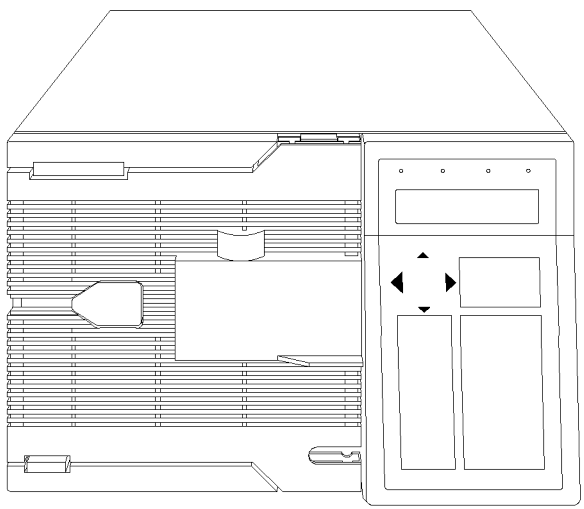
1050 Series of HPLC Modules

Service Handbook - Pumps (79851A/79852A/B)



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IMPORTANT NOTE

This version of the 1050 service manual includes all sections from the 01050-90102 edition 4 (1995) and G1306-90102 edition 2 (May 1994). It merges both sections, the MWD and the DAD.

The series I opticals information (79854A MWD) information has been removed (product went out of support during 2000).

Part numbers have been updated as of 11/2001. Contact your local Agilent support office in case of part number issues or upgrades.

The latest version of this manual is available as Adobe Acrobat Reader (PDF) version only and can be downloaded from the Agilent Technolgies web page www.agilent.com.

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1

Pumps: General Information

This chapter provides general information about the 1050 Pumps

Pumps: General Information

Introduction

This chapter gives general information on

- about this pump
- repair policy
- product structure
- capillaries
- specifications

About this Manual

This manual provides service information about the 1050 Pumps (isocratic and quaternary). The following sections give the detailed descriptions of all electronic and mechanical assemblies. You will find illustrated part-breakdowns interconnection tables connector configurations as well as all necessary replacement procedures in this manual. Detailed diagnostic procedures using firmware resident test methods and error messages are also given in this manual.

About the Pumps

The 1050 Pump modules houses the mechanical devices and the electronic circuitry for either the isocratic or quaternary module which control the various functions of the flow system. The module is controlled via the user interface through which the operator defines his requirements (flow-composition and so on) and which provides the required analytical information.

Repair Policy

The 1050 Pumps are designed that all components are easy accessible Customers are able to repair certain parts of the 1050 Pumps see Operator's Handbook.

For details on repair policy refer to *“Repair Policy” on page 38*.

Product Structure

The 1050 Series of HPLC modules are available in two versions. In the standard version most of the parts used are stainless steel.

In the 1050 Ti Series the flow path of the quaternary pump consists solely of corrosion resistant materials such as titanium, tantalum, quartz, sapphire, ruby, ceramic and fluorocarbon polymers. It is recommended for use with mobile phases containing high salt concentrations, extreme pH solutions and other aggressive mobile phases.

Isocratic Pump	79851A
Quaternary Pump	79852A
Ti - Quaternary Pump	79852B

NOTE

The isocratic pump was also introduced as Ti - version (79851B) but due to the insufficient orders it became obsolete end of FY 91.

Capillaries

In the 1050 Pumps the capillary shipped with the module will have a plastic color coating for identification in terms of material and internal diameter.

All capillaries before the injector have a internal diameter of 0.25 mm. From the injector the internal diameter is reduced to 0.17 mm.

Table 1 **Capillary Color Code**

color	Internal Diameter	Material
blue	0.25 mm	
green	0.17 mm	
red	0.12 mm	
white		tantalum

NOTE For the Ti pumps the fittings are always titanium with a titanium nitrite coating and the front and back ferrules are gold plated.

The Ti capillaries have two color coatings. One for identifying the material covering the main part of the capillary and a small one for the internal diameter.

Specifications

Table 2 **Specifications of 1050 Pumps**

Hydraulic System	Dual-pistons in-series with proprietary servo-controlled variable stroke drive floating pistons and active inlet valve.
Flow Range	Setpoint from 0.001 to 9.999 ml/min in 0.001 ml/min increments.
Piston Displacement	20 to 100 µl, automatic matched to flow rate or user-selectable.
Flow Precision	<0.3% RSD (typically <0.15%) based on retention time at 0.5 ml/min and 2.5 ml/min.
Pressure	Operating range from 0-400 bar (5880 psi) up to 5 ml/min; from 0-200 bar (2950 psi) up to 10 ml/min. Display in bar, psi or MPa.
Pressure Pulsation	<2% amplitude (typically <1%), 1 ml/min isopropanol at all pressures >10 bar.
Compressibility Compensation	User-selectable, based on mobile phase compressibility.
Recommended pH Range	2.3 to 12.5 (stainless steel version). Solvents with pH below 2.3 should not contain acids which attack stainless steel. 1.0 to 14 (TI series).
Gradient Formation	Low pressure quaternary mixing/gradient capability using proprietary high-speed proportioning valve. Delay Volume 900 to 1100 µl dependent on back pressure.
Composition Range	0 to 100% in 0.1% increments from four independent channels.
Composition Precision	±0.25% absolute (typically ±0.15%) peak to peak, binary mixed water/acetonitrile from 0.5 ml/min to 5.0 ml/min without mixer.
Solvent Preparation	Four 1 liter bottles each with individually-regulated helium sparger, cap and filter.

Table 2 **Specifications of 1050 Pumps**

Oven Temperature Range	Ambient +5°C to ambient +60°C in 0.1°C increments.Display in °C, °F or K.
Oven Temperature Stability	±0.15°C
Oven Capacity	Two 25-cm or three 20-cm columns.
Control	Integrated keyboard with function keys; parameter editing during run possible; keyboard lock; optional control by PC.
Parameters	Flow rate, compressibility, stroke volume, upper and lower pressure limits, 2 external contacts; %B, %C, %D (for quaternary pump). Time-programmable Parameters: Flow rate, upper pressure limit, external contacts; %B, %C, %D.
Methods	Battery-backed storage of up to 10 methods. Automatic start up and shut down methods. Editing of stored methods possible in run.
Analog Output	For pressure monitoring, 2 mV/bar.
Communications	Outputs: ready signal and two external outputs (one 24 V relay and one 30V (AC/DC) contact closure, both with 0.25 A. In-and outputs: start, stop and shut down signals. Optional interface for GPIB and RS-232C.
Safety Aids	Extensive diagnostics, error detection and display via front-panel LED's and status logbook. User-definable shutdown method activated in case of error. Leak detection and safe leak handling. Low voltages in major maintenance areas. Column pressure protection with maximum rate of pressure change of <20 bar/sec after a setpoint change.
Environment	4°C to 55°C (constant temperature) with <95% humidity (non-condensing).
Power Requirements	Line voltage: 100-120 or 220-240 VAC ±10% Line frequency: 48-66 Hz Power consumption: 120 VA max.

Table 2 **Specifications of 1050 Pumps**

Dimensions	Height: 208 mm (8.2 in) Width: 325 mm (12.8 in) Depth: 560 mm (22.0 in)

For complete description of test conditions used to obtain specifications, see *Owner's Manual*.

1

Pumps: Hardware Information

This chapter provides hardware information about the 1050 Pumps

Pumps: Hardware Information

This chapter gives general and technical information about the hardware components of the 1050 Pumps.

- Solvent Cabinet
- Pump Hardware
  - ❏ Multi Channel Gradient Valve (MCGV)
  - ❏ Metering Drive Assembly
  - ❏ Pump Head Assembly
  - ❏ Continuous Seal Wash
  - ❏ Active Inlet Valve
  - ❏ Outlet Ball Valve
  - ❏ Frit Adapter Assembly
  - ❏ Purge Valve
  - ❏ High Pressure Damper
- Column Holder

Overview

The 1050 Pump is based on a dual piston series design which comprises all essential functions a solvent delivery system has to fulfill. Metering of solvent and delivery to the high pressure side are performed by one metering assembly which can generate pressure up to 400 bar.

The basic system (isocratic) comprises the metering assembly including an active inlet valve, an outlet valve, a frit adapter assembly and a damping unit.

The gradient operation system includes a highs peed proportioning valve allowing quaternary operation and a solvent cabinet with separate Helium degassing for each solvent channel.

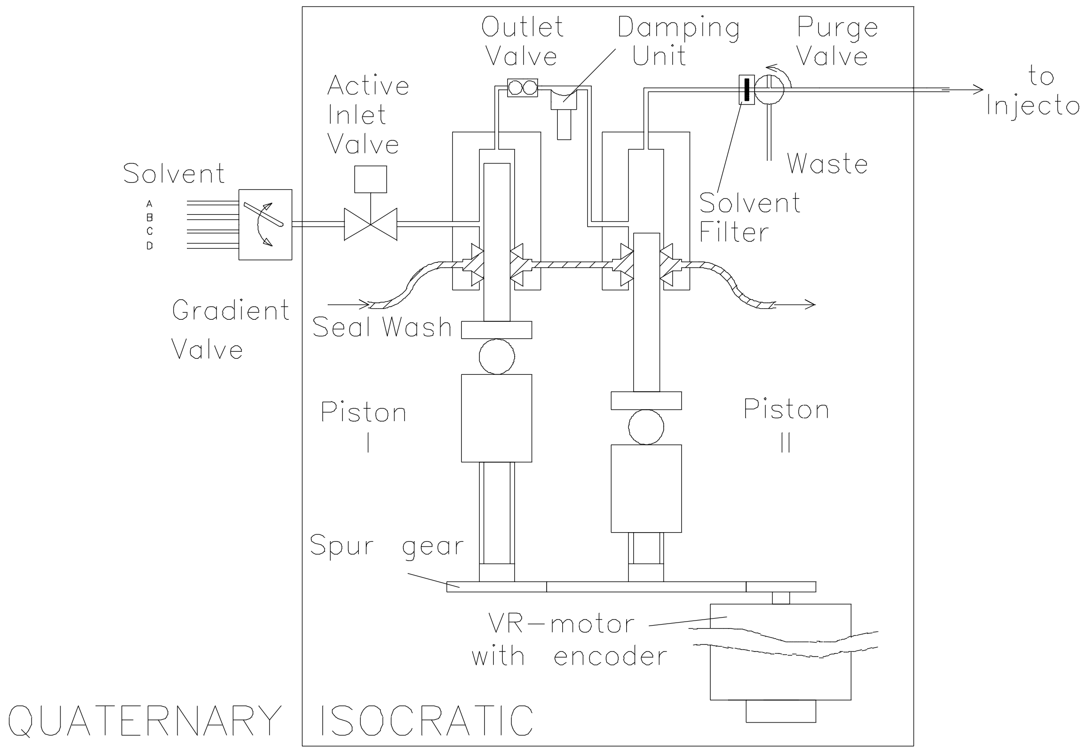
Since the introduction of the G1303A Online Degasser (December 1,1991) the Helium degassing might be replaced by the degasser module.

A purge valve is installed on the pump head for convenient priming of the pump.

An continuous seal wash is available when the pump is used with buffer solutions. It is mandatory in the Ti - pump and can be ordered as an option for the standard version.

The solvent cabinet for the 1050 Pumps can be equipped with a manual injection valve and a column heater.

Figure 1 **Overview Pump System**



How does the Pump Work?

The metering assembly comprises two substantially identical piston pump units. Both pump units comprise a ball screw drive and a pump head with a sapphire piston for reciprocating movement in it. The servo controlled variable reluctance motor drives the two ball drive screws in opposite direction. The gears for the ball screw drives have different circumferences (ratio 2:1) allowing the first piston to move double the stroke length of the second piston. The solvent enters the pump heads close to the bottom limit and leaves it at its top. The outer diameter of the piston is smaller than the inner diameter of the pump head chamber allowing the solvent to fill the gap in between. The first piston has a stroke volume in the range of 20 µl to 100 µl depending on the flow rate. The microprocessor controls all flow rates in a range of 1 µl to 10 ml.

The inlet of the first pumping unit is connected to the active inlet valve which is processor controlled opened or closed allowing solvent to be sucked into the first pump unit. The outlet of the first pump unit is connected via the outlet ball valve and the damping unit to the inlet of the second pump unit. The outlet of the metering assembly is than connected to the following chromatographic system.

Isocratic Operation

When turned on the pump runs through a initialization procedure to determine the upper dead center of the first piston. The first piston moves slowly upwards into the mechanical stop of the pump head and from there it moves back a predetermined path length. The controller stores this piston position in memory. After this initialization the pump starts operation with the set parameters. The active inlet valve is opened and the down moving piston draws solvent into the first pump head. At the same time the second piston is moving upwards delivering into the system. After a controller defined stroke length (depending on the flow rate) the drive motor is stopped and the active inlet valve is closed. The motor direction is reversed and moves the first piston up until it reaches the stored upper limit and at the same time moving the second piston downwards. Then the sequence starts again moving the pistons up and down between the two limits.

During the up movement of the first piston the solvent in the pump head is pressed through the outlet ball valve and the damping unit into the second pumping unit. The second piston draws in half of the volume displaced by the first piston and the remaining half volume is directly delivered into the system.

During the drawing stroke of the first piston the second piston delivers the drawn volume into the system.

Gradient Operation

For gradient operation the multi channel gradient valve (MCGV) connected to solvent containers A, B, C and D is required. The controller makes sure that each intake stroke of the first piston contains the required solvent composition. The controller divides the length of the intake stroke in certain fractions in which the MCGV connects the specified solvent channel to the pump input.

Overview of the Electronics

The figure 2-2 shows the block diagram of the 1050 Pumps including all currently available options.

The common main processor (CMP) controls all functions of the modules. The controller firmware is attached to the relative A/D converter board (RAD).

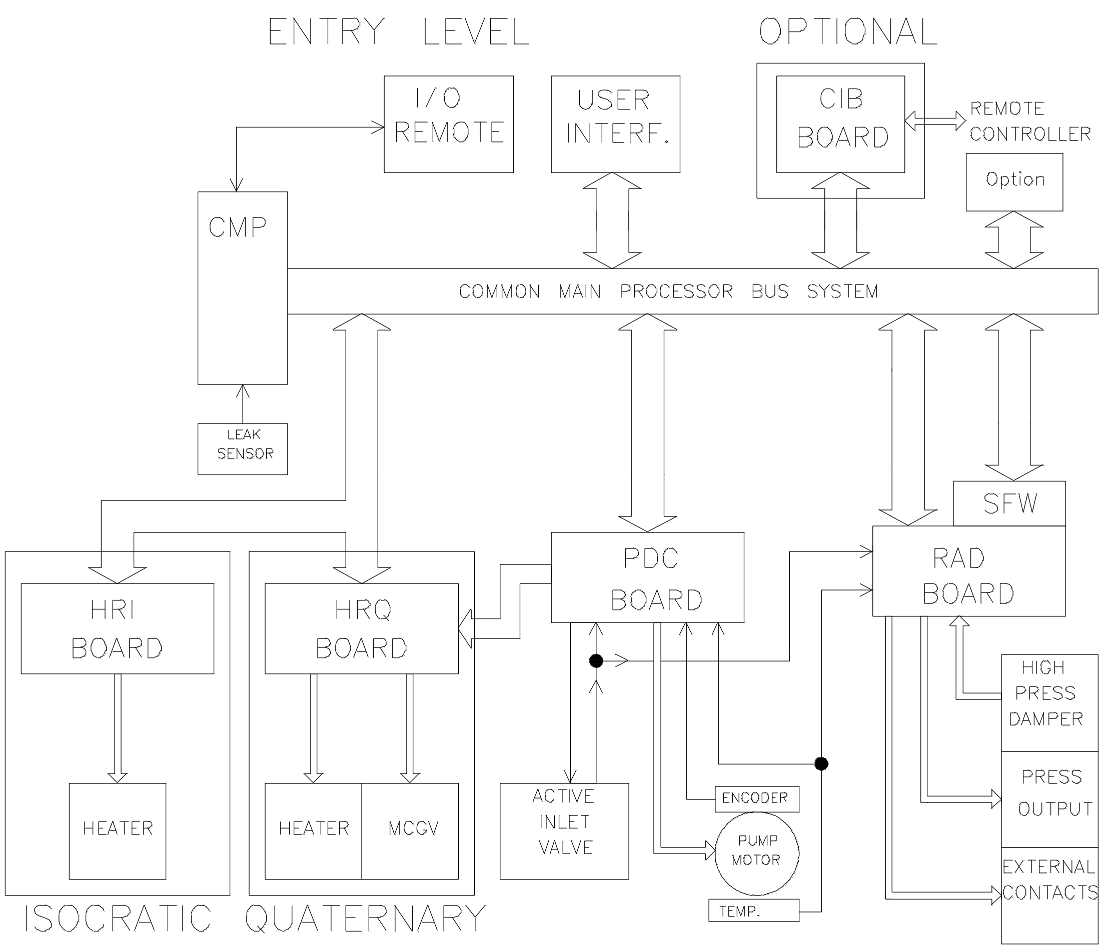
The column heater can be installed into the solvent cabinet. The electronic control is done via the pump module. Two different boards will be available for supporting the column heater in either the isocratic pump (79851A) or the quaternary pump (79852A/B).

For the quaternary pump (79852A/B) the heater quaternary board (HRQ) controls the column heater and drives the multi channel gradient valve (MCGV).

For the isocratic pump (79851A) the heater isocratic board (HRI) controls only the column heater. The HRI board is a subtract of the HRQ Board; the blank board is identical but the components for the gradient operation are not mounted.

The communication interface board (CIB) provides an GPIB and RS232C interface. With the CIB installed the pump can be controlled via the ChemStation or via the 3396B integrator.

Figure 2 **Block Diagram 1050 Pumps**



Overview of the Flow Path

From the bottle head assembly (tube #1) the solvent moves via the gradient valve (MCGV), the connection tube #2 and the active inlet valve into the pump. From the outlet ball valve the capillary #3 is connected to the damper and from there the solvent streams back to the second piston chamber (capillary #4). The standard interface capillary #5 (70 cm long 0.25 mm ID) connects the pump to the next module (for example the autosampler).

In the isocratic pump the solvent sucking tube #2 is directly connected to the solvent bottle and the interface capillary (#5) is connected to the frit adapter.

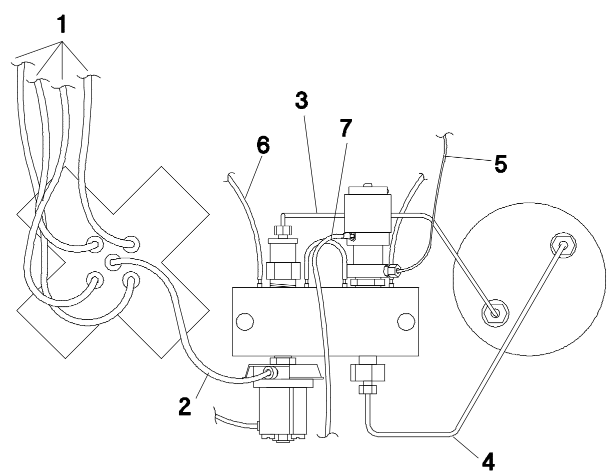
In the quaternary pump the interface capillary (#5) is connected to a purge valve.

The purge valve allows convenient priming of the system. When opened the flow is directed via tubing (#7) in to the waste.

The typical delay volume for the pump is in the range 900 to 1100 µl (depending on system back pressure).

If the seal wash accessory is installed the wash bottle on top of the instrument (tube #6) is connected to the two support rings for back flushing of the piston seals. From the second support ring the wash solvent flows into the collecting vessel.

Figure 3 **Hydraulic Path**



Solvent Cabinet

Repair Level: Component

Table 1 **Product Numbers for Solvent Cabinet**

Item	Part Number
Solvent Cabinet	79856A
Ti - Solvent Cabinet	79856B

The solvent cabinet allows storage of 4 four 1 liter solvent bottles. It is designed to hold the following options:

- Helium degassing; later it was replaced by 1050 online degassing
- Manual injection valve
- Column Heater
- Manual injection valve and column heater

Helium Degassing

NOTE For low pressure mixing degassing is a must. Therefore the Helium degassing or the Online Degasser G1303A is mandatory for the quaternary pump.

If the Helium degassing is selected a internal tubing guides the Helium from the back of the solvent cabinet to an on/off valve and from there to four regulators. Each of the regulator supplies helium to one bottle head assembly for separate sparging of each bottle. The bottle head assembly consists of a sintered glass sparger, stainless steel or titanium filter and a cap with vent position. It is designed for the provided standard bottle, but allows also operation with supply bottles from certain vendors. The bottle head assembly has also a connection for a fume hood tubing (see also “Helium Degassing Principle” on page 269).

NOTE The connected helium pressure has to be in the range 2 to 4 bar (30 to 60 psi). With pressures below 2 bar the helium degassing system may not work correctly. Pressure above 4 bar might damage the helium regulators.

Manual Injection Valve

If ordered with manual injection valve a Rheodyne 7125 valve with 20 µl loop will be installed in the solvent cabinet. If ordered as a Ti version a Rheodyne 7125 titanium valve with Tefzel rotor seal will be present in the cabinet. A remote-start output is available at the back of the cabinet.

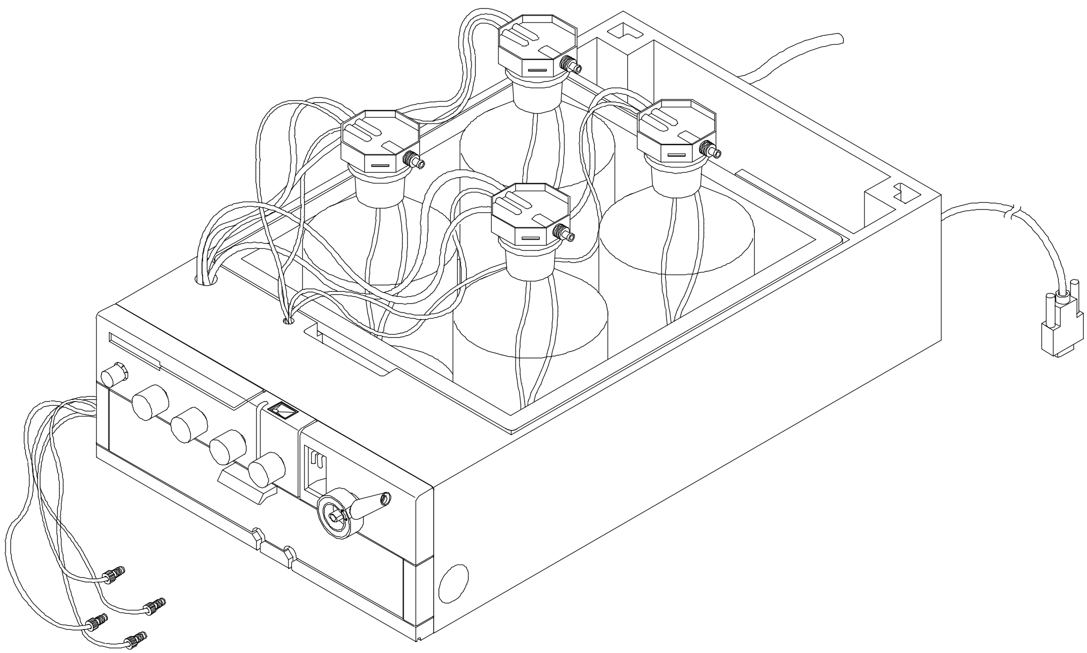
Column Heater

The column heater fits into the recess of the cabinet. Electronic control is done via the pump module. The column heater can hold up to 25 cm long columns. The flow path of the column heater is stainless steel even in the Ti -version.

The heater uses a heating foil which is attached to a aluminum heating block where the solvent capillaries are leading through (heat exchanger). The column rests in the U-shaped heat exchanger. When turned on, the heat exchanger will heat up the solvent, the column and the surrounding air in the compartment.

Temperature is monitored on the heating block via a Pt. 100. A multi (3) color LED shows the actual status of the column heater. The power consumption of the heater is reduced by heat recycling. Incoming and outgoing capillaries of the heat exchanger are in close thermal contact allowing radial heat exchange while the solvent is streaming through.

Figure 4 **Solvent Cabinet including all options**



Multi Channel Gradient Valve (MCGV)

Repair Level: Exchange Assembly

Table 2 **Part Numbers MCGV**

Item	Part Number	Exchange
MCGV	79835-67701	79835-69701
Ti - MCGV	01019-67701	

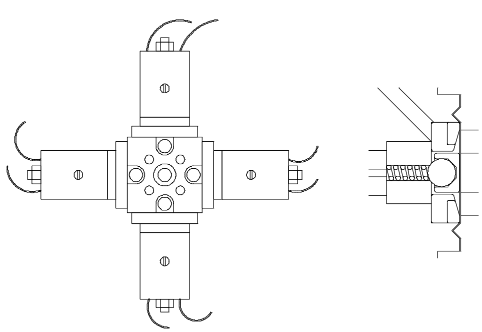
The multi channel gradient valve (MCGV) works like a multi position switch. Depending on the timing of the control electronic the Heater Quaternary Board (HRQ) activates one of the four solenoids connecting the selected channel to the output of the valve.

In the Ti-version of the gradient valve only the materials have been changed.

Table 3 **Technical Data of MCGV**

Switching Time:	approximately 2 ms
Solenoid Voltage:	+12 V (+36 V Chopper Drive)
Ti Series	
Materials in contact with solvent:	PFA, PTFE, sapphire, ruby, ceramic, Titanium

Figure 5 **MCGV**



Metering Drive Assembly

Repair Level: Exchange Assembly

Table 4 **Part Numbers Metering Drive Assembly**

Item	Part Number	Exchange
Metering Drive Assembly	01018-60001	01018-69100

The metering drive assembly is identical for the stainless steel and the Ti version. The metering pump system is driven by a variable reluctance motor (servo) and electrically controlled by the Pump Drive Control Board (PDC). Feedback about actual movement is sensed by a shaft encoder mounted on top of the motor. In order to achieve required flow resolution a gear is used to transmit motor movement to the two pistons. The gears for the ball screw drives have different circumferences (ratio 2:1) allowing the first piston a twice as large stroke volume as the second piston. The second piston operates with a fixed 180° difference relative to the first piston. A sensor on the motor surface checks for over temperature conditions (90°C).

Table 5 **Technical Data of Metering Drive**

Resolution of mechanical system:	6.6 nl/steps of Encoder
Resolution of Encoder:	0.25 degree
Lowest Frequencies:	2.5 Hz
Highest Frequencies:	25 KHz
Number of steps between piston extension limits:	8191

Figure 6 **Metering Drive Assembly**

Pump Head Assembly

Repair Level: Component

Table 6 **Part Numbers Pump Head Assembly**

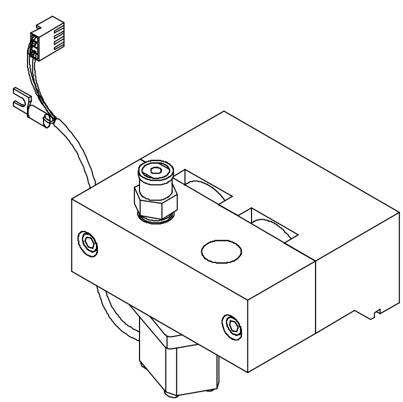
Item	Part Number
Pump Head Assembly	01018-60004
Ti - Pump Head Assembly	01019-60002

Two identical piston move inside the solvent filled chamber in the pump head assembly. The piston are ball loaded on the spindles and center itself in the seal. The built in spring prevents clearances of the plunger affecting flow accuracy (see also “Pump Head Assembly” on page 271).

Table 7 **Technical Data of Pump Head**

Maximum displacement volume:	108 µl
Ti - Series	
Materials in contact with solvents	titanium, gold, sapphire, ceramic

Figure 7 **Pump Head Assembly**



Continuous Seal Wash

Repair Level: Component

Table 8 Part Numbers Seal Wash

Item	Part Number
Seal Wash Kit	01018-68722
Velocity regulator 3/pk	5062-2486

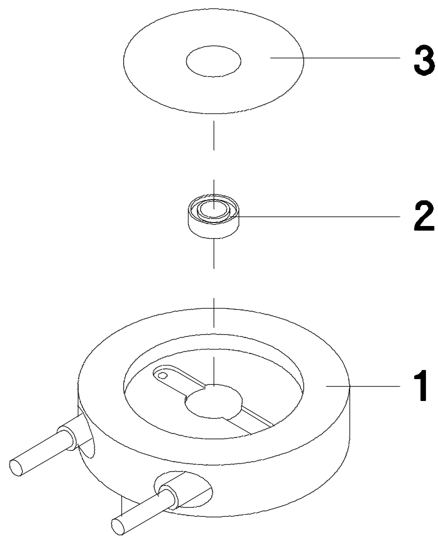
Bioscience application do very often use high concentrated buffer solutions. Therefore the seal wash is installed in each Ti pump. For the stainless steel version it is available as an option and should be used when buffer solutions are used in the instrument. If high buffer concentration are used in the pump the continuous seal wash will maintain the life time of the pump seal. Buffer solutions below 0.1mol normally do not require the seal wash option.

The option is customer installable.

The option consists of a support ring (1) a secondary seal (2) and a gasket (3) for both piston sides. A wash bottle filled with water/isopropanol (90/10) will be placed above the pump module and gravity will maintain a flow through the pump head removing all possible buffer crystals from the back of the pump seal.

NOTE Running dry is the worst case for a seal and drastically reduces the life time of it. Therefore the tubings of the wash option should always be filled with solvent to maintain the life time of the wash seal. Use always a mixture of distilled water (90%) and isopropanol (10%) as wash solvent. The mixture prevents bacteria growth in the wash bottle and reduces also the surface tension of the water. The flow rate should be regulated to approximately 20 drops/minute (velocity regulator 5062-2486).

Figure 8 **Continuous Seal Wash**



Active Inlet Valve

Repair Level: Assembly

Table 9 **Part Numbers Active Inlet Valve**

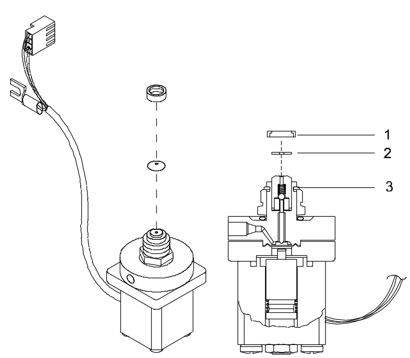
Item	Part Number
Active Inlet Valve	01018-60010
Ti - Active Inlet Valve	01019-60010

The active inlet valve is a solenoid driven check valve. In the Ti version all parts in contact with solvents are corrosion resistant. The solenoid is controlled by the Pump Drive Control Board (PDC). A spring loaded ruby ball sitting in a sapphire seat closes or opens the flow path. If the solenoid is deactivated the keeper of the magnet presses the ruby ball down opening the flow path. At the same time the down moving first piston draws solvent into the pump head. The activated solenoid enables the spring to press the ruby ball in its seat and the flow path is blocked. Older versions do have a solvent protection cover installed.

Table 10 **Ti - Series**

Materials in contact with solvents	titanium, gold, sapphire, ceramic,

Figure 9 **Active Inlet Valve**



Outlet Ball Valve

Repair Level: Assembly

Table 11 **Part Numbers Outlet Ball Valve**

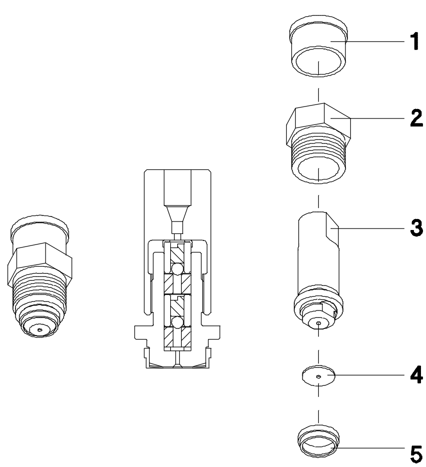
Item	Part Number
Outlet Ball Valve	G1311-60012

The outlet ball valve is made of corrosion resistant materials and can be used in both pump versions. The outlet valve cartridge contains two seat / ball pairs with the necessary seals. A slight weight on top of each ball limits the movement of the ball and maintains a small delay volume. The cartridge (3) is fixed with adhesive and the valve will be damaged if opened. The valve should always be tightened at the housing screw (2) and never at the cartridge (3) itself.

Table 12 **Ti - Series**

Materials in contact with solvents	titanium, gold, ruby, sapphire

Figure 10 **Outlet Ball Valve**



Frit Adapter Assembly

!*Repair Level: Component*

Table 13 **Part Numbers Seal Wash**

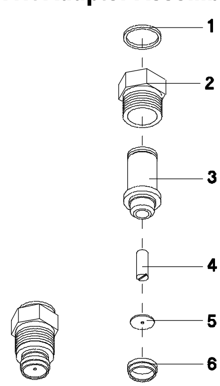
Item	Part Number
Frit Adapter Assembly	01018-60007

The housing of the frit adapter assembly is made from titanium and is suitable for both pump versions. The frit adapter assembly is installed in each isocratic pump. It is the interface to the following system components (for example autosampler) and holds a PTFE frit. The capacity of the frit when installed correctly is large enough to collect all the particles during the normal life time of the piston seal. It is recommended to replace the frit each time the seal has to be replaced as part of the normal pump maintenance. The second criteria for replacing the frit is the pressure across over it. If the pressure drop is more then approximately 10 bar with 5ml/min H_2O the frit should be changed.

Table 14 **Ti - Series**

Materials in contact with solvents	Titanium, PTFE, gold

Figure 11 **Frit Adapter Assembly**



Purge Valve

Repair Level:Assembly except of PTFE frit and gold seal (item 1 to 3)

Table 15 **Part Numbers Purge Valve**

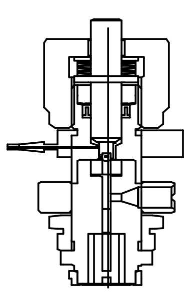
Item	Part Number
Purge Valve (replacement)	G1311-60009
Purge Valve Update Kit	01018-68723

The purge valve was introduced in November 1990. The purge valve is made from corrosion resistant materials and is suitable for both pump versions. The purge valve will be installed on all quaternary pumps and can be ordered as an option to the isocratic pump. The lower part of the purge valve is designed like the frit adapter assembly and holds the PTFE frit. A ball seat combination builds the purge valve. When opened at the thumb screw the ball is lifted out of its seat allowing the solvent to flow through the waste outlet. When the thumbscrew is turned down the internal springs press the ball into the seat. Flow is directed to the following system components.

Table 16 **Ti - Series**

Materials in contact with solvents	Titanium, PTFE, gold, ceramic

Figure 12 **Purge Valve Assembly**



High Pressure Damper

Repair Level:Assembly

Table 17 **Part Numbers High Pressure Damper**

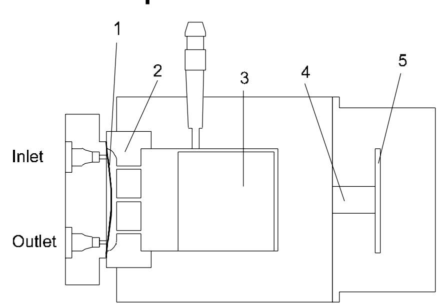
Item	Part Number
Damper	79835-60005
Ti - Damper	01019-60005

For the Ti version of the high pressure damper all parts which are in contact with solvents are gold plated. Two functions are obtained from the High Pressure Damper. Flow is damped (flow ripple reduction) and the pressure in the system is measured. The damping function is provided by an aluminum housing partly filled with water as the compressible medium and a solid steel block (3) which compensates for different coefficients of expansion of water and the aluminum housing. A protection plate (2) mounted between cover and housing prevents membrane (1) damage resulting from pressure excess or pressure shocks. Pressure is measured with a pressure transducer. The electrical circuit that outputs a voltage proportional to the pressure measured is mounted directly to the pressure transducer.

