SERIES 60A
Joystick

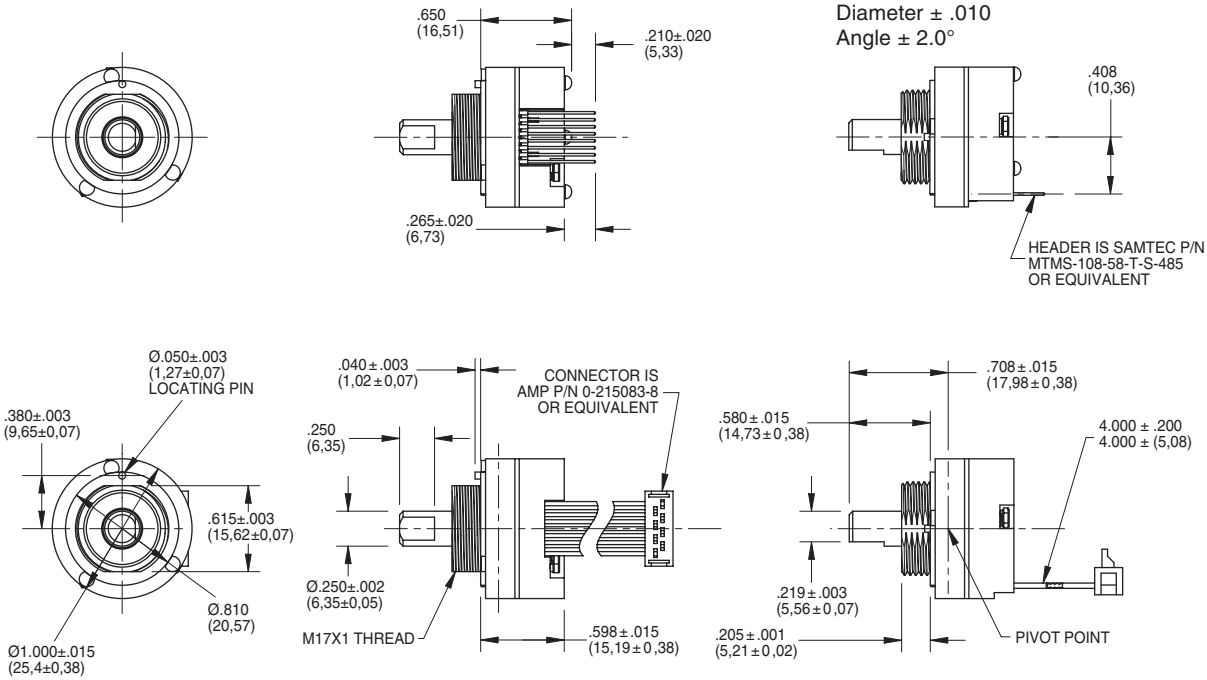
FEATURES
- Optical Encoder, Pushbutton, and Joystick in One Shaft
- Long Life, High Reliability
- Compatible with CMOS, HCMOS, and TTL Logic
- Choices of Cable Length and Termination
- Customized Solutions Available

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

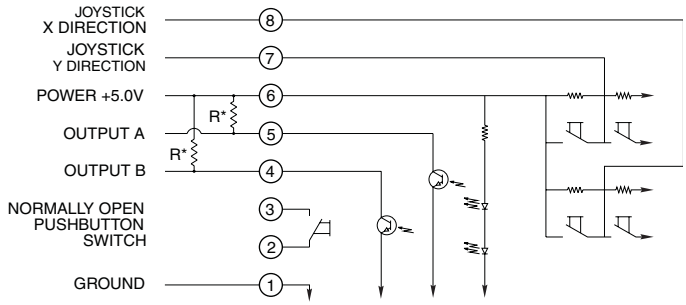
DIMENSIONS In inches (and millimeters)

Pin Version

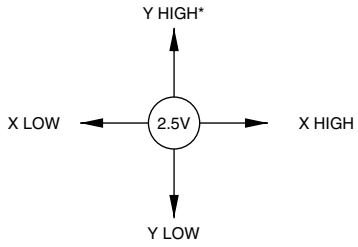
Unless otherwise specified, standard tolerance are:
Linear ± .025
Diameter ± .010
Angle ± 2.0°



CIRCUITRY AND JOYSTICK OPERATION Standard Quadrature 2-Bit Code

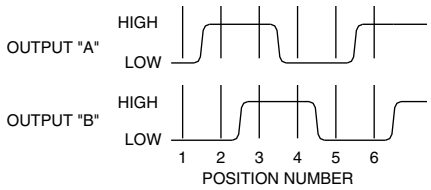


*EXTERNAL PULL-UP RESISTORS REQUIRED FOR OPERATION (2.2kΩ).



