ROCKWELL AUTOMATION   PROCUREMENT SPECIFICATION

2004 CSI PROCUREMENT SPECIFICATION

For The MicroLogix 1000 Controller

Allen-Bradley MicroLogix 1000 Product Note

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The illustrations, charts, and examples shown in this document are intended solely to illustrate the principles of programmable controllers and some of the methods used to apply them. Particularly because of the many requirements associated with any particular installation, Allen-Bradley Company cannot assume responsibility or liability for actual use based upon the illustrative uses and applications.

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Part 1 - General

1.01   General Specifications

A.   This specification has been developed to establish minimum requirements for a solid-state programmable controller designed to provide high reliability in electrical control applications. The internal "wiring" of the controller is to be fixed, with the logic functions it must perform in a given application to be programmed into its memory. The control system shall be supplied with the Packaged Controller (CPU, inputs, outputs, memory, and power supply), and all power and interface cables necessary to function as a complete and operable controller system.

B.   The objective of the packaged controller will be to improve reliability, maintainability, and efficiency by reducing operating costs and downtime.

C.   The specification shall be followed in accordance with the contract and all areas of questions or noncompliance shall be submitted to the purchaser for review and approval.

1.02   Service

A.   The supplier shall provide operating instruction manuals with adequate information pertaining to the following:

1.   System specifications

2.   Electrical power requirements

3.   Application considerations

4.   Assembly and installation procedures

5.   Power up procedures

6.   Troubleshooting procedures

7.   Programming procedures

8.   Explanation of internal fault diagnostics

9.   Shut down procedures

10.   Recommended spare parts list

B.   In cases where the programming is done by the supplier, the supplier shall provide a copy of all working programs on 3-1/2 inch floppy disks as well as a printed program listing.

C.   The supplier shall provide a network of field sales and support personnel located in key cities throughout the United States and internationally. The supplier shall also provide a field service department with experienced representatives stationed in major cities with the capability to provide telephone consultation, prompt on-site service, and field replacement stock.

D.   The supplier shall provide product application assistance by trained and experienced engineers to assist the customer with program and system development through telephone consultation and on-site check-out, debug, and start-up assistance.

E.   The supplier shall provide a customer training program designed to teach the customer's personnel in the understanding and application of the packaged controller. The training program shall include training manuals and "hands-on" programming experience on a packaged controller of a type similar to that provided by the supplier.

F.   The supplier shall have the capability to conduct on-site training programs at a location provided by the customer.

Part 2 - Products

2.01 Assembled Systems

A. The supplier shall assume single source responsibility for system assembly. An assembled system may include mounting and wiring of relays, motor starters, transformers, and disconnecting means, or other control devices as specified by customer-supplied documentation.

B. The supplier shall provide mounting and wiring of the packaged controller system in a NEMA type 12 or other enclosure that may be specified by the customer.

C. If specified, the enclosure shall be able to accommodate an electrical service of 460 volt, 3-phase, 60 Hz. The enclosure shall have sufficient room for a 460V AC (primary) to 115V AC (secondary) control transformer to service the processor, inputs, and outputs.

D. The supplier shall be able to provide a sealed plastic window in the NEMA 12 enclosure door(s) for observing the processor and I/O status indicating lights.

E. The supplier shall have the capability to supply an enclosure with special paint and graphic displays.

F. The supplier shall have the capability to wire all packaged controller inputs and outputs to customer-specified terminal blocks.

G. The assembled system shall include fuse blocks as sized by the customer's application.

H. Within the enclosure all electrical control products shall be grounded to meet the manufacturer's specifications.

I. The supplier shall be able to provide within the enclosure a master control relay to de-energize all I/O and inhibit machine motion. The master control relay must be de-energized directly by a hardwired Emergency Stop pushbutton.

J. All pushbuttons, switches and other operator devices must be UL listed and/or CSA approved.

K. All pushbuttons, switches and other operator devices must be sufficiently large (customer approved) and durable to provide dependable, long life operation.

L. All cables (with associated plugs, connectors and receptacles) requiring user field installation, shall be designed for commercial use to withstand an industrial environment.

