

STATE

OF

TENNESSEE

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City of Morristown
Hamblen County

SPECIAL PROVISION

REGARDING

SECTION 730 - TRAFFIC SIGNALS

General Equipment Specifications:

Preemption:

- #760 3M 700 Series Opticom
- #711 Single Channel one direction
- #721 Single Channel two directions
- #722 Two Channel Two Directions
- #708 Detector Hangers
- #752 Phase Selector 2 Channel
- #754 Phase Selector 4 Channel
- #138 Detector Cable in 500, 1000, or 2500 feet rolls

Malfunction Management Unit:

This unit shall be a EDI smart conflict monitor (MMU-16LEIP) meeting the requirements of this provision and fully compatible with Traffic Controller Unit.

Traffic Controller Unit:

The EAGLE EPAC M54 Controller Unit

Special Provision to Section 730 – Traffic Signals:

Delete Subsection 730.05 and substitute the following:

730.05- Vendor Requirements. It shall be the responsibility of the vendor to be familiar with the specification and to note any exception with the bid document. Any exception, no matter how small, must be noted, with reference to specific paragraph in the specifications.

The vendor shall provide a complete documentation package with the control equipment provided. The documentation shall include the following minimum:

A manual on the operation and maintenance of the equipment is to be provided. This manual shall contain detailed instructions for the proper operation and maintenance of the equipment provided. A manual shall be provided to describe the above for at least the controller unit and signal malfunction management unit.

Schematic/logic diagrams for all equipment are to be housed in the cabinet. Such diagrams shall be detailed to provide sufficient knowledge regarding the proper maintenance of the unit. Circuit designations on the schematic logic diagrams shall correspond to the circuit designation of components on the circuit boards. Circuit board component designations shall be permanently affixed to the circuit board by a permanent process such as silk-screening.

Controller cabinet wiring diagrams shall be provided for each cabinet. Such diagrams shall include all cabinet wiring for the particular cabinet supplied. "Typical" drawings will not be accepted. Drawings will be assigned a specific drawing number, which shall relate to the City order as well as the equipment supplied. The controller manufacturer shall retain the original copy of the cabinet drawing for file reference for the future.

The controller manufacturer shall certify with the bid that the cabinet engineering, design and fabrication were accomplished at facilities under the direct control of the manufacturer. The controller manufacturer shall be required to maintain all records documenting the engineering, fabrication and quality control of the equipment supplied. Such records shall be available to the City upon request at no charge to the City.

Each cabinet shall be provided with a clear envelope for the storage of cabinet drawings.

730.07- Training. The supplier shall be required to provide a technical training session for the controller unit supplied. Such training shall be supplied at a facility provided by the vendor and at a time of not less than ninety (90) days after request for training by the City. Such training shall be of a highly technical nature and shall be conducted by a person in the employ of the controller manufacturer. The training shall include as a minimum, the following requirements:

The training shall be available for five (5) persons to be named by the City. The supplier shall provide a complete set of documentation materials for each person in attendance. The training shall involve at least one (1) four (4) hour class or work session in the field concerning the equipment. Material covered shall include the operation of the controller as well as maintenance of the units provided.

It shall be the responsibility of the supplier to provide the training for City personnel at no cost to the City.

730.16-Cable. Delete the second sentence of the paragraph under **Subsection 730.16-Cable**, and substitute the following:

5-conductor or 9-conductor solid signal conductor wire (AWG #14) shall be used for all signal and accessory circuits.

Add to the end of the second paragraph under 730.20-Strand Cable the following:

If not otherwise specified in the plans, all overhead guy wire is to have a minimum diameter of 3/8", and all down guys are to have a minimum diameter of 5/16".

Substitute for the last sentence of the first paragraph of Subsection 730.24:

All signal head doors and visors shall be black in color. Signal bodies shall be yellow. Visors shall be tunnel visors. Signal head mountings shall have one or more coats of primer followed by two coats of high quality resin enamel of Traffic Signal Yellow and shall meet or exceed Federal Specifications TTC-595 Gloss Yellow.

Delete the first sentence of the fourth paragraph of subsection 730.24 and substitute the following:

Signal heads shall be polycarbonate.

Add to the end of the paragraph on Optical Units in Subsection 730.24:

The red, green, and arrow indications shall be sealed LED units meeting I.T.E. specifications.

Add to the end of section 730.24 under Signal head Mounting and Mounting Brackets:

Signals mounted on mast arms shall be mounted by a bracket secured by cables to the mast arm, so that the signal head is rigidly mounted but adjustable in height, horizontal direction, and vertical direction.

Delete the second paragraph on Directional Louvers in Subsection 730.24 and substitute the following:

Directional louvers shall be so constructed as to have a snug fit in the signal hoods. The outside cylinder and vanes shall be constructed of a non-ferrous metal, galvanized sheet steel, or polycarbonate. Metal louvers shall be painted with two coats of black enamel as specified in these specifications.

Delete the wording under Back plates in Subsection 730.24 and substitute the following:

Where shown on the Plans, back plates shall be furnished and attached to the signal heads. All back plates shall be polycarbonate. They shall be constructed so as to permit installation after signal heads are in place. Back plates shall have a dull black appearance, and shall provide a 5" wide border around the signal head.

Delete all wording under Pedestrian Signals in Subsection 730.24 and substitute the following:

Pedestrian Signals- When shown on the Plans, pedestrian signals shall conform to the following:

1. Pedestrian indications should attract the attention of and be readable to the pedestrian both day and night and at all distances from 3 meters (10 feet) to the full width of the area to be crossed.
2. All pedestrian indications shall consist of the international symbols of a “Walking Figure” and “Upraised Hand”.
3. When illuminated, the “Walking Figure” shall be lunar white meeting the standards of the Institute of Traffic Engineers. All except the symbol shall be black.
4. When illuminated, the “Upraised Hand” shall be Portland orange meeting the standards of the Institute of Traffic Engineers, with all except the symbol being black.
5. When not illuminated, the “Walking Figure” and “Upraised Hand” shall not be distinguishable by pedestrians at the far end of the crosswalk they control.
6. The symbols shall be at least 6 inches high for crossings where the pedestrian enters the crosswalk less than 30 meters (100 feet) from the pedestrian signal indications. For distances of 30 meters (100 feet) or more, the symbols shall be at least 9 inches high.

Each section shall be provided with a visor encompassing the top and sides of the signal face of a size and shape adequate to shield the lens from external light sources or shall be covered by an egg crate style shield. The pedestrian indications shall be LED symbols, either solid or outline.

The housing shall be polycarbonate, clamshell style. Hinge pins shall be stainless steel. The door shall be provided with a neoprene gasket capable of making a weather resistant, dust-proof seal when closed.

All pedestrian signal heads shall have yellow bodies with black faces and visors.

Audible indications for right of way shall be installed in accordance the latest edition of MUTCD for all signals with cross walks according to the plans and sound emitted from the audible equipment shall be a chirp.

Delete Subsection 730.25 and 730.26 and substitute the following:

730.25- Controllers

Cabinet and Wiring - Cabinets shall be provided as complete units, ready for installation with all wiring and materials to accomplish the signal operation as shown on the plans or in attached signal sequence charts.

Cabinets shall be fabricated from aluminum or copper bearing fourteen (14) gauge sheet steel. Aluminum cabinets shall have a minimum wall thickness of 2.5 millimeters (0.100 inches). All

welds shall be neat, smooth and free of blowholes. Where practical, welds shall be internal to present a neat appearance. Non-aluminum cabinets shall be painted aluminum in color.

Cabinets shall have a right-hinged front opening door, which shall include substantially the full area of the cabinet front and one (1) auxiliary police door-in-door for access to emergency controls. The main door shall be equipped with a positive hold fast device to secure the door in at least two (2) open positions, one (1) position being approximately ninety (90) degrees open and the other at one hundred and twenty (120) degrees or more. The hold fast device shall be easily secured and released without the use of tools.

Each door shall be furnished with a neoprene rubber door-sealing gasket to assure the weatherproof integrity of the cabinet doors when closed. The main cabinet door shall employ a heavy gauge aluminum continuous hinge utilizing a non-removable 3/16” diameter stainless steel hinge pin for door support, carriage bolted in place, for ease of door removal. The police panel door shall employ a 14-gauge stainless steel continuous hinge with a 3/32” diameter hinge pin. The switch compartment is mounted flush to the main cabinet door.

