NEMA Standards Publication

NEMA MS 1-2008 (R2014, R2020)

Standard for Determination of Signal-to-Noise Ratio (SNR) in Diagnostic Magnetic Resonance Imaging

National Electrical Manufacturers Association

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Determination of Signal-to-Noise Ratio (SNR)
in Diagnostic Magnetic Resonance Imaging

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Contents

Preamble

This is one of a series of test Standards developed by the medical diagnostic imaging industry for the measurement of performance parameters governing image quality of magnetic resonance (MR) imaging systems. These test Standards are intended for the use of equipment manufacturers, prospective purchasers, and users alike.

Manufacturers are permitted to use these Standards for the determination of system performance specifications. This standardization of performance specifications is of benefit to the prospective equipment purchaser, and the parameters supplied with each NEMA measurement serve as a guide to those factors that can influence the measurement. These Standards can also serve as reference procedures for acceptance testing and periodic quality assurance.

It must be recognized, however, that not all test Standards lend themselves to measurement at the installation site. Some test Standards require instrumentation better suited to factory measurements, while others require the facilities of an instrumentation laboratory to assure stable test conditions necessary for reliable measurements.

The NEMA test procedures are carried out using the normal clinical operating mode of the system. For example, Standard calibration procedures, Standard clinical sequences, and Standard reconstruction processes shall be used. No modifications to alter test results shall be used unless otherwise specified in these Standards.

The NEMA Magnetic Resonance Section has identified a set of key magnetic resonance image quality parameters. This Standards publication describes the measurement of one of these parameters.

Equivalence

It is intended and expected that manufacturers or others who claim compliance with these NEMA Standard test procedures for the determination of image quality parameters shall have carried out the tests in accordance with the procedures specified in the published Standards.

In those cases where it is impossible or impractical to follow the literal prescription of a NEMA test procedure, a complete description of any deviation from the published procedure must be included with any measurement claimed equivalent to the NEMA Standard. The validity or equivalence of the modified procedure will be determined by the reader.

Uncertainty of the Measurements

The measurement uncertainty of the image quality parameter determined using this Standards publication is to be reported together with the value of the parameter. Justification for the claimed uncertainty limits shall also be provided by a listing and discussion of sources and magnitudes of error.

Foreword

This Standards publication is classified as a NEMA Standard unless otherwise noted. It describes four methods to measure image signal-to-noise ratio (SNR). It is intended for use by MRI system manufacturers, manufacturers of accessory equipment (including radiofrequency coils), and by MRI end users.

The major feature of the first method is that the SNR performance of the system is evaluated using a Standard clinical scan procedure. However, it should be noted that since this method involves the subtraction of two images, it can be very sensitive to system instabilities that may occur during the data acquisition process. If results are highly variable, it is advisable to perform the alternative calculation of Standard deviation, described in method #1, or use methods #2, #3, or #4. These alternative methods have been designed to be less susceptible to system instabilities and can be used to determine if any variability in the SNR is due to system instability or genuinely poor SNR. Both methods are intended to measure thermal and other broadband, non-structured noise, and specifically do not address low frequency variations in an image or artifacts as defined herein.

This Standards publication has been developed by the Magnetic Resonance Section of the National Electrical Manufacturers Association. User needs have been considered throughout the development of this publication. Proposed or recommended revisions should be submitted to:

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This Standards publication was developed by the Magnetic Resonance Section. Section approval of the Standard does not necessarily imply that all section Members voted for its approval or participated in its development. At the time it was approved, the Magnetic Resonance Section was composed of the following Members:

Computer Imaging Reference Systems—Norfolk, VA
GE Healthcare, Inc.—Milwaukee, WI
Hitachi Medical Systems America, Inc.—Twinsburg, OH
Invivo—Gainesville, FL
Philips Healthcare—Andover MA
Siemens Medical Solutions, Inc.—Malvern, PA
Toshiba America Medical Systems—Tustin, CA

Rationale

Image SNR is a parameter that relates to clinical usefulness of magnetic resonance images and also is a sensitive measure of hardware performance. Experience has shown that variations in system calibration, gain, coil tuning, radiofrequency shielding, or other similar parameters are usually demonstrated by a corresponding change in image SNR.

Scope

This document defines methods for measuring the signal-to-noise ratio of magnetic resonance images obtained under a specific set of conditions and using single-channel volume receiver coils. This document does not address the use of special purpose coils (see MS 6) or coils that employ multiple receiver channels for operation (see MS 9).