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STACO SWITCH

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APPROVED		3/24/05
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CAGE CODE: **12522**

PRODUCT SPECIFICATION

SERIES 90

Lighted Pushbutton Switches and Indicators

MODEL 91, 92, 93, 98 AND 99 (CODED)
SWITCHES, INDICATORS, AND PUSHBUTTONS

MATRIX OR INDIVIDUALLY MOUNTED, CRIMP-PIN, PCB MOUNT OR SOLDER TERMINATED, ILLUMINATED, 4 LAMP OR INTEGRAL LED LIGHTED, (DRIPPROOF, WATERTIGHT, EMI/RFI SHIELDED, SUNLIGHT READABLE AND NVIS COMPATIBLE)

Revision Log

Rev.	E. R. No.	Revised By	Checked By	Approved By	Rel. Date
NC	17768	E. OGLE	/s/ D.M.	/s/ W.E.B.	9-24-85
A	18021	E. OGLE	/s/ D.M.	/s/ W.E.B.	12-30-85
B	18737	E. OGLE	/s/ D.M.	/s/ W.E.B.	5-1-87
C	18901	E. OGLE	/s/ D.M.	/s/ W.E.B.	7-20-87
D	19111	E. OGLE	/s/ D.M.	/s/ W.E.B.	12-21-87
E	19267	E. OGLE	/s/ D.M.	/s/ W.E.B.	3-28-88
F	19457	E. OGLE	/s/ D.M.	/s/ W.E.B.	8-26-88
G	19521	E. OGLE	/s/ E.O.	/s/ W.E.B.	9-27-88
H	19536	E. OGLE	/s/ E.O.	/s/ W.E.B.	10-6-88
J	19603	E. OGLE	/s/ E.O.	/s/ W.E.B.	11-10-88
K	21771	E. OGLE	/s/ W.E.B.	/s/ T.L.N.	3-5-93
L	22120	E. OGLE	/s/ W.E.B.	/s/ T.L.N.	8-23-93
M	30401	E. OGLE	/s/ W.E.B.	/s/ T.L.N.	7-25-94
N	36081	A. KERTATAMA	A. G.	P. H.	10-27-00
P	38233	A. KERTATAMA	A. G.	P. H.	4-5-02
R	39051	A. KERTATAMA	A. G.	P. H.	4-7-04
T	39637	A. KERTATAMA	A. G.	P. H.	
U	39830	A. KERTATAMA		P.H.	

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SERIES 90

LIGHTED PUSHBUTTON SWITCHES AND INDICATORS

Product Specification

1.0 SCOPE

The StacoSwitch 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.

It is the purpose of this document to cover standard Series 90 "coded" products, and also 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.

This product line meets the general requirements of MIL-PRF-22885, and, in matrix form, MIL-S-24317. It is specifically qualified to the requirements of MIL-PRF-22885/101, MIL-PRF-22885/111, MIL-STD-3009 and MIL-L-85762.

The basic Series 90 product with incandescent lighting has been qualified and is QPL listed under MIL-PRF-22885/101. As such, it is classified as a Category I switch, when completely defined by that specification slash sheet. Customer-specified variations may be classified as Category II products under the /101 specification slash sheet.

The multi-chip LED lighted and crimp-pin terminated configurations are QPL listed under MIL-PRF-22885/111. Both versions have been qualified for NVIS compatibility under MIL-L-85762, and MIL-STD-3009. The High Brightness LED configurations are being prepared for MIL-PRF-22885 compliance.

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-PRF-22885/101	Switch, Pushbutton, Matrix or Individually Mounted, Illuminated, 4-Lamp, SPDT and DPDT, 5.0 Amperes, Silver contacts, 1 Ampere, Gold Contacts (Night Vision Imaging System (NVIS), Dripproof, Sunlight Readable, EMI/RFI Shielded).
MIL-PRF-22885/111	Switches, Pushbutton, Light Emitting Diode (LED) Illuminated, Standard, Night Vision Imaging System (NVIS) and Sunlight Readable Displays, SPDT and DPDT, Low Level to 7 Amperes, Sealed and Unsealed, Solder and Common Termination System (CTS) Terminations.
MIL-S-24317	Switches, Multistation, 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.
MIL-STD-202	Test Methods 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 (MIL-PRF-22885/101 with Legend).

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.

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;
- Unsealed or sealed for either dripproof or splashproof/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;
- Twelve High Brightness LEDs per display;
- Six LED display colors plus seven NVG colors;
- Two standard voltage options;
- Voltage dimming option with 28 VDC 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 (latchdown) 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.
Model 92 "Coded"	Pushbutton assemblies (incandescent or LED).
Model 93 "Coded"	Model 91 switch/indicator assemblies with standard pushbuttons installed.
Model 98 "Coded"	Switch or indicator assemblies without pushbuttons (longer housings with crimp pin receptacle for wire terminations).
Model 99 "Coded"	Model 98 switch/indicator assemblies with standard pushbuttons installed.

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 a number of 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.

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-22885/101. These are documented as StacoSwitch part numbers 631220-TAB. The tab numbers for the StacoSwitch drawing correspond exactly to the tab numbers on the DSCC drawing. (For example, DSCC part identification number 90020-00026 is StacoSwitch part number 631220-00026.)

3.3.6 15 Series

Accessories which may apply to switch products are identified by 15XXX numbers. Refer to Section 5.8 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.

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, Series 94 through 97 Coded.

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

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 in Figure 1. They are the Model 91 "coded" Switch or Indicator, the Model 92 "coded" Pushbutton, and the Model 93 "coded" Switch/Indicator with Pushbutton included. This figure shows the dimensions for the pushbutton as a separate entity. Dimensions for switches/indicators begin with Figure 4.

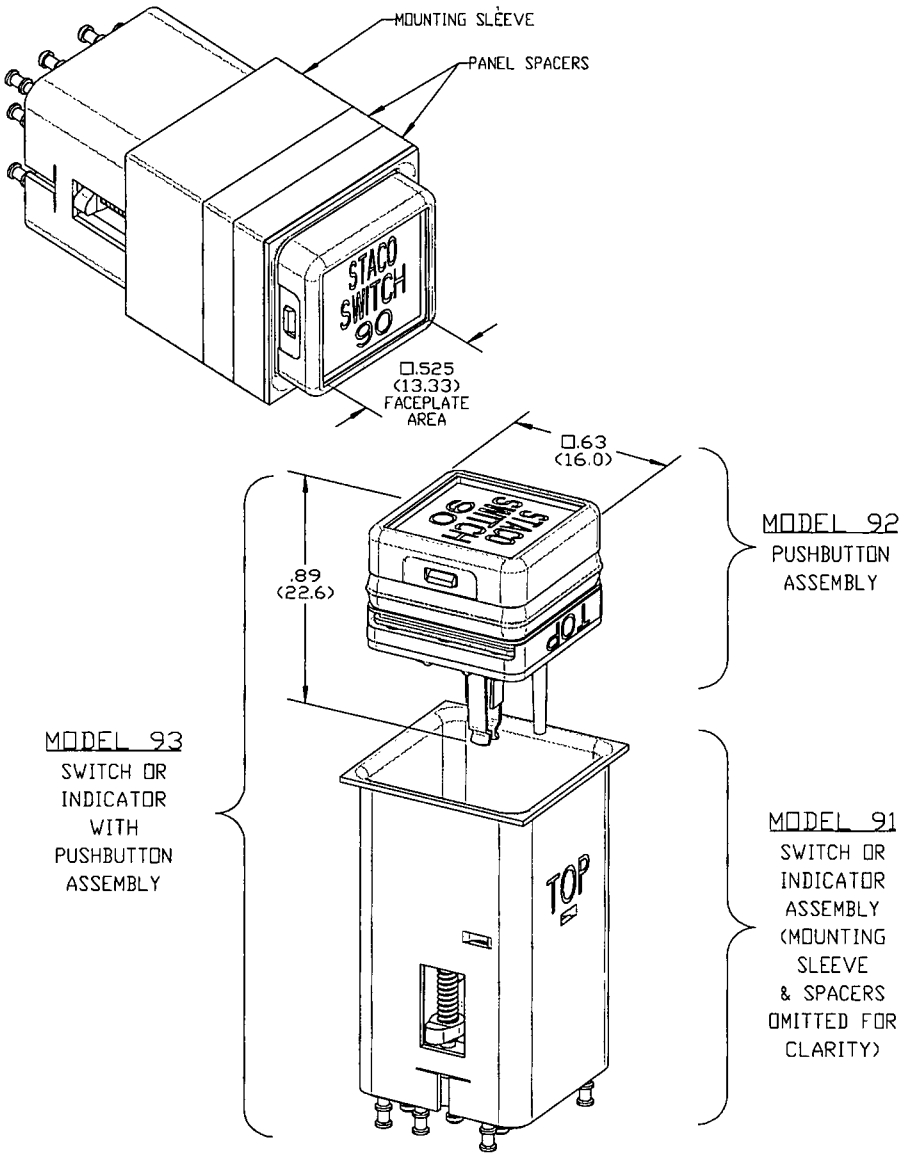


Figure 1 Basic Pushbutton, Switch/Indicator, and Switch/Indicator with Pushbutton Assemblies

Figure 2 shows an exploded view 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 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 mounting cam nuts for the switch/indicator and the ones for the receptacle assembly are shown. This figure also illustrates, for the incandescent lamp versions of this product, how the lamps are replaced.

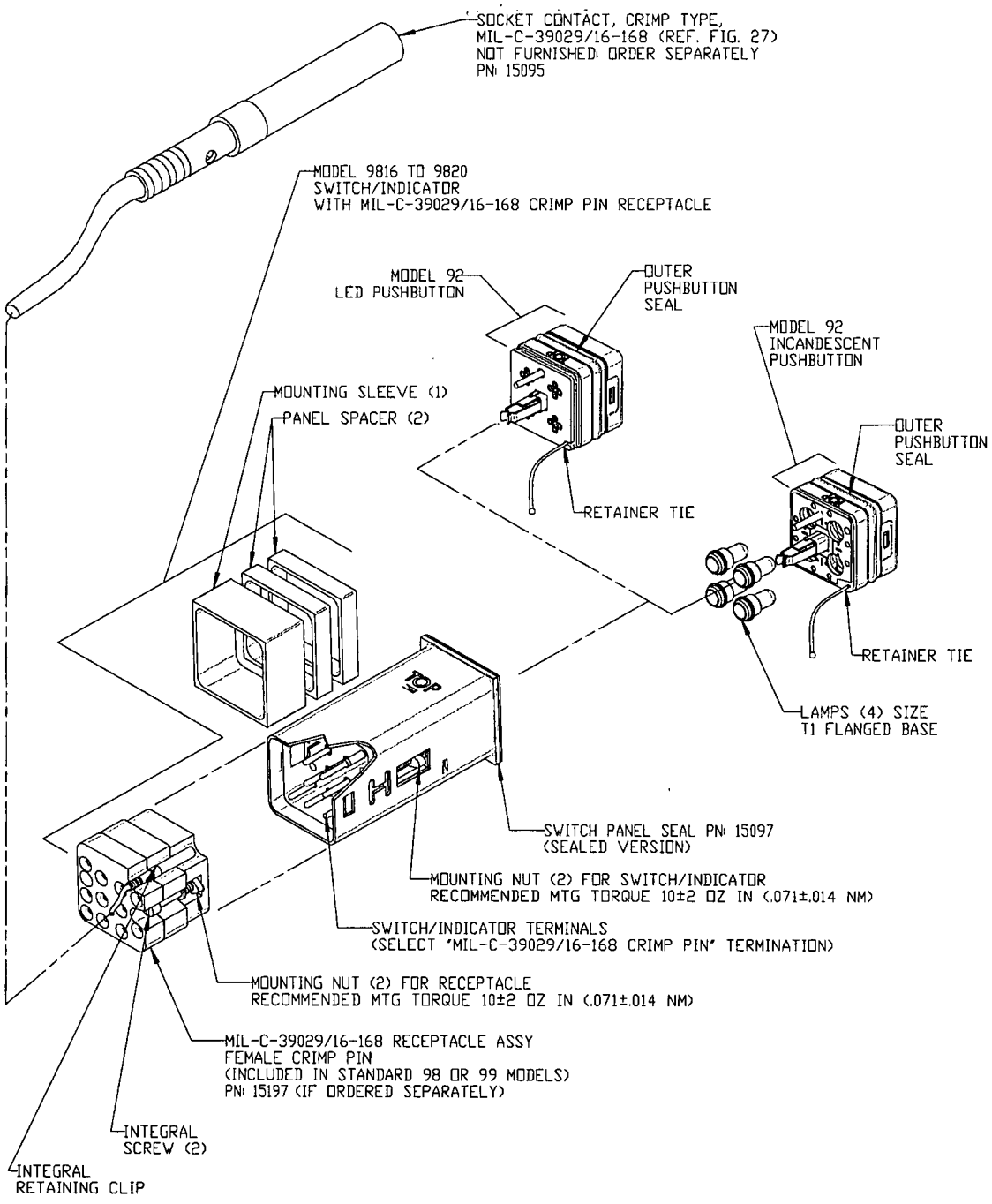


Figure 2 Model 9916 to 9920 Switch/Indicator Crimp Pin with Receptacle and Pushbutton

Note: Model 99 includes both model 98 switch assembly plus model 92 pushbutton assembly.

Figure 3 shows a Model 98 Switch/Indicator and a Model 92 Pushbutton to form a Model 99 Switch Assembly with MIL-C-39029/22-192 crimp pins.

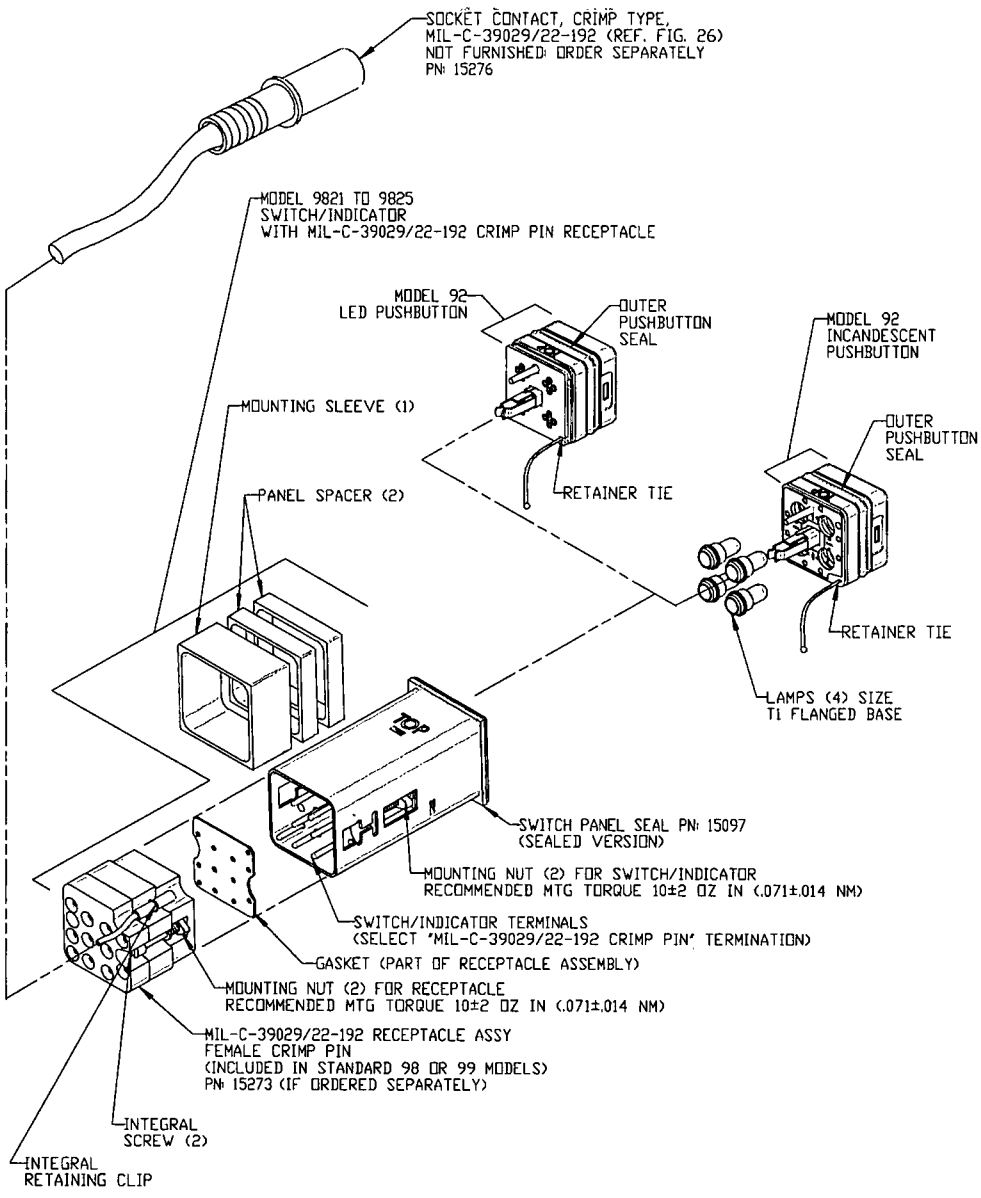


Figure 3 Model 9921 to 9925 Switch/Indicator Crimp Pin with Receptacle and Pushbutton

Note: Model 99 includes both model 98 switch assembly plus model 92 pushbutton assembly.

Detailed physical dimensions of Series 90 Switches/Indicators in various configurations are as shown in Figures 4 through 21.

LED pushbuttons could be supplied either with multi-chip LEDs as described before or with High Brightness LEDs with and without dimming (28 Volt versions only) options.

Panel thicknesses accommodated by each configuration are as shown in Figures 4 through 7 and 10 through 17.

