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1.0 SCOPE

The Staco Systems Series 90 is a broad product line of lighted pushbutton switches and indicators.

This specification defines the detailed requirements for these manually operated illuminated switch/indicator and pushbutton assemblies. They are identified as Models 91, 92, 93, 98, and 99.

Matrix frames, which utilize these switches and indicators, are described in a companion product specification, referred to Series 90 Matrix Housing Assembly for Models 94, 95, 96 and 97 (Model 94-97 Coded).

It is the purpose of this document to cover standard Series 90 "coded" products, and to show the relationship of these to other commonly used part number systems within the Series 90 Product Line for special customized configurations. In addition, this document identifies the companion products of the Series 90 family which are covered by their own specification control drawings (SCDs). Contained in this document is information to specify, through standard coded part numbers, the exact configuration desired.

The basic Series 90 product with incandescent lighting are built in accordance with the applicable requirements of MIL-PRF-22885.

The multi-chip LED lighted and crimp-pin terminated configurations are built in accordance with the applicable requirements of MIL-PRF-22885. Both versions are built in accordance with the applicable requirements of MIL-L-85762, and MIL-STD-3009.

The High Brightness LED configurations are built in accordance with the applicable requirements of MIL-PRF-22885.

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2.0 APPLICABLE SPECIFICATIONS AND STANDARDS

The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto. Detailed working drawings may refer to additional specifications and standards.

2.1. Military Specifications

MIL-C-5541	Chemicals Conversion Coatings on Aluminum Alloys (chem-film).
MIL-A-8625	Anodic Coatings, for Aluminum and Aluminum Alloys.
MIL-S-8805	Switches and Switch Assemblies, Sensitive and Push Snap Action, General Specification for.
MIL-S-8805/4	Switches, Sensitive, SPDT, Unsealed
MIL-P-13949	Plastic Sheet, Laminated, Metal Clad (For Printed Wiring Boards).
MIL-PRF-22885	Switches, Push Button, Illuminated, General Specification for.
MIL-S-24317	Switches, Multi-station, Pushbutton, (Illuminated and Non-Illuminated), General Specification for.
MIL-R-25988	Rubber, Fluorosilicone Elastomer, Oil and Fuel Resistant.
MIL-P-27418	Plating, Soft Nickel (Electrodeposited, Sulfamate Bath).
MIL-C-39029	Contacts, Electrical Connector, General Specification for, (i.e., wire terminations).
MIL-G-45204	Gold Plating, Electrodeposited.
MIL-I-45208	Inspection Systems Requirements.
MIL-P-81728	Plating, Tin Lead (Electrodeposited).
MIL-L-85762	Lighting, Aircraft, Interior, Night Vision Imaging System (NVIS) Compatible.
MIL-L-901	Shock Tests, H. I. (High-Impact) Shipboard Machinery, Equipment, and Systems, Requirements for.

2.2. Military Standards

MIL-STD-108	Definitions of, and Basic Requirements for, Enclosures for Electric and Electronic Equipment.
MIL-STD-130	Identification and Marking of US Military Property.

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MIL-STD-202	Test Method for Electronic and Electrical Component Parts.
MIL-STD-454	Standard General Requirements for Electronic Equipment.
MIL-STD-883	Test Methods and Procedures for Micro-Electronics.
MIL-STD-889	Dissimilar Metals.
MIL-STD-1285	Marking of Electrical and Electronic Parts.
MIL-STD-45662	Calibration System Requirements
MIL-STD-3009	Lighting, Aircraft, Night Vision Imaging System (NVIS) Compatible.

2.3. Other Military Specifications

DSCC DWG 90020 Switch, Pushbutton, Illuminated, 4 Lamp

2.4. Federal Standards

QQ-S-571 Solder, Tin Alloy, Tin-Lead Alloy and Lead Alloy.

ZZ-R-765 Rubber, Silicon.

2.5. Order of Precedence

In the event of a conflict between the text of this document and references cited herein, the text of this document shall take precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

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3.0 THE SERIES 90 PRODUCT LINE

This section provides an overview of the products available, their options, the standard "coded" parts, special configurations or unique design requirements, and how they are identified. The section concludes with a summary of companion standard products, which are part of the Series 90 Product Line, but are covered in separate specifications and documents.

3.1. Product Line Features/Options

The following is a summary of the standard features and options which may be specified:

3.1.1. Overview

- Switches or indicators in the same form-factor;
- Lighting from incandescent, integral LED sources, or LEDs with voltage dimming capability;
- Shock resistance;
- EMI/RFI attenuation option;
- Captive pushbutton option;
- Sealed for either drip-proof or splash-proof/watertight/immersion requirements;
- Optional seal resistant to fuels and solvents.

3.1.2. Display Options

- Sunlight readable;
- Compatible with Night vision goggle (NVG) or Night Vision Imaging Systems(NVIS);
- Eight display styles and ten display types;
- Five standard legend/character sizes;
- Legends of text or special symbols and artwork.

3.1.3. Incandescent Pushbutton Displays

- Four T1 size flange-based lamps per display;
- Five different lamp voltages;
- Eight display colors plus four NVG colors;
- Three lamp-ground configurations.

3.1.4. LED Pushbutton Displays

- Two types of LED are available.

3.1.4.1. Multi-Chip LED

- Integral light emitting diodes;
- Twenty-four LED junctions per display;
- Five LED colors plus three NVG colors;
- Two standard voltage options;
- Current sourcing or sinking;
- Common or split ground circuit configurations.

3.1.4.2. High-Brightness LED

- Integral light emitting diodes;

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- Eight High Brightness LEDs per display;
- Six LED display colors plus seven NVG colors;
- Two standard voltage options;
- Voltage dimming option with 28V DC applied voltage;
- Current sourcing or sinking;
- Common or split ground circuit configurations.

3.1.5. Switch/Indicator Options

- Individual or matrix mounting;
- Single-pole double-throw or double-pole double-throw switching;
- Momentary action and alternate action (latch-down) switches, or indicators (only) for annunciators
- Gold or silver switch contacts;
- Terminations for solder, MIL-C-39029/16-168 and MIL-C-39029/22-192 crimp-pin Common Termination System (CTS), or Printed Circuit Board;
- Internally Common Lamp Bus.

3.2. Standard "Coded" Configurations

Products specifically defined in this document are covered by a set of model numbers which are coded to identify the various features and options which are available with standard coded part numbers. These are:

- Model 91 "Coded" Switch or indicator assemblies without pushbuttons (short housings with solder, PCB or crimp pin terminations). The crimp pin termination can be selected if it is used in a matrix assembly ([Figure 1: Model 91 "Coded" – Solder Version Shown](#))

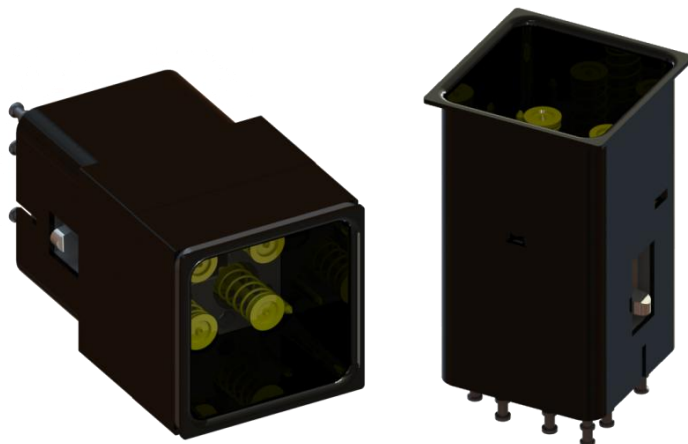


Figure 1: Model 91 "Coded" – Solder Version Shown

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- Model 92 "Coded" Pushbutton assemblies (incandescent or LED) ([Figure 2: Model 92 "Coded" – Incandescent Shown](#) and [Figure 3: Model 92 "Coded" – LED Shown](#)).



Figure 2: Model 92 "Coded" – Incandescent Shown



Figure 3: Model 92 "Coded" – LED Shown

- Model 93 "Coded" Model 91 switch/indicator assemblies with standard pushbuttons installed ([Figure 4: Model 93 "Coded" – Solder Version Shown](#)).

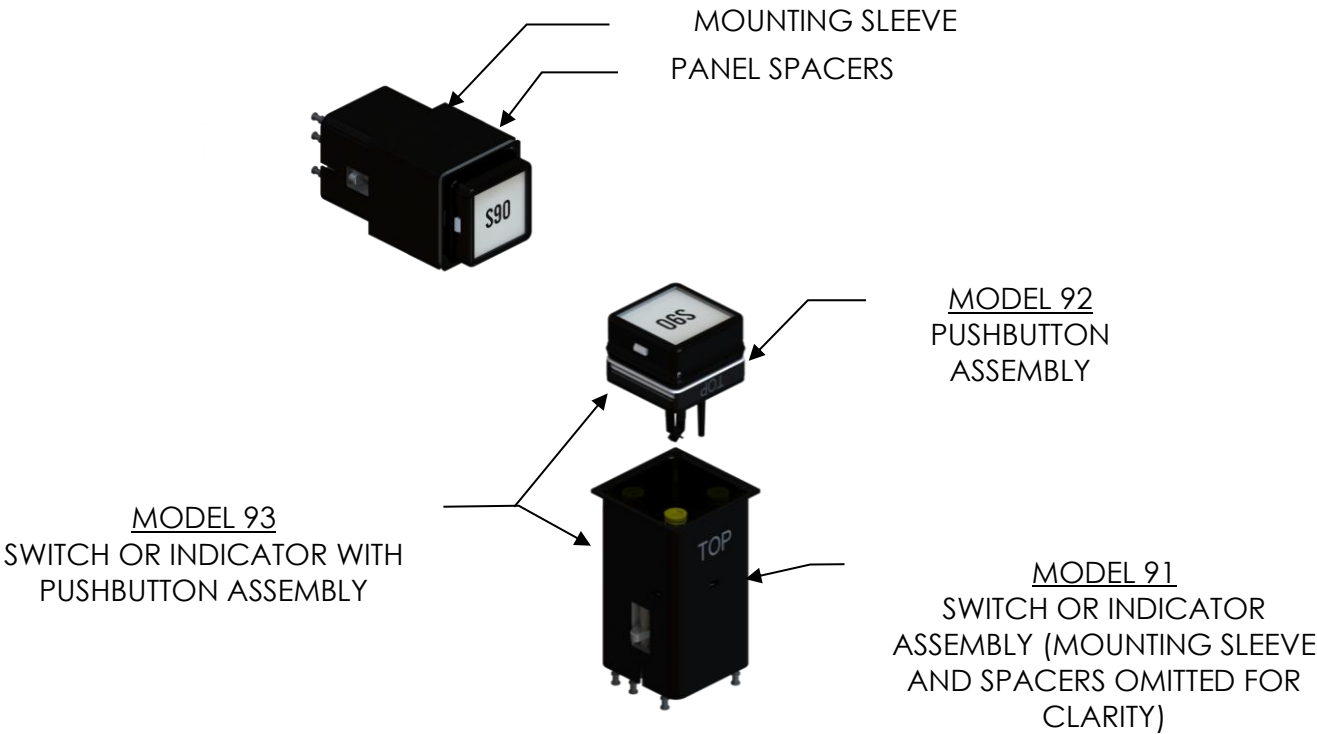


Figure 4: Model 93 "Coded" – Solder Version Shown

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- Model 98 "Coded" Switch or indicator assemblies without pushbuttons (longer housings with crimp pin receptacle for wire terminations) ([Figure 5: Model 98 "Coded" – Long Housing Shown](#)).



Figure 5: Model 98 "Coded" – Long Housing Shown

- Model 99 "Coded" Model 98 switch/indicator assemblies with standard pushbuttons installed ([Figure 6: Model 99 "Coded" – Long Housing Shown](#)).

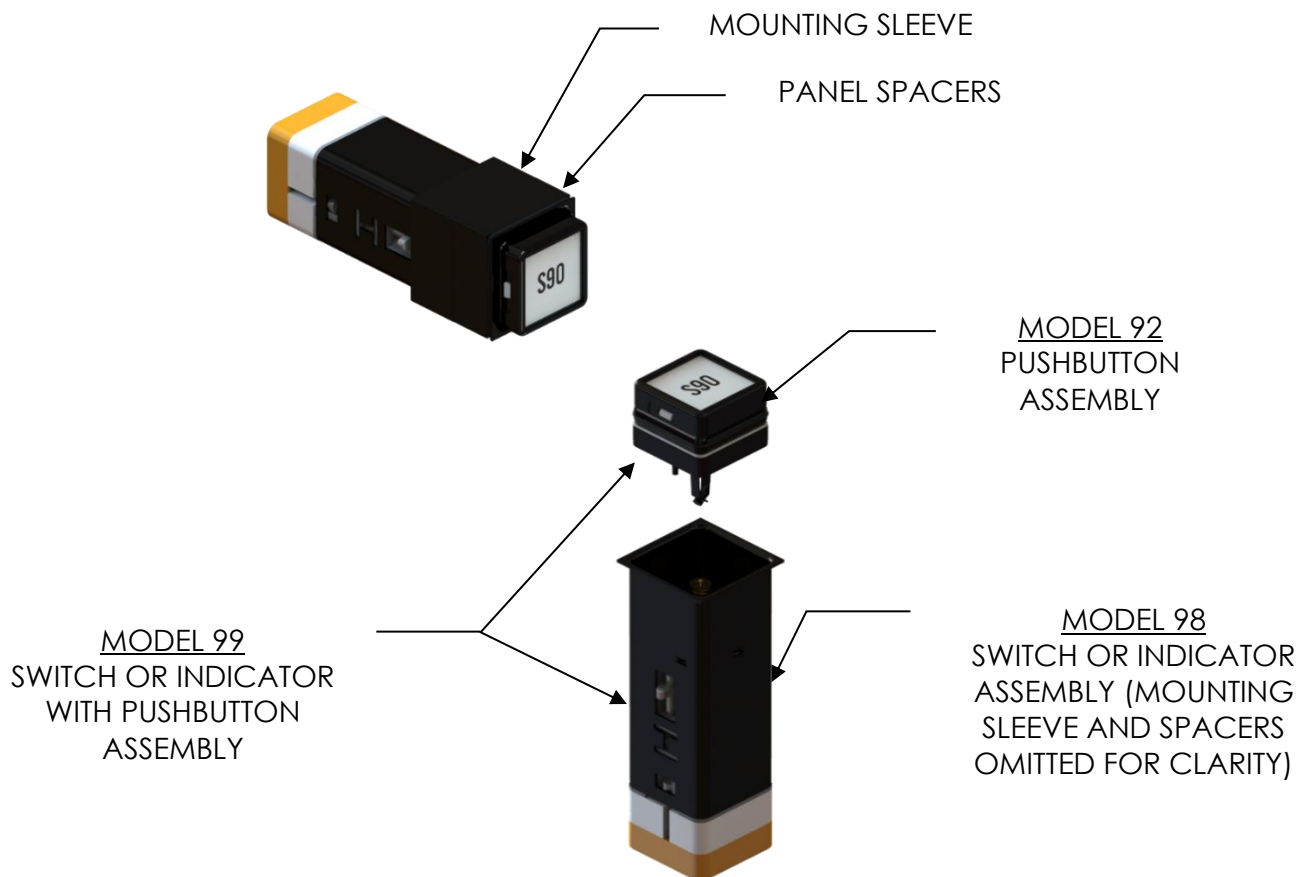


Figure 6: Model 99 "Coded" – Long Housing Shown

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Tables presented in Section 5 of this document define the coded part numbers for each of these assemblies.

3.3. Special Configurations

In addition to the standard options covered by the above "coded" model numbers, there are several "special configurations." These are similar units, based on the Series 90 Product Line, which are "specials" in that they conform to certain customer-defined configurations and/or have unique non-standard requirements for performance or marking.

The "special configurations" listed in the following paragraphs shall be designed and manufactured to meet the requirements of this document whenever possible. However, specific customer-invoked design requirements may compromise certain performance characteristics and thus prevent total compliance with the details of this specification. Reliability, of course, shall not be compromised.

3.3.1. 92P-Type Pushbuttons

Model 92PXXXX numbers shall be used to define unique pushbuttons with special artwork or other non-standard design requirements. The XXXX in this model number is a four-digit, non-coded, sequentially assigned number. Any of these numbers may be tabulated and have a three-digit or, under special circumstances, a four-digit sequential tab number. (Typical example would be of the form 92P1234-123)

3.3.2. 63-Type Model Numbers

The 63XXXX sequence of numbers shall be used instead of the standard 93/99 series of model numbers for certain uniquely defined combinations of switches/indicators with their pushbuttons. These special model numbers may be used for many reasons such as: (1) When, what would otherwise be standard switches, contain 92P type pushbuttons; or (2) When the switches require special marking or special construction; or (3) When the customer (or Sales) requires that a non-coded part number to be used.

The four-digit portion of the part number represented by the X's above shall be assigned sequentially. Normally, the 63XXXX number will have a three-digit tabulated dash number attached. Under certain conditions, the tab number may be four or five digits in length.

3.3.3. 17 Series

The 17XXX series represents pushbuttons, switches and indicators which have been pre-defined for specific industry applications. The Series 17 Specification Control Drawing (SCD) defines these products and may be referred to for details.

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3.3.4. Slash Numbers

Standard Series 90 model numbers shall have a slash number (/XXX or /XXXX) following the standard coded part number to indicate that the unit is identical to the coded unit except for certain specific differences. Examples might be special marking, special plating, or assemblies which are sealed such as watertight and solvent resistant, or special voltages for LED lighting. These slash number special options shall be documented by their own specifications, drawings and/or SCD.

3.3.5. DSCC Drawing 90020

The Defense Supply Center Columbus has established a DSCC drawing, number 90020-TAB, to represent switches with pushbuttons which have specific legends and possibly other non-standard requirements, and which are certified by the manufacturer to comply with the general requirements of MIL-PRF-22885. These are documented as Staco Systems part numbers 631220-TAB. The tab numbers for the Staco Systems drawing correspond exactly to the tab numbers on the DSCC drawing. (For example, DSCC part identification number 90020-00026 is Staco Systems part number 631220-00026.)

3.3.6. 15 Series

Accessories which may apply to switch products are identified by 15XXX numbers. Refer to Section [5.3](#) for typical accessories which apply to the Series 90 Product Line.

3.4. Matrix Frame Assemblies

The standard switches and indicators (Model 91), pushbuttons (Model 92 or 92P), or combined assemblies (Model 93 or 63) may be used in matrix frames. These units are available in the following configurations:

REAR MOUNT FLANGE MATRIX

Model 94 - Standard Housing for Solder or PCB Terminals.

Model 95 - Longer Housing for Crimp Pin Receptacle (including receptacle).

FRONT MOUNT DRESS BEZEL MATRIX

Model 96 - Standard Housing for Solder or PCB Terminals.

Model 97 - Longer Housing for Crimp Pin Receptacle (including receptacle).

For Models 95 and 97, the switches and the receptacles are each secured separately to the matrix frame by screw actuated cam locks. This allows the switch to be serviced from the front of the matrix frame, leaving the receptacle and wiring in place. The receptacle may be removed from the rear of the matrix frame or individual wires may be removed from the receptacle without removing the switch or receptacle from the matrix frame.

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For Models 94 and 96, the switches/indicators are secured separately to the matrix frame by screw actuated cam locks. The wire termination is accomplished directly onto the switch/indicator.

Details on these units are found in the Matrix Frame Assembly Specification Control Drawing, Model 94-97 Coded.

These matrix assemblies are designed and tested to meet the requirements of MIL-S-24317.

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4.0 REQUIREMENTS

This specification defines the detailed requirements for the Series 90 switches, indicators, and pushbuttons, and the assemblies thereof.

4.1. Dimensional Requirements

The design and construction of the assemblies shall be in accordance with the dimensions as described herein and as depicted in the referenced figures to be found at the end of this section.

All dimensions are shown in inches with millimeters given as reference information in parenthesis. Unless otherwise specified, tolerances are:

- . xx = ± .02 inch (± .5 mm)
- . xxx = ± .010 inch (± .25 mm)

4.1.1. Physical Dimensions

Major assemblies referred to in this specification are shown below. They are the Model 91 "coded" Switch or Indicator ([Figure 7: Model 91 Switch – Side View](#) and [Figure 8: Model 91 Switch – Top View](#)), the Model 92 "coded" Pushbutton ([Figure 9: Model 92 Pushbutton – Incandescent Shown](#) and [Figure 10: Model 92 Pushbutton – HB-LED Shown](#)), the Model 93 "coded" Switch/Indicator with Pushbutton included ([Figure 11: Model 93 Switch – Switch and Pushbutton - Side View](#) and [Figure 12: Model 93 Switch – Switch and Pushbutton - Top View](#)) and the Model 93 "coded" Switch/Indicator with Pushbutton included exploded view ([Figure 13: Model 93 Switch – Exploded View](#)).

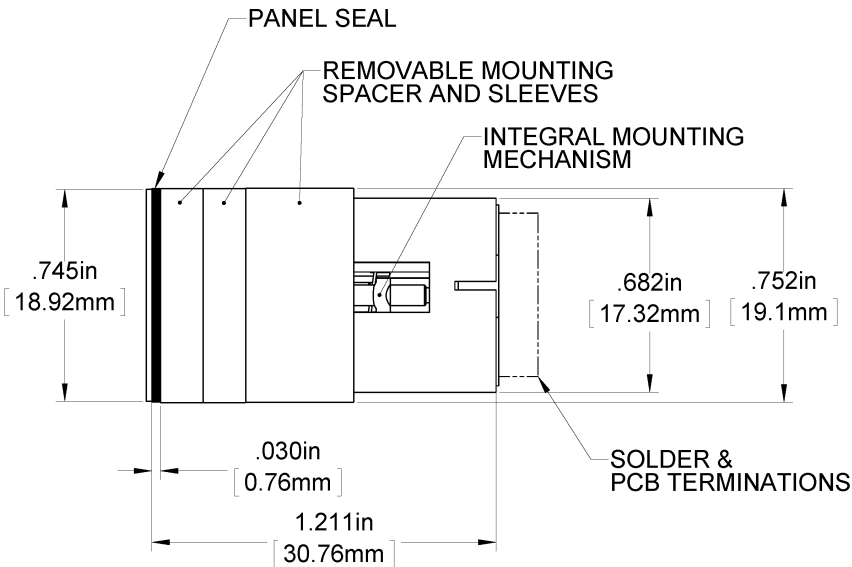


Figure 7: Model 91 Switch – Side View

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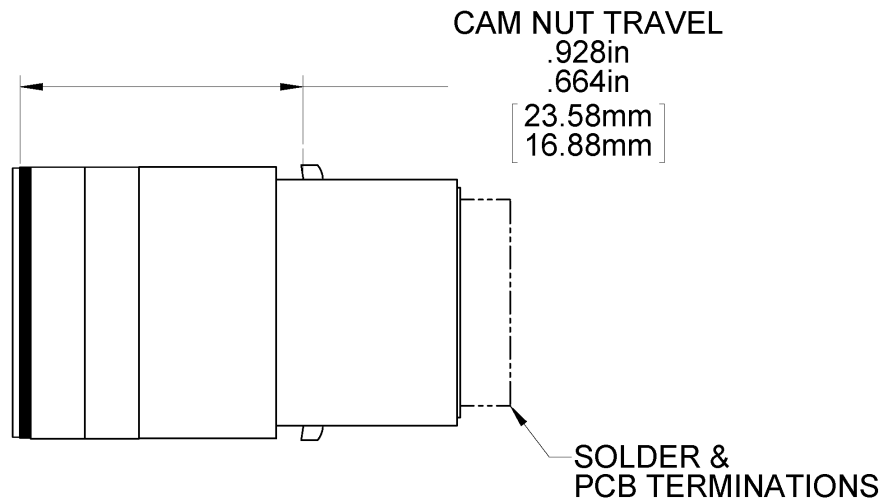


Figure 8: Model 91 Switch – Top View

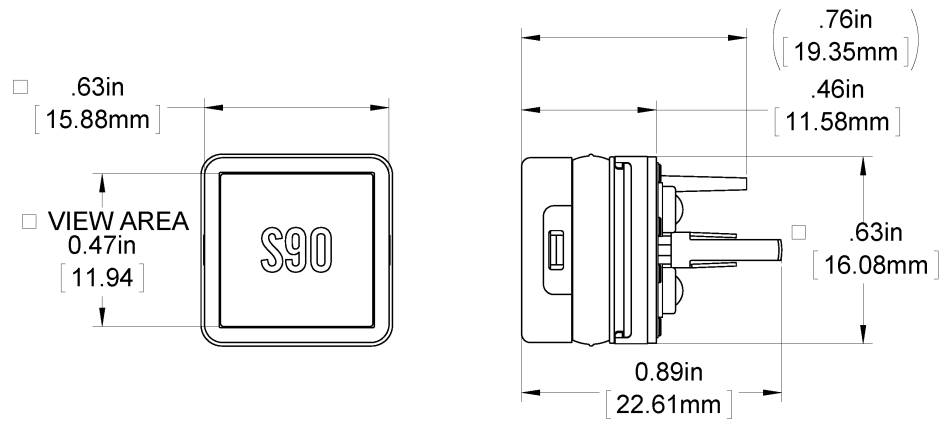


Figure 9: Model 92 Pushbutton – Incandescent Shown

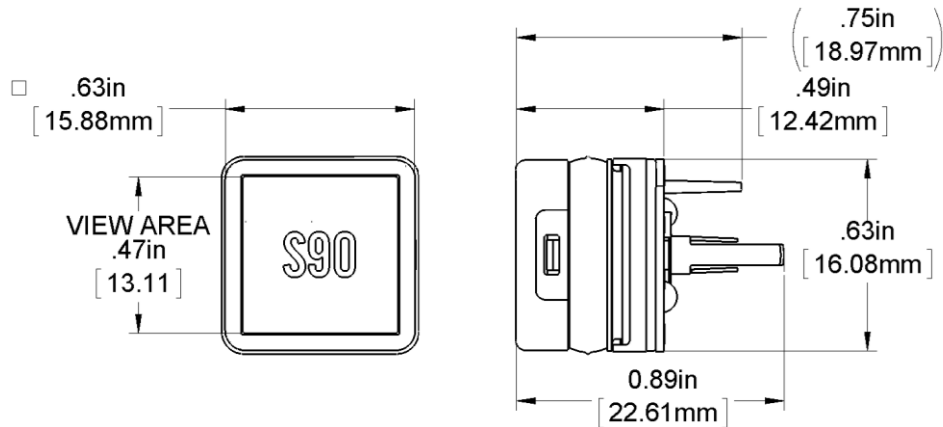


Figure 10: Model 92 Pushbutton – HB-LED Shown

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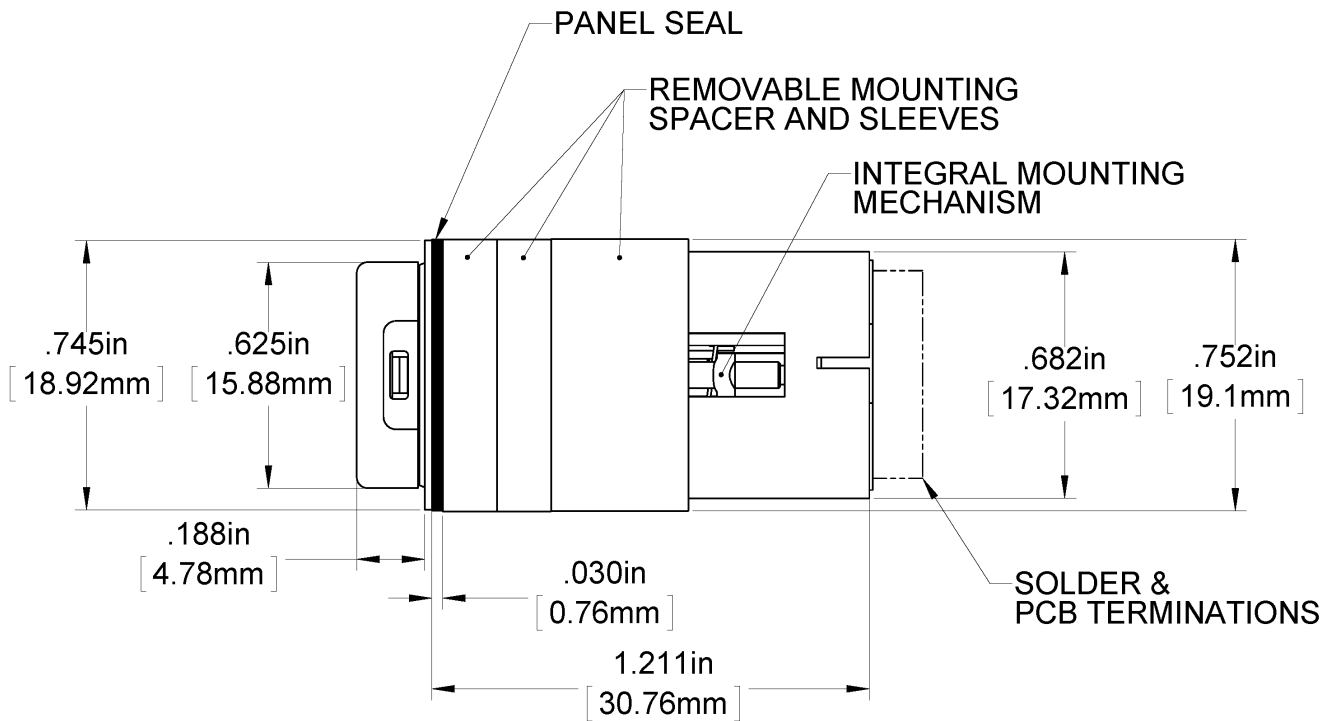


Figure 11: Model 93 Switch – Switch and Pushbutton - Side View

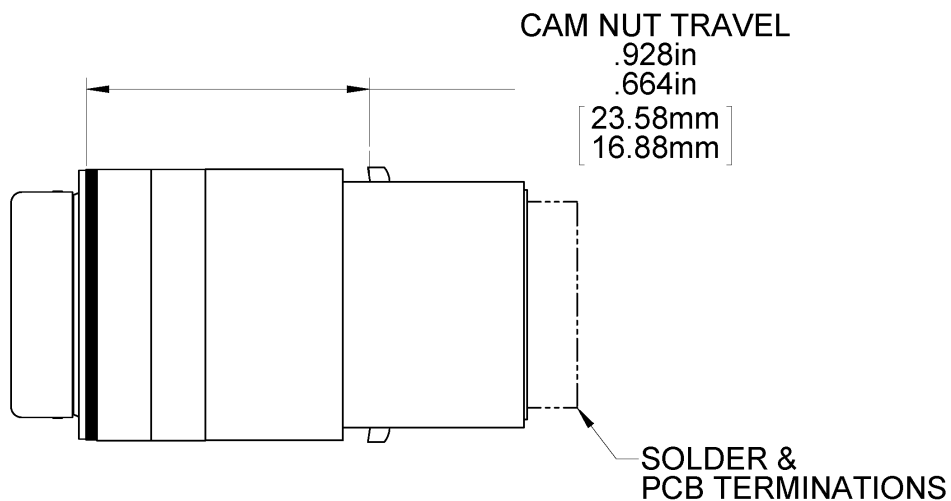


Figure 12: Model 93 Switch – Switch and Pushbutton - Top View

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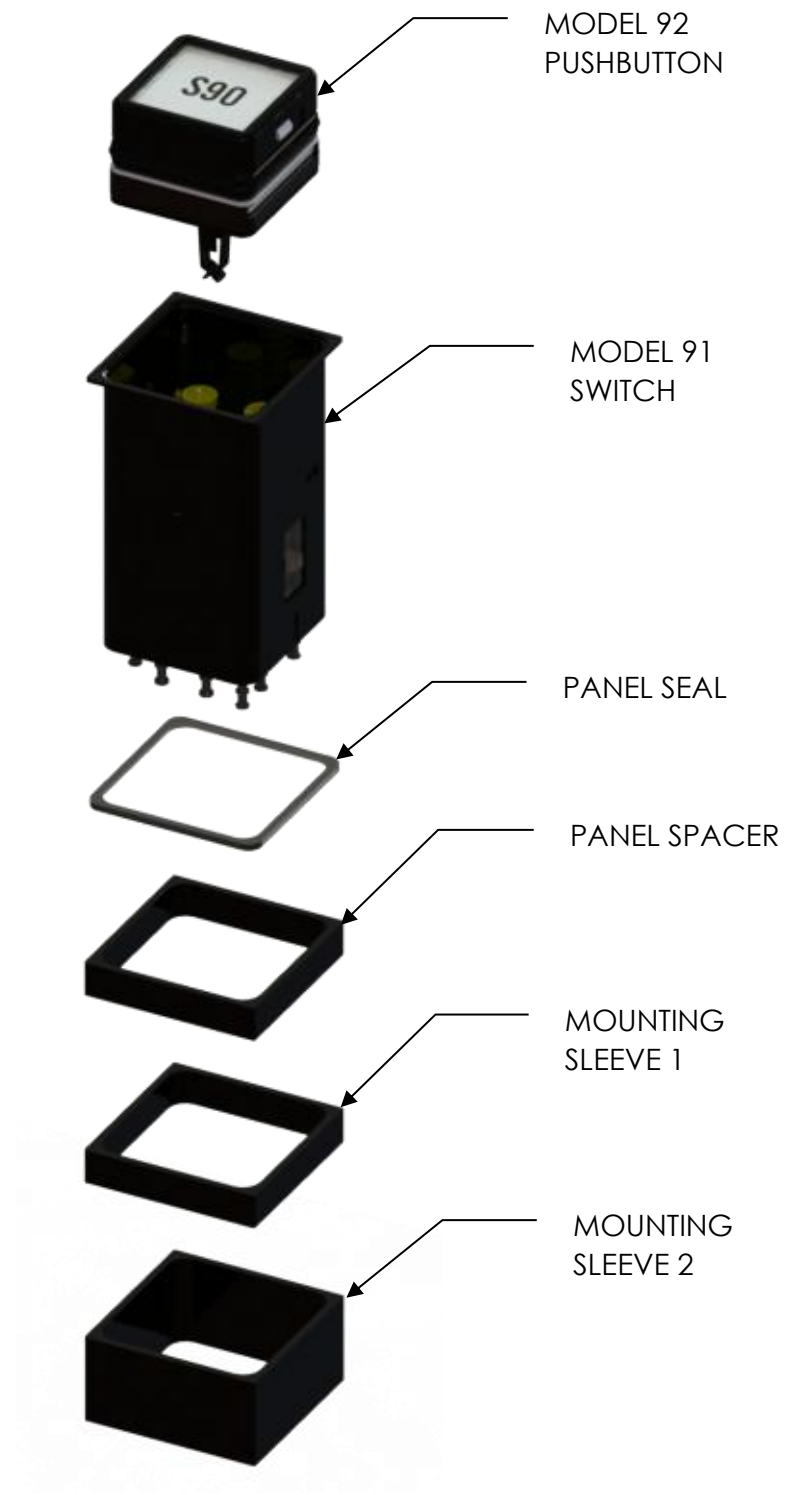


Figure 13: Model 93 Switch – Exploded View

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[Figure 14: Model 98 Switch – Side View](#), [Figure 15: Model 98 Switch – Top View](#), [Figure 16: Model 99 Switch – Side View](#), [Figure 17: Model 99 Switch – Top View](#), and [Figure 18: Model 99 Switch – Long housing shown](#), shows views of the Model 98 Switch/Indicator with a Model 92 Pushbutton to form a Model 99 Switch Assembly. Also shown are the MIL-C-39029/16-168 crimp pins and the receptacles ([Figure 19: MIL-C-39029/16-168 Receptacle Assy - Used in 9816-9820 models](#) and [Figure 20: MIL-C-39029/22-192 Receptacle Assy - Used in 9821 models](#)) which are unique to this configuration. The mounting sleeve and two panel spacers shown accommodate a wide range of allowable panel thickness as specified in subsequent figures. The locations of the integral mounting mechanism for the switch/indicator and the mounting nuts for the receptacle assembly are shown.

