

# TiePieSCOPE HS805

## Instrument manual

Rev. 2.1



TiePie engineering

## ATTENTION!

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

The **outside** of the **BNC connectors** at the TiePieSCOPE HS805 are connected with the **ground** of the computer.

Use a good isolation transformer or a differential probe when measuring at the **line voltage** or at **grounded power supplies!** A short-circuit current will flow if the **ground** of the TiePieSCOPE HS805 is connected to a positive voltage. This short-circuit current can damage both the TiePieSCOPE HS805 and the computer.

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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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 TiePieSCOPE HS805 before connecting any wiring
- 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.
- Measuring directly on the **line voltage** can be very dangerous. The **outside** of the **BNC connectors** at the TiePieSCOPE HS805 are connected with the **ground** of the computer. Use a good isolation transformer or a differential probe when measuring at the **line voltage** or at **grounded power supplies!** A short-circuit current will flow if the **ground** of the TiePieSCOPE HS805 is connected to a positive voltage. This short-circuit current can damage both the TiePieSCOPE HS805 and the computer.

## 8.14 Package

Instrument	TiePieSCOPE HS805
Probes	2 x 1:1 / 1:10 switchable
Accessories	Power adapter Power cord USB cable
Software	Windows 98/2000/ME/XP/Vista-32
Drivers	Windows 98/2000/ME/XP/Vista-32
Manual	Instrument manual and software user's manual

## 8.9 I/O connectors

Ch1-Ch2	BNC
Generator out	BNC
Power	5 pin Mini-DIN socket
USB	type B socket
Extension connector	Sub-D 15 pins female

## 8.10 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

## 8.11 Operating environment

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

## 8.12 Storage environment

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

## 8.13 Certifications and Compliances

C/E mark compliance	Yes
RoHS	Yes

# Declaration of conformity



**TiePie engineering**  
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The Netherlands

## EC Declaration of conformity

We declare, on our own responsibility, that the product

### TiePieSCOPE HS805

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.

## 8.5 Interface

Interface	USB 2.0 High Speed (480 Mbit/s) (USB 1.1 Full Speed (12 Mbit/sec) compatible)
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## 8.6 Power

Power adapter	external
Input	110 – 240 V AC, 50 – 60 Hz 0.85 A Max., 50 VA – 80 VA
Output	5 V DC, 1.5 A 12 V DC, 1.5 A
Dimension	33 x 58 x 102 mm / 1.3 x 2.3 x 4 " (h x w x l)
Consumption	5 V DC, 1500 mA max 12 V DC, 1500 mA max

## 8.7 Probes

Bandwidth	1:1 6 MHz 1:10 250 MHz
Rise time	1:1 58 ns 1:10 1.4 ns
Input impedance	1:1 1 M $\Omega$ (oscilloscope impedance) 1:10 10 M $\Omega$ (incl. 1 M $\Omega$ oscilloscope impedance)
Input capacitance	1:1 47 pF + oscilloscope capacitance 1:10 17 pF
Compensation range	1:1 - 1:10 10 – 35 pF
Working voltage	1:1 300 V CAT I, 150 V CAT II (DC + peak AC) 1:10 600 V CAT I, 300 V CAT II (DC + peak AC)

## 8.8 Physical

Instrument height	57 mm / 2.3"
Instrument length	276 mm / 10.9"
Instrument width	180 mm / 7.1"
Weight	1250 grams / 2.8 lbs
USB cord length	1.2 m / 47"
Power cord length	1.5 m / 59"

System	digital, 2 levels
Source	CH1, CH2, AND, OR, analog external, digital external
Trigger modes	rising slope, falling slope, inside window, outside window
Level adjustment	0–100% of full scale
Hysteresis adjustment	0–100% of full scale
Resolution	0.39% (8 bits)
Pre trigger	0–32Msamples (0–100%, one sample resolution)
Post trigger	0–32Msamples (0–100%, one sample resolution)
<b>Analog external trigger</b>	
Input	BNC
Sensitivity	200 mV .. 80 V full scale
Coupling	AC/DC
Bandwidth	20 MHz
Protection	200 V (DC + AC peak <10 kHz)
<b>Digital external trigger</b>	
Input	extension connector
Sensitivity	0 .. 5 V (TTL)
Coupling	DC

