# HF series

Proportional multi-axis fingertip controllers • non-contacting Hall effect technology

## DISTINCTIVE FEATURES

**One, two or three axis**
**Analog outputs**
**CAN bus J1939 and CANopen options**
**USB 2.0 HID interface options**
**Connectorized housing**

## ENVIRONMENTAL SPECIFICATIONS

- Operating Temperature: -40 °C to +85 °C (-40 °F to +185 °F)
- Storage Temperature: -40 °C to +85 °C (-40 °F to +185 °F)
- Above Panel Sealing: Up to IP67 (subject to final specifications)
- EMC Immunity Level (V/M): EN61000-4-3
- EMC Emissions Level: EN61000-6-3:2001
- ESD: EN61000-4-2
- Output linearity:  ±200 mV
- Dual output interlinearity (X/Y):  ±400 mV
- Dual output interlinearity (Z):  ±600 mV

## SENSOR SPECIFICATIONS

- Sensor: Hall effect, single or dual
- Supply Voltage Range: 5 VDC ±0.01 VDC
- Supply Current: 40 mA typical / 50 mA max (3 axis)
- Reverse Polarity Max: -10 VDC
- Transient Overvoltage Max: 16 VDC
- Ratiometric Output Voltage: see output options
- Output Current: 8 mA
- Output Load: 1 K ohm min
- Output Impedance: 2 Ω

## MATERIALS

- Shaft:  Stainless Steel
- Boot:   Silicone
- Handles:  Glass filled nylon*
- Body: Glass filled nylon

The company reserves the right to change specifications without notice.

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## MECHANICAL SPECIFICATIONS (X/Y AXIS)

- Break Out Force: 1.3N (0.3lbf)
- Operating Force: 2.8N (0.63lbf)
- Maximum Applied Force: 350N (78.00lbf)
- Deflection Angle: 36° (±18° from center)
- Expected Mechanical Life: 5 million lifecycles
- Lever Action:  Single spring, omnidirectional
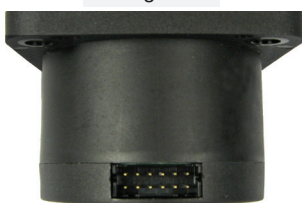
## MECHANICAL SPECIFICATIONS (Z AXIS)

- Break Out Torque: 0.09Nm (0.80lbf in)
- Operating Torque: 0.121Nm (1.07lbf in)
- Maximum Allowable Torque: 9.0Nm (80lbf in)
- Degrees of rotation: 60° (30° from center)
- Expected Mechanical Life: 5 million lifecycles
- Handle Action:  Spring centering
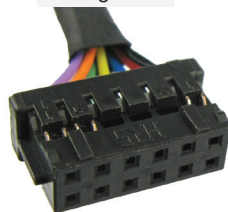
## TERMINATION (ANALOG OUTPUTS ONLY)

- The HF series (Output options AA-HH **only**) features a **Hirose DF11-12DP-2DS9 (24)** header (male receptacle) (Fig 1)
- The mating wire harness is not included but may be selected from the BUILD YOUR PART NUMBER option selection guide.  This optional harness features a **Hirose DF11-12DS-2C** connector (female socket) (Fig 2) to individual stripped and tinned wire leads
- Header specifications:  12 position, 2mm pitch dual row (2x6) pin header
- Wire harness specifications:  22AWG Teflon, 25cm multi-conductor with heat shrink.  Hirose **DF11-12DS-2C** to stripped and tinned wire leads

**JOYSTICK HEADER - HIROSE DF11-12DP-2DS9 (24) PINOUT (Fig 1)**

| PIN 2 | PIN 4 | PIN 6 | PIN 8 | PIN 10 | PIN 12 |
|-------|-------|--------|--------|--------|--------|
| RED | BLUE | YELLOW | GREEN | WHITE | -- |
| BLACK | BLU/WHT | YEL/BLK | GRN/BLK | ORANGE | VIOLET |
| PIN 1 | PIN 3 | PIN 5 | PIN 7 | PIN 9 | PIN 11 |

**MATING WIRE HARNESS COLOR DEFINITION (Fig 2)**

| HIROSE DF11-12DS-2C CONNECTOR PIN # | WIRE COLOR | JOYSTICK FUNCTION |
|:-:|:-:|:-:|
| 1 | Black | Ground |
| 2 | Red | Supply power |
| 3 | Blue / white | X axis (dual output) |
| 4 | Blue | X axis |
| 5 | Yellow / black | Y axis (dual output) |
| 6 | Yellow | Y axis |
| 7 | Green / black | Z axis (dual output) |
| 8 | Green | Z axis |
| 9 | Orange | Button one |
| 10 | White | Button common |
| 11 | Violet | Button two |
| 12 | -- | -- |

