# LED Task Specific Embedded
# Dynamic Message Sign
# Amber LED

## Solar-Powered
## Sample Procurement Specification

## SolarSign 5000 Series

21 Quinton Street, Warwick, Rhode Island 02888

Phone: (401) 232-3370 / (800) 252-6220
www.sesamerica.com

# Contents

SES AMERICA

SAMPLE PROCUREMENT SPECIFICATION

**INTELLIGENT TRANSPORTATION SYSTEM**

**SOLAR POWERED DYNAMIC MESSAGE SIGNS**

SolarSign 5000 SERIES

# 1 Introduction

TSDMS equipment described in this document must comply with the following industry and project standards and requirements;:

- NEMA TS4
- NTCIP Version 2.39
- DOT general specifications and requirements.

This document describes several LED Display board character sizes (8", 12", 18",) in Amber color. The exact types of TSDMS required for the project and their specific options are listed in Appendix A – Bid Item Configuration Sheet.

# 2 TSDMS Equipment

## 2.1 TSDMS Sign Housing

**2.1.1** The TSDMS housing shall be constructed to have a neat, professional appearance. The housing shall be constructed of aluminum alloy 5052-H32 with a minimum thickness of 0.090 inch (2.29 mm). Where extrusion is used for TSDMS structural members such as frames or channel, the extrusions shall be constructed of either 6061-T6 or 6005 T-5 aluminum.

**2.1.2** The TSDMS housing shall be capable of being either surface mounted to, or embedded in, a MUTCD compliant static sign. The housing must provide safe and convenient access to all sign equipment, components, assemblies and other materials. Internal components shall be removable, transportable and capable of being installed by a single technician, and shall be modular in design so that it is not necessary to remove or replace discrete components in the field to analyze and/or correct a failure.

**2.1.3** The housing shall protect internal components from rain, ice, dust and corrosion in accordance with NEMA enclosure Type 3R standards, as described in NEMA Standards Publication 250, Enclosures for Electrical Equipment (1000 Volts Maximum).

**2.1.4** The TSDMS housing shall contain small weep holes for draining any water that may accumulate due to condensation. Weep holes shall be screened by a non-corrosive material to prevent the entrance of insects and small animals.

**2.1.5** Housings shall be designed with an interior construction utilizing a non-corrosive mounting system in which to mount the display modules. The mounting process shall be designed to withstand and minimize effects from vibration to the display modules and/or electronics.

**2.1.6** The TSDMS housing must be equipped with mounting tabs in which to attach the TSDMS housing to the static sign structure or static sign as approved by the engineer. All mounting components and TSDMS housing configurations must meet AASHTO requirements. Several TSDMS may be mounted on a single static sign. The mounting brackets and interfaces shall not interfere with and shall be designed to allow easy installation of all signs.

**2.1.7** The housing must be slim and shall not exceed 5 inches. If the static sign needs to be cut to install an embedded TSDMS, the front face surface of the TSDMS housing shall not protrude more than 4 inches from the front surface of the static sign.

## 2.2 Optional TSDMS Angle Mechanism

If required by the approving engineer, the TSDMS must be designed to be easily adapted to an optional Angularity Mechanism allowing for fine tuning of the TSDMS viewing angle in relation to the roadway. The angularity mechanism must provide a range of adjustment between 0 and 12 degrees. Please refer to "Bid Item Configuration Sheet" in Appendix A.

## 2.3 Front Access TSDMS Housings

**2.3.1** Front Access TSDMS housings and all associated equipment and materials shall be designed and constructed so that all maintenance and repair is performed from the outside through the front access door panels. Doors or panels required to be moved out of their normal closed position for maintenance or repair shall not impede access of maintenance personnel to the internal components of the TSDMS.

**2.3.2 Front Access Door TSDMS shall be equipped with the following features;**

- Single or multiple horizontally hinged rigid door panels, each of which contains a full-height section of the LED display matrix and will open from top to bottom.
- Each door is equipped with a retaining latch, slide or lanyard that will hold the door open to a minimum of 90 degrees.
- Each door is equipped with a locking mechanism to ensure a water tight seal against the inner door opening gasket.
- Each door will seal against flat foam or other type gasket designed to seal the door to NEMA 3R standards through the life of the TSDMS. Gasket material will also conform to NEMA TS4 standards.

**2.3.3** Back surface of the Front Access TSDMS will utilize the following features;

- Rear panels will be bolted to the TSDMS and watertight sealed to block sun light from escaping through the front face area of the TSDMS.
- Cable access connections will be positioned in such a way as to not interfere with installation of the TSDMS housing.
- Each TSDMS will be equipped with one or more enclosure vents to allow pressure buildup within the sign to escape.

## 2.4 Front Face Construction

**2.4.1** The front face construction shall consist of a aluminum mask with a layer of weather tight, ultraviolet protected, non-diffusing polycarbonate (non-matte finish) sheeting attached securely to the inside surface of an aluminum inner door panel.

