

BASIC INSTRUCTIONS ON HOW TO USE THE BSA ALGORITHM
FOR ESTIMATING FM MODULATED SIGNALS WITH ARBITRARY
WAVEFORM MODULATION

Hooke_Jeeves_Student3_Wave_Fourier_Hz_Eng_2.prj

LabWindows/CVI ver. 6.0

The algorithm can be run on any updated version of LabWindows/CVI.

- 1) Check 'Options' in LabWindows panel. Maximum stack size (bytes) should be 1500000 in 'Code generation'. The debugging level should be 'no run-time checking' in 'Debugging options.'
- 2) Open the source file and press Run. Or open the executable file.
- 3) Configuration panel then opens. I selected as default the values you informed today, namely, carrier frequency: approx. 50 Hz, modulation frequency: approx. 5 Hz, and frequency deviation: 25 Hz. I also selected 8,000 samples and the other values shown in the panel as default. Sigma is noise standard deviation. Since I selected as default the sinusoidal modulation, I also selected as default just 3 harmonics in 'Nharm_Gen_Mod'. I use 128 harmonics for triangular modulation.
- 4) Press CONFIGURE.
- 5) Select Measurement panel.
- 6) Measurement panel then opens. I selected as default the values shown on the left column with white background. The values on the right with blue background are the estimates. Rho, epsilon, Rho NLS, epsilon NLS, # of iterations, and # of iter. NLS are convergence parameters for the BSA and NLS. # of variables is the number of the parameters that are estimated by BSA after having estimated the modulating signal parameters with NLS.
- 7) Press MEASURE MOD to estimate the modulating signal parameters with Nonlinear Least Squares. A message appears: CHOOSE THE CONVERGENCE PARAMETERS. The start value of Mod Freq should be close to the actual value. Check again the convergence parameters. Close and ignore the message.
- 8) Press FREQ NLS for estimating the fundamental frequency of the sinusoidal modulating signal. You will notice that the corresponding estimate appears in Final Mod Freq (Hz).
- 9) Press AMPL NLS for estimating the harmonic amplitudes of the sinusoidal modulating signal. You will notice that the estimates appear in Fundamental (V rms), ACRMS (V) and THD.
- 10) Press MEASURE BSA to estimate the remaining three parameters with Bayesian Signal Analysis. A message appears: CHOOSE THE CONVERGENCE PARAMETERS. The start values of Carrier Freq, Mod Phase, and Freq Dev should be close to the actual values. Check again the convergence parameters. Close and ignore the message.

- 11) Press **FREQ BSA** for estimating the carrier frequency, modulating frequency, frequency deviation, and modulating phase. The LED button shines while the algorithm is running the initial search. An **Standard I/O** then opens showing intermediate computations. When the **Standard I/O** stops, press the **Measurement** panel. The **Standard I/O** will then be minimized automatically. You will notice that the estimates appear in **Final Carrier Freq (Hz)**, **Final Mod Phase (rad)**, and **Final Freq Dev (Hz)**. 'nstloge' shows the negative of the maximum logarithm of the probability density for these parameters. This value decreases for increasing noise standard deviation. It shows if convergence succeeded or not. If the algorithm did not converge for a specific **Freq Dev**, try increasing the **grid #** (initial search). Suggested values are 20 (default), 40, and 60.
- 12) Press **AMPL BSA** for estimating the amplitudes of the FM modulated signal. You will notice that the estimate appears in **FM amplitude (V rms)**.
- 13) Select **Uncertainty** panel.
- 14) Press **READ** to display the covariance matrix of the frequencies and amplitudes as computed by **BSA**. An estimate of the noise standard deviation with its associated uncertainty is also provided.
- 15) Select **Graphs** panel.
- 16) Press **DATA** to display the sampled data, the reconstructed waveform and the residuals. Ignore the button **CHANGE SCALE**.
- 17) You may repeat the measurement by reselecting the **Measurement** panel and pressing **MEASURE FM**, **FREQ BSA**, **AMPL BSA** and so on. If you inadvertently press **MEASURE MOD** you will estimate the modulating signal again and then you should press **MEASURE FM** and so on to continue. But it is not necessary to estimate again the modulating parameters. You already know them.
- 18) Select **Close** panel.
- 19) Select **Close** panel again to close the algorithm. An error message may occur since nothing is perfect. Anyway, close all the windows that appeared in order to close the algorithm.