Using FonaDyn with RME digital audio interfaces

Sten Ternström

General

The RME series of digital audio interfaces are highly sophisticated devices of professional caliber. While their large range of built-in functions can seem overwhelming, their high performance and flexibility warrant the extra effort to learn. The interfaces contain not only A/D-D/A converters, but also a complete mixing desk and a signal router, with which you can connect many signal sources and destinations at the same time. For instance, a single RME interface can be used for setting up loudspeaker and/or headphone feeds to the subject, establishing a talkback from a control room, mixing in self-monitoring into headphones, bringing in a synthesizer or background accompaniment, adding some reverb, and anti-aliasing of slow channels, all at the same time. This guide gives some suggestions for getting started with FonaDyn on RME devices. To use the full potential of your device, be sure to study the RME User Guide carefully. There are also several instruction videos on the RME web site www.rme-audio.com. The TotalMix control software is very consistent across all their different models of audio interfaces.

Configuring the hardware

Connect your Fireface to the computer and turn it on. In the on-screen task bar, find the **Fireface USB settings** icon shown here, and click it. (In Windows 10, this icon should appear when you click the ^ symbol in the Task Bar.)

This opens a dialog box with hardware settings for the device. Find the field **Sample Rate** and select 44100 Hz. For **Clock Source**, select **Internal**. Find also the field **DSP** and *un*check the box **EQ+D for Record**. Then choose **OK**.

Controlling the signals

All functions of the interface are controlled through the software app **TotalMix FX**. To start this app, find the (FX) icon and click it. (In Windows 10, this icon should appear when you click the ^ symbol in the Task Bar.) The app will start only if the device is connected and switched on. Once TotalMix FX is running, you can reach it through this icon in the Task Bar.

The TotalMix architecture

An ordinary mixing desk typically has a large number of inputs and a small number of outputs. For instance, a small 8→2 console has 8 inputs that can be mixed together to 2 output 'buses' (main left and main right). There is also a "tape return" route for listening to recordings instead of the inputs, which can have just 2 input channels on a small console, hence (8 or 2)→2; or more when doing multitrack work. Nowadays, "tape return" has been replaced by "software playback", since the recordings reside not on tape, but in the computer.

