

# CS14

Carbon Endless Sensor





## CS14

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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								Extra features							Assembled accessory			
Series	Rotor	Model	Packg.	Ohm value	Taper	Tol.	Life	Track	Detents	Snap in	Housing	Rotor	Wiper	Lin.	Assembly	Ref #	Color	Flam.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16			
CS14	N	V15		- 10K	A	3030	LV15					RSN		LN3%	WT	-14015	-NE	-V0

Standard configuration:	CS14 Through-hole	CS14 SMD
Dimensions:	14mm	
Protection:	IP 54 (dust-proof) On request: Self-extinguishable, to meet UL 94 V-0	
Substrate:	Carbon technology	Carbon technology, special for high temperature
Color:	Green housing + white rotor	Brown housing + grey rotor
Packaging:	Bulk	T & R
Wiper position:	at 50% ±15°	
Terminals:	Straight, without crimping.	J-Lead
Marking:	Resistive value marked on housing. Others on request.	

**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.

## 1 - Series

■ CS14

## 2 - Rotors

B D\* E F\* G K M N\* P T\* X Z\*

\* Rotors available for versions with > 15.000 turns.

## 3 - Model and pitch

H0 H2,5 H5 V12,5 V15 V15...CFF VSMD VSMD...CY

4 - Packaging	Trough-hole	SMD models
Bulk	(blank)... <sup>(1)</sup>	(blank)... <sup>(1)</sup>
T&R (Tape and 13" reel)	(N.A.) <sup>(2)</sup>	T&R
T&R (Tape and 15" reel)	(N.A.) <sup>(2)</sup>	T&R15

Big Box: See page 9

(1) If blank, bulk packaging is implied. (2) N.A., Not Applicable: Tape and Reel packaging is only available for SMD terminals.

## 5 - Resistance value (see also page 10)

100Ω 200Ω 220Ω 250Ω 470Ω 500Ω 1KΩ 2KΩ ... 500KΩ 1MΩ 2MΩ 2M2Ω 4M7Ω 5MΩ

100 200 220 250 470 500 1K 2K 500K 1M 2M 2M2 4M7 5M

## 6 - Resistance law / taper (see also page 10)

Lin - Linear	A
Log - Logarithmic	B
Antilog - Antilogarithmic	C
- Special tapers have codes assigned:	CODE YXXXXX

## 7 - Tolerance (see also page 10)

±30%	+50%,-30%	±20%	±10%	±5%
3030	5030	2020	1010	0505

## 8 - Operating Life (Turns)

Standard (15.000 turns) (others on request).	LV15
Long life: LV + number of turns. ex: LV100 for 100.000 turns, LV150, LV1M	LVXXX: ex: LV100

## 9 - Cut Track - Open circuit

CS14 already has an open circuit area at the base of the potentiometer (between 330° and 0°). Additional cut tracks can be studied on request.

## 10 - Detents (DT) (Available for up to 15.000 turns) Standard 16 detents

X number of detents: ex. 16 detents XDT, ex: 16DT

Special detents are available on request: If you need to assign a voltage value to each detent, please inquire.

## 11 - Terminals (THT)

SNAP IN P	SNP
SNAP IN R	SNR
Shorter tip of terminal, TPXX, where XX is tip length (under request)	TPXX, ex: TP30
Steel Terminals	SH

## 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

## \* Self extinguishable property V0 for housing and rotor

Not V0 (by default)	(leave blank)
Housing and rotor V0	V0
Only housing V0	CJ-V0
Only rotor V0	RT-V0

## 14 - Wiper

**Wiper position** (Standard: 50% ± 15°) (leave blank)

Initial or CCW PI

Final or CW PF

Others: following clock positions. Ex at 3 hours: P3H 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% LNx%, ex: LN3%

Absolute linearity controlled and below x%. Ex: 2,5% LAx%, ex: LA2,5%

## 16 - Potentiometers with assembled accessories

Assembled from terminal side WT

Assembled from collector side WTI

Accessory Reference -XXXXX ex: 14117

See list of shafts and thumbwheels available

Color of shaft or thumbwheel -YY ex: white: BA

Non self-extinguishable. Self-extinguishable according to standard UL 94 (-V0 in box 17 modifies only the accessory, please, note.) (leave blank) -V0