**2.4.2** The front of the sign housing shall be completely surrounded by an area designated as a contrast shield to improve legibility. This shield shall be bolted to the sign or be an integral part of the sign housing and front face design. Either design will not allow light leaks occur. The pixel apertures in both the mask and inner front door panels shall provide openings directly in front of each LED pixel grouping. Each opening shall be of sufficient size as to not interfere with LED light output from the road viewing angles stipulated for the display. The sign face shall be designed to minimize bowing and shall not distort in a manner that adversely affects LED message legibility.

**2.4.3** The sign face shall be designed in such a way that mounting fasteners are hidden from view by oncoming motorists.

## 2.5 Optional Limited view configuration

It may be required that the TSDMS display is seen by some traffic lanes only. In this case, a limited view design shall be provided.

For a limited view TSDMS, the cone of vision of each pixel shall be limited in one horizontal direction (right or left), while the other side remains compliant with the requirements of this specification. The manufacturer must submit for approval a clear design description and explanation of how the angular performance is achieved. Please refer to “Bid Item Configuration” sheet in Appendix A.

## 2.6 Exterior Housing Finish

**2.6.1** To reduce glare, increase contrast ratio and provide a long-lasting professional appearance, the entire TSDMS housing shall be painted or powder coated with a matte black finish to a minimum standard of AAMA 2604-05 specifications.

**2.6.2** All welds shall be neatly formed and free of cracks, blow holes and other irregularities. The housing shall have a smooth, uniform finish.

## 2.7 Lifting Hardware

For TSDMS exceeding 50lbs, galvanized steel lifting eyebolts shall be attached to the top of the TSDMS housing for moving and installation purposes. All mounting points for eyebolts shall be sealed to prevent water from entering the TSDMS housing. Lifting hardware, as well as the sign housing, shall be designed to prevent damage or undue stress to the TSDMS during shipping or temporary storage prior to installation on the TSDMS support structure.

## 2.8 Ventilation

**2.8.1** No ventilation shall be required for the electronic components. The sign shall operate without any exhaust or intake fans or positive pressure ventilation systems.

# 3 Display Properties

The optical system shall provide a uniform display across the sign, so that there is no visible difference in luminous intensity from any one pixel to another pixel, under any brightness level.

The LED display module will be created by pixels utilizing AMBER LEDS.

## 3.1 Contrast Ratio

**3.1.1** TSDMS shall be constructed in accordance with contrast ratio requirements as defined in NEMA TS4 Section 5.2.

**3.1.2** Contrast Ratio is calculated as follows:

$$C_r = (L_{on} - L_{off}) / L_{off}$$

Where:

$C_r$ = contrast ratio

$L_{on}$ = measured luminance from the display with the pixels active or on, at the specified sign illuminance.

$L_{off}$ = measured luminance from the display with the pixels inactive or off, at the **specified sign luminance.**

**3.1.3** Based on this formula, the TSDMS shall meet a contrast ratio of 12, when measured on-axis (0° horizontal and 0° vertical in relation to the center of the sign face) under any illumination lower or equal to 40,000 lux by a solar simulator. The contrast ratio shall be measured at the front of the sign in its final position with any component that could impede or otherwise affect the light output and background luminance (such as the front face, mask, and polycarbonate) in place.

## 3.2 Cone of Vision

**3.2.1** The cone of vision for the AMBER LEDS must be at least 15 degrees as defined by NEMA TS4.

## 3.3 Luminance Intensity Requirements

**3.3.1** The luminance intensity shall be measured at the front of the sign in its final position with any component that could impede or otherwise affect the light output (such as the front face, mask, and polycarbonate) in place.

**3.3.2** The TSDMS manufacturer must submit a test certificate from an independent laboratory to certify that the luminance intensity for the LED Display module illuminating the color AMBER is a minimum of 12,000 cd/$m^2$ under 40,000 Lux.

## 3.4 Display Characteristics

**3.4.1** All provisions of NEMA TS 4 Section 5.6.1 and 5.6.2 shall apply for fonts and alphabets. Each sign shall be able to display a message composed of any combination of ASCII characters 20(hex) through 7E (hex) inclusive.

**3.4.2** The sign displays shall support text and graphic displays in accordance with the requirements of NTCIP.

**3.4.3** For a Full Matrix requirement, the TSDMS display area shall conform to the following display characteristics and requirements:

TABLE 2:

DISPLAY CHARACTERISTICS

| Requirement | Amber | | |
|---|---|---|---|
| **Pixel Pitch (max.)** | **66 mm** | **46 mm** | **29 mm** |
| **Character Height** | **18 in** | **12 in** | **8 in** |
| **Horizontal Spacing (pixels - min.) between lines** | **3** | **3** | **2** |
| **Vertical Spacing (pixels - min.) between characters of the same word** | **2** | **2** | **2** |
| **Default Font Array** | **5x7** | **5x7** | **5x7** |
| **Legibility Distance** | **1000 ft** | **700 ft** | **400 ft** |

## 3.5 Display Change Time

The time required to clear any display and post any new display shall not exceed 500 milliseconds.

# 4 Optical Components

## 4.1 Display Module Design

**4.1.1** Each display module shall consist of only one electronic assembly that contains all of the LED's, LED drivers, memory, microcontroller and network elements to control the LED's.