With RME hardware and the TotalMix software, you have a much larger domain. For instance, even on small models such as the UCX, you have a console that is (18+18)→18 (or 20 on the UCXii). That is, each one of the 18 output buses can receive its own independent mix of up to 36 inputs, of which 18 are from external sources and 18 come from the computer software. The channels are usually paired for stereo, but that still gives 9 vertical control 'stripes' each, for inputs, playbacks and outputs. The larger RME devices have more inputs and outputs.
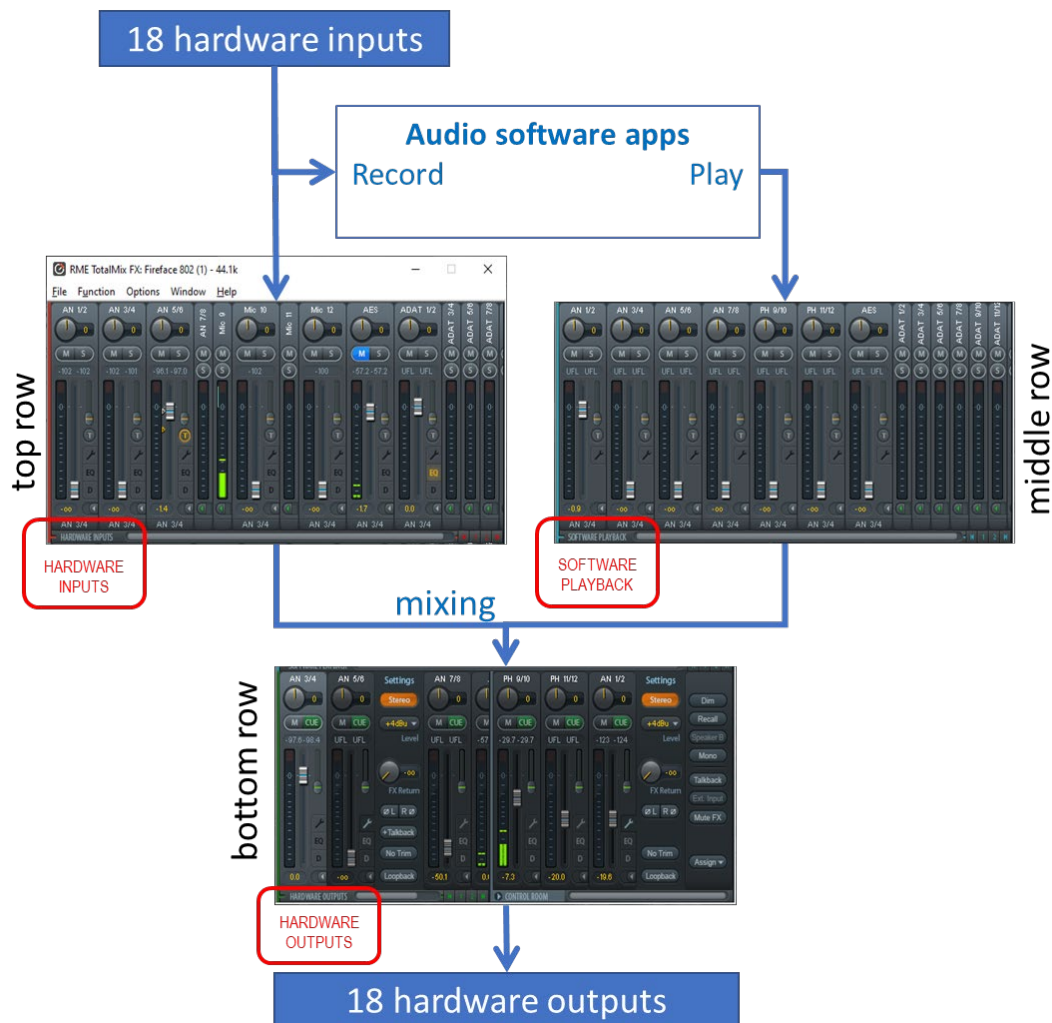
Signal flow as represented in RME's control software TotalMix.

So, and this is important: to direct sound to a given output, *first* click on the stripe for that output, on the *lowest* row, "HARDWARE OUTPUTS". This moves all the input and playback faders into their positions *for that output*. *Then* pull up only the *top row* fader(s) for the HARDWARE INPUTS or *middle row* faders for the SOFTWARE PLAYBACK signal source(s) that you want to hear.

For recording, all inputs go unchanged directly to the computer. So to record using hardware inputs AN1/2, you normally have to select the corresponding audio device in your recording software. (See also Loopback, below.)

The TotalMix layout makes no difference between output buses and AUX buses; they are all equivalent. The only 'special' buses are the internal FX Send and FX Return, which go to/from the built-in effects unit.

Configuring SuperCollider

In SuperCollider you can easily open the startup file for editing, from the File menu.
Edit the file `startup.scd` to contain these lines:

```
Server.local.options.device = "ASIO Fireface";
Server.local.options.numOutputBusChannels = 2;
Server.local.options.numInputBusChannels = 2;
Server.local.options.sampleRate = 44100;   // set the hardware-selected rate
```

FonaDyn (and any other SuperCollider program) can now record on the first two input channels, AN1/2, and play back on the first two playback channels, AN1/2.
If the microphone inputs on your device start at some input number higher than 1, you will need to tell FonaDyn so, see below.

Saving your setups

The TotalMix software has a number of options for saving and restoring its many settings. Please read the manual carefully on this point, because it can save you a lot of time. Briefly,

- There are eight Snapshot memories, each of which contains all settings and layout. Save/Load Snapshot... saves/loads one snapshot file.
- Save/Load Workspace... saves/loads the entire state of the device and of TotalMix itself, in a workspace file. This includes all Snapshots currently in the Workspace. Loading a Workspace file will overwrite the active Snapshots with the ones from the Workspace file.
- The Fireface device has an internal flash memory that stores the most recently used Workspace, even when the device is switched off. (This can make it possible to use the device stand-alone, without a computer.) When you connect the Fireface to a computer, TotalMix will ask if you want to use the settings stored in the device, or replace them with the settings in the current TotalMix workspace as stored in your computer.

