



DC Current Transducers

CT-2000(V)

CT-3000(V)



## User's Manual



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PRECISION CURRENT TRANSDUCERS



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# Document Revisions

| Revision | Date                           | Comment   |
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| 0.1      | November 22 <sup>nd</sup> 2024 | Document created  |
| 0.2      | May 13 <sup>th</sup> 2025      | Updated pictures  |
| 1        | November 10 <sup>th</sup> 2025 | Updated pictures. Updated TEDS section.<br>Update impedance and time constant values in<br>Voltage Output version |



## Safety information - Warnings

CAEN ELS will repair or replace any product within the guarantee period if the Guarantor declares that the product is defective due to workmanship or materials and has not been caused by mishandling, negligence on behalf of the User, accident or any abnormal conditions or operations.

**Please read carefully the manual before operating any part of the instrument**



### Do NOT open the boxes

**CAEN ELS d.o.o. declines all responsibility for damages or injuries caused by an improper use of the Modules due to negligence on behalf of the User. It is strongly recommended to read thoroughly this User's Manual before any kind of operation.**

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### Disposal of the Product

The product must never be dumped in the Municipal Waste. Please check your local regulations for disposal of electronics products.



Read over the instruction manual carefully before using the instrument.  
The following precautions should be strictly observed before using the device:

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**WARNING**

- Do not use this product in any manner not specified by the manufacturer. The protective features of this product may be impaired if it is used in a manner not specified in this manual.
- Do not use the device if it is damaged. Before you use the device, inspect the instrument for possible cracks or breaks before each use.
- Do not operate the device around explosives gas, vapor or dust.
- Always use the device with the cables provided.
- Turn off the device before establishing any connection.
- Do not operate the device with the cover removed or loosened.
- Do not install substitute parts or perform any unauthorized modification to the product.
- Return the product to the manufacturer for service and repair to ensure that safety features are maintained

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**CAUTION**

- This instrument is designed for indoor use and in area with low condensation.

The following table shows the general environmental requirements for a correct operation of the instrument:

| Environmental Conditions | Requirements                   |
|--------------------------|--------------------------------|
| Operating Temperature    | 0°C to 50°C                    |
| Operating Humidity       | 30% to 85% RH (non-condensing) |
| Storage Temperature      | -10°C to 60°C                  |
| Storage Humidity         | 5% to 90% RH (non-condensing)  |

# 1. Introduction

This chapter describes the general characteristics and main features of the  current transducers.

## 1.1 Current Transducers Overview

The  current transducers family is based on a closed loop technology that allows accurate and precise monitoring of DC and AC currents with high bandwidth.

Main characteristics of the entire  family are negligible temperature coefficient, excellent linearity and extremely low noise.

The transducers CT-Series family has a transform ratio between primary and secondary. The transform ratio value depends over the CT-Series model. External plastic casing guarantees galvanic isolation between the primary and the secondary circuits in order to allow to current measurements at a different potential and simplifies interfacing when using the  as the feedback element of current regulated power supplies. The internal conductive casing guarantees higher noise immunity and reduces undesired noise pick-up from external sources.

DC current transformers and transducers represent the ideal replacement for systems where Hall-effect sensors or shunt resistors are used as current sensing elements and better performances are needed.

Main application fields for these current transducers are precise and extremely stable regulated power supplies, power inverters and EV Battery Testing.

Due to the excellent characteristics, the  transformers can be used in a variety of calibration, acceptance testing and quality control applications in the industrial and automotive fields.

## 1.2 CT-2000(V) / CT-3000(V) Models and Versions

The CT-2000(V) and CT-3000(V) current transducers are available in two different versions that differ by the output type:

- standard secondary current output or
- buffered voltage output, where low temperature coefficient shunt resistor and low-noise amplifier are embedded in the internal electronics in the **“V” model**.

Connections for power supply and output signals are provided via a standard D-SUB connector, specifically a DE-9 (also commonly referred to as “DB-9”).

The different models and versions of the CT-2000(V) and CT-3000(V) are summarized in the following table (**Table 1**):

| <b>Product Code</b> | <b>Model</b> | <b>Description</b>   |
|---------------------|--------------|--|
| WCT2000XAAAA        | CT-2000      | <b>2000 A Primary Current 0-FLUCS, DB-9 connector</b>                                |
| WCT2000VXAAA        | CT-2000V     | <b>2000 A Primary Current 0-FLUCS, DB-9 connector, Voltage Output, BNC connector</b> |
| WCT3000XAAAA        | CT-3000      | <b>3000 A Primary Current 0-FLUCS, DB-9 connector</b>                                |
| WCT3000VXAAA        | CT-3000V     | <b>3000 A Primary Current 0-FLUCS, DB-9 connector, Voltage Output, BNC connector</b> |

**Table 1:** CT-2000(V) and CT-3000(V) versions and models

The CT-Series transducer with the current output acts mainly as a transformer (with DC capability) that converts a full-scale bipolar primary current to a secondary current up to  $\pm 1.5$  A.