Fig. 1

Fig. 2

Hirose DF11-12DP-2DS9(24) header

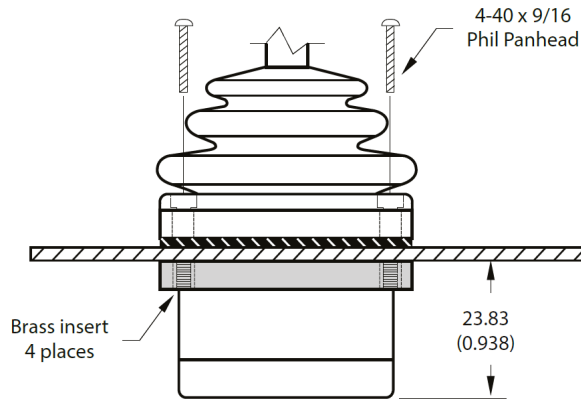Mating wire harness fitted with Hirose DF11-12DS-2C connector

* Most handles, dependent upon configurations

# HF series

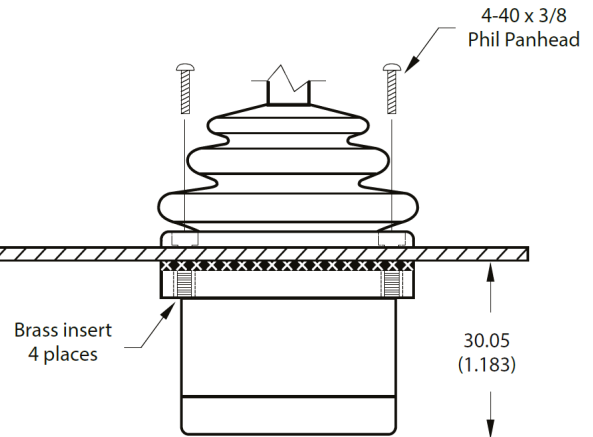## Proportional multi-axis fingertip controllers • non-contacting Hall effect technology
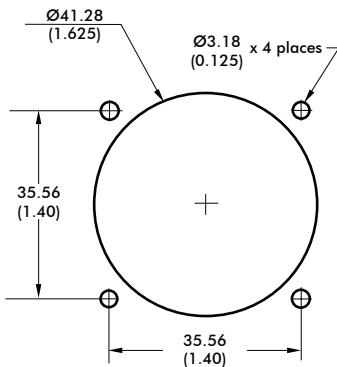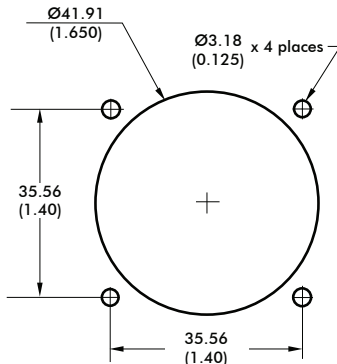
## GENERAL MOUNTING OPTIONS

### DROP-IN MOUNT

4-40 x 9/16
Phil Panhead

Brass insert
4 places

23.83
(0.938)

### REAR MOUNT

4-40 x 3/8
Phil Panhead

Brass insert
4 places

30.05
(1.183)

## PANEL CUT-OUT

### DROP-IN MOUNT

Ø41.28
(1.625)

Ø3.18
(0.125) x 4 places

35.56
(1.40)

35.56
(1.40)

### REAR MOUNT

Ø41.91
(1.650)

Ø3.18
(0.125) x 4 places

35.56
(1.40)

35.56
(1.40)

Not available for option 55 handles

### CLAMPING RING

35.56
(1.40)

7.10
(0.28)

48.26
(1.90)

35.56
(1.40)

48.26
(1.90)

### AXIS ORIENTATION

Z
+ -
Y+
X-        X+
Y-
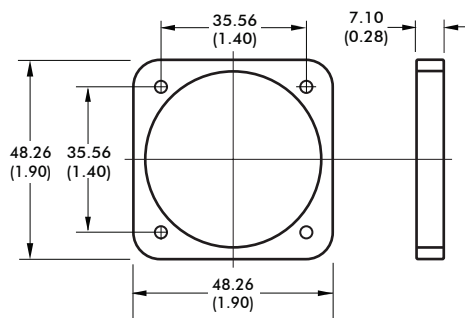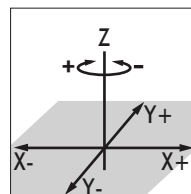
NOTES:

- For DROP-IN mounting, panel thickness can be 1.17 mm to 3.17 mm (0.046 in to 0.125 in).
- For REAR MOUNT, the maximum panel thickness is 1.6 mm (0.063 in).
- A panel thickness of 1/16» (1.6 mm/0.063 in) was considered for all below panel depth values.
- The below panel depth is extended by 7.11 mm (0.28 in) with the USB, Cursor Emulation, Voltage Regulator options.

