SPECIFICATIONS FOR CHANGEABLE MESSAGE SIGN SYSTEM

CMS MODEL 700 SERIES

TEES

CHAPTER 13

January 10, 2019
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### Acronyms and Abbreviations

The following acronyms shall govern this specification:

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Ampere</td>
</tr>
<tr>
<td>AASHTO</td>
<td>American Association of State Highway and Transportation Officials</td>
</tr>
<tr>
<td>AC</td>
<td>Alternating Current</td>
</tr>
<tr>
<td>AC+</td>
<td>120 Volts AC, 60 Hz ungrounded power source</td>
</tr>
<tr>
<td>AC-</td>
<td>120 Volts AC, 60 Hz grounded return to the power source</td>
</tr>
<tr>
<td>AlInGaP</td>
<td>Aluminum Indium Gallium Phosphide</td>
</tr>
<tr>
<td>ANSI</td>
<td>American National Standards Institute</td>
</tr>
<tr>
<td>API</td>
<td>Application Program Interface</td>
</tr>
<tr>
<td>ASCII</td>
<td>American Standard Code for Information Interchange</td>
</tr>
<tr>
<td>ASTM</td>
<td>American Society for Testing and Materials</td>
</tr>
<tr>
<td>AWS</td>
<td>American Welding Society</td>
</tr>
<tr>
<td>b</td>
<td>Bit</td>
</tr>
<tr>
<td>B</td>
<td>Byte</td>
</tr>
<tr>
<td>C</td>
<td>Celsius</td>
</tr>
<tr>
<td>CMS</td>
<td>Changeable Message Sign</td>
</tr>
<tr>
<td>CMS MODEL 700 SERIES</td>
<td>Changeable Message Sign Model 700 Series</td>
</tr>
<tr>
<td>DC</td>
<td>Direct Current</td>
</tr>
<tr>
<td>EG</td>
<td>Equipment Ground</td>
</tr>
<tr>
<td>f</td>
<td>Foot</td>
</tr>
<tr>
<td>F</td>
<td>Fahrenheit</td>
</tr>
<tr>
<td>FSORS</td>
<td>Full, Standardized Object Range Support</td>
</tr>
<tr>
<td>GUI</td>
<td>Graphical user interface</td>
</tr>
<tr>
<td>Hz</td>
<td>Hertz</td>
</tr>
<tr>
<td>IP</td>
<td>Internet Protocol</td>
</tr>
<tr>
<td>IEC</td>
<td>International Electrotechnical Commission</td>
</tr>
<tr>
<td>in</td>
<td>Inch</td>
</tr>
<tr>
<td>ITE</td>
<td>Institute of Transportation Engineers</td>
</tr>
<tr>
<td>ITS</td>
<td>Intelligent Transportation System</td>
</tr>
<tr>
<td>LAN</td>
<td>Local Area Network</td>
</tr>
<tr>
<td>LED</td>
<td>Light-Emitting Diode</td>
</tr>
<tr>
<td>MIB</td>
<td>Management Information Base</td>
</tr>
<tr>
<td>NCHRP</td>
<td>National Cooperative Highway Research Program</td>
</tr>
<tr>
<td>NEMA</td>
<td>National Electrical Manufacturers Association</td>
</tr>
<tr>
<td>NFPA</td>
<td>National Fire Protection Association</td>
</tr>
<tr>
<td>NPT</td>
<td>National Pipe Taper</td>
</tr>
<tr>
<td>NTCIP</td>
<td>National Transportation Communications for ITS Protocol</td>
</tr>
<tr>
<td>PMM</td>
<td>Pixel Matrix Module</td>
</tr>
<tr>
<td>PMPP</td>
<td>Point-to-multi-point protocol</td>
</tr>
<tr>
<td>PPP</td>
<td>Point-to-point protocol</td>
</tr>
<tr>
<td>PQWP</td>
<td>Painting Quality Work Plan</td>
</tr>
<tr>
<td>Abbreviation</td>
<td>Definition</td>
</tr>
<tr>
<td>--------------</td>
<td>------------</td>
</tr>
<tr>
<td>PWM</td>
<td>Pulse-width modulation</td>
</tr>
<tr>
<td>TCP</td>
<td>Transmission Control Protocol</td>
</tr>
<tr>
<td>TMC</td>
<td>Transportation Management Center</td>
</tr>
<tr>
<td>UL</td>
<td>Underwriters Laboratory</td>
</tr>
<tr>
<td>UDP</td>
<td>User Datagram Protocol</td>
</tr>
<tr>
<td>V</td>
<td>Volt</td>
</tr>
<tr>
<td>VAC</td>
<td>Voltage Alternating Current</td>
</tr>
<tr>
<td>VDC</td>
<td>Voltage Direct Current</td>
</tr>
<tr>
<td>W</td>
<td>Watt</td>
</tr>
<tr>
<td>WYSIWYG</td>
<td>WYSIWYG – What You See Is What You Get</td>
</tr>
</tbody>
</table>

**Glossary**

The following definitions shall govern this specification:

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>activate</strong></td>
<td>The action of placing a message in the current buffer and performing the</td>
</tr>
<tr>
<td></td>
<td>logic of running the message. Contrast with &quot;Display&quot; which manipulates</td>
</tr>
<tr>
<td></td>
<td>the sign display to make the current message visible to the driving public.</td>
</tr>
<tr>
<td><strong>active message</strong></td>
<td>The command to direct the Sign Controller to display the message on the</td>
</tr>
<tr>
<td></td>
<td>sign face.</td>
</tr>
<tr>
<td><strong>alternate message</strong></td>
<td>A message that contains more than one page of information/text.</td>
</tr>
<tr>
<td><strong>ambient light level</strong></td>
<td>The amount of light surrounding the sign location.</td>
</tr>
<tr>
<td><strong>axial intensity</strong></td>
<td>The brightness of light on the axis horizontally and vertically perpendicular to the sign face.</td>
</tr>
<tr>
<td><strong>AGENCY</strong></td>
<td>Purchasing Government Agency</td>
</tr>
<tr>
<td><strong>AlInGaP</strong></td>
<td>Aluminum Indium Gallium Phosphide</td>
</tr>
<tr>
<td><strong>Assembly</strong></td>
<td>A complete machine, structure or unit of a machine that was manufactured by</td>
</tr>
<tr>
<td></td>
<td>fitting together parts and/or modules.</td>
</tr>
<tr>
<td><strong>Beacon</strong></td>
<td>A device that directs light on one direction and flashes.</td>
</tr>
<tr>
<td><strong>bit map</strong></td>
<td>A digital representation of an image having bit reference pixels.</td>
</tr>
<tr>
<td><strong>BITMAP</strong></td>
<td>A subset of the SYNTAX type OCTET STRING where every bit is a representation of a part or function.</td>
</tr>
<tr>
<td><strong>BITMAP X</strong></td>
<td>BITMAP with X number of bits</td>
</tr>
<tr>
<td><strong>blank message</strong></td>
<td>A message that is devoid of information content (blank) and the sign face is clear (all pixels off).</td>
</tr>
<tr>
<td><strong>Border</strong></td>
<td>The blank area (no pixels) between the outer most pixels and the outermost edge of the sign housing.</td>
</tr>
<tr>
<td><strong>brightness</strong></td>
<td>See luminance.</td>
</tr>
<tr>
<td><strong>brightness control</strong></td>
<td>A term that defines how the light intensity if a sign is determined/set.</td>
</tr>
<tr>
<td><strong>brightness level</strong></td>
<td>The intensity of the light used to form a message or that would be used to form a message if one is not currently displayed.</td>
</tr>
<tr>
<td><strong>bulb matrix</strong></td>
<td>A matrix of light bulbs, lamps, or LEDs on the face of the message sign</td>
</tr>
<tr>
<td><strong>Cabinet</strong></td>
<td>An enclosure that protects the device's controller and other sign equipment from the elements.</td>
</tr>
<tr>
<td><strong>candela</strong></td>
<td>An SI unit of measure for luminance.</td>
</tr>
<tr>
<td>Term</td>
<td>Definition</td>
</tr>
<tr>
<td>----------------------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>C Language</td>
<td>The ANSI C Programming Language</td>
</tr>
<tr>
<td>Cabinet</td>
<td>An outdoor enclosure generally housing the controller unit and associated equipment</td>
</tr>
<tr>
<td>Certificate of Compliance</td>
<td>A certificate signed by the manufacturer of the material or the manufacturer of assembled materials stating that the materials involved comply in all respects with the requirements of the specifications</td>
</tr>
<tr>
<td>character height</td>
<td>The vertical pitch times the number of pixels in the column of pixels.</td>
</tr>
<tr>
<td>character spacing</td>
<td>The spacing in pixels between two characters in full matrix signs.</td>
</tr>
<tr>
<td>character width</td>
<td>The horizontal pitch times the number of pixels in the row of pixels.</td>
</tr>
<tr>
<td>checksum</td>
<td>A data error-detection scheme.</td>
</tr>
<tr>
<td>character per line</td>
<td>The number of characters than can be displayed on one line.</td>
</tr>
<tr>
<td>Climate control</td>
<td>The ability to control the temperature and other factors affecting the environment in which the sign electronics operates.</td>
</tr>
<tr>
<td>Font</td>
<td>The style and shape of alphanumeric characters that are displayed on the CMS matrix to create messages viewed by motorists and travelers</td>
</tr>
<tr>
<td>Full Matrix Sign</td>
<td>A type of sign with the entire display area containing pixels with the same horizontal pitch and the same vertical pitch without fixed lines or characters.</td>
</tr>
<tr>
<td>Industrially-rated</td>
<td>Components are such that the device shall be able to operate reliably in the temperature range of -40 to +185 degrees Fahrenheit, at 95% humidity.</td>
</tr>
<tr>
<td>Luminance</td>
<td>A photometric measure of the luminous intensity per unit area of light travelling in a given direction. It describes the amount of light that passes through, is emitted or reflected from a particular area, and falls within a given solid angle. The SI unit for luminance is candela per square meter (cd/m²). A non-SI term for the same unit is the &quot;nit&quot;. The CGS unit of luminance is the stilb, which is equal to one candela per square centimeter or 10 kcd/m².</td>
</tr>
<tr>
<td>Message</td>
<td>Information displayed on the CMS for the purpose of visually communicating with motorists. A CMS message can consist of one or more pages of data that are displayed consecutively</td>
</tr>
<tr>
<td>Module</td>
<td>Assembly consisting of a two-dimensional LED pixel array, pixel drive circuitry, and mounting hardware. Modules are installed in the display adjacent to each other to form the display matrix</td>
</tr>
<tr>
<td>Object</td>
<td>An NTCIP term referring to an element of data in an NTCIP-compatible device that can be manipulated to control or monitor the device</td>
</tr>
<tr>
<td>Page</td>
<td>(NTCIP 1203 v2.35) The information that can fit on a sign at one time, together with its message attributes data that is displayed on the CMS display matrix at a given moment in time.</td>
</tr>
<tr>
<td>Pixel</td>
<td>Picture element. (NTCIP 1203 v2.35) The smallest independently controllable visual element of a VMS.</td>
</tr>
<tr>
<td>Rated life</td>
<td>Number of years of operation after which 90 % of the devices are still working.</td>
</tr>
<tr>
<td>Schedule</td>
<td>A set of data that determines the time and date when a Sign Controller will cause a stored message to be displayed on the CMS Model 700 Series.</td>
</tr>
<tr>
<td><strong>Sign Controller</strong></td>
<td>A stand-alone computer that is located at an CMS Model 700 Series site, which controls a single sign. A Sign Controller receives commands and sends information to a control computer.</td>
</tr>
<tr>
<td>---------------------</td>
<td>--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td><strong>Stroke</strong></td>
<td>The vertical width of the lines of a display font. “Single stroke” denotes characters whose vertical lines are one pixel wide. “Double stroke” denotes characters whose vertical lines are two pixels wide.</td>
</tr>
<tr>
<td><strong>Touch Safe</strong></td>
<td>Touch safe is defined as surfaces on energized electrical equipment that qualified personnel can touch without exposure to electrical shock and/or flash hazard. Equipment that is mounted on dead front hinged doors (Interior or Exterior) shall be considered touch safe.</td>
</tr>
<tr>
<td><strong>TSD No.1</strong></td>
<td>8-32 SOUTHCO #47-62-301-20 or equal.</td>
</tr>
<tr>
<td><strong>TSD No.2</strong></td>
<td>8-32 SOUTHCO #47-62-301-60 or equal</td>
</tr>
<tr>
<td><strong>TSD No.3</strong></td>
<td>M3 SOUTHCO #47-82-101-10 or equal</td>
</tr>
</tbody>
</table>
CHAPTER 13-SECTION 1: INTRODUCTION

13.1.1 Introduction

1. Overview

The California Department of Transportation (Caltrans) operates many Changeable Message Signs (CMS) on our freeways across the state of California. The current signs, CMS Model 500 Series, have been in use for a significant number of years. Many of the CMS Model 500 Series signs have exceeded their expected lifecycle and they need to be replaced. Additionally, Caltrans will continue adding signs at many new locations to improve mobility and safety for motorists on California’s freeways.