* DEFINED BY LOCATING PIN ON TOP OF HOUSING

WAVEFORM AND TRUTH TABLE Standard Quadrature 2-Bit Code



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

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

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

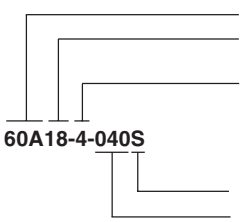
Materials and Finishes

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.

SERIES 60AD

Optical Encoder with integrated Joystick and Pushbutton

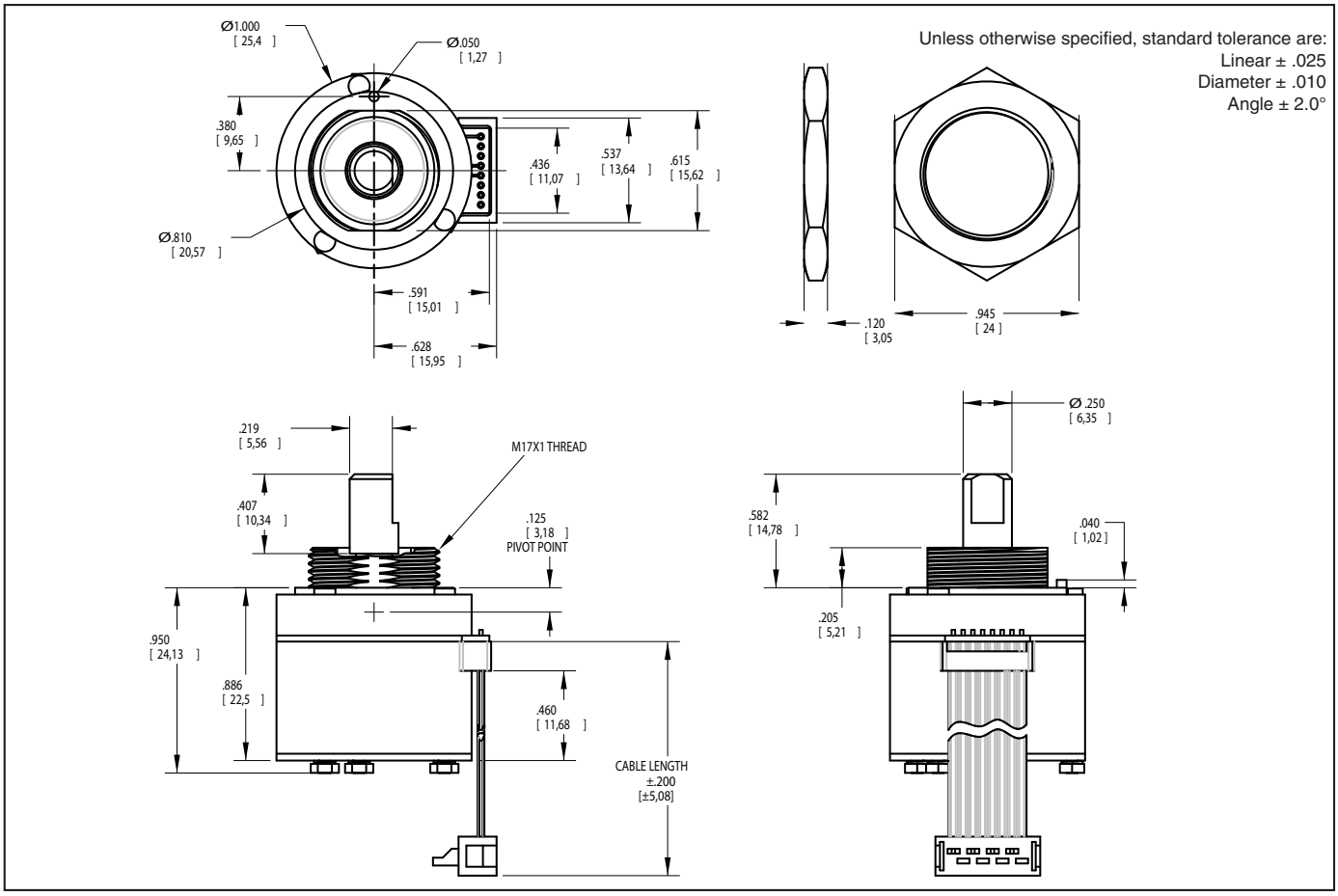
FEATURES

- 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)