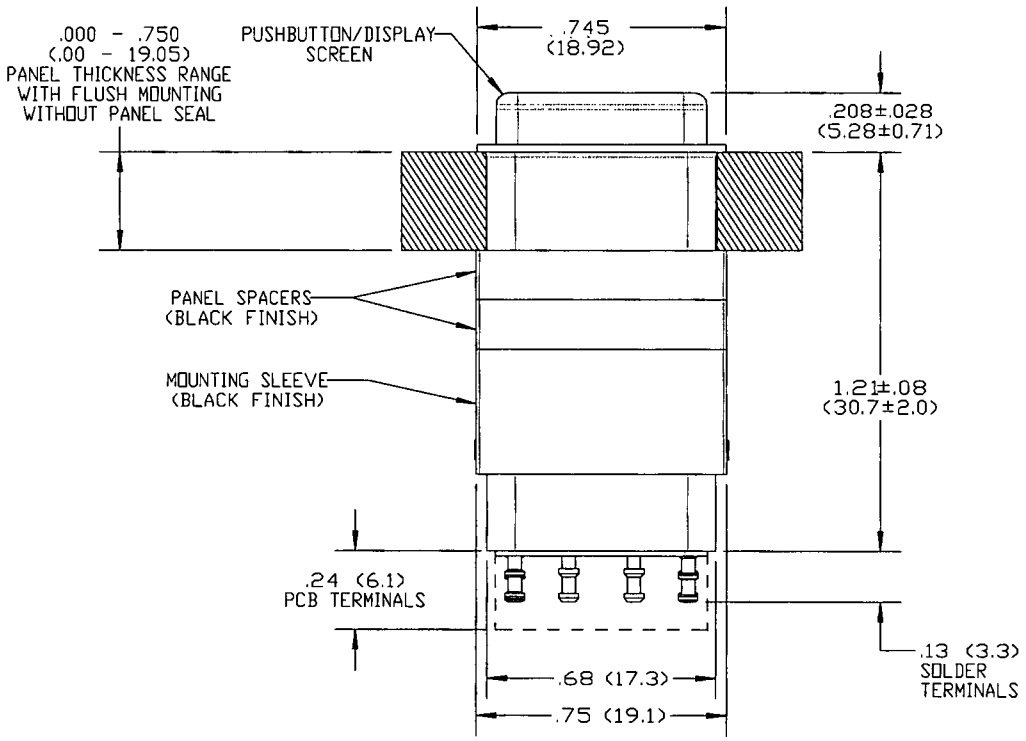


Figure 4 Model 93 Flush-Mount without Panel Seal

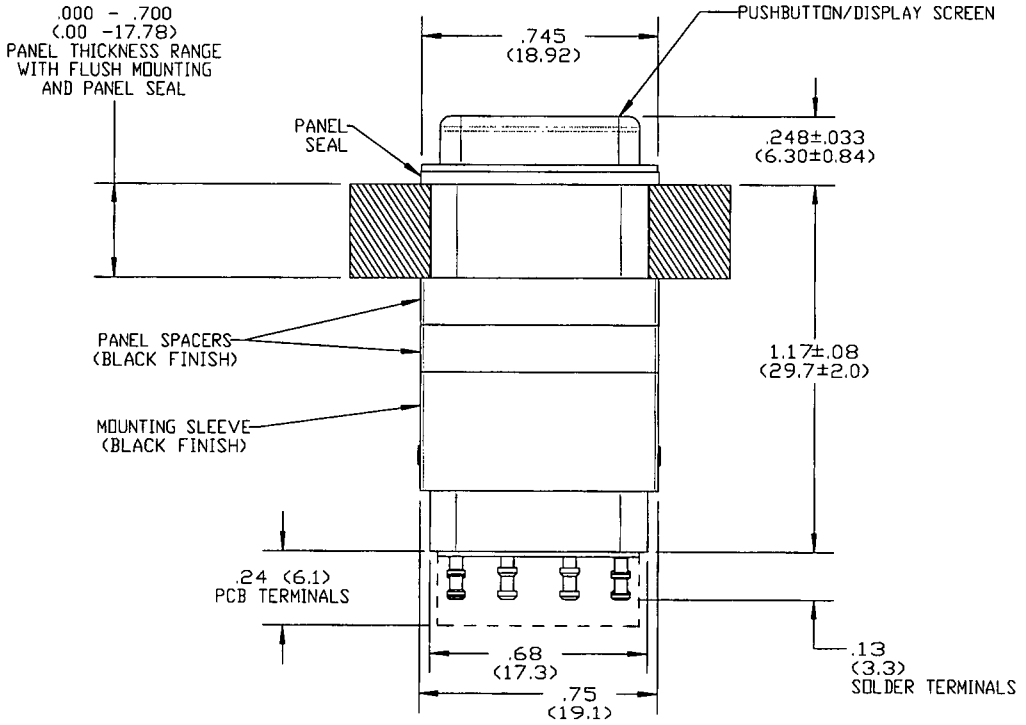


Figure 5 Model 93 Flush-Mount with Panel Seal

CAGE CODE:	DRAWING NO.	REV.	SHT.
12522	SERIES 90 CODED	U	25

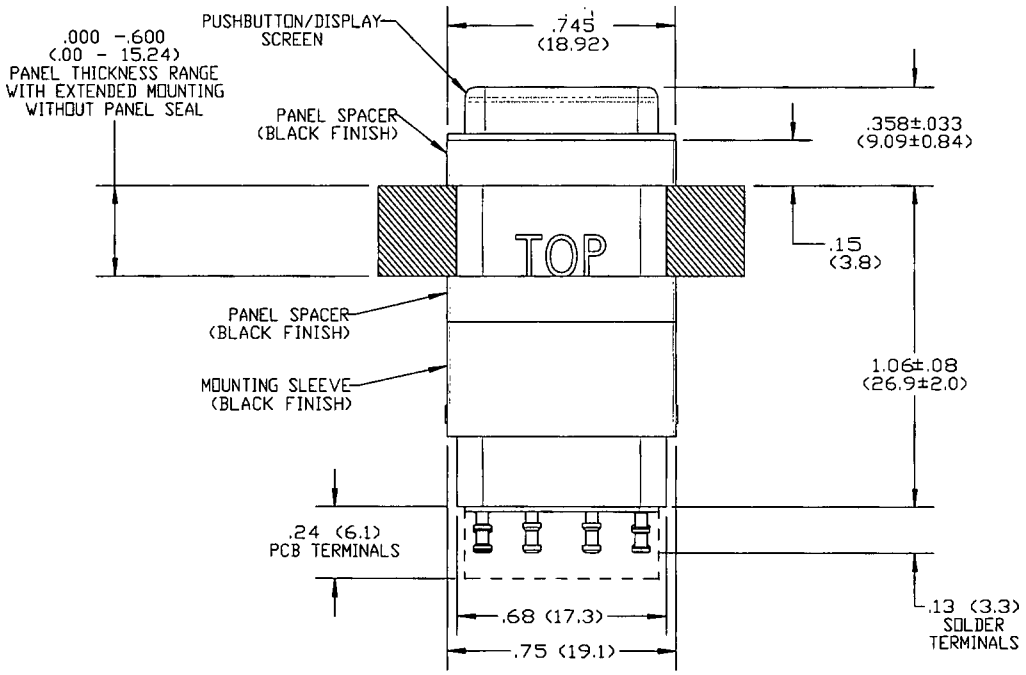


Figure 6 Model 93 Extended-Mount without Panel Seal

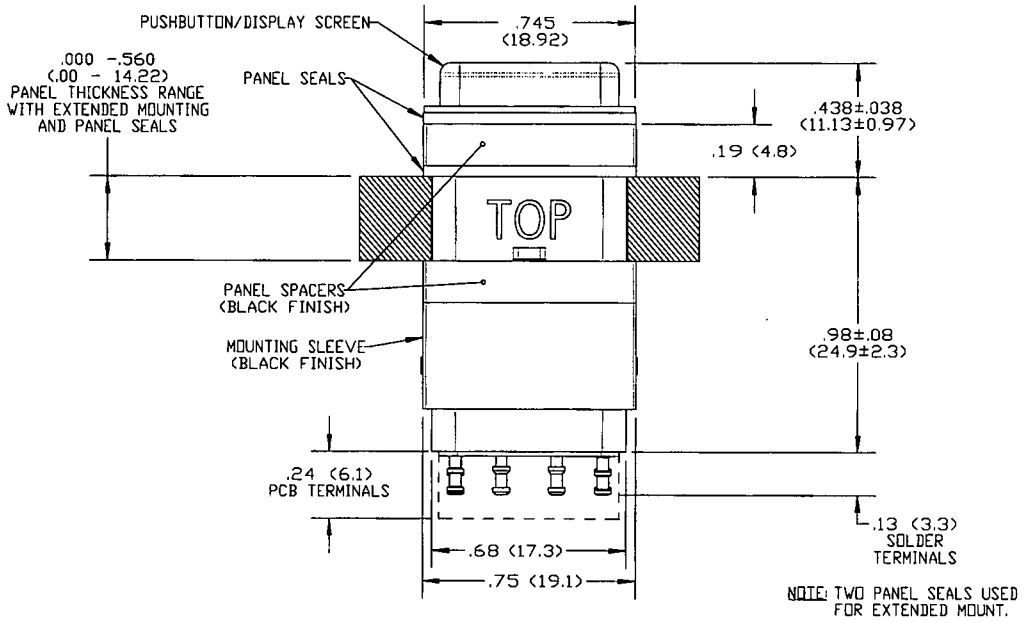


Figure 7 Model 93 Extended-Mount with Panel Seal

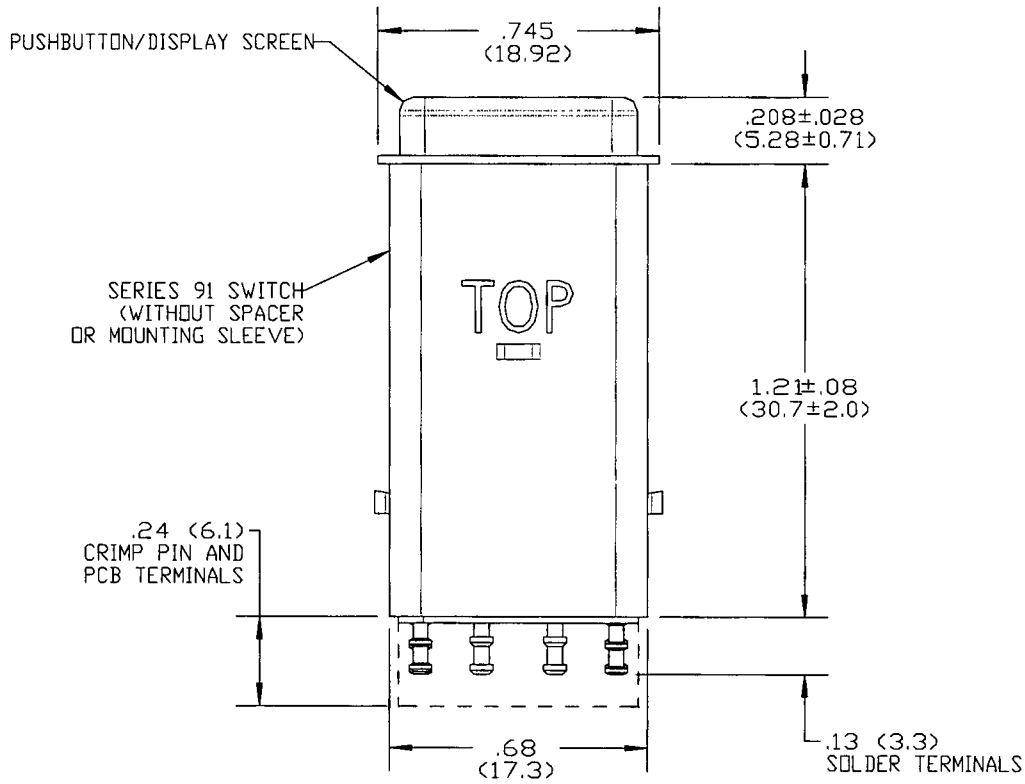


Figure 8 Matrix-Mount Unsealed

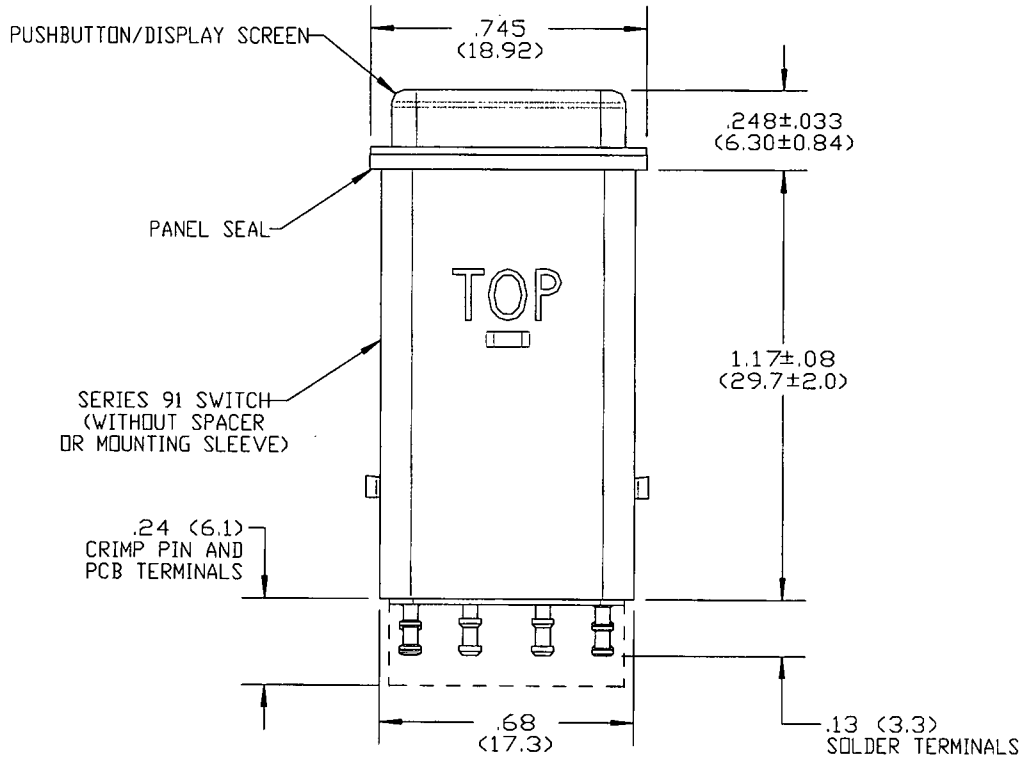


Figure 9 Matrix-Mount Sealed

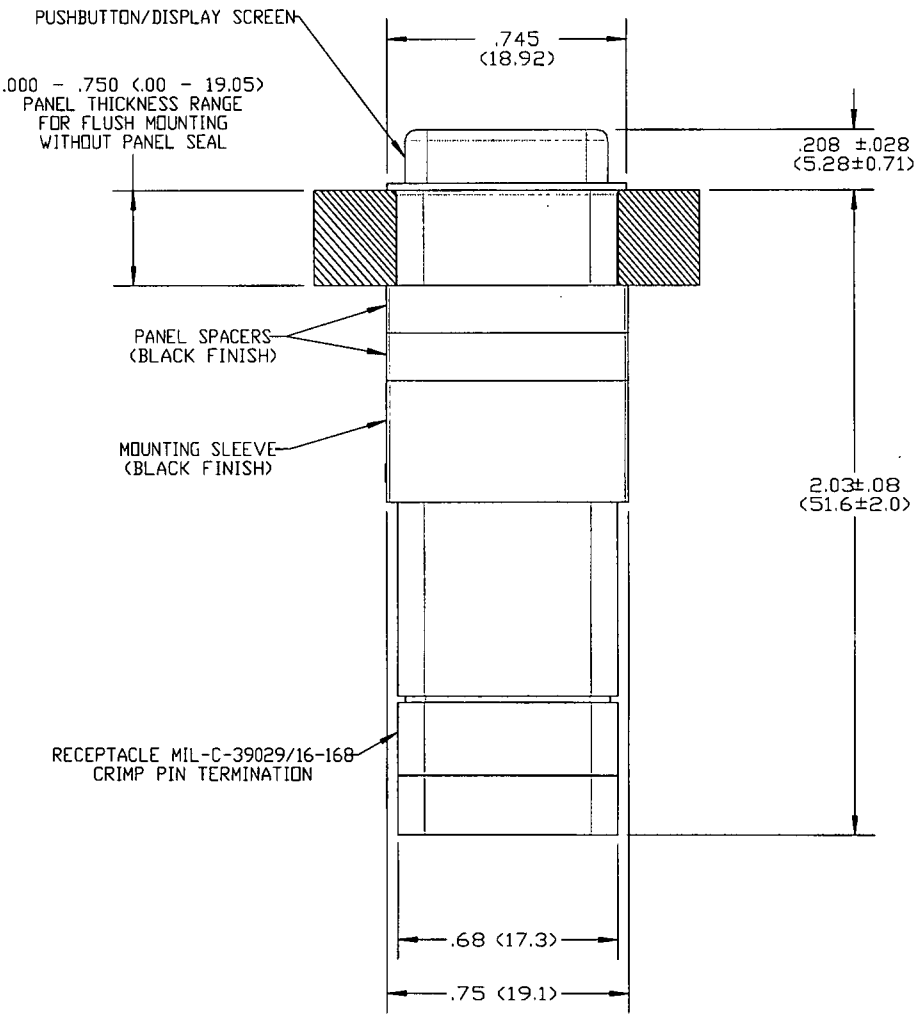


Figure 10 Model 9916 through 9920 Flush-Mount without Panel Seal

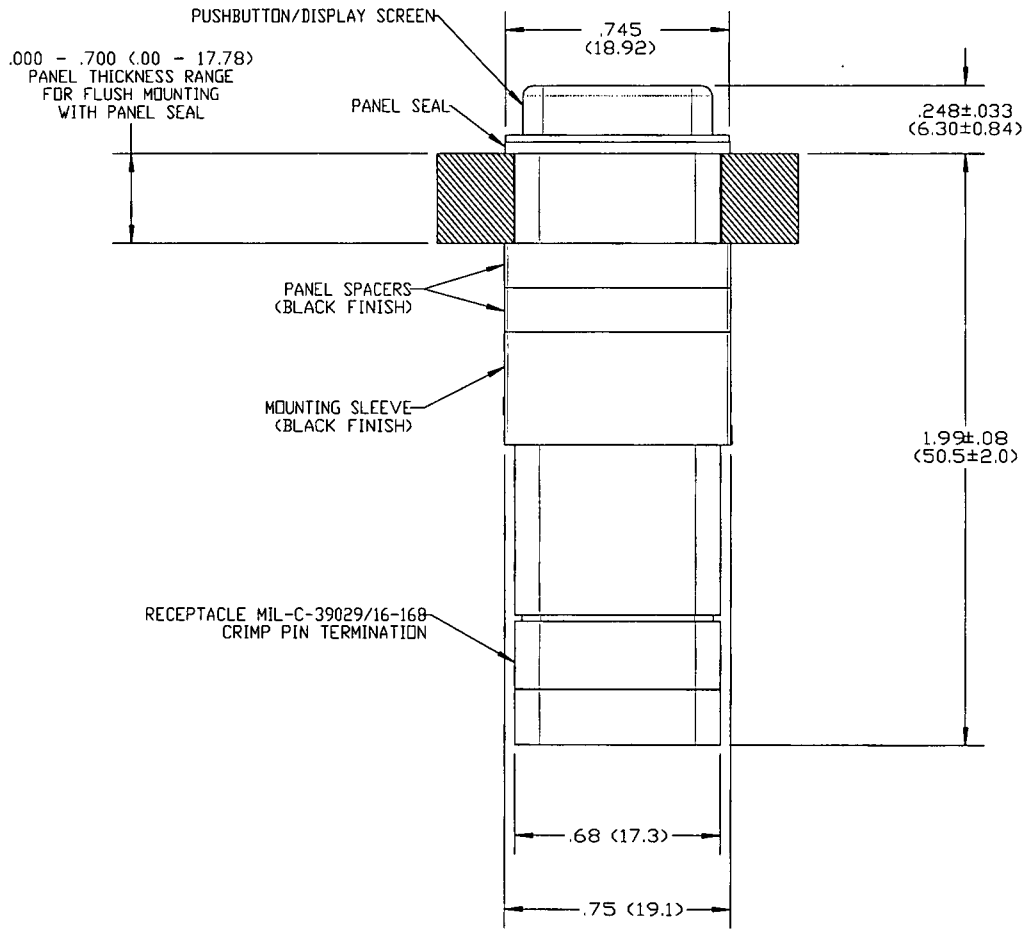


Figure 11 Model 9916 through 9920 Flush-Mount with Panel Seal

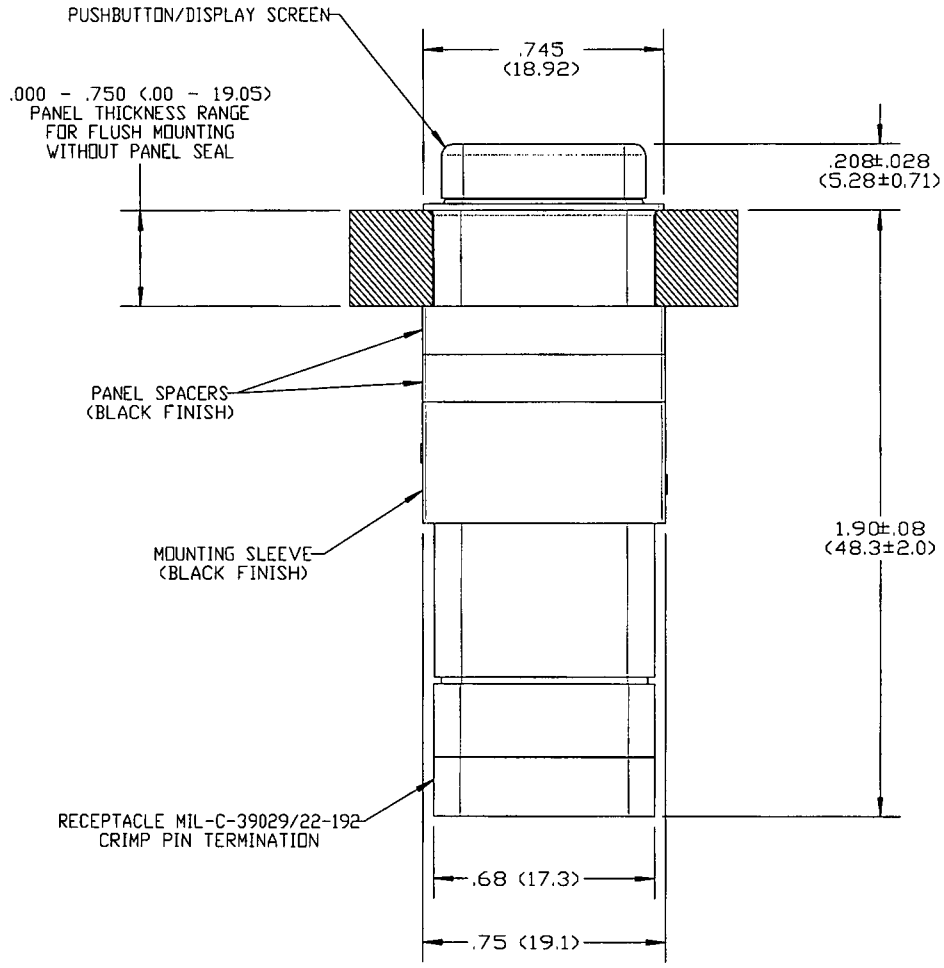


Figure 12 Model 9921 through 9925 Flush-Mount without Panel Seal

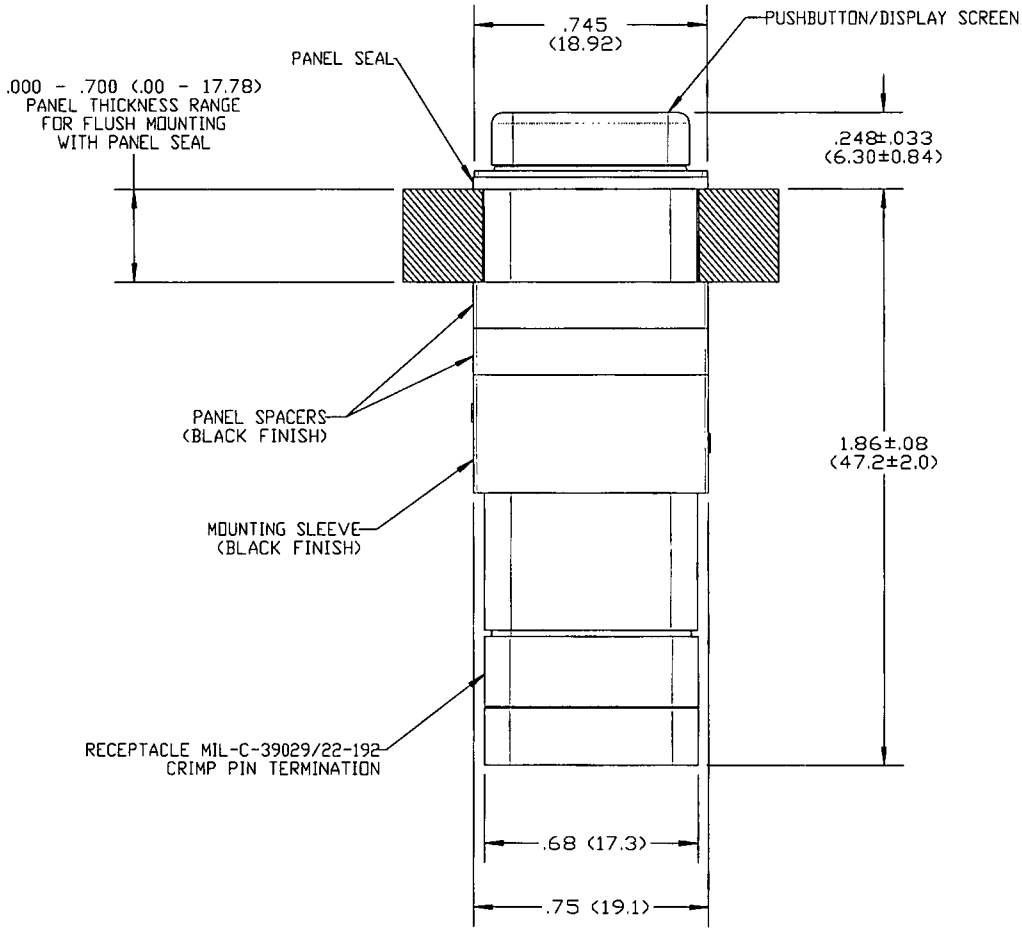


Figure 13 Model 9921 through 9925 Flush-Mount with Panel Seal

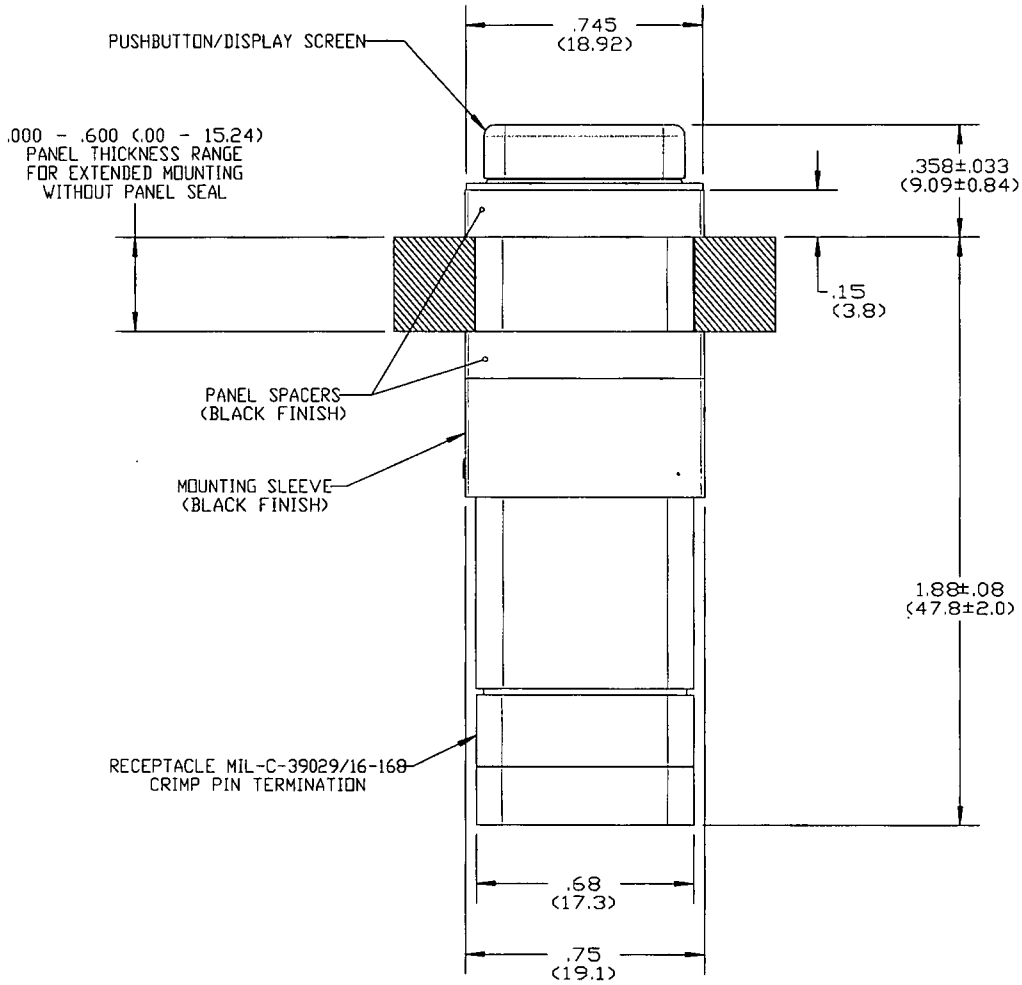


Figure 14 Model 9916 through 9920 Extended-Mount without Panel Seal

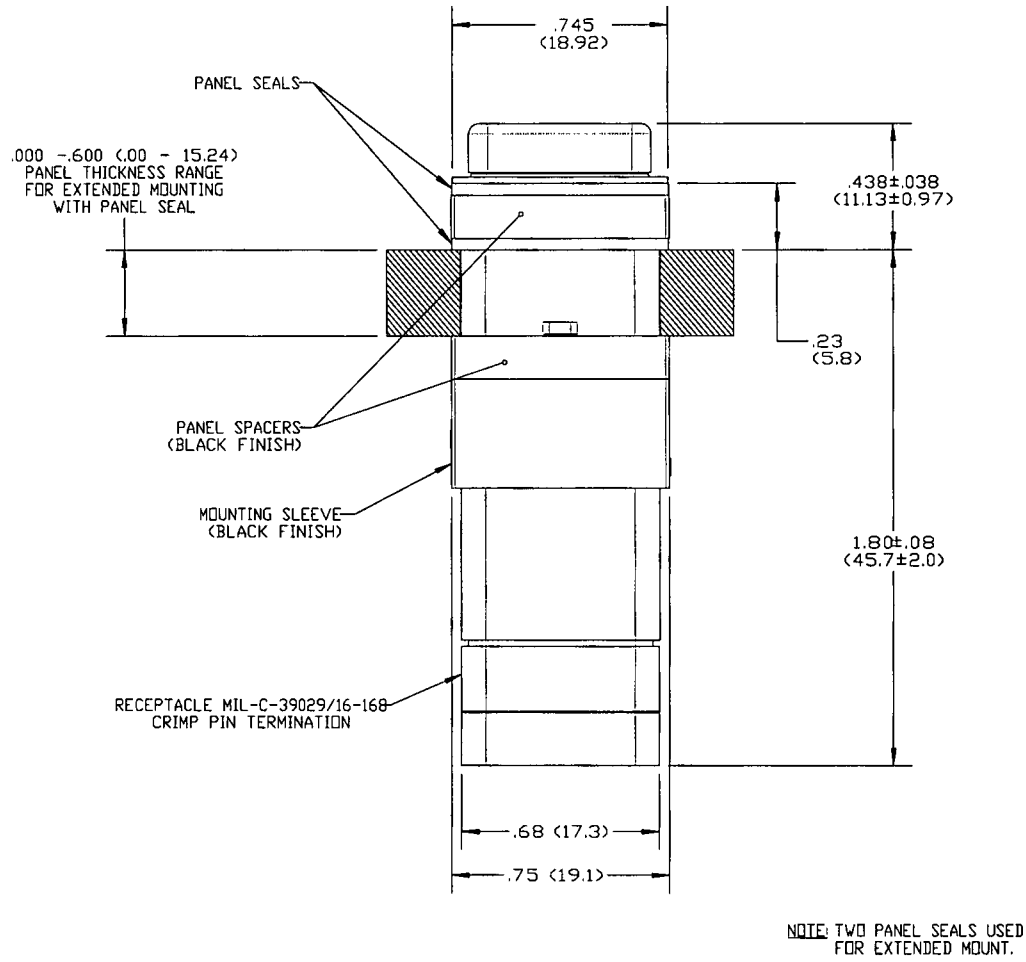


Figure 15 Model 9916 through 9920 Extended-Mount with Panel Seal

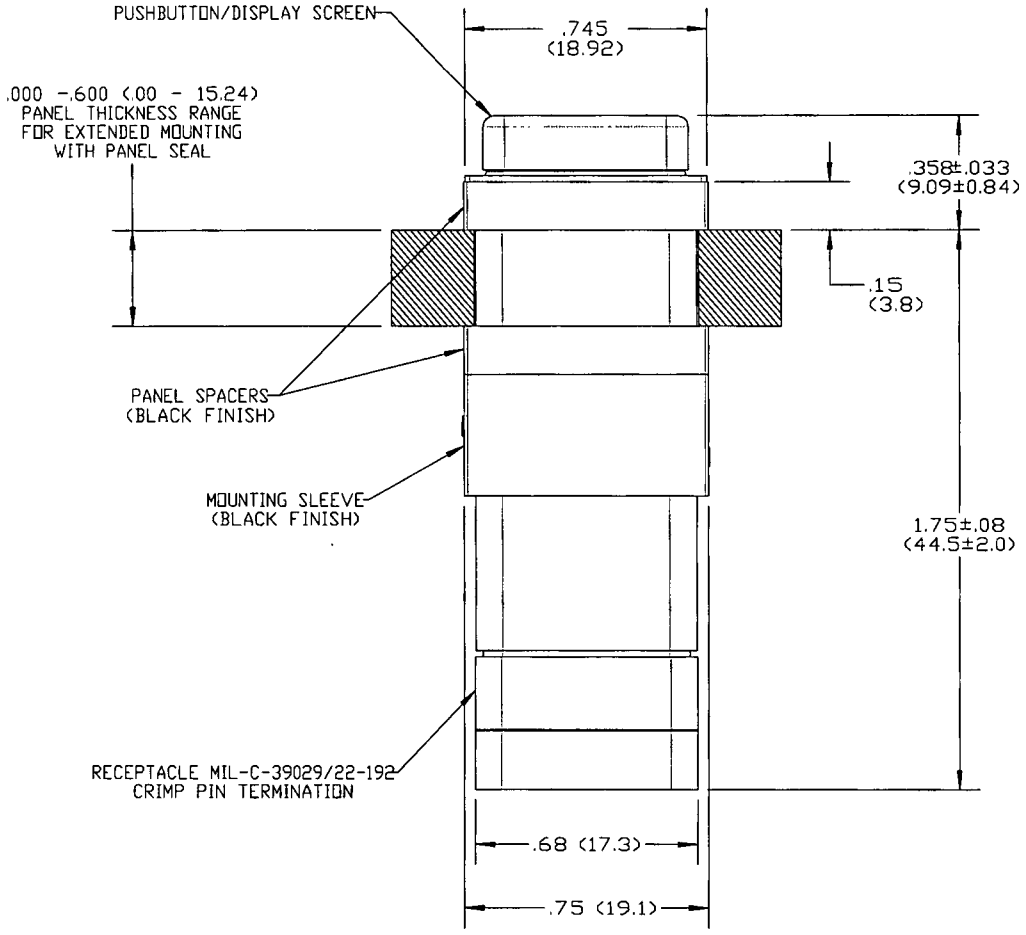


Figure 16 Model 9921 through 9925 Extended-Mount without Panel Seal

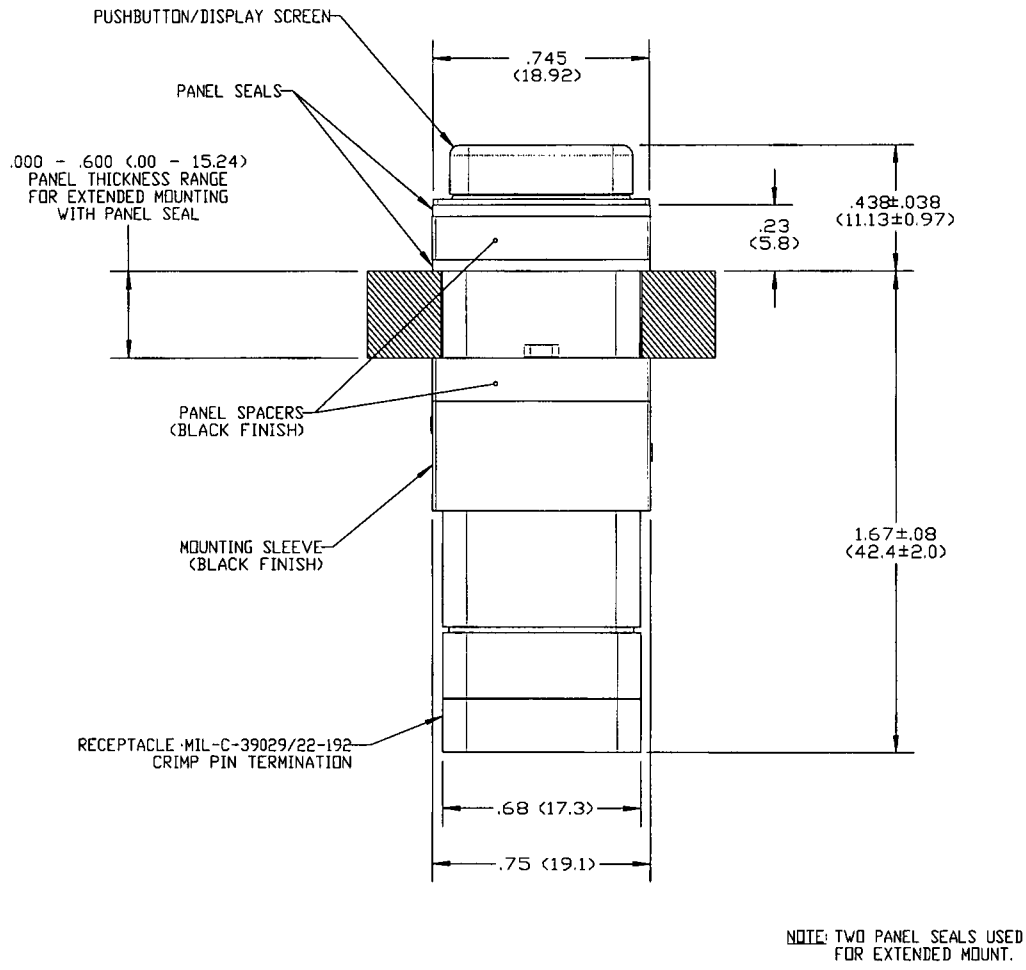


Figure 17 Model 9921 through 9925 Extended-Mount with Panel Seal

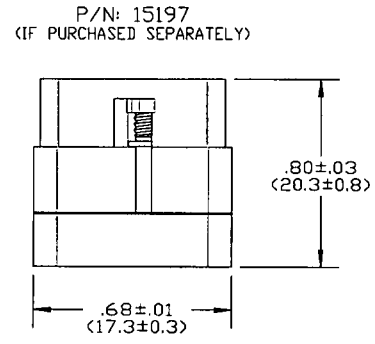


Figure 18 MIL-C-39029/16-168 Receptacle Assembly
Used in 9816 through 9820 models

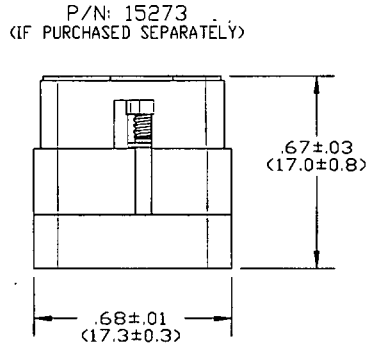


Figure 19 MIL-C-39029/22-192 Receptacle Assembly
Used in 9821 through 9825 models

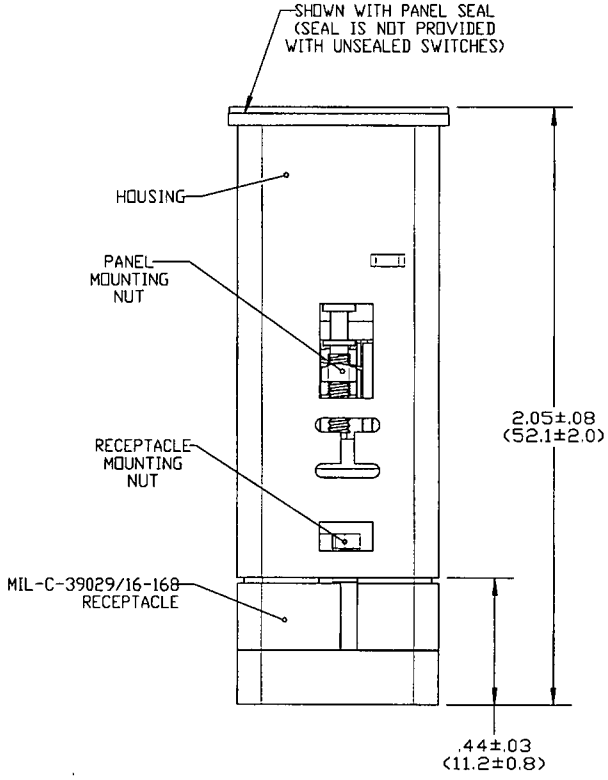


Figure 20 Model 9816 through 9820 Assembly Shown with Panel Seal and without Sleeve or Spacers

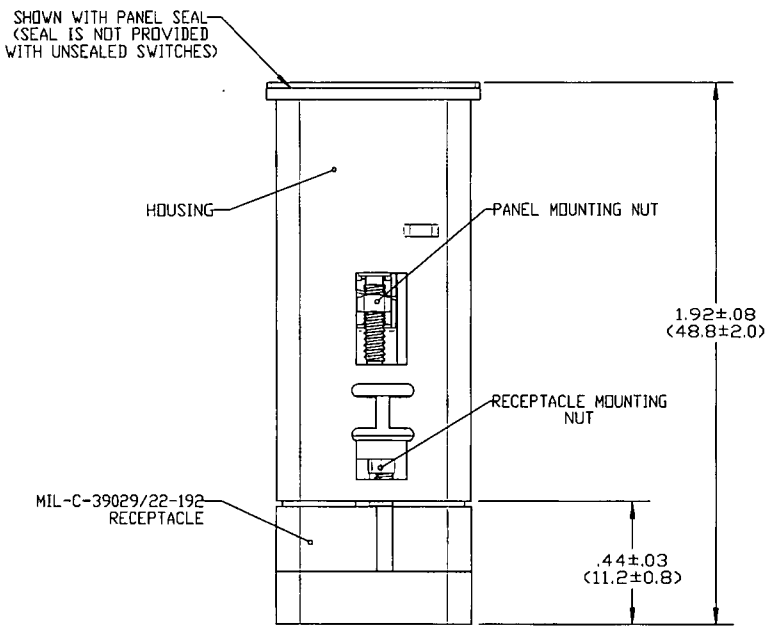


Figure 21 Model 9821 through 9825 Assembly Shown with Panel Seal and without Sleeve or Spacers

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.

The panel seal shown in these dimensional drawings is for dripproof applications. (The seal used for watertight and splashproof type applications is referred to in paragraph 4.1.10 and Figure 30.) For dimensions of matrix frames, see the Series 94, 95, 96 and 97 SCD.

4.1.2 Panel Cutouts and Mounting

The recommended cutout for panel mounting is shown in Figure 22. 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 23. Mounting instructions for switches are given in Appendix G of this document.

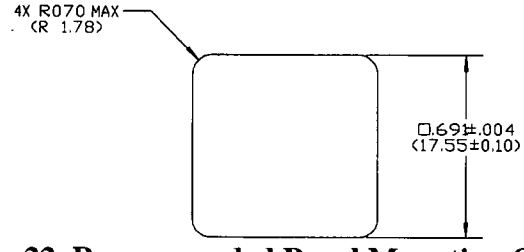


Figure 22 Recommended Panel Mounting Cutout

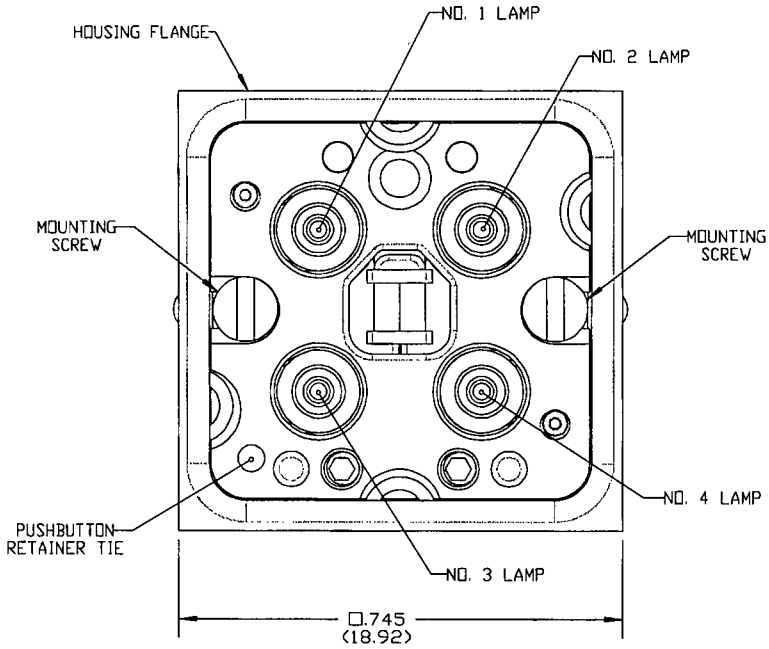


Figure 23 Switch/Indicator Mounting Screw Location
(viewed from front of panel)

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.

