Kipp & Zonen

INSTRUCTION MANUAL

CT24

SIGNAL AMPLIFIER 4 - 20 mA

0305.260

IMPORTANT USER INFORMATION

Reading this entire manual is recommended for full understanding of the use of this product

Should you have any comments on the product or this manual we will be pleased to receive them at:

Kipp & Zonen B.V.	
Röntgenweg 1	2624 BD Delft Holland
P.O. Box 507	2600 AM Delft Holland
Phone	+31 (0)15 2698000
Fax	+31 (0)15 2620351
E-mail	info.kipp@kippzonen.com

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Manual version: 0604

CE

Declaration of Conformity

According to EC guideline 89/336/EEC 73/23/EEC

We **Kipp & Zonen B.V.**
Röntgenweg 1
2624 BD Delft

Declare under our sole responsibility that the product

Type: **CT 24**
Name: **Solar Sensor Amplifier 4 – 20 mA**

To which this declaration relates is in conformity with the following standards:

Imissions	EN 50082-1	Group standard
	IEC 1000-4-2	
	IEC 1000-4-3	
	IEC 1000-4-4	
Emissions	EN 50081-1	Group standard
	EN 55022	
Safety standard	IEC 1010-1	

Following the provisions of the directive

B.A.H. Dieterink
President
KIPP & ZONEN B.V.

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1. GENERAL INFORMATION

With the CT 24 it is possible to convert a low level voltage output from a solar sensor to the standard level of 4 – 20 mA or (using the installed 500 Ohm resistor) to a 2 – 10 Volt signal.
The CT 24 amplifier is designed to use with Kipp & Zonen solar sensors, to allow long cables between sensor and data logger without external interference.

The large operation temperature range from - 30°C to + 70°C and the waterproof housing (IP 65) makes that the CT 24 can be used under the same conditions as all solar sensors.

The amplification can be adjusted from the standard 0 – 20 mV is 4 – 20 mA to a value that takes the calibration factor of the sensor into account, like 0 – 1600 W/m² is 4 – 20 mA.
Even negative inputs are allowed through a positive shift of the zero point from +4 to + 8 mA. This allows for negative input signals of about 250 W/m² like a pyrgeometer and net radiometer produces.

The CT 24 is protected against reversed polarity, voltage surges on input and output lines and is shielded against EMF disturbance.
For pyranometers with temperature sensors there are special connector strips in the CT 24 to connect these sensors from in going to out-going cable.

2. SPECIFICATIONS

Current output range nominal	4 to 20 mA
Voltage output range @ R_L = 500 Ω	2 to 10 V
Gain, factory set	1 mA / mV +/- 0.1%
Gain adjust	+0.5 to +1.0 mA / mV
Zero, factory set	+4 mA +/- 0.1%
Zero adjust	+3 to +8 mA
Non-linearity	< 0.1%
Temperature dependence of gain	within +/- 0.01% / K
Zero drift	typical +/- 0.4 µV / K
Input impedance	1 MΩ
Input range @ gain 0.5, zero 4 mA	0 to +32 mV
@ gain 0.5, zero 8 mA	-8 to +24 mV
@ gain 1, zero 4 mA	0 to +16 mV
@ gain 1, zero 8 mA	-4 to +12 mV
Power supply @ $R_L \leq 100$ Ω	min. 12 to 30 VDC
Power supply for voltage output 10V	min. 20 VDC
Temperature range (operating)	-30°C to +70°C
Housing	Aluminium, grey lacquered
Dimensions W x D x H	64 x 58 x 34 mm
Water proof	IP 65 / DIN 40050
Cable glands size	4 to 6,5 mm

3. CONNECTION OF THE CT 24

The CT 24 is meant to boost the (low level) output signal of a solar sensor. Therefore the CT 24 amplifier needs to be **close to the sensor** to maintain a high signal to noise ratio in the cable.
The internal layout of the CT 24 is shown in figure 3.1.

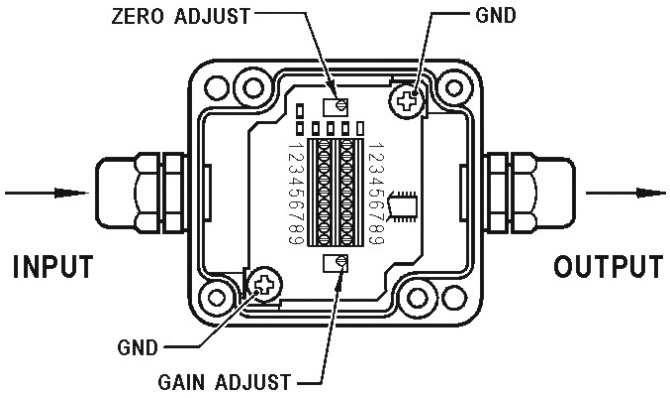


figure 3.1 Internal layout of the CT 24

To prevent errors due to current loops between input and output it is necessary that the sensor outputs are floating (not connected to ground) or that the (–) from the power supply is not connected to ground.

