TiePie engineering Handyprobe HP3 100 MSa/s differential USB High Voltage Oscilloscope User Manual

Contents

TiePie
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Specifications

The accuracy of a channel is defined as a percentage of the Full Scale range. The 6 Full Scale range runs from -range to range and is effectively 2 * range. When the input range is set to 4 V, the Full Scale range is -4 V to 4 V = 8 V. Additionally a number of Least Significant Bits is incorporated. The acuracy is determined in the highest resolution. When the accuracy is specified as ±0.3% of the Full Scale range ± 1 LSB, and the input range is 4 V, the maximum deviation the measured value can have is ±0.3% of 8 V = ±24 mV. ±1 LSB equals 8 V / 1024 (= number of LSB at 10 bit) = ± 7.813 mV. Therefore the measured value will be between 31.813 mV lower and 31.813 mV higher than the actual value. When e.g. applying a 3.75 V signal and measuring it in the 4 V range, the measured value will be between 3.781813 V and 3.718188 V.

- **Acquisition system:**
- **Trigger system:**
  - System digital, 2 levels
  - Source CH1
  - Trigger modes rising slope, falling slope
  - Level adjustment 0 to 100% of full scale
  - Hysteresis adjustment 0 to 100% of full scale
  - Resolution 0.39% (8 bits)
  - Pre trigger 0 to 1 MSamples (0 to 100%, one sample resolution)
  - Post trigger 0 to 1 MSamples (0 to 100%, one sample resolution)
  - Trigger hold-off 0 to 4 MSamples, 1 sample resolution
- **Interface:**
  - Interface USB 2.0 High Speed (480 Mbit/s)
    (USB 1.1 Full Speed (12 Mbit/s) compatible)
- **Power:**
  - Power from USB port
  - Consumption 5 VDC, 400 mA max
- **Physical:**
  - 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

- **I/O connectors:**
  - CH1 isolated banana sockets
  - USB fixed cable with type A plug
- **System requirements:**
  - PC I/O connection USB 2.0 High Speed (480 Mbit/s) (USB 1.1 Full Speed (12 Mbit/s) and USB 3.0 compatible)
  - Operating System Windows 10 / 11, 64 bits
- **Environmental conditions:**
  - Operating
    - Ambient temperature 0°C to 55°C
    - Relative humidity 10 to 90% non condensing
  - Storage
    - Ambient temperature -20°C to 70°C
    - Relative humidity 5 to 95% non condensing
- **Certifications and Compliances:**
  - CE mark compliance Yes
  - RoHS Yes
  - REACH Yes
  - EN 55011:2016/A1:2017 Yes
  - EN 55022:2011/C1:2011 Yes
  - IEC 61000-6-1:2019 EN Yes
  - IEC 61000-6-3:2007/A1:2011/C11:2012 Yes
  - ICES-001:2004 Yes
  - AS/NZS CISPR 11:2011 Yes
  - IEC 61010-1:2010/A1:2019 Yes
  - UL 61010-1, Edition 3 Yes
- **Measure lead:**
  - Model TP-C812A
  - Type differential
  - Connectors
    - Instrument side dual 4 mm red and black shrouded banana plugs, 19 mm apart
    - Test point side red and black 4 mm shrouded banana plugs
  - Bandwidth 8 MHz
  - Safety CAT III, 1000 V, double isolated
  - Dimensions
    - Total length 2000 mm
    - Length to split 800 mm
    - Length individual ends 1200 mm
  - Weight 75 g
  - Color black
  - Heat resistant yes
  - Certification and compliances
    - CE conformity yes

        - RoHS yes
    - Accessories
        - Color coding rings 5 x 3 rings, various colors
    - Suitable instrument Handyprobe HP3
- **Package contents:**

The Handyprobe HP3 is available as standard set and can be delivered with option PS Professional Set. See below for more details.

