

## **HEDS-51X0/61X0 Series, HEDG-512X/612X Series HEDM-512X/61XX Series**



Two and Three Channel Codewheels for Use with Avago Technologies  
Optical Encoder Modules

### **Technical Data**

#### **Description**

Avago Technologies offers a wide variety of codewheels for use with Avago Technologies' HEDS-9000, HEDS-9100, HEDS-9040, and HEDS-9140 series Encoder Modules. Designed for many environments, applications, and budgets, Avago Technologies' codewheels are available in Glass, Film, and Metal. These codewheels are available in resolutions from 96 Counts Per Revolution (CPR) to 1024 CPR on an 11 mm optical radius and 500 to 2048 CPR on a 23.36 mm optical radius.

Each of the three codewheel materials offers a certain advantage. Metal codewheels are the most versatile, with a temperature rating up to 100°C, resolution to 512 CPR (28 mm diameter), as well as 2 and 3 channel outputs. Film codewheels offer higher resolution (up to 1024 CPR on a 28 mm diameter) with an operating temperature of 70°C. Glass codewheels combine the best of film and metal, offering a temperature rating of 100°C and resolutions to 1024 CPR on a 28 mm diameter.

In addition, each material offers a specific reliability rating. It is important to consider the specific application operating environment, long term operating conditions, and temperature ranges when choosing a codewheel material.

#### **Also See:**

- HEDS-9000/HEDS-9100 Encoder Module Data Sheet
- HEDS-9000/9100/9200 Extended Resolution Encoder Module Data Sheet
- HEDS-9040/9140 Three Channel Encoder Module Data Sheet
- HEDS-9700 Small Encoder Module Data Sheet

#### **Features:**

- Codewheels Available in Glass, Film, and Metal
- Available in Two Standard Diameters
- Cost Effective
- Resolutions from 96 CPR to 2048 CPR
- For Use with HEDS-90XX/91XX Series Two and Three Channel Encoders
- Lead Free

### Absolute Maximum Ratings

It is important to consider the environment in which the codewheels will be used when selecting a codewheel material. In brief, metal codewheels are rugged, but do not offer higher resolution capabilities. Film codewheels allow higher resolution, but cannot endure the same temperatures and high humidity as metal. Glass codewheels offer both high temperature and higher resolution, but are also more expensive. Consider the following rating table when choosing a codewheel material.

| Parameter                              | Symbol         | HEDS-XXXX<br>Metal Codewheels | HEDM-XXXX<br>Film Codewheels | HEDG-XXXX<br>Glass Codewheels |
|----------------------------------------|----------------|-------------------------------|------------------------------|-------------------------------|
| Storage Temperature                    | T <sub>S</sub> | -40°C to +100°C               | -40°C to +70°C               | -40°C to +100°C               |
| Operating Temperature                  | T <sub>A</sub> | -40°C to +100°C               | -40°C to +70°C               | -40°C to +100°C               |
| Humidity                               |                |                               | non condensing               |                               |
| Velocity                               |                | 30,000 RPM                    | 30,000 RPM                   | 12,000 RPM                    |
| Shaft Axial Play                       |                | ±0.25 mm<br>(±0.010 in)       | ±0.175 mm<br>(±0.007 in)     | ±0.175 mm<br>(±0.007 in)      |
| Shaft Eccentricity<br>Plus Radial Play |                | ±0.1 mm<br>(±0.004 in) TIR    | ±0.04 mm<br>(±0.0015 in) TIR | ±0.04 mm<br>(±0.0015 in) TIR  |
| Acceleration                           |                | 250,000 Rad/Sec <sup>2</sup>  | 250,000 Rad/Sec <sup>2</sup> | 100,000 Rad/Sec <sup>2</sup>  |

### Recommended Operating Conditions

| Parameter                                 | HEDS-XXXX<br>Metal Codewheels | HEDM-XXXX<br>Film Codewheels | HEDG-XXXX<br>Glass Codewheels |
|-------------------------------------------|-------------------------------|------------------------------|-------------------------------|
| Maximum Count Frequency                   | 100 kHz                       | 200 kHz*                     | 200 kHz                       |
| Shaft Perpendicularity<br>Plus Axial Play | ±0.25 mm<br>(±0.010 in)       | ±0.175 mm<br>(±0.007 in)     | ±0.175 mm<br>(±0.007 in)      |
| Shaft Eccentricity Plus<br>Radial Play    | ±0.1 mm<br>(±0.004 in) TIR    | ±0.04 mm<br>(±0.0015 in) TIR | ±0.04 mm<br>(±0.0015 in) TIR  |

Note: Avago Technologies Encoder Modules are guaranteed to 100 kHz, but can operate at higher frequencies. See Encoder Module Data Sheet for specifications and output load recommendations.

\*HEDM-6140 is guaranteed to 100 kHz with the HEDS-9040 #T00 module.

### Encoding Characteristics

Encoding characteristics over recommended operating range and recommended mounting tolerances unless otherwise specified. Values are for worst error over a full rotation. Please refer to Encoder Module Data Sheet for definitions of Encoding characteristics.

