Associazione Italiana Strumentisti

ISA Italy Section

Associazione Termotecnica Italiana
Sezione Lombardia

VALVOLE DI CONTROLLO E INTERCETTAZIONE, SISTEMI DI AZIONAMENTO, DISCHI DI ROTTURA E DISPOSITIVI DI SICUREZZA UTILIZZATI NELL'INDUSTRIA DI PROCESSO

Milano, 18 Aprile 2018

Auditorio TECNIMONT

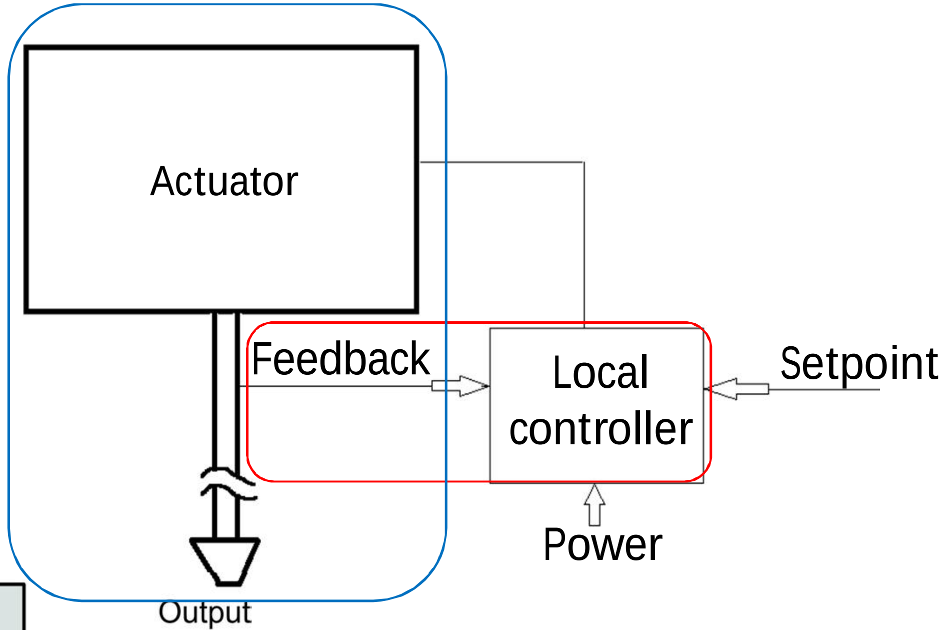
ZERO BACKLASH – INNOVATION ON SCOTCH YOKE CONTROL VALVE ACTUATION

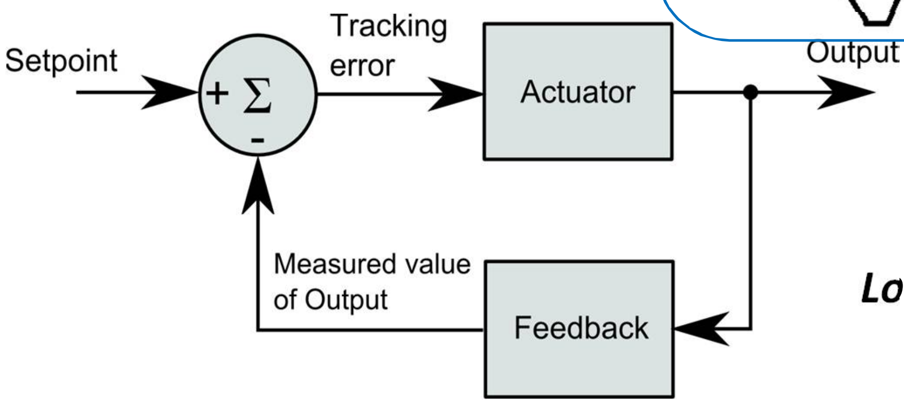
Ing. Nicola Mores
IMI STI

General system description

Scotch-yoke lability causes:

1. *Feedback on closed loop positioner's control system*
2. *Actuator*





Logic Diagram for control purposes

IMI STI

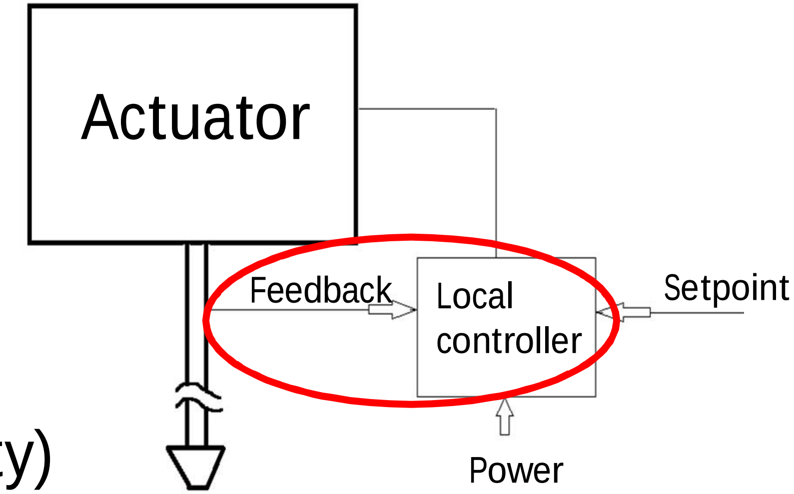
Feedback on closed loop positioner's control system

Main uncertainties:

1. *Sensor*: accuracy, resolution, noise, dynamic
2. *Signal conversion and reading*: noise, resolution

Consequences:

1. *Bad repeatability*
2. *Hysteresis* (overcoming the target)
3. "*Floating*" *band* (low amplitude instability)



IMI STI

Feedback on closed loop positioner's control system

Solution:

> Various control techniques (i.e. proprietary PID) permit to reduce labilities.

NOTE: Not the main focus, they will be supposed theoretical and with perfect response.

Actuator

Define 2 sources of error:

1. Intrinsic to the physics involved (Resolution of the system)
2. Technology used and wear related

Hints on physics related errors

- Difference in static and dynamic friction
- ΔP consequent
- Proportional to % of ΔV

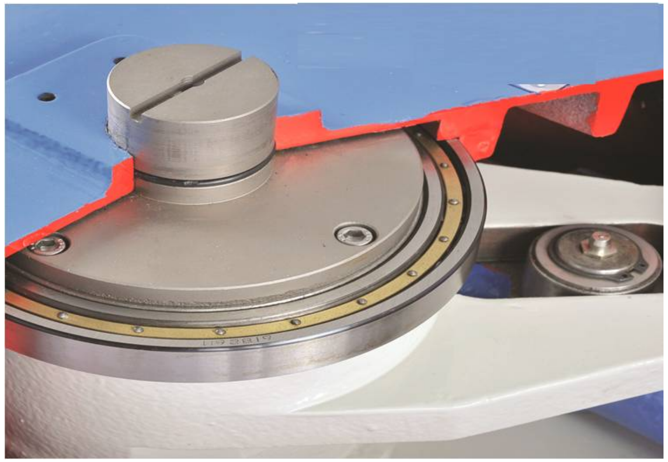
(Stiction phenomena; dynamic response of the elastic medium…)

Hence material choices, size and construction of the actuator and process parameters define the limits of each system’s precision.

Technical and wear error

How to transmit linear force to rotary torque, on scotch-yoke actuators?

