



Electric Actuators

MODULATING RANGE

B BERNARD

A103/02

MODULATING

S U M M A R Y

BERNARD classification	3
Terminology	4
Motor duty service	5
Positioning loops	6
Regulation modes	7
3 classes of actuators	8
Electronic positioner general functions	10
Specialized positioners	11

Bernard modulating classification

A modulating actuator has to be fully adapted to the duty given by the modulating loop. According to the duty or the functioning frequency, the actuator technology and its cost will be different : a choice has to be done within our 3 classes of modulating actuators.

CLASS III

CLASS II

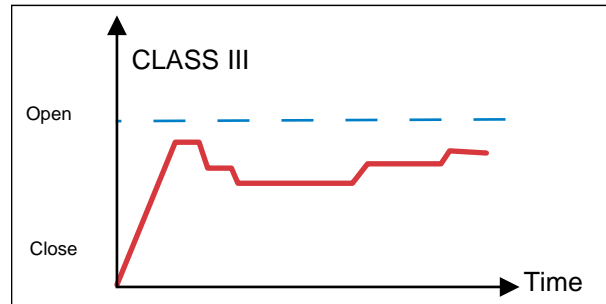
CLASS I

CLASS III POSITIONING

- The actuator is able to reach an intermediate position with a sufficient precision (better than 2%).
- The motor is able to start 1200 times per hour with a duty cycle of 50%, as to say a start every 3 seconds. This starting frequency allows the process to stabilize a position, but shall not be kept permanently.
- A Class III actuator is designed for an average of 360 change of position a day.

Technology : A Class III actuator is selected in the On/Off actuators range.

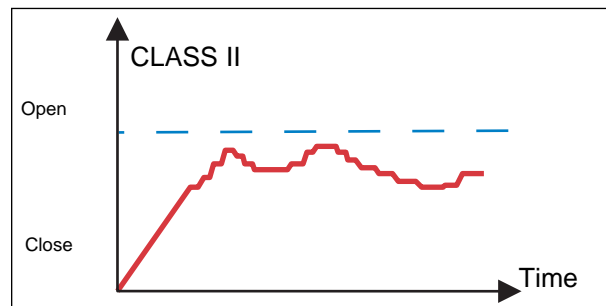
Remark : If you need to use the actuator with an other behaviour, please consult us.



CLASS II PRECISION POSITIONING

- The actuator is able to reach an intermediate position with a good precision (better than 1%).
- The motor is able to start 1800 times per hour with a duty cycle of 100%.
- A Class II actuator is designed to move permanently each 2 or 3 seconds.

Technology : Actuator with high mechanical efficiency, special modulating motor, solid state relay control.

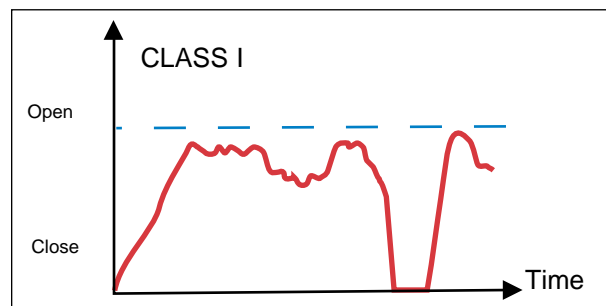


CLASS I FAST POSITIONING

- The actuator is able to reach an intermediate position with a precision of 0,5% or better..
- The actuator can move the valve, full stroke, very quickly.
- A Class I actuator is designed to move permanently.

Technology : Actuator with high mechanical efficiency, brushless electric motor with speed regulation.

Includes PWM (Pulse Width Modulating) power electronics.



Criteria	CLASS III	CLASS II	CLASS I
Modulating type	POSITIONING	PRECISION POSI.	FAST POSITIONING
Precision of positioning	< 2%	< 1%	< 0.5%
Max number of starts per hour	1200	1800	No limits
Operating duty cycle	50 %	100 %	100 %
Start : average for a day	360	not applicable	not applicable
Positioning of a critical or unstable system	Unadvised	Yes	Yes

MODULATING

Terminology

■ PRECISION OF POSITIONING

This is the maximum deviation between the real position and the theoretical position, given as a % of the total stroke.

■ HYSTERESIS

This is the maximum deviation between the position achieved from rotation to open and the same position achieved from rotation to close, as a % of the full stroke.

