Minerva
METROLOGY AND CALIBRATION

Ensuring carefree traceability

MNR-800-HPC400

400 MPa hydraulic pressure controller

CA20200523

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M O D I F I C A T I O N				
Revision	**Date**	**Modification**	**Pages**	**Original Instructions (language)**
0.1	2020-05-22	initial document	--	English

author	**approved by**	
C.G.M. Adolfse technical director Date: 2020-05-22	H. de Lange general manager Date: 2020-05-22	

About this manual

This manual provides information on specific features and procedures that one needs to be aware of for installing and operating the MNR-800-HPC400 (HPC) successfully.

Throughout the manual, the following icons are used :

Warning icon is used in throughout the manual to identify user warnings and cautions.

Note icon is used throughout the manual to identify advice and suggestions.

High pressure liquids and gases are potentially hazardous. Energy stored in these liquids and gases can be released unexpectedly and with extreme force. High pressure systems should be assembled and operated only by personnel who have been instructed in proper safety practices.

This device is not to be operated in any other manner than that specified by the manufacturer.

The device is intended to be used by educated personnel only who are familiar with high pressure and understand the risks involved in working with it.

 Always use safety glasses when working on the MNR-800-HPC400

This manual was originally composed in English.

1. Introduction

The MNR-800-HPC400 high pressure controller (from here forward abbreviated as HPC) is a hydraulic pressure controller intended to generate and precisely control pressure in an attached volume as needed to calibrate and test pressure measuring instruments in a wide variety of applications.

The HPC uses innovative, patented pressure generation and control technology, developed and proven over several years in intensive operation with a major transducer manufacturer.

This versatile technology sets large and small pressure increments very quickly and precisely into varying test volumes over a very wide pressure range. The simple and very robust design provides exceptional reliability, allowing years of uninterrupted operation in most applications.

HPC can be controlled by a local operator using the touch screen front panel or remotely from a computer or control system using its USB or ethernet interface.

High pressure intensifier

The heart of the HPC pressure control system is a high pressure piston-ratio intensifier. The intensifier smoothly and reliably multiplies differential pressure from a powerpack by 20, delivering high pressure to the system under test. Should the intensifier run out of stroke, it is recharged automatically, transparently to the operator and without significantly disturbing the test pressure.

Interchangeable pressure modules

Reference pressure modules that measure the test pressure generated by the HPC are installed and interchanged in minutes. This allows optimization of the pressure measurement range to the device under test range. The modules are compact, stand-alone, plug and play devices that can be calibrated independently of the HPC so the HPC does not need to be taken out of operation or moved for recalibration.

Integrated oil filling and gas purging system

A common problem in the use of hydraulic pressure controllers is failure to fill the system under test with oil and purge trapped air before starting the test. This leads to unpredictable pressure control, pressure target overshoot and premature wear of active hydraulic components. To address this problem, the HPC includes built-in capability to easily and quickly fill and purge the test system. The purge system uses venturi technology to pull a vacuum without moving parts. The operator runs a simple HPC on-board routine at the start of a test to assure a solid, air free test system and excellent pressure control. In most situations, the on-board system eliminates the need for a secondary test fill set up system and procedure.

Local user interface

The HPC includes a color, touchscreen display mounted at a convenient angle for local operator interaction. The user interface provides continuous display of HPC measured pressure and operating status as well as controls and menus for use by a local operator. Operation is straightforward and intuitive. The display can be locked out by remote command to avoid accidental interference.

Automating tests with HPC

HPC has remote communication capability over a USB and Internet interface. SCPI protocol commands are used to control and read from the HPC. Commands are thoroughly documented in the HPC manual. The HPC remote commands can be used in user developed software to automate calibration and testing functions.

Ergonomic enclosure

The HPC enclosure is designed to minimize the HPC footprint, shield operators from high pressure components and provide easy access for servicing or repairs. The user display and controls are presented on an angled front panel. The oil reservoir level can be checked and the reservoir refilled conveniently at the front of the unit. Lockable wheels are fitted so it is easy to move the HPC around without lifting it. The “hood” can be lifted, providing easy access to all internal components.

2. Putting together an HPC system

To put together your HPC system :

- **Select an HPC pressure controller**
  At this time there is only one model, MNR-800-HPC400.
  MNR-800-HPC400 will operate up to 400 MPa, but also handles ranges as low as 70 MPa.

- **Select an HPP powerpack.**
  For 230 V, 50 Hz, use MNR-800-HPP25-230-50.
  For 200 V, use MNR-800-HPP25-200-50 for 50 Hz or the MNR-800-HPP25-200-60 for 60 Hz
  For 110 V, 60 Hz, use MNR-800-HPP25-110-60.

- **Select a powerpack interconnection kit.**
  This kit makes the hydraulic and electrical connections between the HPC controller and the HPP powerpack. The length of the interconnection kit determines the maximum distance between the HPC pressure controller and the HPP powerpack when they are installed.

  For 2 meters, use MNR-800-HPP25-2
  For 4 meters, use MNR-800-HPP25-4
  For 6 meters, use MNR-800-HPP25-6

- **Select one or more HPM pressure modules.**
  Select as needed to support the ranges and uncertainties desired. See 4.4.2 HPM / HPB series pressure module ranges for details.

HPC system components standard delivery		
MNR-800-HPC400 pressure controller	**MRN-800-HPP-25 powerpack**	**MNR-800-HPM pressure module**
The **HPC pressure controller** and : ➢ dial padlock to lock enclosure hood ➢ Spare filter element ➢ Seal kit ➢ Funnel for reservoir filling ➢ 4 x gland and collar, AE250C, HIP HF4 ➢ 2 x gland blind plug, AE250C, HIP HF4 (installed on ports) ➢ 5 l Sebacate hydraulic fluid ➢ Ethernet cable 5 m ➢ USB cable 3 m ➢ RS232 cable including 24 V power supply ➢ General accessories USB stick with manual and test report	The **HPP powerpack** and : ➢ Power cable, 3 m, 2 wire + ground 4 mm^2, one end permanently connected onto HPP control box, other end pigtail ➢ Funnel for reservoir filling ➢ 2 x 20 l can of Castrol hyspin AWS hydraulic fluid, 32ISO	The **HPM pressure module** and : ➢ RS232 cable including 24 V power supply ➢ Short nipple with AE250C, HIP HF4 plastic cap installed ➢ ISO/IEC accredited calibration report

3. Component description and nomenclature

HPC pressure controller	Function	Nomenclature
Main controller 400 MPa	Control pressure up to 400 MPa	MNR-800-HPC400
HPM pressure module	**Function**	**Nomenclature**
Premium class	Measures system pressure	MNR-800-HPMxxxP
Standard class		MNR-800-HPMxxxS
Barometer	Measures barometric pressure	MNR-800-HPB
HPP power pack	**Function**	**Nomenclature**
25 MPa power pack 230 V	Hydraulic supply for HPC	MNR-800-HPP25-230-50
25 MPa power pack 200 V	Hydraulic supply for HPC	MNR-800-HPP25-200-50
		MNR-800-HPP25-200-60
25 MPa power pack 110 V	Hydraulic supply for HPC	MNR-800-HPP25-110-60
HPP interconnection	**Function**	**Nomenclature**
2 meter kit	Connect powerpack to HPC (hydraulic and electrical)	MNR-800-HPP25-2
4 meter kit		MNR-800-HPP25-4
6 meter kit		MNR-800-HPP25-6
Accessories	**Function**	**Nomenclature**
Sebacate 5 litre	Calibration medium	MNR-75-OIL-PRIO-5L
Castrol hyspin 20 litre	Extra oil for powerpack	MNR-75-OIL-HYSPIN-20L
High pressure external filter	To protect HPC against contamination	MNR-800-HPC-HPFLT

3.1 Spare parts

Spare parts	Function	Part Number
N.O. high pressure valve	Isolation or VENT valve	773287
400 MPa intensifier	Transforms 20 MPa to 400 MPa	3151
LP filter HPC	For low pressure (powerpack circuit)	750181
LP filter HPP	Return filter built-in HPP	773299
Electropneumatic manifold	To drive HPC hydro pneumatic valves	773290
Pneumatic pressure regulator	Regulates compressed air supply	773293
Servo valve	Control LP hydraulic pressure	773296

Spare parts	Function	Part Number
Low pressure seal kit	**Seals low pressure side intensifier**	**7318**
<<contains>>		

Part	Part Number	Qty
Low pressure piston stepseal 59.3x70x4.2	702658	1
Low pressure piston slydring 70x9.7x2.5	702661	2
High pressure piston bearing o-ring NBR 70 Shore 45.69x2.62	702664	2
High pressure piston bearing stepseal 15x22.3x3.2	702667	1
Linear pot adapter o-ring NBR 70 Shore 10.77x2.62	702670	1
Internal clamp plate o-ring NBR 70 Shore 64.77x2.62	702673	1
LP end cap o-ring NBR 70 Shore 63.09x3.53	702676	1
LP end cap anti extrusion ring cut 68.4x63x1.4	702679	1
Displacement transducer stepseal 6.3x11.2x2.2	702682	2

Spare parts	Function	Part Number
High pressure seal kit	**Seals hig pressure side intensifier**	**7321**
<<contains>>		

Part	Part Number	Qty
High pressure seal assembly mitre ring, seal and seal insert	702685	1
High pressure seal shim rings	712258	2

4. Specifications

4.1 HPC general specifications

Power requirements	HPC	24 V DC / 60 Watt	
Drive air		500 .. 1000 kPa / 300 l/m clean and dry (70 .. 150 psi / 11 cf/m)	
	Pressure connection	1/4” NPT F	
Operating temperature		10 .. 30 °C (50 .. 90 °F)	
Weight	HPC	150	kg
Dimensions lxbxh	HPC	900 x 550 x 690	mm
Communication	HPC	USB (RS232 simulated) Ethernet	
Operating mode		Gauge / absolute	
Pressure range (internal control sensor)		0 .. 58 kpsi / 0 .. 400 MPa	
Operating media		Sebacate / Priolube 1856 (consult factory about alternate media)	
Pressure connection	HPC test port	AE F250C, HIP HF4	
	Barometer	1/8” NPT F	
HPC intensifier	Displacement	22	cm^3
	Stroke	15	cm
Reservoir		750	cc
CE declaration		On file	

4.1.1 HPC control specifications

HPC control specifications			
Control modes	Standard (STD) or high speed (HS)		
Control precision	Up to	± 0.0025	% of HPC span
Default control hold limit		± 0.01	% of active HPM span
Lowest controllable pressure	0.1		MPa g
Typical control ready time	60		Seconds[1]
Slew rate (0 .. F.S.)	10		Seconds
Test volume	0 .. 300		cm^3 (inquire with factory about larger volumes)

1 Independent of pressure step size, with hold limit of 0.01 % F.S..

4.2 HPP powerpack

Power requirements	230V 50 Hz / 110V 60 Hz 2.2 kW	
	(other voltages on request)	
Operating temperature	10 .. 30 °C	
Weight	80	kg
Dimensions (l x b x h)	800 x 340 x 900	mm
Control	Through HPC (24 V)	
Operating mode	Off / low (5 MPa) / high (21 MPa)	
Operating media	Castrol hyspin AWS hydraulic fluid,32ISO	
Pressure connection	Hydraulic quick connector with internal valve	
Oil reservoir	50	litre
Alarm function	Switch for indication low level oil	
CE declaration	On file	

4.3 HPP interconnection hardware / flex tube

Inner tube	Seamless, oil resistant synthetic rubber
Inner diameter	¼ inch
Inlay reinforcement	2 layers steel woven
Outer tube	Black synthetic wear and chemical resistant rubber
Working pressure	40MPa (6000 psi)
Burst pressure	160MPa (23000 psi)

Electrical connection cable with plugs	Between MNR-800-HPP25 and MNR-800-HPC400

4.4 HPM / HPB general specifications

Power requirements		24 V DC / 1 W	
Operating temperature		10 .. 30 °C	
Weight		1.2	kg
Dimensions		240 x 70 x 70	mm
Communication		RS232 dedicated protocol	
Operating modes		Gauge / absolute	
Pressure range		see 4.4.2 HPM / HPB series pressure module ranges	
Operating media		Sebacate, other liquids possible	
Pressure connection		AE F250C, HIP HF4	
CE declaration		On file	

4.4.1 HPM / HPB metrological specifications

MNR-800-HPM general			
Warm up time	30 minute temperature stabilization recommended from cold power up		
Resolution	To 1 ppm		
Calibration	ISO/IEC 17025 accredited certificate included		
MNR-800-HPM premium			
Ranges	70, 140, 200	280	MPa g^2
Precision	± 0.008	± 0.01	% F.S.
Predicted one year stability	± 0.005	± 0.006	% F.S.
Measurement uncertainty	± 0.01	± 0.02	% F.S.
MNR-800-HPM standard			
Ranges	70, 140, 200	280, 400	MPa g^2
Precision	± 0.015	± 0.030	% F.S.
Predicted one year stability	± 0.025	± 0.040	% F.S.
Measurement uncertainty	± 0.050	± 0.080	% F.S.
MNR-800-HPB			
Range	75 .. 125		kPa a
Precision	± 0.035		% F.S.
Predicted one year stability	± 0.025		% F.S.
Measurement uncertainty	± 0.075		% F.S.

2 Gauge or absolute operation in HPC.

4.4.2 HPM / HPB series pressure module ranges

Pressure module	Range[3]			
MNR-800-HPM70P	0 .. 70	MPa g	0 .. 10 000	psi g
MNR-800-HPM140P	0 .. 140	MPa g	0 .. 20 000	psi g
MNR-800-HPM-200P	0 .. 200	MPa g	0 .. 29 000	psi g
MNR-800-HPM280P	0 .. 280	MPa g	0 .. 40 000	psi g
MNR-800-HPM70S	0 .. 70	MPa g	0 .. 10 000	psi g
MNR-800-HPM140S	0 .. 140	MPa g	0 .. 20 000	psi g
MNR-800-HPM200S	0 .. 200	MPa g	0 .. 29 000	psi g
MNR-800-HPM280S	0 .. 280	MPa g	0 .. 40 000	psi g
MNR-800-HPM400S	0 .. 400	MPa g	0 .. 58 000	psi g
MNR-800-HPB	75 .. 125	kPa a	10 .. 18	psi a

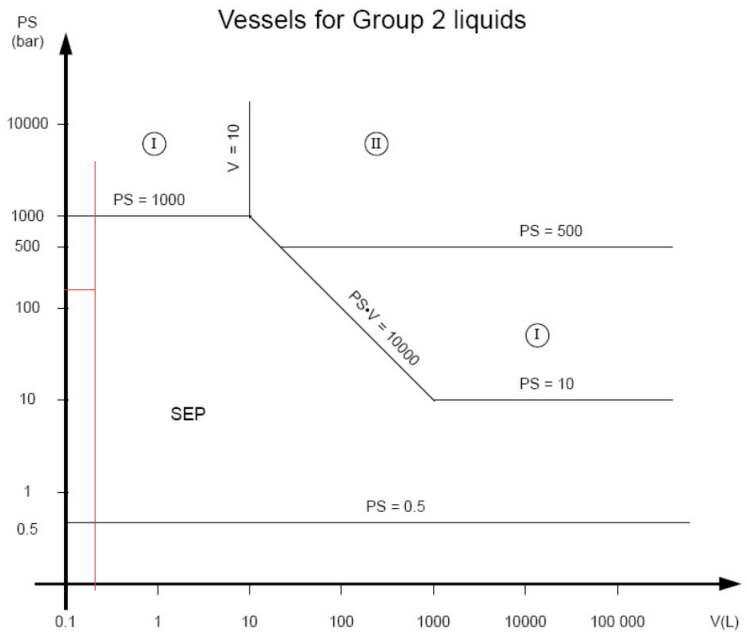
3 Gauge or absolute when in HPC.

5. CE Pressure Equipment Directive (2014/68/EU)

The MNR-800-HPC pressure controller is an assembly of high pressure components. Assemblies are defined as several pieces of pressure equipment assembled by one manufacturer to constitute an integrated and functional whole.

The MNR-800-HPC uses a non hazardous liquid (Sebacate or Priolube 1856) where the product of pressure times volume results in a category 1 classification.

Minerva meettechniek B.V. has all technical documentation and internal production control on file and thus complies to the CE Pressure Equipment Directive (2014/68/EU)

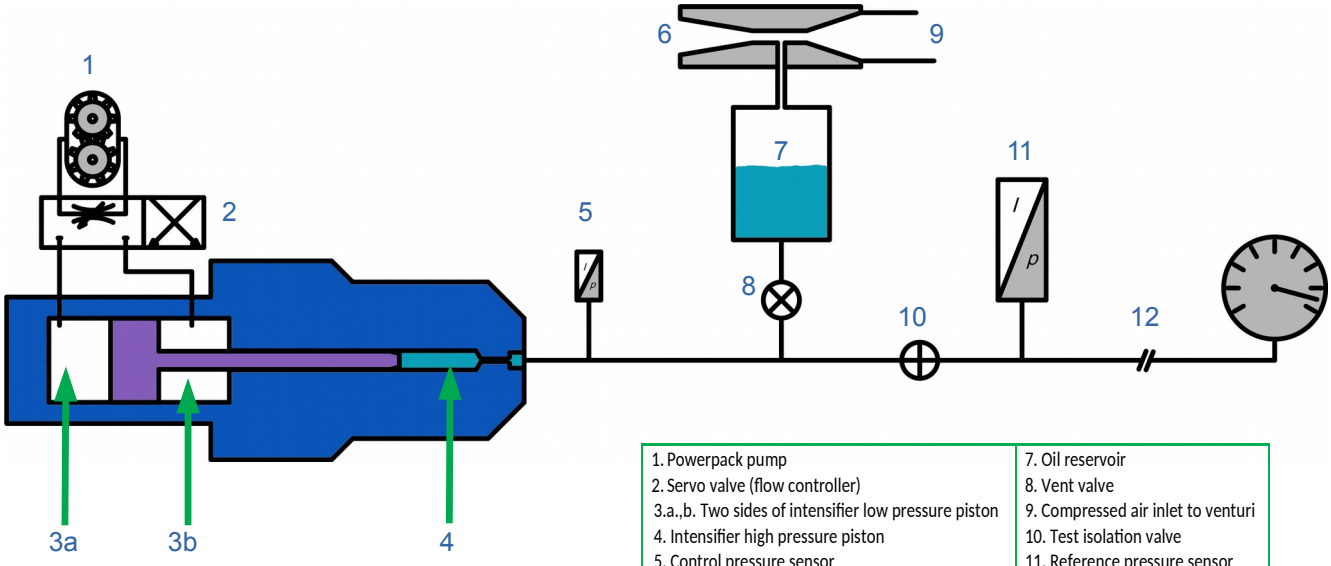


6. System description

6.1 HPC Operating principle

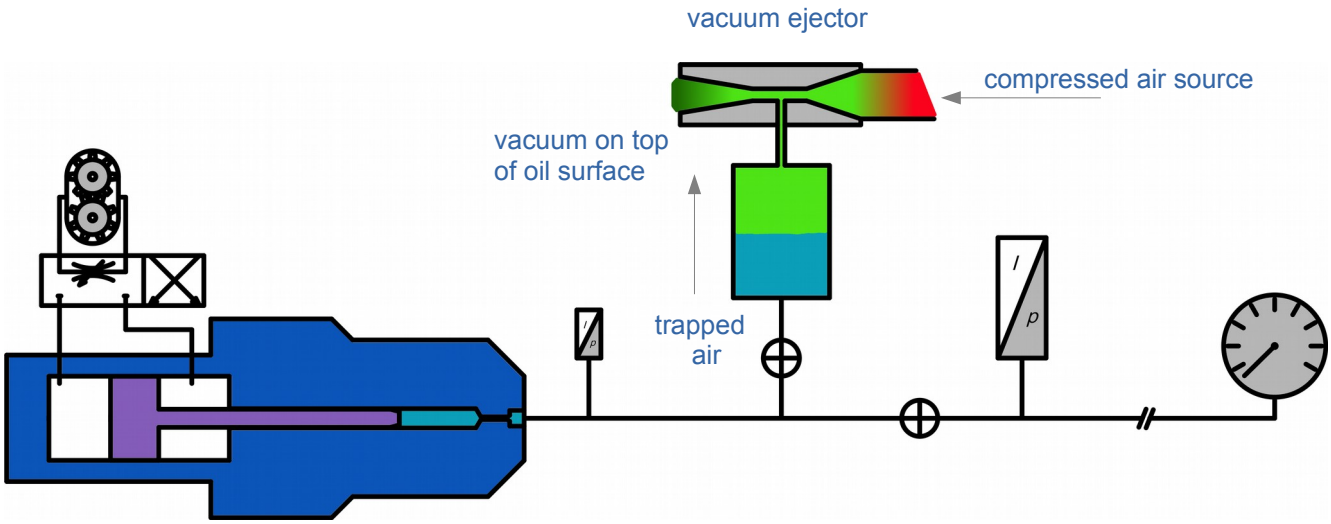
Low pressure (21 MPa) is generated by the powerpack (1). This low pressure from the powerpack goes through a servo valve (2) and back to the powerpack. Two sides of the servo valve are connected to two sides of the intensifier's low pressure piston (3a, 3b). By adjusting the flow through the servo valve (2) the differential pressure across low pressure piston (3a, 3b) is controlled. The intensifier's piston assembly will move to maintain equilibrium between the force on the low pressure piston (3a, 3b) and the force on the high pressure piston (4). As intensifier has a ratio of 20:1, the system is in equilibrium when the high pressure (4) is 20x the low pressure which is equal to differential pressure across (3a) and (3b). The high pressure is generated and controlled by changes in the differential pressure across the low piston. A patented fast control loop steers the servo control valve (2) to control the differential pressure across (3a) and (3b) to obtain the desired pressure value as measured by the control sensor (5). The servo valve is fast and precise and the piston assembly moves with very low friction, resulting in very fast and precise, control of the high pressure.

If the piston runs out of stroke during a test, the controller automatically resets the piston position. Test isolation valve (10) closes to maintain the set pressure in the system (12). The servo valve (2) moves the piston assembly to lower the pressure. Vent valve (8) is opened to the reservoir (7). The servo valve (2) moves the piston to the desired position. Vent valve (8) is closed. The servo valve (2) is used to generate pressure as read by control sensor (5) back to the level of pressure in the system under test as read by the reference sensor (11). Once the two pressures (5, 11) are equal, isolation valve (10) is opened and the test continues. The piston resetting routine is typically only used in unusual situations such as large test volumes, trapped air, or if there is a small leak that must be compensated for by the intensifier piston assembly.



1. Powerpack pump	7. Oil reservoir
2. Servo valve (flow controller)	8. Vent valve
3.a.,b. Two sides of intensifier low pressure piston	9. Compressed air inlet to venturi
4. Intensifier high pressure piston	10. Test isolation valve
5. Control pressure sensor	11. Reference pressure sensor
6. Venturi vacuum ejector	12. Test port

6.2 Vacuum purge system



The vacuum air purging process is supported by an on-board routine accessed through the front panel user interface and can be controlled by remote commands. A device or system under test is connected to and, preferably, has been filled with oil using the oil fill function. When the air purging process is launched, the vent valve and isolation valve are opened. Then a pneumatic valve is opened to allow compressed air to flow through the vacuum ejector. The flow through the ejector causes a vacuum to be applied to the top of the reservoir. The vacuum pulls air from the device or system under test. After a fixed user adjustable time (recommended is one minute), the compressed air valve is closed and the purging process is complete. See section 9.4.4 UTILITIES for purge settings.

7. Pressure control

The HPC has two pressure control modes to cover a wide variety of applications.

Standard pressure control (**STD control**) is intended for applications where setting a pressure as close as possible to the target and with the best stability of the final (ready) pressure is most important and the time taken setting pressures is less important.

High speed control (**HS control**) is intended for applications where minimizing the time taken to set pressures is important and a small deviation between the final (ready) pressure and the setpoint and a slightly less stable final pressure is acceptable.

Both control modes use the same Ready / Not ready criteria as described in section 7.4 Ready / Not ready criteria, but differ in the way they execute a pressure control request.

The HPC measures pressures with both an internal control sensor and a calibrated HPM. The control sensor is aligned with the HPM as described in section 10.9 Control sensor alignment but a small difference between the two will always remain.

Example chart showing typical disagreement between the control sensor and a HPM after alignment.

The HPC pressure control loop uses the control sensor as input to control pressure. In STD control mode the disagreement between the control sensor and the HPM is taken into account and adjusted for in the final stage of pressure control to set the pressure to exactly the nominal setpoint value as read by the HPM using coarse then fine control stages.

In HS control mode the disagreement between the two pressure measurements is not taken into account. The HPC controls to the nominal setpoint as read by the control sensor. skipping the fine control routine to adjust to the set point as read by the HPM. Skipping the fine control routine saves time, but leaves the pressure at the setpoint as read by the internal sensor which may disagree slight with the HPM.

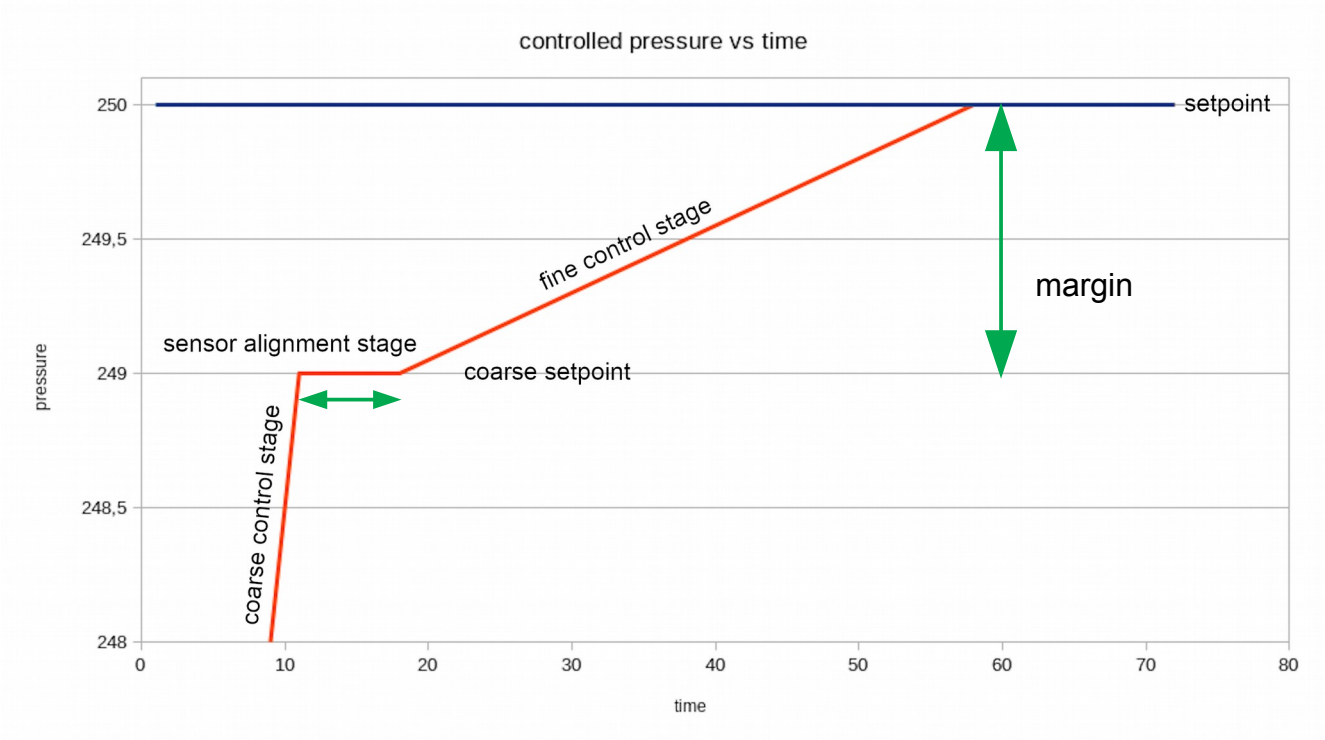
The ultimate uncertainty in the pressure value read from the HPC is the same and as good as possible in both STD control and HS control because the HPM is always the source of that reading.

7.1 Standard pressure control

HPC pressure control in response to a set pressure command in STD control mode consists of three user adjustable stages : 1. Coarse, 2. Sensor alignment stability, 3. Fine control until the pressure is inside the hold limit and meets the stability criterion as described in section 7.4 Ready / Not ready criteria.

This section is intended to give a global description of the HPC STD control logic. See sections 7.1.1 Coarse control stage, 7.1.2 Sensor alignment stability stage and 7.1.3 Fine control stage for details on the three control stages.

Details on adjustable control parameters can be found in section 9.4.2 CONTROL.



Standard (STD) pressure control stages

7.1.1 Coarse control stage

During the coarse control stage, the HPC controls to a point (coarse setpoint) near the entered target taking into account an adjustable margin. During this stage the HPC control loop uses the internal pressure control sensor because it can read it very quickly as needed when controlling pressure that is changing at a rapid rate.

- When controlling from a lower pressure the coarse setpoint is equal to the entered setpoint minus the margin.
- When controlling from a higher pressure the coarse setpoint is equal to the entered setpoint plus the margin.

The **margin** parameter (see section 9.4.2 CONTROL) takes into account the possible misalignment between the pressure control sensor and the HPM to avoid overshoot. See section 10.9 Control sensor alignment for optimizing the alignment between the control sensor and the HPM.

The coarse pressure control stage speed is adjustable via the **slew time** parameter (see section 9.4.2 CONTROL).

Slew time	Result	Remark
Shorter slew time	Reaches coarse setpoint faster.	Higher risk of overshooting, longer sensor alignment stability stage.
Longer slew time	Reaches coarse setpoint more slowly.	Lower risk of overshooting, shorter sensor alignment stability stage.

Standard (STD) pressure control coarse control stage

7.1.2 Sensor alignment stability stage

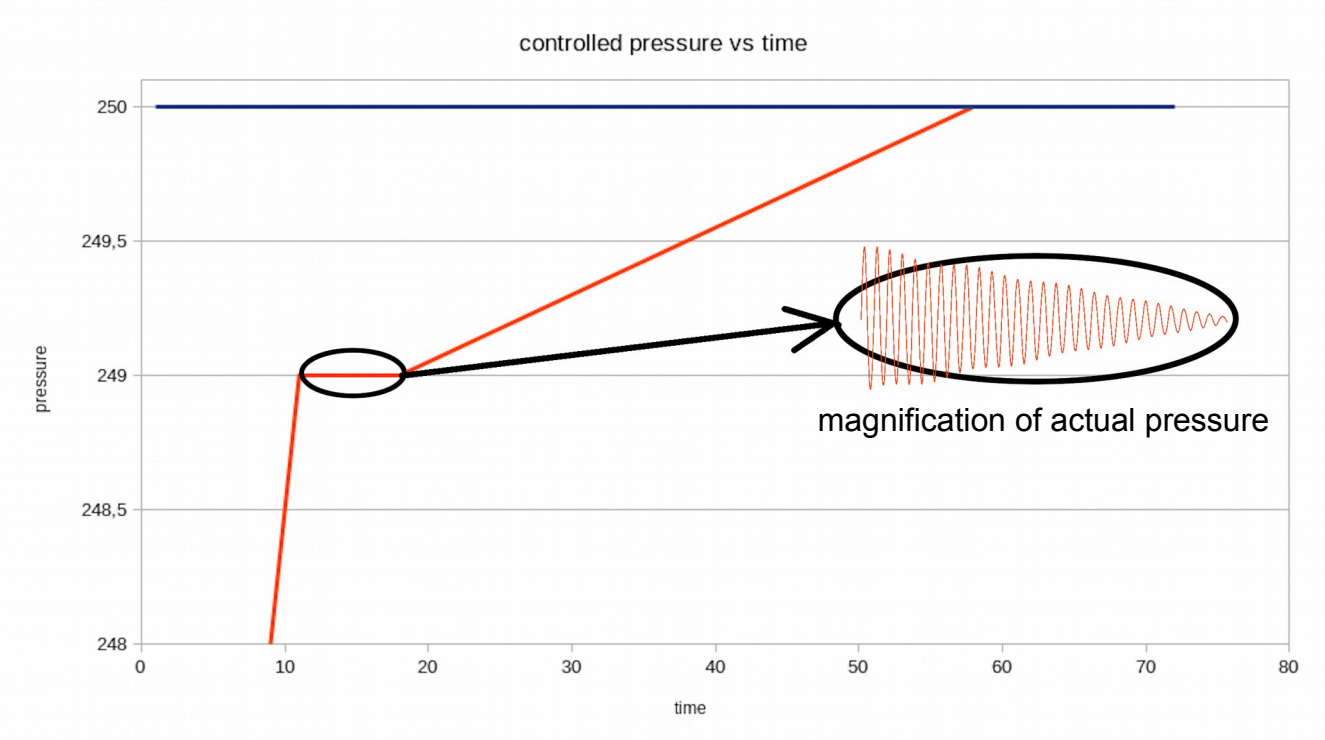
When the HPC has reached the coarse setpoint, it continues to control pressure dynamically to keep the pressure as close as possible to the coarse setpoint. Changing the pressure in a test system causes adiabatic temperature changes, heating when increasing pressure, cooling when decreasing pressure. After a pressure change, the adiabatic heating or cooling dissipates, causing the pressure to change if the pressure is not controlled.

During the sensor alignment stage the HPC controls pressure dynamically to keep it at the coarse setpoint, compensating for the temperature change to maintain the pressure constant.

As the adiabatic pressure effect dissipates over time, stability of the pressure controlled by the HPC improves.

When the actual pressure stability meets the **sensor alignment stability** criterion, the HPC enters its fine control stage to control the pressure to the final target as read by the HPM. The sensor alignment stability parameter is adjustable, see section 9.4.2 CONTROL.

Sensor alignment stability	Result	Remark
Smaller sensor alignment stability	Longer sensor alignment stability stage.	Lower risk of overshooting the target setpoiny.
Larger sensor alignment stability	Shorter sensor alignment stability stage.	Higher risk of overshooting the target setpoint.



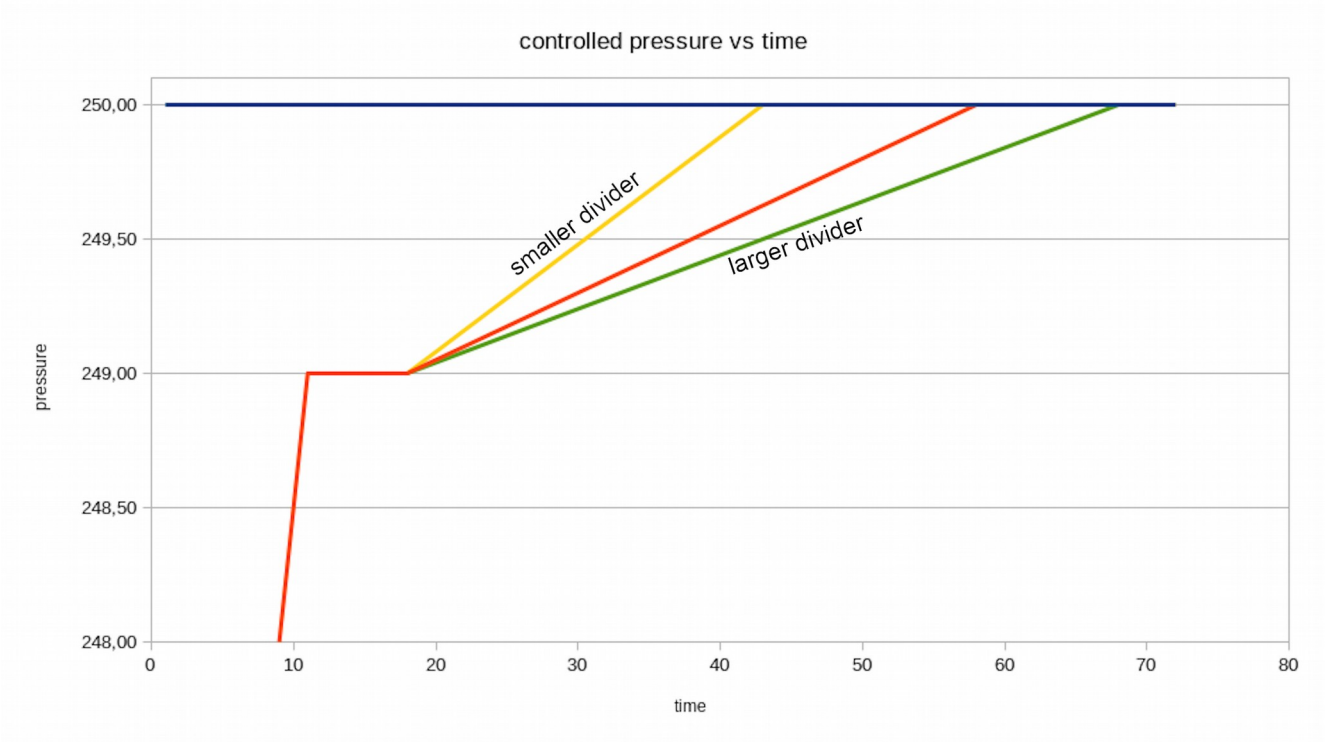
Standard (STD) pressure control sensor alignment stability stage

n.b. The actual pressure magnification is not showing real pressure behavour.

7.1.3 Fine control stage

During the fine control stage the HPC checks the actual pressure measured by the HPM against the entered setpoint and adjusts the control loop to compensate for the difference.
The difference is divided by a user adjustable parameter called **divider** to change the fine control speed, see section 9.4.2 CONTROL.

Divider	Result	Remark
Smaller divider	Reaches setpoint faster.	Higher risk of overshooting, potential lower ultimate pressure stability.
Larger divider	Reaches setpoint slower.	Lower risk of overshooting, potential higher ultimate pressure stability.



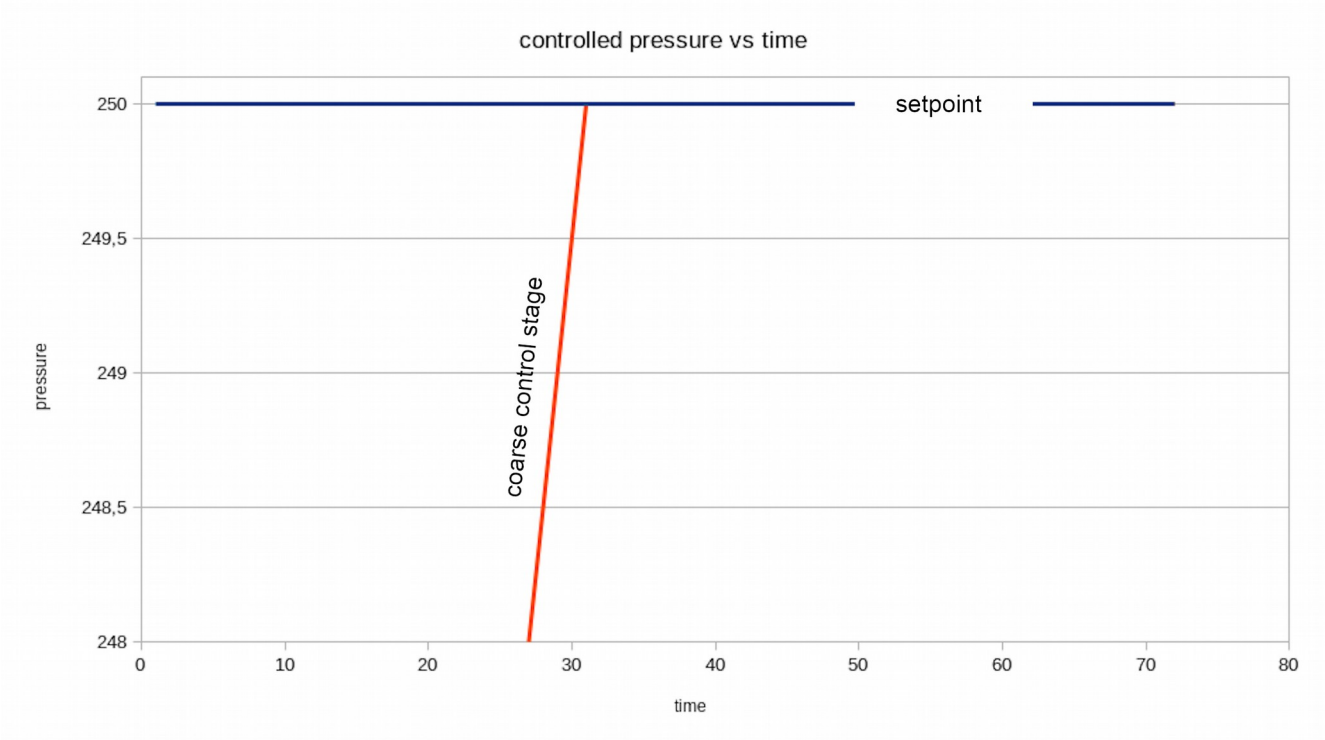
Standard (STD) pressure control fine control stage

The HPC continues to operate in the fine control stage and maintains the pressure as close as possible to the setpoint, keeps it inside the hold limit and meets the stability criterion until pressure control is interrupted by a new set point command, a vent command or going into measure mode.

7.2 High speed pressure control

HPC pressure control in response to a set pressure command in HS control mode consists of one user adjustable stage; coarse control until the pressure is inside the hold limit and meets the stability criterion as described in section 7.4 Ready / Not ready criteria.

This section is intended to give a global description of the HPC HS control logic. Details on adjustable control parameters can be found in section 9.4.2 CONTROL.



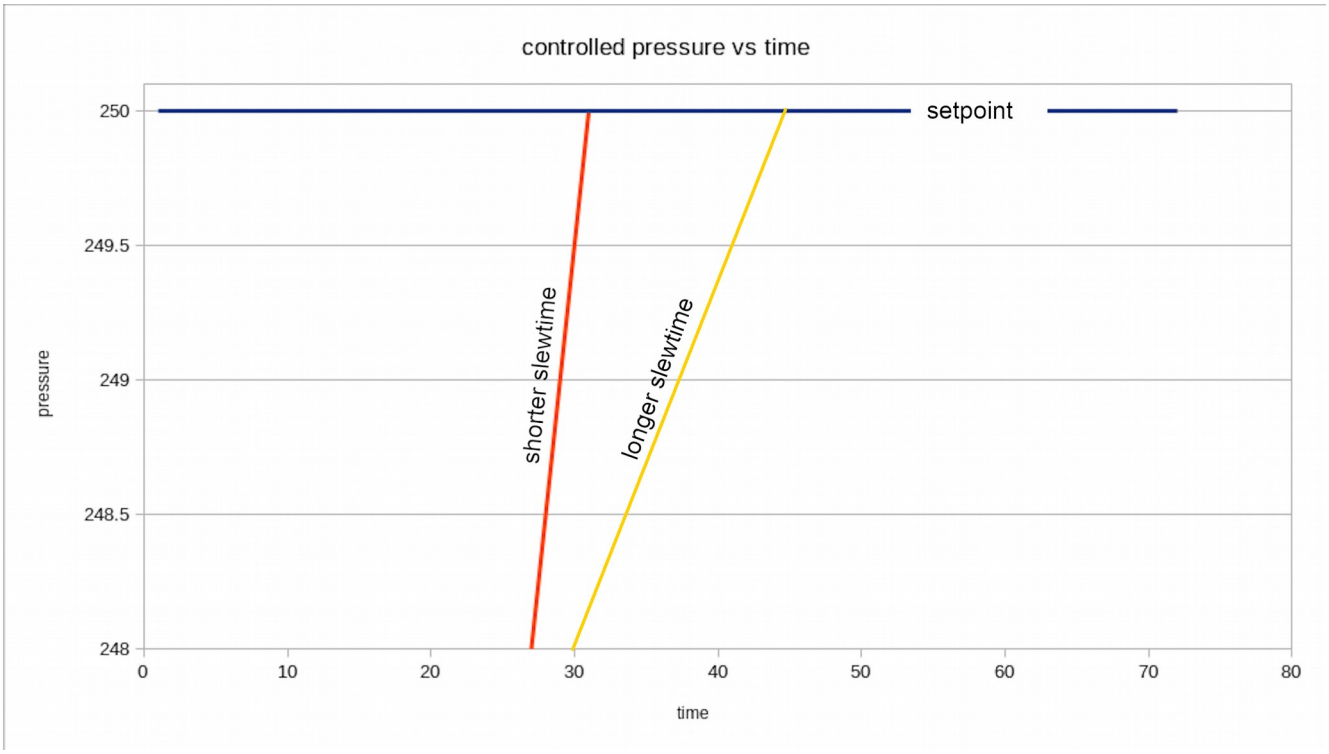
High speed (HS) pressure control.

7.2.1 Coarse control stage

During the coarse control stage, the HPC immediately controls to the entered target value as the setpoint. During this stage the HPC control loop uses the internal pressure control sensor because it can read it very quickly as needed when controlling pressure that is changing at a rapid rate.

The coarse pressure control stage speed is adjustable via the **slew time** parameter.

Slew time	Result	Remark
Shorter slew time	Reaches setpoint faster.	Higher risk of overshooting, takes more time to meet the stability criterion.
Longer slew time	Reaches setpoint more slowly.	Lower risk of overshooting, takes less time to meet the stability criterion.



High speed (HS) pressure control coarse control.

7.2.2 Considerations when using HS control

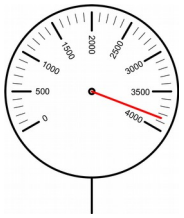
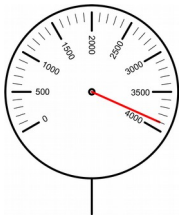
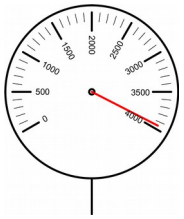
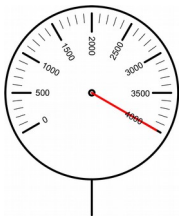
- As mentioned in section 7. Pressure control, the delivered pressure value read by the HPM is not the nominal setpoint as HS control uses the control sensor reading to control the pressure rather than the HPM reading. This means that the pressure value read by the HPM can deviate from the nominal setpoint. When the operator regulary runs the sensor alignment calibration routine as described in section 10.9 Control sensor alignment the deviation between the setpoint and the HPM reading will not exceed 0.1 % of HPM range.
- The control stability criterion is the same for STD and HS control.
- The hold limit criterion value is the same for STD and HS control, except that it is calculated from the HPM reading for STD control and control sensor reading for HS control.

7.3 Setpoint jogging

The HPC has a built-in jog function which can be configured and enabled in the <Setup>, <UTILITIES> menu, see section 9.4.4 UTILITIES. When enabled, an up and down button is shown on the main run screen which makes it possible to make instant small pressure steps.

This function is intended to be used to calibrate analog gauges where putting the gauge needle exactly onto the nominal pressure engraved on its scale is important or in other applications where quick, small pressure adjustments around a setpoint are useful.

