

**SERIES 60A**  
Joystick

**FEATURES**

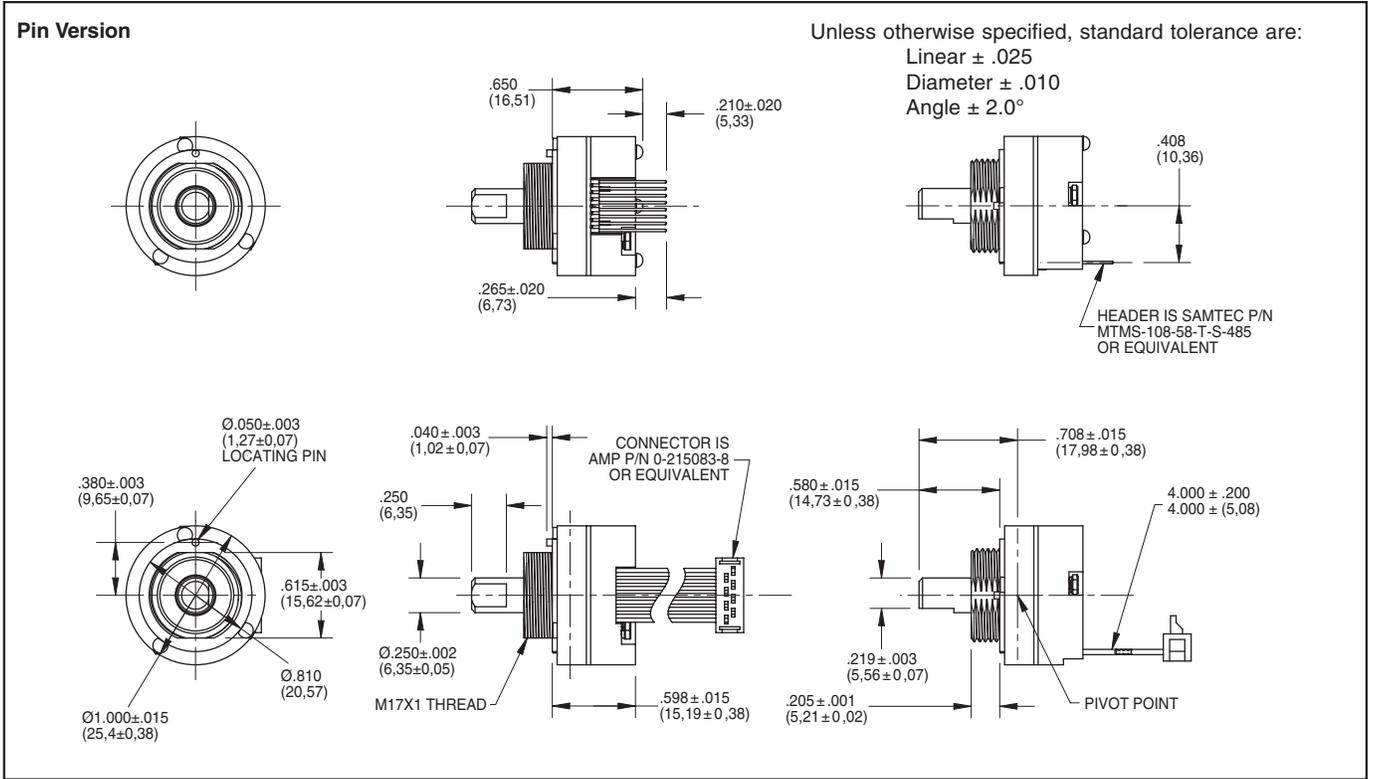
- Optical Encoder, Pushbutton, and Joystick in One Shaft
- Long Life, High Reliability
- Compatible with CMOS, HCMOS, and TTL Logic
- Choices of Cable Length and Termination
- Customized Solutions Available