The passive Kipp & Zonen sensors have floating outputs (not connected to sensor housing or shield), so the inputs of the CT 24 will be floating.
Actually the **rule of thumb** is that any connection between CT 24 input LO and output LO is not allowed (e.g. accidentally both grounded).
In case of doubt check the impedance of the sensor wires against the sensor housing, this should be infinite.

3.1 Minimising interference

Use sensors with shielded cables.
All Kipp & Zonen sensor cables have an internal shield that can be connected to a ground.
Many passive Kipp & Zonen sensors have the shield connected to the sensor housing. If the sensor is mounted to a grounded frame, the shield of the input cable is grounded too.

If the grounding at the sensor is not sure, but shielding is necessary, the shield can be grounded via the output cable or at the CT 24. For this purpose pin 1 of the input connector strips can be used or one of the screws that holds the PC board in place.
The output cable can be unshielded or shielded.

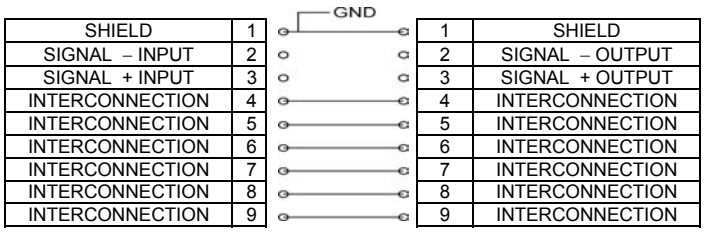


figure 3.2 internal connection strip

3.2 Selecting the supply voltage

The CT 24 operates as a so-called 2 wire current transmitter. This means that the amplifier receives its operating current from the loop that represents the current output signal.
The loop has to be powered with a power supply or active receiver capable of providing a voltage between 12 and 30 Volt @ 100 Ohm “loop resistance”. When later on the current is to be transformed to a voltage, it is important to select the power supply voltage in accordance with the desired output voltage.

Example: Required voltage over the CT 24 is 10 Volt (minimum value)
Required voltage over the 500 Ohm resistor is 10 Volt (@ 20mA)
This implies that the supplied voltage has to be at least 10+10 = 20 Volt.

Be aware that an active sensor (with some electronics) can generally not be powered together with its CT 24 by the same power supply. In that case the sensor output is normally connected with the common of the power supply and consequently also with the CT 24 output LO. This is against the rule of thumb.

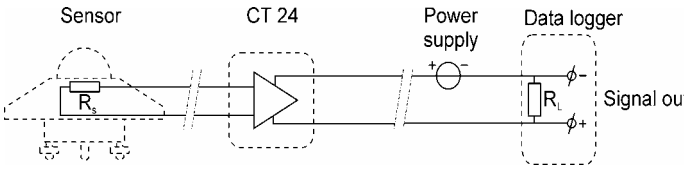
3.3 Connection for current output

When the CT 24 is used as a standard 4–20 mA amplifier (transmitter) only 2 input and 2 output wires have to be connected plus two times the shielding of both cables. This configuration is least sensitive to shielding and grounding problems, because the voltage variations in the cable leads are relative small.

Grounding and coupling of the shields from input cable and output cable is often no problem and the power supply and data logger common may be grounded as well, preferably all at the same ground.

The cable coming from the sensor is lead through the cable gland and directly connected to pin 2 (-) and 3 (+) of the input connector strip.

Check your sensor manual for the colour of the wires. The outgoing cable has the same number of wires as the input cable and can be connected to the output strip. Make sure both cables have their shield connected to ground.
Input connector pins number 4 till 9 are interconnected with the output connector pins and can be used to transfer the signal from temperature sensors like a Pt100 or thermistor to the output cable.
(First remove the 500 Ω resistor from the terminal strip).



