SETTING UP AN OAS INSTRUMENT FOR OPTIMUM SOUND QUALITY

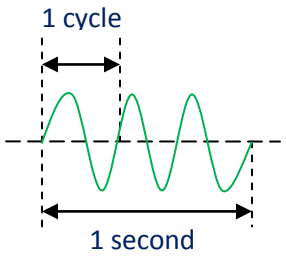
PART 2 – EQUALISATION CONTROLS

Basic Principles

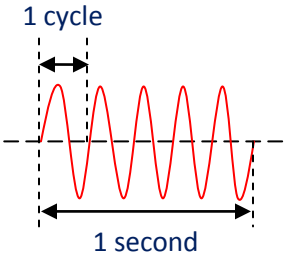
The Nature of Sound

Audio waveforms are very complex in nature. When a note is played on a musical instrument a waveform is generated that sounds at a certain pitch or *frequency*. We call this the *Fundamental Frequency.* Frequency is measured in Hertz (commonly abbreviated to Hz) and is named after the German physicist Heinrich Hertz. The older term for frequency, cycles per second, describes it better. One repeat of the waveform is a cycle so the number of times the waveform repeats itself in one second is the frequency in cycles/second and is directly equal to Hz.

To demonstrate this we shall take the simplest of waveforms for a single note, a sine wave, which in musical terms produces a flute like sound.



3 Hz Waveform

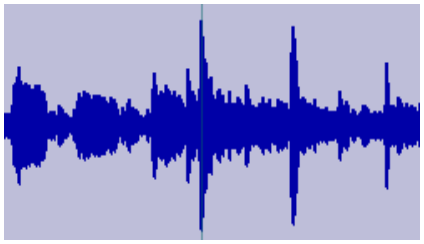


5 Hz Waveform

The first waveform repeats itself 3 times in one second so has a frequency of 3 Hz. The second waveform repeats itself 5 times in one second so has a frequency of 5 Hz. The higher the frequency the higher the pitch, so the second waveform will sound a higher note than the first.

In practice the audio waveform for a single note is much more complex than a simple sine wave. This is because as well as the fundamental frequency there are also multiples of this frequency present at varying levels of reduced intensity. We call these *Harmonics* and it's the different combination of these harmonics that makes one instrument sound distinct from another. Harmonics are generated by the way the sound is produced, for example in a stringed instrument the string will vibrate over its full length (fundamental frequency), half its length (2 x fundamental frequency), a third its length (3 x fundamental frequency) etc. The same is true for a column air in wind instruments and the material that comprises percussion instruments. So now we have a complex composite waveform containing several different frequencies all generated by a single note.

Imagine now that several notes of the same sound are played together. Now we have an even more complex composite waveform as a whole variety of extra frequencies are combined together. Now imagine that we add other notes from other sounds to this one, the composite waveform that is produced now contains an immense spread of frequencies. And so it goes on getting more and more complex as we layer sound upon sound.

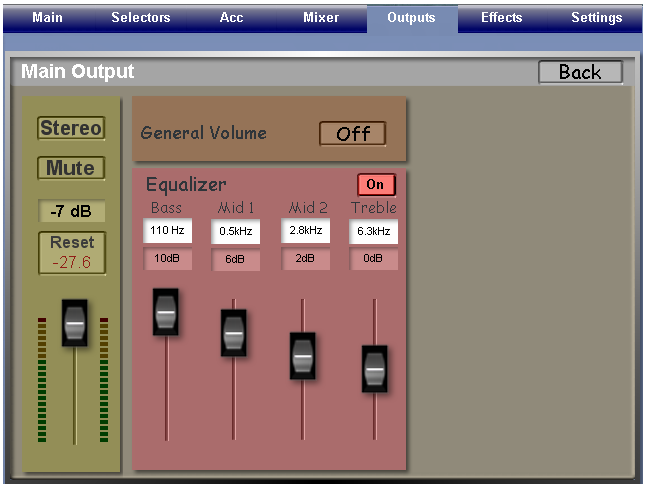


Equalisers

An equaliser is an electronic unit for manipulating the various frequencies in an audio waveform. We are very familiar with the simplest form of equaliser, the treble and bass controls on audio equipment. Here we can boost or attenuate the lower (bass) and the higher (treble) frequencies in the audio waveform. These controls are actually functioning as gain controls increasing or decreasing the volume level of these frequencies. In order for this to work however we need to define the range of frequencies to be adjusted by both controls. This is done by defining a *Centre Frequency* for each control and then building into the electronic circuits of the equaliser a specified range of frequencies either side of this centre value that will be affected by the control. On more up market equalisers this frequency range can be set by the user.