When you have finished setting up the device, always choose File | Save Snapshot or File | Save Workspace. If one configuration is enough for your project, a Snapshot will suffice. If your projects use up to eight Snapshots, save them all in one Workspace file.

Setting up for the microphone and EGG signals

Models Fireface 400, UC, UCX, UCX ii, and Babyface

These models all have their microphone preamps on inputs 1 and 2. This is what FonaDyn expects. Connect your microphone to input 1 using an XLR connector, and your EGG device to input 2 using a ¼" jack plug connector (XLR on the Babyface).

In TotalMix, for each channel strip, there are three extra control panels, which appear when you press the corresponding button: Settings (spanner icon ✎), Equalizer (EQ) and Dynamics (D). Now, for the channel Mic 1,

- Turn the pan knob fully left (L100)
- Press the spanner icon   to open the Settings.
- Turn *off* the Stereo button.
- If the microphone requires phantom power (+48v), then turn on the button 48V .
- Set the Gain control knob to about -12 dB.
- Some RME models have an AutoLevel feature for the microphone, and this must be turned Off. If on, it would break the calibration of sound level.

The control knob called **Gain**, by default, is the only point at which the input gain can be controlled before the A/D converter. We will use this knob for gain calibration, as described in the *FonaDyn Handbook* section 3.3.

> Actually, there *is* a another Gain control, in the **Dynamics** panel. To use it when recording, you need (1) to go to the separate RME applet Fireface USB Settings for hardware configuration, and there check the option "EQ+D for Record", and (2) to turn on Dynamics processing with the round button at the top left of the Dynamics panel. We discourage this, because you might accidentally introduce other Dynamics processing as well.

Now we will configure the EGG input. For the channel Mic 2,

- Turn the pan knob fully right (R100).
- Press the spanner icon ✎ to open the Settings.
- Leave the Stereo button in the off state.
- Make sure that the phantom power is off.
- Turn on Inst (or Pad) if present, to select low gain for channel 2.
- Turn AutoLevel on.

For the EGG signal, the AutoLevel feature (if present) is quite useful, for preventing clipping. FonaDyn does not require the gain for the EGG signal to be calibrated.

Models Fireface 800, 802, UFX, UFX II and UFX+

These models all have their microphone preamps on inputs 9-12 (Fireface 800: inputs 7-10). By default, FonaDyn uses only the first two inputs, and so will not see the microphone signals. To solve this, first choose the inputs on the Fireface that you will use for the voice and EGG signals. They do not need to be adjacent. The microphone requires a pre-amp, while the EGG signal should use a line input. Then specify the chosen inputs in the file `startup.scd`, like so:

```
Server.local.options.device = "ASIO Fireface";
Server.local.options.sampleRate = 44100;
// Enable all inputs up to and including the chosen ones
Server.local.options.numInputBusChannels = 10;
FonaDyn.config(inputVoice: 8, inputEGG: 9);
```

Inputs in SuperCollider are numbered from zero, so FonaDyn will now expect the microphone signal on the *ninth* input and the EGG signal on the *tenth* input, which are the numbers printed on the panel of the Fireface.

On the Fireface models 800 and 802, TotalMix has no Gain control here. Instead, on the front panel of the device, each of the four XLR inputs (7-10 or 9-12) has a physical gain or 'volume' control knob, next to its connector. We will use this physical knob for the gain calibration, as described in the *FonaDyn Handbook* section 3.3. For the following example, we will use inputs 9 and 10, since both models have mic preamps on these inputs.

Connect your microphone to input 9 using an XLR connector, and your EGG device to input 10 using a ¼" jack plug connector.

