Serial Commands for AVNA  
Version 0.61

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1 Introduction

Commands are entered by the USB serial link to the Teensy 3.6 board. The Teensy appears to the Host computer as a “Serial Device”. As such, it can be controlled by an external program for graphing and the like. For manual control, the “Arduino Serial Monitor” that is accessed from the Arduino IDE under the menu “Tools” is useful. This monitor (terminal) supports CTRL-C copy and data can be gathered that way.

2 General Command Syntax

The format for all commands going to the AVNA is

\[ \text{CMD param1 param2 ...} \]

where \( \text{CMD} \) is 1 or more characters, and the number of parameters varies. Only capital letters are valid for the \( \text{CMD} \) field. Error checking is not done.
on parameters. If 5 parameters are allowed, and only the first two are to be set, the last 3 do not need to be sent. Also the delimiter is shown as a space, but commas can be used as well.

For common commands used for manual entry, there are single character short cuts. For instance, \texttt{FREQ} and \texttt{F} are equivalent. See Section 5 for a complete list.

### 3 Operational Commands

**ZMEAS** \texttt{refR} This command sets the measurement to Impedance and the reference resistor value to \texttt{refR}. Valid \texttt{refR} values are either 50 or 5000 ohms.

**TRANSMISSION** \texttt{refR} This command sets the measurement to Transmission and the reference resistor value to \texttt{refR}. Valid \texttt{refR} values are either 50 or 5000 ohms.

**FREQ** \texttt{f} This command sets the measurements to a single (non-sweep) frequency. The frequency is set to \texttt{f} which can be either an integer or a decimal number from 10 to 40000. The parameter \texttt{f} regards 100.0 and 100 as the same. The achieved frequency may be slightly different than \texttt{f} to provide proper averaging of the multiplier outputs.

**SWEEP** No parameters are used. The 13 frequency sweep is set up, but not run (see \texttt{RUN} command).

**LINLOG** \texttt{rs ts} changes the units used for outputs to the serial monitor, or to the Touch Display. The four numbers following the \texttt{LINLOG} command set:

- \texttt{rs = 0} Reflection coefficient to Serial in dB, and phase in degrees
- \texttt{rs = 1} Reflection coefficient to Serial in magnitude (0,1) and phase in degrees
- \texttt{rs = 2} Reflection data to Serial as equivalent Series Impedance or Parallel Suseptance (see \texttt{SERPAR} command)
**ts = 0** Transmission data to Serial in dB, and phase in degrees
**ts = 1** Transmission data to Serial in magnitude and phase in degrees

Default is the original values, for backward compatibility: LINLOG 2 1. Short commands work if you do not want to change the touch display. For instance, LINLOG 0 will just make the serial output in dB and degrees for impedance.

The command LINLOG without any parameters will return the current settings, such as LINLOG 0 0.

Settings are saved in EEPROM and so survive the power shutdown. This makes a variety of Serial outputs available. For instance, for impedance measurement of a 200 uH inductor at 10 KHz:

With LINLOG 0 0: the serial monitor shows a series of lines:
10000.000 Hz
Return Loss = 0.486 dB
Phase = 150.74

With LINLOG 1 0: the serial monitor shows a series of lines:
10000.000 Hz
Reflection Coefficient = 0.94565
Phase = 150.74

With LINLOG 2 0: the serial monitor shows a series of lines:
10000.000 Hz
Series RX: R=1.494 X=13.042 L= 207.6uH Q=8.73
10000.000 Hz
Parallel GB: G=0.008667760 B=-0.075683906 R= 115.37
L= 207.6uH Q=8.73

With LINLOG 2 0 and SERPAR 1 0 the serial monitor omits the susceptance:
10000.000 Hz Series RX: R=1.494 X=13.042 L= 207.6uH Q=8.73

If the output is intended to be read by a program, you do not want all the annotation. When this is stopped by ANNOTATE 0, the data fields become comma separated, which spread sheets are happy with. For instance, the inductor measurement with "LINLOG 1 0 looks
like 10000.000, 0.94565, 150.74. The second number controls the transmission format in a similar manner, but options are only 0 or 1.

**CAL** No parameters are required. This is an immediate calibrate of either Z or T measurements at either a single frequency or all 13 sweep frequencies. This must follow FREQ or SWEEP and ZMEAS or TRANSMISSION to do the proper calibrate. This command must precede **RUN**. Note that component connections can be left in place for **CAL** of impedance measurements, but transmission measurements need a reference path for proper calibration.

**RUN nRun** This command causes the selected measurement to occur, either single frequency or a full set of swept measurements. The parameter, **nRun** is the number of measurement sets made. An **nRun** value of 0 causes a continuous set of measurements to be made. That is, **RUN 1** is a single measurement set; **RUN 27** does 27 sets and stops. Any new command will break the **RUN** command, so **RUN 0** is not really forever.

**POWER** No parameters are required. This is a power sweep of transmission measurements at a single frequency. Implementation is in place, although not thoroughly tested. Documentation is coming.

**SAVE** No parameters are required. This saves the current state to EEPROM for the next power down. This is seldom needed, as it is automatic if a parameter, such as the reference impedance is changed.