More comprehensive equalisers split the frequency range into more than two bands to provide finer control over smaller frequencies ranges. Three band equalisers provide adjustment for bass, mid and treble frequencies. Recording studio equalisers can have over twenty different frequency bands.

The equaliser provided on the OAS Output Mixer is an example of a 4 band equaliser. There are gain control sliders for each of the four bands, namely **Bass**, **Mid 1, Mid 2** and **Treble**, and input windows for setting the centre frequencies for each band.



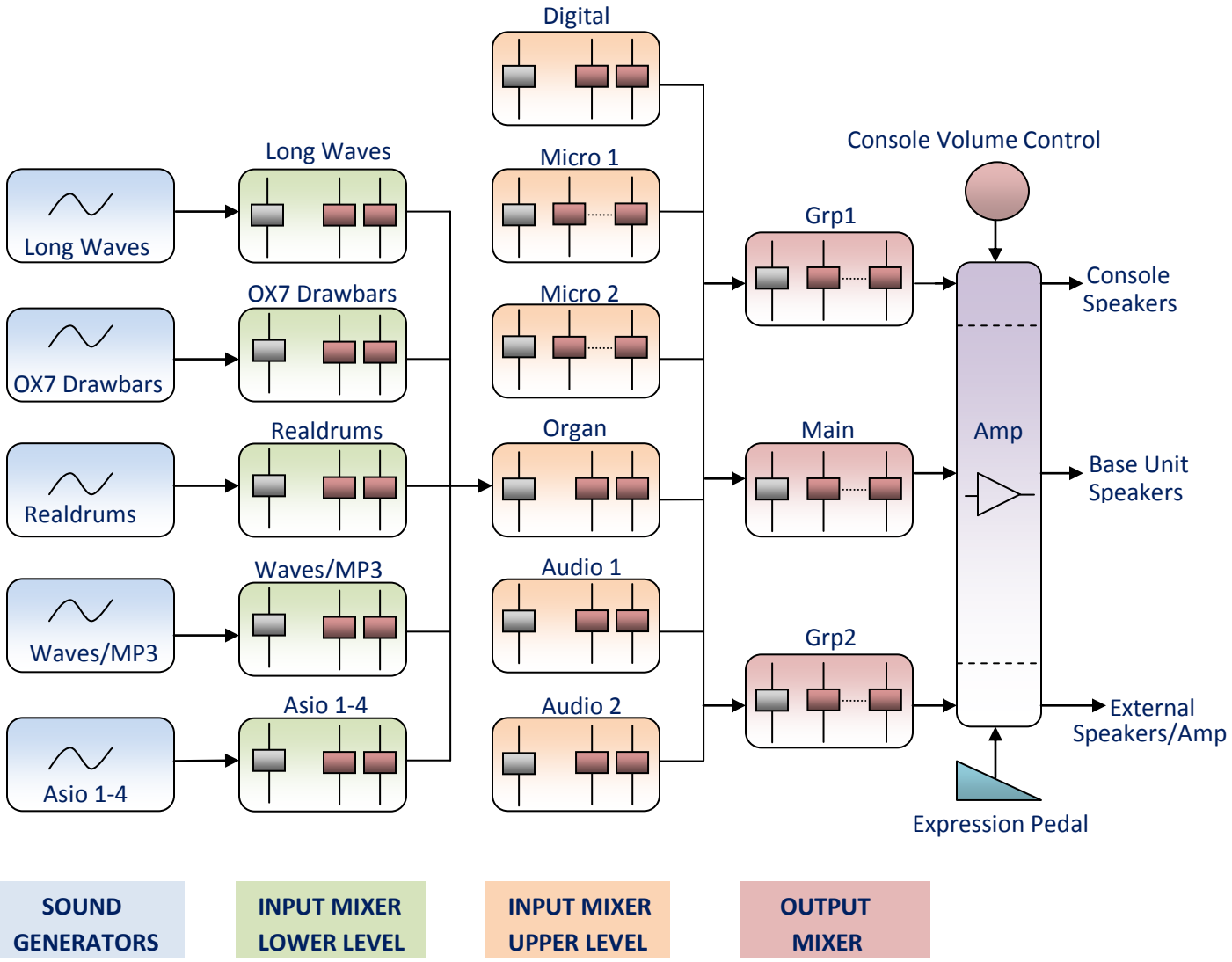
Equaliser Applications

Equalisers have been extensively used in audio engineering for a considerable period of time. They have a wide range of applications. The most common application is to compensate for the acoustics of the environment in which the audio will be played. In cinemas for example the speakers are placed behind a perforated screen. High frequencies are more readily absorbed by the screen, the auditorium furnishings and the people in the audience than lower frequencies so the treble is boosted to compensate. In recording studios, equalisers are utlised for a whole variety of purposes from removing unwanted sounds in the recording to adding clarity to the instruments being recorded. This latter application is especially useful when a number of instruments occupy a similar frequency range and as a result tend to become muddled together. By adjusting their frequency composition they can be made to sound distinct from one another and the recording gains a greater degree of clarity. A further very useful application of an equaliser is to achieve a desired quality of sound. The low frequencies add warmth and body to the sound, the mid frequencies add presence whilst the high frequencies provide clarity and brightness.

It is this last application that we are primarily concerned with in these guidelines.

The OAS Equaliser Controls