Caltrans is proud to introduce the next generation of our Changeable Message Signs, the CMS Model 700 Series. The CMS Model 700 Series signs have been designed to be more reliable and energy efficient than their Model 500 Series predecessors. Caltrans’ engineers took great care in specifying and designing the CMS Model 700 Series signs’ physical size, weight, and mounting details to be comparable with those of the existing Model 500 Series signs to simplify replacement of older signs as well as addition of new signs.

2. Quick Reference: CMS Model 500 Series vs. CMS Model 700 Series

A. CMS Model Cross Reference

<table>
<thead>
<tr>
<th>Existing CMS Model</th>
<th>Upgraded CMS Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>CMS Model 500, Amber</td>
<td>CMS Model 700 Amber Standard-Resolution</td>
</tr>
<tr>
<td>Standard-Resolution</td>
<td>CMS Model 700C Color High-Resolution</td>
</tr>
<tr>
<td>CMS Model 510, Amber</td>
<td>CMS Model 710 Amber Standard-Resolution</td>
</tr>
<tr>
<td>Standard-Resolution</td>
<td>CMS Model 710C Color High-Resolution</td>
</tr>
<tr>
<td>CMS Model 520, Amber</td>
<td>CMS Model 720 Amber Standard-Resolution</td>
</tr>
<tr>
<td>Standard-Resolution</td>
<td>CMS Model 720C Color High-Resolution</td>
</tr>
</tbody>
</table>
B. CMS Model Specifications

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>CMS PMM Layout (type W x H)</td>
<td>T1 12 x 5</td>
<td>T1 21 x 3</td>
<td>T3 21 x 3</td>
<td>T2 12 x 5</td>
<td>T2 19 x 3</td>
<td>T4 19 x 3</td>
<td>T2 6 x 5</td>
<td>T2 11 x 3</td>
<td>T4 11 x 3</td>
</tr>
<tr>
<td>PMM Face Size (W x H inch)</td>
<td>21.968 x 13.178</td>
<td>13.62 x 24.65</td>
<td>13.62 x 24.65</td>
<td>14.00 x 8.75</td>
<td>8.62 x 15.65</td>
<td>8.62 x 15.65</td>
<td>14.00 x 8.75</td>
<td>8.62 x 15.65</td>
<td>8.62 x 15.65</td>
</tr>
<tr>
<td>PMM Pixel Layout (W x H)</td>
<td>8 x 5</td>
<td>5 x 9</td>
<td>15 x 27</td>
<td>8 x 5</td>
<td>5 x 9</td>
<td>15 x 27</td>
<td>8 x 5</td>
<td>5 x 9</td>
<td>15 x 27</td>
</tr>
<tr>
<td>Pixel Pitch (inch)</td>
<td>2.75</td>
<td>2.75</td>
<td>0.917</td>
<td>1.75</td>
<td>1.75</td>
<td>0.583</td>
<td>1.75</td>
<td>1.75</td>
<td>0.583</td>
</tr>
<tr>
<td>CMS Pixels (W x H)</td>
<td>96 x 25</td>
<td>105 x 27</td>
<td>315 x 81</td>
<td>96 x 25</td>
<td>95 x 27</td>
<td>285 x 81</td>
<td>48 x 25</td>
<td>55 x 27</td>
<td>165 x 81</td>
</tr>
<tr>
<td>CMS Max Weight (lbs)</td>
<td>2400</td>
<td>2400</td>
<td>2400</td>
<td>2000</td>
<td>2000</td>
<td>2000</td>
<td>1000</td>
<td>1000</td>
<td>1000</td>
</tr>
<tr>
<td>CMS Width (inch)</td>
<td>306</td>
<td>300</td>
<td>300</td>
<td>230</td>
<td>175</td>
<td>175</td>
<td>94</td>
<td>105 ½</td>
<td>105 ½</td>
</tr>
<tr>
<td>CMS Height (inch)</td>
<td>81</td>
<td>86</td>
<td>86</td>
<td>53 ¼</td>
<td>57</td>
<td>57</td>
<td>53 ¼</td>
<td>57</td>
<td>57</td>
</tr>
<tr>
<td>CMS Depth (inch)</td>
<td>16</td>
<td>16</td>
<td>16</td>
<td>16</td>
<td>16</td>
<td>16</td>
<td>24</td>
<td>16</td>
<td>16</td>
</tr>
</tbody>
</table>

13.1.2 General

1. Minimum Life
   The CMS Model 700 Series shall have a rated life of a minimum of twenty years.

2. Cable
   Each cable shall have a minimum of 2 feet of slack available on each connector or connector assembly end and shall be permanently labeled according to connector pin assignments, device addressing and/or function.

3. Ethernet cable used inside the Changeable Message Sign (CMS)
   All Ethernet cables used inside of the CMS Model 700 Series shall be flexible shielded Cat-5E, industrially-rated for outdoor application with operating temperature in the range of -40°C to 85°C or better.

4. Ethernet cable for connection between the CMS and Controller Ground Cabinet
   All Ethernet cables used for network connection between the CMS Model 700 Series and the controller ground cabinet shall be flexible shielded Cat-6A, industrially-rated for outdoor application with operating temperature in the range of -40°C to 85°C or better.

5. Edges and Corners
   All sharp edges and corners shall be rounded and free of any burrs.

6. Environmental requirements
   The CMS Model 700 Series shall meet NEMA TS4 Environmental requirements.
7. **Air circulations**  
Each assembly and panel shall allow air circulation through its top and bottom.

8. **PCB coating**  
Each PCB shall be conformal coated with a UV Tracer. This coating shall conform to the configuration of the object coated, applied on the completed board assembly. The coating shall be resistant to the effect of moisture and solvents.

9. **Wiring color codes**  
The CMS Model 700 Series shall use the following wiring color codes

A. AC- (Neutral) White  
B. Equipment Ground Solid green or continuous green color with 1 or more yellow stripes.  
C. DC Logic Ground Continuous white with a red stripe.  
D. AC+ (Line) Solid black or continuous black with colored stripe.  
E. DC+ (24V) Red  
F. Other Any color not specified

10. **AC / DC Shielding**  
Wiring containing AC shall be bundled separately or shielded separately from all DC power and logic voltage control circuits.

11. **AC / DC Wiring**  
All wiring used to provide component AC or DC power shall be size AWG 16 or greater.

12. **Component Noise**  
No CMS Model 700 Series item, component, or subassembly shall emit a noise level exceeding the peak level of 55 dBA when measured at a distance of 3 feet away from its surface, except as otherwise noted. No CMS Model 700 Series item, component, or subassembly shall emit a noise level sufficient to interfere with processing and communication functions of the Sign Controller.

13. **Preventative Maintenance**  
The CMS Model 700 Series shall require on-site preventative maintenance no more than twice per year.

13.1.3 **Documentation**

1. **CMS Model 700 Series User Manual**  
Two copies of the manual shall be supplied for each CMS Model 700 Series. Each manual shall conform to the following format:  
A. Each manual shall be bound in durable covers made of either 65-pound stock paper or clear plastic. Each manual shall be printed on letter size paper, with the exception that schematics, layouts, parts lists and plan details may be on larger format sheets.
**B.** Each manual shall include the following sections in the order listed:

1. Table of Contents
2. Glossary
3. General Description
4. General Characteristics
5. Installation
6. Adjustments
7. Theory of Operation
   a. Systems Description (include block diagram)
   b. Detailed Description of Circuit Operation
8. Maintenance
   a. Preventive Maintenance
   b. Trouble Analysis
   c. Trouble Shooting Sequence Chart
   d. Wave Forms
   e. Voltage Measurements
   f. Alignment Procedures.
9. Parts List (include circuit and board designation, part type and class, power rating, component manufacturer, mechanical part manufacturer, data specification sheets for special design components and original manufacturer's part number)
10. Electrical Interconnection Details & Drawings
11. Schematic and Logic Diagram
12. Assembly Drawings and a pictorial diagram showing physical locations and identification of each component or part

2. **Warranty**
   A copy of the warranty shall be provided with complete terms and conditions

3. **Date, Serial Numbers, and Revisions**
   The date, serial numbers, and revision numbers of equipment covered by the manual shall be printed on the front cover of each manual.

4. **Draft User Manual**
   Two copies of the preliminary draft of the manual shall be submitted to the Engineer for approval prior to final printing.

5. **Manuals and Wiring Diagrams**
   Manuals and wiring diagrams shall be furnished in a weatherproof plastic pouch on the inside the access door. Wiring Diagrams shall be on non-fading minimum 22 inch x 34 inch sheets.

6. **Electronic documents**
   An electronic copy of the manual in PDF form shall be submitted to the Engineer.

13.1.4 **Models of Amber Standard-Resolution CMS Model 700 Series**
1. **Model 700 CMS**
   Each **Model 700 CMS** shall have a configuration of 3 Pixel Matrix Modules (PMM) high by 21 Pixel Matrix Modules across (63 modules total) forming a continuous matrix display of 105 pixels across by 27 pixels high (2835 pixels). The PMM’s used in **Model 700 CMS** are of **Type 1**.

2. **Model 710 CMS**
   Each **Model 710 CMS** shall have a configuration of 3 Pixel Matrix Modules (PMM) high by 19 Pixel Matrix Modules across (57 modules total) forming a continuous matrix display of 95 pixels across by 27 pixels high (2565 pixels). The PMM’s used in **Model 710 CMS** are of **Type 2**.

3. **Model 720 CMS**
   Each **Model 720 CMS** shall have a configuration of 3 Pixel Matrix Modules (PMM) high by 11 Pixel Matrix Modules across (33 modules total) forming a continuous matrix display of 55 pixels across by 27 pixels high (1485 pixels). The PMM’s used in **Model 720 CMS** are of **Type 2**.

13.1.5 **Models of Color High-Resolution CMS Model 700 Series**

1. **Model 700C CMS**
   Each **Model 700C CMS** shall have a configuration of 3 Pixel Matrix Modules (PMM) high by 21 Pixel Matrix Modules across (63 modules total) forming a continuous matrix display of 315 pixels across by 81 pixels high (25515 pixels). The PMM’s used in **Model 700C CMS** are of **Type 3**.

