

# VNA Calibration Kit Modelling

## HOWTO: Windows + Octave + NLOpt

IN3OTD has developed a script for Octave which computes Calibration Kit polynomial coefficients from a measurement of a calibration standard. The coefficients are entered into a VNA to accurately describe the open, short or load.

The script takes an s1p file and will produce different output depending on the type of standard.

e.g. For an open, the following is produced, along with a number of graphs which show how well the model fits the data:

```
>> calkit_model("./female-open.s1p", "open")

Optimization results:
offs_delay = 22.037796 ps
offs_loss = 6.311983 Gohm/s
offs_Z0 = 35.666424 ohm
C0 = 221.660950 * 1e-15 F
C1 = 10000.000000 * 1e-27 F/Hz
C2 = 3187.176206 * 1e-36 F/Hz^2
C3 = 1635.525855 * 1e-45 F/Hz^3

Residual RMS error : -49.613724 dB
```

The script is clear and easy to follow, but it has some dependencies which are difficult to install, particularly NLOpt. The documentation available on the NLOpt site doesn't quite cover all of the details required to do the install, so I have tried to cover this in more detail here.

More details about creating calibration standards, and the script itself, can be found on ON3OTD's web site:

[http://www.qsl.net/in3otd/electronics/VNA\\_calkit/calkit.html](http://www.qsl.net/in3otd/electronics/VNA_calkit/calkit.html)

The NLOpt website is here: <https://nlopt.readthedocs.io/en/latest/> and the page on installing on Windows, which this is based on, can be found here: [https://nlopt.readthedocs.io/en/latest/NLOpt\\_on\\_Windows/](https://nlopt.readthedocs.io/en/latest/NLOpt_on_Windows/)

## Install Procedure

Download and install Octave into c:\Octave

```
https://ftp.gnu.org/gnu/octave/windows/octave-4.2.1-w64-installer.exe
```

Add the Octave\bin install directory to your path as you need it later when running the compile step

```
C:\Octave\Octave-4.2.1\bin
```

Create working directory somewhere, and save all of the following downloads into it:



Download the script itself:

[http://www.qsl.net/in3otd/electronics/VNA\\_calokit/calokit.html](http://www.qsl.net/in3otd/electronics/VNA_calokit/calokit.html)

Download SXPParse, which is used to read slp files (MathWorks account is required, you don't need a product key):

<https://au.mathworks.com/matlabcentral/fileexchange/6080-s-parameter-toolbox---z--y--h--g--abcd--t-?focused=5233833&tab=function>

Download NLopt package:

<http://ab-initio.mit.edu/nlopt/nlopt-2.4.2.tar.gz>

Download pre-built Windows 64bit NLopt dll's:

<http://ab-initio.mit.edu/nlopt/nlopt-2.4.2-dll64.zip>

Open a cmd prompt and cd into your working directory where all of the downloads are saved. Unzip the nlopt-2.4.2-dll64.zip file.

```
> cd <working directory>
> dir
28/02/2018  03:03 PM    <DIR>          .
28/02/2018  03:03 PM    <DIR>          ..
28/02/2018  02:56 PM                16,014 calokit_model.m
28/02/2018  03:00 PM    <DIR>          nlopt-2.4.2-dll64
28/02/2018  02:49 PM                541,706 nlopt-2.4.2-dll64.zip
28/02/2018  02:49 PM            2,361,992 nlopt-2.4.2.tar.gz
28/02/2018  02:49 PM                25,724 sbbox.zip
```

Use `dlltool` (which comes with Octave in the `octave\bin` directory which you should have by now added to your path per the above) to create the `.lib` import library

```
dlltool.exe --input-def nlopt-2.4.2-dll64\libnlopt-0.def --dllname
nlopt-2.4.2-dll64\libnlopt-0.dll --output-lib libnlopt-0.lib
```

Example:

```
> dlltool.exe --input-def nlopt-2.4.2-dll64\libnlopt-0.def --dllname
nlopt-2.4.2-dll64\libnlopt-0.dll --output-lib libnlopt-0.lib
ignore this: c:\Octave\Octave-4.2.1\bin\dlltool.exe: Path components
stripped from dllname, 'nlopt-2.4.2-dll64\libnlopt-0.dll'.
```

