

HANOR

**design of a patented
electro-mechanic lock system**

2006.03.20

Prepared by: Kovács, Balázs

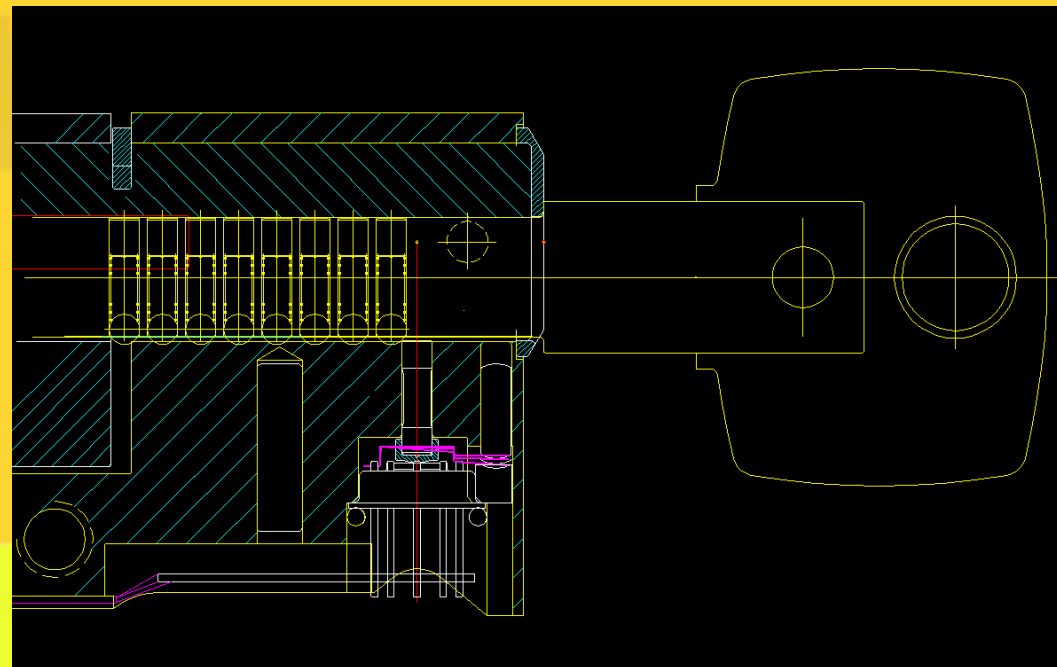
Töttösi, Ákos

Supervisor: Dr. Váradi, Károly

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About the Lock System:

Along the key's edge balls are located in the holes tightened by springs with different stiffness. The forces in the springs are measured by a sensor, one by one. In the case of eight balls, there are 17.000.000 combinations.



