
NEMA CONTROLLER AND CABINET**PART 1 - GENERAL****1.01 SECTION INCLUDES**

NEMA Controller, NEMA cabinet, NEMA conflict monitor, flasher, inductive loop vehicle detector, and auxiliary equipment designated for installation in the project plans, or by the Engineer.

1.02 STANDARDS

Controller, cabinet, and auxiliary equipment shall conform to the requirements of NEMA TS1, latest edition.

PART 2 - PRODUCTS**2.01 CONTROLLER****A. The Controller Shall Provide:**

1. Two through eight phase operation.
2. Fully prompted, menu driven programmability.
3. The following internal functions:
 - a. Local time base scheduler including automatic accommodation for daylight savings time.
 - b. Local coordination control.
 - c. Local preemption control with at least four programmable internal preemption sequences.
4. Means for receiving actuation on all phases. The actuation of a vehicle detector during the extendible portion of an actuated traffic phase having the right-of-way shall cause the retention of right-of-way by the traffic phase for the set Passage time from the end of the actuation but subject to the Maximum green. The actuation of any detector on a traffic phase not having the right-of-way shall cause the transfer of the right-of-way to that traffic phase at the next opportunity in the normal phase sequence.

B. The controller shall be microprocessor type, solid state.

- C. The controller shall utilize digital timing concepts for interval settings for all phases and shall contain vehicular and pedestrian circuits and timing functions for all phases. The length of timing settings shall not deviate by more than plus or minus 100 milliseconds from the set value at a power source frequency of 60 Hz.**

Controller timing shall be set by means of a front-panel keyboard with momentary contact pushbuttons for entering data. It shall not be necessary to remove or change wires or contacts or to use any tools in making interval adjustments.

D. The controller shall be of the latest model with the most current software and documentation.

- E. Component parts and terminals shall be readily accessible when the controller modules are removed from the enclosure for adjustments, testing or service. Modules shall be removable and inserted without the use of any tools. Modules of unlike function shall be mechanically keyed or electrically inter-locked to prevent insertion into the wrong opening. All modules of the same function shall be interchangeable.**

2.01 CONTROLLER (Continued)

- F. Mount the control devices, indicators, fuse holders, switches, input/output connectors, and other components required for controller operation on the front panel of the controller. The front panel of the unit shall be permanently marked to identify the fuses, indicators, switches, controls, etc.
- G. Components shall be amply de-rated with regard to heat dissipating capacity and rated voltage so that, with maximum ambient temperatures and maximum applied voltage, a material shortening of life or shift in values shall not occur. Components under 24 hours a day operating conditions in their circuit applications shall have a minimum life of 5 years.
- H. Each phase shall have identical control parameters, which may be independently set.
- I. Provide indications, labeled appropriately, to facilitate the determination of the operation of the controller unit. These indications shall consist of the following, as a minimum:
 - 1. Phase(s) in service.
 - 2. Next phase(s) to be serviced.
 - 3. Presence of vehicle and pedestrian calls, including memory and detector actuations.
 - 4. Ring status indicators, including the following: Minimum Green; Passage; Yellow Clearance; Red Clearance; Walk; Pedestrian Clearance; Reason for Termination; and Rest State.
- J. The controller shall be capable of programming each phase to operate in the following modes:
 - 1. Nonlocking/locking vehicle detector memory
 - 2. Vehicle recall
 - 3. Pedestrian recall
- K. Data shall be retained in a memory medium which does not require battery backup.
- L. The timing of the Maximum Green shall commence at the beginning of the Green interval. In the absence of detector actuations or assertion of recall switches, the right-of-way indications shall remain on the traffic phase on which the last actuation occurred.
- M. Transfer right-of-way to conflicting phases only after the display of the appropriate change clearance intervals.
- N. Pedestrian actuations received during steady or flashing DON'T WALK indications a phase shall cause the controller to provide pedestrian timing functions for that phase at the next opportunity in the normal phase sequence. Successive pedestrian actuations shall not cause extension of pedestrian intervals.

During coordinated operation if phases are placed in a pedestrian recall mode of operation to operate the controller as a pretimed controller, the WALK intervals shall automatically adjust with changes in the timing plans to provide the maximum amount of WALK interval possible in the phase.
- O. If power is interrupted, the controller shall be capable of automatic reorientation upon power resumption and shall require no manual initiation or switching.

