User manual

Handyscope HS4 Diff

a multifunctional
PC measuring instrument

TiePie engineering

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Contents

Safety

Before you start working with the Handyscope HS4 Diff, first read these safety rules.

- Avoid working alone.
- Check the probes / test leads for damages. Do NOT use them if they are damaged.
- Take care when measuring at voltages higher than 25V AC or 60 V DC.

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EC declaration of Confirmity

We declare, on our own responsibility, that the product

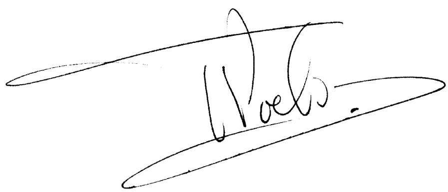
Handyscope HS4 Diff

for which this declaration is valid, is in compliance with

EN55011, EN55022, EN50081-1 and EN50082-1

according the conditions of the EMC standard 89/336/EEG, and the amendments 92/31/EEC and 93/68/EEC

Sneek, 1-8-2005 ir. A.P.W.M. Poelsma



Chapter 1
Introduction

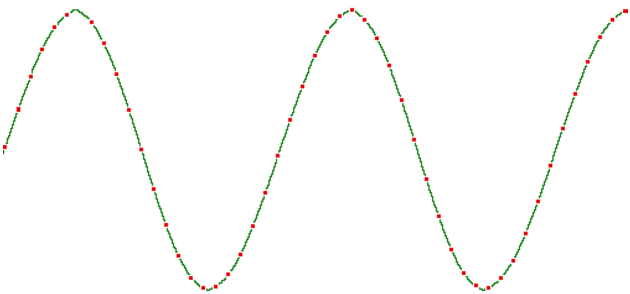
Note before using the Handyscope HS4 Diff, first read the chapter about Safety

Many technicians investigate electrical signals. Though the measurement may not be electrical, the physical variable is often converted to an electrical signal, with a special transducer. Common transducers are accelerometers, pressure probes, current clamps and temperature probes. The advantages of converting the physical parameters to electrical signals are large, since several instruments for examining electrical signals are available.

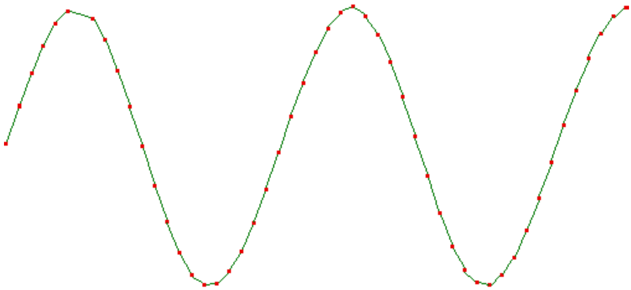
The **Handyscope HS4 Diff** is a four channel, 12 bits, 5, 10, 25 or 50 Msamples/sec measuring instrument with differential inputs. With the acompanying software the **Handyscope HS4 Diff** can be used as an oscilloscope, a storage oscilloscope, a spectrum analyzer, a true RMS voltmeter or a transient recorder. All instruments measure by sampling the input signals, digitizing the values, process them, save them and display them.

Sampling

When sampling the input signal, samples are taken at certain moments. The frequency at which the samples are taken is called the sampling frequency. By taking a (large) number of samples, the input signal can be reconstructed.



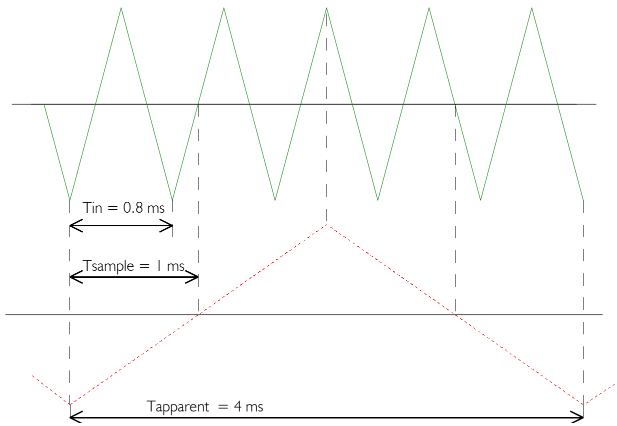
In the latter illustration a sine wave signal is sampled with 50 samples. By connecting the adjacent samples, the original signal can be reconstructed. See also the next illustration.