### Reliability

In addition to the absolute maximum specifications of codewheels, the environment characteristics of the application are also important. For example, consistent, large temperature swings over the life of the product will affect the codewheel performance characteristics depending on the material. The following reliability table shows results of lifetests under varying conditions of temperature and humidity.

| Part Number | Description    | Symbol          | Min. | Typ. | Max. | Units       |
|-------------|----------------|-----------------|------|------|------|-------------|
| HEDS-51XX   | Cycle Error    | $\Delta C$      |      | 3    | 5.5  | °e          |
|             | Position Error | $\Delta \theta$ |      | 10   | 40   | min. of arc |
| HEDS-61XX   | Cycle Error    | $\Delta C$      |      | 3    | 5.5  | °e          |
|             | Position Error | $\Delta \theta$ |      | 7    | 20   | min. of arc |
| HEDM-512X   | Cycle Error    | $\Delta C$      |      | 3    | 7.5  | °e          |
|             | Position Error | $\Delta \theta$ |      | 4    | 40   | min. of arc |
| HEDM-61XX   | Cycle Error    | $\Delta C$      |      | 3    | 7.5  | °e          |
|             | Position Error | $\Delta \theta$ |      | 2    | 20   | min. of arc |
| HEDG-512X   | Cycle Error    | $\Delta C$      |      | 3    | 7.5  | °e          |
|             | Position Error | $\Delta \theta$ |      | 4    | 30   | min. of arc |
| HEDG-612X   | Cycle Error    | $\Delta C$      |      | 3    | 7.5  | °e          |
|             | Position Error | $\Delta \theta$ |      | 2    | 15   | min. of arc |

### Glass Codewheel Tests

| Test                                | Duration   | Number of Parts | Number of Failures |
|-------------------------------------|------------|-----------------|--------------------|
| Storage at 100°C                    | 1000 hours | 44              | 0                  |
| Rotating at 100°C                   | 500 hours  | 10              | 0                  |
| Temperature Cycle: -40°C to +100°C  | 500 cycles | 98              | 0                  |
| Temperature/Humidity: 85°C/85% R.H. | 500 hours  | 43              | 0                  |

### Film Codewheel Tests

| Test                              | Duration    | Number of Parts | Number of Failures |
|-----------------------------------|-------------|-----------------|--------------------|
| Storage at 70°C                   | 1000 hours  | 118             | 0                  |
| Rotating at 70°C                  | 500 hours   | 10              | 0                  |
| Temperature Cycle: -40°C to +70°C | 500 cycles  | 66              | 0                  |
| Temperature Cycle: +20°C to +40°C | 1000 cycles | 64              | 0                  |
| Temperature Cycle: +20°C to +55°C | 1000 cycles | 46              | 0                  |
| Temperature Cycle: +20°C to +70°C | 500 cycles  | 50              | 0                  |

### Mounting Rotary Encoders with Codewheels

There are two orientations for mounting the Avago Technologies encoder module and Avago Technologies codewheel. Figure 1a shows mounting the module with side A as the mounting plane. Figure 1b shows mounting the module with side B as the mounting plane. When assembling the encoder and codewheel, it is important to maintain the tolerances of Side A of the module, and the image side of the codewheel. See module Data Sheets for these tolerances.

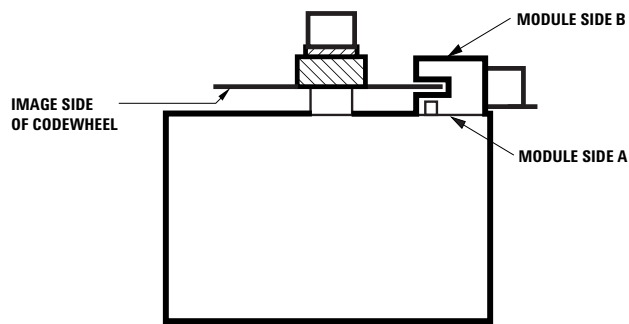


Figure 1a.

### Mounting with Module Side A as the Mounting Plane

Mounting a high resolution or three channel encoder with Module Side A as the mounting plane requires alignment pins in the motor base. These alignment pins provide the necessary centering of the module with respect to the center of the motor shaft. In addition to centering, the codewheel gap is also important. Please refer to the respective encoder data sheet for necessary mounting information.

### Mounting with Module Side B as the Mounting Plane, using Avago Technologies Assembly Tools

Avago Technologies offers centering tools and gap setting tools only for the case when the module is mounted with Side B down. Please refer to the Ordering Information Table to choose the correct assembly tools.

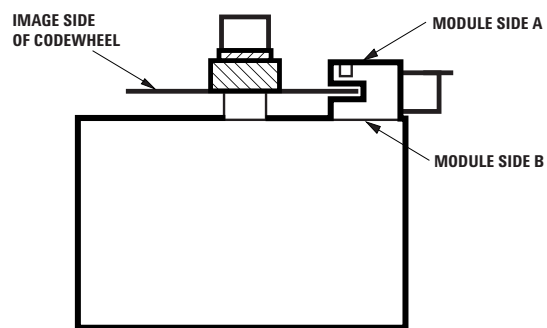


Figure 1b.

\*Please note that the image side of the codewheel must always be facing the module Side A.