M. Upon receipt of the purchase order, but prior to starting the manufacture of the equipment, the supplier shall submit drawings of the complete assembled system for approval by the customer or their consultant.

N. Drawings which are returned to the supplier for correction or revision shall be resubmitted for approval before fabrication, unless the work in question is marked by an approved representative with "approved as noted."

O. All drawings shall include page, sheet, and line numbers.

P. The first page of all drawings and schematics shall be a cover sheet consisting of a Bill of Material, purchase order number, manufacturer's job number, user's name, location, application, and shipping address.

Q. The drawings shall include a mechanical layout detailing the overall external dimensions of the enclosure. The drawings shall include such pertinent information as location of door handles, windows, lifting lugs, and enclosure mounted items such as tachometer or current meters, cooling fans, etc.

R. The supplier shall provide documentation detailing the mounting of the processor, I/O racks, motor starters, disconnect switch, fuse blocks, wireways, etc. All materials shall be labeled to provide easy cross-reference to the Bill of Material listing.

S. Electrical prints detailing all hardwiring, done by the supplier, to devices such as relays, motor starters, disconnect switches, fuse blocks, etc. shall be provided with individual wire numbers and relay contact cross-reference designations.

T. Sections describing inputs shall designate inputs name, and terminal location.

U. The last sheet in the set shall be for terminal block designations each containing their individual terminal numbers.

V. At the time the equipment is shipped, one reproducible copy of each drawing mentioned above shall be provided with the equipment.

2.02   Design Description

A. A major consideration of the packaged controller system shall be its all-in-one (packaged) design so the user can quickly and easily install, service and replace the controller, if necessary. The supplier must have a number of models of the packaged controller that include:

1. Power: 120V AC, 24V DC

2. Inputs: 120V AC, 24V DC, 4-20 mA and +/- 10V Analog

3. Outputs: Relay, 120V AC solid state, 24V DC solid state, 4-20 and 0-10V Analog outputs

B. The packaged design must be part of a larger family of modular rack based programmable controllers that provide program transport (ability to move a customers program between the packaged and module platforms in both directions), and also share programming tools and a common instruction set.

C. All hardware of the packaged controller shall operate at an ambient temperature of 0° to 55° C (32° to 131° F), with an ambient temperature rating for storage of - 40° to 85° C (- 40° to 185° F).

D. The packaged controller hardware shall function continuously in the relative humidity range of 5% to 95% with no condensation.

E. The packaged controller system shall be designed and tested to operate in the high electrical noise environment of an industrial plant, and must meet or exceed:

1. IEC801-2 @ 15 kV (electrostatic discharge)

2. IEC801-3 @ 10V/m, 27 to 1000 MHz (radiated susceptibility)

3. IEC801-4 @ 2 kV Power Supply, 1 kV I/O

F. The packaged controller shall use multiple independent scans designated for processing of input and output information, program logic, and background processing of other processor tasks. Discrete inputs, outputs and internal processor overhead should be scanned in under 210 microseconds. The processing of a typical logic program should not exceed 1.5 milliseconds including throughput. (Input device activation to output device activation with a 500 word program consisting of a general instruction mix.)

G. The packaged controller shall have at least one dedicated serial port which supports RS-232-C signals. This port must be capable of local and remote (via modem) programming, troubleshooting and data manipulation.

H. The packaged controller shall execute Boolean conditional instructions (or contacts) within 1.6 microseconds each. The packaged controller shall execute Boolean output instructions (or coils) within 4.5 microseconds each. The packaged controller shall execute 16 bit Add and Subtract instructions within 33.1 microseconds each. The packaged controller shall execute 16-bit comparison (=, /=, <, < or =, >, > or =) instructions within 23.6 microseconds each. The packaged controller shall execute 16-bit circular comparison (or limit) instructions within 37.0 microseconds each. The packaged controller shall execute 16-bit Move instructions within 25.1 microseconds each.