**APPLICATIONS**

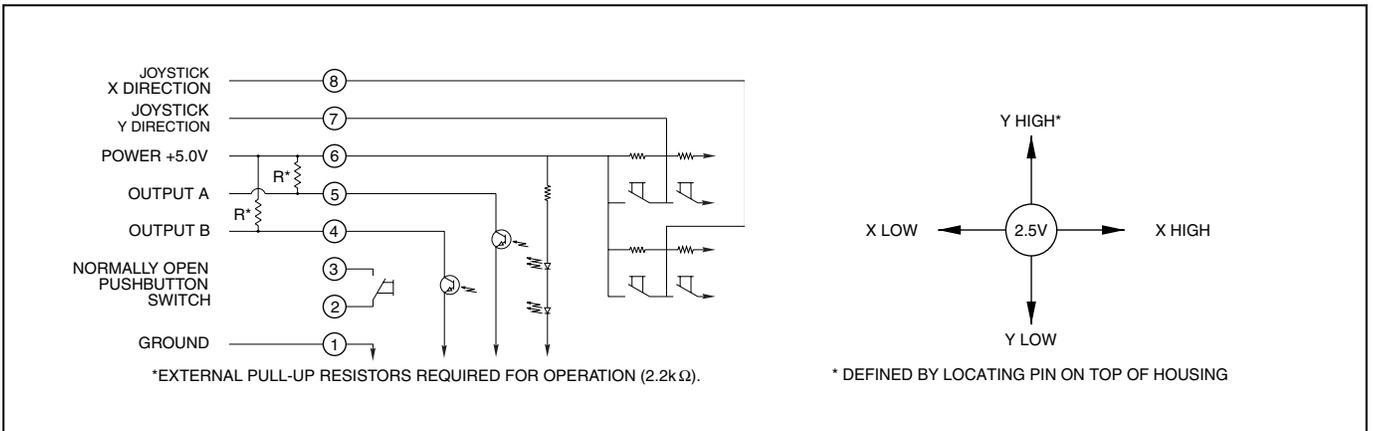
- Global Positioning/Driver Information Systems
- Medical Equipment Control
- Radio Control
- Robotics
- Commercial Appliances



**DIMENSIONS** In inches (and millimeters)

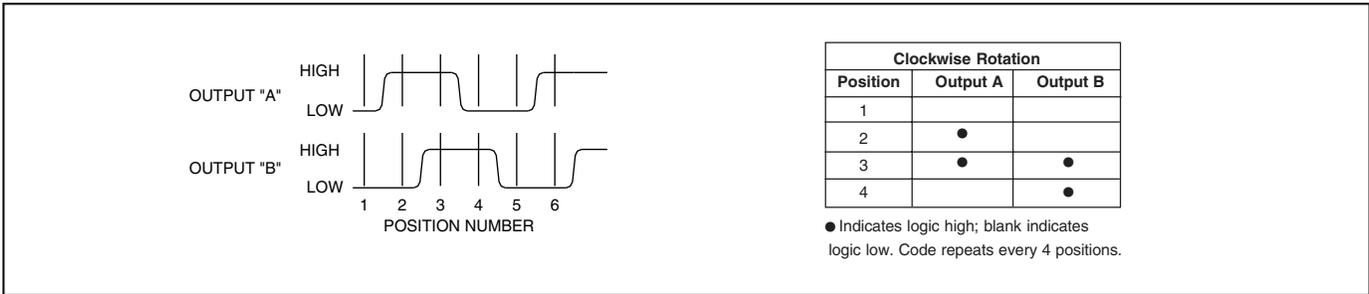


**CIRCUITRY AND JOYSTICK OPERATION** Standard Quadrature 2-Bit Code



Optical and Mechanical Encoders

**WAVEFORM AND TRUTH TABLE** Standard Quadrature 2-Bit Code



**SPECIFICATIONS**

**Rotary Electrical and Mechanical Ratings**

**Operating Voltage:** 5.00 ± 0.25 Vdc  
**Supply Current:** 20 mA maximum at 5 Vdc  
**Output:** Open collector phototransistor.  
 External pull up resistors are required  
**Output Code:** 2-Bit quadrature, channel A leads channel B by 90° electrically during clockwise rotation of the shaft  
**Logic Output Characteristics:**  
 High: No less than 3.5 Vdc  
 Low: No greater than 1.0 Vdc  
**Minimum Sink Current:** 2.0 mA  
**Power Consumption:** 100 mW maximum  
**Mechanical Life:** 1 million rotational cycles of operation (1 cycle is a rotation through all positions and a full return)  
**Average Rotational Torque:** 2.0 ± 1.0 in-oz initially, torque shall be within 50% of initial value throughout life  
**Mounting Torque:** 15 in-lbs. maximum  
**Shaft Push-Out Force:** 45 lbs minimum  
**Shaft Pull-Out Force:** 45 lbs minimum  
**Terminal Strength:** 15 lbs terminal pull-out force minimum for cabled and header termination  
**Solderability:** 95% free of pin holes and voids

