Front-End Compensation for the MSA
Sam Wetterlin
6/14/10

There are various possible front-end attachments that may be used with the MSA between the signal source and the actual MSA input. These include probes, amplifiers and attenuators, among other things. The frequency response of these front-ends will affect the accuracy of the displayed data when in Spectrum Analyzer Mode. (This is not an issue in other modes, because calibration takes care of the necessary compensation.)

In order to correctly display the signal strength, a front-end file can be created for each front-end device. The appropriate file can be loaded using the menu File->Load Front End. When such a file has been loaded, its data will be interpolated to the current scan points. When a scan is conducted, the compensation data will be subtracted from the raw power readings (after adjustment for the normal frequency calibration) to get the final signal power readings.

A new front-end can be loaded at any time. If a front-end file is active, menu File->Load Front End will provide the option to unload it, so that no front-end adjustment is made.

A front-end file is similar to the touchstone files used for VNA data. It is a series of lines, each containing a frequency, in MHz, followed by the dBm correction factor. This can be followed by a phase correction factor, which will be ignored. Items on a line are separated by spaces. Comment lines, beginning with the character "!" may be placed at in the file. The correction factor for a given frequency is the amount that must be subtracted from the raw reading in order to get the true signal strength. Thus, it would be positive for amplifiers and negative for attenuators. The comments may also be followed by the touchstone "options" line (beginning with "#"). The following simple file illustrates the format:

```
! High Impedance Probe Front End File
!
# MHz S DB R 50
! MHz  S21_DB  S21_Degrees
.1    -3.2
500   -12.1
1000 -10.8
```

The foregoing is the format the file will have if created by the following method.

The simplest way to create a front-end file is to perform a transmission mode scan as follows:

1. Attach a 10 dB attenuator to the TG output. This is to improve the TG return loss. More attenuation may be required if the front-end device is an amplifier.

2. Set the sweep range to the full range for which the device may be used. If this is a broad range, use a log sweep. Use enough scan steps to pick up any excursions in the device's frequency response. For a range from 0.1 MHz to 1000 MHz, 500-1000 points may be appropriate.

3. Connect the attenuator output to the MSA input and perform calibration.

4. Connect the attenuator output to the front-end device, whose output is then connected to the MSA input. Perform a single scan.

5. Your transmission graphs will normally show magnitude and phase. Change the phase graph to "None". If phase is on the right axis, this step is not critical because the phase data in a front-end file will be ignored. But it makes the file cleaner to leave out phase.

6. Save the data as a file under any desired name. You probably want to create a single Front End folder to save all front end files. Save the file by using the menu Data->Graph Data to list the data. Then add any desired comments in introductory lines beginning with "!". Then use the File menu of the data window to save the data. Any file name and extension can be used, though they would normally be saved as a .txt or .s1p file.

Front-end files may cover more than just the 1G frequency band, but the above method is only useful to create a file for a single band. To cover more than one band, it is necessary to create a file for each band, and then manually merge them into a single file. This can easily be done with a text editor, by copy/paste. All the 1G data must appear before the 2G data, and the 2G data must appear before the 3G data. There cannot be any overlap between the data for the various modes, because frequencies must be listed in ascending order.