**Appendix G: Extension Process and Results of L-T Matrix**

（1）Basis for Extension

The extension of the L-T matrix is based on Chinese national standards, and the dimension types are shown in Table 1.

Table 1 Quantity and unit

|  |  |  |
| --- | --- | --- |
| Name | GB | Types |
| Quantity and Unit | GB 3102.1 | Physical quantities of space and time |
| GB 3102.2 | Physical quantities of period and related  |
| GB 3102.3 | Physical quantities of mechanics |
| GB 3102.4 | Physical quantities of electromagnetism |
| GB 3102.5 | Physical quantities of electromagnetism |
| GB 3102.6 | Physical quantities of optics |
| GB 3102.7 | Physical quantities of solid state physics |
| GB 3102.8 | Units of physical chemistry and molecular physics |
| GB 3102.9 | Quantities and Units in Atomic and Nuclear Physics |
| GB 3102.10 | Quantities and units of nuclear reaction and ionizing radiation |
| GB 3102.11 | Mathematical symbols used in physical science and technology |
| GB 3102.12 | Characteristic number |
| GB 3102.13 | Quantities and Units of Solid State Physics |

（2）The process of Extension

The dimension of LT is derived from the definition and unit of physical parameters.

Based on the dimension of the existing L-T matrix, the extension of L-T matrix is completed by querying the L-T dimension of the related physical parameters and performing dimensional operations according to the logic in the expression.

Taking GB 3102.4 thermal quantity and unit as an example, the extension process of L-T matrix is briefly explained. Some thermal quantities and units are shown in Table 2

Table 2 Quantity and unit of thermodynamics

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 项号 | 量的名称 | 符号 | 定义 | 单位 |
| 4-11 | Thermal insulance | M |  | $$m^{2}∙K/W$$ |
| 4-12 | Thermal resistance | R |  | $$K/W$$ |
| 4-13 | Thermal conductance | G |  | $$W/K$$ |
| 4-14 | Thermal diffusivity | a |  | $$m^{2}/s$$ |
| 4-15 | Heat capacity | C |  | $$J/K$$ |

According to the definition of physical parameters dimensional derivation. For example, the thermal resistance R is defined as the temperature divided by the heat flow, and the heat flow is the heat Q passing through a surface in unit time t. The dimension of temperature and heat obtained by querying the relevant dimension is L5T-4，the dimension of time is L0T1，The dimension of thermal resistance R can be obtained by dimensional operation as shown in Eq.(1):

|  |  |  |
| --- | --- | --- |
|  |  | (1) |

The dimensional derivation is carried out according to the unit of physical parameter. Such as the thermal insulation coefficient M unit is$ m^{2}⋅K/W$，By querying the relevant dimensions and calculating, the dimension of the thermal insulation coefficient M is shown in Eq.(2):

|  |  |  |
| --- | --- | --- |
|  |  | (2) |

By analogy, the L-T dimensions of other thermal physical parameters can be derived in the above two ways and combined to obtain an extended thermodynamics L-T matrix.

Similarly, according to the above method, the dimensions of other related physical quantity parameters are derived, so as to construct the L-T matrix of related physical quantity parameters, and finally complete the Extension of L-T matrix. The extended results are shown in Table 3-9.

Table 3 Physical quantities of space and time

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | L-2 | L-1 | L0 | L1 | L2 | L3 | L4 | L5 |
| T-5 |  |  |  |  |  |  |  |  |
| T-4 |  |  |  |  |  |  |  |  |
| T-3 |  |  |  |  |  |  |  |  |
| T-2 |  |  | Angular Acceleration | Acceleration, Free fall |  |  |  |  |
| T-1 |  |  | Angular frequency, Frequency, Speed | Velocity |  | Loss of machine of volume |  |  |
| T0 |  | Curvature | Angle, Solid angle | Length, Width, Height, Thickness, Radius, Diameter, Length, Distance, Cartesian coordinates, Curvature radius | Area | Volume |  |  |
| T1 |  |   | Time |  |  |  |  |  |
| T2 |  |  |  |  |  |  |  |  |
| T3 |  |  |  |  |  |  |  |  |

