

# Appendix A

## S-Parameter Data Acquisition System Software

### A.1 gbin.sh

Code A.1: S-Parameter Data Acquisition Shell Script Software

```
1  #!/bin/bash
2  if [ ! -f vnaJ-h1.3.1.3.jar ];
3  then
4      echo ERROR! Missing vnaJ file...
5      exit
6  fi
7
8  if [ -z $(lsusb | grep -e "Future_Technology_Devices")
9      ];
10 then
11     echo ERROR! MiniVNA Pro not connected...
12 fi
13
14 if [ $# -lt 4 ];
15 then
16     echo ERROR! Missing parameters...
17     exit
18 fi
19
20 if [ -z $(lsusb | grep -e "Arduino") ];
21 then
22     echo ERROR! Arduino not connected...
```

```

22 else
23     echo Tx: $1 - $2
24     echo Rx: $3 - $4
25     stty -F /dev/ttyACM0 cs8 9600 ignbrk -brkint -
        imaxbel -opost -onlcr -isig -icanon -iexten -
        echo -echoe -echok -echoctl -echoke noflsh -
        ixon -crttscts -hupcl
26
27     for i in $(seq $1 $2)
28     do
29         if [ "$i" -lt 10 ];
30         then
31             echo sending 0$i to arduino...
32             echo -n "0$i" > /dev/ttyACM0
33         else
34             echo sending $i to arduino...
35             echo -n "$i" > /dev/ttyACM0
36         fi
37
38         echo changing transmitter to $i
39
40         for j in $(seq $3 $4)
41         do
42             echo -n "$j" > /dev/ttyACM0
43             echo changing reciever to $j
44
45             echo Running vnaJ-hl.3.1.3.jar...
46             nohup java -Dconfigfile=gbin.xml -Dfstart
                =70000000 -Dfstop=100000000 -Dfsteps
                =100 -Dcalfile=gbin.cal -Dscanmode=TRAN
                -Dexports=csv -jar vnaJ-hl.3.1.3.jar >
                log.txt
47             path="vnaJ.3.1/export"
48
49             #renaming exported file for post-
                processing
50             [ "$i" -lt 10 ] && tx="0$i" || tx="$i"
51             rcvr=$(expr $j - 24)
52             [ "$rcvr" -lt 10 ] && rx="0$rcvr" || rx="
                $rcvr"
53             mv ${HOME}/${path}/gbin.cal.csv ${HOME}/
                $path/gbin_"$tx"$rx".csv
54         done
55     done
56 fi
57

```

```

58 #running post-processing process
59 mono put2str.exe
60
61 #delete all exported miniVNA files after post-
    processing is done
62 rm -R ${HOME}/${path}/*
63
64 #upload to linked dropbox
65 ./dropbox_uploader.sh /root/grainbin/output output

```

## A.2 put2str.cs

Code A.2: Post-Data Processing Program

```

1 using System.Linq;
2 using System.IO;
3 using System.Collections;
4 using System.Collections.Generic;
5
6 using System;
7 using System.Text;
8
9 class put2string{
10
11     static string[,] sp = new string[256, 3];
12
13     public static void Main(string[] args)
14     {
15         string path = @"/root/vnaJ.3.1/export";
16
17
18         if(Directory.Exists(path))
19             ProcessDirectory(path);
20         else
21             Console.WriteLine("{0} is not a valid
                directory.", path);
22
23         List<string> linesToWrite = new List<string>();
24         for(int rowIndex = 0; rowIndex < 256;
            rowIndex++)
25         {
26             StringBuilder line = new StringBuilder();
27             for(int colIndex = 0; colIndex < 3;
                colIndex++)

