TECH NOTE :: Calculating the force introduction point with PMX

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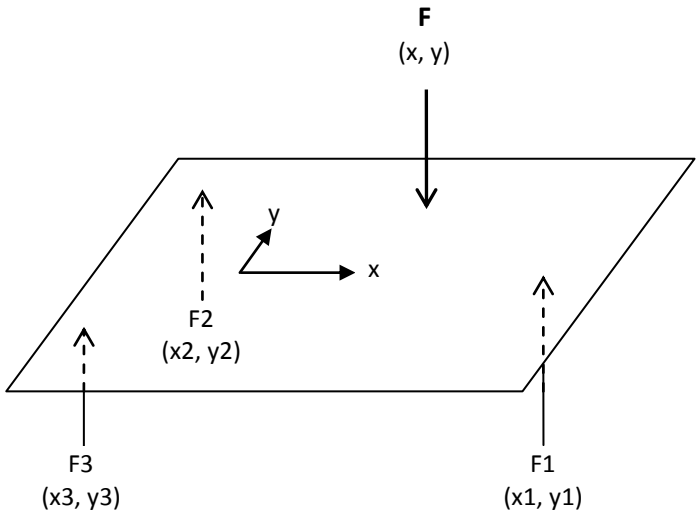
Author: Michael Guckes
Status: HBM: Public

Short description

Determining the force introduction point on a plate with three force transducers.

Introduction

The coordinates of a force F to be measured can easily be determined with three force transducers F1, F2 and F3.



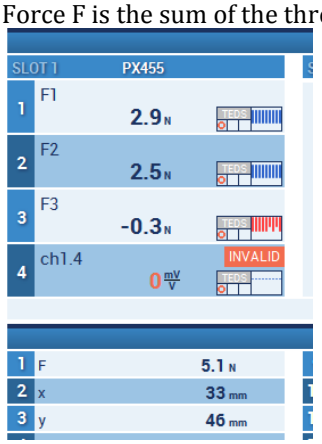
A plate is supported by three transducers and force F is applied against them orthogonally. The point at which the force is introduced is derived from the equilibrium of moments relative to origin

$$x = \frac{F1 * x1 + F2 * x2 + F3 * x3}{F}$$

$$y = \frac{F1 * y1 + F2 * y2 + F3 * y3}{F}$$

Procedure

Force F is the sum of the three individual forces:



Order	Input(s)	Function	Name	Internal ID	Result Channel	Result
1	F1, F2, F3, 0	Adder	sum	{↔67}	1	5.1 N
2	F1, F2, F3, 0	Adder	nom_x	{↔68}	-	
3	F1, F2, F3, 0	Adder	nom_y	{↔69}	-	
4	{↔68}, F	Divider	x_raw	{↔70}	2	33 mm
5	{↔69}, F	Divider	y_raw	{↔71}	3	46 mm

Parameters of Adder

INPUT(S)

Summand 1	1. F1
Summand 2	2. F2
Summand 3	3. F3
Summand 4	constant 0

Name	sum
Multiplier 1	1
Multiplier 2	1
Multiplier 3	1
Multiplier 4	0

OUTPUT

Internal ID	{↔67}
Result Channel	1. F
Name	F
Decimal Places	.0
Physical Unit	N
Update Rate	19200 /s

The counters for the x and y calculation are determined in an interim step. Coordinates x1, y1, x2,.... are in the factors of the summands.
For x:

Order	Input(s)	Function	Name	Internal ID	Result Channel	Result
1	F1, F2, F3, 0	Adder	sum	{↔67}	1	5.1 N
2	F1, F2, F3, 0	Adder	nom_x	{↔68}	-	
3	F1, F2, F3, 0	Adder	nom_y	{↔69}	-	
4	{↔68}, F	Divider	x_raw	{↔70}	2	33 mm
5	{↔69}, F	Divider	y_raw	{↔71}	3	46 mm

Parameters of Adder

INPUT(S)