Example :

Device under test	analog gauge	
Range	0 .. 4000	bar
Scale division	50	bar
Setpoint jogging	enabled	
Pressure step	25	bar
setpoint 4000 bar		
1st jog step (4025 bar)		
2nd jog step (4050 bar)		
3rd jog step (4075 bar)		

7.4 Ready / Not ready criteria

HPC has built-in user adjustable acceptance criteria which result in a simple ready / not ready flag. On the local user interface this ready / not ready is presented by a green or red pressure value. Remotely the replystring from the command MEAS:PRESS2:FILTERED ends with the character “R” when it meets the acceptance criteria or “NR” if not.

Acceptance criteria

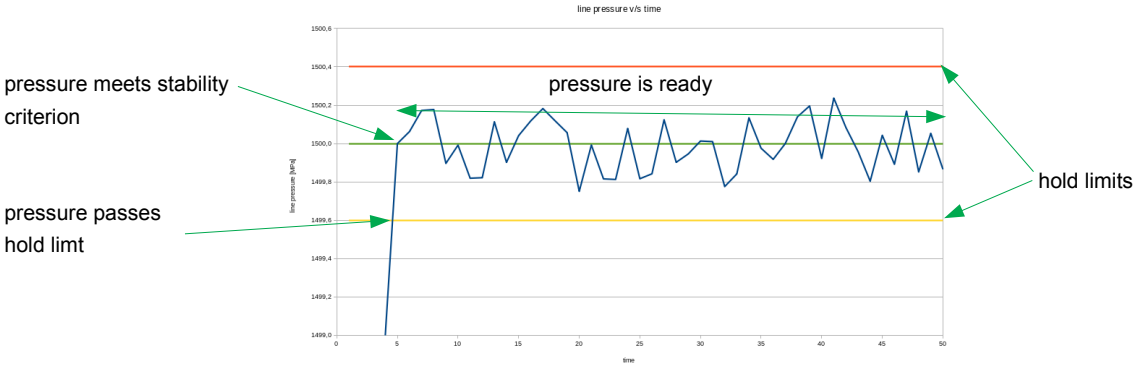
The HPC has two acceptance criteria when controlling a pressure :

1. **Stability**
   The stability criterion is defined as the standard deviation limit measured over the rolling stability time by the active reference pressure module in percent of full scale of the pressure module.
   Standard deviation is chosen as a stability criterion as it is one of the components to use in calculating the overall uncertainty in delivered pressure.

Stability	Result	Remark
Smaller stability value	Meets criterion more slowly.	Risk of never getting ready, when ready, overall uncertainty in delivered pressure is smaller.
Larger stability value	Meets criterion faster.	When ready, overall uncertainty in delivered pressure is larger.

2. **Hold limit**
   A symmetrical positive and negative control limit around the setpoint within which the pressure is maintained in control mode in percent of full scale of the active HPM.

Hold limit	Result	Remark
Smaller hold limit	Meets criterion more slowly.	Risk of never getting ready.
Larger hold limit	Meets criterion faster.	Average pressure value in ready condition still moving towards targeted pressure.



- In STD control mode the hold limit criterion is based on the difference between the actual reading of the **HPM** and the setpoint.
- In HS control mode the hold limit criterion is based on the difference between the actual reading of the **control sensor** and the setpoint.

8. Installation

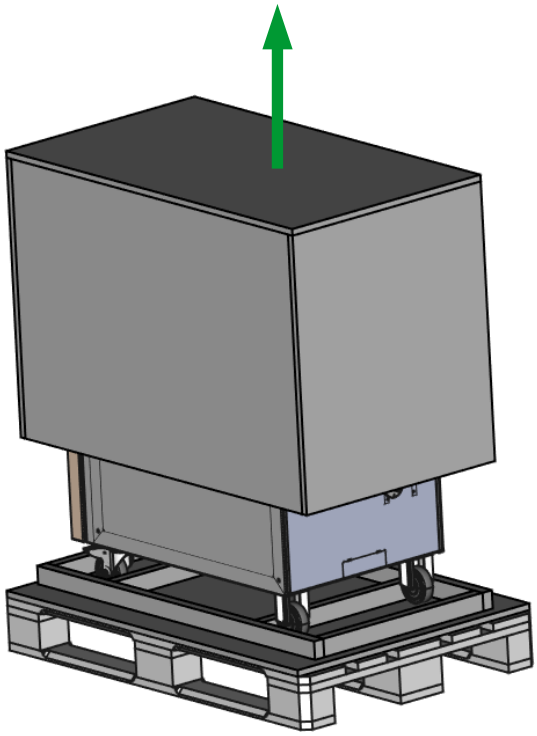
8.1 Unpacking and inspection

8.1.1 MNR-800-HPC400 pressure controller

The HPC is packed in a wooden bottomless crate stacked on a EURO pallet.

- Inspect the crate and EURO pallet on receipt for any transport damage
- Remove the screws on the bottom side of the crate which fastens the crate to the EURO pallet
- Carefully lift the crate over the HPC (2 person job)
- Remove the wooden beams which are fixed on the EURO pallet around the HPC enclosure and wheels
- Make sure the wheel brakes are not engaged
- Carefully push the HPC from the EURO pallet (2 person job)
- Visually inspect the HPC enclosure for signs of damage

HPC weighs ~150 kg. Take appropriate precautions to move and place it safely.



8.1.2 HPC accessories

The HPC comes with the following accessories :

- Spare filter element for HPC low pressure hydraulic circuit
- Seal kit
- One 5 litre can of Sebacate

  Take appropriate precautions when handling the hydraulic oils, read the **M**aterial **S**afety **D**ata **S**heets first!

  - Inspect the hydraulic oil cans for visual damage, in case of damage make sure the cans are stored and handled according to local regulations in respect to chemical liquids
  - Store the hydraulic oil cans on a leak tight oil storage pallet or equivalent

  See ANNEX 1 MSDS sheets of this manual and the MSDS documents glued on the oil cans.

- Funnel for filling HPC with Sebacate

  Take appropriate precautions not to cross-contaminate the funnels as contaminating the controller or powerpack with the incorrect oil can cause damages.

- 4 x Gland + Collar AE F250C, HIP HF4
- 2 x Gland + blind plug AE F250C, HIP HF4 installed on test and HPM port)
- Ethernet cable 5 m
- USB cable 3 m
- General accessories USB stick with user’s manual and test report

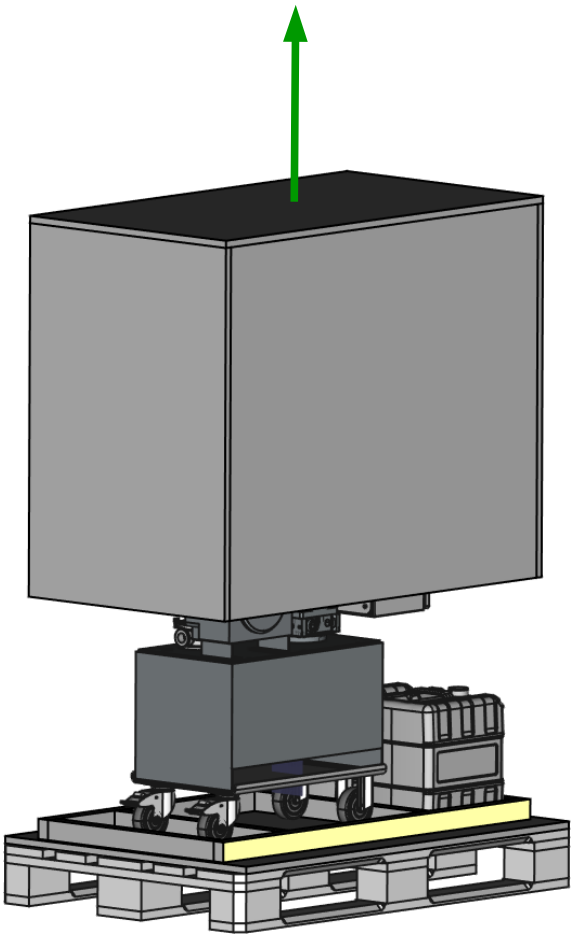
8.1.3 MNR-800-HPP25 powerpack

The MNR-800-HPP25 (from here forward abbreviated as HPP) is packed in a wooden bottomless crate stacked on a EURO pallet together with hydraulic oils, small parts and accessories.

- Inspect the crate and the EURO pallet on receipt for any transport damage
- Remove the screws on the bottom side of the crate which fastens the crate to the EURO pallet
- Remove the hydraulic oil cans, small parts and accessories from the EURO pallet for further inspection

Take appropriate precautions when handling the hydraulic oils, read the **M**aterial **S**afety **D**ata **S**heets first!

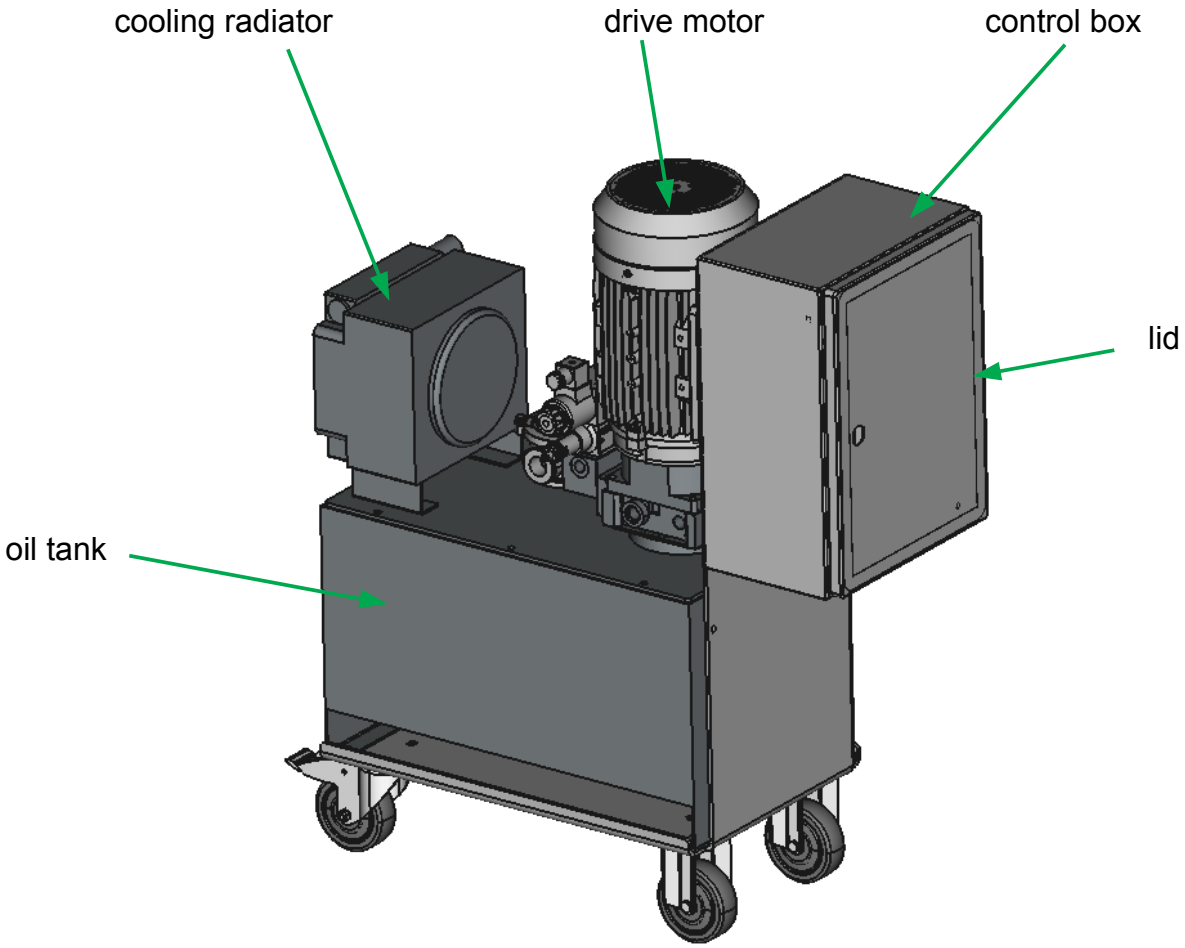
See ANNEX 1 MSDS sheets of this manual and the MSDS documents glued on the oil cans.



- Carefully lift the crate over the HPP (2 person job)

- Remove the wooden beams which are fixed on the EURO pallet around the HPP
- Make sure the wheel brakes are not engaged
- Carefully push the HPP from the EURO pallet (2 man job)
- Visually inspect the HPP enclosure for visible damage

HPP weighs ~80 kg. Take appropriate precautions to move and place it safely.



8.1.4 HPP powerpack accessories

The HPP comes with the following accessories :

- Power cable, three meter length, two wire + ground 4 mm^2 pigtail end
- Two 20 litre cans Castrol hyspin AWS hydraulic fluid,32ISO (for the powerpack)

  Take appropriate precautions when handling the hydraulic oils, read the **M**aterial **S**afety **D**ata **S**heets first!

  - Inspect the hydraulic oil cans for visual damage, in case of damage make sure the cans are stored and handled according to local regulations in respect to chemical liquids
  - Store the hydraulic oil cans on a leak tight oil storage pallet or equivalent

  See ANNEX 1 MSDS sheets of this manual and the MSDS documents glued on the oil cans.

- Funnel for filling HPP w Castrol hyspin AWS hydraulic fluid,32ISO

8.1.5 HPP interconnection kit

This kit makes the hydraulic and electrical connections between the HPC controller and the HPP powerpack. The length of the interconnection kit determines the maximum distance between the HPC pressure controller and the HPP powerpack when they are installed.

Designator	Length [m]
MNR-800-HPP25-2	2
MNR-800-HPP25-4	4
MNR-800-HPP25-6.	6

Inspect the hydraulic hoses and electrical cable for any visual damages due to transport.

If in doubt, do not continue with the installation of HPC and contact the factory for advice.

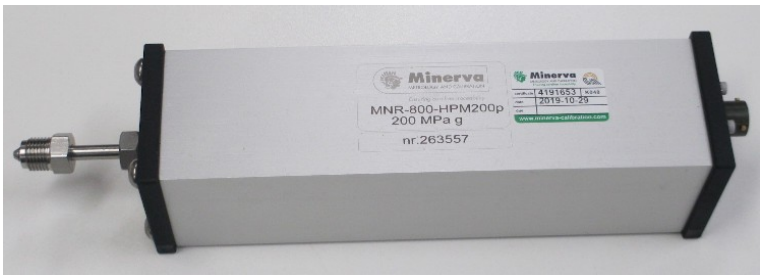
8.1.6 MNR-800HPM pressure module(s)

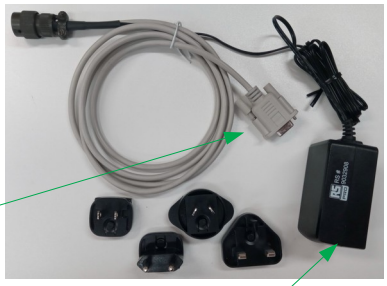
The MNR-800-HPM (from here forward abbreviated as HPM) pressure modules are separately packed in an export quality cardboard box to minimize shocks which might affect their performance.

Open the cardboard box and remove the content of the box. The HPM is delivered with the following accessorizes :

- RS232 cable l = 1800 mm + 24 V power supply

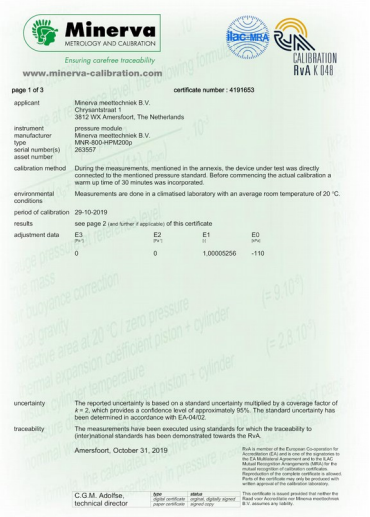
  This cable can be used to power up and communicate with the HPM when calibrating the HPM outside of HPC
- Short nipple with AE250C, HIP HF4 plastic cap installed
- ISO/IEC accredited calibration report





9 pins D-Sub F RS232 plug

power supply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CALIBRATION
RvA K 048
page 1 of 3
certificate number : 4191653
applicant
Minerva meettechniek B.V.
Chrysantstraat 1
3812 WX Amersfoort, The Netherlands
instrument
pressure module
manufacturer
Minerva meettechniek B.V.
type
MNR-800-HPM200p
serial number(s)
263557
asset number
calibration method
During the measurements, mentioned in the annexis, the device under test was directly connected to the mentioned pressure standard. Before commencing the actual calibration a warm up time of 30 minutes was incorporated.
environmental conditions
Measurements are done in a climatised laboratory with an average room temperature of 20 °C.
period of calibration
29-10-2019
results
see page 2 (and further if applicable) of this certificate
adjustment data
E3 E2 E1 E0
0 0 1,00005256 -110
uncertainty
The reported uncertainty is based on a standard uncertainty multiplied by a coverage factor of k = 2, which provides a confidence level of approximately 95%. The standard uncertainty has been determined in accordance with EA-04/02.
traceability
The measurements have been executed using standards for which the traceability to (inter)national standards has been demonstrated towards the RvA.
Amersfoort, October 31, 2019
C.G.M. Adolfse,
technical director

8.2 Site requirements

HPC weighs ~150 kg. Take appropriate precautions to move and place it safely.

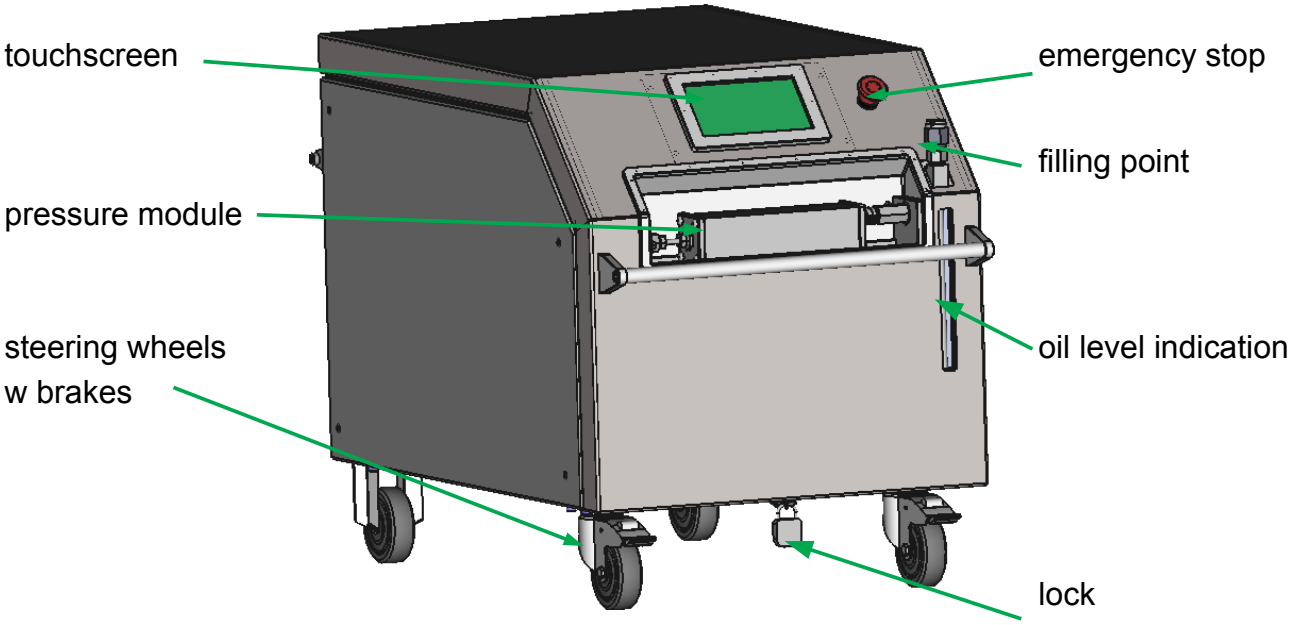
HPP weighs ~80 kg. Take appropriate precautions to move and place it safely.

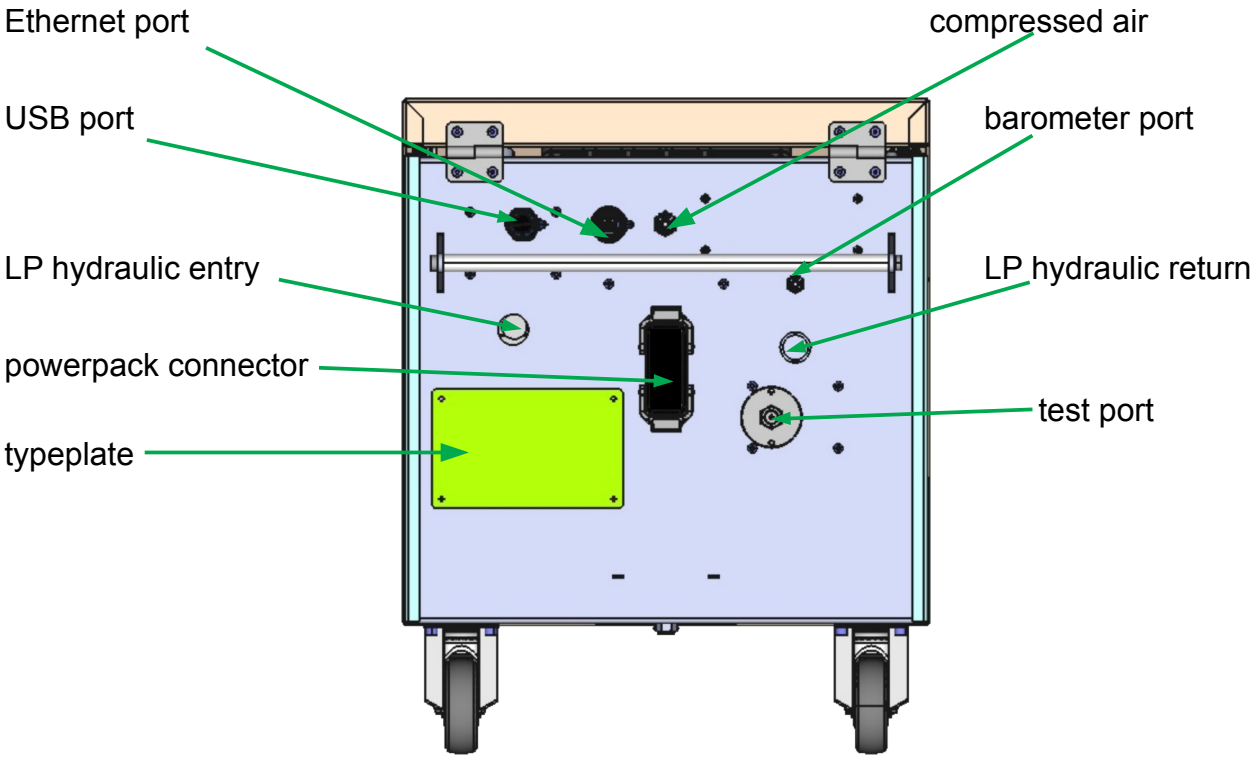
The HPC can be installed under a standard workbench where the touch screen interface can be accessed by the operator sitting beside the instrument.

- Minimizing the distance between the high pressure controller and the device or system under test will enhance control performance and reduce pressure setting times.
- Access to the HPC rear panel should be considered to facilitate making and breaking hydraulic, pneumatic and electrical connections.
- HPP needs to be positioned taking into account the length of the ordered HPP/2 /4 /6 interconnection hardware / flex tube.
- Clean and dry compressed air (ISO8573-1:2010 Class 1.4.2 grade) should be readily available (500 .. 1000 kPa / 300 nl/m)
- 230 V 50 Hz or 110 V 60 Hz / 2.2 kW (other voltages on request) mains supply

Always use tubing with correct pressure rating for pneumatic, powerpack and high pressure connections.

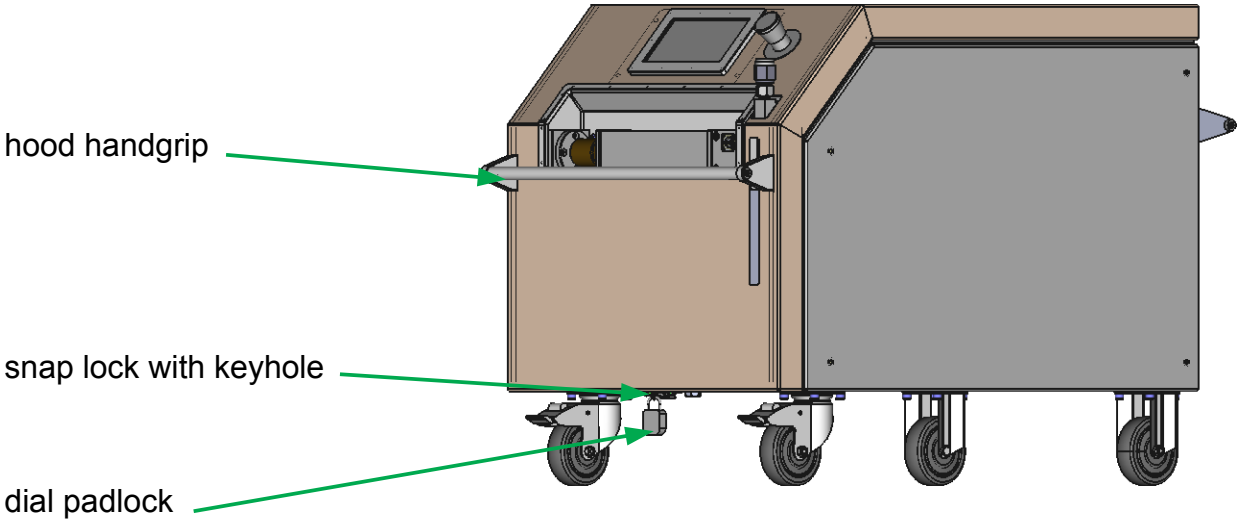
8.3 MNR-800-HPC400 details

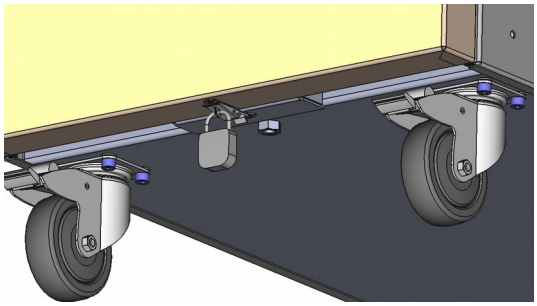




8.3.1 Opening HPC's hood

The HPC enclosure is designed to have easy access to its internal parts for maintenance and inspection.



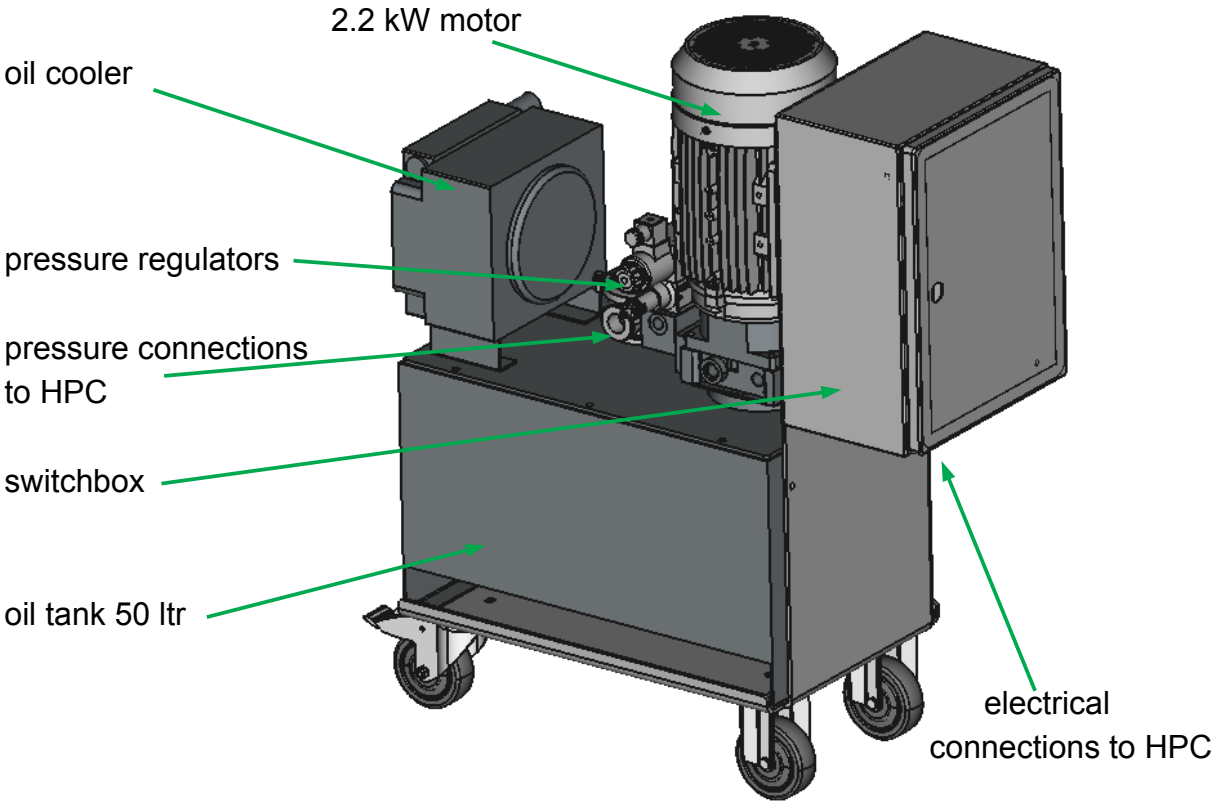


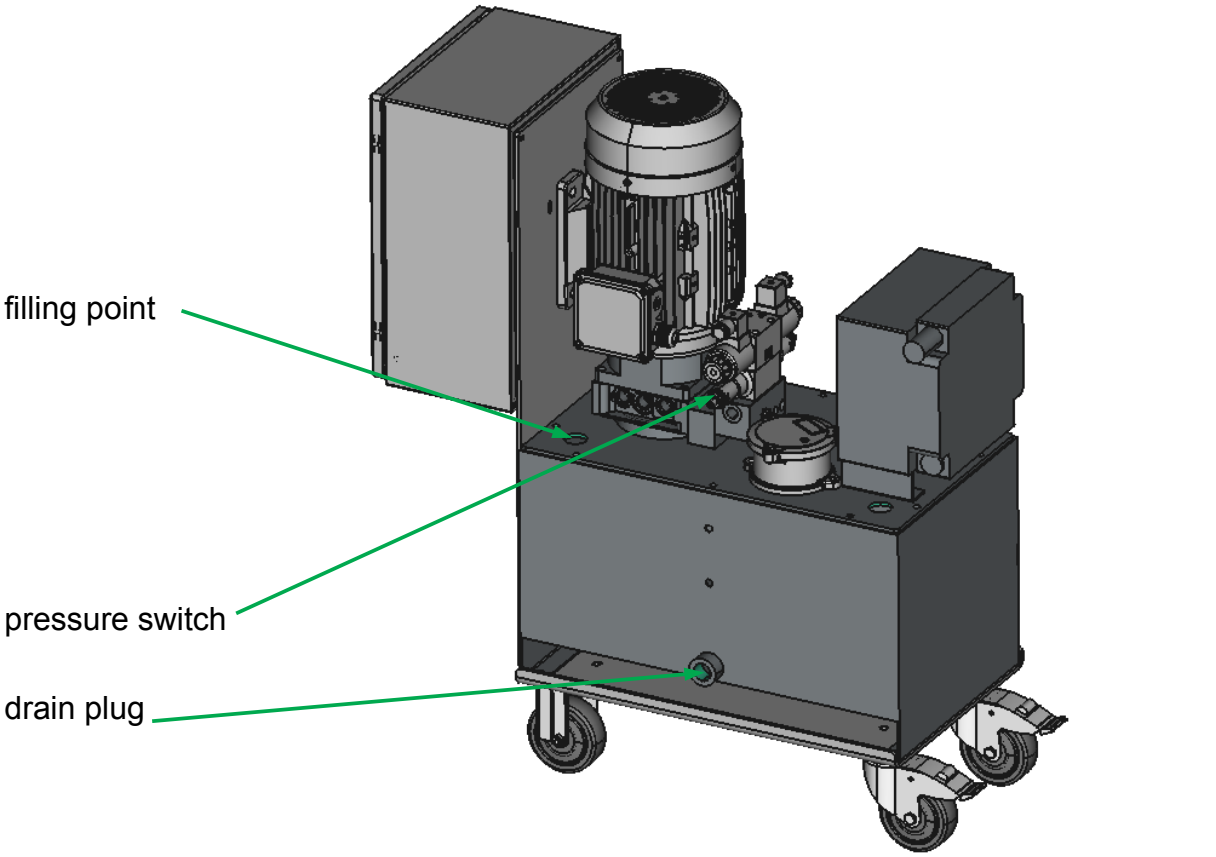
1. Open the dial padlock (default code is 0 0 0)
2. Remove dial padlock from snap lock with keyhole
3. Unlock snap lock
4. Lift the hood with the hood handgrip

The HPC hood mass is balanced with gas springs and stays open when lifted.

When the HPC hood does not stay open, the gas springs need to be replaced. Consult the factory.

8.4 MNR-800-HPP25 details





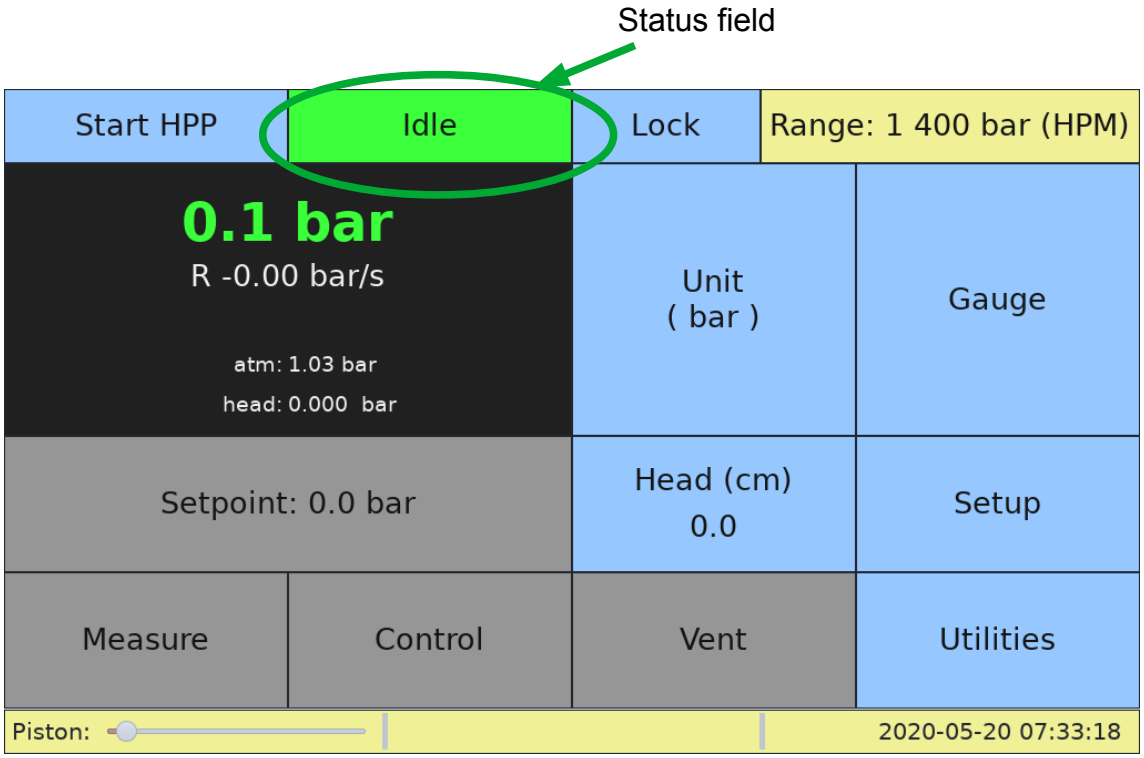
9. Local operation

For local operation, HPC has a touchscreen display with a main run screen consisting of :

- Direct function and menu buttons.
- Status field.
- Informative fields.

The type of field can be recognized by its background color :

Background color	Description
	Measurement indication
	Status ready
	Status not ready
	Informative field
	Button / clickable field
	Inactive / locked button



HPC's main run screen in idle mode.

Button / Menu			Description
Start / Stop HPP			Starts or stops the HPP.
		limit(s)	Only enabled in vented condition.
Setpoint			Setpoint to which HPC will control pressure in current pressure unit of measure.
		limit(s)	Min. > 0.1 MPa max <= pressure module range or user set pressure limit.
Measure			Puts HPC into measure mode (as opposed to control mode). Stops pressure control if active.
		limit(s)	Only accessible from control mode.
Control			Puts HPC into standard or high speed control mode depending the setting in <Setup>, <Control>
		limit(s)	A setpoint needs to be entered first when HPC is in vented condition.
Vent			Causes HPC to execute the vent routine that ends with the HPC vented (open to reservoir).
		limit(s)	No limits, Vent is enabled whenever HPC is in control or measure mode.
Utilities			Displays the 3 Utility buttons.
	Leak		Initiates leak test procedure.
		limit(s)	Only enabled when HPC is in control mode and pressure is Ready.
	Purge		Initiates the vacuum purge routine to remove air from HPC and test.
		limit(s)	Only enabled when HPC is in vented condition.
	Fill		Initiates the oil (pressure) fill routine to fill the test.
		limit(s)	Only enabled when HPC is in vented condition.
Unit			Sets active pressure unit of measure.
		limit(s)	None.
Head (cm)			Sets the reference level offset between HPC and device under test so that a fluid head correction is applied to the reference pressure.
			Positive : device under test reference level is below HPC reference level.
			Negative : device under test reference level is above HPC reference level.
		limit(s)	None.
Gauge / Absolute			Sets HPC into gauge or absolute pressure mode.
		limit(s)	Only enabled when HPC is in vented condition.
Setup			Only enabled when HPC is in vented condition.
	MEASURE		Several measure and control settings.
	CONTROL		Pressure control settings.
	POSITION		Intensifier piston displacement control settings.
	UTILITIES		Sets miscellaneous user parameters.
	CALIBRATION		Access to miscellaneous features to calibrate HPC sensors.
	I/O SETUP		TCP/IP settings.
	SYSTEM SETUP		Software udate and time settings.
	INFO		General information on HPC (digital typeplate).
	STATUS		HPC up- and pressure time info and firmware info.
	LOGIN		Login for Administrator or Factory level access.
		limit(s)	See section 9.2 Access scheme for detailed access.

9.1 Status field overview

Status field	Description	Vent valve	Isolation valve	Vacuum valve	HPP
Idle	HPC is working towards idle mode, powering down HPP when powered up.	o	o	x	on → off
Idle	HPC is at rest	o	o	x	off
Venting	HPC is working towards vented condition, opening the vent valve when it is closed and setting the intensifier piston to its home position.	x → o	o	x	on
Vented	HPC is vented.	o	o	x	on
STD pressure ctrl	HPC is working towards active standard pressure control mode and closing the vent valve.	o → x	o	x	on
STD pressure ctrl	HPC is in standard pressure control mode and actively controlling pressure.	x	o	x	on
HS pressure ctrl	HPC is working towards active high speed pressure control mode and closing the vent valve.	o → x	o	x	on
HS pressure ctrl	HPC is in high speed pressure control mode and actively controlling pressure.	x	o	x	on
Measure	HPC is in measure mode and not actively controlling pressure. The intensifier piston is locked at one position.	x	o	x	on
Fill	HPC is working towards filling mode.	o → x	o	x	on
Fill	HPC is in filling mode and slowly pumps pressure medium through the hydraulic system until it reaches the fill pressure limit.	x	o	x	on
Purging xx	HPC is in purging mode, vacuum valve is closed.	o	o	x → o	on
HPM cal.	HPC is working towards HPM cal. mode and closes the isolation valve.	o	o → x	x	off
HPM cal.	HPC is set to calibrate the mounted HPM module.	o	x	x	off

9.2 Access scheme

Form		Normal User	Administrator	Factory
MEASURE	(Precision)	✔	✔	✔
MEASURE	(other entries)	✘		
CONTROL		✘	✔	✔
CONTROL	(Kp Ki)	✘	✘	✔
POSITION	(all entries)	✘	✔	✔
UTILITIES	(all entries)	✔	✔	✔
CALIBRATION	(all entries)	✘	✔	✔
I/O SETUP	(all entries)	✘	✔	✔
SYSTEM SETUP	(all entries)	✘	✔	✔
INFO		READ ONLY		
STATUS		READ ONLY		
LOGIN		✔	✔	✔

✘ : Read only at that user level
✔ : Read and write

9.3 Detailed descriptions

The following sections describe the menus and buttons available on the local user interface.

9.3.1 Start

User level : No restrictions
Access from : Only at startup

After power up, HPC runs self-diagnostic test and when passed the <START> button is enabled.

If HPC does not pass its self diagnostic test, an error message appears! If this occurs, contact the factory or your service provider.

After pushing the <START> button, the HPC is set in idle state and the main run screen appears.

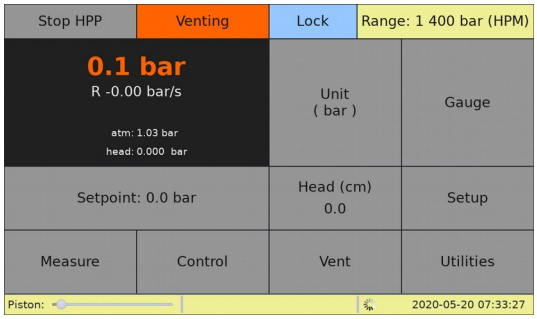
In Idle state, all HPC electronics are powered up except the HPP powerpack. To run the HPC, the HPP needs to be started. If the HPC is not being used for several hours, it is advised to leave the HPC in this state.

When HPC is not used for one or more days, it is advised to completely shut down the HPC by pushing the red emergency knob.

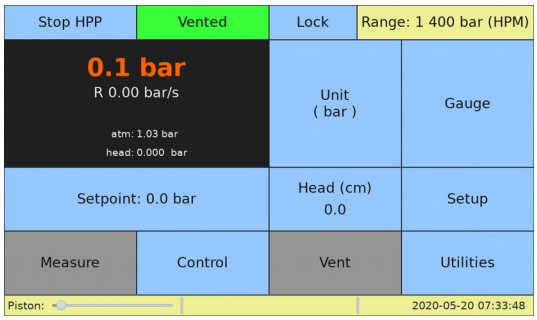
9.3.2 Start / Stop HPP

User level : No restrictions
Access from : Vented condition

To put the HPC in full operation, the <Start HPP> button is pushed. By pushing this button, the HPP is powered up and the HPC is set in vented condition.



HPC is venting in transition to vented condition (HPP is on).

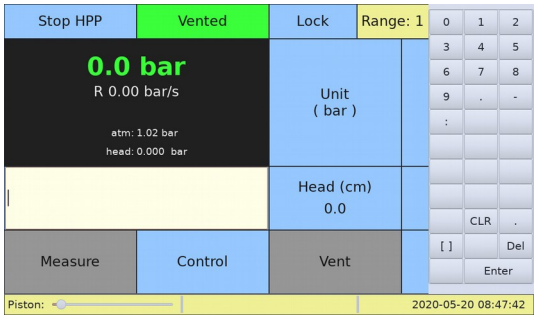


HPC is vented condition (HPP is on, HPM reading not ready yet).

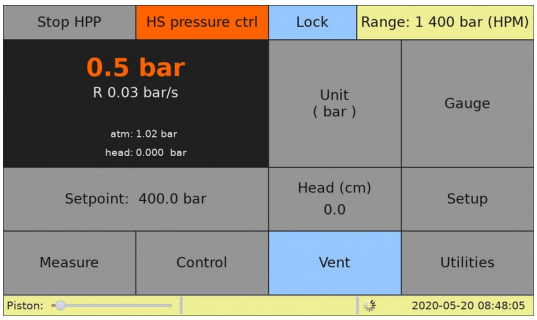
9.3.3 Setpoint

User level : No restrictions
Access from : Vented condition and pressure control mode

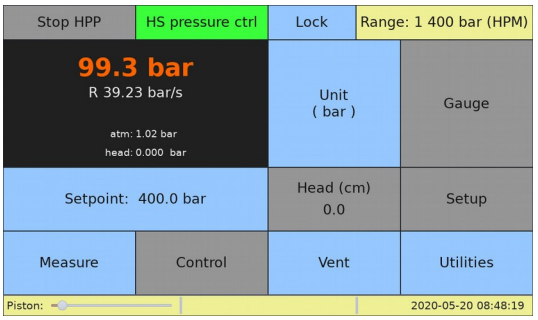
This is the pressure control setpoint entry field. When it is pressed, a numerical keypad pops up to enter a pressure setpoint. Valid entries are pressure values above zero and below the active HPM range (or user adjustable pressure limit).



When already in control mode, pressing the <Enter> key, causes HPC to start control to the entered setpoint. In vented condition, the operator needs to press the <Control> button after pressing the <Enter> key.



HPC in transition to HS pressure control.

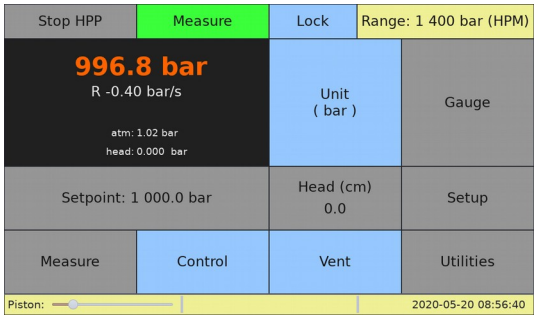


HPC in HS pressure control mode.

9.3.4 Measure

User level : No restrictions
Access from : Pressure control mode

Whenever HPC is actively controlling the pressure, pressing the <Measure> button results in aborting pressure control and freezing the HPC intensifier piston at its current position. The HPC actively keeps its intensifier piston in the same position.



When the pressure is within the stability criterion set in the <Setup>, <MEASURE> settings (see section 9.4.1 MEASURE), the pressure reading becomes green / = ready.

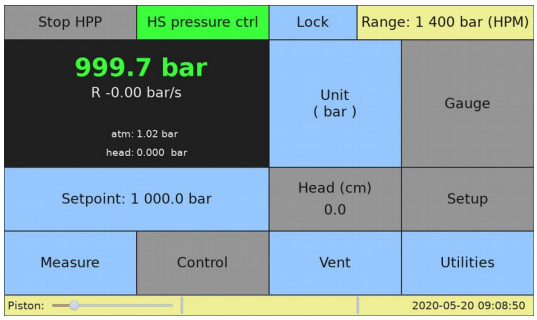
Pressing the <Control> button puts HPC back into control mode and it will control to the entered setpoint.

9.3.5 Control

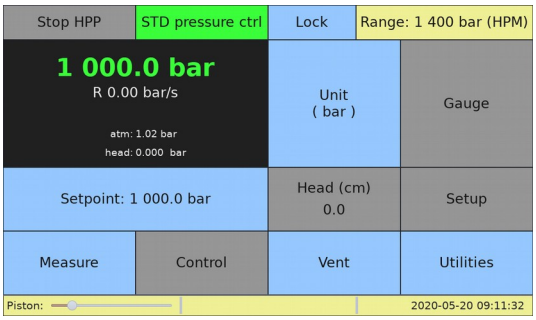
User level : No restrictions
Access from : Vented condition and measure mode

When in control mode, HPC dynamically controls to the entered setpoint. The ultimate achieved pressure value is dependent wether the HPC is in standard or high speed control mode, see section 7. Pressure control for details on both control modes.