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## CAN J1939 INTERFACE SPECIFICATION

The HF Series joystick can be configured with a maximum of three axis and two buttons. All axis and button data are delivered on a CAN 2.0B compliant physical interface. Two additional signals allow configuration of the controller Source Address. Controller messages are delivered per the SAE J1939-71 message protocol.

### CAN 2.0B INTERFACE PARAMETERS

- Baud rate: 250 Kbps
- Transmission repetition rate: 50ms
- BJMI/EJMl interval time: 20ms
- Terminating resistor: No
  (available by special request to factory)

### CAN MESSAGE PROTOCOL

- Primary Axis and button data on Basic Joystick Message 1 (BJM1):
  - Priority: 3
  - Base PGN: 0xFDD6
  - Source address: 0x13
  - Data field: 8 bytes
- Redundant Axis data on Extended Joystick Message 1 ( EJMl):
  - Priority: 3
  - Base PGN: 0xFDD7
  - Source address: 0x13
  - Data field: 8 bytes

### CAN SOURCE ADDRESSES

Alternate source addresses may be selected by gounding combinations of the blue and/or orange wires. For further information, please see TERMINATION on page 6.

| CAN SOURCE ADDRESS | ORANGE WIRE | BLUE WIRE |
|---|---|---|
| 0x13 (default) | OPEN | OPEN |
| 0x23 | OPEN | Grounded |
| 0x33 | Grounded | OPEN |
| 0x43 | Grounded | Grounded |

### BJM1 DATA FIELD STRUCTURE:

| START POSITION (BYTE/BIT) | LENGTH (BITS) | FUNCTION |
|---|---|---|
| 1/1 | 2 | Primary X-axis neutral position status |
| 1/3 | 2 | Primary X-axis left position status |
| 1/5 | 2 | Primary X-axis right position status |
| 1/7 to 2/8 | 10 | Primary X-axis position data |
| 3/1 | 2 | Primary Y-axis neutral position status |
| 3/3 | 2 | Primary Y-axis down position status |
| 3/5 | 2 | Primary Y-axis up position status |
| 3/7 to 4/8 | 10 | Primary Y-axis position data |
| 6/5 | 2 | Button 2 status |
| 6/7 | 2 | Button 1 status |

### EJM1 DATA FIELD STRUCTURE:

| START POSITION (BYTE/BIT) | LENGTH (BITS) | FUNCTION |
|---|---|---|
| 1/1 | 2 | Redundant X-axis neutral position status |
| 1/3 | 2 | Redundant X-axis left position status |
| 1/5 | 2 | Redundant X-axis right position status |
| 1/7 to 2/8 | 10 | Redundant X-axis position data |
| 3/1 | 2 | Redundant Y-axis neutral position status |
| 3/3 | 2 | Redundant Y-axis down position status |
| 3/5 | 2 | Redundant Y-axis up position status |
| 3/7 to 4/8 | 10 | Redundant Y-axis position data |
| 5/1 | 2 | Primary Z-axis neutral position status |
| 5/3 | 2 | Primary Z-axis counter-clockwise position status |
| 5/5 | 2 | Primary Z-axis clockwise position status |
| 5/7 TO 4/8 | 10 | Primary Z-axis position data |

### CUSTOM CAN BUS J1939 FIRMWARE*

- Baud rate: 125 Kbps, 500Kbps, 1Mbps
  (250 Kbps default)
- Custom CAN addresses
- Custom CAN bus output

* Custom CAN bus firmware available upon request.

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## CANOPEN INTERFACE SPECIFICATION

CANOPEN INTERFACE PARAMETERS*

- Baud rate: 250 Kbps
- Node ID:  20h
- Buttons: 1A0H (180H + NODE ID)
- Analog (axis) outputs:  2A0h (280h + Node ID)
- Heartbeat (500ms):  720h (700h + Node ID)
- Axis resolution:  8 bit
- Network Management:  Auto start enabled

### CANOPEN NODE ID SELECTION
Alternate NODE IDs may be selected by gounding the blue and/or orange wires.  For further information, please see TERMINATION on page 6.

| NODE ID SELECT | ORANGE WIRE | BLUE WIRE |
|---|---|---|
| 20H (default) | OPEN | OPEN |
| 21H | OPEN | Grounded |
| 22H | Grounded | OPEN |
| 23H | Grounded | Grounded |

### CANOPEN BUTTON OUTPUT CONFIGURATION

| Button status is transmitted in the one byte data field of frames with an identifier of 1A0 (default) ||
|---|---|
| Identifier | Byte 0 |
| 1A0 | Buttons (2:0) |

### CANOPEN ANALOG OUTPUT CONFIGURATION

| Eight bit analog data is transmitted in the three byte data field of frames with an identifier of 2A0 (default) ||||
|---|---|---|---|
| Identifier | Byte 0 | Byte 1 | Byte 2 |
| 2A0 | A_IN0 (7:0) | A_IN1 (7:0) | A_IN2 (7:0) |