The equaliser controls on an OAS instrument are located on the input and output mixer menus adjacent to the gain controls. By adding the equaliser controls to our signal flow diagram we can now see how both types of controls operate together on the same signal to form an integrated sound quality control system. The equaliser controls enable the volume of individual frequencies in the signal to be adjusted whilst the associated gain control enables the volume of the whole signal to be adjusted. The enhanced diagram below illustrates this integration, again adopting the same structure as that seen on the input/output mixer menus.



On the input mixer most of the equalisers comprise just a **Bass** and a **Treble** control, the exception being those on the external microphone inputs **Micro 1** and **Micro 2** which have the full four band **Bass**, **Mid 1**, **Mid 2** and **Treble** controls. On the Output Mixer all equalisers have the full four band controls.

As with the gain controls we can follow the signal flow from the Sound Generators through the mixers to the amplifier and out to the speakers but this time with respect to the tonal adjustment of the signal rather than its volume.

At the lower level of the Input Mixer we can adjust the tonal quality of the individual signals coming from the Sound Generators using the **OX7 Drawbar**, **Long Waves**, **Realdrums**, **Waves/MP3**, and **Asio** equalisers. When these signals are combined we now have a composite signal that can have different tonal settings for each of the different sound sources on the organ.

This composite signal is then fed to the upper level of the mixer where we can further adjust its tonal quality with the **Organ** equaliser. Also at this level we can also add in the external audio inputs, **Digital**, **Micro 1**, **Micro 2**, **Audio 1** and **Audio 2**, each of which has its own equaliser. The organ signal is combined with these external signals to form a new composite signal that comprises individual tonal settings for all the audio signals being generated and/or input to the instrument. This signal is now passed to the Output Mixer.

At the Output Mixer the signal is routed through three separate channels, each with its own equaliser control. The **Main** equaliser adjusts the tonal quality for the organ's internal base unit speakers. The **Grp1 (**Group 1**)** equaliser adjusts the tonal quality for the organ's internal console speakers, whilst the **Grp2** (Group2) equaliser adjusts the tonal quality for speakers connected externally to the organ.

