



ELAN DIGITAL SYSTEMS LTD.

LITTLE PARK FARM ROAD,
SEGENSWORTH WEST,
FAREHAM,
HANTS. PO15 5SJ.
TEL: (44) (0)1489 579799
FAX: (44) (0)1489 577516
e-mail: support@pccard.co.uk
website: <http://www.pccard.co.uk>

USBwave12 USER'S GUIDE ES390



Important Notice: Please refer to Safety Data 4.8, before using this instrument

All Trademarks are duly acknowledged.
The USBwave12 is Patent Pending.

REVISION HISTORY

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CONTENTS

1	OVERVIEW.....	5
2	ABOUT THE USBWAVE12.....	6
2.1	General	6
2.2	USBwave12 Architecture	7
2.3	Using More Than One USBwave12	8
2.3.1	Stacked Mode.....	8
2.3.1.1	Assembling The Stack.....	8
2.3.1.2	Disassembling The Stack	10
2.3.1.3	USB Connections For Stacked Configurations.....	11
2.3.1.4	Software For Stacked Configurations	11
2.3.1.5	Stacking Do's And Don'ts	13
2.3.2	Non-Stacked (MIS) Mode.....	14
2.3.2.1	USB Connections For Non-Stacked Configurations.....	14
2.3.2.2	Software For Non-Stacked Configurations	14
2.4	Output Control	16
2.4.1	Output Waveform	16
2.4.2	Output Amplitude	16
2.4.3	Output Offset	16
2.4.4	Output Enable	17
2.4.5	Output Frequency.....	17
2.4.6	Output Phase	18
2.4.7	Run Control.....	19
3	SOFTWARE INSTALLATION	21
3.1	Windows 98SE and Windows Me	21
3.2	Windows 2K and XP	23
3.3	Troubleshooting.....	25
4	HARDWARE SPECIFICATION	26
4.1	Power Requirements	26
4.2	Isolation	26
4.3	Performance.....	26
4.4	Mechanical	27
4.5	Environmental	27

4.6	Miscellaneous	27
4.7	Software.....	27
4.8	Safety Data and Maximum Ratings.....	28

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- Increase the separation between the equipment and receiver
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
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Listed Products

The models covered by this installation guide are intended only for installation in Listed computers for use in business or home.



1 OVERVIEW

The USBwave12 is an isolated function generator that has the following features:

- Single channel function generator with BNC output and USB PC interface
- Each USBwave12 can be stacked to increase channel count (each requires its own USB connection)¹
- 300V Cat II isolation between BNC ground and USB ground²
This means that there is no DC path through the USBwave12 from the generators output to the PC's ground
- User selectable sine, square or triangle wave outputs
- Programmable 0 to 12MHz frequency range with 186mHz resolution
- Programmable 0 to 10Vpk (+/-10V pk-pk) amplitude range with 40mV resolution
- Programmable 0 to +/-10V offset range with 80mV resolution
- Programmable 0 to 360 degree phase range with 0.8789 degree resolution
- Uses Direct Digital Synthesis (DDS) for excellent stability
- 50 Ohm output impedance
- Output can be put into Hi-Z state
- Two or more USBwave12s can be synchronised allowing waveform generation with fixed phase relationships
- Host powered from USB (300mA typ)
- Stacked configurations of 2,3 and 4 channels are supported
- Power/activity LED

¹ A stacking connector kit is required

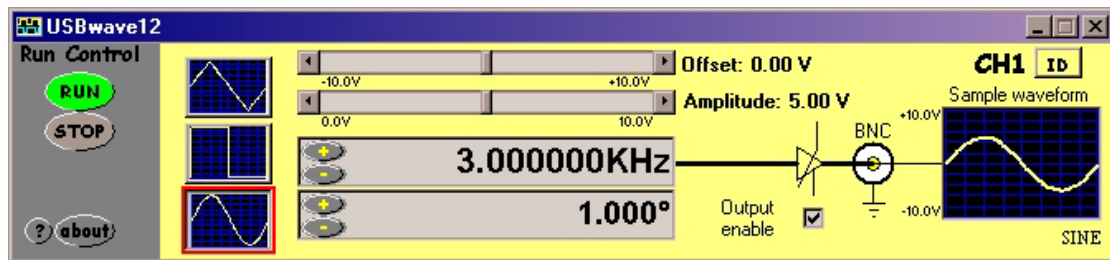
² In stacked configurations the channels share a common ground at the BNC terminals

2 ABOUT THE USBwave12

2.1 General

The USBwave12 has been designed to allow a broad range of waveforms and output frequencies to be generated. The wave shape, amplitude, offset, frequency and phase of the output signal is programmable.

Each USBwave12 can be used as an independent single channel generator but to enhance flexibility several USBwave12s can be stacked together to make a combined 2,3 or 4-channel device. In this case, each generator is synchronised with the others³ so that the compound device acts like a single multi-channel instrument. Each USBwave12 still needs its own USB connection and the combined device shares a common ground between all the BNC connectors i.e. the channels are isolated from the USB but not from each other.



³ The generators use a common clock but their own internal DDS. This allows the phase relationship between channels to be set.

2.2 USBwave12 Architecture

The figure below shows a simplified diagram of the USBwave12.