2. **Model 710C CMS**
   Each **Model 710C CMS** shall have a configuration of 3 Pixel Matrix Modules (PMM) high by 19 Pixel Matrix Modules across (57 modules total) forming a continuous matrix display of 285 pixels across by 81 pixels high (23085 pixels). The PMM’s used in **Model 710C CMS** are of **Type 4**.

3. **Model 720C CMS**
   Each **Model 720C CMS** shall have a configuration of 3 Pixel Matrix Modules (PMM) high by 11 Pixel Matrix Modules across (33 modules total) forming a continuous matrix display of 165 pixels across by 81 pixels high (13365 pixels). The PMM’s used in **Model 720C CMS** are of **Type 4**.

13.1.6 **Weight Limits**

1. **Models 700 and 700C CMS**
   Each Model 700 and 700C CMS shall have a maximum weight of 2400 pounds (~1088.6kg).

2. **Models 710 and 710C CMS**
Each Model 710 and 710C CMS shall have a maximum weight of 2000 pounds (~907.2kg).

3. **Models 720 and 720C CMS**
   Each Model 720 and 720C CMS shall have a maximum weight of 1000 pounds (~453.6kg).

4. **Total weight**
   A verification of the total weight shall be documented and included in the Certificate of Compliance.

13.1.7 **Communications**

1. **OSI layers 1 and 2**
   All OSI layer 1 and 2 module communications interfaces shall be 10/100baseTX Ethernet that complies with all current IEEE 802.3i, 802.3u, 802.3x standards. Each Ethernet interface shall have the ability to be manually configured for the following modes of operation: 10baseT or 100baseTX, half-duplex or full-duplex, manual-setting or auto-negotiate. The configuration settings for these features shall be accomplished via DIP switch settings and shall be retained after any reset or power cycle.

2. **OSI layers 3 and 4**
   All OSI layer 3 and 4 module communications shall be Internet Protocol version 4 (IPv4) over Ethernet that complies with current relevant IETF standards. Each interface shall support the following protocols: ICMP, TCP, UDP, SNMP, HTTPS, HTTP, SSH and Telnet. Each interface shall have the ability to fully configure the following: IP Address, IP Network Mask, IP Default Gateway, IP Broadcast Address and IP Port Number.

3. **Module markings**
   Each IP-addressable module shall have its manufacturer’s name, trademark, model number, serial number, rated voltage, current, power consumption and Ethernet MAC address permanently marked on the back of the panel.

13.1.8 **Supplied CMS Items**

1. **CMS System**
   The CMS System shall include the Model 700, 700C, 710, 710C, 720, or 720C CMS as per contract.

2. **CMS System Components**
   Controller Ground Cabinet, Controller, Controller’s 120VAC or 24VDC power cable and adapter as applicable, and all other required equipment and wiring necessary to operate the system. The Controller shall be State Furnished unless called out in Contract Special Provisions.
13.1.9 **Spare Parts**
The following spare item(s) shall be included per each delivered Model 700, 700C, 710, 710C, 720, or 720C CMS System.

1. **Pixel Matrix Modules (PMM)**
   Two (2) Pixel Matrix Modules (PMM)

2. **Pixel Matrix Modules (PMM) Fuse**
   Three (3) replaceable fuses used on the Pixel Matrix Modules (PMM) as mentioned in Section 13.4.5.4
CHAPTER 13-SECTION 2: PRODUCT TESTING

13.2.1 General

1. Standard Test
The Manufacturer shall burn-in the CMS Model 700 Series by performing the Standard Test continuously for a minimum of 100 hours, without component failure.

2. Test Standards
The Manufacturer shall provide a test report showing that the CMS Model 700 Series has been tested per the following standards:
B. ANSI/AWS D1.2 – Structural Welding Code – Aluminum
C. NCHRP Report 412, Fatigue-Resistant Design of Cantilevered Signal, Sign, and Light Supports
D. NFPA 70, National Electric Code
E. NEMA Standards Publication 250 – Enclosures for Electrical Equipment
F. NEMA Standard TS-4, Section 2 – Environmental Standards and Test Procedures, Traffic Control Systems
G. MIL-STD-810G standard for sand and dust, vibration
H. IPC/WHMA-A-620 Requirements and Acceptance for Cable and Wire Harness Assemblies
I. IPC-J-STD-001D: Requirements for Soldered Electrical & Electronic Assemblies
J. IPC-A-610E: Acceptability of Electronic Assemblies
K. IPC-CC-830: Conformal Coatings
L. NTCIP Standards:
   i. NTCIP 1101, Simple Transportation Management Framework
   ii. NTCIP 1201, Octet Encoding Rules (OER) Base Protocol
   iii. NTCIP 1103, Simple Transportation Network Protocol (STMP)
   iv. NTCIP 1201, Global Object Definitions
   v. NTCIP 1203, Object Definitions for Dynamic Message Signs
   vi. NTCIP 2001, NTCIP Class B Profile
   vii. NTCIP 2104, Subnet Profile for Ethernet
   viii. NTCIP 2201, Transportation Transport Profile
   ix. NTCIP 2202, Internet (TCP/IP and UDP/IP) Transport Profile
   x. NTCIP 2301, Application Profile for Simple Transportation Management Framework (STMF)
   xi. NTCIP 2303, Application Profile for File Transfer Protocol (FTP)
13.2.2 Acceptable Methods of Verification

1. Compliance Verification
   The Caltrans Transportation Laboratory (Translab) shall have the authority to use any of the following methods of verification to ensure compliance with this specification:
   A. Certificates: Conformance certificates shall be provided by a third-party source that verify the equipment design that will allow it to operate in conformance with the applicable sections.
   B. Conformance testing: Conformance testing documents shall be provided by either first, second or third-party sources that verify the equipment is tested and that it operates in conformance with the applicable sections.
   C. Statement: A statement shall consist of one of the following types:
      i. Conformance Statement: The Manufacturer of a component or major unit shall provide written assurance that states that a component or major unit meets the specified criteria.
      ii. Change Statement: The Manufacturer of a component shall provide a written assertion that a change made to a component does not invalidate any previous certifications, or that no changes were made to invalidate any previous certifications. All changes or a statement of no changes shall be listed.
      iii. Conditional Statement: When the criteria do not contain exacting parameters, the Manufacturer of a component or major unit shall provide a written assertion to identify the conditions under which the component or major unit will comply with the specified criteria.
      iv. Inspections: Second- or third-party appraisal of the product is performed to meet applicable codes and/or ordinances.
      v. Evaluation: These items address subjective areas and can be reviewed by first, second or both parties.

2. Final Acceptance and Quality Assurance
   Final acceptance and QA testing of the sign shall be performed by the Translab at the manufacturer’s facility.
CHAPTER 13-SECTION 3: POWER DISTRIBUTION ASSEMBLY (PDA)

13.3.1 General

1. **Electrical component and indicator**
   Each circuit breaker, fuse, switch and indicator shall be visible and accessible when the Sign Electrical Equipment Access Door is open.

2. **Surge suppression**
   Each PDA shall have surge suppression using three-terminal Metal Oxide Varistor (MOV) protection technology with short circuit fusing protection contained within a NEMA 4X (IP66) rated enclosure. The surge system shall include LED status indication, normally open/normally closed contacts change state to indicate a fault. The surge suppressor shall be replaceable and shall be placed such that an explosive failure of the device will not damage other components.

3. **24VDC power supply protection**
   Each 24 volt power supply shall be protected by a circuit breaker installed on the front panel.

4. **PDA receptacles without GFI**
   Each PDA shall have a minimum of 1 duplex NEMA 5-15R Equipment Receptacle without Ground Fault Interruption (GFI) Protection for a sign heater. The duplex output shall be protected by one 15 Amp circuit breaker installed on the front panel and designated “Heater”.

5. **PDA receptacles with GFI**
   Each PDA shall have a minimum of 1 Duplex NEMA 5-15R Equipment Receptacles with Ground Fault Interruption (GFI) Protection mounted on the front panel. The Equipment Receptacles shall be protected by one 15 Amp circuit breaker installed on the front panel and designated “Equipment”.

6. **PDA circuit breaker**
   Each PDA shall have one 1-Pole 30 Amp Circuit Breaker installed on the front panel and designated “Main”.

7. **Breaker’s Arc flash protection**
   Each circuit breaker shall include Arc Flash protection.

8. **Power Service**
   The CMS Model 700 Series shall operate on single phase 120/240 VAC 5KVA service.

9. **Electrical shock prevention**
   All electrical circuits greater than 50 volts shall be covered to prevent electrical shock injury.
10. **Electrical arc flash prevention**
   All electrical circuits greater than 50 volts shall be covered to prevent arc flash injury.

11. **Sign Electrical Connection**
   Each sign shall have a 3-connector power terminal block for connecting the sign to AC 120 volt power service. Each connector shall be marked as follows:
   - A. 120 VAC
   - B. Neutral
   - C. Equipment Ground

12. **Electrical Service Connection**
   120 Volt single phase power shall be provided to the sign:
   - A. 120 VAC terminal connector shall be connected to 120 Volt AC Line (HOT)
   - B. Neutral terminal connector shall be connected to the AC Neutral
   - C. Equipment Ground terminal connector shall be connected to Equipment Ground

13. **Power connector type**
   Each power connector shall be screw-in or push-in type.

14. **Power connector and conductor size**
   Each power connector shall be sized for AWG 4 to AWG 10 wiring.

13.3.2 **24-Volt Power Supplies**

1. **24VDC Power Supplies**
   The CMS Model 700 Series shall have installed seven (7) 24-volt power supplies numbered 1 through 7. Power supplies shall be industrial-safe with wide operating temperature range between -20°C and 70°C or better.

2. **24VDC Power Supplies #1 and #2**
   24-Volt power supplies #1 and #2 shall supply power to the top row of PMM panels.

3. **24VDC Power Supplies #3 and #4**
   24-Volt power supplies #3 and #4 shall supply power to the middle row of PMM panels.

4. **24VDC Power Supplies #5 and #6**
   24-Volt power supplies #5 and #6 shall supply power to the bottom row of PMM panels.

5. **24VDC Power Supply #7**
24-Volt power supply #7 shall supply power to the Remote I/O Box, Ethernet switches if Ethernet switches are rated for 24VDC, any other components that are rated for 24VDC

6. **24VDC Power Supplies #1 and #2 connection**
   24-Volt power supplies’ #1 and #2 24-Volt outputs shall be connected in parallel.

7. **24VDC Power Supplies #3 and #4 connection**
   24-Volt power supplies’ #3 and #4 24-Volt outputs shall be connected in parallel.

8. **24VDC Power Supplies #5 and #6 connection**
   24-Volt power supplies’ #5 and #6 24-Volt outputs shall be connected in parallel.

9. **24VDC Power Supplies #1 through #6 power rating**
   24-volt power supplies #1 though #6 shall be rated at a minimum of 480 W.

10. **24VDC Power Supply #7 power rating**
    24-volt power supply #7 shall be rated at a minimum of 150 W and a maximum of 480W.

11. **24VDC Power Supplies operating voltage**
    Each 24-volt power supply shall have an operating voltage range of 100 to 240 VAC.

12. **24VDC list agency requirement**
    Each 24-volt power supply shall be UL 60950-1 listed.

13. **24VDC connection to PDA**
    Connecting each 24-volt power supply to the Power Distribution Assembly shall not require terminal soldering.

14. **24VDC connection to PMM**
    Connecting each 24-volt power supply to a PMM shall not require terminal soldering.

15. **24VDC power supply label**
    Each power supply shall be labeled with its power supply number.

16. **24VDC power supply enclosure**
    Each 24-volt power supply shall be encased in a metal enclosure.