4.1.4 Mounting Torque

The recommended torque to be applied to the mounting screws during installation is 10 ± 2 ounce-inches (0.071 ± 0.014 Nm). This torque value is applicable to both, the switch panel mounting and to receptacle assembly installation (See Figures 2 and 3).

4.1.5 Printed Circuit Board Mount Terminals

The dimensions for printed circuit board type terminals are shown in Figure 24. (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.)

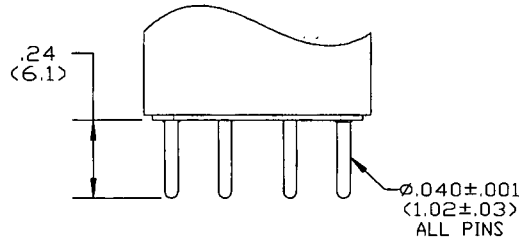


Figure 24 PCB Type Terminals

4.1.6 Solder Terminals

The double turret solder type terminals are dimensioned in Figure 25.

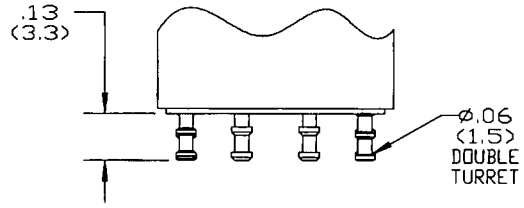


Figure 25 Solder Type Terminals

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 26. Figure 27 shows the MIL-C-39029/16-168 crimp pin.

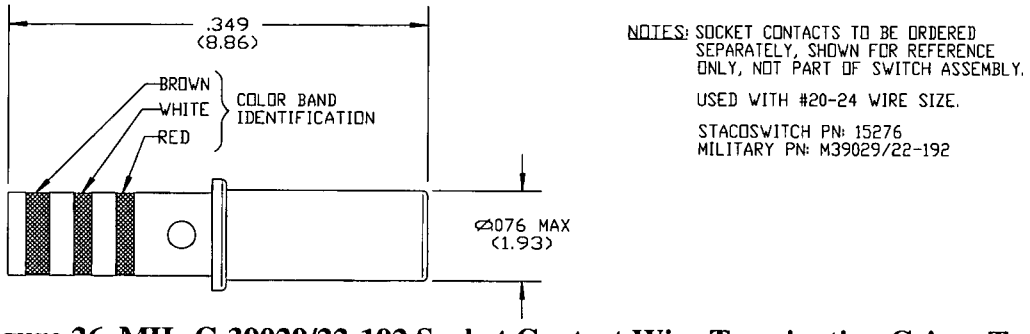


Figure 26 MIL-C-39029/22-192 Socket Contact Wire Termination Crimp Type

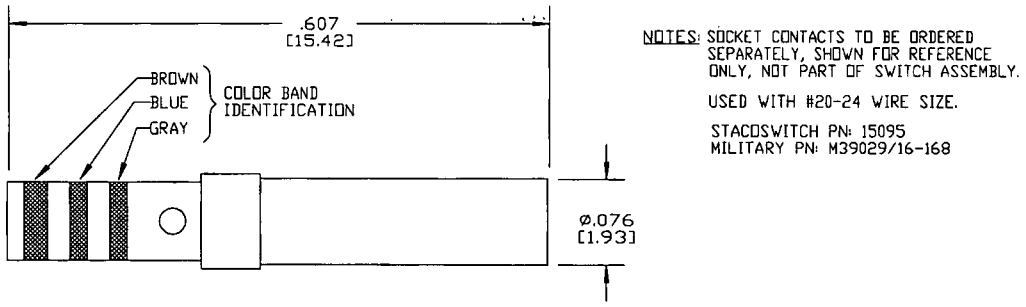


Figure 27 MIL-C-39029/16-168 Socket Contact Wire Termination Crimp Type

4.1.8 Terminal Identification and Location

Figure 28 identifies the terminal numbers (and switch functions) with their relative position on the header.

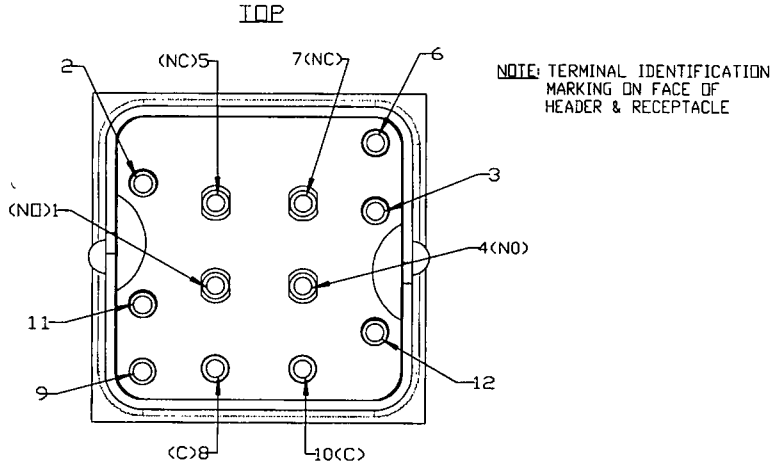


Figure 28 Termination Identification
Rear view of switch header or crimp pin receptacle

4.1.9 PCB Layout Dimensions

For printed circuit board layout purposes, Figure 29 defines the positions of pin-outs.

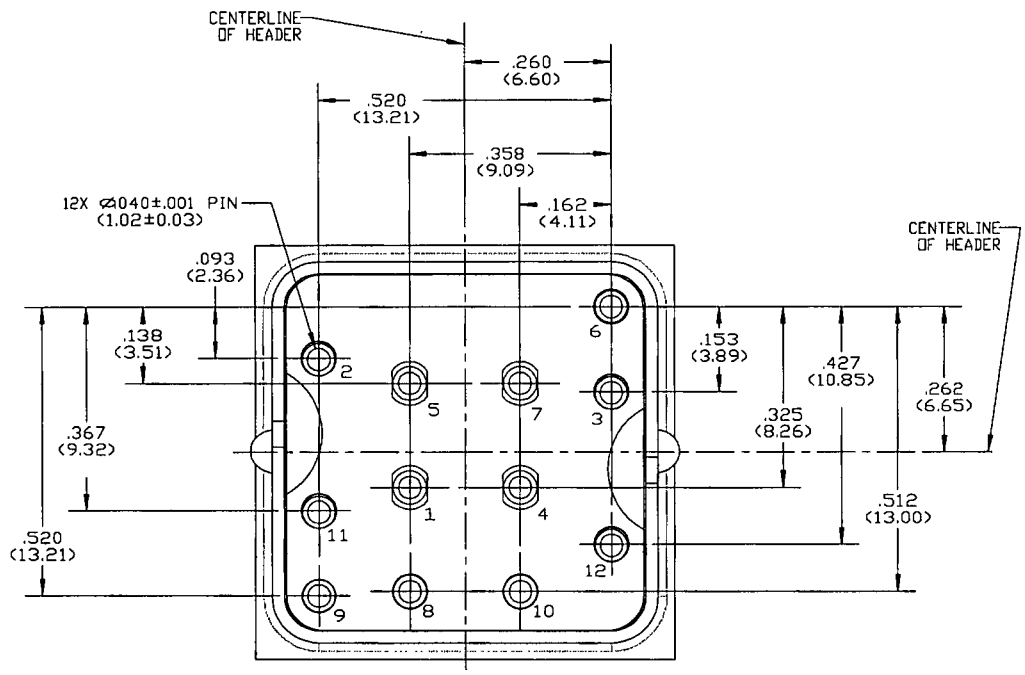
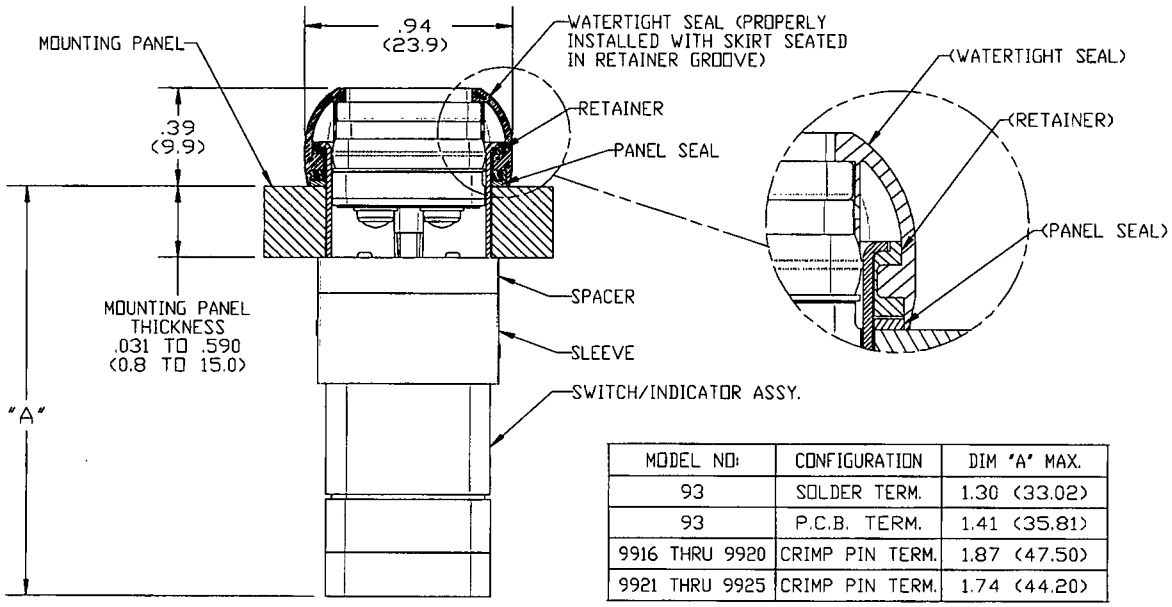


Figure 29 Printed Circuit Board Terminal Location
As viewed from rear side of switch

4.1.10 Watertight/Splashproof Seal

Panel spacing of switches or indicators with watertight or splashproof seals installed is 1.06" (26.9 mm) minimum, center to center, horizontally or vertically. Dimensions for these seals are given in Figure 30.



MODEL NO.	CONFIGURATION	DIM "A" MAX.
93	SOLDER TERM.	1.30 (33.02)
93	P.C.B. TERM.	1.41 (35.81)
9916 THRU 9920	CRIMP PIN TERM.	1.87 (47.50)
9921 THRU 9925	CRIMP PIN TERM.	1.74 (44.20)

Figure 30 Watertight Seal

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.

4.1.11.1 Watertight Seal PBG

The pushbutton guard which is used in conjunction with a watertight/splashproof seal is identified as the 15204/005 and is dimensioned in Figure 31. 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.

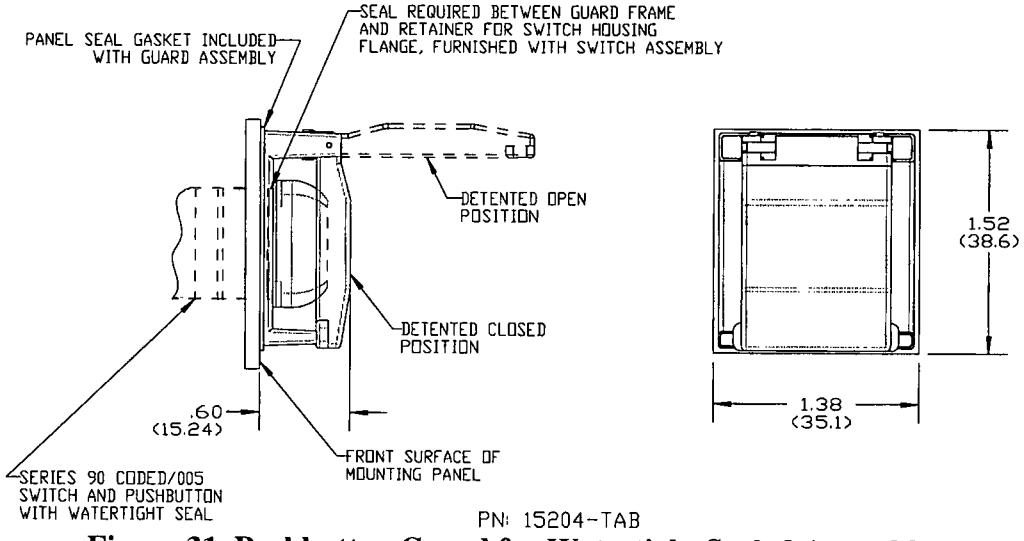


Figure 31 Pushbutton Guard for Watertight Sealed Assembly

4.1.11.2 Standard PBG

The standard pushbutton guard is shown in Figure 32. This accessory, the 15089, is used for Series 90 in either unsealed or dripproof application. 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.

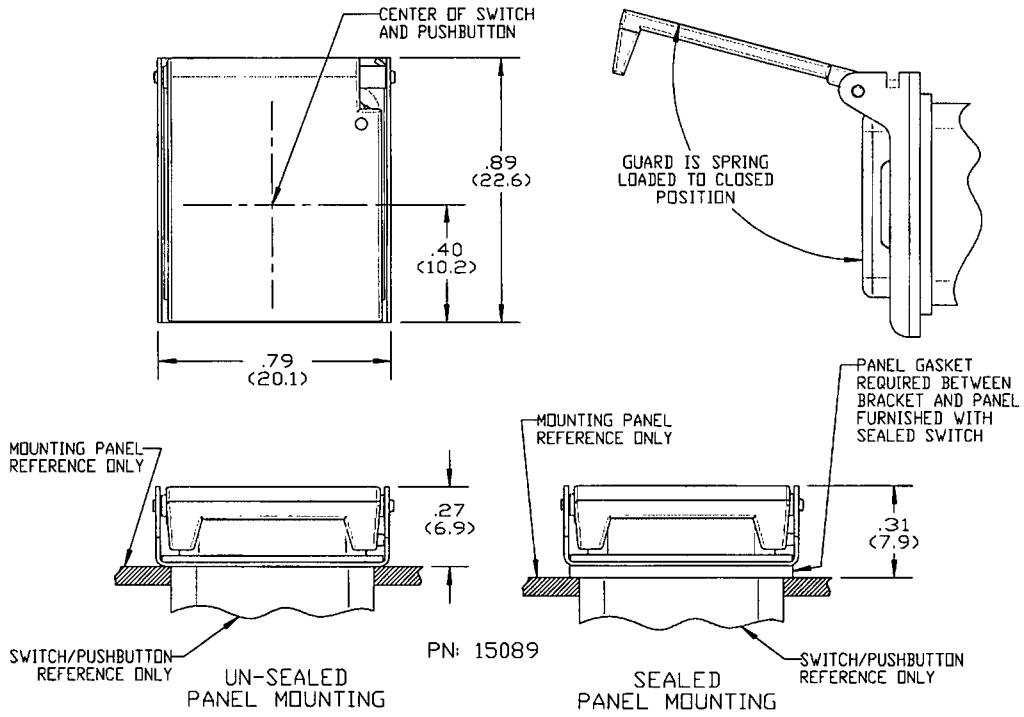


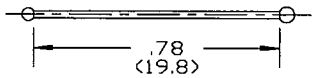
Figure 32 Standard Pushbutton Guard for Dripproof Sealed and Unsealed Assemblies

4.1.12 Other Accessories

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

4.1.12.1 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 relamped. Retainer units are identified by part number 15093 and are shown in Figure 33.



PN: 15093

Figure 33 Pushbutton Retainer Tie

4.1.12.2 Color Filter Caps

The color filter caps shown in Figure 34 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 for color coding, quantity per package and ordering information.

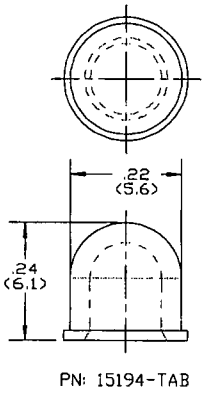


Figure 34 Color Filter Caps

4.1.12.3 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 35.

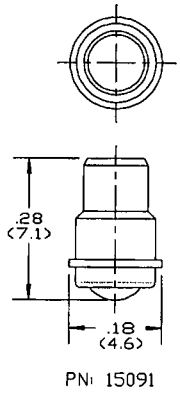


Figure 35 Dummy Lamp

4.2 Switch Connections and Lighting Circuit Control

4.2.1 Operation

Switch 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.

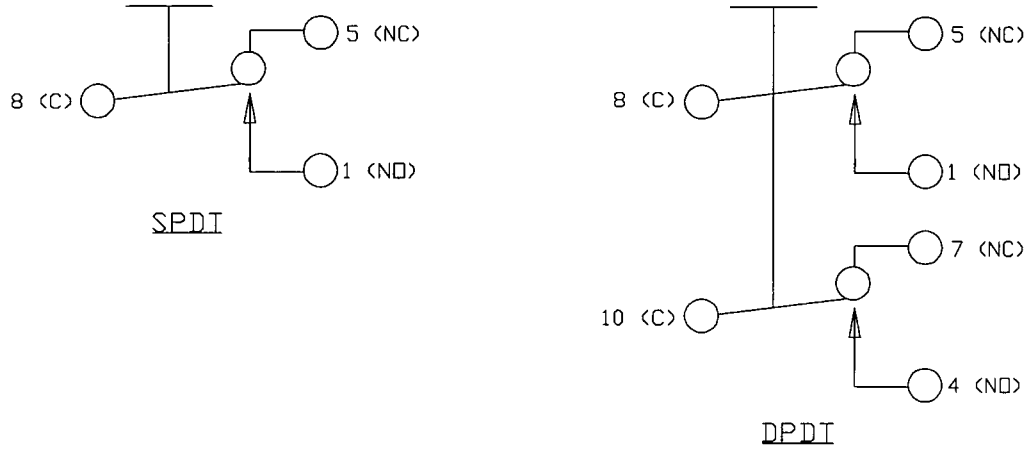
Table A OPERATION CLASSIFICATIONS

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

(EDITORIAL NOTE: Tables in Section 4, Requirements, are identified with letters so that the tables of Section 5, Ordering Information, may retain the same table numbers as used in all previous Series 90 specifications and catalogs.)

4.2.2 Switch Schematics

Single-pole double-throw (SPDT) and double-pole double-throw (DPDT) switch circuits are shown schematically in Figure 36.



TERMINALS 5 & 7 ARE NORMALLY CLOSED (NC).
TERMINALS 1 & 4 ARE NORMALLY OPEN (NO).
TERMINALS 8 & 10 ARE COMMON (C)
FOR INDICATOR ONLY, TERMINALS 1, 4, 5, 7, 8 & 10 ARE OMITTED.
FOR SPDT SWITCH, TERMINALS 4, 7 & 10 ARE OMITTED.

Figure 36 Switching Schematics

For SPDT configurations pin 5 is the normally closed (NC) terminal, pin 1 is the normally open (NO) terminal and pin 8 is the common terminal for the switch. Pins 4, 7 and 10 are not used and are omitted from the header.

DPDT switches again have pin 5 as NC, pin 1 as NO, with pin 8 the common for one of the switch poles. For the second pole pin 7 is NC, pin 4 is NO, with pin 10 being the common.

For units which are indicators only, terminal pins 1, 4, 5, 7, 8 and 10 are omitted.

4.2.3 Incandescent Lighting Circuits

Electrical connections for pushbuttons lighted with incandescent lamps are shown in Figure 37. The lamp circuit ground connections are optionally available with:

a) Common lamp ground for all four lamps (full ground plate);
b) 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);
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. 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.

NUMBER OF REQUIRED WIRES FOR COMMON BUSSED SYSTEM

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

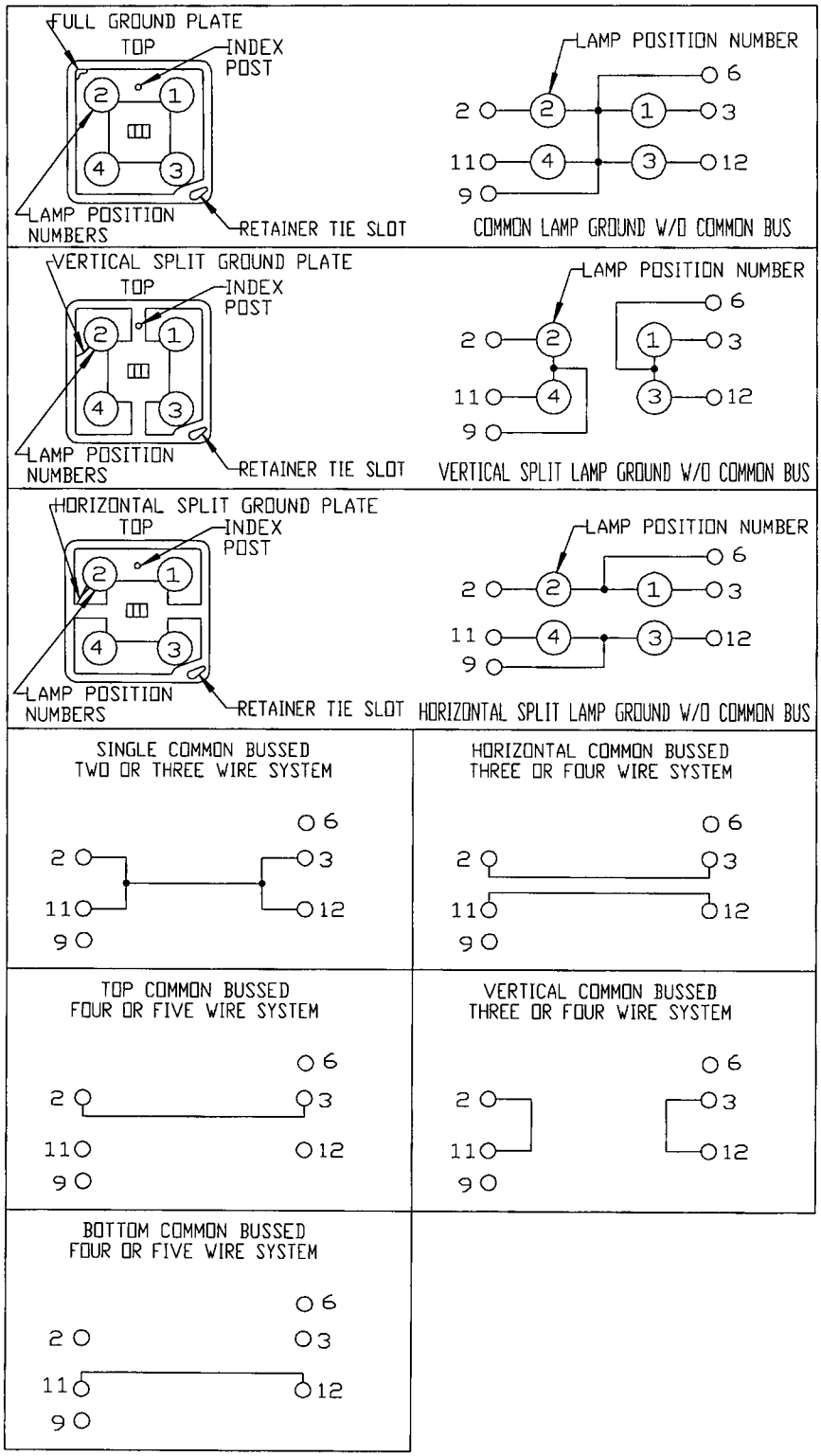


Figure 37 Incandescent Lamp Ground and Bussed Lamp Options
(view is from the rear)

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 Figure 37. The power may be DC or low-voltage AC, as long as it is within the rating of the lamp. Standard lamp selections are listed in Section 5, Table 6A.

4.2.4 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 three High Brightness LEDs per quadrant, giving a total of 12 LEDs per pushbutton. The 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 transistorized voltage dimming circuits (only available on 28 V versions). The transistorized voltage dimming circuit is packaged as Chip Scale Package (CSP) device, and incorporated in the High Brightness LED light source assembly.

Schematics for typical LED configurations are shown in Figure 38. The required current regulating resistors are included in both multi-chip and High Brightness LED pushbuttons.

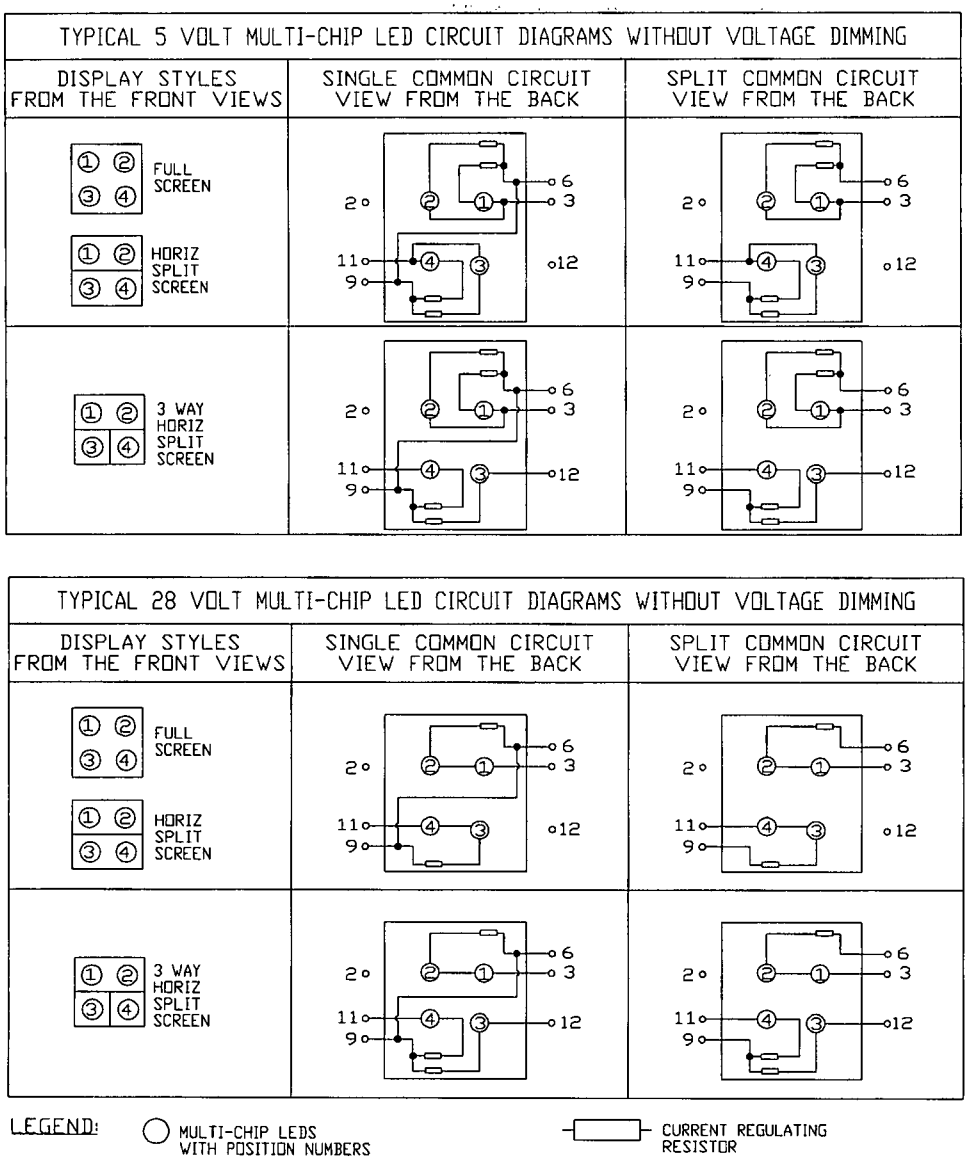


Figure 38 LED Circuit Schematics

CAGE CODE:	DRAWING NO.	REV.	SHT.
12522	SERIES 90 CODED	U	50

Figure 38, continued...

Part 2 of 3

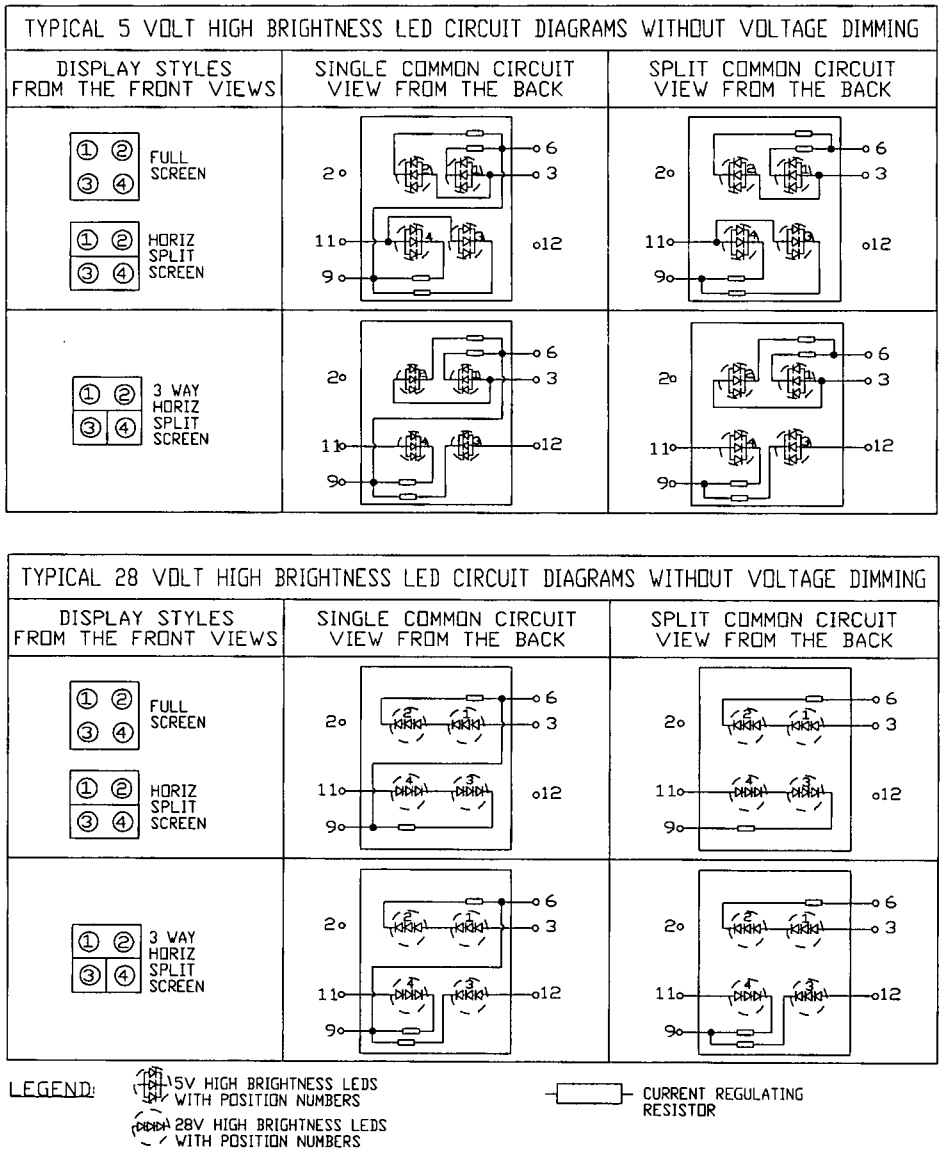


Figure 38 LED Circuit Schematics

Figure 38, continued...