1. Rotary Pin



2. Linear sliding plate

Rotary pin – Technical and wear error

Insert a rotating pin means to:

- Have a native gap
- Locally, exchanged contact forces, grater than plastic strain (increase wear gap)

Linear sliding plate – Technical and wear error

Insert a sliding plate means to :

> Different pieces with possible untoward tolerance permutations (native gap)

> Lower significantly local pressure and subsequent wear gaps

<u>NOTE: This is the most common technology for scotch-yoke control actuators.</u>

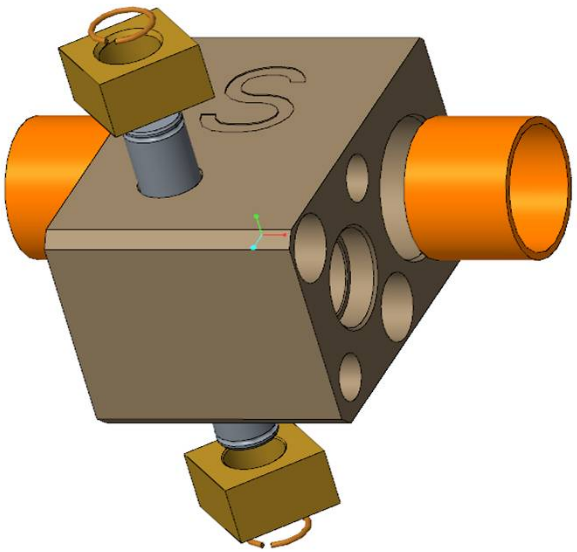
Overcoming main problems

At the same time guarantee:

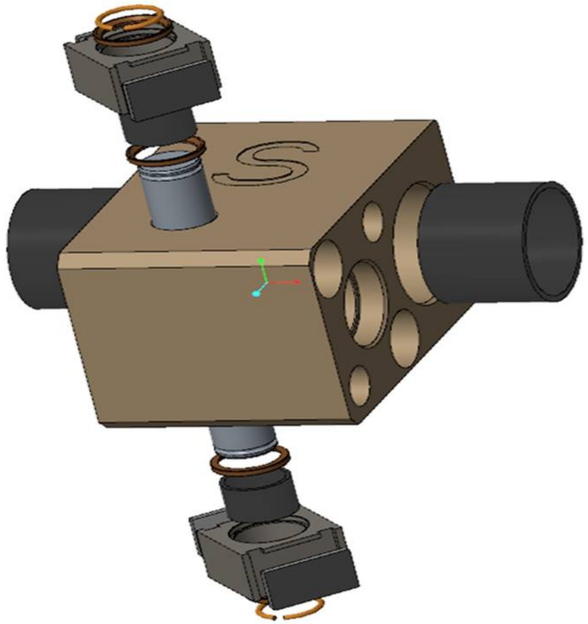
- Eliminate Native gap
- Eliminate Wearing gap during Lifecycle
- Maintain system resolution

Different scotch yoke applications

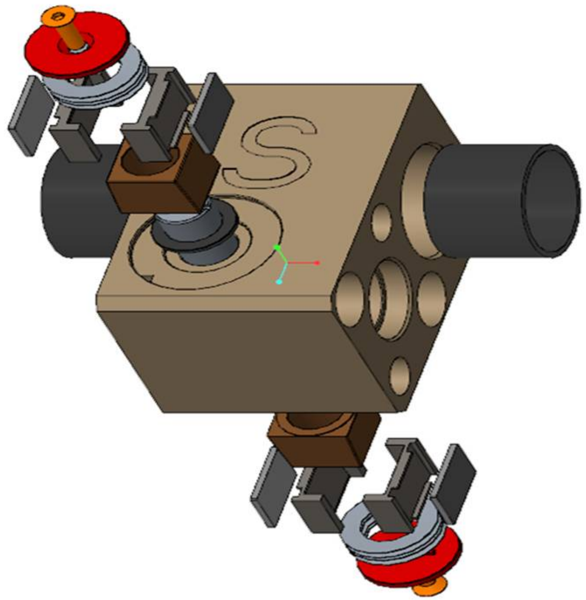
Standard ON-OFF



Standard Modulating (IMI STI)