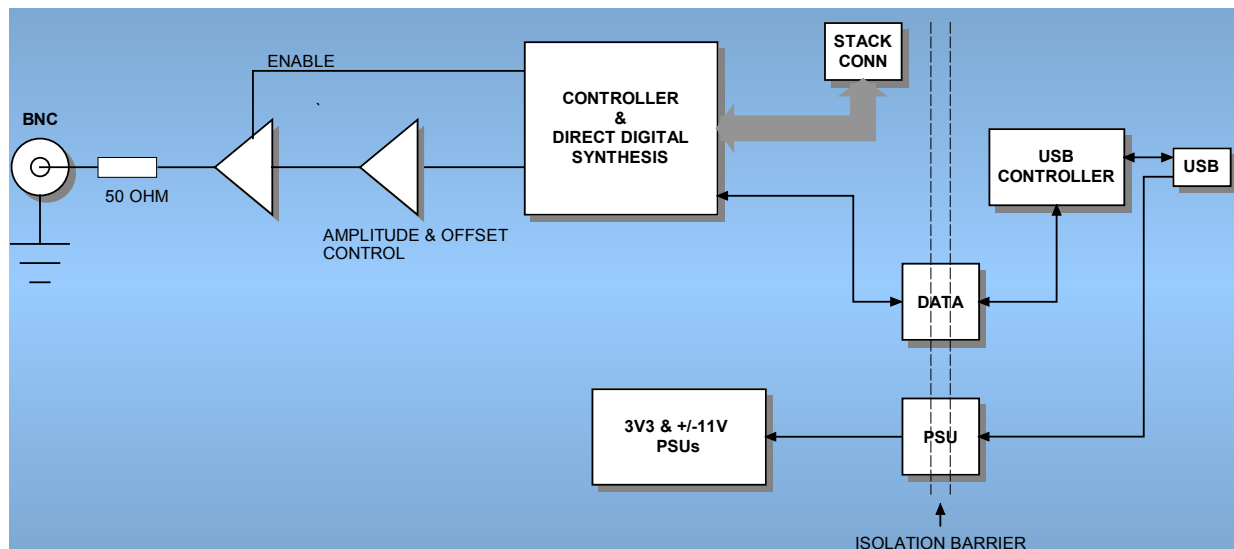


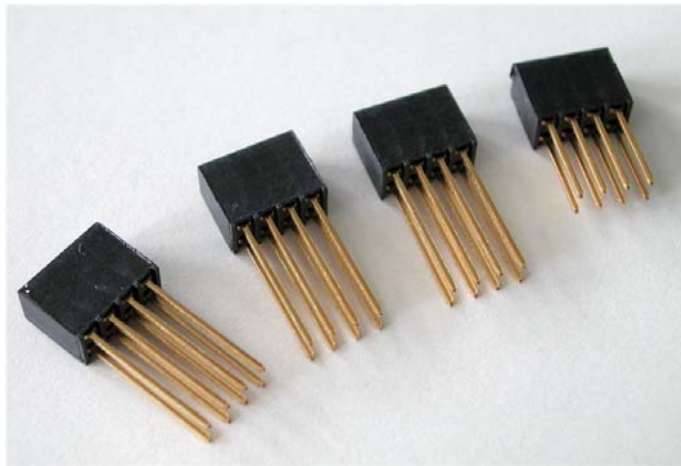
Figure 2.2-1 USBwave12 Architecture Diagram

2.3 Using More Than One USBwave12

2.3.1 Stacked Mode

A unique feature of the USBwave12 architecture is that up to 4 devices⁴ can be stacked to make a multi-channel instrument.

In order to use a stacked configuration, you **must purchase the stacking connector kit**. This kit comprises 3 long lead connectors and 1 short lead connector as shown:



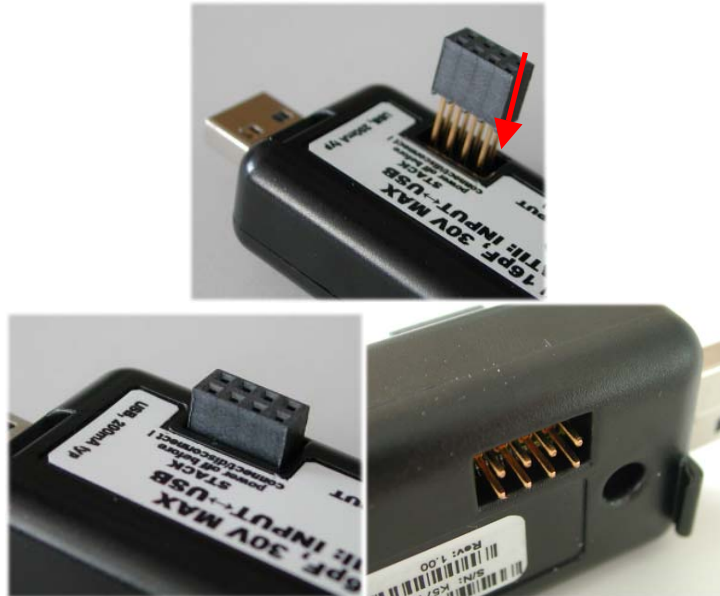
2.3.1.1 Assembling The Stack

To stack the USBwave12 devices, first be sure that none of them are connected to a USB port.

Before you begin, put the short lead connector to one-side...you'll use that one last.