As an example, partial test results are published in the table on the right to appreciate the "precision and hysteresis".

■ RESOLUTION

This is the actuator movement obtained by the smallest possible input signal. The maximum value is given as a % of the full stroke.

■ DEAD BAND

The dead band is an adjustable value at the positioner. If the deviation between the signal and position is less than the dead band, the actuator will not move. Adjustment of the dead band is made to obtain the best compromise between precision and position (narrow dead band) and non-hunting of the actuator (large dead band).

■ RESPONSE TIME

Is the time the actuator requires to travel to the requested position. To simplify, the operating time of the full stroke is taken into consideration.

■ MOMENTARY AVAILABLE TORQUE, PERMANENT MAXIMUM ADMISSIBLE TORQUE

To size the actuator, the two torques must be taken into consideration. Momentary torque is used for close tight operation. This torque is provided but should not be used for modulating duty. Permanent torque is the maximum torque the actuator can work in regulation.

TYPE TEST

Signal mA	Theoretical position	Actual position	Deviation	Hysteresis
4	0	0,0	0,0	0,1
8	25	25,1	0,1	0,4
OPEN direction	12	50	50,0	0,0
	16	75	75,2	0,2
	20	100	100,0	0,0
	16	75	74,9	0,1
CLOSED direction	12	50	49,8	0,2
	8	25	24,7	0,3
	4	0	-0,1	0,1
Precision	max. deviation		0,3%	
Hysteresis	max. deviation		0,4%	

■ OPERATING TIME

This is the time the actuator needs to achieve a full stroke. Electric actuators provide the same operating time in opening and closing direction.

■ STABLE SYSTEM, OCCASIONALLY UNSTABLE SYSTEM OR UNSTABLE SYSTEM

In electric modulating duty the motor has to withstand multiple starts, stops and changes in direction of rotation. For this, it is essential to know what working conditions are present before choosing the actuator.

The actuator travels to a position and may stay there several minutes without changing position. The displacements are of minor amplitude. Changes in direction of rotation are infrequent.

The actuator position may occasionally change due to external interference.

Frequent variations of positioning values requires the actuator to work with large and sustained movements.

Motor duty service

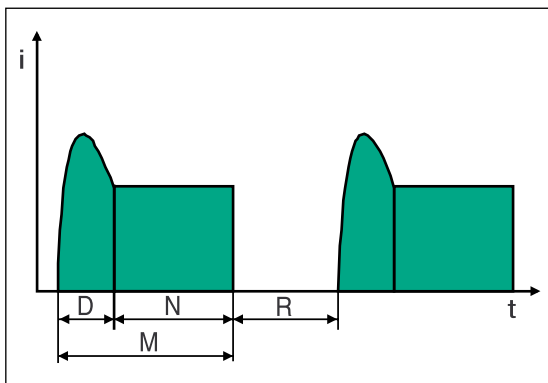
■ OPERATING CONDITIONS

- **S1 : Continuous duty**
 - Continuous operation at load over sufficient time for thermal equilibrium to be reached.

- **S2 : Short time duty**
 - Allows a sufficient rest period between operations for the motor to cool down.

- **S3 : Intermittent periodic duty**
 - Starting current does not significantly effect the temperature rise.
 - Maximum operating time to be specified.

- **S4 : Intermittent periodic duty with starting**
 - Repetition of cycles consisting of :
 - starting period D,
 - period of operation at constant load N,
 - rest period R.



- To be followed by the duty rating in % :

$$\frac{M}{M + R} \times 100$$

as well as the number of starts per hour

- **S5 : Identical to S4, but with electrical braking**

- **S6 : Periodic continuous duty with intermittent load**
 - Continuous operation with intermittent load.

- **S7 : Periodic continuous duty with electrical braking**
 - Identical to S5, but without rest period.

- **S8 : Continuous operation periodic duty with related change of load and speed**
 - Identical to S7, but with different rotation speeds.

- **S9 : Duty with non-periodic variations in load and speed**

- **S10 : Operation at discrete constant loads**
 - This duty consists of a maximum of 4 discrete load values (or equivalent loads), each value being applied for sufficient time to reach thermal balance.

