CS14
Carbon Endless Sensor
14mm rotary position sensor with 360° mechanical rotation angle (electrical angle up to 330°).

Two configurations available:

- Standard, 15,000 turns, combinable with detents.
- Long life, up to 1 million turns.

Our 360° rotary sensor, CS14, can be manufactured in a wide range of possibilities regarding: resistance, tolerance, tapers, click effect (up to 50), positioning of the wiper, housing and rotor color.

Standard taper is linear. ACP can study other special tapers, (even cut tracks, step curves with areas of constant values, etc) as well as more strict linearity.

Through-hole and SMD configurations are available. Terminals and collector are manufactured in tinned brass although versions with steel terminals can be studied under request. Terminals for through-hole models can be provided straight and crimped, which helps hold the component to the PCB during soldering.

CS14 has plastic housing and Ingress Protection rating type IP 54 (high level protection against dust and also against water splashing), according to IEC 60529. Plastic materials can be self-extinguishable according to UL 94 V-0 under request.

Thumbwheels and shafts can be provided either separately or already inserted in the sensor.

**Applications**

Control, function selector, position sensor for household appliances, automotive and industrial.
### CS14 HOW TO ORDER

**EXAMPLE:** CS14NV15-10KA3030 LV15 RSN LN3% WT-14015-NE-V0

#### Standard features

<table>
<thead>
<tr>
<th>Series</th>
<th>Rotor</th>
<th>Model</th>
<th>Packg.</th>
<th>Ohm value</th>
<th>Taper</th>
<th>Tol.</th>
<th>Life</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS14</td>
<td>N</td>
<td>V15</td>
<td>-10K</td>
<td>A</td>
<td>3030</td>
<td>LV15</td>
<td></td>
</tr>
</tbody>
</table>

#### Extra features

<table>
<thead>
<tr>
<th>Track</th>
<th>Detents</th>
<th>Snap in</th>
<th>Housing</th>
<th>Rotor</th>
<th>Wiper</th>
<th>Lin</th>
<th>RSN</th>
<th>LN3%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Assembled accessory

<table>
<thead>
<tr>
<th>Assembly</th>
<th>Ref #</th>
<th>Color</th>
<th>Flamm.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>16</td>
<td></td>
<td></td>
</tr>
<tr>
<td>WT</td>
<td>-14015</td>
<td>-NE</td>
<td>-V0</td>
</tr>
</tbody>
</table>

### Customized products

A drawing is requested when ordering a customized product. Series, rotor, model and total resistive value are indicated before the code that includes all special specifications. Example: CS14NV15-10K CODE C00111.

#### Standard configuration:

- **CS14 Through-hole**

- **CS14 SMD**

### Dimensions

1.4mm

### Protection

IP 54 (dust-proof)

### Substrate

Carbon technology

### Color

Green housing + white rotor

Brown housing + grey rotor

### Packaging

Bulk

T & R

### Wiper position

at 50% ±15º

### Terminals

Straight, without crimping.

### Marking

Resistive value marked on housing. Others on request.

### Extra features

**12 - Housing**

- **Color:** For colors other than standard: -See color chart below- CJ-color, ex., red: CJ-RO

**13 - Rotor**

Rotors N, T, Z RSN

All others rotors: (leave blank)

- **Color:** For colors other than standard: -See color chart below- RT-color, ex., blue: RT-AZ

**14 - Wiper**

Wiper position (Standard: 50º ±15º) (leave blank)

- **Initial or CCW**

- **Final or CW**

- **PXH**, ex: P3H

**Wiper torque**

Standard for 15.000 turns: <2.5 Ncm, detents <3.5 Ncm (leave blank)

Special low torque for 15.000 turns <1.5 Ncm PGB

Standard for >15.000 turns <1.5 Ncm (leave blank)

- **Stronger or softer feeling than above, available on request.**

**15 - Linearity**

Standard, according to IEC 190 (leave blank)

- **Independent linearity controlled and below x%:** Ex: 3% LN3%

- **Absolute linearity controlled and below x%:** Ex: 2.5% LAx%, ex. LA2,5%

**16 - Potentiometers with assembled accessories**

- **Assembled from terminal side**

- **Assembled from collector side**

**Accessory Reference**

- **See list of shafts and thumbwheels available**

**Color chart for rotor, housing and accessories**

- **Black** (1) White

- **Neutral:** Transp.