Table 18 **Ti - Series**

Materials in contact with solvents	gold

Figure 13 **High Pressure Damper**



Column Holder

Repair Level:Assembly

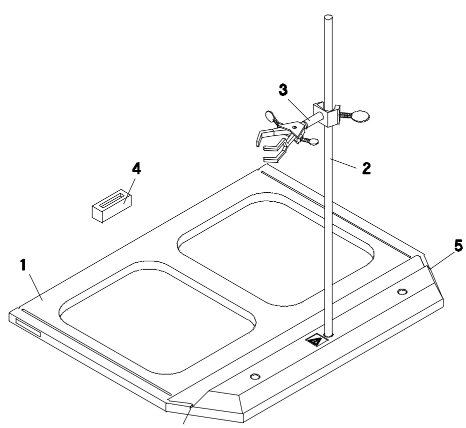
Table 19 **Part Numbers High Pressure Damper**

Item	Part Number
Column Holder Assembly	5062-2469

The column holder is standard for the 1050 Ti Pumps. It is designed for use with any of the 1050 Series modules either separately or in a stack. A 1050 module will fit onto the column holder base (1) and the stand (2) can be used to attach columns which do not fit into the solvent module compartment using the clamp (3). Possible leaks will be collected in the groove (5). The support block (4) maintains the correct height adjustment of the autosampler foot support (100 vial tray).

WARNING **The column holder is not intended for use with solvents which are flammable or toxic. If such solvents are used you must use a leak tray or equivalent. You must also position the column so that any leaking solvent is collected by the leak tray.**

Figure 14 **Column Holder**



1

Pumps: Electronic Information

This chapter provides electronic information about the 1050 Pumps

Pumps: Electronic Information

- This chapter gives information about the electronic of the pumps:
- Overview
- Pump Drive Control Board (PDC)
- Relative A/D Converter Board (RAD)
- Firmware Board (SWF)
- Heater Isocratic Board (HRI)
- Heater Quaternary Board (HRQ)
- High Pressure Transducer Board (HPT)
- Connector Board (CON)
- Pump Motherboard (HPS)

Overview

All electronic boards (except the FIP, behind the keyboard and the CON, above the MCGV) are located in the rear part of the module and they are connected to the Motherboard (HPS). Excess to the boards is from the back of the instrument. Slot numbers for the boards (as shown in the status screen) are counted from left to right. The power supply board is located in slot 1 and the common main processor is located in slot 7.

In the 1050 pumps the following electronic assemblies are available:

Table 1 **Electronic Boards**

Description	Part Number	Exchange
Power Supply (DPS-B)	5061-3374	01050-69374
Common Main Processor (CMP)	5061-3380	01050-69580
Pump Drive Control (PDC^2)	01018-66532	
Relative A/D Converter (RAD)	01018-66503	01018-69503
Firmware Board (SFW)	01018-66506	
Heater Isocratic Board (HRI)	01018-66517	
Heater Quaternary Board (HRQ)	01018-66518	01018-69518
Connector Board (CON)	01018-66505	
Motherboard (HPS)	01018-66501	
Display Interface Board (FIP)	5061-3376	
Communication Interface (CIB)	5061-2482	

NOTE For information about Power Supply, Common Processor and Fluorescent Interface refer to *“Common: Electronic Information” on page 39*.

Figure 1 **Rear of 1050 Pumps**

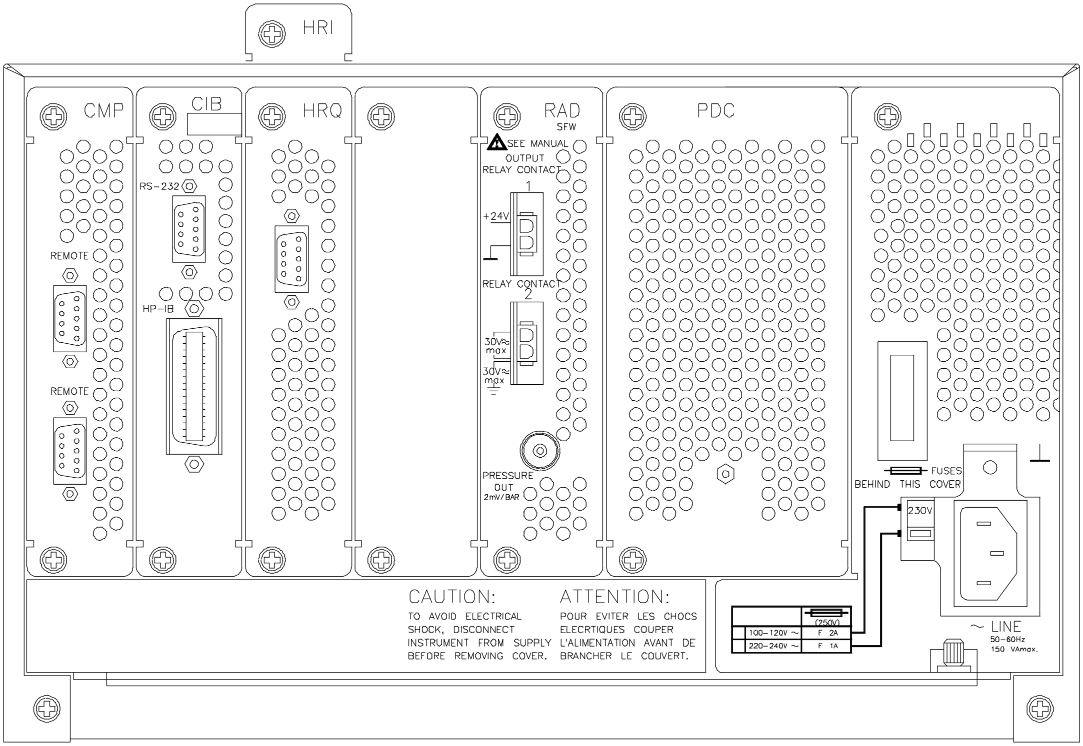
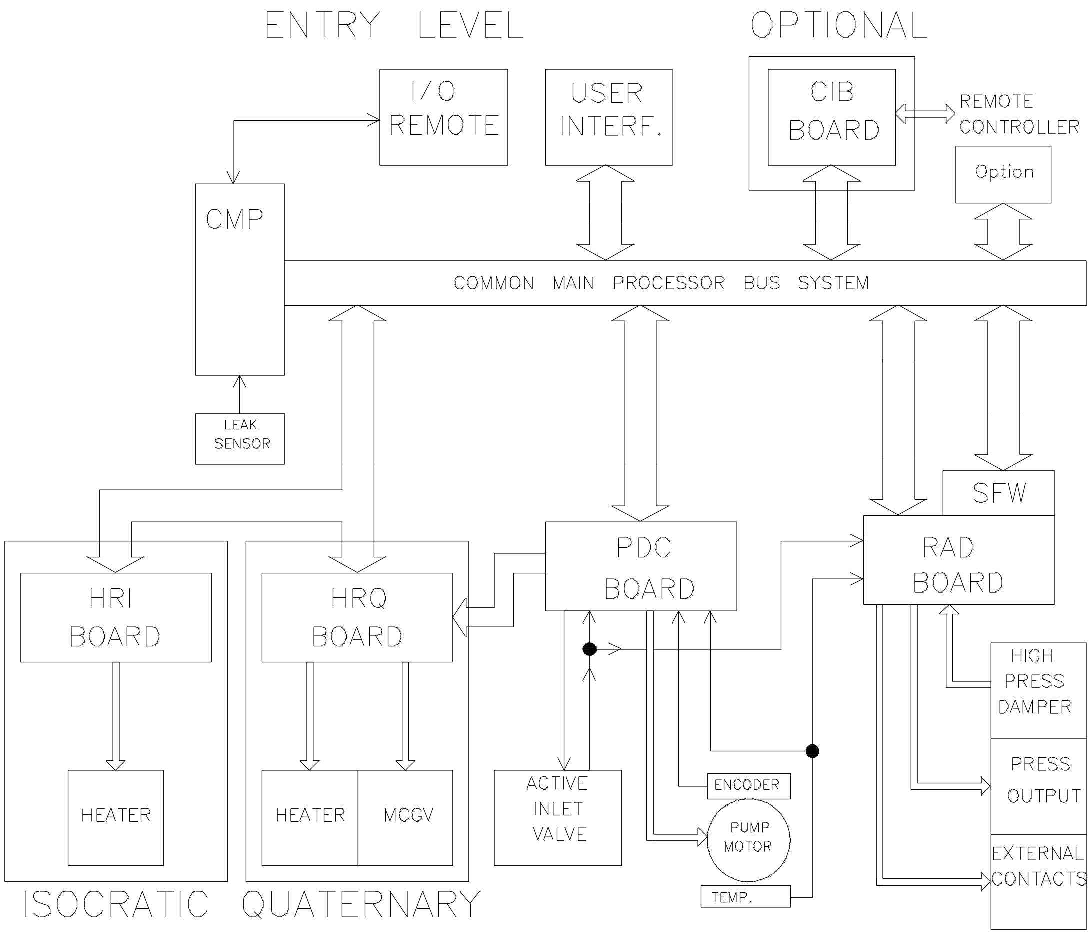


Figure 2 **Block Diagram 1050 Pumps**



Pump Drive Control Board (PDC^2)

Repair Level: Board, Fuses and U78, U79

Table 2 Part Numbers for ASC Board

Item	Part Number
PDC^2	01018-66532
PDC	replaced by PDC^2
Fuse: F16 (PDC), F481 (PDC2) 1.5 A	2110-0304
Fuse F891, F892 (PDC); F112, F113 (PDC2) on board 500 mA	2110-0934
U78 (MC78L15ACP)	1826-0274
U79 (MC79L15ACP)	1826-0281

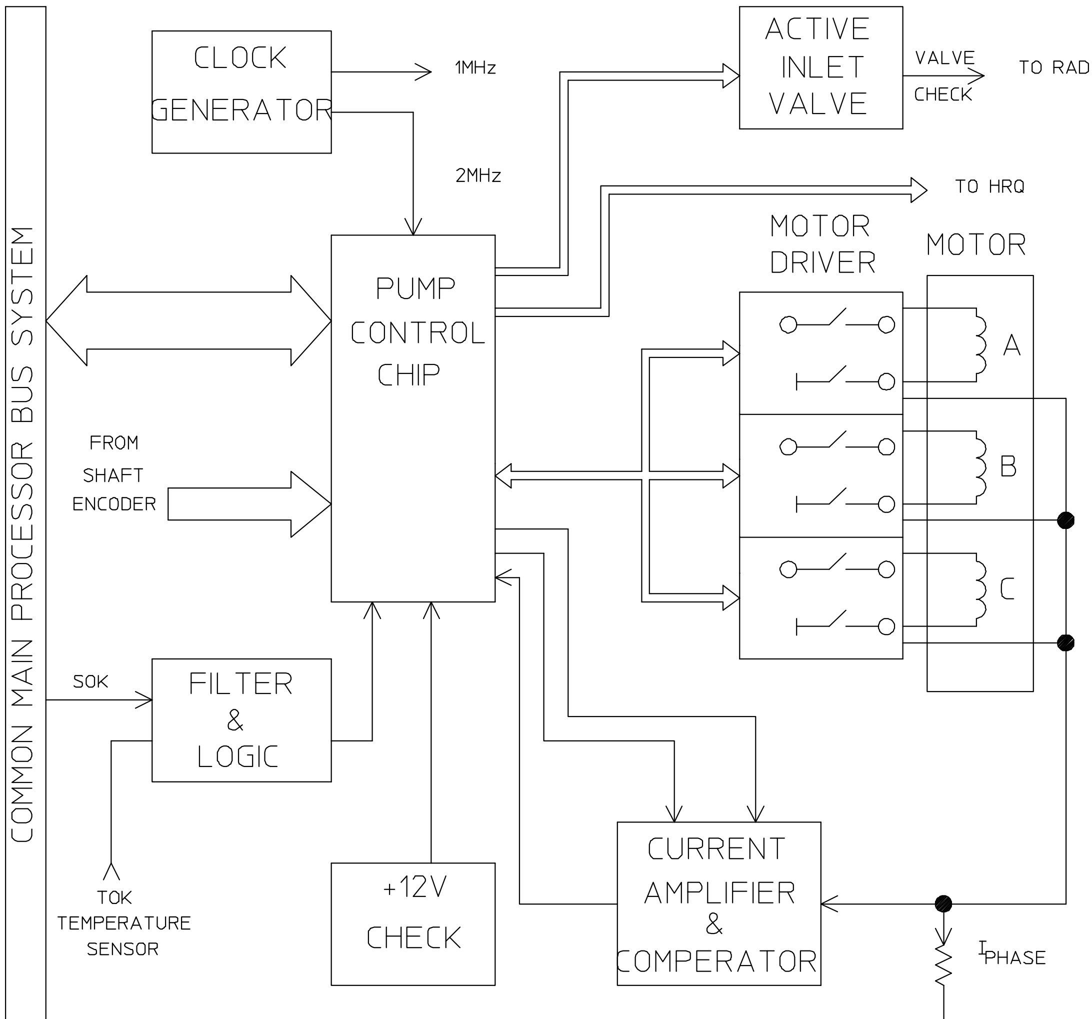
The main functions of the PDC board are the control of the pump motor and the active inlet valve.

For the quaternary system the PDC board has also to generate the control signals for the gradient valve circuit on the Heater Quaternary Board (HRQ). The PDC2 board succeeds the PDC board. For standardization and cost reduction reasons part of the circuit has been implemented in ASIC (Application Specific Integrated Circuit). The board size was reduced the board is also used in the other APG products and a stainless steel plate extends the board to 1050 board size.

Fuses

Fuse F16 (PDC) or F481 (PDC2) (1.5 A) protects the +36 V for servo motor and active inlet valve for overcurrent conditions on the old PDC board. F891 (PDC) or F113 (PDC2) (500 mA) protects the active inlet valve for overcurrent conditions while F892 (PDC) or F112 (PDC2) is for future use (space for additional connector on CON board).

Figure 3 **Block Diagram PDC^2 Board**



U78, U79

PDC Boards revision A need an replacement of U78 and U79 when the metering drive (01018-69100) of the instrument has to be changed.

Clock Generator

The clock generator provides the clocks for the different pump boards. The pump control chip needs the 2 MHz clock and the pump control logic on the Relative A/D Board (RAD) and the Gradient Valve Driver Board (GVD) need the 1 MHz clock.

Filter and Logic

The filter and logic circuit disables the operation of the control chip in case of malfunctions in the system. Input signals for the block is the system OK (SOK) signal from the common main processor (CMP) which is active when the processor has locked up. The second signal connected to the circuit comes from the over temperature sensor on the surface of the pump motor. The TOK signal is active when the motor temperature exceeds 90°C.

12 V Check

The +12 V voltage will be checked for under voltage conditions. In case the voltages drops below approximately +10 V a proper working of the pump is no longer possible and the pump control chip will be disabled.

Pump Control Chip

The pump control chip is the brain of the PDC board. It handles all time critical and time consuming tasks for the digital position control of the pumping system. The chip works independent from the processor which supplies only the pump parameters (for example flow, stroke, compensation, gradient information and so on). All parameter changes will be transferred directly to the pump control chip. The feedback from the motor comes to the chip via the shaft encoder and allows accurate control of the motor (speed, direction and so on).

The control chip sends the signals for the motor driver to energize the various motor windings. The control chip influences the current through the motor windings by changing the pulse width and by an amplification factor (Gain). The actual value of the current is supplied by the current amplifier and comparator circuit.

The active inlet valve gets its control signals from the control chip. The optional gradient valve driver board (GVD), which controls the MCGV works under the supervision of the control chip.

Motor Driver

The motor driver circuit block contains the power stages for the motor. The motor is a three phase variable reluctance motor.

Current Amplifier and Comparator

One task of this circuit block is to measure the current through all the windings and to feed this signal into the control chip. From the control chip the circuit gets the pulse width (PW) and gain (GA) signals. With the pulse width the current value through the windings is determined. If the gain signal is active the amplifier multiplies the current with a factor (1.4). This is necessary to assure a constant torque at all motor positions.

Active Inlet Valve

The control chip provides the signals to activate or deactivate the active inlet valve. Figure 31 shows the control signal from the control chip and the current in the solenoid valve. The high current allows fast switching of the valve while the holding current reduces the heat dissipation of the solenoid.

Figure 4 **Inlet Valve Control**

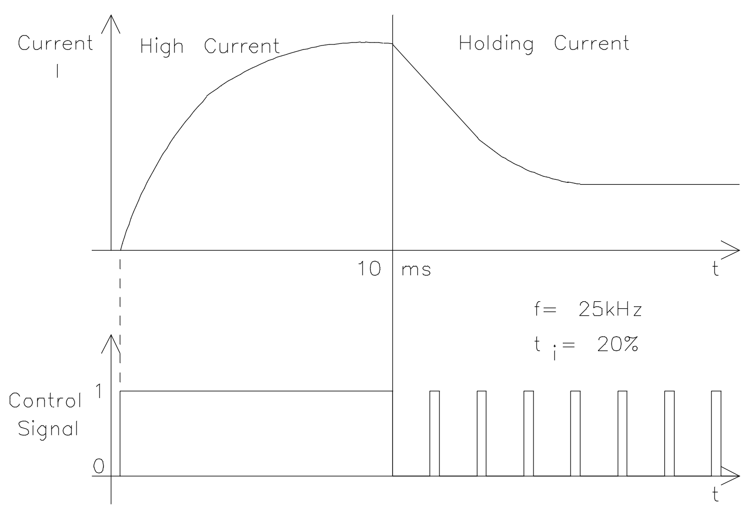
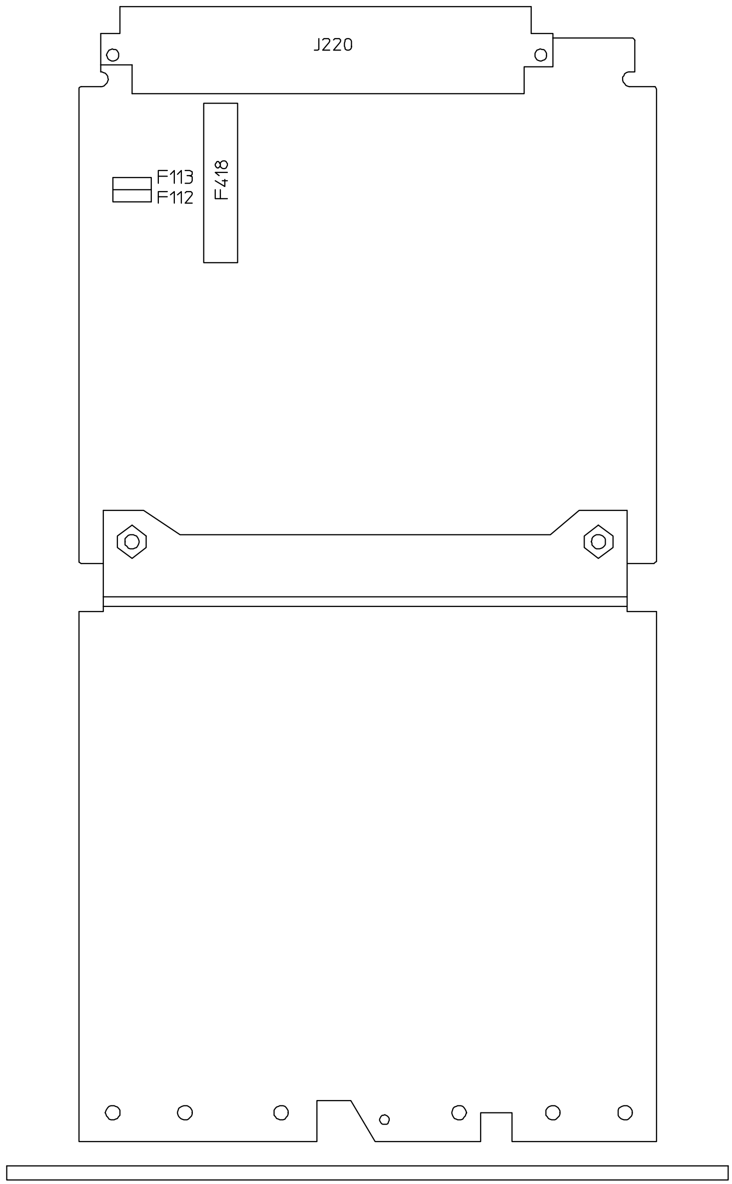


Figure 5 **Board Layout PDC**



Relative A/D Converter Board (RAD)

Repair Level: Exchange Board or Fuses

Table 3 **Part Numbers for ASC Board**

Item	Part Number	Exchange
RAD	01018-66503	01018-69503
Fuse: F12, F22, 250 mA	2110-0004	

The main function of the board is the relative A/D conversion with an analog pressure output and overpressure measurement for the flow reduction. In addition the RAD board controls the two external contacts and checks for the status of active inlet valve and motor temperature. The firmware board (SFW) which contains the module firmware is attached to the RAD board and is used by the common main processor (CMP).

Control Logic

The control logic synchronizes the communication between the RAD and the main processor.

Status Register

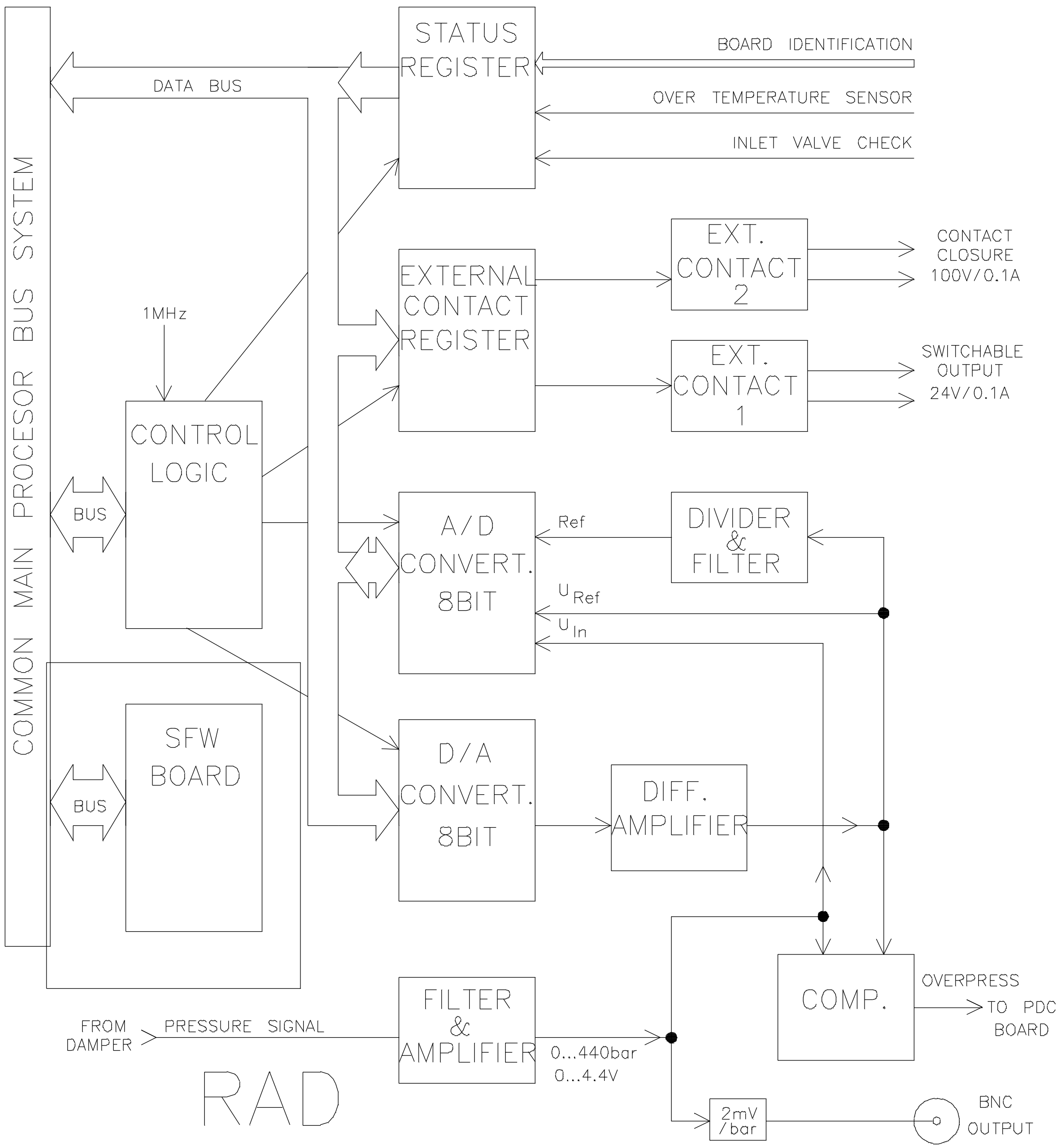
The status register sends information about board identification motor temperature and active inlet valve to the main processor.

Via the board identification the main processor identifies the board in the card cage. In case of a wrong board position the processor does not allow signals to the board.

The over temperature sensor on the pump motor surface generates an error message when the motor temperature exceeds 90°C (fan defective?).

If the active inlet valve is not connected an error message is generated (when pump will be turned on) and the operation of the pump is inhibited.

Figure 6 **Block Diagram RAD**



Relay Contact Register

The relay contact register activates the two relay contact circuits on request of the processor. When activated contact 1 provides fused (250 mA) +24 V while contact 2 provides a fused (250 mA) 30 V (AC/DC) rated contact closure. For more technical information about the relay contacts see “External Contacts” on page 56.

Relative A/D Conversion

The relative A/D conversion consist of a A/D converter a D/A converter with differential amplifier and a divider and filter. In addition a filter and amplifier for the pressure signal is needed and a comparator for the overpressure signal.

The relative A/D converter delivers a binary data word which is independent from the absolute value of the signal. The output data word shows the % difference of the actual value compared to a reference value.

The 8 bit D/A converter and the differential amplifier provide the reference voltage U_{Ref}. The dynamic range for the relative measurement represents ±6.4% of the absolute value of the signal. The divider and filter stage determines the Reference signal which is Ref=U_{Ref} x 12.8%.

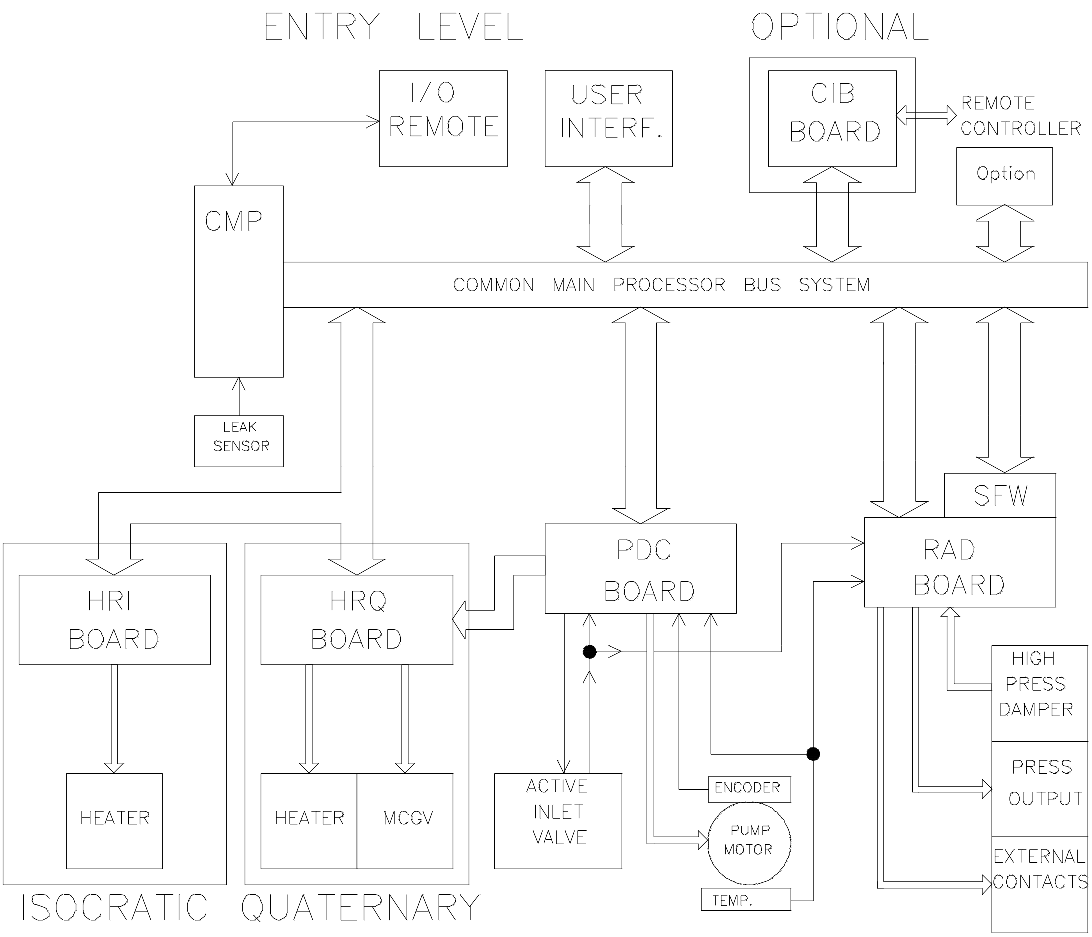
The pressure signal from the high pressure damper is filtered and amplified. The outlet of this stage is the input voltage (U_{In}) for the A/D converter. The same signal is directly fed to the BNC output which has a resolution of 2 mV/bar for the range between 0 to 440 bar. The output has an offset of 30 mV (typical value) for offset compensation of the damping unit.

The comparator compares reference signal and actual pressure signal. In case of overpressure conditions the flow will be reduced via the PDC board.

The A/D converter allows different operation modes. Measurements of the difference between U_{Ref} - U_{In} in relation to the reference (Ref) value or the absolute measurement of U_{In} - AGND in relation to Ref is possible. The results will be used by the processor to show the pressure ripple and the actual pressure on the display. It is also used to reduce the flow in case of overpressure conditions and for the online diagnostic (for example gas bubble detector, ball valve check, and so on).

The BNC output is an additional diagnostic tool for checking the performance of the pump. For normal operation the use of the displayed pressure ripple is sufficient.

Figure 7 **Board Layout RAD**



Firmware Board (SFW)

Repair Level: Board

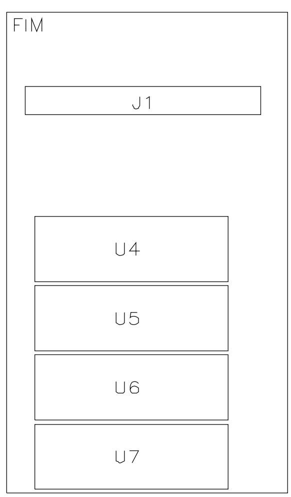
Table 4 **Part Numbers for FIM Board**

Item	Part Number
Firmware Board (SWF)	01018-66506

The SFW board is a piggy back board, placed on RAD board ('personality module').

- The programmed SFW contains the firmware of the 1050 pump module.
- The board is designed for on board programming.
- The FIM contains 128K x 8bit EPROMs.
- All inputs/outputs are pulled down for electrostatic discharge protection.

Figure 8 **Layout of SFW Board**



HRI Board - Heater Isocratic Board

Repair Level: Board or Fuses

Table 5 **Part Numbers for HRI Board**

Item	Part Number
HRI	01018-66517
Fuse: F4, 2.5 A	2110-0083

The main function of the board is to control the column heater in the solvent conditioning module of the 1050 Isocratic Pump.

Fuse

Fuse F4 (2.5A) protects the +24V for the heater foil for overcurrent conditions.

Control Logic

The control logic synchronizes the communication between the HRI and the main processor.

Status Register

The register provides the main processor with the board identification.

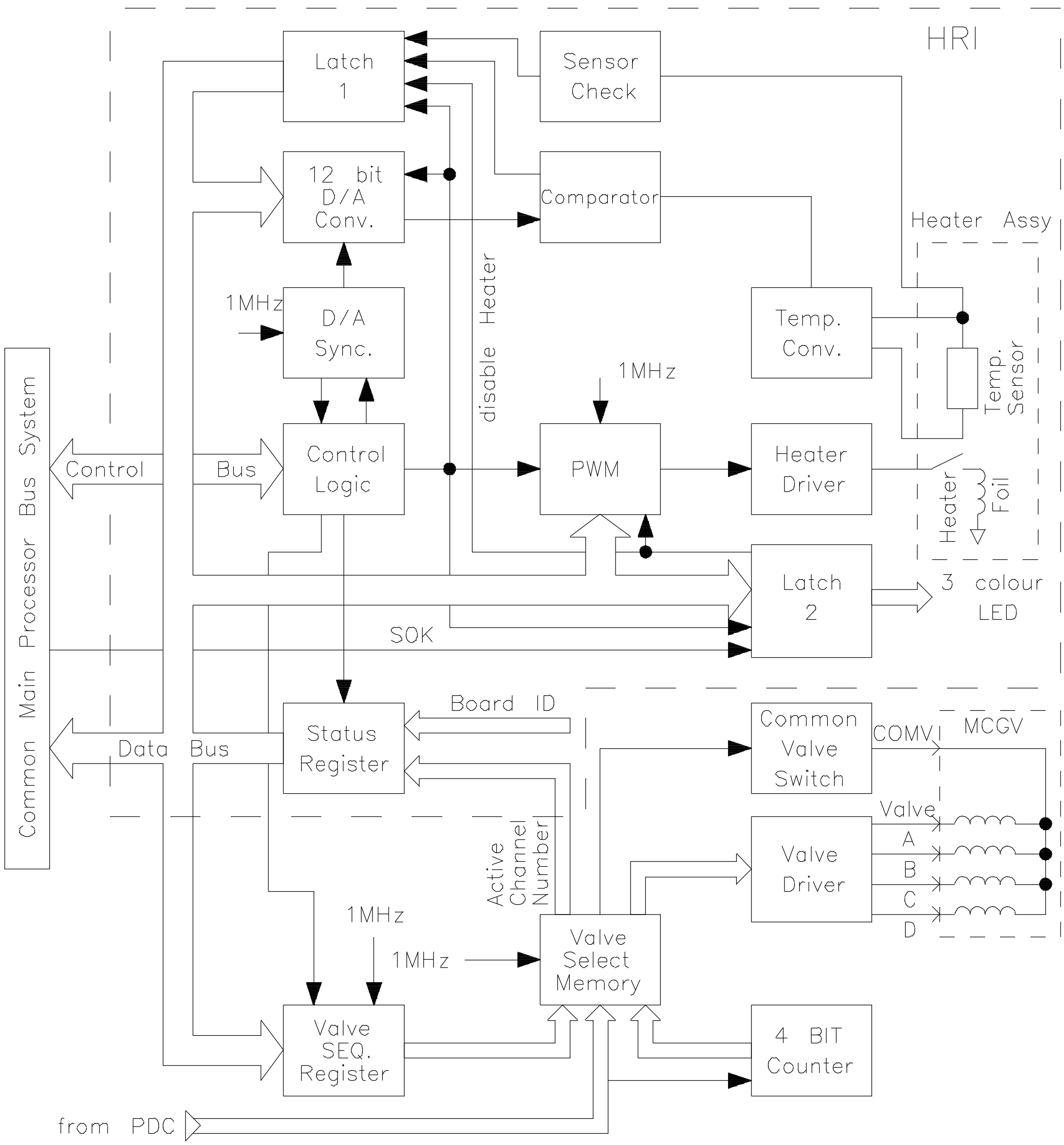
Synchronization

The circuit receives the timing for the D/A converter from the main processor via the control logic. Synchronization adapts the timing to the needs of the 12 bit D/A converter.