The main door shall have pin-tumbler cylinder lock keyed for a #2 key. The police panel door shall be furnished with a standard police sub-treasury lock. Two (2) keys for each lock shall be provided with each cabinet.

All cabinets shall be of the base type with size according to the type of controller to be housed. A “P” cabinet shall be mounted on a concrete pad 30” deep X 48” wide X 24” high, with an extension in front of the cabinet 36” deep X 48” wide X 4” high to stand on while working in the cabinet. An “M” cabinet shall be mounted on a concrete pad 21” deep X 34” wide X 24” high, with an extension in front of the cabinet 36” deep X 34” wide X 4” high. If the cabinet base is located so that there is a paved area in front of the cabinet door, the extension may be omitted. Dimensions of the cabinets shall be as follows:

	Eight Position Cabinet	Twelve Position Cabinet	Sixteen Position Cabinet
Height	49”	57”	55”
Depth	16-17”	16-17”	26”
Width	30”	30-34”	44”

All hardware for mounting shall be furnished, including hot dipped galvanized anchor bolts, nuts and washers.

All cabinets shall be equipped with substantial metal shelves to support included hardware.

All cabinets shall be equipped with thermostatically controlled exhaust fan with filtered air inlet. The fan shall be of the permanently lubricated type with roller bearings and shall have an operating capacity of 0.8 cubic meters (130 cubic feet) per minute with the filter installed. The filter shall be of the replaceable furnace type. The thermostat shall be adjustable over the range of 20-65 degrees C (70-150 degrees F), with surge protection/transient suppressor across the

contacts. The filtered opening shall be in the lower part of the cabinet door, with positive retention of the filter.

Wiring in the cabinet shall be done in a neat, workmanlike manner. All wiring shall be routed and secured to minimize the effects of vibration.

All wiring shall take place at barrier-type terminals. Each wire shall be terminated into a fork-tongue or push-on compression fitting of the insulated type. Compression fittings shall be sized according to the cable and termination point. Compression fittings shall be installed by a calibrated pressure compression tool. Ground connections need not meet this requirement.

Field terminations shall be at barrier type terminals meeting the following requirements:

1. FIELD OUTPUTS for signal circuits shall be made at barrier terminal strips of the double-tie, removable link type. Barrier spacing shall be a minimum of 14 millimeters (0.55 inches) and securing screws shall be a minimum #10 size. There shall be no connections made to the "B" (Output) side of the signal output terminal strip.
2. DETECTOR LOOP INPUTS shall be terminated at barrier terminals with minimum screw size #8.
3. All other cabinet terminals shall utilize screw terminations with screw size no less than #6.

The cabinet shall be provided with an AC service connection protected by a magnetic/hydraulic circuit breaker of a size to properly protect the cabinet wiring and supply the current necessary to operate the specified signal operation. The circuit breaker shall be designed to accept ten (10) gauge copper wire. The AC common line shall be attached to a copper lug designed to accept a #10 copper wire.

There shall be a grounded neutral copper ground buss with multiple screw terminals for twelve (12) gauge copper wire (minimum of twenty-four (24) positions) and a four (4) gauge copper each connection.

Field wiring termination points shall be provided in the quantity shown below:

	4Ø	8Ø
Signal Outputs	32	48
Detector Inputs	12	24
Interconnect	8	8
Pedestrian Detectors	4	8

*Interconnect connections required only if specified in the plans.

The above quantities are minimum. Cabinets shall be supplied to accomplish the specified operation shown in the plans.

NEMA Signal load switch base plates shall be wired in the cabinet according to the following:

	Eight Position	Twelve Position	Sixteen Position
Vehicle Phase	4	4	8
Overlap	2	4	4
Pedestrian Phase	2	4	4
Programmable X	X	X	X

These numbers are minimal and quantity supplied shall be sufficient to meet the specified sequence. Programming of load switch base plates shall be via front panel mounted jumpers between barrier terminal strips (solder connections not permitted).

Noise/transient suppression shall be provided to minimize the noise levels in the cabinet. The supplier shall take care to provide suppression where noise generation may occur.

Suppression Equipment - Noise/transient suppression shall be provided to protect equipment in the cabinet in accordance with NEMA. Suppression devices shall be provided that meet or exceed both NEMA and the following requirements:

1. All lightning arrestors and surge protectors shall be easily accessible from the front of the panel.
2. The transient voltage surge suppressor shall have a peak surge current rating of 100 kA per phase. The peak clamping voltage shall be 395 VAC. Normal operating current is 15 Amps with an operating temperature of -40C to +85C. All relay devices shall have resistor/capacitor network across the coil terminals of the relay.
3. The fan and thermostat control shall have adequate noise suppression.
4. Interconnect lines shall be protected by a unit capable of withstanding a 10 KA, 8 x 20 nanosecond surge five times without damage. The response time of the unit shall be less than 50 nanoseconds. The maximum clamping voltage shall be no greater than 400 volts at one MA. The units must be individually packaged for interconnect line protection and in a package of three for the signal loads.
5. Signal loads (Load Switch Outputs) shall be protected by a three circuit protective device capable of withstanding a 10ka (8x20 microsecond) waveform. Occurrences should be >100 at 200 amps with a maximum clamp voltage of 475 volts per occurrence. Resistor Loads shall be provided for any unused Load Switch Output. Load switches should be mounted on the rear panel near the field outputs.
6. Each detector input line from a remote detector or pedestrian push-button shall be protected by a two-stage hybrid device capable of withstanding a minimum of 30 surges of at least 5,000 amperes each applied to the input. The device shall have one input lead, one output lead, and a ground lug in order for the signal wire to "pass through" the protector. The voltage across the output must be held to 30 volts when the input is subject to a 2,000 ampere, 10:20 microsecond surge. The unit must not interfere with the normal operation of the signal equipment, and must respond in less than 20 nanoseconds.

7. The manufacturer shall provide cabinet noise suppression as required by the particular controller.
8. The external data communications pair (twisted pair FSK cable) shall be protected at the cabinet entry point by a two stage series of hybrid device capable of withstanding a peak surge of 4,000 amps, 8 x 20 microsecond waveform. The device shall have a minimum life of 50 surges at 4000 amps with a response time of less than 20 nanoseconds. The maximum clamping voltages shall be 200V on the incoming telephone line and 15V on the incoming multi-pair voice grade interconnect line.
9. If radio communications is required in the cabinet assembly then an EDCO CXFN or approved equal coax arrester shall be installed across the coax input from the antenna. An EDCO SRS232-25 or approved equal arrester shall be installed across the serial input to the traffic signal controller.

Other cabinet facilities shall include:

1. A GFI Duplex receptacle and a standard duplex receptacle with fifteen (15) amp breaker protection.
2. Fluorescent cabinet lamp with manual on/off switch.
3. The receptacle and lamp shall be wired so that they may be used when the main circuit breaker is off.

Cabinet switch facilities shall be provided according to the following:

1. The police auxiliary panel shall contain the following switches:
 - a. Signal Automatic/Flashing. (Controller power to be removed when in the Flashing Mode)
 - b. Signal On/Off.
2. On the panel behind the police panel, the following switches shall be provided:
 - a. Signal Automatic/Flashing (Controller remains on when in flash mode).
 - b. Signal On/Off. (Removes only signal power when in Off).
 - c. Cabinet Lamp On/Off.
 - d. Individual phase vehicle and pedestrian detector test switches to be miniature toggle of the On-Off Momentary type to place:
 - (1) No Call - Call provided by detectors.
 - (2) Locked detector call.
 - (3) Momentary detector call.
 - e. Switch terminals on back of main cabinet door shall be insulated or shielded so that no live parts are exposed.
 - f. Leads from the terminal block to the auxiliary door switches shall be no less than 0.82 square millimeters (No. 18 AWG) stranded, with TW plasticized polyvinyl chloride or nylon insulation enclosed in an insulating loom and shall be of sufficient length to permit full opening of the main cabinet door.

All cabinet wiring shall be neat, with no in-line splicing of wires. All wires shall be securely terminated with minimal excess wiring length. All wiring shall be stranded conductor.

