

Test&Motion
Application Module

**KU 16 – Tension Test for vulcanized rubber and
elastomers, method A (D412-06a)**

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Contents:

1	INTRODUCTION	4
1.1	Symbols.....	4
2	KU 16 – TENSION TEST FOR VULCANIZED RUBBER AND ELASTOMERS TEST METHOD A (ACC. TO ASTM D412-06A)	5
2.1	Field of application	5
2.2	Test graphic KU 16.....	5
2.3	Input values KU 16.....	5
2.4	Results KU 16	7
2.5	Notes for test KU 16.....	8
2.5.1	Preliminary force F0.....	8
2.5.2	Test speeds.....	8
2.5.3	Yield stress criteria.....	8
2.5.4	Tensile modulus limits.....	8
2.5.5	Elongation, extension.....	9
2.5.6	Pairs of reference values	9
2.5.7	Behaviour at Av.....	9
2.5.8	Input values M1 and M2.....	9
2.5.9	Output value Et	9
2.5.10	Input values E1, E2, E3 and output values A11,A12, A21,A22, A31,A32	9
2.5.11	Output values Ystress and Fy, Ay and dLy.....	10

1 Introduction

Dear customer, thank you for choosing a product of **DOLI Elektronik GmbH**. **Test&Motion** is a modern application for the operating systems Microsoft Windows 7/10®.

This manual does not deal with the **Test&Motion software** in general but with the application module **KU 16** in particular. Hence, it is recommended to read the **Test&Motion** application manual in order to get familiar with the software. Please follow the demands and safety hints listed in the manual!

1.1 Symbols

The different symbols in this manual will allow you to find your way more easily.

Table 1: Symbols and their meaning.

Symbol	Meaning
	Safety Instructions: In order to avoid interruptions in the work flow as well as damages to man and machine, follow the safety instructions at all cost.
	Job/work instructions: Instructive part of the document with precise work instructions. Here you are asked to do something.
	Information: General information and descriptions of working procedures, etc.
	Note: Important note for the operation, the function or for the working procedures.
	Tip: Gives tips for easy handling of the Test&Motion Software , the EDCs or the testing instrument.

2 KU 16 – Tension test for vulcanized rubber and elastomers Test method A (acc. to ASTM D412-06a)

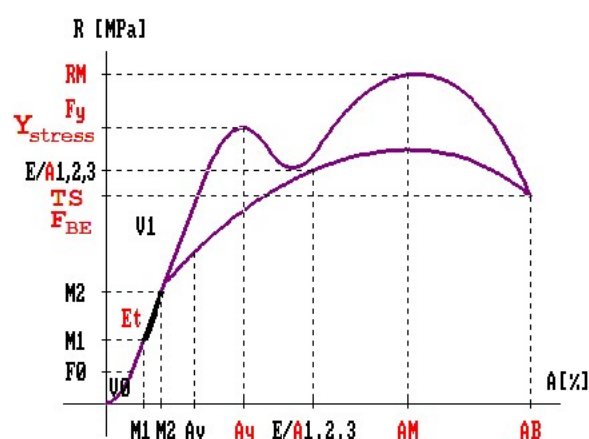
2.1 Field of application

Determination of tensile characteristics (tension properties) of vulcanized thermoset rubbers and thermoplastic elastomers.