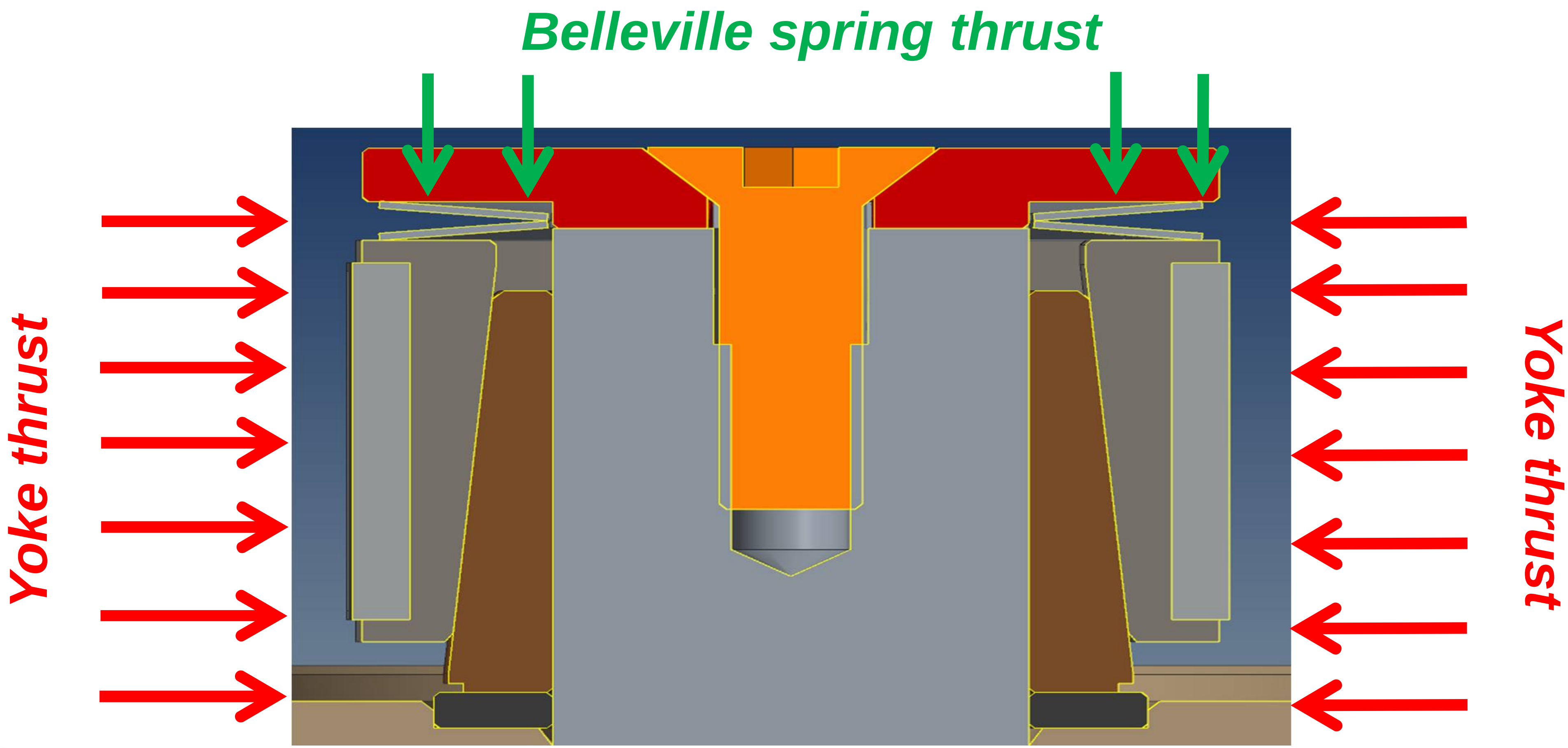


ZB Modulating



IMI STI

ZB solution

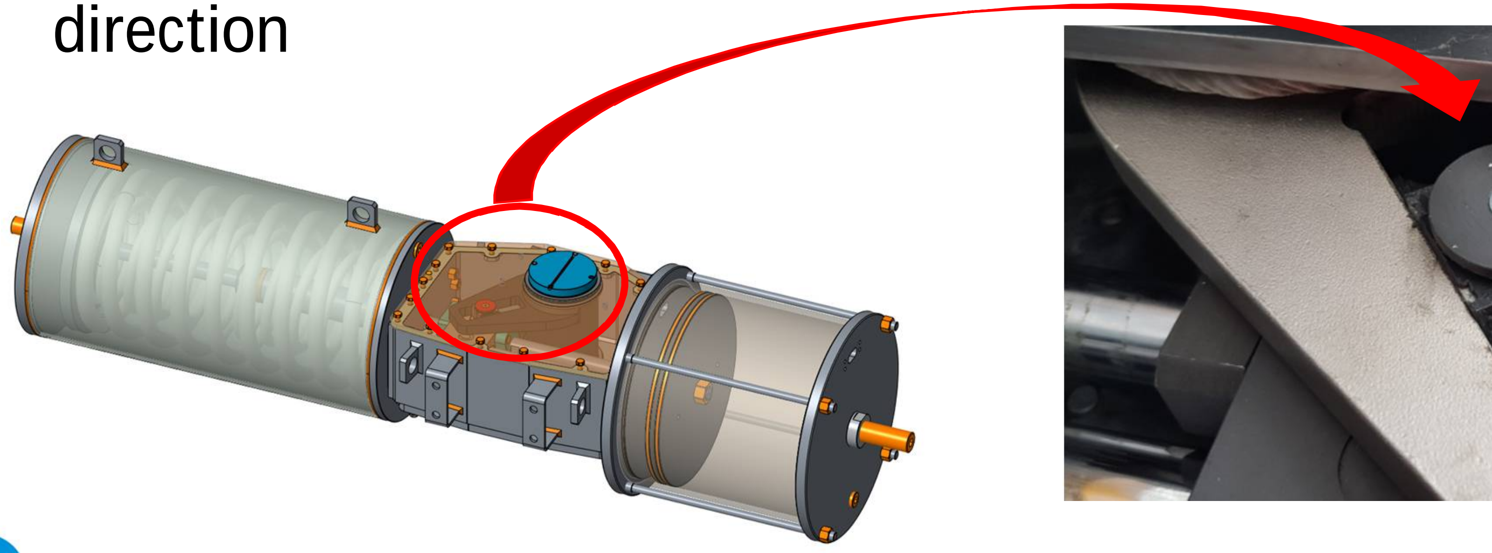


IMI STI

M14 This image is only to show the principles, does not represent the actual proportion of the different components.
Between the sliding surfaces there's a proprietary technology that permits the movement only in the direction of the gaps.
MoresN; 05/04/2018

Characteristics

- > Auto adjusting on yoke gap
- > Reciprocating force on yoke negligible
- > Angle and components interface permitting to slide only in one direction



Characteristics

Video done during tests comparison:

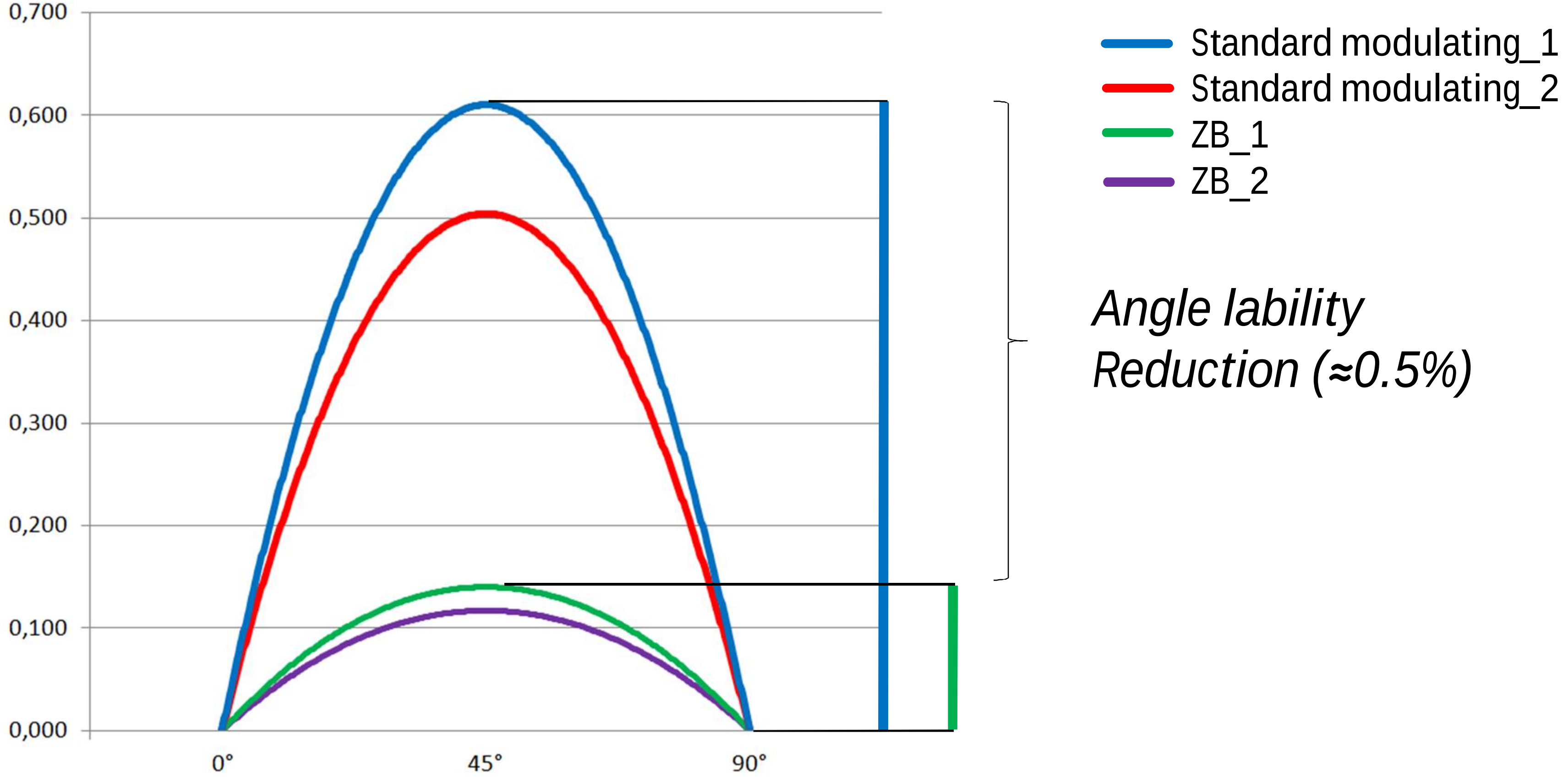
1. Standard Modulating (IMI STI) version
2. ZB Modulating version – Test start
3. ZB Modulating version – Test finish

Testing ZB

Different tests performed, such as long time cycling conducted twice, with:

- Couple of identical actuators (standard modulating version and ZB mounted)
- Native gap measured at 0°-45°-90° as reference value
- Wearing gaps measured at the end of Lifecycle endurance test

Long term cycle tests results



Angle lability Reduction (≈0.5%)

Test Results Analysis

- > Max positioning error considered
- > Mechanical stop at stroke ends
- > Good repeatability of the results between series in laboratory conditions
- > From 0.6% to 0.1% lability caused by scotch-yoke mechanism

<u>Improvement in behaviour consistency during lifetime exceeding 400% compared to standard solution.</u>

Conclusions

- The behaviour variability during lifetime span becomes much lower. Showing a trend close to physics system limits.
- The component transforming linear position in rotary position is no longer the limiting factor of modulating systems performance.


Any
questions?