

References (database v4.2, 04.06.2024)

References for the low frequency dielectric conductivities listed in our material properties database. Values for tissues of which the properties are not available in the literature are substituted with values from other tissues. In these cases, the tissue used for the value is listed instead of a reference. The rationale for each individual substitution is provided in the Rationale for Tissue Substitutions.

| Tissue | Low Frequency Conductivity |
|---------------------------|---|
| Air | Gabriel et al., 1996 |
| Bile | Gabriel et al., 2009 Geddes and Baker, 1967 |
| Blood | Gabriel et al., 2009 Geddes and Baker, 1967 Hahn et al., 1980 Mohapatra and Hill, 1975 Istuk et al., 2021 |
| Blood Plasma | Geddes and Baker, 1967 |
| Blood Serum | Geddes and Baker, 1967 |
| Blood Vessel Wall | Gabriel et al., 1996 |
| Bone | Geddes and Baker, 1967 |
| Bone (Cancellous) | Saha and Williams, 1989 Sierpowska et al., 2003 Gabriel et al., 1996 |
| Bone (Cortical) | Balmer et al., 2018 |
| Bone (Cortical) - Accross | Reddy and Saha, 1984 |
| Bone (Cortical) - Along | Reddy and Saha, 1984 |
| Bone (Cortical) - Around | Reddy and Saha, 1984 |
| Bone Marrow (Red) | Ibrahim et al., 2019 Padhani et al., 2013 Sigman et al., 1936 |
| Bone Marrow (Yellow) | Gabriel et al., 1996 Haacke et al., 1991 Padhani et al., 2013 |

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| Tissue | Low Frequency Conductivity |
|--|--|
| Brain | Akhtari et al.,2006 Baysal et al., 2004 Cohen et al., 1983 Dabek et al., 2016 Dannhauer et al., 2011 Eriksen et al., 1990 Freygang and Landau, 1955 Geddes and Baker, 1967 Goncalves et al., 2003a Goncalves et al., 2003b Gutierrez et al., 2004 Haacke et al., 1991 Hampe et al., 2018 Kim et al., 2014 Lee et al., 2015 Oostendorp et al., 2000 Van Harreveld et al.,1963 |
| Brain (Grey Matter) | Chauhan et al., 2018 Gattellaro et al., 2009 Gurler et al., 2016 Huang et al., 2017 Koessler et al., 2015 Latikka et al., 2001 Michel et al., 2017 Oypornkochagorn et al., 2014 Pierpaoli et al., 1996 Raicu et al., 1998 Rullmann et al., 2009 Sekino et al., 2005 Sorensen et al., 1999 Stoy et al., 1982 Ulug et al., 1999 Van Harreveld et al.,1963 vanLier et al., 2012 Voigt et al., 2011 Wang et al., 2010 Yedlin et al., 1974 Zhang et al., 2013 Gabriel et al., 1996 |
| Brain (Grey Matter) - x along | Yedlin et al., 1974 |
| Brain (Grey Matter) - y across | Yedlin et al., 1974 |
| Brain (Grey Matter) - z Normal to Surface Axis | Yedlin et al., 1974 |

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| Tissue | Low Frequency Conductivity |
|--------------------------------------|--|
| Brain (White Matter) | Gattellaro et al., 2009 Gurler et al., 2016 Horger et al., 2009 Huang et al., 2017 Huhndorf et al., 2013 Koessler et al., 2015 Latikka et al., 2001 Oypornkochagorn et al., 2014 Pierpaoli et al., 1996 Ropella et al., 2017 Rullmann et al., 2009 Sekino et al., 2005 Sorensen et al., 1999 Stoy et al., 1982 Ulug et al., 1999 Voigt et al., 2009 Voigt et al., 2011 Zhang et al., 2013 Gabriel et al., 1996 |
| Brain (White Matter) - across fibers | Güllmar et al., 2010 Jahng et al., 2021 Nicholson, 1965 |
| Brain (White Matter) - along fibers | Chauhan et al., 2018 Jahng et al., 2021 Nicholson, 1965 |
| Breast Fat | Fat |
| Breast Gland | Jossinet, 1998 |
| Bronchi | Sanchez et al., 2013 |
| Bronchi lumen | Air |
| Cartilage | Aoki et al., 2012 Binette et al., 2004 Juras et al., 2007 Morita et al., 2012 de Visser et al., 2008 |
| Cerebellum | Hiwatashi et al., 2014 Huhndorf et al., 2013 Voigt et al., 2009 Nicholson and Freeman, 1975 |
| Cerebellum - x | Nicholson and Freeman, 1975 |
| Cerebellum - y | Nicholson and Freeman, 1975 |
| Cerebellum - z | Nicholson and Freeman, 1975 |

