Handyscope HS5

User manual

TiePie engineering

ATTENTION!

Measuring directly on the **line voltage** can be very dangerous. The **outside** of the **BNC connectors** at the Handyscope HS5 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 Handyscope HS5 is connected to a positive voltage. This short-circuit current can damage both the Handyscope HS5 and the computer.

Revision 2.14, January 2016

Contents

Safety 1

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 V_{AC} or 60 V_{DC} should only be performed by qualified personnel.
- Avoid working alone.
- Observe all indications on the Handyscope HS5 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 25 V_{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 Handyscope HS5 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 Handyscope HS5 is connected to a positive voltage. This short-circuit current can damage both the Handyscope HS5 and the computer.

Declaration of conformity 2

TiePie engineering
Koperslagersstraat 37
8601 WL Sneek
The Netherlands

EC Declaration of conformity

We declare, on our own responsibility, that the product

Handyscope HS5-540(XM/S/XMS)
Handyscope HS5-530(XM/S/XMS)
Handyscope HS5-220(XM/S/XMS)
Handyscope HS5-110(XM/S/XMS)
Handyscope HS5-055(XM/S/XMS)

for which this declaration is valid, is in compliance with

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

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

and also with

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

Sneek, 29-5-2012

ir. A.P.W.M. Poelsma

Environmental considerations

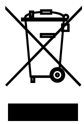
This section provides information about the environmental impact of the Handyscope HS5.

Handyscope HS5 end-of-life handling

Production of the Handyscope HS5 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 Handyscope HS5'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 Handyscope HS5 in an appropriate system that will ensure that most of the materials are reused or recycled appropriately.

The symbol shown below indicates that the Handyscope HS5 complies with the European Union's requirements according to Directive 2002/96/EC on waste electrical and electronic equipment (WEEE).



Restriction of Hazardous Substances

The Handyscope HS5 has been classified as Monitoring and Control equipment, and is outside the scope of the 2002/95/EC RoHS Directive.

3 Introduction

Before using the Handyscope HS5 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 Handyscope HS5 is a portable two channel measuring instrument with Arbitrary Waveform Generator. The Handyscope HS5 is available in several models with different maximum sampling frequencies: 50 MS/s, 100 MS/s, 200 MS/s or 500 MS/s. The native resolutions are 8, 12 and 14 bits and a user selectable resolution of 16 bits is available too, with adjusted maximum sampling frequencies:

Handyscope HS5	Channels	Resolution		
		8 / 12 bit	14 bit	16 bit
Model 540	CH1	500 MS/s	100 MS/s	6.25 MS/s
	CH1+CH2	200 MS/s		
Model 530	CH1	500 MS/s	100 MS/s	6.25 MS/s
	CH1+CH2	200 MS/s		
Model 220	CH1	200 MS/s	50 MS/s	3.125 MS/s
	CH1+CH2	100 MS/s		
Model 110	CH1	100 MS/s	20 MS/s	1.25 MS/s
	CH1+CH2	50 MS/s		
Model 055	CH1	50 MS/s	10 MS/s	625 kS/s
	CH1+CH2	20 MS/s		

Table 3.1: Maximum sampling frequencies

The Handyscope HS5 supports high speed continuous streaming measurements. The maximum streaming rates are:

Handyscope HS5	Channels	Resolution		
		8 bit	12/14 bit	16 bit
Model 540	CH1	40 MS/s	20 MS/s	6.25 MS/s
	CH1+CH2	20 MS/s	10 MS/s	
Model 530	CH1	40 MS/s	20 MS/s	6.25 MS/s
	CH1+CH2	20 MS/s	10 MS/s	
Model 220	CH1	20 MS/s	10 MS/s	3.125 MS/s
	CH1+CH2	10 MS/s	5 MS/s	
Model 110	CH1	10 MS/s	5 MS/s	1.25 MS/s
	CH1+CH2	4 MS/s	2 MS/s	
Model 055	CH1	4 MS/s	2 MS/s	625 kS/s
	CH1+CH2	2 MS/s	1 MS/s	

Table 3.2: Maximum streaming rates

The Handyscope HS5 is available with two memory configurations, these are:

Memory	Model 540	Model 530	Model 220	Model 110	Model 055
Standard model	128 KiS	128 KiS	128 KiS	128 KiS	128 KiS
Option XM	32 MiS	32 MiS	32 MiS	32 MiS	32 MiS

Table 3.3: Maximum record lengths per channel

Optionally available for the Handyscope HS5 are SureConnect connection test and resistance measurement. SureConnect connection test tells you immediately whether your test probe or clip actually makes electrical contact or not. No more doubt whether your probe doesn't make contact or there really is no signal. This is useful when surfaces are oxidized and your probe cannot get a good electrical contact. Simply activate the SureConnect and you know whether there is contact or not. Also when back probing connectors in confined places, SureConnect immediately shows whether the probes make contact or not.

