

# Handyprobe HP3

## Instrument manual

Rev. 2.1



TiePie engineering

## ATTENTION!

Measuring directly on the **line voltage** can be very dangerous.

Despite the care taken for the compilation of this user manual, TiePie engineering can not be held responsible for any damages resulting from errors that may appear in this book.  
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## 6.8 System requirements

PC I/O connection	USB 2.0 High Speed (480 Mbit/s) (USB 1.1 Full Speed (12 Mbit/sec) compatible)
Operating System	Windows 98/ME/2000/XP/Vista/32

## 6.9 Operating environment

Ambient temperature	0 - 55°C
Relative humidity	10 to 90% non-condensing

## 6.10 Storage environment

Ambient temperature	-20 - 70°C
Relative humidity	5 to 95% non-condensing

## 6.11 Certifications and Compliances

CE mark compliance	Yes
RoHS	Yes

## 6.12 Package

Instrument	Handyprobe HP3
Test lead	low noise differential with 4 mm banana jacks
Accessories	2 test probes with 4 mm banana socket 2 crocodile clips with 4 mm banana socket Wrist strap Color coding rings Hard carry case
Software	Windows 98/2000/ME/XP/Vista-32
Drivers	Windows 98/2000/ME/XP/Vista-32
Manual	Instrument manual and software user's manual

System	digital, 2 levels
Source	CHI
Trigger modes	rising slope, falling slope
Level adjustment	0–100% of full scale
Hysteresis adjustment	0–100% of full scale
Resolution	0.39% (8 bits)
Pre trigger	0–1Msamples (0–100%, one sample resolution)
Post trigger	0–1Msamples (0–100%, one sample resolution)

Interface	USB 2.0 High Speed (480 Mbit/s) (USB 1.1 Full Speed (12 Mbit/sec) compatible)
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Power	from USB port
Consumption	5 V DC, 400 mA max

Instrument height	25 mm / 1.0"
Instrument length	177 mm / 6.9"
Instrument width	68 mm / 2.7"
Weight	290 gram / 10.2 ounce
USB cord length	1.8 m / 71"
Test lead length	1.9 m / 75"

Ch1	isolated banana sockets
USB	fixed cable with type A plug

When working with electricity, no instrument can guarantee complete safety. It is the responsibility of the person who works with the instrument to operate it in a safe way. Maximum security is achieved by selecting the proper instruments and following safe working procedures. Save working tips are given below:

- Always work according (local) regulations.
- Work on installations with voltages higher than 25 V AC or 60 V DC should only be performed by qualified personnel.
- Avoid working alone.
- Observe all indications on the Handyprobe HP3 before connecting any wiring
- The Handyprobe HP3 is designed for CAT II measurement category: Maximum working voltage 600 Vrms or 800 Vdc. Do not exceed the rated voltage.
- 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.
- Do not operate the equipment in an explosive atmosphere or in the presence of flammable gases or fumes.
- Do not use the equipment if it does not operate properly. Have the equipment inspected by qualified service personal. If necessary, return the equipment to TiePie engineering for service and repair to ensure that safety features are maintained.



## 6.1 Acquisition system

Number of input channels	1 analog
Maximum sampling rate	100 MS/sec real time, 10 ns
Sampling source	Internal, quartz
Accuracy	±0.01%
Stability	±100 ppm over -40°C to +85°C
Memory	1 MSamples

## 6.2 Banana input Ch1

Connector	Isolated 4mm banana sockets
Measure mode	Differential
Resolution	10 bit
Amplitude Accuracy	0.3%
Ranges	200 mV .. 800 V full scale
Coupling	AC/DC
Impedance	2.1 MΩ / 15 pF
Protection	600 V RMS CAT II; derated at 3 dB/decade above 20 kHz to 25 V pk-pk at 50 MHz
Maximum Common Mode voltage	200 mV .. 8 V range: 12 V 20 V .. 80 V range: 120 V 200 V .. 800 V range : 800 V
Common Mode Rejection Ratio voltage	60 dB
Bandwidth (-3dB)	50 MHz
AC coupling cut off frequency (-3dB)	±1.5 Hz
Rise time	10 ns
Overshoot	1 %

The first part of the new driver is now installed. Click "**Finish**" to close the wizard and start installation of the second part, which follows identical steps.

