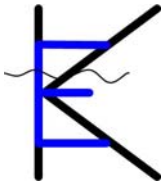
Keron Engineering Pty Ltd
Offshore Engineering Consultants



Excel_ent Formula Checker

VSTO add-in

Document Number KEL-2024-001

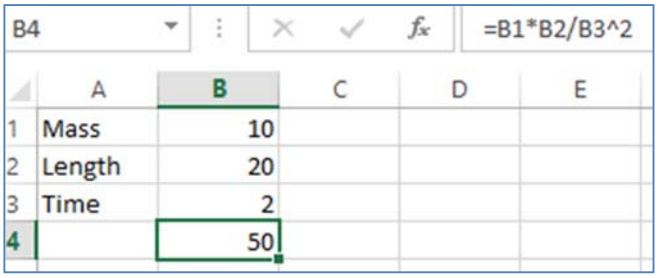
Date	Software Revision	Document revision	Author	Checked
12/8/2025	1.0.0.27	A	NAK	

Contents

1 SUMMARY

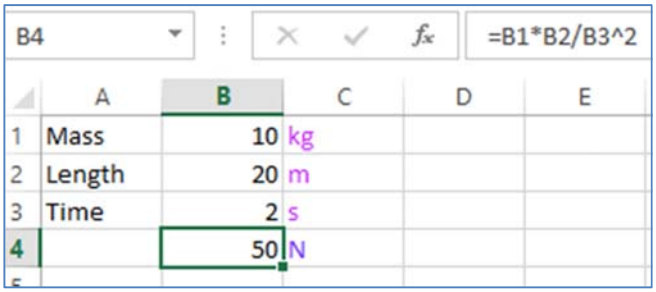
Excel worksheets are notoriously difficult to check and maintain quality of the calculations. The Excel_ent Formula Checker add-in (EFC) provides a powerful quality control tool by performing dimensional analysis of scientific and engineering calculations in an Excel worksheet.

For example, if Excel is being used without the add-in and the user enters values for the quantities mass, length and time at cells B1,B2 and B3.



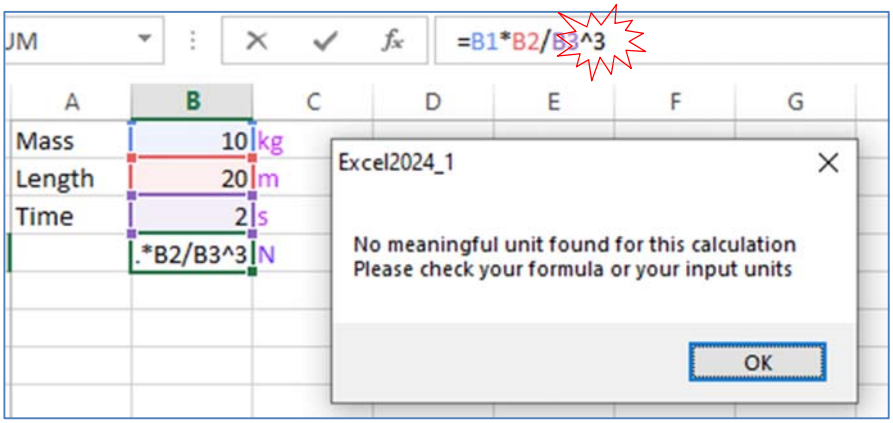
If the user enters the formula = B1*B2/B3^2 at cell B4, the quantity calculated is a force in Newtons. But if the user mistakenly enters =B1*B2/B3^3, Excel still calculates a valid number but the quantity is not a force. Only a rigorous check of the worksheet would find this error.

When the Formula Checker add-in is switched on, with a few simple keystrokes, the user can enter SI units of the quantities at B1 – B3.

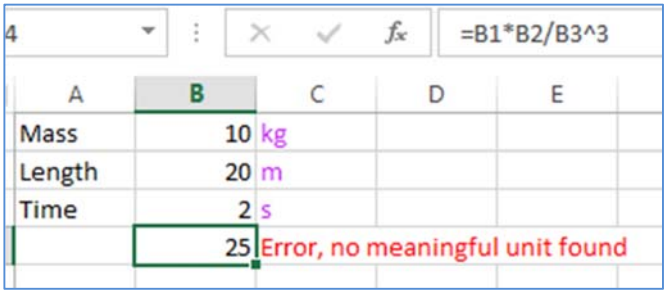


Now the add-in will automatically calculate the unit of the output quantity and write it to the adjacent cell, C4.

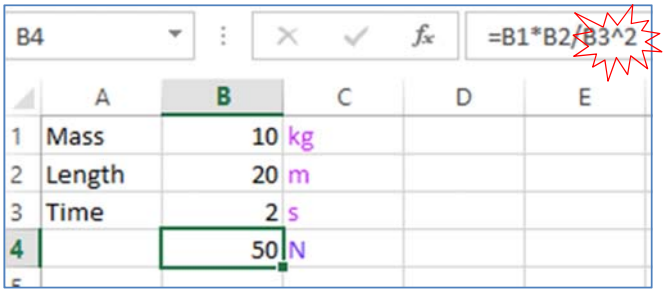
While the add-in is running, if the user makes a mistake in entering the formula eg 3 instead of 2 for the exponent, the add-in informs the user that there is no meaningful unit for the calculation.



An error message is written to the worksheet.

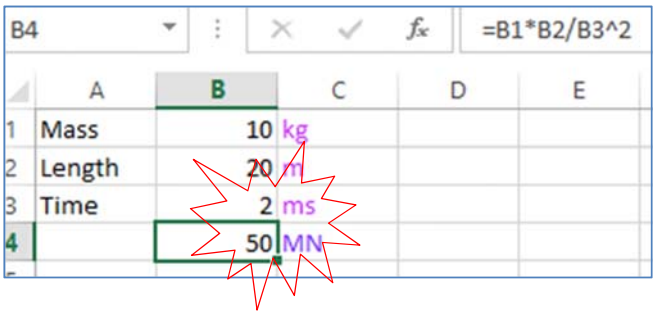


Upon correction of the formula, the add-in clears the error message and writes the correct output unit.



If cell B4 has dependent cells, the error message is repeated at all dependent cells and is cleared at all dependent cells when the formula error is corrected.

The add-in handles SI prefixes automatically. For instance, if the unit of cell B3 is revised to milliseconds, the output unit is revised to MN;



The add-in provides a powerful check on the correctness of all scientific and engineering formulae entered to an Excel worksheet.

2 GETTING STARTED

2.1 64 bit or 32 bit

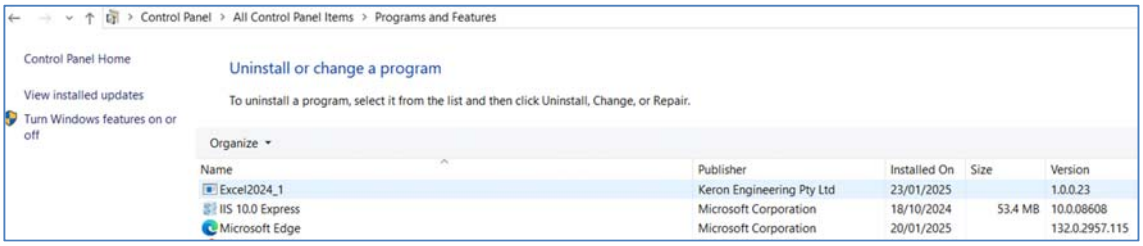
The add-in installer is set for 64 bit Windows 10. Excel comes in 64 or 32 versions.

If you have 64 bit Excel, download FC_1_0_0_24.

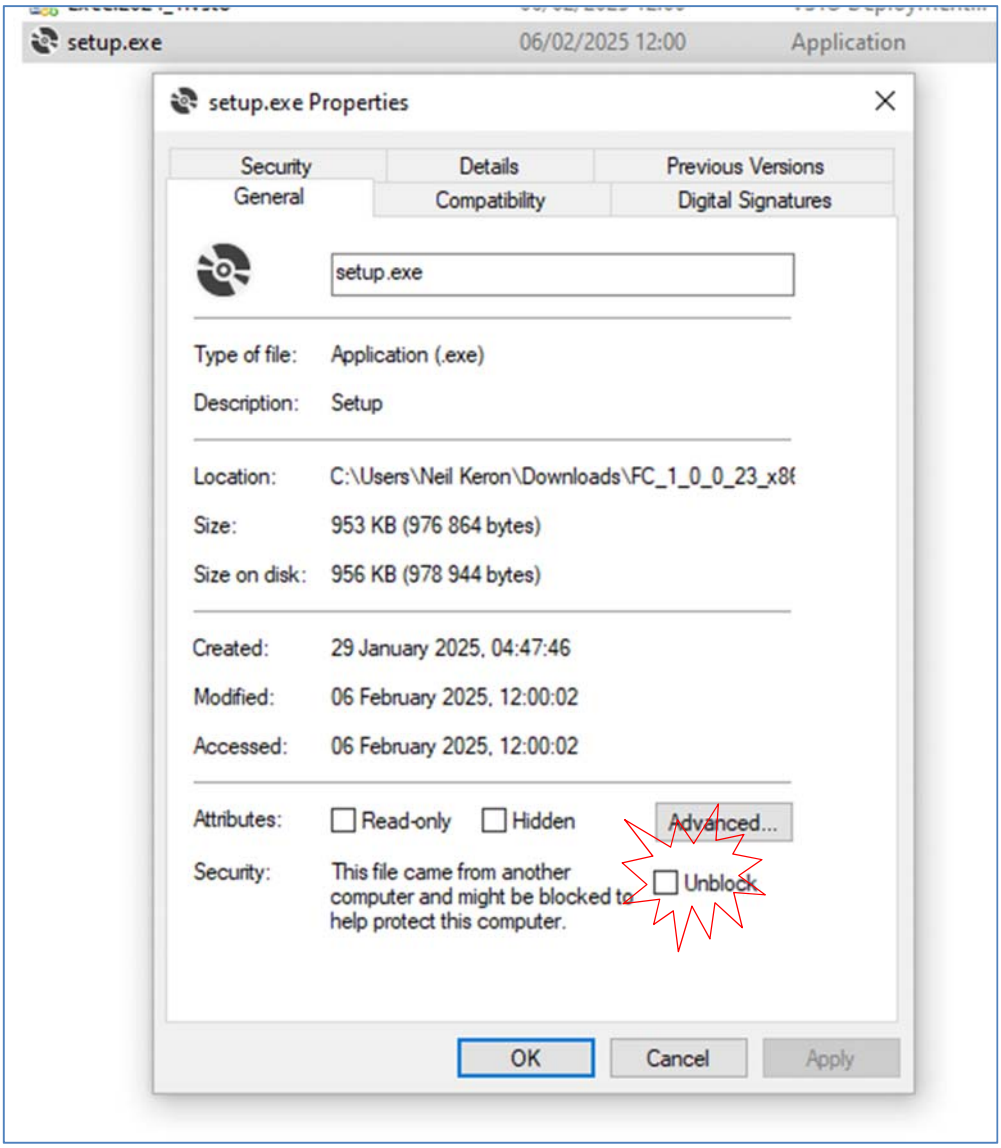
If you have 32 bit Excel, download FC_1_0_0_24_x86

2.2 Click Once deployment

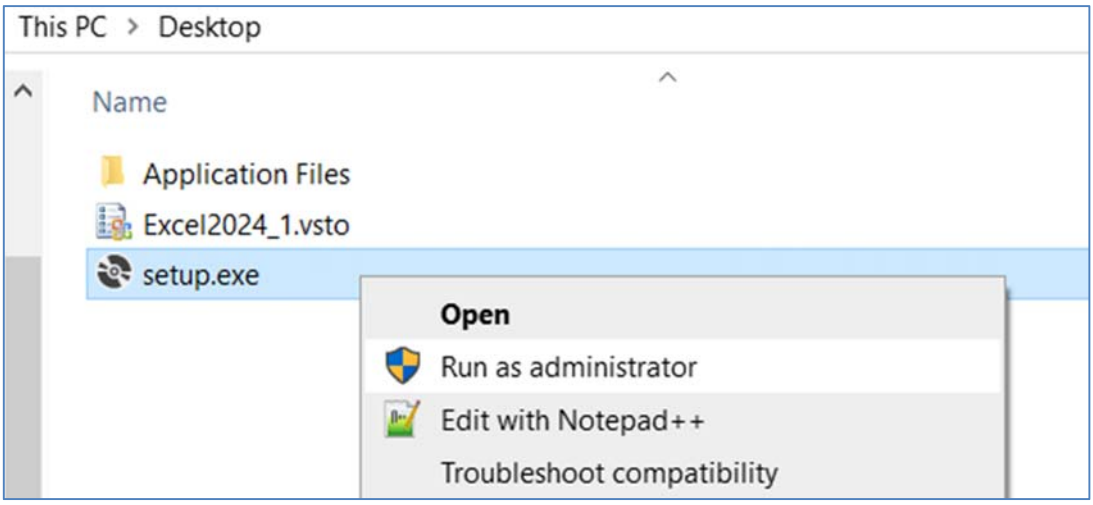
- If you have previously installed an earlier version of the addin, go to Control Panel/Programs and Features and Uninstall. This is important. If you try to install a new version when the old version is still installed, it will not install



- Download FC_0_0_0_24 or FC_1_0_0_24_x86 from the DropBox website.
- Copy the myExcelAddIn zip file to the Desktop
- Extract the files.
- Open the folder FC_0_0_0_24
- Microsoft may have blocked the files, right click on the setup.exe file and select properties

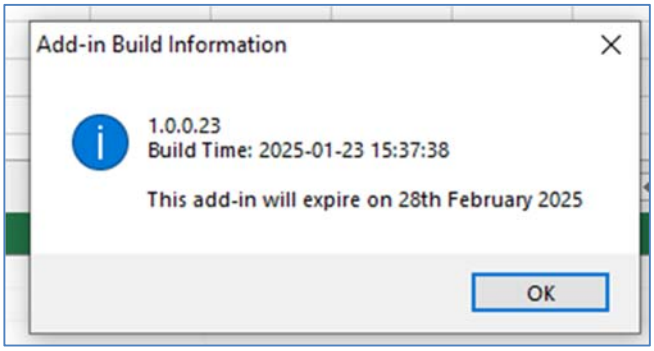


- If the Unblock box is present, check the box, click Apply and close
- Repeat the unblocking for each remaining file (7 more in total)
- Make sure you have a decent internet connection (the installer will download and install Microsoft Visual Studio 2010 Tools for Office Runtime)
- Right click the setup.exe file and select Run as administrator



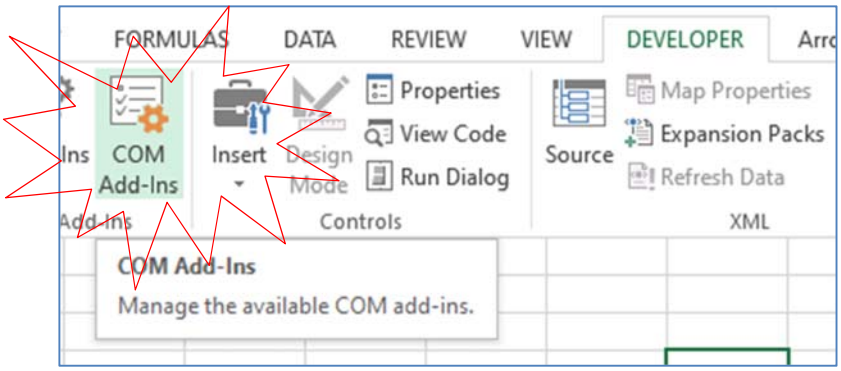
- Wait for the installer to complete.

When you start Excel, there should be a message identifying the version and build time;

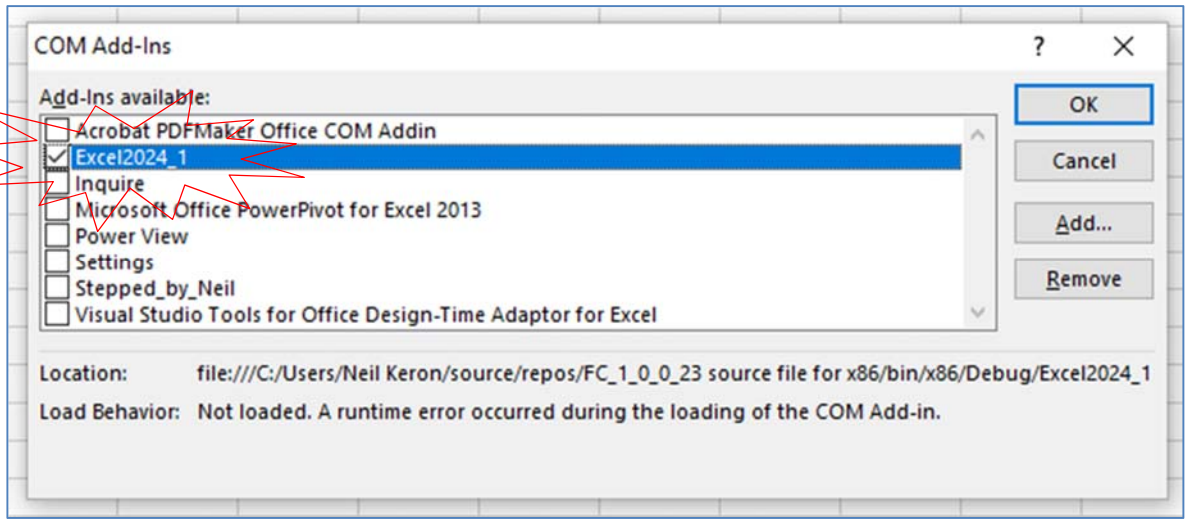


Click OK and the add-in should be running.

If it doesn't appear automatically, go to the COM addins drop down list

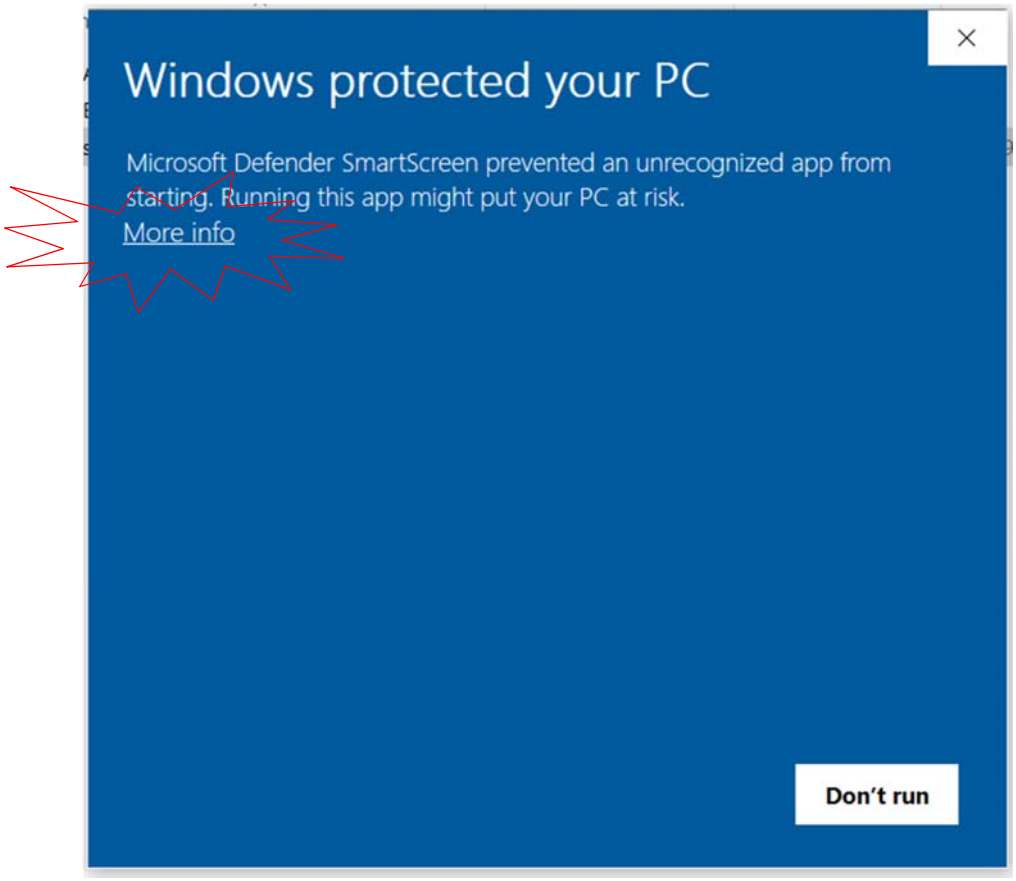


And tick the Excel2024_1 box

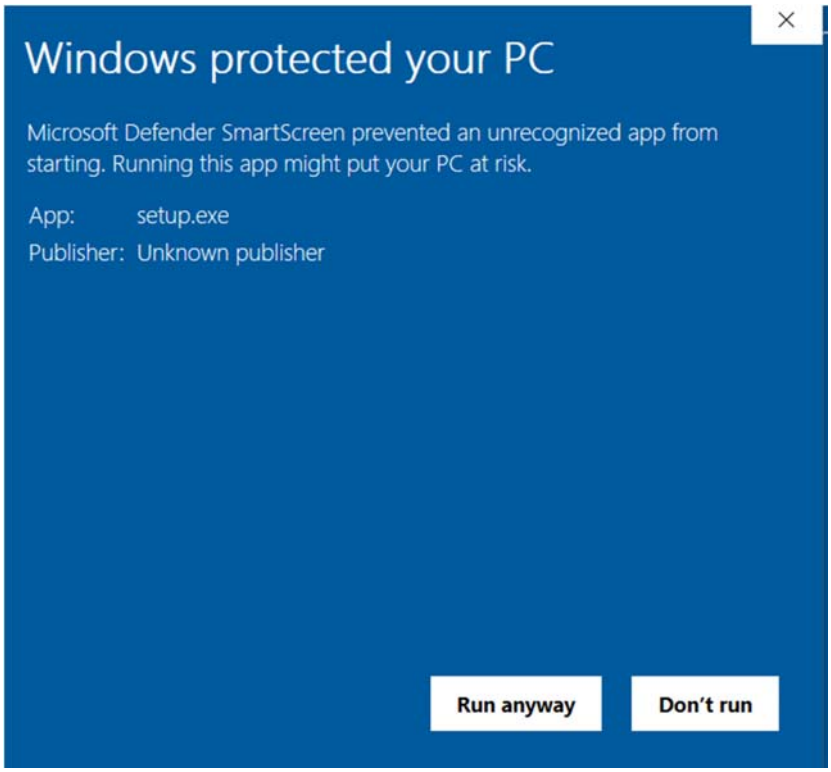


2.3 Protection by Windows

When software has been downloaded from the internet, it is possible that Microsoft will add another layer of protection. When installing or first running the addin, it is possible that you will see this message:



It looks as though you don't have an option to run the software but if you click the "More info" button you will be presented with this box:



Click “Run anyway” and you should be in business.