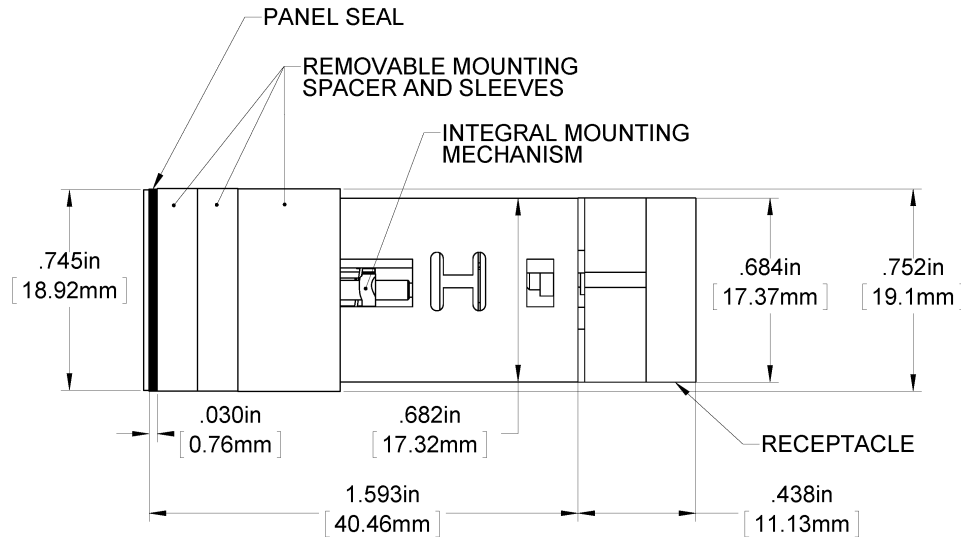


Figure 14: Model 98 Switch – Side View

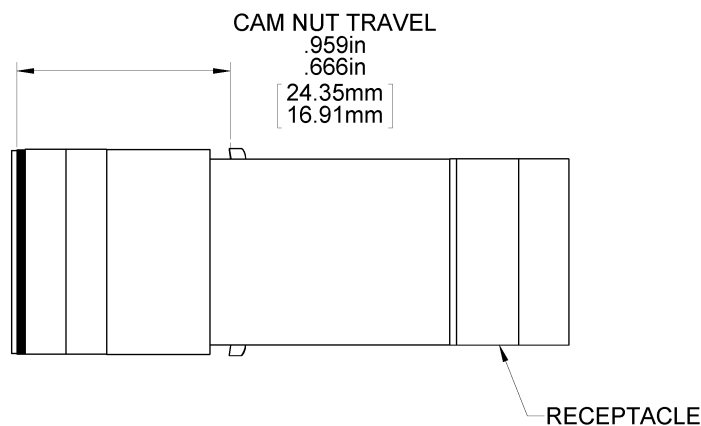


Figure 15: Model 98 Switch – Top View

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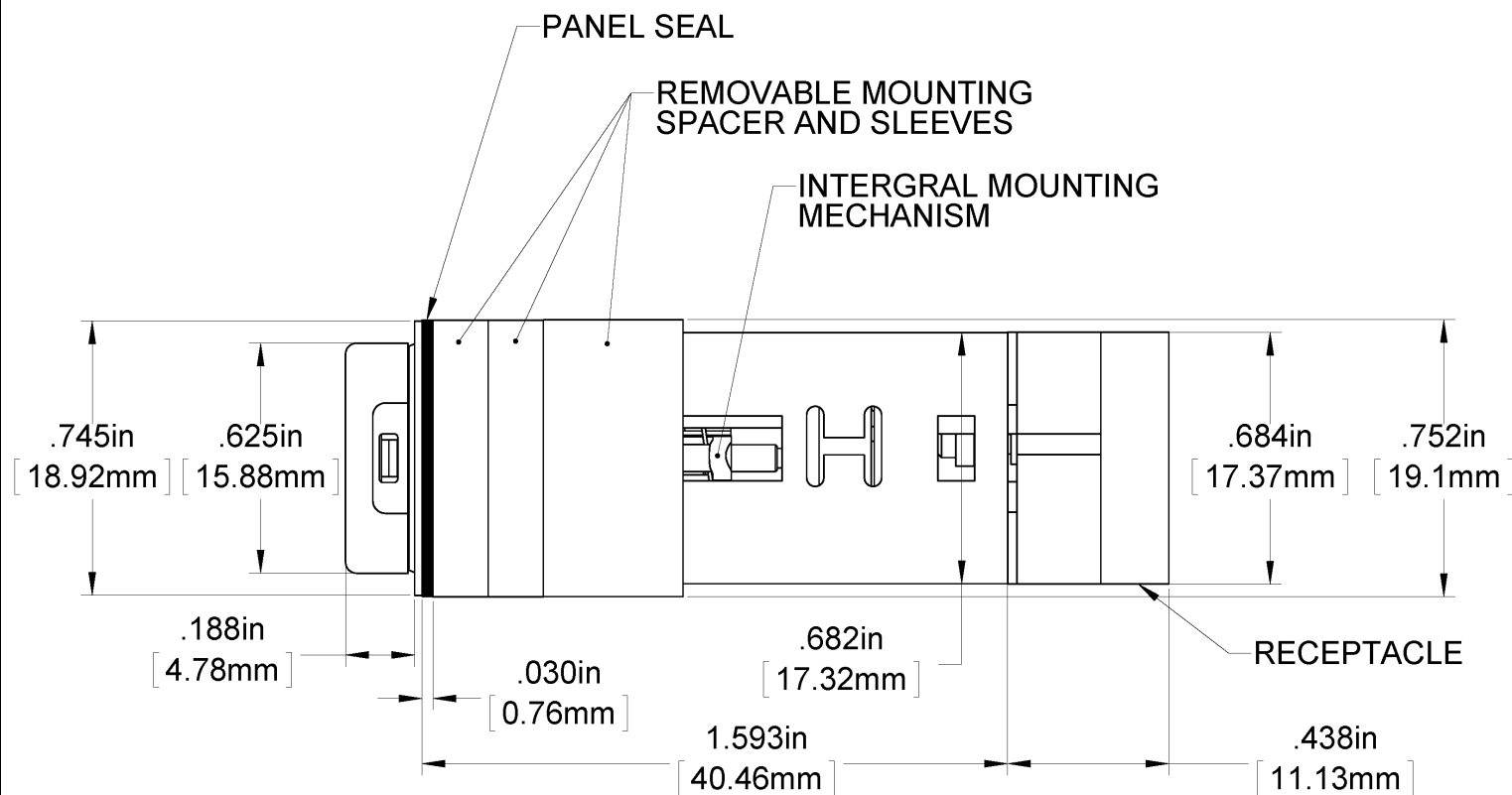


Figure 16: Model 99 Switch – Side View

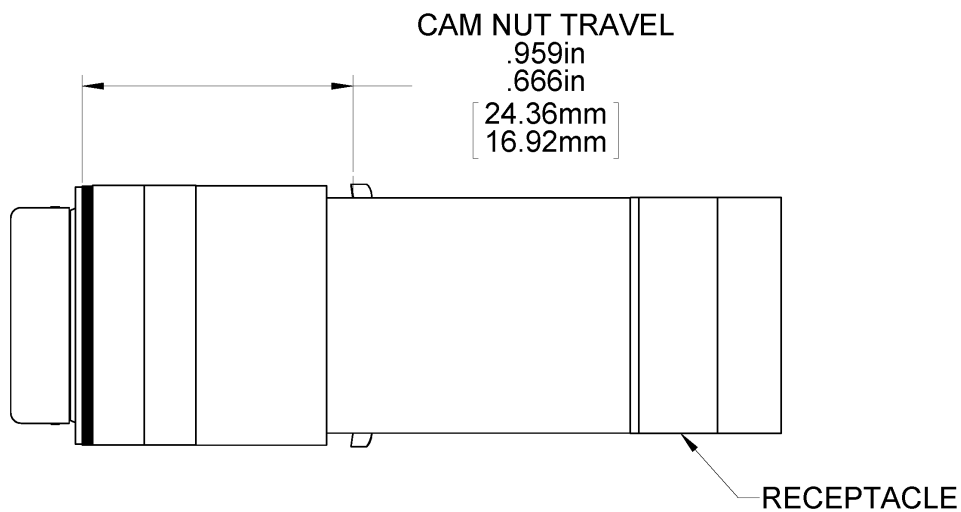


Figure 17: Model 99 Switch – Top View

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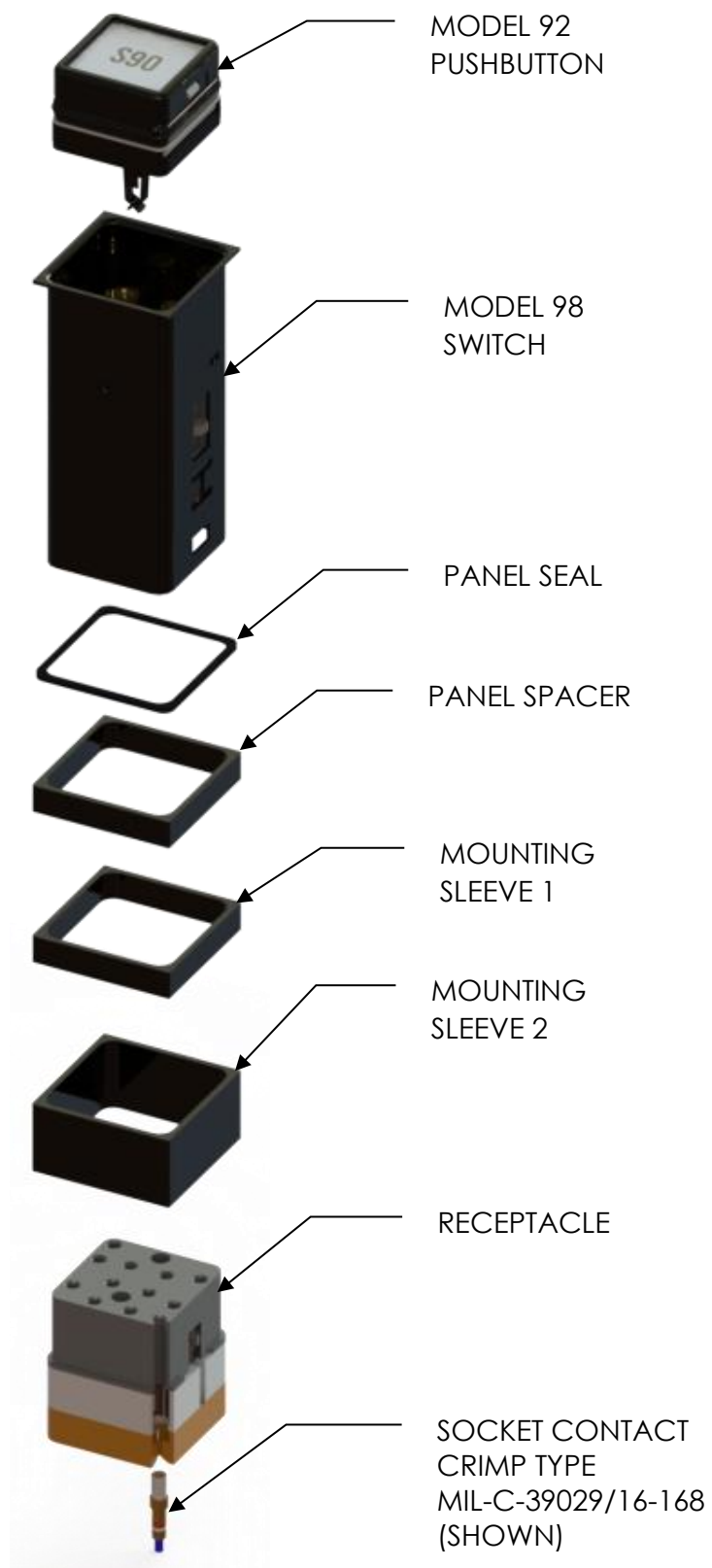


Figure 18: Model 99 Switch – Long housing shown

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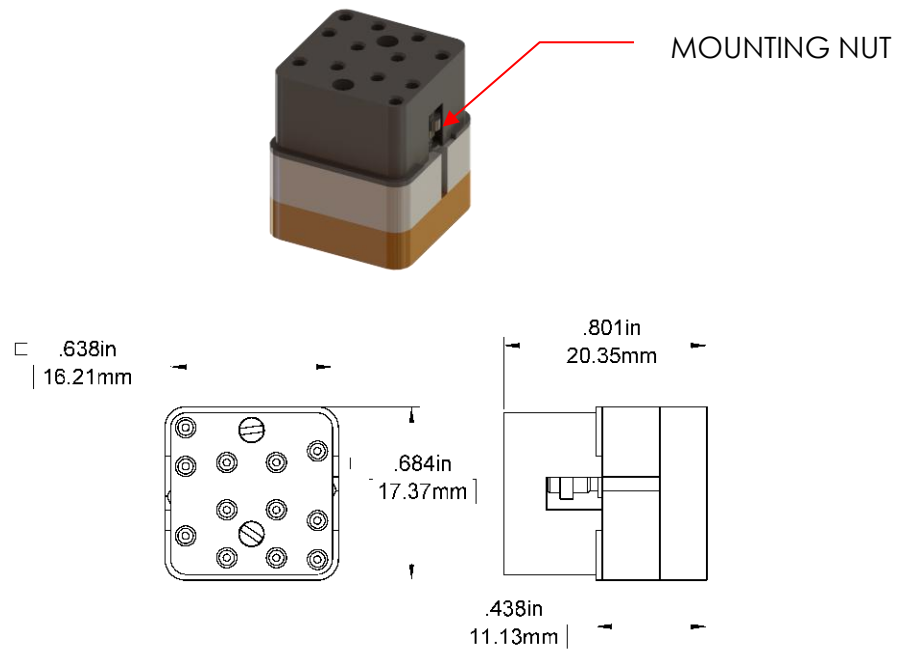


Figure 19: MIL-C-39029/16-168 Receptacle Assy - Used in 9816-9820 models

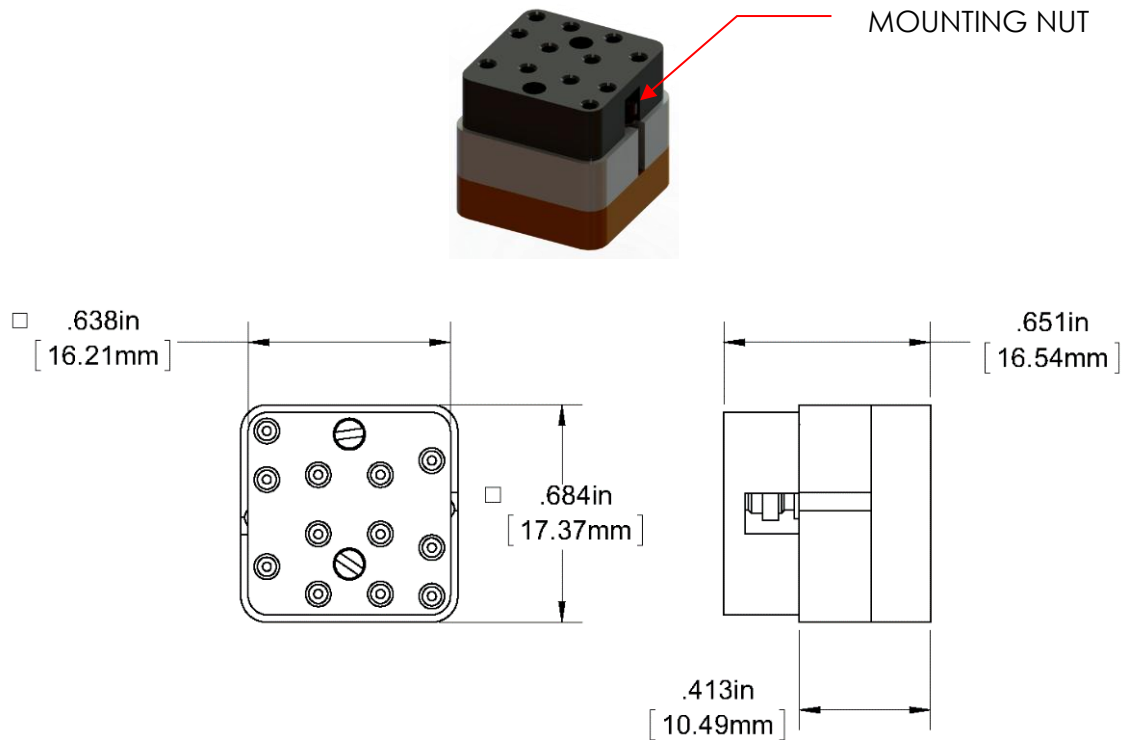


Figure 20: MIL-C-39029/22-192 Receptacle Assy - Used in 9821 models

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4.1.2. Panel Cutouts and Mounting

The recommended cutout for panel mounting is shown in [Figure 21: Recommended Panel Mounting Cutout](#), [Figure 22: Cutout Spacing for Individual Mount](#), and [Figure 23: Cutout Spacing for Watertight](#). The location of the mounting screws within the switch housing (as viewed from the front panel without the pushbutton being installed) is shown in [Figure 24: Switch/Indicator Mounting Screw Location](#).

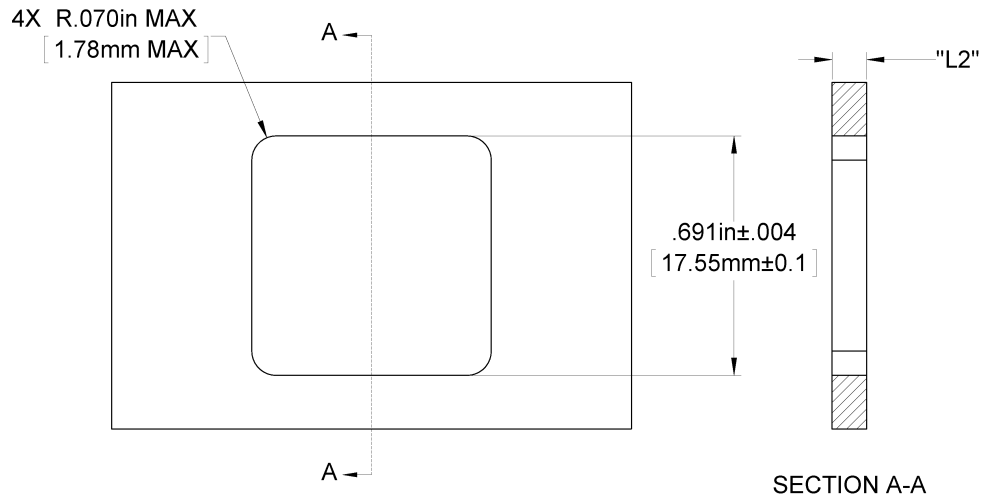


Figure 21: Recommended Panel Mounting Cutout

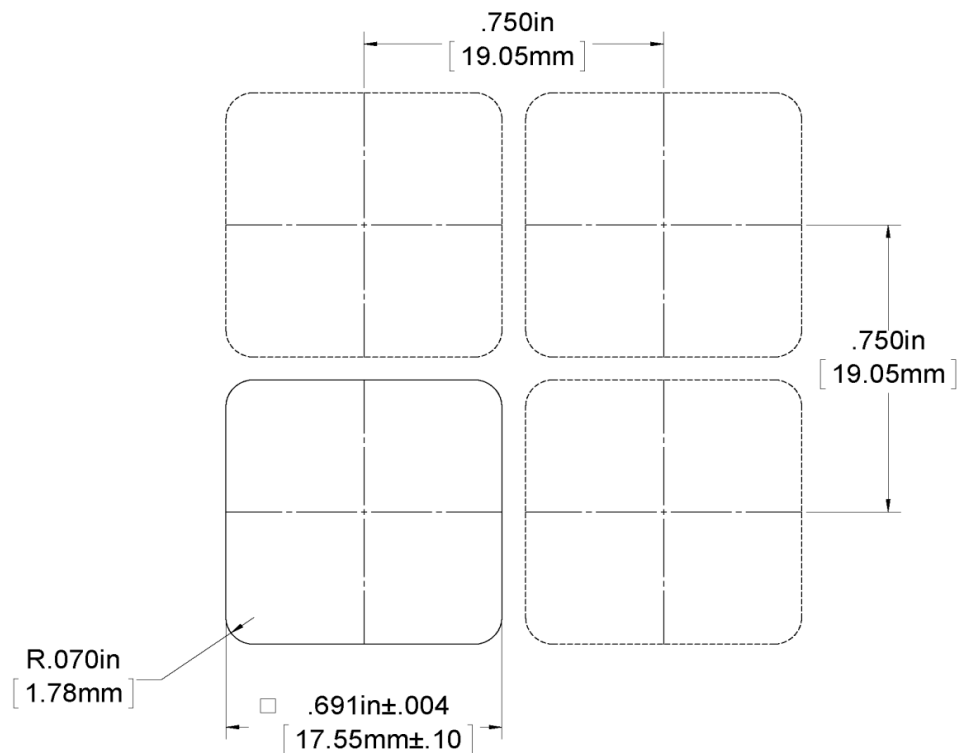


Figure 22: Cutout Spacing for Individual Mount

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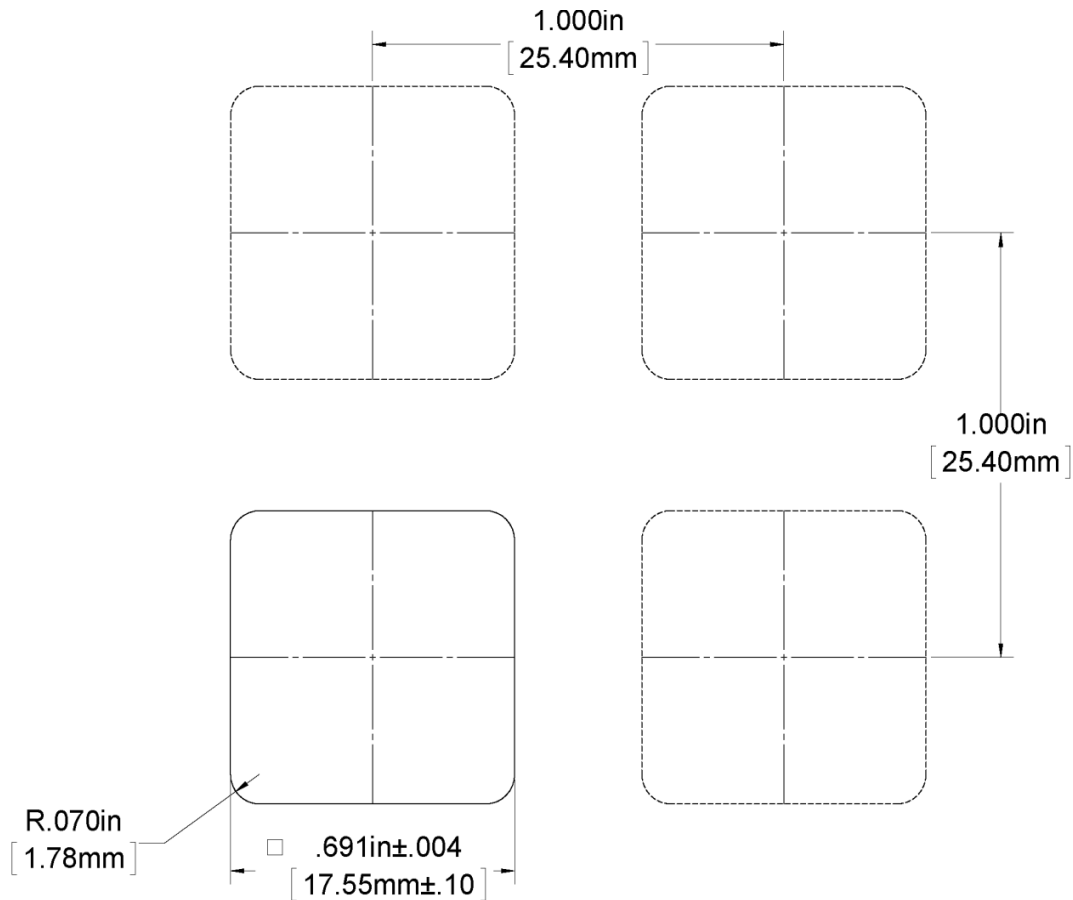


Figure 23: Cutout Spacing for Watertight

For applications where horizontal or vertical slot mounting of two or more individual mount switch/indicator is required, the following formula provides cut-out dimensions for the slot mounting.

$$L [in] = 0.752[in] * (n-1) + 0.690 [in]$$

$$L [mm] = 19.1 [mm] * (n-1) + 17.5 [mm]$$

NOTE:

- Where L = length of horizontal or vertical mounting slot.
- Where N = number of units in a row or column.
- Slot mounting not available with immersion seals (90/005 or 90/006)
- Panel seals are not applicable to slot mounting configurations.

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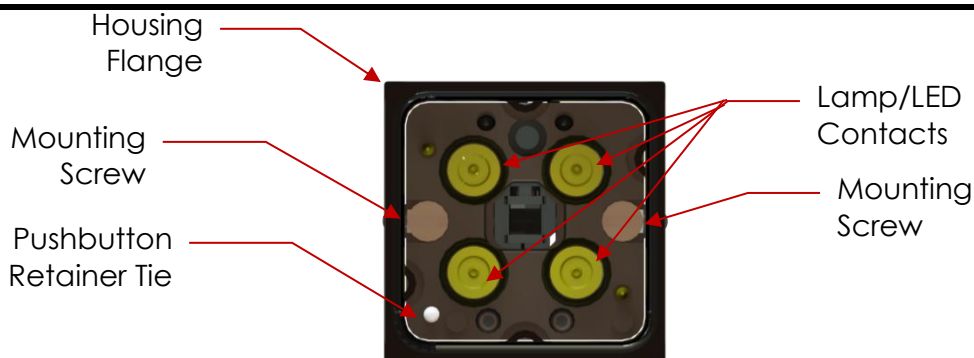


Figure 24: Switch/Indicator Mounting Screw Location
(viewed from front of panel)

4.1.3. Mounting Hardware

Each switch or indicator intended for individual mount application is provided with mounting hardware. This consists of a mounting sleeve and two panel spacers which are used, in conjunction with the mounting screws and cam nuts, to install the switches in panels up to a possible maximum of .75" (19.1 mm) thick ([Figure 25: Mounting Hardware Dimensions \(Model 93 – Solder Version Shown\)](#)) and [Table I: Mounting Hardware Dimensions](#)).

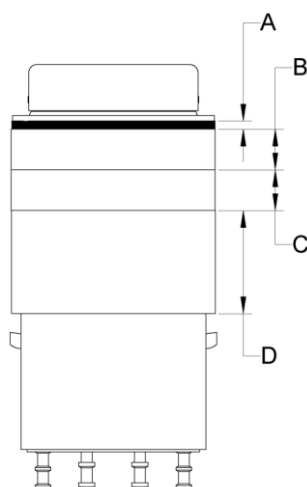


Figure 25: Mounting Hardware Dimensions (Model 93 – Solder Version Shown)

Table I: Mounting Hardware Dimensions

Symbol	Description	Dimensions
A	Splash-proof panel seal*	0.030" [0.76 mm]
B	Panel spacer 1	0.150" [3.81 mm]
C	Panel spacer 2	0.150" [3.81 mm]
D	Mounting sleeve	0.380" [9.65 mm]

*Free height or uncompressed, splash proof panel seal = 0.040" [1.02mm]

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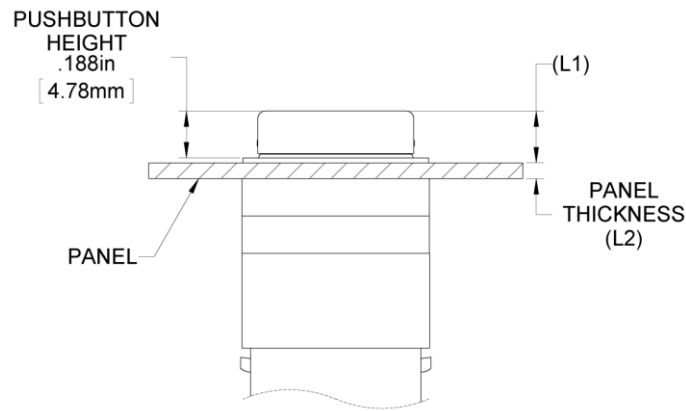


Figure 26: Flush Mount without Panel Seal

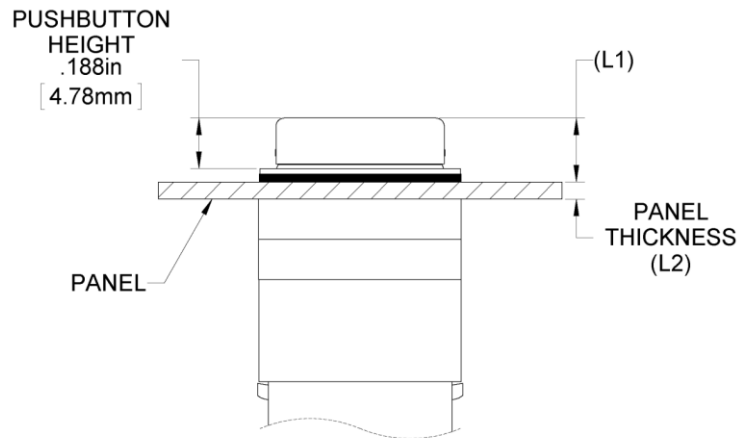


Figure 27: Flush Mount with Panel Seal

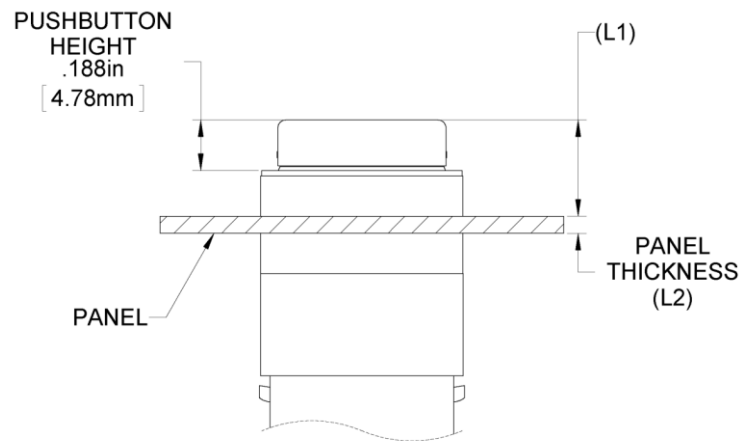


Figure 28: Extended Mount without Panel Seal

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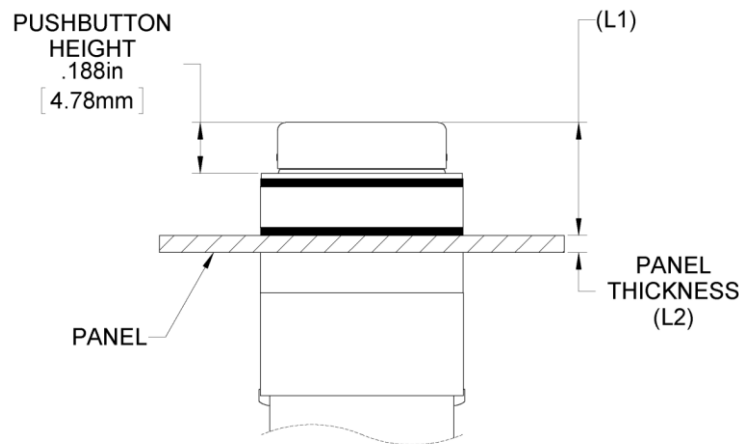


Figure 29: Extended Mount with Panel Seals

Table II: Mounting Panel Thickness Maximum

Description	Flushed mount		Extended mount	
	Cap Protrusion (L1)	Panel Thickness Max. (L2)	Cap Protrusion (L1)	Panel Thickness Max. (L2)
Without Seal	0. 208" [5. 28mm]	0. 750" [19. 05mm]	0. 358" [9. 09mm]	0. 600" [15. 24mm]
Splash-proof	0. 248" [6. 30mm]	0. 700" [17. 78mm]	0. 418" [10. 62mm]	0. 600" [15. 24mm]

It will be noted that the panel spacer is 0. 15" (3. 8 mm) to enable the pushbutton to align with commonly used edge-lighted panels when applicable ([Figure 28: Extended Mount without Panel Seal](#) and [Figure 29: Extended Mount with Panel Seals](#))

The panel seal shown in these dimensional drawings is for drip-proof applications. (The seal used for watertight and splash-proof type applications is referred to in paragraph [4.1.10](#) and [Figure 36: Watertight Seal](#)) For dimensions of matrix frames, see the Model 94-97 Coded SCD.