2.02 CONTROLLER CABINET AND AUXILIARY EQUIPMENT

- A. House the controller and associated equipment in a sturdy, unpainted aluminum cabinet having no sharp edges, corners or projections. The size of the cabinet shall provide ample space for housing the controller and auxiliary equipment. Provide a hinged door, with an approved doorstop assembly, permitting complete access to the interior of the cabinet. When closed, the door shall fit closely to neoprene or other suitable gasketing material, making the cabinet weatherproof and dust-tight. Door shall be provided with a strong lock and two sets of keys. Door hinges and pins shall be of a non-corroding material. The cabinet shall contain strong mounting tables, sliding trays, or other suitable supports for the controller and associated equipment.
- B. In addition to the main door of the controller cabinet, there shall be an auxiliary police door provided in the main door provided with a strong lock and keys (two) of different design than that of the main door of the cabinet. The panel behind the auxiliary police door shall contain a switch to change from normal function to flashing operation. The controller shall remain in full operation during flashing operation. Provide a signal on-off switch to interrupt power to the signal heads only and continue controller operation.
- C. Locate a maintenance panel on the inside of the main door containing the following test switches:
1. Controller Power Switch
 2. Detector Test Switches
 3. Stop Time Switch
 4. Signal Flash Switch
- D. The cabinet shall be provided with the following:
1. A heavy-duty clear plastic envelope, securely attached to the inside wall of the cabinet or cabinet door, for stowing cabinet wiring diagrams. Minimum dimensions shall be 9 inches wide by 12 inches deep.
 2. A ventilation fan controlled by a thermostat, and suitable dust filters for the capacity of the ventilating system. The filters shall be dry type, easily removed and replaced, and standard dimensions commercially available. Ventilation fan shall be fused separately and wired after the main AC+ circuit breaker.
 3. At least an 8 position back panel when the plans call for expansibility to four phases and at least a 12 position back panel when the plans call for expansibility to eight phases.
 4. Power protection devices which include the main AC+ power circuit breakers, radio interference suppressors, and lightning and surge protectors. These devices shall be in addition to any protection devices furnished with the controller and auxiliary equipment. The protection devices shall be mounted on a panel that is securely fastened to an interior wall of the cabinet.

The AC+ field service shall be connected directly to a circuit breaker. This circuit breaker shall be a single pole, nonadjustable, magnetic breaker rated for 117 VAC operation. It shall be equipped with a solderless connector suitable for terminating the power lead-in wire. The circuit breaker shall be capable of manual operation and shall be clearly marked to indicate the "ON" and "OFF" positions.

The distribution of the 117 VAC throughout the cabinet shall not occur until the AC+ has first passed through the power protection devices.

2.02 CONTROLLER CABINET AND AUXILIARY EQUIPMENT (Continued)

- a. Radio interference suppressors (RIS), adequate in number to handle the power requirements for the cabinet, shall be wired in series with and after the main AC+ circuit breaker. The RIS shall be designed to minimize interference in all broadcast, transmission and aircraft frequency bands.
 - b. The lightning arrestor/surge suppressor on the AC service shall be an ACP 340 manufactured by EDCO Inc., or approved equal which meets or exceeds the following requirements:
 - 1) Capable of withstanding repeated 20,000 ampere surges (minimum of 25).
 - 2) Have internal follow current limiters (resistive elements).
 - 3) Contain a minimum of three active clamping stages.
 - 4) Self-extinguish within 8.3 milliseconds after trailing edge surge.
 - 5) Parallel impedance of limiters must be less than 15 ohms.
5. An easily accessible AC+ convenience outlet with a 3 wire grounding type receptacle with ground fault protection. This receptacle shall be separately fused from the main AC+ circuit breaker.
 6. An incandescent lamp receptacle mounted on the interior wall of the cabinet which accommodates a standard base light bulb. Lamp shall be controlled by a manual switch mounted on the maintenance panel. Fuse and connect lamp with the convenience outlet.
 7. A complete system documentation. Documentation shall consist of:
 - a. Three complete operations manuals for each controller and associated equipment including equipment wiring diagrams, schematics, and parts lists sufficient for ordering any parts.
 - b. Three sets of cabinet wiring diagrams. Indicate corresponding phase numbers for each movement from the intersection layout diagram on the cabinet wiring diagram.
- E. Use molded composition barrier type terminal blocks for termination of the incoming and outgoing signals within the cabinet assembly. Each terminal block shall be of one-piece construction with a minimum of 12 terminals. Each terminal shall have a threaded contact plate with a binder head screw. The terminal blocks shall have a minimum rating of 600 volts.

Arrange terminal block facilities in function groupings and mount to either panels or brackets fastened to the interior walls of the cabinet. Retain each terminal block using either machine or self-tapping screws which are easily removed and replaced.

The minimum terminals are as follows:

1. Terminal with circuit breaker with integral power line switch for the incoming power line.
2. Terminal unfused for the neutral side of the incoming power line.
3. Terminals and bases for each vehicle and pedestrian signal circuit.
4. Terminals for vehicle phase detector and pedestrian pushbutton cables. Terminals for vehicle detectors include AC+, AC neutral, relay common, relay closure, and the loops or probes from the field.
5. Terminals and bases for signal flasher and outgoing signal field circuits.
6. Terminals for controller input and output circuits including those circuits not used on the project.
7. Terminals for required auxiliary equipment.

Provide adequate electrical clearance between terminals. Label terminals in accordance with the cabinet wiring diagrams. Terminals shall be accessible without removal of equipment contained in the cabinet.