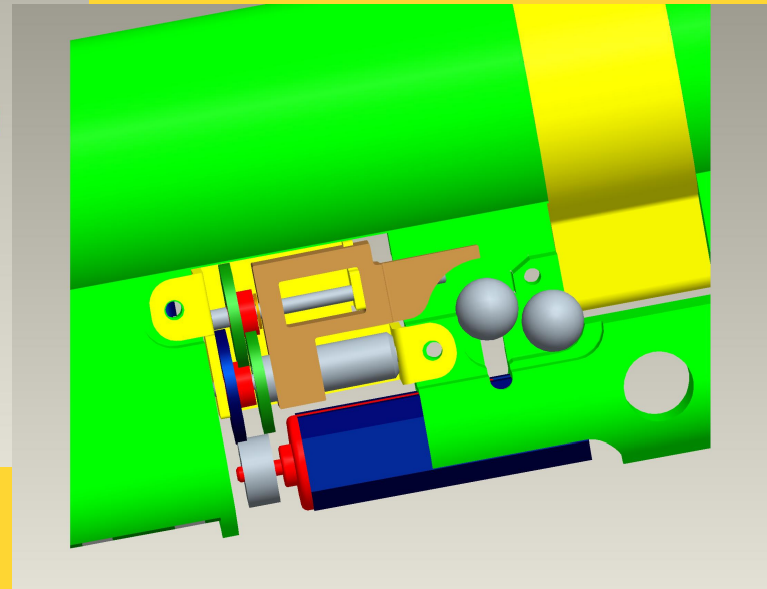
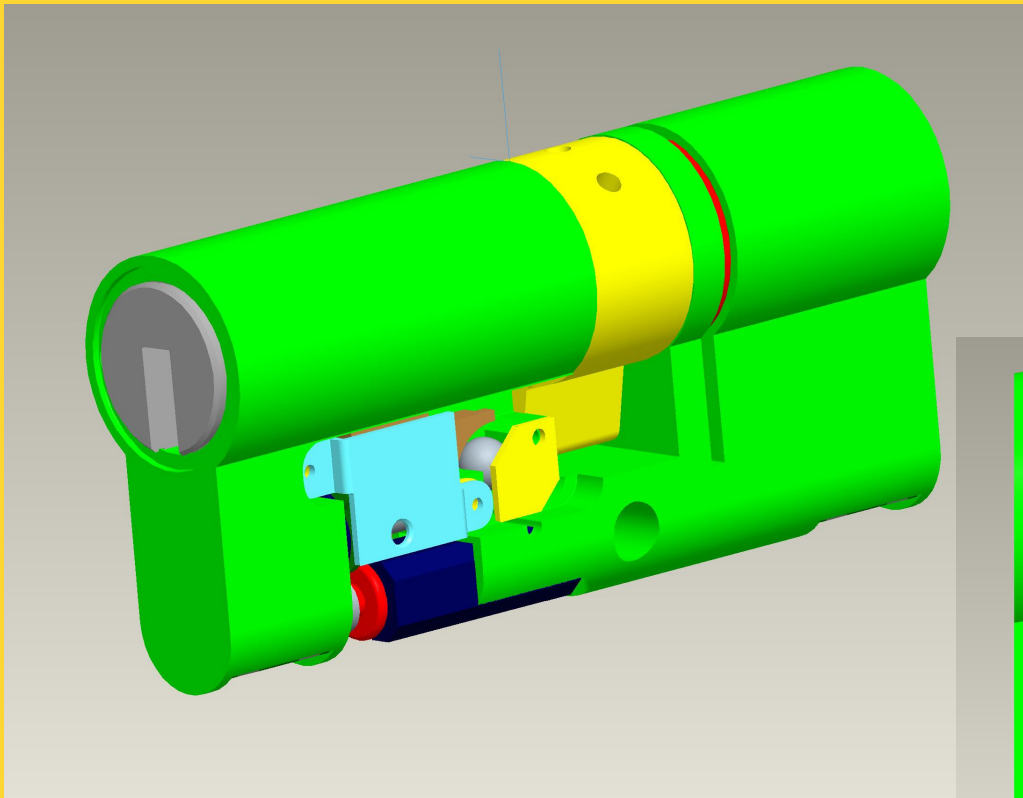
Operation Principle