Test method A: Dumbbell and straight section specimen Application module KU 16

Test method B: Cut ring specimen Application module KU 16R

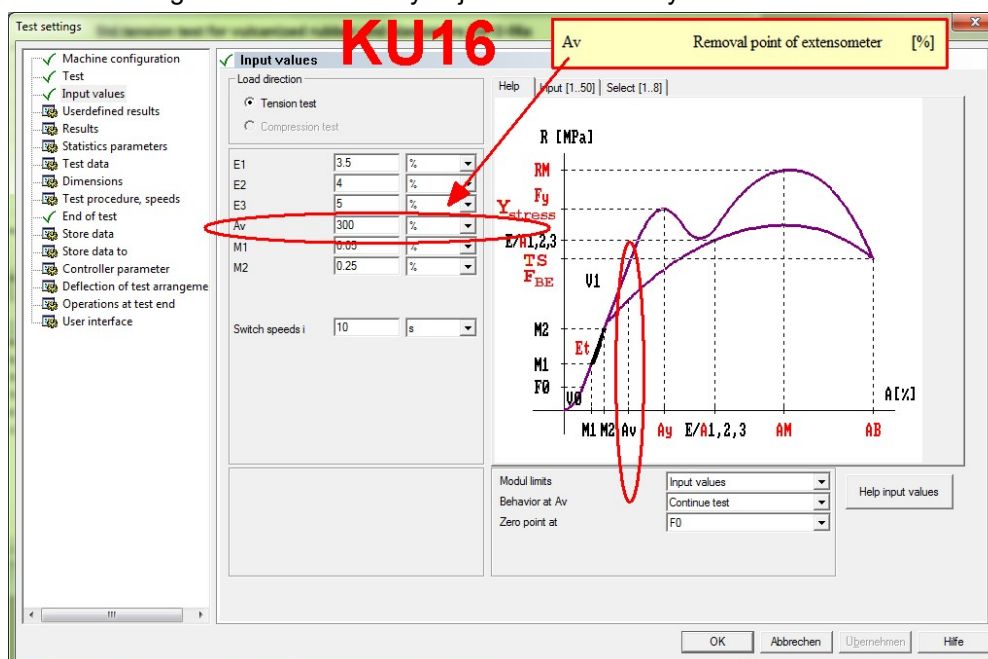
2.2 Test graphic KU 16



2.3 Input values KU 16



1. Click **Menu Test → Command Settings → Input values**. Here you can already find expedient input values for this test regulation. If necessary adjust the values to your needs.



The button 'Help input values' opens a help page containing all input values and their meanings, as they are explained in the following tables, also.

Table 2: Input values for test KU 16.

Parameter	Meaning	Dimension / Selection possibilities
E1	Reference value 1	[N, kN], [N/mm ²], [mm_S], [mm_dL], [%], [s, min, h], [Dim User1], .., [Dim User8]
E2	Reference value 2	dimensions analogue E1
E3	Reference value 3	dimensions analogue E1
Av	Removal point of extensometer	[%] or [mm]
M1	Force drop for recognition of the force peaks	[%] or [N, kN]
M2	Force drop for recognition of the first force peak	[%] oder [N, kN]
Switch speeds i	= 0 -> switch from speed1 to speed2 in default acceleration, = 10 -> use a speed ramp of 10 sec from speed 1 to speed 2	
The following input values can be found in dialog Test procedure, speeds (Menu Test → Command Settings)		
F0	Preliminary force	
V0	Test rate until preliminary force F0 is reached	
V1	Test rate after reaching preliminary force F0	