Once the second part of the driver is installed, measurement software can be installed and the Handyprobe HP3 can be used.

### 5.3 Plug into a different USB port

When the Handyprobe HP3 is plugged into a different USB port, some Windows versions will treat the Handyprobe HP3 as different hardware and will ask to install the drivers again. This is controlled by Microsoft Windows and is not caused by TiePie engineering.

## Declaration of conformity



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## EC Declaration of conformity

We declare, on our own responsibility, that the product

**Handyprobe HP3-5**  
**Handyprobe HP3-20**  
**Handyprobe HP3-100**

for which this declaration is valid, is in compliance with

EN 55011:2009/A1:2010    EN 61000-6-1:2007  
EN 55022:2006/A1:2007    EN 61000-6-3:2007

according to the conditions of the EMC standard 2004/108/EC.

Sneek, 1-11-2010

ir. A.P.W.M. Poelsma

A handwritten signature in blue ink, appearing to read "A.P.W.M. Poelsma", written over a horizontal line.

Since the drivers are already pre-installed on the computer, Windows will be able to find them automatically. Select *“Install the software automatically”* and click *“Next”*.

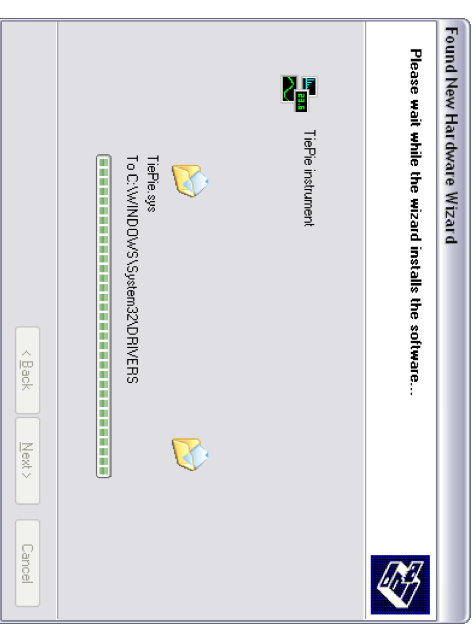


Figure 5.3: Hardware install: step 3

The New Hardware wizard will now copy the required files to their destination.



Figure 5.4: Hardware install: step 4

## Introduction



Before using the Handyprobe HP3 first read chapter 1 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 many instruments for examining electrical signals are available.

The Handyprobe HP3 is a single channel, 10 bits, 100 MSamples/sec measuring instrument with differential input with high input range.

With the accompanying software the Handyprobe HP3 can be used as an 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.

### 3.1 Differential input

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.

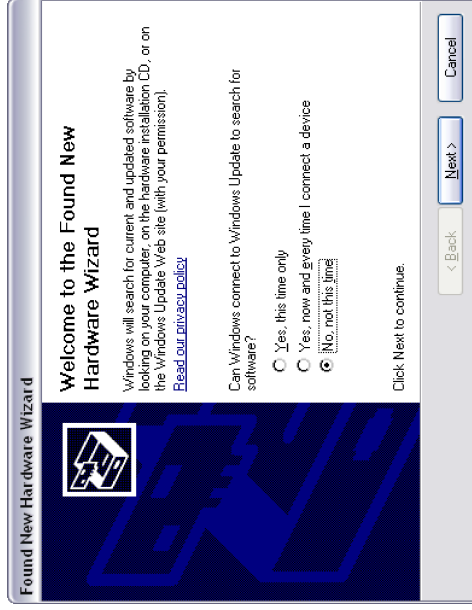


Figure 5.1: Hardware install: step 1

This window will only be shown in Windows XP SP2 or newer. No drivers for the Handyprobe HP3 can be found on the Windows Update Web site, so select "No, not *this time*" and click "Next".