The more samples are taken, the better the signal can be reconstructed. The sampling frequency must be higher than 2 times the highest frequency in the input signal. This is called the Nyquist frequency. Theoretically it is possible to reconstruct the input signal with more than 2 samples. In practice, 10 to 20 samples are necessary to be able to examine the signal thoroughly.

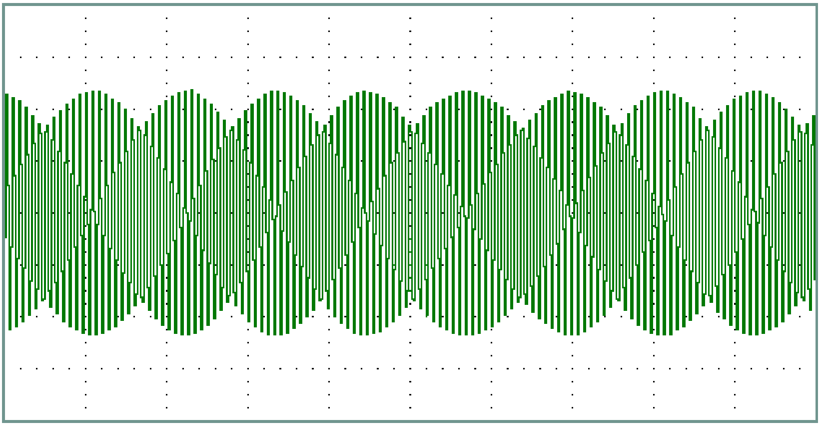
Aliasing

If the sampling frequency is lower than 2 times the frequency of the input signal, 'aliasing' will occur. The following illustration shows how aliasing occurs.



The input signal is a triangular signal with a frequency of 1.25 kHz (upper most in the illustration). The signal is sampled at a frequency of 1 kHz. The dotted signal is the result of the reconstruction. From that triangular signal the periodical time is 4 ms, which corresponds with an apparent frequency (alias) of 250 Hz (1.25 kHz - 1 kHz).
To avoid aliasing, the sample frequency must be higher than 2 times the maximum frequency of the input signal.

Aliasing is not always visible on an oscilloscope. In the latter illustration, it gives a 'good looking' picture. It is not apparent that aliasing occurs. The next illustration gives an example of visible aliasing.



This time it is a sine wave signal with a frequency of 25.7 kHz, which is sampled at a frequency of 5 kHz. The minimal sampling frequency should have been 51.4 kHz. For proper analysis, the sampling frequency should have been 500 kHz.

Digitizing

After taking a sample of the input signal, it is digitised. This is done with an Analog to Digital Convertor, ADC. The ADC converts the size of the signal to a digital number. This is called quantifying.

The first condition for accurate measurement is to have as many as possible quantifying steps. This can be realised by using an ADC with a resolution as high as possible.

The resolution of ADC's is often given in bits. The number of bits determines the number of quantifying steps according the formula:

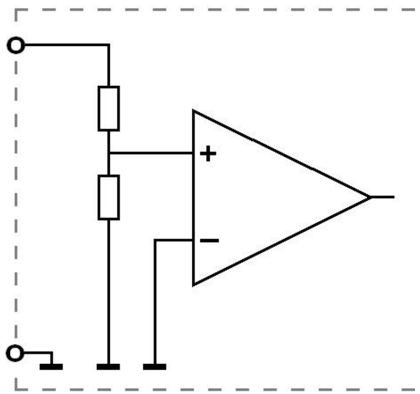
$$\text{number of quantifying steps} = 2^{\text{number of bits}}$$

A 2 bits ADC has 4 quantifying steps. With an input range of 10 Volt, this ADC can divide the input range in 4 parts of each 2.5 Volt.

By increasing the number of bits, the resolution increases, the number of quatifying steps increases and the sub-divisions get smaller.

