# SERIES 61C

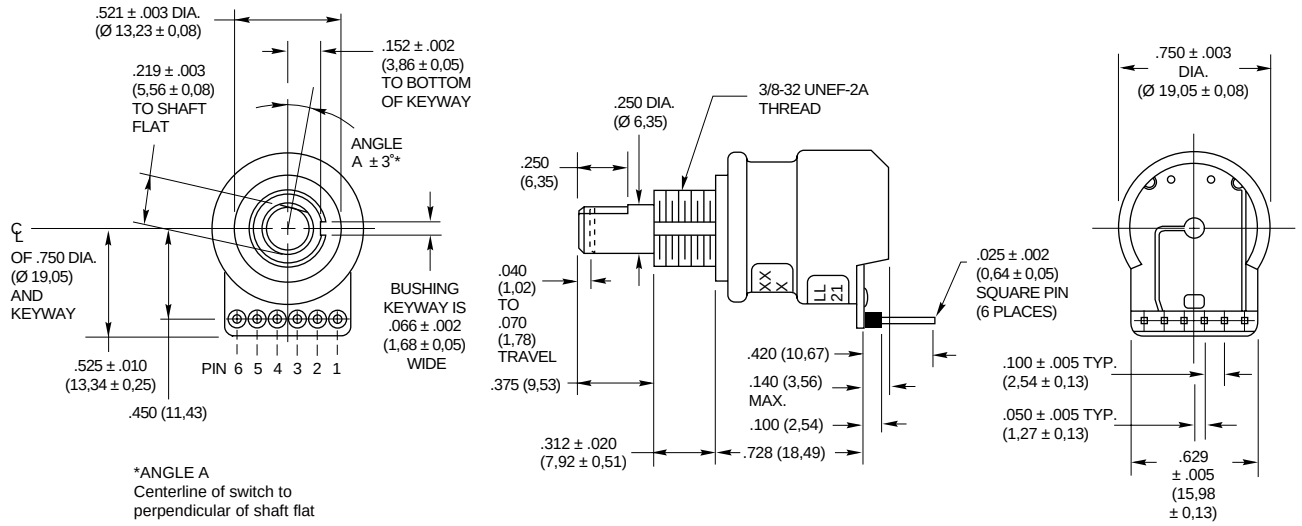
## 16 or 32 Position with Pushbutton

### FEATURES

- Competitively Priced to Similar Electromechanical Switches
- Optically Coupled For More Than A Million Trouble-Free Rotations
- Has Data Entry Pushbutton Switch Activated By Switch Shaft
- Compatible With CMOS, TTL and HCMOS Logic
- Operationally Used to Move Display Icon and Input Data
- Used to Set Radio Frequency, Drill Depth, RPM, etc.



### DIMENSIONS In inches (and millimeters)



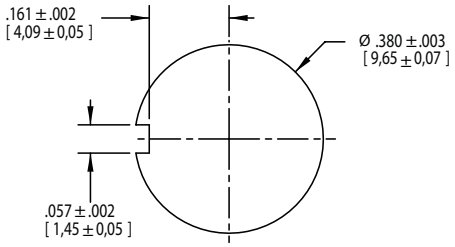

*ANGLE A
Centerline of switch to perpendicular of shaft flat

| | |
|---|---|
| 32 Pos. | 28.125° |
| 16 Pos. | 56.25° |

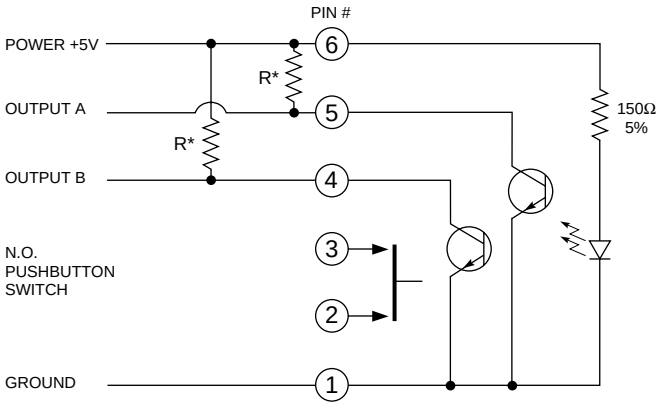
Grayhill part number and date code marked on label. Customer part number marked on request.