Output channel	1 analog, BNC
Resolution	14 bit @ 200 MHz
Amplitude	-12 V .. 12 V
Amplitude step	0 - ±0.12 V range, 12 bit resolution ±0.1 - ±1.2 V range, 12 bit resolution ±0.9 - ±12 V range, 12 bit resolution
Coupling	DC
Impedance	50 Ω
Bandwidth	DC to 20 MHz
DC level	0 - ±12 V, 12 bit resolution
Maximum sampling rate	100 MHz
Sampling source	internal, 0.01%
Memory	32M points
Waveforms	sine, triangle, square, DC, noise and user defined
Symmetry	0.1 - 99.9%, 0.1% steps



Before using the TiePieSCOPE HS805 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 TiePieSCOPE HS805 is a two channel, 8 bits, 1 GSamples/sec (on one channel, 500 MSamples/sec on two channels) measuring instrument with Arbitrary Waveform Generator.

With the accompanying software the TiePieSCOPE HS805 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

## 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.

## 8.1 Acquisition system

Number of input channels	2 analog
Ch1, Ch2	BNC
Maximum sampling rate	one channel : 1 GS/sec real time, 1 ns two channels : 500 MS/sec real time, 2 ns
Sampling source	Internal $\pm 0.01\%$ , external
Memory	32 MSamples each channel

## 8.2 BNC inputs Ch1, Ch2

Measure mode	Voltage
Resolution	8 bit
Accuracy	1% $\pm$ 1 LSB
Sensitivity	200 mV .. 80 V full scale
Coupling	AC/DC
Impedance	1 M $\Omega$ / 30 pF
Protection	200 V (DC + AC peak <10 kHz)
Bandwidth (-3dB)	DC to 250 MHz maximum
AC coupling cut off frequency (-3dB)	$\pm 1.5$ Hz

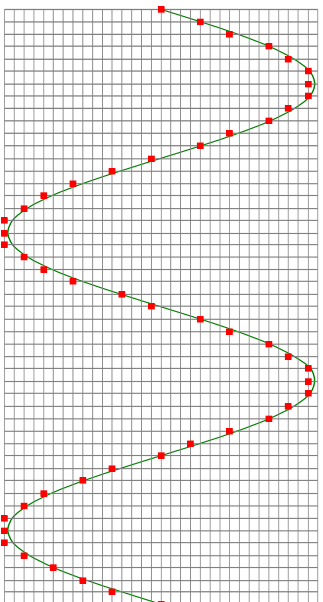


Figure 3.1: Sampling

The sine wave in figure 3.1 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 3.2.

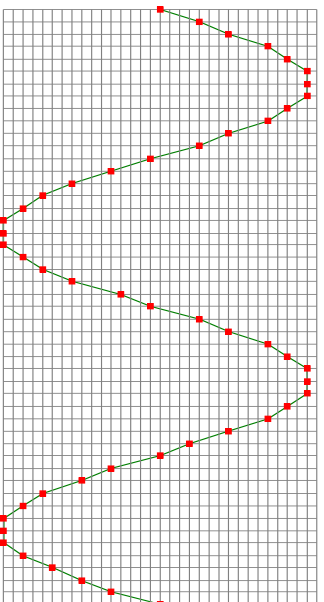


Figure 3.2: "connecting" the samples

## 3.2 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 3.3, with a higher sampling frequency, the original signal can be reconstructed much better from the measured samples.

work on a computer with a USB 1.1 interface, but will then operate at 12 Mbit/sec.

## 7.3 EXT TRIG

The Ext Trig input BNC can be used to connect an external analog signal. The outside of the BNC connector is connected to the ground of the TiePieSCOPE HS805. Connecting the outside of the BNC connector to a potential other than ground will result in a short circuit that may damage the device under test, the TiePieSCOPE HS805 and the computer.