Part 3 of 3

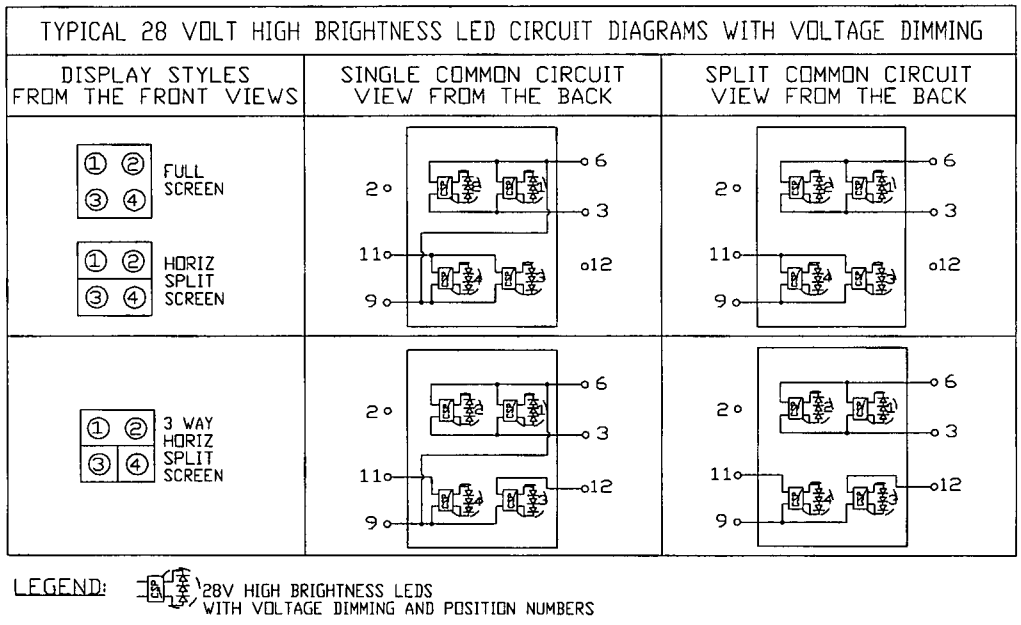


Figure 38 LED Circuit Schematics

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 volt or 28 volt lamp supply voltages may require that each quadrant be individually controlled.)

It is recommended to the end user that both ground terminals (typically pins 6 and 9) be used as the common return circuit for redundancy.
The schematics of Figure 38 are typical. See Appendix A, B, C, D and E for a complete set of schematics for all standard LED configurations.

4.2.5 Current Requirements for LED Lighting

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

4.2.5.1 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 Section 5, Table 6B.

4.2.5.2 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 Section 5, Table 6C.

Another configuration of High Brightness LEDs are offered with voltage dimming capabilities. These pushbuttons are configured with CSP devices that would receive input voltage from a variable voltage source (from 8.4 VDC to 28 VDC) and would dim the LED brightness similar to that of incandescent light source. The output current of a CSP device at 8.4 VDC is about 200 μA, and the output current of a CSP device at 28 VDC is about 20 mA ± 2 mA. This means that total nominal current of one pushbutton is 80 mA at 28 VDC. The following figure shows the output current vs input voltage of a CSP device. 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 CSP device 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.

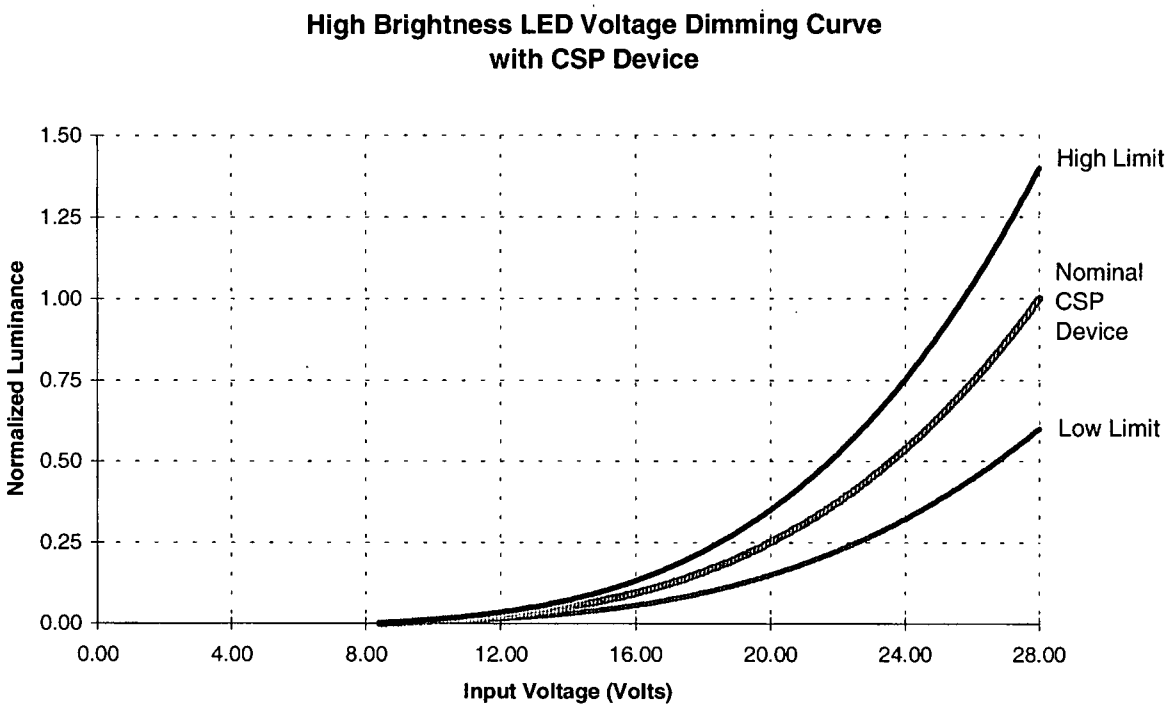


Figure 39 High Brightness LED Voltage Dimming Curve with CSP Device

4.2.6 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 at a rate of several thousand times per second, or operating High Brightness LEDs with voltage dimming (CSP devices).

Turning the LEDs on and off at a rate can be accomplished by using StacoSwitch DDM111 or DDM111A Digital Dimming Module. During the period of time 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 StacoSwitch DDM111 and DDM111A Digital Dimming Modules are an ideal way to precisely control LED brightness if the pushbutton is not facilitated with voltage dimming (CSP devices). The brightness of LEDs with voltage dimming can be controlled by varying the amplitude of the applied DC voltage similar to controlling the brightness of incandescent lamps. Digital Dimming Module is not required to control the brightness of LEDs with voltage dimming.

Table B identifies the pins used to control the lighting of the specific portions of the displays on LED-based pushbuttons.

Table B LED PUSHBUTTON LIGHTING CONTROL TERMINAL 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		Pins	
	Top ½	3	6 and/or 9	pin 6
	Bottom ½	11		pin 9
2x	2-WAY HORZ.			
	Top ½	3	6 and/or 9	pin 6
	Bottom ½	11		pin 9
3x	2-WAY VERT.			
	Left ½	12	6 and/or 9	pin 6
	Right ½	2		pin 9
4x	3-WAY, UP			
	Top ½	3	6 and/or 9	pin 6
	Bottom ¼s	12, 11		pin 9
5x	4-WAY			
	Top ¼s	3, 2	6 and/or 9	pin 6
	Bottom ¼s	, 12, 11		pin 9
6x	3-WAY, LEFT			
	Left ½	12	6 and/or 9	Not
	Right ¼s	2, 11		Available
7x	3-WAY, DOWN			
	Top ¼s	3, 2	6 and/or 9	pin 6
	Bottom ½	11		pin 9
8x	3-WAY, RIGHT			
	Left ¼s	3, 12	6 and/or 9	Not
	Right ½	2		Available

1/ Display Style Code is two-digit code of Section 5, Table 5.
2/ Common Circuit Return is Code 7, 8, A, B, E or F of Section 5, Table 4.
3/ Split Circuit Return is Code 9, 0, C, D, G or H of Section 5, Table 4.
4. See Appendix A, B, C, D and E for detailed schematics.

4.2.7 Current Sourcing/Sinking for LEDs

For application information, Figure 40 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 together).

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 together).

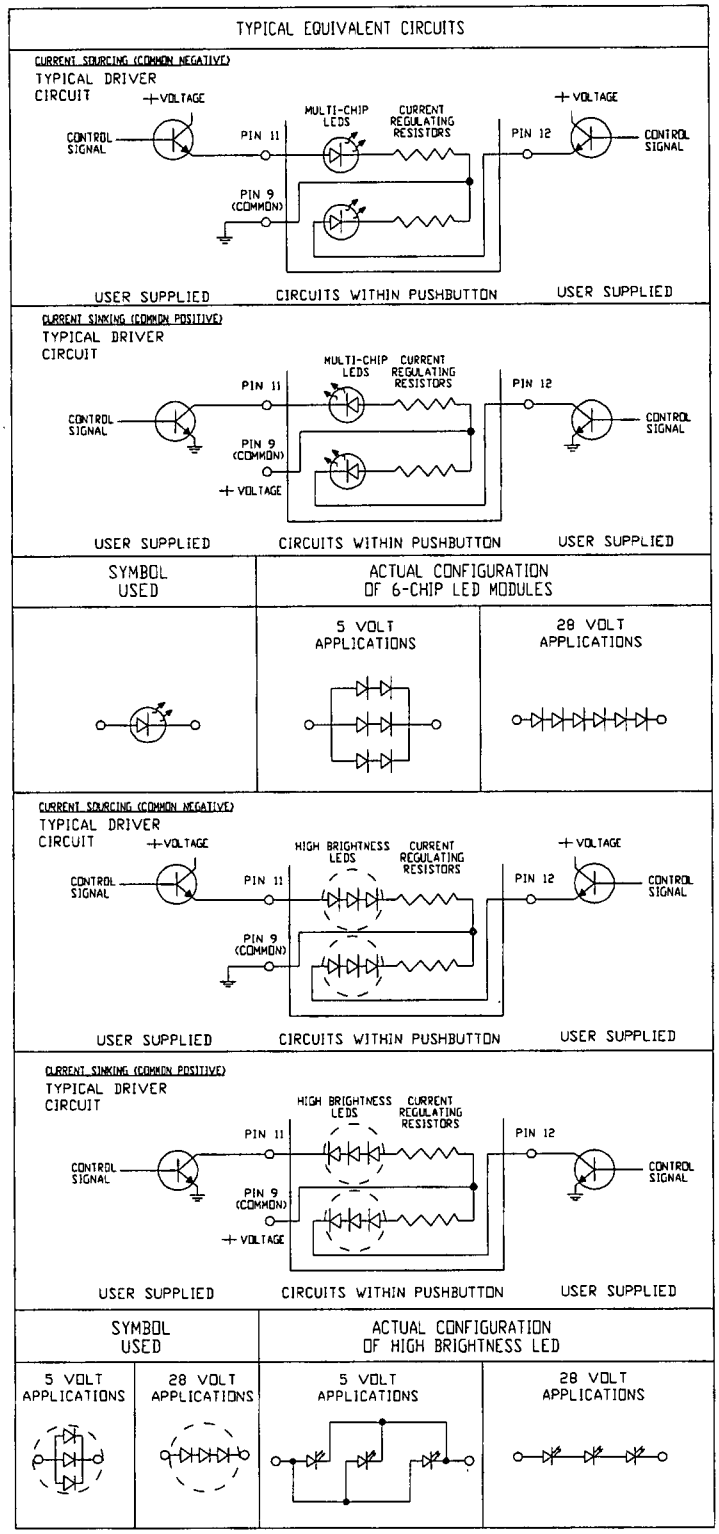


Figure 40 Typical Equivalent LED and Driver Circuits

Note: Please refer to wiring diagrams in Appendices A-E for pushbutton wiring details.

Figure 40, continued...

Part 2 of 2

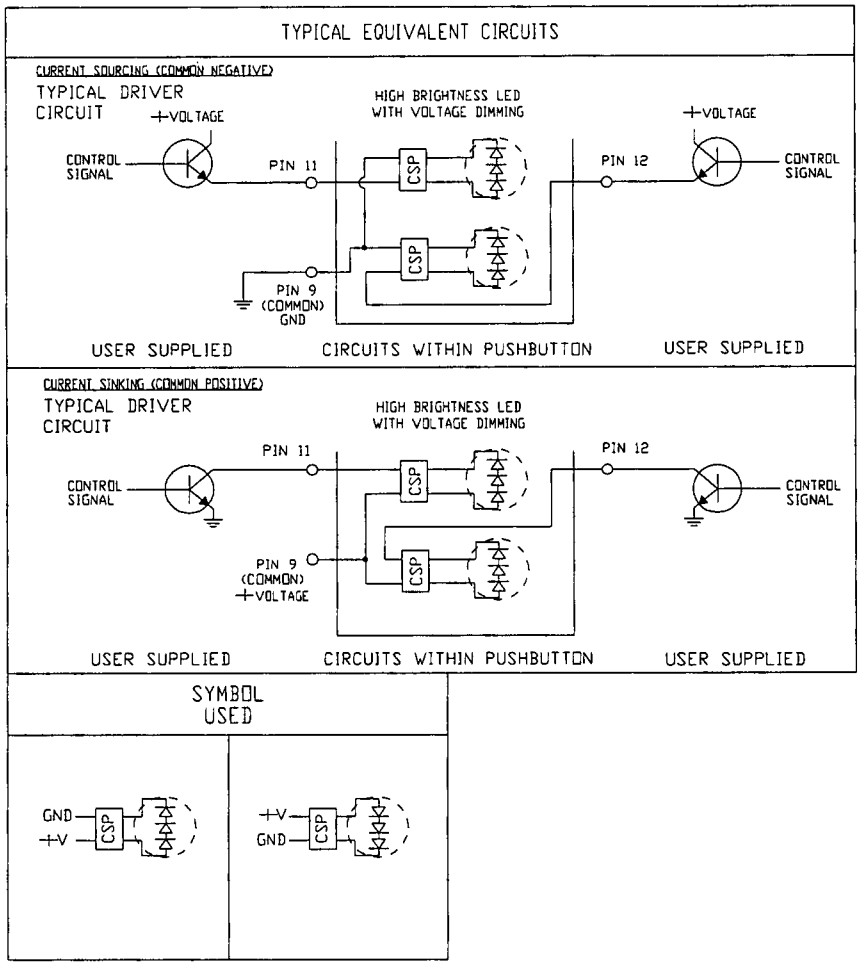


Figure 40 Typical Equivalent LED and Driver Circuits

Note: Please refer to wiring diagrams in Appendices A-E 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 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 the following table:

Table C CONTACT RATINGS

Power Circuits
(silver contacts)

28 V DC Rating			
	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 V AC, 60 Hz Rating			
	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).		

Logic Circuits
(gold contacts)

28 V DC Rating			
	Resistive	Sea Level	1.0 Amps
	Inductive	Sea Level	0.5 Amps

Low Level Circuits
(gold contacts)

	Basic switch, per MIL-S-8805:		
	30 millivolts		30 mA

NOTE: In MIL-PRF-22885/101 the required electrical contact rating for resistive loads is 5 Amps, and the required contact rating for inductive loads is 3 Amps. The above values correspond to the requirements of MIL-PRF-22885/111.

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 ± 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 x 1% = 40 milliohms. (In accordance with MIL-PRF-22885/101, following electrical endurance, contact resistance is not applicable for switches which are tested at the rated inductive load.)

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.

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/deactuation 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 also 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 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 ± 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 V 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 in excess of 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 V 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 in excess of 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 ± 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 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 megaohms. At the end of the specified 24-hour drying period, the insulation resistance shall not be less than 1,000 megaohms.

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.

Table D ENCLOSURE DESIGNS

MIL-PRF-22885 Symbol	Seal Description
1	Unsealed
2	Dripproof 1/
3	Watertight 1/
4	Splashproof 1/

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 gms) and the pushbutton, are given in Table E.

Table E COMPONENT WEIGHT

Assembly	Ounces	Grams
Mdl 93 Switch (DPDT w/ PB & 4 Lamps or LEDs)	0.61	17
Mdl 93 Switch (SPDT w/ PB & 4 Lamps or LEDs)	0.58	16
Mdl 93 Indicator (w/ PB & 4 Lamps or LEDs)	0.50	14
Mdl 99 Switch (DPDT w/ PB & 4 Lamps or LEDs)	1.09	31
Mdl 99 Switch (SPDT w/ PB & 4 Lamps or LEDs)	1.06	30
Mdl 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:

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. (NOTE: MIL-PRF-22885/101 requires only 50,000 cycles.)

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, relamped 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 Latchdown Actuation and Displacement

On alternate action (maintained) contact switches, the pushbutton is retained in a latchdown 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

Per MIL-PRF-22885/101, 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 relamping operations.

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-numerics shall be viewable from a distance of 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 F VIEWING AREA

Viewing Area	Nominal Dimensions Inch (mm)
Full Screen	.495" (12.57) square
Half Screen, Horizontal	.495 x .217" (12.57 x 5.51)
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 6A. When lamps are not furnished with the pushbuttons, a removable fiberboard plate 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 6A. These have a mean spherical candle power (MSCP) tolerance of ± 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 ±.01 MSCP.

4.5.3.2 Multi-Chip Light Emitting Diodes (LEDs)

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 in Section 5, Table 6B. These multi-chip LEDs are an integral part of the pushbutton and are not field replaceable.

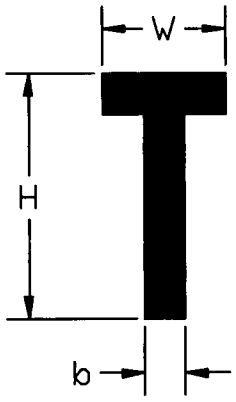
4.5.3.3 High Brightness (HB) Light Emitting Diodes (LEDs)

The High Brightness LED pushbuttons shall have three individual LEDs per quadrant. Unless otherwise specified, the operating voltage options for HB LED pushbuttons with ballast resistors are 5 or 28 VDC. The operating voltage range for HB LED pushbuttons with voltage dimming device is from 8.4 VDC to 28 VDC. The LED polarity and other options are as specified in Section 5, Table 6C. The High Brightness (HB) Light Source Assembly is field replaceable and the various configurations are detailed under the P/Ns in section 5.8.16.

4.5.4 Legends

4.5.4.1 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:



LETTER HEIGHT-TO-WIDTH RATIO
FOR THE LETTER "T" (SHOWN) ≈ 2

STROKE WIDTH RATIO $\frac{H}{b} \approx 6:1$

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 .072, .087, .100, .125 and .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 G.

Table G STANDARD LEGEND SIZES

.072" ABCDEFGHIJKLMNOPQRSTUVWXYZ1234567890

.087" ABCDEFGHIJKLMNOPQRSTUVWXYZ1234567890

.100" ABCDEFGHIJKLMNOPQRSTUVWXYZ1234567890

.125" ABCDEFGHIJKLMNOPQRSTUVWXYZ1234567890

.145" ABCDEFGHIJKLMNOPQRSTUVWXYZ1234567890

Other AG2 character heights, available by special order (or, if needed, for special artwork) are: .060, .066, .075, .077, .080, .082, .090, .094, .097, .105, .110, .114, .120, .132, .139, .155, .164, .175, .188, .203, .219, .239, .263, .293, and .329.

4.5.4.3 Standard Character/Symbol Set

The standard AG2 typeface provides capital letters and numerics 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 !, @, #, $, %, &, (,), ', ., +, /, :, ;, =, ?, \, _, <, >, *, ±, °, ½, ¼, ↑, ↓, and others. The entire AG2 character set is shown in Table H.

Table H ALTERNATE GOTHIC NO. 2 CHARACTER SET

ABCDEFGHIJKLMNOPQRSTUVWXYZ

0123456789!@#$%^&*()'.,"+/

:;<=>?_'~≠≒#※↑←→↓∨©

¿¡"«»—®°±¹²³¼½¾ÀÁÂÃÄÅÈÉÊÌÍÎ

ÏÑÒÓÔÕÖÙÚÛÜÝ

TABLE H 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 5 of Section 5. 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 a given area exceed the space available, but by no more than 10%, the characters shall be condensed by 10%, using the same height but less width, in order to accommodate the legend as requested by the customer.

4.5.4.5 Optional Fonts

By special order, Helvetica Light and Helvetica Medium are available in a range of sizes similar to that of AG2. Either of these Helvetica typefaces may also be ordered in their normal, condensed, bold, or expanded variations. Both of these typefaces provide capital letters, numbers, lower case characters, and many of the symbols and European characters identified in the previous paragraph. Examples of the Helvetica type faces are shown in Table I. Due to the increased character width of the Helvetica fonts, the number of characters per line is about one-third less than for AG2.

Table I AVAILABLE FONTS

Alternate Gothic No. 2, the Standard Font:

ABCDEFGHIJKLMNOPQRSTUVWXYZ1234567890

Helvetica Light, Optional Font:

ABCDEFGHIJKLMNOPQRSTUVW
XYZ1234567890abcdefghijklmno

Helvetica Medium, Optional Font:

ABCDEFGHIJKLMNOPQRSTUV
WXYZ1234567890abcdefghijk

4.5.4.6 Math and Greek Symbol Sets

Math symbols and Greek characters ($\alpha, \beta, \Gamma, \pi, \sum, \mu, \tau, \Phi, \theta, \Omega, \delta, \varepsilon,$ etc.) are available by special order and may be mixed with the standard AG2 font. The complete symbol sets for the Math and Greek fonts are shown in Table J.

Table J AVAILABLE GREEK AND MATH SYMBOLS

Greek Symbols, Optional Font:

ABΨΔΕΦΓΗΙΞΚΛΜΝΟΠϑΡΣΤΘ
ΩϑΧΥΖ1234567890αβψδεφγηιξκ
λμνοπφρστθωςχυζ

Math Symbols, Optional Font:

0123456789!"‖∓'()×+±− . /:: :<=>∦√
∅∈⊂≒≅≮∴∟≠≶∞∮⊥∪≤≡≙≃−:[\]∦∇∼
⊃÷≈≃≯∵→≧≳∝∫⊢∩≥≢≙≑∂{|}~

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 "PCX" files on IBM PC-compatible diskettes.

4.5.4.9 Text and Graphics 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 K, which follows, along with the corresponding symbol used in MIL-PRF-22885.

Table K DISPLAY TYPES DEFINED

Series 90 Type	MIL-PRF-22885 Symbol	Description
1	C	COLORED BACKGROUND: Legends appear black against a colored background, when nonilluminated and illuminated
2	B	HIDDEN LEGEND: Black legend on a colored background when lighted, black legend on a black background when unlighted.
3	H	HIDDEN LEGEND: Legend appears in color on a black background when lighted, but is hidden with black on black appearance when unlighted. (Similar to Type 6 except contrast requirements do not apply.)
4	N	LIGHTED LETTERS: Legend appears white on a black background until illuminated and then legend appears in color, background remains black.
5	W	LIGHTED BACKGROUND: Legend appears black on a white background until illuminated and then background appears in color, legend remains black.
6	S	SUNLIGHT READABLE: Legend not legible until illuminated, and then characters appear in color, background remains black.
7	S	NIGHT-VISION GOGGLE COMPATIBLE: Same appearance as Type 6. Legend appears in color of NVG-compatible filter when illuminated.
8	B	CUSTOMER REPLACEABLE LEGEND: Similar to Type 2 Display.
9	W	CUSTOMER REPLACEABLE LEGEND: Similar to Type 5 Display.
0	H	CUSTOMER REPLACEABLE LEGEND: Similar to Type 6 Display, except contrast ratio requirements do not apply.

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. 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. Figure 41 illustrates how these particular assemblies are put together. 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.

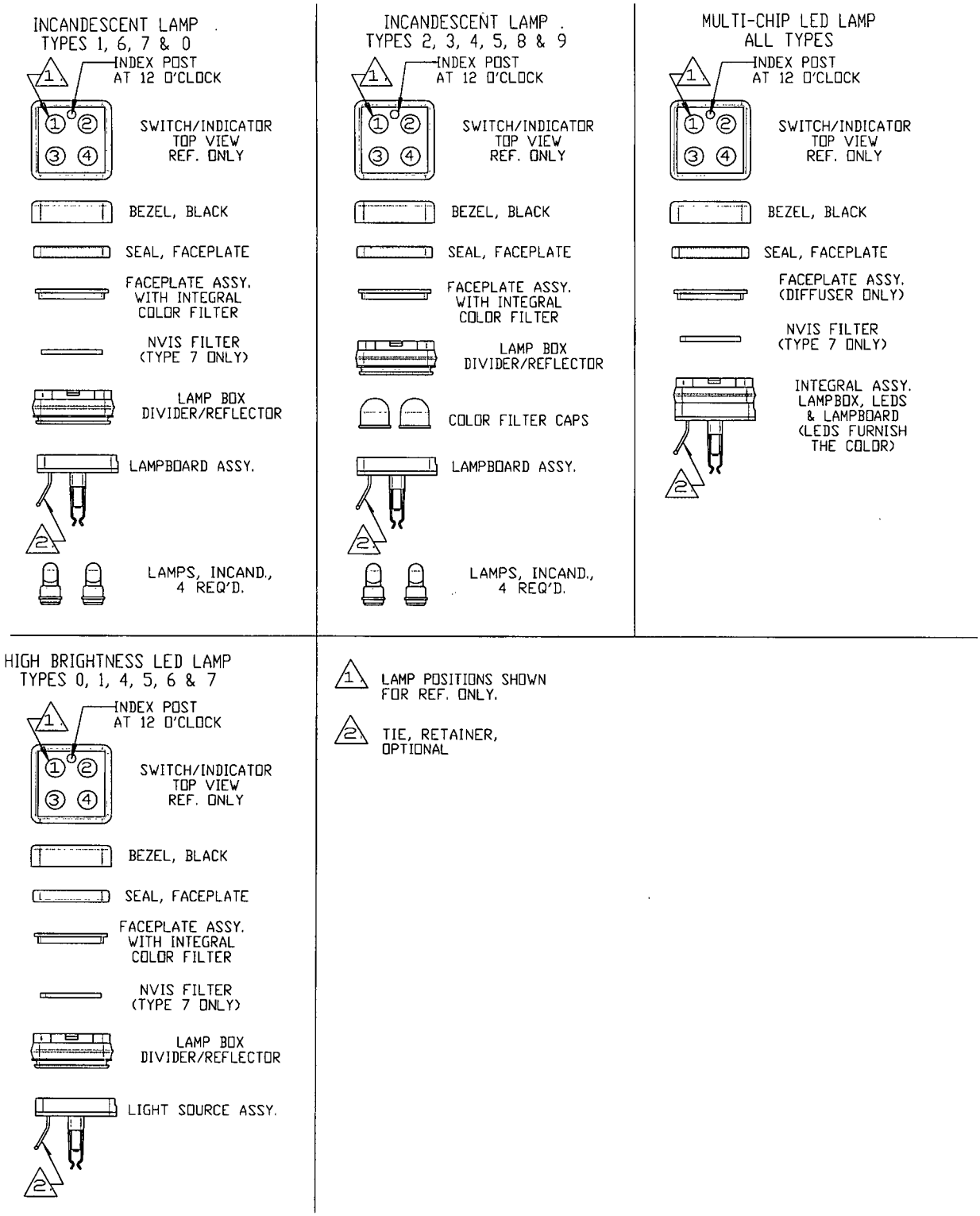


Figure 41 Typical Pushbutton Construction

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. Figure 42 illustrates the stack-up and surface orientation for these display types.

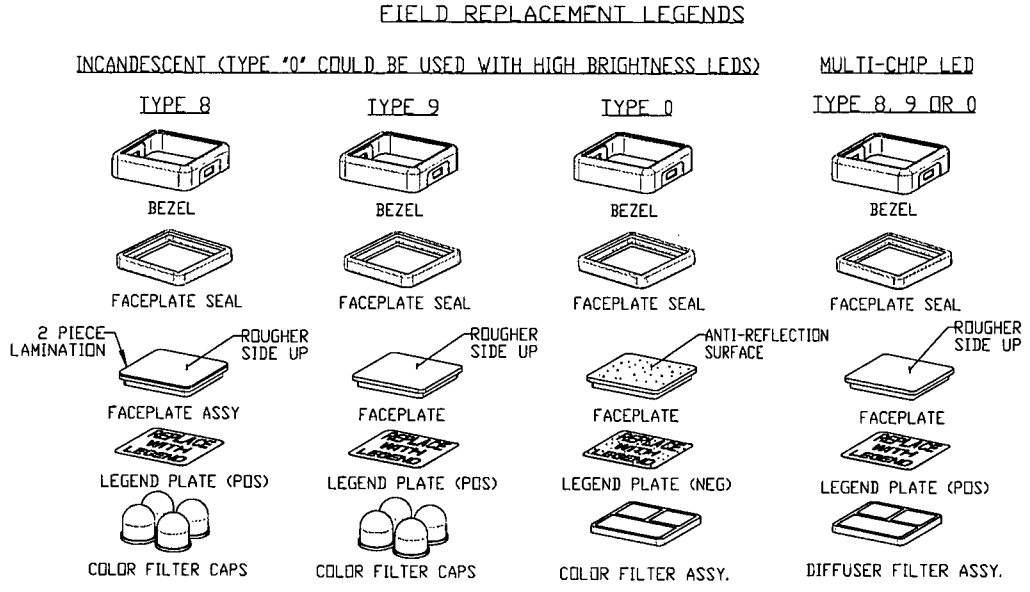


Figure 42 Faceplate Assemblies for Replaceable Legend Plates

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).

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 StacoSwitch 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 lampbox, and the legend used in the test. QPL tests are conducted with a standard test legend, the specified lampbox configuration and utilize lamp type 3071 (5 volt, with a Kelvin temperature of 2350 °K). Results with other legends, lampbox 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 ± .01.

Unless otherwise specified, standard catalog lamps have mscp values with a tolerance of ± 25%. Refer to Section 5 Table 6A 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 millicandellas, 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 amp ± .001 through the LED junctions. (See Table 6B of Section 5 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 6C for current specification of High Brightness LEDs. The dimming characteristics of High Brightness LEDs with CSP device is depicted in Figure 39.

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 M 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.

Table L LUMINANCE PERFORMANCE -- INCANDESCENT LIGHTING

Part 1 of 2

DISPLAY TYPE		COLOR			LUMINANCE (footlamberts)		
Ser 90 Code	M22885 Symbol	Ser 90 Code	M/101 Code	Color Description	M/101 Spec.	Ser 90 Typical	Notes
1	C	0	W	White	350/175	370	
1	C	1	R	Red	80/40	150	
1	C	2	G	Green	60/30	180	
1	C	3	Y	Aviation Yellow	350/175	550	
1	C	4	D	Lunar White	300/175	390	
1	C	5	- - -	Lemon Yellow	N/A	690	
1	C	6	B	Blue	40/20	75	
1	C	7	Z	Aviation Green	60/30		
2	B	0	W	White	N/A	170	
2	B	1	R	Red	N/A	30	
2	B	2	G	Green	N/A	35	
2	B	3	Y	Aviation Yellow	N/A	110	
2	B	4	D	Lunar White	N/A	80	
2	B	5	- - -	Lemon Yellow	N/A	150	
2	B	6	B	Blue	N/A	10	
2	B	7	Z	Aviation Green	N/A		Uses /016
3	H	0	W	White	N/A	150	
3	H	1	R	Red	N/A	30	
3	H	2	G	Green	N/A	35	
3	H	3	Y	Aviation Yellow	N/A	100	
3	H	4	D	Lunar White	N/A	70	
3	H	5	- - -	Lemon Yellow	N/A	140	
3	H	6	B	Blue	N/A	10	
3	H	7	Z	Aviation Green	N/A		
4	N	0	W	White	N/A	110	
4	N	1	R	Red	N/A	20	
4	N	2	G	Green	N/A	20	
4	N	3	Y	Aviation Yellow	N/A	70	
4	N	4	D	Lunar White	N/A	50	
4	N	5	- - -	Lemon Yellow	N/A	120	
4	N	6	B	Blue	N/A	6	
4	N	7	Z	Aviation Green	N/A	30	
4*	N	*	W	White	300/150	750	*92P0067-05
4*	N	*	R	Red	50/25	150	*92P0067-06
4*	N	*	G	Green	40/20	185	*92P0067-07
4*	N	*	Y	Aviation Yellow	200/100	500	*92P0067-08
4*	N	*	D	Lunar White	250/150		*92P0067-10
4*	N	*	B	Blue	25/12	45	*92P0067-09
4*	N	*	Z	Aviation Green	40/20		*92P0067-11

Table L, continued...