Cabinet space and clearances shall be adequate to house any standardized NEMA device with maximum allowed NEMA dimensions without modifications to or adjustments of cabinet wiring or appurtenances.

In addition, the vendor shall certify in writing that he has operated the controller and all of the auxiliary equipment successfully for a period of not less than (50) fifty hours burn in time.

Cabinet wiring facilities shall be positioned according to the following:

1. AC Service connections shall be on the lower right wall. Detector and remote inputs shall be on the lower left wall.
2. All controller wiring, signal monitor wiring, etc. shall take place on a single panel, which shall be mounted on the rear wall. All terminals on the rear wall panel shall be silk-screen labeled according to a number sequence, which will identify all termination points.

The cabinet wiring shall be such that it shall be possible to program each phase output to flash Red, Yellow, or No Flash. Flash programming shall employ simple measures using color-coded jumper wire(s) to indicate flash output.

Signal circuits which are designated as flash shall be routed through mechanical flash transfer relays. Flash transfer relays shall be in the energized position for non-flash operation and shall fail-safe to flash operation. Flash transfer relays shall operate from 115 VAC, and shall be heavy-duty type. Contact rating shall be ten (10) amperes minimum. Relays shall be of the male plug type, and shall have a minimum plug length of 18 millimeters (0.70 inches). Contacts shall be of a silver bearing material to reduce contact pitting.

When specified on the plans, or the bid document, loop vehicle detector card rack assembly shall be wired in place. The card rack assembly shall have slots spaced at 2.25” to facilitate the use of 2” or 2.25” detectors, either video or inductive loop. Each position to be wired as follows:

<u>Slot</u>	<u>Function</u>
1	Rack Power Supply
2	Ch1=Ø1, Ch2-4=Ø6
3	Ch1=Ø5, Ch2-4=Ø2
4	Ch1=Ø3, Ch2-4=Ø8
5	Ch1=Ø7, Ch2-4=Ø4

This configuration shall be considered “STANDARD” unless otherwise specified. The call wires shall be hooked to a terminal strip on the detector panel. The wires shall be movable to actuate a different phase if so desired. The detectors and rack must meet NEMA specifications.

730.25 K. MALFUNCTION MANAGEMENT UNIT

This section sets forth the minimum requirements for a shelf-mountable, sixteen channel, solid-state Malfunction Management Unit (MMU) with Ethernet capability. The MMU shall meet, as a minimum, all applicable sections of the *NEMA Standards Publication No. TS2-2003*. Where differences occur, this specification shall govern. The system supplied must be fully compatible with the Controller Timer specified in this provision.

1. MONITORING FUNCTIONS

The following monitoring functions shall be provided in addition to those required by the NEMA Standard Section 4.

A. DUAL INDICATION MONITOR

Dual Indication monitoring shall detect simultaneous input combinations of active Green (Walk), Yellow, or Red (Don't Walk) field signal inputs on the same channel. In Type 12 mode this monitoring function detects simultaneous input combinations of active Green and Yellow, Green and Red, Yellow and Red, Walk and Yellow, or Walk and Red field signal inputs on the same channel.

When voltages on two inputs of a vehicle channel are sensed as active for more than 450 msec, the MMU shall enter the fault mode, transfer the OUTPUT relay contacts to the Fault position, and indicate the DUAL INDICATION fault. The MMU shall remain in the fault mode until the unit is reset by the RESET button or the EXTERNAL RESET input. When voltages on two inputs of a vehicle channel are sensed as active for less than 200 msec, the MMU shall not transfer the OUTPUT relay contacts to the Fault position.

When operating with Port 1 communications enabled, Bit #68 (Spare Bit #2) of the Type #129 response frame shall be set to indicate a Dual Indication fault has been detected.

Dual Indication Monitoring shall be disabled when the RED ENABLE input is not active.

DUAL INDICATION PROGRAMMING

Programming shall be provided to enable the Dual Indication monitoring function for the Green and Red, Green and Yellow, and Yellow and Red combinations for each individual channel. In the Type 12 mode, the Walk inputs shall be logically OR'ed with the Green inputs for purposes of Dual Indication programming.

B. FIELD CHECK MONITORING

The Field Check Monitor function shall provide two modes of operation, Field Check Fault and Field Check Status.

Field Check Monitoring shall be disabled when the RED ENABLE input is not active.

(1) FIELD CHECK MONITOR

In the Field Check Fault mode, when the field signal input states sensed by the MMU do not correspond with the data provided by the Controller Unit in the Type #0 message for 10 consecutive messages, the MMU shall enter the fault mode, transfer the OUTPUT relay contacts to the Fault position, and indicate the FIELD CHECK FAIL fault. Bit #67 (Spare Bit #1) of the Type #129 response frame shall be set to indicate a Field Check fault has been detected. The MMU shall remain in the fault mode until the unit is reset by the RESET button or the EXTERNAL RESET input.

(2) FIELD CHECK STATUS

The Field Check Status mode shall work in combination with the other fault monitoring functions of the MMU. When a Conflict, Red Fail, Clearance Fail, or Dual Indication Fail triggers the MMU, the Channel Status Display and Fault Status Display shall correspond to that detected fault. If Field Check errors were detected while the fault was being timed, the inputs on which the Field Check errors were detected shall be reported on the Channel Status display. Bit #67 (Spare Bit #1) of the Type #129 response frame shall also be set to indicate Field Check errors have been detected.

(3) FIELD CHECK PROGRAMMING

Programming shall be provided to enable the Field Check monitoring function for each Green, Yellow, and Red input individually. Programming shall be provided to enable the Field Check monitoring function for channel 2, 4, 6, and 8 Walk input individually when operating in the Type 12 with SDLC mode.

C. RECURRENT PULSE MONITORING

The Signal Monitor shall detect Conflict, Red Fail, and Dual Indication faults that result from intermittent or flickering field signal inputs. These recurring pulses shall result in a latching fault with the RECURRENT PULSE STATUS indicated along with the resulting Conflict, Red Fail, or Dual Indication status. An option shall be provided to disable the RP detect function for testing purposes.

When operating with Port 1 communications enabled, Bit #69 (Spare Bit #3) of the Type #129 response frame shall be set to indicate a Recurrent Pulse status has been detected.

D. EXTERNAL WATCHDOG MONITORING

The MMU shall provide the capability to monitor an optional external logic level output from a Controller Unit or other external cabinet circuitry. If the MMU does not receive a change in state on the EXTERNAL WATCHDOG input for 1500 msec (± 100 msec), the MMU shall enter the fault mode, transfer the OUTPUT relay contacts to the Fault position, and indicate the WATCHDOG fault. The MMU shall remain in the fault mode until the unit is reset by the RESET button or the EXTERNAL RESET input. An MMU Power Failure shall reset the WATCHDOG fault state of the monitor. The EXTERNAL WATCHDOG input shall be wired to connector MSB-S.

When operating with Port 1 communications enabled, Bit #70 (Spare Bit #4) of the Type #129 response frame shall be set to indicate an External Watchdog fault has been detected.

E. TYPE FAULT MONITOR

The MMU shall verify at power-up that the Type 12 or Type 16 operating mode as determined by the TYPE SELECT input is consistent with the mode set by the last external reset.

Detection of a Type Fault shall place the MMU into the fault mode, transfer the OUTPUT relay contacts to the Fault position, and indicate the TYPE 12/16 fault. The MMU shall remain in the fault mode until the unit is reset by the RESET button or the EXTERNAL RESET input. An MMU Power Failure shall reset the Type Fault state of the monitor.

F. FLASHING YELLOW ARROW PPLT SUPPORT

The MMU shall be designed to monitor an intersection with up to four approaches using the four section Flashing Yellow Arrow (FYA) movement outlined by the NCHRP Research Project 3-54 on Protected/Permissive signal displays with Flashing Yellow Arrows. Two cabinet configurations shall be supported for both the MMU Type 16 and Type 12 modes depending on the number of load switches provided and the capabilities of the Controller Unit. In both modes the MMU shall be designed to provide the same fault coverage for the FYA approaches as it does for conventional protected left turn phases including Conflict, Red Fail, Dual Indication, and both Minimum Yellow and Minimum Yellow Plus Red Clearance monitoring.