Unless otherwise indicated, tolerances are ± .010 (0,25).

### RECOMMENDED PANEL CUTOUT



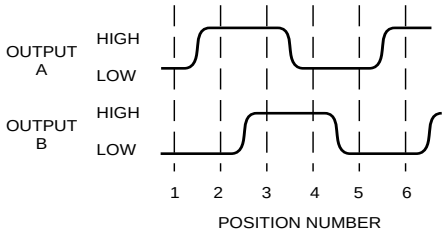
## CIRCUITRY, TRUTH TABLE, AND WAVEFORM: Standard Quadrature 2-Bit Code




* External pull-up resistors required for operation.
8.2 kΩ is suggested for TTL; 3.3 kΩ is suggested for CMOS.

| Clockwise Rotation | | |
|---|---|---|
| Position | Output A | Output B |
| 1 | | |
| 2 | ● | |
| 3 | ● | ● |
| 4 | | ● |

● Indicates logic high; blank indicates logic low. Code repeats every 4 positions.




## SPECIFICATIONS

### Pushbutton Switch Ratings

**Rating:** 5 Vdc, 10 mA, resistive
**Contact Resistance:** less than 10 ohms (TTL or CMOS Compatible)
**Voltage Breakdown:** 250 Vac between mutually insulated parts.
**Contact Bounce:** Less than 4 milliseconds at make and less than 10 milliseconds at break.
**Actuation Life:** 3,000,000 operations.
**Actuation Force:** maximum actuation force of 330 grams and a minimum actuation force of 250 grams.

### Encoder Ratings

**Coding:** 2-bit quadrature coded output.
**Operating Voltage:** 5.0 ±.25 Vdc
**Supply Current:** 30 mA maximum at 5 Vdc
**Logic High:** 3.8V for CMOS and 2.7V for TTL minimum.
**Logic Low:** 0.8V maximum
**Logic Rise and Fall Times:** Rise Time less than 30 mS at 16.6 RPM. Fall Time less than 30 mS at 16.6 RPM.
**Operating Torque:** 1.5 in-oz ± 30% initial (1.0 in-oz ± 50% after life for 32 position only)
**Rotational Life:** more than 1,000,000 cycles of operation (1 cycle = 360° rotation and return)
**Shaft Push Out Force:** 20 lbs minimum
**Mounting Torque:** 10 in-lbs maximum

### Environmental Ratings

**Operating Temperature Range:** –40°C to 85°C
**Storage Temperature Range:** –55°C to 100°C
**Relative Humidity:** 90-95% at 40°C for 96 hours.
**Vibration Resistance:** Harmonic motion with amplitude of 15g, within a varied 10 to 2000 Hz frequency for 12 hours per MIL-STD-202, Method 204
**Shock Resistance:** Test 1: Tested at 100g for 6 mS, half sine, 12.3 ft/s Test 2: 100g for 6 mS, sawtooth, 9.7 ft/s

### Materials and Finishes

**Bushing:** Reinforced thermoplastic
**Shaft:** Reinforced thermoplastic
**Mounting Hardware:** One brass, cadmium-plated nut and lockwasher supplied with each switch. Nut is 0.094 inches thick by 0.562 inches across flats.

## ORDERING INFORMATION


**Series**
**Style:** C = Standard
**Angle of Throw:** 00 = No detent
11 = 11.25° or 32 Positions
22 = 22.25° or 16 Positions
**Coding:** 01 = Quadrature

**Pushbutton Option:** 01 = Without pushbutton, 02 = With pushbutton
**Number of Changes per Revolution:** 04 for no detent and 22.25° angle of throw
08 for no detent and 11.25° angle of throw

Custom knobs available, see page I-57.

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

## ACCESSORIES

See page I-41.

