



ESDU 17012

Issued December 2017
Supersedes ESDU 66017

Combination of levels in dB



Endorsed by
The Royal Aeronautical Society

ESDU DATA ITEMS

Data Items provide validated information in engineering design and analysis for use by, or under the supervision of, professionally qualified engineers. The data are founded on an evaluation of all the relevant information, both published and unpublished, and are invariably supported by original work of ESDU staff engineers or consultants. The whole process is subject to independent review for which crucial support is provided by industrial companies, government research laboratories, universities and others from around the world through the participation of some of their leading experts on ESDU Technical Committees. This process ensures that the results of much valuable work (theoretical, experimental and operational), which may not be widely available or in a readily usable form, can be communicated concisely and accurately to the engineering community.

We are constantly striving to develop new work and review data already issued. Any comments arising out of your use of our data, or any suggestions for new topics or information that might lead to improvements, will help us to provide a better service.

THE PREPARATION OF THIS DATA ITEM

The work on this particular Data Item which supersedes ESDU 66017, was monitored and guided by the Vibration and Acoustic Fatigue Committee. This Committee first met in 1966 and now has the following membership:

Chairman	
Prof. R.D. Adams	— University of Bristol
Members	
Dr N.S. Ferguson	— University of Southampton
Mr E. Green	— Rolls-Royce plc, Derby
Dr P. Green*	— BAE Systems, Preston, Lancashire
Dr A. Grillenbeck*	— IABG Space Test Center, Germany
Mr A.R. Harris*	— Northrop Grumman, USA
Dr D.M.A. Millar*	— Bombardier Aerospace Short Brothers plc, Belfast
Mr C.D. Munger*	— The Boeing Company, USA
Dr S. Patsias	— Rolls-Royce plc, Derby
Dr J. Santiago Prowald*	— European Space Agency (ESTEC), The Netherlands
Mr E. Smyth	— Bombardier Aerospace Short Brothers plc, Belfast
Prof. R.G. White	— University of Southampton (Member Emeritus)
Dr. Ir. J.J. Wijker	— University of Twente, Enschede, The Netherlands.

* Corresponding Member

The construction and subsequent development of the Data Item were undertaken by

Dr J. Anderson	— Principal Engineer
Dr M. Bratos-Anderson	— Consultant

The person with overall responsibility for the work in this subject area is Dr C.B. Chinoy, Head of the Aircraft Noise and Structural Dynamics Group.

COMBINATION OF LEVELS IN DB (SUPERSEDES ESDU 66017)

CONTENTS

	Page
1. NOTATION	1
2. ADDITION OF LEVELS IN dB	1
3. SUBTRACTION OF BACKGROUND LEVELS IN dB	4
3.1 Example	5
4. REFERENCE	5

COMBINATION OF LEVELS IN dB (supersedes ESDU 66017)

1. NOTATION

C	correction to be subtracted from total sound pressure level	dB
L	sound pressure level (of all sources)	dB
L_{bg}	sound pressure level of background noise	dB
L_i	sound pressure level of i^{th} sound source ($i = 1, 2, \dots$)	dB
L_1	sound pressure level of first source; sound pressure level corrected for background noise (Section 3)	dB
n	number of sound sources	
p	sound pressure caused by n sound sources	Pa
p_i	sound pressure of i^{th} sound source	Pa
p_{ref}	reference sound pressure (2×10^{-5})	Pa
p_{rms}	r.m.s. sound pressure	Pa
ΔL	amount of level to be added to L_1 (Section 2)	dB
—	indication of averaging over time	

2. ADDITION OF LEVELS IN dB

The concept of levels is associated with the decibel scale, which is applied in acoustics to the ratios of physical magnitudes, such as mean-squared sound pressures, sound intensities and sound powers. The decibel scale is logarithmic, hence it provides a compact presentation of measurement data obtained for a wide range of sound pressure amplitudes. The sound level is specified relative to a reference level and its value is given in decibels (dB). The method, described in this Item, is concerned with combining sound pressure levels. The method applies to sound fields with many sources, which are mutually incoherent (Pierce, 1989). In other words the signals from the sources must be statistically independent. The cross correlation between the two signals would be zero.

The sound pressure level enables the r.m.s. sound pressure p_{rms} to be expressed in a logarithmic scale. The sound pressure level L in decibels (dB) is defined as

$$L = 10 \log \frac{p_{rms}^2}{p_{ref}^2}, \quad (2.1)$$

where $p_{rms}^2 = \overline{p^2(t)}$ and p_{ref} is a reference sound pressure, normally 2×10^{-5} Pa. The mean-squared