

# \*UNIT

The keyword \*UNIT provides a coherent way to specify units in an LS-DYNA problem: Initially, it will be used to define the default units of a problem, and then the units in any LS-DYNA solver or keyword card that implements this capability. Its initial use is with the \*DUALCESE solver. See Vol. III for details about those solvers. \*DUALCESE uses this unit information to convert to and from external physical databases, such as the EOS libraries REFPROP and COOLPROP. Later, this information will also be used for connecting \*DUALCESE with Chemkin-type chemistry databases.

\*UNIT\_AMOUNT

\*UNIT\_ANGLE

\*UNIT\_DEFAULTS

\*UNIT\_DERIVED

\*UNIT\_ELECTRIC\_CURRENT

\*UNIT\_LENGTH

\*UNIT\_LUMINOUS\_INTENSITY

\*UNIT\_MASS

\*UNIT\_SYSTEM

\*UNIT\_TEMPERATURE

\*UNIT\_TIME

**WARNING:** Including these cards in the same input deck with \*INCLUDE\_TRANSFORM with non-unity values for FCTMAS, FCTLEN, or FCTTIM is undefined. The same applies to the case of \*INCLUDE\_TRANSFORM with a non-blank specification for FCTTEM.

# \*UNIT

## \*UNIT\_DEFAULTS

### \*UNIT\_DEFAULTS

Purpose: Specify the user units for the current keyword input deck. These \*UNIT cards are designed for when a solver and an external database to which the solver is connecting are in different units. It is also intended to be used for converting the units of data exchanged between solvers. Other applications are being planned.

*Only one* \*UNIT\_DEFAULTS card is allowed per problem.

Card 1	1	2	3	4	5	6	7	8
Variable	LENGTH	MASS	TIME	TEMP	CURRENT	AMOUNT	LUMIN	ANGLE
Type	A	A	A	A	A	A	A	A
Default	m	kg	sec	K	ampere	mole	candela	radian

VARIABLE	DESCRIPTION
LENGTH	Length units: EQ.M: meter (default) EQ.KM: kilometer EQ.MM: millimeter EQ.CM: centimeter EQ.DM: decimeter EQ.UM: micron EQ.NM: nanometer EQ.MIL: mil EQ.IN: inch EQ.FT: foot EQ.YD: yard EQ.A: Angstrom EQ.MILE: mile EQ.ROD: rod EQ.LIGHTYEAR: lightyear

<b>VARIABLE</b>	<b>DESCRIPTION</b>
MASS	Mass units: EQ.KG: kilogram (default) EQ.G: gram EQ.CENTIG: centigram EQ.MG: milligram EQ.MICROG: microgram EQ.OUNCE: ounce EQ.POUND: pound EQ.POUNDAL: poundal EQ.TON: ton EQ.METRICTON: metric ton EQ.SHORTTON: short ton EQ.SLUG: pound × second <sup>2</sup> / foot EQ.AMU: amu
TIME	Time units: EQ SEC: second (default) EQ.MILLISEC: millisecond EQ.MICROSEC: microsecond EQ.NANOSEC: nanosecond EQ.PICOSEC: picosecond EQ.MIN: minute EQ.HOUR: hour EQ.DAY: day EQ.WEEK: week EQ.MONTH: month EQ.YEAR: year
TEMP	Temperature units: EQ.K: Kelvin (default) EQ.C: Celsius

**\*UNIT****\*UNIT\_DEFAULTS**

<b>VARIABLE</b>	<b>DESCRIPTION</b>
	EQ.F: Fahrenheit EQ.R: Rankine
CURRENT	Electric current units: EQ.AMPERE: ampere (default) EQ.MA: milliampere EQ.ABAMP: abampere EQ.STATSMP: statampere EQ.BIOT: Biot (same as abampere)
AMOUNT	Amount units: EQ.MOLE: moles (default)
LUMIN	Luminosity units: EQ.CANDELA: candela (default) EQ.VIOLLE: violle EQ.CANDLE_GER: Candle Germany
ANGLE	Angle units: EQ.RADIAN: radians (default) EQ.DEGREE: degrees EQ.DEGREE_MIN: degree minute EQ.DEGREE_SEC: degree second EQ.REV: revolutions

**\*UNIT\_DERIVED****\*UNIT****\*UNIT\_DERIVED**

Purpose: Derive a new unit based upon products of powers of \*UNIT default units: m, kg, sec, K, ampere, mole, candela, and radian. This derived unit is then made available for use in the current keyword input deck.