Standard oscilloscope inputs

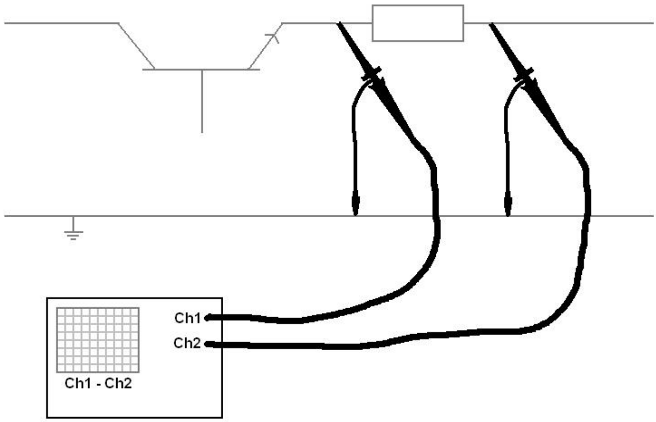
Most oscilloscopes are equipped with standard, single ended inputs, which are referenced to ground. This means that one side of the input is always connected to ground and the other side to the point of interest in the circuit under test.



So the voltage that is measured with an oscilloscope with standard, single ended inputs is always measured between that specific point and ground.

What if the voltage you're interested in is not referenced to ground? Connecting a standard single ended oscilloscope input to the two points would create a short circuit between one of the points and ground, possibly damaging the circuit and the oscilloscope.

A safe way would be to measure the voltage at one of the two points, in reference to ground and at the other point, in reference to ground and then calculate the voltage difference between the two points. On most oscilloscopes this can be done by connecting one of the channels to one point and another channel to the other point and then use the math function Ch1 - Ch2 in the oscilloscope to display the actual voltage difference.

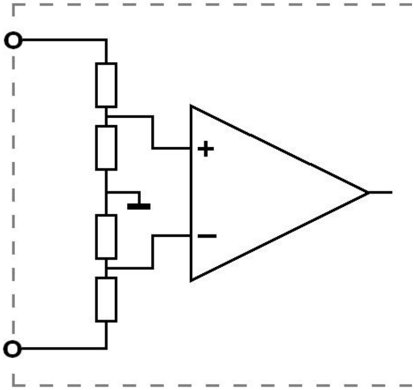


There are some disadvantages to this method:

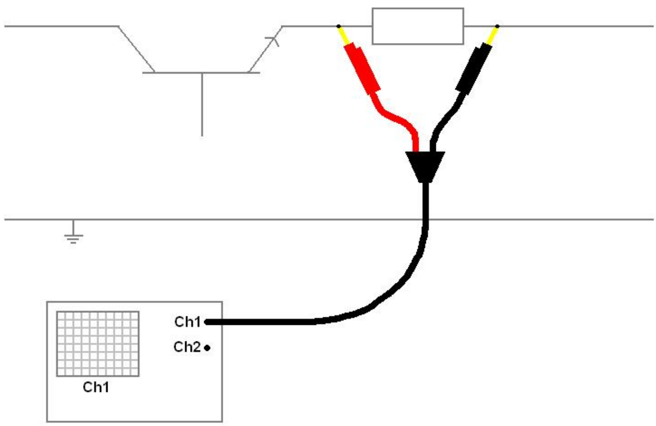
- to measure one signal, two channels are occupied
- by using two channels, the measurement error is increased, the errors made on each channel will be combined, resulting in a larger total measurement error
- The Common Mode Rejection Ratio (CMRR) of this method is relatively low. If both points have a relative high voltage, but the voltage difference between the two points is small, the voltage difference can only be measured in a high input range, resulting in a low resolution

Differential inputs

A much better way is to use an oscilloscope with a differential input. A differential input is not referenced to ground, but both sides of the input are "floating".