- Standard set
    - Container cardboard box
        - Instrument Handyprobe HP3
        - Test lead –
        - Accessories –
        - Software Windows 10 / 11, 64 bits, via website
        - Drivers Windows 10 / 11, 64 bits, via website
        - Software Development Kit Windows 10 / 11 (64 bits) and Linux, via website
        - Manual Instrument manual and software manual via website
    - Professional Set
        - Container BB271 Carry case
            - Instrument Handyprobe HP3
            - Test lead Measure Lead TP-C812A
            - Accessories 2 Alligator Clips TP-AC80I, red and black
              2 Test Probes TP-TP90, red and black
              Wrist strap
              Color coding rings
            - Software Windows 10 / 11, 64 bits, via website
            - Drivers Windows 10 / 11, 64 bits, via website
            - Software Development Kit Windows 10 / 11 (64 bits) and Linux, via website
            - Manual Printed instrument manual and software manual

Safety

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.

Safe working tips are given below:

- Always work according (local) regulations.
- Work on installations with voltages higher than 25 VAC or 60 VDC 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 25 VAC or 60 VDC.
- 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.

Driver Installation

Introduction: Before using the Handyprobe HP3, you need to install the drivers.

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

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.

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. 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.

Executing the installation utility
To start the driver installation, execute the downloaded driver setup program. The driver install utility can be used for a first time 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.

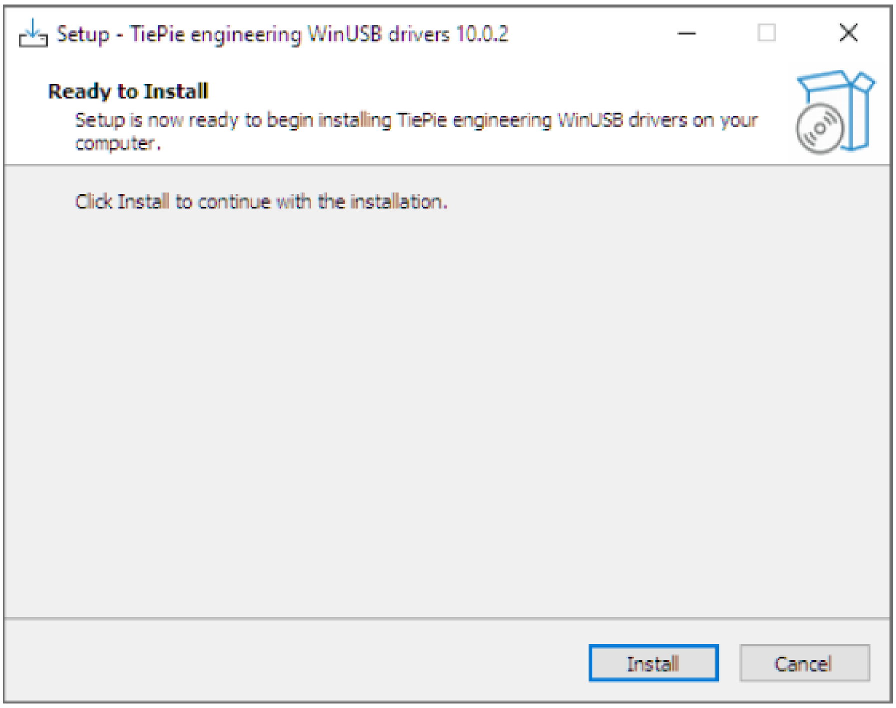


Figure 4.1: Driver install: step 1

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. 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.