Part 2 of 2

LUMINANCE PERFORMANCE -- INCANDESCENT LIGHTING

DISPLAY TYPE		COLOR			LUMINANCE (footlamberts)		
Ser 90 Code	M22885 Symbol	Ser 90 Code	M/101 Code	Color Description	M/101 Spec.	Ser 90 Typical	Notes
5	W	0	W	White	300/150	600	
5	W	1	R	Red	70/35	120	
5	W	2	G	Green	50/25	170	
5	W	3	Y	Aviation Yellow	350/175	450	
5	W	4	D	Lunar White	N/A	350	
5	W	5	- - -	Lemon Yellow	N/A	690	
5	W	6	B	Blue	30/12	50	
5	W	7	Z	Aviation Green	50/25	190	
6	S	0	W	White	275/225	480	
6	S	1	R	Red	185/150	195	
6	S	2	G	Green	185/150	210	
6	S	3	Y	Aviation Yellow	275/225	600	
6	S	4	D	Lunar White	250/200	510	
6	S	5	- - -	Lemon Yellow	N/A	900	
6	S	6	B	Blue	85/- - -	50	
6	S	7	Z	Aviation Green	250/200	375	
7	S	1	L	NVIS Red	N/A	35	
7	S	2	J	NVIS Green B	N/A	160	
7	S	5	K	NVIS Yellow	N/A	275	
7	S	6	H	NVIS Green A	N/A	105	

NOTES:

1. "Display Type, Series 90 Code" identifies the code used in coded part number. Also see Table K Display Types Defined, and Section 5 Table 7 for Display Type Description.
2. "Display Type, M22885 Symbol" identifies symbol used in MIL-PRF-22885.
3. "Color, Series 90 Code" specifies colors. Also see Table O for tabulation of Illuminated Color Limits, CIE Charts of Figures 43 and 46, and Section 5 Table 8 for Cell Color coding.
4. "M/101 Code" is color symbol per MIL-PRF-22885/101.
5. "Luminance (Foot Lamberts), M/101 Spec." are values per MIL-PRF-22885/101. The two values are "without/with EMI/RFI".
6. "Luminance Values, Series 90 Typical" refers to typical values measured on Ser 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-22885/101 Table IV, Type N.

Table M LUMINANCE PERFORMANCE -- MULTI-CHIP LED LIGHTING

DISPLAY TYPE		COLOR			LUMINANCE (Foot Lamberts)		
Ser 90 Code	M22885 Symbol	Ser 90 Code	M/111 Code	Color Description	Ser 90 Typical	M/111 Spec.	Notes
4	N	1	RD	Red	100	70	
4	N	2	GR	Green	65	55	
4	N	3	AY	Amber Yellow	105	85	
4	N	7	LG	Lime Green	130	170	
4	N	8	OR	Orange	85	70	
5	W	1	RD	Red	100	70	
5	W	2	GR	Green	65	55	
5	W	3	AY	Amber Yellow	85	85	
5	W	7	LG	Lime Green	130	170	
5	W	8	OR	Orange	85	70	
6	S	1	RD	Red	70	70	
6	S	2	GR	Green	55	55	
6	S	3	AY	Amber Yellow	85	85	
6	S	7	LG	Lime Green	100	170	
6	S	8	OR	Orange	70	70	
7	S	1	LL	NVIS Red	9	8	
7	S	2	JJ	NVIS Green B	48	40	
7	S	5	KK	NVIS Yellow	94	50	

NOTES:

1. Display Type, Series 90 Code, also see Table 7, Section 5.
2. Display Type, "M22885" Symbol, per MIL-PRF-22885.
3. Color, Series 90 Code, see Figures 44, 46, and Sec 5 Table 8.
4. Color and Luminance, "M/111" per MIL-PRF-22885/111.

Table N LUMINANCE PERFORMANCE -- HIGH BRIGHTNESS LED LIGHTING

DISPLAY TYPE		COLOR		LUMINANCE (footlamberts)	
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 7, Section 5.
2. Display Type, "M22885" Symbol, per MIL-PRF-22885.
3. Color, Series 90 Code, see Figures 45, 46, and Sec 5 Table 8.

4/ All luminance values are preliminary and subject to changes. Contact factory for updated information.

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 volt 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 ± .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 in accordance with MIL-PRF-22885/101 for incandescent configurations, per MIL-PRF-22885/111 for LED configurations, per MIL-L-85762, and MIL-STD-3009 for all NVIS-compatible configurations.

Figure 43 shows the standard colors for incandescent versions of the Series 90 plotted on the CIE 1931 Chromaticity Diagram.

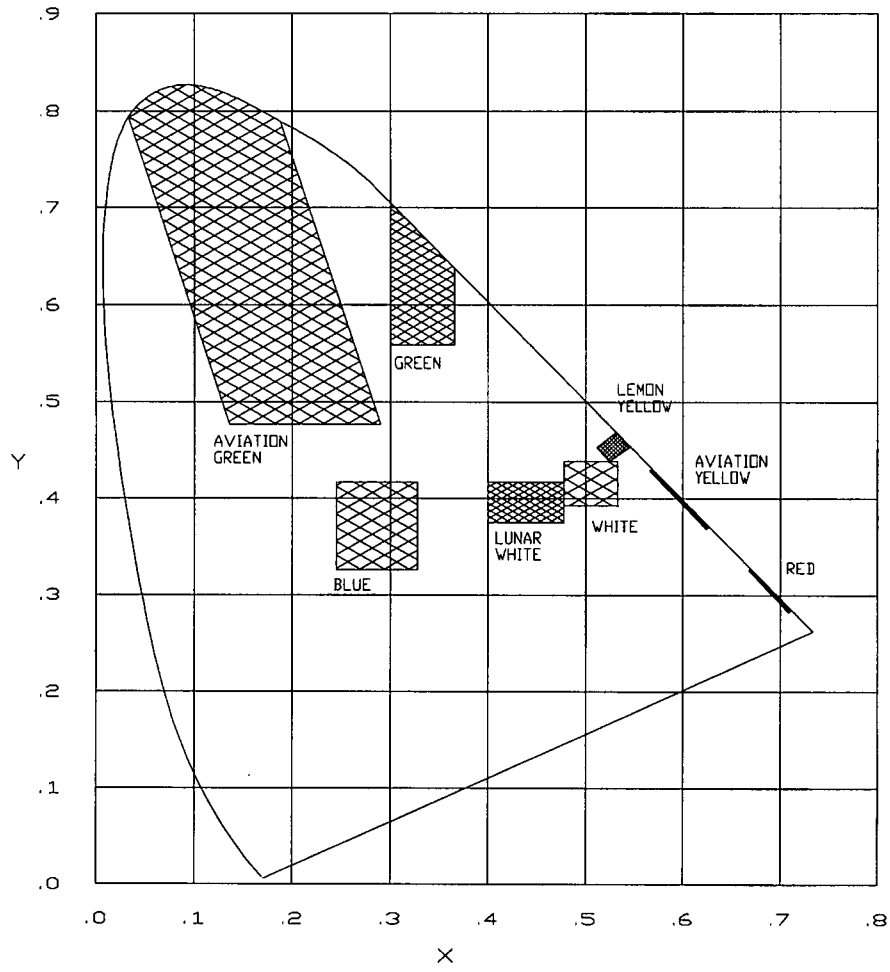


Figure 43 Incandescent Colors-CIE 1931 Chromaticity Diagram

Multi-chip LED colors are shown in the CIE 1931 Chromaticity Diagram of Figure 44.

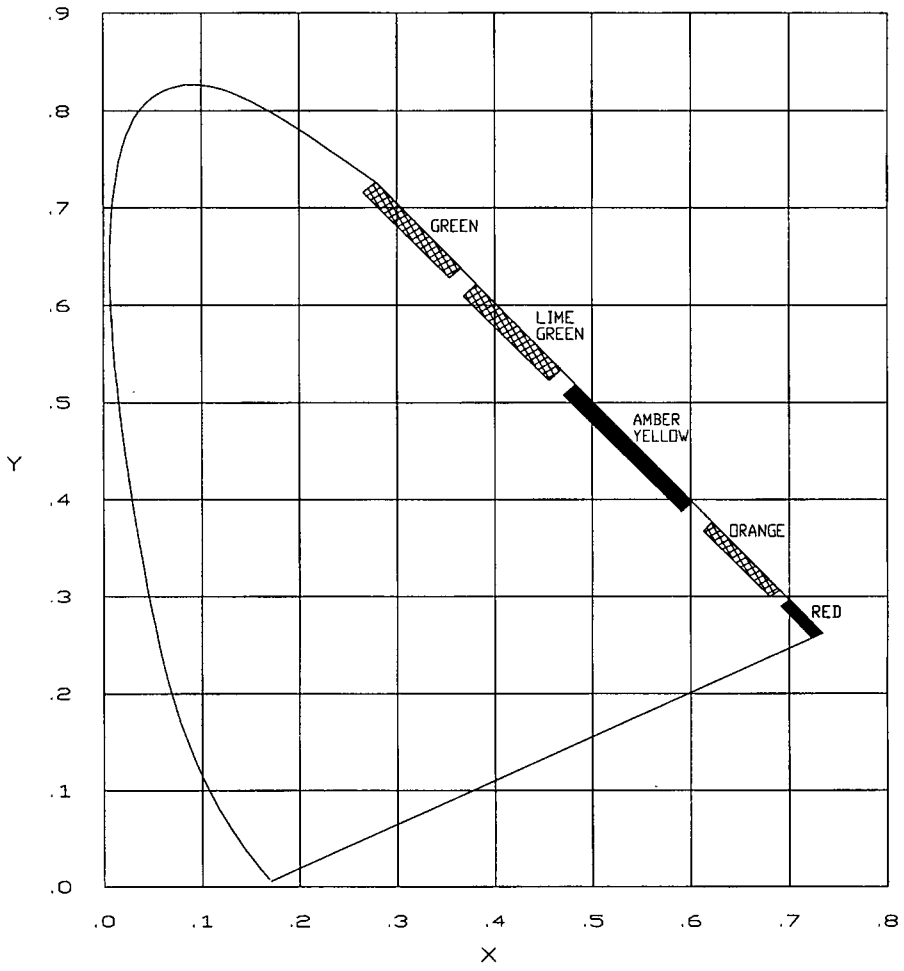


Figure 44 Multi-Chip LED Colors-CIE 1931 Chromaticity Diagram

High Brightness LED colors are shown in the CIE 1931 Chromaticity Diagram of Figure 45. Note: The color limits of the Chromaticity Diagram of Figure 45 and Table O are preliminary and subject to change.

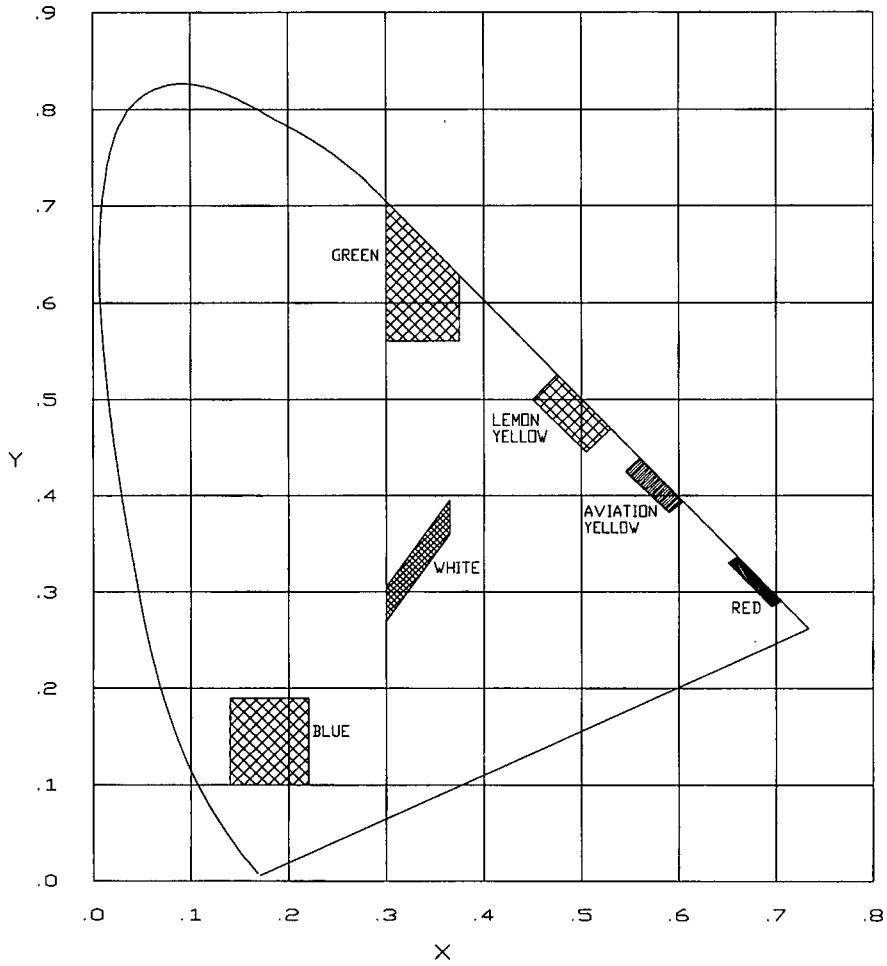


Figure 45 High Brightness LED Colors-CIE 1931 Chromaticity Diagram

NVIS-compatible color areas are plotted in the CIE 1976 Chromaticity Diagram format of Figure 46.

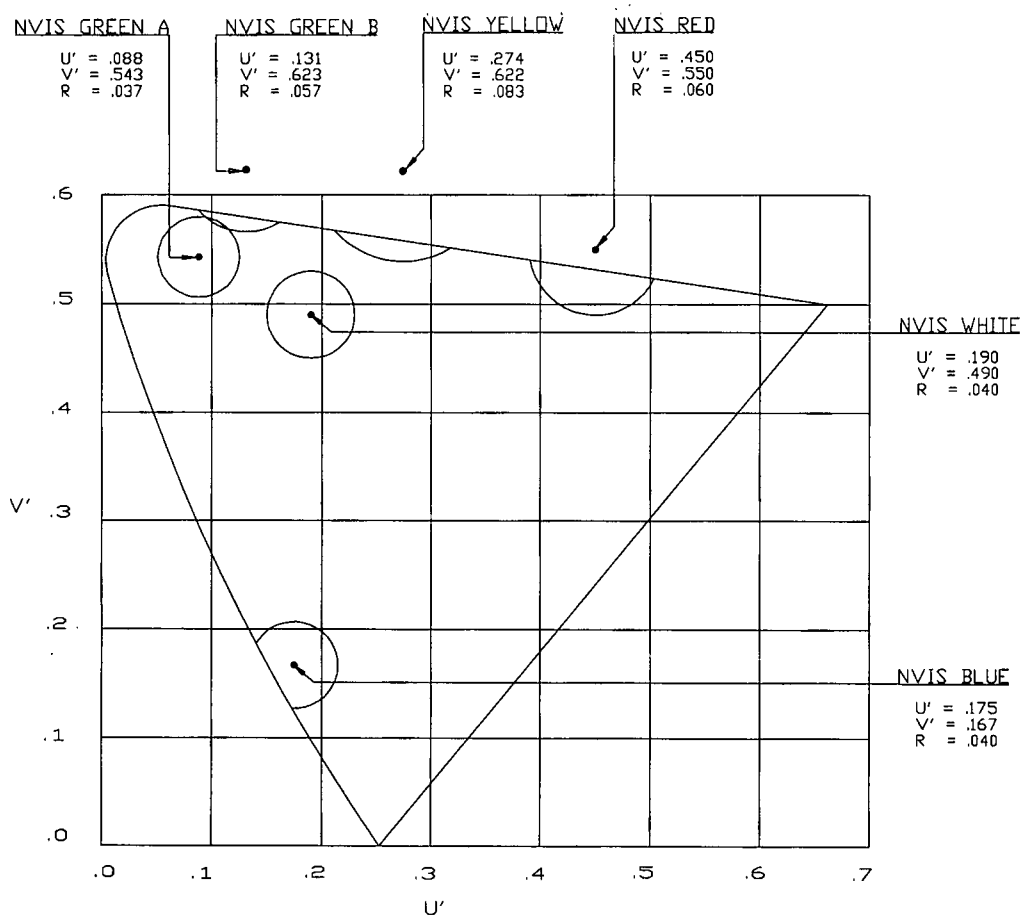


Figure 46 NVIS Compatible Colors-CIE 1976 Chromaticity Diagram

The NVIS blue values are preliminary data.

Table O provides the Illuminated Color Limits by X-Y coordinates for standard colors of both incandescent and LED configurations.

Table O ILLUMINATED COLOR LIMITS[1]

COLOR (CODE)	INCANDESCENT VERSION 3/ x	INCANDESCENT VERSION 3/ y	MULTI-CHIP LED VERSION 4/ x	MULTI-CHIP LED VERSION 4/ y	HIGH BRIGHTNESS LED VERSION 9/ x	HIGH BRIGHTNESS LED VERSION 9/ y
WHITE (0)	0.480	0.395	----	----	0.300	0.270
	0.480	0.435	----	----	0.300	0.305
	0.540	0.431	----	----	0.365	0.395
	0.540	0.391	----	----	0.365	0.360
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/ (3) MULTI-CHIP LED: AMBER YELLOW	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/ (7) MULTI-CHIP LED: LIME GREEN	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 (for Table O, ILLUMINATED COLOR LIMITS):

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, 5 VDC, T-1 midget-flange base, subminiature, aged and selected, with .15 ± .01 mean spherical candlepower (MSCP), and operating at a color temperature of 2350 °K.

4/ Chromaticity values for LED light sources are at full rated voltage.

5/ "Aviation Yellow" replaces previous Series 90 "Amber Yellow" without change to the filter color or material. Color coordinates are per MIL-PRF-22885/101 Rev C, and include the area previously called "Amber Yellow".

6/ "Lunar White" replaces previous Series 90 "Blue White" without change to the filter color or material. Coordinates were introduced with Rev C of MIL-PRF-22885/101 and include area of Series 90 "Blue White".

7/ Blue is not recommended for displays required to operate in high-intensity lighting (sunlight readable) environments if the light source is from incandescent lamps.

8/ "Aviation Green" is a new color introduced with Rev C of MIL-PRF-22885/101.

9/ 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 actually 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 C_L and C_{UL} shall be calculated for each character.

The lighted contrast (ON/BACKGROUND) is defined by

$$C_L = (B_2 - B_1)/B_1$$

The unlighted contrast (OFF/BACKGROUND) is defined by

$$C_{UL} = (B_3 - B_1)/B_1$$

B_1 = Average background luminance
B_2 = Average character luminance, legend lighted
B_3 = Average character luminance, legend unlighted

Lamps for testing shall be aged and selected for a mean spherical candlepower (mscp) of .15 ± .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 deadfront (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 Dripproof, Splashproof or Watertight seals. SLR requirements do not apply to Solvent Resistant or Hazardous Environment Seals.

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 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 P, which follows, and are shown graphically in CIE chart form in Figure 46.

Table P CHROMATICITY REQUIREMENTS OF NVIS-COMPATIBLE LIGHT SOURCES

NVIS COLOR	1976 UCS CHROMATICITY COORDINATES			LUMINANCE
	u'	v'	r	fL
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 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 measurement 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 Q, 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 Q NVIS 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	----	$1.7x10^{-10}$	----	$1.7x10^{-10}$	0.1
Green B	----	$1.7x10^{-10}$	----	$1.7x10^{-10}$	0.1
Yellow	$5.0x10^{-8}$	$1.5x10^{-7}$	$4.7x10^{-8}$	$1.4x10^{-7}$	15
Red	NOT APPLICABLE		$4.7x10^{-8}$	$1.4x10^{-7}$	15
White	----	$1.0x10^{-9}$	----	$1.0x10^{-9}$	0.1
Blue	----	$1.7x10^{-10}$	----	$1.7x10^{-10}$	0.1
TYPE II 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	----	$1.7x10^{-10}$	----	$1.7x10^{-10}$	0.1
Green B	----	$1.7x10^{-10}$	----	$1.7x10^{-10}$	0.1
Yellow	----	$1.5x10^{-7}$	----	$1.4x10^{-7}$	15
Red	NOT APPLICABLE		----	$1.4x10^{-7}$	15
White	----	$1.0x10^{-9}$	----	$1.0x10^{-9}$	0.1
Blue	----	$1.7x10^{-10}$	----	$1.7x10^{-10}$	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 R, compares the performance of incandescent, multi-chip LED and High Brightness LED lighted pushbuttons to the values of Table Q. 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 current 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 R.

Multi-chip LED NVIS Green B, Yellow and Red: All multi-chip LED configurations meet chromaticity, and NVIS radiance for both NRA 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 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	----	----	PASS	N/A	----	----	N/A	----	----	PASS	N/A	PASS	PASS
Max NR_A	PASS	PASS	PASS	N/A	PASS	PASS	N/A	PASS	PASS	PASS	N/A		
Class B:													
Min NR_B	----	----	PASS	----	----	PASS	----	----	----	PASS	----	PASS	PASS
Max NR_B	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS		
Type II Class A:													
Min NR_A	----	----	----	N/A	----	----	N/A	----	----	----	N/A	PASS	PASS
Max NR_A	PASS	PASS	PASS	N/A	PASS	PASS	N/A	PASS	PASS	PASS	N/A		
Class B:													
Min NR_B	----	----	----	----	----	----	----	----	----	----	----	PASS	PASS
Max NR_B	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, MIL-PRF-22885/101, nor MIL-PRF-22885/111 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 as follows:

Table S 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).

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 in excess of 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 MIL-PRF-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 in excess of 10 microseconds. At the conclusion of 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 Dripproof 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 dripproof 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 panel seal, into the pushbutton, or into the switch, as determined by visual examination and the dielectric test. Dripproof seal options are ordered for switches using Table 3 and for pushbuttons using either Table 6A, 6B or 6C.

4.7.8 Splashproof 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 splashproof 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. Splashproof seals are also watertight. They may be ordered as described in paragraphs 5.7.2 and 5.7.3 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 5.7.2 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 splashproof 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 5.7.3.

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. This corrosion resistance requirement applies to either sealed or unsealed switch configurations.

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 at the conclusion of the test.

4.7.13 Sand and Dust

(Applies to switches equipped with seals for Dripproof, Splashproof, 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 at the conclusion of 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 Materials 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 StacoSwitch Engineering Design Standard on Dissimilar Metals and to MIL-STD-889 for guidance. The products described in this specification shall use compatible couples with an 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.

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 Plated 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 Plated 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), hydrochloroflurocarbons (HCFC's), methyl chloroform, carbon tetrachloride and halons.]

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

4.9.1.3 Switch/Indicator Housings

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

Unless otherwise specified, pushbuttons shall be marked as follows:

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 (StacoSwitch 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, StacoSwitch document 88105.

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, burrs, 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.

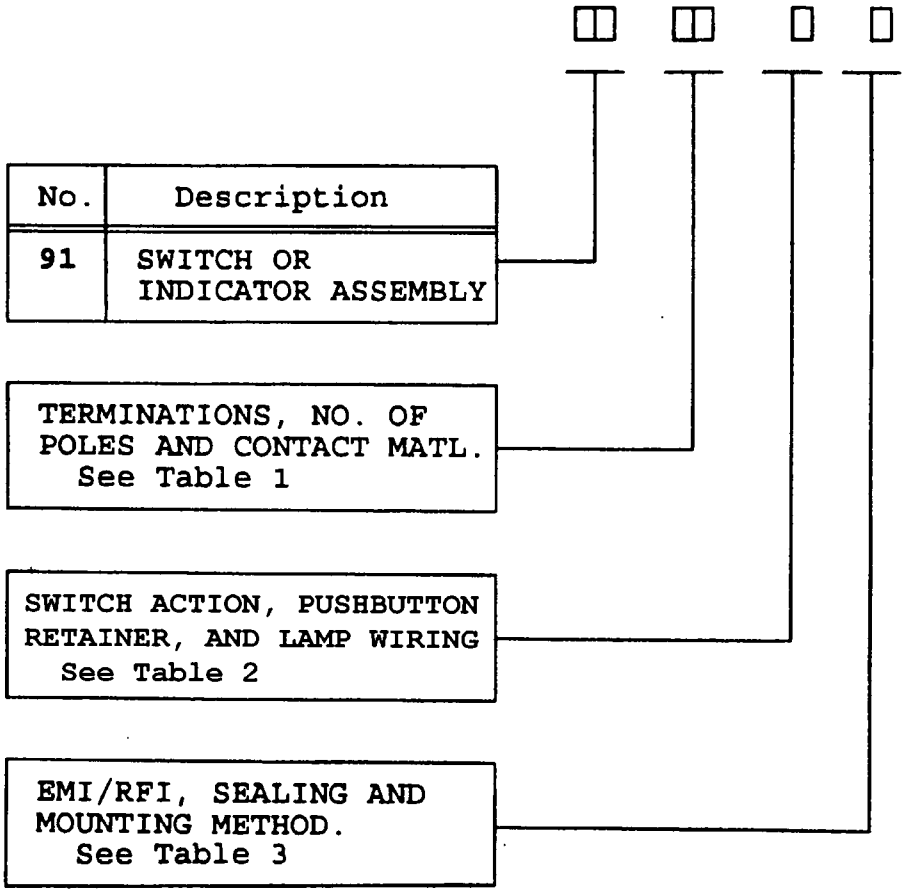
4.9.5 Changes in Specifications

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

5.0 ORDERING INFORMATION

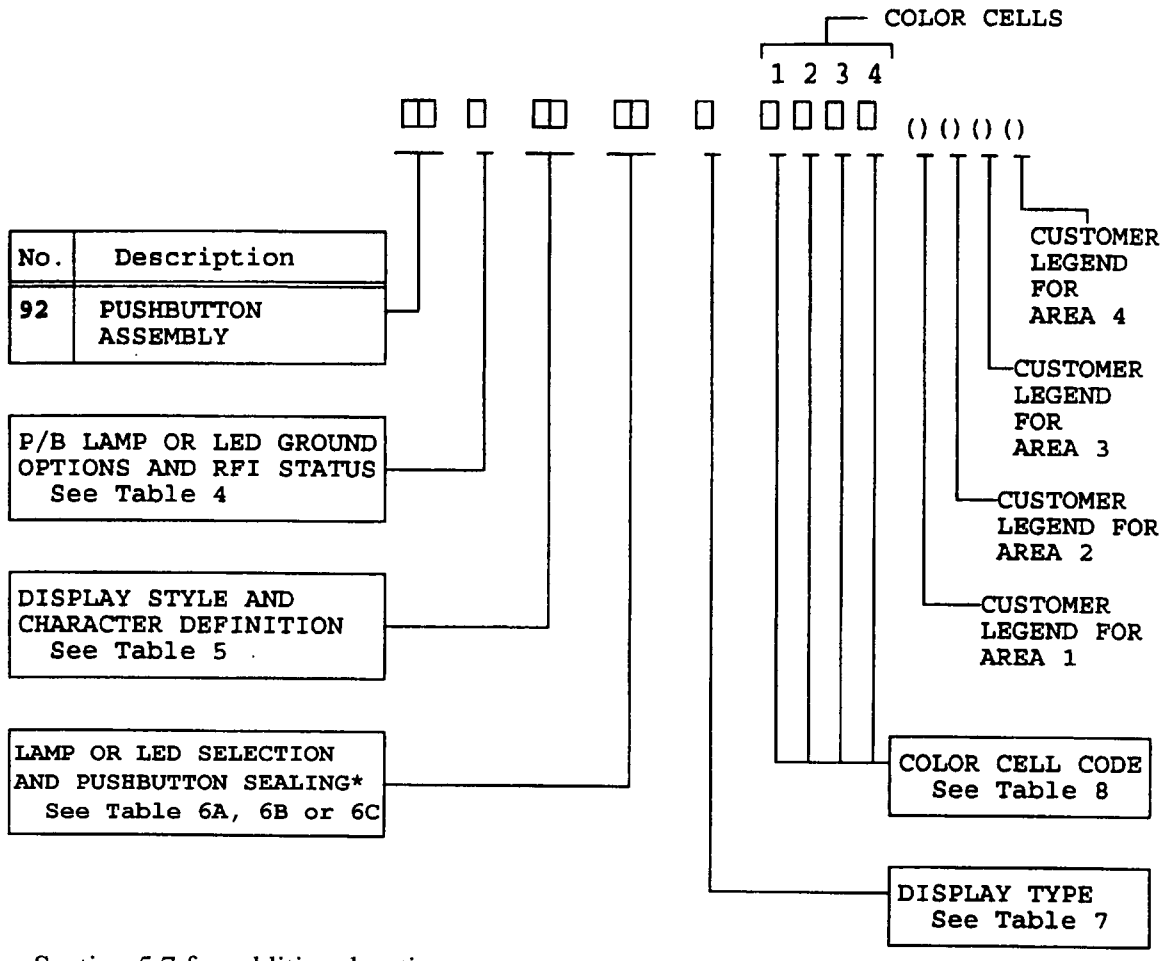
This section contains the information necessary to order each of the standard and optional features of the Series 90 Switch and Indicator configurations described in this specification. The model number (or "coded" part number) of each switch, indicator, pushbutton, or combined assembly, is established by using the configurator charts which follow. Tables 1 through 8 of this section are used to fill in the appropriate code number in each blank, forming the complete part number.

5.1 Model 91 Switches or Indicators Only



A typical switch part number would be **910241**.
This represents a switch (without pushbutton), code **91**; which is DPDT, with silver contacts, and solder-type terminals, code **02** (Table 1); has an alternate action mechanism, no retainer tie, code **4** (Table 2); and is an individual mount, with a dripproof seal, and has no RFI requirements, code **1** (Table 3).

5.2 Model 92 Display Pushbuttons Only



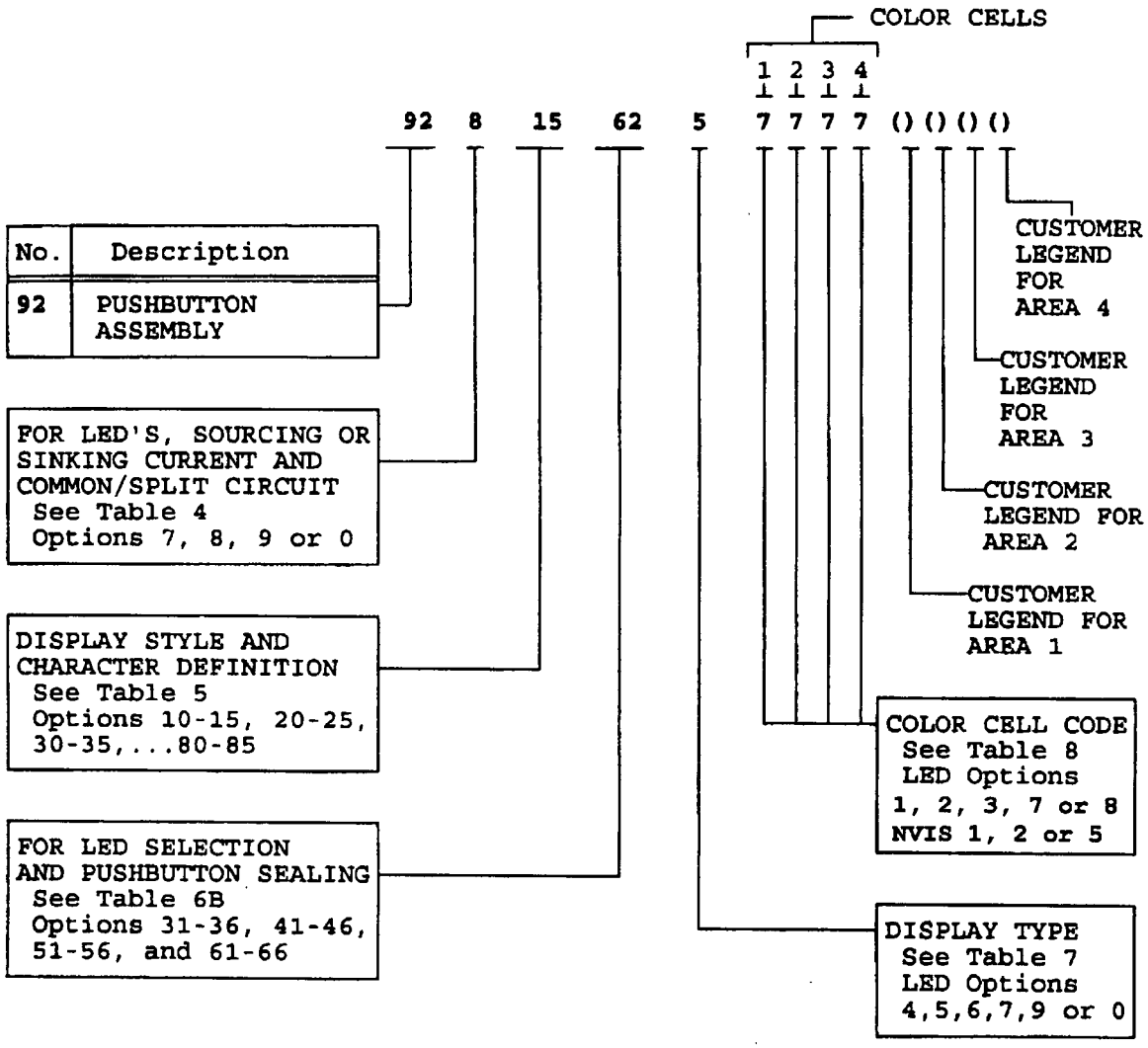
* See Section 5.7 for additional options.

