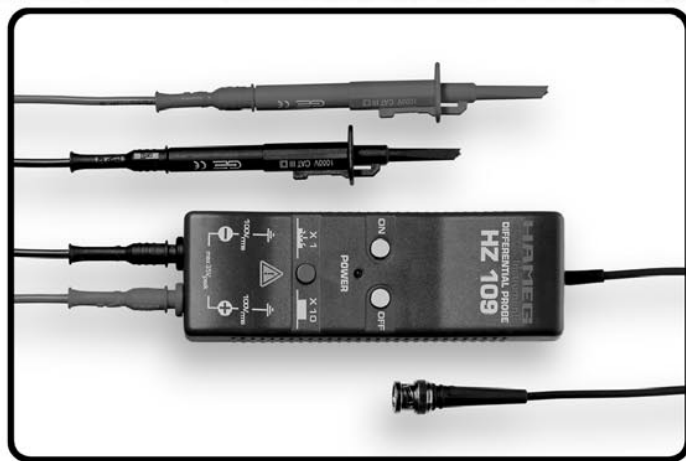


# HZ 109

Differential probe for oscilloscopes



- 40 MHz bandwidth
- Common mode voltage range  $\pm 35$  V
- x 1 and x 10 attenuation
- > 50 dB CMRR (1MHz)
- Automatic Switch-off
- Battery operation with external supply option
- Low battery indication

CE IEC 1010 Cat III

**HAMEG**  
Instruments

## Contents

1. Safety precautions
2. Introduction to the differential probe
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## Symbols used

The following safety signs are used on the probe and in these instructions:



Caution, danger !  
Read instructions !

## 1. Safety precautions

Prior to using the differential probe for the first time, read the following carefully:

- The probe must only be used by qualified personnel.
- Earthing the probe:  
By means of the BNC output socket, connect the probe to the oscilloscope in order to earth it. It is therefore necessary to check that the oscilloscope itself is connected to earth via a lead which conforms to regulations.  
Then connect the Probe to the oscilloscope, prior to connecting the leads to the item to be tested.  
It is imperative not to disconnect the probe from the oscilloscope until after the test leads been disconnected.
- Use only high quality accessories which conform to safety standards.
- Never open the probe whilst the input leads are connected.
- Never exceed the maximum input voltage of 100 V<sub>rms</sub> at earth (IEC 1010-1 Cat.III).
- Do not expose the probe to humidity, steam or an aggressive or explosive environment.
- Keep the case and the connection leads in a clean condition and prevent humidity or liquid from being able to penetrate inside the probe or its component parts.
- Do not use the probe if there is any reason to think that it is not operating properly or that it is faulty.
- The mains power supply must conform to the standards in force.
- If the probe is not to be used for a prolonged period, remove the battery, so that it will not damage the battery compartment.

## 2. Introduction to the differential probe

OUTPUT max.  $\pm 3,5$  V

Socket for external supply 12 V DC / 30 mA

OFF button

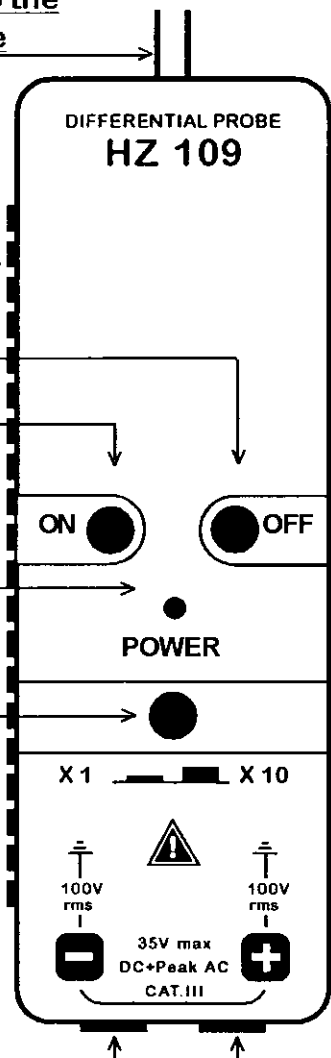
ON button (and RE ON after automatic shut-off)

LED illuminated while the unit is on, flashes at  $U_{batt} < 6$  V)

Attenuation switch pressed: 1 : 1  
not pressed: 10 : 1

The screws for opening the probe are located on the rear face.