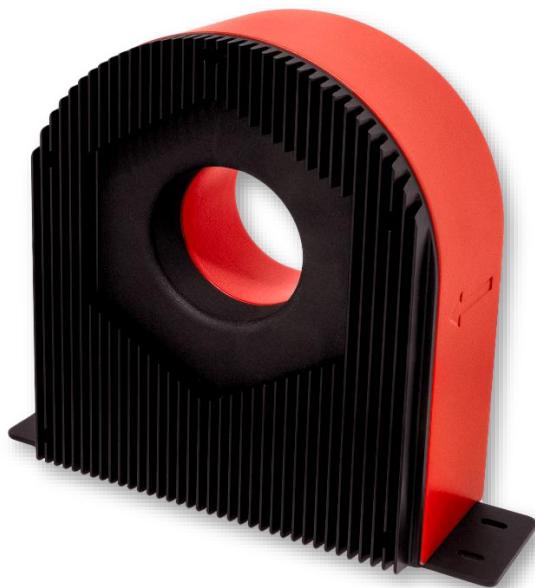
The voltage-output “V” version converts the primary bipolar full-scale current to a secondary output voltage of  $\pm 10$  V.

Front view of a CT-2000(V) and CT-3000(V) current transducer is presented in **Figure 1**.



**Figure 1:** front view of a CT-2000(V), CT-3000(V)  current transducer

Rear view of the same current transducer is presented in **Figure 2**.



**Figure 2:** rear view of a CT-2000(V) and CT-3000(V)  current transducer

## 2. Installation and Operation

General considerations and description of pinout and functionalities are herein presented.

### 2.1 Primary cable routing

Each version of the CT-Series current transducer presents an embossed “arrow” on one side of the plastic casing that indicates the verse of the positive primary current measurement. This arrow can be seen in **Figure 3** on the left side of the enclosure.



**Figure 3:** embossed arrow indicating the direction of positive primary current

## 2.2 Power Supply Voltage Rating

The CT-2000(V) and CT-3000(V) supply voltage recommended is 24 V.

Accepted Voltage range [24 V  $\pm$  3%]:

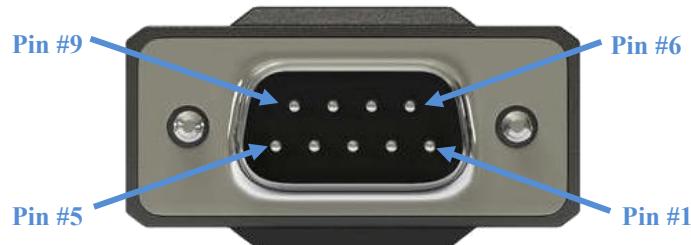
| $V_{Min}$ | $V_{Nom}$ | $V_{Max}$ |
|-----------|-----------|-----------|
| 23,3      | 24        | 24,7      |

Supply voltages have to be fed to pin #9 (+24V) and to pin #4 (GND) of the D-sub 9-pin connector.

Maximum current that can be drawn respectively from CT-2000(V) and CT-3000(V) supply voltages is of 1.2 A and 1.7 A – i.e. (a maximum of 200 mA for supplying the internal electronics circuits and respectively a maximum of 1 A and 1.5 A for the secondary current).

## 2.3 Connector Pinout

The CT-2000(V) and CT-3000(V) have a standard D-SUB 9-pin (or, commonly referred to as “DE-9”) in both their current output and voltage output versions. The standard pin numbering to refer to is herein presented in **Figure 4**.



**Figure 4:** D-sub 9 connector pin numbering

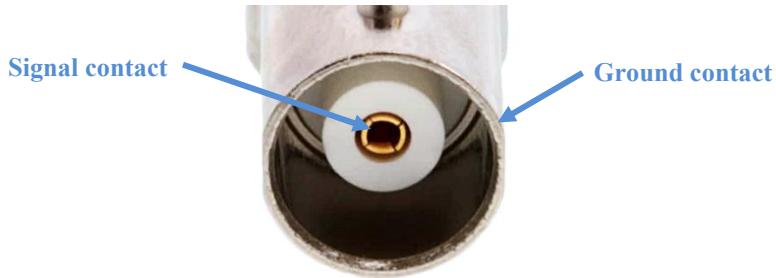
The pinout is presented in **Table 2**.

| Pin # | CT-2000, CT-3000 | CT-2000V, CT-3000V    |
|-------|------------------|-----------------------|
| 1     | Is return        | <b>Do not connect</b> |
| 2     | <b>TEDS+</b>     | <b>TEDS+</b>          |
| 3     | Status -         | <b>Status -</b>       |
| 4     | <b>GND</b>       | <b>GND</b>            |
| 5     | Nc               | <b>Nc</b>             |
| 6     | Is               | <b>Do not connect</b> |
| 7     | <b>TEDS-</b>     | <b>TEDS-</b>          |
| 8     | <b>Status +</b>  | <b>Status +</b>       |
| 9     | <b>+24V</b>      | <b>+24V</b>           |

**Table 2:** CT-2000(V) and CT-3000(V) pinout

Pins not internally connected are indicated in **Table 2** as *Nc*.

The “V”-version have also a BNC connector. **Figure 5** indicates the signal connection.



**Figure 5:** BNC connector for voltage output

## 2.4 Secondary Current (current versions only)

On the “standard” current output versions the secondary current output  $I_S$ , scaled by its current transformation ratio is fed to pin #6. The current return is on pin #1.

Maximum secondary current depends over the full-scale range and the current transform ratio of the sensor. For example, for a CT-2000 the full-scale range is  $\pm 2000$  A and its transformation ratio is 1:2000, thus its maximum secondary current is rated at  $\pm 1$  A. An external shunt resistor, which can be placed close to the user's desired measuring circuit (to avoid the noise pick-up), is needed in order to convert the current signal to a voltage.

