# SPECIFICATION

## Infrared Activated, Data-Encoded, Traffic Signal Priority Control System

### I. SYSTEM DESCRIPTION

The required priority control system will employ data-encoded infrared communication to identify the presence of designated priority or probe vehicles. A record of system users by vehicle classification and identification number shall be created. In priority vehicle mode, the data-encoded communication will request the traffic signal controller to advance to and/or hold a desired traffic signal display selected from phases normally available. In probe vehicle mode, no traffic signal priority is requested--only a record of the probe vehicle's presence is generated.

The priority control system will consist of a matched system of data-encoded emitters, infrared detectors, detector cable, phase selectors and system software.

The emitter will generate an infrared, data-encoded signal. The data-encoded signal will be detected and recognized by the infrared detectors at or near the intersection over a line-of-sight path of up to 2,500 feet (762m) under clear atmospheric conditions. The phase selector will process the electrical signal from the detector to ensure that the communication (1) is a valid base frequency, (2) is correctly data encoded, and (3) is within user-settable range. If these conditions are met, the phase selector will generate a priority control request (i.e., a green light) for the approaching priority vehicles, or record the presence of approaching probe vehicles by classification and identification number.

The system will require no action from the vehicle operator other than to turn the emitter on. The system will operate on a first-come, first-served basis. Higher priority (Command) requests will override lower priority (Advantage) requests. The system will interface with most traffic signal controllers and will not compromise normal operation or existing safety provisions.

### II. MATCHED SYSTEM COMPONENTS

The required priority control, data-encoded, infrared communications system will be comprised of five basic matched components: data-encoded emitter, infrared detector, detector cable, phase selector and system software. In addition, a card rack and an electromechanical interface card shall be available if required. To ensure system integrity, operation and compatibility, all components will be from the same manufacturer. The system will offer compatibility with most signal controllers, e.g., NEMA (National Electrical Manufacturers Association), 170, 2070.

A. Data-Encoded Emitter. The data-encoded emitter will trigger the system. It will send the encoded infrared signal to the detector. It will be located on the priority or probe vehicle.

B. Infrared Detector. The detector will change the infrared signal to an electrical signal. It will be located at or near the intersection. It will send the electrical signal, via the detector cable, to the phase selector.

C. Detector Cable. The detector cable will carry the electrical signal from the detector to the phase selector.

D. Phase Selector. The phase selector will accommodate data-encoded communication and will validate, identify, classify and record the signal from the detector. It will be located within the controller cabinet at the intersection. It will request the controller to provide priority to the requesting vehicle and/or record presence of a probe vehicle.

E. System Software. The system software will be a Windows™ XP/2000 compliant program. It supports system configuration and gathering of operational information.

F. Card Rack. The card rack will provide simplified installation of a phase selector into controller cabinets that do not already have a suitable card rack.

## III. SYSTEM COMPONENT SPECIFICATIONS

A. Data-Encoded Infrared Emitter and Programming Software

1. The required data-encoded emitter will generate the infrared signal, which serves as the trigger to the rest of the priority control system. The infrared signal generated by the data encoded emitter will be a series of intense flashes from a single light source with integral power supply. The flash signal will consist of a fixed frequency base signal and a coded overlay signal that can be used to transmit information.

2. The data-encoded emitter will be powered by the DC voltage supplied from the vehicle's battery, 10 to 16 volts DC. The unit will be equipped with a weatherproof in-line fuse holder and a weatherproof quick-disconnect plug.

3. The unit, including all electronics, shall be miniaturized to a size no greater than 5.900 inches (14.986 cm) wide by 3.800 inches (9.652 cm) high by 3.500 inches (8.890 cm) deep to accommodate standalone and internal lightbar installation.