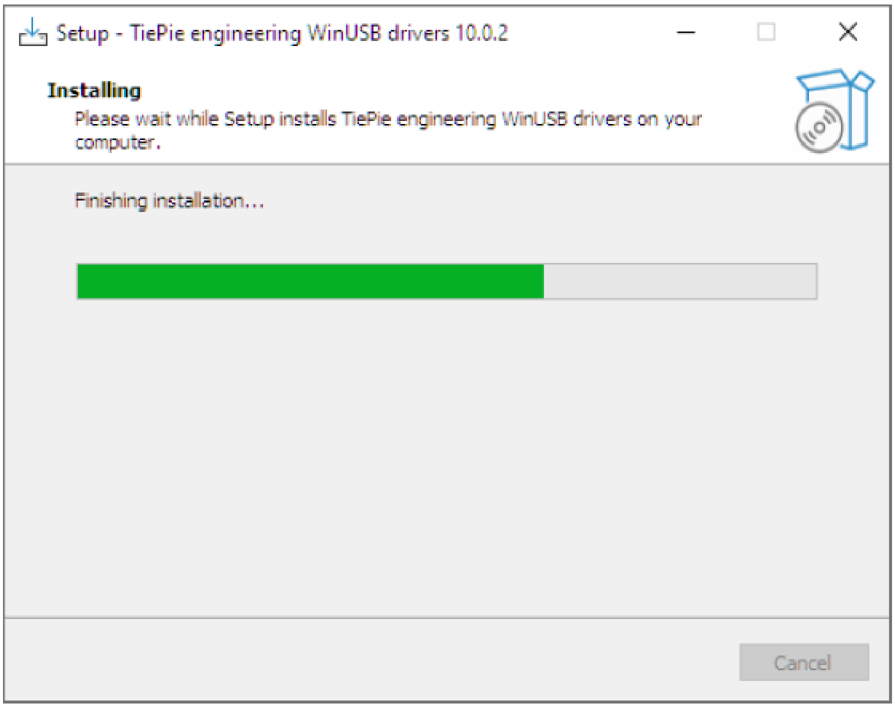


Figure 4.2: Driver install: Copying files

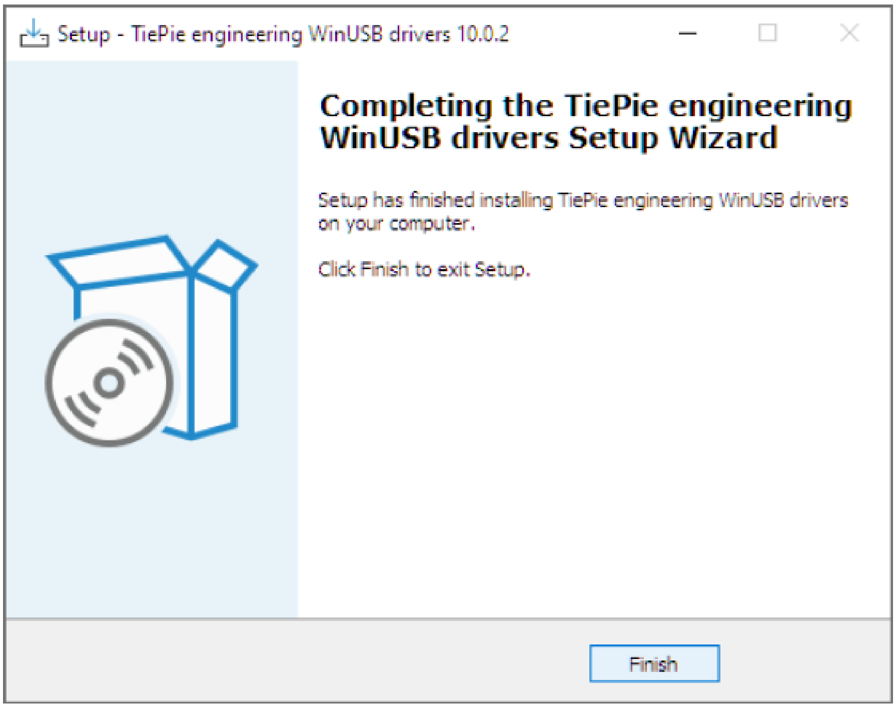


Figure 4.3: Driver install: Finished

Hardware Installation

Power the instrument: Connect the power source to the Handyprobe HP3.