2. CONFIGURATION OPTIONS

A. RYG ONLY RED FAIL OPTION

The MMU shall provide the capability to exclude the Walk inputs from the Red Fail fault detection algorithm when operating in the Type 12 mode. When the option is selected, the absence of signals on the Green, Yellow, and Red field outputs of a channel will place the MMU unit into

the fault mode, transfer the OUTPUT relay contacts to the Fault position, and indicate the RED FAIL fault.

B. LED SIGNAL THRESHOLD ADJUST

The MMU shall provide the capability to sense field inputs signals with the following thresholds:

Conflict, Dual Indication Low Threshold Signal Inputs (Green, Yellow, and Red)

No Detectless than 15 Vrms

Detectgreater than 25 Vrms

Red Fail High Threshold Signal Inputs (Green, Yellow, and Red)

No Detectless than 50 Vrms

Detectgreater than 70 Vrms

C. CVM LOG DISABLE OPTION

The MMU shall provide a means to disable the logging of CVM fault events.

3. DISPLAY FUNCTIONS

The following display functions shall be provided in addition to those required by the NEMA TS-2 Standard Section 4. A PC shall not be required to display the following parameters.

A. FIELD SIGNAL VOLTAGES DISPLAY

A mode shall be provided to display the RMS voltage of each field signal input. If the MMU is not in the fault mode, the displayed voltage will be the currently applied RMS voltage. If the MMU is in the fault mode, the displayed voltage will be the applied RMS voltage at the time of the fault.

B. CABINET CONTROL SIGNAL VOLTAGES DISPLAY

A mode shall be provided to display the RMS voltage of the AC Line and Red Enable, the frequency of the AC Line, and the ambient temperature measured at the MMU. If the MMU is not in the fault mode, the displayed values will be the currently applied values. If the MMU is in the fault mode, the displayed values will be the applied values at the time of the fault.

C. FIELD CHECK STATUS DISPLAY

When the MMU is in the fault mode, a display screen for the front panel display shall be provided to identify all field signal inputs with Field Check status.

D. RECURRENT PULSE STATUS DISPLAY

When the MMU is in the fault mode, a display screen for the front panel display shall be provided to identify all field signal inputs with Recurrent Pulse status.

- E. **CONFIGURATION DISPLAY**
A display mode for the front panel display shall be provided that allows the setting and viewing of all MMU configuration parameters. The configuration parameters provided on the program card shall be viewable only. A PC shall not be required to completely program or view the MMU configuration parameters.
 - F. **EVENT LOGS DISPLAY**
A display mode for the front panel display shall be provided to review all details of the Previous Fail log, AC Line log, and the Monitor Reset log.
 - G. **CLOCK SET DISPLAY**
A display mode for the front panel display shall be provided to view and set the time and date of the MMU real time clock.
4. **OPERATING MODES**
The MMU shall operate in both the Type 12 mode and Type 16 mode as required by the NEMA Standard.
- A. **HELP SYSTEM**
A context sensitive Help system shall be provided that is activated by a separate Help button. The Main Status display shall respond with text messages relevant to the position in the menu navigation level. When the MMU is in the fault mode the Help system shall respond with the Diagnostic mode.
 - B. **SETUP WIZARD**
A built-in setup mode shall be provided that automatically configures the Dual Indication enable, Field Check enable, Red Fail enable, and Minimum Yellow Plus Red Clearance enable parameters from user input consisting only of channel assignment and class (vehicle, ped, pp-turn, etc) responses.
 - C. **DIAGNOSTIC WIZARD**
A built-in Diagnostic Wizard shall be provided that displays detailed diagnostic information regarding the fault being analyzed. This mode shall provide a concise view of the signal states involved in the fault, pinpoint faulty signal inputs, and provide guidance on how the technician should isolate the cause of the malfunction. The Diagnostic Wizard shall be automatically invoked when the MMU is in the fault mode and the HELP button is pressed. It shall also be automatically invoked when the MMU is in the Previous Fail (PF) event log display and the HELP button is pressed.
 - D. **TS-1 TYPE 12 WITH SDLC MODE**
The MMU shall be capable of operating in the Type 12 mode with SDLC communications enabled on Port 1. The Channel Status display shall

operate in the Type 12 configuration and provide the field check function for up to four pedestrian Walk inputs.

5. ENCLOSURE

A. SIZE

The MMU shall be compact so as to fit in limited cabinet space. It shall be possible to install on a shelf that is at least 7" deep. Overall dimensions, including mating connectors and harness, shall not exceed 10.5" x 4.5" x 11" (H x W x D).

B. MATERIAL

The enclosure shall be constructed of sheet aluminum with a minimum thickness of 0.062", and shall be finished with an attractive and durable protective coating. Model, serial number, and program information shall be permanently displayed on the top surface.

6. ELECTRONICS

A. MICROPROCESSOR MONITOR

A microprocessor shall be used for all timing and control functions. Continuing operation of the microprocessor shall be verified by an independent monitor circuit, which shall force the OUTPUT RELAY to the de-energized "fault" state and illuminate the DIAGNOSTIC indicator if a pulse is not received from the microprocessor within a defined period not to exceed 500 ms. Only an MMU Power Failure shall reset the DIAGNOSTIC fault state of the monitor.

B. RMS VOLTAGE MEASUREMENT

High speed sampling techniques shall be used to determine the true RMS value of the AC field inputs. Each AC input shall be sampled at least 32 times per line cycle. The RMS voltage measurement shall be insensitive to phase, frequency, and waveform distortion.

C. SOCKETS

In the interest of reliability, no IC sockets shall be used.

D. BATTERY

All user programmed configuration settings shall be stored in an electrically erasable programmable read-only memory (EEPROM). Designs using a battery to maintain configuration data shall not be acceptable. If a battery is used, it shall provide power only to the real time clock.

E. FIELD INPUT TERMINALS

All 120 VAC field terminal inputs shall provide an input impedance of at least 150K ohms and be terminated with a discrete resistor having a power dissipation rating of 0.5 Watts or greater.

- F. COMPONENT TEMPERATURE RANGE
All electrical components used in the MMU except the front panel Status LCD shall be rated by the component manufacturer to operate over the full NEMA temperature range of -34°C to +74°C.
- G. PRINTED CIRCUIT BOARDS
All printed circuit boards shall meet the requirements of the NEMA Standard plus the following requirements to enhance reliability:
 - a. All plated-through holes and exposed circuit traces shall be plated with solder.
 - b. Both sides of the printed circuit board shall be covered with a solder mask material.
 - c. The circuit reference designation for all components and the polarity of all capacitors and diodes shall be clearly marked adjacent to the component. Pin #1 for all integrated circuit packages shall be designated on both sides of all printed circuit boards.
 - d. All printed circuit board assemblies shall be coated on both sides with a clear moisture-proof and fungus-proof sealant.

7. FRONT PANEL AND CONNECTORS

- A. MMU STATUS DISPLAY
A four line by 20 character alpha-numeric LCD display shall be provided to report MMU status, time and date, menu navigation, etc. This display shall be separate from the full intersection channel status display.
- B. FULL INTERSECTION CHANNEL STATUS DISPLAY
A separate Red, Yellow, and Green indicator shall be provided for the channel status LCD display for each channel to show full intersection status simultaneously. For Type 12 mode operation a separate Red, Yellow, Green and Walk indicator shall be provided for each channel to show full intersection status simultaneously. Individual icons shall also be provided to indicate channels involved in a fault.
- C. LED DISPLAY INDICATORS
The following LED display indicators shall be provided:
 - (1) POWER INDICATOR
The green POWER indicator shall flash at a rate of 2Hz when the AC LINE voltage is below the drop-out level. It shall illuminate steadily when the AC LINE voltage returns above the restore level. It shall extinguish when the AC Line voltage is less than 75 Vrms.
 - (2) FAULT INDICATOR
The red FAULT indicator shall illuminate when the MMU is in the fault mode and the OUTPUT relay has transferred to the Fault position.

