

Noise measurements for UAS (unmanned aircraft systems)

Contents

Page

| | |
|---|-----------|
| Foreword | v |
| Introduction | vi |
| 1 Scope | 1 |
| 2 Normative reference documents | 1 |
| 3 Terms and definitions | 1 |
| 4 Abbreviated terms | 5 |
| 5 Instrumentation | 5 |
| 5.1 General | 5 |
| 5.2 Calibration | 5 |
| 6 General requirements | 5 |
| 6.1 General | 5 |
| 6.2 Requirements of acoustic far-field condition | 6 |
| 6.3 Requirements of position of UAS to reduce aerodynamic flow effect | 6 |
| 6.4 Requirements of position control | 6 |
| 6.4.1 General | 6 |
| 6.4.2 Requirement of position accuracy | 6 |
| 6.4.3 Requirement of speed accuracy | 7 |
| 6.5 Requirements of background noise | 7 |
| 7 Anechoic chamber tests | 7 |
| 7.1 General | 7 |
| 7.2 Requirements of anechoic chamber | 8 |
| 7.2.1 Size | 8 |
| 7.2.2 Anechoic chamber qualification | 8 |
| 7.3 Measurement configurations | 8 |
| 7.3.1 General | 8 |
| 7.3.2 Hover and yaw: 4-microphone approach | 10 |
| 7.3.3 Hover and yaw: multiple microphone approach | 12 |
| 7.3.4 Take-off and landing | 13 |
| 7.3.5 Cruise flight | 15 |
| 8 Anechoic wind tunnel tests | 16 |
| 8.1 General | 16 |
| 8.2 Requirements of anechoic wind tunnel | 16 |
| 8.2.1 General | 16 |
| 8.2.2 Wind tunnel test configurations | 16 |
| 8.2.3 Refraction correction | 17 |
| 8.2.4 Microphone clearance distance | 17 |
| 8.2.5 Anechoic chamber size | 17 |
| 8.3 Measurement configurations | 17 |
| 8.3.1 General | 17 |
| 8.3.2 Take-off and landing | 18 |
| 8.3.3 Cruise flight | 20 |
| 9 Outdoor tests | 22 |
| 9.1 General | 22 |
| 9.2 Recommendations of the test site | 23 |
| 9.3 Recommendations and requirements of the meteorological conditions | 24 |

| | | |
|--|---|-----------|
| 9.4 | Microphone configuration and layout | 24 |
| 9.4.1 | Microphone configuration | 24 |
| 9.4.2 | Microphone layout | 24 |
| 9.5 | Measurement corrections and limitations | 25 |
| 9.6 | Measurement procedures | 26 |
| 9.6.1 | General | 26 |
| 9.6.2 | Hover and yaw | 26 |
| 9.6.3 | Take-off and landing | 26 |
| 9.6.4 | Cruise flight | 27 |
| 10 | Uncertainties | 27 |
| 10.1 | General | 27 |
| 10.2 | Uncertainty sources and requirements | 27 |
| 10.3 | Evaluation of the uncertainty | 28 |
| 11 | Information to report | 29 |
| 11.1 | Test methods | 29 |
| 11.2 | Selected noise metrics | 29 |
| 11.3 | UAS under test | 29 |
| 11.4 | Test environment | 29 |
| 11.5 | Data acquisition system | 29 |
| 11.6 | Measurement | 30 |
| 11.7 | Results | 30 |
| Annex A (Informative) Examples of the procedures to compute noise metrics from the recorded sound pressure signals | 31 | |
| Annex B (Informative) Numerical examination of the acoustic far-field condition | 34 | |
| Annex C (Informative) Measurement of far-field condition for a UAS propeller noise | 38 | |
| Annex D (Informative) An example of adjusting the UAS location to realize different equivalent observer angles | 40 | |
| Annex E (Informative) The effect of using windscreen for UAS propeller noise measurements | 41 | |
| Annex F (Informative) Examples of ground-board mounted microphone configurations | 43 | |
| Annex G (Informative) Uncertainty analysis example of a UAS noise measurement | 45 | |
| Bibliography | 48 | |