when the system power is on and the field power is off.
- 5.10 The following types of I/O should be available:
- | | |
|----------------|------------------------------------|
| AC/DC (120V) | Analog (0-5V, 0-10V, -10V to +10V) |
| AC/DC (240V) | Analog (4-20mA) |
| DC (12-24V) | BCD |
| DC (24-48V) | High Speed Counter |
| TTL (5V) | Single Axis Servo |
| Contact Output | Isolated Output |
| Thermocouple | Stepper Motor |
6. MACHINE, PROCESS, PROGRAM DIAGNOSTIC, AND COMMUNICATIONS CAPABILITIES:
- 6.1 Fault definition shall be available to the system Loader/Terminal, laterally via peer-to-peer communications, and vertically within a hierarchical communications network.
- 6.2 Data comparison for diagnostics shall be capable at bit, word and block/rung level.

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7. TRAINING AND SUPPORT DOCUMENTATION:

- 7.1 The PLC manufacturer shall make training services and materials available for engineering, maintenance, and operating personnel. Available materials shall include videotapes, interactive media, and self-paced instruction manuals.
- 7.2 The PLC manufacturer shall make a detailed trouble-shooting guide available. A block diagram format is preferred.
- 7.3 The PLC manufacturer shall provide detailed hardware and software manuals that cover installation, application, and programming.
- 7.4 The PLC manufacturer shall provide 24 hour, 7 days per week, and 365 days per year engineering and application support service to assist the user with technical product information and application analysis.
- 7.5 The PLC manufacturer shall have available a documentation system that will print the PLC program logic with alphanumeric descriptions for all inputs, outputs, data, counters, and timers. It shall also display I/O utilization, and cross reference information of all utilized I/O and data to their corresponding logic rung number. The system shall also have the capability to merge detailed user generated text documentation where required by the user in the hard copy listing. Modifications to the user's database shall be made through a line editor as a minimum.

8. ENVIRONMENT AND ENCLOSURE:

- 8.1 *****WINDOWS IN DOORS:** When specified, a sealed window, minimum 0.125 inches thick Lexan No. 940, or equivalent polycarbonate resin), shall be provided in NEMA 12/IP54 enclosure door(s) for observing status indicating lights. Radio frequency suppression material (screen or film type) shall be applied to the window to maintain the RF immunity of the panel.
- 8.2 **POWER SUPPLY REQUIREMENTS:**
 - 8.2.1 *****LINE OR LOAD SIDE POWER:** Power supplied to an isolation transformer shall be sourced from the LOAD side of the enclosure's main disconnect (See Appendix A). At the requisitioning activity's WRITTEN OPTION, power shall be supplied from an approved transformer disconnect connected to the LINE side of the enclosure's main disconnect (See Appendix B). The transformer disconnect (or its NEMA 1 enclosed switch and fuse portion for those units with separate transformers sized 2000 VA and larger) shall be mounted behind the same control enclosure door as the main disconnect.
 - 8.2.2 *****POWER PROVIDED THROUGH CRM CONTACTS:** When the line side transformer disconnect option is used, all electrical equipment powered from an external source, and

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