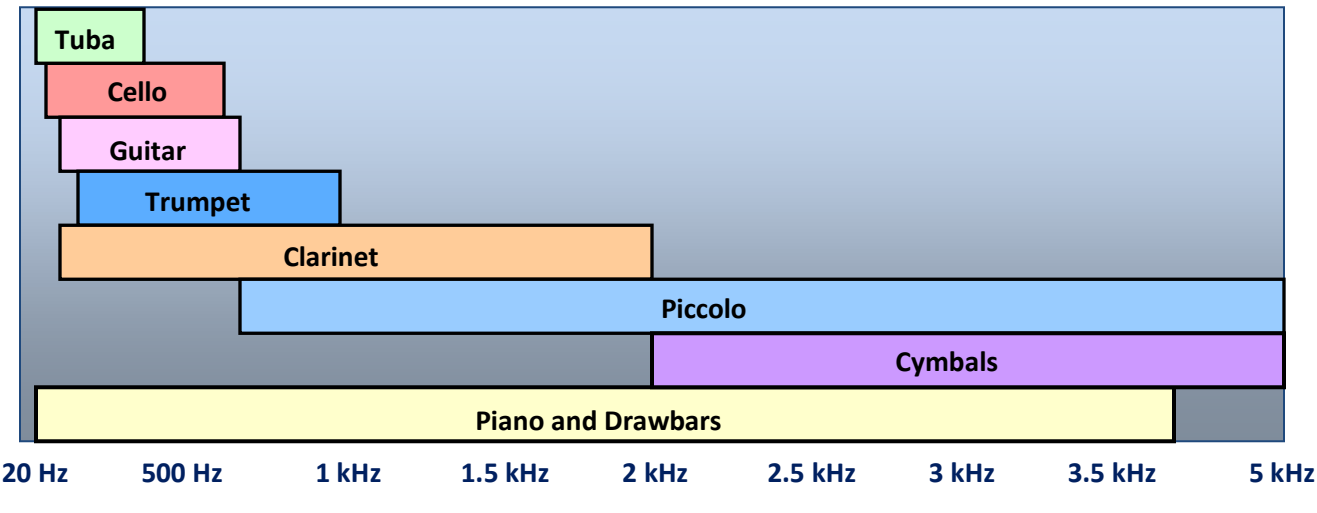
From this discussion it will be clear that a signal is operated on by a number of separate equalisers, which makes it essential that we have a strategy to ensure that all these controls work together in an integrated way to enhance the sound quality rather than detract from it.

Sound Quality Strategy

The strategy for obtaining optimum sound quality is twofold. Firstly we need to set up a preferred tonal quality at a specified point on the sound spectrum between warm and full bodied at one end and bright and brassy at the other. Secondly we need to ensure that this tonal quality is propagated consistently throughout the mixer system. The first is implemented by the Output Mixer, the second by the Input Mixer.

Output Mixer

As we have seen, the Output Mixer provides a four band equaliser unit for each of the three outputs **Main**, **Grp 1** and **Grp 2**. In order to achieve a particular tonal quality we have to be aware of the contribution made to the overall sound by the various frequency bands. The frequency range of human hearing is from 20 Hz to 20 kHz (k for kilo is used as an abbreviation for 1000) and audio equipment is designed to handle this range. The fundamental frequencies of musical instruments however have a more limited frequency range and as such occupy various segments within this range. Some examples are shown below.



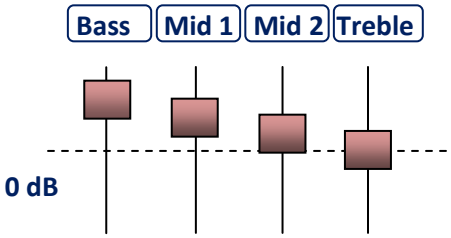
Note that these fundamental frequencies will also be accompanied by their harmonics as previously discussed. This will extend the frequency range upwards towards the top end of the audio range at 20 kHz.

From the chart we can observe that a significant portion of the pitch of most of the orchestral instruments lies within the lower register of the frequency spectrum where the **Bass** and **Mid 1** equaliser controls are most effective, whilst for their harmonics and for other instruments whose pitch extends towards the higher register of the spectrum, the **Mid 2** and **Treble** controls are most effective.

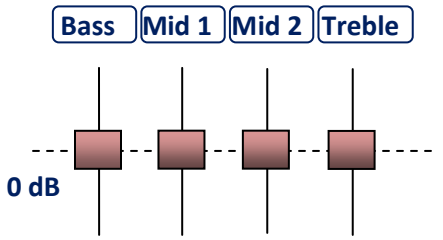
The default Centre Frequencies on the output mixer equalisers define appropriate frequency bands for this type of instrument so we can leave these values as they are and now formulate the effect of each of the gain controls on sound quality.