Now, insert one of the long connectors from the top of one of the generators (it doesn't really matter which one). Push the pins of the connector into the top of the stacking connector from the side where you can see the top of the black connector down inside the generator. Be careful when doing this, don't use too much force or you may damage the connector pins. Push the long connector all the way in until it seats down on the generator's internal connector. You should be able to see the gold pins about 2-3mm beyond the bottom surface of the generator. The connectors have no pin orientation...they can go in 2 possible ways round...both are OK.

⁴ Don't stack more than 4, the software will reject this.



Repeat this for all except the last generator to be stacked.

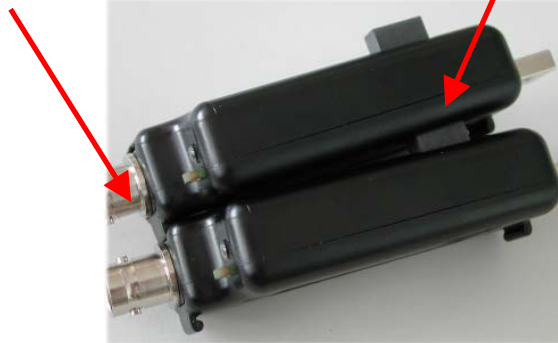
For the last generator in the stack, do the same as above but use the short length connector. This time, the pins are shorter so they stop well inside the generator's case. **This generator MUST be the bottom generator in the stack.** The reason for this is that if you use the long connector, the pins could be shorted out accidentally, or you may touch the pins when the generator is connected to a high voltage and you could get an electric shock! Similarly, if you plan to use only one generator, make sure there is no stack connector fitted or the shorter connector type is fitted.



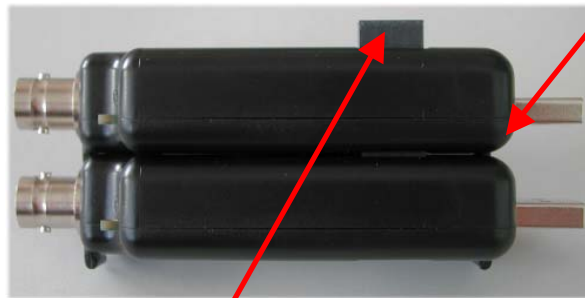
This is a safety critical point so please note it carefully.

Now you can assemble the stack.

Start with the bottom generator. Hold it in one hand, and put the next generator on top of the 1st, the same way around. Align the stacking connectors and when the stacking connectors are partly mated engage the front “P” shaped clip (BNC end) on the 2nd generator into the “P” shaped slot on the 1st generator.



Now, bring the back edge “P” clip (USB end) of the 2nd generator down until it clicks into the 1st generator’s slot. These two generators are now mated.



Check that as you pushed the 2nd generator down, the stack connector has not been forced upward...if it has simply press it down until it seats correctly (see picture above for a guide as to the normal exposed connector depth after stacking). Repeat this for each remaining generator, adding each one on top of the previous one.

The generators are now stacked.

2.3.1.2 Disassembling The Stack

Start with the top generator in the stack. Grasp the stack in one hand and with the other hand’s thumb and forefinger, pinch between the interface between the top two generators, near the back “P” clip (USB end). With moderate force, the top generator will pop up and come free. Remove the stacking connector from the free generator.

Repeat this for all generators in the stack.

2.3.1.3 USB Connections For Stacked Configurations

All stacked generators need a USB connection. A standard hub may be useful for multi-channel stacks to get enough USB ports.

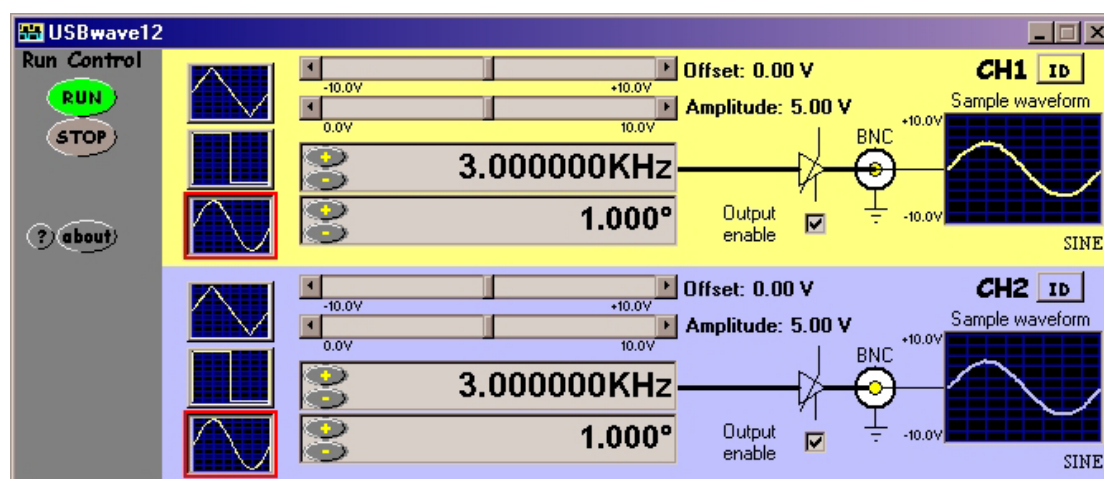
Each generator needs about 300mA. Plugging more than 1 generator into a hub will mean that the hub may need to be powered externally. Please refer to the hub's documentation for more details about the power available per port.