Pressure becomes ready when the pressure is within the hold limit and when it meets the stability criterion. See 9.4.1 MEASURE and 9.4.2 CONTROL.



HPC in high speed control mode.



HPC in standard control mode.

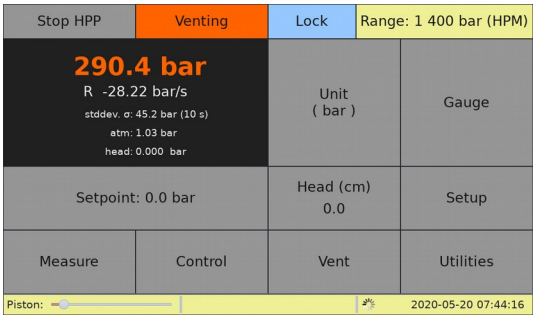
9.3.6 Vent

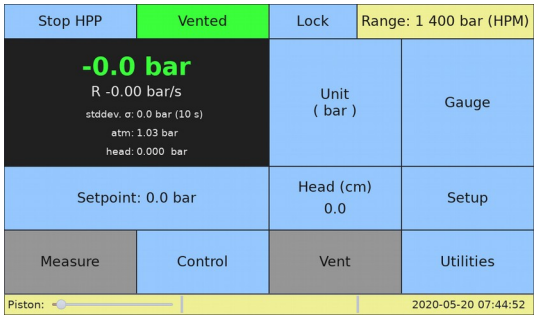
User level : No restrictions
Access from : Pressure control and measure mode

Pressing the <Vent> button initiates the vent routine :

- HPC controls back to the user adjustable vent pressure
- HPC intensifier piston position is locked at its current position
- Vent valve is opened

Controlling back to a low vent pressure protects the vent valve as opening the vent valve at higher pressures will result in a faster wear of the needle and the seat.
A low vent pressure also protects the control sensor, reference pressure module and any attached instrument under test from very sudden, large pressure drops which might harm them.





9.3.7 Utilities

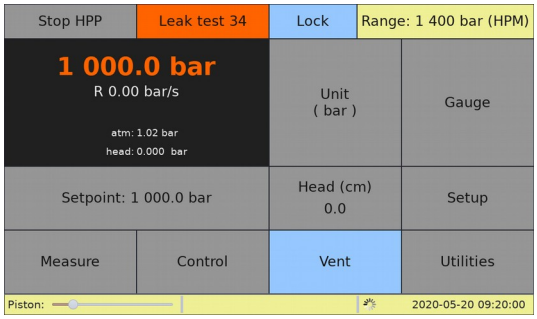
The utilities menu contains three functions :

9.3.7.1 Leak test

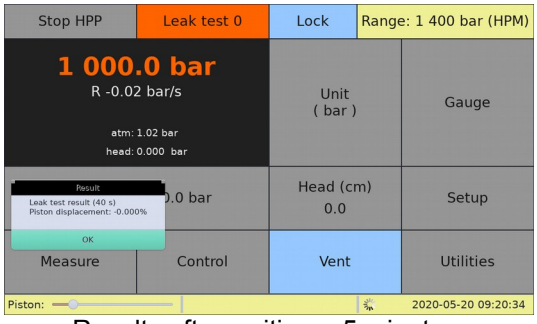
User level : No restrictions
Access from : Pressure control mode when pressure is ready

The leak test is conducted in control mode at a pressure when the pressure is Ready. When leak testing, it is good practice to set the leak test pressure and wait for at least 5 minutes before starting the leak test to let adiabatic effects settle.

The leak test monitors the intensifier displacement over xx seconds while maintaining the pressure at the pressure when it was initiated. The value of xx can be set in the <Setup>, <UTILITIES> menu (Leak test time default is 40 seconds).



The leak test result is in percent of intensifier stroke. A leak tight system should have a leak test value of < 0.005% over 40 seconds test time.



Results after waiting ~ 5 minutes.

n.b. The leak test piston displacement value can be a negative value if the system / environment is heating up during the leak test procedure or if you are leak testing at a lower pressure after remaining for an extended period at a higher pressure.

At the end of the leak test, the HPC returns to active pressure control.

The operator can abort the Leak test function by pushing the <Vent> button.

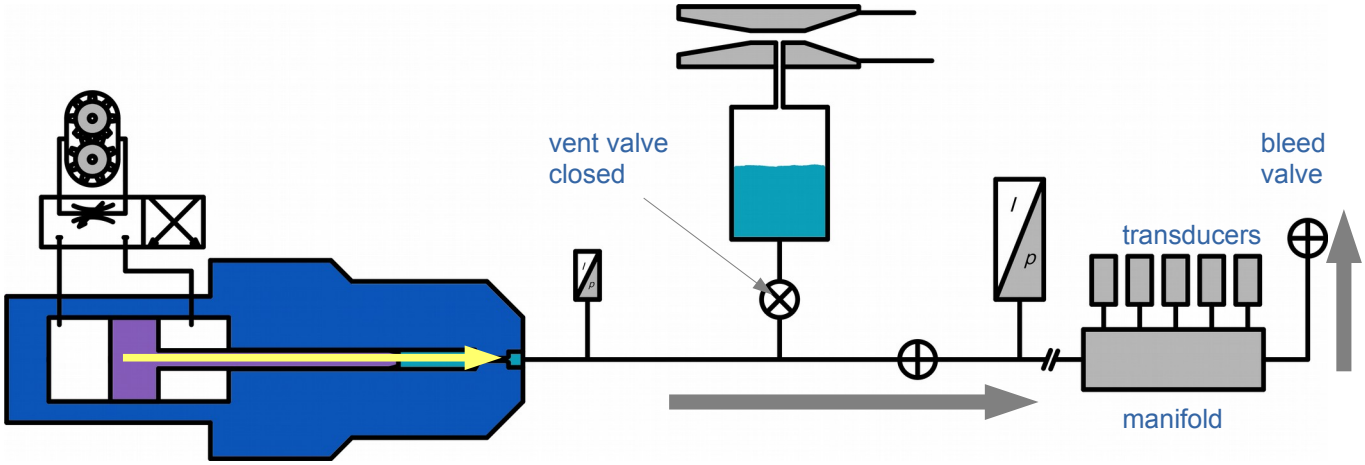
9.3.7.2 Fill function

User level : No restrictions
Access from : Vented condition

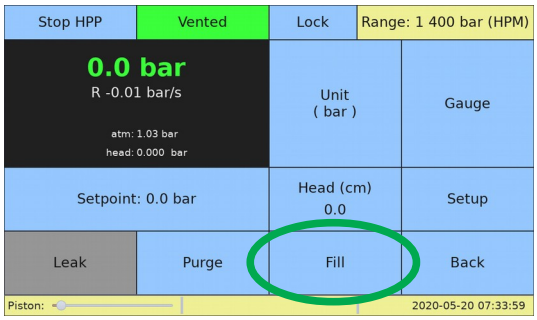
The fill function is intended to fill internal and external tubing, manifold(s) and/or devices under test, using the intensifier as a pump. Open a high point of the external tubing, manifold(s) or device under test to atmosphere, then initiate the fill routine using <Utilities>, <Fill>.

The HPC vent valve closes after which the intensifier moves slowly from its home position pushing oil into the external volume. When oil starts leaking out the open point, close it.

Once the external volume is closed, HPC will build up pressure until it reaches the fill pressure as entered under <Setup>, <UTILITIES> and vents.



With the HPC in vented condition, click on <Utilities>, <Fill>

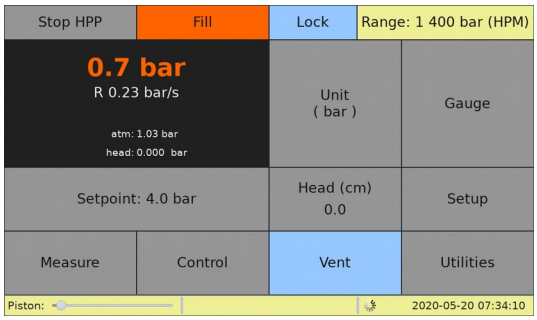


This will activate the fill function which is an automated way to fill internal and external tubing, manifold(s) and/or devices under test with oil. The procedure consists of the following three steps :

1. VENT valve closes.
2. Fill pressure is set (see section 9.4.4 UTILITIES for defining the fill pressure value), HPC goes into pressure control mode and controls to the setpoint xx.
3. When the fill pressure is reached the HPC goes back to vented condition.

The operator can abort the Fill function by pushing the <Vent> button.

If there is a large volume to fill the HPC piston may reach the end of its stroke before the volume is filled. In this case it will recharge itself as many times as necessary to fill the volume and reach the pressure setpoint xx. This could take some time.

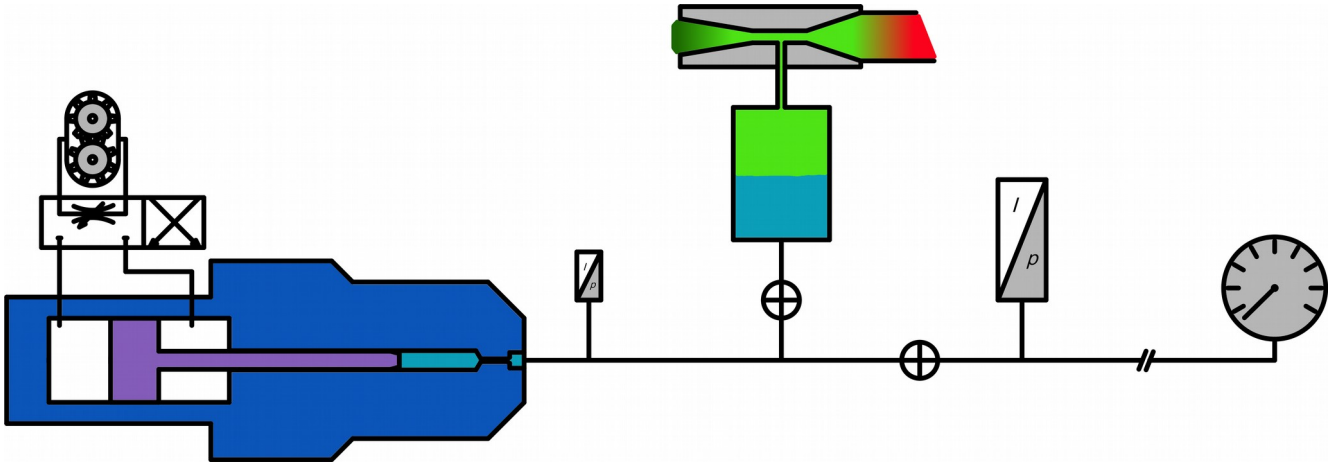


During the filling process when the intensifier piston is moving towards the end of its stroke, the operator can loosen the test port plug by one revolution to allow air to bleed from the system. Make sure to tighten the test port plug before the intensifier piston reaches the end of its stroke and recharges to avoid air being sucked into the system during the recharge.

9.3.7.3 Purge function

User level : No restrictions
Access from : Vented condition

The purge routine is intended to remove air from internal and external tubing, manifold(s) and/or devices under test by means of applying a vacuum to the surface of the internal oil reservoir. For this a vacuum ejector (compressed air driven vacuum system by means of a venturi) is built into HPC. The vacuum ejector has no moving parts and is not affected by (oil) contamination.



With the HPC in vented condition, press <Utilities>, <Purge>

This will activate the vacuum purging procedure which is an automated way to remove trapped air from internal and external tubing, manifold(s) and / or devices under test. The procedure consists of the following four steps :

1. Intensifier piston position is set to 90% of its stroke.
2. Pneumatic valve supplying compressed air to the vacuum ejector (venturi) is opened thus creating a vacuum in the HPC oil reservoir.
3. Pneumatic valve to vacuum ejector is closed after a user adjustable time, 60 seconds is recommended.
4. Intensifier piston returns to its home position.

The operator can abort the Purge function by pushing the <Vent> button.

With a newly installed system, it is recommended to repeat the above 3 .. 4 times with a 30 seconds pause between the purge cycles.

reference pressure under vacuum

piston position set to ~90%

With a newly installed HPC or a large volume of air in the test system being purged, the ultimate vacuum during the 1st purge cycles most likely is lower than shown above due to the air still trapped in the system.

If the ultimate vacuum pressure after 4 .. 5 cycles does not go below -0.5 bar g / 0.5 bar a, please check if the test circuit couplings are properly tightened, the reference pressure module collar and gland are properly mounted and tightened and / or the test system is closed off from atmopshere.

Another possible cause could be insufficient compressed air supply

9.3.8 Unit

User level : No restrictions
Access from : No restrictions

HPC can be set to a choice of common pressure units of measure. Internal HPC calculations are all in Pascal. The table below lists the available pressure units and their multipliers to Pascal :

Unit		Multiplier to Pascal
Pascal	Pa	1
kilo Pascal	kPa	1.00E-003
bar	bar	1.00E-005
Mega Pascal	MPa	1.00E-006
milli bar	mbar	0.01
pounds per square inch	psi	0.0001450
millimeter of mercury	torr	0.00750063
micron of mercury	mtorr	7.50063000
millimeter of mercury	mmHg	0.00750063
millimeter of water	mmH2O	0.1019716
millimeter of water at 4 °C	mmH2O@4oC	0.1019716
millimeter of water at 20 °C	mmH2O@20oC	0.1021520
kilogramforce per square centimeter	kgf/cm2	1.019716E-005
inches of mercury	"Hg	0.0002953
hecto Pascal	hPa	0.01
centimeter of water	cmH2O	0.01019716
inches of water at 4 °C	“H2O@4oC	0.004014649

9.3.9 Head height

User level : No restrictions
Access from : Vented condition

The HPC reference level is the pressure connection of the reference pressure module. When a devices under test is positioned at a different height, a correction on the pressure can be applied with the below calculation :

$$p_{DUT} = p_{HPC} + (\rho_{oil} - \rho_{atm}) \cdot g_l \cdot \Delta h$$

where	p_{DUT}	: pressure at device under test reference level	[Pa]
	p_{HPC}	: pressure at HPC reference level	[Pa]
	ρ_{oil}	: density of oil in HPC	[kg/m^3]
	ρ_{atm}	: density of air	[kg/m^3]
	g_l	: local gravity	[N/kg]
	Δh	: height difference between HPC and device under test reference level	[m]

The Δh can be a positive (device under test reference level is below the HPC reference level) or negative value (device under test reference level is above the HPC reference level).

The density (ρ_{oil} – ρ_{atm}) and local gravity are entered in the <Setup>, <UTILITIES> menu.

9.3.10 Gauge / Absolute

User level : No restrictions
Access from : Vented condition

Use this button to toggle between gauge or absolute pressure mode. The current mode is displayed.

The HPC is designed with flexibility in mind. The user can select from a variety of reference pressure module ranges and accuracy classes. The pressure modules are intrinsically gauge and are zeroed when in vented condition. This has a big advantage over absolute pressure modules as any zero drift in between calibration intervals is compensated for by a simple tare.

Absolute pressures are achieved by atmospheric pressure addition using the pressure reading of HPC's built-in barometric pressure module :

$$p_{abs} = p_{module} + p_{baro}$$

where p_{abs} : calculated absolute pressure [Pa a]
p_{module} : gauge pressure reading HPM reference pressure module [Pa g]
p_{baro} : absolute pressure reading HPB barometer pressure module [Pa a]

9.3.11 Lock / Unlock

User level : No restrictions
Access from : No restrictions

This button toggles between Lock (disable local buttons) and Unlock (enables local buttons). Its main purpose is to avoid unintended pushing of buttons.

9.4 Setup

Under setup one can set various measure, control and other HPC settings organized into logical tabs. The tabs include buttons for various tasks :

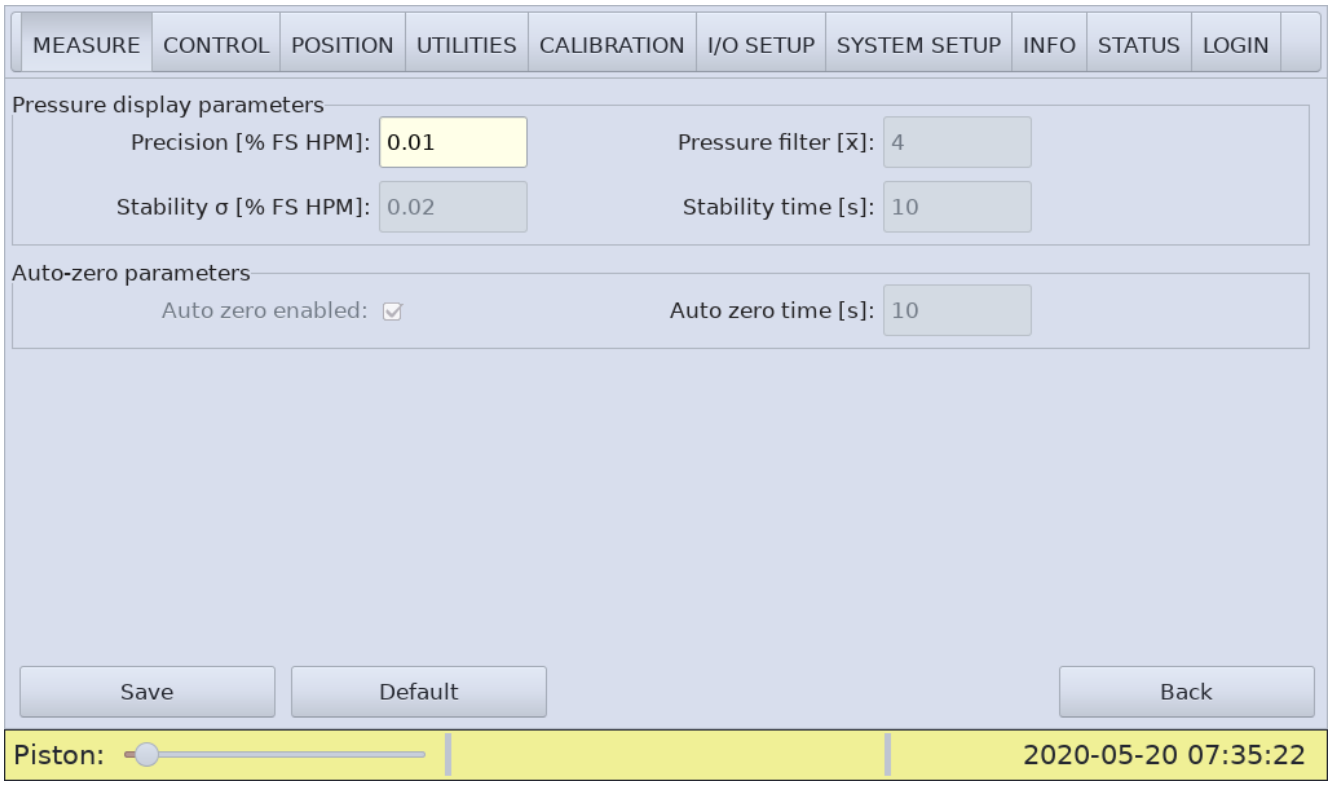
Save	Newly entered values on the active tab are saved into non-volatile memory and activated if you push this button. If you do not push this button, the new values are not saved and the old value will remain active.
Default	Sets all values on the active tab back to factory default values. Default values will be activated after pushing the <Save> button.
Back	Return to the main run screen when once viewing, editing and saving are complete.

Changing setup values can result in poor pressure control and unsafe situations. Potentially dangerous settings are NOT accessible for normal users and can only be accessed after logging in as Administrator. See section 9.2 Access scheme for a detailled overview of settings and their access level.

9.4.1 MEASURE

User level : Precision : No restrictions
Other fields : Administrator, Factory
Access from : Vented condition

Here one can alter settings which are related to pressure measurement.



Pressure display parameters :

Precision [% FS HPM]	
Description	Sets the display of the HPC measured pressure in percent of full scale of the active reference pressure module.
Function	This parameter determines in how many digits the pressure value on the main run screen is displayed.
Default value	0.01 [% FS HPM]
Comment	In some applications such as the calibration of analog gauges the operator does not need high resolution and it is more convenient for the operator to see for example a steady pressure of 100.0 MPa rather than a fluctation pressure of 99.99 .. 100.01 MPa.

Pressure filter [$\bar{x}$]	
Description	Averages the raw pressure value from the reference pressure module. Averages the last x values + the actual value divided by (x+1).
Function	Filters white noise from the pressure signal which mostly is caused by the pressure sensing element and/or electronics.
Default value	4 [-]
Comment	The HPC measurement and control are not affected by the pressure filter.

Stability σ [% FS HPM]	
Description	Standard deviation limit measured over the rolling stability time by the active reference pressure module in percent of full scale of the pressure module or sensor.
Function	**In control mode :** When actual standard deviation is smaller than the limit AND the current pressure value is within the setpoint ± hold limit the pressure signal is “Ready” (displayed in green). **In measure mode :** When actual standard deviation is smaller than the limit the pressure signal is “Ready” (displayed in green).
Default value	0.02 [% F.S. HPM]
Comment	A larger value will result in meeting this criterion in a shorter period of time but obviously the actual pressure stability will be lower.

Stability time [s]	
Description	The rolling time value over which pressure stability is calculated.
Function	Determine the time over which pressure stability is calculated
Default value	10 [s]
Comment	The default value is optimzed for pressure increments typically set with a 400 MP`a controller. Generally, changing pressure control parameters from the default values is used only to adapt HPC for unusual operating conditions.

Autozero enabled	
Description	When the HPC is vented, the gauge pressure in the HPC circuit is zero by definition. The autozero routine measures the offset of the HPM and/ or the HPC control sensor under vented conditions and automatically updates and corrects for this offset to compensate for zero drift.
Function	Enables / disables autozero when HPC is in vented condition.
Default value	Enabled
Comment	HPM reference pressure modules and the HPC control sensor are all intinsically gauge mode. Absolute pressures is calculated by adding the HPB reading to the gauge pressure value. Autozero when enabled is active both in gauge and absolute mode.

The autozero offset is not stored permanently. When the HPC is shut down and powered up, it is normal behavior for the initial pressure reading in vented condition to be other than zero. After stabilization and “Autozero time” the pressure reading is autozeroed and zero is displayed unless the head height value is not zero.

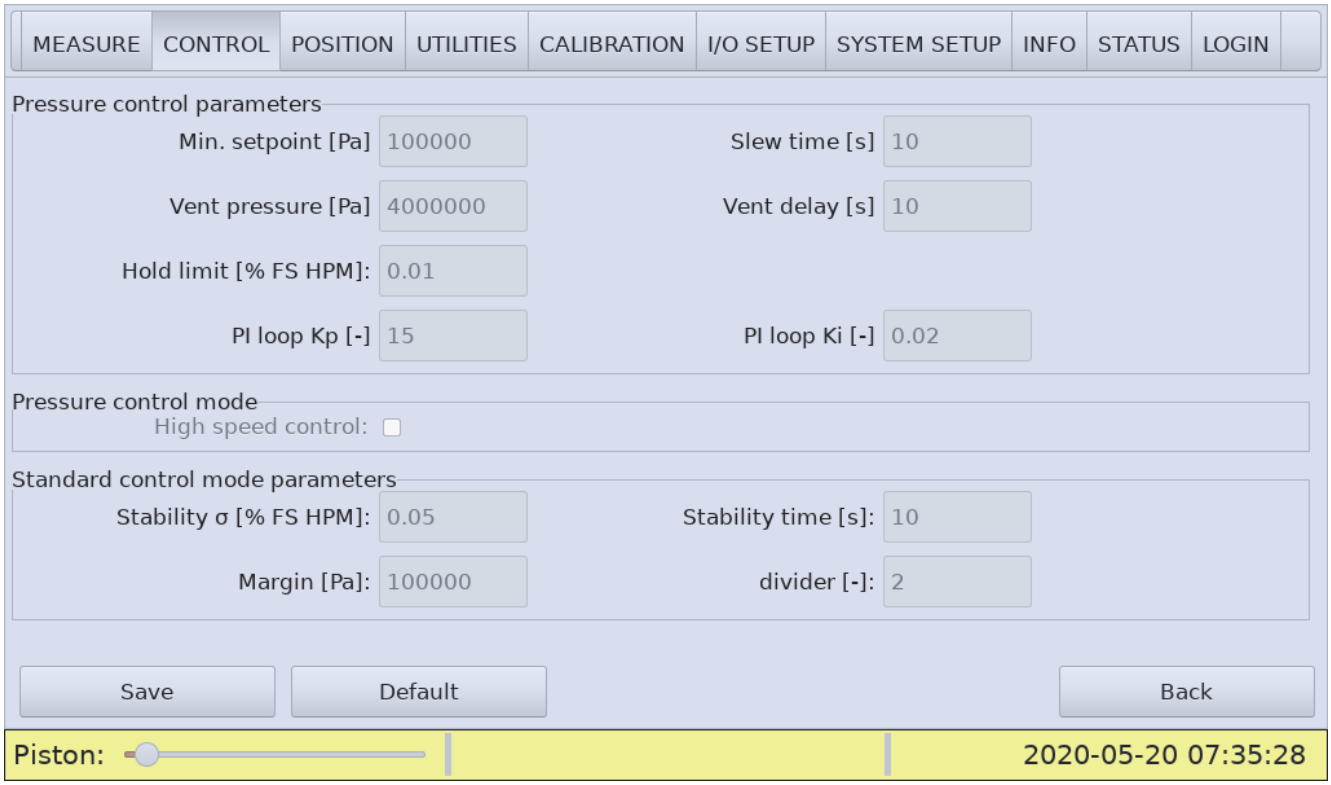
When vented with Autozero on, if there is a head height entered (see 9.3.9 Head height) the displayed pressure value and the value obtained via remote command is not zero as the head height is added or substracted from the HPM and/or the HPC control sensor. The value displayed is the value in pressure of the entered head.

Autozero time [s]	
Description	After the vent valve is opened, the system pressure by definition is “0” gauge. This delay allows adiabatic effects from venting pressure to dissipate before the Autozero function runs.
Function	Delay between reaching stable pressure in vented condition and the actual autozeroing of the pressure signal.
Default value	10 [s]
Comment	Settling of adiabatic effects after a pressure step is relatively slow. In order not to have Autozero zero out a measured value that may include significant adiabatic effects, a delay of at least 10 seconds after venting should be maintained.

9.4.2 CONTROL

User level : Administrator, Factory
Access from : Vented condition

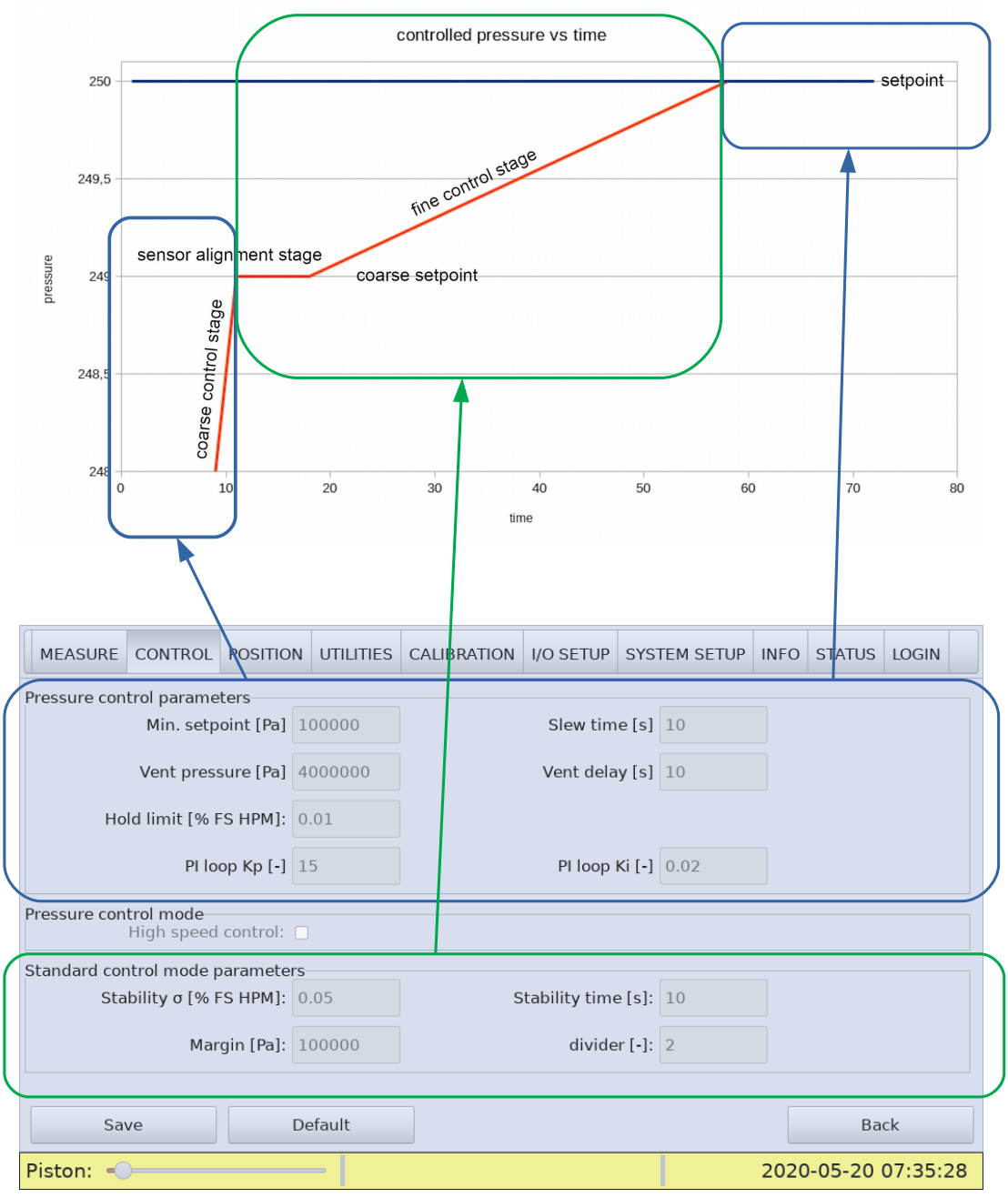
Here one can alter settings which are related to pressure control.



A description of the HPC control logic can be found in section 7. Pressure control.

The pressure control parameter tab is divided into three logical sections :

1. Pressure control parameters
   The parameters in this section are applicable for both STD and HS control mode.
2. Pressure control mode
   Here one can enable HS control mode. STD control mode is default.
3. Standard control mode parameters
   The parameters in this section are only valid for STD control mode.



Pressure control parameters :

Min. setpoint [Pa]	
Description	You can set a minimum setpoint pressure here.
Function	This determines the lowest pressure control setpoint that can be entered or accepted from a remote command.
Default value	100000 [Pa]
Comment	Due to the pressure medium density, pressure settings near atmosphere are not possible. The minimum setpoint avoids entry of pressure values at which pressure control may not operate properly.

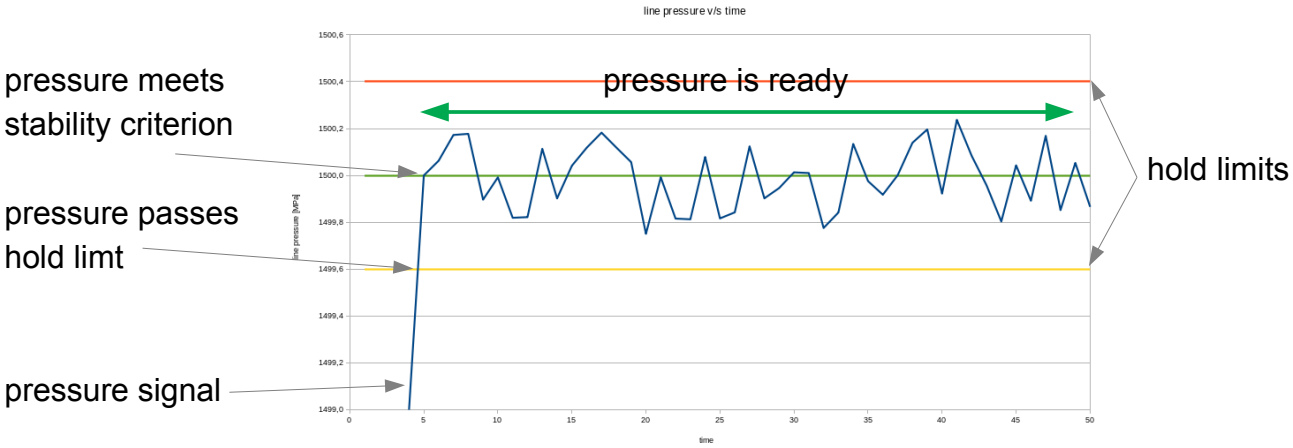
Slew time [s]	
Description	The slew time affects the coarse control speed; the shorter the time the faster HPC controls to the nominal next pressure setpoint. The minimum accepted slew time is ten seconds.
Function	Adjust the amount of time the HPC will target to get from the current pressure to the nominal next pressure set point.
Default value	10 [s]
Comment	The slew time affects the coarse control stage of pressure setting only. The default value is optimzed for fast pressure increments typically set with a 400 MPa controller. In some applications a high control speed is not desired, to reduce the control speed it may be useful to increase the slew time. Generally, changing pressure control parameters from the default values is used only to adapt HPC for unusual operating conditions. See also section 7.1.1 Coarse control stage.

Vent pressure [Pa]	
Description	When going to vent, HPC controls to this pressure before opening the vent valve.
Function	This setting avoids large large and fast pressure drops which are bad for most pressure measurement and control devices.
Default value	4000000 [Pa]
Comment	Vent pressure can be used to set a lower vent pressure to further reduce the size of the sudden pressure drop in the vent routine. Generally, changing pressure control parameters from the default values is used only to adapt HPC for unusual operating conditions.

Vent delay [s]	
Description	Vent delay is the time HPC waits after reaching the vent pressure before opening the vent valve. Minimum value is ten seconds.
Function	To allow adiabatic settling of HPC pressure in the transition from active pressure control to vented condition.
Default value	10 [s]
Comment	When HPC reaches Vent pressure, it locks the intensifier piston at its position during the vent delay period. The vent delay period is to cover the inertia of mechanical parts involved in the transition period from control to vented condition.

During the “Vent delay” adiabatic effects will cause the pressure to evolve while waiting for the vent vale to open. This is normal behavior.

Hold limit [% F.S. HPM]	
Description	A symmetrical positive and negative control limit around the setpoint within which the pressure is maintained in control mode in percent of full scale of the active reference pressure module.
Function	To assure the actual pressure is within a known distance of the target pressure when “ready” is indicated.
Default value	0.01 [% F.S. HPM]
Comment	The ready / not ready flag is represented on the local user interface through a green or red pressure value on the display, through remote commands the HPC replies with a “R” or “NR” at the end of the reply string, see 12.2 HPC detailed remote command description.



Example pressure control curve with setpoint 1500 bar

PI Kp and Ki	
Description	A proportional–integral–derivative controller (PID controller or three-term controller) is a control loop mechanism employing feedback that is widely used in industrial control systems and a variety of other applications requiring continuously modulated control. A PID controller continuously calculates an error value. For hydraulic pressure control the derivative control parameter is not applicable.
Function	Defines the setpoint offset to control valve signal relationship.
Default value	15 / 0.02
Comment	These are the base control parameters. These values are factory settings!

Pressure control mode :

High speed control	
Description	Dependent on the application, one can choose between standard (STD) control and high speed (HS) control.
Function	Enables / disables high speed control.
Default value	Disabled
Comment	See section 7. Pressure control for a detailled description of the HPC control modes.

Standard control mode parameters :

Stability σ [% F.S. HPM]	
Description	Standard deviation limit in percent of full scale of the pressure measured over the rolling stability time by the active reference pressure module.
Function	When the active pressure signal standard deviation over the time set in “stability time” is smaller than this limit, HPC starts fine control of the pressure to set and maintain the reference pressure module within the pressure control hold limit.
Default value	0.05 [% F.S. HPM]
Comment	This parameter influences the sensor alignment stability time, see section 7.1.2 Sensor alignment stability stage.

Stablity time [s]	
Description	The rolling time value over which pressure stability is calculated.
Function	Determine the time over which pressure stability is calculated
Default value	10 [s]
Comment	The default value is optimzed for pressure increments typically set with a 400 MPa controller. Generally, changing pressure control parameters from the default values is used only to adapt HPC for unusual operating conditions.

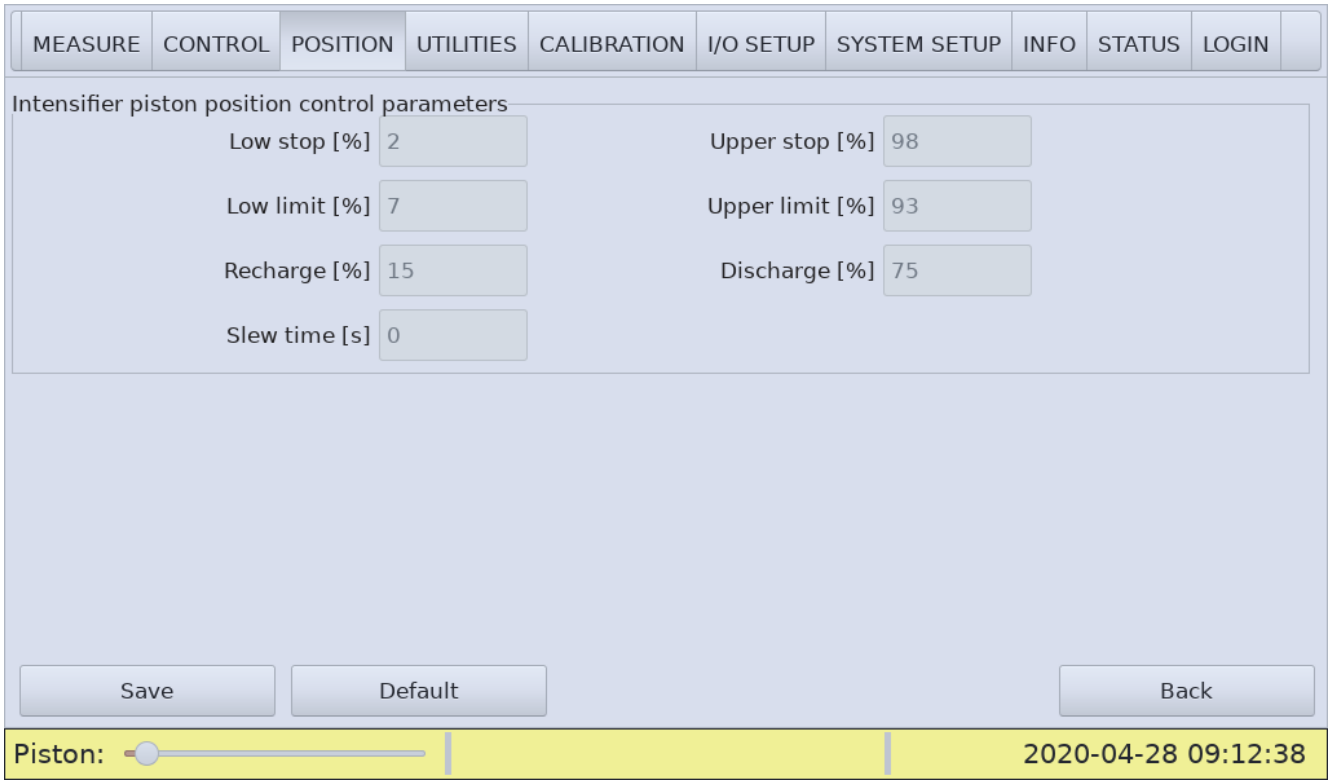
Margin [Pa]	
Description	Offset in Pascal to assure the pressure does not overshoot the setpoint in standard control mode.
Function	This value is implemented to cover a possible difference in pressure reading between the control sensor and the reference pressure module. • In an upwards excursion this value is substracted from the initial setpoint. • In a downwards excursion this value is added to the initial setpoint.
Default value	100000 [Pa]
Comment	A smaller value can result in faster pressure control but with a greater risk of overshoot events. See also section 7.1.1 Coarse control stage.

divider [-]	
Description	Sets how fast HPC adjusts its setpoint during the fine control stage of standard control mode to set and maintain the pressure at the setpoint.
Function	To optimize pressure control for the application
Default value	2 [-]
Comment	If the HPC fine pressure control around the setpoint appears to be changing too aggressively, increase the divider value. The setpoint adjustment is NOT a 100% compensation for the difference between actual pressure and entered setpoint, but it has an internal factory maximum step size of 25000 Pa to avoid unwanted pressure oscillations. See also section 7.1.3 Fine control stage.

9.4.3 POSITION

User level : Administrator, Factory
Access from : Vented condition

Here one can alter settings which are related to control of the HPC intensifier piston assembly position.



Intensifier piston position control parameters :

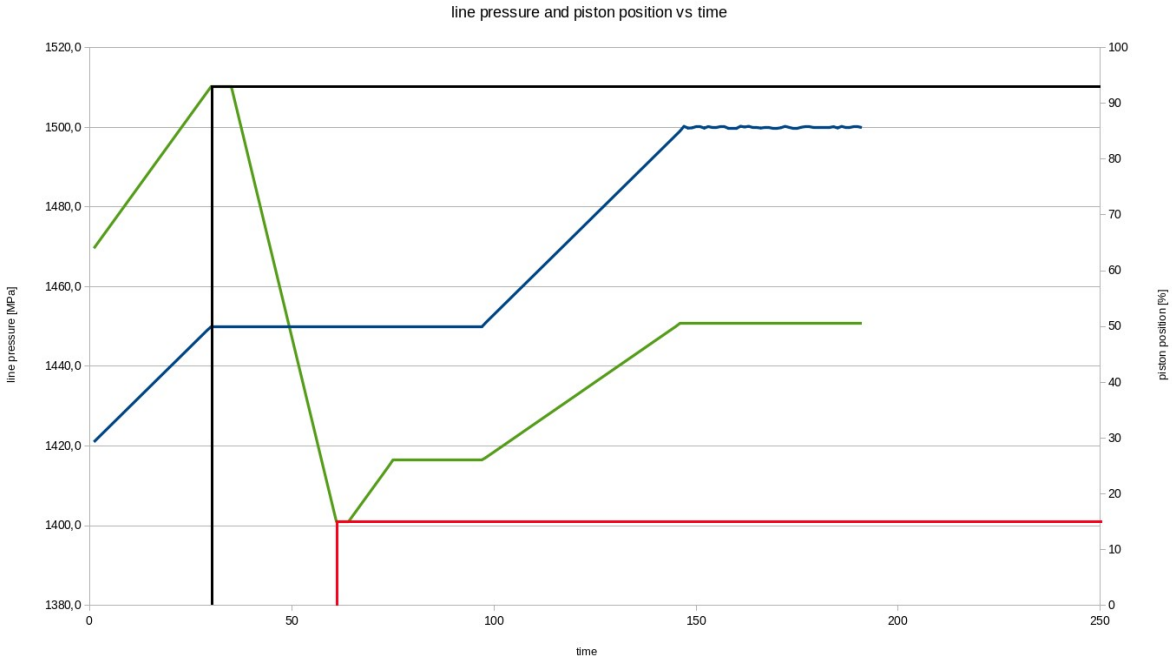
Low STOP [%]	
Description	A fixed value just above the mechanical lower end of the intensifier stroke.
Function	When the intensifier piston reaches this point the HPC freezes the intensifier piston at this position amd stops pressure control. The operator needs to push the <Stop> button to go to idle state and push the <Vent> button after that to return to normal operation. It's not 0% to assure this point is always reachable even if the position sensor reading has drifted.
Default value	2 [%]
Comment	This value is a Factory setting!

Upper STOP [%]	
Description	A fixed value just below the mechanical upper end of the intensifier.
Function	When the intensifier piston reaches this point the HPC freezes the intensifier piston at this position and stops pressure control. The operator needs to push the <Stop> button to go to idle state and push the <Vent> button after that to return to normal operation. It's not 100% to assure this point is always reachable even if the position sensor reading has drifted.
Default value	98 [%]
Comment	This value is a Factory setting!

Low limit [%]	
Description	A fixed value above the **Low stop** at which the intensifier discharge function is triggered to avoid running out of intensifier stroke when setting a descending pressure point.
Function	Low limit [%] is that point in the intensifier stroke, in a descending pressure control increment, at which the piston position discharge function is triggered.
Default value	7 [%]
Comment	In some situations --for example when lowering the temperature in a temperature chamber-- this value can be raised to avoid that the intensifier piston reaches the **Low stop** and stops pressure control before the discharge function starts.
	When the intensifier piston reaches the **Low stop** the HPC freezes the intensifier piston at this position and stops pressure control. The operator needs to push the <Stop HPP> button to go to idle state and push the <Start HPP> button after that to return to normal operation.

Upper limit [%]	
Description	A fixed value below the Upper stop at which the intensifier recharge function is triggered to avoid running out of intensifier stroke when setting an ascending pressure point.
Function	Upper limit [%] is that point at the stroke, in a ascending pressure control increment, at which the piston position recharge occurs.
Default value	93 [%]
Comment	In some occasions --for example when raising the temperature in a temperature chamber-- this value can be lowered to avoid that the intensifier piston reaches the **Upper stop** and stops pressure control before the discharge function starts.
	When the intensifier piston reaches the **Upper stop** the HPC freezes the intensifier piston at this position and stops pressure control. The operator needs to push the <Stop HPP> button to go to idle state and push the <Start HPP> button after that to return to normal operation.

