SERIES 82
Lightable

FEATURES
- $^{11}/_{16}$" Between Button Centers
- Long, Stroke, Wiping Contact
- Lightable Modules
- Choice of 5 Circuitries with Unlighted Modules
- User Legendable

Lightable Modules

Unlighted Modules

MOUNTING

Build a custom keyboard with identical button distances no matter how you stack them. Designed to plug into any printed circuit board from $^{1}/16$" to $^{1}/8$" thick, modules stack in any configuration, maintaining $^{11}/16$" button centers.

For Lightable Modules which will be continuously lit, mixing vertically mounted modules with horizontally mounted modules is not recommended; the orientation of the rectangular, lighted area will differ. See drawings.

See Figure 1 Panel Cutout diagram for 6 button module mounting dimensions. Refer to drawings for other module dimensions.

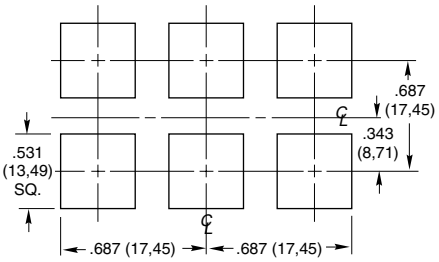


Figure 1 Panel Mount Cutout Diagram

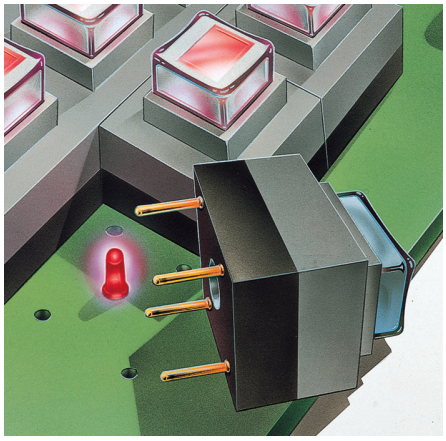
LIGHTABLE MODULES

Light Source and Lamp Mounting

Each lightable button fits over a T-1 size LED or incandescent lamp mounted to PC board (see Figure 2-2a). The height of the lamp should not exceed .250" (6,35 mm) from the surface of the board. (Note: Grayhill does not manufacture or sell LED's or incandescent lamps).

For easy light replacement, mount the lamp or LED through the back or solder side of the board (see Figure 2). This method of mounting allows you to replace light source without removing the keyboard module. The other method of light mounting (Figure 2a) requires desoldering the keyboard module then desoldering the lamp when it's necessary to replace the light source.

The chart below lists ratings for a size T-1 incandescent lamp. To extend the life of the lamp, use an alternating current and reduced voltage. The chart also lists maximum temperatures the module can withstand. For higher temperatures, Grayhill offers modules made of special plastics, polyester switch housing and polycarbonate internal button. All measurements were determined under laboratory conditions. (Mounted model continuously lit in temperature controlled oven with continuously circulating air for 24 hours.)



Incandescent Lamp–Size T-1

Lamp Number*	Intensity and Mean Spherical Candle Power	Volts	Service Life in Hours	Current Per Lamp	Maximum Allowable Ambient Temperature	Max, Temp. for Modules With Special Plastics
715	Bright .15 MSCP	5 V	40,000	115 mA	130°F	200°F
680	Moderate .03 MSCP	5 V	100,000	60 mA	150°F	220°F

*Lamps not available from Grayhill.

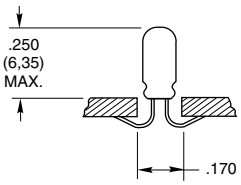


Figure 2
Easy replacement mounting

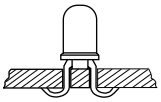


Figure 2a
Mounted from component side

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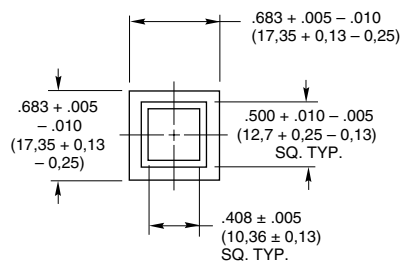
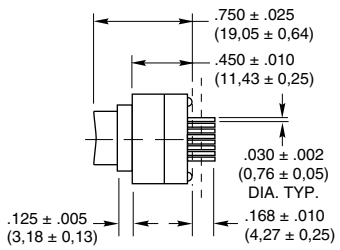
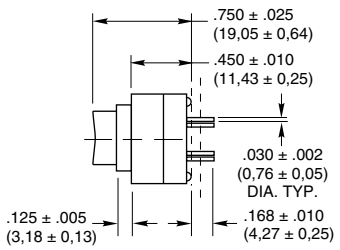
DIMENSIONS In inches (and millimeters)

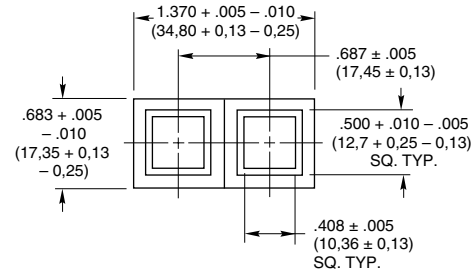


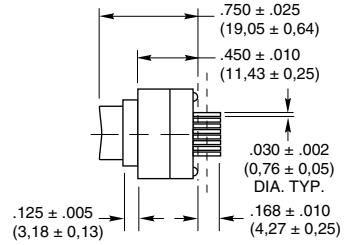


Unlighted

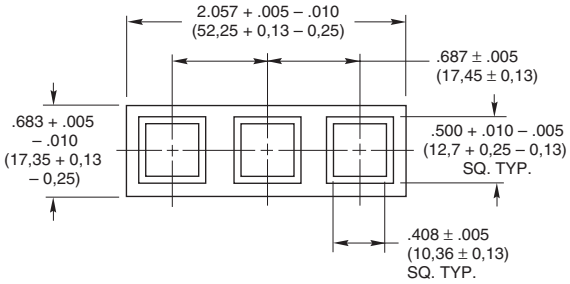


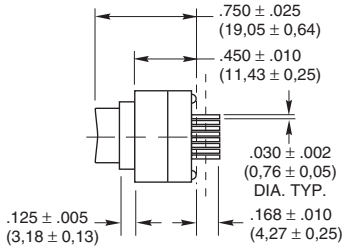
Lightable





Unlighted (only)





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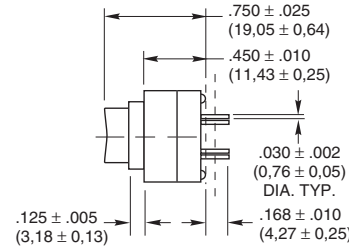
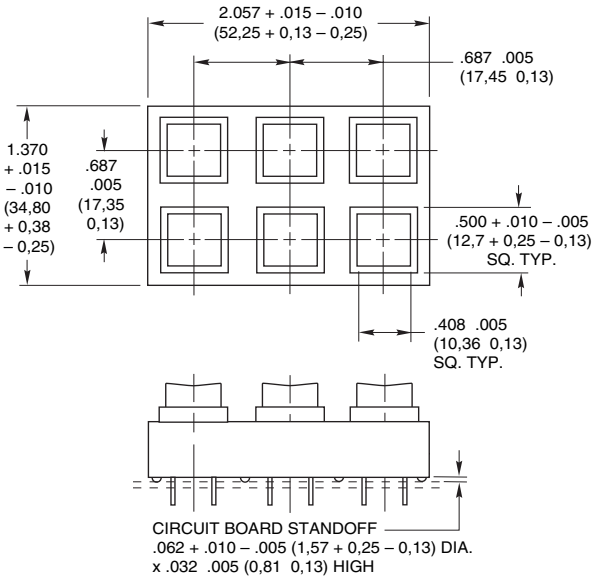
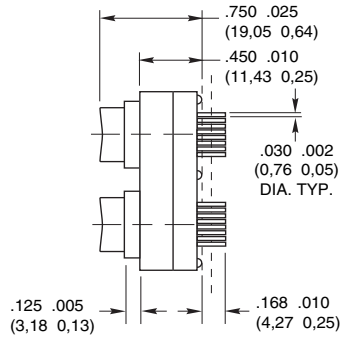


Lightable





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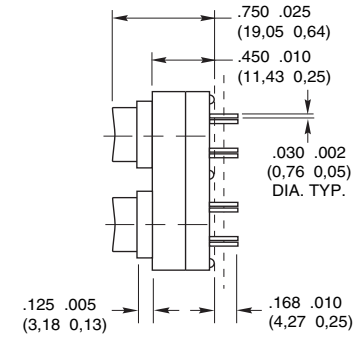


Lightable

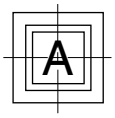
TERMINAL ARRANGEMENTS

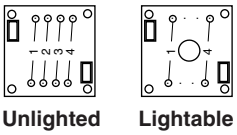
For continuously lit keyboards, mixing horizontally and vertically mounted modules is not recommended. See lamp mounting on page D-33.

Letters shown in front views are for identification only; product is marked on back as shown. Pin locations correspond to circuit diagrams.

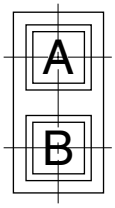
Vertical Mount

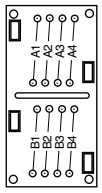
Button Identification | **Rear Views and Pin Locations**





Unlighted | Lightable





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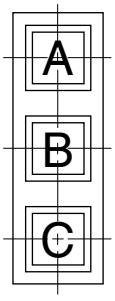
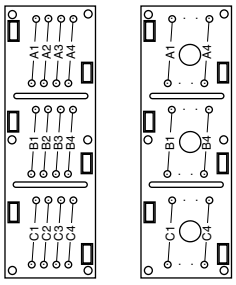
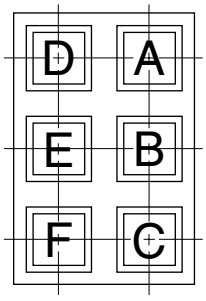
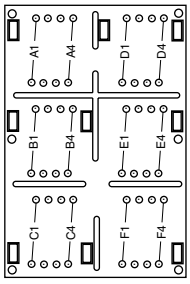




Unlighted | Lightable





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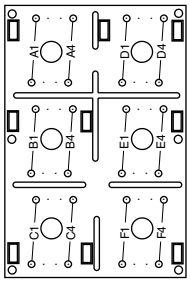

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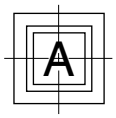
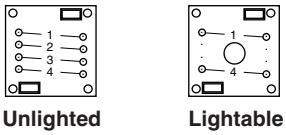
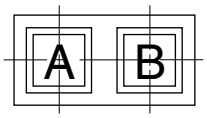
Horizontal Mount

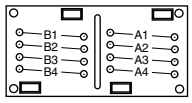
Button Identification | **Rear Views and Pin Locations**





Unlighted | Lightable





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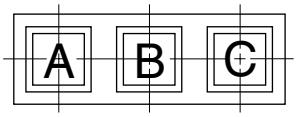

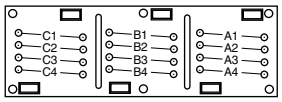

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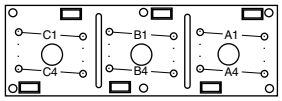
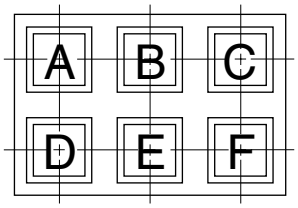
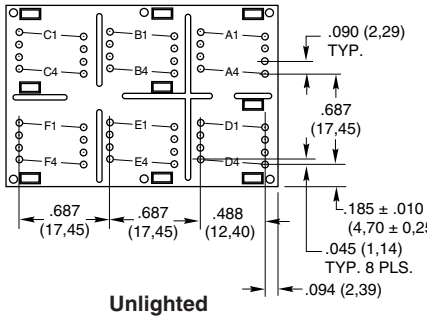
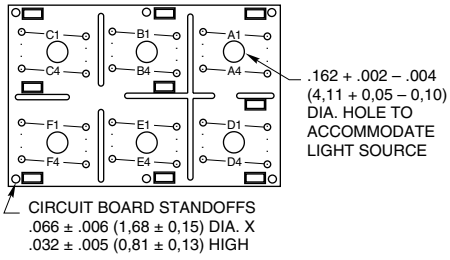


Lightable





Unlighted



Lightable

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ORIENTATION OF MODULES

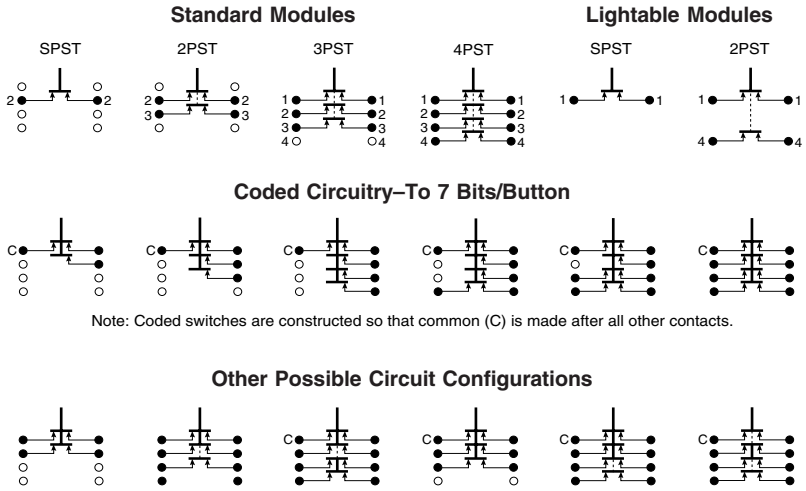
A module, depending on circuitry, may not be symmetrical. Rotating it 180° will result in a different pin location. Please note the button identification, the pin location for the desired circuitry, and the direction of mounting. It is important to use this information when designing a printed circuit board layout and when communicating with Grayhill. See Ordering Information–Special Keyboard Modules on the next page.

CIRCUIT DIAGRAMS

The bottom view of the line drawings shows number (A1, A2, etc.) next to the pin locations of each switch section. These pin numbers are directly related to the circuit diagrams. For example, if the switch under Button A of a standard module were SPST, the pins would be located at the "#2" Position. If the module were a lightable one with SPST circuitry, the pins would be located at the "#1" Position. If other locations are desired, specify them.

The coded circuits shown are suggested possibilities and each button may carry a different circuit. Location of active pins on each button may be varied to conform with layout of the printed circuit board. Up to a 7-bit code is possible under each button.

Combinations of simple circuitries are also possible as shown in the sample diagrams.

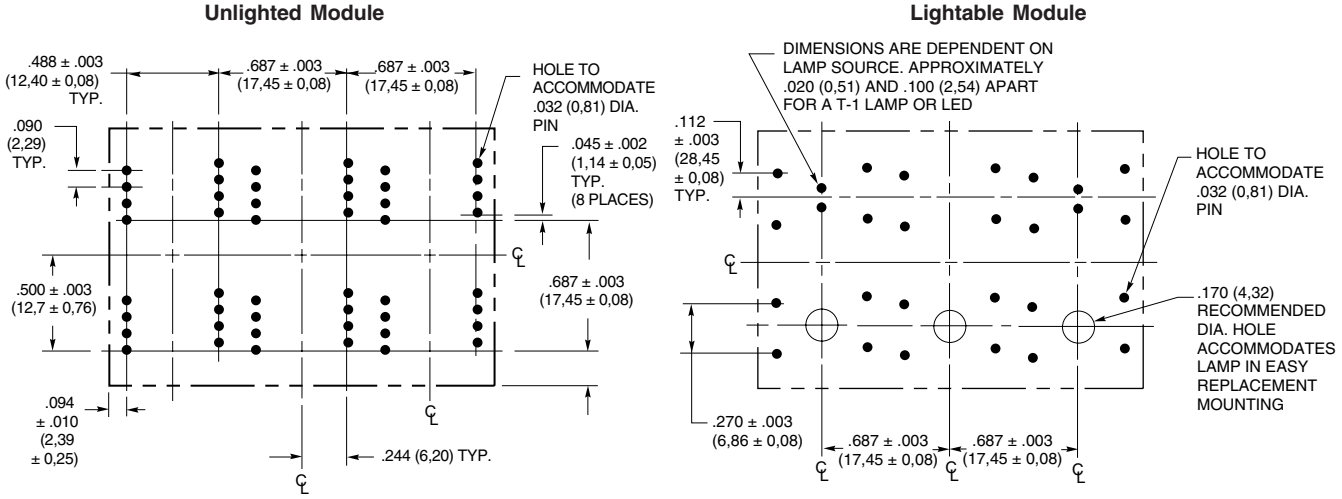


Note: Coded switches are constructed so that common (C) is made after all other contacts.

PRINTED CIRCUIT BOARD LAYOUT

This layout provides the horizontal printed circuit board layout as viewed from the top side of the PC board. Turning end to end will result in a different pin location. However, the dimensional relationship will remain the same.

Lightable Modules–per drawing below.
This drawing indicates the layout to be used for a 6 button module with light sources mounted two ways: the lamps for the upper 3 buttons are mounted from the top or component side of the board, and the lamps for the lower 3 buttons are mounted by the easy replacement method. (See also Light Source and Lamp Mounting.) Light sources, when mounted from the top side of the board, must be mounted before the keyboard modules; when mounted, lamp should extend no more than .250" (6,35 mm) above the board.



SPECIFICATIONS

Rating

Rating at 5 Vdc: 100 milliamps
Contact Resistance: 25 milliohms or less on a new switch
Voltage Breakdown: 250 Vac between mutually insulated parts
Insulation Resistance: 1,000 megaohms minimum
Life Expectancy: 1,000,000 operations
Contact Bounce: 10 milliseconds or less for the life of the switch
Operating Temperature: -40°C to 80°C

Materials and Finishes

Pin Contact: Brass, gold plate over nickel plate
Spring Contact: Copper alloy, gold plate over nickel plate
Housing: ABS plastic (gray)
Base: PPS plastic (black)
Return Spring: Tinned music wire
Other Parts: (By Module and Legend Style): For unlighted module with molded legends or top surface printed legends. Internal Button is acetal and the Button is ABS plastic (gray).

For unlighted module with sub-surface printed legends or insertable legends, Internal Button is acetal; Internal Cap is ABS plastic (gray); and Clear Cap is polycarbonate plastic. For lightable modules, the Internal Button and the Clear Cap are polycarbonate. The Internal Cap for gray modules is acrylic; for the black modules, the Internal Cap with window is polycarbonate.

For special lightable modules for higher temperatures, internal button cap is polycarbonate and housing is polyester.

Operating Features

Action: Momentary, wiping contact
Button Travel: 0.130" (3,30 mm) total travel
Overtravel: 0.080" nominal
Operating Force: 8 ± 3 ounces (depends on number of poles.)

Soldering Instructions

Series 82 Keyboard Modules have been successfully tested for heat resistance to soldering up to 260°C (500°F) for a maximum of 5 seconds. Careful flux cleaning is required since the switch is not sealed. For applications in excess of these limits or that require vapor spray or immersion cleaning, contact Grayhill.

STANDARD LEGENDS

Telephone Keyset

Two 6-button modules form the keyset. White telephone legend is molded into a gray button. SPST, 2PST, 3PST, and 4PST circuitry available from distributors, see ordering information; order special circuitry from Grayhill.

Non-Legend, Lighted Modules

Standard lightable module configurations without cap slot for insertable legend.

Insertable Legend Styles

Prototypes can look professional with insertable legend modules. Just slip imprinted legend insert through the slot of the clear button cap.

Legend Sheet

Available for each module style. Each sheet contains commonly used symbols, terms, alpha characters, and 0-19 in News Gothic Condensed type on polyester film, ready to be cut and inserted. Deadfront legends are invisible until lit.

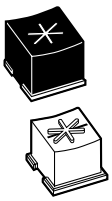
White on Clear: For unlighted gray modules — **Part No. 82AC2017-1**
Black on Clear: For lighted gray modules — **Part No. 82AC2050-1**
Translucent White on Black: For black modules — **Part No. 82AC2060**
Deadfront on Black: For black modules

SPECIAL LEGENDS

Molded-In Legends

For Unlighted Modules

In addition to standard white legend on gray button, long-wearing, molded-in legends are available in white button with black legend and white legend with red, green or black buttons. Other color combinations are possible.



Printed Legends (2 Styles)

Virtually anything which can be photographed can be printed. Sturdy epoxy ink printing bonds to the surface of the button. Standard printing for the gray unlighted buttons is white; standard printing for the translucent white buttons of the lightable modules is black.

Top Surface Printing: Legend is applied directly to top of button. Available on all standard, unlighted modules.

Sub Surface Printing: Provides maximum wear for printed surfaces. Available for lighted and unlighted gray modules. Printed internal button cap is protected by a clear outer cap.

Printed Type styles

The type style chart below illustrates type style and approximate sizes and limits for button cap legends; other sizes are also available. Limitations for legends differ with type size and character. Legends for lightable modules are further limited by the size of the internal button and lighted area. Grayhill's library includes many popular legends. Contact Grayhill for complete information.

Special Colors

Besides the standard gray and black housings, you may order white, beige or brown. Button colors may also be specially ordered. For more information, see next page.

Type No. and Typical Height	Sample Style and Typical Sizes	Sub Surface Character and Line Limitations	Top Surface Character and Line Limitations	Lightable Module Character and Line Limitations*
4GH088 .083"	ABCDEFGH	5 Char. 2 Lines — TAB INDEX	8 Char. 3 Lines — RESEARCH SYSTEMS 12345678	4 Char. 2 Lines — STOP 1234
1GH125 .138"	ABCDE	4 Char. 1 Line — OPER	4 Char. 2 Lines — CODE SEND	3 Char. 1 Line — OFF
3GH187 .207"	ABCD	2 Char. 1 Line — ON	3 Char. 1 Line — OFF	2 Char. 1 Line — ON
2GH250 .276"	ABC	2 Char. 1 Line — 15	2 Char. 1 Line — 15	N/A — N/A

Note: Limitations for legends differ with surface to be printed and actual characters. If your application exceeds the approximations in the chart, contact Grayhill for more information.
* For top and sub-surface printed modules.

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ORDERING INFORMATION: Special Legends

To order non-standard modules, information is required for the areas listed below.

Your special order will be assigned a part number for future identification. This number is sequentially assigned and is non-descriptive.

1. **Type of Module.** Unlighted: 1-, 2-, 3-, or 6-button. Lightable: 1-, 3-, or 6-button.

2. **Mounting Orientation.** Horizontal or vertical.

3. **Circuitry.** Requirements for each button must be listed by its reference letter designation. For example: Button A = SPST, Button B = 4PST, Button C = 3PST, etc. For coded or other available circuitry patterns a descriptive diagram is required for each button.

4. **Button Type (Legend).** Grayhill offers four legend types: molded-in; top surface printed; sub-surface printed; and insertable. Unlighted modules are available in all types. Lightable modules are available in all types but molded-in legends.

5. **Button Color.** Standard color for molded-in legend modules is gray button with white legend. Special button colors available are white with black legends, red, green or black buttons with white legends. Additional custom colors are available by special order.

   Lightable gray modules have a standard translucent white button with black legend. Special button color includes translucent red, amber, yellow, blue and green. Lightable black modules have a special opaque black button; discuss special colors with Grayhill.