- (3) PORT 1 RECEIVE INDICATOR
The yellow RECEIVE indicator shall illuminate for a 40 msec pulse each time a Port 1 message is correctly received from the Controller Unit.
- (4) PORT 1 TRANSMIT INDICATOR
The yellow TRANSMIT indicator shall illuminate for a 40 msec pulse each time a Port 1 message is transmitted from the MMU.
- (5) COMM RECEIVE INDICATOR
The yellow COMM indicator shall illuminate for a 40 msec pulse each time a message is correctly received on the Ethernet port.
- (6) DIAGNOSTIC INDICATOR
The red DIAGNOSTIC indicator shall illuminate when the MMU has detected an internal diagnostic failure.

D. CONTROLS

All displays, controls, and connectors shall be mounted on the front panel of the MMU.

HELP BUTTON

A momentary contact button shall be provided that initiates the context sensitive help system.

E. MS CONNECTORS

The MS connectors on the MMU shall have a metallic shell and be attached to the chassis internally. The connectors shall be mounted on the front of the unit in accordance with the following: Connector A shall intermate with a MS 3116 22-55 SZ, and Connector B shall intermate with a MS 3116 16-26 S.

In the interest of reliability and repair ability, printed circuit board mounted MS connectors shall not be acceptable. Internal MS harness wire shall be a minimum of AWG #22, 19 strands.

F. ETHERNET PORT

An Ethernet port capable of both 10 and 100 Mbps operation shall be provided on the front panel. The Ethernet port shall be electrically isolated from the MMU electronics using optical couplers and shall provide a minimum of 2500 Vrms isolation. The connector shall be an RJ-45 eight pin connector.

8. MONITOR CONFIGURATION PARAMETERS

All NEMA standard configuration parameters shall be provided by a program card meeting the requirements of clause 4.3.6 of Nema TS-2. All configuration parameters for functions and options beyond the requirements of the standard shall be stored in non-volatile memory within the MMU. This memory shall be programmable from the front panel menu driven interface, data downloaded via the Ethernet port, or loaded from shadow memory located on the program card.

9. PROGRAM CARD MEMORY

The program card supplied with the MMU shall provide non-volatile memory that contains the configuration parameters for the enhanced features of the MMU, such that transferring the program card to a different MMU completely configures that MMU. The non-volatile memory device used on the program card shall not utilize any I/O pins designated as “Reserved” by NEMA TS-2.

10. EVENT LOGGING

The MMU shall be capable of storing in non-volatile memory a minimum of 100 events. Each event shall be marked with the time and date of the event. These events shall consist of fault events, AC Line events, reset events, and configuration change events. The capability to assign a four digit identification number and 30 character description to the unit shall be provided. The event logs shall be uploaded to a PC using the serial port of the MMU and Windows based software provided by the manufacturer.

Each event log report shall contain the following information:

- a) Monitor ID#: a four digit (0000-9999) ID number and 30 character description assigned to the monitor.
- b) Time and Date: time and date of occurrence.
- c) Event Number: identifies the record number in the log. Event #1 is the most recent event.

11. WAN NETWORK DISCOVERY

The communications software running on the PC shall be able to search the network and display a list of IP addresses and Monitor IDs of MMUs responding on the network. The communications software shall also be capable of making changes to the MMU network parameters such as IP address and subnet mask.

12. ETHERNET PORT HTML INTERFACE

An HTML based capability shall be provided in the MMU to configure the network parameters of the MMU Ethernet port using a standard HTML browser.

13. REPORTS

A. MONITOR STATUS REPORT (CS)

The Current Status report shall contain the following information:

- a) Fault Type: the fault type description.
- b) Field Status: the current GYR(W) field status and field RMS voltages if the monitor is not in the fault state, or the latched field status and field RMS voltages and fault channel status at the time of the fault.
- c) Cabinet Temperature: the current temperature if the monitor is not in the fault state, or the latched temperature at the time of the fault.

- d) AC Line Voltage: the current AC Line voltage and frequency if the monitor is not in the fault state, or the AC Line voltage and frequency at the time of the fault.
- e) Control Input Status: the current state and RMS voltages of the Red Enable input & Load Switch Flash bit input if the monitor is not in the fault state, or the status latched at the time of the fault.

B. PREVIOUS FAULT LOG (PF)

The Previous Fault log shall contain the following information:

- a) Fault Type: the fault type description.
- b) Field Status: the latched field status with RMS voltages, fault channel status, RP Detect status and Field Check status at the time of the fault.
- c) Cabinet Temperature: the latched temperature at the time of the fault.
- d) AC Line Voltage: the AC Line voltage & frequency at the time of the fault.
- e) Control Input Status: the latched state of the Red Enable input at the time of the fault.

C. AC LINE EVENT LOG (AC)

The AC Line log shall contain the following information:

- a) Event Type: describes the type of AC Line event that occurred.
Power-up - AC on, monitor performed a cold start
Interrupt - AC Line < Brownout level
Restore - AC restored from AC brown-out or AC interruption (AC Off), no cold start
- b) AC Line Voltage: the AC Line voltage & frequency at the time of the event.

D. MONITOR RESET LOG (MR)

The Monitor Reset log shall contain the following information:

The monitor was reset from a fault by the front panel Reset button, or External Reset input, or a non-latched event clear.

E. CONFIGURATION CHANGE LOG (CF)

The Configuration Change log shall contain the following information:

- a) The status of all configuration programming including the contents of the Program Card.

- b) Any configuration programming inputs such as 24V Inhibit, Port 1 Disable, Type Select.
- c) Configuration Check Value: A unique check value that is based on the configuration of items #a and #b above.

The log shall also indicate which items have been changed since the last log entry.

F. SIGNAL SEQUENCE LOG (SSQ)

A minimum of five logs shall be provided that graphically display all field signal states and Red Enable for up to 30 seconds prior to the current fault trigger event. The resolution of the display shall be at least 50 milliseconds.

14. REMOTE MONITOR CONFIGURATION

A. SETUP WIZARD

A setup mode shall be provided by the Windows based software that automatically configures the Dual Indication enable, Field Check enable, Red Fail enable, and Minimum Yellow Plus Red Clearance enable parameters from user input consisting only of channel assignment and class (vehicle, ped, pp-turn, etc) responses.

B. UPLOAD FROM FILE

All configuration parameters for functions and options beyond the requirements of the standard shall be programmable by transferring a file from a PC to the MMU via the front panel Ethernet port. These parameters shall be stored in nonvolatile memory in the MMU.

C. DOWNLOAD TO FILE

All configuration parameters for functions and options beyond the requirements of the standard shall be downloadable to a PC by transferring a file from the MMU to a PC via the front panel Ethernet port.

Miscellaneous

Overlaps shall be generated internally and programmable. Programming shall be via the keyboard.

730.26- Traffic Actuated Controllers.

This specification will be used to govern the acceptable design standard for all equipment provided. This specification covers electrically operated control devices which shall function continuously and unattended at a street or highway location to assign vehicle and/or pedestrian right-of-way by illuminating a standard traffic signal.

All electrical equipment to be provided under this contract shall conform to the applicable approved and current standards of the National Electrical Manufacturers Association (NEMA), the Manual on Uniform Traffic Control Devices (MUTCD) and any other local ordinance which may be applicable. Should there be any conflict between these Standards and this Specification, this Specification shall prevail.

The manufacture and model of the unit must be an EPAC M54 which must meet the following minimal requirements:

Controller Timer

Design – The controller unit shall be a self-enclosed fully actuated controller unit with operational, programming and diagnostic capabilities. The controller shall be made of injection molded, high impact polycarbonate and designed for easy access to the boards without disassembly. A molded handle for ease of carrying is desired. It shall be compact and able to fit easily on a shelf in the cabinet. Each controller shall have a unique serial number that is permanently and neatly displayed, along with the model, either on the face or on the top.

Controller units shall contain the necessary communications ports to provide the communications called for in the Plans or in any Special Provisions. All controller units shall be capable of interconnection by twisted pair cable, spread spectrum radio, Ethernet, or fiber optic cable as required on the Plans or in any Special Provisions.

The controller shall have a removable, hand-held LCD alphanumeric backlit display unit, with 8-line, 40 characters per line display capability. The display shall connect to the controller via a dedicated C60 port.