Pulse Width Modulator

When the column heater is turned on the main processor provides control signals to the pulse width modulator. The output is a TTL signal with a duty cycle which depends on the temperature difference (error signal) between actual and setpoint temperature.

Figure 9 **Block Diagram HRI/HRQ Board**



Temperature Measurement

The temperature of the heat exchanger is measured with a Pt. 100 temperature sensor. (Resistance 1000 Ohm; at 0°C and approximately 1400 Ohm; at 100°C). The temperature converter circuit provides an analog signal (0V to +5V) correlating to the temperature of the heating block. The chosen setpoint temperature is converted in a reference voltage via the 12 bit A/D converter. Actual and setpoint temperature are then compared in the comparator.

The derived error signal is send via Latch 1 to the main processor which updates the necessary signals for the heating section. The sensor check circuit provides information whether the temperature sensor is installed or not.

Heater Driver

The heater driver circuit contains the power stages for the heater foil. If the temperature of the heater block exceeds 100°C a over-temperature switch on the heater foil interrupts the connection to the heater driver.

Latch 2

The latch provides the signals to the multi color LED which gives visible information about the heater status. The LED shines green when the heater is on and at correct temperature. When maintaining the temperature the LED flashes yellow indicating the percentage of power used. The LED shines yellow when the heater is on and is at correct temperature but the not ready time has not been elapsed. During the heating up phase the LED flashes yellow. A red LED appears in case of error conditions.

The system ok signal (SOK) of the processor is connected to the latch. In case of problems Latch 1 and the PWM are disabled and the heating process is interrupted.

Board Layout

Refer to “Board Layout HRI/HRQ” on page 133.

Heater Quaternary Board (HRQ)

Repair Level: Exchange Board or Fuses

Table 6 **Part Numbers for HRQ Board**

Item	Part Number	Exchange
HRQ	01018-66518	01018-69518
Fuse: F4, 2.5 A	2110-0083	
Fuse: F16, 1 A	2110-0007	

The main function of the board is the control of the column heater as well as the multi channel gradient valve (MCGV). The board comprises the function of the HRI Board. Therefore only the multi channel gradient control has been described. The HRQ board replaced the gradient valve driver board (GVD) which controlled the MCGV.

Block Diagram

Refer to “Block Diagram HRI/HRQ Board” on page 129.

Fuses

Fuse F16 (1A) protects the +36V for the multi channel gradient valve (MCGV) for overcurrent conditions. Originally the fuse had 500 mA which was a incorrect value.

Control Logic

The control logic synchronizes the communication between the HRQ and the main processor.

Valve Sequence Register

The valve sequence register contains the information about the sequence in which the solenoids of the MCGV should be activated (for example A, B, C, D or A, C, D and so on).

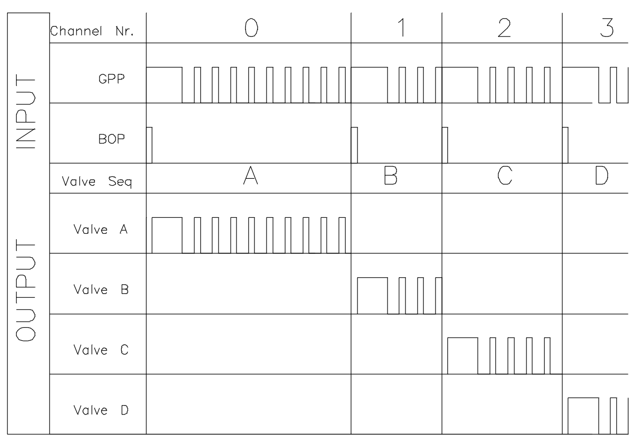
4 Bit Counter

The control chip divides the piston path length for one stroke into four parts. The length for each part is depending on the flow composition. The four bit counter gets a pulse each time the portion is changed. The output is a 2 bit data word for the valve select memory.

Valve Select Memory

The following figure shows an example for the input and output of the valve select memory circuit. The channel number information comes from the 4 bit counter. The pump drive control board (PDC) supplies the gradient power pulse (GPP) and the blank out pulse (BOP). GPP delivers the power switching signals for the multi channel gradient valve (MCGV). BOP makes sure that all solenoids of the MCGV are switched off before opening the next one. Valve sequence register gives the relation between the four piston portions and the solvent channels. Output of the valve select memory is the accurate timing for the four solenoids of the MCGV.

Figure 10 **Valve Select Memory Signals**



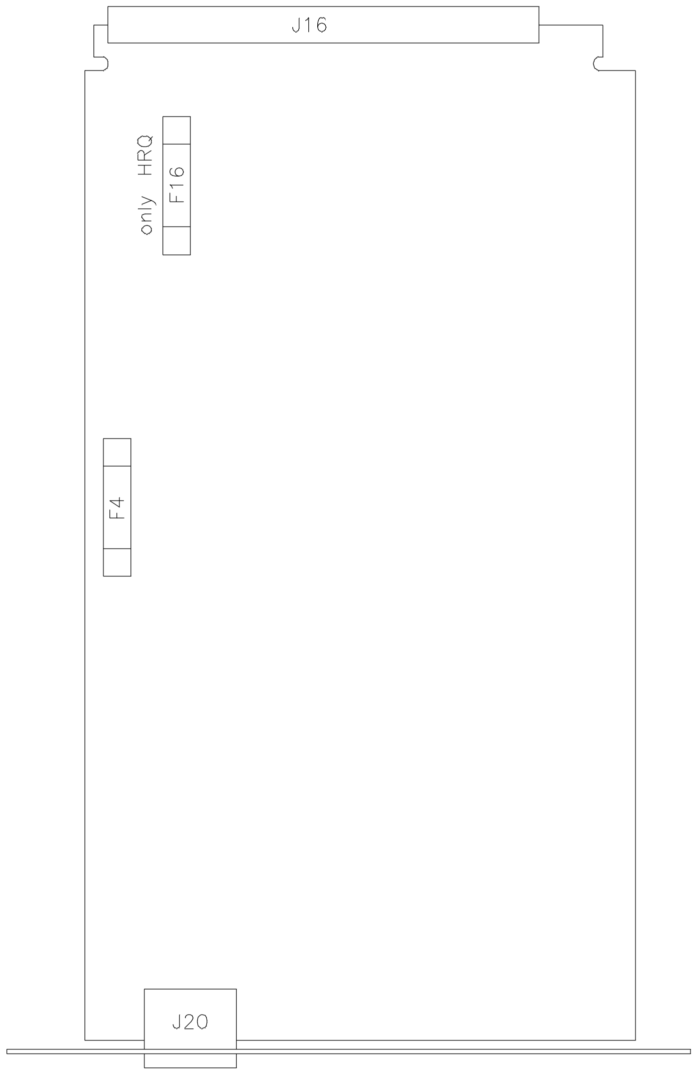
Valve Driver

The valve Driver contains the power stages for the multi channel gradient valve (MCGV).

Common Valve Switch

Fast switching of the four valves without any interference between the channels is achieved with the common valve switch. One side of all the four valves is connected together and is opened each time before switching to the next valve (BOP).

Figure 11 **Board Layout HRI/HRQ**



High Pressure Transducer Board (HPT)

Repair Level: Damper

The High Pressure Transducer Board (HPT) is built into the High Pressure Damper and measures the system pressure on the high pressure side. A negative going voltage is provided showing a linear characteristic between 0 bar to 440 bar from -1 V to -8 V. The measurement is taken with a strain gauge bridge. The firmware of the pump allows a interactive offset adjustment for the damping unit. In certain limits the software compensates the offset of the high pressure transducer.

NOTE The HPT is installed and preadjusted in the factory. In case of malfunctions the complete assembly should be replaced in the field.

Figure 12 **HPT Pressure Diagram**

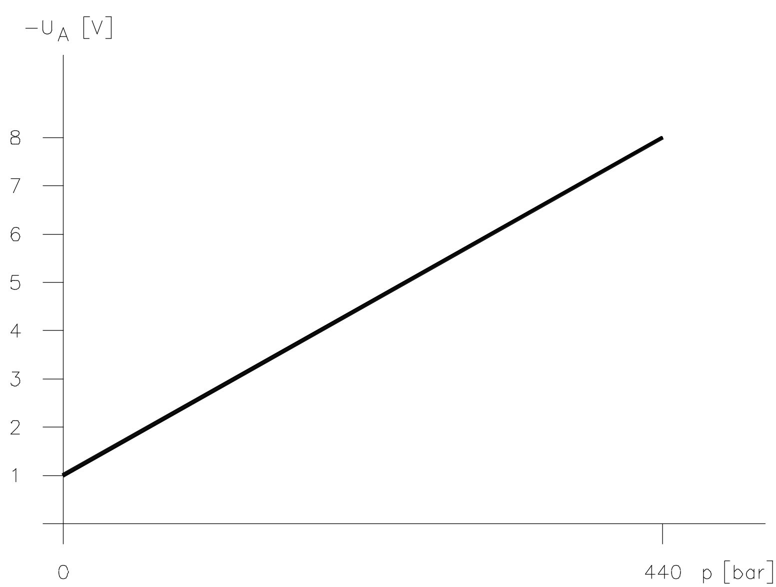
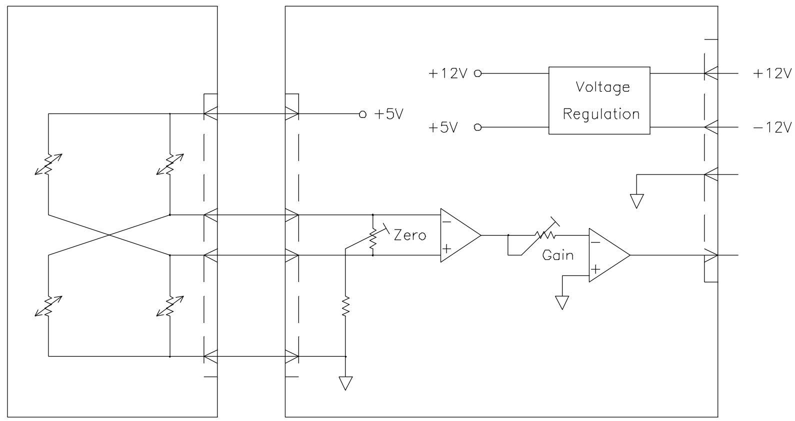


Figure 13 **Block Diagram HPT**



Connector Board (CON)

Repair Level: Board or Fuse

Table 7 **Part Numbers for CON Board**

Item	Part Number
CON (NEW)	01018-66505
Fuse: F2, 375 mA	2110-0421

The connector board (CON) allows easy access to plugs for the multi channel gradient valve (MCGV) active inlet valve and the leak sensor. The connector cable transmits the signals to the motherboard and from there it is fed to the various boards. The fuse protects the active inlet valve circuit for overcurrent conditions (only on board revisions B and greater).

Figure 14 **Board Layout CON**

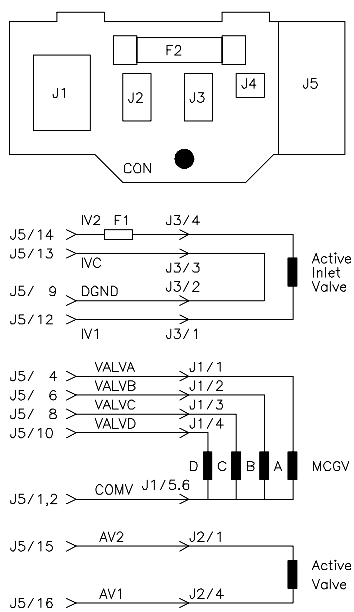


Table 8 **CON Connectors**

Connector	Function
J1	MCGV
J2	not used
J3	Active Inlet Valve
J4	Leak Sensor
J5	Cable
J1	MCGV

Pump Motherboard (HPS)

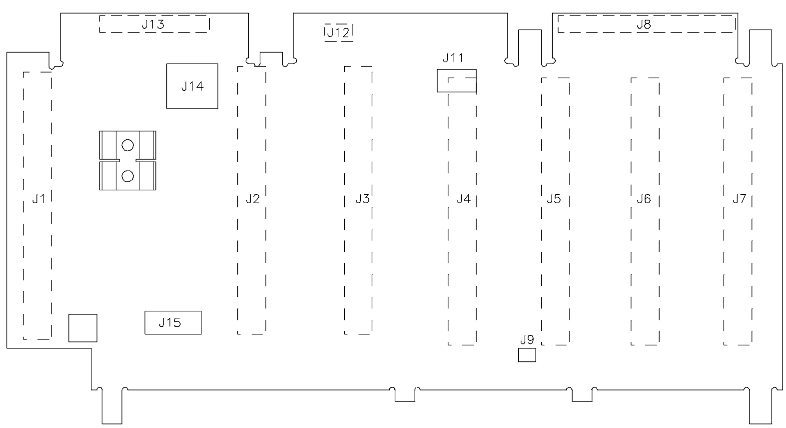
Repair Level: Board

Table 9 **Part Numbers for LUM Board**

Item	Part Number
HPS Board	01018-66501

The Motherboard connects the various boards of the pump to each other and supplies the signals for the front parts like metering drive, damper, MCGV, fan and keyboard. Figure 42 shows the location of all connectors, Figure 43 to Figure 45 show the main signals of the pump.

Figure 15 **Layout of Pump Motherboard**



J1 - Power Supply	J6 - Not used	J11 - Fan
J2 - PDC Board	J7 - CMP	J12 - High Pressure Damper
J3 - RAD/SFW Board	J8 - FIP Keyboard	J13 - Connector Board Cable
J4 - not used yet	J9 - Temperature Sensor	J14 - Metering Drive Motor
J5 - HRI/HRQ Board	J10	J15 - Shaft Encoder

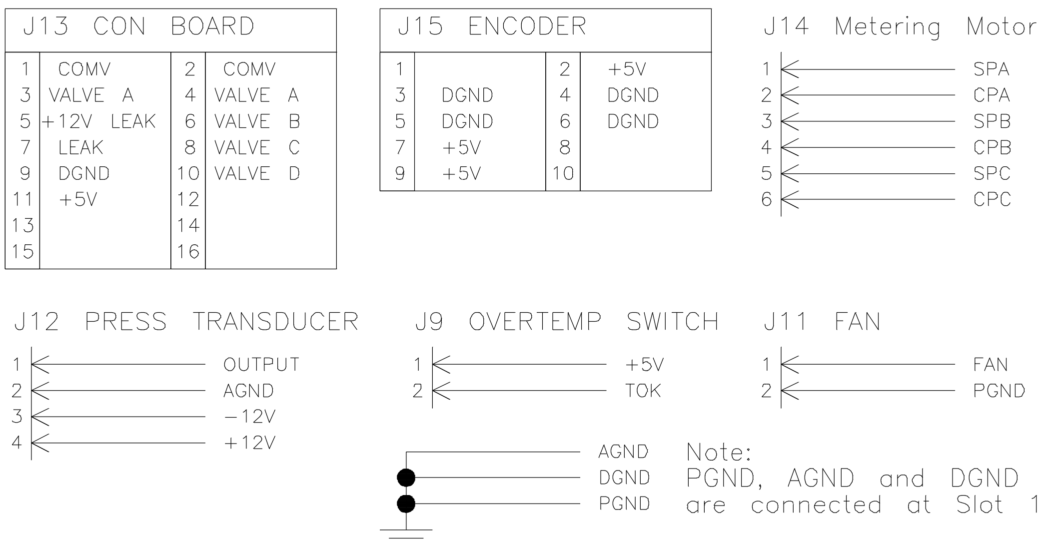
Figure 16 **Connection Table HPS (I)**

	J1 SLOT #1 P.S.			J2 SLOT #2 PDC			J3 SLOT #3 RAD			J4 SLOT #4		
	a	b	c	a	b	c	a	b	c	a	b	c
1				SPC	SPC	SPC						
2				CPC	CPC	CPC						
3				CPB	CPB	CPB						
4				CPA	CPA	CPA						
5				SPB	SPB	SPB	FAN	FAN	FAN			
6				SPA	SPA	SPA						
7				+24V	+24V	+24V	+24V	+24V	+24V	+24V	+24V	+24V
8				+36V	+36V	+36V	+36V	+36V	+36V	+36V	+36V	+36V
9				PGND	PGND	PGND	PGND	PGND	PGND	PGND	PGND	PGND
10				+19V	+19V	AGND	+19V	+19V	AGND	+19V	+19V	AGND
11				AGND	AGND	−19V	AGND	AGND	−19V	AGND	AGND	−19V
12				+5V	+5V	+5V	+5V	+5V	+5V	+5V	+5V	+5V
13				DGND	DGND	DGND	DGND	DGND	DGND	DGND	DGND	DGND
14				+12V	−12V	AGND	+12V	−12V	AGND	+5V		
15	PGND									+5V		
16	PGND						TOK			DGND	DGND	
17	+24V		AGND							SIG A	SIG B	
18	+24V		(12V ON)									
19	+24V		+24V				TIMER1			TIMER1		
20	+36V		+36V									
21	+36V		+36V									
22	+5V		PGND									
23	+5V		PGND									
24	+5V		+19V									
25	+5V		AGND									
26	+5V		−19V	PFAIL−			PFAIL−			PFAIL−		
27	DGND		PFAIL−									
28	DGND		+5V									
29	DGND		+5V	TOK	SOK−		POK	SOK−		POK	SOK−	
30	DGND		+5V									
31	DGND		DGND		OVP	DGND		OVP	DGND		DGND	
32	DGND		DGND		+5V	1MHZ			1MHZ			

Figure 17 **Connection Table LUM (II)**

	J5 SLOT #5 HRI / HRQ			J6 SLOT #6			J7 SLOT #7 CMP				J8 FIB
	a	b	c	a	b	c	a	b	c		
1	COMV		COMV				LEAK	+12VLEAK		1	DGND
2	VALVE A	VALVE A	VALVE A							2	
3	VALVE B	VALVE B	VALVE B							3	DGND
4	VALVE C	VALVE C	VALVE C							4	
5	VALVE D	VALVE D	VALVE D							5	DGND
6										6	
7	+24V	+24V	+24V	+24V	+24V	+24V	N.C.	N.C.	N.C.	7	DGND
8	+36V	+36V	+36V	+36V	+36V	+36V	N.C.	N.C.	N.C.	8	
9	PGND	PGND	PGND	PGND	PGND	PGND	BAT/DGND			9	DGND
10	+19V	+19V	AGND	+19V	+19V	AGND	+19V	+19V		10	
11	AGND	AGND	-19V	AGND	AGND	-19V	AGND	AGND	-19V	11	DGND
12	+5V	+5V	+5V	+5V	+5V	+5V	+5V	+5V	+5V	12	
13	DGND	DGND	DGND	DGND	DGND	DGND	DGND	DGND	DGND	13	DGND
14										14	
15										15	DGND
16	DGND	DGND		DGND	DGND					16	
17	1MHZ									17	DGND
18										18	
19	TIMER1			TIMER1			TIMER1			19	DGND
20										20	
21										21	+5V
22										22	
23										23	+5V
24										24	
25										25	+5V
26	PFAIL-			PFAIL-			PFAIL-			26	
27										27	+5V
28										28	
29	POK	SOK-		POK	SOK-		POK	SOK-		29	+5V
30										30	
31		DGND			DGND					31	+5V
32									DGND	32	
										33	+5V
										34	+5V

Figure 18 **Connection Table LUM (III)**



1

Pumps: Diagnostic Information

This chapter provides information on error messages and diagnostic features of the 1050 Pumps

Pumps: Diagnostic Information

This chapter provides information about:

- Test Functions
- Flow (Pressure) Tests
- Pump Pressure Ripple
- Normal Pressure Test
- Modified Pressure Test
- Flow Test Method - Firmware Revision 1.0
- Flow Test Method - Firmware Revision 3.0 and above
- Gradient Test
- Error Messages
- Selftest
- Common 1050 Messages
- Pump Initialization
- Normal Operation
- Column Heater
- Online Monitor
- Troubleshooting Hints (Pressure Tests)
- Pressure Tests with water and methanol
- Pressure Tests when the pump is broken

How to use the Diagnostic Test Functions

The test function of the firmware is part of the control section. The first test function is a online monitor of the actual pressure ripple. The two other programs allow verification of the pump performance. The two test methods are also used for the final test of the 1050 Pump modules.

Press CTRL and with Next move the cursor to

`TEST FUNCTIONS (enter)`

After pressing Enter the following TEST FUNCTIONS are accessible.

`PUMP PRESSURE RIPPLE YY.Y%`

Monitors the actual flow ripple if the diagnosis level (Configuration) is turned on (1, 2 or 3).

`LOAD FLOW TEST METHOD`

Loads a special program (pressure test) for performance verification of the flow system.

`LOAD GRADIENT TEST METHOD`

Loads a gradient test program (tracer test) for the performance of the gradient system.

Pump Pressure Ripple

The pressure ripple display shows the actual pressure variation of the solvent flow. It can be used as a quick check for determination of gas bubbles in the system. If the online diagnostic is turned on no pressure ripple (--.-%) indicates either no flow in the system or too many gas bubbles in the system exceeding the measurement range or a pressure below 30 bar to 50 bar.

Positive pressure ripple values (for example 0.5%) are shown when the pump is overcompensated. Negative pressure ripple values (for example -0.8%) are shown in case of an under compensated pump.

Whether the values in the display are either positive or negative is strictly depending on the solvents in use and the respective pressure compensation values which are user selectable. Typical pressure ripple readings are in the range ±1%. A higher ripple which can not be reduced by pressure compensation changes may indicate an air bubble.

NOTE In purge mode the pressure ripple is not measured. The display might show incorrect values during this time.

Flow (Pressure) Tests

The pump has an analog output for the pressure signal for monitoring and troubleshooting purposes. The tightness and performance of the pump can be tested with various pressure tests. The outlet of the pump will be blocked and depending on the chosen pressure test the system pressure rises until it is stopped either by the program itself or the pressure limit.

The plotted pressure signal provides information about the performance of the system. In case of system failures it might be possible to combine the pressure tests for clear identification of the failing part.

Firmware revision 3.0 and above

These firmware provide an additional feature which allows to monitor which of the two piston is delivering into the system. This is a very helpful tool when troubleshooting the system. Pressure drops in the pressure tests can be related to the delivering piston. Conclusions which parts failed are much easier done.

Press Status and twice Next to get the following display.

```
currently active piston 1
```

The display shows whether piston 1 or piston 2 are just delivering into the system. ** indicates that the change from one piston to the other is to fast to be monitored (flow >1.2 ml/min).

Prerequisites for the Pressure Tests

1 Place a bottle of isopropanol (HPLC grade) into the solvent cabinet and connect it to one of the solvent channels (lets take channel B).

2 Switch on the degassing for that channel and establish an appropriate helium flow rate in the bottle.

3 Connect the signal cable between RAD board and integrator input (for example a 339X integrator). The pressure signal provides 2 mV/bar.

4 Purge the channel (B). Observe the pressure reading until the value is stable. The pump pressure ripple display should show a value in the range ±0.5% for isopropanol (with default settings).

NOTE If the system is not well primed or degassed incorrect measurements may be taken resulting in wrong interpretation of the plots.

5 Set Integrator parameters (339X series).

Zero 10

ATT 2^{10}

CHART SPEED 2 cm/min

Normal Pressure Test

This test is well known for verifying system tightness.

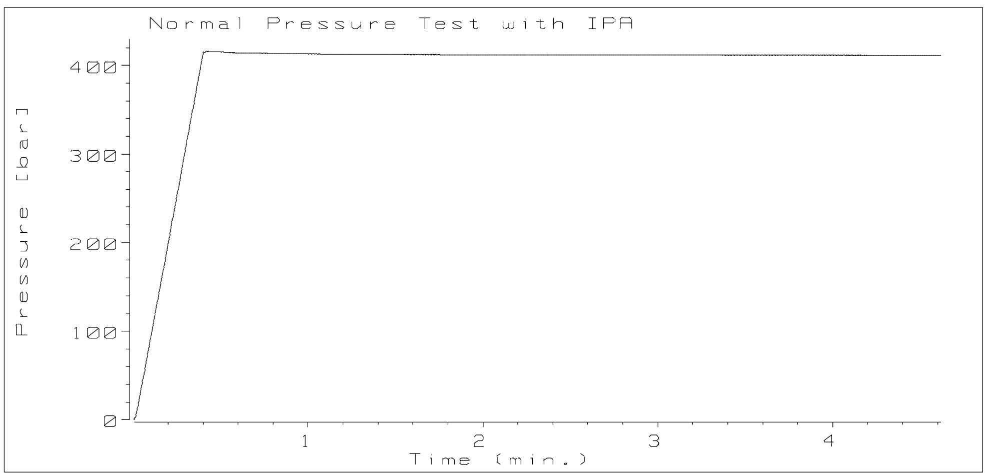
❑ Turn on pump and set `FLOW 0.000 ml/min` and disconnect the interface tubing at pump outlet.

❑ Plug pump outlet with a blank nut (01080-83202).

❑ Start the integrator with the plot mode.

❑ Set Flow `FLOW 1.000 ml/min` to start the pressure test.

Figure 1 **Normal Pressure Plot with IPA**



Explanations to Plot

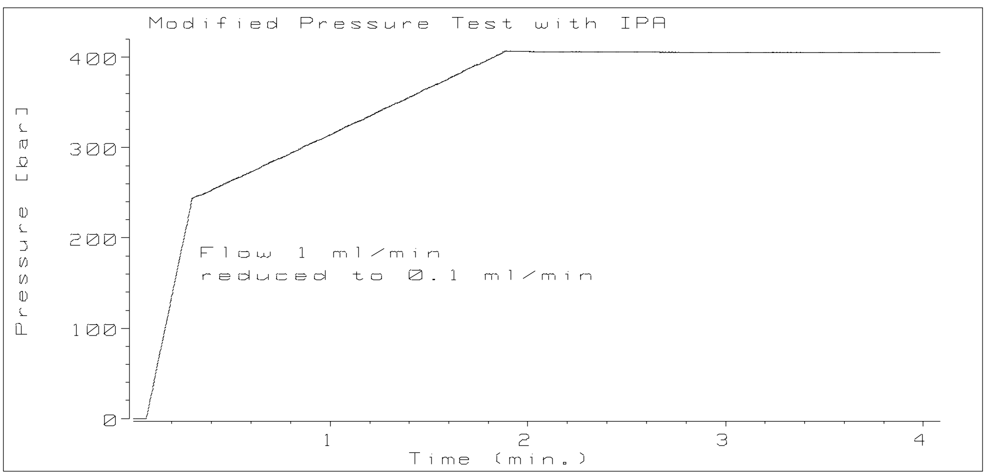
The plot shows a typical pressure profile of a normal performing 1050 Pump. With the flow of 1 ml/min the pressure in the system raises until the pump stops via the overpressure condition at 400 bar. After one minute wait time the pressure drop should not exceed 5 bar/min.

The Modified Pressure Test

This test is a slight modification of the previous used normal pressure test.

- ❑ Turn pump on, set `FLOW 0.000ml/min` and disconnect the interface capillary at the outlet of the pump.
- ❑ Plug pump outlet with a blank nut (01080-83202).
- ❑ Start the integrator with the plot mode.
- ❑ Set Flow `FLOW 1.000ml/min` to start the pressure test.
- ❑ Observe the pressure display and reduce the flow to `FLOW 0.100ml/min` at approximately 200 bar.

Figure 2 **Modified Pressure Test with IPA**



Explanations to the Modified Pressure Plot

The plot shows a typical pressure profile of a normal performing 1050 Pump. The pressure in the system rises as seen in the previous test. When switched to the reduced flow rate the pressure increases with a lower slope. During the time until the system pressure limit will be reached piston I and II deliver alternately into the system. A straight line as seen indicates that both piston chambers are leak free. After switched off at 400 bar and one minute wait time the pressure drop should not exceed 5 bar/min.

Flow Test Method

The firmware of the pump module holds a firmware resident flow test method which contains the parameters for the pressure test. The parameters cannot be displayed. During the life time of the instrument the firmware has been changed (communication update rev. 1.0 to 3.0) and the flow test method was revised. Therefore firmware revision 1.0 and 3.0 run different tests when the flow test method will be executed.

❑ Place a bottle of isopropanol (HPLC grade) into the solvent cabinet and connect it to one of the solvent channels (lets assume its channel B).

❑ Set `PRIMARY CHANNEL B`

NOTE The Test Method uses exclusively the solvent specified by the primary channel and ignores the setting of the % display. However for flushing the system a setting %B 100 is necessary.

❑ Connect the signal cable between RAD board and integrator input.

❑ Flush the system. Observe the pressure reading until the value is stable. (hint: use pressure ripple display).

❑ Set `FLOW 0.000ml/min` and disconnect interface tubing at pump outlet.

❑ Load Flow Test Method.

NOTE Loading the flow test method resets the pump an action which moves the pistons into a predefined position. In addition the instrument sets the actual flow to zero (`FLOW 0.000ml/min`) if not already set.

❑ Plug the pump outlet with a blank nut (01080-83202).

❑ Set integrator parameters (339XA)

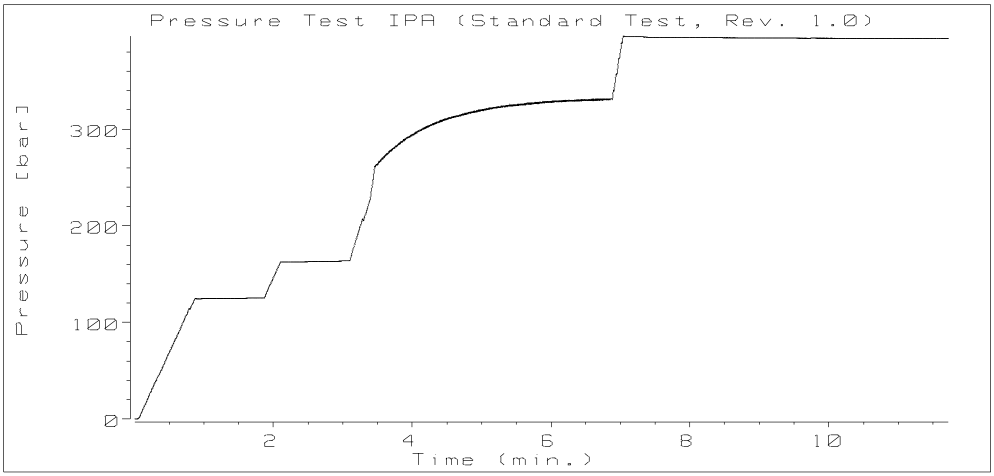
Attenuation 2^{10}

Chart Speed 1 cm/min (PLOT mode).

❑ Press START, then ENTER to run the test method.

Flow Test Method - Firmware Rev. 1.0

Figure 3 **Pressure Test (Rev. 1.0) with IPA**



Explanations to Pressure Plot

The plot shows a typical pressure profile of a normal performing 1050 Pump. Following are some remarks to the various steps in the plot.

NOTE

The pump displaces approximately 150 µl until the first plateau will be reached at a pressure of 120 to 130 bar. After pump initialization the 1. piston is in its upper position which means the 2. piston starts delivering into the system. With the given stroke length of 70 µl strokes of both pistons (II-I-II- I)l are necessary to reach the 1. plateau. Drastic leaks at active inlet valve outlet ball valve or seals will disturb the intake stroke of the 1. piston. The result might be a pressure drop when the 1. piston takes over to deliver into the system at a pressure between 20 to 40 bar. If the pressure test does not reach the first plateau the pressure plot cannot give any reliable diagnostic or troubleshooting hints.

1 From the predefined position the pistons start moving with a flow of 150 µl and rises the pressure in the pump.

2 At the first plateau the firmware makes sure that the first piston is delivering into the pump. With the very small flow rate of 2 µl the pump pressure should remain stable. During the 1min at this plateau a maximum pressure drop of 5 bar is allowed (pressure display). At this position the tightness of the whole system is measured.

3 Pressure is increased until the second piston is delivering.

4 At the second plateau the second piston is delivering into the system with a flow of 2 µl. Again a straight line is expected. A pressure drop of 5 bar during the 1min is allowed.

5 The pistons move now with a higher speed (flow 500 µl/min) increasing the pressure in the system.

6 While increasing system pressure the pistons move with a stroke volume of 4 µl. The system pressure must reach a value of 330 bar ±30 bar. This part of the test checks for the mechanical tolerances from system to system and is of minor interest for system troubleshooting.

7 The system pressure is increased until the system shows an overpressure condition (>400 bar) which turns the pump off. 1 min after turning off the pump pressure drop should not exceed 5 bar/min.

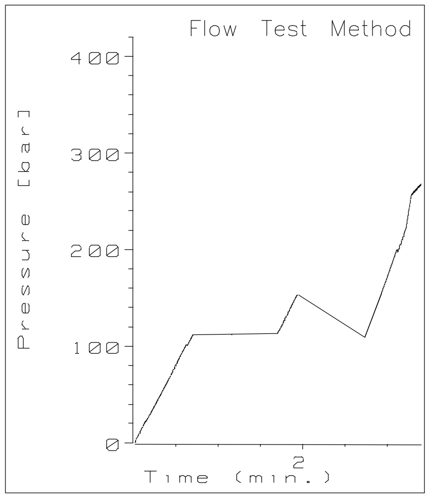
Possible Failure Modes

The most relevant service information are obtained from the plot of the first (2) and second (4) plateau of the pressure plot. Three major failure modes are possible. For troubleshooting the system both plateaus should be seen together and not separately.

The following plots show the different failure modes.

Straight line at first plateau but negative slope at second plateau

Figure 4 **Negative Slope at second Plateau**



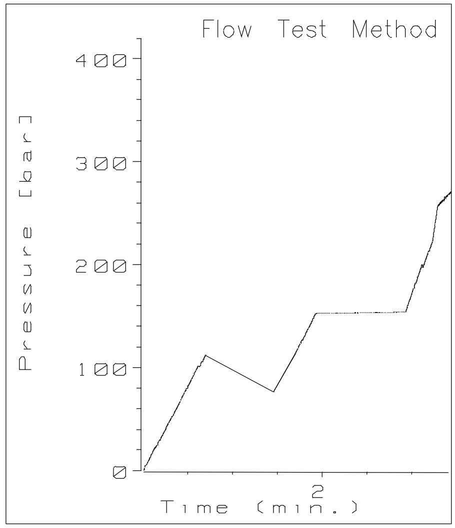
The plot shows a leak free system when the first piston provides the flow. But during the stroke of the second piston the pressure drops down indicating a internal leak. The pump seals are definitely ok.

Possible failure:

Contaminated outlet ball valve (backflow).