**Pushbutton Electrical and Mechanical Ratings**

**Rating:** 10 mA at 5 Vdc resistive  
**Contact Resistance:** less than 10 ohms  
**Life:** 1 million actuations minimum  
**Contact Bounce:** < 4 mS make, 10 mS break  
**Actuation Force:** 400 ± 150 grams force  
**Shaft Travel:** 0.020 ± 0.010 inches

**Joystick Electrical and Mechanical Ratings**

**Supply Current:** 5 mA maximum  
**Output Code:** 2-Bit  
**Logic Output Characteristics:**  
 Neutral: 2.5 ± 0.5 Vdc  
 High: > 4.5 Vdc  
 Low: < 0.5 Vdc  
**Angle of Throw:** 8° ± 2° in all directions  
**Life:** 500,000 actuations in each direction

**Environmental Ratings**

**Operating Temperature Range:** -40°C to 85°C  
**Storage Temperature Range:** -55°C to 100°C  
**Relative Humidity:** 96 hours at 90-85% humidity at 40°C  
**Vibration:** Harmonic motion with amplitude of 15g, within a varied 10 to 2000 Hz frequency for 12 hours  
**Mechanical Shock:**  
 Test 1: 100g for 6ms half-sine wave with a velocity change of 12.3 ft/s  
 Test 2: 100g for 6ms sawtooth wave with a velocity change of 9.7 ft/s

**Materials and Finishes**

**Assembly Studs:** 305 Stainless steel  
**Detent Housing:** Polyamide polymer (nylon 6/10 alloy)  
**Printed Circuit Boards:** Glass cloth epoxy double clad with copper gold over nickel plated  
**Infrared Emitting Diode Chips:** Gallium aluminum arsenide  
**Silicon Phototransistor Chips:** Gold and aluminum alloys

**Resistors:** Metal oxide on ceramic substrate

**Solder Pins:** Brass, Plated with tin

**Shaft:** Polyamide polymer (nylon 6/10 alloy) with stainless steel insert

**Detent Balls:** Carbon steel plated with nickel

**Detent Springs:** Music wire plated with tin

**Code Rotor:** 33% Glass reinforced nylon 66

**Pushbutton Dome:** Stainless steel

**Pushbutton Dome Retainer:** Polycarbonate

**Joystick Housing:** Polyamide polymer (nylon 6/10 alloy)

**Joystick Contact:** Stainless steel, silicone rubber, brass with silver cladding, high-temp thermoplastic, phosphor bronze with silver cladding

**Cable:** Copper stranded with plating in PVC insulation

**Connector:** PA 4.6 with tin over nickel plated phosphor bronze

**Lockwashers:** Stainless steel with passivate finish

**Hex Nuts:** 303 Stainless steel

**Label:** TT406 Thermal transfer cast film

**Solder:** Sn/Ag/Cu, Lead-Free, No Clean

**Mounting Nut:** Polyurethane

**Lubricating Grease:** Nye nyogel 774L

**OPTIONS**

Contact Grayhill for custom terminations, rotational torque, number of positions, shaft configurations, and resolutions. Control knobs are also available.

**ORDERING INFORMATION**

**Series**  
**Angle of Throw:** Detent: 18 = 18° or 20 positions; Non-detent: 08 = 18° or 20 positions; Non-Turn: 00 = Joystick and Pushbutton only  
**Joystick Contacts:** 2 = 2 Discrete Contacts  
 4 = 4 Discrete Contacts  
 8 = 4 Contacts in 8 possible directions  
**Termination:** S = Stripped cable; .050" centers; C = Connector; .050" centers; P = Pin; .050" centers  
**Cable Termination:** 040 = 4.0in. Cable is terminated with Amp Connector P/N 215083-6.  
 See Amp Mateability Guide for mating connector details.  
*\*Eliminate cable length if ordering pins (Ex: 60A18-4-P)*

