NORHOF LN2 Microdosing System #900 Series

Automatic advanced programmable Liquid Nitrogen Microdosing system

- Controllable LN2 flow, from some drops up to 1 liter/minute;
- Several LN2 level control possibilities:
  - one temperature sensor and time;
  - two temperature sensors (high and low level);
  - PID control with one temperature sensor;
  - Full remote control by software and PC
- Software monitoring and data logging possibility;
- Pressure-less flowing LN2, without spilling, noise, vibrations, etc.

Norhof LN2 microdosing systems

Norhof 900 series pump, mounted on a 35 Liter Dewar

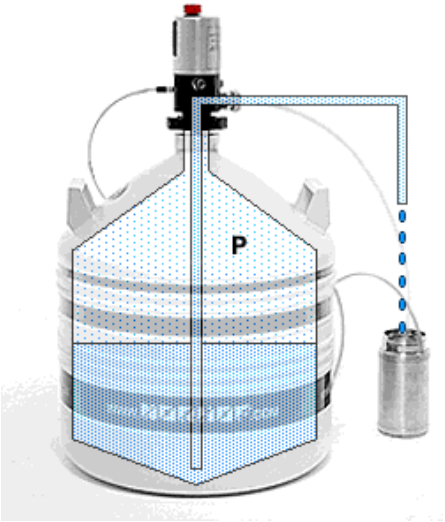
Norhof manufactures LN2 microdosing systems. Liquid Nitrogen (LN2) is used as the cooling medium and is taken from a storage vessel (Dewar) with low pressure (max. 300 mBar) and delivered (pumped) through a fill line to the application in a micro dosing way.

The Norhof LN2 microdosing system is designed to overcome the drawbacks of LN2 under pressure in which a solenoid valve is used to switch the supply ON / OFF. You may compare the Norhof system with a water tap, but instead of giving water, it gently gives liquid nitrogen, with an adjustable flow, possible to regulate from some drops, up to 1 Liter/minute. Our pump can pump LN2 up to 5 meters above the pump itself

Working principle

The pressure above the liquid level inside the Dewar is built by heating a small amount of liquid in the bottom of the Dewar.
With only up to 100 mBar of overpressure, the liquid will gentle rise out of the rise pipe and fall into the fill hose.
Because we evaporate some LN2 to build pressure, there is no adding of ice inside the Dewar, such as with manual systems which use air from the environment..

When LN2 is required, a small overpressure is generated by a small heater element in the LN2, and liquid flows out of the system like water from a tap, without spilling, noise, vibrations etc.



In these systems a pressure less storage Dewar is used as a reservoir for LN2. On the Dewar our unique automatic microdosing pump is mounted. Inside the housing of the pump a microprocessor is used to control the various actions, depending upon the mode selected. The selection of a particular mode is made by a 16-position switch, also located inside the pump housing.

By controlling the pressure at time of liquid transport, the flow is controlled and thus any temperature between ambient and -196°C can be realized.

Any #900 series model will work without modifications as:

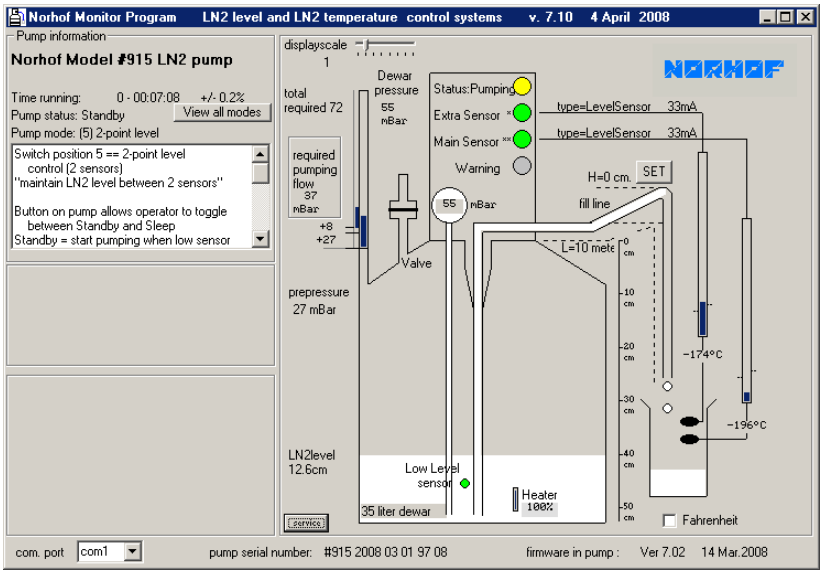
- autonomous stand-alone unit;
- direct remote controlled unit;
  (controlled by your existing PID controller, PLC, computer with A/D conversion card, etc.);
- will operate on any voltage between 12-24 V (AC or DC);
  or with our power supply (115V or 230 V);
- computer controlled unit (#915-series only) ;
- a system with almost no installation time required.