Table 4 Physical quantities of mechanics

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | L-2 | L-1 | L0 | L1 | L2 | L3 | L4 | L5 |
| T-5 |  |  |  |  |  |  |  | power |
| T-4 |  |  |  |  | Pressure, Normal stress, Shear stress, Elastic modulus, Shear modulus, Rigid quantity, Modulus, Bulk modulus | Surface tension | Force, Weight | Torque, Force moment, Torque, Energy, Work, Potential energy, Kinetic energy |
| T-3 |  |  |  |  | ( dynamic ) Viscosity | Mass flow | Momentum, Impulse, | Moment of momentum, Angular momentum, Angular impulse |
| T-2 |  |  | Volume mass | Surface quality, Surface density | Line quality, Linear density | Quality |  | Rotational inertia, Moment of inertia |
| T-1 |  |  |  |  | Kinematic viscosity, | Volumetric flowrate |  |  |
| T0 |  |  | Relative volume mass, Relative ( mass ) density, Gravitational constant |  |  | Factor of section | Sectional secondary Moment, sectional secondary moment axis moment, Moment of inertia, Secondary cross section |  |
| T1 |  |  | Mass volume, Specific volume |  |  |  |  |  |
| T2 | ( volume ) Compression ratio |  |  |  |  |  |  |  |
| T3 |  |  |  |  |  |  |  | Power |

Table 5 Physical quantities of thermodynamics

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | L-2 | L-1 | L0 | L1 | L2 | L3 | L4 | L5 |
| T-5 |  |  |  |  |  |  |  |  |
| T-4 |  |  |  |  |  | Area, Heat flow |  | Heat flow rate |
| T-3 |  |  |  |  |  |  | Temperature gradient | Celsius temperature, Thermodynamic energy, Thermodynamic temperature, Heat, Energy, Enthalpy |
| T-2 |  |  |  |  |  |  |  |  |
| T-1 |  |  |  |  | Mass energy, Mass thermodynamic energy, Mass enthalpy, Mass Helmholtz free energy, Mass Gibbs free energy |  |  | 、 |
| T0 | Heat transfer coefficient | Thermal conductivity | Conductance |  | Thermal diffusivity |  |  |  |
| T1 |  |  | Heat capacity, Mass heat capacity ratio, Isentropic exponent,Entropy, Planck function |  |  |  |  |  |
| T2 |  |  | Thermal resistance |  |  |  |  |  |
| T3 |  |  |  |  |  |  |  |  |

Table 6 Physical quantities of electromagnetism

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | L-2 | L-1 | L0 | L1 | L2 | L3 | L4 | L5 |
| T-5 |  |  |  |  |  | Poynting vector |  | ( DC ) Power, ( Active ) Power, Apparent power, Performance power, Reactive power,  |
| T-4 |  |  |  |  | Volume electromagnetic energy, Electromagnetic energy density, |  |  | ( Active ) Electrical energy,  |
| T-3 |  |  |  | Area current, Current density | Electric field intensity, Wire current, Current line density, Magnetic field intensity, Magnetization intensity, | Current, Magnetic potential difference, Magnetic potential difference, Magnetic flux potential, Magnetomotive force, Current chain,  |  | ( surface ) Magnetic moment |
| T-2 |  |  | Volume charge | Area charge, Electric flux density, Electric polarization intensity, Magnetoresistance,  | Potential, Potential, Potential difference, Potential difference, Voltage, Electromotive force, | Charge, Electric flux, | Electric dipole moment |  |
| T-1 |  |  | Magnetic flux density, Magnetic induction intensity, Magnetic polarization intensity, Conductivity, Frequency, Rotation frequency, Angular frequency | Magnetic vector position, Magnetic vector potential, Phase plane velocity of electromagnetic wave, Propagation velocity of electromagnetic wave in vacuum, ( DC ) Conduction, Admittance, Admittance mode, ( AC ) Conductivity, Electrona | Magnetic flux, |  |  |  |
| T0 |  |  | Dielectric constant, Vacuum dielectric constant, Relative dielectric constant, Relative capacitance rate, Electric polarization rate, Coupling factor, Coupling system, Magnetic flux leakage factor, Magnetic flux leakage coefficient, Relative permeability, Magnetic susceptibility, Number of winding turns, Phase number, Phase difference, Phase ( displacement ), Quality factor, Loss factor, Loss angle, Power factor, | Capacitance |  |  |  |  |
| T1 |  | ( Current ) Resistance, Impedance, Impedance mode, ( AC ) Resistance, Reactance | Resistivity, |  |  |  |  |  |
| T2 | Magnetic permeability, Vacuum permeability,  | Self-perception, Mutual inductance, Magnetic conductance |  |  |  |  |  |  |
| T3 |  |  |  |  |  | Poynting vector |  | ( DC ) Power, ( Active ) Power, Apparent power, Performance power, Reactive power, |