3 INTRODUCTION

The add-in automatically calculates the units of a formula from the units of the precedents of the formula. For instance, if cells B1, B2 and B3 represent quantities of mass, length and time in units of kg, m and seconds, when the formula "=B1*B2/B3^2" is entered at B4, the add-in automatically writes the units of the B4 calculated quantity at cell C4 as N.

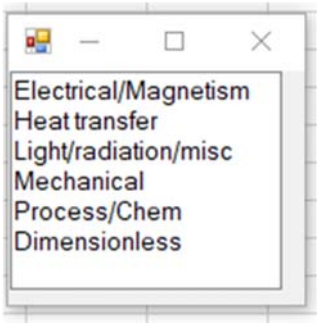
If the user mistakenly enters =B1*B2/B3^3, basic Excel will still calculate a value but the calculated quantity no longer represents a force in Newtons. But the user has no indication of the error. If the FormulaChecker add-in is running, an error message is displayed to say that no meaningful unit can be found for this calculation.

The add-in allows the user to specify SI units of an entered value. This is done with drop down lists and can all be completed with keystrokes. (eliminating inefficient repeated hand movement between keyboard and mouse).

3.1 ENTERING UNITS

3.1.1 Choosing the discipline group

On first use of the add-in it is necessary to choose a discipline group with the keystrokes Ctrl, Alt g. This displays a list of groups (disciplines).



Typing a first letter from the list brings up the list of quantities relevant to the chosen discipline. The required unit can then be chosen as detailed below. The chosen group (discipline) remains active so that subsequent values and units from the same group can be input with keystrokes Ctrl Alt u (for unit).

The chosen group, in this case Mechanical, remains selected until Ctrl Alt g is re-typed

3.1.2 Entering a unit

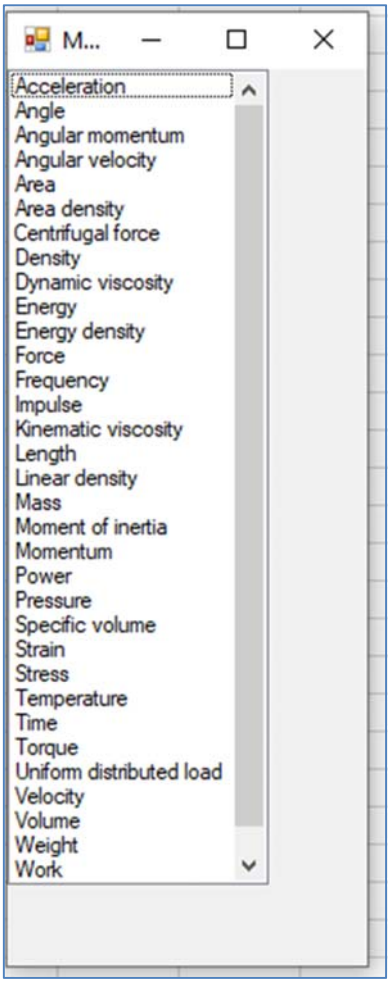
The addin is structured so that manual entry of units or automatic calculation of units occurs in the cell immediately to the right of the selected cell.

So units can be entered with either of two processes:

Method A Enter a value and then assign unit

To enter a value and assign a unit to the value, the user should:

1. Type the value to the chosen cell, say A1
2. Type Ctrl, Enter (this enters the value to cell A1 without moving the selection to A2)
3. Type Ctrl, Alt, u (while the selection is still at A1 (or Ctrl Alt g if this is the first unit in the workbook)
4. When the drop down list of quantities appears, select a quantity either by typing a first letter from the list or scrolling up and down with arrow keys or mouse clicking on the chosen quantity
5. Type Enter (the unit for the selected quantity will be written to cell B1)

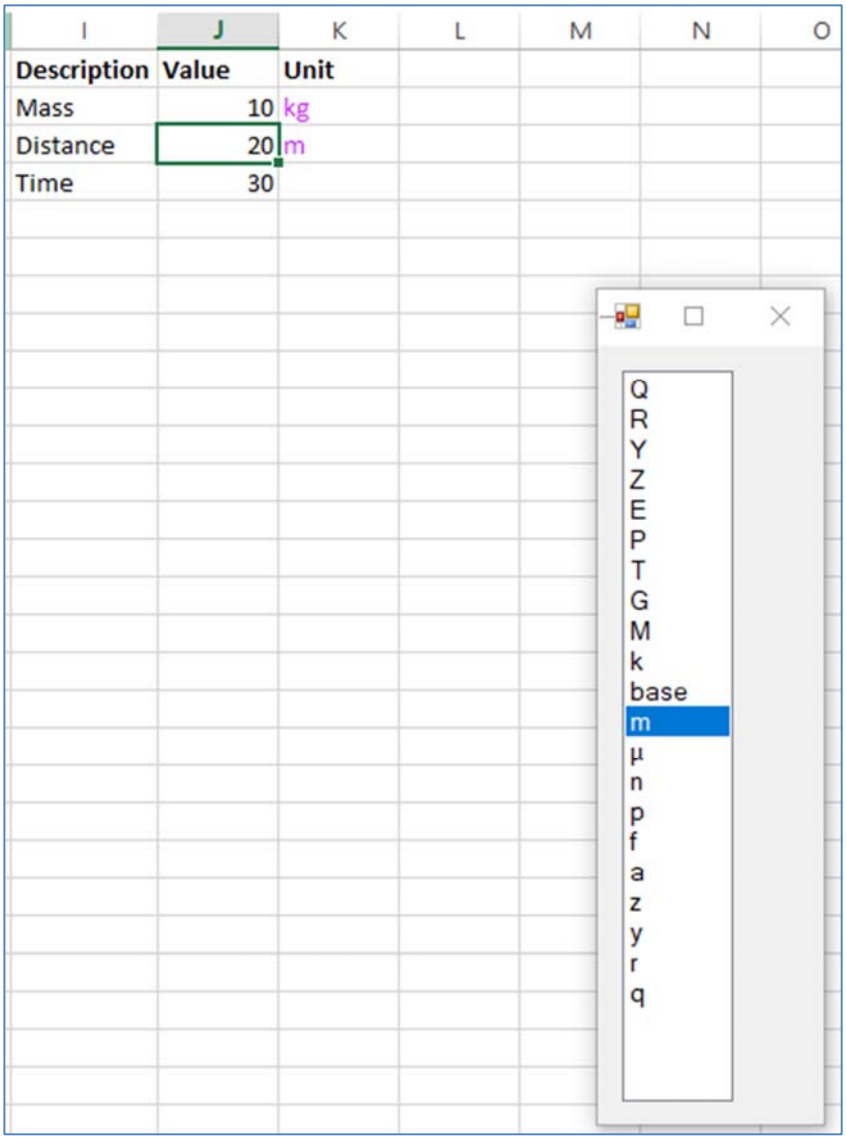


Method B Enter a unit, then enter a value

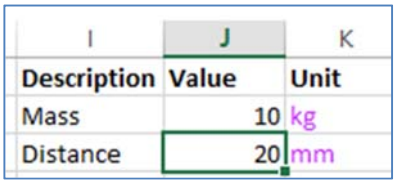
At the cell where you intend to enter a value, type Ctrl Alt u (or Ctrl Alt g if this is your first unit in the workbook), select the unit from the drop down list and press Enter. (Unit is added to the cell to the right)
Then type your desired value in to the selected cell and press Enter (Value is entered and selection moves one cell down)

3.1.3 Specifying an SI prefix for a unit

If an SI prefix is required for the unit, typing Ctrl Alt p (for prefix) brings up a further drop down list allowing the user to specify the SI prefix of the unit.



In this case, m for micro. The prefixed unit is then written to the right of the selected cell.



A prefix can be cleared at any time with Ctrl Alt p and selecting “base” from the dropdown list.

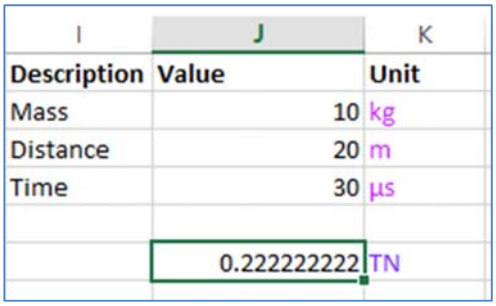
(IT IS NOT ESSENTIAL TO ENTER THE UNIT AT THE SAME TIME AS ENTERING THE VALUE BUT WHEN ADDING OR REVISING UNITS TO A PARTICULAR VALUE, ALWAYS SELECT THE VALUE EG J3 WHOSE UNIT IS TO BE REVISED (NOT THE UNIT EG K3), THEN KEYSTROKES Ctrl Alt u or Ctrl Alt p)

An alternate method for inputting a unit is Ctrl Alt Enter. This will bring up the Groups menu, then the menu for the chosen group eg Mechanical, then the prefix group. This is effectively the same as Ctrl Alt g, followed by Ctrl Alt u, followed by Ctrl Alt p. After inputting a unit with this method, the chosen group remains the same so input of another unit from the same group can start with Ctrl Alt u, thereby saving 2 keystrokes.

3.1.4 Formula entry

When a formula is entered in another cell on the worksheet, eg cell J6

the add-in finds all the precedent cells of that formula, looks at the units adjacent to the precedents, performs a dimensional analysis on the formula and enters the resultant units in the cell adjacent to the formula, including the correct SI prefix.



3.2 Summary of keyboard shortcuts

These should all be activated while the selected cell is the value whose unit is being dealt with (the Target). i.e. if A1 is a number of metres, A1 should remain selected when actioning, for instance, Ctrl Atl u to enter the unit of “m”. (Ctrl Enter after a number is typed will enter the number and keep the selection at the same cell)

Ctrl Alt Enter Starts the process of inputting units.

Ctrl Alt g (for Group) Brings up list of groups of units – ie an alternative to Ctrl Alt Enter.

Ctrl Alt u (for Unit) Brings up list of quantities in last group chosen. (This bypasses the need to choose a group)

Ctrl Alt p (for Prefix) Brings up list of SI prefixes.

Ctrl Alt d (for Delete) Allows deletion of a unit created by the add-in.

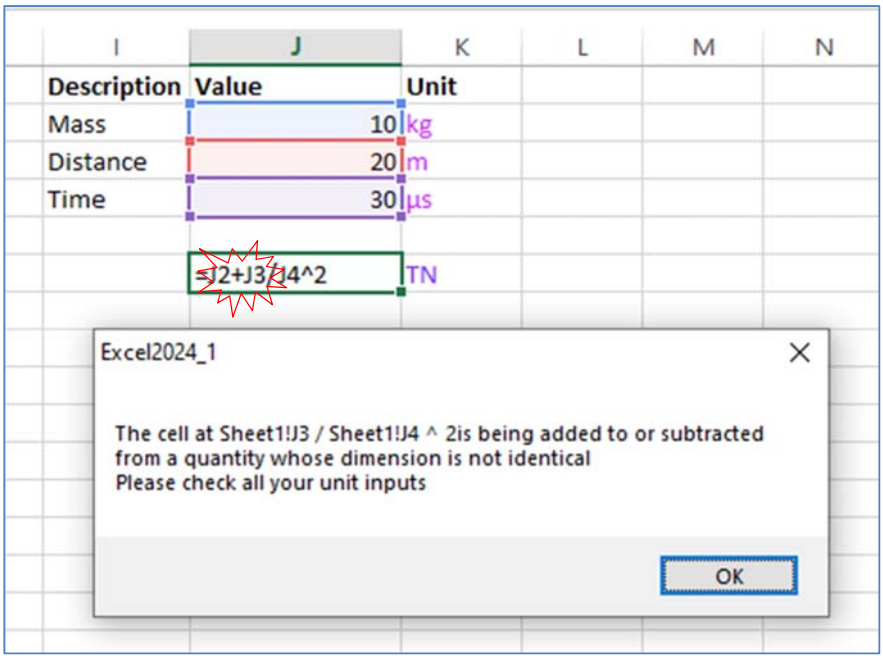
Ctrl Alt k (for Konversion factor) Brings up list of user defined conversion factors. This function needs 3 empty cells to the right of the Target because it enters the non-SI unit, the converted value and the SI unit. See section 7.1

Ctrl Alt r (for Reverse konversion) ie SI to non-SI Brings up the same list of user defined factors. This function should be used in the cell immediately to the right of an SI unit. It then writes the converted value to the selected cell and the non-SI unit to the cell immediately to the right of the selected cell. (Section 7.2)

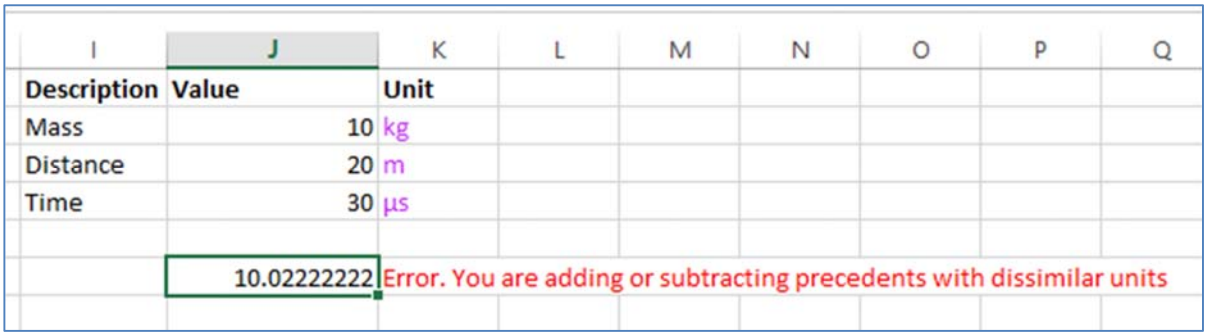
Ctrl Alt o (for override). Overrides the normal calculation of output unit of a formula even if a full set of SI units is supplied for the precedents. See section 7.3

3.3 ERROR CHECKING

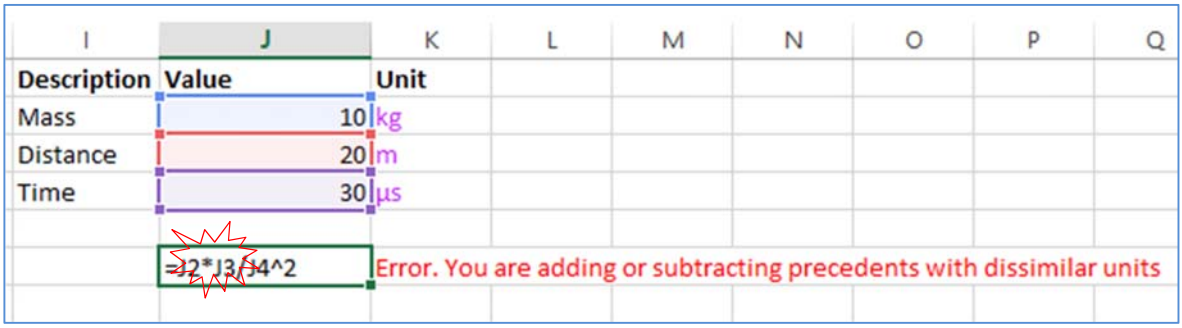
If the user makes an error when entering the formula such as a + sign instead of * between J2 * & J3, basic Excel does not care that the formula now makes no physical sense and will still give the user a valid numerical calculation. However, the add-in recognises the error and advises the user accordingly:



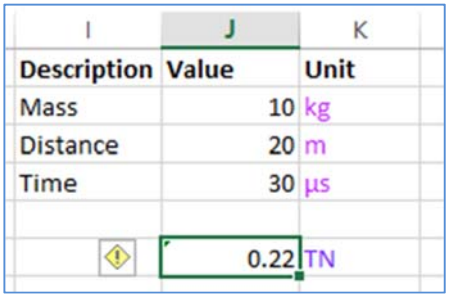
An error message is added to the worksheet:



If the user corrects the error in the formula,

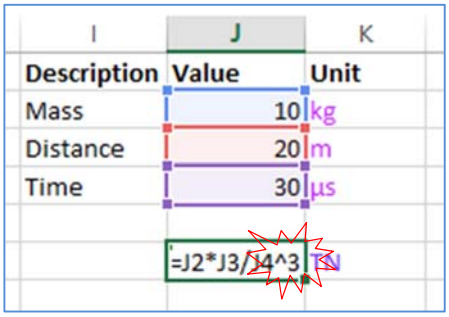


the error message is cleared and the correct output unit is entered



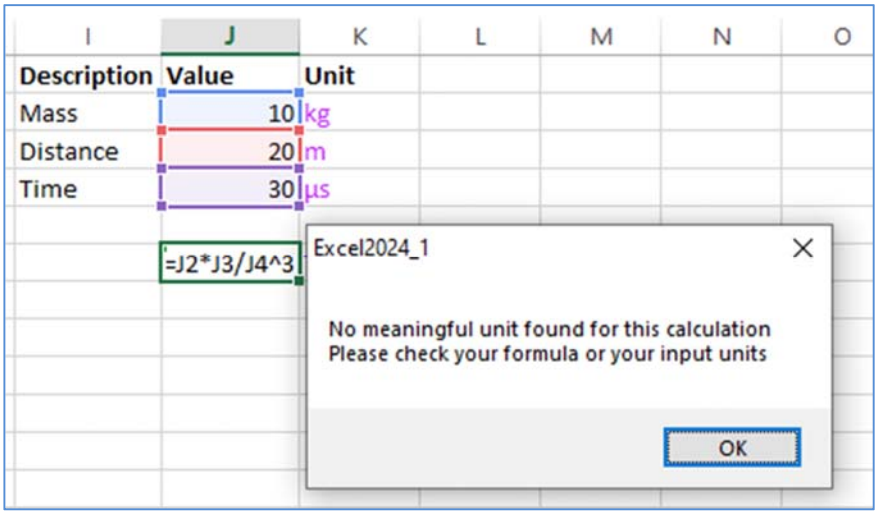
	I	J	K
	Description	Value	Unit
	Mass	10	kg
	Distance	20	m
	Time	30	µs
		0.22	TN

A second type of error picked up by the add-in might simply result in an invalid physical unit. For instance, if the user incorrectly types 3 for the time exponent instead of 2 (an easy keyboard error to make), Excel does not care that this makes no physical sense and returns a value for the formula at J6.



	I	J	K
	Description	Value	Unit
	Mass	10	kg
	Distance	20	m
	Time	30	µs
		=J2*J3/J4^3	N

But the add-in advises that there is no sensible physical meaning to the formula.



	I	J	K	L	M	N	O
	Description	Value	Unit				
	Mass	10	kg				
	Distance	20	m				
	Time	30	µs				
		=J2*J3/J4^3					

and writes an error message to the worksheet;

	I	J	K	L	M
	Description	**Value**	**Unit**		
	Mass	10	kg		
	Distance	20	m		
	Time	30	µs		
		0.01	Error, no meaningful unit found		

Correction of the formula

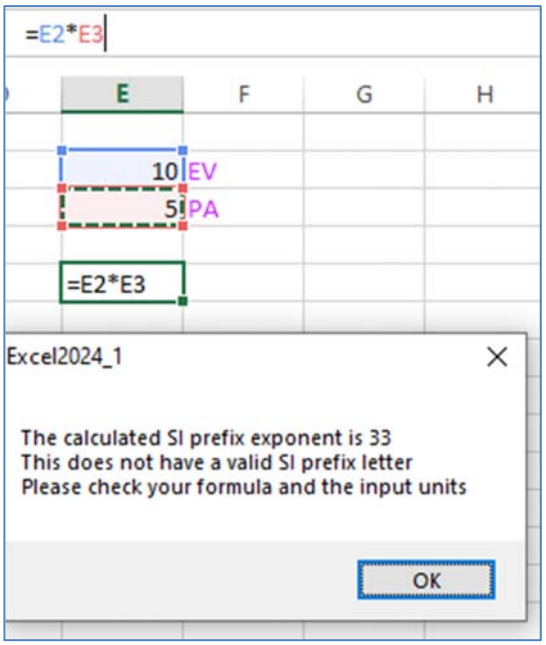
	I	J	K	L	M
	Description	**Value**	**Unit**		
	Mass	10	kg		
	Distance	20	m		
	Time	30	µs		
		=J2*J3^J4^2	Error, no meaningful unit found		

results in the error message being cleared and the correct unit being written.

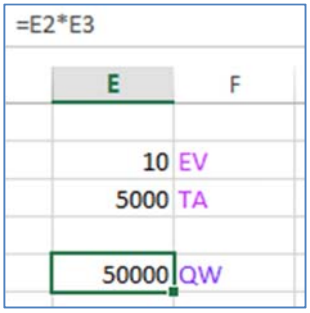
	I	J	K
	Description	**Value**	**Unit**
	Mass	10	kg
	Distance	20	m
	Time	30	µs
		0.22	TN

3.3.1 Maximum & minimum prefixes

SI prefixes range from quetta (symbol Q = 10^30) to quecto (symbol q = 10^ -30). If a formula is entered whose units create a prefix outside this range, an error message is displayed and the user is asked to revise the input.