Thanks to our unique static pump design there is:

- no need for a pressurized supply of LN2;
- no need for a cryogenic solenoid valve ;
- no need for additional control instruments.

Software

To display sensor temperatures, vessel pressure, status of LED's on the pump etc. our Norhof Monitoring software is included with any #900 series pump. This software works under Windows '98 - 2000 - ME - NT - Vista - W7 – Windows 10



With each #915 system a software Datalogger function is included. This recorder allows you to document any parameter value over time

With each #915 system 2 application drivers are included. When you are familiar with Visual Basic 6.0 you simply look how our programs are written and use these as a guide for writing your own application driver.

Summary of #900 series

Model:	#905	#910	#915
autonomous operation	√	√	√
remote control by TTL signal	√	√	√
remote control by +24V signal	√	√	√
display system status on PC screen	√	√	√
control flow with 0-5 Volt external signal	-	√	√
control temperature setpoint with 0-5V external signal	-	√	√
control by desktop PC, RS232	-	-	√
make history file	-	-	√
control by direct RS232 commands	-	-	√

900 series Technical Specifications

Static evaporation rate	< 0,5 liters per day		
Flow rate	adjustable from 0.01mBar to 270 mBar (by potmeter on pump) == from dripping up to 0.5 Liter/minute (with a fill line of 2 meter and 4 mm ID)		
Maximum working pressure	< 300 mBar		
Reaction time	+/- 2 minutes for cooling down the fill line (with 2 meters fill line)		
Power connection	115V / 230V AC with supplied power supply or 12-24 Volt AC/DC		
Power consumption	average 5 Watts, during pumping 50 watts		
Storage container volume	**35 Liter**	**50 Liter**	**100 Liter**
Outside dimensions (diameter)	480	500 mm	500 mm
Height dimensions	791	875 mm	1235 mm
Weight (empty, full)	13 / 41,5 kg	17 / 57,5 kg	32 / 113 kg
Standard fill line	6.25 mm OD, 4 mm ID PTFE tube, with 32mm foam insulation		
System includes	Dewar, pump, fill line 2.00 m, phase separator, power supply, cables level sensors, PC software.		
Working modes	#905, working mode 1 to 7 for level control #910, working mode 1 to D including temperature control #915, working mode 1 to F including full RS232 control		
External control	#905, 5 volt signals for ON, OFF and RS232 signals for ON, OFF #910 and #915, more signals to control, depending on mode		
PC software	Monitor software, to monitor pump behavior, and for some working modes to adjust some parameters. For #915 advance pump utilities and software for RS232 control		
Alarms/warning acoustical/ visual / mechanical	Dewar empty, Dewar 5 liters LN2 left, broken sensor(s), frozen alarm, mechanical overpressure protection valve.		
Options	Transport trolley 5 wheels (10 cm height) Stand for pump (when Dewar is refilled) Custom built adaptor to fixate sensor(s) on application		

All #900 models look the same from the outside and can be internally set in different working modes for the application. All models can be connected to a PC in order to display the status of the system. The software + hardware needed to do this is included with each pump.

900 series advantages:

- **there is no LN2 valve required;**
  that implies no unnecessary heat input
- **there is no additional control unit required;**
  which adds to a clean and elegant setup
- **the pump is software driven and many control modes are already built-in;**
  1-point level control, 2-point level control, timer based control, subzero temperature control, flow control by 0-5V input, control by RS232 line, etc.
- **level or temperature sensors are plugged directly into the pump housing;**
  and not into a separate control box
- **the system can deliver LN2 liquid with a flow optimized for the application;**
  without noise, vibration, excessive waste, etc.
- **the variable flow feature makes subzero temperature control extremely easy;**
  see the website under SOFTWARE > sample drivers > freeze curve
- **the system is prepared to be connected to a PC;**
  perfect for monitoring and data logging or remote control
- **P.E.D. 99/36/EC (Pressure European Directive) for pressurized vessels does not apply for this system;**
  The maximum possible pressure is lower than 300mBar.Therefore this system is allowed to be used inside the lab, near your working place, without danger.