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

Optical and Mechanical Encoders

## SERIES 60AD

### Optical Encoder with integrated Joystick and Pushbutton

#### FEATURES

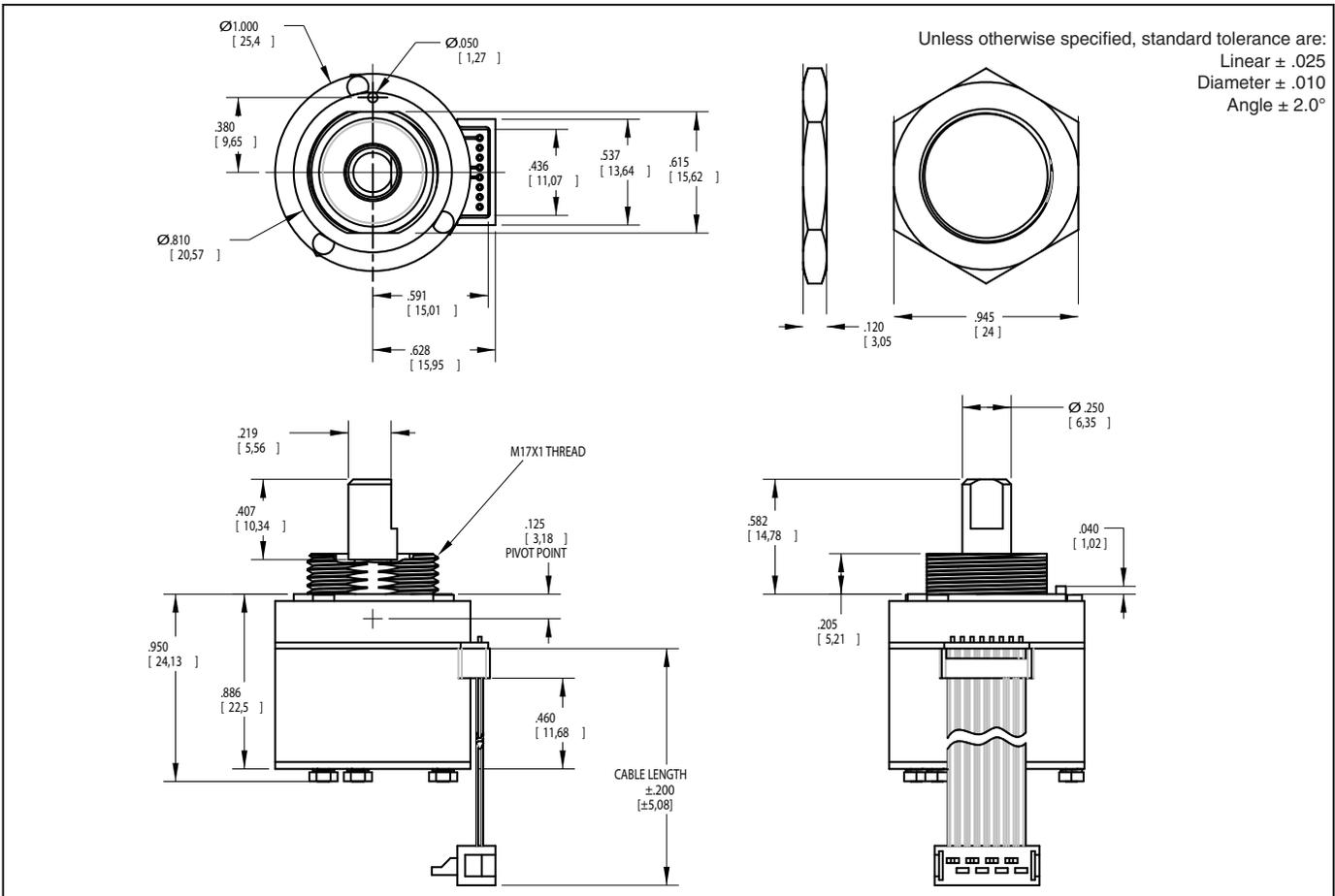
- Dome contacts provide excellent tactile feedback in all directions
- Choices of actuation force, cable length and termination
- Customized solutions available

#### APPLICATIONS

- Aerospace
- Automotive
- Medical devices



#### DIMENSIONS in inches (and millimeters)



Optical and Mechanical Encoders

#### ORDERING INFORMATION

**60AD18-4-M-060S**

Angle of Throw: 18= 18° or 20 positions  
 Joystick: 4= Four contacts & directions;  
 8= Four contacts & eight directions