# Optical Encoder Engineering Information

## QUADRATURE

All Grayhill encoders use quadrature output code, which is the same as a 2-bit, repeating gray code. Quadrature is the most popular and cost effective output format because only two detectors are required. However, quadrature can only be used in applications where incremental data is required. Absolute positioning is not possible because the code repeats every four positions. In other words, changes in the encoder in magnitude and direction can be determined, but the actual position of the encoder cannot. In most applications this is not a problem.

In a quadrature rotary optical encoder two detectors are used to provide outputs, "A" and "B". The code rotor either blocks the infrared light or allows it to pass to the detectors. As the shaft turns the rotor, the outputs change state to indicate position. The resulting output is two square waves which are 90° out of phase.

## OPEN COLLECTOR OUTPUT

The open collector output is typical of the Series 61B, 61C and 62, and is the simplest form of output available. The first step in interfacing with open collector outputs is to provide an external pull-up resistor from each output to the power source. These pull-up resistors provide the output with the high-state voltage when the phototransistor is "off".

In a phototransistor, base current is supplied when light strikes the detector, which effectively grounds the output. Typically, the detector is operated in saturation. This means sufficient light is provided to completely sink, or ground, all the current provided by the pull up resistor plus that of the interfacing electronics. In the logic high state, the light is sufficiently blocked by the rotor and the detector functions like an open circuit. The pull up resistor then provides sourcing current to the interfacing electronics. This "on" or "off" digital arrangement allows the open collector to interface with popular integrated circuit technologies such as TTL, TTL LS, CMOS, and HCMOS.

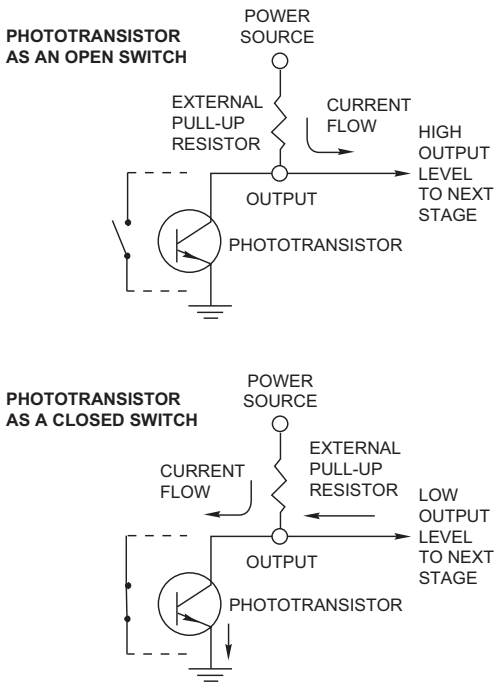
## SCHMITT TRIGGERS

To provide signal enhancement it is recommended that a Schmitt Trigger be connected to each output. This device is already included in the Series 61K, 61R, 63K and 63R encoders. The Schmitt Trigger "cleans up" the output into a pure digital signal. It does this by removing the small linear region between the "on" and "off" states of the detector. During this transition the light is only partially blocked and the output is somewhere between what the interfacing circuit might consider to be "on" or "off". In other words, the output is not completely digital. The Schmitt Trigger contains a very important feature which makes it attractive for this application. The device has a higher threshold, or trigger level, when it is in the "on" state than it does in the "off" state. This hysterisis filters any electrical noise, which can cause the output to change state rapidly during the transition. And since the output from the Schmitt Trigger is a pure digital signal and is isolated from the phototransistor, the signal is basically immune to loading problems that can effect encoders without the Schmitt Trigger. Schmitt Triggers are available in most popular IC technologies.

## SHAFT AND PANEL SEAL

A shaft and panel seal are available to provide water-tight mounting for the Series 61B, 61D, 61K, 61R and 62 encoders. Sealing is accomplished by an o-ring shaft seal and a panel seal washer. The panel seal washer in the 61B and 61D encoders does not affect the overall dimensions of the switches. In the 61K and 61R encoders, the .045" thick washer is placed over the threads and sits flat on the base of the bushing. The 61KS and 61RS are also epoxy-sealed on the bottom of the switch to provide a completely sealed switch.

**Open Collector Output**




**Schmitt Trigger**