**LOAD** No parameters are required. Complements **SAVE** and retrieves settings from EEPROM. Also seldom needed.

**DELAY msDelay** sets a delay between repeated runs (see **RUN** command). The parameter **msDelay** is the amount of delay in milliseconds. This applies to measurements over the serial link and not the touch display.

**CALDAT** Not used at this time.

**SERPAR ser par** sets type of output data sent back to a host PC, during Z measurements, where:
ser = 0  Do not transmit series R-X data
ser = 1  Transmit series R-X data
par = 0  Do not transmit parallel G-B data
par = 1  Transmit parallel G-B data

For instance, the command SERPAR 0 1 would include data for parallel G-B representation of the measured impedance.

The normal representation for an impedance is the (ser = 1) series form specified by a resistance, R, and a reactance, X connected in series.

When par = 1, representation is the mathematically related parallel conductance, G, and susceptance, B.

Note that annotation of the general form "R=" can be added for both impedance forms by the "ANNOTATE 1" command.

Avoid having both ser = 0 and par = 0, as there will be no output to the PC, and there will be no obvious reason.

Unless modified by a SERPAR command, the unit defaults to SERPAR 1 1.

TEST rys sws This command sets the three relays and switches. This is not normally used for measurements, as the proper relay settings will be made by a measurement command, such as ZMEAS. (See TestCommand() in the .INO)

BAUD Do not use. All USB communications on the USB port are at 12 MBits/sec

ANNOTATE 0 or 1 Responses can have annotation (1) or no annotation (0), over the serial communication.

VERBOSE 0 or 1 For (1), extra information is transmitted. For (0), no extra information is transmitted.
4  Setup Commands

**PARAM1 num refR50 refR5K** This command is used to set the ”exact” values of the two reference resistors (refR50 and refR5K), if known. refR50 and refR5K default to the design values of 50.00 ohms and 5000.00 ohms respectively. The parameter num is either 0 or 99. A value 0 causes the reference resistor values to be set to the two parameter values, refR50 and refR5K. A num value 99 causes ALL EEPROM values to be set to the defaults, including PARAM2 below. *Use the 99 value with care.* An example is “PARAM1 0 50.22 5017.3” which sets the two reference values, refR50 and refR5K, to 50.22 and 5017.3 ohms respectively. PARAM1 with no following parameters returns the current two reference resistor values.

**PARAM2 capInput resInput capCouple seriesR seriesL** Serves the changing of correction factors for the impedance measurements. For instance,

"PARAM2 37.0 1000000.0 0.22 0.07 20.0"

[units] pF Ohm uF Ohm nH

sets the input shunt capacity, the shunt resistance, the coupling cap, lead resistance and lead inductance. Note capInput is the most likely item to change, and it can be changed with simply "PARAM2 34.8" To obtain current values, type PARAM2 with no parameters

**TUNEUP n** is a set of six commands (n = 1, 2, 3, 4, 5, or 6) used at setup time or whenever values need to be checked. These are the values that correct for circuit “stray” components to improve the accuracy of impedance measurements. This command is available only over the serial port (no touch screen). It is directed manually, since components, opens, and shorts need to be connected. These measurements determine the six values that are listed by the two commands, PARAM1 and PARAM2 (not including the non-critical 0.22 uF coupling capacitor). The intention is that TUNEUP be used in 1 to 5 order. (See the separate write-up on doing the tuneup.) The TUNEUP family includes:
**TUNEUP** with no "n" prints a summary of this procedure.

**TUNEUP 1** with a short circuit on the Z terminals measures the stray resistance and inductance (seriesR & seriesL).

**TUNEUP 2 REXT50** (1) find a resistor around 50 ohms, (2) as accurately as possible, measure the actual resistance of this resistor (in ohms), (3) then run TUNEUP 2 REXT50; enter the actual measured value (which will probably not be exactly 50 ohms) in place of REXT50.

**TUNEUP 3 REXT5K** (1) find a resistor around 5000 ohms, (2) as accurately as possible, measure the actual resistance of this resistor (in ohms), (3) then run TUNEUP 3 REXT5K; entering the actual measured value (which will probably not be exactly 5000 ohms) in place of REXT5K.

**TUNEUP 4** with the Z terminals open measures the internal 1 Megohm resistor and the input capacity (resInput & capInput).

**TUNEUP 5** causes the six values to be made permanent.

**TUNEUP 6** reverts to the original six values that were used before TUNEUP was started.

Any of the steps can be omitted, e.g., if no precise resistor around 50 ohms is available. But, the ascending order from 1 to 5 is important, in that, for instance, the value of the 5000 ohm reference affects the open circuit answers.

### 5 EXAMPLE of COMMANDS

As an example, a swept measurement of transmission data, as commanded for non-manual use, might look like the following: This does 1 Hz steps from 950 to 1050 Hz. Obviously, the F xxx R 1 repetition would be done by a loop in a control program.
T 50
SWEEP
CAL
(Connect device to be measured for transmission)
F 950
R 1
F 951
R 1
F 952
R 1
...
F 1049
R 1
F 1050
R 1
## 6 Shortened Form of Commands

<table>
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<th>Full Command</th>
<th>Abbreviation</th>
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<td>Z</td>
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<tr>
<td>TRANSMISSION</td>
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<td>FREQ</td>
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