Models of the Handyscope HS5 with SureConnect come with resistance measurement on all channels. Resistances up to 2 MOhm can be measured directly. Resistance can be shown in meter displays and can also be plotted versus time in a graph, creating an Ohm scope.

With the accompanying software the Handyscope HS5 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.

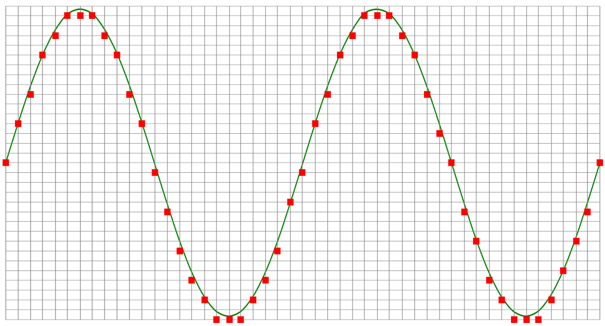


Figure 3.1: Sampling

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.

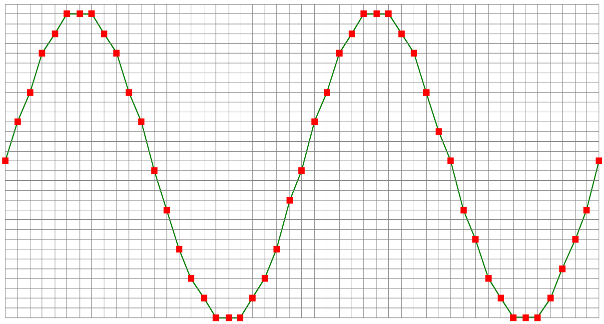


Figure 3.2: ”connecting” the samples

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.

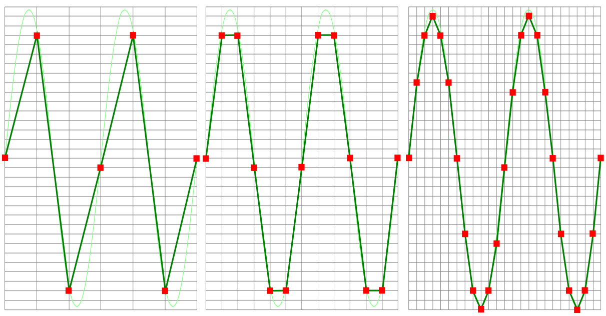


Figure 3.3: The effect of the sampling frequency

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

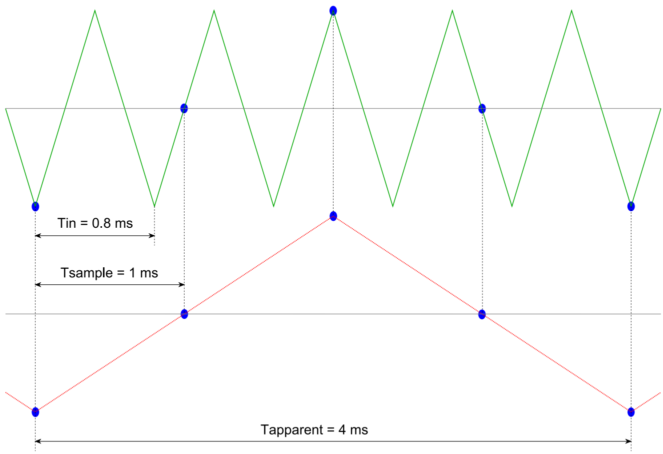


Figure 3.4: Aliasing

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 1/1000Hz = 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 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 kHz - 1 kHz).

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

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).

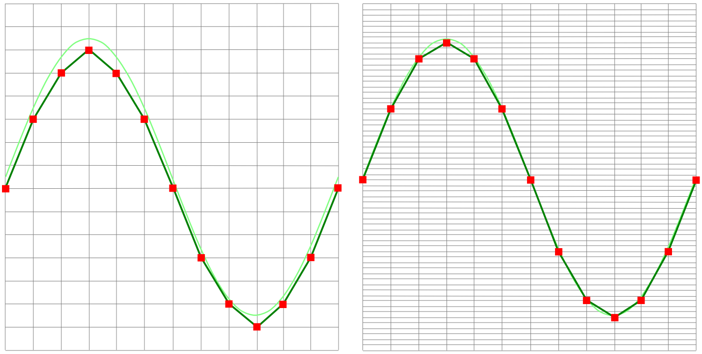


Figure 3.5: The effect of the resolution

The Handyscope HS5 measures at e.g. 14 bit resolution (2^{14}=16384 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/16384 = 24.41 μV.

3.4 Signal coupling

The Handyscope HS5 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 Handyscope HS5 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 equiped 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.