Negative slope at first plateau and stable plot at second plateau

Figure 5 **First Plateau unstable**



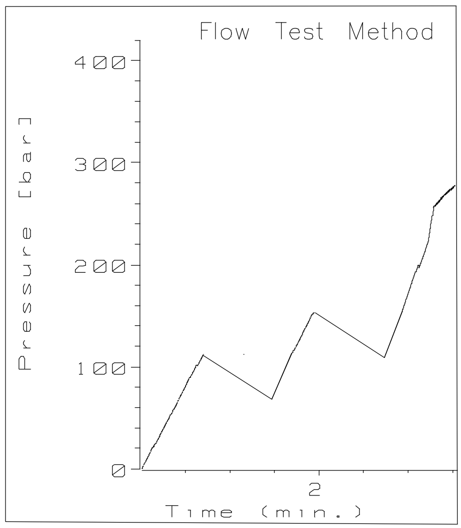
Plot shows malfunction in the system when the first piston maintains the pressure in the system. The delivery stroke of the second piston is separated from the first one via the outlet ball valve and shows no problem.

Possible failure:

- leak at first piston seal
- leak at active inlet valve
- no tight connection at outlet ball valve.

Negative slope at both pistons

Figure 6 **Problems at both Plateaus**



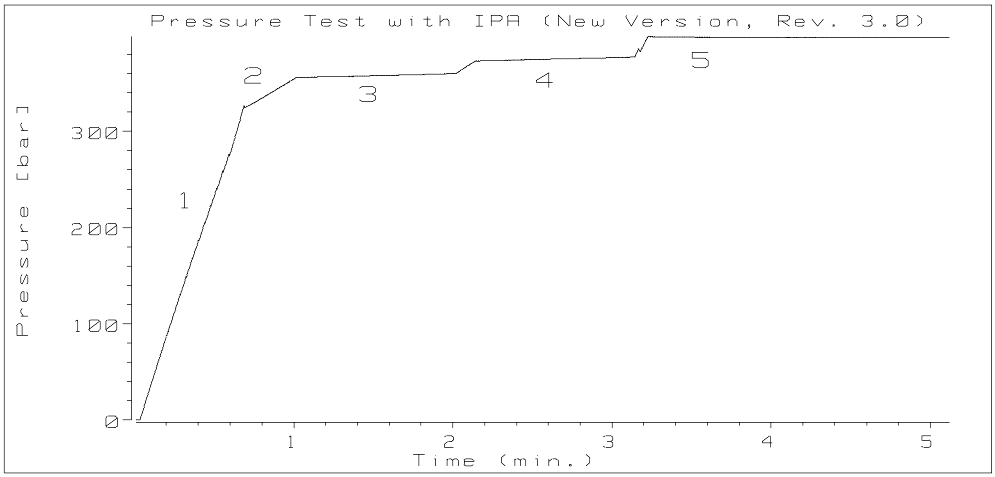
Plot shows same failure mode on both pistons when maintaining the pressure in the pump. Under the assumption that the slope has the same angle for both “plateaus” it can be said that the problem is probably coming from the second piston chamber. Different angles indicate more than one leak in the pump.

Possible failure

- Blank nut not tight enough
- Fittings at frit adapter assembly or damper not tight
- Leaking piston seal at second piston.

Flow Test Method - Firmware Rev. 3.0 and above

Figure 7 **Pressure Test (Rev. 3.0) with IPA**



Explanations to Pressure Plot

NOTE This flow test method is pressure controlled. The actual pressure has to exceed at least 270 bar for the first step otherwise the test cannot reach the following steps.

1 Starting with a flow of 500 µl/min and a stroke of 20 µl the pump starts delivering into the system. The pressure rises until the damper detects a system pressure of more than 270 bar. The pump continues to deliver with the same parameters until piston I reaches its upper limit. At this position the stroke is changed to 80 µl and piston II delivers one stroke with the larger stroke volume.

2 Now the flow is changed to 100 µl/min (stroke 80 µl) and piston I continues with this parameters for about 1/3 of its stroke.

3 At the plateau piston I delivers for approximately 1 minute with a very low flow rate (4 µl) into the system. A straight line or a slight pressure increase is expected for a normal performing pump. A pressure drop during this minute indicates a problem in the pump.

4 Piston II delivers into the system. At the end of the first plateau the flow is increased back to 500 µl until piston II reaches approximately 1/3 of its stroke. At the second plateau piston II delivers with a very low flow rate (4 µl) into the system. A straight line or a slight pressure increase is expected for a normal performing pump. A pressure drop during this minute indicates a problem in the pump.

5 The flow is increased to 250 µl and the pumps works with this rate until the damper detects more than 390 bar. The flow is set to zero and the test is finished. It might happen that the system stops with a pressure slightly below 400 bar. This allows to restart the pump without reset. In most of the cases the pressure will exceed the upper pressure limit of 400 bar and will show the error message. 1 minute after reaching the maximum pressure of the test the pressure drop should not exceed 5 bar/min.

Possible Failure Modes

The plateaus (3, 4) of the pressure test provide the same information like in the previous test (Rev. 1.0). The only difference is that the two plateaus are moved to higher pressure values. The section pressure plots of this manual will provide additional pressure tests under failure conditions of the pump.

Gradient Test Method

The test measures all the relevant data which have an influence on the pump performance. The step performance of the MCGV and the gradient linearity are controlled with this tracer test. The tracer test is a chromatographic test and therefore requires a UV detector connected (no column installed) to the 1050 Pump module. The gradient test is decided into two parts. The first part tests the step reproducibility of a gradient and the second part tests the linearity of a gradient.

Prerequisites for the Gradient Test Method

Place the following solvents (HPLC grade) into the solvent cabinet and degas them thoroughly.

Channel A	Distilled Water
Channel B	Tracer (Isopropanol + 0.5% Acetone)
Channel C	Isopropanol
Channel D	Isopropanol

Running the Gradient Test Method

1. Flush each channel for a couple of minutes.
2. Connect the outlet capillary of the pump to a detector.
3. Set detector parameters Sample Wavelength 267 nm (Bandwidth 4 nm) or equivalent, Reference Wavelength 550 nm, 100 (if available) or equivalent or fixed reference.
4. Connect the signal cable between detector and integrator.

5 Set integrator parameters (339X).

Zero = 5

Att 2^ = **

CHT SP = 1.0

PK WD = 0.01

THRSH = 11

AT 12 min Att 2^ = **

AT 12 min CHT SP = 0.5

AT 45 min STOP

** The tracer concentration may vary from mixture to mixture. Therefore check for the appropriate integrator attenuation. Start the integrator manually change %B = 7 observe the plot and adjust the attenuation to a value which gives the highest deflection without exceeding the paper range.

Proceed in the same way with %B = 100. Set the pump parameters back to start values (%B = 0).

6 Load gradient test method.

7 Press START, then ENTER to run the test method.

Figure 8 **Gradient Test Method (part 1)**

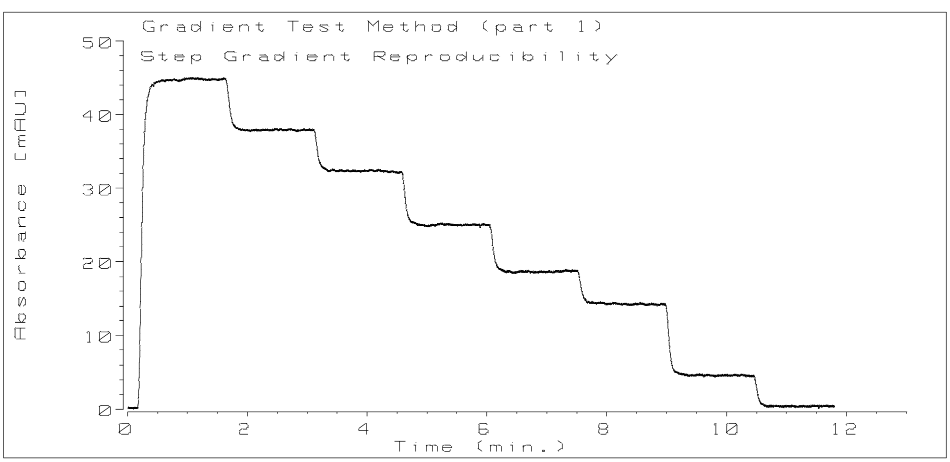
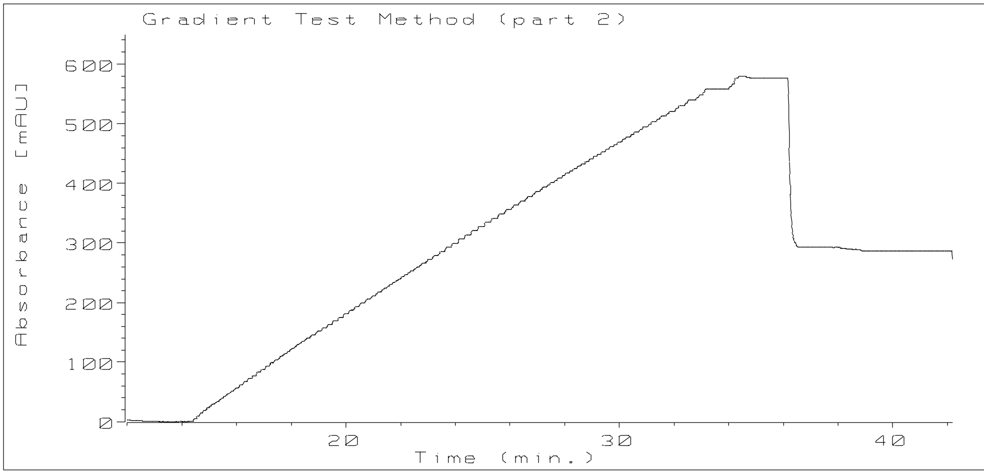


Figure 9 **Gradient Test Method (part 2)**



Explanations to Gradient Test

In the first part of the test the step reproducibility will be tested. The steps should have all the same height except the last two steps. The last steps (from 2% to 1% to 0%) will not have the same step height because of a too small solvent volume versus the switching time at this positions. In addition the composition precision can be tested. The noise on each of the steps should not exceed 50% of the step height. Typically values of 30% representing a composition precision of ±0.15% are reached.

In the second part of the test the gradient linearity will be verified. Except of the bump at the upper end of the gradient the curve should show a straight line indicating a good linearity of the system. Be aware that the performance of the detector (linearity, stray light, and so on) will have a significant impact on the results.

Error Messages

The error messages will help to locate and repair a failure. In case an error message appears the Error LED will be turned on and the message will be written into the system logbook. `Reset Pump` or switching on the pump again will reset the error. The entry in the logbook remains.

The error messages can be divided into the following blocks:

- Selftest
- PANIC Error
- Common 1050 Messages
- Pump Initialization
- Normal Operation
- Column Heater
- Online Monitor

Selftest

ROM/RAM Test

RAM and display can be tested via the build in selftest. The selftest will be performed when CRTL will be pressed while the module is turned on at the LINE~ switch. In case of a failure one of the following messages appears. The complete test requires approximately two minutes.

ROM test failed

`( ROM test failed )`

The ROMs on the SFW board are tested. In case of a checksum error the ROM test fails.

❑ Replace the SFW board.

RAM test failed

`( RAM test failed )`

The RAM's on the CMP board will be tested. In case of a failure the error message appears and the CMP has to be replaced.

❑ Replace the CMP board.

Panic Error / Bus Error Address Error

`PANIC: XXXXXXH BUS ERROR`

`PANIC: XXXXXXH Address ERROR`

The panic error messages should not appear under normal operation conditions. In case of hardware or firmware problems the instrument might try to access a wrong or not existing address which results in the error message on the display. The instrument is locked up and has to be switched off/on.

Reason for the PANIC error message can be any disturbance on the bus lines due to bad contacts (high resistance) or defective IC on any of the boards.

- ❑ Check boards for good connections or corrosions at the contacts (clean contact pins).
- ❑ Check revision of firmware board (SWF). It should be revision C or higher. Revision C boards do have a dynamic bus termination for spike suppression on the bus lines.
- ❑ Replace one board at a time to identify the faulty one.
- ❑ If board replacement will not cure the problem replace the motherboard.

Common 1050 Error Messages

The common messages are either event or error messages which may appear in all the 1050 series modules. The messages are identical or very similar in the various modules.

E00 : Power Fail

```
E00 HH:MM DDMMM power fail >
```

This message indicates that the instrument has either been disconnected from line source or a line power voltage drop has occurred. System clock will stop and has to be set again after turning on the pump.

E01 : Leak Detected

```
E01 HH:MM DDMMM leak detected >
leak detected in pump
```

The leak detection system uses a PTC resistor as leak sensing item. Liquid cooling the PTC results in a decrease of the resistance. The PTC is built in a resistor divider which is connected to a constant voltage. From the voltage divider a signal can now be obtained depending on the current through the PTC and hence depending on the temperature. The leak detection circuit is located on the CMP board and checks continuously for presence and leak conditions. If the sensor is missing (defect) or in leak condition the PTC is cooled down the error message appears (only when pump motor was turned on beforehand otherwise only a status information is given). When the module is turned on the leak message will be disabled for a short period of time (30 seconds) to allow the sensor to warm up and stabilize.

Working condition of the PTC

Normal:	about 75°C	400...500 Ohm
Error:	below 55°C	about 150 Ohm

Actions:

- ❑ Check for leaks in the pump module.
- ❑ Check connector of the sensor.
- ❑ Check resistance of leak sensor.
- ❑ Change leak sensor.
- ❑ Change CMP board.
- ❑ Change SFW board.

E02 : Shutdown In Other Module

```
E02 HH:MM DDMMM shut down >
error in other module
```

An external device pulled the shut down line of the remote connector down. This forces the pump to stop the pump motor inhibiting a flow into the system. Probably a leak appeared in one of the connected modules.

E03 : Error Method loaded

```
E03 HH:MM DDMMM error method >
error method has been loaded
```

The operator may define a method as a error method. The event message indicates that the module detected an error and that the error method was loaded.

E04 : Time Out

```
E04 HH:MM DDMMM time out
```

The operator may define a time after which the instruments stops all further actions. Mainly two cases will lead to the time out message. First if a normal run is finished the pump is turned off after the specified time (only if no new start command appears during this time). Second a not ready condition in a sequence mode or in multiple run mode will start the time out timer eventually leading to the message.

Pump Initialization Error Messages

During the pump initialization the system performs some start up routines to prepare the motor drive system for normal operation. The system starts the servo system and measures the upper dead center of the first piston. Malfunctions during the turn on process will lead to the following error messages.

E11 : Gradient feedback failed

```
E11 HH:MM DDMMM init failed >
gradient feedback failed
```

In case the gradient valve (MCGV) is installed and recognized during boot up the system turns on the Primary Channel before it starts with any other action. The error message indicates that the primary channel could not be turned on. Reason is an communication problem between the pump drive control board (PDC) and gradient valve driver board (HRQ).

- ❏ Check for proper connection of HRQ and PDC boards.
- ❏ Replace HRQ board.
- ❏ Replace PDC board.

Work around: Set different primary channels one of them should work. Use pre mixed solvents and connect the solvent directly to the active inlet valve.

E12 : Servo restart failed

```
E12 HH:MM DDMMM init failed >
servo restart failed >
```

The first action for the servo motor is to switch on the C-phase of the variable reluctance motor. The rotor will move to one of the C-positions. This action is called the Servo Restart. From such a rotor stator relation the servo will be able to take over the phase sequencing with the commutator (on the PDC board). If the rotor is not able to move or the C-phase cannot be reached the error message appears.

- ❏ Check Fuse on the PDC board.
- ❏ Check cables to pump motor.
- ❏ Check for mechanical blockage of the drive system.
- ❏ Change PDC board.
- ❏ Change drive assembly.

E13 : Pump timeout

```
E13 HH:MM DDMMM init failed >
pump timeout
```

After restart the pump will move the first piston to its upper position. The upper position is recognized when the piston touches the mechanical stop rising drive power for the blocked motor. If the piston will not reach the upper limit within one minute the initialization will be stopped and the error message appears.

❏ Check gears of the drive assembly (broken coupler?).

❏ Change PDC board.

❏ Change the drive assembly.

E14 / E15 / E16

The following three error messages use the same measurement principle with different limits. During the pump initialization the first piston hits the upper dead center of the pump head and stops there. To make sure that the piston will not run into this mechanical stop during normal operation the index hole of the motor shaft encoder wheel is used as the initialization reference. From the upper center the piston travels back until it reaches the index hole. There will be no reinitialization during normal operation (initialization only during pump on procedure or pump reset command). The Index position is expected in a certain range from the upper dead center. If the Index does not appear in this range one of the three messages will show up on the display.

E14 : Home position not found

E14 HH:MM DDMMM init failed >
home position not found

After the piston has hit the upper limit it will move down to find the first Index hole of the encoder. If the Index is not found in the maximum allowed number of steps this error message appears. The communication to the shaft encoder index hole is missing.

❏ Check cable and connector of the encoder.

❏ Check PDC board connection.

❏ Change PDC board.

❏ Change Drive Assembly.

E15 : Home position out of limit

```
E15 HH:MM DDMMM init failed >
home position out of limit
```

When the motor is stopped for reversing the direction the moment of inertia of motor and spindle will continue the movement for certain steps until it finally stops. Therefore an minimum number of steps is necessary until the Index should be reached. In case the number is to small this error message appears. Changed adjustment or sticking movement of the system can be the reason for this.

- ❑ Check drive system for smooth movement.
- ❑ Change motor drive assembly.
- ❑ Change PDC board.

E16 : Pump head missing

```
E16 HH:MM DDMMM init failed >
pump head missing
```

The mechanical tolerances from one system to the other need an offset compensation to make sure that the piston reverses its direction always at the same position. If the distance between the upper limit and the first index exceeds the compensation range but is still below the maximum limit (E14) the error message will show up. Reason can be that the pump head is missing or not mounted in the right way.

- ❑ Mount pump head correctly.
- ❑ Check drive system for smooth movement.
- ❑ Change motor drive assembly.
- ❑ Change PDC board.

E17 : Idle power exceeded

```
E17 HH:MM DDMMM init failed >
idle power exceeded
```

The PDC board measures the actual electrical current. If the motor needs more then a defined current for a pressure free pump it indicate a failure in the system. Reason is either an tight mechanical system or a defective motor.

- ❑ Check drive system for smooth movement.
- ❑ Check PDC board.

E18 : Stroke length misadjusted

```
E18 HH:MM DDMMM init failed >
stroke length misadjusted
```

This error message appears only when the pump is running in DIAGNOSE LEVEL 3 which is a manufacturing test. The error indicates a incorrect spindle position adjustment.

Hint: If error message E27 occurs when pump works with 100 µl stroke volume diagnose level 3 allows a quick check of the pump. Set diagnose level 3 and turn on pump. If E18 occurs the metering drive is mis-adjusted and generates the E27 problem. Metering drive has to be changed.

Normal Operation Error Messages

Operation error messages can be detected at any time of a normal operation. They are normally independent of the current state of the pump. The ERROR LED will be ON and the message will be entered in the logbook. Restarting the pump will reset the error.

E19 : Pressure above upper limit

```
E19 HH:MM DDMMM press too high >
pressure above upper limit
```

The actual pressure in the system is continuously monitored during operation of the pump. The firmware allows only operation up to the user defined upper limit, if not in purge mode. If the high pressure damper detects more than the upper limit the pump is turned off or a specified error method will be activated and the error message appears. All this measurements are performed on the RAD board.

- ❑ Check flow system for blockages.
- ❑ Check Flow setting.
- ❑ Change RAD board.

E20 : Pressure above maximum limit

```
E20 HH:MM DDMMM press too high >
pressure above maximum limit
```

The system pressure is normally checked with the upper and lower limit values. In case of any malfunction (for example pump does not stop at 400 bar rapid fast pressure increase) in the system which allow the pressure to rise above 420 bar the pump is stopped and the error message appears. This message shows up when the system is blocked and the pressure shoots up very fast (pressure test).

- ❑ Check flow system for blockages.
- ❑ Check flow setting.
- ❑ Change RAD board.
- ❑ Change PDC board.

E21 : Pressure below lower limit

```
E21 HH:MM DDMMM press too low >
pressure below lower limit
```

The lower limit value function is firmware controlled. In case the system pressure drops once below a user defined value the pump motor will be turned off or the specified error method will be activated and the error message appears. The error message allows to check the system for empty solvent bottles, broken capillaries, fitting leakage and so on.

- ❑ Check flow value and solvent composition.
- ❑ Check all seals and fittings in the complete LC system.

E22 : Temperature sensor failed

```
E22 HH:MM DDMMM sensor failed >
temperature sensor failed
```

While the pump is turned on the firmware checks for the presence of the temperature sensor. In case the sensor is disconnected defective or the sensor is activated (switch open) by an over temperature condition the error message appears. The temperature sensor switch opens at 90°C and the pump motor will be turned off.

- ❑ Check fan.
- ❑ Check air filters.
- ❑ Check sensor with meter.
- ❑ Change metering drive.
- ❑ Change RAD board.

E23 : Motor temperature exceeded limit

```
E23 HH:MM DDMMM overtemperature>
motor temp exceeded limit
```

The highest power consumption in the module is inside the variable reluctance motor. High system back pressure at low flow rates results in maximum heat dissipation. A fan and a special designed foam part make sure that the heat of the motor is brought out of the instrument. In case the airstream of the module is interrupted or the fan fails the motor temperature will rise above allowed limits. A thermal switch is mounted on the surface of the motor and turns off the pump when the temperature exceeds 90°C.

The error event circuit reacts immediately on the PDC board and turns off the pump motor power. The same signal line on the PDC board is also used from the system ok command (SOK). This means that the error also appears in case of a SOK error. The SOK is set when the processor has locked up preventing damage of pump or others or one of the boards holds the signal down.

- ❏ Check fan.
- ❏ Check air flow path.
- ❏ Check temperature of the motor.
- ❏ Change PDC board.
- ❏ Check all other boards in the system.
- ❏ Change CMP board.

E24 : Inlet valve disconnected

```
E24 HH:MM DDMMM valve missing >
inlet valve disconnected
```

If the active inlet valve is disconnected and the first piston is delivering solvent the valve may be damaged. Therefore the presence of the active inlet valve is controlled. In case the active inlet valve is not connected during the initialization of the pump the pump motor is turned off and the message occurs.

- ❏ Check Connector of the valve.
- ❏ Check the connector cable to the motherboard.
- ❏ Change RAD board.

E25 : Adjust pressure offset

```
E25 HH:MM DDMMM pressure offset>
adjust pressure offset
```

The high pressure damping unit measures the system pressure in the range from 0 to 400 bar. Thermal drift of the electronic components may cause drift to negative values. If the pressure offset is below -15 bar the error message appears on the display. Incorrect adjustment may influence the pump performance (pressure ripple measurement and so on).

- ❏ Perform offset adjustment.
- ❏ Check connector of damping unit.
- ❏ Change RAD board.
- ❏ Change damping unit.

E26 : Pump drive lost init values

```
E26 HH:MM DDMMM init lost
pump drive lost init values
```

The reference position for the upper limit of the piston is reached during each pump cycle. In case the difference of the actual value in relation to the value of the initialization is too large the system will turn off the pump and the error message appears.

- ❑ Check connector and cable of the encoder.
- ❑ Change PDC board.
- ❑ Change motor drive assembly.

E27 : Max motor drive power exceeded

```
E27 HH:MM DDMMM power use high>
max motor drive power exceeded
```

The power consumption of the motor drive will be monitored. In case of servo failures or blockages of the ball screw drive the motor current will exceed the maximum limit and the processor will turn off the pump.

- ❑ Check motor drive for smooth movement.
- ❑ Check the +12 V on the PDC board.
- ❑ Change PDC board.
- ❑ Change motor drive assembly.
- ❑ Check outlet ball valve for blockages.

E28 : Secondary Powerfail

```
E28 HH:MM DDMMM Sec Powerfail >
+12 V analog supply failed
```

The +12 V generated on the PDC board will be continuously checked for under voltage conditions. In case the voltages drops below approximately +10 V the pump will shut down and the error message will appear. The +12 V will be also used on the RAD board and the pressure transducer board of the damping unit.

- ❑ Change the PDC Board.
- ❑ Change the RAD Board.
- ❑ Change the Damping Unit.

Column Heater Error Messages

The following messages may appear as you work with the column heater.

E33 : Column heater cable disconnected

```
E33 HH:MM DDMMM column heater >
cable disconnected
```

The firmware recognizes the column heater option when the cable is correct installed. If afterwards the cable is disconnected or a wrong cable is connected to the HRI/HRQ board the error message appears and the red error LED is turned on.

NOTE

When the remote cable is connected to the HRI/HRQ board the error message will appear and the +24 V of the board is disabled to prevent damage of the modules which are connected to the remote cable.

If the column heater cable is connected to the remote connector of the pump module the LED on the heater module will lit yellow/red.

❑ Check for correct cabling of the column heater module.

E34 : Column heater board failed

```
E34 HH:MM DDMMM column heater >
board failed
```

The watch dog circuit on the CMP board (SOK signal) controls the correct communication between processor and interface boards. If the SOK signal is activated the error massage appears and the error LED of the pump module is turned on and the column heater LED shines red. Reason for the error can be either an electronic component failure or interference on the bus lines.

❑ Reboot the pump module.

❑ Reseat all boards in the card cage.

❑ Change the HRI/HRQ board.

❑ Change the CMP board.

❑ Change the CIB board.

❑ Change the SFW board.

❑ Change the HPS board.

E35 : Column heater overtemperature

```
E35 HH:MM DDMMM column heater >
overtemperature
```

The column temperature is normally checked with the Pt. 100. In case of malfunctions the temperature may exceed the normal working range. At 90°C the firmware disables the heater circuit, sets the error message and turns on the red error LED at the pump and the column heater. In case the heater transistor is defective and still heats up the heat exchanger the over temperature switch on the heater foil opens at 100°C and interrupts heating.

- ❑ Change the HRI/HRQ board.

E36 : Column heater fuse blown

```
E36 HH:MM DDMMM column heater >
fuse blown
```

With the column heater turned on the firmware checks for the presence of the +24 V on the HRI/HRQ board. If fuse F4 is blown, the +24 V is missing and the instrument shows the error message, turns on the red error LED on the pump and the column heater module. The fuse blows in case of a shortage on the +24 V line.

- ❑ Replace fuse F4.

Online Monitor Messages

The online monitor function checks the metering pump during normal operation and is described in the diagnostic section. Messages may appear when the chromatographic performance might be influenced or the instrument is in a special mode (initialization purge).

The messages except of M01 and M11 are related to the Diagnose Level (0, 1, 2) of the instrument. If the diagnose level is turned off (0) the messages will be suppressed. Diagnose Level 1 writes the messages into the logbook with no further action. Diagnose Level 2 writes the messages into the logbook and the Not Ready LED will be turned ON. For more information about the online monitor, see the diagnostic chapter.

M01 : Pump reference initialized

```
M01 HH:MM DDMMM initialized >
pumps reference initialized
```

The initialization of the metering drive reference values appears under three conditions. First after initial turn on of the pump after boot up second with a reset pump command (Control Function) and third when the pump is turned on and the reference values have been lost for any reasons. In this case the message is an indication that a covered problem appeared while the pump was turned off. Because of its state (off) the pump could not show the malfunction and the instrument performs a new initialization. During this initialization the probable error will be cleared and when the error is not solid the pump will be turned on without problem.

M02 / M03 : Gas bubble

```
M02 HH:MM DDMMM gas bubble >
gas problem ripple too high
```

```
M03 HH:MM DDMMM bubble solved >
problem solved ripple in range
```

If the pressure ripple of the pump exceeds a certain range the message M02 appears. In case of a temporary disturbance the ripple might return to its normal working range and indicates this with message M03.

- ❏ Check for proper degassing.
- ❏ Check for appropriate compressibility setting.

M04 / M05 : 1st piston leak

M04 HH:MM DDMMM 1st piston leak>
check seals or inlet valve

```
M05 HH:MM DDMMM 1st piston ok >
problem solved leak in range
```

If the online monitor function detects a leak in the first piston chamber the above message M4 appears. If the instrument returns to normal operation (problem solved by user) the message M5 indicates a good working instrument. The occurrence of M4 is a very good indicator when the seals should be changed.

- ❑ Check for leaks a fittings.
- ❑ Check for tight connection of the active inlet valve.
- ❑ Change seals.
- ❑ Change active inlet valve.

M06 / M07 : Valve backflow

```
M06 HH:MM DDMMM valve backflow>
check outlet valve
```

```
M07 HH:MM DDMMM valve tight >
problem solved no backflow
```

M06 indicates that the pump detected a backflow in the outlet valve which indicates that the valve has been closed but is not tight. M07 indicates that the problem was solved.

- ❑ Clean outlet valve.
- ❑ Change outlet ball valve.

M08 / M09 : Outlet Valve

```
M08 HH:MM DDMMM outlet valve >
clean outlet valve
```

```
M09 HH:MM DDMMM outlet valve ok>
problem solved outlet valve ok
```

M08 appears when the outlet ball valve shows a time delay before it blocks the flow path in the correct way. This is an indication that the valve sticks and need to be cleaned.

- ❑ Clean outlet ball valve.
- ❑ Change outlet ball valve.

M11 : Purging mode activated

```
M11 HH:MM DDMMM purging >
purge mode activated
```

This message shows when the instrument was purged the last time.

Troubleshooting Hints

This section gives practical hints in troubleshooting the pumps according to the pressure plots:

- Pressure Tests with different Solvents (water methanol)
- Pressure Tests when the Pump is broken

Standard Pressure Tests with different Solvents

The factory tests all the 1050 Pumps with isopropanol (IPA). Therefore the tests should be done with this solvent for comparison reasons. Sometimes isopropanol is not available at customer side. Following are pressure tests which are performed with water and methanol.

Modified Pressure Tests

The pressure profile looks very similar to the one with isopropanol. There are little steps when the piston change there direction. This is due to the compressibility compensation setting (default 100). It is important that the slope for both pistons are parallel to each other.

With methanol the pressure drop at 400 bar is larger than with isopropanol because of the lower viscosity.

Figure 10 **Modified Pressure Test with Water**

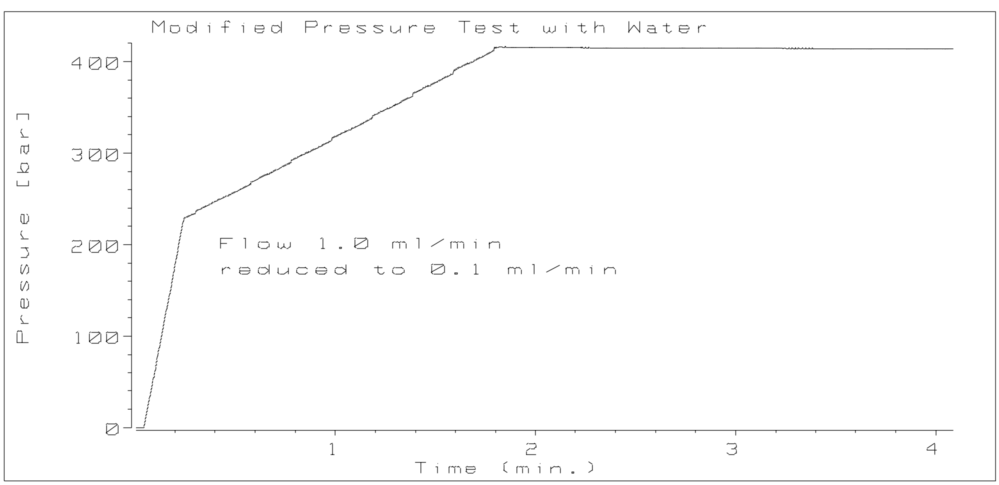
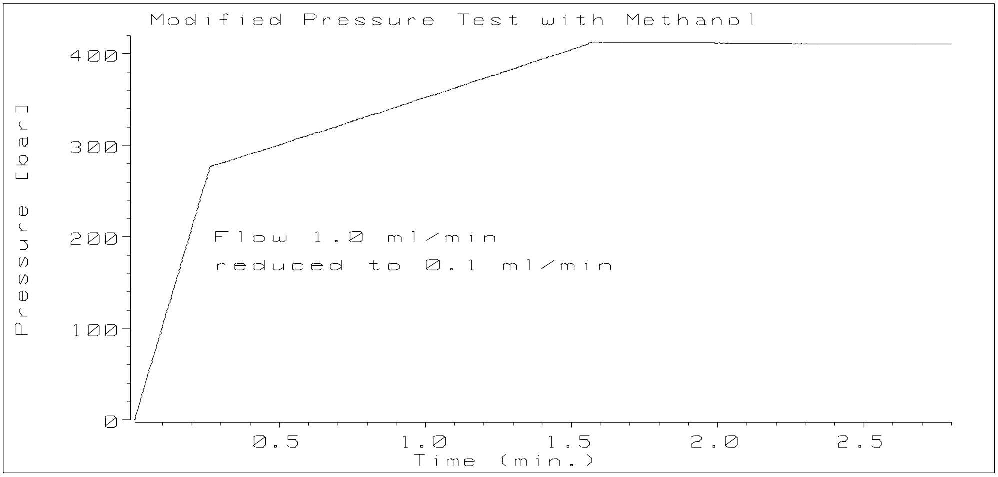


Figure 11 **Modified Pressure Test with Methanol**



With methanol the pressure drop at 400 bar is larger than with isopropanol because of the lower viscosity.

Pressure Tests - Firmware Revision 1.0

The results with water and methanol are similar than the one with isopropanol. The plateaus reach approximately the same height. Also the step 6 should be in the range 300 bar to 360 bar. The test with water shows that the step 6 exceeds already the upper pressure limit (400 bar). Reason is the lower compressibility of water compared to isopropanol.

Figure 12 **Pressure Test (Rev. 1.0) with Water**

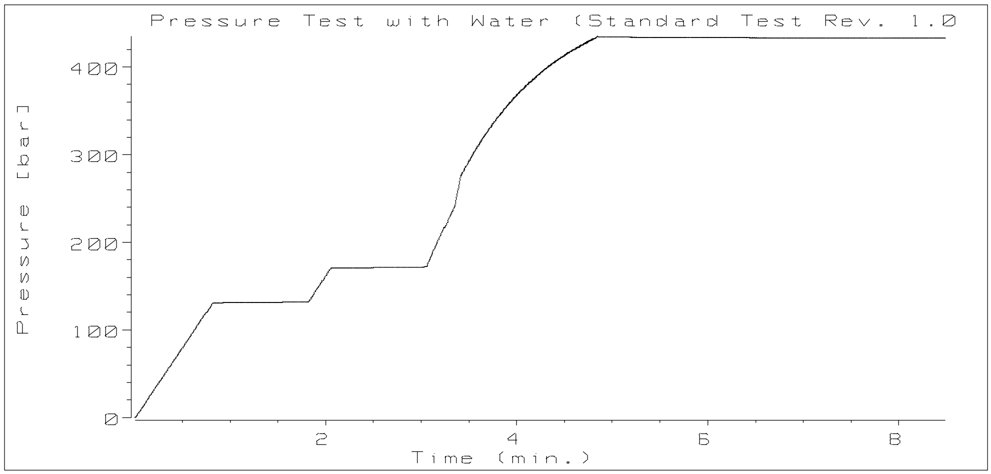
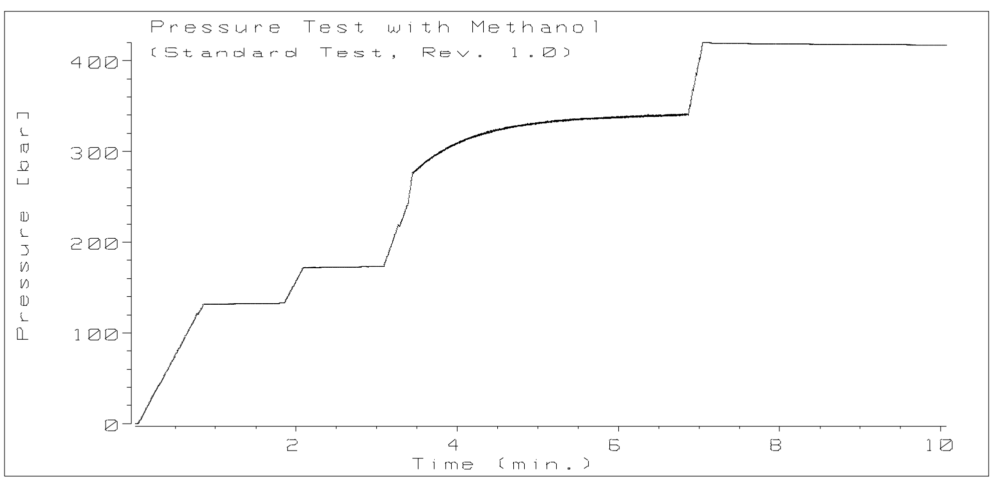


Figure 13 **Pressure Test (Rev. 1.0) with Methanol**



Pressure Tests - Firmware Revision 3.0 and above

Due to the pressure controlled test the results are very similar as the one with isopropanol. The pressure drop with methanol is slightly larger.

