

Sync-One2[®] v2

User Manual



Sync-One2 is an easy to use hand held tool suitable for professional and amateur users to quickly and easily analyse audio/visual synchronisation problems.

This manual is for Firmware release v2.0.0

! IMPORTANT !

To obtain the best results the use of supplied test files is recommended. These files consist of very brief flashes of light and sound beeps. As these flashes are brief and intense they may be perceived as stroboscopic lights. Accordingly, persons with photosensitive epilepsy or similar condition that can be triggered by flashing images should take suitable precautions when using these test files and do so at their own risk.

Overview

Within the digital Audio Visual (AV) world the audio and video signals are often processed by different pieces of equipment, which when combined with the processing delay introduced by digital display devices can lead to problems with audio video synchronisation – or lip sync problems. Within the realm of digital video editing, errors can also occur if tracks are not aligned correctly or frames are dropped during processing. These problems can occur in areas such as a home cinema, professional AV installations such as a Lecture Theatre, post-production editing, Digital Cinema, TV broadcasts, and many more.

Sync-One2 is a small handheld device designed to aid with correct setup of AV systems and to verify the output is synchronised. By measuring the time difference between a pulse of light and sound, it becomes easy to get the optimal configuration for almost any application, or to just check that things are as they should be.

The measurement results are available in various formats, depending on the user requirement and combined with statistical analysis of readings help give a real indication as to what is going on in any audio-visual system. An API interface is also available to enable Sync-One2 to be remotely controlled. A separate manual covers the API commands.

Sensors

The system sensors are located at the top of the unit, so when holding Sync-One2 the sensors are naturally pointed toward the screen.

The microphone is on the left, with the light sensor on the right.



! IMPORTANT !

Do not cover the sensors, if covered readings may not be taken or will be inaccurate
Do not insert anything into the sensor apertures, doing so may damage Sync-One2 and prevent correct operation. Take care not to permit liquid to enter the apertures.


External interfaces

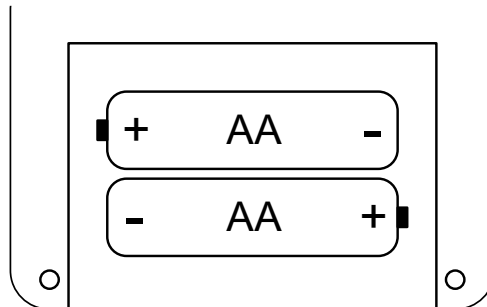
There are two external interfaces, a 3.5mm stereo audio jack and a mini-USB port.

The audio jack permits Sync-One2 to be connected to a headphone or line-out audio port, switchover to use the external audio source is automatic during calibration, but may be overridden in the menus.

The USB Mini-B port offers data logging of readings in real time, an API interface for remote control, firmware upgrades, and will also supply power.

Power

Sync-One2 uses 2 AA batteries (including rechargeable), a low battery indication  is shown when new batteries are required. Should the batteries get too low, a warning is displayed and Sync-One2 will switch itself off to avoid incorrect operation. Power may also be supplied via the mini-USB port.



Orientation of the batteries in the battery compartment

Buttons



Press and hold to turn on, press again to turn off.



Is used to move between Measurement mode and Menu mode (with additional functionality available in some specific menus as given below)