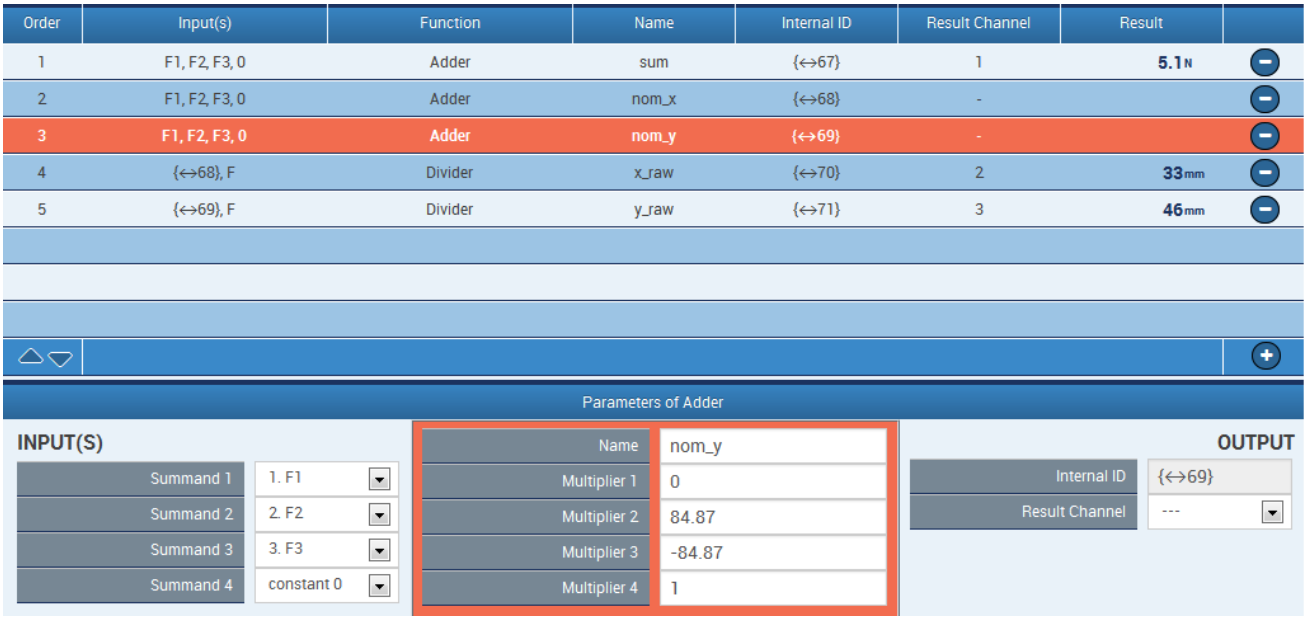
Summand 1	1. F1
Summand 2	2. F2
Summand 3	3. F3
Summand 4	constant 0

