Re :	**Application Notes PCD2.W3xx**					
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Doc. no. :						
For action		**For your files**		**Circulation**		

SUMMARY

This document is intended as a supplement to the manual, showing a few typical typical cable layouts. It should make the user sensitive to points that need special attention if the best possible results are to be achieved with the PCD2.W3xx modules.
In addition, since 7.6.2000 a chapter has been included at the end of this document giving details of tolerances and their significance.

Date	Modification	Carried out by
29.03.2000	Initial document	MO / 417
23.05.2000	Addition of ‘pseudo differential measurement’	MO / 417
07.06.2000	Additional chapter giving information on tolerances	MO / 417

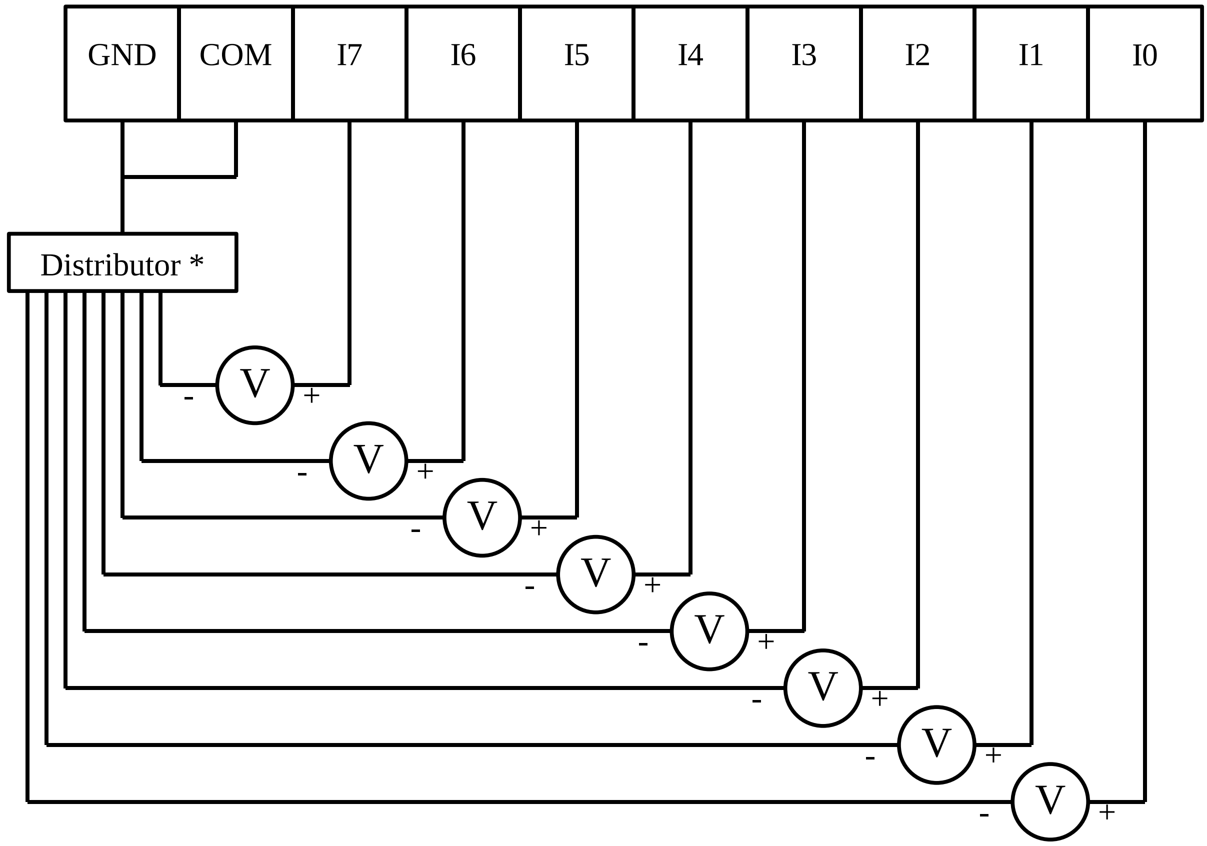
CONTENTS

1. USE OF POTENTIAL-FREE TRANSMITTERS

The PCD2.W3xx series of modules is based on the single-ended measuring principle, according to which all 8 input channels refer to a common frame potential.
These modules offer maximum performance if consideration is given to the following points when signal transmitters and sensors are connected.

1.1 CONNECTION OF 0..10V SIGNAL TRANSMITTERS

The following connection diagram shows a typical wiring layout for voltage inputs, such as can be found on **W300 and W340 modules**:



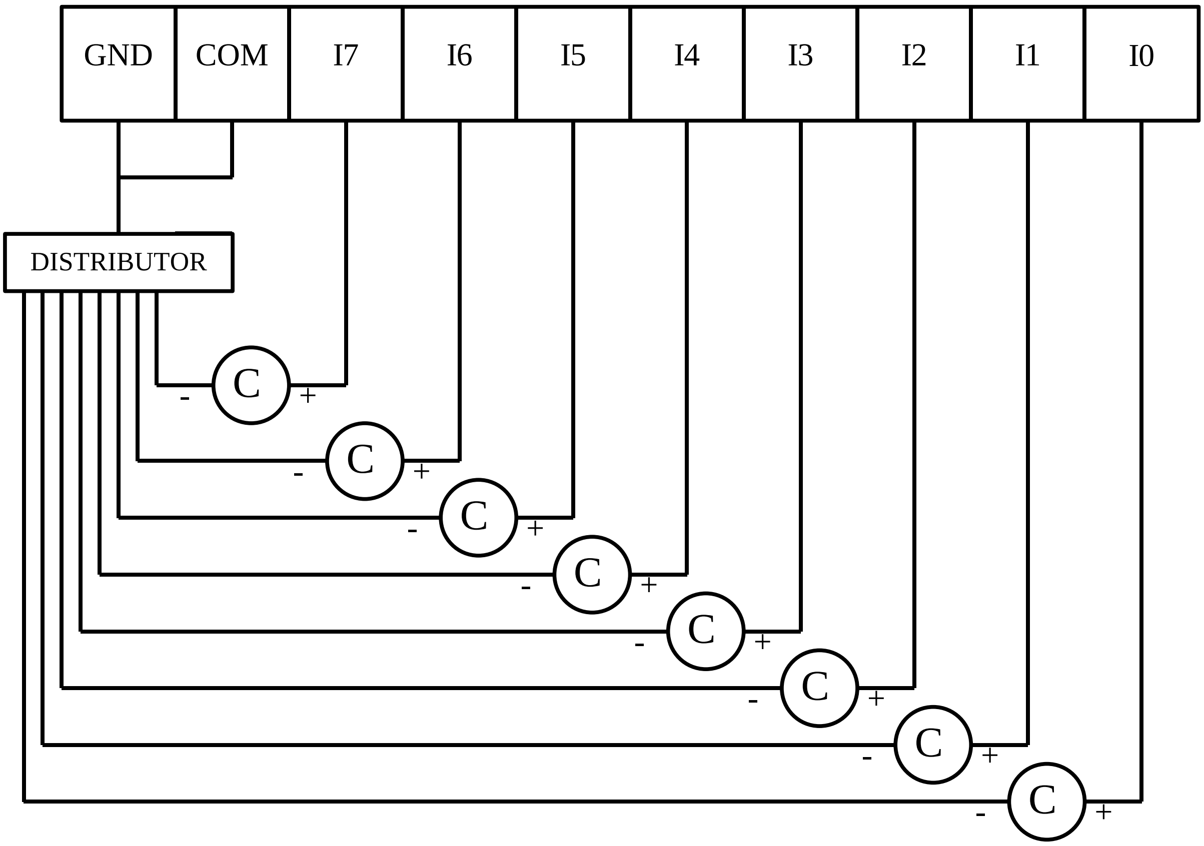
*) Potential-free

Notes:

- The reference potentials of signal sources are brought together on one distribution terminal. To obtain optimum results from measurement, any connection with the earthing bar should be avoided.
- If screened cables are used, screening should be continued to the external earthing bar.

1.2 CONNECTION OF 0..20mA CURRENT LOOP

When connecting current loops to the **W310 and W340 modules,** a similar connection scheme to that previously described for voltage inputs is recommended:



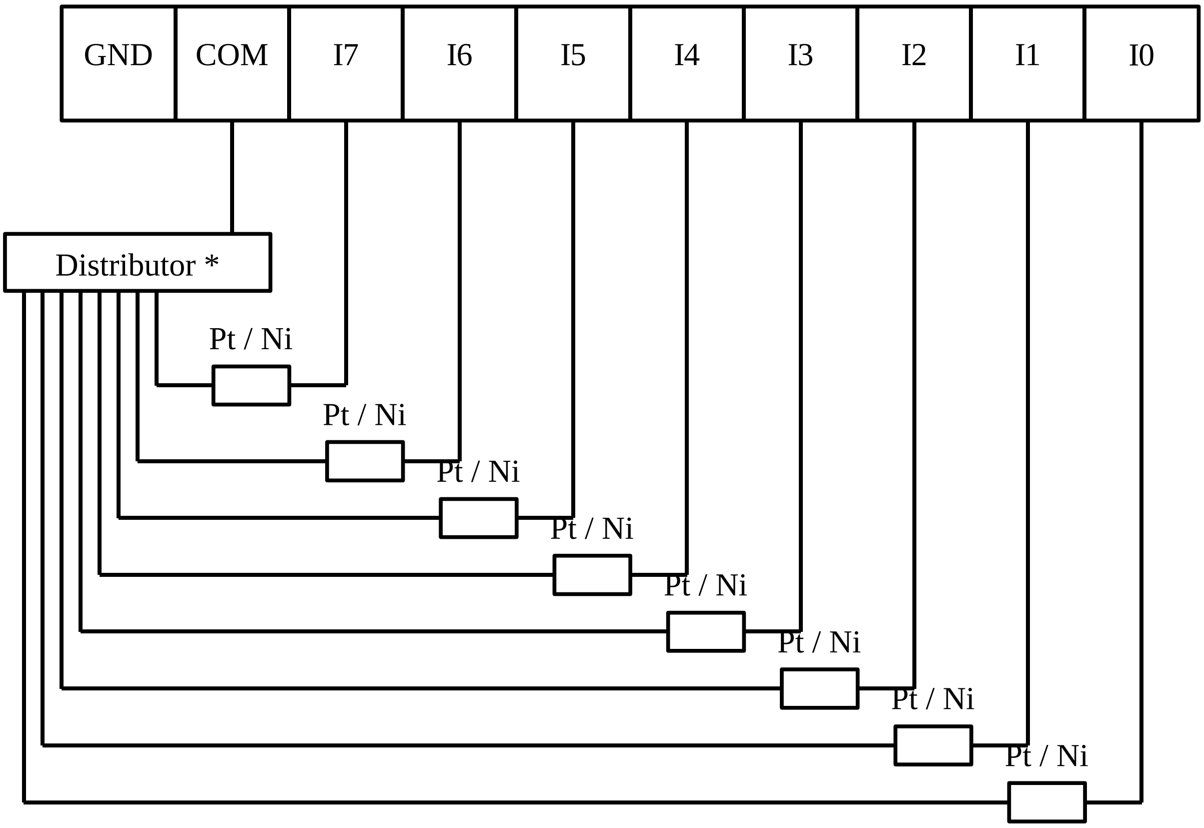
*) Potential-free

Notes:

- Here too the reference potentials of signal sources are carried via a distribution terminal to the GND connection. In this case also, any connection to the earthing bar should be avoided.
- If screened cables are used, screening should be continued to the external earthing bar.
- The [GND → COM] connection must be as short as possible (ideally: $1mm^2$; length < 40mm)

1.3 CONNECTION OF RESISTANCE THERMOMETERS

The PCD2.W3xx series of modules also offers a variety of modules that can be used to detect temperatures **(W340 / W350 / W360).** To guarantee optimum evaluation of the signals measured, connection must take place according to the following diagram:



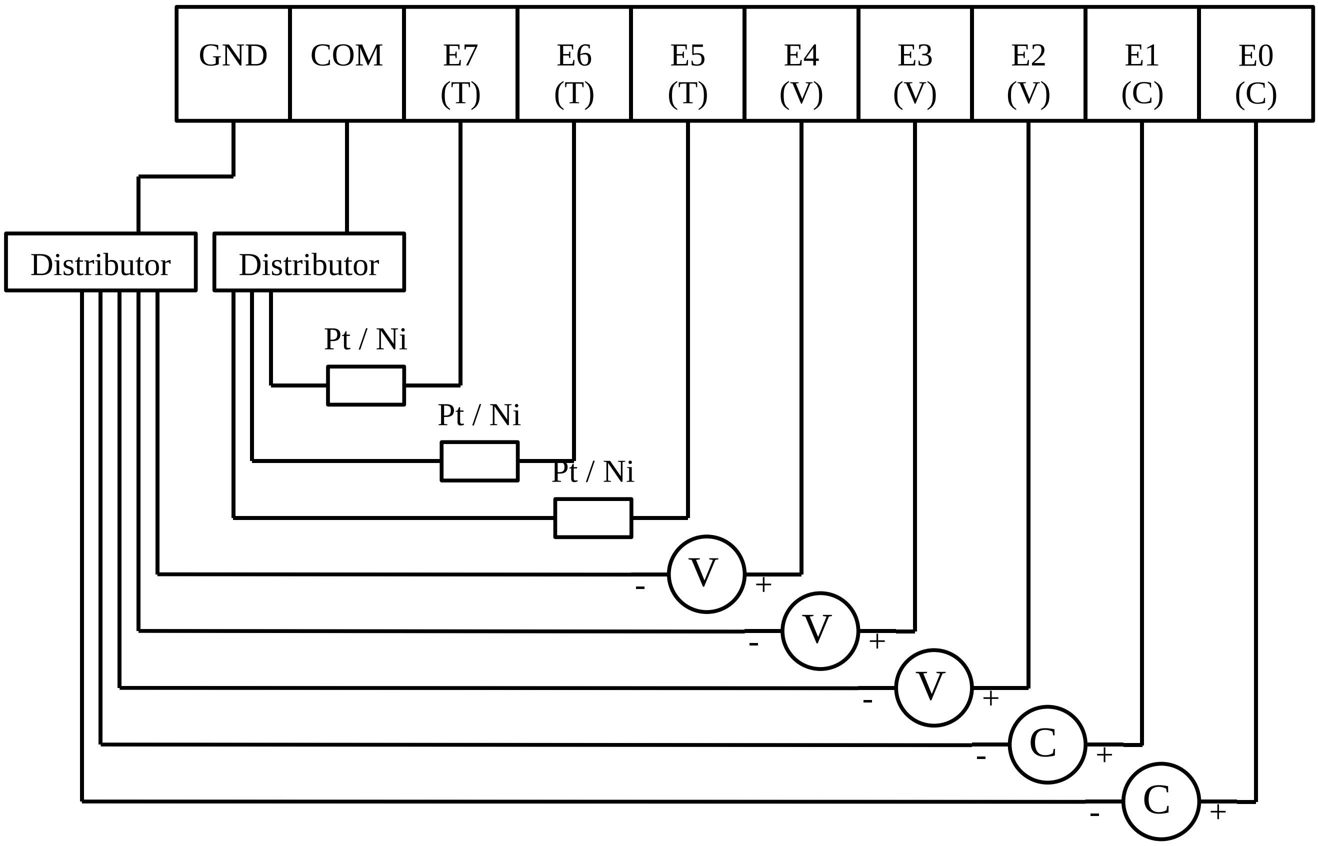
*) Potential-free

Notes :

- The reference potential for temperature measurements is the COM connection on the terminal. The latter should be used as ground for the temperature sensors, without any external earth connection and without any connection to GND.
- If screened cables are used, screening should be continued to the external earthing bar.

1.4 COMBINATION OF DIFFERENT RANGES

On the **W340 module** the input range for each channel can be configured individually. The following representation uses an example to illustrate how the wiring layout should be:



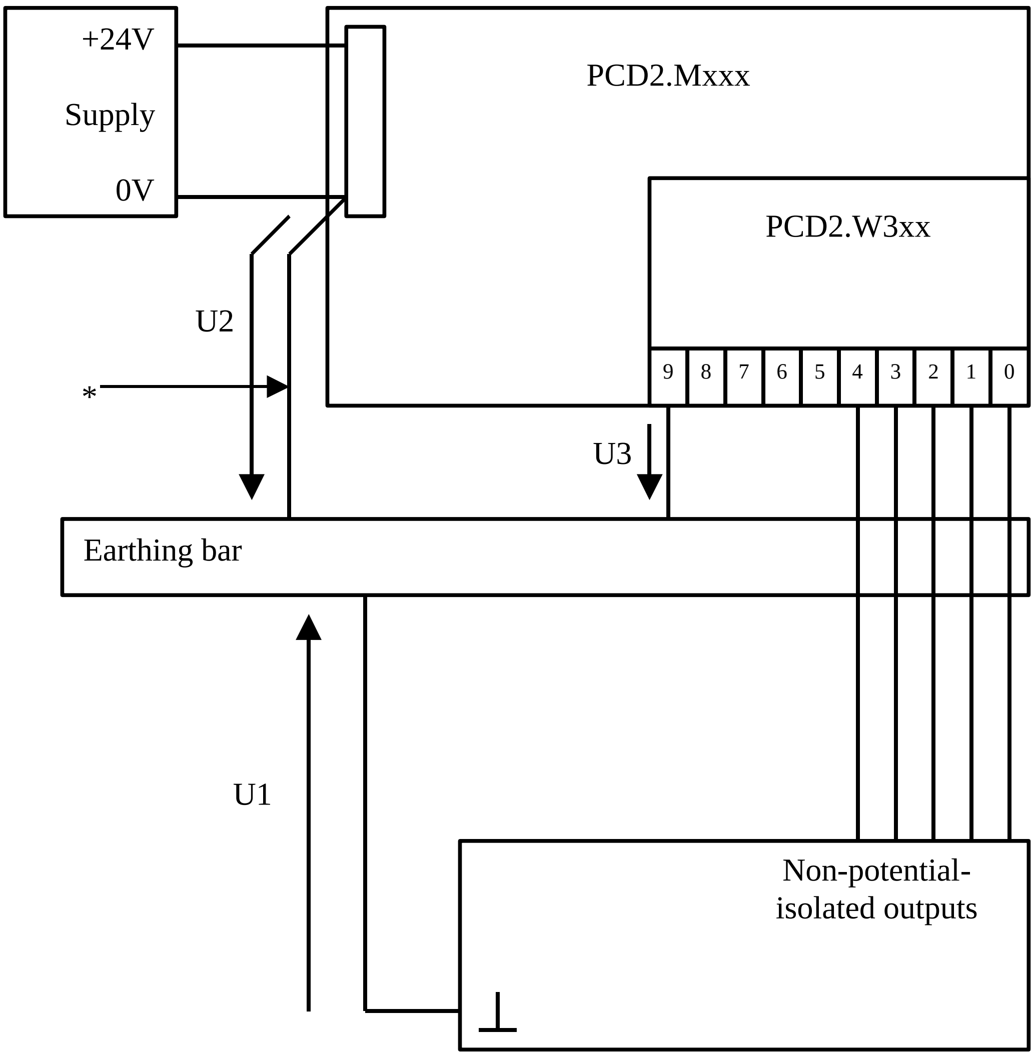
*) Potential-free

Notes :

- The reference potential for temperature measurements is the COM connection on the terminal. The latter should be used as ground for the temperature sensors, without any external earth connection and without any connection to GND.
- For voltage and current inputs according to the above configuration, the GND connection should be used as the reference potential, so that temperature measurement cannot be affected by signals from current inputs.
- If screened cables are used, screening should be continued to the external earthing bar.

2. USE OF NON-POTENTIAL-FREE TRANSMITTERS

In principle, the use of non-potential-free transmitters should be avoided whenever possible. Differential input modules offer considerable advantages for such applications, since they prevent ground loops and, during measurement, can take into account any differences in potential at the ground.
The following example is intended to explain which areas require attention when wiring the ground, so that the best possible results can still be obtained with PCD2.W3xx modules:



Specification for connecting cable:

Length: < 0.2m
Cross-section: min. 2.5 mm^2

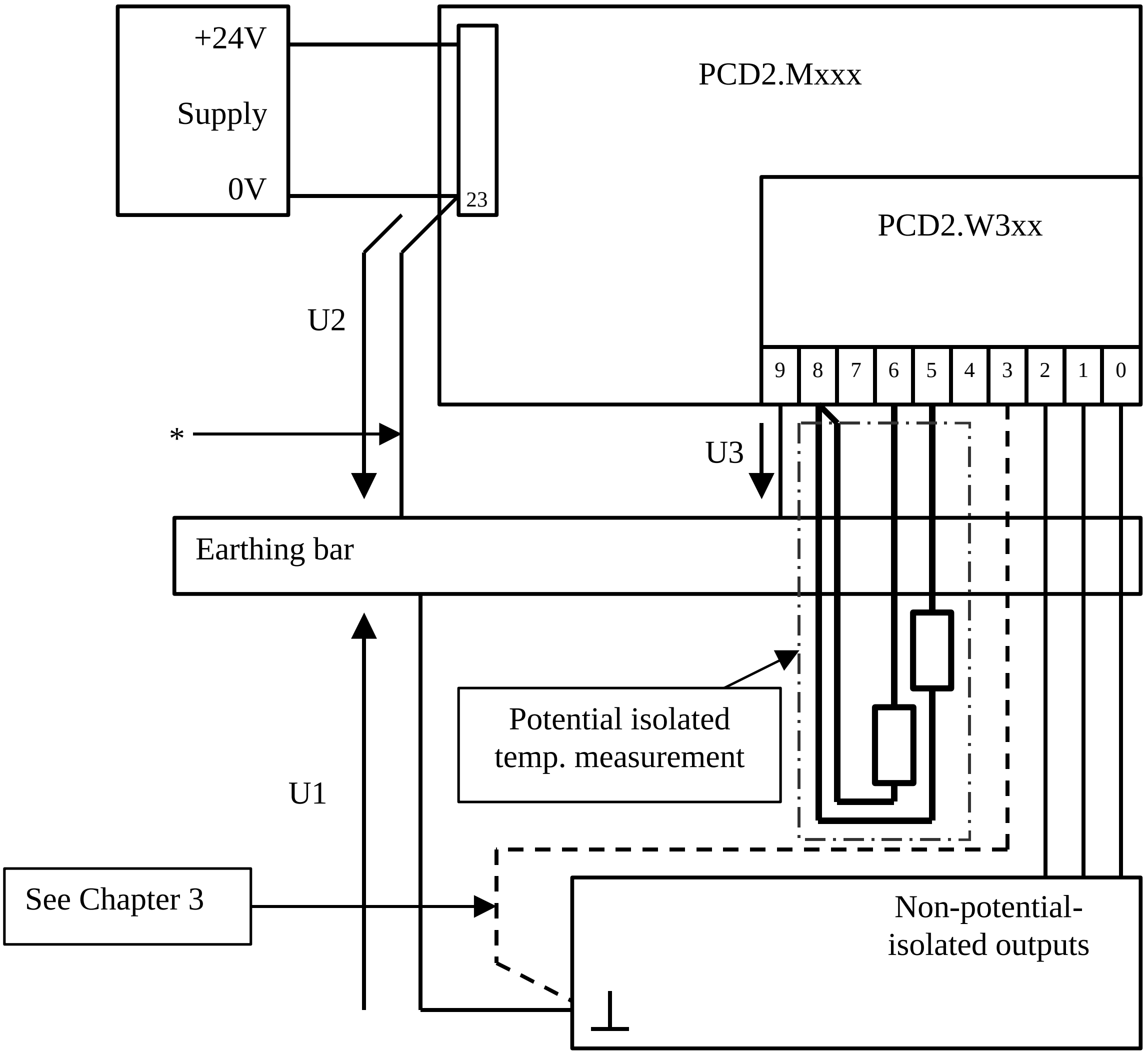
→See also hardware manual for PCD1 and PCD2 series, section 2.2.