2.03   Main Hardware

A.   The CPU shall be a self-contained unit, and will be capable of displaying Ladder Rung program execution through its communication port. The CPU will also control all I/O scanning and communications servicing.

B.   All components of the packaged controller control system shall be housed in a single chassis (power supply, I/O circuitry, CPU, Memory and communications shall reside in one enclosure).

C.   The CPU within the system shall perform internal diagnostic checking and give visual indication to the user by illuminating a "green" indicator when no fault is detected and a "red" indicator when a fault is detected.

D.   The packaged controller shall be designed to operate in a free air flow environment (convection cooling only, no fans or other air moving devices shall be required).

E.   The main front panel of the packaged PLC shall include the following indicators:

   1.   Power

   2.   Run

   3.   Fault

   4.   Force

F.   Processor mode shall be selected by a command from a programming device. Available settings must include "program", "run", and "test" modes.

   RUN - No ladder edits possible, program always executing.

   PROGRAM - Programming allowed or program execution disabled.

   SINGLE SCAN TEST - The PLC scans and solves the user program once, does NOT control the real world outputs, and stops.

   CONTINUOUS SCAN TEST - The PLC continuously scans the user program but does NOT control the real world outputs.

G.   Non-volatile memory shall store the operating system, user program, and all user data information to protect against loss in the case of power loss or system shut-down.

2.04   Power

A.   The packaged controller shall operate in compliance with an electrical service of either 120/240V AC, single phase, in power systems that operate on 50/60 Hz. It must be capable of auto-detect to operate with either of these AC voltages or frequencies without the user needing to jumper or setup the unit. The controller must also be available with an operating voltage of 24V DC.

B.   All AC powered controllers must be capable of supplying 24V DC at 200 mA. This external power is to be used for powering external 24V DC input devices (sensors, switches, etc.).

C.   The onboard power supply must be capable of supplying all necessary power to all subsystems (CPU, Memory, I/O, etc.). External power supplies must not be needed to provide power to controller circuitry.

D.   The power supply shall provide surge protection, isolation, and outage carry-over of at least one cycle of the AC line.

E.   In cases where the AC line is especially unstable or subject to unusual variations, it shall be possible to install a constant voltage transformer having a sinusoidal output waveform.

F.   At the time of power-up, the power supply shall inhibit operation of the processor and I/O modules until the DC voltages are within specifications.

2.05   Program Storage

A.   The program storage medium shall be a solid state non-volatile type. The system must be capable of a minimum of 50,000 program/data "saves." Batteries or capacitors used to maintain the user program during power outage are not allowed.

B.   The packaged controller system shall be capable of addressing up to 1024 words, where each word is comprised of 16 data bits.

C.   Available user memory shall consist of a minimum of 1024 words of program and data.

D.   The packaged controller system must provide the capability to use an EEPROM memory cartridge as a program and data backup device. This cartridge must be removable for ease of program transport, and may reside either in the controller or a handheld (preferred) programming device.

E.   The operator should be able to backup memory, including data and program logic onto either a 3-1/2 inch floppy diskette, hard disk, or a handheld programmer at their option.

F.   The packaged controller system must be capable of storing the following data:

   1.   External Output Status

   2.   External Input Status

   3.   Timer Values

   4.   Counter Values

   5.   Signed Integer Numbers (16-bit)

   6.   Binary Numbers

   7.   BCD Numbers

   8.   Direct and Indexed addressing

   9.   Internal Processor Status Information

   The above listed data shall be distinguishable to the CPU by the addressing format. Management of the data into memory subsections shall be an automatic function of the CPU operating system. Any data can be displayed in Binary, Hexadecimal, or Decimal. Function-specific data such as processor status shall have dedicated displays that annotate the meaning of specific control bits and words within them and allow for selective control where appropriate.

G.   If contacts or entire rungs are intentionally deleted from an existing logic program, the remaining program shall be automatically repositioned to fill this void. Whenever contacts or entire rungs are intentionally inserted into an existing program, the original program shall automatically be repositioned to accommodate the enlarged program.

H.   To reduce the effective scan time in order to detect short pulse duration inputs, it must be possible to immediately update (read) specific inputs by using special ladder instructions.