   Colors can be intermixed, ie. buttons A-E gray; and F, white.

6. **Housing Color.** Base in black. Upper housing is black for lightable legends and gray for all other module styles. Other stock colors available include white, beige and brown.

7. **Legends.** List legend requirement for each button (Button A legend, "10", is type style 4GH088. Button B, "ON", is type style 1GH125, etc.). For legend information, see page D-37.

Price: Contact Grayhill

ORDERING INFORMATION: STANDARD MODULES

Type of Module	Description	Part No.
Top Half of Telephone Legend (Molded-in)	6 Buttons, SPST 6 Buttons, 2PST 6 Buttons, 3PST 6 Buttons, 4PST	**82-601-85** **82-601-86** **82-601-87** **82-601-88**
Bottom of Telephone Legend (Molded-in)	6 Buttons, SPST 6 Buttons, 2PST 6 Buttons, 3PST 6 Buttons, 4PST	**82-601-89** **82-601-90** **82-601-91** **82-601-92**
Unlighted Gray Modules For Legend Inserts	1 Button, SPST 1 Button, 4PST	**82-101-71** **82-101-74**
	2 Buttons, SPST 2 Buttons, 4PST	**82-201-41** **82-201-44**
	3 Buttons, SPST 3 Buttons, 4PST	**82-301-61** **82-301-64**
	6 Buttons, SPST 6 Buttons, 4PST	**82-601-81** **82-601-84**
Lightable Gray Modules Non-Legend	1 Button, SPST 1 Button, 2PST	**82-150-17** **82-150-15**
	3 Buttons, SPST 3 Buttons, 2PST	**82-350-10** **82-350-8**
	6 Buttons, SPST 6 Buttons, 2PST	**82-650-10** **82-650-8**
Lightable Gray Modules For Legend Inserts	1 Button, SPST 1 Button, 2PST	**82-150-38** **82-150-16**
	3 Buttons, SPST 3 Buttons, 2PST	**82-350-12** **82-350-9**
	6 Buttons, SPST 6 Buttons, 2PST	**82-650-19** **82-650-9**
Lightable Black Modules For Legend Inserts	1 Button, SPST 1 Button, 2PST	**82-150-211** **82-150-213**
	3 Buttons, SPST 3 Buttons, 2PST	**82-350-41** **82-350-43**
	6 Buttons, SPST 6 Buttons, 2PST	**82-650-71** **82-650-73**
Legend Sheets	White: For Unlighted Gray Black: For Lightable Gray Deadfront: For Lightable Black	**82AC2017-1** **82AC2050-1** **82AC2060**

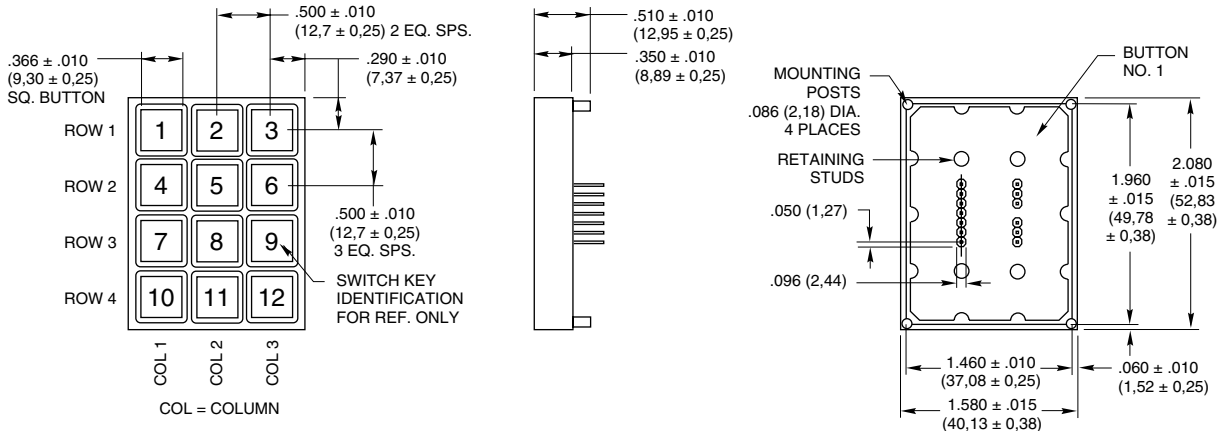
Available from your local Grayhill Distributor. For prices and discounts, contact a local Sales Office, an authorized local Distributor or Grayhill.

SERIES 83
Unsealed, .500" Centers

FEATURES
- ½" Button Centers
- Post Mounted
- Mount by Grooveless Retaining Ring or Heat Upset Post
- Snap-Dome Contact Provides Positive Feedback

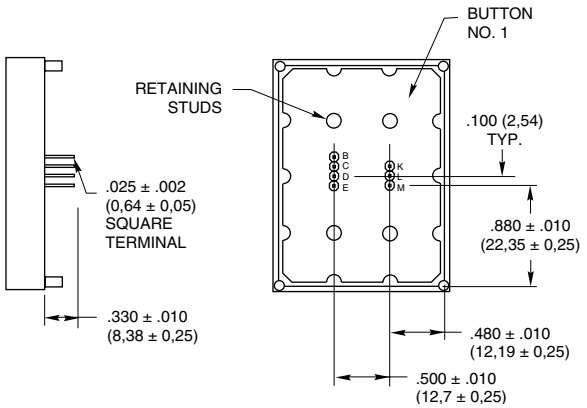
DIMENSIONS In inches (and millimeters)

3x4 Keyboard

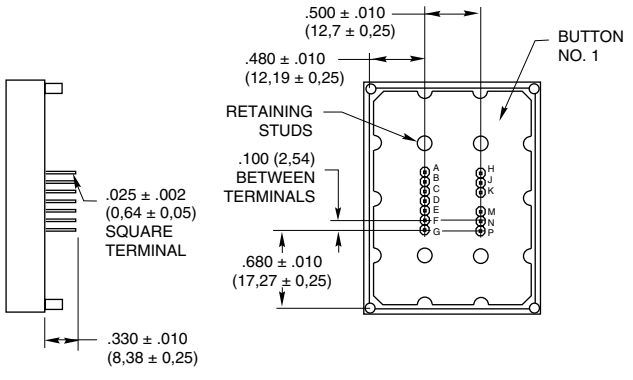


Termination In inches (and millimeters)

3x4 Matrix Output



Single Pole/Common Bus



SERIES 83

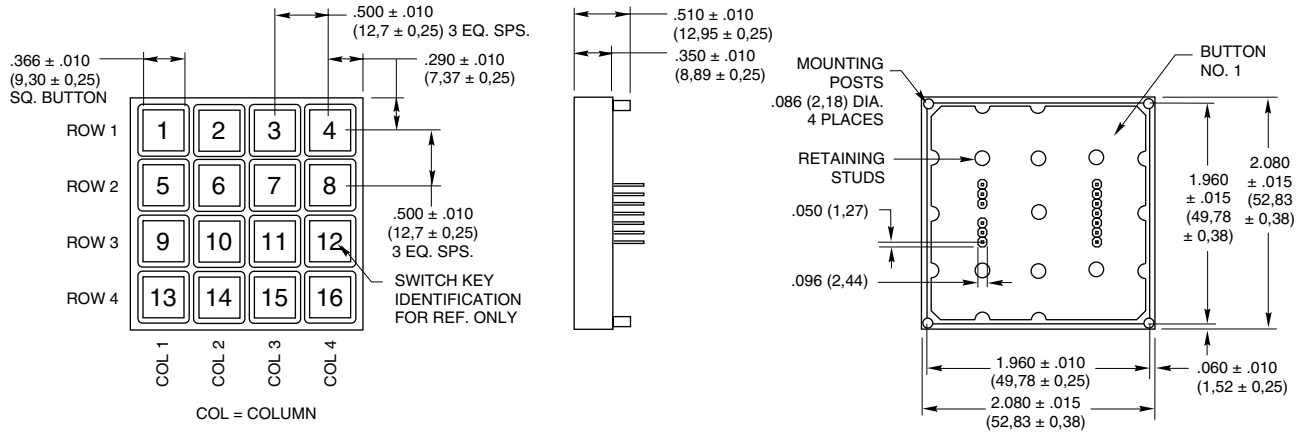
Unsealed, .500" Centers

FEATURES

- 1/2" Button Centers
- Post Mounted
- Mount by Grooveless Retaining Ring or Heat Upset Post
- Snap-Dome Contact Provides Positive Feedback

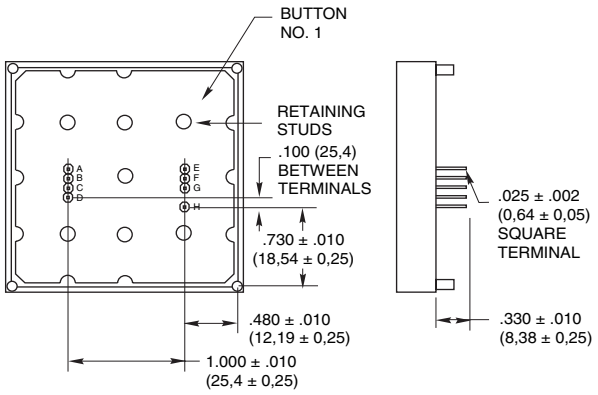
DIMENSIONS In inches (and millimeters)

4x4 Keyboard

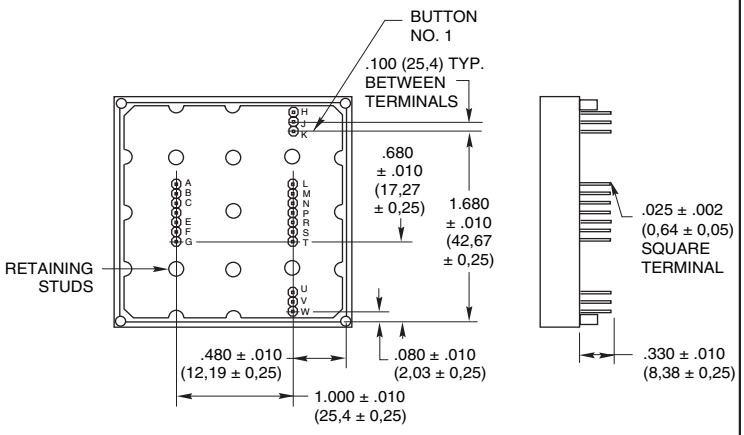


Termination In inches (and millimeters)

4x4 Matrix Output



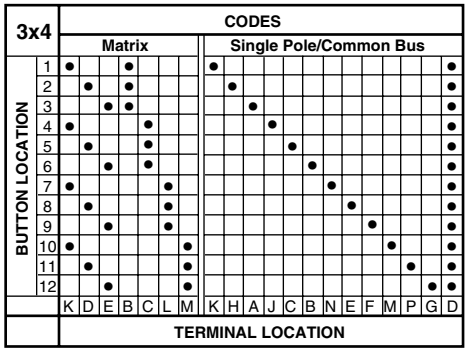
Single Pole/Common Bus



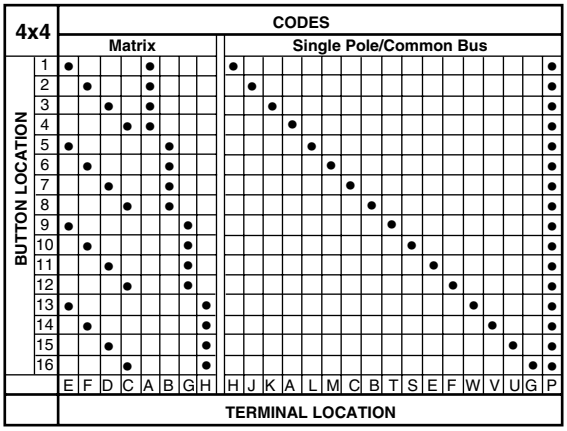
CODE AND TRUTH TABLES

Dots in the chart indicate connected terminals when switch is closed.
Terminals are identified on the keyboard.

12 Button Keypads



16 Button Keypads



SPECIFICATIONS

Rating Criteria

Rating at 24 Vdc: 10 milliamps, resistive
Contact Resistance: Compatible with MOS, TTL and DTL (10 ohms maximum)
Voltage Breakdown: 250 Vac between mutually insulated parts
Life Expectancy: 3,000,000 operations per button

Contact Bounce: Less than 4 milliseconds at make, 10 milliseconds at break
Operating Temperature: -40°C to +80°C

Materials and Finishes

Housing: ABS polycarbonate, black
Buttons: ABS plastic, white. Legends are black.
Snap-On-Cap: Clear polycarbonate

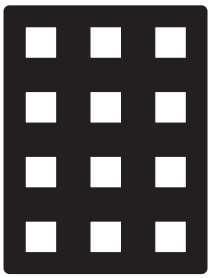
Contact Dome: Stainless steel, selectively gold-plated
Terminals: Phosphor bronze

Operating Features

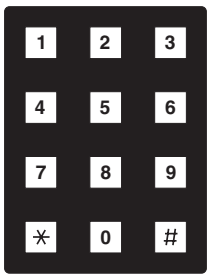
Button Travel: 0.015" (0,38 mm) nominal total travel
Typical Operating Force: 350 grams

STANDARD LEGENDS

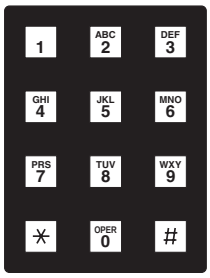
Insertable legend version (legend numbers -101 and -001) has a removable cap. The revealed button surface can be legended by an insert or a dry transfer of a blank legend insert. This surface can also be ink stamped by Grayhill in higher volume quantities. When the cap is replaced, the assembly extends approximately .015" (0,38 mm) above the surface. The legend sheet information follows the legend presentation. All other legends incorporate molded-in (two shot) legends.



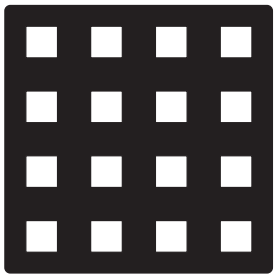
-101 (Insertable)



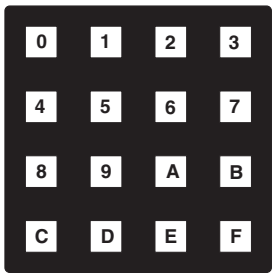
-102 (Molded-in)



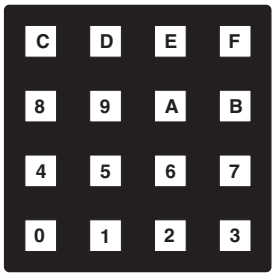
-103 (Molded-in)



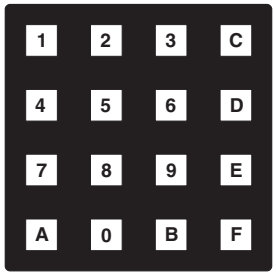
-001 (Insertable)



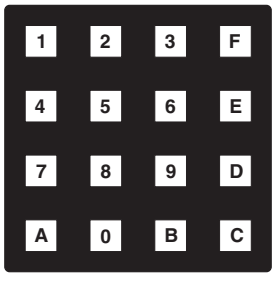
-002 (Molded-in)



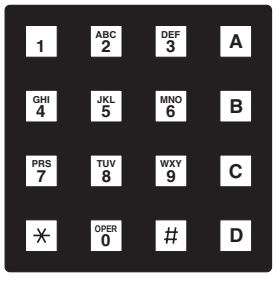
-003 (Molded-in)



-004 (Molded-in)



-005 (Molded-in)



-006 (Molded-in)

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INSERTABLE LEGEND SHEETS

For use with -101 or -001 legend option. Legends are die cut to fit button surface when cap is removed. Dry transfer legends offer some flexibility to customize the blank inserts included on the sheet of popular legend letters, words and symbols provided or on the insertable legends sheet.

Description	Part No.
Sheet of Legend Inserts	**87AC2046**
Dry Transfer Lettering, Small	**87-DT-2096-088**
Dry Transfer Lettering, Medium	**87-DT-2096-125**
Dry Transfer Lettering, Large	**87-DT-2096-187**

For prices and discounts, contact a local Sales Office, an authorized local Distributor or Grayhill.

PRINTED LEGENDS

For Maximum Versatility

Printing allows you the flexibility to create your own legend using whole words and symbols with various type styles. Durable epoxy ink printing bonds to the button cap surface. There are two types of button cap printing:

Top Surface Printing: Legend is applied directly to the top of the button. Button is recessed slightly below the keyboard housing.

Sub-Surface Printing: For insertable legend models. Provides maximum wear for printed surfaces. Printed internal button cap is protected by clear snap-on cap.

Printed Typestyles: The typestyle chart illustrates type style, size and approximate character limits for button caps. Grayhill's library of typefaces includes most popular legends.

Type No. and Typical Height	Sample Style and Typical Sizes	Sub Surface Character and Line Limitations	Top Surface Character and Line Limitations
4GH088 .083"	ABCDEFGH	4 Characters 2 Lines	4 Characters 2 Lines
1GH125 .138"	ABCDE	3 Characters 1 Line	3 Characters 1 Line
3GH187 .207"	ABCD	2 Characters 1 Line	2 Characters 1 Line
2GH250 .276"	ABC	N/A	2 Characters 1 Line

ORDERING INFORMATION: Special Legends

Follow this procedure:

1. **Basic Keyboard.** Formulate the part number with the exception of the legend suffix.

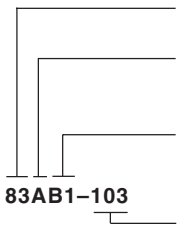
2. **Mounting.** Standard mounting is shown in our dimensional drawings. These drawings relate the terminal location to the button legend orientation. It is possible to rotate the button legends by 90°, changing the orientation. When mounting the keypad, it would be rotated 90° to have the legends appear upright. A 3x4 keypad thus becomes a 4x3.

3. **Color.** Many colors, other than our standard black housing, are available. Buttons can be made from equivalent plastic in black, red, green, blue and yellow. White legends are used with dark color buttons, black with light ones. Other colors available on special order.

4. **Buttons.** Legends can be printed on button surface and protected by a snap-on cap in a similar fashion to our insertable legend types. A second option is printing a 'blank' button. (One that has the same dimensions as a molded-in legend button with a flat top surface.) Disadvantage is legend wear over time. A third option is molded-in legends, usually requiring tooling. Molded buttons are available with a flat or concave top surface.

5. **Legends.** Specify the legend requirements for each button. Identify buttons per our dimensional drawings. Caution if keypad has been rotated.

ORDERING INFORMATION



Grayhill Series Number

Size Option
A = 3x4
B = 4x4

Circuitry Option
B1 = Matrix code
C1 = Single pole/common bus

Standard Legend Choices
3x4 Size: -101, -102 or -103
4x4 Size: -001, -002, -003, -004, -005 or -006

Available from your local Grayhill Distributor. For prices and discounts, contact a local Sales Office, an authorized local Distributor or Grayhill.

SERIES 86

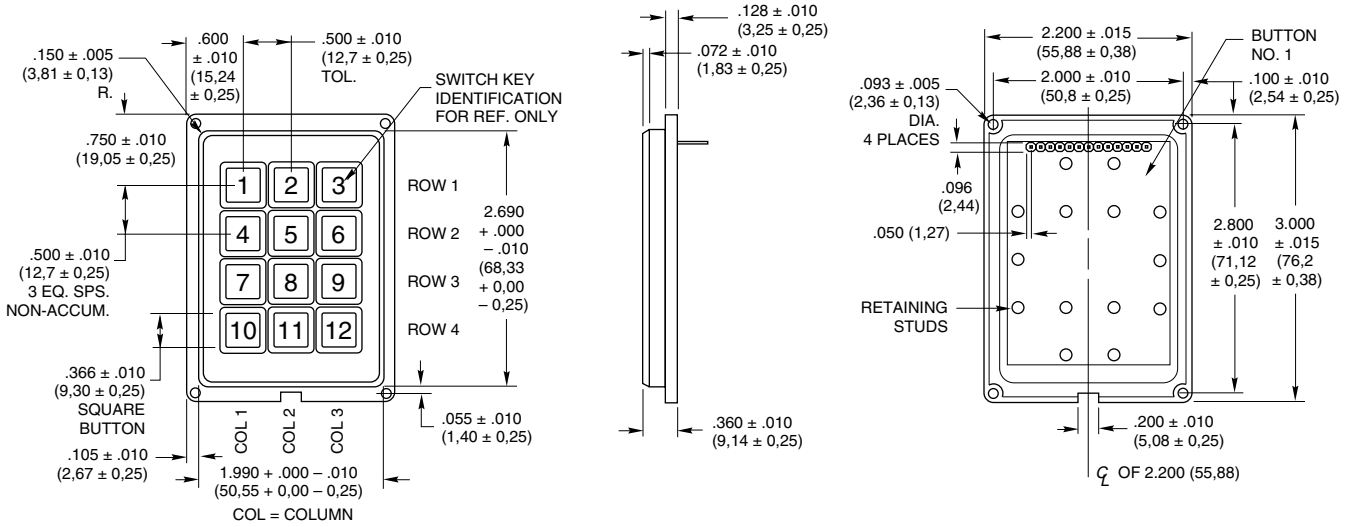
Unsealed, .500" Centers, Flange Mounted

FEATURES

- 1/2" Button Centers
- Flange Mounted
- Top Surface or Sub Surface Mounting
- Snap-Dome Contact Provides Positive Feedback

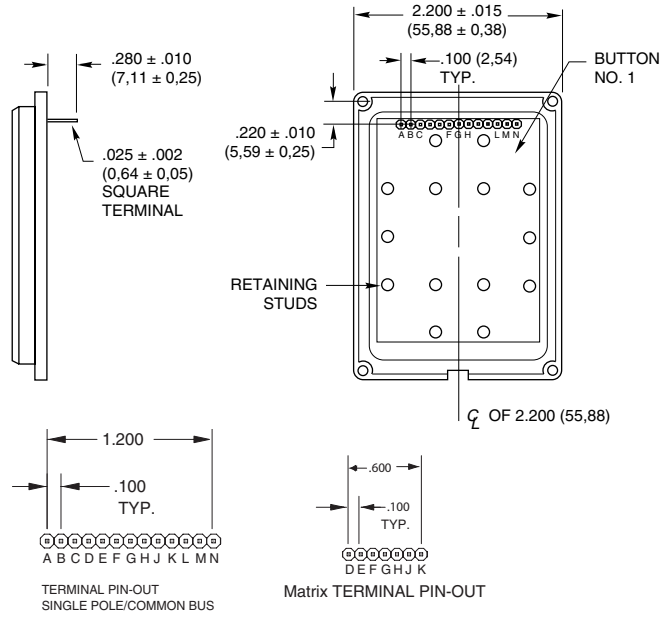
DIMENSIONS In inches (and millimeters)

3x4 Keyboard



Termination In inches (and millimeters)

3x4



Code and Truth Table

Dots in the chart indicate connected terminals when switch is closed. Terminals are identified on the keyboard.