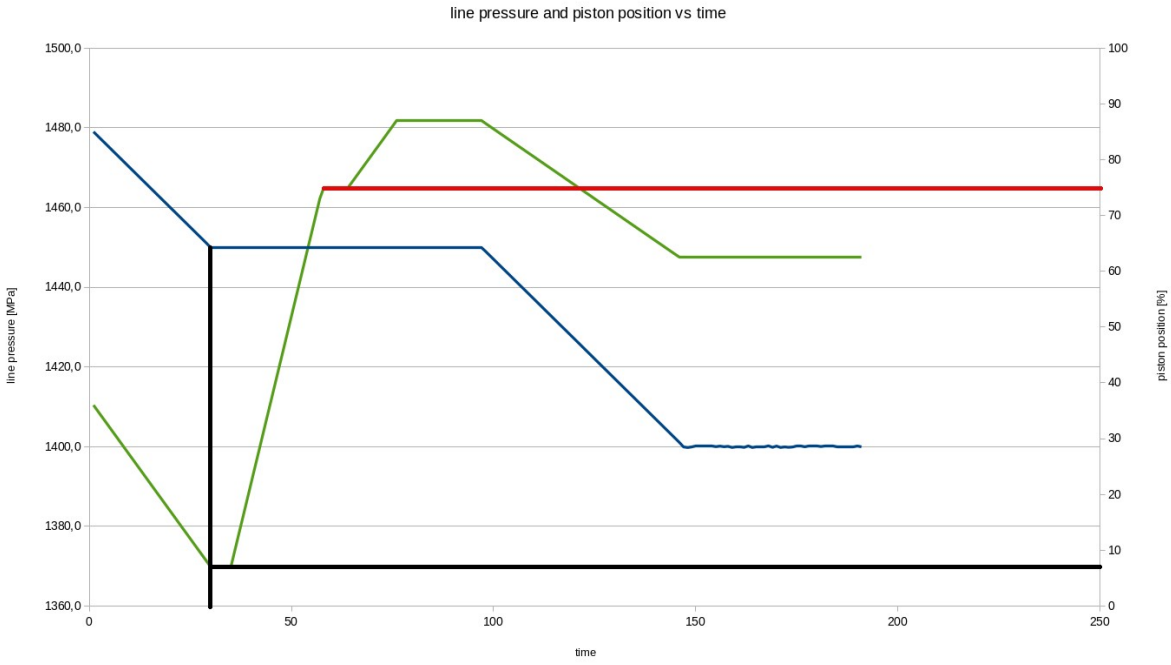
Recharge [%]	
Description	When the intensifier reaches the end of of its stroke during an increasing pressure excursion, HPC memorizes the set test pressure and closes the isolation valve thus keeping the attached devices under test under pressure, see section 6. System description for details. Then the HPC is vented and the intensifier piston is set to the recharge point. After reaching the recharge point, the vent valve is closed and HPC controls to the pressure it memorized. Next the isolation valve is opened again to continue the pressure excursion.
Function	To determine where the intensifier piston position will be set to continue control after an upper limit intensifier end of stroke event.
Default value	15 [%]
Comment	-



graphical presentation of a recharge event

: intensifier piston position
: intensifier pistion reaches the **Upper limit** (93 %)
: pressure signal
: intensifier pistion reaches the **Recharge** position (15 %)

Discharge [%]	
Description	When the intensifier reaches the beginning of its stroke during a descending pressure excursion, the HPC memorizes the set test pressure and closes the isolation valve thus keeping the attached devices under test under pressure, see 6. System description for details. Then the HPC is vented and the intensifier piston is set to the discharge point. After reaching the discharge point, the vent valve is closed and HPC controls to the pressure it memorized. Next the isolation valve is opened again to continue the pressure excursion. The optimal setting of the discharge intensifier piston position is dependent on the application. Default value is 70% of the intensifier piston stroke.
Function	To determine where the intensifier piston position will be set to continue control after a lower limit end of stroke event.
Default value	75 [%]
Comment	-



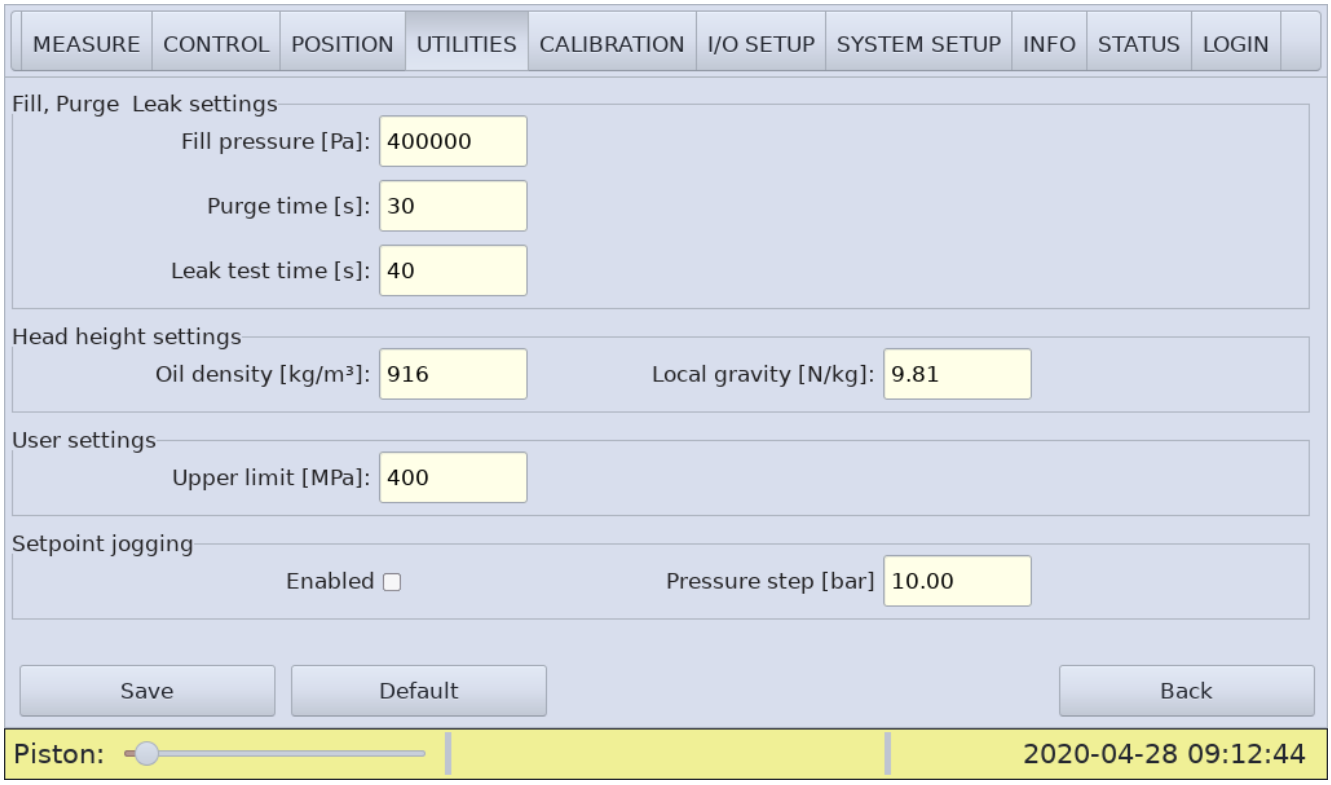
graphical presentation of a discharge event

: intensifier piston position
: intensifier pistion reaches the **Lower limit** (7 %)
: pressure signal
: intensifier pistion reaches the **Discharge** position (75 %)

9.4.4 UTILITIES

User level : No restrictions
Access from : Vented condition

Here one can alter settings which are related to the utility functions and head height correction.



Fill, Purge and Leak settings :

Fill pressure [Pa]	
Description	The pressure in Pascal to which the fill function will pump oil into the system. When the HPM reading reaches this value the fill function stops and the system is vented.
Function	To fill a system with hydraulic fluid. See also section 9.3.7.2 Fill function
Default value	400000 [Pa]
Comment	If the Fill pressure is not reached within 60 seconds, the Fill routine stops and vents.

Purge time [s]	
Description	The time in seconds over which the purge function flows compressed air through the vacuum ejector applying a vacuum to the HPC reservoir.
Function	To remove trapped air from the hydraulic system (HPC internal and attached). See section 9.3.7.3 Purge function.
Default value	30 [s]
Comment	This function also sets the intensifier piston to 90% of its stroke before activating the vacuum ejector. The effectiveness of the built-in vacuum ejector is dependent on the compressed air pressure and flow, see section 4.1 HPC general specifications for compressed air specifications.

Leak test time [s]	
Description	The duration in seconds of the leak test
Function	The leak test is intended to do an unbiased validation of the HPC leaktightness including external attached tubing and/or devices.
Default value	40 [s]
Comment	The outcome of a leak test is % of displacement of the intensifier piston, see section 9.3.7.1 Leak test .

Head height settings :

Oil density [kg/m3]	
Description	The density of the pressure medium used in in the HPC that is used to calculate the pressure head correction. The default HPC pressure medium is Sebacate.
Function	To calculate the pressure difference between HPC and a Device Under Test due to pressure reference level difference.
Default value	916 [kg/m^3]
Comment	See section 9.3.9 Head height.

Local gravity [N/kg]	
Description	The local gravity in N/kg. Default entry is normal gravity. Normal gravity is sufficiently accurate to calculate the head height correction in almost all conditions. If desired the value can be changed to the actual local gravity.
Function	To calculate the pressure difference between HPC and a Device Under Test due to a pressure reference level difference.
Default value	9.81 [N/kg]
Comment	See section 9.3.9 Head height.

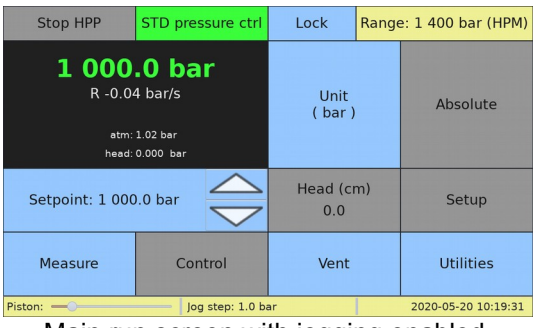
User settings :

Upper limit [active pressure units]	
Description	The user can set a system maximum pressure here in active pressure units. The HPC will refuse pressure control commands greater than the upper limit setting. The active pressure module range always overrules the upper limit when the pressure module has a lower maximum pressure.
Function	To protect devices under test from accidentally entered setpoints higher than their maximum allowable pressure.
Default value	400 MPa / 58000 psi
Comment	This value does not change when swapping pressure modules.

Setpoint jogging :

Enabled	
Description	When enabled, the jog direct pressure control keys, ⇧ and ⇩ appear on the main run screen, to increase or decrease the setpoint value by a nominal amount (pressure step) each time they are pressed. If pressure control is active, the HPC adjusts pressure using a special pressure control mode to execute the change very quickly.
Function	Enables / disables jog function.
Default value	Disabled
Comment	This function is intended to be used to calibrate analog gauges where putting the gauge needle exactly onto the nominal pressure engraved on its scale is important or in other applications where quick, small pressure steps around a setpoint are useful.

Pressure step	
Description	The pressure step is dependent for example on the scale division size (resolution) of the analog gauge to be calibrated.
Function	Defines the step size of the pressure step in active pressure units when the jog function is enabled.
Default value	0.4 MPa / 58 psi
Comment	For example if the scale division of an analog gauge is 10 bar, the pressure step might be set to 2.5 bar, ¼ of the division to allow the gauge needle to be set exavtly on the nominal point as read by the gauge.

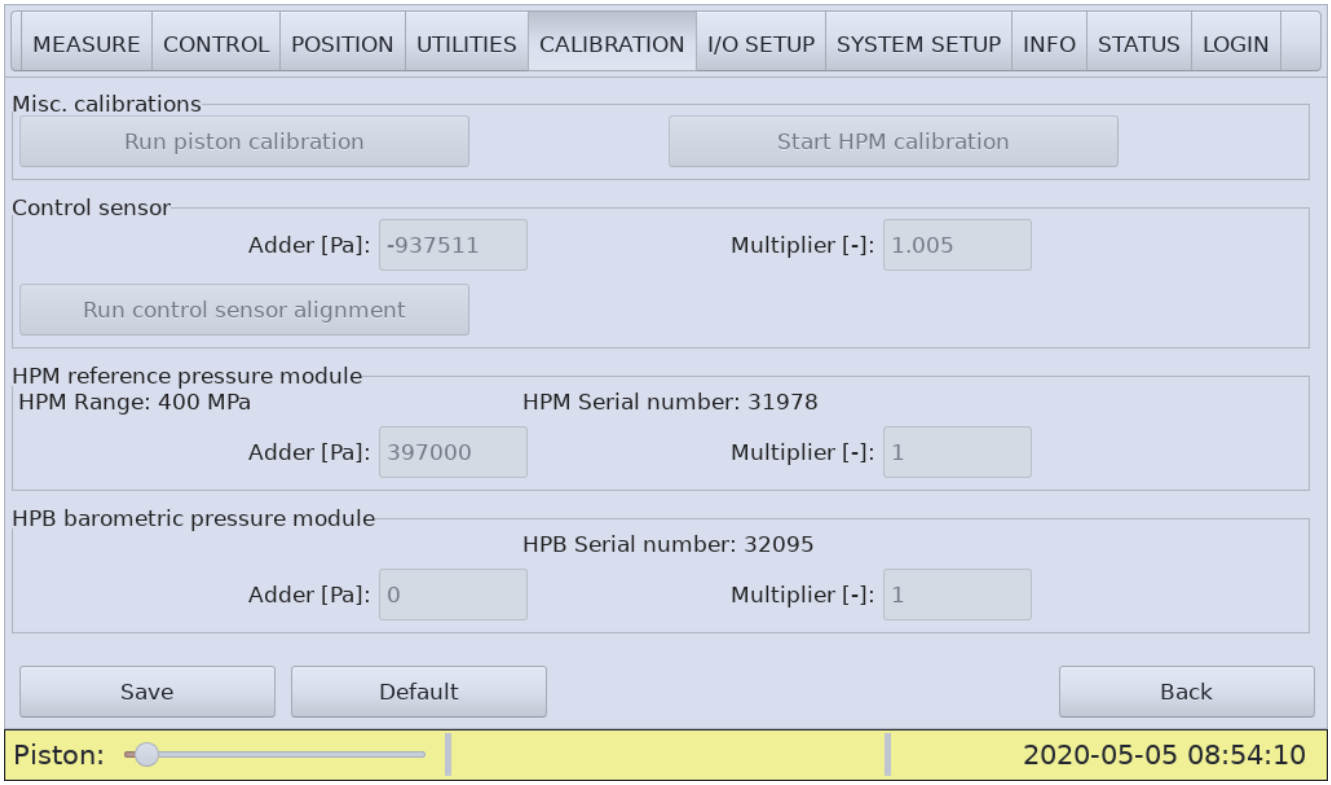


Main run screen with jogging enabled.

9.4.5 CALIBRATION

User level : Administrator, Factory
Access from : Vented condition / idle state

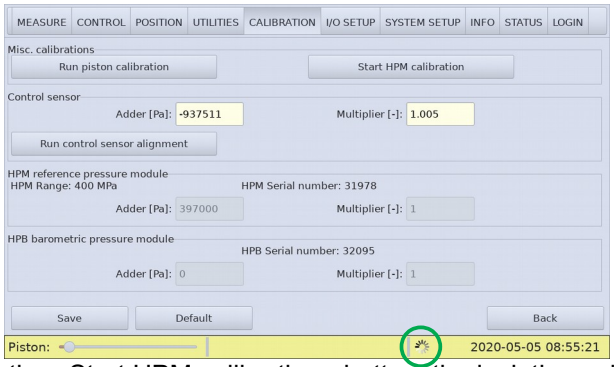
The HPC has several sensors which need regular adjustment/calibration.



Misc. calibrations

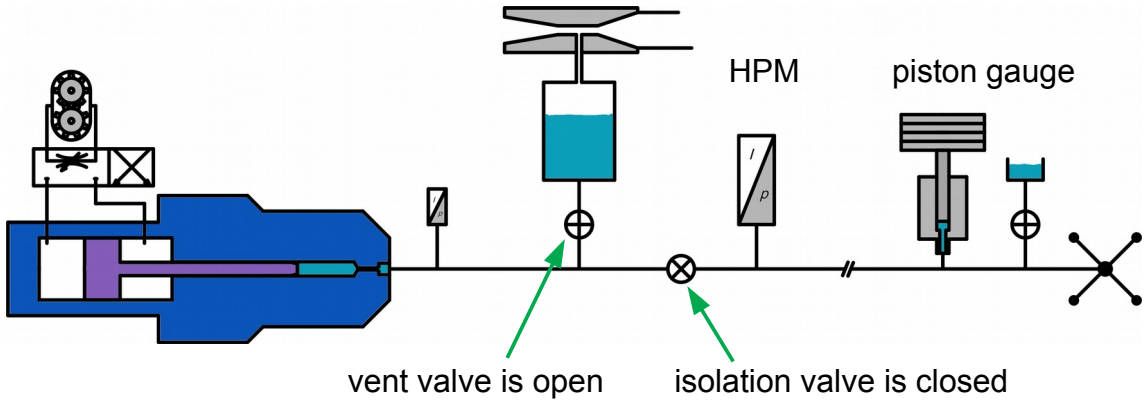
Run piston calibration	
Description	The <Run piston calibration> button initiates an automated function to calibrate the piston position sensor. In vented condition it will control the piston to its mechanical beginning and end stops (0 and 100%) and calculates a zero offset and slope.
Function	To align the mechanical piston stroke limits with the intensifier piston displacement transducer reading.
Default value	n/a
Comment	A suggested interval for this function is once every 3 months.

Start HPM calibration	
Description	Pushing the “Start HPM calibration” puts HPC in a state in which one can apply a reference pressure to the HPC test port to calibrate the installed HPM as described in section 14.2.1 Calibrating HPM installed in HPC.
Function	In HPM calibration mode the HPM is isolated from HPC’s hydraulic circuit to be able to apply a reference pressure from the test port to the HPM only.
Default value	n/a
Comment	This button is active only when the HPC is in idle mode. The HPP stays off. See also section 9.1 Status field overview.



After pushing the <Start HPM calibration> button, the isolation valve is closing.

HPC main run screen in HPM calibration mode,pushing the <Stop> button puts HPC back in idle mode



Control sensor

Run control sensor alignment	
Description	The <Run control sensor alignment> button initiates a fully automated routine to align the control sensor with the mounted HPM. From vented condition the pressure is set to 10% of the HPM range and the reading of both the control sensor and the HPM are recorded. Next stage pressure is set to 75% of the HPM range and again both readings are recorded. With the four readings HPC calculates and applies --after operator evaluation-- the zero offset and the slope to best align the control sensor with the HPM.
Function	To align the control sensor with the installed (calibrated) HPM. This optimizes pressure control and avoids potential overshooting.
Default value	n/a
Comment	It is recommended to run the control sensor alignment routine any time the HPM is changed. A detailed alignment procedure and interval suggestion can be found in section 14. Calibration of this manual.

The HPC will pop up a warning message with the maximum pressure it will control to. Please make sure anything attached to the HPC test port is compatible with this pressure.

When the routine is finished, it will show the adder and multiplier on the form for evaluation by the user. The user needs to click on the <Save> button to store the new values in memory and activate them. If the <Save> button is not used, the new values are not stored and the old values remain active.

The multiplier generally is a value between 0.9800 and 1.0200, when the value is outside this window, do not save. Run the calibration routine again.

If the multiplier remains outside this acceptance window after repeated runs of the control sensor alignment function, consult the factory.

HPM reference pressure module

The HPM can be calibrated mounted in the HPC or externally using the HPM power cord + RS232 kit.

A 1st degree adjustment is possible by calculating an adder and multiplier. The entry fields in the form show the current adders and multipliers. A suggested calibration procedure and interval can be found in section 14.2 HPM (reference pressure module) calibration of this manual.

HPB barometric pressure module

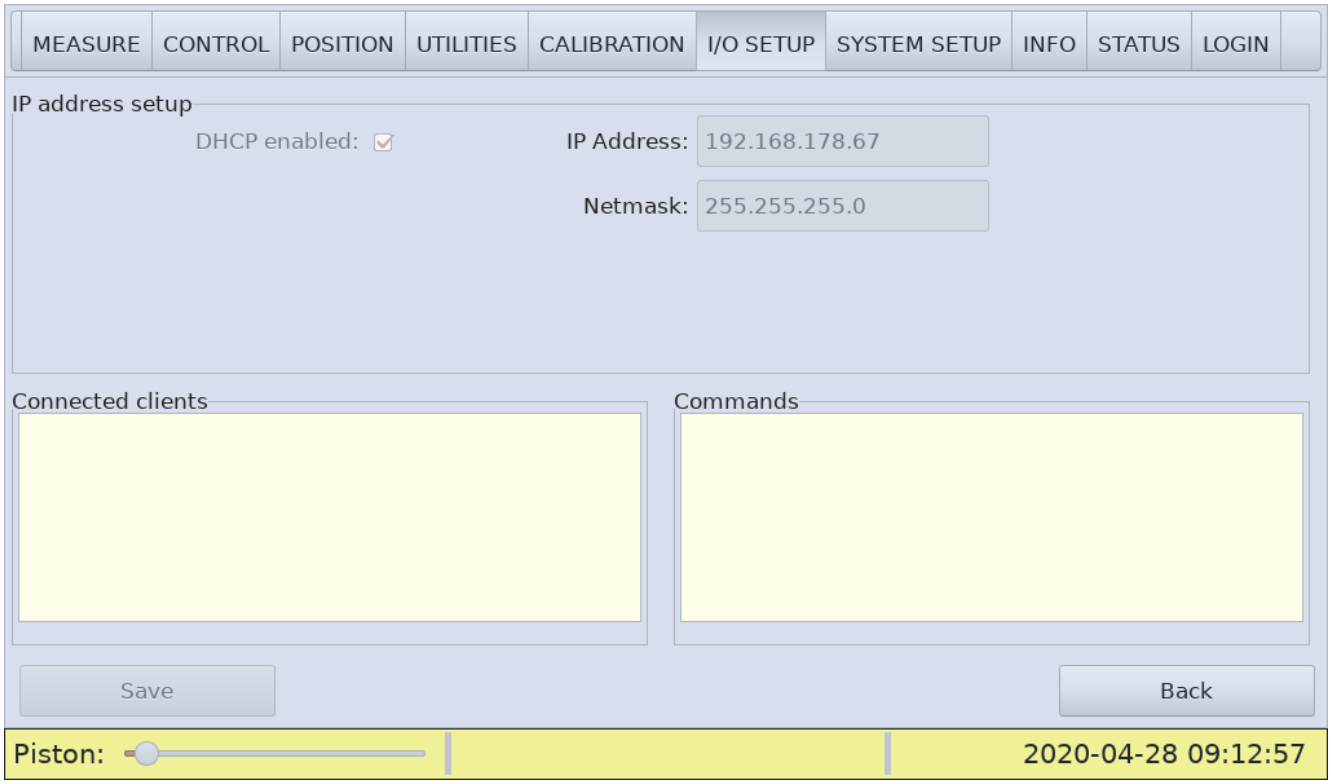
The HPB can be calibrated mounted inside the HPC or externally using the HPM power cord + RS232 kit.

A 1st degree adjustment is possible by calculating an adder and multiplier. The entry fields in the form show the current adders and multipliers. A suggested calibration procedure and interval can be found in section 14.3 HPB (barometer module) calibration of this manual.

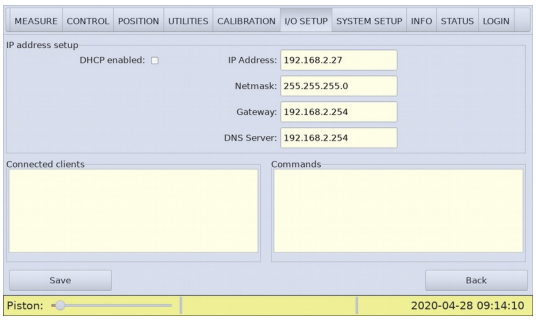
9.4.6 I/O SETUP

User level : Administrator, Factory
Access from : Vented condition

Here one can alter Ethernet settings. The simulated RS232 port on the HPC accepts any RS232 setting from a host and does not require specific settings.



DHCP enabled	
Description	When a DHCP Server is available on the local network you should enable DHCP. The DHCP server automatically provides and assigns IP addresses, default gateways and other network parameters to the HPC. It relies on the standard protocol known as Dynamic Host Configuration Protocol or DHCP to respond to broadcast queries by clients.
Function	Automates the IP settings
Default value	Enabled
Comment	When DHCP is enabled, the entry fields are greyed out and display only the assigned IP address and Netmask. When DHCP is not enabled you need to enter IP address, Netmask, Gateway and DNS server.



I/O SETUP window with DHCP not enabled.

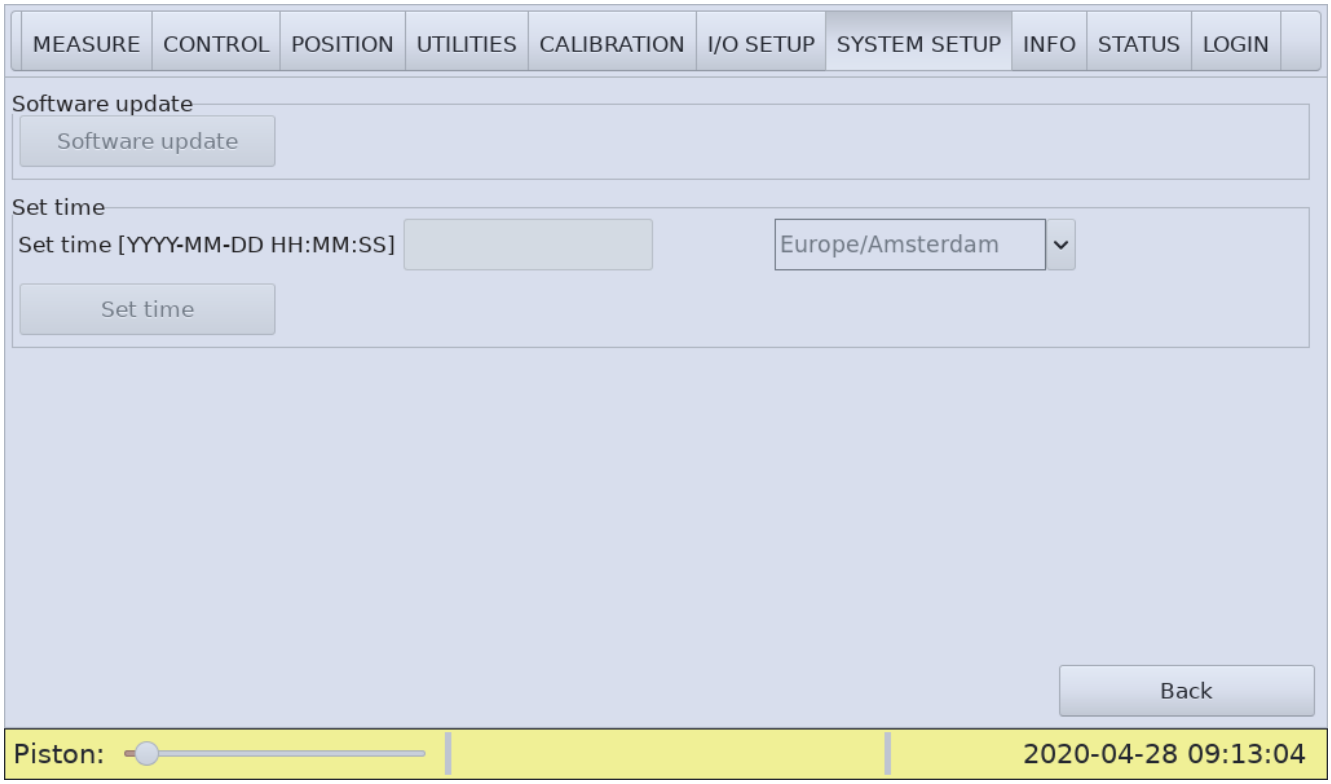
Connected clients	
Description	An overview of connected clients (through Ethernet)
Function	HPC supports a maximum of six hosts to connect over its Ethernet port, the active connections are listed here.
Comment	A possible scenario is that HPC is running an unattended calibration procedure using a local calibration program such as Compass for Pressure® over the USB port where an operator can follow the progress via the HPC Ethernet port from home via Internet.

Commands	
Description	An overview of commands received by the HPC over its USB and/or Ethernet port AND HPC replies.
Function	To debug remote communication.
Comment	-

9.4.7 SYSTEM SETUP

User level : Administrator, Factory
Access from : Vented condition

When logged in as Administrator or Factory, the operator can perform a firmware update, see section 15. Upgrading firmware , system time and time zone.



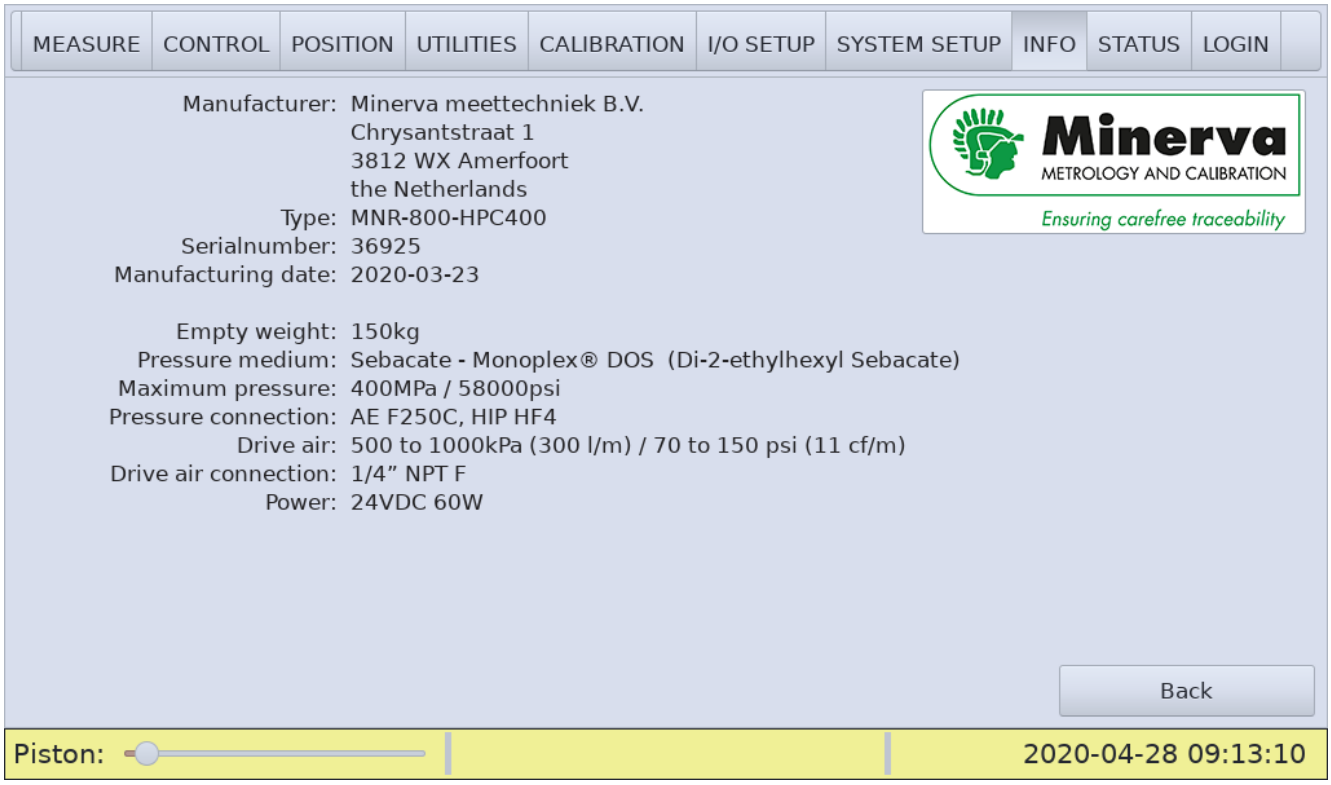
When the HPC is connected to a network with Internet access, it synchronizes its system time automatically with an NTP server.

9.4.8 INFO

User level : Read only for all levels.

Access from : Vented condition

This window shows hardware and firmware details.

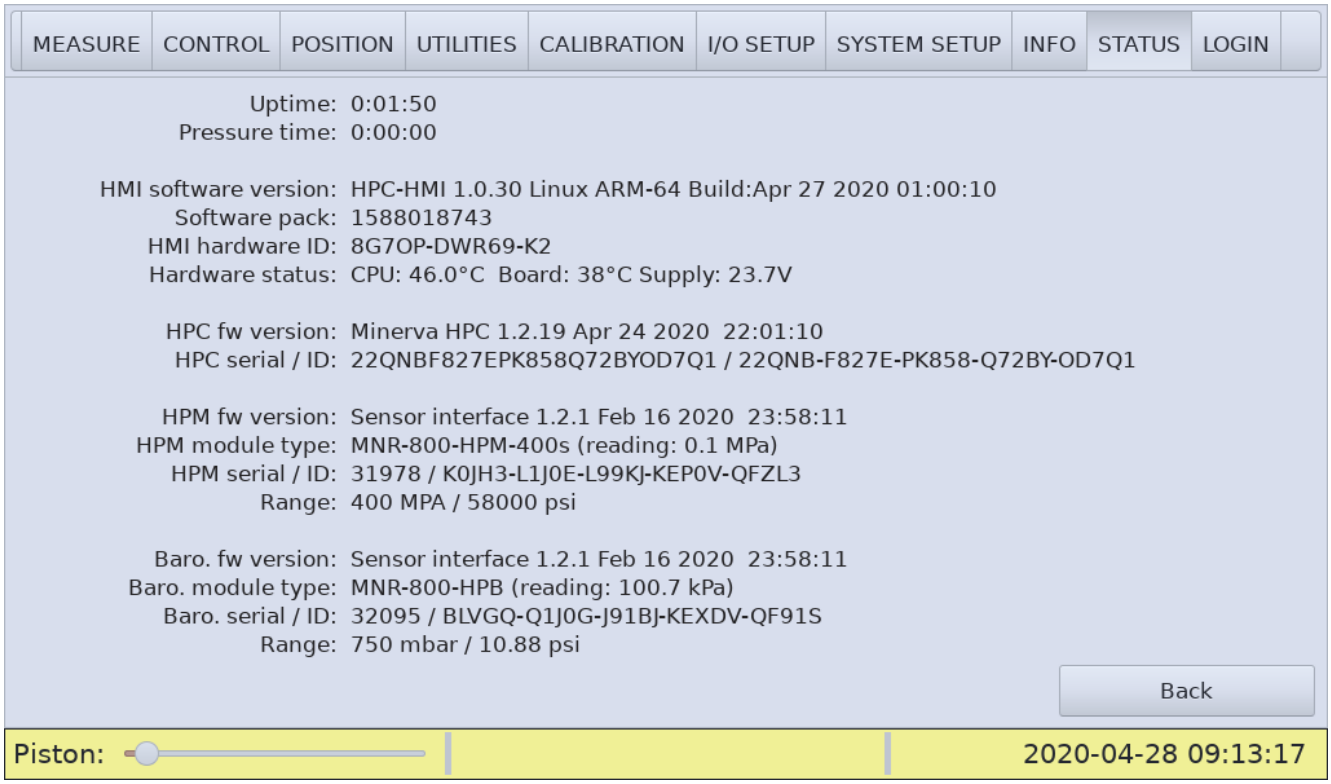


9.4.9 STATUS

User level : Read only for all levels.

Access from : Vented condition

This window shows uptime and system under pressure time, HPC firmware version and firmware versions + details of the connected HPM and HPB modules.



The HPC has internal components and moving parts to control and measure high liquid pressure. The seals require regular maintenance. The recommended maintenance interval is every 2500 hours of pressurized operation, see section 13. Inspection and maintenance.

The time the HPC spends under pressure is accumulated by the Pressure time.

1. Uptime : total time HPC is powered up
2. Pressure time : total time HPC is under pressure

9.4.10 LOGIN

User level : No restrictions

Access from : Vented condition

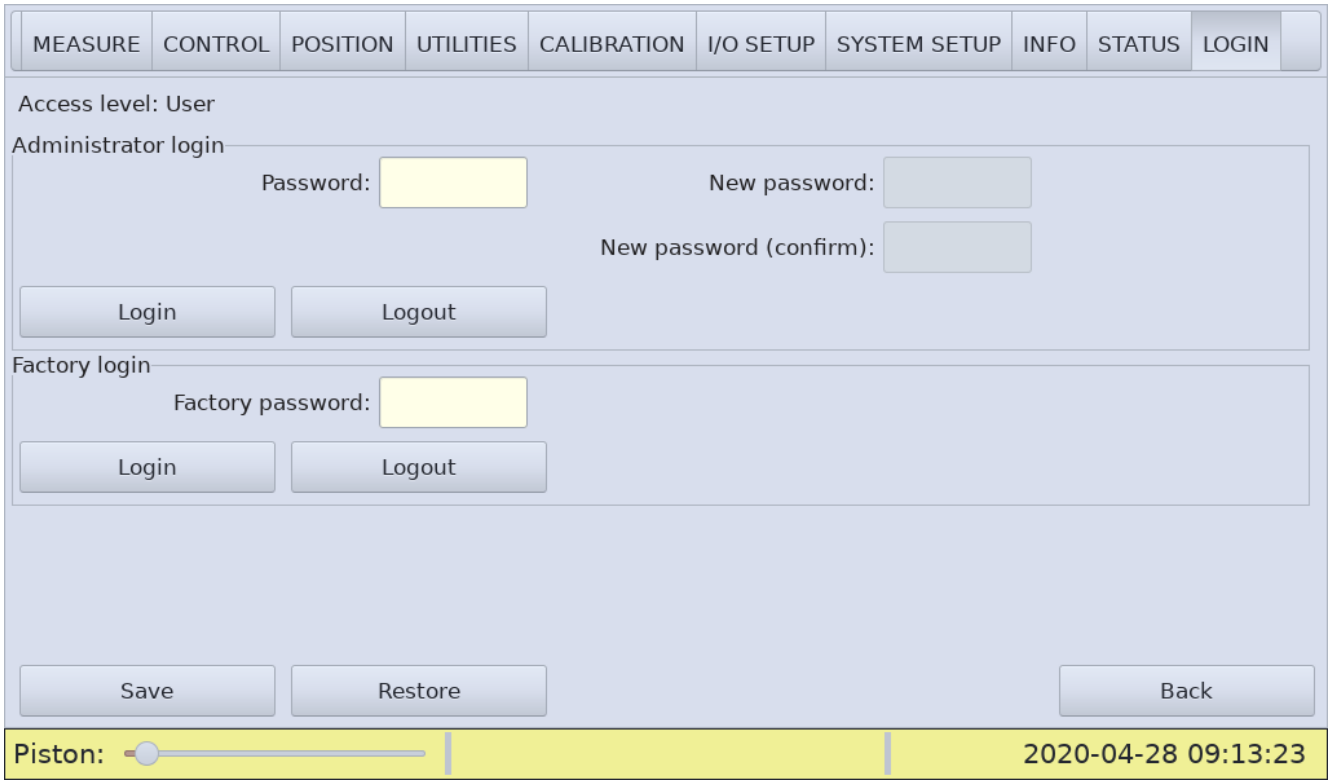
Here you can login as Administrator (or Factory) to gain access to the Administrator or Factory functions. Critical functions which require in depth knowledge of the HPC and calibration in general are read only at the normal user level and can only be changed at the Administrator or Factory level.

Factory login is only intended to be accessed by the factory, login credentials are not shared.

See section 9.2 Access scheme for detailled access per function.

The default Administrator password is “Minerva”, this password can be changed by the user.

If the password is lost, please contact the factory for a recovery password.



After entering a new Administrator password, do not forget to push the <Save> button.

10. Installation

10.1 Reference pressure module

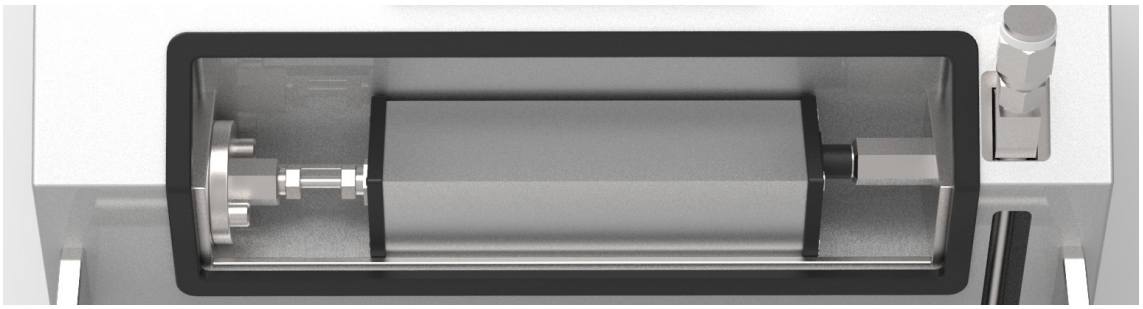
Mount a pressure module in the dedicated HPC pressure module dock, tighten the high pressure connection and connect the electrical interface plug.

See also 11.3 Installing a different HPM (range)

Recommended torque on the gland is 34 Nm

high pressure connection

electrical connection



Reference pressure module (HPM) mounted in HPC.

10.2 Powerpack

- install an appropriate mains power plug on the mains supply cable pigtail.

Mains supply is dangerous, installing mains socket plugs should only be performed by personnel who have been instructed in proper safety practices.

Here are some general instructions on how to install a mains power plug on the mains supply cable pigtail. Please note that these instructions might not be applicable in all situations

- The three wires inside the mains supply cable are freed and crimps on the bare ends are pre-installed by the factory (pigtail)
- Remove the mains power plug cover by either "snapping" or unscrewing it
- Unscrew the little screws on each of the plug's pins.
- Insert the crimped bare end wires into the holes in the pins.
- The green and yellow wire must always be inserted into the ground pin
- The blue wire is inserted into the pin which is marked with a blue spot or the letter N.
- The brown wire is inserted into the pin is marked with a brown spot or the letter L
- Tighten the little screw on each of the plug's pins.
- Make sure the mains supply cable is firmly gripped by the arrestor clips.
- Replace the cover of the plug.

	
Example 110 V 32 A plug (not part of delivery).	Example 230 V 16 A plug (not part of delivery)

Make sure to use the appropriate current rating when selecting the mains plug, 110 V 32 A / 230 V 16 A

- Connect hydraulic flexible hoses and electrical connections between the HPC and the HPP using the ordered HPP/2 /4 /6 interconnection hardware / flex tube.

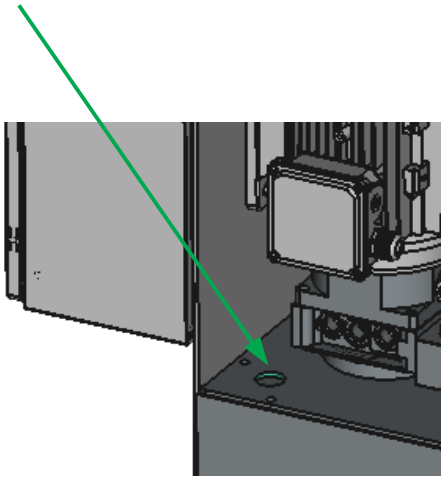
10.3 Compressed air

- Connect pneumatic drive air (see 8.2 Site requirements)

We recommend ISO8573-1:2010 Class 1.4.2 grade compressed air

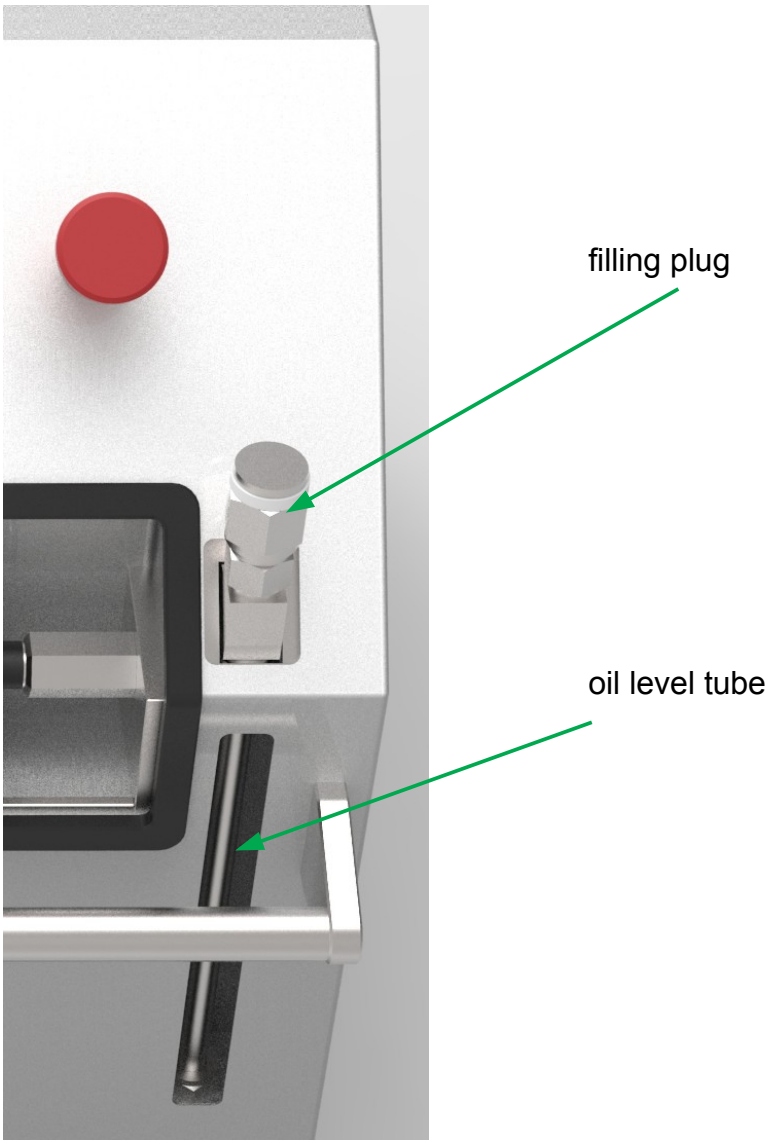
10.4 Filling the powerpack with oil

- Fill the HPP powerpack with 40 litre of Castrol hyspin AWS hydraulic fluid, 32ISO using the supplied funnel.



10.5 Filling the HPC reservoir with oil

1. Make sure the test port is / remains plugged[4]
2. Remove the filling plug on the fill point of the oil reservoir
3. Use the funnel for filling HPC with Priolube 1856 (see marking on funnel) to fill the internal oil reservoir till the maximum level as indicated on the oil level tube.
4. Reinstall the filling plug and tighten it



4 Make sure the test port plug is properly torqued with the recommended 34 Nm! During transport the plug may be loosened!

10.6 Removing air from the HPC internal tubing

The HPC hydraulic oil is removed before shipment. Prior to attaching anything to the HPC test port, it is necessary to remove any trapped air from the internal tubing and the intensifier.

The HPC has two on board functions to remove trapped air; Fill and Purge. At this stage we want to focus on the trapped air inside HPC so the test port remains plugged.

1. Connect the HPP to the mains supply

Make sure that the mains supply has the correct voltage and power rating

2. Power up the HPC by releasing the red emergency knob on the front panel

If the HPC does not power up, check the mains supply and safety switch inside the HPP switchbox

3. From the main run screen enable the HPC by pressing the blue colored <START> button on the lower right of the touchscreen. After pressing this button, the main run screen appears.

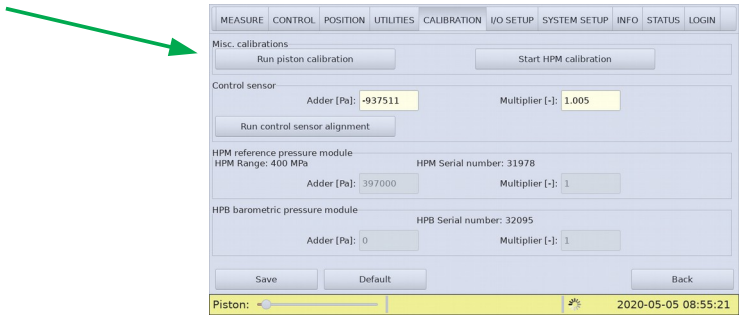
4. From the main run screen push <Start HPP>
   This will activate the HPP and sets the HPC to vented condition ready to generate pressure.
5. Run the Fill procedure as described in section 9.3.7.2 Fill function
6. Run the Purge procedure as described in section 9.3.7.3 Purge function

In practice a sequence of the Fill and then Purge functions works best to remove trapped air from the HPC.