## 7.4 EXTENSION CONNECTOR

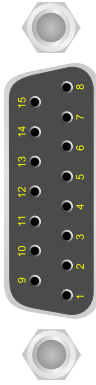


Figure 7.3: Extension connector

Pin	Description	Pin	Description
1	GND	9	5 V DC Out, 10 mA max
2	NC	10	Do not connect
3	External Trigger In (TTL)	11	Trigger out (TTL)
4	External Clock P (LVDS)	12	External Clock N (LVDS)
5	Do not connect	13	Do not connect
6	Generator Ext Trig in (TTL)	14	Digital Ext. trigger in (TTL)
7	Do not connect	15	I <sup>2</sup> C SDA
8	I <sup>2</sup> C SCL		

Table 7.1: Pin description Extension connector.

Pins 3, 6 and 14 are 3.3 Volt TTL signals which are 5 Volt tolerant, so they can be connected to a 5 Volt TTL system. Pin 11 is an open collector output. Connect a pull-up resistor of 1 kOhm to pin 9 when using this signal.

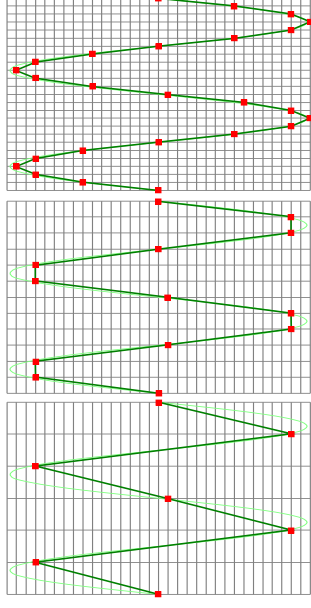


Figure 3.3: The effect of the sampling frequency

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.

### 3.2.1 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

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

## Rear panel

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.

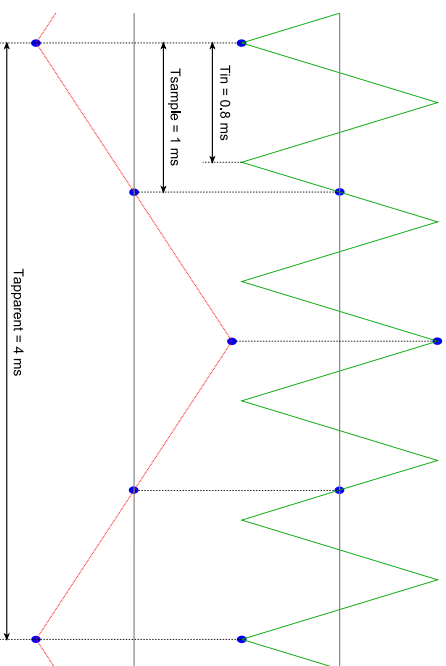


Figure 3.4: Aliasing

In figure 3.4, 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 (alias) 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.

## 7.1 Power

The TiePieSCOPE HSS805 is delivered with an external power adapter, that can be connected to any mains power net that supplies 100 – 240 V AC, 50 – 60 Hz. To connect the power adapter to the instrument, a 5 pin mini-DIN female socket is available.

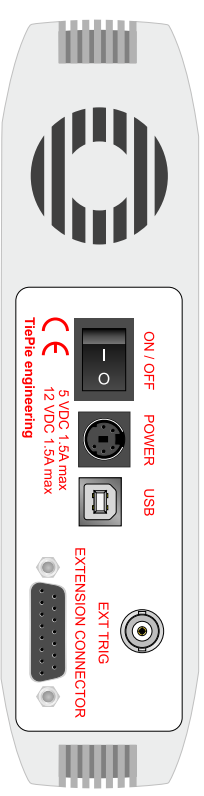
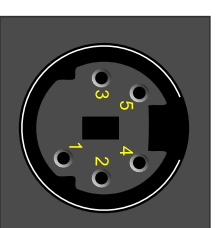


Figure 7.1: Rear panel



Pin	Description
1	+12 Volt
2	+5 Volt
3	GND
4	+5 Volt
5	GND

Figure 7.2: Power connector

## 7.2 USB

A USB type B socket is available to connect the TiePieSCOPE HSS805 to the computer. The TiePieSCOPE HSS805 is equipped with a USB 2.0 High speed (480 Mbit/sec) interface. It will also

## 6.4 Status indicator

A status indicator is situated at the right hand side of the front panel. It is lit when the instrument driver has successfully made a connection with the TiePieSCOPE HS805 through USB.