Card 1	1	2	3	4	5	6	7	8
Variable	UNITNAME							
Type	A							
Remarks	2, 4							

Card 2	1	2	3	4	5	6	7	8
Variable	EXP LENG	EXPMASS	EXP TIME	EXPTEMP	EXPCURR	EXPAMT	EXPLUMIN	EXPANGLE
Type	F	F	F	F	F	F	F	F
Default	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Remarks	1	1	1	1, 3	1	1	1	1

VARIABLE	DESCRIPTION
UNITNAME	Name of derived unit
EXP LENG	Power of length unit
EXPMASS	Power of mass unit
EXP TIME	Power of time unit
EXPTEMP	Power of temperature unit
EXPCURR	Power of electric current unit
EXPAMT	Power of amount unit
EXPLUMIN	Power of luminosity unit

**\*UNIT****\*UNIT\_DERIVED**

<b>VARIABLE</b>	<b>DESCRIPTION</b>
EXPANGLE	Power of angle unit

**Remarks:**

1. **Excluding Fundamental Unit.** If the exponent of a given fundamental unit is zero, then that unit is not part of the derived unit.
2. **Validity.** In order to define a valid derived unit, at least one of the fundamental units must have its exponent be nonzero.
3. **Temperature in Derived Unit.** If temperature is involved in deriving a new unit, it must be converting from the Kelvin (K) temperature unit (without a shift).
4. **Availability.** This derived unit is made available for use with all unit systems setup by the user.

**\*UNIT\_AMOUNT****\*UNIT****\*UNIT\_AMOUNT**

Purpose: Specify a new user amount unit to make it available for use in the current keyword input deck.

Card 1	1	2	3	4	5	6	7	8
Variable	AMOUNT_UNIT		AMOUNT_SCALE					
Type	A		F					
Default	none		1.0					

**VARIABLE****DESCRIPTION**

AMOUNT\_UNIT

Name of new amount unit

AMOUNT\_SCALE

Scale factor to convert from this new unit amount to moles

**Remarks:**

1. **Conversion Factor.** The scale factor should be such that:

$$[\text{mole}] = \text{AMOUNT\_SCALE} \times [\text{AMOUNT\_UNIT}] .$$

# \*UNIT

## \*UNIT\_ANGLE

### \*UNIT\_ANGLE

Purpose: Specify a new user angle unit to make it available for use in the current keyword input deck.

Card 1	1	2	3	4	5	6	7	8
Variable	ANGLE_UNIT		ANGLE_SCALE					
Type	A		F					
Default	none		1.0					

VARIABLE	DESCRIPTION
ANGLE_UNIT	Name of new angle unit
ANGLE_SCALE	Scale factor to convert from this new angle unit to radians

### Remarks:

1. **Conversion Factor.** The scale factor should be such that:

$$[\text{radians}] = \text{ANGLE\_SCALE} \times [\text{ANGLE\_UNIT}] .$$

**\*UNIT\_ELECTRIC\_CURRENT**

Purpose: Specify a new user electric current unit to make it available for use in the current keyword input deck.

Card 1	1	2	3	4	5	6	7	8
Variable	EC_UNIT		EC_SCALE					
Type	A		F					
Default	none		1.0					

<b>VARIABLE</b>	<b>DESCRIPTION</b>
EC_UNIT	Name of new electric current unit
EC_SCALE	Scale factor to convert from this new electric current unit to amperes

**Remarks:**

- Unit Conversion.** The scale factor should be such that:

$$[\text{ampere}] = \text{EC\_SCALE} \times [\text{EC\_UNIT}] .$$

# **\*UNIT**

## **\*UNIT\_LENGTH**

### **\*UNIT\_LENGTH**

Purpose: Specify a new user length unit to make it available for use in the current keyword input deck.

Card 1	1	2	3	4	5	6	7	8
Variable	LENGTH_UNIT		LENGTH_SCALE					
Type	A		F					
Default	none		1.0					

<b>VARIABLE</b>	<b>DESCRIPTION</b>
LENGTH_UNIT	Name of new length unit
LENGTH_SCALE	Scale factor to convert from this new length unit to meters

### **Remarks:**

1. **Conversion Factor.** The scale factor should be such that:

$$[m] = \text{LENGTH\_SCALE} \times [\text{LENGTH\_UNIT}] .$$

**\*UNIT\_LUMINOUS\_INTENSITY****\*UNIT****\*UNIT\_LUMINOUS\_INTENSITY**

Purpose: Specify a new user luminous intensity unit to make it available for use in the current keyword input deck.