Figure 14 **Pressure Test (Rev. 3.0) with Water**

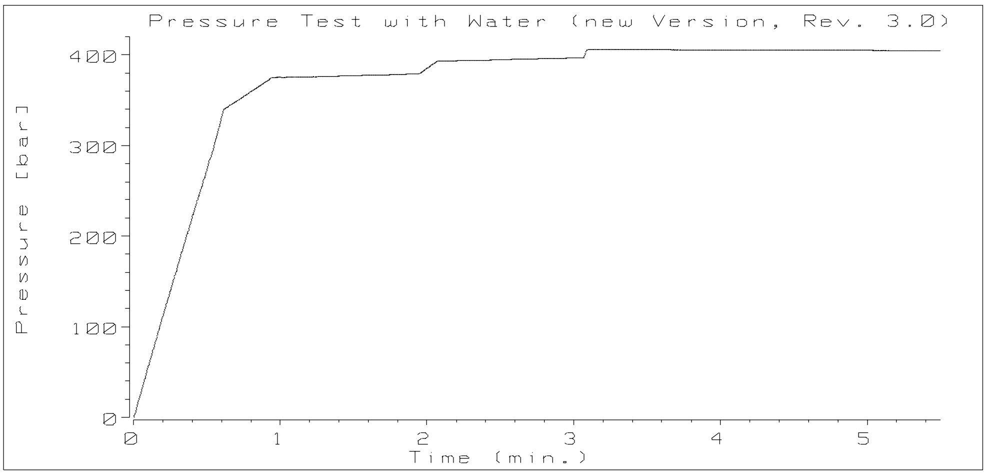
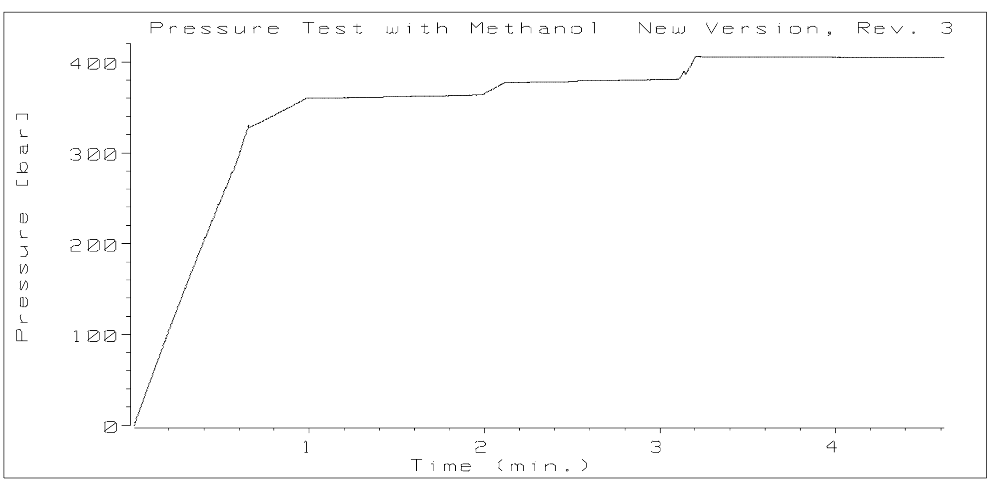


Figure 15 **Pressure Test (Rev. 3.0) with Methanol**



Pressure Tests when the Pump is broken

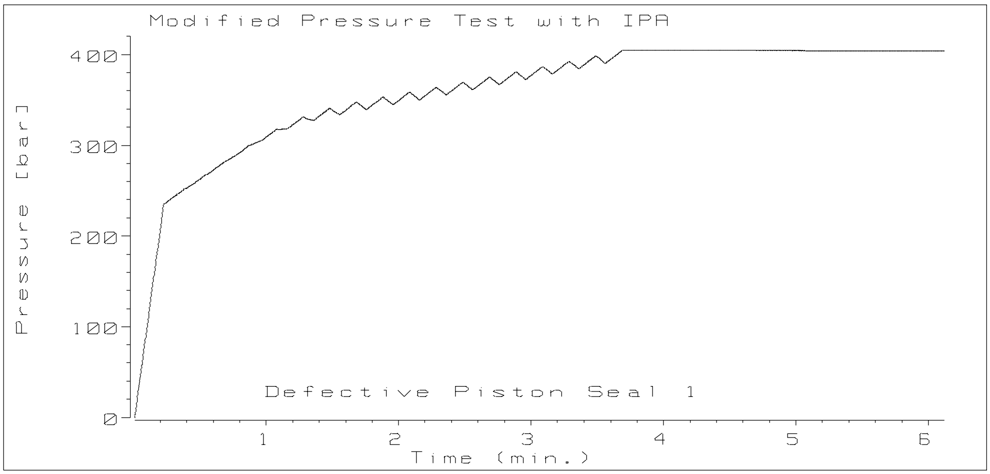
The pressure plots of the 1050 Pumps are a helpful tool for troubleshooting the pumping system. Online diagnostic messages and flow related error messages should be always verified by the previous described pressure plots.

This section shows examples of pressure plots for different in the factory generated failure modes. They should give indications how a possible failure looks like. The modified pressure test and the flow test method for firmware revision 1.0 and 3.0 are shown for the same failure symptom.

The modified test and the flow test method should be always used together to get a clear information about the problem of the pump.

Pressure Tests - Leak at Piston Seal 1

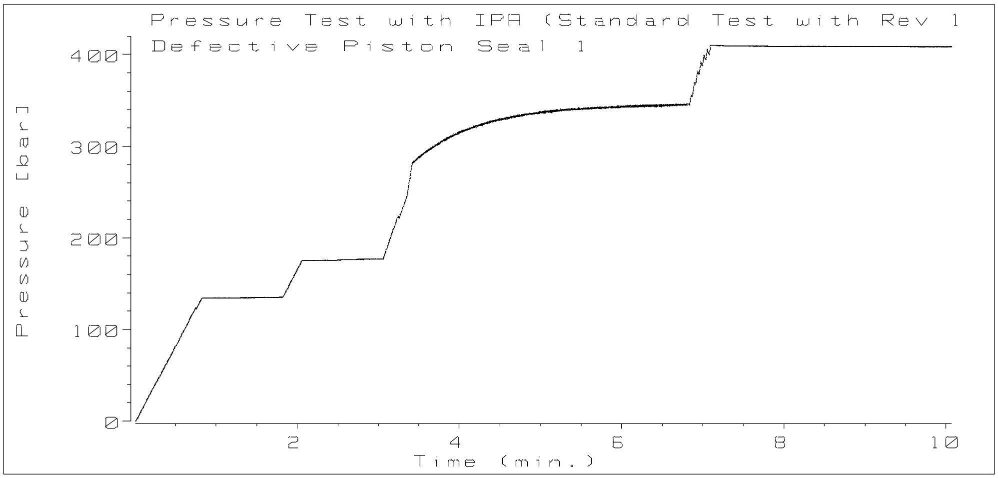
Figure 16 **Modified Pressure Test - Leak at Piston Seal 1**



The flow is reduced to 0.1 ml/min at approximately 240 bar. From this point both piston deliver with a constant value and increase the pressure to <nobreak|320 bar|. From this point the pressure moves up to 400 bar in an oscillating curve. This means that one of the two pistons has a leak rate when delivering into the system. At the upper pressure limit (400 bar) the pressure is stable. The outlet ball valve is closed in this position and indicates that the leak is probably on the first piston side. In this case it is a defective piston seal.

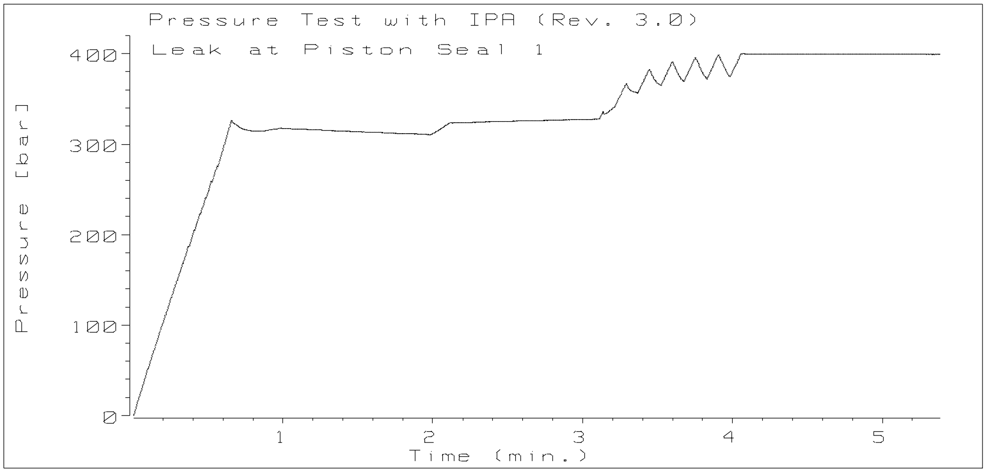
Firmware revision 3.0 allows to identify the leaky piston side via the current active piston display.

Figure 17 **Pressure Test (Rev. 1.0) - Leak at Piston Seal 1**



The flow test method shows a quite normal pressure profile. Only on the slope to reach the upper limit some pressure fluctuations can be seen. The modified pressure test showed that the seal leaked at more than 320 bar. Therefore the flow test method cannot detect this defective seal.

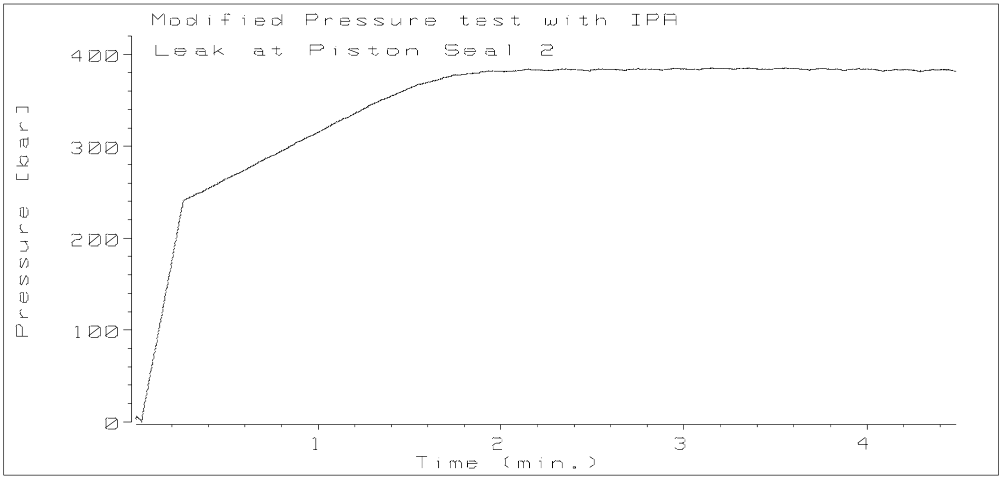
Figure 18 **Pressure Test (Rev. 3.0) - Leak at Piston Seal 1**



The flow test method reduces the flow to 100 µl at approximately 320 bar. The pressure drops and when the piston I delivers with its small flow rate a continuous pressure drop can be observed at the first plateau. The second plateau shows a slight pressure increase and the upper limit shows stable conditions. The pressure drop at the first plateau indicates a leak on the first piston side. In this case a leaky piston seal.

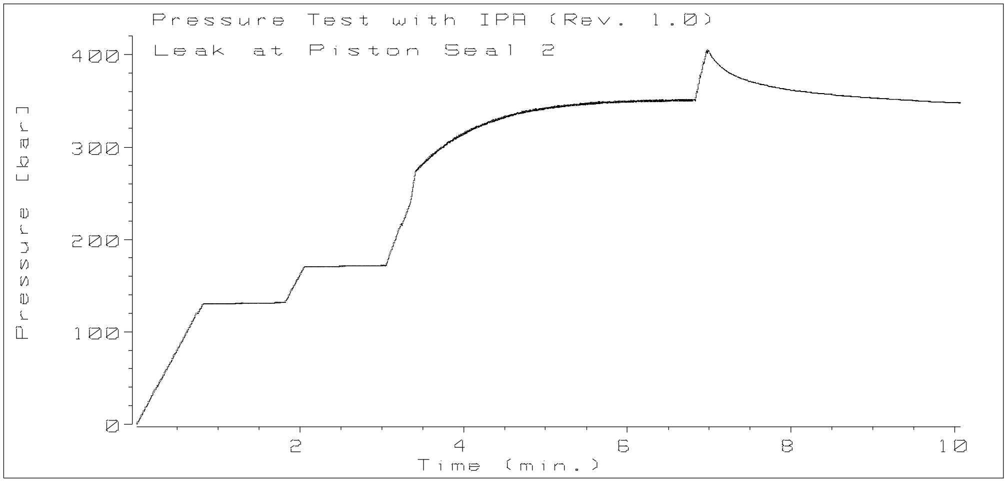
Pressure Tests - Leak at Piston Seal 2

Figure 19 **Modified Pressure Test - Leak at Piston Seal 2**



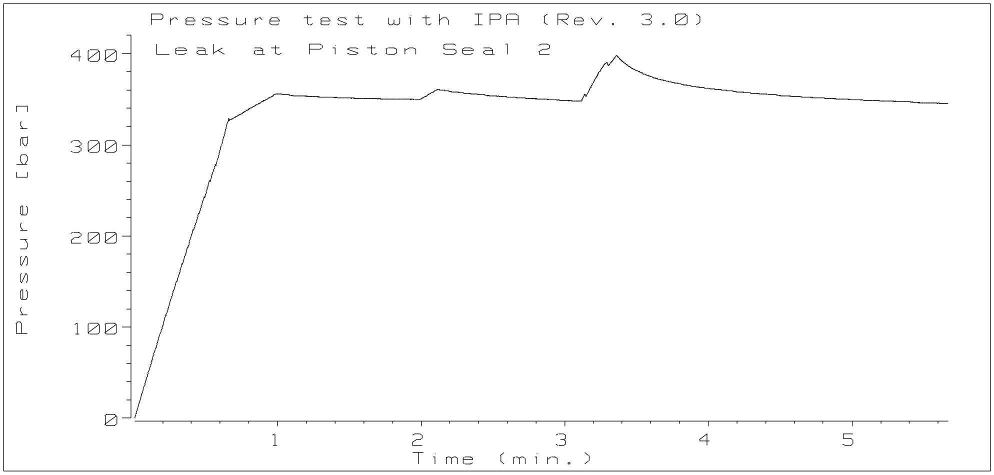
The flow is reduced to 0.1 ml/min at approximately 240 bar. From this point both piston deliver into the system with a constant rate. At 360 bar to <nobreak|370 bar| the curve is bent. With both pistons still delivering into the system the pressure cannot exceed more than 380 bar. The fact that both piston cannot increase the pressure above a certain value point to a leak on the second piston side. In this case a leaky piston seal.

Figure 20 **Pressure Test (Rev. 1.0) - Leak at Piston Seal 2**



The pressure profile shows a pressure drop at the upper limit. The modified test showed that the leak appears at more than 370 bar. Therefore the two plateaus cannot show the malfunction. At the upper limit the outlet ball valve is closed which indicates that the problem is on the second piston side. In this case the flow test method cannot clearly identify the leaky seal. The modified test is needed in addition.

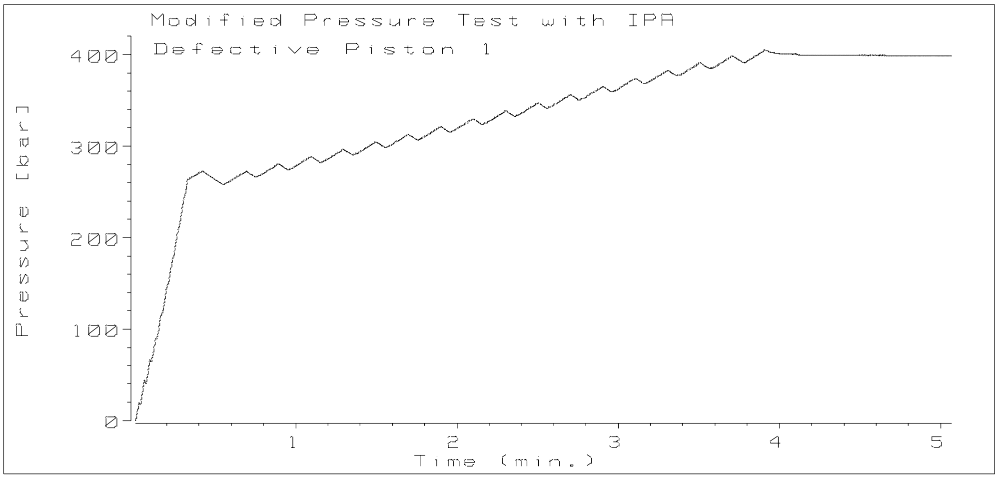
Figure 21 **Pressure Test (Rev. 3.0) - Leak at Piston Seal 2**



Both plateaus for piston 1 and piston 2 and the upper limit of the test show a certain pressure drop. Here it is very obvious that the problem is on the second piston side. In this case it is the second piston seal.

Pressure Tests - Defective Piston 1

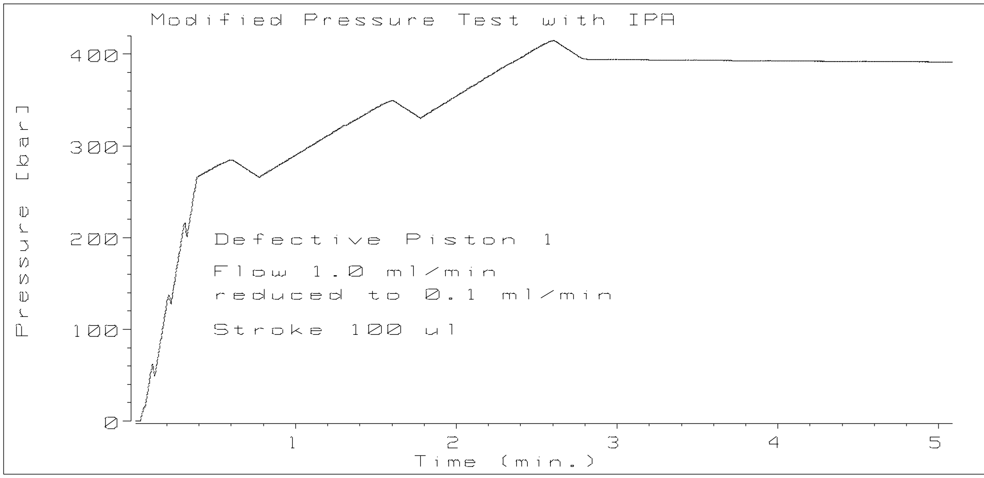
Figure 22 **Modified Pressure Test - Defective Piston 1 (Stroke AUTO)**



The pump is working with the default stroke (AUTO) setting. The flow is reduced to 0.1 ml/min at approximately 260 bar. The pressure moves up to the upper pressure limit in a oscillating curve. At the upper limit the pressure remains stable. One of the two pistons generates a small leak when delivering (pressure drop). The stable pressure line at 400 bar points to a problem on the first piston side. Firmware revision 3.0 allows to verify that the pressure drop appears on piston 1.

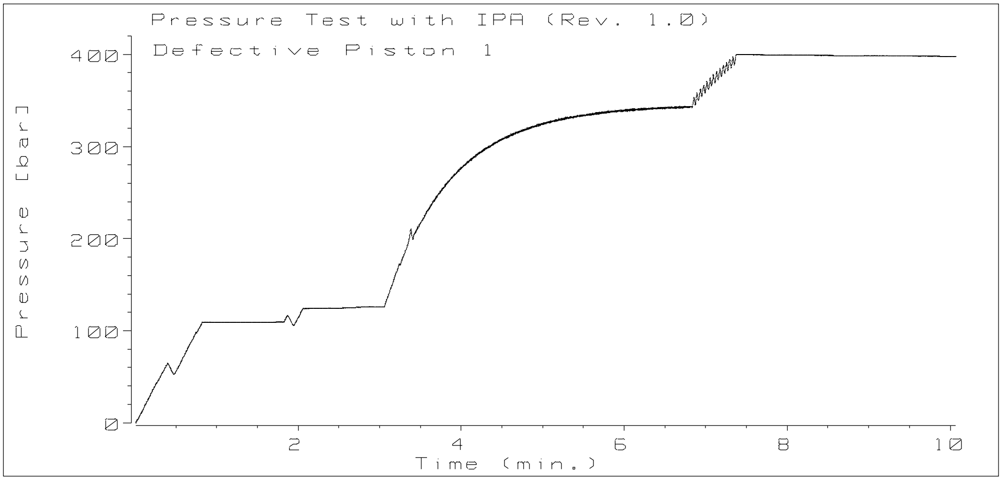
NOTE When the piston is scratched in a certain part the failure cannot be always detected when using the default stroke setting. Therefore the test should be done also with a stroke of 100 µl.

Figure 23 **Modified Pressure Test - Defective Piston 1 (Stroke 100 µl)**



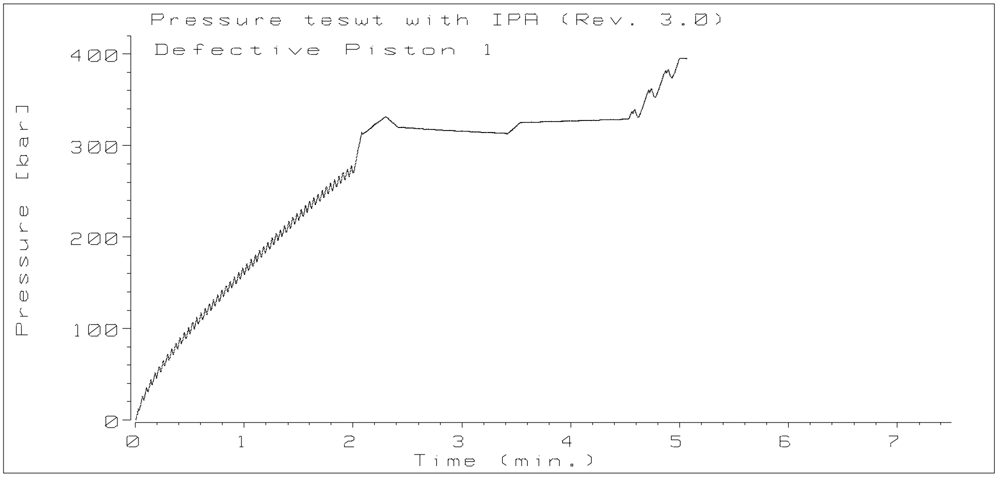
Here the pressure test has been done with a stroke of 100 µl. The pressure profile gives additional information to the previous plot. When delivering with the small flow rate the pressure increases for a long time but drops only for a relatively short time. With the currently active display of firmware revision 3.0 it can be seen that the pressure drops while the first piston is in the middle of its stroke. This indicates that the piston itself is the source of the problem. The test checks the pressure tightness of the seal over the full length of the piston.

Figure 24 **Pressure Test (Rev. 1.0) - Defective Piston Seal 1**



Before the pressure reaches the two plateaus there is always a pressure dip when the piston change there direction. Before the pressure reaches the upper limit an oscillating curve can be seen. At the upper limit the pressure is stable. All this indicates that the pump is not working correctly but it is very difficult to locate the source of the problem.

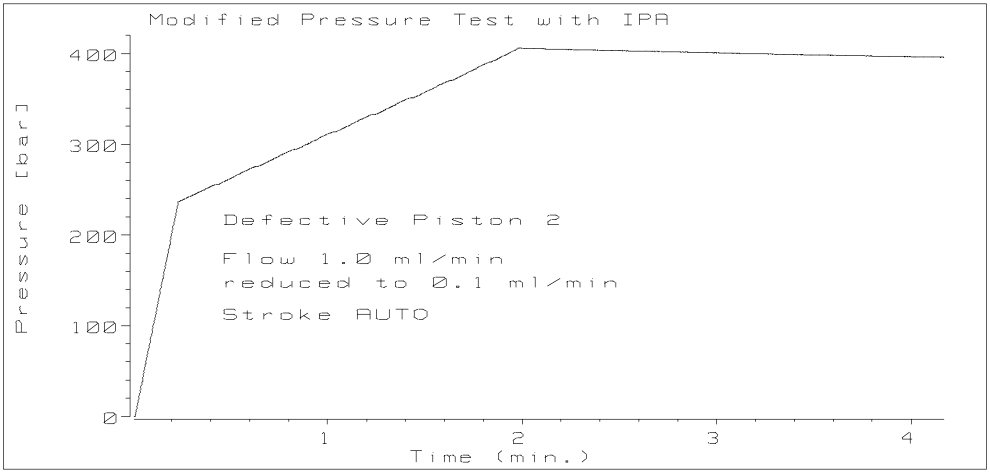
Figure 25 **Pressure Test (Rev. 3.0) - Defective Piston 1**



The pressure increases in an oscillating curve. When exceeding 270 bar piston 2 delivers with one large stroke into the system and increases the pressure by more than 40 bar. This points already to a problem on the first piston side. Now piston 1 delivers into the system increases the pressure for a short time and then the pressure decreases for the whole plateau. The second plateau looks quite normal and also the upper value when reached after some pressure dips is stable. It is quite obvious that the problem is on the first piston side. In this case the piston is defective.

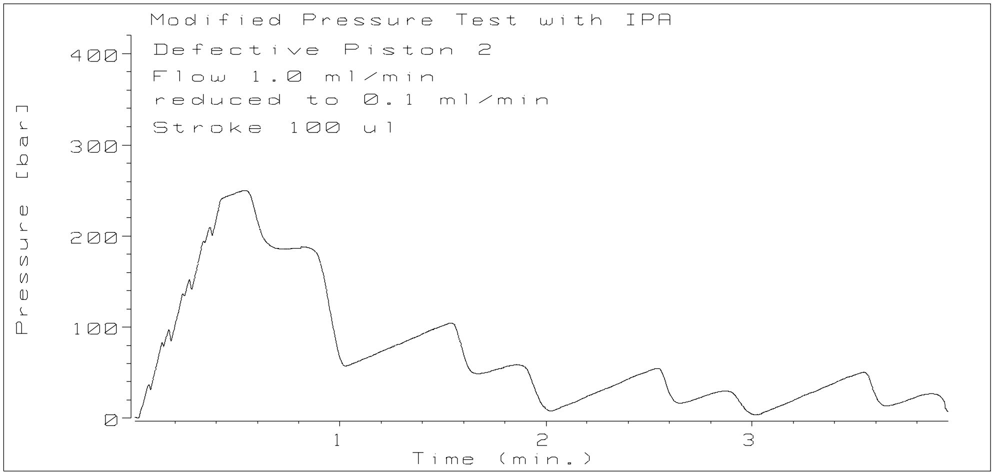
Pressure Tests - Defective Piston 2

Figure 26 **Modified Pressure Test (Stroke AUTO) - Defective Piston 2**



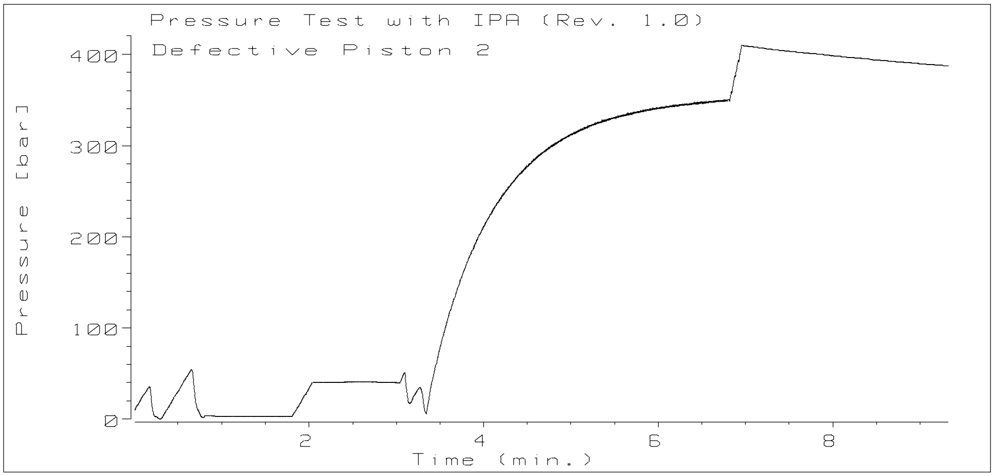
Even with the reduced flow of 0.1 ml/min the pistons deliver with constant rate into the system. After reaching the upper pressure value a continuous pressure drop occurs. This indicates a problem. Therefore the test was repeated with a stroke of 100 µl.

Figure 27 **Modified Pressure Test (Stroke 100 µl) - Defective Piston 2**



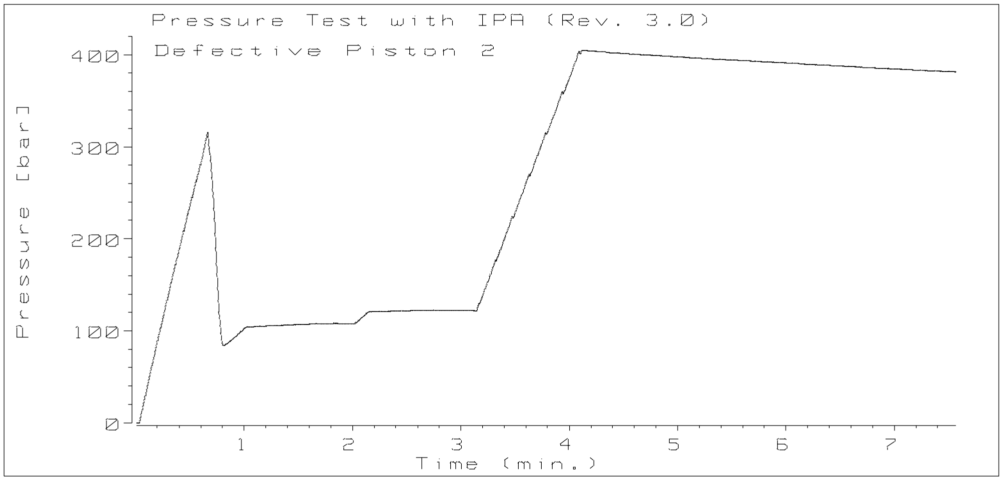
This pressure profile shows a totally different behavior then the previous one. There are already pressure drops when the flow is 1.0 ml/min and the piston change there directions. When the flow is reduced to 0.1 ml/min the pressure drops with each stroke of the pistons until it is zero. With firmware revision 3.0 it can be checked that the pressure drops appear on both pistons but that the slight pressure increase is generated by piston 1. The piston is scratched in its lower part. Delivering with a small stroke volume into the system generates no problem. With the maximum flow rate of 100 µl the scratched part has to move through the seal and is obviously leaking.

Figure 28 **Pressure Test (Rev. 1.0) - Defective Piston 2**



The both pressure plateaus cannot be reached but when switching to the part where the instrument uses a stroke volume of 4 µl the pressure increases up to its normal value. At the upper limit a slight leak rate is visible. The scratches in the lower part of the piston are not visible when the pump is working with its small stroke volume.

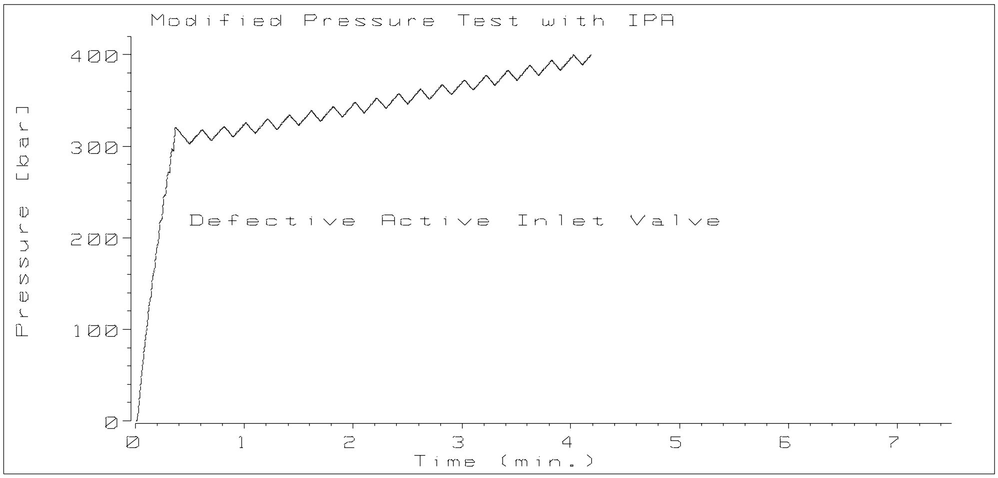
Figure 29 **Pressure Test (Rev. 3.0) - Defective Piston 2**



The pressure profile looks very strange. In the first part the pressure increases up to approximately 320 bar and than it drops down to about 100 bar with normal behavior of the two plateaus and afterwards an increase of the pressure to 400 bar with a slight pressure decrease at the upper limit. Before reaching the first plateau the second piston performs one large (80 µl) stroke. At this point the pressure drops. When the piston is moving only with the upper part through the seal no leak can be seen. But when the scratched part of the piston moves through the seal the system is no longer tight and the pressure drops. At the low pressure value the system is still tight and therefore the plateaus show no problem. The pump then reaches the upper limit with 250 µl and a stroke volume of 20 µl. Here the piston uses again only the unscratched part of the piston.