ORDERING INFORMATION

		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

60AD18-4-M-060S

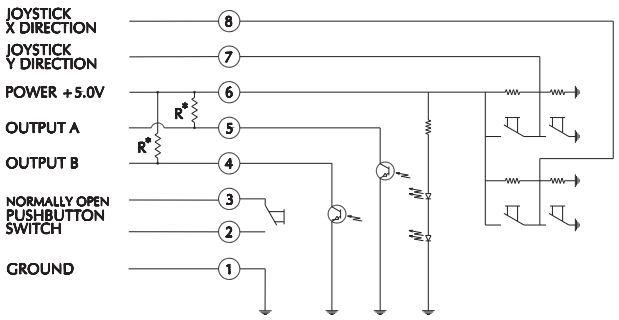
Angle of Throw: 18= 18° or 20 positions
Joystick: 4= Four contacts & directions;
8= Four contacts & eight directions

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

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

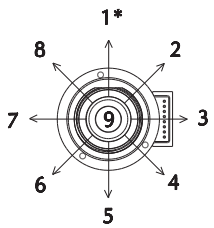
SWITCH SCHEMATIC



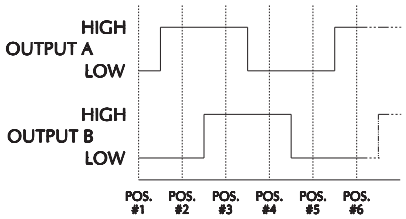
*EXTERNAL PULL-UP RESISTORS REQUIRED FOR OPERATION (2.2kΩ).

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 ± 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 Ω 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 ± .010 in.

Joystick Specifications

Supply Current: 5mA max
Output Code: 2-Bit
Logic Output Characteristics:
Neutral Position: 2.5 ± 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

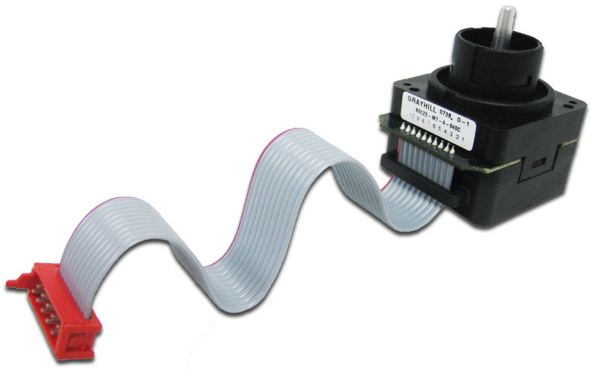
Materials and Finishes

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

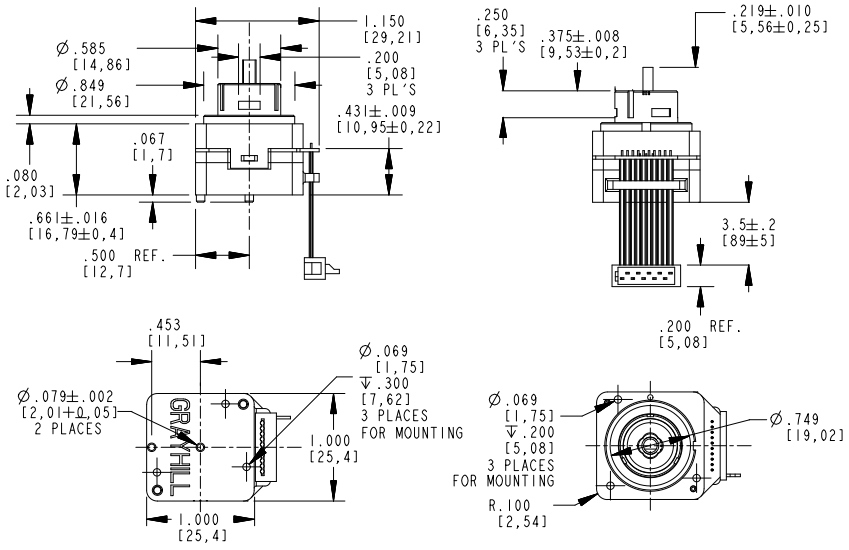


FEATURES
- Three-in-One Joystick, Optical Encoder and Pushbutton
- Compact Packaging
- Choices of Cable Length and Termination
- Customized Solutions Available