## 3.3

### 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 3.5, the same signal is digitized, using two different amounts of levels: 16 (4-bit) and 64 (6-bit).

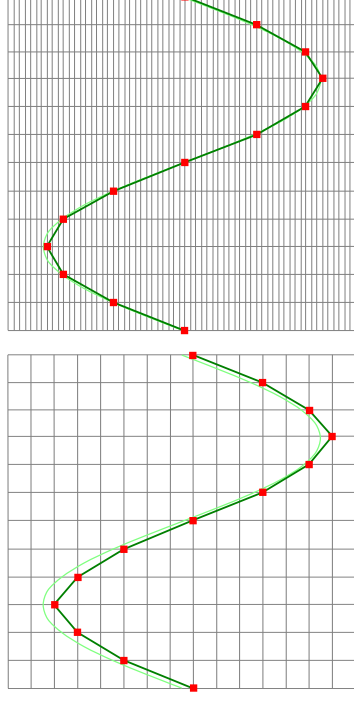


Figure 3.5: The effect of the resolution

The TiePieSCOPE HS805 measures at 8 bit resolution ( $2^8=256$  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  $0.400V/256 = 1.5625mV$ .

## 3.4 Signal coupling

The TiePieSCOPE HS805 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.

### 3.5 Probe compensation

The TiePieSCOPE HSS05 is shipped with a probe for each input channel. These are 1x/10x selectable passive probes. This means that the input signal is passed through directly or 10 times attenuated.



When using an oscilloscope probe in 1:1 the setting, the bandwidth of the probe is only 6 MHz. The full bandwidth of the probe is only obtained in the 1:10 setting

The x10 attenuation is achieved by means of an attenuation network. This attenuation network has to be adjusted to the oscilloscope input circuitry, to guarantee frequency independency. This is called the low frequency compensation. Each time a probe is used on an other channel or an other oscilloscope, the probe must be adjusted. Therefore the probe is equipped with a setscrew, with which the parallel capacity of the attenuation network can be altered. To adjust the probe, switch the probe to the x10 and attach the probe to a 1 kHz square wave signal. Then adjust the probe for a square front corner on the square wave displayed. See also the following illustrations.

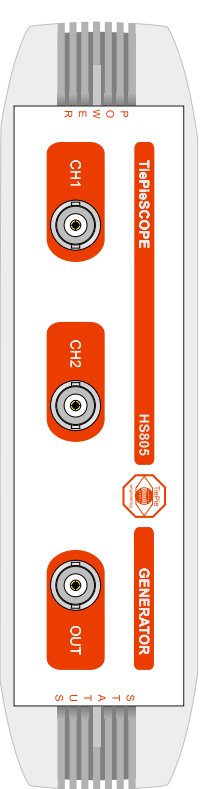


Figure 6.1: Front panel

### 6.1 CH1 and CH2 input connectors

The CH1 and CH2 BNC connectors are the main inputs of the acquisition system. The outside of all three BNC connectors is connected to the ground of the TiePieSCOPE HSS05. Connecting the outside of the BNC connector to a potential other than ground will result in a short circuit that may damage the device under test, the TiePieSCOPE HSS05 and the computer.

### 6.2 GENERATOR output connector

The OUT BNC connector is the output of the internal Arbitrary Waveform Generator. The outside of this BNC connector is connected to the ground of the TiePieSCOPE HSS05.

### 6.3 Power indicator

A power indicator is situated at the left hand side of the front panel. It is lit when the TiePieSCOPE HSS05 is powered.