CUSTOM CANOPEN FIRMWARE*

- Baud rate: 125 Kbps, 500Kbps, 1Mbps (250 Kbps default)
- Custom Node IDs (default 20 hexadecimal)
- 10-bit axis resolution
- 12-bit axis resolution
- Signed resolution
- Custom CANopen output

## CANOPEN LSS INTERFACE SPECIFICATION

The CANopen LSS interface option follows the CiA305 and CiA401 standards for CAN in automation.  The node ID, baud rate and additional configurations can be set and stored in the EEPROM by Service Data Object. The default settings are as follows:

## CANOPEN LSS INTERFACE SPECIFICATION

CANOPEN INTERFACE PARAMETERS*

- Baud rate: 250 Kbps
- Node ID:  20h (default)
- Buttons: 1A0H (180H + NODE ID)
- Analog (axis) outputs:  2A0h (280h + Node ID)
- Heartbeat (500ms):  720h (700h + Node ID)
- Axis resolution:  10-bit
- Network Management:  Auto start enabled

### CANOPEN LSS BUTTON OUTPUT CONFIGURATION

| Button status is transmitted in the one byte data field of frames with an identifier of 1A0 (default) ||
|---|---|
| Identifier | Byte 0 |
| 1A0 | Buttons (2:0) |

### CANOPEN LSS ANALOG OUTPUT CONFIGURATION

| Ten bit analog data is transmitted in the six byte data field of frames with an identifier of 2A0 (default) ||||
|---|---|---|---|
| Identifier | Byte 0 | Byte 1 | Byte 2 |
| 2A0 | A_IN0 (7:0) | A_IN0 (9:8) | A_IN1 (7:0) |
| Identifier | Byte 3 | Byte 4 | Byte 5 |
| 2A0 | A_IN1 (9:8) | A_IN2 (7:0) | A_IN2 (9:8) |

* Custom CAN bus firmware available upon request.

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## TERMINATION (CAN OUTPUTS ONLY)

• HF series joysticks configured with CAN outputs (Output options NN-QQ **only**) feature a
**JST B6B-PH-S(LF)(SN)** header (male receptacle) (Fig 1) and are supplied with a mating wire harness (Fig 2)

• Header specifications:  JST B6B-PH-S(LF)(SN) - 6 position, 2mm pitch, single row header (Fig 1)

• Mating wire harness specifications:  Six conductor, 22AWG, 56cm PTFE, JST PHR-6 to stripped and tinned wire leads (Fig 2)

Fig. 1

Fig. 2

+ X

- Y

+ Y

- X

JST B6B-PH-S(LF)(SN) header

Mating wire harness fitted with JST PHR-6 connector

**HEADER PINOUT AND MATING WIRE HARNESS COLOR DEFINITION**

| HEADER PINOUT | | | MATING WIRE HARNESS |
|---|---|---|---|
| JST B6B-PH-S(LF)(SN) HEADER PIN # | CAN bus FUNCTION | CANopen FUNCTION | WIRE COLOR |
| 1 | Supply power | Supply power | Red |
| 2 | Ground | Ground | Black |
| 3 | ID select MSB | Node ID select MSB | Orange |
| 4 | ID select LSB | Node ID select LSB | Blue |
| 5 | CAN Hi | CAN Hi | Green |
| 6 | CAN Lo | CAN Lo | White |

* Custom CAN bus firmware available upon request.

# HF series

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### CANOPEN LSS INTERFACE SPECIFICATIONS

The CANopen LSS interface option follows the CiA305 and CiA401 standards for CAN in automation.  The node ID, baud rate and additional configurations can be set and stored in the EEPROM by Service Data Object.  The default settings are as follows:

| SETTINGS | DEFAULT CONFIGURATION |
| --- | --- |
| Baud rate | 250 kbits/s |
| Node ID | 20h |
| Analog (axis) outputs | 2A0h (280h + Node ID) |
| Buttons | 1A0h (180h + Node ID) |
| Heartbeat (500ms) | 720h (700h + Node ID) |
| Axis Resolution | Unsigned 10-bit |