17. **24VDC power supply physical size**
    Each power supply shall be no larger than 3”H x 7”W x 10”D.
CHAPTER 13-SECTION 4: PIXEL MATRIX MODULE (PMM)

13.4.1 General and Mechanical

1. PMM components
   Each PMM shall consist of display pixel LEDs, connector header for 24VDC power, ethernet connection (RJ45), diagnostic circuitry that provides feedback to the Sign Controller on the PMM health and pixel status.

2. PMM pitch
   Each PMM shall have an identical horizontal and vertical pitch between pixels. Separation between the last column or row of one PMM and the first column or row of the adjacent PMM shall be equal to the pixel pitch of the PMM.

3. PMM Driver
   Each PMM shall consist of an integrated LED driver board.

4. PMM water resistance requirement
   Each PMM shall be sealed and coated for water resistance.

5. PMM Thumb/Screwdriver captive screws
   Each PMM shall be attached to the structural ribs with four captive screws that can be tightened by hands and with either Pan or Phillips head option for maximum tightening by a screwdriver.

6. PMM panel mounting & removal
   Each PMM display face of the sign shall allow for panel mounting and removal.

7. Amber Standard-Resolution PMM pixel configuration
   Each amber standard-resolution PMM shall be 5 pixels wide by 9 pixels high.

8. Color High-Resolution PMM pixel configuration
   Each color high-resolution PMM shall be 15 pixels wide by 27 pixels high.

9. PMM Options
   Each PMM shall be of the PMM Type as per Chapter 13, Section 13.4.6.

10. PMM weight
    The maximum weight of each PMM shall be 9 pounds.

11. PMM rated minimum life
    Each PMM shall have a rated life of a minimum of ten years.

12. PMM sign face installation and removal
Each PMM shall require no tools for removal or reinstallation except the tool required to loosen or tighten the fasteners.

13. PMM PCB boards protection
Pixel Matrix Modules PCB boards located on the sign access doors shall be covered to prevent damage to the exposed electronic parts.

13.4.2 Communications

1. PMM communication protocol
Each PMM shall be microprocessor-controlled and shall communicate with the Sign Controller on an IP over Ethernet communication network using UDP.

2. PMM functionality
The PMM shall process commands from the Sign Controller to display data, perform diagnostic tests, and report pixel and diagnostic status.

3. PMM’s default IP assignment
The PMM’s upper 3 octets of the IP Address default shall be 192.168.110.

4. PMM’s address DIP switch
Each PMM shall have the lowest octet of its IP Address selectable with one 8-bit DIP switch.

5. PMM default Broadcast
The PMM’s default Broadcast Address shall be 192.168.110.255

6. PMM default Gateway
The PMM’s default Gateway Address shall be 192.168.110.254

7. PMM default Network Mask
The PMM’s default Network Mask shall be 255.255.255.0

8. PMM default receiving port for UDP
The PMM’s default port number for receiving UDP data from the CMS Model 700 Series Sign Controller shall be 10020.

9. PMM default transmission port for UDP
The PMM’s default port number for the transmission of UDP data to the CMS Model 700 Series Sign Controller shall be 10025.

10. PMM IP address configuration
Each PMM’s IP Address shall be fully configurable.

11. PMM IP address setting
Each PMM shall have the upper 3 octets of its IP Address set to its default value.

12. PMM broadcast address configuration
Each PMM’s Broadcast Address shall be fully configurable.

13. PMM broadcast address setting
Each PMM’s Broadcast Address shall be set to the PMM’s default value.

14. PMM gateway address configuration
Each PMM’s Gateway Address shall be fully configurable.

15. PMM gateway address setting
Each PMM’s Gateway Address shall be set to the PMM’s default value.

16. PMM network mask configuration
Each PMM’s Network Mask shall be fully configurable.

17. PMM network mask setting
Each PMM’s Network Mask shall be set to the PMM’s default value.

18. PMM UDP receiving port configuration
Each PMM’s UDP receiving port shall be fully configurable.

19. PMM UDP transmission port configuration
Each PMM’s UDP transmission port shall be fully configurable.

20. PMM UDP receiving port setting
Each PMM’s UDP receiving port shall be set to its default configuration.

21. PMM UDP transmission port setting
Each PMM’s UDP transmission port shall be set to its default configuration.

22. PMM reset using DIP switch
Setting the PMM DIP switch to a value of 255 shall reset the module back to the module’s default IP Address, Broadcast Address, Gateway Address, Network Mask and port numbers.

23. PMM internal memory buffers
The PMM shall have 10 internal memory buffers numbered 0 to 9 to hold messages that are ready to be displayed.

24. PMM active message buffer
The PMM shall have an additional active message buffer (read only) numbered 253, which will hold the bitmap for the currently displayed message.

25. Response to Get Status Requests with buffer 254 selected
The PMM shall respond to Get Status Requests when buffer 254 has been selected by returning a pixel error value for each pixel color level in the packet. Current pixel errors are:

<table>
<thead>
<tr>
<th>Bit</th>
<th>Value</th>
<th>Error Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
<td>Pixel Exists</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>Pixel does not exist (LSB)</td>
</tr>
<tr>
<td>2</td>
<td>0</td>
<td>OK</td>
</tr>
<tr>
<td>1</td>
<td>Pixel LED String #1 has failed</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>0</td>
<td>OK</td>
</tr>
<tr>
<td>1</td>
<td>Pixel LED String #2 has failed</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>0</td>
<td>OK</td>
</tr>
<tr>
<td>1</td>
<td>Pixel LED String #3 has failed</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>0</td>
<td>OK</td>
</tr>
<tr>
<td>1</td>
<td>Any pixel driver reports a thermal alert</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>0</td>
<td>OK</td>
</tr>
<tr>
<td>1</td>
<td>Any pixel driver reports a thermal shutdown</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>0</td>
<td>OK</td>
</tr>
<tr>
<td>1</td>
<td>Any pixel driver fails or no response to a driver status Request</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Always 0</td>
<td>For future use (MSB)</td>
</tr>
</tbody>
</table>

26. **Response to Get Status Requests with buffer 255 selected**

The PMM shall respond to Get Status Requests when buffer 255 has been selected by returning the current commanded pixel color level value for a working pixel or a pixel color level of zero (0) for any malfunctioning or non-existent pixel.

27. **PMM Display Buffer**

The PMM Display Buffer command shall cause the PMM to copy the bit map from the selected buffer to the display buffer (253).

28. **PMM default bitmap**

The PMM default bitmap for all buffers shall be a level of zero for all pixels.

29. **PMM’s usage of message buffers**

The PMM shall use memory for all message buffers which do not have specified read/write cycle limitations.

30. **Response time for message display**

Each PMM shall be able to display a buffered message within 20ms of receiving a “Display Buffer Message” message from the Sign Controller.

31. **Response time to blank sign when no buffer packet received**

If the PMM has not received a PMM Display Buffer Packet, a PMM Set Packet, or a PMM Get Packet for more than 5 minutes, then each PMM shall set all pixels to dark and set all pixels in pixel buffers 0 through 9 to a value of zero.

13.4.3 **Light-Emitting Diode (LED)**

1. **Pixel LED Mean Time Between Failures (MTBF)**

Each pixel LED shall have a rating of 100,000 hours MTBF or longer.

2. **Amber Pixel LED Technology**

Each pixel LED shall be AlInGaP semiconductor technology and shall emit amber light that has a peak wavelength of 592 +/- 5 nm.
3. **Color Pixel LED Technology**
   Each color pixel LED shall be AlInGaP semiconductor technology and shall emit red, green and blue light that has a peak wavelength of 620nm +/- 5nm on red, 521nm +/- 5nm on green, and 470nm +/- 5nm on blue. Each pixel shall be configured for white point at 6500K (D65).

4. **Pixel LED character uniformity**
   Each pixel LED shall be from the same manufacturer and shall have a uniform color and viewing angle, the same MTBF, and have the same manufacturer’s part number.

5. **Pixel LED production uniformity**
   Each pixel LED shall have been manufactured within a period not greater than 3 months apart.

6. **Pixel LED luminance uniformity**
   Each pixel LED shall have the uniformity above 50% or below 50% luminance nonuniformity with brightness control of 0 to 255.

13.4.4 **Pixels**

1. **Luminosity degradation**
   Each pixel’s luminosity shall not degrade more than 10% in a 60 month interval.

2. **Amber pixel viewing angle**
   Each amber pixel shall have a viewing angle of 30 degrees or more. Each LED on a given sign shall have the same viewing angle.

3. **Color pixel viewing angle**
   Each color pixel shall have the following beam angle: Horizontal +15, -15 degrees and Vertical 0, -10 degrees, minimum. Each LED on a given sign shall have the same viewing angle.

4. **Amber LED Failure & light output**
   A failure of one LED in a LED cluster shall not result in a loss of more than 33% of light output for a selected pixel.

5. **Amber Pixel Luminous Intensity requirement**
   LED’s suitable for outdoor signage applications with luminous intensity:
   - Amber at 43 +/- 3 candelas

6. **Amber Pixel Brightness at level 0**
   Each pixel shall have a brightness of 0 candelas at a display level of 0.

7. **Amber Pixel Brightness at level 255**
Each pixel shall have a brightness of 43 +/- 3 candelas at a display level of 255.

8. Amber Pixel Brightness at levels between 1 and 254
   Each pixel shall have its brightness adjusted linearly between 0 and 43 candela when the display level is set to between 1 and 254.

9. Amber Pixel Cluster Shape & Arrangement
   The shape of an individual pixel shall be square and the LEDs shall be evenly distributed in the pixel.

10. Amber LED array size
    Each pixel cluster shall have a maximum LED array diameter size of 1.5 inches.

11. Color Pixel Minimum Luminance
    Each pixel shall have luminance of not less than 9,000 cd/m² (candelas per square meter)

12. Color Pixel Luminous Intensity requirement
    Use LED’s suitable for outdoor signage applications with luminous intensity:
    - Red at 790 millicandela minimum
    - Green at 2400 millicandela minimum
    - Blue at 500 millicandela minimum

13. Color Pixel Brightness at level 0
    Each pixel shall have a brightness of 0 candelas at a display level of 0.

14. Color Pixel Brightness at level 255
    Each pixel shall have a brightness of 9,000 cd/m² at a display level of 255

15. Color Pixel Brightness at levels between 1 and 254
    Each pixel shall have its brightness adjusted linearly between 0 and 9,000 cd/m² when the display level is set to between 1 and 254.

16. Drive current
    Each pixel shall be driven by Pulse Width Modulation (PWM) of the drive current to control its intensity. This LED driver circuitry shall vary the current pulse width to achieve the proper display intensity levels for all light conditions. The drive current pulse shall be modulated at a frequency high enough to provide flicker-free operation over 255 brightness levels.

17. Uniform brightness
    Each pixel on each PMM shall have uniform brightness when illuminated.

18. LED string open circuit detection
    Each string of LED’s shall detect when the LED string has an open circuit regardless of pixel activation status (on-the-fly).
19. **LED string short circuit detection**
   Each string of LED’s shall detect when more than 80% of the LED string is shorted regardless of pixel activation status (on-the-fly).

20. **LED string during Pixel Panel open circuit**
    If a string of LED’s needs to be energized during Pixel Panel open circuit detection the pixels shall be energized for less than 3ms.

21. **LED string during Pixel Panel short circuit**
    If a string of LED’s needs to be energized during Pixel Panel short circuit detection the pixels shall be energized for less than 3ms.

22. **Pixel’s refresh rate**
    Each pixel’s refresh rate shall be a minimum of 600 times per second.

