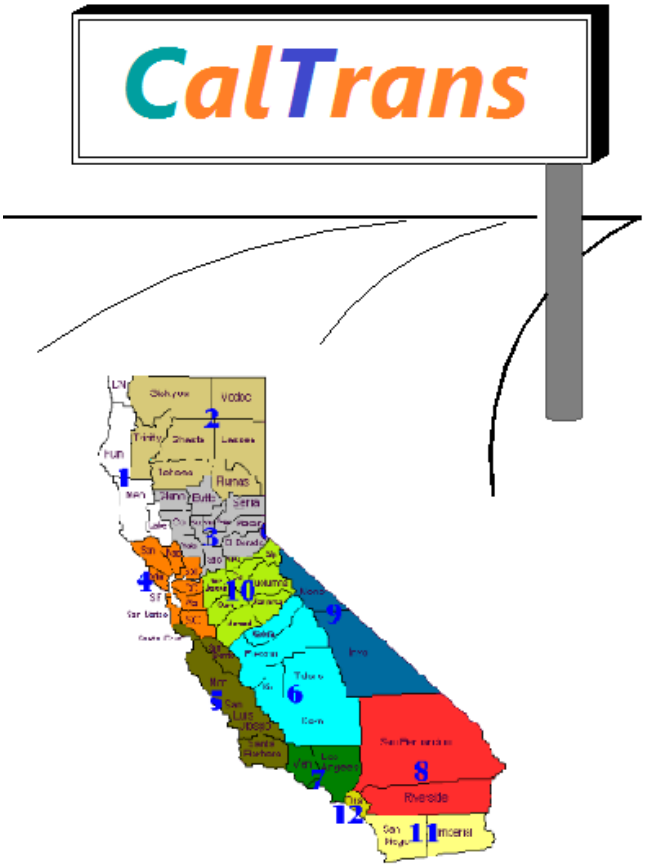
SPECIFICATIONS FOR
CHANGEABLE MESSAGE SIGN SYSTEM

CMS MODEL 700 SERIES

TEES 2020 ERRATA 1
CHAPTER 13



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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
IRIS	Intelligent Roadway Information System, a Transportation Management Software
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
SWRI	Southwest Research Institute
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
AlInGaP	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/m2). 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/m2.
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.

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 800 Color High-Resolution
CMS Model 510, Amber Standard-Resolution	CMS Model 710 Amber Standard-Resolution CMS Model 710C Color High-Resolution CMS Model 810 Color High-Resolution
CMS Model 520, Amber Standard-Resolution	CMS Model 720 Amber Standard-Resolution CMS Model 720C Color High-Resolution CMS Model 820 Color High-Resolution

B. CMS Model Specifications

CMS Models ➔	500	700 (Std. Res)	700C (Hi. Res)	800 (Hi. Res)	510	710 (Std. Res)	710C (Hi. Res)	810 (Hi. Res)	520	720 (Std. Res)	720C (Hi. Res)	820 (Hi. Res)
CMS PMM Layout (type W x H)	T1 12 x 5	T1 21 x 3	T3 21 x 3	T5 23 x 12	T2 12 x 5	T2 19 x 3	T4 19 x 3	T5 13 x 7	T2 6 x 5	T2 11 x 3	T4 11 x 3	T5 7 x 7
PMM Face Size (W x H inch)	21.968 x 13.178	13.62 x 24.65	13.62 x 24.65	12.24 x 5.98	14.00 x 8.75	8.62 x 15.65	8.62 x 15.65	12.24 x 5.98	14.00 x 8.75	8.62 x 15.65	8.62 x 15.65	12.24 x 5.98
PMM Pixel Layout (W x H)	8 x 5	5 x 9	15 x 27	16 x 8	8 x 5	5 x 9	15 x 27	16 x 8	8 x 5	5 x 9	15 x 27	16 x 8
Pixel Pitch (inch)	2.75	2.75	0.917	0.787	1.75	1.75	0.583	0.787	1.75	1.75	0.583	0.787
CMS Pixels (W x H)	96 x 25	105 x 27	315 x 81	368 x 96	96 x 25	95 x 27	285 x 81	208 x 56	48 x 25	55 x 27	165 x 81	112 x 56
CMS Max Weight (lbs)	2400	2400	2400	2600	2000	2000	2000	2000	1000	1000	1000	1000
CMS Width (inch)	306	300	300	308.2	230	175	175	175	94	105 ½	105 ½	100
CMS Height (inch)	81	86	86	87.34	53 ¾	57	57	55	53 ¾	57	57	56.4
CMS Depth (inch)	16	16	16	18	16	16	16	14	24	16	16	14

13.1.2 General

1. Minimum Life

The CMS Models 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. 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. All serial cables used inside of the CMS Model 800 Series shall be industrially-rated for outdoor application with operating temperature in the range of -40°C to 85°C.

4. Ethernet cable for connection of the CMS Model 700 series to Ground Cabinet or of CMS Model 800 series to Ground Cabinet

All Ethernet cables used for network connection of the CMS Model 700 Series to the ground cabinet or of CMS Model 800 series to the 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.

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 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 or 5V)	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 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 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 shall require on-site preventative maintenance no more than twice per year.

13.1.3 Documentation

1. CMS User Manual

Two copies of the manual shall be supplied for each CMS. 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
  - **c.** Preventive Maintenance
  - **d.** Trouble Analysis
  - **e.** Trouble Shooting Sequence Chart
  - **f.** Wave Forms
  - **g.** Voltage Measurements
  - **h.** 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

C. Warranty

A copy of the warranty shall be provided with complete terms and conditions

D. 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.

E. Draft User Manual

Two copies of the preliminary draft of the manual shall be submitted to the Engineer for approval prior to final printing.

F. 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.

G. 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 and 800 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**.

4. Model 800 CMS

Each **Model 800 CMS** shall have a configuration of 12 Pixel Matrix Modules (PMM) high by 23 Pixel Matrix Modules across (276 modules total) forming a

continuous matrix display of 368 pixels across by 96 pixels high (35,328 pixels). The PMM's used in **Model 800 CMS** are of **Type 5**.

5. **Model 810 CMS**

   Each **Model 810 CMS** shall have a configuration of 7 Pixel Matrix Modules (PMM) high by 13 Pixel Matrix Modules across (91 modules total) forming a continuous matrix display of 208 pixels across by 56 pixels high (11,648 pixels). The PMM's used in **Model 810 CMS** are of **Type 5**.

6. **Model 820 CMS**

   Each **Model 820 CMS** shall have a configuration of 7 Pixel Matrix Modules (PMM) high by 7 Pixel Matrix Modules across (49 modules total) forming a continuous matrix display of 112 pixels across by 56 pixels high (6,272 pixels). The PMM's used in **Model 820 CMS** are of **Type 5**.

13.1.6 Weight Limits

1. **Models 700 and 700C and 800 CMS**

   Each Model 700 and 700C and 800 CMS shall have a maximum weight of 2700 pounds (~1224.8kg).

2. **Models 710 and 710C and 810 CMS**

   Each Model 710 and 710C and 810 CMS shall have a maximum weight of 2000 pounds (~907.2kg).

3. **Models 720 and 720C and 820 CMS**

   Each Model 720 and 720C and 820 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 support 10/100baseTX Ethernet that complies with all current IEEE 802.3i, 802.3u, 802.3x standards.

2. **OSI layers 3 and 4**

   All OSI layer 3 and 4 module communications shall support 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 for CMS 700 Series

Each IP-addressable PMM 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, 710, 720, 700C, 710C, 720C, 800, 810, 820 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.

13.1.9 Spare Parts

The following spare item(s) shall be included per each delivered Model 700, 710, 720, 700C, 710C, 720C, 800, 810, or 820 CMS System.

1. Pixel Matrix Modules (PMM)

Two (2) Pixel Matrix Modules (PMM)

2. CMS Field Box Interface (FBI) Unit

One (1) CMS FBI Unit as referenced in Chapter 13, Section 9

3. For CMS Model 700 series ONLY: Remote I/O Unit

One (1) Remote I/O Unit as referenced in Chapter 13, Section 8.

4. In-sign Ethernet Switch

One (1) In-sign Ethernet Switch as referenced in Chapter 13, Section 15

5. For CMS Model 800 series ONLY

At least 500 retainer screws used to secure the LED Pixel Panels

CHAPTER 13-SECTION 2: PRODUCT TESTING

13.2.1 General

1. Standard Test

The Manufacturer shall burn-in the CMS 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 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 or 5VDC power supply protection

Each 24-Volt or 5-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

A. For CMS Model 700 Series: Each PDA shall have one 1-Pole 30 Amp Circuit Breaker installed on the front panel and designated "Main".

B. For CMS Model 800 Series: Each PDA shall have one 1-Pole 50 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 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 surge protective device such as EDCO Model SHA-1250 ITS or equal.

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 PMM and LED Pixel Panels Power Supplies

1. 24VDC Power Supplies

The CMS Models 700, 710, 720, 700C, 710C, and 720C 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.

2. 24VDC Power Supplies #1 and #2 for CMS Models 700, 710, 720, 700C, 710C, and 720C

24VDC power supplies #1 and #2 shall supply power to the top row of PMM's via 24VDC bus or buses. Individual power cable harness used to connect each of the PMM is to be soldered to a 24VDC bus or buses. The solder joint is to be sealed and protected

3. 24VDC Power Supplies #3 and #4 for CMS Models 700, 710, 720, 700C, 710C, and 720C

24VDC power supplies #3 and #4 shall supply power to the top row of PMM's via 24VDC bus or buses. Individual power cable harness used to connect each of the PMM is to be soldered to a 24VDC bus or buses. The solder joint is to be sealed and protected

4. 24VDC Power Supplies #5 and #6 for CMS Models 700, 710, 720, 700C, 710C, and 720C

24VDC power supplies #4 and #5 shall supply power to the top row of PMM's via 24VDC bus or buses. Individual power cable harness used to connect each of the PMM is to be soldered to a 24VDC bus or buses. The solder joint is to be sealed and protected

5. **24VDC Power Supply #7 for CMS Models 700, 710, 720, 700C, 710C, and 720C**

   24-Volt power supply #7 shall supply power to the Remote I/O Box, Ethernet switch if Ethernet switch is rated for 24VDC, any other components that are rated for 24VDC

6. **24VDC Power Supplies #1 and #2 connection for CMS Models 700, 710, 720, 700C, 710C, and 720C**

   24-Volt power supplies' #1 and #2 24-Volt outputs shall be connected in parallel.

7. **24VDC Power Supplies #3 and #4 connection for CMS Models 700, 710, 720, 700C, 710C, and 720C**

   24-Volt power supplies' #3 and #4 24-Volt outputs shall be connected in parallel.

8. **24VDC Power Supplies #5 and #6 connection for CMS Models 700, 710, 720, 700C, 710C, and 720C**

   24-Volt power supplies' #5 and #6 24-Volt outputs shall be connected in parallel.

9. **24VDC Power Supplies #1 through #6 power rating for CMS Models 700, 710, 720, 700C, 710C, and 720C**

   24-volt power supplies #1 though #6 shall be rated at a minimum of 480 W.

10. **24VDC Power Supply #7 power rating for CMS Models 700, 710, 720, 700C, 710C, and 720C**

    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 for CMS Models 700, 710, 720, 700C, 710C, and 720C**

    Each 24-volt power supply shall have an operating voltage range of 100 to 240 VAC.

12. **24VDC list agency requirement for CMS Models 700, 710, 720, 700C, 710C, and 720C**

    Each 24-volt power supply shall be UL 60950-1 listed.

13. 24VDC connection to PDA for CMS Models 700, 710, 720, 700C, 710C, and 720C

Connecting each 24-volt power supply to the Power Distribution Assembly shall not require terminal soldering.

14. 24VDC connection to PMM for CMS Models 700, 710, 720, 700C, 710C, and 720C

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

15. 24VDC power supply label for CMS Models 700, 710, 720, 700C, 710C, and 720C

Each power supply shall be labeled with its power supply number.

16. 24VDC power supply enclosure for CMS Models 700, 710, 720, 700C, 710C, and 720C

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

17. 24VDC power supply physical size for CMS Models 700, 710, 720, 700C, 710C, and 720C

Each power supply shall be no larger than 3"H x 7" W x 10" D.

18. Power supply for CMS Models 800, 810, and 820

Power supplies shall meet the following requirements:

A. Output of 5VDC

B. Arrangements and number of 5VDC power supplies shall provide sufficient power output to fully power all connected PMM/LED Panels of each CMS system.

C. Operating temperature range from -40°C to +85°C

D. Output of 5VDC UL 60950-1 listed

CHAPTER 13-SECTION 4: PIXEL MATRIX MODULE (PMM)

13.4.1 General and Mechanical

1. PMM components for CMS Model 700 Series

A. Each PMM shall contain an integrated store-and-forward 3-port network switch per the IEEE 802.3, 802.3u, and 802.x specifications. Ports 1 and 2 shall be routed to a corresponding RJ45 connector via Magnetics. The third port shall be routed to the PMM processor.

B. Each PMM shall consist of display pixel LEDs, diagnostic circuitry that provides feedback to the Sign Controller on the PMM health and pixel status, and connector header for 24VDC power. The 24VDC power connector header

is to be of Type VH, 4-position locking header, 3.96mm pitch for Disconnectable Crimp style connectors

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 for CMS Model 700 Series**
   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 Guiding / Alignment**
   For CMS Models 700, 710, 720, 700C, 710C, and 720C: Each PMM shall have four (4) guiding / alignment pins for alignment and ease of installation & removal of PMM from the sign's structural ribs.
   For CMS Models 800, 810, and 820: Each PMM shall provide ease of alignment for quick, secured, and accurate installation.

6. **PMM Thumb/Screwdriver captive screws**
   Each PMM shall be attached to the structural ribs with minimum of four (4) captive or retainer screws that can be tightened by hands or with either Pan or Phillips head option for maximum tightening.

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

8. **Amber Standard-Resolution PMM pixel configuration (For CMS Models 700, 710, 720)**
   Each amber standard-resolution PMM shall be 5 pixels wide by 9 pixels high.

9. **Color High-Resolution PMM pixel configuration for CMS 700C, 710C, and 720C**
   Each color high-resolution PMM shall be 15 pixels wide by 27 pixels high.

10. **Color High-Resolution PMM pixel configuration for CMS 800, 810, and 820**
    Each color high-resolution PMM shall be 16 pixels wide by 8 pixels high.

11. **PMM Options (For CMS Models 700, 710, 720, 700C, 710C, 720C)**
    Each PMM shall be of the PMM Type as per Chapter 13, **Section 13.4.6**.

12. PMM weight

The maximum weight of each PMM shall be 9 pounds.

13. PMM rated minimum life

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

14. 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.

15. 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.

16. PMM Compatibility and Upgradability (For CMS Models 700, 710, 720, 700C, 710C, 720C)

The Model 700C PMMs shall allow for upgrading of Caltrans Amber PMMs to Color.

13.4.2 Communications

1. PMM communication protocol (For CMS Models 700, 710, 720, 700C, 710C, 720C)

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 (For CMS Models 700, 710, 720, 700C, 710C, 720C)

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 (For CMS Models 700, 710, 720, 700C, 710C, 720C)

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

4. PMM's address DIP switch (For CMS Models 700, 710, 720, 700C, 710C, 720C)

Each PMM shall have the lowest octet of its IP Address selectable with one 8-bit DIP switch. The Least Significant Bit (LSB) is to be the last switch on the right of the DIP switch as it is facing its viewer.

5. PMM's DIP switch address map on sign face (For CMS Models 700, 710, 720, 700C, 710C, 720C)

PMM address set through address DIP switch is to follow the below convention as PMM's are arranged from left to right on the CMS sign face:

- First PMM of top row starts at 1 and step up by 1 increasement horizontally through the last PMM on this row
- First PMM of middle row starts at 31 and step up by 1 increasement horizontally through the last PMM on this row
- First PMM of bottom row starts at 61 and step up by 1 increasement horizontally through the last PMM on this row

6. PMM default Broadcast (For CMS Models 700, 710, 720, 700C, 710C, 720C)

The PMM's default Broadcast Address shall be 192.168.110.255

7. PMM default Gateway (For CMS Models 700, 710, 720, 700C, 710C, 720C)

The PMM's default Gateway Address shall be 192.168.110.254

8. PMM default Network Mask (For CMS Models 700, 710, 720, 700C, 710C, 720C)

The PMM's default Network Mask shall be 255.255.255.0

9. PMM default receiving port for UDP (For CMS Models 700, 710, 720, 700C, 710C, 720C)

The PMM's default port number for receiving UDP data from the CMS Sign Controller shall be 10020.

10. PMM default transmission port for UDP (For CMS Models 700, 710, 720, 700C, 710C, 720C)

The PMM's default port number for the transmission of UDP data to the CMS Sign Controller shall be 10025.

11. PMM IP address configuration (For CMS Models 700, 710, 720, 700C, 710C, 720C)

Each PMM's IP Address shall be fully configurable.

12. PMM IP address setting (For CMS Models 700, 710, 720, 700C, 710C, 720C)

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

13. PMM broadcast address configuration (For CMS Models 700, 710, 720, 700C, 710C, 720C)

Each PMM's Broadcast Address shall be fully configurable.

14. PMM broadcast address setting (For CMS Models 700, 710, 720, 700C, 710C, 720C)

Each PMM's Broadcast Address shall be set to the PMM's default value.

15. PMM gateway address configuration (For CMS Models 700, 710, 720, 700C, 710C, 720C)

Each PMM's Gateway Address shall be fully configurable.

16. PMM gateway address setting (For CMS Models 700, 710, 720, 700C, 710C, 720C)

Each PMM's Gateway Address shall be set the PMM's default value.

17. PMM network mask configuration (For CMS Models 700, 710, 720, 700C, 710C, 720C)

Each PMM's Network Mask shall be fully configurable.

18. PMM network mask setting (For CMS Models 700, 710, 720, 700C, 710C, 720C)

Each PMM's Network Mask shall be set the PMM's default value.

19. PMM UDP receiving port configuration (For CMS Models 700, 710, 720, 700C, 710C, 720C)

Each PMM's UDP receiving port shall be fully configurable.

20. PMM UDP transmission port configuration (For CMS Models 700, 710, 720, 700C, 710C, 720C)

Each PMM's UDP transmission port shall be fully configurable.

21. PMM UDP receiving port setting (For CMS Models 700, 710, 720, 700C, 710C, 720C)

Each PMM's UDP receiving port shall be set to its default configuration.

22. PMM UDP transmission port setting (For CMS Models 700, 710, 720, 700C, 710C, 720C)

Each PMM's UDP transmission port shall be set to its default configuration.

23. PMM reset using DIP switch (For CMS Models 700, 710, 720, 700C, 710C, 720C)

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.

24. PMM internal memory buffers (For CMS Models 700, 710, 720, 700C, 710C, 720C)

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

25. PMM active message buffer (For CMS Models 700, 710, 720, 700C, 710C, 720C)

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

26. Response to Get Status Requests with buffer 254 selected (For CMS Models 700, 710, 720, 700C, 710C, 720C)

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.

For Cluster LED Technology, 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**)

For Single-Lens or RBG LED Technology, 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 = OK
Bit 4 0 = OK 1 = OK
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**)

27. Response to Get Status Requests with buffer 255 selected (For CMS Models 700, 710, 720, 700C, 710C, 720C)

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.

28. PMM Display Buffer (For CMS Models 700, 710, 720, 700C, 710C, 720C)

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

29. PMM default bitmap (For CMS Models 700, 710, 720, 700C, 710C, 720C)

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

30. PMM's usage of message buffers (For CMS Models 700, 710, 720, 700C, 710C, 720C)

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

31. Response time for message display (For CMS Models 700, 710, 720, 700C, 710C, 720C)

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

32. Response time to blank sign when no buffer packet received (For CMS Models 700, 710, 720, 700C, 710C, 720C)

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

33. General Communications (For CMS Models 800, 810, 820)

All PMM or LED Panels shall be configured to communicate properly to receive and display messages on the CMS Sign.

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 AllnGaP 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: Type-1 PMM at 43 +/-3 candelas and Type-2 PMM at 20 +/- 5candelas

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 cd/pixel for Type-1 PMM and 20 +/- 5 cd/pixel for Type-2 PMM 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 for Type-1 PMM or 0 and 20 candelas for Type-2 PMM 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/m^2 (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/m^2 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/m^2 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

For CMS Models 700, 710, 720, 700C, 710C, and 720C:

Each pixel's refresh rate shall be a minimum of 600 times per second.

For CMS Models 800, 810, and 820:

Each pixel's refresh rate shall be a minimum of 100 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

For CMS Models 700, 710, 720, 700C, 710C, and 720C: Each PMM shall accept 22 VDC to 26 VDC (24 VDC nominal) as input voltage.

For CMS Models 800, 810, and 820: Each PMM shall accept 5 VDC as input voltage.

4. Circuit protection for CMS Model 700, 710, 720, 700C, 710C, and 720C

The supply input circuit of each PMM shall be fused with surface-mount fuse. Use PCB reference designator **F1** for this fuse.

5. Overheat and ground fault protection for CMS Model 700 Series

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

6. Ground fault protection for CMS Model 800 Series

Each PMM shall have an automatic shut down and restart for such conditions as 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.

5. **Type 5 PMM, High-Resolution with Color LED's (Used on CMS 800, 810, and 820)**
   - **A.** Each Type 5 PMM shall have a pixel pitch of 0.787 inches.
   - **B.** Each Type 5 PMM shall be 12.24 inches wide by 5.98 inches high.

CHAPTER 13-SECTION 5: SIGN CONTROLLER

13.5.1 General

1. Sign Controller

Each CMS Model 700 and 800 Series system shall be controlled and monitored by its own Sign Controller.

2. Requirement

The CMS Model 700 and 800 Series controller shall be industrially rated and capable of running the Caltrans CMS Model 700 AVMS Software or use fully NTCIP compliant communications software that has been demonstrated to work with ActiveITS and IRIS.

3. Software

The CMS controller shall either have the Caltrans CMS Model 700 Series System software installed or a fully compliant NTCIP communication 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 (CMS Model 700 Series)

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 CMS FBI, and for local system access etc. The Sign Controller shall be able to communicate using the AVMS 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.

C. Front panel

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

2. Serial or Others (CMS Model 800 Series)

Each Sign Controller shall have its own communication ports to allow proper communication with the sign system

13.5.4 System Default Internet Protocol (IP) Addresses for CMS Model 700 Series

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. CMS FBI Unit 192.168.110.205
H. Ethernet switch 10/100baseTX (Quantity 1)
Network Mask: 255.255.255.0
Default Gateway: Leave blank
Address: 192.168.110.101

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 FOR CMS MODEL 700 SERIES

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 FOR CMS MODEL 700 SERIES

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 in 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 or front 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: CMS FIELD BOX INTERFACE (FBI) Unit

13.9.1 General

1. Height
Each CMS FBI unit shall be no more than 3.5 inches (2U) in height.

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

3. Operating voltage
Each CMS FBI unit shall have an operating voltage of 120 VAC.

13.9.2 Communication

1. Protocol (CMS Model 700 Series)
The CMS FBI unit shall be microprocessor-controlled and shall communicate with the Sign Controller on an IP over Ethernet communication network using UDP.

2. Default broadcast address (CMS Model 700 Series)
The CMS FBI unit's default Broadcast Address shall be 192.168.110.255

3. Default gateway address (CMS Model 700 Series)
The CMS FBI unit's default Gateway Address shall be 192.168.110.254

4. Default network mask (CMS Model 700 Series)
The CMS FBI unit's default Network Mask shall be 255.255.255.0

5. Broadcast address configuration (CMS Model 700 Series)
Each CMS FBI unit's Broadcast Address shall be fully configurable.

6. Default broadcast address setting (CMS Model 700 Series)
Each CMS FBI unit's Broadcast Address shall be set its default value.

7. Gateway address configuration (CMS Model 700 Series)
Each CMS FBI unit's Gateway Address shall be fully configurable.

8. Default gateway address setting (CMS Model 700 Series)
Each CMS FBI unit's Gateway Address shall be set to its default value.

9. Network mask configuration (CMS Model 700 Series)

Each CMS FBI unit's Network Mask shall be fully configurable.

10. Default network mask setting (CMS Model 700 Series)

Each CMS FBI unit's Network Mask shall be set to its default value.

11. Receiving UDP default port configuration (CMS Model 700 Series)

The CMS FBI unit's default port number for the receiving of UDP data from the CMS Sign Controller shall be 10012.

12. Transmission UDP default port configuration (CMS Model 700 Series)

The CMS FBI unit's default port number for the transmission of UDP data to the CMS Sign Controller shall be 10012.

13. CMS FBI "receive" UDP port configuration (CMS Model 700 Series)

The CMS FBI unit's "receive" UDP port shall be fully configurable.

14. CMS FBI "transmit-to" UDP port configuration (CMS Model 700 Series)

The CMS FBI unit's "transmit-to" UDP port shall be fully configurable.

15. CMS FBI "receive" UDP port setting (CMS Model 700 Series)

The CMS FBI unit's "receive" UDP port shall be set to its default configuration.

16. CMS FBI "transmit-to" UDP port setting (CMS Model 700 Series)

The CMS FBI unit's "transmit to" UDP port shall be set to its default configuration.

17. Reset switch (CMS Model 700 Series)

Depressing the CMS FBI'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 (CMS Model 700 Series)

The CMS FBI's reset button shall be recessed to prevent accidental reset.

19. Data transmission (CMS Model 700 Series)

Each CMS FBI 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) (CMS Model 700 Series)

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.

21. Communication for CMS Model 800 Series

Communication between the FBI and CMS 800 Series systems shall allow for the diagnostic test functions as specified in **Section 13.9.4.5**

13.9.3 Contact Sensors

1. Discrete Contact Sensors

CMS FBI unit 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 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 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 for CMS Model 700 Series

When a CMS FBI unit's switch is depressed, the FBI shall send a UDP message to the sign controller to initiate the selected test.

3. Switches' function for CMS Model 800 Series

When a CMS FBI unit's switch is depressed, the FBI shall send a message to the sign to initiate the selected test as follows:

When Button # Pressed	Test
1	Standard Test: LED R,B,G,A – display full green, blue, red, and amber color on the sign inn sequential manner (duration of each phase is 5 seconds)
2	Standard Test: LED – All Pixels Green – display full green color on the sign
3	Standard Test: LED – All Pixels Blue -- display full blue color on the sign
4	Standard Test: LED – All Pixels Red -- display full red color on the sign
5	Standard Test: LED - All Pixels Amber -- display full amber color on the sign
6	Future
7	Standard Test: LED – All Pixels White -- display full white color on the sign
8	Photo Level Test
9	Bright Level Test
10	Communication Test -- triggers comms test and displays on the sign comm status (example: Ok or Error)
11	Temperature Test
12	Power Supplies Test
13	Text Message Test – test using all 3 rows as many texts
14	Photo Test – test using a PNG graphic file
15	Increment Test – triggers Row and Column LED pixel test – scroll message that consists of vertical and horizontal while test rows or columns. (??? Is it run checkboard test on each module)
16	End all test (blank the sign) – terminates all test patterns

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 sign.

7. Circuit Protection

The heater power shall have a heater circuit breaker that is separate from all other CMS 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 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 sign power is off (Isocket GSM Power Socket Model ASGMS706US - or similar).

CHAPTER 13-SECTION 11: SIGN STRUCTURE AND HOUSING

13.11.1 Sign Housing Requirements

1. Housing

The housing shall include, but not limited to, the following:

A. Doors
B. Ventilation
C. Latches/Handles
D. Gaskets
E. Hinges and Door Catches
F. Cage Supports and Mounting for PMM and CMS 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 holes

Each CMS shall have one 3" and one 2" conduit holes at the bottom of the housing to allow cable routing. Unused conduit holes shall have plugs installed.

8. Protection from the elements

The CMS Model 700, 710, 720, 700C, 710C, 720C housings shall have an environmental rating of NEMA enclosure Type 4X standard.

The CMS Model 800, 810, 820 housings shall have an environmental rating of NEMA 3R or better.

9. Water resistance requirement

The CMS Models CMS 700, 710, 720, 700C, 710C, 720C housing shall resist water infiltration during an intense water spray per NEMA 250 - Class 4X requirements. The CMS Models CMS 800, 810, 820 housing shall resist water infiltration during an intense water spray per NEMA 250 - Class 3R or better requirements.

10. Drain holes

Each CMS housing shall have 3/8" diameter water drain holes along the bottom side. The number of drain holes shall be sufficient in draining excess water quickly & effectively from inside the housing in the events of water intrusion.

11. Operating condition

The CMS 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 Models 700, 710, 700C, 710C, 800, and 810 housing shall be provided with 2 lifting eyes and the Models 720, 720C, and 820 shall be provided with one lifting eye to be used when placing the housing on the sign structure. Each lifting 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 Door

1. Access door

The CMS housing shall have one (1) access door, **EITHER** a left **OR** a right **OR** a front access door as specified by purchase order. This access door shall provide access to the Sign Equipment Rack, the 24 Volt and 5 Volt Power Supplies, all other required components, and ground cabinet termination points without the removal of any Pixel Matrix Modules.

2. Access door requirement

CMS Models CMS 700, 710, 720, 700C, 710C, and 720C: Each Access Door shall have a NEMA 4X rating.

CMS Models CMS 800, 810, and 820: Each Access Door shall have a NEMA 3R or better rating.

3. Door hinge

Access door shall have hinge(s)

4. Door latch

For CMS Models 700, 710, 720, 700C, 710C, 720C: Each Access Door latch shall be located on the bottom contrast border and shall be locked and released using a breaker bar with a ¾" drive.

For CMS Models 800, 810, 820: Access Door(s) shall have latches to provide secured closure.

5. Door catches

For CMS Models 700, 710, 720, 700C, 710C, and 720C: 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.

For CMS Models 800, 810, 820: Access Door(s) shall have mechanism to maintain secured open position when intended.

6. Door locking plate (For CMS Models 700, 710, 720, 700C, 710C, and 720C)

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 (For CMS Models 700, 710, 720, 700C, 710C, and 720C)

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

For CMS Models 700, 710, 720, 700C, 710C, and 720C: 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

For CMS Models 700, 710, 720, 700C, 710C, and 720C: Sign door latches' mechanism shall prevent damage caused by the user attempting to overturn the door handle.

11. Door locking bar

CMS Models 700, 710, 720, 700C, 710C, and 720C Access Door locking bar shall be no more than 4 feet from the bottom of the sign.

12. Door locking mechanism

CMS Models 700, 710, 720, 700C, 710C, and 720C Access Door latch shall be multi point locking mechanism with a minimum of 2 locking points.

13.11.5 Fan Box for CMS Model 700 Series

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/inch^2.

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.

2. Ventilation for CMS 800 Series

The CMS Model 800 Series must NOT have active ventilation

13.11.11 In-Sign Electrical Equipment Mounting Area

1. Electrical equipment mounting area

The CMS Models 700, 710, 720, 700C, 710C, and 720C 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.