### CAN BUS SPECIFICATIONS

DIMENSIONS
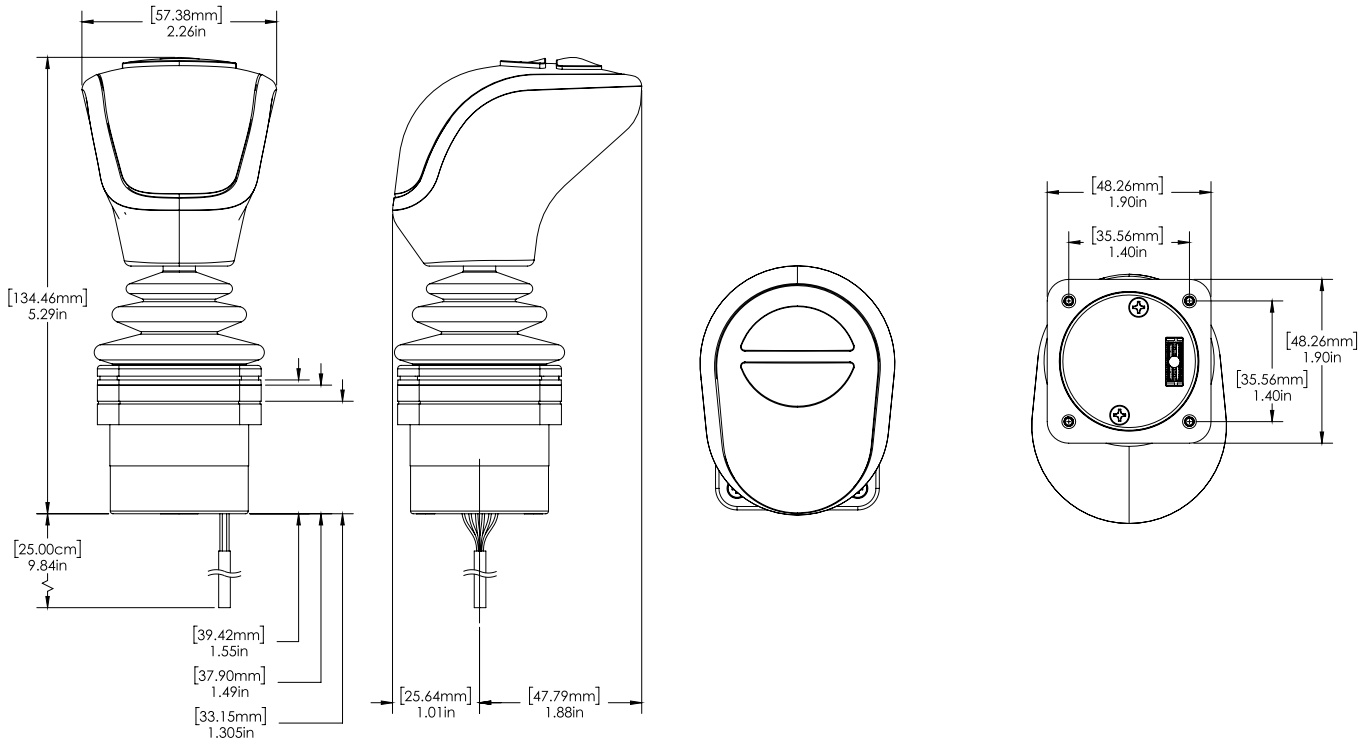
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## ⤫ USB SPECIFICATIONS

- Supply Voltage Range:  5.00VDC
- Maximum current:  70mA
- USB version:  2.0

### USB GAME CONTROLLER
Featuring USB 2.0 HID compliant interface, APEM's USB joysticks
are recognized as standard HID "game controller" devices.  Ad-
hering to the HID specification, APEM's USB joysticks are plug-
and-play with most versions of Windows.  Joystick button and axis
assignments are dependent upon the controlled application.

**Features**

- USB 2.0 HID compliant "game controller" device
- Easy to install and operate
- Functions determined by controlled application
- 12-bit (0 to 4095) axis resolution

**Termination (supplied cable)**

- USB Male Type A Connector (198 cm)

### USB CURSOR EMULATION
The Cursor Emulation option converts multi-axis joystick output
into a mouse or cursor control device.  The Cursor Emulation op-
tion is ideal for vehicle applications subjected to dirt and high vi-
bration which makes operating a traditional cursor control device
difficult.  Cursor simulation is only compatible with Window OS.

**Features**

- HID compliant "mouse" device

**Button Function**

- B1:  Left Mouse Click
- B2:  Right Mouse Click

**Termination (supplied cable)**

- USB Male Type A Connector (198 cm)

**SUPPORTED OPERATING SYSTEMS**:  USB
GAME CONTROLLER AND CURSOR EMULA-
TION

**Windows Operating System**

- Windows 7
- Windows 8.1
- Windows 10

**Linux Operating System**
APEM's USB joysticks are compatible with Linux,
although system compatibility is not guaran-
teed.  The user is responsible for verifying spe-
cific Linux OS compatibility.

**Custom Firmware**
Custom configurations and firmware is avail-
ableupon request.  Available options include:

- 8-bit axis resolution
- 10-bit axis resolution
- Signed bit axis resolution
- Custom USB product name

## ⤫ VOLTAGE REGULATOR SPECIFICATIONS

The Voltage Regulator allows APEM's Hall effect joysticks to ope-
rate with a range of supply voltages..