### 13.4.5 Power

1. **Wires**
   Each PMM shall have two secured, color coded, 600V, 16 AWG minimum, jacketed wires, conforming to the National Electric Code, rated for service at +105°C, for 24 VDC electrical power connection. Each wire shall be at a minimum of 3 feet in length.

2. **Power consumption**
   Each Amber Standard-Resolution PMM shall consume the maximum of 35 Watts.
   Each Color High-Resolution PMM shall consume the maximum of 35 Watts.

3. **Voltage rating**
   Each PMM shall accept 22 VDC to 26 VDC (24 VDC nominal) as input voltage.

4. **Circuit protection**
   The supply input circuit of each PMM shall be fused with replaceable fuse.

5. **Overheat and ground fault protection**
   Each PMM shall have an automatic shut down and restart for such conditions as over-heating, over-current, or a ground fault.

### 13.4.6 PMM Types

1. **Type 1 PMM, Standard-Resolution with Amber LED’s (Used on CMS 700)**
   A. Each Type 1 PMM shall have a pixel pitch of 2.75 inches.
   B. Each Type 1 PMM shall be 13.62 inches wide by 24.65 inches high.
2. **Type 2 PMM, Standard-Resolution with Amber LED’s (Used on CMS 710 and 720)**
   A. Each Type 2 PMM shall have a pixel pitch of 1.75 inches.
   B. Each Type 2 PMM shall be 8.62 inches wide by 15.65 inches high.

3. **Type 3 PMM, High-Resolution with Color LED’s (Used on CMS 700C)**
   A. Each Type 3 PMM shall have a pixel pitch of 0.917 inches.
   B. Each Type 3 PMM shall be 13.62 inches wide by 24.65 inches high.

4. **Type 4 PMM, High Resolution with Color LED’s (Used on CMS 710C and 720C)**
   A. Each Type 4 PMM shall have a pixel pitch of 0.583 inches.
   B. Each Type 4 PMM shall be 8.62 inches wide by 15.65 inches high.
CHAPTER 13-SECTION 5: SIGN CONTROLLER

13.5.1 General

1. Sign Controller
   The CMS Model 700 Series shall be controlled and monitored by its own Sign Controller.

2. Requirement
   The CMS Model 700 Series controller shall be industrially-rated and capable of running the Caltrans CMS Model 700 Series System Software.

3. Software
   The CMS Model 700 Series controller shall have the Caltrans CMS Model 700 Series System Software installed.

4. Mean time between failures (MTBF)
   Each Sign Controller shall have a mean time between critical failures of greater than 200,000.00 hours. For this section, a critical failure shall be any failure which prevents a local or remote authorized user from being able to display a new or previously created message.

5. Enclosure
   Each Sign Controller shall be housed in a metal enclosure.

6. Height
   Each Sign Controller shall be no more than 7 inches (4U) in height.

7. Mounting
   Each Sign Controller shall include a complete set of hardware which allows the controller to be mounted in an EIA 19 inch rack cage.

8. Cooling
   Each Sign Controller shall be cooled solely through convection (i.e. no fan).

9. Weight
   Each Sign Controller shall weigh no more than 25 pounds.

10. Firmware memory storage
    All Sign Controller firmware shall be stored in solid-state memory.

11. Message library memory storage
    All Sign Controller library messages shall be stored in solid-state memory.

12. Power and reset capability
Each Sign Controller shall have power and reset capability both locally and through remote operation.

13.5.2 Power

1. **Maximum power consumption**
   The maximum power consumption of each Sign Controller shall be 120W.

2. **Operating voltage and power cable**
   Each Sign Controller shall have either an operating voltage of 24VDC or 120VAC.
   A. If a 24VDC-rated controller is selected, an industrially-rated AC Adapter and cable shall be included to be used with the controller. The AC Adapter cable shall be 6 feet minimum and 9 feet maximum in length.
   B. If a 120VAC-rated controller is selected, a power cable shall be included to be used with the controller. The cable shall be 6 feet minimum and 9 feet maximum in length.
   C. Use outlet on the Remote Power Switch to power the controller. Refer to Section 13.12.2.D.

13.5.3 Communication

1. **Ethernet ports**
   Each Sign Controller shall have 2 independent IP over Ethernet ports, each of which is fully configurable and independently addressable:
   A. Port #1 is intended to be on the CMS Model 700 Series Local Area Network (LAN) for control of the PMMs and Warning Beacons, to receive data from the Remote I/O Box and Test Box, and for local system access etc. The Sign Controller shall be able to communicate using the Model 700 protocol through port #1. The default IP address for Port #1 shall be 192.168.110.200.
   B. Port #2 is intended to be on the field element Wide Area Network (WAN) for CMS Model 700 Series access from a Transportation Management Center (TMC). The Sign Controller shall be able to communicate using both NTCIP and SIGNVIEW protocols through port #2. The default IP address for Port #2 shall be 192.168.1.100.

2. **Front panel**
   The Sign Controller shall have a LED mounted on its front panel that shall be illuminated when the controller is on.

13.5.4 System Default Internet Protocol (IP) Addresses

1. **Internet protocol (IP) Assignment**
   The default IP addresses shall be:
   A. PMM (Row 1) 192.168.110.1 through 192.168.110.21
   B. PMM (Row 2) 192.168.110.31 through 192.168.110.51
<table>
<thead>
<tr>
<th></th>
<th>Description</th>
<th>IP Address</th>
</tr>
</thead>
<tbody>
<tr>
<td>C.</td>
<td>PMM (Row 3) 192.168.110.61 through 192.168.110.81</td>
<td></td>
</tr>
<tr>
<td>D.</td>
<td>Sign Controller (Ethernet Port #1)</td>
<td>192.168.110.200</td>
</tr>
<tr>
<td>E.</td>
<td>Sign Controller (Ethernet Port #2)</td>
<td>192.168.110.100</td>
</tr>
<tr>
<td>F.</td>
<td>Remote I/O Box</td>
<td>192.168.110.204</td>
</tr>
<tr>
<td>G.</td>
<td>Test Box</td>
<td>192.168.110.205</td>
</tr>
<tr>
<td>H.</td>
<td>Ethernet switch 10/100baseTX (Quantity 3)</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Network Mask:</strong> 255.255.255.0</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Default Gateway:</strong> Leave blank</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Address:</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Switch #1 (top row)</td>
<td>192.168.110.101</td>
</tr>
<tr>
<td></td>
<td>Switch #2 (middle row)</td>
<td>192.168.110.102</td>
</tr>
<tr>
<td></td>
<td>Switch #3 (bottom row)</td>
<td>192.168.110.103</td>
</tr>
</tbody>
</table>
CHAPTER 13-SECTION 6: PHOTO SENSOR

13.6.1 General

1. Ambient luminosity measurement
   Each Photo Sensor shall measure the current ambient luminosity in 255 linear steps.

2. Output voltage
   Each Photo Sensor shall emit a 0 to 5 volt analog DC signal corresponding to the current light intensity
CHAPTER 13-SECTION 7: TEMPERATURE SENSOR

13.7.1 General

1. **Internal temperature measurement**
   Each Temperature Sensor shall measure the current CMS Model 700 Series internal temperature in degrees F.

2. **Output voltage**
   Each Temperature Sensor shall emit a 0 to 5 volt analog DC signal corresponding to the current temperature
CHAPTER 13-SECTION 8: REMOTE I/O BOX

13.8.1 General

1. Power switch & status indicator
   Each Remote I/O Box shall have an on and off switch with a LED indicating power status.

2. Operating voltage
   The Remote I/O Box shall have either an operating voltage of 24VDC or 120VAC.

3. Mounting
   The Remote I/O Box shall be mounted on a CMS Model 700 Series sign using a mounting rail as specified in IEC 60715.

4. Sensors
   The Remote I/O Box shall contain 16 discrete contact sensors and 6 analog sensors.

5. Sensor connection
   Connecting sensors to the Remote I/O Box shall not require soldering.

6. Electrical isolation
   Remote I/O Box’s sensors shall be electrically isolated.

13.8.2 Communication

1. Protocol
   The Remote I/O Box shall be microprocessor-controlled and shall communicate with the Sign Controller on an IP over Ethernet communication network using UDP.

2. Default broadcast address
   The Remote I/O Box’s default Broadcast Address shall be 192.168.110.255

3. Default gateway address
   The Remote I/O Box’s default Gateway Address shall be 192.168.110.254

4. Default network mask
   The Remote I/O Box’s default Network Mask shall be 255.255.255.0

5. Broadcast address configuration
   Each Remote I/O Box’s Broadcast Address shall be fully configurable.

6. Default broadcast address setting
   Each Remote I/O Box’s Broadcast Address shall be set to its default value.
7. **Gateway address configuration**  
   Each Remote I/O Box’s Gateway Address shall be fully configurable.

8. **Default gateway address setting**  
   Each Remote I/O Box’s Gateway Address shall be set to its default value.

9. **Network mask configuration**  
   Each Remote I/O Box’s Network Mask shall be fully configurable.

10. **Default network mask setting**  
    Each Remote I/O Box’s Network Mask shall be set to its default value.

11. **Receiving UDP default port number**  
    The Remote I/O Box’s default port number for the receiving UDP data from the CMS Model 700 Series Sign Controller shall be 10011.

12. **Transmission UDP default port number**  
    The Remote I/O Box’s default port number for the transmission of UDP data to the CMS Model 700 Series Sign Controller shall be 10011.

13. **Remote I/O “receive” UDP port configuration**  
    The Remote I/O Box’s “receive” UDP port shall be fully configurable.

14. **Remote I/O “transmit-to” UDP port configuration**  
    The Remote I/O Box’s “transmit-to” UDP port shall be fully configurable.

15. **Remote I/O “receive” UDP port setting**  
    The Remote I/O Box’s “receive” UDP port shall be set to its default configuration.

16. **Remote I/O “transmit-to” UDP port setting**  
    The Remote I/O Box’s “transmit-to” UDP port shall be set to its default configuration.

17. **Reset switch**  
    Depressing the Remote I/O Box’s reset button shall reset the box back to the box’s default IP Address, Broadcast Address, Gateway Address, Network Mask and port numbers.

18. **Reset switch placement**  
    The Remote I/O Box’s reset button shall be recessed to prevent accidental reset.