4. The data-encoded emitter will be supplied complete with a 25 foot (8.0m) installation cable.

5. The flash sequence generated by the data-encoded emitter will carry three types of information:

   a. The first type will be one of three distinctly different base frequencies of either 9.63855Hz ±0.0014Hz for an Advantage priority emitter, or 14.03509Hz ±0.003Hz for a Command priority emitter, or 11.25873Hz ±0.00190Hz for Probe frequency.

   b. The second type of information generated by the data-encoded emitter will be a vehicle classification and identification code that is interleaved into the base frequency flashes. Setting the vehicle classification and identification code will be accomplished through emitter programming software. Each data-encoded emitter will be capable of setting 10 different classifications with 1,000 different identification numbers per class for a total of 10,000 codes per base frequency.

   c. The third type of information generated by the data-encoded emitter will be reserved for setting the intersection detection range. The system will enable the traffic engineer to activate the range code from his/her vehicle using a specially equipped emitter control module with a range setting command switch. The system will accommodate setting a separate range from 200 feet (61m) to 2,500 feet (762m) for both Command and Advantage priority signals.

6. The emitter will include a multi-purpose port compliant with the SAE J1708 communication standard. This port enables unit configuration to be set into the emitter and read from the emitter.

7. While operating, the data-encoded emitter will conduct self-diagnostics designed to monitor data transmission integrity by checking for missing pulses. Any failures of the self-diagnostic tests shall be displayed by flashing of the ON/OFF switch indicator light.

8. An ON/OFF switch (available for each data-encoded emitter) will be equipped with an indicator light providing internal diagnostics to assist in troubleshooting. The indicator light will operate as follows:

   a. Steady on when the emitter is operating
   b. Flash at a 0.5Hz rate when the emitter is intentionally disabled
   c. Flash at a 4Hz rate when the emitter is inoperative

9. The data-encoded emitter will be equipped with a disable input that, when activated, will cease unit operation, thereby eliminating the possibility of inadvertent signal transmission after the priority vehicle has arrived at its destination. Operation of the disable input shall be programmable using software.

10. The data-encoded emitter shall be available with an optional visible light-blocking filter.

11. The data-encoded emitter shall be configured with a grating to provide precise directionality control.

12. The data-encoded emitter shall have a consistent flash intensity. The energy output per flash shall be 0.84 Joules.

13. The data-encoded emitter will operate over a temperature range of –30°F (-34°C) to +165°F (+74°C).

14. The data-encoded emitter will operate over a relative humidity range of 5% to 95%.

15. Windows™ based software shall be available for programming the emitter through its J1708 compatible multi-purpose port.

B. Infrared Detector

1. The required detector will be a lightweight, weatherproof device capable of sensing and transforming pulsed infrared energy into electrical signals for use by the phase selection equipment.

2. The infrared detector will be designed for mounting at or near an intersection on mast arms, pedestals, pipes or span wires.

3. Each infrared detector will be supplied with mounting hardware to accommodate installation on mast arms. Additional hardware shall be available for span wire installations.

4. The infrared detector design shall include adjustable tubes to enable their reorientation for span wire mounting without disassembly of the unit.

5. The detector will accept infrared signals from one or two directions and will provide single or dual electrical output signal(s).

6. The infrared detector will be available in three configurations:

   a. Uni-directional with one output channel.

b. Bi-directional with one output channel.
c. Bi-directional with two output channels.

7. The detector will allow aiming of the two infrared sensing inputs for skewed approaches or slight curves.

8. The infrared detector will have a built-in terminal block to simplify wiring connections.

9. The infrared detector will receive power from the phase selector and will have internal voltage regulation to operate from 18 to 37 volts DC.

10 The infrared detector will respond to a clear lens data-encoded emitter with 0.84 (±10%) Joules of energy output per flash at a distance of 2,500 feet (762m) under clear atmospheric conditions. If the emitter is configured with a visible light filter, the detector will respond at a distance of 1800 feet (549m) under clear atmospheric conditions. The noted distances shall be comparable day and night.

11. The infrared detector will deliver the necessary electrical signal to the phase selector via a detector cable up to 1,000 feet (305m) in length.

C. Detector Cable

1. The detector cable shall deliver sufficient power from the phase selector to the infrared detector and will deliver the necessary quality signal from the detector to the phase selector over a non-spliced distance of 1,000 feet (305m).

2. The cable will be of durable construction to satisfy the following installation methods:

a. Direct burial.
b. Conduit and mast arm pull.
c. Exposed overhead (supported by messenger wire).

3. The outside diameter of the detector cable will not exceed 0.3 inches (7.62mm).

4. The insulation rating of the detector cable will be 600 volts minimum.

5. The temperature rating of the detector cable will be +158°F (+70°C) minimum.

6. The conductors will be shielded with aluminized polyester and have an AWG #20 (7 x 28) stranded and individually tinned drain wire to provide signal integrity and transient protection.