■ APPLICATION FOR ACTUATORS

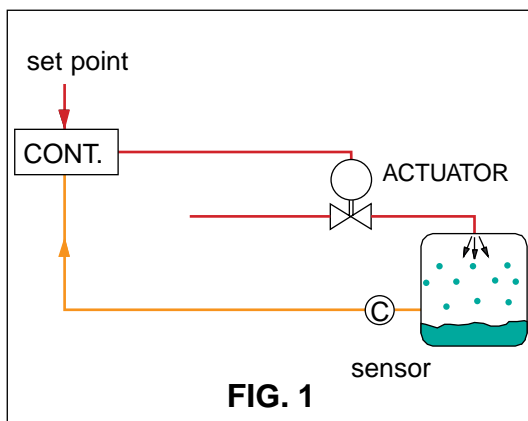
Actuators operate at S4 type of duty which requires that duty rating and the number of starts per hour be mentioned to complete operating conditions.

For ON-OFF applications, number of starts per hour may be low but the operating time long, therefore the motor temperature rise is mainly influenced by the duty cycle.

For modulating applications number of starts per hour may be high but the operating time short, therefore the motor temperature rise is mainly influenced by the number of starts/hour.

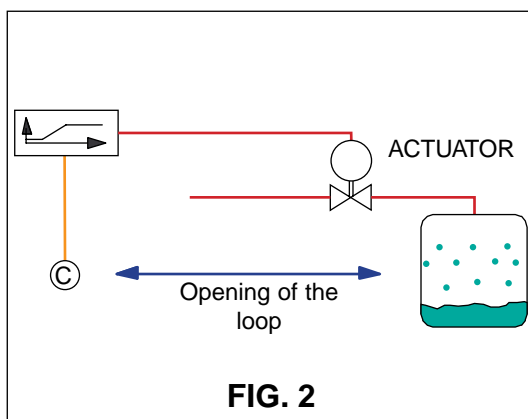
Positioning loops

To maintain a physical value within acceptable parameters (for instance, pressure in the tank (fig. 1)), the pressure is continuously monitored by the sensor. This value is compared with the controller set point and any deviation results in movement of the regulating device until an equilibrium is reached.



■ OPEN LOOP

In the case of an open loop system (fig. 2), the regulating device operates according to a positioning law driven by a measured value which is independent from the deviation of the physical value to be set. For instance, for a measurement M1 of the sensor actuator, the position will be P1% and for a M2 measurement, the position will be P2%.



This type of regulation will work only if the internal disturbance of the system is negligible.

■ CLOSED LOOP

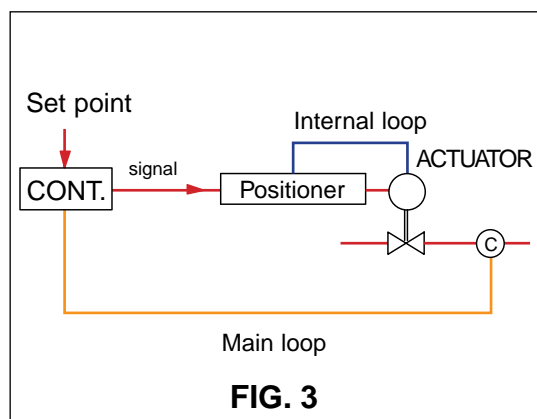
In an open loop system all deviations or disturbances are ignored. To overcome this problem and maintain balanced conditions, a sensor C (fig. 1) monitors the situation.

Any deviation between command and sensor signals causes the actuator to modulate.

■ OVERLAPPED LOOP

The actuator can be controlled by the sensor provided the pulses are plus or minus, causing open or closed direction. This system is generally used where the actuator response time is long. In order to make the system more efficient an additional loop is connected.

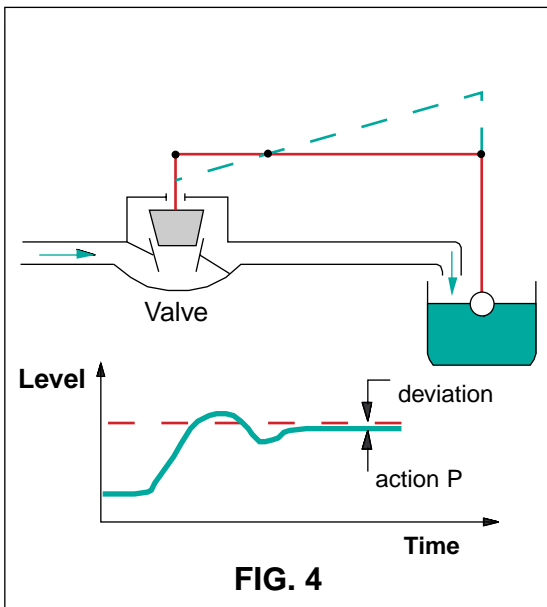
The command signal, usually 4.20mA, is balanced against the valve position. The positioner is an integral part of the valve actuator.