In TotalMix, for the channel Mic 9,
- turn the pan knob fully left (L100),
- Press the spanner ✐ to open the Settings
- turn *off* the Stereo button,
- if the microphone requires phantom power (+48v), then press the button 48V .

Now we will configure the EGG input. For the channel Mic 10,
- Turn the pan knob fully right (R100).
- Press the spanner to open the Settings.
- Turn on **Inst**, to select the jack input instead of XLR.
- Leave the Stereo button in the off state.
- Turn the phantom power off (although it does not affect the jack input).

Now save the settings in a TotalMix 'Snapshot' and give the Snapshot the name 'FonaDyn'. Then save it to a TotalMix file using **File** -> **Save Snapshot As…**

EQ settings

The EQ (equalizer) settings allow you to insert filters that change the frequency response of the channel. Normally, you should make sure that the EQ section is completely disabled on both input channels. Each 'EQ' indicator should be dark, not lit up in orange.

FonaDyn always applies a fixed 30 Hz high-pass filter of its own to the microphone signal. FonaDyn has no phase issues with the microphone signal. If you have a very good microphone *and* a great deal of low-frequency background noise in the room, you may still face problems with low-frequency rumble. If so, then in TotalMix, on the microphone channel, you might want to activate the built-in low-cut (LC) filter. In the EQ panel, turn on the LC switch and adjust the slope and cutoff of the low-cut (high-pass) filter as desired.

Do not apply any EQ to the EGG signal. If you do, the EGG pulse shapes will be distorted, and change in an undesired way with the fundamental frequency.

Setting up for playback

For listening to recordings, and for live monitoring of the microphone, FonaDyn will play back the Voice signal on the first two channels of Software Playback.

Default playback device

To avoid disturbances from alert sounds from your operating system, make sure that the Fireface outputs AN1/2 (sometimes called "Main" or "Speakers") are *not* configured as the **default playback sound device** for your computer. This is done in your computer's system control panel.

If you do want to hear alert sounds, or if you want to play other sounds from the same computer to the participant, you can set the Fireface outputs AN3/4 as the default playback device, and, using TotalMix, route Software Playback AN3/4 to the Fireface's headphone output.

Browsing recordings with a soundfile editor

FonaDyn on its own can only analyze a file sequentially, from beginning to end. If you have recorded a long file that you would like to explore or analyze in little bits, even non-sequentially, the RME 'loopback' feature proves to be very useful.

First, configure your system's "Default playback device" to be *neither* AN 1/2 or AN 3/4, otherwise system alert sounds could intrude into FonaDyn. Arrange the editor and FonaDyn windows conveniently on the screen.

Now, set up your soundfile editor to play on Software playback AN 3/4. Route this to the RME Hardware outputs 1/2 (Speakers or Main), and activate Loopback on AN 1/2 (or on the alternative channels that you may have specified with `FonaDyn.config`).

In FonaDyn, select Playback/Echo Off, Source: Live signals, and press ▶START. In the editor, select the portion of the Voice+EGG signals that you want to analyze, and play back from the soundfile editor. FonaDyn will now think that it is recording a pair of live signals, but the signals are actually coming from your soundfile editor.

Even with this loopback, it is important to maintain the **level calibration**, and this can not be done automatically. To calibrate the loop-back, open the supplied .WAV file with the 94 dB calibration tone in the editor, play it, and adjust the TotalMix slider for Software playback AN 3/4 so that the cursor in FonaDyn sits at 94 dB, just below the 95 dB gridline. (If the gridlines are 10 dB apart, increase the height of the FonaDyn main window.)