The standard current output versions do not include the BNC connector.

## 2.5 Voltage Output (“V” versions only)

A buffered output voltage signal is present on the voltage output versions of the transducers in order to allow easier connection of the DCCT to an external circuit or an Analog to Digital converter (ADC).

The full-scale bipolar output signal  $V_O$  of the BNC is as follows:

- +10V output if the primary current is equal to positive full scale of the sensor;
- -10V output if the primary current is equal to negative full scale of the sensor.

This behavior can be resumed in the gain parameter  $G$ , in [V/A], expressed as the ratio between the transducer output voltage  $V_O$  and the primary current  $I_P$ .

$$G = \frac{V_O}{I_P}$$

BNC Ground contact is internally connected to GND (pin #4).

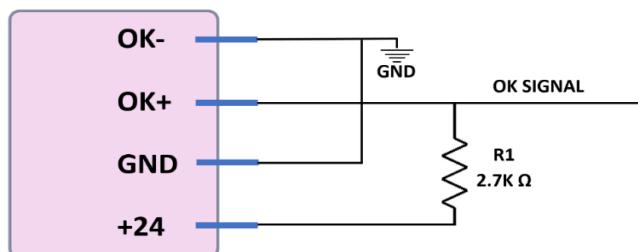
In the voltage output “V”-version of the transducers the current output pin I<sub>S</sub> (pin #6) and its return (pin #1) shall not be connected to any external circuit.

Please note that output impedance for the “V”-version models is 10 Ω and it is low-pass filtered with a 0.16-μs time constant.

## 2.6 STATUS Signal

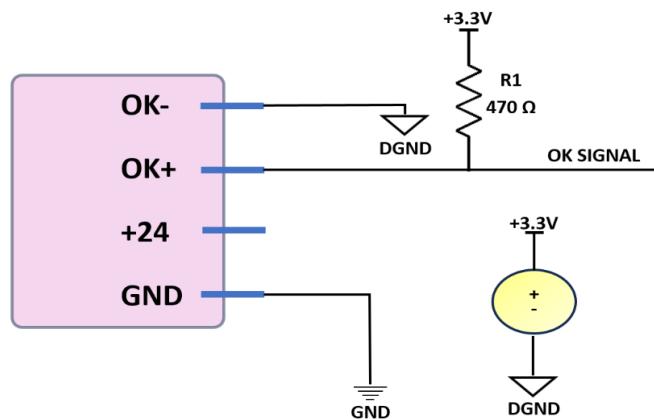
A STATUS signal, obtained from the outputs of an optocoupler phototransistor (**Status+** and **Status-**, pins #8 and #3) is present on all versions. Please note that the **OK-** signal is not internally connected to the ground potential and can be connected to an external reference potential. A green LED is also present on the front side of the DCCT indicating the correct operation of the devices.

A pull-up resistor is needed (between the **OK+** and some supply voltage referred to the **OK-** potential) in order to correctly obtain the correct signaling. Two examples on how to connect the **OK+** and **OK-** signals are hereafter presented in **Figure 6** and in **Figure 7**.



**Figure 6:** OUT OK signals connections using the +24V and the GND pins

Note that the connection scheme in **Figure 6** refers to the GND potential. The **OK\_SIGNAL** is at a **low level** (<0.4V) when the current transducer is working correctly. If the transducer is not working, the **OK\_SIGNAL** is at a **high level** (>23.5V).



**Figure 7:** OUT OK signals connections as digital interfacing to +3.3V

In the configuration presented in **Figure 7**, the current transducer can be easily interfaced to a digital microcontroller, a Digital Signal Processor or an FPGA, supplied by a +3.3V voltage source.

Please note that the +3.3V supply and the OK\_SIGNAL is referred to DGND potential, which can be the same or different from the GND potential on which the transducer device is supplied from. The OK\_SIGNAL is at low level (<0.4V) when the transducer is correctly working and at high-level (>3V) when not.



**Figure 8:** STATUS – OUT OK indications

The OUT OK green light is on, as shown in **Figure 8**, whenever the device is correctly working and regulating secondary output current – i.e. zero flux is established and secondary circuit is closed on the shunt resistor (external or internal in the “V” versions).

## 2.7 TEDS (Transducers Electronic DataSheet)

TEDS is used to implement data and to store the electronic datasheet of the transducer in an embedded 1-Wire EEPROM memory. Communication and power are provided by pins 2 and 7 (TEDS+ and TEDS-, respectively) of the D-Sub9 connector.

To access the EEPROM memory and insert, read or update information, a programmer is required. Furthermore, a 2.2k  $\Omega$  pull up resistor is needed to obtain the correct voltage reference for the provided signaling.

An example of the connection between a microcontroller and the EEPROM memory is displayed in **Figure 9**.