2.3.1.4 Software For Stacked Configurations

When you run USBwave12, it will automatically detect the generators connected via USB and will also check to see if the generators are electrically connected together via the stack. It will then initialise all connected generators, one at a time. This may take a few seconds.

If you stack several generators but forget to connect say one of the generators to a USB port, the software will warn you and will not run.

The software will display a channel diagram for each generator in use.



The channel number allocated to each generator depends on its serial number, so the order you stacked them will almost certainly NOT be the same as the channel order allocated by software.

To find out which generator is Channel 1, use the CH1 tab and click the "id" button.



The LED on that generator will blink rapidly for about 4 seconds, or until you click the button again.

Repeat this for each channel in the stack to identify them.

If you like, you can stop the software, and unplug all the generators from their USB connections, and then re-stack them in their channel order.

The “about” tab lists all the generators that have been found. The list shows the serial number and revision data for each generator.



2.3.1.5 Stacking Do's And Don'ts

- Do power off all generators (remove USB lead) before connecting and disconnecting generators from the stack
- Don't remove any generators from the stack while the software is running
- Don't remove any generators from the stack while any of them are powered
- Don't stack several generators and leave one or more generators un-stacked...this configuration will ignore the un-stacked generators
- Don't short circuit any of the stack connector pins, or bend the pins or use excessive force trying to mate the connectors
- Don't probe or drive any of the stack connector signals
- Avoid touching the stack connector pins/signals during stacking
- Do make sure that each stack connector is properly seated in place before trying to stack another channel on top
- Don't allow water or dirt etc to enter the generator via the stack connector access hole
- Do remember that generators in the stack **are NOT isolated from each other, they are only isolated from the USB ports. To re-iterate, stacked generators have their BNC connector bodies connected together through the stack connector.**

2.3.2 Non-Stacked (MIS) Mode

It is also possible to use multiple USBwave12s as independent instruments. In this mode, the generators are NOT connected together via the stacking interface⁵.

This configuration is also termed Multi-Instrument mode or MIS mode.

In MIS mode, each generator can use its own timebase setting, and each generator input will remain electrically isolated from the others (unless you connect their BNC grounds together).

2.3.2.1 USB Connections For Non-Stacked Configurations

All generators need a USB connection. A standard hub may be useful for multi generator use to get enough USB ports.

Each generator needs about 300mA. Plugging more than 1 generator into a hub will mean that the hub may need to be powered externally. Please refer to the hub's documentation for more details about the power available per port.

2.3.2.2 Software For Non-Stacked Configurations

By default when you run USBwave12, it will automatically detect all the generators connected via USB and will also check to see if the generators are electrically connected together via the stack. To run in Non-Stacked MIS mode, the software must be “told” to drive one particular generator. You can then simply run multiple copies of the USBwave12 software, one copy for each particular generator.

In order to achieve this mode of operation, USBwave12 accepts a command line parameter

“USBwave12 /MISp:c”

⁵ They can of course still be snapped together, but remember NOT to fit any of the stacking connectors so that the generators remain electrically independent of each other.

where “p” is the COM port number and “c” is the assigned channel number.

For example, if you want to run 2 generators in MIS mode, use Window’s Device Manager to get the two COM port numbers for the two generators (see 3.2). Lets assume they are COM4 and COM5.

Next, locate the USBwave12.exe program (normally under “Program Files\USBwave12”) and highlight the file. Right click the file and use “Create Shortcut” to make TWO shortcuts to the program. Then for the first shortcut, right click it and bring up “Properties”. In the “Target” field, add “ /MIS4:1” to the end of the line⁶. Do the same for the second shortcut but add “ /MIS5:2”.

Now, double click the first shortcut. An instance of USBwave12 will run and configure the generator on COM4. Next, double click the second shortcut and this will launch a second instance of USBwave12 but this time configuring the generator on COM5, and also note that this second generator appears as a “CH2” tab. This way you can easily identify which instance of software is for which generator.

Note that you could also have chosen /MIS4:1 and /MIS5:1. Both generators would then act like a CH1 tab. Its up to you how you choose to configure the system.

In MIS mode, the settings for a particular software instance will be saved when you exit, and will be separate to any other generator’s settings.

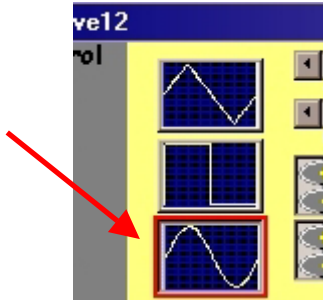
You can run up to 4 generators in MIS mode and you can assign channel numbers from 1 to 4.

⁶ Note the space

2.4 Output Control

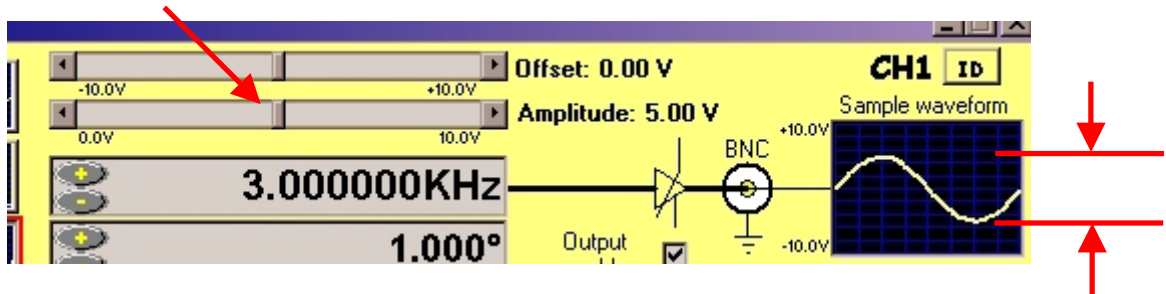
2.4.1 Output Waveform

The USBwave12 supports 3 different types of output waveform, sine, square and triangular. The required waveform is selected by pressing the appropriate wave shape button.