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Gantt-diagram

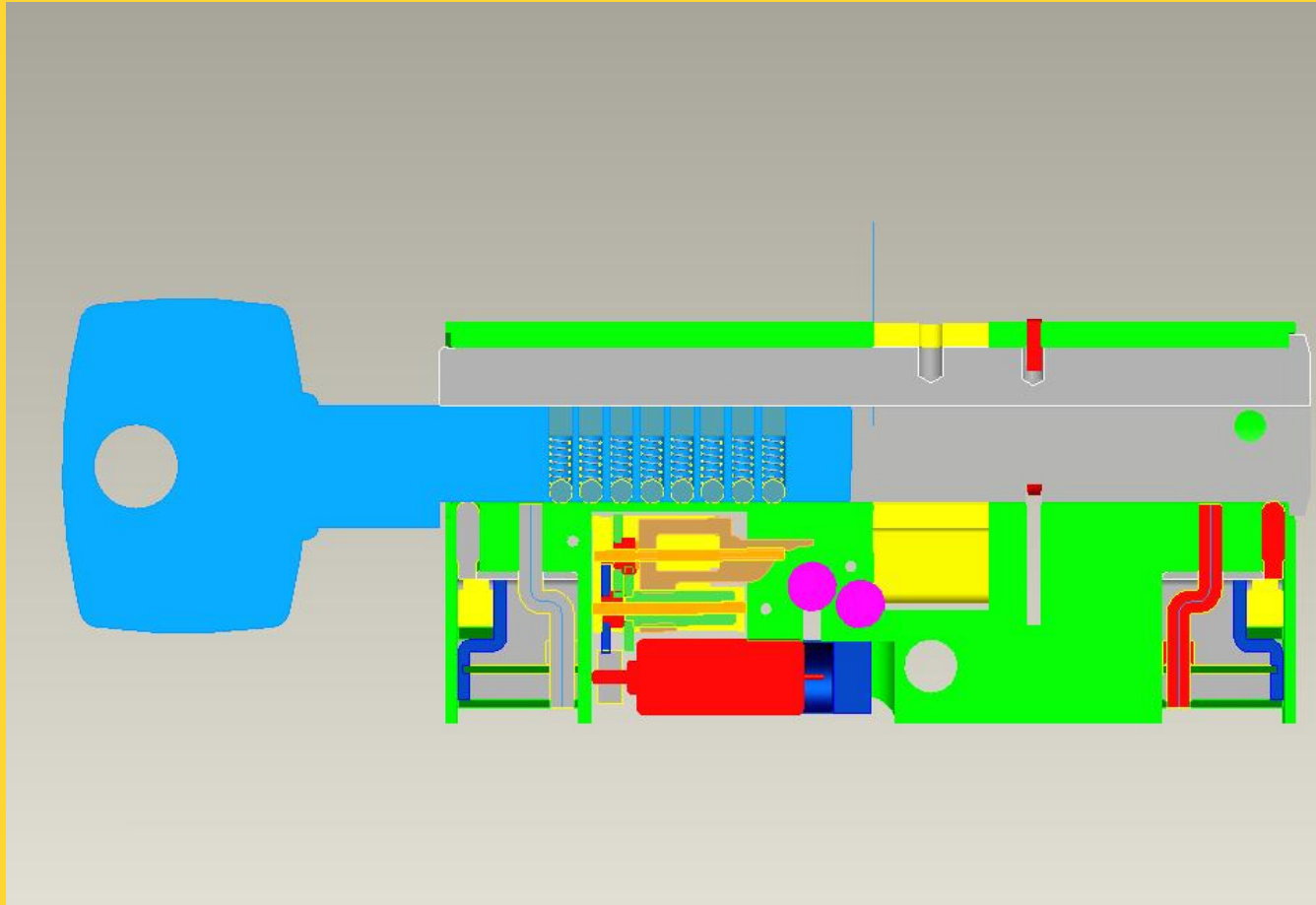
| Problem | week | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|---|------|---|---|---|---|---|---|---|---|---|----|----|----|----|----|
| Preparing 3D solid model | | ■ | ■ | | | | | | | | | | | | |
| Motion simulation | | | | | | | ■ | ■ | | | | | | | |
| FE analysis of breaking the lock's cylinder | | | | ■ | ■ | ■ | | | | | | | | | |
| Redesign due to the FE simulation | | | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | |
| FE analysis of the pressure sensitive element | | | | ■ | ■ | ■ | ■ | | | | | | | | |
| Redesign of the lock's body | | | | | | | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | |
| Assembly of a micro switch | | | | | | | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | |
| Fixing the cylinder in vertical position | | | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | |
| Designing the dust free door | | | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | |
| Presentation 1. | | | | ■ | ■ | ■ | | | | | | | | | |
| Presentation 2. | | | | | | | | | | | | | | ■ | ■ |
| Preparing 2D documentation | | | | | | | | | | | | | | ■ | ■ |
| Final report and documentation | | | | | | | | | | | | | | ■ | ■ |

3D CAD model



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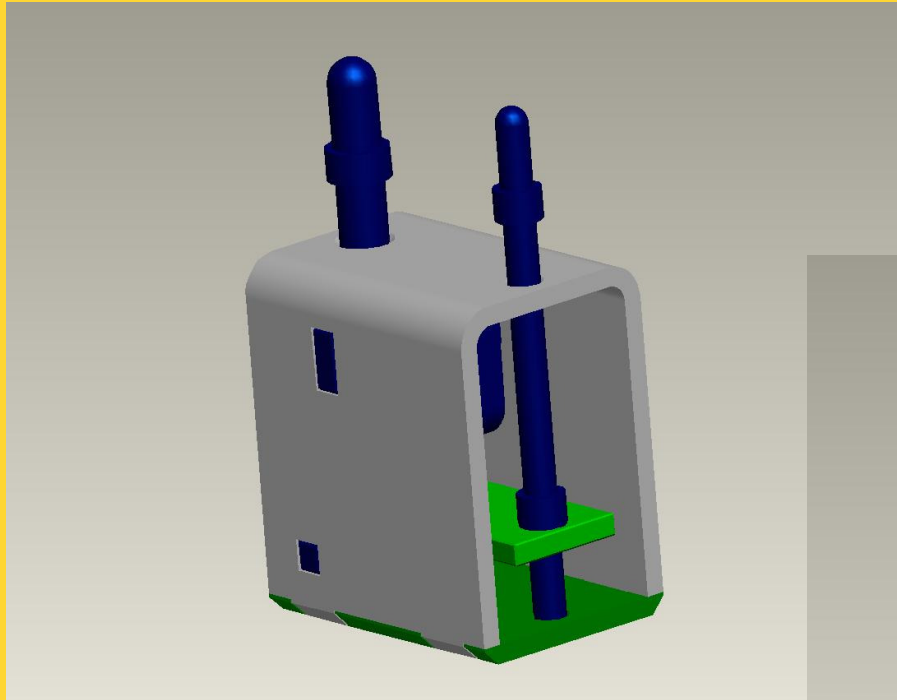
3D CAD model