Gain Control	Centre Frequency	Effect
Bass	110 Hz	Adds depth and body to the pedalboard sounds and to bass instruments.
Mid 1	500 Hz	Adds warmth and fullness to the orchestral sounds and drawbars
Mid 2	2.8 kHz	Adds clarity to lower register sounds and presence to higher register sounds
Treble	6.3 kHz	Adds clarity to higher register sounds and presence to percussion instruments

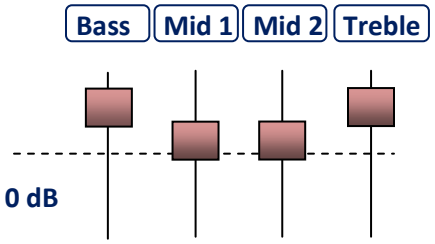
We can now apply this information to the positions of the equaliser gain controls in order to achieve a preferred type of sound quality. It's useful to think in terms of shapes for these positions rather than actual settings, as these will vary depending on preferences and room acoustics. The following templates are suggested, the intensity of the prescribed sound quality will vary as the patterns are shifted up or down from the 0 dB level. Positions shown here are for near maximum intensity.



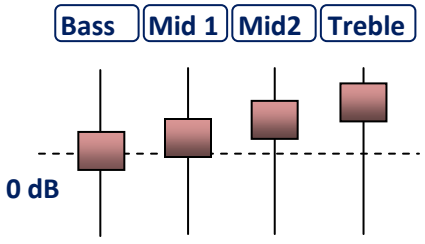
Warm, Rich and Full Bodied



Thin and Neutral



Full and Clear



Light, Bright and Brassy

Input Mixer

The strategy for achieving optimum sound quality throughout the mixer system is to set the preferred tonal quality on the Output Mixer equalisers and then work backwards through the Input Mixer equalisers replicating this setting. In this way we achieve tonal consistency. For example, if we require the bass accentuated for the orchestral sounds, setting the controls in this way on the Long Waves equaliser ensures that we get a good strong bass component in the signal when fed to the Output Mixer. If we feed through a weak bass component we will not be able boost the bass in this signal significantly to the required level at the Output Mixer.

The Input Mixer equalisers provide only **Bass** and **Treble** Controls so we should set these in line with the Bass and Treble controls on the Output Mixer. Since however we have individual equalisers for each of the sound generator signals, this gives us the flexibility to tailor the settings to the type of sound being generated. The following recommendations are suggested.

Organ Equaliser

We can see from the signal flow diagram that the Organ equaliser interfaces directly with the Output Mixer equaliser. In electronics, analogies are often made between the flow of electricity and that of liquids. Imagine then that the connection between the output of the Organ equaliser and its input to the Output Mixer comprises two lengths of pipe that have to be joined together. If the pipes are of equal diameter then we get optimum flow. If they are of different diameters then the flow is compromised. So adjust the gain controls of the Organ equaliser to match those of the Output Mixer equaliser.

OX7 Drawbars, Long Waves, Waves/MP3 and Asio Equalisers

With the exception of the Drums equaliser on the Long Waves Input Mixer menu, these are all processing the instrumental and drawbar sounds for the organ so set all these to match those of the Output Mixer equaliser.

Drums and Realdrums

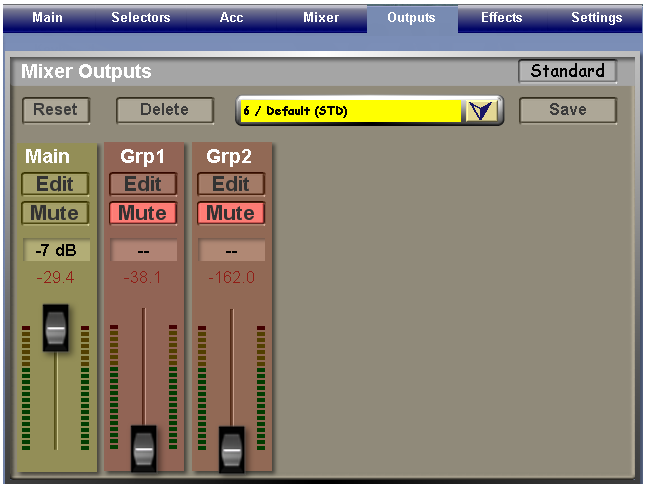
These contain sounds at the two extremes of the frequency spectrum e.g. bass drum at one end and cymbal at the other. You may wish to adjust these controls differently to provide fullness at the bottom and clarity at the top depending on which sound quality choice you have selected.