Used to navigate up and down the Main Menu, and to alter values within menus

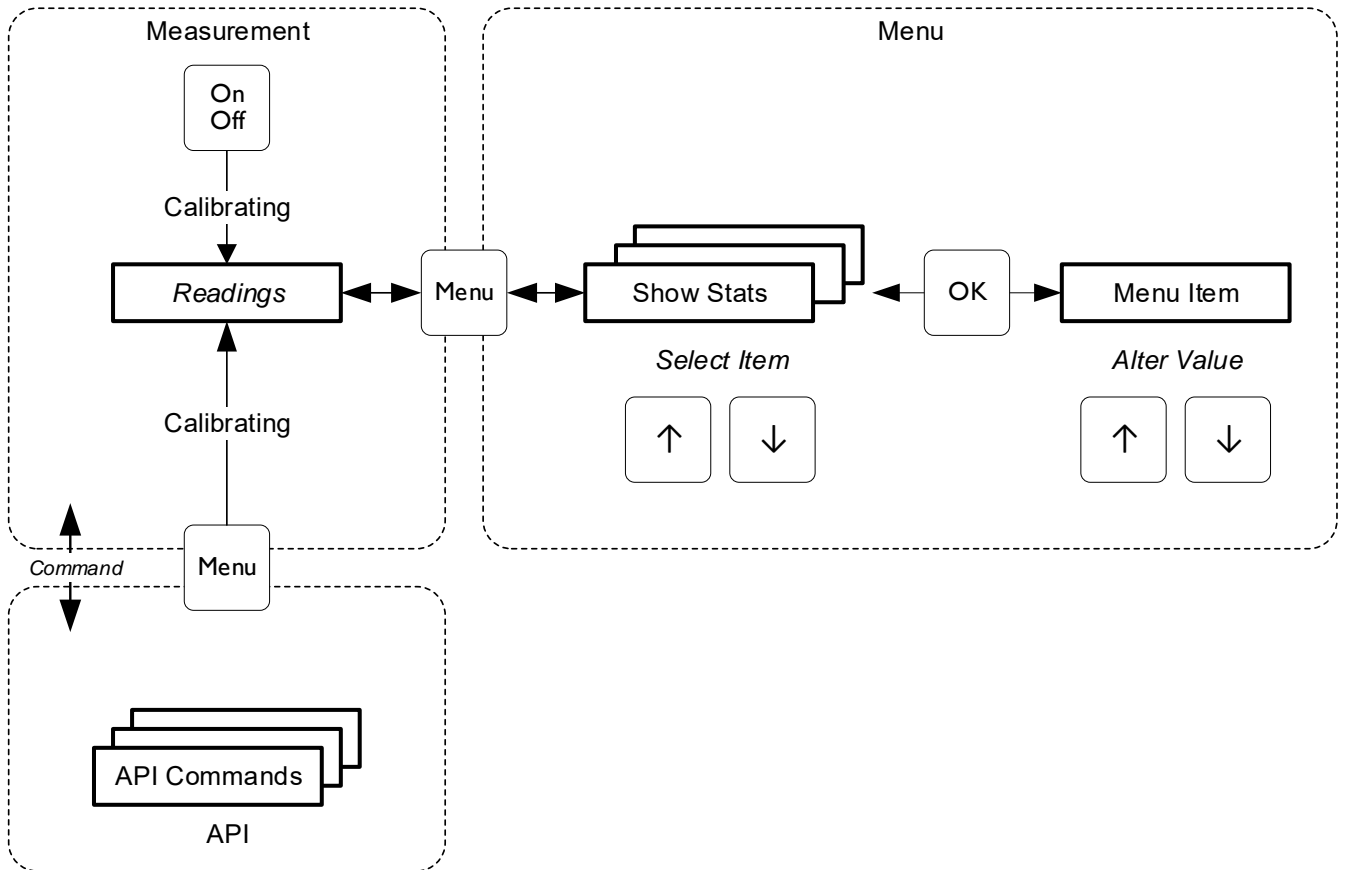



Used to enter a specific menu item and return to the Main menu

Operating Modes


Sync-One2 runs in three distinct modes;

- Measurement mode, where the actual readings are taken and displayed in real time
- Menu mode, to display statistics and set various system options
- API mode, where Sync-One2 comes under remote control



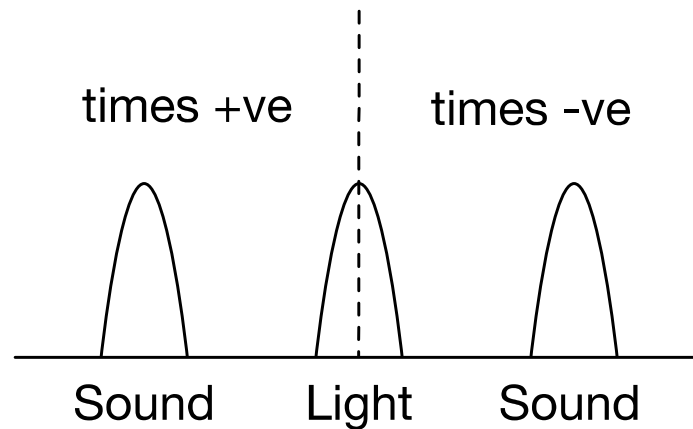
Moving between Measurement mode and Menu mode is via the  button.