10.7 Piston position calibration

Before shipping the HPC, the piston position sensor has been calibrated, but transport / temperature shocks might have affected the calibration. After installing the HPC and priming and purging, it is good practice to run the piston position calibration routine through :

<Setup>, <Calibration>, <Misc. calibrations>, <Run piston calibration>



Calibration menu is only accessible as Administrator.

10.8 HPC leak test

After assuring the piston position sensor is calibrated, the next step is checking HPC for any leaks which might have been caused by (rough) transport.

At this stage we do not have any external volume attached to the test port and the test port is plugged.

Run a leak test as described in section 9.3.7.1 Leak test at the following pressures :

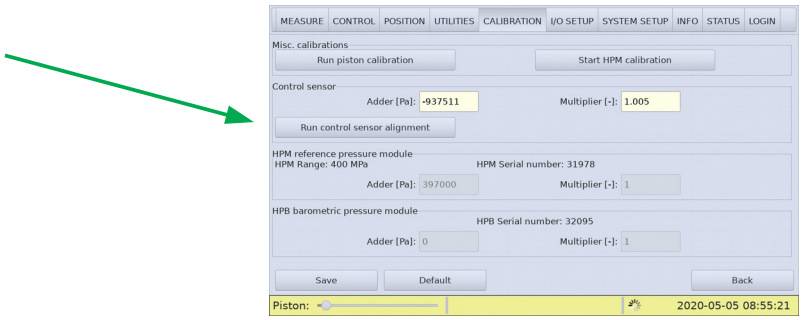
1. ~10% of the active HPM range
   if successful continue with :
2. ~50% of the active HPM range
   if successful continue with :
3. ~90% of the active HPM range

If the leak test at one of the above stages is unsuccessful, abort the test, locate and fix the leak(s) and start again.

10.9 Control sensor alignment

Prior to shipping the control sensor is aligned against a calibrated 400 MPa reference pressure module. After installing the HPC and priming and purging, it is good practice to run the control sensor alignment procedure using the mounted HPM to optimize the control sensor fit over the active range :

<Setup>, <Calibration>, <Run control sensor alignment>



Calibration menu is only accessible as Administrator.

When HPC is equipped with a reference pressure module (HPM), a fully automated routine is available to align the control sensor with the HPM. From vented condition HPC is set to 10% of the HPM range and records the reading of both the control sensor and the HPM. Then the HPC controls to 75% of the HPM range and again records the readings of both the control sensor and the HPM.

With the 2 readings HPC calculates the zero offset and the slope.

When the routine is finished, it will show the adder and multiplier on the form for evaluation by the operator. Press the <Save> button to store the new values in memory and activate them. If the <Save> button is not used, the new values are not stored and the old values remain active.

The multiplier generally is a value between 0.9600 and 1.0400. If the value is outside this window, do not save and run the calibration routine again.

If the multiplier remains outside the acceptance window, consult the factory.

It is suggested to run the control sensor alignment routine each time the user swaps the HPM. A detailed alignment procedure and interval can be found in the maintenance section of this manual.

10.10 Attaching external tubing

ALWAYS use external tubing and fittings rated for pressure equal to or greater than the maximum pressure HPC will be used to generate.

HPC uses AE F250C, HIP HF4 high pressure connection which is a gland and collar type fitting for 1/4 in. (6.35 mm) coned and left hand threaded tubing

Minimizing the length of the test connection tubing and overall test internal volume will enhance control performance and reduce pressure setting time. For normal operation, the optimum total volume of the device or system under test including connecting tubing is 50 cc (3 in^3) and should be less than 100 cc (6 in^3).

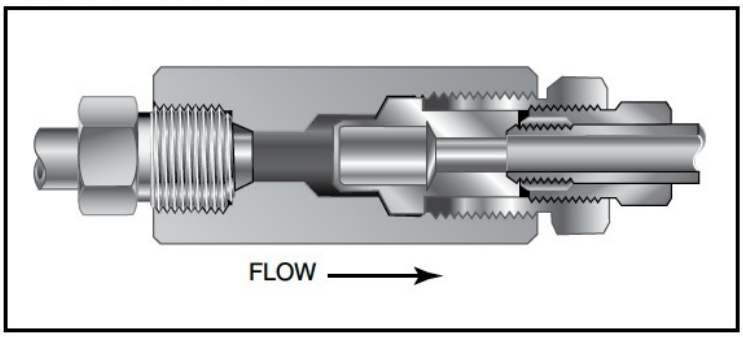
When the HPC is vented, the system connected to the test port is connected to the reservoir. If there is an open point in the system below the fluid level in the reservoir, liquid will run out of the reservoir through the open point.

10.10.1 Installing a line filter to protect HPC

It is recommended to install a high pressure line filter between HPC and external devices to protect HPC from contamination from devices under test when used in a harsh environment.

High flow cup-type line filters are recommended which can cope with high flow rates and have maximum filter surface area. For example a Parker Item # CF4-5, High Pressure Cup-Type Line Filter can be used.

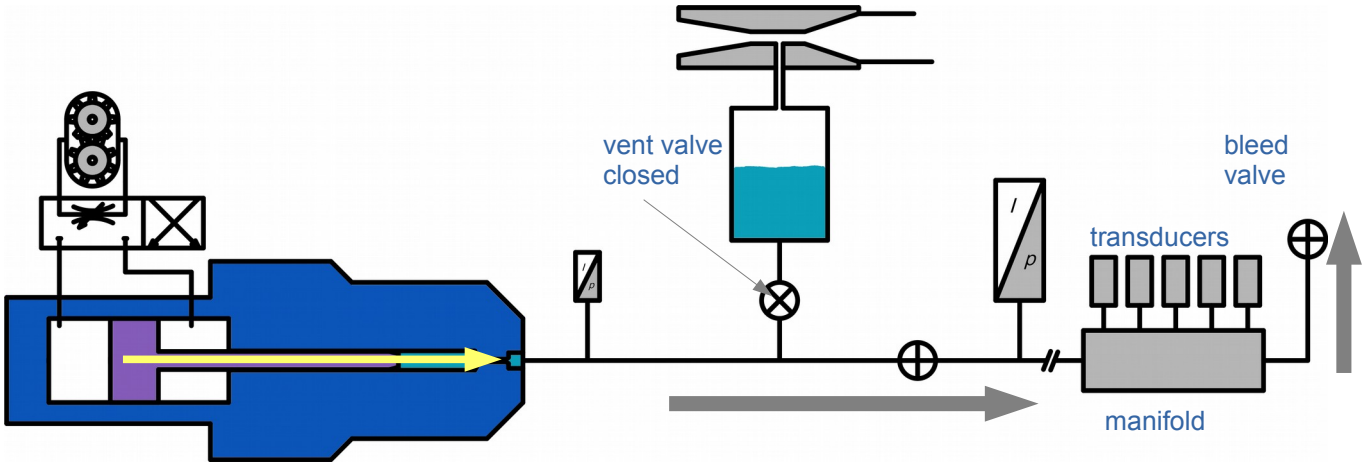
Cup-Type Line Filters



10.11 Removing air from the external tubing

Similar to the procedure described in 10.6 Removing air from the HPC internal tubing, trapped air in the volume connected to the test port can be removed with a combination of filling and vacuum purging. In this stage we have connected external tubing, a device under test and or a manifold to the test port.

It is good practice to design the test system connected to the test port in such that the high point has a means to be opened to bleed air. This can be a valve or a removable plug.



1. Run the Fill procedure as described in section 9.3.7.2 Fill function
2. Run the Purge procedure as described in section 9.3.7.3 Purge function

In practice a sequence of the Fill and then Purge functions works best to remove trapped air from the HPC.

10.11.3 External tubing leak test

After filling and purging the test volume, the next step is checking the complete system for leaks. As we already checked the HPC with plugged test port, any leaks identified are in the test volume attached to the test port.

Run a leak test as described in section 9.3.7.1 Leak test at the following pressures :

1. ~10% of the active HPM range
   if successful continue with :
2. ~50% of the active HPM range
   if successful continue with :
3. ~90% of the active HPM range

If the leak test at one of the above stages is unsuccessful, abort the test, locate and fix the leak(s) and start again.

11. Operation

This section of the manual describes typical HPC operation when calibrating a device under test.

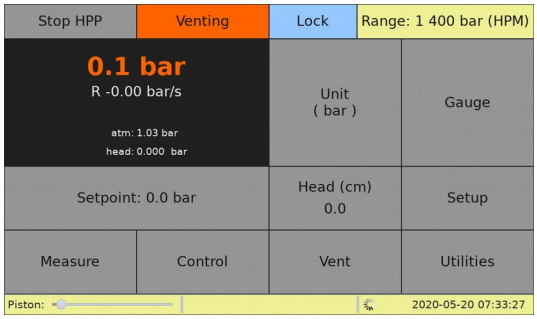
At this stage it is assumed that the HPC is installed and commissioned with an external test system to connect a device under test as described in section 10. Installation.

11.1 Preparing HPC for operation

Action		Function
1. Release	Red safety button	Powers up HPC.
2. Push	<Start> button	HPC diagnostics runs and releases HPC functions when passed.
3. Push	<Start HPP> button	Powers up HPP and sets HPC to vented condition.

Startup screen appears after step (1).

Main run screen after step (2).



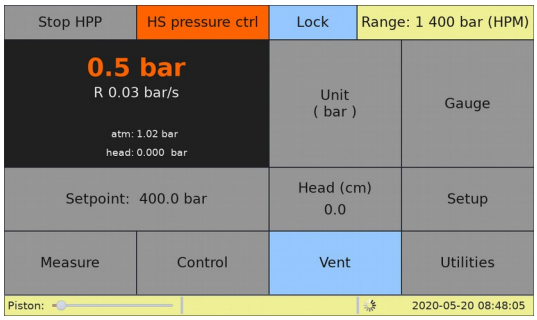
Main run screen after step (3) / (working towards vented condition).

11.2 Setting a pressure

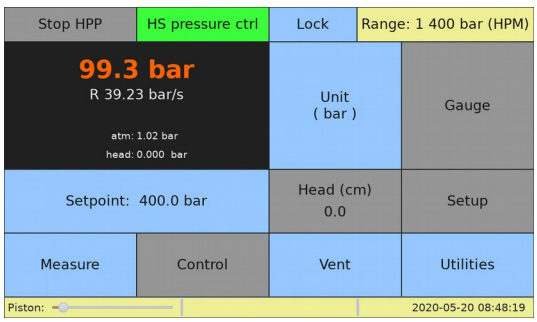
1. Enter setpoint (example 400 bar).

2. Press <Enter> button on on-screen keypad.

3. Press <Control> to set HPC in control mode.



The HPC status field becomes red to indicate that HPC is going from vented condition to HS pressure control mode. Going from vented condition to a pressure control mode takes some time to assure the vent valve is closed. After a short waiting period, the HPC controls to the entered setpoint and indicates a green colored pressure value when the actual pressure is within hold limit and meets the stability criterion, see 9.4.2 CONTROL.

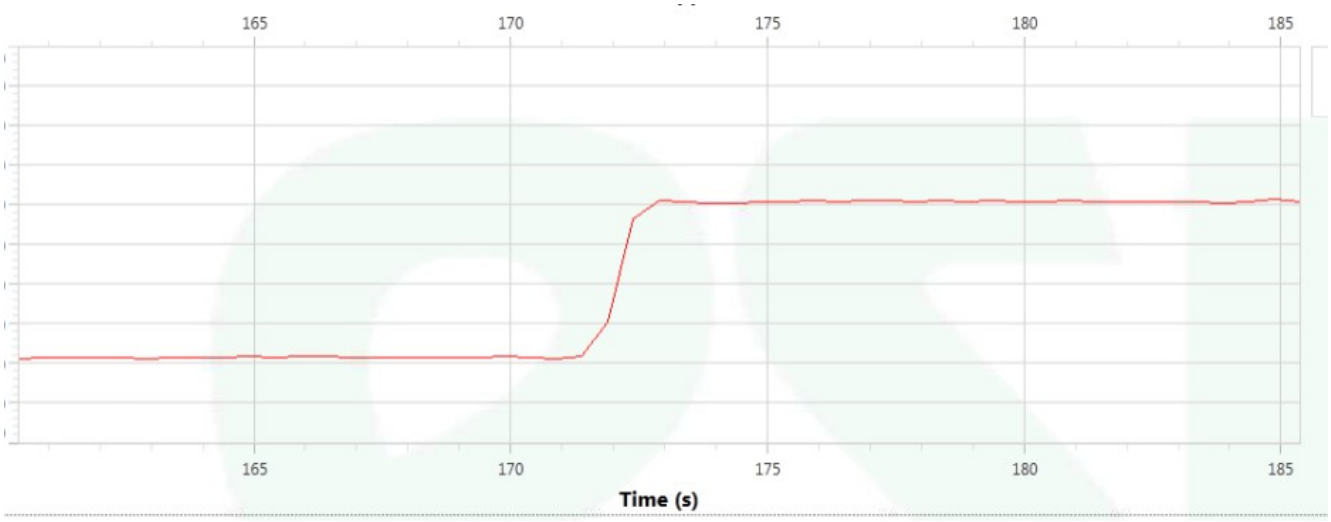


11.2.1 Jogging

Controlling to a setpoint typically takes 60 seconds. In some applications there is a need for a small adjustment of the setpoint in a short period of time. HPC can make fast small pressure steps with a default maximum of 0.4 MPa (58 psi). When entering a new setpoint where the difference between the current pressure and the target pressure is less than 0.4 MPa (58 psi), HPC will control to the new setpoint in less than 10 seconds.

Instead of entering a new setpoint, the HPC jog function can be enabled and pressure step size set. To enable this control function, see section 9.4.4 UTILITIES.

Making an instant 1 bar step.



11.3 Installing a different HPM (range)

HPC can be configured to the optimal range for performing a calibration job. The procedure below describes how to remove an active HPM and install another HPM.

The HPC must be in vented condition for this operation.

The HPM modules are hot swappable, there is no need to power down HPC.

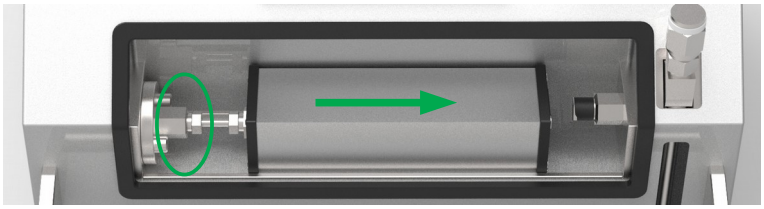
Do not leave the HPM pressure connection port on the HPC open to atmosphere longer than necessary as air will enter the HPC hydraulic circuit.

Take appropriate precautions when handling the hydraulic oils, read the **M**aterial **S**afety **D**ata **S**heets first!

See ANNEX 1 MSDS sheets of this manual and the MSDS documents glued on the oil cans.

1. Disconnect the electrical interface plug.
   The plug is secured by a bayonet ring. Rotate the ring to disengage and slide the connector to the right.

2. Loosen the high pressure connection on the bulkhead side leaving the short high pressure nipple on the HPM. Slide the HPM to the right until the nipple is fully extracted from the bulkhead.

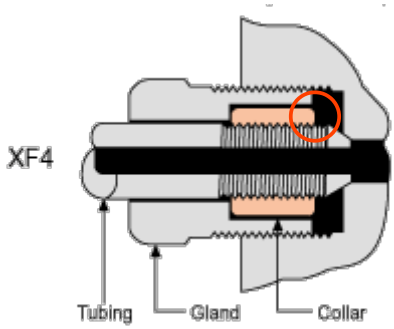


   Small drops of oil can come out of the nipple and or the bulkhead. The oil is collected in the cradle drain pipe.
3. Remove the HPM from the cradle.
4. Clean the cradle with a paper towel.

Take appropriate precautions when handling the hydraulic oils, read the **M**aterial **S**afety **D**ata **S**heets first!

See ANNEX 1 MSDS sheets of this manual and the MSDS documents glued on the oil cans.

5. Place the new HPM including the short high pressure nipple in the cradle.
6. Make sure the collar is positioned correctly on the nipple leaving at least two exposed threads of the left hand thread.

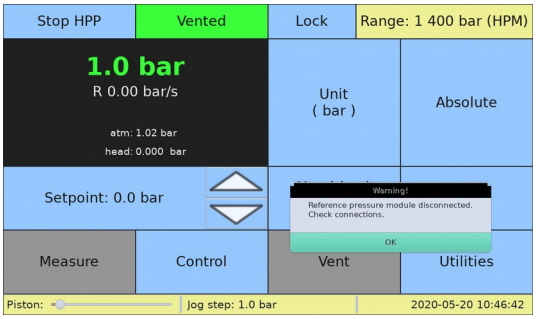


7. Slide the HPM to the left and tighten the gland.

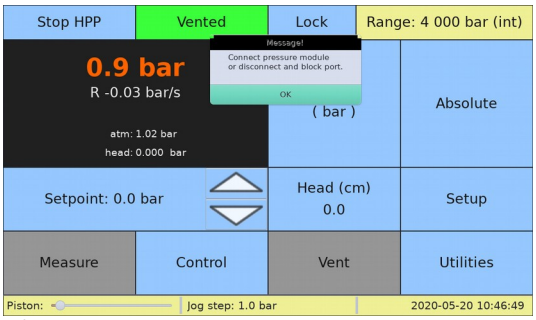
Recommended torque on the gland is 34 Nm.

8. Slide the electrical interface plug to the left and secure it by means of the bayonet ring.
9. Optional : Run the purge routine as described in 9.3.7.3 Purge function to remove air from the inside of the HPM.

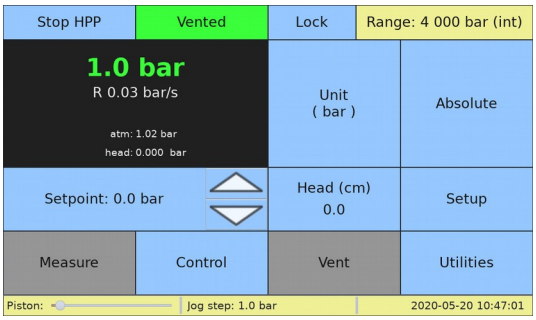
11.3.1 HPC messages when installing an HPM



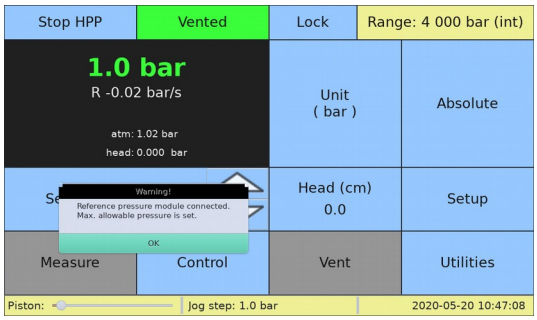
Electrical interface plug disconnected.



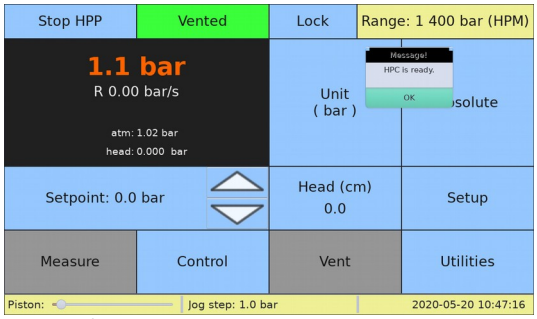
2nd message after disconnected interface plug.



Main run screen with no HPM connected, range ends with “”(int)” for “internal sensor”.



Message after connecting a new HPM.



2nd message after HPM connected.

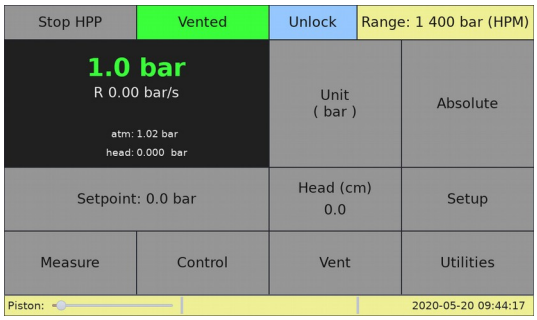
12. Remote operation

Most HPC front panel functions can also be executed in response to commands from a remote computer. The host computer can communicate with the HPC using the HPC's USB (simulated RS232) or the Ethernet port.

The simulated RS232 port on the HPC accepts any RS232 setting from a host and does not require adjustment. The Ethernet port can be configured either by using remote commands via RS232 or using the settings menu on the HPC local user interface.

When using the HPC under remote control, it is good practice to send the command SYST:REM to the HPC.

This locks the HPC touch screen buttons except for the <Unlock> button, protecting against inadvertent conflicts between local and remote HPC instructions.



To enable touchscreen buttons, the user can either send the command SYST:LOC or press the <Unlock> button on the HPC local user interface.

12.1 HPC remote command overview

Command	Short description	Typical reply
	MEAS: commands	
MEAS:PRESS1	Returns the current control sensor pressure reading	6.82294807E-02 bar g R
MEAS:PRESS2	Returns the current reference pressure module (HPM) unfiltered pressure reading	1.65978010E-02 bar a R
MEAS:PRESS2:FILTERED	Returns the current reference pressure module (HPM) filtered pressure reading.	5.28121521E-03 bar g R
MEAS:PRESS3	Returns the current barometer (HPB) pressure reading barometer	1.01304862E+00 bar
MEAS:POS	Returns intensifier piston position (%)	1.44691044E+01
	CALC: commands	
CALC:LIM:PRESS:UPP	Get/set high pressure limit, in active units limited by HPM range.	4.00000000E+03 bar
	CAL: commands	
CAL:PRESS1:PA	Get/set control sensor adder	-5.76432999E+00 bar
CAL:PRESS1:PM	Get/set control sensor multiplier	1.00524000
CAL:PRESS1:RANGE	Get/set control sensor range	4.00000000E+03 bar
CAL:PRESS2:PA	Get/set reference pressure module (HPM) adder	0.00000000E+00 bar
CAL:PRESS2:PM	Get/set reference pressure module (HPM) multiplier	1.00000000
CAL:PRESS2:RANGE	Get/set reference pressure module (HPM) range	4.00000000E+03 bar
CAL:PRESS3:PA	Get/set barometer (HPB) adder	0.00000000E+00 bar
CAL:PRESS3:PM	Get/set barometer (HPB) multiplier	1.00000000
CAL:PRESS3:RANGE	Get/set barometer (HPB) range	7.50000000E-01 bar
	OUTP: commands	
OUTP:MODE:PRESS	Gets HPC active mode status	VENT / IDLE / MEAS etc
OUTP:MODE:PRESS IDLE	Go to idle state, power pack (HPP) off and do the self test	OK
OUTP:MODE:PRESS MEAS	Go to measure mode (freezes intensifier piston position)	OK
OUTP:MODE:PRESS CONT	Go into pressure control mode (actively controls to pressure setpoint)	OK
OUTP:MODE:PRESS VENT	Initiates VENT routine (vent pressure to reservoir, safe state with power pack on)	OK
OUTP:MODE:PRESS CALHPM	Go into HPM calibration mode (isolation valve closed)	OK
OUTP:MODE:PRESS PURGE 30	Initiates vacuum purge routine when a purge time is specified in seconds (only accepted in vented condition)	OK / ERROR
OUTP:MODE:PRESS PRIME	Initiates fill mode (only accepted when in vented condition)	OK / ERROR
OUTP:MODE:PRESS LEAK 30	Initiates leak test for a number in seconds (accepted fromcontrol mode when pressure is Ready)	OK / ERROR
	SENSE: commands	
SENSE:SETUP:RES	Get/set pressure display resolution	1.00000000E-03
SENSE:SETUP:MODE	Get/set pressure mode	GAUGE / ABSOLUTE
SENSE:SETUP:MODE ABS	Set absolute pressure mode	OK
SENSE:SETUP:MODE GAU	Set gauge pressure mode	OK
SENSE:SETUP:REF:HEIGHT	Get/set head height in meters referenced to HPC ref. level	1.00000000E-02
SENSE:POWER:LEV	Get oil level switch state (OK or ALARM)	OK
SENSE:PRESS1:SER	Returns control sensor serial number	31415
SENSE:PRESS1:RANGE	Returns control sensor full scale in active pressure units	4.00000000E+03 bar
SENSE:PRESS2:SER	Returns reference pressure module (HPM) serial number	K0JH3L1J0EL99KJKEP0
SENSE:PRESS2:RANGE	Returns reference pressure module (HPM) full scale in active pressure units	4.00000000E+03 bar
SENSE:PRESS3:SER	Returns barometer (HPB) serial number	BLVGQQ1J0GJ91BJKEXD
SENSE:PRESS3:RANGE	Returns barometer (HPB) full scale in active pressure units	7.50000000E-01 bar
SENSE:HPC:SER	Returns HPC serial number	22QNB-F827E-PK858-Q72BY-OD7Q1
SENSE:HPC:VER	Get HPC firmware version	Minerva HPC 1.2.15 Feb 1 2020 23:44:54

Command	Short description	Typical reply
SENSE:STAT	Get system status data in compact form	14041074;8;3;0.00000000;7.00000000;6.99770951;6.82294807e+03;1.60632889e+03;-0.93812076
SENSE:CURSTATE	Get HPC state and name	8 HPCSTAT_VENT_IDLE
	SOURCE: commands	
SOURCE:PRESS 20	Sets pressure control setpoint in current pressure units	OK / ERROR
	SYST: commands	
SYST:DATETIME	Get/set system date, time	2020,02,03 11:42:25 CET
SYST:KLOC ON	Disables touchscreen (except <Unlock> button)	OK
SYST:KLOC OFF	Enables touchscreen	OK
SYST:REM	Disables touchscreen (except <Unlock> button)	OK
SYST:LOC	Enables touchscreen	OK
SYST:VERS	Get firmware version of the HMI	HPC-HMI 1.0.22 Linux x86-64 Build:Feb 1 2020 23:38:46
SYST:PDATE	Get/set HPC production date	2020-03-23
SYST:UPTIME	Get HPC uptime	20:57:29
SYST:PRESSTIME	Get HPC uptime under pressure	19:57:23
SYST:LEV	get HPC user level setting	User / Admin / Factory
SYST:HPCSTAT	Read actual sensor and process control variables from the HPC	14587444;19;2;1.89657400e+06;7.00000000;7.28885490;1.88971774e+06;1.89350530e+06;-0.94990747
	UNIT: commands	
UNIT:PRESS	Get/set pressure units	BAR bar

12.2 HPC detailed remote command description

MEAS:PRESS1		
Purpose		Returns the current control sensor pressure reading in active pressure unit
Command Type		Get
Arguments		n/a
Limitations		None
Examples	MEAS:PRESS1	6.82294807E-02 bar g R
	MEAS:PRESS1	8.67845328E+03 MPa a NR
Related information		2. Putting together an HPC system 4.4.1 HPM / HPB metrological specifications 6.1 HPC Operating principle 7. Pressure control 7.4 Ready / Not ready criteria 9.3.8 Unit 9.3.10 Gauge / Absolute
Remarks		
The reply string includes the actual pressure value in scientific format followed by the actual pressure unit, mode (a for absolute / g for gauge) and ready (R) or not ready (NR) argument. In control mode a ready condition is defined by meeting both stability criterion and actual pressure within hold limit. Note: The HPC is normally used with a reference pressure module (HPM) installed which is the source of calibrated, low uncertainty pressure measurements. In normal operation, MEAS:PRESS1 is not used and MEAS:PRESS2 is used to retrieve pressure values from the HPC system.		

MEAS:PRESS2		
Purpose		Returns the current RAW pressure reading of the reference pressure module (HPM) in the active pressure unit
Command Type		Get
Arguments		n/a
Limitations		None
Examples	MEAS:PRESS2	6.82294807E-02 bar g R
	MEAS:PRESS2	8.67845328E+03 MPa a NR
Related information		See MEAS:PRESS2:FILTERED command.
Remarks		
This command is available in addition to the MEAS:PRESS2:FILTERED. The filter is a low pass filter which filters out white noise. This command returns the instantaneous, raw HPM pressure reading and is not used in normal HPC system operation.		

MEAS:PRESS2:FILTERED		
Purpose		Returns the current FILTERED pressure reading of the reference pressure module (HPM) in the active pressure unit
Command Type		Get
Arguments		n/a
Limitations		None
Examples	MEAS:PRESS2	6.82294807E-02 bar g R
	MEAS:PRESS2	8.67845328E+03 MPa a NR
Related information		2. Putting together an HPC system 4.4.1 HPM / HPB metrological specifications 6.1 HPC Operating principle 7. Pressure control 7.4 Ready / Not ready criteria 9.3.8 Unit 9.3.10 Gauge / Absolute
Remarks		
The reply string includes the actual pressure value in scientific format followed by the actual pressure unit, mode (a for absolute / g for gauge) and ready (R) or not ready (NR) argument. In control mode a ready condition is defined by meeting both stability criterion and actual pressure within hold limit. In typical use of the HPC, this command is the one used to retrieve calibration, low uncertainty pressure values from the HPC system.		

MEAS:PRESS3		
Purpose		Returns the current pressure reading of the barometer (HPB) in the active pressure unit
Command Type		Get
Arguments		n/a
Limitations		None
Examples	MEAS:PRESS3	1.01304862E+00 bar
Related information		4.4.1 HPM / HPB metrological specifications 9.3.10 Gauge / Absolute
Remarks		
The reply string includes the actual barometric pressure value in scientific format followed by the actual pressure unit. Ready / not ready criteria are not applicable for the barometric pressure reading, mode is always absolute.		

MEAS:POS		
Purpose		Returns the current intensifier piston position (%)
Command Type		Get
Arguments		n/a
Limitations		None
Examples	MEAS:POS	1.44691044E+01
Related information		6.1 HPC Operating principle 9.4.5 CALIBRATION
Remarks		
The reply string includes the actual intensifier piston position value in scientific format in percent of stroke.		

CALC:LIM:PRESS:UPP		
Purpose		High pressure limit in the active pressure unit
Command Type		Get / set
Arguments		Pressure value in actual pressure unit
Limitations		Set only possible as Administrator
Examples	CALC:LIM:PRESS:UPP	4.00000000E+03 bar
	CALC:LIM:PRESS:UPP 2E+03	OK
Related information		9.4.4 UTILITIES
Remarks		
The upper limit is a limit on the value of pressure control setting the HPC will accept. The default upper limit is 400 MPa. In order to protect devices under test, a lower value can be entered. Both in remote and local operation, setpoints higher than the entered limit are refused. If an HPM with a full scale lower than the high pressure limit is installed, its upper limit overrides the set upper limit.		

CAL:PRESS1:PA		
Purpose		Defines the control sensor zero offset
Command Type		Get / set
Arguments		Value in current pressure unit
Limitations		Set only possible as Administrator
Examples	CAL:PRESS1:PA	-5.76432999E+00 bar
	CAL:PRESS1:PA -6E-01	OK
Related information		9.4.1 MEASURE 9.4.5 CALIBRATION
Remarks		
This command is intended to correct for the zero offset of the control sensor. Normally this value is set automatically during the control sensor alignment routine and it is advised not to alter this value directly. With autozero enabled, HPC corrects for any zero offsets automatically every time it is in vented condition.		

CAL:PRESS1:PM		
Purpose		Defines the control sensor slope correction
Command Type		Get / set
Arguments		Unitless value
Limitations		Set only possible as Administrator
Examples	CAL:PRESS1:PM	1.00524000
	CAL:PRESS1:PM 1.00023	OK
Related information		9.4.5 CALIBRATION
Remarks		
This command is intended to correct for the slope of the control sensor. Normally this value is set automatically during the control sensor alignment routine and it is advised not to set this value directly.		

CAL:PRESS1:RANGE		
Purpose		Control sensor range
Command Type		Get / set
Arguments		Value in current pressure unit
Limitations		Set only possible as FACTORY
Examples	CAL:PRESS1:RANGE	4.00000000E+03 bar
	CAL:PRESS1:RANGE 4E+03	OK
Related information		6.1 HPC Operating principle 7. Pressure control
Remarks		
Defines the range of the control sensor. For the MNR-800-HPC400 it is 400 MPa.		

CAL:PRESS2:PA		
Purpose		Defines the HPM zero offset
Command Type		Get / set
Arguments		Value in current pressure unit
Limitations		Set only possible as Administrator
Examples	CAL:PRESS2:PA	-5.76432999E+00 bar
	CAL:PRESS2:PA -6E-01	OK
Related information		9.4.1 MEASURE 9.4.5 CALIBRATION 12.3 HPM and HPB remote commands 14.2 HPM (reference pressure module) calibration
Remarks		
This command is intended to correct for the zero offset of the HPM. Typically used when calibrating the HPM when mounted in the HPC. The value is stored in the HPM. With autozero enabled, HPC will correct for any zero offsets automatically every time it is in vented condition. Note: The HPM can also be communicated with directly outside the HPC.		

CAL:PRESS2:PM		
Purpose		Defines the HPM slope correction
Command Type		Get / set
Arguments		Unitless value
Limitations		Set only possible as Administrator
Examples	CAL:PRESS2:PM	1.00524000
	CAL:PRESS2:PM 1.00023	OK
Related information		9.4.1 MEASURE 9.4.5 CALIBRATION 12.3 HPM and HPB remote commands 14.2 HPM (reference pressure module) calibration
Remarks		
This command is intended to correct for the slope of the HPM. Typically used when calibrating the HPM when mounted in the HPC. The value is stored in the HPM. Note: The HPM can also be communicated with directly outside the HPC.		

CAL:PRESS2:RANGE		
Purpose		Reference pressure module (HPM) range
Command Type		Get
Arguments		Value in current pressure unit
Limitations		factory set
Examples	CAL:PRESS2:RANGE	4.00000000E+03 bar
Related information		6.1 HPC Operating principle 4.4.2 HPM / HPB series pressure module ranges
Remarks		
Defines the range of the HPM, set by the factory.		

CAL:PRESS3:PA		
Purpose		Defines the barometer (HPB) zero offset
Command Type		Get / set
Arguments		Value in current pressure unit
Limitations		Set only possible as Administrator
Examples	CAL:PRESS3:PA	-5.76432999E+00 bar
	CAL:PRESS3:PA -6E-01	OK
Related information		9.4.5 CALIBRATION 12.3 HPM and HPB remote commands 14.3 HPB (barometer module) calibration
Remarks		
This command is intended to correct for the zero offset of the HPB. Typically used when calibrating the HPB when mounted in the HPC. The value is stored in the HPB.		

CAL:PRESS3:PM		
Purpose		Defines the barometer (HPB) slope correction
Command Type		Get / set
Arguments		Unitless value
Limitations		Set only possible as Administrator
Examples	CAL:PRESS3:PM	1.00524000
	CAL:PRESS3:PM 1.00023	OK
Related information		9.4.5 CALIBRATION 12.3 HPM and HPB remote commands 14.3 HPB (barometer module) calibration
Remarks		
This command is intended to correct for the slope of the HPB. Typically used when calibrating the HPB when mounted in the HPC. The value is stored in the HPB.		

CAL:PRESS3:RANGE		
Purpose		Barometer (HPB) range
Command Type		Get
Arguments		Value in current pressure unit
Limitations		Set only possible as FACTORY
Examples	CAL:PRESS3:RANGE	7.50000000E-01 bar
	CAL:PRESS3:RANGE 8.0E-01	OK
Related information		6.1 HPC Operating principle 4.4.2 HPM / HPB series pressure module ranges
Remarks		
Defines the range of the HPB. Set by the factory. The range is defined as the maximum pressure reading of the barometer minus the minimal pressure reading of the barometer.		

OUTP:MODE:PRESS			
Purpose		Returns the actual HPC state	
Command Type		Get / set	
Arguments (get / set)		VENT CONT MEASURE IDLE POSIT MAN	
Arguments (get only)		PURGE FILL	
Limitations		From	To
		IDLE	MEASURE
		VENT	MEASURE
Examples	OUTP:MODE:PRESS	VENT	
	OUTP:MODE:PRESS	CONTROL	
Related information		9.1 Status field overview	
Remarks			
Sets or retrieves the current operational mode of the HPC.			

OUTP:MODE:PRESS PURGE xx		
Purpose		Initiates HPC vacuum purge routine
Command Type		Set
Arguments		Time in seconds
Limitations		Only possible in vented condition
Examples	OUTP:MODE:PRESS PURGE 30	OK
Related information		6.2 Vacuum purge system 9.3.7.3 Purge function
Remarks		
Actual HPC state can be checked via OUTP:MODE:PRESS		

OUTP:MODE:PRESS PRIME		
Purpose		Initiates HPC fill routine
Command Type		Set
Arguments		n/a
Limitations		Only possible in vented condition
Examples	OUTP:MODE:PRESS PRIME	OK
Related information		9.4.4 UTILITIES 9.3.7.2 Fill function
Remarks		
Runs the HPC fill routine until the fill pressure is achieved. Fill pressure can be set remotely with (SENSE:SETUP:FILLP). Actual HPC state can be checked with OUTP:MODE:PRESS.		

OUTP:MODE:PRESS LEAK xx		
Purpose		Initiates HPC leak check routine
Command Type		Set
Arguments		Time in seconds
Limitations		Only possible in control mode when pressure is ready
Examples	OUTP:MODE:PRESS LEAK 30	-0.0025%
	OUTP:MODE:PRESS LEAK 60	-0.0001%
Related information		9.3.7.1 Leak test
Remarks		
Runs the HPC leak check routine for the duration of the argument. Actual HPC state can be checked with OUTP:MODE:PRESS		

SENSE:SETUP:RES		
Purpose		Defines HPC pressure resolution in percent of HPM full scale
Command Type		Get / set
Arguments		Percent of active HPM
Limitations		None
Examples	SENSE:SETUP:RES	1.00000000E-03
	SENSE:SETUP:RES 1E-02	OK
Related information		9.4.1 MEASURE
Remarks		
A global setting which adapts the HPC resolution based on the active HPM. The resolution is automatically reset when another HPM is installed.		

SENSE:SETUP:MODE		
Purpose		Reads or sets pressure mode
Command Type		Get / set
Arguments		GAUGE / ABSOLUTE
Limitations		None
Examples	SENSE:SETUP:MODE	GAUGE
	SENSE:SETUP:MODE ABSOLUTE	OK
Related information		9.3.10 Gauge / Absolute
Remarks		
The HPC can measure pressure in both gauge and absolute modes when using the control sensor or an reference pressure module (HPM). This command sets or read the current measurement mode.		

SENSE:SETUP:REF:HEIGHT		
Purpose		Defines head height between HPC reference level and device under test
Command Type		Get / set
Arguments		Height (positive or negative) in meters
Limitations		None
Examples	SENSE:SETUP:REF:HEIGHT	1.00000000E-02
	SENSE:SETUP:REF:HEIGHT 1E-01	OK
Related information		9.3.9 Head height
Remarks		
Positive : device under test reference level is below HPC reference level Negative : device under test reference level is above HPC reference level		

SENSE:POWER:LEV		
Purpose		Retrieve HPP oil level switch status
Command Type		Get
Arguments		OK / ALARM
Limitations		None
Examples	SENSE:POWER:LEV	OK
Related information		4.2 HPP powerpack 16. Troubleshooting
Remarks		
HPC won't start when the powerpack reservoir level switch is indicating a low oil level.		

SENSE:PRESS1:SER		
Purpose		Control sensor serial number
Command Type		Get
Arguments		Serial number
Limitations		Set only possible as FACTORY
Examples	SENSE:PRESS1:SER	31415
	SENSE:PRESS1:SER 31415	ok
Related information		6.1 HPC Operating principle
Remarks		
None		

SENSE:PRESS1:RANGE		
Purpose		Control sensor range
Command Type		Get
Arguments		Value in actual pressure units
Limitations		Set only possible as FACTORY
Examples	SENSE:PRESS1:RANGE	4.00000000E+03 bar
	SENSE:PRESS1:RANGE 3E+03	OK
Related information		6.1 HPC Operating principle
Remarks		
Alias for CAL:PRESS1:RANGE		

SENSE:PRESS2:SER		
Purpose		HPM serial number
Command Type		Get
Arguments		Serial number
Limitations		Factory set
Examples	SENSE:PRESS2:SER	31415
Related information		2. Putting together an HPC system 4.4 HPM / HPB general specifications 6.1 HPC Operating principle
Remarks		
Is stored in HPM		

SENSE:PRESS2:RANGE		
Purpose		HPM range
Command Type		Get
Arguments		Value in actual pressure units
Limitations		Factory set
Examples	SENSE:PRESS2:RANGE	4.00000000E+03 bar
Related information		2. Putting together an HPC system 4.4 HPM / HPB general specifications 6.1 HPC Operating principle
Remarks		
Alias for CAL:PRESS2:RANGE, stored in HPM		

SENSE:PRESS3:SER		
Purpose		HPB serial number
Command Type		Get
Arguments		Serial number
Limitations		Factory set
Examples	SENSE:PRESS3:SER	31415
Related information		4.4 HPM / HPB general specifications
Remarks		
Is stored in HPB		

SENSE:PRESS3:RANGE		
Purpose		HPB range
Command Type		Get
Arguments		Value in active pressure units
Limitations		Factory set
Examples	SENSE:PRESS3:RANGE	7.50000000E-01 bar
Related information		4.4 HPM / HPB general specifications
Remarks		
Alias for CAL:PRESS3:RANGE, stored in HPB		

SENSE:HPC:SER		
Purpose		HPC serial number
Command Type		Get
Arguments		Serial number
Limitations		Factory set
Examples	SENSE:HPC:SER	22QNB-F827E-PK858-Q72BY-OD7Q1
Related information		9.4.8 INFO
Remarks		
None		

SENSE:HPC:VER		
Purpose		HPC firmware version
Command Type		Get
Arguments		version
Limitations		factory set
Examples	SENSE:HPC:VER	Minerva HPC 1.2.15 Feb 1 2020 23:44:54
Related information		9.4.8 INFO
Remarks		
None		

SENSE:STAT		
Purpose		actual HPC sensor values
Command Type		Get
Arguments		None
Limitations		None
Examples	SENSE:STAT	16864434;8;3;0.00000000;7.00000000;6.99613467;5.98304165e+04;6.94874588e+03;-0.75909660
Related information		None
Remarks		
Used for debugging purposes		

SENSE:CURSTATE		
Purpose		actual HPC status
Command Type		Get
Arguments		None
Limitations		None
Examples	SENSE:CURSTATE	8 HPCSTAT_VENT_IDLE
Related information		None
Remarks		
Used for debugging purposes		

SOURCE:PRESS		
Purpose		Pressure control setpoint
Command Type		Get / set
Arguments		value in actual current pressure units
Limitations		None
Examples	SOURCE:PRESS	1.00000000E+02 bar
	SOURCE:PRESS 100	OK
Reference information		7. Pressure control 9.3.5 Control
Remarks		
Determines the control mode pressure target setpoint. Will be overwritten when, for example, going from idle to vent mode. Is only used in pressure control mode. Note : A SOURCE:PRESS xx command is ignored when the HPC is venting.		

SYST:DATETIME		
Purpose		System date and time (in local timezone)Time
Command Type		Get / set
Arguments		Yyyy,mm,dd hh:mm:ss
Limitations		Set only possible as Administrator
Examples	SYST:DATETIME	2020,02,04 15:19:23 CET
	SYST:DATETIME 2020,02,04 15:19:23	OK
Related information		9.4.6 I/O SETUP 9.4.7 SYSTEM SETUP
Remarks		
When the HPC is connected to the internet it sets its system time automatically via an NTP server.		

SYST:KLOC		
Purpose		Enables/ disables HPC touchscreen buttons
Command Type		Get / set
Arguments		ON / OFF
Limitations		None
Examples	SYST:KLOC	OFF
	SYST:KLOC ON	OK
Related information		9.3.11 Lock / Unlock
Remarks		
Only the <Lock> / <Unlock> button stays enabled when the touchscreen buttons are locked.		

SYST:REM / SYST:LOC		
Purpose		Enables / disables HPC touchscreen buttons
Command Type		Get / set
Arguments		None
Limitations		None
Examples	SYST:REM	OK
	SYST:LOC	OK
Related information		9.3.11 Lock / Unlock
Remarks		
Alias for SYST:KLOC. Only the <Lock> / <Unlock> button stays enabled when the touchscreen buttons are locked.		

SYST:VERS		
Purpose		Retrieves HMI firmware version
Command Type		Get
Arguments		None
Limitations		Factory set
Examples	SYST:VERS	HPC-HMI 1.0.22 Linux x86-64 Build:Feb 1 2020 23:38:46
Related information		9.4.9 STATUS
Remarks		
None		

SYST:PDATE		
Purpose		Retrieve the HPC production date
Command Type		Get
Arguments		yyyy:mm:dd
Limitations		Factory set
Examples	SYST:PDATE	2020:02:20
Related information		9.4.8 INFO
Remarks		
None		

SYST:UPTIME		
Purpose		Retrieve HPC uptime
Command Type		Get
Arguments		hhhh:mm:ss
Limitations		Automatically set
Examples	SYST:UPTIME	0210:45:02
Related information		9.4.9 STATUS
Remarks		
Uptime is the amount of time HPC has been powered up.		

SYST:PRESSTIME		
Purpose		Retrieve HPC under pressure time
Command Type		Get
Arguments		hhhh:mm:ss
Limitations		Automatically set
Examples	SYST:PRESSTIME	0123:34:12
Related information		9.4.9 STATUS
Remarks		
Under pressure time is the amount of time the PPCH has not been in vented or idle mode.		

SYST:LEV		
Purpose		User access level
Command Type		Get / set
Arguments		USER ADMIN
Limitations		Set only possible with ADMIN password
Examples	SYST:LEV	User
	SYST:LEV:ADMIN <password>	OK
Related information		9.2 Access scheme 9.4.10 LOGIN
Remarks		
When no password is given, returns an error message. From Administrator level back to user level via SYST:LEV:USER does not require a password.		

SYST:HPCSTAT		
Purpose		reads process variables
Command Type		Get
Arguments		None
Limitations		None
Examples	SYST:HPCSTAT	20859544;8;3;0.00000000;7.00000000;7.00104959;5.98304165e+04;257.75763000;-0.84489209
Related information		None
Remarks		
For debugging purposes		

UNIT:PRESS		
Purpose		Pressure unit of measure
Command Type		Get / set
Arguments		Pressure unit from HPC supported pressure unit list
Limitations		HPC supported pressure unit list
Examples	UNIT:PRESS	BAR bar
	UNIT:PRESS MPa	OK
Related information		9.3.8 Unit
Remarks		
Sets pressure unit from units supported by HPC. Use UNIT:PRESLIST for available pressure units. Based on resolution as set via SENSE:SETUP:RES the pressure resolution will be altered with a limit of 0 digits. Pressure unit argument is NOT case sensitive, e.g. mPa will not be set as millipascal!		

