

## HEDC-55xx/HEDC-56xx

Two or Three Channel Quick Assembly Encoders  
With Connector Latch



## Data Sheet



### Description

The HEDC-5xxx-xxx, while similar to the industry standard HEDS-5xxx kit encoder, provides a connector latch on the cover housing to improve connector retention. This device is built upon the HP/Agilent/Avago HEDS-9000 series encoder module, and provides the same performance, low cost, high reliability, high resolution, and ease of assembly customers have come to expect.

Each encoder contains a lensed LED source, an integrated circuit with detectors and output circuitry. A codewheel (disk) which rotates between the emitter and detector IC generates two square waves in quadrature. Three channel units include an index pulse (high state) of 90°e, which is generated once for each full rotation.

HEDC-5xxx-xxx provides resolutions from 50 to 1024 CPR, and accommodating shaft diameters from 2 mm to 8 mm.

This kit encoder may be quickly and easily mounted to a motor. The electrical interface is through five (single ended) or ten (differential versions) 0.025 inch square pins on 0.100 centers. Interface cable assemblies to meet customer requirements are available also.

The differential (line driver) version offers enhanced performance when the encoder is used in noisy environments, or when it is required to drive long cables. It uses an industry standard RS422 compatible line driver IC, AEIC 7272, which provides differential outputs for each of the encoder channels. Suggested line receivers are 26LS32 and 26LS33.

### Features

- Available in two or three channel encoder A, B and I
- Latching connector design
- Single 5 V supply
- Resolution of up to 1024 CPR
- TTL compatible, with single ended or differential output.
- Quick assembly
- No signal adjustment required
- Small size -40° C to 100° C operating temperature

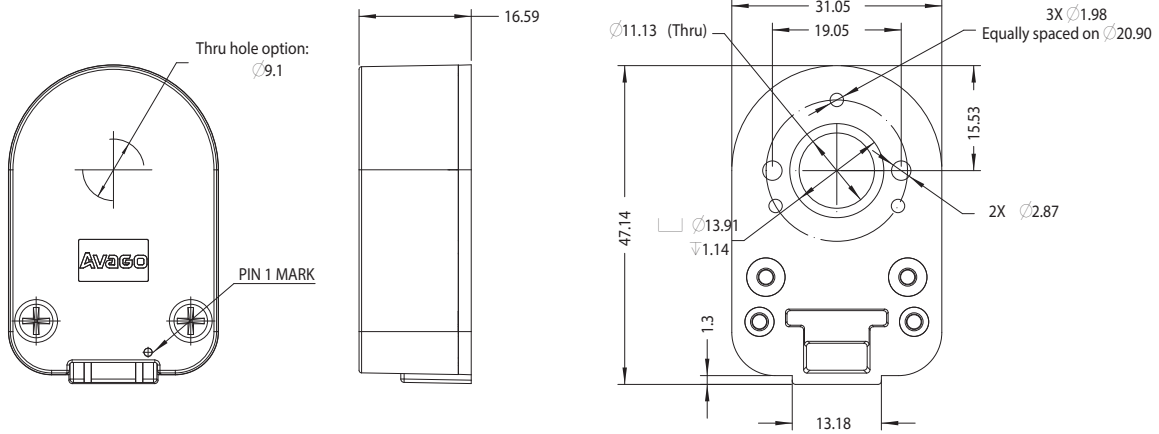
### Applications

High volume applications such as printers, plotters, tape drives, textile machines, positioning tables and also automatic handlers among others.

Note: Avago Technologies encoders are not recommended for use in safety critical applications, e.g., ABS braking systems, power steering, life support systems and critical care medical equipment. Avago's products and software are not specifically designed, manufactured or authorized for sale as parts, components or assemblies for the planning, construction, maintenance or direct operation of a nuclear facility or for use in medical devices or applications. Customers are solely responsible, and waive all rights to make claims against Avago or its suppliers, for all losses, damage, expense or liability in connection with such use. Please contact your local sales representative if more clarification is needed.