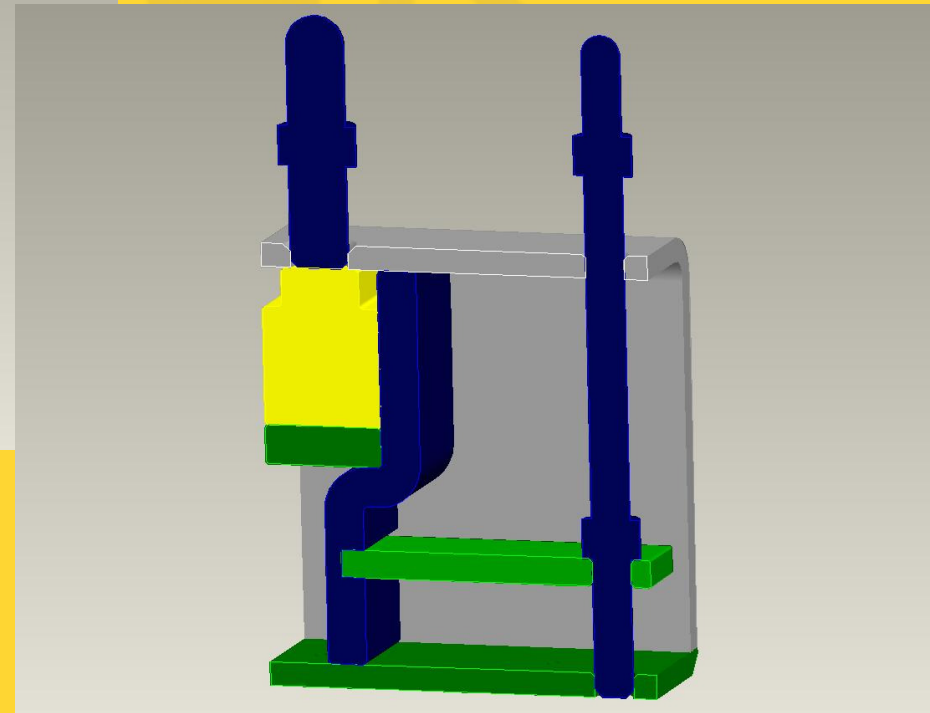
The operation

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Design of a Pressure Sensitive Switch