- **Red**

- **Green**

- **Yellow**

- **Blue**

- **Grey**

- **Brown**

(1) Black is not an option for housings.

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*Specifications on this catalog are for reference only, as they are subject to change without notice.*
N is the standard rotor for CS14, but the following options are also available. Rotors are drawn in their standard positioning, 50% of rotation. Alternative delivery positioning can be requested.

Accessories in this catalogue are designed for N, Z and T rotors, unless otherwise stated. Other rotor styles, on request.

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*Please, note that for more than 15.000 turns (up to 1.000.000 turns) the following rotors are available: D, F, N, T, Z.

Models

H0, H2,5, H5, V12,5, V15, V15...CFF, VSMD, VSMD...CY. For other models, such as those shown for the CA14, please inquire.
Position indicating notch included on all LV15 rotors, except types M and P.

**Tapers**

The Standard taper is linear (A). Log (B) and Antilog (C) tapers are also available, as well as special tapers according to customer specifications. See an example on the application described on page 11.

**Potentiometers with detents**

ACP’s patented detent (DT) feature is especially suitable for control applications where the end user will turn a knob inserted in the potentiometer. Detents can be used to add a click feeling to the turning of the potentiometer or to control the position in which the wiper is placed, assuring a particular output value with a narrow tolerance.

Detents can be light or strong, or even a combination of different feelings. They can be evenly distributed along the angle (standard) or tailored to match customers’ request. They can also be combined with special tapers: constant value areas, open circuit zone, different slopes, etc. One common example is a potentiometer with detents and matching non-overlapping voltage values in specific angular positions, used to feed in a voltage value to a microprocessor.

Examples of some potentiometers with detents:

<table>
<thead>
<tr>
<th>16DT Standard</th>
<th>17DT (Max. non overlapping V)</th>
<th>50DT (Max. for feeling)</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="16DT" /></td>
<td><img src="image2" alt="17DT" /></td>
<td><img src="image3" alt="50DT" /></td>
</tr>
</tbody>
</table>

Our patented design with two wipers gives more stable electrical parameters, improved reliability and Contact Resistance Variation (CRV), as well as narrower tolerances for detent positioning.

For potentiometers with detents, mechanical life is also 15,000 turns if no additional turns are mentioned. Please, indicate the number of turns needed. When needing a special number of detents or matching taper, a drawing is kindly requested.

**Terminals**

By default, terminals are always straight, as shown on the “models” section. ACP can provide crimped terminals (with snap in, “SNP” or “SNR”), to better hold the component to the PCB during the soldering operation.

<table>
<thead>
<tr>
<th>SNP</th>
<th>SNR</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image4" alt="SNP" /></td>
<td><img src="image5" alt="SNR" /></td>
</tr>
</tbody>
</table>

Also, there is an option of having shorter terminal tips.
Possibilities for insertion of accessories

Accessories can be mounted on potentiometers through either the front side (WT) or the metal collector side (WTI). For the specific angular position of shafts with planes, a drawing with the exact position is requested.

**Shafts**

Shafts are available in different colors (color chart in “how to order” section) and with self-extinguishable property, according to UL 94 V-0, under request. ACP can study special shaft designs.

Shafts can be sold separately or already mounted on the potentiometer.