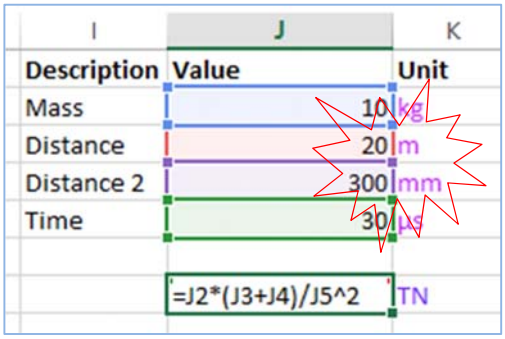


Revision of the value and the unit prefix result in a correct output

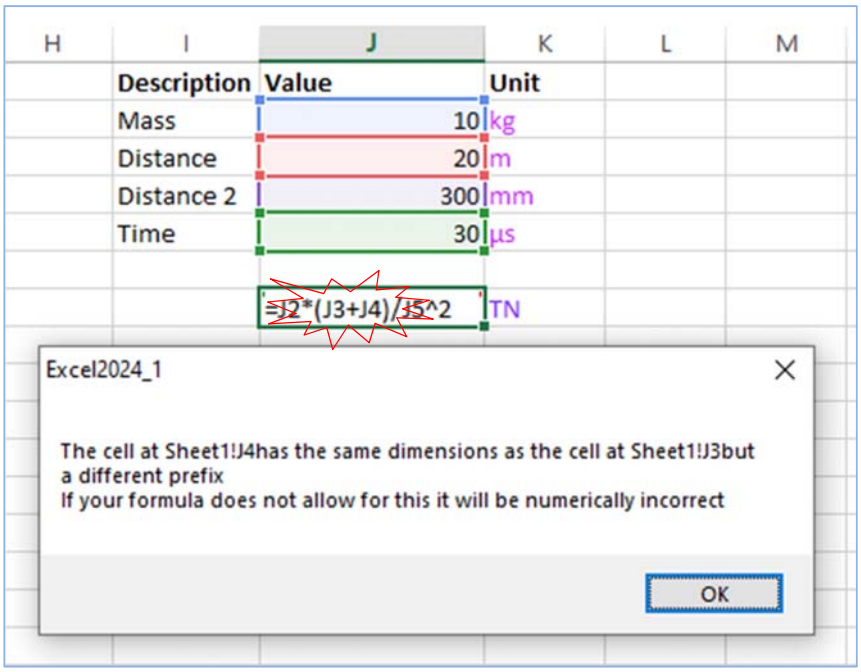


3.3.2 Mixed prefixes

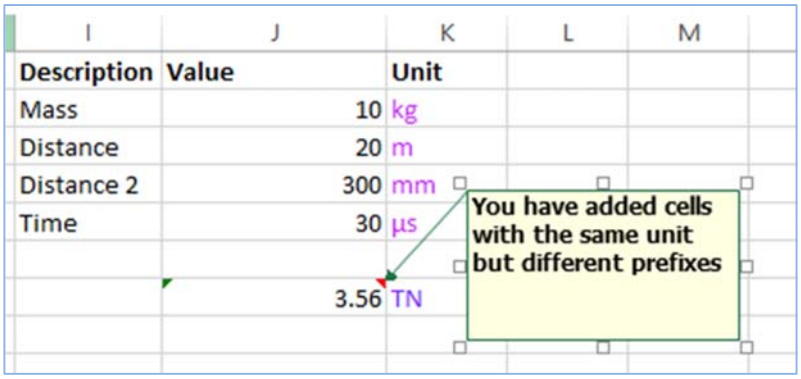
If the user enters a formula which adds precedents with the same unit but different SI prefixes



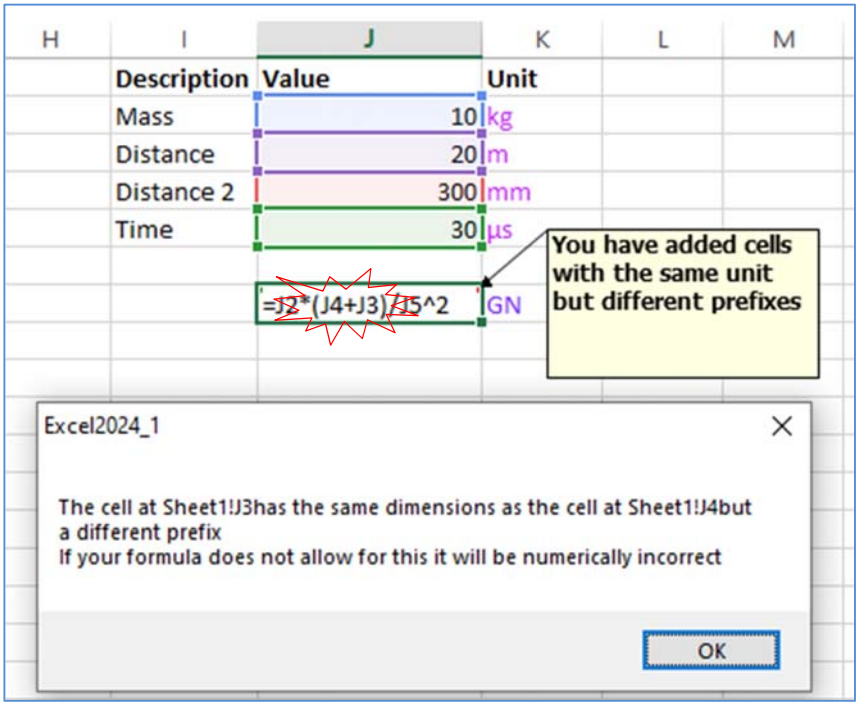
the add-in advises the user of this:



A warning comment is added to the cell and a unit is displayed based on the prefix of the **first distance** specified in the formula.



So if the length units had been entered in the reverse order;



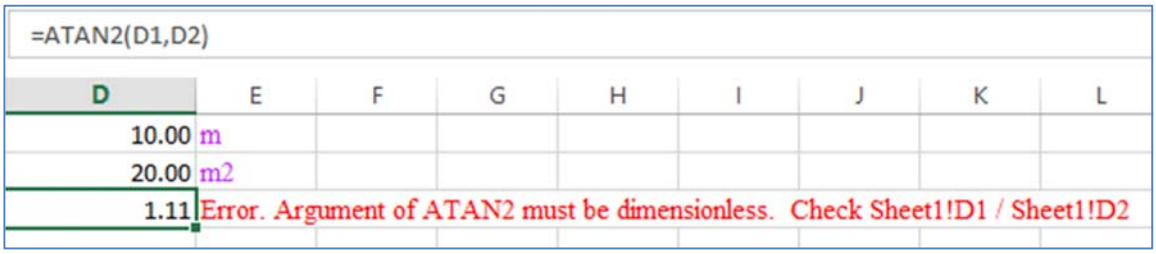
the resulting unit is now GN.

3.3.3 Check of Functions requiring dimensionless argument

SIN, COS, TAN, ASIN, ACOS, ATAN, LN, LOG, LOG10, EXP all take a dimensionless argument. For instance, if C1 has the formula '=SIN(E1/E2)' where cells E1 and E2 have values representing sides of a triangle is only meaningful if E1/E2 is dimensionless. If F1 and F2 have units of 'm' (metres), the output unit is 'D'less'. If either of the units at F1, F2 is not 'm' or if an error is entered to the formula such as =SIN(A1*A2) a message box is displayed and the error message is written to cell D1:

3.3.4 Check of Functions having two arguments which require to resolve to dimensionless

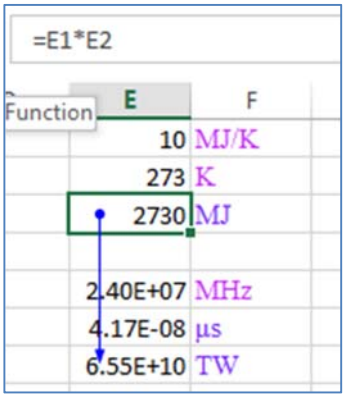
The functions ATAN2, MOD, RANDBETWEEN each require 2 arguments. For instance = ATAN2(A1,A2) calculates the angle in radians in the 360 degrees space of the vector having x, y coordinates specified in A1 and A2. This is only meaningful if A1/A2 is dimensionless. The Formula Checker tests for this and creates an error message if the result is not dimensionless.



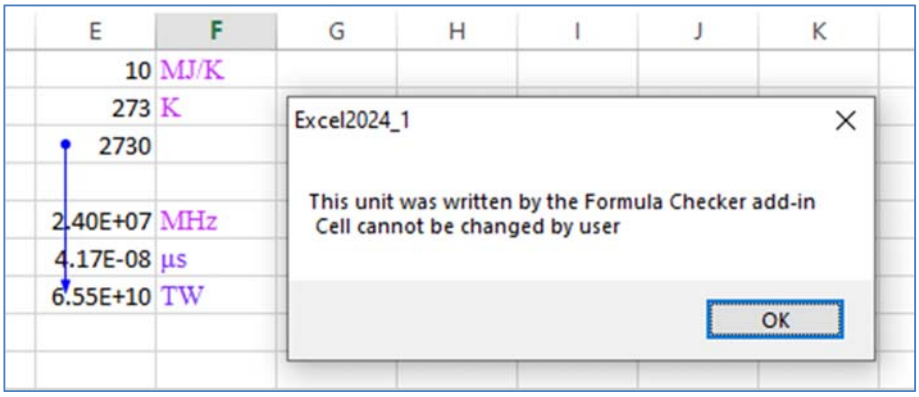
3.4 Protection of calculated units

3.4.1 Protection while add-in is loaded.

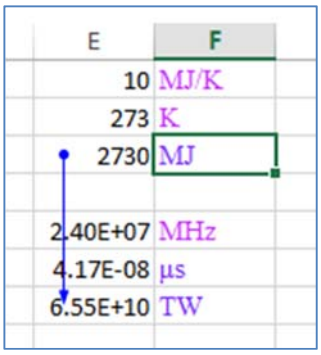
The Formula Checker add-in automatically maintains the integrity of the units of a series of calculations. For instance, in the example below cell E3 is a precedent of the formula at E7:



If the unit of 'MJ' at cell E3 was deleted, the calculated unit of 'TW' at E7 would not be correct. The add-in therefore prevents the user from deleting any units calculated by the add-in:

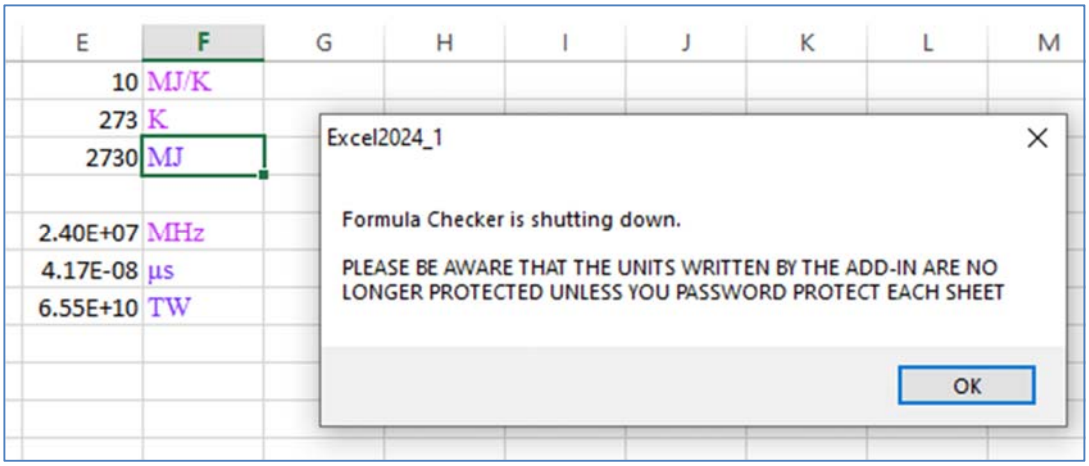


The user has attempted to delete the unit at F3 and is presented with a message saying that this unit cannot be changed by user. Upon clicking 'OK' the message is removed and the unit is reinstated:

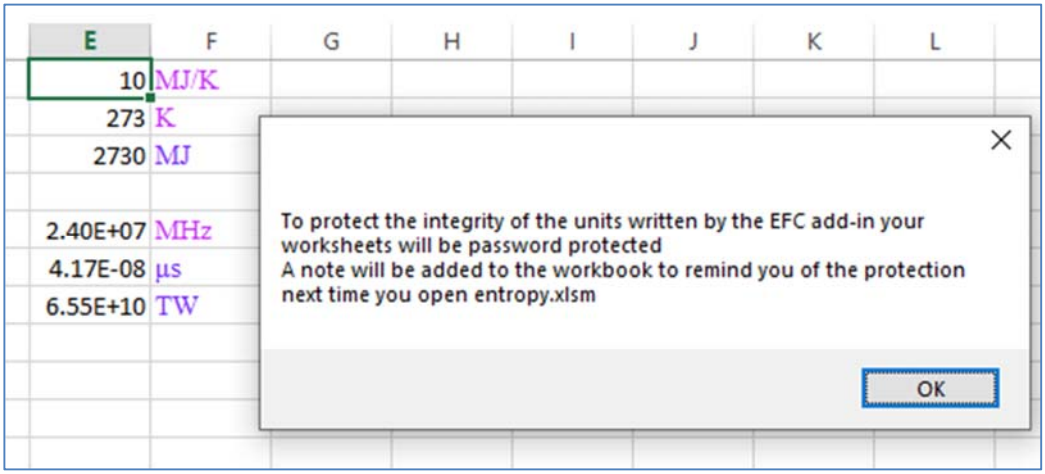


3.4.2 Protection of units when Formula Checker add-in is not loaded

The protection described above is only operative when the add-in is loaded. To prevent accidental deletion of units when the add-in is unloaded, all the cells containing Formula Checker units are locked and the worksheets are password protected. A note advising of this is written to screen when the add-in is unloaded:



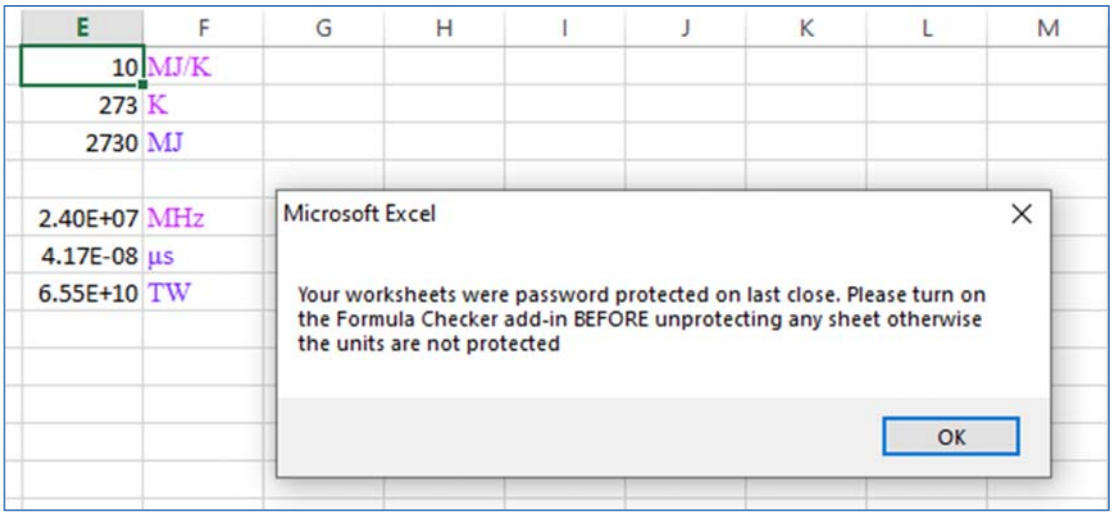
Upon closing a workbook which contains Formula Checker units, all the worksheets are automatically password protected by the add-in and a message advises the user of this:



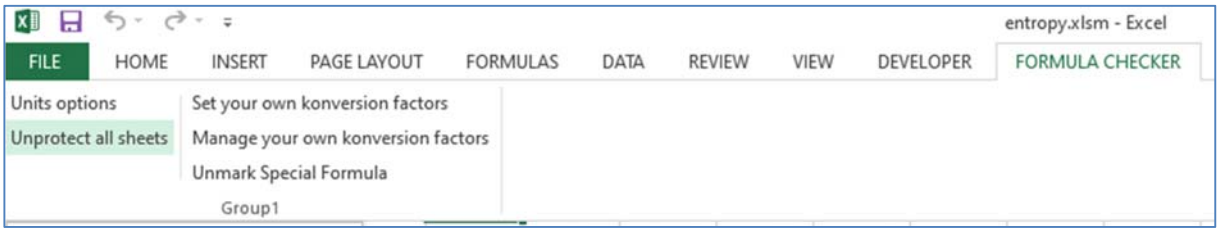
If the user applies their own password to any sheet, that password will remain valid. If the user has not applied a password, the add-in applies the password ‘password’ to all sheets.

3.4.3 Re-opening of protected workbook

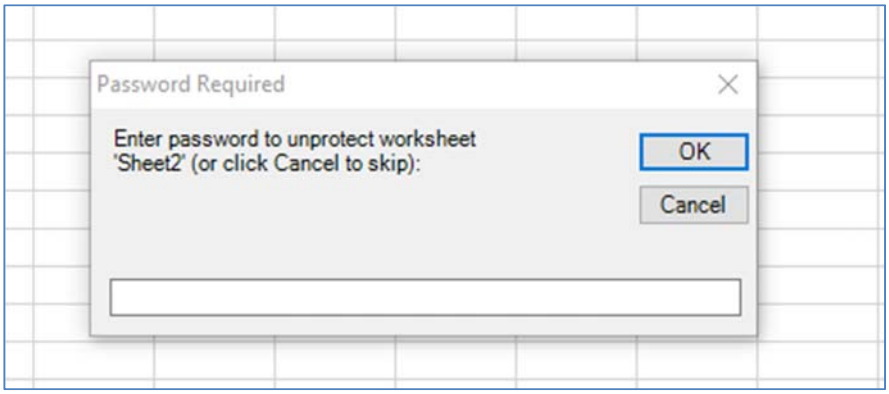
Upon re-opening a workbook that was password protected by the add-in, a message is displayed reminding the user to load the add-in before unprotecting worksheets:



When the Formula Checker add-in has been turned on, all the worksheets can be unprotected with a single click under the FORMULA CHECKER ribbon tab:



If the user has applied a password to any sheet, the add-in asks for this:



Otherwise, the add-in unprotects all sheets with the password ‘password’.

3.5 REVISION OF INPUT UNITS

If a formula, for which a valid SI has been calculated by the add-in, is deleted by the user, the associated unit is deleted and any dependent cells are recalculated.

3.6 DELETION OF FORMULA OR INPUT UNITS

3.6.1 Deletion of a formula

Deletion of a formula that has a calculated SI output results in the deletion of the unit.

3.6.2 Deletion of a value

Deletion of a value that has previously been assigned an SI unit results in deletion of the unit.

3.6.3 Deletion of units

3.6.3.1 Deletion of input units

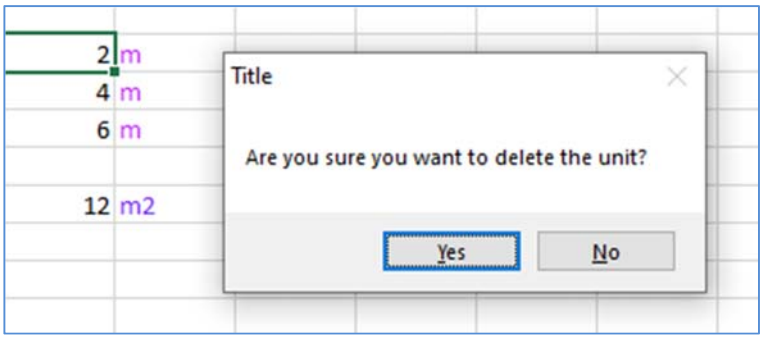
When an input unit is created with Ctrl Alt Enter, the cell is locked and the sheet protected so that the unit cannot be deleted with the normal Excel delete key. (Unprotecting the sheet will allow manual deletion but this will destroy the integrity of the worksheet units)

If it is necessary to delete an add-in created unit, the cell to the left of the unit (ie the value of the unit) should be selected. Ctrl Alt d will then delete the unit.

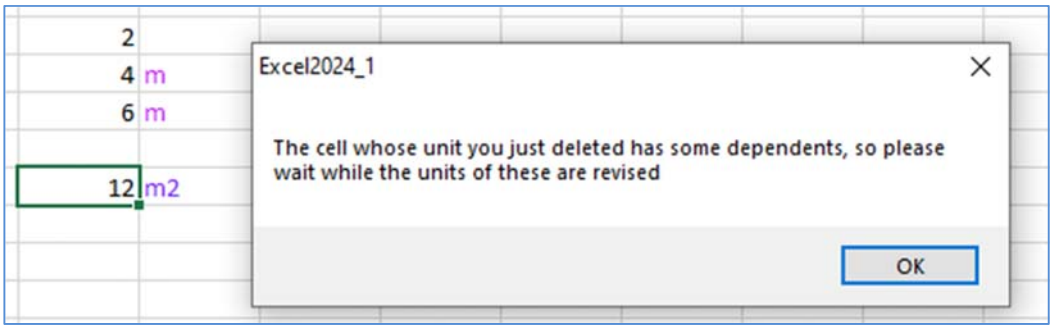
The value whose unit has just been deleted is then checked for dependents. The dependent units are then calculated according to the add-in rules eg if the value is a precedent of a formula which previously had a full set of SI units, that formula will no longer have a full set of SI units so its calculated unit is deleted.

For instance, D19 has the formula =PRODUCT(D15,D17)

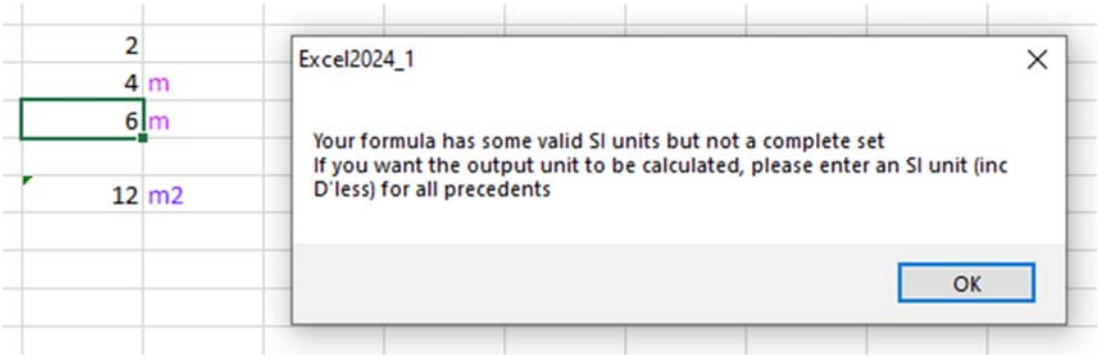
With valid units at D15 and D17, the output unit is m2. If D15 is selected and Ctrl Alt d is invoked, the add-in first asks the user to confirm the deletion.