API mode is activated once a command is received and the display will show `API Control`

To exit API mode, issue the exit command or press the  button

What do all the numbers mean?

All measurements are taken and presented with reference to the light pulse, so if the audio is ahead of the light the readings are positive. Should the audio be behind the video then the readings are negative.



Readings are given in milliseconds (`ms`), and frames (`F`) if a frame rate has been entered.

For example, in a home cinema environment, if the synchronisation error were detected as +100ms then introducing that delay within the AV Receiver/Pre-Amplifier would bring things back into sync.

The results vary a lot, what's going on?

This is, surprisingly, normal. With all the digital processing that goes on in modern equipment it is rare to get a set of readings that all exactly match one another. That is why Sync-One2 calculates various statistics to help with the analysis, details on these are given later within the guide.

What is all this Calibration business?

Whenever Sync-One2 goes into Measurement mode it will calibrate itself. It is measuring the current ambient levels of light and background noise, and then automatically adjusting to be able to filter these out for more accurate readings and fewer false readings.

Ideally, always have Sync-One2 in the measuring position (i.e. pointed at the light/sound sources) when turning on, or going back to the Measurement mode, to obtain optimal results.

During calibration flags indicating if an external audio source is in use, or a reminder that a Mask Length (the minimum time between measurements, see `Mask Length` command) above the standard has been set.




External audio source is being used for measurements



A Mask Time other than the default has been set

Measurement Mode Basics



The display only updates once a successful reading has been taken, which is indicated with a . The symbol remains during the Mask Time, so only when the symbol disappears will Sync-One2 be ready to take the next reading.

The display gives the latest detected reading in milliseconds, in this example the audio was detected as being 33ms ahead of the video as the reading is positive. If it were a negative number this would mean the audio lags behind the video.



```
ms
+033
```

If a frame rate has been set, the reading is also given in frames. Using the same example, with a frame rate of 25 frames the audio is ahead by 00.84 frames.



```
25F  ms
00.84 +033
```

The running average of the current measurement session can also be displayed in milliseconds or frames. This average is calculated on the current measuring session and is not stored.



```
25F  ms  A
00.84 +033 +032
```

If the average has been set to show in frames rather than milliseconds, and there is a frame rate set, then the average is shown in frames. The ^F next to the A shows this.



```
25F  ms  AF
00.84 +033 +0.80
```

Three flags could also be shown, which indicate when external audio is selected, or various features that impact readings have been set.



External audio source is being used for measurements



A speaker distance has been set and the displayed reading incorporates the adjustment



A manual offset has been set and the displayed reading incorporates the adjustment

More details on these settings are given in the Advanced Operation section.

Memory buffer and Statistics

Whilst measurements are being taken, the most recent 60 readings are stored in memory and are available to view via the `View Stats` menu option.

When the memory becomes full, the oldest readings are discarded so it always contains the most recent 60 readings. This memory is retained between sets of measurements and only erased when Sync-One2 is turned off or cleared manually via the `Clear All Stats` menu option.

When the statistics are displayed the span and average of all the readings in the buffer is calculated to better indicate the performance of the system under test.

The span is the difference between the two most extreme readings in the buffer. For example, if the extreme readings in the buffer were -50ms and +100ms the span would be 150ms. A low span means the system is stable in its operation, a span of 10ms or lower is ideal.

The average, calculated from all the readings in the buffer, gives an indication as to the true delay of the system. Naturally an average of 0ms / 0.00 frames would be perfect but in the real world anything under 10ms will be hard for anyone to detect.

Full details of the statistics provided are given in the Advanced Operation section.