Differential input (4 mm safety sockets)



## 3. Items supplied with the probe

The differential probe is supplied with the following:

- 1 9 V monobloc battery 6LF22
- 2 safety test leads (red and black)
- 2 sprung hook (red and black)
- 1 operating instructions

## 4. Technical characteristics

|                |                                                                                                                                                                                      |                                                                                                                                        |
|----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------|
| Input          | max. different. input voltage at 1x<br>max. different. input voltage at 10x<br>Voltage at each input to earth<br>Warning: the both above conditions must be respected simultaneously | $\pm 3,5$ V max. DC + peak AC<br>$\pm 35$ V max. DC + peak AC<br>100 V max.<br>(IEC 1010-1 CAT.III)                                    |
| Frequency      | Input impedance<br>Attenuation<br>Accuracy after 5 min.<br>Bandwidth at x1<br>Bandwidth at x10<br>Risetime at x1<br>Risetime at x10                                                  | 20 M $\Omega$ ; 5 pF (10 M $\Omega$ ; 10 pF at input)<br>x1 and x10<br>$\pm 3\%$ (18 - 80 °C)<br>30 MHz<br>40 MHz<br>12 nsec<br>9 nsec |
| Output         | Output voltage<br>Output impedance<br>Noise<br>Common-mode rejection ratio                                                                                                           | max. $\pm 3,5$ V (1 MHz)<br>50 Ohm<br>max. 2 mV<br>DC 70 dB<br>AC > 50 dB (at 1                                                        |
| MHz)<br>Supply | Battery<br>Low battery indication<br>Optional power supply<br>Operating time on one battery<br>Battery switch-off                                                                    | 9 V block (6LF22)<br>LED flashes at $U_{batt} < 6$ V<br>12 V DC < 30 mA<br>approx. 20 hours<br>automatic, after 10 min                 |
| Accessories    | 2 safety test leads<br>2 sprung hooks                                                                                                                                                | 50 cm, red and black<br>red and black                                                                                                  |
| Dimensions     | Case (LxWxH)<br>Weight<br>Material                                                                                                                                                   | 157 x 60 x 26 mm<br>180 g without battery<br>ABS, internal screening<br>by Cu/NiCr spraying                                            |
|                | Cable length                                                                                                                                                                         | 50 cm each                                                                                                                             |

## 5. Using the probe



Before using the differential probe for the first time, read carefully the section on the precautionary measures at the beginning of these instructions.

### ● Inserting or replacing the 9 V battery

Before using the differential probe for the first time, the battery supplied with the device must be inserted in the battery compartment and connected up by means of the clip.

If the LED lamp (battery indicator) flashes during operation, the voltage of the battery has dropped to approximately 6 V.

In order to ensure that the probe is operating correctly, it will then be necessary to replace the battery.



*At the time of inserting or replacing the battery, the input leads must not be connected to an item to be tested !*

*Never operate the probe with the case open.*

To insert or replace the battery, remove the three screws on the rear face of the case and then open the probe. If necessary, the old 9 V battery can then be removed and insert the new one in the compartment. Always ensure not to damage or move the electronic components, in particular the control device. After inserting the new battery, close the case and tighten the three fastening screws.

### ● Using an external power supply

Using the socket on the side of the probe, it is possible to connect the device to an external power supply. The internal battery is then disconnected and the battery saving automatic switch-off does not operate. A mains transformer, for example, can be used for the external power supply. The power supply voltage must lie within the range of 12 - 14 V DC. The current consumption will be approximately 30 mA. Take into account the fact that the output voltage of some supplies considerably exceeds their nominal value ! Only use on external power supply that conforms with all the safety and EMC standards in force.

- **Connecting the probe**

Prior to connecting the probe, read the section on the safety precautions at the beginning of these instructions!

Connect the output of the probe to the input of the oscilloscope, with the coaxial lead inserted into the BNC socket. The input impedance of the oscilloscope must be  $1\text{ M}\Omega$ . In view of the high impedance connection it is not advisable to extend the cable considerably.

In the case of using an oscilloscope incorporating a  $50\ \Omega$  input, the output voltage of the probe is reduced by half.

In addition, the output signal is then limited to  $\pm 3\text{ V}$ . It should also be taken into account the fact that consumption may also increase. In the case of a low impedance connection, it is possible to extend the cable without difficulty. Use of the safety leads ensures reliable measurements up to a maximum voltage of  $\pm 35\text{ V DC} + \text{peak AC}$ . Nevertheless, at high frequencies, it is difficult to achieve optimum transmission of signals with these leads.

Should accessories be used which were not supplied with the probe, it is essential to check that they conform to safety standards!

- **Switching the probe on and off**

The probe is switched on by pressing briefly on the ON button. The operating condition is indicated by the LED lamp lighting up. The device can be switched off by pressing briefly on the OFF button.

In order to increase the life of the battery, the device switches itself off automatically after an operating time of approximately 10 minutes. If the ON button is pressed again before the end of this period, the operating time is again reset to 10 minutes. The automatic shutoff facility is cancelled when an external supply is connected.

- **Choice of attenuation**

The probe offers the choice of two attenuation factors:  $\times 1$  and  $\times 10$ .

For an attenuation factor of  $\times 1$  (selector depressed), the voltage at the inputs is equal to the voltage displayed on the oscilloscope  $\times 1$ .

For an attenuation factor of  $\times 10$  (selector not depressed), the voltage at the inputs is equal to the voltage displayed on the oscilloscope  $\times 10$ .