**Voltage Regulator - Unipolar**

- Supply Voltage Range:  8-35VDC
- Output Voltage Range:  see output options
- Maximum Current: 90mA

**Voltage Regulator - Bipolar**

- Supply Voltage Range:  11-35VDC
- Output Voltage Range:  ±10VDC
- Maximum Current: 90mA

**Termination (supplied cable)**

- 28 AWG 16.5cm ±1.25cm PTFE

APEM

# HF series

## Proportional multi-axis fingertip controllers • non-contacting Hall effect technology

## BUILD YOUR PART NUMBER

**SERIES**

| HF |
|---|

**HANDLE**

| 10 | Ball tip (2 axis) |
|---|---|
| 11 | Tapered (2 axis) |
| 22 | **1** Pushbutton (2 axis) |
| 27 | 1 Pushbutton (2 axis), IP67 sealed |
| 33 | 3 Axis |
| 44 | 1 Pushbutton (3 axis) |
| 45 | 2 Pushbuttons (3 axis) |
| 46 | Low profile (3 axis) |
| 50 | 3 Axis, IP67 Sealed |
| 51 | 3 Axis, 1 Pushbutton, IP67 sealed |
| 52 | 3 Axis, 2 Pushbuttons, IP67 sealed |
| 55 | 3 Axis, 2 Pushbuttons, IP67 sealed |

**LIMITER PLATE**

| S | Square | □ |
|---|---|---|
| R | Round | ○ |
| X | Slotted | ▬ |
| Y | Slotted | ▌ |
| P | Plus | ✚ |
| C | Cross | ✖ |
| W | Guided Feel Square | |
| Z | Guided Feel Round | |

**MOUNTING**

| 1 | Drop-in |
|---|---|
| 4 | Rear Mount * |

\* Rear mount not available with handle 55

**OUTPUT OPTIONS[1]**

| 0 | 0V-5V |
|---|---|
| 1 | 0.5V-4.5V |
| 2 | 0.25V-4.75V |
| 3 | 1V-4V |
| 4 | 0V to 5V - Sensor 1<br>0V to 5V - Sensor 2 |
| 5 | 0.5V to 4.5V - Sensor 1<br>0.5V to 4.5V - Sensor 2 |
| 6 | 0.25V to 4.75V - Sensor 1<br>0.25V to 4.75V - Sensor 2 |
| 7 | 1V to 5V - Sensor 1<br>1V to 5V - Sensor 2 |
| 8 | 0V to 5V - Sensor 1<br>5V to 0V - Sensor 2 |
| 9 | 0.5V to 4.5V - Sensor 1<br>4.5V to 0.5V - Sensor 2 |
| 10 | 0.25V to 4.75V - Sensor 1<br>4.75V to 0.25V - Sensor 2 |
| 11 | 1V to 4V - Sensor 1<br>4V to 1V - Sensor 2 |
| 0U | USB-Horizontal, mini B termination[2] |
| 2U | USB-Vertical cable exit[3] |
| 1J | Cursor Emulation |
| 0V | **0V TO 5V** (Voltage Regulator)* |
| BV | **±10V** (Voltage Regulator)** |
| 2C | **CAN** bus J1939 |
| 3C | **CAN**open |

1  Output voltage is ratiometric to supple voltage
2  Cable length is 6' from side of joystick to USB connector
3  Cable length is 7' from side of joystick to USB connector

\*  Requires operating voltage 6V ≥ 35V
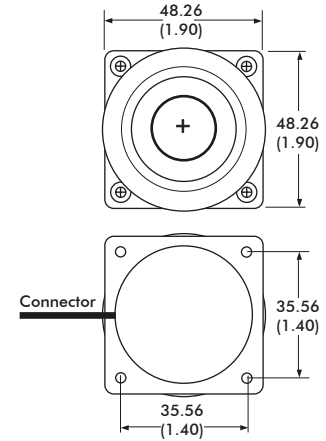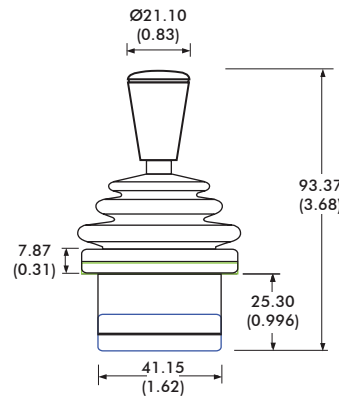\*\* Requires operating voltage 11V ≥ 35V