**For ordering spare accessories:** Accessory reference - color- flammability. Ex. 14117-AZ-V0 is a blue self-extinguishable 14117 thumbwheel XXXX-YY-V0

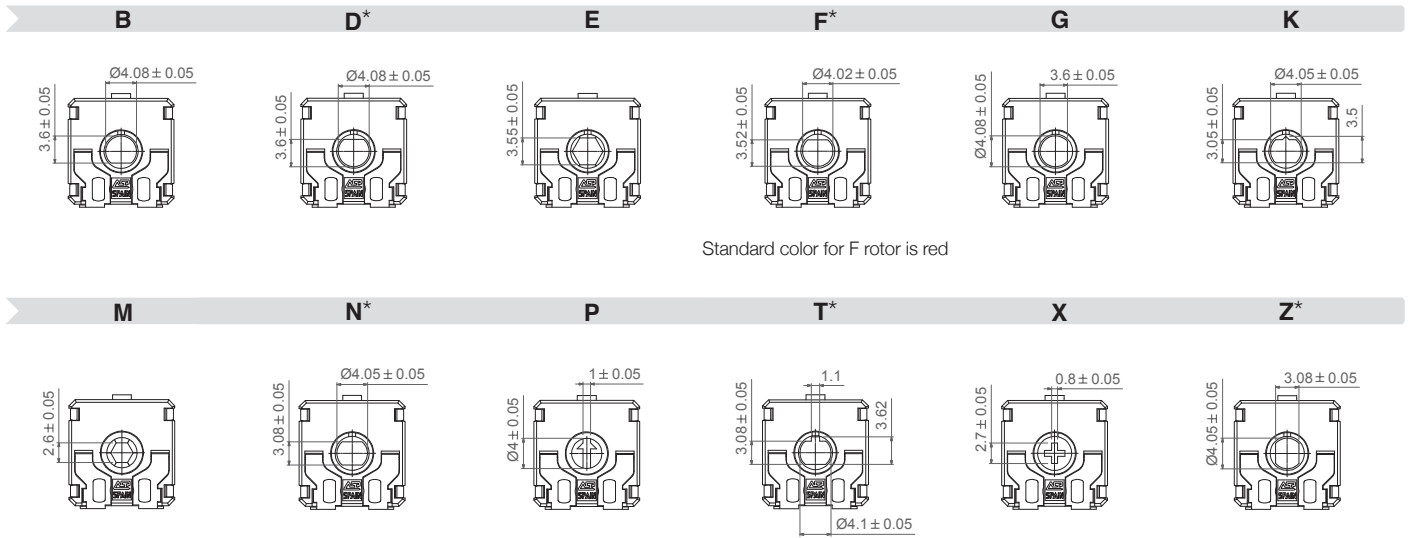
## Color chart for rotor, housing and accessories

Black <sup>(1)</sup>	White	Neutral	Transp.	Red	Green	Yellow	Blue	Grey	Brown
NE	BA	IN	TA	RO	VE	AM	AZ	GS	MR

(1) black is not an option for housings.