Data Logging

Real time data logging of readings taken in Measurement mode is available via the USB Mini-B port. Details of the data logged, format, and connection details are available in the API manual.

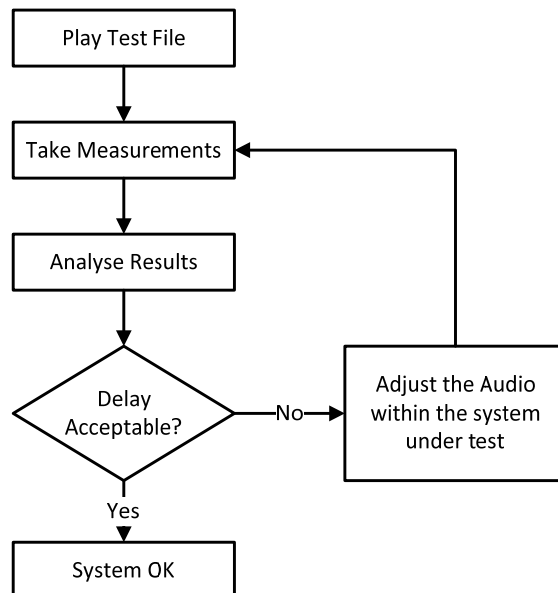
Basic operation

When powered on, Sync-One2 will start up and display its serial number and any configured splash screen then go into Measurement mode, following a brief self-calibration. For best results, hold the unit in the measuring position in relation to the display equipment during the calibration sequence, as this will give the best results.

The measurement position is the when the unit is held fairly close to the display, with the light sensor pointing at the display, or if a projector is in use within the light beam of the projector. Typically, as in the picture below:



A basic use, for example, is to check or help to set-up a home cinema environment. The typical workflow to achieve this is as below:



This uses two modes of Sync-One2, Measurement mode and Menu mode. Measurement mode takes the readings and stores the most recent in a memory buffer. Always take a number of readings to determine the error, to smooth out the variances in signal processing.

Once several readings have been taken, enter Menu mode and choose the `Show Stats` option. This displays the average and span of the readings and gives the best indication of the situation in any given system.

For example, if after a series of measurements, the Show Stats menu gives the following screen. The low span indicates the system is stable but suffers from a video delay of about 32ms. If this were a home cinema, adding an audio delay of 32ms and re-testing should result in a synchronised solution.



Should the span reading be high, say over 25ms this may suggest there could be inaccurate/anomalous results within the memory buffer. Details of how to go through the memory buffer and remove any suspect readings is given in the `Show Stats` menu item section of the guide.

If any adjustments have been made to the system under test, then always run the test again to confirm the adjustments have brought things back into synchronisation. (Note, remember to clear the memory buffer via the `Clear All Stats` menu item or the results could be confusing).

Depending on the various possible input paths, e.g. Blu-Ray players, network streamers, games consoles etc. it might be required to configure a delay for each of the input devices if the audio processor supports multiple values. If it is not possible to configure the individual input channels, pick the most commonly used input, which is able to play suitable test file.

Advanced Operation

Within post production or video editing, workflow is based around video frames, rather than time in milliseconds. Within Sync-One2 you can set a frame rate between 1 and 99 frames/sec. Whilst some frame rates are fractional, for example 29.97, Sync-One2 uses whole frames, which is accurate enough. Simply pick the closest whole frame rate to the actual one of the systems you are working with.

With a frame rate selected, the Measurement mode displays the readings in milliseconds and in frames, at the chosen frame rate. However, more importantly, when performing analysis within the `Show Stats` menu item the readings for average and span are also given in frames, as is each of the individual memory buffers.

Using the same readings taken in the Basic Operation example above, with a frame rate set the stats display will alternate between the reading in milliseconds and frames. So, in this case the frame rate set is 25 frames/sec, the span is 00.1 frames with the average reading of +0.80 frames.

```
A +032 M01
S 0002 ms +033
```

```
A+0.80 M01
S 00.1 25F +0.84
```


The value below the memory position indicates if the readings displayed are in milliseconds or frames, and the frame the rate entered. The display will start to alternate a couple of seconds after a given memory position is shown. When moving between the memory positions, the readings are shown in milliseconds but will start to alternate once a given memory position has been shown for a couple of seconds.