2.4.2 Output Amplitude

The USBwave12 supports programmable output amplitude via the slider control.



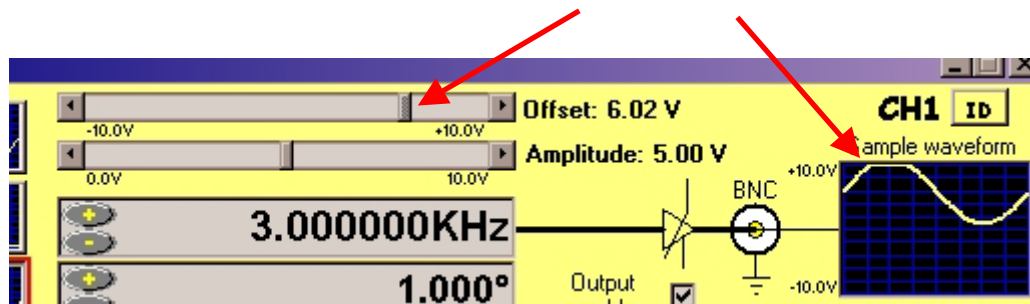
When you adjust the slider, the on-screen waveform adjusts to show the approximate amplitude you have selected.

Amplitudes from 0V to 10.00V (+/-10V pk-pk) are possible, and the slider control adjusts in steps of 40mV per step.

2.4.3 Output Offset

A DC offset voltage can be applied to the output waveform via the Offset slider control.

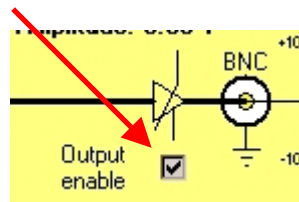
As with the amplitude adjustment, when you adjust the slider, the on-screen waveform adjusts to show the approximate DC offset level. The on-screen waveform will also indicate if any clipping of the waveform is likely to occur.



DC offsets from 0V to +/-10.0V are possible, and the slider control adjusts in steps of +/-80mV per step.

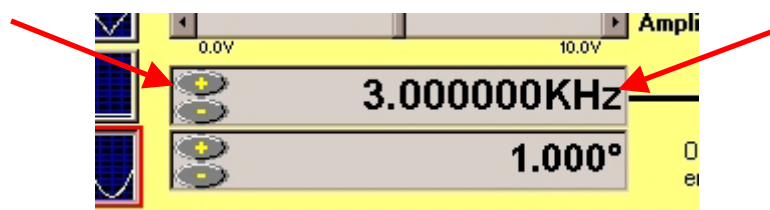
2.4.4 Output Enable

The output of the generator can be placed into a Hi-Z mode using the button shown. When placed into Hi-Z, the MOSFET relay at the output of the USBwave12 turns off. The maximum leakage current when in the off state is 1uA. In enabled mode the output impedance is approximately 50 Ohms at DC.



2.4.5 Output Frequency

The output frequency of the generator is also programmable by the user and is set by either entering a numeric value into the frequency box, or by clicking on the increment/decrement buttons.



When entering a numeric value into the frequency box, the following qualifiers apply:

Frequency box	Range
No qualifier or H or h	Hertz
m	MilliHertz
K or k	KiloHertz
M	MegaHertz

When using the increment/decrement buttons, click on or highlight the digit that needs to be changed, then press either the increment or decrement button. That digit will be changed accordingly. The other digits will increment/decrement automatically if required.

Each of the three selectable waveform shapes has a maximum programmable output frequency associated with it. These are as follows:

Wave shape	Maximum Frequency
Sine	12MHz
Square	5MHz
Triangle	1MHz

If a value greater than those shown in the table above is entered into the frequency box, it will automatically be changed to the maximum value for the currently selected waveform shape.

The generator has a frequency resolution of 186mHz. If the value in the frequency box is less than 1kHz, it will automatically be adjusted to be a multiple of 186mHz. For values of 1kHz or above the value displayed is unaltered as the actual output frequency will be a very close approximation to the required frequency.

2.4.6 Output Phase

The phase of the output waveform is also programmable and is set by either entering a numeric value into the phase box, or by clicking on the increment/decrement buttons.



When using the increment/decrement buttons, click on or highlight the digit that needs to be changed, then press either the increment or decrement button. That digit will be changed accordingly. The other digits will increment/decrement automatically if required.

Values from 0 degrees to 360 degrees can be entered. The generator has a fixed resolution of 0.08789 degrees.

Although a phase value can be entered when just one USBwave12 is in use, it has little real effect. The phase value is designed for use with multiple USBwave12s, allowing a phase difference to be applied to one unit relative to another.