I.   The number of times that a normally open (N.O.) and/or normally closed (N.C.) contact of an address can be programmed shall be limited only by the memory capacity to store these instructions.

J.   Ladder logic programs must have immediate access to the sub-elements of control structures (timers, counters, sequencers, etc.) by word (presets, accumulators, etc.) and bit (status bits).

2.06   Inputs/Outputs

2.06A Inputs / Outputs – General

A.   All inputs and outputs shall be located on the self-contained base unit.

B.   Isolation shall be used between all internal logic and external power circuits. This isolation shall meet the minimum specification of 250 VRMS continuous.

C.   Each input and output point shall have a visual indicator to display ON/OFF status.

D.   All user wiring to I/O modules shall be through a heavy-duty terminal strip. Pressure-type screw terminals shall be used to provide fast, secure wire connections.

E.   All inputs shall have adjustable filter time constants to improve input performance in high speed applications, and to limit the effects of voltage transients.

2.06B Inputs / Outputs - Specific

A.   The packaged controller manufacturer shall offer input/output hardware consisting of the following types:

    1.   **Inputs:**

        a.   DC inputs for devices which operate at 24V.

        b.   AC inputs for devices which operate at 120V, 50/60 Hz.

        c.   Analog inputs for devices which operate at 4 -20 mA and -10 to 10V DC.

    2.   **Outputs:**

        a.   AC solid state outputs for devices which operate at 120/240V AC, 50/60 Hz with a current carrying capacity of ½ amp.

        b.   DC solid state outputs for devices which operate at 24V DC with a current carrying capacity of 1 amp.

        c.   Relay outputs for AC devices which operate at 5-264V AC with 2.5 amp continuous current capacity.

        d.   Relay outputs for DC devices which operate at 5-125V DC, with 2 amp continuous current capacity at 24V DC, and 1 amp continuous current capacity at 125V DC.

        e.   Each packaged controller in the supplier's line of packaged controllers must have a minimum of two individually isolated relay outputs per model.

B.   Each controller with 24V DC inputs must have a high speed counter (HSC) capable of detecting a 6.6 kHz pulse stream-built onboard. The HSC must be capable of detecting pulses as narrow as 75 microseconds (6.6 kHz) and directly control (turn on or off) controller outputs independent of the processor scan. The HSC must be cable of detecting single ended inputs, quadrature inputs, and high speed inputs with external controls (hold and reset). The HSC must be completely configurable (input filters, modes of operation, etc.) through the either a Hand Held Programmer, or computer based software. Runtime control of the HSC must be allowed through commands used in the user (ladder) program (Reset accumulator, change presets, change output patterns and setpoints, enable/disable HSC operation, etc.). Data and status within the HSC must also be accessible from external devices through the communications port on the controller.

2.07　Networking and Communications

A.　The packaged controller shall support direct connection to a programming computer equipped with a standard RS-232 serial port.

B.　The packaged controller shall support direct connection to a modem for remote programming functionality.

C.　The packaged controller shall support full function peer-to-peer communications (program management, controller to controller messaging, etc.) over a network that supports a minimum of 32 devices.

D.　The packaged controller family shall support connectivity with an industry standard "open" device level network.

E.　The packaged controller shall support half-duplex slave communications on a network capable of at least of 250 nodes. The half-duplex network shall support program upload/download, monitoring, and peer-to-peer (slave-to-slave) communications.

Part 3 - Execution

3.01　Interfacing and Peripherals

A.　The programming means shall be an IBM or compatible desktop/portable, or industrial quality programming terminal. The terminal shall include a monochrome or color CRT screen and a keyboard for program entry, editing, search, monitoring, and troubleshooting functions.

B.　Programming tools must be available that run on MS DOS, and Windows 95/NT environments.

C.　The terminal keyboard shall allow for loading of the program format and ASCII characters.

D.　The terminal shall be able to function as a stand-alone ASCII (alphanumeric) data terminal with an RS-232-C interface allowing connection to an in-house computer, data terminal, or modem.