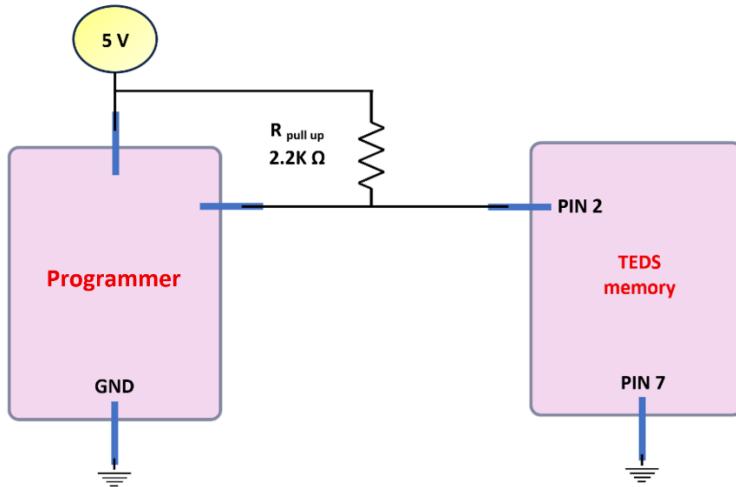


Figure 9: EEPROM and programmer connection.

The basic TEDS electronic datasheet content is defined by the information in the following table:

| BASIC TEDS             |            |                             |
|------------------------|------------|-----------------------------|
|                        | Bit Length | Allowable Range             |
| <b>Manufacturer ID</b> | <b>14</b>  | <b>17-16381</b>             |
| <b>Model Number</b>    | <b>15</b>  | <b>0-32767</b>              |
| <b>Version Letter</b>  | <b>5</b>   | <b>A-Z (data type Chr5)</b> |
| <b>Version Number</b>  | <b>6</b>   | <b>0-63</b>                 |
| <b>Serial Number</b>   | <b>24</b>  | <b>0-16777215</b>           |

Table 3: Basic TEDS.

## 2.8 Mounting

The current transducers can be mounted in different positions, depending on user's needs and opportunities, but heatsink shall never be faced to the floor.

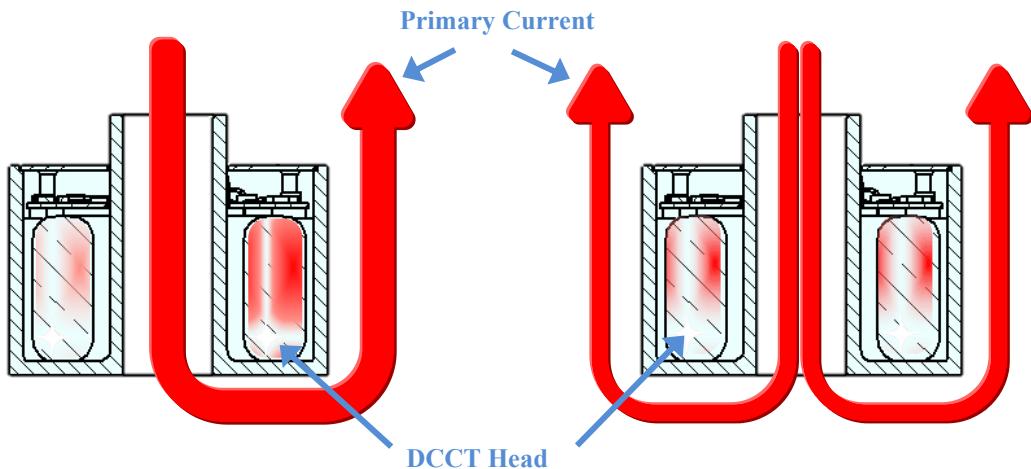
The transducers are designed to be used in rack-mount applications, by means of four holes are present on the bottom of the device as indicated in the **Figure 10**.



Figure 10: bottom mounting holes pattern

## 2.9 Primary Current Path

A non-symmetrical layout of the primary current return path may degrade the accuracy and the noise of the current transducer. A cross section of the transducer plastic case illustrates what happens if the primary current is not equally distributed over the perimeter of the current transducer head.



**Figure 11:** primary current path; non-recommended layout (left) and recommended layout (right)

**Figure 11** (left) shows what happens if the primary current is routed over one side of the DCCT head: the Magnetic flux density is higher in the area between the “U” path.

If the current path return is split in two or more paths over the DCCT Head, the magnetic flux density is more homogenous over the perimeter and the resulting measurement will be more accurate. If the split return path is not possible, it is preferable to keep the retuning cable as far as possible from the DCCT Head.

## 2.10 Full-Scale Current

Rated full-scale primary current can be easily changed by carrying out multiple turns on the primary conductor hole.

The full-scale current can then be scaled by a factor of  $N$ , with  $N$  = number of turns of the primary conductor around the hole. As an example (see figure **Figure 12**), a primary full-scale current of 3000 A (in the CT-3000 model) can be easily scaled by a factor 2 (applying two primary turns), and so the obtained full-scale will be 1500 A or by a factor 3 (applying three turns) and so the obtained full-scale will be 1000 A and so on.