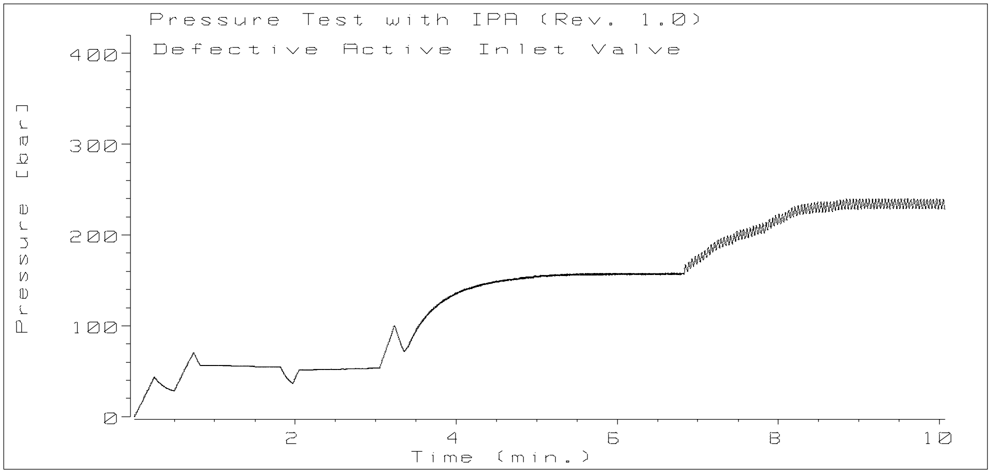
Pressure Tests - Defective Active Inlet Valve

Figure 30 **Modified Pressure Test - Defective Active Inlet Valve**



With the reduced flow rate of 0.1 ml/min the pressure increases slowly in an oscillating curve until the upper limit is reached. At the upper limit the pressure is stable pointing onto a problem on the first piston side. The actively current piston display of firmware revision 3.0 shows that the pressure drop is on the first piston side.

Figure 31 **Pressure Test (Rev. 1.0) - Defective Active Inlet Valve**

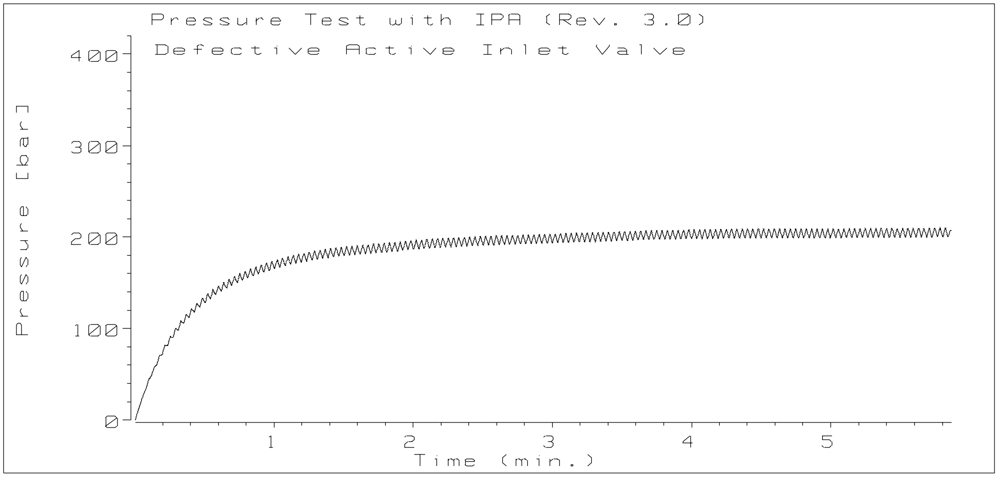


The test fails completely. The pressure in the system cannot be increased to reach the plateaus at a pressure of more than 100 bar. Also the rest of the test does not reach useful pressure values. Therefore the test provides no information about the problem in the system.

NOTE

In such a case the pump can be troubleshooted in the following way. Move the solvent inlet tubing out of the bottle and let the pump draw a large air bubble (for example 5 cm in the tubing). In a normal working pump the bubble will move during the intake stroke of piston 1 and will stop when the first piston is delivering into the system. If the active inlet valve is internally leaky the air bubble will move forwards during the intake stroke and the whole time backwards when the piston is delivering into the system.

Figure 32 **Pressure Test (Rev. 3.0) - Defective Active Inlet Valve**



Also the new version of the test fails. The pressure in the system cannot be increased to the two plateaus (>270 bar). The pressure in the system stabilizes below that value. The pump can be troubleshooted as described before.

1

Pumps: Maintenance Information

This chapter provides provide procedures for service and maintenance of the 1050 Pumps

Pumps: Maintenance Information

This section provides information on the procedures used for maintenance replacement and alignment of assemblies in the pump. You will find procedures for:

- Solvent Cabinet and Column Heater
    - ❑ Heat Exchanger
    - ❑ Solvent Cabinet Cable Assembly
- Pump Mainframe
    - ❑ Active Inlet Valve
    - ❑ Outlet Ball Valve
    - ❑ Frit Adapter Assembly
    - ❑ Purge Valve
    - ❑ Pump Head Assembly
    - ❑ Continuous Seal Wash
    - ❑ Fan
    - ❑ Metering Drive Assembly

Solvent Cabinet and Column Heater

Replacing the Heat Exchanger

- ❏ Open column heater door and disconnect all capillaries from the heat exchanger.
- ❏ Using a flat screw driver loosen the solvent cabinet screws.
- ❏ Carefully take out the front panel with helium valves and manual injection valve and place on top of the solvent module.
- ❏ Move the insulation out of its position and take it out.
- ❏ Take out the plastic heat shield.
- ❏ Disconnect the heater flex cable from the zero insertion force connector on the cable board.

NOTE Pull the outer sleeve of the connector to its front position. This releases the tension from the cable and it can be removed from the connector without problem.

- ❏ The heat exchanger holding screws are accessible from underneath the solvent module. Therefore move the module above the table and remove the two screws with the washers.
- ❏ Take the heat exchanger out of the column heater compartment.
- ❏ Place the new heat exchanger assembly into the column heater compartment. Place the washers onto the screws and fix the heat exchanger assembly in its position.
- ❏ Insert the flex cable into the zero insertion force connector and push the sleeve back to fix the cable in its position.
- ❏ Insert the heat shield into the compartment.
- ❏ Place the insulation into the heat shield and carefully press it into its position. Make sure that the parts are inserted underneath the plastic ledge at the back panel of the compartment.

- ❏ Slide the front base back into its guiding slits. Assure that the front edge of the plastic heat shield is guided into the gap between the front panel and the connected metal panel.
- ❏ Tighten the two solvent cabinet screws.
- ❏ Reinstall all capillaries at the column heater assembly.

Replacing the Cable Assembly

- ❏ Follow the above mentioned steps for replacing the heat exchanger assembly.
- ❏ Remove bottle tub and solvent bottles from the cabinet.
- ❏ Remove the front base by pushing the plastic knobs from underneath the solvent cabinet and slide it out of the instrument.
- ❏ Put the solvent cabinet onto the side loosen the cable holding screw at the back of the module and slide the cable out of the position.
- ❏ Loosen the screw which fixes the cable connector board in its position and slide the board out of the recess.
- ❏ Remove the tape which fixes the multi color LED.
- ❏ Put the solvent cabinet onto the side and move the cable assembly through the holes in the back panels to get it out of the solvent cabinet.
- ❏ Place the new cable assembly into the solvent cabinet that the board is located in the column heater compartment.
- ❏ Slide the board into its recess place the end of the cable insulation under the washer and tighten the holding screw.

NOTE Do not clamp the single wires of the cable.

- ❏ Fix the multi color LED with a piece of tape in the groove.
- ❏ Reinsert the base plate and fix it with the two plastic knobs. Make sure that the LED is positioned correctly and that the cables are not clamped.

NOTE The rear end of the front base must fit into the recess at the back panel of the compartment.

- ❏ Reinstall the heat exchanger assembly by following steps described in section replacing the heat exchanger assembly.

Replacing the Active Inlet Valve

❑ Remove the ESD cover.

❑ Disconnect the solenoid cable from the connector board.

❑ Loosen the screw which holds the shield cable and unplug the spade lug.

❑ Disconnect the active inlet valve inlet tubing.

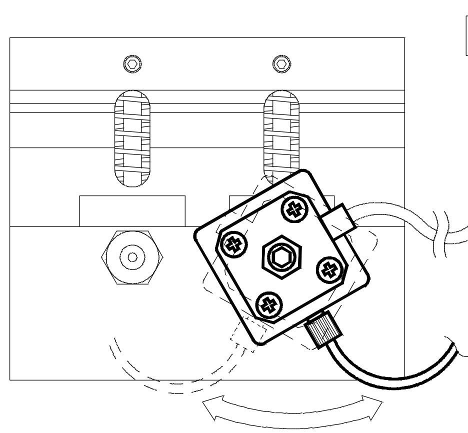
❑ Using the supplied 12 mm wrench (8710-1841) loosen the valve and remove it.

NOTE It is recommended to insert a new gold seal into the plastic cap when changing the active inlet valve.

❑ Place new inlet seal into the plastic cap and fix it onto the valve.

❑ Insert the active valve and screw it hand tight. In this position counter hold the screw with the wrench. By hand turn the solenoid itself in either direction until the capillary connection hole is about 60° to 90° away from its final position.

Figure 1 **Valve Final Position (Pump head disassembled)**



- ❑ Using the 12 mm wrench tighten the screw of the valve by turning the assembly in its final position (should not be more than a quarter turn). Make sure that the ESD cover and the solvent sucking tube can be installed with the valve in its position.
- ❑ Fix the spade lug of the shield cable in its position and reconnect the solenoid cable to the connector board.

NOTE If the active inlet valve is installed in an instrument without connection for the shield connector connect the spade lug to the holding screw of the connector board.

- ❑ Connect the valve inlet tube to the active inlet valve.
- ❑ Install the ESD cover
- ❑ Perform the pressure tests to verify tightness of the system.

Replacing the Outlet Ball Valve

❑ Using the 14 mm wrench (8710-1924) loosen the valve screw and remove it.

NOTE It is recommended to insert a new gold seal into the seal cap when the same valve will be used again.

❑ Before inserting a new valve check for correct center position of the cap with the gold seal.

❑ Insert the valve into the pump head and screw it hand tight. Fix the valve by turning another quarter turn with the 14 mm wrench.

NOTE The plastic cover should always be installed. This prevents loosing the holding screw when disassembled and does not allow to damage the outlet ball valve by tightening at the cartridge itself.

❑ Perform the pressure tests to verify the tightness of the system.

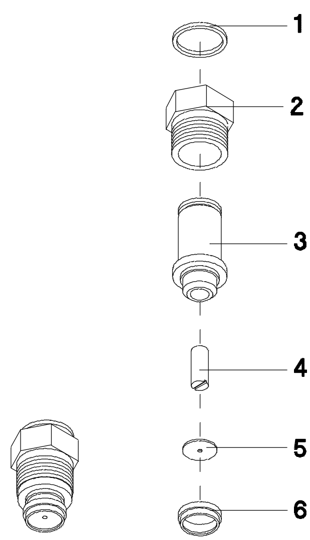
Maintaining the Frit Adapter Assembly

- ❑ Using the 14 mm wrench (8710-1924) loosen the frit adapter assembly and remove it.
- ❑ Remove the cap (6) with the gold seal (5) and take out the dirty frit (4).
- ❑ Clean the adapter chamber from all particles. Best is to use a degreaser spray.
- ❑ Insert the new frit into the adapter. Ensure that the slit of the frit is facing downwards, otherwise the filter capacity is reduced.
- ❑ Place cap and gold seal onto adapter.

NOTE It is recommended to use always a new gold seal when the frit adapter assembly was removed from the pump head.

- ❑ Insert the frit adapter assembly into the pump head and screw it hand tight. Fix the assembly by turning another quarter turn with the 14 mm wrench.
- ❑ Perform the pressure tests to verify the tightness of the pump.

Figure 2 **Frit Adapter Assembly**



Maintaining the Purge Valve

Changing the PTFE Frit

- ❏ Disconnect capillary to injector and waste tube from purge valve outlet.
- ❏ Using the 14 mm wrench open the purge valve at the hexagonal nut.
- ❏ For the next steps refer to “Maintaining the Frit Adapter Assembly” on page 210.

Cleaning the Purge Valve

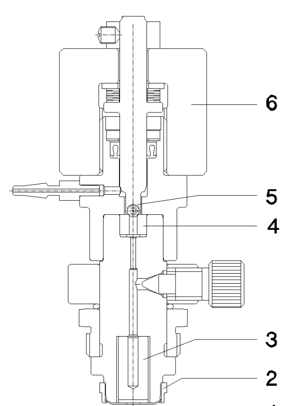
NOTE Leaks in the purge valve can be due to particles (for example salt precipitation) between seat and ball. Therefore the cleaning procedure should be performed before replacing the whole valve.

- ❏ Remove the purge valve from the pump head as described before.
- ❏ Open the purge valve counter clockwise until the had screw (6) is loose.

NOTE Do not open the securing ring on top of the hand screw and do not change the seat.

- ❏ Clean the upper and lower part in a ultrasonic bath using methanol or isopropanol.
- ❏ Re-assemble the purge valve parts and re-install purge valve.

Figure 3 **Purge Valve**



Maintaining the Pump Head Assembly

There are two different versions of the pump head available. In the latest version the spring is integrated in the plunger housing. The following table shows the serial number prefix at introduction of the new plunger housing design.

Table 1 **Pump Head Versions**

Pump	SN Prefix	Procedure
79851A	3447 G	2
79852A/B	3447 G	2
79851A	3448 A	2
79852A/B	3448 A	2

Procedure 1: Pump Head with old Plunger Housing

NOTE The pump head has two identical channels. When disassembling the pump head it is advisable not to interchange the parts of each channel for better failure identification.

NOTE Since introduction of the new plunger housing design the old plunger housing parts are no longer available. The new parts are fully compatible to all existing pump heads.

Stage 1: Removing the Pump Head Assembly

❏ Disconnect all four capillaries from the pump head assembly.

❏ Remove the ESD cover and disconnect the cable of the active inlet valve.

❏ Remove the two pump head screws and take out the pump head assembly.

Stage 2: Disassembling the Pump Head assembly

❏ Place the assembly on the head and remove the three holding screws.

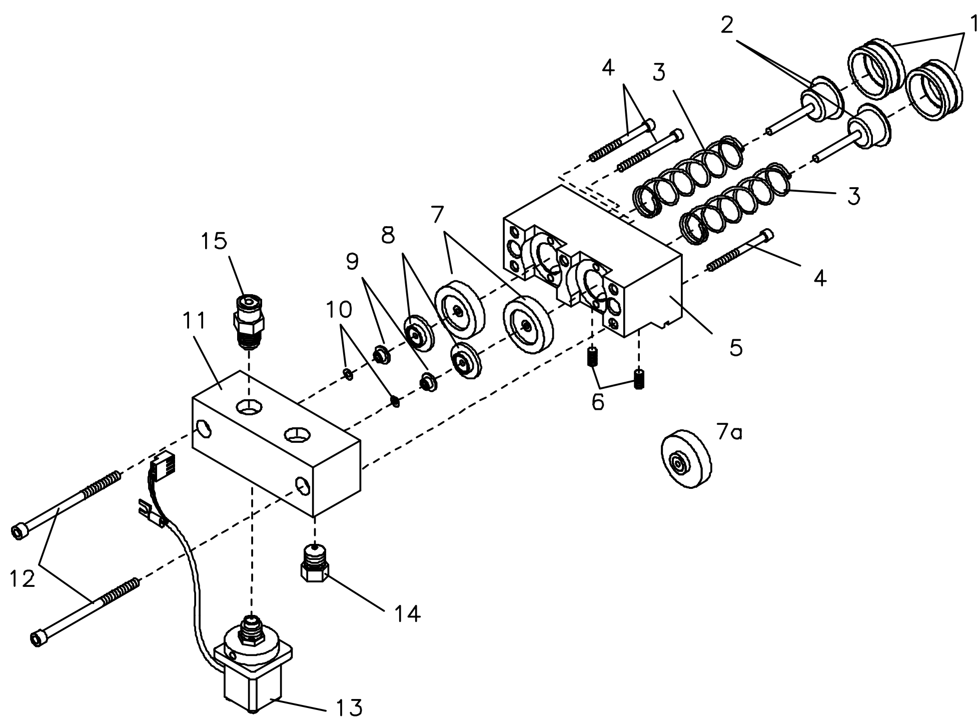
❏ Carefully separate the head from the plunger housing.

CAUTION Do not twist the parts while separating. This could break the sapphire plunger.

Stage 3: Replacing the Seals

- ❑ Remove the two seal keeper (8) or the support seal assembly (7a).
- ❑ Using the three millimeter hexagonal key remove the two seals (9).
- ❑ Remove the two wear retainer (10).
- ❑ Clean the pump head chamber from all seal particles. Best is to use a degreaser spray.
- ❑ Place new wear retainer (10) into the pump chambers.
- ❑ Insert new seals (9).
- ❑ Place the two seal keeper (8) onto the seal. The support seal assembly will be installed onto the plunger housing.

Figure 4 **Pump Head Assembly**

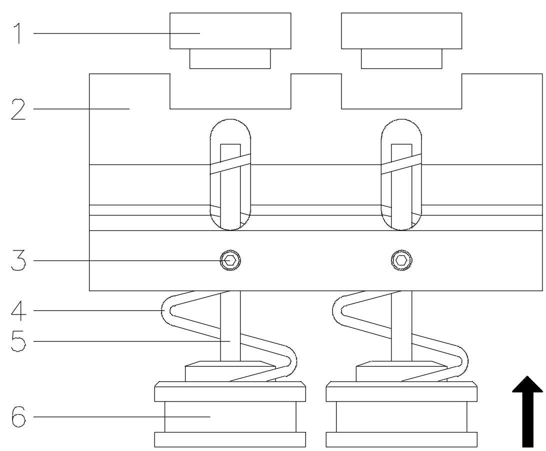


Stage 4: Disassembling the Plunger Housing

WARNING **The very strong spring will catapult the adapter up when released without holding it down.**

- ❏ Remove the two support rings (1) or the support seal assembly.
- ❏ Hold the adapter (2) down on a table and loosen the setscrew (3) of one of the plungers (5). Carefully release the tension of the spring.
- ❏ Proceed with the second plunger in the same way.

Figure 5 **Plunger Housing**



Stage 5: Reassembling the Plunger Housing

❏ Place the plunger keeper (6) on a table and insert plunger (5) and spring (4).

❏ Take the plunger housing (2) and place it on top of the spring (4).

NOTE Make sure that the spring (4) does not stick before the top of the housing (2).

❏ Press the housing (2) down over the plunger keeper (6) and when flat on the table tighten the setscrew (3).

NOTE The plunger keeper (6) should not stick out of the bottom of the plunger housing (2).

❏ Proceed in the same way for the second plunger.

❏ Slide the two support rings or the support seal assembly onto the plungers but do not try to press it in its position.

NOTE If the support ring or the support seal assembly (1) sticks at the housing (2) carefully push the plunger from the bottom. This will center the plunger and the support ring slides into its final position.

Check the alignment by lifting the support ring out of its position. Release the support ring and check that it slides back in its position without sticking.

The support seal assembly should be installed onto the plungers as described before.

Stage 6: Reassembling the Pump Head Assembly

See Figure 81 on page 214.

❑ Prepare the head and the plunger housing as described beforehand.

NOTE The seal keeper (8) should be installed on the head in front of the seals. In this position they guide the plunger into the seal and reduce the possibility of breaking the plunger during the assembling of head and plunger housing.

❑ Mount the plunger housing onto the head. The guiding pins prevent incorrect mounting.

❑ Grease the three screws with the white Teflon lubricant (79841-65501).

❑ Insert the three screws and tighten them stepwise with increased torque. Observe the slit between the two parts and make sure that they are in parallel to each other.

Stage 7: Mounting the Pump Head Assembly

❑ Place the pump head assembly onto the two stay bolts of the metering drive. Make sure that no capillary sticks between pump head and metering drive.

❑ Put a light coating of white Teflon grease onto the mounting screws.

❑ Insert the two screws and tighten them crosswise.

❑ Reinstall the capillaries to the valves and the connector screw.

❑ Reconnect the active inlet valve connector and fix the shield to ground.

Procedure 2: Pump Head with new Plunger Housing

NOTE The pump head has two identical channels. When disassembling the pump head it is advisable not to interchange the parts of each channel for better failure identification.

Stage 1: Removing the Pump Head Assembly

- ❑ Disconnect all four capillaries from the pump head assembly.
- ❑ Remove the ESD cover and disconnect the cable of the active inlet valve.
- ❑ Remove the two pump head screws and take out the pump head assembly.

Stage 2: Disassembling the Pump Head Assembly

- ❑ Place the assembly on the head and remove the three holding screws.
- ❑ Pull the block straight up from the head being careful not to put any sidewards strain on the sapphire pistons since they could shear and break.
- ❑ Put the plunger housing aside taking care to avoid dropping the pistons from the plunger housing.

NOTE The pistons are not secured in the plunger housing and will fall out when the housing is turned upside down.

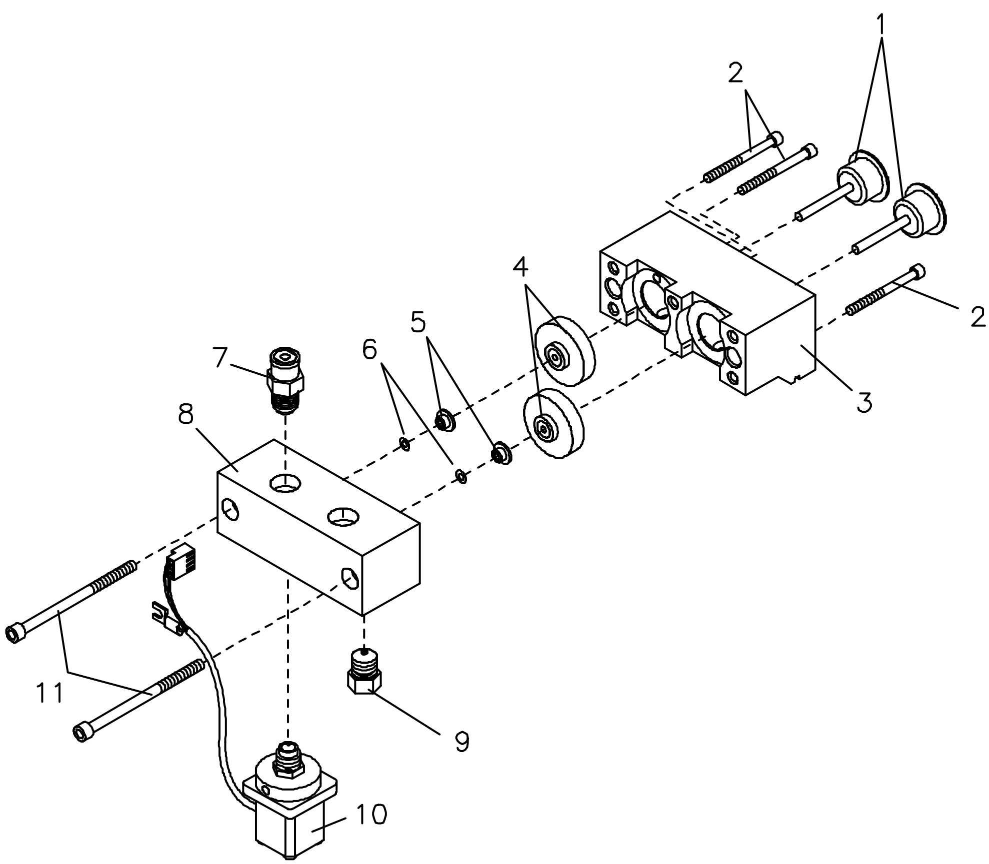
- ❑ Remove the pistons from the plunger housing.
- ❑ Check for scratches and dirt on the piston.

NOTE Dirt can be removed by using a small quantity of tooth paste.

Stage 3: Replacing the Seals

- ❑ Remove the two support seal assemblies.
- ❑ Using the three millimeter hexagonal key remove the two seals.
- ❑ Remove the two wear retainer.
- ❑ Clean the pump head chamber from all seal particles. Best is to use a degreaser spray.
- ❑ Place new wear retainer into the pump chambers.
- ❑ Insert new seals.
- ❑ Place the two support seal assemblies onto the seal.

Figure 6 **Pump Head Assembly (new plunger housing design)**



Stage 4: Reassembling the Pump Head Assembly

- ❑ Prepare the head as described beforehand.
- ❑ Place the plunger housing without the pistons onto the head.
- ❑ Tighten the three socket head screws hand tight.

NOTE Tightening the screws fully will require much more force to insert the pistons into its position in the seals.

- ❑ Insert the pistons into the assembly and carefully push it into the seal.
- ❑ Tighten the three screws stepwise with increasing torque. Make sure that the head and plunger housing surfaces are in parallel.

Stage 5: Mounting the Pump Head Assembly

- ❑ Place the pump head assembly onto the two stay bolts of the metering drive. Make sure that no capillary sticks between pump head and metering drive.
- ❑ Put a light coating of white Teflon grease onto the mounting screws.
- ❑ Insert the two screws and tighten them crosswise.
- ❑ Reinstall the capillaries to the valves and the connector screw.
- ❑ Reconnect the active inlet valve connector and fix the shield to ground.

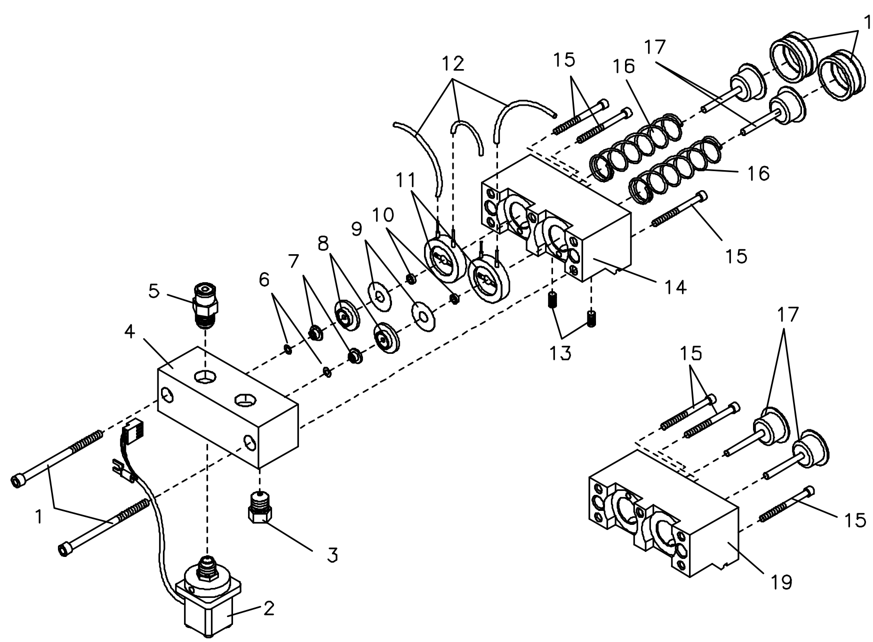
Continuous Seal Wash Option

NOTE

The previous described procedures for the pump heads are also applicable for the seal wash option. This procedure will only describe the secondary seal replacement.

- ❏ Remove the pump head assembly and disassemble it following stage 1 and stage 2.
- ❏ Remove the two support rings from the plunger housing.
- ❏ Remove the gasket from the support ring.
- ❏ Using the tool from the upgrade kit (01018-23702) remove the wash seal.
- ❏ Place the new seal onto the tool and insert the new wash seal into the support ring. Ensure that the wash seal clicks into place in the support ring.

Figure 7 **Pump Head with continuous seal wash**



Replacing the Fan

- ❏ Remove the top cover.
- ❏ Disconnect the fan cable at the motherboard.
- ❏ Lift the foam part at the left side of the module and slide it out to the front.
- ❏ Carefully remove the fan from the foam part (one edge after the other).

NOTE In case it is not possible to get the fan out of the foam cut the foam part at the back side between the two naps.

- ❏ With the blade of a screwdriver separate the protection cover from the fan.
- ❏ Insert the new fan into the foam part. The air stream should be into the module (arrow pointing down). Cable should show to the back.
- ❏ Place the fan protection cover onto the new fan.
- ❏ Place the foam part into its place.

NOTE The foam part must be inserted into the chassis and must be replaced close to the back panel. Make sure that the upper foam part fits behind the ridge of the bottom part. It might be more convenient to replace the foam part when the motor plug is disconnected.

Removing the Metering Drive Assembly

- ❑ Remove the pump head assembly.
- ❑ Remove the top cover.
- ❑ Remove the foam part with the fan.
- ❑ Disconnect the three cable of the metering drive.
- ❑ Unscrew the three holding screws of the base of the metering drive.

NOTE The third screw is accessible through the bottom foam part.

- ❑ Move the motor of the metering drive out of the foam part and take it out.

Pumps: Parts Information

This chapter provides information on parts of the 1050 Pumps

Pumps: Parts Information

This chapter gives complete parts listings and exploded views for the HP 1050 (Ti) Pumps.

- Electronic Boards
- All Ti - Parts
- Solvent Cabinet
- Overall Diagram
- Flow Path
- Metering Drive Assembly
- Pump Head Assemblies
- Active Inlet Valve
- Outlet Ball Valve
- Frit Adapter Assembly
- Purge Valve Assembly
- Special Tools

Electronic Boards

For fuses refer to Table 47 on page 228.

Table 1 **Electronic Boards**

Item	Description		Part Number	Exchange PN
1	Power Supply Board	DPS-B	5061-3374	01050-69374
2	Pump Drive Control 2 Board	PDC^2	01018-66532	
#	U 78 MC78L15ACP		1826-0274	
#	U 79 MC79L15ACP		1826-0281	
3	Relative A/D Converter	RAD	01018-66503	01018-69503
4	Firmware Board	SFW	01018-66506	
5	Heater Isocratic Board	HRI	01018-66517	
6	Heater Quaternary Board	HRQ	01018-66518	01018-69518
7	Communication Interface Board	CIB	5061-3382	01050-69582
8	Common Main Processor Board	CMP	5061-3380	01050-69580
9	Fluorescent Indicator Module	FIP	5061-3376	
10	Connector Board	CON	01018-66505	
11	Motherboard	HPS	01018-66501	

U 78 and U 79 have to be replaced when a new metering device 01018-60001/-69100 (parts included) is installed in a pump with PDC board revision A.

Table 2 **Fuses**

Description	Board	Part Number
Fuse 110V operation (3 A)	DPS-B	2110-0003
Fuse 220V operation (2 A)	DPS-B	2110-0002
Fuse F16 (PDC); F481 (PDC^2) 1.5 A	PDC^2	2110-0304
Fuse F891, F892 on board 500 mA	PDC	2110-0934
Fuse F112, F113 on board 500 mA	PDC^2	2110-0934
Fuse F12, F22 250 mA	RAD	2110-0004
Fuse F4 2.5 A	HRI, HRQ	2110-0083
Fuse F15 1 A	HRQ	2110-0007
Fuse ICP1 1 A	FIP	2110-0099
Fuse F1 375 mA	CON	2110-0421

Complete List of Ti-Parts

Table 3 **Complete List of Ti-Parts**

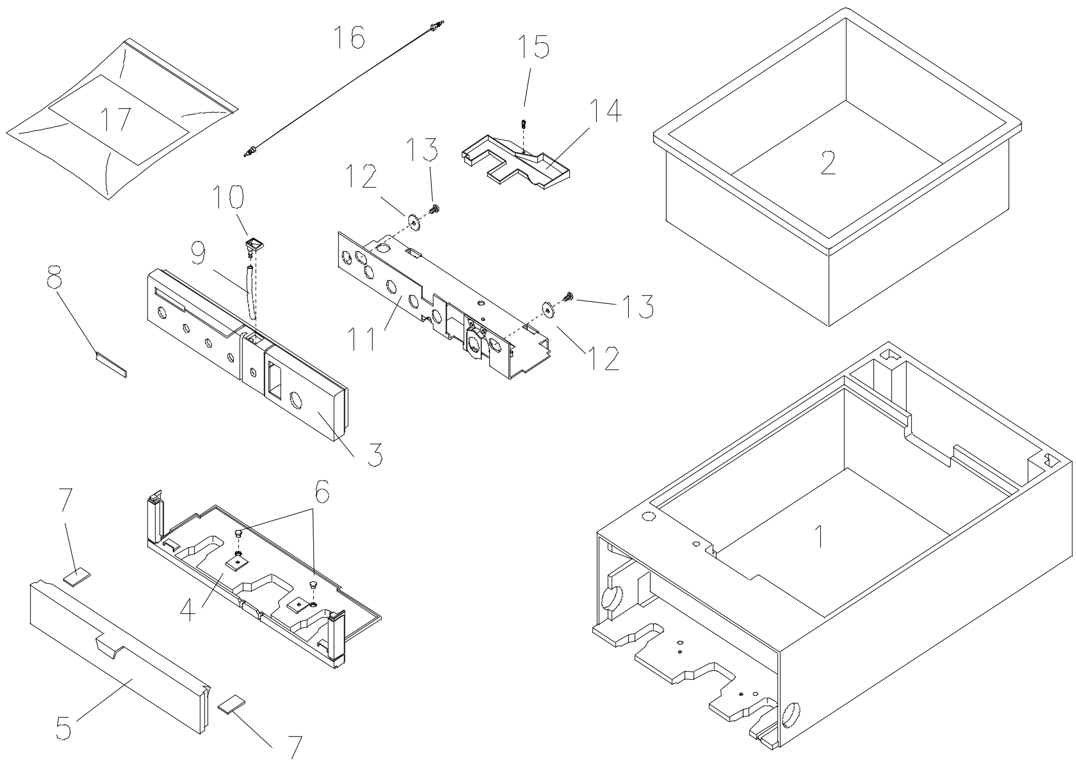
Description	Part Number	Description	Part Number
Ti - Pump Head Assembly	01019-60002	Ti - Capillary ID 0.17 35 cm lg	01019-87608
Ti - Pump Chamber Housing	01019-25205		
Ti - Active Inlet Valve	01019-60010	**Accessories**	
Ti - Piston Seal	0905-1199	PCTFE - Adapter	5021-1872
Ti - Damping Unit	01019-60005		
Ti - MCGV	01019-67701	Ti - Maintenance Kit	01019-68724
Ti - Manual Injection Valve	obsolete	includes:	
Ti - Rotor Seal Tefzel	0101-0620	Ti - Piston Seal (2x)	0905-1199
Ti - Stator	0101-0663	PTFE Frits 5/PK	01018-22707
Ti - Loop Capillary 20 µl	0101-0655	Gasket Seal Wash (2x) 6/pk	5062-2484
Ti - Bottle Head Assembly	obsolete	Seal Wash (2x)	0905-1175
Ti - Bushing	01019-21734	Seal Gold Outlet (5x)	5001-3707
Solvent Glass Filter Adapter	5041-2168 5062-8517	Cap Outlet (5x) 4/pk	5042-1346
Ti - He - Sparge Assembly	01019-82702		
Ti - Screw Tube	01019-23232?	Ti - High Pressure Solvent Filter Kit	01019-68709
Ti - Name Plate		includes:	
Ti - Capillary Piston 1 260 mm lg	01019-67301	Ti - Capillary ID 0.25 13 cm lg	01019-87308
Ti - Capillary Piston 2 210 mm lg	01019-67302	Ti - Fitting Insert (2x)	01019-27601
Ti - Tubing ID 0.25 mm 700 mm lg	01019-67305	Fitting Nut (1x)	79900-25701
Ti - Sucking Tube	see item 13	Fitting Screen (1x)	79900-22401
		Fitting Insert (1x)	01019-27601