The CMS Models 800, 810, and 820 shall have Sign Electrical Equipment Mounting Area inside the system to accommodate Left-Hand or Right-Hand CMS site installation options.

2. Electrical equipment for CMS Model 700 Series

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 Ethernet Switch (Active)
D. Industrially-rated Ethernet Switch (Spare, tested and unplugged from all cables)
E. 24-Volt Power Supplies

3. Electrical equipment rack mounting for CMS Model 700 Series

The Remote I/O Box, Ethernet Switches, and 24 Volt Power Supplies shall be rack mounted in the Equipment Mounting Area.

4. Electrical equipment removal & re-installation for CMS Model 700 Series

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.

5. Network cable labels for CMS Model 700 Series

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 for CMS Model 700 Series

The CMS Models 700 Series shall have two identification plates located on the inside of both the left and right Service Doors

2. Identification plate content for CMS Model 700 Series

Each identification plate shall have the following:
A. Caltrans' Contract Number (CTCN:)
B. Serial Number (SN:)
C. Specification that the CMS Models 700, 710, 720, 700C, 710C, and 720C was built to (SPEC:)
D. Purchase Order Number (PO #:)
E. Purchase Order Date (Date:)
F. Name of the manufacturer

3. Lettering for CMS Model 700 Series

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 for CMS Model 700 Series

Each plate shall be readable with the Service Door open.

5. Serial number for CMS Model 700 Series

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

CMS-<Sign Model Number>-<Sign Incremental Number>-<Month Year Built>-<Options>
CMS-XXXX-XXXX-MMMYYYY-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 **Month Year Built** shall consist of the 3-letter month and the 4-digit year that the sign was built.
D. If any Options are requested, then the CMS Models 700, 710, 720, 700C, 710C, and 720C 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 CMS Model 700 Series Identification Plate shall be formatted as shown:

Example:

CTCN: 123456789
SN: CMS-700C-0001-DEC2018-BHW
SPEC: TEES 2020

PO #: 12345 Date: 11/05/2020

Manufacturer: ABC Inc.

Figure 1. CMS Model 700 Series Sign Identification Plate

6. Sign identification plate visibility for CMS Model 800 Series

Sign Identification plate shall be large enough and readable with the Service Door open.

7. Serial number for CMS Model 800 Series

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

CMS-<Sign Model Number>-<Sign Incremental Number>-<Month Year Built>
CMS-XXXX-XXXX-MMMYYYY

8. Identification plate content for CMS Model 800 Series

Each identification plate shall at least have the following:

A. Manufacture:
B. Serial Number:
C. Shipping Date:
D. Enclosure Type (i.e. Type 3R Enclosure, Suitable For Wet Locations)
E. Power Supply / Alimentation: (i.e. 110/120VAC, 60Hz
F. Sign Maximum Power: (i.e. 3935W)
G. Spare GFCI/Outlet Power: (i.e. 4200W)

The CMS Model 800 Series Identification Plate shall be formatted as shown:

Example:

Manufacturer: ABC Inc. Serial Number: CMS-0800-0001-DEC2018 Shipping Date: 10-2019 Enclosure Type: Type 3R Enclosure Suitable for Wet Locations Power Supply / Alimentation: 100/120VAC, 60Hz Sign Maximum Power: 3935W Spare GFCI/Outlet Power: 4200W

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 November 5, 2020. When a NEMA enclosure for the FBI unit is not mounted to the structure of the CMS, install a disconnect means to the sign structure rated for the CMS' PDA. When a NEMA enclosure for the FBI unit is mounted to the CMS structure, mount the disconnect switch inside the NEMA enclosure. The disconnect means must be a NEMA 3R rated knife switch.

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

Each CMS system shall include the minimum electronic equipment mounted or installed in the Model 334LS ground cabinet:

A. Industrially-rated Sign Controller (if the sign controller is not built into the sign itself and is instead a stand-alone physical unit separate from the sign)

B. CMS Field Box Interface (FBI) unit
C. Rackmount industrially-rated or hardened managed ethernet switch
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. One (1) spare Remote I/O **(for CMS 700 Series ONLY)** unit and one (1) spare CMS FBI unit are to be rack mounted in the free rack spaces at the bottom most of the 334LS cabinet.
F. Quantity of three (3) approximately 300-feet long CAT-6A ethernet cables are to be wrapped & secured inside the ground cabinet. These cables are to be used to make connections between the ground cabinet and the CMS Sign at time of CMS Sign Installation.

3. Remote Power Management

The remote power management must be rack mounted in the controller cabinet. This device will power by the service panel assembly. All devices with a three-prong plug must be powered by remote power management.

4. CMS FBI mounting and power

The CMS FBI unit 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.

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 3R. Copyright@NEMA
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	NEMA * 3R Criteria	Procedure
Weather-Tight Enclosure	1st or 2nd Party Conformance Test	Mandatory	3.1.1	NEMA 250 3R	NEMA 250 4X
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	Conformance Statement	Optional	3.1.2.2		

Sign Operation					
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

* NEMA 3R applied to CMS Models 800, 810, and 820

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	Evaluation	Optional	4.4.2	

And Driver Module Locations				

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: IN-SIGN ETHERNET SWITCHES

13.15.1 General

1. Ethernet switch type and capability

Industrially-rated hardened Layer-2 Gigabit managed ethernet switch that supports ring protocols for fault tolerant operation.

2. Cooling and temperature range

Fanless cooling only with -40°C to 85°C operating temperature range.

13.15.2 Ethernet Interface

1. Number of ports

10/100/1000Base T(X) Ports (RJ45): Minimum 16 ports
100/1000Base SFP Ports: Minimum 4 ports

2. The In-Sign Network Switch shall comply with the following standards as a minimum:

IEEE 802.1D-2004 for Spanning Tree Protocol
IEEE 802.1p for Class of Service
IEEE 802.1Q for VLAN Tagging
IEEE 802.1s for Multiple Spanning Tree Protocol
IEEE 802.1w for Rapid Spanning Tree Protocol
IEEE 802.1X for authentication
IEEE 802.3 for 10BaseT
IEEE 802.3ab for 1000BaseT(X)

13.15.3 Advanced Security

1. The In-Sign Network Switch shall provide the following security features as a minimum:

Static and dynamic port security
Authentication: SNMPv3, 802.1x, RADIUS, TACACS+ AAA/3.0, web and MAC
Encryption: MD5, TLS, TACACS+ AAA/3.0
Access Control List (ACL) per IP/MAC/VLAN/TCP/UDP
Secure Web (HTTPS/SSL) and Telnet (SSH)
Rate limiting and multicast storm protection
IP Source Guard, DPCP Snooping and Option 82

13.15.4 Active and Spare Ethernet Switches

1. Switch Setup

Each CMS Models 700, 710, 720, 700C, 710C, and 720C sign will include 2 identical Ethernet switches. One of the 2 switches will be **ACTIVE** (i.e. in use) and the other a **SPARE**. Both switches shall be configured identically. Like the ACTIVE switch, the SPARE switch is to be tested for full functionality, then unplugged from all cables including the power source until such time that it needs to be used as a replacement for the failed ACTIVE switch

13.15.5 Rack Mounting

1. Mounting

The Ethernet Switches shall be mounted in the CMS Models 700, 710, 720, 700C, 710C, and 720C sign using mounting rails as specified in IEC 60715 or shall include complete sets of hardware which allow the switches to be mounted in an EIA 19-inch rack cage.

CHAPTER 13-SECTION 16: CMS Models 700 Series INTERNAL COMMUNICATIONS AVMS PROTOCOL

13.16.1 General

1. Models 700, 710, 720, 700C, 710C, 720C Protocol

The internal Communications AVMS Protocol shall be used for internal communications by the CMS Models 700, 710, 720, 700C, 710C, 720C systems

Internal Communications Models 700, 710, 720, 700C, 710C, 720C Protocol Version 2.0 Internal

CMS 700 (9 x 5) Set Buffer Command

Sign Controller → PMM

Byte	Description
1	Set Command [0x02]
2	Set Command Sub-Type [0x01]
3	Number of Bytes in Packet [0xBC]
4	Buffer Number [0x00 to 0x09]
5	Code Byte 1 [0xFF] (Future Use)
6	Code Byte 2 [0xFF] (Future Use)
7	Pixel 1 Red Level
8	Pixel 1 Green Level
9	Pixel 1 Blue Level
10	Pixel 1 Amber Level
11	Pixel 2 Red Level
12	Pixel 2 Green Level
13	Pixel 2 Blue Level
14	Pixel 2 Amber Level
15	Pixel 3 Red Level
16	Pixel 3 Green Level
17	Pixel 3 Blue Level
18	Pixel 3 Amber Level
19	Pixel 4 Red Level
20	Pixel 4 Green Level
21	Pixel 4 Blue Level
22	Pixel 4 Amber Level
23	Pixel 5 Red Level
24	Pixel 5 Green Level
25	Pixel 5 Blue Level
26	Pixel 5 Amber Level
27	Pixel 6 Red Level
28	Pixel 6 Green Level
29	Pixel 6 Blue Level
30	Pixel 6 Amber Level

31	Pixel 7 Red Level
32	Pixel 7 Green Level
33	Pixel 7 Blue Level
34	Pixel 7 Amber Level
35	Pixel 8 Red Level
36	Pixel 8 Green Level
37	Pixel 8 Blue Level
38	Pixel 8 Amber Level
39	Pixel 9 Red Level
40	Pixel 9 Green Level
41	Pixel 9 Blue Level
42	Pixel 9 Amber Level
43	Pixel 10 Red Level
44	Pixel 10 Green Level
45	Pixel 10 Blue Level
46	Pixel 10 Amber Level
47	Pixel 11 Red Level
48	Pixel 11 Green Level
49	Pixel 11 Blue Level
50	Pixel 11 Amber Level
51	Pixel 12 Red Level
52	Pixel 12 Green Level
53	Pixel 12 Blue Level
54	Pixel 12 Amber Level
55	Pixel 13 Red Level
56	Pixel 13 Green Level
57	Pixel 13 Blue Level
58	Pixel 13 Amber Level
59	Pixel 14 Red Level
60	Pixel 14 Green Level
61	Pixel 14 Blue Level
62	Pixel 14 Amber Level
63	Pixel 15 Red Level
64	Pixel 15 Green Level
65	Pixel 15 Blue Level
66	Pixel 15 Amber Level
67	Pixel 16 Red Level
68	Pixel 16 Green Level
69	Pixel 16 Blue Level
70	Pixel 16 Amber Level
71	Pixel 17 Red Level
72	Pixel 17 Green Level
73	Pixel 17 Blue Level
74	Pixel 17 Amber Level
75	Pixel 18 Red Level
76	Pixel 18 Green Level

77	Pixel 18 Blue Level
78	Pixel 18 Amber Level
79	Pixel 19 Red Level
80	Pixel 19 Green Level
81	Pixel 19 Blue Level
82	Pixel 19 Amber Level
83	Pixel 20 Red Level
84	Pixel 20 Green Level
85	Pixel 20 Blue Level
86	Pixel 20 Amber Level
87	Pixel 21 Red Level
88	Pixel 21 Green Level
89	Pixel 21 Blue Level
90	Pixel 21 Amber Level
91	Pixel 22 Red Level
92	Pixel 22 Green Level
93	Pixel 22 Blue Level
94	Pixel 22 Amber Level
95	Pixel 23 Red Level
96	Pixel 23 Green Level
97	Pixel 23 Blue Level
98	Pixel 23 Amber Level
99	Pixel 24 Red Level
100	Pixel 24 Green Level
101	Pixel 24 Blue Level
102	Pixel 24 Amber Level
103	Pixel 25 Red Level
104	Pixel 25 Green Level
105	Pixel 25 Blue Level
106	Pixel 25 Amber Level
107	Pixel 26 Red Level
108	Pixel 26 Green Level
109	Pixel 26 Blue Level
110	Pixel 26 Amber Level
111	Pixel 27 Red Level
112	Pixel 27 Green Level
113	Pixel 27 Blue Level
114	Pixel 27 Amber Level
115	Pixel 28 Red Level
116	Pixel 28 Green Level
117	Pixel 28 Blue Level
118	Pixel 28 Amber Level
119	Pixel 29 Red Level
120	Pixel 29 Green Level
121	Pixel 29 Blue Level
122	Pixel 29 Amber Level

123	Pixel 30 Red Level
124	Pixel 30 Green Level
125	Pixel 30 Blue Level
126	Pixel 30 Amber Level
127	Pixel 31 Red Level
128	Pixel 31 Green Level
129	Pixel 31 Blue Level
130	Pixel 31 Amber Level
131	Pixel 32 Red Level
132	Pixel 32 Green Level
133	Pixel 32 Blue Level
134	Pixel 32 Amber Level
135	Pixel 33 Red Level
136	Pixel 33 Green Level
137	Pixel 33 Blue Level
138	Pixel 33 Amber Level
139	Pixel 34 Red Level
140	Pixel 34 Green Level
141	Pixel 34 Blue Level
142	Pixel 34 Amber Level
143	Pixel 35 Red Level
144	Pixel 35 Green Level
145	Pixel 35 Blue Level
146	Pixel 35 Amber Level
147	Pixel 36 Red Level
148	Pixel 36 Green Level
149	Pixel 36 Blue Level
150	Pixel 36 Amber Level
151	Pixel 37 Red Level
152	Pixel 37 Green Level
153	Pixel 37 Blue Level
154	Pixel 37 Amber Level
155	Pixel 38 Red Level
156	Pixel 38 Green Level
157	Pixel 38 Blue Level
158	Pixel 38 Amber Level
159	Pixel 39 Red Level
160	Pixel 39 Green Level
161	Pixel 39 Blue Level
162	Pixel 39 Amber Level
163	Pixel 40 Red Level
164	Pixel 40 Green Level
165	Pixel 40 Blue Level
166	Pixel 40 Amber Level
167	Pixel 41 Red Level
168	Pixel 41 Green Level

169	Pixel 41 Blue Level
170	Pixel 41 Amber Level
171	Pixel 42 Red Level
172	Pixel 42 Green Level
173	Pixel 42 Blue Level
174	Pixel 42 Amber Level
175	Pixel 43 Red Level
176	Pixel 43 Green Level
177	Pixel 43 Blue Level
178	Pixel 43 Amber Level
179	Pixel 44 Red Level
180	Pixel 44 Green Level
181	Pixel 44 Blue Level
182	Pixel 44 Amber Level
183	Pixel 45 Red Level
184	Pixel 45 Green Level
185	Pixel 45 Blue Level
186	Pixel 45 Amber Level
187	FCS-16 Checksum (MSB)
188	FCS-16 Checksum (LSB)

CMS 700 (9 x 5) Set Buffer Response
PMM → Sign Controller

Byte	Description
1	Acknowledge [0x03]
2	Type Command that was sent (SET) [0x02]
3	Type of Set Message Sub-Type [0x01]
4	Number of Bytes in Packet [0x08]
5	PMM Node Number (LSB of IP Address Octet)
6	PMM Status [0 = Good, 1 = Message Error, 2 = PMM internal error]
7	FCS-16 Checksum (MSB)
8	FCS-16 Checksum (LSB)

CMS 700C (27 x 15) Set Buffer Command
Sign Controller → PMM

Byte	Description
1	Set Command [0x02]
2	Set Command Sub-Type [0x02]
3	Number of Bytes in Packet MSB [0x04]
4	Number of Bytes in Packet LSB [0xC8]
5	Buffer Number [0x00 to 0x09]
6	Code Byte 1 [0xFF] (Future Use)
7	Code Byte 2 [0xFF] (Future Use)
8	Pixel 1 Red Level
9	Pixel 1 Green Level
10	Pixel 1 Blue Level

11	Pixel 2 Red Level
12	Pixel 2 Green Level
13	Pixel 2 Blue Level
14	Pixel 3 Red Level
15	Pixel 3 Green Level
16	Pixel 3 Blue Level
17	Pixel 4 Red Level
18	Pixel 4 Green Level
19	Pixel 4 Blue Level
20	Pixel 5 Red Level
21	Pixel 5 Green Level
22	Pixel 5 Blue Level
23	Pixel 6 Red Level
24	Pixel 6 Green Level
25	Pixel 6 Blue Level
26	Pixel 7 Red Level
27	Pixel 7 Green Level
28	Pixel 7 Blue Level
29	Pixel 8 Red Level
30	Pixel 8 Green Level
31	Pixel 8 Blue Level
32	Pixel 9 Red Level
33	Pixel 9 Green Level
34	Pixel 9 Blue Level
35	Pixel 10 Red Level
36	Pixel 10 Green Level
37	Pixel 10 Blue Level
38	Pixel 11 Red Level
39	Pixel 11 Green Level
40	Pixel 11 Blue Level
41	Pixel 12 Red Level
42	Pixel 12 Green Level
43	Pixel 12 Blue Level
44	Pixel 13 Red Level
45	Pixel 13 Green Level
46	Pixel 13 Blue Level
47	Pixel 14 Red Level
48	Pixel 14 Green Level
49	Pixel 14 Blue Level
50	Pixel 15 Red Level
51	Pixel 15 Green Level
52	Pixel 15 Blue Level
53	Pixel 16 Red Level
54	Pixel 16 Green Level
55	Pixel 16 Blue Level
56	Pixel 17 Red Level

57	Pixel 17 Green Level
58	Pixel 17 Blue Level
59	Pixel 18 Red Level
60	Pixel 18 Green Level
61	Pixel 18 Blue Level
62	Pixel 19 Red Level
63	Pixel 19 Green Level
64	Pixel 19 Blue Level
65	Pixel 20 Red Level
66	Pixel 20 Green Level
67	Pixel 20 Blue Level
68	Pixel 21 Red Level
69	Pixel 21 Green Level
70	Pixel 21 Blue Level
71	Pixel 22 Red Level
72	Pixel 22 Green Level
73	Pixel 22 Blue Level
74	Pixel 23 Red Level
75	Pixel 23 Green Level
76	Pixel 23 Blue Level
77	Pixel 24 Red Level
78	Pixel 24 Green Level
79	Pixel 24 Blue Level
80	Pixel 25 Red Level
81	Pixel 25 Green Level
82	Pixel 25 Blue Level
83	Pixel 26 Red Level
84	Pixel 26 Green Level
85	Pixel 26 Blue Level
86	Pixel 27 Red Level
87	Pixel 27 Green Level
88	Pixel 27 Blue Level
89	Pixel 28 Red Level
90	Pixel 28 Green Level
91	Pixel 28 Blue Level
92	Pixel 29 Red Level
93	Pixel 29 Green Level
94	Pixel 29 Blue Level
95	Pixel 30 Red Level
96	Pixel 30 Green Level
97	Pixel 30 Blue Level
98	Pixel 31 Red Level
99	Pixel 31 Green Level
100	Pixel 31 Blue Level
101	Pixel 32 Red Level
102	Pixel 32 Green Level

103	Pixel 32 Blue Level
104	Pixel 33 Red Level
105	Pixel 33 Green Level
106	Pixel 33 Blue Level
107	Pixel 34 Red Level
108	Pixel 34 Green Level
109	Pixel 34 Blue Level
110	Pixel 35 Red Level
111	Pixel 35 Green Level
112	Pixel 35 Blue Level
113	Pixel 36 Red Level
114	Pixel 36 Green Level
115	Pixel 36 Blue Level
116	Pixel 37 Red Level
117	Pixel 37 Green Level
118	Pixel 37 Blue Level
119	Pixel 38 Red Level
120	Pixel 38 Green Level
121	Pixel 38 Blue Level
122	Pixel 39 Red Level
123	Pixel 39 Green Level
124	Pixel 39 Blue Level
125	Pixel 40 Red Level
126	Pixel 40 Green Level
127	Pixel 40 Blue Level
128	Pixel 41 Red Level
129	Pixel 41 Green Level
130	Pixel 41 Blue Level
131	Pixel 42 Red Level
132	Pixel 42 Green Level
133	Pixel 42 Blue Level
134	Pixel 43 Red Level
135	Pixel 43 Green Level
136	Pixel 43 Blue Level
137	Pixel 44 Red Level
138	Pixel 44 Green Level
139	Pixel 44 Blue Level
140	Pixel 45 Red Level
141	Pixel 45 Green Level
142	Pixel 45 Blue Level
143	Pixel 46 Red Level
144	Pixel 46 Green Level
145	Pixel 46 Blue Level
146	Pixel 47 Red Level
147	Pixel 47 Green Level
148	Pixel 47 Blue Level

149	Pixel 48 Red Level
150	Pixel 48 Green Level
151	Pixel 48 Blue Level
152	Pixel 49 Red Level
153	Pixel 49 Green Level
154	Pixel 49 Blue Level
155	Pixel 50 Red Level
156	Pixel 50 Green Level
157	Pixel 50 Blue Level
158	Pixel 51 Red Level
159	Pixel 51 Green Level
160	Pixel 51 Blue Level
161	Pixel 52 Red Level
162	Pixel 52 Green Level
163	Pixel 52 Blue Level
164	Pixel 53 Red Level
165	Pixel 53 Green Level
166	Pixel 53 Blue Level
167	Pixel 54 Red Level
168	Pixel 54 Green Level
169	Pixel 54 Blue Level
170	Pixel 55 Red Level
171	Pixel 55 Green Level
172	Pixel 55 Blue Level
173	Pixel 56 Red Level
174	Pixel 56 Green Level
175	Pixel 56 Blue Level
176	Pixel 57 Red Level
177	Pixel 57 Green Level
178	Pixel 57 Blue Level
179	Pixel 58 Red Level
180	Pixel 58 Green Level
181	Pixel 58 Blue Level
182	Pixel 59 Red Level
183	Pixel 59 Green Level
184	Pixel 59 Blue Level
185	Pixel 60 Red Level
186	Pixel 60 Green Level
187	Pixel 60 Blue Level
188	Pixel 61 Red Level
189	Pixel 61 Green Level
190	Pixel 61 Blue Level
191	Pixel 62 Red Level
192	Pixel 62 Green Level
193	Pixel 62 Blue Level
194	Pixel 63 Red Level

195	Pixel 63 Green Level
196	Pixel 63 Blue Level
197	Pixel 64 Red Level
198	Pixel 64 Green Level
199	Pixel 64 Blue Level
200	Pixel 65 Red Level
201	Pixel 65 Green Level
202	Pixel 65 Blue Level
203	Pixel 66 Red Level
204	Pixel 66 Green Level
205	Pixel 66 Blue Level
206	Pixel 67 Red Level
207	Pixel 67 Green Level
208	Pixel 67 Blue Level
209	Pixel 68 Red Level
210	Pixel 68 Green Level
211	Pixel 68 Blue Level
212	Pixel 69 Red Level
213	Pixel 69 Green Level
214	Pixel 69 Blue Level
215	Pixel 70 Red Level
216	Pixel 70 Green Level
217	Pixel 70 Blue Level
218	Pixel 71 Red Level
219	Pixel 71 Green Level
220	Pixel 71 Blue Level
221	Pixel 72 Red Level
222	Pixel 72 Green Level
223	Pixel 72 Blue Level
224	Pixel 73 Red Level
225	Pixel 73 Green Level
226	Pixel 73 Blue Level
227	Pixel 74 Red Level
228	Pixel 74 Green Level
229	Pixel 74 Blue Level
230	Pixel 75 Red Level
231	Pixel 75 Green Level
232	Pixel 75 Blue Level
233	Pixel 76 Red Level
234	Pixel 76 Green Level
235	Pixel 76 Blue Level
236	Pixel 77 Red Level
237	Pixel 77 Green Level
238	Pixel 77 Blue Level
239	Pixel 78 Red Level
240	Pixel 78 Green Level

241	Pixel 78 Blue Level
242	Pixel 79 Red Level
243	Pixel 79 Green Level
244	Pixel 79 Blue Level
245	Pixel 80 Red Level
246	Pixel 80 Green Level
247	Pixel 80 Blue Level
248	Pixel 81 Red Level
249	Pixel 81 Green Level
250	Pixel 81 Blue Level
251	Pixel 82 Red Level
252	Pixel 82 Green Level
253	Pixel 82 Blue Level
254	Pixel 83 Red Level
255	Pixel 83 Green Level
256	Pixel 83 Blue Level
257	Pixel 84 Red Level
258	Pixel 84 Green Level
259	Pixel 84 Blue Level
260	Pixel 85 Red Level
261	Pixel 85 Green Level
262	Pixel 85 Blue Level
263	Pixel 86 Red Level
264	Pixel 86 Green Level
265	Pixel 86 Blue Level
266	Pixel 87 Red Level
267	Pixel 87 Green Level
268	Pixel 87 Blue Level
269	Pixel 88 Red Level
270	Pixel 88 Green Level
271	Pixel 88 Blue Level
272	Pixel 89 Red Level
273	Pixel 89 Green Level
274	Pixel 89 Blue Level
275	Pixel 90 Red Level
276	Pixel 90 Green Level
277	Pixel 90 Blue Level
278	Pixel 91 Red Level
279	Pixel 91 Green Level
280	Pixel 91 Blue Level
281	Pixel 92 Red Level
282	Pixel 92 Green Level
283	Pixel 92 Blue Level
284	Pixel 93 Red Level
285	Pixel 93 Green Level
286	Pixel 93 Blue Level

287	Pixel 94 Red Level
288	Pixel 94 Green Level
289	Pixel 94 Blue Level
290	Pixel 95 Red Level
291	Pixel 95 Green Level
292	Pixel 95 Blue Level
293	Pixel 96 Red Level
294	Pixel 96 Green Level
295	Pixel 96 Blue Level
296	Pixel 97 Red Level
297	Pixel 97 Green Level
298	Pixel 97 Blue Level
299	Pixel 98 Red Level
300	Pixel 98 Green Level
301	Pixel 98 Blue Level
302	Pixel 99 Red Level
303	Pixel 99 Green Level
304	Pixel 99 Blue Level
305	Pixel 100 Red Level
306	Pixel 100 Green Level
307	Pixel 100 Blue Level
308	Pixel 101 Red Level
309	Pixel 101 Green Level
310	Pixel 101 Blue Level
311	Pixel 102 Red Level
312	Pixel 102 Green Level
313	Pixel 102 Blue Level
314	Pixel 103 Red Level
315	Pixel 103 Green Level
316	Pixel 103 Blue Level
317	Pixel 104 Red Level
318	Pixel 104 Green Level
319	Pixel 104 Blue Level
320	Pixel 105 Red Level
321	Pixel 105 Green Level
322	Pixel 105 Blue Level
323	Pixel 106 Red Level
324	Pixel 106 Green Level
325	Pixel 106 Blue Level
326	Pixel 107 Red Level
327	Pixel 107 Green Level
328	Pixel 107 Blue Level
329	Pixel 108 Red Level
330	Pixel 108 Green Level
331	Pixel 108 Blue Level
332	Pixel 109 Red Level

333	Pixel 109 Green Level
334	Pixel 109 Blue Level
335	Pixel 110 Red Level
336	Pixel 110 Green Level
337	Pixel 110 Blue Level
338	Pixel 111 Red Level
339	Pixel 111 Green Level
340	Pixel 111 Blue Level
341	Pixel 112 Red Level
342	Pixel 112 Green Level
343	Pixel 112 Blue Level
344	Pixel 113 Red Level
345	Pixel 113 Green Level
346	Pixel 113 Blue Level
347	Pixel 114 Red Level
348	Pixel 114 Green Level
349	Pixel 114 Blue Level
350	Pixel 115 Red Level
351	Pixel 115 Green Level
352	Pixel 115 Blue Level
353	Pixel 116 Red Level
354	Pixel 116 Green Level
355	Pixel 116 Blue Level
356	Pixel 117 Red Level
357	Pixel 117 Green Level
358	Pixel 117 Blue Level
359	Pixel 118 Red Level
360	Pixel 118 Green Level
361	Pixel 118 Blue Level
362	Pixel 119 Red Level
363	Pixel 119 Green Level
364	Pixel 119 Blue Level
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366	Pixel 120 Green Level
367	Pixel 120 Blue Level
368	Pixel 121 Red Level
369	Pixel 121 Green Level
370	Pixel 121 Blue Level
371	Pixel 122 Red Level
372	Pixel 122 Green Level
373	Pixel 122 Blue Level
374	Pixel 123 Red Level
375	Pixel 123 Green Level
376	Pixel 123 Blue Level
377	Pixel 124 Red Level
378	Pixel 124 Green Level

379	Pixel 124 Blue Level
380	Pixel 125 Red Level
381	Pixel 125 Green Level
382	Pixel 125 Blue Level
383	Pixel 126 Red Level
384	Pixel 126 Green Level
385	Pixel 126 Blue Level
386	Pixel 127 Red Level
387	Pixel 127 Green Level
388	Pixel 127 Blue Level
389	Pixel 128 Red Level
390	Pixel 128 Green Level
391	Pixel 128 Blue Level
392	Pixel 129 Red Level
393	Pixel 129 Green Level
394	Pixel 129 Blue Level
395	Pixel 130 Red Level
396	Pixel 130 Green Level
397	Pixel 130 Blue Level
398	Pixel 131 Red Level
399	Pixel 131 Green Level
400	Pixel 131 Blue Level
401	Pixel 132 Red Level
402	Pixel 132 Green Level
403	Pixel 132 Blue Level
404	Pixel 133 Red Level
405	Pixel 133 Green Level
406	Pixel 133 Blue Level
407	Pixel 134 Red Level
408	Pixel 134 Green Level
409	Pixel 134 Blue Level
410	Pixel 135 Red Level
411	Pixel 135 Green Level
412	Pixel 135 Blue Level
413	Pixel 136 Red Level
414	Pixel 136 Green Level
415	Pixel 136 Blue Level
416	Pixel 137 Red Level
417	Pixel 137 Green Level
418	Pixel 137 Blue Level
419	Pixel 138 Red Level
420	Pixel 138 Green Level
421	Pixel 138 Blue Level
422	Pixel 139 Red Level
423	Pixel 139 Green Level
424	Pixel 139 Blue Level

425	Pixel 140 Red Level
426	Pixel 140 Green Level
427	Pixel 140 Blue Level
428	Pixel 141 Red Level
429	Pixel 141 Green Level
430	Pixel 141 Blue Level
431	Pixel 142 Red Level
432	Pixel 142 Green Level
433	Pixel 142 Blue Level
434	Pixel 143 Red Level
435	Pixel 143 Green Level
436	Pixel 143 Blue Level
437	Pixel 144 Red Level
438	Pixel 144 Green Level
439	Pixel 144 Blue Level
440	Pixel 145 Red Level
441	Pixel 145 Green Level
442	Pixel 145 Blue Level
443	Pixel 146 Red Level
444	Pixel 146 Green Level
445	Pixel 146 Blue Level
446	Pixel 147 Red Level
447	Pixel 147 Green Level
448	Pixel 147 Blue Level
449	Pixel 148 Red Level
450	Pixel 148 Green Level
451	Pixel 148 Blue Level
452	Pixel 149 Red Level
453	Pixel 149 Green Level
454	Pixel 149 Blue Level
455	Pixel 150 Red Level
456	Pixel 150 Green Level
457	Pixel 150 Blue Level
458	Pixel 151 Red Level
459	Pixel 151 Green Level
460	Pixel 151 Blue Level
461	Pixel 152 Red Level
462	Pixel 152 Green Level
463	Pixel 152 Blue Level
464	Pixel 153 Red Level
465	Pixel 153 Green Level
466	Pixel 153 Blue Level
467	Pixel 154 Red Level
468	Pixel 154 Green Level
469	Pixel 154 Blue Level
470	Pixel 155 Red Level