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Proportional multi-axis fingertip controllers •
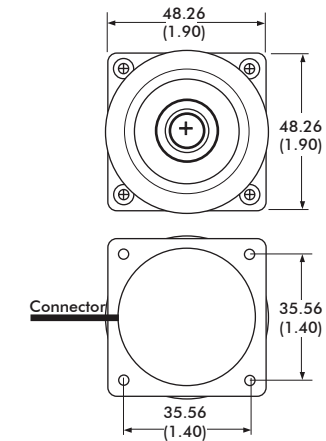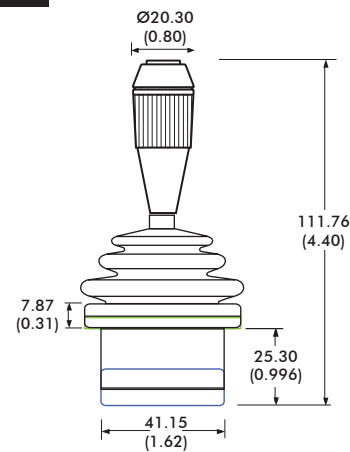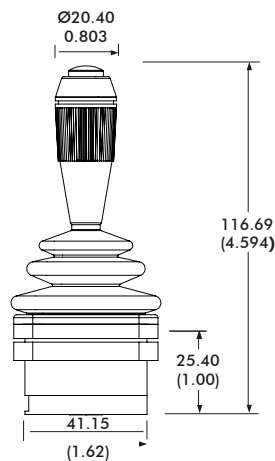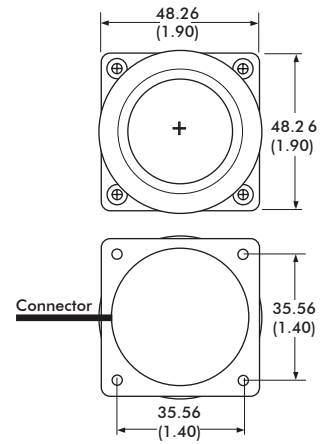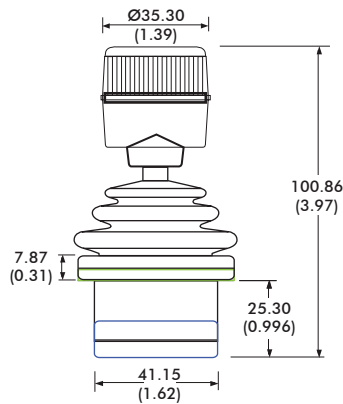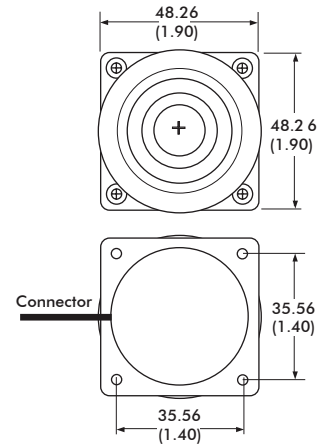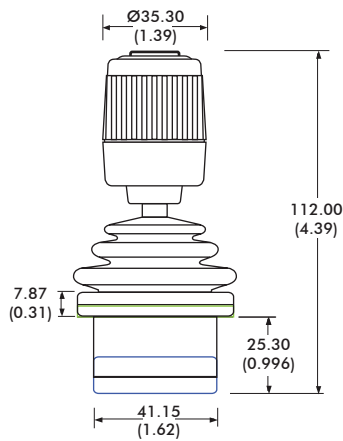non-contacting Hall effect technology

## HANDLE 10



Ø31.80
(1.25)

90.58
(3.57)

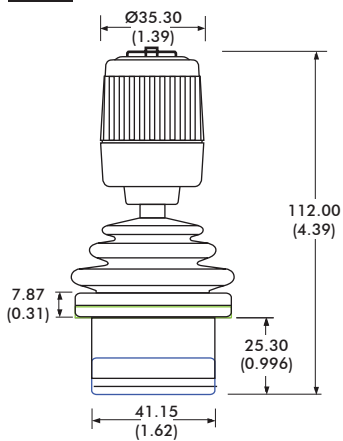7.87
(0.31)

25.30
(0.996)

41.15
(1.62)

48.26
(1.90)

48.2 6
(1.90)

Connector

35.56
(1.40)

35.56
(1.40)

## HANDLE 11



Ø21.10
(0.83)

93.37
(3.68)

7.87
(0.31)

25.30
(0.996)

41.15
(1.62)

48.26
(1.90)

48.26
(1.90)

Connector

35.56
(1.40)

35.56
(1.40)

## HANDLE 22



Ø20.30
(0.80)

111.76
(4.40)

7.87
(0.31)

25.30
(0.996)

41.15
(1.62)

48.26
(1.90)

48.26
(1.90)

Connector

35.56
(1.40)

35.56
(1.40)

## HANDLE 27



Ø20.40
0.803

116.69
(4.594)

25.40
(1.00)

41.15
(1.62)

48.26
(1.90)

48.26
(1.90)

Connector

35.56
(1.40)

35.56
(1.40)

# HF series

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## HANDLE 33



Ø35.30
(1.39)