3x4	CODES	
	Matrix	Single Pole/Common Bus
BUTTON LOCATION 1	●	●
2	●	●
3	●	●
4	●	●
5	●	●
6	●	●
7	●	●
8	●	●
9	●	●
10	●	●
11	●	●
12	●	●
	F E D K J H G	J E A K F B L G C M H D N
	TERMINAL LOCATION	

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SERIES 86

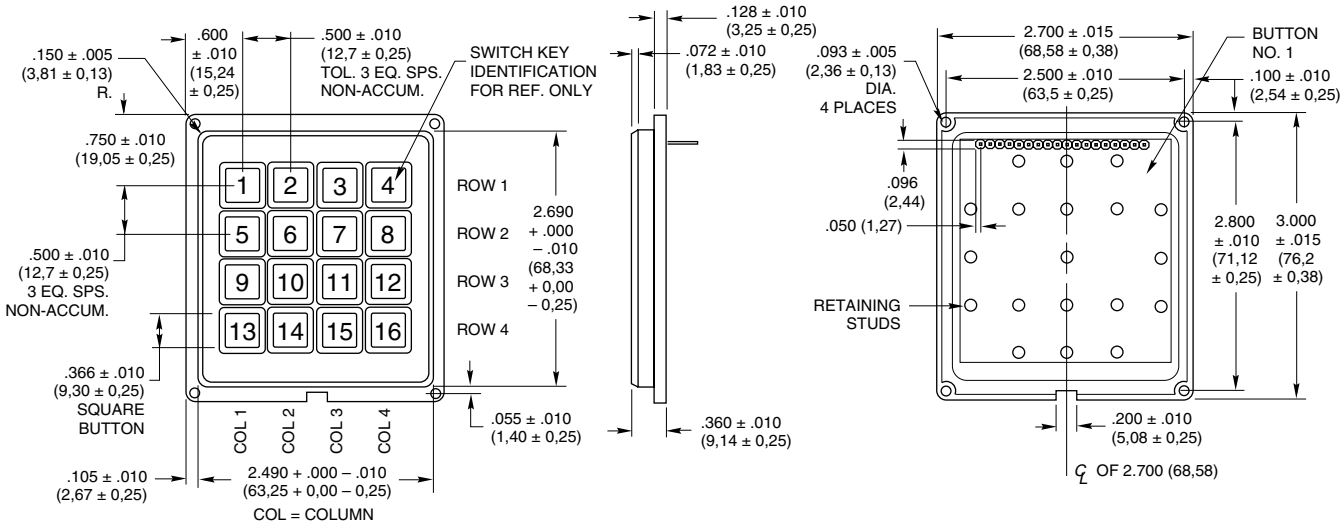
Unsealed, .500" Centers, Flange Mounted

FEATURES

- 1/2" Button Centers
- Flange Mounted
- Top Surface or Sub Surface Mounting
- Snap-Dome Contact Provides Positive Feedback

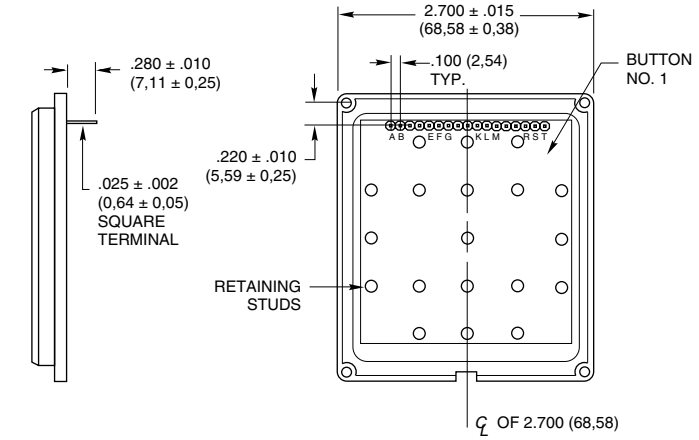
DIMENSIONS In inches (and millimeters)

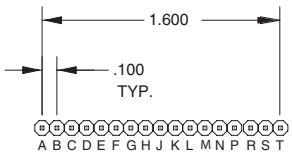
4x4 Keyboard



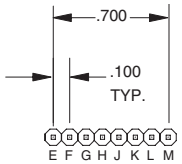
Termination In inches (and millimeters)

4x4





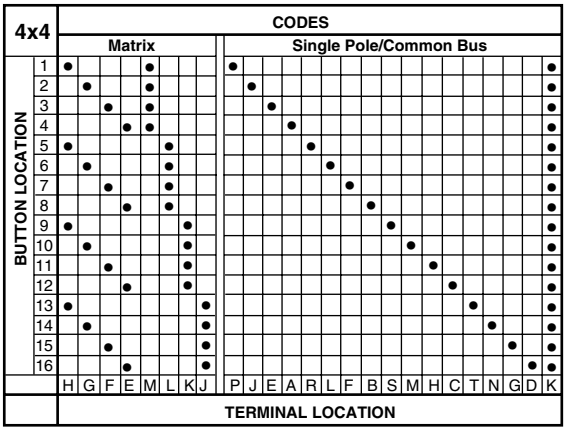
SINGLE POLE COMMON BUS TERMINAL



MATRIX TERMINAL PIN-OUT

Code and Truth Table

Dots in the chart indicate connected terminals when switch is closed. Terminals are identified on the keyboard.



SERIES 86

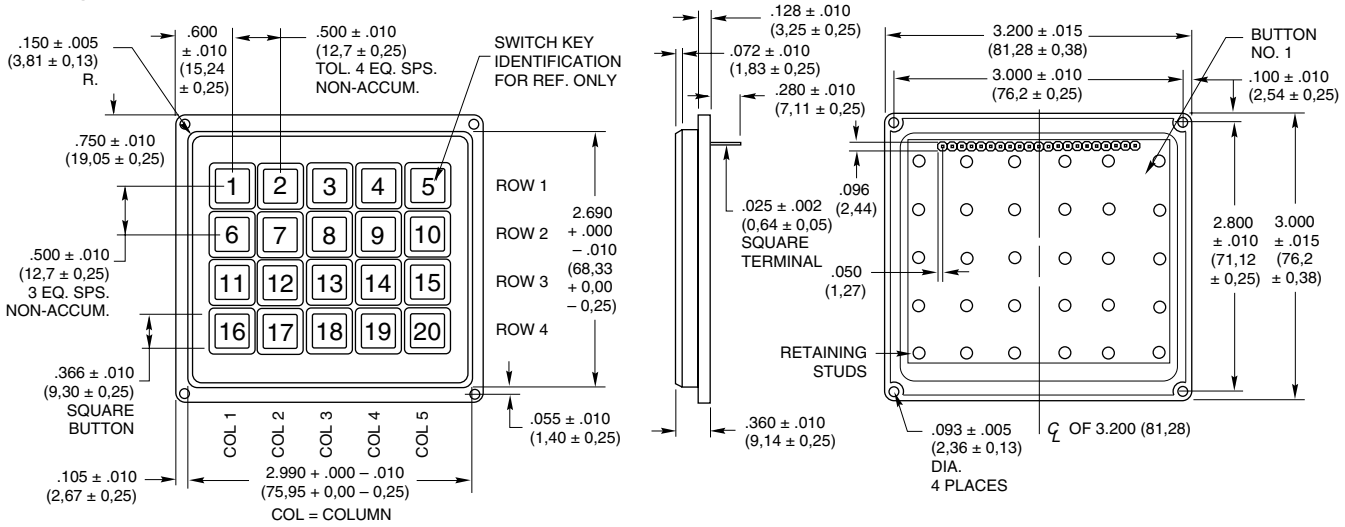
Unsealed, .500" Centers, Flange Mounted

FEATURES

- 1/2" Button Centers
- Flange Mounted
- Top Surface or Sub Surface Mounting
- Snap-Dome Contact Provides Positive Feedback

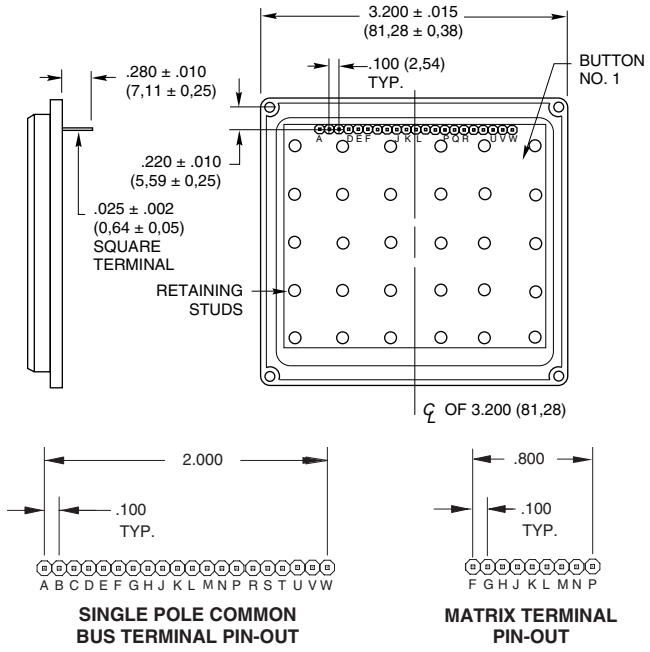
DIMENSIONS In inches (and millimeters)

5x4 Keyboard



Termination In inches (and millimeters)

5x4



Code and Truth Table

Dots in the chart indicate connected terminals when switch is closed. Terminals are identified on the keyboard.

5x4	CODES	
	Matrix	Single Pole/Common Bus
BUTTON LOCATION	TERMINAL LOCATION	

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SPECIFICATIONS

Rating Criteria

Rating at 24 Vdc: 10 milliamps, resistive
Contact Resistance: Compatible with MOS, TTL and DTL (10 ohms maximum)
Voltage Breakdown: 250 Vac between mutually insulated parts
Life Expectancy: 3,000,000 operations per button
Contact Bounce: Less than 4 milliseconds at make, 10 milliseconds at break
Operating Temperature: -40°C to +80°C

Materials and Finishes

Housing: ABS polycarbonate, black
Buttons: ABS plastic, white. Legends are black.
Snap-On-Cap: Clear polycarbonate
Contact Dome: Stainless steel, selectively gold-plated
Terminals: Phosphor bronze

Operating Features

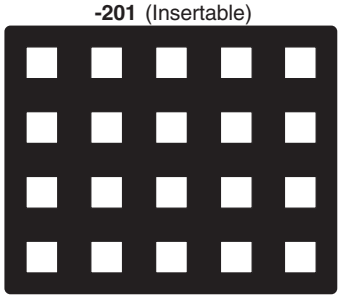
Button Travel: 0.015" nominal total travel
Typical Operating Force: 350 grams

STANDARD LEGENDS

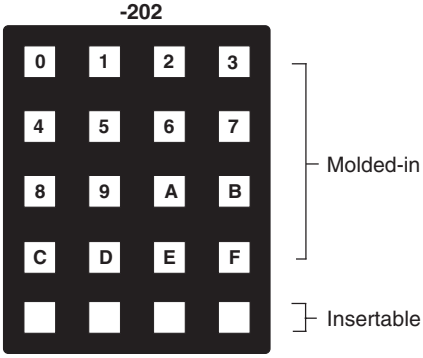
Insertable legend version (legend numbers -101, -001, -201 and row or column indicated in -202 and -203) has a removable cap. The revealed button surface can be legended by an insert or a dry transfer of a blank legend insert. This surface can also be ink stamped by Grayhill in higher volume quantities. When the cap is replaced, the assembly extends approximately .015" (0,38 mm) above the surface. The legend sheet information follows the legend presentation. All other legends incorporate molded-in (two shot) legends with the exception of legend numbers -202 and -203. The blank legends or spaces in legends -202 and -203 are insertable legends, others are molded-in.

5x4: Shown below

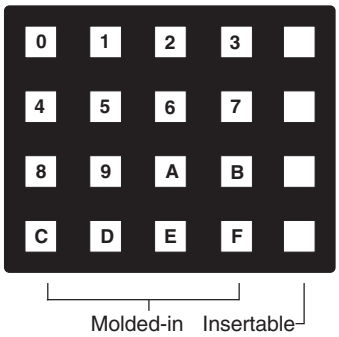
-201 (Insertable)



-202



-203



INSERTABLE LEGENDS

For use with -101, -001, -201, -202 and -203 legend options. Legends are die cut to fit button surface when cap is removed. Dry transfer legends offer some flexibility to customize the blank inserts included on the sheet of popular legend letters, words and symbols provided or on the insertable legends sheet.

Description	Part No.
Sheet of Legend Inserts	**87AC2046**
Dry Transfer Lettering, Small	**87-DT-2096-088**
Dry Transfer Lettering, Medium	**87-DT-2096-125**
Dry Transfer Lettering, Large	**87-DT-2096-187**

ORDERING INFORMATION

86AB2–103

Grayhill Series Number
Size Option
A = 3x4
B = 4x4
J = 5x4
Circuitry Option
B2 = Matrix code
C2 = Single pole/common bus
Standard Legend Choices
3x4 Size: -101, -102 or -103
4x4 Size: -001, -002, -003, -004, -005 or -006
5x4 Size: -201, -202, or -203

Available from your local Grayhill Distributor. For prices and discounts, contact a local Sales Office, an authorized local Distributor or Grayhill.

SERIES 84

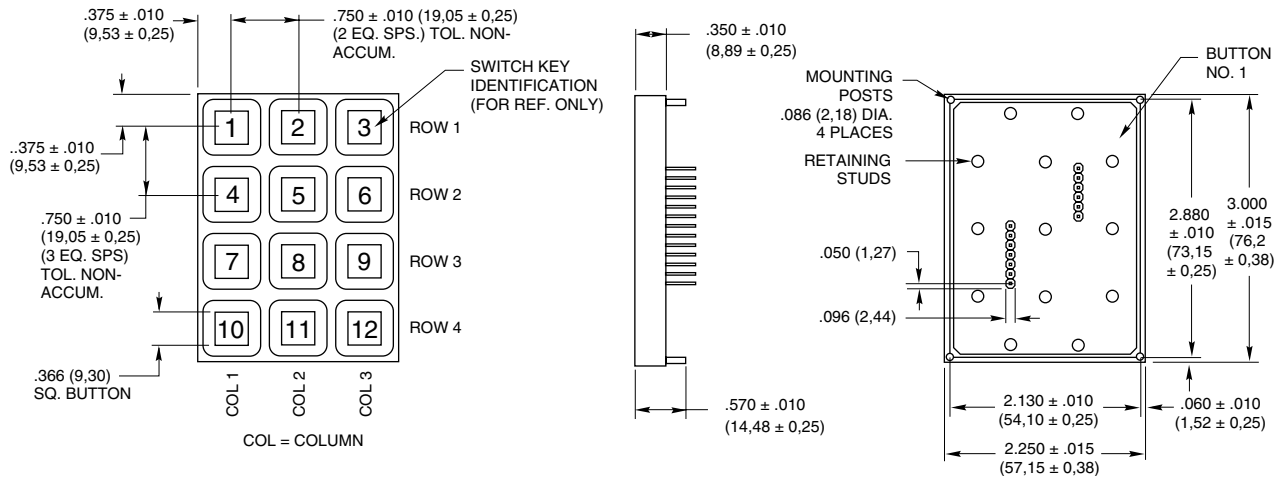
Unsealed, .750" Centers

FEATURES

- 3/4" Button Centers
- Post Mounted
- Mounts by Grooveless Retaining Rings or Heat Upset Post
- Snap-Dome Contact Provides Positive Feedback

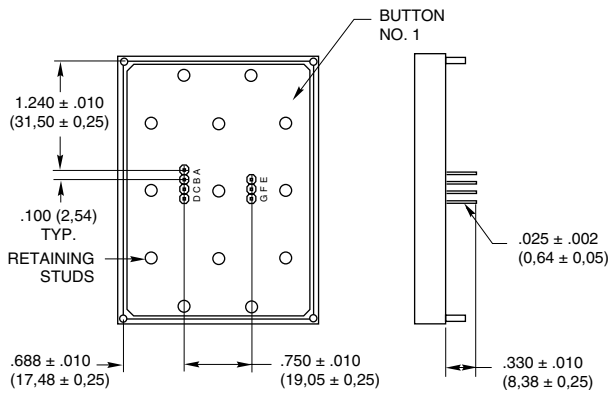
DIMENSIONS In inches (and millimeters)

3x4 Keyboard

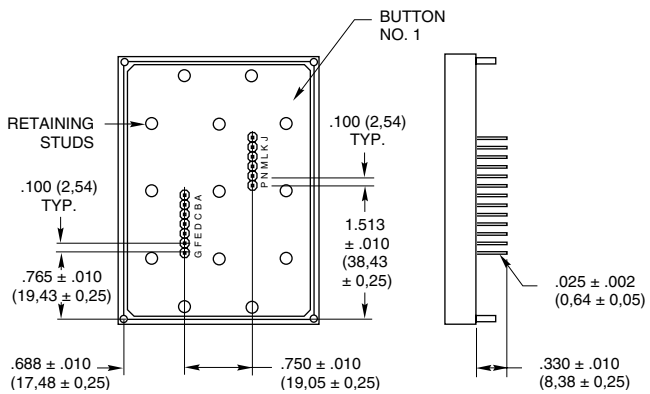


Termination In inches (and millimeters)

3x4 Matrix Output



Single Pole/Common Bus



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SERIES 84

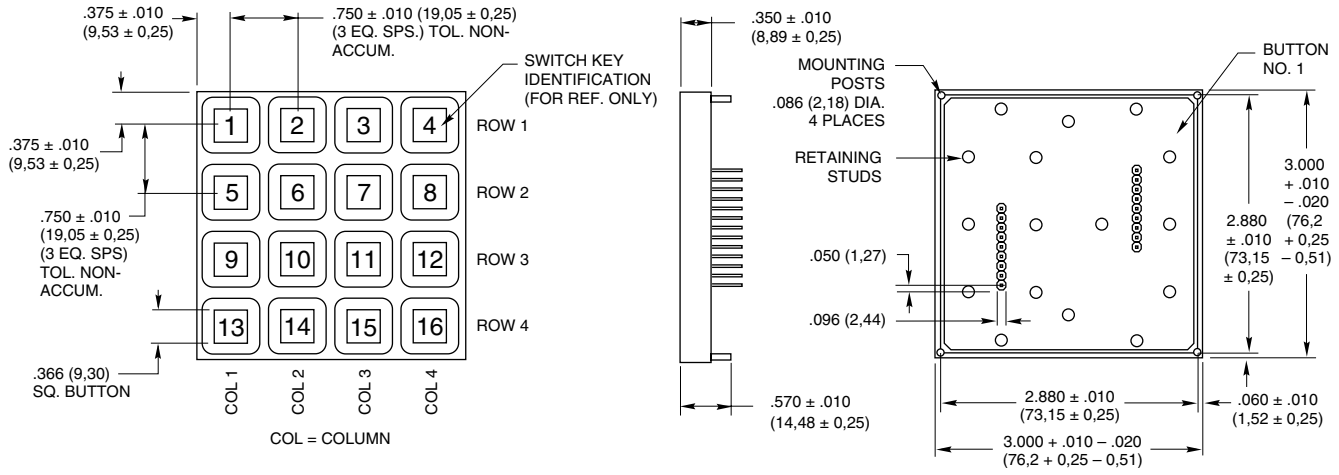
Unsealed, .750" Centers

FEATURES

- 3/4" Button Centers
- Post Mounted
- Mounts by Grooveless Retaining Ring or Heat Upset Post
- Snap-Dome Contact Provides Positive Feedback

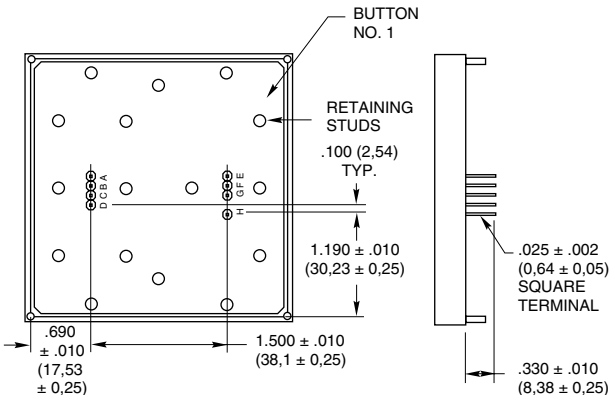
DIMENSIONS In inches (and millimeters)

4x4 Keyboard

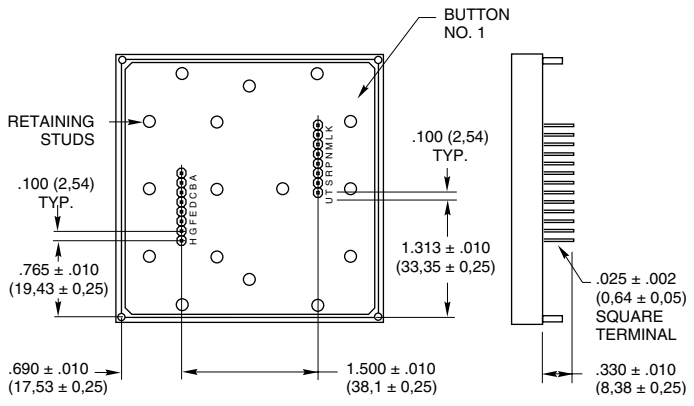


Termination In inches (and millimeters)

4x4 Matrix Output



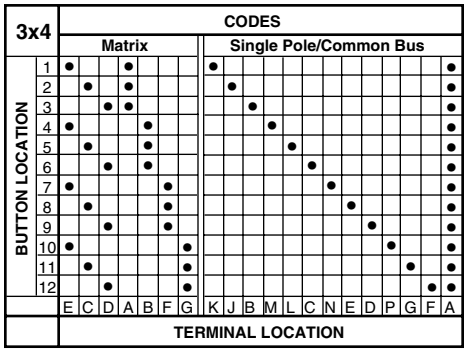
Single Pole/Common Bus



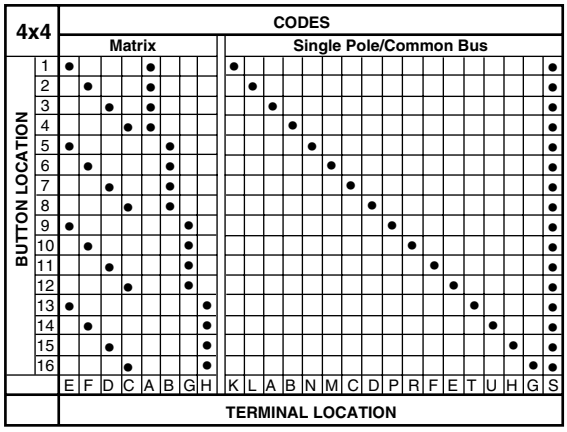
CODE AND TRUTH TABLES

Dots in the chart indicate connected terminals when switch is closed.
Terminals are identified on the keyboard.