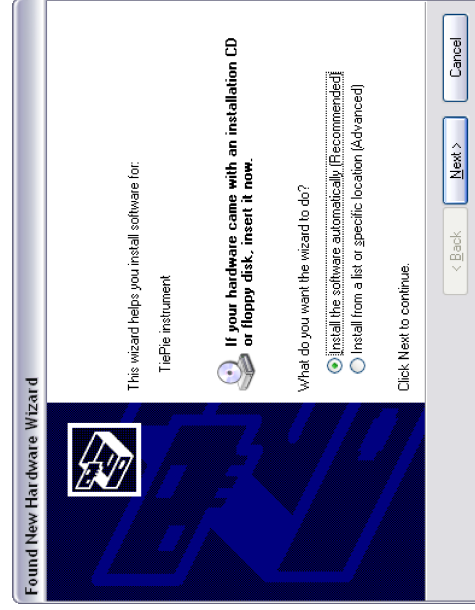


Figure 5.2: Hardware install: step 2



Drivers have to be installed before the Handyprobe HP3 is connected to the computer for the first time. See chapter 4 for more information.

## 5.1 Power the instrument

The Handyprobe HP3 is powered by the USB, no external power supply is required. Only connect the Handyprobe HP3 to a bus powered USB port, otherwise it may not get enough power to operate properly.

## 5.2 Connect the instrument to the computer

After the new driver has been pre-installed (see chapter 4), the Handyprobe HP3 can be connected to the computer. When the Handyprobe HP3 is connected to a USB port of the computer, Windows will report new hardware. The Found New Hardware Wizard will appear.

Depending on the Windows version, the New Hardware Wizard will show a number of screens in which it will ask for information regarding the drivers of the newly found hardware. The appearance of the dialogs will differ for each Windows version and might be different on the computer where the Handyprobe HP3 is installed.



The driver consists of two parts which are installed separately.

Once the first part is installed, the installation of the second part will start automatically. Installation of the second part is identical to the first part, therefore they are not described individually here.

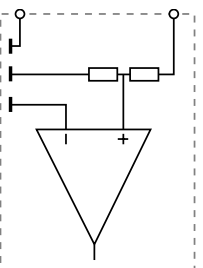


Figure 3.1: Single ended input

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

When the voltage 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:

- a short circuit to ground can be created when an input is wrongly connected
- 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

A much better way is to use an oscilloscope with a differential input.

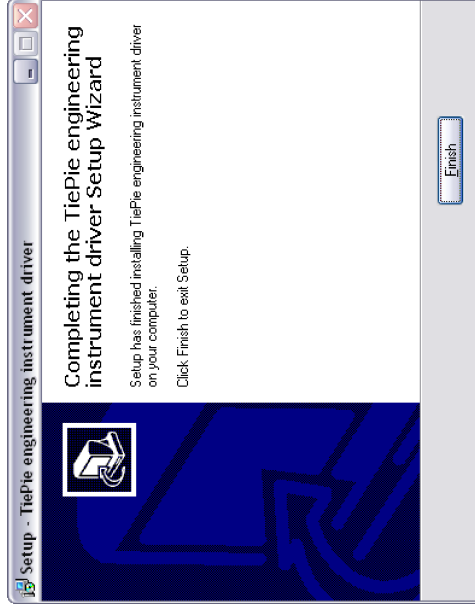


Figure 4.8: Driver install: Finished

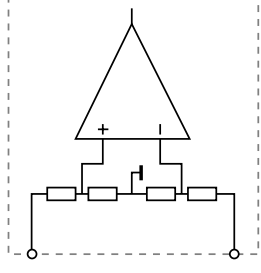


Figure 3.2: Differential input

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:

- No risk of creating a short circuit to ground
- Only one channel is required to measure the signal
- More accurate measurements, 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

### 3.1.1 Differential test lead

The Handyprobe HP3 comes with a special differential test lead. This test lead is specially designed to ensure a good CMRR. The special heat resistant differential test lead provided with the Handyprobe HP3 is designed to be immune for noise from the surrounding environment.

## 3.2 Sampling

When sampling the input signal, samples are taken at fixed intervals. At these intervals, the size of the input signal is converted to a number. The accuracy of this number depends on the resolution of the instrument. The higher the resolution, the smaller the voltage

steps in which the input range of the instrument is divided. The acquired numbers can be used for various purposes, e.g. to create a graph.