## Rotors

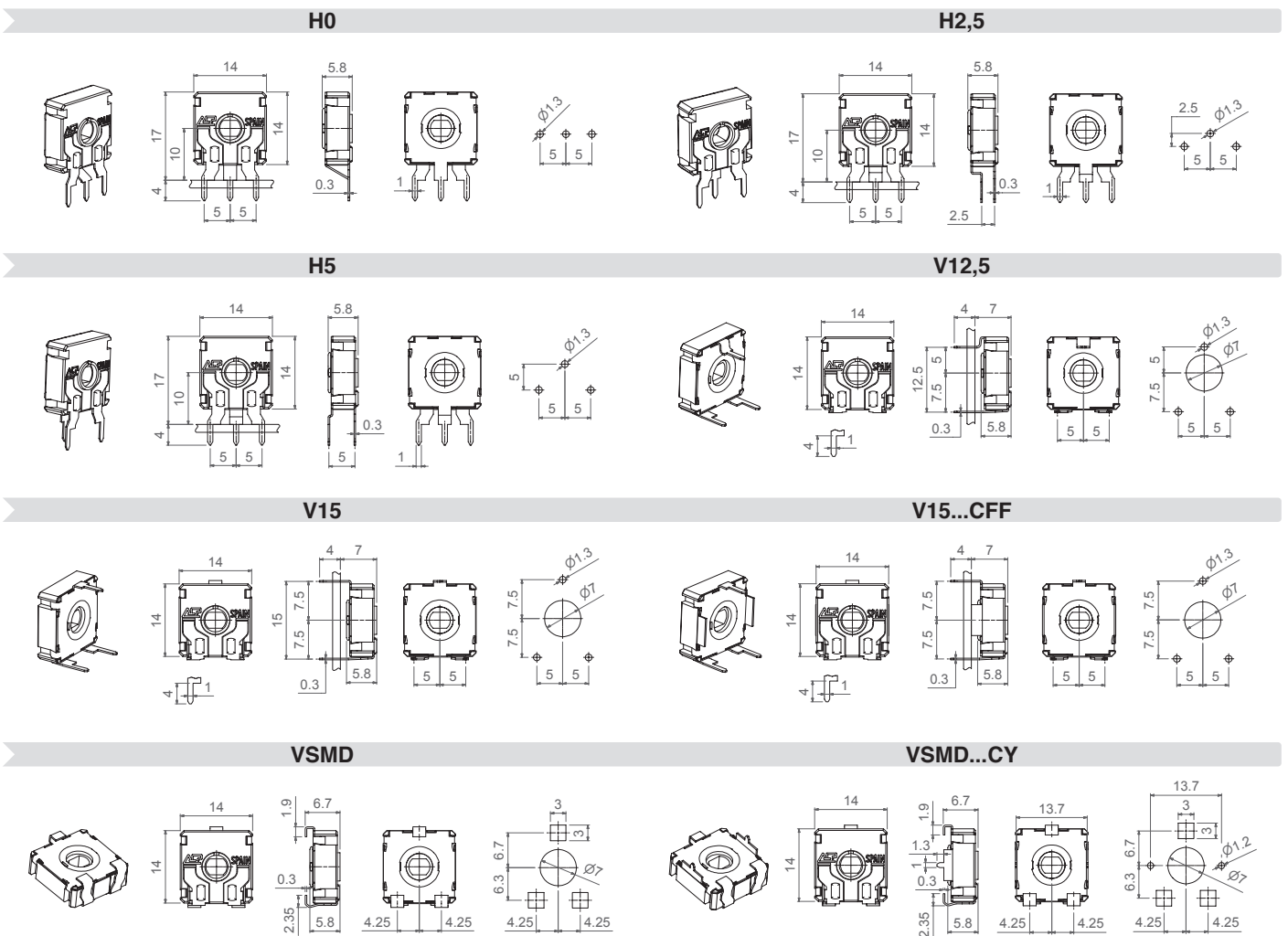
N is the standard rotor for CS14, but the following options are also available. Rotors are drawn in their standard positioning, 50% of rotation. Alternative delivery positioning can be requested. Accessories in this catalogue are designed for N, Z and T rotors, unless otherwise stated. Other rotor styles, on request.



\*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.

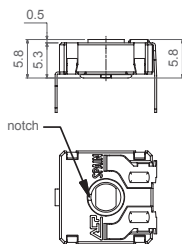
## Models

H0, H2,5, H5, V12,5, V15, V15...CFF, VSMD, VSMD...CY. For other models, such as those shown for the CA14, please inquire.

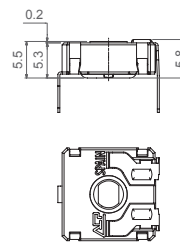


## Models

### LV 15



### > LV 15



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.

