# Nomenclature

| | | |
|---|---|---|
| $a_n$ | $n^{th}$ relative skew multipole component | - |
| $A$ | enclosed surface | $m^2$ |
| $A_n$ | $n^{th}$ multipole skew component | T |
| $A_{str}$ | cross-section of a strand | $m^2$ |
| $b_n$ | $n^{th}$ relative normal multipole component | - |
| $B$, **B** | magnetic field | T |
| $B_a$ | applied magnetic field | T |
| $B_{bi}$ | field caused by the BICCs | T |
| $B_C$ | critical magnetic field | T |
| $B_{cc}$ | field caused by the coupling currents | T |
| $B_{ce}$ | central field in the aperture of a magnet | T |
| $B_{geo}$ | field caused by geometrical deviations | T |
| $B_i$ | induced field | T |
| $B_{if}$ | field caused by the IFCCs | T |
| $B_{inj}$ | injection field | T |
| $B_{is}$ | field caused by the ISCCs | T |
| $B_m$ | field caused by the filament magnetisation | T |
| $B_n$ | $n^{th}$ multipole normal component | T |
| $B_{nucd}$ | field caused by a NUCD | T |
| $B_p$ | penetration field | T |
| $B_q$ | quench field | T |
| $B_s$ | field in the interior of a strand | T |
| $B_{tr}$ | field caused by the transport current | T |
| $B_0$ | constant in the Kim relation | T |
| $d_f$ | diameter filament | m |
| $d_s$ | diameter strand | m |
| $d_s^*$ | diameter of the outer layer of filaments in a strand | m |
| $E$, **E** | electric field | $Vm^{-1}$ |
| $E_{dyn}$ | electric field caused by the dynamic resistance | $Vm^{-1}$ |
| $f$ | frequency | $s^{-1}$ |
| $h_1$, $h_2$ | height of a cable (thick edge and thin edge) | m |

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|---|---|---|
| $I$ | current | A |
| $I_a$ | current in resistance $R_a$ | A |
| $I_c$ | current in resistance $R_c$ | A |
| $I_C$ | critical current | A |
| $I_f$ | surface current density | $Am^{-1}$ |
| $I_{if}$ | net interfilament coupling current | A |
| $I_q$ | quench current | A |
| $I_{q,np}$, $I_{q,p}$ | quench current obtained without/with a precycle | A |
| $I_s$ | coupling current in a strand | A |
| $I_{str}$ | total strand current | A |
| $I_{tr}$ | transport current | A |
| $I_{tr,cab}$ | transport current in a cable | A |
| $I_{tr,str}$ | transport current in a strand | A |
| $I_{tr,str,max}$ | maximum transport current in a strand | A |
| $I_0$, $J_0$ | constants in the Kim relation | A, $Am^{-2}$ |
| $J$, $\mathbf{J}$ | current density | $Am^{-2}$ |
| $J_C$ | critical current density | $Am^{-2}$ |
| $J_{tr}$ | transport current density | $Am^{-2}$ |
| $l_{cab}$ | cable length | m |
| $l_{coil}$ | length of a pick-up coil | m |
| $l_M$ | magnet length | m |
| $l_s$ | length of a strand section between two nodes | m |
| $L$ | inductance | H |
| $L_{p,f}$ | twist pitch of the filaments | m |
| $L_{p,s}$ | twist pitch of the strands (or cable pitch) | m |
| $M$ | magnetisation | $Am^{-1}$ |
| $M$ | mutual inductance | H |
| $n$ | harmonic component | - |
| $n$ | shape factor | - |
| $n$ | $n$-value of the resistive transition | - |
| $N_b$ | band number | - |
| $N_B$ | total number of bands of a cable | - |
| $N_c$ | number of cable pieces in a stack | - |
| $N_{MUT}$ | number of bands for the calculation of mutual inductances | - |
| $N_s$ | number of strands in a cable | - |
| $N_T$ | number of turns in a coil | - |
| $p_{cab}$ | packing factor of a cable | - |
| $P$ | power loss | W |
| $P_a$ | power loss in the resistances $R_a$ | W |
| $P_c$ | power loss in the resistances $R_c$ | W |
| $P_{cool}$ | cooling power | W |
| $P_{if}$ | interfilament coupling power loss | W |
| $P_R$ | power loss in the connections | W |
| $P_s$ | power loss in the strands | W |