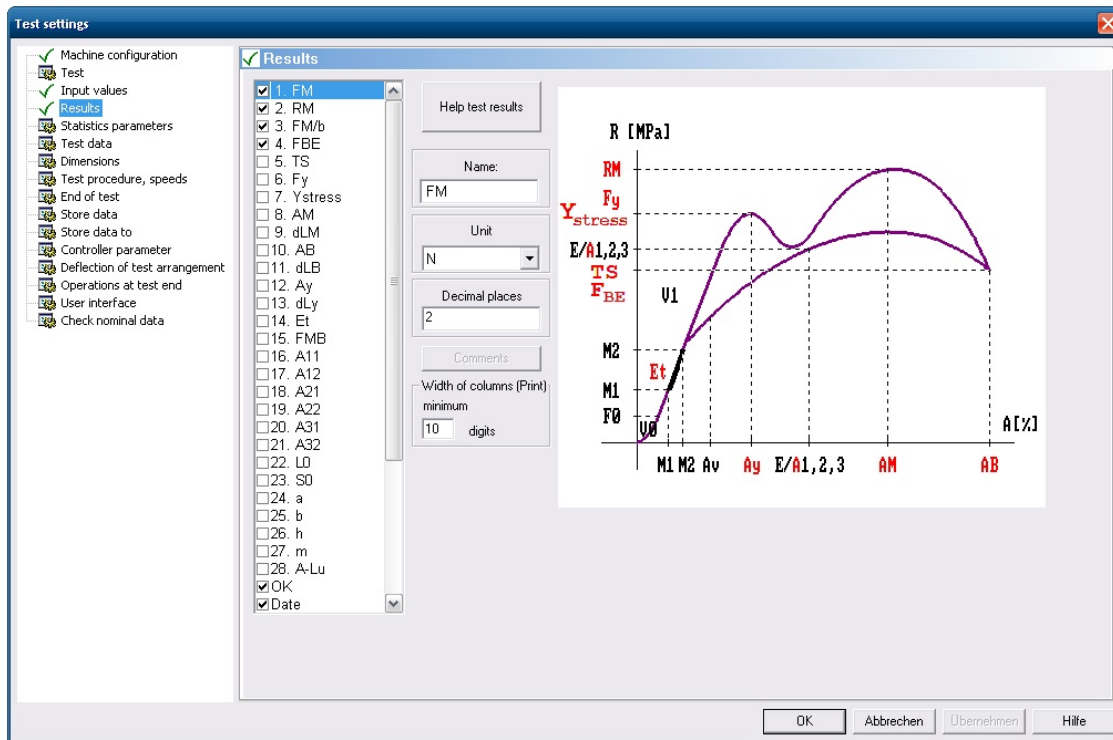
Table 3: KU 16 Selections and their meanings.

Selection	Meaning
Modulus limits	Chose the mode you want to use to search modulus limits:
Search automatic secante	The software automatically determines the limits of the tensile modulus with the help of the 'steepest increase'
Input values	the user presets the tensile modulus limits himself with input values M1 and M2
Search automatic regression line	
Behaviour at Av	Chose, how the system shall continue, when Av is reached:
Continue test	Test will be continued
Stop test	Test will be stopped
Stop, clip off extensometer	Test will be stopped and extensometer will be removed
Continue, clip off extensometer	Test will be continued and extensometer will be removed
Zero point at	F0
	Intersection point modulus with X-axis

2.4 Results KU 16



2. Click **Menu Test → Command Settings → Results**. Here you can already find expedient results. If necessary, chose and adjust the values to your needs.



3. By clicking on one of the test results in the list, you can change its unit, decimal places and width of colums for the printout in the fields beside the list, if necessary.

The button 'Help test results' opens a help page containing all output values and their meanings, as they are explained in the following tables, also.

Table 4: Results for test KU 16.

Parameter	Meaning
FM	Max. test force
RM	Tensile strength (tensile stress at max. test force)
FM / b	Max. test force / b
FBE	Breaking force
Ts	Stress at break
Fy	Force at yield stress
Ystress	Yield stress
AM	Strain at tensile strength
dLM	Elongation at tensile strength
AB	Breaking elongation
dLB	Elongation at break
Ay	Extension

dLy	Elongation at yield stress
Et	Tensile modulus
FMB	Max. test force in reference to width
A11, A12	Reference values for input value E1
A21, A22	Reference values for input value E2
A31, A32	Reference values for input value E3
L0	Measured length
S0	Test piece section
PA1	Test piece dimension 1 (not for all test piece shapes)
PA2	Test piece dimension 2 (not for all test piece shapes)

2.5 Notes for test KU 16

2.5.1 Preliminary force F0

For the test control the elongation and the extension are set to zero at this point.

The measuring length is corrected to $L0' = L0 + dL(F0)$

whereas

$L0'$ corrected measuring length

$L0$ measuring length

$dL(F0)$ sample deformation at F0

2.5.2 Test speeds

When determining the tensile modulus you should enter the test speed in such a way that $V1 \leq 2 \cdot V0$ is fulfilled.