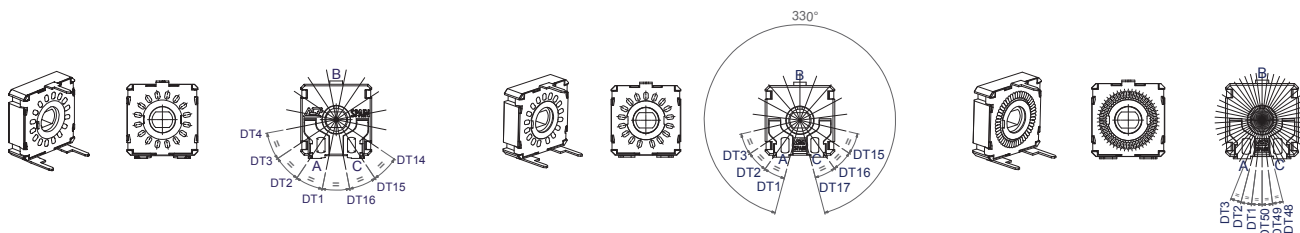
Detents can be light or strong, or even a combination of different feelings. They can be evenly distributed along the angle (standard) or tailored to match customers' request. They can also be combined with special tapers: constant value areas, open circuit zone, different slopes, etc. One common example 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:

### 16DT Standard

### 17DT (Max. non overlapping V)

### 50DT (Max. for feeling)



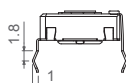
Our patented design with two wipers gives more stable electrical parameters, improved reliability and Contact Resistance Variation (CRV), as well as narrower tolerances for detent positioning.

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.

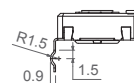
## Terminals

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.

### SNP

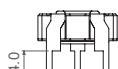


### SNR

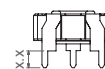


Also, there is an option of having shorter terminal tips.

### Standard Terminal



### Shorter terminal, TPXX (under request)



**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.

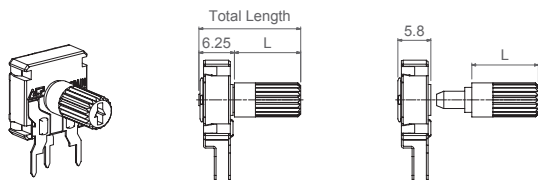
**Shafts**

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.

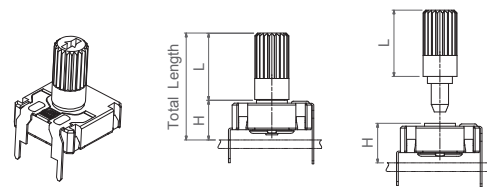
Shafts can be sold separately or already mounted on the potentiometer.

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:

**H potentiometer + shaft**



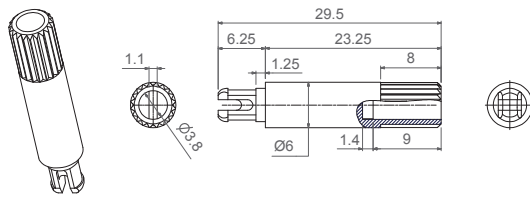
**V potentiometer + shaft**



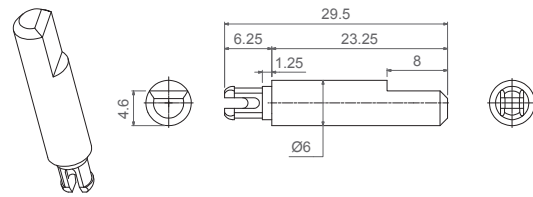
(H is set by the potentiometer model. See page 5)

<b>Shaft</b>	14042	14065 (For E rotor)	14117	14056	14081	14187	14251	14067	14008	14015	14066	14084	14250	14072	14073
<b>L Dimension</b>	7.05	11.50	11.70	12.25	18.25	18.75	18.75	27.75	23.25	23.25	23.50	23.50	25.00	31.75	38.50