Using extra DC-coupled A/D converters

Audio devices, by design, will block low frequencies and DC, making them useless for slow physiological signals such as flow, pressure and volume measurements. However, there are A/D converters that do pass DC, and that can be connected via the ADAT light-pipe interface on your RME device. These converters come from the analog music synthesizer community, where they are used for control voltages. For how to record such slow signals with FonaDyn, see the FonaDyn Handbook (3.1.0), section 3.2.8. Also the EGG signal can benefit somewhat from being acquired via such a converter, as the lowest frequencies are not blocked.
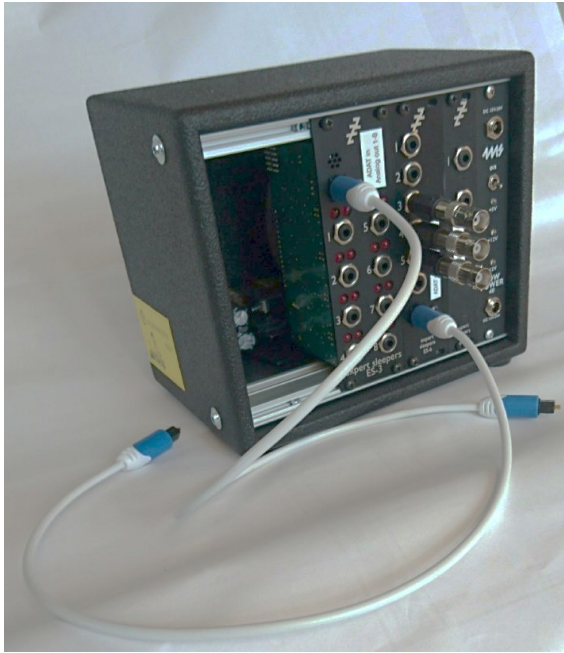
Mini Eurorack-mount case (from Doepfer) with 8 A/D and 8 D/A channels with DC response. These connect to the ADAT ports of your studio digital audio interface, using the lightpipe cables (blue connectors).

The photo shows a rackmount case (Doepfer) to the Eurorack standard, with A/D and D/A converters from ExpertSleepers: models ES-3, ES-6 and ES-7. The total price should be around 800€. Note that this equipment is designed for analog music synthesizer applications and is not certified for clinical use. The modules connect to the ADAT ports of the RME Fireface via two TosLink lightpipes (RME OUT → ES-3 IN, ES-6 OUT → RME IN). This provides 8 extra inputs and 8 extra outputs with a voltage swing of ±10V at 48kHz or 44.1 kHz, all with DC coupling and 24-bit resolution. You will need also a small box for the rack-mounting and maybe an extra power supply module. The power converter that comes built-in with the case in the photo is a bit too weak for these modules, so an extra power strip has been mounted at the far right. This strip in turn needs to be supplied using a 15-20 V DC power brick such as is commonly used for laptop computers. You may have an old one lying around. The outputs on the ES-3 module are rarely used, but the module is necessary anyway, for receiving the sample synchronization clock signal from the Fireface.

This combination can be used to acquire respiratory signals as well as intraoral pressure and the larynx height signal from an EGG device. In principle, also the voice and EGG signals could be acquired on the first 2 inputs of the ES-6, although the voice signal would then need a preamplifier. All these new inputs will appear as ADAT inputs in RME's TotalMix.

Anti-alias filtering of slow signals

Because most physiological signals are very slow compared to audio, it makes sense to sample them at a low sample rate; it saves a lot of disk space and handling time. A selection of suitable slow rates is given in FonaDyn's **Settings...** dialog box, with 100 Hz being the default.[1] Slow signals need to be band-limited to half the sample rate, in this case to 50 Hz, in order to avoid the appearance of unwanted aliased frequency components below 50 Hz. The bad news is that FonaDyn itself does not perform this low-pass filtering (it would load the CPU and also require one more control panel). The good news is that you can achieve a band-limiting function that suffices in most cases, by using the EQ sections that are built-in on all inputs and outputs of the RME interface.

At the beginning of this guide, we wrote that you should disable Dynamics and EQ for recording; but, for this purpose, we take that back. In the applet **Fireface USB settings**, find the field **DSP** and *check* the box **EQ+D for Record**.

