

Evaluation of harmonics for airborne equipment according to EUROCAE ED-14D

The basic standard concerning the power measurement in the avionics is EUROCAE ED-14D. It defines a measuring procedure for testing avionics power supply systems.

There are some particular requirements for the measurement of harmonics which are listed below in table 1. According to this standard the harmonics must be evaluated in the following frequency ranges.

Table 1

Power system	Fundamental frequency	Resolution	Frequency range
A(CF)	400 Hz	20 Hz	16 kHz
A(NF)	360 Hz, 650 Hz	20 Hz	14,4 kHz or 26 kHz
A(WF)	360 Hz, 800 Hz	20 Hz	14,4 kHz or 32 kHz

The minimum sampling rate should equal 100 kHz. The cut-off frequency of an antialiasing filter should be between 25 kHz and 50 kHz.

The most suitable measuring instrument for these purposes is a LMG500. The technical data of the LMG500, bandwidth, accuracy and sampling rate, completely fulfil above listed requirements. However, the built-in tools for harmonic analysis (CE-Harm and Harm100) don't allow to carry out the evaluation according to table 1.

The application of TERM-L5 with the possibility of a spectral analysis of captured waveform conquers such drawback. By means of TERM-L5 (release 2.03 or later) it is possible to perform a spectral analysis up to half the sampling frequency. It covers the frequency ranges DC up to 25 kHz for LMG450 and DC up to 1,5 MHz for LMG500, respectively. The resolution in frequency domain depends on the length of the time window. When capturing waveforms over 1 s, the resolution equals 1 Hz. The time window of 2,5 ms corresponds to a resolution of 400 Hz. To reach the required resolution of 20 Hz, the waveforms must be analysed within a 0,05 s window.

TERM-L5 manages the transfer of the sampling values from a LMG buffer. The window length is settable by user. It can be done either by entering start and stop bounds or the number of periods of analysed signal. The frequency of the signal is detected automatically. The sampling values can be plotted both in frequency and time domain, as well as can be saved in ASCII format.

There are two possibilities to fulfil a discrete Fourier transformation (DFT).

- All sampling values from the actually defined time window will be used for the calculation of the spectrum. However, if this window contains a non-integer number of periods, the estimation of main frequency as well as harmonics will fail. If the window was defined through the number of signal periods, the spectrum will be calculated properly.
- If the window contains a non-integer number of periods it is also possible to perform the DFT between the first zero crossing from negative to positive and the last one on the same type. It tunes the algorithm to estimate the base frequency.

The obtained data can be presented both graphically (linear or logarithmic scaling) or as a table. The further data processing can be carried out by means of regular data processing tools, like MS-Excel.

Internal information (for distributors and customers only)

The spectrum analysis is available when operating without a NDL5, only. Take care about the length of the time window, while setting up the limits or the number of periods to be analysed. TERM-L5 allows the customer to perform a complete spectrum analysis. It means you can calculate spectrum from DC up to 1,5 MHz with a resolution of approximately 0,15 Hz. It sounds very attractive and motivates certain users to try this feature without considering that the computer resources are limited. Therefore such a calculation will take several hours. That is why, it is recommendable to configure the time window very carefully to evaluate only harmonics and interharmonics, you really need.

The approach to analysing spectra contains following steps:

1. Starting TERM-L5
2. Choosing the operation mode without NDL5 (Fig. 1)
3. Configuring the measurement in the normal measuring mode (Fig. 2)
4. Activating the transfer of sampling values in the step mode (Fig. 3)

5. Initialising LMG
 6. Capturing waveforms. Fig. 3 shows the details of setting the bounds of the time window
 7. Spectrum analysis. Fig. 4 and Fig. 5 show the calculated spectrum as plot and as a table, respectively
 8. Saving the spectrum as a ASCII file
- Repeat the steps 6 up to 8 to capture and analyse the waveforms again