The controller unit shall be completely solid-state and digitally timed. Timing of the controller shall be derived from the 60 hertz /120 volt power line. The electronics shall be modular and shall consist of vertical circuit boards designed to plug in and out of a motherboard or harness within the unit.

The controller unit shall have a minimum of 16 phases with 4 timing rings, 16 overlaps, and 80 detectors. Each controller shall be capable of operating as a Master controller via software. Each controller shall have all operating timing parameters as specified in NEMA on a per phase basis, including all Volume/Density features. Each phase shall have a defeatable Last Car Passage feature wherein the last vehicle receiving the Phase Green shall receive at least one full Passage Time increment.

The controller shall include a front mounted 10/100Mbps Ethernet Port that can be configured with specific network parameters such as an IP address. The controller shall also include an available serial port for connection to the conflict monitor so that its information can be uploaded through the controller. The controller shall have a Data key option to carry data from controller to controller.

In accordance with NEMA, the following are minimum standard features of controller units:

- a. Actuated control
- b. Volume density timing
- c. Conditional service
- d. Additional detectors
- e. Delay/extension/switching detectors
- f. Dual entry
- g. Alternate phase sequences
- h. Start-up flash
- i. Automatic flash
- j. Dimming
- k. Coordination
- l. Preemption (six inputs; six sequences)
- m. Time base including daylight savings and leap year adjustments
- n. Internal diagnostics (memory diagnostics; processor monitoring; conflict monitoring checking; detector diagnostics)

The controller unit shall have a removable alphanumeric backlit liquid crystal display for each ring of the controller to provide an English language menu for programming with displays for programming or reading all controller features. The unit shall display all menus and fields required by NEMA.

It shall be possible to inspect and alter any currently programmed value while the controller is in operation without affecting the field operation. The controller shall continue to operate the intersection as values are inspected or altered.

The display screen shall provide both programming area identification and editing prompts.

An RS-232C interface and connector shall be provided for interconnecting to a printer, another like controller unit, a local personal computer, or a remote personal computer through an external modem.

Programming - User programming of timing intervals shall be via a single front panel mounted keypad. All of the features listed below shall be user programmable via the keypad:

1. All controller-timing values specified in the above section.
2. Controller start-on sequence. The start-on sequence shall include the phase and overlap display.

3. Phase detector status, on a per phase basis, including Lock Detector Call, Non-Lock Detector Call, Minimum Recall, Maximum Recall, Pedestrian Recall and Non-Actuated Phase.
4. RED START time and RED REVERT time.
5. The phase(s) to be designated as the Non-Actuated Phase for NEMA function CALL NON-ACTUATED I & II.
6. On a per phase basis, FLASHING WALK output shall be selectable.

There shall be a data entry security code with the following features:

1. User entered values shall not be altered without first entering the security code.
2. The security code shall be user changeable via the keypad.
3. The security code requirement shall not preclude the inspection of controller data.

Front Panel Displays - The controller shall be provided with a removable front panel LCD alphanumeric backlit display with a minimum of 8-lines, 40 characters per line, English language menus. The display system shall display the following information.

The display shall indicate the following information for each ring of the controller. (Dual ring controllers shall have dual indications to display both rings simultaneously).

- A. Phase in Service
- B. Phase Next in Service
- C. Interval currently timing.
- D. Detector/Recall status of phase currently timing.
- E. Cause for termination of phase.
- F. Maximum Green II in effect.
- G. HOLD input applied to phase.
- H. Phase in REST mode.

The display system shall indicate the following time values:

- A. Maximum Green time remaining
- B. Time before Reduction Remaining
- C. Walk time remaining

The following coordination data shall be displayed:

- A. Cycle, Offset and Split in effect.
- B. Time remaining in the local cycle length.
- C. Time Remaining in the programmed split for a phase.
- D. Active offset and programmed offset.

Preemption / Priority. Each controller shall include:

1. 6 Preempt Routines providing complete signal control
2. 6 Priority Routines providing complete phase control and in-sync return to coordination.

Preempt activity can be monitored on a Preempt Status display which denotes:

- *Preempt In Control, Interval Timing, and Interval Countdown
- *Individual Preempt Status and Timing
- *Individual Priority Status and Timing

Delete Subsection 730.27 and substitute the following:

730.27-Auxiliary Equipment for Traffic Actuated Controllers. When called for in the Specifications, or the Plans, accessory equipment shall meet the following requirements:

Signal Load Switches - Load switches shall be solid state. All physical, electrical and operational characteristics shall be in accordance with "Three-Circuit Solid State Load Switches", of NEMA Traffic Control Systems Standards, latest revision. The load switches shall have controller output indicators mounted on the front panel of the switch as well as load switch output indicators. Units shall be rated at ten (10) amperes per circuit. Shall be compatible with all "Energy Star" LED signal lamps including arrow indications.

Time Clock Switches - Where specified in the plans, time clock switches shall be of solid state circuitry, continuous duty, with a 7 day cycle clock operating from the 120 VAC service line. Switching shall be provided for a minimum of six (6) independent outputs and the time of day selection shall be adjustable to within one minute of the desired time. A battery or capacitor back-up system shall be provided which can maintain time keeping and memory a minimum of 24 hours after power interruption. An omitting device shall be furnished as an integral part of the time switch to enable the switching operation to be skipped for any preselected day or days of the week. Time clocks shall meet NEMA environmental specifications.

Flasher Mechanism - A two-circuit solid state flasher mechanism, rated at a minimum of 15 amps per circuit, shall be provided to permit the substitution of flashing signal indications for the normal specified interval sequence. The cabinet shall be wired for and include a NEMA flasher mounted on the back panel. All physical, electrical and operational characteristics shall be in accordance with "Solid State Flashers", of NEMA Traffic Control Systems Standards, latest revision.

Priority Control System – Priority control systems when required in the plans shall be used for establishing priority for detected movements to allow preemption for emergency vehicles or priority for transit vehicles. All priority control equipment shall meet NEMA environmental specifications. Ample lightning protection to provide effective defense against high transient voltages caused by lightning discharges or from other sources shall be provided.

Priority control systems may be of the following type: Optically Data Encoded Infrared.

The system must meet the following criteria:

1. The system shall be a date encoded matched component system to ensure system security and prevent unauthorized use.

Ethernet Access Devices - Where specified in the plans, an Ethernet access device (EAD) shall be included with the cabinet assembly.

Traffic Interconnect Network Element:

System Architecture – Overview

The traffic interconnect network element (client network element) shall operate on the City of Morristown’s existing Regional Public Safety Wireless Network operated and maintained by the Morristown Engineering Department.

Client Network Element:

The Client Network Element radio unit shall provide IP network access from traffic control equipment to a wireless access point. The unit shall be located in a traffic control cabinet and be connected to a POE CAT6/RJ45 Ethernet switch.

The external antenna:

- Shall be mounted on the controller cabinet or on an adjacent traffic signal pole
- Shall be vandal resistant
- If directional must meet good vandal resistant and easy directional adjusting.
- Shall have a 4 dBi rating or greater

The radio unit shall:

- Be Rohs compliant
- Be FCC Part 15.247, IC RS210 compliant
- Have power over ethernet (POE) connection
- Operate in an environment -20C to +70C (System PCB optimized for hi-temp)
- Operate in Humidity in the range of 5% to 95%
- Be 802.11b/g/n compliant
- Operate in 2 Ghz or 5 Ghz compliancy

Contractor shall provide:

- All additional specifications of radio unit for advanced feature comparisons
- Provide data sheet for dBm and bandwidth capabilities (transmit and receive charts)
- Provide antenna coverage map
- Provide manufacturer’s mean time between failures

INTEGRATED ETHERNET SWITCHING CAPABILITIES:

For the purpose of this specification, the Managed Gigabit Traffic Ethernet Switch (MGTES) shall be a layer 2 switch, having (7) 10/100 RJ45, (1) 10/100/1000 RJ45, and (2) 1000Mb SFP Gigabit ports. The SFP slots can be populated with user selected SFP gigabit fiber transceivers.

The MGTES shall be a managed layer 2 switch.

The MGTES shall be RoHS Manufactured for Environmental Protection.

The MGTES shall be Green Ethernet certified and shall consume less than 8 Watts of power under full operating conditions.

The MGTES shall be EMC - Industrial Level 4 certified.

