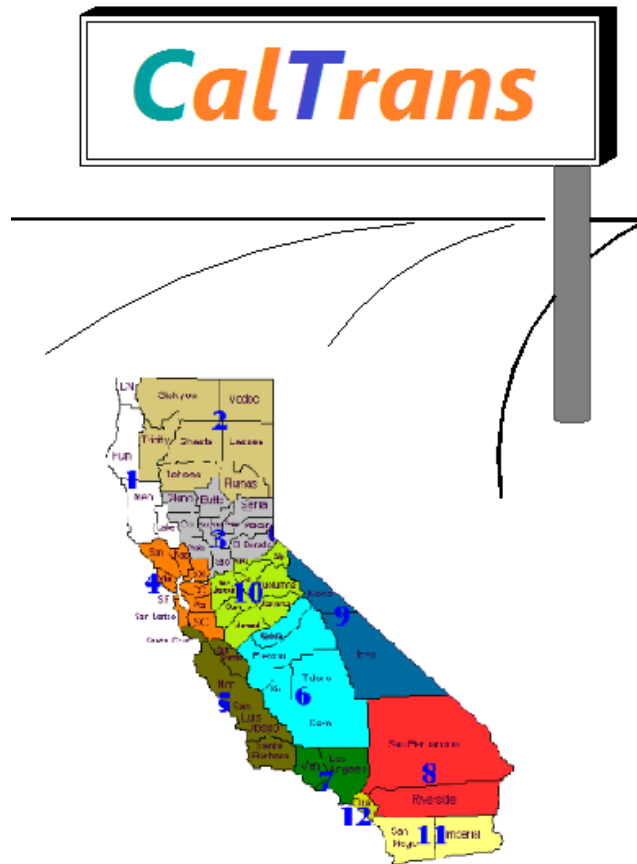




**SPECIFICATIONS FOR
CHANGEABLE MESSAGE SIGN SYSTEM
CMS MODEL 700 SERIES
TEES
CHAPTER 13**



January 10, 2019

**STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION**



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CHAPTER 13-SECTION A: ACRONYMS AND GLOSSARY

Acronyms and Abbreviations

The following acronyms shall govern this specification:

A	Ampere
AASHTO	American Association of State Highway and Transportation Officials
AC	Alternating Current
AC+	120 Volts AC, 60 Hz ungrounded power source
AC-	120 Volts AC, 60 Hz grounded return to the power source
AlInGaP	Aluminum Indium Gallium Phosphide
ANSI	American National Standards Institute
API	Application Program Interface
ASCII	American Standard Code for Information Interchange
ASTM	American Society for Testing and Materials
AWS	American Welding Society
b	Bit
B	Byte
C	Celsius
CMS	Changeable Message Sign
CMS MODEL 700 SERIES	Changeable Message Sign Model 700 Series
DC	Direct Current
EG	Equipment Ground
f	Foot
F	Fahrenheit
FSORS	Full, Standardized Object Range Support
GUI	Graphical user interface
Hz	Hertz
IP	Internet Protocol
IEC	International Electrotechnical Commission
in	Inch
ITE	Institute of Transportation Engineers
ITS	Intelligent Transportation System
LAN	Local Area Network
LED	Light-Emitting Diode
MIB	Management Information Base
NCHRP	National Cooperative Highway Research Program
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
NPT	National Pipe Taper
NTCIP	National Transportation Communications for ITS Protocol
PMM	Pixel Matrix Module
PMPP	Point-to-multi-point protocol
PPP	Point-to-point protocol
PQWP	Painting Quality Work Plan

PWM	Pulse-width modulation
TCP	Transmission Control Protocol
TMC	Transportation Management Center
UL	Underwriters Laboratory
UDP	User Datagram Protocol
V	Volt
VAC	Voltage Alternating Current
VDC	Voltage Direct Current
W	Watt
WYSIWYG	WYSIWYG – What You See Is What You Get

Glossary

The following definitions shall govern this specification:

activate	The action of placing a message in the current buffer and performing the logic of running the message. Contrast with "Display" which manipulates the sign display to make the current message visible to the driving public.
active message	The command to direct the Sign Controller to display the message on the sign face.
alternate message	A message that contains more than one page of information/text.
ambient light level	The amount of light surrounding the sign location.
axial intensity	The brightness of light on the axis horizontally and vertically perpendicular to the sign face.
AGENCY	Purchasing Government Agency
AllnGaP	Aluminum Indium Gallium Phosphide
Assembly	A complete machine, structure or unit of a machine that was manufactured by fitting together parts and/or modules
Beacon	A device that directs light on one direction and flashes.
bit map	A digital representation of an image having bit reference pixels.
BITMAP	A subset of the SYNTAX type OCTET STRING where every bit is a representation of a part or function.
BITMAP X	BITMAP with X number of bits
blank message	A message that is devoid of information content (blank) and the sign face is clear (all pixels off).
Border	The blank area (no pixels) between the outer most pixels and the outermost edge of the sign housing.
brightness	See luminance.
brightness control	A term that defines how the light intensity if a sing is determined/set.
brightness level	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.
bulb matrix	A matrix of light bulbs, lamps, or LEDs on the face of the message sign
Cabinet	An enclosure that protects the device's controller and other sign equipment from the elements.
candela	An SI unit of measure for luminance.

C Language	The ANSI C Programming Language
Cabinet	An outdoor enclosure generally housing the controller unit and associated equipment
Certificate of Compliance	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
character height	The vertical pitch times the number of pixels in the column of pixels.
character spacing	The spacing in pixels between two characters in full matrix signs.
character width	The horizontal pitch times the number of pixels in the row of pixels.
checksum	A data error-detection scheme.
character per line	The number of characters than can be displayed on one line.
Climate control	The ability to control the temperature and other factors affecting the environment in which the sign electronics operates.
Font	The style and shape of alphanumeric characters that are displayed on the CMS matrix to create messages viewed by motorists and travelers
Full Matrix Sign	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.
Industrially-rated	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.
Luminance	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/m ²). A non-SI term for the same unit is the "nit". The CGS unit of luminance is the stilb, which is equal to one candela per square centimeter or 10 kcd/m ² .
Message	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
Module	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
Object	An NTCIP term referring to an element of data in an NTCIP-compatible device that can be manipulated to control or monitor the device
Page	(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.
Pixel	Picture element. (NTCIP 1203 v2.35) The smallest independently controllable visual element of a VMS.
Rated life	Number of years of operation after which 90 % of the devices are still working.
Schedule	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.

Sign Controller	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.
Stroke	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.
Touch Safe	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.
TSD No.1	8-32 SOUTHCO #47-62-301-20 or equal.
TSD No.2	8-32 SOUTHCO #47-62-301-60 or equal
TSD No.3	M3 SOUTHCO #47-82-101-10 or equal

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

Existing CMS Model	Upgraded CMS Model
CMS Model 500, Amber Standard-Resolution	CMS Model 700 Amber Standard-Resolution CMS Model 700C Color High-Resolution
CMS Model 510, Amber Standard-Resolution	CMS Model 710 Amber Standard-Resolution CMS Model 710C Color High-Resolution
CMS Model 520, Amber Standard-Resolution	CMS Model 720 Amber Standard-Resolution CMS Model 720C Color High-Resolution

B. CMS Model Specifications

CMS Models →	500	700 (Std. Res)	700C (Hi. Res)	510	710 (Std. Res)	710C (Hi. Res)	520	720 (Std. Res)	720C (Hi. Res)
CMS PMM Layout (type W x H)	T1 12 x 5	T1 21 x 3	T3 21 x 3	T2 12 x 5	T2 19 x 3	T4 19 x 3	T2 6 x 5	T2 11 x 3	T4 11 x 3
PMM Face Size (W x H inch)	21.968 x 13.178	13.62 x 24.65	13.62 x 24.65	14.00 x 8.75	8.62 x 15.65	8.62 x 15.65	14.00 x 8.75	8.62 x 15.65	8.62 x 15.65
PMM Pixel Layout (W x H)	8 x 5	5 x 9	15 x 27	8 x 5	5 x 9	15 x 27	8 x 5	5 x 9	15 x 27
Pixel Pitch (inch)	2.75	2.75	0.917	1.75	1.75	0.583	1.75	1.75	0.583
CMS Pixels (W x H)	96 x 25	105 x 27	315 x 81	96 x 25	95 x 27	285 x 81	48 x 25	55 x 27	165 x 81
CMS Max Weight (lbs)	2400	2400	2400	2000	2000	2000	1000	1000	1000
CMS Width (inch)	306	300	300	230	175	175	94	105 ½	105 ½
CMS Height (inch)	81	86	86	53 ¾	57	57	53 ¾	57	57
CMS Depth (inch)	16	16	16	16	16	16	24	16	16

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:
- i.** Table of Contents
 - ii.** Glossary
 - iii.** General Description
 - iv.** General Characteristics
 - v.** Installation
 - vi.** Adjustments
 - vii.** Theory of Operation
 - a.** Systems Description (include block diagram)
 - b.** Detailed Description of Circuit Operation
 - viii.** Maintenance
 - a.** Preventive Maintenance
 - b.** Trouble Analysis
 - c.** Trouble Shooting Sequence Chart
 - d.** Wave Forms
 - e.** Voltage Measurements
 - f.** Alignment Procedures.
 - ix.** 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)
 - x.** Electrical Interconnection Details & Drawings
 - xi.** Schematic and Logic Diagram
 - xii.** 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:

- A.** AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaries and Traffic Signals, Fourth Edition.
- 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 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 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:

Bit 1	0 = Pixel Exists	1 = Pixel does not exist (LSB)
Bit 2	0 = OK	1 = Pixel LED String #1 has failed
Bit 3	0 = OK	1 = Pixel LED String #2 has failed
Bit 4	0 = OK	1 = Pixel LED String #3 has failed
Bit 5	0 = OK	1 = Any pixel driver reports a thermal alert
Bit 6	0 = OK	1 = Any pixel driver reports a thermal shutdown
Bit 7	0 = OK	1 = Any pixel driver fails or no response to a driver status Request

Bit 8 Always 0 = For future use (**MSB**)

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 millicandelas minimum
- Green at 2400 millicandelas minimum
- Blue at 500 millicandelas 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 35Watts.
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 13.12.2.2D**.

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

- C. PMM (Row 3) 192.168.110.61 through 192.168.110.81
- D. Sign Controller (Ethernet Port #1) 192.168.110.200
- E. Sign Controller (Ethernet Port #2) 192.168.1.100
- F. Remote I/O Box 192.168.110.204
- G. Test Box 192.168.110.205
- H. Ethernet switch 10/100baseTX (Quantity 3)
 - Network Mask: 255.255.255.0
 - Default Gateway: Leave blank
 - Address: Switch #1 (top row) 192.168.110.101
 - Switch #2 (middle row) 192.168.110.102
 - Switch #3 (bottom row) 192.168.110.103

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 to the 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:

A. Photo Sensor #1	0 to 5 VDC	Terminal #1
B. Photo Sensor #2	0 to 5 VDC	Terminal #2
C. Photo Sensor #3	0 to 5 VDC	Terminal #3
D. Temperature Sensor #1	0 to 5 VDC	Terminal #4
E. Temperature Sensor #2	0 to 5 VDC	Terminal #5
F. Future Use	0 to 5 VDC	Terminal #6

2. Digital Contact Sensor connections

The Remote I/O Box's digital contact-closure sensors shall be connected as follows:

- A. Contact #1 shall measure left door 1 open switch.
Closed = door closed, Open = door open.
- B. Contact #2 shall measure right door 1 open switch.
Closed = door closed, Open = door open.
- C. Contact #3 shall measure the #1 cooling fan status.
Closed = fan working normally, Open = fan failure.
- D. Contact #4 shall measure the #2 cooling fan status.
Closed = fan working normally, Open = fan failure.
- E. Contact #5 shall measure the air filter status.
Closed = filter is unclogged, Open = filter clogged.
- F. Contact #6 shall measure the AC power status.
Closed = normal power, Open = alternate power.
- G. Contact #7 shall measure the sign humidity.
Close = humidity within limits, Open = humidity exceeds limits.
- H. Contact #8 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**).
- I. Contact #9 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**).
- J. Contact #10 shall measure the status of 24-Volt Power Supply #1.
(0 = Off, 1 = On).
- K. Contact #11 shall measure the status of 24-Volt Power Supply #2.
(0 = Off, 1 = On).
- L. Contact #12 shall measure the status of 24-Volt Power Supply #3.
(0 = Off, 1 = On).
- M. Contact #13 shall measure the status of 24-Volt Power Supply #4.
(0 = Off, 1 = On).
- N. Contact #14 shall measure the status of 24-Volt Power Supply #5.
(0 = Off, 1 = On).
- O. Contact #15 shall measure the status of 24-Volt Power Supply #6.
(0 = Off, 1 = On).
- P. Contact #16 shall measure the status of 24-Volt Power Supply #7.
(0 = Off, 1 = On).

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 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 contract 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 (Isocet 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 $\frac{3}{4}$ " 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.

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

Table 1. Exterior Grade Latex Paint

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.

Property	Test	Value
Adhesion	ASTM D 3359, Test Method B	5B
Dry film hardness, min	ASTM D 3363	HB
Impact resistance, 50 lbf-in	ASTM D 2794	No delamination

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-foot 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

1. California Department of Transportation, Maintenance Manual, July 2006.
<http://www.dot.ca.gov/hq/maint/manual/maintman.htm> on February 1, 2007.
2. NEMA Standards Publication TS 4-2005: Hardware Standards for Variable Message Signs (DMS) with TCIP Requirements, National Electrical Manufacturers Association, Rosslyn [VA]: 2005.
3. NTCIP 1201:2005: National Transportation Communications for ITS Protocol (NTCIP) Global Object (GO) Definitions, V. 02, American Association of State Highway and Transportation Officials, Institute of Transportation Engineers and National Electrical Manufacturers Association, October 2005.
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

Excerpt from NEMA TS 4-2005 v01.33, March 2005 edition.