Termination: 0.050" center P= pin header; C= connector; S= stripped cable  
 Cable Length: 020 thru 250 in 1/2 inch increments, 060= 6.0 inch cable  
 Force Option: (see table) L=low, M=medium, H=high

	OPTION		
	L	M	H
1 ACTUATION FORCE (JOYSTICK) [g]	550±200	725±200	1050±250
2 ACTUATION FORCE (PUSHBUTTON) [g]	625±200	800±200	1100±250
3 AVERAGE ROTATIONAL TORQUE [in-oz]	1.50±0.75	3.50±1.75	5.00±2.00

For prices and custom configurations, contact a local sales office, an authorized distributor, or Grayhill's sales department.

**JOYSTICK OPERATION + ENCODER WAVEFORM AND TRUTH TABLE** Standard Quadrature 2-Bit Code

### SWITCH SCHEMATIC

**\*EXTERNAL PULL-UP RESISTORS REQUIRED FOR OPERATION (2.2k $\Omega$ ).**

### JOYSTICK POSITION DIAGRAM

\* INDICATES DIRECTION OF D-FLAT ON BUSHING

### ENCODER WAVEFORM (C.W. ROTATION)

### ENCODER TRUTH TABLE (C.W. ROTATION)

POSITION	OUTPUT A	OUTPUT B
#1	○	○
#2	○	○
#3	○	○
#4	○	○

○ INDICATES LOGIC-HIGH  
○ INDICATES LOGIC-LOW  
CODE REPEATS EVERY FOUR POSITIONS

### JOYSTICK TRUTH TABLE

POSITION	X OUTPUT	Y OUTPUT
1	NEUTRAL	HIGH
2	HIGH	HIGH
3	HIGH	NEUTRAL
4	HIGH	LOW
5	NEUTRAL	LOW
6	LOW	LOW
7	LOW	NEUTRAL
8	LOW	HIGH
9	NEUTRAL	NEUTRAL

**SPECIFICATIONS**

**Rotary Specifications**

- Operating Voltage:** 5.00  $\pm$  0.25 Vdc
- Supply Current:** 20mA max at 5 Vdc
- Minimum Sink Current:** 2.0mA at 5 Vdc
- Power Consumption:** 0.1mW max at 5 Vdc
- Output:** Open collector phototransistor, 2.2k  $\Omega$  external pull-up resistors are required
- Output Code:** 2-Bit quadrature, channel A leads channel B by 90° in clockwise rotation
- Logic Output Characteristics:**  
High: No less than 3.5 Vdc  
Low: No greater than 1.0 Vdc
- Mechanical Life:** 1 million rotational cycles (through all positions and a full return)
- Rotational Torque:** see table
- Maximum Rotational Speed:** 100 RPM
- Mounting Torque:** 15 in-oz. maximum
- Shaft Push/Pull Out Force:** 45 lbs min.
- Shaft Side-Load Force:** 20 lbs. min.
- Terminal Strength:** 15 lbs pull-out force min.

**Pushbutton Specifications**

- Rating:** 10 mA at 5 Vdc resistive
- Contact Resistance:** less than 10 ohms
- Contact Bounce:** < 4ms make, <10 ms break
- Mechanical Life:** 1 million actuations min.
- Actuation Force:** see table
- Pushbutton Travel:** .027  $\pm$  .010 in.

**Joystick Specifications**

- Supply Current:** 5mA max
- Output Code:** 2-Bit
- Logic Output Characteristics:**  
Neutral Position: 2.5  $\pm$  0.5 Vdc  
High-State Position: >4.5 Vdc  
Low-State Position: <0.5 Vdc
- Mechanical Life:** 500k cycles min.
- Actuation Force:** see table
- Angle of Throw:** 3.5° +2°/-1°

**Environmental Ratings**

- Operating Temp. Range:** -40°C to 85°C
- Storage Temp. Range:** -55°C to 100°C
- Relative Humidity:** 96 hours at 90-95% humidity at 40°C
- Vibration:** Harmonic motion with amplitude of 15g, within 10 to 2000 Hz for 12 hours
- Mechanical Shock:**  
Test 1: 100g for 6ms half-sine wave with a velocity change of 12.3 ft/s  
Test 2: 100g for 6ms sawtooth wave with a velocity change of 9.7 ft/s