7. The shield wrapping will have a 20% overlap to ensure shield integrity following conduit and mast arm pulls.

8. The detector cable will have four conductors of AWG #20 (7 x 28) stranded, individually tinned copper, color-coded insulation as follows:

a. Orange for delivery of detector power (+).
b. Drain wire for detector power return (-).
c. Yellow for detector signal #1.
d. Blue for detector signal #2 or ground, depending on model.

9. The characteristic impedance of the detector cable shall be:
0.6ohms/1000'

14.3uF/1000'

D. Phase Selector

1. The phase selector, designed to be installed in the traffic controller cabinet, will accommodate data-encoded signals and is intended for use directly with numerous controllers. These include California/New York Type 170 controllers with compatible software, NEMA controllers, or other controllers along with the system card rack and suitable system interface equipment and controller software.

2. The phase selector will be a plug-in, two or four channel, multiple-priority device intended to be installed directly into a card rack located within the controller cabinet.

3. The phase selector will be powered from 115 volt (95 volts AC to 135 volts AC), 60Hz mains and will contain an internal, regulated power supply that supports up to twelve infrared detectors.

4. Programming the phase selector and retrieving the data stored in it will be accomplished using an IBM PC-compatible computer and the system interface software. The connection can be made either directly, via the computer's communication (COM) port, or remotely via a modem. The communication port on the phase selector will be an RS232 interface located on the front and back of the unit.

5. The phase selector shall include the ability to directly sense the green traffic controller signal indications through the use of dedicated sensing circuits and wires connected directly the field wire termination points in the traffic controller cabinet.

6. The phase selector will have the capability of storing up to 1000 of the most recent priority control calls, probe frequency passages, or unauthorized vehicle occurrences. When the log is full, the phase selector will drop the oldest entry to accommodate the new entry. The phase selector will store the record in non-volatile memory and will retain the record if power terminates. Each record entry will include ten points of information about the priority call, as follows:

   a. Classification: Indicates the type of vehicle.
   b. Identification number: Indicates the unique ID number of the vehicle.
   c. Priority level: Indicates whether Command or Advantage priority, or Probe frequency is requested by the vehicle.
   d. Direction: Channel A, B, C, or D; Indicates the vehicle's direction of travel.
   e. Call duration: Indicates the total time in seconds the priority status is active.
   f. Final greens at end of call: Indicates which phases are green.
   g. Duration of final greens: Indicates the total time of priority greens.
   h. Time and date call ended: Indicates the time a priority status ended; Provided in second, minute, hour, day, month, year.
   i. Maximum signal intensity: Indicates the strongest signal intensity measured by the phase selector during call.
   j. Priority output active: Indicates if the phase selector requested priority from the controller for the call.

7. The phase selector will include several control timers that will limit or modify the duration of a priority control condition, by channel, and can be programmed from an IBM PC-compatible computer. The control timers will be as follows:

    a. MAX CALL TIME: Will set the maximum time a channel is allowed to be active. It will be settable from 120 to 65,535 seconds in one-second increments. Its factory default must be the maximum time.
    b. CALL HOLD TIME: Will set the time a call is held on a channel after the priority signal is no longer being received. It will be settable from one to 255 seconds in one-second increments. Its factory default must be six seconds.
    c. CALL DELAY TIME: Will set the time a call must be recognized before the phase selector activates the corresponding output. It will be settable from zero to 255 seconds in one-second increments. Its factory default must be zero seconds.

8. The phase selector's default values shall be re-settable by the operator using an IBM PC-compatible computer, or manually using switches located on its front.

9. The phase selector will be capable of three levels of discrimination of data-encoded infrared signals, as follows:

    a. Verification of the presence of the base infrared signal of either 14.03509Hz ± 0.01773Hz for Command priority, 9.63855Hz ± 0.00836Hz for Advantage priority or 11.25873Hz ±0.01141Hz for Probe frequency.
    b. Validation of the infrared signal data-encoded pulses.
    c. Determination of when the vehicle is within the prescribed range.