19. **Data transmission**  
    The Remote I/O Box shall transmit the current sensor status over UDP to the Sign Controller immediately following a reboot, upon the change of state of any discrete contract sensor, and once every minute thereafter.
### 13.8.3 Sensors

#### 1. Analog Contact Sensor connections
The Remote I/O Box’s analog sensor shall be connected as follows:

<table>
<thead>
<tr>
<th>Sensor Type</th>
<th>Range</th>
<th>Terminal</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Photo Sensor #1</td>
<td>0 to 5 VDC</td>
<td>#1</td>
</tr>
<tr>
<td>B. Photo Sensor #2</td>
<td>0 to 5 VDC</td>
<td>#2</td>
</tr>
<tr>
<td>C. Photo Sensor #3</td>
<td>0 to 5 VDC</td>
<td>#3</td>
</tr>
<tr>
<td>D. Temperature Sensor #1</td>
<td>0 to 5 VDC</td>
<td>#4</td>
</tr>
<tr>
<td>E. Temperature Sensor #2</td>
<td>0 to 5 VDC</td>
<td>#5</td>
</tr>
<tr>
<td>F. Future Use</td>
<td>0 to 5 VDC</td>
<td>#6</td>
</tr>
</tbody>
</table>

#### 2. Digital Contact Sensor connections
The Remote I/O Box’s digital contact-closure sensors shall be connected as follows:

<table>
<thead>
<tr>
<th>Sensor Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Contact #1</td>
<td>Shall measure left door 1 open switch. Closed = door closed, Open = door open.</td>
</tr>
<tr>
<td>B. Contact #2</td>
<td>Shall measure right door 1 open switch. Closed = door closed, Open = door open.</td>
</tr>
<tr>
<td>C. Contact #3</td>
<td>Shall measure the #1 cooling fan status. Closed = fan working normally, Open = fan failure.</td>
</tr>
<tr>
<td>D. Contact #4</td>
<td>Shall measure the #2 cooling fan status. Closed = fan working normally, Open = fan failure.</td>
</tr>
<tr>
<td>E. Contact #5</td>
<td>Shall measure the air filter status. Closed = filter is unclogged, Open = filter clogged.</td>
</tr>
<tr>
<td>F. Contact #6</td>
<td>Shall measure the AC power status. Closed = normal power, Open = alternate power.</td>
</tr>
<tr>
<td>G. Contact #7</td>
<td>Shall measure the sign humidity. Closed = humidity within limits, Open = humidity exceeds limits.</td>
</tr>
<tr>
<td>H. Contact #8</td>
<td>Shall inform the CMS Model 700 Series System Software to turn on Special Message 1 (0 = Off, 1 = Turn on Message, Highest number message has priority over other special messages).</td>
</tr>
<tr>
<td>I. Contact #9</td>
<td>Shall inform the CMS Model 700 Series System Software to turn on Special Message 2. (0 = Off, 1 = Turn on Message, Highest number message has priority over other special messages).</td>
</tr>
<tr>
<td>J. Contact #10</td>
<td>Shall measure the status of 24-Volt Power Supply #1. (0 = Off, 1 = On).</td>
</tr>
<tr>
<td>K. Contact #11</td>
<td>Shall measure the status of 24-Volt Power Supply #2. (0 = Off, 1 = On).</td>
</tr>
<tr>
<td>L. Contact #12</td>
<td>Shall measure the status of 24-Volt Power Supply #3. (0 = Off, 1 = On).</td>
</tr>
<tr>
<td>M. Contact #13</td>
<td>Shall measure the status of 24-Volt Power Supply #4. (0 = Off, 1 = On).</td>
</tr>
<tr>
<td>N. Contact #14</td>
<td>Shall measure the status of 24-Volt Power Supply #5. (0 = Off, 1 = On).</td>
</tr>
<tr>
<td>O. Contact #15</td>
<td>Shall measure the status of 24-Volt Power Supply #6. (0 = Off, 1 = On).</td>
</tr>
<tr>
<td>P. Contact #16</td>
<td>Shall measure the status of 24-Volt Power Supply #7. (0 = Off, 1 = On).</td>
</tr>
</tbody>
</table>
3. **LED indicators**  
Above each contact sensor shall be a LED which shall display the status of each contact sensor. **On** = sensor closed, **Off** = sensor open.

**13.8.4 Beacon Relays**

1. **Type**  
The Remote I/O Box shall contain 2 sets of relays, each of which shall contain one normally-open and one normally-closed contact.

2. **LED indicators**  
The Remote I/O Box shall have a LED for each set of contact switches. The LED shall be illuminated when the relay is energized and off when the relay is de-energized.
CHAPTER 13-SECTION 9: TEST BOX

13.9.1 General

1. Height
   Each Test Box shall be no more than 3.5 inches (2U) in height.

2. Mounting
   Each Test Box shall include a complete set of hardware which allows the Test Box to be mounted in an EIA 19 inch rack cage.

3. Operating voltage
   Each Test Box shall have an operating voltage of 120 VAC.

13.9.2 Communication

1. Protocol
   The Test Box shall be microprocessor-controlled and shall communicate with the Sign Controller on an IP over Ethernet communication network using UDP.

2. Default broadcast address
   The Test Box’s default Broadcast Address shall be 192.168.110.255

3. Default gateway address
   The Test Box’s default Gateway Address shall be 192.168.110.254

4. Default network mask
   The Test Box’s default Network Mask shall be 255.255.255.0

5. Broadcast address configuration
   Each Test Box’s Broadcast Address shall be fully configurable.

6. Default broadcast address setting
   Each Test Box’s Broadcast Address shall be set to its default value.

7. Gateway address configuration
   Each Test Box’s Gateway Address shall be fully configurable.

8. Default gateway address setting
   Each Test Box’s Gateway Address shall be set to its default value.

9. Network mask configuration
   Each Test Box’s Network Mask shall be fully configurable.
10. Default network mask setting
   Each Test Box’s Network Mask shall be set to its default value.

11. Receiving UDP default port configuration
   The Test Box’s default port number for the receiving of UDP data from the CMS Model 700 Series Sign Controller shall be 10012.

12. Transmission UDP default port configuration
   The Test Box’s default port number for the transmission of UDP data to the CMS Model 700 Series Sign Controller shall be 10012.

13. Test Box “receive” UDP port configuration
   The Test Box’s “receive” UDP port shall be fully configurable.

14. Test Box “transmit-to” UDP port configuration
   The Test Box’s “transmit-to” UDP port shall be fully configurable.

15. Test Box “receive” UDP port setting
   The Test Box’s “receive” UDP port shall be set to its default configuration.

16. Test Box “transmit-to” UDP port setting
   The Test Box’s “transmit to” UDP port shall be set to its default configuration.

17. Reset switch
   Depressing the Test Box’s reset button shall reset the box back to the box’s default IP Address, Broadcast Address, Gateway Address, Network Mask and port numbers.

18. Reset switch placement
   The Test Box’s reset button shall be recessed to prevent accidental reset.

19. Data transmission
   Each Test Box shall transmit over UDP the current sensor status immediately following a reboot, upon the change of state of any discrete contact sensor and once every minute thereafter.

20. Beacons Relay (Relay #1)
   The Beacons Relay (Relay #1) shall be de-energized if the Remote I/O Box has not received a Remote I/O Box Beacon Set Packet or a Remote I/O Box Beacon Get Packet for more than 5 minutes.

13.9.3 Contact Sensors
   1. The Test Box shall have 8 discrete contact sensors arranged as follows.
      A. Contact #1 shall measure control cabinet front door open switch. Closed = door closed, open = door open.
B. Contact #2 shall measure control cabinet rear door open switch. Closed =
door closed, open = door open.
C. Contact #3 shall measure cabinet fan. Closed = fan operating, open = fan
off.
D. Contact #4 shall measure cabinet power. Closed = normal power, open =
alternate power.
E. Contact #5 shall inform the CMS Model 700 Series System Software to
turn on Special Message 3 (0 = Off, 1 = Turn on Message, Highest number
message has priority over other special messages).
F. Contact #6 shall inform the CMS Model 700 Series System Software to
turn on Special Message 4 (0 = Off, 1 = Turn on Message, Highest number
message has priority over other special messages).
G. Contact #7 shall be for future use.
H. Contact #8 shall be for future use.

13.9.4 Test Switches

1. Switches and LED indicators
   It shall consist of 16 momentary button switches, each with an associated LED.

2. Switches’ function
   When a Test Box switch is depressed, the Test Box shall send a UDP message to
   the sign controller to initiate the selected test.
CHAPTER 13-SECTION 10: SIGN OPTIONS

13.10.1 Warning Beacon Option

1. Placement
   The sign shall have an option where two beacons are mounted on top left and right of the sign to emphasize a critical message.

2. Intensity
   The intensity of the two warning beacons shall be equivalent to or greater than the sign message.

3. Type
   Each beacon shall use LED’s.

4. Operating voltage
   Each beacon shall have an operating voltage of 120 VAC.

5. Color and Mount
   Each beacon shall be circular Amber and mount onto a 1.5 inch NPT fitting.

6. Beacon flash
   When energized each flashing beacon shall flash at a rate of 60 times per minute with a duty cycle of 50%. Multiple beacons shall be able to be set to operate either simultaneously or alternately when activated.

7. Circuit protection
   The beacon shall be electrically protected by one circuit breaker installed on the PDA’s front panel and designated “Beacon”.

8. Control
   Each beacon shall be controlled from the Remote I/O Box.

13.10.2 Heater Option

1. Heating requirement
   The heater shall be capable of keeping the sign at a minimum of 50°F, when the ambient temperature is 15°F or lower.

2. Placement
   The heater shall be placed in such a way as to create sufficient airflow which shall prevent any component from exceeding 150°F when used at temperatures below 30°F.

3. Snow and freezing rain prevention
The heater shall prevent snow and freezing rain from adhering to the sign and obstructing sign PMM visibility.

4. Agency listed
   The heater shall be UL listed.

5. Removal and installation
   The heater shall not require soldering for removal or installation.

6. Power service circuit
   The heater power shall not be on the same power service circuit as the CMS Model 700 Series sign.

7. Circuit Protection
   The heater power shall have a heater circuit breaker that is separate from all other CMS Model 700 Series power.

13.10.3 PMM Wide Visibility Option

1. Viewing angle
   When selected, each pixel shall have a viewing angle of 70 degrees or more. All LEDs on a given sign shall have the same viewing angle, appropriate for the implementation site.

13.10.4 PMM Option

1. Color option
   Each PMM type shall have a color and resolution as defined in Chapter 13, Section 4.

13.10.5 Transformer Option

1. Electrical isolation
   The PDA shall have a 5KVA isolation transformer that electrically isolates/steps down the CMS Model 700 Series sign service voltage.

13.10.6 Power-Off Notification Option

1. Communication device
   A device shall be installed which allows a phone/e-mail notification to be sent to a specified location by cell phone whenever the CMS Model 700 Series sign power is off (Isocket GSM Power Socket Model ASGMS706US - or similar).
CHAPTER 13-SECTION 11: SIGN STRUCTURE AND HOUSING

13.11.1 Sign Housing Requirements

1. Housing
   The housing shall include, but not limited to, the following:
   A. Doors
   B. Ventilation
   C. Latches/Handles
   D. Gaskets
   E. Hinges and Door Catches
   F. Cage Supports and Mounting for PMM and CMS Model 700 Series Equipment

2. Logos
   Company or vendor logos shall NOT appear anywhere on the exterior of the sign housing.

13.11.2 Sign Housing Construction

1. Housing material
   The housing shall be fabricated from 0.125-inch minimum thickness 5052-H32 aluminum alloy and shall be designed to withstand 33 pounds per square foot as specified in the latest AASHTO publication entitled "Standard Specification for Structural Supports for Highway Signs, Luminaries and Traffic Signals".

2. Frame
   The housing shall have interior cage support frames to mount the PMM. The cage support frame shall withstand or minimize vibration when the sign is mounted with any number of PMM.

3. Housing component material
   The doors, lifting eyes, gasket channels and all supports welded to the housing shall be fabricated of 0.125 inch minimum thickness aluminum sheet. Bolted-on supports shall be either 0.125-inch minimum thick 5052-H32 aluminum alloy or 0.105 inch minimum steel sheet.

4. Housing support material
   The exterior Z-bar supports shall be fabricated from 0.250 inch minimum thickness 5052-H32 aluminum alloy.

5. PMM IP Address stencil
   Each PMM mounting position shall be stenciled with 2-inch black lettering that states the default lowest octet of the PMM IP address for the related module position.
6. Terminal block
Each PMM mounting position shall have a terminal block mounted behind the panel location which shall supply the PMM with power.

7. Conduit hole
The CMS Model 700 Series shall have one 3” and one 2” conduit hole below each Sign Equipment Rack mounting point. Unused conduit holes shall have plugs installed.

8. Protection from the elements
The CMS Model 700 Series housing shall protect the internal components from rain, ice, dust, and corrosion in accordance with NEMA enclosure Type 3R standard.

9. Water resistance requirement
The CMS Model 700 Series housing shall resist water infiltration during hose-directed water per NEMA 250 - Class 3R requirements.