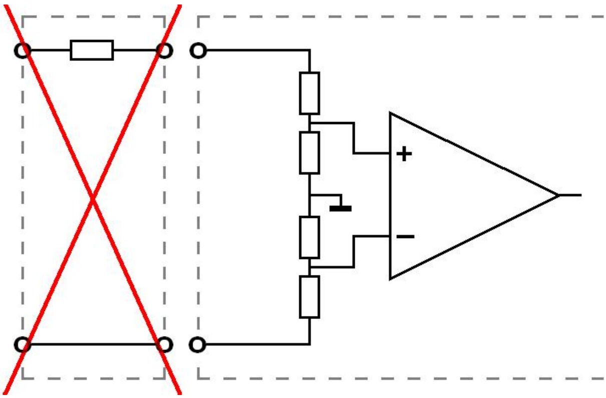
It is therefore possible to connect one side of the input to one point in the circuit and the other side of the input to the other point in the circuit and measure the voltage difference directly.



Advantages of a differential input:

- Only one channel is used to measure the signal
- More accurate measurement, since only one channel introduces a measurement error
- The CMRR of a differential input is high. If both points have a relative high voltage, but the voltage difference between the two points is small, the voltage difference can be measured in a low input range, resulting in a high resolution

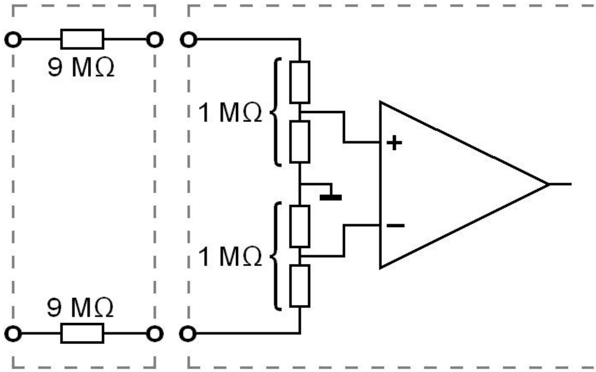
When the input signal exceeds the highest input range, the signal must be attenuated. Using a conventional attenuating oscilloscope probe will not be a solution.



Since the differential input requires an attenuation in both signal paths and a conventional oscilloscope probe provides an attenuation in only one signal path, significan measurement errors will be made.

Therefore, the **Handyscope HS4 Diff** is shipped with four differential attenuators.

The TiePie engineering Differential Attenuator can be used to attenuate differential signals by a factor 10, specifically designed to be used with the **Handyscope HS4 Diff**.



The Differential Attenuator and the inputs of the Handyscope HS4 Diff are differential, which means that the outside of the BNC's are not grounded, but carry life signals.

When using the attenuator, the following points have to be taken into consideration:

- do not connect other cables to the attenuator than the ones that are supplied with the instrument
- do not touch the metal parts of the BNC's when the attenuator is connected to the circuit under test, they can carry a dangerous voltage. It will also influence the measurements and create measurement errors.
- do not connect the outside of the two BNC's of the attenuator to each other as this will short circuit a part of the internal circuit and will create measurement errors
- do not connect the outside of the BNC's of two or more attenuators that are connected to different channels of the Handyscope HS4 Diff to each other
- do not apply excessive mechanical force to the attenuator in any direction (e.g. pulling the cable, using the attenuator as handle to carry the Handyscope HS4 Diff, etc.)

Chapter 2
Hardware installation

The **Handyscope HS4 Diff** is an external measuring instrument which can be connected to a PC.

The **Handyscope HS4 Diff** is connected to a USB port of the PC using the attached cable.

The **Handyscope HS4 Diff** does not need an external power supply, but is powered by the computer, through the USB.

The USB can deliver only a limited amount of power. In case the USB can not supply enough power, an extra cable is supplied which can be connected to the **Handyscope HS4 Diff** and between the computer and the keyboard cable. In that case the **Handyscope HS4 Diff** will be powered by the keyboard connection.

Note The outside of the external power connector is connected to +5 Volt. In order to avoid shortage, first connect the cable to the **Handyscope HS4 Diff** and then to the keyboard connector.