10. The phase selector's card edge connector will include primary infrared detector inputs and power outputs. Two additional detector inputs per channel will be provided on a front panel connector.

11. The phase selector will include one opto-isolated NPN output per channel that provides the following electrical signal to the appropriate pin on the card edge connector:

    a. 6.25Hz ± 0.1Hz 50% on/duty square wave in response to an Advantage priority call.
    b. A steady ON in response to a Command priority call.

12. The phase selector will accommodate three methods for setting intensity thresholds (emitter range) for high and low priority signals:

    a. Using a data-encoded emitter with range-setting capability.
    b. Using any encoded emitter by manipulating the front panel switches.
    c. Inputting the range requirements via the communication port.

13. The phase selector will have a solid state POWER ON LED indicator that flashes to indicate unit diagnostic mode and illuminates steadily to indicate proper operation.

14. The phase selector will have internal diagnostics to test for proper operation. If a fault is detected, the phase selector will use the front panel LED indicators to display fault information.

15. The phase selector will have a Command (High) and Advantage (Low) solid state LED indicator for each channel to display active calls.

16. The phase selector will have a test switch for each channel to test proper operation of Command or Advantage priority.

17. The phase selector will properly identify a Command priority call with the presence of 10 Advantage priority data-encoded emitter signals being received simultaneously on the same channel.

18. The phase selector will have write-on pads to allow identification of the phase and channel.

19. The phase selector shall provide one isolated confirmation light control output per channel. These outputs are user configurable through software for a variety of confirmation light sequences.

20. The NEMA model of the phase selector shall have outputs for the control of NEMA controllers that lack internal preemption capability. This function shall be accomplished through the use of Manual Control Enable, Interval Advance, and Phase Omit options.

21. The phase selector shall have the capability of recording the presence of a vehicle transmitting at the specified Probe frequency. The phase selector shall at no time attempt to modify the intersection operation in response to the Probe frequency.

22. The phase selector shall have the capability of providing Advantage priority in a mode where the output to the controller is gated or controlled by timing relationships within the controller cycle.

23. The phase selector shall have the capability to assign a relative priority to a call request within Command or Advantage priority. This assignment is based on the received vehicle class.

24. The phase selector shall have the capability to discriminate between individual ID codes, and allow or deny a call output to the controller based on this information.

25. The phase selector shall have the capability to log call requests by unauthorized vehicles.

26. The phase selector shall have the ability to command an emitter to relay a received code to the next intersection.

27. The phase selector shall have the capability of functionally testing connected detector circuits and indicating via front panel LEDs non-functional detector circuits.

28. The phase selector shall incorporate a precision real time clock synchronized to the utility AC power line frequency.

29. An auxiliary interface panel shall be available to facilitate interconnections between the phase selector and traffic cabinet wiring.

E. Card Rack

1. The required card rack will provide simplified installation of a phase selector into controller cabinets that do not already have a suitable card rack.

2. The card rack will be factory wired to one connector, located behind the card slot, and a terminal block, located next to the phase selector slot, on the front of the card rack.

3. The card rack connector on the front, will provide for all connections to the traffic controller.

4. The card rack will provide labeled terminal blocks for connecting the primary infrared detectors to a phase selector.

F. Interface Software

1. The priority control interface software will be provided on 3.5", 1.44MB diskettes to interface with the phase selector. It must run on most IBM-compatible computers equipped with at least 16MB RAM, Windows™ XP/2000 and color VGA display capability.

2. The priority control interface software must accommodate:

   a. Setting up and presenting user-determined system parameters.
   b. Viewing and changing settings.
   c. Viewing activity screens.

   d. Displaying and/or downloading records of previous activity showing class, code, priority, direction, call duration, final greens at end of call, duration of final greens, time call ended in real time plus maximum signal intensity (vehicle location information). This information may be used to reconstruct the route taken by a priority (or probe) vehicle to track the vehicle.

3. The priority control interface software must accommodate operation via a mouse or via the keyboard, or in combination.

4 The priority control interface software must provide menu displays to enable:

   a. Setting of valid vehicle ID and class codes.
   b. Establishing signal intensity thresholds (detection ranges), modem initialization, intersection name and timing parameters.
   c. Setting of desired green signal indications during priority control operation and upload and download capability to view.
   d. Resetting and/or retrieving logged data and priority vehicle activity.
   e. Addressing for each card in a multi-drop connected system.
   f. Confirmation light configuration.
   g. NEMA Control Parameters.