5.2.1 Typical Incandescent Pushbutton

A typical part number would be **921421462231(OIL;OK)(LO)(HOT).**

This pushbutton, code **92**; would be incandescent, common lamp ground, no EMI/RFI requirement (Table 4, code **1**); with a three-way split display screen, with .087" character height (which allows for a maximum of 2 horizontal lines for each of the three areas, and 10 characters per line in area 1, and 5 characters per line in areas 2 and 3), (Table 5, code **42**); unsealed, with 28 V lamps (Table 6A, code **14**); display type has lighted legend with deadfront if unlighted (Table 7, code **6**); with the colors specified as green in color cells 1 and 2 (top half), amber for color cell 3 (lower left quadrant), and red for color cell 4 (lower right quadrant), four digits (Table 8, codes **2,2,3,1**); and, finally, the text with parenthesis identifying the text for each display area, and a semi-colon separating lines within a display area (in this case the word "OIL" is above "OK" in display area 1).

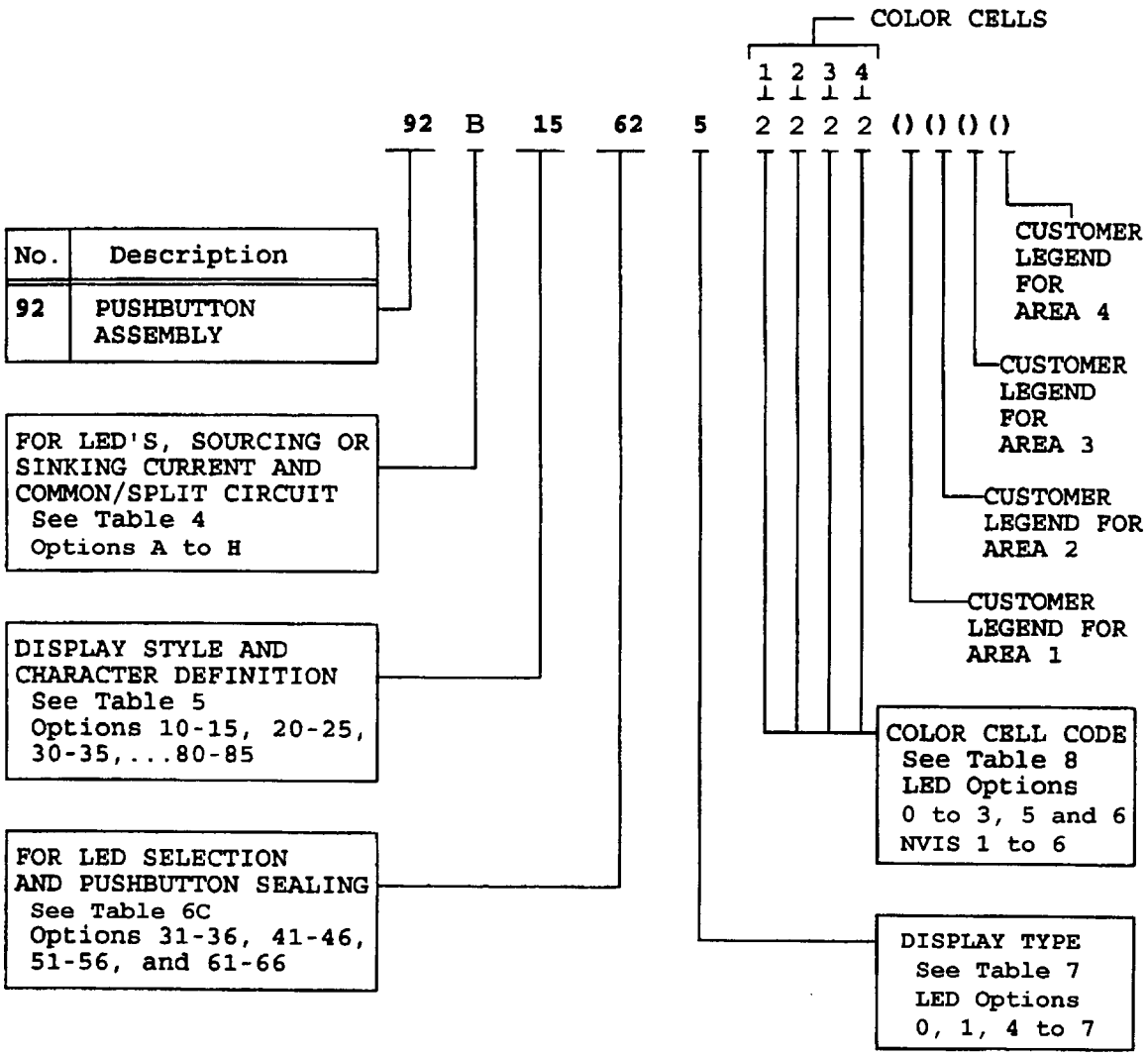
5.2.2 Typical Multi-Chip LED Pushbutton



A typical part number would be **928156257777(MULTI;CHIP)**.

This pushbutton, code **92**; would be multi-chip LED-based, current sinking, with common circuit configuration, which meets EMI/RFI requirements, (Table 4, code **8**); with a full screen display using characters which are .145" high (which typically allows for two lines with up to six characters/spaces per line (Table 5, code **15**); design voltage selected as 28 volts (which uses 30 mA at full brightness), sealed, full screen configuration (Table 6B, code **62**); display type 5 background lighted) (Table 7, code **5**); lime green multi-chip LEDs in all four quadrants (Table 8, codes **7,7,7,7**); and the text of two lines separated by the semi-colon and enclosed in parenthesis.

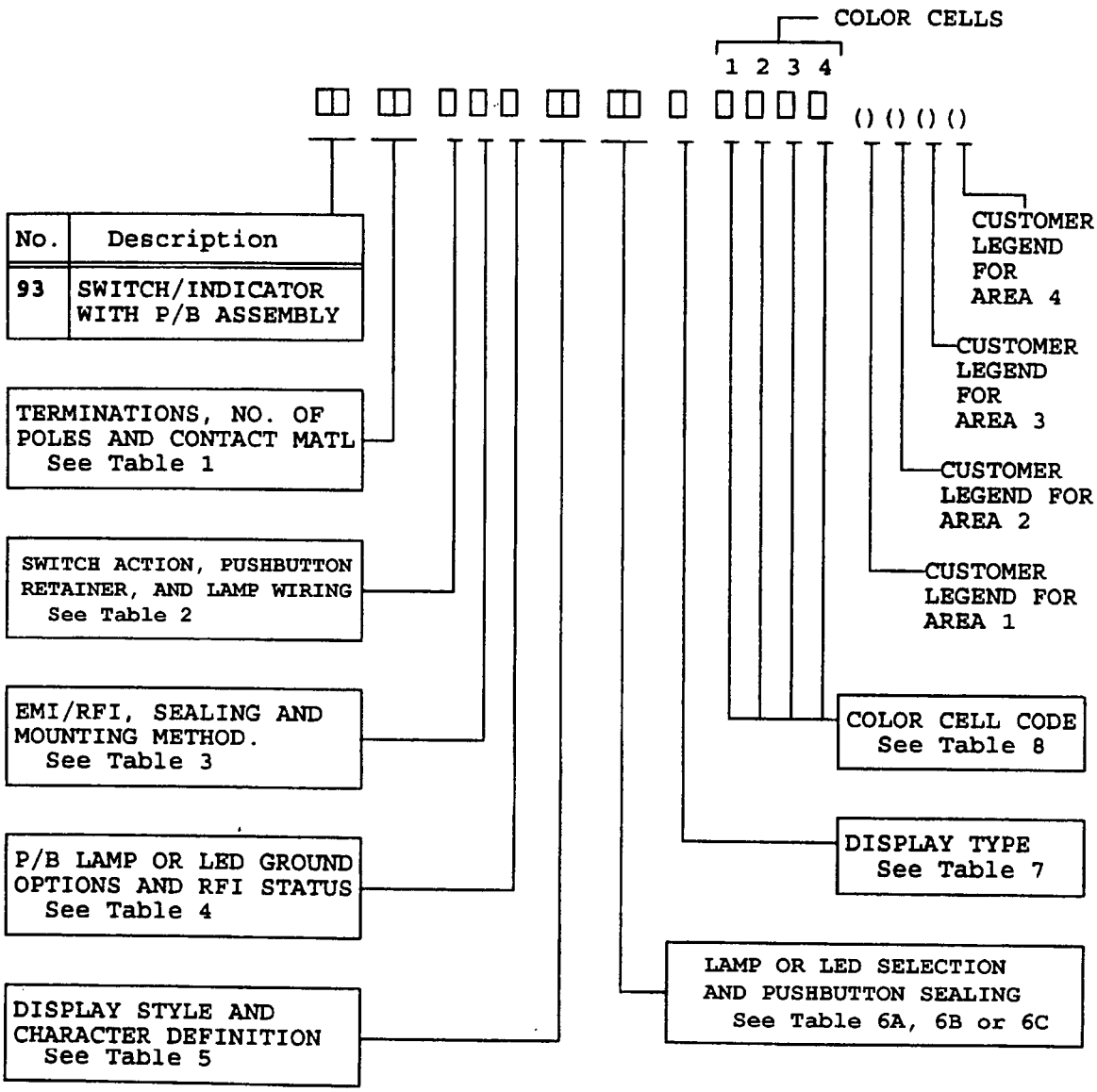
5.2.3 Typical High Brightness LED Pushbutton



A typical part number would be **92B156252222(HB;LED)**.

This pushbutton, code **92**; would be High Brightness LED-based, current sinking, with common circuit configuration, which meets EMI/RFI requirements, (Table 4, code **B**); with a full screen display using characters which are .145" high (which typically allows for two lines with up to six characters/spaces per line (Table 5, code **15**); design voltage selected as 28 volts (which uses 40 mA at full brightness), sealed, full screen configuration (Table 6C, code **62**); display type 5 background lighted) (Table 7, code **5**); green High Brightness LEDs in all four quadrants (Table 8, codes **2,2,2,2**); and the text of two lines separated by the semi-colon and enclosed in parenthesis.

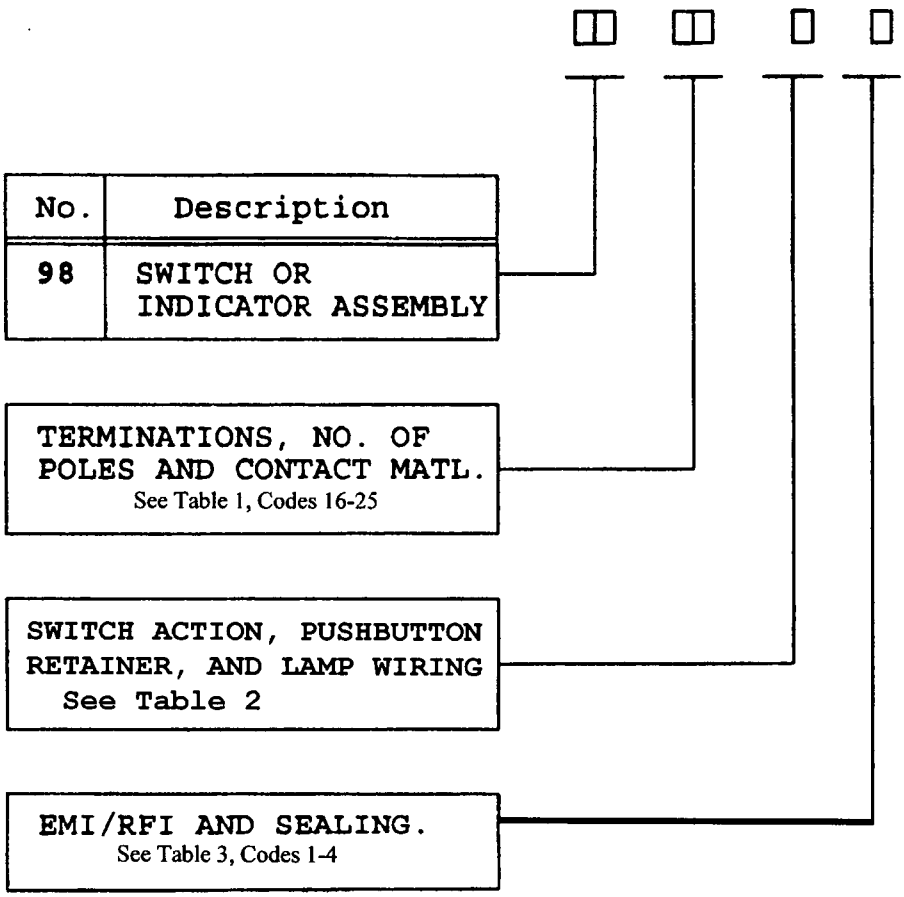
5.3 Model 93 Switches/Indicators with Display Pushbuttons



A typical part number would be **930241-1421462231(OIL;OK)(LO)(HOT)**.

This would be a complete assembly of the switch described in Section 5.1 and the pushbutton example of Section 5.2.1. The hyphen is for internal StacoSwitch use to serve as a delimiter between the switch and pushbutton portions of the part number. This hyphen is not for use in customer documentation or shipping/billing documents.

5.4 Model 98 Switches or Indicators Only



Each Model 98 Switch/Indicator is supplied with a crimp pin termination receptacle installed in its longer housing. (Neither solder terminals nor PCB mount terminations apply to Models 98 or 99.) Switching mechanism and coding for the configurator charts is essentially the same as for the Model 91 Switch/Indicators.

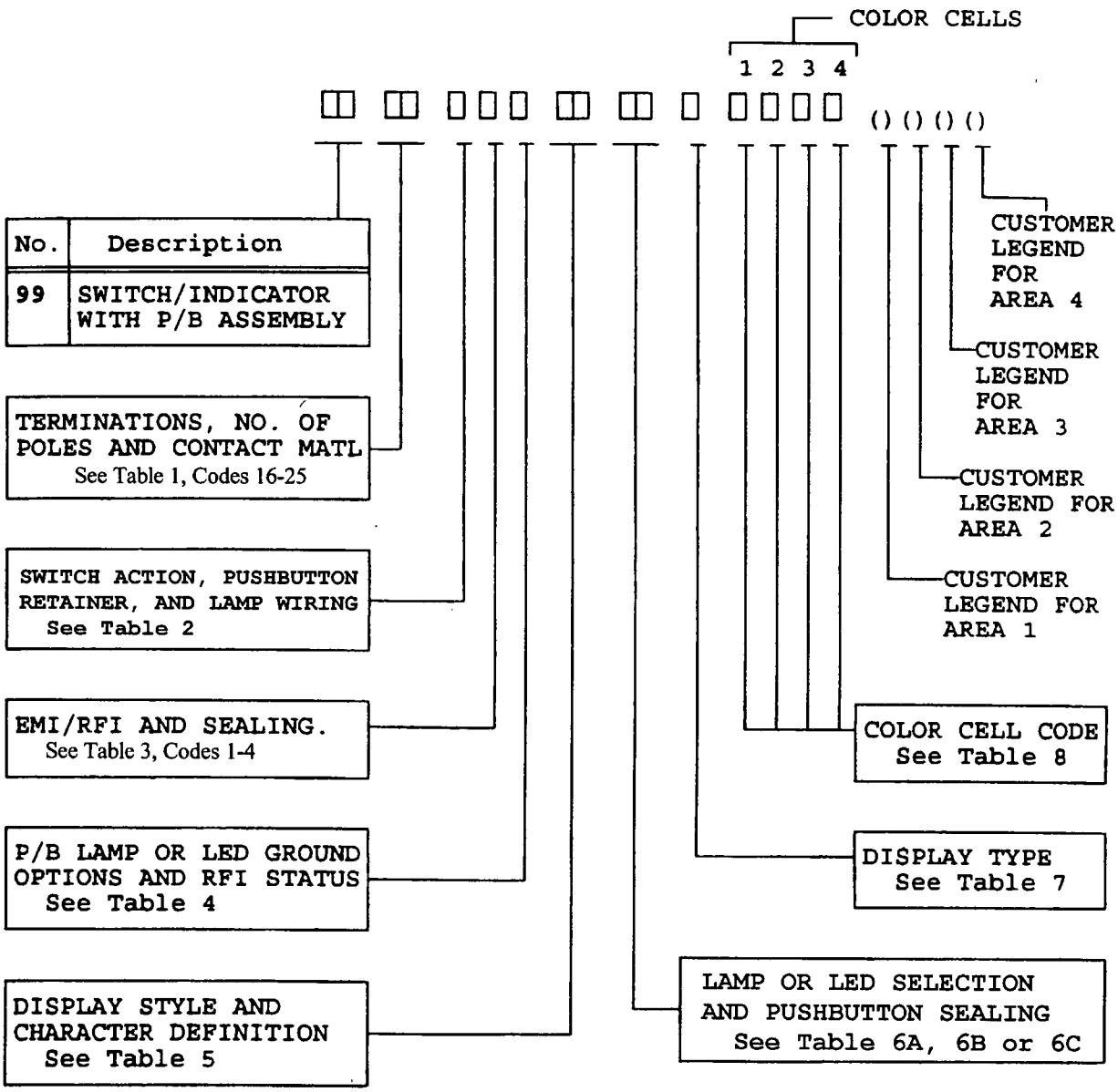
A typical switch part number would be **982441.**

This represents an individually-mounted, MIL-C-39029/22-192 crimp-pin terminated, switch (without pushbutton), code **98**; which is DPDT, with gold contacts, for crimp-pin application, code **24** (Table 1); has an alternate action mechanism, no retainer tie, code **4** (Table 2); has a dripproof seal and no EMI/RFI requirements, code **1** (Table 3).

To order Model 98 switches and MIL-C-39029/16-168 crimp pin terminations separately, use 9816-coded/010 to 9820-coded/010 (for example 981741/010) for switches without termination receptacles, and part number 15197 for the receptacles.

To order Model 98 switches and MIL-C-39029/22-192 crimp pin terminations separately, use 9821-coded/010 to 9825-coded/010 (for example 982241/010) for switches without termination receptacles, and part number 15273 for the receptacles.

5.5 Model 99 Switches/Indicators with Display Pushbuttons



A typical part number would be **992441-8156257777(MULTI;CHIP)**.

This would be a complete assembly of the switch described in Section 5.4 and the pushbutton example of Section 5.2.2. The hyphen is for internal StacoSwitch use to serve as a delimiter between the switch and pushbutton portions of the part number. This hyphen is not for use in customer documentation or shipping/billing documents.

5.6 Configurator Tables

Table 1 TERMINATIONS, CIRCUITRY AND CONTACT MATERIAL

CODE	TYPE OF TERMINATION	NUMBER OF POLES OR INDICATORS	SWITCH CONTACT MATERIAL
01	Solder	Single Pole Double Throw (SPDT)	Silver
02	Solder	Double Pole Double Throw (DPDT)	Silver
03	Solder	Single Pole Double Throw (SPDT)	Gold
04	Solder	Double Pole Double Throw (DPDT)	Gold
05	Solder	Indicator Only	None
06	PCB	Single Pole Double Throw (SPDT)	Silver
07	PCB	Double Pole Double Throw (DPDT)	Silver
08	PCB	Single Pole Double Throw (SPDT)	Gold
09	PCB	Double Pole Double Throw (DPDT)	Gold
10	PCB	Indicator Only	None
16	Crimp Pin 1/	Single Pole Double Throw (SPDT)	Silver
17	Crimp Pin 1/	Double Pole Double Throw (DPDT)	Silver
18	Crimp Pin 1/	Single Pole Double Throw (SPDT)	Gold
19	Crimp Pin 1/	Double Pole Double Throw (DPDT)	Gold
20	Crimp Pin 1/	Indicator Only	None
21	Crimp Pin 2/	Single Pole Double Throw (SPDT)	Silver
22	Crimp Pin 2/	Double Pole Double Throw (DPDT)	Silver
23	Crimp Pin 2/	Single Pole Double Throw (SPDT)	Gold
24	Crimp Pin 2/	Double Pole Double Throw (DPDT)	Gold
25	Crimp Pin 2/	Indicator Only	None

1/ 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.

2/ 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.

NOTE: Code numbers 11 through 15 have been deleted. They previously represented wire wrap terminations and have been discontinued.

Table 2 SWITCH ACTION, PUSHBUTTON RETAINER, AND LAMP WIRING REQUIREMENT

CODE	TYPE OF UNIT	TYPE OF ACTION	PUSHBUTTON RETAINER	LAMP WIRING COMMON BUS CONFIGURATION
1	Switch	Momentary	Yes 1/	No
2	Switch	Alternate	Yes 1/	No
3	Switch	Momentary	No	No
4	Switch	Alternate	No	No
5	Indicator	None	Yes 1/	No
6	Indicator	None	No	No
7	Switch	Momentary	Yes 1/	Yes 2/ Single Two or Three Wire System
8	Switch	Alternate	Yes 1/	Yes 2/ Single Two or Three Wire System
9	Switch	Momentary	No	Yes 2/ Single Two or Three Wire System
Ø	Switch	Alternate	No	Yes 2/ Single Two or Three Wire System
A	Indicator	None	Yes 1/	Yes 2/ Single Two or Three Wire System
B	Indicator	None	No	Yes 2/ Single Two or Three Wire System
C	Switch	Momentary	Yes 1/	Yes 2/ Horizontal Three or Four Wire System
D	Switch	Alternate	Yes 1/	Yes 2/ Horizontal Three or Four Wire System
E	Switch	Momentary	No	Yes 2/ Horizontal Three or Four Wire System
F	Switch	Alternate	No	Yes 2/ Horizontal Three or Four Wire System
G	Indicator	None	Yes 1/	Yes 2/ Horizontal Three or Four Wire System
H	Indicator	None	No	Yes 2/ Horizontal Three or Four Wire System

Table continues on the next sheet...

TABLE 2 (Continued)

CODE	TYPE OF UNIT	TYPE OF ACTION	PUSHBUTTON RETAINER	LAMP WIRING COMMON BUS CONFIGURATION
i 3/	Switch	Momentary	Yes 1/	Yes 2/ Bottom Four or Five Wire System
J	Switch	Alternate	Yes 1/	Yes 2/ Bottom Four or Five Wire System
K	Switch	Momentary	No	Yes 2/ Bottom Four or Five Wire System
L	Switch	Alternate	No	Yes 2/ Bottom Four or Five Wire System
M	Indicator	None	Yes 1/	Yes 2/ Bottom Four or Five Wire System
N	Indicator	None	No	Yes 2/ Bottom Four or Five Wire System
_ 4/	Switch	Momentary	Yes 1/	Yes 2/ Top Four or Five Wire System
P	Switch	Alternate	Yes 1/	Yes 2/ Top Four or Five Wire System
Q	Switch	Momentary	No	Yes 2/ Top Four or Five Wire System
R	Switch	Alternate	No	Yes 2/ Top Four or Five Wire System
S	Indicator	None	Yes 1/	Yes 2/ Top Four or Five Wire System
T	Indicator	None	No	Yes 2/ Top Four or Five Wire System

Table continues on the next sheet...

TABLE 2 (Continued)

CODE	TYPE OF UNIT	TYPE OF ACTION	PUSHBUTTON RETAINER	LAMP WIRING COMMON BUS CONFIGURATION
U	Switch	Momentary	Yes 1/	Yes 2/ Vertical Three or Four Wire System
V	Switch	Alternate	Yes 1/	Yes 2/ Vertical Three or Four Wire System
W	Switch	Momentary	No	Yes 2/ Vertical Three or Four Wire System
X	Switch	Alternate	No	Yes 2/ Vertical Three or Four Wire System
Y	Indicator	None	Yes 1/	Yes 2/ Vertical Three or Four Wire System
Z	Indicator	None	No	Yes 2/ Vertical Three or Four Wire System

1/ Retainer applies only when ordered as part of assemblies which include pushbuttons.
2/ Common bus configuration applies only to incandescent lamp based switch and indicator. See Figure 37 for electrical connection diagrams.
3/ Lower case letter "i". Do not use upper case letter "I" to differentiate it with number "1".
4/ Underscore "_". Do not use dash "-", because a dash is used as a delimiter between the switch and pushbutton portions of a part number within StacoSwitch.

Table 3 EMI/RFI, SEALING AND MOUNTING METHOD

CODE	TYPE OF MOUNTING	DRIP SEAL VS. UNSEALED	EMI/RFI VERSUS NON-EMI/RFI SHIELDED
1	Individual	Sealed	Non-EMI/RFI
2	Individual	Sealed	EMI/RFI
3	Individual	Unsealed	Non-EMI/RFI
4	Individual	Unsealed	EMI/RFI
5	Matrix 1/	Sealed	Non-EMI/RFI
6	Matrix 1/	Sealed	EMI/RFI
7	Matrix 1/	Unsealed	Non-EMI/RFI
8	Matrix 1/	Unsealed	EMI/RFI

1/ For mounting requirements, see Series 94, 95, 96 & 97 coded matrix frame assembly.

Table 4 INCANDESCENT OR LED LIGHT SOURCE, GROUND CIRCUIT OPTIONS AND EMI/RFI STATUS

CODE	LIGHT SOURCE	COMMON CIRCUIT CONFIGURATION	EMI/RFI SHIELDED	CURRENT SOURCING OR SINKING
1	Incandescent	Single Common	No	Not Applicable
2	Incandescent	Vertical Split	No	Not Applicable
3	Incandescent	Horizontal Split	No	Not Applicable
4	Incandescent	Single Common	EMI/RFI	Not Applicable
5	Incandescent	Vertical Split	EMI/RFI	Not Applicable
6	Incandescent	Horizontal Split	EMI/RFI	Not Applicable
7	Multi-chip LED	Single Common	EMI/RFI	Sourcing
8	Multi-chip LED	Single Common	EMI/RFI	Sinking
9	Multi-chip LED	Split Common	EMI/RFI	Sourcing
0	Multi-chip LED	Split Common	EMI/RFI	Sinking
A	High Brightness (HB) LED	Single Common	EMI/RFI	Sourcing
B	High Brightness (HB) LED	Single Common	EMI/RFI	Sinking
C	High Brightness (HB) LED	Split Common	EMI/RFI	Sourcing
D	High Brightness (HB) LED	Split Common	EMI/RFI	Sinking
E	HB LED with Voltage Dimming 1/	Single Common	EMI/RFI	Sourcing
F	HB LED with Voltage Dimming 1/	Single Common	EMI/RFI	Sinking
G	HB LED with Voltage Dimming 1/	Split Common	EMI/RFI	Sourcing
H	HB LED with Voltage Dimming 1/	Split Common	EMI/RFI	Sinking

1/ Available for 28 VDC only.

Table 5 DISPLAY STYLE & CHARACTER DEFINITION

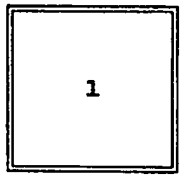
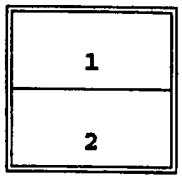
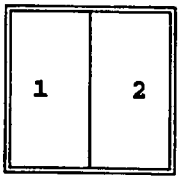
CODE NO.	CHARACTER SIZE IN INCHES (REF.)	DISPLAY AREA NO.	LEGEND AREA: (H) HORIZ. LINES PER AREA (C) CHARACTERS PER LINE 1/				DISPLAY STYLE DESCRIPTION
			1 HXC	2 HXC	3 HXC	4 HXC	
10	NONE		NONE	NONE	NONE	NONE	Full Screen Display
11	.072		5 X 12	X	X	X	
12	.087		4 X 10	X	X	X	
13	.100		4 X 9	X	X	X	
14	.125		3 X 7	X	X	X	
15	.145		2 X 6	X	X	X	
20	NONE		NONE	NONE	NONE	NONE	2-Way Horizontal Split Screen Display
21	.072		2 X 12	2 X 12	X	X	
22	.087		2 X 10	2 X 10	X	X	
23	.100		1 X 9	1 X 9	X	X	
24	.125		1 X 7	1 X 7	X	X	
25	.145		1 X 6	1 X 6	X	X	
26	Two Sizes		7/	7/	X	X	
30	NONE		NONE	NONE	NONE	NONE	2-Way Vertical Split Screen Display
31	.072		5 X 6	5 X 6	X	X	
32	.087		4 X 4	4 X 4	X	X	
33	.100		4 X 4	4 X 4	X	X	
34	.125		3 X 3	3 X 3	X	X	
35	.145		2 X 2	2 X 2	X	X	
36	Two Sizes		7/	7/	X	X	

Table continues on the next sheet...

TABLE 5 (Continued)

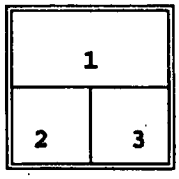
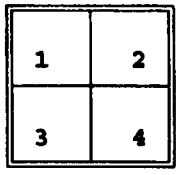
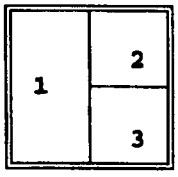
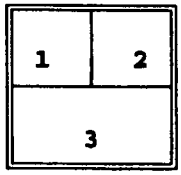
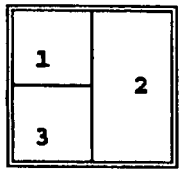
CODE NO.	CHARACTER SIZE IN INCHES (REF.)	DISPLAY AREA NO.	LEGEND AREA: (H) HORIZ. LINES PER AREA (C) CHARACTERS PER LINE 1/				DISPLAY STYLE DESCRIPTION
			1 HXC	2 HXC	3 HXC	4 HXC	
40	NONE		NONE	NONE	NONE	NONE	3-Way Split Screen Display *(Horizontal top half)*
41	.072		2 X 12	2 X 6	2 X 6	X	
42	.087		2 X 10	2 X 4	2 X 4	X	
43	.100		1 X 9	1 X 4	1 X 4	X	
44	.125		1 X 7	1 X 3	1 X 3	X	
45	.145		1 X 6	1 X 2	1 X 2	X	
46	Multiple		7/	7/	7/	X	
50	NONE		NONE	NONE	NONE	NONE	4-Way Split Screen Display
51	.072		2 X 6	2 X 6	2 X 6	2 X 6	
52	.087		2 X 4	2 X 4	2 X 4	2 X 4	
53	.100		1 X 4	1 X 4	1 X 4	1 X 4	
54	.125		1 X 3	1 X 3	1 X 3	1 X 3	
55	.145		1 X 2	1 X 2	1 X 2	1 X 2	
56	Multiple		7/	7/	7/	7/	
60	NONE		NONE	NONE	NONE	NONE	3-Way Split Screen Display *(Vertical left half)*
61	.072		5 X 6	2 X 6	2 X 6	X	
62	.087		4 X 4	2 X 4	2 X 4	X	
63	.100		4 X 4	1 X 4	1 X 4	X	
64	.125		3 X 3	1 X 3	1 X 3	X	
65	.145		2 X 2	1 X 2	1 X 2	X	
66	Multiple		7/	7/	7/	X	

Table continues on the next sheet...