The left panel in the figure below shows the optimal way of setting a TotalMix EQ section to work as an anti-aliasing filter at 50 Hz. You should use these settings on all your 'slow' channels in TotalMix. The settings are also provided as an EQ preset file `AntiAlias-50Hz.tmeq`, which you can Import using the **Preset** drop-down menu at the top of the EQ panel. If you want to run at a slow rate other than 100 Hz, then scale the **Freq** settings proportionally.
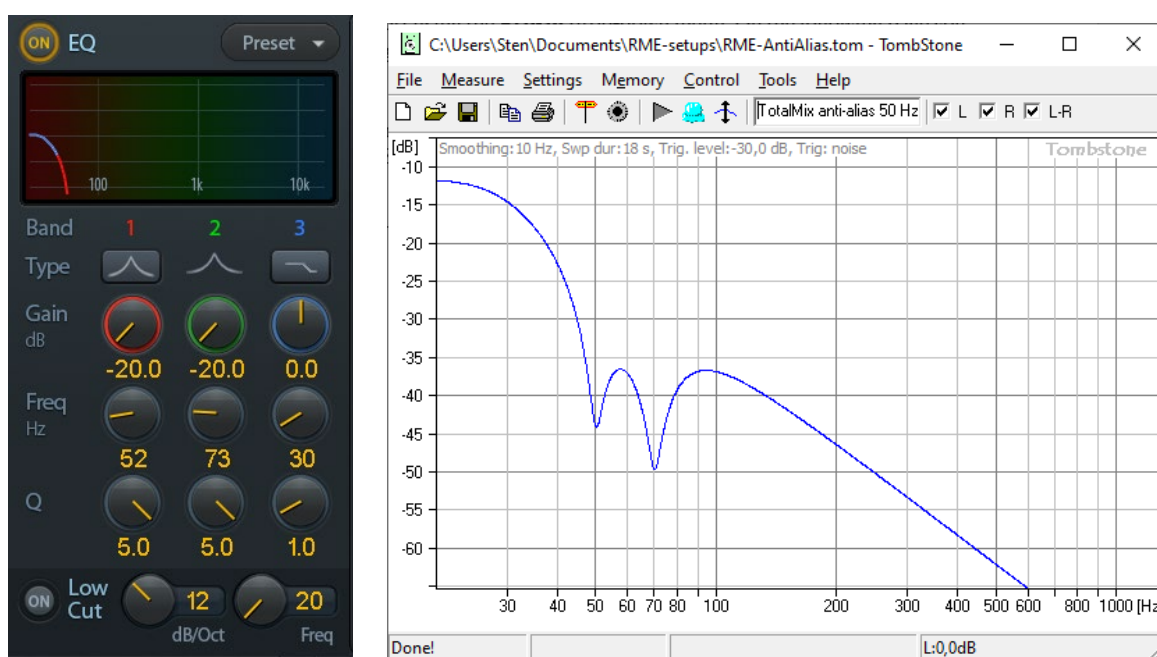
The resulting frequency response is shown in the right panel above. This plot was made using the freeware program *TombStone* by Svante Granqvist, which is downloadable from www.tolvan.com. To make this and similar plots, load the TombStone settings file `RME-AntiAlias.tos` , and set up a TotalMix loopback so that the input device chosen in TombStone receives the signal that is output by TombStone.

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[1] These rates are achieved internally simply by decimating (undersampling) the 44100 Hz signals coming from the ADAT inputs, with the custom UGen GatedDiskOut.

A note on the Expert Sleepers ES-9 module

The newer ES-9 module from ExpertSleepers has both inputs and outputs, it connects to the computer using a USB connection on its own, and also provides flexible routing and mixing internally. At first glance, it seems like a more affordable rival to the RME Fireface. Note, though, that the ES-9 has no microphone preamps, and its control software is very rudimentary compared to RME's TotalMix. The ES-9, too, has an optical lightpipe interface, but it carries only two channels (SPDIF), not 8 channels (ADAT). These can be used to receive one or two high-quality microphone signals from an RME interface, although care must be taken to synchronize correctly. Note that with *both* an RME and the ES-9 connected to your computer, your system will have a bewildering number of audio devices to configure, which for most users is not very practical.