Connect to the computer: Use the provided cable to connect the Handyprobe HP3 to your computer.

Plug into a different USB port: If there are connection issues, try plugging the Handyprobe HP3 into a different USB port on your computer.

FAQ

1. **Q: Is it safe to measure line voltage directly with Handyprobe HP3?**

   A: No, measuring directly on the line voltage can be very dangerous. Avoid direct contact with line voltage to prevent harm or damage.

ATTENTION!
Measuring directly on the line voltage can be very dangerous.

Revision 2.49, August 2024
This information is subject to change without notice. Despite the care taken for the compilation of this user manual, TiePie engineering can not be held responsible for any damage resulting from errors that may appear in this manual.

Declaration of conformity

TiePie engineering
Koperslagersstraat 37
8601 WL Sneek
The Netherlands

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 EC directive 2011/65/EU (the RoHS directive) including up to amendment 2021/1980, EC regulation 1907/2006 (REACH) including up to amendment 2021/2045,
and with
EN 55011:2016/A1:2017
EN 55022:2011/C1:2011
IEC 61000-6-1:2019 EN
IEC 61000-6-3:2007/A1:2011/C11:2012 EN
according the conditions of the EMC standard 2004/108/EC, also with

- Canada: ICES-001:2004
- Australia/New Zealand: AS/NZS CISPR 11:2011

and

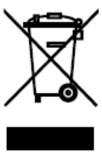
- IEC 61010-1:2010/A1:2019
- USA: UL 61010-1, Edition 3

and is categorized as CAT II 600 VRMS, 800 Vpk, 800 VDC
Sneek, 1-9-2022
ir. A.P.W.M. Poelsma

Environmental considerations

This section provides information about the environmental impact of the Handy-probe HP3.

End-of-life handling



Production of the Handyprobe HP3 required the extraction and use of natural resources. The equipment may contain substances that could be harmful to the environment or human health if improperly handled at the Handyprobe HP3’s end of life.

In order to avoid release of such substances into the environment and to reduce the use of natural resources, recycle the Handyprobe HP3 in an appropriate system that will ensure that most of the materials are reused or recycled appropriately. The shown symbol indicates that the Handyprobe HP3 complies with the European Union's requirements according to Directive 2002/96/EC on waste electrical and electronic equipment (WEEE).

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 measuring instrument with differential input with high input range. The Handyprobe HP3 is available in several models with different maximum sampling rates and different maximum streaming rates.

	HP3-100	HP3-20	HP3-5
Maximum sampling rate Maximum streaming rate	100 MSa/s 10 MSa/s	20 MSa/s 2 MSa/s	5 MSa/s 500 kSa/s

Table 3.1: Maximum sampling rate

The Handyprobe HP3 is available with two memory configurations, these are:

Memory	HP3-100	HP3-20	HP3-5
Standard model Option XM	16 kSa 1 MSa	16 kSa 1 MSa	16 kSa 1 MSa

Table 3.2: Maximum record lengths per channel
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.

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.

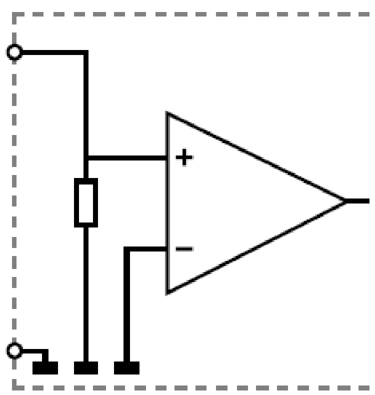


Figure 3.1: Single ended input

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.