## Assembly Instructions Using Avago Technologies Assembly Tools

### Instructions

1. Place codewheel on shaft.
2. Set codewheel height:
  - (a) Place the correct gap setting tool (per Ordering Information Table) on motor base, flush up against the motor shaft as shown in Figure 2. The shim has two different size steps. Choose the one that most closely matches the width of the codewheel boss. The shim should not contact the codewheel boss.
  - (b) Push codewheel down against gap setting shim. The codewheel is now at the proper height.
  - (c) Tighten codewheel setscrew.
3. Insert mounting screws through module and thread into the motor base. Do not tighten screws.
4. Slide the HEDS-8905 or HEDS-8906 centering tool over codewheel hub and onto module as shown in Figure 3. The pins of the alignment tool should fit snugly inside the alignment recesses of the module.
5. While holding alignment tool in place, tighten screws down to secure module.
6. Remove alignment tools.

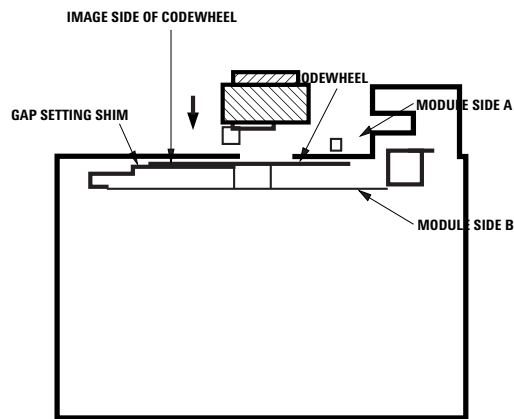


Figure 2. Alignment Tool is Used to Set Height of Codewheel.

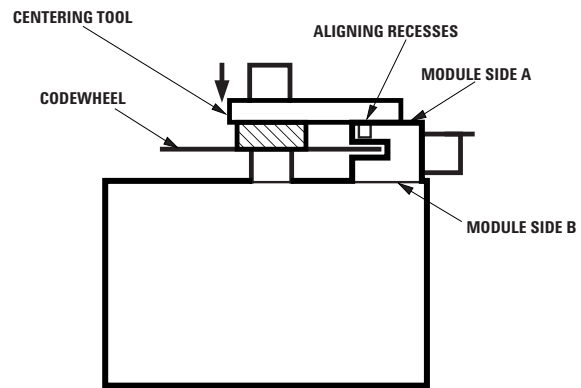


Figure 3. Alignment Tool is Placed over Shaft and onto Codewheel Hub. Alignment Tool Pins Mate with Aligning Recesses on Module.

## Mechanical Drawings

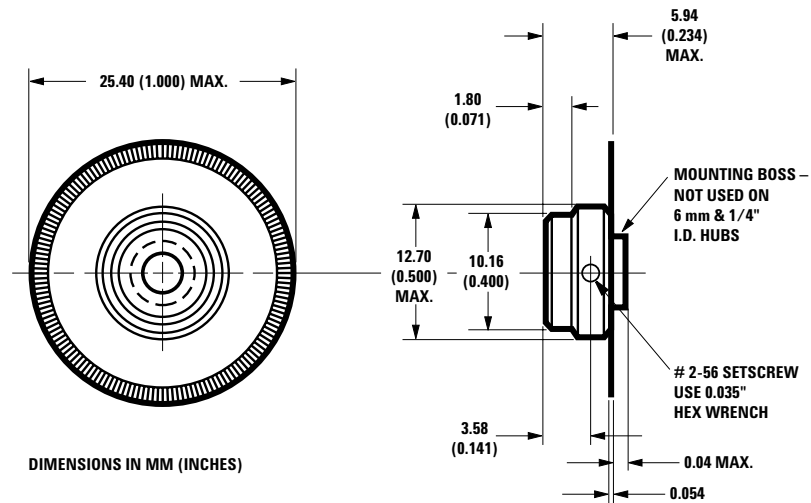


Figure 4. HEDS-5120 Codewheel.

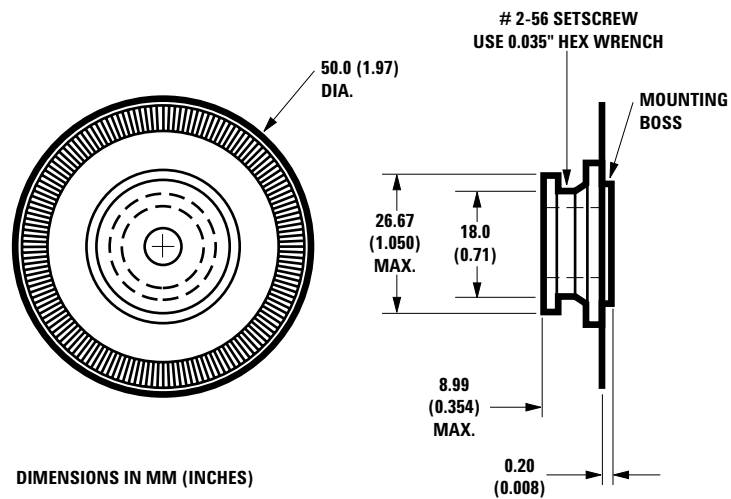


Figure 5. HEDS-6100 Codewheel.