Notes:

- As the previous picture shows, the signal measured does not necessarily correspond to the actual transmitter signal. Voltages **U1** and **U3** directly affect the signal measured. Care must therefore be taken during installation to ensure that voltages U1..U3 are minimal. This can be achieved by avoiding large currents on the lines concerned.
- Especially with variable, external current, it is possible to minimize falsification by increasing the conductor cross-section.
- The connection [GND (9) → earthing bar] serves to stabilize the earth when external conditions are not ideal.

2.1 TEMPERATURE MEASUREMENTS

If the situation is as just described, with non-potential-free transmitters, and in addition temperature measurement or potential-free voltage measurement is to occur at some inputs, the **COM-**connection can be used for this purpose.
This method can be used to connect potential-free resistance thermometers and voltage signals to **COM,** in accordance with Chapter 1:



Note:

According to the above principle, potential isolated voltage transmitters can also be connected. However, for current inputs the **GND** connection should be used as reference potential, since the measurement current is not allowed to run through **COM**.

Specification for connecting cable:

Length: < 0.2m
Cross-section: min. 2.5 mm^2

→See also hardware manual for PCD1 and PCD2 series, section 2.2.

3. PSEUDO–DIFFERENTIAL MEASUREMENT METHOD

This method can be used under certain conditions to obtain better measurement results, even with non-potential isolated transmitters.

3.1 PRINCIPLE

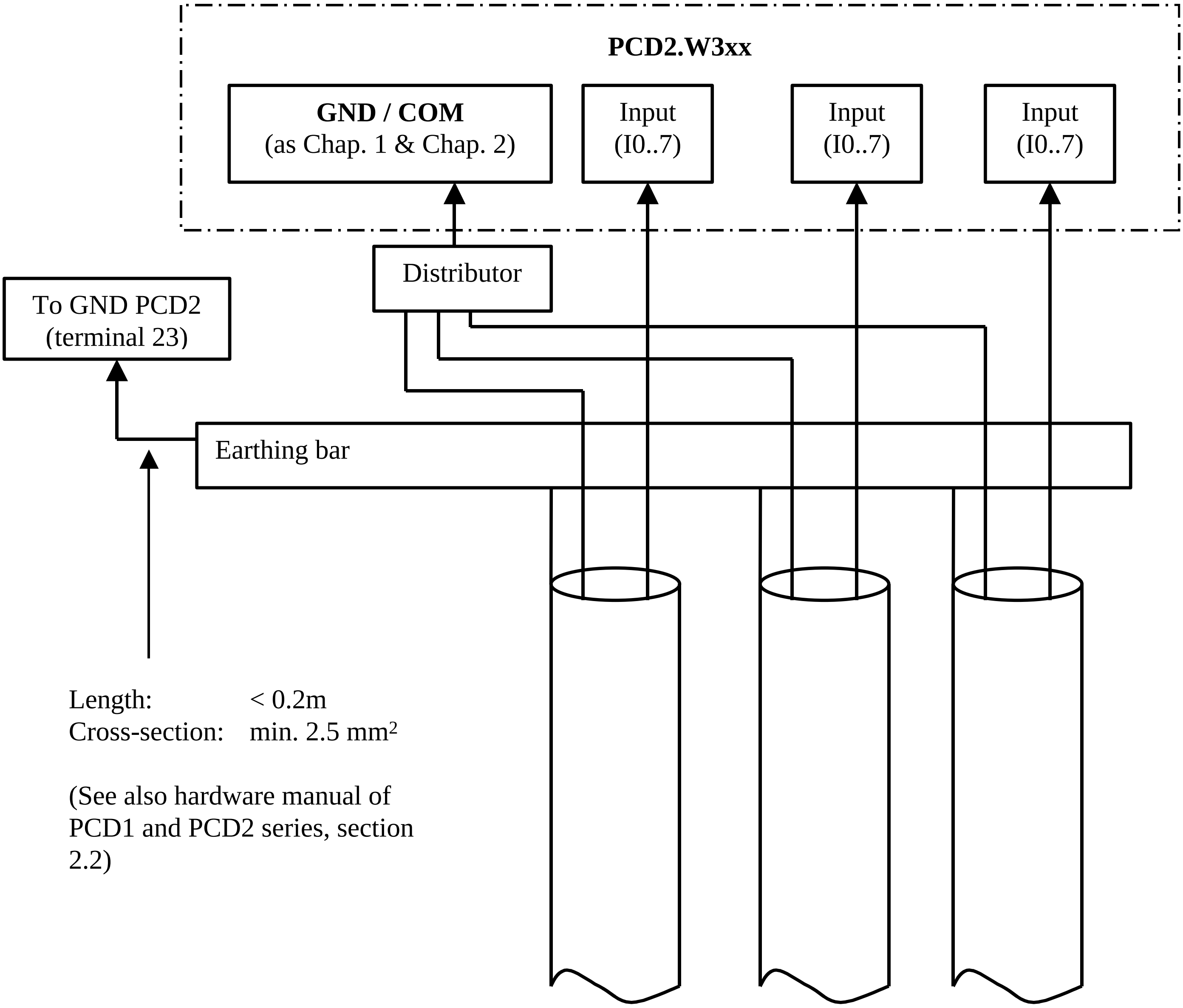
One channel of the analogue input module is used to detect the potential of the transmitter ground.
(→Connection indicated by broken line in figure 2.1)
Since unipolar input ranges only are available with the W3xx, it is necessary when wiring up the installation to ensure that the voltage from transmitter ground to PCD ground cannot become negative.