Implementation

The following settings in this section are for a Warm, Rich and Full Bodied tone. Simply substitute the corresponding equaliser settings for your preferred sound quality.

Output Mixer

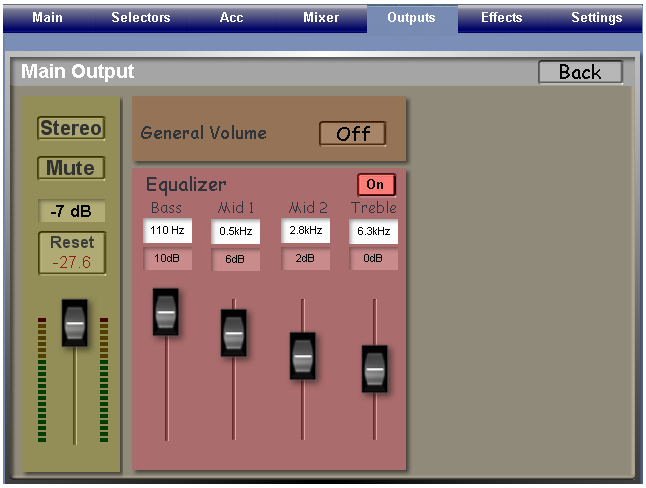
Call up the Output Mixer menu from the Main Display page by selecting the **Outputs** button from the top menu bar. Now you will see the Mixer Outputs menu with the gain controls for Main, Grp1 and Grp2 displayed. Check that **Main** gain control is not muted and that the **Grp1** and **Grp2** controls are set to their minimum positions and/or muted as previously set up in Part 1.The menu should be as shown opposite.



Main Output Equaliser

Select the **Edit** button on the **Main** gain control to display the Main Output menu. Ensure that the equaliser is activated by checking that its **On** button is red. Check also that the centre frequencies are the default values and adjust each if necessary by selecting its white window and setting to the required value with the tempo wheel.

Slide the equaliser gain controls to your preferred setting.



Save these settings as a preset and set this as your standard by returning to the Mixer Outputs menu with the **Back** button. Select the **Save** button and chose a free location from the drop down list. You can change the name of the preset if you wish by selecting the grey name bar, entering a new name with the displayed keyboard and confirm by selecting the **Enter** button. Now select the **Save Preset** button to store the preset. To set this as your standard setting select the **Standard** button on the Mixer Outputs menu and confirm by selecting the **Yes** button when asked 'Do you want to save this setting as Standard'

Mixer Inputs

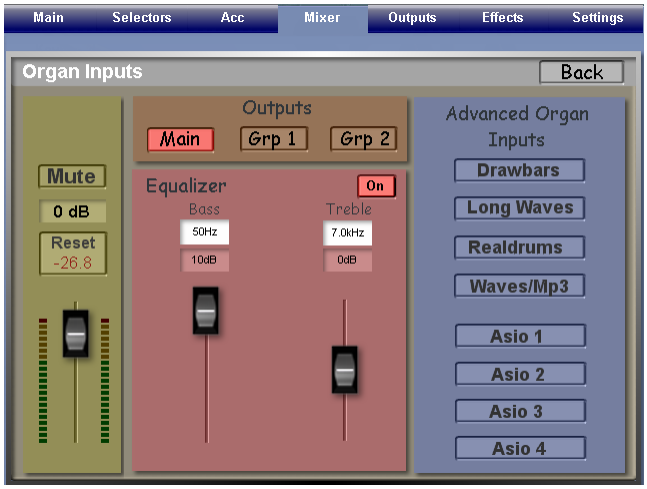
Call up the Input Mixer menu from the Main Display page by selecting the **Mixer** button from the top menu bar. Now you will see the upper level of the mixer (Mixer Inputs menu) with the Organ and external gain controls displayed. The gain controls should be as set up in Part 1

Move to the lower level of the mixer menu (Organ Inputs menu) by selecting the **Edit** button on the **Organ** gain control.