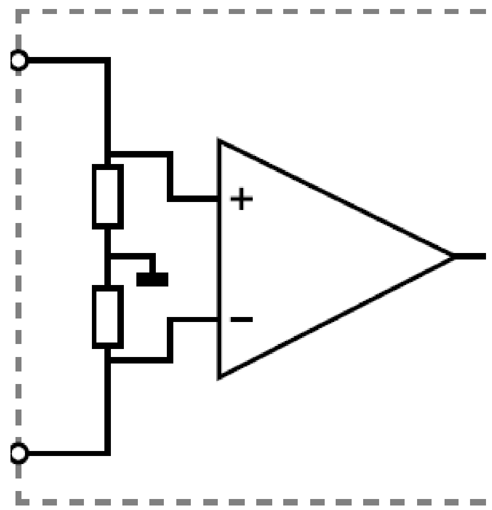


Figure 3.2: Differential input

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

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

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.

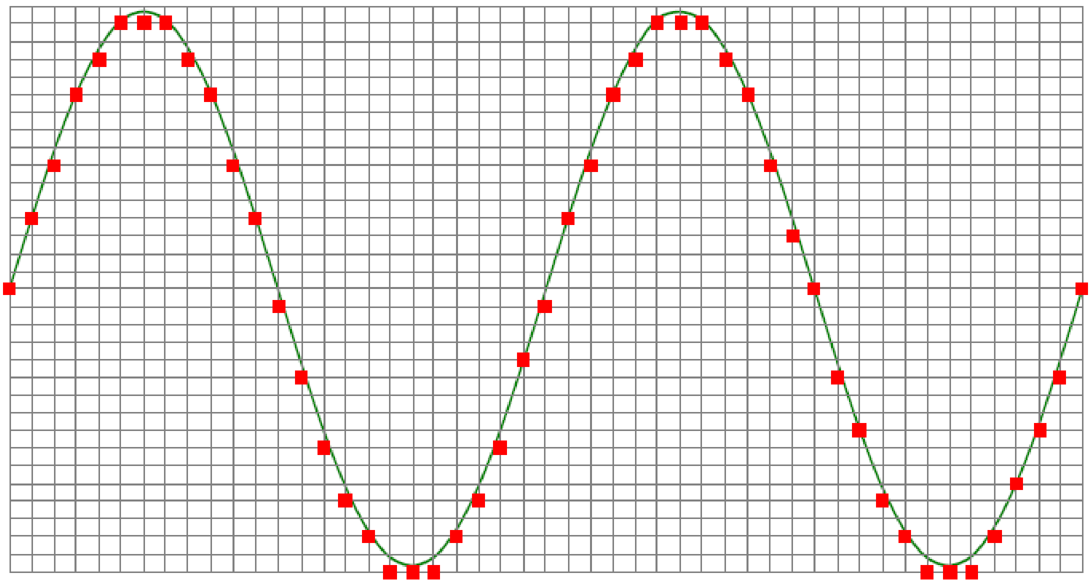


Figure 3.3: Sampling

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.