12.3 HPM and HPB remote commands

HPM and HPB pressure modules can be interfaced directly via RS232 using the delivered RS232 cable including 24 V power supply. This cable is intended to be used when calibrating an HPM or HPB outside the HPC.

HPM / HPB RS232 settings	
Baud rate	9600
Parity	N
Data bits	8
Stop bits	1
Handshake	None

12.3.1 HPM / HPB command protocol

The HPM / HPB protocol uses the following format :

*0100<cmd>=<param><CR><LF> (to set a parameter)

or :

*0100<cmd><CR><LF> (to request a parameter)

Critical commands which affect calibration (adder / multiplier) are password protected, see 14. Calibration.

12.4 HPM and HPB remote command overview

Command	Short description	Typical reply
*0100P3	Get pressure in kPa g	*0001136.18420422
*0100SN	Get HPM / HPB serial number	*0001K0JH3L1J0EL99KJKEP0VQFZL3
*0100VR	Get firmware version	*0001Sensor interface 1.1 Mar 29 2019 20:31:47
*0100MN	Get module type	*0001MNR-800-HPM400S
*0100PF	Get full scale of module in kPa	*00014e+05
*0100PA	Get / set the pressure module adder in kPa	*0001397.00000000
*0100PM	Get / set the pressure module multiplier	*00011.00000000
*0100EW	Enables writing mode	<combined with other commands>
*0100PP	Input password	*0001OK

12.5 HPM and HPB detailed remote command description

***0100P3**		
Purpose		pressure value in kPa g
Command Type		Get
Arguments		n/a
Limitations		None
Examples	*0100P3	*0001136.18420422
Related information		14. Calibration
Remarks		
The HPM / HPB module replies with the actual pressure reading in kPa g where the first 5 characters need to be removed. In the example reply the pressure value is 136.18420422 kPa g The pressure value is corrected with the 1st order PA and PM values.		

***0100SN**		
Purpose		HPM / HPB serial number
Command Type		Get
Arguments		n/a
Limitations		None / factory set
Examples	*0100SN	*0001K0JH3L1J0EL99KJKEP0VQFZL3
Related information		None
Remarks		
The HPM / HPB module replies with its serial number where the first 5 characters need to be removed. In the example reply, the serial number is K0JH3L1J0EL99KJKEP0VQFZL3.		

*0100VR		
Purpose		Retrieve pressure module (HPM or HPB) firmware version
Command Type		Get
Arguments		n/a
Limitations		None / factory set
Examples	*0100VR	*0001Sensor interface 1.1 Mar 29 2019 20:31:47
Related information		None
Remarks		
The HPM / HPB module replies with its firmware version where the first 5 characters need to be removed. In the example reply, the firmware version is Sensor interface 1.1 Mar 29 2019 20:31:47.		

*0100MN		
Purpose		Retrieve pressure module (HPM or HPB) model
Command Type		Get
Arguments		n/a
Limitations		None / factory set
Examples	*0100MN	*0001MNR-800-HPM400S
Related information		4.4.2 HPM / HPB series pressure module ranges
Remarks		
The HPM / HPB module replies with the model where the first five characters need to be removed. In the example reply, the module type is MNR-800-HPM400S.		

*0100PF		
Purpose		Retrieve full scale of pressure module (HPM or HPB) in kPa
Command Type		Get
Arguments		n/a
Limitations		None / factory set
Examples	*0100PF	*00014e+05
Related information		4.4.2 HPM / HPB series pressure module ranges
Remarks		
The HPM / HPB module replies with the full scale in kPa where the first 5 characters need to be removed. In the example reply, the full scale is 4e+05 kPa (400 MPa).		

*0100PA		
Purpose		Pressure module (HPM or HPB) user adder in kPa
Command Type		Get / set
Arguments		Adder in kPa
Limitations		Password protected
Examples	*0100PA	*0001397.00000000
Related information		14.2.2 Calibrating HPM outside HPC 14.3.3 Calibrating HPB outside HPC
Remarks		
The HPM / HPB module replies with the pressure module user adder in kPa where the first five characters need to be removed. In the example reply, the user adder is 397.00000000 kPa.		

***0100EW**		
Purpose		Write calibration adjustment parameters to a pressure module (HPM or HPB)
Command Type		Set
Arguments		n/a
Limitations		Used in combination with other commands
Examples	*0100EW*0100PP=M1nerv#	*0001OK
Related information		14.2.2 Calibrating HPM outside HPC 14.3.3 Calibrating HPB outside HPC
Remarks		
When you want to change a user adder or multiplier, the module needs to be set to writing mode first. This command is combined with other commands. In the above example, combined with the password command, it sets the pressure module in a mode in which it accepts for example a user adder or multiplier. See 14. Calibration for examples.		

***0100PP**		
Purpose		Send password to a pressure module (HPM or HPB)
Command Type		Set
Arguments		password
Limitations		Used in combination with other commands
Examples	*0100EW*0100PP=M1nerv#	*0001OK
Related information		14.2.2 Calibrating HPM outside HPC 14.3.3 Calibrating HPB outside HPC
Remarks		
Before sending the *0100PP command, the *0100EW command is sent. HPM / HPB module password is M1nerv#		

12.6 Writing adjustment parameters to the HPM or HPB

When a HPM or HPB pressure module is calibrated outside the HPC as described in 14.2.2 Calibrating HPM outside HPC and 14.3.3 Calibrating HPB outside HPC and adjustment is needed, the 1st order adjustment parameters (adder PA and multiplier Pm) need to be stored in the HPM or HPB.

The remote commands to write these into the HPM or HPB are protected and a special sequence of commands is needed.

Changing 1st order adjustment parameters directly affects the HPM or HPB measurements and metrology. Only qualified personnel who are familiar with calibration and understand the risks involved should perform adjustment.

It is recommended to perform an as left pressure calibration sequence after entering the new adder and multiplier to assure the HPM or HPB reading is within specifications.

Example changing adder :

New adder : 123 kPa

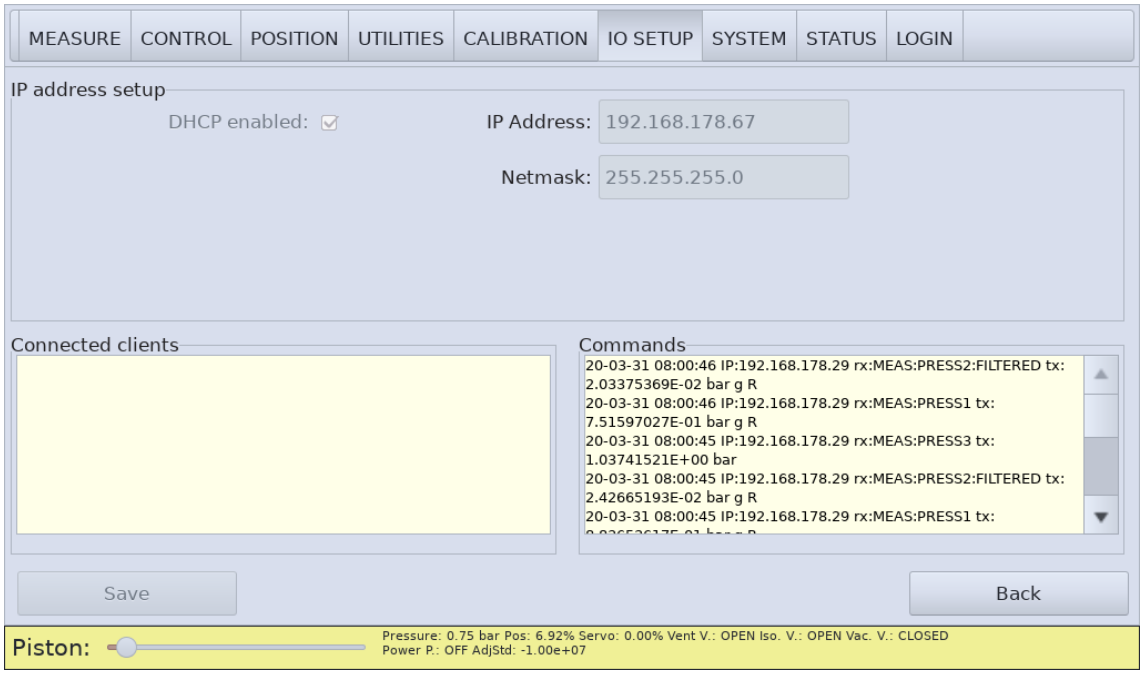
Command	Short description	Typical reply
*0100EW*0100PP=M1nerv#	Enables writing mode	*0001OK
*0100EW*0100PA=123	Writes new adder 123 kPa	*0001123.00000000
*0100EW*0100PP=M	Forces value in non volatile memory	*0001ERROR

The last command in fact is sent with an incorrect password which immediately forces the new adder value into non volatile memory. If you do not send this command, it takes two minutes for the new value to be stored in non volatile memory.

12.7 Example HPC remote command setup

In this section we describe an example setup for running automated calibrations in Fluke Compass for Pressure® (from here forward abbreviated as Compass). The described steps are examples which can be used in other software too. The following sections are not intended as an in-depth Compass training course.

In general it is good practice to test remote commands by sending single commands to the HPC using a terminal program such as Hyperterminal or Putty. When the replies from the HPC are not as expected, a debug window on the local human interface is available under <Setup>, <IO SETUP>. See also section 9.4.6 I/O SETUP.



12.7.1 Pressure controller description

In this example we are using the below HPC configuration :

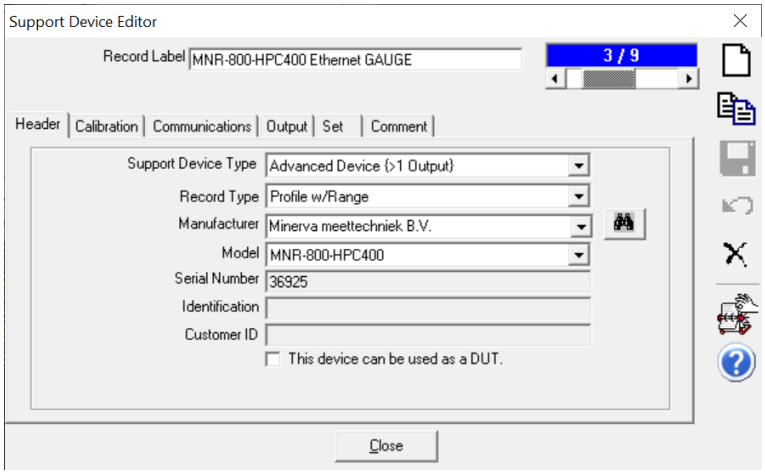
Manufacturer	: Minerva meettechniek B.V.	
Type	: MNR-800-HPC400	
Serial number	: 36925	
Range	: 400	MPa g
Pressure module	: MNR-800-HPM400S	
Serial number	: 31978	
Range	: 400	MPa g
Barometer module	: MNR-800-HPB	
Serial number	: 32095	
Range	: 75 .. 125	kPa a
Communcation	: TCP/IP	
IP address	: 192.168.178.67	

Pressure units	: bar
Mode	: gauge

12.7.2 Setting up the profile in Compass

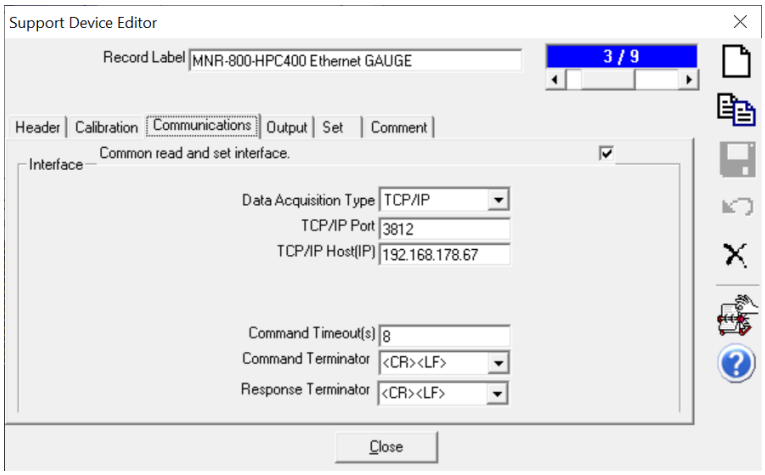
In Compass a pressure controller is defined as a support device, so we are going to set up the HPC in the support device editor. As the HPC is a pressure controller, it is an Advanced Device.

12.7.2.1 Header tab



12.7.2.2 Communications tab

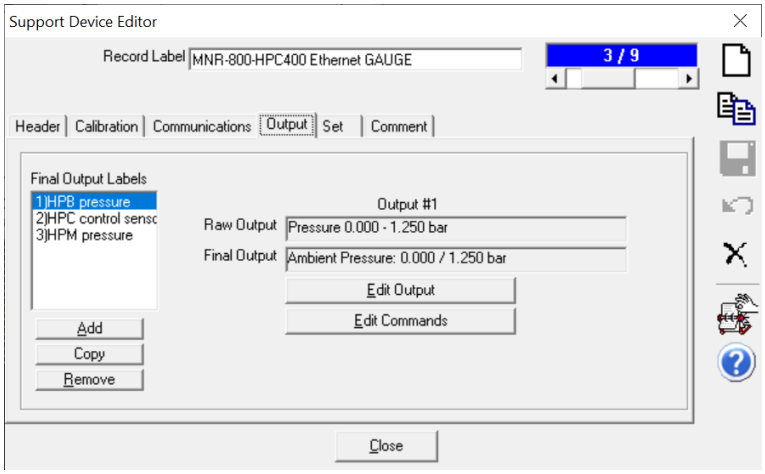
In this example we are skipping the Calibration tab and continue with the Communication tab.



All communications to and from the HPC are done via one common read and set interface. Settings are entered as described in section 12.7.1 Pressure controller description.

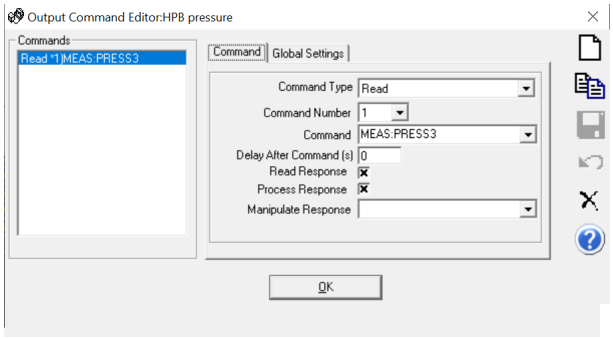
12.7.2.3 Output tab

In the Output tab we are going to define the following pressure channels; HPB barometer module; HPC control sensor; HPM pressure module.



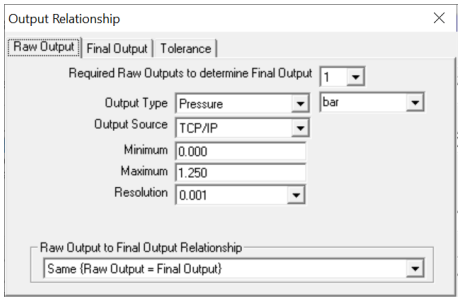
- **HPB Commands**

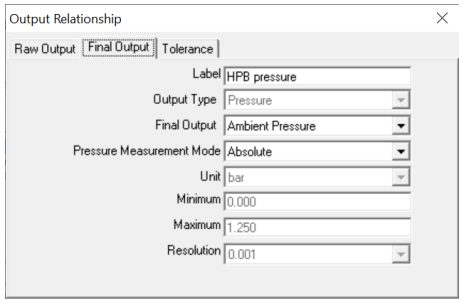
  The barometer module pressure unit of measure will not be set from this channel but from the HPM. This means we only have one command to enter; MEAS:PRESS3. The reply from HPC is a string only containing the pressure reading, so no additional filters are necessary.



- **HPB Output**

  The output of the HPB is absolute pressure and its purpose is to measure ambient pressure.

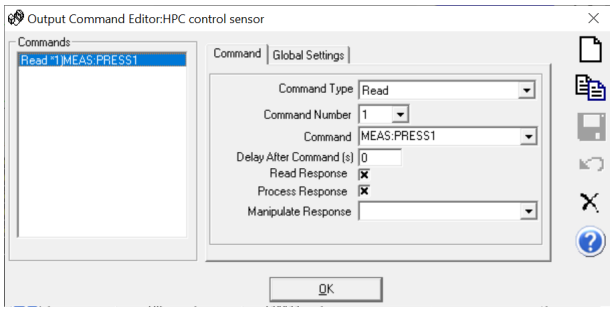




- **HPC control sensor Commands**

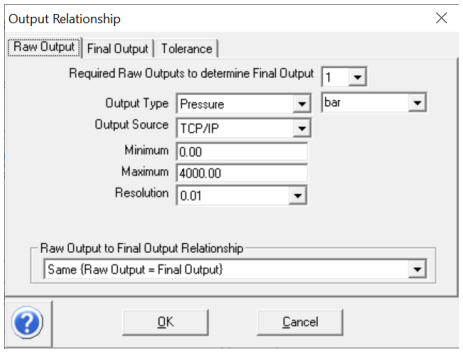
  Although the HPC control sensor is not used in the calibration process, we can read its pressure value. In order to familiarize yourself with the HPC functionality you can even run a calibration routine using the HPM pressure reading as reference pressure and the HPC control sensor reading as Device Under Test reading.

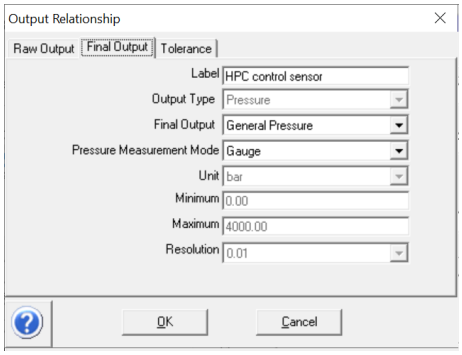
  The HPC control sensor read command is MEAS:PRESS1. The reply from HPC is a string starting with the pressure reading value and ends with an “R” when the pressure reading meets ready criteria or “NR” when its not meeting these criteria. See sections 9.4.1 MEASURE and 9.4.2 CONTROL for details on ready criteria. As the ready / not ready flag is at the end of the string, Compass just ignores it when it receives the reply string.The ready / not ready flag and its use is described under the HPM pressure description.



- **HPC control sensor Output**

  The output of the HPC control sensor is gauge pressure and its main purpose in HPC is fast feedback in the control loop. In this example we classify the reading as “General Pressure”.

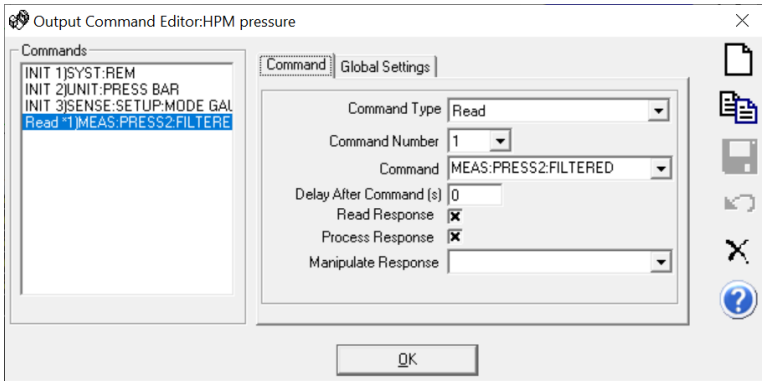




- **Reference pressure Commands**

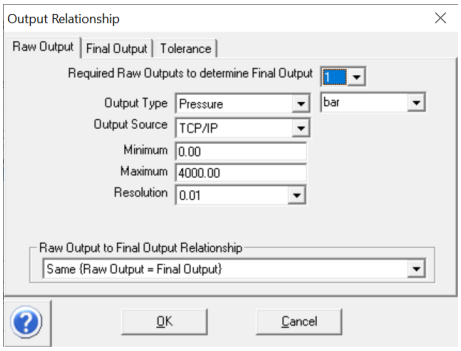
  In this example we have grouped all initialization commands in the reference pressure channel of the HPC which is the reading of the active HPM. We are putting the HPC in remote to lock the local touchscreen, select bar as pressure unit and select gauge mode. These commands are sent once at the beginning of the test.

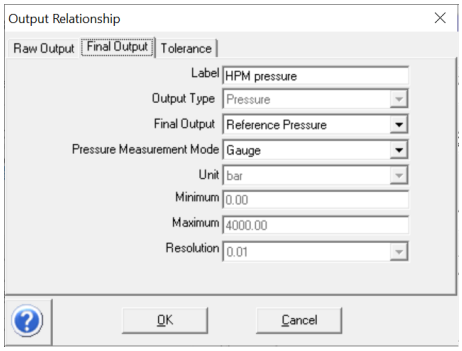
  After the initialization commands we use the command MEAS:PRESS2:FILTERED to retrieve pressure values from the HPC. The ready / not ready flag is at the end of the replystring, so no filters are needed to filter ot the pressure value.



- **Reference pressure Output**

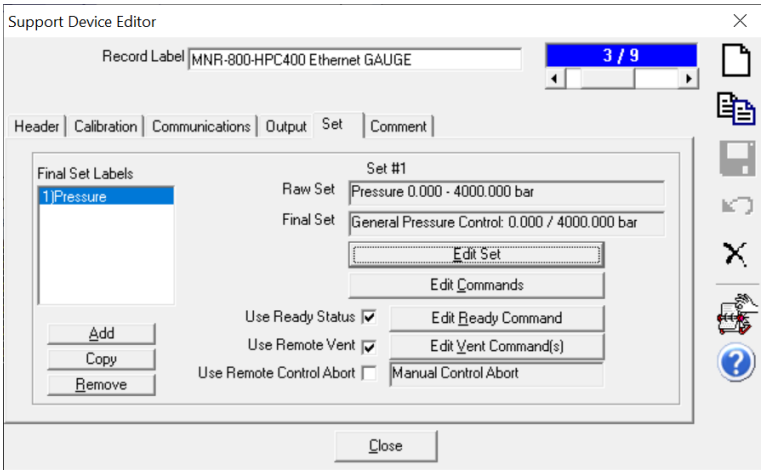
  The output of the reference pressure channel is gauge pressure and it is our pressure reference so it is classified as reference pressure.





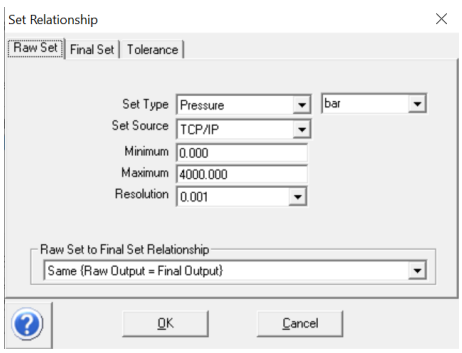
12.7.2.4 Set tab

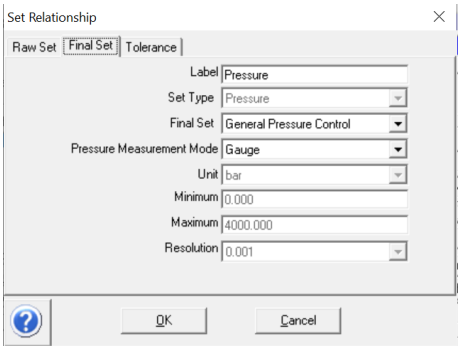
In the Set tab we are going to define the commands to set pressure with the HPC, process the ready / not ready flag and to open the vent valve.



- **Edit Set**

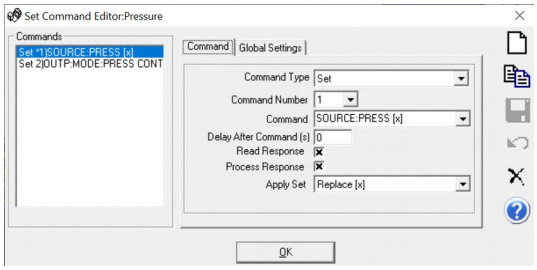
  This is to tell Compass what the set command does.

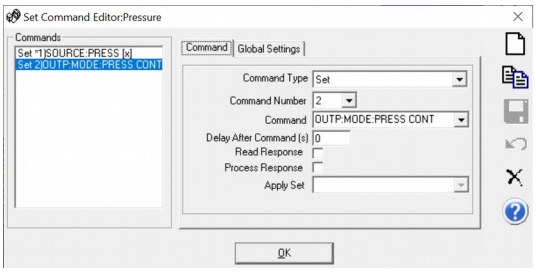




- **Edit Set Commands**

  For HPC to control pressure from vented condition it needs two commands; the first command sends the setpoint value to the HPC, the second command sets the HPC in control mode. When the HPC already is in control mode, the second command does not do anything.

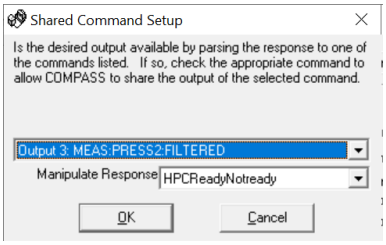


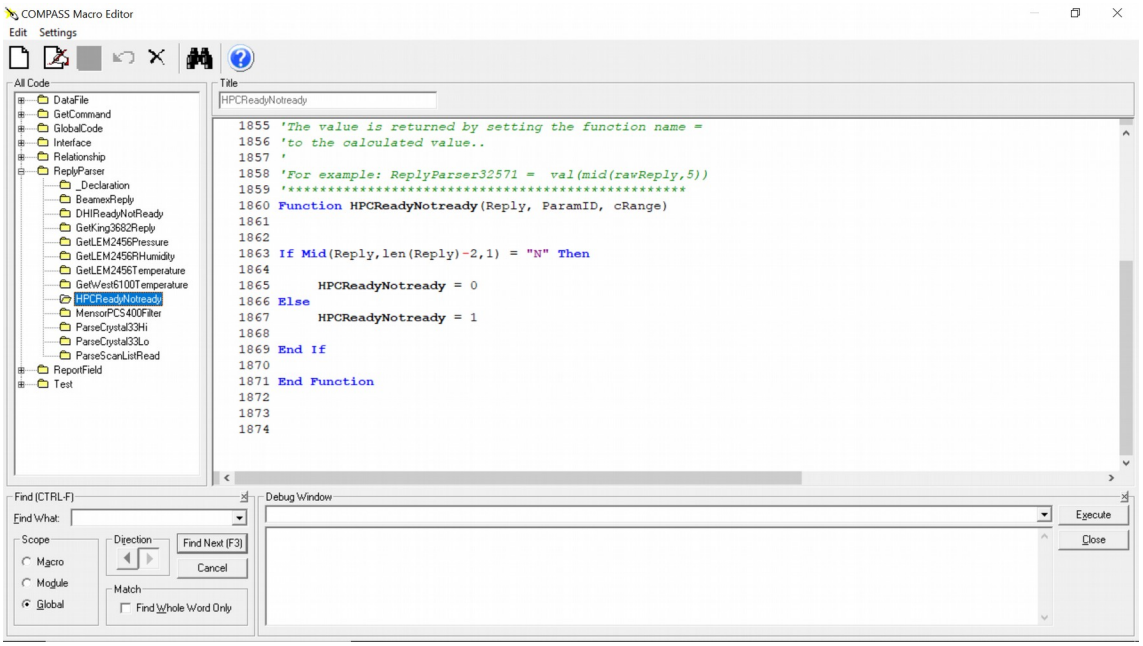


Compass has a convenient feature to include the setpoint from a test definition to the set command by selecting “Replace [x]” in the Apply set field.

- **Edit Ready Command**

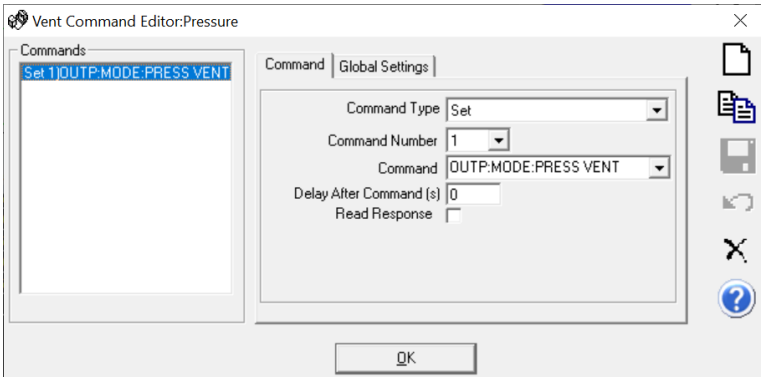
As mentioned earlier, the reply string obtained by Compass after sending the MEAS:PRESS2:FILTERED command includes a ready / not ready flag at the end of the replystring. In order to use this flag in Compass we use a macro named HPCReadyNotReady to tell Compass in what replystring to look for the flag and how to retrieve it from the replystring.





The above macro checks if the second to last character in the replystring is an “N”, if this is the case the macro sets the Compass flag to not ready, if not the Compass flag is set to ready.

- **Edit Vent Command**
  Here we enter the command to put the HPC in vented condition by sending the command OUTP:MODE:PRESS VENT.



13. Inspection and maintenance

For HPC to operate reliably and within specifications over time, regular inspection, maintenance and calibration is required. This section addresses inspection and maintenance, see 14. Calibration for information on regular calibration and adjustments. Inspection and maintenance procedures can be separated between HPC and HPP.

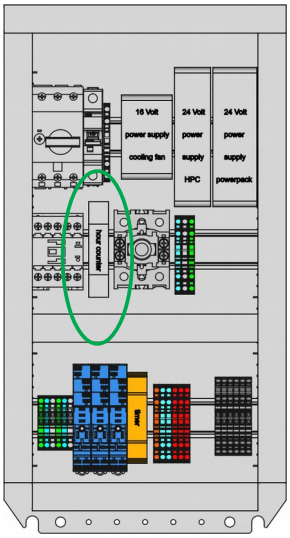
Routine HPC and HPP maintenance is recommended **yearly** or every **2500 hours** of time under pressure. Both HPC and the HPP include under pressure hour counters.

High pressure liquids and gases are potentially hazardous. Energy stored in these liquids and gases can be released unexpectedly and with extreme force. High pressure systems should be assembled and operated only by personnel who have been instructed in proper safety practices.

Take appropriate precautions when handling the hydraulic oils, read the **M**aterial **S**afety **D**ata **S**heets first!

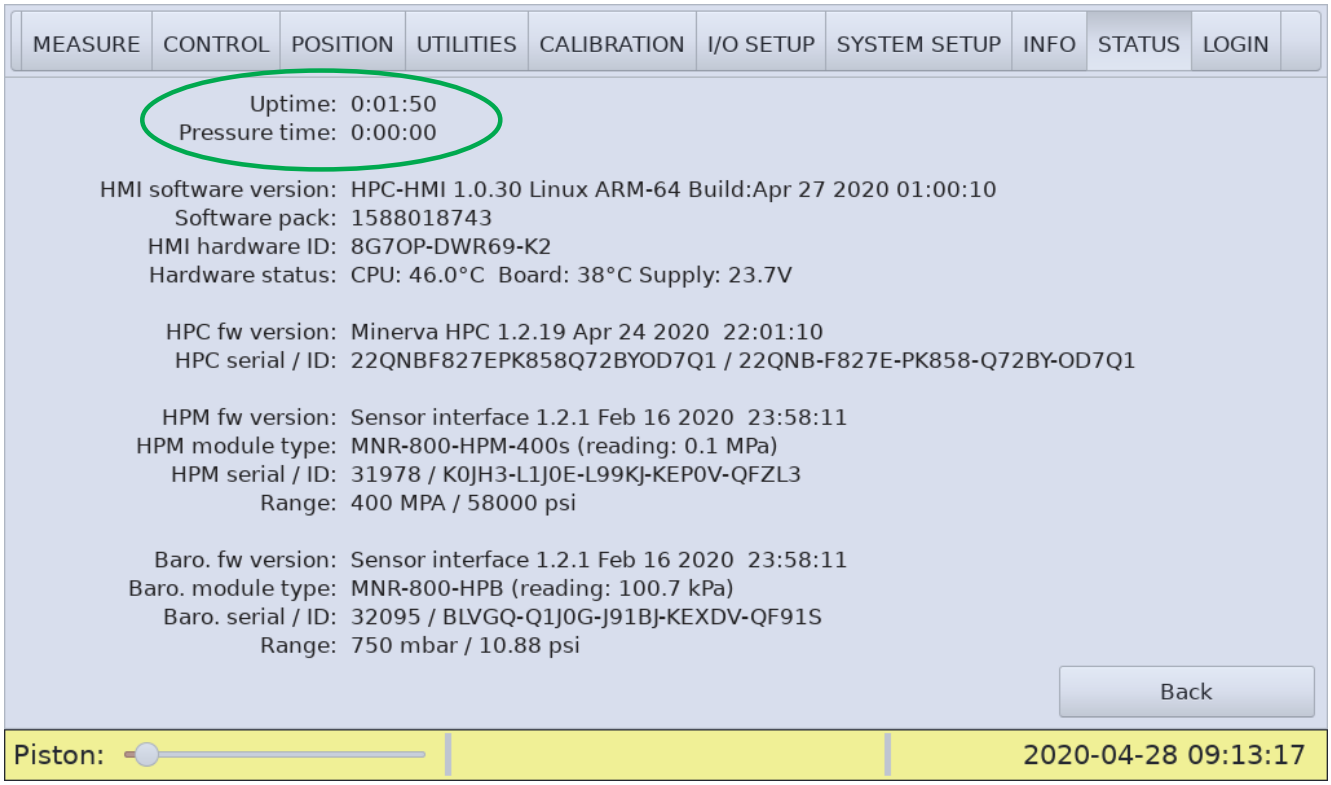
See ANNEX 1 MSDS sheets of this manual and the MSDS documents glued on the oil cans.

The HPP control box is equipped with an hour counter for service planning purposes. The counter counts the time the HPP is running and generating pressure. To access the hour counter you need to open the control box lid. See 8.1.3 MNR-800-HPP25 powerpack.



Before opening the powerpack control box lid, make sure the HPP is disconnected from electrical power.

The HPC logs both the time it has been powered on (uptime) and the time it has been actively running under pressure (pressure time). This information can be found in the <Setup>, <STATUS> menu.



13.1 Overall daily visual inspection

- Inspect hydraulic hoses between HPP and HPC for mechanical damage and leaks

Mechanical damage or defects can result in potentially dangerous situations. If the hydraulic hoses show signs or wear or damage, stop all operations and replace the hoses

- Inspect electrical drive cable between HPP and HPC for mechanical damage or defects

Mechanical damage or defects can result in failing of HPC. If the cable shows signs of wear or damage, stop all operations and replace the cable.

- Inspect HPM pressure connection for leaktightness

Leakage can result in potentially dangerous situations. If any leaks are identified, stop operating HPC, clean up oil and correct / tighten the HPM pressure connection.

Leakage can result in invalid pressure readings.

Recommended torque on the high pressure gland is 34 Nm

- Inspect HPP for wet surfaces

Wet surfaces can be caused by loosened adapters on the HPP and can result in potentially dangerous situations, stop operating HPC and determin what's causing the wet surface

- Inspect mains electrical cables

Mechanical defects on mains supply cables can result in short circuiting and can cause circuit damage, overheating, fire or explosion.

- Inspect external high pressure tubing for leaks

Leaks in the high pressure system connected to the HPC test port can result in potentially dangerous situations. If leaks are identified, stop operating HPC, clean up the oil and fix the leaks.

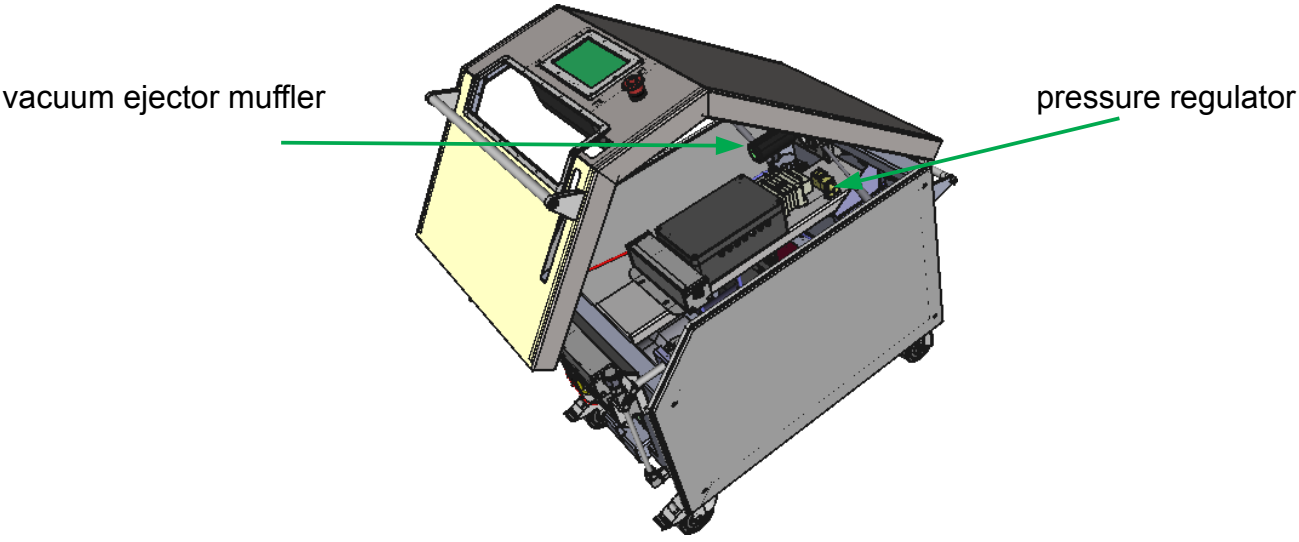
13.2 Overall monthly visual inspection

- Lift the HPC hood and inspect the inside of the device for any anomalies, see 8.3.1 Opening HPC's hood for details.

  - Look for accumulated oil which can indicate a leaking internal component. Identify the leak, clean up the oil and correct the leak.
  - Check that all internal screws, bolts and nuts are tight. Tighten as necessary.
  - Check hydraulic and pneumatic hoses for mechanical defects, replace when defects are found.
  - Audible check on compressed air fitting tightness with compressed air source attached
  - Check analog gauge reading on pressure regulator with compressed air source attached. Reading should be 5 ± 0.25 bar g / 72.5 ± 3.6 psi g.

When the compressed air pressure is too low, it can result in hydropneumatic valves not closing properly and HPC operating failures.

  - Check vacuum ejector (venturi) muffler for (oil) contamination. Clean with solvent

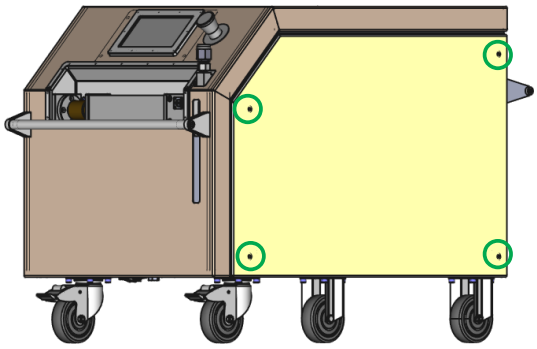


13.3 HPC maintenance

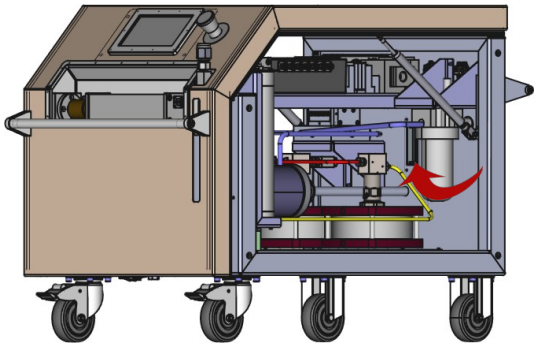
13.3.1 Replacing the low pressure filter

During the yearly / 2500 hours maintenance we recommend replacement of the low pressure inlet filter of the HPC low pressure circuit.

1. Remove the HPC right hand panel by unscrewing the 4 screws.



2. Carefully unscrew the filter bowl by turning it clockwise (viewed from above).



When unscrewing the filter bowl, Castrol hyspin AWS hydraulic fluid, 32ISO can spill out. Use protective gloves to avoid direct skin contact.

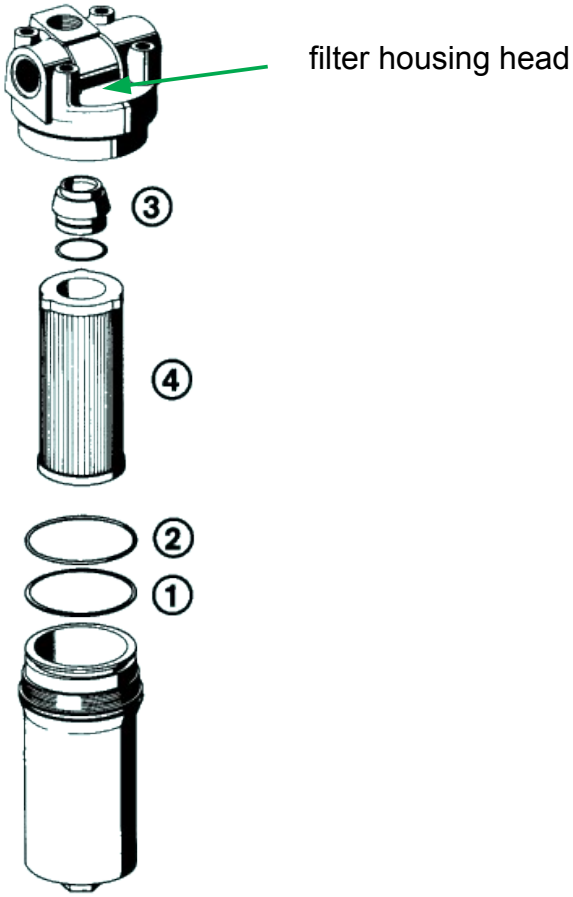
See ANNEX 1 MSDS sheets of this manual and the MSDS documents glued on the oil cans.

3. Empty the filter bowl, taking into account the applicable oil waste regulations.

When emptying the filter bowl it is good practice to investigate the debris (if present) at the bottom of the filter bowl.
If you find metal or other particles, please consult the factory.

4. Clean the bowl using a non abrassive cleaning solvent such as cleaning alcohol.
5. Remove filter element from the filter housing head with a side-to-side motion.
6. Check O-ring and back-up ring on the filter bowl for damage. Replace, if necessary.
7. Make sure that the filter element is the correct model, see 3.1 Spare parts. Open the plastic bag and push the element over the spigot in the filter head. Now remove plastic bag.
8. Complete installation by screwing on the bowl, turning clockwise

(1) anti extrusion ring
(2) o-ring
(3) upper filter seal / spigot
(4) filter element



The first time the HPP is connected to the HPC and started after replacement of the filter element, it is possible that the HPP shuts down and HPC gives an error message that the HPP is not building up pressure.
This is normal behaviour caused by trapped air in the HPP hydraulic circuit which needs to be pumped out. A second start should end up in normal operation.

13.3.2 Cleaning the oil reservoir

During use the HPC oil can become contaminated, for example from connecting unclean devices under test. It is good practice to clean devices and systems under test as well as possible prior to connecting them to the HPC as contaminating the HPC oil can potentially lead to failure of parts such as valves and the intensifier. Use of an external filter to protect the HPC as described in section 10.10.1 Installing a line filter to protect HPC is recommended.

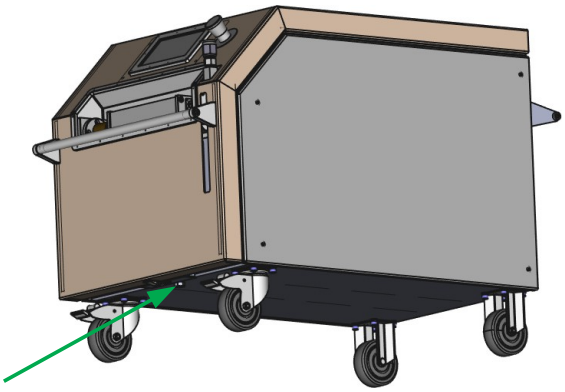
As 100% protection from contamination is not possible, it is recommended to empty the HPC oil reservoir and flush the tubing during its yearly maintenance.

When working on the HPC hydraulic circuit use protective gloves to avoid direct skin contact with the hydraulic fluid.

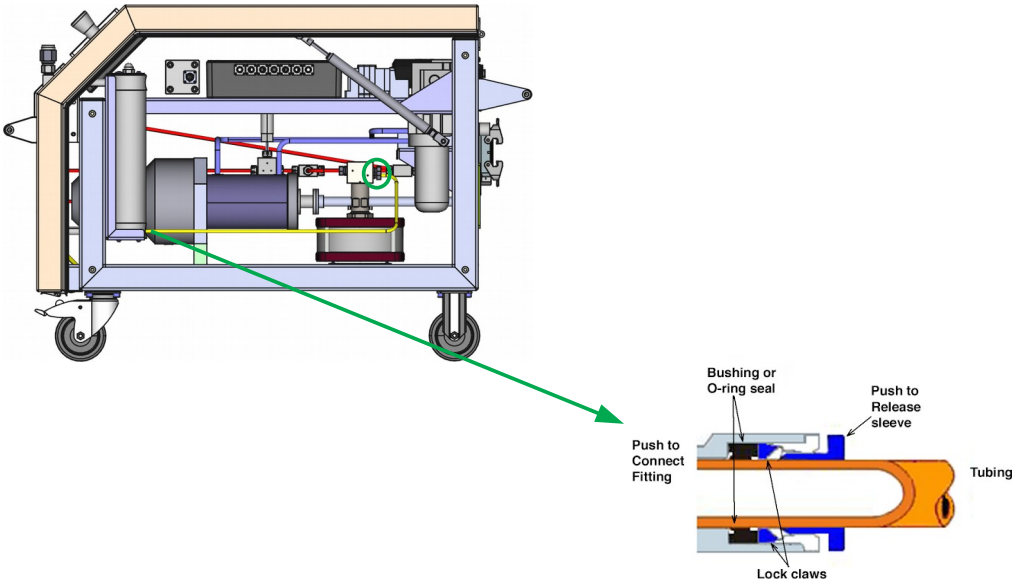
See ANNEX 1 MSDS sheets of this manual and the MSDS documents glued on the oil cans.

Make sure the HPC is disconnected from electrical power and compressed air supply before opening the hood and accessing internal components.

1. Open the HPC hood, as described in section 8.3.1 Opening HPC's hood.
2. Remove the right hand panel by unscrewing the four screws, see 13.3.1 Replacing the low pressure filter.
3. Place a liquid tight and medium compatible tray under the drain hole located at the bottom of the HPC enclosure. The tray capacity should be larger than the content of the HPC oil reservoir (750 cc).



4. Loosen the bottom plastic tube from the oil reservoir by pushing the quick connector release sleeve towards the reservoir and pulling the tube out of the connector.



5. Let the content of the oil reservoir flow into the enclosure and out into the tray.

Check for any debris coming out of the reservoir. If metal or other particles are observed contact the factory.