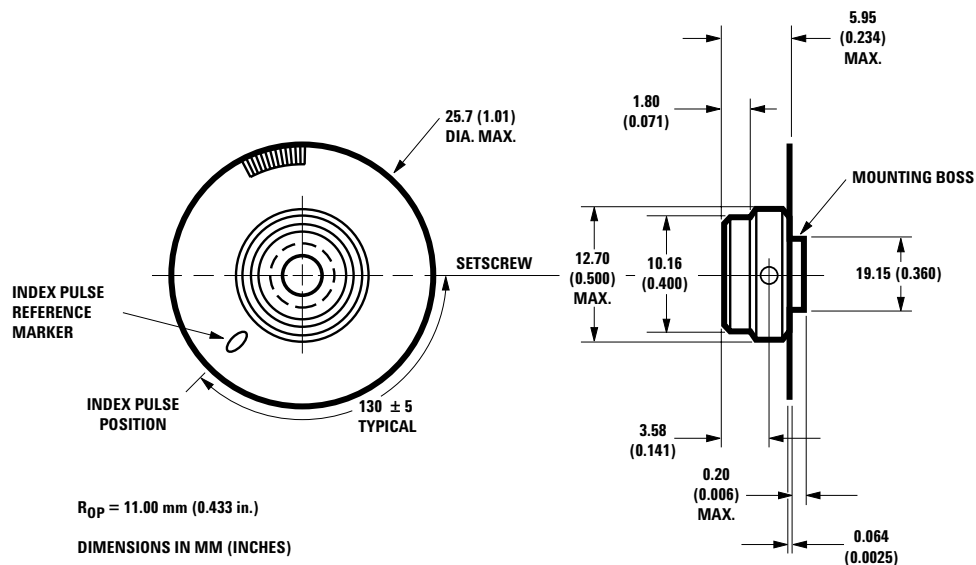


Figure 6. HEDS-5140 Codewheel Used with HEDS-9140.

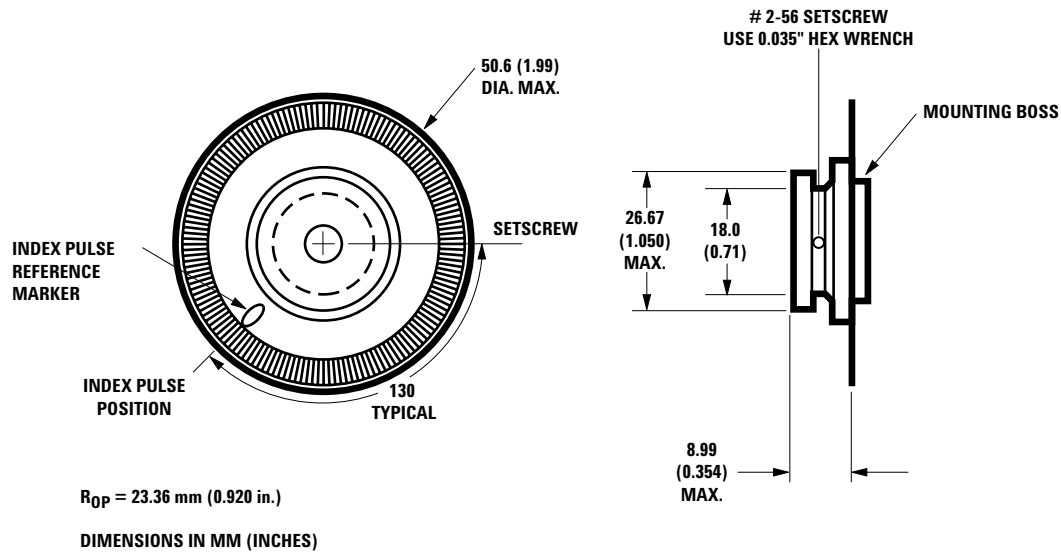


Figure 7. HEDS-6140 Codewheel Used with HEDS-9040.

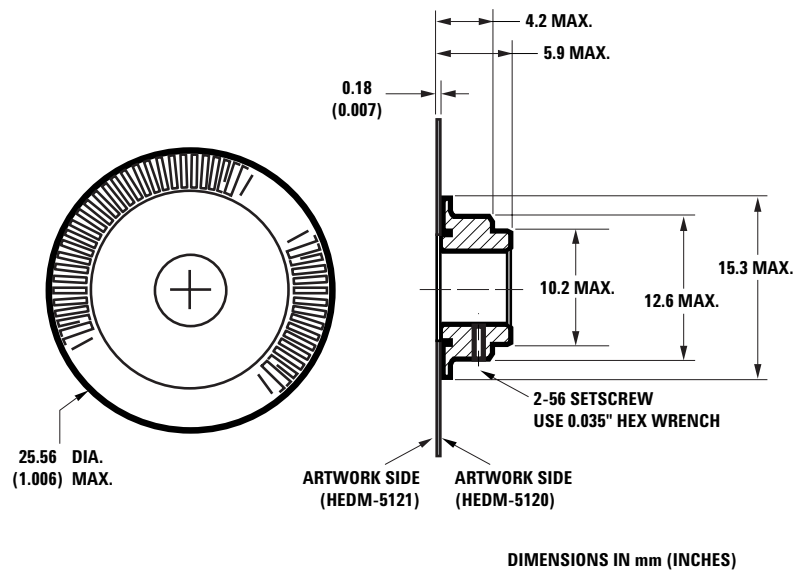


Figure 8. HEDM-5120 Codewheel/HEDM-5121 Codewheel.