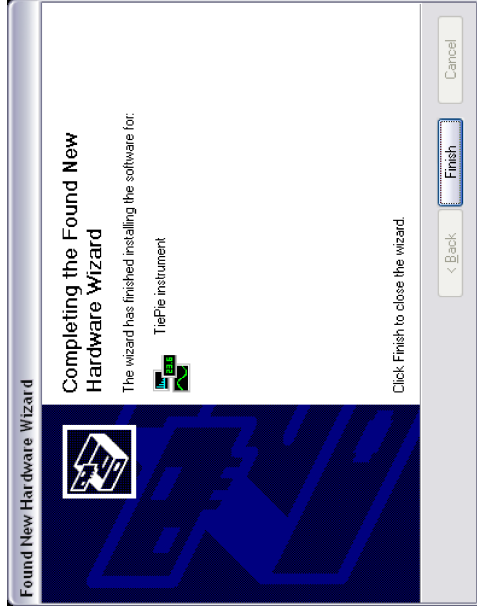


Figure 5.4: Hardware install: step 4

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 TiePieSCOPE HS805 can be used.

### 5.3 Plug into a different USB port

When the TiePieSCOPE HS805 is plugged into a different USB port, some Windows versions will treat the TiePieSCOPE HS805 as different hardware and will ask to install the drivers again. This is controlled by Microsoft Windows and is not caused by TiePie engineering.

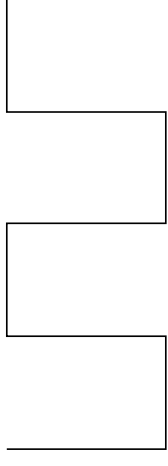


Figure 3.6: correct

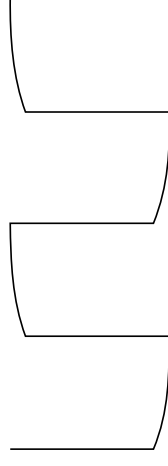


Figure 3.7: under compensated

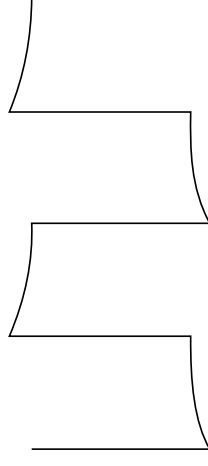


Figure 3.8: over compensated



Figure 5.2: Hardware install: step 2

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”*.

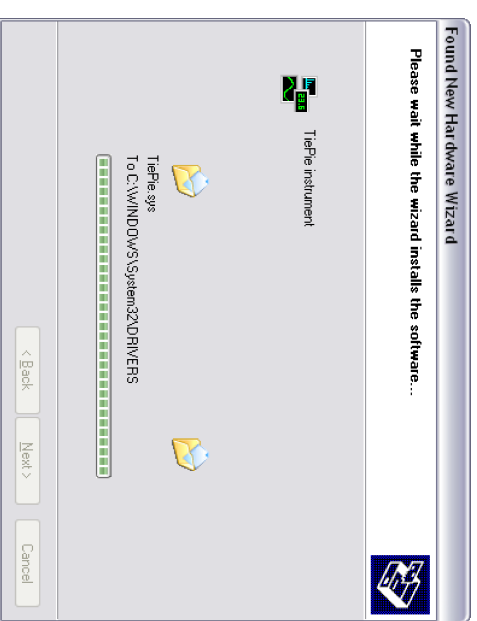


Figure 5.3: Hardware install: step 3

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

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.

### 5.2.1 Found New Hardware Wizard

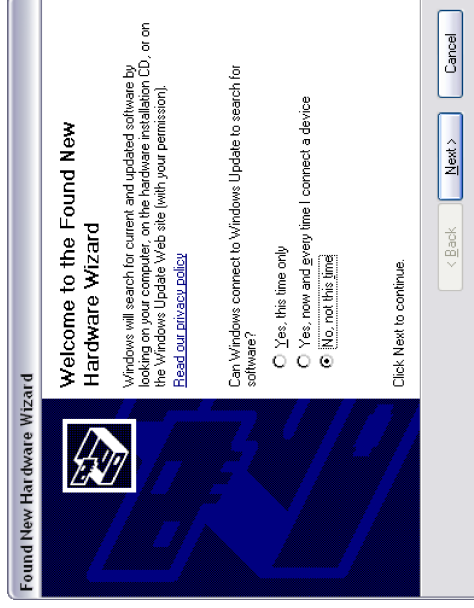


Figure 5.1: Hardware install: step 1

This window will only be shown in Windows XP SP2 or newer. No drivers for the TiePieSCOPE HS805 can be found on the Windows Update Web site, so select "No, not *this time*" and click "Next".