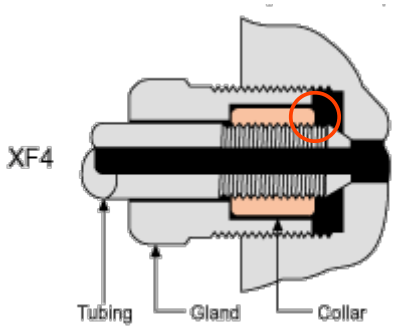
6. Optionally remove the oil reservoir from the HPC enclosure and dismantle the reservoir to clean the inside with a non abbrassive solvent such as cleaning alcohol.

unscrew the top nut
to dismantle the reservoir

7. Loosen the bottom plastic tube from the vent valve by unscrewing the high pressure connector on the vent valve inlet.
8. Carefully flush the oil out of the tube.

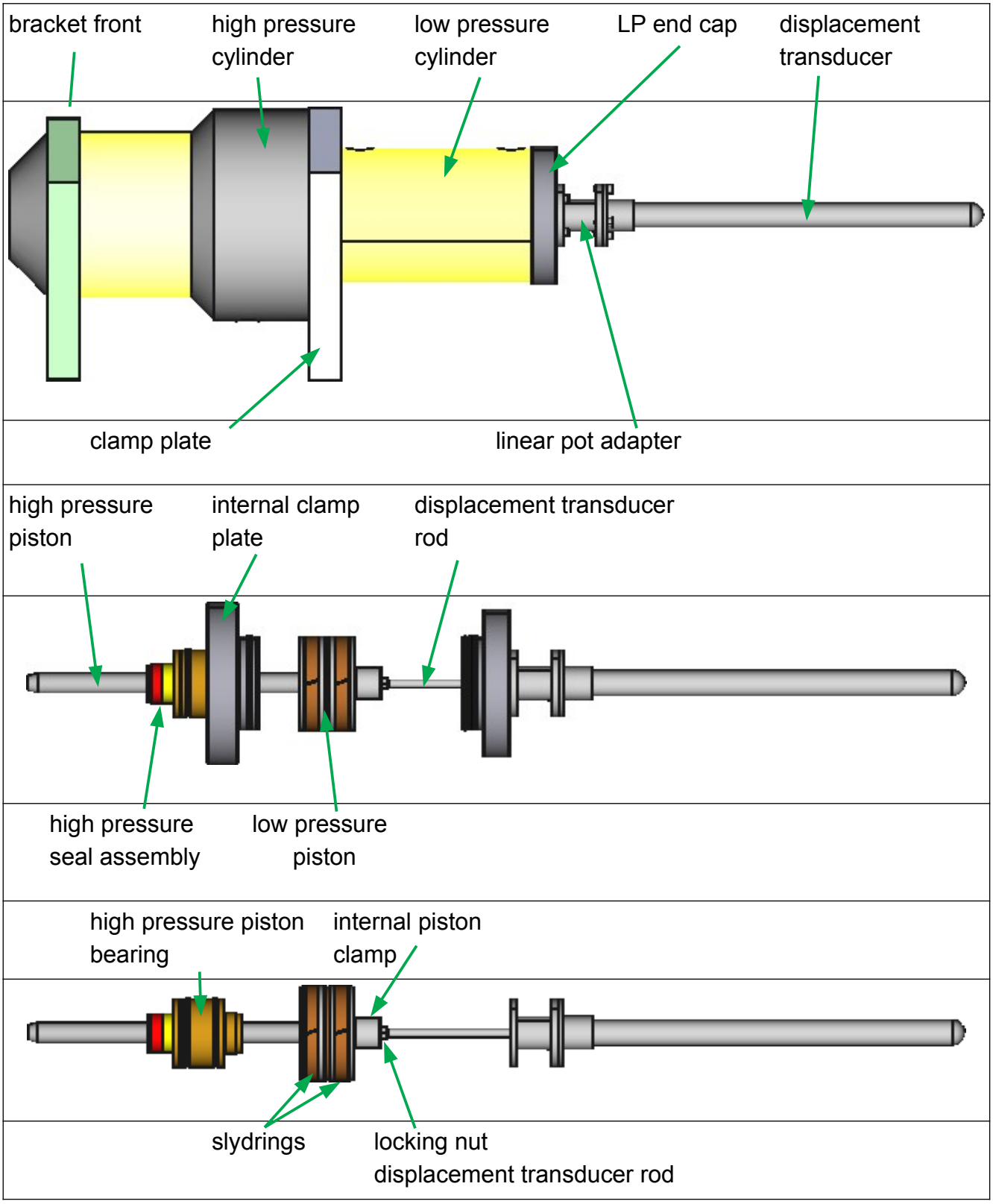
Check for any debris coming out of the tube. If metal or other suspicious particles are observed contact the factory.

9. Refit the bottom plastic tube on the vent valve, leaving the high pressure gland slightly loose. Make sure the collar is positioned correctly on the nipple leaving at least two exposed threads of the left hand thread.



10. Push the other side of the tube into the oil reservoir quick connector and make sure it is pushed in all the way.
11. Fill the oil reservoir as described in section 10.5 Filling the HPC reservoir with oil.
12. Remove air from the system as described in section 10.6 Removing air from the HPC internal tubing.

13.4 Intensifier service

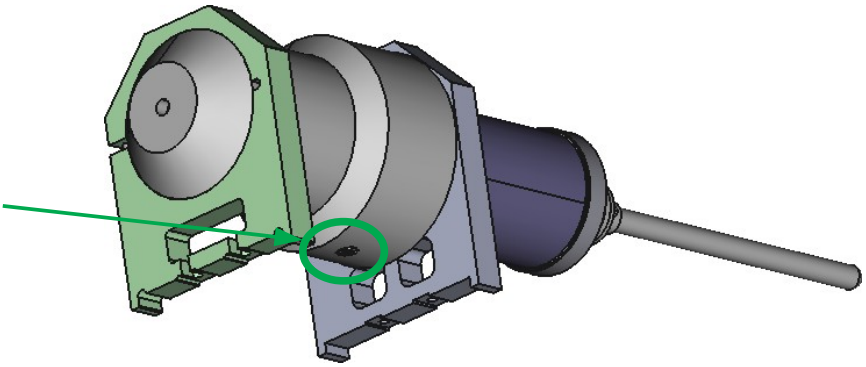


The HPC intensifier contains moving parts, seals and guiding strips (slydrings) which are subject to wear.

- **High pressure intensifier seal assy**
  The intensifier high pressure seal assembly seals the moving tungsten carbide high pressure piston and is exposed to high forces, so it is normal that the high pressure seal wears in time.

  The intensifier has a bleed hole where in normal operation oil will occasionally drip out when slewing pressure. When a setpoint pressure has been achieved and maintained, the high pressure seal is energised and stops any leakage.

  When a worn out / leaking high pressure seal is suspected, check all hydraulic connections for potential leaks and run a leak test as described in section 10.8 HPC leak test. Before starting the leak test clean and dry the intensifier bleed hole and the surface directly underneath it. When the piston movement recorded by the leak test is higher than expected and oil leakage is observed from the bleed hole, it is likely that the high pressure seal assembly needs to be replaced. See section 3.1 Spare parts for the correct partnumber.



The reliability of the intensifier high pressure seal assembly is highly dependent on the HPC condition of use and the cleanliness of the attached tubing and devices. When operated in a laboratory envirionment, MTBF well over 2000 hours under pressure can easily be achieved.

It is recommended to take advantage of having the intensifer disassembled to replace both the high pressure and low pressure seals as both are subject to wear and will eventually need replacement.

- **Low pressure intensifier seals**
  Seals other than the high pressure seal in the HPC intensifier are less likely to wear as they are not exposed to high differential pressures and/or are not sealing moving parts. Also slight leaks in the low pressure seals do not affect the control performance.

The HPC enclosure is designed to provide easy access to all serviceable items including the heart of the HPC –the intensifier--. The intensifier slides out of the enclosure without lifting it.

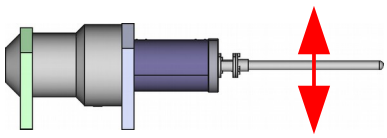
Please assure that the HPC has been shut down with the intensifier piston assembly in its home position which is the normal situation when the HPC is in vented condition. See section 9.3.6 Vent.

The intensifier is a very heavy part (approximately. 70 kg) which should not be lifted by one person alone.

When working on the intensifier, Castrol hyspin AWS hydraulic fluid, 32ISO and Sebacate can spill out. Use protective gloves to avoid direct skin contact.

See ANNEX 1 MSDS sheets of this manual and the MSDS documents glued on the oil cans.

Avoid oil spillage by placing a tray below the HPC as described in section 13.3.2 Cleaning the oil reservoir.

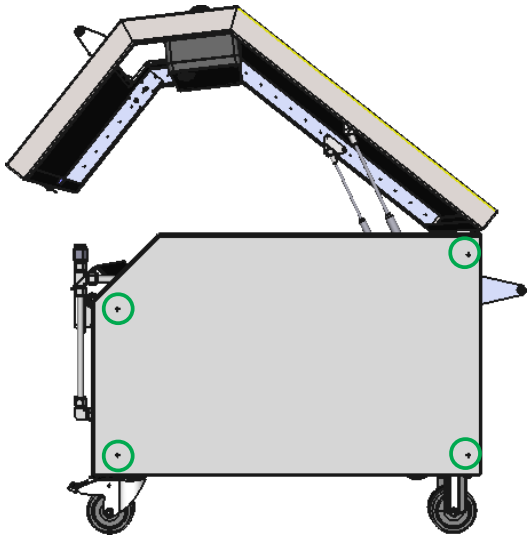


Make sure not to apply any force on the displacement transducer.

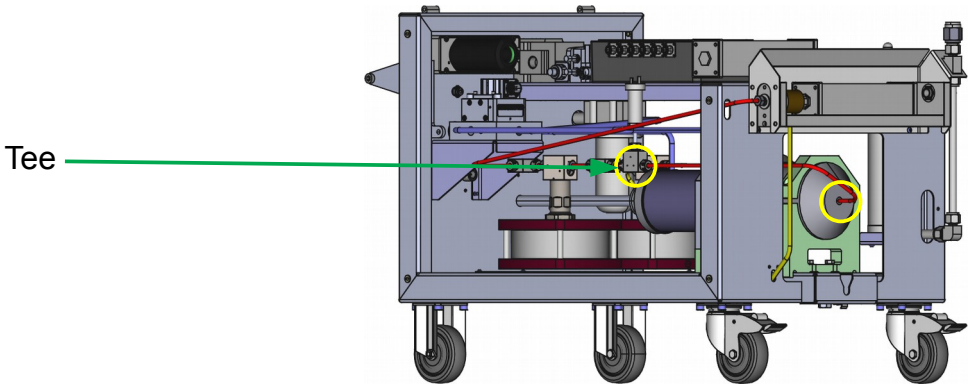
Slightly grease all surfaces and o-rings during assembly

13.4.1 Removing the intensifier from the HPC enclosure

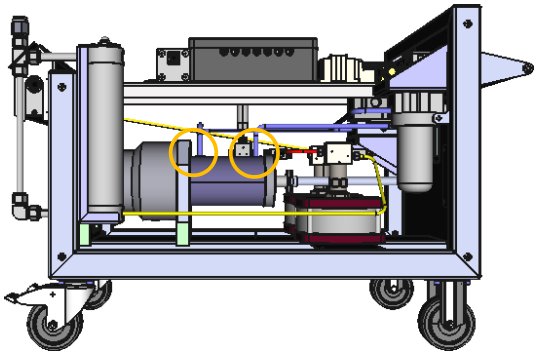
1. Open and lift the HPC hood, as described in section 8.3.1 Opening HPC's hood.
2. Remove both HPC side panels by unscrewing the 8 screws.



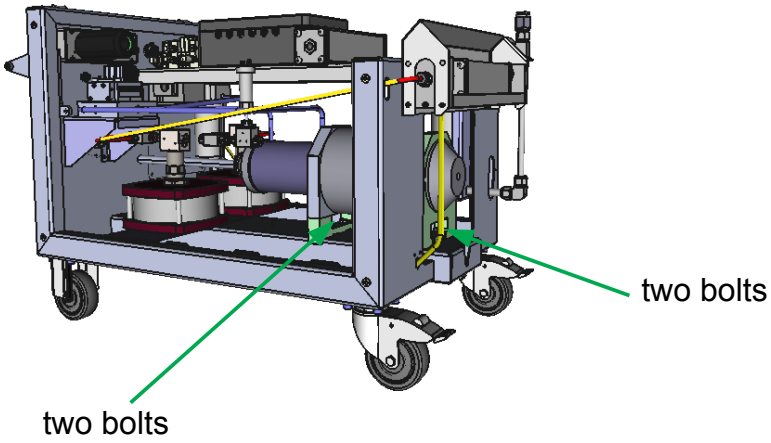
3. Remove the high pressure tubing between the intensifier and the tee at the control sensor.



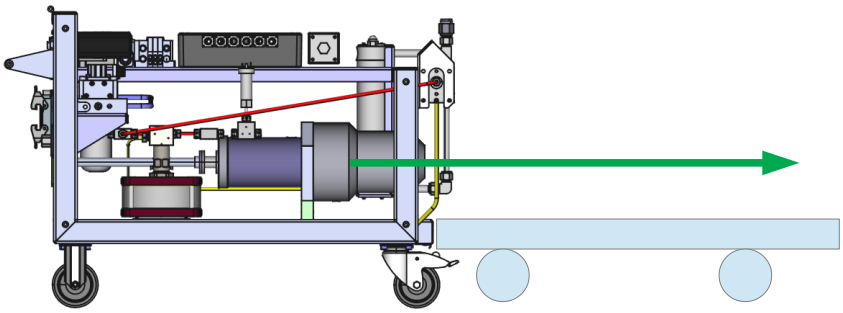
4. Plug the open port of the tee to avoid the oil reservoir emptying.
5. Remove the two flex tubes on the low pressure side of the intensifier.



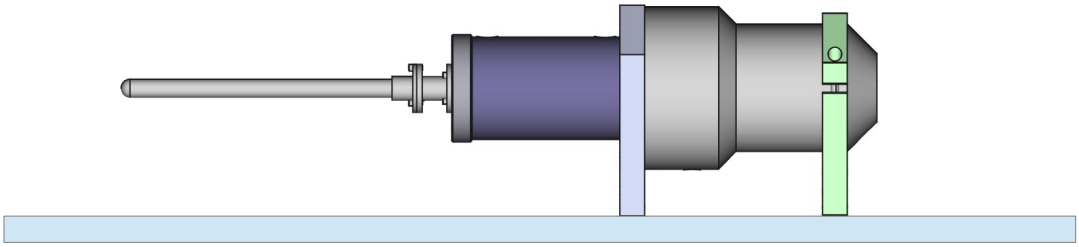
6. Remove the four M8 bolts which attach the intensfier to the HPC frame.



7. Disconnect the intensifier piston position sensor electric wires from the controllerboard.
8. Place a trolley in front of the HPC frame and slide the intensifier out of the HPC frame onto the trolley.

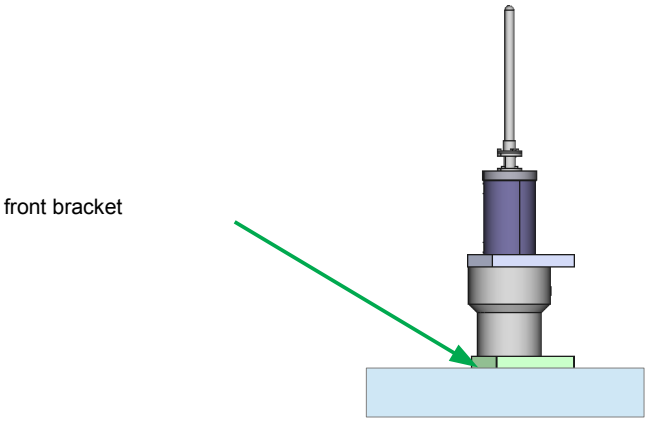


9. Us a lifting trolley, lift the intensifier and place it on a sturdy workbench.

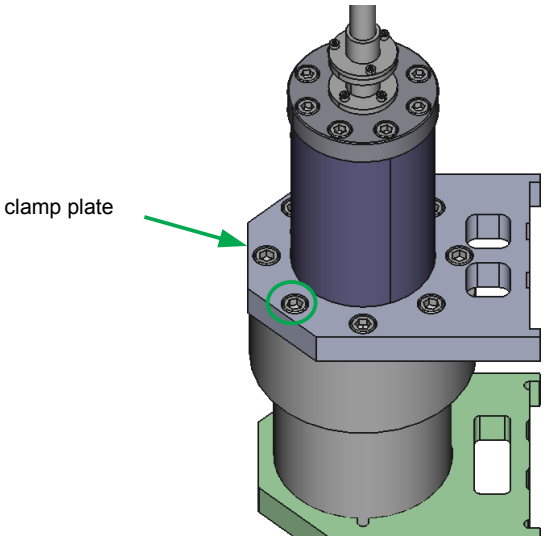


When working on the intensifier, oil will pour out. Make sure the oil is collected properly.

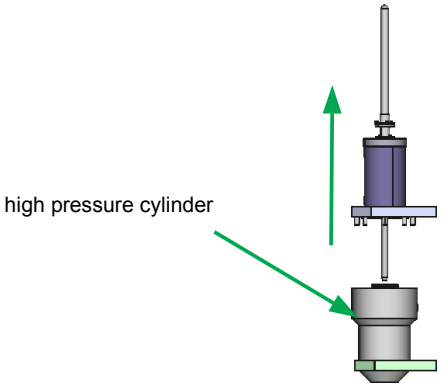
10. Place the intensifier on its high pressure connection surface. In order to stabilize the intensifier, you can place two blocks of wood below the front bracket.



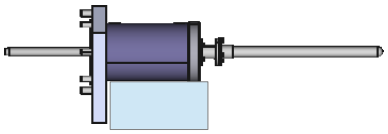
11. Unscrew the eight M12 bolts from the intensifier clamp plate.



12. Slide the low pressure cylinder with clamp plate and high pressure piston out of the high pressure cylinder.



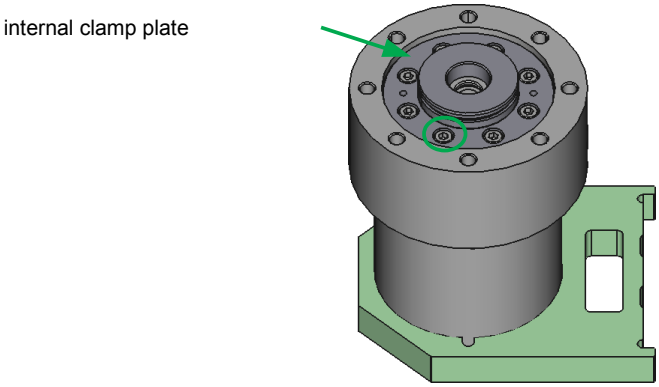
13. Carefully place the low pressure cylinder with clamp plate and high pressure piston horizontally on the workbench in such a way that the intensifier piston displacement transducer is not exposed to force, for example by placing a block under the cylinder.



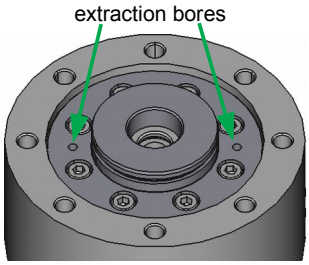
14. Clean the high pressure piston surface with cleaning alcohol and inspect the surface for any surface defects such as scratches or wear. The high pressure piston is manufactured from Tungsten Carbide, so it is rare that surface defects occur.

In the unlikely event defects are observed on the Tungsten Carbide piston, please contact the factory!

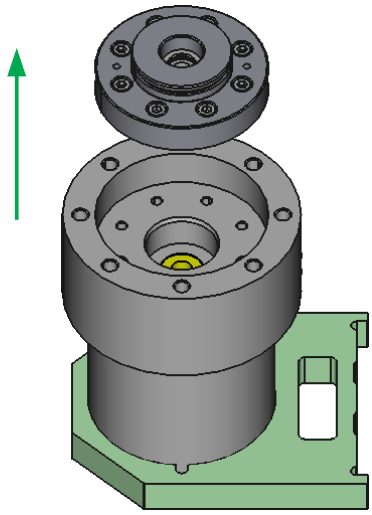
15. Unscrew the eight M8 bolts and remove them from the internal clamp plate.



16. Extract the internal clamp plate and the high pressure piston bearing from the high pressure cylinder by evenly screwing two M6 x 80 mm bolts (not supplied) into the threaded internal clamp plate extraction bores.



17. Lift the internal clamp plate with high pressure piston bearing from the high pressure cylinder.

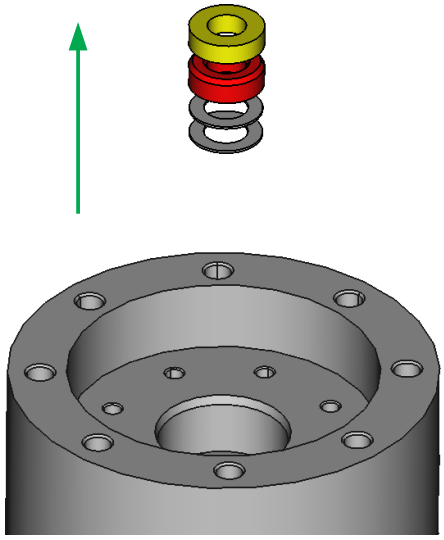


13.4.2 Replacing the high pressure seal assembly

A high pressure seal kit is needed to perform the work, see section 3.1 Spare parts for ordering information.

Part	Part Number	Qty
high pressure seal assembly mitre ring, seal and seal insert	702685	1
high pressure seal shim rings	712258	2

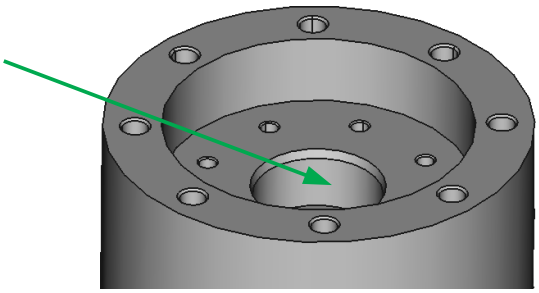
1. Pull out the high pressure seal assembly and shims.



2. Clean all parts with cleaning alcohol and blow compressed air through all bores.

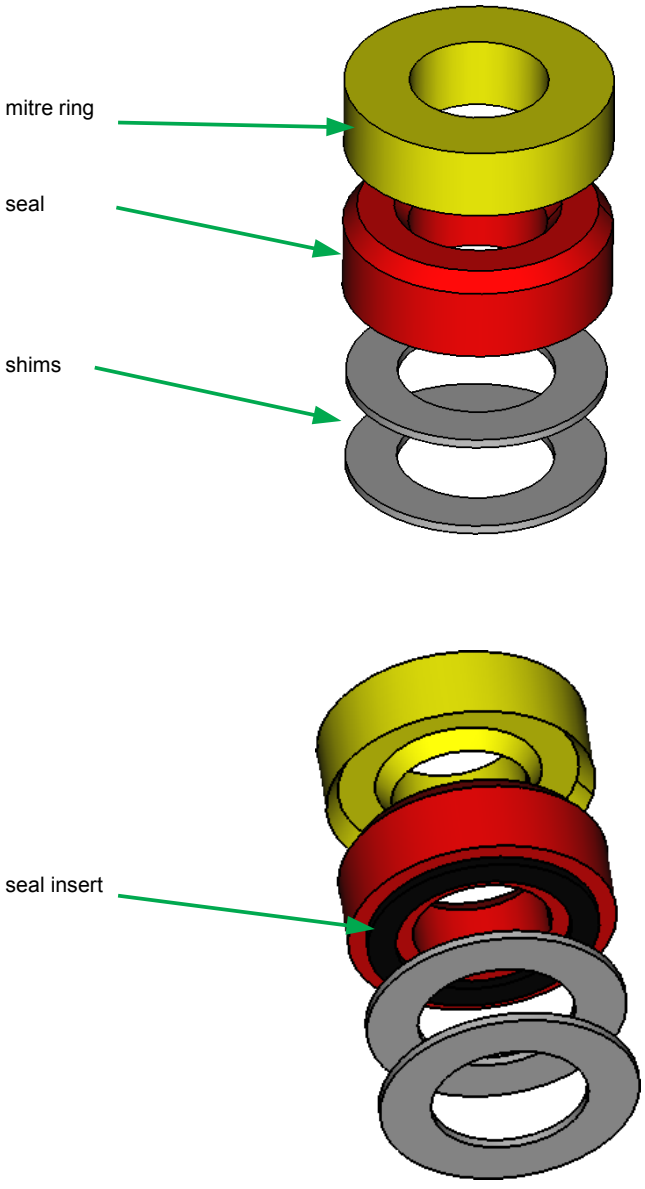
Always use safety glasses when working with compressed air.

3. Grease the cylindrical surface of the high pressure seal chamber



4. Carefully insert the shims first and then thenew seals in the high pressure seal chamber.

Detailed high pressure seal configuration drawing :



5. Reassemble the intensifier in the reverse order as described in section 13.4 Intensifier service

13.4.3 Replacing the low pressure seals

This part of the maintenance is conducted after the steps described in section 13.4 Intensifier service.

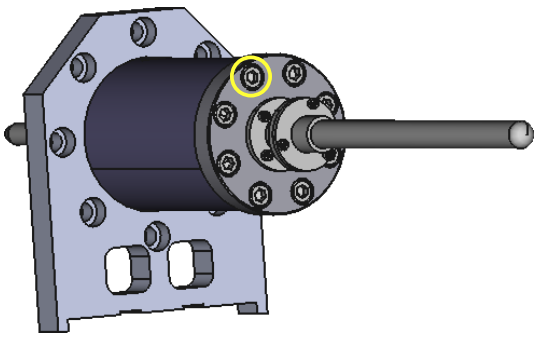
A standard low pressure seal kit is needed to perform the work, see section 3.1 Spare parts for ordering information.

1. **Replacing the low pressure (LP) end cap and displacement transducer seals.**

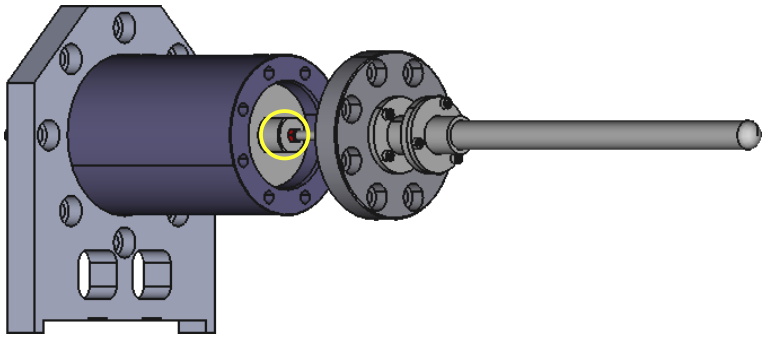
Part	Part Number	Qty
LP end cap o-ring NBR 70 Shore 63.09x3.53	702676	1
Linear pot adapter o-ring NBR 70 Shore 10.77x2.62	702670	1
LP end cap anti extrusion ring cut 68.4x63x1.4	702679	1
displacement transducer step seal 6.3x11.2x2.2	702682	2

As we stopped the HPC in vented condition, the intensifier is at the beginning of its stroke, I.e. the low pressure piston is near the LP end cap.

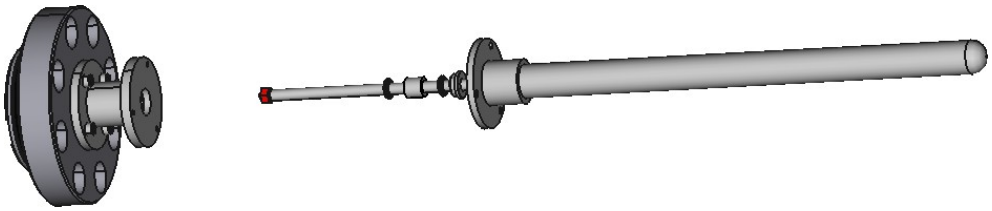
a) Unscrew the eight M10 bolts from the LP end cap



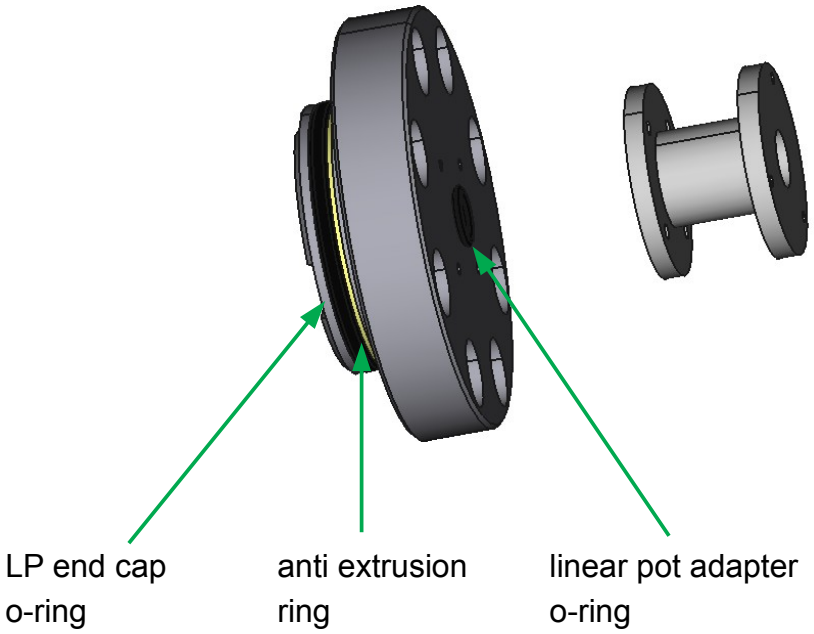
b) Carefully slide the LP end cap and displacement transducer from the low pressure cylinder, release the M5 locking nut and unscrew the displacement transducer rod from the internal piston clamp.



c) Remove the displacement transducer from the linear pot adapter by unscrewing the three M4 bolts.



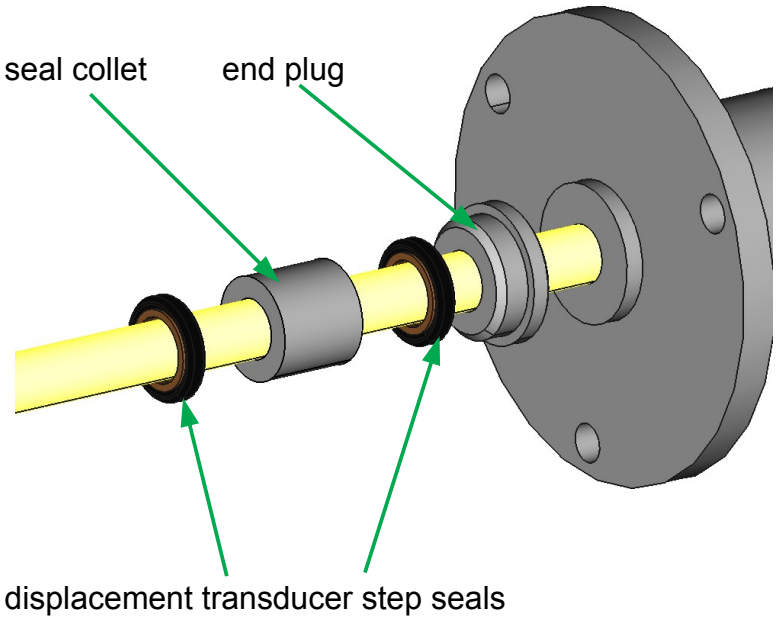
d) Remove the linear pot adapter from the LP end cap by unscrewing the four M4 bolts.

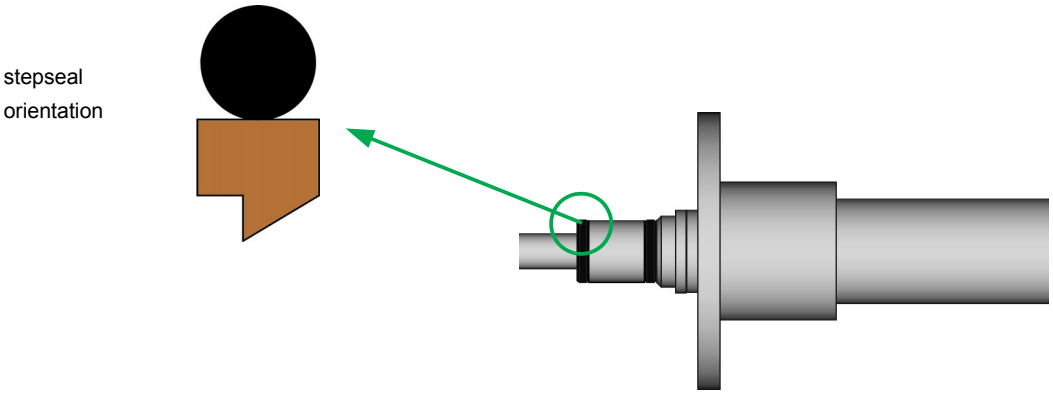


e) Replace the LP end cap o-ring and anti extrusion ring.

f) Replace the linear pot adapter o-ring and remount the linear pot adapter with its four M4 bolts.

g) Re-assemble the displacement transducer in reverse order.

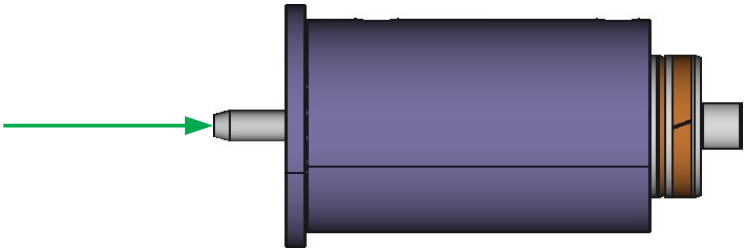




2. Replacing the low pressure piston seal and guiding strips (slydrings)

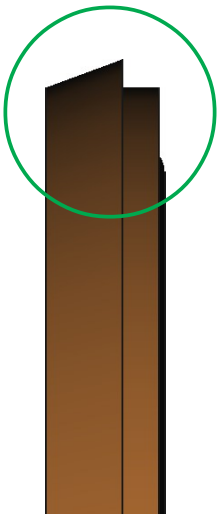
Part	Part Number	Qty
low pressure piston slydring 70x9.7x2.5	702661	2
low pressure piston stepseal 59.3x70x4.2	702658	1

a) Carefully slide the low pressure piston from its cylinder.

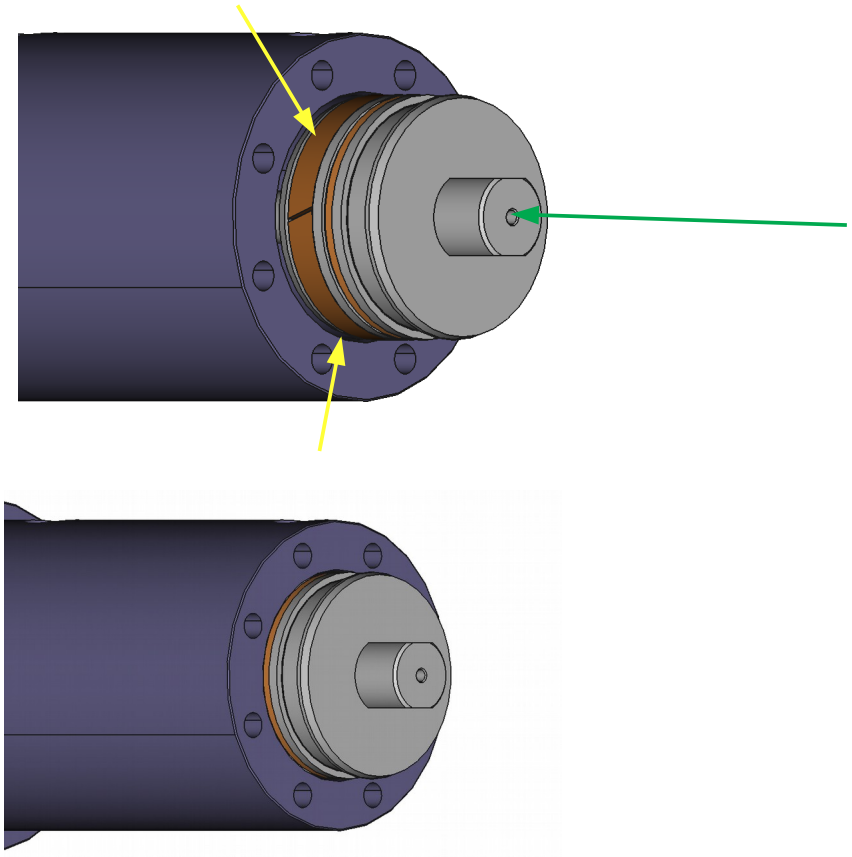


b) Remove the old stepseal and slydrings.
c) Mount the new o-ring part of the stepseal in its groove.
d) Put the teflon part of the stepseal in hot water (~70 oC / 158 oF) for 10 minutes to make it flexible.
e) Push the teflon part of the stepseal in its groove.

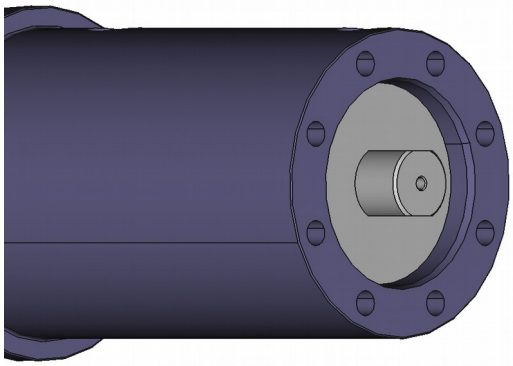
detail of teflon stepseal orientation



f) Bend the first slydring in its groove and slide the low pressure piston in its cylinder until the stepseal just slides into the cylinder.



g) Bend` the second slydring in its groove and slide the low pressure piston further in its cylinder until the low pressure piston is fully inserted into the cylinder.



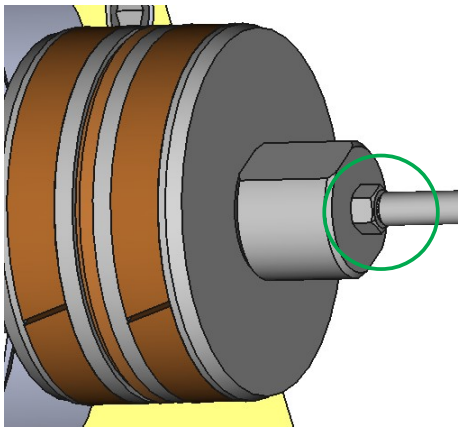
h) Slide the clamp plate over the low pressure cylinder.

i) Now the LP end cap with displacement transducer can be re assembled onto the low pressure piston and cylinder.

- Screw the displacement transducer rod with locking nut into the internal piston clamp. Make sure no stress is applied to the displacement transducer rod to avoid bending it.

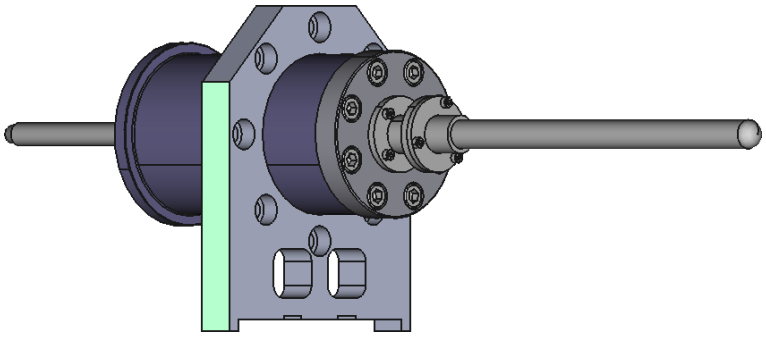
Use Loctite 242 to secure the displacement transducer rod and the locking nut.

- Tighten the locking nut.



j) Push the LP end cap into the low pressure cylinder and align the LP end cap bores with the threaded bores of the low pressure cylinder. Screw in and handtighten the eight M10 bolts. After all eight bolts are screwed in, tighten the bolts evenly.

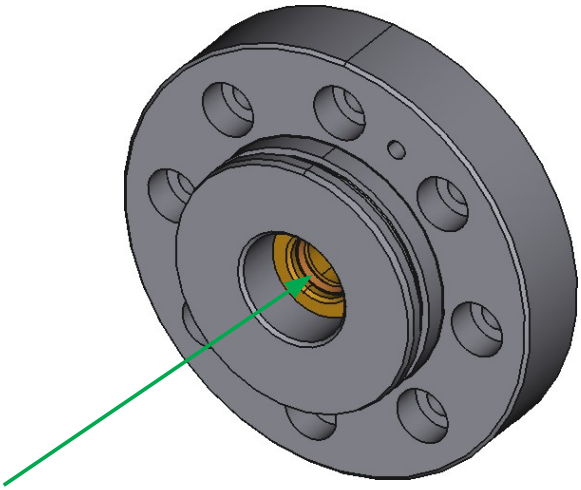
Recommended torque for the eight M10 bolts is 79 Nm (58 pound-foot).



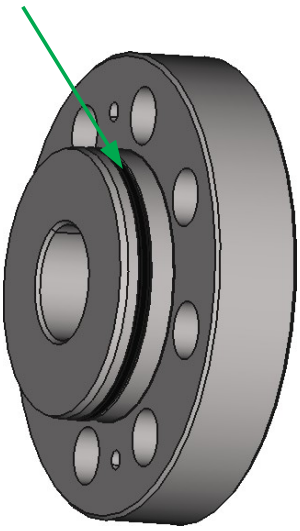
3. Replacing the high pressure piston bearing and internal clamp plate seals

Part	Part Number	Qty
internal clamp plate o-ring NBR 70 Shore 64.77x2.62	702673	1
high pressure piston bearing o-ring NBR 70 Shore 45.69x2.62	702664	2
high pressure piston bearing stepseal 15x22.3x3.2	702667	1

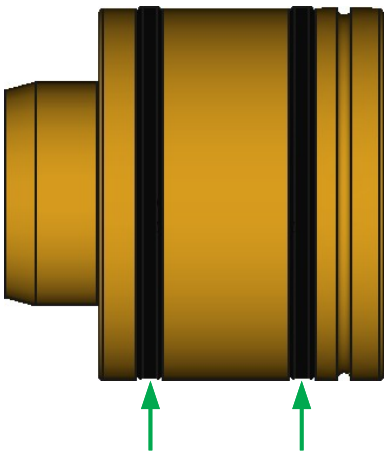
a) Carefully slide the high pressure piston bearing out of the internal clamp plate.



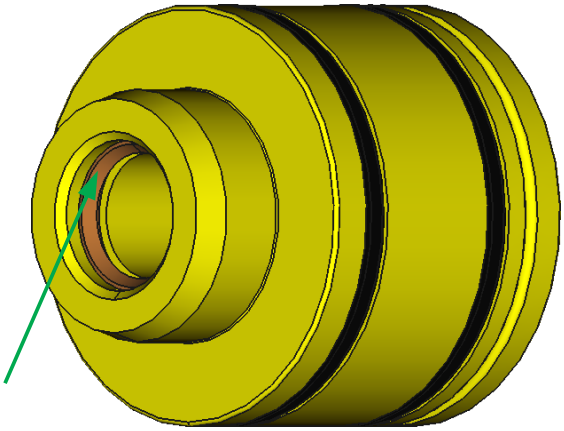
b) Replace the o-ring on the internal clamp plate.



c) Replace both o-rings on the high pressure piston bearing.



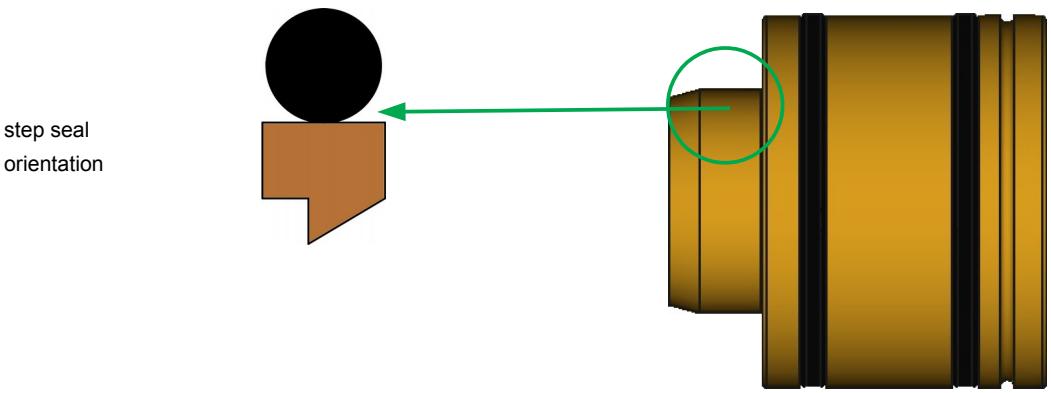
d) Remove the high pressure piston bearing step seal from the high pressure piston bearing.



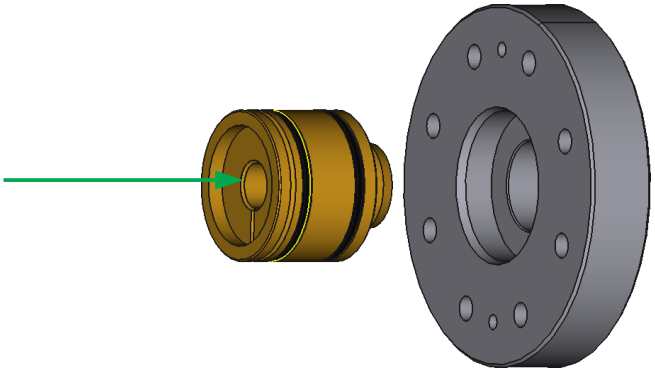
e) Mount the new o-ring part of the stepseal in its groove.

f) Put the teflon part of the stepseal in hot water (~70 oC / 158 oF) for 10 minutes to make it flexible.

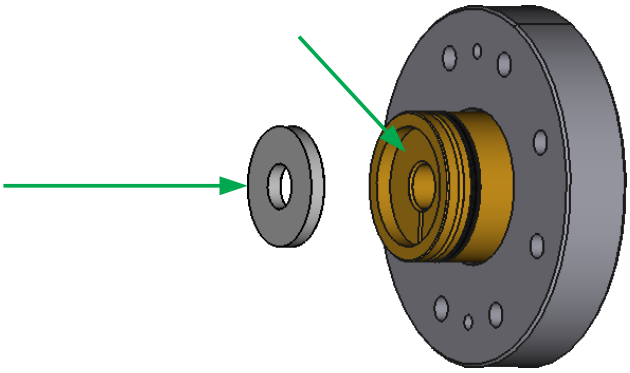
g) Push the teflon part of the stepseal in its groove.



h) Push the high pressure piston bearing back into the internal clamp plate.



i) Put some grease on the high pressure piston bearing force plate chamber and push the force plate into the chamfer. The grease assures that the force plate sticks into its chamber.