10. Drain holes
The CMS Model 700 Series housing shall have 3/8” diameter water drain holes along the bottom side. The drain holes shall be located as specified on the drawings.

11. Operating condition
The CMS Model 700 Series shall be capable of operating in rain, snow, sun, thunderstorms and withstand a wind load of 100 mph without damage to sign, sign structure, mechanical equipment or electrical equipment.

12. Lifting eyes
The Model 700 and 710 housing shall be provided with 2 lifting eyes and the Model 720 shall be provided with one lifting eye to be used when placing the housing on the sign structure. The lifting eyes shall be located as specified on the plans. Each eye shall have a minimum diameter of 1.00 inch. The fully assembled sign shall have sufficient structural strength to be lifted and moved by either lifting eye, or both lifting eyes, without damage or permanent deformation to any part of the sign. A label shall be attached near each lifting eye reading, "Lift Vertically to Prevent Damage".

13.11.3 Welding

1. Exterior seams
All exterior seams shall be continuously welded and each weld shall be a uniform flow.

2. Welding method
Welding on aluminum housings shall be done as follows:
A. On all exterior seams, only the gas tungsten arc (TIG) process using bare aluminum welding electrodes shall be used.

B. On all interior seams, the gas metal arc (MIG) or gas tungsten arc (TIG) process using bare aluminum welding electrodes shall be used.

3. **Welding requirement**

   The aluminum welding electrodes shall conform to the requirements of AWS A5.10 for ER5356 aluminum alloy bare welding electrodes. Procedures, welders and welding operators for welding on aluminum shall be qualified in accordance with the requirements of AWS B3.0, "Welding Procedure and Performance Qualification", and to the practices recommended in AWS C5.6.

4. **Gasket proofing requirement**

   Proper gaskets shall be installed on all door openings and Pixel Matrix Modules (PMM) to provide dust-tight and water-tight seals. Gaskets shall be 0.25 inch minimum thickness closed cell neoprene or silicone (BOYD R-10480 or equivalent) and shall be permanently bonded to the metal. If neoprene is used, the mating surface of the gasket seals shall be covered with a silicone lubricant to prevent it from sticking to the mating metal surface. A gasket top channel shall be provided to support the top gasket on the door to prevent gasket gravitational fatigue.

5. **Weld inspection**

   All welds shall be inspected before sign delivery.

**13.11.4 Sign Equipment Access Doors**

1. **Access doors**

   The CMS housing shall have a left and right Access Doors to provide access to the Sign Equipment Rack, the 24 Volt Power Supplies and ground cabinet termination points without the removal of any Pixel Matrix Modules.

2. **Access door requirement**

   Each Access Door shall have a NEMA 3R rating or better.

3. **Door hinges**

   Access Door hinges shall be located on the inside edge left and right contrast border.

4. **Door latch**

   Each Access Door latch shall be located on the bottom contrast border and shall be locked and released using a breaker bar with a ¾” drive.

5. **Door catches**

   Each Access Door shall be provided with catches to hold the door open 90 +/- 10 degrees. The catch minimum diameter shall be either 0.375 inch for plated steel or
aluminum rods or 0.25 inch for Stainless steel. The catches shall be capable of holding the door open at 90 degrees in a 40 mph wind acting at an angle perpendicular to the plane of the door.

6. **Door locking plate**
   Each door shall have a 4-inch x 4-inch (4”x4”) door locking plate attached to the bottom of the door which shall overlap the bottom border of the sign’s contrast border when closed.

7. **Door locking plate bolt**
   Each door locking plate shall have a 9/16 inch (9/16”) bolt to allow the user to secure the bottom of the sign door to the sign contrast border.

8. **Door locking plate bolt retainer**
   Each door locking plate bolt shall have a bolt retainer to prevent loss of the bolt after releasing the door.

9. **Door locking plate slot for padlock**
   Each door locking plate shall have a slot which will go over an adjacent loop located on the sign contrast border. This will allow the user to lock the door utilizing a padlock.

10. **Door latches’ mechanism**
    Sign door latches’ mechanism shall prevent damage caused by the user attempting to overturn the door handle.

11. **Door locking bar**
    CMS Model 700 Series Access Door locking bar shall be no more than 4 feet from the bottom of the sign.

12. **Door locking mechanism**
    CMS Model 700 Series Access Door latch shall be multi point locking mechanism with a minimum of 2 locking points.

13.11.5 Fan Box

1. **Housing**
   Ventilation Fans, Fan detector, filter dirty detector, and exterior door shall be housed in a fan box.

2. **Location**
   The Fan Box shall be inserted on the side of the sign which houses the equipment rack.

3. **Fans**
   Each Fan box shall have 2 independent fans installed.
4. **Fans specification**  
Each Fan Box fan shall have ball or roller bearings and a capacity of at least 60 cubic feet of free air delivery per minute.

5. **Fan Box specification**  
Each Fan Box fan shall be a thermostatically controlled device adjustable to turn ON between 91°F and 140°F with a differential of not more than 10°F between automatic turn ON and OFF. Thermostat indication shall be marked in 20°F increments. Manual adjustment shall be provided.

6. **Air filter size**  
The Fan Box air filter shall be 16-inch x 12-inch x 1-inch.

7. **Air filter location**  
The Fan Box air filter shall be firmly held place within the fan box.

8. **Air filter installation**  
The Fan Box air filter shall be held in place with bottom and side brackets and a spring-loaded top clamp.

9. **Air flow**  
The Fan Box shall have a watertight door with ventilation to allow airflow through the air filter and into the sign.

10. **Door handle**  
The Fan Box shall have a door handle.

11. **Agency Listing**  
The Fan Box filter shall meet UL Class 2 flame retardant requirements and have a MERV 8 efficiency rating. Filter shall be rated to a maximum temperature of 220°F.

13.11.6 **Coatings**

1. **Surfaces**  
The surfaces of the sign housing and display shall be designed to have no chipping, fading, or peeling over the 20-year design life of the sign under normal environmental and operating conditions. The contractor will select coatings, primers, and surface preparation to achieve this design life.

2. **Black coating**  
Black coating - Coating shall meet Federal Standard 595, Color No. 37038 and shall be applied to the front facing sign border of the CMS Model 700 Series housing including screen assemblies, Control Cabinet Door, and each PMM. The coating will exhibit no visible color change when tested for 800 hours under ASTM D4587, Test Cycle 2.
3. **Cream coating**
   Cream coating - Coating shall meet Federal Standard 595 Color No. 37769 and shall be applied to the other surfaces of the CMS Model 700 Series housing including Z-Bars.

4. **Surface treatment**
   The Contractor shall have the options of coatings and surface treatments. The Contractor shall submit a Painting Quality Work Plan (PQWD) to the Transportation Laboratory for approval prior to performing work. The plan shall contain at a minimum:
   
   A. Contractor shall provide Coating manufacturer’s guidelines and recommendations for surface preparation, painting, drying, curing, handling, shipping and storage of all components of the CMS Model 700 Series assemblies.
   
   B. Contractor shall provide proposed material datasheets and equipment to be used for all coating applications.
   
   C. Contractor shall provide proposed methods to protect the CMS Model 700 Series assembly coatings during curing, shipping, handling and storage.
   
   D. Contractor shall provide a detailed coating repair plan for the repair of damaged areas.

5. **Test coupons**
   In addition to the PQWP the contractor shall provide 3 test coupons at least 3-inch x 6-inch of the coating system. The test coupon shall be manufactured by the same process as the sign assemblies. The Caltrans Transportation Lab will test them for compliance to these specifications.

### 13.11.7 Anodizing

1. **Specification**
   The anodic coating shall conform to MIL-A-8625F, Type II, Class 2. The coating will be sealed in a 5% aqueous solution of nickel acetate (pH 5.5-5.8) for 15 minutes at 212°F. The minimum coating thickness is 0.0007 inches and minimum coating weight of 0.952 ounces/inch².

### 13.11.8 Paint

1. **Surface preparation**
   Prepare and prime the surface in accordance with the written recommendations of the manufacturer of the coating.

2. **Paint coats**
   All surfaces will get a minimum of 2 coats of paint conforming to the requirements for White Tintable Finish Paint, Formula PWB-174, or exterior grade latex paint as described in Table 1.
### Table 1. Exterior Grade Latex Paint

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
<th>ASTM Designation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pigment content, %</td>
<td>24 Max</td>
<td>D3723</td>
</tr>
<tr>
<td>Nonvolatile content Wt%</td>
<td>40 Min</td>
<td>D2369</td>
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<tr>
<td>Viscosity, KU</td>
<td>75 - 90</td>
<td>D562</td>
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<tr>
<td>Drying time at 77° F, 4 mil wet film</td>
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<td>D1640</td>
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<tr>
<td>Set to touch, minutes</td>
<td>30 Max</td>
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<tr>
<td>Dry through, hours</td>
<td>1 Max</td>
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</table>

3. **Coating thickness**  
The dry film thickness of each application of coating will not be less than 2 mils or more than 4 mils. The total dry film thickness of the paint system will be not less than 4 mils or more than 8 mils. A minimum drying time of 12 hours shall be allowed between finished coats.

4. **Coating adhesion**  
After finished paint has cured adequately, the adhesion of the coating to the substrate when tested according to ASTM D 3359, Test Method A shall be 4A or higher.

### 13.11.9 Powder coat

1. **Requirement**  
Powder coat shall be a TGIC polyester meeting the weathering requirement in the American Architectural Manufacturers Association Publication No. 2604.

2. **Coating for aluminum component**  
Clean and coat the aluminum component by a process that will produce a finished coating that will meet the properties in Table 2. The powder coating will be at least 2 mils thick.

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<tr>
<th>Property</th>
<th>Test</th>
<th>Value</th>
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</thead>
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<td>ASTM D 3359, Test Method B</td>
<td>5B</td>
</tr>
<tr>
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<td>ASTM D 3363</td>
<td>HB</td>
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<tr>
<td>Impact resistance, 50 lbf-in</td>
<td>ASTM D 2794</td>
<td>No delamination</td>
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</table>

**Table 2. Powder Coat**

### 13.11.10 Ventilation

1. **Requirement**
The Control Compartment shall contain sufficient active and passive ventilation to allow the LEDs to stay within manufacturer-specified temperature ratings during normal environmental conditions.

13.11.11 In-Sign Electrical Equipment Mounting Area

1. Electrical equipment mounting area
   The CMS Model 700 Series shall have Sign Electrical Equipment Mounting Area both on the left and right inside edges which allows for mounting of equipment on either the left or the right side of the sign.

2. Electrical equipment
   CMS Model 700 Series shall include the minimum electronic equipment mounted in the Sign Electrical Equipment Mounting Area:
   A. Power Distribution Assembly (PDA)
   B. Remote Input/Output (I/O) Box
   C. Industrially-rated 10/100baseTX Ethernet Switches
   D. 24-Volt Power Supplies

3. Industrially-rated 10/100baseTX Ethernet switch requirements
   The Ethernet switches shall meet the following requirements:
   A. UL Listed
   B. 1U in height
   C. 120VAC operating voltage

4. Electrical equipment rack mounting
   The Remote I/O Box, Ethernet Switches, and 24 Volt Power Supplies shall be rack mounted in the Equipment Mounting Area of the CMS Model 700 Series.

5. Electrical equipment removal & re-installation
   Electrical Equipment shall be able to be removed and re-installed on either the left or right hand side of the sign without the need of any supplemental hardware.

6. Network cable labels
   Cat-5E cables between the network switches and the Pixel Matrix Modules (PMM) shall be labeled at both ends with the PMM’s least significant Ethernet address octet (node number).