Solvent Cabinet

Table 4 Solvent Conditioning Module

Item	Description	Part Number	Item	Description	Part Number
1	Solvent Compartment incl. (2)	01018-60019	11	Holder He-Valves	01018-05501
2	Bottle Tub	no PN	12	Washer	5001-3746
3	Front Panel	no PN	13	Screw	0624-0045
	Cover Cap, no injection valve	6960-0024	14	Injector Tub	01018-44503
	Cover Cap, no Helium on/off valve	6960-0027	15	Screw M3 4 mm lg	0515-1508
	Cover Cap, no Helium Regulators	6960-0028	16	Capillary ID 0.17 400 mm lg	79826-87608
4	Front Base	01018-40512	16	Ti - Capillary ID 0.17 35 cm lg	01019-87608
5	Oven Door	01018-60302			
6	Bolt	01018-43701	17	Accessory Kit, includes following items	01018-68704
7	Door Hinge	01018-45101		Angle Injection Position (part of Sensor Assembly)	01018-00511
8	Name Plate	5041-2170		Sensor Assembly	5062-2432
9	Tubing Flexible ID 4 mm OD 5 mm			Screw lock female (2x)	1251-7788
10	Funnel Leak	01018-43211		Washer M4 (2x)	3050-0893

Figure 1 **Solvent Cabinet**

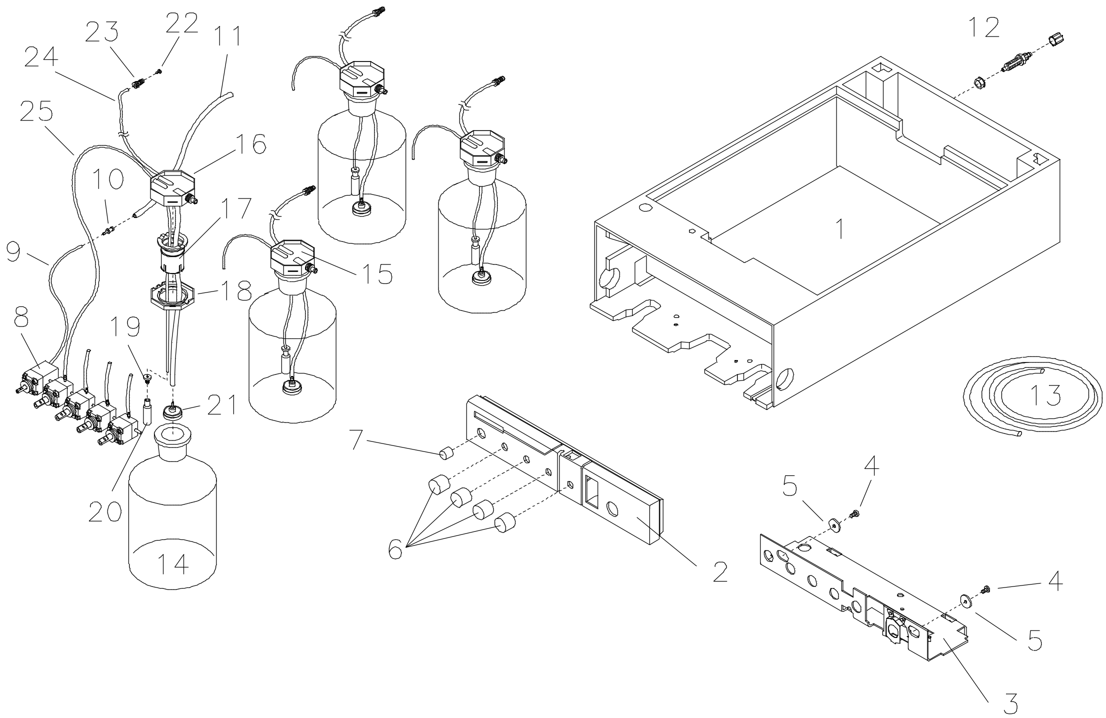


Solvent Cabinet with Helium Degassing

Table 5 **Solvent Cabinet with Helium Degassing**

Item	Description	Part Number	Item	Description	Part Number
1	Solvent Compartment, incl. (2)	01018-60019	14	Solvent Bottle, 1 liter	9301-0656
2	Front Panel	no PN	15	Bottle Head Assembly, includes item 16 to 25	01018-60017
3	Holder He-Valves	01018-05501	15	Ti - Bottle Head Assembly, includes item 16 to 25	01019-60017
4	Screw	0624-0045	16	Bottle Head Cap	01018-44111
5	Washer	5001-3746	17	Bottle Head Shaft	01018-43711
6	Regulator Knob A	01018-47413	18	Bottle Head Washer	01018-48811
	Regulator Knob B	01018-47414		Helium Sparge Assembly, includes item 19 and 20	01019-82702
	Regulator Knob C	01018-47415	19	Connector Helium Sparger (6/pk)	5062-8515
	Regulator Knob D	01018-47416	20	Helium Sparger 10-16 µl	5041-8339
7	Knob On/Off	01018-47412	21	Solvent Filter SST	01018-60025
8	Helium Regulator Assembly, includes item 6 an 7	01018-67001	21	Solvent Glass Filter Adapter	5041-2168 5062-8517
9	Tubing PTFE ID 1/16” OD 1/8”	0890-0746	22	Tube Bushing Teflon	79835-21734
10	Fitting	0100-1430	22	Ti - Bushing	01019-21734
11	Tubing Flexible ID 0,156”	0890-0581	23	Tube Screw	5041-2163
12	Fitting	0100-1047	24	Tubing FEP ID 1.5 mm OD 3 mm 5 m	5062-2483
	Filter Disc (part of 12)		25	Tubing PTFE ID 1.45 mm OD 2.5 mm 5 m	5062-2461
13	Air Tubing Flexible 5 m	5021-7127			

Figure 2 **Solvent Cabinet with Helium Degassing**

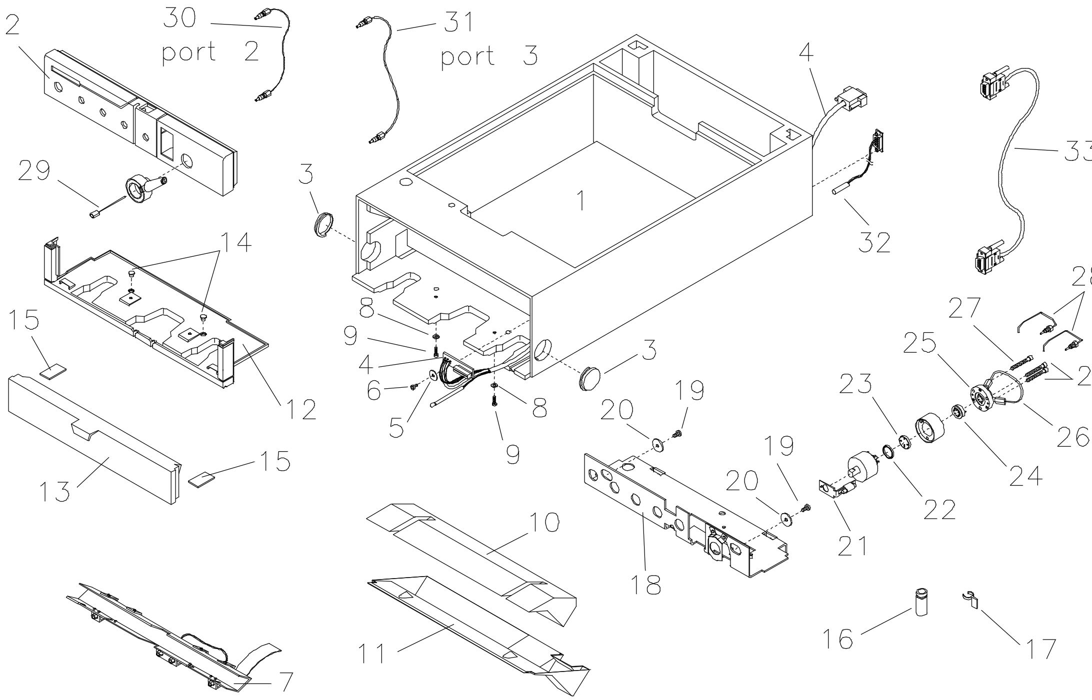


Solvent Cabinet with Column Heater and Manual Injection Valve

Table 6 Solvent Cabinet with Column Heater and Manual Injection Valve

Item	Description	Part Number	Item	Description	Part Number
1	Solvent Compartment, incl. (2)	01018-60019		Rheodyne Valve 7125 complete, includes item 22 to 29	0101-0607
2	Front Panel	no PN	22	Isolation Seal	1535-4046
3	Plug	01018-44103	23	Rotor Seal Vespel	0101-0623
4	Cable Assembly Heater	01018-61600	23	(Ti) Rotor Seal Tefzel (high pH)	0101-0620
5	Washer	5001-3746	24	Stator Face Assembly	no PN
6	Screw M4 6 mm lg	0515-0915	25	Stator (Head)	1535-4044
7	Heater Assembly	01018-66901	25	Ti - Stator (Head)	0101-0663
8	Washer	3050-0893	26	Loop Capillary 20µl	0101-0377
9	Screw M3 16 mm lg	0515-0986	26	Ti - Loop Capillary 20 µl	0101-0655
10	Insulation	01018-45401	27	Stator Screw	1535-4857
11	Heat Shield	01018-40601	28	Connector Capillary	no PN
12	Front Base	01018-40512	29	Valve Transport Protection	no PN
13	Oven Door	01018-60302	30	Capillary ID 0.17 400 mm lg	79826-87608
14	Bolt	01018-43701	30	Ti - Capillary ID 0.17 35 cm lg	01019-87608
15	Door Hinge	01018-45101	31	Tubing ID 0.25 mm 700 mm lg	01018-67305
16	Waste Vial	9301-1168	31	Ti - Tubing ID 0.25 mm 700 mm lg	01019-67305
17	Vial Holder	01018-44901	32	Sensor Assembly	5062-2432
18	Holder He-Valves	01018-05501	33	Remote Cable	5061-3378
19	Screw	0624-0045		Syringe 25 µl	9301-0633
20	Washer	5001-3746		Needle 10-100 µl	9301-0679
21	Angle Injection Position	01018-00511			

Figure 3 **Solvent Cabinet with Column Heater and Manual Injection Valve**



Overall Diagram

Table 7 **Overall Diagram**

Item	Description	Part Number	Item	Description	Part Number
1	Fan Grill	3160-0544	35	Screw (plastic) for MCGV	0515-1256
2	DC Fan	01048-68500	36	no longer used	no PN
3	Cooling Drain	01018-47706	37	no longer used	no PN
4	Push Button, white	5041-1203	38	no longer used	no PN
5	Power Actuator	5041-2162	39	Leakage Tray right	01018-44502
6	Spring Compression	1460-1510	40	High Pressure Damper	79835-60005
7	Cover Hinge	5041-2147	41	Active Inlet Valve	01018-60010
8	Sheet Metal Kit	01018-68701	42	Frit Adapter Assembly	01018-60007
9	Foot Front	5041-2161	42	Purge Valve	G1311-60009
10	Cable to Connector Board	5062-2416	43	Adapter short	01018-23207
11	Connection Tube 150 mm lg	G1311-67304	44	Outlet Ball Valve	G1311-60008
12	MCGV Exchange	79835-67701 79835-69701	45	Metering Drive Assembly	01018-60001
13	Connector Board	01018-66505	46	Pump Head Assembly includes item 41 to 44	01018-60004
14	Front Plate	01018-04106	47	Pump Plate	01018-04704
15	Leakage Tray, left	01018-44501	48	Capillary Piston 1 ID 0.5 27 cm lg	01018-67309
16	Leak Sensor	5061-3356	49	Capillary Piston 2 ID 0.5 21 cm lg	01018-67302
17	Logo Base	5041-2144	50	Power Supply (DPS-B) Exchange	5061-3374 01050-69374
18	Name Plate	5041-2170	51	PDC^2 Board	01018-66532
19	Front Door	01018-60301	52	SFW Board (Firmware)	01018-66506
20	Power Switch Base	5041-2145	53	RAD Board Exchange	01018-66503 01018-69503

Table 7 **Overall Diagram**

Item	Description	Part Number	Item	Description	Part Number
21	ESD Cover	01018-44106	54	HRI Board	01018-66517
22	Cover Keyboard	5001-3736	54	HRQ Board	01018-66518
23	Leak Assembly, includes item 24, 25, 26	5062-8551	56	Motherboard	01018-66501
27	Keyboard Module	01018-60201	57	Cover Plate P/S	5001-3728
28	Fluorescent Interface	5061-3376	58	Top Cover	5001-3724
29	Cable to Display Board	5061-3400	59	Plate Cover, 1.5 inch	5001-3722
30	Screw M3.5 6 mm lg	0515-0889	60	Plate Cover, 1.3 inch	5001-3721
31	Bumper	0403-0427	61	Card Cage	no PN
32	Screw M4 6 mm lg	0515-0898	62	Screw M3.5 6 mm lg also for AIV ground cable	0515-0887
33	Screw M4 20 mm lg (special)	0515-1918		Screw, ESD cover	5021-1862
34	Screw M3 8 mm lg	0515-0912			

Overall Diagram

Figure 4 **Overall Diagram Part 1**

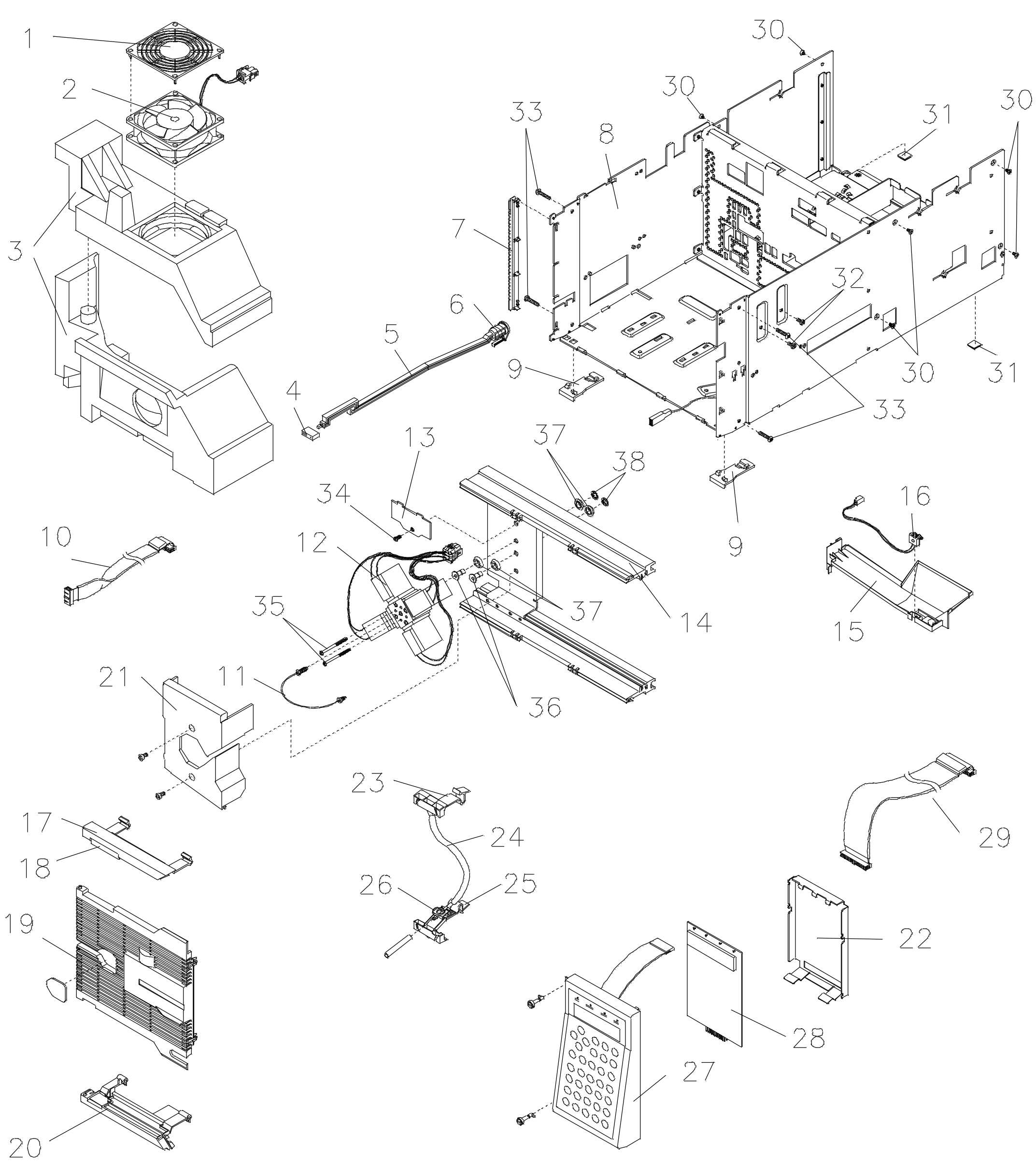
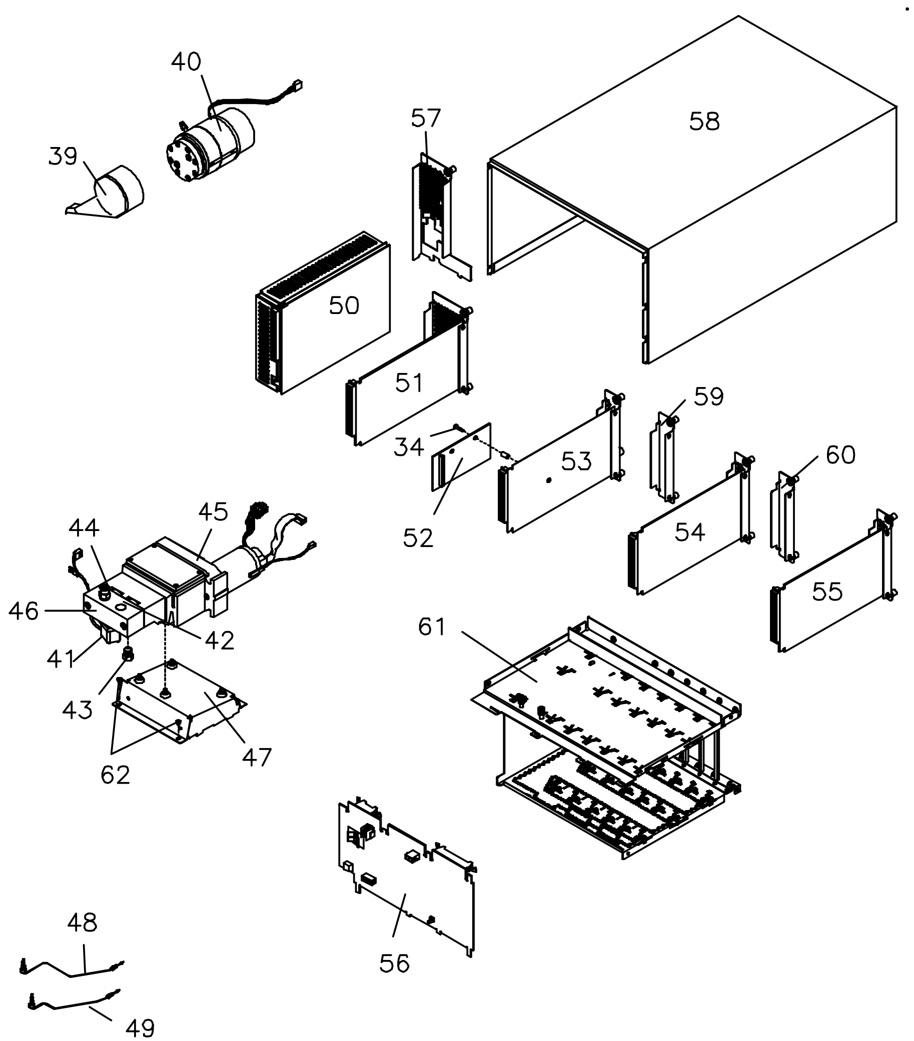


Figure 5 **Overall Diagram Part 2 (Pars II)**



Hydraulic Flow Path

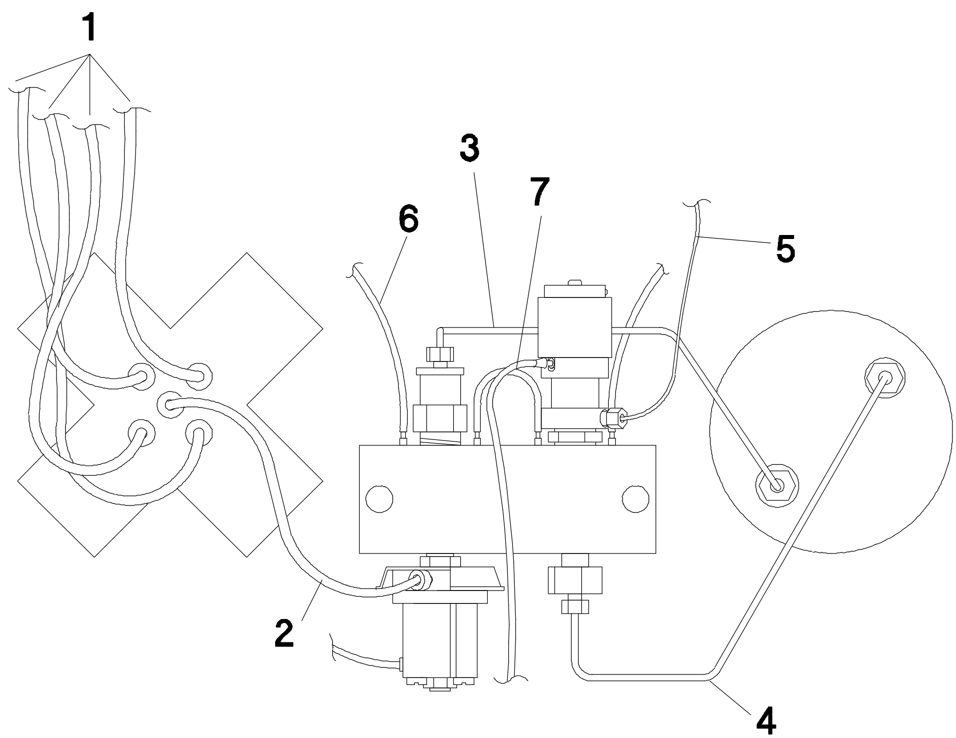
Table 8 **Hydraulic Flow Path Quaternary Pump**

Item	Description	Part Number	Item	Description	Part Number
1	Drawing Tubing consists of	no PN		Gripper MCGV	0100-1431
	Solvent Filter SST	01018-60025		Connector MCGV	0100-1432
	Helium Sparger 10-16 µl	5041-8339		Ferrule, inlet valve 20/pk	5061-3321
	Connector Helium Sparger (6/pk)	5062-8515		Gripper, inlet valve 20/pk	5061-3322
	Tubing FEP ID 1.5 mm OD 3 mm 5 m	5062-2483		Male, inlet valve 20/pk	5061-3323
	Tube Bushing Teflon	79835-21734		Buffer Disc, inlet valve 40/pk	5061-3324
	Screw Tube	5041-2163	3	Capillary Piston 1 ID 0.5 27 cm lg	01018-67309
			3	Ti - Capillary Piston 1 260 mm lg	01019-67301
1	Ti - Drawing Tubing, consists of	no PN	4	Capillary Piston 2 ID 0.5 21 cm lg	01018-67302
	Solvent Glass Filter Adapter	5041-2168 5062-8517	4	Ti - Capillary Piston 2 210 mm lg	01019-67302
	Tubing FEP ID 1.5 mm OD 3 mm 5 m	5062-2483	5	Tubing ID 0.25 mm 700 mm lg	01018-67305
	Ti - Bushing	01019-21734	5	Ti - Tubing ID 0.25 mm 700 mm lg	01019-67305
	Screw Tube	5041-2163	6	Teflon Tubing ID 1 mm OD 3 mm	0890-1764
2	Connection Tube, consists of	G1311-67304	7	Tubing PTFE ID 1.45 mm OD 2.5 mm 5 m	5062-2461
	Flex Tubing PTFE ID 0.7 mm5 m lg	5062-2462			

Table 9 **Hydraulic Flow Path Isocratic Pump**

Item	Description	Part Number	Item	Description	Part Number
2	Drawing Tubing, consists of	01018-67303	2	Ti - Drawing Tubing, consists of	01019-67303
	Solvent Filter SST	01018-60025		Solvent Glass Filter Adapter	5041-2168 5062-8517
	Tubing FEP ID 1.5 mm OD 3 mm 5 m	5062-2483		Tubing FEP ID 1.5 mm OD 3 mm 5 m	5062-2483
	Nut	79835-25731		Nut	79835-25731
	Screw Tube	79835-23231		Ti - Screw Tube	01019-23232

Figure 6 **Hydraulic Path**

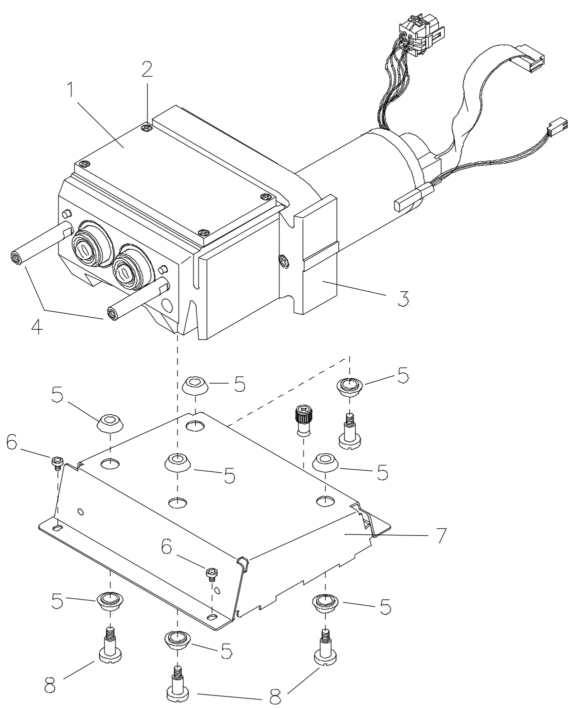


Metering Drive Assembly

Table 10 **Metering Drive Assembly**

Item	Description	Part Number	Item	Description	Part Number
3	Metering Drive Assembly	01018-60001	5	Bumper	5021-1839
	Exchange Assembly, includes item 1, 2, 4, U78 and U79 for PDC board rev. A	01018-69100	6	Screw M3.5 8 mm lg	0515-0887
1	Cover	01018-44102	7	Pump Plate	01018-04704
2	Screw M2.5 6 mm lg	0515-0894	8	Screw M4	5021-1841
4	Stay Bolt	01018-23704			

Figure 7 **Metering Drive Assembly**

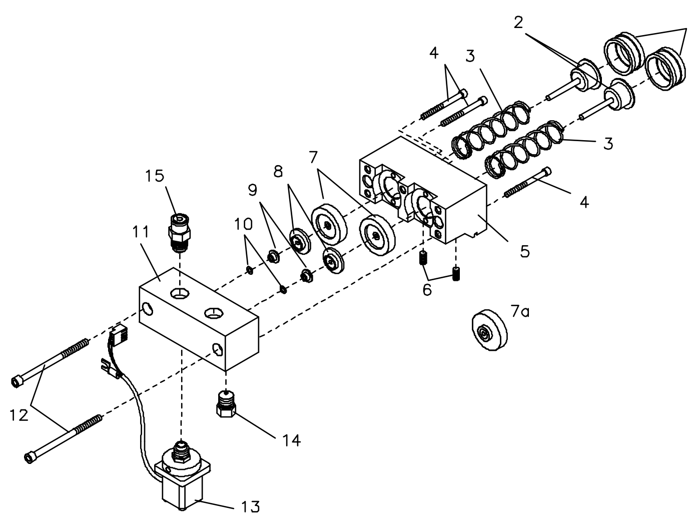


Pump Head Assembly (old version)

Table 11 **Pump Head Assembly (old version)**

Item	Description	Part Number	Item	Description	Part Number
	Complete Assembly	01018-60004	11	Pump Chamber Housing	01018-25203
1	Plunger Keeper		12	Screw M5 50 mm lg	0515-1220
2	Sapphire Plunger	5063-6586	13	Active Inlet Valve	01018-60010
3	Spring Compression	1460-2220	14	Adapter short	01018-23207
4	Screw M4 40 mm lg	0515-0850	15	Outlet Ball Valve	G1311-60008
5	Plunger Housing	see page 245			
6	Set Screw M3 8 mm lg	0515-1917		**Tools**	
7	Support Seal Assembly	5001-3739		Wrench 12 mm	8710-1841
8	Seal Keeper	part of (7)		Wrench 14 mm	8710-1924
9	Plunger Seal (2/Pk)	5063-6589		Insert Tool Seals	01018-23702
10	Wear Retainer (10/pk)	5064-8249		Teflon Grease	79841-65501

Figure 8 **Pump Head Assembly (old version**

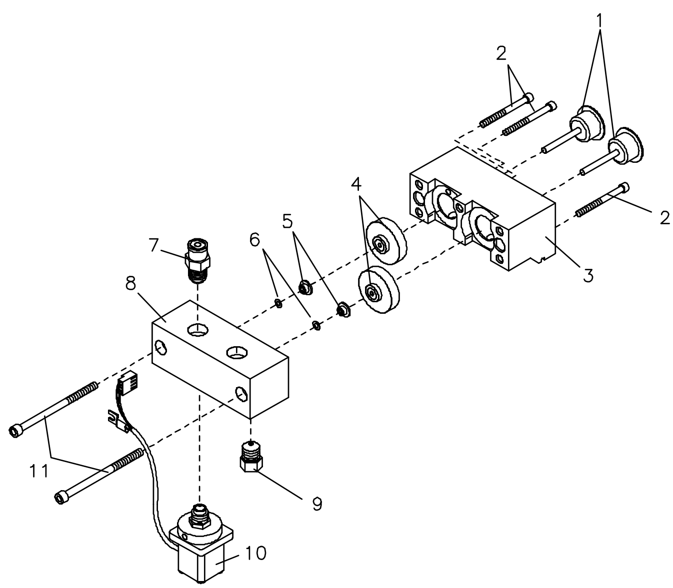


Pump Head Assembly (new version)

Table 12 **Pump Head Assembly (new version)**

Item	Description	Part Number	Item	Description	Part Number
	Complete Assembly	01018-60004	9	Adapter short	01018-23207
1	Sapphire Plunger	5063-6586	10	Active Inlet Valve	01018-60010
2	Screw M4 40 mm lg	0515-0850	11	Screw M5 50 mm lg	0515-1220
3	Plunger Housing	01018-60006		**Tools**	
4	Support Seal Assembly	5001-3739		Wrench 12 mm	8710-1841
5	Plunger Seal (2/Pk)	5063-6589		Wrench 14 mm	8710-1924
6	Wear Retainer (10/pk)	5064-8249		Insert Tool seals	01018-23702
7	Outlet Ball Valve	G1311-60008			
8	Pump Chamber Housing	01018-25203		Teflon Grease	79841-65501

Figure 9 **Pump Head Assembly (new version)**

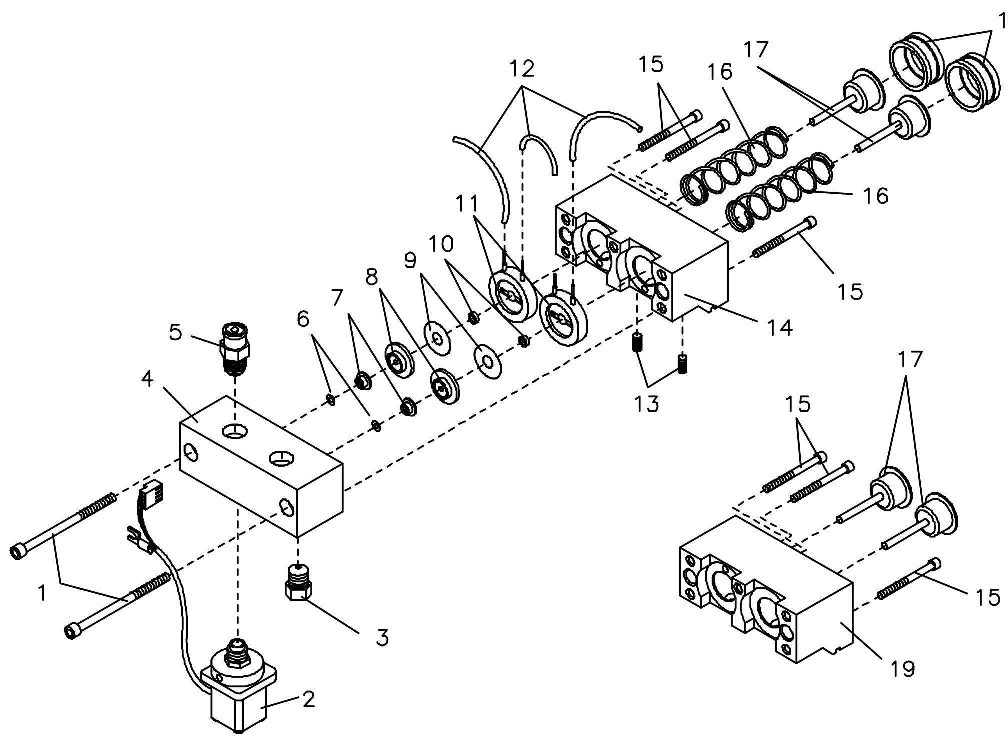


Pump Head Assembly with Seal Wash

Table 13 **Pump Head Assembly with Seal Wash**

Item	Description	Part Number	Item	Description	Part Number
	Complete Assembly	01018-60005	17	Sapphire Plunger	5063-6586
	Ti - Complete Assembly	01019-60002	18	Plunger Keeper	no PN
1	Screw M5 50 mm lg	0515-1220	19	Plunger Housing	01018-60006
2	Active Inlet Valve	01018-60010			
2	Ti - Active Inlet Valve	01019-60010		**Tools**	
3	Adapter short	01018-23207		Wrench 12 mm	8710-1841
4	Pump Chamber Housing	01018-25203		Wrench 14 mm	8710-1924
4	Ti - Pump Chamber Housing	01019-25205		Insert Tool, seals	01018-23702
5	Outlet Ball Valve	G1311-60008		Teflon Grease	79841-65501
6	Wear Retainer (10/pk)	5064-8249			
7	Plunger Seal (2/Pk)	5063-6589		**Accessories**	
7	Ti - Seal	0905-1199		Seal Wash Option Update Kit includes tubing, seals (2x), support ring (2x) and items #	01018-68722
8	Seal Keeper	5001-3743			
9	Gasket, seal wash (6/Pk)	5062-2484	#	Syringe	9301-0411
10	Seal Wash	0905-1175	#	Adapter Luer (3x)	0100-1681
11	Support Ring Seal Wash	5062-2465	#	Abrasive Paper TP 240	
12	Teflon Tubing ID 1 mm OD 3 mm	0890-1764	#	Insert Tool Seal	01018-23702
13	Set Screw M3 8 mm lg	0515-1917	#	Seal Keeper (item 8) (2x)	5001-3743
14	Plunger Housing (old version)	order 19			
15	Screw M4 40 mm lg	0515-0850		Velocity Regulator (3/pk)	5062-2486
16	Spring Compression	1460-2220			