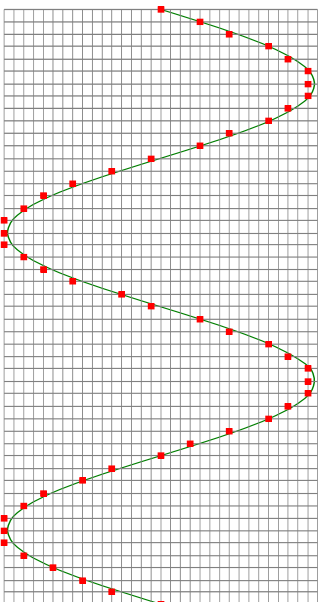


Figure 3.3: Sampling

The sine wave in figure 3.3 is sampled at the dot positions. By connecting the adjacent samples, the original signal can be reconstructed from the samples. You can see the result in figure 3.4.

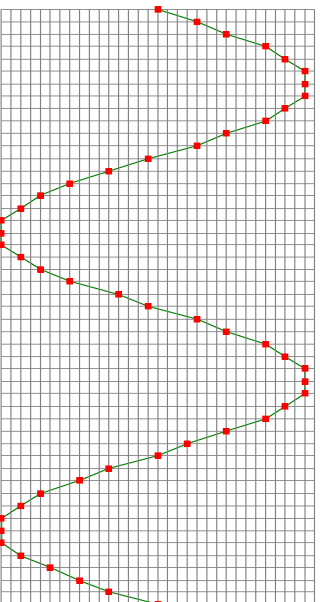


Figure 3.4: "connecting" the samples

### 3.3 Sample frequency

The rate at which the samples are taken is called the **sampling frequency**, the number of samples per second. A higher sampling frequency corresponds to a shorter interval between the samples. As is visible in figure 3.5, with a higher sampling frequency, the

The driver install utility now has enough information and can install the drivers. Clicking "**Install**" will remove existing drivers and install the new driver. A *remove entry* for the new driver is added to the software applet in the Windows control panel.

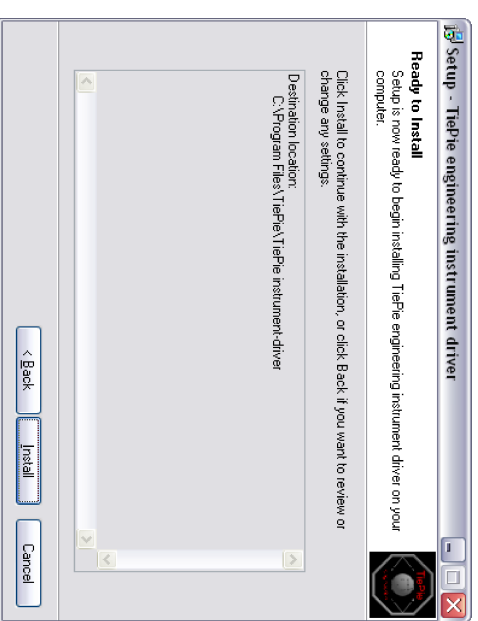


Figure 4.6: Driver install: step 5

As mentioned, Windows XP SP2 and newer may warn for the USB drivers not being Windows Logo tested. Please ignore this warning and continue anyway.

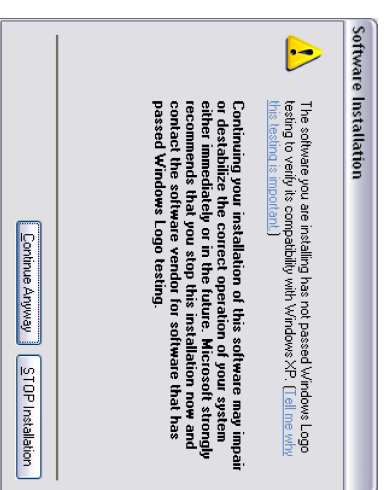


Figure 4.7: Driver install: Ignore warning and continue

original signal can be reconstructed much better from the measured samples.