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

ENVIRONMENTAL

Item	Type (Test, certificate, evaluation, inspection)	Requirement	NEMA TS 4 Criteria	Procedure
Electrical	3rd Party Conformance Test	Mandatory	2.1.3	2.2.4
Transients	3rd Party Conformance Test	Mandatory	2.1.4	2.2.4
Temperature & Humidity	3rd Party Conformance Test	Mandatory	2.1.5	2.2.4
Vibration	3rd Party Conformance Test	Mandatory	2.1.6	2.2.5
Shock	3rd Party Conformance Test	Mandatory	2.1.7	2.2.6
Time & Timing	3rd Party Conformance Test	Mandatory	2.1.8	2.2.8
Power Interrupt	3rd Party Conformance Test	Mandatory	2.1.3	2.2.7

SIGN MECHANICAL CONSTRUCTION

Item	Type (Test, certificate, evaluation, inspection)	Requirement	NEMA TS 4 Criteria	Procedure
Weather-Tight Enclosure	1st or 2nd Party Conformance Test	Mandatory	3.1.1	NEMA 250
Water and Dust Resistance	1st or 2nd Party Conformance Test	Mandatory	3.1.1.1	
Access Panel And Doorway Gaskets	Conformance Statement	Optional	3.1.1.2	
Vents	Conformance Statement	Optional	3.1.1.3	
Ventilation Considerations for Housings that may be Entered	Conformance Statement	Optional	3.1.2.1	
Temperature Considerations for Continued Sign Operation	Conformance Statement	Optional	3.1.2.2	
Sign Face Material	Conformance Statement	Optional	3.1.3.1	
Sign Face Condensation	Statement with explanation of conformance.	Optional	3.1.3	
Galvanic Protection	Statement	Optional	3.1.4	
Light Leaks	Evaluation	Mandatory	3.1.5	Not applicable

FIXED-LOCATION DMS

Item	Type (Test, certificate, evaluation, inspection)	Requirement	NEMA TS 4 Criteria	Procedure
Structural Integrity	Certificate	Mandatory	3.2.1	
Alloys and Structural Members	Certificate	Mandatory	3.2.2.1	
Exterior Housing Finish	Evaluation	Optional	3.2.2.2	
Front and Rear Access DMS	Evaluation	Optional	3.2.4	
Front Access DMS	Evaluation	Optional	3.2.5	
Rear Access DMS	Evaluation	Optional	3.2.6	
Walk-in Access DMS	Evaluation	Optional	3.2.7	
Access Doors	Evaluation	Optional	3.2.7.1	
Work Area	Conformance Statement	Optional	3.2.7.2	
Nighttime Service Lighting	Conformance Statement	Optional	3.2.7.3	
Electrical Service Outlets	Inspection	Optional	3.2.8	

CONTROLLER TO SIGN INTERFACE

Item	Type (Test, certificate, evaluation, inspection)	Requirement	NEMA TS 4 Criteria	Procedure
Wiring	Inspection	Mandatory	4.2	
Conduit	Inspection	Mandatory	NEC	
Power Supply Locations	Evaluation	Optional	4.4.1	
Microprocessor And Driver Module Locations	Evaluation	Optional	4.4.2	

DISPLAY PROPERTIES

Item	Type (Test, certificate, evaluation, inspection)	Requirement	NEMA TS 4 Criteria	Procedure
Contrast Ratio	3rd Party Conformance Test	Mandatory	5.2	CEN prEN 12966, Draft July 17, 2001
Cone of Vision	3rd Party Conformance Test	Mandatory	5.3	CEN prEN 12966, Draft July 17, 2001
Luminance Intensity	3rd Party Conformance Test	Mandatory	5.4	CEN prEN 12966, Draft July 17, 2001
Luminous Intensity Uniformity	Evaluation	Mandatory	5.4.1	
Chromaticity Limits	3rd Party Conformance Test	Mandatory	5.5.1	
Chromaticity Uniformity	Conformance Statement	Optional	5.5.2	
Fonts	Conformance Statement with list of displayed characters	Mandatory	5.6	
Font Alphabets	Conformance Statement	Mandatory	5.6.1	
Required Fonts by Sign Type	Conformance Statement with list of displayed characters	Mandatory	5.6.2	
Display Change Time	1st Party Conformance Test	Mandatory	5.7	
Moving Arrows	Evaluation	Optional	5.8	
Coefficient of Retro reflection	1st Party Conformance Test	Mandatory	5.9.1.4	

OPTICAL COMPONENTS

Item	Type (Test, certificate, evaluation, inspection)	Requirement	NEMA TS 4 Criteria	Procedure
Pixel Spacing	Conformance Statement	Mandatory	6.1.1	
Character Module Spacing	Conformance Statement	Optional	6.1.2	
Interchangeability of Character Modules	Conformance Statement	Mandatory	6.1.3	
Character Module Replacement	Conformance Statement	Optional	6.1.4	
Shuttered Fiberoptic Light System	Conformance Statement	Mandatory	6.2	
LED Light System	Conformance Statement	Mandatory	6.3	
Fiber Optic Hybrid Light System	Conformance Statement	Mandatory	6.4	
LED Hybrid Light System	Conformance Statement	Mandatory	6.5	

CONTROL CABINET

Item	Type (Test, certificate, evaluation, inspection)	Requirement	NEMA TS 4 Criteria	Procedure
Layout	1st Party Conformance Statement	Mandatory	7.2.1	
Protection	Certification	Mandatory	7.2.2	

ELECTRONIC AND ELECTRICAL

Item	Type (Test, certificate, evaluation, inspection)	Requirement	NEMA TS 4 Criteria	Procedure
General Electronic Components	Conformance Statement	Mandatory	8.1	
Components General	Conformance Statement	Mandatory	8.2.1	
Electronic Components	Conformance Statement	Mandatory	8.2.2	
Capacitors	Conformance Statement	Mandatory	8.2.3	
Potentiometers	Conformance Statement	Mandatory	8.2.4	
Resistors	Conformance Statement	Mandatory	8.2.5	
Semiconductor Devices	Conformance Statement	Mandatory	8.2.6	
Transformers and Inductors	Conformance Statement	Mandatory	8.2.7	
Triacs	Conformance Statement	Mandatory	8.2.8	
Circuit Breakers	Conformance Statement	Mandatory	8.2.9	
Fuses	Conformance Statement	Mandatory	8.2.10	
Switches	Conformance Statement	Mandatory	8.2.11	
Wiring, Cabling Harnesses	Conformance Statement	Mandatory	8.2.12	
Controller Indicators and Character Displays	Conformance Statement	Mandatory	8.2.13	
Connectors	Conformance Statement	Mandatory	8.2.14	
Wire Terminal	Conformance Statement	Mandatory	8.2.14.2	
Flat Cable Connector	Conformance Statement	Mandatory	8.2.14.3	
Mechanical Requirements	Conformance Statement	Mandatory	8.3	
Printed Circuit Boards	Conformance Statement	Mandatory	8.4	
Location and Provisions of Driving Electronics	Conformance Statement	Mandatory	8.5	
Cabinet Wiring	Conformance Statement	Mandatory	8.6	
Communication Interfaces	Conformance Statement	Mandatory	8.7.1	
Communication	1st Party Conformance Testing or Change Statement	Mandatory	8.7.2	
Brightness Controls	2nd Party Conformance Testing or Change Statement	Mandatory	8.8	
Ambient Light Sensing	2nd Party Conformance Testing or Change Statement	Mandatory	8.8.1	
DMS Controller Electronics -	Conformance Statement	Mandatory	8.9.1	

Item	Type (Test, certificate, evaluation, inspection)	Requirement	NEMA TS 4 Criteria	Procedure
General				
Central Processor Unit	Conformance Statement	Mandatory	8.9.2	
Input/Output	Conformance Statement	Mandatory	8.9.3	
Internal Clock	Conformance Statement	Mandatory	8.9.4	
Watchdog Timer	Conformance Statement	Mandatory	8.9.5	
Loss of Power	Conformance Statement	Mandatory	8.9.6	
Communications Link Monitor	Conformance Statement	Mandatory	8.9.7	
Manual Test Interface	Conformance Statement	Mandatory	8.9.8	
Controller Reset Switch	Conformance Statement	Mandatory	8.9.9	
Controller Functions - General	Conformance Statement	Mandatory	8.10.1	
Display Modes	2nd Party Conformance Testing	Mandatory	8.10.3.1	
Changing to a New Display	2nd Party Conformance Testing	Mandatory	8.10.3.2	
Recording and Logging	Conformance Statement	Mandatory	8.10.3.3	
Stored Messages	2nd Party Conformance Testing	Mandatory	8.10.3.5	
Centralized Messaging Architecture	Conformance Statement	Mandatory	8.10.4	
Local Messaging Architecture	Conformance Statement	Mandatory	8.10.5	
Display Writing Control	Conformance Statement	Mandatory	8.10.6.1	
NTCIP Protocol and Command Sets	1st Party Conformance Testing, or Change Statement; or 2nd Party Conformance Testing	Mandatory	8.10.7	
Local Control	1st Party Conformance Testing	Mandatory	8.11	

PERFORMANCE MONITORING

Item	Type (Test, certificate, evaluation, inspection)	Requirement	NEMA TS 4 Criteria	Procedure
Incandescent Lamp Tests	2nd Party Conformance Testing	Mandatory	9.1.1	
Shutter and Disk Monitoring	Conformance Statement	Mandatory	9.1.2	8.7.6.1.2
LED Pixel Tests	2nd Party Conformance Testing	Mandatory	9.1.3	
LED Temperature Monitor	Conformance Statement	Mandatory	9.1.4	
Watchdog Timer	Conformance Statement	Mandatory	9.2.1	
Results of Controller Failures	2nd Party Conformance Testing	Mandatory	9.2.2	
Power Line Failures	2nd Party Conformance Testing	Mandatory	9.2.3	
Communications Link Failure	2nd Party Conformance Testing	Mandatory	9.2.4	
Subsystem Component Communications	2nd Party Conformance Testing	Mandatory	9.2.5	
Message Verifications	2nd Party Conformance Testing	Mandatory	9.4	

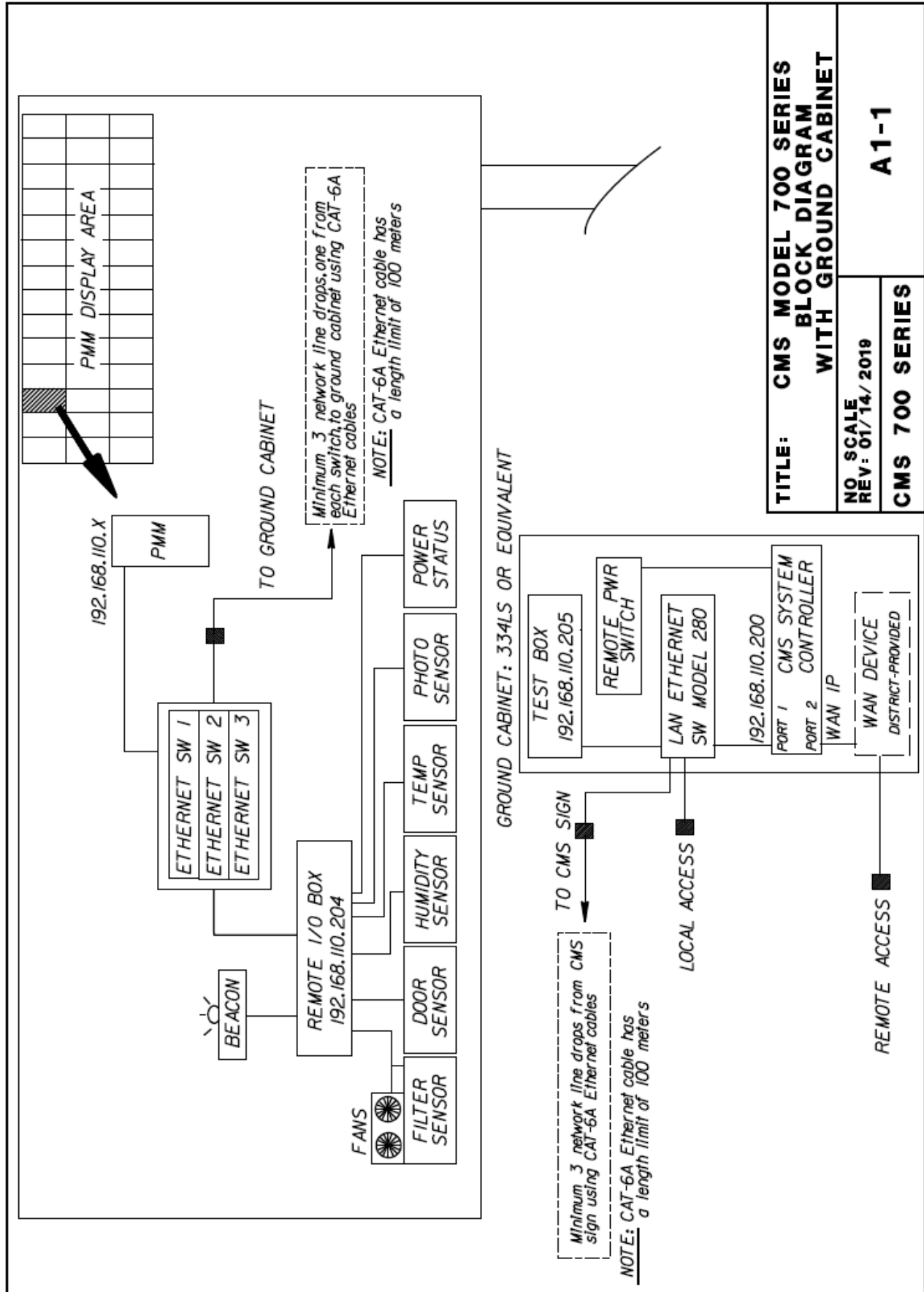
POWER REQUIREMENTS

Item	Type (Test, certificate, evaluation, inspection)	Requirement	NEMA TS 4 Criteria	Procedure
AC or DC Electrical Service	Conformance Statement	Mandatory	10.1	
Power Panels for AC Only	Conformance Statement	Mandatory	10.2.1	
Distribution Panels for DC	Conformance Statement	Mandatory	10.3	
Electrical Isolation	Conformance Statement	Mandatory	10.4	
Service Protection Device	Conformance Statement	Mandatory	10.5	
Service Outlets AC Only	Conformance Statement	Mandatory	10.6	
Calculated Electrical Load	Conformance Statement	Mandatory	10.7	