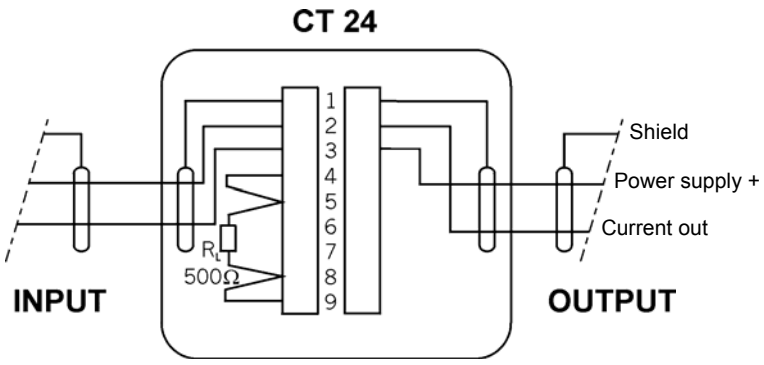


figure 5.3 connection for current output

3.4 Connection for voltage output

When a voltage signal is needed directly from the CT 24, the conversion from current to voltage can be made inside the CT 24. For this purpose a precision 500 Ohm resistor is supplied that can be connected through the connection strip. This requires however four wires. The wires used to supply the current and the wires that carry the voltage output can not be combined. Even though the return from the current loop and the low of the voltage output are connected to the same level, the voltage drop over the cable makes it necessary to use separate wires for the voltage output.

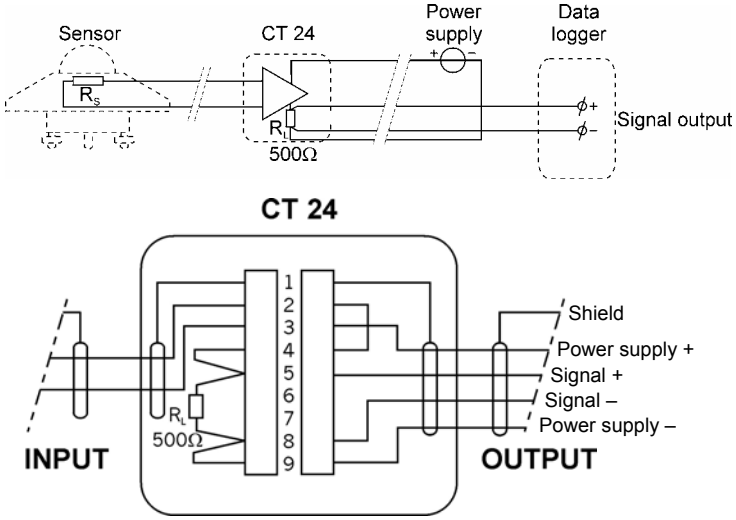


figure 3.4 voltage output connection

So when the CT 24 is used with a voltage output, 2 input and 4 output wires have to be connected plus two times the shielding of both cables.

Of course any other R_L can be used to transform the output current to a voltage, as long as the guideline from chapter 5 is followed. (E.g. RL= 50 Ω to make an output voltage range of 0.2 to 1 V).
If the resistor is placed at the end of the current loop (near the power supply), only two wires are necessary.

The power supply but also the loop "indicator" or passive receiver should be floating from ground to give highest freedom of connection or configuration.

With a voltage output connection it is most advantageous to use a power supply and read out equipment both floating from ground.
Only in that case the shield of the input cable or the sensor housing (and not more) can be grounded at the sensor side.
Connect only input cable shield and output cable shield together, if you have to ground at the data logger side. The CT 24 will oscillate probably, but connecting the signal+ of the data logger to the same ground will stop this. This is of course only possible with floating data logger and floating power supply of course.
(At principle a shielded output cable is no must and the input cable shield can also be carried on to the data logger by a single wire).

At this place we have to precise the **rule of thumb**. The oscillating occur due to a certain capacitive coupling (> 500 pF) between CT 24 input LO and common of power supply and data logger, especially in the voltage output mode with the internal RL= 500 Ω active. The capacitive loop consists of a capacitance from input leads to (grounded) input cable shield. This capacitance is in series with the capacitances from power supply- and data logger- and the corresponding lead in the cable to respectively ground and output cable shield.
The effect of the coupling can be minimized by using a very short input cable, an unshielded output cable and/or making the output voltage swing as low as possible, preferable by using the current output configuration or by reducing the voltage swing to 0.2 to 1 V with an RL = 50 Ω.

Consequently if power supply – and/or data logger – are connected to a ground, grounding the shield of the input cable directly or via the sensor housing introduces oscillation of the CT 24.
Generally speaking no second ground reference is tolerated in a configuration with power supply or data logger connected to ground.
Consequently no shielding against external E.M. fields is possible and also the sensor housing must be floating.
The application field of this configuration is therefore restricted and should be tested at location firstly.

4. NEGATIVE INPUT SIGNALS

When using a pyrgeometer or net radiometer as input, the signal can be both positive and negative. To allow for negative inputs the zero point from the CT 24 can be adjusted to + 8mA. (See fig 3.1 zero adjust)

Example with a pyrgeometer CG 1:

> Sensor output –250 to + 250 W/m^2 = -3.750 mV to + 3.750 mV
> Gain is set to 1 mA / mV
> Output range is 3.75 x 2 = 7.5 mA
>
> To see both negative and positive signals on the output the zero has to be shifted +4 mA (3.75 V minimal) to +8 mA.