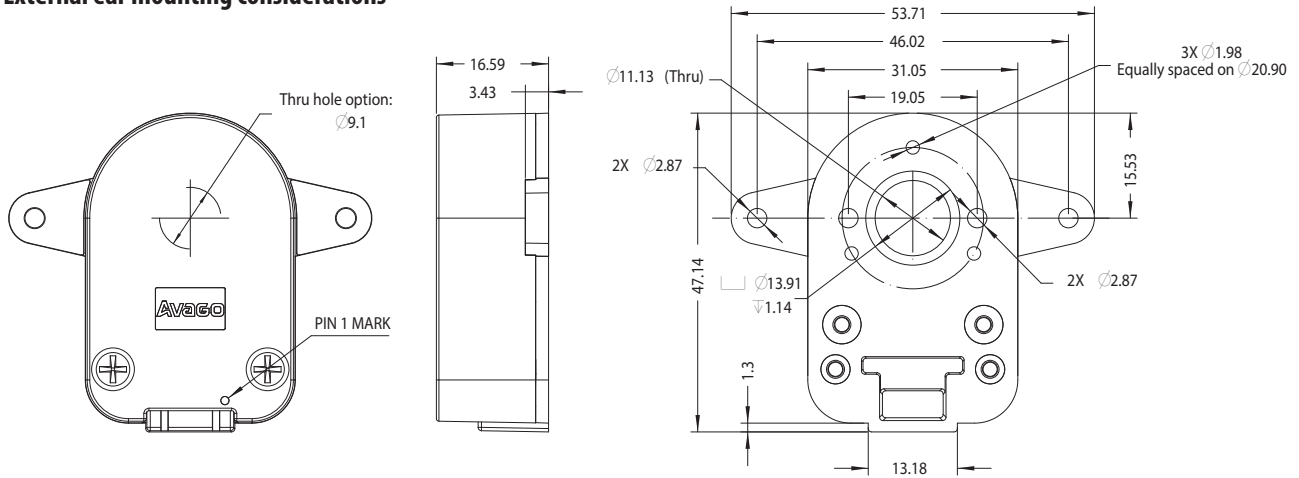
## Package Dimensions - HEDC-55xx / HEDC-56xx Single ended output:

### Standard mounting considerations



Single ended output with standard mounting base plate

### External ear mounting considerations

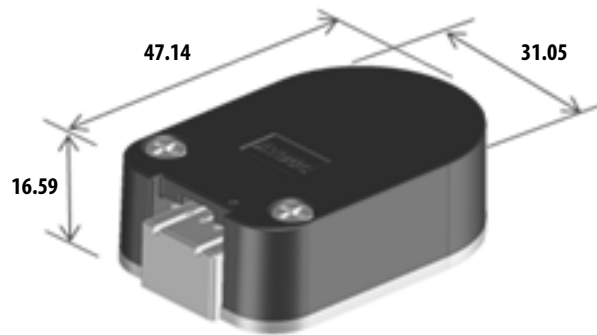


Single ended output with external ear mounting base plate

### Package Dimensions

	single ended	differential/ line driver	unit
width	31.05	31.05	mm
height	16.59	16.59	mm
length	47.14	51.76	mm

A latching connector design is used on both versions.