CHAPTER 13-SECTION 15: APPENDIX, CMS MODEL 700 SERIES DRAWINGS

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**TITLE: CMS MODEL 700 SERIES
BLOCK DIAGRAM
WITH GROUND CABINET**

**NO. SCALE
REV: 01/14/ 2019**

CMS 700 SERIES

A1-1

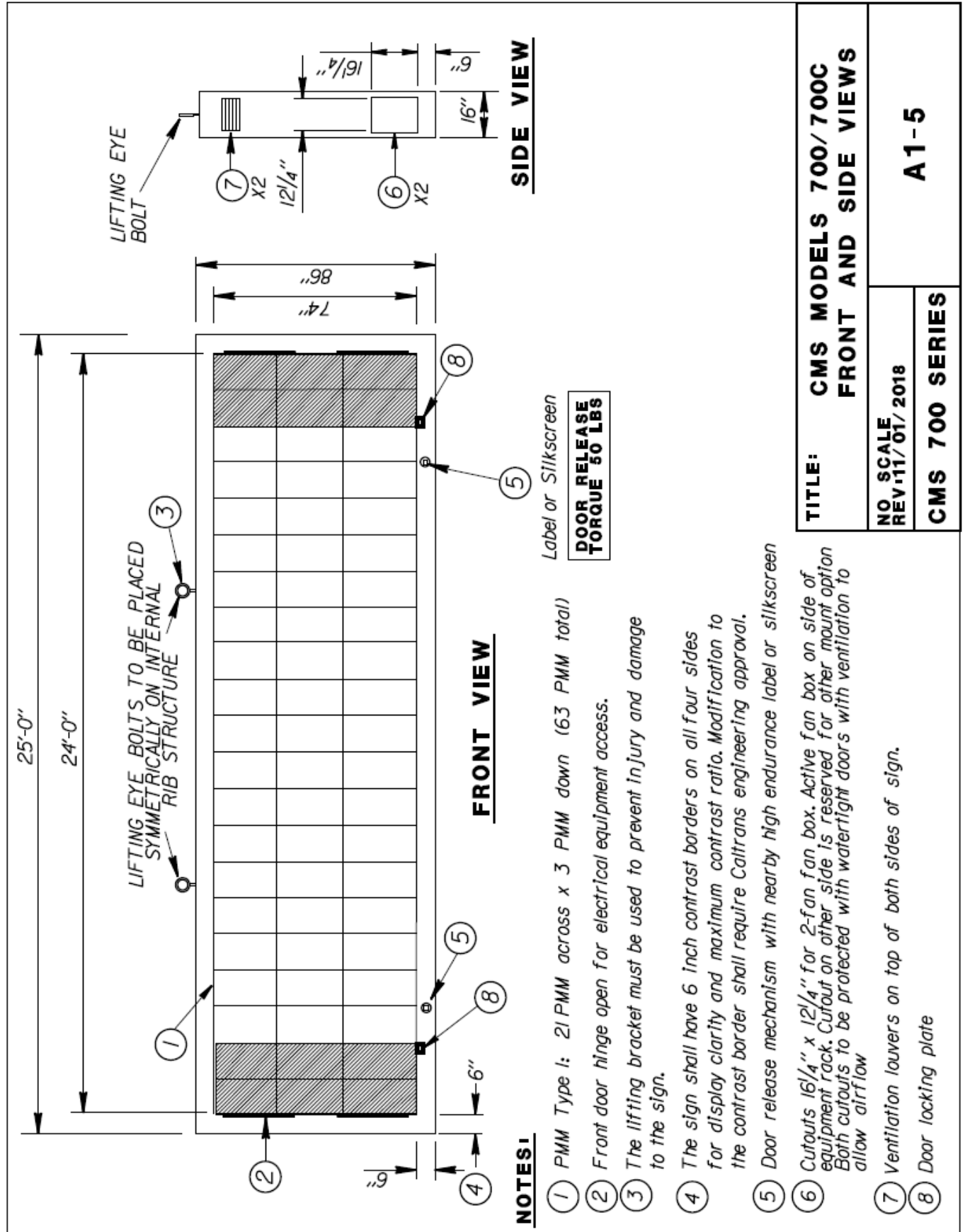
TYPICAL PMM IP ADDRESS CONFIGURATION

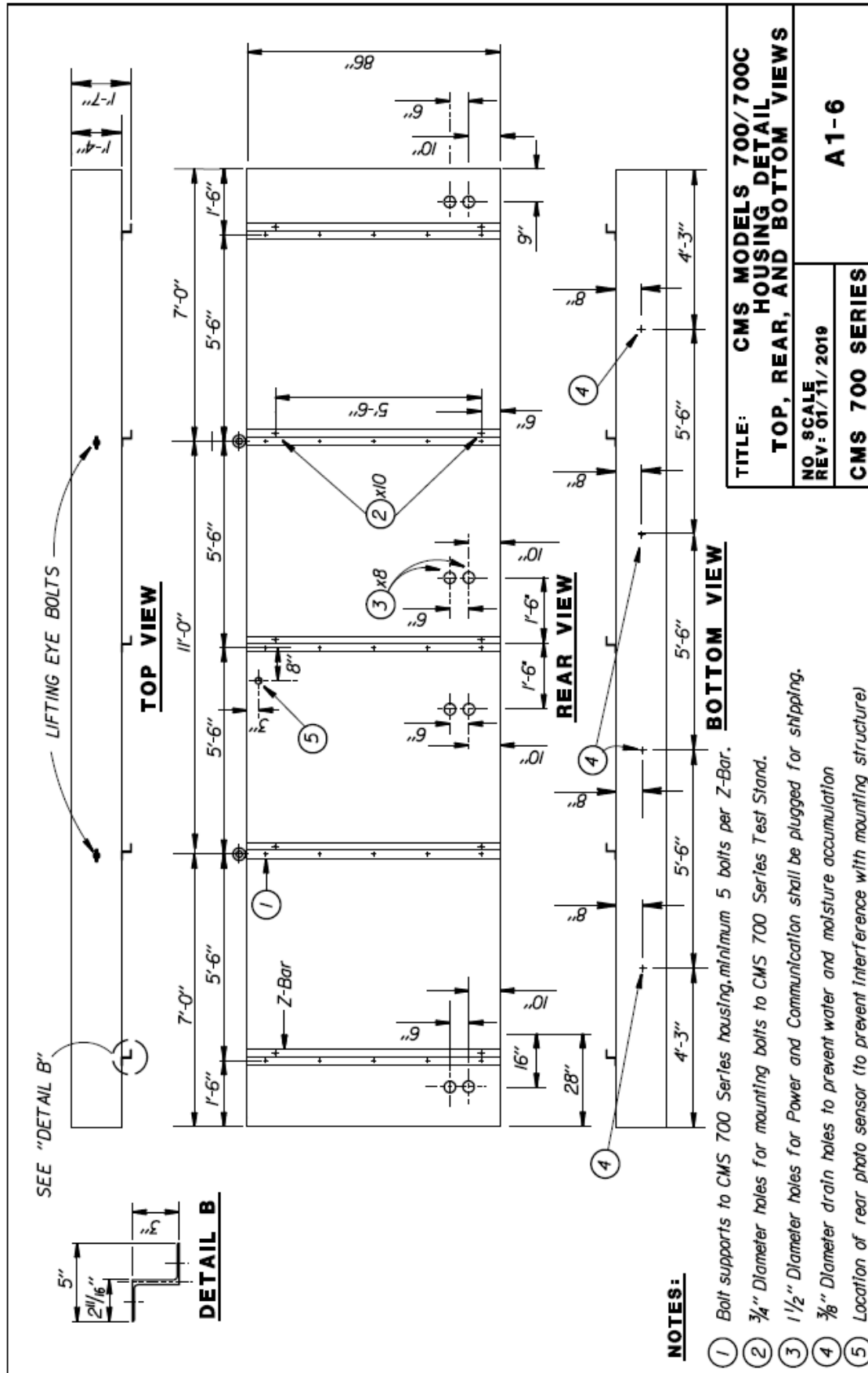
192.168.110.21	192.168.110.51	192.168.110.81
192.168.110.20	192.168.110.50	192.168.110.80
192.168.110.19	192.168.110.49	192.168.110.79
192.168.110.18	192.168.110.48	192.168.110.78
192.168.110.17	192.168.110.47	192.168.110.77
192.168.110.16	192.168.110.46	192.168.110.76
192.168.110.15	192.168.110.45	192.168.110.75
192.168.110.14	192.168.110.44	192.168.110.74
192.168.110.13	192.168.110.43	192.168.110.73
192.168.110.12	192.168.110.42	192.168.110.72
192.168.110.11	192.168.110.41	192.168.110.71
192.168.110.10	192.168.110.40	192.168.110.70
192.168.110.9	192.168.110.39	192.168.110.69
192.168.110.8	192.168.110.38	192.168.110.68
192.168.110.7	192.168.110.37	192.168.110.67
192.168.110.6	192.168.110.36	192.168.110.66
192.168.110.5	192.168.110.35	192.168.110.65
192.168.110.4	192.168.110.34	192.168.110.64
192.168.110.3	192.168.110.33	192.168.110.63
192.168.110.2	192.168.110.32	192.168.110.62
192.168.110.1	192.168.110.31	192.168.110.61