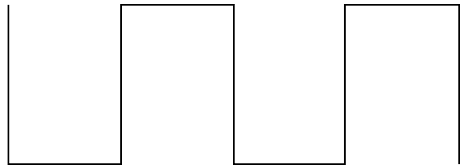


Figure 3.6: correct

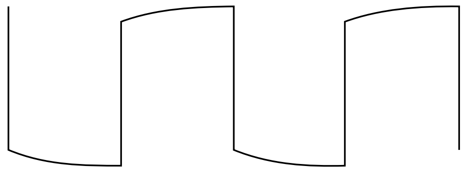


Figure 3.7: under compensated

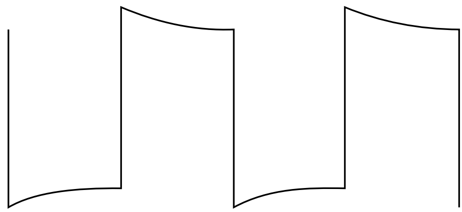


Figure 3.8: over compensated

Driver installation

4

Before connecting the Handyscope HS5 to the computer, the drivers need to be installed.

4.1 Introduction

To operate a Handyscope HS5, 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 Handyscope HS5 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.

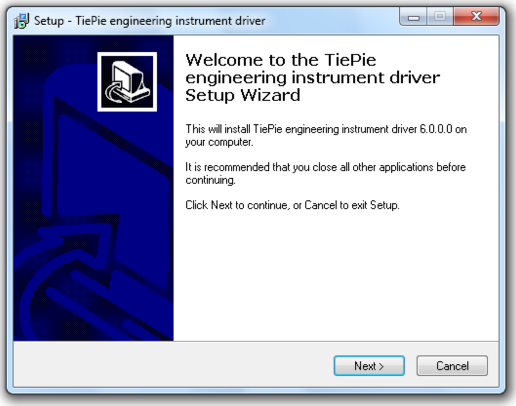


Figure 4.1: Driver install: step 1

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 Handyscope HS5 is disconnected from the computer prior to starting the driver install utility. When the Handyscope HS5 is used with an external power supply, this must be disconnected too.

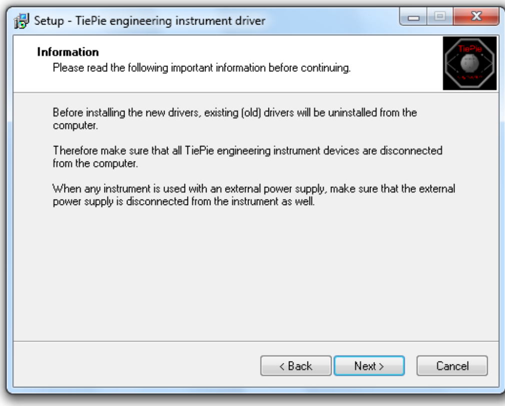


Figure 4.2: Driver install: step 2

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

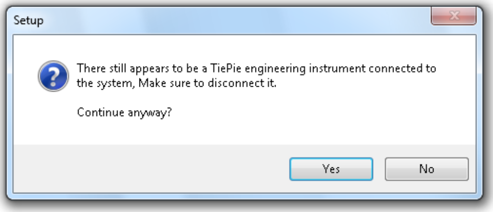


Figure 4.3: Driver install: Instrument is still connected

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.

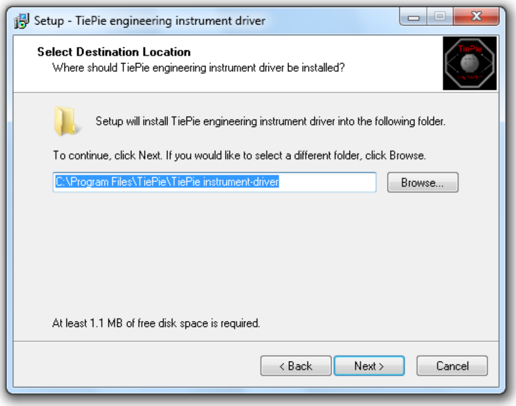


Figure 4.4: Driver install: step 3

On Windows XP, 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.

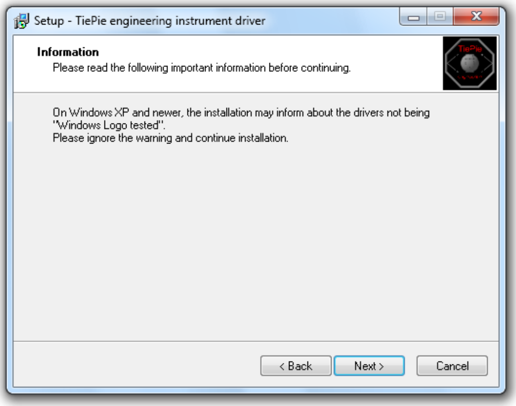


Figure 4.5: Driver install: step 4

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.