# 4

## Driver installation



Before connecting the TiePieSCOPE HS805 to the computer, the drivers need to be installed.

### 4.1

## Introduction

To operate a TiePieSCOPE HS805, 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 TiePieSCOPE HS805 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

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.

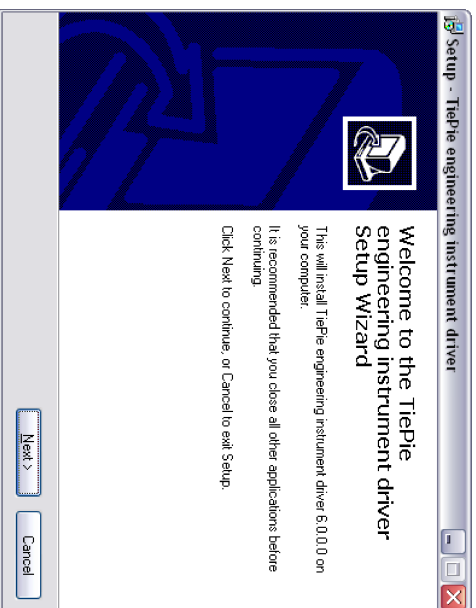


Figure 4.1: Driver install: step 1

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 TiePieSCOPE HS805 is disconnected from the computer prior to starting the driver install utility.



Drivers have to be installed before the TiePieSCOPE HS805 is connected to the computer for the first time. See chapter 4 for more information.

## 5.1 Power the instrument

The TiePieSCOPE HS805 comes with a universal power supply, that can be connected to a power outlet using the appropriate cable. The 5 pin Mini-DIN connector attached to the power supply must be plugged into the power connector at the rear of the TiePieSCOPE HS805. Refer to paragraph 7.1 for specifications of the external power input. The power switch at the rear of the TiePieSCOPE HS805 must be turned on for operation.

## 5.2 Connect the instrument to the computer

After the new driver has been pre-installed (see chapter 4), the TiePieSCOPE HS805 can be connected to the computer. When the TiePieSCOPE HS805 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 TiePieSCOPE HS805 is installed.



The driver consists of two parts which are installed separately.

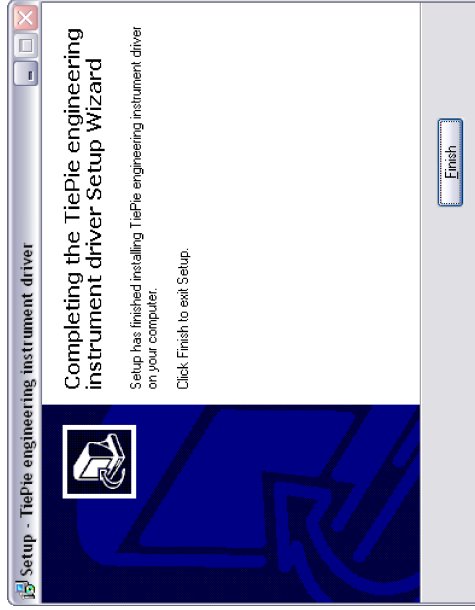


Figure 4.8: Driver install: Finished

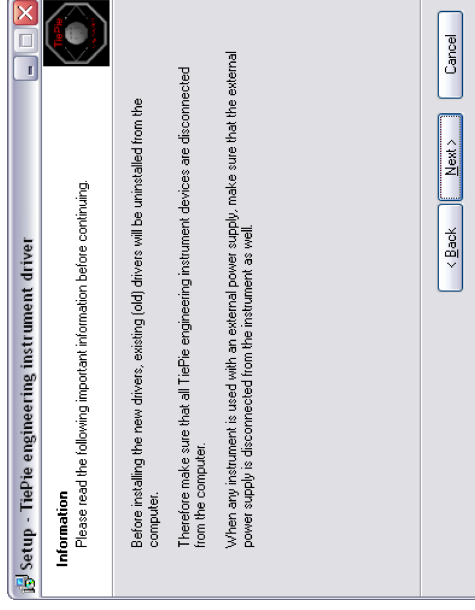


Figure 4.2: Driver install: step 2

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.