4.1.4. Mounting Torque

The recommended torque to be applied to the mounting screws during installation is 10 ± 2 ounce-inches ($0. 071 \pm 0. 014$ Nm). This torque value is applicable to both, the switch panel mounting and to receptacle assembly installation (Reference TB-206, Section [0](#)).

4.1.5. Printed Circuit Board Mount Terminals

The dimensions for printed circuit board type terminals are shown in [Figure 30: PCB Type](#). (This type of terminal also is the intermediate connection between the switch and the receptacle assembly for crimp pin applications, i.e., Model 98 Individually Mounted Switches and Series 95 and 97 Matrix Assemblies.)

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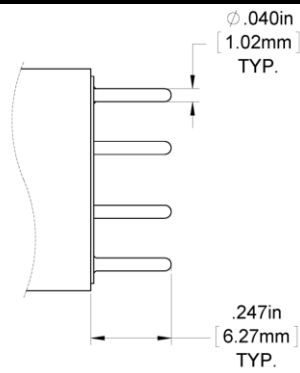


Figure 30: PCB Type

4.1.6. Solder Terminals

The double turret solder type terminals are dimensioned in [Figure 31: Solder Type Terminals](#).

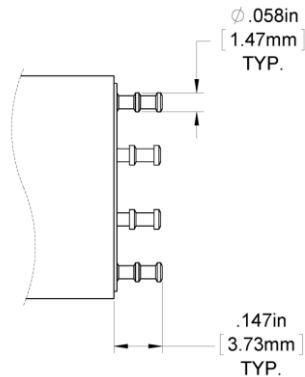


Figure 31: Solder Type Terminals

4.1.7. Crimp Pin Wire Terminations

Color band identification and reference dimensions of the Socket Contact used in MIL-C-39029/22-192 crimp pin applications are shown in [Figure 33: MIL-C-39029/22-192 Socket Contact Wire Termination Crimp Type](#). [Figure 32: MIL-C-39029/16-168 Socket Contact Wire Termination Crimp Type](#) shows the MIL-C-39029/16-168 crimp pin.

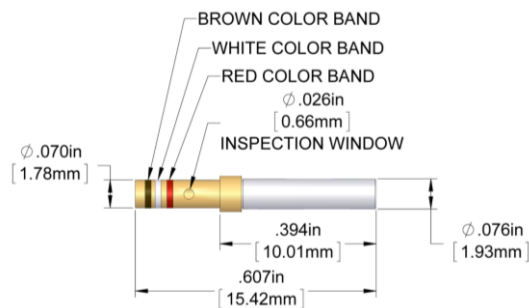


Figure 32: MIL-C-39029/16-168 Socket Contact Wire Termination Crimp Type

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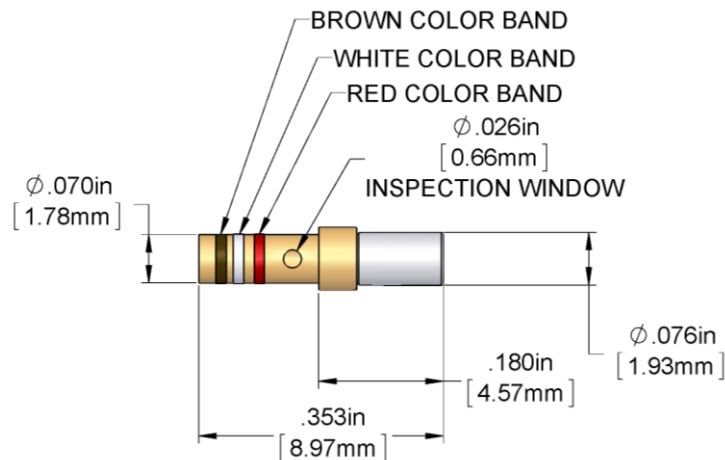


Figure 33: MIL-C-39029/22-192 Socket Contact Wire Termination Crimp Type

4.1.8. Terminal Identification and Location

[Figure 34: Termination Identification](#) identifies the terminal numbers (and switch functions) with their relative position on the header.

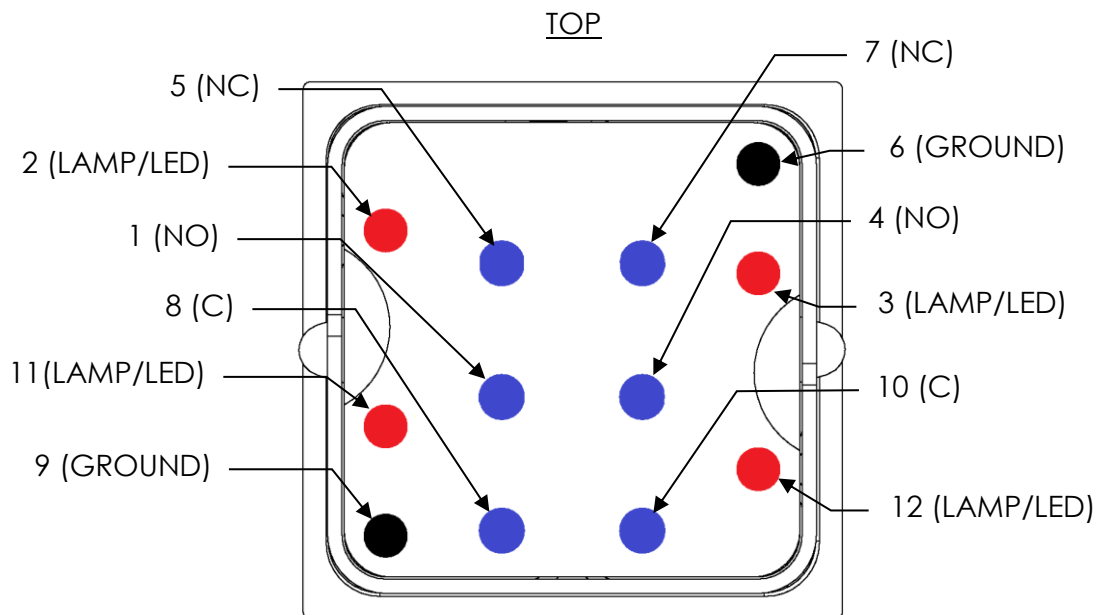


Figure 34: Termination Identification

Rear view of switch header or crimp receptacle

4.1.9. PCB Layout Dimensions

For printed circuit board layout purposes, [Figure 35: Printed Circuit Board Terminal Location](#) defines the positions of pin-outs.

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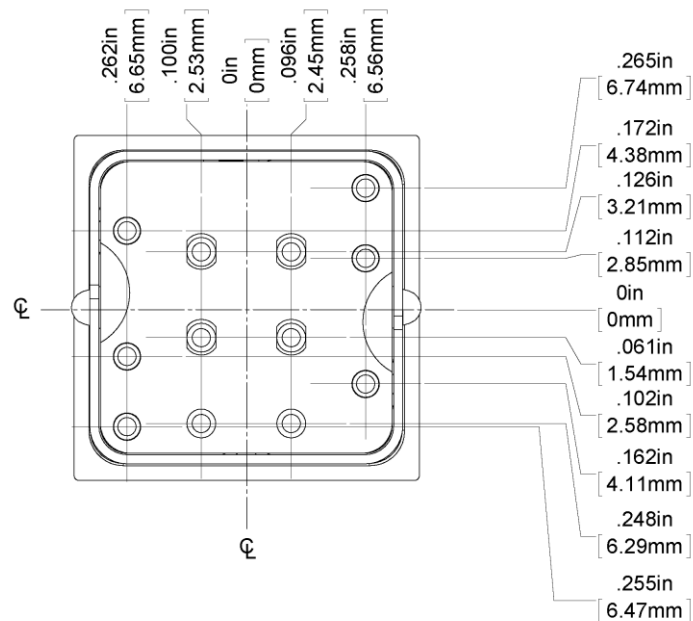


Figure 35: Printed Circuit Board Terminal Location
As viewed from rear side of switch

4.1.10. Watertight/Splash-proof Seal

Panel spacing of switches or indicators with watertight or splash-proof seals installed is 1.06" (26.9 mm) minimum, center to center, horizontally or vertically. Dimensions for these seals are given in [Figure 36: Watertight Seal](#) and [Table III: Watertight Dimensions](#).

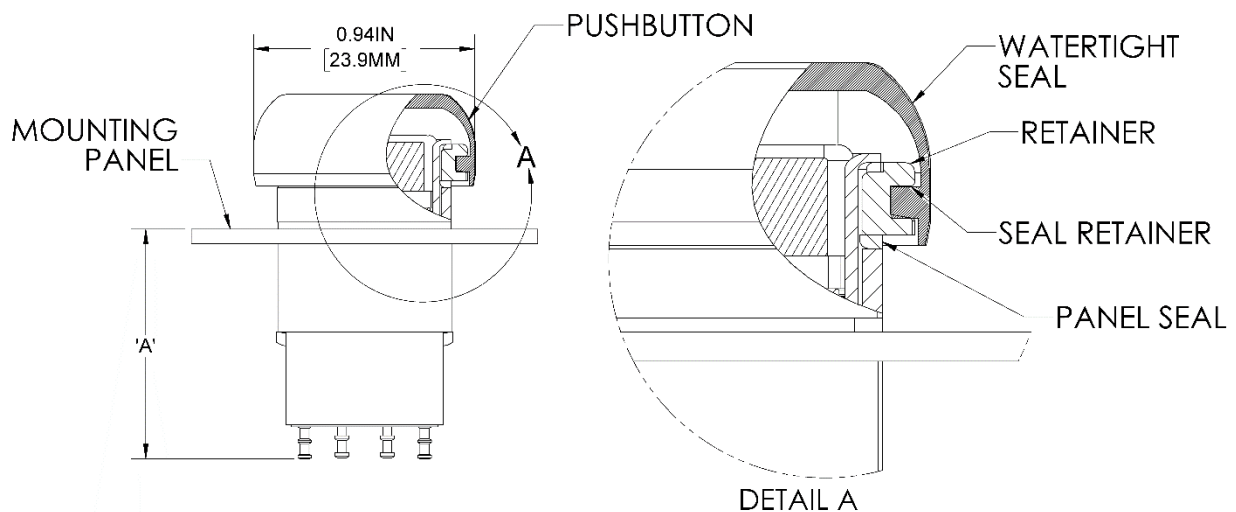


Figure 36: Watertight Seal

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Table III: Watertight Dimensions

Model No.	Configuration	Dim. 'A' MAX
93	Solder Termination	1.30 (33.02)
93	PCB Termination	1.41 (35.81)
9916 thru 9920	Crimp Termination	1.87 (47.50)
9921 thru 9925	Crimp Termination	1.74 (44.20)

These same dimensions also apply for the fuel and solvent resistant seals. Performance capabilities of seals are described in Section [4.7](#), Environmental Requirements.

4.1.11. Pushbutton Guards

Pushbutton guards (PBGs) are transparent covers which must be lifted to allow actuation of the switch, thereby preventing accidental actuation. There are two different PBG designs which apply to the Series 90 Product Line.

4.1.12. Watertight Seal PBG

The pushbutton guard which is used in conjunction with a watertight/splash-proof seal is identified as the 15204/005 and is dimensioned in [Figure 37: Pushbutton Guard for Watertight Sealed Assembly](#). When this pushbutton guard is used, the minimum panel spacing is 1.40" (35.6 mm), center to center, when two units are mounted side by side. This guard may be detented to the open position where it will hold its position until manually returned to the closed position. An alternate version, the 15204/006, is available for fuel and solvent resistant applications. Both units have the same dimensions.

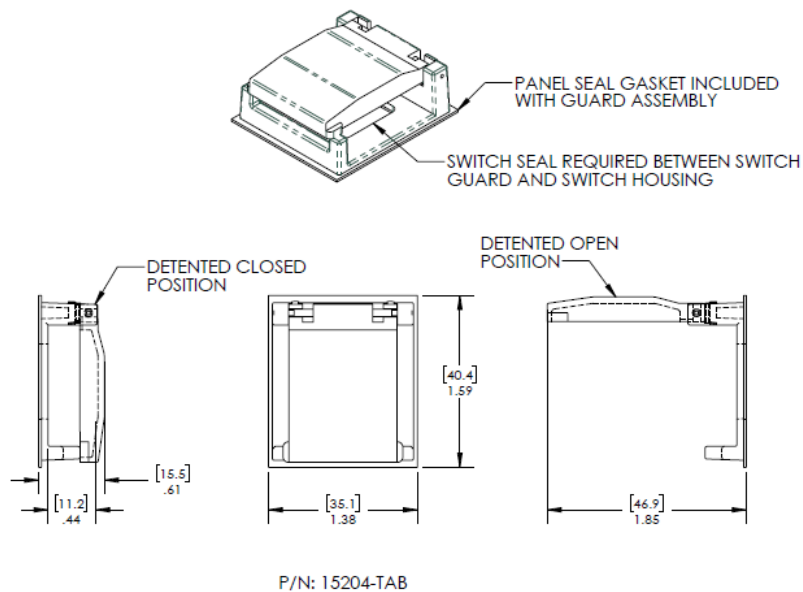


Figure 37: Pushbutton Guard for Watertight Sealed Assembly

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4.1.13. Standard PBG

The standard pushbutton guard is shown in [Figure 38: Standard Pushbutton Guard for Drip-proof Sealed Assemblies](#). The minimum panel spacing required for this standard guard is .871" (22.12 mm), center to center. This guard is spring loaded to the closed position.

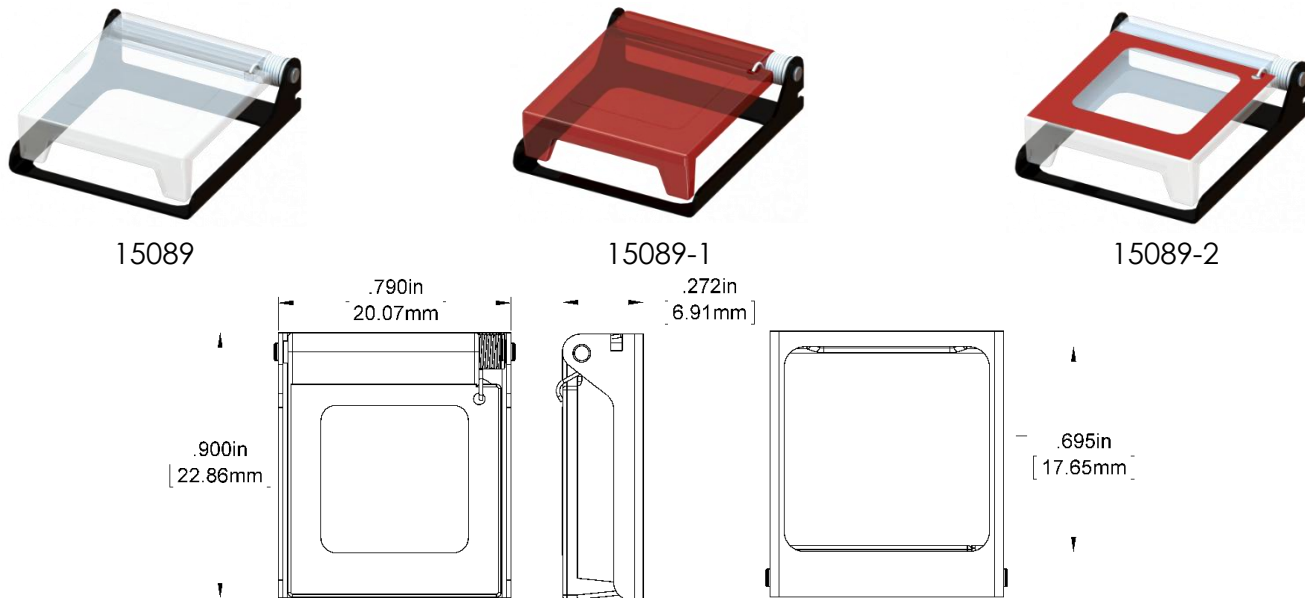


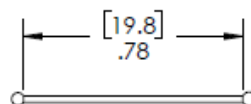
Figure 38: Standard Pushbutton Guard for Drip-proof Sealed Assemblies

4.1.14. Other Accessories

Additional accessories, applying to the Series 90 switch products and shown in figures of this specification, include the following:

4.1.14.1. Pushbutton Retainers

Model 93 and 99 switch/indicator with display pushbutton assemblies are supplied with a pushbutton retainer tie when ordered with the "retained pushbutton" option. Its purpose is to secure the pushbutton to the switch/indicator assembly while the pushbutton is being re-lamped. Retainer units are identified by part number 15093 and are shown in [Figure 39: Pushbutton Retainer Tie](#).



P/N: 15093

Figure 39: Pushbutton Retainer Tie

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4.1.14.2. Color Filter Caps

The color filter caps shown in [Figure 40: Color Filter Caps](#) apply to Series 90 pushbuttons which have T-1 incandescent lighting and are utilized with display types 2, 3, 4, 5, 8 and 9. For these configurations, the color filter cap of any quadrant may be changed without tools. Kits of additional caps are identified with part number 15194-TAB, where the tab is a one-digit number corresponding to the color. Refer to Section 5.8, [Table XL: Color Filter Caps](#) for color coding, quantity per package and ordering information.

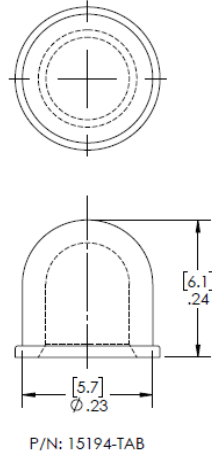


Figure 40: Color Filter Caps

4.1.14.3. Dummy Lamps

The dummy lamp is designed as a substitute for the T-1 flange base lamp. When less than four incandescent lamps are required, the dummy lamp must be installed in the unused positions. They also ensure that a uniform actuation force is maintained. They are identified as part number 15091 and shown in [Figure 41: Dummy Lamp](#).

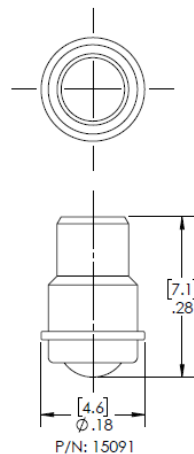


Figure 41: Dummy Lamp

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4.2. Switch Connections and Lighting Circuit Control

4.2.1. Operation

Switch operation classifications shown in [Table IV: Operation Classifications](#) which are available in this product line are shown in the following table along with the corresponding symbol as defined in MIL-PRF-22885.

Table IV: Operation Classifications

MIL-PRF-22885 SYMBOL	OPERATION
A	Momentary Action
B	Alternate Action, Latch Down
H	Indicator Only

4.2.2. Switch Schematics

Single-pole double-throw (SPDT) and double-pole double-throw (DPDT) switch circuits are shown schematically in [Table V: Switch and termination Diagram](#).

Table V: Switch and termination Diagram

Indicator 2/.		None	None
Single pole double throw 3/.		(NC) PIN 5 (NO) PIN 1 PIN 8	Pin 5 (NC) Pin 1 (NO)
Two pole double throw		(NC) PIN 5 (NO) PIN 1 PIN 8 (NC) PIN 7 (NO) PIN 4 PIN 10	Pin 5 (NC) Pin 1 (NO) Pin 7 (NC) Pin 4 (NO)

- Note: Shown in normal position.
- 2/. For Indicator only, pins 1, 4, 5, 7, 8 and 10 are omitted
- 3/. For Single pole double throw pins 4, 7 and 10 are omitted.
- Refer to [Figure 34: Termination Identification](#) for terminal designations.

4.2.3. Incandescent Lighting Circuits

Electrical connections for pushbuttons lighted with incandescent lamps are shown in Table VI. The lamp circuit ground connections are optionally available with:

- Common lamp ground for all four lamps (full ground plate);
- Vertically split ground plate (the two lamps on the left half and the two lamps on the right half may be on separate power circuits with separate grounding);

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- c) Horizontally split ground plate (lighting for the top half and bottom half may be on separate power circuits).

In addition, to reduce the number of input wires, a Bussed lamp option is available for switch/indicator modules. It can internally connect selected lamp terminals as shown in Figure 37. The Bussed lamp options are:

- a) Single Common Bussed, two or three wire system;
- b) Horizontal Common Bussed, three or four wire system;
- c) Vertical Common Bussed, three or four wire system;
- d) Top Common Bussed, four or five wire system;
- e) Bottom Common Bussed, four or five wire system.

The number of input wires to light the four incandescent lamps in a pushbutton depends on the Common Bussed and Lamp Ground options as shown in [Table VI: Switch and termination Diagram](#). For example, a pushbutton with the Single Common Bussed system and Common Ground Lamp, only two wires are required to light the four incandescent lamps. The following chart shows the required number of wires that are required to light the four incandescent lamps in a pushbutton for each Lamp Ground option if Common Bussed System option is used.

Table VI: Switch and termination Diagram

COMMON BUSSED SYSTEM	LAMP GROUND		
	COMMON	SPLIT	
		VERTICALLY	HORIZONTALLY
Single	2	3	3
Horizontal	3	4	4
Vertical	3	4	4
Top	4	5	5
Bottom	4	5	5

4.2.4. Incandescent Lamp Ground and Bussed Lamp Options

For single common applications, it is recommended to the end user that both common terminations (pins 6 and 9) be used as the common return circuit for redundancy.

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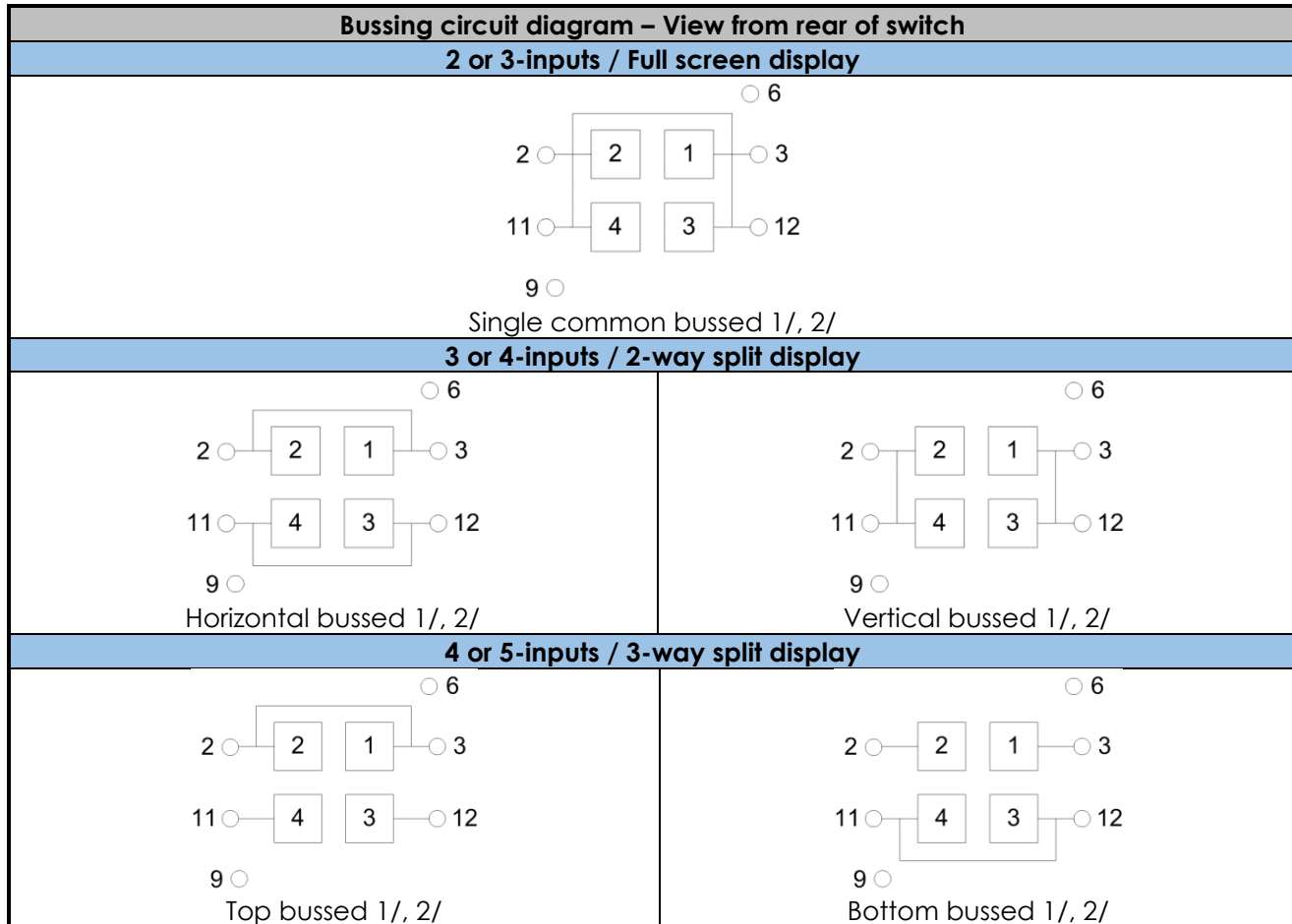
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Table VII: Bussing Circuit Diagram



1/. Applicable to incandescent versions of the Series 90, Note: bussing is completed in the switch, not the pushbutton. When converting to HB-LED where the bussing is completed in the pushbutton there may be a conflict.

2/. Applicable to both Multi-chip and HB-LED versions of the Series 90.

As application information, it should be noted that the choice of lamp circuit grounding scheme is completely independent of the selection of legend display style (full screen display, two-way horizontal split, etc., as shown in Section 5; Table 5). The split grounds allow the lamps of a display to be powered from two separate power sources.

Each incandescent lamp is lighted independently from the other three by applying power to the pin designated in the schematics of [Table VII: Bussing Circuit Diagram](#). The power may be DC or low-voltage AC, if it is within the rating of the lamp. Standard lamp selections are listed in [Table XIX: Incandescent Lamps](#).

4.2.5. LED Lighting Circuits

Light emitting diode (LED) arrays within the Series 90 pushbuttons are available as an alternative to incandescent lamps. Each of the four quadrants of a display is lighted either using an assembly of six LED junctions per quadrant, giving a total of 24 LED junctions per pushbutton, or two High Brightness LEDs per quadrant, giving a total of 8 LEDs per pushbutton. The

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High Brightness LEDs are offered in two configurations. The first configuration is High Brightness LEDs with current regulating resistors, and the second configuration is High Brightness LEDs with voltage dimming circuit (only available on 28 V versions). The voltage dimming circuit is in the High Brightness LED light source assembly.

Schematics for typical LED configurations are shown in [Table VIII: 5 VDC Multi-Chip LED Circuit Diagram](#), [Table IX: 28 VDC Multi-Chip LED Circuit Diagram](#), [Table X: 5 VDC High Bright LED Circuit Diagram](#), [Table XI: 28 VDC High Bright LED Circuit Diagram](#), and [Table XII: 28 VDC High Bright LED Circuit Diagram \(Voltage Dimming\)](#). The required current regulating resistors are included in both multi-chip and High Brightness LED pushbuttons.