Regulation modes

■ PROPORTIONAL TYPE “P”

Positioning is achieved by the proportional displacement of the motorized valve with respect to the deviation between the position order and the measured value. An example of the system is shown by the sketch (fig. 4) where the valve closes progressively when the water level rises.



If there is a variation in the load (float weight), the water level will be established at a new value resulting in a permanent deviation of water level.

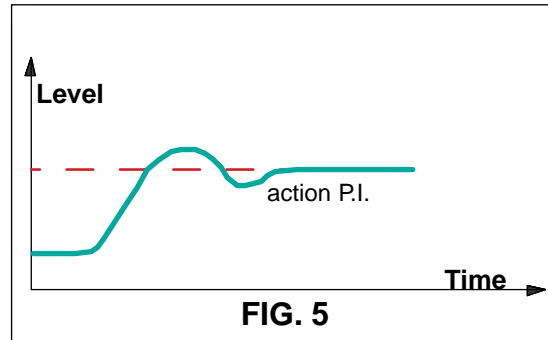
This deviation is a typical feature of the proportional control.

■ PROPORTIONAL AND INTEGRAL “P.I.”

To avoid the permanent deviation experienced with proportional control, an integral control is added.

The integral feature which ensures the control function of the motorized valve is proportional to the deviation position - position order is restored.

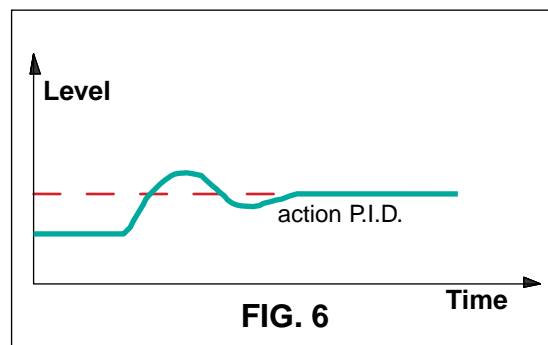
The use of proportional and integrated controls combine to give a reasonably fast response time, with the added benefits of stability from proportional control and precision from integrated control.



■ PROPORTIONAL INTEGRAL AND DERIVED “P.I.D.”

When a quicker reaction to a disturbance is required, a derived action can be added (if the actuator and the process permits it).

The derived action feature consists in that the position of the motorized valve is proportional to the speed variation of the deviation.



When the disturbance occurs, the derived action rectifies most of the disturbance encountered but only for a short moment.

The proportional positioning continues and the integral action finishes by eliminating the residual deviation.

MODULATING

3 classes of actuators

■ CLASS III ACTUATORS

designed to associate positioning control technology and economical objectives.

Based on the success of the BERNARD actuator's technology, a complete range of actuators has been selected and tested under the positioning CLASS III criteria.

- 1200 starts/hour (360 starts/day in average),
- Large sized electro-mechanical reversing starter (**INTEGRAL+** and **POSIGAM+** versions),
- Position sensor by precision potentiometer.

CLASS III modulating motorisation may use 3 phase, single phase and direct current power supplies. The performance summary presents a large choice : quarter turn, multiturn, linear actuators, as well as electric fail safe spring return actuators.

■ CLASS II ACTUATORS

A complete actuator program ranging from direct quarter turn to linear actuators as well as rotating systems with operating levers.

