

## TECH NOTE :: Calculating the force introduction point with PMX

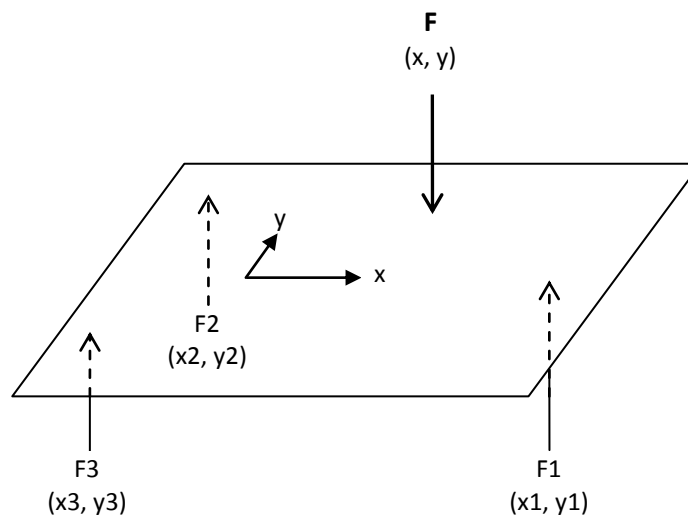
Version: 2018-04-13  
 Author: Michael Guckes  
 Status: HBM: Public

### 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  $F_1$ ,  $F_2$  and  $F_3$ .



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

$$x = \frac{F_1 * x_1 + F_2 * x_2 + F_3 * x_3}{F}$$

$$y = \frac{F_1 * y_1 + F_2 * y_2 + F_3 * y_3}{F}$$

### Procedure

Force  $F$  is the sum of the three individual forces:

SLOT	Channel	Value	Unit
1	F1	2.9	N
2	F2	2.5	N
3	F3	-0.3	N
4	ch1.4	0	mV/V
INVALID			
1	F	5.1	N
2	x	33	mm
3	y	46	mm

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)		Name		OUTPUT	
Summand 1	1. F1	sum	1	Internal ID	{↔67}
Summand 2	2. F2	Multiplier 1	1	Result Channel	1. F
Summand 3	3. F3	Multiplier 2	1	Name	F
Summand 4	constant 0	Multiplier 3	1	Decimal Places	.0
		Multiplier 4	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)		Name		OUTPUT	
Summand 1	1. F1	nom_x	98	Internal ID	{↔68}
Summand 2	2. F2	Multiplier 1	-49	Result Channel	---
Summand 3	3. F3	Multiplier 2	-49		
Summand 4	constant 0	Multiplier 3	0		
		Multiplier 4	0		

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	⊖

Parameters of Adder

INPUT(S)		Name		OUTPUT	
Summand 1	1. F1	Multiplier 1	nom_y	Internal ID	{↔69}
Summand 2	2. F2	Multiplier 2	0	Result Channel	---
Summand 3	3. F3	Multiplier 3	84.87		
Summand 4	constant 0	Multiplier 4	-84.87		
			1		

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	⊖

Parameters of Divider

INPUT(S)		Name		OUTPUT	
Dividend	{↔68} nom_x		x_raw	Internal ID	{↔70}
Divisor	{↔67} sum			Result Channel	2. x
				Name	x
				Decimal Places	.
				Physical Unit	mm
				Update Rate	19200 /s

**Implausible values in unloaded state**

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

SLOT 1		PX455	
1	F1	0.0 <sub>N</sub>	
2	F2	-0.0 <sub>N</sub>	
3	F3	0.0 <sub>N</sub>	
4	ch1.4	0.00 <sub>mV</sub>	INVALID

1	F	-0.0 <sub>N</sub>
2	x	-58 <sub>mm</sub>
3	y	485 <sub>mm</sub>
4	calc	0.00

**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	-0.0N	⊖
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}	-		⊖