When a shaft is mounted on a potentiometer, the distance from the top of the potentiometer to the top of the shaft is marked with “L” in the table below, as shown in the drawing:

<table>
<thead>
<tr>
<th>H potentiometer + shaft</th>
<th>V potentiometer + shaft</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shaft</td>
<td>L Dimension</td>
</tr>
<tr>
<td>14042</td>
<td>7.05</td>
</tr>
<tr>
<td>14065 (For E rotor)</td>
<td>11.50</td>
</tr>
<tr>
<td>14117</td>
<td>11.70</td>
</tr>
<tr>
<td>14056</td>
<td>12.25</td>
</tr>
<tr>
<td>14081</td>
<td>18.25</td>
</tr>
<tr>
<td>14187</td>
<td>18.75</td>
</tr>
<tr>
<td>14251</td>
<td>18.75</td>
</tr>
<tr>
<td>14067</td>
<td>23.75</td>
</tr>
<tr>
<td>14088</td>
<td>23.25</td>
</tr>
<tr>
<td>14151</td>
<td>23.50</td>
</tr>
<tr>
<td>14096</td>
<td>23.50</td>
</tr>
<tr>
<td>14072</td>
<td>25.00</td>
</tr>
<tr>
<td>14073</td>
<td>31.75</td>
</tr>
<tr>
<td>14074</td>
<td>38.50</td>
</tr>
</tbody>
</table>

(H is set by the potentiometer model. See page 5)

Specifications on this catalog are for reference only, as they are subject to change without notice.
Shafts

14073

14081

14084

14117

14187

14250

14251

Thumbwheels are available in different colors (color chart in “how to order” section) and with self-extinguishable property according to UL 94 V-0, under request. Thumbwheels can be mounted on the potentiometers at ACP or sold separately. ACP can study special thumbwheel designs.
Packaging

**Bulk packaging:**

<table>
<thead>
<tr>
<th>CS14 model</th>
<th>With shaft or thumbwheel inserted?</th>
<th>Pieces per small box (150 x 100 x 70)</th>
<th>Pieces per bigger box (250 x 150 x 70) add CG at the end of the product description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS14</td>
<td>None, only potentiometers.</td>
<td>200</td>
<td>700</td>
</tr>
<tr>
<td>CS14</td>
<td>14003, 14117, 14042, 14056, 14065</td>
<td>100</td>
<td>400</td>
</tr>
<tr>
<td>CS14</td>
<td>14008, 14015, 14066, 14067, 14072, 14073, 14081, 14084, 14187, 14250.</td>
<td>75</td>
<td>To be determined.</td>
</tr>
</tbody>
</table>

**Tape & Reel packaging:**

<table>
<thead>
<tr>
<th>VSMD</th>
<th>With thumbwheel inserted?</th>
<th>13” Reel, with 24mm width tape</th>
<th>15” Reel, with 24mm width tape</th>
</tr>
</thead>
<tbody>
<tr>
<td>None, only potentiometers.</td>
<td>500 pcs per reel, 16mm step between cavities.</td>
<td>800 pcs per reel, 16mm step between cavities.</td>
<td></td>
</tr>
<tr>
<td>14003</td>
<td>450 pcs per reel, 16mm step between cavities.</td>
<td>To be determined.</td>
<td></td>
</tr>
<tr>
<td>None, only potentiometers.</td>
<td>350 pcs per reel, 20mm step between cavities.</td>
<td>500 pcs per reel, 20mm step between cavities.</td>
<td></td>
</tr>
<tr>
<td>14003</td>
<td>To be determined.</td>
<td>To be determined.</td>
<td></td>
</tr>
</tbody>
</table>

Sticker on component available on request.

**VSMD-T&R**

**VSMD-T&R...WT-14003**

**VSMD-T&R...CY**

**VSMD-T&R...CY WT-14003**

**13” Reel**

**15” Reel**
These are standard features; other specifications and out of range values can be studied on request.

### Mechanical Specifications

<table>
<thead>
<tr>
<th>Range of resistance values*</th>
<th>CS14 Through-hole</th>
<th>CS14 SMD (upon availability)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lin (A)</td>
<td>100Ω ≤ Rn ≤ 5MΩ</td>
<td>100Ω ≤ Rn ≤ 1MΩ</td>
</tr>
<tr>
<td>Log (B) / Antilog (C)</td>
<td>1 KΩ ≤ Rn ≤ 2MΩ</td>
<td>1 KΩ ≤ Rn ≤ 1 MΩ</td>
</tr>
</tbody>
</table>

**Tolerance**

(please inquire for >100K turns)

- 100Ω ≤ Rn ≤ 100KΩ
- 100KΩ ≤ Rn ≤ 1MΩ
- 1MΩ ≤ Rn ≤ 5MΩ
- Rn > 5MΩ

±30% ±30% ±30% ±50%, -30% (out of range)

**Variation laws**

Lin (A). Other tapers available on request

**CRV - Contact Resistance Variation (dynamic)**

Lin (A) Electrical Angle 330° ±20° ≤ 3% Rn.