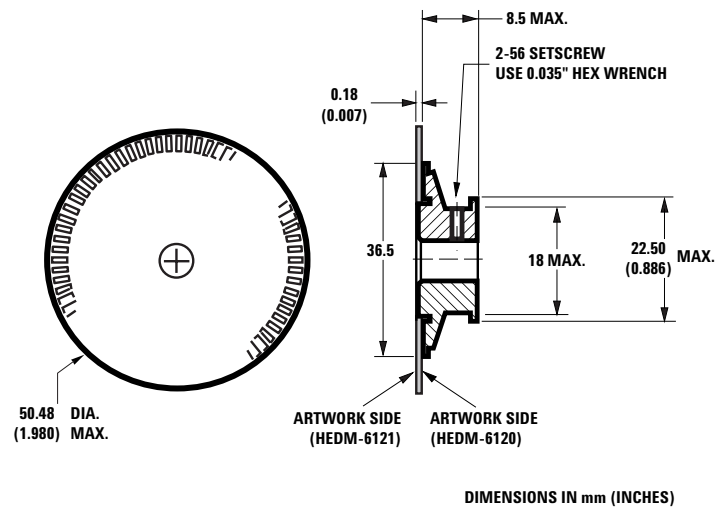


Figure 9. HEDM-6120 Codewheel/HEDM-6121 Codewheel.

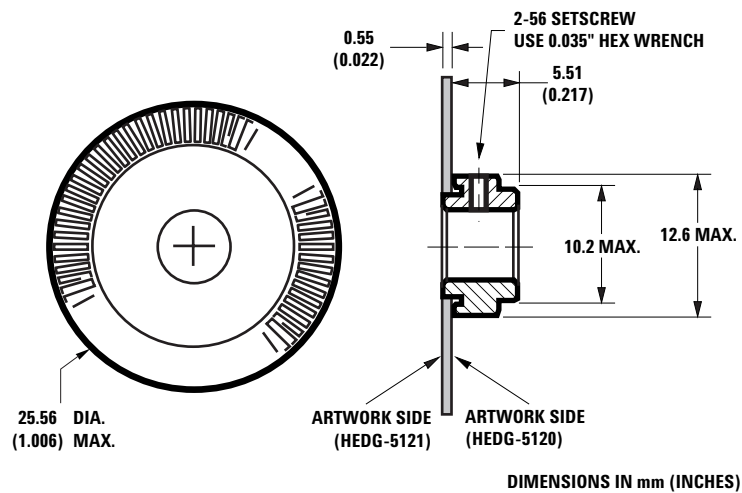


Figure 10. HEDG-5120 Codewheel/HEDG-5121 Codewheel.

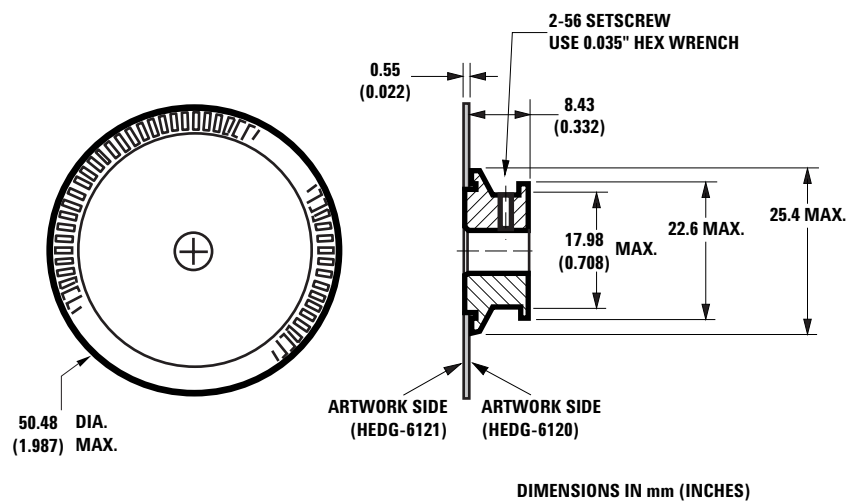


Figure 11. HEDG-6120 Codewheel/HEDG-6121 Codewheel.