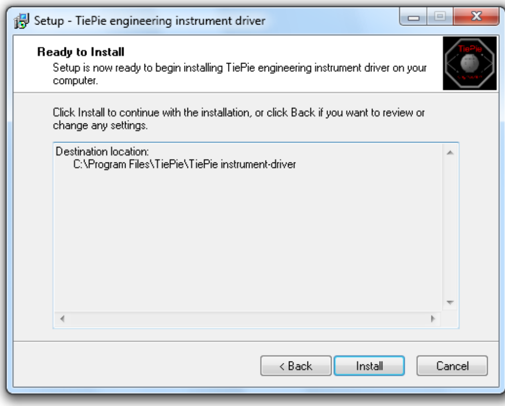


Figure 4.6: Driver install: step 5

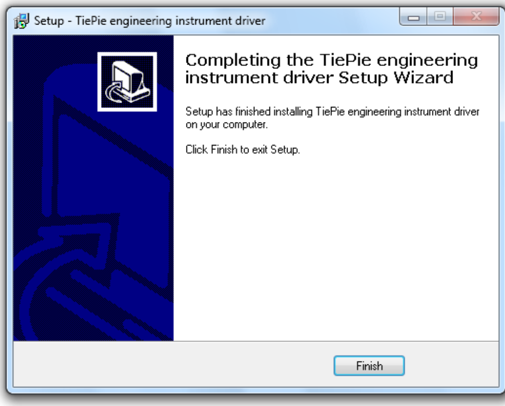


Figure 4.7: Driver install: Finished

Hardware installation 5

Drivers have to be installed before the Handyscope HS5 is connected to the computer for the first time. See chapter 4 for more information.

5.1 Power the instrument

The Handyscope HS5 is powered by the USB, no external power supply is required. Only connect the Handyscope HS5 to a bus powered USB port, otherwise it may not get enough power to operate properly.

5.1.1 External power

In certain cases, the Handyscope HS5 cannot get enough power from the USB port. When a Handyscope HS5 is connected to a USB port, powering the hardware will result in an inrush current higher than the nominal current. After the inrush current, the current will stabilize at the nominal current.

USB ports have a maximum limit for both the inrush current peak and the nominal current. When either of them is exceeded, the USB port will be switched off. As a result, the connection to the Handyscope HS5 will be lost.

Most USB ports can supply enough current for the Handyscope HS5 to work without an external power supply, but this is not always the case. Some (battery operated) portable computers or (bus powered) USB hubs do not supply enough current. The exact value at which the power is switched off, varies per USB controller, so it is possible that the Handyscope HS5 functions properly on one computer, but does not on another.

The Handyscope HS5 comes with a universal power supply, that can be connected to a power outlet using the appropriate adapter. The 3.5 mm connector attached to the power supply must be plugged into the power connector at the rear of the Handyscope

HS5. Refer to paragraph 8.1 for specifications of the external power intput.

When the Arbitrary Waveform Generator is used, the power that the Handyscope HS5 requires may strongly increase. It is recommended to use the external power supply when the Handyscope HS5 Arbitrary Waveform Generator is used.

5.2 Connect the instrument to the computer

After the new driver has been pre-installed (see chapter 4), the Handyscope HS5 can be connected to the computer. When the Handyscope HS5 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 Handyscope HS5 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.

5.2.1 Found New Hardware Wizard

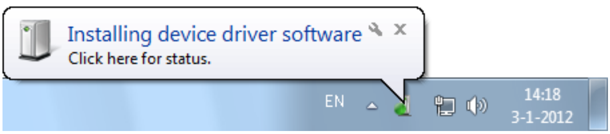


Figure 5.1: Hardware install: step 1

Windows has detected new hardware and starts installing the drivers.

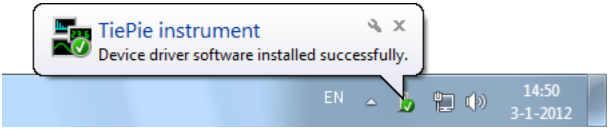


Figure 5.2: Hardware install: step 2

Once ready, Windows will report that the driver is installed.

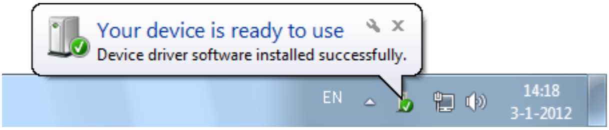


Figure 5.3: Hardware install: step 3

Now the driver is installed, the measurement software can be installed and the Handyscope HS5 can be used.

5.3 Plug into a different USB port

When the Handyscope HS5 is plugged into a different USB port, some Windows versions will treat the Handyscope HS5 as different hardware and will ask to install the drivers again. This is controlled by Microsoft Windows and is not caused by TiePie engineering.

5.4 Operating conditions

The Handyscope HS5 is ready for use as soon as the software is started. However, to achieve rated accuracy, allow the instrument to settle for 20 minutes. If the instrument has been subjected to extreme temperatures, allow additional time for internal temperatures to stabilize. Because of temperature compensated calibration, the Handyscope HS5 will settle within specified accuracy regardless of the surrounding temperature.

6 Combining instruments

When more channels are required than one instrument can offer, multiple instruments can be combined into a larger combined instrument. To combine two or more instruments, the instruments need to be connected to each other using special cables.