**4.1.2** All like-size modules shall be fully interchangeable within a sign or different type of sign using the same pitch from the same TSDMS manufacturer. The same type of display board must be used for either character matrix, line matrix or full matrix TSDMS in order to reduce spare part inventory and maintenance cost.

**4.1.3** A dedicated rotary switch must be available at the rear of each display module to adjust the brightness for each display module independently of the other modules.

**4.1.4** The replacement of a display module shall be possible without the use of any tools, drawings or diagnostic equipment.

**4.1.5** All the connections between boards shall be made with rugged, positive locking, quick release, and coded connectors. Their size and shape shall be such that they are easy to manipulate.

**4.1.6** Each display board shall contain one DC power and one data communication connector.

**4.1.7** An eight position DIP switch must be provided for addressing each individual board. A label identifying the display board address will be adhered to a nearby location for easy board replacement.

**4.1.8** A separate connector shall be available for diagnostics.

**4.1.9** **Each display module will operate from a DC voltage input of 24 VDC.**

## 4.2 LEDs

All AMBER LEDs provided for the manufacture of the TSDMS shall conform to the following requirements.

### 4.2.1 Amber LEDs

**4.2.1.1** LED package style shall be surface-mount LEDs or through-hole LEDs.

**4.2.1.2** LEDs shall emit a true amber color at a wavelength of 592 nm (±5nm).

**4.2.1.3** LEDs shall come from the same LED component manufacturer and shall be non-tinted, non-diffused, high intensity, solid state lamps utilizing aluminum indium gallium phosphide (AllnGaP) LED technology.

**4.2.1.4** LED luminous output shall be a minimum of 3,000 mcd luminous intensity at 20 mA forward current.

**4.2.1.5** The TSDMS manufacturer will assure color uniformity and consistency by requiring the display boards be manufactured using only LEDs from two adjacent color bins and two adjacent intensity bins LEDs shall be nominally rated for 100,000 hours of operation under 100% intensity (at manufacturer's stated current) under NEMA TS-4 environmental conditions (-34°F / +165°F). (-34°C / +74°C).

**4.2.1.6** LEDs shall have a nominal viewing angle of 15 degrees (7.5° measured from the longitudinal axis of the LED). The use of optical enhancing lenses to achieve the specified viewing angle is not allowed and will be cause for rejection.

**4.2.1.7** Each display module shall include a label indicating the intensity and color bin of the LEDs used.

**4.2.1.8** The hardware design of the LED driver circuitry shall be such that the LED current shall be hardware restricted so it can never exceed 75 % of Maximum Forward Current as defined by the LED Manufacturer. These criteria must be met even if there is a software failure in the system.

**4.2.1.9** The change of brightness must occur simultaneously on all display modules in the sign.

## 4.3 Pixel Sizing

Each display module shall include a minimum number of LEDs per pixel for the various character sizes as specified below.

18" = 3 LEDs per pixel

12" = 2 LEDs per pixel

8" = 1 LED per pixel

## 4.4 Pixel Spacing

**4.4.1** The horizontal and vertical pixel spacing (pitch) shall be equal and shall be in accordance to the sizes as shown below.

- 18 inch display module – 2.57 inches (66 mm)
- 12 inch display module –1.81 inches (46 mm)
- 8 inch display module – 1.14 inches (29 mm)

## 4.5 Energy Efficiency

The solar system and TSDMS shall be designed to be energy efficient and to consume the minimum amount of power in order to reduce the solar system size in both number of components needed and installation costs as well as provide increased autonomy. The maximum power consumption of the sign and solar system components shall be as follows:

- Controller = 5 Watts max.
- Amber Display board 18" nominal (40% of pixels, daytime brightness) = 2.2 W, at maximum brightness = 5.3 W
- Amber Display board 12" nominal = 1.1 W, at maximum brightness = 2.4 W
- Amber Display board 8" nominal = .9 W, at maximum brightness = 2.0 W
- Solar Charge Controller = 2.7Watts/hr.
- Solar Charge Controller Low Voltage Disconnect = 5 Watts/hr.
- Photocell sensor device = 1 Watt/hr.
- Solar Chain Monitoring board = 2.5 Watts/hr.
- The supplier must provide calculation to justify the power consumption of each TSDMS system and component, based on the following:
- Display at daily brightness (40% of pixels ON)
- Ventilation ON if required by the manufacturer
- Controller and all other devices (for example light sensors) ON

## 4.6 Surge Protection

TSDMS equipment shall be protected by a double-pole, thermal-magnetic breaker. Additional protection shall be provided for overvoltage and lightning on both the DC and communication circuits.

## 4.7 Electrical Panel

Circuit breakers of the appropriate size shall be provided with each panel and wiring shall be rated in accordance with appropriate articles of the NEC and the anticipated loads.

# 5 TSDMS Controller

## 5.1 General Requirements

**5.1.1** TSDMS shall be controlled by a microprocessor based sign controller (designed specifically for TSDMS/DMS usage) capable of operating and monitoring all sign functions.

**5.1.2** The controller must allow the user to operate the sign via 3 different interfaces namely from the front panel touchscreen, web-based interface, and NTCIP central software.