12 Button Keypads



16 Button Keypads



SPECIFICATIONS

Rating Criteria

Rating at 24 Vdc: 10 milliamps, resistive
Contact Resistance: Compatible with MOS, TTL and DTL (10 ohms maximum)
Voltage Breakdown: 250 Vac between mutually insulated parts
Life Expectancy: 3,000,000 operations per button
Contact Bounce: Less than 4 milliseconds at make, 10 milliseconds at break
Operating Temperature: -40°C to +80°C

Materials and Finishes

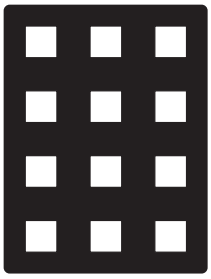
Housing: Polycarbonate/ABS blend, black; meets UL94V-O
Buttons: ABS plastic, white. Legends are black.
Snap-On-Cap: Clear polycarbonate
Contact Dome: Stainless steel, selectively gold-plated
Terminals: Phosphor bronze

Operating Features

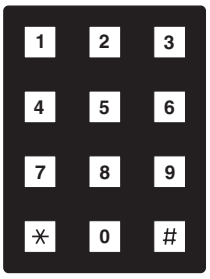
Button Travel: 0.015" (0,38 mm) nominal total travel
Typical Operating Force: 350 grams

STANDARD LEGENDS

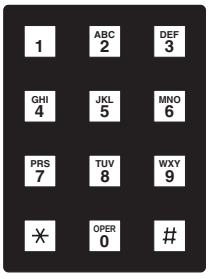
Insertable legend version (legend numbers -101 and -001) has a removable cap. The revealed button surface can be legended by an insert or a dry transfer of a blank legend insert. This surface can also be ink stamped by Grayhill in higher volume quantities. When the cap is replaced, the assembly extends approximately .015" (0,38 mm) above the surface. The legend sheet information follows the legend presentation. All other legends incorporate molded-in (two shot) legends.



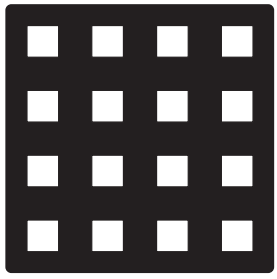
-101 (Insertable)



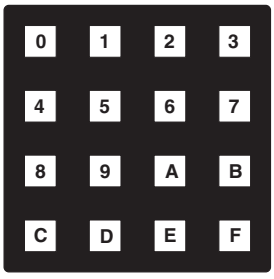
-102 (Molded-in)



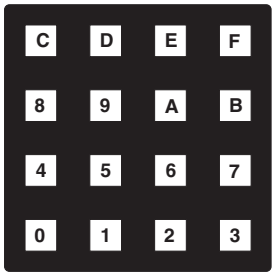
-103 (Molded-in)



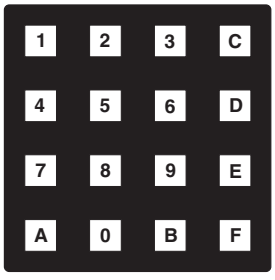
-001 (Insertable)



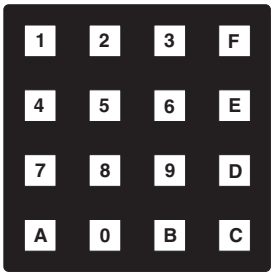
-002 (Molded-in)



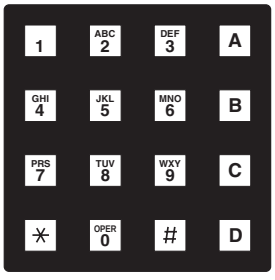
-003 (Molded-in)



-004 (Molded-in)



-005 (Molded-in)



-006 (Molded-in)

INSERTABLE LEGEND SHEETS

For use with -101 or -001 legend option. Legends are die cut to fit button surface when cap is removed. Dry transfer legends offer some flexibility to customize the blank inserts included on the sheet of popular legend letters, words and symbols provided or on the insertable legends sheet.

Description	Part Number
Sheet of Legend Inserts	**87AC2046**
Dry Transfer Lettering, Small	**87-DT-2096-088**
Dry Transfer Lettering, Medium	**87-DT-2096-125**
Dry Transfer Lettering, Large	**87-DT-2096-187**

For prices and discounts, contact a local Sales Office, an authorized local Distributor, or Grayhill.

PRINTED LEGENDS

For Maximum Versatility

Printing allows you the flexibility to create your own legend using whole words and symbols with various type styles. Durable epoxy ink printing bonds to the button cap surface. There are two types of button cap printing:

Top Surface Printing: Legend is applied directly to the top of the button. Button is recessed slightly below the keyboard housing.

Sub-Surface Printing: For insertable legend models. Provides maximum wear for printed surfaces. Printed internal button cap is protected by clear snap-on cap.

Printed Typestyles: The typestyle chart illustrates type style, size and approximate character limits for button caps. Grayhill's library of typefaces includes most popular legends.

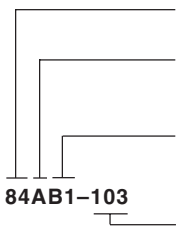
Type No. and Typical Height	Sample Style and Typical Sizes	Sub Surface Character and Line Limitations	Top Surface Character and Line Limitations
4GH088 .083"	ABCDEFGH	4 Characters 2 Lines END DATA	4 Characters 2 Lines END DATA
1GH125 .138"	ABCDE	3 Characters 1 Line LAD	3 Characters 1 Line LAD
3GH187 .207"	ABCD	2 Characters 1 Line ON	2 Characters 1 Line ON
2GH250 .276"	ABC	N/A N/A	2 Characters 1 Line 15

ORDERING INFORMATION: Special Legends

Follow this procedure:

1. **Basic Keyboard.** Formulate the part number with the exception of the legend suffix.
2. **Mounting.** Standard mounting is shown in our dimensional drawings. These drawings relate the terminal location to the button legend orientation. It is possible to rotate the button legends by 90°, changing the orientation. When mounting the keypad, it would be rotated 90° to have the legends appear upright. A 3x4 keypad thus becomes a 4x3.
3. **Color.** Many colors, other than our standard black housing, are available. Buttons can be made from equivalent plastic in black, red, green, blue and yellow. White legends are used with dark color buttons, black with light ones. Other colors available on special order.
4. **Buttons.** Legends can be printed on button surface and protected by a snap-on cap in a similar fashion to our insertable legend types. A second option is printing a 'blank' button. (One that has the same dimensions as a molded-in legend button with a flat top surface.) Disadvantage is legend wear over time. A third option is molded-in legends, usually requiring tooling. Molded buttons are available with a flat or concave top surface.
5. **Legends.** Specify the legend requirements for each button. Identify buttons per our dimensional drawings. Caution if keypad has been rotated.

ORDERING INFORMATION



Grayhill Series Number

Size Option
A = 3x4
B = 4x4

Circuitry Option
B1 = Matrix code
C1 = Single pole/common bus

Standard Legend Choices
3x4 Size: -101, -102 or -103
4x4 Size: -001, -002, -003, -004, -005 or -006

Available from your local Grayhill Distributor. For prices and discounts, contact a local Sales Office, an authorized local Distributor or Grayhill.

SERIES 84B

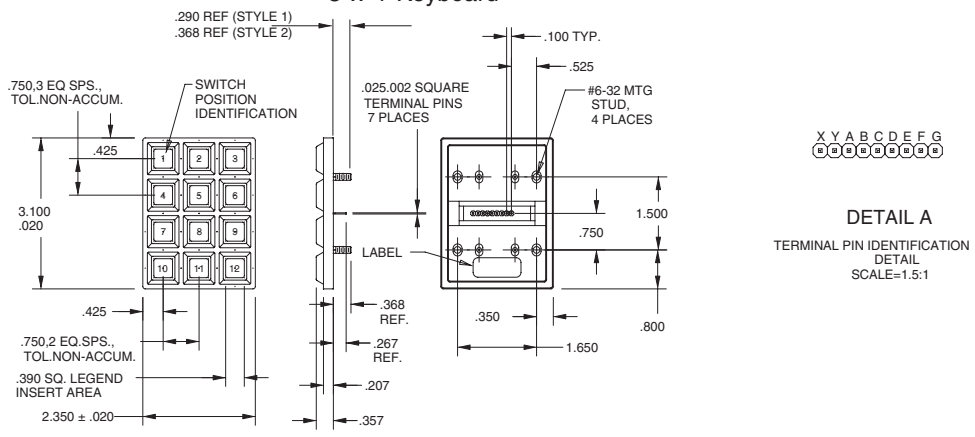
Backlit with Self Adhesive Legends

FEATURES

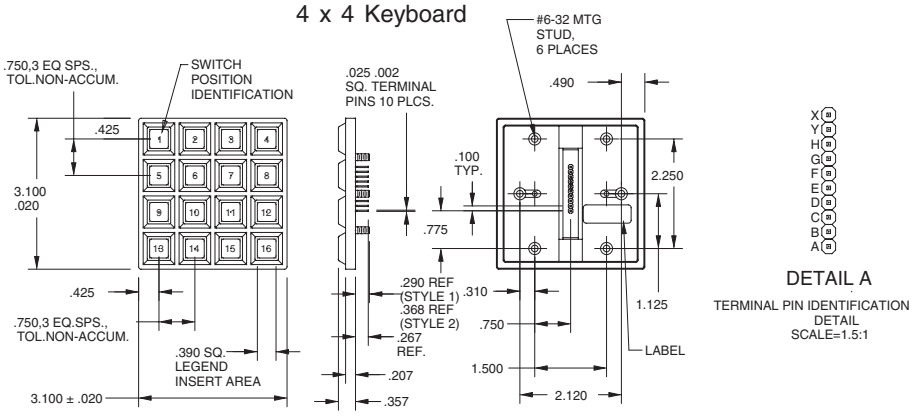
- Backlit for Low Light Applications
- Waterproof Silicone Rubber
- Audible, Tactile Contacts
- Low Contact Resistance
- Optional RFI/EMI Shielding
- 3,000,000 Operations per Button

DIMENSIONS In inches (and millimeters)

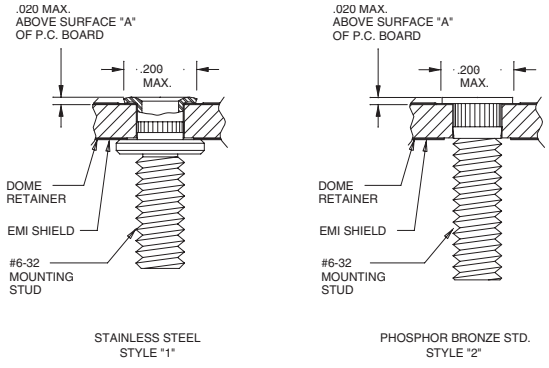
3 x 4 Keyboard



4 x 4 Keyboard

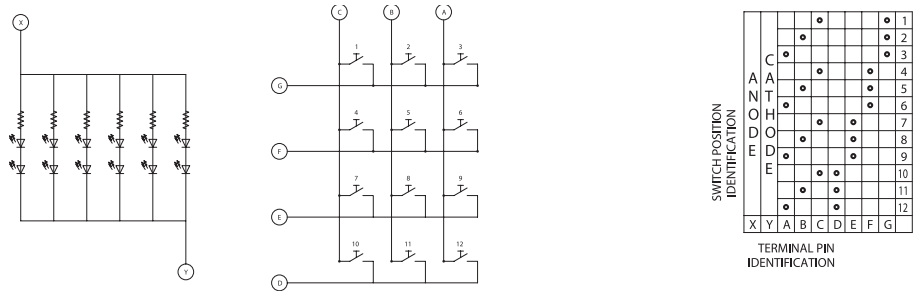


Stud Detail

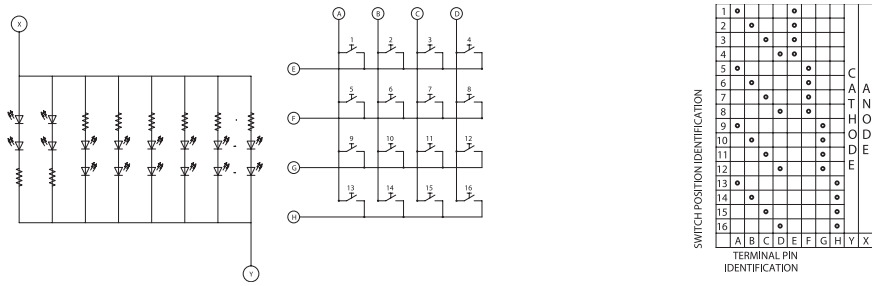


SCHEMATIC AND TRUTH TABLE

3 x 4



4 x 4



LED Color	Forward Voltage			Resistor (OHMS)	Typ. Current Consumption (With 5V Pwr. Supply)	
	Min.	Typ.	Max.		3 x 4	4 x 4
Red	-	1.95	2.40	43	155mA	205mA
Yellow/Green	-	1.95	2.40	43	155mA	205mA
Green	1.50	-	2.40	43	155mA	205mA
Orange	-	1.95	2.40	43	155mA	205mA

SPECIFICATIONS

Rating Criteria

Rating at 24 Vdc: - 10 milliamps resistive (max.)
Contact Bounce: 4 milliseconds maximum at make; 10 milliseconds, at break
Contact Resistance: 10 ohms maximum
Life Expectancy: 3 million operations/button
Insulation Resistance: >1,000 megohms

Operating Features

Pre-Travel: .030 inches minimum
Operating Force: 20 ± 4 ounces
Humidity: 0 to 98% (no condensation)

Materials and Finishes

Terminal Pins: Copper alloy CDA 725
PC Board: FR-4 glass cloth epoxy
Dome Retainer/Rear Seal Sheet: Polyester
Mounting Studs: Style 1: Stainless steel, Style 2: Phosphor bronze
Optional Hex Nut: Stainless steel, passivated
Optional EMI Shield: Aluminum foil
Keypad: Silicone rubber

SELF-ADHESIVE LEGEND SHEETS

Each 8.5" x 11" legend sheet contains commonly used symbols, terms, alpha characters and 0-9 in helvetica bold type. Self- adhesive legends are clear urethane on a chrome mylar base. Adhesive is silicone/acrylic. Legends can be purchased in the following ways:
1. Entire legend sheets: Part numbers 84AC5012-1, -2, -3 OR -4.
2. Individual legends: Part numbers 84AC5012-0001, -0002 etc. (Individual legend pins are for groups of 10 legends each)
3. See Grayhill drawing 84AC5012-X for detailed information on available legends, sizes and fonts.

ORDERING INFORMATION

84BN-AB1-022AN

- **84B =** Insertable Legend, Sealed and Shielded
- **84BN =** Insertable Legend, Sealed and Non-Shielded
- **Keyboard Size:** A = 3 x 4, B = 4 x 4
- B = Matrix Code
- 1 = Style "1" Terminal Pin Header (see stud detail), 2 = Style "2" Terminal Pin Header (see stud detail)
- N = Mounting Nuts Supplied and Shipped Loose, Blank = No Nuts Supplied
- **Led Color:** A = Red, B = Yellow, C = Green, D = Orange

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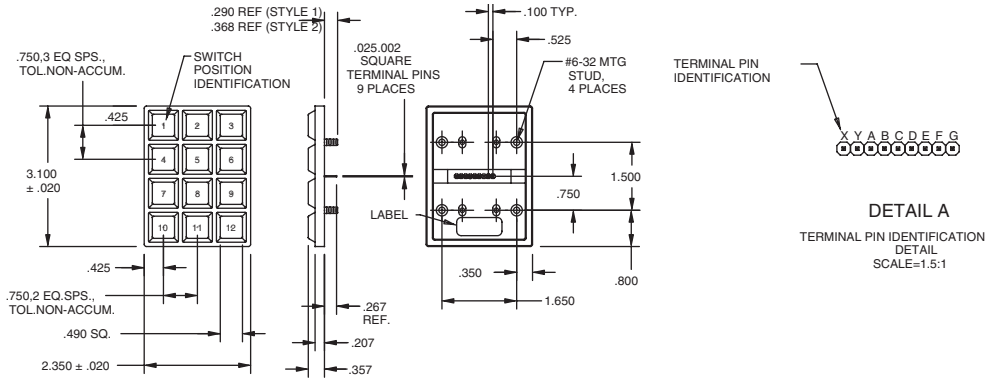
SERIES 84BL
Standard Backlit

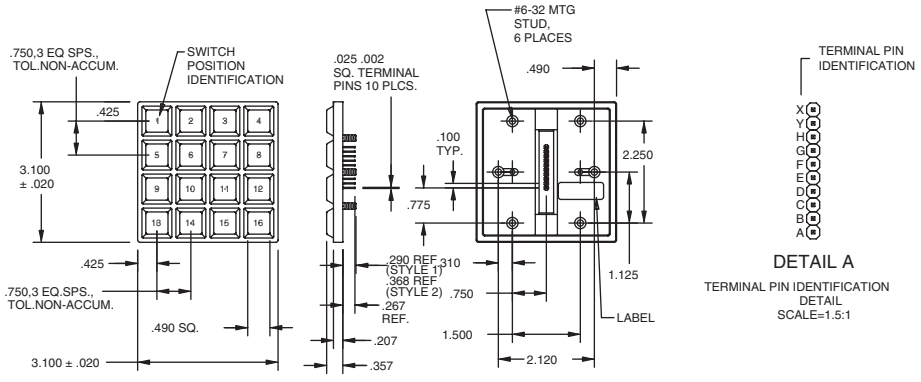
FEATURES
- Backlit for Low Light Applications
- Waterproof Silicone Rubber
- Audible, Tactile Contacts
- Low Contact Resistance
- Optional RFI/EMI Shielding
- 3,000,000 Operations per Button

DIMENSIONS In inches (and millimeters)

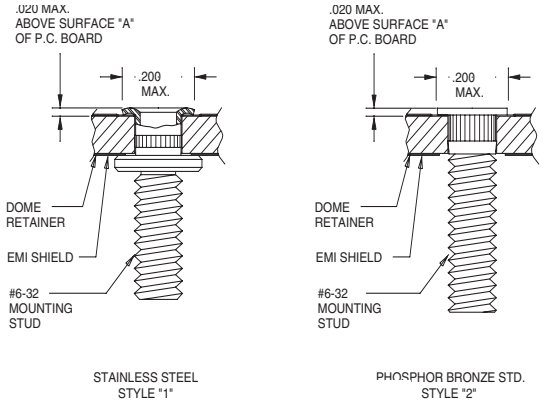
3 x 4 Keyboard



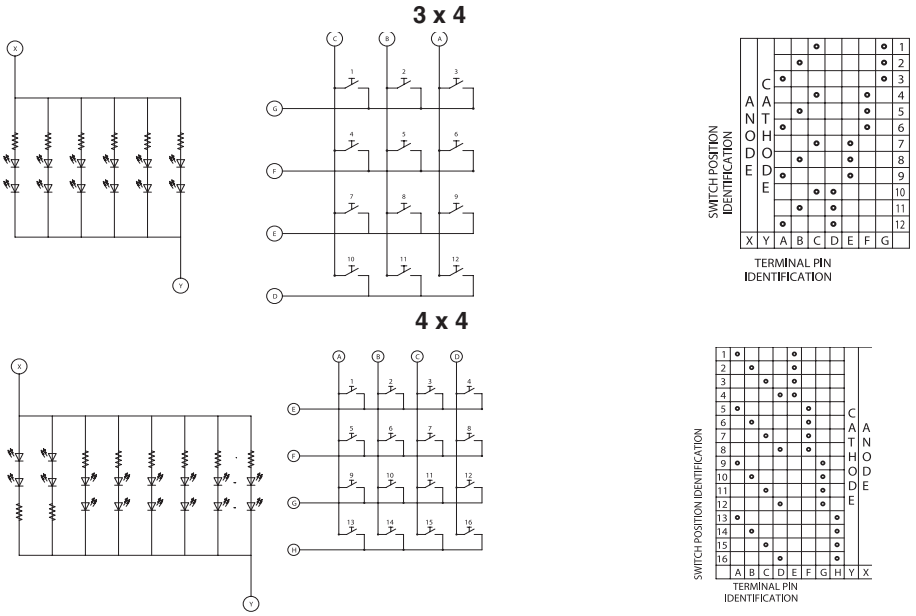
4 x 4 Keyboard



Stud Detail



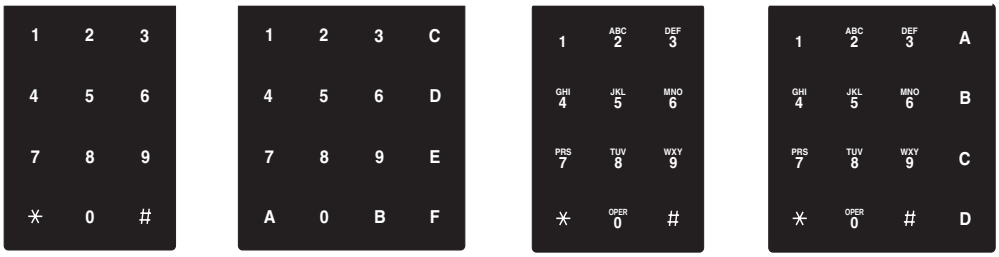
SCHEMATIC AND TRUTH TABLE



LED Color	Forward Voltage			Resistor (OHMS)	Typ. Current Consumption (With 5V Pwr. Supply)	
	Min.	Typ.	Max.		3 x 4	4 x 4
Red	-	1.95	2.40	43	155mA	205mA
Yellow	-	1.95	2.40	43	155mA	205mA
Green	1.50	-	2.40	43	155mA	205mA
Orange	-	1.95	2.40	43	155mA	205mA

STANDARD LEGENDS

Available through Grayhill Distributors To order one of the configurations below, use the dash number shown here; select the keypad size and order the part number with the appropriate legend dash number. Contact Grayhill for Customs.



-112 **-014** **-113** **-016**

SPECIFICATIONS

Rating Criteria

Rating at 24 Vdc: - 10 milliamps resistive
Contact Bounce: 4 milliseconds maximum at make; 10 milliseconds, at break
Contact Resistance: 10 ohms maximum

Life Expectancy: 3 million operations/button
Insulation Resistance: •1,000 megohms

Operating Features

Pre-Travel: .030 inches minimum
Operating Force: 20 ± 4 ounces
Humidity: 0 to 98% (no condensation)

Materials and Finishes

Terminal Pins: Copper alloy CDA 725
PC Board: FR-4 glass cloth epoxy
Dome Retainer/Rear Seal Sheet: Polyester
Mounting Studs: Style 1: Stainless steel, Style 2: Phosphor bronze
Optional Hex Nut: Stainless steel, passivated
Optional EMI Shield: Aluminum foil
Keypad: Silicone rubber

ORDERING INFORMATION

84BL = Printed Legend, Sealed and Shielded
84BLN = Printed Legend, Sealed and Non-Shielded
Keyboard Size: A = 3 x 4, B = 4 x 4
B = Matrix Code
1 = Style "1" Terminal Pin Header (see stud detail), 2 = Style "2" Terminal Pin Header (see stud detail)

84BLN-AB1-XXXAN

N = Mounting Nuts Supplied and Shipped Loose, Blank = No Nuts Supplied
Led Color: A = Red, B = Yellow, C = Green, D = Orange
Standard Legends: -112 or -113 for 3x4, -014 or -016 for 4x4

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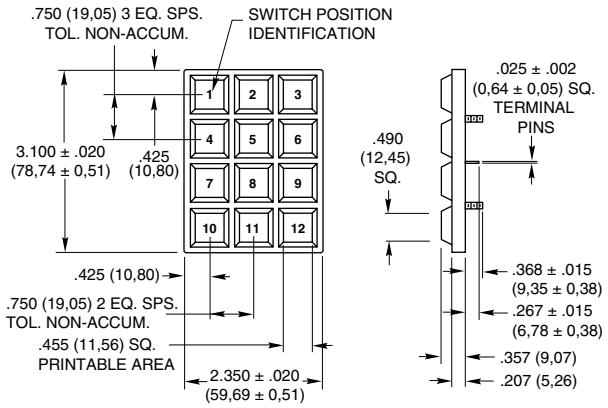
SERIES 84LS
Sealed, Low Profile

FEATURES
- Waterproof Silicone Rubber
- Easily Customized Legends
- Audible, Tactile Contacts
- Low Contact Resistance
- Optional RFI/EMI Shielding
- 3,000,000 Operations per Button

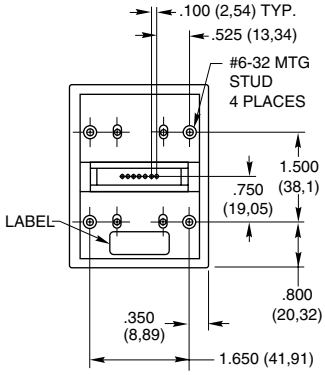
DESCRIPTION
The Series 84LS is the low profile version of Grayhill's popular Series 84S sealed keypads. These keypads are legended by epoxy ink printing the rubber key tops. Custom legends and colors are available at a nominal cost. The Series 84LS is offered with a choice of matrix or single pole/common bus circuitries and EMI shielding.