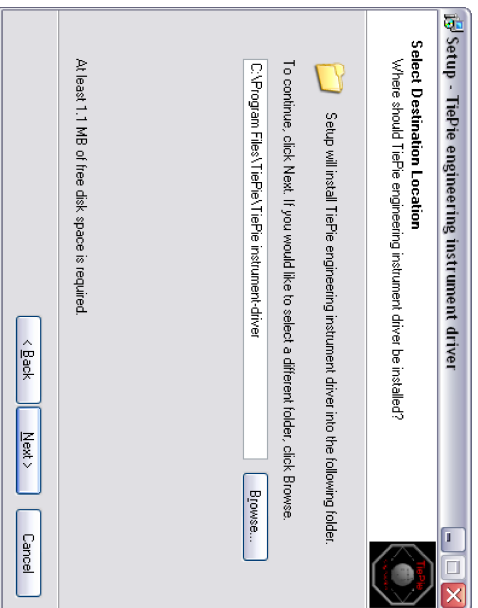


Figure 4.4: Driver install: step 3

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.

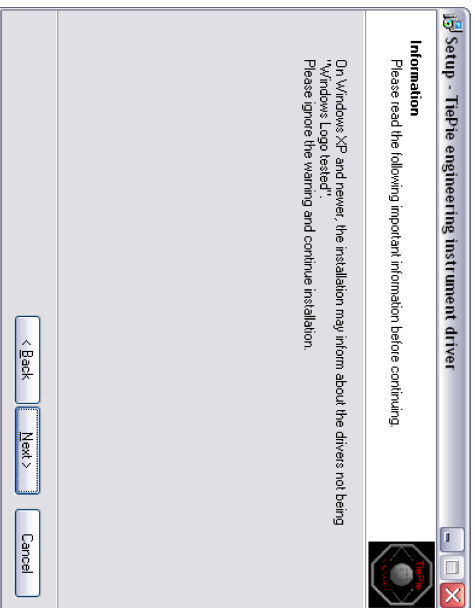


Figure 4.5: Driver install: step 4

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.

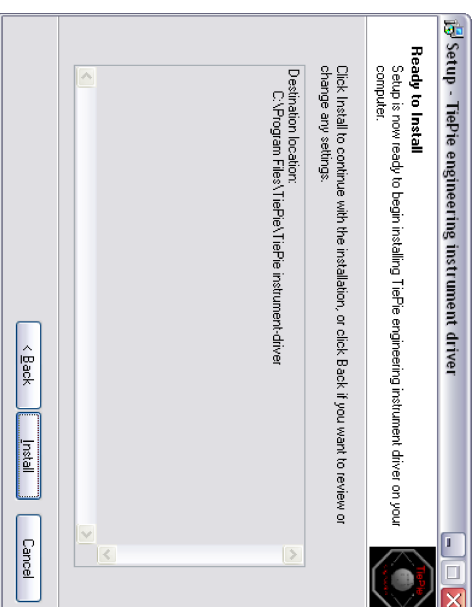


Figure 4.6: Driver install: step 5

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.

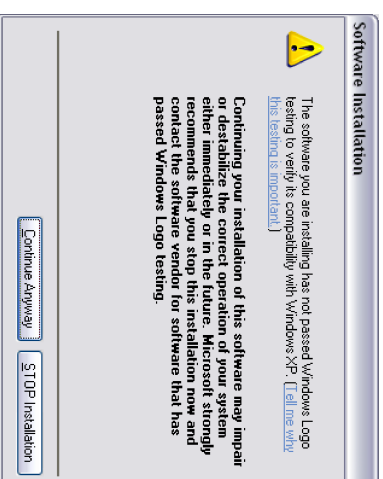


Figure 4.7: Driver install: Ignore warning and continue