Figure 10 **Pump Head Assembly with Seal Wash**

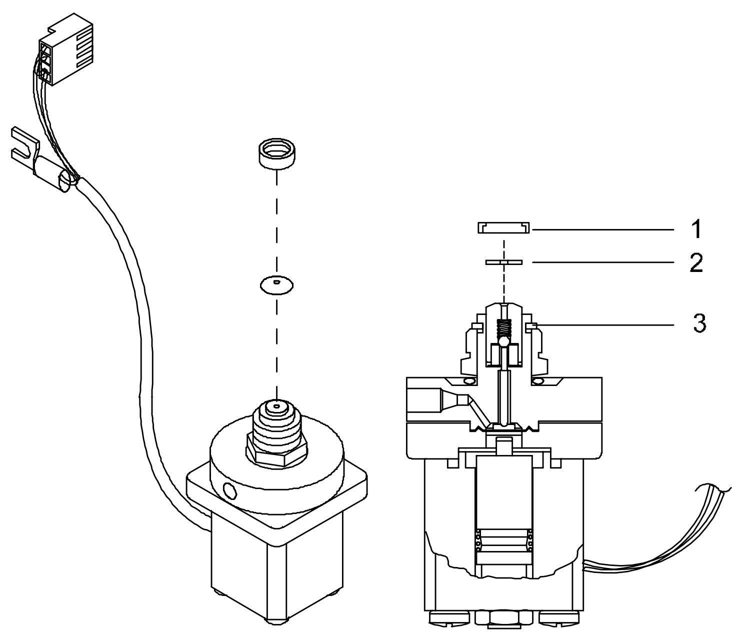


Active Inlet Valve

Table 14 **Active Inlet Valve**

#	Description	Part Number
	AIV Assembly, complete	01018-60010
	Ti - AIV Assembly, complete	01019-60010
1	Cap Inlet Valve	01018-21207
2	Gold Seal	5001-3708
3	Retainer Ring, gold coated	5021-1874

Figure 11 **Active Inlet Valve**

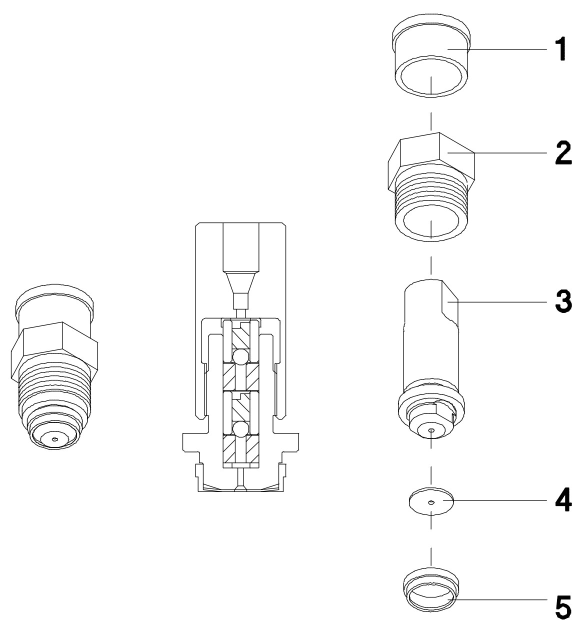


Outlet Ball Valve

Table 15 **Outlet Ball Valve**

#	Description	Part Number
	Outlet Ball Valve Assembly, complete	G1311-60008
	Ti - Outlet Ball Valve Assembly, complete	01018-60032
1	Socket Cap	5042-1345
2	Housing Screw	01018-22410
3	Outlet Valve Cartridge	no PN
4	Gold Seal, Outlet	5001-3707
5	Cap	5062-2485

Figure 12 **Outlet Ball Valve**

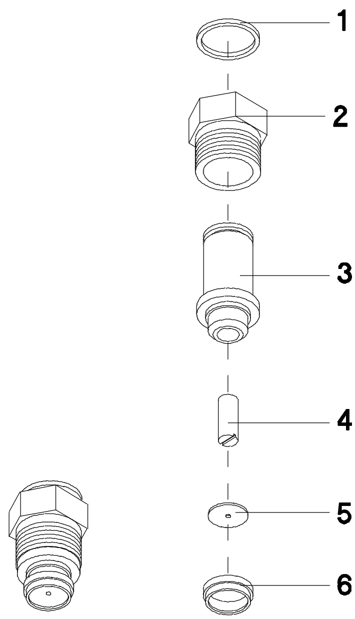


Frit Adapter Assembly

Table 16 **Frit Adapter Assembly**

#	Description	Part Number
	Frit Adapter Assembly, complete	01018-60007
1	O-ring (12/Pk)	5180-4167
2	Housing Screw	01018-22410
3	Adapter	01018-23209
4	PTFE Frit (5/Pk)	01018-22707
5	Gold Seal	5001-3707
6	Cap (4/pk)	5062-2485

Figure 13 **Frit Adapter Assembly**

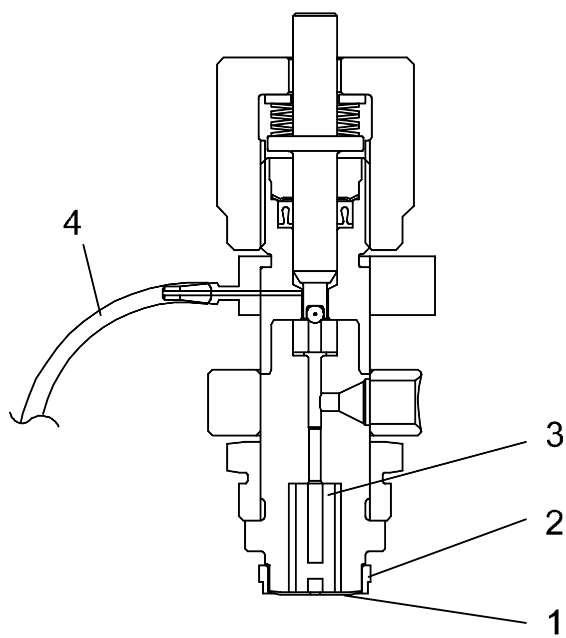


Purge Valve Assembly

Table 17 **Purge Valve Assembly**

#	Description	Part Number
	Purge Valve Assembly, complete	G1311-60009
1	Gold Seal	5001-3707
2	Cap (4/pk)	5062-2485
3	PTFE Frit (5/Pk)	01018-22707
4	Tubing PTFE ID 1.45 mm OD 2.5 mm 5 m	5062-2461

Figure 14 **Purge Valve Assembly**

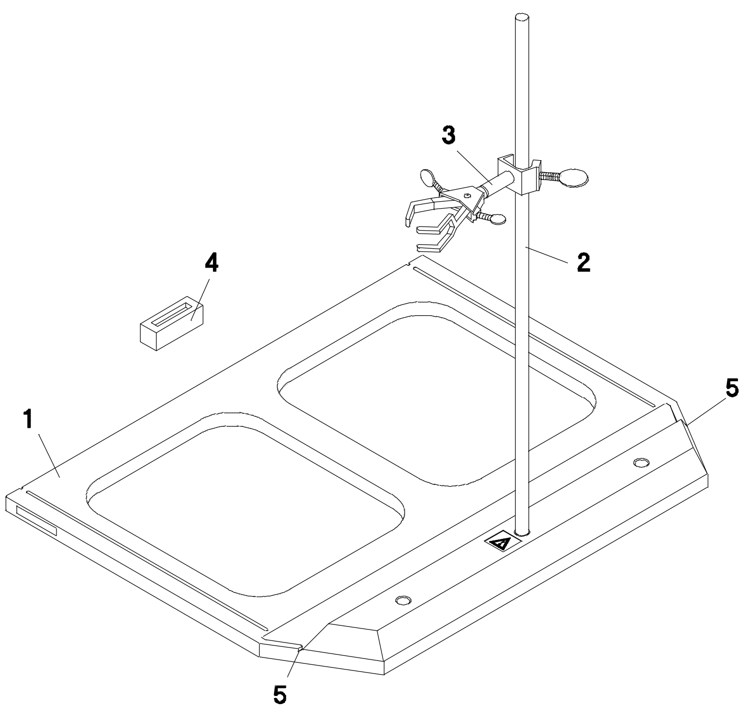


Column Holder Assembly

Table 18 **Column Holder Assembly**

#	Description	Part Number
	Column Holder Assembly	5062-2469
1	Holder Brass	no PN
2	Stand	5001-3738
3	Clamp	no PN
4	Support Block	no PN

Figure 15 **Column Holder Assembly**



Special Tools

Table 19 **Special Tools**

#	Description	Part Number
	Wrench, 12 mm	8710-1841
	Wrench, 14 mm	8710-1924
	Insert Tool, Seals	01018-23702
	Teflon Grease	79841-65501

Special Tools

1

Pumps: Additional Information

This chapter provides additional information about the 1050 Pumps

Pumps: Additional Information

This section gives information about:

- Pumps Prefix History
- Pumps Firmware History
- Online Monitor
- Operational Hints
- Helium Degassing Principle
- Isocratic Pumps
- Pump Head Assembly
- PDC Board
- HRQ Board
- Wear Retainer
- Outlet Ball Valve
- Flow Test Method
- Method Loading
- Flow Gradients
- Manual Injection Valve

Product History

Since introduction of the 1050 Pumps in 1988 a couple of hardware and firmware changes have been implemented in production. With most of this changes the serial number prefix has been changed too. Following is a list of all prefix changes done in Waldbronn and Little Falls.

Table 1 **Product History 79851A and 79852A/B**

S/N Prefix	Changes
2813 G	Introduction of the 1050 Pumps
2913 G	ESD cover added to the gradient valve. Hardware changes of extrusion and holding bracket for the MCGV.
2949 G ..... 2949 A.....	Wear retainer installed in front of each seal.
3010 G ..... 3012 A	Introduction of the current pump head version. In the meantime all old pump heads have been updated.
3016 G ..... 3019 A	Introduction of firmware revision 3.0 and introduction of column heater. Introduction of HRI/HRQ Board (HRQ replaces GVD board).
3031 G ..... 3034 A ... (51A) or 3032 A ... (52A)	Introduction of firmware revision 3.1
3045 G	Purge Valve added to all quaternary pumps
3106 G ..... 3106 A ... (51A) or 3107 A ... (52A)	New voltage regulators on PDC board (rev B), exchange metering drives require a PDC update.
3117 G ..... 3117 A ... (51A) or 3118 A ... (52A)	Introduction of firmware revision 3.2
3206 G	Introduction of dedicated seal and hardware modifications of pump chamber and seal keeper
3243 G .....3244 A...(51A) or 3145 A...(52A)	Introduction of PDC^2 board.

Table 1 **Product History 79851A and 79852A/B**

S/N Prefix	Changes
3312 G	Integrated spindle for metering drive assembly 01018-60001
3334 G	Support seal assembly replaces support ring and seal keeper
3404 G ..... 3404 A ... (51A) or 3405 A ... (52A)	Introduction of Damper with new pressure sensor and electronic board (Rev. G)
3447 G ..... 3448 A	Spring integrated in plunger housing
June 1996	Active Inlet Valve with Exchangeable Valve Cartridge
March 1998	Plunger Housing with new springs available
November 1998	Part Number Change for DC-Fans
September 2001	End of Support of 1050 Isocratic Pump 79851B TI ends September 30, 2001

Table 2 **Product History Solvent Cabinet**

S/N Prefix	Changes
3019 G	Solvent Cabinet 79856A/B serialized
3205 G	Improvement of Helium Regulators; better regulation range and tightening behavior.
3216G...	Modification of Bottle Head Shaft of the Bottle Head Assembly.

Firmware History

Revision 1.0

Revision 1.0 was the firmware at introduction of the 1050 Pumps.

Known Problems

In purge mode flow values above 5 ml/min will not be shown on the display. At higher values the display remains at 5 ml/min but the pump is purging with the set value.

Revision 3.0

Europe/ICON	SN 3016 G.....
US/Canada	SN 3019 A .....

Revision 3.0 incorporates:

- Communication with the GPIB communication interfaces.
- Support of the column heater.
- Improved flow test method.

Known Problems

1 If a gradient test method is started directly after running the build in flow test method the gradient might be distorted. Switching the pump off and on again after a pressure test solves the problem.

2 For applications with system pressures below 30 to 40 bar the lower pressure limit is not applicable.

3 Internal tests of the DOS workstation (Phoenix) revealed a couple of bugs in the communication part of the firmware.

Revision 3.1

Europe/ICON	SN 3031 G.....
US/Canada	SN 3034 A ..... (for 79851A/B)
	SN 3033 A ..... (for 79852A/B)

This firmware revision fixes the bugs encountered with the ChemStation.

Known Problems

Due to an internal timing problem relay contact 1 and 2 may switch incorrectly when used together in the timetable. Relay contact 2 might be activated together with contact 1 even when the timetable shows only an entry for contact 1.

Revision 3.2

Europe/ICON	SN 3117 G.....
US/Canada	SN 3117 A .....

This revision fixes the known bug of firmware revision 3.1.

How does the On-line Monitor work

The online monitor is part of the 1050 Pump firmware and checks the performance of the metering pump. The online Monitor detects appearing leaks `1st piston leak` valve problems `valve backflow` and checks via the pressure ripple for gas bubbles in the system `gas bubble`.

NOTE

The online monitor is a user selectable function and can be enabled or disabled via the diagnose level in the configuration displays. The online monitor is only active if the pressure in the pump is above 50 bar.

`DIAGNOSIS LEVEL 0` disables the online monitor and none of the following messages will be generated.

`DIAGNOSIS LEVEL 1` turns the online monitor on. Any measured deviation from the normal operation modes will generate an entry in the logbook.

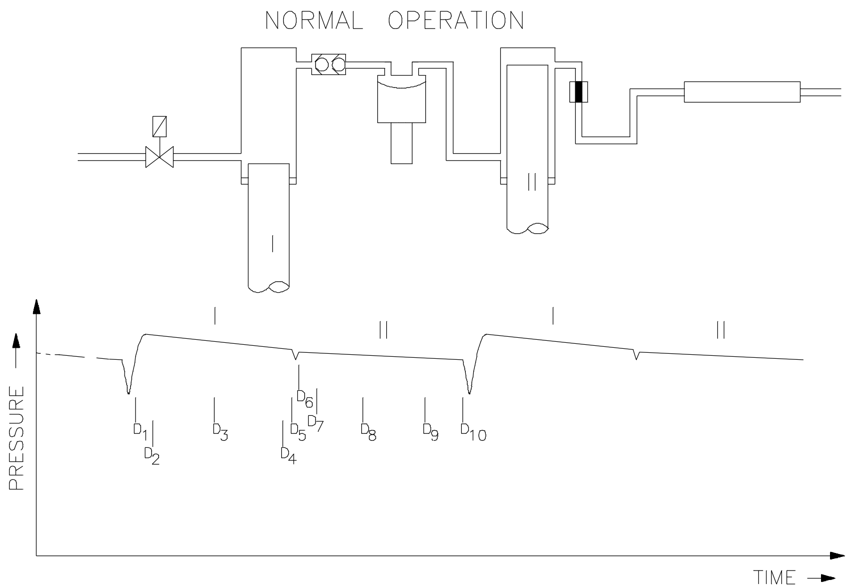
`DIAGNOSIS LEVEL 2` comprises the same functions like level 1 and in addition lids the not ready LED at the keyboard. The remote output shows the not ready condition and disables further injections when connected to the 1050 Autosampler.

`DIAGNOSIS LEVEL 3` is used for factory adjustment of the metering drive.

Normal Operation

The figure below shows the normal pressure profile of the instrument. The curve is ideal and can only be recorded with a very fast transient recorder. A normal integrator (339X) is too slow to record the very fast changes of the curve and shows a smoothed one. However occurring operation problems can be also seen on a integrator plot. During the delivering strokes of the two pistons the instrument measures the pressure at the points D1 to D10. Failure conditions like leaks or gas bubbles influence the pressure curve from which the processor can determine certain failure modes.

Figure 1 **Online Diagnostic: Normal Operation**



M2 Gas Bubble

The following figure shows the pressure profile when a gas bubble was drawn from the bottle. During the delivery phase of piston I the gas bubble will be compressed first before solvent can be delivered into the second chamber. This means the pressure will drop during the compression phase of the air bubble before it returns to normal behavior. The pressure profile of the second piston shows no deviation. The pressure drop at the beginning of the stroke generates a higher pressure ripple which is used to determine a gas bubble problem.

The pressure ripple is depending on various parameters like solvent, flow, compressibility and so on. For this reasons the pressure ripple has to exceed a certain range before a gas bubble can be detected. The relation between pressure ripple and compressibility setting is shown in the respective figure.

NOTE Drastic pressure changes (for example suddenly no more solvent to pump due to empty bottle) can not be detected under all circumstances. To make sure that the system will stop in such a case (for example running out of solvent during an unattended sequence) a lower pressure limit should be set.

Figure 2 **Online Diagnostic: Gas Bubble**

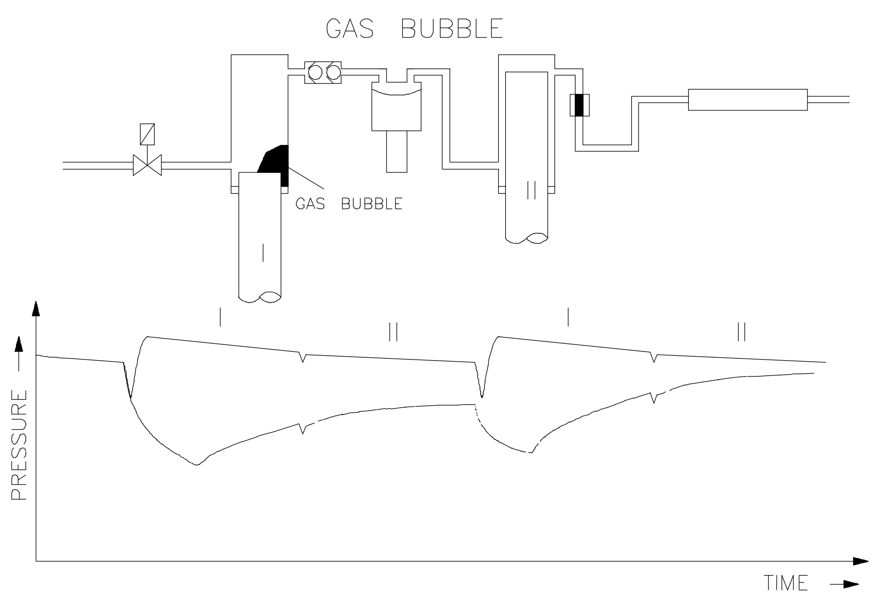
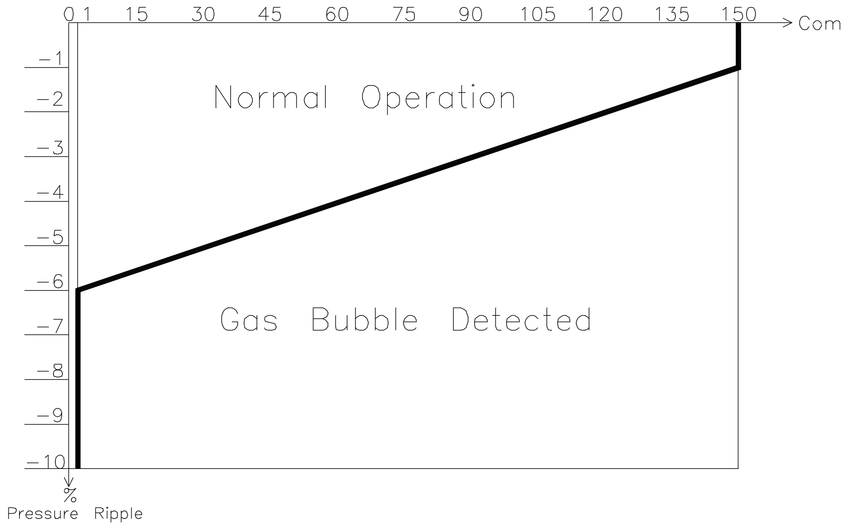


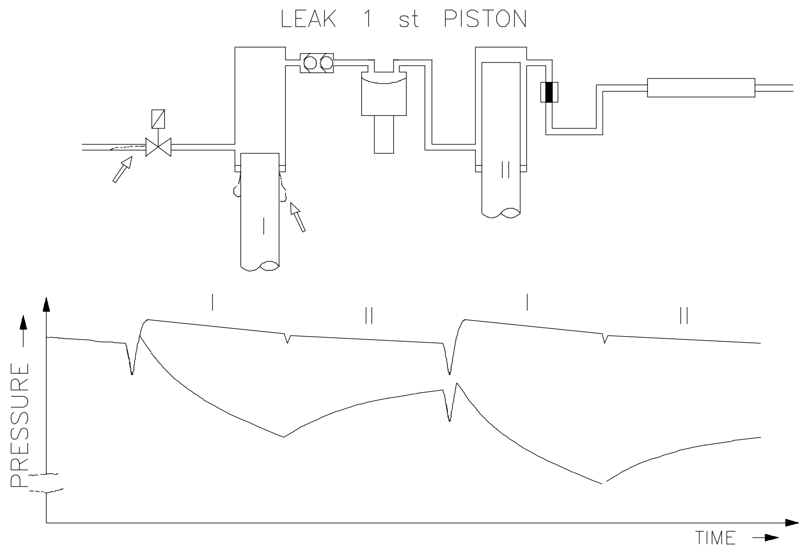
Figure 3 **Online Diagnostic: Compressibility vs. Pressure Ripple**



M4 Leak at first Piston

The following figure shows the pressure profile when the system is leaky either at the inlet valve or at the piston seal. The delivery stroke of piston I shows a pressure drop while piston II delivers without any problems.

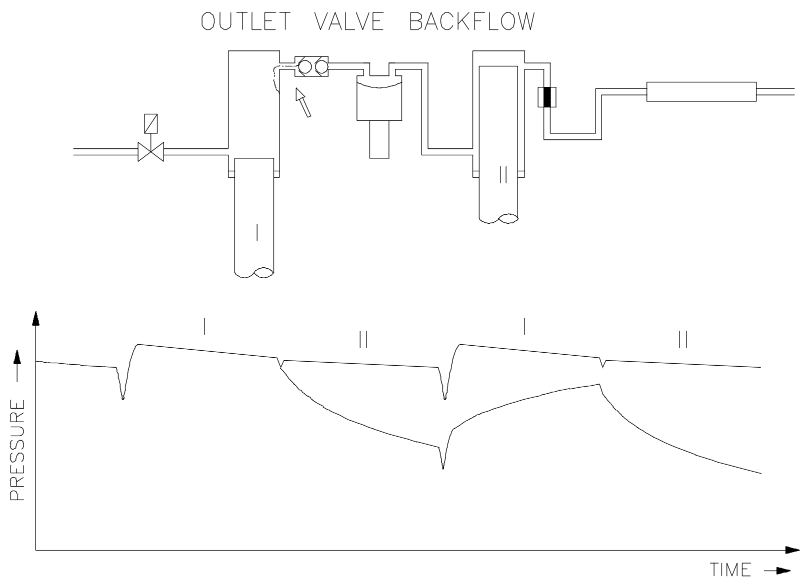
Figure 4 **1050 Online Diagnostic: Leak at first piston**



M6 Valve Backflow

The following figure shows the pressure profile when the outlet ball valve is not working correctly. Delivery stroke of piston I shows normal behavior while during the stroke of piston II the pressure drops because of the internally leaking ball valve.

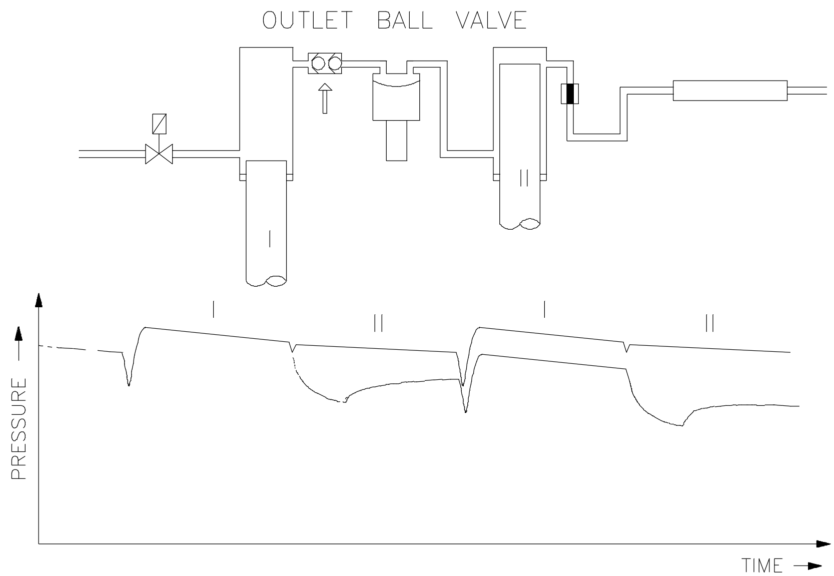
Figure 5 **Online Diagnostic: Outlet Ball Valve Backflow**



M8 Outlet Valve Problem

The following figure shows the pressure profile when the outlet valve sticks in its position. During the delivery stroke of piston II the pressure drops because a sticky ruby ball needs longer time to be closed.

Figure 6 **Online Diagnostic: Outlet Ball Valve**



If You Need Operational Hints

You will find general information about the pumps and certain parts followed by description of known behaviors of the instrument.

This section gives information about:

- Helium Degassing Principle
- Helium Regulators
- Isocratic Pumps
- Pump Head Assembly
- PDC Board
- HRQ Board
- Wear Retainer
- Outlet Ball Valve
- Flow Test Method
- Method Loading
- Flow Gradients
- Manual Injection Valve

Helium Degassing Principle

The Helium degassing works in two stages. First, replacing the dissolved gas in the solvent. Helium streams through the solvent and replaces the air dissolved. So after some time the solvent is saturated with Helium. Second, prevent that air diffuses back into the solvent. The compartment above the solvent will also be filled with Helium. The Helium above the solvent is absolutely necessary to make sure that no air can be introduced back into the solvent. So the bottle head has to be in its position otherwise the degassing will not work or it will require a too high Helium stream through the solvent.

NOTE If the vent position of the bottle head is connected to a fume hood, make sure that the Helium is not sucked out of the bottle. Best is to install a restriction (for example change diameter from 1/4" to 1/8") to make sure that the Helium blanket above the solvent surface remains in its place. Otherwise performance problems especially with gradient runs or excessive high Helium consumption might be the result.

Helium Regulators

The helium regulators allow the regulation of the helium flow. The regulator design does not allow to set the helium stream to zero. A small flow of helium is still possible.

Bottle Head Assembly

During the lifetime of the solvent cabinet a problem with the bottle head assembly was encountered.

The helium leaves the bottle head assembly through the vent connector. To reach this vent the helium has to pass the bottle head shaft. The helium passes through the gaps between the holes in the shaft and the supply tubings for helium and solvent. Variations in the tolerances for hole size and tubing diameter may restrict the helium flow out of the solvent bottle. This may cause the effect that the solvent gets oversaturated with helium. Oversaturation may lead to problems in pump and detector.

For that reason the bottle head assemblies have been modified with a separate vent hole (1 mm to 2 mm in diameter) to the bottle head shaft (01018-43711). All solvent cabinets 79856A/B with serial number prefix 3216 G... and greater will have the modification installed.

Instruments without the vent hold should be updated. Using a screwdriver simply punch a hole of 1 mm to 2 mm diameter in the shafts of the bottle head assemblies (01018-43711).

Isocratic Pumps

Isocratic pumps are often sold without the solvent conditioning module option. The bottle is then placed beside the instrument. Tests have shown that best results in regards of pressure ripple stability, air sensitivity and so on are reached when the solvent bottle is placed on top of the module or even higher (for example on top of a stack of modules). The slight gravity pressure reduces the under pressure the pump requires to draw solvent from the solvent bottle.

Pump Head Assembly

In February 1992, the pump head assembly was improved. The seal, the pump chamber housing and the seal keeper have been changed. All together the changes will assure a higher lifetime for the pump seal.

Seal

A dedicated seal was designed for the 1050 Pumps. Compared to the old seal used in 1050 and in the 1090 the seal is the same material and color, but slightly different in appearance. Nevertheless the seals are fully backward compatible. They should be used in all existing 1050 pumps. Lifetime should be expected the same as always. The wear retainer is still required.

Pump Chamber Housing and Seal Keeper

A groove has been added to the seal surface of the pump chamber and a cutting edge was added to the seal keeper. These both changes ensure a better compression of the new seal resulting in a higher lifetime. Part numbers of the two parts were not changed because of there compatibility.

PDC Board

When exchanging the metering drive assembly 01018-69100 in a pump with PDC Board revision A installed (*see "Product History" on page 257*), the voltage regulators U78 and U79 on the board have to be replaced. Parts are included in the exchange metering drive. PDC Board revision B and greater and the PDC^2 Board do not have the new type voltage regulator already installed. A short in the active inlet valve cable (for example cable squeezed between pump head and metering drive) will generate excessive current on the components of the PDC board. This overcurrent will at least damage (unsolder) one resistor on the board. The fuse added to the CON board (introduction approximately January 1992) will prevent damage of the PDC board.

PDC^2 Board

In a standardization (board will also be used in other APG products) and cost reduction program part of the circuit was implemented in ASIC (Application Specific Integrated Circuit) which allowed a reduction in board size. A stainless steel plate and the cover plate assure compatibility to the 1050 board.

HRQ Board

Originally the fuse F16 on the HRQ board was a 500 mA type. Evaluation of returned defective exchange boards showed that the fuse was blown in most of the cases. The fuse was to weak and could be blown without circuit failure. Therefore the fuse was changed to a 1 A type.

GVD Board

At introduction of the 1050 Pumps the Gradient Valve Driver (GVD) board controlled the multi channel gradient valve (MCGV). During the design phase of the column heater option it was decided that the control of the heater should be also done via the same board. Therefore the GVD was replaced by the HRQ board for control of column heater and gradient valve (*see "Product History" on page 257*).

Wear Retainer

The abrasion of the seal is a very well known fact. The wear retainer is a device which keeps the departed particles around the seal instead of allowing to move immediately into the flow path. The retainer consist of a small porous Teflon disc placed directly in front of the seal. When installed the retainer disc deflects and with the piston diameter slightly bigger than the one of the Teflon disc a recess for the seal material is build.

With the operation time the plunger will widen the diameter of the disc allowing part of the particles to move into the flow system. Therefore the wear retainer should always be changed together with the seal. The high pressure filter in the purge valve will collect all this materials without problem. When changing the seals also the high pressure filter should be changed too.

Outlet Ball Valve

The outlet ball valve is a cartridge type and does not need any maintenance. It is not spring loaded and therefore uses gravity and the back pressure for closing. To increase the reliability of this type of valve two ceramic seat/ ball packages are used. The valve is less sensitive to contaminations and does not require a sieve assembly in front. The cap in front of the valve holds a gold seal for proper tightening. If the valve fails it is probably contaminated. Cleaning can be done either in a sonic bath or by flushing using degreaser spray in flow direction. Disassembling will damage the valve. The outlet ball valve should only be tightened at the holding screw and not at the cartridge itself. Under worst case conditions this could damage the cartridge generating leaks at the seat/ball packages.

Flow Test Method

The flow test method should be always started with the remote mode in LOCAL.

If set to GLOBAL the test method can be inhibited when a manual injection valve in inject position is connected via the remote connector.

If the remote mode is set to HPSYSTEM the flow test will not be started at all, because of the start request which is send out instead of a start.

Method loading

If a method will be loaded while pumping, the pump might be switched off when there is a lower pressure limit set in the new method.

Flow Gradients

Timetables containing flow gradients with a starting point of 0 ml/min will not be executed. Gradient parameter changes will always be executed at the culmination point of the first piston. With a flow set to zero, this point will never be reached.

Manual Injection Valve

Starting a 3390A or 3394A from the remote start of the manual injector requires a slight modification of the injection sensor. 3390/94 integrators need a dynamic signal which the manual injector can provide only if position sensor is installed into an upright position.

Metering Drive Repairs

Evaluation of defective metering drives 01018-69100 showed that the wiper in the spindle housing was broken or bent. The wiper defines the position of the spindles to each other. Discussions with CE's revealed that some people try to check out the metering drive without the pump head installed, especially when troubleshooting E27 (max motor drive power exceeded) problems.

When the pump head is removed and the pump is initialized the spindle movement is stopped by the wiper. The pump displays the message `pumphead missing`. This is generally no problem for the mechanical system. The following problems may occur when operating from this point on.

❑ The pump is turned on again without reinstalling the pump head.

  Under this condition the pump will start with normal operation. The wiper position is used as reference point. The movement of the spindle is always stopped by hitting the wiper. This operation condition may damage the wiper or misalign the spindles.

❑ The pump head is reinstalled without initializing the pump.

  The pump still uses the previous determined position as the reference values for the pump. So when started the piston may run with full flow speed into the mechanical stop. This can crack the pistons.

  This problems can be avoided by:

  ❑ NOT running the pump without pump head installed (also not for test reasons).

  ❑ Always do a pump initialization when the pump head is re-installed.

Troubleshooting E27 Errors (Max Motor Drive Power Exceeded)

The E27 can have two reasons - a problem in the metering drive and also a blocked outlet ball valve.

- ❑ Blocked Outlet Ball Valve. It is possible that the valve is blocked (for example the pin on the ball canted). In such a case the first piston cannot deliver anything onto the high pressure side. The pressure in the first chamber rises to values far above 400 bar. This pressure in the first chamber cannot be detected by the pressure damper as it is located behind the outlet ball valve. The pump motor working against a too high pressure will exceed the maximum allowed drive power and gives error E27. This can also be an intermittent problem.

  Troubleshooting Procedure:

  - ❑ Remove outlet ball valve and let the pump run without the valve.
  - ❑ Replace the outlet ball valve and pump at high back pressure (restriction). Error E27 under this condition verifies metering drive problems. No error messages identify faulty outlet ball valves.

- ❑ Problem with Metering Drive. Possible problems on the metering drive are defective bearings defective motors or misalignment of the wipers.

  Troubleshooting Procedure

  - ❑ Proceed in the same way as described before. Intermittent motor problems might be identified.
  - ❑ Remove pump head and press down spindle by hand. This should be possible without too much resistance. High resistance indicates a bearing defect.
  - ❑ Remove metering covers and check for broken or loose wipers.

Piston with Conical Holder

Reports from the field and evaluation of returned parts showed that the spring in the piston housing can scratch at the piston holder and may generate a squeaking noise. This will not lead to a malfunction of the pump but the noise has lead to customer complaints.

The piston holder was changed and now has a conical shape. The spring should no longer scratch at the piston holder.

Ghost Leak messages

If the pump shows intermittent leak messages without any solvent in the leak tray you should check the following two points.

- Make sure that the leak sensor is not in close proximity of the plastic funnel. This can cool down the sensor to the trigger level resulting in ghost error messages.
- Check the revision of the CMP board. CMP boards with revision E and higher do have a improved leak sensor circuit installed. CMP boards with revision D or below can be modified by soldering two 100nF capacitors (0160-6623 or 0160-0576) between pin 12 and 11 and pin 12 and 9 of U45. U45 is the sixth IC in the bottom row of the board (main connector on right side). There are two fourteen pin IC beside each other. U45 is the right one.

PANIC Errors

Intermittent PANIC errors are mostly generated by spikes (disturbances) on the bus lines. A dynamic bus termination has been added to the FIM board to suppress the spikes and to reduce the possibility of this failure mode.

All firmware boards with revision C and higher do have the dynamic bus termination installed (RC-network instead of a R-network). In case of intermittent PANIC errors replace FIM boards (rev A or B) with the current version.

Agilent Technologies

In This Book

This manual contains technical information about the Agilent 1050 liquid chromatographs.

This manual is available as electronic version (Adobe Acrobat Reader file) only.