The Handyscope HS5 has an advanced clock distribution system, making it very easy to connect multiple instruments to each other to create a large multi channel instrument that uses a shared sampling clock and shared trigger signals.

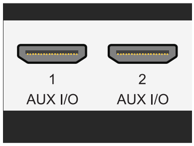


Figure 6.1: Auxilary I/O connectors

Connecting is done by daisy chaining the auxiliary I/O connectors of the instruments prior to starting the software, using a special coupling cable (order number TP-C50H). The software will detect how the instruments are connected to each other and will automatically terminate the connection bus. The software will combine the connected instruments to one large instrument. The combined instruments will now sample using the same clock, with a deviation of 0 ppm.

Figure 6.2: 3 Handyscope HS5's combined

A six channel instrument is easily made by connecting three Handyscope HS5's to each other.

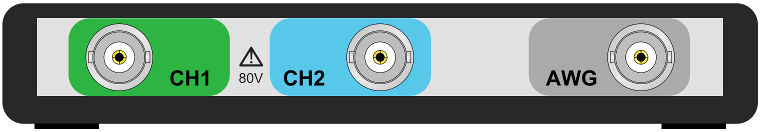


Figure 7.1: Front panel

7.1 CH1 and CH2 input connectors

The CH1 and CH2 BNC connectors are the main inputs of the acquisition system. The outside of the BNC connectors is connected to the ground of the Handyscope HS5. 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 Handyscope HS5 and the computer.

7.2 AWG output connector

The AWG BNC connector is the output of the internal Arbitrary Waveform Generator. The outside of this BNC connector is connected to the ground of the Handyscope HS5.

7.3 Power indicator

A power indicator is situated at the top cover of the instrument. It is lit when the Handyscope HS5 is powered.

Rear panel

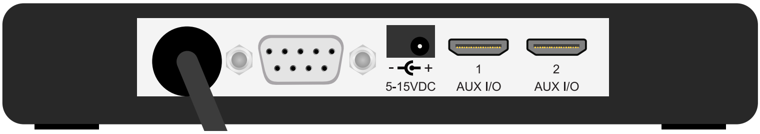
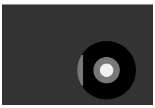


Figure 8.1: Rear panel

8.1 Power

The Handyscope HS5 is powered through the USB. If the USB cannot supply enough power, it is possible to power the instrument externally. The Handyscope HS5 has two external power inputs located at the rear of the instrument: the dedicated power connector and a pin of the 9 pin D-sub extension connector. The specifications of the dedicated power connector are:



Pin	Dimension	Description
Center pin	Ø1.3 mm	positive
Outside bushing	Ø3.5 mm	ground

Figure 8.2: Power connector

To power the instrument through the extension connector, the power has to be applied to pin 7 of the extension connector. Pin 6 can be used as ground. The following minimum and maximum voltages apply to the power inputs:

Minimum	4.5 V_{DC} / 2 A max.
Maximum	15 V_{DC} / 1 A max.

Table 8.1: Maximum voltages

Note that the externally applied voltage should be higher than the USB voltage to relieve the USB port.

8.1.1 Power adapter

The Handyscope HS5 comes with an external power adapter that can be connected to any mains power net that supplies 100 – 240 V_{AC}, 50 – 60 Hz. The external power adapter can be connected to the dedicated power connector.

Figure 8.3: Power adapter

8.1.2 USB power cable

A special USB external power cable is supplied with the Handyscope HS5 that can be used instead of a power adapter. One end of this cable can be connected to a second USB port on the computer, the other end can be plugged in the dedicated power connector at the rear of the instrument. The power for the instrument will then be taken from two USB ports.

Figure 8.4: USB power cable

8.2 USB

The Handyscope HS5 is equipped with a USB 2.0 High speed (480 Mbit/s) interface with a fixed cable with type A plug. It will also work on a computer with a USB 1.1 interface, but will then operate at 12 Mbit/s.

8.3 Extension Connector

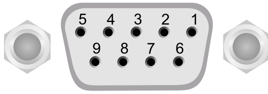


Figure 8.5: Extension connector

A 9 pin female D-sub connector is available at the back of the Handyscope HS5 containing the following signals:

Pin	Description	Pin	Description
1	EXT 1 (LVTTL)	6	GND
2	EXT 2 (LVTTL)	7	Power IN
3	EXT 3 (LVTTL)	8	Power OUT (see description)
4	I^2C SDA	9	reserved
5	I^2C SCL		

Table 8.2: Pin description Extension connector

Pins EXT 1, EXT 2 and EXT 3 are equipped with internal 1 kOhm pull-up resistors to 2.5 V. These pins can simultaneously be used as inputs and outputs. Each pin can be configured as external digital trigger input for the acquisition system and/or the generator of the Handyscope HS5. Also, each pin can be configured to output one of the following function generator outputs:

- Generator start
- Generator stop
- Generator new period

The I^2C pins are equipped with internal 2.2 kOhm pull-up resistors connected to 3 V.