Microswitch: 3 x 6 mm



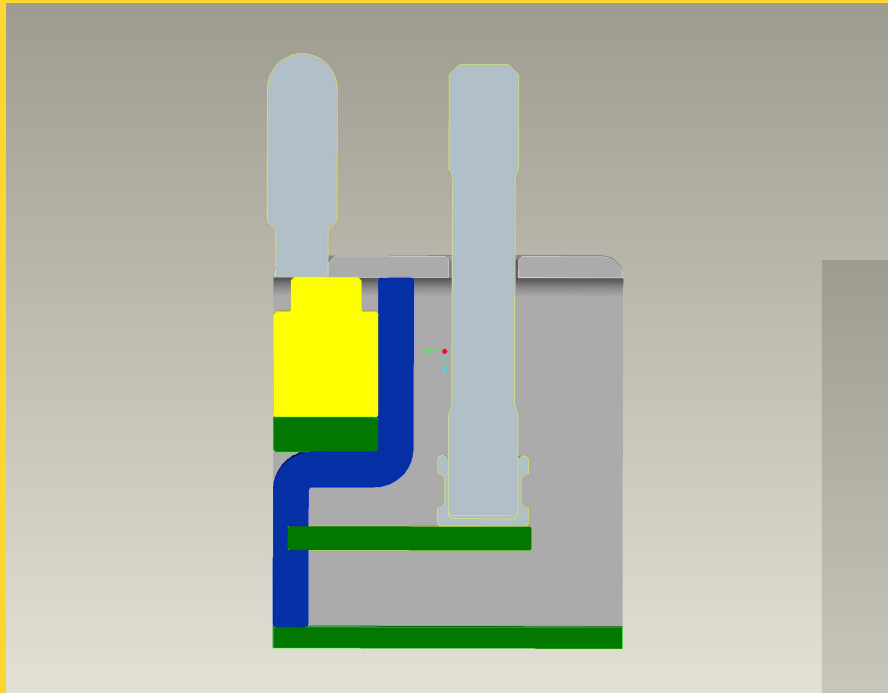
Length of the gauge: 8 mm

width: 2-4 mm

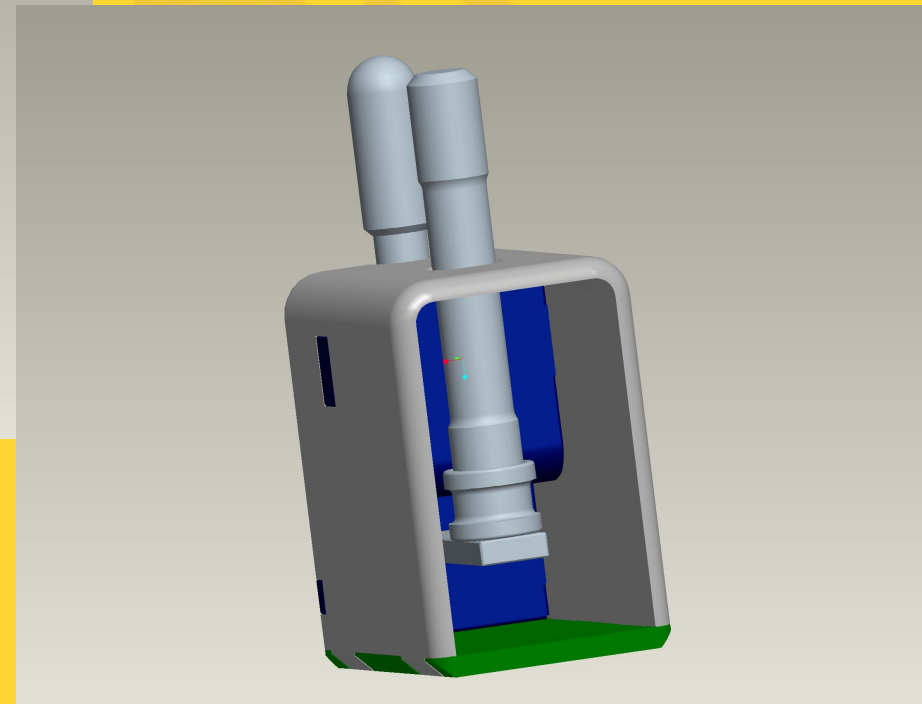
Solution 1

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Design of a Pressure Sensitive Switch