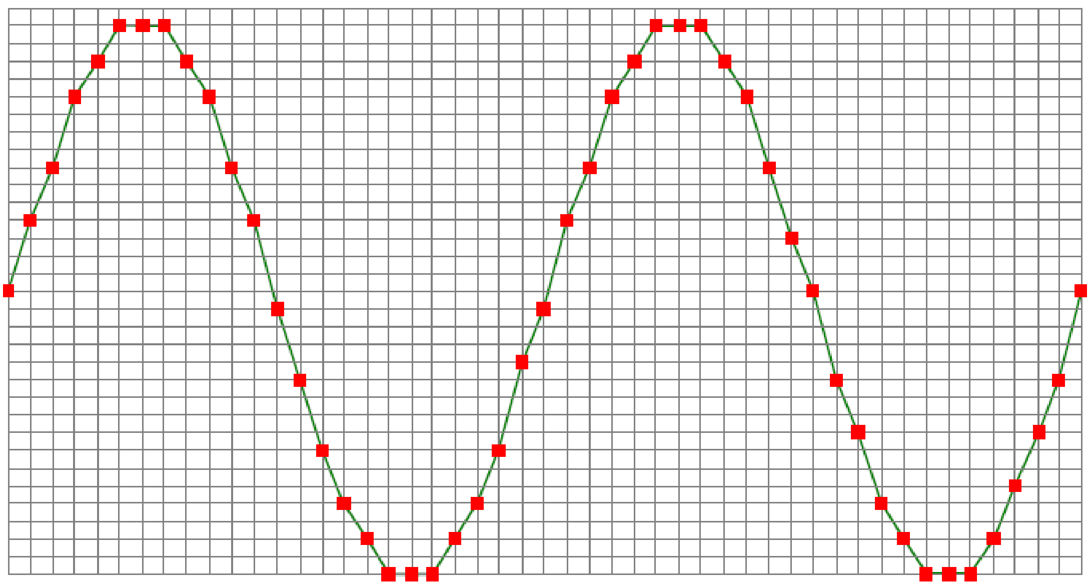


Figure 3.4: "connecting" the samples

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

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

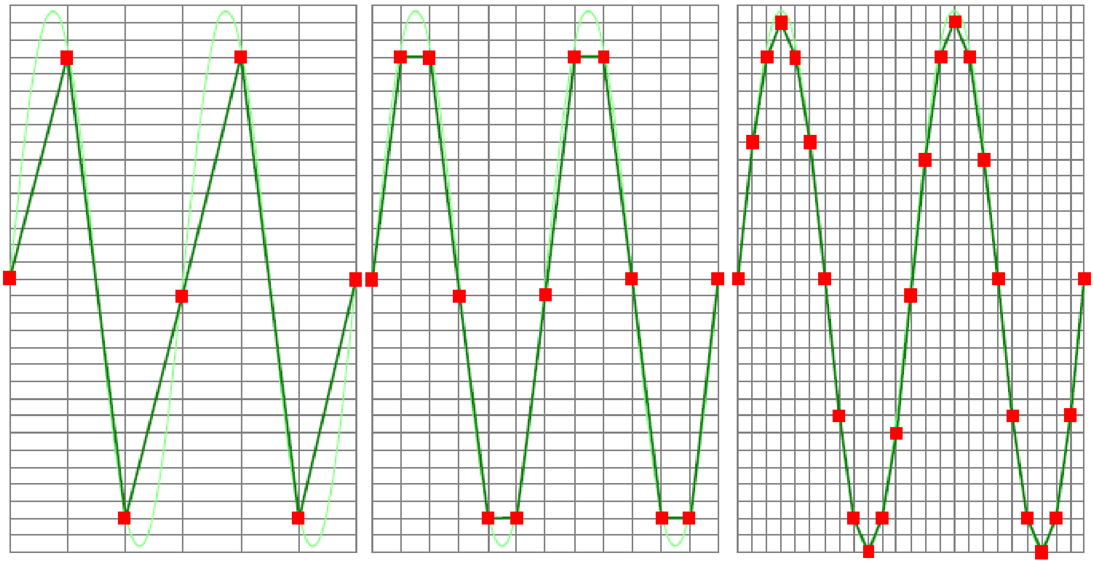


Figure 3.5: The effect of the sampling rate

The sampling rate 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.

Aliasing

When sampling an analog signal with a certain sampling rate, signals appear in the output with frequencies equal to the sum and difference of the signal frequency and multiples of the sampling rate.

For example, when the sampling rate is 1000 Sa/s and the signal frequency is 1250 Hz, the following signal frequencies will be present in the output data:

Multiple of sampling rate	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 3.3: Aliasing

As stated before, when sampling a signal, only frequencies lower than half the sampling rate can be reconstructed. In this case the sampling rate is 1000 Sa/s, so we can we 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 rate is lower than twice the frequency of the input signal, aliasing will occur. The following illustration shows what happens.