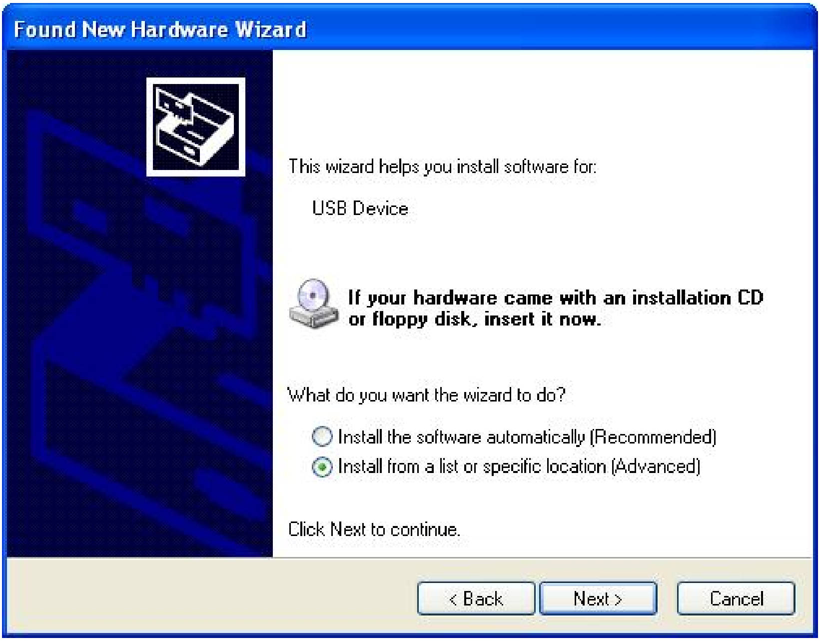
Driver installation

Before the **Handyscope HS4 Diff** is connected to the computer, first the software has to be installed. The software can be found on the CDROM that came with the **Handyscope HS4 Diff**. When the software is installed, the **Handyscope HS4 Diff** can be connected to the computer.

When the **Handyscope HS4 Diff** is connected to an USB port of the computer of the first time, Windows will report new hardware.

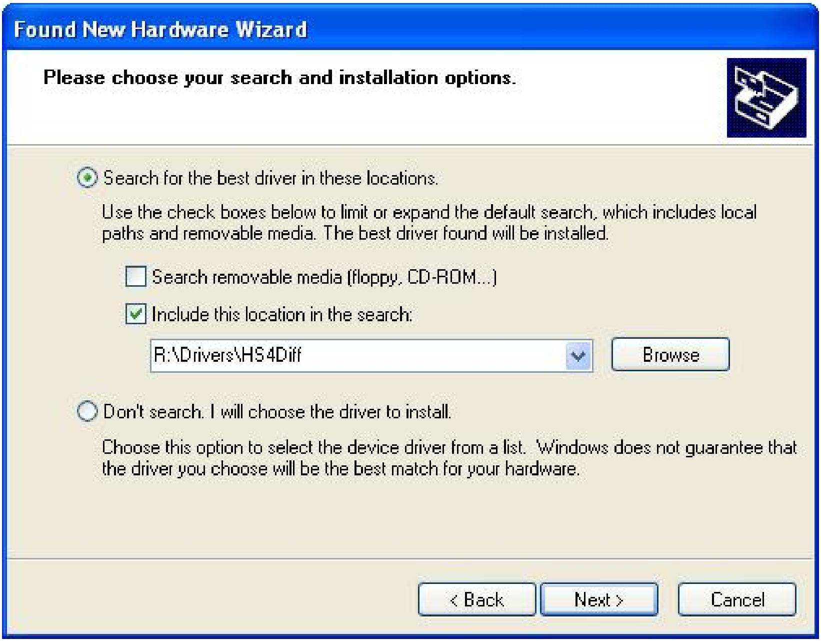
Windows will request for the location where the drivers can be found. The appearance of the dialogs will differ for each windows version and might be different on the computer where the **Handyscope HS4 Diff** is installed.

There are no drivers for the **Handyscope HS4 Diff** on the Windows Update Web site, so select "No, not this time" and click Next.



Insert the TiePie software CD in the CDROM drive of your computer. Select **Install from a list or specific location** and click **Next >**.

Now a location for the drivers has to be specified:



Select **Search for the best driver** and check **Include this location**. Use the **Browse** button to browse to the folder Drivers\HS4Diff on the TiePie software CD. Then click **Next >**.

Windows wil now report that it has found the **Handyscope HS4 Diff**. Windows XP will report that the driver is not certified and warn for possible danger.