TABLE 5 (Continued)

CODE NO.	CHARACTER SIZE IN INCHES (REF.)	DISPLAY AREA NO.	LEGEND AREA: (H) HORIZ. LINES PER AREA (C) CHARACTERS PER LINE 1/				DISPLAY STYLE DESCRIPTION
			1 HXC	2 HXC	3 HXC	4 HXC	
70	NONE		NONE	NONE	NONE	NONE	
71	.072		2 X 6	2 X 6	2 X 12	X	
72	.087		2 X 4	2 X 4	2 X 10	X	3-Way Split Screen Display *(Horizontal bottom half)*
73	.100		1 X 4	1 X 4	1 X 9	X	
74	.125		1 X 3	1 X 3	1 X 7	X	
75	.145		1 X 2	1 X 2	1 X 6	X	
76	Multiple		7/	7/	7/	X	
80	NONE		NONE	NONE	NONE	NONE	
81	.072		2 X 6	5 X 6	2 X 6	X	
82	.087		2 X 4	4 X 4	2 X 4	X	3-Way Split Screen Display *(Vertical right half)*
83	.100		1 X 4	4 X 4	1 X 4	X	
84	.125		1 X 3	3 X 3	1 X 3	X	
85	.145		1 X 2	2 X 2	1 X 2	X	
86	Multiple		7/	7/	7/	X	

NOTES FOR TABLE 5 -- Display Style & Character Definition:

1/ This is an approximate value. Actual number of characters will depend on the specific characters used. If the specific characters used exceed the space available, but by no more than 10%, the characters will be condensed by 10%, using the same height, in order to accommodate the legend as requested.

2. The character format for legend alpha-numerics is Alternate Gothic Number 2 (AG2), a condensed, sans serif font.

3. The character height, as defined here, is the distance (in decimal inches) from the top to the bottom of a capital letter (excluding descenders) in the standard AG2 font. Unless otherwise specified, the size of punctuation and symbols in that font will be artistically proportional to the size specified for the capital letters.

4. The standard type font, AG2, provides capitals and numerics; lower case characters are not available in this font. Many foreign characters, such as Ä, Å, É, Ö, Ñ, Ü, and others are available. Helvetica typefaces, math symbols and Greek characters are available by special order.

5. Camera ready art, at 10 times the final size, is required for non-Roman characters (such

as Hebrew, Japanese, Korean, Chinese, and Russian).

6. For special graphic artwork, contact the factory-based Sales Department.

7/ Provides for a different character height in each display area. The number of lines and quantity of characters allowed in each display area is consistent with the corresponding configuration of display screen and character height in this table. Using this code requires a 92P-sheet to specify the character size to be used in each area. The use of more than one character size within a single area requires that a special artwork number be assigned.

Table 6A INCANDESCENT LAMP SELECTION AND PUSHBUTTON SEALING

CODE		INCANDESCENT	MAXIMUM	MAXIMUM	RESULTING	AVERAGE	LIFE
7/ NOT SEALED	SEALED	LAMP TYPE 1/ 2/	DESIGN VOLTS	MILLIAMPS PER P.B. 3/	POWER WATSS / P.B.	M.S.C.P. 10/	HOURS
00	10	109213 - Fiberboard Plate "Discard" Required 5/					
01	11	3071	5	240	1.2	0.15	5,000
02	12	718	5	460	2.3	0.15	40,000
03	13	N/A					
04	14	8/ 3335	28	64	1.8	0.08 9/	10,000
05	15	3042	6	240	1.4	0.13 9/	3,000
06	16	1099	12	240	2.9	0.15	16,000
07	17	3229	14	160	2.2	0.15	16,000
08	18	6839	28	96	2.7	0.15	16,000
09	19	15091 Dummy Lamp Plug 6/					

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. StacoSwitch 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 insure 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 ± 25%.

Table 6B MULTI-CHIP LED CIRCUIT SELECTION AND PUSHBUTTON SEALING

CODE				MULTI-CHIP LED DISPLAY CONFIGURATION	OPERATING VOLTS 6/	NOMINAL MILLIAMP PER PUSHBUTTON
CURRENT SOURCING		CURRENT SINKING				
5/ NOT SEALED	SEALED	5/ NOT SEALED	SEALED			
31	41	51	61	Full or 2-Way	5	180
32	42	52	62	Full or 2-Way	28	30
33	43	53	63	3-Way	5	180
34	44	54	64	3-Way	28	45
35	45	55	65	4-Way	5	180
36	46	56	66	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 StacoSwitch 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:

	Order Part Number
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

* See paragraph 3.3.4

Table 6C HIGH BRIGHTNESS (HB) LED CIRCUIT SELECTION AND PUSHBUTTON SEALING

CODE				HIGH BRIGHTNESS LED DISPLAY CONFIGURATION	OPERATING VOLTS	MAXIMUM MILLIAMP PER PUSHBUTTON 2/
CURRENT SOURCING		CURRENT SINKING				
NOT SEALED	SEALED	NOT SEALED	SEALED			
31	41	51	61	Full or 2-Way	5	180
32	42	52	62	Full or 2-Way	28	40
33	43	53	63	3-Way	5	180
34	44	54	64	3-Way	28	60
35	45	55	65	4-Way	5	180
36	46	56	66	4-Way	28	80

NOTES:

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

Table 7 DISPLAY TYPE

TYPE CODE note /	MIL-S-22885 SYMBOL	NON-ILLUMINATED		ILLUMINATED		LIGHT AND COLOR SOURCES		
		LEGEND	BACK-GROUND	LEGEND	BACK-GROUND	INCAN-DESCENT LAMP	MULTI-CHIP LED	HIGH BRIGHTNESS LED
1 1/	C	Black	Translucent Color	Black	Color	Flat Filter	--- ---	Flat Filter
2	B	Hidden Black	Black	Black	Visible In Color	Lamp Cap	--- ---	--- ---
3	H	Hidden	Black	Visible In Color	Black	Lamp Cap	--- ---	--- ---
4 2/	N	Translucent White	Black	Visible In Color	Black	Lamp Cap	LED	Flat Filter
5 2/ 3/	W	Black	Translucent White	Black	Color	Lamp Cap	LED	Flat Filter
6 2/ 4/	S	Hidden	Black	Visible In Color	Black	Flat Filter	LED	Flat Filter
7 2/ 5/	S	Hidden	Black	NVG Color	Black	NVG Filter	NVG Filter	NVG Filter
CUSTOMER REPLACEABLE LEGENDS								
8 6/ 7/	B	Hidden Black	Black	Black	Visible In Color	Lamp Cap	--- ---	--- ---
9 6/ 8/	W	Black	Translucent White	Black	Color	Lamp Cap	LED	--- ---
0 2/ 6/ 9/	H	Hidden	Black	Visible In Color	Black	Flat Filter	LED	Flat Filter

NOTES:

1/ Type **1** - Styles 20 through 85 (Ref Table 5) 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 5) 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-22885/101. Unilluminated legends shall not be discernible. Recommended legend height is .100 inch. Multi-chip LED-based units have a similar deadfront 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 in order to clarify positive/negative film type and to show the position of the legend plate within the pushbutton stack-up.
Legends and faceplate assemblies which are produced in the field may not be of equal quality to those which are factory made.

7/ Type **8** - Similar to Type **2**.

8/ Type **9** - Similar to Type **5**.

9/ Type **0** - Similar to Type **6.**

Table 8 CELL COLORS

CODE NO.	INCANDESCENT LAMP LEGEND DISPLAY All types Except 7 2/		INCANDESCENT LAMP OR LED LEGEND DISPLAY NIGHT VISION GOGGLE (NVG) COMPATIBILITY Types 7 Only			MULTI-CHIP LED LEGEND DISPLAYS Types 4, 5, 6, 9 & 0 2/		HIGH BRIGHTNESS LED LEGEND DISPLAY Types 0, 1, 4, 5 & 6 2/
	COLOR	MIL-PRF-22885 /101 SYMBOL	COLOR	MIL-PRF-22885 /101 SYMBOL	MIL-PRF-22885 /111 SYMBOL	COLOR	MIL-PRF-22885 /111 SYMBOL	COLOR
0	White	W	NVIS Blue		TBD	---	---	White
1	Red	R	NVIS Red	L	LL	Red	RD	Red
2	Green	G	NVIS Green B	J	JJ	Green	GR	Green
3	Aviation Yellow	Y	NVIS Yellow Class B	K	KK	Amber Yellow	AY	Aviation Yellow
4	Lunar White	D	NVIS White		TBD	---	---	---
5	Lemon Yellow	--	NVIS Yellow Class A	K	KK	---		Lemon Yellow
6	Blue 3/	B	NVIS Green A	H	TBD	---	---	Blue
7	Aviation Green 4/	Z	---	---	---	Lime Green 5/	LG	---
8	---	---	---	---	---	Orange 5/		---

NOTES:

1 All NVIS filters availability per MIL-STD-3009 are subject to final R&D test results.

2/ Colors of incandescent lamp, multi-chip LED and High Brightness LED are slightly different.

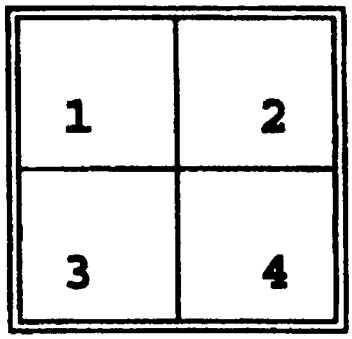
3/ May not be suitable for high intensity light applications.

4/ For types 2, 3, 4, 5, 8, and 9 use 90-CODED/016.

5/ Orange and lime green are available in multi-chip LED, but not in High Brightness LED. Please contact factory for new colors.

COLOR CELL
NUMBERING/LOCATION SYSTEM

TOP



(FRONT VIEW)

NOTE:

A color code number is required for each of the four cell areas.

5.7 Seals

5.7.1 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 Figures 2 and 3.) 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 dripproof 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.

5.7.2 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 splashproof and watertight protection to a switch/indicator and also to the areas behind the panel. (See Figure 30 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
Switch/Indicator Assembly	98XXXX/005
Pushbutton Assembly	92XXXXXXXXXX/005
Switch/Indicator Assembly w/Pushbutton	93XXXXXXXXXXXXXX/005
Switch/Indicator Assembly w/Pushbutton	99XXXXXXXXXXXXXX/005

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.

5.7.3 Solvent Resistant Seals (/006)

Applicable installations requiring resistance to most petroleum based fuels, solvents, oils and greases (as well as being splashproof 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 deadfront, but SLR contrast ratios do not apply.

5.8 Accessories

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

5.8.1 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. The following applies to either unsealed or dripproof configurations. (Refer to Figure 32 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.

5.8.2 Pushbutton Guard, Watertight Seal (15204/tab)

This pushbutton guard is used with watertight/splashproof 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 31 for dimensions.) Center to center spacing for adjacent covers is 1.40" (35.6 mm).

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

5.8.3 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 34 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:

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

5.8.4 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 33.) Their purpose is to secure the pushbutton to the switch during relamping 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.

5.8.5 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 35.) To order, specify Part Number 15091.

5.8.6 Pushbutton Extraction Tool (15193)

Facilitates the removal of display pushbuttons, particularly when installed in multi-station matrix assemblies. (Refer to the 15193 SCD for drawing.) To order, specify Part Number 15193.

5.8.7 Matrix Switch Extraction Tool (15056)

It facilitates the easy removal of switch/indicator assemblies from matrix housing when change of switch or indicator function is desired. After removing the pushbutton and loosening the two locking cams, the tool is inserted in the front of the assembly and its rubber block expanded by tightening the looped handle. Switch assembly can then be easily removed from the front of the matrix housing. (Refer to the 15056 SCD for drawing.) To order, specify Part Number 15056.

5.8.8 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 Figures 2, 3, 18 and 19.) 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.

5.8.9 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.

5.8.10 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 2, 3, 26 and 27.) Crimp pins are ordered separately, in the quantity desired.

5.8.11 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 Stacoswitch part number and the corresponding military standard part number.

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 to 15191, 15192, 15278, and 15279 SCDs for drawings.) Each part number must be ordered separately.

5.8.12 Wire Connector Insertion and Removal Tool (15190)

Standard M81969/16-01 Insertion and Removal Tool used for inserting or removing of wire connectors with crimp pins used with Models 98 and 99 Individual Mount Switches/Indicators or with Models 95 and 97 Matrix Housings configured with. (Refer to 15190 SCD for drawing.) The wire connector insertion and removal tool can be used with MIL-C-39029/16-168 and MIL-C-39029/22-192 pins. To order, specify Part Number 15190.

5.8.13 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 to 15177 SCD for drawing.) 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.

5.8.14 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.

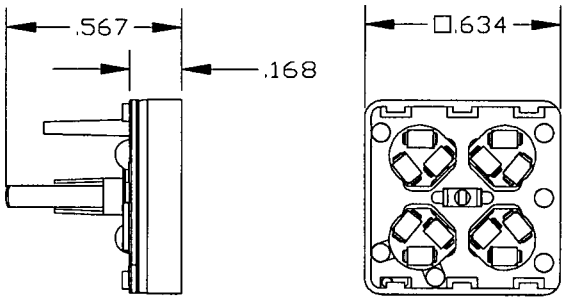
5.8.15 Digital Dimming Module (DDM111 and DDM111A)

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.

5.8.16 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.



Light Source Assembly

To order, use the following part number.

5 VOLT LIGHT SOURCE ASSEMBLY PART NUMBERS

Display Style		Part Number			
		Common Circuit		Split Circuit	
Code	Description	Sourcing	Sinking	Sourcing	Sinking
1 2	Full Screen Horizontal Split Screen	15306-001	15307-001	15306-002	15307-002
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

28 VOLT LIGHT SOURCE ASSEMBLY PART NUMBERS

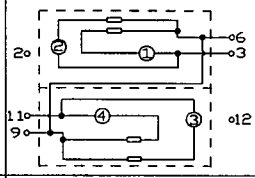
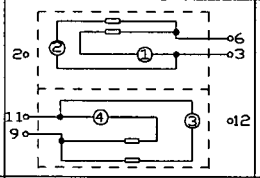
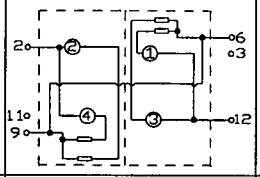
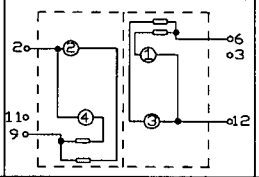
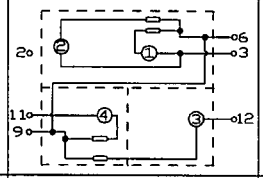
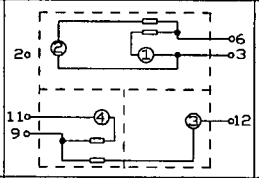
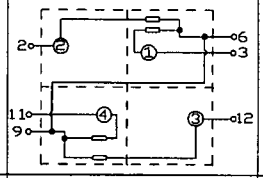
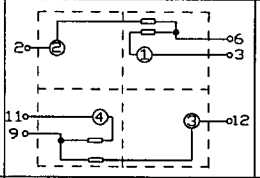
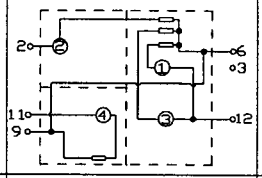
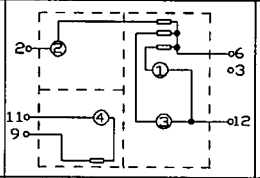
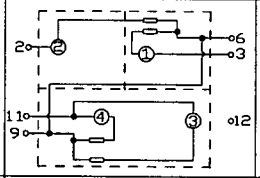
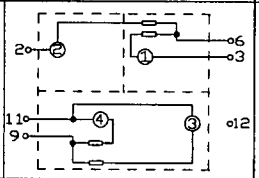
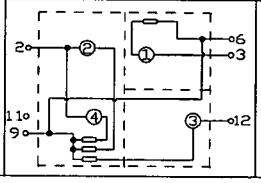
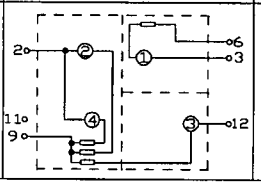
Display Style		Part Number			
		Common Circuit		Split Circuit	
Code	Description	Sourcing	Sinking	Sourcing	Sinking
1 2	Full Screen Horizontal Split Screen	15292-001	15293-001	15292-002	15293-002
3	Vertical Split Screen	15294-001	15295-001	15294-002	15295-002
4	3 Way Split Screen (Horizontal Top Half)	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

28 VOLT WITH VOLTAGE DIMMING LIGHT SOURCE ASSEMBLY PART NUMBERS

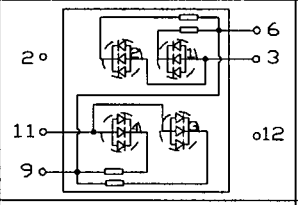
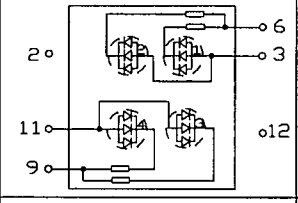
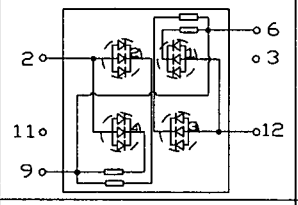
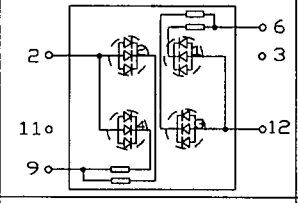
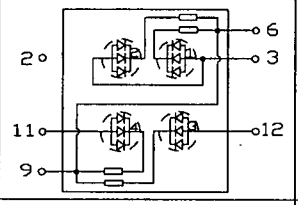
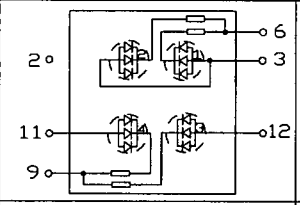
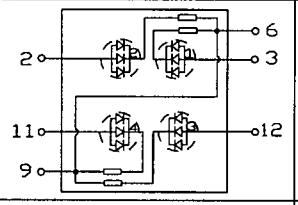
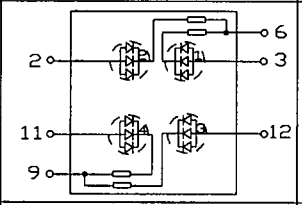
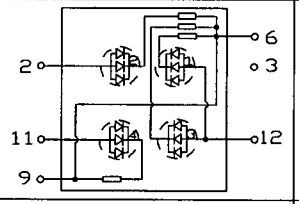
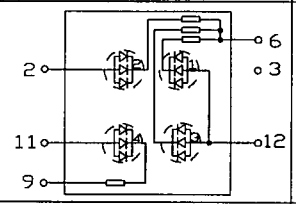
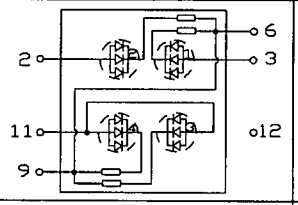
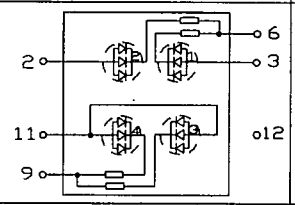
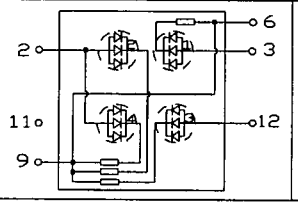
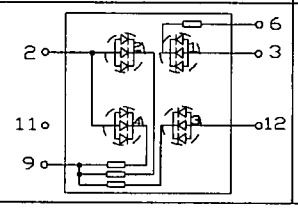
Display Style		Part Number			
		Common Circuit		Split Circuit	
Code	Description	Sourcing	Sinking	Sourcing	Sinking
1 2	Full Screen Horizontal Split Screen	15320-001	15321-001	15320-002	15321-002
3	Vertical Split Screen	15322-001	15323-001	15322-002	15323-002
4	3 Way Split Screen (Horizontal Top Half)	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

APPENDIX

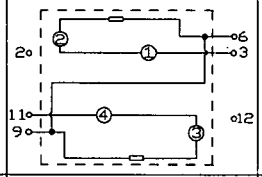
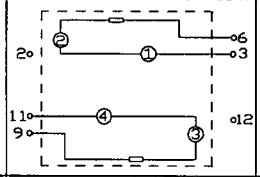
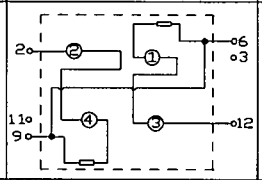
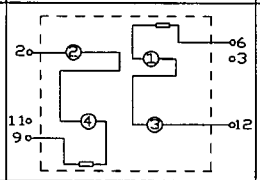
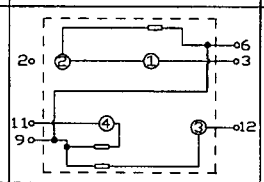
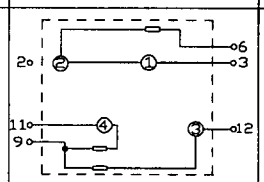
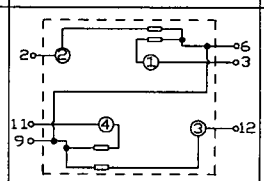
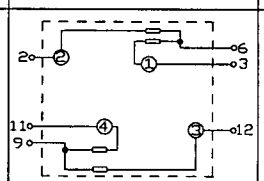
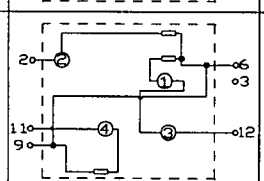
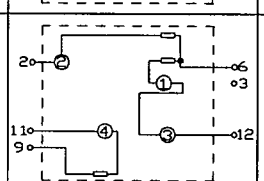
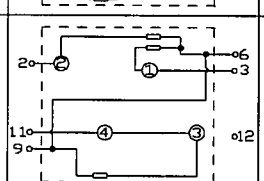
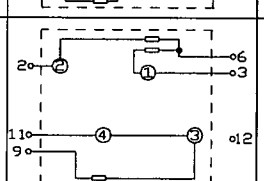
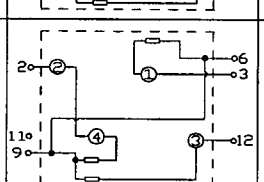
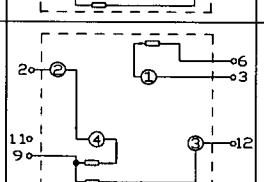
Appendix A 5 VOLT MULTI-CHIP LED WITHOUT VOLTAGE DIMMING CIRCUIT DIAGRAMS

DISPLAY STYLES			COMMON CIRCUIT CODE					SPLIT CIRCUIT CODE			
			7		8			9		0	
CODE	STYLES VIEWED FROM THE FRONT	COMMON LAMP CIRCUIT VIEWED FROM THE BACK	SEALED				SPLIT LAMP CIRCUIT VIEWED FROM THE BACK	SEALED			
			NO	YES	NO	YES		NO	YES	NO	YES
1	① ② ③ ④ FULL SCREEN		31	41	51	61		31	41	51	61
2	① ② ③ ④ HORIZ SPLIT SCREEN										
3	① ② ③ ④ VERT. SPLIT SCREEN		31	41	51	61		31	41	51	61
4	① ② ③ ④ 3 WAY HORIZ. SPLIT SCREEN		33	43	53	63		33	43	53	63
5	① ② ③ ④ 4 WAY SPLIT SCREEN		35	45	55	65		35	45	55	65
6	① ② ③ ④ 3 WAY VERT. SPLIT SCREEN		33	43	53	63		33	43	53	63
7	① ② ③ ④ 3 WAY HORIZ. SPLIT SCREEN		33	43	53	63		33	43	53	63
8	① ② ③ ④ 3 WAY VERT. SPLIT SCREEN		33	43	53	63		33	43	53	63

Appendix B 5 VOLT HIGH BRIGHTNESS LED WITHOUT VOLTAGE DIMMING CIRCUIT DIAGRAMS

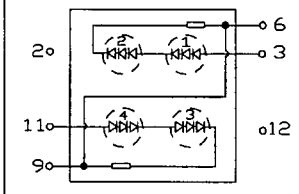
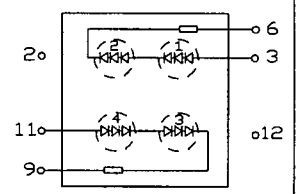
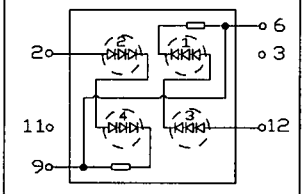
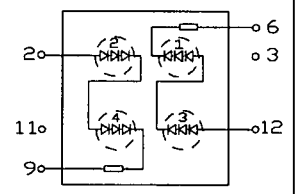
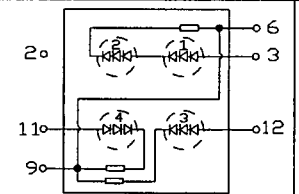
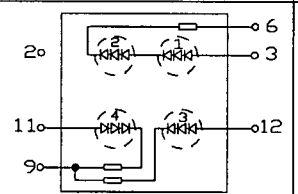
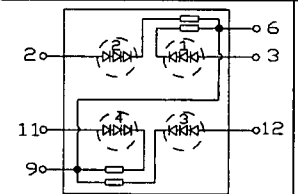
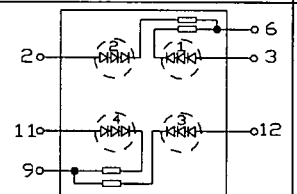
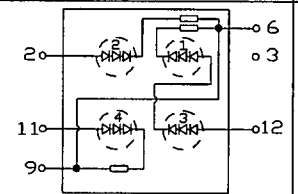
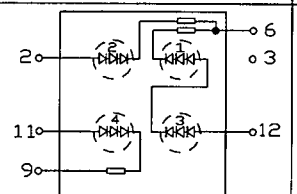
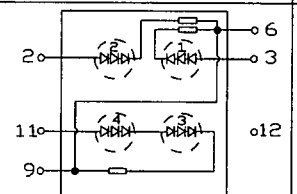
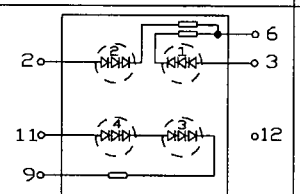
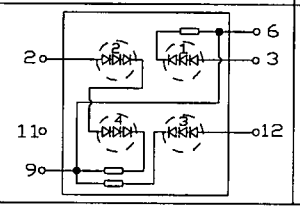
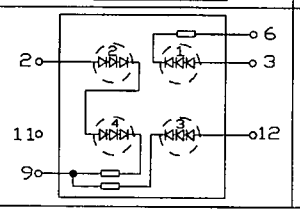
DISPLAY STYLES		COMMON LED CIRCUIT VIEWED FROM THE BACK (sourcing diagrams shown)	COMMON CIRCUIT CODE				SPLIT LED CIRCUIT VIEWED FROM THE BACK (sourcing diagrams shown)	SPLIT CIRCUIT CODE			
			SOURCING A		SINKING B			SOURCING C		SINKING D	
			SEALED		SEALED			SEALED		SEALED	
CODE	STYLES VIEWED FROM THE FRONT		NO	YES	NO	YES		NO	YES	NO	YES
1	① ② ③ ④ FULL SCREEN		31	41	51	61		31	41	51	61
2	① ② ③ ④ HORIZ. SPLIT SCREEN										
3	① ② ③ ④ VERT. SPLIT SCREEN		31	41	51	61		31	41	51	61
4	① ② ③ ④ 3 WAY HORZ. SPLIT SCREEN		33	43	53	63		33	43	53	63
5	① ② ③ ④ 4 WAY SPLIT SCREEN		35	45	55	65		35	45	55	65
6	① ② ③ ④ 3 WAY VERT. SPLIT SCREEN		33	43	53	63		33	43	53	63
7	① ② ③ ④ 3 WAY HORZ. SPLIT SCREEN		33	43	53	63		33	43	53	63
8	① ② ③ ④ 3 WAY VERT. SPLIT SCREEN		33	43	53	63		33	43	53	63

Appendix C 28 VOLT MULTI-CHIP LED WITHOUT VOLTAGE DIMMING CIRCUIT DIAGRAMS

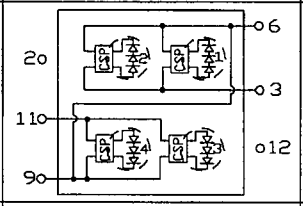
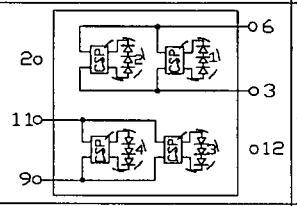
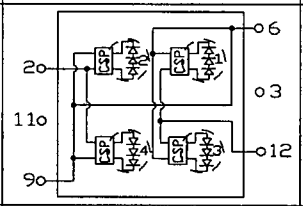
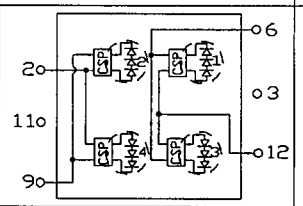
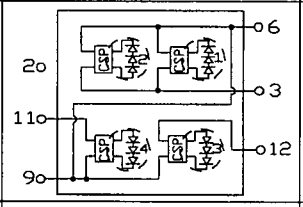
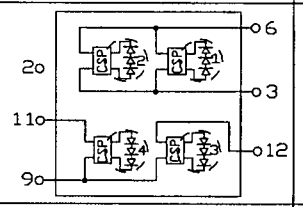
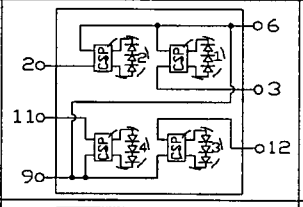
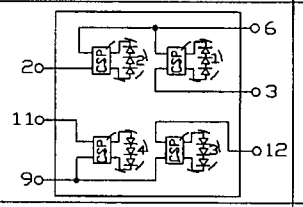
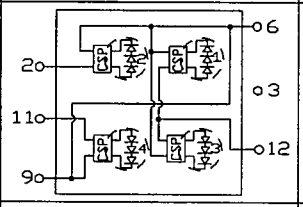
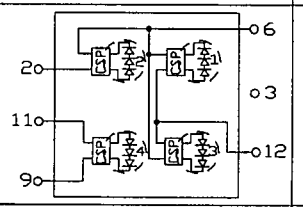
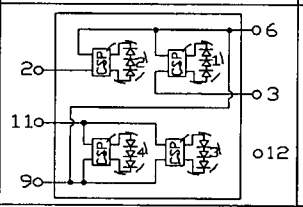
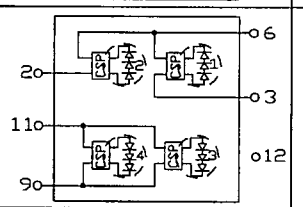
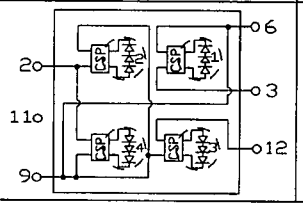
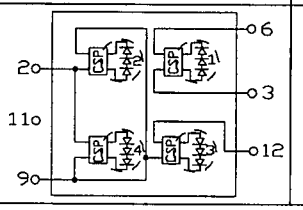
DISPLAY STYLES			COMMON CIRCUIT CODE					SPLIT CIRCUIT CODE			
			7		8			9		0	
CODE	STYLES VIEWED FROM THE FRONT	COMMON LAMP CIRCUIT VIEWED FROM THE BACK	SEALED		SEALED		SPLIT LAMP CIRCUIT VIEWED FROM THE BACK	SEALED		SEALED	
			NO	YES	NO	YES		NO	YES	NO	YES
1	① ② ③ ④ FULL SCREEN		32	42	52	62		32	42	52	62
2	① ② ③ ④ HORIZ SPLIT SCREEN										
3	① ② ③ ④ VERT. SPLIT SCREEN		32	42	52	62		32	42	52	62
4	① ② ③ ④ 3 WAY HORIZ. SPLIT SCREEN		34	44	54	64		34	44	54	64
5	① ② ③ ④ 4 WAY SPLIT SCREEN		36	46	56	66		36	46	56	66
6	① ② ③ ④ 3 WAY VERT. SPLIT SCREEN		34	44	54	64		34	44	54	64
7	① ② ③ ④ 3 WAY HORIZ. SPLIT SCREEN		34	44	54	64		34	44	54	64
8	① ② ③ ④ 3 WAY VERT. SPLIT SCREEN		34	44	54	64		34	44	54	64

CAGE CODE:	DRAWING NO.	REV.	SHT.
12522	SERIES 90 CODED	U	130

Appendix D 28 VOLT HIGH BRIGHTNESS LED WITHOUT VOLTAGE DIMMING CIRCUIT DIAGRAMS

DISPLAY STYLES		COMMON LED CIRCUIT VIEWED FROM THE BACK (sourcing diagrams shown)	COMMON CIRCUIT CODE				SPLIT LED CIRCUIT VIEWED FROM THE BACK (sourcing diagrams shown)	SPLIT CIRCUIT CODE			
			SOURCING A		SINKING B			SOURCING C		SINKING D	
			SEALED		SEALED			SEALED		SEALED	
CODE	STYLES VIEWED FROM THE FRONT		NO	YES	NO	YES		NO	YES	NO	YES
1	FULL SCREEN		32	42	52	62		32	42	52	62
2	HORIZ. SPLIT SCREEN										
3	VERT. SPLIT SCREEN		32	42	52	62		32	42	52	62
4	3 WAY HORZ. SPLIT SCREEN		34	44	54	64		34	44	54	64
5	4 WAY SPLIT SCREEN		36	46	56	66		36	46	56	66
6	3 WAY VERT. SPLIT SCREEN		34	44	54	64		34	44	54	64
7	3 WAY HORZ. SPLIT SCREEN		34	44	54	64		34	44	54	64
8	3 WAY VERT. SPLIT SCREEN		34	44	54	64		34	44	54	64

Appendix E 28 VOLT HIGH BRIGHTNESS LED WITH VOLTAGE DIMMING CIRCUIT DIAGRAMS

DISPLAY STYLES		COMMON LIGHTING CIRCUIT VIEWED FROM THE BACK (sourcing diagrams shown)	COMMON CIRCUIT CODE				SPLIT LIGHTING CIRCUIT VIEWED FROM THE BACK (sourcing diagrams shown)	SPLIT CIRCUIT CODE			
			SOURCING E		SINKING F			SOURCING G		SINKING H	
			SEALED		SEALED			SEALED		SEALED	
CODE	STYLES VIEWED FROM THE FRONT		NO	YES	NO	YES		NO	YES	NO	YES
1	① ② ③ ④ FULL SCREEN		32	42	52	62		32	42	52	62
2	① ② ③ ④ HORIZ. SPLIT SCREEN										
3	① ② ③ ④ VERT. SPLIT SCREEN		32	42	52	62		32	42	52	62
4	① ② ③ ④ 3 WAY HORZ. SPLIT SCREEN		34	44	54	64		34	44	54	64
5	① ② ③ ④ 4 WAY SPLIT SCREEN		36	46	56	66		36	46	56	66
6	① ② ③ ④ 3 WAY VERT. SPLIT SCREEN		34	44	54	64		34	44	54	64
7	① ② ③ ④ 3 WAY HORZ. SPLIT SCREEN		34	44	54	64		34	44	54	64
8	① ② ③ ④ 3 WAY VERT. SPLIT SCREEN		34	44	54	64		34	44	54	64

Appendix F MOUNTING PROCEDURE

(Figures 2, 3 and 23 aid in the following procedure.)