900 series applications

Over the years we encountered various applications for LN2 cooling and came to realize that cooling applications can generally be divided in level control and temperature controlled applications:

Level controlled applications (#905 pump):

- filling cold traps in vacuum systems;
- filling biological storage vessels;
- filling various small vessels one after the other at the press of a button;
- filling actions at timer set intervals;
- maintaining a certain level around 1 sensor;
- maintaining a level between 2 sensors.

In this kind of applications a system is used to transfer liquid from the storage vessel to the application at a given rate, until a sensor or other signal (e.g. switch or timer) stops the flow. This implies "on-off" control of the liquid flow, this with a flow which can be extremely gentle if necessary.

Temperature controlled applications (#910 and #915 pump):

- thermal analysis systems;
- computer controlled freezing;
- gas chromatography;
- temperature stages in microscopes;
- sub-zero temperature control systems;
- stopping chemical reactions;
- cooling of targets, IR cells, cuvettes etc.

In these applications a system is used in a micro-dosing way to bring just enough "cold" to the application as is needed, more at first to achieve the required sub-zero temperature and later less to maintain the temperature. This implies flow control in an analogue fashion of "more-less" based on temperature measurement.

Each system is designed to be truly universal. It's various built-in modes of operation is of paramount importance for OEM and research applications as one system covers almost all possible needs for cooling, without the need for additional valves, control instruments etc. This means that standardisation within the facility is no longer wishful thinking, despite the various applications.

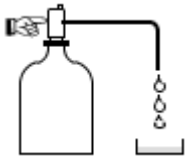
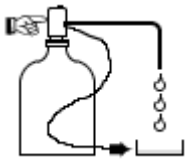
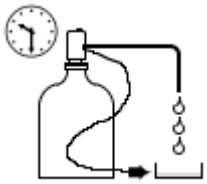
For any system a host of control possibilities are foreseen. This makes it possible to control a system from existing analytical equipment, PLC's, simple switches, computers etc. almost without any adaptations.

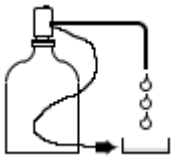
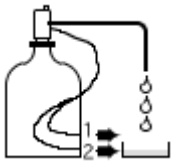
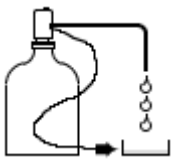
900 series working modes explanation

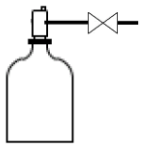
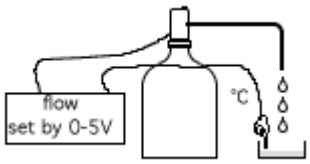
On the PCB in the pump, under the cap, is a 16-position switch to select the working mode. This working mode determines how the pump reacts on the sensor, button, RS232 signals, etc.

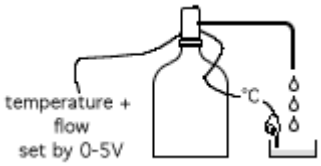
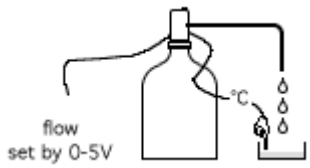
Each working mode is designed for a specific function.

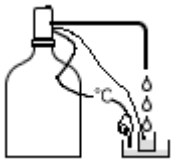
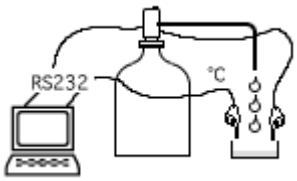
You must select a working mode (only once) to let the working correspond with your application.