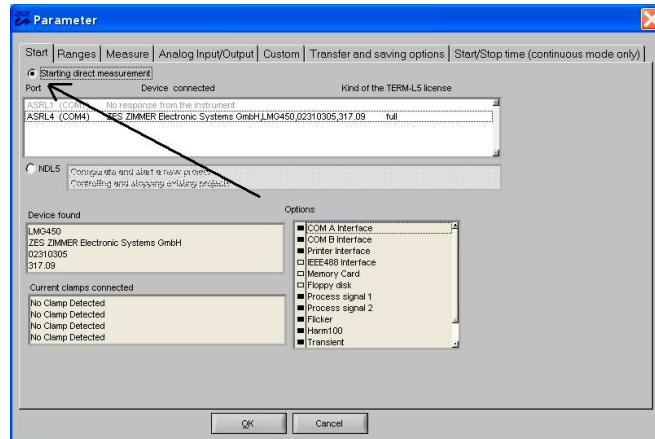


Fig. 1. Spectrum analysis in operation mode without NDL5

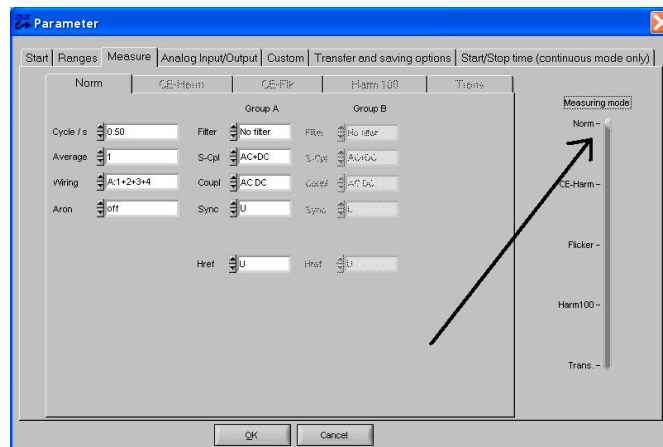


Fig. 2. Configuration of the measurement in the normal measuring mode

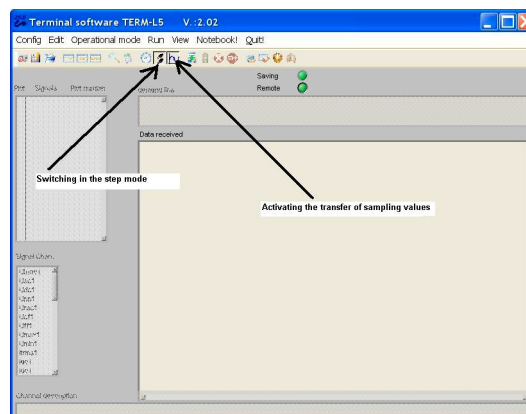


Fig. 3. Activation of the sampling values transfer in step mode

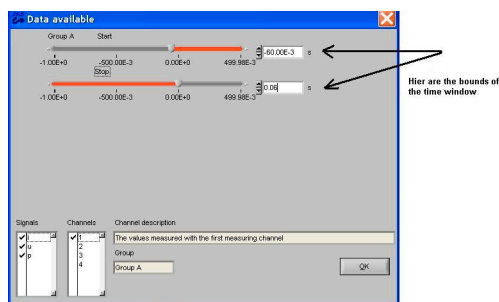


Fig. 4. Setting the time window bounds

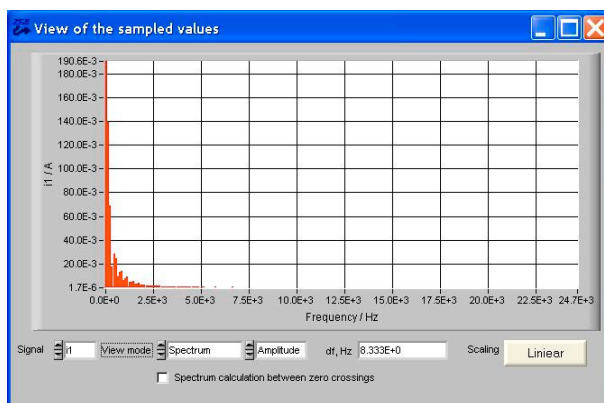


Fig. 5. Spectrum presented graphically

Terminal software TERM-L5 V.:2.03

Config Edit Operational mode Run View Notebook Quit

Print Signals Print numbers

Save Remote

Waiting Transferring

Waveforms received: Date 09-27-2004, Time 16:19:01, Sampling frequency 49342 Hz

Frequency / Hz	Amplitude spectrum I1 / A	Phase / grad
0.0e+00	0.01167	180.0
9.333407e+00	0.000465	123.861755
1.666681e+01	0.000465	-9.266369
2.500022e+01	0.001681	-100.743027
3.333363e+01	0.003286	-136.889365
4.166704e+01	0.003888	-178.641846
5.000044e+01	0.190778	142.980942
5.833385e+01	0.003442	112.914139
6.666726e+01	0.003318	78.2714
7.500066e+01	0.001812	39.591199
8.333408e+01	0.000609	-53.853207
9.166748e+01	0.000509	-146.454803
1.000009e+02	0.001431	122.31817
1.083343e+02	0.000837	94.055283
1.166677e+02	0.000195	-45.159214
1.250011e+02	0.001128	-158.021194
1.333345e+02	0.002135	176.348541
1.416679e+02	0.002115	116.724623
1.500013e+02	0.139078	83.755196
1.583347e+02	0.001965	83.440246
1.666681e+02	0.002282	28.163111
1.750016e+02	0.001251	-19.664402
1.833350e+02	0.000608	-109.310081
1.916684e+02	0.000454	172.388562
2.000018e+02	0.000624	161.565491
2.083352e+02	0.0005	64.81755
2.166686e+02	0.000213	23.181171

Channel description

Fig. 6. Spectrum as a table