13.11.12 Identification Plates

1. Identification plate mounting locations
   The CMS Model 700 Series shall have two identification plates located on the inside of both the left and right Service Doors

2. Identification plate content
Each identification plate shall have the following:

A. Caltrans’ Contract Number (CTCN:)
B. Serial Number (SN:)
C. Specification that the CMS Model 700 Series was built to (SPEC:)
D. Purchase Order Number (PO #:)
E. Purchase Order Date (Date:)
F. Name of the manufacturer

3. Lettering

Lettering on each plate shall be a minimum of 1-inch high and permanently stamped into a suitably-sized metal plate.

4. Identification plate visibility

Each plate shall be readable with the Service Door open.

5. Serial number

CMS Model 700 Units shall follow the following serial number format:

CMS-<Sign Model Number>-<Sign Incremental Number>-<Year Built>-<Options>

CMS-XXXX-XXXX-XXXX-X . . .

A. The Sign Model Number shall consist of the sign model number (700, 700C, 710, 710C, 720, or 720C).
B. The Sign Incremental Number shall consist of the incremental 4-digit sign number that has been built for that year.
C. The Year Built shall consist of the 4-digit year that the sign was built.
D. If any Options are requested, then the CMS Model 700 Series serial number shall consist of one or more letters that represent one or more additional options.

At this time, the CMS Model 700 Series options are:

B Beacon
C Color
H Heater
W Wide Visibility
T Transformer Option
P Power-Off Notification Option

The Identification plate shall be formatted as shown:
Example:

CTCN: 123456789
SN: CMS-700C-0001-2018-BHW
SPEC: TEES ERRATA NO. 3

PO #: 12345    Date: 12/10/2017

Manufacturer: ABC Inc.

Figure 1. Sign Identification Plate
CHAPTER 13-SECTION 12: CONTROLLER GROUND CABINET

13.12.1 Cabinet Model 334LS
Cabinet shall comply with chapters 1, 3 & 6 of the Transportation Electrical Equipment Specifications (TEES), dated May 12, 2009.

13.12.2 General Requirements

1. CMS ground cabinet
The CMS system shall include a cabinet Model 334LS, which will be mounted nearby on the ground to provide connectivity with the CMS’s in-sign equipment rack.

2. Electronic equipment
The CMS system shall include the minimum electronic equipment mounted or installed in the Model 334LS ground cabinet:
A. Industrially-rated Sign Controller
B. Test Box
C. Model 280 Input File Ethernet Switch Unit
D. A 4-port minimum Remote Power Switch with LAN/WAN/Web and Phone control capability (Example: Ambery Corporation Model IP-P3 or equivalent)
E. Quantity of three (3) approximately 300-feet long CAT-6A ethernet cables are to be wrapped & secured inside the ground cabinet. These cables are to be used to make connections between the ground cabinet and the CMS Sign at time of CMS Sign Installation. (See Drawing A1-29).

3. Remote Power Switch mounting and power
Remote power switch shall be rack mounted in the Model 334LS Cabinet. This device will be powered by the cabinet’s included PDA.

4. Test box mounting and power
The Test Box shall be rack mounted in the Model 334LS Cabinet. This device will be powered by the cabinet’s included PDA.

5. Sign controller mounting and power
The Sign Controller shall be rack mounted in the Model 334LS Cabinet. This device will be powered by the Remote Power Switch as per Section 13.12.2.2D. This will provide remote power reset capability to the sign controller.

6. Ethernet switch mounting and power
The Model 280 Input File Ethernet Switch Unit shall be secured and powered by being inserted into one of the empty slots in the Input File cage of the 334LS cabinet.
CHAPTER 13-SECTION 13: REFERENCE DOCUMENTS


4. NTCIP 1203:1997: National Transportation Communications for ITS Protocol (NTCIP) Object Definitions for Variable Message Signs (DMS), V02.35a, American Association of State Highway and Transportation Officials, Institute of Transportation Engineers and National Electrical Manufacturers Association, 2007
CHAPTER 13-SECTION 14: TS 4-2005 CONFORMANCE TABLE

Based on NEMA TS 4-2005 Clause 11.5 Conformance Table. Copyright@NEMA

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<td>Service Outlets AC Only</td>
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### ELEVATION VIEW

NOTE: CMS Model 700 configuration. Total of 63 Pixel Matrix Modules

---

## TYPICAL CMS 700 SERIES PMM IP ADDRESS CONFIGURATION

**NO. SCALE:**

**REV.:** 03/20/2018

**TITLE:** TYPICAL CMS 700 SERIES PMM IP ADDRESS CONFIGURATION

**CMS 700 SERIES**

---

**A1-4**
NOTES:

1. PMM Type I: 21 PMM across x 3 PMM down (63 PMM total)
2. Front door hinge open for electrical equipment access.
3. The lifting bracket must be used to prevent injury and damage to the sign.
4. The sign shall have 6 inch contrast borders on all four sides for display clarity and maximum contrast ratio. Modification to the contrast border shall require Comtrans engineering approval.
5. Door release mechanism with nearby high endurance label or silkscreen.
6. Cutouts 16¼” x 12¼” for 2-fan fan box. Active fan box on side of equipment rack. Cutout on other side is reserved for other mount option. Both cutouts to be protected with watertight doors with ventilation to allow airflow.
7. Ventilation louvers on top of both sides of sign.
8. Door locking plate

Title: CMS Models 700/700C
Front and Side Views

No. Scale
Rev.: 11/01/2018

CMS 700 Series
A1-5
**NOTES:**

1. Bolt supports to CMS 700 Series housing, minimum 5 bolts per Z-Bar.
2. 3/4" Diameter holes for mounting bolts to CMS 700 Series Test Stand.
3. 11/2" Diameter holes for Power and Communication shall be plugged for shipping.
4. 3/8" Diameter drain holes to prevent water and moisture accumulation.
5. Location of rear photo sensor (to prevent interference with mounting structure).
PALLETTIZED CMS
FRONT VIEW

Note: See drawing A1-8 for pallet and cradle dimensions.
Pallet, Top View

Pallet, Front View

Cradle, Front View

Cradle, Top View

NOTE: Apply 1/2" thick rubber gasket to each surface that is in contact with the sign panel.
DETAILED A

FOR 3/8" BOLTS TO HOLD CHAIN TO LIFT SIGN. PAIR OF HOLES SHALL BE CENTERED ON PANEL.

DETAILED B

THIS BRACKET IS USED BY THE CALTRANS WAREHOUSE FOR LOADING AND UNLOADING OF MODEL 710 AVMS USING A FORKLIFT. VARIATIONS MAY BE USED DEPENDING ON REQUIREMENTS OR CONSTRAINTS.
NOTES:

1. PMM Type 2: 19 PMM across x 3 PMM down (57 PMM total)
2. Front door hinge open for electrical equipment access.
3. The lifting bracket must be used to prevent injury and damage to the sign.
4. The sign shall have 5-inch contrast borders on all four sides for display clarity and maximum contrast ratio. Modification to the contrast border shall require Caltrans engineering approval.
5. Door release mechanism with nearby high endurance label or silkscreen
6. Hole on each side - 16¼” x 12¼” for fan box installation.
7. Ventilation louvers on top of both sides of sign
8. Door locking plate

TITLE: CMS MODELS 710/710C FRONT AND SIDE VIEWS

NO SCALE
REVI 11/01/2018

CMS 700 SERIES

A1-10
NOTES:

1. Bolt supports to CMS 700 Series housing, minimum 5 bolts per Z-Bar.
2. 3/8" Diameter holes for mounting bolts to CMS 700 Series Test Stand.
3. 1 1/2" Diameter holes for Power and Communication shall be plugged for shipping.
4. 3/8" Diameter drain holes to prevent accumulation of water and moisture.
CRADLE/ SIGN, TOP VIEW

PALLET/ SIGN, FRONT VIEW

Notes: Apply 1/8" thick white micro foam gasket to each surface that is in contact with the sign panel.

PALLET, SIDE VIEW

TITLE: CMS MODEL 710/710C
SHIPPING PALLET DIMENSIONS

NO. SCALE REV: 11/01/2018 A1-12
CMS 700 SERIES
DETAIL B

This bracket is used by the Caltrans warehouse for loading and unloading of CMS model 710 using a forklift. Variations may be used depending on requirements or constraints.

DETAIL A

For 3/4" bolts to hold chain to lift sign. Pair of holes shall be centered on panel.

Title: CMS Models 710/710C Lifting Bracket

No. Scale Rev. 11/01/2018

CMS 700 Series A1-13
NOTES:

1. PMM Type 2; 11 PMM across x 3 PMM down (33 PMM total)
2. Front door hinge open for electrical equipment access.
3. The lifting bracket must be used to prevent injury and damage to the sign.
4. The sign shall have 5-inch contrast borders on all four sides for display clarity and maximum contrast ratio. Modification to the contrast border shall require Caltrans engineering approval.
5. Door release mechanism with nearby high endurance label or silkscreen
6. Hole on each side - 16/4” x 12/4” for fan box installation.
7. Door locking plate

TITLE: CMS MODELS 720/720C
FRONT AND SIDE VIEWS

NO. SCALE
REV: 11/01/2018

CMS 700 SERIES
A1-14
NOTES:

1. 1 1/2" Diameter holes for Power and Communication shall be plugged for shipping.

2. 3/8" Diameter drain holes to prevent accumulation of water and moisture.

TITLE: CMS MODELS 720/720C
SIGN HOUSING DETAIL

REV.: 11/01/2019
A1-15
Pallet/Sign, Front and Rear View

Pallet, Side View

NOTE: Apply 1/8" thick white micro foam gasket to each surface that is in contact with the sign panel.

Pallet, Top View

Cradle/Sign, Top View

Title: CMS Models 720/720C
Shipping Pallet Dimensions

No. Scale
Rev: 11/01/2018

CMS 700 Series

A1-16
SIDEx View

NOTES:

1. All pixels shall be mounted to the same PC board.
2. Captive thumbscrews (type M6)
3. 8 Bit DIP switch for address.
4. RJ45 10Base -T/100Base -TX Ethernet port.
5. Alignment pin
NOTE:
Device shall be mountable in a Standard 19" EIA Rack.
NOTE:

1. 1" Flange around box so that it can be bolted to sign.
NOTES:
1. The Ethernet switches and Remote I/O box can be powered by either 24V DC or 120V AC.
2. When Sub Panel #1 is powered on Sub Panel #2 is powered off.
3. Solid state relays are controlled by the remote I/O box beacon 3 and 4 output.
NOTES:

1. 9” Max for depth.
2. Rack shall be no closer than 8” from the edge of sign.
NOTES:

1. Bulb shall be located at center of sign and visible through the polycarbonate lens from street level when lit.

2. Bulb must be GREEN LED in standard E26 socket. Bulb's brightness must be a minimum of 250 lumens. Bulb's lifetime must be a minimum of 25,000 hours.
NOTES:

1. Ethernet drops (3 minimum) for CMS-to-Cabinet network communication. CAT-6A cable has a length limit of 100 meters. If longer cable is required, use proper equipment to maintain communication signal integrity.

2. Incoming power to Service Cabinet, 120/240 Single Phase.

3. Sign Controller rated at 24VDC or 120VAC.

4. If sign controller is rated at 24VDC, an industrially-rated 120V AC adapter is required. The sign controller is to be powered from the Remote Power Switch.

5. Connect the 3 Ethernet Switches as shown. Sw*1 to Sw*2 and Sw*2 to Sw*3.
NOTES:

1. Pixel array shall be symmetrical within the panel.
2. Captive thumbscrews (type M6)
3. 8-Bit DIP switch for address
4. RJ45 10Base-T / 100Base-TX Ethernet port