Generator Sweep Equalisation Notes

These notes relate to the script "Sweep Generator Equalisation.dss"

Background
It is sometimes useful to pre-equalise the generator output of a sweep to take into account the frequency charactaristics of a source device. For example, a transducer being used as a sound source may have an inherently uneven frequency response. Being able to compensate for this by adjusting the level of the generator at each point enables us to flatten the response from that device.

In order to do this, a measurement is taken using the device in question and the measurement is saved. The saved measurement is then used to compensate the generator amplitude against frequency so as to repeat the sweep with a constant received level at each point.

Principles of Operation
The dScope Series III software currently does not provide the functionality to equalise the generator output in a sweep, so this functionality has been provided in the script "Sweep Generator Equalisation.dss". The basic principle is that the frequency response of the reference system is measured and the trace data saved as a CSV file (Comma Separated Value). This is then available as a reference.

The script retrieves this CSV file and uses it to compensate the generator level as a sweep progresses. The number of points in the sweep can be changed (increased or decreased) and, as long as the frequencies are within the range of the reference trace, the script will use linear interpolation to set the generator to the required value to compensate. There are some limitations: the script is only written to control channel A of the dScope (if the generator channels are set to "tied", this will control both channels if sweeping both channels). The sweep must be of frequency against amplitude, and the amplitude must be in dB units (dBu, dBFS, dBr, etc.)
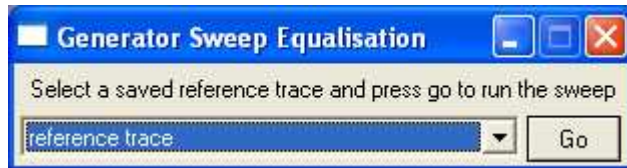
Installing the script
The script should simply be copied to the dScope scripts\automation folder. If it is to be run frequently, a button can be put on the user toolbar to accomodate this. Otherwise it can be run from the "run script" option in the "automation" menu, or using the "run script" button on the toolbar. It uses no other configuration or script files.

Using the Script
There are several simple steps to use this script:

- **Create a reference trace:** The first thing you will need before the script is useful, is a reference trace. To do this, measure the reference system over a frequency range equal to or greater than the range you wish to measure at. Ideally, you should use the same range. You can either use the same number of points as you wish to measure later, or use a larger number of points. If you use a different number of points and the frequencies do not line up, the script will use linear interpolation between points. For best precision, use the same number of points. For more flexibility and good precision, use a large number of points.
- **Save the reference trace:** once you have a trace of the required kind, you need to save it to a CSV file. To do this, select the trace you wish to save so that it is highlighted in the trace legend. (if the trace legend is missing, make sure the trace window is the active window, and select "legend" from the dScope "view" menu.) Next, click on the "Display list of values" button on the trace window toolbar (not the main toolbar). This is the button with the list of numbers on it. At the top of the list that appears are two buttons. Use the right hand one of the two to save the file as CSV. Give it name and save it to the default location.

- **Start the script:** If it is to be run frequently, a button can be put on the user toolbar to facilitate this. Otherwise it can be run from the "run script" option in the "automation" menu, or using the "run script" button on the toolbar. You will get a little interface with just a drop-list and a "go" button as below. Initially the go button will be disabled until you have actively selected a reference trace.

Generator Sweep Equalisation

Select a saved reference trace and press go to run the sweep

reference trace ▼ | Go

- **Select a reference trace:** The drop list simply lists all the CSV files in the traces folder. Select the reference you saved earlier. A message box will pop up that gives some information about the selected file. This includes the amplitude range and the level at 1kHz. You should note these values as they will give an indication of the amount of gain or attenuation that will be applied to the generator level. The currently set level on the generator will be retained and used for the 1kHz level. Any other frequencies will be boosted or cut according the difference between the level at that frequency and the 1kHz level in the reference trace.
- **Set up your sweep:** The sweep set-up can be adjusted at this point if necessary. You can also change the generator level. Whatever you set it to at this point will be used as the level at 1kHz and frequencies either side of it will be equalised according to the reference trace.
- **Press Go:** Pressing Go starts the sweep with whatever values are currently present in the sweep set-up. If they are not appropriate (ie, frequencies beyond the reference trace, or units not dB), you will get a warning message. The script will adjust the level of the generator on the fly as the sweep progresses. In order to achieve this, it may be necessary to increase the settling time for the reading that is being used. See the "sweep settling" parameters in the "Sweeps/Regulation" menu. If you run the sweep using the normal dScope menu or toolbar button, the sweep will run without the equalisation. You can, however, stop a sweep that has been started from the script by using the "stop sweep" button on the dScope toolbar.
- **Normalise the trace** By selecting the sweep trace in the trace legend, and right clicking it, you can select "edit trace transforms" and normalise the resulting trace to a frequency of your choice in the menu that is presented. Note that the normalisation takes place at the end of the sweep.

Other Notes:

Generator Amplitude Protection: It is quite easy, with a device that has a response that drops off heavily at low or high frequencies, to end up with a situation where the dScope generator is attempting to compensate by putting out much higher levels than are attainable by the device. To make matters worse, these are usually at frequencies that are hard to hear so it may not be obvious that the script is trying to kill the device (eg, with ultrasound). To protect against this, there is a parameter hard-coded into the script (approximately line 80) that is used to restrict the generator level. This is set by the variable `dGenProtectMax` and appears in the script as below. By default it is set to 0 (the units are whatever are set in the generator)

```
'=========================================================
'USER VARIABLE: Generator Protection Max level
'=========================================================
dGenProtectMax = 0 'in whatever units the generator is set to
```

Every time the script attempts to set the generator to a new value, it will be checked against this parameter and limited if necessary. If you run a sweep and the generator is limited in this way, you will get a message box to inform you that it has happened after the sweep has run. You will need to adjust this parameter and the generator level to get the required output.

Frequency and level dependent gain: some devices present gain that is dependent on frequency and level such that increasing the level at one frequency will not result in the same increase at other frequencies. Multi-band compressors are one example of this kind of behaviour. Another, slightly different example of this is some hi-fi type amplifiers which have automatic "loudness" controls such that their frequency response is level dependent with extra boost at low and high frequencies when the volume is turned down. In such cases, the compensation may not work consistently, but this is not something that can easily be compensated for. The script assumes a linear relationship. It would be possible to manually adjust the CSV values but this will only work for one particular level.

dScope Path: The script assumes a default dScope installation and sets the path to the traces to the following:

strPath = "c:\program files\prism sound\dScope Series III\traces"

If the installation is not default, it will not find any traces, and this will need to be adjusted to point to the correct folder.

Version This script was written and tested with dScope software version 1.11e. It should work with previous versions, but is untested.

Any problems or suggestions, please contact scripting@prismsound.com

IAH 13 September 2006