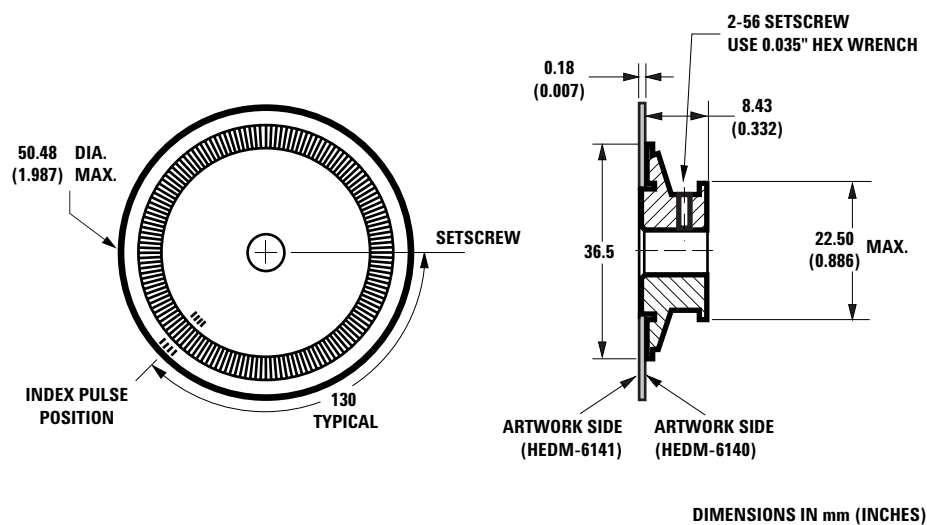
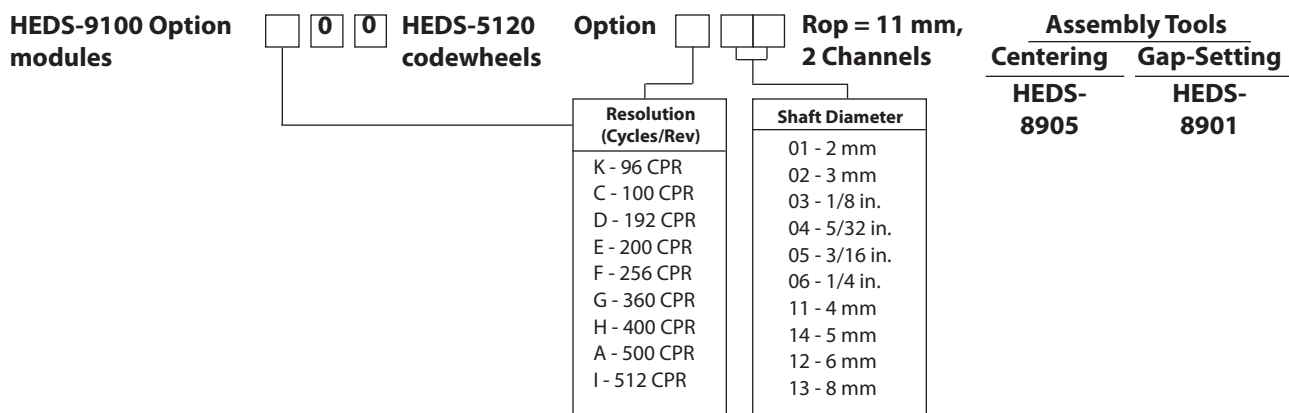


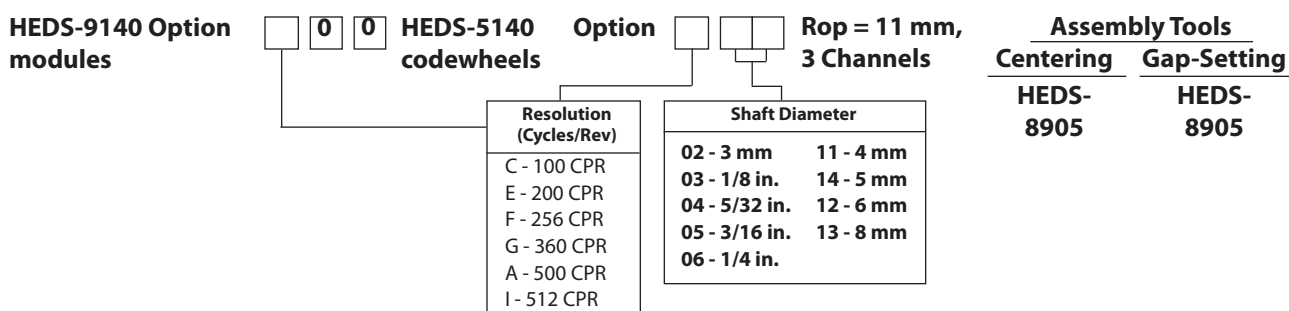
Figure 12. HEDM-6140 Codewheel/HEDM-6141 Codewheel.

## Ordering Information Encoder Modules, Codewheel and Assembly Tools

### Metal Codewheels



|            |   | 01 | 02 | 03 | 04 | 05 | 06 | 08 | 09 | 10 | 11 | 12 | 13 | 14 |
|------------|---|----|----|----|----|----|----|----|----|----|----|----|----|----|
| HEDS-5120# | A | *  | *  | *  | *  | *  | *  |    |    |    | *  | *  | *  | *  |
|            | C |    | *  |    |    |    | *  |    |    |    | *  | *  | *  | *  |
|            | D |    |    |    |    | *  |    |    |    |    |    |    |    |    |
|            | E |    |    |    |    |    | *  |    |    |    |    | *  |    |    |
|            | F |    |    |    |    | *  |    |    |    |    |    |    |    |    |
|            | G |    | *  | *  |    | *  | *  |    |    |    | *  |    |    | *  |
|            | H |    | *  |    |    |    | *  |    |    |    | *  | *  |    | *  |
|            | I |    | *  |    | *  |    | *  |    |    |    | *  | *  | *  |    |
|            | K |    | *  |    |    |    |    |    |    |    |    |    | *  |    |



|           |   | 01 | 02 | 03 | 04 | 05 | 06 | 08 | 09 | 10 | 11 | 12 | 13 | 14 |
|-----------|---|----|----|----|----|----|----|----|----|----|----|----|----|----|
| HEDS-5140 | A |    | *  |    | *  | *  | *  |    |    |    | *  | *  | *  | *  |
|           | C |    |    |    | *  |    | *  |    |    |    |    | *  | *  |    |
|           | E |    |    |    |    |    | *  |    |    |    | *  | *  |    | *  |
|           | F |    |    |    | *  |    |    |    |    |    |    | *  |    | *  |
|           | G |    |    |    |    |    | *  |    |    |    |    | *  |    | *  |
|           | I |    | *  |    | *  |    | *  |    |    |    | *  | *  | *  | *  |