100.86
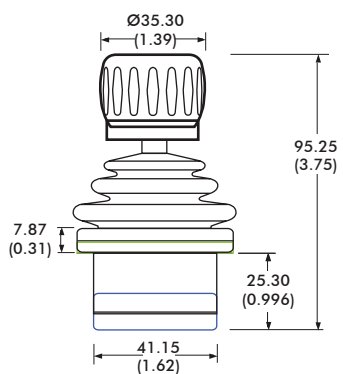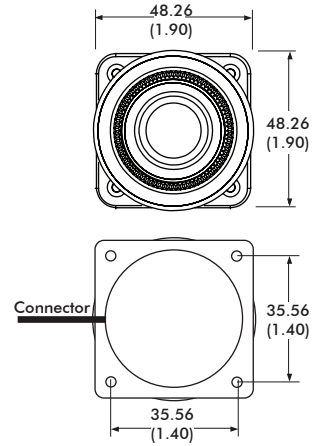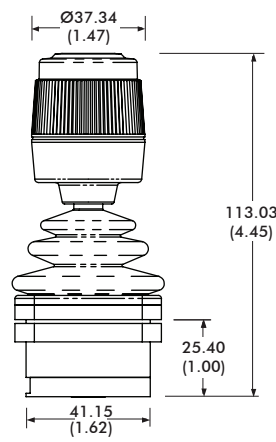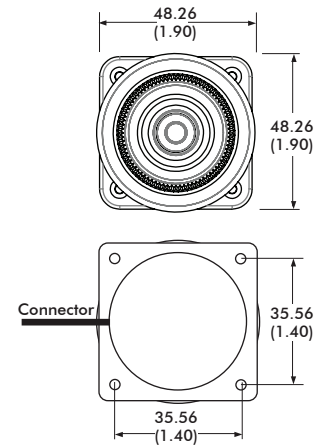(3.97)

7.87
(0.31)

25.30
(0.996)

41.15
(1.62)

48.26
(1.90)

48.2 6
(1.90)

Connector

35.56
(1.40)

35.56
(1.40)

## HANDLE 44



Ø35.30
(1.39)

112.00
(4.39)

7.87
(0.31)

25.30
(0.996)

41.15
(1.62)

48.26
(1.90)

48.2 6
(1.90)

Connector

35.56
(1.40)

35.56
(1.40)

## HANDLE 45



Ø35.30
(1.39)

112.00
(4.39)

7.87
(0.31)

25.30
(0.996)

41.15
(1.62)

48.26
(1.90)

48.2 6
(1.90)

Connector

35.56
(1.40)

35.56
(1.40)

## HANDLE 46



Ø35.30
(1.39)

95.25
(3.75)

7.87
(0.31)

25.30
(0.996)

41.15
(1.62)

48.26
(1.90)
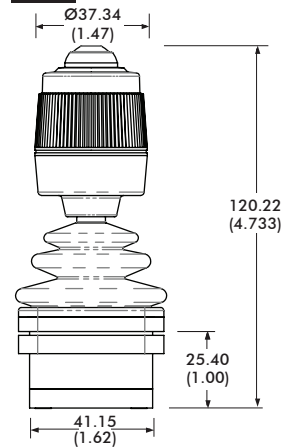
48.2 6
(1.90)

Connector

35.56
(1.40)

35.56
(1.40)

# HF series

Proportional multi-axis fingertip controllers •
non-contacting Hall effect technology

## HANDLE 50



Ø37.34
(1.47)

113.03
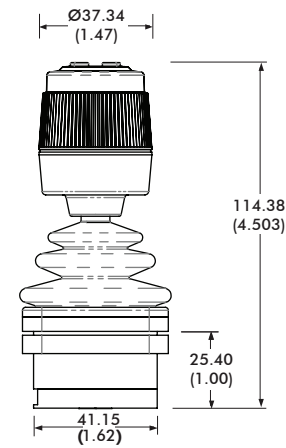(4.45)
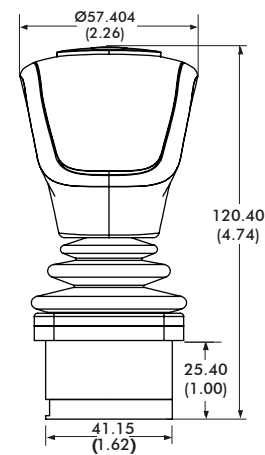
25.40
(1.00)

41.15
(1.62)

48.26
(1.90)

48.26
(1.90)

Connector

35.56
(1.40)

35.56
(1.40)

## HANDLE 51



Ø37.34
(1.47)

120.22
(4.733)

25.40
(1.00)

41.15
(1.62)

48.26
(1.90)

48.26
(1.90)

Connector

35.56
(1.40)

35.56
(1.40)

## HANDLE 52



Ø37.34
(1.47)

114.38
(4.503)

25.40
(1.00)

41.15
(1.62)

48.26
(1.90)

48.26
(1.90)

Connector

35.56
(1.40)

35.56
(1.40)

## HANDLE 55



Ø57.404
(2.26)

120.40
(4.74)

25.40
(1.00)

41.15
(1.62)

25.65
(1.01)

47.75
(1.88)

48.26
(1.90)
35.56
(1.40)

35.56
(1.40)

48.26
(1.90)

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