Organ Inputs Equaliser

The Organ Inputs menu will now be displayed, as shown opposite. As before check that the equaliser is activated and that the centre frequencies are the default values (Bass 50 Hz, Treble 7.0 kHz).

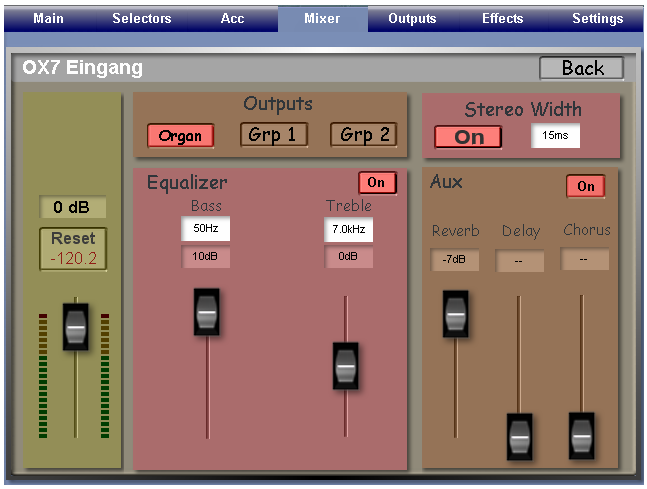
Slide the equaliser gain controls to your preferred setting, replicating those chosen for the Main Output Equaliser.



OX7 Inputs Equaliser

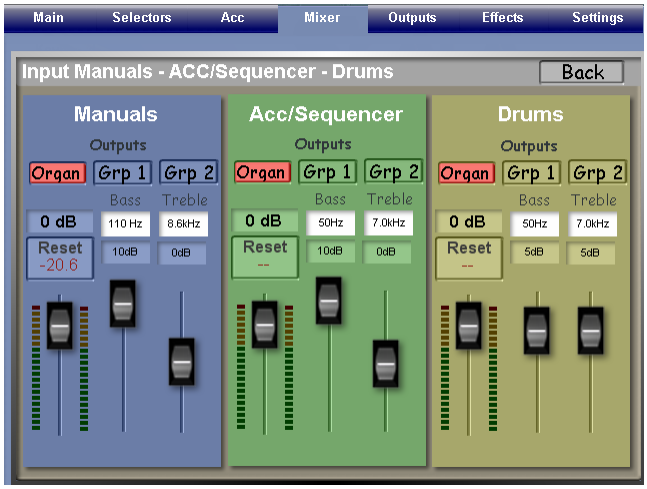
Select the **Drawbars** button from the Advanced Organ Inputs menu on the right hand side of the organ Inputs menu to display the OX7 Inputs menu. Again check that the equaliser is switched on and that the centre frequencies are the same as before.

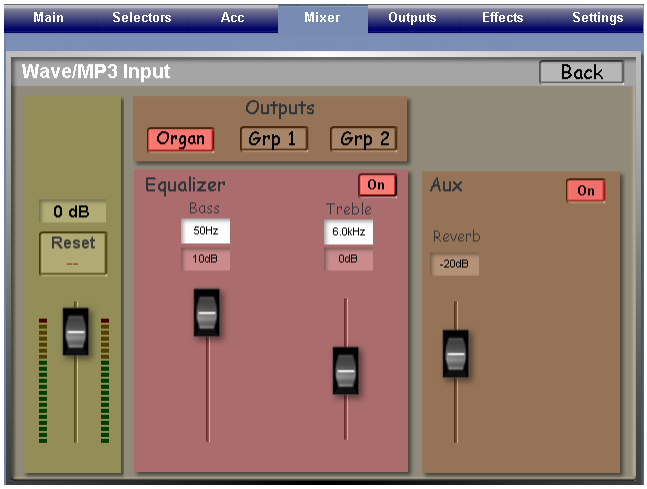
Slide the equaliser gain controls to your preferred setting, replicating those chosen for the Main Output Equaliser.