## Ordering Information (Cont'd.)

HEDS-9000 Option  
modules

HEDS-6100  
codewheels

Option

Rop = 23 mm,  
2 Channels

| Resolution<br>(Cycles/Rev) |
|----------------------------|
| A - 500 CPR                |
| B - 1000 CPR               |

| Shaft Diameter |
|----------------|
| 06 - 1/4 in.   |
| 08 - 3/8 in.   |
| 09 - 1/2 in.   |
| 10 - 5/8 in.   |
| 11 - 4 mm      |
| 12 - 6 mm      |
| 13 - 8 mm      |

| Assembly Tools |             |
|----------------|-------------|
| Centering      | Gap-Setting |
| HEDS-8906      | HEDS-8901   |

|            | 01 | 02 | 03 | 04 | 05 | 06 | 08 | 09 | 10 | 11 | 12 | 13 | 14 |
|------------|----|----|----|----|----|----|----|----|----|----|----|----|----|
| HEDS-6100# | A  |    |    |    |    |    |    | *  |    |    | *  | *  |    |
|            | B  |    |    |    |    | *  | *  | *  | *  |    |    |    |    |

HEDS-9040 Option  
modules

HEDS-6140  
codewheels

Option

Rop = 23.36 mm,  
3 Channels

| Resolution<br>(Cycles/Rev) |
|----------------------------|
| B - 1000 CPR               |
| J - 1024 CPR               |

| Shaft Diameter |
|----------------|
| 06 - 1/4 in.   |
| 08 - 3/8 in.   |
| 09 - 1/2 in.   |
| 10 - 5/8 in.   |
| 11 - 4 mm      |
| 12 - 6 mm      |
| 13 - 8 mm      |

| Assembly Tools |             |
|----------------|-------------|
| Centering      | Gap-Setting |
| HEDS-8906      | HEDS-8906   |

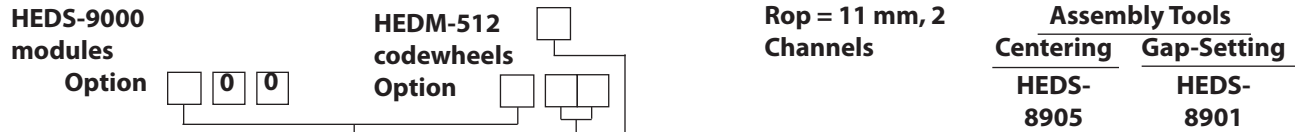
|            | 01 | 02 | 03 | 04 | 05 | 06 | 08 | 09 | 10 | 11 | 12 | 13 | 14 |
|------------|----|----|----|----|----|----|----|----|----|----|----|----|----|
| HEDS-6140# | B  |    |    |    |    | *  | *  | *  | *  | *  | *  | *  |    |
|            | J  |    |    |    |    | *  |    | *  |    |    | *  | *  |    |

### Note:

- For the lower resolution, two channel encoders, (11 mm ≤ 512 CPR; 23.36 mm ≤ 1024 CPR) the centering tool and gap-setting shim are not necessary, but sometimes helpful in an assembly process.

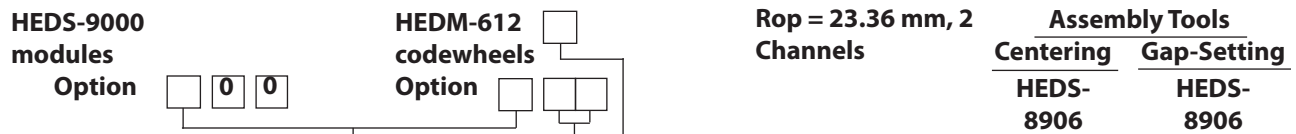
## Ordering Information (Cont'd.)

### Film Codewheels



| Resolution (Cycles/Rev)      | Artwork Orientation                                                                                                        | Shaft Diameter                                      |
|------------------------------|----------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------|
| B - 1000 CPR<br>J - 1024 CPR | 0 - Artwork on hub side (use when module side B is down)<br>1 - Artwork opposite hub side (use when module side A is down) | 02 - 3 mm<br>06 - 1/4 in.<br>11 - 4 mm<br>12 - 6 mm |

|            | 01 | 02 | 03 | 04 | 05 | 06 | 08 | 09 | 10 | 11 | 12 | 13 | 14 |
|------------|----|----|----|----|----|----|----|----|----|----|----|----|----|
| HEDM-5120# | B  | *  |    |    |    | *  |    |    |    | *  | *  |    |    |
|            | J  |    |    |    |    | *  |    |    |    | *  |    |    |    |
| HEDM-5121  | B  |    |    |    | *  | *  |    |    |    |    |    |    |    |
|            | J  |    |    |    |    |    |    |    |    |    |    |    |    |