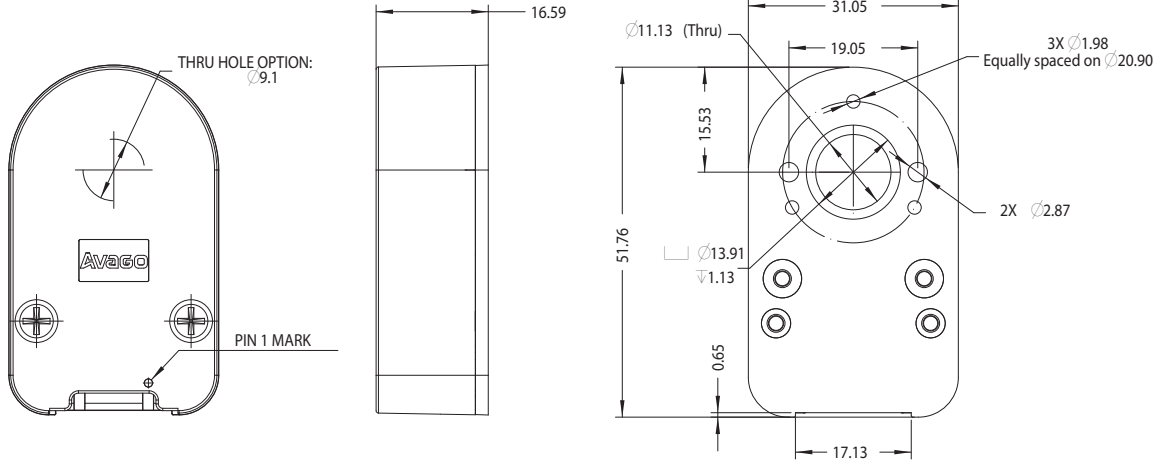


Single Ended Output Signals

Note: All dimensions are in millimeters

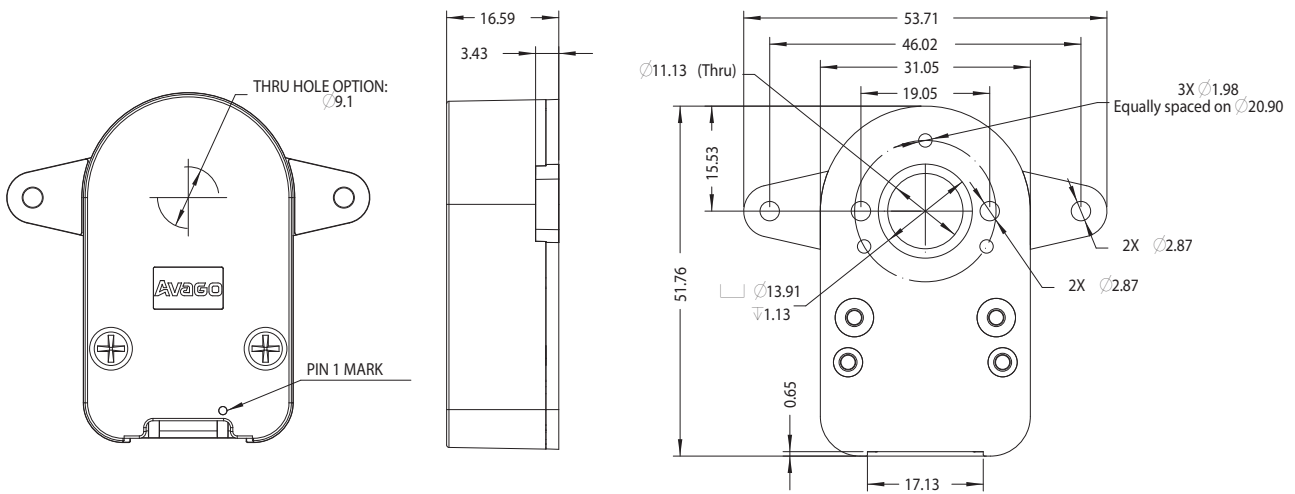
## Package Dimensions - HEDC-55xx / HEDC-56xx Differential output:

### Standard mounting considerations



Differential output with standard mounting base plate

### External ear mounting considerations

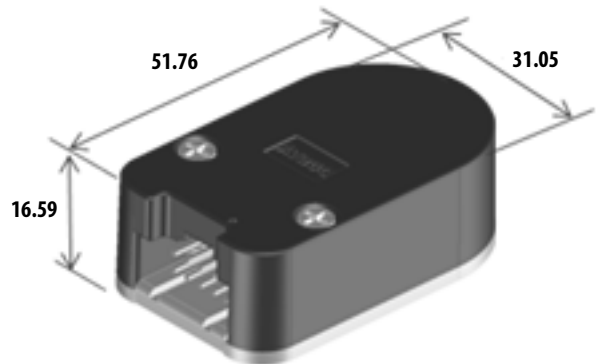


Differential output with external ear mounting base plate

### Package Dimensions

	single ended	differential/ line driver	unit
width	31.05	31.05	mm
height	16.59	16.59	mm
length	47.14	51.76	mm

A latching connector design is used on both versions.