For post-production work having the reading in frames makes it much easier to correct the issue than just milliseconds. When the frame reading is below 10 frames the resolution is to 1/100th of a frame, above 10 frames resolution is to 1/10th of a frame.

Manually offsetting readings

There are situations where being able to enter a known offset can also help understand readings where equipment delays are known in advance. For example, should a display have a known processing delay of 45 milliseconds, when the readings are taken the with the signals leaving the computer exactly in sync, the best obtainable result would be the audio leading the video by 45 milliseconds (+45ms) because of the delay in the display. To correct for this, you could enter a user offset of -45, then the processing delay of the screen has been accounted for.

The user offset is input in milliseconds (via the `User ms Offset` Menu Item) however if a frame rate is also set the delay calculated in frames will be displayed too.


Measurements taken with an offset applied are tagged with a  symbol to indicate the setting is active.

Use in larger spaces


Another example for Professional use is within large spaces, such as Lecture Theatres or Cinemas. Given sound travels much slower than light, in larger spaces setting the synchronisation delay at the screen could mean it is out for those in some areas of the space. The optimal would be to take readings when sitting in a central listening position. Depending on the ambient environment doing this may not result in accurate readings. Combine taking accurate readings with the problem that a central position is also unlikely to have a speaker close by, things get tricky to determine the optimal adjustments needed.

To get around this problem, a speaker distance can be input which would result in the readings taken being adjusted for the time it would take the sound to travel the distance input (well, for sound travelling at 21°C at sea level).

For example, in a lecture theatre the central seating position is 5m from the nearest speaker and it's much easier to take measurements at the front of house close to one of the main speakers. When measurements are taken an adjustment would be required to cater for the time it takes the sound to travel the 5m to the central seating position. However, by setting a speaker distance of 5m the measurements taken and statistics calculated are automatically adjusted to take account of the time for sound to travel the 5m to the seating position.

When a distance is input (via the `Speaker Dist` Menu Item), all measurements taken with a speaker distance set are tagged with a  to indicate the setting is active.

Larger spaces may also have longer reverberation times, this can lead to false detections when the beep from a test file decays slower than Sync-One2 takes to re-arm for the next reading. This time is called the Mask Time and defaults to 150ms, however you can increase this in steps up to 900ms.

To help spot if this may be the case, the  shown when a successful measurement is taken will only clear once the Mask Time expires.

Other Adjustments

The default setting is to have the Audio and Visual sensors running at their maximum sensitivity, which should be fine in most environments as the unit self-calibrates to account for ambient conditions. However, should false readings continue to be taken, then a lower trigger level is probably required. Five levels are available, independently set for the audio and visual sensor.

Menu Mode

Menu mode gives access to the memory of stored readings and gives access to various options and settings;

Show Stats	Gives access to the last 60 readings and various statistics
Clear all Stats	Clears all the stored readings/statistics
Display Size	Changes the Measurement mode display size from normal to large *
Display Average	Enables the running average during Measurement mode *
Frame Rate	Sets a frame rate to be used for calculation and display *
User ms Offset	Manually set a millisecond offset *
Speaker Dist	Set a speaker distance, an allowance is made for the distance of the speaker in the readings *
Mask Length	Adjust the Mast Time *
Detection Test	Used to check the detectors are picking up audio and video signals
Audio Tris Lvl	To adjust the sensitivity of the audio sensor *
Video Tris Lvl	To adjust the sensitivity of the video sensor *
Audio In Select	Changes the audio input selection *
Auto Switchoff	Changes, or disables, the auto-off period *
Reset Settings	Resets all settings to default
System Info	Gives the serial number and any custom splash display
Firmware Upgrade	Used to activate the firmware upgrade mode

* The state/value of these options is stored in flash memory, so are retained if Sync-One2 is switched off.

Within some menu options user input will be required, such as choosing between two options or inputting values. Where user input is required, this is shown by displaying a flashing cursor near to the requested action.