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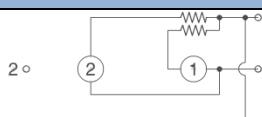
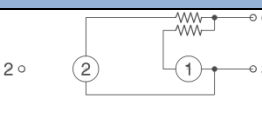
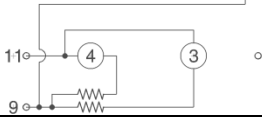
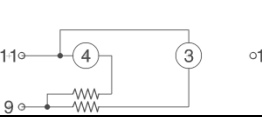
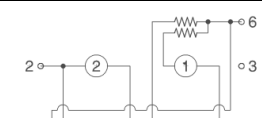
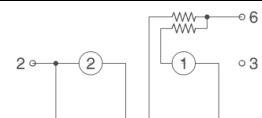
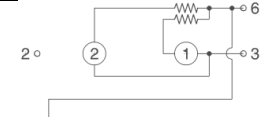
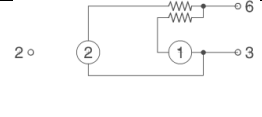
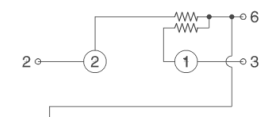
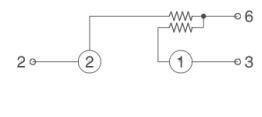
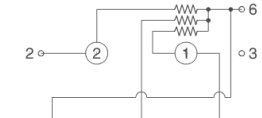
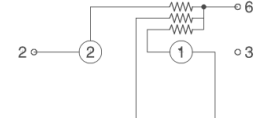
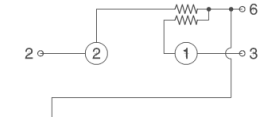
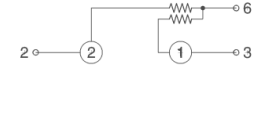
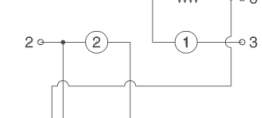
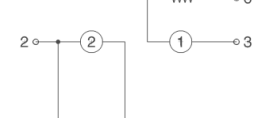
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Table VIII: 5 VDC Multi-Chip LED Circuit Diagram

CODE	DISPLAY STYLE (FRONT VIEW)	COMMON CIRCUIT DIAGRAM (REAR VIEW)	COMMON CIRCUIT CODE				SPLIT CIRCUIT DIAGRAM (REAR VIEW)	SPLIT CIRCUIT CODE				
			7		8			9		0		
			[SOURCING]		[SINKING]			[SOURCING]		[SINKING]		
SEALED												
1		FULL		31	41	54	61		31	41	54	61
		HZ SPLIT										
3		VERT SPLIT		31	41	54	61		31	41	54	61
4		3-WY HZ TOP SPLIT		33	43	53	63		33	43	53	63
5		4-WY SPLIT		53	45	55	65		53	45	55	65
6		3-WY VERT LEFT SPLIT		33	43	53	63		33	43	53	63
7		3-WY HZ BOTTOM SPLIT		33	43	53	63		33	43	53	63
8		3-WY VERT RIGHT SPLIT		33	43	53	63		33	43	53	63

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Table IX: 28 VDC Multi-Chip LED Circuit Diagram

CODE	DISPLAY STYLE (FRONT VIEW)	COMMON CIRCUIT DIAGRAM (REAR VIEW)	COMMON CIRCUIT CODE				SPLIT CIRCUIT DIAGRAM (REAR VIEW)	SPLIT CIRCUIT CODE			
			7	8	9	0					
			[SOURCING]	[SINKING]	[SOURCING]	[SINKING]					
SEALED											
1	1 2 3 4 FULL		32	42	52	62		32	42	52	62
2	1 2 3 4 HZ SPLIT										
3	1 2 3 4 VERT SPLIT		32	42	52	62		32	42	52	62
4	1 2 3 4 3-WY HZ TOP SPLIT		34	44	54	64		34	44	54	64
5	1 2 3 4 4-WY SPLIT		36	46	56	66		36	46	56	66
6	1 2 3 4 3-WY VERT LEFT SPLIT		34	44	54	64		34	44	54	64
7	1 2 3 4 3-WY HZ BOTTOM SPLIT		34	44	54	64		34	44	54	64
8	1 2 3 4 3-WY VERT RIGHT SPLIT		34	44	54	64		34	44	54	64

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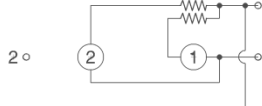
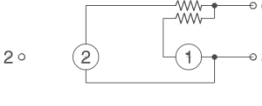
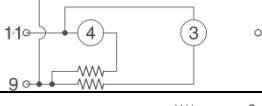
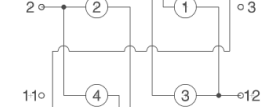
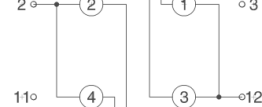
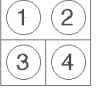
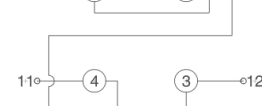
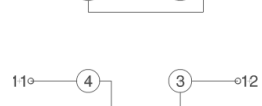
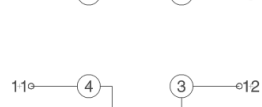
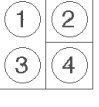
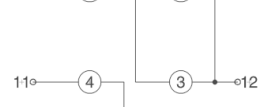
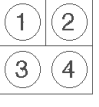
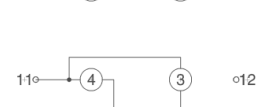
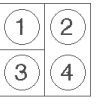
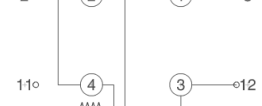
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Table X: 5 VDC High Bright LED Circuit Diagram

CODE	DISPLAY STYLE (FRONT VIEW)	COMMON CIRCUIT DIAGRAM (REAR VIEW)	COMMON CIRCUIT CODE				SPLIT CIRCUIT DIAGRAM (REAR VIEW)	SPLIT CIRCUIT CODE				
			A		B			C		D		
			[SOURCING]	[SINKING]	[SOURCING]	[SINKING]		[SOURCING]	[SINKING]	[SOURCING]	[SINKING]	
SEALED												
1		FULL		31	41	54	61		31	41	54	61
	2		HZ SPLIT									
3		VERT SPLIT		31	41	54	61		31	41	54	61
4		3-WY HZ TOP SPLIT		33	43	53	63		33	43	53	63
5		4-WY SPLIT		53	45	55	65		53	45	55	65
6		3-WY VERT LEFT SPLIT		33	43	53	63		33	43	53	63
7		3-WY HZ BOTTOM SPLIT		33	43	53	63		33	43	53	63
8		3-WY VERT RIGHT SPLIT		33	43	53	63		33	43	53	63

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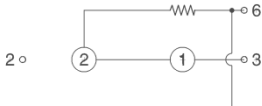
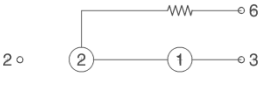
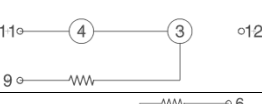
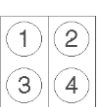
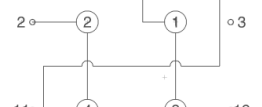
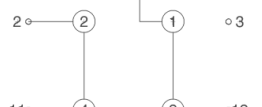
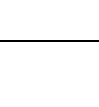
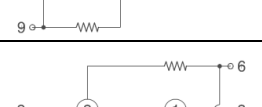
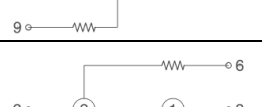
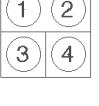
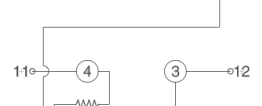
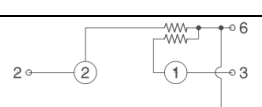
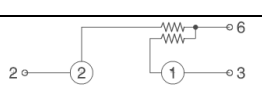
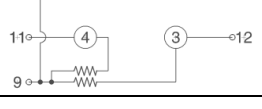
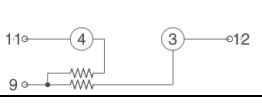
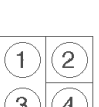
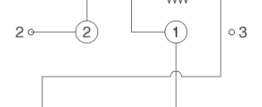
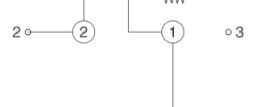
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Table XI: 28 VDC High Bright LED Circuit Diagram

CODE	DISPLAY STYLE (FRONT VIEW)	COMMON CIRCUIT DIAGRAM (REAR VIEW)	COMMON CIRCUIT CODE				SPLIT CIRCUIT DIAGRAM (REAR VIEW)	SPLIT CIRCUIT CODE						
			A		B			C		D				
			[SOURCING]	[SINKING]	[SOURCING]	[SINKING]		[SOURCING]	[SINKING]	[SOURCING]	[SINKING]			
SEALED														
1		FULL									32	42	52	62
	2		HZ SPLIT											
3		VERT SPLIT									32	42	52	62
	4		3-WY HZ TOP SPLIT											
5		4-WY SPLIT									36	46	56	66
	6		3-WY VERT LEFT SPLIT											
7		3-WY HZ BOTTOM SPLIT									34	44	54	64
	8		3-WY VERT RIGHT SPLIT											

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Table XII: 28 VDC High Bright LED Circuit Diagram (Voltage Dimming)

CODE	DISPLAY STYLE (FRONT VIEW)	COMMON CIRCUIT DIAGRAM (REAR VIEW)	COMMON CIRCUIT CODE				SPLIT CIRCUIT DIAGRAM (REAR VIEW)	SPLIT CIRCUIT CODE			
			E [SOURCING]		F [SINKING]			G [SOURCING]		H [SINKING]	
			SEALED					SEALED			
1	12 34 FULL		32	42	52	62		32	42	52	62
2	12 34 HZ SPLIT										
3	12 34 VERT SPLIT		32	42	52	62		32	42	52	62
4	12 34 3-WY HZ TOP SPLIT		34	44	54	64		34	44	54	64
5	12 34 4-WY SPLIT		36	46	56	66		36	46	56	66
6	12 34 3-WY VERT LEFT SPLIT		34	44	54	64		34	44	54	64
7	12 34 3-WY HZ BOTTOM SPLIT		34	44	54	64		34	44	54	64
8	12 34 3-WY VERT RIGHT SPLIT		34	44	54	64		34	44	54	64

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It will be noted that, unlike the incandescent versions, power need be applied to only one pin to control the lighting of a half-screen LED display if the display style is either full-screen or one which includes half-screen displays. (However, special LED lighted pushbuttons using other than the standard 5 volts or 28-volt lamp supply voltages may require that each quadrant be individually controlled.)

4.2.6. Current Requirements for LED Lighting

The current requirements of multi-chip LED configuration and High Brightness LED configuration are not the same.

4.2.6.1. Multi-Chip LED Current Requirements

For 5-volt DC systems, all multi-chip configurations use 45 mA per quadrant when illuminated. Thus, a full-screen unit would use 180 mA, a two-way split with one half lighted would use 90 mA, etc.

For 28-volt multi-chip systems, the current requirements depend upon the configuration. When operated at 28 volts DC, either for a full-screen or two-way split configuration, the forward current is 15 mA for each half screen which is illuminated (30 mA with both illuminated).

For 28-volt multi-chip three-way split pushbutton, the one-half screen is 15 mA and each quarter screen is 15 mA (for a total of 45 mA with all three areas illuminated). On 28-volt multi-chip four-way split pushbuttons, each quadrant uses 15 mA (60 mA with all four areas illuminated).

Maximum current usage for each configuration is tabulated in [Table XX: Multi-Chip LED's](#).

4.2.6.2. High Brightness LED Current Requirements

For 5-volt DC systems, all High Brightness configurations use 45 mA per quadrant when illuminated. Thus, a full-screen unit would use 180 mA, a two-way split with one half lighted would use 90 mA, etc.

For 28-volt High Brightness systems, the current requirements depend upon the configuration. When operated at 28 volts DC, either for a full-screen or two-way split configuration, the maximum forward current is 20 mA for each half screen which is illuminated (40 mA with both illuminated).

For 28-volt High Brightness three-way split pushbutton, the one-half screen maximum current is 20 mA and each quarter screen is 20 mA (for a total of 60 mA with all three areas illuminated). On 28-volt High Brightness four-way split pushbuttons, each quadrant uses 20 mA (80 mA with all four areas illuminated).

Maximum current usage for each configuration is tabulated in

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Table XXI: High Brightness LED's.

Another configuration of High Brightness LEDs are offered with voltage dimming capabilities. These pushbuttons are configured with Voltage Dimming Circuit (VDC) devices that would receive input voltage from a variable voltage source (from 8.4V DC to 28V DC) and would dim the LED brightness like that of incandescent light source. At 28V DC, each quadrant uses 18 mA $\pm$ 2 mA (72 mA nominal with all four areas illuminated).

Figure 42: High Brightness LED Curve with Voltage Dimming Circuit (VDC) shows the output current vs input voltage of a Voltage Dimming Circuit (VDC). Note that the LED brightness is directly proportional to its input current, thus any variation to High Brightness LED input current as discussed above, would result in the proportional variation of the LED light source output luminous intensity. Since the Voltage Dimming Circuit (VDC) controls the input current of the High Brightness LEDs and such variation is depicted in a graph that lies between the high and low boundary curves, the resultant luminance graph of the High Brightness LEDs (output luminance vs applied voltage) will too fall between such boundary curves.

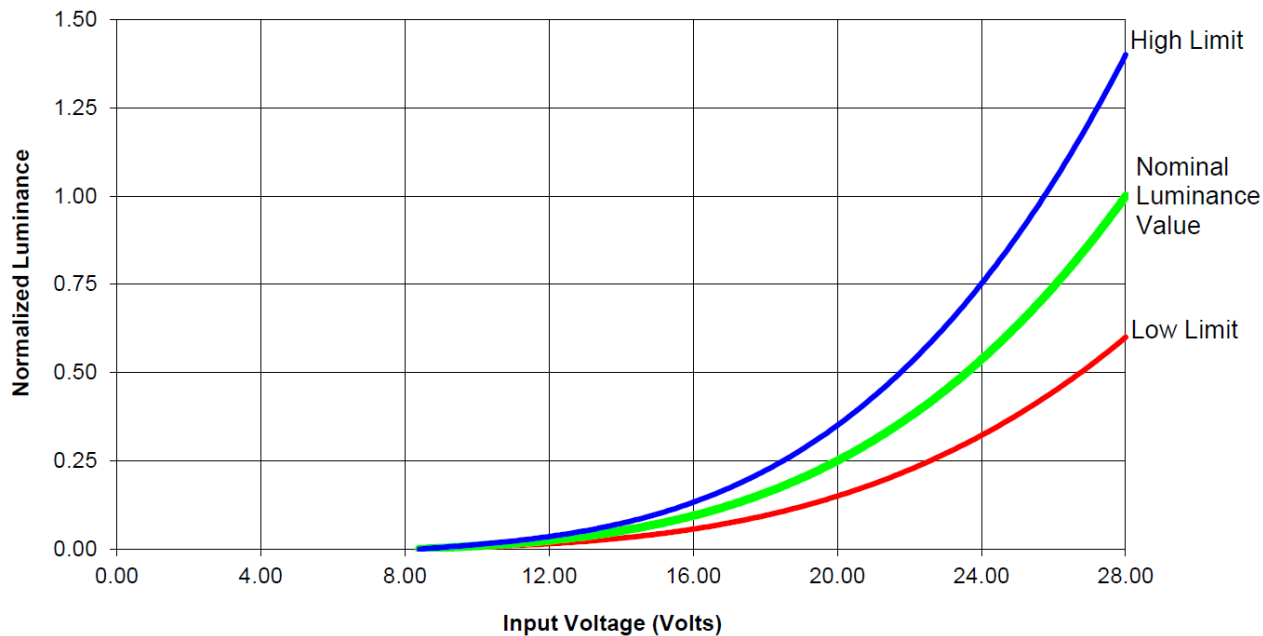


Figure 42: High Brightness LED Curve with Voltage Dimming Circuit (VDC)

4.2.7. LED Pushbutton Lighting Control

While incandescent lighting may be controlled by varying the amplitude of the applied AC or DC voltage, this is not the ideal way to control multi-chip LED lighting. LEDs are current-driven devices and operate best at the rated current. Dimming could be accomplished by turning the LEDs on and off

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at a rate of several thousand times per second or operating High Brightness LEDs with Voltage Dimming Circuit (VDC).

Turning the LEDs on and off at a rate can be accomplished by using Staco Systems DDM111 or DDM111A Digital Dimming Module. During the period that LEDs are on, the LEDs are driven at their rated current. The ratio of on-time to off-time then controls the brightness. The Staco Systems DDM111 and DDM111A Digital Dimming Modules are an ideal way to precisely control LED brightness if the pushbutton is not facilitated with Voltage Dimming Circuit (VDC). The brightness of LEDs with voltage dimming can be controlled by varying the amplitude of the applied DC voltage like controlling the brightness of incandescent lamps. Digital Dimming Module is not required to control the brightness of LEDs with voltage dimming.

[Table XIII: LED Pushbutton Lighting Control Termination Pin Connections](#) identifies the pins used to control the lighting of the specific portions of the displays on LED-based pushbuttons.

Table XIII: LED Pushbutton Lighting Control Termination Pin Connections

STYLE CODE 1/	DISPLAY STYLE	CONTROL TERMINALS (Pin No)	COMMON CIRCUIT RETURN 2/ code 7, 8, A, B, E or F	SPLIT CIRCUIT RETURN 3/ code 9, 0, C, D, G or H
1X	FULL SCREEN Top 1/2 Bottom 1/2	3 11	Pins 6 and/or 9	pin 6 pin 9
2X	2-WAY HORZ. Top 1/2 Bottom 1/2	3 11	6 and/or 9	pin 6 pin 9
3X	2-WAY VERT. Left 1/2 Right/	12 2	6 and/or 9	pin 6 pin 9
4X	3-WAY, UP Top 1/2 Bottom Vas	3 12, 11	6 and/or 9	pin 6 pin 9
5X	4-WAY Top Vas Bottom 'As	3, 2 12, 11	6 and/or 9	pin 6 pin 9
6X	3-WAY, LEFT Left 1/2 Right 's	12 11	6 and/or 9	Not Available
7X	3-WAY, DOWN Top Vas Bottom 1/2	2 11	6 and/or 9	pin 6 pin 9
8X	3-WAY, RIGHT Left 'As Right 1/2	3, 12 2	6 and/or 9	Not Available

1. Display Style Code is two-digit code of Section 5, [Table XXIV: Characters per Legend Display area](#).
2. Common Circuit Return is Code 7, 8, A, B, E or F of Section 5, [Table XXXV: Model 92 Incandescent Pushbutton Configuration Table](#), [Table XXXVI: Model 92 Multi-chip LED Pushbutton Configuration Table](#), and [Table XXXVII: Model 92 High Brightness LED Pushbutton Configuration Table](#).

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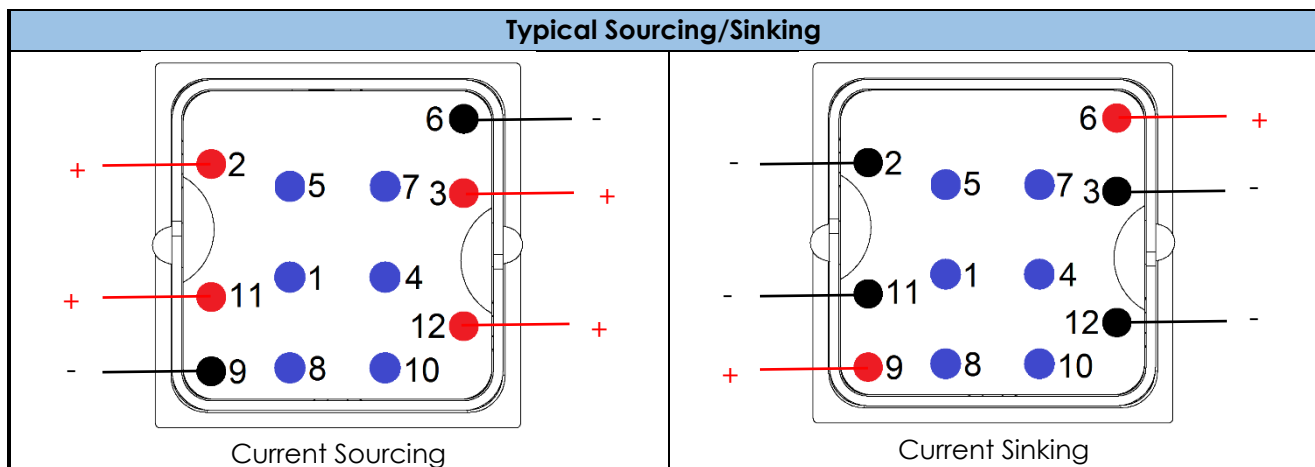
3. Split Circuit Return is Code 9, 0, C, D, G or H of Section 5, [Table XXXV: Model 92 Incandescent Pushbutton Configuration Table](#), [Table XXXVI: Model 92 Multi-chip LED Pushbutton Configuration Table](#), and [Table XXXVII: Model 92 High Brightness LED Pushbutton Configuration Table](#).
4. See [Table VIII: 5 VDC Multi-Chip LED Circuit Diagram](#), [Table IX: 28 VDC Multi-Chip LED Circuit Diagram](#), [Table X: 5 VDC High Bright LED Circuit Diagram](#), [Table XI: 28 VDC High Bright LED Circuit Diagram](#), and [Table XII: 28 VDC High Bright LED Circuit Diagram \(Voltage Dimming\)](#) for detailed schematics.

4.2.8. Current Sourcing/Sinking for LED's

For application information, Table XIV: Typical Sourcing/Sinking shows simplified schematics of typical control circuits for driving the LED circuits. LED lighted pushbuttons may be configured for either current sourcing or current sinking. In current sourcing, the LED is energized by applying current to the LED anode (positive) terminals since the LED cathode (negative) leads are in common (connected).

In current sinking, the LED is energized by applying current to the LED cathode (negative) terminals since the LED anode (positive) leads are in common (connected).

Table XIV: Typical Sourcing/Sinking



Note: Please refer to wiring diagrams in [Table VIII: 5 VDC Multi-Chip LED Circuit Diagram](#), [Table IX: 28 VDC Multi-Chip LED Circuit Diagram](#), [Table X: 5 VDC High Bright LED Circuit Diagram](#), [Table XI: 28 VDC High Bright LED Circuit Diagram](#), and [Table XII: 28 VDC High Bright LED Circuit Diagram \(Voltage Dimming\)](#) for pushbutton wiring details.

One characteristic of current sourcing is that it can be used to isolate the lamp load from direct power connection if desired. For this, the cathode side of the LED is always grounded through a current-regulating resistor. The driving circuits supply voltage to the anode side of the LEDs to illuminate them.

Current sinking, on the other hand, enables the controlling circuits to switch the cathodes to ground to light the LEDs. This is a simpler control circuit to

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implement if MOSFET logic is being used. Also, multi-channel output driver ICs with common grounded emitters are readily available.

4.3. Electrical Performance Requirements

4.3.1. Switch Contact Ratings

Electrical contacts shall perform as specified in [Table XV: Contact Ratings](#):

Table XV: Contact Ratings

<u>Power Circuits</u> (silver contacts)			
28V DC Rating Incandescent	Resistive	Sea Level	5.0 Amps
		70,000 Ft	5.0 Amps
	Inductive	Sea Level	3.0 Amps
		70,000 Ft	2.0 Amps
	Lamp	Sea Level	1.0 Amps
		70,000 Ft	1.0 Amps
28 VDC Rating Multi-Chip LED High Bright LED	Resistive	Sea Level	7.0 Amps
		50,000 Ft	4.0 Amps
	Inductive	Sea Level	4.0 Amps
		50,000 Ft	2.5 Amps
	Lamp	Sea Level	2.5 Amps
		50,000 Ft	2.5 Amps
115 VAC, 60 Hz Rating Multi-Chip LED High Bright LED	Resistive	Sea Level	7.0 Amps
	Inductive	Sea Level	7.0 Amps
	Lamp	Sea Level	2.0 Amps
250 V AC Rating		UL listed, 7 Amps, (21SX83-H340).	
<u>Logic Circuits</u> (gold contacts)			
<u>28 V DC Rating</u>	Resistive	Sea Level	1.0 Amps
	Inductive	Sea Level	0.5 Amps
<u>Low Level Circuits</u> (gold contacts)			
Basic switch, per MIL-S-8805: 30 millivolts 30 mA			

4.3.2. Switch Contact Resistance

4.3.2.1. Power Circuits (silver contacts)

Per MIL-PRF-22885, prior to electrical endurance testing, contact resistance shall be 25 milliohms, using a test current of 0.1 ampere $\pm$ 5% and an open-circuit test voltage of 6 ± 1 V DC. After electrical endurance testing, contact resistance shall be 1% of the load resistance, i.e., 7 amps resistive at 28 volts = 4 ohms $\times$ 1% = 40 milliohms.

4.3.2.2. Low Level Circuits (gold contacts)

When switches are tested as specified in MIL-PRF-22885, contact resistance of any individual switch circuit shall be less than 3.0 ohms during each contact closure through the 50,000-cycle test.

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4.3.3. Electrical Endurance

During qualification and subsequent qualification retention testing, the switches are tested in accordance with the electrical endurance tests of MIL-PRF-22885 which consist of three stages as summarized below:

4.3.3.1. Overload Preconditioning

Prior to electrical endurance testing the switches are subjected to overload cycling at 150% of the rated load for 50 cycles.

4.3.3.2. Rated Load Tests

The switches are then tested for 25,000 cycles (i.e., movement of the actuating means through the entire range of its travel, causing the switch contacts to change from one position to another position and then return to their original position). For an alternate-action switch, this is equivalent to 50,000 actuation/de-actuation strokes.

Maximum rated load voltage, current, frequency, and operating cycles are used in testing switches for both AC and DC voltages applied to resistive, inductive and lamp loads. Each of these load types is tested at high temperature (71 °C) at sea level and at altitude in room ambient temperature. All lamps or LEDs are continuously energized at their maximum rated voltage during cycling. Immediately following the electrical endurance test at the rated resistive current, the switch contacts are tested for temperature rise.

4.3.3.3. Test Conclusion

When the switches are tested in accordance with the detailed requirements of MIL-PRF-22885 as summarized above, there shall be no contact which fails to open or close its individual circuit in proper sequence; the temperature rise shall not exceed 50 °C; and the switch contact resistance shall not exceed 1% of load resistance following electrical life at rated load.

4.3.4. Low Level Life

Switches with gold contacts are tested as specified in MIL-STD-202, Method 311, for 50,000 cycles, with open-circuit voltage of 30 millivolts and current of 10 mA. For this test, 50% of the test cycles are at the maximum temperature specified (+85 °C), then 25% at the minimum temperature specified (-55 °C) and then the final 25% at room ambient. The contact resistance shall be less than 3.0 ohms during each contact closure. No contact shall fail to open or close its individual circuit in proper sequence.

4.3.5. Contact Bounce and Transfer Time

When switches are tested per MIL-PRF-22885, contact closure bounce time shall be less than 6 milliseconds. A certain amount of pre-opening contact "noise" may also be observed as the moving contact pulls away from the fixed contact. This contact opening phenomenon, in which a previously

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closed contact becomes open, shall not exceed 5 milliseconds. There also is a contact transit time, which is the time required for the moving contact to leave one stationary contact and strike the opposite stationary contact. This is the break-before-make time and shall be less than 6 milliseconds.

(NOTE: Simultaneity of action between separate poles on two-pole switches is not specified.)

4.3.6. Lamp Contact Resistance

Lamp contact resistance shall not exceed 1.0 ohm when the test plug specified in MIL-PRF-22885 is used at a test current of $0.1 \pm 5\%$ ampere, test voltage of 6 ± 1 V DC, and with three insertions of test plug. NOTE: This test does not apply to LED-lighted switches/indicators.

4.3.7. Dielectric Strength

During qualification, this test is performed after each of the following tests: electrical life, vibration, shock, moisture resistance, seal (at sea level only), and after short circuit tests. Tests are performed at both sea level and at a reduced barometric pressure simulating 70,000 feet altitude. These two requirements are summarized as follows:

4.3.7.1. At Atmospheric Pressure

Switches are tested in accordance with MIL-STD-202, Method 301, with the following details applied:

- a) Test potential 1,000 Volts RMS;
- b) Duration of 1 minute for qualification and group B tests, 5 seconds for group A tests; and
- c) Points of application: (1) between each terminal and exposed non-current carrying metal or grounded parts; (2) between adjacent terminals of mutually insulated circuits; and (3) between all unconnected contact terminals of the same pole (this test not applicable after electrical endurance).

There shall be no flashover, arcing, breakdown, or current flow more than 500 microamperes.

4.3.7.2. At Reduced Barometric Pressure

Switches are tested in accordance with MIL-STD-202, Method 105, with the following details applied:

- a) Test potential 400 Volts RMS;
- b) Test condition C (maximum pressure of 1.31" Hg or 33 mm Hg to simulate an altitude of 70,000 feet or 21,336 meters).

There shall be no flashover, arcing, breakdown, or current flow more than 500 microamperes.

4.3.8. Insulation Resistance

When switches are tested in the dry condition, the insulation resistance shall be not less than 1,000 megaohms at a test potential of 500 volts $\pm 10\%$ when tested in accordance with MIL-STD-202, Method 302, test condition B. The points of measurement are: (1) between each terminal and exposed non-current carrying metal or grounded parts; (2) between adjacent terminals

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of mutually insulated circuits; and (3) between all unconnected contact terminals of the same pole.

When switches are tested in the wet condition following the moisture resistance test of MIL-STD-202, Method 106, the insulation resistance shall be not less than 10 megohms. At the end of the specified 24-hour drying period, the insulation resistance shall not be less than 1,000 megohms.

4.3.9. Short Circuit

When switches are tested as specified in MIL-PRF-22885, Method I, there shall be no damage and no welding or sticking of contacts. Switches shall be mechanically and electrically operative at the end of the test.

4.4. Mechanical Requirements

4.4.1. Enclosure Design

An enclosure, as used in this document, is an auxiliary housing providing protection and means for mounting and actuating of the basic switch. All enclosure classifications which are defined in MIL-PRF-22885 are available in the Series 90 Product line as shown in [Table XVI: Enclosure Designs](#).

Table XVI: Enclosure Designs

MIL-PRF-22885 Symbol	Seal Description
2	Drip-proof <u>1/</u>
3	Watertight <u>1/</u>
4	Splash-proof <u>1/</u>

1/ In accordance with MIL-STD-108.

4.4.2. Weight

The typical weights of the switch or indicator, including mounting hardware of .07 oz., (2 grams) and the pushbutton, are given in [Table XVII: Component Weight](#).

Table XVII: Component Weight

Assembly	Ounces	Grams
Model 93 Switch (DPDT w/ PB & 4 Lamps or LEDs)	0.61	17
Model 93 Switch (SPDT w/ PB & 4 Lamps or LEDs)	0.58	16
Model 93 Indicator (w/ PB & 4 Lamps or LEDs)	0.50	14
Model 99 Switch (DPDT w/ PB & 4 Lamps or LEDs)	1.09	31
Model 99 Switch (SPDT w/ PB & 4 Lamps or LEDs)	1.06	30
Model 99 Indicator (w/ PB & 4 Lamps or LEDs)	0.98	28
Pushbutton (with 4/Lamps or LEDs)	0.13	4
Additional Weight for Seals, symbols 3 or 4	0.08	2

4.4.3. Mechanical Endurance

During qualification and subsequent qualification retention testing, switches are tested in accordance with the MIL-PRF-22885 mechanical endurance test, which is summarized as follows:

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4.4.3.1. Mechanical Actuation Life

The switches are subjected to 100,000 cycles of accumulative mechanical actuation with 5,000 cycles of operation at -55 °C, 10,000 cycles at 85 °C, and 85,000 cycles at room temperature. Switches shall be continuously monitored to determine whether any contact has failed to open or close its individual circuit in proper sequence.

4.4.3.2. Incandescent Lamp Retention

After completion of the preceding test, a lamp retention test plug shall be inserted and withdrawn five times and then installed and verified that the plug remains captive to the lamp-holder when inverted.

4.4.3.3. General Mechanical Life

Upon completion of the preceding tests, the pushbutton assembly shall be completely engaged and removed from the switch/indicator assembly 10 times. The lamp-holder assembly shall be completely removed, re-lamped and installed 100 times. After these tests, the switch shall be examined for any physical damage, sticking of actuator, loose latching of lens assembly or broken, deformed clips or springs.

4.4.4. Pushbutton Actuation Travel

For momentary and alternate action (maintained) switches, the pushbutton travel shall be .12-inch (3.0 mm) maximum. Pushbutton travel of indicator type units shall be less than .030 inch (.76 mm).

4.4.5. Latch-down Actuation and Displacement

On alternate action (maintained) contact switches, the pushbutton is retained in a latch-down or actuated switch position until pushbutton is depressed a second time, releasing the pushbutton and deactivating the switch. When the switch is in the actuated position, the face of the pushbutton is mechanically held depressed from its normal height by approximately .080 inch (2.03 mm).

4.4.6. Actuation Force

The force required to actuate momentary or alternate switch is 5 pounds (22.2 N) maximum.

4.4.7. Pushbutton Extraction Force

The extraction force shall be between 2 to 5 pounds (9 to 22 N). This requirement is not applicable to watertight seal switches.

4.4.8. Pushbutton Retainer

As an option, a pushbutton retainer tie is available to keep a given pushbutton physically linked to a given switch during re-lamping operations.

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4.4.9. Solder Terminals

Solder terminals shall be double turret to ensure that wires can be mechanically secured prior to soldering. Solderability testing is in accordance with MIL-STD-202, Method 208. Terminal strength tests are conducted as prescribed by MIL-STD-202, Method 211, test condition A, 3 pounds in the direction perpendicular to the long axis of the terminal and 5 pounds in the direction parallel to the long axis of the terminal.

4.4.10. Printed Circuit Board Terminals

Printed Circuit Board Terminals shall be suitably plated to facilitate hand, wave or flow soldering methods. Terminal strength is 1 pound maximum.

4.4.11. Crimp Pin Terminals

Crimp Pin Terminals shall be gold plated per MIL-G-45204. Two types of Crimp Pin Terminals are available. The first type mates with Crimp-On Wire Terminations per MIL-C-39029/16-168, and the second type mates with Crimp-On Wire Terminations per MIL-C-39029/22-192. Crimp pin shall withstand a pull force along the axis of the terminals of up to 5 pounds force.

4.5. Display System Requirements

4.5.1. Field of view

The visibility of any legend, symbology or alpha-numeric shall be viewable from three feet, without any restrictions by the periphery of the enclosure for the display, at all angles within an 80° cone perpendicular to the viewing surface.

4.5.2. Legend Viewing Dimensions

The display area available for legends shall be as follows:

Table XVIII: Viewing Area

Viewing Area	Nominal Dimensions Inch (mm)
Full Screen	.495" (12.57) square
Half Screen, Horizontal	.495 x .217" (12.57 x .51)
Half Screen, Vertical	.217 x .495" (5.51 x 12.57)
Quarter Screen	.217" (5.51) square

4.5.3. Light Sources

Three means for legend lighting are available in the Series 90 product line. The three light sources are incandescent lamp, multi-chip LED, and High Brightness LED.

4.5.3.1. Incandescent Lamps

Lamps shall be flange based, incandescent, T-1 sub-midget type. They shall be field replaceable from the front panel. Selection options are specified in Section 5, [Table XXXV: Model 92 Incandescent Pushbutton Configuration Table](#). When lamps are not furnished with the pushbuttons, a removable fiberboard plate

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shall be installed at the factory. This plate is removed and discarded when lamps are installed in the field. For proper operation, four T-1 lamps, or a combination of lamps and "dummy plugs" (devices which simulate the specified lamps) must be used to prevent damage to the unit.