Now you should have a `.lib` file



```
> dir
28/02/2018 02:56 PM          16,014 calkit_model.m
28/02/2018 03:03 PM      187,864 libnlopt-0.lib
28/02/2018 03:00 PM      <DIR>          nlopt-2.4.2-dll64
28/02/2018 02:49 PM      541,706 nlopt-2.4.2-dll64.zip
28/02/2018 02:49 PM    2,361,992 nlopt-2.4.2.tar.gz
28/02/2018 02:49 PM      25,724 sbbox.zip
```

Untar the nlopt-2.4.2.tar.gz package. You can use 7-zip twice, once on the .tar.gz and once on the tar, or any other method if you know what you are doing.

```
> dir
28/02/2018 02:56 PM          16,014 calkit_model.m
28/02/2018 03:03 PM      187,864 libnlopt-0.lib
21/05/2014 07:37 AM      <DIR>          nlopt-2.4.2
28/02/2018 03:00 PM      <DIR>          nlopt-2.4.2-dll64
28/02/2018 02:49 PM      541,706 nlopt-2.4.2-dll64.zip
28/02/2018 02:49 PM    2,361,992 nlopt-2.4.2.tar.gz
28/02/2018 02:49 PM      25,724 sbbox.zip
```

Copy libnlopt-0.dll file from precompiled dll zip and nlopt\_optimize.cc from nlopt\octave

```
> dir
28/02/2018 02:56 PM          16,014 calkit_model.m
28/02/2018 03:00 PM    1,352,710 libnlopt-0.dll
28/02/2018 03:03 PM      187,864 libnlopt-0.lib
21/05/2014 07:37 AM      <DIR>          nlopt-2.4.2
28/02/2018 03:00 PM      <DIR>          nlopt-2.4.2-dll64
28/02/2018 02:49 PM      541,706 nlopt-2.4.2-dll64.zip
28/02/2018 02:49 PM    2,361,992 nlopt-2.4.2.tar.gz
28/02/2018 03:01 PM      10,374 nlopt_optimize-oct.cc
28/02/2018 02:49 PM      25,724 sbbox.zip
```

Find and Replace all occurrences of "Octave\_map" with "octave\_map" inside [nlopt\\_optimize.cc](#)

```
e.g. Change
static int struct_val_default(Octave_map &m, const std::string& k,
to
static int struct_val_default(octave_map &m, const std::string& k,
```

Compile the Octave plugin



```
mkoctfile -Inlopt-2.4.2\api -Inlopt-2.4.2\octave -L. -lnlopt-0 --output  
nlopt_optimize.oct nlopt_optimize-oct.cc  
  
(ignore warnings)
```

Copy dll into Octave bin dir

```
copy libnlopt-0.dll c:\Octave\Octave-4.2.1\bin\
```

Copy .m files for NLOpt and SXPParse into Octave site dir.

You can also copy the optimisation script itself if you like. I prefer to keep it in my working directory to make editing it easier.

```
copy nlopt-2.4.2\octave\*.m  
C:\Octave\Octave-4.2.1\lib\octave\site\oct\x86_64-w64-mingw32  
copy sbox\sbox\*.m  
C:\Octave\Octave-4.2.1\lib\octave\site\oct\x86_64-w64-mingw32
```

Start Octave, in the Command Window inside Octave, cd to the working directory so that Octave can find the script if you did not copy it to the site directory (note Unix format path)

```
cd "/data/working_directory"
```

Run the script, it will take a few minutes, but you should see some graphs pop up, and something like the following:



```
>> calkit_model("./female-open.slp", "open")
```

```
nlopt_optimize eval #1: 1.00331535
```

```
...
```

```
nlopt_optimize eval #7000: 0.00330642
```

```
Optimization results:
```

```
offs_delay = 22.037796 ps
```

```
offs_loss = 6.311983 Gohm/s
```

```
offs_Z0 = 35.666424 ohm
```

```
C0 = 221.660950 * 1e-15 F
```

```
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```
Residual RMS error : -49.613724 dB
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