**Materials and Finishes**

- Detent Housing:** Nylon 6/10
- Shaft:** Nylon 6/10
- Shaft Insert:** 303 stainless steel
- Joystick Housing:** Nylon 6,10
- Centering Plate:** Nylon 6,10
- Detent Balls:** Carbon steel
- Detent Springs:** Music wire
- Dome Contacts:** Stainless steel
- Dome Housings:** Polycarbonate over brass-lead frame
- Dome Retainers:** Nylon 6,0; 30% glass-filled
- Joystick Actuators:** Polyphthalamide; 50% glass filled
- Pushbutton Dome Retainer:** Polycarbonate
- Printed Circuit Board:** NEMA grade FR-4. Glass-cloth epoxy, double clad with copper
- Infrared Emitter:** Gallium arsenide
- Phototransistor:** Planar silicon
- Resistors:** Metal oxide on ceramic substrate
- Solder:** 95.5% SN, 3% AG, 0.5% CU

**OPTIONS**

Contact Grayhill for custom terminations, rotational torque, number of positions, shaft configurations, and resolutions.

# SERIES 60C

## Multi-Function Joystick

### FEATURES

- Three-in-One Joystick, Optical Encoder and Pushbutton
- Compact Packaging
- Choices of Cable Length and Termination
- Customized Solutions Available

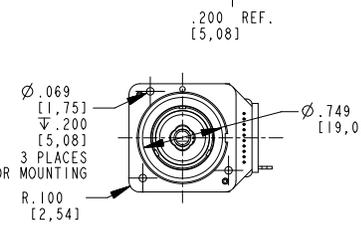
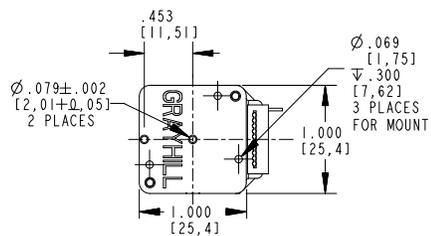
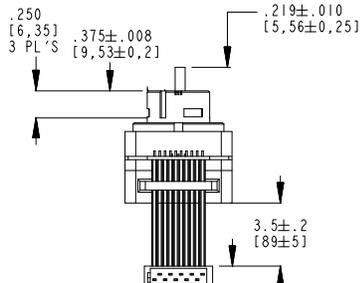
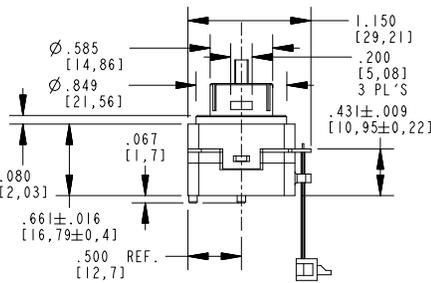
### APPLICATIONS

- Avionics
- Medical Equipment
- Automotive Navigation, Information & Entertainment Equipment

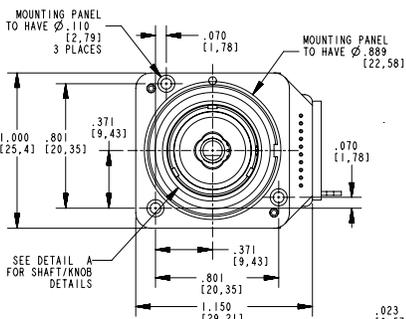


### DIMENSIONS in inches (and millimeters)

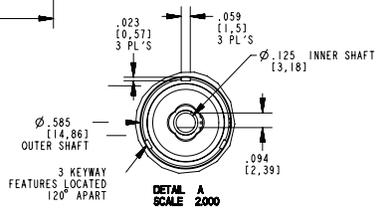
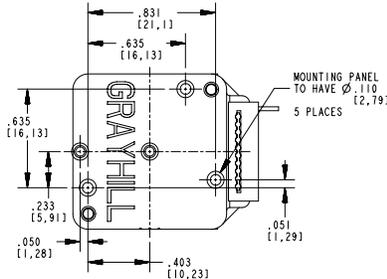
Unless otherwise specified, standard tolerance are:  
 Linear ± .025  
 Diameter ± .010  
 Angle ± 2.0°