471	Pixel 155 Green Level
472	Pixel 155 Blue Level
473	Pixel 156 Red Level
474	Pixel 156 Green Level
475	Pixel 156 Blue Level
476	Pixel 157 Red Level
477	Pixel 157 Green Level
478	Pixel 157 Blue Level
479	Pixel 158 Red Level
480	Pixel 158 Green Level
481	Pixel 158 Blue Level
482	Pixel 159 Red Level
483	Pixel 159 Green Level
484	Pixel 159 Blue Level
485	Pixel 160 Red Level
486	Pixel 160 Green Level
487	Pixel 160 Blue Level
488	Pixel 161 Red Level
489	Pixel 161 Green Level
490	Pixel 161 Blue Level
491	Pixel 162 Red Level
492	Pixel 162 Green Level
493	Pixel 162 Blue Level
494	Pixel 163 Red Level
495	Pixel 163 Green Level
496	Pixel 163 Blue Level
497	Pixel 164 Red Level
498	Pixel 164 Green Level
499	Pixel 164 Blue Level
500	Pixel 165 Red Level
501	Pixel 165 Green Level
502	Pixel 165 Blue Level
503	Pixel 166 Red Level
504	Pixel 166 Green Level
505	Pixel 166 Blue Level
506	Pixel 167 Red Level
507	Pixel 167 Green Level
508	Pixel 167 Blue Level
509	Pixel 168 Red Level
510	Pixel 168 Green Level
511	Pixel 168 Blue Level
512	Pixel 169 Red Level
513	Pixel 169 Green Level
514	Pixel 169 Blue Level
515	Pixel 170 Red Level
516	Pixel 170 Green Level

517	Pixel 170 Blue Level
518	Pixel 171 Red Level
519	Pixel 171 Green Level
520	Pixel 171 Blue Level
521	Pixel 172 Red Level
522	Pixel 172 Green Level
523	Pixel 172 Blue Level
524	Pixel 173 Red Level
525	Pixel 173 Green Level
526	Pixel 173 Blue Level
527	Pixel 174 Red Level
528	Pixel 174 Green Level
529	Pixel 174 Blue Level
530	Pixel 175 Red Level
531	Pixel 175 Green Level
532	Pixel 175 Blue Level
533	Pixel 176 Red Level
534	Pixel 176 Green Level
535	Pixel 176 Blue Level
536	Pixel 177 Red Level
537	Pixel 177 Green Level
538	Pixel 177 Blue Level
539	Pixel 178 Red Level
540	Pixel 178 Green Level
541	Pixel 178 Blue Level
542	Pixel 179 Red Level
543	Pixel 179 Green Level
544	Pixel 179 Blue Level
545	Pixel 180 Red Level
546	Pixel 180 Green Level
547	Pixel 180 Blue Level
548	Pixel 181 Red Level
549	Pixel 181 Green Level
550	Pixel 181 Blue Level
551	Pixel 182 Red Level
552	Pixel 182 Green Level
553	Pixel 182 Blue Level
554	Pixel 183 Red Level
555	Pixel 183 Green Level
556	Pixel 183 Blue Level
557	Pixel 184 Red Level
558	Pixel 184 Green Level
559	Pixel 184 Blue Level
560	Pixel 185 Red Level
561	Pixel 185 Green Level
562	Pixel 185 Blue Level

563	Pixel 186 Red Level
564	Pixel 186 Green Level
565	Pixel 186 Blue Level
566	Pixel 187 Red Level
567	Pixel 187 Green Level
568	Pixel 187 Blue Level
569	Pixel 188 Red Level
570	Pixel 188 Green Level
571	Pixel 188 Blue Level
572	Pixel 189 Red Level
573	Pixel 189 Green Level
574	Pixel 189 Blue Level
575	Pixel 190 Red Level
576	Pixel 190 Green Level
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578	Pixel 191 Red Level
579	Pixel 191 Green Level
580	Pixel 191 Blue Level
581	Pixel 192 Red Level
582	Pixel 192 Green Level
583	Pixel 192 Blue Level
584	Pixel 193 Red Level
585	Pixel 193 Green Level
586	Pixel 193 Blue Level
587	Pixel 194 Red Level
588	Pixel 194 Green Level
589	Pixel 194 Blue Level
590	Pixel 195 Red Level
591	Pixel 195 Green Level
592	Pixel 195 Blue Level
593	Pixel 196 Red Level
594	Pixel 196 Green Level
595	Pixel 196 Blue Level
596	Pixel 197 Red Level
597	Pixel 197 Green Level
598	Pixel 197 Blue Level
599	Pixel 198 Red Level
600	Pixel 198 Green Level
601	Pixel 198 Blue Level
602	Pixel 199 Red Level
603	Pixel 199 Green Level
604	Pixel 199 Blue Level
605	Pixel 200 Red Level
606	Pixel 200 Green Level
607	Pixel 200 Blue Level
608	Pixel 201 Red Level

609	Pixel 201 Green Level
610	Pixel 201 Blue Level
611	Pixel 202 Red Level
612	Pixel 202 Green Level
613	Pixel 202 Blue Level
614	Pixel 203 Red Level
615	Pixel 203 Green Level
616	Pixel 203 Blue Level
617	Pixel 204 Red Level
618	Pixel 204 Green Level
619	Pixel 204 Blue Level
620	Pixel 205 Red Level
621	Pixel 205 Green Level
622	Pixel 205 Blue Level
623	Pixel 206 Red Level
624	Pixel 206 Green Level
625	Pixel 206 Blue Level
626	Pixel 207 Red Level
627	Pixel 207 Green Level
628	Pixel 207 Blue Level
629	Pixel 208 Red Level
630	Pixel 208 Green Level
631	Pixel 208 Blue Level
632	Pixel 209 Red Level
633	Pixel 209 Green Level
634	Pixel 209 Blue Level
635	Pixel 210 Red Level
636	Pixel 210 Green Level
637	Pixel 210 Blue Level
638	Pixel 211 Red Level
639	Pixel 211 Green Level
640	Pixel 211 Blue Level
641	Pixel 212 Red Level
642	Pixel 213 Green Level
643	Pixel 213 Blue Level
645	Pixel 213 Red Level
646	Pixel 213 Green Level
647	Pixel 213 Blue Level
648	Pixel 214 Red Level
649	Pixel 214 Green Level
650	Pixel 214 Blue Level
651	Pixel 215 Red Level
652	Pixel 215 Green Level
653	Pixel 215 Blue Level
654	Pixel 216 Red Level
655	Pixel 216 Green Level

656	Pixel 216 Blue Level
657	Pixel 217 Red Level
658	Pixel 217 Green Level
659	Pixel 217 Blue Level
660	Pixel 218 Red Level
661	Pixel 218 Green Level
662	Pixel 218 Blue Level
663	Pixel 219 Red Level
664	Pixel 219 Green Level
665	Pixel 219 Blue Level
666	Pixel 220 Red Level
667	Pixel 220 Green Level
668	Pixel 220 Blue Level
669	Pixel 220 Red Level
670	Pixel 221 Green Level
671	Pixel 221 Blue Level
672	Pixel 222 Red Level
673	Pixel 222 Green Level
674	Pixel 222 Blue Level
675	Pixel 223 Red Level
676	Pixel 223 Green Level
677	Pixel 223 Blue Level
678	Pixel 224 Red Level
679	Pixel 224 Green Level
680	Pixel 224 Blue Level
681	Pixel 225 Red Level
682	Pixel 225 Green Level
683	Pixel 225 Blue Level
684	Pixel 226 Red Level
685	Pixel 226 Green Level
686	Pixel 226 Blue Level
687	Pixel 227 Red Level
688	Pixel 227 Green Level
689	Pixel 227 Blue Level
690	Pixel 228 Red Level
691	Pixel 228 Green Level
692	Pixel 228 Blue Level
693	Pixel 229 Red Level
694	Pixel 229 Green Level
695	Pixel 229 Blue Level
696	Pixel 230 Red Level
697	Pixel 230 Green Level
698	Pixel 230 Blue Level
699	Pixel 231 Red Level
700	Pixel 231 Green Level
701	Pixel 231 Blue Level

702	Pixel 232 Red Level
703	Pixel 232 Green Level
704	Pixel 232 Blue Level
705	Pixel 233 Red Level
706	Pixel 233 Green Level
707	Pixel 233 Blue Level
708	Pixel 234 Red Level
709	Pixel 234 Green Level
710	Pixel 234 Blue Level
711	Pixel 235 Red Level
712	Pixel 235 Green Level
713	Pixel 235 Blue Level
714	Pixel 236 Red Level
715	Pixel 236 Green Level
716	Pixel 236 Blue Level
717	Pixel 237 Red Level
718	Pixel 237 Green Level
719	Pixel 237 Blue Level
720	Pixel 238 Red Level
721	Pixel 238 Green Level
722	Pixel 238 Blue Level
723	Pixel 239 Red Level
724	Pixel 239 Green Level
725	Pixel 239 Blue Level
726	Pixel 240 Red Level
727	Pixel 240 Green Level
728	Pixel 240 Blue Level
729	Pixel 241 Red Level
730	Pixel 241 Green Level
731	Pixel 241 Blue Level
732	Pixel 242 Red Level
733	Pixel 242 Green Level
734	Pixel 242 Blue Level
735	Pixel 243 Red Level
736	Pixel 243 Green Level
737	Pixel 243 Blue Level
738	Pixel 244 Red Level
739	Pixel 244 Green Level
740	Pixel 244 Blue Level
741	Pixel 245 Red Level
742	Pixel 245 Green Level
743	Pixel 245 Blue Level
744	Pixel 246 Red Level
745	Pixel 246 Green Level
746	Pixel 246 Blue Level
747	Pixel 247 Red Level

748	Pixel 247 Green Level
749	Pixel 247 Blue Level
750	Pixel 248 Red Level
751	Pixel 248 Green Level
752	Pixel 248 Blue Level
753	Pixel 249 Red Level
754	Pixel 249 Green Level
755	Pixel 249 Blue Level
756	Pixel 250 Red Level
757	Pixel 250 Green Level
758	Pixel 250 Blue Level
759	Pixel 251 Red Level
760	Pixel 251 Green Level
761	Pixel 251 Blue Level
762	Pixel 252 Red Level
763	Pixel 252 Green Level
764	Pixel 252 Blue Level
765	Pixel 253 Red Level
766	Pixel 253 Green Level
767	Pixel 253 Blue Level
768	Pixel 254 Red Level
769	Pixel 254 Green Level
770	Pixel 254 Blue Level
771	Pixel 255 Red Level
772	Pixel 255 Green Level
773	Pixel 255 Blue Level
774	Pixel 256 Red Level
775	Pixel 256 Green Level
776	Pixel 256 Blue Level
777	Pixel 257 Red Level
778	Pixel 257 Green Level
779	Pixel 257 Blue Level
780	Pixel 258 Red Level
781	Pixel 258 Green Level
782	Pixel 258 Blue Level
783	Pixel 259 Red Level
784	Pixel 259 Green Level
785	Pixel 259 Blue Level
786	Pixel 260 Red Level
787	Pixel 260 Green Level
788	Pixel 260 Blue Level
789	Pixel 261 Red Level
790	Pixel 261 Green Level
791	Pixel 261 Blue Level
792	Pixel 262 Red Level
793	Pixel 262 Green Level

794	Pixel 262 Blue Level
795	Pixel 263 Red Level
796	Pixel 263 Green Level
797	Pixel 263 Blue Level
798	Pixel 264 Red Level
799	Pixel 264 Green Level
800	Pixel 264 Blue Level
801	Pixel 265 Red Level
802	Pixel 265 Green Level
803	Pixel 265 Blue Level
804	Pixel 266 Red Level
805	Pixel 266 Green Level
806	Pixel 266 Blue Level
807	Pixel 267 Red Level
808	Pixel 267 Green Level
809	Pixel 267 Blue Level
810	Pixel 268 Red Level
811	Pixel 268 Green Level
812	Pixel 268 Blue Level
813	Pixel 269 Red Level
814	Pixel 269 Green Level
815	Pixel 269 Blue Level
816	Pixel 270 Red Level
817	Pixel 270 Green Level
818	Pixel 270 Blue Level
819	Pixel 271 Red Level
820	Pixel 271 Green Level
821	Pixel 271 Blue Level
822	Pixel 272 Red Level
823	Pixel 272 Green Level
824	Pixel 272 Blue Level
825	Pixel 273 Red Level
826	Pixel 273 Green Level
827	Pixel 273 Blue Level
828	Pixel 274 Red Level
829	Pixel 274 Green Level
830	Pixel 274 Blue Level
831	Pixel 275 Red Level
832	Pixel 275 Green Level
833	Pixel 275 Blue Level
834	Pixel 276 Red Level
835	Pixel 276 Green Level
836	Pixel 276 Blue Level
837	Pixel 277 Red Level
838	Pixel 277 Green Level
839	Pixel 277 Blue Level

840	Pixel 278 Red Level
841	Pixel 278 Green Level
842	Pixel 278 Blue Level
843	Pixel 279 Red Level
844	Pixel 279 Green Level
845	Pixel 279 Blue Level
846	Pixel 280 Red Level
847	Pixel 280 Green Level
848	Pixel 280 Blue Level
849	Pixel 281 Red Level
850	Pixel 281 Green Level
851	Pixel 281 Blue Level
852	Pixel 282 Red Level
853	Pixel 282 Green Level
854	Pixel 282 Blue Level
855	Pixel 283 Red Level
856	Pixel 283 Green Level
857	Pixel 283 Blue Level
858	Pixel 284 Red Level
859	Pixel 284 Green Level
860	Pixel 284 Blue Level
861	Pixel 285 Red Level
862	Pixel 285 Green Level
863	Pixel 285 Blue Level
864	Pixel 286 Red Level
865	Pixel 286 Green Level
866	Pixel 286 Blue Level
867	Pixel 287 Red Level
868	Pixel 287 Green Level
869	Pixel 287 Blue Level
870	Pixel 288 Red Level
871	Pixel 288 Green Level
872	Pixel 288 Blue Level
873	Pixel 289 Red Level
874	Pixel 289 Green Level
875	Pixel 289 Blue Level
876	Pixel 280 Red Level
877	Pixel 290 Green Level
878	Pixel 290 Blue Level
879	Pixel 291 Red Level
880	Pixel 291 Green Level
881	Pixel 291 Blue Level
882	Pixel 292 Red Level
883	Pixel 292 Green Level
884	Pixel 292 Blue Level
885	Pixel 293 Red Level

886	Pixel 293 Green Level
887	Pixel 293 Blue Level
888	Pixel 294 Red Level
889	Pixel 294 Green Level
890	Pixel 294 Blue Level
891	Pixel 295 Red Level
892	Pixel 295 Green Level
893	Pixel 295 Blue Level
894	Pixel 296 Red Level
895	Pixel 296 Green Level
896	Pixel 296 Blue Level
897	Pixel 297 Red Level
898	Pixel 297 Green Level
899	Pixel 297 Blue Level
900	Pixel 298 Red Level
901	Pixel 298 Green Level
901	Pixel 298 Blue Level
902	Pixel 299 Red Level
903	Pixel 299 Green Level
904	Pixel 299 Blue Level
905	Pixel 300 Red Level
906	Pixel 300 Green Level
907	Pixel 300 Blue Level
908	Pixel 301 Red Level
909	Pixel 301 Green Level
910	Pixel 301 Blue Level
911	Pixel 302 Red Level
912	Pixel 302 Green Level
913	Pixel 302 Blue Level
914	Pixel 303 Red Level
915	Pixel 303 Green Level
916	Pixel 303 Blue Level
917	Pixel 304 Red Level
918	Pixel 304 Green Level
919	Pixel 304 Blue Level
920	Pixel 305 Red Level
921	Pixel 305 Green Level
922	Pixel 305 Blue Level
923	Pixel 306 Red Level
924	Pixel 306 Green Level
925	Pixel 306 Blue Level
926	Pixel 307 Red Level
927	Pixel 307 Green Level
928	Pixel 307 Blue Level
929	Pixel 308 Red Level
930	Pixel 308 Green Level

931	Pixel 308 Blue Level
932	Pixel 309 Red Level
933	Pixel 309 Green Level
934	Pixel 309 Blue Level
935	Pixel 310 Red Level
936	Pixel 310 Green Level
937	Pixel 310 Blue Level
938	Pixel 311 Red Level
939	Pixel 311 Green Level
940	Pixel 311 Blue Level
941	Pixel 312 Red Level
942	Pixel 312 Green Level
943	Pixel 312 Blue Level
944	Pixel 313 Red Level
945	Pixel 313 Green Level
946	Pixel 313 Blue Level
947	Pixel 314 Red Level
948	Pixel 314 Green Level
949	Pixel 314 Blue Level
950	Pixel 315 Red Level
951	Pixel 315 Green Level
952	Pixel 315 Blue Level
953	Pixel 316 Red Level
954	Pixel 316 Green Level
955	Pixel 316 Blue Level
956	Pixel 317 Red Level
957	Pixel 317 Green Level
958	Pixel 317 Blue Level
959	Pixel 318 Red Level
960	Pixel 318 Green Level
961	Pixel 318 Blue Level
962	Pixel 319 Red Level
963	Pixel 319 Green Level
964	Pixel 319 Blue Level
965	Pixel 320 Red Level
966	Pixel 320 Green Level
967	Pixel 320 Blue Level
968	Pixel 321 Red Level
969	Pixel 321 Green Level
970	Pixel 321 Blue Level
971	Pixel 322 Red Level
972	Pixel 322 Green Level
973	Pixel 322 Blue Level
974	Pixel 323 Red Level
975	Pixel 323 Green Level
976	Pixel 323 Blue Level

977	Pixel 324 Red Level
978	Pixel 324 Green Level
979	Pixel 324 Blue Level
980	Pixel 325 Red Level
981	Pixel 325 Green Level
982	Pixel 325 Blue Level
983	Pixel 326 Red Level
984	Pixel 326 Green Level
985	Pixel 326 Blue Level
986	Pixel 327 Red Level
987	Pixel 327 Green Level
988	Pixel 327 Blue Level
989	Pixel 328 Red Level
990	Pixel 328 Green Level
991	Pixel 328 Blue Level
992	Pixel 329 Red Level
993	Pixel 329 Green Level
994	Pixel 329 Blue Level
995	Pixel 330 Red Level
996	Pixel 330 Green Level
997	Pixel 330 Blue Level
998	Pixel 331 Red Level
999	Pixel 331 Green Level
1000	Pixel 331 Blue Level
1001	Pixel 332 Red Level
1002	Pixel 332 Green Level
1003	Pixel 332 Blue Level
1004	Pixel 333 Red Level
1005	Pixel 333 Green Level
1006	Pixel 333 Blue Level
1007	Pixel 334 Red Level
1008	Pixel 334 Green Level
1009	Pixel 334 Blue Level
1010	Pixel 335 Red Level
1011	Pixel 335 Green Level
1012	Pixel 335 Blue Level
1013	Pixel 336 Red Level
1014	Pixel 336 Green Level
1015	Pixel 336 Blue Level
1016	Pixel 337 Red Level
1017	Pixel 337 Green Level
1018	Pixel 337 Blue Level
1019	Pixel 338 Red Level
1020	Pixel 338 Green Level
1021	Pixel 338 Blue Level
1022	Pixel 339 Red Level

1023	Pixel 339 Green Level
1024	Pixel 339 Blue Level
1025	Pixel 340 Red Level
1026	Pixel 340 Green Level
1027	Pixel 340 Blue Level
1028	Pixel 341 Red Level
1029	Pixel 341 Green Level
1030	Pixel 341 Blue Level
1031	Pixel 342 Red Level
1032	Pixel 342 Green Level
1033	Pixel 342 Blue Level
1034	Pixel 343 Red Level
1035	Pixel 343 Green Level
1036	Pixel 343 Blue Level
1037	Pixel 344 Red Level
1038	Pixel 344 Green Level
1039	Pixel 344 Blue Level
1040	Pixel 345 Red Level
1041	Pixel 345 Green Level
1042	Pixel 345 Blue Level
1043	Pixel 346 Red Level
1044	Pixel 346 Green Level
1045	Pixel 346 Blue Level
1046	Pixel 347 Red Level
1047	Pixel 347 Green Level
1048	Pixel 347 Blue Level
1049	Pixel 348 Red Level
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1051	Pixel 348 Blue Level
1052	Pixel 349 Red Level
1053	Pixel 349 Green Level
1054	Pixel 349 Blue Level
1055	Pixel 350 Red Level
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1057	Pixel 350 Blue Level
1058	Pixel 351 Red Level
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1060	Pixel 351 Blue Level
1061	Pixel 352 Red Level
1062	Pixel 352 Green Level
1063	Pixel 352 Blue Level
1064	Pixel 353 Red Level
1065	Pixel 353 Green Level
1066	Pixel 353 Blue Level
1067	Pixel 354 Red Level
1068	Pixel 354 Green Level

1069	Pixel 354 Blue Level
1070	Pixel 355 Red Level
1071	Pixel 355 Green Level
1072	Pixel 355 Blue Level
1073	Pixel 356 Red Level
1074	Pixel 356 Green Level
1075	Pixel 356 Blue Level
1076	Pixel 357 Red Level
1077	Pixel 357 Green Level
1078	Pixel 357 Blue Level
1079	Pixel 358 Red Level
1080	Pixel 358 Green Level
1081	Pixel 358 Blue Level
1082	Pixel 359 Red Level
1083	Pixel 359 Green Level
1084	Pixel 359 Blue Level
1085	Pixel 360 Red Level
1086	Pixel 360 Green Level
1087	Pixel 360 Blue Level
1088	Pixel 361 Red Level
1089	Pixel 361 Green Level
1090	Pixel 361 Blue Level
1091	Pixel 362 Red Level
1092	Pixel 362 Green Level
1093	Pixel 362 Blue Level
1094	Pixel 363 Red Level
1095	Pixel 363 Green Level
1096	Pixel 363 Blue Level
1097	Pixel 364 Red Level
1098	Pixel 364 Green Level
1099	Pixel 364 Blue Level
1100	Pixel 365 Red Level
1101	Pixel 365 Green Level
1102	Pixel 365 Blue Level
1103	Pixel 366 Red Level
1104	Pixel 366 Green Level
1105	Pixel 366 Blue Level
1106	Pixel 367 Red Level
1107	Pixel 367 Green Level
1108	Pixel 367 Blue Level
1109	Pixel 368 Red Level
1110	Pixel 368 Green Level
1111	Pixel 368 Blue Level
1112	Pixel 369 Red Level
1113	Pixel 369 Green Level
1114	Pixel 369 Blue Level

1115	Pixel 370 Red Level
1116	Pixel 370 Green Level
1117	Pixel 370 Blue Level
1118	Pixel 371 Red Level
1119	Pixel 371 Green Level
1120	Pixel 371 Blue Level
1121	Pixel 372 Red Level
1122	Pixel 372 Green Level
1123	Pixel 372 Blue Level
1124	Pixel 373 Red Level
1125	Pixel 373 Green Level
1126	Pixel 373 Blue Level
1127	Pixel 374 Red Level
1128	Pixel 374 Green Level
1129	Pixel 374 Blue Level
1130	Pixel 375 Red Level
1131	Pixel 375 Green Level
1132	Pixel 375 Blue Level
1133	Pixel 376 Red Level
1134	Pixel 376 Green Level
1135	Pixel 376 Blue Level
1136	Pixel 377 Red Level
1137	Pixel 377 Green Level
1138	Pixel 377 Blue Level
1139	Pixel 378 Red Level
1140	Pixel 378 Green Level
1141	Pixel 378 Blue Level
1142	Pixel 379 Red Level
1143	Pixel 379 Green Level
1144	Pixel 379 Blue Level
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1148	Pixel 381 Red Level
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1150	Pixel 381 Blue Level
1151	Pixel 382 Red Level
1152	Pixel 382 Green Level
1153	Pixel 382 Blue Level
1154	Pixel 383 Red Level
1155	Pixel 383 Green Level
1156	Pixel 383 Blue Level
1157	Pixel 384 Red Level
1158	Pixel 384 Green Level
1159	Pixel 384 Blue Level
1160	Pixel 385 Red Level

1161	Pixel 385 Green Level
1162	Pixel 385 Blue Level
1163	Pixel 386 Red Level
1164	Pixel 386 Green Level
1165	Pixel 386 Blue Level
1166	Pixel 387 Red Level
1167	Pixel 387 Green Level
1168	Pixel 387 Blue Level
1169	Pixel 388 Red Level
1170	Pixel 388 Green Level
1171	Pixel 388 Blue Level
1172	Pixel 389 Red Level
1173	Pixel 389 Green Level
1174	Pixel 389 Blue Level
1175	Pixel 390 Red Level
1176	Pixel 390 Green Level
1177	Pixel 390 Blue Level
1178	Pixel 391 Red Level
1179	Pixel 391 Green Level
1180	Pixel 391 Blue Level
1181	Pixel 392 Red Level
1182	Pixel 392 Green Level
1183	Pixel 392 Blue Level
1184	Pixel 393 Red Level
1185	Pixel 393 Green Level
1186	Pixel 393 Blue Level
1187	Pixel 394 Red Level
1188	Pixel 394 Green Level
1189	Pixel 394 Blue Level
1190	Pixel 395 Red Level
1191	Pixel 395 Green Level
1192	Pixel 395 Blue Level
1193	Pixel 396 Red Level
1194	Pixel 396 Green Level
1195	Pixel 396 Blue Level
1196	Pixel 397 Red Level
1197	Pixel 397 Green Level
1198	Pixel 397 Blue Level
1199	Pixel 398 Red Level
1200	Pixel 398 Green Level
1201	Pixel 398 Blue Level
1202	Pixel 399 Red Level
1203	Pixel 399 Green Level
1204	Pixel 399 Blue Level
1205	Pixel 400 Red Level
1206	Pixel 400 Green Level

1207	Pixel 400 Blue Level
1208	Pixel 401 Red Level
1209	Pixel 401 Green Level
1210	Pixel 401 Blue Level
1211	Pixel 402 Red Level
1212	Pixel 402 Green Level
1213	Pixel 402 Blue Level
1214	Pixel 403 Red Level
1215	Pixel 403 Green Level
1216	Pixel 403 Blue Level
1217	Pixel 404 Red Level
1218	Pixel 404 Green Level
1219	Pixel 404 Blue Level
1220	Pixel 405 Red Level
1221	Pixel 405 Green Level
1222	Pixel 405 Blue Level
1223	FCS-16 Checksum (MSB)
1224	FCS-16 Checksum (LSB)

CMS 700C (27 x 15) Set Buffer Response

PMM → Sign Controller

Byte	Description
1	Acknowledge [0x03]
2	Type Command that was sent (SET) [0x02]
3	Type of Set Message Sub-Type [0x02]
4	Number of Bytes in Packet [0x08]
5	PMM Node Number (LSB of IP Address Octet)
6	PMM Status [0 = Good, 1 = Message Error, 2 = PMM internal error]
7	FCS-16 Checksum (MSB)
8	FCS-16 Checksum (LSB)

PMM Set Packet

CMS 700 (9 x 5) Get Status Command

Sign Controller → PMM

Byte	Description
1	Get Command [0x01]
2	Get Request Sub-Type [0x01]
3	Number of Bytes in Packet [0x06]
4	Buffer Number [0x00 to 0x09, 253, 254, 255]
5	FCS-16 Checksum (MSB)
6	FCS-16 Checksum (LSB)

CMS 700 (9 x 5) Get Status Response

PMM → Sign Controller

Byte	Description
1	Acknowledge [0x03]
2	Type Command that was sent (GET) [0x01]

3	Type of Get Request Sub-Type [0x01]
4	Number of Bytes in Packet [0xBF]
5	Buffer Number [0x00 to 0x09, 253, 254, 255]
6	PMM Node Number (LSB of IP Address Octet)
7	Health Status [0 = Module Good, 1 = Module Error)
8	Code Byte 1 [0xFF] (Future Use)
9	Caltrans Firmware Revision Number [0x00]
10	Pixel 1 Red Level
11	Pixel 1 Green Level
12	Pixel 1 Blue Level
13	Pixel 1 Amber Level
14	Pixel 2 Red Level
15	Pixel 2 Green Level
16	Pixel 2 Blue Level
17	Pixel 2 Amber Level
18	Pixel 3 Red Level
19	Pixel 3 Green Level
20	Pixel 3 Blue Level
21	Pixel 3 Amber Level
22	Pixel 4 Red Level
23	Pixel 4 Green Level
24	Pixel 4 Blue Level
25	Pixel 4 Amber Level
26	Pixel 5 Red Level
27	Pixel 5 Green Level
28	Pixel 5 Blue Level
29	Pixel 5 Amber Level
30	Pixel 6 Red Level
31	Pixel 6 Green Level
32	Pixel 6 Blue Level
33	Pixel 6 Amber Level
34	Pixel 7 Red Level
35	Pixel 7 Green Level
36	Pixel 7 Blue Level
37	Pixel 7 Amber Level
38	Pixel 8 Red Level
39	Pixel 8 Green Level
40	Pixel 8 Blue Level
41	Pixel 8 Amber Level
42	Pixel 9 Red Level
43	Pixel 9 Green Level
44	Pixel 9 Blue Level
45	Pixel 9 Amber Level
46	Pixel 10 Red Level
47	Pixel 10 Green Level
48	Pixel 10 Blue Level

49	Pixel 10 Amber Level
50	Pixel 11 Red Level
51	Pixel 11 Green Level
52	Pixel 11 Blue Level
53	Pixel 11 Amber Level
54	Pixel 12 Red Level
55	Pixel 12 Green Level
56	Pixel 12 Blue Level
57	Pixel 12 Amber Level
58	Pixel 13 Red Level
59	Pixel 13 Green Level
60	Pixel 13 Blue Level
61	Pixel 13 Amber Level
62	Pixel 14 Red Level
63	Pixel 14 Green Level
64	Pixel 14 Blue Level
65	Pixel 14 Amber Level
66	Pixel 15 Red Level
67	Pixel 15 Green Level
68	Pixel 15 Blue Level
69	Pixel 15 Amber Level
70	Pixel 16 Red Level
71	Pixel 16 Green Level
72	Pixel 16 Blue Level
73	Pixel 16 Amber Level
74	Pixel 17 Red Level
75	Pixel 17 Green Level
76	Pixel 17 Blue Level
77	Pixel 17 Amber Level
78	Pixel 18 Red Level
79	Pixel 18 Green Level
80	Pixel 18 Blue Level
81	Pixel 18 Amber Level
82	Pixel 19 Red Level
83	Pixel 19 Green Level
84	Pixel 19 Blue Level
85	Pixel 19 Amber Level
86	Pixel 20 Red Level
87	Pixel 20 Green Level
88	Pixel 20 Blue Level
89	Pixel 20 Amber Level
90	Pixel 21 Red Level
91	Pixel 21 Green Level
92	Pixel 21 Blue Level
93	Pixel 21 Amber Level
94	Pixel 22 Red Level