Differential Output Signals

Note: All dimensions are in millimeters

## Theory of Operation

This encoder translates rotary motion of a shaft into a two or three-channel digital output.

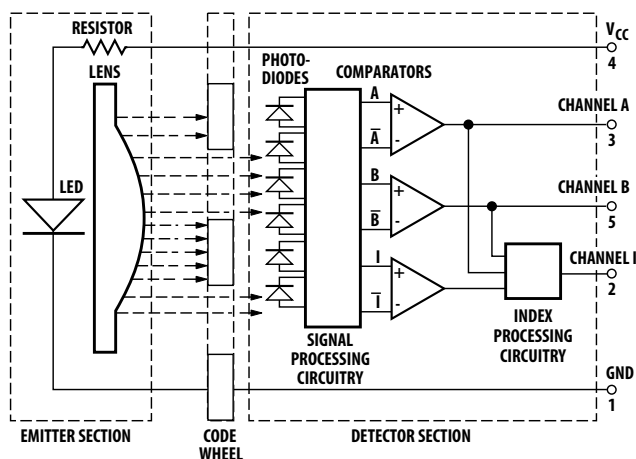
As shown in the block diagram, these encoders contain a single Light Emitting Diode (LED) as its light source. The light is collimated into a parallel beam by means of a single polycarbonate lens located directly over the LED. Opposite the emitter is the integrated detector circuit. This IC consists of multiple sets of photodiodes and the signal processing circuitry necessary to produce the digital waveforms.

The codewheel rotates between the emitter and detector, causing the light beam to be interrupted by the pattern of spaces and bars on the codewheel. The photodiodes which detect these interruptions are arranged in a pattern that corresponds to the radius and design of the codewheel. The photodiode outputs are then fed through the signal processing circuitry resulting in A, A-Bar, B and B-Bar (also I and I-Bar for 3-channel units). Comparators receive these signals and produce the final outputs for channels A and B. Due to this integrated phasing technique, the digital output of channel A is in quadrature with that of channel B (90 degrees out of phase).

The output of the comparator for I and I-Bar is sent to the index processing circuitry along with the outputs of channels A and B.

The final output of channel I is an index pulse PO which is generated once for each full rotation of the codewheel. This output PO is a one state width (nominally 90 electrical degrees), high state true pulse which is coincident with the low states of channels A and B.

## Block Diagram



## Definitions (see phase diagram)

**Count (N):** The number of bar and window pairs or counts per revolution (CPR) of the codewheel.

**One Cycle (C):** 360 electrical degrees ( $^{\circ}$ e), 1 bar and window pair.

**One Shaft Rotation:** 360 mechanical degrees, N cycles.

**Position Error ( $\Delta\Theta$ ):** The normalized angular difference between the actual shaft position and the position indicated by the encoder cycle count.

**Cycle Error ( $\Delta C$ ):** An indication of cycle uniformity. The difference between an observed shaft angle which gives rise to one electrical cycle, and the nominal angular increment of  $1/N$  of a revolution.

**Pulse Width (P):** The number of electrical degrees that an output is high during 1 cycle. This value is nominally  $180^{\circ}$ e or  $1/2$  cycle.

**Pulse Width Error ( $\Delta P$ ):** The deviation, in electrical degrees, of the pulse width from its ideal value of  $180^{\circ}$ e.

**State Width (S):** The number of electrical degrees between a transition in the output of channel A and the neighbouring transition in the output of channel B. There are 4 states per cycle, each nominally  $90^{\circ}$ e.

**State Width Error ( $\Delta S$ ):** The deviation, in electrical degrees, of each state width from its ideal value of  $90^{\circ}$ e.