Options such as Yes/No, On/Off, or Large/Small, use the keys to toggle the input and to select the input.

If values are required to be input, use the keys to increase/decrease the value, and to confirm the value. For some menu items, holding the arrow key will step up or down in multiple units.

Show Stats

This allows you to view the memory of the latest 60 readings, with reading 01 the most recent and 60 the oldest. A typical display is shown below:





```
A +032 M01
S 0002 ms +033
```


A is the average of all the readings in memory

S is the span, or the difference between the largest and smallest readings in the memory

M is the reading currently on the screen, with 01 being the most recent

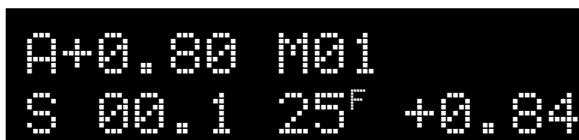
+033 is the delay measured for the reading being displayed

You can move through the readings using the   keys, if you think of the memory as being a vertical stack, with 01 at the top, the down arrow moves down through the stack to older readings and the up arrow moves up through the stack to newer readings. The most recent reading will always be 01.

If a reading in the memory is considered inaccurate, pressing  will enable the reading to be erased from the memory and all the statistics re-calculated. People speaking during a measurement session, for example, can cause such errors.




Details of why these stats are gathered are given in the Stats Analysis section later in the guide, which gives the details for how to best understand the readings.

If no frame rate has been set, the display simply gives all the readings and statistics in milliseconds. If a frame rate has been selected, then all the readings alternate between milliseconds and frames, based on the selected frame rate after memory position has been displayed for a couple of seconds.



```
A+0.80 M01
S 00.1 25F +0.84
```

For the memory position shown above with a frame rate of 25 frames/sec set, the same information is displayed but showing the readings calculated in frames at the selected rate rather than milliseconds.

Three flags (,  and ) may also be shown, if the specific reading was taken from the External audio port, a Speaker distance was set, or an Offset were set.

Clear all Stats

Used to wipe the entire memory of readings taken, without the need to delete them individually or to turn Sync-One2 on and off. Confirmation is required.



Display Size


When in Measurement mode a large number display can be activated for easier reading. This simply gives the reading in milliseconds without the additional data. However, all the normal statistics and readings are still stored, it's just an alternate display mode should it be required.

Display Average

In Measurement mode, whilst readings are being stored for future analysis a running average of the current measurement session can be displayed. There is a choice between the average being displayed in milliseconds (M/Sec) or frames ($Frames$). If frames are chosen but no frame rate is set, the display will show the average in milliseconds. This is handy to see if this running average is starting to head up or down, which can indicate a small delay error getting worse over time. The average can be calculated over huge numbers of consecutive readings, although any 'false' readings will be included within the average. Millisecond and frame averages are indicated by an A or A^F respectively.

Frame Rate


A video frame rate per second can be entered using the   keys, which is used to calculate the millisecond delay measured into frames. Any frame rate from 1 to 99 can be entered.


Holding an arrow key will step up/down in 10's and pressing the  key will quickly reset the value to zero.

In the screen below, a frame rate of 30 Frames/Sec has been input.



User ms Offset

A manual offset can be input, when an offset is set the readings are tagged with a  symbol to indicate the setting is active. The offset entered is processed during readings and statistics calculations.


Holding an arrow key will step up/down in 10's and pressing the  key will quickly reset the value to zero.


In the screen below, an offset of 45 milliseconds has been input, with a frame rate of 25 frames/sec having previously already been set.



User ms Offset
+45ms 1.12 @ 25F

Speaker Dist

A speaker distance can be input, when set all readings are tagged with a  to indicate the setting is active. The time it takes sound to travel from the speaker to the “target” point is automatically calculated by Sync-One2 based on the distance value entered. This delay is processed during readings and statistics calculations. Distances between 0m and 20m can be input, in 0.5m increments.

The delay can quickly be reset back to zero by pressing the  key.


In the screen below, a speaker distance of 5m has been input, the distances are also given in feet and inches.