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|---|---|---|
| $P_{wed}$ | power loss in the wedges | W |
| $q$ | effective thermal-conductivity coefficient | $Wm^{-3}K^{-1}$ |
| $Q_{hys}$ | hysteresis loss | J |
| $Q_{if}$ | interfilament coupling loss | J |
| $Q_{is}$ | interstrand coupling loss | J |
| $Q_{tot}$ | total loss | J |
| $r$ | radius | m |
| $r_0$ | reference radius | m |
| $R$ | resistance | Ω |
| $R_a$ | contact resistance between adjacent strands | Ω |
| $R_c$ | contact resistance between crossing strands | Ω |
| $R_{c,UI}$ | $R_c$-value determined by the UI method | Ω |
| $R_{mat}$ | resistance of the matrix | Ω |
| $R_s$ | strand resistance | Ω |
| $t$ | time | s |
| $t_d$ | decay time | s |
| $t_m$ | time at the discrete step $m$ | s |
| $t_r$ | ramp time | s |
| $T$ | temperature | K |
| $T_b$ | helium bath temperature | K |
| $T_{cab}$ | cable temperature | K |
| $T_C$ | critical temperature | K |
| $T_M$ | field factor of a magnet | $TA^{-1}$ |
| $U$ | voltage | V |
| $U_{ee}$ | voltage between the strands at both edges of a cable | V |
| $U_{ind}$ | induced or inductive voltage | V |
| $U_R$ | resistive voltage | V |
| $U_{str}$ | voltage over a strand | V |
| $v_1$, $v_2$, $v_3$ | volume fractions | - |
| $V$ | volume | $m^3$ |
| $w$ | width of a cable | m |
| $x$, $y$, $z$ | cartesian coordinates | m |
| $x_0$, $y_0$ | reference point | m |

**Greek symbols**

| | | |
|---|---|---|
| $\alpha_{cond}$ | aspect ratio of a monolithic conductor | - |
| $\alpha_k$ | keystone angle | deg |
| $\alpha_{cab}$ | aspect ratio of a cable | - |
| $\alpha_0$ | aspect ratio of a cable having strands with a round cross-section | - |
| $\alpha_m$ | coefficient of magnetoresistivity | $T^{-1}$ |
| $\beta_I$ | field geometry factor for the ISCCs | - |
| $\beta_P$ | field geometry factor for the ISCL | - |

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|---|---|---|
| $\beta_{str}$ | field geometry factor at a strand position | - |
| $\eta$ | volumetric proportion of superconductor in a composite | - |
| $\theta$ | angle (see Figs. 4.1 and 2.2a) | deg |
| $\lambda$ | copper to superconductor (Cu/SC) ratio | - |
| $\lambda_{cu}$ | thermal conductivity coefficient of copper | $Wm^{-1}K^{-1}$ |
| $\lambda_{ins}$ | thermal conductivity coefficient of a cable insulation | $Wm^{-1}K^{-1}$ |
| $\mu$ | permeability | $Hm^{-1}$ |
| $\mu_{eff}$ | effective permeability | $Hm^{-1}$ |
| $\mu_0$ | permeability of vacuum | $Hm^{-1}$ |
| $\xi$ | characteristic length of the BICCs | m |
| $\rho_{cu}$ | resistivity of copper | Ωm |
| $\rho_{eff}$ | effective transverse resistivity of a strand | Ωm |
| $\rho_c$ | effective resistivity of a cross contact | Ωm |
| $\rho_{mat}$ | matrix resistivity | Ωm |
| $\rho_s$ | effective resistivity of a strand | Ωm |
| $\sigma$ | stress | Pa |
| $\tau$ | time constant | s |
| $\tau_{bi}$ | characteristic time of the BICCs | s |
| $\tau_{if}$ | time constant of the IFCCs | s |
| $\tau_{is}$ | time constant of the ISCCs | s |
| $\varphi$ | angle (see Figs. 3.5 and 4.1) | deg |
| $\omega$ | angular frequency ($=2\pi f$) | rad $s^{-1}$ |

**Common subscripts**

| | |
|---|---|
| $\perp$ | normal component |
| $\|\|$ | parallel component |
| *a* | between adjacent strands |
| *av* | average |
| *bi* | boundary-induced |
| *c* | between crossing strands |
| *cab* | cable |
| *eff* | effective |
| *i* | turn number |
| *if* | interfilament |
| *is* | interstrand |
| *M* | magnet |
| *str* | strand |
| *st* | stack |
| *tot* | total |
| *tr* | transport |

**Abbreviations**

| | |
|---|---|
| A1, A2 | Nomenclature of the apertures (see Fig. 6.4) |
| A11, A12, A21, A22 | Nomenclature of the poles (see Fig. 6.4) |
| B1, B2, …, B6 | Block numbers (see Fig. 2.2b) |
| BICC | Boundary-Induced Coupling Current |
| FPC | Fixed Pick-up Coil (see scetion 7.6) |
| H12, H3, H4, H5, H67 | Pick-up coils (see section 7.7) |
| IFCC | InterFilament Coupling Current |
| ISCC | InterStrand Coupling Current |
| IFCL | InterFilament Coupling Loss |
| ISCL | InterStrand Coupling Loss |
| LHC | Large Hadron Collider |
| NUCD | Non-Uniform Current Distribution |
| PBD | Pink Book Dipole magnet (see Table 2.1) |
| PC | Persistent Current |
| RPC | Rotating Pick-up Coil (see section 7.6) |
| RRL | Ramp Rate Limitation |
| SA | Single-Aperture |
| TA | Twin-Aperture |
| WBD | White Book Dipole magnet (see Table 2.1) |