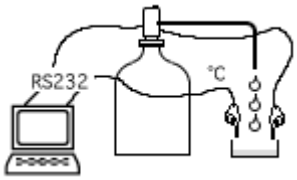
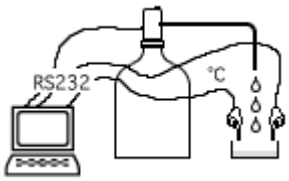
Working mode	Description	Details
model #905,910,915 **<u>Working mode 1</u>** straight pumping mode (no sensors) 	**deliver LN2 as controlled by pumpbutton or external signal**	Button on pump allows operator to toggle between Active and Sleep Active = pumping on Sleep = stop Active, set internal freeze protector ON to prevent ice clogging in riser pipe pump can be put in ACTIVE mode with TTL signal or +24V signal on 25D connector pump can be put in SLEEP mode with TTL signal or +24V signal on other pin of 25D connector FLOWRATE is set by potmeter on pump
model #905,910,915 **Working mode 2** FILL control (1 sensor) 	**fill various vessels, one after the other**	Button on pump allows operator to toggle between Active and Sleep Active = pumping on as long as sensor is warm, stop pumping when sensor is cold, return to sleep Sleep = stop Active, set internal freeze protector ON to prevent ice clogging in riser pipe pump can be put in ACTIVE mode with TTL signal or +24V signal on 25D connector pump can be put in SLEEP mode with TTL signal or +24V signal on other pin of 25D connector FLOWRATE is set by potmeter on pump
model #905,910,915 **Working mode 3** automatic FILL control with timer (1 sensor) 	**fill application repeatedly with timer**	Button on pump allows operator to toggle between Active and Sleep Active = start pumping on as long as sensor is warm, stop pumping when sensor is cold, repeat after 1* hour Sleep = stop Active, reset timer, set internal freeze protector ON to prevent ice clogging in riser pipe pump can be put in ACTIVE mode with TTL signal or +24V signal on 25D connector pump can be put in SLEEP mode with TTL signal or +24V signal on other pin of 25D connector FLOWRATE is set by potmeter on pump *NOTE: timer setting can be changed in display screen on a computer in steps of 1 minute between 5 minutes minimum and 7 days maximum *NOTE: for this application the EXTRA sensor connection must be used

Working mode	Description	Details
model #905,910,915 **Working mode 4** 1-point level control (1 sensor) 	**maintain LN2 level at sensor height**	Button on pump allows operator to toggle between Active and Sleep Active = pumping as long as sensor is warm, not pumping when sensor is cold Sleep = stop Active, set internal freeze protector ON to prevent ice clogging in riser pipe pump can be put in ACTIVE mode with TTL signal or +24V signal on 25D connector pump can be put in SLEEP mode with TTL signal or +24V signal on other pin of 25D connector FLOWRATE is set by potmeter on pump
model #905,910,915 **Working mode 5** 2-point level control (2 sensors) 	**maintain LN2 level between 2 sensors**	Button on pump allows operator to toggle between Active and Sleep Active = start pumping when low sensor is warm, not pumping when high sensor is cold Sleep = stop Active, set internal freeze protector ON to prevent ice clogging in riser pipe pump can be put in ACTIVE mode with TTL signal or +24V signal on 25D connector pump can be put in SLEEP mode with TTL signal or +24V signal on other pin of 25D connector FLOWRATE is set by potmeter on pump
model #905,910,915 **Working mode 6** 1-point level flow control (1 sensor) 	**maintain LN2 level at sensor height, keep dripping to hold that level**	Button on pump allows operator to toggle between Standby and Sleep Standby = pumping as long as sensor is warm, slower pumping when sensor is almost cold, stop pumping when sensor is completely cold Sleep = stop Standby, set internal freeze protector ON to prevent ice clogging in riser pipe pump can be put in STANDBY mode with TTL signal or +24V signal on 25D connector pump can be put in SLEEP mode with TTL signal or +24V signal on other pin of 25D connector FLOWRATE is set by potmeter on pump