Card 1	1	2	3	4	5	6	7	8
Variable	LI_UNIT		LI_SCALE					
Type	A		F					
Default	none		1.0					

<b>VARIABLE</b>	<b>DESCRIPTION</b>
LI_UNIT	Name of new luminous intensity unit
LI_SCALE	Scale factor to convert from this new luminous intensity unit to candela

**Remarks:**

- Unit Conversion.** The scale factor should be such that:

$$[\text{candela}] = \text{LI\_SCALE} \times [\text{LI\_UNIT}] .$$

# **\*UNIT**

## **\*UNIT\_MASS**

### **\*UNIT\_MASS**

Purpose: Specify a new user mass unit to make it available for use in the current keyword input deck.

Card 1	1	2	3	4	5	6	7	8
Variable		MASS_UNIT		MASS_SCALE				
Type		A		F				
Default		none		1.0				

<b>VARIABLE</b>	<b>DESCRIPTION</b>
MASS_UNIT	Name of new mass unit
MASS_SCALE	Scale factor to convert from this new mass unit to kilograms

### **Remarks:**

1. **Conversion Factor.** The scale factor should be such that:

$$[\text{kg}] = \text{MASS\_SCALE} \times [\text{MASS\_UNIT}] .$$

**\*UNIT\_SYSTEM****\*UNIT****\*UNIT\_SYSTEM**

Purpose: Specify the user units for the current keyword input deck. These \*UNIT cards are designed for when a solver and an external database to which the solver is connecting are in different units. It is also intended to be used for converting the units of data exchanged between solvers. Other applications are being planned.

For the built-in options for each type of unit, refer to \*UNIT\_DEFAULTS.

Card 1	1	2	3	4	5	6	7	8
Variable	UNITSYS							
Type	A							

Card 2	1	2	3	4	5	6	7	8
Variable	LENGTH	MASS	TIME	TEMP	CURRENT	AMOUNT	LUMIN	ANGLE
Type	A	A	A	A	A	A	A	A
Default	m	kg	sec	K	ampere	mole	candela	radian

VARIABLE	DESCRIPTION
UNITSYS	Name of new unit system
LENGTH	Length units
MASS	Mass units
TIME	Time units
TEMP	Temperature units
CURRENT	Electric current units
AMOUNT	Amount units
LUMIN	Luminosity units
ANGLE	Angle units

# \*UNIT

# \*UNIT\_TEMPERATURE

## \*UNIT\_TEMPERATURE

Purpose: Specify a new user temperature unit to make it available for use in the current keyword input deck.

Card 1	1	2	3	4	5	6	7	8
Variable	TEMP_UNIT		TEMP_SCALE		TEMP_SHIFT			
Type	A		F		F			
Default	none		1.0		0.0			

VARIABLE	DESCRIPTION
TEMP_UNIT	Name of new temperature unit
TEMP_SCALE	Scale factor to convert from this new temperature unit to degrees Kelvin
TEMP_SHIFT	Shift to apply to a temperature in this new temperature unit before applying the TEMP_SCALE scaling to obtain degrees Kelvin

### Remarks:

1. **Unit Conversion.** As the only unit specification that can include a shift, the new temperature unit must satisfy this relation, where [K] represents degrees Kelvin:

$$[K] = \text{TEMP\_SCALE} \times ([\text{TEMP\_UNIT}] + \text{TEMP\_SHIFT})$$

**\*UNIT\_TIME**

Purpose: Specify a new user time unit to make it available for use in the current keyword input deck.

Card 1	1	2	3	4	5	6	7	8
Variable		TIME_UNIT		TIME_SCALE				
Type		A		F				
Default		none		1.0				

<b>VARIABLE</b>	<b>DESCRIPTION</b>
TIME_UNIT	Name of new time unit
TIME_SCALE	Scale factor to convert from this new time unit to seconds

**Remarks:**

1. **Unit Conversion.** The scale factor should be such that:

$$[\text{sec}] = \text{TIME\_SCALE} \times [\text{TIME\_UNIT}] .$$