95	Pixel 22 Green Level
96	Pixel 22 Blue Level
97	Pixel 22 Amber Level
98	Pixel 23 Red Level
99	Pixel 23 Green Level
100	Pixel 23 Blue Level
101	Pixel 23 Amber Level
102	Pixel 24 Red Level
103	Pixel 24 Green Level
104	Pixel 24 Blue Level
105	Pixel 24 Amber Level
106	Pixel 25 Red Level
107	Pixel 25 Green Level
108	Pixel 25 Blue Level
109	Pixel 25 Amber Level
110	Pixel 26 Red Level
111	Pixel 26 Green Level
112	Pixel 26 Blue Level
113	Pixel 26 Amber Level
114	Pixel 27 Red Level
115	Pixel 27 Green Level
116	Pixel 27 Blue Level
117	Pixel 27 Amber Level
118	Pixel 28 Red Level
119	Pixel 28 Green Level
120	Pixel 28 Blue Level
121	Pixel 28 Amber Level
122	Pixel 29 Red Level
123	Pixel 29 Green Level
124	Pixel 29 Blue Level
125	Pixel 29 Amber Level
126	Pixel 30 Red Level
127	Pixel 30 Green Level
128	Pixel 30 Blue Level
129	Pixel 30 Amber Level
130	Pixel 31 Red Level
131	Pixel 31 Green Level
132	Pixel 31 Blue Level
133	Pixel 31 Amber Level
134	Pixel 32 Red Level
135	Pixel 32 Green Level
136	Pixel 32 Blue Level
137	Pixel 32 Amber Level
138	Pixel 33 Red Level
139	Pixel 33 Green Level
140	Pixel 33 Blue Level

141	Pixel 33 Amber Level
142	Pixel 34 Red Level
143	Pixel 34 Green Level
144	Pixel 34 Blue Level
145	Pixel 34 Amber Level
146	Pixel 35 Red Level
147	Pixel 35 Green Level
148	Pixel 35 Blue Level
149	Pixel 35 Amber Level
150	Pixel 36 Red Level
151	Pixel 36 Green Level
152	Pixel 36 Blue Level
153	Pixel 36 Amber Level
154	Pixel 37 Red Level
155	Pixel 37 Green Level
156	Pixel 37 Blue Level
157	Pixel 37 Amber Level
158	Pixel 38 Red Level
159	Pixel 38 Green Level
160	Pixel 38 Blue Level
161	Pixel 38 Amber Level
162	Pixel 39 Red Level
163	Pixel 39 Green Level
164	Pixel 39 Blue Level
165	Pixel 39 Amber Level
166	Pixel 40 Red Level
167	Pixel 40 Green Level
168	Pixel 40 Blue Level
169	Pixel 40 Amber Level
170	Pixel 41 Red Level
171	Pixel 41 Green Level
172	Pixel 41 Blue Level
173	Pixel 41 Amber Level
174	Pixel 42 Red Level
175	Pixel 42 Green Level
176	Pixel 42 Blue Level
177	Pixel 42 Amber Level
178	Pixel 43 Red Level
179	Pixel 43 Green Level
180	Pixel 43 Blue Level
181	Pixel 43 Amber Level
182	Pixel 44 Red Level
183	Pixel 44 Green Level
184	Pixel 44 Blue Level
185	Pixel 44 Amber Level
186	Pixel 45 Red Level

187	Pixel 45 Green Level
188	Pixel 45 Blue Level
189	Pixel 45 Amber Level
190	FCS-16 Checksum (MSB)
191	FCS-16 Checksum (LSB)

CMS 700C (27 x 15) Get Status Command
Sign Controller → PMM

Byte	Description
1	Get Command [0x01]
2	Get Request Sub-Type [0x02]
3	Number of Bytes in Packet [0x06]
4	Buffer Number [0x00 to 0x09, 253, 254, 255]
5	FCS-16 Checksum (MSB)
6	FCS-16 Checksum (LSB)

CMS 700C (27 x 15) Get Status Response
PMM→ Sign Controller

Byte	Description
1	Acknowledge [0x03]
2	Type Command that was sent (GET) [0x01]
3	Type of Get Request Sub-Type [0x02]
4	Number of Bytes in Packet (MSB) [0x04]
5	Number of Bytes in Packet (LSB) [0xCB]
6	Buffer Number [0x00 to 0x09, 253, 254, 255]
7	PMM Node Number (LSB of IP Address Octet)
8	Health Status [0 = Module Good, 1 = Module Error)
9	Code Byte 1 [0xFF] (Future Use)
10	Caltrans Firmware Revision Number [0x00]
11	Pixel 1 Red Level
12	Pixel 1 Green Level
13	Pixel 1 Blue Level
14	Pixel 2 Red Level
15	Pixel 2 Green Level
16	Pixel 2 Blue Level
17	Pixel 3 Red Level
18	Pixel 3 Green Level
19	Pixel 3 Blue Level
20	Pixel 4 Red Level
21	Pixel 4 Green Level
22	Pixel 4 Blue Level
23	Pixel 5 Red Level
24	Pixel 5 Green Level
25	Pixel 5 Blue Level
26	Pixel 6 Red Level
27	Pixel 6 Green Level

28	Pixel 6 Blue Level
29	Pixel 7 Red Level
30	Pixel 7 Green Level
31	Pixel 7 Blue Level
32	Pixel 8 Red Level
33	Pixel 8 Green Level
34	Pixel 8 Blue Level
35	Pixel 9 Red Level
36	Pixel 9 Green Level
37	Pixel 9 Blue Level
38	Pixel 10 Red Level
39	Pixel 10 Green Level
40	Pixel 10 Blue Level
41	Pixel 11 Red Level
42	Pixel 11 Green Level
43	Pixel 11 Blue Level
44	Pixel 12 Red Level
45	Pixel 12 Green Level
46	Pixel 12 Blue Level
47	Pixel 13 Red Level
48	Pixel 13 Green Level
49	Pixel 13 Blue Level
50	Pixel 14 Red Level
51	Pixel 14 Green Level
52	Pixel 14 Blue Level
53	Pixel 15 Red Level
54	Pixel 15 Green Level
55	Pixel 15 Blue Level
56	Pixel 16 Red Level
57	Pixel 16 Green Level
58	Pixel 16 Blue Level
59	Pixel 17 Red Level
60	Pixel 17 Green Level
61	Pixel 17 Blue Level
62	Pixel 18 Red Level
63	Pixel 18 Green Level
64	Pixel 18 Blue Level
65	Pixel 19 Red Level
66	Pixel 19 Green Level
67	Pixel 19 Blue Level
68	Pixel 20 Red Level
69	Pixel 20 Green Level
70	Pixel 20 Blue Level
71	Pixel 21 Red Level
72	Pixel 21 Green Level
73	Pixel 21 Blue Level

74	Pixel 22 Red Level
75	Pixel 22 Green Level
76	Pixel 22 Blue Level
77	Pixel 23 Red Level
78	Pixel 23 Green Level
79	Pixel 23 Blue Level
80	Pixel 24 Red Level
81	Pixel 24 Green Level
82	Pixel 24 Blue Level
83	Pixel 25 Red Level
84	Pixel 25 Green Level
85	Pixel 25 Blue Level
86	Pixel 26 Red Level
87	Pixel 26 Green Level
88	Pixel 26 Blue Level
89	Pixel 27 Red Level
90	Pixel 27 Green Level
91	Pixel 27 Blue Level
92	Pixel 28 Red Level
93	Pixel 28 Green Level
94	Pixel 28 Blue Level
95	Pixel 29 Red Level
96	Pixel 29 Green Level
97	Pixel 29 Blue Level
98	Pixel 30 Red Level
99	Pixel 30 Green Level
100	Pixel 30 Blue Level
101	Pixel 31 Red Level
102	Pixel 31 Green Level
103	Pixel 31 Blue Level
104	Pixel 32 Red Level
105	Pixel 32 Green Level
106	Pixel 32 Blue Level
107	Pixel 33 Red Level
108	Pixel 33 Green Level
109	Pixel 33 Blue Level
110	Pixel 34 Red Level
111	Pixel 34 Green Level
112	Pixel 34 Blue Level
113	Pixel 35 Red Level
114	Pixel 35 Green Level
115	Pixel 35 Blue Level
116	Pixel 36 Red Level
117	Pixel 36 Green Level
118	Pixel 36 Blue Level
119	Pixel 37 Red Level

120	Pixel 37 Green Level
121	Pixel 37 Blue Level
122	Pixel 38 Red Level
123	Pixel 38 Green Level
124	Pixel 38 Blue Level
125	Pixel 39 Red Level
126	Pixel 39 Green Level
127	Pixel 39 Blue Level
128	Pixel 40 Red Level
129	Pixel 40 Green Level
130	Pixel 40 Blue Level
131	Pixel 41 Red Level
132	Pixel 41 Green Level
133	Pixel 41 Blue Level
134	Pixel 42 Red Level
135	Pixel 42 Green Level
136	Pixel 42 Blue Level
137	Pixel 43 Red Level
138	Pixel 43 Green Level
139	Pixel 43 Blue Level
140	Pixel 44 Red Level
141	Pixel 44 Green Level
142	Pixel 44 Blue Level
143	Pixel 45 Red Level
144	Pixel 45 Green Level
145	Pixel 45 Blue Level
146	Pixel 46 Red Level
147	Pixel 46 Green Level
148	Pixel 46 Blue Level
149	Pixel 47 Red Level
150	Pixel 47 Green Level
151	Pixel 47 Blue Level
152	Pixel 48 Red Level
153	Pixel 48 Green Level
154	Pixel 48 Blue Level
155	Pixel 49 Red Level
156	Pixel 49 Green Level
157	Pixel 49 Blue Level
158	Pixel 50 Red Level
159	Pixel 50 Green Level
160	Pixel 50 Blue Level
161	Pixel 51 Red Level
162	Pixel 51 Green Level
163	Pixel 51 Blue Level
164	Pixel 52 Red Level
165	Pixel 52 Green Level

166	Pixel 52 Blue Level
167	Pixel 53 Red Level
168	Pixel 53 Green Level
169	Pixel 53 Blue Level
170	Pixel 54 Red Level
171	Pixel 54 Green Level
172	Pixel 54 Blue Level
173	Pixel 55 Red Level
174	Pixel 55 Green Level
175	Pixel 55 Blue Level
176	Pixel 56 Red Level
177	Pixel 56 Green Level
178	Pixel 56 Blue Level
179	Pixel 57 Red Level
180	Pixel 57 Green Level
181	Pixel 57 Blue Level
182	Pixel 58 Red Level
183	Pixel 58 Green Level
184	Pixel 58 Blue Level
185	Pixel 59 Red Level
186	Pixel 59 Green Level
187	Pixel 59 Blue Level
188	Pixel 60 Red Level
189	Pixel 60 Green Level
190	Pixel 60 Blue Level
191	Pixel 61 Red Level
192	Pixel 61 Green Level
193	Pixel 61 Blue Level
194	Pixel 62 Red Level
195	Pixel 62 Green Level
196	Pixel 62 Blue Level
197	Pixel 63 Red Level
198	Pixel 63 Green Level
199	Pixel 63 Blue Level
200	Pixel 64 Red Level
201	Pixel 64 Green Level
202	Pixel 64 Blue Level
203	Pixel 65 Red Level
204	Pixel 65 Green Level
205	Pixel 65 Blue Level
206	Pixel 66 Red Level
207	Pixel 66 Green Level
208	Pixel 66 Blue Level
209	Pixel 67 Red Level
210	Pixel 67 Green Level
211	Pixel 67 Blue Level

212	Pixel 68 Red Level
213	Pixel 68 Green Level
214	Pixel 68 Blue Level
215	Pixel 69 Red Level
216	Pixel 69 Green Level
217	Pixel 69 Blue Level
218	Pixel 70 Red Level
219	Pixel 70 Green Level
220	Pixel 70 Blue Level
221	Pixel 71 Red Level
222	Pixel 71 Green Level
223	Pixel 71 Blue Level
224	Pixel 72 Red Level
225	Pixel 72 Green Level
226	Pixel 72 Blue Level
227	Pixel 73 Red Level
228	Pixel 73 Green Level
229	Pixel 73 Blue Level
230	Pixel 74 Red Level
231	Pixel 74 Green Level
232	Pixel 74 Blue Level
233	Pixel 75 Red Level
234	Pixel 75 Green Level
235	Pixel 75 Blue Level
236	Pixel 76 Red Level
237	Pixel 76 Green Level
238	Pixel 76 Blue Level
239	Pixel 77 Red Level
240	Pixel 77 Green Level
241	Pixel 77 Blue Level
242	Pixel 78 Red Level
243	Pixel 78 Green Level
244	Pixel 78 Blue Level
245	Pixel 79 Red Level
246	Pixel 79 Green Level
247	Pixel 79 Blue Level
248	Pixel 80 Red Level
249	Pixel 80 Green Level
250	Pixel 80 Blue Level
251	Pixel 81 Red Level
252	Pixel 81 Green Level
253	Pixel 81 Blue Level
254	Pixel 82 Red Level
255	Pixel 82 Green Level
256	Pixel 82 Blue Level
257	Pixel 83 Red Level

258	Pixel 83 Green Level
259	Pixel 83 Blue Level
260	Pixel 84 Red Level
261	Pixel 84 Green Level
262	Pixel 84 Blue Level
263	Pixel 85 Red Level
264	Pixel 85 Green Level
265	Pixel 85 Blue Level
266	Pixel 86 Red Level
267	Pixel 86 Green Level
268	Pixel 86 Blue Level
269	Pixel 87 Red Level
270	Pixel 87 Green Level
271	Pixel 87 Blue Level
272	Pixel 88 Red Level
273	Pixel 88 Green Level
274	Pixel 88 Blue Level
275	Pixel 89 Red Level
276	Pixel 89 Green Level
277	Pixel 89 Blue Level
278	Pixel 90 Red Level
279	Pixel 90 Green Level
280	Pixel 90 Blue Level
281	Pixel 91 Red Level
282	Pixel 91 Green Level
283	Pixel 91 Blue Level
284	Pixel 92 Red Level
285	Pixel 92 Green Level
286	Pixel 92 Blue Level
287	Pixel 93 Red Level
288	Pixel 93 Green Level
289	Pixel 93 Blue Level
290	Pixel 94 Red Level
291	Pixel 94 Green Level
292	Pixel 94 Blue Level
293	Pixel 95 Red Level
294	Pixel 95 Green Level
295	Pixel 95 Blue Level
296	Pixel 96 Red Level
297	Pixel 96 Green Level
298	Pixel 96 Blue Level
299	Pixel 97 Red Level
300	Pixel 97 Green Level
301	Pixel 97 Blue Level
302	Pixel 98 Red Level
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304	Pixel 98 Blue Level
305	Pixel 99 Red Level
306	Pixel 99 Green Level
307	Pixel 99 Blue Level
308	Pixel 100 Red Level
309	Pixel 100 Green Level
310	Pixel 100 Blue Level
311	Pixel 101 Red Level
312	Pixel 101 Green Level
313	Pixel 101 Blue Level
314	Pixel 102 Red Level
315	Pixel 102 Green Level
316	Pixel 102 Blue Level
317	Pixel 103 Red Level
318	Pixel 103 Green Level
319	Pixel 103 Blue Level
320	Pixel 104 Red Level
321	Pixel 104 Green Level
322	Pixel 104 Blue Level
323	Pixel 105 Red Level
324	Pixel 105 Green Level
325	Pixel 105 Blue Level
326	Pixel 106 Red Level
327	Pixel 106 Green Level
328	Pixel 106 Blue Level
329	Pixel 107 Red Level
330	Pixel 107 Green Level
331	Pixel 107 Blue Level
332	Pixel 108 Red Level
333	Pixel 108 Green Level
334	Pixel 108 Blue Level
335	Pixel 109 Red Level
336	Pixel 109 Green Level
337	Pixel 109 Blue Level
338	Pixel 110 Red Level
339	Pixel 110 Green Level
340	Pixel 110 Blue Level
341	Pixel 111 Red Level
342	Pixel 111 Green Level
343	Pixel 111 Blue Level
344	Pixel 112 Red Level
345	Pixel 112 Green Level
346	Pixel 112 Blue Level
347	Pixel 113 Red Level
348	Pixel 113 Green Level
349	Pixel 113 Blue Level

350	Pixel 114 Red Level
351	Pixel 114 Green Level
352	Pixel 114 Blue Level
353	Pixel 115 Red Level
354	Pixel 115 Green Level
355	Pixel 115 Blue Level
356	Pixel 116 Red Level
357	Pixel 116 Green Level
358	Pixel 116 Blue Level
359	Pixel 117 Red Level
360	Pixel 117 Green Level
361	Pixel 117 Blue Level
362	Pixel 118 Red Level
363	Pixel 118 Green Level
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365	Pixel 119 Red Level
366	Pixel 119 Green Level
367	Pixel 119 Blue Level
368	Pixel 120 Red Level
369	Pixel 120 Green Level
370	Pixel 120 Blue Level
371	Pixel 121 Red Level
372	Pixel 121 Green Level
373	Pixel 121 Blue Level
374	Pixel 122 Red Level
375	Pixel 122 Green Level
376	Pixel 122 Blue Level
377	Pixel 123 Red Level
378	Pixel 123 Green Level
379	Pixel 123 Blue Level
380	Pixel 124 Red Level
381	Pixel 124 Green Level
382	Pixel 124 Blue Level
383	Pixel 125 Red Level
384	Pixel 125 Green Level
385	Pixel 125 Blue Level
386	Pixel 126 Red Level
387	Pixel 126 Green Level
388	Pixel 126 Blue Level
389	Pixel 127 Red Level
390	Pixel 127 Green Level
391	Pixel 127 Blue Level
392	Pixel 128 Red Level
393	Pixel 128 Green Level
394	Pixel 128 Blue Level
395	Pixel 129 Red Level

396	Pixel 129 Green Level
397	Pixel 129 Blue Level
398	Pixel 130 Red Level
399	Pixel 130 Green Level
400	Pixel 130 Blue Level
401	Pixel 131 Red Level
402	Pixel 131 Green Level
403	Pixel 131 Blue Level
404	Pixel 132 Red Level
405	Pixel 132 Green Level
406	Pixel 132 Blue Level
407	Pixel 133 Red Level
408	Pixel 133 Green Level
409	Pixel 133 Blue Level
410	Pixel 134 Red Level
411	Pixel 134 Green Level
412	Pixel 134 Blue Level
413	Pixel 135 Red Level
414	Pixel 135 Green Level
415	Pixel 135 Blue Level
416	Pixel 136 Red Level
417	Pixel 136 Green Level
418	Pixel 136 Blue Level
419	Pixel 137 Red Level
420	Pixel 137 Green Level
421	Pixel 137 Blue Level
422	Pixel 138 Red Level
423	Pixel 138 Green Level
424	Pixel 138 Blue Level
425	Pixel 139 Red Level
426	Pixel 139 Green Level
427	Pixel 139 Blue Level
428	Pixel 140 Red Level
429	Pixel 140 Green Level
430	Pixel 140 Blue Level
431	Pixel 141 Red Level
432	Pixel 141 Green Level
433	Pixel 141 Blue Level
434	Pixel 142 Red Level
435	Pixel 142 Green Level
436	Pixel 142 Blue Level
437	Pixel 143 Red Level
438	Pixel 143 Green Level
439	Pixel 143 Blue Level
440	Pixel 144 Red Level
441	Pixel 144 Green Level

442	Pixel 144 Blue Level
443	Pixel 145 Red Level
444	Pixel 145 Green Level
445	Pixel 145 Blue Level
446	Pixel 146 Red Level
447	Pixel 146 Green Level
448	Pixel 146 Blue Level
449	Pixel 147 Red Level
450	Pixel 147 Green Level
451	Pixel 147 Blue Level
452	Pixel 148 Red Level
453	Pixel 148 Green Level
454	Pixel 148 Blue Level
455	Pixel 149 Red Level
456	Pixel 149 Green Level
457	Pixel 149 Blue Level
458	Pixel 150 Red Level
459	Pixel 150 Green Level
460	Pixel 150 Blue Level
461	Pixel 151 Red Level
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463	Pixel 151 Blue Level
464	Pixel 152 Red Level
465	Pixel 152 Green Level
466	Pixel 152 Blue Level
467	Pixel 153 Red Level
468	Pixel 153 Green Level
469	Pixel 153 Blue Level
470	Pixel 154 Red Level
471	Pixel 154 Green Level
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473	Pixel 155 Red Level
474	Pixel 155 Green Level
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479	Pixel 157 Red Level
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482	Pixel 158 Red Level
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484	Pixel 158 Blue Level
485	Pixel 159 Red Level
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494	Pixel 162 Red Level
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497	Pixel 163 Red Level
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506	Pixel 166 Red Level
507	Pixel 166 Green Level
508	Pixel 166 Blue Level
509	Pixel 167 Red Level
510	Pixel 167 Green Level
511	Pixel 167 Blue Level
512	Pixel 168 Red Level
513	Pixel 168 Green Level
514	Pixel 168 Blue Level
515	Pixel 169 Red Level
516	Pixel 169 Green Level
517	Pixel 169 Blue Level
518	Pixel 170 Red Level
519	Pixel 170 Green Level
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521	Pixel 171 Red Level
522	Pixel 171 Green Level
523	Pixel 171 Blue Level
524	Pixel 172 Red Level
525	Pixel 172 Green Level
526	Pixel 172 Blue Level
527	Pixel 173 Red Level
528	Pixel 173 Green Level
529	Pixel 173 Blue Level
530	Pixel 174 Red Level
531	Pixel 174 Green Level
532	Pixel 174 Blue Level
533	Pixel 175 Red Level

534	Pixel 175 Green Level
535	Pixel 175 Blue Level
536	Pixel 176 Red Level
537	Pixel 176 Green Level
538	Pixel 176 Blue Level
539	Pixel 177 Red Level
540	Pixel 177 Green Level
541	Pixel 177 Blue Level
542	Pixel 178 Red Level
543	Pixel 178 Green Level
544	Pixel 178 Blue Level
545	Pixel 179 Red Level
546	Pixel 179 Green Level
547	Pixel 179 Blue Level
548	Pixel 180 Red Level
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550	Pixel 180 Blue Level
551	Pixel 181 Red Level
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554	Pixel 182 Red Level
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557	Pixel 183 Red Level
558	Pixel 183 Green Level
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560	Pixel 184 Red Level
561	Pixel 184 Green Level
562	Pixel 184 Blue Level
563	Pixel 185 Red Level
564	Pixel 185 Green Level
565	Pixel 185 Blue Level
566	Pixel 186 Red Level
567	Pixel 186 Green Level
568	Pixel 186 Blue Level
569	Pixel 187 Red Level
570	Pixel 187 Green Level
571	Pixel 187 Blue Level
572	Pixel 188 Red Level
573	Pixel 188 Green Level
574	Pixel 188 Blue Level
575	Pixel 189 Red Level
576	Pixel 189 Green Level
577	Pixel 189 Blue Level
578	Pixel 190 Red Level
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580	Pixel 190 Blue Level
581	Pixel 191 Red Level
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584	Pixel 192 Red Level
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586	Pixel 192 Blue Level
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589	Pixel 193 Blue Level
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607	Pixel 199 Blue Level
608	Pixel 200 Red Level
609	Pixel 200 Green Level
610	Pixel 200 Blue Level
611	Pixel 201 Red Level
612	Pixel 201 Green Level
613	Pixel 201 Blue Level
614	Pixel 202 Red Level
615	Pixel 202 Green Level
616	Pixel 202 Blue Level
617	Pixel 203 Red Level
618	Pixel 203 Green Level
619	Pixel 203 Blue Level
620	Pixel 204 Red Level
621	Pixel 204 Green Level
622	Pixel 204 Blue Level
623	Pixel 205 Red Level
624	Pixel 205 Green Level
625	Pixel 205 Blue Level

626	Pixel 206 Red Level
627	Pixel 206 Green Level
628	Pixel 206 Blue Level
629	Pixel 207 Red Level
630	Pixel 207 Green Level
631	Pixel 207 Blue Level
632	Pixel 208 Red Level
633	Pixel 208 Green Level
634	Pixel 208 Blue Level
635	Pixel 209 Red Level
636	Pixel 209 Green Level
637	Pixel 209 Blue Level
638	Pixel 210 Red Level
639	Pixel 210 Green Level
640	Pixel 210 Blue Level
641	Pixel 211 Red Level
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643	Pixel 211 Blue Level
645	Pixel 212 Red Level
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651	Pixel 214 Red Level
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660	Pixel 217 Red Level
661	Pixel 217 Green Level
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663	Pixel 218 Red Level
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667	Pixel 219 Green Level
668	Pixel 219 Blue Level
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670	Pixel 220 Green Level
671	Pixel 220 Blue Level
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673	Pixel 221 Green Level
674	Pixel 221 Blue Level
675	Pixel 222 Red Level
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677	Pixel 222 Blue Level
678	Pixel 223 Red Level
679	Pixel 223 Green Level
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681	Pixel 224 Red Level
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683	Pixel 224 Blue Level
684	Pixel 225 Red Level
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686	Pixel 225 Blue Level
687	Pixel 226 Red Level
688	Pixel 226 Green Level
689	Pixel 226 Blue Level
690	Pixel 227 Red Level
691	Pixel 227 Green Level
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693	Pixel 228 Red Level
694	Pixel 228 Green Level
695	Pixel 228 Blue Level
696	Pixel 229 Red Level
697	Pixel 229 Green Level
698	Pixel 229 Blue Level
699	Pixel 230 Red Level
700	Pixel 230 Green Level
701	Pixel 230 Blue Level
702	Pixel 231 Red Level
703	Pixel 231 Green Level
704	Pixel 231 Blue Level
705	Pixel 232 Red Level
706	Pixel 232 Green Level
707	Pixel 232 Blue Level
708	Pixel 233 Red Level
709	Pixel 233 Green Level
710	Pixel 233 Blue Level
711	Pixel 234 Red Level
712	Pixel 234 Green Level
713	Pixel 234 Blue Level
714	Pixel 235 Red Level
715	Pixel 235 Green Level
716	Pixel 235 Blue Level
717	Pixel 236 Red Level
718	Pixel 236 Green Level

719	Pixel 236 Blue Level
720	Pixel 237 Red Level
721	Pixel 237 Green Level
722	Pixel 237 Blue Level
723	Pixel 238 Red Level
724	Pixel 238 Green Level
725	Pixel 238 Blue Level
726	Pixel 239 Red Level
727	Pixel 239 Green Level
728	Pixel 239 Blue Level
729	Pixel 240 Red Level
730	Pixel 240 Green Level
731	Pixel 240 Blue Level
732	Pixel 241 Red Level
733	Pixel 241 Green Level
734	Pixel 241 Blue Level
735	Pixel 242 Red Level
736	Pixel 242 Green Level
737	Pixel 242 Blue Level
738	Pixel 243 Red Level
739	Pixel 243 Green Level
740	Pixel 243 Blue Level
741	Pixel 244 Red Level
742	Pixel 244 Green Level
743	Pixel 244 Blue Level
744	Pixel 245 Red Level
745	Pixel 245 Green Level
746	Pixel 245 Blue Level
747	Pixel 246 Red Level
748	Pixel 246 Green Level
749	Pixel 246 Blue Level
750	Pixel 247 Red Level
751	Pixel 247 Green Level
752	Pixel 247 Blue Level
753	Pixel 248 Red Level
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756	Pixel 249 Red Level
757	Pixel 249 Green Level
758	Pixel 249 Blue Level
759	Pixel 250 Red Level
760	Pixel 250 Green Level
761	Pixel 250 Blue Level
762	Pixel 251 Red Level
763	Pixel 251 Green Level
764	Pixel 251 Blue Level

765	Pixel 252 Red Level
766	Pixel 252 Green Level
767	Pixel 252 Blue Level
768	Pixel 253 Red Level
769	Pixel 253 Green Level
770	Pixel 253 Blue Level
771	Pixel 254 Red Level
772	Pixel 254 Green Level
773	Pixel 254 Blue Level
774	Pixel 255 Red Level
775	Pixel 255 Green Level
776	Pixel 255 Blue Level
777	Pixel 256 Red Level
778	Pixel 256 Green Level
779	Pixel 256 Blue Level
780	Pixel 257 Red Level
781	Pixel 257 Green Level
782	Pixel 257 Blue Level
783	Pixel 258 Red Level
784	Pixel 258 Green Level
785	Pixel 258 Blue Level
786	Pixel 259 Red Level
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789	Pixel 260 Red Level
790	Pixel 260 Green Level
791	Pixel 260 Blue Level
792	Pixel 261 Red Level
793	Pixel 261 Green Level
794	Pixel 261 Blue Level
795	Pixel 262 Red Level
796	Pixel 262 Green Level
797	Pixel 262 Blue Level
798	Pixel 263 Red Level
799	Pixel 263 Green Level
800	Pixel 263 Blue Level
801	Pixel 264 Red Level
802	Pixel 264 Green Level
803	Pixel 264 Blue Level
804	Pixel 265 Red Level
805	Pixel 265 Green Level
806	Pixel 265 Blue Level
807	Pixel 266 Red Level
808	Pixel 266 Green Level
809	Pixel 266 Blue Level
810	Pixel 267 Red Level

811	Pixel 267 Green Level
812	Pixel 267 Blue Level
813	Pixel 268 Red Level
814	Pixel 268 Green Level
815	Pixel 268 Blue Level
816	Pixel 269 Red Level
817	Pixel 269 Green Level
818	Pixel 269 Blue Level
819	Pixel 270 Red Level
820	Pixel 270 Green Level
821	Pixel 270 Blue Level
822	Pixel 271 Red Level
823	Pixel 271 Green Level
824	Pixel 271 Blue Level
825	Pixel 272 Red Level
826	Pixel 272 Green Level
827	Pixel 272 Blue Level
828	Pixel 273 Red Level
829	Pixel 273 Green Level
830	Pixel 273 Blue Level
831	Pixel 274 Red Level
832	Pixel 274 Green Level
833	Pixel 274 Blue Level
834	Pixel 275 Red Level
835	Pixel 275 Green Level
836	Pixel 275 Blue Level
837	Pixel 276 Red Level
838	Pixel 276 Green Level
839	Pixel 276 Blue Level
840	Pixel 277 Red Level
841	Pixel 277 Green Level
842	Pixel 277 Blue Level
843	Pixel 278 Red Level
844	Pixel 278 Green Level
845	Pixel 278 Blue Level
846	Pixel 279 Red Level
847	Pixel 279 Green Level
848	Pixel 279 Blue Level
849	Pixel 280 Red Level
850	Pixel 280 Green Level
851	Pixel 280 Blue Level
852	Pixel 281 Red Level
853	Pixel 281 Green Level
854	Pixel 281 Blue Level
855	Pixel 282 Red Level
856	Pixel 282 Green Level