Name	nom_x
Multiplier 1	98
Multiplier 2	-49
Multiplier 3	-49
Multiplier 4	0

OUTPUT

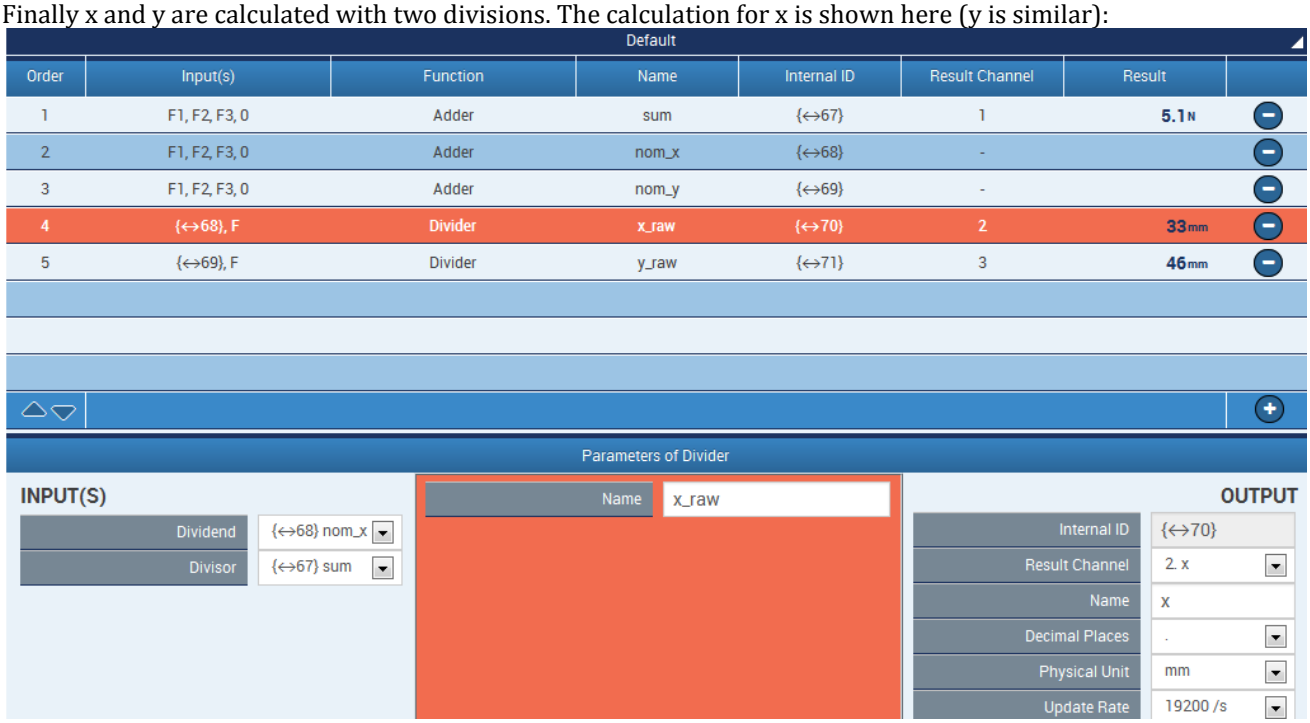
Internal ID	{↔68}
Result Channel	---

For y:



Order	Input(s)	Function	Name	Internal ID	Result Channel	Result
1	F1, F2, F3, 0	Adder	sum	{↔67}	1	5.1 N
2	F1, F2, F3, 0	Adder	nom_x	{↔68}	-	
3	F1, F2, F3, 0	Adder	nom_y	{↔69}	-	
4	{↔68}, F	Divider	x_raw	{↔70}	2	33 mm
5	{↔69}, F	Divider	y_raw	{↔71}	3	46 mm

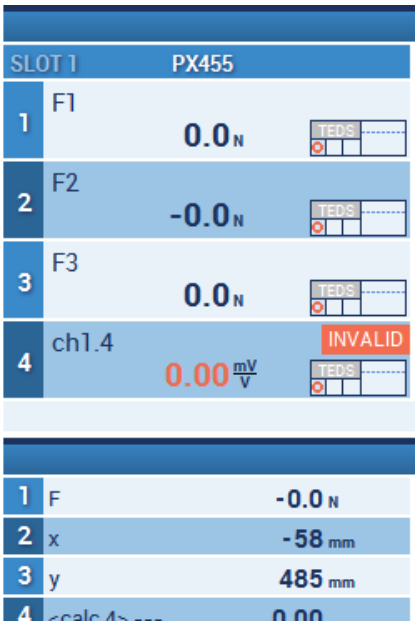
Finally x and y are calculated with two divisions. The calculation for x is shown here (y is similar):