- **Procedure for using the differential probe**

- Check the mains earth connection to the oscilloscope.
- Connect the probe to the oscilloscope.
- Adjust the vertical sensitivity on the oscilloscope (V/div.).
- Select the attenuation factor on the probe ( $\times 1$  or  $\times 10$ ).
- Switch the probe ON.
- If necessary, adjust the reference line on the oscilloscope.
- Connect the test leads to the input sockets and to the item to be tested.

## **6. Maintenance and repair**

The differential probe does not require any special maintenance. If necessary, clean the case with a damp cloth. Ensure that no moisture enters inside the device.



**Do not use the probe if there is any reason to think that it is not operating properly or that it is faulty.**

**In the case of repair, send the device to the distributor. Do not attempt to service or repair the probe yourself.**

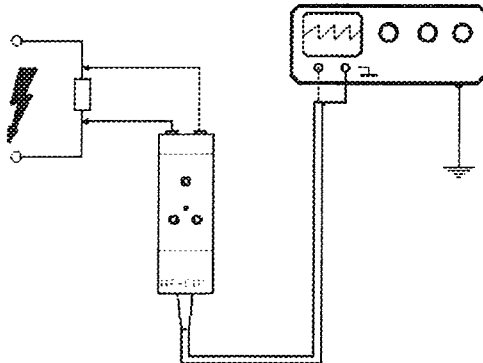
## 7. Examples of differential probe applications

- **Reference potential and safety**

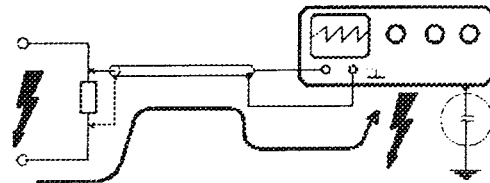
The measuring inputs of a normal mains operated oscilloscope are referenced to mains earth potential because they are connected, via the oscilloscope power cord, to the mains earth. Also, other exposed metal parts of the oscilloscope are connected to earth. Therefore, if an oscilloscope is connected to measure live mains circuits such as switching controllers, thyristors or power MOSFETs then this can cause short circuits damaging the system components and extreme user safety hazards.

These safety hazards still exist if the oscilloscope earth is disconnected or if is powered through a mains isolating transformer because the oscilloscope input and other metal parts will be raised to the test circuit voltage.

However, the use of differential probes provides safe single or multi-channel measuring connections.



*Differential probe for safe measurements*



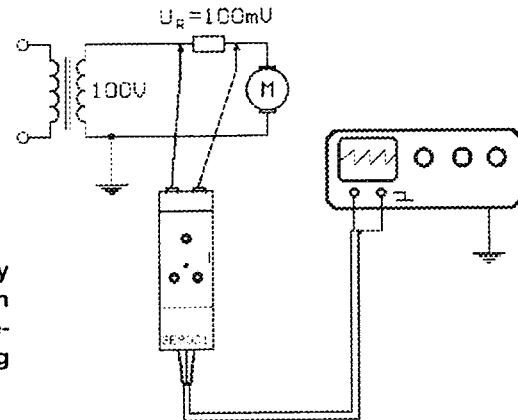
*The oscilloscope casing may carry lethal voltages when the ground lead is detached.*

Apart from the danger which exists when taking measurements with floating potential, further problems arise in multi-channel measurements because ground connections still exist between the oscilloscope inputs. Using a differential probe ensures safety. This probe allows measurements between any two points of a circuit without a reference point. However, since the output is related to ground, it can be easily connected to the input of the earthed oscilloscope.

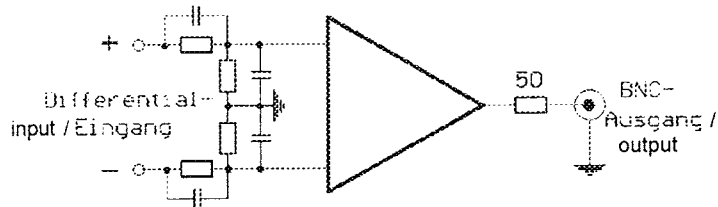
- **Earth loop circuits and common mode voltages**

Whilst the ground potential can in principle be used as a common reference point in many cases, it is often impossible to make reference connections to the same common point. This may create earth loops which means that a voltage may build up between the ground potential of the investigated circuit and the ground potential of the oscilloscope. It can be greater than the signal voltage and falsify the measuring result. The use of a differential probe is frequently the only solution in such cases or when a high common-mode voltage is present.

*Example: Voltage at the motor series resistor is only a fraction of the common-mode voltage which is superimposed on the measuring voltage*



Highly accurate measurements largely unaffected by interference voltages can be made thanks to the high degree of common-mode rejection offered by the differential probe and the possibility of tapping the measuring voltage direct at the signal source.



*Differential probe principle*

The differential probe expands each oscilloscope input to provide differential input connections for safe measuring on floating potential circuits. The probe also provides rejection of common-mode signals.