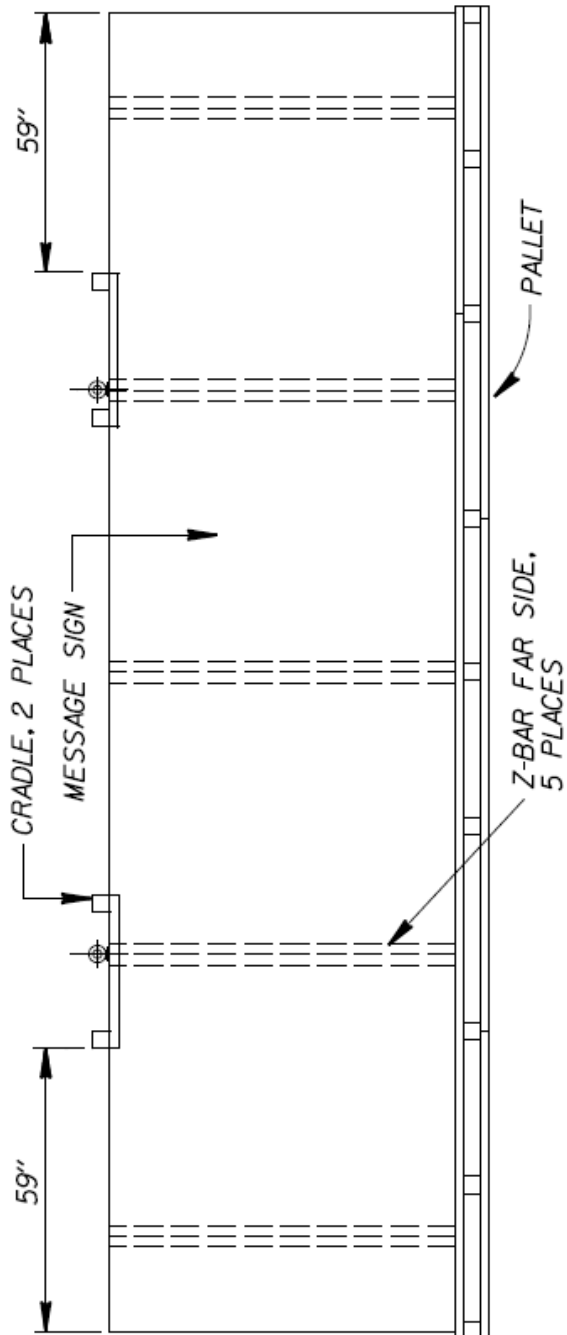
ELEVATION VIEW

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

TITLE: TYPICAL CMS 700 SERIES PMM IP ADDRESS CONFIGURATION		
NO SCALE REV: 03/20/2018	A1-4	
	CMS 700 SERIES	



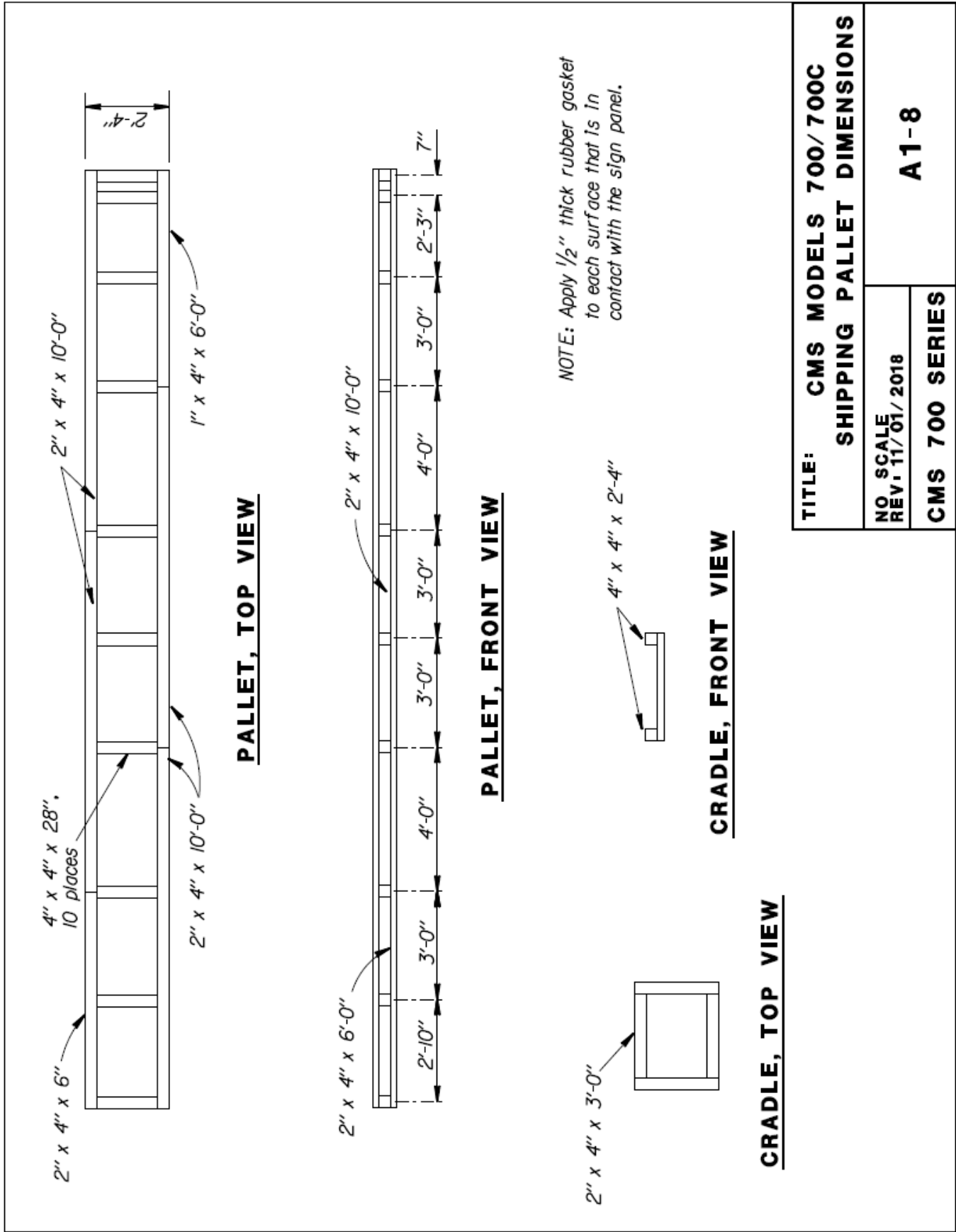


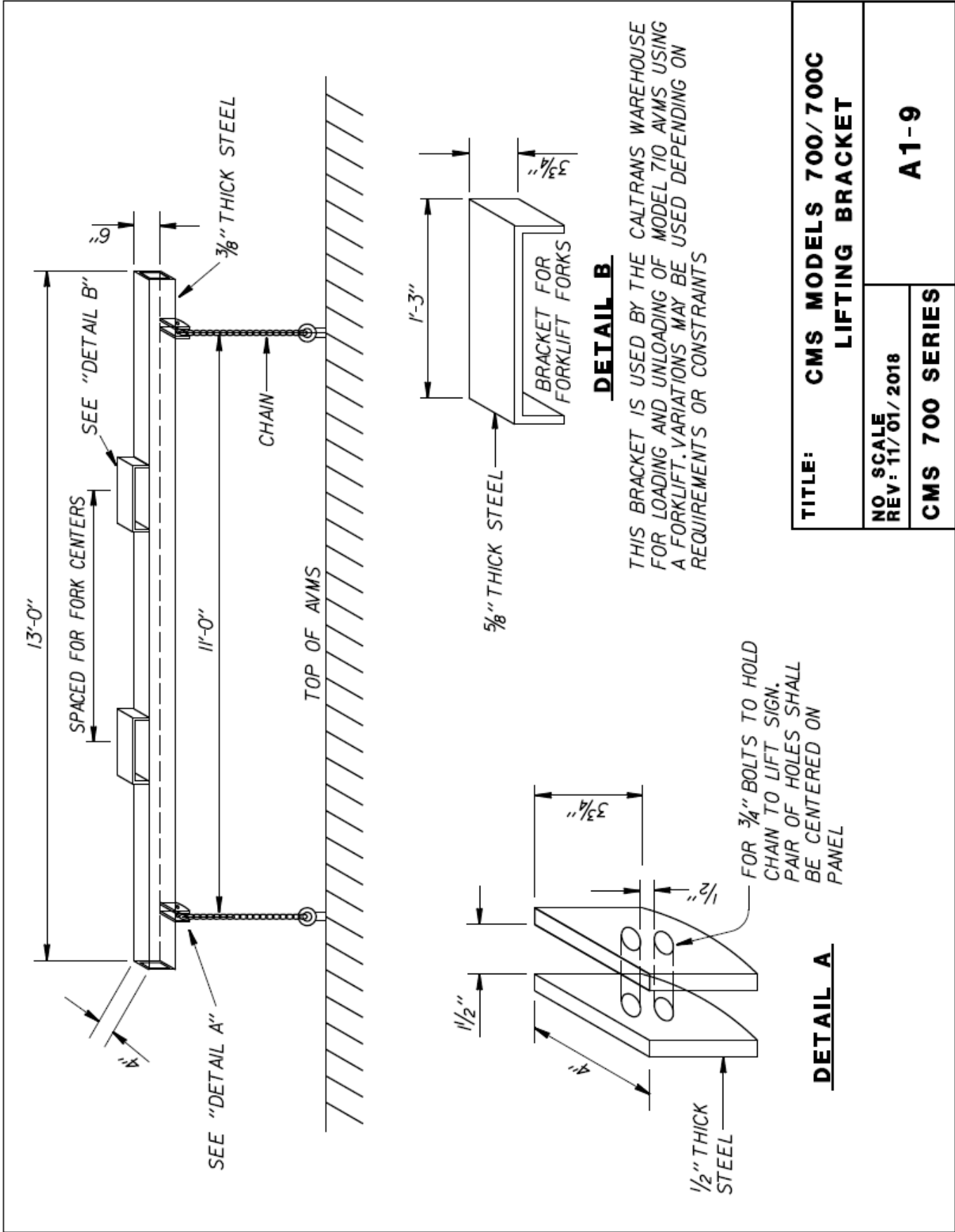


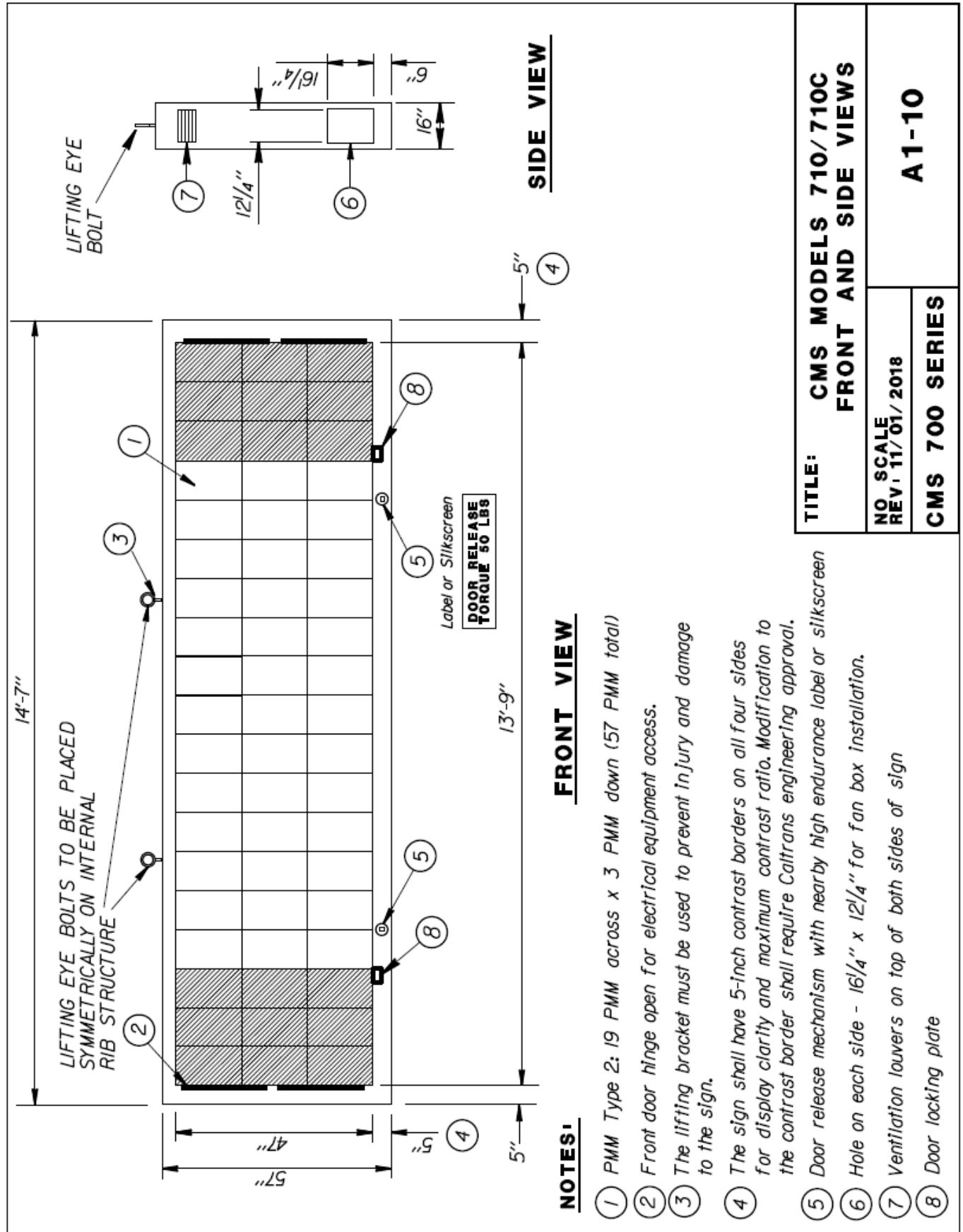
PALLETIZED CMS
FRONT VIEW

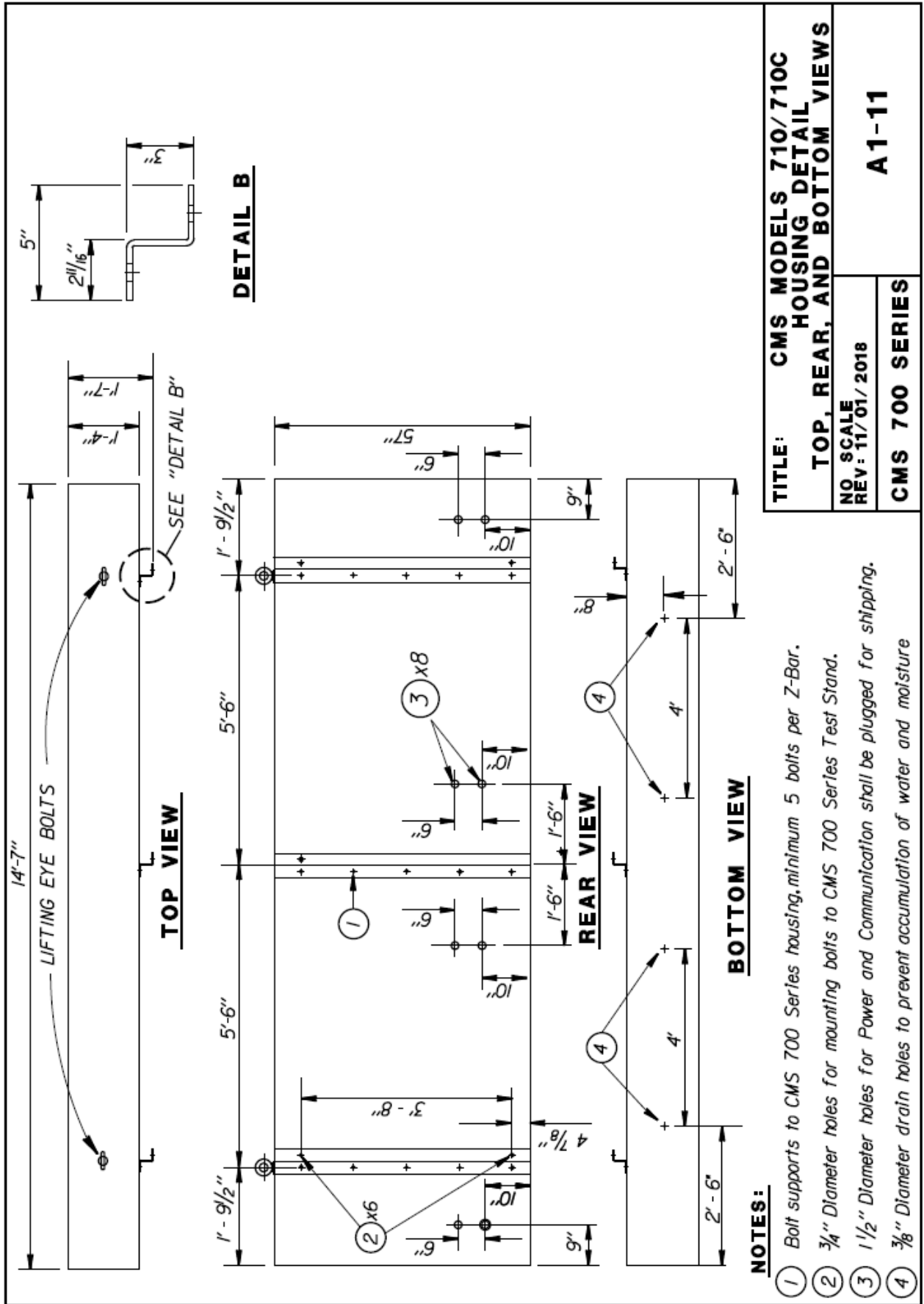
Note: See drawing A1-8 for pallet and cradle dimensions.