Default

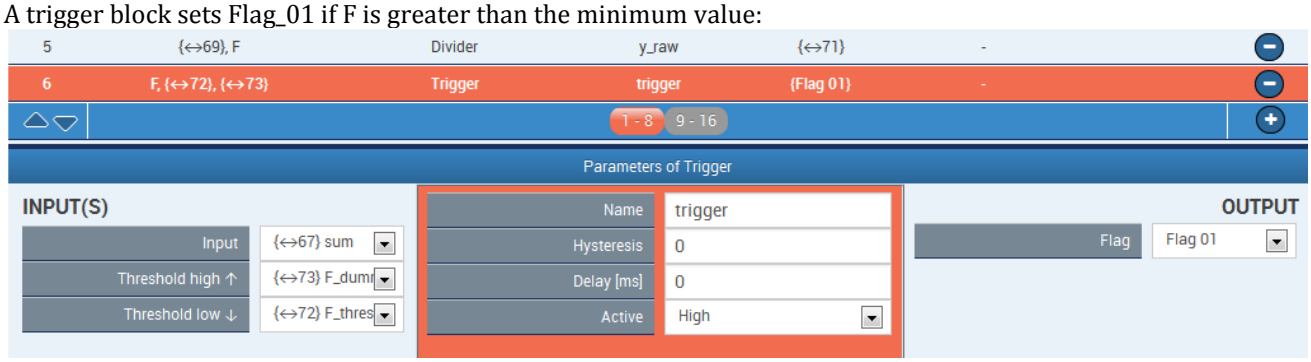
Order	Input(s)	Function	Name	Internal ID	Result Channel	Result
1	F1, F2, F3, 0	Adder	sum	{↔67}	1	5.1 N
2	F1, F2, F3, 0	Adder	nom_x	{↔68}	-	
3	F1, F2, F3, 0	Adder	nom_y	{↔69}	-	
4	{↔68}, F	Divider	x_raw	{↔70}	2	33 mm
5	{↔69}, F	Divider	y_raw	{↔71}	3	46 mm

Implausible values in unloaded state
Noise predominates when F is close to zero. Implausible values are returned for x and y:

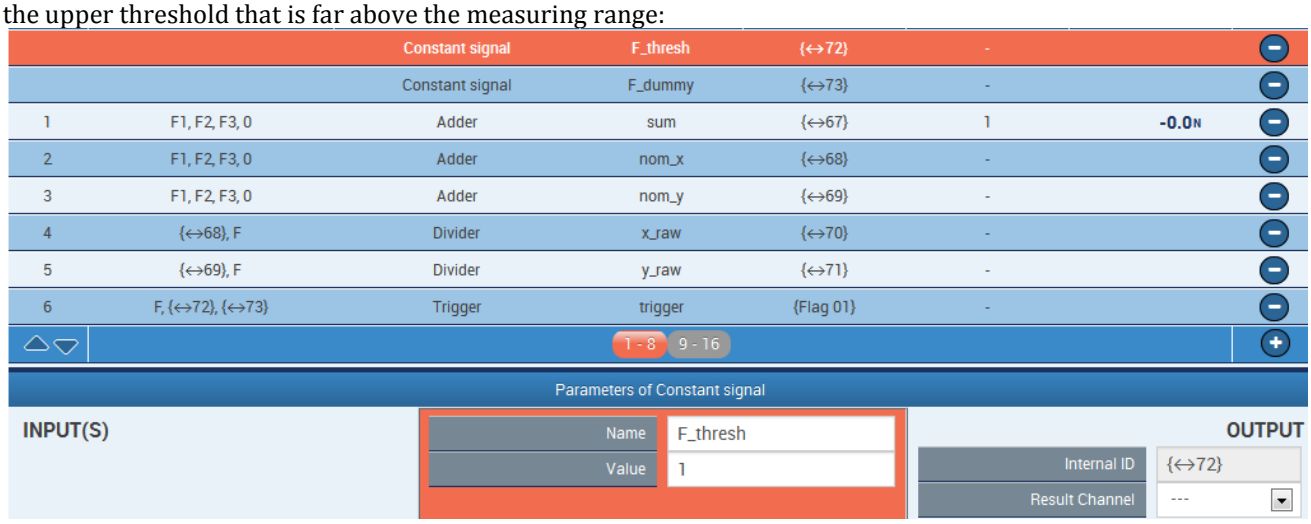


Remedy: Output for x and y is not regular until F is greater than 1 N, for example. Otherwise zero will be returned each time.