Factory-supplied lamps have nominal brightness as specified by the manufacturer in [Table XIX](#): Incandescent Lamps. These have a mean spherical candle power (MSCP) tolerance of $\pm 25\%$. Unless otherwise specified, all brightness tests performed at the factory, and those published in this specification, shall utilize calibrated lamps with a luminous intensity of $.15 \pm .01$ MSCP.

Table XIX: Incandescent Lamps

INCANDESCENT LAMP TYPE	MAXIMUM DESIGN VOLTS	MAXIMUM MILLIAMPS PER P.B. <u>3/</u>	RESULTING POWER WATSS / P.B.	AVERAGE M.S.C.P. <u>10/</u>	LIFE HOURS
109213 - Fiberboard Plate "Discard" Required <u>5/</u>					
3071	5	240	1.2	0.15	5,000
718	5	460	2.3	0.15	40,000
N/A					
3335 <u>8/</u>	28	64	1.8	0.08 <u>9/</u>	10,000
3042	6	240	1.4	0.13 <u>9/</u>	3,000
1099	12	240	2.9	0.15	16,000
3229	14	160	2.2	0.15	16,000
6839	28	96	2.7	0.15	16,000
15091 Dummy Lamp Plug <u>6/</u>					

NOTES:

1. All incandescent lamps are T-1 sub-midget flange based.
2. Lamp code numbers 01 through 09 and 11 through 19 require four (4) for each pushbutton.
- 3/. Current (milliamp) values are maximum, with four lamps lighted.
4. Lamp specifications and performance are as published by the lamp manufacturers. Staco Systems does not warrant lamp performance as specified.
- 5/. When lamps are not furnished with pushbuttons, a removeable fiberboard plate is installed at the factory in order, to ensure that the pushbutton returns to full normal position. This plate is removed and discarded when lamps are installed. Applies to Codes 00 and 10.
- 6./ Caution: Do not install pushbutton without lamps or dummy lamps in all four positions, or a fiberboard plate (discard) in place. Otherwise, when power is connected, a short circuit will result.
7. Pushbuttons with Night Vision Imaging System (NVIS) compatible display (Type 7, NVG) must be "sealed."
- 8/. Recommended for lower faceplate temperature.
- 9/. SLR performance may be degraded with these lamps.
- 10/. Unless otherwise specified, MSCP values are $\pm 25\%$.

4.5.3.2. Multi-Chip LED's

The multi-chip LED pushbuttons shall have six LED chips per quadrant. Unless otherwise specified, voltage options are 5 or 28 volts. The multi-chip LED polarity and other options are as specified

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in [Table XX: Multi-Chip LED's](#). These multi-chip LEDs are an integral part of the pushbutton and are not field replaceable.

Table XX: Multi-Chip LED's

MULTI-CHIP LED DISPLAY CONFIGURATION	OPERATING VOLTS	NOMINAL MILLIAMPER PER PUSHBUTTON
Full or 2-Way	5	180
Full or 2-Way	28	30
3-Way	5	180
3-Way	28	45
4-Way	5	180
4-Way	28	60

NOTES:

1. All multi-chip LEDs are a permanent and integral part of the pushbutton. Six multi-chip LED chips are installed per quadrant. Twenty-four multi-chip LEDs are installed in a pushbutton.
2. Current (milliamp) values are with all four quadrants lighted at full brightness.
3. Life is rated at 100,000 hours at 30 % duty cycle.
4. For dimming control, the Staco Systems Digital Dimming Module, DDM111 or DDM111A, is recommended.
5. Pushbuttons with Night Vision Imaging System (NVIS) compatible display (Type 7, NVG) must be "sealed."
6. To specify product that is the same as Standard multi-chip LED Pushbutton Part,

Except:

	<u>Order Part Number</u>
24 V, Current Sourcing	92-CODED/001
24 V, Current Sinking	92-CODED/015
28 V, Voltage Variation Tolerant, Current Sourcing	92-CODED/013
28 V, Voltage Variation Tolerant, Current Sinking	92-CODED/014
12 V, Current Sinking	92-CODED/002

4.5.3.3. High Brightness LED's

The High Brightness LED pushbuttons shall have two individual LEDs per quadrant. Unless otherwise specified, the operating voltage options for HB LED pushbuttons with ballast resistors are 5 or 28V DC. The operating voltage range for HB LED pushbuttons with voltage dimming device is from 8.4V DC to 28V DC. The LED polarity and other options are as specified in [Table XXI: High Brightness LED's](#). The High Brightness (**HB**) Light Source Assembly is field replaceable and the various configurations are detailed under the P/Ns in Section [5.3.14](#).

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Table XXI: High Brightness LED's

HB-LED DISPLAY CONFIGURATION	OPERATING VOLTS	NOMINAL MILLIAMPS PER PUSHBUTTON
Full or 2-Way	5	180
Full or 2-Way	28	40
3-Way	5	180
3-Way	28	60
4-Way	5	180
4-Way	28	80

NOTES:

1. All pushbuttons with voltage dimming require 80 mA at 28 V.
2. Actual current can be significantly lower.

4.5.4. Legends4.5.4.1. Type Style and Fonts

The standard type face used for legend text shall be Alternate Gothic Number 2 (AG2), a condensed gothic, sans serif style. For reference only, the nominal letter height-to-width and stroke width ratios are as follows in [Figure 43: Character Height:](#)

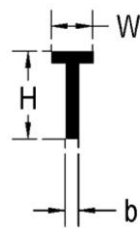
RECOMMENDED LETTER RATIOHEIGHT TO WIDTH RATIO: $H/W=2$ HEIGHT TO STROKE WIDTH: $H/b=6$

Figure 43: Character Height

The letter 'T' is used here for reference only. Individual character height (H), width (W), and stroke width (b) will be proportional to the basic character heights specified.

4.5.4.2. Character Heights

The character height, as defined in this document, shall be the distance (in decimal inches) from the top to the bottom of a capital letter (no descenders) in the standard font, AG2. Unless otherwise specified, the size of punctuation and symbols in that font will be artistically proportional to the size specified for the capital letters.

The standard character heights for the Series 90 Product Line are 0.072, 0.087, 0.100, 0.125 and 0.145. The character height selection option is included in the model number coding per Table 5 in Section 5 of this document. Examples of the character heights are shown in [Table XXII: Standard Legend Sizes](#).

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Table XXII: Standard Legend Sizes

.072" ABCDEFGHIJKLMNOPQRSTUVWXYZ1234567890
 .087" ABCDEFGHIJKLMNOPQRSTUVWXYZ12345611390
 .100" ABCDEFGHIJKLMNOPQRSTUVWXYZ1234561890
.125" ABCDEFGHIJKLMNOPQRSTUVWXYZ1234561890
.145" ABCDEFGHIJKLM
NOPQRSTUVWXYZ1234567890

Other AG2 character heights, available by special order (or, if needed, for special artwork) are: 0.060, 0.066, 0.075, 0.077, 0.080, 0.082, 0.090, 0.094, 0.097, 0.105, 0.110, 0.114, 0.120, 0.132, 0.139, 0.155, 0.164, 0.175, 0.188, 0.203, 0.219, 0.239, 0.263, 0.293, and 0.329.

4.5.4.3. Standard Character/Symbol Set

The standard AG2 typeface provides capital letters and numeric in all the sizes listed above. Lower case characters are not available in this font. Many typical European characters, such as Ä, Å, É, Ö, Ñ, Ü and others, are available as standard within this font. Other symbols available in AG2 include !, @, #, \$, %, &, (,), +, /, :, =, ?, \, <, >, *, ±, °, 1/2, 1/4, and others. The entire AG2 character set is shown in [Table XXIII: Alternate Gothic No. 2 Character Set](#).

Table XXIII: Alternate Gothic No. 2 Character Set

ABCDEFGHIJKLMNOPQRSTUVWXYZ
 Z
 0123456789!@#\$%^&*('),." \+/
 ..<=>? \ `~±#©;¡“”»—+123

NOTES:

1. The "character height" of an arrow is the length from the tip of the point to the end of the shaft, independently of its orientation, i.e., a .145" arrow will have the same appearance if vertical or horizontal (↑ or →).
2. The symbols * and # are available either as proportional to the size of the AG2 font or as full-size characters with the same height of the capital letters. Unless otherwise specified, the symbol used will be the proportional one.

4.5.4.4. Characters per Legend Display area

The approximate number of AG2 characters of a given size which will fit into a display area is given in [Table XXIV: Characters per Legend Display area](#). Since AG2 characters are proportionally spaced (i.e., a character "M" or "W" is about three times as wide as the character "I") the actual number of characters will depend on the specific characters used. If the specific characters used in each area exceed the space available, but by no more than 10%, the characters shall be condensed by 10%, using the same height but

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less width, to accommodate the legend as requested by the customer.

Table XXIV: Characters per Legend Display area

CODE NO.	CHARACTER SIZE IN INCHES (REF)	DISPLAY AREA NO.	LEGEND AREA NO.				DISPLAY STYLE DESCRIPTION
			(H) HORIZ.LINES PER AREA				
			(C) CHARACTERS PER LINE 1/				
			1 HxC	2 HxC	3 HxC	4 HxC	
10	NONE		NONE	NONE	NONE	NONE	FULL SCREEN DISPLAY
11	0.072		5X12	X	X	X	
12	0.087		4X10	X	X	X	
13	0.100		4X9	X	X	X	
14	0.125		3X7	X	X	X	
15	0.145		2X6	X	X	X	
20	NONE		NONE	NONE	NONE	NONE	2-WAY HORIZONTAL SPLIT SCREEN DISPLAY
21	0.072		2X12	2X12	X	X	
22	0.087		2X10	2X10	X	X	
23	0.100		1X9	1X9	X	X	
24	0.125		1X7	1X7	X	X	
25	0.145		1X6	1X6	X	X	
30	NONE		NONE	NONE	NONE	NONE	2-WAY VERTICAL SPLIT SCREEN DISPLAY
31	0.072		5X6	5X6	X	X	
32	0.087		4X4	4X4	X	X	
33	0.100		4X4	4X4	X	X	
34	0.125		3X3	3X3	X	X	
35	0.145		2X2	2X2	X	X	
40	NONE		NONE	NONE	NONE	NONE	3-WAY SPLIT SCREEN DISPLAY HORIZONTAL TOP HALF
41	0.072		2X12	2X6	2X6	X	
42	0.087		2X10	2X4	2X4	X	
43	0.100		1X9	1X4	1X4	X	
44	0.125		1X7	1X3	1X3	X	
45	0.145		1X6	1X2	1X2	X	
50	NONE		NONE	NONE	NONE	NONE	4-WAY SPLIT SCREEN DISPLAY
51	0.072		2X6	2X6	2X6	X	
52	0.087		2X4	2X4	2X4	X	
53	0.100		1X4	1X4	1X4	X	
54	0.125		1X3	1X3	1X3	X	
55	0.145		1X2	1X2	1X2	X	
60	NONE		NONE	NONE	NONE	NONE	3-WAY SPLIT SCREEN DISPLAY VERTICAL LEFT HALF
61	0.072		5X6	2X6	2X6	X	
62	0.087		4X4	2X4	2X4	X	
63	0.100		4X4	1X4	1X4	X	
64	0.125		3X3	1X3	1X3	X	
65	0.145		2X2	1X2	1X2	X	
70	NONE		NONE	NONE	NONE	NONE	3-WAY SPLIT SCREEN DISPLAY HORIZONTAL BOTTOM HALF
71	0.072		2X6	2X6	2X12	X	
72	0.087		2X4	2X4	2X10	X	
73	0.100		1X4	1X4	1X9	X	
74	0.125		1X3	1X3	1X7	X	
75	0.145		1X2	1X2	1X6	X	
80	NONE		NONE	NONE	NONE	NONE	3-WAY SPLIT SCREEN DISPLAY VERTICAL RIGHT HALF
81	0.072		2X6	5X6	2X6	X	
82	0.087		2X4	4X4	2X4	X	
83	0.100		1X4	4X4	1X4	X	
84	0.125		1X3	3X3	1X3	X	
85	0.145		1X2	2X2	1X3	X	

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4.5.4.5. Optional Fonts

By special order, Helvetica Light and Helvetica Medium are available in a range of sizes like that of AG2. Either of these Helvetica typefaces may also be ordered in their normal, condensed, bold, or expanded variations. Both typefaces provide capital letters, numbers, lower case characters, and many of the symbols and European characters identified in the previous paragraph.

4.5.4.6. Math and Greek Symbol Sets

Math symbols and Greek characters (α , β , Γ , π , Σ , μ , τ , Φ , Θ , Ω , δ , ϵ , etc.) are available by special order and may be mixed with the standard AG2 font.

4.5.4.7. Other Non-Roman Alphabets

Camera ready art, at 10 times the final size, is required for legends using other non-Roman characters such as Hebrew, Japanese, Korean, Chinese, Russian, Arabic, Sanskrit, etc. A bold face character set, with a stroke width ratio of 6:1 or 8:1, is recommended.

4.5.4.8. Special Artwork

Simple shapes, such as squares, rectangles, borders, circles or diagonal lines, may be generated in the normal legend-making process. For complex shapes, icons, or other graphic symbols, it is recommended that the customer supply either camera-ready artwork, at 10:1 scale, or supply artwork files in DXF format.

4.5.4.9. Text and Graphic Resolution

Prior to the 10:1 photographic reduction, characters and graphics shall have a minimum resolution of 300 x 300 dots-per-inch (DPI), yielding an equivalent resolution of 3,000 x 3,000 DPI for the pushbutton legend.

4.5.5. Display Types

The display types available as standard products in the Series 90 are listed in [Table XXV: Display Types Defined](#), which follows, along with the corresponding symbol used in MIL-PRF-22885.

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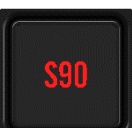
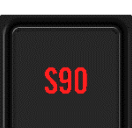
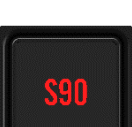
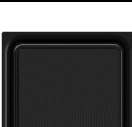
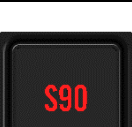
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Table XXV: Display Types Defined

TYPE CODE note /	MIL-S- 22885 SYMBOL	DESCRIPTION	LIGHT AND COLOR SOURCES			Non- Illuminated	Illuminated
			INCAN- DESCENT LAMP	MULTI- CHIP LED	HIGH BRIGHTNESS LED		
1 <u>1/</u>	C	Visible opaque black legends on translucent color background. When illuminated, the background appears in color while the legends remain opaque black.	Flat Filter	---	Flat Filter		
2	B	Obscure legends on opaque black background. When illuminated, the background appears in color while the legends remain opaque black.	Lamp Cap	---	---		
3	H	Obscure legends on opaque black background. When illuminated, the legends appear in color while the background remains opaque black.	Lamp Cap	---	---		
4 <u>2/</u>	N	Visible trans-reflective white legends on an opaque black background. When illuminated, the legends appear in color while the background remains opaque black.	Lamp Cap	LED	Flat Filter		
5 <u>2/ 3/</u>	W	Visible opaque black legends on trans-reflective white background. When illuminated, the background appears in color while the legends remain opaque black.	Lamp Cap	LED	Flat Filter		
6 <u>2/ 4/</u>	S	Obscure legends on opaque black background. When illuminated, the legends are sunlight readable while the background remains opaque black.	Flat Filter	LED	Flat Filter		
7 <u>2/ 5/</u>	S	Obscure legends on opaque black background. When illuminated, the legends are NVIS compatible while the background remains opaque black.	NVG Filter	NVG Filter	NVG Filter		

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CUSTOMER REPLACEABLE LEGENDS							
TYPE CODE note /	MIL-S- 22885 SYMBOL	DESCRIPTION	LIGHT AND COLOR SOURCES			Non- Illuminated	Illuminated
			INCAN- DESCENT LAMP	MULTI- CHIP LED	HIGH BRIGHTNESS LED		
8 1/	C	Similar to a Type 2 display.	Lamp Cap	---	---		
9 1/	C	Similar to a Type 5 display.	Lamp Cap	LED	---		
0 1/	C	Similar to a Type 6 display, except contrast ratio requirements do not apply.	Flat Filter	LED	Flat Filter		

NOTES:

1. Type 1 - Styles 20 through 85 (Ref [Table XXIV: Characters per Legend Display area](#)) will have .026" black bars as visual split screen separators.
2. Available in both multi-chip and High Brightness LED lighted configurations (including High Brightness with voltage dimming).
3. Multi-chip LED Type 5 - Styles 20 through 85 (Ref [Table XXIV: Characters per Legend Display area](#)) will have .046" black bars as visual split screen separators.
4. Type 6 - Sunlight readable display applies to incandescent configurations. When illuminated, display shall be readily discernible under 10,000 foot-candles of direct light when tested per MIL-PRF-22885. Unilluminated legends shall not be discernible. Recommended legend height is .100 inch. Multi-chip LED-based units have a similar dead-front appearance but may not be SLR under the same test conditions. Incandescent colors Blue and Aviation Green are not recommended for displays required to operate in high-intensity (sunlight readable) environments.
5. Type 7 - Night Vision Imaging System (NVIS) compatible display. When illuminated, legends are compatible with NVIS (Gen III) night vision goggles. Applies to both incandescent and LED configurations. Incandescent versions are also sunlight readable. Nonilluminated legend shall not be discernible. (Available in "sealed" version only.)
6. Pushbuttons with customer replaceable legends are Display Types 8, 9 and 0. Customers may specify legend text in the normal manner when ordering pushbuttons or assemblies of switches and pushbuttons. If no legend is specified by the customer, a temporary film legend with the words "Replace With Legend" will be installed at the factory to clarify positive/negative film type and to show the position of the legend plate within the pushbutton stack-up.
7. Legends and faceplate assemblies which are produced in the field may not be of equal quality to those which are factory made.
8. Type 8 - Similar to Type 2.
9. Type 9 - Similar to Type 5.
10. Type 0 - Similar to Type 6.

4.5.6. Lens and Faceplate Assemblies

The lens and faceplate assemblies are part of the pushbutton assembly. These pushbuttons are removable from the front of the panel to allow the replacement of incandescent lamps without the need for special tools.

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Multi-chip LEDs are not replaceable. The light source assembly of pushbutton with High Brightness LEDs can be replaced in the field if required.

4.5.6.1. Color Filters

Incandescent lamp-based pushbuttons that have display type 2, 3, 4, 5, 8 or 9 utilize color filter caps which may be interchanged among the four-color cell areas or replaced with color caps ordered from the factory. Incandescent lamp-based pushbuttons that have display types 1, 6, 7 or 0 utilize flat color filters which are an integral part of the faceplate assembly and are not replaceable in the field.

On all configurations of multi-chip LED based pushbuttons, the color is derived from the multi-chip LEDs (and, in the case of type 7 displays, the color is derived from the combination of the multi-chip LEDs and the NVG-compatible filter). Multi-chip LED colors are not changeable in the field.

On all configurations of High Brightness LED based pushbuttons, color is derived from color filters, and in the case of type 7 displays, the color is derived from the NVG-compatible filter. High Brightness LED based pushbuttons that have display types 0, 1, 4, 5, 6, or 7 utilize flat color filters which are an integral part of the faceplate assembly and are not replaceable in the field.

4.5.6.2. Customer Replaceable Legends

Display types 8, 9 and 0 allow for customer replaceable legends. Each type is available for configurations with incandescent lamps pushbuttons. Display type 0 is available for High Brightness LED based pushbuttons. For multi-chip LED-lighted pushbuttons display types 9 and 0 are available. The overall size of the replaceable faceplate is .575" (14.61 mm) square, with a viewing area of .495" (12.57 mm) square. Displays with customer installed legends may not be of equal quality to that of factory installed assemblies with laminated legends. Section [6.0](#), TB-12-A-29 illustrates the stack-up and surface orientation for these display types.

NOTE: Factory supplied replaceable legends are available by indicating the desired text in the normal manner. If no specific legend is identified, a temporary film chip (REPLACE;WITH;LEGEND) will be installed in the pushbutton at the factory.

4.6. Lighting System Requirements

4.6.1. Luminance

All luminance (brightness) readings shall be taken in completely dark surroundings with a calibrated photoelectric photometer. Unless otherwise specified, all measurements are made at the full-rated voltage of the pushbutton. The standard unit of measurement is footlamberts (fL).

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Measurements shall be made at three points per character (as specified in MIL-PRF-22885, Figure 9) and averaged for each character on the legend. Unless otherwise specified, the luminance of the pushbutton is the average of the readings for all characters of the legend.

Only those measurements taken under the controlled environment of the Staco Systems Lighting Laboratory, using calibrated instruments and light sources, shall be considered valid.

Luminance measurements for a given legend type may vary depending on the shape of the lamp filament required for its design voltage, the orientation of the filament within the lamp-box, and the legend used in the test. QPL tests are conducted with a standard test legend, the specified lamp-box configuration and utilize lamp type 3071 (5 volt, with a Kelvin temperature of 2350 °K). Results with other legends, lamp-box configurations or lamps will be different.

4.6.1.1. Lamps

Unless otherwise specified, T-1 size flange based incandescent lamps used for laboratory luminance testing shall be aged and selected for a mean spherical candlepower (MSCP) of $.15 \pm .01$.

Unless otherwise specified, standard catalog lamps have MSCP values with a tolerance of $\pm 25\%$. Refer to [Table XIX: Incandescent Lamps](#) for selection of lamps with various MSCP values.

4.6.1.2. Led Version

Measurements of LED-lighted pushbuttons are readings on a display area in footlamberts (not millicandelas, which apply only to the LEDs and not to the displays). Unless otherwise specified, multi-chip LEDs used for luminance testing shall be with a forward current of $.015 \text{ amp} \pm .001$ through the LED junctions. (See [Table XX: Multi-Chip LED's](#) for the nominal current per switch used at 5 volts and 28 volts for each LED display configuration.). The applied current of 28 Volts High Brightness LED current shall not exceed 20 mA per quadrant. See [Table XXI: High Brightness LED's](#) for current specification of High Brightness LEDs. The dimming characteristics of High Brightness LEDs with Voltage Dimming Circuit (VDC) is depicted in [Figure 42: High Brightness LED Curve with Voltage Dimming Circuit \(VDC\)](#).

4.6.1.3. Luminance Requirements

Legend brightness, for a given display type, shall be the same with or without EMI/RFI shielding. Table L gives the luminance performance of pushbutton display configurations using incandescent lamps. [Table XXVI: Luminance Performance - Incandescent Lighting](#) is for multi-chip LED configurations, and Table N is for High Brightness LED configurations. In each case, explanatory notes are given at the end of the table.

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Table XXVI: Luminance Performance - Incandescent Lighting

DISPLAY TYPE					
Ser 90 Code	M22885 Symbol	Ser 90	Color Description	Ser 90 Typical	Notes
1	C	0	White	370	
1	C	1	Red	150	
1	C	2	Green	180	
1	C	3	Aviation Yellow	550	
1	C	4	Lunar White	390	
1	C	5	Lemon Yellow	690	
1	C	6	Blue	75	
1	C	7	Aviation Green		
2	B	0	White	170	
2	B	1	Red	30	
2	B	2	Green	35	
2	B	3	Aviation Yellow	110	
2	B	4	Lunar White	80	
2	B	5	Lemon Yellow	150	
2	B	6	Blue	10	
2	B	7	Aviation Green		Uses /016
3	H	0	White	150	
3	H	1	Red	30	
3	H	2	Green	35	
3	H	3	Aviation Yellow	100	
3	H	4	Lunar White	70	
3	H	5	Lemon Yellow	140	
3	H	6	Blue	10	
3	H	7	Aviation Green		
4	N	0	White	110	
4	N	1	Red	20	
4	N	2	Green	20	
4	N	3	Aviation Yellow	70	
4	N	4	Lunar White	50	
4	N	5	Lemon Yellow	120	
4	N	6	Blue	6	
4	N	7	Aviation Green	30	
4*	N	*	White	750	*92P0067-05
4*	N	*	Red	150	*92P0067-06
4*	N	*	Green	185	*92P0067-07
4*	N	*	Aviation Yellow	500	*92P0067-08
4*	N	*	Lunar White		*92P0067-10
4*	N	*	Blue	45	*92P0067-09
4*	N		Aviation Green		*92P0067-11

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Luminance Performance - Incandescent Lighting Continued

DISPLAY TYPE					
Ser 90 Code	M22885 Symbol	Ser 90 Code	Color Description	Ser 90 Typical	Notes
5	W	0	White	600	
5	W	1	Red	120	
5	W	2	Green	170	
5	W	3	Aviation Yellow	450	
5	W	4	Lunar White	350	
5	W	5	Lemon Yellow	690	
5	W	6	Blue	50	
5	W	7	Aviation Green	190	
6	S	0	White	480	
6	S	1	Red	195	
6	S	2	Green	210	
6	S	3	Aviation Yellow	600	
6	S	4	Lunar White	510	
6	S	5	Lemon Yellow	900	
6	S	6	Blue	50	
6	S	7	Aviation Green	375	
7	S	1	NVIS Red	35	
7	S	2	NVIS Green B	160	
7	S	5	NVIS Yellow	275	
7	S	6	NVIS Green A	105	

Notes:

1. "Display Type, Series 90 Code" identifies the code used in coded part number. Also see [Table XXV: Display Types Defined](#), and [Table XXXV: Model 92 Incandescent Pushbutton Configuration Table](#), [Table XXXVI: Model 92 Multi-chip LED Pushbutton Configuration Table](#), and [Table XXXVII: Model 92 High Brightness LED Pushbutton Configuration Table](#).
2. "Display Type, M22885 Symbol" identifies symbol used in MIL-PRF-22885.
3. "Color, Series 90 Code" specifies colors. Also see [Table XXIX: Color Limits](#) for tabulation of Illuminated Color Limits, CIE Charts of [Figure 44: Incandescent Color – CIE 1931 Chromaticity Diagram](#) and [Figure 46: High Brightness LED Colors – CIE 1931 Chromaticity Diagram](#), and [Table XXXV: Model 92 Incandescent Pushbutton Configuration Table](#).
4. The two values are "without/with EMI/RFI".
6. "Luminance Values, Series 90 Typical" refers to typical values measured on Series 90 products apart from the published mil-spec value. For the Series 90, legend brightness is independent of EMI/RFI shielding.
7. Display Type Code "4*" is a special version of Series 90 Type 4 for special high-intensity applications, reference 92P0067-TAB. This display type meets the unusually bright display requirements of MIL-PRF-22885, [Table XXXV: Model 92 Incandescent Pushbutton Configuration Table](#), Type 4.

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Table XXVII: Luminance Performance - Multi-Chip LED Lighting

DISPLAY TYPE		LUMINANCE (Foot Lamberts)		
Ser 90 Code	M22885 Symbol	Ser 90 Code	Color Description	Ser 90 Typical
4	N	1	Red	100
4	N	2	Green	65
4	N	3	Amber	105
4	N	7	Lime Green	130
4	N	8	Orange	85
5	W	1	Red	100
5	W	2	Green	65
5	W	3	Amber	85
5	W	7	Lime Green	130
5	W	8	Orange	85
6	S	1	Red	70
6	S	2	Green	55
6	S	3	Amber	85
6	S	7	Lime Green	100
6	S	8	Orange	70
7	S	1	NVIS Red	9
7	S	2	NVIS Green	48
7	S	5	NVIS Yellow	94

Notes:

1. Display Type, Series 90 Code, also see [Table XXXVI: Model 92 Multi-chip LED Pushbutton Configuration Table](#).
2. Display Type, "M22885" Symbol, per MIL-PRF-22885.
3. Color, Series 90 Code, see [Figure 44: Incandescent Color – CIE 1931 Chromaticity Diagram](#) and [Figure 46: High Brightness LED Colors – CIE 1931 Chromaticity Diagram](#).

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Table XXVIII: Luminance Performance – High Brightness LED Lighting

DISPLAY TYPE		COLOR		LUMINANCE (Foot Lamberts)	
Series 90 Code	M22885 Symbol	Series 90 Code	Color Description	Minimum Average 4/	Notes
1	C	0	White	240	
1	C	1	Red	40	
1	C	2	Green	180	
1	C	3	Aviation Yellow	185	
1	C	5	Lemon Yellow	350	
1	C	6	Blue	165	
4	N	0	White	530	
4	N	1	Red	75	
4	N	2	Green	170	
4	N	3	Aviation Yellow	410	
4	N	5	Lemon Yellow	850	
4	N	6	Blue	85	
5	W	0	White	530	
5	W	1	Red	75	
5	W	2	Green	170	
5	W	3	Aviation Yellow	410	
5	W	5	Lemon Yellow	850	
5	W	6	Blue	85	
6	S	0	White	740	
6	S	1	Red	180	
6	S	2	Green	490	
6	S	3	Aviation Yellow	630	
6	S	5	Lemon Yellow	990	
6	S	6	Blue	220	
7	S	0	NVIS Blue	180	
7	S	1	NVIS Red	170	
7	S	2	NVIS Green B	180	
7	S	3	NVIS Yellow, Class B	250	
7	S	4	NVIS White	600	
7	S	5	NVIS Yellow, Class A	250	
7	S	6	NVIS Green A	350	

Notes:

1. Display Type, Series 90 Code, also see [Table XXXVII: Model 92 High Brightness LED Pushbutton Configuration Table](#).
2. Display Type, "M22885" Symbol, per MIL-PRF-22885.
3. Color, Series 90 Code, see [Figure 46: High Brightness LED Colors – CIE 1931 Chromaticity Diagram](#) below, and [Table XXXVII: Model 92 High Brightness LED Pushbutton Configuration Table](#).
- 4/ All luminance values are preliminary and subject to changes. Contact factory for updated information.

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4.6.2. Chromaticity

4.6.2.1. Color Measurements

The chromaticity of illuminated colors shall be determined by means of a calibrated spectroradiometer (MIL-PRF-22885 Method II) utilizing a complete illuminated pushbutton assembly. And, unless otherwise specified, shall use either calibrated lamps of a specified color temperature or both multi-chip and High Brightness LEDs operated at their rated current.

Standard incandescent colors are specified based on tests which are conducted at a Kelvin temperature of 2350 °K (using the 5 volts T1 lamp type 3071 which has an MSCP of .15). While data obtained with other lamps may be useful, the results may differ from that specified herein.

LED colors are specified at full rated voltage.

NVIS-compatible colors shall be measured at either $15 \pm .5$ footlamberts (fL) or at the full rated voltage of the illuminating source, whichever is less.

4.6.2.2. Illuminated Colors

The illuminated colors of displays shall be built in accordance with MIL-PRF-22885 for incandescent configurations, Multi-chip LED configurations, and for Multi-chip LED configurations, per MIL-L-85762, and MIL-STD-3009 for all NVIS-compatible configurations. [Figure 44: Incandescent Color – CIE 1931 Chromaticity Diagram](#) shows the standard colors for incandescent versions of the Series 90 plotted on the CIE 1931 Chromaticity Diagram.