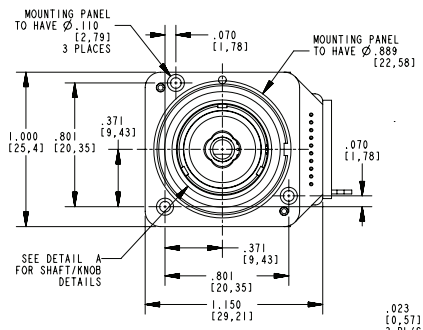
APPLICATIONS
- Avionics
- Medical Equipment
- Automotive Navigation, Information & Entertainment Equipment

DIMENSIONS in inches (and millimeters)

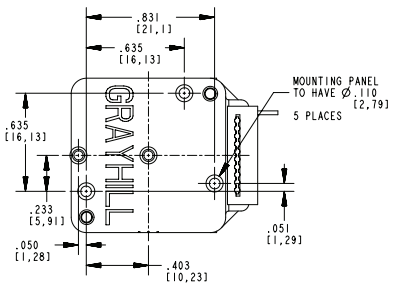
Unless otherwise specified, standard tolerance are:
Linear ± .025
Diameter ± .010
Angle ± 2.0°

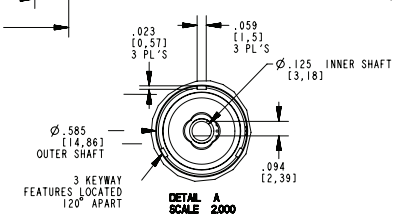


FRONT MOUNTING

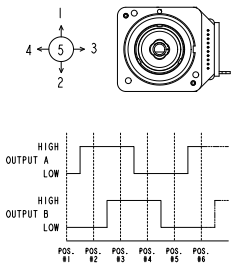


REAR MOUNTING





JOYSTICK OPERATION ENCODER WAVEFORM



TRUTH TABLE Standard Quadrature 2-Bit Code

○ INDICATES LOGIC HIGH
○ INDICATES LOGIC LOW

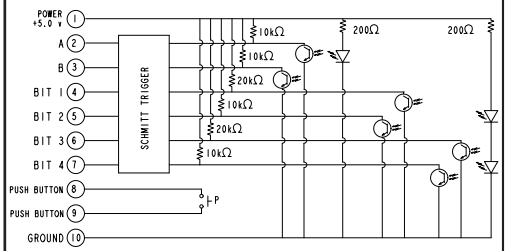
JOYSTICK

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

ENCODER

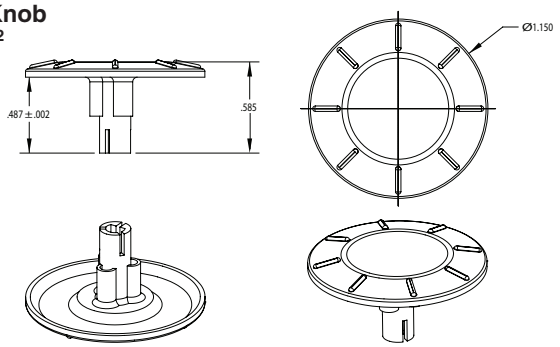
POSITION	OUTPUT A	OUTPUT B
#1	○	○
#2	◯	○
#3	◯	◯
#4	○	◯

SWITCH SCHEMATIC

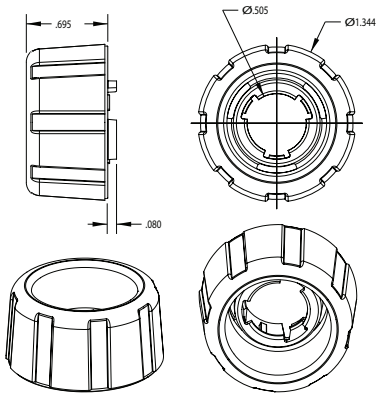


CONTROL KNOBS

Inner Knob
P/N 607702



Outter Knob
P/N 607703



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: Thermplastic
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

60C22-M7-4-060S

Series
Angle of Throw: 22= 22.5° or 16 positions
Rotation Torque: M= Medium torque
Pushbutton: 7= 485 grams
Joystick: 4= Four directions

Termination: 0.050" center ribbon cable with; C= Connector; S= 0.1" stripped end
Cable Length: 025 thru 250 in 1/2 inch increments, 060= 6.0 inch cable

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