**5.1.3** The sign controller shall be housed in a durable enclosure and shall be 19 inch EIA rack mountable. Controllers shall be capable of driving all sign components via a RS485 network and be fully NTCIP compliant.

## 5.2 Physical requirements are;

**5.2.1 The controller shall provide LEDs to indicate the status of the following items.**

- DC Power
- Battery Status
- CPU Status
- CPU Fault Status
- Ethernet Link and Activity Status
- RS232 Receive and Transmit Activity
- RS485 Receive and Transmit Activity
- Digital Input Status
- Digital Output status

**5.2.2 The front panel provides the following:**

- Two (2) Ethernet 10/100 full-duplex ports,
- Two (2) RS-232 serial ports,
- Two (2) RS-485 serial ports,
- Four (4) digital outputs.,
- Four (4) digital inputs,
- One (1) reset push button,
- Power On/Off switch,
- Full Color Touch Screen with WYSIWYG display.

**5.2.3** The controller must have a Full Color Touch Screen with WYSIWYG display of a minimum size 4 5/8 inches width x 3 1/2 inches high.

**5.2.4** All electrical connections between the controller and subassemblies located within the Controller Cabinet and the TSDMS are provided on the front panel to avoid maintenance access problems associated with connectors located at the rear of the controller.

**5.2.5** Rugged, keyed connectors must be used to prevent misplacement of the connectors.

## 5.3 Digital I/O

The controller must be equipped with a minimum of 4 Digital inputs capable of accepting dry contact closures. These digital inputs can provide status inputs from items such as door switches. These inputs can also trigger software functions such as displaying preprogrammed messages. The controller shall provide a minimum of 4 Digital Outputs capable of driving relays or commands to external devices.

## 5.4 Clock

**5.4.1** The TSDMS controller shall contain a computer-readable time-of-year clock with a lithium battery or equivalent backup capable of operating the clock properly without external power.

**5.4.2** The clock shall be set by the TSDMS controller microprocessor and shall be accurate to within 1 minute per month.

## 5.5 Front Panel User Interface

- The TSDMS controller shall be equipped with a full color, front panel touch screen LCD display. This user interface shall be capable of:
- Display sign current message in WYSIWYG format including blinking function, multi-page messages, flashers, etc.
- Allow display of all available TSDMS display test patterns.
- Perform all diagnostics testing of various system components, including pixels, power systems, sensors, etc.
- Activate a blank message or other messages stored in non-volatile memory of the TSDMS Controller.
- Control mode selection (Remote or Local).
- Select automatic or manual brightness mode of operation.

### 5.5.1 The GUI of the front panel touch screen shall meet the following requirements:

- Provide a main menu with icons used to select the main controller functionalities like the display screen, maintenance screen, communication and configuration screens.
- Display in real time the exact messages (graphic or text) displayed on the TSDMS. In the case were the controller is connected to several TSDMS, all TSDMS message displays shall be available
- Display the brightness level
- Display manual or automatic brightness control mode
- Display symbols portraying major functionality like power availability, communication, light sensor status, stored event logs configuration upload and download.
- Navigation buttons to navigate from one screen to another.
- A specific screen to display communication configuration and sign address (IP addresses)

### 5.6 Controller Software

**5.6.1** The TSDMS controller software at minimum shall support NTCIP 1203 V2.39 and be backward compatible as noted in Section 9 of this specification.

**5.6.2** The TSDMS controller shall be configurable by the user to define the number of LED display elements (pixels) faults before the controller blanks the sign.

**5.6.3** Provide a remote capable web-server interface that will allow remote interface of all front panel user functions.

### 5.7 Display Presentation

**5.7.1** The sign controller shall control the display modules to create the desired message on the sign. At a minimum, the signs shall be able to display the characters as described in NEMA sections 5.6.1 and 5.6.2.

## 6 Dimming System:

**6.1.1** TSDMS shall be provided with a display intensity control system. In case of locations with multiple TSDMS, only one light sensor system shall be provided and connected to the controller. All TSDMS shall dim simultaneously and shall have the same brightness level at any given time.

**6.1.2** The system shall contain a minimum of two ambient light sensors to measure light levels and report the levels to the display control system. The sensors shall be positioned so that one sensor shall monitor the light levels on the front of the TSDMS, a second sensor shall monitor the light striking the back of the TSDMS.

**6.1.3** The levels reported to the sign controller shall be processed so that the highest light level sensed will be considered the controlling level and shall be compared against a table containing a minimum of 6 configurable intensity levels.

**6.1.4** The intensity levels shall be user configurable.

**6.1.5** Each intensity level shall consist of an entry and exit value that allows the overlapping of levels to prevent display fluctuation with minor ambient light changes and flickering of the display during intensity level changes.

**6.1.6** The dimming system shall conform to the following requirements:

**6.1.7** At a minimum, the front facing photocell shall be enclosed within the sign case with a transparent covered window that allow light to pass from the exterior of the sign case to the surface of the photocell. The rear facing sensor can either be placed within the sign housing or be a remote sensor positioned in such a way to gather light input exposed to the rear of the TSDMS. Sensors shall be capable of being continually exposed to direct sunlight without impairment of performance.