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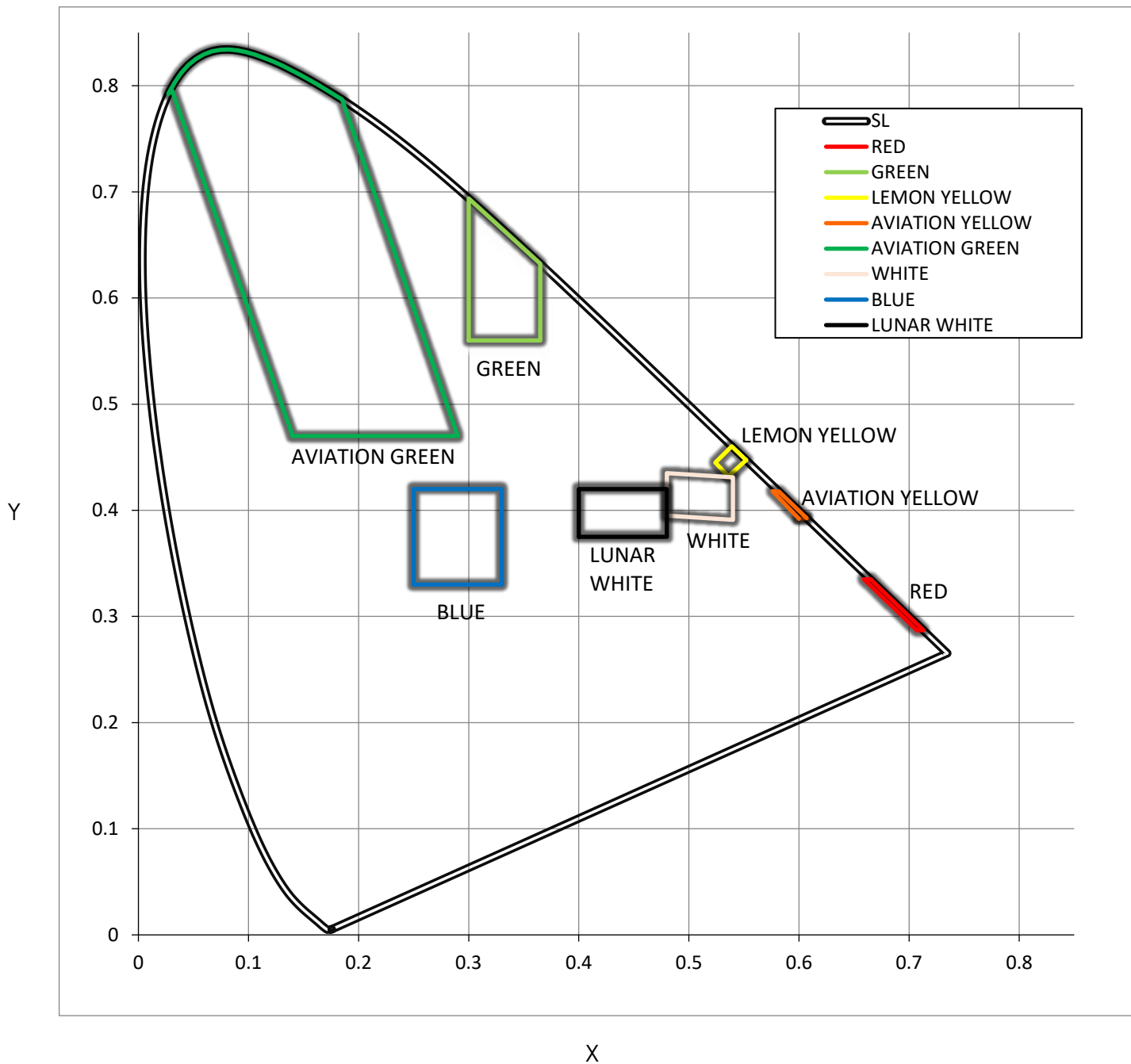


Figure 44: Incandescent Color – CIE 1931 Chromaticity Diagram

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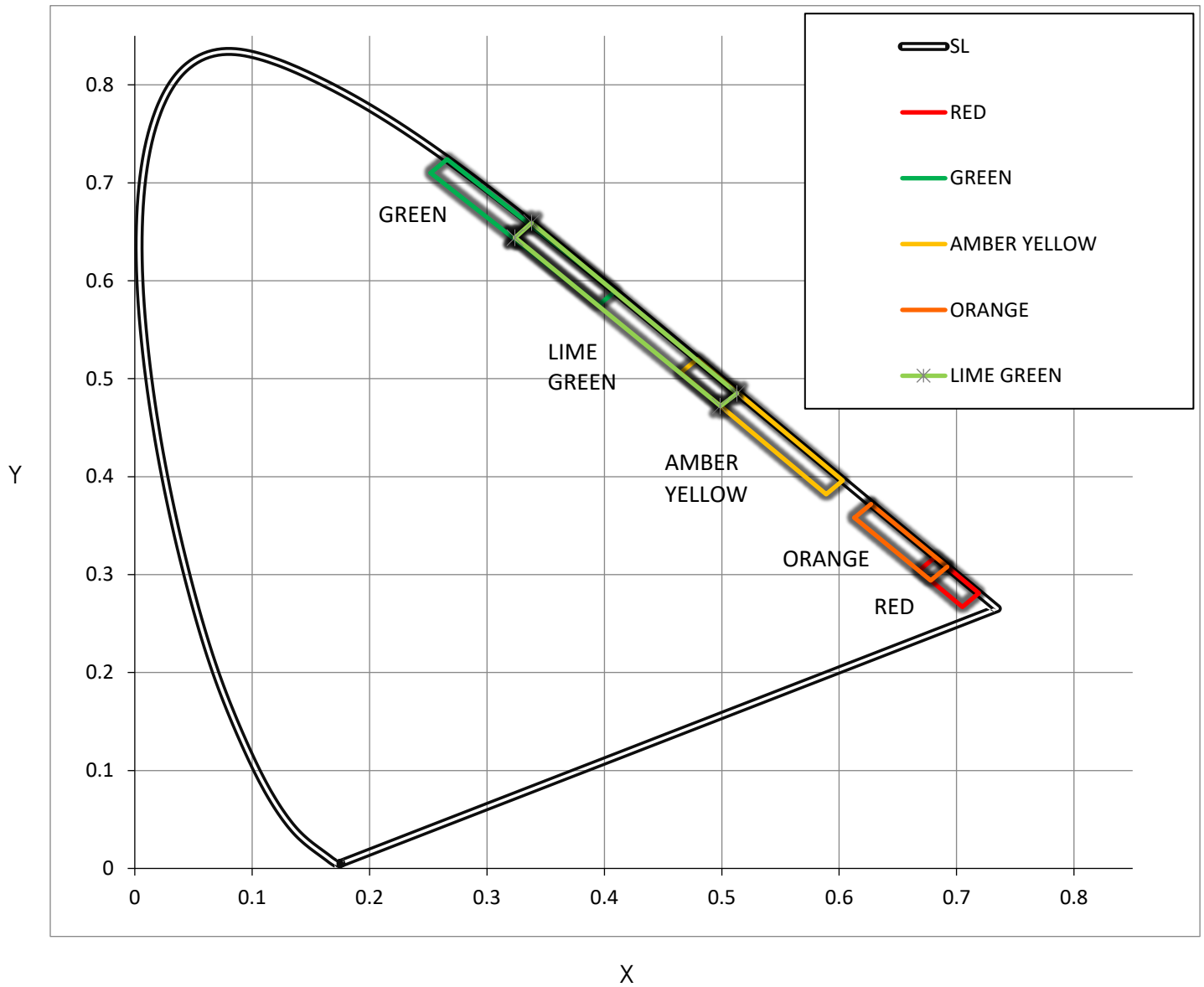


Figure 45: Multi-Chip LED Colors – CIE 1931 Chromaticity Diagram

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High Brightness LED colors are shown in [Figure 46: High Brightness LED Colors – CIE 1931 Chromaticity Diagram](#). Note: The color limits of [Figure 46: High Brightness LED Colors – CIE 1931 Chromaticity Diagram](#) and [Table XXIX: Color Limits](#) are preliminary and subject to change.

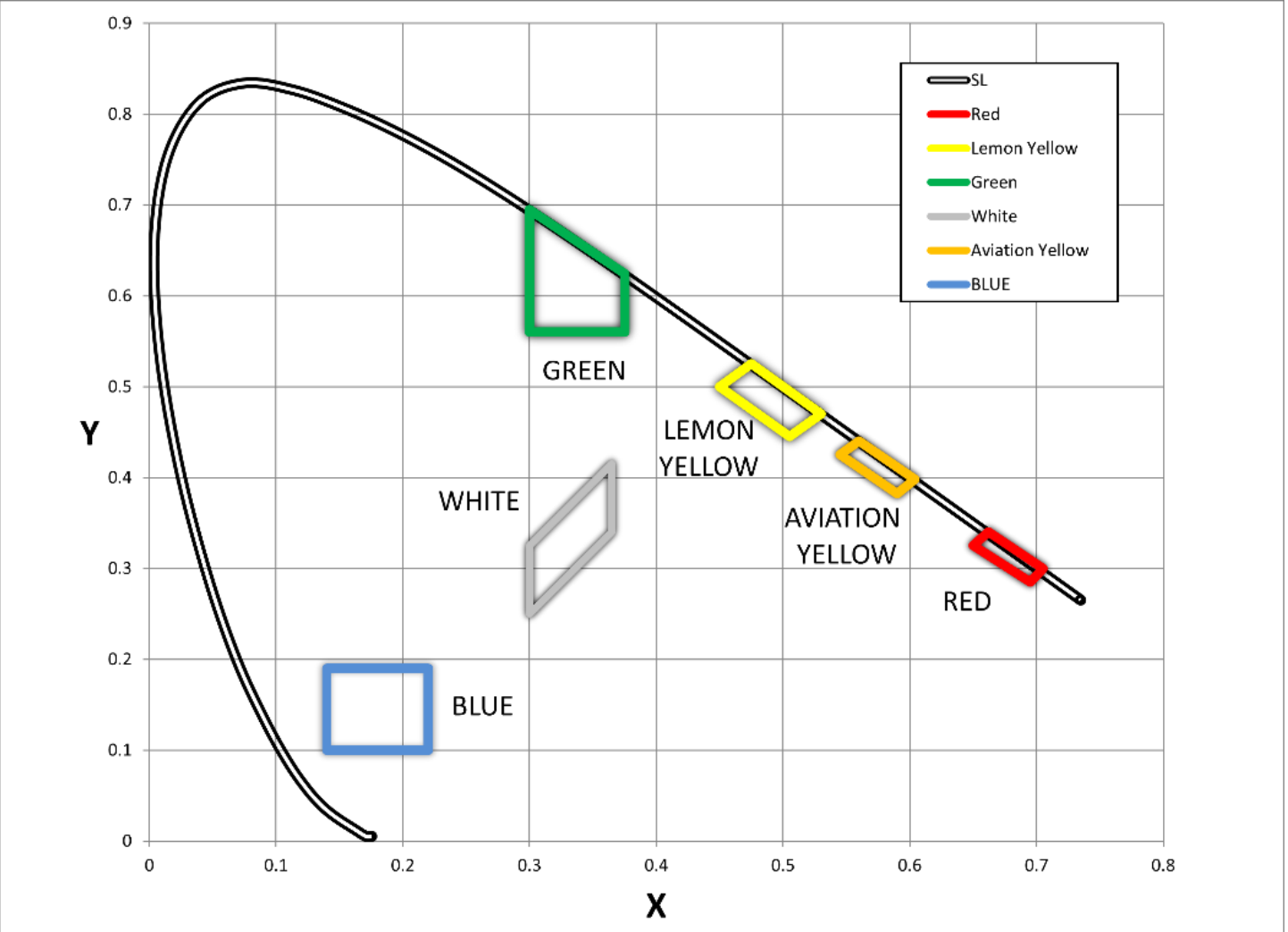


Figure 46: High Brightness LED Colors – CIE 1931 Chromaticity Diagram

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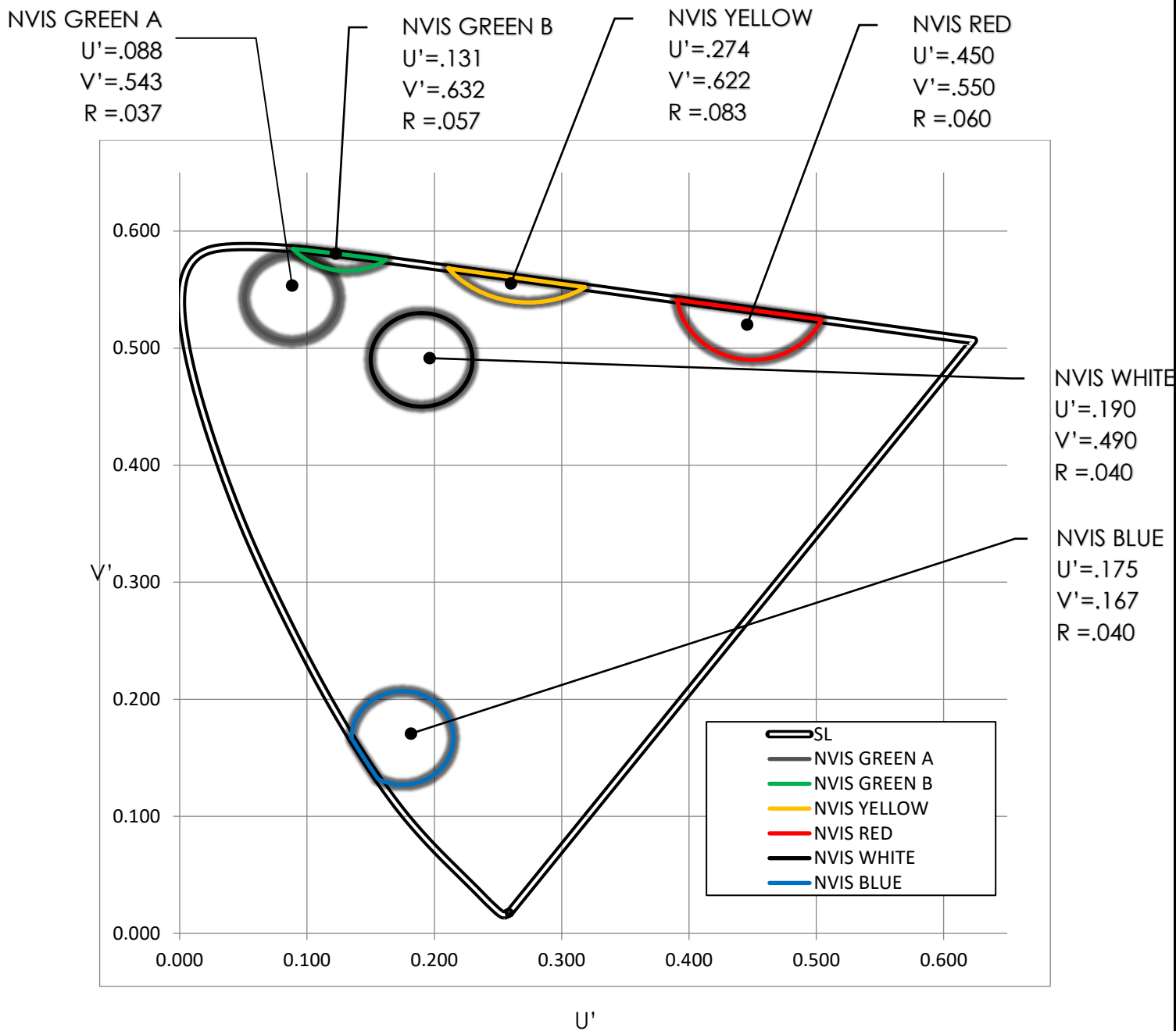


Figure 47: NVIS Compatible Colors – CIE 1976 Chromaticity Diagram

The NVIS blue values are preliminary data. [Table XXIX: Color Limits](#) provides the Illuminated Color Limits by X-Y coordinates for standard colors of both incandescent and LED configurations.

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Table XXIX: Color Limits

COLOR	(CODE)	INCANDESCENT VERSION 3/		MULTI-CHIP LED VERSION 4/		HIGH BRIGHTNESS LED VERSION 9/	
		x	y	x	y	x	y
WHITE	(0)	0.480	0.395	----	----	0.300	0.250
		0.480	0.435	----	----	0.300	0.325
		0.540	0.431	----	----	0.365	0.415
		0.540	0.391	----	----	0.365	0.340
RED	(1)	0.665	SL 2/	0.668	0.304	0.695	0.285
		0.659	0.335	0.682	0.318	0.705	SL 2/
		0.707	0.287	0.705	0.267	0.650	0.330
		0.713	SL 2/	0.719	0.281	0.660	SL 2/
GREEN	(2)	0.300	0.560	0.252	0.710	0.300	0.560
		0.300	SL 2/	0.266	0.724	0.300	SL 2/
		0.365	0.560	0.395	0.575	0.375	0.560
		0.365	SL 2/	0.409	0.589	0.375	SL 2/
AVIATION YELLOW 5/ MULTI-CHIP LED: AMBER YELLOW	(3)	0.582	SL 2/	0.465	0.506	0.545	0.425
		0.607	SL 2/	0.479	0.520	0.560	SL 2/
		0.576	0.418	0.589	0.382	0.590	0.382
		0.600	0.392	0.603	0.396	0.604	SL 2/
LUNAR WHITE 6/	(4)	0.400	0.375	----	----	----	----
		0.400	0.420	----	----	----	----
		0.480	0.375	----	----	----	----
		0.440	0.420	----	----	----	----
LEMON YELLOW	(5)	0.552	SL 2/	----	----	0.450	0.500
		0.536	0.432	----	----	0.475	SL 2/
		0.524	0.445	----	----	0.505	0.445
		0.539	SL 2/	----	----	0.530	SL 2/
BLUE 7/	(6)	0.250	0.330	----	----	0.140	0.100
		0.250	0.420	----	----	0.140	0.190
		0.330	0.330	----	----	0.220	0.100
		0.330	0.420	----	----	0.220	0.190
AVIATION GREEN 8/ MULTI-CHIP LED: LIME GREEN	(7)	0.140	0.470	0.324	0.644	----	----
		0.290	0.470	0.338	0.659	----	----
		0.030	SL 2/	0.499	0.472	----	----
		0.185	SL 2/	0.513	0.485	----	----
MULTI-CHIP LED: ORANGE	(8)	----	----	0.613	0.358	----	----
		----	----	0.627	0.372	----	----
		----	----	0.678	0.294	----	----
		----	----	0.692	0.308	----	----

NOTES:

1. The colors are expressed as "x" and "y" coordinates on the standard 1931 CIE chromaticity diagram. Illuminated colors, measured as specified herein, shall be within the limits bounded by the coordinates listed for each color.
2. The term "SL" indicates where intersections occur with the spectrum locus on the CIE chromaticity diagram.
3. Chromaticity values are measured when switch is illuminated by four lamps, 5V DC, T-1 mid get-flange base, subminiature, aged and selected, with $.15 \pm .01$ mean spherical candle power (MSCP), and operating at a color temperature of 2350 °K.
4. Chromaticity values for LED light sources are at full rated voltage.

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5. "Aviation Yellow" replaces previous Series 90 "Amber Yellow" without change to the filter color or material.
6. "Lunar White" replaces previous Series 90 "Blue White" without change to the filter color or material. Blue is not recommended for displays required to operate in high-intensity lighting (sunlight readable) environments if the light source is from incandescent lamps.
7. The color limits are preliminary and subject to change. The limits are not applicable to Type 1 displays.

4.6.3. Sunlight Readability

Sunlight readable displays in the Series 90 Product Line provide a black, non-reflective, dead-front appearance when not lighted and brightly lighted legend characters, in the specified colors, when the displays are energized. This display (type 6) protects the crew station viewer from false indications in direct sunlight at high altitude. The design overcomes two problems associated with high-intensity light directed at the instrument panel. First, when lighted, it enables the viewer to read the legend despite the intense brightness of direct sunlight at 70,000 feet altitude. Secondly, the design prevents this high intensity light from causing the legends to falsely appear to be lighted when they are unlighted. The measure of its effectiveness is by means of calculating two sets of contrast ratios based on laboratory measurements conducted under very specific conditions.

4.6.3.1. Contrast Ratios

The average contrast ratio of each legend character to the background shall be measured with an incidental illumination of 10,000 foot-candles minimum, at 5,000° ± 500° Kelvin color temperature, directed at an angle of 45° ± 2° to the normal of the viewing surface. Luminance readings shall be point readings taken with a calibrated photoelectric photometer directed perpendicular to the display surface. At least three readings shall be taken at equally spaced points on each legend character and the readings averaged. At least three readings shall then be taken at points in the background immediately adjacent to each character. The background readings shall also be averaged. Unless otherwise specified, the contrast ratios CL and CUL, shall be calculated for each character.

The lighted contrast (ON/BACKGROUND) is defined by

$$CL = (B2 - B1)/B1$$

The unlighted contrast (OFF/BACKGROUND) is defined by

$$CUL = (B3 - B1)/B1$$

B1 = Average background luminance

B2 = Average character luminance, legend lighted

B3 = Average character luminance, legend unlighted

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Lamps for testing shall be aged and selected for a mean spherical candle power (MSCP) of $.15 \pm .01$. The standard legend for SLR testing has a character height of 0.1 inch (2.54 mm), two display lines, and the words "REMOTE" on the top half and "ALT LOW" on the bottom half.

4.6.3.2. Incandescent Type 6

The average contrast ratio of each lighted legend character to background shall be 0.6 minimum, except for blue which shall be 0.2 minimum. In the unlighted legend condition, the average contrast ratio of each legend character to the background shall have an absolute value less than or equal to 0.1.

4.6.3.3. LED Type 6

Minimum contrast ratios for multi-chip LED lighted legends shall be 0.4 for lime green. These are considered sunlight readable (MIL-PRF-22885 symbol S). The minimum contrast ratios for orange shall be 0.25, and the other colors 0.20. These are considered dead-front (MIL-PRF-22885 symbol H). Unlighted contrast ratios for all colors shall be less than 0.1.

Minimum contrast ratios for High Brightness LED lighted legends shall be at least 0.6 for all colors. Unlighted contrast ratios for all colors shall be less than 0.1 (sunlight readable per MIL-PRF-22885).

4.6.3.4. SLR Performance of NVIS – Compatible Type 7

Incandescent pushbuttons with NVIS-compatible colors shall have an average contrast ratio of each lighted legend character to the background of 0.4 for NVIS Green A, Green B and Yellow. The unlighted contrast ratio for each individual character shall not exceed 0.1. NVIS Red shall have an average lighted contrast ratio for the entire legend of 0.4 or greater, however, individual characters may be below that contrast ratio. Likewise, for NVIS Red, the average unlighted contrast ratio for the entire legend shall not exceed 0.15. Sunlight readability requirements do not apply to NVIS-compatible multi-chip LED pushbutton configurations.

NVIS compatible colors of High Brightness LED based pushbuttons (excluding red) shall meet sunlight readability requirements of MIL-PRF-22885. Red color legends shall have lighted contrast ratio of 0.4 minimum.

4.6.3.5. SLR Performance of Sealed Switches

SLR performance shall not be degraded for standard Drip-proof, Splash-proof or Watertight seals. SLR requirements do not apply to Solvent Resistant or Hazardous Environment Seals.

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4.6.4. Night Vision Imaging System Compatibility

Series 90 Products, when type 7 legends are specified, provide instrumentation displays which are compatible with night vision imaging systems (NVIS). Or, to use another common expression of this, they are night vision goggle compatible (NVGC).

4.6.4.1. Night Vision Instrumentation Colors

NVIS-compatible colors used in the Series 90 Product Line shall be in accordance with MIL-L-85762 and MIL-STD-3009. Available NVIS colors are Green A, Green B, Yellow, and Red for incandescent versions. Colors available for multi-chip LED-based products are NVIS Green B, Yellow and Red. Colors available for High Brightness LED-based products are NVIS Green A, Green B, Yellow, White, Blue and Red.

NVIS Green A and Green B are used for illuminated controls, caution and advisory signals. NVIS Yellow is used for master caution and warning signals. NVIS Red is only applicable to Class B systems (see Section [4.6.4.3](#)) and is used as a warning signal.

Chromaticity performance of NVIS-compatible colors shall be measured as specified in the applicable MIL, specification using a calibrated spectroradiometer or photometer. Chromaticity requirements are simplified and given in [Table XXX: Chromaticity Requirements of NVIS Compatible Light Sources](#), which follows, and are shown graphically in CIE chart form in [Figure 47: NVIS Compatible Colors – CIE 1976 Chromaticity Diagram](#).

Table XXX: Chromaticity Requirements of NVIS Compatible Light Sources

NVIS COLOR	1976 UCS CHROMATICITY COORDINATES			LUMINANCE fL
	u'	v'	r	
Green A	0.088	0.543	0.037	0.1
Green B	0.131	0.623	0.057	0.1
Yellow	0.274	0.622	0.083	15
Red	0.450	0.550	0.060	15
White	0.190	0.490	0.040	0.1
Blue	0.175	0.167	0.040	0.1

Where:

u' and v' = 1976 UCS chromaticity coordinates of the center point of the specified color area.

r = radius of the allowable circular area for the color.

fL = footlamberts

NOTES:

1. All values are per MIL-L-85762, Table VIII, and MIL-STD-3009.

4.6.4.2. Night Vision Imaging System Types

MIL-L-85762 and MIL-STD-3009 define night vision imaging systems by type and class. Type I is direct view imaging where the Gen III night vision goggle (NVG) is used to view outside the cockpit and

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pilot glances under the goggles to view the instruments (typically AN/AVS-6 applications). Type II also is a Gen III goggle but uses a projected image where the pilot simultaneously views both external and internal information through optical mixers.

4.6.4.3. Night Vision Imaging System Classes

Two NVIS classes have been defined, based on the cut-off frequency of the filters used in the goggles. Class A NVIS uses the 625 nanometer (nm) minus blue objective lens filter while Class B uses the 665 nm filter. The lower cut-off of the Class A filters allows for maximum near-IR response to tree bark, grass and other green vegetation, a general requirement for helicopter applications operating below tree-top level. The Class B filter, with the higher cut-off, allows the goggles to be used in conjunction with orange and red warning indicators in the cockpit, and is intended for aircraft which are operating above tree level.

4.6.4.4. NVIS Radiance

The NVIS radiance (NR) is measured for Class A (NRA) for compatibility with 625 nm applications, and for Class B (NRB) for 665 nm systems. Both are the result of spectral radiance measurements, in 5 nm increments, from 450 to 930 nm. The readings are automatically scaled by the spectroradiometer system to a selected brightness level given in footlamberts.

NVIS spectral radiance measurements for the Series 90 shall be made on a calibrated spectroradiometer. The luminance setting for these measurements shall be 15 ± 0.5 fL (or full rated drive condition, whichever is less) as determined either by photometer or spectroradiometer measurement. The NVIS radiance value shall then be scaled from the NR value at the measured luminance to the NR at the specified luminance level.

4.6.4.5. NVIS Radiance Requirements

[Table XXXI: Radiance Requirements of NVGC Light Sources](#), which follows, summarized the NVIS radiance specification (MIL-L-85762, Table IX, and MIL-STD-3009, Table III, a) for configurations which are applicable to the Series 90 Product Line.

Table XXXI: Radiance Requirements of NVGC Light Sources

TYPE I SYSTEMS					
NVIS COLOR	CLASS A GOGGLES		CLASS B GOGGLES		LUMINANCE fL
	Min NR _A	Max NR _A	Min NR _B	Max NR _B	
Green A	----	1.7×10^{-10}	----	1.7×10^{-10}	0.1
Green B	----	1.7×10^{-10}	----	1.7×10^{-10}	0.1
Yellow	5.0×10^{-8}	1.5×10^{-7}	4.7×10^{-8}	1.4×10^{-7}	15
Red	NOT APPLICABLE		4.7×10^{-8}	1.4×10^{-7}	15
White	----	1.0×10^{-9}	----	1.0×10^{-9}	0.1
Blue	----	1.7×10^{-10}	----	1.7×10^{-10}	0.1

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TYPE II SYSTEMS					
NVIS COLOR	CLASS A GOGGLES		CLASS B GOGGLES		LUMINANCE fL
	Min NRA	Max NRA	Min NRB	Max NRB	
Green A	----	1.7×10^{-10}	----	1.7×10^{-10}	0.1
Green B	----	1.7×10^{-10}	----	1.7×10^{-10}	0.1
Yellow	----	1.5×10^{-7}	----	1.4×10^{-7}	15
Red	NOT APPLICABLE		----	1.4×10^{-7}	15
White	----	1.0×10^{-9}	----	1.0×10^{-9}	0.1
Blue	----	1.7×10^{-10}	----	1.7×10^{-10}	0.1

NOTES:

1. All values are per MIL-L-85762, Table IX, and MIL-STD-3009.

4.6.4.6. Performance of NVGC Light Sources

[Table XXXII: R Performance of NVGC Light Sources](#), compares the performance of incandescent, multi-chip LED and High Brightness LED lighted pushbuttons to the values of [Table XXXI: Radiance Requirements of NVGC Light Sources](#). This information is correct and complete as of the release date of this revision of this specification. As filter technology and manufacturing processes improve, the table will be updated. The status is summarized as follows:

NVIS Green A, Incandescent: Meets all requirements for chromaticity, NVIS radiance for both NRA and NRB for Type I and Type II applications when scaled to 0.1 fL and is sunlight readable at full brightness.

NVIS Green B, Incandescent: Also meets all requirements for chromaticity, NVIS radiance for both NRA and NRB for Type I and Type II applications when scaled to 0.1 fL and is sunlight readable at full brightness.

NVIS Yellow, Incandescent: Standard configurations meet all NVIS radiance requirements for Type I Class A (NRA) as well as for Type II Class A (NRA) or Class B (NRB) when operated at the specified luminance level of 15 fL Type I and type II Class B configuration is available by special order. All NVIS Yellow pushbuttons meet the requirements for chromaticity. When operated at full brightness, NVIS Yellow displays meet the sunlight readability requirements as well.

NVIS Red, Incandescent: When operated at the luminance level of 15 fL, NVIS Red meets the requirements for chromaticity. Sunlight readability for this display is achieved at full brightness. NVIS Red does not apply to Class A (625 nm) equipment, therefore NRA it is indicated as "N/A" in [Table XXXII: R Performance of NVGC Light Sources](#).

Multi-chip LED NVIS Green B, Yellow and Red: All multi-chip LED configurations meet chromaticity, and NVIS radiance for both NRA

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and NRB for Type I and Type II as applicable, for each NVIS colors which is available in LED configurations (Green B, Yellow and Red). Sunlight readability does not apply to multi-chip LED-based NVIS displays.

Table XXXII: R Performance of NVGC Light Sources

PARA- METER	INCANDESCENT NVIS LIGHT SOURCE				MULTI-CHIP LED NVIS LIGHT SOURCE			HIGH BRIGHTNESS LED NVIS LIGHT SOURCE					
	Green A	Green B	Yellow	Red	Green B	Yellow	Red	Green A	Green B	Yellow	Red	White	Blue
Chromaticity Color	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	TBD
Type I Class A: Min NR _A Max NR _A	---- PASS	---- PASS	PASS PASS	N/A N/A	---- PASS	---- PASS	N/A N/A	---- PASS	---- PASS	PASS PASS	N/A N/A	PASS	PASS
Class B: Min NR _B Max NR _B	---- PASS	---- PASS	PASS PASS	---- PASS	---- PASS	PASS PASS	---- PASS	---- PASS	---- PASS	PASS PASS	---- PASS	PASS	PASS
Type II Class A: Min NR _A Max NR _A	---- PASS	---- PASS	---- PASS	N/A N/A	---- PASS	---- PASS	N/A N/A	---- PASS	---- PASS	---- PASS	N/A N/A	PASS	PASS
Class B: Min NR _B Max NR _B	---- PASS	---- PASS	---- PASS	---- PASS	---- PASS	---- PASS	---- PASS	---- PASS	---- PASS	---- PASS	---- PASS	PASS	PASS
Sunlight Readability	PASS	PASS	PASS	PASS	----	----	----	PASS	PASS	PASS	PASS	PASS	PASS

NOTES:

1. Status given is as of the release date of this revision of this specification.
2. The dashes (----) mean that neither MIL-L-85762, MIL-STD-3009 set requirements.
3. N/A = Not applicable (NVIS red is not used in systems with Class A goggle applications).
4. PASS = Passes all requirements unconditionally.

4.7. Environmental Requirements

4.7.1. Temperature Range

Classification Symbol 1 per MIL-PRF-22885 is applicable for this requirement. The operating and storage temperature ranges of the Series 90 product line are shown in [Table XXXIII: Temperature Range](#) as follows:

Table XXXIII: Temperature Range

Condition	Celsius
Operating without Lamps Energized	-55 °C to +85 °C
Operating with Lamps Energized	-55 °C to +71 °C

4.7.2. Thermal Shock

There shall be no mechanical or electrical damage, loosening of fastening devices, discoloration or deformation of the faceplate when switches are tested in accordance with MIL-STD-202, Method 107, Test Condition A (-55 °C to +85 °C).

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4.7.3. Vibration

The switches shall meet the requirements of MIL-PRF-22885 vibration grade 3 (10-2,000 Hz) when tested in accordance with MIL-STD-202, Method 204, Test Condition B (15 G peak), and rigidly mounted by their normal means on a rigid metal panel. There shall be no opening of closed contacts or closing of open contacts in excess of 10 microseconds in the switch circuit. No discontinuity more than 10 milliseconds in lamp or LED circuits is allowed. At test conclusion, there shall be no broken, loose, deformed or displaced parts.

4.7.4. Shock

The switches and indicators covered by this document shall meet the shock requirements of MILPRF-22885 Method I, 75 G (MIL-STD-202, Method 213, Condition B) when mounted by their normal mounting means. During the test, there shall be no opening of closed contacts or closing of open contacts more than 10 microseconds. After the test, there shall be no broken, loose, deformed, or displaced parts. No part of the switch shall become displaced from its normal, ready to operate, position during shock testing.

4.7.5. Shock – High Impact

Series 90 switches and indicators shall meet the high-impact shock requirements of MIL-S-901, Grade A, Class II (for deck-mounted equipment) when attached to the anvil plate of the shock machine by means of standard mounting fixture 11-C (MIL-S-901, figure 12) with simulated console, which provides resilient mounting typical of in-service use within "deck-mounted" electronic cabinets or panels. (These units are not recommended for direct "hull mounted" applications.)

4.7.6. Moisture Resistance

All switches shall meet the test requirements of MIL-STD-202, Method 106, with the details and exceptions as specified by MIL-PRF-22885. In the wet condition, the insulation will be not less than 10 megaohms, and after the drying period, the insulation resistance will not be less than 1,000 megaohms. At test conclusion there will be no excessive corrosion, breaking, cracking, spalling or loosening of terminals, and mounting hardware will be readily removable. Excessive corrosion is defined as any corrosive condition which interferes with the electrical or mechanical performance of the switch.

