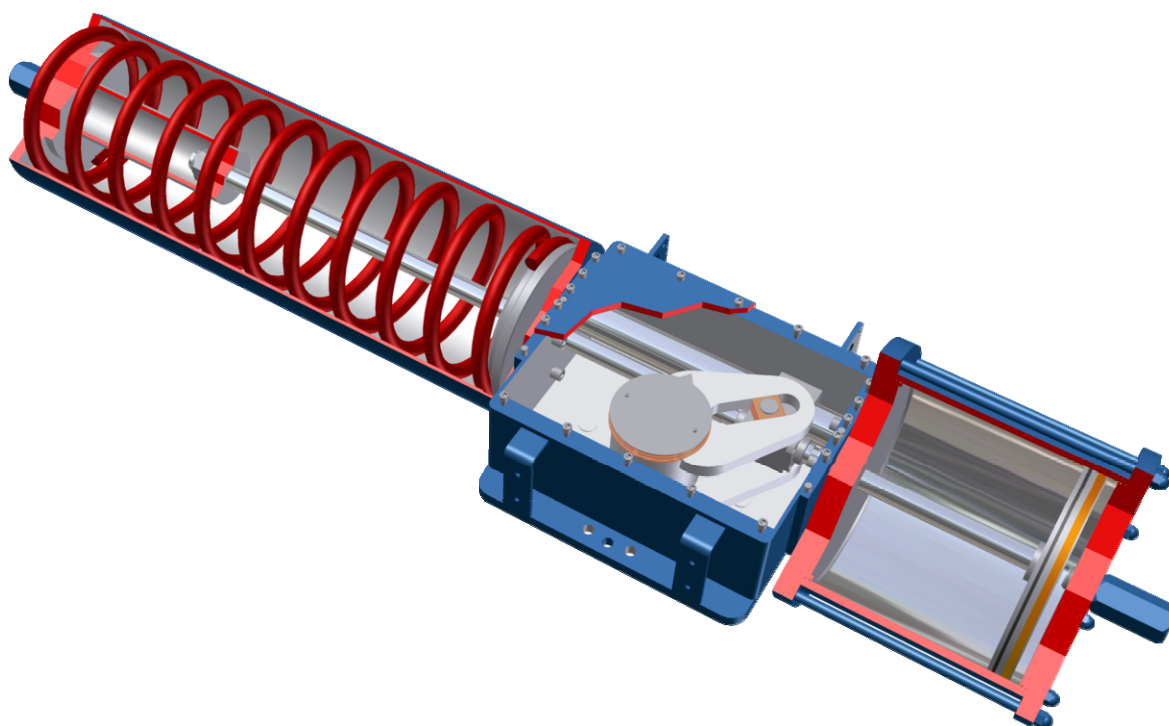


# INSTALLATION, COMMISSIONING & MAINTENANCE MANUAL

## PNS, PND & PNC-Series Pneumatic Scotch-Yoke Valve Actuators



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## 1. Introduction

This manual is designed to allow a qualified user to install, commission and maintain Paladon Systems Ltd PNS, PND and PNC Series valve actuators. This manual should be used in conjunction with any additional documentation supplied at the time of shipping. Current versions of all Paladon Systems Ltd documentation are available from [www.paladonsystems.com](http://www.paladonsystems.com).

It is the user's responsibility to ensure that all applicable Health and Safety Legislation is followed when undertaking any service work. This manual is not designed to supersede or replace any user's plant safety or work procedures; in the event of any conflict, please contact Paladon Systems Ltd or an authorised distributor.

## 2. Inspection Requirements on Initial Receipt of Actuator

- Check paint to ensure that no damage has occurred during transit. In the event of any paint damage, thoroughly clean the applicable area(s) and repaint as required.
- Check that the information detailed on the actuator's tag plate (comprises of the actuator serial number, model number, maximum torque output, pneumatic supply pressure range and valve tag number) matches those detailed on the Sales Order Acknowledgement, Test Certificates and Delivery Note. In the event of any discrepancies, please contact Paladon Systems Ltd or an authorised distributor.

## 3. Storage Requirements

### 3.1 Short-Term Storage

To ensure optimum performance, the following should be undertaken prior to actuator storage for any duration:

- Check that all pneumatic and electrical connections are suitably sealed to prevent any environmental ingress.
- For any actuator not yet assembled to a valve, place actuator on a wooden pallet to prevent any damage to the valve coupling flange.

### 3.2 Long-Term Storage

In addition to the short-term storage requirements detailed above, for long-term storage the following should be undertaken:

- Protect the coupling parts (stem adaptor and coupling joint, coupling flange etc) with grease or protective oil.
- Keep actuators dry and protected against the direct action of weather elements.
- Stroke the actuator and ensure all pneumatic and electrical connections are properly sealed after.

## 4. Actuator Overview

PNS, PND and PNC Series pneumatic valve actuators are suitable for use with quarter-turn valves or mechanisms, and have been designed to provide years of efficient and reliable operation in heavy-duty applications.

The main components of PNS, PND and PNC Series valve actuators are:

## 4.1 Standard Components

### 4.1.1 Frame

The frame contains the scotch-yoke mechanism which converts the linear movement of the pneumatic piston into a quarter-turn rotary movement. To protect personnel from injury and the scotch-yoke mechanism from corrosion, the frame is a fully enclosed carbon steel fabricated construction. To support the transverse forces generated by scotch-yoke mechanisms, and to ensure correct alignment of the piston rod, sliding blocks and yoke bushing, the body also contains a chromium plated guide bar.

### 4.1.2 Pneumatic Cylinder

Contains the pneumatic piston, which generates the linear movement which is converted into a quarter-turn rotary movement by the scotch yoke mechanism housed in the actuator's frame.

### 4.1.3 End Stop Screws

Allow precise adjustment of a scotch-yoke mechanism's angular stroke by means of two end stop screws. One end stop screw is always located on the end flange of the pneumatic cylinder. For double-acting actuators, the remaining end stop screw is either located on the body's blanking flange, or in the event a manual override is fitted, on the manual override. For spring-return actuators, the remaining end stop screw is located on the outer spring-cylinder flange, or in the event a manual override is fitted, on the manual override.

### 4.1.4 Local Position Indicator

Connected directly to the scotch-yoke mechanism, the local position indicator protrudes through the top of the body to provide precise local visual indication of the actuator's angular position.

