



General Description

The RaneGain test set is a handy tool kit based on techniques first developed by Pat Brown¹ of *Syn-Aud-Con* for use in quickly setting sound system gain controls. Using the RaneGain pair makes correctly setting level controls a snap.

Comprised of a precision 400 Hz sine wave Generator and a matching piezo Transducer, the test set makes use of the Fourier principle that all periodic waves can be broken down into a sum of pure sine waves. If a pure 400 Hz tone is the source in a system, and the system is turned up until clipping, then what comes out is the 400 Hz fundamental, plus a whole string of predominately odd-order harmonics. Spectrum analysis of the output will show the 400 Hz fundamental, plus strong harmonics at the odd harmonic intervals of 1.2 kHz, 2 kHz, 2.8 kHz, 3.6 kHz, 4.4 kHz and so on. The RaneGain Transducer is a piezo tweeter designed to reproduce mid-to-high audio frequencies, so while it doesn't reproduce the 400 Hz fundamental worth a hoot, the harmonics make it scream.

Operation

PRESET ALL LEVEL CONTROLS IN THE SYSTEM

After all equipment is hooked-up, verify system operation by sending an audio signal through it. *Do this first before trying to set any gain/level controls.* This is to make sure all wiring has been done correctly, that there are no bad cables, and that there is no audible hum or buzz being picked up by improperly grounded interconnections (See RaneNote 110).

Once you are sure the system is operating quietly and correctly, then you are ready to proceed.

Turn down all power amplifier level/sensitivity controls.

Turn *off* all power amplifiers. (This allows you to set the maximum signal level through the system without making yourself and others stark raving mad.)

Set all gain/level controls to their *off* or *minimum* settings.

Defeat all dynamic controllers such as compressors/ limiters, gate/expanders, and enhancers by setting the Ratio controls to 1:1, and/or turning the Threshold controls way up (or down for gate/expanders).

Use no *equalization* until after correctly setting the gain.

CONSOLE/MIC PREAMP GAIN SETTINGS

A detailed discussion of how to run a mixing console lies outside the range of this Note, but a few observations are relevant. *Think about the typical mixer signal path.* At its most basic, each input channel consists of a mic stage, some EQ, routing assign switches and level controls, along with a channel master fader. All of these input channels are then mixed together to form various outputs, each with its own level control or fader. To set the proper mixer gain structure, you want to maximize the overall S/N (signal-to-noise) ratio. *Now think about that a little:* because of the physics behind analog electronics, each stage contributes noise as the signal travels through it. (Digital is a bit different and is left to another Note and another day.) Therefore each stage works to *degrade* the overall signal-to-noise ratio. Here's the important part: *The amount of noise contributed by each stage is* (relatively) independent of the signal level passing through it. So, the bigger the input signal, the better the output S/N ratio (in general).

The rule here is to take as much gain as necessary to bring the signal up to the desired average level, say, +4 dBu, *as soon as possible.* If you need 60 dB of gain to bring up a mic input, you don't want to do it with 20 dB here, 20 dB there, and 20 dB some other place. You want to do it all at once at the input mic stage. For most applications, *the entire system S/N (more or less) gets fixed at the mic stage.* Therefore set it for as much gain as possible without excessive clipping. Note the wording *excessive* clipping. A little clipping is not audible in the overall scheme of things. Test the source for its expected *maximum input level.* This means, one at a time, having the singers sing, and the players play, as loud as they expect to sing/play during the performance. Or, if the source is recorded, or off-the-air, turn it up as loud as ever expected. Set the input mic gain trim so the mic OL (overload) light just occasionally flickers. *This is as much gain as can be taken with this stage.* Any more and it will clip all the time; any less and you are hurting your best possible S/N. (Note that a simple single mic preamp is set up in the same manner as a whole mixing console.)

OUTBOARD GEAR I/O LEVEL CONTROLS

All outboard unit level controls (except active crossovers — see below) exist primarily for two reasons:

- They provide the flexibility to operate with all signal sizes. If the input signal is too small, a gain control brings it up to the desired average level, and if the signal is too large, an attenuator reduces it back to the desired average.
- Level controls for equalizers: the need to provide make-up gain in the case where significant cutting of the signal makes it too small, or the opposite case, where a lot of boosting makes the overall signal too large, requiring attenuation.

Many outboard units operate at “unity gain,” and do not have *any* level controls — what comes in (magnitude-wise) is what comes out. For a perfect system, *all* outboard gear would operate in a unity gain fashion. *It is the main console’s (or pre-amp’s) job* to add whatever gain is required to all input signals. After that, all outboard compressors, limiters, equalizers, enhancers, effects, or what-have-you need not provide gain beyond that required to offset the amplification or attenuation the box provides.

With that said, you can now move ahead with setting whatever level controls *do* exist in the system.

Whether the system contains one piece of outboard gear, or a dozen, gains are all set the same way. Again, the rule is to maximize the S/N through each piece of equipment, thereby maximizing the S/N of the whole system. And that means setting things such that your *maximum system signal* goes straight through every box without clipping.

SETTING SIGNAL PROCESSING LEVEL CONTROLS

First, a sound source is connected to the mixing console (or separate mic preamp) to provide the *maximum system signal* output, then this signal is used to set the outboard units.

Connect the RainGain (RG) Generator to an unused channel in the mixing console or to the input of the mic preamp. Carefully set the channel input fader so the mic stage does not overload. Next, plug the RG Transducer into the console’s (or preamp’s) master balanced output XLR jack. Turn up the master output fader (or preamp output level control) until the Transducer first sounds; reduce the level until the Transducer stops. This is now the *maximum system signal* output.

Outboard gear gain/level controls fall into three categories:

- No controls
- One control, either Input or Output
- Both Input & Output Controls

Obviously, the first category is not a problem!

If there is only one level control, regardless of its location, set it to give the maximum output level using the RG Transducer.

With two controls it is very important to set the *Input control* first. Do this by turning up the Output control just enough to pass the signal without clipping. Set the Input control to barely buzz the RG Transducer, then back it down a hair. Now set the Output control also to just buzzing.

For Rane digital audio products, where input A/D (analog-to-digital) metering is provided with software, setting the input level gain is particularly easy and *extremely important*: Using the maximum system signal as the input, open up the Input Trim box and simply slide the control until the 0 dBFS indicator begins lighting. This indicates the onset of “digital clipping,” and is definitely something you want to avoid, so this is the maximum gain point.

See the RaneNote “Setting Sound System Level Controls” for setting active crossovers and power amplifiers.

Specifications

Generator

Frequency: 400 Hz ($\pm 10\%$) sine wave
Level: 0 dBu (± 1 dB)
Phantom Power (*Required*): 12-48 VDC
THD: 2% max

Transducer

Type: Piezo
Capacitance: 10,000 pF ($\pm 30\%$) (40,000 Ω @ 400 Hz)
Max Voltage: +26 dBu
Max Current: 2 mA
Life: 500 Hours (average)

References

1. Pat Brown, “Piezo Magic,” *The Syn-Aud-Con Newsletter*, Vol. 24, No. 2, Spring 1996.
2. Dennis Bohn “Setting Sound System Level Controls,” *Rane-Note* (Rane Corporation, 1997)