The MGTES shall use convection cooling and require no venting of the case. This will prevent dirt and contaminants from being introduced into the electronics of the switch.

The RJ45 ports of the MGTES shall automatically negotiate both speed and duplex. The ports shall automatically determine MDI/MDIX so that crossover cables are not required.

Power input shall be supplied to the MGTES by the NEMA/CalTrans rack it is plugged into.

The MGTES shall have an MTBF of greater than 30 years.

Warranty: 5 years all parts and labor.

DEVICE MANAGEMENT CAPABILITIES:

The MGTES shall support Remote management via SNMP, web (HTTP), and Telnet.

The MGTES shall have CLI command line interface, accessible via serial cable, telnet, and SSH.

The MGTES shall support https (secure) through Secure Web Management with SSL Secure Sockets Layer and TLS Transport Layer Security protocol support.

The MGTES shall support SNMP v1, v2, and v3, rich commands including access control and remote monitoring via third party network management software.

The MGTES shall support SNMPv3 for encrypted authentication and enhanced access security.

The MGTES shall support the ability to restrict remote management to computers authorized by IP address, providing additional remote access security beyond traditional capabilities.

The MGTES shall support FTP remote software update.

The MGTES shall support RMON (RFC 1757).

The MGTES shall support Port Security, controlled access by MAC address and IP filtering to limit access to MGTES.

The MGTES shall support Access Control Lists (ACLs) and shall support MAC plus Port ACLs access restriction.

The MGTES shall support Radius Server and TACACS+ for enhanced security and a centralized means of managing switch access.

SWITCHING CAPABILITIES

The MGTES shall support packet buffers: 240 KB for 10/100 and 120KB for 1000 Mb

The MGTES shall have a latency of no more than $6\mu\text{s}$ + packet time max (TX - TX, TX - FX, FX - FX, TX-G, G-G)

The MGTES shall support back pressure and flow control option per port capability.

The MGTES shall support store and forward with IEEE 802.3x full-duplex flow control. All Ports non-blocking.

The MGTES shall support MAC and IP Address Conflict Detection.

The MGTES shall perform Enhanced Broadcast Storm Control.

PROTOCOL SUPPORT

The MGTES shall support VLANs – PVLAN, Ring VLANs, Tag-based, with GVRP, VLAN hopping, VLAN security, VLAN tagging and VLAN trunking support.

The MGTES shall support industry standard Spanning Tree Protocol, 802.1d, and the latest 2004 version of industry standard Rapid Spanning Tree Protocol, IEEE 802.1w for interoperability.

The MGTES shall support Link Aggregation 802.3ad port trunking.

The MGTES shall support QoS, multi-level 802.1p.

The MGTES shall support IGMP v1 and v2 for Snooping and multicast pruning.

The MGTES shall support IGMP Snooping, which allows management of multicast streams, while remaining a layer 2 device.

The MGTES shall support DNS Client which allows users to access other devices using logical names instead of IP addresses. Avoiding explicit IP address information preventing spoofing attacks and providing additional security.

The MGTES shall support Port Mirroring for selective traffic analysis.

Additional Protocols:

IEEE802.3

IEEE802.3u
IEEE802.3z
IEEE802.1q

MECHANICAL SPECIFICATIONS

The MGTES enclosure shall be IP40-rated with an aluminum housing and using a convection-cooled fanless design.

The MGTES shall be mounted by insertion into any standard NEMA or CalTrans detector rack / input file.

The MGTES shall have dimensions to fit within two (2) slots of the detector rack / input file, with all ports and removable connectors placed on the outward face. Approximate dimensions shall be 2.28" x 4.49" x 8.07" (W x H x D).

The MGTES shall weigh less than 2.0 lbs.

The MGTES shall have an electrical power usage of less than 8 Watts, and utilize the 12VDC or 24VDC power from detector rack / input file.

The MGTES shall have status LED indicators for Power and System Status. It shall also have status LEDs for each Ethernet port showing Ethernet Link and Activity.

The MGTES shall have an operating temperature rating of 40 to 85°C (-40 to 185°F).

INDUSTRIAL CERTIFICATIONS AND APPROVALS

The MGTES shall have met or complied with, at a minimum, all the following approvals or standards:

IEC61000-4-2(ESD): ±8KV contact discharge, ±15KV air discharge

IEC61000-4-3(RS): 10V/M (80-1000MHz)

IEC61000-4-4(EFT): ±4KV power line, ±2KV data line

IEC61000-4-5(Surge): power line ±4KV CM/ ±2KV DM, data line ±2KV IEC61000-4-6(CS):3V (10KHZ-150KHZ), 10V (150 KHz-80MHz)

IEC61000-4-8(Power frequency magnetic field):100A/m ct.

1000A/m, 1s to 3s

IEC61000-4-12/18(Damped oscillatory wave):2.5KV CM, 1KV DM

IEC61000-4-10(Damped oscillatory):30A/m

IEC61000-4-16(Common mode conduct):30V cont. 300V, 1s

FCC CFR47 Part 15/EN55022: Class A&B

IEC61000-6-2 (Industrial Standards)

IEC61850-3 (Substations),

IEEE1613 (Electric Power Substations)

EN50121-4 (Railway Applications)

730.29 Detectors

1. The following specifications define the minimum acceptable design, operational and functional performance requirements for high performance, multiple channel, inductive loop vehicle detectors utilizing a Liquid Crystal Display (LCD) to indicate the operational, setup, and loop diagnostic parameters of the detector/loop system.
2. Detectors supplied to this specification shall have a manufacturer's warranty to be free of defects in materials and workmanship for a period of not less than 2 years.
3. The Detector shall meet, as a minimum, all applicable sections of the *NEMA Standards Publication No. TS2-2003*. Where differences occur, this specification shall govern.
4. Detector units shall be in full compliance with the environmental, transient and size requirements of NEMA Standards TS1-1994 Section 15, TS2-2003 Section 6.5, and California/New York Type 170/179 specifications, and shall meet the design, operation, electrical and functional performance requirements of these specifications.
5. The detector unit shall have two or four operationally independent channels that scan sequentially.
6. The detector unit shall be microprocessor controlled, fully digital, and self tuning. The detector unit shall be configured as a rack mounted printed circuit board for insertion into a NEMA TS-1 / TS-2 rack or Caltrans 170 type detector input file.
7. Detector units shall be designed to operate over a voltage range of 10.8 to 28 VDC.
8. The detector shall include optically isolated, solid state outputs designed to provide a continuous "fail-safe" (Fail-call) output in the event of power loss to the unit.
9. The detector shall utilize two spring loaded toggle switches per channel to navigate the menu driven user interface.
10. The detector unit shall display and record the occurrence of an open loop, shorted loop, or excess inductance change (> 25%). The type of error shall be displayed both by the LCD and a yellow fault LED. The LCD shall display "shorted loop", "open loop" or "25% DL/L" and shall log the 25 most recent events. All information shall be stored in non-volatile memory.
11. Each channel shall provide a continuous (fail-safe) output and indication in response to an open or shorted loop.

12. Each channel shall include two, wide angle, high visibility LED indicators.
 - a. Each channel shall have a red LED to display channel detect output status, output state and also the status of the delay and extension timers plus a yellow LED to display loop fault monitor diagnostics (open loop, shorted loop, >25% inductance change).
 - b. The red channel detect LED indicator shall flash at a rate of 2 Hz during delay timing.
 - c. The red channel detect LED shall flash at a rate of 4 Hz during extension timing.
 - d. The yellow fault LED shall flash once to indicate an open loop.
 - e. The yellow fault LED shall flash twice to indicate a shorted loop.
 - f. The yellow fault LED shall flash three times to indicate an excessive change in inductance.
 - g. During fault indication, the red channel detect LED shall flash at the same rate as the fault LED to indicate a current fault. If the fault self-heals, the red led will return to normal operation (indicating calls) while the yellow fault LED continues to flash indicating a prior fault.
13. **Graphic Liquid Crystal Display**
 - a. The unit shall be capable of displaying ALL (2 or 4) channels simultaneously.
 - b. The unit shall be capable of setting up and resetting all channels individually.
 - c. The unit shall be capable of changing setup parameters (sensitivity, frequency) dynamically while detecting vehicles.
 - d. The unit shall be capable of setting up all channels simultaneously.
 - e. The unit shall utilize a white back light for the LCD. (No electro-luminescence allowed)
14. **LCD Full Prompting Menu System**
 - A. The LCD shall prompt the user utilizing word prompts for easy setup, operation, diagnostic and information gathering operations. All prompting from the display shall be in clear English. There shall be no need to memorize any special switch setting combinations to setup or change the operational parameters of the detector. As long as the user understands the operations of standard loop detectors, there will be no need for a user manual or prior knowledge to setup and use the detector.
 - B. The menu system shall prompt the end user for the following input during setup and operation.
 - h. Channel Output Control: Each channel's output shall be user selected as "On" for normal operations, "Call" to output a constant

call for diagnostic purposes, and “Off” for when a channel is not in use.