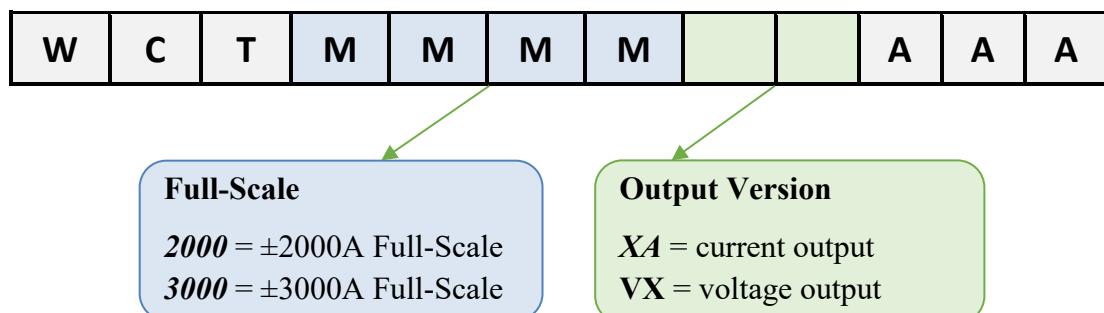


**Figure 12:** primary full-scale current scaled by a factor 2 (2 primary turns - left) and scaled by 3 (3 primary turns - right)

**Do not apply rated nominal full-scale primary current (for example 3000A for CT-3000) when carrying out multiple turns on primary conductor hole.**

### 3. Ordering Options

The CT-2000(V) and CT-3000(V) current transducers have two different versions differing by the secondary output signal types. The ordering code is formatted as follows:



*NOTE: fields/characters shaded in grey color are fixed.*

## 4. Technical Specifications

Technical Specifications for current transducers of the CT-2000(V) and CT-3000(V) series are herein presented.

| Technical Specifications                                | CT-2000(V)  | CT-3000(V)  |
|---|---|---|
| Current Transformation Ratio - N                        | 1:2000  | 1:2000  |
| Maximum DC Primary Current - $I_{P(DC)}$                | $\pm 2000 \text{ A}$  | $\pm 3000 \text{ A}$  |
| Maximum RMS Primary Current - $I_{P(RMS)}$              | 1414 A  | 2121 A  |
| Current Polarity  | Bipolar   |   |
| Maximum DC Secondary Current - $I_{S(DC)}$              | $\pm 1 \text{ A}$   | $\pm 1.5 \text{ A}$   |
| Maximum RMS Secondary Current - $I_{S(RMS)}$            | 707 mA  | 1.06 A  |
| External Shunt Resistor Value - $R_S$                   | 0...10 $\Omega$   | 0...5 $\Omega$  |
| Small Signal Bandwidth ( $\pm 3 \text{ dB}$ ) – typ. BW | $> 100 \text{ kHz}$   |   |
| Equivalent Input Noise (@Bandwidth) *                   | $< 2.5 \text{ ppm} (@200 \text{ Hz})$<br>$< 15 \text{ ppm} (@50 \text{ kHz})$ | $< 2 \text{ ppm} (@200 \text{ Hz})$<br>$< 10 \text{ ppm} (@50 \text{ kHz})$ |
| Output Voltage ("V"-version) - $V_{OUT}$                | $\pm 10 \text{ V}$  |   |
| Output Voltage Gain ("V"-version) - $V_{OUT}/I_{P(DC)}$ | 5 mV/A  | (1/300) V/A   |
| Maximum Output Current ("V"-version)                    | $\pm 15 \text{ mA}$   |   |
| Temperature Coefficient - TC                            | $< 0.5 \text{ ppm/K}$<br>$< 3 \text{ ppm/K} ("V"-version)$                    |   |
| Non-Linearity   | $< 3 \text{ ppm/FS}$<br>$< 15 \text{ ppm/FS} ("V"-version)$                   |   |
| Induction into Primary (0-100 kHz) typ.                 | $< 90 \mu\text{V(RMS)}$   |   |
| Offset (with factory calibration)                       | $< 10 \text{ ppm/FS}$   |   |
| Protection Signal                                       | OK Status - Primary Over-Current  |   |
| Supply Voltage ( $\pm 3\%$ )                            | $+24 \text{ V}$   |   |
| Current Consumption                                     | 200 mA + $I_S$  |   |
| Secondary Coil Resistance - $R_{SEC}$ *                 | 7.8 $\Omega$  | 7.8 $\Omega$  |
| Accuracy (typ.)   | $< 100 \text{ ppm / FS}$<br>$< 0.25\% / FS ("V" - version)$                   |   |
| Connections   | D-sub 9 connector<br>BNC connector ("V"-version)                              |   |
| Operating Temperature Range                             | 0°C - 50°C  |   |
| Mechanical (Outer) Dimensions                           | 236 x 215 x 98 mm   | 236 x 215 x 98 mm   |
| Primary Conductor Hole Diameter - $\emptyset$           | 67 mm   |   |
| Clearance   | 24mm  |   |
| Maximum Weight  | 5 kg  |   |

\* The measure of the secondary coil resistance made at standard 25°C temperature