3.2 ADVANTAGES / DISADVANTAGES / RESTRICTIONS

- By detecting ground potential, one input channel is lost. Compared with a differential input module, however, even 7 channels still represent a large total.
- This type of measurement costs much less than genuine differential measurement.
- The application of this method, however, presupposes accurate knowledge of the installation concerned. Individual checks must be made of the actual situation.
- If the potential of the transmitter ground is lower than the PCD-GND, this methode cannot be used, as negative input signals cannot be detected with the W3xx.

4. CONNECTION OF SCREENED LINES

Screened lines should always be connected according the the diagram below:



The earthing bar drawn above can also be used for other devices. The lower the impedance achieved when the screening is carried to the earth, the better that screening can fulfil its purpose.

General note on the use of screened cables:

Ground loops can even occur across screening, if the screening on both sides of the cable is connected to ground!

5. MEASURING ACCURACY

5.1 TOLERANCE INFORMATION IN THE MANUAL

In the PCD2.W3xx hardware manual the following information can be found:

Accuracy at 25°C:
W300, W310: ± 0,5%
W340, W350, W360: ± 0,3%

Repeating accuracy under similar conditions:
All modules: ± 0.05%

Temperature error:
All modules: ± 0.2%

This information refers generally to the ‘Range’, i.e. to the ‘Scale end value’. As a result, a tolerance field around the setpoint is produced, which is **constant across the whole measurement range**.

MODULE	RANGE	TOLERANCE IN %	TOLERANCE AT INPUT SIZE	TOLERANCE IN LSB
W300	0..10V	± 0.5%	± 50mV	± 20 LSB
W310	0..20mA	± 0.5%	± 100µA	± 20 LSB
W340	0..10V 0..20mA Pt 1000 Ni 1000	± 0.3%	± 30mV ± 60µA ± 1.7°C … ± 2.9°C ***** ± 1.1°C … ± 1.5°C *****	± 12 LSB ± 12 LSB ± 12 LSB ± 12 LSB
W350	Pt 100 Ni 100	± 0.3%	± 1.7°C … ± 2.4°C ***** ± 0.7°C … ± 1.5°C *****	± 12 LSB ± 12 LSB
W360	Pt 1000	± 0.3%	± 0.8°C … ± 1.1°C *****	± 12 LSB

*) Calculated according to specified accuracy (± 0.3%).

! Temperature inputs are significantly more accurate than described here !

Detailed information on temperature inputs and maximum possible deviations follow from Chapter 6.

5.2 ACCURACY VERIFIED IN THE FUNCTION TEST

The function test is only passed by modules that fulfil the following specifications:

W300, W310:	Tolerance on range:	± 0.25%
	Tolerance on input signal:	± 0.25%
W340, W350, W360 :	Tolerance on range :	± 0.15%
	Tolerance on input signal :	± 0.15%

All modules that pass the final inspection meet the tolerance specifications mentioned above.

Voltage inputs / current inputs:

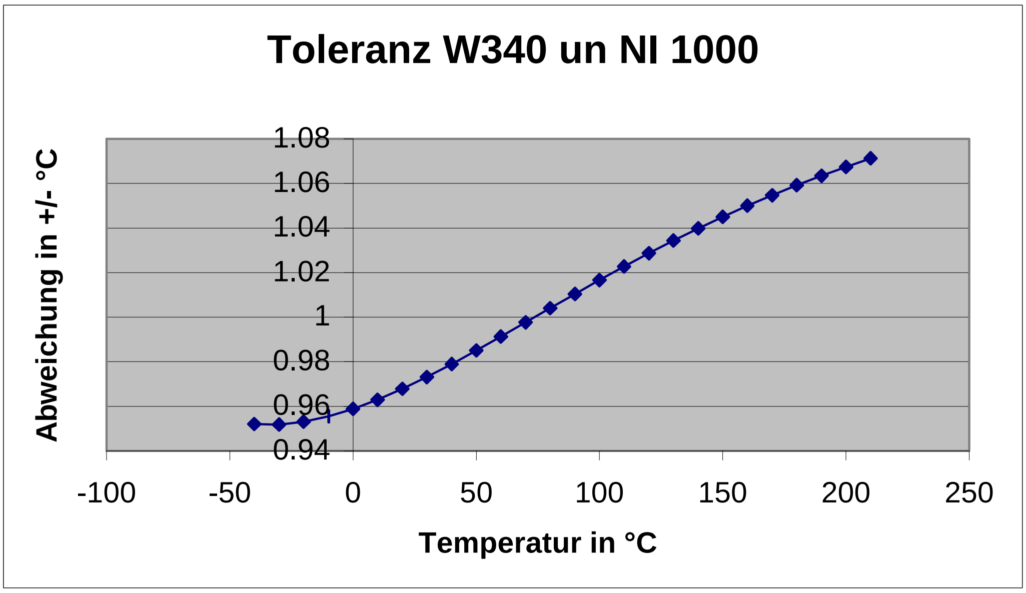
For voltage and current inputs, direct calculation is possible with the above information.

Temperature inputs:

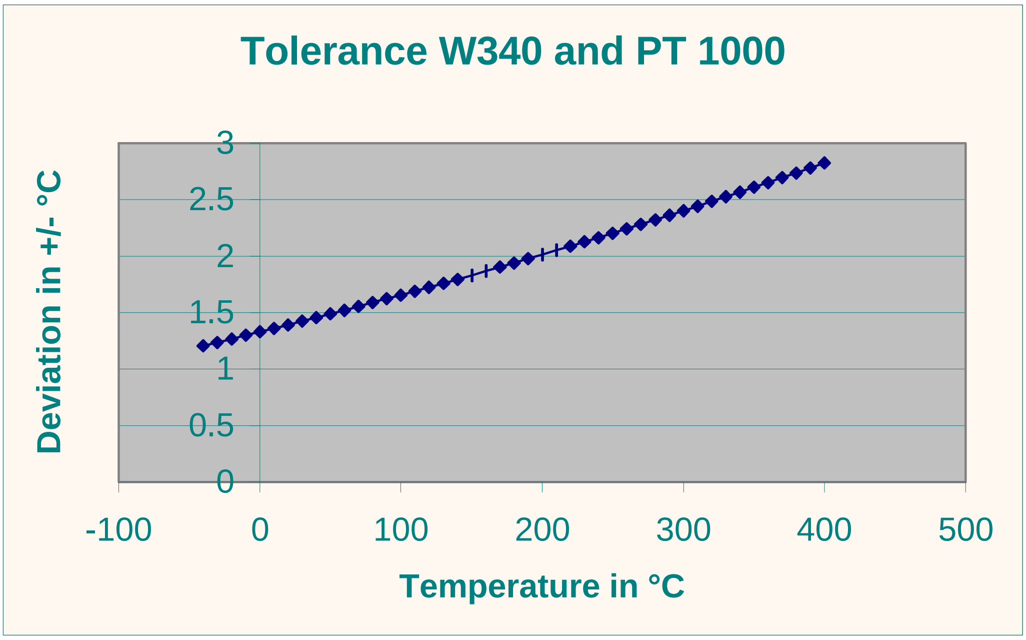
Temperature inputs also meet the above specifications. However, since the tolerance refers to the measured digital value, it is not possible to determine the error directly in °C.
For this one must include the characteristics (non-linear) of the temperature sensors. More precise information on this can be consulted in the next two chapters.

6. TEMPERATURE INPUTS

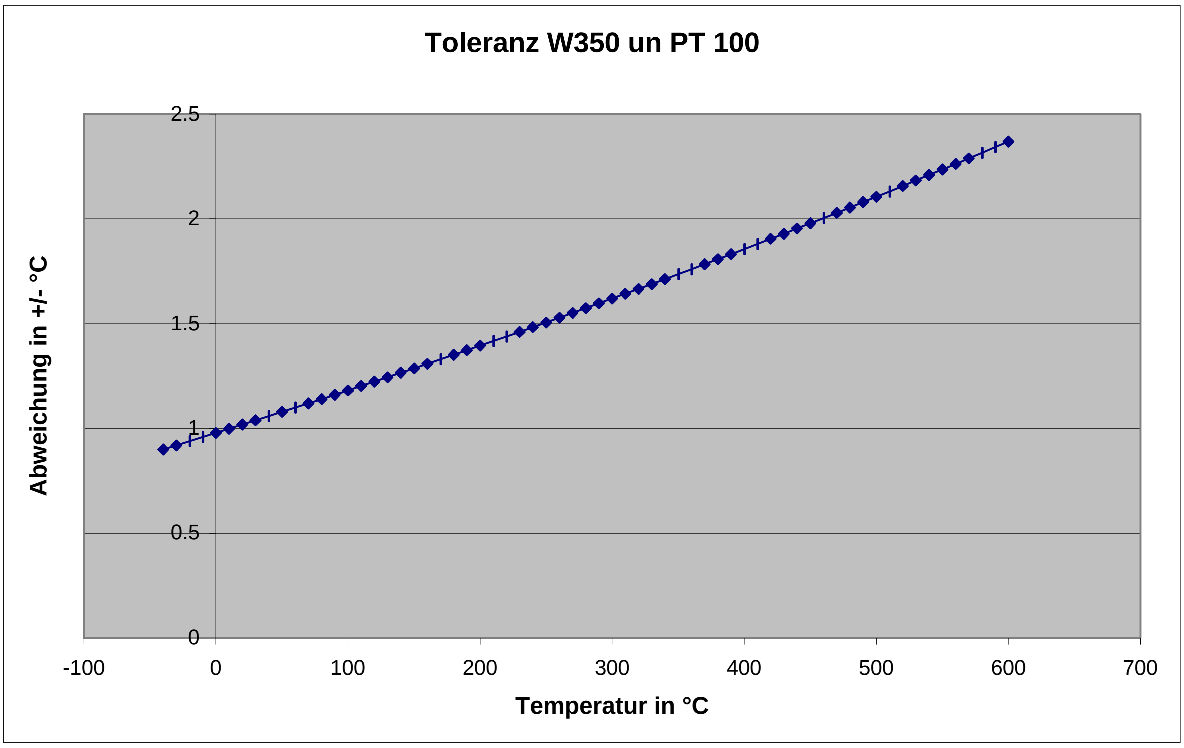
All tolerance curves shown in the following take into consideration the characteristics of the temperature sensor concerned. Moreover, all calculations have been made with verified accuracy in our function test.
In each case the deviation in ± °C is represented as a function of measured temperature.