Microswitch: 3 x 6 mm



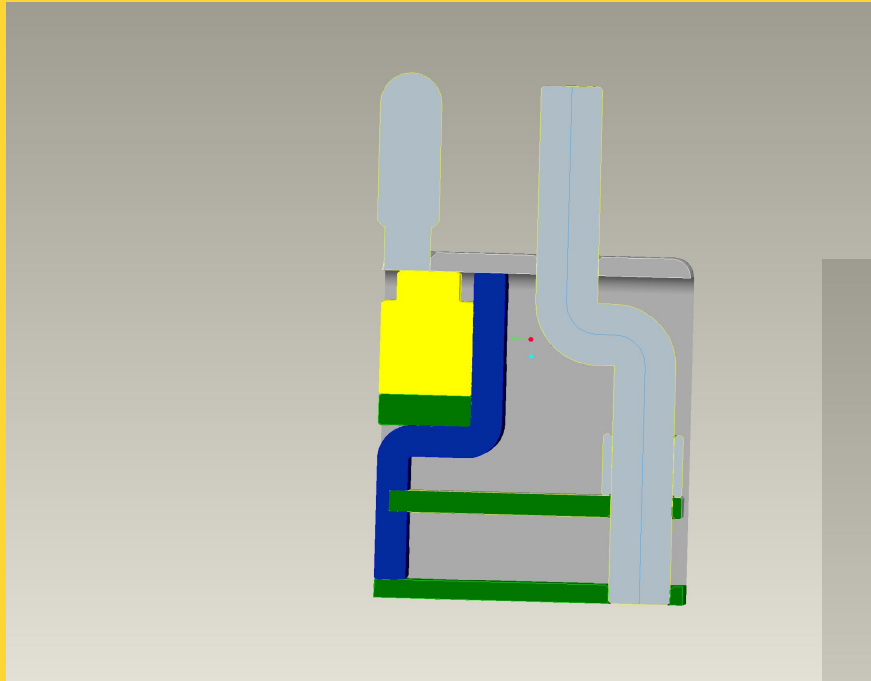
Length of the gauge: 5 mm

width: 2-4 mm

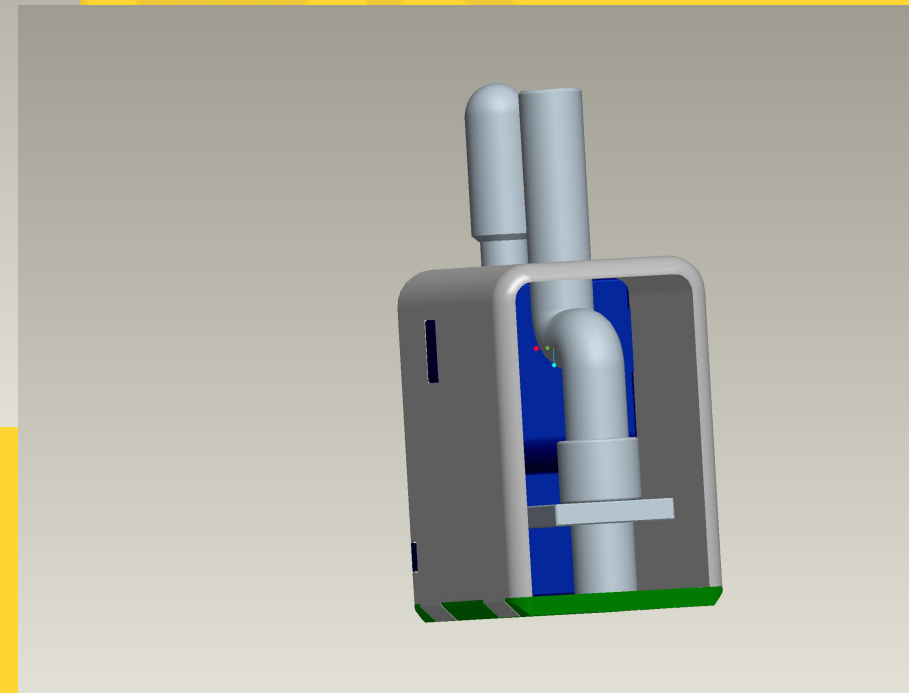
Solution 2

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Design of a Pressure Sensitive Switch



Microswitch: 3 x 6 mm



Length of the gauge: 8 mm

width: 2-4 mm

Solution 3

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FE Analysis of the Deformable Gauge

- The required strain is 1000 μ strain at the tensoned side for the maximum load
- Load range: min: 0,3 N
max: 1,7 N
- Design aim: selecting the proper material

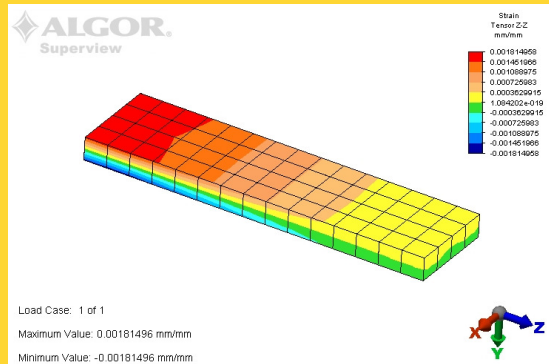
Solutions for the Deformable Gauges

| | | | | | | |
|-----------------------|-----------------|----------|-------------|----------|----------|----------|
| E: | Mpa | 16000,00 | 16000,00 | 16000,00 | 16000,00 | 70000,00 |
| Thickness | mm | 0,70 | 0,70 | 0,70 | 0,70 | 0,70 |
| Width | mm | 4,00 | 4,00 | 2,00 | 2,00 | 4,00 |
| Length | mm | 8,00 | 8,00 | 8,00 | 8,00 | 8,00 |
| Load | N | 1,70 | 0,30 | 1,70 | 0,30 | 1,70 |
| | | | | | | |
| Moment of Inertia (I) | mm ⁴ | 0,114333 | 0,114333333 | 0,057167 | 0,057167 | 0,114333 |
| Deflection | mm | 0,158601 | 0,027988338 | 0,317201 | 0,055977 | 0,036252 |