Speaker Dist
5.00m 16' 5"



Mask Length

The Mask Time can be adjusted to help with measurements in spaces with long reverberation times. The Mask Time is the time Sync-One2 will wait after taking a measurement before re-arming to take the next measurement. A space with a long reverberation time can cause Sync-One2 to detect the still fading beep of the previous measurement, so a longer Mask Time can be used to prevent that.

If anything, other than the default 150ms is set then an  is displayed during calibration as a reminder.



Detection Test

If there is some doubt about the ability of readings being taken in any given environment, a detection test will simply display Audio and/or Video when the sound or light level is sufficient to trigger the sensors based on the last calibration performed.

The flashing  is to show the system is running looking for signals, the detection test will run for 1 minute or unless stopped early by pressing .

Audio Trigger Level / Video Trigger Level

The sensitivity of the audio and video sensors can be adjusted, by default they are set to their highest setting to obtain the most accurate readings. If required, this can be reduced which has the effect of louder sound or brighter light being required to be able to take readings.

There are five levels of adjustment available, move between them with the  and  keys.

Audio In Select

This option enables the ability to override the automatic detection of which audio input to use for measurements. The default is to autodetect during calibration, if a cable is connected to the 3.5mm audio input then it becomes the audio source.

You can choose from `Auto`, `Internal`, or `External` depending on your requirement.

Auto Off

By default, if no buttons are pushed for 15 minutes, the unit will switch itself off to save the battery. This can be adjusted in the range from disabling it completely to switching off after 60 minutes. Regardless of setting, if the battery gets too low Sync-One2 will give you a warning then switch itself off anyway. This helps prevent rechargeable batteries from being run down too low.

Reset Settings

After confirming the action, Sync-One2 will be restored back to the factory defaults for all the settings & options with the exception of any configured splash message.

System Info

Displays the unit serial number and firmware revision plus any customised splash screen text. A custom splash message can be set via the API interface if desired, but only if a permanent splash message was not specified at the time of order.

Firmware Upgrade

Enables Sync-One2 firmware upgrade mode. When connected to a PC Sync-One2 will appear as a serial port, have the PC based software ready and the correct port selected to upload new firmware when prompted.

Sync-One2 will then display `Waiting for PC`. Once the update is in progress the display will show `FW Uploading`, once complete Sync-One2 will reboot.

! IMPORTANT !

Do not disconnect Sync-One2 whilst a firmware upgrade is in progress.
Doing so will prevent operation until a firmware update completes successfully.

Using Sync-One2 effectively

There are some basic tips which when combined with an understanding of the statistics gathered will enable effective measuring of synchronisation errors.

The light trigger is based on detecting the change from dark to light and is very sensitive. When testing involves projectors however, it may be required to put Sync-One2 into the projector beam (facing the projector, naturally) rather than rely on the reflected light from a screen. Audio detection is essentially looking for the start of a noise, it doesn't matter if the audio is in or out of phase. Ideally perform tests in a darkened room with low ambient noise, doing so makes the distinction of the light flash and sound easier to detect and so measurements will be more accurate and reliable.

When turning the unit on or going back into Measurement mode Sync-One2 will calibrate to take account for ambient light and noise. It is best to hold the unit in the measuring position when turning on or going back into Measurement mode such that the calibration can be optimally set for the current measurement conditions and unit position.

In any given installation there will be a variance between all the readings taken. This is because when digital processing is involved there will be slight differences in how the signals are processed, this is where the use of statistics is the most useful to determine any given error.

Always take a number of readings to determine an error, to help smooth out the variances. Then the average and span of a set of readings give the best indication of the situation in any given system. A low span of readings means the system is stable in its operation, ideally a span of 10ms or 0.5 frames or lower is ideal. The average will give the delay in the system, naturally an average of 0ms / 0.00 frames would be perfect but in the real world anything under 10ms or 0.5 frames would be hard for anyone to detect.