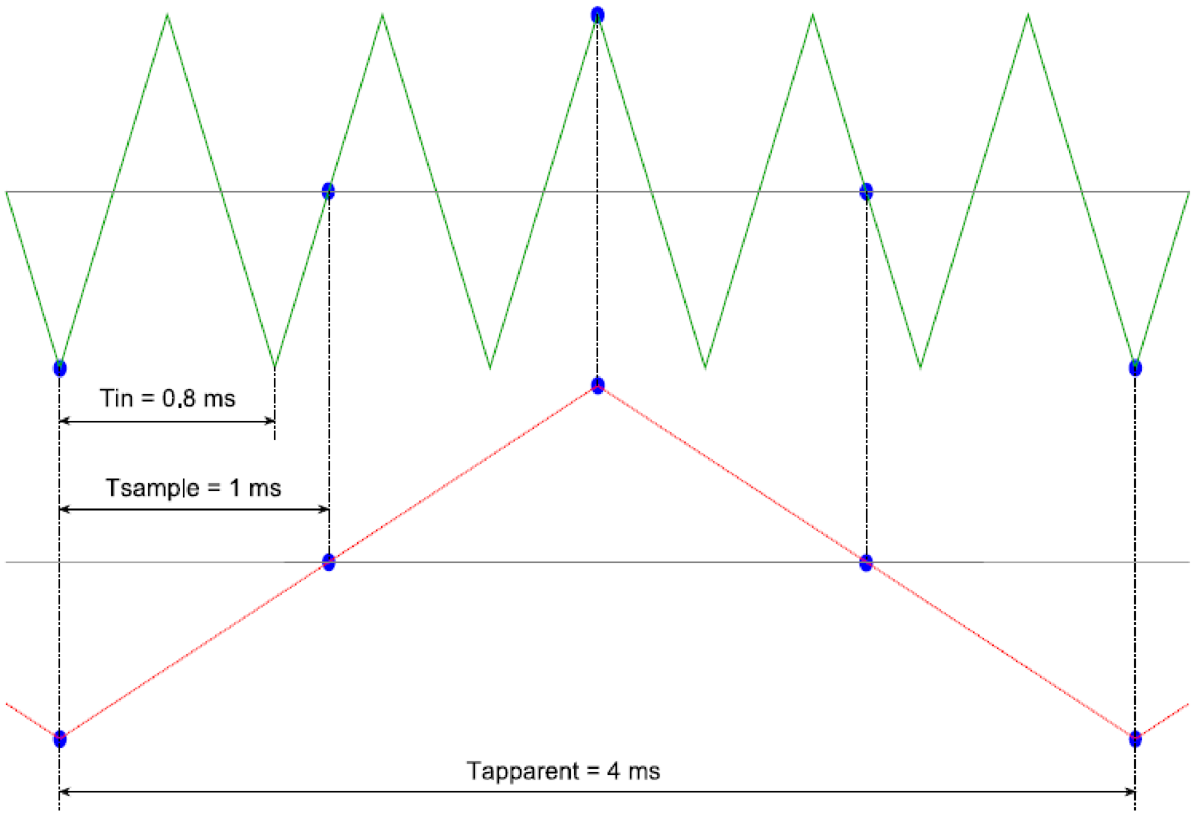


Figure 3.6: Aliasing

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 rate of 1 kSa/s. The corresponding sampling interval is 1/1000Hz = 1ms. The positions at which the signal is sampled are depicted with the blue dots. The red dotted signal (bottom) is the result of the re-construction. The period time of this triangular signal appears to be 4 ms, which corresponds to an apparent frequency (alias) of 250 Hz (1.25 kHz – 1 kHz).
To avoid aliasing, always start measuring at the highest sampling rate and lower the sampling rate if required.

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 = 2Resolution.
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).