```

```

28         line.Append(sp[rowIndex,
29                     colIndex]).Append("\t");
30         linesToWrite.Add(line.ToString());
31     }
32     //export file to sp.dat
33     System.IO.File.WriteAllLines(@"root/grainbin/output/sp.dat",
34                                 linesToWrite.ToArray());
35 }
36 // Process all files in the directory passed in
37 public static void ProcessDirectory(string
38     targetDirectory)
39 {
40     // Process the list of files found in the
41     // directory.
42     string [] fileEntries =
43         Directory.GetFiles(targetDirectory,
44                             "*.csv");
45     if(fileEntries.Length == 0)
46         Console.WriteLine("ERROR! No files in
47                             directory to process");
48     else{
49         int count = 0;
50         foreach(string fileName in
51                     fileEntries)
52         {
53             string dataID =
54                 Path.GetFileNameWithoutExtension(fileName);
55             string tx =
56                 dataID.Substring(dataID.Length-4,2);
57             string rx =
58                 dataID.Substring(dataID.Length-2,2);
59             sp[count, 0] = tx;
60             sp[count, 1] = rx;
61             // Console.WriteLine("TX: {0}\tRX:
62                                 {1}", sp[count, 0], sp[count,
63                                 1]);
64             ProcessFile(fileName, count);
65             count++;
66         }
67     }
68 }
69 // Insert logic for processing found files here.

```

```

60     public static void ProcessFile(string file, int
        count)
61     {
62         string[] lines =
            System.IO.File.ReadAllLines(file);
63         string data = "";
64         foreach(string line in lines.Skip(1)){
65
66             string[] val = line.Split(',');
67
68             double magdb = Convert.ToDouble(val[1]);
69             double ph = Convert.ToDouble(val[2]);
70             double mag = Math.Pow(10, magdb/20);
71             double a = mag*Math.Cos(ph);
72             double b = mag*Math.Sin(ph);
73
74             data = string.Concat(data,
                string.Concat(a.ToString("N7") + "\t",
                    b.ToString("N7") + "\t"));
75
76             sp[count, 2] = data;
77         }
78
79         // Console.WriteLine("Processed file '{0}'.",
            file);
80     }
81 }

```

### A.3 button.py

**Code A.3:** Button and LED function on Raspberry Pi 2

```

1  import RPi.GPIO as GPIO
2  from time import sleep
3  from sys import exit
4  import os
5
6  # to use Raspberry Pi board pin numbers
7  GPIO.setmode(GPIO.BCM)
8
9  # set up the GPIO channels - one input and one output
10 GPIO.setup(17, GPIO.IN) #push button
11 GPIO.setup(23, GPIO.OUT) #led
12
13 # input from pin 11
14 #input_value = GPIO.input(17)

```

```

15
16 try:
17     while True:
18         # output to pin 12
19         if(GPIO.input(17) == True):
20             #print("ON!")
21             GPIO.output(23, True)
22             sleep(0.5)
23             GPIO.output(23, False)
24             sleep(0.5)
25             os.system("sh gbintest.sh 18 18 45 50")
26         else:
27             #print("OFF!")
28
29 finally: GPIO.cleanup()

```

## A.4 gbin.xml

Code A.4: miniVNA PRO XML Software Configuration File

```

1 <?xml version="1.0" encoding="UTF-8" standalone="no"?>
2 <!DOCTYPE properties SYSTEM "http://java.sun.com/dtd/
3   properties.dtd">
4 <properties>
5 <comment>Thu Jan 29 15:20:12 CST 2015</comment>
6 <entry key="MainWindow.Height">600</entry>
7 <entry key="PrintFooter">true</entry>
8 <entry key="VNADriverConfigDialog.Width">720</entry>
9 <entry key="ApplicationLogger.logging">>false</entry>
10 <entry key="VNADeviceConfig.StartFrequency">70000000</
11   entry>
12 <entry key="VNAHelpDialog.Height">400</entry>
13 <entry key="VNADDataAnalysisDialog.Width">800</entry>
14 <entry key="VNADDataAnalysisDialog.Y">100</entry>
15 <entry key="VNADDataAnalysisDialog.X">100</entry>
16 <entry key="VNACalibrationSaveDialog.Height">514</
17   entry>
18 <entry key="CableLength.Y">100</entry>
19 <entry key="CableLength.X">100</entry>
20 <entry key="VNAFrequencyCalibrationDialog.Y">100</
21   entry>
22 <entry key="VNAFrequencyCalibrationDialog.X">100</
23   entry>
24 <entry key="VNACalibrationLoadDialog.Width">498</entry>
25 <entry key="VNA.exportFileName">VNA</entry>