## 4.2 Optional Components

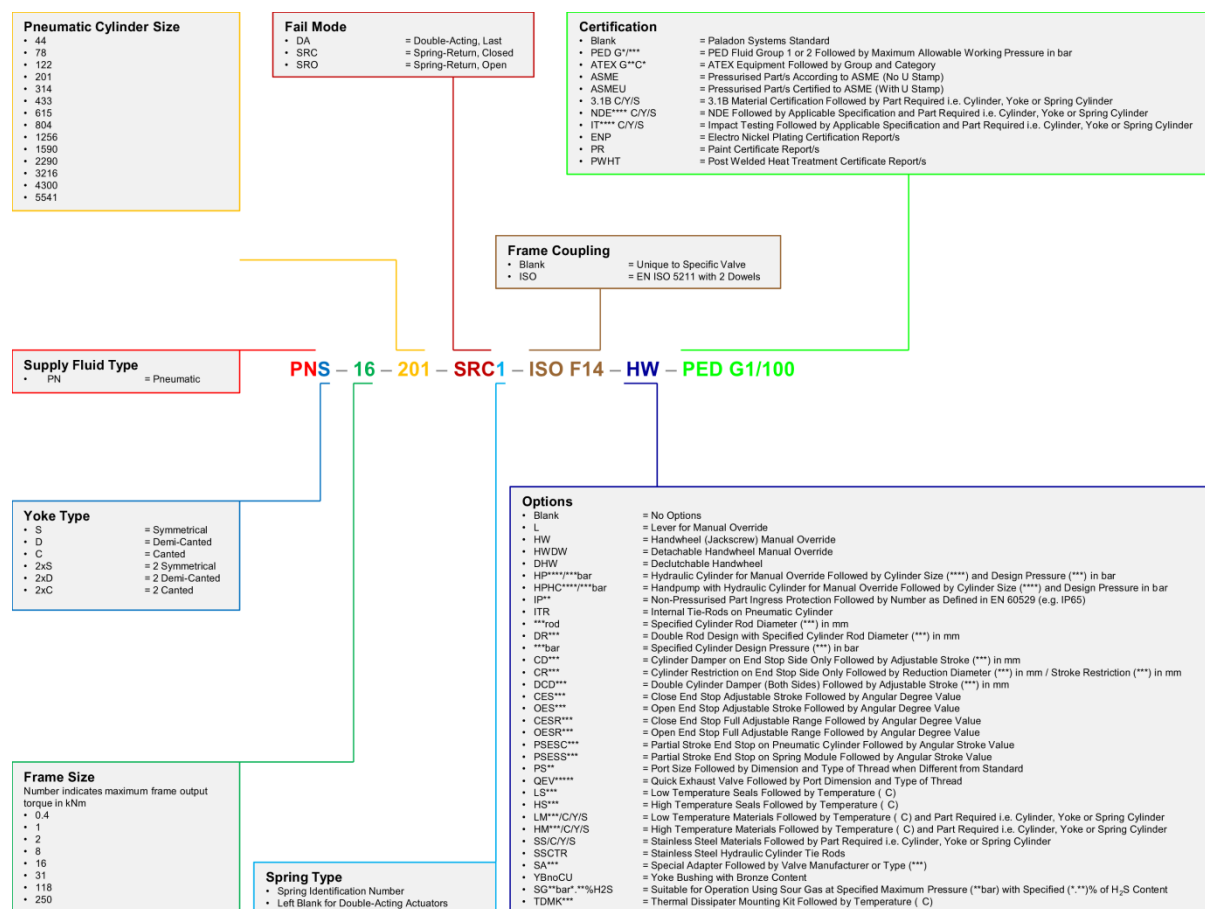
### 4.2.1 Spring Cylinder

Supplied with all spring-return PNS, PND and PNC Series valve actuators, the spring cylinder comprises of a scragged pre-compressed spring contained within a fully welded carbon steel container. **WARNING! The spring cylinder is non-serviceable; any attempt to disassemble it may result in serious injury or death.**

### 4.2.2 Manual Override

There are two types of manual override mechanisms which can be provided; Jackscrew or Hydraulic Handpump. Jackscrew type manual overrides comprise of a handwheel and jackscrew to create a linear motion, which is converted to a rotary motion via the scotch-yoke mechanism. Hydraulic handpump manual overrides comprise of a hydraulic cylinder and handpump to create a linear motion, which is converted to a rotary motion via the scotch-yoke mechanism.

## 5. Model Number Designations



## 6. Tool Requirements

No special tools are required for the installation, commissioning and maintenance of Paladon Systems Ltd actuators.

## 7. Valve/Actuator Mounting

Valve mounting is achieved through one of the following:

- Direct mounting using threaded holes on the actuator's body flange.
- Stem adapter mounting using an adapter and coupling joint.

Paladon Systems Ltd actuators can be mounted in any orientation; however, it is common industry practice to align the centreline of the actuator's pneumatic cylinder with that of the valve pipework. **NOTE: Certain control components require mounting in a specific orientation with respect to gravity in order to function correctly.**

To assemble the actuator to the valve:

- 7.1 Check that the coupling dimensions of the actuator are suitable for those of the valve flange and stem.
- 7.2 Move the valve to the open or closed position to match the rest position of the actuator.

- 7.3 Thoroughly clean all mounting flanges, taking special care to ensure that all grease is removed.
- 7.4 To assist with assembly, lubricate the valve stem with suitable oil or grease.
- 7.5 Lift the actuator by its lifting eyes and, if possible, ensure that the valve stem is in the vertical position. **NOTE: Do not lift the actuator using slings around the actuator's hydraulic or spring cylinders; doing so may result in damage.**
- 7.6 If valve mounting is via a stem adapter and coupling joint (supplied loose), assemble the coupling joint to the valve stem before proceeding further.
- 7.7 Lower the actuator onto the valve so that the valve stem slips in the actuator's yoke. Fasten the actuator to the valve by means of stud bolts, which are screwed into the valve's coupling flange.
- 7.8 Tighten the nuts to the stud bolts in accordance with the following torques:

Thread Size	Torque
M8	20 Nm
M10	40 Nm
M12	70 Nm
M14	110 Nm
M16	160 Nm
M20	320 Nm
M22	420 Nm
M24	550 Nm
M27	800 Nm
M30	1100 Nm
M33	1400 Nm
M36	1700 Nm

- 7.9 Stroke the actuator to ensure smooth and full opening and closing of the valve.

## 8. Adjusting Open and Closed Valve Positions

The precise valve open and closed positions are set using the end stop screws. **NOTE: Certain valves incorporate their own end stops. For these types of valves, it is recommended that the valve's end stops be adjusted to their maximum travel so that the valve's end positions are achieved using the actuator's end stop screws only.**

To adjust the open and closed valve positions:

- 8.1 Loosen the protective nut on each of the end stop screws.
- 8.2 Move the actuator yoke away from the applicable end stop screw.
- 8.3 Screw the applicable end stop screw to reduce the actuator's angular stroke, unscrew to increase it.
- 8.4 Move the actuator yoke towards the applicable end stop screw.

- 8.5 Check valve position and repeat steps 2 to 4 until desired valve position is reached.
- 8.6 Tighten the protective nut on the applicable end stop screw.
- 8.7 Repeat steps 8.2 to 8.6 for the remaining end stop screw.

## **9. Preparations for Start-Up**

### **Pneumatic Connections & Considerations**

- 9.1 Prior to connecting the pneumatic supply line(s), check that all pipes and fittings are in accordance with the plant specifications.
- 9.2 Check that all pneumatic supply lines are free of any contaminants or debris, and that they are suitably supported to minimise any stress caused by vibration.
- 9.3 Connect the pneumatic supply line fasteners.
- 9.4 Check fasteners for any leaks, and ensure that they are sufficiently tightened to avoid the chance of becoming loose due to any vibrations created during operation.

### **Electrical Connections & Considerations**

**NOTE: All electrical connections are the responsibility of the user.**

- 9.5 For installations in hazardous areas, ensure all electrical fittings have the correct hazardous area certification.
- 9.6 Ensure that the actuators and any control components are suitably protected against lightning strikes, electrical surges and spikes; and any magnetic fields.

### **Actuator Stroking**

- 9.7 Stroke the actuator to check that smooth and continuous operation is achieved. In the event of uneven stroking, or stroking speeds below those detailed on the test certificate; first check to ensure correct pneumatic supply pressure and flow rate. Further fault finding procedures can be found in Section 16.

## **10. Manual Override Operation**

### **10.1 Double-Acting Actuator with Handwheel Type Manual Override** (See Section 16.6, Dwg. HYX-XXX-HDXXX-00-001-PL)

- a. Isolate pneumatic supply, depressurise actuator and control system.
- b. Remove tubing and fittings from actuator supply inlets to ensure that both sides of the piston are free to 'breathe' to atmosphere.
- c. Move the lever on the handwheel frame mounting flange to the 'ENGAGED' position.
- d. Rotate the handwheel clockwise to close, or anti-clockwise to open the valve.

- e. Once the desired valve position has been achieved, disengage the manual override by moving the lever on the handwheel frame mounting flange to the 'DISENGAGED' position.
- f. Re-connect pneumatic supply connections.

### **10.2 Double-Acting Actuator with Handpump Type Manual Override** (See Section 16.8, Dwg. HYX-XXX-CYXXX-00-002-PL)

- a. Isolate pneumatic supply, depressurise actuator and control system.
- b. Remove tubing and fittings from actuator supply inlets to ensure that both sides of the piston are free to 'breathe' to atmosphere.
- c. Move the 3-way ball valve and cylinder link ball valve levers to the horizontal position.
- d. Move the handpump selector valve to the required flow direction.
- e. Operate handpump until desired valve position is achieved.
- f. Return 3-way ball valve, cylinder link ball valve and handpump selector valves to automatic position.
- g. Re-connect pneumatic supply lines.