857	Pixel 282 Blue Level
858	Pixel 283 Red Level
859	Pixel 283 Green Level
860	Pixel 283 Blue Level
861	Pixel 284 Red Level
862	Pixel 284 Green Level
863	Pixel 284 Blue Level
864	Pixel 285 Red Level
865	Pixel 285 Green Level
866	Pixel 285 Blue Level
867	Pixel 286 Red Level
868	Pixel 286 Green Level
869	Pixel 286 Blue Level
870	Pixel 287 Red Level
871	Pixel 287 Green Level
872	Pixel 287 Blue Level
873	Pixel 288 Red Level
874	Pixel 288 Green Level
875	Pixel 288 Blue Level
876	Pixel 289 Red Level
877	Pixel 289 Green Level
878	Pixel 289 Blue Level
879	Pixel 280 Red Level
880	Pixel 290 Green Level
881	Pixel 290 Blue Level
882	Pixel 291 Red Level
883	Pixel 291 Green Level
884	Pixel 291 Blue Level
885	Pixel 292 Red Level
886	Pixel 292 Green Level
887	Pixel 292 Blue Level
888	Pixel 293 Red Level
889	Pixel 293 Green Level
890	Pixel 293 Blue Level
891	Pixel 294 Red Level
892	Pixel 294 Green Level
893	Pixel 294 Blue Level
894	Pixel 295 Red Level
895	Pixel 295 Green Level
896	Pixel 295 Blue Level
897	Pixel 296 Red Level
898	Pixel 296 Green Level
899	Pixel 296 Blue Level
900	Pixel 297 Red Level
901	Pixel 297 Green Level
901	Pixel 297 Blue Level

902	Pixel 298 Red Level
903	Pixel 298 Green Level
904	Pixel 298 Blue Level
905	Pixel 299 Red Level
906	Pixel 299 Green Level
907	Pixel 299 Blue Level
908	Pixel 300 Red Level
909	Pixel 300 Green Level
910	Pixel 300 Blue Level
911	Pixel 301 Red Level
912	Pixel 301 Green Level
913	Pixel 301 Blue Level
914	Pixel 302 Red Level
915	Pixel 302 Green Level
916	Pixel 302 Blue Level
917	Pixel 303 Red Level
918	Pixel 303 Green Level
919	Pixel 303 Blue Level
920	Pixel 304 Red Level
921	Pixel 304 Green Level
922	Pixel 304 Blue Level
923	Pixel 305 Red Level
924	Pixel 305 Green Level
925	Pixel 305 Blue Level
926	Pixel 306 Red Level
927	Pixel 306 Green Level
928	Pixel 306 Blue Level
929	Pixel 307 Red Level
930	Pixel 307 Green Level
931	Pixel 307 Blue Level
932	Pixel 308 Red Level
933	Pixel 308 Green Level
934	Pixel 308 Blue Level
935	Pixel 309 Red Level
936	Pixel 309 Green Level
937	Pixel 309 Blue Level
938	Pixel 310 Red Level
939	Pixel 310 Green Level
940	Pixel 310 Blue Level
941	Pixel 311 Red Level
942	Pixel 311 Green Level
943	Pixel 311 Blue Level
944	Pixel 312 Red Level
945	Pixel 312 Green Level
946	Pixel 312 Blue Level
947	Pixel 313 Red Level

948	Pixel 313 Green Level
949	Pixel 313 Blue Level
950	Pixel 314 Red Level
951	Pixel 314 Green Level
952	Pixel 314 Blue Level
953	Pixel 315 Red Level
954	Pixel 315 Green Level
955	Pixel 315 Blue Level
956	Pixel 316 Red Level
957	Pixel 316 Green Level
958	Pixel 316 Blue Level
959	Pixel 317 Red Level
960	Pixel 317 Green Level
961	Pixel 317 Blue Level
962	Pixel 318 Red Level
963	Pixel 318 Green Level
964	Pixel 318 Blue Level
965	Pixel 319 Red Level
966	Pixel 319 Green Level
967	Pixel 319 Blue Level
968	Pixel 320 Red Level
969	Pixel 320 Green Level
970	Pixel 320 Blue Level
971	Pixel 321 Red Level
972	Pixel 321 Green Level
973	Pixel 321 Blue Level
974	Pixel 322 Red Level
975	Pixel 322 Green Level
976	Pixel 322 Blue Level
977	Pixel 323 Red Level
978	Pixel 323 Green Level
979	Pixel 323 Blue Level
980	Pixel 324 Red Level
981	Pixel 324 Green Level
982	Pixel 324 Blue Level
983	Pixel 325 Red Level
984	Pixel 325 Green Level
985	Pixel 325 Blue Level
986	Pixel 326 Red Level
987	Pixel 326 Green Level
988	Pixel 326 Blue Level
989	Pixel 327 Red Level
990	Pixel 327 Green Level
991	Pixel 327 Blue Level
992	Pixel 328 Red Level
993	Pixel 328 Green Level

994	Pixel 328 Blue Level
995	Pixel 329 Red Level
996	Pixel 329 Green Level
997	Pixel 329 Blue Level
998	Pixel 330 Red Level
999	Pixel 330 Green Level
1000	Pixel 330 Blue Level
1001	Pixel 331 Red Level
1002	Pixel 331 Green Level
1003	Pixel 331 Blue Level
1004	Pixel 332 Red Level
1005	Pixel 332 Green Level
1006	Pixel 332 Blue Level
1007	Pixel 333 Red Level
1008	Pixel 333 Green Level
1009	Pixel 333 Blue Level
1010	Pixel 334 Red Level
1011	Pixel 334 Green Level
1012	Pixel 334 Blue Level
1013	Pixel 335 Red Level
1014	Pixel 335 Green Level
1015	Pixel 335 Blue Level
1016	Pixel 336 Red Level
1017	Pixel 336 Green Level
1018	Pixel 336 Blue Level
1019	Pixel 337 Red Level
1020	Pixel 337 Green Level
1021	Pixel 337 Blue Level
1022	Pixel 338 Red Level
1023	Pixel 338 Green Level
1024	Pixel 338 Blue Level
1025	Pixel 339 Red Level
1026	Pixel 339 Green Level
1027	Pixel 339 Blue Level
1028	Pixel 340 Red Level
1029	Pixel 340 Green Level
1030	Pixel 340 Blue Level
1031	Pixel 341 Red Level
1032	Pixel 341 Green Level
1033	Pixel 341 Blue Level
1034	Pixel 342 Red Level
1035	Pixel 342 Green Level
1036	Pixel 342 Blue Level
1037	Pixel 343 Red Level
1038	Pixel 343 Green Level
1039	Pixel 343 Blue Level

1040	Pixel 344 Red Level
1041	Pixel 344 Green Level
1042	Pixel 344 Blue Level
1043	Pixel 345 Red Level
1044	Pixel 345 Green Level
1045	Pixel 345 Blue Level
1046	Pixel 346 Red Level
1047	Pixel 346 Green Level
1048	Pixel 346 Blue Level
1049	Pixel 347 Red Level
1050	Pixel 347 Green Level
1051	Pixel 347 Blue Level
1052	Pixel 348 Red Level
1053	Pixel 348 Green Level
1054	Pixel 348 Blue Level
1055	Pixel 349 Red Level
1056	Pixel 349 Green Level
1057	Pixel 349 Blue Level
1058	Pixel 350 Red Level
1059	Pixel 350 Green Level
1060	Pixel 350 Blue Level
1061	Pixel 351 Red Level
1062	Pixel 351 Green Level
1063	Pixel 351 Blue Level
1064	Pixel 352 Red Level
1065	Pixel 352 Green Level
1066	Pixel 352 Blue Level
1067	Pixel 353 Red Level
1068	Pixel 353 Green Level
1069	Pixel 353 Blue Level
1070	Pixel 354 Red Level
1071	Pixel 354 Green Level
1072	Pixel 354 Blue Level
1073	Pixel 355 Red Level
1074	Pixel 355 Green Level
1075	Pixel 355 Blue Level
1076	Pixel 356 Red Level
1077	Pixel 356 Green Level
1078	Pixel 356 Blue Level
1079	Pixel 357 Red Level
1080	Pixel 357 Green Level
1081	Pixel 357 Blue Level
1082	Pixel 358 Red Level
1083	Pixel 358 Green Level
1084	Pixel 358 Blue Level
1085	Pixel 359 Red Level

1086	Pixel 359 Green Level
1087	Pixel 359 Blue Level
1088	Pixel 360 Red Level
1089	Pixel 360 Green Level
1090	Pixel 360 Blue Level
1091	Pixel 361 Red Level
1092	Pixel 361 Green Level
1093	Pixel 361 Blue Level
1094	Pixel 362 Red Level
1095	Pixel 362 Green Level
1096	Pixel 362 Blue Level
1097	Pixel 363 Red Level
1098	Pixel 363 Green Level
1099	Pixel 363 Blue Level
1100	Pixel 364 Red Level
1101	Pixel 364 Green Level
1102	Pixel 364 Blue Level
1103	Pixel 365 Red Level
1104	Pixel 365 Green Level
1105	Pixel 365 Blue Level
1106	Pixel 366 Red Level
1107	Pixel 366 Green Level
1108	Pixel 366 Blue Level
1109	Pixel 367 Red Level
1110	Pixel 367 Green Level
1111	Pixel 367 Blue Level
1112	Pixel 368 Red Level
1113	Pixel 368 Green Level
1114	Pixel 368 Blue Level
1115	Pixel 369 Red Level
1116	Pixel 369 Green Level
1117	Pixel 369 Blue Level
1118	Pixel 370 Red Level
1119	Pixel 370 Green Level
1120	Pixel 370 Blue Level
1121	Pixel 371 Red Level
1122	Pixel 371 Green Level
1123	Pixel 371 Blue Level
1124	Pixel 372 Red Level
1125	Pixel 372 Green Level
1126	Pixel 372 Blue Level
1127	Pixel 373 Red Level
1128	Pixel 373 Green Level
1129	Pixel 373 Blue Level
1130	Pixel 374 Red Level
1131	Pixel 374 Green Level

1132	Pixel 374 Blue Level
1133	Pixel 375 Red Level
1134	Pixel 375 Green Level
1135	Pixel 375 Blue Level
1136	Pixel 376 Red Level
1137	Pixel 376 Green Level
1138	Pixel 376 Blue Level
1139	Pixel 377 Red Level
1140	Pixel 377 Green Level
1141	Pixel 377 Blue Level
1142	Pixel 378 Red Level
1143	Pixel 378 Green Level
1144	Pixel 378 Blue Level
1145	Pixel 379 Red Level
1146	Pixel 379 Green Level
1147	Pixel 379 Blue Level
1148	Pixel 380 Red Level
1149	Pixel 380 Green Level
1150	Pixel 380 Blue Level
1151	Pixel 381 Red Level
1152	Pixel 381 Green Level
1153	Pixel 381 Blue Level
1154	Pixel 382 Red Level
1155	Pixel 382 Green Level
1156	Pixel 382 Blue Level
1157	Pixel 383 Red Level
1158	Pixel 383 Green Level
1159	Pixel 383 Blue Level
1160	Pixel 384 Red Level
1161	Pixel 384 Green Level
1162	Pixel 384 Blue Level
1163	Pixel 385 Red Level
1164	Pixel 385 Green Level
1165	Pixel 385 Blue Level
1166	Pixel 386 Red Level
1167	Pixel 386 Green Level
1168	Pixel 386 Blue Level
1169	Pixel 387 Red Level
1170	Pixel 387 Green Level
1171	Pixel 387 Blue Level
1172	Pixel 388 Red Level
1173	Pixel 388 Green Level
1174	Pixel 388 Blue Level
1175	Pixel 389 Red Level
1176	Pixel 389 Green Level
1177	Pixel 389 Blue Level

1178	Pixel 390 Red Level
1179	Pixel 390 Green Level
1180	Pixel 390 Blue Level
1181	Pixel 391 Red Level
1182	Pixel 391 Green Level
1183	Pixel 391 Blue Level
1184	Pixel 392 Red Level
1185	Pixel 392 Green Level
1186	Pixel 392 Blue Level
1187	Pixel 393 Red Level
1188	Pixel 393 Green Level
1189	Pixel 393 Blue Level
1190	Pixel 394 Red Level
1191	Pixel 394 Green Level
1192	Pixel 394 Blue Level
1193	Pixel 395 Red Level
1194	Pixel 395 Green Level
1195	Pixel 395 Blue Level
1196	Pixel 396 Red Level
1197	Pixel 396 Green Level
1198	Pixel 396 Blue Level
1199	Pixel 397 Red Level
1200	Pixel 397 Green Level
1201	Pixel 397 Blue Level
1202	Pixel 398 Red Level
1203	Pixel 398 Green Level
1204	Pixel 398 Blue Level
1205	Pixel 399 Red Level
1206	Pixel 399 Green Level
1207	Pixel 399 Blue Level
1208	Pixel 400 Red Level
1209	Pixel 400 Green Level
1210	Pixel 400 Blue Level
1211	Pixel 401 Red Level
1212	Pixel 401 Green Level
1213	Pixel 401 Blue Level
1214	Pixel 402 Red Level
1215	Pixel 402 Green Level
1216	Pixel 402 Blue Level
1217	Pixel 403 Red Level
1218	Pixel 403 Green Level
1219	Pixel 403 Blue Level
1220	Pixel 404 Red Level
1221	Pixel 404 Green Level
1222	Pixel 404 Blue Level
1223	Pixel 405 Red Level

1224	Pixel 405 Green Level
1225	Pixel 405 Blue Level
1226	FCS-16 Checksum (MSB)
1227	FCS-16 Checksum (LSB)

PMM Get Packet

CMS 700C (27 x 15) Set Brightness Command
Sign Controller → CMS

Byte	Description
1	Set Brightness Command [0x06]
2	Set Brightness Sub-Type (SET) [0x10]
3	Number of Bytes in Packet [0x06]
4	Brightness Level
5	FCS-16 Checksum (MSB)
6	FCS-16 Checksum (LSB)

CMS 700C (27 x 15) Set Brightness Response
CMS → Sign Controller

Byte	Description

No Response from CMS

CMS 700C Brightness Control

PMM Display Buffer Message Command
Sign Controller → PMM

Byte	Description
1	Display Buffer Command [0x04]
2	Display Buffer Command Sub-Type [0x01]
3	Number of Bytes in Packet [0x06]
4	Buffer Number [0x00 to 0x09]
5	FCS-16 Checksum (MSB)
6	FCS-16 Checksum (LSB)

PMM Display Buffer Response
PMM → Sign Controller

Byte	Description

No Response from PMM

PMM Display Buffer Packet

CMS Field Box Interface (FBI) Unit
FBI → Sign Controller

Byte	Description
1	Sensor Information [0x05]
2	Sensor Information Request Sub-Type [0x10]
3	Number of Bytes in Packet [0x0B]
4	FBI Status (0 = Good, Greater than 0 = Error)
5	Switch Set (MSB) (0 = Not Selected, 1 = Switch Selected)
6	Switch Set (LSB) (0 = Not Selected, 1 = Switch Selected)

7	Input Sensor Contacts 1 to 8 (0 = Open, 1 = Closed)
8	Future Use [0x00]
9	Future Use [0x00]
10	FCS-16 Checksum (MSB)
11	FCS-16 Checksum (LSB)

FBI Sensor Data Packet

Remote I/O Box

Remote I/O Box → Sign Controller

Byte	Description
1	Sensor Information Request [0x05]
2	Sensor Information Request Sub-Type [0x20]
3	Number of Bytes in Packet [0x0F]
4	Sensor Box Status (0 = Good, Greater than 0 = Error)
5	Input Sensor Contacts 9 to 16 (0 = Open, 1 = Closed)
6	Input Sensor Contacts 1 to 8 (0 = Open, 1 = Closed)
7	Photo Sensor #1 level (0 = 0 Lux, 255 = 100,000 Lux)
8	Photo Sensor #2 level (0 = 0 Lux, 255 = 100,000 Lux)
9	Photo Sensor #3 level (0 = 0 Lux, 255 = 100,000 Lux)
10	Temperature Sensor #1 (0 = -50F, 255 = 205F, Value is temperature in F above -50)
11	Temperature Sensor #2 (0 = -50F, 255 = 205F, Value is temperature in F above -50)
12	Status of Warning Beacon Output Contacts 1 to 8 (Bitwise) (beacon = 1, Subpanel Relay = 2, Both = 3)
13	Future Use [0x00]
14	FCS-16 Checksum (MSB)
15	FCS-16 Checksum (LSB)

Remote I/O Box Sensor Data Packet

Remote I/O Box Beacon

Sign Controller → Remote I/O Box Beacon

Byte	Description
1	Set Command [0x02]
2	Set Command Sub-Type [0x30]
3	Number of Bytes in Packet [0x07]
4	Set Output Contacts 1 to 8 (Bitwise)
5	Future Use [0x00]
6	FCS-16 Checksum (MSB)
7	FCS-16 Checksum (LSB)

Remote I/O Box Beacon

Remote I/O Box Beacon→ Sign Controller

Byte	Description
1	Acknowledge [0x03]
2	Type Command that Was Sent (SET) [0x02]
3	Set Command Sub-Type [0x030]

4	Number of Bytes in Packet [0x06]
5	FCS-16 Checksum (MSB)
6	FCS-16 Checksum (LSB)

Remote I/O Box Beacon Set Packet

Remote I/O Box Beacon

Sign Controller → Remote I/O Box Beacon

Byte	Description
1	Get Command [0x01]
2	Get Command Sub-Type [0x30]
3	Number of Bytes in Packet [0x05]
4	FCS-16 Checksum (MSB)
5	FCS-16 Checksum (LSB)

Remote I/O Box Beacon

Remote I/O Box Beacon→ Sign Controller

Byte	Description
1	Acknowledge [0x03]
2	Type Command that Was Sent (GET) [0x01]
3	Get Command Sub-Type [0x030]
4	Number of Bytes in Packet [0x08]
5	Beacon Status (0 = Good, Greater Than Zero = Error)
6	Bitwise state of Beacons (Beacon 1 is lowest significant byte ie. 00000001)
7	FCS-16 Checksum (MSB)
8	FCS-16 Checksum (LSB)

Remote I/O Box Beacon Get Packet

Set Device IP Address Message

Sign Controller → Sensor Box, FBI or PMM

Byte	Description
1	Set Command [0x02]
2	Set Command Sub-Type [0x90]
3	Number of Bytes in Packet [0x1D]
4	IP Address (MSB)
5	IP Address (NMSB)
6	IP Address (NLSB)
7	IP Address (LSB) (Note: Used only for Sensor Box and FBI)
8	Network Mask (MSB)
9	Network Mask (NMSB)
10	Network Mask (NLSB)
11	Network Mask (LSB)
12	Broadcast Address (MSB)
13	Broadcast Address (NMSB)
14	Broadcast Address (NLSB)
15	Broadcast Address (LSB)
16	Default Gateway (MSB)
17	Default Gateway (NMSB)

18	Default Gateway (NLSB)
19	Default Gateway (LSB)
20	Port Number (MSB)
21	Port Number (LSB)
22	Transmit To IP Address (MSB)
23	Transmit To IP Address (NMSB
24	Transmit To IP Address (NLSB)
25	Transmit To IP Address LSB
26	Transmit To Port Number (MSB)
27	Transmit To Port Number (LSB)
28	FCS-16 Checksum (MSB)
29	FCS-16 Checksum (LSB)

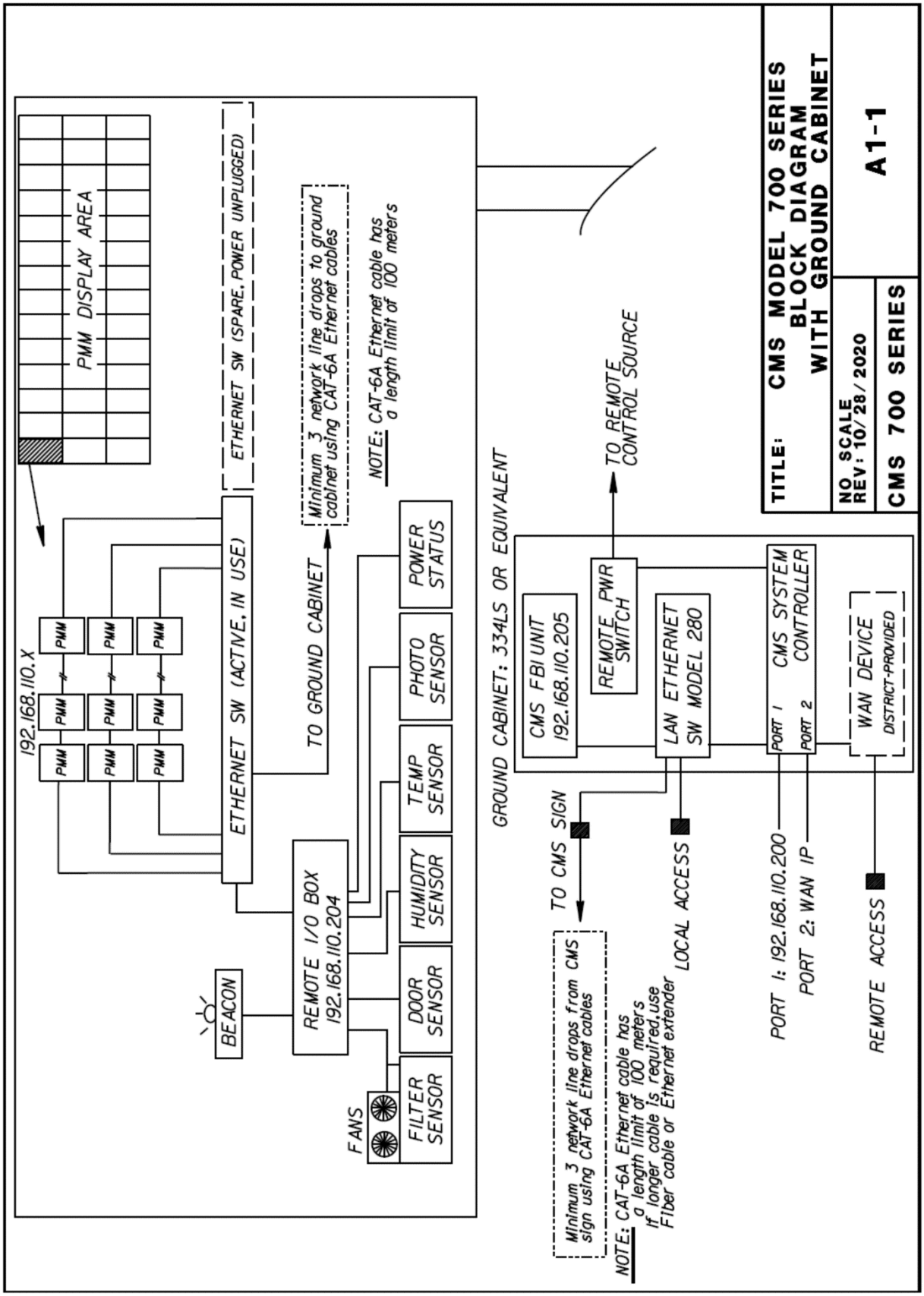
Set IP Address Message Response
Sensor Box, FBI or PMM → Sign Controller

Byte	**Description**
1	Acknowledge [0x03]
2	Type Command that Was Sent (GET) [0x1]
3	Set Message Sub-Type [0x90]
4	Number of Bytes in Packet [0x07]
5	PMM Node Number (PMM = LSB of IP Address Octet, Sensor Box = 0xF0, FBI = 0xF1)
6	FCS-16 Checksum (MSB)
7	FCS-16 Checksum (LSB)

Set Device IP Address Packet

CHAPTER 13-SECTION 17: APPENDIX, CMS MODELS 700, 710, 720, 700C, 710C, and 720C DRAWINGS – ALL AMBER AND COLOR HI-RES MODELS

13.17.1 Drawing A1-1



13.17.2 Drawing A1-4

TYPICAL PMM IP ADDRESS CONFIGURATION

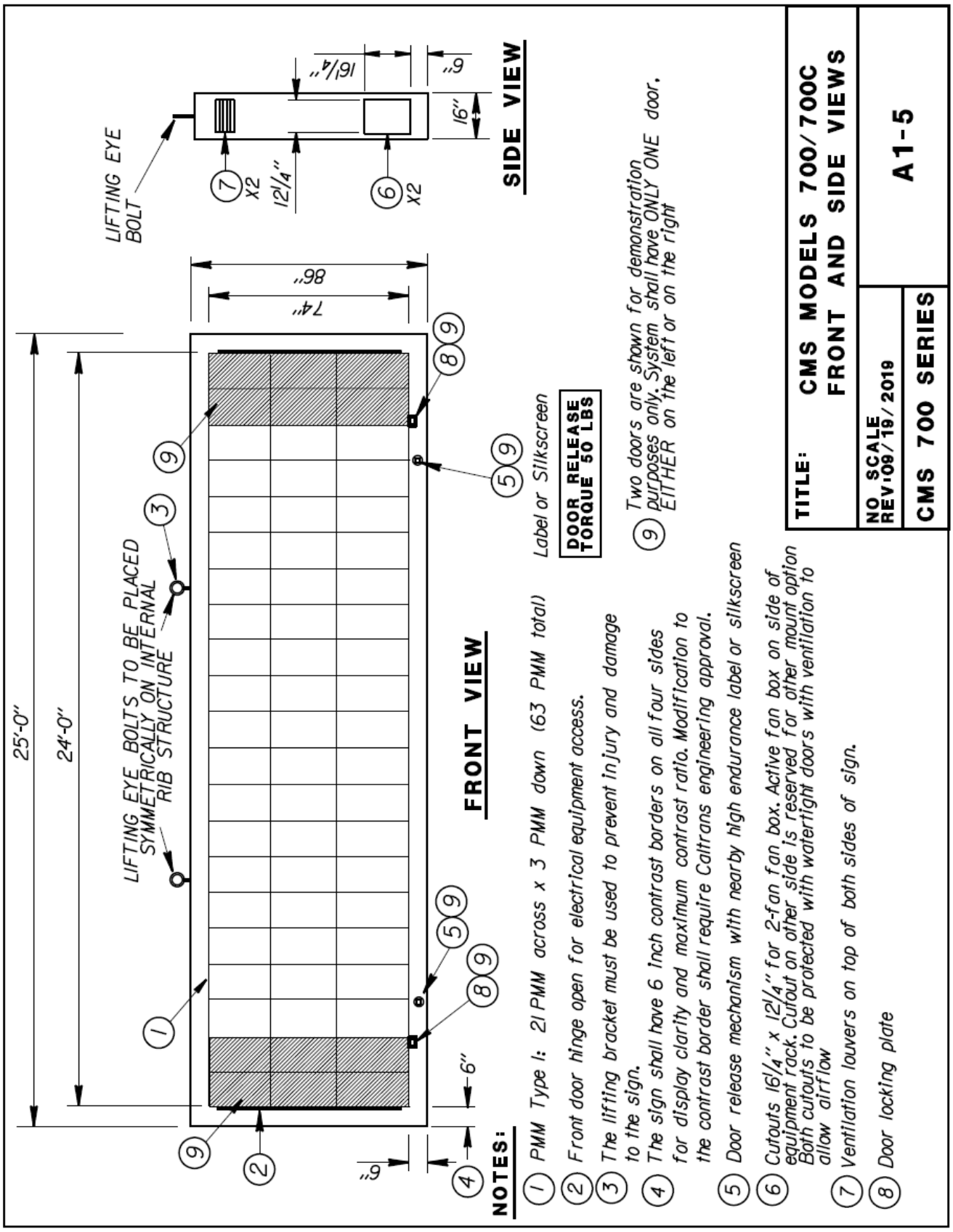
192.168.110.21	192.168.110.51	192.168.110.81
192.168.110.20	192.168.110.50	192.168.110.80
192.168.110.19	192.168.110.49	192.168.110.79
192.168.110.18	192.168.110.48	192.168.110.78
192.168.110.17	192.168.110.47	192.168.110.77
192.168.110.16	192.168.110.46	192.168.110.76
192.168.110.15	192.168.110.45	192.168.110.75
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

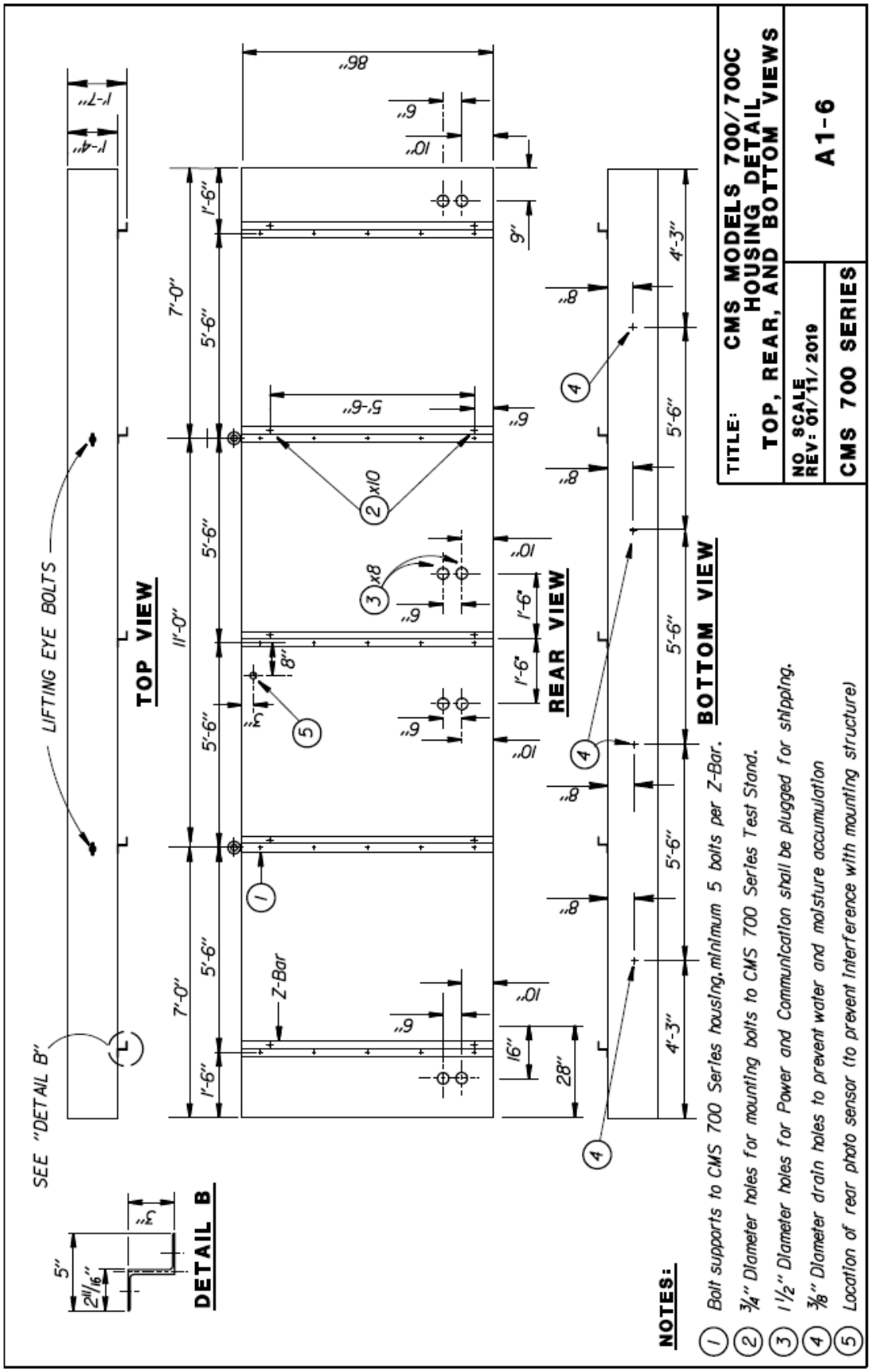
NOTE: CMS Model 700 configuration. Total of 63 Pixel Matrix Modules