E.　The programming terminal shall be compatible for interfacing with an electrical service of either 120V AC, 50/60 Hz or 220V AC, 50/60 Hz.

F.　The terminal shall provide for selecting the communication rate between 110 and 38400 baud for RS-232-C communications.

G.　The terminal shall be capable of displaying a minimum of 30 graphic (line drawing) characters.

H.　The programming terminal shall be capable of displaying a rung consisting of a maximum of seven series elements and six parallel elements.

I.　The means to indicate contact or output status shall be by intensification of the contact or output on the CRT screen. Each element's status shall be shown independently, regardless of circuit configuration.

J.　The packaged controller system shall be able to interface with a data terminal which is RS-232-C compatible (up to 38400 baud) to generate hard copy logic diagrams and/or message generation.

K.　The system shall have the capability to interface to a 3-1/2 or 5-1/4 inch magnetic floppy disk and/or a hard disk for loading a user program into, or recording the contents of, the processor's memory. It shall be possible to load or record the entire contents or selected portions of memory.

L.　The system shall have a handheld programmer (HHP) capable of performing all functions available in the software based programming system (program creation, edit, monitor, save, upload/download, etc.).

M.　The HHP must be small enough to fit in an average adults hand, must have at least two lines of viewable data, and must be built to industrial standards for ruggedness.

N.　The HHP must be powered solely from the packaged PLC, and must not require power from an external source (wall type power supply).

O.   The HHP shall also have the ability to store the user developed program on a non-volatile removable memory cartridge. The memory cartridge must be capable of saving at least eight user-developed programs, and be small, rugged and easy to transport/ship.

P.   The HHP must have enhanced troubleshooting features built in. Items that facilitate searching of contacts and coils, and the ability to display predefined digital data resident within the controller with a single keystroke is required.

Q.   The packaged PLC must also have a small easy to use operator interface (OI) specifically designed to enhance operator interaction with the control system. The OI device should be available in two formats, either panel mountable or handheld versions. Features required are menu capabilities, security features, active display of data, limit test of entered data, and scaling of data to and from the controller. The OI device must utilize an easy to program system for programming, preferably based on an IBM compatible running MS Windows, at a minimum the programming system must run on MS DOS version 3.0 or newer. The system should make use of intuitive on screen programming features. All OI programs must be capable of being saved to disk and transported to other OI devices or programming computers. OI programs should be transferred via a RS-232 serial communications link between the computer and the OI device.

3.02   Programming Techniques

A.   The programming format shall be traditional relay ladder diagram.

B.   It shall be possible to program a maximum instruction matrix containing as many as 128 instructions.

C.   The capability shall exist to change a contact from normally open to normally closed, add instructions, change addresses, etc. It shall not be necessary to delete and reprogram the entire rung.

D.   It shall be possible to insert relay ladder diagram rungs anywhere in the program, even between existing rungs, provided there is sufficient memory to accommodate these additions.

E.   A single program command or instruction shall suffice to delete an individual ladder diagram rung from memory. It shall not be necessary to delete the rung contact by contact.

F.   It shall be necessary to issue a two part command to delete all relay ladder rungs from memory to provide a safeguard wherein the operator must verify their intentions before erasing the entire program.

G.   Latch functions shall be internal and programmable.

H.   The system shall have the capability to address a minimum of 40 software timers, 32 software counters, 512 internal bits and 105 integer words. All management of these instructions in memory shall be handled by the CPU. Instructions shall permit programming timers in the "ON" or "OFF" delay modes. Timer programming shall also include the capability to interrupt timing without resetting the timers. Counters shall be programmable using up-increment, down-increment or both. All timer and counter data must be accessible from the ladder program and also any communications device.

I.   Timer instructions shall include selectable time bases in increments of 1.0 second and 10 milliseconds. The timing range of each timer shall be from 0 to 32,767 increments. It shall be possible to program and display separately the timer's preset and accumulated values.

J.   The packaged controller shall use a signed integer data format. The signed integer format (-32,768 to 32,767) must be used throughout the controller (counters, storage registers, math operations, etc.).