Working mode	Description	Details
model #905,910,915 **Working mode 7** internal pressure control 	**Maintain LN2 pressure on a stable level in the supply line to an external valve**	Button on pump allows operator to toggle between Active and Sleep Active = pumping on Sleep = stop Active, set internal freeze protector ON to prevent ice clogging in riser pipe pump can be put in ACTIVE mode with TTL signal or +24V signal on 25D connector pump can be put in SLEEP mode with TTL signal or +24V signal on other pin of 25D connector PRESSURE is set by potmeter on pump
model #910,915 **Working mode 8** local temperature control (1 sensors) 	**deliver LN2 as controlled by temperature setpoint on pump, or external analogue 0-5V signal**	Button on pump allows operator to toggle between Active and Sleep Active = pumping as long as sensor is above- , not- or soft-pumping when sensor is below temperature setpoint (*1) pumping flow is depending of the speed of the temperature changes. (P.I.D.) Sleep = stop Active, set internal freeze protector ON to prevent ice clogging in riser pipe pump can be put in ACTIVE mode with TTL signal or +24V signal on 25D connector pump can be put in SLEEP mode with TTL signal or +24V signal on other pin of 25D connector FLOWRATE is set by potmeter on pump (*1)temperature setpoint is depending on jumper setting JP7 (*2)range is depending on jumper setting JP6JP6 open = range -200 to +70 degrees CelciusJP6 closed = range +/- 30 degrees relative to potmeter P1 on print
model #910,915 **Working mode 9** FLOW control by external signal (no sensors) 	**deliver LN2 as controlled by external analogue 0-5V signal**	Button on pump allows operator to toggle between Active and Sleep Active = pumping with flow as set by external 0-5 volt signal (0 volt = stop pumping)(*1) Sleep = stop Active, set internal freeze protector ON to prevent ice clogging in riser pipe pump can be put in ACTIVE mode with TTL signal or +24V signal on 25D connector pump can be put in SLEEP mode with TTL signal or +24V signal on other pin of 25D connector Maximum FLOWRATE is set by potmeter on pump (*1) external analogue signal on pin 10 of 25 p D connector delivers a flow depending on the setting of the flow potmeter on the pump 0 - 5 Volt delivers 0 - 100% of the adjustment of the Flow Potmeter on the pump.

Working mode	Description	Details
model #910,915 **Working mode A** remote temperature control (1 sensor)  	**deliver LN2 as controlled by external analogue 0-5V signal(s)**	Button on pump allows operator to toggle between Active and Sleep Active = pumping as long as sensor is above- , not- or soft-pumping when sensor is below temperature setpoint(*1) pumping flow is depending of the speed of the temperature changes. (P.I.D.) Active = when pumping, use maximum flow as set by external 0-5 volt signal (0 volt = stop pumping)(*3) Sleep = stop Active, set internal freeze protector ON to prevent ice clogging in riser pipe pump can be put in ACTIVE mode with TTL signal or +24V signal on 25D connector pump can be put in SLEEP mode with TTL signal or +24V signal on other pin of 25D connector Maximum FLOWRATE is set by potmeter on pump (*1)temperature setpoint is depending on jumper setting JP7 (*2)range is depending on jumper setting JP6JP6 open = range -200 to +70 degrees CelciusJP6 closed = range +/- 30 degrees relative to potmeter P1 on print (*3) external analogue signal on pin 10 of 25 p D connector delivers a flow depending on the setting of the flow potmeter on the pump 0 - 5 Volt delivers 0 - 100% of the adjustment of the Flow Potmeter on the pump. (*4) external analogue signal for temperature setpoint 0 - 5 Volt gives a setpoint from -200 to +70ºC according PT100 characteristics
model #910,915 **Working mode B** FLOW control by external signal (and 1 sensor)  	**deliver LN2 as controlled by external analogue 0-5V signal and 1 sensor**	Button on pump allows operator to toggle between Active and Sleep Active = pumping with flow as set by external 0-5 volt signal (0 volt = stop pumping)(*1) pumping as long as sensor is warm, not pumping when sensor is cold Sleep = stop Active, set internal freeze protector ON to prevent ice clogging in riser pipe pump can be put in ACTIVE mode with TTL signal or +24V signal on 25D connector pump can be put in SLEEP mode with TTL signal or +24V signal on other pin of 25D connectorMaximum maximum FLOWRATE is set by potmeter on pump (*1) external analogue signal on pin 10 of 25 p D connector delivers a flow depending on the setting of the flow potmeter on the pump 0 - 5 Volt delivers 0 - 100% of the adjustment of the Flow Potmeter on the pump.