### **10.3 Spring Return Actuator with Handwheel Type Manual Override** (See Section 16.7, Dwg. XXX-XXX-SHXXX-00-001-PL)

- a. Isolate pneumatic supply, depressurise actuator and control system.
- b. Remove tubing and fittings from actuator supply inlet to ensure that both sides of the piston are free to 'breathe' to atmosphere.
- c. Ensure actuator is in its fail position.
- d. Rotate the handwheel anti-clockwise to open the actuator (for fail close 'SRC' actuators) or in clockwise direction to close the actuator (for fail open 'SRO' type actuators).
- e. Before restoring automatic hydraulic operation, rotate the handwheel in the opposite direction to the above bullet in order to move the actuator to its fail position.
- f. Reconnect pneumatic supply lines.

### **10.4 Spring Return Actuator with Handpump Type Manual Override** (See Section 16.9, Dwg. PNX-XXX-CYXXX-00-002-PL)

- a. Isolate pneumatic supply, depressurise actuator and control system.
- b. Remove tubing and fittings from actuator supply inlet to ensure that both sides of the piston are free to 'breathe' to atmosphere.
- c. Close the handpump stop valve by rotating its handle clockwise.
- d. Operate handpump until desired valve position is achieved.



- e. Reconnect pneumatic supply line.
- f. Open the handpump stop valve by rotating its handle anti-clockwise.

## 11. Maintenance

- 11.1 All Paladon Systems Ltd actuators have been designed to provide long service with minimum maintenance; however, a preventative maintenance program is recommended. Preventative maintenance programs not only help avoid unanticipated and costly down time, but also typically reduce the overall cost of ownership.
- 11.2 It is the user's responsibility to ensure that all applicable health and safety legislation is followed when undertaking any maintenance work.
- 11.3 **WARNING! Before commencing any maintenance work, the actuator's pneumatic supply line, actuator and associated controls must be fully depressurised. After system depressurisation, the actuator and controls must be isolated from the supply line, and from any remote control signals. Failure to follow any of these steps may result in unanticipated actuator and valve movement, possibly resulting in serious injury or death.**
- 11.4 Any unauthorised maintenance or modification to the actuator and, where applicable, the control system may invalidate the warranty.
- 11.5 Periodic inspection is recommended, specifically;
  - That smooth valve operation is maintained, and within the required stroking time.
  - That there is no external damage to any components.
  - The pneumatic supply pressure is kept within the specified range.
  - Pneumatic connections do not show any signs of leakage.
  - Paint system remains undamaged.
  - That any dirt or debris is removed from actuator surfaces.

## 12. Pneumatic Cylinder Seal Replacement

- 12.1 Remove the blank head flange retaining nuts (see Section 16.3, Dwg. PNX-XXX-CYXXX-00-001-PL, Item 7 – commercial part).
- 12.2 Remove the blank head flange (see Section 16.3, Dwg. PNX-XXX-CYXXX-00-001-PL, Item 5 – manufactured part).
- 12.3 Slide off the cylinder liner (see Section 16.3, Dwg. PNX-XXX-CYXXX-00-001-PL, Item 1 – manufactured part).
- 12.4 Remove the frame cover retaining screws (see Section 16.1, Dwg. XXX-XXX-FRXXX-00-001-PL, Item 1 – commercial part).
- 12.5 Remove the frame cover (see Section 16.1, Dwg. XXX-XXX-FRXXX-00-001-PL, Item 2 – manufactured part).

- 12.6 Loosen the tie rods (see Section 16.3, Dwg. PNX-XXX-CYXXX-00-001-PL, Item 6 – manufactured part).
- 12.7 Unscrew the piston rod and slide it off (see Section 16.3, Dwg. PNX-XXX-CYXXX-00-001-PL, Item 3 – manufactured part).
- 12.8 Unscrew the frame fixing screws (see Section 16.3, Dwg. PNX-XXX-CYXXX-00-001-PL, Item 9 – commercial part).
- 12.9 Remove the rod head flange (see Section 16.3, Dwg. PNX-XXX-CYXXX-00-001-PL, Item 4 – manufactured part).
- 12.10 Remove the O-rings, the piston gasket, the sliding rings and the gaskets; and clean all O-ring grooves (see Section 16.3, Dwg. PNX-XXX-CYXXX-00-001-PL, Items 1, 2, 3, 4, & 5 – commercial part).
- 12.11 Replace all seals with new ones, and ensure that they are lubricated with grease (see Section 16.3, Dwg. PNX-XXX-CYXXX-00-001-PL, Items 1, 2, 3, 4 & 5 – commercial part).
- 12.12 Re-assemble the piston rod (see Section 16.3, Dwg. PNX-XXX-CYXXX-00-001-PL, Item 3 – manufactured part) by screwing it into the guide block (see Section 16.1, Drg. XXX-XXX-FRXXX-00-001-PL, Item 6 – manufactured part).
- 12.13 Tighten the tie rods (see Section 16.3, Dwg. PNX-XXX-CYXXX-00-001-PL, Item 6 – manufactured part).
- 12.14 Re-assemble the cylinder liner (see Section 16.3, Dwg. PNX-XXX-CYXXX-00-001-PL, Item 1 – manufactured part) and blank head flange (see Section 16.3, Drg. PNX-XXX-CYXXX-00-001-PL, Item 5 – manufactured part).
- 12.15 Uniformly tighten the blank head flange retaining nuts (see Section 16.3, Dwg. PNX-XXX-CYXXX-00-001-PL, Item 7 – commercial part).
- 12.16 Replace the paste gasket of the mechanism cover (see Section 16.1, Dwg. XXX-XXX-FRXXX-00-001-PL, Item 1 – manufactured part).
- 12.17 Replace the frame cover (see Section 16.1, Dwg. XXX-XXX-FRXXX-00-001-PL, Item 2 – manufactured part).
- 12.18 Replace and tighten the frame cover retaining screws (see Section 16.1, Dwg. XXX-XXX-FRXXX-00-001-PL, Item 1 – commercial part).
- 12.19 Check for proper actuator operation and for any seal leaks.

### 13. Lubrication

Usually it is not necessary to lubricate the actuator as all moving parts are lubricated for life; however, in the unlikely event that additional lubrication is required, the following lubricant should be used:

Manufacturer	AGIP
Trade Name	AGIP GR MU EP
Colour	Yellow/Brown
Oil Type	Mineral
Consistency (NLGI Grade) – ASTM D217	1
Worked Penetration at 25°C – ASTM D217	325 dmm
Dropping Point ASTM D2265	185°C
Viscosity of Base Oil at 40°C – ASTM D445	160 mm <sup>2</sup> /s

### 14. Replacement Seal Kits

When undertaking any service work, it is strongly recommended that all seals removed during disassembly be replaced. Please refer to the below tables when ordering replacement seal kits:

#### 14.1 Pneumatic Cylinder Spares Kits

Pneumatic cylinder spares kits comprise of the following items:

- Piston Sliding Ring (1 off with 1 off enclosed O-ring)
- Piston Rod Sliding Ring (1 off with 1 off enclosed O-ring)
- Flange O-ring (2 off)
- Piston Rod O-ring (1 off)
- End Stop O-ring (1 off)

For more information regarding the above items, please see Section 16.3, Dwg. PNX-XXX-CYXXX-00-001-PL.

#### 14.2 Frame Spares Kits

Frame spares kits comprise of the following items:

- Yoke O-Ring (2 off)
- Guide Bar O-Ring (2 off)
- Plug O-Ring (1 off)
- Bushing O-Ring (2 off)

For more information regarding the above items, please see Section 16.1, Dwg. XXX-XXX-FRXXX-00-001-PL.