Table 4: Technical Specification

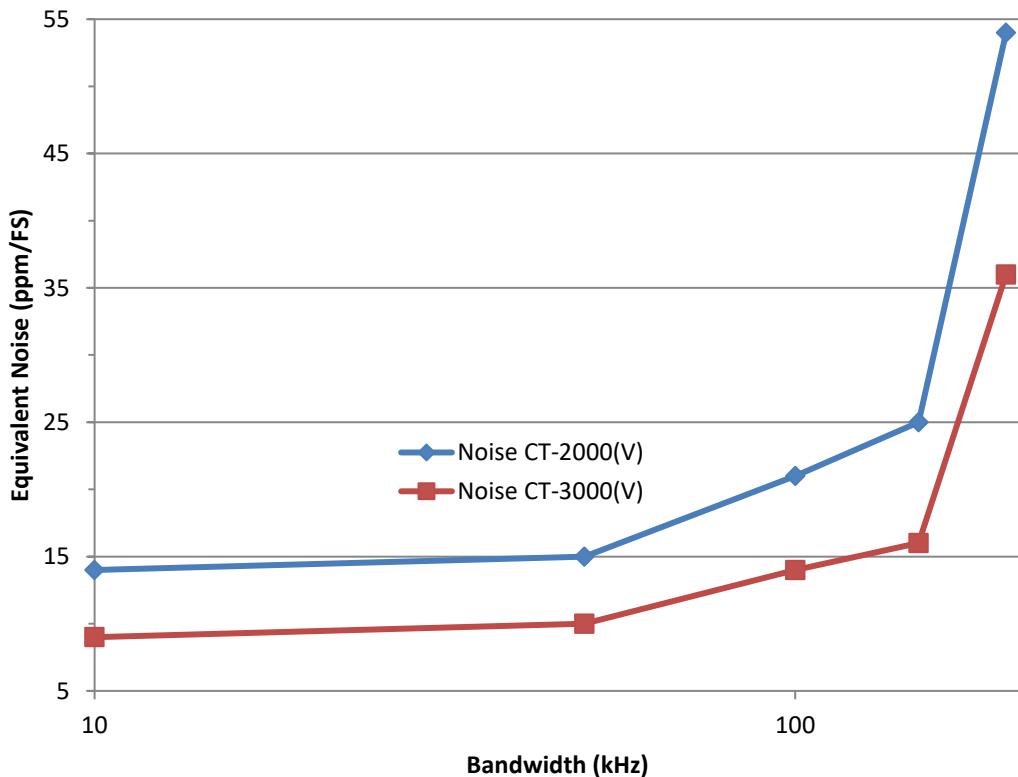


## 4.1 Equivalent Input Noise

The typical equivalent input noise of the transducers is hereafter presented as a function of the measuring bandwidth and of the output version. The table and its graph are valid for both current and voltage output options.

| Bandwidth | CT-2000(V)<br>Equivalent Noise<br>(ppm/FS) | CT-3000(V)<br>Equivalent Noise<br>(ppm/FS) |
|-----------|--|--|
| 10 kHz    | 14   | 9  |
| 50 kHz    | 15   | 10   |
| 100 kHz   | 21   | 14   |
| 150 kHz   | 25   | 15   |
| 200 kHz   | 54   | 36   |

**Table 5:** Equivalent Noise (typical values)



**Figure 13:** Equivalent noise graph (typical values)

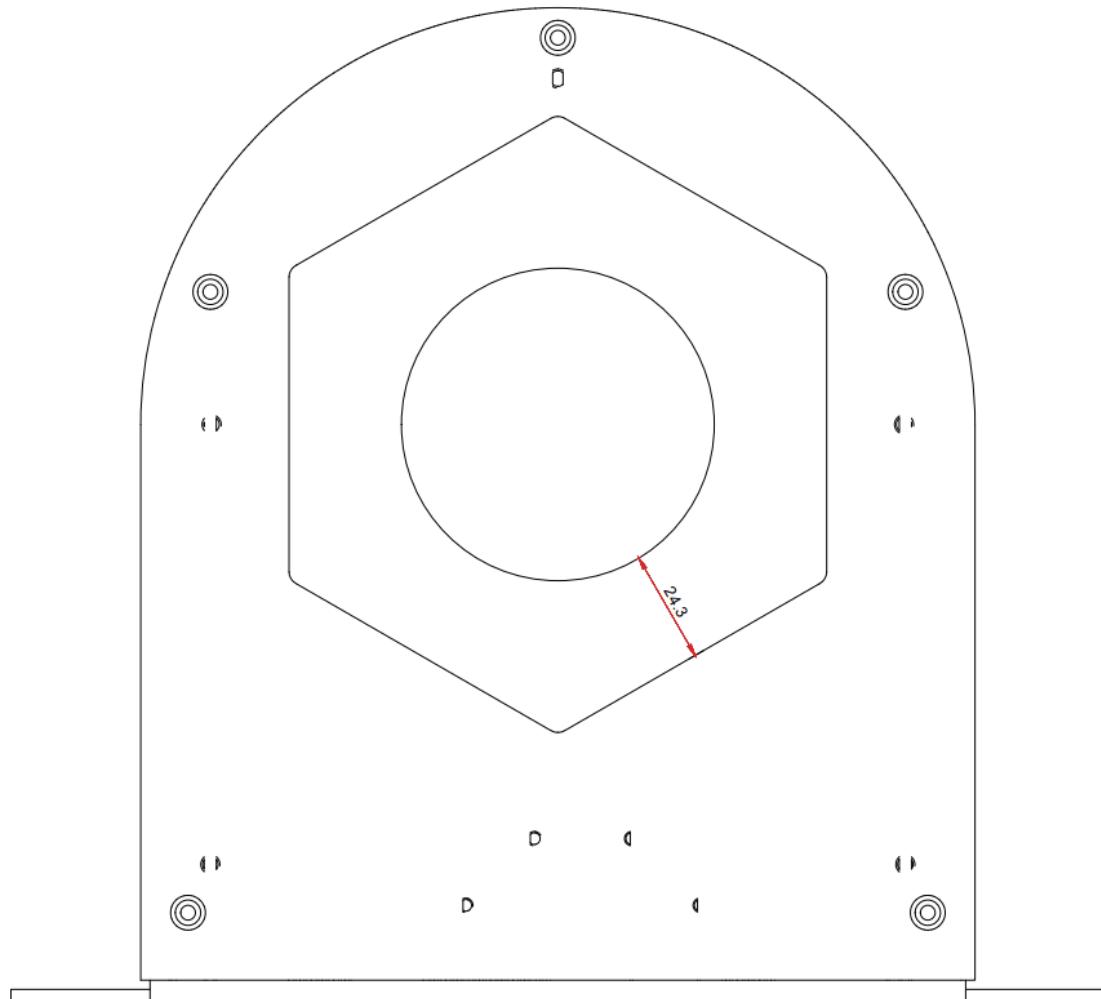
## 4.2 Insulation characteristics

In the following table are represented the insulation characteristics of the CT-2000(V) and CT-3000(V) current transducers.