**Phase ( $\phi$ ):** The number of electrical degrees between the center of the high state of channel A and the center of the high state of channel B. This value is nominally  $90^{\circ}$ e for quadrature output.

**Phase Error ( $\Delta\phi$ ):** The deviation of the phase from its ideal value of  $90^{\circ}$ e.

**Index Pulse Width ( $P_0$ ):** The number of electrical degrees that an index output is high during one full shaft rotation. This value is nominally  $90^{\circ}$ e or  $1/4$  cycle.

## Absolute Maximum Ratings

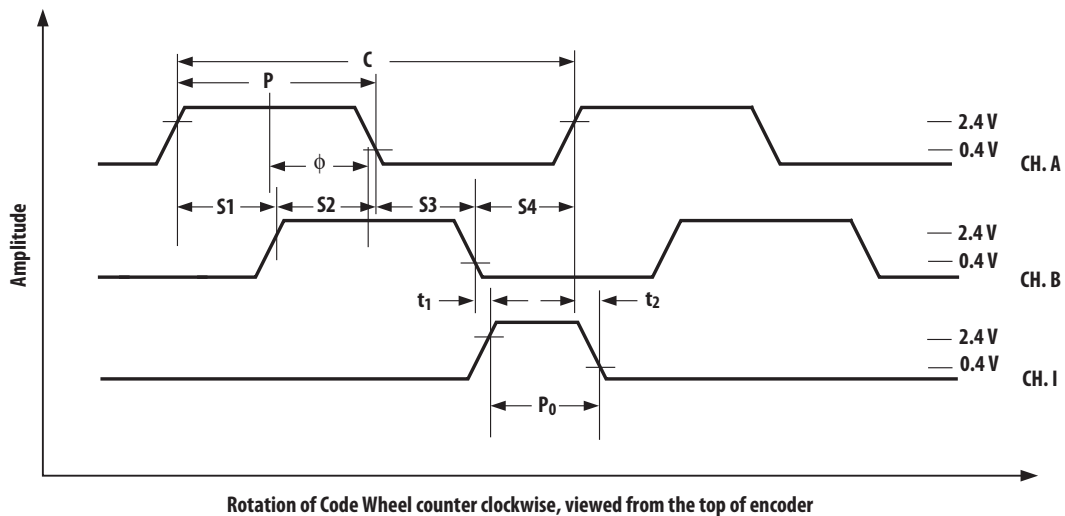
Parameter	
Storage Temperature, $T_S$	-40° C to 100° C
Operating Temperature, $T_A$	-40° C to 100° C
Supply Voltage, $V_{CC}$	-0.5 V to 7 V
Output Voltage, $V_O$	-0.5 V to $V_{CC}$
Output Current per Channel, $I_{OUT}$ (Single ended)	-1.0 mA to 5 mA
Vibration	20 g, 5 to 1000 Hz
Shaft Axial Play	± 0.25 mm (± 0.010 in)
Shaft Eccentricity Plus Radial Play	0.1 mm (0.004 in)
Velocity	30,000 RPM
Acceleration	250,000 rad/sec <sup>2</sup>

**Direction of Rotation:** When the codewheel rotates in the clockwise direction (as viewed from the encoder end of the motor), channel A will lead channel B. If the codewheel rotates in the counter-clockwise direction, channel B will lead channel A.

**Index Pulse Width ( $P_0$ ):** The number of electrical degrees that an index output is high during one full shaft rotation. This value is nominally 90°e or ¼ cycle.

## Output Waveform Phase Diagram

### Clockwise Rotation – A leads B



## Recommended Operating Conditions

Parameter	Sym.	Min.	Typ.	Max.	Units	Notes
Temperature	T <sub>A</sub>	-40		100	°C	
Supply Voltage	V <sub>CC</sub>	4.5	5.0	5.5	Volts	Ripple < 100 mV <sub>p-p</sub>
Load Capacitance	C <sub>L</sub>			100	pF	2.7 kΩ pull-up
Count Frequency	f			100	kHz	Velocity (rpm) x N/60

## Electrical Characteristics

Electrical Characteristics over Recommended Operating Range.