See the next chapter for the calibration procedure.

Pyranometer signals can go slightly negative during clear nights. This information is not lost, if a normal zero-point of 4 mA is applied. The loop current can decrease down linearly down to 3 mA.

5. CALIBRATION PROCEDURE

Calibration can be performed in two ways, either the CT 24 is calibrated standard with an amplification of 1mA per 1 mV and no offset adjusted (see chapter 5.1)
Or a special calibration is made where the amplification and / or offset are adapted to the sensor (see chapter 5.2).

Necessary equipment for calibration:

- accurate voltage source
- power supply (+12 to +30 Volt)
- accurate multimeter (current and voltage)
- small screwdriver to adjust the potentiometers
- Resistor (R_S) equal to the sensor element impedance

Caution: Read the warning at chapter 3.4 carefully.

5.1 Standard calibration

To perform a standard calibration, connect R_S in the CT 24 to the input terminal strip pin 2 and 3. The power supply has to be connected to the output pins 2 and 3. Measure the loop current with the multimeter on mA range.
In this situation a zero input is simulated and the zero output can be adjusted to +4 mA with the zero adjust potentiometer.

Then a +16 mV signal has to be applied to the input. With the gain potentiometer the output is adjusted to +20 mA. This gives a maximum full-scale input of +16 mV.

Finally connect the sensor with its shielding etc. and check whether the dark signal (sensor darkened) is again close to 4 mA.
If not, the CT 24 can oscillate etc., and the output signal is unreliable. Check whether the rules of thumb of chapter 3.4 are fulfilled.

5.2 Special calibration.

With special calibration is meant that the sensitivity of the sensor (pyranometer) is used to adjust the gain. This is to obtain for instance a conversion of 200 W/m^2 per mA.

Example: CM 11 with a sensitivity of 5.14 x 10^{-6} V / W/m^2 and max. irradiance of 2000 W/m^2
The zero point is set as described above under standard calibration.

For 200 W/m^2 / mA the applied voltage to the input to set the gain, is calculated in the following way:

5.14 x 10^{-6} x 2000 = 10,28 mV, and adjust the output to +4 mA + (2000/200) = 14 mA

This should always be smaller than 20 mA.

An input signal change of 0 to 2000 W/m^2 gives an output change of 4 to 14 mA.
With the 500 Ohm resistor this results in a voltage change of 2 to 7 Volt.

Depending on the sensor output it can be better to use a conversion of 50 or 100 W/m^2 per mA.
Of course using the total +16 mA range gives the optimal resolution on the output.

6. PART NUMBERS

CT 24	**0305 710**
Resistor 500Ω	**2686 002**
Instruction manual	**0305 260**

Customer Support

Our customer support remains at your disposal for any maintenance or repair, calibration, supplies and spares. The address is as follows:

Für Servicearbeiten und Kalibrierung, Verbrauchs-material und Ersatzteile steht Ihnen unsere Customer Support Abteilung unter folgender Adresse zur Verfügung:

Notre service 'Support Clientèle' reste à votre entière disposition pour tout problème de maintenance, réparation ou d'étalonnage ainsi que pour les accessoires et pièces de rechange. Leur adresse est la suivante :

Holland **Kipp & Zonen B.V.**
Röntgenweg 1
2624 BD DELFT
T +31 15 269 8000
F +31 15 262 0351
E kipp.holland@kippzonen.com

UK **Kipp & Zonen Ltd.**
P.O. Box 819,
LINCOLN, Lincolnshire LN6 0WY
T +44 1522 695 403
F +44 1522 696 598
E kipp.uk@kippzonen.com

Germany **Gengenbach Messtechnik**
Heinrich-Otto-Strasse 3
D-73262 REICHENBACH/FILS
T +49 7153 9258 0
F +49 7153 9258 160
E info@rg-messtechnik.de

USA **Kipp & Zonen USA Inc.**
125, Wilbur Place
BOHEMIA/NY 11716
T +1 631 589 2065
F +1 631 589 2068
E kipp.usa@kippzonen.com

France **Kipp & Zonen S.A.R.L.**
7, avenue Clément Ader
ZA Ponroy - Bât. M
F-94420 LE PLESSIS TREVISE
T +33 1 49 62 4104
F +33 1 49 62 4102
E kipp.france@kippzonen.com

Kipp & Zonen

WWW.KIPPZONEN.COM