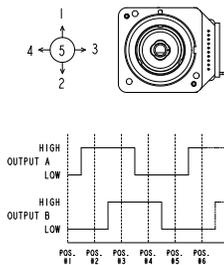
### FRONT MOUNTING



### REAR MOUNTING



### JOYSTICK OPERATION ENCODER WAVEFORM



### TRUTH TABLE Standard Quadrature 2-Bit Code

○ INDICATES LOGIC HIGH  
 ○ INDICATES LOGIC LOW

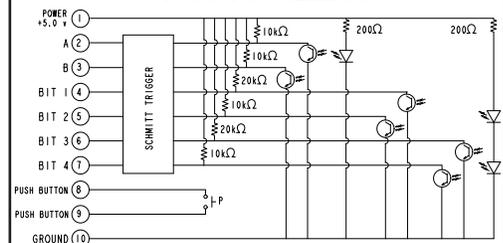
### JOYSTICK

POSITION	BIT 1	BIT 2	BIT 3	BIT 4
1	○	○	○	○
2	○	○	○	○
3	○	○	○	○
4	○	○	○	○
5	○	○	○	○

### ENCODER

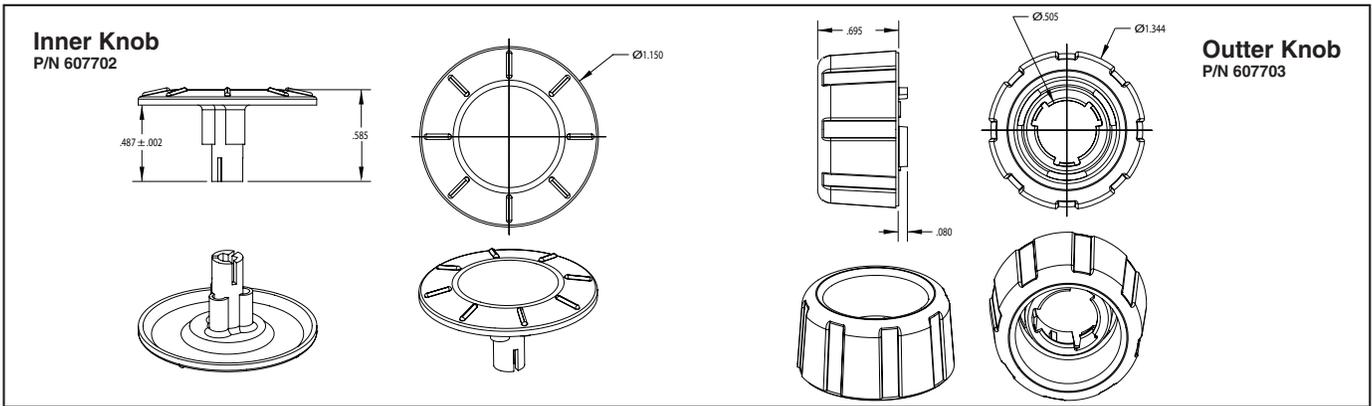
POSITION	OUTPUT A	OUTPUT B
#1	○	○
#2	○	○
#3	○	○
#4	○	○

### SWITCH SCHEMATIC



Optical and Mechanical Encoders

**CONTROL KNOBS**



**SPECIFICATIONS**

**Rotary**

**Electrical and Mechanical Ratings**

**Operating Voltage:** 5.00 ± 0.25 Vdc  
**Supply Current:** 35mA TYP at 5 Vdc  
**Power Consumption:** 175mW TYP at 5Vdc  
**Output:** Direct output from inverting Schmitt trigger  
**Output Code:** 2-Bit quadrature, channel A leads channel B by 90° in cw rotation  
**Logic Output Characteristics:**  
 High: No less than 3.5 Vdc  
 Low: No greater than 1.0 Vdc  
**Mechanical Life:** 500K rotational cycles (through all positions and a full return)  
**Rotational Torque:** medium torque option 3.00±2.00 in-oz, torque shall be within 50% of initial value throughout life  
**Mounting Torque:** 15 in-lbs. maximum  
**Shaft Push/Pull Out Force:** 25 lbs minimum  
**Terminal Strength:** 15 lbs terminal minimum