DIMENSIONS In inches (and millimeters)

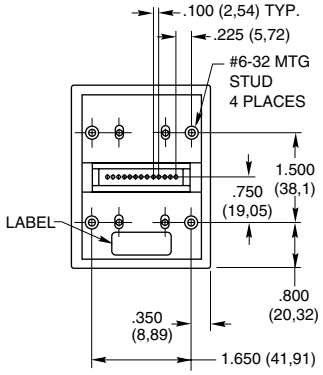
3x4 Keyboard

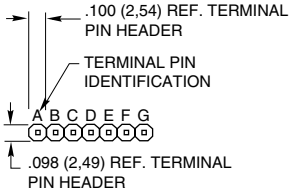


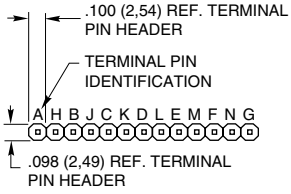
Matrix Output



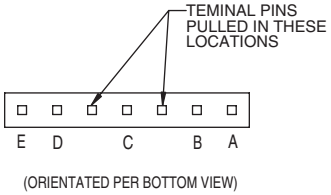
Single Pole/Common Bus



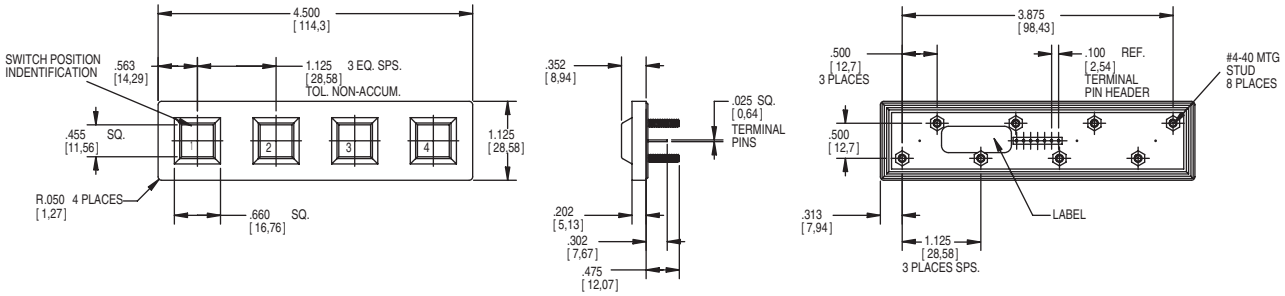




1x4 Keyboard

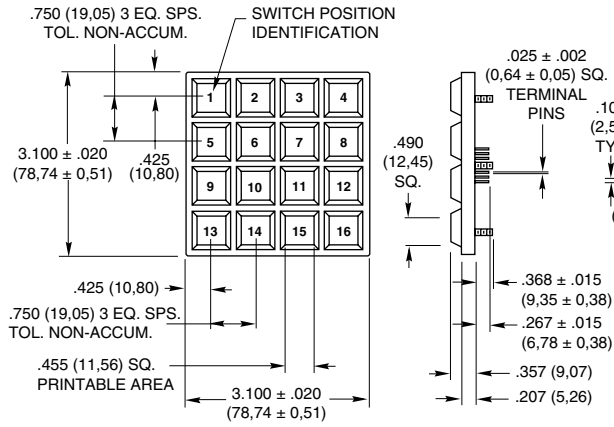


Single Pole/Common Bus

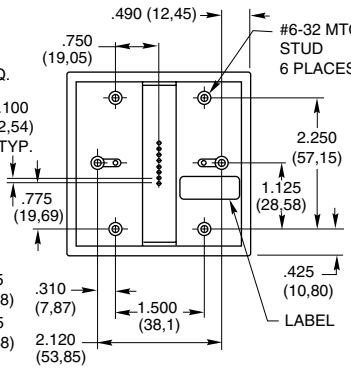


DIMENSIONS In inches (and millimeters)

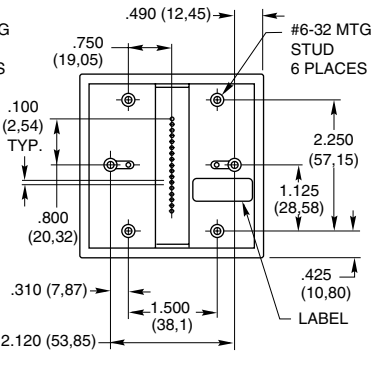
4x4 Keyboard



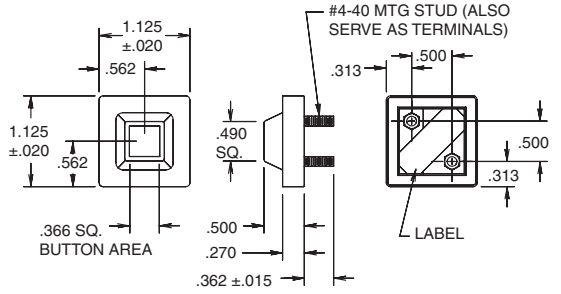
Matrix Output

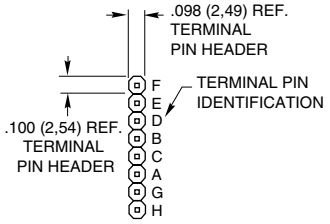


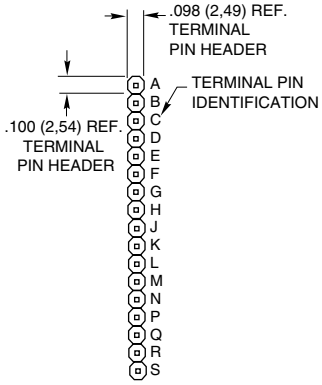
Single Pole/Common Bus



1x1 Keyboard



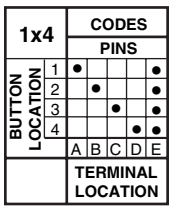




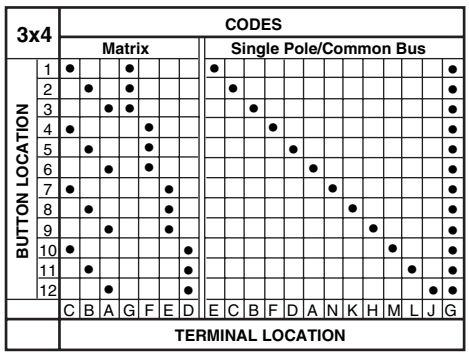
CODE AND TRUTH TABLES

The chart indicates the relationship of the terminal pins to each key switch.
The dot indicates a closed switch. Terminals are identified on the keyboard.

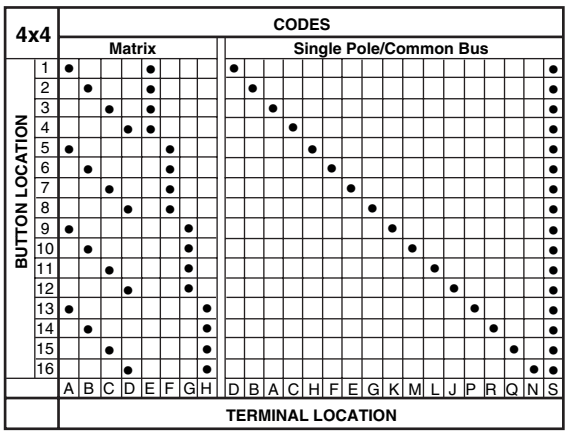
4 Button Keypads



12 Button Keypads



16 Button Keypads



SPECIFICATIONS

Rating Criteria

Rating at 24 Vdc: ≤ 10 milliamps resistive
Contact Bounce: 4 milliseconds maximum at make; 10 milliseconds, at break
Contact Resistance: MOS, TTL, and DTL compatible. (10 ohms maximum)
Operating Temperature: -55°C to 85°C
Life Expectancy: 3 million operations/button
Insulation Resistance: 1,000 megohms

Operating Features

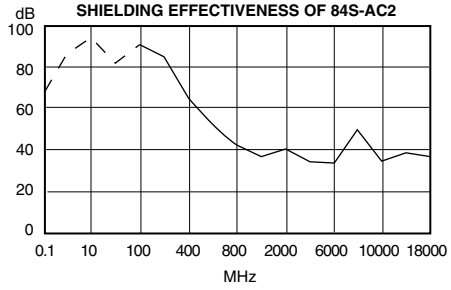
Pre-Travel: .030 inches minimum
Operating Force: 20 ± 4 ounces
Humidity: 0 to 98% (no condensation)
Minimum Push Out Force Per Pin: 5 pounds

Materials and Finishes

Terminal Pins: Copper alloy CDA 725
PC Board: FR-4 glass cloth epoxy
Dome Retainer/Rear Seal Sheet: Polyester
Mounting Studs: Phosphor bronze
Optional Hex Nut: Stainless steel, passivated
Optional EMI Shield: Aluminum foil
Keypad: Silicone rubber

Shielding Effectiveness

Results shown are typical for a standard Grayhill Series 84LS Keyboard. A conductive gasket will generally increase the shielding, depending on the size and shape of the gasket and its material. Data derived for E-Field Radiation.



– – Represents shielding effectiveness greater than or equal to line.

Frequency MHz	Rating in dB
0.1	66.2
10	94.8
100	89.0
400	70.6
800	42.5
2,000	39.5
6,000	32.6
10,000	45.2
18,000	42.2

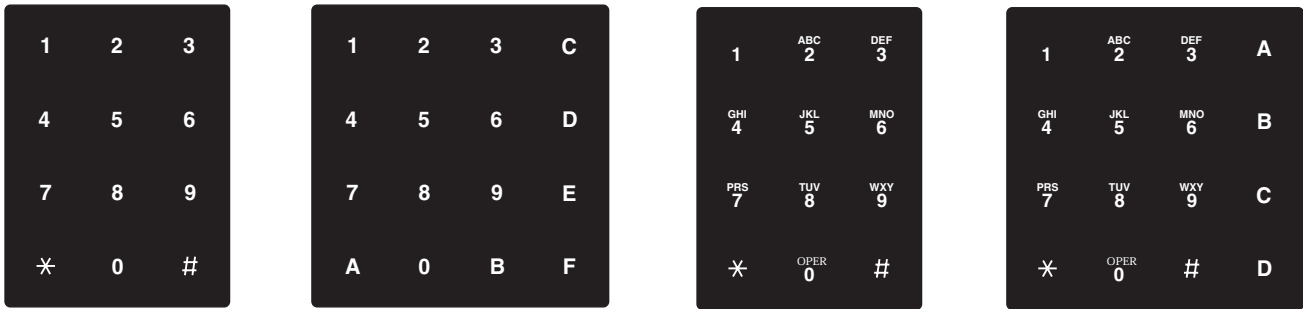
Test Method:
Measurements were made with the keyboard mounted to a brass plate, which in turn was mounted to a shielded enclosure containing the receiving equipment. A signal generator provided the frequency source that was radiated from the transmitting antenna to the enclosed receiving antenna. The spacing between antennas was maintained constant throughout the frequency range. The effectiveness rating is determined by establishing a reference reading without obstruction between the two antennas and determining the difference between that reading and the test setup reading.

Note:
When measured in actual equipment, shielding effectiveness is determined by many factors. This method accurately represents the shielding effectiveness of the Grayhill Series 84LS under ideal test conditions.

STANDARD LEGENDS

Available through Grayhill Distributors

To order one of the configurations below, use the dash number shown here; select the keypad size and code, and order the part number with the appropriate legend dash number.



CUSTOM LEGENDS

Any reasonable legend can be printed in the key area. Fax a sketch of your requirements to Grayhill. Printing and symbols will be coordinated in keeping with concepts of good design. Or, if required, the details of your submitted artwork will be matched as closely as possible. Allow 3 to 4 weeks for custom legend delivery. A nominal charge, depending on the total quantity of keypads ordered and the complexity of the legend, will be assessed.

HEADER CONNECTORS

Compatible with:
Samtec, Inc. Header Series BCS, BSW, CES, ESW, ESQ, SLW, SSW, SSQ, IDSS and IDSD or equivalent.

ORDERING INFORMATION

84LS-AC2-113-N

Grayhill Series Number
Shielded or Non-Shielded Option
S = Shielded
SN = Non-Shielded
Size Option
A = 3x4 B = 4x4 C = 1x1 F = 1x4
Circuitry Option
B2 = Matrix in-line pins C2 = Single pole/common bus, in-line pins
Mounting Nut Option
N = Provided with hex nuts for mounting
Blank = Nuts not provided
Standard Legend Choices
3x4 Size, choose -112 or -113
4x4 Size, choose -014 or -016
1x4 Size, choose -301 or -302
1x1 Size, choose -201

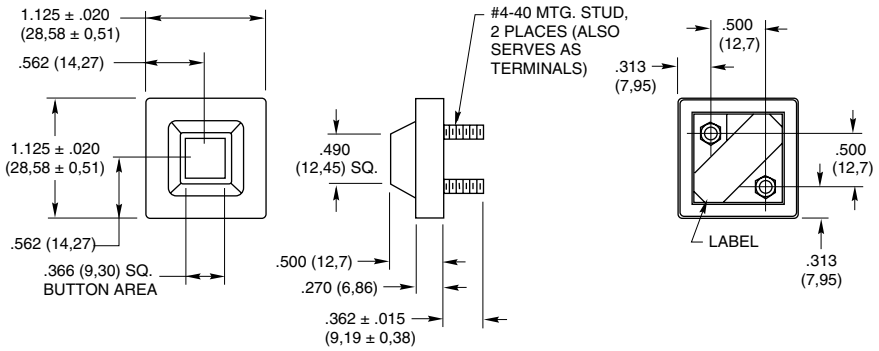
Available from your local Grayhill Distributor.
For prices and discounts, contact a local Sales Office, an authorized local distributor or Grayhill.

SERIES 84S
Sealed

FEATURES
- Waterproof Silicone Rubber
- Easily Customized Legends
- Audible, Tactile Contacts
- Low Contact Resistance
- Optional RFI/EMI Shielding
- 3,000,000 Operations per Button

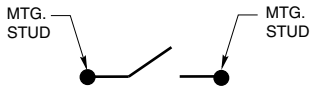
DIMENSIONS In inches (and millimeters)

1 Button Module



Unless otherwise noted, linear dimension tolerances are ± .010 (0,25)

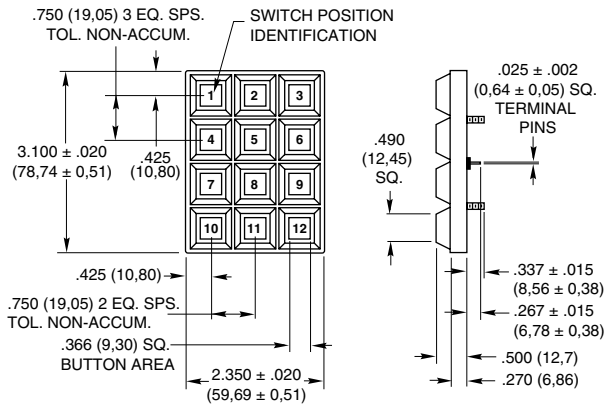
CIRCUITRY



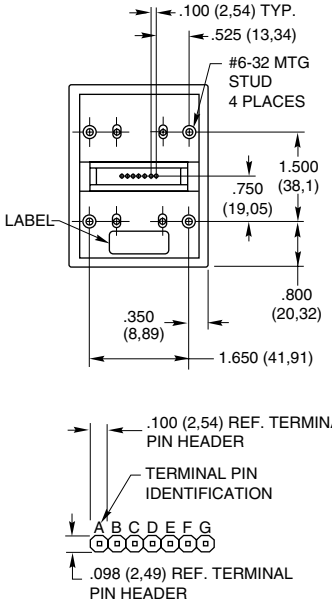
SINGLE THROW,
NORMALLY OPEN

Note: Mounting studs serve as terminals.

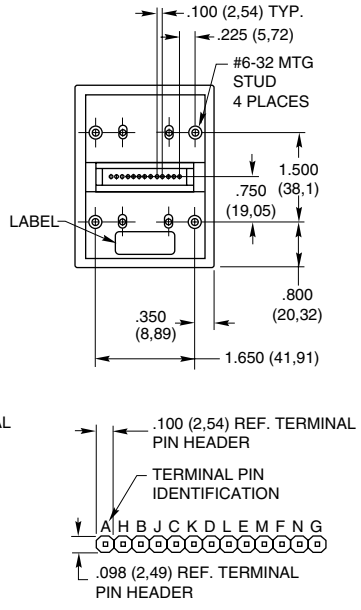
3x4 Keyboard



Matrix Output

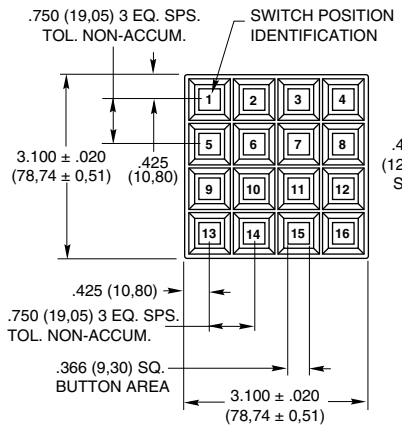


Single Pole/Common Bus

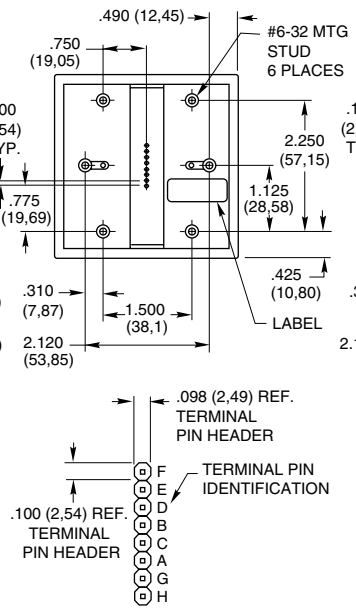


DIMENSIONS In inches (and millimeters)

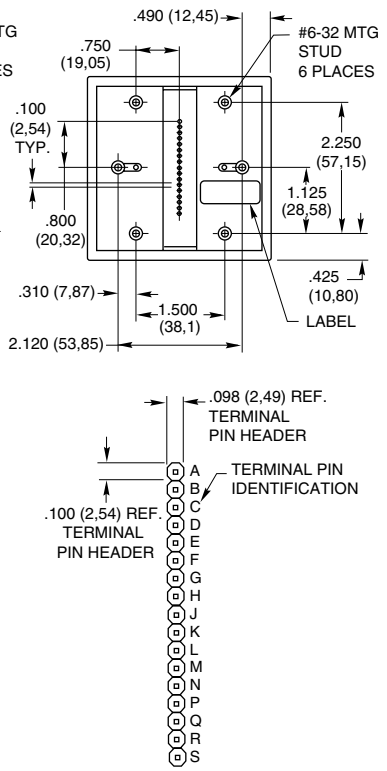
4x4 Keyboard



Matrix Output



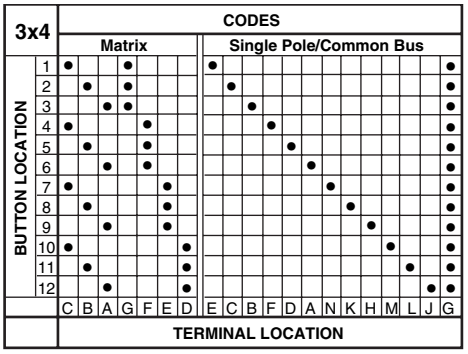
Single Pole/Common Bus



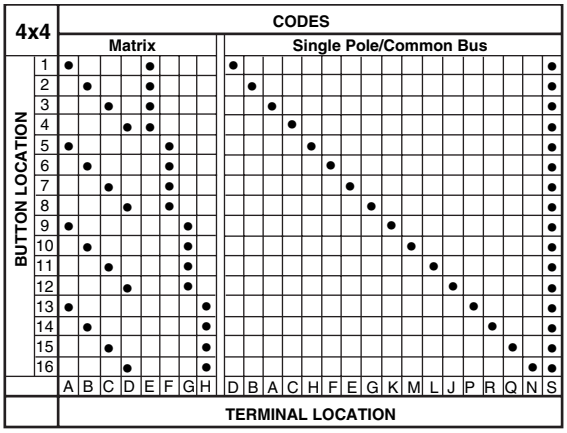
CODE AND TRUTH TABLES

Dots in the chart indicate connected terminals when switch is closed. Terminals are identified on the keyboard.

12 Button Keypads



16 Button Keypads



SPECIFICATIONS

Rating Criteria

Rating at 24 Vdc: ≤10 milliamps resistive
Contact Bounce: 4 milliseconds maximum at make; 10 milliseconds at break
Contact Resistance: MOS, TTL, and DTL compatible. (10 ohms maximum)
Life Expectancy: 3 million operations/button
Insulation Resistance: □1,000 megohms

Operating Features

Pre-Travel: .030 inches minimum
Operating Temperature: -55°C to 85°C
Operating Force: 20 ± 4 ounces
Humidity: 0 to 98% (no condensation)
Minimum Push Out Force Per Pin: 5 pounds

Materials and Finishes

Terminal Pins: Copper alloy CDA 725, solder-plated
PC Board: FR-4 glass cloth epoxy
Contact Dome: Stainless steel, selectively gold-plated
Dome Retainer/Rear Seal Sheet: Polyester
Mounting Studs: Phosphor bronze
Optional Hex Nut: Stainless steel, passivated
Optional EMI Shield: Aluminum foil
Keypad: Silicone rubber
Buttons: ABS Cycolac, grade FR15U

Shielding Effectiveness

Results shown are typical for a standard Grayhill Series 84S Keyboard. A conductive gasket will generally increase the shielding, depending on the size and shape of the gasket and its material. Data derived for E-Field Radiation.