**NOTE: Each seal kit includes a tube of silicone to replace any paste gaskets seals broken during maintenance.**

## 15. Trouble-Shooting

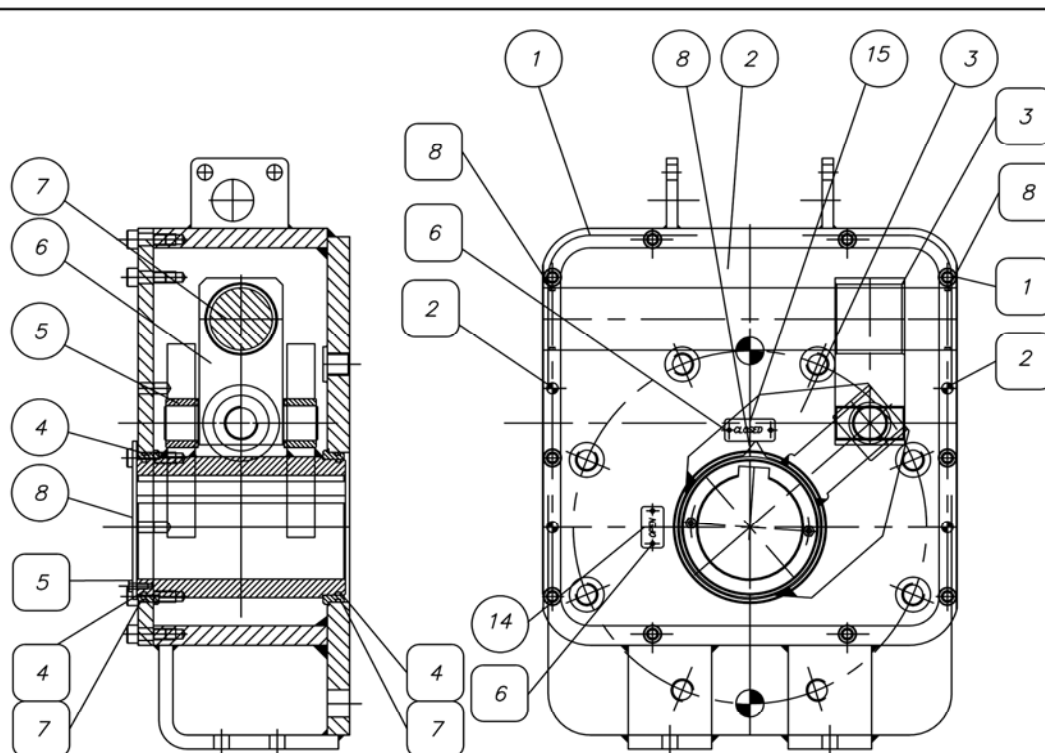
In the unlikely event of incorrect actuator operation, please refer to the below trouble-shooting guide.

Fault	Cause	Corrective Action
Erratic or slow operation	Supply pressure erratic or below minimum specified pressure.	Check supply pressure and correct as required.
	Worn components.	Disassemble and visually inspect parts for obvious wear and tear, and replace as required.
	Inadequate lubrication.	Disassemble and lubricate as required.
	Defective valve.	Consult with the valve manufacturer.
Short stroke	Incorrect setting of end stops.	Check and adjust position of actuator end stops (see section 7). Where applicable, check and adjust position of valve end stops.
	Debris in either pneumatic cylinder or frame.	Disassemble and remove debris. Check for seal damage and replace as required.
	Defective valve.	Consult with the valve manufacturer.
Insufficient torque output	Supply pressure below specified minimum.	Check supply pressure and correct as required. Check valve torque requirements are in accordance with those specified; if not, consult with valve manufacturer.
	Pipework blocked, crushed or leaking.	Examine pipework; clean or replace as required.
	Defective piston seal.	Disassemble hydraulic cylinder, check seals for damage, and replace as required.

## 16. Drawings

Section	Drawing	Description
16.1	XXX-XXX-FRXXX-00-001-PL	Frame Assembly with symmetrical scotch-yoke mechanism
16.2	XXX-XXX-FRXXX-00-002-PL	Frame Assembly with demi-canted scotch-yoke mechanism
16.3	PNX-XXX-CYXXX-00-001-PL	Pneumatic Cylinder Assembly
16.4	XXX-XXX-SRXXX-00-001-PL	Spring Cylinder Assembly (one spring for low spring stroke torques)
16.5	XXX-XXX-SRXXX-00-002-PL	Spring Cylinder Assembly (three springs for high spring stroke torques)
16.6	HYX-XXX-HDXXX-00-001-PL	Handwheel Manual Override Assembly for Double-Acting Actuators
16.7	XXX-XXX-SHXXX-00-001-PL	Handwheel Manual Override Assembly for Spring Return Actuators
16.8	HYX-XXX-CYXXX-00-002-PL	Handpump Manual Override for Double Acting Actuators
16.9	PNX-XXX-CYXXX-00-002-PL	Handpump Manual Override Assembly for Spring Return Actuators

16.1 XXX-XXX-FRXXX-00-001-PL



00 MANUFACTURED PART

N°	PART NAME	MATERIAL
1	HOUSING	CARBON STEEL
2	COVER	CARBON STEEL
3	SCOTCH YOKE	ALLOY STEEL
4	BUSHING	BRONZE
5	SLIDING BLOCK	BRONZE
6	GUIDE BLOCK	CARBON STEEL
7	GUIDE BAR	ALLOY STEEL (*)
8	POSITION INDICATOR	CARBON STEEL
14	PLATE	STAINLESS STEEL
15	PLATE	STAINLESS STEEL

Note: (\*) = CHROMIUM PLATED

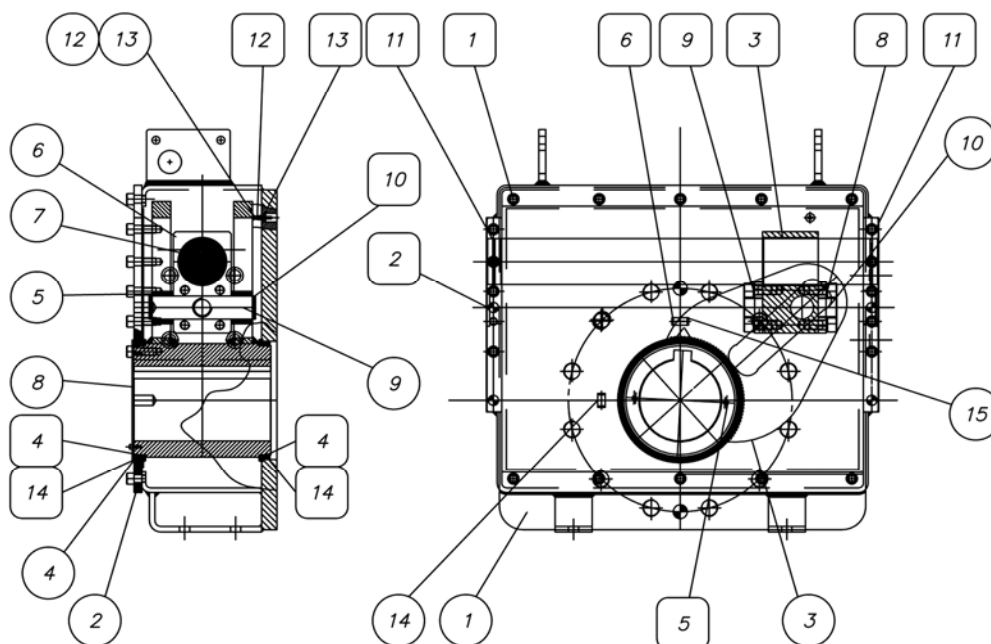
00 COMMERCIAL PART

N°	PART NAME	MATERIAL
1	SCREW	ALLOY STEEL
2	PIN	COMMERCIAL
3	DU-BEARING	Fe-Bz-TEFLON
4	O-RING (SP)	NBR
5	SCREW	COMMERCIAL
6	RIVET	COMMERCIAL
7	O-RING (SP)	NBR
8	O-RING (SP)	NBR

Note: (SP) = RECOMMENDED SPARE PARTS

<p>THIS DRAWING IS PROPERTY OF PALADON WHICH RESERVES THE RIGHTS GUARANTEED BY LAW</p> <p><b>Paladon</b></p>	MODEL TYPE:	DRAWING N°:	
	DESCRIPTION:		
	PNX	XXX-XXX-FRXXX-00-001-PL	
	FRAME	REV.: _	DATE: _
		SCALE: 1:4	DATE: 31-05-03
		DRAWN.: T.S.	CHECKED.: E.Bettinardi

16.2 XXX-XXX-FRXXX-00-002-PL



00 MANUFACTURED PART

N°	PART NAME	MATERIAL
1	HOUSING	CARBON STEEL
2	COVER	CARBON STEEL
3	SCOTCH YOKE	ALLOY STEEL
4	BUSHING	BRONZE
5	SLIDING BLOCK	BRONZE
6	GUIDE BLOCK	CARBON STEEL
7	GUIDE BAR	ALLOY STEEL (*)
8	POSITION INDICATOR	CARBON STEEL
9	ROLLER PIN	ALLOY STEEL (*)
10	CONNECTION	CARBON STEEL
12	PLUG	ALLOY STEEL
13	SPRING	SPRING STEEL
14	PLATE	STAINLESS STEEL
15	PLATE	STAINLESS STEEL