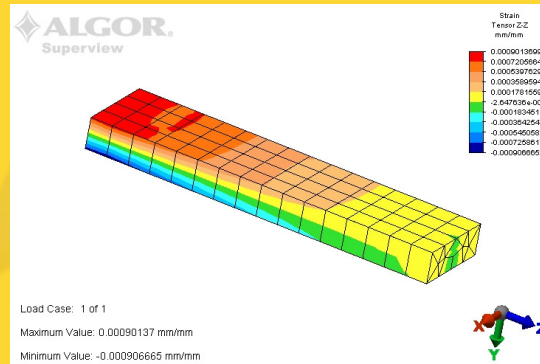
| | | | | | | | | |
|-----------------------|-----------------|----------|----------|----------|----------|----------|----------|----------|
| E: | Mpa | 70000,00 | 70000,00 | 70000,00 | 10500,00 | 8000,00 | 21000,00 | 8000,00 |
| Thickness | mm | 0,70 | 0,70 | 0,70 | 0,50 | 0,70 | 0,50 | 0,70 |
| Width | mm | 4,00 | 2,00 | 2,00 | 4,00 | 2,00 | 2,00 | 2,00 |
| Length | mm | 8,00 | 8,00 | 8,00 | 5,00 | 5,00 | 5,00 | 5,00 |
| Load | N | 0,30 | 1,70 | 0,30 | 1,70 | 1,70 | 1,70 | 0,30 |
| | | | | | | | | |
| Moment of Inertia (I) | mm ⁴ | 0,114333 | 0,057167 | 0,057167 | 0,041667 | 0,057167 | 0,020833 | 0,057167 |
| Deflection | mm | 0,006397 | 0,072503 | 0,012795 | 0,161905 | 0,154883 | 0,161905 | 0,027332 |

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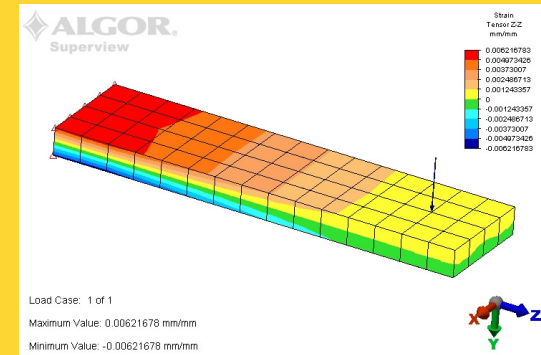
FE Analysis of the Deformable Gauges