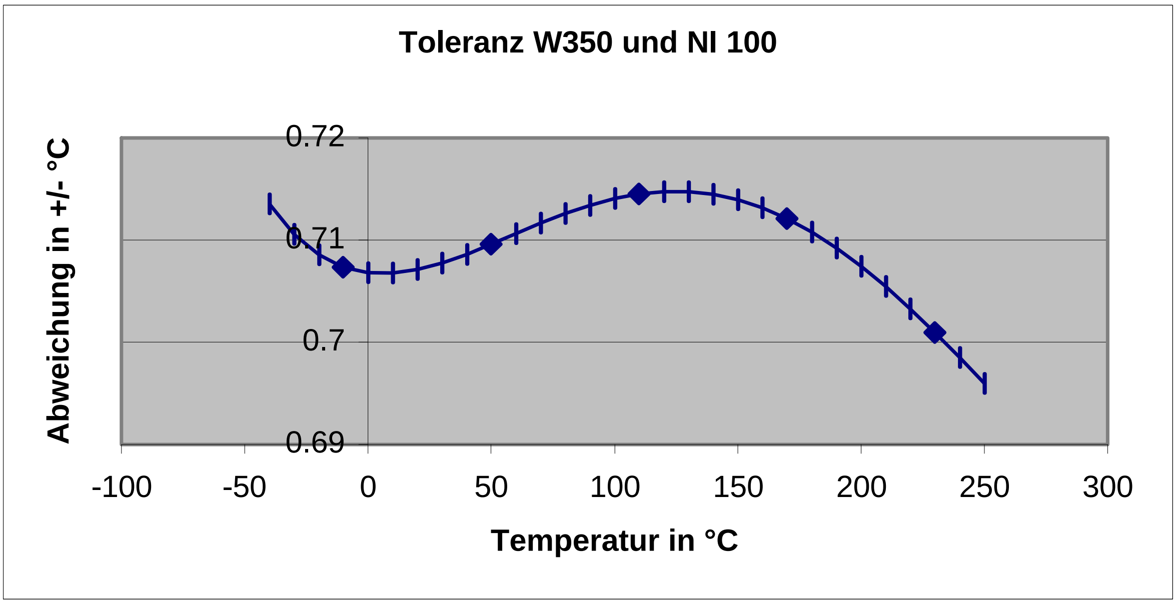


6.1 PCD2.W340

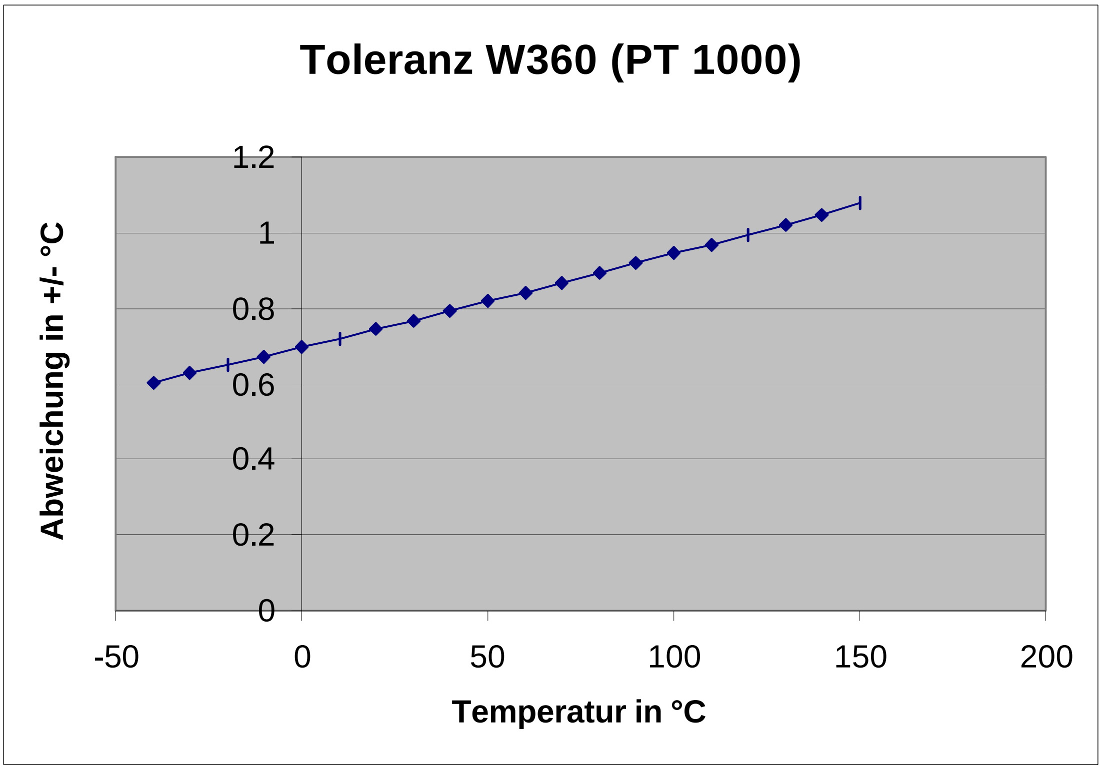


6.2 PCD2.W350


Toleranz W350 un PT 100
Abweichung in +/- °C
2.5
2
1.5
1
0.5
0
-100
0
100
200
300
400
500
600
700
Temperatur in °C


Toleranz W350 und NI 100
Abweichung in +/- °C
0.72
0.71
0.7
0.69
-100
-50
0
50
100
150
200
250
300
Temperatur in °C

6.3 PCD2.W360



6.4 NOTES

- The tolerance curves reflect the actual behaviour of modules. On some occasions, therefore, marked unlinearity is evident, which cannot be expressed as simple, clear tolerance information.
- In addition, all curves possess an offset error. If this offset is compensated in the installation, a significantly smaller error can be expected.

7. TOLERANCE = F (MEASURED TEMPERATURE)

With the following formulae, one comes close to the tolerance curves demonstrated in the graphs above. This involves dividing the possible deviation into two components:

Constant error (Offset): This portion does not present a problem, since it can be corrected in common with the wiring of the installation. A reference measurement must be carried out on the final system, in order to determine which installation offset to take into account.

Variable error: This component can also be corrected by means of reference measurements and determining a correction factor. However, the work involved is somewhat more demanding than for a simple offset correction.
In most applications it will not be necessary to correct the variable proportion of error.

MODULE	SENSOR	MEASUREMENT RANGE	CONSTANT ERROR (OFFSET) AT –50°C	VARIABLE ERROR TOL. = F(TMEAS)
W340	Pt 1000 Ni 1000	-50 … +400°C -50 … +200°C	± 1.2°C * ± 0.95°C *	± (ΔTmeas)*0.00356 ± (ΔTmeas)*0.00048
W350	Pt 100 Ni 100	-50 … +600°C -50 … +250°C	± 0.8°C * ± 0.7°C *	± (ΔTmeas)*0.00246 ± 0.02°C
W360	Pt 1000	-50 … +150°C	± 0.6°C *	± (ΔTmeas)*0.00250

*) Offset can be compensated from software.

D**Tmeas:** Difference between compensation temperature and measured temperature, for which the maximum error is to be determined.

D**Tmeas = Tcompens - Tmeas**

7.1 OPTIMUM OFFSET COMPENSATION

The most logical approach is to compensate the offset for whichever temperature must be measured with particular accuracy in the installation. For this item there subsequently results no further variable error, according to the above formulae.

For example, if the range –50°C … +50°C is required, the best measurement results will be obtained if offset compensation is carried out at 0°C. The tolerance field can therefore be centred on the optimum position in the required range, so that the smallest possible error results at its limit values.