4.7.7. Dip-proof Seal

In accordance with definitions and test procedures of MIL-STD-108, an optional enclosure design Symbol 2 per MIL-PRF-22885 may be provided. This seal is designed such that the equipment behind the panel is protected and the enclosed switch shall operate satisfactorily in the presence of drops of liquid or solid particles falling at angles up to 15 degrees from its normal mounting position. With the switch mounted by its normal means, the switch shall be subjected to the drip-proof test of MIL-STD-108, 15-degree method, with a five-gallon quantity of water flowing over the specimen for a period of five minutes duration. There shall be no leakage of water through the

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panel seal, into the pushbutton, or into the switch, as determined by visual examination and the dielectric test. Drip-proof seal options are ordered for switches using [Table XXXIV: Model 91/98 Switches/Indicator Configuration Table](#) and for pushbuttons using either [Table XXXV: Model 92 Incandescent Pushbutton Configuration Table](#), [Table XXXVI: Model 92 Multi-chip LED Pushbutton Configuration Table](#), or [Table XXXVII: Model 92 High Brightness LED Pushbutton Configuration Table](#).

4.7.8. Splash-proof Seal

In accordance with definitions and test procedures of MIL-STD-108, an optional enclosure design Symbol 4 per MIL-PRF-22885 may be provided. This seal is designed such that the equipment behind the panel is protected and the enclosed switch shall operate satisfactorily in the presence of a coarse spray of liquid or solid particles directed at it or its mounting surface. With the switch mounted by its normal means, the switch shall be subjected to the splash-proof test of MIL-STD-108, with fifteen gallons per minute of water flowing over the specimen for a period of five minutes duration. There shall be no leakage of water through the panel seal, into the pushbutton, or into the switch, as determined by visual examination and the dielectric test. Splash-proof seals are also watertight. They may be ordered as described in paragraphs [5.2.2](#) and [5.2.3](#) of this document.

4.7.9. Watertight Seal

In accordance with definitions and test procedures of MIL-STD-108, an optional enclosure design Symbol 3 per MIL-PRF-22885 may be provided. This seal prevents leakage of water striking or covering the enclosure and the enclosed switch shall operate satisfactorily when temporarily submerged to a depth of three feet. With the switch mounted by its normal means, the switch shall be subjected to the submergence test of MIL-STD-108 to a depth of three feet (1.3 psi) for a period of one-hour duration. The switch shall be operated three times during the test. There shall be no leakage of water through the panel seal, into the pushbutton, or into the switch, as determined by visual examination and the dielectric test. This seal protects against the natural elements such as rain, fog, snow, salt spray, sand and dust. See paragraphs [5.2.2](#) for ordering information on watertight seals.

Additional information and dimensional drawings for this seal (and the seal described in the following paragraph) may be found in the document "Series 90/005 Specification Control Drawing for Series 90 Switches and Pushbuttons with Watertight Seals."

4.7.10. Solvent Resistant Seal

An optional enclosure design feature may be provided in which the seal and legend faceplate are resistant to most petroleum-based fuels, solvents, oils, and greases, in addition to the elements listed under watertight seal. This seal shall pass the splash-proof seal and watertight seal requirements listed above. This seal is the /006 version of the basic Watertight Seal. Ordering information for solvent resistant seals is found in paragraph [5.2.3](#).

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4.7.11. Salt Spray (Corrosion)

Switches are tested in accordance with MIL-STD-202, Method 101, Test Condition A, 96 hours. There shall be no evidence of warping, cracking or excessive corrosion. Excessive corrosion is defined as any corrosive condition which interferes with the electrical or mechanical performance of the switch.

4.7.12. Explosion

Switches are subjected to the Explosive Atmosphere Test in accordance with MIL-STD-202, Method 109. During the test the switches shall be operated at their rated inductive current and maximum rated DC voltage in the specified explosive environment. The switches, including the lamp circuits, shall be checked for electrical and mechanical operation after the test.

4.7.13. Sand and Dust

(Applies to switches equipped with seals for Drip-proof, Splash-proof, Watertight or Solvent Resistant options.) Switches are tested in accordance with MIL-STD-202, Method 110, Condition B and MIL-PRF-22885. There shall be no operating characteristic degradation, and the switches shall be mechanically and electrically operative after the test.

4.7.14. EMI/RFI Shielding

Switches equipped with EMI/RFI shields and when tested for shielding efficiency (in accordance with Paragraph 4.7.33.2 of MIL-PRF-22885), the minimum shielding attenuation shall be in accordance with corresponding slash sheets.

4.8. Material Requirements

Materials and processes shall be as specified herein. Detailed part drawings, bills of material, bills of operation, process specifications and other manufacturing documentation are subordinate to this specification. In case of conflict, this document shall prevail. When a definite material is not specified herein, material or process shall be used which will enable the switches to meet the performance requirements of this specification.

4.8.1. Dissimilar Metals

If dissimilar metals are used in intimate contact with each other, protection shall be provided against electrolysis and corrosion by galvanic action. Refer to Staco Systems Engineering Design Standard on Dissimilar Metals and to MIL-STD-889 for guidance. The products described in this specification shall use compatible couples with air anodic index of 25 or less.

4.8.2. Corrosion Resistance

All metal parts, including current carrying parts, shall be of corrosion-resistant material, or shall be suitably protected to resist corrosion.

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4.8.3. Fungus

Plastic materials used in these products shall pass the fungus test specified in MIL-STD-454, Requirement 4.

4.8.4. Flame Retardant

Materials contained in these products shall be flame retardant.

4.8.5. Non-Toxic

Materials contained in these products shall be non-toxic.

4.8.6. Front Panel Exposure

Parts designed to be exposed at the front of the panel after assembly shall have a black lusterless finish. These include pushbutton housings, panel spacers, pushbutton guards, and other associated mounting hardware designed to be exposed at the front of the panel after assembly.

4.8.7. Finish

Black anodize over aluminum alloy, when used, shall be per MIL-A-8625, Type II, Class 2. Chemical film finishes, when used, shall be per MIL-C-5541, Class 3.

4.8.8. Terminal Plating

Tin-lead plating, when used, shall be per MIL-P-81728. Gold plating, when specified, shall be per MIL-G-45204. Printed circuit board terminals shall be suitably plated to facilitate hand, wave or flow soldering methods. Crimp pin terminals shall be gold plated per MIL-G-45204.

4.8.9. Silicone Rubber

Silicone rubber, when used, shall be in accordance with ZZ-R-765, Rubber, Silicone.

4.8.10. Fluorosilicone Rubber

Fluorosilicone Rubber, when used, shall be in accordance with MIL-R-25988, Rubber, Fluorosilicone Elastomer, Oil and Fuel Resistant.

4.8.11. Tin Plate Finishes

Pure tin plating is prohibited as a final finish and as an undercoat since it may result in tin whisker growth which may adversely affect the operation of electronic equipment systems. Use of tin-lead (Sn-Pb) finishes are acceptable provided that the minimum lead content is 3%.

4.8.12. Cadmium Plate Finishes

Cadmium plating shall not be used on any parts for this product line.

4.8.13. Ozone Depleting Chemicals

Ozone depleting chemicals (ODC's) shall not be used in any products or manufacturing processes used in this product line. [ODC's include chlorofluorocarbons (CFC's), hydrochlorofluorocarbons (HCFC's), methyl chloroform, carbon tetrachloride and halons.]

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4.9. Other Requirements

4.9.1. Marking

4.9.1.1. Identification of Terminals

Lamp and switch terminal numbers shall be identified on header base.

4.9.1.2. Identification of Product

Switches and/or individual packaging shall be permanently and legibly marked per MIL-STD-1285 as follows:

- a. Staco Systems name and (optional) logo
- b. Staco Systems manufacturer's CAGE Code 12522
- c. Part number
- d. Manufacturing date code
- e. Military part number (when applicable)

4.9.1.3. Switch/Indicator Housing

Unless otherwise specified, switch and indicator housings shall be marked as specified above with the switch or indicator part number marked on the housing.

4.9.1.4. Pushbuttons

- a) Incandescent configuration - date code (and slash number if applicable, and/or tab number if specified).
- b) LED configurations - date code and rated voltage (and slash number if applicable, and/or tab number if specified). Multi-chip LED current-sourcing configurations shall have green or straw-colored printed circuit boards; current-sinking shall have blue colored PCBs.
- c) Night vision imaging system (NVIS) type and class as specified in MIL-L-85762 (when applicable).
- d) All pushbuttons shall have the word TOP marked on the same side as the index post as an orientation aid when installing the pushbutton into the switch.
- e) High Brightness LED lighted pushbutton is identified by "H.B.".
- f) High Brightness LED lighted pushbuttons with dimming features are marked as H.B.D.

4.9.1.5. Permanency of Marking

All required markings shall be legible following the test specified in MIL-STD-202, method 215, under the conditions specified in MIL-PRF-22885.

4.9.2. User Instructions

Each overpack containing switches or indicators shall contain a copy of Panel Mounting Instructions (Staco Systems document 88101, sheet 4 only). Each overpack containing Pushbutton Types 8, 9 or 0 (pushbuttons with user replaceable legends) shall contain a copy of the text and figures from the Legend Replacement Procedure, Staco Systems document 88105.

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4.9.3. Workmanship

Products shall be manufactured in such a manner as to be uniform in quality and free from cracked or displaced parts, sharp edges, buns, and other defects which would be detrimental to their serviceability or performance.

4.9.4. Quality

Material and products shall be controlled and inspected per the requirements of MIL-I-45208. The maintenance of the calibration system to control the accuracy of the measuring and test equipment shall be in accordance with MIL-STD-45662, except that the requirement for out of tolerance evaluators is not applicable. Inspection of product for delivery shall consist of Group A inspections per MIL-PRF-22885 and the applicable slash sheet.

4.9.5. Changes in Specification

Specifications defined herein are accurate at the time of release and publication of this revision of this document. Staco Systems reserves the right to make changes without prior notice.

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5.0 Ordering Information

This section contains the information necessary to order each of the standard and optional features of the Series 90 Switch and Indicator configurations described in this specification. The model number (or "coded" part number) of each switch, indicator, pushbutton, or combined assembly, is established by using the configurator charts which follow. [Figure 48: Model 91/98 Switches or Indicators Coding](#), [Table XXXIV: Model 91/98 Switches/Indicator Configuration Table](#), [Figure 49: Model 92 Pushbutton Coding](#), [Table XXXV: Model 92 Incandescent Pushbutton Configuration Table](#), [Table XXXVI: Model 92 Multi-chip LED Pushbutton Configuration Table](#), [Table XXXVII: Model 92 High Brightness LED Pushbutton Configuration Table](#), [Figure 50: Model 93 Switch/Indicator Assembly with Pushbutton Assembly Coding](#), [Table XXXVIII: Model 93 Switch/Indicator and Pushbutton Assembly Configuration Table](#), [Figure 51: Model 99 Switch/Indicator Assembly with Pushbutton Assembly Coding](#), and [Table XXXIX: Model 99 Switch/Indicator and Pushbutton Assembly Configuration Table](#) of this section are used to fill in the appropriate code number in each blank, forming the complete part number.

5.1. Series 90 Coding and Configuration Tables

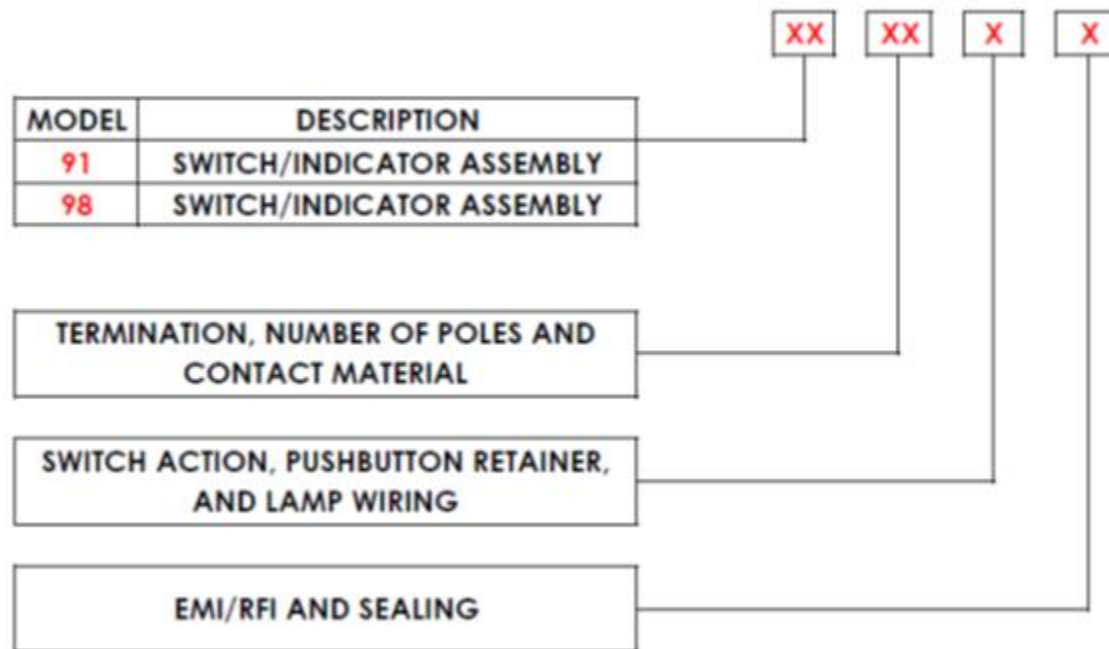


Figure 48: Model 91/98 Switches or Indicators Coding

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Table XXXIV: Model 91/98 Switches/Indicator Configuration Table

MODEL	TERMINATION, NUMBER OF POLES AND CONTACT MATERIAL	SWITCH ACTION, PUSHBUTTON RETAINER, AND LAMP WIRING	EMI/RFI AND SEALING
XX	XX	X	X
91 1/	01 – SOLDER SPDT SILVER	1 – MOMENTARY RETAINER NO BUSSING	1 – INDIVIDUAL PANEL SEAL NON-EMI/RFI
98 2/.	02 – SOLDER DPDT SILVER	2 – ALTERNATE RETAINER NO BUSSING	2 – INDIVIDUAL PANEL SEAL EMI/RFI
	03 – SOLDER SPDT GOLD	3 – MOMENTARY NO RETAINER NO BUSSING	3 – INDIVIDUAL NO PANEL SEAL NON-EMI/RFI
	04 – SOLDER DPDT GOLD	4 – ALTERNATE NO RETAINER NO BUSSING	4 – INDIVIDUAL NO PANEL SEAL EMI/RFI
	05 – SOLDER INDICATOR	5 – INDICATOR RETAINER NO BUSSING	5 – MATRIX PANEL SEAL NON-EMI/RFI 6/.
	06 – PCB SPDT SILVER	6 – INDICATOR NO RETAINER NO BUSSING	6 – MATRIX PANEL SEAL EMI/RFI 6/.
	07 – PCB DPDT SILVER	7 – MOMENTARY RETAINER SINGLE BUSSING 5/.	7 – MATRIX NO PANEL SEAL NON-EMI/RFI 6/.
	08 – PCB SPDT GOLD	8 – ALTERNATE RETAINER SINGLE BUSSING 5/.	8 – MATRIX NO PANEL SEAL EMI/RFI 6/.
	09 – PCB DPDT GOLD	9 – MOMENTARY NO RETAINER SINGLE BUSSING 5/.	
	10 – PCB INDICATOR	0 – ALTERNATE NO RETAINER SINGLE BUSSING 5/.	
	16 – CRIMP PIN (LONG) SPDT SILVER 3/.	A – INDICATOR RETAINER SINGLE BUSSING 5/.	
	17 – CRIMP PIN (LONG) DPDT SILVER 3/.	B – INDICATOR NO RETAINER SINGLE BUSSING 5/.	
	18 – CRIMP PIN (LONG) SPDT GOLD 3/.	C – MOMENTARY RETAINER HORIZONTAL BUSSING 5/.	
	19 – CRIMP PIN (LONG) DPDT GOLD 3/.	D – ALTERNATE RETAINER HORIZONTAL BUSSING 5/.	
	20 – CRIMP PIN (LONG) INDICATOR 3/.	E – MOMENTARY NO RETAINER HORIZONTAL BUSSING 5/.	
	21 – CRIMP PIN (SHORT) SPDT SILVER 4/.	F – ALTERNATE NO RETAINER HORIZONTAL BUSSING 5/.	
	22 – CRIMP PIN (SHORT) DPDT SILVER 4/.	G – INDICATOR RETAINER HORIZONTAL BUSSING 5/.	
	23 – CRIMP PIN (SHORT) SPDT GOLD 4/.	H – INDICATOR NO RETAINER HORIZONTAL BUSSING 5/.	
	24 – CRIMP PIN (SHORT) DPDT GOLD 4/.	I – MOMENTARY RETAINER 3-WAY BOTTOM BUSSING 5/.	
	25 – CRIMP PIN (SHORT) INDICATOR 4/.	J – ALTERNATE RETAINER 3-WAY BOTTOM BUSSING 5/.	
		K – MOMENTARY NO RETAINER 3-WAY BOTTOM BUSSING 5/.	
		L – ALTERNATE NO RETAINER 3-WAY BOTTOM BUSSING 5/.	
		M – INDICATOR RETAINER 3-WAY BOTTOM BUSSING 5/.	
		N – INDICATOR NO RETAINER 3-WAY BOTTOM BUSSING 5/.	
		O – MOMENTARY RETAINER 3-WAY TOP BUSSING 5/.	
		P – ALTERNATE RETAINER 3-WAY TOP BUSSING 5/.	
		Q – MOMENTARY NO RETAINER 3-WAY TOP BUSSING 5/.	
		R – ALTERNATE NO RETAINER 3-WAY TOP BUSSING 5/.	
		S – INDICATOR RETAINER 3-WAY TOP BUSSING 5/.	
		T – INDICATOR NO RETAINER 3-WAY TOP BUSSING 5/.	
		U – MOMENTARY RETAINER VERTICAL BUSSING 5/.	
		V – ALTERNATE RETAINER VERTICAL BUSSING 5/.	
		W – MOMENTARY NO RETAINER VERTICAL BUSSING 5/.	
		X – ALTERNATE NO RETAINER VERTICAL BUSSING 5/.	
		Y – INDICATOR RETAINER VERTICAL BUSSING 5/.	
		Z – INDICATOR NO RETAINER VERTICAL BUSSING 5/.	

NOTES:

- 1/. Model 91, short housing, available in solder and PCB termination. Crimp available for 94, 95, 96 & 97 coded matrix frame assembly.
- 2/. Model 98, long housing available in crimp termination only.
- 3/. Used with Model 98 Switch Base or Model 99 Switch Assembly, and Series 95 or 97 Matrix Assemblies (long) requiring MIL-C-39029/16-168 Crimp Pin Receptacles.
- 4/. Used with Model 98 Switch Base or Model 99 Switch Assembly, and Series 95 or 97 Matrix Assemblies (short) requiring MIL-C-39029/22-192 Crimp Pin Receptacles.
- 5/. Common bus configuration applies only to incandescent lamp-based switch and indicator. See [Table VII: Bussing Circuit Diagram](#) for electrical connection diagrams.
- 6/. For mounting requirements, see Series 94, 95, 96 & 97 coded matrix frame assembly.

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Table XXXV: Model 92 Incandescent Pushbutton Configuration Table

SERIES	LAMP GROUND AND EMI OPTION	DISPLAY STYLE	CHARACTER DEFINITION	LAMP SELECTION & SEAL	DISPLAY TYPE						COLOR		
XX	X	X	X	XX	X						XXXX		
92 - Series 90 Pushbutton	1 - Single Common, Non-EMI	1 - Full	0 - NONE	00 - Fiberboard, seal	CODE	FILTER	NON-ILLUMINATED		ILLUMINATED		CODE	STD	NVIS
	2 - Vert split, Non-EMI	2 - 2-Way horiz split	1 - 0.072 inch	01 - 3071 (5VDC), seal			LEGEND	BACKGROUND	LEGEND	BACKGROUND			
	3 - Horiz split, Non-EMI	3 - 2-Way vert split	2 - 0.087 inch	02 - 718 (5VDC), seal	1	STD	Black	Translucent color	Black	Color	0	White	---
	4 - Single common, EMI/RFI	4 - 3-Way horiz top	3 - 0.100 inch	04 - 3335 (28VDC), seal	2	STD	Hidden black	Black	Black	Visible in color	1	Red	Red
	5 - Vert split, EMI/RFI	5 - 4-Way	4 - 0.125 inch	05 - 3042 (6VDC), seal	3	STD	Hidden	Black	Visible in color	Black	2	Green	Green B
	6 - Horiz split, EMI/RFI	6 - 3-Way vert left	5 - 0.145 inch	06 - 1099 (12VDC), seal	4	STD	Translucent white	Black	Visible in color	Black	3	Aviation yellow	Yellow B
		7 - 3-Way horiz bottom		07 - 3229 (14VDC), seal	5	STD	Black	Translucent white	Black	Color	4	Lunar white	---
		8 - 3-Way vert right		08 - 6839 (28VDC), seal	6	STD	Hidden	Black	Visible in color	Black	5	Lemon yellow	Yellow A
				09 - Dummy plug, seal	7	NVIS	Hidden	Black	Visible in color	Black	6	Blue	Green A
				10 - Fiberboard, seal	8	STD	Hidden black	Black	Black	Visible in color	7	Aviation green	
				11 - 3071 (5VDC), seal	9	STD	Black	Translucent white	Black	Color			
				12 - 718 (5VDC), seal	0	STD	Hidden	Black	Visible in color	Black			
				14 - 3335 (28VDC), seal									
				15 - 3042 (6VDC), seal									
				16 - 1099 (12VDC), seal									
				17 - 3229 (14VDC), seal									
				18 - 6839 (28VDC), seal									
				19 - Dummy plug, seal									

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Table XXXVI: Model 92 Multi-chip LED Pushbutton Configuration Table

SERIES	LAMP GROUND AND EMI OPTION	DISPLAY STYLE	CHARACTER DEFINITION	LAMP SELECTION & SEAL	DISPLAY TYPE						COLOR		
XX	X	X	X	XX	X						XXXX		
92 - Series 90 Pushbutton	7 - Multi-Chip LED, common, EMI/RFI, Sourcing	1 - Full	0 - None	31 - Sourcing, seal, full or 2-way, 5 VDC	CODE	FILTER	NON-ILLUMINATED		ILUMINATED		CODE	STD	NVIS
	8 - Multi-Chip LED, common, EMI/RFI, Sinking	2 - 2-Way horiz split	1 - 0.072 inch	32 - Sourcing, seal, full or 2-way, 28 VDC			LEGEND	BACKGROUND	LEGEND	BACKGROUND			
	9 - Multi-Chip LED, split, EMI/RFI, Sourcing	3 - 2-Way vert split	2 - 0.087 inch	33 - Sourcing, seal, 3-way, 5 VDC	1	---	---	---	---	---	0	---	---
	0 - Multi-Chip LED, split, EMI/RFI, Sinking	4 - 3-Way horiz top	3 - 0.100 inch	34 - Sourcing, seal, 3-way, 28 VDC	2	---	---	---	---	---	1	Red	Red
		5 - 4-Way	4 - 0.125 inch	35 - Sourcing, seal, 4-way, 5 VDC	3	---	---	---	---	---	2	Green	Green B
		6 - 3-Way vert left	5 - 0.145 inch	36 - Sourcing, seal, 4-way, 28 VDC	4	STD	Translucent white	Black	Visible in color	Black	3	Amber yellow	Yellow B
		7 - 3-Way horiz bottom		41 - Sourcing, seal, full or 2-way, 5 VDC	5	STD	Black	Translucent white	Black	Color	4	---	---
		8 - 3-Way vert right		42 - Sourcing, seal, full or 2-way, 28 VDC	6	STD	Hidden	Black	Visible in color	Black	5	---	Yellow A
				43 - Sourcing, seal, 3-way, 5 VDC	7	NVIS	Hidden	Black	Visible in color	Black	6	---	---
				44 - Sourcing, seal, 3-way, 28 VDC	8	---	---	---	---	---	7	Lime Green	---
				45 - Sourcing, seal, 4-way, 5 VDC	9	STD	Black	Translucent white	Black	Color	8	Orange	---
				46 - Sourcing, seal, 4-way, 28 VDC	0	STD	Hidden	Black	Visible in color	Black			
				51 - Sinking, seal, full or 2-way, 5 VDC									
				52 - Sinking, seal, full or 2-way, 28 VDC									
				53 - Sinking, seal, 3-way, 5 VDC									
				54 - Sinking, seal, 3-way, 28 VDC									
				55 - Sinking, seal, 4-way, 5 VDC									
				56 - Sinking, seal, 4-way, 28 VDC									
				61 - Sinking, seal, full or 2-way, 5 VDC									
				62 - Sinking, seal, full or 2-way, 28 VDC									
				63 - Sinking, seal, 3-way, 5 VDC									
				64 - Sinking, seal, 3-way, 28 VDC									
				65 - Sinking, seal, 4-way, 5 VDC									
				66 - Sinking, seal, 4-way, 28 VDC									

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Table XXXVII: Model 92 High Brightness LED Pushbutton Configuration Table

SERIES	LAMP GROUND AND EMI OPTION	DISPLAY STYLE	CHARACTER DEFINITION	LAMP SELECTION & SEAL	DISPLAY TYPE						COLOR		
XX	X	X	X	XX	X						XXXX		
92 - Series 90 Pushbutton	A - HB LED, common ground, EMI/RFI, Sourcing	1 - Full	0 - NONE	31 - Sourcing, seal, full or 2-way, 5 VDC	CODE	FILTER	NON-ILLUMINATED		ILLUMINATED		CODE	STD	NVIS
	B - HB LED, common ground, EMI/RFI, Sinking	2 - 2-Way horiz split	1 - 0.072 inch	32 - Sourcing, seal, full or 2-way, 28 VDC			LEGEND	BACKGROUND	LEGEND	BACKGROUND			
	C - HB LED, split ground, EMI/RFI, Sourcing	3 - 2-Way vert split	2 - 0.087 inch	33 - Sourcing, seal, 3-way, 5 VDC	1	STD	Black	Translucent color	Black	Color	0	White	Blue
	D - HB LED, split ground, EMI/RFI, Sinking	4 - 3-Way horiz top	3 - 0.100 inch	34 - Sourcing, seal, 3-way, 28 VDC	2	---	---	---	---	---	1	Red	Red
	E - HB LED/voltage dimming, common ground, EMI/RFI, Sourcing	5 - 4-Way	4 - 0.125 inch	35 - Sourcing, seal, 4-way, 5 VDC	3	---	---	---	---	---	2	Green	Green B
	F - HB LED/voltage dimming, common ground, EMI/RFI, Sinking	6 - 3-Way vert left	5 - 0.145 inch	36 - Sourcing, seal, 4-way, 28 VDC	4	STD	Translucent white	Black	Visible in color	Black	3	Aviation Yellow	Yellow B
	G - HB LED/voltage dimming, split ground, EMI/RFI, Sourcing	7 - 3-Way horiz bottom		41 - Sourcing, seal, full or 2-way, 5 VDC	5	STD	Black	Translucent white	Black	Color	4	---	White
	H - HB LED/voltage dimming, split ground, EMI/RFI, Sinking	8 - 3-Way vert right		42 - Sourcing, seal, full or 2-way, 28 VDC	6	STD	Hidden	Black	Visible in color	Black	5	Lemon Yellow	Yellow A
				43 - Sourcing, seal, 3-way, 5 VDC	7	NVIS	Hidden	Black	Visible in color	Black	6	Blue	Green A
				44 - Sourcing, seal, 3-way, 28 VDC	8	---	---	---	---	---	7	---	---
				45 - Sourcing, seal, 4-way, 5 VDC	9	---	---	---	---	---	8	---	---
				46 - Sourcing, seal, 4-way, 28 VDC	0	STD	Hidden	Black	Visible in color	Black			
				51 - Sinking, seal, full or 2-way, 5 VDC									
				52 - Sinking, seal, full or 2-way, 28 VDC									
				53 - Sinking, seal, 3-way, 5 VDC									
				54 - Sinking, seal, 3-way, 28 VDC									
				55 - Sinking, seal, 4-way, 5 VDC									
				56 - Sinking, seal, 4-way, 28 VDC									
				61 - Sinking, seal, full or 2-way, 5 VDC									
				62 - Sinking, seal, full or 2-way, 28 VDC									
				63 - Sinking, seal, 3-way, 5 VDC									
				64 - Sinking, seal, 3-way, 28 VDC									
				65 - Sinking, seal, 4-way, 5 VDC									
				66 - Sinking, seal, 4-way, 28 VDC									

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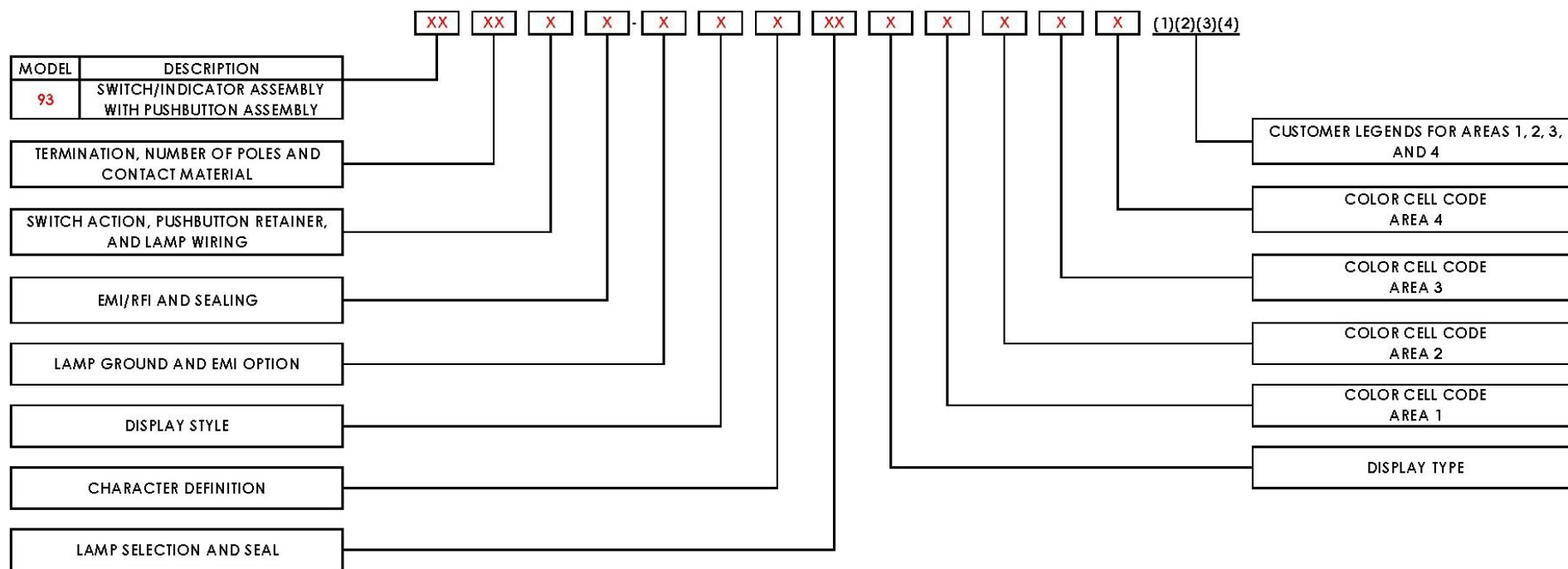


Figure 50: Model 93 Switch/Indicator Assembly with Pushbutton Assembly Coding

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Table XXXVIII: Model 93 Switch/Indicator and Pushbutton Assembly Configuration Table

SWITCH/INDICATOR PN: 91 XX X X

PART NUMBER
PLACEMENT CODE: 91 AB C D

PLACEMENT CODES
RELEATED TO SWITCH
CONFIGURATION

SWITCH/INDICATOR
AND PUSHBUTTON
ASSEMBLY CODING:

93 AB C D - E F G HI J K L M N

PLACEMENT CODE RELEATED TO
PUSHBUTTON CONFIGURATION

PART NUMBER
PLACEMENT CODE:

92 E F G HI J K L M N

PUSHBUTTON PN:

92 X X X XX X X X X X

[Table XXXIV: Model 91/98 Switches/Indicator Configuration Table](#)

[Table XXXVI: Model 92 Multi-chip LED Pushbutton Configuration Table](#)

[Table XXXVII: Model 92 High Brightness LED Pushbutton Configuration Table](#)