Note: (\*) = CHROMIUM PLATED

00 COMMERCIAL PART

N°	PART NAME	MATERIAL
1	SCREW	ALLOY STEEL
2	PIN	COMMERCIAL
3	DU-BEARING	Fe-Bz-TEFLON
4	O-RING (SP)	NBR
5	SCREW	COMMERCIAL
6	RIVET	COMMERCIAL
8	SCREW	COMMERCIAL
9	SCREW	COMMERCIAL
10	CIRCLIP	COMMERCIAL
11	O-RING (SP)	NBR
12	CIRCLIP	COMMERCIAL
13	O-RING (SP)	NBR
14	O-RING (SP)	NBR

Note: (SP) = RECOMMENDED SPARE PART

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PND-140

DESCRIPTION:

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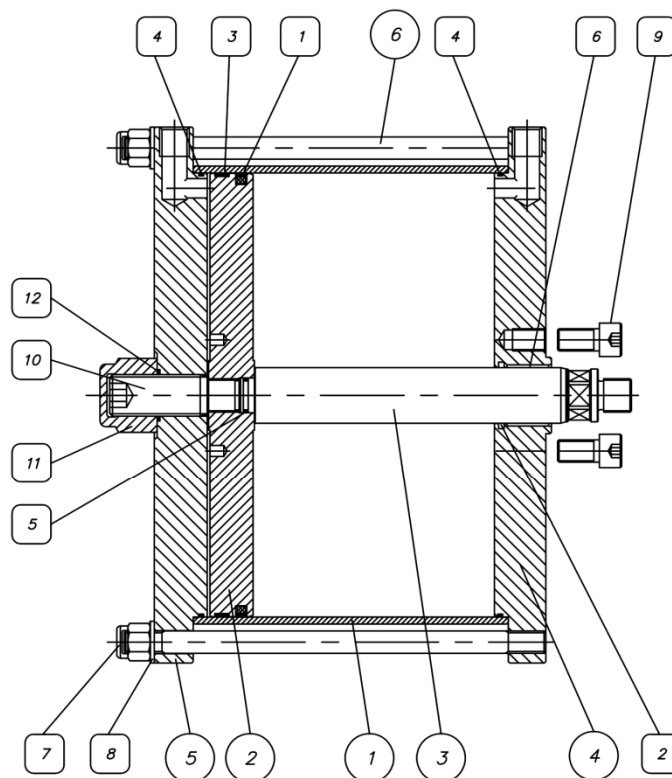
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DATE: 1/9/2010

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16.3 PNX-XXX-CYXXX-00-001-PL



00 MANUFACTURED PART

N°	PART NAME	MATERIAL
1	CYLINDER LINER	CARBON STEEL
2	PISTON	CARBON STEEL
3	PISTON ROD	ALLOY STEEL (*)
4	ROD HEAD FLANGE	CARBON STEEL
5	BLANK HEAD FLANGE	CARBON STEEL
6	TIE ROD	CARBON STEEL

Note: (\*) = CHROMIUM PLATED

00 COMMERCIAL PART

N°	PART NAME	MATERIAL
1	GLIDER + O-RING (SP)	COMMERCIAL
2	GLIDER + O-RING (SP)	COMMERCIAL
3	GUIDE SLIDER	TEFLON+15% GRAPHITE
4	O-RING (SP)	NBR
5	O-RING (SP)	NBR
6	DU-BEARING	Fe-Bz-TEFLON
7	HEX. NUT	ALLOY STEEL
8	WASHER	COMMERCIAL
9	SCREW	COMMERCIAL
10	DOWEL	CARBON STEEL
11	CUP	CARBON STEEL
12	O-RING (SP)	NBR

Note: (SP) = RECOMMENDED SPARE PARTS

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MODEL TYPE:

PNX

DESCRIPTION:

CYLINDER

DRAWING N°:

PNX-XXX-CYXXX-00-001-PL

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31-05-03

DRAWN.:

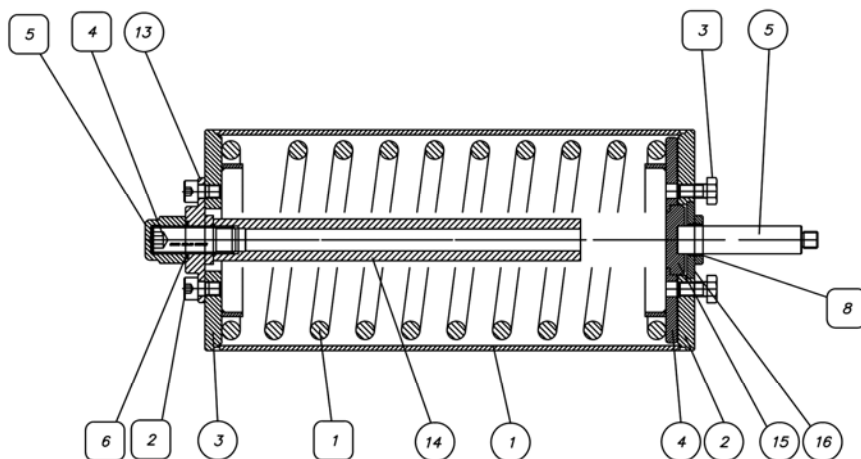
T. S.

CHECKED.:

E. Bettinardi



16.4 XXX-XXX-SRXXX-00-001-PL



00 MANUFACTURED PART

N°	PART NAME	MATERIAL
1	SPRING LINER	CARBON STEEL
2	SPRING HEAD FLANGE	CARBON STEEL
3	SPRING END FLANGE	CARBON STEEL
4	DISK	CARBON STEEL
5	PUSH BAR	ALLOY STEEL (*)
13	FLANGE	CARBON STEEL
14	STOP GRAIN	CARBON STEEL
15	DISK ADAPTOR	STAINLESS STEEL
16	FLANGE ADAPTOR	STAINLESS STEEL

Note: (\*) = CHROMIUM PLATED

00 COMMERCIAL PART

N°	PART NAME	MATERIAL
1	SPRING	SPRING STEEL
2	SCREW	COMMERCIAL
3	SCREW	COMMERCIAL
4	DOWEL	CARBON STEEL
5	CUP	CARBON STEEL
6	O-RING (SP)	NBR
7	SCREW	COMMERCIAL
8	DU-BEARING	Fe-Bz-TEFLON

Note: (SP) = RECOMMENDED SPARE PARTS

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PALADON WHICH RESERVES THE  
RIGHTS GUARANTEED BY LAW



MODEL TYPE:

CMY

DESCRIPTION:

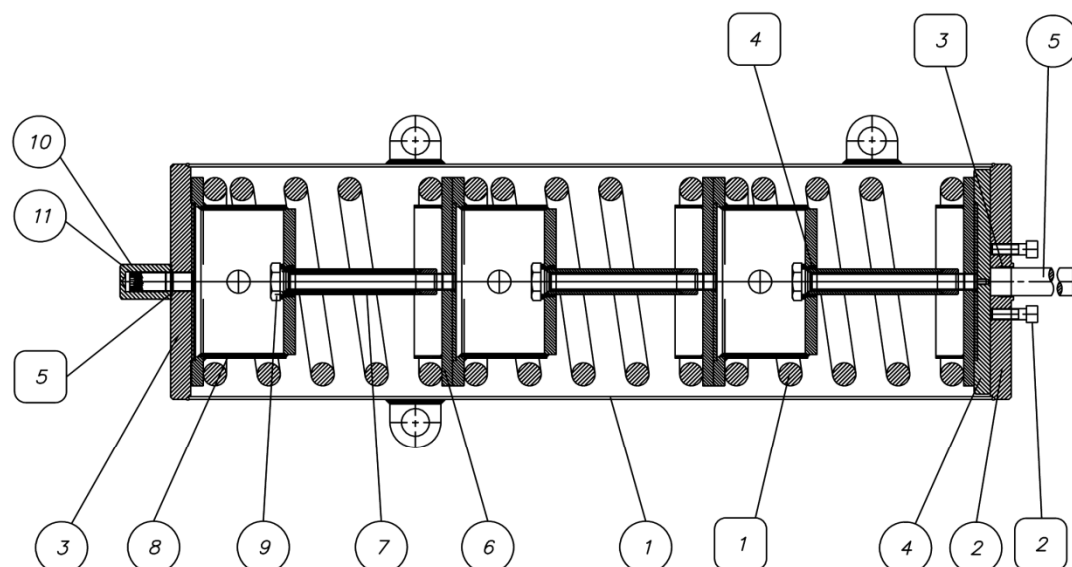
SPRING CAN N.1

DRAWING N°:

XXX-XXX-SRXXX-00-001-PL

REV.: —	DATE: —
SCALE: 1: 4	DATE: 1/9/2010
DRAWN.: RF	CHECKED.: E.Bettinardi

16.5 XXX-XXX-SRXXX-00-002-PL



00 MANUFACTURED PART

N°	PART NAME	MATERIAL
1	SPRING LINER	CARBON STEEL
2	SPRING HEAD FLANGE	CARBON STEEL
3	SPRING END FLANGE	CARBON STEEL
4	FLANGE	CARBON STEEL
5	PUSH BAR	ALLOY STEEL (*)
6	DISK	CARBON STEEL
7	CONNECTING ROD	CARBON STEEL
8	FLANGE	CARBON STEEL
9	BUSHING	BRONZE
10	CUP	CARBON STEEL
11	DOWEL	CARBON STEEL

Note: (\*) = CHROMIUM PLATED

00 COMMERCIAL PART

N°	PART NAME	MATERIAL
1	SPRING	SPRING STEEL
2	SCREW	COMMERCIAL
3	DU-BEARING	Fe-Bz-TEFLON
4	SCREW	COMMERCIAL
5	O-RING (SP)	NBR

Note: (SP) = RECOMMENDED SPARE PART

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MODEL TYPE:

PND-140

DESCRIPTION:

SPRING CAN (MULTIPLE SPRING)

DRAWING N°:

XXX-XXX-SRXXX-00-002-PL

REV.:

—

DATE:

—

SCALE:

1:12

DATE:

31-05-03

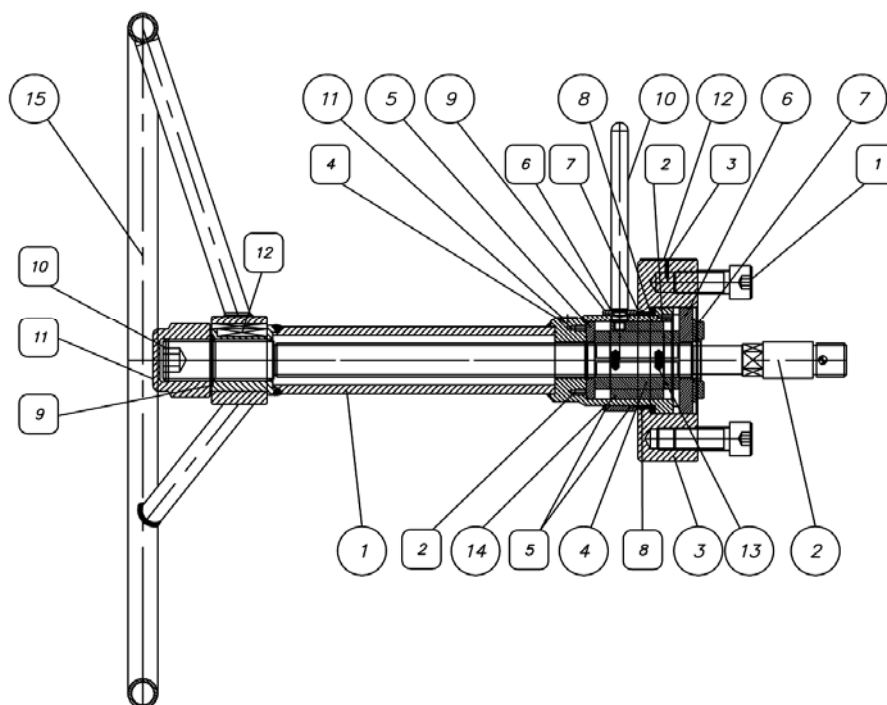
DRAWN.:

T. S.

CHECKED.:

E. Bettinardi

16.6 HYX-XXX-HDXXX-00-001-PL



00 MANUFACTURED PART

N°	PART NAME	MATERIAL
1	SLEEVE	CARBON STEEL
2	SCREW	CARBON STEEL
3	FLANGE	CARBON STEEL
4	SPLIT NUT	CARBON STEEL
5	FLANGE	CARBON STEEL
6	DISK	CARBON STEEL
7	BUSHING	BRONZE
8	BUSHING	BRONZE
9	RING	CARBON STEEL
10	HAND GRIP	CARBON STEEL
11	NAME PLATE	AISI303
12	NAME PLATE	AISI303
13	SPRING	CARBON STEEL
14	ECCENTRIC	AISI 420F
15	WHEEL	CARBON STEEL

Note: (\*) = CHROMIUM PLATED

00 COMMERCIAL PART

N°	PART NAME	MATERIAL
1	SOCKET HEAD SCREW	COMMERCIAL
2	PIN	COMMERCIAL
3	RIVET	COMMERCIAL
4	RIVET	COMMERCIAL
5	O-RING (SP)	NBR
6	O-RING (SP)	NBR
7	O-RING (SP)	NBR
8	O-RING (SP)	NBR
9	O-RING (SP)	NBR
10	STOP GRAIN	CARBON STEEL
11	STOP NUT	CARBON STEEL
12	KEY	COMMERCIAL

Note: (SP) = RECOMMENDED SPARE PARTS

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RIGHTS GUARANTEED BY LAW

MODEL TYPE:

HW-DA

DRAWING N°:

HYX-XXX-HDXXX-00-001-PL



DESCRIPTION:

MANUAL OVERRIDE

REV.: -

SCALE: 1:25

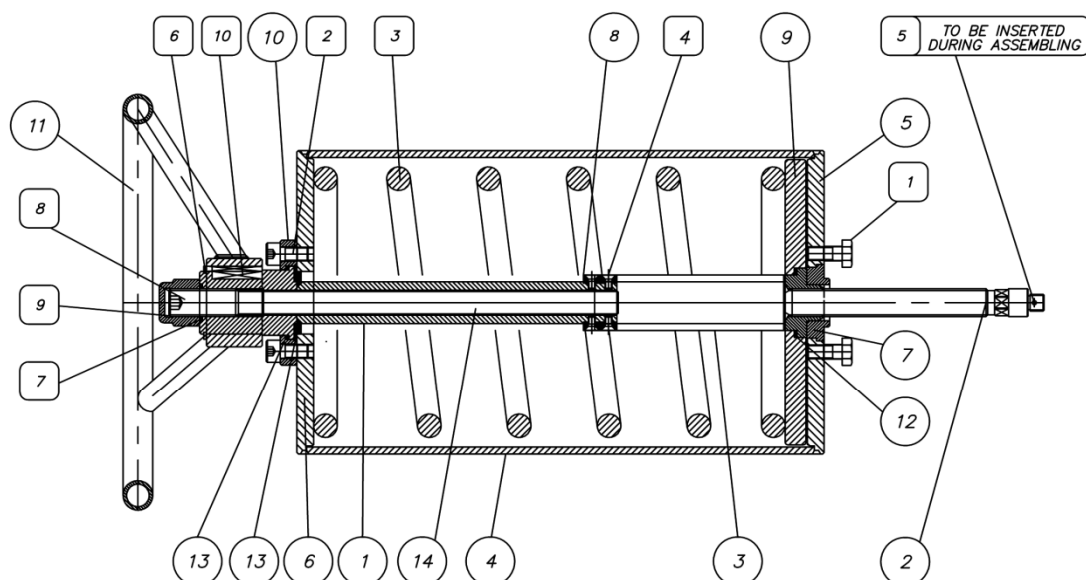
DRAWN.: F

DATE: -

DATE: 1/9/2010

CHECKED.: E. Bettinardi

16.7 XXX-XXX-SHXXX-00-001-PL



00 MANUFACTURED PART

N°	PART NAME	MATERIAL
1	BODY	CARBON STEEL
2	SCREW	CARBON STEEL
3	TUBE	CARBON STEEL
4	SPRING LINER	CARBON STEEL
5	SPRING HEAD FLANGE	CARBON STEEL
6	SPRING END FLANGE	CARBON STEEL
7	BUSHING	BRONZE
8	KEY	CARBON STEEL
9	DISK	CARBON STEEL
10	END FLANGE	CARBON STEEL
11	HANDWHEEL	CARBON STEEL
12	BUSHING	BRONZE
13	BUSHING	BRONZE
14	STOP PIN	CARBON STEEL