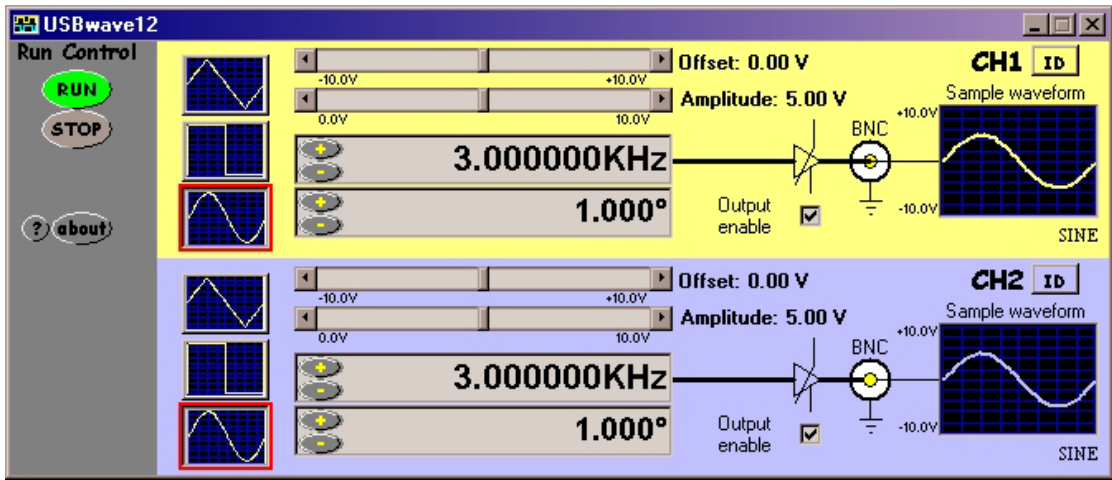
2.4.7 Run Control

Overall free-run or stop mode is controlled by the RUN and STOP buttons.



The RUN button must be activated for the generators to operate. The STOP button de-activates all of the generators.

One set of RUN and STOP buttons are used to control all of the generators connected, see below:



3 SOFTWARE INSTALLATION

3.1 Windows 98SE and Windows Me

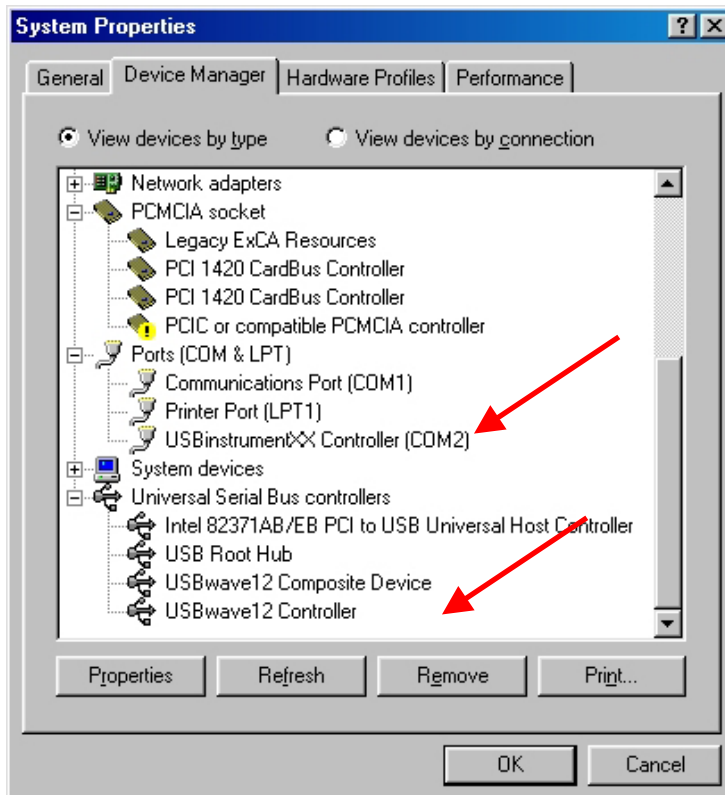
Before plugging in the hardware:

Use the supplied install CD and run the setup program. This will copy all the required files and drivers to your PC.

After running the setup program:

Insert the USBwave12 into a free USB socket, or into a USB hub port. A USB extension cable can be used if needed.

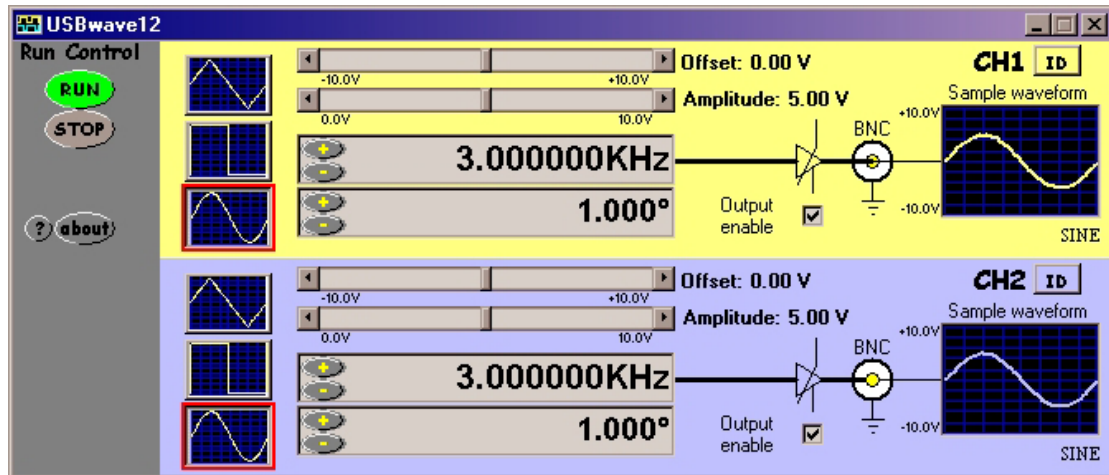
During installation, **three** new hardware devices are detected: The “*USBwave12 Composite Device*” first, followed (twice) by the “*USBwave12 Controller*” itself. **The installation is automatic and requires no user input.** After the drivers have started, you will not get any indication that everything went OK except by checking the device manager. After installation the device manager will look like this⁷:



⁷ The COM port number will be platform specific, this is just an example

Once the hardware has installed, there is no need to make any settings for the allocated COM port...the software takes care of all this at run time.

Start the USBwave12 software and you will see the following display⁸:



To find out what the various buttons and knobs do, simply hover over them for a brief explanation.

⁸ A 2 channel example is shown

3.2 Windows 2K and XP⁹

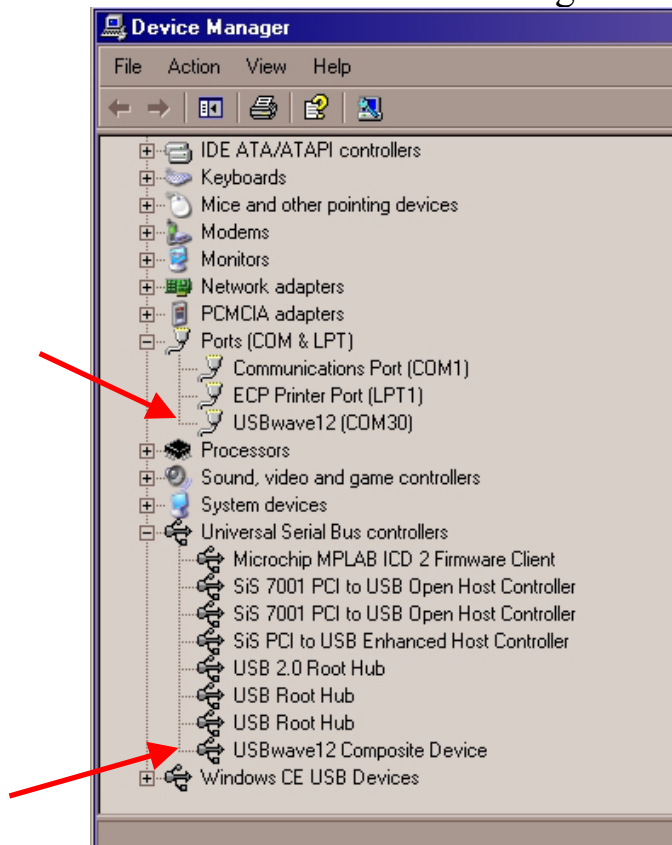
Before plugging in the hardware:

Use the supplied install CD and run the setup program. This will copy all the required files and drivers to your PC.

After running the setup program:

Insert the USBwave12 into a free USB socket, or into a USB hub port. A USB extension cable can be used if needed.

During installation, **two** hardware devices are detected: The “USBwave12 Composite Device” first, followed by the “USBwave12” itself. **It is vital to complete the installation of both devices¹⁰**. After installation the device manager will look like this¹¹:



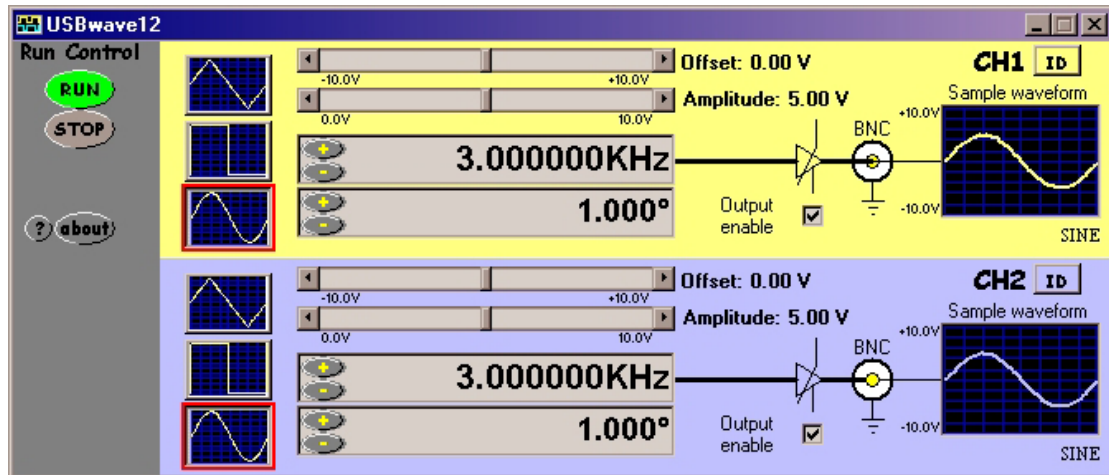
⁹ Include Language variants using the DBCS character mappings e.g. Chinese, Japanese, Korean etc

¹⁰ **If Windows prompts to search the Internet for a driver, select “Not this time”, and when it warns about Unsigned Drivers you MUST click on “Continue Anyway”**

¹¹ The COM port number will be platform specific, this is just an example

Once the hardware has installed, there is no need to make any settings for the allocated COM port...the software takes care of all this at run time.