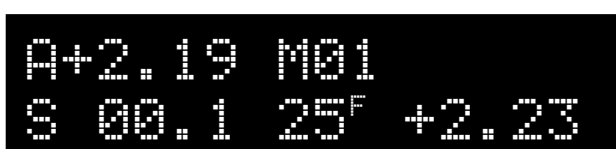
For example, if after a series of measurements, the Show Stats menu gives the following screen...



```
A +046 M01
S 0002 ms +047
```

...the low span of 2 milliseconds indicates the system is stable but suffers from a video delay of about 46ms. If this were a home cinema, adding an audio delay of 46ms and re-testing should result in a synchronised solution.


If the same readings were obtained with a frame rate set, for example in a post-production environment, the screen would alternate between the stats in milliseconds and frames. With the same measurements with a frame rate of 48 frames/second set there is a span of 00.1 frames, which is good. The average error is the audio leads the video by 2.19 frames, so adjustments need to be made.



```
A+2.19 M01
S 00.1 25F +2.23
```

Note when the low battery symbol comes on, it really does mean it's time to change the batteries. The system will continue to operate until they get too low to effectively support operations, then the unit will display a message and switch itself off.

Troubleshooting

- | | |
|--|--|
| Unit does not power on? | You must hold down the  button for more than a second to turn the unit on. |
| | Check the batteries are installed the right way around and that they are not discharged (i.e. flat). If Sync-One2 comes on when using USB power than the problem will be the batteries. |
| I don't seem to be able to detect anything? | Often just turning up the brightness or volume is enough to restore things to normal. |
| | Use the <code>Detection Test</code> option to indicate when audio and/or video triggers are detected based on the previous calibration. Should there still be no detection, check the trigger levels have not been lowered or simply reset the settings and try again. |
| The audio seems to trigger all the time? | If the environment is very quiet then Sync-One2 may detect sounds of someone holding the unit, to counter this create some low-level ambient noise during calibration. Gently humming has proven to be effective... |
| I turn Sync-One2 on and all I get is <code>Waiting for PC</code> | A firmware upgrade did not complete successfully so try the process again.

If this message appears without a firmware update being attempted, try to upload new firmware. If the message remains the unit will require servicing. |

Specifications

The specifications of Sync-One2 are below:

- 2 x AA (LR6) batteries, rechargeable AA batteries are fine too
- Power consumption is low, so a standard set of AA batteries should last for around 50 hours of continuous use. Whilst off, Sync-One2 does draw a tiny amount of battery power (less than 0.1 μ A), however if not being used for some time, it is always best to remove the batteries.
- Dimensions (H x W x D) 144mm x 90mm x 30mm (5.6" x 3.5" x 1.2")
- 165g (5.8oz) excluding batteries
- 16x2 OLED display for easy viewing and low power consumption
- Reverse battery protection
- Low battery indication and auto shutdown when batteries too low to sustain operation
- External power via USB Mini-B port
- External audio connection via 3.5mm audio jack, maximum signal level of 3v RMS (9v peak to peak). Stereo or mono inputs are accepted and downmixed to mono internally.
- Measurement of audio visual delay up to ± 750 milliseconds
- Adjustable Mask Time length, for spaces with long reverberation times
- Internal minimum delay measurement accuracy of 0.05 milliseconds, display rounded to the nearest millisecond
- Detection unaffected by phase of the audio signal
- Best detection is with a clean audio signal between 1 KHz and 3 KHz
- Self-calibration adjusts for ambient noise and light (including fluorescent light flicker), with automatic microphone gain adjustment
- Data logging of readings via USB Mini-b port presents as Serial over USB. Port settings are 115,200 8,n,1
- API for remote control over the USB Mini-B port
- Upgradeable firmware for new features

There are no elements within Sync-One2 which require internal end user adjustment.

Standards compliance



EN 55103-1 Part 1 (EMC Emissions)
EN 55103-2 Part 2 (EMC Immunity)
EN 55103-2 (Magnetic Immunity)
IEC 61000-4-2 (ESD)

Sync-One2 is RoHS compliant and lead free

For additional support or information please visit the website, or e-mail sync-one2@harkwood.co.uk

sync-one2.harkwood.co.uk

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