Pin 8, Power OUT, has the same potential as the Handyscope HS5 power supply. When the Handyscope HS5 is USB powered, it is at USB power level. When the Handyscope HS5 is externally powered, it is at the same level as the external power input.

8.4 AUX I/O

The Handyscope HS5 has two Auxiliary I/O connectors at the rear of the instrument. These can be used to combine multiple instruments to a single combined instrument to perform synchronized measurements.

Figure 8.6: Auxiliary I/O connector

Pin	Description	Pin	Description
1	GND	11	Data OK P EXT (LVDS)
2	EXT CLK P (LVDS)	12	Data OK N EXT (LVDS)
3	EXT CLK N (LVDS)	13	reserved
4	GND	14	Generator Trigger (I/O)
5	Data OK (I/O)	15	reserved
6	reserved	16	reserved
7	GND	17	GND
8	Ext Trigger (I/O)	18	reserved
9	reserved	19	GND
10	GND		

Table 8.3: Pin description Auxiliary I/O connector

The I/O signals (pins 5, 8 and 14) can be used as input and output. They are digital signals switching between 0 V and 2.5 V. The LVDS external clock (pins 2 and 3) must be 10 MHz, ±1%.

The Auxiliary I/O connectors use HDMI type C sockets, but are not HDMI compliant. They can not be used to connect an HDMI device to the Handyscope HS5.

9 Specifications

To achieve rated accuracy, allow the instrument to settle for 20 minutes. When subjected to extreme temperatures, allow additional time for internal temperatures to stabilize. Because of temperature compensated calibration, the Handyscope HS5 will settle within specified accuracy regardless of the surrounding temperature.

9.1 Acquisition system

Number of input channels	2 analog
CH1, CH2	BNC
Type	Single ended
Resolution	8, 12, 14, 16 bit user selectable
Accuracy	0.25% of full scale ± 1 LSB
Range	±200 mV to ±80 V full scale
Coupling	AC/DC
Impedance	1 MΩ / 25 pF
Maximum voltage	200 V (DC + AC peak <10 kHz)
Maximum voltage 1:10 probe	600 V (DC + AC peak <10 kHz)
Bandwidth (-3dB)	at 75% of full scale input
Ch1	250 MHz
Ch2	100 MHz
AC coupling cut off freq. (-3dB)	±1.5 Hz
SureConnect	Optionally available (option S)
Maximum voltage on connection	200 V (DC + AC peak <10 kHz)
Resistance measurement	Optionally available (option S)
Ranges	100 Ohm to 2 MOhm full scale
Accuracy	1%
Response time (to 95%)	<10 μs
Sampling source	
Internal	TCXO
Accuracy	±0.0001%
Stability	±1 ppm over 0 °C to +55 °C
Time base aging	±1 ppm per year time base aging
External	LVDS, on auxilary connectors
Input range	10 MHz
Memory	
Standard model	128 KiSamples per channel
XM option	32 MSamples per channel when measuring 2 channels 64 MSamples when measuring 1 channel

9.2 Acquisition system (continued)

Maximum sampling rate	Depending on model
Model 540, Model 530	
8/12 bit, measuring one channel	500 MS/s
8/12 bit, measuring two channels	200 MS/s
14 bit	100 MS/s
16 bit	6.25 MS/s
Model 220	
8/12 bit, measuring one channel	200 MS/s
8/12 bit, measuring two channels	100 MS/s
14 bit	50 MS/s
16 bit	3.125 MS/s
Model 110	
8/12 bit, measuring one channel	100 MS/s
8/12 bit, measuring two channels	50 MS/s
14 bit	20 MS/s
16 bit	1.25 MS/s
Model 055	
8/12 bit, measuring one channel	50 MS/s
8/12 bit, measuring two channels	20 MS/s
14 bit	10 MS/s
16 bit	625 kS/s
Maximum streaming rate	Depending on model. On some computers, the highest streaming rates may not be available, due to computer restrictions.
Model 540, Model 530	
8 bit, measuring one channel	40 MS/s
8 bit, measuring two channels	20 MS/s
12/14 bit, measuring one channel	20 MS/s
12/14 bit, measuring two channels	10 MS/s
16 bit	6.25 MS/s
Model 220	
8 bit, measuring one channel	20 MS/s
8 bit, measuring two channels	10 MS/s
12/14 bit, measuring one channel	10 MS/s
12/14 bit, measuring two channels	5 MS/s
16 bit	3.125 MS/s
Model 110	
8 bit, measuring one channel	10 MS/s
8 bit, measuring two channels	4 MS/s
12/14 bit, measuring one channel	5 MS/s
12/14 bit, measuring two channels	2 MS/s
16 bit	1.25 MS/s
Model 055	
8 bit, measuring one channel	4 MS/s
8 bit, measuring two channels	2 MS/s
12/14 bit, measuring one channel	2 MS/s
12/14 bit, measuring two channels	1 MS/s
16 bit	625 kS/s

