GM WORLDWIDE ENGINEERING STANDARDS	Test Procedure	GMW15223

Calculating Coherence for Structural Durability Testing

1 Introduction

Note: Nothing in this standard supercedes applicable laws and regulations.

Note: In the event of conflict between the English and domestic language, the English language shall take precedence.

1.1 Purpose. This procedure explains when coherence could be used in a project, how to calculate it, and some guidelines in interpreting coherence results.

1.2 Applicability. Coherence is used to estimate the likelihood that a given drive signal, when used as input into a given system, causes the given response signal.

This procedure is applicable for digital time histories in Remote Parameter Control (RPC) format when one set of channels is identified as drive channels and one set is identified as response channels. Traditionally, the drive channels have been rig drive channels, and the response channels are remote parameter channels, however, a method is available to calculate pseudo-coherence selecting some channels as pseudo-drives and some as pseudo-responses. Appendix A, Figure A1 illustrates the traditional process for calculating coherence using RPCpro software. Any automated tool must comprehend all processing steps shown, plus optional steps necessary for calculating pseudo-coherence. These optional steps for pseudo-coherence in an RPCpro environment include extracting both the Response and Drive channels. The drive and response files must have the same length of time, same sample rate, and same frame size. There does not need to be the same number of drive and response channels.

2 References

Note: Only the latest approved standards are applicable unless otherwise specified.

2.1 External Standards/Specifications.

None

2.2 GM Standards/Specifications.

None

3 Resources

3.1 Facilities.

3.1.1 Calibration. The test facilities and equipment shall be in good working order and shall have a valid calibration label.

3.1.2 Alternatives. Alternative test facilities and equipment may also be used. However, all measuring variables as specified in this standard shall be determined correctly with respect to their physical definition.

3.2 Equipment. Not applicable.

3.3 Test Vehicle/Test Piece. Not applicable.

3.4 Test Time. Variable depending on number of channels and files to process.

3.5 Test Required Information. Not applicable.

3.6 Personnel/Skills. Test technician familiar with test facilities and equipment.

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4 Procedure

4.1 Preparation. Not applicable.

4.2 Conditions.

4.2.1 Environmental Conditions. Not applicable.

4.2.2 Test Conditions. Deviations from the requirements of this standard shall have been agreed upon. Such requirements shall be specified on component drawings, test certificates, reports, etc.

4.3 Instructions.

4.3.1 Select Channels for Analysis. Determine likely response channels for the available drive channels. Coherence calculations give an estimate of the likelihood that a given response is caused either in part or in total by a given drive channel or set of drive channels. Select the drive and response channels to analyze. Traditionally, the drive channels were in drive files and response channels were in response files. A fully capable automated tool should have options to either:

4.3.1.1 Select a set of response files and their corresponding drive files.

4.3.1.2 From a single set of files, select the response channels and the drive channels.

Note: An example of such a tool is the RPCpro Coherence tool.

4.3.2 Calculate Coherence. Select whether Partial, Multiple or both types of coherence are needed and calculate.

4.3.3 Analyze the Results. When the coherence is calculated, plots may be generated from the software used. For RPCpro the tool is the RPC Matrix Plotter. Plot only amplitude, and force the vertical scale to a linear scale with the maximum forced to 1.0. Plotted frequency may range from 0 to Nyquist, but typically is of interest only out to about 60 Hz, or at most 100 Hz. Coherence is calculated for each spectral line. For a given response channel, a value of 1 indicates perfect correlation between the input and response channels. Coherence values > 0.8, or so, typically indicate high coherence, that is, there is a high degree of probability that the drive channel(s) are the cause of the response channel under study. If this is partial coherence under study, then the coherence is against a single drive channel, if it is multiple, then the coherence is against all drive channels. Summing partial coherence for a given spectral line across all drive channels does **NOT** give the multiple coherence. Low multiple coherence values indicate the presence of measurement noise, system non-linear characteristics, or absent inputs. Similarly for the partial coherence, except that in this case it is not for the combination of all inputs. Ordinary coherence assumes a single input and single output. See Appendix B, Figure B1 for an example of interpreting Coherence.

5 Data

5.1 Calculations. See 4.3.2.

5.2 Interpretation of Results. See 4.3.3.

5.3 Test Documentation. All data is to be archived per local process in RPCIII file format.

6 Safety

This Engineering Standard may involve safety requirements for hazardous materials, the method of operations and equipment. This standard does not propose to address all the safety issues associated with its use. It is the responsibility of the user of this standard to ensure compliance with all appropriate safety and health practices. This would include any specific training that may be required. The safety and health standards include site specific rules and procedures, company rules and procedures, and Government Standards. Contact shall be made with the appropriate site Safety and Health personnel for further direction and guidance in these matters.

7 Notes

7.1 Glossary.

Auto-Spectral Density (ASD): The ensemble average of the square of the amplitude of the Fourier transform of a signal. The Auto-Spectral Density (ASD), also known as a Power Spectral Density, is proportional to the power content of a signal. The integral of the area under an ASD is the mean square value of the signal.

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