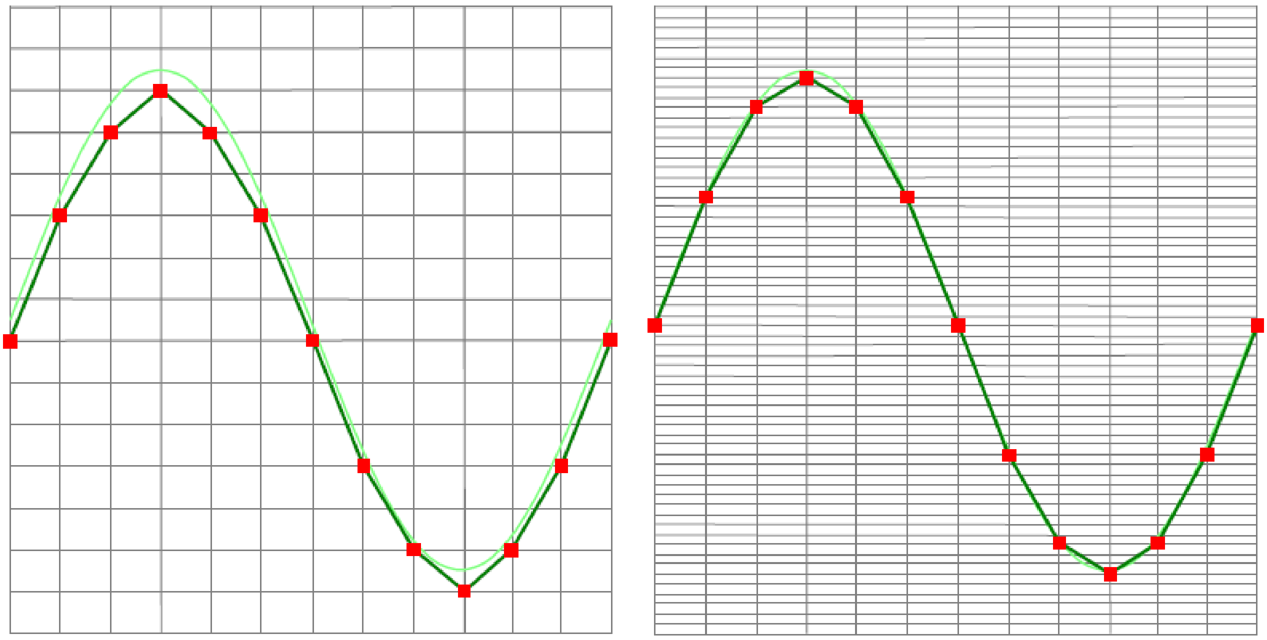


Figure 3.7: The effect of the resolution

The Handyprobe HP3 measures at 10 bit resolution (210=1024 levels). The smallest detectable voltage step depends on the input range.

This voltage can be calculated as:
V oltageStep = F ullInputRange/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 0.400 V / 1024 = 0.3906 mV.

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

Hardware installation

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

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.

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 detect new hardware. Depending on the Windows version, a notification can be shown that new hardware is found and that drivers will be installed. Once ready, Windows will report that the driver is installed. When the driver is installed, the measurement software can be installed and the Handyprobe HP3 can be used.

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 install the drivers again for that port. This is controlled by Microsoft Windows and is not caused by TiePie engineering.

If you have any suggestions and/or remarks regarding this manual, please contact:
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- Fax: +31 515 418 819
- E-mail: support@tiepie.nl
- Site: www.tiepie.com

TiePie engineering Handyprobe HP3 instrument manual revision 2.49, August 2024

Documents / Resources

	**TiePie engineering Handyprobe HP3 100 MSa/s differential USB High Voltage Oscilloscope** [pdf] User Manual Handyprobe HP3 100 MSas differential USB High Voltage Oscilloscope, Handyprobe HP3, 100 MSas differential USB High Voltage, 100 MSas differential USB High Voltage Oscillo scopeOscillo scope, differential USB High Voltage Oscillo scopeOscillo scope, USB High Voltag e Oscillo scopeOscillo scope, Voltage Oscillo scopeOscillo scope, Oscillo scopeOscillo scope, s copeOscillo scope, scope

References

- TiePie - USB oscilloscopes, spectrum analyzers, data loggers, multimeters, Arbitrary Waveform Generators
- User Manual