- Powerful asynchrone type motor modulation technics with low inertia associated to a high mechanical efficiency is proof which garantees a product particularly adapted to modulating requirements in all fields of industry with difficult environments.
- Ball bearings, planetary gears with satellites, machining technics of worm/wheel gears are reasons of optimum efficiency.
- The electric power parts were upgraded to the level of the actuator performance by replacing electric mechanical reversing starters by 3 phase or single phase solid state power relays. Thus, avoiding all risks of sparks and all risks of contacts stiking and obtaining a long life duration.
- Special care has been given to the position sensors, a basic element for positioning liability. Axis mounted on ball bearings and



● COUPLINGS AND DIMENSIONS

All flanges and output shafts, as well as the overall dimensions, are identical to our SD-Range and ST-Range. For details consult the corresponding catalogues.

● wiring diagram

Class III actuators can be supplied with 4-20 mA positioner type **POSIGAM+**. They are also available in standard design (without contactor) and with **INTEGRAL+** design for remote control Open/Close/Stop.



plastic tracks guarantee an excellent long life time (100 million possible operations).

- Modulating actuator up to 1800 starts/hour - 100% duty
 - Complete solid state power control
 - Position sensor plastic track potentiometer and with ball bearing mounting axis
 - Multiturn and direct quarter turn actuators output shaft ball bearing mounted⁽¹⁾
 - Manual declutchable handwheel⁽¹⁾
 - **MODUGAM+** integrated positioner on sole 3 phase or single phase supply
- (1) except for type OAP

■ CLASS I ACTUATORS

The range of the CLASS I actuators was designed to obtain a fast and precise operation of modulating valves. The positioner **PRECIGAM** together with the brushless motor actuator offer an extremely performant motorization for valves.

The special DC motor design without brushes is a reliable system requiring no maintenance. Thanks to the integrated numeric sensors, the control of speed and torque guarantee the modulation precision in spite of important torque variations during the stroke of the valve.

- Brushless motor with samarium-cobalt,
- Confirmed modulation module using the GAMX card,
- Motor control module controlling speed, current and torque,
- Power control module with wide pulse MOS technology, direct supply from 24 V to 500 V according to available power supply.

The technology of brushless motor application generally used with robots offers an alternative to pneumatic and hydraulic actuators and also to normal DC motors with brushes. The power supply may be 3 phase or single phase of voltages generally used in industry.

● EASY TO INSTALL

The positioner is located in a metallic box with tight enclosure which can be placed near the actuator.

- Input signal 4-20mA,
- Sole power supply of motor and electronics : 3 phase, single phase and direct current.

The electronic modules include 4 cards for different functions.

- A power control card adapted to the available voltage,
- The CONT2 card controls the power control card and the total electrical separation between power and control circuitry.
- The CONT1 card, to control and adjust all the motor parameters. These adjustments are available for all types of valves and all response times. Adjustments are made in our works and no further correction on site is necessary.
- The GAMX card : positioner card for setting of the 0 and 100% of the stroke, same as the



standard GAMX, L. BERNARD card.

- STANDARD EQUIPMENT FOR PRECIGAM POSITIONER
 - Adjustment of the proportional speed band
 - Adjustment of the proportional torque band (for reversible actuators)
 - Maximum torque
 - Maximum speed
 - Speed reduction at end of closing
 - Torque limitation with control
 - Torque holding on the motor after torque switch tripping (for reversible actuators)
 - Input signal out of limits, 3 possible actions :
 - actuator stays in last position, actuator goes to open position, actuator goes to close position
 - Fault signalling :
 - torque limiter operation
 - thermal motor protection tripping,
 - power supply failure
 - Signal of electronic torque limiter tripping

Electronic positioner general functions

■ CONTROL

● REMOTE CONTROL :

■ *By proportional*

current : 4-20mA, 0-20mA, 4-12mA, 12-20mA,

voltage : 0-10V

■ *By means of contacts*

external power supply

electronic board supplying power supply (24V)

■ *By pulse signal*

one pulse for open, close or stop

■ *By maintained signal*

actuator continues to function as long as the signalling is maintained, stopping when released

■ **ESD**

Emergency Shut Down for Open or Close.

● INTERNAL MANUAL COMMAND

- For commissioning or test use

- Automatic calibration according to the selected signal

■ POSITION SIGNALING

Proportional signaling of position is of same scale as the control signal :

example :

input signal 4-12mA

output signal 4-12mA

exception

input signal 0-10V

output signal 0-20mA

■ SIGNALS

● FAULT RELAY :

The board detects all malfunction or unavailabilities and communicates the information remotely :

- Power supply failure or blown fuse

- Loss of 1 phase in 3 PH

- Thermal motor protection tripped

- Selector in "Local" position

- No 4-20 mA signal (not available in 0-10V or 0-20mA)

Choice possible between the following faults :

- Torque limiter tripped not into account

- Selector in "Local" position not into account

- No signaling not into account

● REMOTE SIGNALS :

- 4 informations to be chosen among 16 possible

■ PROTECTIONS

● FUSES :

protect against short circuit.