1. Remove pushbutton from switch/indicator assembly.
2. Rotate locking screws inside front of switch/indicator assembly counter-clockwise with a small screwdriver. This will release mounting cams.
3. Slide mounting sleeve and panel spacer off of the switch/indicator assembly.
4. Install switch/indicator assembly through panel cut-out from front of panel. Assembly is marked with word "TOP" to help properly orient position of the assembly in the panel.
5. Replace panel spacers and mounting sleeve.
6. Rotate locking screws clockwise to bring mounting cams to lock position. Recommended mounting torque is 10 ± 2 ounce inches (0.071 ± 0.014 Nm).
7. Be certain that incandescent type pushbuttons have lamps and/or dummy lamps installed in all four positions before inserting into mating switch/indicator assembly.
8. To insert the pushbutton properly, be sure that the index post is at the top and that the pushbutton is held square to the switch housing.
9. The two panel spacers, together with the mounting sleeve, provide various options for fitting the switch/indicator assembly to mounting panels with thicknesses ranging from essentially zero to a maximum of about .75" (see dimensional drawings for exact thickness for each configuration).
10. For extended mounting of the assembly, as in conjunction with edge-lit panels, the black panel spacer is left installed on the assembly before it is inserted in the panel cut-out so as to be in front of the panel when installation is complete.
11. On sealed switch/indicator assemblies mounted flush, the panel seal is installed under the housing flange and on the front of the panel. On extended mount sealed units, the panel seal is placed between the panel spacer and the front of the panel. (Refer to Figure 7 dimensional drawing for position.)

Appendix G SLOT MOUNTING INDIVIDUAL SWITCH/INDICATOR

Figure 22 provides the recommended panel mounting hole cut-out dimensions for a single mount switch or indicator. For multistation configurations, matrix mounting is the preferred method (Refer to the Matrix Frame Assembly SCD, Series 94 through 97, Coded for dimensional information).

However, for those applications where horizontal or vertical slot mounting of two or more individual mount switch/indicators is required, a simple formula provides cut-out dimensions for the slot. In the following formula, which is used to establish the over-all length, L = length of horizontal or vertical mounting slot and n = number of units.

L(inches) = .752" x (n - 1) + .690"

L(mm) = 19.1 mm x (n - 1) + 17.5 mm

The formula will provide slot length for any number of units in a row. The width of the slot should be .690" (17.53 mm). For two or more parallel rows, either horizontally or vertically, a minimum of .140" (3.56 mm) spacing between rows is recommended.

NOTES:

1. Slot mounting can not be used with Immersion Seals (90/005 or 90/006).

2. Panel seals are not applicable to slot mounting configurations.

Appendix H CLEANING INSTRUCTIONS

For Lighted Pushbuttons Displays with an Anti-reflective Coating Such as Series 80 and 90 Type 6 (SLR) and Type 7 (NVIS)

PURPOSE:
To provide instructions on how to clean these face-plates that have an anti-reflective coating so that the low reflective qualities of these displays is not compromised.

GENERAL PRECAUTION:
It is preferred that cleaning of these anti-reflective coated displays be minimized, or avoided all together if possible. However, if cleaning is deemed necessary, then it must be performed with great care or the anti-reflective qualities of the display will be impaired.

MATERIALS

A) Soft clean lint-free cloths.
B) Cleaning agent: Naptha or a *mixture* of dishwasher detergent and distilled water (one drop per 8 fluid ounces of water) and additional distilled water for rinsing.

PROCEDURE

A. Use a soft cloth to apply the cleaning agent with a patting motion - do not rub the surface of the display. The idea is to blot up any contaminants rather than try to scrub them off. Due to the rough texture of the anti-reflective coating, a blotting action with a cleaning solution is the only practical way there is for removing contaminants from such a surface.

B. Rinsing:

- If naptha was used, no rinsing is necessary as it will evaporate from the surface quite rapidly.
- If the detergent and water mixture was used, use a fresh cloth soaked with distilled water to rinse off the cleaning agent, again using a patting motion. Then use a dry cloth to blot up the residual water left on the surface. The rest of the water will evaporate naturally and leave no visible residue.

Appendix I RECEPTACLE ASSEMBLY Installation PROCEDURE

For Series 90 Switches, Indicators, and Matrices

For crimp-pin terminated Series 98 and 99 switches/indicators and Series 95 and 97 matrix assemblies, the installation of the receptacle assembly is an extremely important operation. If improperly performed, the receptacle possibly could become disengaged from the switch housing. The locking cam nuts used to retain the receptacle must be fully engaged in the "window" area of the housing and tightened to the specified torque. The recommended procedure for receptacle assembly installation is as follows:

1. Before inserting the receptacle assembly into a switch, be sure that both cam nuts (see Figure 47) on the two opposite sides of a receptacle, are positioned at the end of the mounting screw threads, next to the wall of the retainer plate, a position which is furthest from the wiring end. If any cam nut is not at the required position, turn screws counter clockwise until each cam nut reaches the position shown.

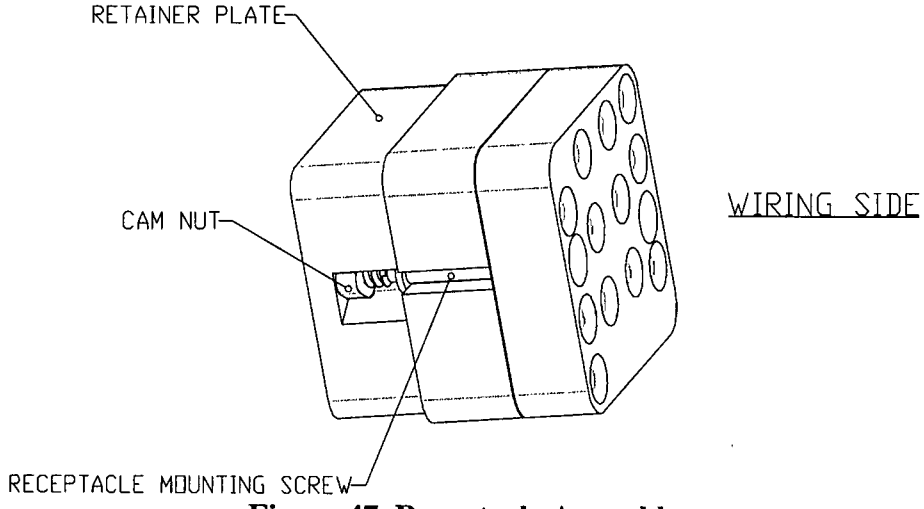


Figure 47 Receptacle Assembly

2. Be sure that the side wall of every cam nut is parallel to the corresponding adjacent surface of the retainer plate so that no part of cam nuts protrudes beyond the outside of this surface.
3. If it is possible, inspect both walls (that have rectangular holes) of the switch housing to make sure that their walls near the ends on the receptacle side are straight and not bowed outward as a result of improper handling or because of previous unsuccessful attempts to install a receptacle. Walls could be slightly bowed inward to assure a good fit with retainer plate.
4. Put the receptacle in its proper position in relation to the switch contact pins and carefully, but firmly, insert pre-wired receptacle assembly into the switch housing until it is fully engaged with switch pins (there shall be no sizable gaps between edges of switch housing and stopping surface of the retainer plate). See Figure 48 for reference.

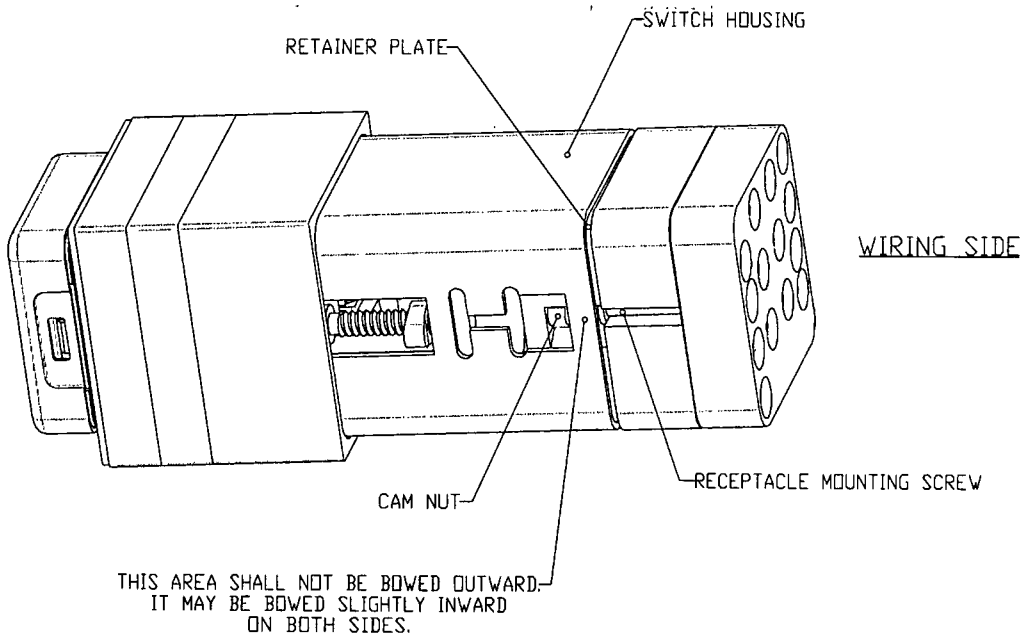


Figure 48 Switch Assembly

5. While holding receptacle in the position described above, use torque limiting screwdriver to tighten one of the retaining screws clockwise to the torque value of 10 ± 2 ounce-inches (.071 ± .014 Nm). Then tighten the second screw with the same torque.
6. If it is possible, inspect positions of cam nuts to assure that all nuts are visible in their rectangular windows, that they are turned approximately 90 degrees from their initial position, and that they have moved to the ends of these windows closest to the wiring side, as shown in Figure 46.
7. Repeat this installation procedure for all of the remaining switches.

Appendix J CRIMP CONTACT TERMINATED WIRING SYSTEMS INSTALLATION PROCEDURE

For Series 90 Switches, Indicators, and Matrices

A reliable Common Termination System (CTS) connection can be made only if all the components of this system, the parts and subassemblies, are properly designed, manufactured, and assembled. While the reliability of the design and fabrication is determined by the manufacturer, CTS assemblies are commonly fabricated in the field at customer locations. Most customers have extensive experience with this type of assembly and do not encounter any problems with installing StacoSwitch Series 90 Switches in their application. Other customers need help in setting up proper procedures and training people for the necessary assembly operations. This technical bulletin is intended to address this need.

A cross-section of a complete wire connection to the switch is shown on Figure 49. Each wire of the harness coming to switch module is crimped to its socket contact, forming a contact-wire assembly. This assembly is attached to the corresponding pin contact of the switch. The socket contact is locked into the receptacle assembly housing, between retainer plate and retainer clip, by means of two locking tabs. The retainer clip is positioned in the housing between the retainer plate and the guide. The plate and guide are held together with two screws, forming the housing for all other parts. The rubber seal is cemented to the guide to protect the receptacle assembly from outside contamination. The two tabs of the retainer clip are the major means of firmly holding each contact-wire assembly to the switch. Located directly against the socket contact shoulders, tabs keep the sockets connected to the switch pin contacts and do not allow the wire-contact assembly to slide out of the receptacle, even if the wire is pulled.

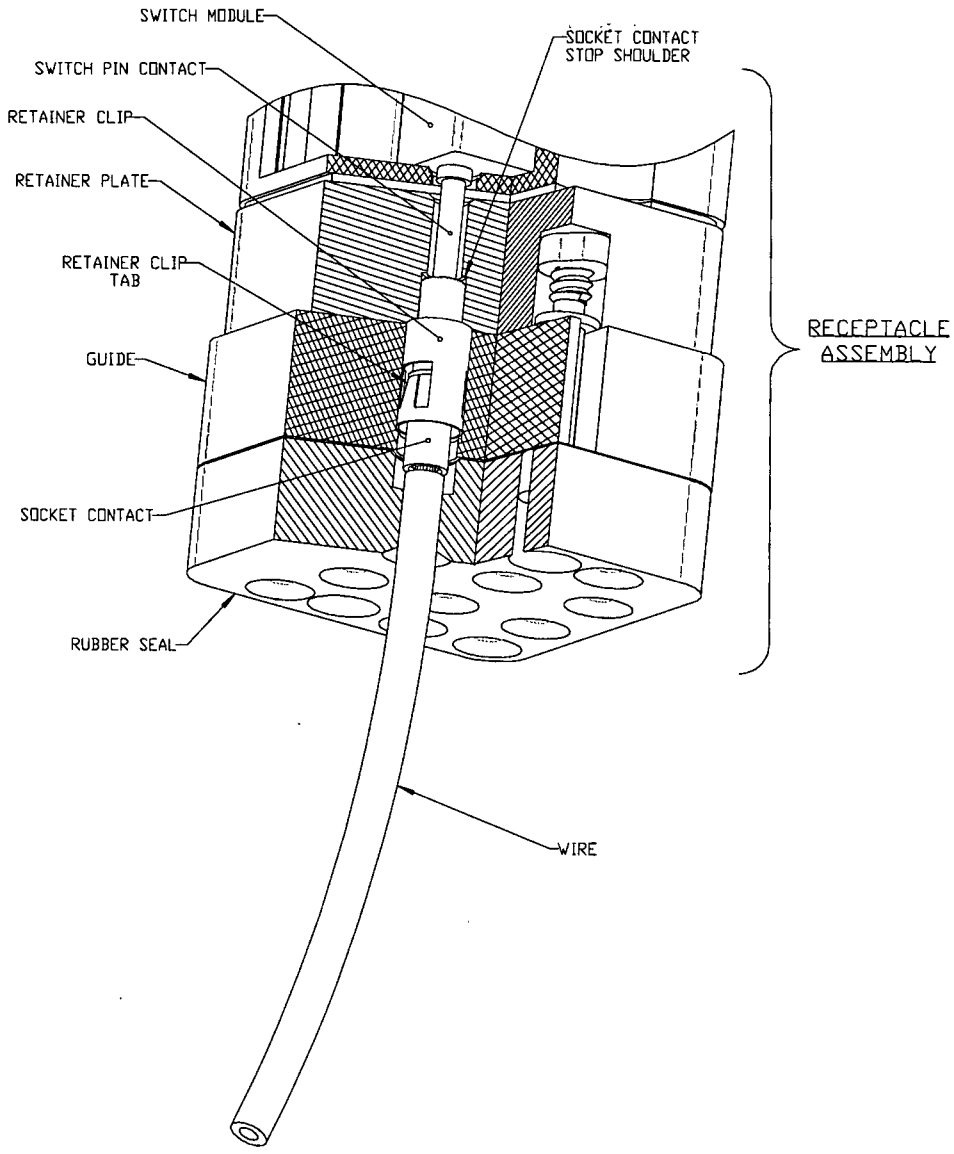


Figure 49 Socket Contact in Place

If the wiring connection needs to be removed, as it is seen from Figure 50, the retainer clip tabs can be spread out (retracted) beyond the shoulders of a socket by inserting a special tubular end of a socket contact removal (extraction) tool. In such a case, only friction will hold wire-contact assembly inside of the receptacle. The wire assembly, together with the tool, can be pulled out from the receptacle to disconnect one wire connection at a time.

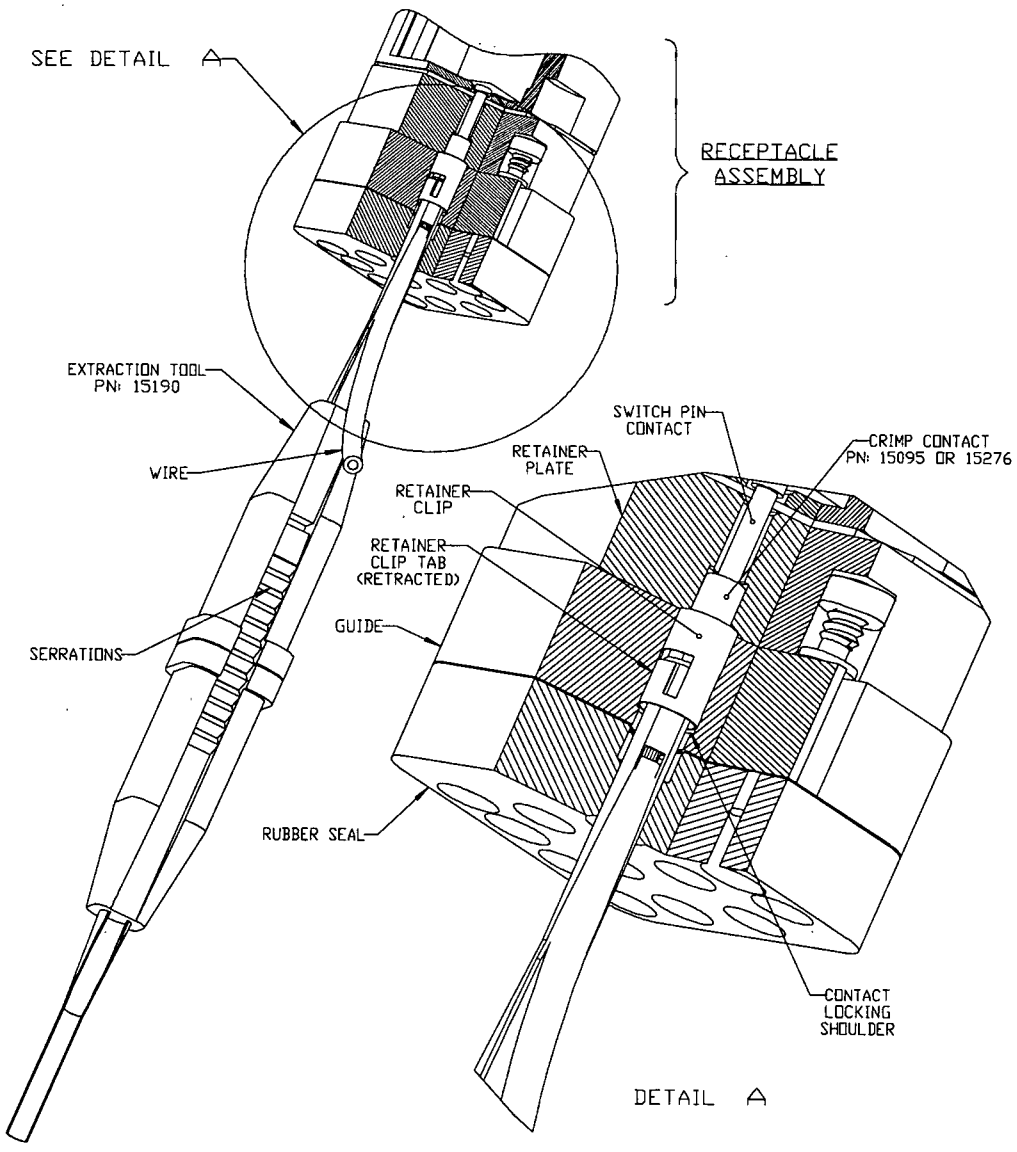


Figure 50 Extraction of Wire-Contact Assembly

Insertion of a new wire-contact assembly can be accomplished with a contact installing (insertion) tool, as it is shown on the Figure 51. This tool is very similar to the extraction tool; however, the tip of its tubular end has a notch, making its edge look like an approximately half-a-circle arc. This feature creates a small opening on the side of the tool, next to the ends of the retaining clip tabs, when the tool is inserted (See Figure 51). Prior to insertion, the wire–contact assembly is placed into the tubular part of the insertion tool. Then, it is pushed through the holes in the rubber seal, the retaining clip, and the retainer plate, onto the pin contact of the switch module.

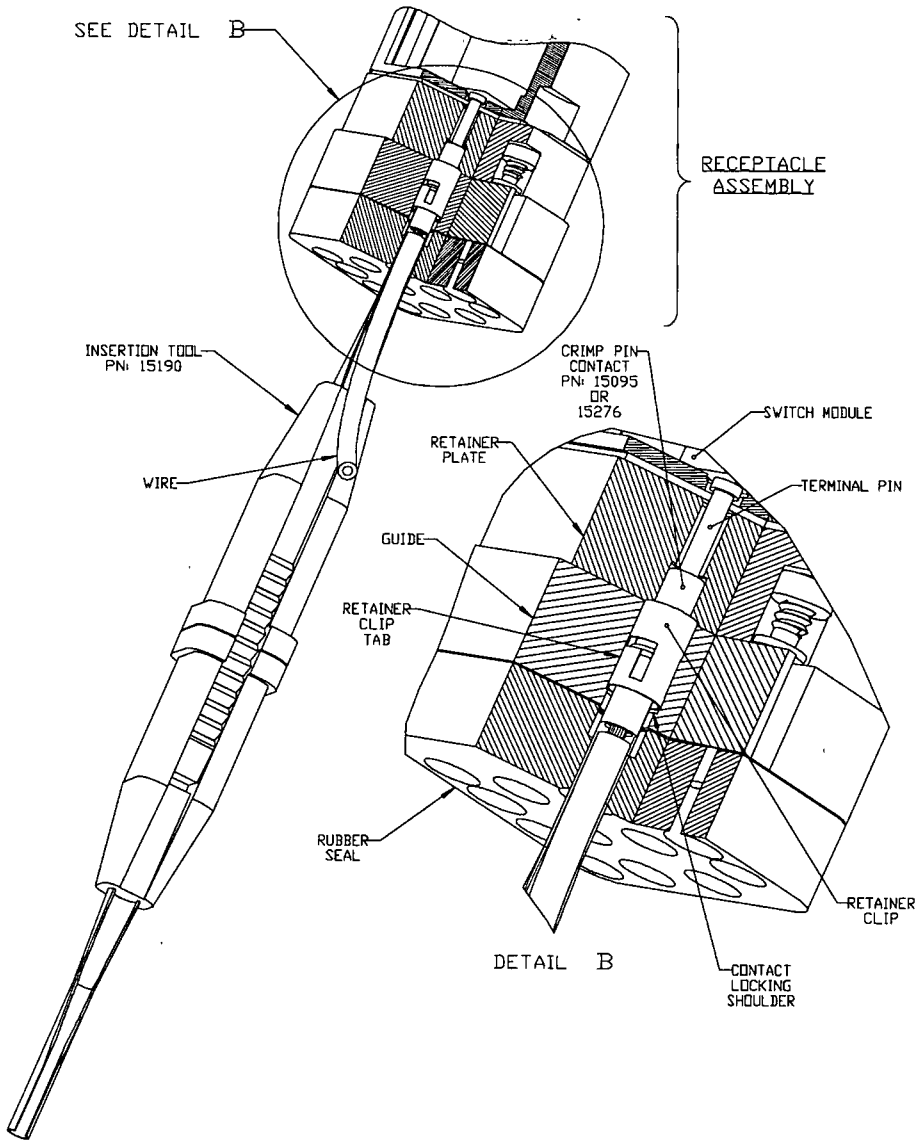


Figure 51 Insertion of Wire-Contact Assembly

As it can be seen from the same Figure 51, during the insertion process, the tip of the tool is pushing against the locking shoulder of the socket contact. While being inserted into the receptacle assembly, the socket contact spreads the tabs of the retaining clip. After passing the tabs, the contact is moved further, until it reaches its stop, the retainer plate. At this position, the insertion tool still spreads one of the retainer clip tabs out, while another tab becomes engaged with the contact locking shoulder, holding the contact in place. When the tool starts to retract from the receptacle assembly, this second tab will retain the contact in its final position. After the tool is retracted further, the first tab will engage also, and the locked socket contact will stay in the receptacle.

All components of this assembly are precision made and go together with a minimal effort. The procedures recommended by StacoSwitch are based on insertion and extraction tool manufacturers' assembly instructions and, when properly implemented, give excellent results. The following are the recommended CTS assembly procedures.

WIRE CRIMPING PROCEDURE

Crimping tool, StacoSwitch PN 15191 with Positioner, PN 15192 (M22520/2-01 and M22520/2-14, correspondingly) is recommended for crimp pin contact PN 15095 (MIL-C-39029/16-168). Use crimping tool, StacoSwitch PN 15278 with Positioner PN 15279 (M22520/7-01 and M22520/7-12, correspondingly) for crimp pin contact PN 15276 (MIL-C-39029/22-192).

1. Burn through the insulation with a hot wire stripper or use other approved stripping method. Do not remove the insulation at this point. This will protect the wire strands from splaying. Recommended wire strip length is approximately .22 inch.
2. Drop the contact to be crimped into the crimping tool with the contact crimp barrel facing up.
3. Remove the small piece of insulation from the wire, insert the bare wire into the open end of the contact and squeeze the crimp tool. The crimp tool will only release the contact when the full crimping cycle has been performed. Remove the crimped contact from the tool.
4. Check the visibility of the wire in the contact inspection hole that will indicate that the wire is crimped into the contact at the proper depth.

CRIMP CONTACT INSTALLING PROCEDURE

Installing and removal tool, StacoSwitch PN 15190 (M81969/16-01) is recommended for this operation.

1. Holding the wire to form a slight curve, slide the wire into wider portion of the slot on the colored (red) side of the plastic tool, leaving the contact about ½ inch from the tool end.
2. Support the tool with forefinger and force (slide) the wire into the tubular area of the tool with the thumbnail, moving it to the end of the tool.
3. Pull the wire back though the tool until the tip of the tool seats against the contact shoulder.
4. Firmly holding the tool and the wire together by squeezing them in the slot serration area, position the contact and tool perpendicular to the rear rubber surface of the receptacle assembly. Align them with the appropriate cavity on the wire entry side of the connector and slowly push the contact into the cavity.

A firm stop will be evident when the contact positively seats in the connector and is locked into place. Release the wire and pull the tool from the cavity. A slight move of the wire in and out will assure that the contact is firmly seated.

CRIMP CONTACT REMOVING PROCEDURE

Installing and removal tool, StacoSwitch PN 15190 (M81969/16-01) is recommended for this operation.

1. Holding the wire of the contact to be removed to form a slight curve, slide this wire into the full length of the slot on the white end of the plastic tool.
2. Align the tool perpendicular to the surface of the connector. Slide the tool into the cavity until the positive resistance is felt. The contact retaining clip is now in the unlocked position.
3. Simultaneously withdraw both the tool and the contact-wire assembly from the connector. Squeeze the wire with the fingers against the serration of the tool to simplify the removal process.

GENERAL RECOMMENDATIONS

Sometimes assembly personnel use their own "tricks" to facilitate work or apply excessive force during insertion or contact removal operations. While people usually develop their own individual techniques to perform the same operations, the basics of these recommendations should be followed.

1. If possible, make wire-contact assembly insertion operations with receptacles already installed in the switch module. Switch contact pins will align the socket contacts better and will positively define and support the proper contact position in the receptacle housing.
2. Never use excessive forces during contact insertion or contact removal operations. Normally, these forces do not exceed 2 or 3 pounds. Do not ever use force more than 6 pounds. If unusual resistance is encountered during any of these operations, stop, go back and check the wire-contact assembly, tool integrity and accuracy of your actions. Then make necessary corrections and repeat the operation.
3. Make sure that during assembly, only minimal wire pulling force is used at angles other than perpendicular to the rear surface of the receptacle. Socket contacts are installed in their holes with a radial gap for better alignment with the pins of the switch. If angular pull force is applied to the wire-contact subassembly, the contact will assume a "diagonal" position in its cavity. This may result in only one retaining clip tab supporting the contact in its position, which will greatly reduce the maximum holding force of the receptacle assembly. This is especially important if insertion is performed with receptacle separated from the switch.
4. While making wire harnesses be sure that all wire bundles are supported and no weight or other forces are transferred to the connector through the wires. Wires inserted into receptacles must be as close to perpendicular to the rear surface as possible. Allow for sufficient length of service loops to permit a minimum of two repairs of a crimp.
5. Do not influence contact insertion or removal by twisting or rotating the tool around its axis. Because the tubular part of the tool has a gap with exposed slot edges, these edges can catch the tabs of the retaining clip and deform or break them, making good contact retention impossible.

NOTE

Some customers use metal insertion and removal tools instead of the recommended plastic tool for receptacle assembly operations. While tools made for the corresponding contacts may be suitable, care must be taken that all electric power sources are disconnected during the assembly or disassembly operations.