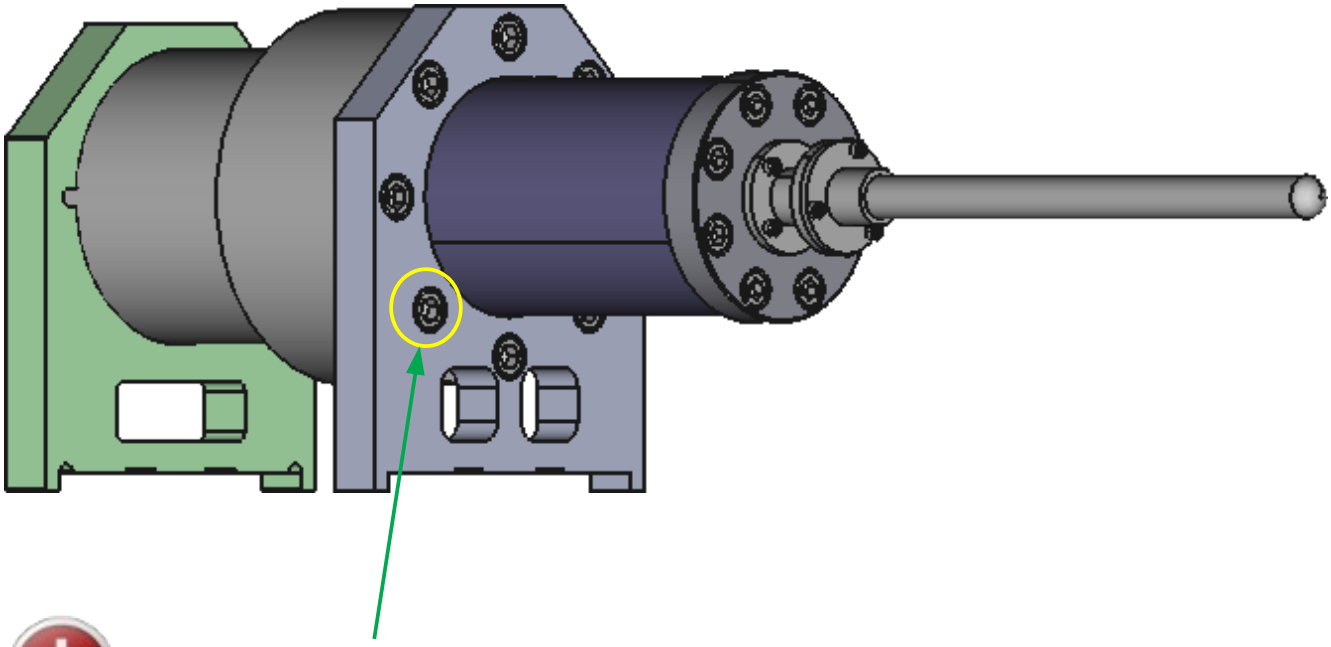


Prior to (j) the high pressure seal assembly has been placed into the cylinder as described in section 13.4.2 Replacing the high pressure seal assembly'

j) Push the high pressure piston bearing and the internal clamp plate into the high pressure cylinder and align the internal clamp plate bores with the threaded bores of the high pressure cylinder. Screw in and handtighten the eight M8 bolts. After all eight bolts are screwed in, tighten the bolts evenly.

Recommended torque for the eight M8 bolts is 40 Nm (29.5 pound-foot).

4. **Reassemble the intensifier in the reverse order of section 13.4 Intensifier service.**



Recommended torque for the eight M12 clamp plate bolts is 137 Nm (101 pound-foot).

13.5 HPP maintenance

Before working in the HPP, please make sure it is disconnected from electrical power.

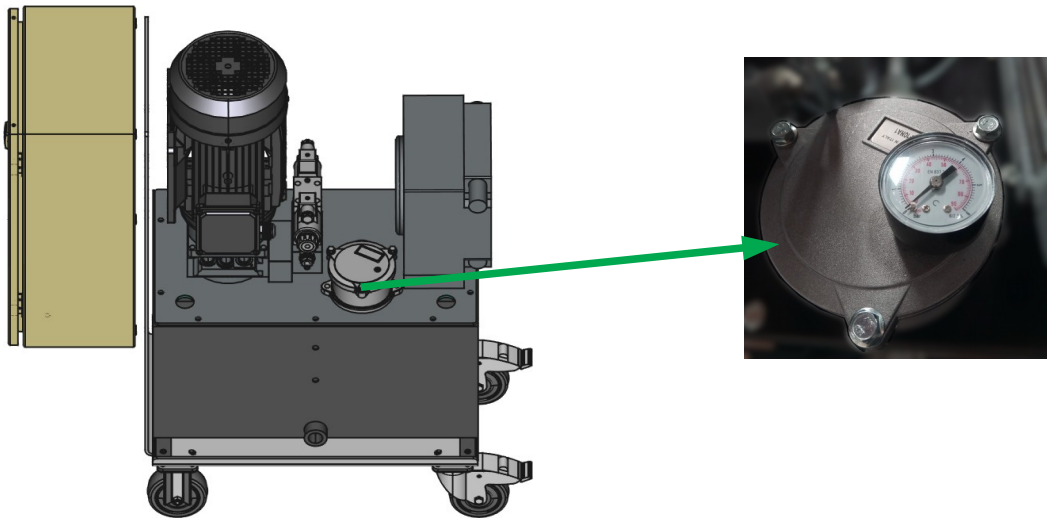
When operating, HPP motor and other parts heat up to as much as ~70 ºC (160 ºF). Wait at least one hour for the HPP to cool down before starting to work on it.

Visually inspect the HPP for oil leakage and inspect all electrical cables for visual damage

13.5.1 Maintenance schedule

In order to keep the HPP in optimal condition, the guidelines below should be followed :

- **First 50 hours of operation (see timer inside HPP control box)**
  - Weekly check the return filter on the HPP



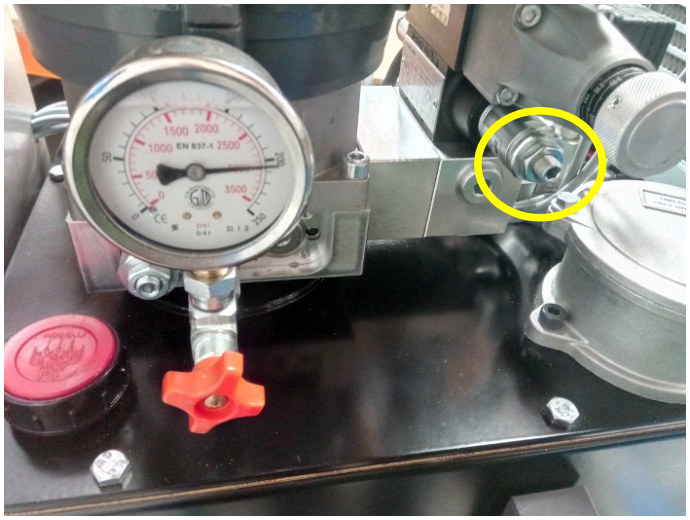
The analog gauge on the filter cap indicates the differential pressure over the filter. If the gauge indicates a pressure > 1 bar, the filter needs to be replaced.

  - Weekly check oil level of the tank before operating HPC

- **Every 500 hours or 6 months**
  - Take a sample of the oil and check it for cleanliness, acceptable contamination according to below schedule :

Contamination level	
ISO 4406	NAS 1638
15/11	4 -6

  - Visually inspect :
    - Hydraulic connections.
    - Electrical connections (also inside control box).
    - Air flow paths (motor and oil cooler) for any obstructions / contamination and clean when necessary.
  - Check return filter gauge.
  - Check oil level of the tank before operating HPC.
  - Check pressure regulator settings, ultimate pressure measured on the analog gauge should be ~21 MPa / when necessary adjust the regulator.



Screwing the nut in increases the pressure, unscrewing decreases the pressure.

Do not forget to tighten the locnut after readjusting the regulator.

- **Every 2500 hours or 12 months**
  - Drain the oil from the HPP reservoir and refill with new Castrol hyspin AWS hydraulic fluid, 32ISO.

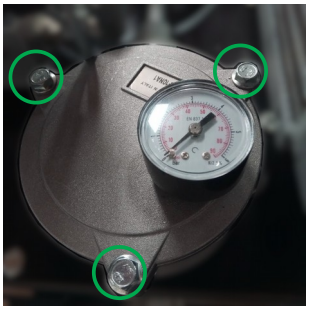
Take appropriate precautions when handling the hydraulic oils, read the **M**aterial **S**afety **D**ata **S**heets first!

See ANNEX 1 MSDS sheets of this manual and the MSDS documents glued on the oil cans.

Check for any debris coming out of the HPP reservoir. If metal or other particles are observed contact the factory.

- Replace the return filter on HPP.

To access the filter element, loosen and remove the filter cap by unscrewing the three bolts.



- Visually inspect :
  - Hydraulic connections.
  - Electrical connections (including the inside control box).
  - Air flow paths (motor and oil cooler) for any obstructions / contamination and clean when necessary.
- Check pressure regulator settings, ultimate pressure measured on the analog gauge should be ~21 MPa / when necessary adjust the regulator.

13.5.2 HPP electric motor

The HPP electric motor should be maintained according to the schedule below :

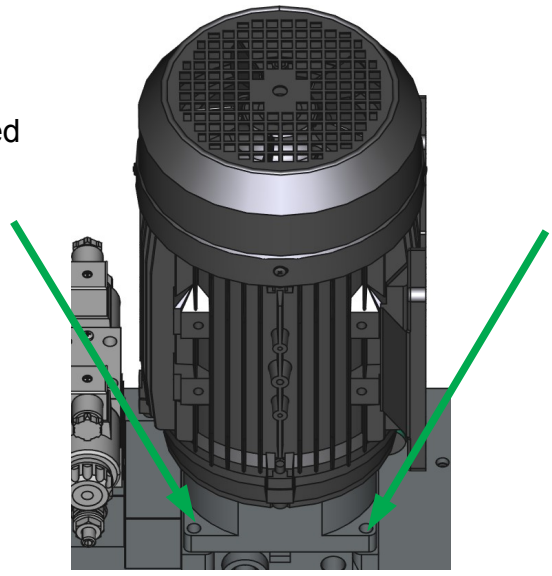
Lubrication interval			
Motor		Duty hours	
size	poles	@ 25 °C	@ 40 °C
100	4	4000	3000

Before working in the HPP, please make sure it is disconnected from electrical power.

To access the hour counter, open the lid of the HPP control box, see 13. Inspection and maintenance

The electric motor can easily be removed from the HPP and serviced at a company specialized in servicing electric motors

The electric motor is mounted with 4 bolts.



14. Calibration

As mentioned in 9.4.5 CALIBRATION there are several items related the HPC operation subject to recalibration ;

- **Intensifier piston position sensor**
  This is an automated function which does not require any interaction with the user other than pushing the button to start the function.
  This calibration is an operational maintenance function that does not affect the metrology of the HPC system.
- **Control sensor alignment**
  This is an automated function which does not require any interaction with the user other than pushing the button to start the function.
  This calibration is an operational maintenance function that does not affect the metrology of the HPC system.
- **HPM reference pressure module**
  The HPM is subject to calibration as described in section 14.2 HPM (reference pressure module) calibration.
  This calibration is required to maintain the metrology of the HPC system measurements.
- **HPB barometer module**
  The HPB is subject to calibration as described in section 14.3 HPB (barometer module) calibration
  This calibration is required to maintain the metrology of the HPC system measurements if the HPC will be used in absolute mode.

For both the HPM and HPB a spreadsheet to assist the user is on the General accessories USB stick called “HPC calibration spreadsheet”.

14.1 Calibration spreadsheet

The “HPC calibration spreadsheet” includes four tabs :

1. General data

This tab needs to be completed prior to starting the calibration

pressure unit	[psi]	(dropdown)
instrument	MNR-800-HPC400	
serialnumber	1234	
pressure module	MNR-800-HPM70S	(dropdown)
serialnumber	5678	
adder	0	[Pa]
multiplier	1,00000	[-]
barometer module	MNR-800-HPB	
serialnumber	9876	
adder	0	[Pa]
multiplier	1,00000	[-]

2. HPM full calibration worksheet

This tab is filled with calibration data resulting from a full calibration as described in 14.2 HPM (reference pressure module) calibration.

pressure module	MNR-800-HPM70S	
serialnumber	5678	
existing adder	3214	[Pa]
existing multiplier	1,001200	[-]
new adder	**-1164**	**[Pa]**
new multiplier	**1,001085**	**[-]**

	excursion 1		excursion 2		excursion 3	
	reference pressure [MPa] gauge	HPM pressure [MPa] gauge	reference pressure [MPa] gauge	HPM pressure [MPa] gauge	reference pressure [MPa] gauge	HPM pressure [MPa] gauge
1	0,0000	0,0097	0,0000	0,0065	0,0000	0,0055
2	7,0008	7,0045	7,0002	7,0096	7,0008	7,0098
3	14,0004	14,0039	14,0006	14,0091	14,0000	14,0032
4	21,0002	21,0117	21,0007	21,0067	21,0001	21,0055
5	28,0009	28,0106	28,0006	28,0122	28,0007	28,0107
6	35,0006	35,0050	35,0004	35,0134	35,0006	35,0085
7	42,0005	42,0134	42,0004	42,0093	42,0000	42,0121
8	49,0003	49,0136	49,0007	49,0072	49,0007	49,0053
9	56,0003	56,0083	56,0009	56,0087	56,0006	56,0122
10	63,0003	63,0132	63,0004	63,0140	63,0010	63,0127
11	70,0001	70,0086	70,0001	70,0146	70,0004	70,0086
12	63,0005	63,0100	63,0000	63,0122	63,0005	63,0078
13	56,0006	56,0088	56,0008	56,0123	56,0003	56,0112
14	49,0004	49,0105	49,0009	49,0051	49,0003	49,0096
15	42,0005	42,0069	42,0004	42,0077	42,0004	42,0132
16	35,0004	35,0081	35,0007	35,0096	35,0006	35,0098
17	28,0000	28,0071	28,0005	28,0120	28,0008	28,0031
18	21,0006	21,0030	21,0006	21,0034	21,0002	21,0119
19	14,0009	14,0038	14,0006	14,0107	14,0003	14,0017
20	7,0007	7,0071	7,0008	7,0015	7,0004	7,0107
21	0,0000	0,0091	0,0000	0,0094	0,0000	0,0007

After completing the pressure values of the three excursions, the new adder and multipliers are calculated. These new values are entered in the HPC, see 9.4.5 CALIBRATION to store the new values.

3. HPB verification adjustment

This tab is intended to calculate a one point offset against a reference barometer as described in 14.3.1 Verification HPB installed in HPC.

model	MNR-800-HPB	
serialnumber	9876	
existing adder	10,0	[Pa]
existing multiplier	0,9998112	[-]
HPB reading	0,9998	[bar] abs
Reference reading	1,0010	[bar] abs
new adder	**130,0**	**[Pa]**
new multiplier	**0,9998112**	**[-]**

4. HPB full calibration worksheet

Similar to the HPM full calibration, this tab is filled with calibration data resulting from a full calibration as described in 14.3.2 Calibrating HPB installed in HPC and 14.3.3 Calibrating HPB outside HPC.

pressure module	MNR-800-HPB	
serialnumber	9876	
existing adder	10	[Pa]
existing multiplier	0,999811	[-]
new adder	**9**	**[Pa]**
new multiplier	**0,999758**	**[-]**

	excursion 1		excursion 2		excursion 3	
	reference pressure [bar] absolute	HPB pressure [bar] absolute	reference pressure [bar] absolute	HPB pressure [bar] absolute	reference pressure [bar] absolute	HPB pressure [bar] absolute
1	0,750000	0,75006	0,750000	0,75003	0,750000	0,75001
2	0,800001	0,80007	0,800001	0,80008	0,800009	0,80007
3	0,850005	0,85007	0,850008	0,85005	0,850001	0,85009
4	0,900005	0,90003	0,900009	0,90011	0,900005	0,90003
5	0,950006	0,95006	0,950009	0,95010	0,950006	0,95008
6	1,000001	1,00012	1,000001	1,00012	1,000004	1,00005
7	1,050006	1,05012	1,050003	1,05004	1,050001	1,05010
8	1,100003	1,10004	1,100006	1,10012	1,100006	1,10013
9	1,150002	1,15013	1,150009	1,15010	1,150010	1,15006
10	1,200010	1,20011	1,200008	1,20014	1,200004	1,20007
11	1,250004	1,25005	1,250000	1,25011	1,250004	1,25014
12	1,200004	1,20009	1,200000	1,20010	1,200006	1,20012
13	1,150008	1,15012	1,150004	1,15010	1,150006	1,15011
14	1,100008	1,10011	1,100009	1,10013	1,100003	1,10006
15	1,050007	1,05005	1,050001	1,05006	1,050003	1,05009
16	1,000010	1,00005	1,000009	1,00008	1,000007	1,00008
17	0,950001	0,95009	0,950009	0,95007	0,950001	0,95004
18	0,900008	0,90002	0,900002	0,90007	0,900002	0,90007
19	0,850005	0,85011	0,850008	0,85006	0,850002	0,85005
20	0,800001	0,80008	0,800003	0,80005	0,800003	0,80005
21	0,750002	0,75004	0,750000	0,75001	0,750003	0,75003

After completing the pressure values of the three excursions, the new adder and multipliers are calculated. These new values are entered in the HPC, see 9.4.5 CALIBRATION to store the new values.

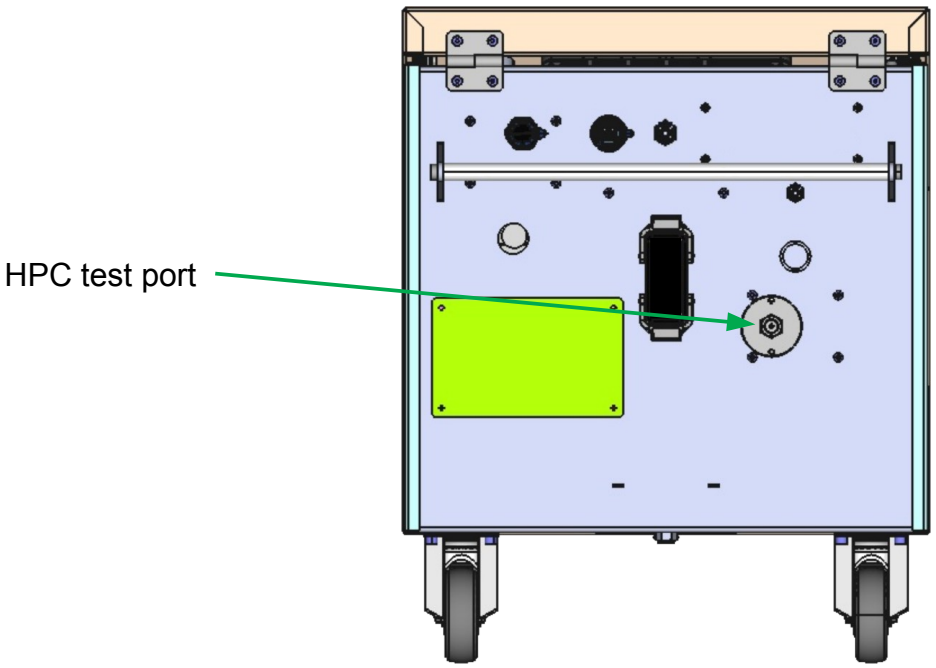
14.2 HPM (reference pressure module) calibration

To calibrate a HPM, reference pressures from a piston gauge are applied to the module at ascending and descending increments typically equally divided over the range. We recommend following the “Comprehensive Calibration Procedure” as described in EURAMET Calibration Guide No. 17 which can be found on the Euramet website.

The pressure defined by the piston gauge and the HPM reading are recorded at each point. After all of the pressures have been applied and recorded, a 1st order fit is calculated to align the HPM with the piston gauge pressures. An example spreadsheet which calculates adjustment coefficients can be found on the general accessories USB stick included in the HPC delivery.

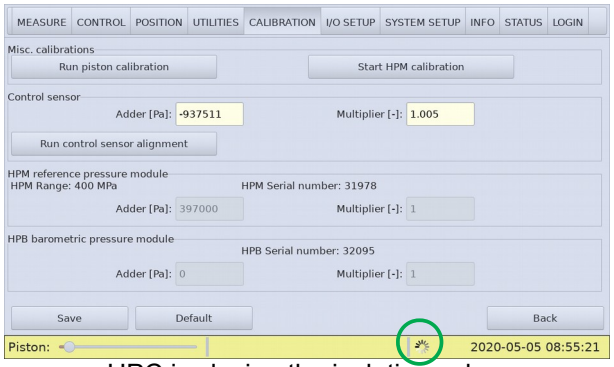
New 1st order adder and multiplier values are stored in the HPM module itself and can be entered via the HPC <Setup>, <Calibration> menu, see 9.4.5 CALIBRATION.

The HPM can be calibrated installed in the HPC or stand alone using the RS232 cable with power supply included in the HPM delivery.

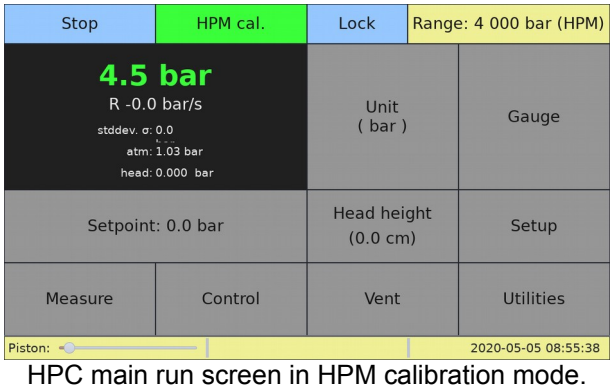


14.2.1 Calibrating HPM installed in HPC

- HPC is powered up for at least 1 hour and is in **Idle** state, no need to power up HPP for calibration. See 11.1 Preparing HPC for operation step <2>.
- Head height on HPC is set to “0”.
- Connect the piston gauge to the HPC test port and make sure the HPC reference level is aligned with the piston gauge reference level (or in case of a reference level difference a head correction is applied **on the piston gauge pressure**).
- Make sure the system is filled, purged and leaktight, see 10.11 Removing air from the external tubing.
- At this stage, make sure the piston gauge (control) is vented.
- Record the existing HPM adder and multiplier, see 9.4.5 CALIBRATION.
- Set HPC to “HPM calibration” by pressing the <Start HPM calibration> button in the calibration menu, see 9.4.5 CALIBRATION. This will close the HPC isolation valve and return to the main run screen.



HPC is closing the isolation valve.



HPC main run screen in HPM calibration mode.

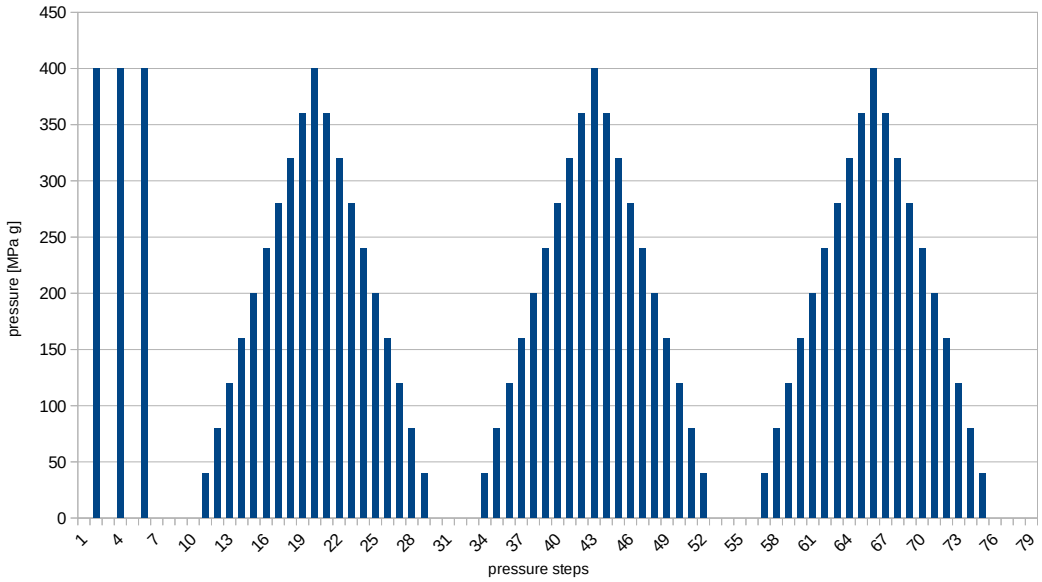
- When running the HPM calibration, if possible, use data acquisition software to record HPM readings using remote commands as described in 12.1 HPC remote command overview.

1. Using the pressure control capabilities of the piston gauge, exercise the HPM module three times between zero and ~95% of the HPM range.
2. Disable HPC autozero, see 9.4 Setup for instructions.
3. Wait at least 5 minutes in vented condition after completing the exercising.
4. Record the HPM pressure reading using an average calculated over at least 30 seconds, preferably by means of data acquisition software.
5. Load the mass on the piston gauge needed to realize the 1st test point.
6. Close the piston gauge vent valve.
7. Adjust the pressure on the piston gauge and float the piston of the piston gauge.
8. After reaching stability, wait at least 60 seconds to settle adiabatic effects (re-adjust the pressure if needed to keep the piston gauge piston floating).
9. Record the HPM pressure reading using an average calcuated over at least 30 seconds, preferably by means of data acquisition software.
10. Load the mass set on the piston gauge needed to realize the next test point.
11. Adjust the pressure on the piston gauge and float the piston of the piston gauge.
12. After reaching stability, wait at least 60 seconds for adiabatic effects to settle (re-adjust the pressure if needed to keep the piston gauge piston floating).
13. Record the HPM pressure reading using an average calcuated over at least 30 seconds, preferably by means of data acquisition software.
14. Repeat with 10.. 13 for every point in the calibration sequence.

A total of three sequences is recommended where every sequence starts at 3. (in vented condition). After completing the calibration, calculate the new adder and multiplier using the spreadsheet, see 14.1 Calibration spreadsheet and enter the new values in HPC as described in 9.4.5 CALIBRATION.

Entering a new adder and multiplier will immediately affect the measurements of the HPC. Only qualified personnel who are familiar with pressure calibration and understand the risks involved should perform this task.

It is recommended to perform an as left pressure calibration sequence after entering the new adder and multiplier to assure the HPM reading is within specifications.



graphical presentation of the pressure steps of the calibration

14.2.2 Calibrating HPM outside HPC

- HPM is removed from HPC and the HPM port on the HPC is plugged. See 11.3 Installing a different HPM (range) for instructions how to remove an HPM.
- HPM is hydraulically connected to a piston gauge in such a way that the HPM orientation is the same as when mounted in HPC (horizontal).
- HPM reference level is aligned with the piston gauge reference level (or in case of a reference level difference a head correction is applied to the pressure defined by the piston gauge).
- HPM is electrically connected with the RS232 cable / 24 V power supply (included in the HPM delivery).
- HPM is powered up for at least 1 hour.
- Assure that the tubing between the HPM and the piston gauge is filled, purged and leaktight.
- Record the existing existing HPM adder and multiplier, see 12.4 HPM and HPB remote command overview.
- Use a terminal program like Hyperterminal or Putty to record HPM readings using remote commands as described in 12.4 HPM and HPB remote command overview.

The actual calibration is equal to the **numbered** steps as described in 14.2.1 Calibrating HPM installed in HPC.

A total of three sequences is recommended where every sequence starts at 3. (in vented condition). After completion of the calibration, calculate the new adder and multiplier using the spreadsheet, see 14.1 Calibration spreadsheet and enter the new values in HPC as described in 9.4.5 CALIBRATION.

Entering a new adder and multiplier will immediately affect the measurements of the HPC. Only qualified personnel who are familiar with pressure calibration and understand the risks involved should perform this task.

It is recommended to perform an as left pressure calibration sequence after entering the new adder and multiplier to assure the HPM reading is within specifications.

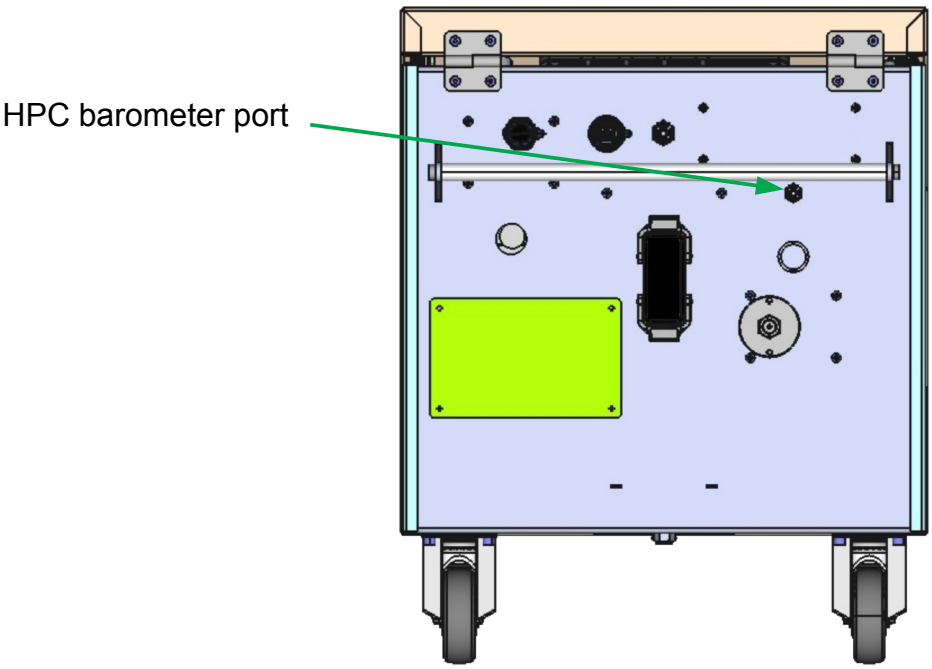
14.3 HPB (barometer module) calibration

Relative to the available HPM pressure ranges, HPB's influence on the overall uncertainty in pressure is small. As the HPB is used over a very small range (local changes in atmospheric pressure), the dominant long term drift is a zero drift. In order to compensate for zero drift, the user can decide to verify the HPB pressure reading by means of a one point comparison against a calibrated barometer and if applicable adjust for the drift. See 14.3.1 Verification HPB installed in HPC

To perform a full calibration of the HPB, reference pressures from a piston gauge or high accuracy barometer (the pressure reference) are applied to the barometer module at ascending and descending increments typically equally divided over the range. For a full calibration we recommend following the "Comprehensive Calibration Procedure" as described in EURAMET Calibration Guide No. 17 which can be found on the Euramet website.

The pressure defined by the pressure reference and the HPB readings are recorded at each point. After all of the pressures have been applied and recorded, a 1st order fit can be calculated to align the HPB with the pressure reference. An example spreadsheet which calculates adjustment coefficients can be found on the general accessories USB stick included in the HPC delivery.

The HPB can be calibrated installed in the HPC or stand alone by using the RS232 cable with power supply included in the HPC delivery.



14.3.1 Verification HPB installed in HPC

- HPC is powered up for at least 1 hour and is in Idle state, no need to turn on the HPP for this calibration. See 11.1 Preparing HPC for operation step <2>.
- Open the “HPC calibration spreadsheet” which can be found on the general accessories USB stick included in the HPC delivery.

1. Record existing existing HPB adder and multiplier from the HPC settings menu, see 9.4.5 CALIBRATION.
2. Record HPB pressure reading from the HPC main run screen.
3. Record calibrated barometer reading.
4. Complete the general data tab on the “HPC calibration spreadsheet”.
5. Enter the existing adder and multiplier on the “HPC calibration spreadsheet”.
6. Enter the HPB and reference barometer reading on the “HPC calibration spreadsheet”.
7. The example spreadsheet calculates the new adder (old multiplier remains the same).
8. Enter the new HPB adder using HPC <Setup>, <CALIBRATION> menu (need to log in as Administrator).

model	MNR-800-HPB	
serialnumber	9876	
existing adder	10,0	[Pa]
existing multiplier	0,9998112	[-]
HPB reading	0,9998	[bar] abs
Reference reading	1,0010	[bar] abs
new adder	**130,0**	**[Pa]**
new multiplier	**0,9998112**	**[-]**

Example entry single point verification and adjustment.

14.3.2 Calibrating HPB installed in HPC

- HPC is powered up for at least 1 hour and is in Idle state, no need to turn on the HPP for this calibration. See 11.1 Preparing HPC for operation step <2>.
- Connect the pressure reference to the HPC barometer port and make sure the HPC reference level is aligned with the pressure reference level (or in case of a reference level difference a head correction is applicable).
- Assure that the tubing between HPB and pressure reference is leaktight.
- Record the existing HPB adder and multiplier, see 9.4.5 CALIBRATION.
- If possible, use data acquisition software to record HPM readings using remote commands as described in 12.1 HPC remote command overview.

1. Exercise the HPB module three times between 75 and 125 kPa a.
2. Wait at least 5 minutes after completing the exercising.
3. Set the pressure reference at 75 kPa.
4. Wait till pressure reference and HPB readings are stable.
5. After reaching stability, wait at least 60 seconds to settle adiabatic effects (re-adjust the pressure if needed).
6. Record both the pressure reference and HPB pressure reading averaged over 30 seconds for example by means of data acquisition software.
7. Adjust the pressure on the pressure reference to the next pressure step.
8. After reaching stability, wait at least 60 seconds for adiabatic effects to settle (re-adjust the pressure if needed).
9. Record both the pressure reference and HPB pressure reading averaged over 30 seconds.
10. Repeat 7.. 9 for every point in the calibration sequence.

A total of three sequences is recommended where every sequence starts at 3. After completing the calibration, calculate the new adder and multiplier using the spreadsheet, see 14.1 Calibration spreadsheet and enter the new values in HPC as described in 9.4.5 CALIBRATION.

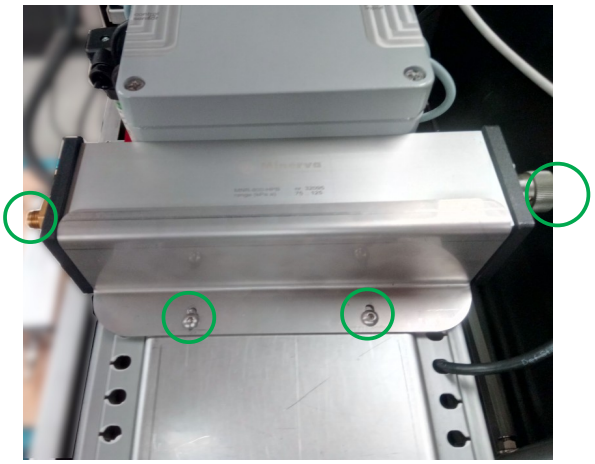
Entering a new adder and multiplier will immediately affect the measurements of the barometer. Only qualified personnel who are familiar with pressure calibration and understand the risks involved should perform this task.

It is recommended to perform an as left pressure calibration sequence after entering the new adder and multiplier to assure the HPB reading is within specifications.

14.3.3 Calibrating HPB outside HPC

- HPB is removed from HPC.

disconnect plastic tube



disconnect electrical connection

loosen the 2 bolts 10 turns

- HPB is pneumatically connected to a pressure reference in such that HPB orientation is the same as when mounted in HPC (horizontal).
- HPB reference level is aligned with the pressure reference reference level (or in case of a reference level difference a head correction is applied).
- Assure that the tubing between HPB and piston gauge is filled, purged and leaktight.
- HPB is electrically connected with the RS232 cable / 24 V power supply (included in the HPC delivery).
- HPB is powered up for at least 1 hour.
- Assure that the tubing between HPB and pressure reference is leaktight.
- Record the existing HPM adder and multiplier, see 12.4 HPM and HPB remote command overview.
- If possible, use data acquisition software to record HPB readings using remote commands as described in 12.4 HPM and HPB remote command overview.

The calibration sequence is described in 14.3.2 Calibrating HPB installed in HPC.

A total of three sequences is recommended where every sequence starts at 3. After completing the calibration, calculate the new adder and multiplier using the spreadsheet, see 14.1 Calibration spreadsheet and enter the new values in HPC as described in 9.4.5 CALIBRATION.

Entering a new adder and multiplier will immediately affect the measurements of the barometer. Only qualified personnel who are familiar with pressure calibration and understand the risks involved should perform this task.

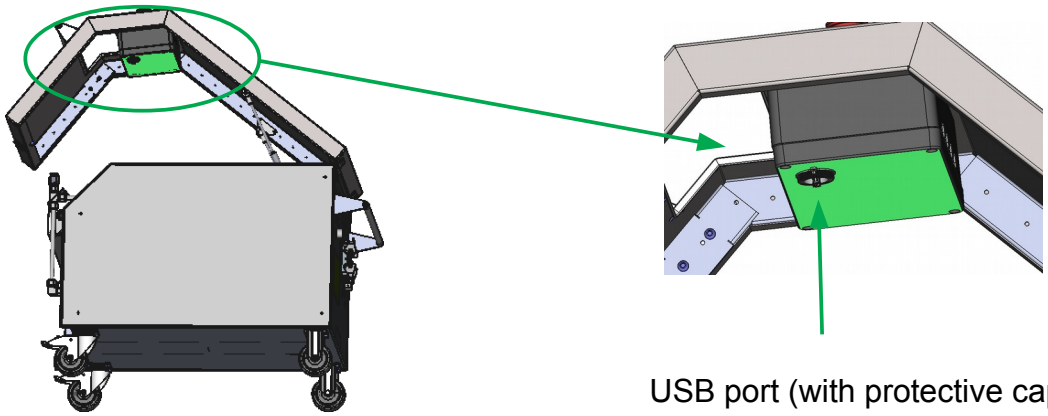
It is recommended to perform an as left pressure calibration sequence after entering the new adder and multiplier to assure the HPB reading is within specifications.

15. Upgrading firmware

Before starting the process to upgrade the firmware, turn the HPC off and back on which puts it is in idle state. If the HPC is not in idle state, the HPC firmware upgrade tool forces HPC into idle state.

To upgrade the software for the HPC interface :

1. Go to minerva-calibration.com.
2. Download the HPC firmware image.
3. Copy the file onto an empty USB stick.
4. Open the HPC hood, see section 8.3.1 Opening HPC's hood.
5. Unscrew the protective cap from the USB port as shown below.



USB port (with protective cap)

6. Stick the USB stick in the USB port.
7. Log in as Administrator throught the local user interface, see section 9.4.10 LOGIN.
8. Open <Setup>, <SYSTEM SETUP> from the local user interface.
9. Push the <Software update> button to upgrade the HPC firmware, an "Are you sure" popup window appears, when <Yes> button is pushed, the firmware upgrading process starts.
10. When the process has finished, the HPC restarts.
11. Remove the USB stick and screw the protective cap back on the USB port.
12. Close the HPC hood and lock it.

After completion, you can check the firmware version through the HPC local user interface via the <Setup>, <STATUS> menu.

16. Troubleshooting

Operating HPC in different configurations and with different attached devices can result in unexpected behavior. This behavior can be caused by external influences or a system defect.

Unexpected behavior is not necessarily caused by a defective HPC. The operator should be familiar with operating the HPC and have read this manual.

The following troubleshooting guide is intended to guide the operator towards a possible cause and determine if this is internal (HPC) or external.

Symptom	Possible cause	Solution
Does not power up.	Mains supply not connected.	Connect mains supply.
	Cable between HPP and HPC not plugged in.	Plug in cable.
	Main switch on HPP switchbox door is set to off.	Set main switch to on.
	Main switch (red panic button) on HPC is set to off.	Release the panic button.
Touch screen is not responsive.	HPC has just been powered on and the start button needs to be pushed.	Push <Start> button.
	HPC has been used remotely or the <Lock> button is enabled.	Push the <Unlock> button.
Powerpack (HPP) is not running.	HPC is in idle state.	Push <HPP on> to start HPP..
Powerpack starts but shuts down immediately.	Oil level in HPP too low.	Fill HPP reservoir with Castrol hyspin AWS hydraulic fluid, 32ISO.
	HPP is not building up pressure and shuts down as a safety precaution.	Check hydraulic hoses between HPP and HPC for damage. If damaged, replace them. Try again.
HPC is not generating pressure.	Compressed air is not connected or insufficient so the HPC valves are not operating.	Check compressed air supply, see section 4.1 HPC general specifications for details on compressed air.
	Internal pressure regulator is defective or setting has changed.	Check analog gauge mounted on internal pressure regulator. See section 13.2

Symptom	Possible cause	Solution
		Overall monthly visual inspection for correct adjustment of the internal pressure regulator.
	External pressure connection not tightened.	Check for any oil spillage and tighten pressure connections as needed.
	Internal pressure connection has loosened.	Check for any internal oil spillage and tighten pressure connections when needed.
	Hydraulic system contains air.	Purge the system as described in section 10.6 Removing air from the HPC internal tubing.
HPC is not reaching its maximum pressure.	HPP pressure is too low.	Adjust the HPP pressure regulator as described in section 13.5.1 Maintenance schedule.
Pressure is never “ready”	Incorrect stability and hold limits.	Check settings, see section 9.4.2 CONTROL. Try default limits if uncertain of necessary values.
Pressure over- or undershoots setpoint.	Misalignment between control sensor and HPM.	Run control sensor alignment routine as described in section 10.9 Control sensor alignment .

Before taking any maintenance actions and or ship a defective product, please follow the safe condition procedure.

This product is covered by a limited one (1) year warranty. Unauthorized service or repair during the warranty period is undertaken at the owner’s risk and may cause damage that is not covered under warranty and/or may void the warranty. See 17. Warranty for details

17. Warranty

During the design and manufacturing of this instrument the utmost attention has been given to quality and durability.

This manual contains information needed for the safe and effective use of the capabilities of the instrument. Please read the manual carefully before operating the instrument. By doing so possible damage to the instrument or damage caused by the incorrect use of the instrument can be avoided.

Minerva meettechniek B.V. warrants the instrument in accordance with the Standard Terms and Conditions of the Instrument Trade as issued by the Association bearing the name "Federation Het Instrument" (The Instrument Federation), filed with the Clerk of Utrecht District Court on 13 January 1993 under number 16/93 and with the Chamber of Commerce and Industry in Amerfoort on 18 January 1993. A copy is available on request.

Minerva meettechniek B.V. warrants that this product will be free from defects in materials and workmanship for a period of 12 months from the date of shipment. If any such product proves defective during this warranty period, Minerva meettechniek B.V., at its option, will either repair the defective product without charge for parts or labor, or will provide a replacement in exchange for the defective product.

In order to obtain service under this warranty, The customer must notify Minerva meettechniek B.V. of the defect before the expiration of the warranty period and make suitable arrangements for the execution of the service.

The customer shall be responsible for packaging and shipping of the defective product to the service center designated by Minerva meettechniek B.V, with shipping charges prepaid.

If no defect can be found the customer can be charged for costs of the investigation.

This warranty shall not apply to any defect, failure or damage caused by :

a. Improper use of the instrument.
b. Normal wear of the product.
c. Modification or repair carried out by or on behalf of the owner or by a third party
d. Modifications to the product that are not supplied or implemented by Minerva meettechniek B.V.

Minerva meettechniek B.V. and its distributors will not be liable for any indirect, special, incidental or consequential damages irrespective of whether Minerva meettechniek B.V. or the vendor has advance notice of the possibility of such damages.

The type number and serial number of the product, as listed on the instrument, should always be mentioned in any correspondence concerning the product.

ANNEX 1 MSDS sheets

SAFETY DATA SHEET
according to Regulation (EC) No. 1907/2006

CRODA

PRIOLUBE™ 1856-LQ-(GD)

Version 2.1 | Revision Date 01.12.2015 | Print Date 13.05.2019

SECTION 1: Identification of the substance/mixture and of the company/undertaking

1.1 Product identifier

Trade name : PRIOLUBE™ 1856-LQ-(GD)

Product code : ESG1856

Registration number : Confidential

1.2 Relevant identified uses of the substance or mixture and uses advised against

Use of the Sub-stance/Mixture : Lubricant base fluid

1.3 Details of the supplier of the safety data sheet

Company : Croda GmbH
Herrenpfad-Sud 33
41334 Nettetal
DE

Telephone : +49215781730

Telefax : +49215713250

E-mail address : SDSCompiler@Croda.com

1.4 Emergency telephone number

USA: 24 Hour Emergency Response Information CHEMTREC toll free: 1-800-424-9300; direct/international: 1-703-527-3887. CANADA: CANUTEC 1-888-CAN-UTEC (226-8832), 613-996-6666 or *666. EUROPE: 00 32 3575 5555. ASIA PACIFIC - excl. China: +65 6542-9595. CHINA: +86 816-635 2206. AUSTRALIA: +61 2 7808 3390. SOUTH AFRICA: +32 3 575 55 55. BRASIL:Suatrans 0800 707 7022 / 0800 707 1767. LATAM: Suatrans (+55) 11 98149-0850 / (+55) 19 3833-5300. INDIA: +91 22 30948601/2. JAPAN: +65 6542 9595 (24 時間 日本語対応無料通話, シンガポール). TÜRKIYE: Sağlik Bakanliği Ulusal Zehir Merkezi - 114

SECTION 2: Hazards identification

2.1 Classification of the substance or mixture

Classification (REGULATION (EC) No 1272/2008)
Not a hazardous substance or mixture.

Classification (67/548/EEC, 1999/45/EC)
Not a hazardous substance or mixture according to EC-directives 67/548/EEC or 1999/45/EC.

Full MSDS can be found on General accessories USB stick.

Conforms to Regulation (EC) No. 1907/2006 (REACH), Annex II, as amended by Commission Regulation (EU) 2015/830

SAFETY DATA SHEET

SECTION 1: Identification of the substance/mixture and of the company/undertaking

1.1 Product identifier

Product name	**Hyspin AWS 32**
Product code	456615-BE02
SDS no.	456615
Product type	Liquid.

1.2 Relevant identified uses of the substance or mixture and uses advised against

Use of the substance/ mixture	Hydraulic fluid. For specific application advice see appropriate Technical Data Sheet or consult our company representative.

1.3 Details of the supplier of the safety data sheet

Supplier	Castrol (UK) Limited PO Box 352, Chertsey Road, Sunbury On Thames, Middlesex, TW16 9AW Orders/Enquiries: 0845 9645111 Technical Enquiries: 0845 9000209
E-mail address	MSDSadvice@bp.com

1.4 Emergency telephone number

EMERGENCY TELEPHONE NUMBER	Carechem: +44 (0) 1235 239 670 (24/7)

SECTION 2: Hazards identification

2.1 Classification of the substance or mixture

Product definition Mixture

Classification according to Regulation (EC) No. 1272/2008 [CLP/GHS]

Not classified.

See sections 11 and 12 for more detailed information on health effects and symptoms and environmental hazards.

2.2 Label elements

Signal word	No signal word.
Hazard statements	No known significant effects or critical hazards.
Precautionary statements	
Prevention	Not applicable.
Response	Not applicable.
Storage	Not applicable.
Disposal	Not applicable.
Supplemental label elements	Not applicable.

EU Regulation (EC) No. 1907/2006 (REACH)

Annex XVII - Restrictions on the manufacture, placing on the market and use of certain dangerous substances, mixtures and articles	Not applicable.

Special packaging requirements

Full MSDS can be found on General accessories USB stick.

Minerva
METROLOGY AND CALIBRATION

Ensuring carefree traceability

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