Part No.	Parameter	Sym	Min	Typ.*	Max.	Units	Notes
2 channel	Supply Current	I <sub>CC</sub>		17	40	mA	
	High Level Output Voltage	V <sub>OH</sub>	2.4			V	I <sub>OH</sub> = -40 μA max
	Low Level Output Voltage	V <sub>OL</sub>			0.4	V	I <sub>OL</sub> = 3.2 mA
	Rise Time	t <sub>r</sub>		200		ns	C <sub>L</sub> = 25 pF
	Fall Time	t <sub>f</sub>		50		ns	R <sub>L</sub> = 11 kΩ pull-up
3 channel	Supply Current	I <sub>CC</sub>	30	57	85	mA	
	High Level Output Voltage	V <sub>OH</sub>	2.4			V	I <sub>OH</sub> = -200 μA max
	Low Level Output Voltage	V <sub>OL</sub>			0.4	V	I <sub>OL</sub> = 3.86 mA
	Rise Time	t <sub>r</sub>		180		ns	C <sub>L</sub> = 25 pF
	Fall Time	t <sub>f</sub>		40		ns	R <sub>L</sub> = 2.7 kΩ pull-up
Line Driver	Rise/Fall time	t <sub>r</sub>		120**		ns	C <sub>L</sub> = 40 pF
		t <sub>f</sub>					R <sub>L</sub> = 100 Ω

\* Typical values specified at V<sub>CC</sub> = 5.0 V and 25° C and for single ended, unless otherwise stated.

\*\*Applicable for line driver output version.

## Mechanical Characteristics

Parameter	Symbol	Dimension	Tolerance	Units
Codewheels Fit These Shaft Diameters		2, 3, 4, 5, 6, 8	+0.000 -0.015	mm
		5/32, 1/8, 3/16, 1/4	+0.0000 -0.0007	in
Moment of Inertia	J	0.6 (8.0 x 10 <sup>-6</sup> )		g-cm <sup>2</sup> (oz-in-s <sup>2</sup> )
Required Shaft Length		14.0 (0.55)	± 0.5 (± 0.02)	mm (in.)
Bolt Circle <sup>[3]</sup>	2 screw mounting	19.05 (0.750)	± 0.13 (± 0.005)	mm (in.)
	3 screw mounting	20.90 (0.823)	± 0.13 (± 0.005)	mm (in.)
	external mounting ears	46.0 (1.811)	± 0.13 (± 0.005)	mm (in.)
Mounting Screw Size	2 screw mounting	M 2.5 or (2-56)		mm (in.)
	3 screw mounting	M 1.6 or (0-80)		mm (in.)
	external mounting ears	M 2.5 or (2-56)		mm (in.)
Encoder Base Plate Thickness		0.33 (0.130)		mm (in.)
Hub Set Screw		(2-56)		(in.)

### Notes

1. An optional cover provides an 8.9 mm (0.35 inch) diameter hole through the housing for longer motor shaft.
2. Encoder must be aligned as shown in the "Encoder Mounting and Assembly" instructions.
3. The recommended mounting screw torque for 2 screw mounting is 1.0 kg-cm (0.88 in-lbs). The recommended mounting screw torque for 3 screw mounting is 0.50 kg-cm (0.43 in-lbs).

## Encoding Characteristics

Encoding characteristics are applicable per the Recommended Operating Conditions, unless otherwise specified. Values are for the worst case error over the full rotation.