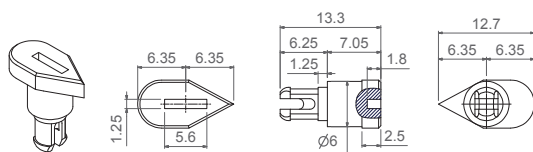
**14008**



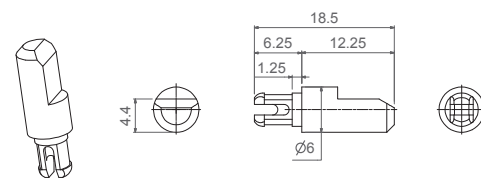
**14015**



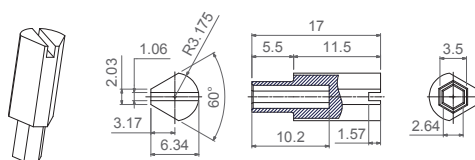
**14042**



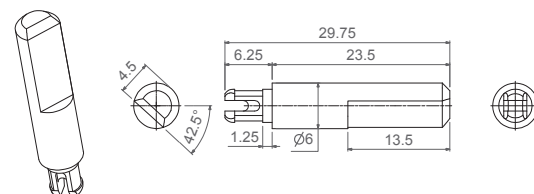
**14056**



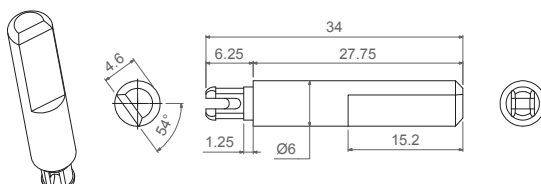
**14065 (Designed for E rotor)**



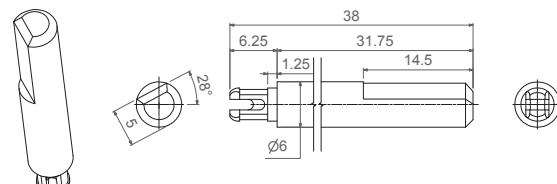
**14066**



**14067**

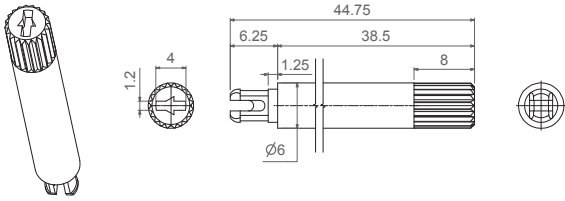


**14072**

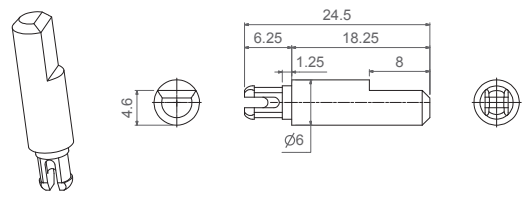


**Shafts**

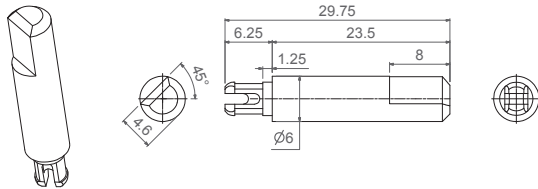
**14073**



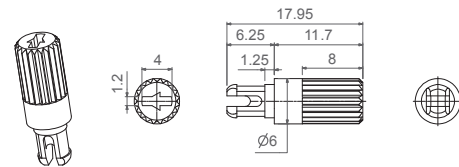
**14081**



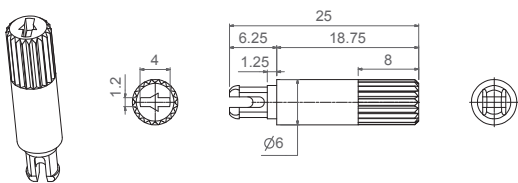
**14084**



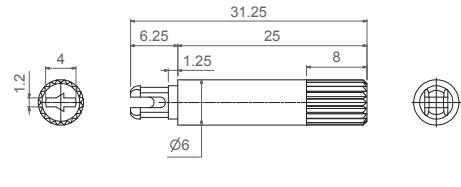
**14117**



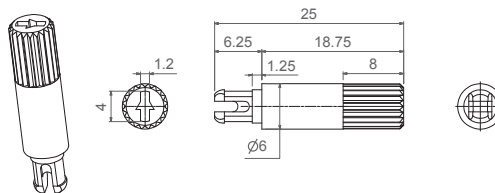
**14187**



**14250**



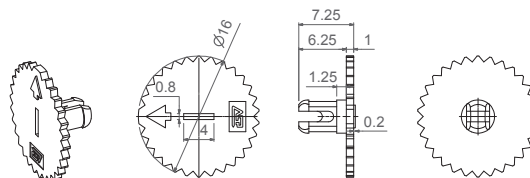
**14251**



**Thumbwheel**

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.