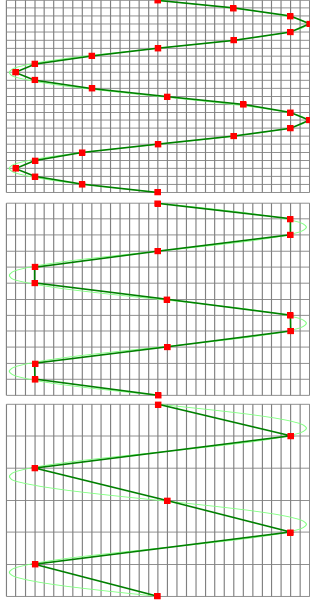


Figure 3.5: The effect of the sampling frequency

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 per period. In practice, 10 to 20 samples per period are recommended to be able to examine the signal thoroughly.

### 3.3.1

## Aliasing

When sampling an analog signal with a certain sampling frequency, signals appear in the output with frequencies equal to the sum and difference of the signal frequency and multiples of the sampling frequency. For example, when the sampling frequency is 1000 Hz and the signal frequency is 1250 Hz, the following signal frequencies will be present in the output data:

Multiple of sampling frequency	1250 Hz signal	-1250 Hz signal
...		
-1000	$-1000 + 1250 = 250$	$-1000 - 1250 = -2250$
0	$0 + 1250 = 1250$	$0 - 1250 = -1250$
1000	$1000 + 1250 = 2250$	$1000 - 1250 = -250$
2000	$2000 + 1250 = 3250$	$2000 - 1250 = 750$
...		

Table 3.1: Aliasing

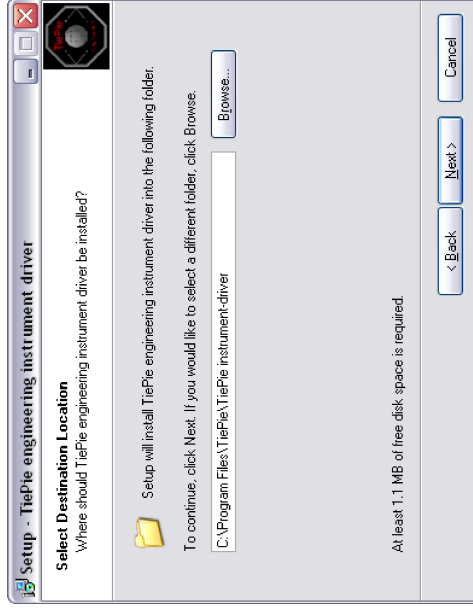


Figure 4.4: Driver install: step 3

On Windows XP and newer, the installation may inform about the drivers not being "Windows Logo Tested". The driver is not causing any danger for your system and can be safely installed. Please ignore this warning and continue the installation.

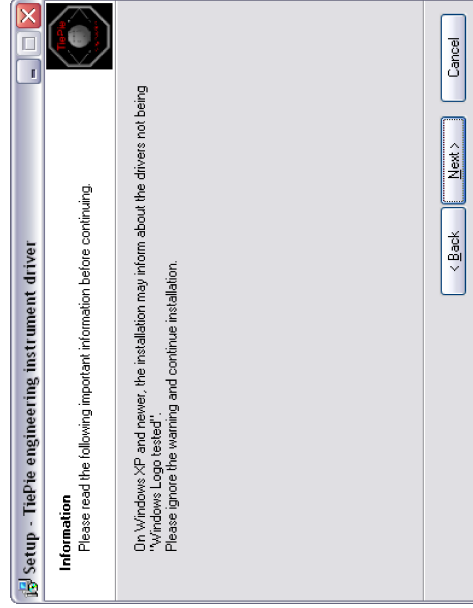


Figure 4.5: Driver install: step 4

As stated before, when sampling a signal, only frequencies lower than half the sampling frequency can be reconstructed. In this case the sampling frequency is 1000 Hz, so we can only observe signals with a frequency ranging from 0 to 500 Hz. This means that from the resulting frequencies in the table, we can only see the 250 Hz signal in the sampled data. This signal is called an **alias** of the original signal.

If the sampling frequency is lower than twice the frequency of the input signal, **aliasing** will occur. The following illustration shows what happens.