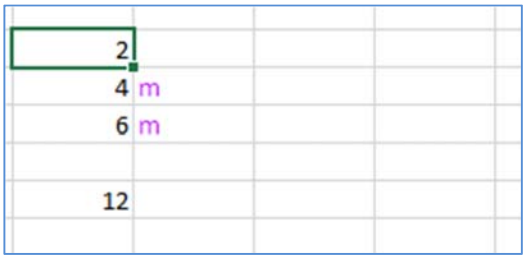
If confirmed, the unit is deleted and the user is advised that there are dependents.



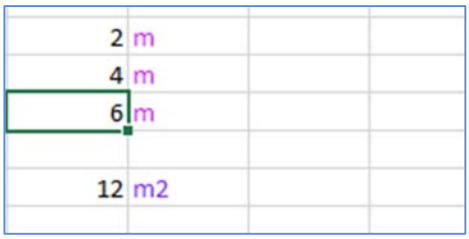
In this example, D19 no longer has a complete set of SI units so the user is advised



and the dependent unit is deleted (because a formula must have a full set of valid SI units for an output unit to be calculated).

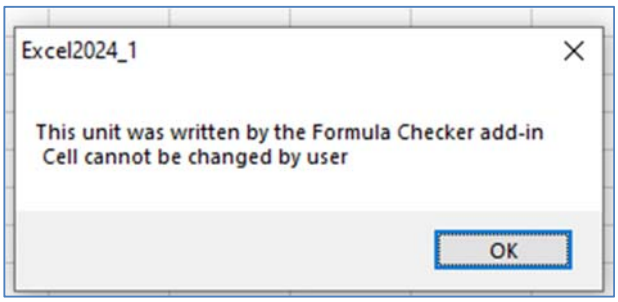


Re-instatement of the deleted unit with Ctrl Alt Enter, automatically updates the output unit



3.6.3.2 Attempted deletion of output units

Calculated output units cannot be deleted with Ctrl Alt d. If this is attempted, the user is advised that the sheet integrity will be destroyed.



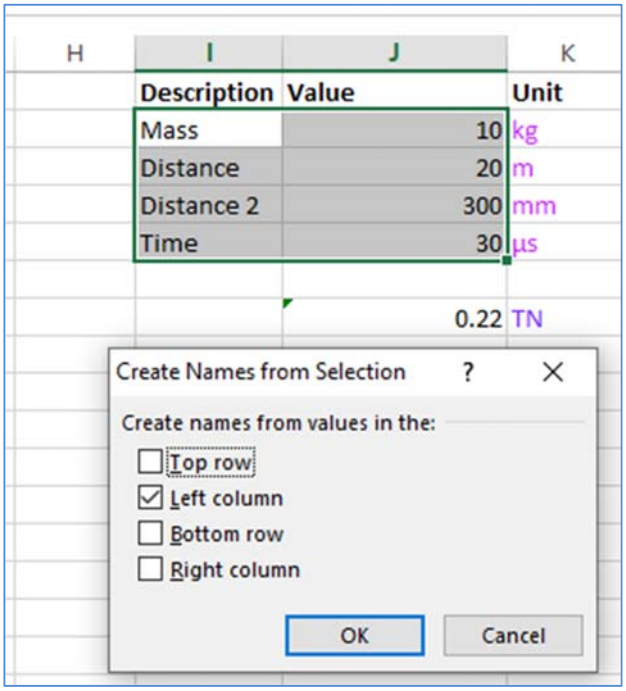
Upon clicking OK, normal control is returned to the worksheet.

4 FURTHER FORMULA INPUTS

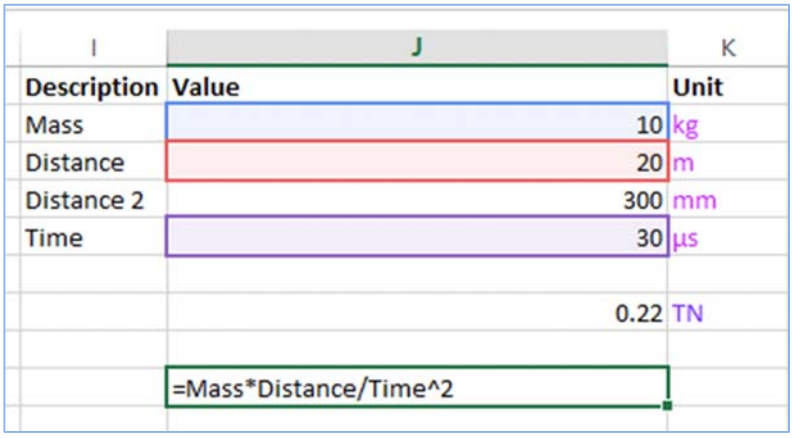
4.1 CELL ADDRESSES

The Formula Checker can handle relative addresses eg J2, absolute addresses eg J2, cell addresses referencing another sheet eg Sheet2!A1 or named cells eg ‘Mass’ in the example at cell J2.

For example, if cells J2, J3 and J5 are assigned the names Mass, Distance and Time



Then entering the formula at J9 using the named cells:



correctly shows the output units

I	J	K
Description	**Value**	**Unit**
Mass	10	kg
Distance	20	m
Distance 2	300	mm
Time	30	µs
	0.22	TN
	0.22	TN

The add-in works across all worksheets in an open workbook. ie precedents for a formula in Sheet1A1 can be located in other sheets in the workbook.

If a user, revises the units of a precedent after a formula has been entered, the add-in will find all the dependents of the quantity whose unit has been revised and then recalculate the output unit of all the dependents affected. See section 3 for more detail.

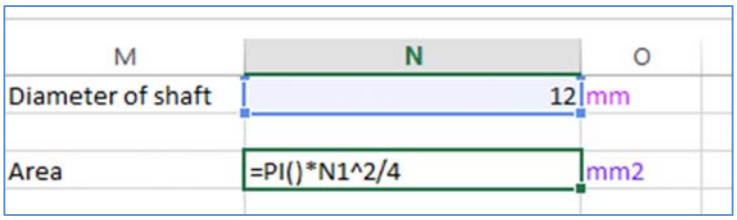
4.2 Prefix modifiers in formula

It is sometimes convenient for the user to convert a prefix of an input unit to a different prefix on the output unit by inclusion of 1000 multiples in a formula. For instance, the diameter at cell N1 has units of mm. It may be convenient to output the result of an area calculation in m2. If the area formula includes a divisor of 1000 000, the area unit is show as m2.

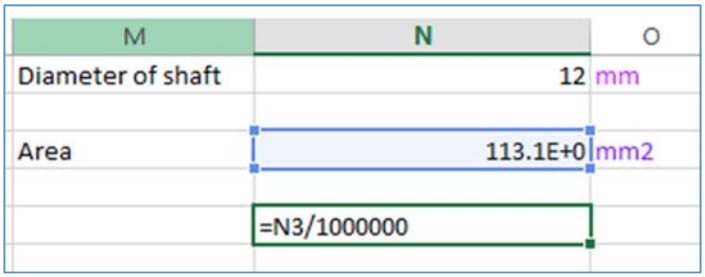
M	N	O
Diameter of shaft	12	mm
Area	=pi()*N1^2/4000000	

M	N	O
Diameter of shaft	12	mm
Area	113.1E-6	m2

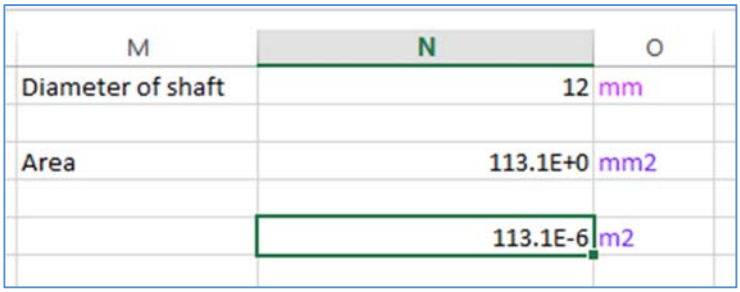
Or the conversion can be carried out in 2 steps:



Followed by division of the area in mm2:

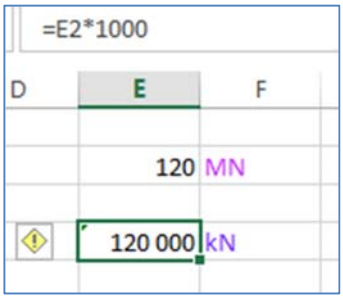


To give m2:



For this to work, the 1000s divisor or multiplier must be at the end of the formula.

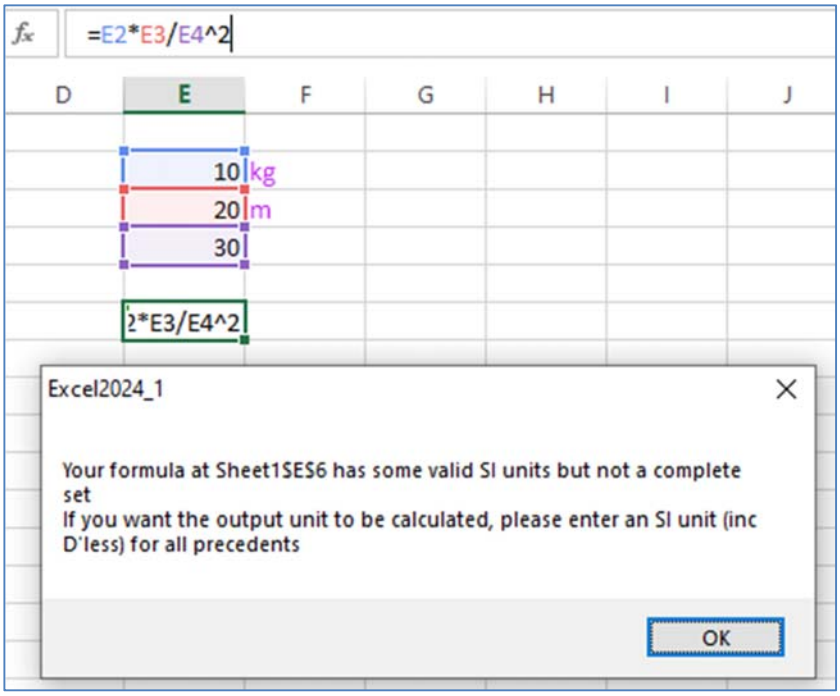
This process works in the opposite direction by inclusion of a 1000s multiplier eg



4.3 Formulae without SI units or with incomplete SI units

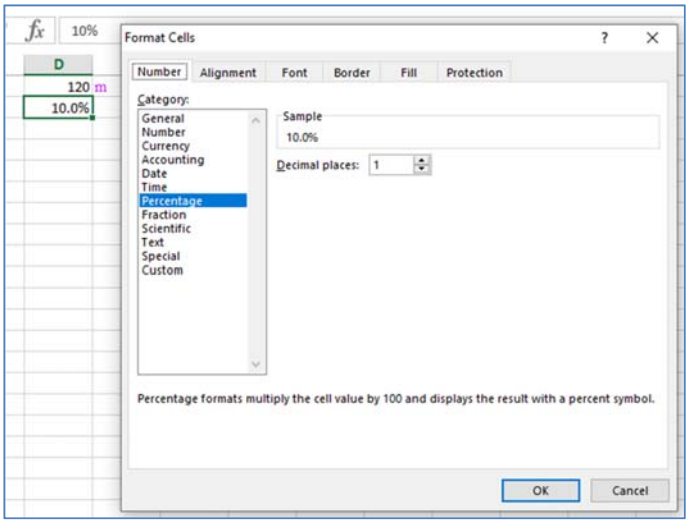
The add-in will ignore any formulae that have no valid SI units for the precedents.

If a formula has one or more precedents with valid SI units but not a full set, a warning message is displayed. This requires that any dimensionless precedents must have the D'less "unit" entered. This may seem a bit superfluous but it does ensure rigour throughout the dimensional analysis procedure.

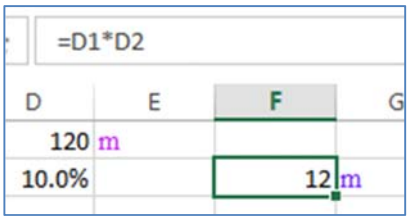


4.4 Percentage format

Excel includes a format for designating numbers as a percentage. When this is applied to a cell, Excel treats the value as a fraction. For instance, if 0.1 is entered to a cell and then formatted as Percentage, the cell is displayed as '10%' but in a formula this is still treated as a value of 0.1.

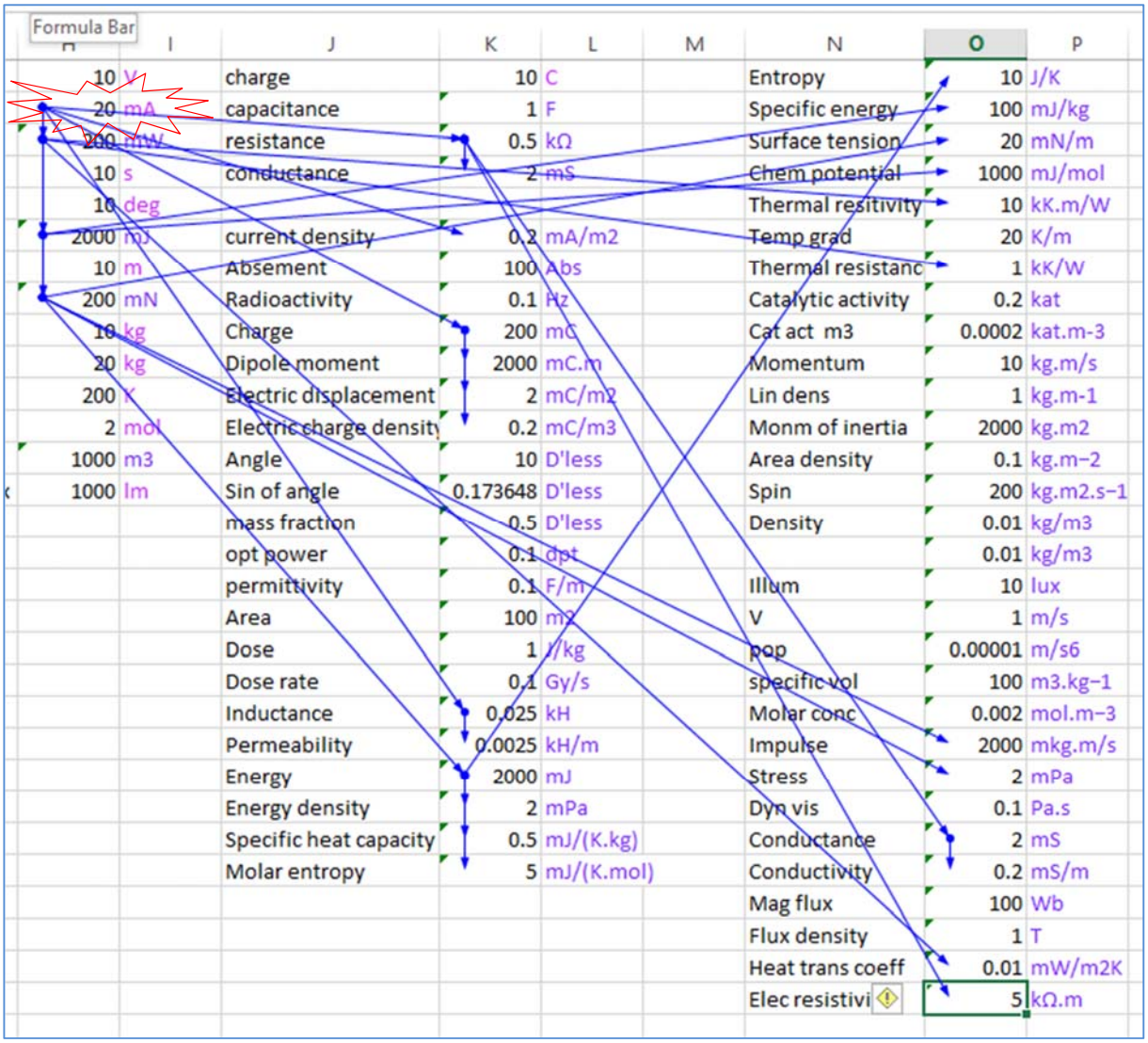


If a number formatted as Percentage is used in a formula when the addin is active, the number is treated as dimensionless. Thus:


=D1*D2
D
E
F
G
120 m
10.0%
12 m

5 DEPENDENT CELLS

The add-in looks for dependents of any revised cells and updates the units of these. For instance, in the worksheet below, cell H2 with units of mA has 28 dependent cells.



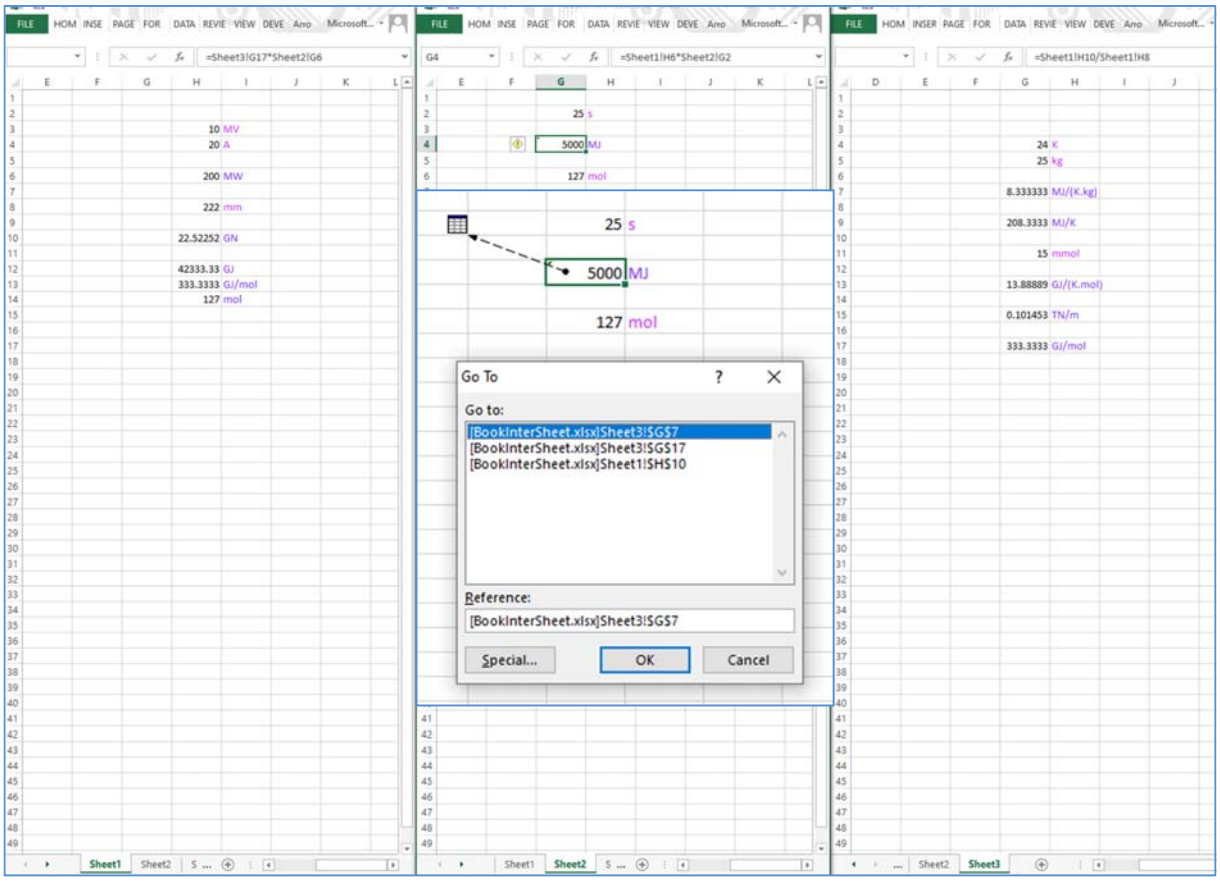
Revision of the units of H2 from mA to A results in all dependent cells being updated.