	Description	Sym.	Min.	Typ.*	Max.	Units
Two Channel	Pulse Width Error	$\Delta P$		7	45	$^{\circ}e$
	Logic State Width Error	$\Delta S$		5	45	$^{\circ}e$
	Phase Error	$\Delta \Phi$		2	20	$^{\circ}e$
	Position Error	$\Delta \Theta$		10	40	min. of arc
	Cycle Error	$\Delta C$		3	5.5	$^{\circ}e$
Three Channel	Pulse Width Error	$\Delta P$		5	45	$^{\circ}e$
	Logic State Width Error	$\Delta S$		5	35	$^{\circ}e$
	Phase Error	$\Delta \Phi$		2	15	$^{\circ}e$
	Position Error	$\Delta \Theta$		10	40	min. of arc
	Cycle Error	$\Delta C$		3	5.5	$^{\circ}e$
	Index Pulse Width	$P_O$	55	90	125	$^{\circ}e$
	CH.I rise after CH.A or CH. B fall	$t_1$	-40 $^{\circ}$ C to +100 $^{\circ}$ C	-300	100	250
CH.I fall after CH.A or CH. B rise	$t_2$	-40 $^{\circ}$ C to +100 $^{\circ}$ C	70	150	1000	ns

## Electrical Interface

To ensure reliable encoding performance, the three channel single ended encoders require 2.7 k $\Omega$  ( $\pm 10\%$ ) pull-up resistors on output pins 2, 3 and 5 (Channels A, B and I) as shown in Figure 1. These pull-up resistors should be located as close to the encoder as possible (within 4 feet). Each of the outputs can drive a single TTL load in this configuration. The two channel version does not normally require pull-up resistors. However, 3.2 k $\Omega$  pull-up resistor on output pins 3 and 5 (Channel A and B) are recommended to improve rise times, especially when operating above 100 KHz frequencies.

For the line driver option, differential loading of 100  $\Omega$  and 40 pf (RS422 configuration), yields rise and fall times of 120 ns typical, with approximately 60 ns of skew. Driving moderate to long lengths of cable un-terminated reduces power consumption and can reduce skew to < 10 ns.

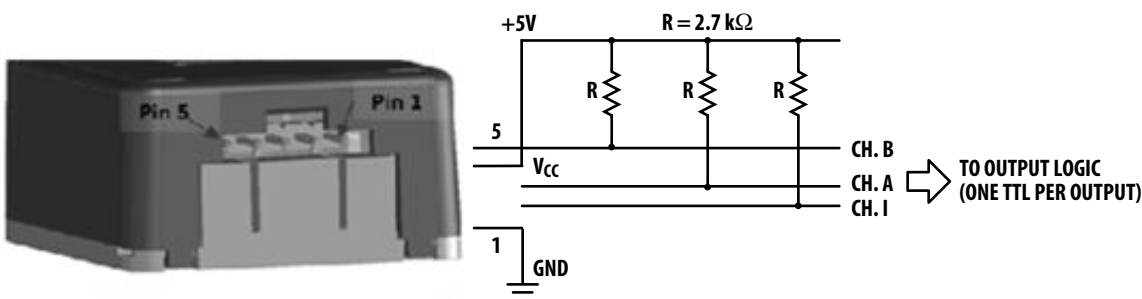
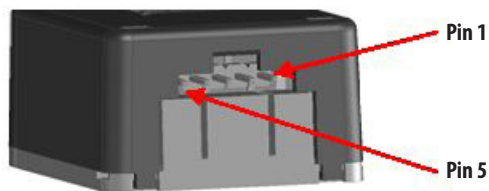
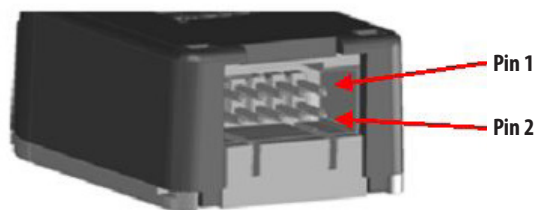


Figure 1. Pull-up resistors on 3 Channel encoder output

## Pin out descriptions



5 Pin (Single Ended) Version



10 Pin (Differential Line Driver) Version

Pin #	Description
1	Ground
2	CH I (*)
3	CH A
4	+ 5 VDC
5	CH B

Pin #	Description Standard	Description HP/Agilent Option
1	Ground	No connection
2	Ground	+ 5 VDC
3	Ch I- (*)	Ground
4	Ch I+ (*)	No connection
5	Ch A-	CH A -
6	Ch A+	CH A +
7	+5VDC	CH B -
8	+5VDC	CH B +
9	CH B-	CH I - (*)
10	CH B+	CH I + (*)