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| Tissue | Low Frequency Conductivity |
|---------------------------|---|
| Cerebrospinal Fluid | Baumann et al., 1997 Chauhan et al., 2018 Cohen et al., 1983 Gurler et al., 2016 Haacke et al., 1991 Huang et al., 2017 Jahng et al., 2021 Lee et al., 2016 Michel et al., 2017 Oypornkochagorn et al., 2014 Pierpaoli et al., 1996 Ropella et al., 2017 Sorensen et al., 1999 Ulug et al., 1999 vanLier et al., 2011 Voigt et al., 2009 Voigt et al., 2011 Zhang et al., 2013 Gabriel et al., 2009 |
| Cervix | Gabriel et al., 2009 Gabriel et al., 1996 |
| Commissura Anterior | Brain (White Matter) |
| Commissura Posterior | Brain (White Matter) |
| Connective Tissue | Jossinet, 1998 |
| Diaphragm | Muscle |
| Diaphragm - Parallel | Muscle - Parallel |
| Diaphragm - Perpendicular | Muscle - Perpendicular |
| Dorsal Column | Rank and BeMent, 1965 |
| Dorsal Column - Across | Rank and BeMent, 1965 |
| Dorsal Column - Along | Rank and BeMent, 1965 |
| Ductus Deferens | Blood Vessel Wall |
| Dura | Oozeer et al., 2005 Sin and Coburn, 1983 |
| Epididymis | Ovary |
| Esophagus | Large Intestine |
| Esophagus Lumen | Air |
| Extracellular Fluids | Baysal et al., 2004 Karatag et al., 2015 Razek and Samir, 2019 |
| Eye (Aqueous Humor) | Cerebrospinal Fluid |
| Eye (Choroid) | Blood |
| Eye (Ciliary Body) | Muscle |
| Eye (Cornea) | Eye (Sclera) |
| Eye (Iris) | Muscle |
| Eye (Lens) | Pauly and Schwan, 1964 |
| Eye (Retina) | Brain (Grey Matter) |
| Eye (Sclera) | Gabriel et al., 1996 |
| Eye (Vitreous Humor) | Pauly and Schwan, 1964 Meral and Bilgili, 2010 |
| Eye Lens (Cortex) | Pauly and Schwan, 1964 |
| Eye Lens (Nucleus) | Pauly and Schwan, 1964 |
| Tissue | Low Frequency Conductivity |

| | |
|----------------------------|---|
| Fat | Gabriel et al.,2009 Geddes and Baker, 1967 Hahn et al., 1980 Hershkovic et al., 2019 Jossinet, 1998 Lee et al., 2016 Rush et al., 1963 Schwan and Kay, 1957 Gabriel et al., 1996 |
| Fat (Average Infiltrated) | Fat |
| Fat (Not Infiltrated) | Fat |
| Gallbladder | Bladder Wall |
| Heart Lumen | Blood |
| Heart Muscle | Cinca et al., 1997 Ellenby et al., 1987 Fallert et al., 1993 Gabriel et al.,2009 Geddes and Baker, 1967 Hahn et al., 1980 Schwan and Kay, 1957 Smith et al., 1995 Tsai et al., 2002 Gabriel et al., 1996 |
| Heart Muscle - Longitudial | Rush et al., 1963 Steendijk et al., 1994 |
| Heart Muscle - Longitudial | Rush et al., 1963 Steendijk et al., 1994 |
| Hippocampus | Brain (Grey Matter) |
| Hypophysis | Hiwatashi et al., 2014 |
| Hypothalamus | Brain (Grey Matter) |
| Intervertebral Disc | Cartilage |
| Kidney | Hahn et al., 1980 Stoy et al., 1982 Gabriel et al., 1996 |
| Kidney (Cortex) | Kidney |
| Kidney (Medulla) | Kidney |
| Large Intestine | Gabriel et al., 1996 |
| Large Intestine Lumen | Muscle |
| Larynx | Cartilage |
| Liver | Gabriel et al.,2009 Geddes and Baker, 1967 Haemmerich et al., 2009 Hahn et al., 1980 Raicu et al., 1998 Rush et al., 1963 Schwan and Kay, 1957 Stoy et al., 1982 Zurbuchen et al., 2010 |