H	I	J	K	L	M	N	O	P
10	V	charge	10	C		Entropy	10	mJ/K
20	A	capacitance	1	F		Specific energy	100	J/kg
200	W	resistance	0.5	Ω		Surface tension	20	N/m
10	s	conductance	2	S		Chem potential	1000	J/mol
10	deg					Thermal resitivity	10	K.m/W
2000	J	current density	0.2	A/m2		Temp grad	20	K/m
10	m	Absement	100	Abs		Thermal resistanc	1	K/W
200	N	Radioactivity	0.1	Hz		Catalytic activity	0.2	kat
10	kg	Charge	200	C		Cat act m3	0.0002	kat.m-3
20	kg	Dipole moment	2000	C.m		Momentum	10	kg.m/s
200	K	Electric displacement	2	C/m2		Lin dens	1	kg.m-1
2	mol	Electric charge density	0.2	C/m3		Monm of inertia	2000	kg.m2
1000	m3	Angle	10	D'less		Area density	0.1	kg.m−2
1000	lm	Sin of angle	0.173648	D'less		Spin	200	kg.m2.s−1
		mass fraction	0.5	D'less		Density	0.01	kg/m3
		opt power	0.1	dpt			0.01	kg/m3
		permittivity	0.1	F/m		Illum	10	lux
		Area	100	m2		V	1	m/s
		Dose	1	J/kg		pop	0.00001	m/s6
		Dose rate	0.1	Gy/s		specific vol	100	m3.kg−1
		Inductance	0.025	H		Molar conc	0.002	mol.m−3
		Permeability	0.0025	H/m		Impulse	2000	kg.m/s
		Energy	2000	J		Stress	2	Pa
		Energy density	2	Pa		Dyn vis	0.1	Pa.s
		Specific heat capacity	0.5	J/(K.kg)		Conductance	2	S
		Molar entropy	5	J/(K.mol)		Conductivity	0.2	S/m
						Mag flux	100	Wb
						Flux density	1	T
						Heat trans coeff	0.01	W/m2K
						Elec resistivity	5	Ω.m

5.1 Inter-Sheet Dependencies

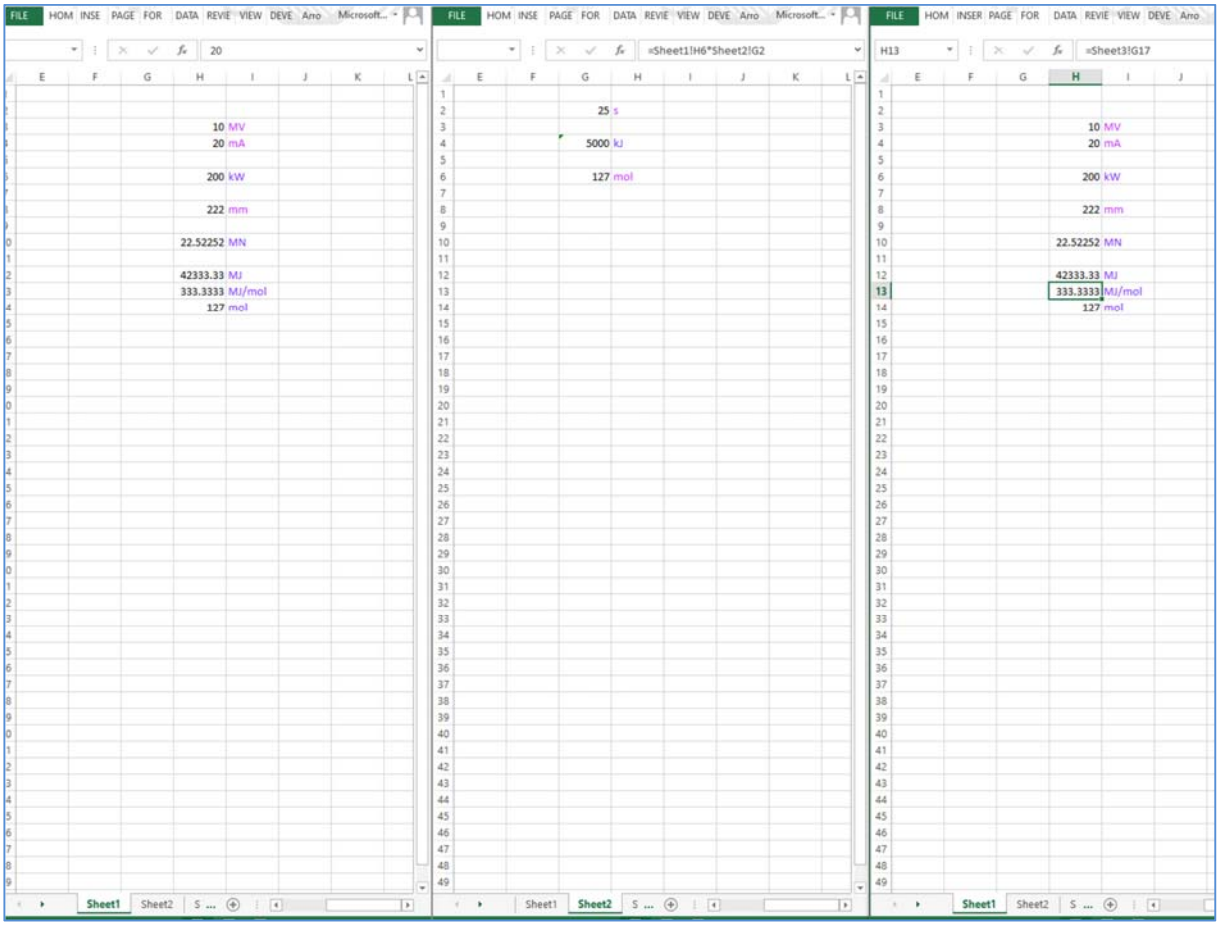
The dependent updating works across all sheets within a workbook.

For instance, Sheet2!G4 is dependent on Sheet1!H6. It has dependencies on Sheet 3



Sheet1!H12 is dependent on Sheet3!G17.

Revision of Sheet1!H4 from A to mA, flows across all sheets and back to Sheet1!H12:



6 USING THE ADD-IN

6.1 Limitations

Workbook filenames should not have spaces – use underscore or dash if you need to improve the readability of the name.

eg “My_Workbook” not “My Workbook”

YOU MUST KEEP THE CELL IMMEDIATELY TO THE RIGHT OF YOUR ENTERED VALUE CLEAR OF YOUR OTHER WORK BECAUSE THE ADD-IN WILL OVER-WRITE WHATEVER IS IN THAT CELL.

THE ADD-IN WILL ONLY WORK WITH ONE WORKBOOK OPEN AT A TIME

6.2 Scope of Add-In

6.2.1 Sheets and workbooks

The add-in should work OK across all worksheets in a workbook. It will not reference precedents or dependents in a separate workbook.

6.2.2 Formulae not affected by the add-in

The add-in only works with SI units. You may want to include a formula that, say, converts feet to metres. In this case, the add-in will not try to calculate an output unit. It only acts on formulae that have a valid SI unit specified for each precedent. It therefore requires the user to specify “D’less” for any dimensionless precedents in the formula.

If a formula is entered which has at least one valid SI unit, but not a complete set, the add-in assumes that the user wants the output unit to be calculated and will ask the user to provide units for any precedents which are missing their units.

6.2.3 Formulae containing a constant

All constants in formulae are treated as dimensionless. For instance, if cell A1 has the value 10 and B1 has the unit m , the formula =PI()*A1^2/4 gives the output unit of m2.

6.3 Excel Functions

The Add-In should handle most of the common Excel functions except for:

array functions

sumif

sumproduct

power

SQRTPI

6.3.1 Sum & Product

The add-in will handle the SUM and PRODUCT functions with either a continuous range using : eg SUM(B1:B5) or cells collected with commas eg SUM(B1,B3,B5)

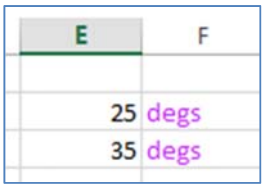
The current release will not handle a mixture of these or multiple continuous ranges joined with commas eg SUM(B1:B5,B10:B15)

PRODUCT is handled in the same manner

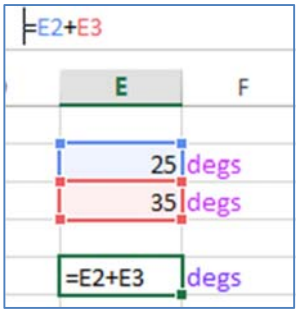
All the input cells must have valid SI units (and for SUM, identical SI units)

6.3.2 Angles and Trigonometric functions

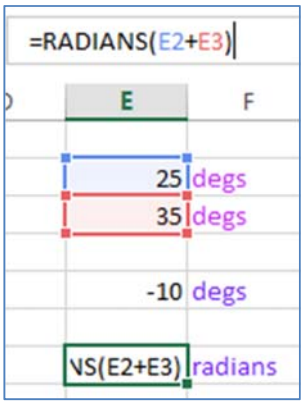
Angles can only be input in degrees.



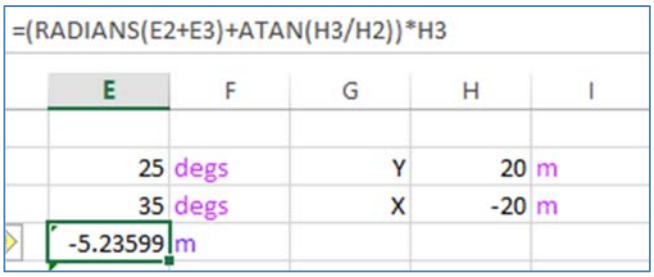
Angles are treated as dimensionless quantities when evaluating a formula which incorporates angles in to a wider formula. But a formula involving only degrees will output the unit as degrees eg:



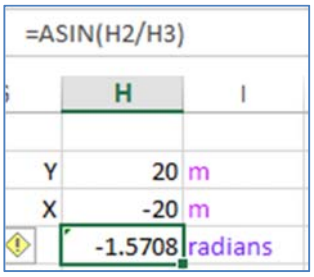
Conversion of degrees to radians with the Excel RADIANS function treats the angle as dimensionless in a wider formula. But a formula involving only the RADIANS function outputs the unit as radians



When included in a wider formula the output of RADIANS is treated as a dimensionless quantity. Inverse trigonometric functions are treated as (dimensionless) radians eg



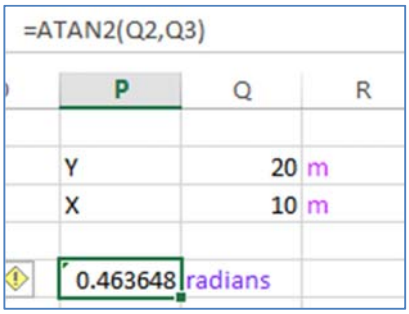
Stand-alone Inverse trig functions output as radians eg



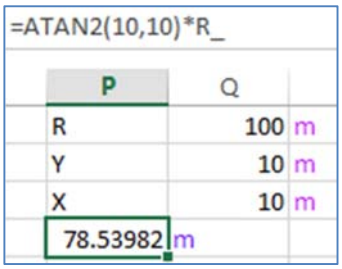
6.3.3 ATAN2

Excel includes a function ATAN2 which takes two arguments, the X & Y coordinates of vector. (This is to correctly calculate the angle in all four quadrants, which ATAN does not do)

For ATAN2 to work correctly with the Dimensional Analysis addin, the arguments of ATAN2 need to be specified as cell references with valid SI dimensions eg



If the arguments are included as values in the formula eg =ATAN2(2,1), the add-in does not calculate an output unit but if used in a wider formula is correctly treated as dimensionless eg.



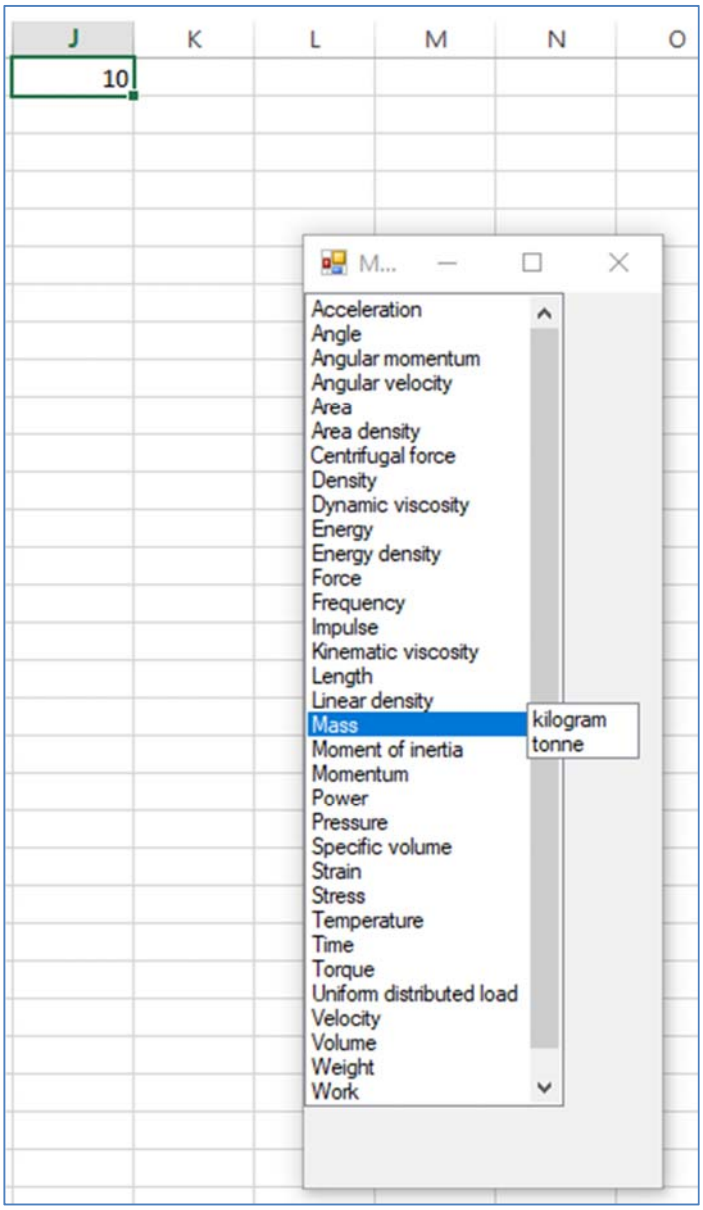
6.3.4 Trigonometric functions

Output of the SIN, COS, TAN and COT functions are treated as dimensionless.

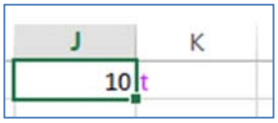
If a number is entered as eg =SIN(PI()/2) where there is no precedent cell in the argument, the unit is not written. If this cell is to be used in a further SI formula, the user should use Ctrl Alt Enter to declare that the value is dimensionless (D'less).

6.3.5 Mass units

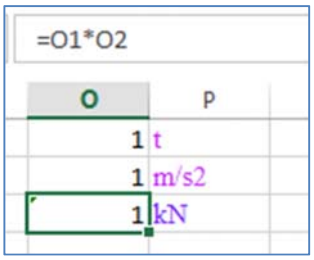
When 'Mass' is selected from the Mechanical group, a sub list is displayed allowing the user to choose either 'kilogram' or 'tonne'



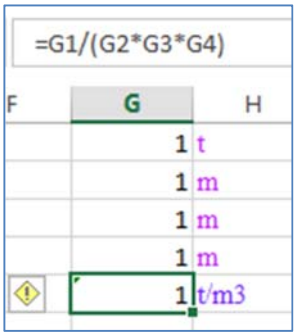
The desired unit can be selected either by typing the first letter or arrowing up/down and then pressing enter. 'kg' or 't' is displayed.



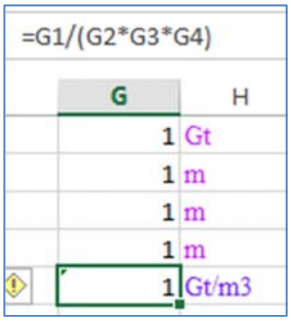
For calculation of the unit of a formula, 't' is treated as 'kkg' eg:



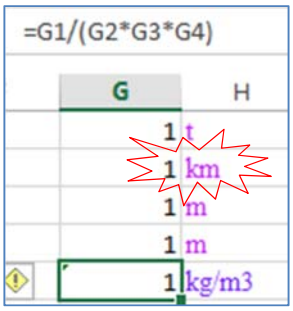
If the output unit includes a mass term eg kg/m3, if the input mass unit is ‘t’ and the calculated prefix is ‘kilo’ or above, the output will use ‘t’ eg



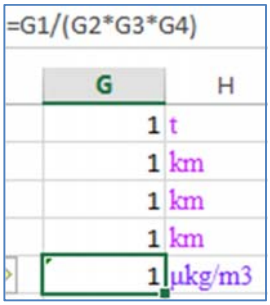
Or:



If the output would result in a tonne prefix of milli or smaller, the unit is shown in kg eg



Or

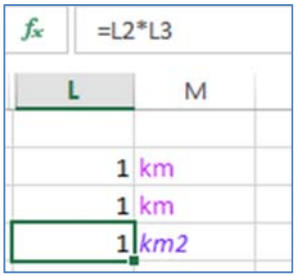


(one thousand kg / 10^9 m3 = 10^{-6} kg per m^3)

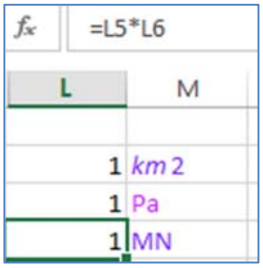
6.3.6 km2 or *km*2 and mm2 or *mm*2

An area of 1 km length by 1 metre width is an area of 1 000 m2 or 1 thousand m2 or in strict SI output 1 km2.

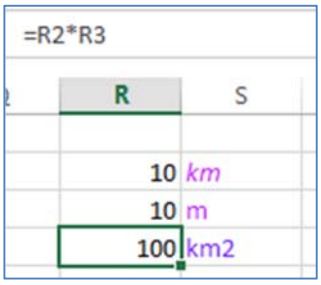
However, an area of 1 km length x 1 kilometre width is an area of 1 000 000 m2 or 1 million m2 or in strict SI output = 1 Mm2. But in common parlance, an area of 1 km length x 1 kilometre wide is 1 square kilometre or 1 km2. ***To avoid confusion, if both inputs to an area calculation have units of km, the output will be the quasi SI unit km2 but will have the km italicised thus***



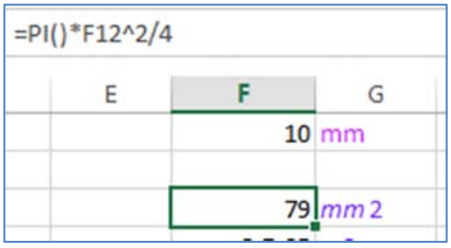
For the purposes of calculating dependent formulae, the quantity is treated as 1 million m2. Eg



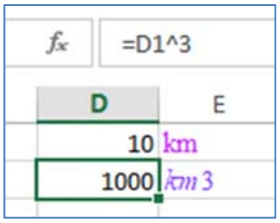
A mix of km and metres will result in the output in the true SI unit of km2 ie 1000 m2 eg



A similar treatment is used when calculating area where both inputs are in mm (or a mm input is squared eg

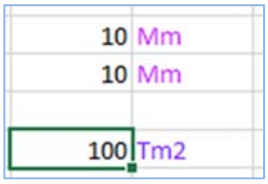


A similar treatment is used when calculating volume where inputs are in km or mm eg



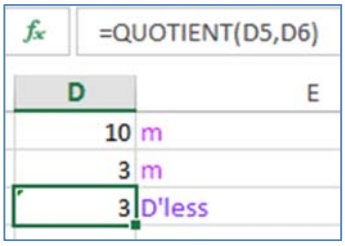
All other length prefixes are treated as true SI prefixes eg 10 Mm means 10 million metres, so

10 million metres x 10 million metres results in 100 million million square metres -



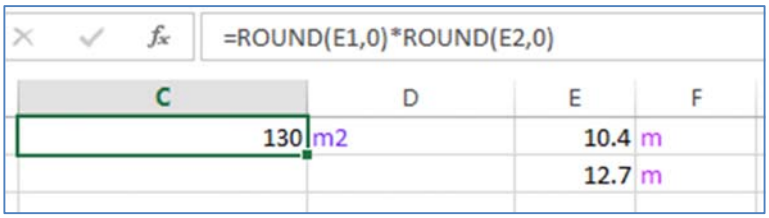
6.3.7 QUOTIENT

This will treat the arguments as if they are inputs of a division. The output will be dimensionless if the units of both arguments are the same. eg

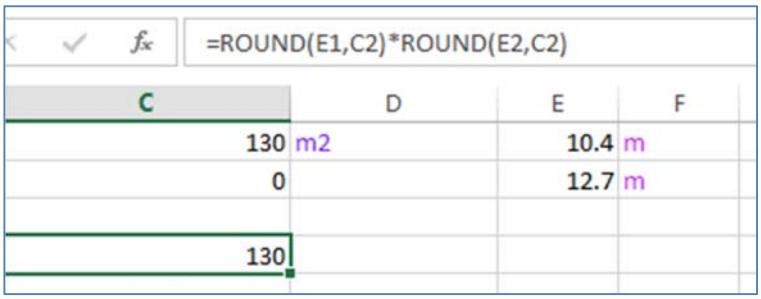


6.3.8 ROUND (UP, DOWN)

These functions will give the correct output if the first argument is a cell reference with a valid SI unit and the second argument is an integer entered in to the formula eg

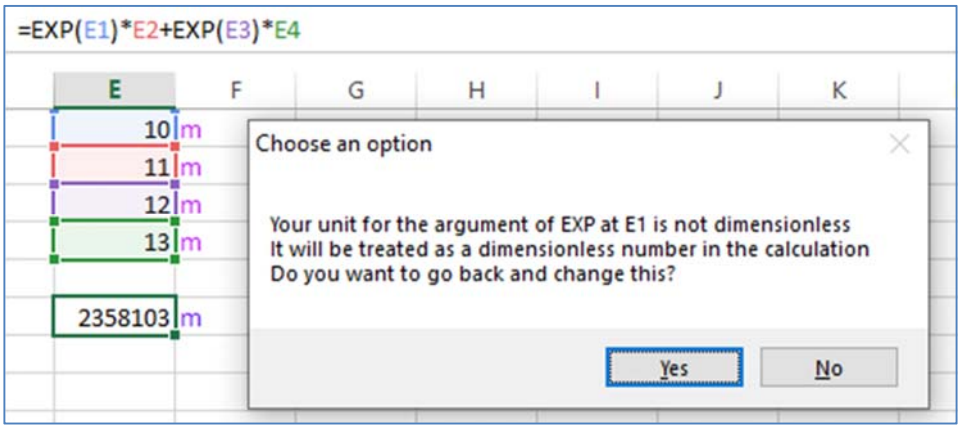


But if a cell reference is used for the second parameter, the add-in will not generate an output unit eg



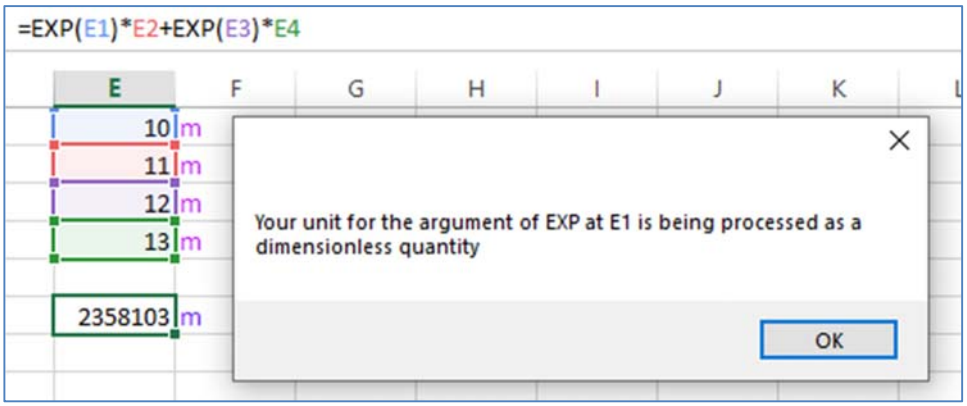
6.3.9 EXP function

The result of the EXP() function is always dimensionless. If the argument is a cell reference, the units of the argument should be a dimensionless quantity. The add-in will check the unit of the argument and display a message if the unit is not dimensionless.