A trigger block sets Flag_01 if F is greater than the minimum value:



The two limit values for the trigger. Only the lower switching threshold is required for 1 N. A value is selected for the upper threshold that is far above the measuring range:



Order	Input(s)	Function	Name	Internal ID	Result Channel	Result
		Constant signal	F_thresh	{↔72}	-	
		Constant signal	F_dummy	{↔73}	-	
1	F1, F2, F3, 0	Adder	sum	{↔67}	1	-0.0 N
2	F1, F2, F3, 0	Adder	nom_x	{↔68}	-	
3	F1, F2, F3, 0	Adder	nom_y	{↔69}	-	
4	{↔68}, F	Divider	x_raw	{↔70}	-	
5	{↔69}, F	Divider	y_raw	{↔71}	-	
6	F, {↔72}, {↔73}	Trigger	trigger	{Flag 01}	-	

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Parameters of Constant signal

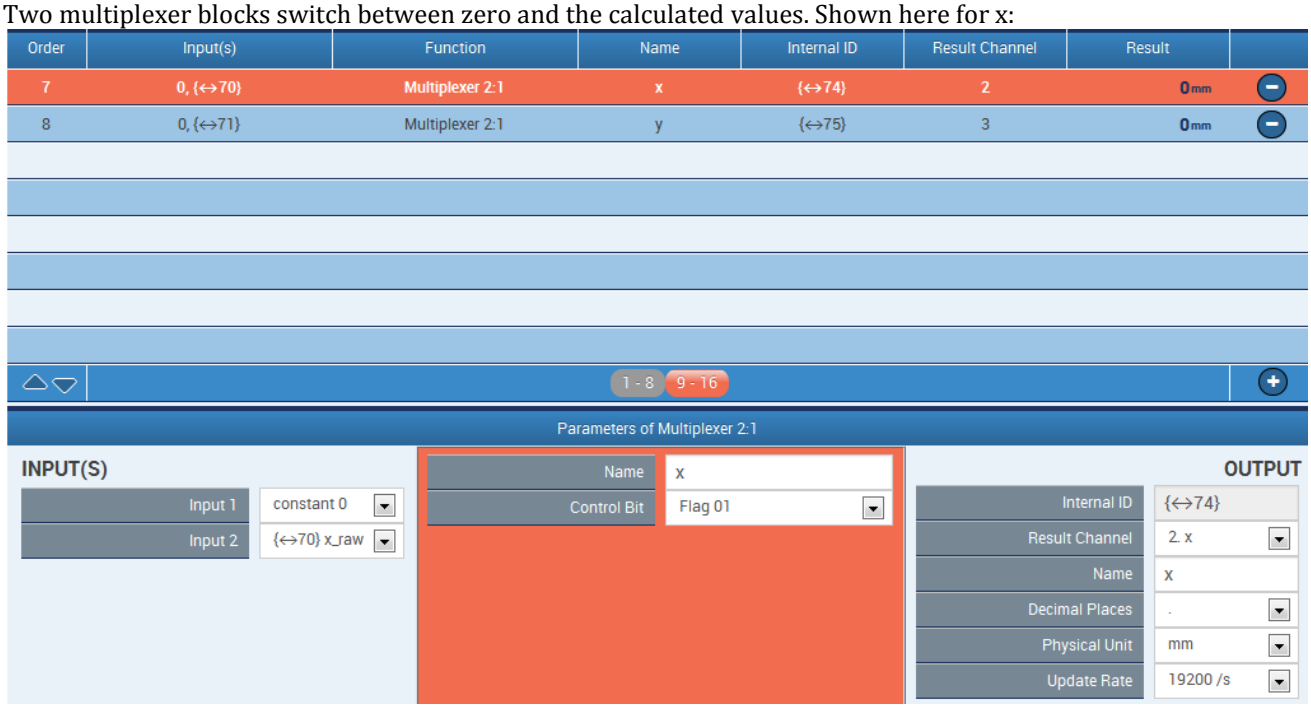
INPUT(S)