(\*) – Applicable to 3 channel units only

## Standard Cable options

**Cable Description (All include one end terminated with the mating latching connector, and the other end has flying leads.)**

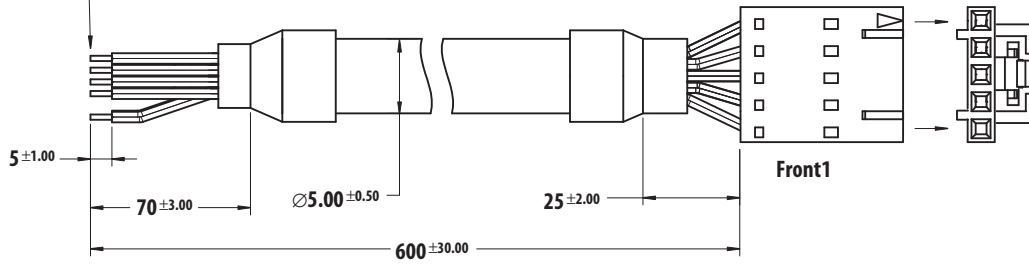
	Part Number	Shielded Cable Length
5 conductor, unshielded 22 ga (for single ended use)	HEDC-8520-0060	600 mm
8 conductor, shielded, 24 ga (for line driver use) – Standard option	HEDC-8850-0060	600 mm
8 conductor, shielded, 24 ga (for line driver use) – HP/Agilent/Avago option	HEDC-8851-0060	600 mm

For other cable options or customization request, please contact your Avago representative or distributor.



**Connector (HEDC-8520-0060)**

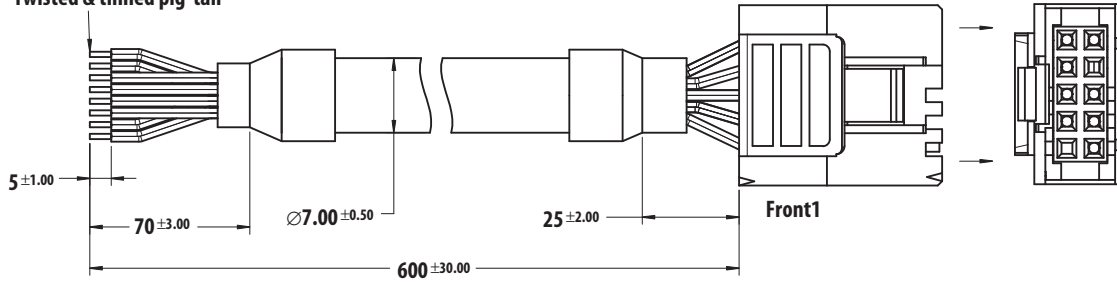
Twisted & tinned pig tail



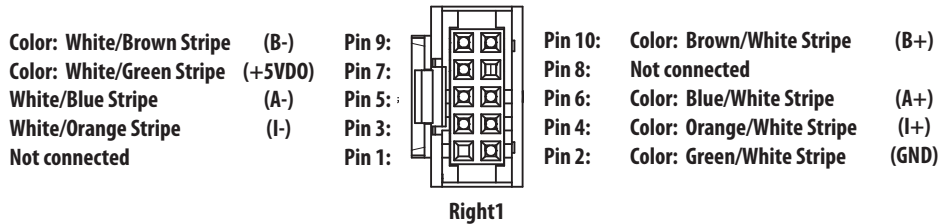
- Pin 1: Color: Black (GND)
- Pin 2: Color: Green (I)
- Pin 3: Color: White (A)
- Pin 4: Color: Red (+5VDC)
- Pin 5: Color: Brown (B)

**Connector (HEDC-88xx-0060)**

Twisted & tinned pig tail



**Standard connector pin out (HEDC-8850-0060)**



**HP/Agilent/Avago connector pin out (HEDC-8851-0060)**