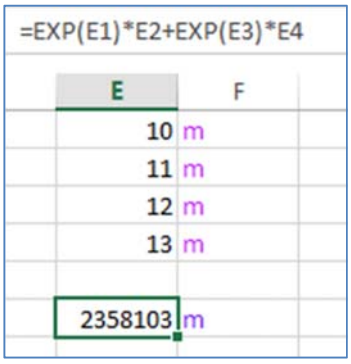


If the user clicks Yes, the add-in exits without writing any output unit.

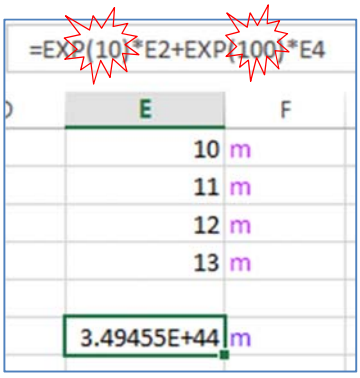
If the user clicks No, there is a reminder that the unit of the argument of EXP will be treated as dimensionless:-



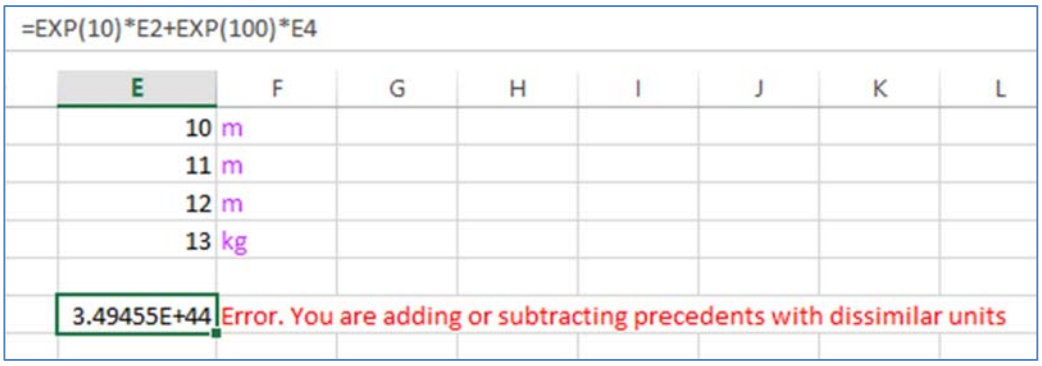
The add-in repeats this for EXP(E3) and processes the formula.



If the argument of the EXP function is a constant, the add-in treats it as dimensionless and processes the formula units:

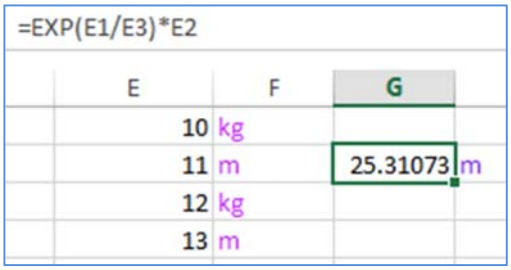


An error in the non-EXP parts of the formula is treated in accordance with the usual analysis eg mixing kg and m at cells E2 and E4:-



6.3.9.1 Formula as argument of EXP

If the argument of the EXP function is a formula and if the formula evaluates to dimensionless, the add-in will process the output dimension correctly:-



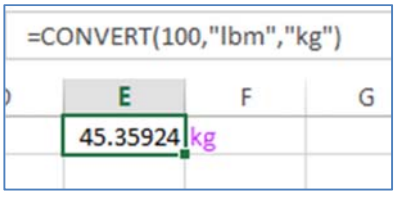
[1]

6.3.10 Excel CONVERT function

Excel provides a CONVERT function whereby a user can input a value and have it converted from one unit to another. The format is CONVERT(value,"input_unit","output_unit") eg CONVERT(100,"lbm","kg"). The arguments can be entered directly to the function or can be cell references.

The CONVERT function can be used with the Dimensional Analysis add-in.

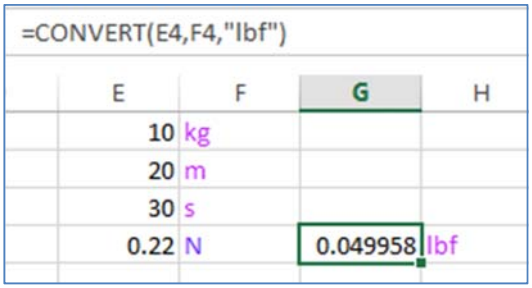
eg



Provided that the third argument (which can be directly entered in the formula or a cell reference containing the string) is an SI unit recognised by the add-in, the SI unit is written to the worksheet. It is then treated as a valid add-in unit for further calculations.

[1]

The CONVERT function can be used to convert the output of an add-in calculation eg

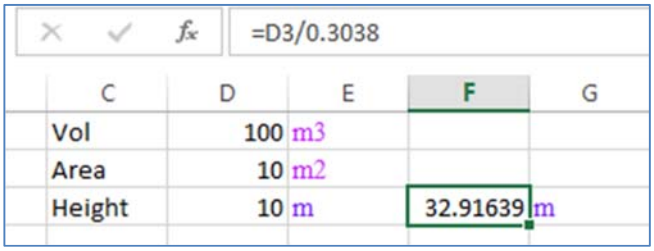


6.3.11 SUBTOTAL function

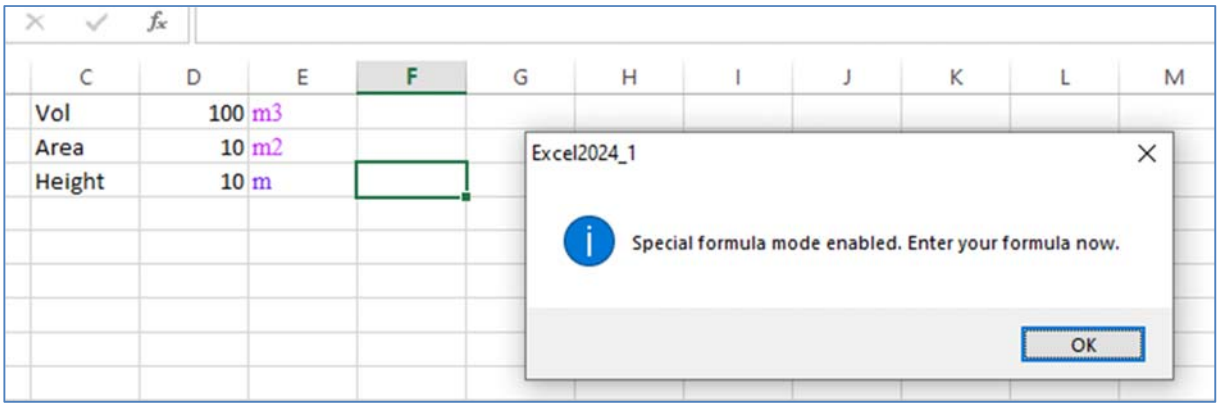
The addin will work with the Excel SUBTOTAL function

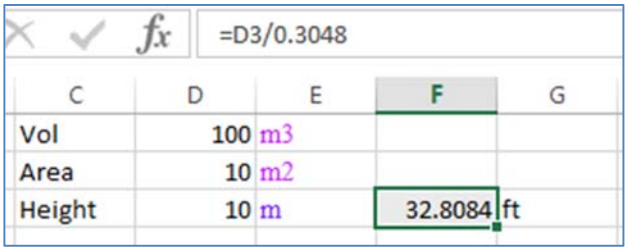
6.4 Override of automatic units

Ctrl Alt o (for override). Overrides the normal calculation of output unit of a formula even if a full set of SI units is supplied for the precedents. This allows the user to override the calculated unit to add a Non SI unit. For instance, if a calculation chain has produced an output at D3 =D1/D2 of 10 m. Under normal Formula Checker operation, if the user enters at F3 "=D1/0.3048" intending to convert metres to feet, the Formula Checker will enter m at G4 because there is a full set of SI units and the constant 0.3048 is treated as dimensionless.



Ctrl Alt o before entering the formula will override the Formula Checker thereby allowing the user to enter 'ft' at G4.





A formula including a constant can be written to the cell without the addin acting on it. A 'manual' unit can be written to the adjacent cell. The special cell is indicated with a pale grey background.

The override can be removed from a selected cell by choosing 'Remove formula override' from the Formula Checker ribbon menu.


FILE
HOME
INSERT
PAGE LAYOUT
FORMULAS
DATA
REVIEW
VIEW
DEVELOPER
FORMULA CHECKER
Units options
Unprotect all sheets
Set your own konversion factors
Manage your own konversion factors
Remove formula override

6.5 Closing workbooks

When you close a workbook with the Add-in installed, it will ask if you want to un-install it. You can opt to not un-install, in which case it will still be installed for any subsequent workbooks eg your timesheet, that you open.

On closing a workbook, while the EFC add-in is loaded, the worksheets are protected – see 5.4 below.

6.6 Protection of EFC written units

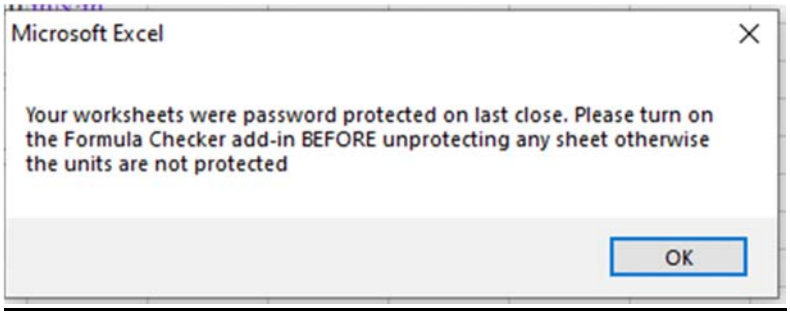
The units written to a worksheet by the Excel_ent Formula Checker (EFC) form a consistent chain across all dependent formulae. To protect the integrity of the chain, any unit written by EFC can not be changed 'manually' by the user. This applies to 'starter' units written by the Ctrl Alt u process and by calculated units written by EFC.

This protection is effected by the EFC add-in. The protection is not effective if the add-in is not loaded.

To add an extra level of protection, when the workbook is closed, each worksheet in the workbook is password protected. All the EFC written units are then locked, even though the add-in is not loaded. If the user has applied their own password protection to a worksheet, that password remains in place. If the user has not applied a password, the add-in uses the password "password".

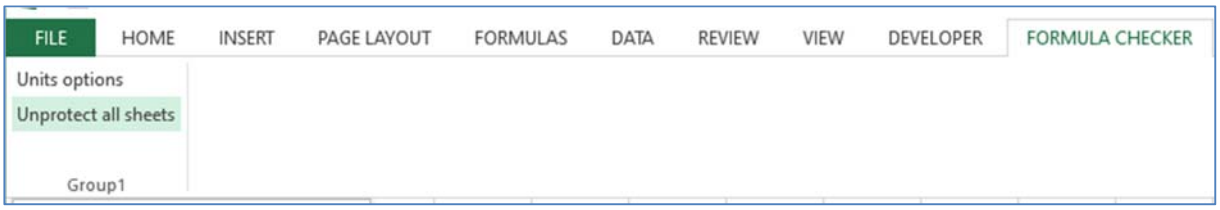
When a workbook which has utilised the EFC add-in, is re-opened a message is displayed to remind the user that:

- all worksheets are password protected
- **if the EFC add-in is not loaded and the worksheet is unprotected, any of the EFC written units can be edited by the user, which destroys the integrity of the chain.**



Removing the password can be done either with the standard Excel REVIEW tab and Unprotect Sheet:-

Or with the 'Unprotect all sheets' button on the FORMULA CHECKER tab:-



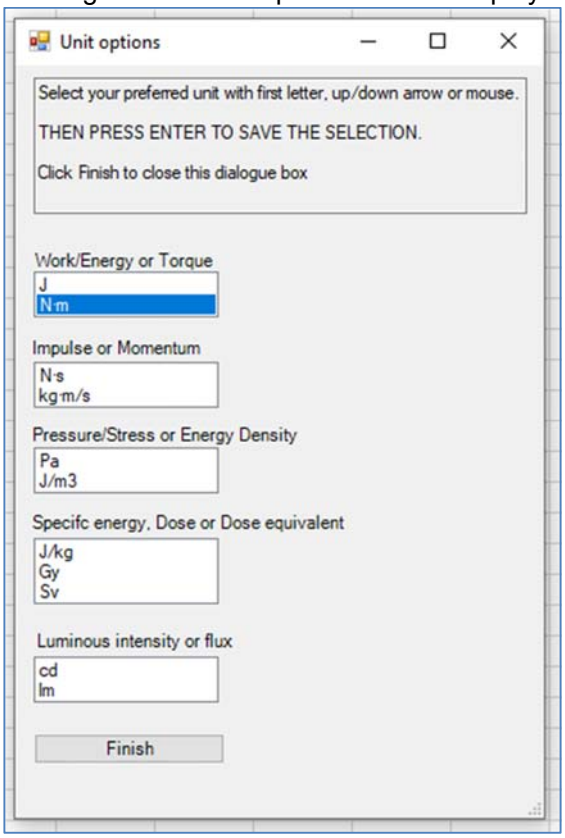
If the user has applied their own password to a sheet, this button will ask for the user to input that. Otherwise it unprotects all sheets with the default password "password".

6.7 Preferred output units

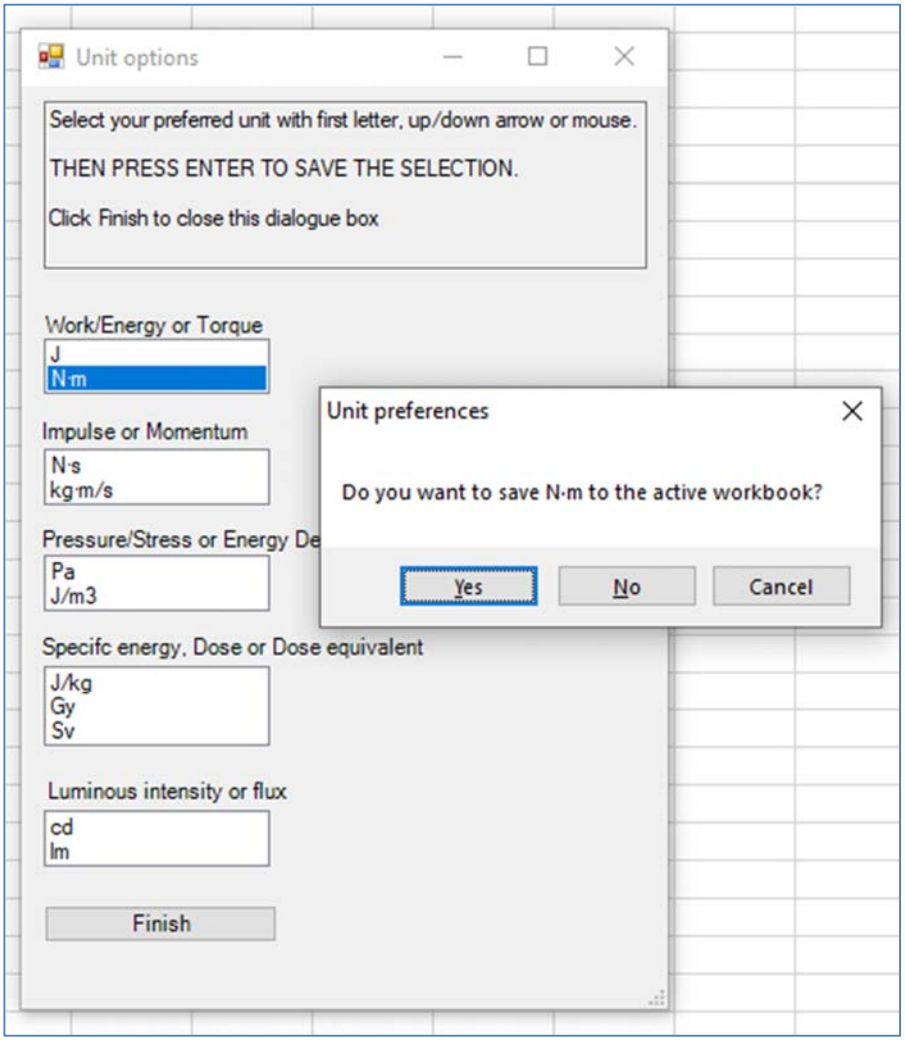
Within SI there are a few instances of different quantities which have identical dimensions, for instance energy (Joules) or torque (Newton metres). The user can specify which unit should be written to a formula result.

Selecting "FORMULA CHECKER" from the ribbon displays a "Units options" button on the left hand side:-

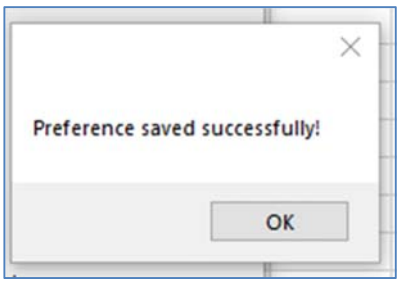
Clicking on the Units options buttons displays a form for selecting preferred output units:-



For each quantity, the preferred unit can be selected with mouse, up/down arrow or first letter. After selection, ‘Enter’ will bring up message to ask for confirmation that the unit is to be stored.



Upon acceptance, a confirmation message is displayed:-



Pressing ‘Finish’ will close the dialogue box.

The preferred unit has now been stored in the active workbook. The preference will remain until changed with the same process. The preference is preserved on closing and is available next time the workbook is opened.

IT IS NOT NECESSARY TO CHOOSE A PREFERENCE FOR ALL THESE QUANTITIES – ONLY THE ONE(S) RELEVANT TO THE USERS ACTIVE WORKBOOK. Further choices can be made for other quantities at any time.

6.8 Notes & Warnings

1. Workbook names: Workbook names should not include spaces. Use underscore or capitals if more clarity is needed eg ‘my_workbook’ or ‘myWorkbook’. Not ‘my workbook’
2. The add-in protects cells to which it writes units. If the add-in is unloaded, this protection no longer works. To counter this, on workbook close, the add-in will password protect all worksheets (with the password ‘password’. The units are then locked until the worksheets are unprotected.)
3. **WHEN THE WORKSHEET HAS BEEN MANUAL UNPROTECTED, ANY UNITS WHICH HAVE BEEN CREATED BY THE ADD-IN CAN BE ‘MANUALLY’ DELETED. THIS CAN THEN MAKE THE SPREADSHEET INCONSISTENT. DO NOT DELETE ANY ADD-IN UNITS EXCEPT BY USING Ctrl Alt d**
4. **The add-in uses a very specific font colour for the units. DO NOT CHANGE THIS FONT otherwise the add-in will not work properly.** (The next revision of the add-in will include a facility for the user to choose their own font colour)
5. ‘Angle’ in the units drop down list means plane angle. Solid angle is shown under ‘Solid angle’.
6. POWER function is not yet handled by the add-in.
7. The add-in handles the following trignometric and other functions:

   ```
   "SIN", "COS", "TAN", "ASIN", "ACOS", "ATAN", "ATAN2", "ACOSH", "ACOT", "ACOTH",
   "ASINH", "ATANH", "COSH", "COT", "COTH", "CSC", "CSCH", "SEC", "SECH", "SINH",
   "TANH", "RADIANS", "LN", "LOG", "LOG10", "EXP", "MOD", "BETWEEN"
   ```

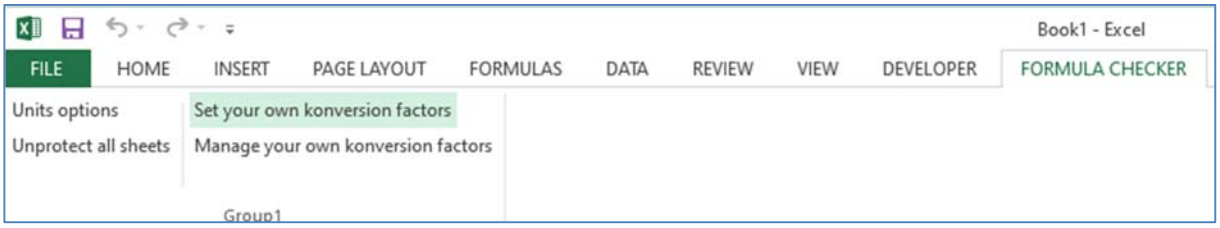
   If you use a named range that includes any of these character strings eg ‘CAPACITANCE’ containing the string ‘TAN’, the formula checker will not work correctly. This is case sensitive so’ Capacitance’ is OK

7 KONVERT FUNCTION

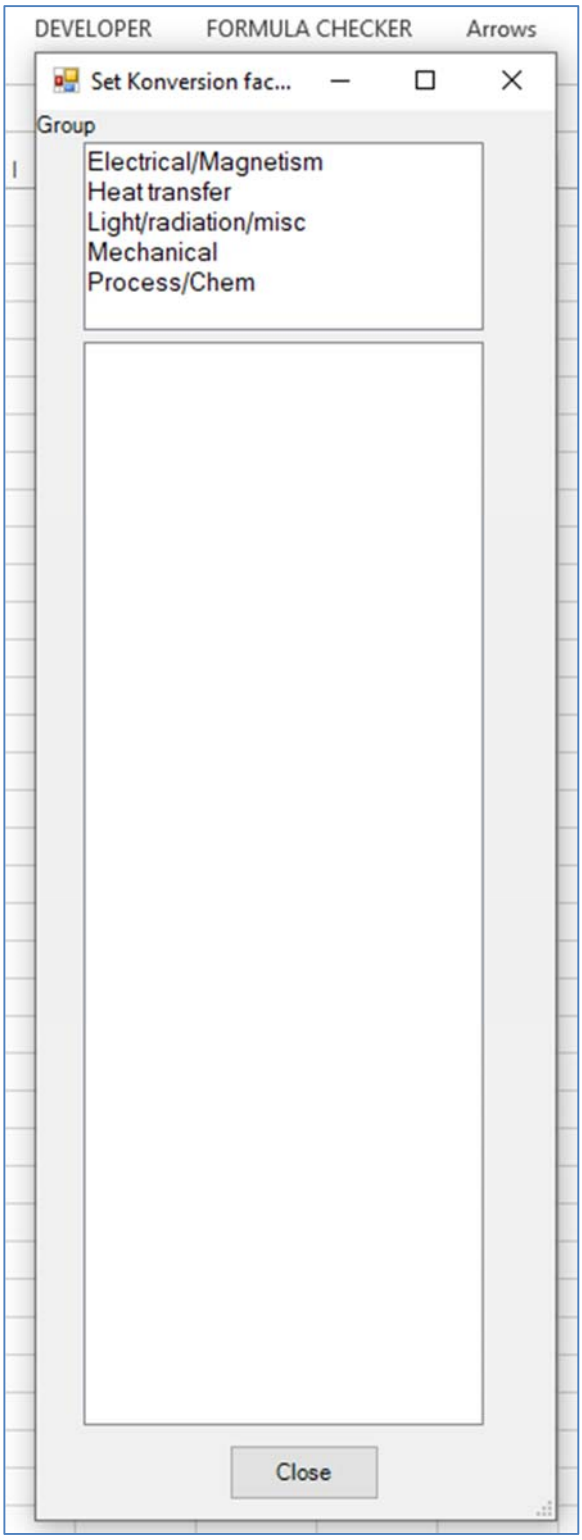
Excel CONVERT function is limited and not easy to use. The Excel_ent Formula Checker therefore provides the facility for the user to specify their own conversion factors and enter these with simple keystrokes. This is designated the KONVERT facility to differentiate it from Excel CONVERT function.