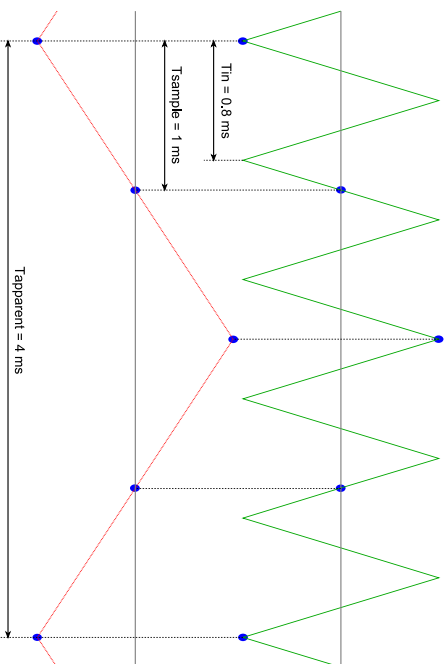


Figure 3.6: Aliasing

In figure 3.6, the green input signal (top) is a triangular signal with a frequency of 1.25 kHz. The signal is sampled with a frequency of 1 kHz. The corresponding sampling interval is  $1/1000\text{Hz} = 1\text{ms}$ . The positions at which the signal is sampled are depicted with the blue dots. The red dotted signal (bottom) is the result of the reconstruction. The period time of this triangular signal appears to be 4 ms, which corresponds to an apparent frequency (alias) of 250 Hz ( $1.25\text{ kHz} - 1\text{ kHz}$ ).



To avoid aliasing, always start measuring at the highest sampling frequency and lower the sampling frequency if required.

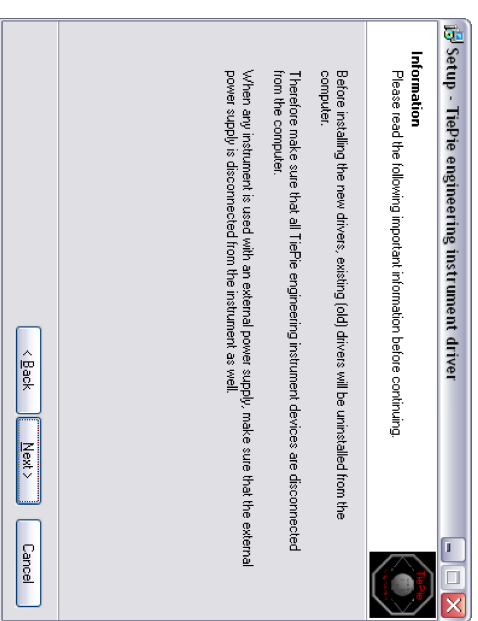


Figure 4.2: Driver install: step 2

When the instrument is still connected, the driver install utility will recognize it and report this. You will be asked to continue anyway.

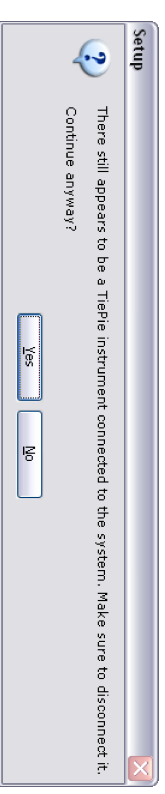


Figure 4.3: Driver install: Instrument is still connected

Clicking **"No"** will bring back the previous screen. The instrument should now be disconnected. Then the removal of the existing driver can be continued by clicking **"Next"**.

Clicking **"Yes"** will ignore the fact that the instrument is still connected and continue removal of the old driver. This option is **not** recommended, as removal may fail, after which installation of the new driver may fail as well.

When no existing driver was found or the existing driver is removed, the location for the pre-installation of the new driver can be selected.

installation of a driver on a system and also to update an existing driver.

The screen shots in this description may differ from the ones displayed on your computer, depending on the Windows version.