## IV. RELIABILITY

A. All equipment supplied as part of the infrared priority control system intended for use in the controller cabinet will meet the following electrical and environmental specifications spelled out in the NEMA Standards Publication TS2 1992, Part 2:

1. Line voltage variations per NEMA TS2 1992, Paragraph 2.1.2.
2. Power source frequency per NEMA TS2 1992, Paragraph 2.1.3.
3. Power source noise transients per NEMA TS2 1992, Paragraph 2.1.6.1.
4. Temperature range per NEMA TS2 1992, Paragraph 2.1.5.1.
5. Humidity per NEMA TS2 1992, Paragraph 2.1.5.2.
6. Shock test per NEMA TS2 1992, Paragraph 3.13.9.
7. Vibration per NEMA TS2 1992, Paragraph 3.13.8.

B. Each piece of equipment supplied as part of the priority control system intended for use in or on priority vehicles will operate properly across the entire spectrum of combinations of environmental conditions (temperature range, relative humidity, vehicle battery voltage) per the individual

component specifications.

## V. QUALIFICATIONS

A. The manufacturer of the required infrared priority control system will verify the proven, safe operation of the system's infrared communication technology. Upon request, the manufacturer will produce a list of 20 user agencies having two years or more experience interfacing priority control equipment with solid state and programmable controller types.

B. The manufacturer will demonstrate the ability to finance ongoing technical support, written product warranties, and responsibility for product failure.

## VI. RESPONSIBILITIES

A. The manufacturer of the required infrared priority control system and/or the manufacturer's representative will provide responsive service before, during and after installation of the priority control system. The manufacturer and/or the manufacturer's representative, as consultants to the installer, will provide certified, trained technicians having traffic systems industry experience and operational knowledge of priority control systems.

B. The lowest fully responsive bidder will be required to supply working production components specified in this Specification within 14 calendar days from the bid opening date. Failure to do so will render the bid non-responsive.

C. Paragraph B will not be required if, prior to the bid opening, the bidder demonstrated to the city that the equipment bid meets these specifications.

## VII. SUBSTANTIATED WARRANTY

A. The manufacturer of the required infrared priority control system will warrant that, provided the priority control system has been properly installed, operated and maintained, component parts of a matched component system (see Section II) that prove to be defective in workmanship and/or material during the first five (5) years from the date of shipment from the manufacturer will be covered in a documented system-protection plan, plus provide an added five-year maintenance coverage for repair or replacement at a fixed deductible charge for a total of ten (10) years of product coverage.

The manufacturer must substantiate its ability to respond to warranty claims. The guarantee will be determined in reference to the manufacturer's experience over the preceding five-year period.

B. The protection plan will warrant that component parts of a matched component system that are not subject to coverage limitations and prove to be defective in workmanship and/or material during the first five (5) years from the date of shipment from manufacturer will be repaired at no charge, and that extended coverage with a fixed repair deductible will be available for an additional five (5) years.

C. In total, the warranty/maintenance coverage must assure that system components will be available to allow system operation during the ten (10) year warranty/maintenance coverage.

D. A copy of the manufacturer's written warranty outlining the conditions stated above will be supplied with the bid. Coverage and coverage limitations are to be administered as detailed in the manufacturer's Warranty/Maintenance document.

## VIII. CERTIFICATE OF INSURANCE

The manufacturer of the required infrared priority control system will provide a certificate of product liability insurance protection for $5,000,000 assuring the priority control user that the manufacturer is insured against civil damages if proven to be at fault for an accident due to equipment failure within the system of matched priority control components. This certificate, however, need not, and is not meant to, provide liability insurance protection to the priority control system dealer, installer or user.

## IX. USER SUPPORT SERVICES

The manufacturer of the required infrared priority control system will offer support programs to assist the purchase and implementation of a priority control system program, including:

A. Intersection survey service to document appropriate equipment interfaces.
B. Driver Training Program

## X. CERTIFICATION

The manufacturer of the required infrared priority control system will certify that all component products are designed, manufactured and tested as a system of matched components and will meet or exceed the requirements of this specification.