**6.1.8** Dimming Levels - Manual and automatic dimming modes shall be provided enabling the user to select the desired mode of operation.

# 7 Diagnostics and System Failure:

## 7.1 Failure Reports

The sign controller shall implement the status reporting objects required by NTCIP and have them available from a poll from central or the Local Connection. Sign controller shall log error conditions and make them available for future reporting.

## 7.2 Power Interruptions

The controller's configuration and controller state must be saved in non-volatile memory. In the event of a power interrupt, the controller must resume operation once power is restored. Upon recovering from a power interruption, the controller shall report to the central computer that it has recovered from a power-interruption.

# 8 Solar Power System

The solar power system shall consist of a solar PV panel powered, battery operated renewable power system. The solar system shall power the TSDMS and all associated control and communications equipment year-round., 24 hours per day with an average load of 50 percent of pixels ON, with no external charge required. The Solar System shall consist of a Solar PV Panel Array, Battery Bank, Battery Box, Solar Charge Controller, Solar Chain Monitoring Boards and any associated racking, hardware, cables, fuses, circuit breakers and switchgear which shall conform to the following specifications:

## 8.1 Solar Panel Array

**8.1.1** The Solar Panel Array shall consist of photovoltaic panels properly sized to limit the number of panels needed at each location and shall be inclinable in two axis to optimize the charging capabilities of the photovoltaic panels (see Section 8.5). The solar panels shall rotate a full 360° and shall tilt up to 65° from horizontal (in a maximum of 20° increments). The Photovoltaic panels shall include a minimum 10 year manufacturer's warranty and have a rated efficiency above 15 percent.

**8.1.2** The Solar Power Array shall provide sufficient power to the LED Display Modules to meet the minimum luminance intensity for the light emitting diodes under full connected power (not reserve rower) as defined in Table 5-8 of NEMA Standards Publication TS 4-2005, *"Hardware Standards for Dynamic Message Signs (DMS) with NTCIP Requirements."*

**8.1.3** The Solar Panel Array shall provide sufficient current to the LED pixels on each LED Display Module to maintain the legibility of the display even when the TSDMS is under a direct sign face solar illuminance of 40,000 lux.

**8.1.4** The Solar Panel Array shall supply enough energy to supply the total daily power requirements of the TSDMS LED Display Modules and all electrical equipment within the TSDMS Controller Cabinet given the environmental conditions present year round at the deployment locations (Solar Power Array and Battery Bank recharging calculations shall be supplied by the Contractor and approved in advance of the installation).

## 8.2 Battery Bank

**8.2.1** All batteries shall be valve regulated lead-acid with gel and tubular technologies. Batteries shall be maintenance free and shall not emit vapors.

**8.2.2** Each Battery Bank shall be wired in a series, to prevent wiring resistance and non-uniform charging/discharging created through parallel wiring effects. Battery capacity shall be selected to avoid parallel battery connections and provide ample power for a minimum of XX days autonomy. Contact SESA prior to issuing the specification in order to get a free analysis and system size estimate. By doing so, the system offered should be consistent with the requirements and budget of the project.

**8.2.3** Battery Bank State of Charge (SOC) calculations shall take into account data provided by the Solar Monitoring Boards (temperature, current and voltage) and report via NTCIP commands (NTCIP object fuelLevel).

**8.2.4** When State of Charge reaches the threshold of 25%, a NTCIP fault shall appear (in shortErrorStatus, bit 2 for power error).

**8.2.5** The Battery Bank shall supply enough energy to provide the TSDMS and all associated control and communications equipment with at least XX days of autonomy without any charge from any device (solar panels disconnected) considering all environmental impacts (cold or heat) on the battery bank as per IEEE recommended practice for sizing lead-acid batteries (the calculations must be supplied).

- Batteries shall be easily accessible for maintenance purposes
- Batteries shall be deep-cycle type designed for solar power applications
- Batteries shall be installed in the battery box.

The batteries supplied must meet the following minimum criteria:

- Easily accessible for maintenance purposes
- Deep-cycle type designed for solar power applications
- Installed in battery box with ample ventilation
- Sealed AGM battery – maintenance free with no emitted gases

### 8.2.6 Battery Box

A Battery Box enclosure shall be provided to accommodate all batteries required for the battery bank within the solar system. The battery box shall be installed on a concrete pad or be pole mounted, and shall meet or exceed the following requirements:

- Constructed of 0.125” 5052-H32 aluminum
- NEMA 3R environmental rating
- Stainless steel hinge
- Include screened louvers on both sides to provide filtered ventilation
- Include 2” extruded polystyrene insulation
- Include stainless steel padlock hasp
- All welds shall be sanded smooth
- Include ground skids for mounting on the concrete pad

## 8.3 Solar Charge Controller

**8.3.1** The Solar Charge Controller shall include all metering and data logging features required to measure and log the following parameters: minimum and maximum battery voltage, alarms and faults, maximum solar array voltage and power output, charge in amp-hours and watt-hours, minimum and maximum battery temperature; and absorption, float and equalize charging states.