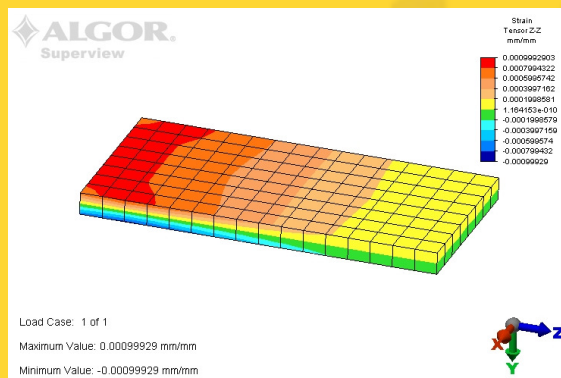
2 x 8 x 0.5 mm



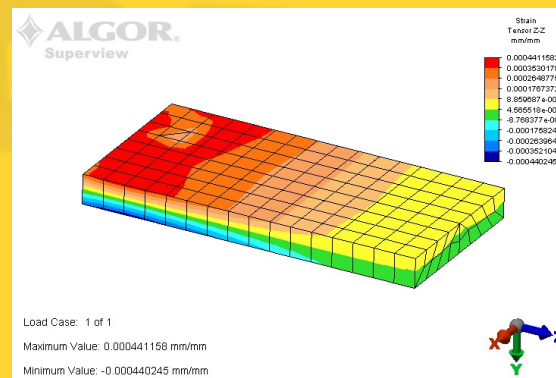
2x8x0.7 mm



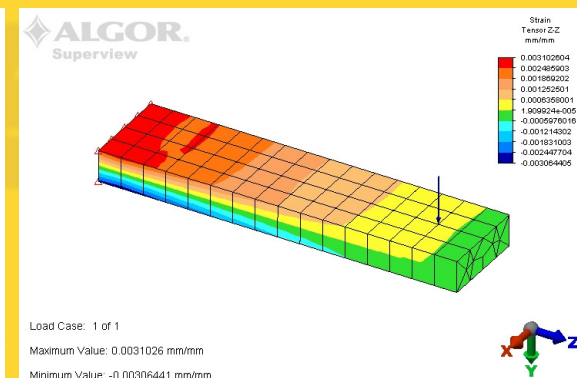
2 x 8 x 0.5 mm



4 x 8 x 0.5 mm



4 x 8 x 0.7 mm



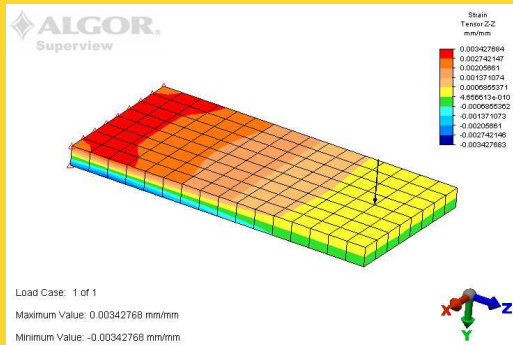
2 x 8 x 0.7 mm

Aluminium E=70.000Mpa

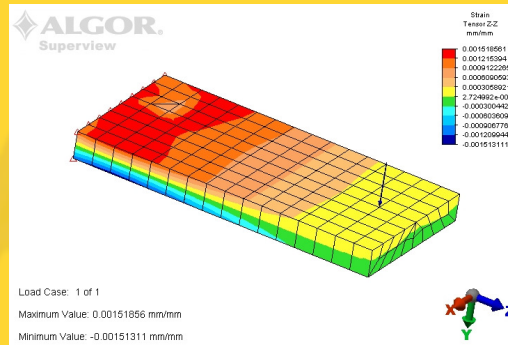
glass fiber epoxy, E= 20.000 Mpa

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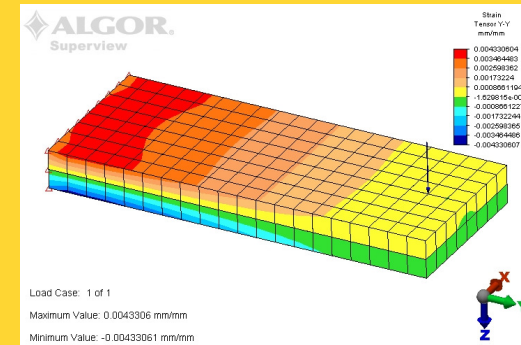
FE Analysis of the Deformable Gauges



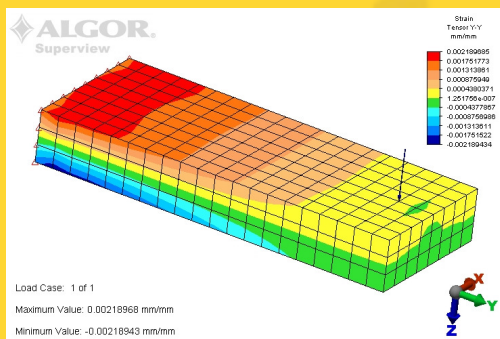
4 x 8 x 0.5 mm



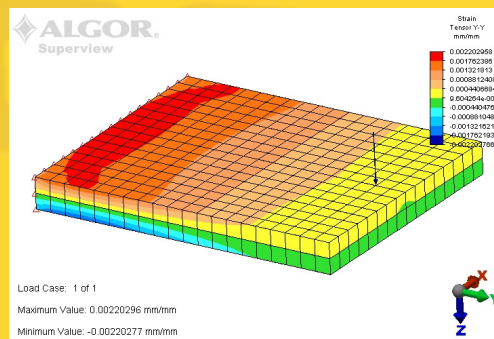
4 x 8X x 0.7 mm



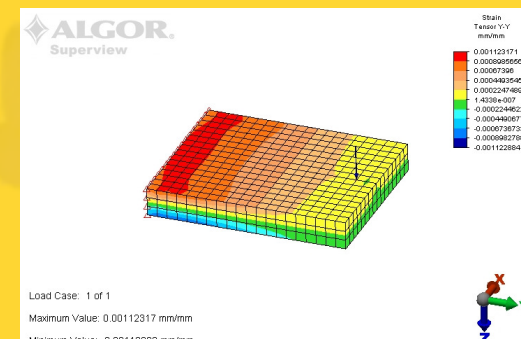
2 x 5 x 0.5 mm



2 x 5 x 0.7 mm



4 x 5 x 0.5 mm



4 x 5 x 0.7 mm

Aluminium E=70.000Mpa

glass fiber epoxy, E= 20.000 Mpa

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Discussion

| Gauge | Material/ E-modulus | |
|---------|---------------------|---------|
| | Al | E=20000 |
| | | |
| 2x8x0.5 | 1088 | 3730 |
| 2x8x0.7 | 539 | 1252 |
| 4x8x0.5 | 599 | 1371 |
| 4x8x0.7 | 264 | 609 |
| 2x5x0.5 | | 2598 |
| 2x5x0.7 | | 1313 |
| 4x5x0.5 | | 1321 |
| 4x5x0.7 | | 673 |