**14003**



**Bulk packaging:**

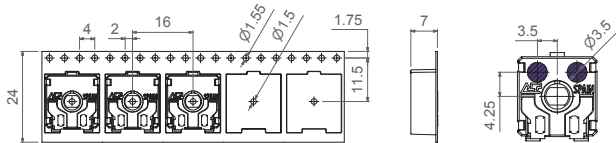
CS14 model	With shaft or thumbwheel inserted?	Pieces per small box (150 x 100 x 70)	Pieces per bigger box (250 x 150 x 70) add CG at the end of the product description
H0 - H2,5 - H5 - V12,5 V15 - V15CFF	None, only potentiometers.	200	700
	14003, 14117, 14042, 14056, 14065	100	400
	14008, 14015, 14066, 14067, 14072, 14073, 14081, 14084, 14187, 14250.	75	To be determined.

**Tape & Reel packaging:**

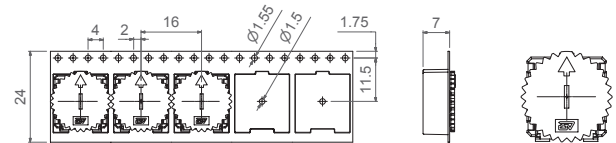
	With thumbwheel inserted?	13" Reel, with 24mm width tape	15" Reel, with 24mm width tape
VSMD (on request*)	None, only potentiometers.	500 pcs per reel, 16mm step between cavities.	800 pcs per reel, 16mm step between cavities.
	14003	450 pcs per reel, 16mm step between cavities.	To be determined.
VSMD...CY (on request*)	None, only potentiometers.	350 pcs per reel, 20mm step between cavities.	500 pcs per reel, 20mm step between cavities.
	14003	To be determined.	To be determined.

Sticker on component available on request.

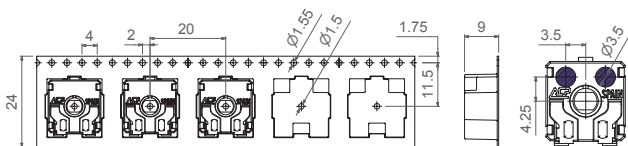
**VSMD-T&R**



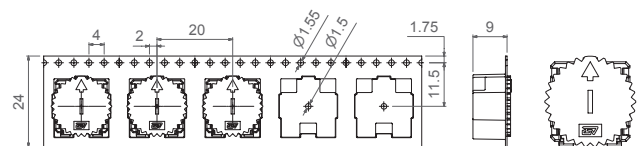
**VSMD-T&R...WT-14003**



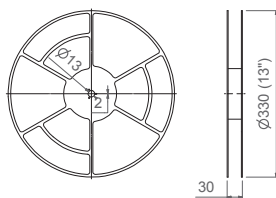
**VSMD-T&R...CY**



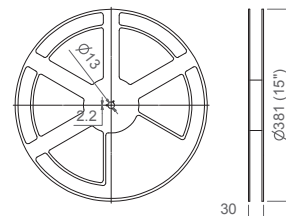
**VSMD-T&R...CY WT-14003**



**13" Reel**



**15" Reel**





## Electric Specifications

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

	CS14 Through-hole	CS14 SMD (upon availability)
Range of resistance values* Lin (A) Log (B) Antilog (C)	100Ω ≤ Rn ≤ 5MΩ 1 KΩ ≤ Rn ≤ 2M2Ω	100Ω ≤ Rn ≤ 1MΩ 1 KΩ ≤ Rn ≤ 1 MΩ
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)	- ±30% ±40% ±50% -
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 ≤ 5MΩ	+200/ -300 ppm +200/ -500 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.