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

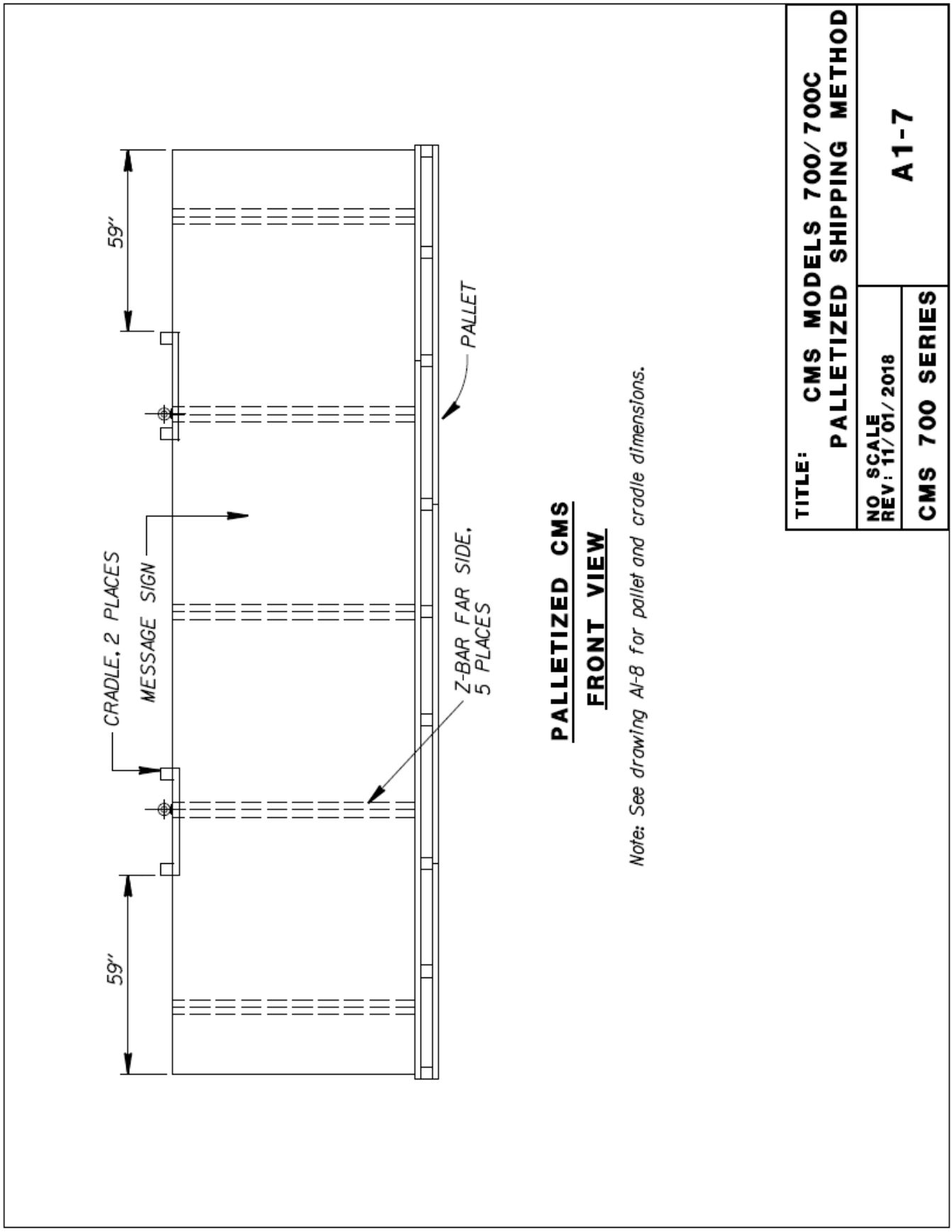
13.17.3 Drawing A1-5



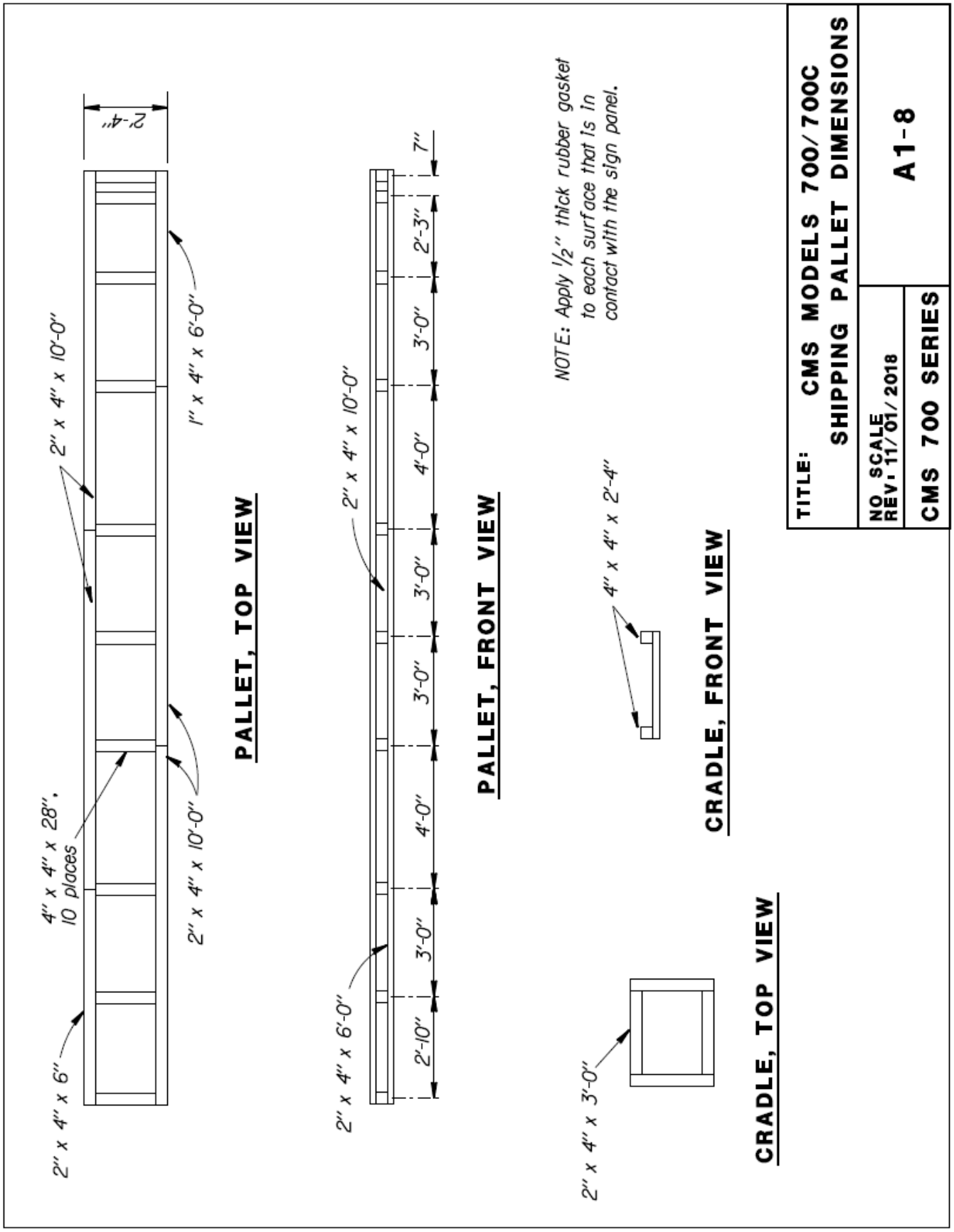
13.17.4 Drawing A1-6



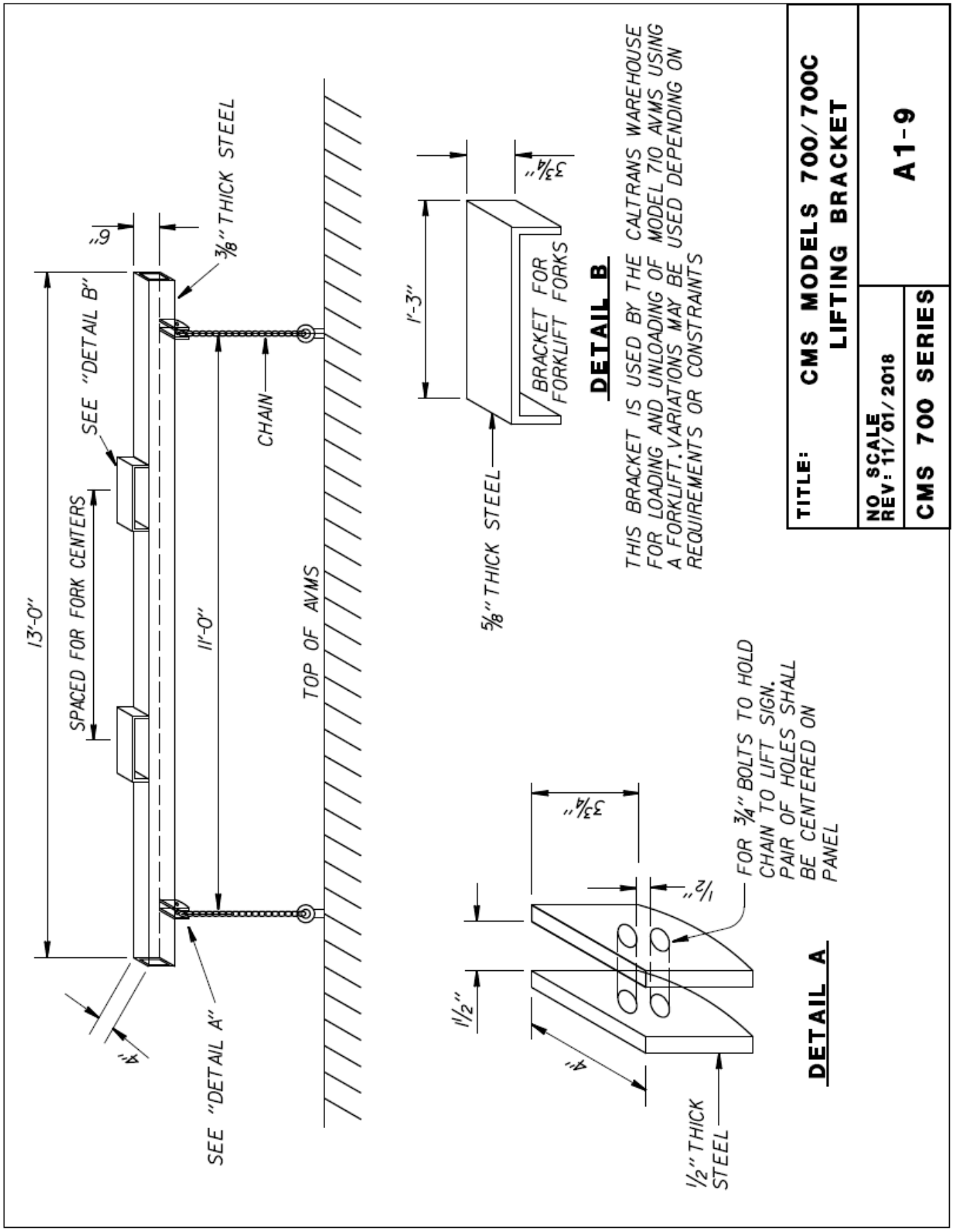
13.17.5 Drawing A1-7



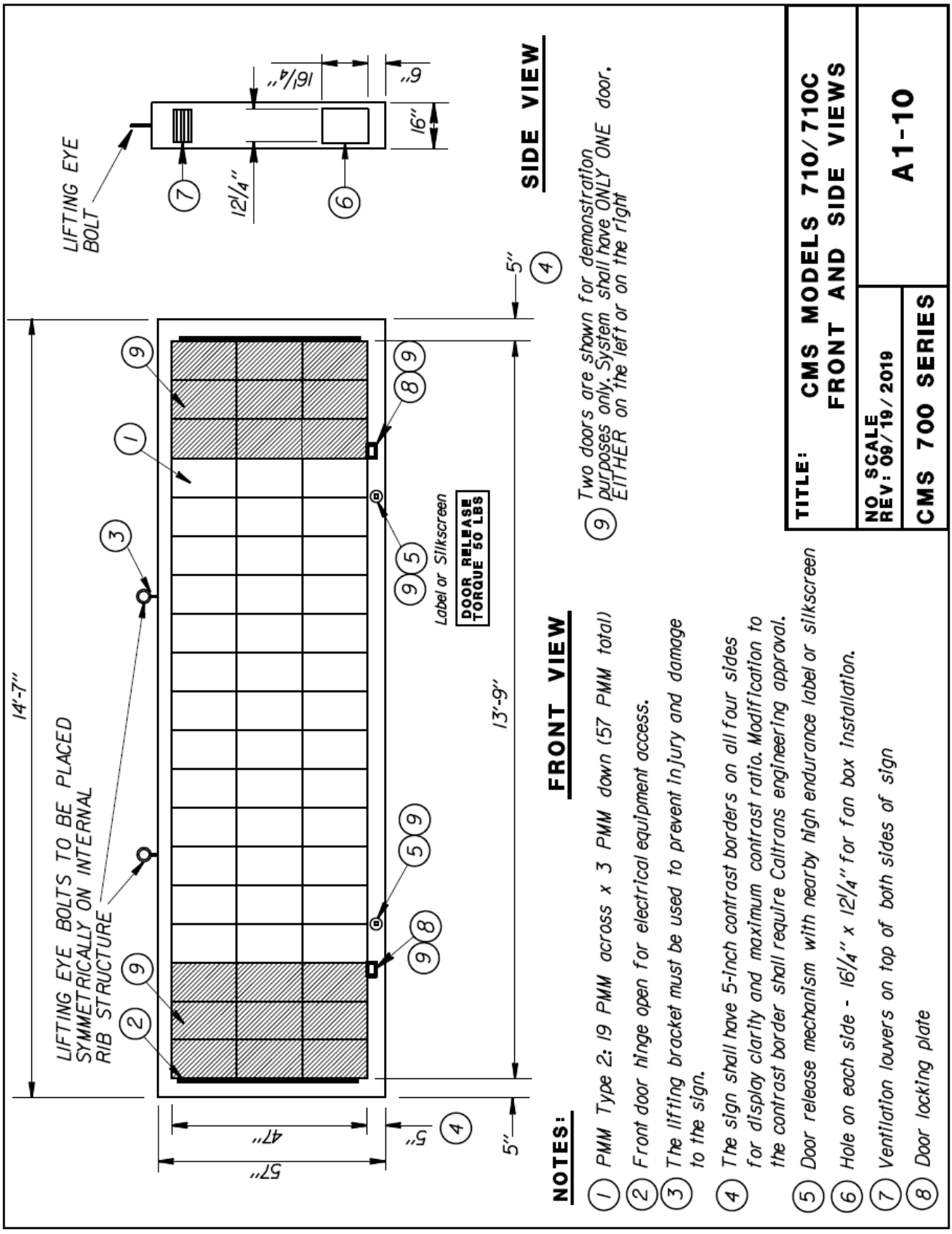
13.17.6 Drawing A1-8



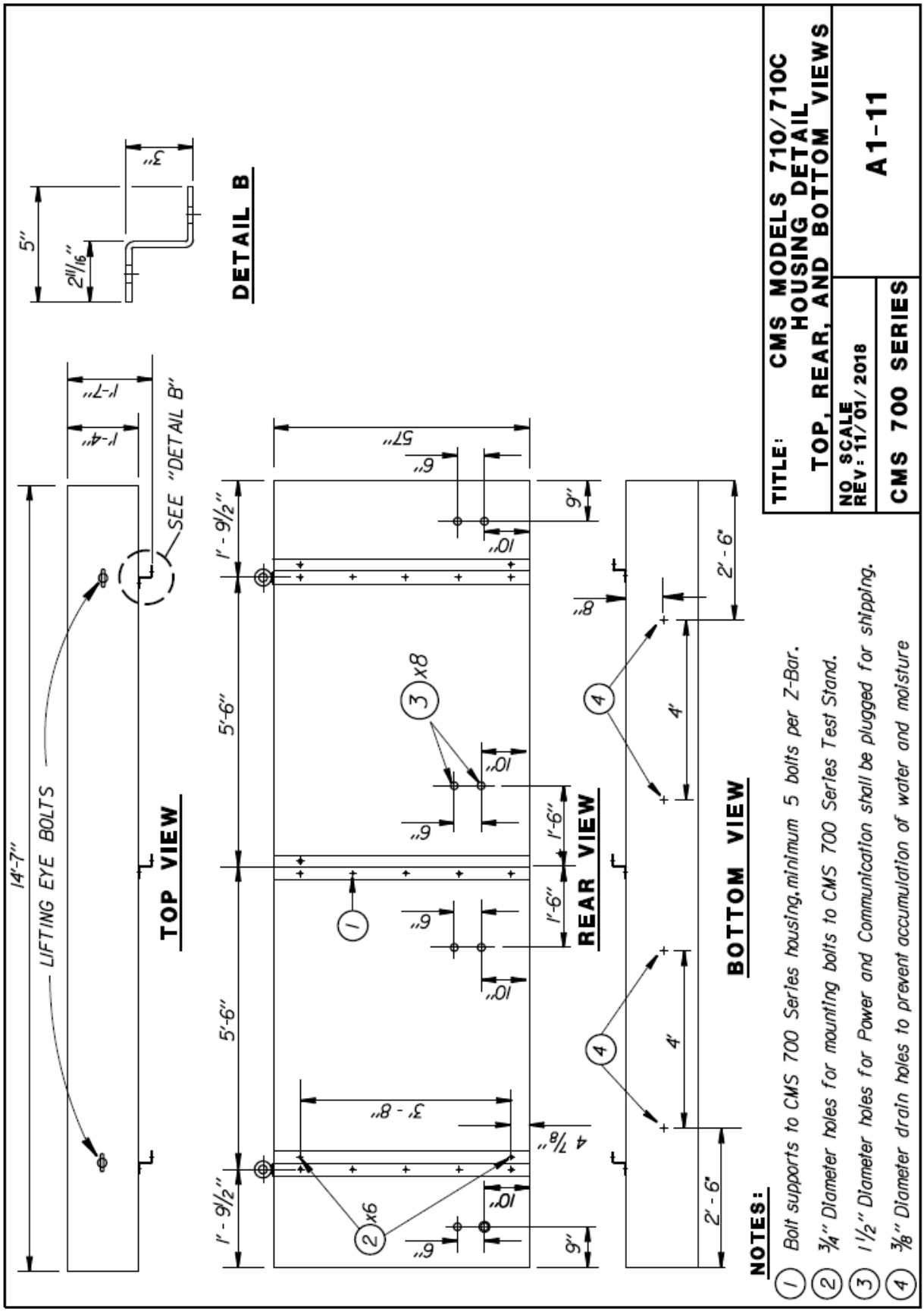
13.17.7 Drawing A1-9



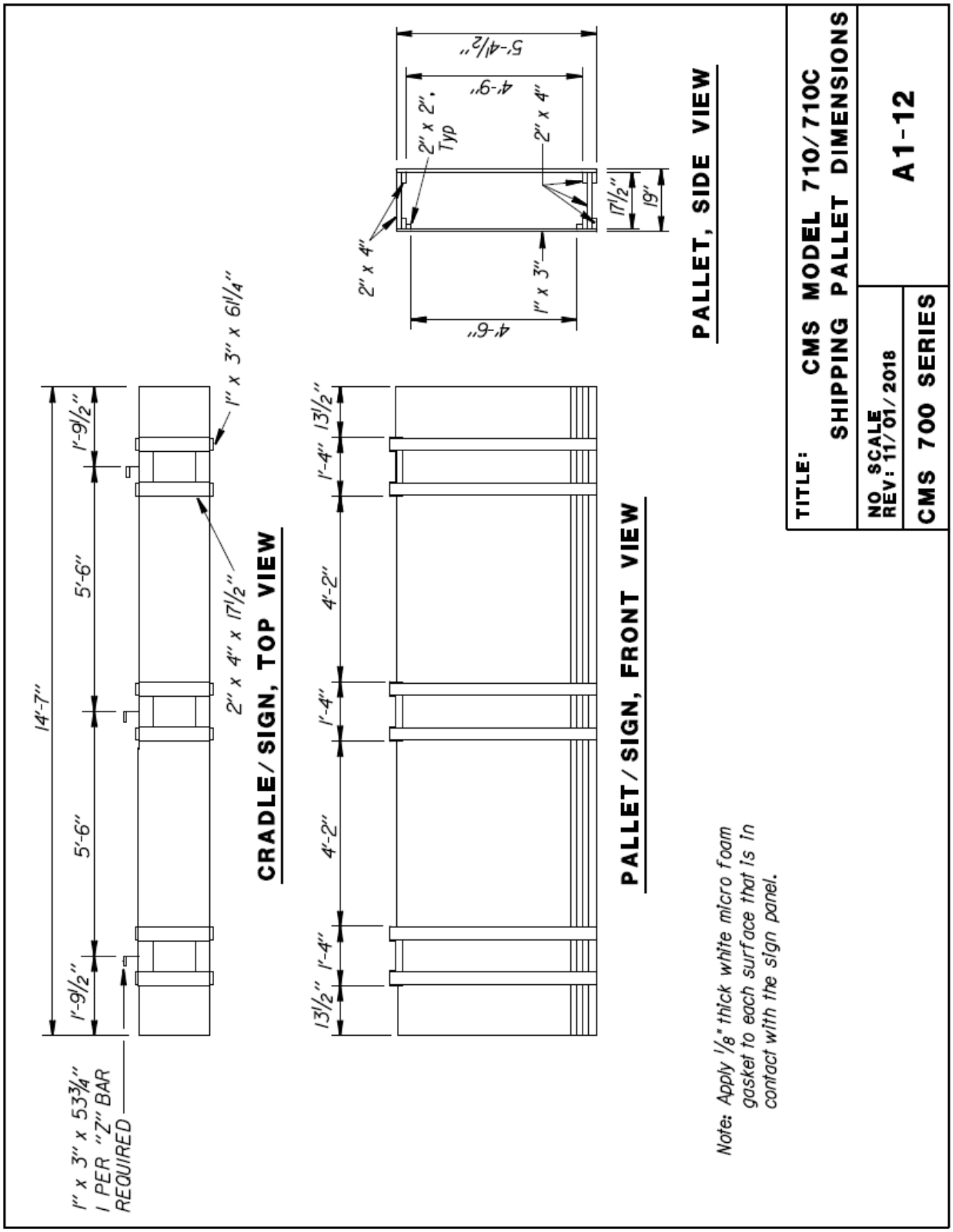
13.17.8 Drawing A1-10



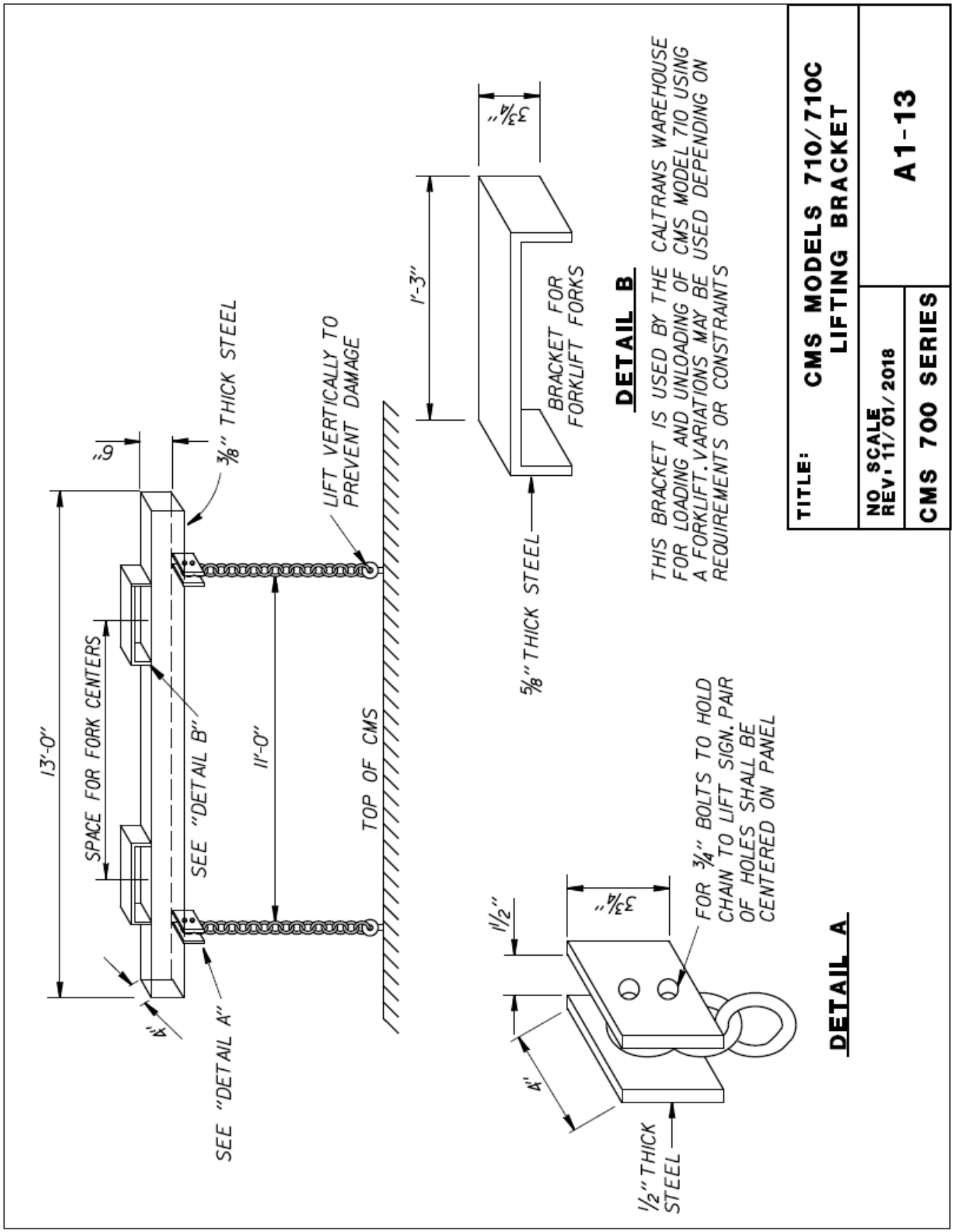
13.17.9 Drawing A1-11



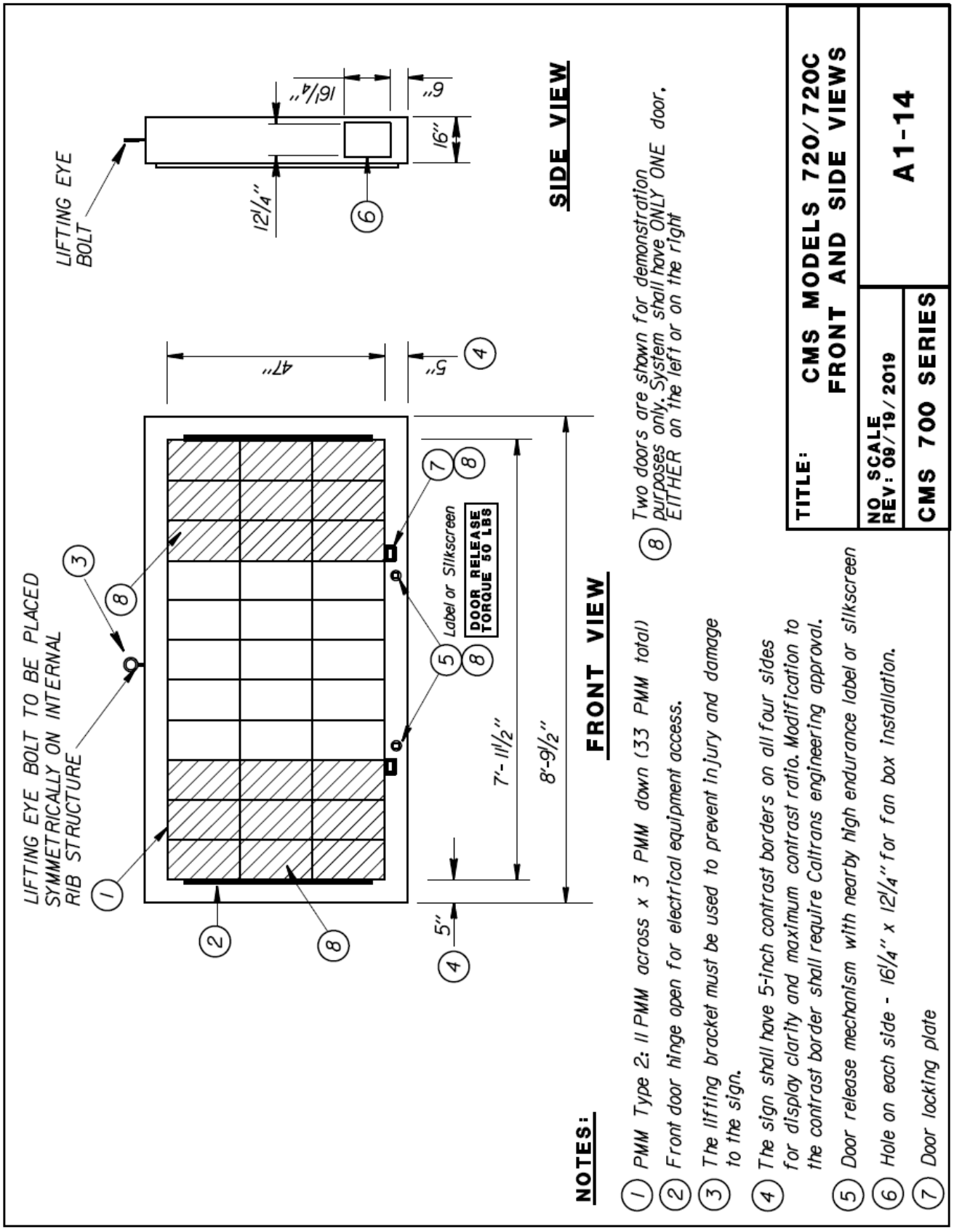
13.17.10 Drawing A1-12



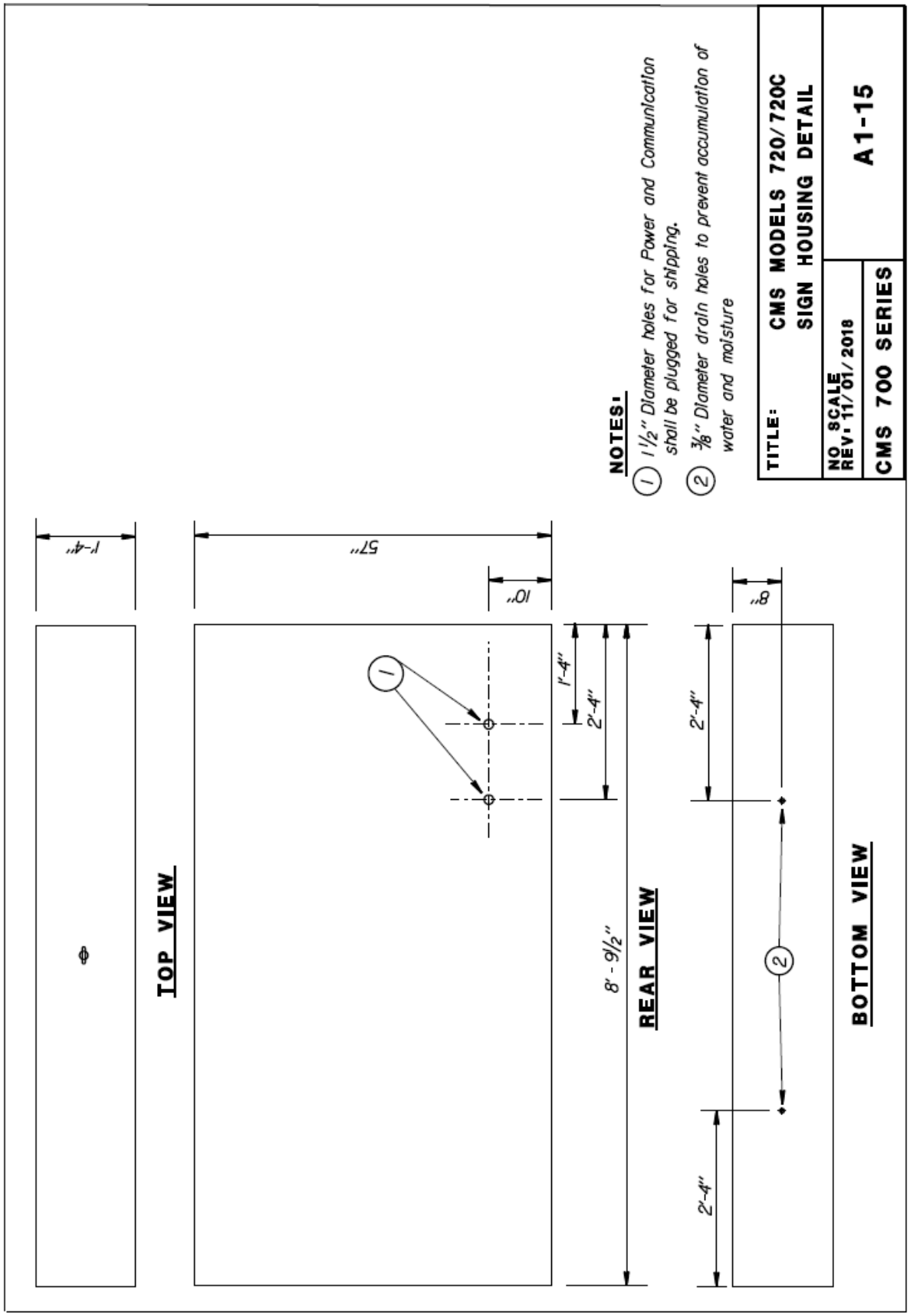
13.17.11 Drawing A1-13