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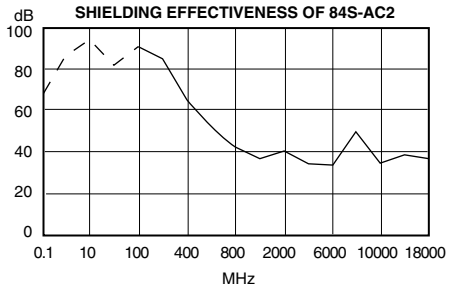


Frequency MHz	Rating in dB
0.1	66.2
10	94.8
100	90.5
400	64.2
800	42.3
2,000	40.5
6,000	33.1
10,000	34.4
18,000	37.0

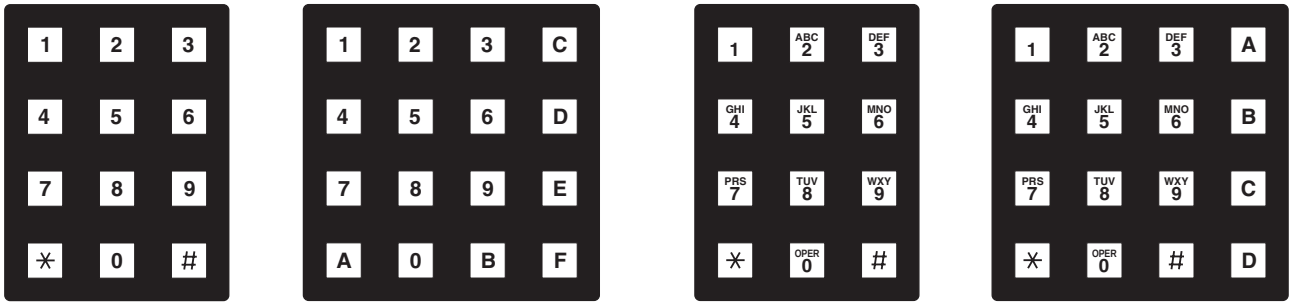
Test Method:
Measurements were made with the keyboard mounted to a brass plate, which in turn was mounted to a shielded enclosure containing the receiving equipment. A signal generator provided the frequency source that was radiated from the transmitting antenna to the enclosed receiving antenna. The spacing between antennas was maintained constant throughout the frequency range. The effectiveness rating is determined by establishing a reference reading without obstruction between the two antennas and determining the difference between that reading and the test setup reading.

Note:
When measured in actual equipment, shielding effectiveness is determined by many factors. This method accurately represents the shielding effectiveness of the Grayhill Series 84S under ideal test conditions.

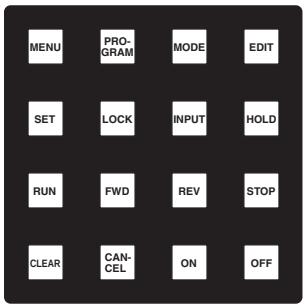
STANDARD LEGENDS

Available through Grayhill Distributors

To order one of the configurations below, use the dash number shown here; select the keypad size and code, and order the part number with the appropriate legend dash number. The buttons in these keypads can be removed, and reinserted in any configuration.



CUSTOM LEGENDS



Library of Legends

Grayhill maintains a legend library which contains the most often requested special legends and many unusual ones. If the legend is in the library, the cost to utilize this legend in your keypad configuration is minimal. If the legend is not available, Grayhill can list the charges required to add your legend to the library. In this manner, new legends are added on a periodic basis. Custom legends to fit your unique requirements may not be as expensive as you think, contact Grayhill.

Adding Color

Use colored buttons to segregate button groupings or to provide originality. Available in black legends on white or yellow buttons, or in white legends on black, green, red or blue buttons. Two popular combinations, black on white and white on black, are available from Grayhill stock. Delivery time will increase for other color combinations.

HEADER CONNECTORS

Compatible with: Samtec, Inc. Header Series BCS, BSW, CES, ESW, ESQ, SLW, SSW, SSQ, IDSS and IDSD or equivalent.

Available from your local Grayhill Distributor. For prices and discounts, contact a local Sales Office, an authorized local Distributor or Grayhill.

ORDERING INFORMATION

84S-AC2-113-N

Grayhill Series Number

Shielded or Non-Shielded Option
S = Shielded; SN = Non-Shielded

Size Option: A = 3x4; B = 4x4; C = 1 Button

Circuitry Option *(B2 and C2 not applicable to 1 button)*
B2 = Matrix in-line pins
C2 = Single pole/common bus, in-line pins
C3 = 1 Button, SPST–N.O., non-shielded only

Mounting Nut Option
N = Provided with hex nuts for mounting; Blank = Nuts not provided

Standard Legend Choices
3x4 Size: -112 or -113; -000, No buttons; -101, Blank Buttons
4x4 Size: -014 or -016; -000, No buttons; -001, Blank Buttons
1 Button Size: -001, No legend, white button

SERIES 86

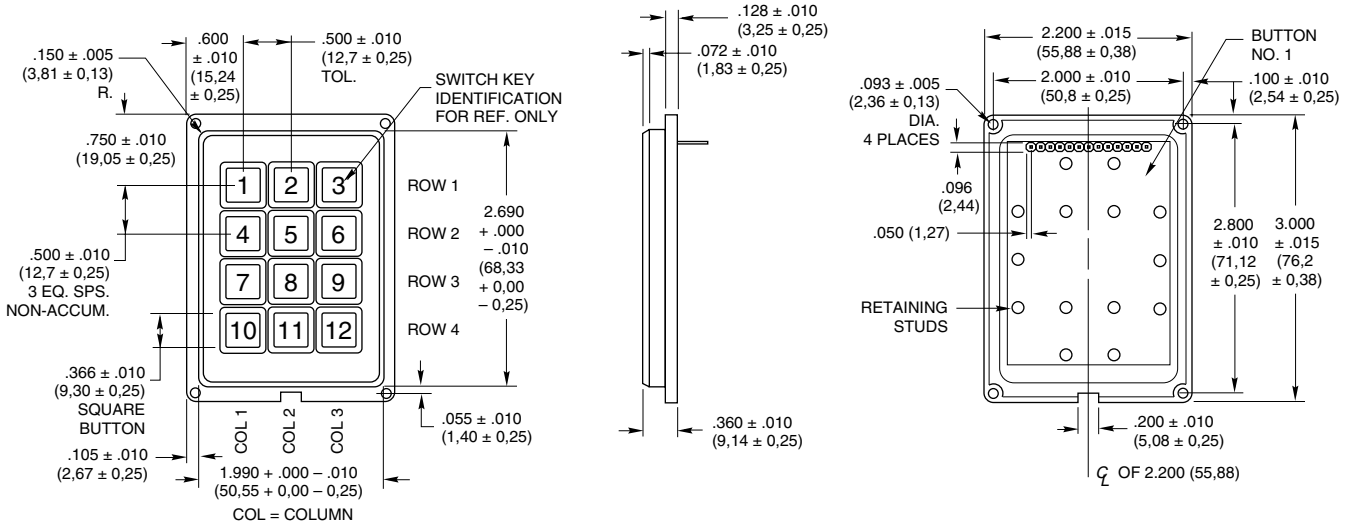
Unsealed, .500" Centers, Flange Mounted

FEATURES

- 1/2" Button Centers
- Flange Mounted
- Top Surface or Sub Surface Mounting
- Snap-Dome Contact Provides Positive Feedback

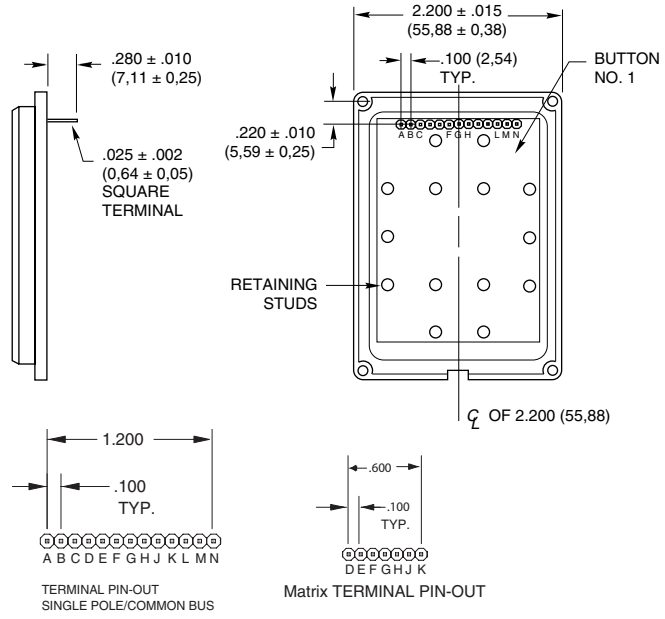
DIMENSIONS In inches (and millimeters)

3x4 Keyboard



Termination In inches (and millimeters)

3x4



Code and Truth Table

Dots in the chart indicate connected terminals when switch is closed. Terminals are identified on the keyboard.

3x4	CODES	
	Matrix	Single Pole/Common Bus
BUTTON LOCATION 1	●	●
2	●	●
3	●	●
4	●	●
5	●	●
6	●	●
7	●	●
8	●	●
9	●	●
10	●	●
11	●	●
12	●	●
	F E D K J H G	J E A K F B L G C M H D N
	TERMINAL LOCATION	

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SERIES 86

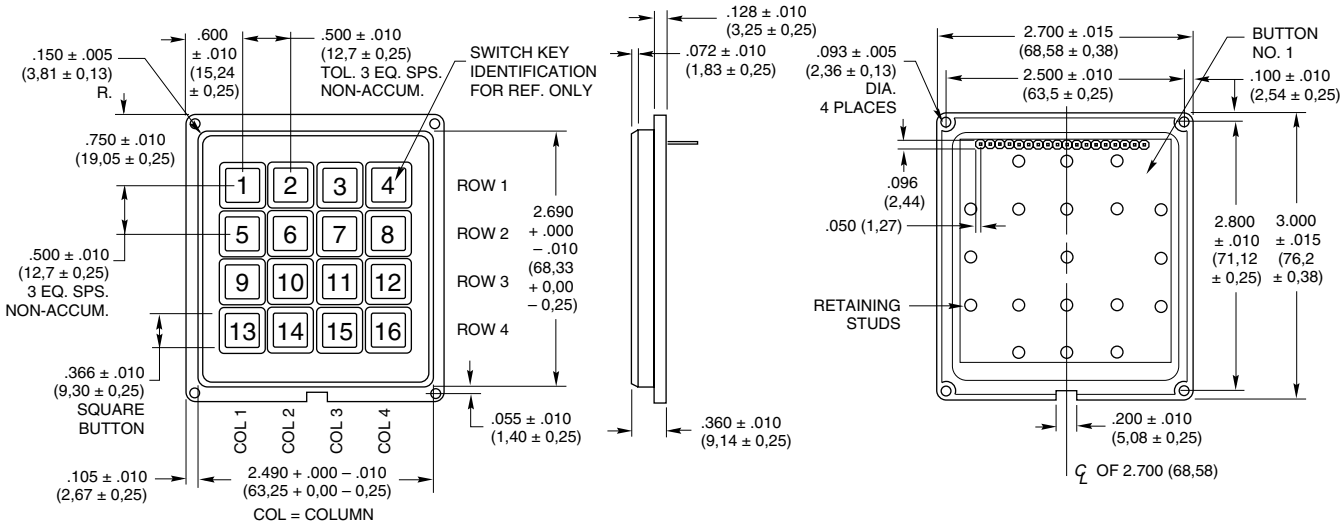
Unsealed, .500" Centers, Flange Mounted

FEATURES

- 1/2" Button Centers
- Flange Mounted
- Top Surface or Sub Surface Mounting
- Snap-Dome Contact Provides Positive Feedback

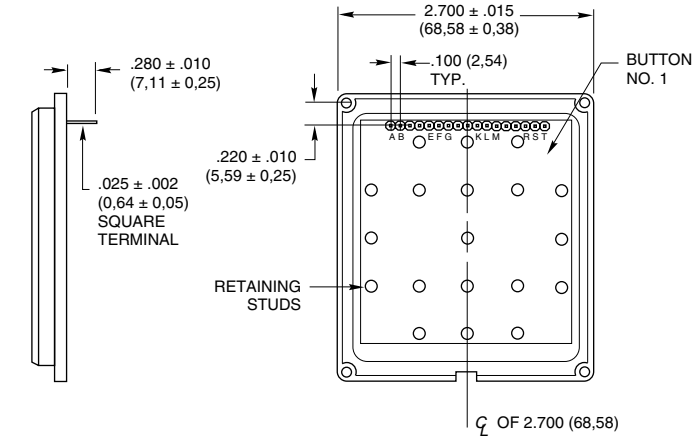
DIMENSIONS In inches (and millimeters)

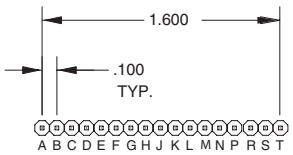
4x4 Keyboard



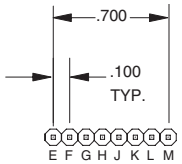
Termination In inches (and millimeters)

4x4





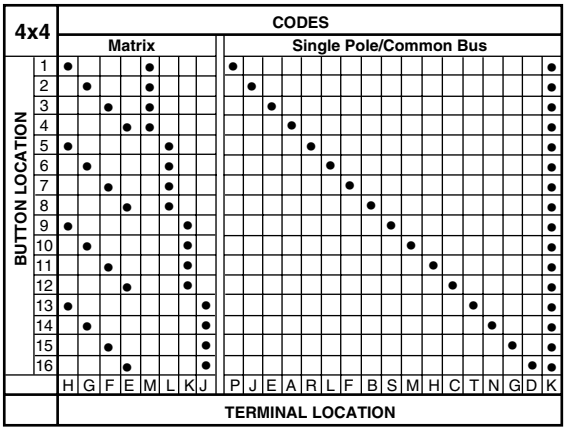
SINGLE POLE COMMON BUS TERMINAL



MATRIX TERMINAL PIN-OUT

Code and Truth Table

Dots in the chart indicate connected terminals when switch is closed. Terminals are identified on the keyboard.



SERIES 86

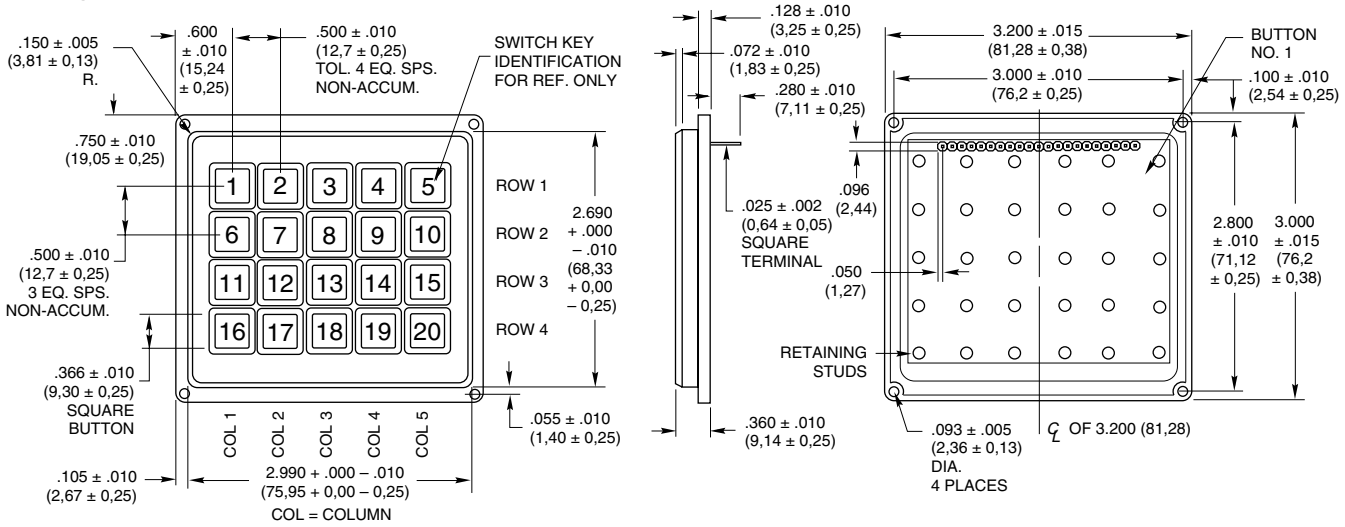
Unsealed, .500" Centers, Flange Mounted

FEATURES

- 1/2" Button Centers
- Flange Mounted
- Top Surface or Sub Surface Mounting
- Snap-Dome Contact Provides Positive Feedback

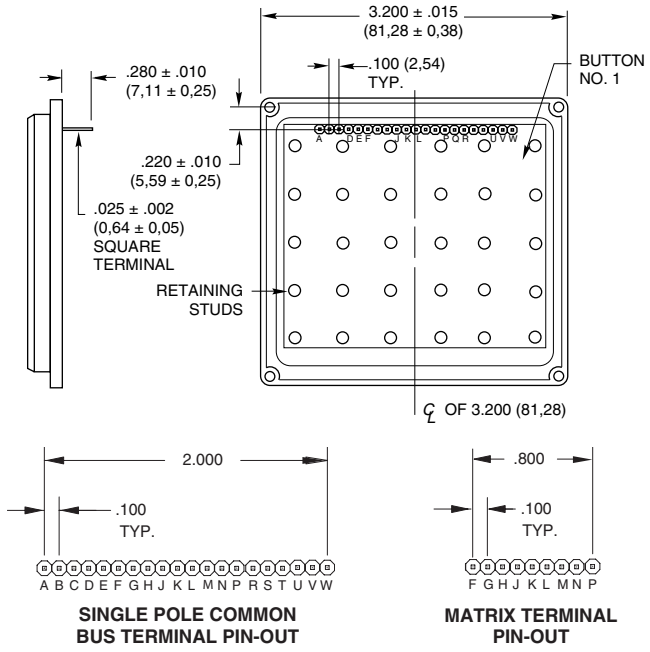
DIMENSIONS In inches (and millimeters)

5x4 Keyboard



Termination In inches (and millimeters)

5x4



Code and Truth Table

Dots in the chart indicate connected terminals when switch is closed. Terminals are identified on the keyboard.

5x4	CODES	
	Matrix	Single Pole/Common Bus
BUTTON LOCATION	TERMINAL LOCATION	

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SPECIFICATIONS

Rating Criteria

Rating at 24 Vdc: 10 milliamps, resistive
Contact Resistance: Compatible with MOS, TTL and DTL (10 ohms maximum)
Voltage Breakdown: 250 Vac between mutually insulated parts
Life Expectancy: 3,000,000 operations per button
Contact Bounce: Less than 4 milliseconds at make, 10 milliseconds at break
Operating Temperature: -40°C to +80°C

Materials and Finishes

Housing: ABS polycarbonate, black
Buttons: ABS plastic, white. Legends are black.
Snap-On-Cap: Clear polycarbonate
Contact Dome: Stainless steel, selectively gold-plated
Terminals: Phosphor bronze

Operating Features

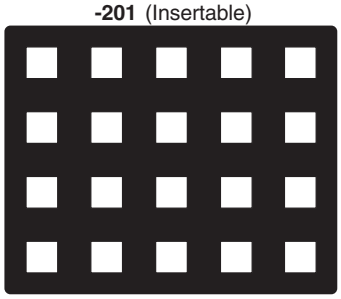
Button Travel: 0.015" nominal total travel
Typical Operating Force: 350 grams

STANDARD LEGENDS

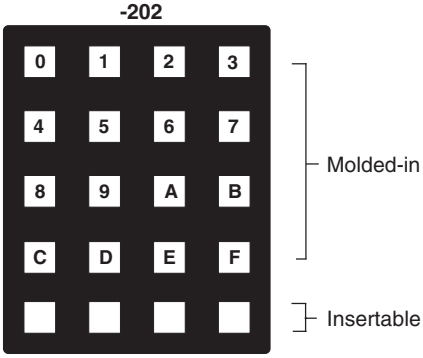
Insertable legend version (legend numbers -101, -001, -201 and row or column indicated in -202 and -203) has a removable cap. The revealed button surface can be legended by an insert or a dry transfer of a blank legend insert. This surface can also be ink stamped by Grayhill in higher volume quantities. When the cap is replaced, the assembly extends approximately .015" (0,38 mm) above the surface. The legend sheet information follows the legend presentation. All other legends incorporate molded-in (two shot) legends with the exception of legend numbers -202 and -203. The blank legends or spaces in legends -202 and -203 are insertable legends, others are molded-in.

5x4: Shown below

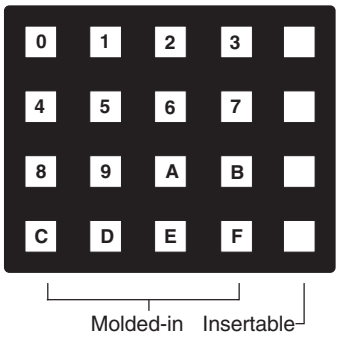
-201 (Insertable)



-202



-203



INSERTABLE LEGENDS

For use with -101, -001, -201, -202 and -203 legend options. Legends are die cut to fit button surface when cap is removed. Dry transfer legends offer some flexibility to customize the blank inserts included on the sheet of popular legend letters, words and symbols provided or on the insertable legends sheet.

Description	Part No.
Sheet of Legend Inserts	**87AC2046**
Dry Transfer Lettering, Small	**87-DT-2096-088**
Dry Transfer Lettering, Medium	**87-DT-2096-125**
Dry Transfer Lettering, Large	**87-DT-2096-187**

ORDERING INFORMATION

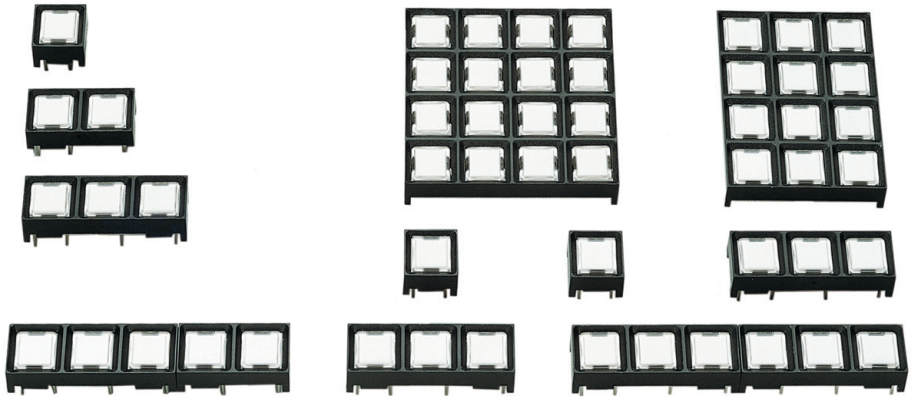
86AB2–103

Grayhill Series Number
Size Option
A = 3x4
B = 4x4
J = 5x4
Circuitry Option
B2 = Matrix code
C2 = Single pole/common bus
Standard Legend Choices
3x4 Size: -101, -102 or -103
4x4 Size: -001, -002, -003, -004, -005 or -006
5x4 Size: -201, -202, or -203

Available from your local Grayhill Distributor. For prices and discounts, contact a local Sales Office, an authorized local Distributor or Grayhill.