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| Tissue | Low Frequency Conductivity |
|------------------------|---|
| Lung | Geddes and Baker, 1967 Schwan and Kay, 1957 |
| Lung (Deflated) | Gabriel et al.,2009 Hahn et al., 1980 Rush et al., 1963 |
| Lung (Inflated) | Gabriel et al.,2009 Hahn et al., 1980 Rush et al., 1963 |
| Lymphnode | Spleen |
| Mandible | Bone (Cortical) Epstein and Foster, 1983 Geddes and Baker, 1967 Rush et al., 1963 |
| Medulla Oblingata | Michel et al., 2017 |
| Meniscus | Cartilage |
| Mucous Membrane | Muscle |
| Midbrain | Michel et al., 2017 |
| Muscle | Gabriel et al.,2009 Geddes et al., 1967 Haacke et al., 1991 Stoy et al., 1982 Gabriel et al., 1996 |
| Muscle - Parallel | Gabriel et al.,2009 Epstein and Foster, 1983 Geddes and Baker, 1967 Rush et al., 1963 |
| Muscle - Perpendicular | Gabriel et al.,2009 Epstein and Foster, 1983 Geddes and Baker, 1967 Rush et al., 1963 |
| Nerve | Brain (White Matter) |
| Ovary | Gabriel et al., 1996 |
| Pancreas | Geddes and Baker, 1967 |
| Patella | Bone (Cortical) |
| Penis | Blood Vessel Wall |
| Pharynx | Air |
| Pineal Body | Thyroid Gland |
| Placenta | Blood |
| Pons | Hiwatashi et al., 2014 Michel et al., 2017 |
| Prostate | Halter et al., 2007 |
| Salivary Gland | Prostate |
| SAT (Subcutaneous Fat) | Fat |
| Scalp | Armugam et al., 2017 Baysal et al., 2004 Cohen et al., 1983 Dabek et al., 2016 Dannhauer et al., 2011 Eriksen et al., 1990 Fernandez-Corazza et al., 2018 Gutierrez et al., 2004 Huang et al., 2017 |

| Tissue | Low Frequency Conductivity |
|-----------------------|--|
| Seminal vesicle | Prostate |
| Skin | Hershkovic et al., 2019 Yamamoto and Yamamoto, 1976 Wake et al., 2016 |
| Skull | Akhtari et al., 2002 Armugam et al., 2017 Baysal et al., 2004 Clerc et al., 2005 Cohen et al., 1983 Dabek et al., 2016 Dannhauer et al., 2011 Eriksen et al., 1990 Fernandez-Corazza et al., 2018 Goncalves et al., 2003a Goncalves et al., 2003b Gutierrez et al., 2004 Huang et al., 2017 Law et al., 1993 Oostendorp et al., 2000 |
| Skull (Compact) | Fernandez-Corazza et al., 2018 |
| Skull (Cancellous) | Gabriel et al., 2009 |
| Skull (Cortical) | Gabriel et al., 2009 |
| Skull (Inner Compact) | Akhtari et al., 2002 |
| Skull (Outer Compact) | Akhtari et al., 2002 Tang et al., 2008 |
| Skull (Spongy) | Akhtari et al., 2002 Fernandez-Corazza et al., 2018 |
| Skull (Suture) | Law et al., 1993 Tang et al., 2008 |
| Small Intestine | Large Intestine |
| Small Intestine Lumen | Muscle |
| Spinal Cord | Facon et al., 2005 Hasseltine et al., 2005 Song et al., 2011 |
| Spleen | Geddes and Baker, 1967 Hahn et al., 1980 Stoy et al., 1982 Gabriel et al., 1996 |
| Stomach | Large Intestine |
| Stomach Lumen | Muscle |
| Tendon\Ligament | Gabriel et al., 1996 |
| Testis | Ovary |
| Thalamus | Michel et al., 2017 |
| Thymus | Spleen and Fat |
| Thyroid Gland | Gabriel et al., 1996 |
| Tongue | Muscle |

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|----------------------|--|
| Tooth | Bone (Cortical) |
| Tooth (Dentine) | Bone (Cortical) |
| Tooth (Enamel) | Bone (Cortical) |
| Trachea Lumen | Air |
| Ureter\Urethra | Blood Vessel Wall |
| Urinary Bladder Wall | Keshtkar et al., 2006 |
| Urine | Geddes and Baker, 1967 |
| Uterus | Gabriel et al., 1996 |
| Vagina | Large Intestine |
| Vertebrae | Bone (Cortical) |
| Water | Aldosky and Shamdeen, 2011 |

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