2.5.3 Yield stress criteria

In order to determine a yield limit, the following search criteria are applied in this sequence to the force elongation curve $F = f(dL)$. If one criterion determines no yield limit, processing with continue with the next one.

- Local maximum force, local minimum force
In the case of a local maximum force there is a yield limit in case the force sinks afterwards by at least 0.5% and subsequently a local minimum force occurs, after which the force increases again by at least 1%.
- Local maximum force, turning point
In the case of a local maximum force there is a yield limit in case the force sinks afterwards by at least 0.5% and the curve subsequently shows a turning point (change from falling to rising increase tendency).
- Force plateau
In case an area of constant force with increasing elongation is found, this is a yield limit at the beginning of this area. For this, the force must not deviate more than 0.5 % up or down over an elongation area of 0.2% of the measured length.

2.5.4 Tensile modulus limits

The tensile modulus limits can be determined automatically or preset by the user.

In the case of automatic determination, the steepest increase straight over an elongation area of 0.2% of the measured length $L0$ is searched for in the area between preliminary force $F0$ and maximum force FM on the force-elongation curve $F = f(dL)$. The tensile modulus is calculated between the ends points of the straights found.

In case the tensile modulus is not to be determined automatically, you can set the end points of the tensile modulus straights with the input values $M1$ and $M2$ yourself.

2.5.5 Elongation, extension

During the test:

Elongation and extension are equal to 0 until preliminary force F0 is reached (see figure on the left). The elongation the lengthening f the test piece body from F0. The extension is calculated from elongation according to the following formula:

$$Ax = \frac{dL(Fx) - dL(F0)}{L0'} * 100\%$$

After the test:

on completion of a test, elongation and extension are re-calculated. During this, the zero point of the elongation is defined by the elongation of the tensile modulus straights on the X-axis in the force-elongation diagram.

2.5.6 Pairs of reference values

In the case of the 3 available pairs of reference values, selection of the required output values is made through the unit of the pertinent input value.

2.5.7 Behaviour at Av

The following selection possibilities are available such as the test should be continued on reaching the elongation value Av:

- Continue test:
the test is continued normally. Av has no influence.
- End test:
the test is ended on reaching Av.
- Stop, remove extensometer:
the test is interrupted. The user is given the possibility of removing a clip-on extensometer before he continues the test. An automatic extensometer is removed automatically before the test is continued. This option is intended for fragile sensors.
- Continue, remove extensometer:
the test is not interrupted. A clip-on extensometer can be removed by the user after a corresponding message, whereby the test is continued. An automatic extensometer is removed automatically.

2.5.8 Input values M1 and M2

M1, M2 Limits for the tensile modulus

They are to be entered at [dialog Input values](#) and are used only, if you chose the option "input values" at selection point 'Modulus limits'. With doing so, you specify that the tensile modulus limits are not searched for automatically.

2.5.9 Output value Et

Et Tensile modulus

You can search for the modulus limits automatically with the help of the 'steepest increase' or determine them manually using the input values M1 and M2.

2.5.10 Input values E1, E2, E3 and output values A11,A12, A21,A22, A31,A32

You enter the supporting points E1, E2, E3 at [dialog Input values](#). The meaning of the input values is determined by the various units that can be selected. Correspondingly, various output values are determined in the test.

Table 5: Dimensions of values and their meanings.

Dimension of the input value / result	Meaning
N, kN	Force
N/mm ²	Strength (stress)
%	Strain (extension)
mm_dL	Elongation
mm_S	Crosshead travel path
s, min, h	Time
Dim User1 ... Dim User8	Userdefined value 1 ... 8

2.5.11 Output values Ystress and Fy, Ay and dLy

Ry Yield stress

Fy Force at yield stress

Ay Yield extension (extension at yield stress)

dLy Elongation at yield stress

The yield stress is the first stress value at which an increase in the extension occurs without increasing the stress.