● MOTOR TEMPERATURE SENSOR :

efficient protection of motor against overheating. If the temperature in the winding is too high, motor supply is impossible and restart is possible only after decrease of temperature.

● TORQUE LIMITER :

the electronic board memorizes action of the torque limiter and forbids restarting in the same rotational direction. This system guaranties complete full stop even if the torque limiter pressure is released.

● PHASE DISCRIMINATOR :

protects against wrong 3 phase connection included with automatic phase correction

■ OPTIONS

● REMOTE INFORMATION :

3 informations for Open/Close/Supply

● LOCAL INFORMATION :

3 LED's for Open/Close/Supply

● SOLID STATE RELAYS

● LOCAL CONTROL :

■ *by pulse signal* : one pulse for open, close or stop

■ *by maintained signal* : actuator continues to function as long as the signalling is maintained, stopping when released

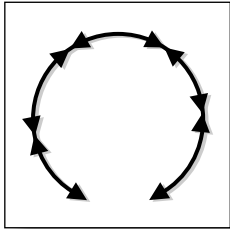
■ local/remote/stop lockable **selector** in every 3 positions.

● TIMING CONTROL:

This optional card will allow extension of the valve operation speed. The actuator operates by successive pulses adjusted at the card. One part of the stroke can have normal operating speed and the other part an extended speed control. An auxiliary limit switch gives the order to switch over from normal to slow speed. The adjustments are independent in open and close direction. The operating time for the full valve stroke can be very long. The device is used to avoid hammer effects when opening a valve on a line.

Specialized positioners

■ POSIGAM+ : POSITIONING EQUIPMENT FOR CLASS III ACTUATORS

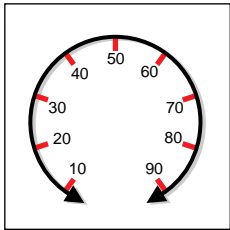


POSIGAM+ has proven to be the most reliable positioning equipment for Class III actuators.

It includes :

- A GAM-K positioner
- A precision potentiometer of 1000 Ω , linearity < 0.5%
- A contactor based power circuit

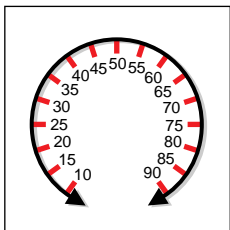
■ MODUGAM+ : POSITIONING EQUIPMENT FOR CLASS II ACTUATORS



- A positioner for intense duty cycles
- Complete solid state power control
- Plastic track potentiometer - 100 million operations

MODUGAM+ includes all of the GAM-K equipment and options. MODUGAM+ is related to Modulating Class II actuators of the OAP, MA, MB and UX type, sole actuators able to withstand the operating frequency imposed by this type of modulation.

■ PRECIGAM : POSITIONING EQUIPMENT FOR CLASS I ACTUATORS



- Fast and precise positioning
- Speed control module for a brushless DC motor with samarium cobalt magnets
- Power control module with wide pulse MOS technology
- Direct power supply : 3 phase, single phase or direct current 24 to 500 V.

Various operations are available :

- Adjustment of the proportional speed band
 - Adjustment of the proportional torque band (for reversible actuators)
 - Maximum torque (electronic)
- Maximum speed
 - Speed reduction at end of closing
 - Torque limitation with control
 - Torque holding on the motor after torque switch tripping (for reversible actuators)
 - Input signal out of limits, 3 possible actions : actuator stays in last position, actuator goes to open position or actuator goes to close position.

and also :

■ INTELLI+

INTELLI+ is equipped as a standard with the positioner function that drives the valve disc to the chosen position. An additional analog board can be added to drive proportionally the actuator with an analog input signal in current (ex. 4-20mA) or in voltage (ex. 0-10V).

Setting of the positioner is automatic. However, the dead band value can be modified by the user. This Analog input signal interface provides torque and position transmission and is electrically isolated from the input signal.