**8.3.2** The Solar Charge Controller shall be equipped with Maximum Power Point Tracking (MPPT).

**8.3.3** The Solar Charge Controller shall monitor the batteries and provide an automatic shut off of the LED modules on the TSDMS if operating voltage drops below 11.5 VDC (or manufacturer recommended voltage) in order to prevent the batteries from being over-drained and to preserve their operational life.

**8.3.4** The Solar Charge Controller shall include an Ethernet connection for a fully web-enabled remote IP interface that provides system monitoring, data logging and adjustability. The unit shall be configurable to send an email or text message if a system fault, alarm or programmable event is detected and shall be able to monitor and receive messages on an SNMP network.

**8.3.5** The Solar Charge Controller shall meet or exceed the following electrical requirements, electronic protections and battery charging requirements:

| | |
|---|---|
| Maximum Battery Current | 60 Amps |
| Nominal Maximum Solar Power | 800 Watts at 12 Volts |
| Peak Efficiency | 99% |
| Transient Surge Protection | 4500 Watts/port |

## 8.4 Solar Chain Monitoring Boards

The solar power system shall include Solar Chain Monitoring Boards installed inside the battery cabinet and equipped with sensors capable of measuring current and voltage supplied by the solar system as well as power consumption of the associated TSDMS, internal temperature of the battery cabinet and battery temperature.

Solar Chain Monitoring Boards shall provide measurements (temperature, current and voltage) to assist in calculation of State of Charge (SOC) and configured through RS485 protocol. Addressing shall be configured with DIP switches, as shown on submitted electrical drawings.

## 8.5 Solar System Sizing and Component Calculations

The solar system used in conjunction with the TSDMS must be designed by the TSDMS manufacturer and optimized for each location. A solar site survey must be performed and a solar map will be created to determine the proper installation of the PV Panels and confirm overall sizing of the system. For consistency and to achieve the most reliable and highest quality solar system, the following characteristics must be maintained.

### 8.5.1 Average Daily DC Consumption (System Load)

Every device in the TSDMS and solar system must be taken into consideration for power draw. The draw of each item must be calculated on a 24-hr day.

This calculation must take into account every item in the complete system; power delivery, TSDMS, and communications. For example the calculations must include; each LED Display board, modem, controller, photocell device. Every device in the complete system has a load and it must be accounted for.

### 8.5.2 Sizing the Battery Bank

When sizing the battery bank there are a number of items to take in account. The following items are required and must be accounted for.

- Average Daily DC Consumption (System Load)
- DC System Voltage – must be 24 Volts
- Days of Autonomy Required. XXX
- Allowable depth of discharge - must be 50 percent
- Minimum expected operating temperature – 0 degree Celsius
- Battery Temperature Derating Factor – must be 85 percent +/- 2 percent at 0 degree Celsius

### 8.5.3 Sizing the Solar Array

There are many factors to consider when sizing a solar array. Below is a list of factors that must be included in the calculations.

- Average Daily DC Consumption (System Load)
- Critical Design Month Insolation – as published by the National Energy Research Laboratory (NERL) for the specific site installation
- DC System Voltage – must be 24 Volts
- Battery Charging Efficiency
- Soiling Factor
- Temperature Coefficient for voltage
- Maximum Expected Module Temperature
- Rating Reference Temperature – must use the PTC value based at 20 degrees Celsius
- PTC values for the following information – modules maximum rated power current, modules rated maximum power voltage, modules rated maximum power in watts

# 9 NTCIP Communication Requirements

Each NTCIP Component covered by these specifications shall implement the most recent versions of the standard. At a minimum, the following MIB Object definitions shall be followed for each NTCIP section required for compliance to this specification. When viewing the tables, supported items are required.

## 9.1 Overall NTCIP Compliance

| Standard | Name | Recommended version | Supported version | Comments |
|---|---|---|---|---|
| Base standards | | | | |
| **1102** | **OER** | **1.15** | **1.15** | |
| **1103** | **TMP** | **2.16** | **2.16** | |
| **8004** | **SMI** | **2.12** | **2.12** | |
| Device Data Dictionaries | | | | |
| **1201** | **Global object definition** | **2.32** | **2.32** | |
| **1203** | **DMS** | **2.35** | **2.35** | |
| Subnetwork profiles | | | | |
| **2101** | **PMPP/RS232** | **1.19** | **1.19** | |
| **2102** | **PMPP/FSK** | **1.09** | **1.09** | |
| **2103** | **PPP/RS232** | **1.09** | **1.09** | |
| **2104** | **Ethernet** | **1.11** | **1.11** | |
| Transport profiles | | | | |
| **2201** | **Transportation** | **1.15** | **1.15** | |
| **2202** | **Internet** | **1.05** | **1.05** | |
| Application profiles | | | | |
| **2301** | **STMF** | **1.08** | **2.12** | **1.08 refers to obsolete standards** |

## 9.2 NTCIP 1101:1996 (V01.12) Simple Transportation Management Framework, December, 2001 with Amendment 1 v08

- Must be supported (replaced by NTCIP 1102, 1103 and 8004).

## 9.3 NTCIP 1102:2004 (V01.15) Octet Encoding Rules (OER) Base Protocol, October, 2005

- Must be supported (replaced by NTCIP 1102, 1103 and 8004).