Parameters of Constant signal

INPUT(S)	Name	F_dummy	OUTPUT
	Value	99999	
	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	⊖

Parameters of Multiplexer 2:1

INPUT(S)	Input 1	constant 0	OUTPUT	
	Input 2	{↔70} x_raw		
	Name	x	Internal ID	{↔74}
	Control Bit	Flag 01	Result Channel	2. x
			Name	x
			Decimal Places	.
			Physical Unit	mm
			Update Rate	19200 /s

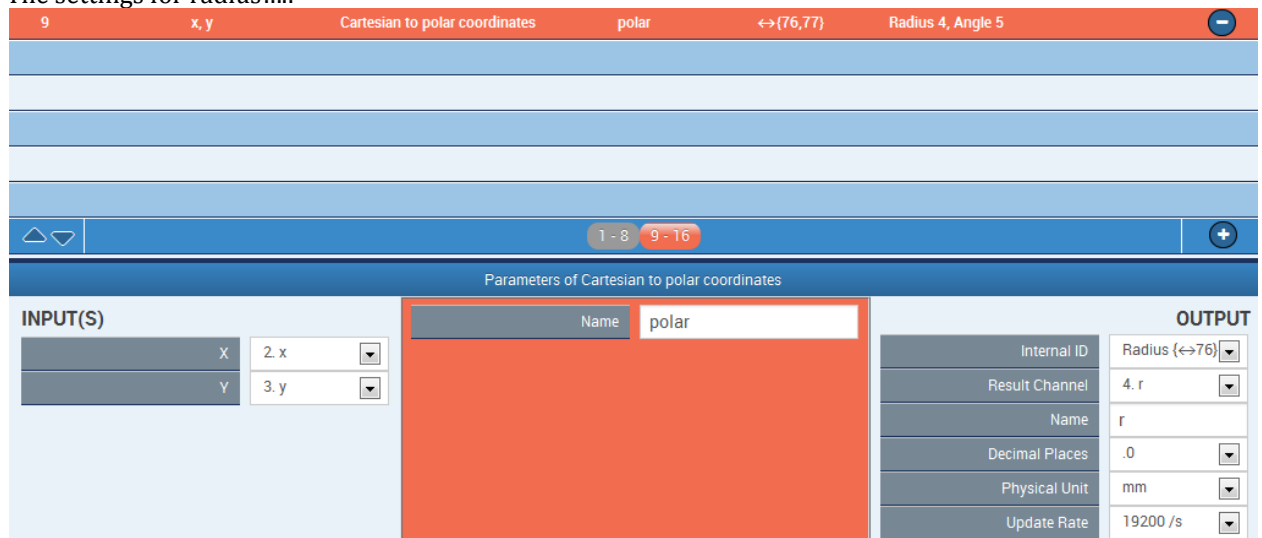
## Appendix

### 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:

1	F	5.0 N
2	x	57 mm
3	y	61 mm
4	r	83.1 mm
5	angle	47 °

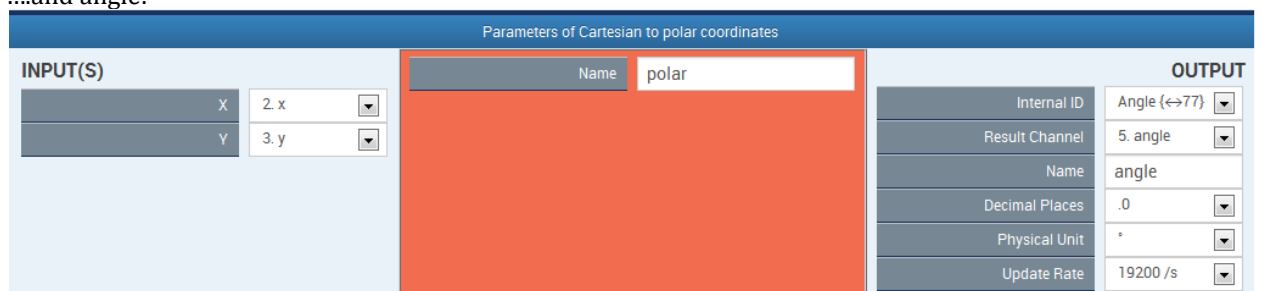
The settings for radius....:



The screenshot shows the configuration for a 'Cartesian to polar coordinates' block. The block is named 'polar' and is connected to a 'Radius 4, Angle 5' output. The 'INPUT(S)' section shows 'X' connected to '2.x' and 'Y' connected to '3.y'. The 'OUTPUT' section is configured as follows:

Parameter	Value
Internal ID	Radius (↔76)
Result Channel	4. r
Name	r
Decimal Places	.0
Physical Unit	mm
Update Rate	19200 /s

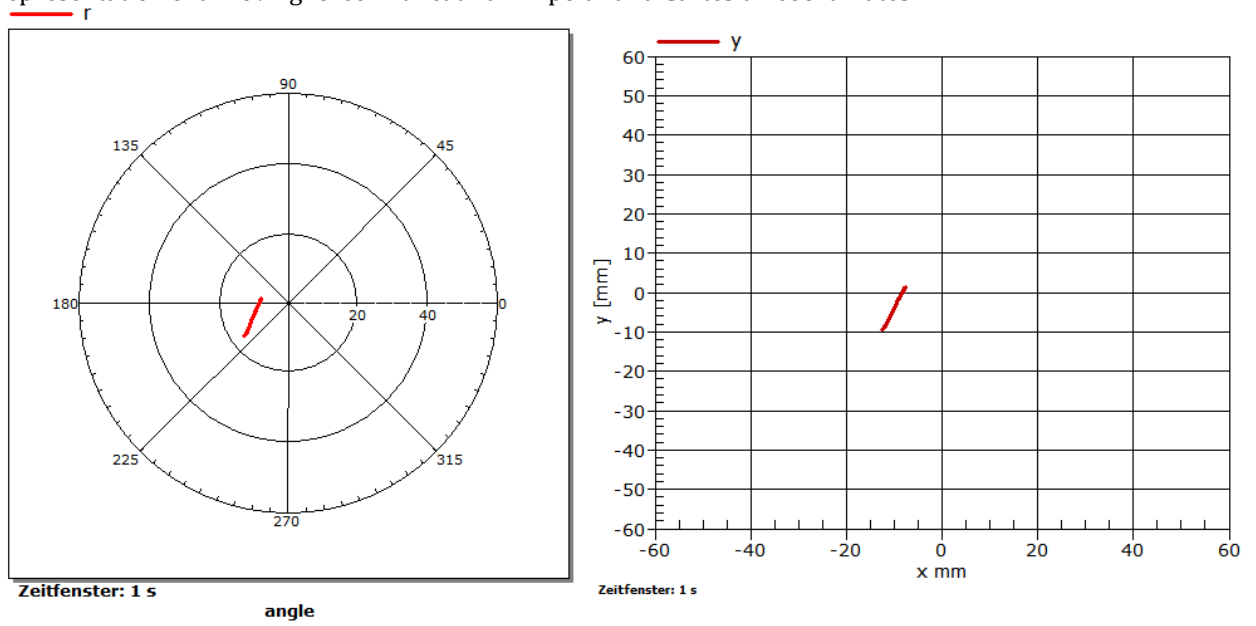
....and angle:



The screenshot shows the configuration for the same 'Cartesian to polar coordinates' block, but with the 'Angle' output selected. The 'INPUT(S)' section remains the same. The 'OUTPUT' section is configured as follows:

Parameter	Value
Internal ID	Angle (↔77)
Result Channel	5. angle
Name	angle
Decimal Places	.0
Physical Unit	°
Update Rate	19200 /s

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.