Working mode	Description	Details
model #910,915 **Working mode C** local temperature control (2 sensors) 	**deliver LN2 as controlled by temperature setpoint on pump, or external analog 0-5V signal, and extra sensor for STOP**	Button on pump allows operator to toggle between Active and Sleep Active = pumping as long as sensor is above- , not- or soft-pumping when sensor is below temperature setpoint (*1). Pumping as long as extra sensor is warm, not pumping when extra sensor is cold. Pumping flow is depending of the speed of the temperature changes. (P.I.D.) Sleep = stop Active, set internal freeze protector ON to prevent ice clogging in riser pipe pump can be put in ACTIVE mode with TTL signal or +24V signal on 25D connector pump can be put in SLEEP mode with TTL signal or +24V signal on other pin of 25D connector FLOWRATE is set by potmeter on pump (*1)temperature setpoint is depending on jumper setting JP7 (*2)range is depending on jumper setting JP6. JP6 open = range -200 to +70ºC. JP6 closed = range +/- 30 degrees relative to potmeter P1 on print
model #915 **Working mode E** remote temperature control (1 sensor controls pumping, additional sensor optional for measurement) 	**deliver LN2 as controlled by external RS232 signals and 1 sensor**	Button on pump allows operator to toggle between Active and Sleep Active = pumping as long as sensor is above- , not- or soft-pumping when sensor is below temperature setpoint as set by RS232 signal Pumping flow is depending of the speed of the temperature changes. (P.I.D.) input RS232 signal for temperature setpoint(*1) input RS232 signal for flow(*2) input RS232 signal for pumping status SLEEP, ACTIVE output RS232 signal from pump status output RS232 signal from both sensors output RS232 signal from maximum flow setting on pump output RS232 signal from setpoint output RS232 signal from pressure, LED status, Beeper Sleep = stop Active, set internal freeze protector ON to prevent ice clogging in riser pipe pump can be put in ACTIVE mode with TTL signal or +24V signal on 25D connector

Working mode	Description	Details
model #915 **Working mode E** remote temperature control (1 sensor controls pumping, additional sensor optional for measurement)  	**deliver LN2 as controlled by external RS232 signals and 1 sensor**	pump can be put in SLEEP mode with TTL signal or +24V signal on other pin of 25D connector Maximum FLOWRATE is set by potmeter on pump (*1) input RS232 signal for temperature setpoint -200 to 50 gives a setpoint from -200 to +50ºC. (*2) input RS232 signal for flow delivers a flow depending on the setting of the flow potmeter on the pump. 0 - 100 delivers 0 - 100% of the adjustment of the Flow Potmeter on the pump.
model #915 **Working mode F** remote temperature control (2 sensors optional for measurement)  	**deliver LN2 as controlled by external RS232 signals**	Button on pump allows operator to toggle between Active and Sleep Active = pumping as dictated by RS232 signals input RS232 signal for flow (*1) input RS232 signal for pumping status SLEEP, ACTIVE, PUMPING output RS232 signal from pump status output RS232 signal from both sensors output RS232 signal from maximum flow setting on pump output RS232 signal from pressure, LED status, Beeper Sleep = stop Active, set internal freeze protector ON to prevent ice clogging in riser pipe pump can be put in ACTIVE mode with TTL signal or +24V signal on 25D connector pump can be put in SLEEP mode with TTL signal or +24V signal on other pin of 25D connector (Maximum FLOWRATE is NOT set by potmeter on pump) (*1) input RS232 signal for flow 0 - 250 delivers a flow from 0 to 250 mBar.

900 series 25 p Dconn pins
1=14 AC1 AC or DC 12 to 24 Volts Power supply (min. 4 A.) **13=25** AC2 AC or DC 12 to 24 Volts Power supply (min. 4 A.) **17=18=19=20** system ground **8** RXD serial connection **9** TXD serial connection **4** TTL_1 input, 0 or 5 Volt, 0 Volt = switch pump to SLEEP **5** TTL_2 input, 0 or 5 Volt, 0 Volt = switch pump to ACTIVE **10** ext. flow input, analog 0-5 Volt **11** ext. temp setpoint input, analog 0-5 Volt **6** ext. EXTRA sensor input (PT100 element) to ground **7** ext. MAIN sensor input (PT100 element) to ground **15** opt1C optocoupler input 1 neg. **2** opt1A optocoupler input 1 pos. : 0 or 5-24 Volt input. 5-24 V. to switch pump to ACTIVE **16** opt2C optocoupler input 2 neg. **3** opt2A optocoupler input 2 pos. : 0 or 5-24 Volt input. 5-24 V. to switch pump to SLEEP (*) connect C to ground and supply positive signal to A to switch (*) OR, connect A to ground to use negative signal on C to switch **12** output TTL 5 Volt external heater LOW = active (*) **21** optEXH1E optocoupler output emitter for external heater (*) **22** optEXH1C optocoupler output collector for external heater (*) **23** optAL2E optocoupler output emitter ALARM **24** optAL2C optocoupler output collector ALARM (*) connect E = emitter to ground to switch a positive signal (*) OR, connect C = collector to ground to switch a negative signal