## 9.4 NTCIP 1103: 2009 (V02.16) Transportation Management Protocols (TMP), March, 2009

| **NTCIP 1103: 2009 (V02.16) Transportation Management Protocols (TMP), March, 2009** | | | |
|---|---|---|---|
| Object group/Section | Support | | Comment |
| | | **MIB Detail** | |
| Section 3: SNMP | Supported | | |
| Section 4: SFMP | Not Supported | | |

| | | | |
|---|---|---|---|
| Section 5: STMP | Not Supported | | |
| Section 7: Logical names | Not Supported | | Center to Center communication |
| Section 8: Security | Supported | | |
| A.2: Objects for SFMP | Not Supported | | |
| A.3-A.5: Objects for STMP | Not Supported | | |
| A.6: Logical names | Not Supported | | |
| A.7: Report parameters | Supported | | |
| | | **maxEventClasses** | **Max = 65** |
| | | **maxEventLogConfig** | **Max = 255** |
| | | **maxEventLogSize** | **Max = 1024** |
| A.8: Security objects | Supported | | |
| | | **communityNameMax** | **Max = 16** |

### 9.5 NTCIP 8004: 2008 (V01) Structure and Identification of Management Information (SMI), May, 2008

- Must be supported.

## 9.6 NTCIP1203:2007 (V2.35) Object Definitions for Dynamic Message Signs (DMS), March 2007

| NTCIP1203:2007 (V2.35) Object Definitions for Dynamic Message Signs (DMS), March 2007 | | | |
|---|---|---|---|
| Object group | Support | | Comment |
| 5.2 Sign configuration and capability | Supported | | |
| 5.3 VMS configuration | Supported | | |
| 5.4 Font definition | Supported | | |
| | | **numFont** | **Max = 16** |
| | | **maxFontCharacters** | **Max = 255** |
| | | **fontMaxCharacterSize** | **Max = 64** |
| 5.5 MULTI Configuration | Partial | | |
| | | **defaultJustificationLine** | **Supported values: 2..4** |
| | | **defaultCharacterSet** | **Support value 2 (height bits)** |
| | | **dmsMaxNumberPages** | **Max = 10** |
| | | **dmsMaxMultiStringLength** | **Max = 1024** |
| 5.6 Messages | Supported | | |
| | | **dmsNumPermanentMsg** | **Max = 255** |
| | | **dmsMaxChangeableMsg** | **Max = 255** |
| | | **dmsMaxVolatileMsg** | **Max = 255** |
| | | **dmsMaxMultiStringLength** | **Max = 1024** |
| 5.7 Sign Control | Supported | | |
| 5.8 Illumination/Brightness | Supported | | |
| | | **dmsIllumControl** | **timer (value 3) not required. V1 modes still supported if required** |
| 5.9 Scheduling Action | Supported | | |
| | | **numActionTableEntries** | **Max = 255** |
| 5.10 Auxiliary I/O | | | See NTCIP 1201 |
| 5.11.1 Sign Status: Core Status | Partial | | |
| | | **dmsCurrentSpeed** | **Not required** |
| | | **dmsCurrentSpeedLimit** | **Not required** |
| 5.11.2 Sign Status: Status Error | Partial | | |
| | | **Climate status objects** | **Not required** |
| | | **pixelStatusTable** | |

| | | | |
|---|---|---|---|
| | | **Lamp status objects** | **Not required** |
| | | **Drum status objects** | **Not required** |
| 5.11.3 Sign Status: Power Status | Partial | | |
| | | **Fuel and engine status objects** | **Not required** |
| 5.11.4 Sign Status: Temperature Status | Supported | | |
| 5.12 Graphic definition | Partial | | |
| | | **Transparent color** | |
| | | **dmsGraphicMaxEntries** | **Max = 255** |
| Section 3 MULTI TAGS | | | |
| 6.4.1 Color background [cb] | Supported | | |
| 6.4.2 Page background color [pb] | Supported | | |
| 6.4.3 Color foreground [cf] | Supported | | |
| 6.4.4 color rectangle [cr] | Supported | | |
| 6.4.5 Field [fx,y] | Partial | | |
| | | Speed (ID 5 and ID 6) | Not required |
| 6.4.6 Flash time [fl] | Supported | | |
| 6.4.7 Font [fo] | Supported | | |
| 6.4.8 Graphic [g] | Supported | | |
| 6.4.9 Hexadecimal Character [hc] | Supported | | |
| 6.4.10 Justification Line [jl] | Partial | | |
| | | [jl5] (full justification) | |
| 6.4.11 Justification Page [jp] | Supported | | |
| 6.4.12 Manufacturer specific [ms] | Not supported | | |
| 6.4.13 Moving text [mv] | Supported | | |
| 6.4.14 New Line [nl] | Supported | | |
| 6.4.15 New Page [np] | Supported | | |
| 6.4.16 Page time [pt] | Supported | | |
| 6.4.17 Spacing character [sc] | Supported | | |
| 6.4.18 Text Rectangle | Not supported | | |