9.3 Trigger system

System	Digital, 2 levels
Source	CH1, CH2, digital external, OR, generator start, generator new period, generator stop
Trigger modes	Rising edge, falling edge, any edge, inside window, outside window, enter window, exit window, pulse width
Level adjustment	0 to 100% of full scale
Hysteresis adjustment	0 to 100% of full scale
Resolution	0.024 % (12 bits)/0.006 % (14/16 bits)
Pre trigger	0 to 64 MSamples measuring 1 channel, 0 to 32 MSamples measuring 2 channels, 1 sample resolution
Post trigger	0 to 64 MSamples measuring 1 channel, 0 to 32 MSamples measuring 2 channels, 1 sample resolution
Trigger hold-off	0 to 64 MSamples, 1 sample resolution
Trigger delay	0 to 16 GSamples, 1 sample resolution
Segmented trigger	Available via LibTiePie SDK
Maximum number of segments	1024
Minimum segment length	1 sample
Maximum segment length	64 M / number of segments measuring 1 channel 32 M / number of segments measuring 2 channels
Trigger rearm time	Sample frequency dependent, $<$ 700 ns on highest sample frequency
Digital external trigger	
Input	Extension connector pins 1, 2 and 3
Range	0 to 2.5 V (TTL)
Coupling	DC
Jitter	Depending on source and sample frequency
Source = channel	$\leq$ 1 sample
Source = external or generator	
Sample frequency = 500 MS/s	$\leq$ 8 samples
Sample frequency $<$ 500 MS/s	$\leq$ 4 samples
Sample frequency $\leq$ 100 MS/s	$\leq$ 1 sample

9.4 Arbitrary Waveform Generator

Output channel	1 analog, BNC
DAC resolution	14 bit @ 240 MS/s
Output range	-12 to +12 V (open circuit)
Amplitude	
Range	0.12 V, 1.2 V, 12 V (open circuit)
Resolution	12 bit
Accuracy	0.4% of range
DC offset	
Range	-12 V to +12 V (open circuit)
Resolution	12 bit
Accuracy	0.4% of range
Noise level	
0.12 V	900 μV_{RMS}
1.2 V	1.3 mV_{RMS}
12 V	1.5 mV_{RMS}
Coupling	DC
Impedance	50 Ω
Overload protection	Output turns off when overload is applied. Instrument will tolerate a short circuit to ground indefinitely.
System	Constant Data Size
Memory	
Standard model	256 KiSamples
XM option	64 MiSamples
Operating modes	Continuous, triggered, gated
Maximum sampling rate	Depending on model
model 540, Model 530	240 MS/s
model 530	240 MS/s
model 220	200 MS/s
model 110	100 MS/s
model 055	50 MS/s
Sampling source	Internal TCXO
Accuracy	0.0001 %
Stability	$\pm$1 ppm over 0 °C to +55 °C
Time base aging	$\pm$1 ppm per year
Waveforms	
Standard	Sine, square, triangle, pulse, noise, DC
Built-in arbitrary	Exponential Rise and Fall, Sin(x)/x, Cardiac, Haversine, Lorentz, D-Lorentz

Arbitrary Waveform Generator - continued

Signal characteristics	
Sine	
Frequency range	Depending on model
Model 540	1 μHz to 40 MHz
Model 530	1 μHz to 30 MHz
Model 220	1 μHz to 20 MHz
Model 110	1 μHz to 10 MHz
Model 055	1 μHz to 5 MHz
Amplitude flattness	Relative to 1 kHz
<100 kHz	±0.1 dB
<5 MHz	±0.15 dB
<20 MHz	±0.3 dB
<30 MHz	±0.4 dB
<40 MHz	±1 dB
Spurious	
<100 kHz	-75 dB_c
100 kHz to 1 MHz	-70 dB_c
1 MHz to 10 MHz	-60 dB_c
10 MHz to 15 MHz	-55 dB_c
15 MHz to 20 MHz	-45 dB_c
20 MHz to 30 MHz	-35 dB_c
30 MHz to 40 MHz	-30 dB_c
Square	
Frequency range	Depending on model
Model 540	1 μHz to 40 MHz, above 30 MHz not specified
Model 530	1 μHz to 30 MHz
Model 220	1 μHz to 20 MHz
Model 110	1 μHz to 10 MHz
Model 055	1 μHz to 5 MHz
Rise/fall time	<8 ns
Overshoot	<1%
Variable duty cycle	0.01 % to 99.99 %
Asymmetry	<0 % of period + 5 ns (@ 50% duty cycle)
Jitter (RMS)	<50 ps
Triangle	
Frequency range	Depending on model
Model 540	1 μHz to 40 MHz, above 30 MHz not specified
Model 530	1 μHz to 30 MHz
Model 220	1 μHz to 20 MHz
Model 110	1 μHz to 10 MHz
Model 055	1 μHz to 5 MHz
Nonlinearity (of peak output)	<0.01 %
Symmetry	0 % to 100 %, 0.1% steps
Pulse	
Period	100 ns to 1 Ms
Pulse width	1 digit to period-1 digit (min. 20 ns and period-20 ns)
Step size	6 digits, mininum of 1 ns
Overshoot	<1 %
Jitter (RMS)	<50 ps