TITLE: CMS MODELS 700/700C PALLETIZED SHIPPING METHOD		
NO SCALE REV: 11/01/ 2018		A1-7
CMS 700 SERIES		







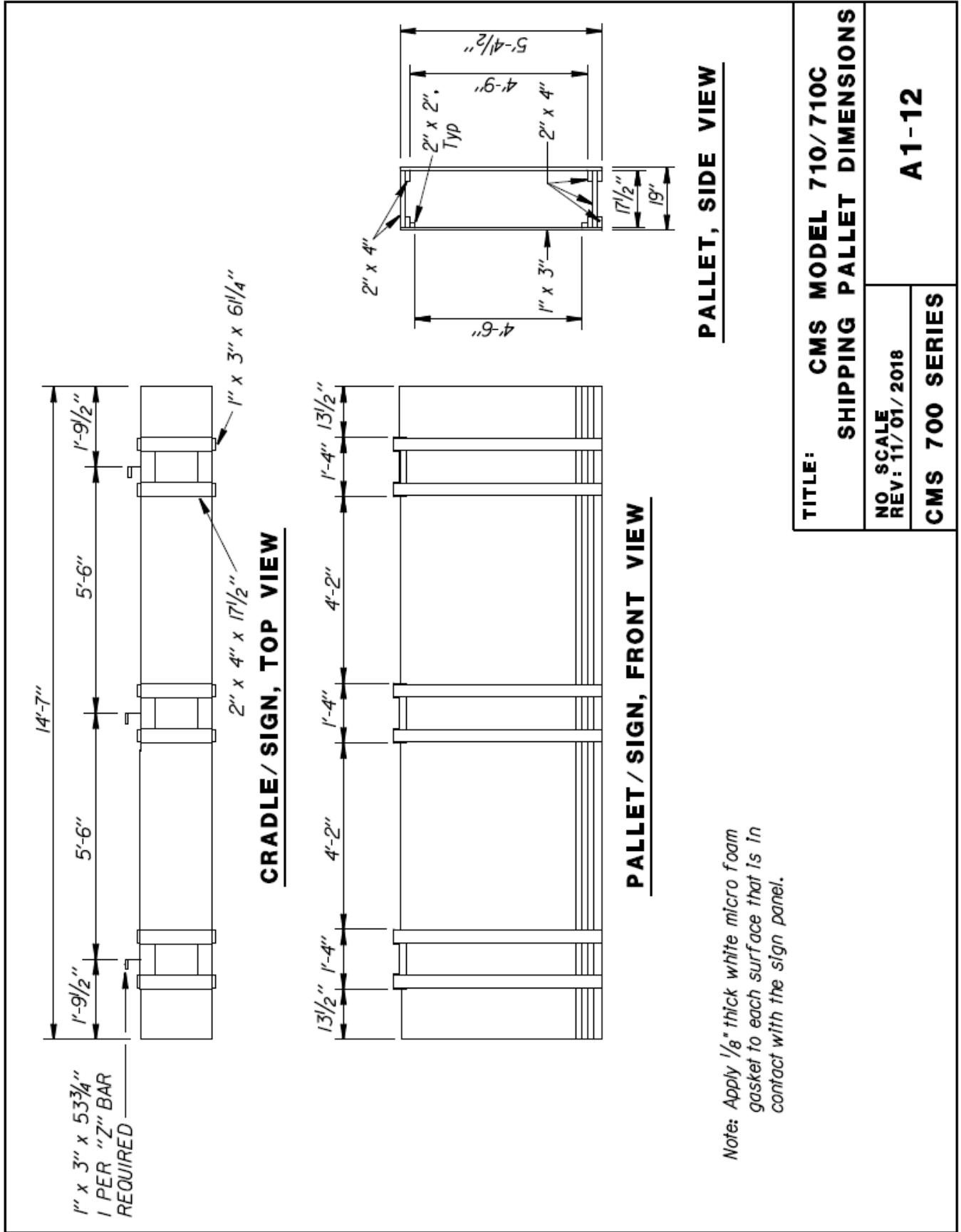


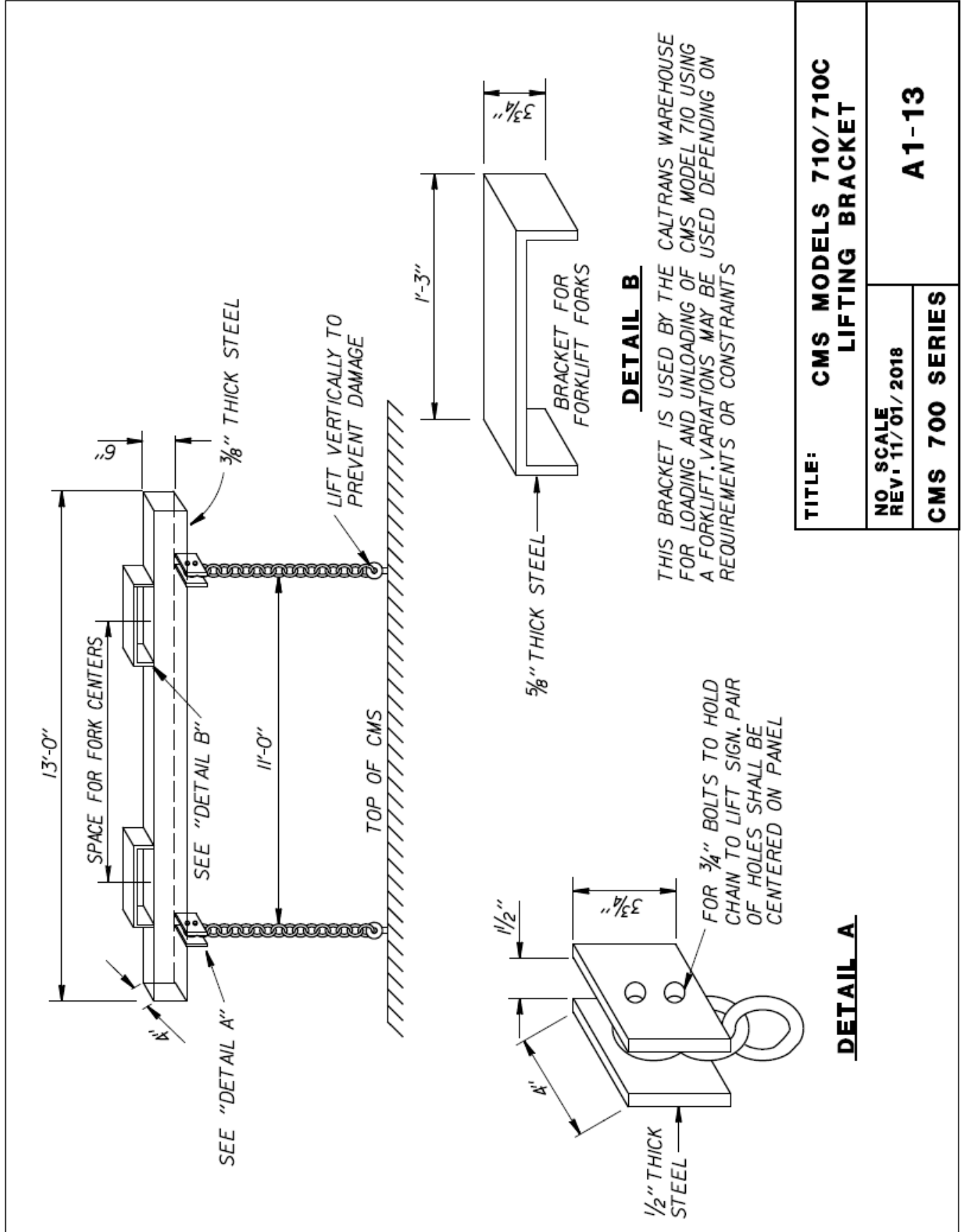
**TITLE: CMS MODELS 710/710C
HOUSING DETAIL
TOP, REAR, AND BOTTOM VIEWS**

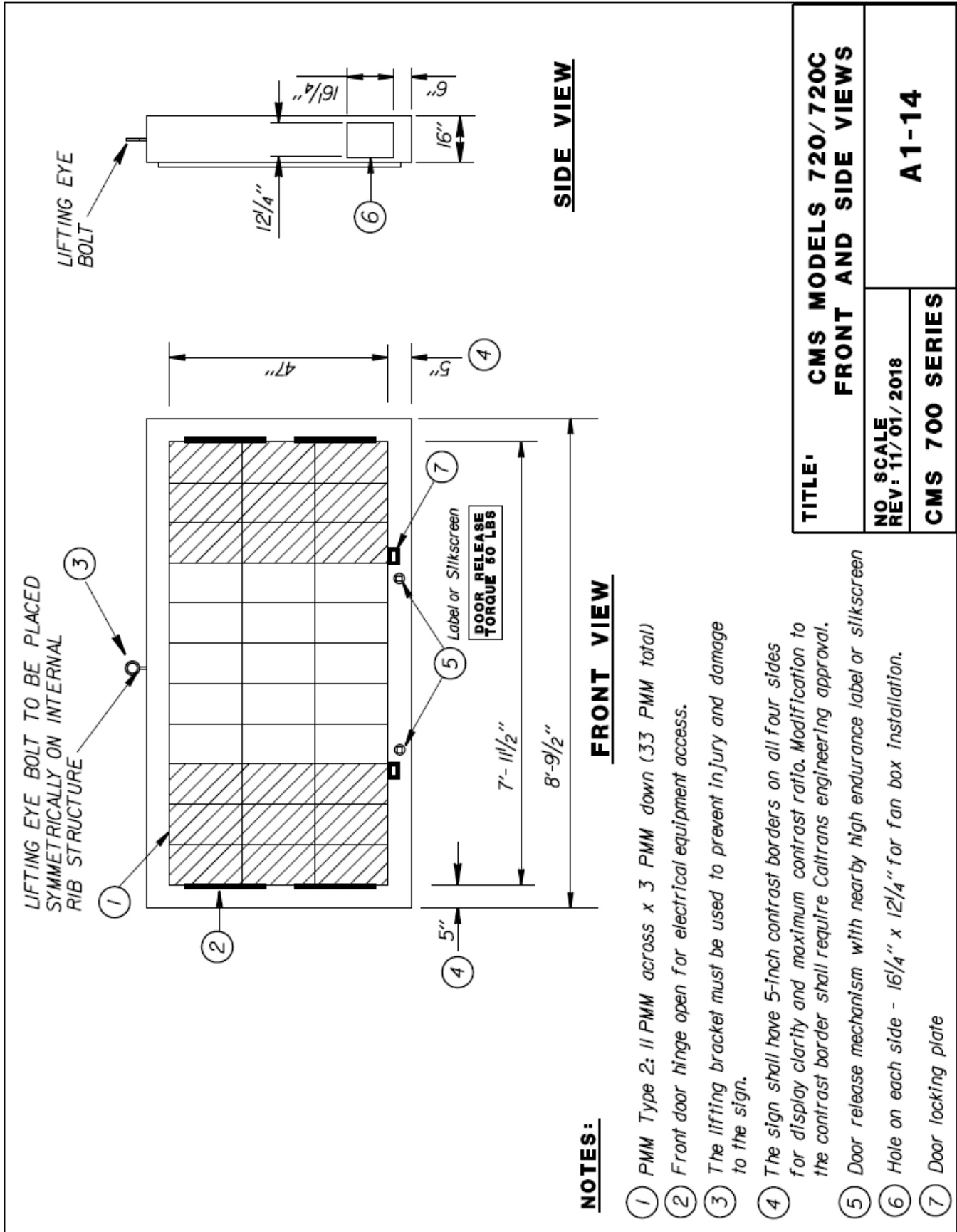
**NO. SCALE
REV: 11/01/2018**

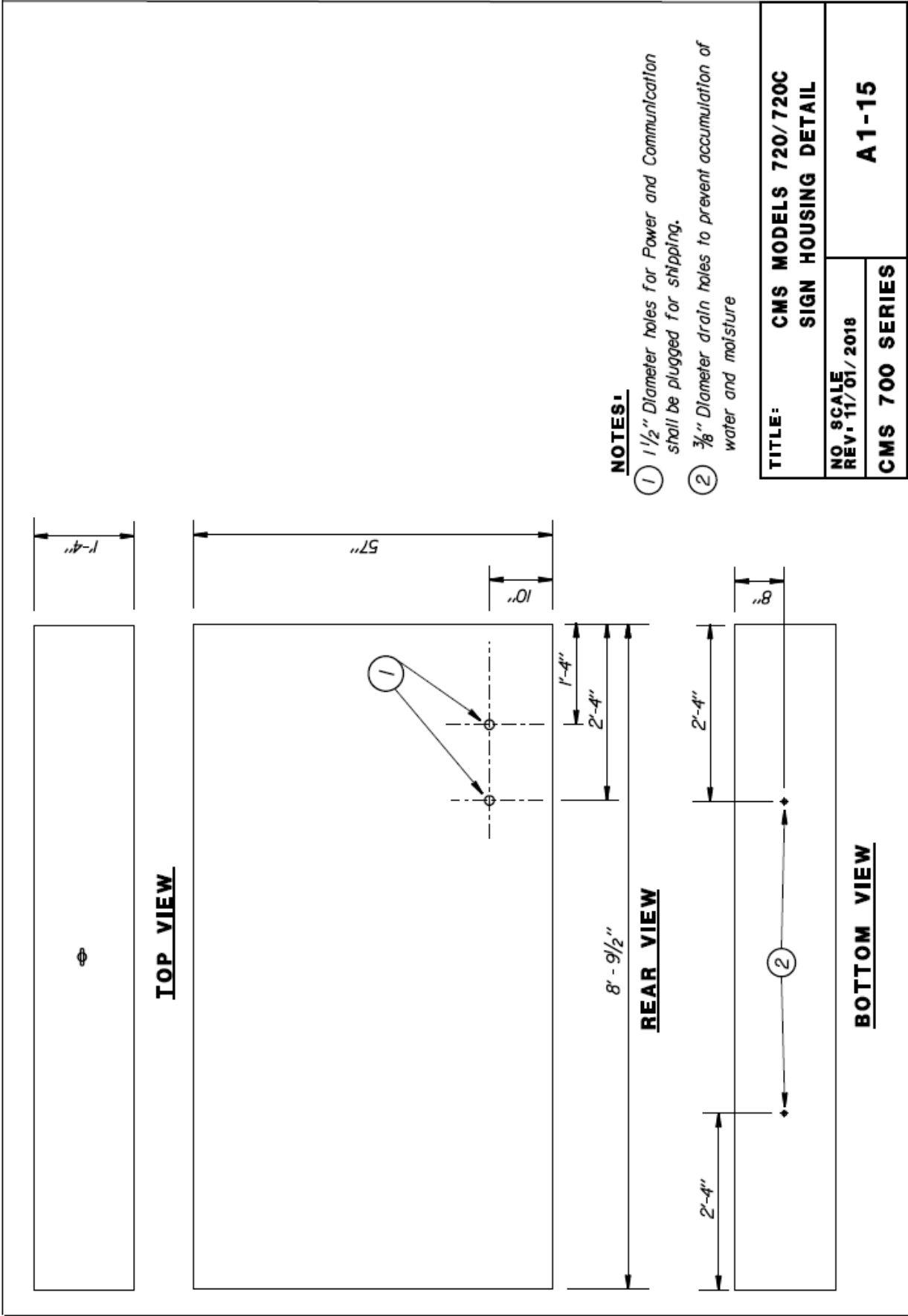
A1-11

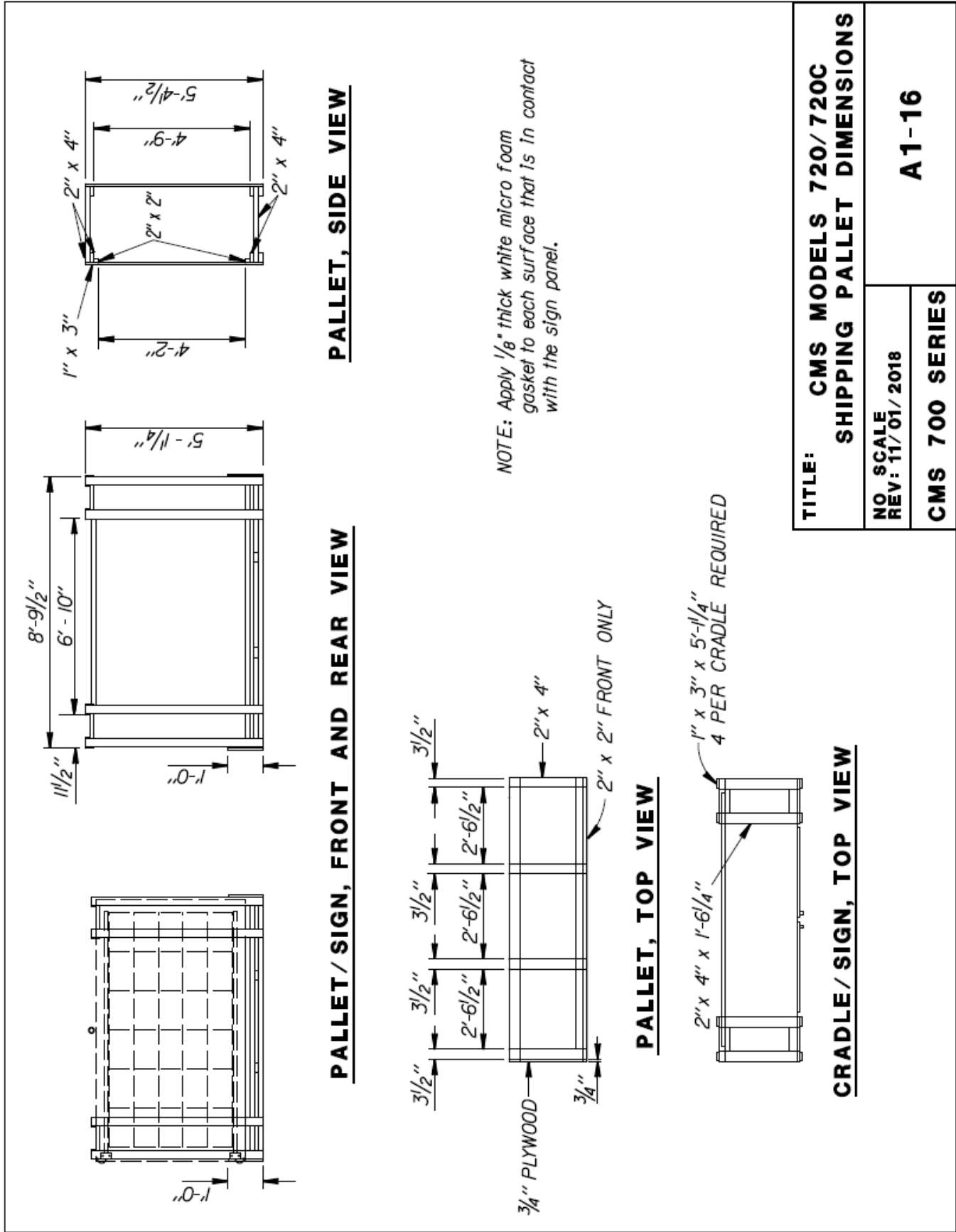
CMS 700 SERIES

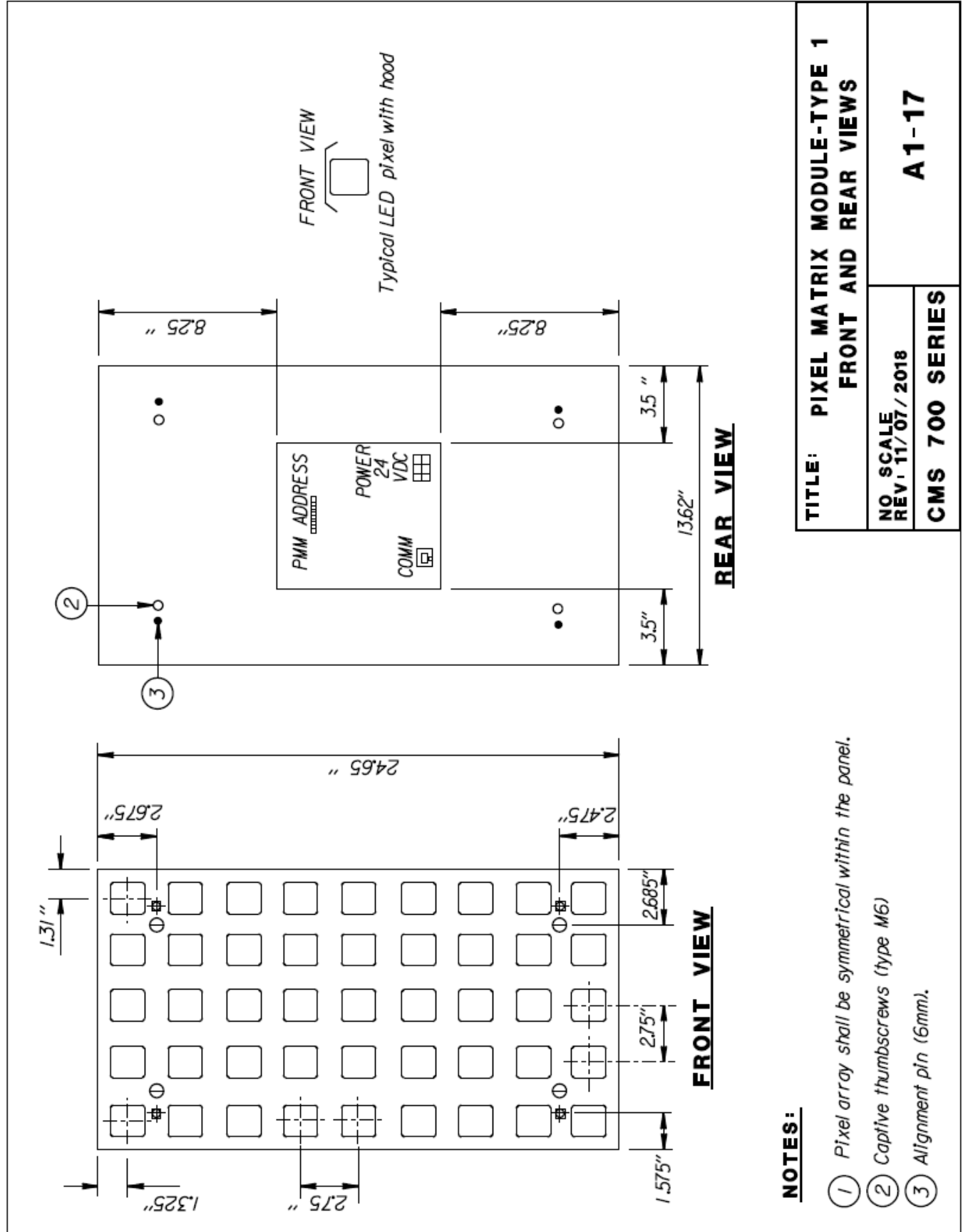


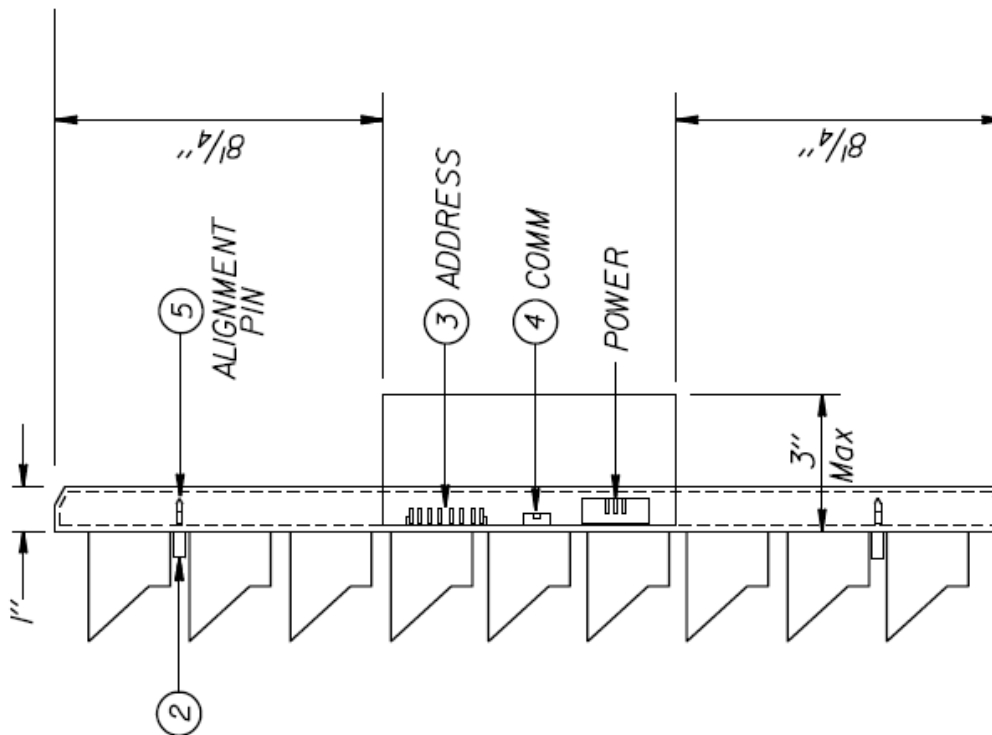










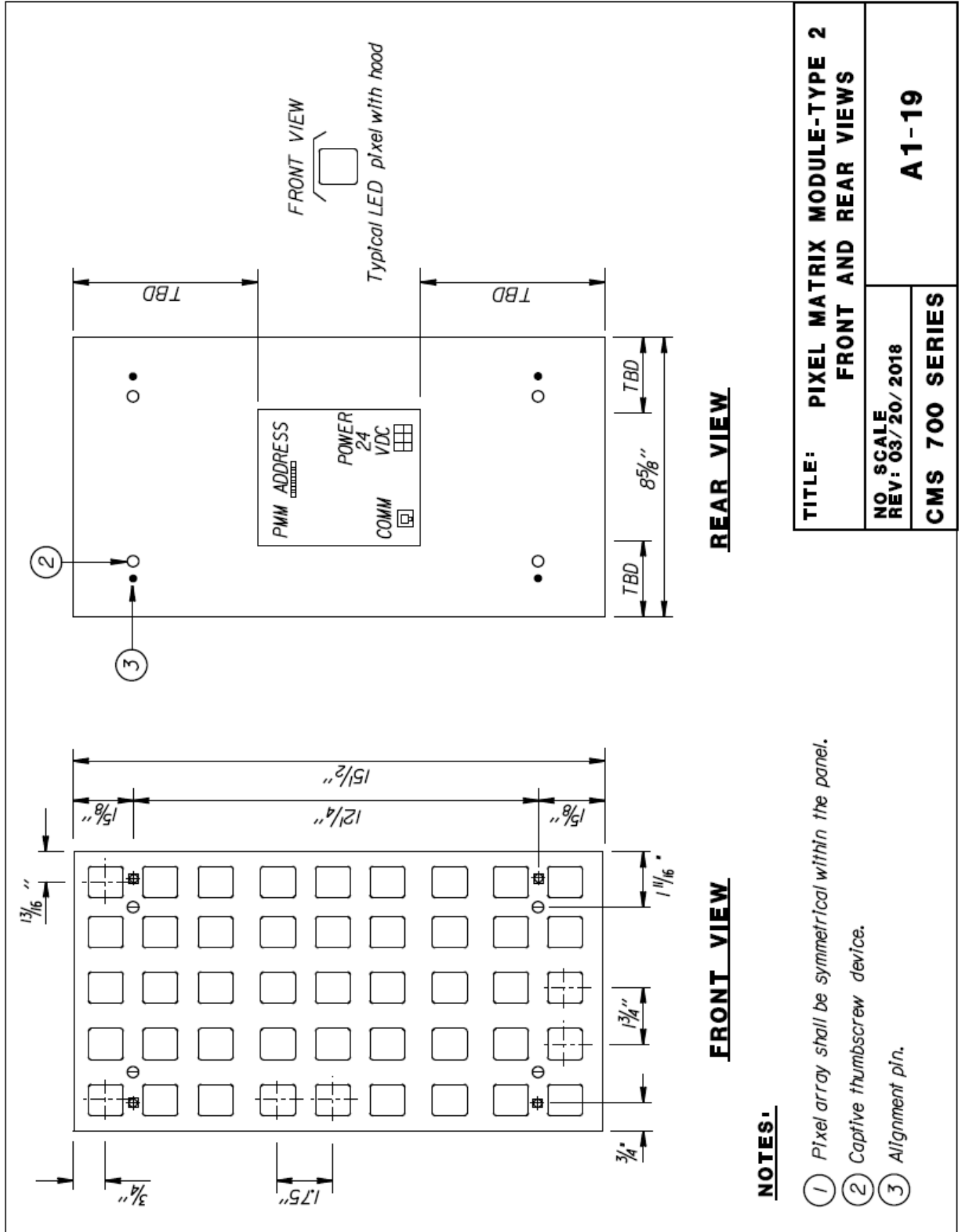


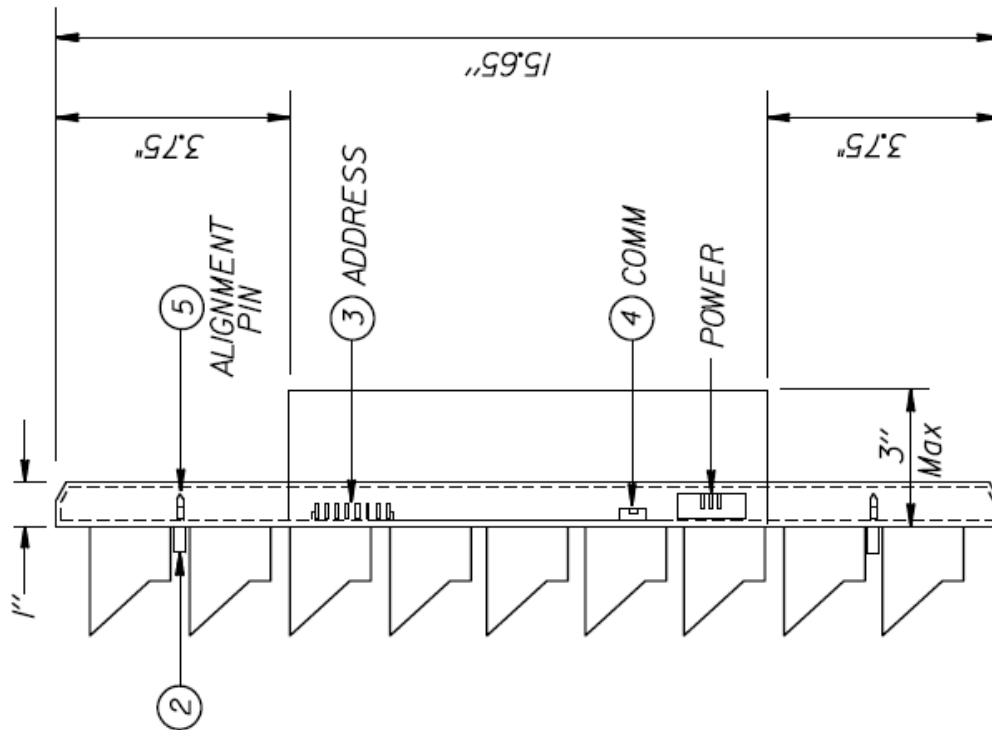
NOTES:

- 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 IOBase - T/100Base -TX Ethernet port.
- ⑤ Alignment pin

SIDE VIEW