Note: (\*) = CHROMIUM PLATED

00 COMMERCIAL PART

N°	PART NAME	MATERIAL
1	SCREW	COMMERCIAL
2	SCREW	COMMERCIAL
3	SPRING	SPRING STEEL
4	SCREW	COMMERCIAL
5	ELASTIC PIN	COMMERCIAL
6	SEGER	COMMERCIAL
7	O-RING (SP)	NBR
8	STOP GRAIN	COMMERCIAL
9	NUT	COMMERCIAL
10	KEY	COMMERCIAL

Note: (SP) = RECOMMENDED SPARE PARTS

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MODEL TYPE:

CMY-JS

DESCRIPTION:

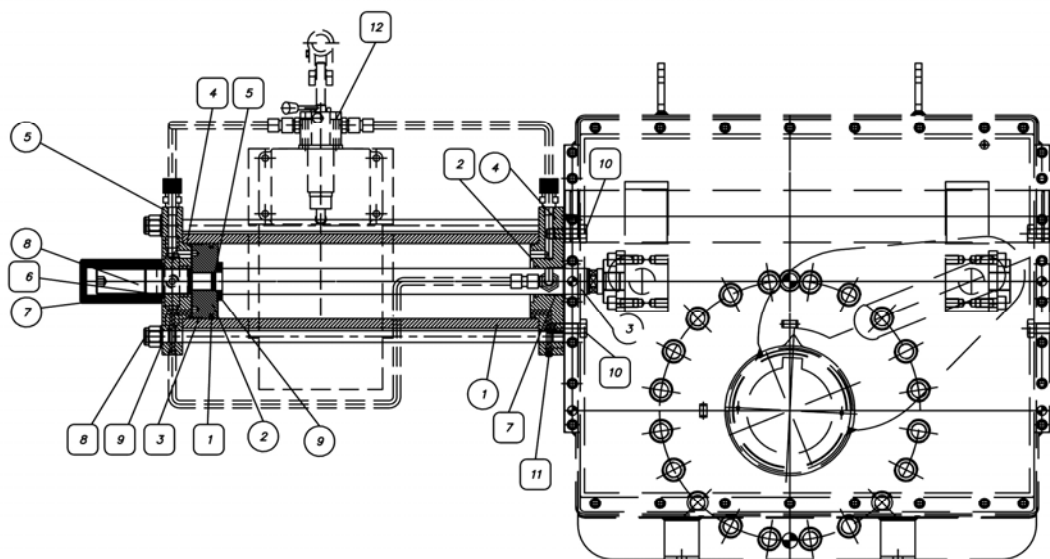
JACKSCREW SPRING CAN

DRAWING N°:

XXX-XXX-SHXXX-00-001-PL

REV.: —	DATE: —
SCALE: 1: 4	DATE: 1/9/2010
DRAWN.: RF	CHECKED.: E.Bettinardi

16.8 HYX-XXX-CYXXX-00-002-PL



00 MANUFACTURED PART

N°	PART NAME	MATERIAL
1	CYLINDER LINER	CARBON STEEL
2	PISTON	CARBON STEEL
3	PISTON ROD	ALLOY STEEL (*)
4	HEAD FLANGE	CARBON STEEL
5	BOTTOM FLANGE	CARBON STEEL
6	TIE ROD	CARBON STEEL
7	RETAINING NUT	CARBON STEEL
8	STOP SCREW	CARBON STEEL
9	PISTON ROD WASHER	CARBON STEEL

Note: (\*) = CHROMIUM PLATED

00 COMMERCIAL PART

N°	PART NAME	MATERIAL
1	SLIDING RING (PISTON) (SP)	COMMERCIAL
2	SLIDING RING (PISTON ROD) (SP)	COMMERCIAL
3	SCRAPER RING	TEFLON+15% GRAPHITE
4	O-RING (SP)	NBR
5	O-RING (SP)	NBR
6	O-RING (SP)	NBR
7	ROD GASKET	Fe-Bz-TEFLON
8	NUT	ALLOY STEEL
9	WASHER	COMMERCIAL
10	SCREW	COMMERCIAL
11	PLUG	CARBON STEEL
12	HAND PUMP UNIT	COMMERCIAL

Note: (SP) = RECOMMENDED SPARE PART

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MODEL TYPE:

PNx-DA-HP

DESCRIPTION:

HYDRAULIC CYLINDER (FOR DA-HP)  
ASSEMBLY DRAWING

DRAWING N°:

HYX-XXX-CYXXX-00-002-PL

REV.:

SCALE: 1:12

DRAWN: T. S.

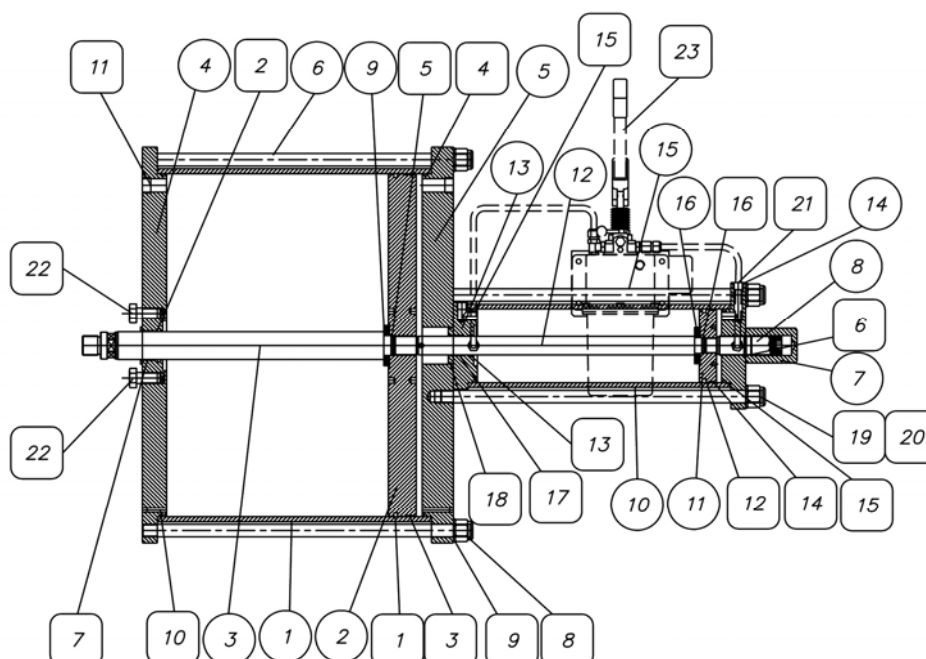
DATE:

DATE: 30-05-03

CHECKED:

E. Bettinardi

16.9 PNX-XXX-CYXXX-00-002-PL



00 MANUFACTURED PART


N°	PART NAME	MATERIAL
1	CYLINDER LINER	CARBON STEEL
2	PISTON	CARBON STEEL
3	PISTON ROD	ALLOY STEEL (*)
4	ROD HEAD FLANGE	CARBON STEEL
5	BLANK HEAD FLANGE	CARBON STEEL
6	TIE ROD	CARBON STEEL
7	CUP	CARBON STEEL
8	DOWEL	CARBON STEEL
9	WASHER	CARBON STEEL
10	CYLINDER LINER	CARBON STEEL
11	PISTON	CARBON STEEL
12	PISTON ROD	ALLOY STEEL (*)
13	ROD HEAD FLANGE	CARBON STEEL
14	BLANK HEAD FLANGE	CARBON STEEL
15	TIE ROD	CARBON STEEL
16	WASHER	CARBON STEEL