| Parameter | Value | Reference                                      |
|-----------|-------|--|
| Clearance | 24 mm | Shorter distance path<br>(primary – secondary) |
| Creepage  | 24 mm | Shorter distance path<br>(primary – secondary) |
| CTI       | 600 V | Comparative tracking index<br>(IEC 60112)      |

**Table 6:** Insulation characteristics

The voltage insulation category could be improved, if insulated cable is used for the primary circuit.



**Figure 14:** Minimum clearance

### 4.3 External Shunt Resistor

The maximum value of the external shunt resistor that can be connected on the  $I_s$  output pin in the current-output versions is shown hereafter in the following charts.

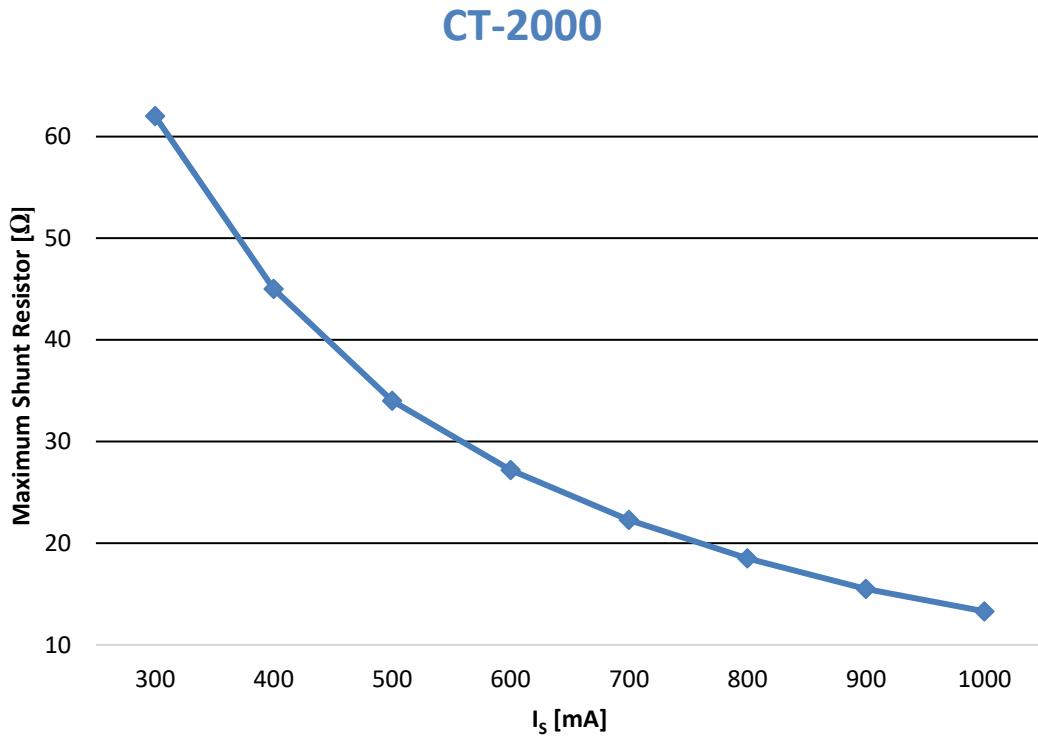


Figure 15: CT-2000 maximum external shunt resistor (Current version only)