K.   The packaged controller shall support signed integer math functions consisting of addition, subtraction, multiplication, division, scale data and square root.

L.   Instructions shall be provided for file manipulation instructions such as high speed "file fill", "first in-first out", "last in-first out" shall be supported by the system. Four function math instructions and instructions for performing "logical OR", "logical AND", "exclusive OR", and comparison instructions such as "less than", "greater than", and "equal to" shall be included within the system. All instructions shall execute on either single words or files.

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M.   The system shall contain instructions which will construct synchronous 16-bit word shift registers. Additional instructions shall be provided to construct synchronous bit shift registers.

N.   The packaged controller shall have a jump instruction which will allow the programmer to jump over portions of the user program to a portion marked by a matching label instruction.

O.   In applications requiring repeatable logic rungs it shall be possible to place such rungs in a subroutine section. Instructions which call the subroutine and return to the main program shall be included within the system. It shall be possible to program several subroutines and define each subroutine by a unique label. The processor will support nesting of subroutines up to eight levels deep. The program format as displayed on the CRT shall clearly define the main program and all subroutines.

P.   The program format shall display all instructions on a CRT programming panel with appropriate mnemonics to define all data entered by the programmer. The system shall be capable of providing a "HELP" instruction which when called by the programmer will display on the CRT a list of instructions and all data required to enter an instruction into the system memory.

Q.   At the request of the programmer, data contained in system memory shall be displayed on the CRT programming panel. This monitoring feature shall be provided for input/output status, timer/counter data, files, and system status. Ladder logic rungs shall be displayed on the CRT with rung numbers in sequential order.

R.   The system shall have the capability to enter rung comments above ladder logic rungs. These comments may be entered at the same time the ladder logic is entered.

S.   It shall be possible to manually set (force) either on or off all hardwired input or output points. Removal of these forced I/O points shall be either individually or totally through selected keystrokes. The programming terminal shall be able to display forced I/O points.

T.   The execution of the program logic shall be accelerated by scanning the rung only until a positive decision as to the state of the outputs has been made. In many cases this will mean skipping over logic elements if the output condition has been predetermined.

U.   A means to program a fault recovery routine shall exist. When a major system fault occurs in the system, the fault recovery routine shall be executed and then the system shall determine if the fault has been eliminated. If the fault is eliminated, program execution resumes. If the fault still exists, the system will shut down.

V.   An interrupt routine shall be programmable such that the routine shall be executed regularly. The interval at which the routine is executed shall be user-specified in the range of 10 to 32767 milliseconds in 10 millisecond increments. This routine must be able to close an asynchronous control loop consisting of 32 Input points, 32 output points, 100 contact/coils, 10 addition instructions, 10 subtraction instructions and 32 circular comparison (Limit) instructions while never exceeding a 3 millisecond interval. The measurement of this interval is from after the Input filter delay time to the time that the physical outputs start to transition.

W.   The ability to program ladder logic via symbols from the global database of the packaged controller shall exist.

X.   The CPU shall support indexed addressing of inputs and outputs, along with all data table words (integer, binary, timers, and counters) for the software instruction set.

Y.   The system shall support both bit and word level diagnostic instructions.

Z.   To facilitate conditional event detection programming, output instructions shall include a "one shot" instruction which may be triggered on the low-to-high (rising) rung condition.

AA.   The processor shall support Master Control Reset (Relay) type functionality to selectively disable sections of relay ladder logic.

3.03   Quality Requirements

A.   The packaged controller shall be able to withstand conducted susceptibility tests as outlined in:

1.   Electrostatic Discharge   IEC801-2 @ 15 kV

2.   Radiated Susceptibility   IEC801-3 @ 10V/m, 27 MHz - 1000 MHz

3.   Fast Transient   IEC801-4 @ 2 kV Power Supply, 1kV I/O

4.   Isolation   1500V AC, 250V DC continuous

B.   The packaged controller and its associated peripherals shall be listed or recognized by the following registrations: UL listed, CSA, and CE certified.