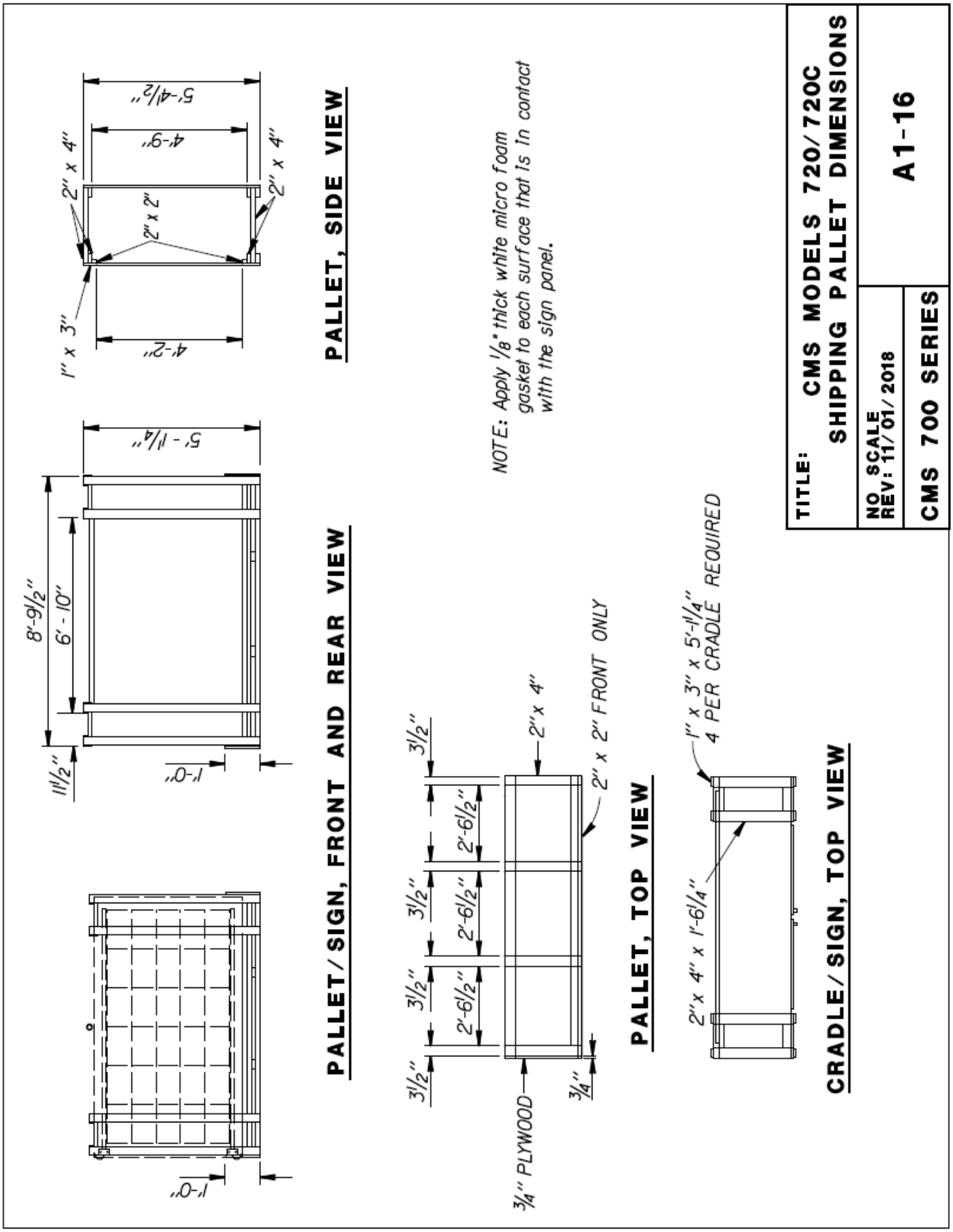
13.17.12 Drawing A1-14



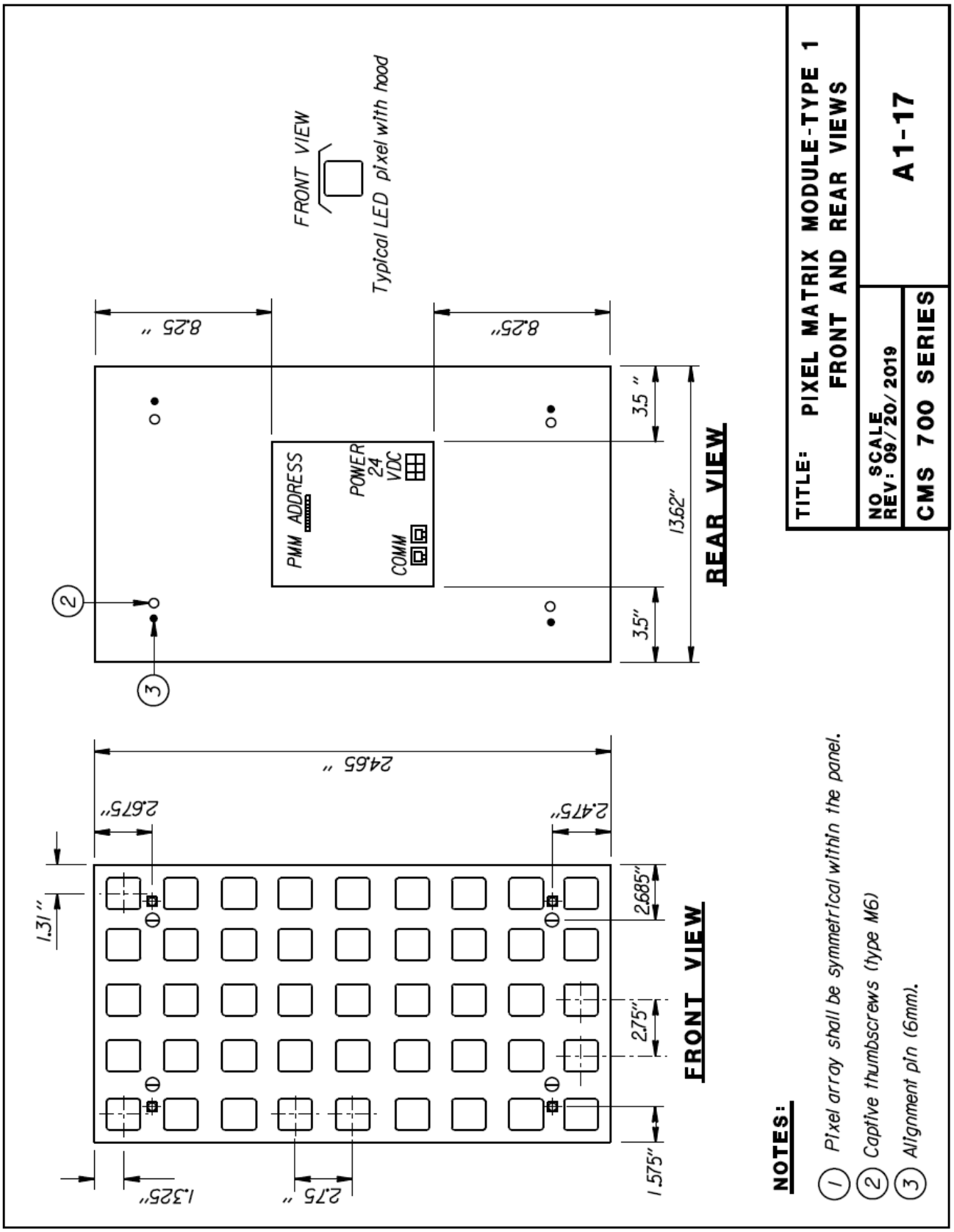
13.17.13 Drawing A1-15



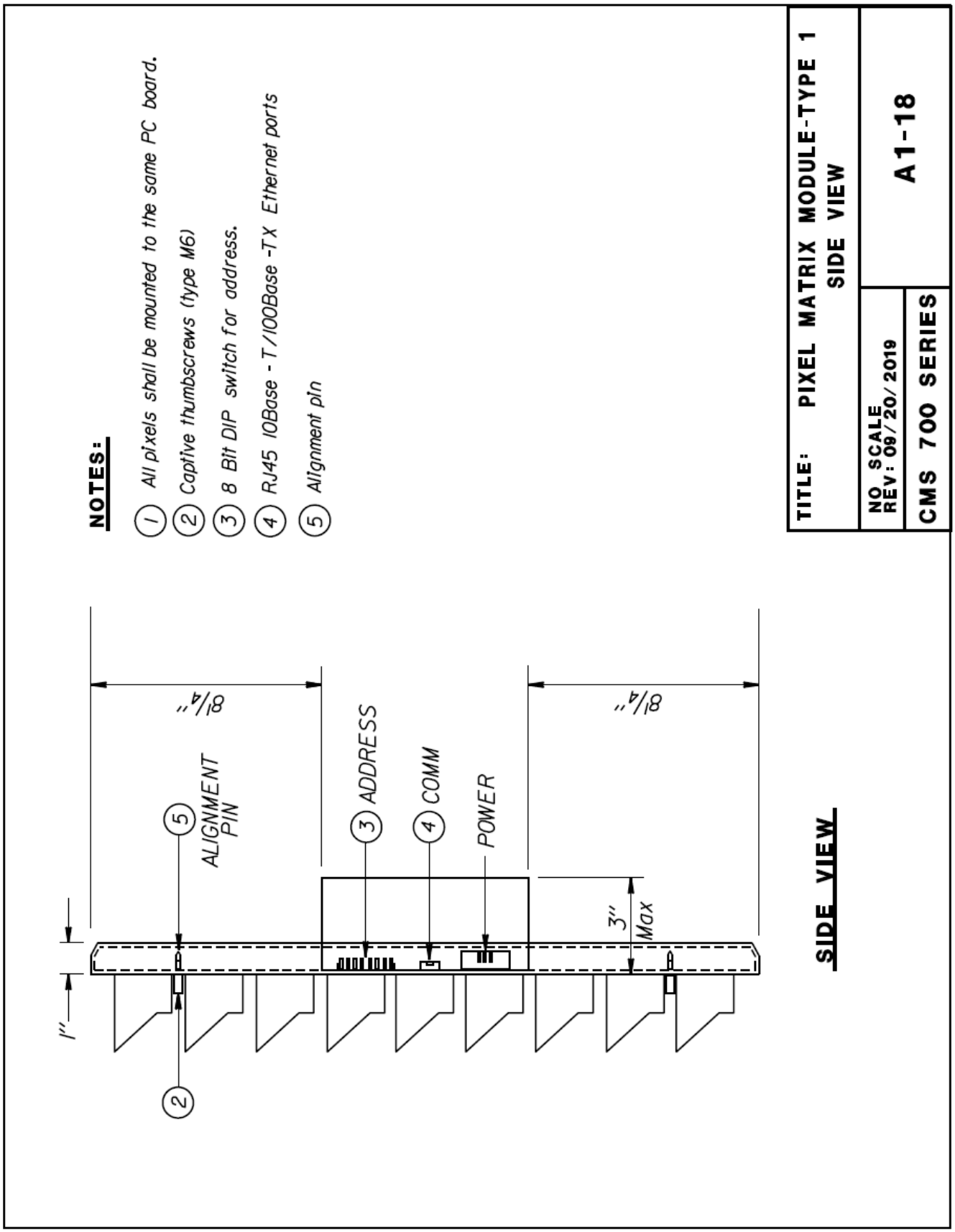
13.17.14 Drawing A1-16



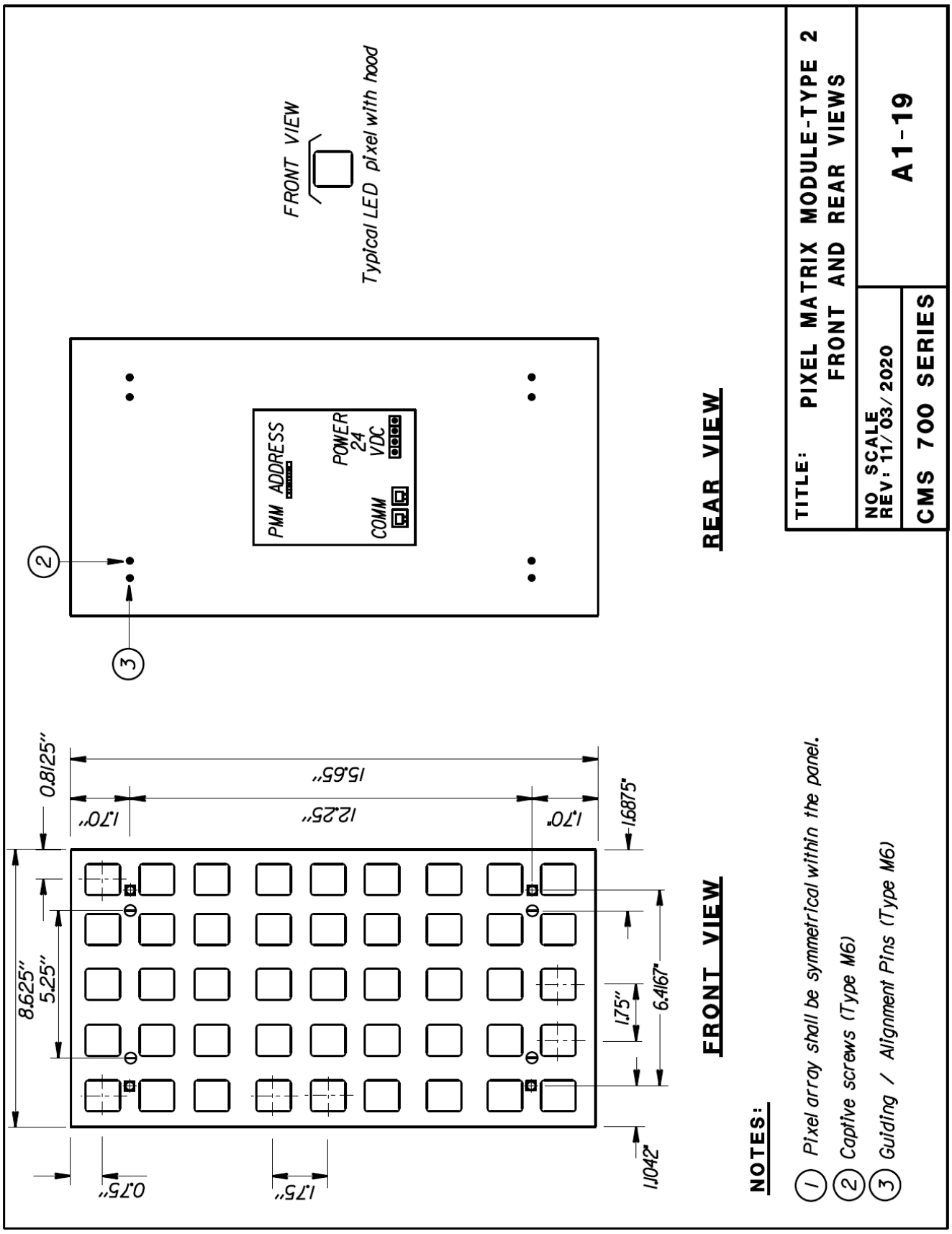
13.17.15 Drawing A1-17



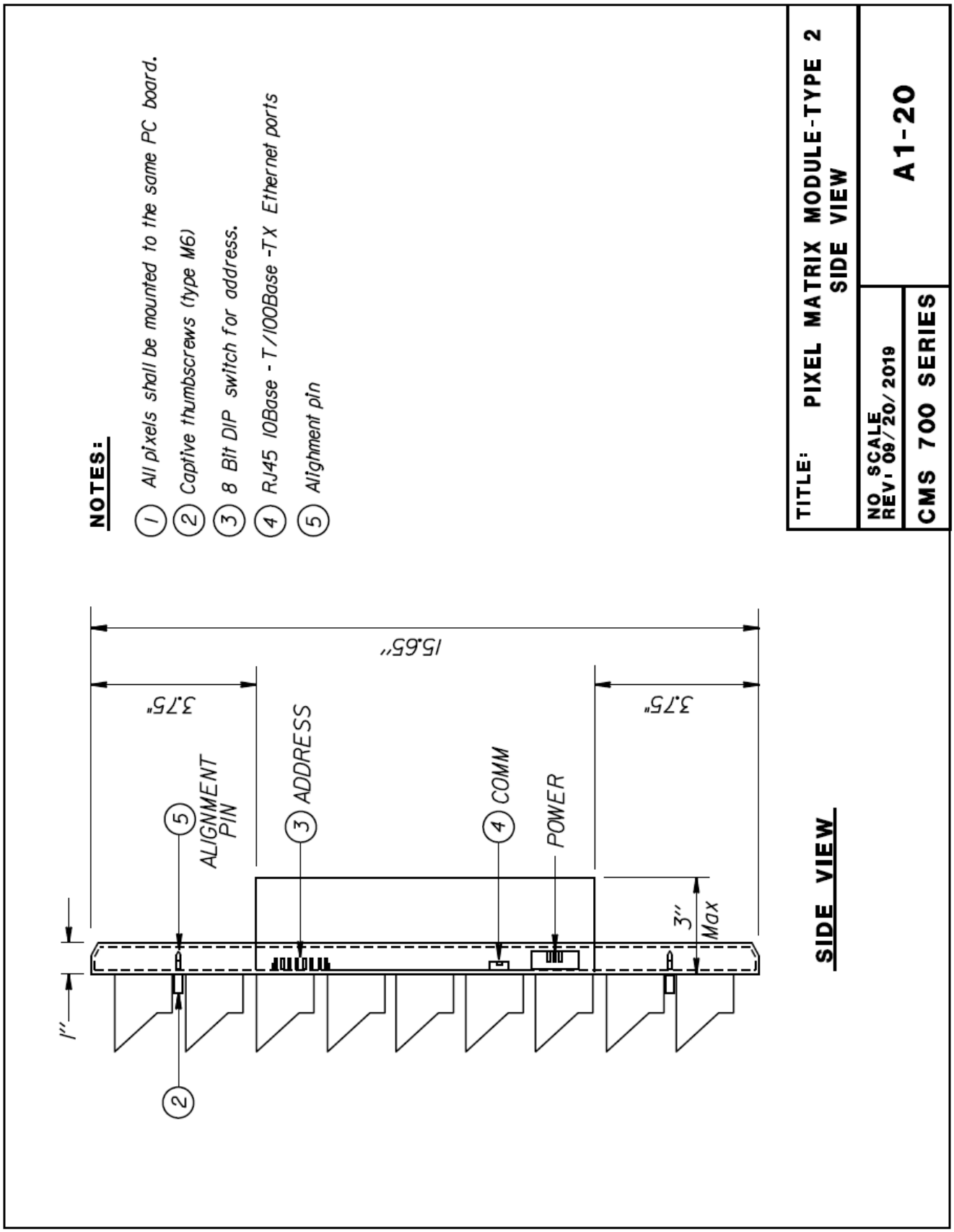
13.17.16 Drawing A1-18



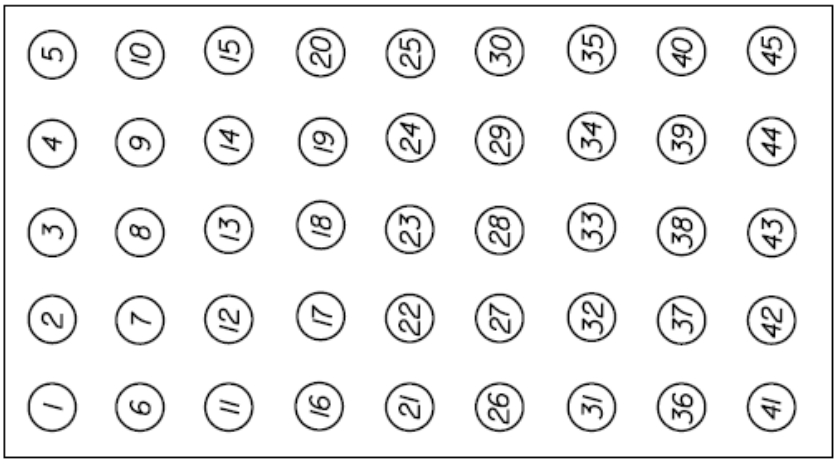
13.17.17 Drawing A1-19



13.17.18 Drawing A1-20



13.17.19 Drawing A1-21



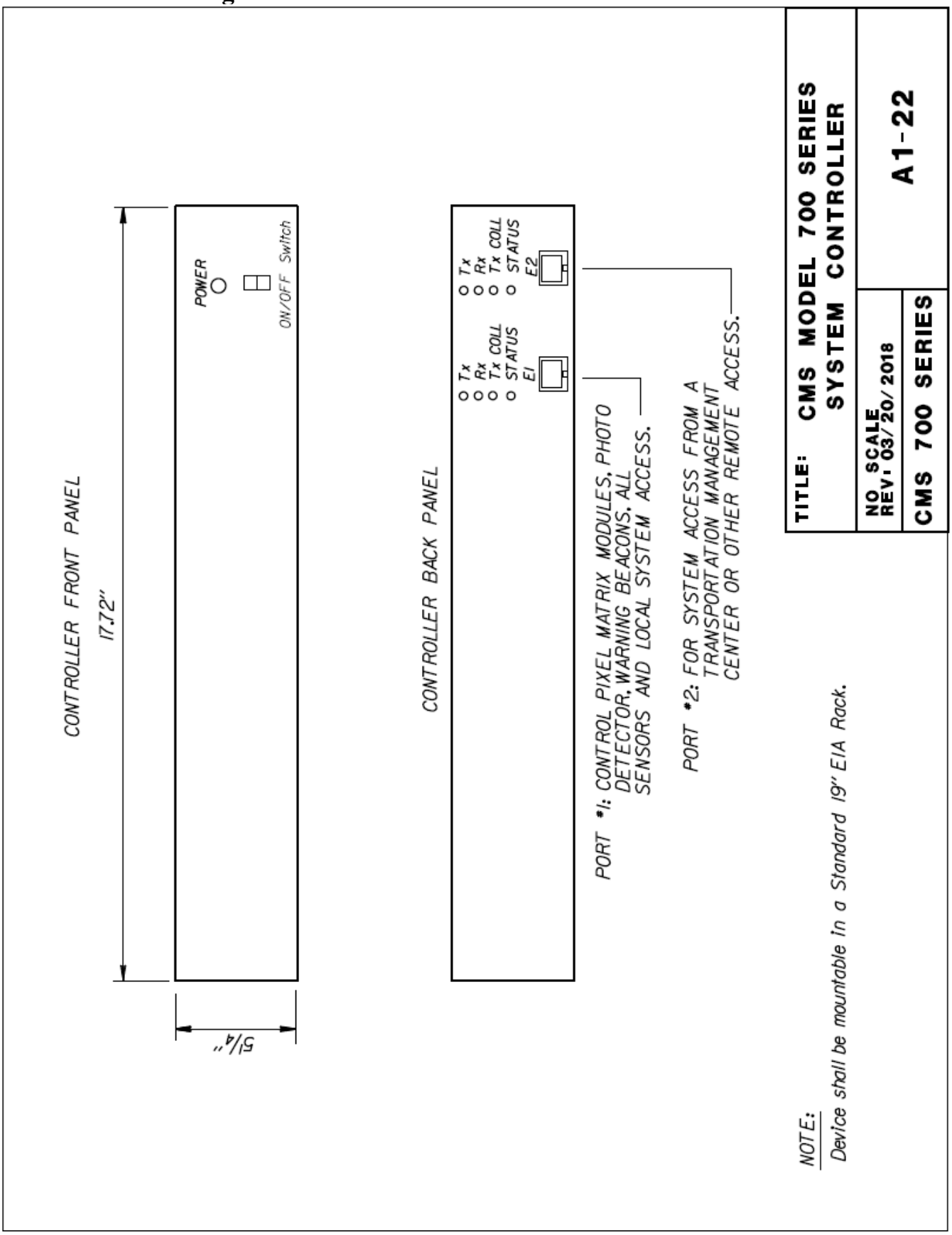
TITLE: PIXEL MATRIX MODULE
LED ASSIGNMENTS: TYPES 1 AND 2

NO SCALE
REV: 03/20/2018

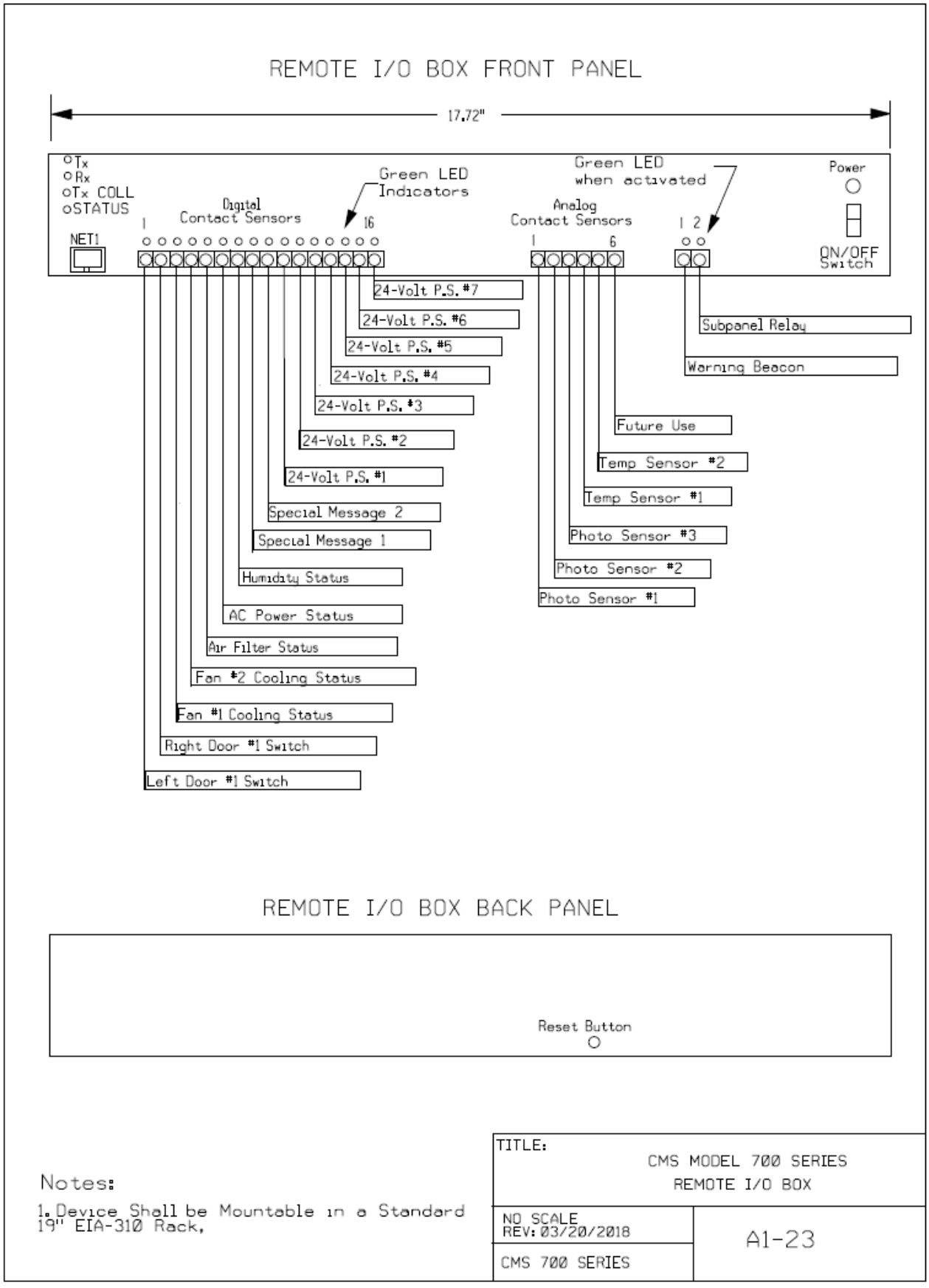