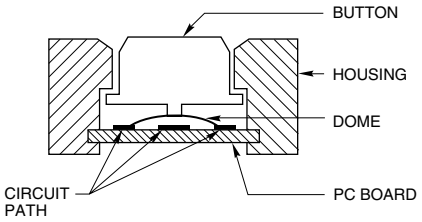
SERIES 87
Low Profile

FEATURES
- 1, 2, 3, 4, 5 and 6 Button Individual Keyswitches
- 12 and 16 Button Keypads
- Maintain 1/2" Button Centers, no Matter How You Mount Modules or What Combination You Use
- Up to 3,000,000 Operations per Button
- Low Profile Design



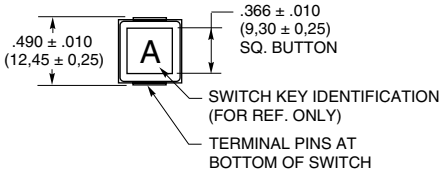
Legends For Any Need
Design Keyboards and Individual Keyswitches to Virtually any Configuration Without Costly Tooling.
Prototypes and small quantities: create your own with economical, insertable legend style modules.
Production quantities: choose either custom printing or permanent molded-in legends.

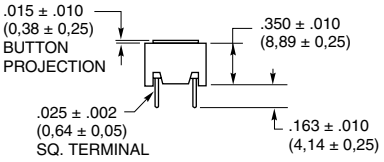
Snap Dome Contact System
Hear and feel button actuation
You're assured of reliable button actuation with the metal snap-dome under each Series 87 button. When actuated, the dome changes shape, providing audible and tactile feedback to the operator.

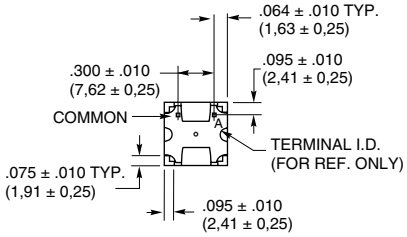


DIMENSIONS In inches (and millimeters)

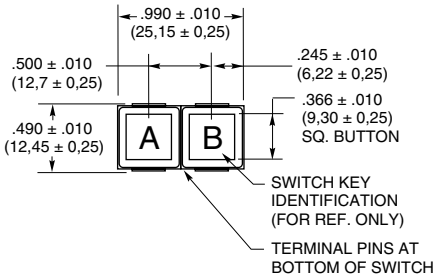
One Button Module

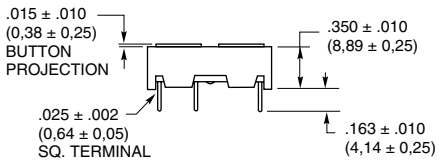


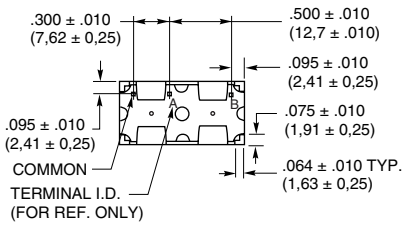




Two Button Module







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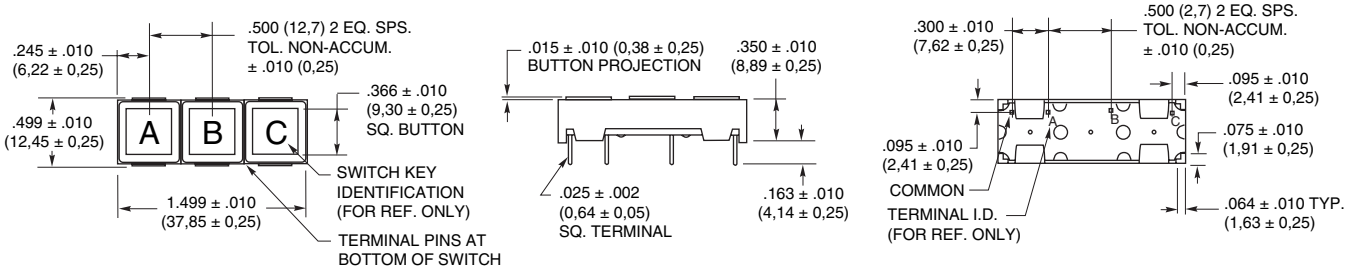
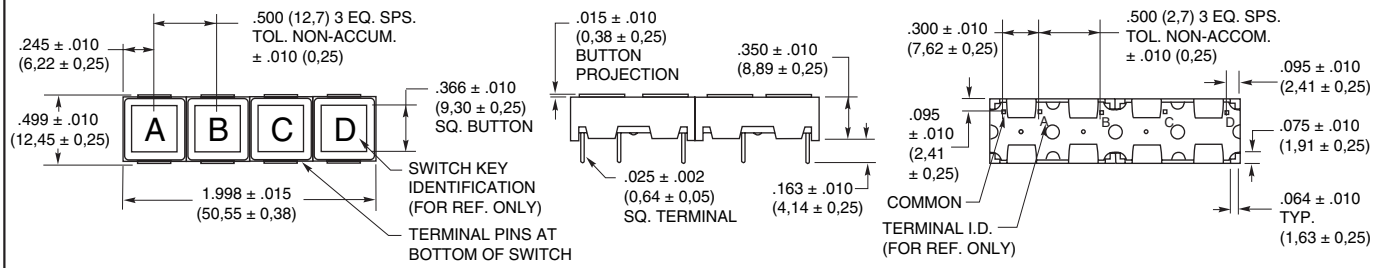
DIMENSIONS In inches (and millimeters)

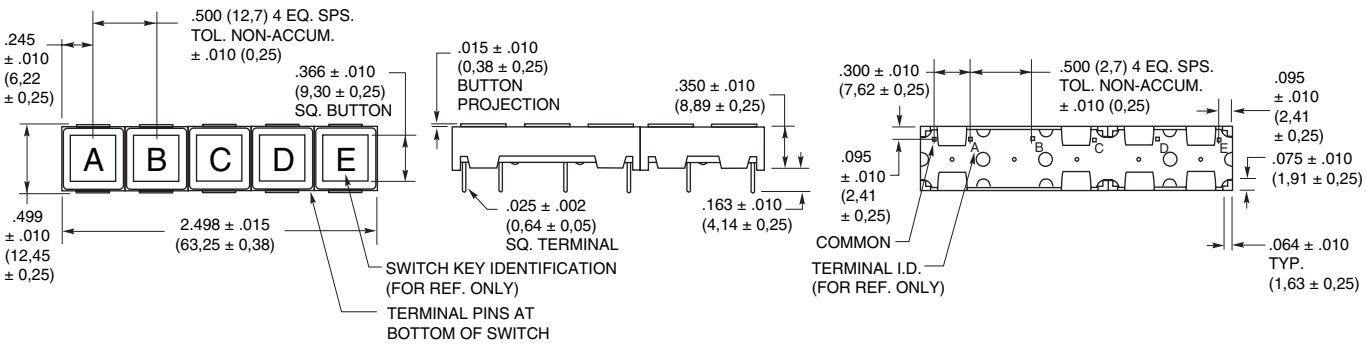
Three Button Module



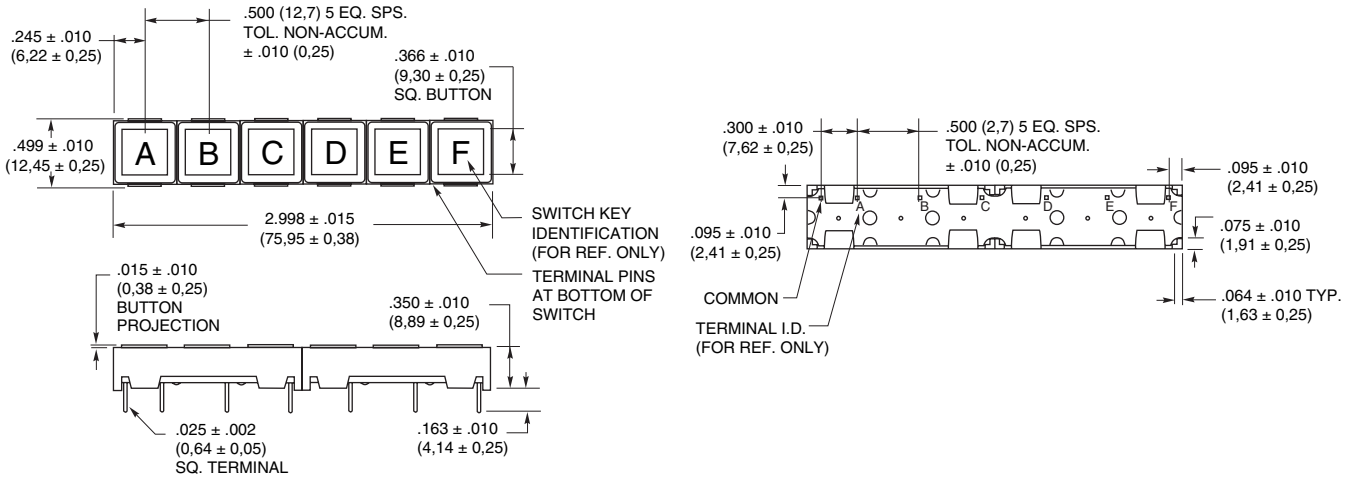
Four Button Module



Five Button Module

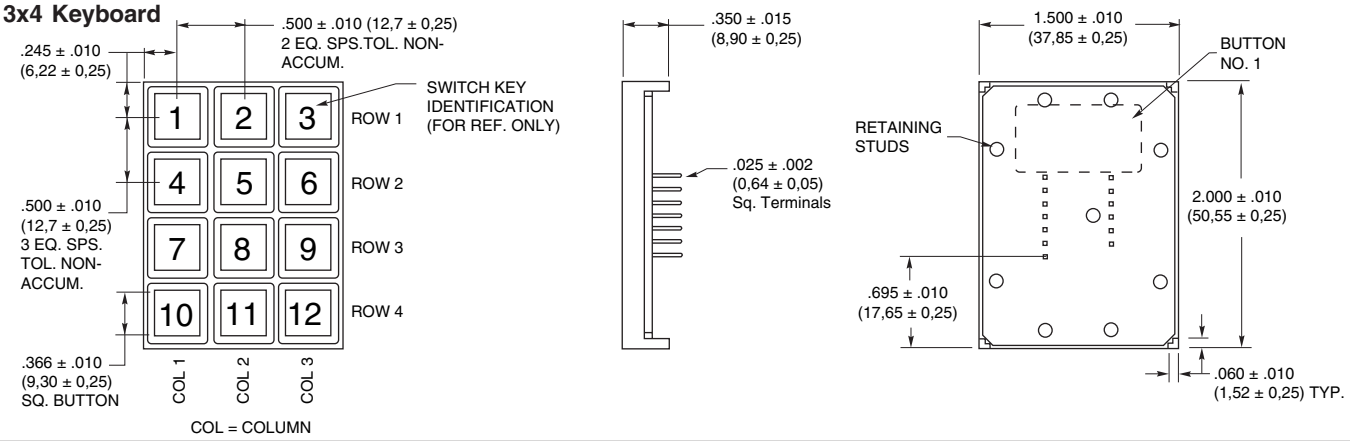


Six Button Module



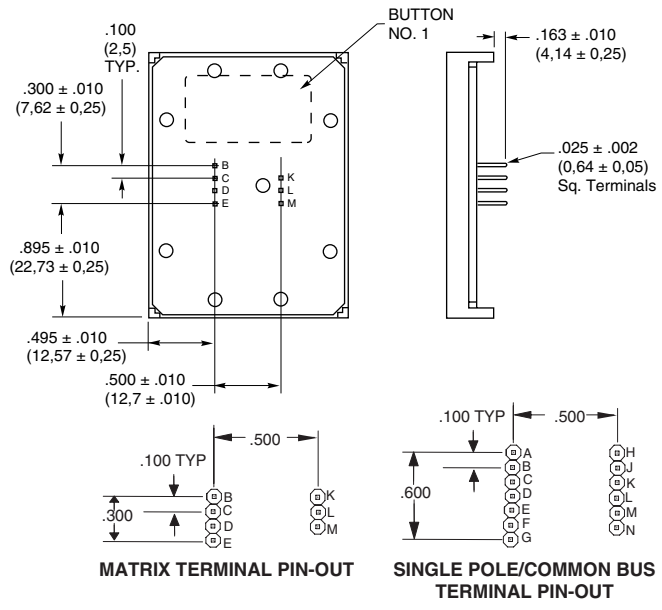
DIMENSIONS In inches (and millimeters)

3x4 Keyboard

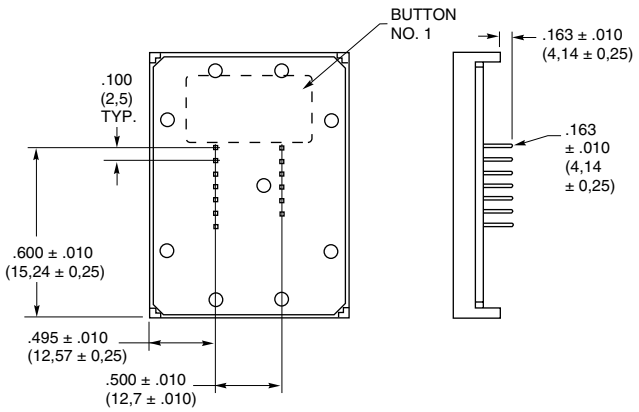


Termination In inches (and millimeters)

3x4 Matrix Output

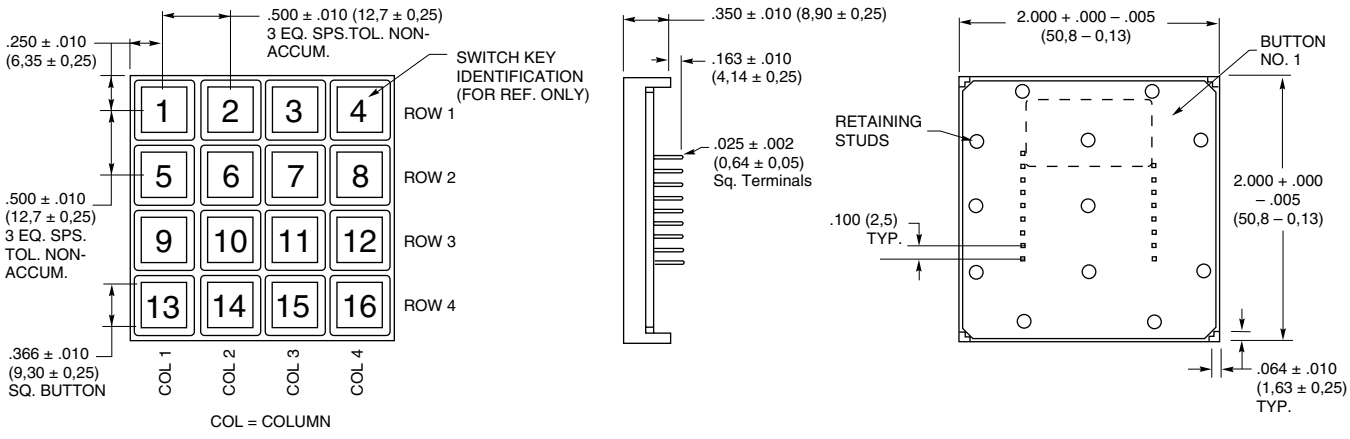


Single Pole/Common Bus



DIMENSIONS In inches (and millimeters)

4x4 Keyboard



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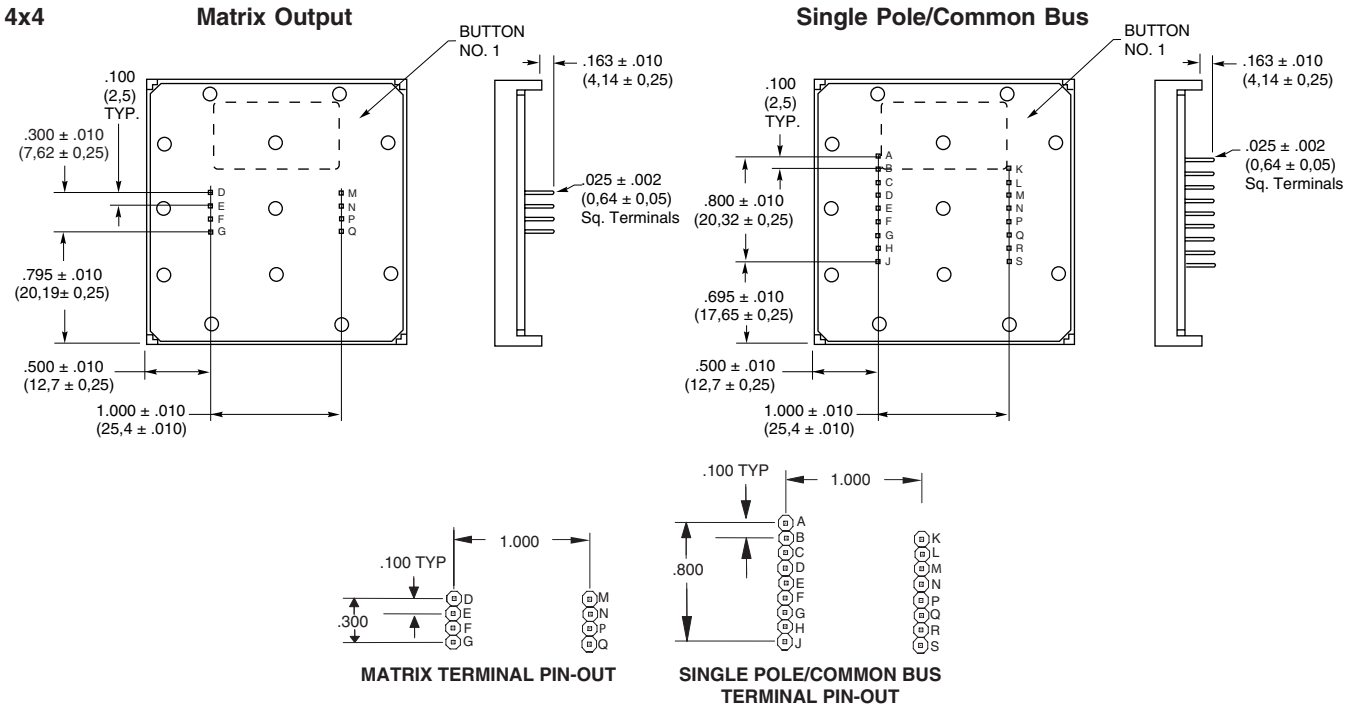
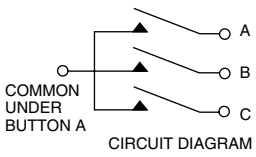
Termination In inches (and millimeters)



CIRCUITRY, CODE AND TRUTH TABLES

Circuitry for Module Strips

The one-button thru six-button modules have single pole/common bus circuitry as shown in the circuit diagram. The common is located under button A; it is not marked on the actual product.



CIRCUIT DIAGRAM

Code and Truth Table

Dots in the chart indicate connected terminals when switch is closed. Terminals are identified on the keyboard.

3x4

BUTTON LOCATION	CODES: Matrix						CODES: Single Pole/Common Bus											
	K	D	E	B	C	L	M	K	H	A	J	C	B	M	E	F	L	N	G	D
1	•						•	•												•
2		•					•		•											•
3			•				•			•										•
4	•						•				•									•
5		•					•					•								•
6			•				•						•							•
7	•						•							•						•
8		•					•								•					•
9			•				•									•				•
10	•						•										•			•
11		•					•											•		•
12			•				•												•	•

TERMINAL LOCATION

4x4

BUTTON LOCATION	CODES: Matrix								CODES: Single Pole/Common Bus																			
	M	N	G	F	D	E	P	Q	K	N	B	A	L	M	D	C	Q	P	F	G	S	R	E	H	J
1	•						•		•																			
2		•					•			•																		
3			•				•				•																	
4				•			•					•																
5	•							•					•															
6		•						•						•														
7			•					•							•													
8				•				•								•												
9	•							•									•											
10		•						•										•										
11			•					•											•									
12				•				•																				
13	•							•														•						
14		•						•															•					
15			•					•																•				
16				•				•																	•			

TERMINAL LOCATION

SPECIFICATIONS

Rating

Rating at 24 Vdc: 10 milliamps, resistive
Contact Resistance: MOS, CMOS, TTL, DTL compatible (10 ohms maximum)
Voltage Breakdown: 250 Vac between mutually insulated parts
Insulation Resistance: 1,000 megohms min.
Life Expectancy: 3,000,000 operations per button
Contact Bounce: Less than 4 milliseconds at make, 10 milliseconds at break

Materials and Finishes

Housing: ABS polycarbonate, black
Buttons: ABS plastic, white. Legends are black.
Snap-On-Cap: Clear polycarbonate
Contact Dome: Stainless steel, selectively gold-plated
Terminals: Phosphor bronze

Operating Features

Button Travel: 0.011" (0,28) nominal, total travel
Operating Temperature: -40°C to +80°C
Typical Operating Force: 300 grams
Mounting: Mounts to 1/32" to 1/8" thick PC board

STANDARD LEGENDS

Insertable Style Modules

For prototypes and small quantities

Standard insertable legend modules are an economical way to create your own keyboard legend. Just remove the clear button cap, add any legend, and replace the snap-on cap.

Legend Inserts

For insertable legend modules

Give your keyboard modules the appearance of being printed without the cost. Self-adhesive, printed legend inserts are die cut to fit the buttons. Legend sheet includes commonly used symbols, terms, alpha characters A-Z, and numeric characters 0-99 in News Gothic Condensed typestyle, printed in black on clear backing. Legend sheets also include blank inserts for dry transfer lettering.

87 Series Legend Sheet **Part No. 87AC2046**

Dry Transfer Legends

For additional legend inserts

Sheets include A thru Z in upper and lower case, the numeric characters 0 thru 9, as well as commonly used symbols. The typestyle and size are similar to the chart for printed legends shown below.

Small Print	**Part No. 87-DT-2096-088**
Medium Print	**Part No. 87-DT-2096-125**
Large Print	**Part No. 87-DT-2096-187**

SPECIAL LEGENDS

Printed Legends

For medium volume or short runs

Virtually any character, symbol or pattern which can be photographed can be printed on the button. Grayhill uses epoxy ink which bonds to the surface of the button.

The legend can be printed on either of two surfaces: the top surface of a one-piece button, or the internal surface on the snap-on cap style for maximum wear.

The typestyle chart shows the style and the approximate limitations of Grayhill's standard type. However, limitations differ with the surface to be printed and the actual characters to be used. If your legend exceeds the chart limits, contact Grayhill for more information. Unless specified, black legends are printed on white buttons.

Additional Ink Color: White ink is stocked for use on dark colored buttons.

Additional Button Colors: For a molding charge, we can provide buttons from other colors which we may have in stock, such as black, red, green, blue, or yellow. Non-stock button/ink colors may require minimum material purchase. To order, or to check currently stocked colors, contact Grayhill.