Other tapers, please inquire

**CRV - Contact Resistance Variation (static)**

Lin (A) Electrical Angle 330° ±20° ≤ 5% Rn.

Other tapers, please inquire

**Maximum power dissipation**

Lin (A) at 50°C, 0.15W

**Maximum voltage**

Lin (A) 250VDC

**Operating temperature**

-25°C ... +70°C (+85°C on request)

Special Version 120°C

**Angle of rotation (electrical)**

330° ± 20°

**Temperature coefficient**

100Ω ≤ Rn ≤ 10KΩ

10KΩ < Rn ≤ 1MΩ

1MΩ < Rn ≤ 5MΩ

Rn > 5MΩ

+200°/-300 ppm

+200°/-500 ppm

+200°/-1000 ppm

**Variation laws**

Lin (A). Other tapers available on request

**CRV - Contact Resistance Variation (dynamic)**

Lin (A) Electrical Angle 330° ±20° ≤ 3% Rn.

Other tapers, please inquire

**CRV - Contact Resistance Variation (static)**

Lin (A) Electrical Angle 330° ±20° ≤ 5% Rn.

Other tapers, please inquire

**Maximum power dissipation**

Lin (A) at 50°C, 0.15W

**Maximum voltage**

Lin (A) 250VDC

**Operating temperature**

-25°C ... +70°C (+85°C on request)

Special Version 120°C

**Angle of rotation (electrical)**

330° ± 20°

**Temperature coefficient**

100Ω ≤ Rn ≤ 10KΩ

10KΩ < Rn ≤ 1MΩ

1MΩ < Rn ≤ 5MΩ

Rn > 5MΩ

+200°/-300 ppm

+200°/-500 ppm

+200°/-1000 ppm

* Out of range ohm values and tolerances are available on request, please, inquire.

** Dissipation of special tapers will vary, please, inquire.

### Electric Specifications

- Resistive element: Carbon technology
- Angle of rotation (mechanical): 360°
- Wiper standard delivery position: 50% ± 15°
- Max. push/pull on rotor: 35 N / 50 N
- Wiper torque*

  - For 15,000 turns <2.5 Ncm, detents <3.5 Ncm
  - For >15,000 turns <1.5Ncm
- Mechanical life

  - Standard is 15,000 turns.
  - Up to 1,000,000 turns available depending on configuration

* Stronger or softer torque feeling is available on request.

### Test results

The following typical test results (with 95% confidence) are given at 23°C ±2°C and 50% ±25% RH.

<table>
<thead>
<tr>
<th>Test condition</th>
<th>Typical variation of Rn</th>
</tr>
</thead>
<tbody>
<tr>
<td>Damp heat</td>
<td>±20%</td>
</tr>
<tr>
<td>Temperature Coefficient</td>
<td>±20%</td>
</tr>
<tr>
<td>Load life</td>
<td>±20%</td>
</tr>
<tr>
<td>Mechanical life</td>
<td>±20%</td>
</tr>
<tr>
<td>Storage (3 years)</td>
<td>±3%</td>
</tr>
</tbody>
</table>
CS14 as alternative to a 4 bit absolute encoder.

The CS14 wide electrical angle of 330° gives the possibility to include up to 17 silver zones guaranteeing that there will be no voltage overlapping of contiguous positions. Let’s take a look at the particular case of 16 silver zones combined with 16 detents:

The step function that results from this configuration (see the graph on figure 1) makes it possible to differentiate 16 non overlapping different voltage levels from the collector output pin. (B in figure 2)

The detents are set to position and fix the wiper contact on the surface of each silver zone thus absorbing any mechanical play and printing tolerances. The electrical contact between the metal surface of the wiper and the silver area minimizes the contact resistance. The mechanical detents are evenly spread 22.5°±3° from each other along the circumference as it can be seen in the figure 2 drawing.