TITLE: PIXEL MATRIX MODULE-TYPE 1		SIDE VIEW	
NO SCALE			A1-18
REV: 11/01/ 2018			
CMS 700 SERIES			





NOTES:

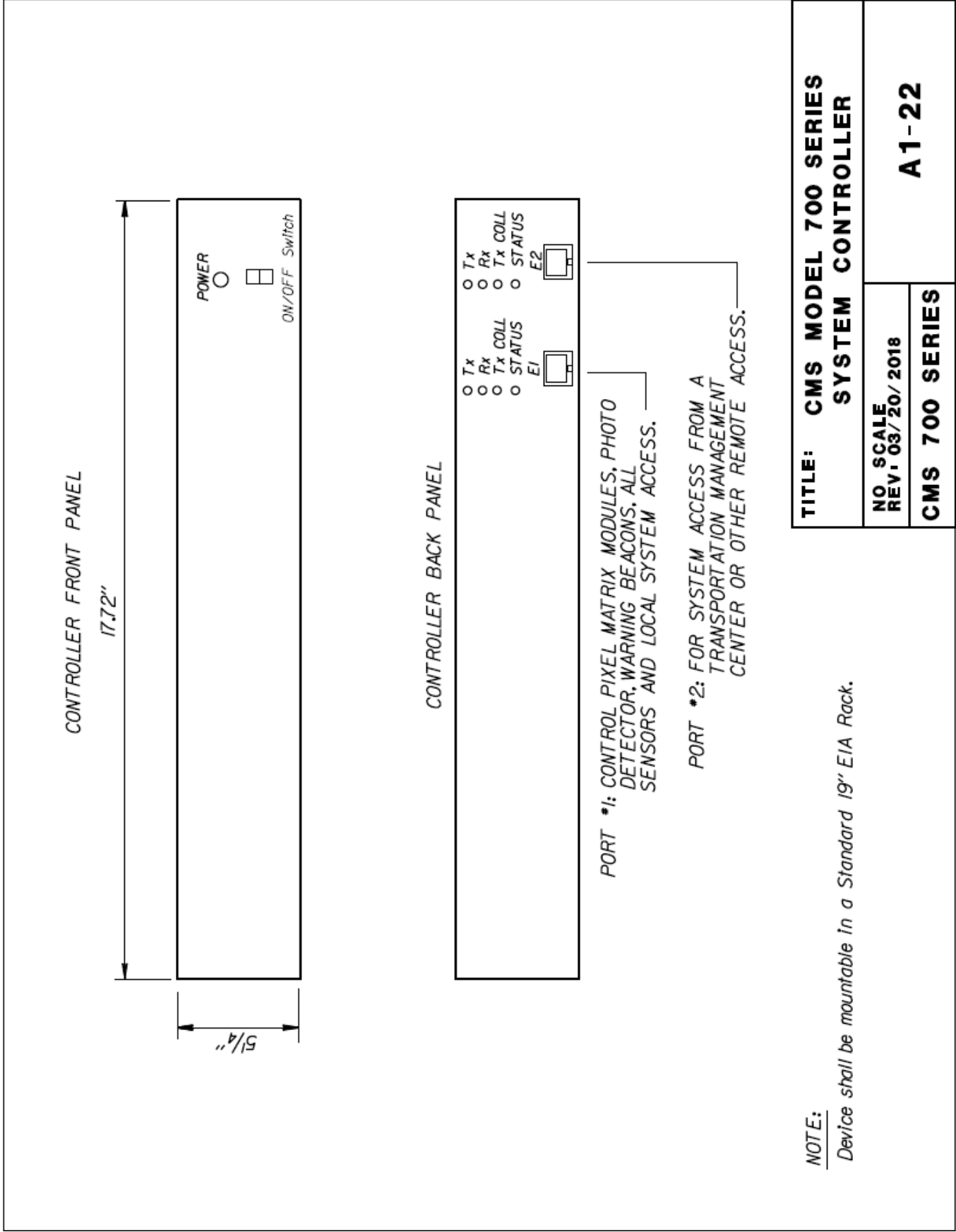
- ① All pixels shall be mounted to the same PC board.
- ② Captive thumbscrews (type M6)
- ③ 8 Bit DIP switch for address.
- ④ RJ45 IOBase - T/100Base -TX Ethernet port.
- ⑤ Alignment pin

SIDE VIEW

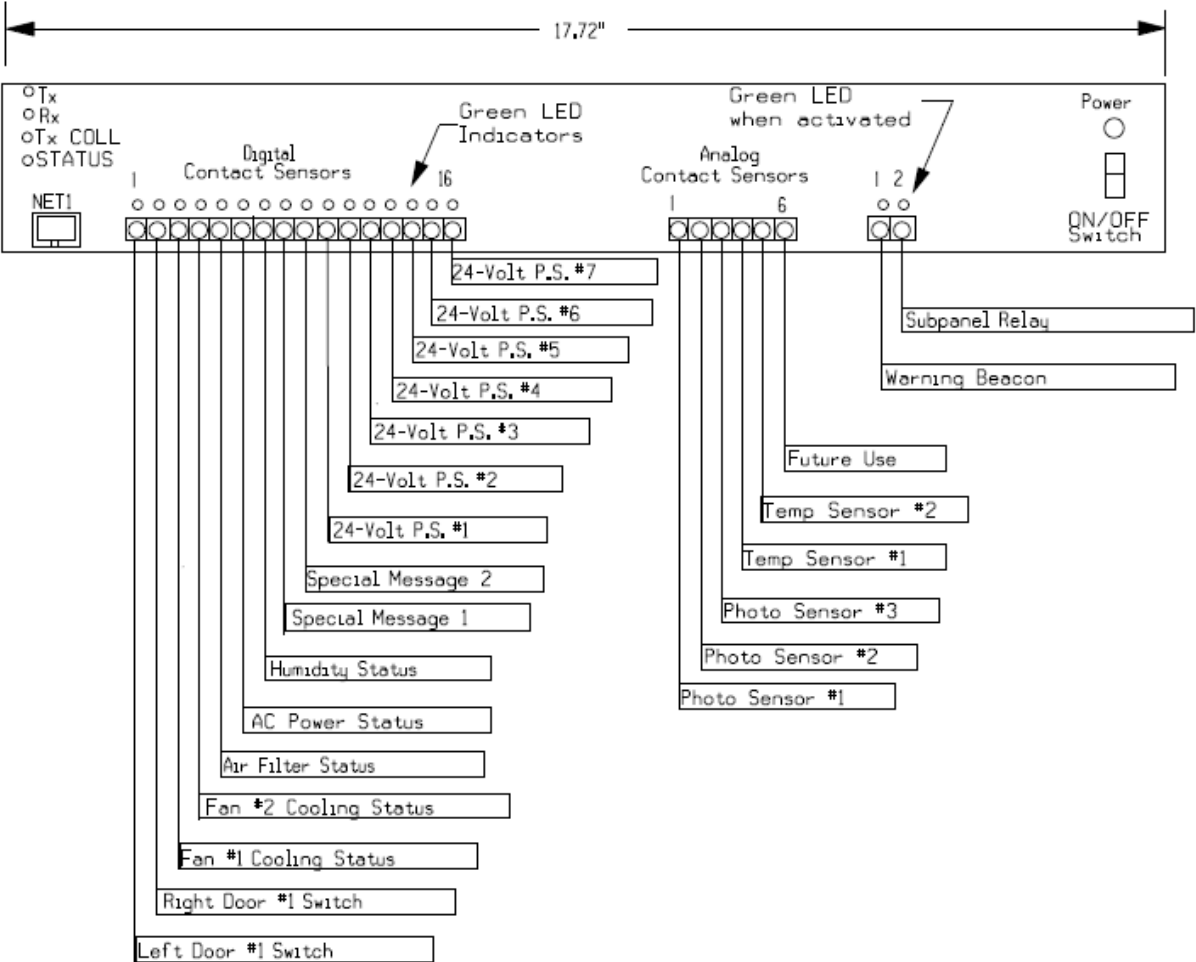
TITLE: PIXEL MATRIX MODULE-TYPE 2		SIDE VIEW
NO SCALE		
REV. 11/01/ 2018		
CMS 700 SERIES		A1-20

1	2	3	4	5
6	7	8	9	10
11	12	13	14	15
16	17	18	19	20
21	22	23	24	25
26	27	28	29	30
31	32	33	34	35
36	37	38	39	40
41	42	43	44	45

TITLE: PIXEL MATRIX MODULE		
LED ASSIGNMENTS: TYPES 1 AND 2		
NO SCALE		A1-21
REV: 03/20/2018		
CMS 700 SERIES		



REMOTE I/O BOX FRONT PANEL



REMOTE I/O BOX BACK PANEL



Notes:

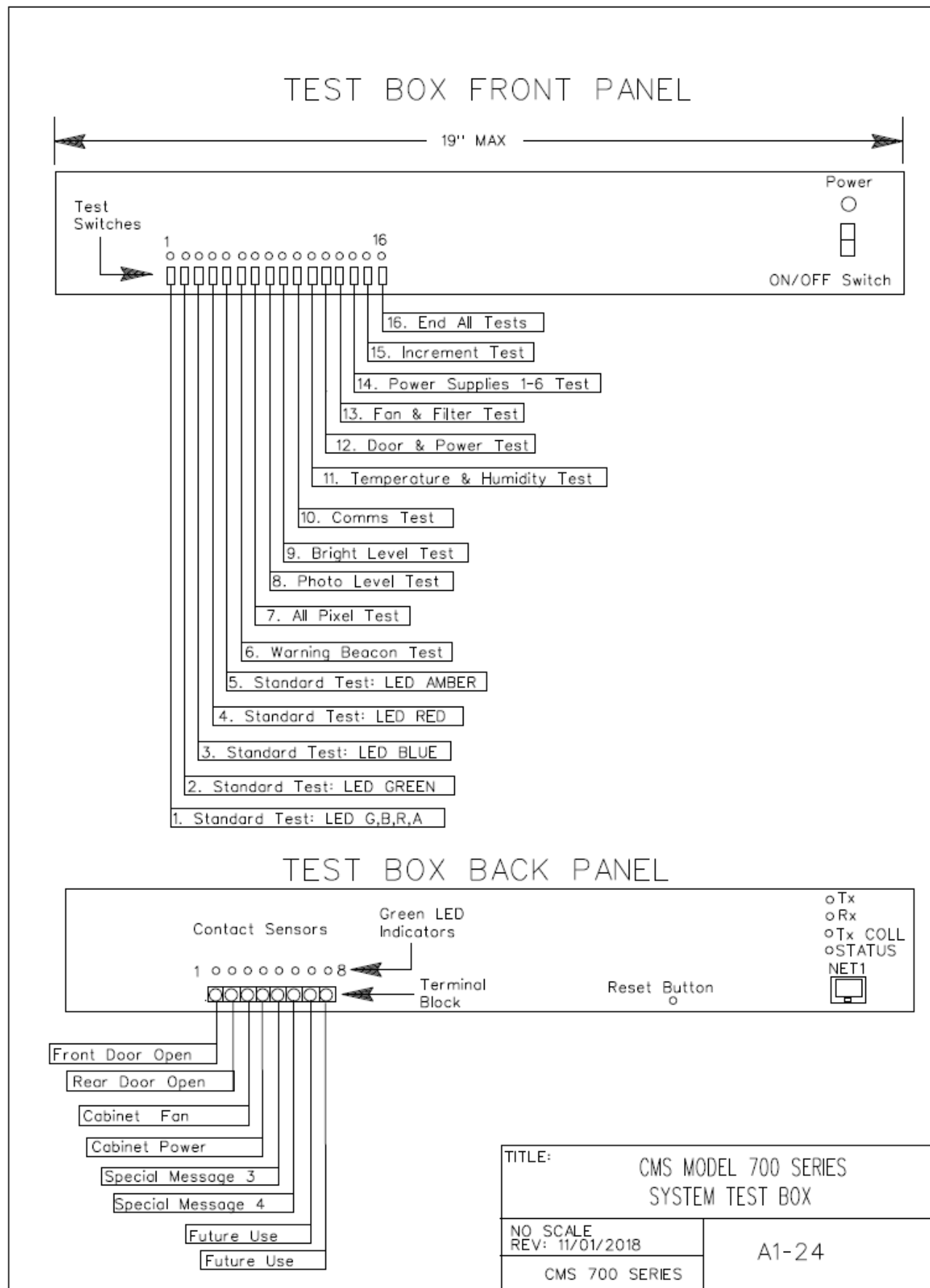
1. Device Shall be Mountable in a Standard 19" EIA-310 Rack,

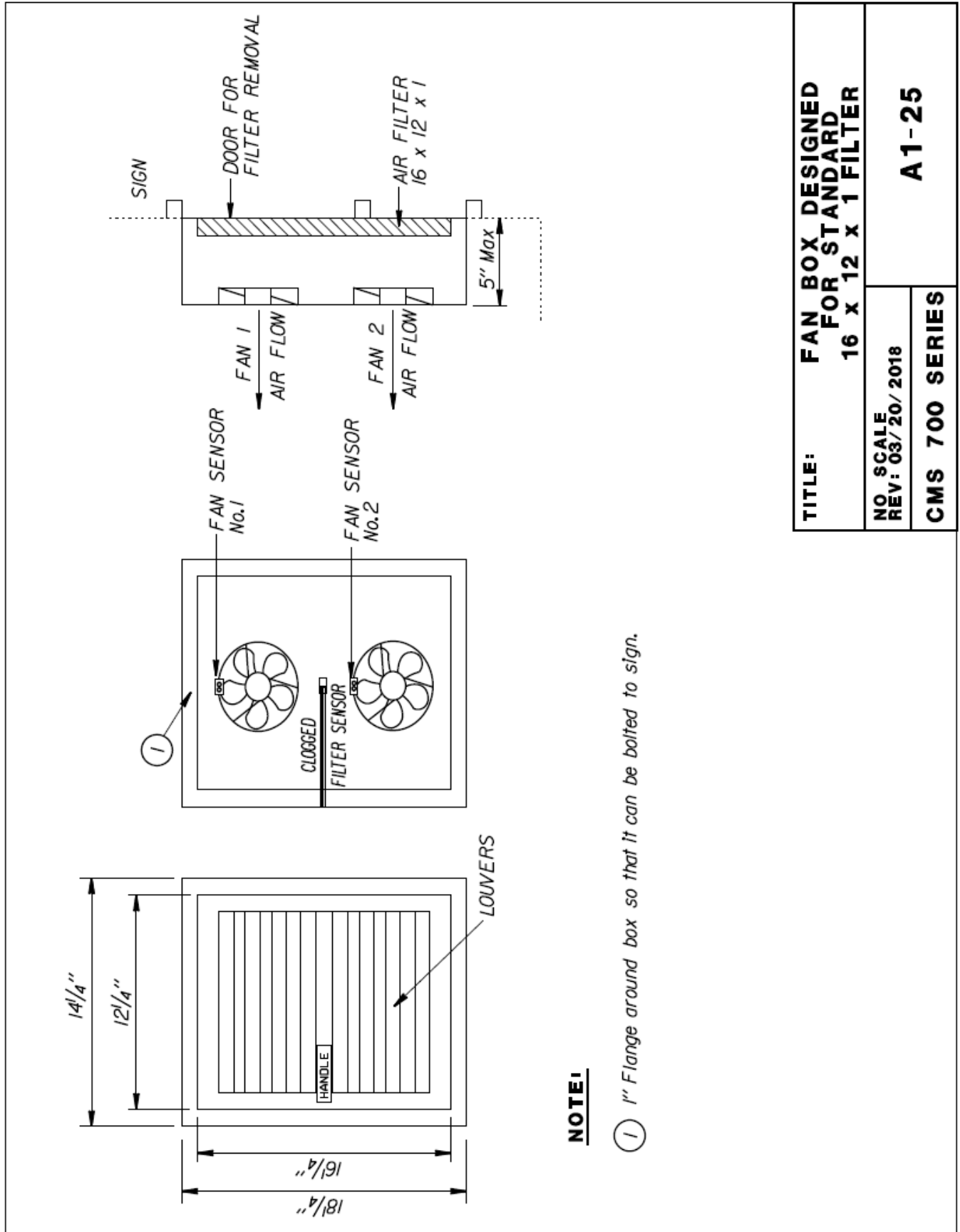
TITLE: CMS MODEL 700 SERIES
REMOTE I/O BOX