Type No. and Typical Height	Sample Style and Typical Sizes	Sub Surface Character and Line Limitations	Top Surface Character and Line Limitations
4GH088 .083"	ABCDEFGH	4 Characters 2 Lines END DATA	4 Characters 2 Lines END DATA
1GH125 .138"	ABCDE	3 Characters 1 Line LAD	3 Characters 1 Line LAD
3GH187 .207"	ABCD	2 Characters 1 Line ON	2 Characters 1 Line ON
2GH250 .276"	ABC	N/A N/A	2 Characters 1 Line 15

Molded-in Legends

For high volume production

For legends that will stand up to abuse and constant wear for the life of your keyboard, use molded-in legends. The two-shot molding process molds the legend and button together. Your special legend can be made from existing Grayhill molds or we can tool special ones.

Buttons are available with black legends molded in white or other light backgrounds, or with white legends molded into dark backgrounds. See Printed Buttons, Additional Button Colors. To order, contact Grayhill.

ORDERING INFORMATION

Type of Module or Legend	Part Number
1 Button	**87CC3-201**
2 Button	**87DC3-201**
3 Button	**87EC3-201**
4 Button	**87FC3-201**
5 Button	**87GC3-201**
6 Button	**87HC3-201**
12 Button–Matrix	**87AB3-201**
12 Button–SP/Com Bus	**87AC3-201**
16 Button–Matrix	**87BB3-201**
16 Button–SP/Com Bus	**87BC3-201**
Insertable Legend Card	**87AC2046**
Dry Transfer–Small	**87-DT-2096-088**
Dry Transfer–Medium	**87-DT-2096-125**
Dry Transfer–Large	**87-DT-2096-187**

Special Legends

To order non-standard modules, information is required for the areas listed below.

Your special order will be assigned a part number for future identification. This number is sequentially assigned and is non-descriptive.

1. **Type of Module.** 1, 2, 3, 4, 5, 6, 12 or 16 button.
2. **Mounting Orientation.** Horizontal or vertical.
3. **Circuitry.** Single pole/common bus is standard for all single row modules. For 12 or 16 button keyboard, specify single pole/common bus or matrix.
4. **Housing Color.** Standard housing is black. Optional stock colors include beige and gray.
5. **Button Types.** Flat or concave buttons are available for molded legends; flat, concave, and snap-on cap styles are available for printed legends.
6. **Button Color.** Standard buttons for molded and printed legends are white with black legend. Other colors available include white legends with red, green, dark blue, dark gray and black buttons, or black legends with yellow, blue, light gray, beige and white buttons. Additional legend colors such as red are also available.
7. **Legend Style.** Two-shot molded or printed. Printed legends may be top or sub-surface printed.
8. **Actual Legend.** Specify for each button using the button identification on drawings. **Price**–Contact Grayhill.

Available from your local Grayhill Distributor. For prices and discounts, contact a local Sales Office, an authorized local Distributor or Grayhill.

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SERIES 88

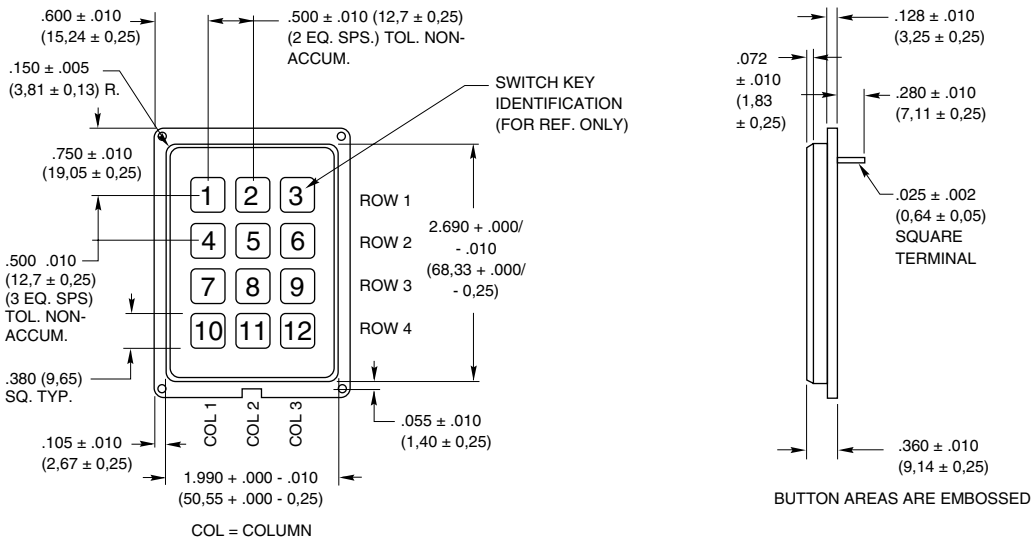
Sealed, Flange Mounted

FEATURES

- Sealed Keyboard
- Colorful Graphic Overlay
- Audible, Snap-Dome Contact
- User Legendable Styles
- 3,000,000 Operations per Button
- Optional Panel Seal Gasket to Protect Your Equipment

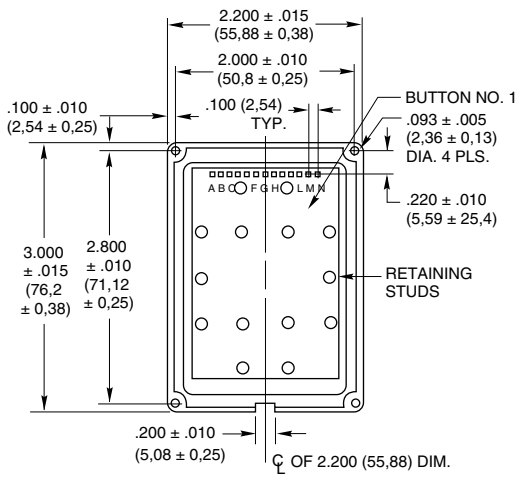
DIMENSIONS In inches (and millimeters)

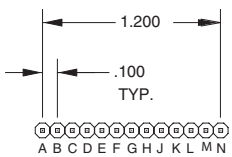
3x4 Keyboard



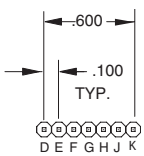
Termination In inches (and millimeters)

3x4





SINGLE POLE COMMON BUS TERMINAL



MATRIX TERMINAL PIN-OUT

Code and Truth Table

Dots in the chart indicate connected terminals when switch is closed. Terminals are identified on the keyboard.

3x4	CODES																					
	Matrix						Single Pole/Common Bus															
BUTTON LOCATION 1	●			●			●															●
2		●		●				●														●
3			●	●					●													●
4	●				●					●												●
5		●			●						●											●
6			●		●							●										●
7	●					●							●									●
8		●				●								●								●
9			●			●									●							●
10	●															●						●
11		●															●					●
12			●																		●	●
	F	E	D	K	J	H	G	J	E	A	K	F	B	L	G	C	M	H	D	N		
	TERMINAL LOCATION																					

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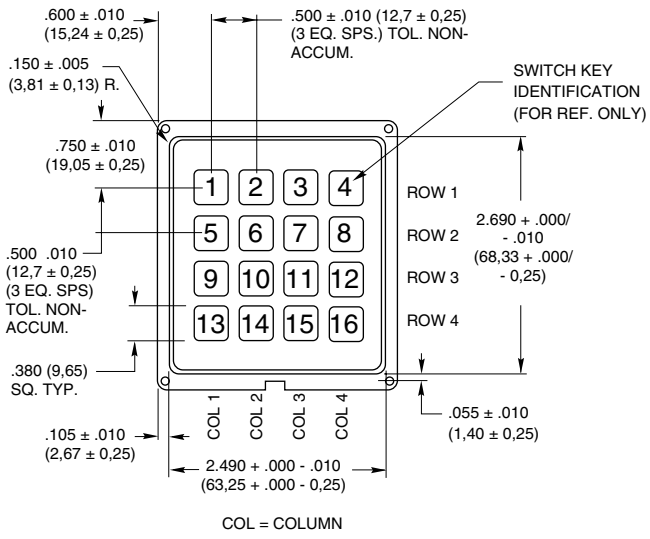
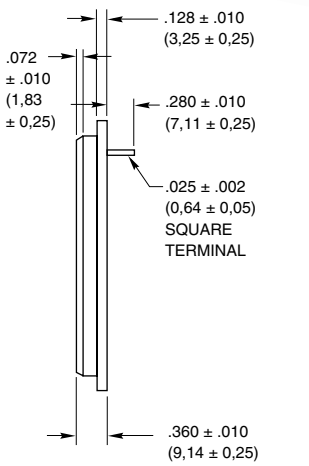
- Optional Panel Seal Gasket to Protect Your Equipment

DIMENSIONS In inches (and millimeters)

4x4 Keyboard



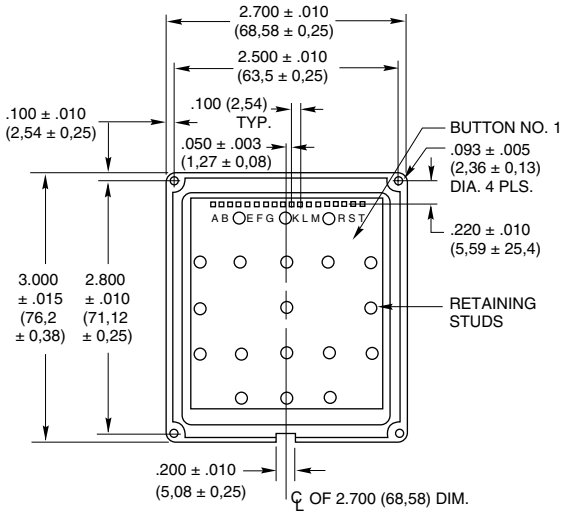
COL = COLUMN



BUTTON AREAS ARE EMBOSSED

Termination In inches (and millimeters)

4x4



Code and Truth Table

Dots in the chart indicate connected terminals when switch is closed. Terminals are identified on the keyboard.

4x4	CODES	
	Matrix	Single Pole/Common Bus
BUTTON LOCATION 1	●	●
2	●	●
3	●	●
4	●	●
5	●	●
6	●	●
7	●	●
8	●	●
9	●	●
10	●	●
11	●	●
12	●	●
13	●	●
14	●	●
15	●	●
16	●	●
	H G F E M L K J	P J E A R L F B S M H C T N G D K
	TERMINAL LOCATION	

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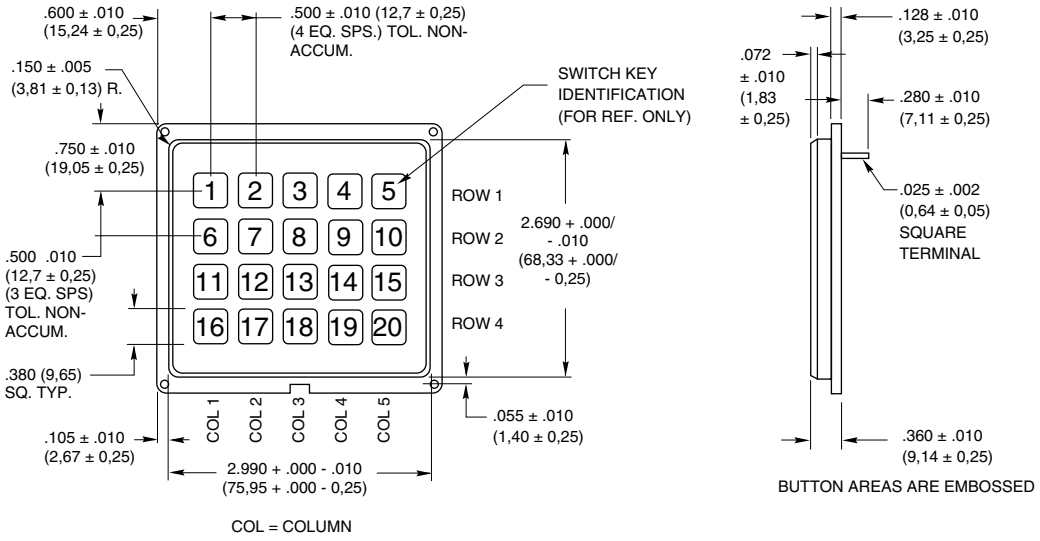
- Optional Panel Seal Gasket to Protect Your Equipment

DIMENSIONS In inches (and millimeters)

5x4 Keyboard

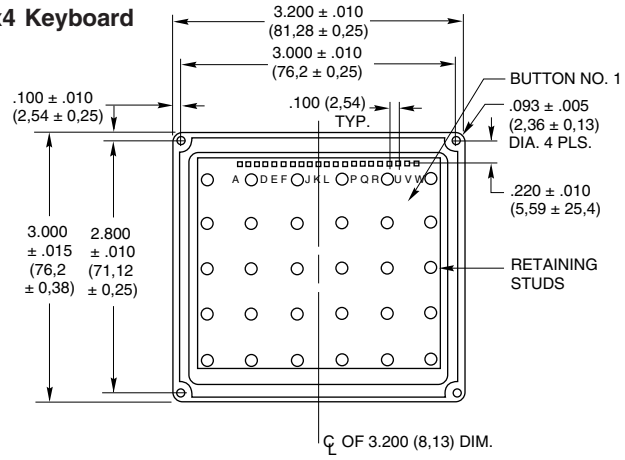


COL = COLUMN

BUTTON AREAS ARE EMBOSSED

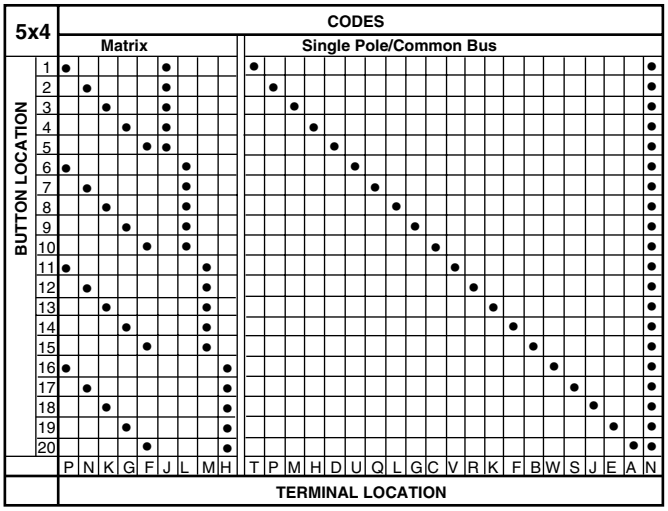
Termination In inches (and millimeters)

5x4 Keyboard



Code and Truth Table

Dots in the chart indicate connected terminals when switch is closed. Terminals are identified on the keyboard.



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SPECIFICATIONS

Rating Criteria

Rating at 24 Vdc: 10 milliamps, resistive
Contact Resistance: Compatible with MOS, TTL and DTL (10 ohms maximum)
Voltage Breakdown: 250 Vac between mutually insulated parts
Life Expectancy: 3,000,000 operations per button
Contact Bounce: Less than 4 milliseconds at make, 10 milliseconds at break
Temperature: -40°C to +80°C

Operating Features

Button Travel: 0.015"(0,38 mm) nominal total travel
Typical Operating Force: 350 grams

Materials and Finishes

Housing: ABS polycarbonate, black
Graphic Overlay: Polyester
Contact Dome: Stainless steel, selectively gold-plated
Terminals: Phosphor bronze

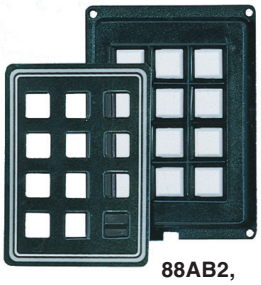
STANDARD LEGENDS

Colorful graphic overlays are polyester with a tough acrylic bond to provide maximum protection against dirt and moisture. Second surface printed, the overlay wipes clean and continues to look bright and bold throughout the keyboard life. Available through distributors. For instant custom legends, order separate blank keyboards as indicated in the Ordering Information section and choose one of the clear window overlays below; then order a sheet of legend inserts. Or, if you prefer, order the keyboard custom printed by Grayhill; see Ordering Information.

-143

-152

-172

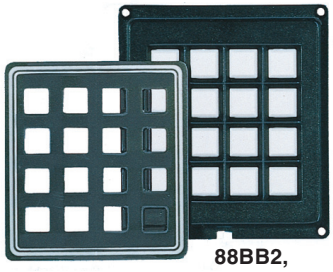


88-101 88AB2, 88AC2

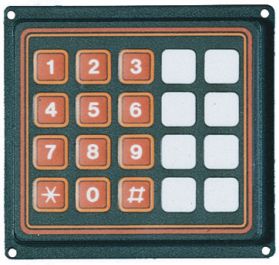
-052

-072

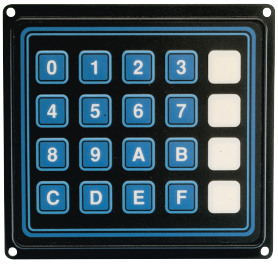
-082



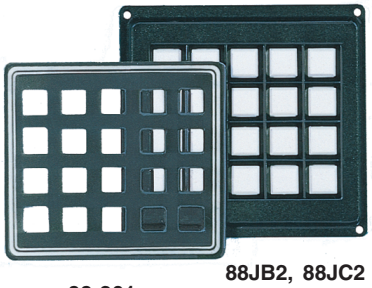
88-001 88BB2, 88BC2



-252



-262



88-201 88JB2, 88JC2

SEALING OF KEYBOARDS

The graphic legend is silk-screen printed on the second surface of a clear polyester film, providing maximum legend protection. It withstands high humidity, and it is resistant to scratching, marring, and dulling of the surface caused by fingernails, wiping cloths, and cleaning materials. It has excellent solvent resistance to water, petroleum oil, alcohols and aliphatic hydrocarbons.

These common liquids do not attack the overlay: 5% acetic acid, 5% citric acid, 2% detergent solution, soapy water, 30% hydrogen peroxide, wine, beer, whiskey, coffee, cocoa, milk, tomato juice, lemon juice, etc. Hydrocarbons, ketones and freon do not affect the overlay. But, we recommend that you do not subject the keyboard to these chemicals, since they may affect the switch housing, which is ABS plastic. To discuss a particular solvent, contact Grayhill.

Protect your equipment in outdoor or harsh environmental conditions by sealing the keyboard to the equipment panel. Use an optional gasket with the keyboard. There are two types of gaskets: one for mounting the keyboard beneath the panel, and one for mounting it above the equipment panel. See Panel Seal Gaskets.

The contact system is internally sealed by a special adhesive backed sheet that holds the domes in position on the PC board.

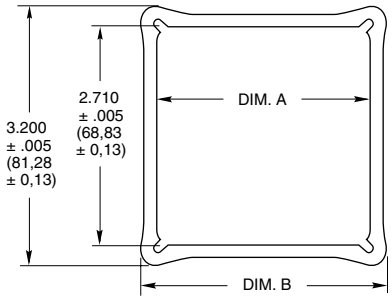
PANEL SEAL GASKETS

Weatherproof and waterproof your subpanel and topside mounted keyboards with optional panel seal gaskets.

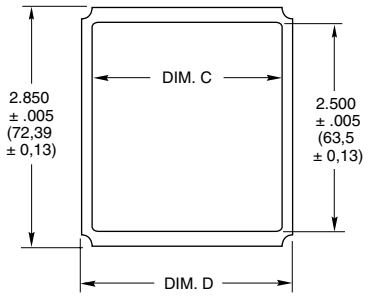
Subpanel keyboard gasket is .062" (1,57 mm) thick; topside keyboard gasket is .094" (2,39 mm).

Material is cellulose fiber, foam, nitrile rubber. Order gaskets separately from keyboard.

Subpanel Mounting



Topside Mounting



Subpanel 3x4 **Part No. 88M2001-2**
Subpanel 4x4 **Part No. 88M2009-2**
Subpanel 5x4 **Part No. 88M2019-1**

Topside 3x4 **Part No. 88M2012-1**
Topside 4x4 **Part No. 88M2015-1**
Topside 5x4 **Part No. 88M2018-1**

Size of Keyboard	Subpanel Mount Dim. A	Subpanel Mount Dim. B	Topside Mount Dim. C	Topside Mount Dim. D
3x4	2.010 ± .005 (51,05 ± 0,.13)	2.400 ± .005 (60,96 ± 0,13)	1.800 ± .005 (45,72 ± 0,13)	2.040 ± .005 (51,82 ± 0,13)
4x4	2.510 ± .005 (63,75 ± 0,13)	2.900 ± .005 (73,66 ± 0,13)	2.300 ± .005 (58,42 ± 0,13)	2.540 ± .005 (64,52 ± 0,13)
5x4	3.010 ± .005 (76,45 ± 0,13)	3.400 ± .005 (86,36 ± 0,13)	2.800 ± .005 (71,12 ± 0,13)	3.040 ± .005 (77,22 ± 0,13)

INSTANT CUSTOM LEGENDS

Available through Distributors
Create your own legends using these 3 items: 1) a blank keyboard, 2) the clear window overlays shown on Standard Legend page and 3) a sheet of legend inserts.

Blank Keyboards
The numbers below order blank keyboards for the user to legend. For description, refer to the part numbering scheme below. The keyboards and overlays are ordered separately.

3x4 Matrix **Part No. 88AB2**
3x4 SP/Com Bus **Part No. 88AC2**
4x4 Matrix **Part No. 88BB2**
4x4 SP/Com Bus **Part No. 88BC2**
5x4 Matrix **Part No. 88JB2**
5x4 SP/Com Bus **Part No. 88JC2**

Legend Insert Sheet and Dry Transfers
Self-adhesive inserts are die-cut to fit the button. Legends are printed in black on clear film in News Gothic Condensed type style. They include letters A through Z, numbers 0-69, telephone legends, commonly used words, symbols and blanks.
Part No. 87AC2046

Use matching dry transfer lettering on blank inserts of legend sheet: upper and lower case letters, 0-9, and common symbols.

Small Print **Part No. 87-DT-2096-088**
Medium Print **Part No. 87-DT-2096-125**
Large Print **Part No. 87-DT-2096-187**

Clear Window Overlays
Order separately from keyboards. See also ordering information.

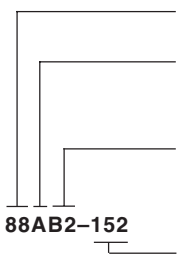
3x4 Overlay **Part No. 88-101**
4x4 Overlay **Part No. 88-001**
5x4 Overlay **Part No. 88-201**

PRINTED LEGENDS

Not available through Distributors. For medium volume applications, or where legends cannot be produced by the self legend method, you can order epoxy ink printed legends. Virtually anything which can be photographed can be printed. Grayhill will print your legend and then add the clear window overlay.

Type I.D. No.	Simulated Style & Size	Character & Line Limitations *
4GH088	ABCDEFGH	END DATA
1GH125	ABCDE	LAD
3GH187	ABCD	ON
2GH250	ABC	15

ORDERING INFORMATION



Grayhill Series Number
Size Option
A = 3x4
B = 4x4
J = 5x4
Circuitry Option
B2 = Matrix code
C2 = Single pole/common bus
Standard Legend Choices
3x4 Size: -143, -152, or -172
4x4 Size: -052, -072 or -082
5x4 Size: -252 or -262

Available from your local Grayhill Distributor. For prices and discounts, contact a local Sales Office, an authorized local Distributor or Grayhill.

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