Table 7 Physical quantities of optics

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | L-2 | L-1 | L0 | L1 | L2 | L3 | L4 | L5 |
| T-5 |  |  |  |  |  |  |  |  |
| T-4 |  |  |  |  |  | Brightness, Radiant energy flow rate, Light emittance, Radiance, Irradiance, Illuminance |  | Radiation flux, Radiation intensity, Luminous intensity |
| T-3 |  |  |  | Spectral radiation energy density | Radiation energy density | Radiation flow, Radiation exposure, Exposure |  | Radiation energy, Light quantity |
| T-2 |  |  |  |  |  |  |  |  |
| T-1 |  |  |  |  |  |  |  |  |
| T0 | Photon brightness, photon emittance, photon illuminance |  | Frequency, angular frequency, photon flux, photon intensity | light velocity |  |  |  |  |
| T1 | Exposure quantum | Wavenumber, Angular wavenumber, Linear attenuation coefficient, Focal power | Boltzmann constant, Emissivity, spectral emissivity, Spectral directional emissivity, Photon number, Refractive index | Wavelength, Focal length, Object distance, Image distance, Top focal length | Molar absorption coefficient |  |  |  |
| T2 |  |  |  |  |  |  |  |  |
| T3 |  |  |  |  |  |  |  |  |

Table 8 Physical quantities of acoustics

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | L-2 | L-1 | L0 | L1 | L2 | L3 | L4 | L5 |
| T-5 |  |  |  |  |  |  | Sound intensity ( degree ) |  |
| T-4 |  |  | Acoustic stiffness |  |  | Static pressure, Sound pressure, Sound energy density | Quality, Strength | Power |
| T-3 |  |  | Acoustic impedance, Acoustic resistance |  | Acoustic impedance rate, Characteristic impedance, flow resistance |  | Mechanical impedance |  |
| T-2 |  |  | acoustic mass | Density | Particle acceleration, Vibration acceleration |  | Force resistance |  |
| T-1 |  |  |  | Frequency, Angular frequency, Circular frequency, Damping coefficient, Decay constant, Decay rate | Particle velocity, Sound velocity, Vibration velocity |  | Volume velocity, Sound source intensity |  |
| T0 |  |  | Circular wave number, Propagation coefficient, Attenuation coefficient, Phase coefficient | Frequency range, Sound pressure level, Sound intensity level, Sound power number, Logarithmic decrement, Sound pressure reflection coefficient, Sound pressure transmission coefficient, Porosity, Sound insulation, Sound transmission loss, Sound source directivity factor, Sound source pointing factor, Acoustic insertion loss, Vibration transmission ratio | Wavelength, Particle displacement, Vibration displacement | Sound absorption, Acoustic room constant |  |  |
| T1 |  |  |  | Period, Tme constant, Relaxation constant, Reverberation time |  |  |  |  |
| T2 |  |  |  | Free-field sensitivity |  |  |  |  |
| T3 | Force admittance |  |  |  | Acoustic admittance, Acoustic conductance, Sonar |  |  |  |

Table 9 Physical quantities of solid state physics

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | L-2 | L-1 | L0 | L1 | L2 | L3 | L4 | L5 |
| T-5 |  |  |  |  |  |  |  |  |
| T-4 |  |  |  |  |  |  |  | Acceptor ionization energy, Donor ionization energy, Debye temperature, Fermi temperature, Curie temperature, Work function, Electron affinity, Fermi energy, Band gap |
| T-3 |  |  |  |  |  |  |  |  |
| T-2 |  |  |  | Peltier coefficient | Effective mass |  |  |  |
| T-1 |  | Debye frequency, Thermodynamic superconducting critical flux density, Lower critical flux density, Upper critical flux density |  | Fluxon |  |  |  |  |
| T0 | Reciprocal lattice vector, Reciprocal lattice basis vector, Fermi wave number, Debye wave number | Long-order parameter, Short-order parameter, Greeneisen parameter, Madelung constant, Reflection order, Bragg angle, Mobility ratio | Lattice basis vector,Ion equilibrium vector, Ion displacement vector, Phonon ( Electron ) mean free path, Interplanar spacing, Diffusion length, Coherence length |  |  |  |  |  |
| T1 |  | Residual resistivity, Relaxation time, Carrier lifetime |  |  |  |  |  |  |
| T2 |  | Hall coefficient |  |  |  |  |  |  |
| T3 |  |  |  |  |  |  |  |  |