Start the USBwave12 software and you will see the following display¹²:



To find out what the various buttons and knobs do, simply hover over them for a brief explanation.

¹² A 2 channel example is shown

3.3 Troubleshooting

- Check that the generator hardware installed properly. Use the device manager as shown above and check that there are no yellow exclamation marks on any of the USBwave12 devices. If there are, try deleting that device, then un-plug and re-plug the generator.
- Make sure that you do not press cancel or stop during any part of the hardware installation. If you did, use the device manager to delete any USBwave12 devices shown, the re-plug the device and try again
- When you run the software you get a run time error. This could be caused by a much older version of the USBwave12 software that was installed previously but did not un-install its registry hive settings. To correct this, go to the USBwave12 install directory and double click the “**remove_settings.reg**” file and click OK when prompted. This will remove the registry hive associated with USBwave12¹³. Now try running the software again.
- If you are still having problems please use the Windows “PrtScr” button to make a screen capture of the application. Then paste this into a Word or Paint document and send it to tech support.

¹³ This is where USBwave12 saves the generator settings.

4 HARDWARE SPECIFICATION

All parameters typical @ 20°C unless otherwise stated

4.1 Power Requirements

Supply Voltage: 5.0V $\pm 10\%$ from host USB bus
Total Supply Current: 300mA avg

4.2 Isolation

Isolation rating: 300V CAT II, 500V CAT I between BNC ground and USB ground
Transient isolation¹⁴: BNC ground to USB ground +/-2.5KV

4.3 Performance

Operating modes: Continuous stream (RUN), halted (STOP)
RUN mode: Output state depends on Output Enable status
STOP mode: Output is de-asserted
Output states: **Hi-Z** (disabled) Max leakage current = 1uA
Normal (enabled)
Output DC resistance: 50ohms typical when enabled
Output frequency range: Sinewave 0 to 12MHz
Squarewave 0 to 5MHz
Trianglewave 0 to 1MHz
Output frequency resolution: 186mHz
Relative phase range: 0 to 360 degrees
Relative phase resolution: 0.08789 degrees
Output amplitude range: 0V to 10Vpk (+/-10V pk-pk)
Output amplitude resolution: 40mVpk
Output dc offset range: 0V to +/-10.0V
Output dc offset resolution: +/-80mV
Output protection: Short circuit to ground < 1 minute
Master clock: 12.50MHz, initial accuracy $\pm 0.01\%$, ageing and drift after 1 year $\pm 0.005\%$, temp coefficient $\pm 0.005\%/^{\circ}\text{C}$
Master clock skew: For 2 or more stacked USBwave12s, typical 2ns between units

¹⁴ This figure derives from the 300V CAT II isolation rating and defines the peak transient voltage that can be safely tolerated between the BNC ground and the USB ground.

4.4 Mechanical

Mass: 42g typ.
Case Material Data: Polycarbonate (UL94V rated)
Size (typical in mm): 99.6¹⁵ x 30.6 x 17.5¹⁶

4.5 Environmental

Humidity: <80% non condensing
General Operating Temperature: -10°C to +45°C Ambient
Storage Temperature: -40°C to +80°C Ambient
Operating Location: Indoor or under-cover use only
Operational Category: Cat II
Pollution Degree: 2

4.6 Miscellaneous

USB transfer rate: USB 1.1¹⁷ Full Speed 12Mbits/sec
USB device ID: 10C4 F002

4.7 Software

USBwave12 support: Win98SE/Me/2000/XP
Recommended system: Pentium Class 600MHz or better, 16-Bit colour depth graphics or better with graphics acceleration, 800x600 min screen resolution, 256MBytes RAM

¹⁵ From BNC end to USB end

¹⁶ Not including "P" clips on base

¹⁷ Works in USB 1.1 or USB 2.0 hosts using the 12Mbits/sec full speed mode

4.8 Safety Data and Maximum Ratings



Important Safety Precautions

Always observe these when using the USBwave12

The USBwave12 contains no user serviceable parts inside. Do not open the plastic housing.

There may be lethal voltages inside the plastic housing. Do not use the instrument if the housing is damaged or is poorly fitting. In such a case do not connect anything to the USBwave12 to avoid a hazard. The USBwave12 will have to be repaired or replaced in such a situation.

Do not exceed the maximum ratings listed below.

Never use the instrument if it becomes damp for any reason. This includes situations where condensation has formed on the unit due to sudden temperature or humidity changes.

Never use test leads that are damaged or have insufficient or incomplete insulation.

Never allow any conductive part of any test lead to contact the host computer ground. Doing so will bypass the safety isolation in the USBwave12 and could cause a lethal hazard.

Remember that the isolation is between the BNC and the USB connectors. The BNC is, of course, at the same potential as the test lead ground clip to which it is connected. Be careful when measuring hazardous voltages not to touch the BNC connector ground for this reason.

Only use the shorter length stack connector in the bottom generator of the stack, and if using a single generator, don't fit any stack connector at all. This is to avoid touching the contacts