```

```

21 <entry key="VNAFrequencyCalibrationDialog.Width">320</
    entry>
22 <entry key="VNAExportSettingsDialog.Y">100</entry>
23 <entry key="VNAExportSettingsDialog.X">100</entry>
24 <entry key="VNA.autoExportDirectory">/root/vnaJ.3.1/
    export</entry>
25 <entry key="FontSizeTextMarkers">15</entry>
26 <entry key="VNADriverSerialProDialog.Width">500</entry
    >
27 <entry key="VNADataAnalysisDialog.Height">497</entry>
28 <entry key="VNACalibrationDialog.Height">709</entry>
29 <entry key="MainWindow.Y">23</entry>
30 <entry key="VNAHelpDialog.Y">189</entry>
31 <entry key="MainWindow.X">37</entry>
32 <entry key="VNAHelpDialog.X">178</entry>
33 <entry key="apple.awt.graphics.UseOpenGL">>false</entry
    >
34 <entry key="CableLength.Width">450</entry>
35 <entry key="VNADriver.Sample.PortName">DummySamplePort
    </entry>
36 <entry key="VNADriverSerialProDialog.Height">550</
    entry>
37 <entry key="CableLength.userLength"/>
38 <entry key="ErrorLogger.logging">>true</entry>
39 <entry key="ApplicationLogger.shortclassname">>true</
    entry>
40 <entry key="VNA.numberOfOversample">1</entry>
41 <entry key="VNACalibrationSaveDialog.Y">100</entry>
42 <entry key="VNA.type">2</entry>
43 <entry key="VNA.ExportDiagramWidth">1280</entry>
44 <entry key="VNACalibrationSaveDialog.X">100</entry>
45 <entry key="VNAConfigEditDialog.Y">100</entry>
46 <entry key="VNAConfigEditDialog.X">100</entry>
47 <entry key="http.nonProxyHosts">local|*.local
    |169.254/16|*.169.254/16</entry>
48 <entry key="exportOverwrite">>true</entry>
49 <entry key="VNADriver.Serial.Pro.PortName">ttyUSB0</
    entry>
50 <entry key="VNA.exportTitleFontSize">24</entry>
51 <entry key="VNA.exportDecimalSeparator">.</entry>
52 <entry key="VNACalibrationLoadDialog.Height">485</
    entry>
53 <entry key="VNA.ExportDiagramHeight">1024</entry>
54 <entry key="CableLength.userVelFactor"/>
55 <entry key="VNADriverSerialProDialog.Y">100</entry>
56 <entry key="VNADriverSerialProDialog.X">100</entry>

```

```

57 <entry key="VNAConfigEditDialog.Width">651</entry>
58 <entry key="VNAHelpDialog.Width">400</entry>
59 <entry key="VNADeviceConfig.StopFrequency">99999760</entry>
60 <entry key="VNA.exportDirectory">/root/vnaJ.3.1/export</entry>
61 <entry key="MainWindow.Width">1000</entry>
62 <entry key="CableLength.Height">600</entry>
63 <entry key="VNACalibrationLoadDialog.Y">100</entry>
64 <entry key="VNACalibrationLoadDialog.X">100</entry>
65 <entry key="socksNonProxyHosts">local|*.local|169.254/16|*.169.254/16</entry>
66 <entry key="ftp.nonProxyHosts">local|*.local|169.254/16|*.169.254/16</entry>
67 <entry key="Tracer.tracing">>false</entry>
68 <entry key="VNAExportSettingsDialog.Height">550</entry>
69 <entry key="VNAFrequencyCalibrationDialog.Height">340</entry>
70 <entry key="ApplicationLogger.classname">krause.util.ras.logging.ConsoleLogger</entry>
71 <entry key="VNA.autoExportFilename">{12}</entry>
72 <entry key="VNACalibrationSaveDialog.Width">799</entry>
73 <entry key="VNAExportSettingsDialog.Width">850</entry>
74 <entry key="ErrorLogger.classname">krause.util.ras.logging.ConsoleErrorLogger</entry>
75 <entry key="VNACalibrationDialog.Y">22</entry>
76 <entry key="VNACalibrationDialog.X">0</entry>
77 <entry key="VNA.exportComment">Date: {0}
78 Mode: {1}
79 Analyser: {2} / {3}
80 Scan
81 Start: {4} / {6}
82 Stop: {5} / {7}
83 Samples: {8}
84 Overscan: {9}
85 Calibration
86 Samples: {10}
87 Overscan: {11}
88 File: {12}
89 User: {13}</entry>
90 <entry key="ErrorLogger.shortclassname">>true</entry>
91 <entry key="gopherProxySet">>false</entry>
92 <entry key="VNA.exportTitle">gbin</entry>
93 <entry key="VNAConfigEditDialog.Height">576</entry>