A1-21

CMS 700 SERIES

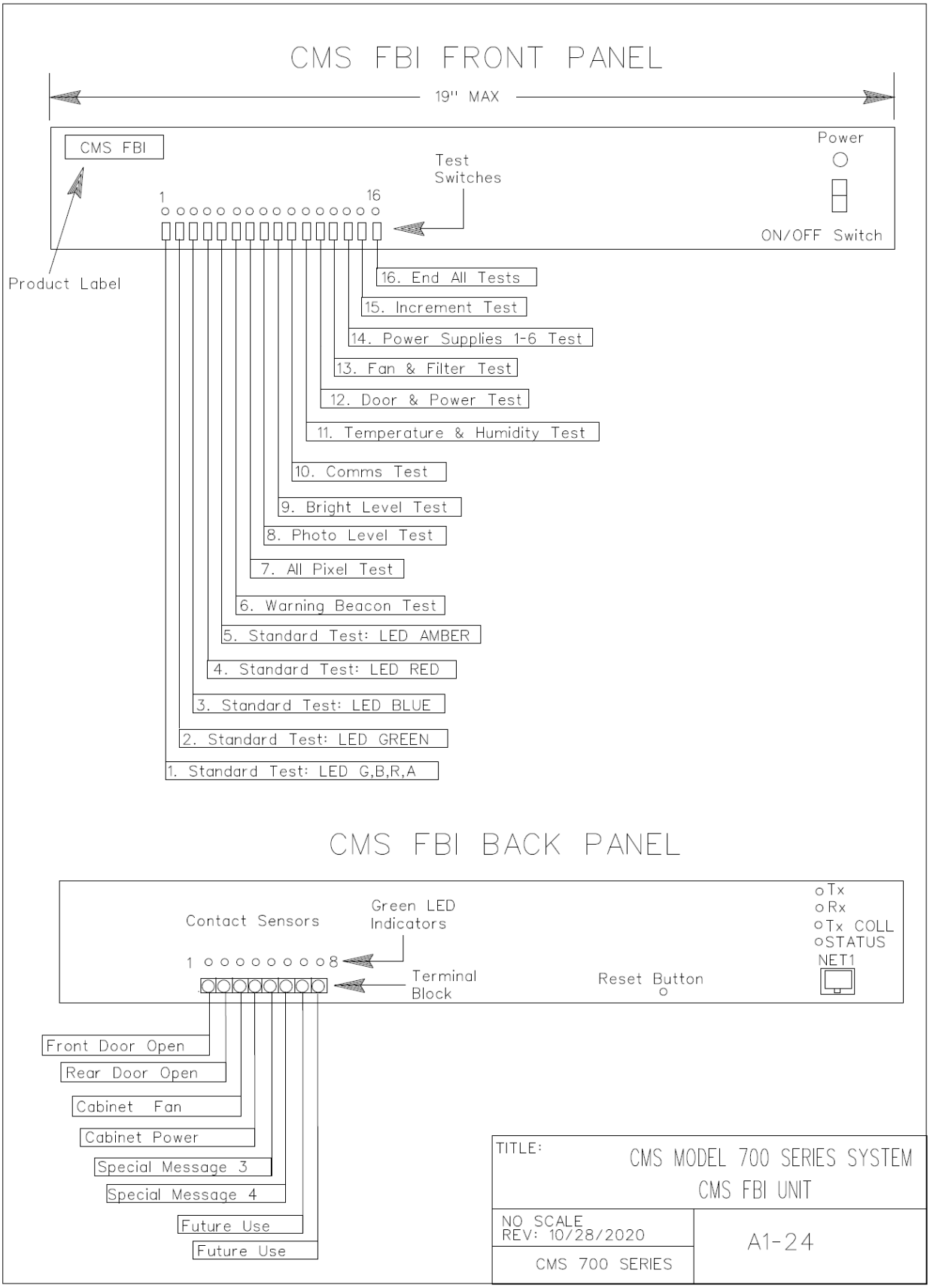
13.17.20 Drawing A1-22



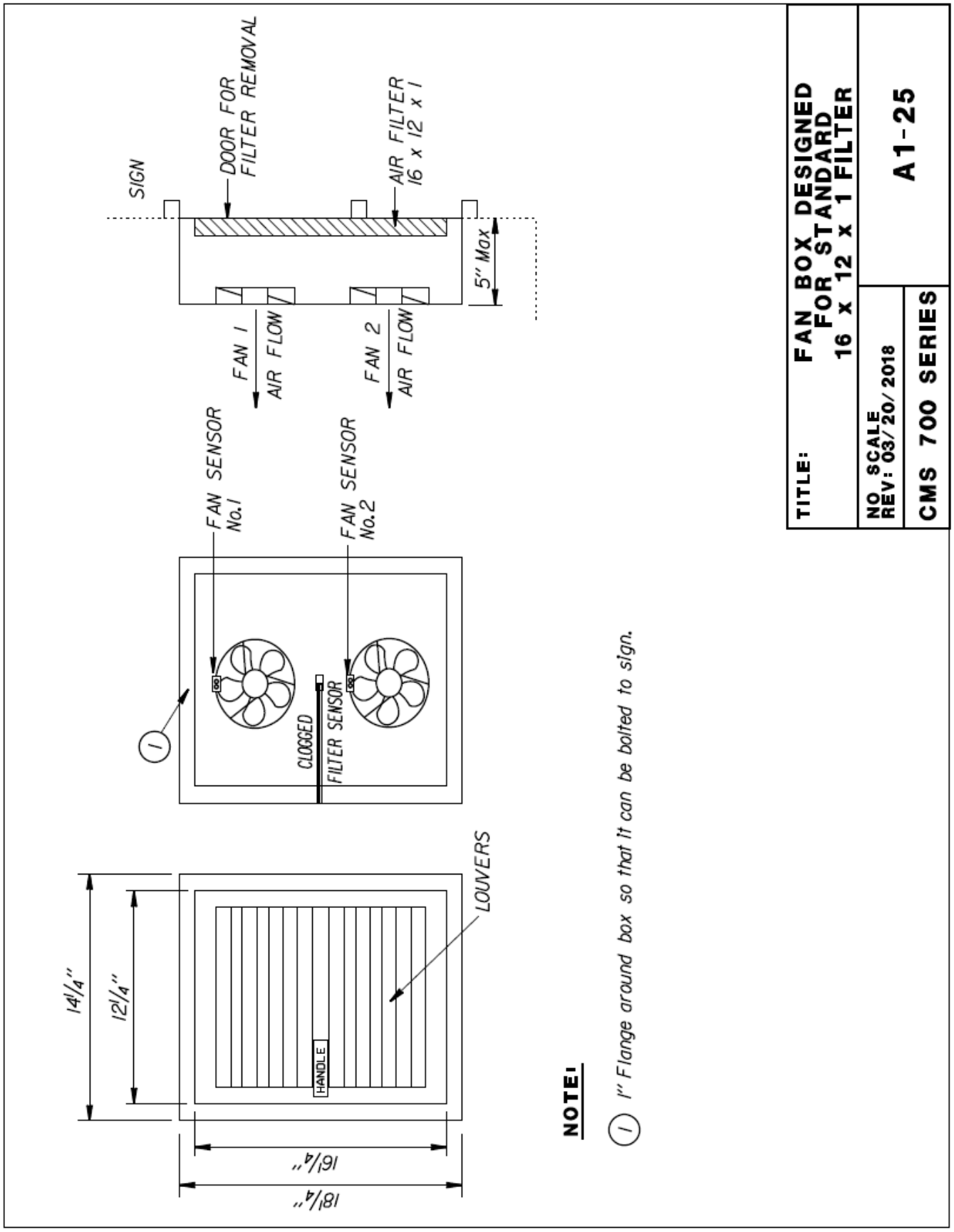
13.17.21 Drawing A1-23



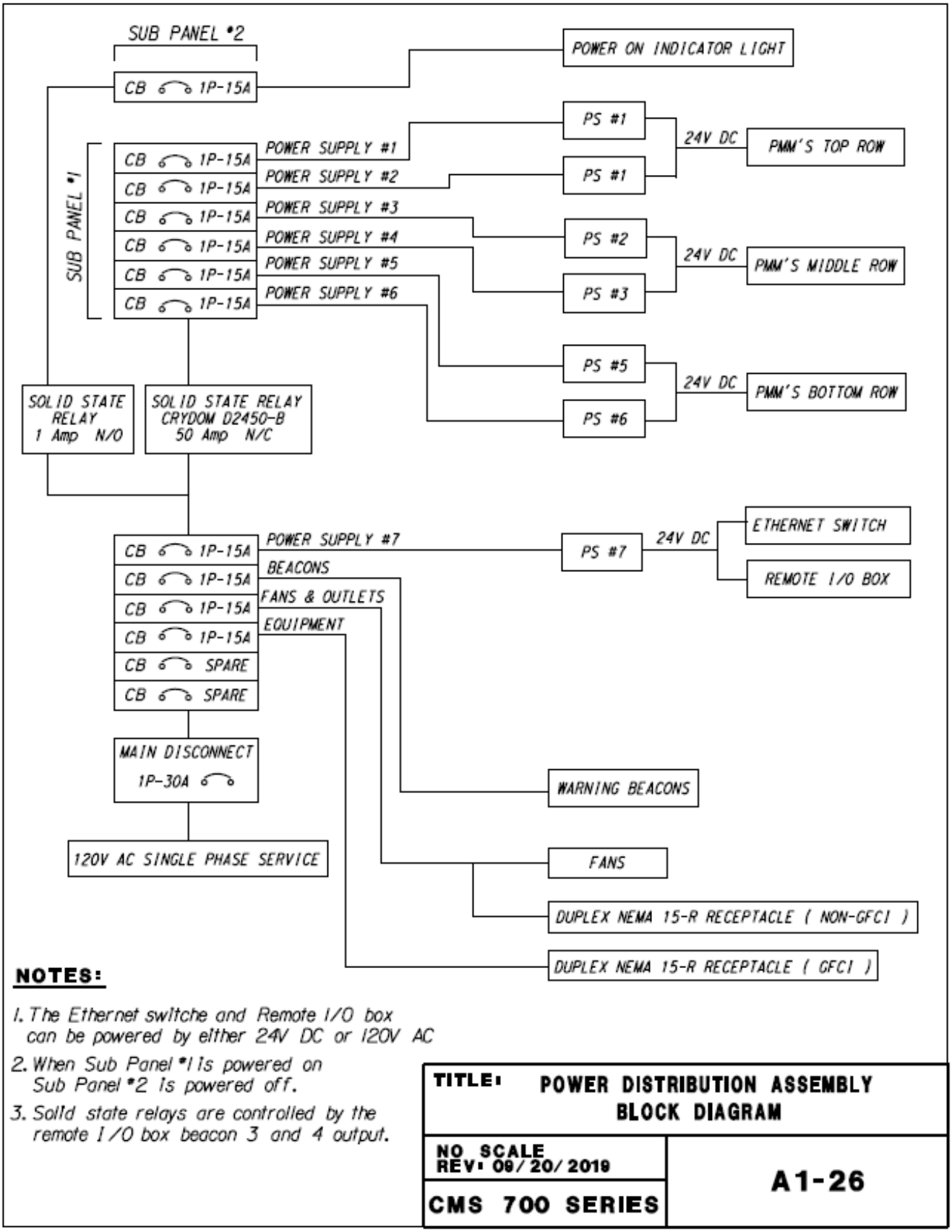
13.17.22 Drawing A1-24



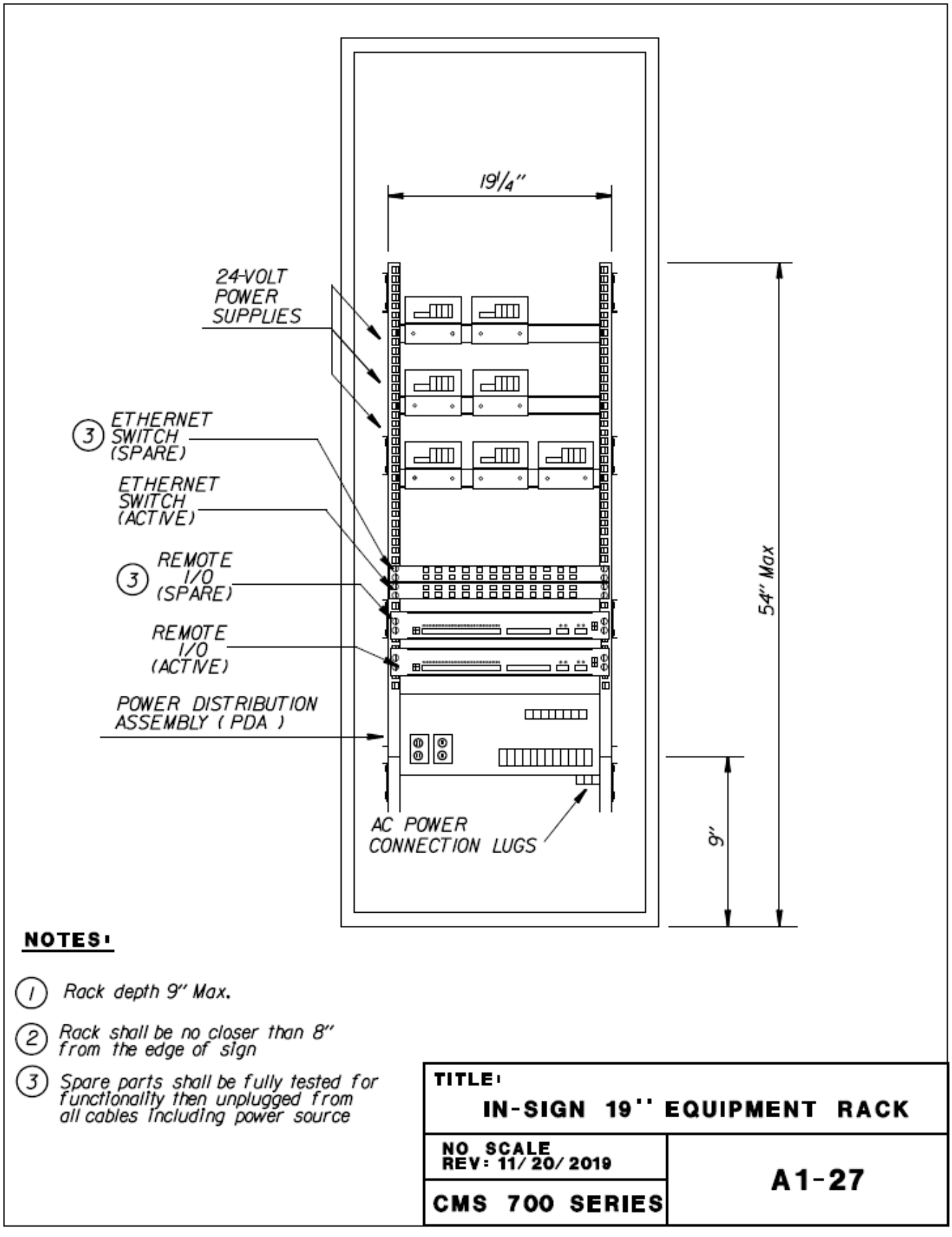
13.17.23 Drawing A1-25



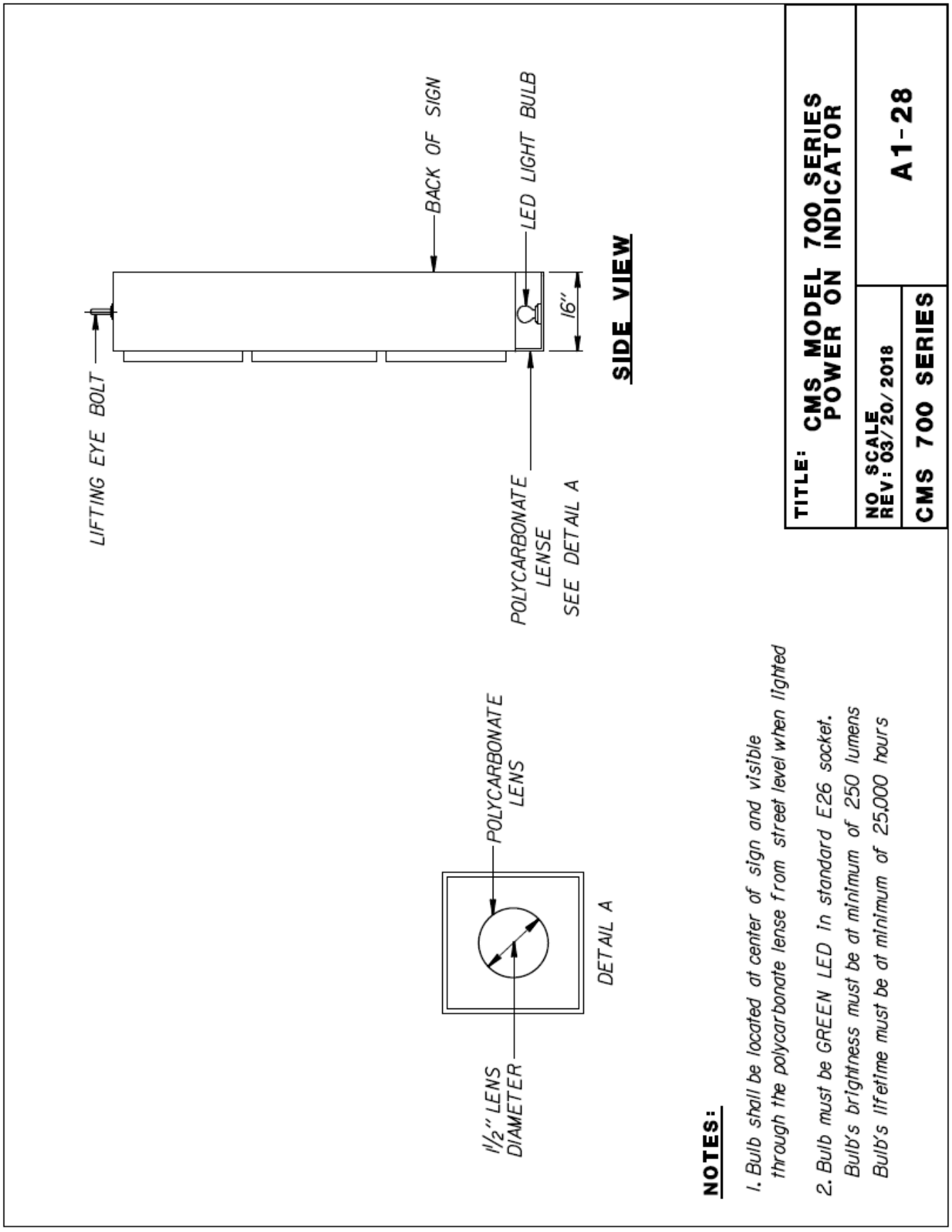
13.17.24 Drawing A1-26



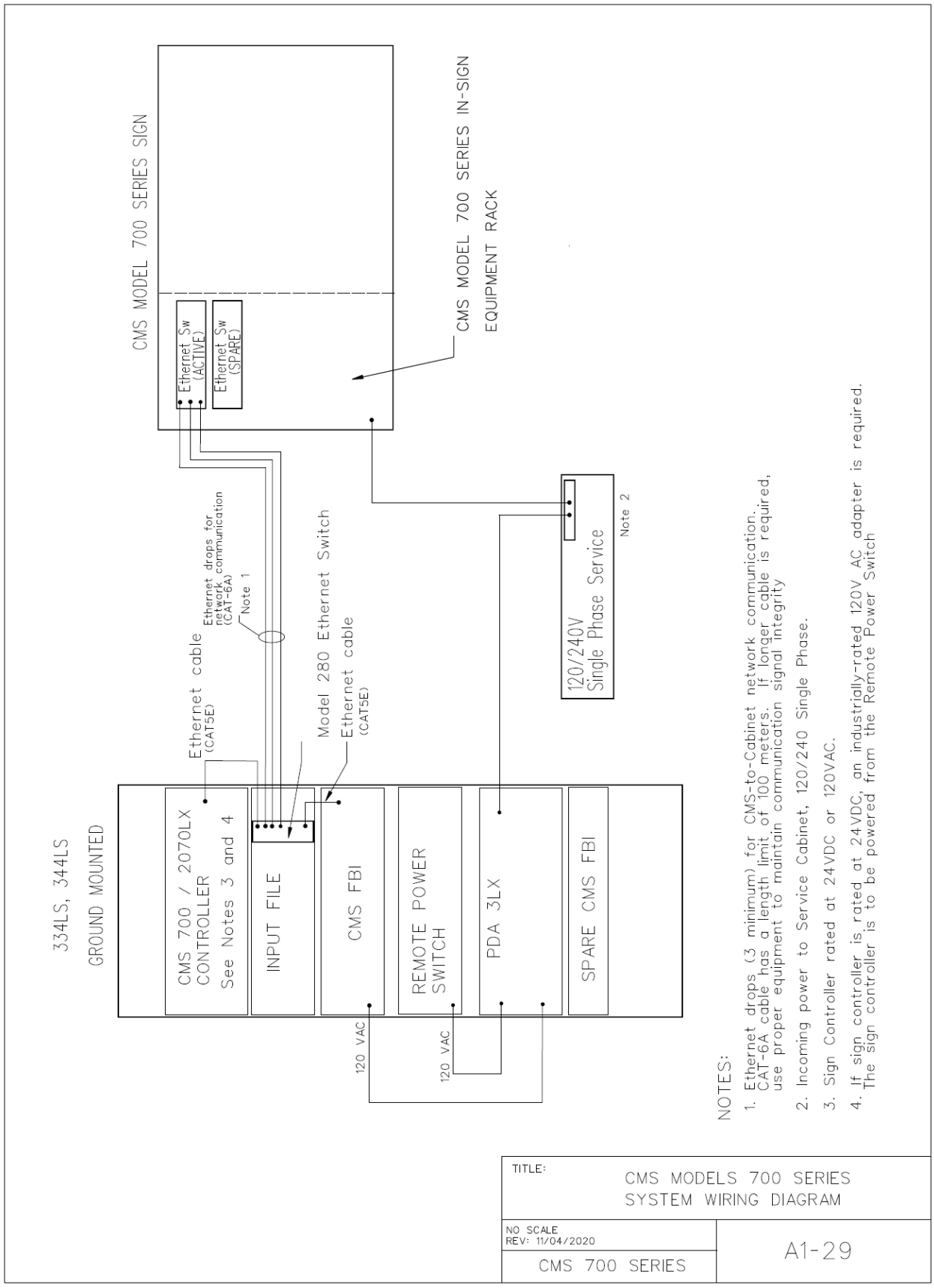
13.17.25 Drawing A1-27



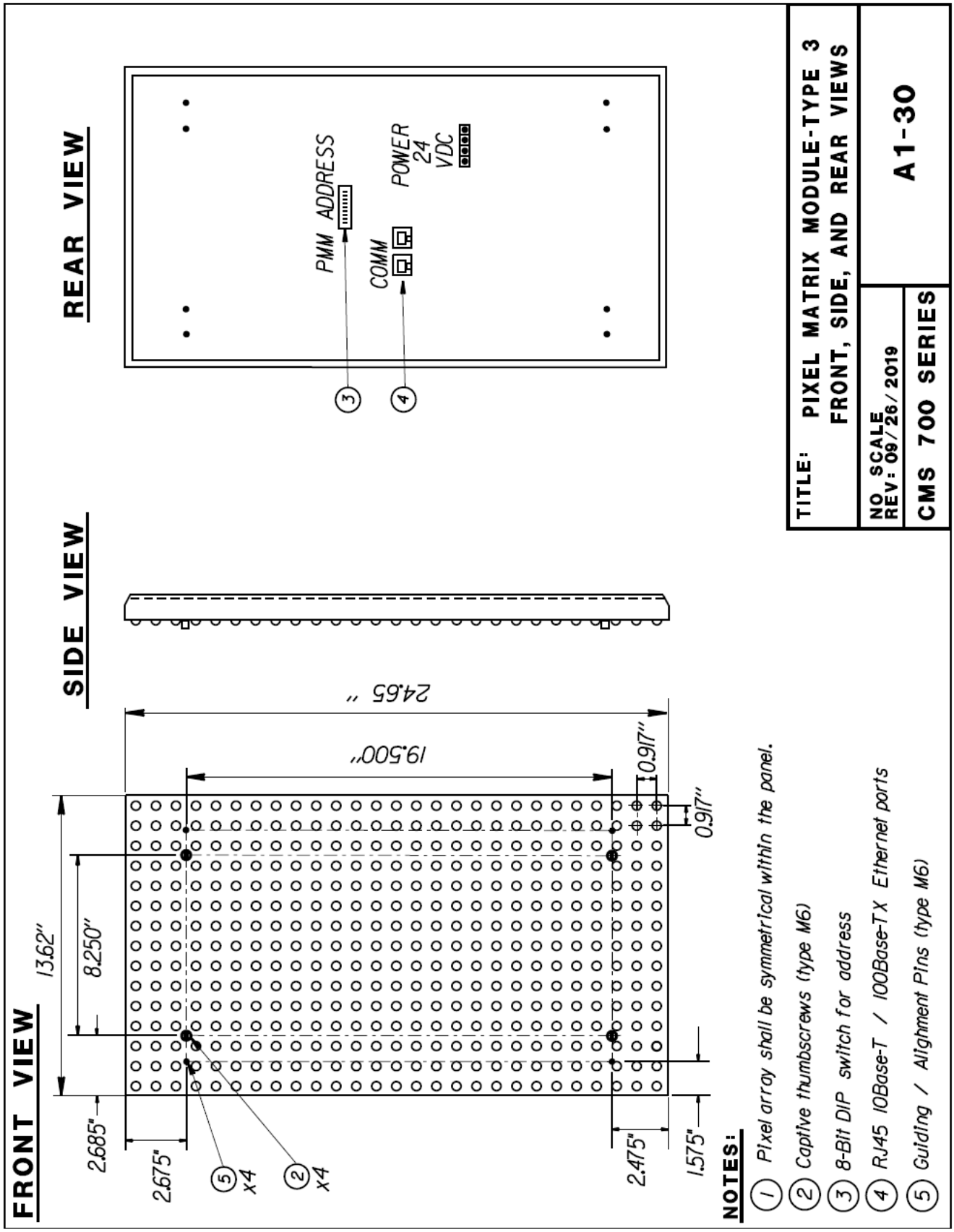
13.17.26 Drawing A1-28



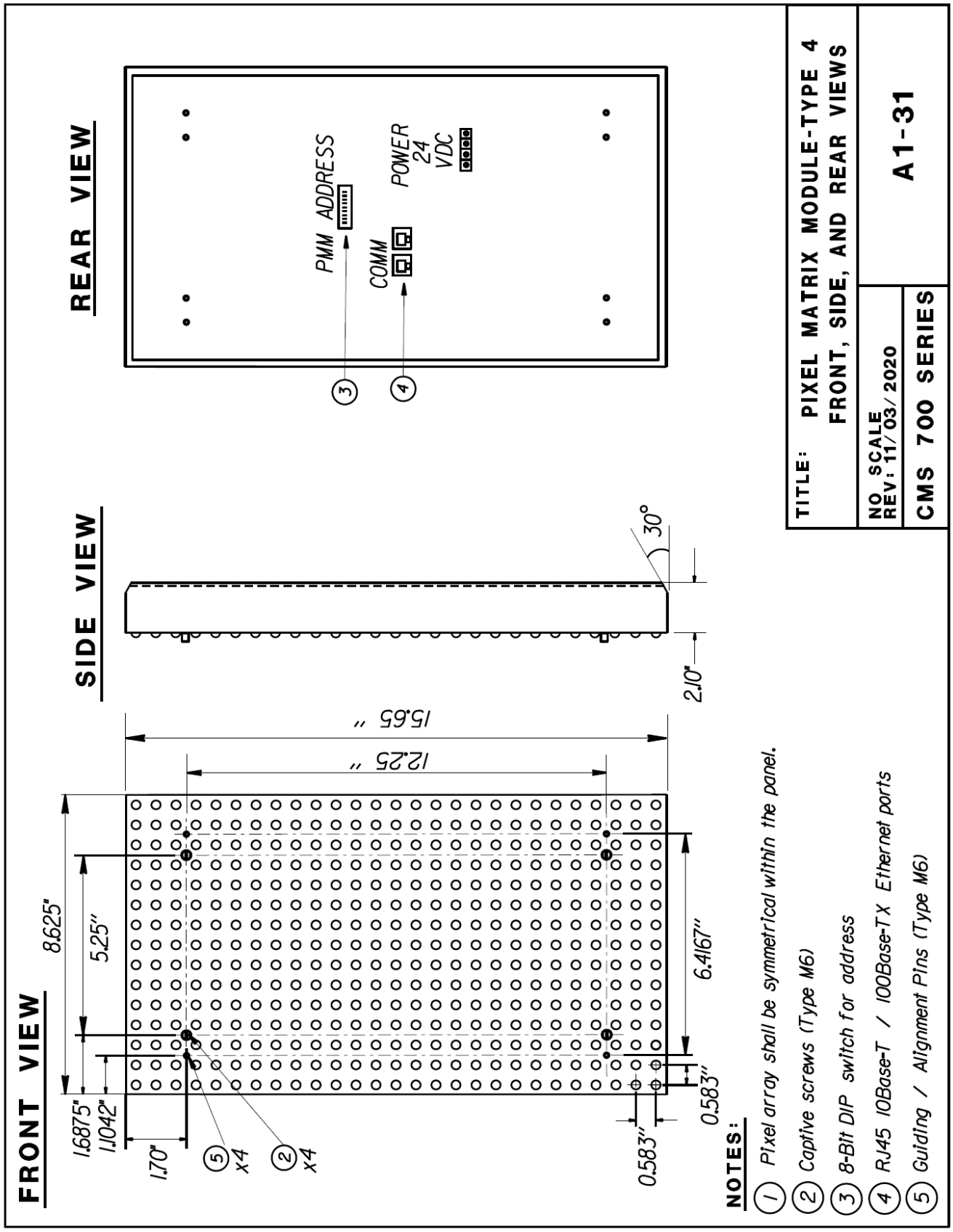
13.17.27 Drawing A1-29



13.17.28 Drawing A1-30



13.17.29 Drawing A1-31



13.17.30 Drawing A1-32