## Mechanical Specifications

### CS14 Through-hole and SMD

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.

### CS14 Through-hole and SMD

	Test conditions	Typical variation of Rn
Damp heat	500 h. at 40°C and 95% RH	±20%
Temperature Coefficient	16 h at 85°C, plus 2 h at -25°C	±20%
Load life	1.000 h. at 50°C	±20%
Mechanical life	15.000 turns at 10 c.p.m. and at 23°C ± 2°C	±20%
Storage (3 years)	3 years at 23°C ± 2°C	±3%

**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 guarantying 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)

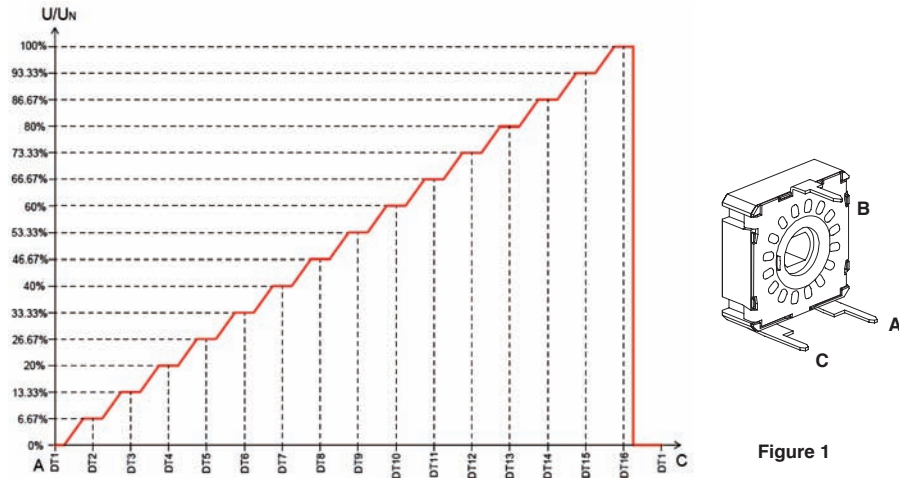


Figure 1

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  $22.5^\circ \pm 3^\circ$  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 ( $U/U_n = 100\%$ ) to the detent number 1 ( $U/U_n = 0\%$ ). 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% ( $U/U_n$ ) 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)

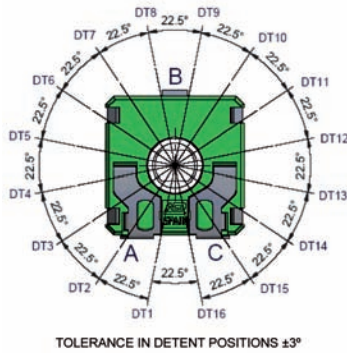


Figure 2

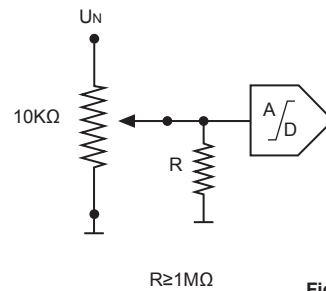


Figure 3

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.

Detent	U/UN	Decimal	Hexadecimal	Binary	Octal
1	(0,00±3,32)%	0	0	0000	0
2	(6,67±3,32)%	1	1	0001	1
3	(13,33±3,32)%	2	2	0010	2
4	(20,00±3,32)%	3	3	0011	3
5	(26,67±3,32)%	4	4	0100	4
6	(33,33±3,32)%	5	5	0101	5
7	(40,00±3,32)%	6	6	0110	6
8	(46,67±3,32)%	7	7	0111	7
9	(53,33±3,32)%	8	8	1000	10
10	(60,00±3,32)%	9	9	1001	11
11	(66,67±3,32)%	10	A	1010	12
12	(73,33±3,32)%	11	B	1011	13
13	(80,00±3,32)%	12	C	1100	14
14	(86,67±3,32)%	13	D	1101	15
15	(93,33±3,32)%	14	E	1110	16
16	(100,00±3,32)%	15	F	1111	17

Figure 4