Name	F_dummy
Value	99999

OUTPUT

Internal ID	{↔73}
Result Channel	---

Two multiplexer blocks switch between zero and the calculated values. Shown here for x:



Order	Input(s)	Function	Name	Internal ID	Result Channel	Result
7	0, {↔70}	Multiplexer 2:1	x	{↔74}	2	0 mm
8	0, {↔71}	Multiplexer 2:1	y	{↔75}	3	0 mm

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Parameters of Multiplexer 2:1

INPUT(S)

Input 1	constant 0
Input 2	{↔70} x_raw

Name	x
Control Bit	Flag 01

OUTPUT

Internal ID	{↔74}
Result Channel	2. x
Name	x
Decimal Places	.
Physical Unit	mm
Update Rate	19200 /s

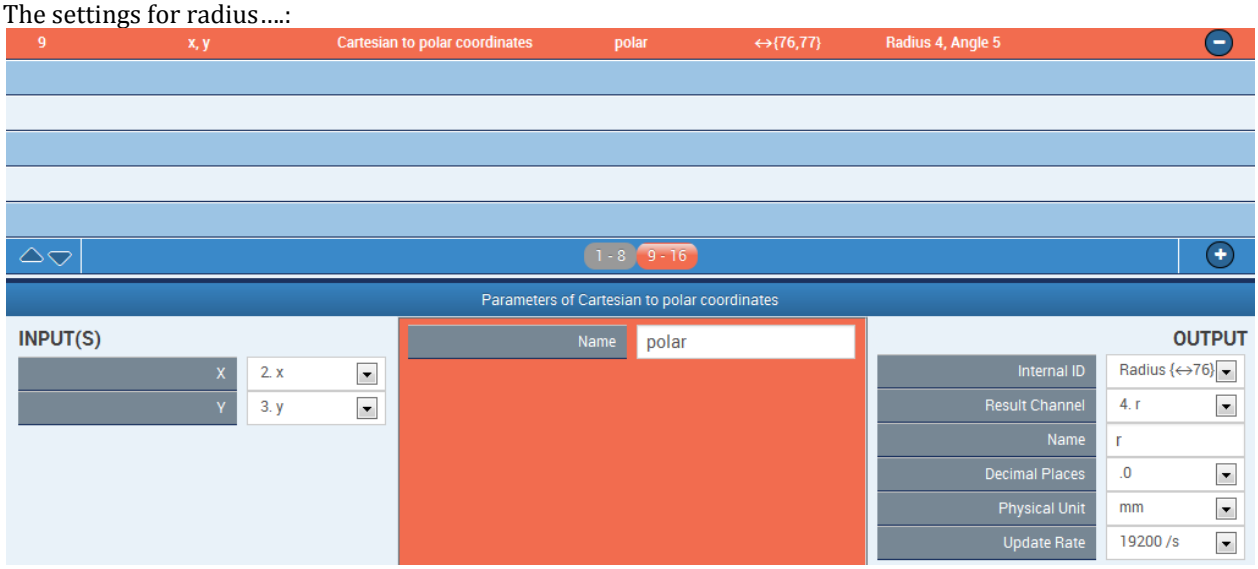
Appendix

Tips

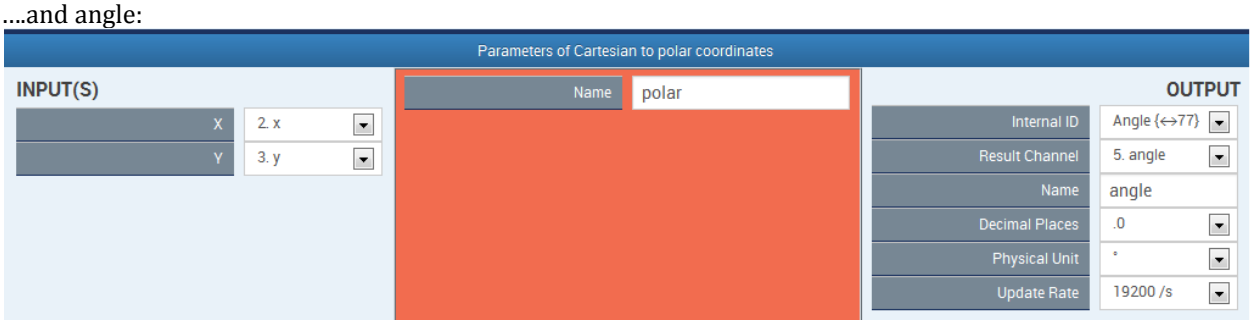
1. In case of division by zero, a divisor block returns Not-a-Number (NaN).

2. Polar coordinates can also be returned if necessary:

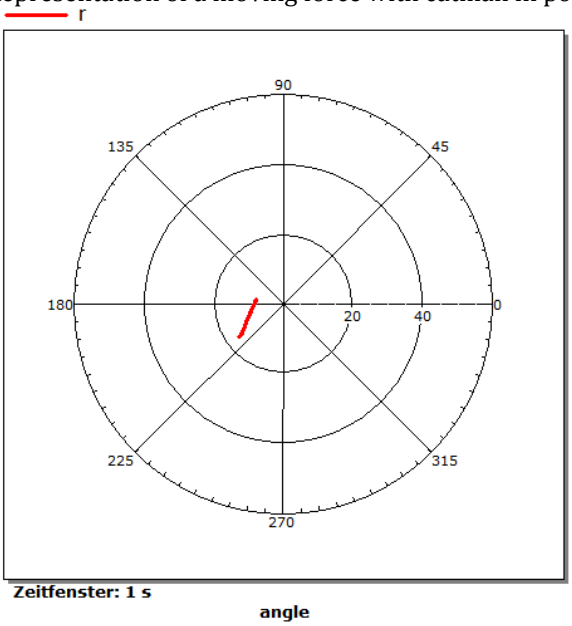
The settings for radius….:

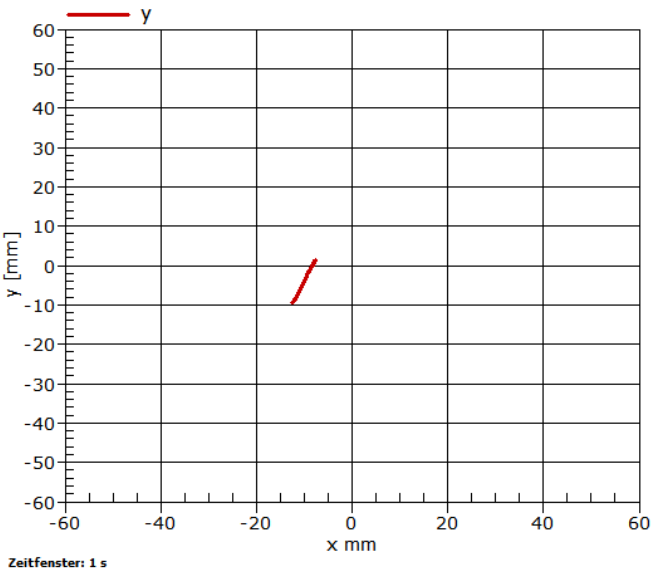


….and angle:



Representation of a moving force with catman in polar and Cartesian coordinates:





Disclaimer

These examples are simply for the purpose of illustration. They cannot be used as the basis for any warranty or liability claims.