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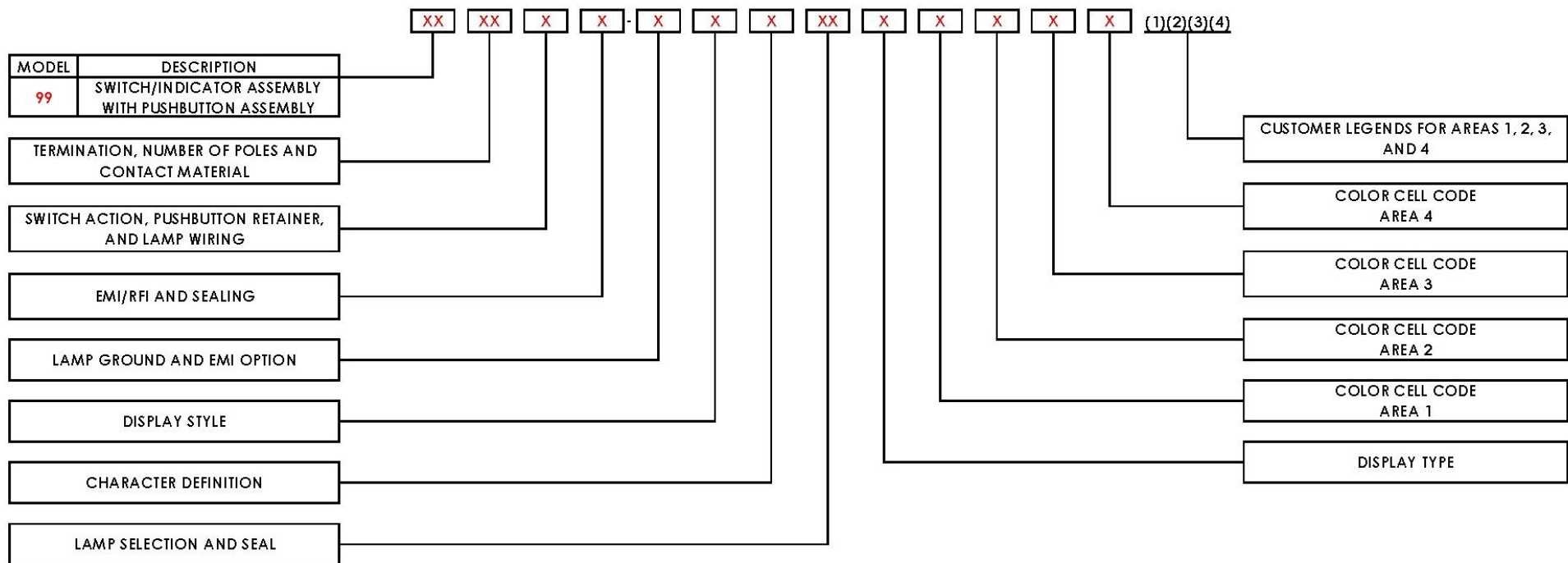
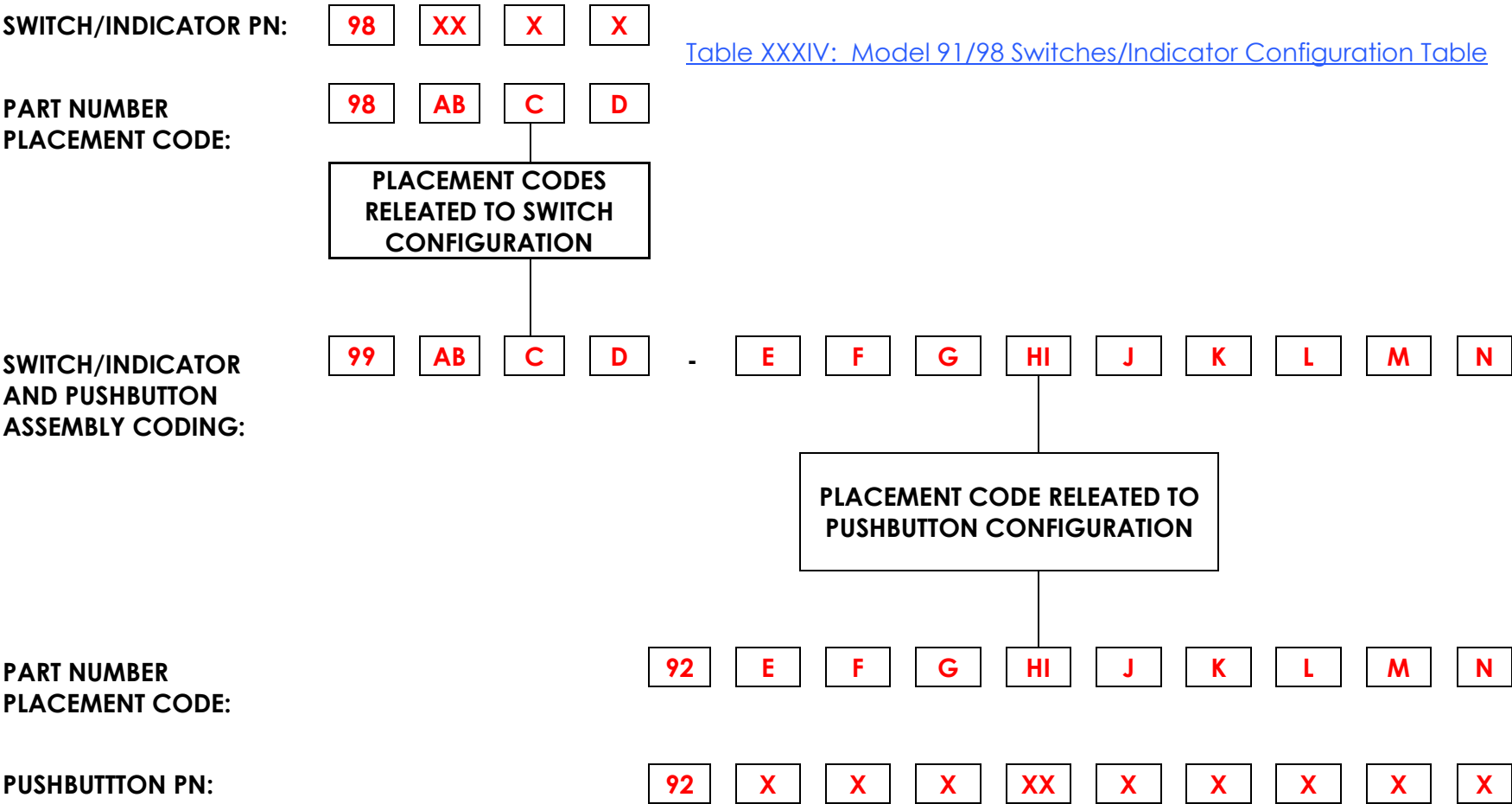


Figure 51: Model 99 Switch/Indicator Assembly with Pushbutton Assembly Coding

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Table XXXIX: Model 99 Switch/Indicator and Pushbutton Assembly Configuration Table



[Table XXXIV: Model 91/98 Switches/Indicator Configuration Table](#)

[Table XXXVI: Model 92 Multi-chip LED Pushbutton Configuration Table](#)

[Table XXXVII: Model 92 High Brightness LED Pushbutton Configuration Table](#)

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5.2. Seals

5.2.1. Panel Seals (15097)

Series 90 switch/indicators may be ordered as sealed units with the panel seal installed on the switch/indicator housing. (Refer to [Figure 13: Model 93 Switch – Exploded View](#) and [Figure 18: Model 99 Switch – Long housing shown](#)) The panel seal also may be ordered separately, packaged as 10 in a plastic envelope, for replacement parts or for field upgrade of the switch/indicator. To order panel seals specify Part Number 15097.

NOTE: In order to attain drip-proof sealing for the unit, a pushbutton seal is required in addition to the panel seal. This must be factory installed and a fine coating of a special lubricant applied to the throat of the switch housing.

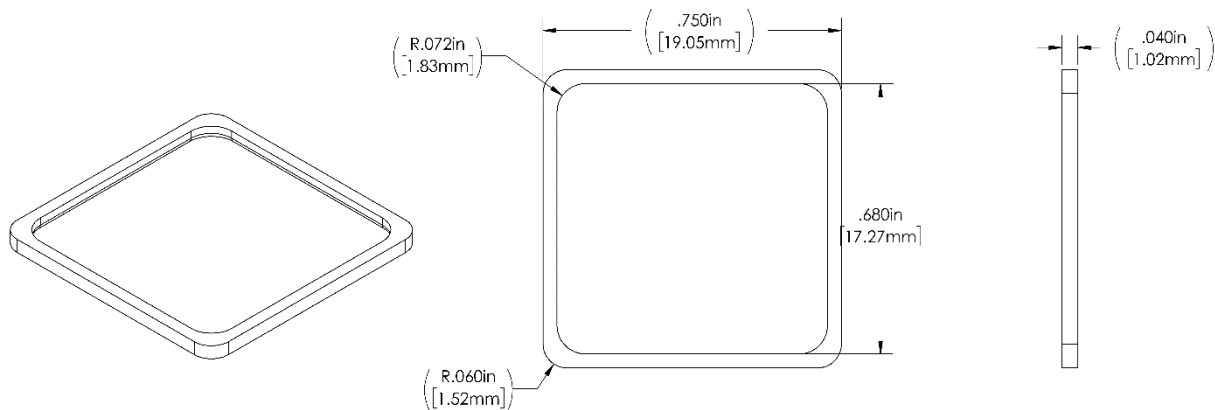


Figure 52: Panel Seal

5.2.2. Watertight Seals (/005)

A flexible elastomeric boot, which is an integral part of the pushbutton and, together with special parts on the switch housing, acts to provide splash-proof and watertight protection to a switch/indicator and also to the areas behind the panel. (See [Figure 36: Watertight Seal](#) for a drawing and refer to Series 90/005 SCD for detailed specifications and installation instructions.) The minimum panel separation for switches with immersion seals (but without pushbutton guards) is 1.06" (26.9 mm).

The part numbering system for ordering Series 90 switches and pushbuttons with watertight seals is to use the standard part numbering system with a /005 at the end to designate parts with the watertight seal included. In the following part numbers, the X's represent the digits of the coded part number for a similar assembly without this seal option.

Switch/Indicator Assembly	91XXXX/005
Pushbutton Assembly	98XXXX/005
Switch/Indicator Assembly	92XXXXXXXXXX/005
Switch/Indicator Assembly w/Pushbutton	93XXXXXXXXXXXX/005
Switch/Indicator Assembly w/Pushbutton	99XXXXXXXXXXXX/005

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Text for legends, when applicable, follows the /005. An example, using the Model 99 example of Section 5.5 with watertight seal would be:

992441-8156257777/005 (MULTI;CHIP).

NOTE: Switches, indicators and pushbuttons cannot be reworked in the field to retrofit existing equipment with the Watertight Seal. All applications requiring the use of the Watertight Seal must use factory supplied and assembled hardware.

A switch/indicator service kit is offered which contains ten sets of panel seals and retainers. This kit, PN: 15196/005, can be used to replace damaged or misplaced parts.

Matrix assemblies utilizing Series 90 switches cannot make use of this watertight Seal. Customer replaceable legends (Display Types 8 and 9) are not available with watertight seals.

5.2.3. Solvent Resistant Seals (/006)

Applicable installations requiring resistance to most petroleum-based fuels, solvents, oils and greases (as well as being splash-proof and watertight) the /006 version of the basic Watertight seal may be specified. The same restrictions apply and the same numbering system is used, except the /005 is replaced with a /006. Available in Display Types 1 through 7. Type 6 is dead-front, but SLR contrast ratios do not apply.

5.3. Accessories

Accessories are available for the Series 90 Product Line (both individual mount and matrix mount configurations) include the following:

5.3.1. Pushbutton Guard, General Purpose (15089)

Transparent cover must be lifted to allow actuation of the switch. It prevents any accidental operation of the switch. Spring loaded pushbutton guard cover remains closed until manually lifted; returns to closed position when released. Guard simply slips over the switch housing assembly at time of installation. (Refer to [Figure 38: Standard Pushbutton Guard for Drip-proof Sealed Assemblies](#) for dimensions.) Minimum center to center spacing is .871" (22.1 mm). To order, specify Part Number 15089.

Other variations include 15089-1 which has a red translucent cover, and the 15250-TAB which may be secured with a safety wire through .060" holes at bottom of corner guard.

5.3.2. Pushbutton Guard, Watertight Seal (15204/TAB)

This pushbutton guard is used with watertight/splash-proof seal applications. Transparent cover is lifted to allow access to pushbutton for switch actuation; will stay in open position until manually returned to its closed position. (Refer to [Figure 37: Pushbutton Guard for Watertight Sealed Assembly](#) for dimensions.) Center to center spacing for adjacent covers is 1.40" (35.6 mm).

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To order specify Part Number 15204/005 for use with basic Watertight Seals. Applications requiring Solvent Resistant Seals should order Part Number 15204/006.

5.3.3. Color Filter Caps (15194-TAB)

The following is intended for use in Model 92 Pushbuttons with incandescent T-1 Flange Based Lamps. These color filter caps allow changing of pushbutton cell area colors without the use of tools. It applies to legend types 2, 3, 4, 5, 8 and 9. (Refer to [Figure 40: Color Filter Caps](#) for size and shape.) These color filter caps are available in kits containing 25 pieces of a given color. To order, use part number code as follows:

Table XL: Color Filter Caps

PART NUMBER	COLOR
15194-0	Clear (Transparent) White
15194-1	Red
15194-2	Green
15194-3	Aviation Yellow
15194-4	Lunar White
15194-5	Lemon Yellow
15194-6	Blue
15194-7	Aviation Green

5.3.4. Pushbutton Retainer Tie (15093)

When Model 93 or Model 99 switch and pushbutton assemblies are ordered as "retained" configurations, these parts are included in the assembly. (Refer to Figures 2 and 3. As a separate part, it is shown in [Figure 39: Pushbutton Retainer Tie](#).) Their purpose is to secure the pushbutton to the switch during re-lamping to avoid possible mix-ups. Replacement of retainer ties for incandescent-based pushbuttons may be accomplished in the field. However, field replacement of retainer ties in LED-based pushbuttons is not recommended. Additional parts may be ordered by specifying Part Number 15093.

5.3.5. Dummy Lamp (15091)

The dummy lamp is designed as a substitute for the T-1 flange based incandescent lamp. When less than four lamps are used, the dummy lamp is required to prevent a short circuit condition and to maintain a uniform actuation force. (Refer to [Figure 41: Dummy Lamp](#)) To order, specify Part Number 15091.

5.3.6. Pushbutton Extraction Tool (15193)

Facilitates the removal of display pushbuttons, particularly when installed in multi-station matrix assemblies. (Refer to [Figure 53: Pushbutton Extraction Tool](#)) To order, specify Part Number 15193.

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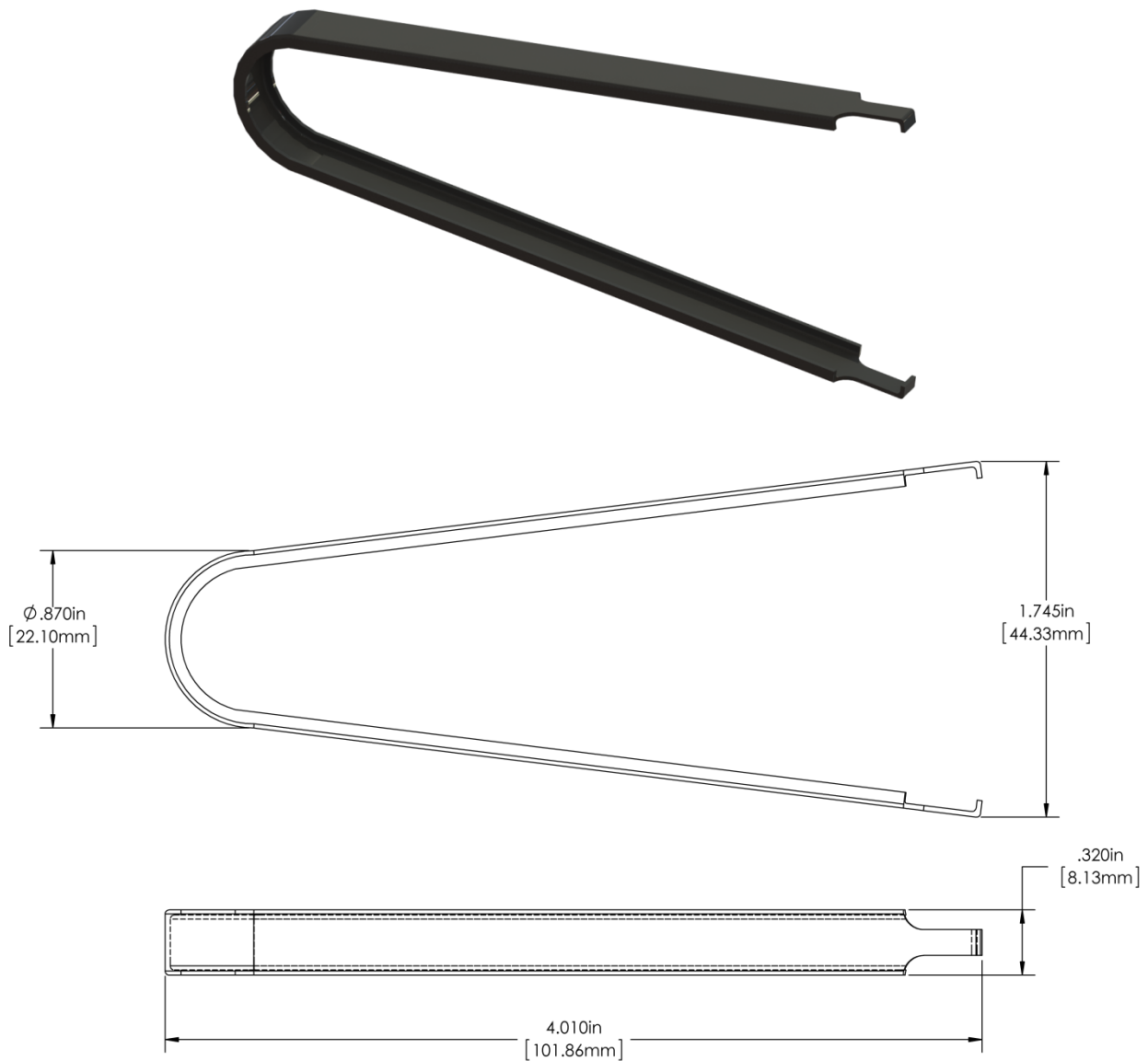


Figure 53: Pushbutton Extraction Tool

5.3.7. Crimp Pin Wire Termination Receptacles – Individual Mount (15197 and 15273)

The Model 98 Switch/Indicator Assembly and the Model 99 Switch/Indicator with Display Pushbutton are supplied with crimp pin wire termination receptacles installed. (Refer to [Figure 19: MIL-C-39029/16-168 Receptacle Assy - Used in 9816-9820 models](#) and [Figure 20: MIL-C-39029/22-192 Receptacle Assy - Used in 9821 models](#)). Two types of individual mount crimp pin wire termination receptacles are available. Part Number 15197 is designed for MIL-C-39029/16-168 socket contact wire termination crimp pins, and Part Number 15273 is designed for MIL-C-39029/22-192 socket contact wire termination crimp pins. Additional receptacles may be ordered separately as replacement parts or for use with Model 98 coded /010 switches without receptacles included.

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5.3.8. Crimp Pin Wire Termination Receptacles – Matrix Mount (15096 and 15280)
Model 95 or 97 Series 90 Matrix Housings are supplied with crimp pin wire termination receptacles installed. (Refer to the Matrix Frame Assembly Specification, Series 94 through 97 Coded.) Two types of matrix mount crimp pin wire termination receptacles are available. Part Number 15096 is designed for MIL-C-39029/16-168 socket contact wire termination crimp pins, and Part Number 15280 is designed for MIL-C-39029/22-192 socket contact wire termination crimp pins. Additional receptacles may be ordered separately as replacement parts.

5.3.9. Socket Contact Wire Termination Crimp Pins (15095 and 15276)
Two types of socket contact wire termination crimp pins are available. Part Number 15095 is per MIL-C-39029/16-168, and Part Number 15276 is per MIL-C-39029/22-192. The military standard part number of the 15095 is M39029/16-168, and the military standard part number of the 15276 is M39029/22-192. These are standard crimp pins, for #20-24 wires for Models 98 or Model 99 individual mount switch/indicator units or for Models 95 or 97 Matrix Housings. (See [Figure 32: MIL-C-39029/16-168 Socket Contact Wire Termination Crimp Type](#) and [Figure 33: MIL-C-39029/22-192 Socket Contact Wire Termination Crimp Type](#)) Crimp pins are ordered separately, in the quantity desired.

5.3.10. Crimping Pin Tools and Positioners (15191, 15278, 15192 and 15279)
Two types of crimp pin tool and positioner are available. Part Number 15191 and 15192 are to be used with MIL-C-39029/16-168 socket contact wire termination crimp pins. Part Number 15278 and 15279 are to be used with MIL-C-39029/22-192 socket contact wire termination crimp pins. The following table shows Staco Systems part number and the corresponding military standard part number.

Table XLI: Crimping Pin Tool and Positioner Part Numbers

Part Number	Standard Military Part Number
15191	M22520/2-01
15192	M22520/2-14
15278	M22520/7-01
15279	M22520/7-12

Crimping Tool and Turret are used for attaching socket contact crimp to #20-24 wires for Models 98 or Model 99 individual mount switch/indicator units or for Models 95 or 97 Matrix Housings.

(Refer [Figure 54: Crimping Pin Tools and Positioner](#)) Each part number must be ordered separately.

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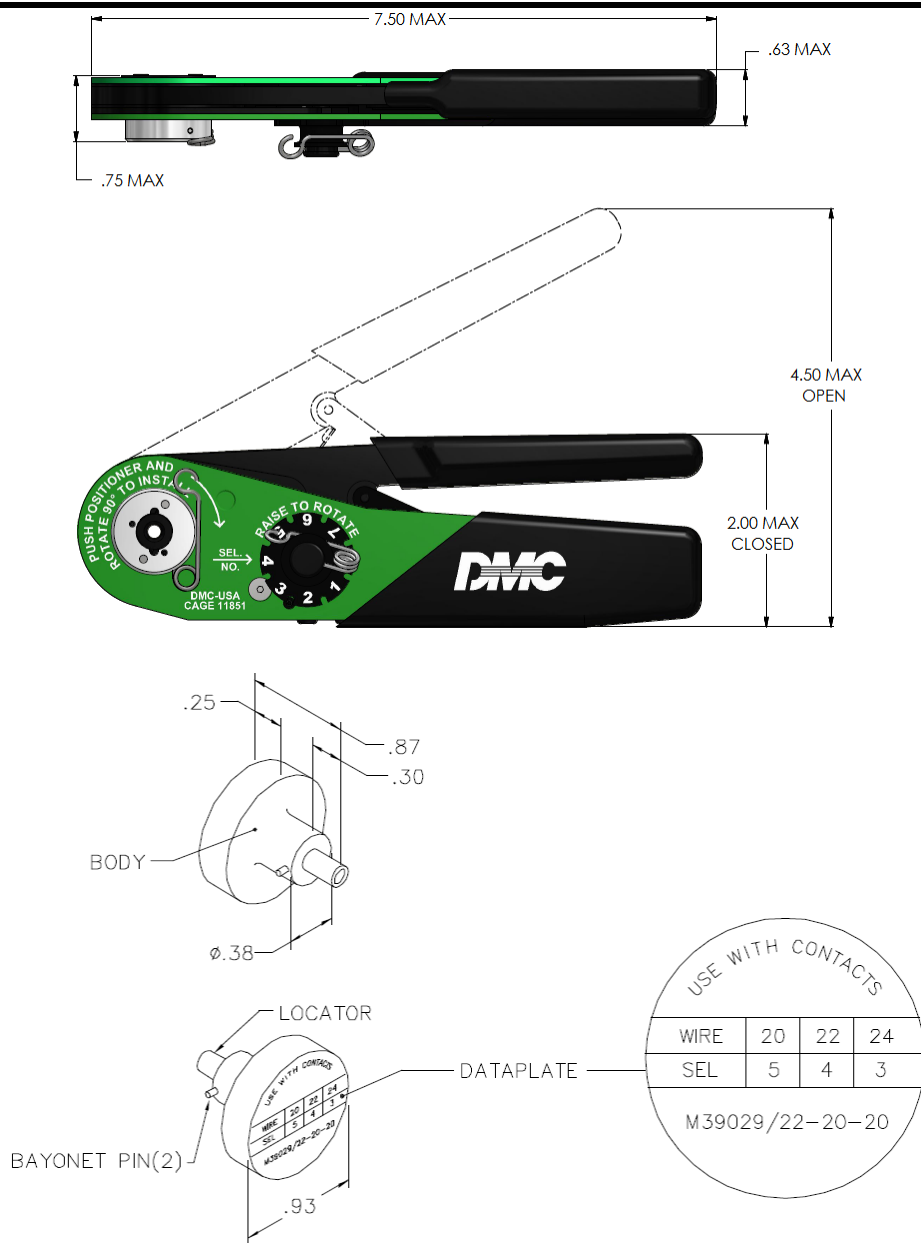


Figure 54: Crimping Pin Tools and Positioner

5.3.11. Insulator Plug (15177)

Unused terminal openings in termination receptacles of Models 98 and 99 individual mount switches or Model 95 and 97 Matrix Housing can be closed off by inserting standard MS27488- A20 plastic insulator plugs. (Refer [Figure 55: Insulator Plug](#)) The insulator plugs can be used with MIL-C-39029/16-168 and MIL-C-39029/22-192 receptacles. To order, specify Part Number 15177.

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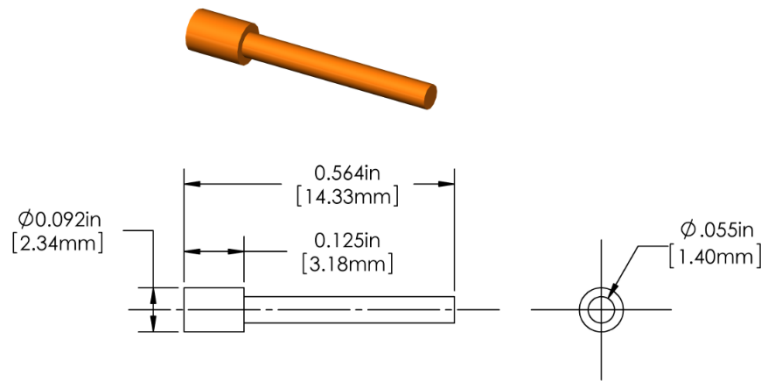


Figure 55: Insulator Plug

5.3.12. Dress Bezel Mounting Cleat Assembly (15098)

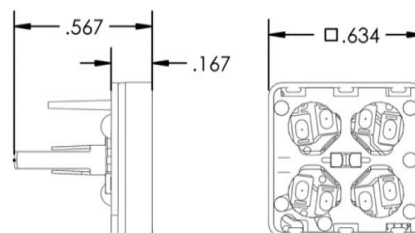
The mounting cleat assemblies, required for installing Models 96 or 97 Series 90 Matrix Housings, are supplied as standard parts with the front mounting dress bezel housing. The quantity will depend on the size of the housing. (Refer to the Matrix Frame Assembly SCD, Series 94 through 97 Coded.) Additional cleat assemblies may be ordered, if desired, for applications of severe vibration or shock. They are packaged 5 to a plastic envelope. To order, specify Part Number 15098.

5.3.13. Digital Dimming Module (DDM111 and DDM111A)

The DDM111 and DDM111A are a solid state dimmer which is highly recommended for the brightness control of multi-chip LED-lighted pushbutton switches and indicators. It may also be used for incandescent lighting. The DDM111 or DDM111A provides up to 15 levels of brightness control with a range of .025% to 100% of rated brightness. The level of brightness may be set by a 4-bit parallel input such as from a digital switch or an electronic device. Alternately, an internal counter allows display brightness to be controlled by "up/down" command lines from a three-position toggle switch or an electronic controller. Other commands include "full brightness over-ride" and "blanking override." One DDM111 or DDM111A controls up to 10 amps of lamp current.

5.3.14. Light Source Assemblies (15290-TAB thru 15331-TAB)

The following is intended for use in Model 92 Pushbuttons with High Brightness LED. These light source assemblies allow the user to replace the pushbutton light source assemblies without the use of tools. Refer to the following figure for size and shape.



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Figure 56: Light Source Assemblies

To order, use the following part number

Table XLII: 5 Volt Light Source Assembly Part Numbers

Display Style		Part Number			
		Common Circuit		Split Circuit	
Code	Description	Sourcing	Sinking	Sourcing	Sinking
1	Full Screen	15306-001	15307-001	15306-002	15307-002
2	Horizontal Split Screen				
3	Vertical Split Screen	15308-001	15309-001	15308-002	15309-002
4	3 Way Split Screen (Horizontal Top Half)	15310-001	15311-001	15310-002	15311-002
5	4 Way Split Screen	15304-001	15305-001	15304-002	15305-002
6	3 Way Split Screen (Vertical Left Half)	15314-001	15315-001	15314-002	15315-002
7	3 Way Split Screen (Horizontal Bottom Half)	15312-001	15313-001	15312-002	15313-002
8	3 Way Split Screen (Vertical Right Half)	15316-001	15317-001	15316-002	15317-002

Table XLIII: 28 Volt Light Source Assembly Part Numbers

Display Style		Part Number			
		Common Circuit		Split Circuit	
Code	Description	Sourcing	Sinking	Sourcing	Sinking
1	Full Screen	15292-001	15293-001	15292-002	15293-002
2	Horizontal Split Screen				
3	Vertical Split Screen	15294-001	15295-001	15294-002	15295-002
4	3 Way Split Screen (Horizontal Top Half)	15296-001	15297-001	15296-002	15297-002
5	4 Way Split Screen	15290-001	15291-001	15290-002	15291-002
6	3 Way Split Screen (Vertical Left Half)	15300-001	15301-001	15300-002	15301-002
7	3 Way Split Screen (Horizontal Bottom Half)	15298-001	15299-001	15298-002	15299-002
8	3 Way Split Screen (Vertical Right Half)	15302-001	15303-001	15302-002	15303-002

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Table XLIV: 28 Volt with Voltage Dimming Light Source Assembly Part Numbers

Display Style		Part Number			
		Common Circuit		Split Circuit	
Code	Description	Sourcing	Sinking	Sourcing	Sinking
1	Full Screen	15320-001	15321-001	15320-002	15321-002
2	Horizontal Split Screen				
3	Vertical Split Screen	15322-001	15323-001	15322-002	15323-002
4	3 Way Split Screen (Horizontal Top Half)	15324-001	15325-001	15324-002	15325-002
5	4 Way Split Screen	15318-001	15319-001	15318-002	15319-002
6	3 Way Split Screen (Vertical Left Half)	15328-001	15329-001	15328-002	15329-002
7	3 Way Split Screen (Horizontal Bottom Half)	15326-001	15327-001	15326-002	15327-002
8	3 Way Split Screen (Vertical Right Half)	15330-001	15331-001	15330-002	15331-002

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6.0 Technical Bulletins

Table XLV: Technical Bulletins

Technical Bulletin Number	Description
TB-12-A-27	SHORT CIRCUIT PREVENTION - LAMP CIRCUITS
TB-12-A-28A	CAPTIVE PUSHBUTTON, INSTALLATION OF TIE RETAINER P/N 15093
TB-12-A-29	PROCEDURE, LEGEND REPLACEMENT, SERIES 92 PUSHBUTTON
TB-12-A-29A	LEGEND REPLACEMENT PROCEDURE APPLICABLE TO SERIES 92 FACEPLATE TYPES 8, 9,
TB-12-A-30	INSTALLATION AND REMOVAL TOOLS AND PROCEDURES SERIES 90
TB-12-A-32	CAPTIVE PUSHBUTTON, INCANDESCENT, SERIES 90, INSTALLATION OF TIE PUSHBUTTON
TB-12-A-33	CAPTIVE PUSHBUTTON, LED LIGHTED, SERIES 90, INSTALLATION OF TIE PUSHBUTTON
TB-12-A-34	CLEANING INSTRUCTIONS FRO LIGHTED PUSHBUTTONS DISPLAYS WITH ANTI-REFLECTIVE
TB-12-A-35B	WATERTIGHT SEAL LUBRICATION
TB-146	RECEPTACLE ASSEMBLY INSTALLATION PROCEDURE
TB-147	INSTALLATION PROCEDURE WATERTIGHT SEAL FIELD RETROFIT KT P/N 15238
TB-148	INSTALLATION PROCEDURE FOR CRIMP CONTACT TERMINATED WIRING SYSTEMS
TB-152	PUSHBUTTON CONTACTS CLEANING SERIES 90
TB-158	SOLDERING INSTRUCTIONS FOR SWITCH TERMINALS
TB-167	SERIES 90/100 PUSHBUTTON REMOVAL AND INCANDESCENT LAMP REMOVAL
TB-205	INSTALLATION PROCEDURE FOR SWITCHES USING WATERTIGHT METAL GUARDS
TB-206	INSTALLATION PROCEDURE FOR PUSHBUTTON SWITCH ASSEMBLY
TB-207	INSTALLATION PROCEDURE FOR CRIMP PIN RECEPTACLE ASSEMBLY
TB-212	PUSHBUTTON SEAL REPLACEMENT FOR S90/S100
TB-217	SOLDERING PROCEDURE FOR SERIES 90 / 100 SWITCH / INDICATOR ASSEMBLY
TB-218	IN-FIELD REPAIR PROCEDURE FOR 92P0367-TAB

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