- a. Sensitivity: A value between 1 and 20 may be selected. A pie graph shall be displayed to assist in determining the correct sensitivity by showing the deflection caused by vehicles on the loop. Also, an XY Graph showing Deflectometer values and vehicle calls over time shall be displayed.
 - b. Frequency: One of Eight frequency values may be selected depending on the frequencies of the adjacent loops. The actual frequency is displayed and can be compared to adjacent detectors so that the maximum separation can be achieved between loops adjacent to one another. The unit shall be capable of graphically displaying noise or crosstalk on the display.
 - c. Operational Mode: One of two modes may be selected, Pulse or Presence. If Presence is selected then the user shall be prompted for Short, Long, or User defined presence.
 - d. Timing: Delay and Extension timing shall prompt for a yes or no response. If yes, it shall then prompt for the amount of delay and extension timing desired.
 - e. Count: Shall control the secondary count outputs and prompt for a yes or no response (2EC only). If yes is selected the user shall be prompted for the loop configuration the counts are to be taken from and also whether the secondary count outputs shall be active. The counts (1 thru 999,999) shall be displayed.
 - f. Paired Channels: Pairs channels 1 & 2 (2E, 2EC) and 3 & 4 (4E, 4EC) to perform one of the following functions:
 - (1) 3rd Car Mode: Is used for determining the number of cars in a left turn lane. When 2 loops, usually 6’ x 20’, are in a left turn lane and both have detection, a call is output.
 - (2) Directional Logic Mode: Uses two loops to determine the direction of a vehicle.
 - g. Approach ID: The user is prompted to select up to 5 alpha numeric characters to identify the approach that channel is related to, e.g. SBLT4 (South Bound Left Turn Phase 4).
- C. Display: This selection determines the display that shall be shown during normal operation. Channel ID, Sensitivity setting, Countdown timers, and the Deflectometer are shown on all with the option of Frequency (Freq), Inductance (Induct), or Count (Count).

Event Logs: Selecting Logs shall allow the user to view the last 25 events with the most recent being first on a per channel basis. The log shall include the type of fault (open loop, shorted loop, >25% inductance change). It shall also include power up, power loss and reset events. The time elapsed after each event will also be displayed.

15. Mechanical

Height	4.50	inches
Width (2E and 2EC)	1.20	inches
Width (4E and 4EC)	2.30	inches
Depth (excluding handle)	6.875	inches
Weight (2E and 2EC)	7.0	ounces
Weight (4E and 4EC)	10.0	ounces

16. Electrical Specifications

- A. Power Supply: 10.8 to 28.8 Vdc max 100 mA (2E, 2EC) 200 Ma (4E, 4EC).
- B. Tuning Range: 20 to 2500 uH Loop plus lead-in (approx 15 to 60 kHz)
- C. Q factor: 5 min.
- D. Inputs: Low (true) less than 8 volts, High (false) greater than 16 volts
- E. Call Output: Solid State optically isolated. “On” voltage shall be less than 1.5 volts at 50mA collector current.
- F. Status and Count Outputs: 50 volts max collector voltage, “On” voltage less than 1.5 volts with 50mA collector current.

17. Environmental: -34°C to + 74°C. humidity 95% max (non-condensing)

730.30- Coordination. All controllers supplied shall include a coordinating device as specified herein. The coordination unit shall be an internal component of the controller. All controllers shall be supplied with a Time Based Coordination (TBC) unit. Also, the Time Based Coordination unit shall be an internal component of the controller. Additionally, when required by the bid documents, hard-wire coordination functions and cabinet wiring facilities shall be supplied. Controllers for closed loop systems shall have an internal connectivity (Ethernet port, serial port for external radio, internal MM or SM fiber modem, internal TDM-FSK modem, etc.) to enable it to communicate with an on-street master or the central office.

Modes of Coordination:

- 1. Permissive Mode
- 2. Yield Mode
- 3. Permissive Yield Mode

4. Permissive Omit Mode
5. Sequential Omit Mode
6. Full Actuated Mode

Coordination – Coordination via the controller shall provide the following functions:

1. Sixteen independent coord plans, programmable from 10 seconds to 255 seconds, in one second increments.
2. Three independent offsets per plan, programmable over the range of 0-255 seconds, in one second increments.
3. FREE (Non-coordinated) operation.

The controller coordination shall be user programmable via the keypad for all of the following:

1. Values required by the functions of 1 and 2 listed above.
2. At a minimum the following offset correction methods shall be available:
 - A. Shortway
 - B. Dwell with Maximum dwell time.
 - C. Shortway Plus
3. Standby operation with selection of Cycle, Offset, Split and Sequence for the condition of loss of interconnect.
4. Manual operation of the controller.

The coordinator shall compute and generate the necessary Force Off, Hold(s) and Omit(s) based upon the controller time settings and the maximum split times programmed in the coordinator for each phase.

Loss of Interconnect - In such cases, the user shall be able to pre-select which of the following will prevail:

- FREE (Non-Coordinated) operation.
- Pre-selected Cycle, Offset and Split.
- Operation (Coordination) by TBC on a Time-of-Day basis.

730.31 - Time Based Coordination. Time Based Coordination shall emulate the function of interconnect cable on a time-of-day, day-of-week, week-of-year basis in the following manner.

The following user programmable functions shall be provided:

1. 99 year calendar

2. Defeatable daylight savings time correction, the date for which shall be user programmable.
3. Capacitor back-up for user programmed data, with 100-hour operation and timing accuracy of 0.0015%. The capacitor shall also maintain the real time clock.
4. User programmable resynch method for compatibility with currently available systems.
5. Timing programs shall be selected via a combination of the following user programmable functions:
 - a. A minimum of 250 events which may be used to select timing patterns for any combination of 10 different weeks or 99 different days or special days.
 - b. Time-of-day resynch via external input as a resynch line when TBC is used in hard-wire system(This function to be an output when the plans or specifications require a TBC MASTER).
 - c. Four user selectable hard-wire outputs for use for such things as Max II select, flash, etc.

Adaptive Traffic Control - Controller shall be capable of performing the following routines:

Adaptive Maximum Routines which are enabled via Time Base, offer three separate Step values to cause the running maximum to increase or decrease smoothly based on current traffic conditions. Separate Dynamic Maximum parameters are available for each Step value.

Adaptive Protected/Permissive Routines measure the volume of Left Turn vehicle traffic and available gap windows in the conflicting Through-Vehicle traffic to determine whether the Left Turn should operate protected or permissive.

Coordination Virtual Split Routine provides for actuated coord phase vehicle and pedestrian modes. This control provides for a period of time of each cycle which is distributed to the Coord phase(s) or non-coord phases, based on Coord Phase vehicle traffic activity.

Coordination Adaptive Split Routines which are enabled via Time Base adjust split times smoothly based on current traffic conditions.

External Adaptive Control Option – The controller shall be compatible with the overall centrally controlled adaptive solution should this be required in the future. Modification to the firmware or hardware of the controller shall not be necessary.

730.32 Cantilever Signal Supports

Delete the first sentence under Finish in Subsection 730.32-Cantilever Signal Supports and substitute in its place the following:

Steel poles, mast arms, and hardware, shall be galvanized in accordance with ASTM A123.

Delete the first sentence under Finish in Subsection 730.33-Steel Strain Poles and substitute in its place the following:

Steel poles and hardware shall be galvanized in accordance with ASTM A123.