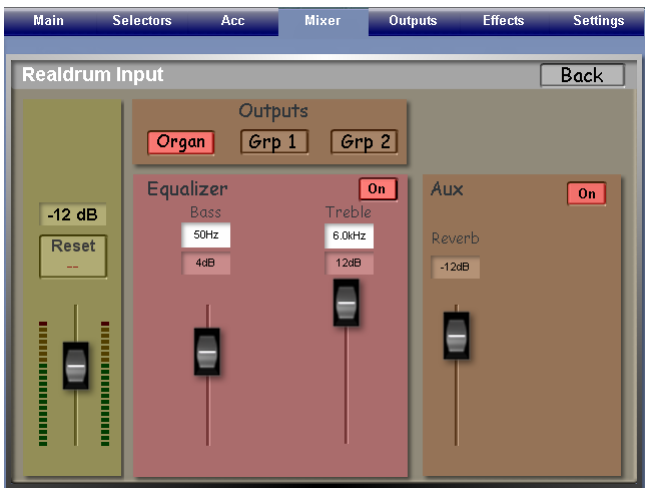


Long Waves, Realdrums, Waves/Mp3, Asio Inputs Equalisers

Select the **Back** button on this menu to return to the Organ Inputs menu and repeat this process with the **Long Waves**, **Realdrums** and **Waves/Mp3** menus (also any of the **Asio 1 – 4** menus if you have VST packages installed) by selecting them from the Advanced Organ Inputs menu on the right hand side of the screen. Note that the default centre frequencies are different for some of the inputs. Slide the equaliser gain controls to your preferred setting, replicating those chosen for the Main Output Equaliser. You may wish to set the Drums and Realdrums differently depending on which sound quality choice you have selected. The various menus should now look as shown below with your preferred settings substituted.







Save this configuration and set this as your standard setting. Repeatedly select the **Back** button to return to the Mixer Inputs menu and follow the same procedure as for the Output Mixer.

Grp1 Output

So far we have not activated the Grp1 output controls. The Main organ speakers deliver a full frequency response but high frequencies are more directional than lower frequencies and are more easily absorbed. Because these speakers are located in the base unit of the instrument you may find that some of the treble in the sound lacks clarity. If this is the case you can utilise the console speakers to enhance this part of the frequency spectrum. To achieve this we need to activate the Grp1 channel on both the Input and Output Mixer menus and set its associated gain controls and equalisers to appropriate levels. The procedure is as follows :-

Output Mixer

- De-activate the **Mute** button for **Grp1** on the Mixer Outputs menu and set its gain control initially to that of the **Main** output gain control.
- Adjust the equaliser settings on the Grp1 Output menu to match those of the Main Output equaliser.
- Save these settings as Standard

Input Mixer

- Activate the **Grp1** button on the Organ Inputs menu
- Activate the **Grp1** buttons on the Long Waves (Manuals, Acc/Sequencer, Drums) and Realdrums Input menus. Note that Grp1 cannot be activated on the Drawbars, Waves/Mp3 and Asio menus.
- Save these settings as Standard

Now play suitable long waves, drawbar, accompaniment and drum sounds and re-adjust the **Grp1** output gain control until the treble from the console speakers is appropriately balanced. You may also wish to re-adjust the Grp1 output equaliser settings and/or de-activate some of the Grp1 buttons on the input menus according to your preferred type of sound quality. Remember to save your settings as Standard when adjustment is complete.

Hints and Tips for Setting up the Equalisers

Bear in mind that increasing an equaliser control increases the volume of its corresponding frequency band so:-

- Don’t set adjacent controls too far apart otherwise notes played in one octave will sound louder than those in other octaves.
- Be careful in setting the Bass controls, too high a setting could overdrive the speakers at high volumes.
- Don’t think exclusively in terms of increasing a particular frequency band, often you can achieve a better balance by keeping this at a moderate level and decreasing the other bands.
- Frequencies in the range 2 kHz to 4 kHz can add harshness to the sound quality so avoid excessive use of the Mid 2 gain control.

This concludes the equaliser part of the setup procedure. You can now proceed to Part 3 to set up the Reverberation Controls of the instrument.

Jeff Ormerod
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