```



```

94 <entry key="VNA.autoExportFormat">0</entry>
95 <entry key="VNADriverConfigDialog.Height">370</entry>
96 <entry key="NumberOfSamples">588</entry>
97 <entry key="PrintMainLegend">true</entry>
98 <entry key="configfile">gbin.xml</entry>
99 <entry key="mrj.build">11M4609</entry>
100 <entry key="showToolBar">true</entry>
101 <entry key="CableLength.selIdx">0</entry>
102 <entry key="mrj.version">1070.1.6.0_65-462</entry>
103 <entry key="CalibrationBlocks.miniVNA-pro.2">
    REFL_miniVNA-pro.cal</entry>
104 <entry key="CalibrationBlocks.miniVNA-pro.1">
    TRAN_miniVNA-pro.cal</entry>
105 <entry key="PrintMarkerDataInDiagramm">false</entry>
106 <entry key="apple.awt.graphics.UseQuartz">false</entry>
107 <entry key="Tracer.classname">krause.util.ras.logging.
    ConsoleTracer</entry>
108 <entry key="PrintMarkerDataHorizontal">false</entry>
109 <entry key="VNADeviceConfig.TransmissionMode">1</entry>
110 <entry key="VNA.MarkerSize">2</entry>
111 <entry key="VNADriverConfigDialog.Y">100</entry>
112 <entry key="PrintSubLegend">false</entry>
113 <entry key="VNADriverConfigDialog.X">100</entry>
114 <entry key="VNACalibrationDialog.Width">1280</entry>
115 <entry key="askOnExit">false</entry>
116 <entry key="Tracer.shortclassname">true</entry>
117 </properties>

```

## A.5 Dropbox Setup on the Raspberry Pi 2

The instructions below shows how a user can setup Dropbox on the Raspberry Pi 2 and how it can be linked to their Dropbox account. Note that an Internet connection is required for this installation. For more information on the Dropbox Uploader shell script, please refer to Andrea Fabrizi's Github [?].

### A.5.1 Setup Instructions

1. The Dropbox shell script can be downloaded using the following command:

```
$ wget https://raw.githubusercontent.com/andreafabrizi/Dropbox-Uploader/master/dropbox_uploader.sh
```

2. Permissions on the shell script will need to be changed to make it executable. This can be done by the following command:

```
$ chmod +x dropbox_uploader.sh
```

3. Now Dropbox can be configured for the first time by running

```
$ ./dropbox_uploader.sh
```

4. Follow the instructions on the screen to create a new Dropbox app on your account from another web browser. Copy the app key and app secret given by Dropbox after filling out the create a new app form to the terminal window that is running the Dropbox shell script.
5. If the given information is correct, you will receive a oAUTH URL to enter into your web browser to verify app access to your Dropbox.
6. Dropbox on the Raspberry Pi 2 is now linked to your account. See below for Dropbox commands that can run on the Raspberry Pi 2.

### A.5.2 'dropbox-uploader.sh' Commands

< *file/folder* > is a required parameter

[*file/folder*] is an option parameter

```
./dropbox-uploader.sh upload <LOCAL_FILE/DIR ...> <REMOTE_FILE/DIR>
```

```
./dropbox-uploader.sh download <REMOTE_FILE/DIR> [LOCAL_FILE/DIR]
```

```
./dropbox-uploader.sh delete <REMOTE_FILE/DIR>
```

```
./dropbox-uploader.sh move <REMOTE_FILE/DIR> [REMOTE_FILE/DIR]
```

```
./dropbox-uploader.sh copy <REMOTE_FILE/DIR> [REMOTE_FILE/DIR]
```

```
./dropbox-uploader.sh mkdir <REMOTE_DIR>
```

```
./dropbox-uploader.sh list <REMOTE_DIR>
```

```
./dropbox-uploader.sh share <REMOTE_DIR>
```

```
./dropbox-uploader.sh info
```

```
./dropbox-uploader.sh unlink
```