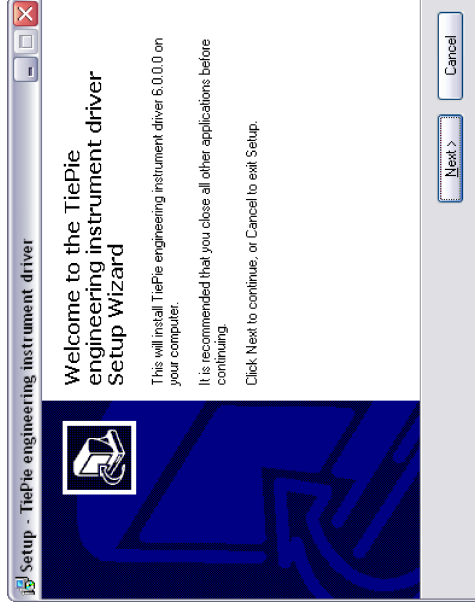


Figure 4.1: Driver install: step 1

When drivers were already installed, the install utility will remove them before installing the new driver. To remove the old driver successfully, **it is essential** that the Handyprobe HP3 is disconnected from the computer prior to starting the driver install utility.

### 3.4 Digitizing

When digitizing the samples, the voltage at each sample time is converted to a number. This is done by comparing the voltage with a number of levels. The resulting number is the number corresponding to the level that is closest to the voltage. The number of levels is determined by the resolution, according to the following relation:  $LevelCount = 2^{Resolution}$ .

The higher the **resolution**, the more levels are available and the more accurate the input signal can be reconstructed. In figure 3.7, the same signal is digitized, using two different amounts of levels: 16 (4-bit) and 64 (6-bit).

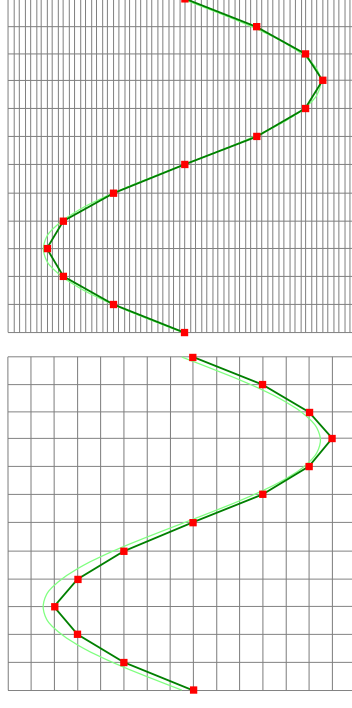


Figure 3.7: The effect of the resolution

The Handyprobe HP3 measures at 10 bit resolution ( $2^{10}=1024$  levels). The smallest detectable voltage step depends on the input range. This voltage can be calculated as:

$$VoltageStep = FullInputRange / LevelCount$$

For example, the 200 mV range ranges from -200 mV to +200 mV, therefore the full range is 400 mV. This results in a smallest detectable voltage step of  $0.400V/1024 = 0.3906mV$ .

### 3.5 Signal coupling

The Handyprobe HP3 has two different settings for the signal coupling: AC and DC. In the setting DC, the signal is directly coupled

to the input circuit. All signal components available in the input signal will arrive at the input circuit and will be measured. In the setting AC, a capacitor will be placed between the input connector and the input circuit. This capacitor will block all DC components of the input signal and let all AC components pass through. This can be used to remove a large DC component of the input signal, to be able to measure a small AC component at high resolution.



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When measuring DC signals, make sure to set the signal coupling of the input to DC.

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Before connecting the Handyprobe HP3 to the computer, the drivers need to be installed.

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## 4.1 Introduction

To operate a Handyprobe HP3, a driver is required to interface between the measurement software and the instrument. This driver takes care of the low level communication between the computer and the instrument, through USB. When the driver is not installed, or an old, no longer compatible version of the driver is installed, the software will not be able to operate the Handyprobe HP3 properly or even detect it at all.

The installation of the USB driver is done in a few steps. Firstly, the driver has to be pre-installed by the driver setup program. This makes sure that all required files are located where Windows can find them. When the instrument is plugged in, Windows will detect new hardware and install the required drivers.

## 4.2 Where to find the driver setup

The driver setup program and measurement software can be found in the download section on TiePie engineering's website and on the CD-ROM that came with the instrument. It is recommended to install the latest version of the software and USB driver from the website. This will guarantee the latest features are included.

## 4.3 Executing the installation utility

To start the driver installation, execute the downloaded driver setup program, or the one on the CD-ROM that came with the instrument. The driver install utility can be used for a first time