The endless rotation feature of the CS14 allows to move the wiper from the detent number 16 (U/Un = 100%) to the detent number 1 (U/Un=0%). During the transition between these two detents it will slide on a dead zone for a few degrees, meaning that at that moment there will be no electrical contact with the resistive track.

In order to cope with this, a pull-up or a pull-down resistor is to be introduced into the circuit design. ACP recommendation is the latter, a pull-down resistor whose value has to be at least 100 times the potentiometer nominal value. In that case, the collector pin output will be 0% (U/Un) when the slider transits on the dead zone.

ACP standard configuration is a potentiometer of 10K Ohm recommending a pull-down resistor to be equal or greater than 1MΩ. (Figure 3)

Connecting the collector terminal to the AD port of a microcontroller to feed the output voltage of said configuration will allow for the selection of 16 different functions.

The table below (figure 4) shows the equivalence between the output function of this potentiometer, indicating the tolerance at each detent, and a 4 bit digital encoder signal. In summary, a CS14 fitted with these features can be used as an alternative to a 4 bit rotary encoder.

<table>
<thead>
<tr>
<th>Detent</th>
<th>U/Un</th>
<th>Decimal</th>
<th>Hexadecimal</th>
<th>Binary</th>
<th>Octal</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.00±3.32%</td>
<td>0</td>
<td>0</td>
<td>0000</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>0.67±3.32%</td>
<td>1</td>
<td>1</td>
<td>0001</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>13.33±3.32%</td>
<td>2</td>
<td>2</td>
<td>0010</td>
<td>2</td>
</tr>
<tr>
<td>4</td>
<td>20.00±3.32%</td>
<td>3</td>
<td>3</td>
<td>0011</td>
<td>3</td>
</tr>
<tr>
<td>5</td>
<td>26.67±3.32%</td>
<td>4</td>
<td>4</td>
<td>0100</td>
<td>4</td>
</tr>
<tr>
<td>6</td>
<td>33.33±3.32%</td>
<td>5</td>
<td>5</td>
<td>0101</td>
<td>5</td>
</tr>
<tr>
<td>7</td>
<td>40.00±3.32%</td>
<td>6</td>
<td>6</td>
<td>0110</td>
<td>6</td>
</tr>
<tr>
<td>8</td>
<td>46.67±3.32%</td>
<td>7</td>
<td>7</td>
<td>0111</td>
<td>7</td>
</tr>
<tr>
<td>9</td>
<td>53.33±3.32%</td>
<td>8</td>
<td>8</td>
<td>1000</td>
<td>10</td>
</tr>
<tr>
<td>10</td>
<td>60.00±3.32%</td>
<td>9</td>
<td>9</td>
<td>1001</td>
<td>11</td>
</tr>
<tr>
<td>11</td>
<td>66.67±3.32%</td>
<td>10</td>
<td>A</td>
<td>1010</td>
<td>12</td>
</tr>
<tr>
<td>12</td>
<td>73.33±3.32%</td>
<td>11</td>
<td>B</td>
<td>1011</td>
<td>13</td>
</tr>
<tr>
<td>13</td>
<td>80.00±3.32%</td>
<td>12</td>
<td>C</td>
<td>1100</td>
<td>14</td>
</tr>
<tr>
<td>14</td>
<td>86.67±3.32%</td>
<td>13</td>
<td>D</td>
<td>1101</td>
<td>15</td>
</tr>
<tr>
<td>15</td>
<td>93.33±3.32%</td>
<td>14</td>
<td>E</td>
<td>1110</td>
<td>16</td>
</tr>
<tr>
<td>16</td>
<td>100.00±3.32%</td>
<td>15</td>
<td>F</td>
<td>1111</td>
<td>17</td>
</tr>
</tbody>
</table>