**Joystick**

**Electrical and Mechanical Ratings**

**Operating Voltage:** 5.00 ± 0.25 Vdc  
**Supply Current:** 35mA at TYP at 5 Vdc  
**Power Consumption:** 175mW TYP at 5Vdc  
**Output:** Direct output from inverting Schmitt trigger  
**Logic Output Characteristics:**  
 High: No less than 3.5 Vdc  
 Low: No greater than 1.0 Vdc  
**Mechanical Life:** 500K cycles (through all positions and a full return)  
**Angle of Throw:** 8° max. in all directions

**Pushbutton**

**Electrical and Mechanical Ratings**

**Rating:** 10 mA at 5 Vdc resistive  
**Contact Resistance:** less than 10 ohms  
**Contact Bounce:** < 4ms make, 10 ms break  
**Mechanical Life:** 500K actuations minimum  
**Actuation Force:** option 7 = 485 ± 115grams  
**Pushbutton Travel:** 0.033 ± 0.015 inches to contact; 0.075 inches maximum

**Environmental Ratings**

**Operating Temperature Range:** -40°C to 85°C  
**Storage Temperature Range:** -55°C to 100°C  
**Relative Humidity:** 96 hours at 90-95% humidity at 40°C  
**Vibration:** Harmonic motion with amplitude of 15g, within a varied 10 to 2000 Hz  
**Mechanical Shock:**  
 Test 1: 100g for 6ms half-sine wave with a velocity change of 12.3 ft/s  
 Test 2: 100g for 6ms sawtooth wave with a velocity change of 9.7 ft/s  
**Thermocycle:** 4 hours cycling between -40°C to 85°C

**Materials and Finishes**

**Bushing:** Thermoplastic  
**Shaft Outer:** Thermoplastic  
**Upper Housing:** Thermoplastic  
**Pushbutton Rocker:** Thermoplastic  
**Pushbutton Actuator:** Thermoplastic  
**Inner Shaft Slide:** Thermoplastic

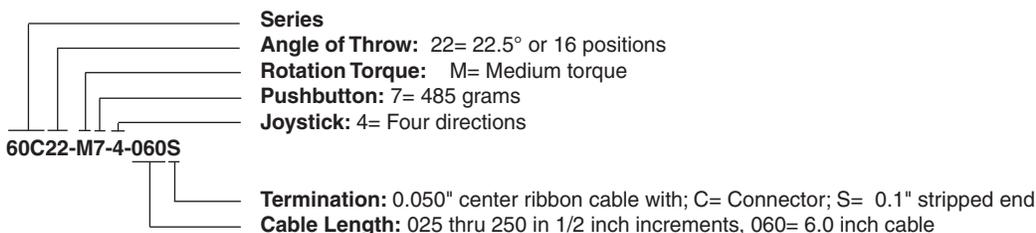
**Slider Plate:** Thermoplastic

**Backplate:** Thermoplastic  
**Lightpipe, Joystick:** Thermoplastic  
**Lightpipe, 16 pos:** Thermoplastic  
**Centering Profile:** Thermoplastic  
**Shaft Inner:** Aluminum  
**Pins:** Stainless steel  
**Barbed Rivet:** Stainless steel  
**Detent Balls:** Carbon steel 100 with nickel finish  
**Centering Balls:** Carbon steel 100 with nickel finish  
**Detent Springs:** Tinned music wire  
**Centering Springs:** Tinned music wire  
**Cable ASM:** .050 round conductor flat cable, PVC coated. Conductors are stranded, top-coated wire  
**Solder:** 95.5% SN, 4% AG, 0.5% CU  
**Dome:** Stainless steel  
**PCB 16 Pos:** NEMA grade FR-4. Plating is gold or palladium over nickel  
**Infrared Emitter:** Gallium aluminum arsenide  
**Phototransistor:** Planar silicon  
**Resistor:** Carbon film  
**Schmitt Trigger:** RoHS Compliant TSSOP, 14 pin  
**Lubricating Grease:** Nyogel 774L  
**Label:** TT406 Thermal transfer cast film

**OPTIONS**

Contact Grayhill for custom terminations, rotational torque, number of positions, shaft configurations, and resolutions. Control knobs are also available.

**ORDERING INFORMATION**



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