7.1 Setting Konversion factors

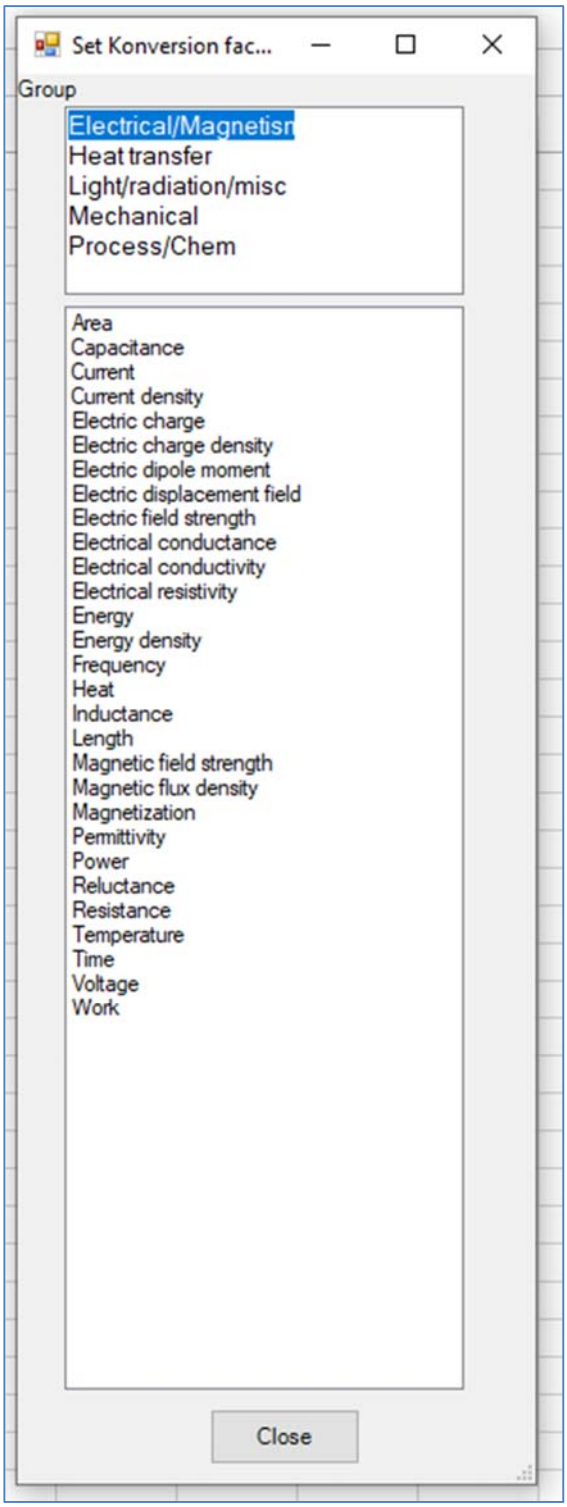
The first step is for the user to create their own konversion factor using the form chosen from the 'Set your own konversion factors' button on the FORMULA CHECKER drop down menu.



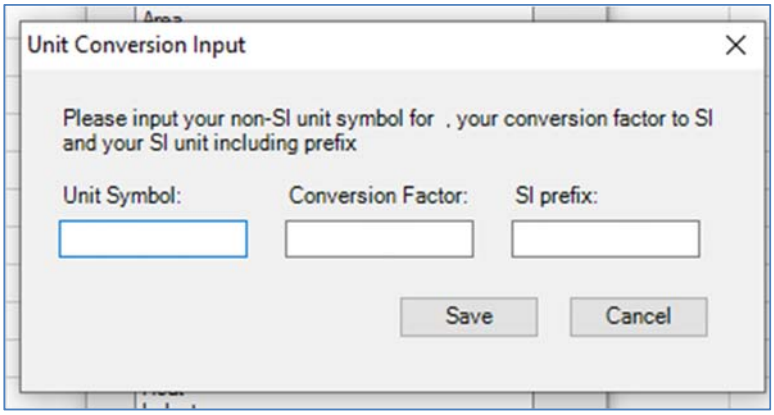
This brings up a form displaying the same groups from which input units are selected:



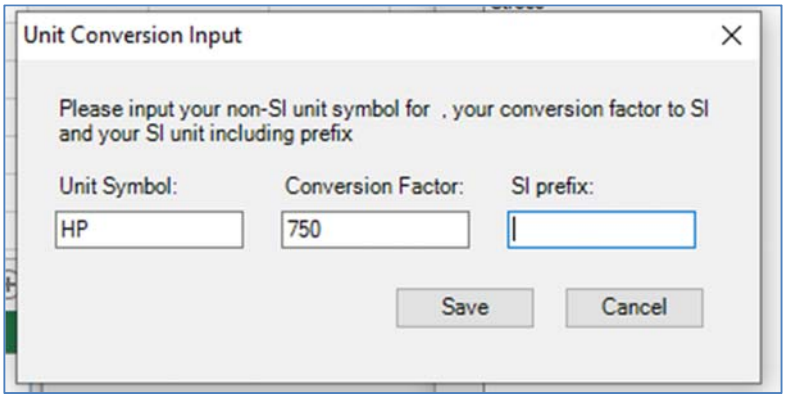
Typing the first letter of the required group brings up the relevant list of quantities:


Set Konversion fac...
Group
Electrical/Magnetism
Heat transfer
Light/radiation/misc
Mechanical
Process/Chem
Area
Capacitance
Current
Current density
Electric charge
Electric charge density
Electric dipole moment
Electric displacement field
Electric field strength
Electrical conductance
Electrical conductivity
Electrical resistivity
Energy
Energy density
Frequency
Heat
Inductance
Length
Magnetic field strength
Magnetic flux density
Magnetization
Permittivity
Power
Reluctance
Resistance
Temperature
Time
Voltage
Work
Close

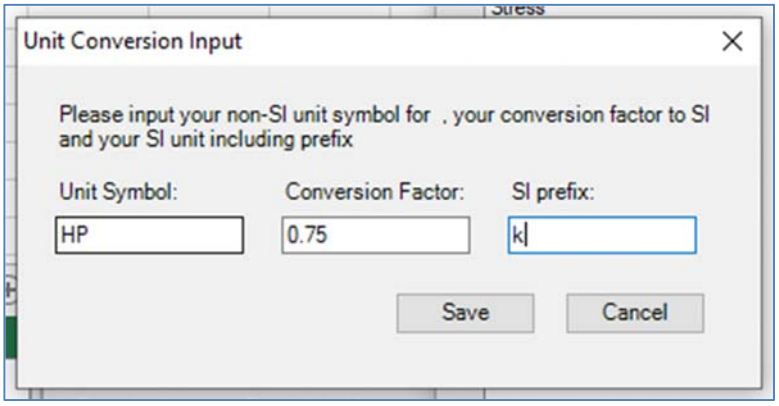
Tab followed by a first letter from the list of quantities (or mouse selection) displays an input form:



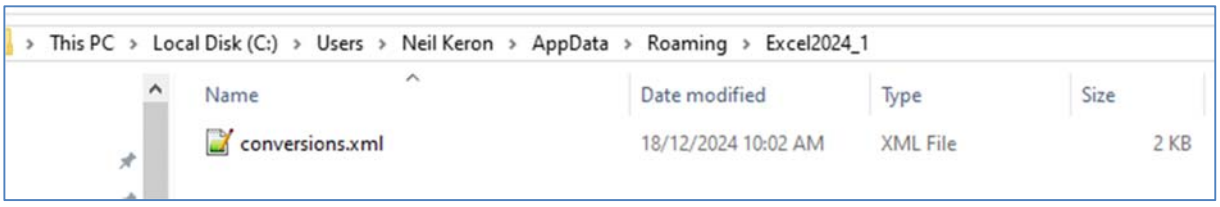
In the 'Unit Symbol' box, the user types their chosen symbol for a non-SI unit eg "HP" for horsepower. Tab moves to 'Conversion Factor' where the user enters the numerical value converting HP to the SI unit Watts:



If the user wants the konversion to be from HP to kW, the prefix "k" is entered in to the 'SI prefix box BUT in this case the Conversion Factor value would be 0.75 (or whatever level of accuracy the user requires)



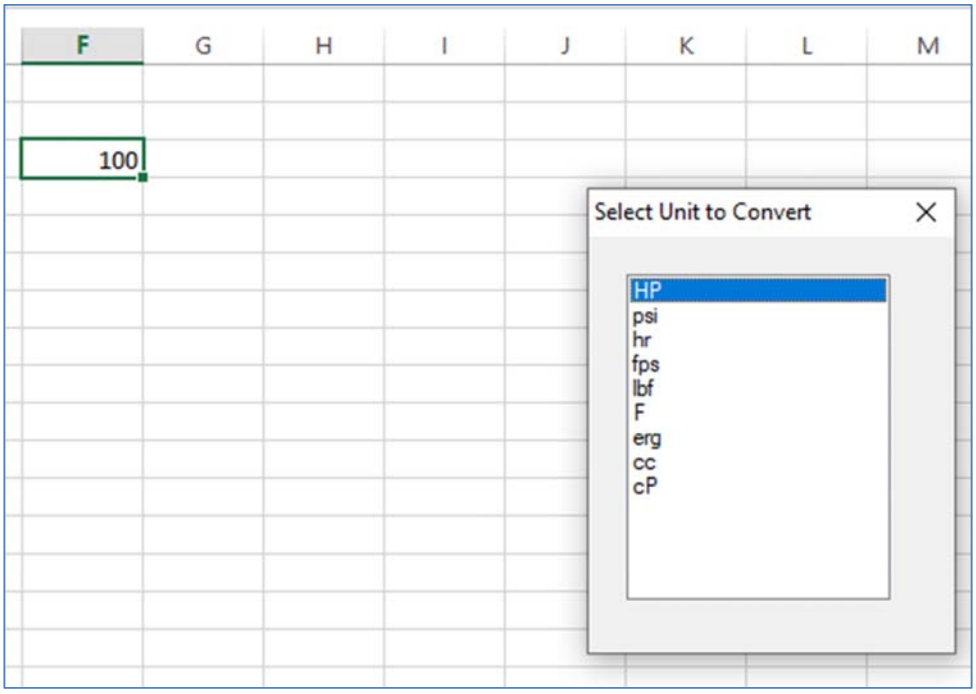
Clicking the Save button creates an xml file in the users AppData Roaming folder eg:



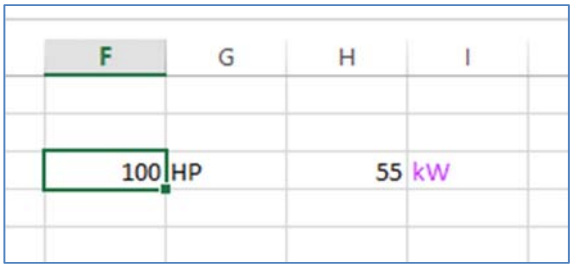
WARNING: In version 23, after entering and saving a konversion factor, it is necessary to unload the addin, then reload it before the new konversion factor is available as per section 6.2

7.2 Using konversion factors

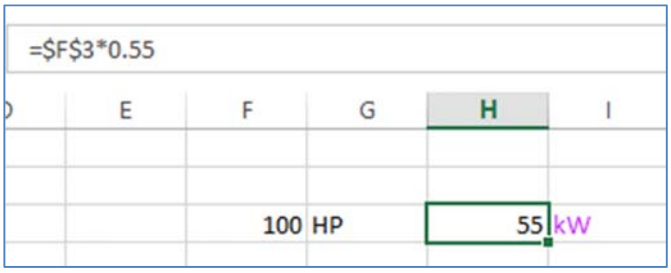
When the user requires a non-SI unit converted to SI, after entering a value at say cell F3 (with Ctrl Enter so that the selection remains at F3), keystrokes Ctrl Alt k (for konversion) brings up a dropdown list of the user's own non-SI units:



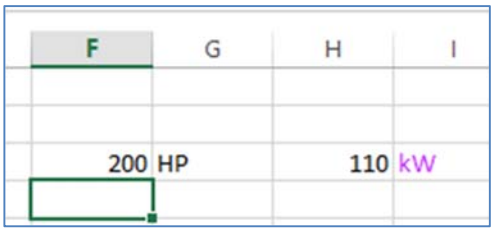
Typing first letter followed by Enter enters the selected unit in G3 and also enters the konversion formula in H3 and the appropriate SI unit in I3:



The entry at H3 is a formula, not a value:



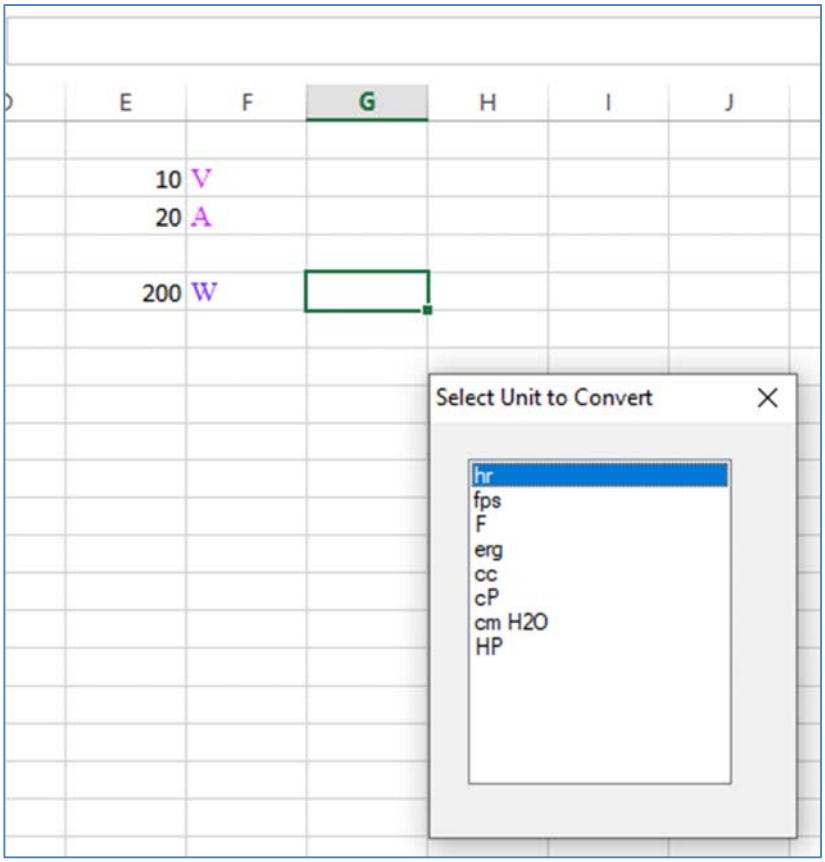
So that subsequent revisions to F3 are reflected at H3:



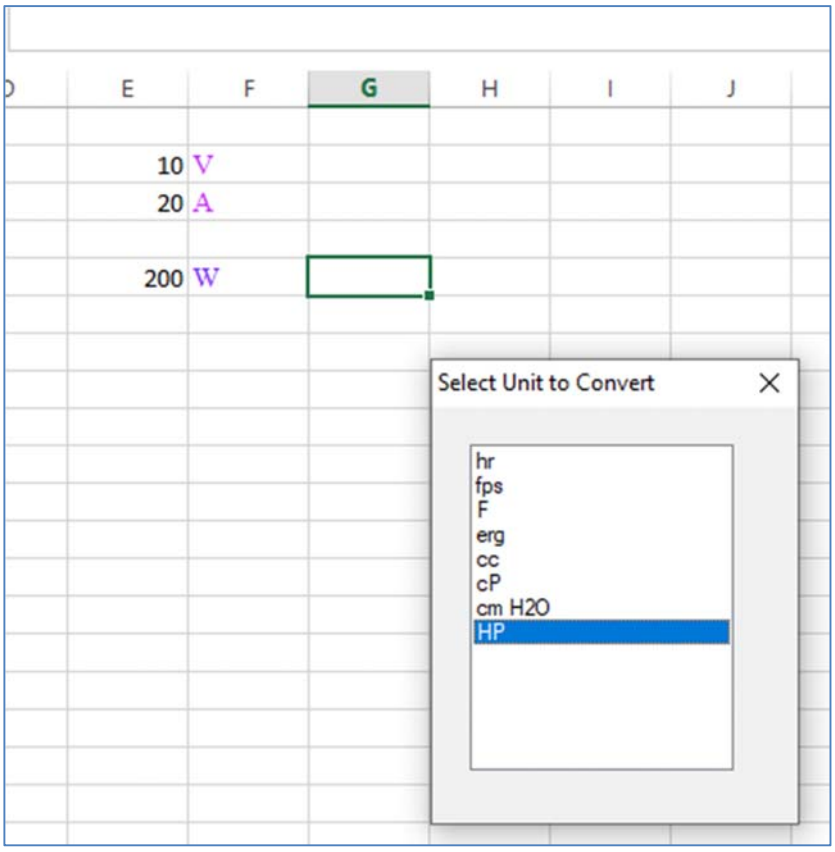
USE OF THIS FUNCTION OBVIOUSLY REQUIRES THERE TO BE 3 CLEAR CELLS TO THE RIGHT OF SELECTED CELL EG F3

7.3 Reverse konvert function.

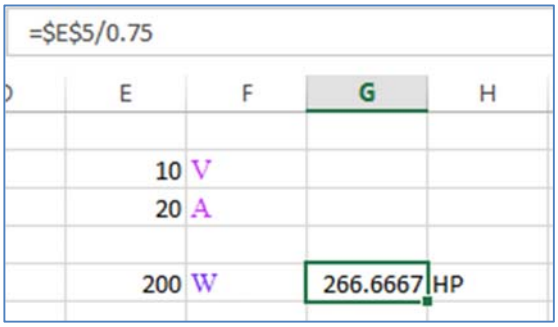
To convert from an SI unit back to the user's chosen non-SI unit, select a cell (eg G5) immediately to the right of an SI unit (E5) and press Ctrl Alt r (for Reverse konvert) (make sure there is another empty cell to the right of the selected cell.) This brings up the list of user defined konversion factors:



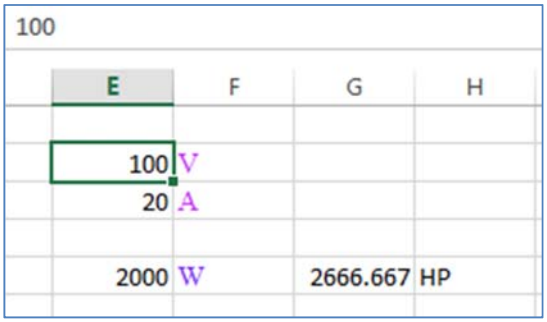
Typing a first letter or scrolling down and hitting Enter



writes the reverse konversion formula to the selected cell and the non-SI unit to the adjacent cell:

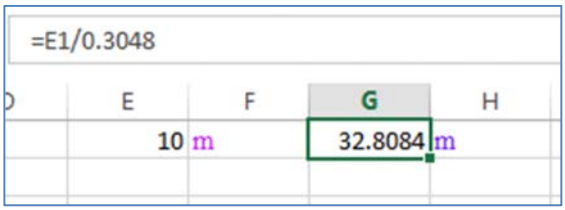


Because G5 contains a formula, not a hard entry, revision to the original inputs flows through to the non-SI unit



7.4 Override of automatic unit calculation.

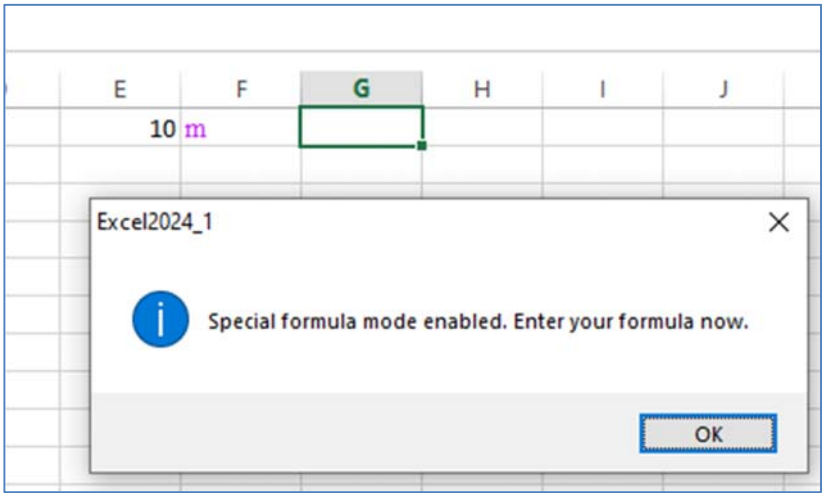
Section 7.3 describes automatic konversion of SI to non-SI units using user defined konversion factors. However, there may be times when the user wants to convert an SI unit to a non-SI for which there is not yet a user defined function For example, converting a value at E1 in metres to feet with the local formula at G1 =E1/0.3048. Because Excel_ent Formula Checker (EFC) treats any constants in a formula as dimensionless, it evaluates the units of G1 according to its rules and outputs the unit m at H1.