## 9.7 NTCIP 1201:2005 (V02.32) Global Object (GO) Definitions - Version 02, October 2005

| Object group | | | |
|---|---|---|---|
| | **Supported or Not-Supported** | **Detail** | **Comment** |
| 2.2 Global configuration | Supported | | |
| | | **globalModuletable** | **1 entry for controller's software<br>1 entry for controller's hardware** |
| 2.3 Global Database management | Not supported | | |
| 2.4 Global Time Management | Supported | | |
| | | **globlaDaylightSaving** | **Supported values: 2..6** |
| | | **maxTimeBaseScheduleEntries** | **Max = 255** |
| | | **maxDayPlan** | **max = 128** |
| | | **maxDayPlanEvents** | **max = 96** |
| | | **globalLocalTimeDifferential** | **Supported from v1** |
| 2.5 Report Parameter | | | See NTCIP 1103 |
| 2.6 PMPP Object | Supported | | |
| | | **maxGroupAddresses** | **Max = 16** |
| 2.7 SECURITY | | | See NTCIP 1103 |
| 2.8 Auxiliary I/O | Not supported | | |

## 9.8 NTCIP 2101:2001 (V01.19) Point to Multi-Point Protocol Using RS-232 Subnetwork Profile, November, 2001

| Object group/Section | | | |
|---|---|---|---|
| | **Supported or Not-Supported** | **Detail** | |
| Sections 2.1 - 2.4 | Partial | | |
| | | **Section 2.2.1: T2 counter** | **Not changeable** |
| | | **Section 2.2.4: IPI** | **IPI supported = 0xC1.<br>IPI 0x21 (IP) not supported** |
| | | **Section 2.2.8: Frame type** | **Test Command not supported** |
| Sections 2.5.1, HDLC group | Partial | | |
| | | **LapBAdmnTransmitN1FrameSize** | **Not supported** |
| | | **LapBAdmnReceiveN1FrameSize** | **Not supported** |
| | | **LapBAdmnT1AckTimer** | **Not supported** |
| | | **LapBAdmnT2AckDelayTimer** | **Not supported** |
| Sections 2.5.2, RS232 group | Supported | | |
| Sections 2.5.3, RS232 Async. group | Supported | | |
| Sections 2.5.4, HDLC group addr. | Supported | | See NTCIP 1201 |

## 9.9 NTCIP 2103 (V02.07) Point-to-Point Protocol over RS-232 Subnetwork Profile, December, 2008

- **Not required to be supported.**

## 9.10 NTCIP 2104:2003 (V01.11) Ethernet Subnetwork Profile, September, 2005

- **Not required to be supported.**

## 10 References, Support, and Quality Assurances

It is the intention of this specification for the End-User to receive a reliable TSDMS system that is proven by a record of low maintenance requirements, low power consumption and overall reliable service at actual field installations elsewhere.

It is also the intention of this specification for the End-User to be reasonably assured that the high level of support mentioned throughout this document, shall continue to be available for the equipment throughout the equipment's normal life cycle. This support shall include, but not be limited to, prompt in-house spare and replacement parts availability; in-house field services for repairs, modifications, and paid upgrades; and in-house software support for any custom software supplied by the TSDMS Supplier or TSDMS Manufacturer.

The Bidder shall furnish a letter from the TSDMS Manufacturer or TSDMS Supplier listing the compliance to the provisions of this Section, with a toll free phone number that the End-User may use for telephone technical support during the term of this contract.

The Bidder shall furnish a compliance matrix listing each paragraph of this entire specification with an appropriate statement indicating whether the Bidder will comply with that part of the specification. In cases where the Bidder does not intend to comply with the specification, the Bidder shall indicate clearly how his equipment and/or work differs from the requirements listed herein, and what his intentions are to satisfy the requirements.

The Bidder shall include a certification from the TSDMS Manufacturer that the manufacturer has: a) at least five (5) years' experience in manufacturing, supplying, and supporting fully assembled TSDMS systems, and b) that in-house field service staff, phone support, and sufficient stocked spare parts are available from a USA location.

The Bidder shall furnish a list of five (5) US transportation agencies that have operated and maintained the TSDMS Supplier's systems, for no fewer than three (3) years. This list shall include the names, addresses, and telephone numbers of the agency's responsible contact person.

The Bidder shall identify any projects or circumstances where the Bidder and/or the TSDMS Supplier were required to pay liquidated damages, or defend themselves against liquidated damages in the last five years. Failure to supply this information shall be cause for rejection.

## 11 Appendix A - Bid Item Configuration Sheet

| SPECIFIC SIGN CONFIGURATION | TYPE I | TYPE II | TYPE III | TYPE IV |
|---|---|---|---|---|
| Number of Signs | | | | |
| Amber Display Pitch<br>46mm or 66mm or 29mm | | | | |
| For Full Matrix<br>Number of Pixels per Sign | _____ x _____ | _____ x _____ | _____ x _____ | _____ x _____ |
| Rear or Front Access<br>(R or F) | | | | |
| Sign dimensions<br>(length x height ) | | | | |
| Max Sign weight (Lbs.) | | | | |
| Sign maximum power consumption | | | | |
| Cabinet Mounting<br>(Pole, Ground or Sign (for walk-in)) | | | | |