Arbitrary Waveform Generator - continued

Signal characteristics - continued	
Noise	
Bandwidth (typical)	30 MHz
Arbitrary	
Frequency range	Depending on model
Model 540, Model 530	1 μHz to 30 MHz
Model 220	1 μHz to 20 MHz
Model 110	1 μHz to 10 MHz
Model 055	1 μHz to 5 MHz
Pattern length	1 to 64 MiSamples
Maximum sample rate	Depending on model
model 540, Model 530	240 MS/s
model 530	240 MS/s
model 220	200 MS/s
model 110	100 MS/s
model 055	50 MS/s
Rise/fall time	$<$8 ns
Nonlinearity (of peak output)	$<$0.01 %
Settling time	$<$8 ns to 10 % final value
Jitter (RMS)	$<$50 ps
Burst	
Waveforms	Sine, square, triangle, noise, arbitrary
Count	1 to 65535
Trigger	Software, external
Sweep	Available only on models with extended memory option XM
Waveforms	Sine, square, triangle, noise, arbitrary
Type	Linear, logarithmic
Count	Up, down
Trigger	Software, external
Modulation	
AM	
Carrier waveforms	Sine, square, triangle, arbitrary
Modulating waveforms	Sine, square, triangle, noise, arbitrary
Modulating frequency	2 mHz to 20 MHz
Depth	0.0% to 100%
Source	Internal
FM	
Carrier waveforms	Sine, square, triangle, arbitrary
Modulating waveforms	Sine, square, triangle, noise, arbitrary
Modulating frequency	2 mHz to 20 MHz
Peak deviation	DC to 20MHz
Source	Internal
FSK	
Carrier waveforms	Sine, square, triangle, arbitrary
Modulating waveforms	50% duty cycle square
Modulating frequency	2 mHz to 20 MHz
Peak deviation	1 μHz to 20MHz
Source	Internal

9.5 Power

Power	From USB or external input
Consumption	5 V_{DC}, 500 mA max
Power adapter	External
Input	110 to 240 V_{AC}, 50 to 60 Hz 0.85 A Max., 50 VA to 80 VA
Output	5.5 V_{DC}, 2 A
Dimension	
Height	30 mm / 1.2"
Width	45 mm / 1.8"
Length	75 mm / 3"
Order number	TP-UE15WCP1-055200SPA
Replaceable mains plugs for	EU, US, AU, UK

9.6 Multi-instrument synchronization

Maximum number of instruments	Limited by available number of USB ports
Synchronization accuracy	0 ppm

9.7 Physical

Height	25 mm / 1.0"
Length	170 mm / 6.7"
Width	140 mm / 5.2"
Weight	430 g / 15 ounce
USB cord length	1.8 m / 70"

9.8 I/O connectors

CH1, CH2	BNC
AWG	BNC
USB	Fixed cable with USB type A plug, 1.8 m
Extension connector	D-sub 9 pins female
Power	3.5 mm power socket
Auxiliary I/O connectors 1–2	HDMI type C socket

9.9 Interface

Interface	USB 2.0 High Speed (480 Mbit/s) (USB 1.1 Full Speed (12 Mbit/s) and USB 3.0 compatible)

9.10 System requirements

PC I/O connection	USB 1.1, USB 2.0 or newer
Operating System	Windows XP/Vista/7/8/10 32 and 64 bits

9.11 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

9.12 Certifications and Compliances

CE mark compliance	Yes
RoHS	Yes
EN 55011:2009/A1:2010	Yes
EN 55022:2006/A1:2007	Yes
IEC 61000-6-1/EN 61000-6-1:2007	Yes
IEC 61000-6-1/EN 61000-6-1:2007	Yes
Canada: ICES-001:2004	Yes
Australia/New Zealand: AS/NZS	Yes

9.13 Probes

Model	HP-9250
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 MΩ (oscilloscope impedance)
1:10	10 MΩ (incl. 1 MΩ oscilloscope impedance)
Input capacitance	
1:1	47 pF + oscilloscope capacitance
1:10	17 pF
Compensation range	
1:1	-
1:10	10 to 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)

9.14 Package contents

Instrument	Handyscope HS5
Probes	2 x 1:1 / 1:10 switchable, HP-9250
Accessories	External power adapter USB power cable
Software	Windows 2000/XP/Vista/7/8/10
Drivers	Windows 2000/XP/Vista/7/8/10
Manual	Instrument manual and software user's manual

If you have any suggestions and/or remarks regarding this manual, please contact:

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