Note: (\*) = CHROMIUM PLATED

00 COMMERCIAL PART

N°	PART NAME	MATERIAL
1	GLIDER + O-RING (SP)	COMMERCIAL
2	GLIDER + O-RING (SP)	COMMERCIAL
3	GUIDE SLIDER	TEFLON+15% GRAPHITE
4	O-RING (SP)	NBR
5	O-RING (SP)	NBR
6	O-RING (SP)	NBR
7	DU-BEARING	Fe-Bz-TEFLON
8	HEX. NUT	ALLOY STEEL
9	WASHER	COMMERCIAL
10	PLUG	CARBON STEEL
11	PLUG	CARBON STEEL
12	GLIDER + O-RING (SP)	COMMERCIAL
13	GLIDER + O-RING (SP)	COMMERCIAL
14	GUIDE SLIDER	TEFLON+15% GRAPHITE
15	O-RING (SP)	NBR
16	O-RING (SP)	NBR
17	DU-BEARING	Fe-Bz-TEFLON
18	O-RING (SP)	NBR
19	HEX. NUT	ALLOY STEEL
20	WASHER	COMMERCIAL
21	PLUG	CARBON STEEL
22	SCREW	COMMERCIAL
23	HAND PUMP UNIT	COMMERCIAL

Note: (SP) = RECOMMENDED SPARE PART

<p>THIS DRAWING IS PROPERTY OF PALADON WHICH RESERVES THE RIGHTS GUARANTEED BY LAW</p> 	MODEL TYPE:	DRAWING N°:	
	PNX-SRC-HPHC	PNX-XXX-CYXXX-00-002-PL	
<p>DESCRIPTION:</p> <p>CYLINDER WITH HYDRAULIC OVERRIDE</p>	REV.:	DATE:	
	SCALE: 1:12	DATE: 30-05-03	
	DRAWN.: T. S.	CHECKED.: E. Bettinardi	



## 17. Spares Kit Ordering & Additional Service Support

When requesting service support or ordering spares kits, please provide the following contract details:

- Actuator Serial Number (6 or 7 digit number with a RFPL prefix)
- Paladon Contract Number (5 digit number with an ACCP, ACE, ACP, ACSP, CCP, CE, CGH, CP, CPC or CSP prefix)
- General Arrangement or Control Schematic Drawing Number
- Full Actuator Model Number(s) and Descriptions
- Tag Number(s)

Please see below to find your nearest Paladon Systems representative:

- **Paladon Systems Ltd**  
Ferro Fields, Brixworth, Northampton, NN6 9UA, England  
Tel: +44 (0)1604 880700 Fax: +44 (0)1604 882424  
[info@paladonsystems.com](mailto:info@paladonsystems.com)
- **Paladon Systems Ltd**  
Kings Point House, Unit 4, Kingshill Park,  
Venture Drive, Arnhill Business Park,  
Westhill, Aberdeen, AB32 6FL, Scotland  
Tel: +44 (0)1224 772442  
[info.scotland@paladonsystems.com](mailto:info.scotland@paladonsystems.com)
- **Paladon Italia**  
Via Barbieri, 24, 27040 Pinarolo Po, PV, Italy  
Tel: +39 0383 878524 Fax: +39 0383 878042  
[info.italia@paladonsystems.com](mailto:info.italia@paladonsystems.com)
- **Paladon Systems Sdn Bhd**  
No. 8 Jalan Serendah 26/39, Seksyen 26,  
40400 Shah Alam, Selangor Darul Ehsan, Malaysia  
Tel: +603 5614 3211 Fax: +603 5614 4511  
[info.asiapacific@paladonsystems.com](mailto:info.asiapacific@paladonsystems.com)
- **Paladon SDT**  
121352 Davydkovskaya Str. 12/3 ,  
Moscow, The Russian Federation  
Tel/Fax: +7 495 735 28 07 (08) (09)  
[info.russianfederation@paladonsystems.com](mailto:info.russianfederation@paladonsystems.com)
- **Paladon Americas**  
14514 Luthe Road, Houston, TX 77039, USA  
Tel: +1 855 725 2366 Fax: +1 832 310 2370  
[info.usa@paladonsystems.com](mailto:info.usa@paladonsystems.com)
- [www.paladonsystems.com](http://www.paladonsystems.com)

## 18. Functional Safety Data

Parameter name	Symbol	Equation / source	PNL / HYL Actuator	HY/DG actuator	PN actuator
Proof Test Interval	T1		8760	8760	8760
Type A/B	type A		type A	type A	type A
Total failures:	$\lambda$	From FMEA	2.14E-06	1.30E-06	8.48E-07
Safe diagnosed failures:	$\lambda_{SD}$	From FMEA	0.00E+00	0.00E+00	0.00E+00
Safe undiagnosed failures:	$\lambda_{SU}$	From FMEA	1.65E-06	8.26E-07	5.37E-07
Dangerous diagnosed failures:	$\lambda_{DD}$	From FMEA	0.00E+00	0.00E+00	0.00E+00
Dangerous undiagnosed failures:	$\lambda_{DU}$	or High demand mode, PFH per (hour)	4.95E-07	4.75E-07	3.11E-07
Safe Failure Fraction:	SFF	$(\lambda_{SD} + \lambda_{SU} + \lambda_{DD}) / \lambda$	76.92%	63.48%	63.29%
PFD <sub>AVG</sub> (using 61508-6 equation)	PFD <sub>AVG</sub>	$(\lambda_{DU} + \lambda_{DD}) t_{CE}$	2.17E-03	2.09E-03	1.37E-03
SIL capability (High demand mode)			SIL 2	SIL 2	SIL 2

Parameter name	Symbol	Equation / source	PNL / HYL Actuator	HY/DG actuator	PN actuator
Proof Test Interval	T1	Given, for this example	8760	8760	8760
Hardware Fault Tolerance	HFT		1	1	1
Type A/B	type A	Given, for this example	type A	type A	type A
Total failures:	$\lambda$	$\lambda_{SD 1002} + \lambda_{SU 1002} + \lambda_{DD 1002} + \lambda_{DU 1002}$	2.40E-07	1.38E-07	8.82E-08
Safe diagnosed failures:	$\lambda_{SD 1002}$	$2\lambda_{SD}^2 MTTR + \beta \lambda_{SD}$	0.00E+00	0.00E+00	0.00E+00
Safe undiagnosed failures:	$\lambda_{SU 1002}$	$\lambda_{SU}^2 T + \beta \lambda_{SU}$	1.89E-07	8.86E-08	5.62E-08
Dangerous diagnosed failures:	$\lambda_{DD 1002}$	$2\lambda_{DD}^2 MTTR + \beta \lambda_{DD}$	0.00E+00	0.00E+00	0.00E+00
Dangerous undiagnosed failures:	$\lambda_{DU 1002}$	$\lambda_{DU}^2 T + \beta \lambda_{DU}$	5.16E-08	4.95E-08	3.20E-08
Safe Failure Fraction:	SFF <sub>1002</sub>	$(\lambda_{SD 1002} + \lambda_{SU 1002} + \lambda_{DD 1002}) / \lambda_{1002}$	79%	64%	64%
PFD <sub>AVG</sub> (using simplified equation)	PFD <sub>AVG 1002</sub>	$\lambda_{DU 1002} (T / 2 + MTTR) + (\lambda_{DD 1002} * MTTR)$	2.26E-04	2.17E-04	1.40E-04
SIL capability (1002)			SIL 3	SIL 3	SIL 3

### 18.1 Operating limits and Conditions

The actuators must be operated within the pressure and temperature limits shown in the product test certificate and displayed on the actuator nameplate. DO NOT EXCEED THESE LIMITS.

The hardware fault tolerance is shown in the above table – HFT=0 is SIL2 capable, HFT=1 is SIL3 capable.

The Proof Test Interval is shown in the table above. Proof test can be carried out by full or partial stroking of the actuator.



### 18.2 Normal Operating condition:

Under no fault (normal) conditions the PN, HY and DG scotch yoke actuators behave as follows:

- a) Correct pressure is supplied the pneumatic/hydraulic module; this forces the piston rod to move linearly; operating the yoke assembly. The scotch yoke assembly will then continue the movement of the piston rod which will compress the spring module. In this position the valve under actuation will be open and the indicator will correctly show the position.
- b) When the actuated valve needs to be closed, the actuator must move to the 'end' position. The pressure input in the pneumatic/ hydraulic module will decrease, allowing the spring to fully expand, turning the yoke assembly and putting the piston to the end position. In this position the valve under actuation is fully closed and the indicator will correctly show the position.

### 18. 3 Maintenance Requirement

The actuators are to be periodically inspected and maintained fully in accordance with Section 11 of this manual.