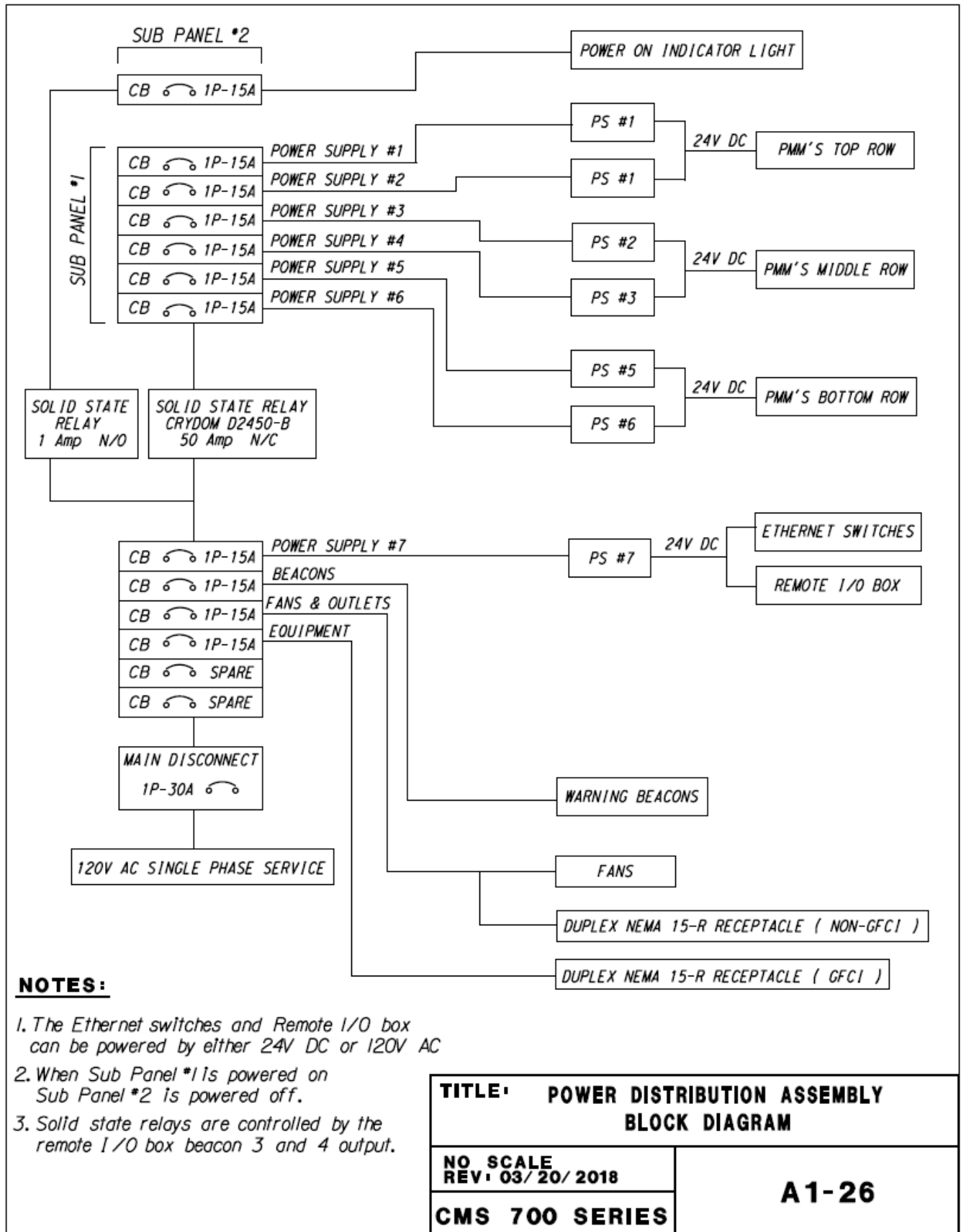
NO SCALE
REV: 03/20/2018

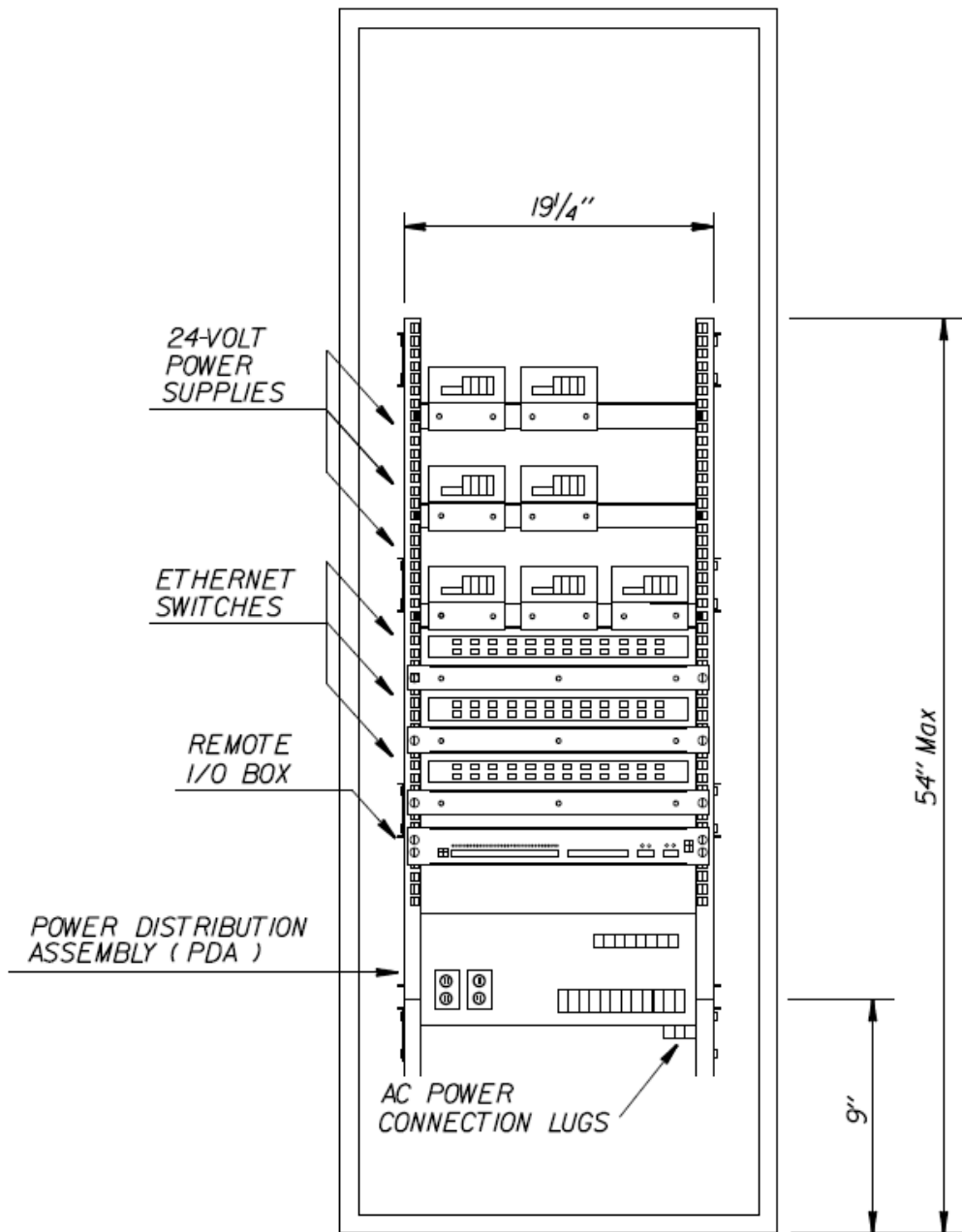
CMS 700 SERIES

A1-23





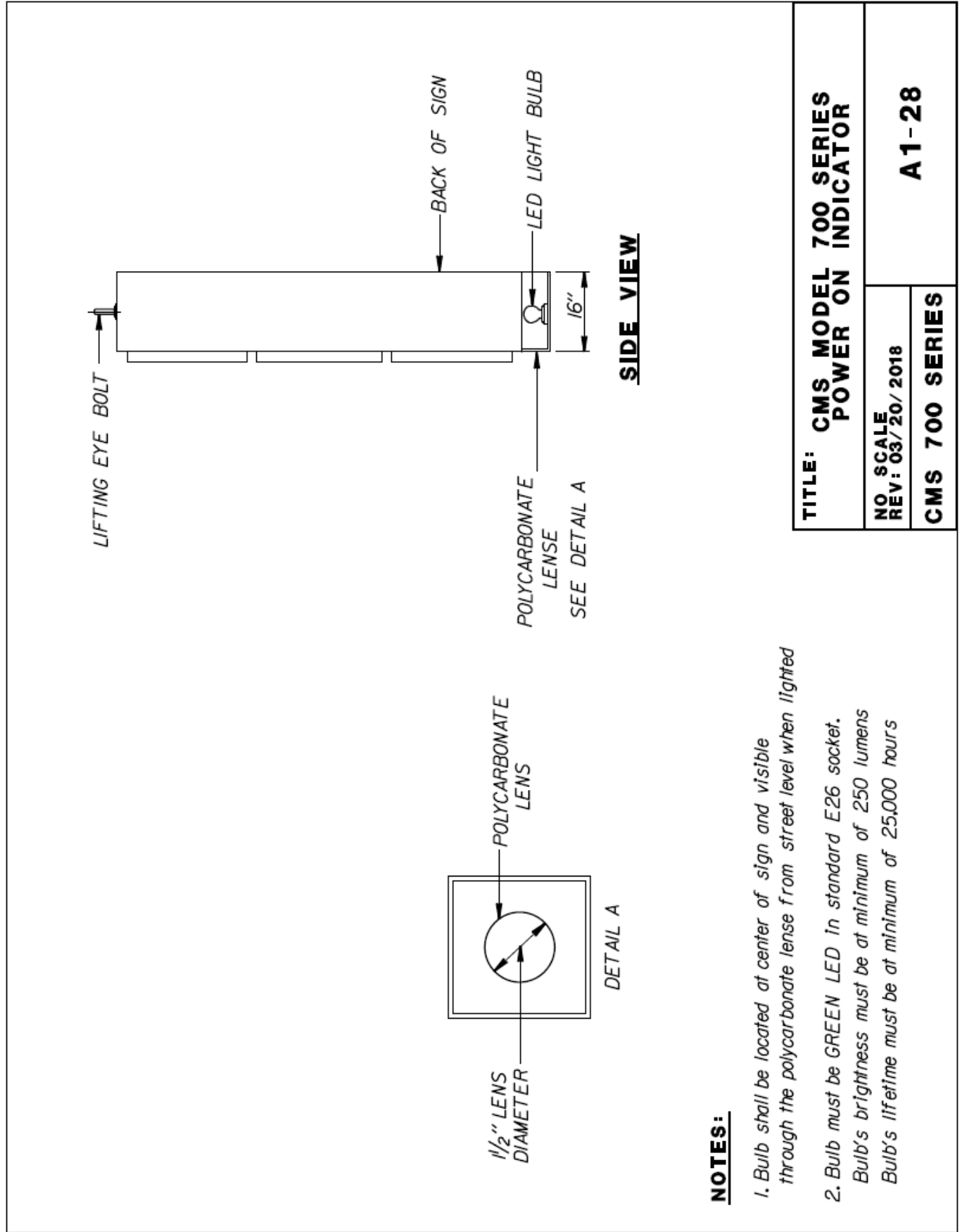


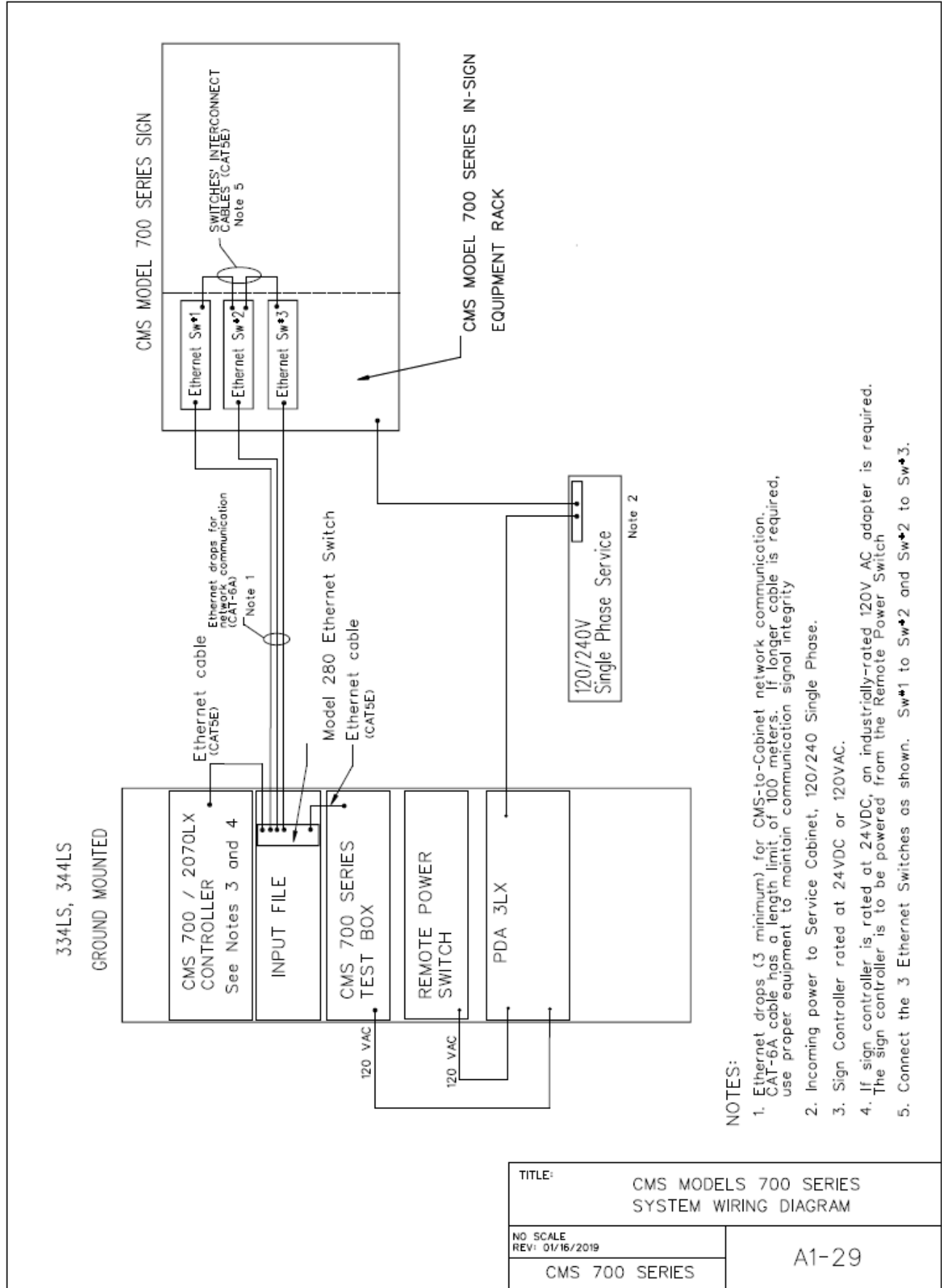


NOTES:

- ① 9" Max for depth.
- ② Rack shall be no closer than 8" from the edge of sign.

TITLE:	
IN-SIGN 19'' EQUIPMENT RACK	
NO SCALE	A1-27
REV: 03/ 20/ 2018	
CMS 700 SERIES	





NOTES:

- 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
- Incoming power to Service Cabinet, 120/240 Single Phase.
- Sign Controller rated at 24VDC or 120VAC.
- If sign controller is rated at 24VDC, an industrially-rated 120V AC adaptor is required. The sign controller is to be powered from the Remote Power Switch
- Connect the 3 Ethernet Switches as shown. Sw*1 to Sw*2 and Sw*2 to Sw*3.

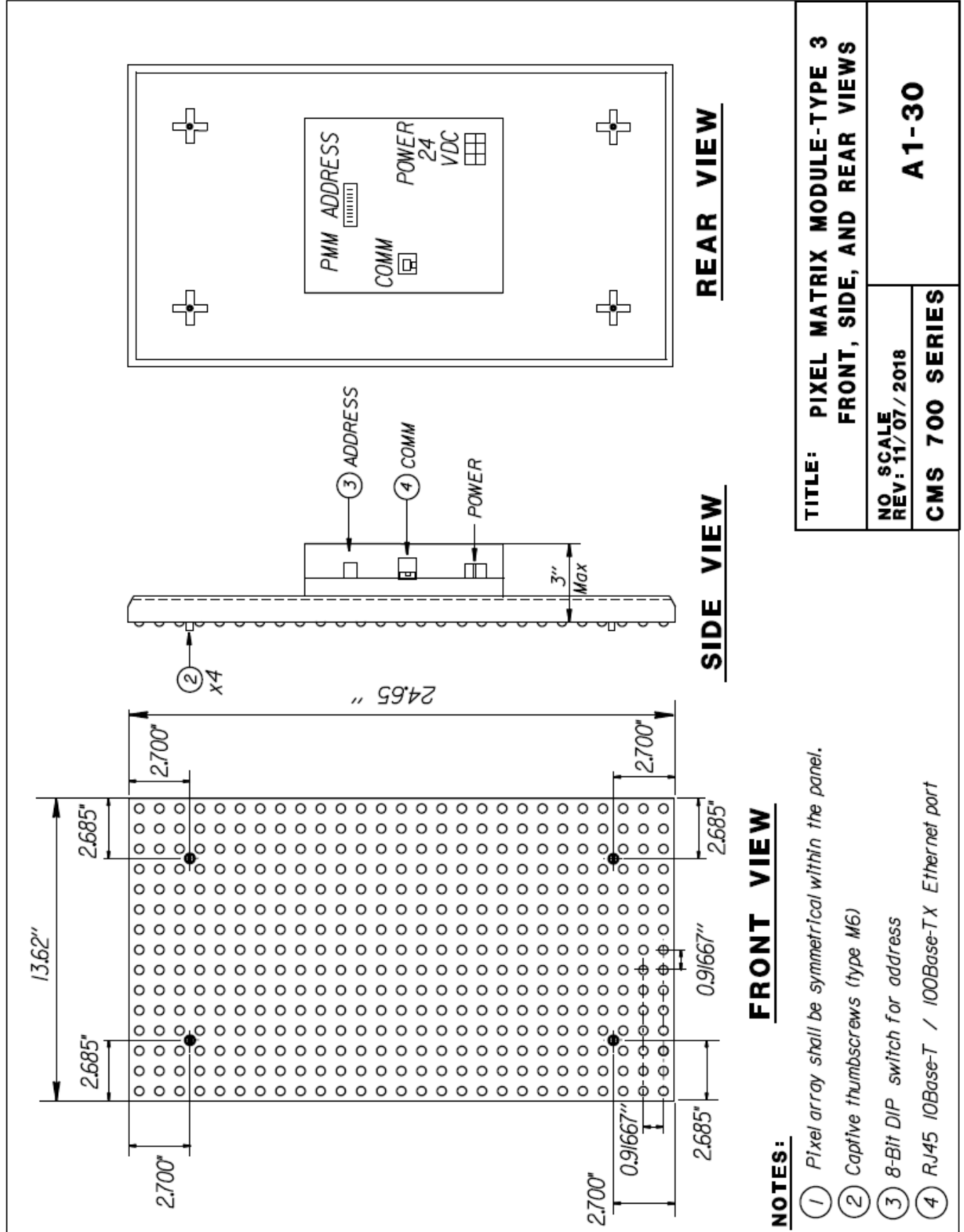
TITLE:

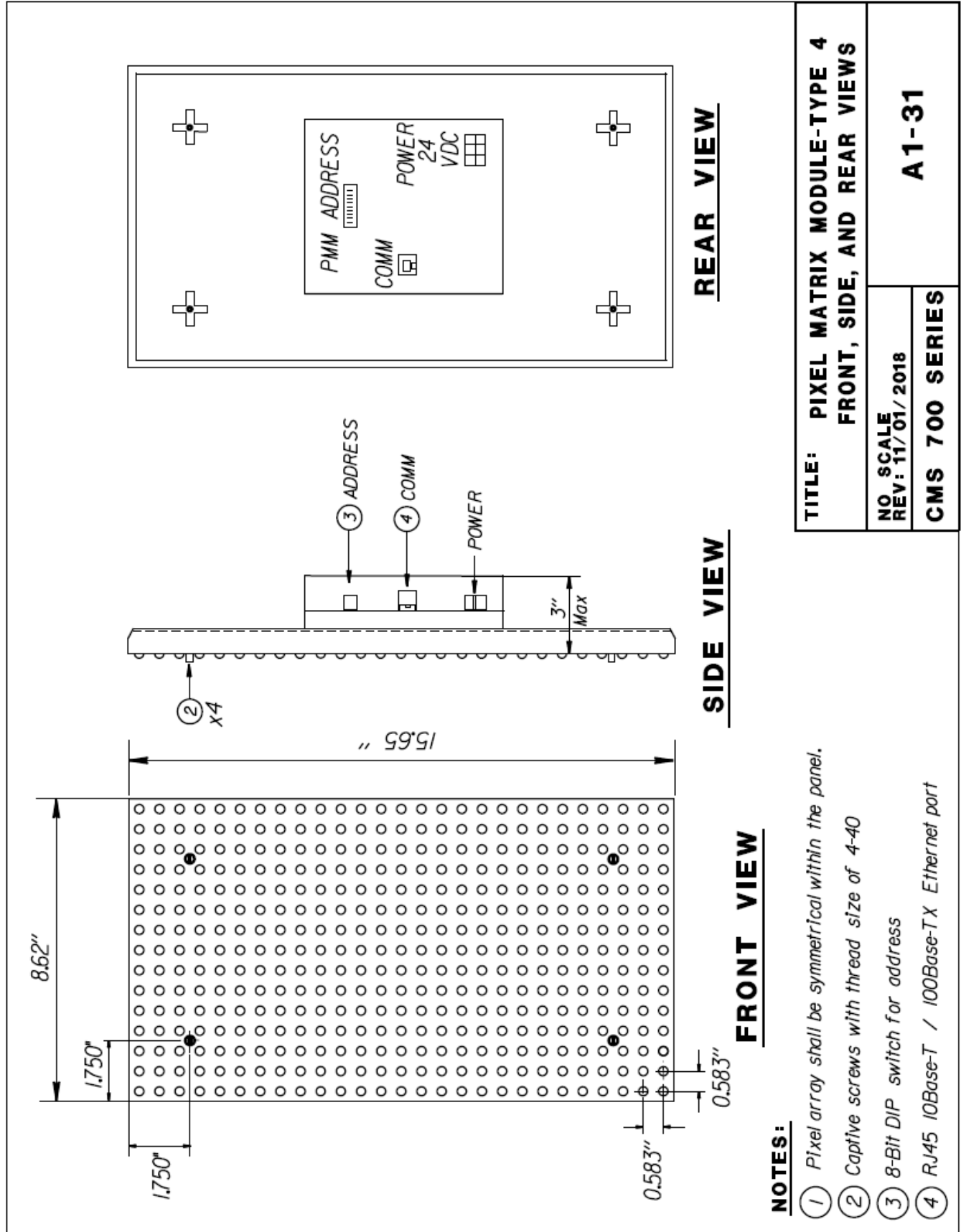
CMS MODELS 700 SERIES
SYSTEM WIRING DIAGRAM

NO SCALE
REV: 01/16/2019

CMS 700 SERIES

A1-29





1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
16	-	-	-	-	-	-	-	-	-	-	-	-	-	-
31	-	-	-	-	-	-	-	-	-	-	-	-	-	-
46	-	-	-	-	-	-	-	-	-	-	-	-	-	-
61	-	-	-	-	-	-	-	-	-	-	-	-	-	-
76	-	-	-	-	-	-	-	-	-	-	-	-	-	-
91	-	-	-	-	-	-	-	-	-	-	-	-	-	-
106	-	-	-	-	-	-	-	-	-	-	-	-	-	-
121	-	-	-	-	-	-	-	-	-	-	-	-	-	-
136	-	-	-	-	-	-	-	-	-	-	-	-	-	-
151	-	-	-	-	-	-	-	-	-	-	-	-	-	-
166	-	-	-	-	-	-	-	-	-	-	-	-	-	-
181	-	-	-	-	-	-	-	-	-	-	-	-	-	-
196	-	-	-	-	-	-	-	-	-	-	-	-	-	-
211	-	-	-	-	-	-	-	-	-	-	-	-	-	-
226	-	-	-	-	-	-	-	-	-	-	-	-	-	-
241	-	-	-	-	-	-	-	-	-	-	-	-	-	-
256	-	-	-	-	-	-	-	-	-	-	-	-	-	-
271	-	-	-	-	-	-	-	-	-	-	-	-	-	-
286	-	-	-	-	-	-	-	-	-	-	-	-	-	-
301	-	-	-	-	-	-	-	-	-	-	-	-	-	-
316	-	-	-	-	-	-	-	-	-	-	-	-	-	-
331	-	-	-	-	-	-	-	-	-	-	-	-	-	-
346	-	-	-	-	-	-	-	-	-	-	-	-	-	-
361	-	-	-	-	-	-	-	-	-	-	-	-	-	-
376	-	-	-	-	-	-	-	-	-	-	-	-	-	-
391	392	393	394	395	396	397	398	399	400	401	402	403	404	405

TITLE: PIXEL MATRIX MODULE LED ASSIGNMENTS: TYPES 3 AND 4		A1-32
NO. SCALE REV: 11/01/2018		
		CMS 700 SERIES