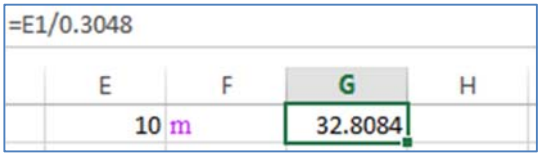
To allow simple conversion like this, it is possible to override the normal EFC rules.

If the previous formula at G1 is deleted, the unit at H1 will be deleted by EFC.

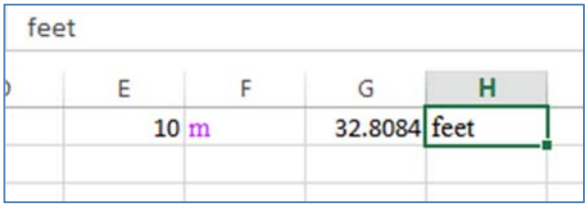
Then with the selection at G1, Ctrl Alt o (for override) will bring up a message saying that this will be treated as a special cell:



Now the EFC function is overridden and a formula can be entered without an SI unit being written:

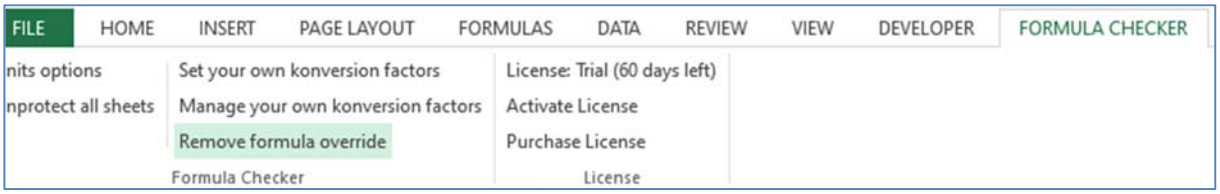


A text value can then be entered at H1:

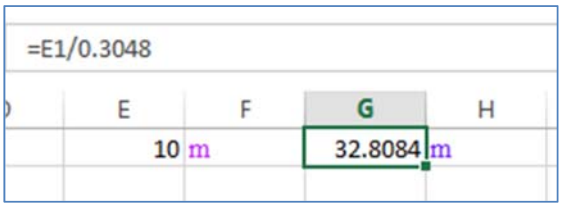


7.4.1 Restoration of special cells to normal

If it is necessary to restore an overridden cell to normal EFC function, the cell should be selected and ‘Remove formula override’ clicked from the FORMULA CHECKER menu:



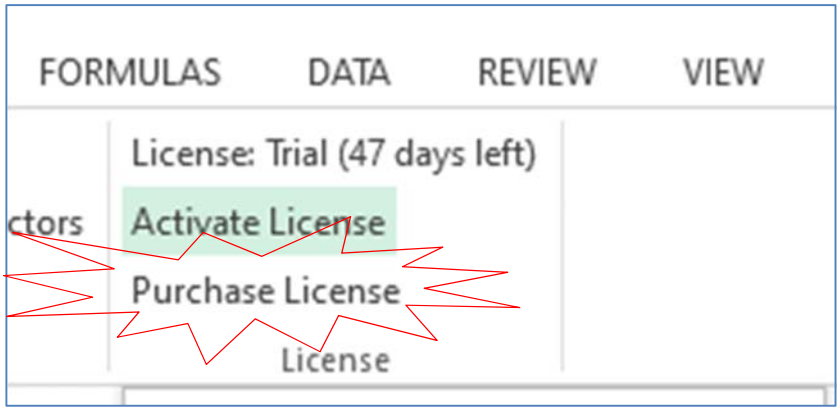
Now if the formula at G1 is refreshed, the SI unit of m is written to H1:



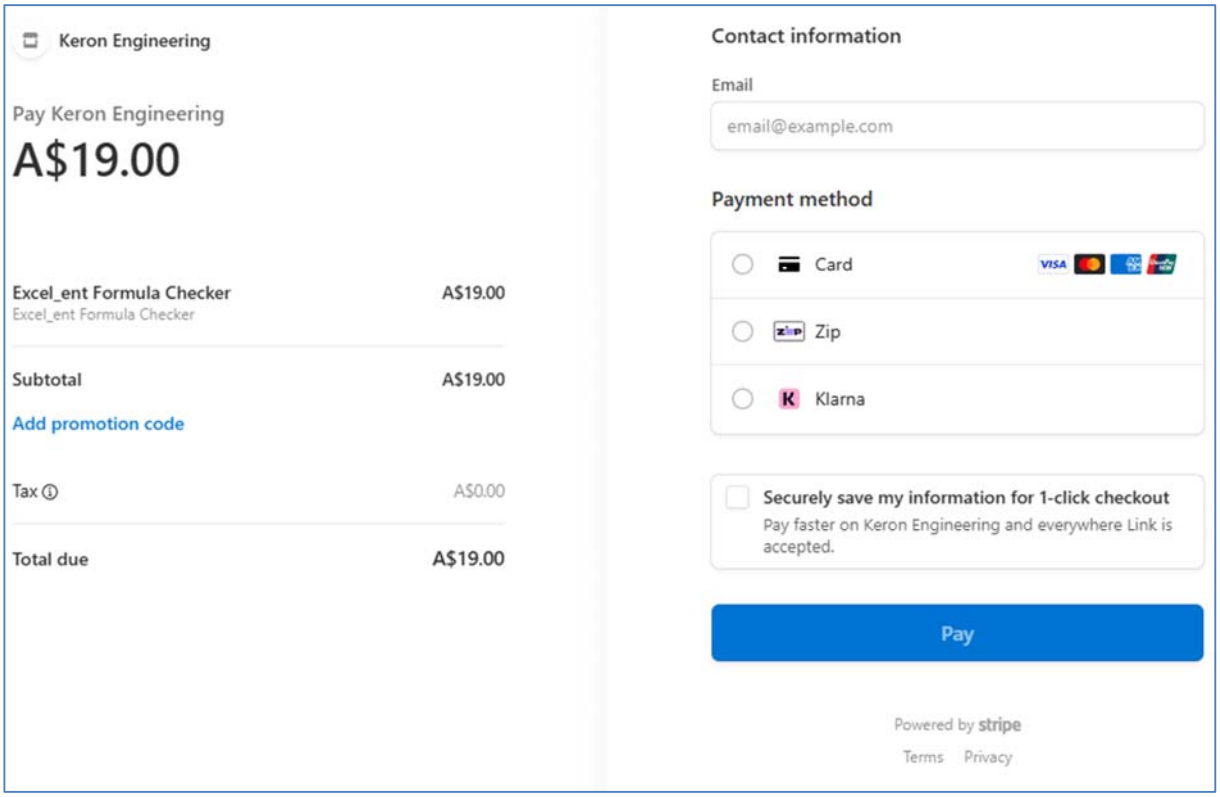
8 PURCHASE OF PERPETUAL LICENCE

When first installed from the Keron Engineering website, the addin has a trial period of 60 days. At any time during this period, you can purchase a perpetual licence for a one-off fee.

Click on the Purchase License button in the Formula Checker ribbon.

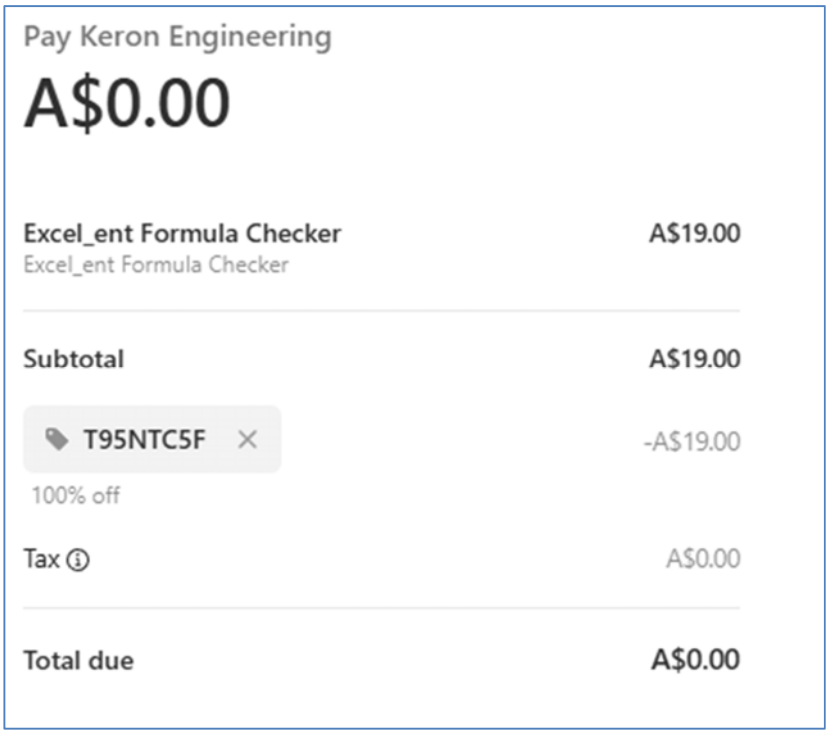


This should take you to a payment page:



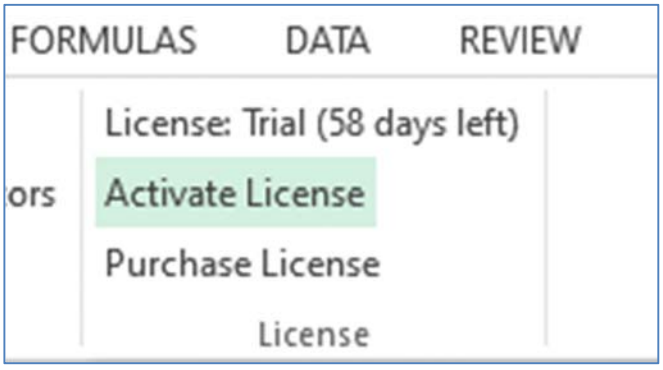
Enter email address (a Product Key will be sent to this address, so make sure it is correct). Complete the payment process.

If you have been given a discount promotion code, enter this at “Promotion Code” and click Apply. The price should be revised accordingly:

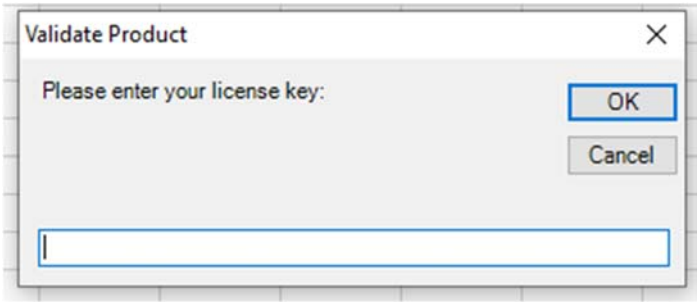


8.1.1 Activation of licence

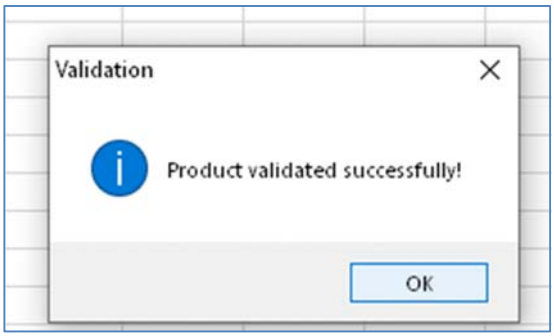
Click on the ‘Activate License’ button



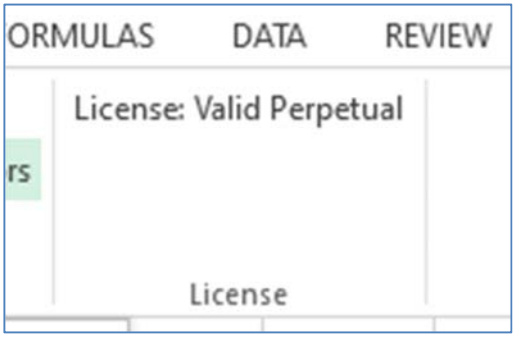
and a ‘Validate Product’ screen should appear.



Copy the product key from the email sent to you and paste to this box. After several seconds (up to 30 so be patient) you should see

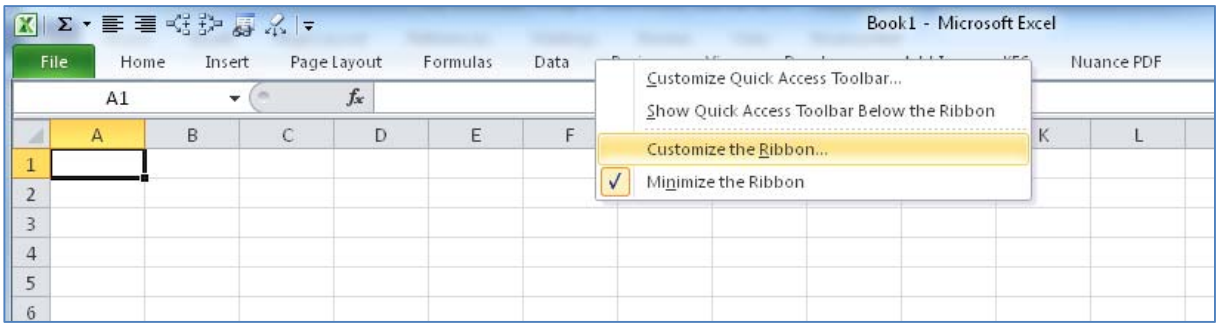


Click OK and the licence tab in the ribbon should now say ‘Valid Perpetual’

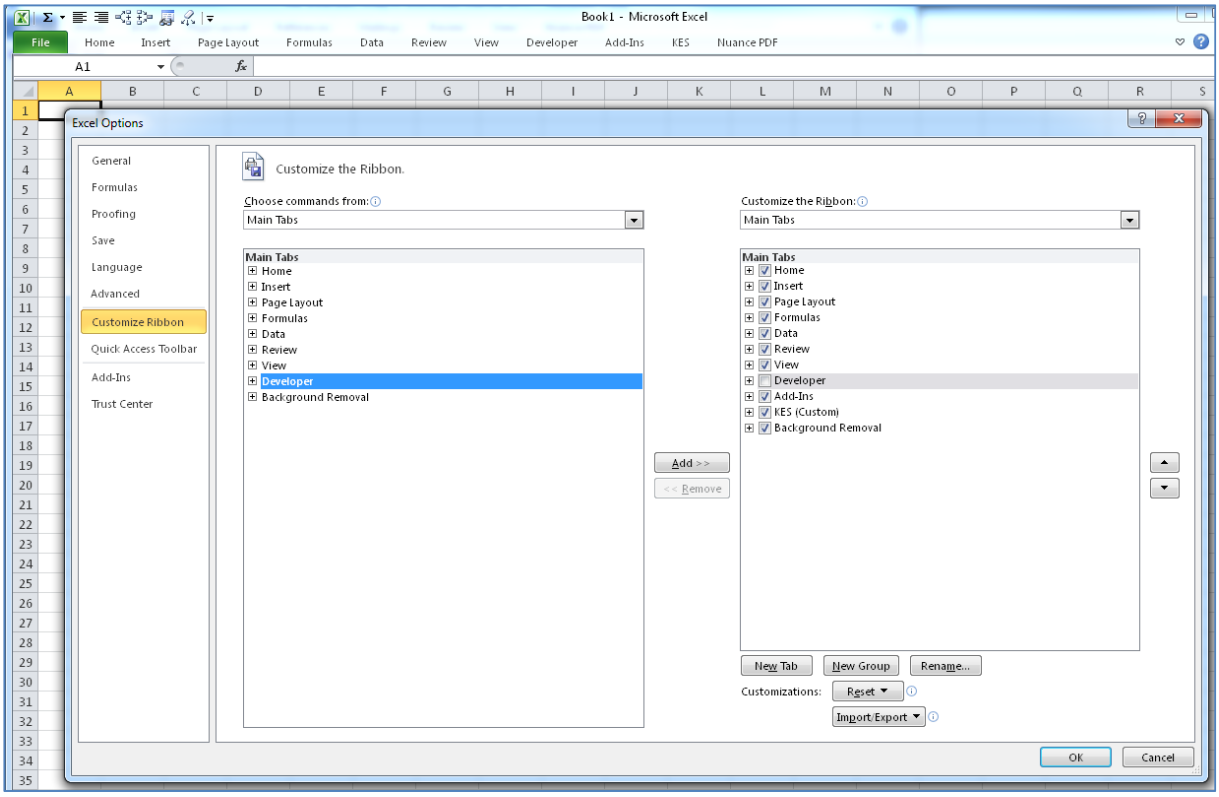


9 DEVELOPER TAB

If the developer menu is not visible, right click anywhere in the ribbon and choose ‘Customize the Ribbon’



From the Main Tab, select ‘Developer’, click ‘Add’ & click ‘OK’ button. ‘Developer’ should now appear in the main ribbon



10 REFERENCES

The International System of Units 9th edition by Bureau International des Poids et Mesures

The SI Metric SystelD of Units and SPE METRIC STANDARD Society of Petroleum Engineers

https://en.wikipedia.org/wiki/List_of_physical_quantities

https://en.wikipedia.org/wiki/SI_derived_unit

11 KNOW ERRORS/BUGS

1. =A1^(1/2) does not behave. Use =A1^0.5 or SQRT(A1)
2. If you take the SIN etc of a dimensioned quantity, it returns the dimension of that quantity eg SIN(A1) where B1 is radians returns “D’less” but SIN(A2) where B2 is in metres returns “m”
3. Ditto RADIANS, LN, LOG
4. mm x mm x mm/1 000 000 000 not behaving correctly
5. SIN etc does not check for mixed prefixes
6. CONVERT formula does not work when converting to any unit containing ^ eg CONVERT(100,”m”,”ft^2”)
7. CONVERT can not be embedded in to a formula doing further calculation. It needs to stand alone, then its output can be used in subsequent formulae.
8. Attempting to delete an individual SI unit is prevented by the FC add-in but selecting a region which includes an SI unit and hitting delete will delete all the cells including the SI unit which might have dependents. And does not issue any warnings or error messages

12 FUTURE ENHANCEMENTS

1. Option for user to choose font and colour of add-in written units

2.

13 APPENDIX 1 QUANTITIES AND UNITS INCLUDED IN THE ADD-IN

(Version 1.0.0.19)

Quantity	Unit
Length	m
Mass	kg
Time	s
Current	A
Temperature	K
Amount of substance	mol
Luminous intensity	cd
Absement	Abs
Absorbed dose rate	Gy/s
Acceleration	m/s2
Angle	degs
Angle	rad
Angular acceleration	rad/s2
Angular momentum	kg.m2/s
Angular velocity	rad/s
Area density	kg.m−2
Area	m2
Capacitance	F
Catalytic activity concentration	kat.m-3
Catalytic activity	kat
Centrifugal force	N.rad
Chemical potential	J/mol
Crackle	m/s5
Current density	A/m2
Density	kg/m3
Dose equivalent	Sv
Dummy	m4
Dynamic viscosity	Pa.s
Electric charge density	C/m3
Electric charge	C
Electric dipole moment	C.m
Electric displacement field	C/m2
Electric field strength	V/m
Electrical conductance	S
Electrical conductivity	S/m
Electrical resistivity	Ω.m
Energy density	J.m-3
Energy	J
Entropy	J/K
Force	N
Frequency	Hz
Half-life	s
Heat capacity	J/K

Heat flux density	W/m2
Heat transfer coefficient	W/(m2.K)
Heat	J
Illuminance	lux
Impedance	Ω
Impulse	N.s
Inductance	H
Intensity	W/m2
Irradiance	W/m2
Jerk	m/s3
Jounce (Or snap)	m/s4
Kinematic viscosity	m2/s
Linear density	kg.m-1
Luminous flux	lm
Mach number	D'less
Magnetic field strength	A/m
Magnetic flux density	T
Magnetic flux	Wb
Magnetization	A/m
Mass diffusivity	m2/s
Mass fraction	D'less
Mean lifetime	s
Molar concentration	mol.m−3
Molar energy	J/mol
Molar entropy	J/(K.mol)
Molar heat capacity	J/(K.mol)
Moment of inertia	kg.m2
Momentum	kg.m/s
Optical power	dpt
Permeability	H/m
Permittivity	F/m
Pop	m/s6
Power	W
Pressure	Pa
Radiance	W/(m2.sr)
Radiant intensity	W/sr
Radioactive activity	Bq
Radioactive dose	Gy
Reaction rate	mol/(m3.s)
Refractive index	D'less
Reluctance	H−1
Resistance	Ω
Solid angle	sr
Specific energy	J/kg
Specific heat capacity	J/(K.kg)
Specific volume	m3.kg−1
Spin	kg.m2.s−1
Strain	D'less
Stress	Pa

Surface tension	J/m2
Temperature gradient	K/m
Thermal conductance	W/K
Thermal conductivity	W/(m.K)
Thermal resistance	K/W
Thermal resistivity	K.m/W
Torque	N.m
Uniform distributed load	N/m
Velocity	m/s
Voltage	V
Volume	m3
Volumetric flow rate	m3.s−1
Wave number	m-1
Wave vector	m-1
Wavelength	m
Weight	N
Work	J
Young's modulus	Pa