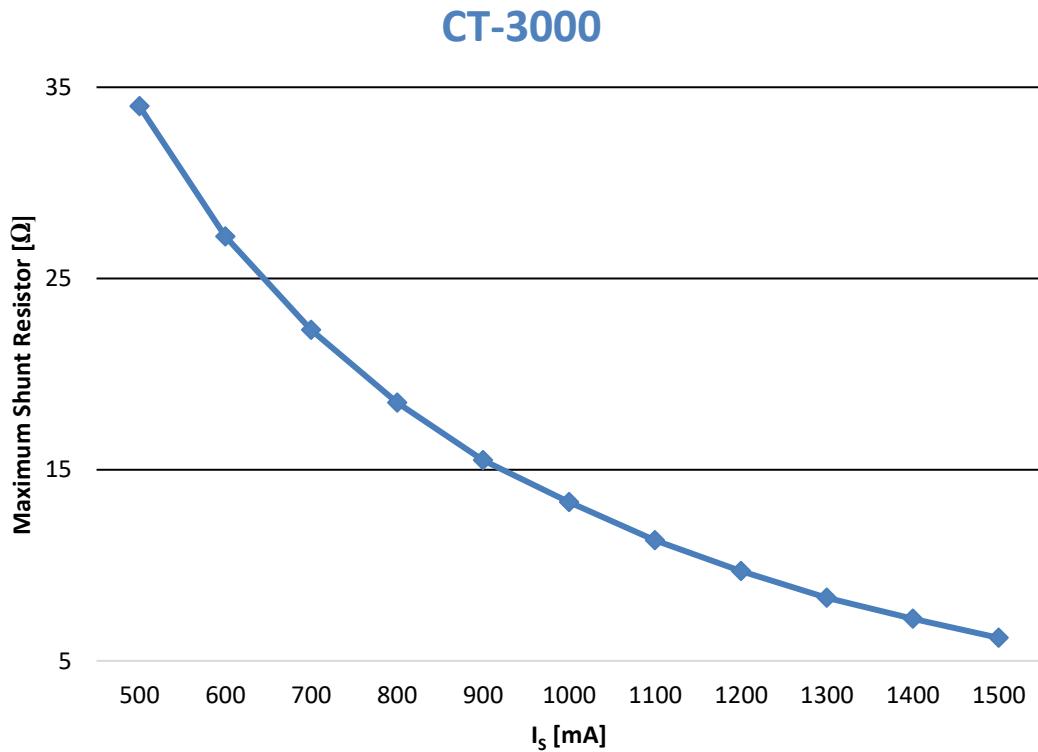


Figure 16: CT-3000 maximum external shunt resistor (Current version only)

## 5. Mechanical Dimensions

The mechanical dimensions of the CT-2000(V) and CT-3000(V) case are hereafter presented (all dimensions are in **mm**).

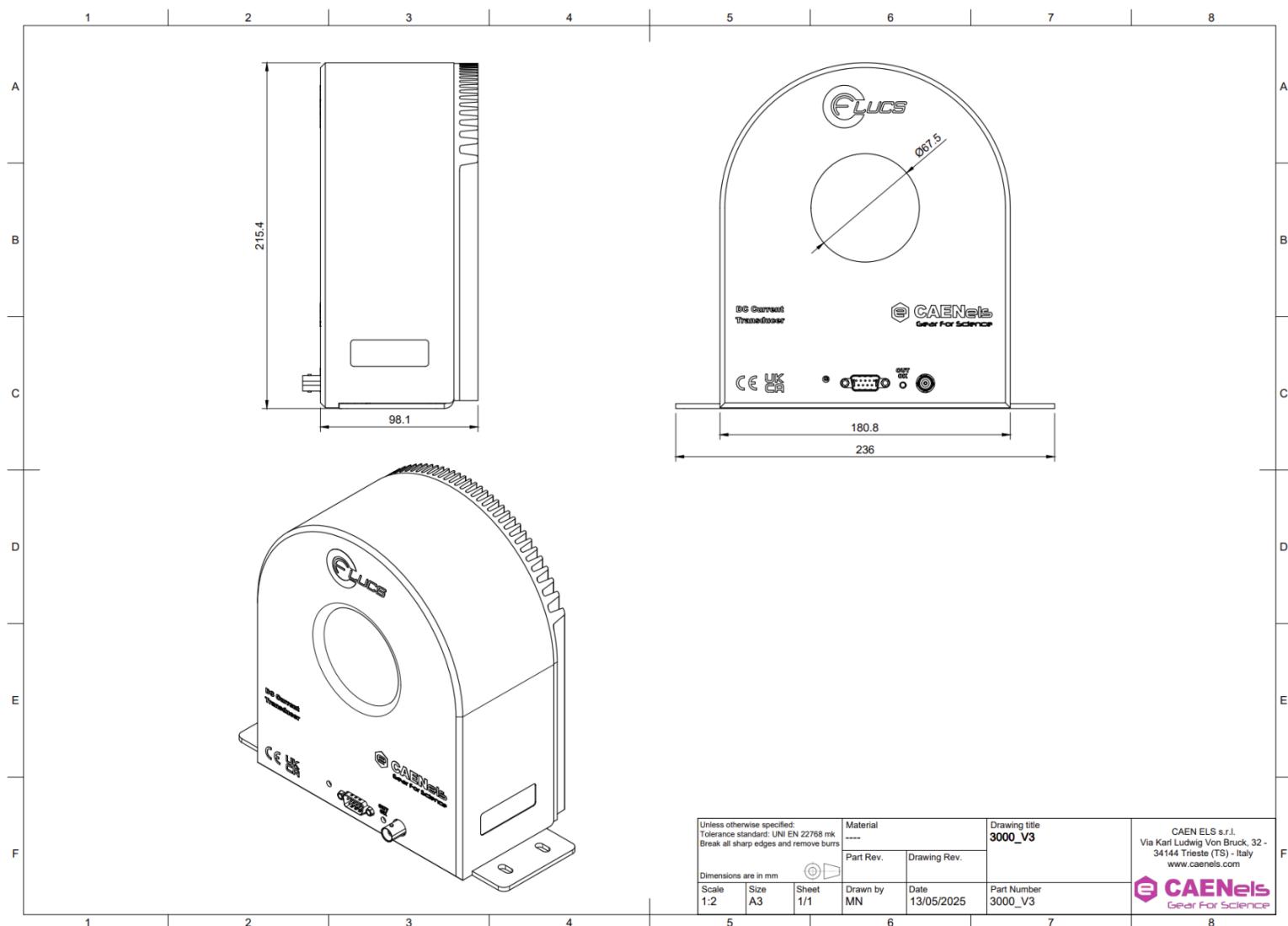


Figure 17: Mechanical drawings