2.02 CONTROLLER CABINET AND AUXILIARY EQUIPMENT (Continued)

- F. Furnish hardware necessary for assembly and installation of the cabinet.
- G. Electrical connections from the controller and auxiliary devices to outgoing and incoming circuits shall be made in such a manner that the controller or auxiliary device can be replaced with a similar unit, without the necessity of disconnecting and reconnecting the individual wires. This may be accomplished by means of a multiple pin jack, a spring connected mounting or approved equivalent arrangement.
- H. Neatly train wiring throughout the cabinet and attach to the interior panels using nonconductive clamps or tie-wraps. Bundles of cables shall be laced, tied, or enclosed in a sheathing material. The cabinet wiring shall not interfere with the entrance, training, or connection of the incoming or outgoing field conductors. Arrange the controller, auxiliary equipment, panel(s), terminals and other accessories within the cabinet to facilitate the entrance and connection of incoming conductors.

Except where terminated by direct soldering, wires shall be provided with terminal lugs for attachment to terminal blocks using screws. Wires shall be identified and labeled in accordance with the cabinet wiring prints.

All wire insulation shall have a minimum rating of 600 volts.

- I. The outgoing signal circuits shall be of the same polarity as the line (+) side of the power service. The incoming signal indication conductors shall be common and of the same polarity as the grounded (-) side of the power service. The neutral (-) side of the power service shall be connected to the cabinet in an approved manner to a copper ground bus located on the panel with the main AC+ circuit breaker. The cabinet shall, in turn, be connected to an earth ground through a ground rod.
- J. Load switches shall provide LED indicator lights on the front of the load switch to designate the active circuit. The closing or opening of signal circuits shall be positive without objectionable dark intervals, flickering of lights, or conflicting signal indications.

2.03 CONFLICT MONITOR

- A. Provide a solid state conflict monitor within the cabinet external to and electrically independent of the controller and enclosed in a finished metal case. The monitor shall detect the occurrence of conflicting Green, Yellow or Walk indications and shall cause the signals to go into predetermined flashing operation with stop timing applied simultaneously should conflicts be sensed.
- B. The conflict monitor shall utilize liquid crystal displays providing four indicators which display an active Red, Yellow, Green, and Walk input for each channel monitored.
- C. If the actual conflict has been cleared, a reset switch (front mounted) on the conflict monitor shall return the controller to normal operation when depressed.

2.04 FLASHER

- A. Provide a separate solid state flasher to permit substitution of flashing signal indications for normal vehicle or pedestrian actuated operation. The solid state flasher shall have no contact points or moving parts and shall utilize zero-point switching. The flasher unit shall have a built-in effective radio interference filter. LED indicator lights shall be provided on the front of the flasher to indicate the active circuit. Flashing rate shall not vary when the power source remains within the specified limits.

2.04 FLASHER (Continued)

- B. Obtain flashing of vehicular signal indications from one or more flashers, each of which is a self contained device designed to plug into a panel in the controller cabinet. If the flashing is provided by two flashers, they shall be wired to assure that the flashing of all indications on the same approach is simultaneous.
- C. The cabinet shall contain a power and flash transfer relay assembly to transfer the AC+ power and operation from the controller and load switches to the solid state flasher. This transfer relay assembly shall be controlled by either the flash mode switches located on the Police and maintenance panels or the conflict monitor. The plug-in transfer relays shall be rated at a minimum of 10 amps per pole and shall be enclosed in a transparent case for protection against dust and for visual observance of operation.

2.05 INDUCTIVE LOOP VEHICLE DETECTOR

- A. Provide a detector harness for each detector amplifier. The harness shall be tagged to indicate the detector number(s) and phase. In case of a failure in the power supply unit for the card rack, fail-safe operation will be provided in that a constant call will be placed on all detector channels.
- B. The detector unit shall be solid state, digital, dual channel, providing detection channel with a minimum inductance range of 50 to 1500 micro-henries. Output circuits of the detector unit shall be provided by relays.
- C. The detector unit shall include the following capabilities:
 - 1. Detection of all licensed motor vehicles.
 - 2. Indicator light for visual indication of each vehicle detection.
 - 3. Fail-safe operation (continuous call) in the event of detector loop failure.
 - 4. Respond to an absolute change (delta L).
- D. The detector unit shall be capable of disabling delay timing by external means during that detector's associated green phase. The delay inhibit on each detector unit shall be in effect during the associated green phase.
- E. The detector unit shall contain a fuse or other reliable protection in the power supply. The fuse shall provide short circuit protection to the power supply and be accessible without removal of the case.
- F. The detector unit shall be capable of normal operation without interference and false calls between sensor units ("crosstalk"). It shall be possible to install the connecting cable in the same conduit as the signal cables, power cables and other detector cables without affecting the normal operation of the detector.

PART 3 - EXECUTION**3.01 CONTROLLER CABINET AND AUXILIARY EQUIPMENT**

- A. Install the controller cabinet on pre-placed caulking material on the concrete base. After the cabinet is installed, place caulking material around the base of the cabinet.
- B. For card rack style detectors, mount detector mounting racks on shelf in the controller cabinet. Wire all detector slots in the cabinet to provide for future use. Label card rack positions with loop numbers.

END OF SECTION