The driver is not causing any danger for your system and can be safely installed.

Click **Continue Anyway** to install this driver.

Windows will now install the drivers for the **Handyscope HS4 Diff**. When the installation is complete, Windows will report:

The driver is built up in two stages. Stage 1 is installed now. Installation of stage 2 follows immediately and requires the same steps as stage one.

When state 2 is installed, the **Handyscope HS4 Diff** is now known in Windows and ready to use.

When the **Handyscope HS4 Diff** is disconnected, the required drivers will be removed from the memory of the computer.

The next time the **Handyscope HS4 Diff** is connected, the required drivers wil be loaded again. The CD is no longer required for that.

Connections

Extension connector

To connect to the Handyscope HS4 Diff, a 25 pin female Sub-D connector is available, containing the following signals:

1	Ground	14	Ground
2	Reserved	15	Ground
3	External power in 5V DC / 500 mA	16	Reserved
4	Ground	17	Ground
5	5 V out, 10 mA max.	18	Reserved
6	External sampling clock in (3.3 V TTL)	19	Data OK in (TTL)
7	Ground	20	Reserved
8	External trigger in (3.3 V TTL)	21	Reserved
9	Data OK out (3.3 V TTL)	22	Ground
10	Ground	23	I^2C SDA
11	Trigger out (3.3 V TTL)	24	I^2C SCL
12	Reserved	25	Ground
13	External sampling clock out (3.3 V TTL)		

The TTL signals are 3.3 Volt TTL signals which are 5 Volt tolerant, so they can be connected to 5 Volt TTL systems.

Pins 9, 11 and 13 are open colloctor outputs. Connect a pull-up resistor of 1 kOhm to pin 5 when using one of these signals.

The **Handyscope HS4 Diff** is powered through the USB. If the USB can not deliver enough power, an external power cable, to the PS2 keyboard connector, can be connected.

Note The outside of the external power connector is connected to +5 Volt. To avoid shortage, first connect the cable to the **Handyscope HS4 Diff** and then to the keyboard connector.

Center pin	Ø 1.3 mm	Ground
Outside bushing	Ø 3.5 mm	+ 5 V DC

Chapter 5
Specifications

Hardware

Channels

input	4 differential analog, BNC
output	-

Analog input

input sensitivity	200 mV - 80 V full scale, in 2, 4, 8 sequence
resolution	12 bits 0.025 %, 14 bits and 16 bits selectable
maximum voltage	200 volt DC + AC peak, <10 kHz
input impedance	2 x 1 MOhm / 30 pF
bandwidth	DC to 50 MHz
coupling	AC / DC
accuracy	0.3 % ± 1 LSB

Trigger system

system	digital, 2 levels
source	Ch1, Ch2, Ch3, Ch4, combination of these, digital external
modes	rising/falling slope, inside/outside window
level adjustment	0 .. 100% of full scale, 12 bit resolution
hysteresis adjustment	0 .. 100% of full scale, 12 bit resolution

Acquisition system

memory depth		128 K samples per channel
sampling frequency	12 bit	5 MHz, 10 MHz, 25 MHz or 50 MHz
	14 bit	3 MHz
	16 bit	200 kHz
pre/post trigger		0 .. 131060 samples (0 .. 100%)

General

interface	USB 2.0 and USB 1.1
power	from USB, 500 mA @ 5 V
operation temperature	0°C .. +50 °C
storage temperature	-10°C .. +70 °C
relative humidity	5 % .. 90 %
dimensions h x l x b	1.0" x 6.7" x 5.2" / 25 x 170 x 140 mm
weigth	approx. 17 ounce / 480 gram
cable length	approx. 70 " / 1.8 m

Accessories

Differential attenuator	4, 1:10
maximum voltage	300 volt DC + AC peak, <10 kHz
input impedance	10 Mohm / 15 pF
bandwidth	DC to 25 MHz
external power cable to keyboard connector	
Connector types	PS2 male, PS2 female
length	70 " / 1.8 m

PC requirements

Windows version	Windows 98 / ME / 2000 / XP

If you have any suggestions and/or remarks regarding the **Handyscope HS4 Diff** or the manual, please contact:

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