| Resolution (Cycles/Rev)      | Artwork Orientation                                                                                                        | Shaft Diameter                                         |
|------------------------------|----------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------|
| T - 2000 CPR<br>U - 2048 CPR | 0 - Artwork on hub side (use when module side B is down)<br>1 - Artwork opposite hub side (use when module side A is down) | 06 - 1/4 in.<br>08 - 3/8 in.<br>12 - 6 mm<br>13 - 8 mm |

|            | 01 | 02 | 03 | 04 | 05 | 06 | 08 | 09 | 10 | 11 | 12 | 13 | 14 |
|------------|----|----|----|----|----|----|----|----|----|----|----|----|----|
| HEDM-6120# | T  |    |    |    |    | *  | *  |    |    |    | *  | *  |    |
|            | U  |    |    |    |    |    |    | *  |    |    |    |    |    |
| HEDM-6121# | T  |    |    |    |    |    |    | *  |    |    |    |    |    |

## Ordering Information (Cont'd.)

**HEDS-9040  
modules**  
Option

□ 0 0

**HEDM-614  
codewheels**  
Option

□ □ □

**Rop = 23.36 mm, 3  
Channels**

| Assembly Tools |             |
|----------------|-------------|
| Centering      | Gap-Setting |
| HEDS-8906      | HEDS-8906   |

| Resolution<br>(Cycles/Rev) |
|----------------------------|
| T - 2000 CPR               |

| Artwork Orientation*                                                    |
|-------------------------------------------------------------------------|
| 0 - Artwork on hub side<br>(use when module<br>side B is down)          |
| 1 - Artwork opposite<br>hub side (use when<br>module side A is<br>down) |

| Shaft Diameter |
|----------------|
| 10 - 5/8 in.   |
| 12 - 6 mm      |

|            | 01 | 02 | 03 | 04 | 05 | 06 | 08 | 09 | 10 | 11 | 12 | 13 | 14 |
|------------|----|----|----|----|----|----|----|----|----|----|----|----|----|
| HEDM-6140# | T  |    |    |    |    |    |    |    |    |    | *  |    |    |
| HEDM-6141# | T  |    |    |    |    |    |    |    | *  |    |    |    |    |

## Glass Codewheels

**HEDS-9100  
modules**  
Option

□ 0 0

**HEDG-512  
codewheels**  
Option

□ □ □

**Rop = 11 mm, 2  
Channels**

| Assembly Tools |             |
|----------------|-------------|
| Centering      | Gap-Setting |
| HEDS-8905      | HEDS-8932   |

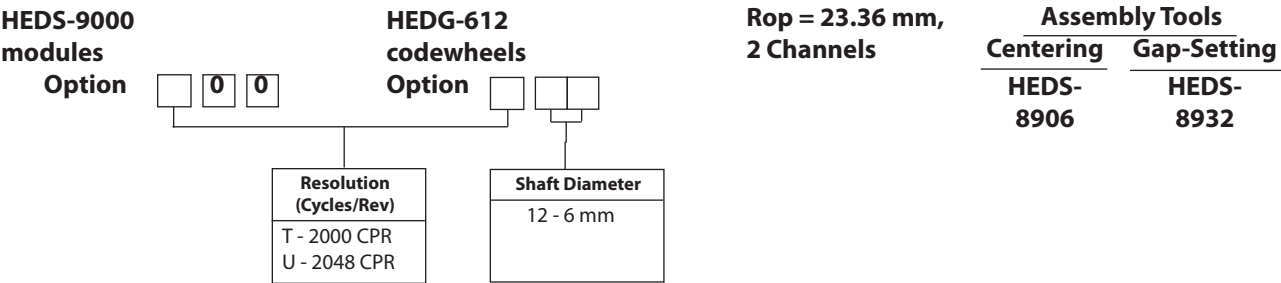
| Resolution<br>(Cycles/Rev) |
|----------------------------|
| B - 1000 CPR               |
| J - 1024 CPR               |

| Artwork Orientation                                                     |
|-------------------------------------------------------------------------|
| 0 - Artwork on hub side<br>(use when module<br>side B is down)          |
| 1 - Artwork opposite<br>hub side (use when<br>module side A is<br>down) |

| Shaft Diameter |
|----------------|
| 06 - 1/4 in.   |
| 14 - 5 mm      |

|            | 01 | 02 | 03 | 04 | 05 | 06 | 08 | 09 | 10 | 11 | 12 | 13 | 14 |
|------------|----|----|----|----|----|----|----|----|----|----|----|----|----|
| HEDG-5121# | B  |    |    |    |    | *  |    |    |    | *  |    |    |    |
|            | J  |    |    |    |    |    |    |    |    |    |    | *  |    |

Ordering Information (Cont'd.)



| 01 02 03 04 05 06 08 09 10 11 12 13 14 |   |  |  |  |  |  |  |  |  |  |   |  |  |
|----------------------------------------|---|--|--|--|--|--|--|--|--|--|---|--|--|
| HEDG-6120#                             | U |  |  |  |  |  |  |  |  |  | * |  |  |

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