

KrosFlo[®] MiniKros **P I L O T**



Product Information and Operating Instructions

Spectrum's KrosFlo® MiniKros Pilot System meets strict quality control standards and is warranted against defects in material and workmanship for a period of one (1) year from date of purchase.

The information contained herein is believed to be accurate and is offered in good faith for the convenience of the user. PRODUCTS ARE FURNISHED UPON THE CONDITION THAT THE USER ASSUMES ALL RISKS AND LIABILITIES AND THAT NEITHER THE SELLER NOR MANUFACTURER SHALL BE LIABLE FOR ANY LOSS OR DAMAGE, DIRECT OR CONSEQUENTIAL, ARISING FROM THE USE OF THESE PRODUCTS.

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Introduction

Spectrum's MiniKros® Pilot TFF System is ideal for the control & optimization of disposable bioseparation processes ranging from 10 to 1000 liters. This "all-in-one" process system combines a digitally controlled 26 LPM capacity peristaltic pump, a pressure & flow monitor w/ auto shut-off control and real-time data collection software into a single and efficient filtration system. Spectrum's KF Comm is an Excel based software that records & graphs inlet, outlet, permeate and TMP pressures as well as recirculation & permeate flow rates and provides 5 user-defined pressure alarms with auto pump shut-off. Integrate the MiniKros® Pilot System with KrosFlo® hollow fiber modules and KrosFlo® MBTs (Module-Bag-Tubing) to create a completely disposable filtration system.

The function, set-up and use of the major components will be described in Sections I-III of this manual.

KrosFlo® MiniKros® Pilot System Components

- **Peristaltic Pump Console w/ Integrated Pressure & Flow Monitors**
- **Pump Head**
- **Filter Stand**
- **Flow Meter**
- **RS232 Extension Cable for connection to PC**
- **Digital Pressure Transducers (ACPM-499-03N – 3/pk)**
- **Octopus Cable**
- **Power Cable**
- **KF Comm Software CD**
- **Manual**

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Section I.A - MiniKros Pilot Pump Drive

1. Safety Precautions

DANGER:  High voltages exist and are accessible in the KrosFlo® MiniKros Pilot System. Use extreme caution when servicing internal components.

WARNINGS:  Tubing breakage may result in fluid being sprayed from pump. Use appropriate measures to protect operator and equipment.
Turn drive off before removing or installing tubing. Fingers or loose clothing may get caught in drive mechanism.

CAUTION:  Power must be turned off before connecting the external remote control cable to prevent damage to the drive.

CAUTION:  To avoid electrical shock, the power cord protective grounding conductor must be connected to ground. Not for operation in wet locations as defined by EN 61010-1.

CAUTION:  Risk of crushing. Keep fingers away from rotor while pump is in operation. Stop pump before loading or unloading tubing.

Explanation of Symbols

CAUTION:  Risk of Danger. Consult Operating Instructions for nature of hazard and corrective actions.

CAUTION:  Risk of electric shock. Consult Operating Instructions for nature of hazard and corrective actions.

WARNING: PRODUCT USE LIMITATION

This product is not designed for, nor intended for use in patient connected applications; including, but not limited to, medical and dental use, and accordingly has not been submitted for FDA approval.

2. Specifications

Output:

Speed:	1 to 650 rpm
Torque Output, Maximum:	
Continuous	580 oz-in (41.8 kg•cm)
Start-up	1750 oz-in (126 kg•cm)
Speed Regulation:	
Line	±0.25% F.S.
Load	±0.25% F.S.
Drift	±0.25% F.S.
Display:	Four-digit and three-digit, seven-segment LED

Construction:

Dimensions (L x W x H):	18 3/8" x 11" x 17" (467 cm x 279 cm x 432 cm)
Weight:	70 lb (31.7 kg)
Enclosure Rating:	IP 66 per IEC 529/NEMA 4v (Indoor Use)

Environment:

Temperature, Operating:	0° to 40° C (32° to 104° F)
Temperature, Storage:	-25° to 65° C (-13° to 149° F)
Humidity:	10% to 100%
Altitude:	2000 m or less
Pollution Degree:	Pollution Degree 3 (Indoor use – sheltered locations)
Chemical Resistance:	Enclosure in 316 stainless steel

Compliance:

UL508C, CSA C22.2, No. 14
(For CE Mark):
EN61010-1 (EU Low Voltage Directive) and
EN61326 (EU EMC Directive)

3. Introduction

The KrosFlo® MiniKros Pilot Pump Drive is used in conjunction with the KrosFlo® MiniKros Pilot Pump Head to provide flow rates from 0.12 to 17 LPM or 26 LPM with two pump heads.

The pump drive can be used to operate a single pump head or two pump heads in tandem to generate two separate flowstreams.

4. Pump Control/Display Functions

1. Press keys to activate function.
2. Use up/down (▲, ▼) arrow keys to correct or change a flashing display.
3. Press any key to enter new values.

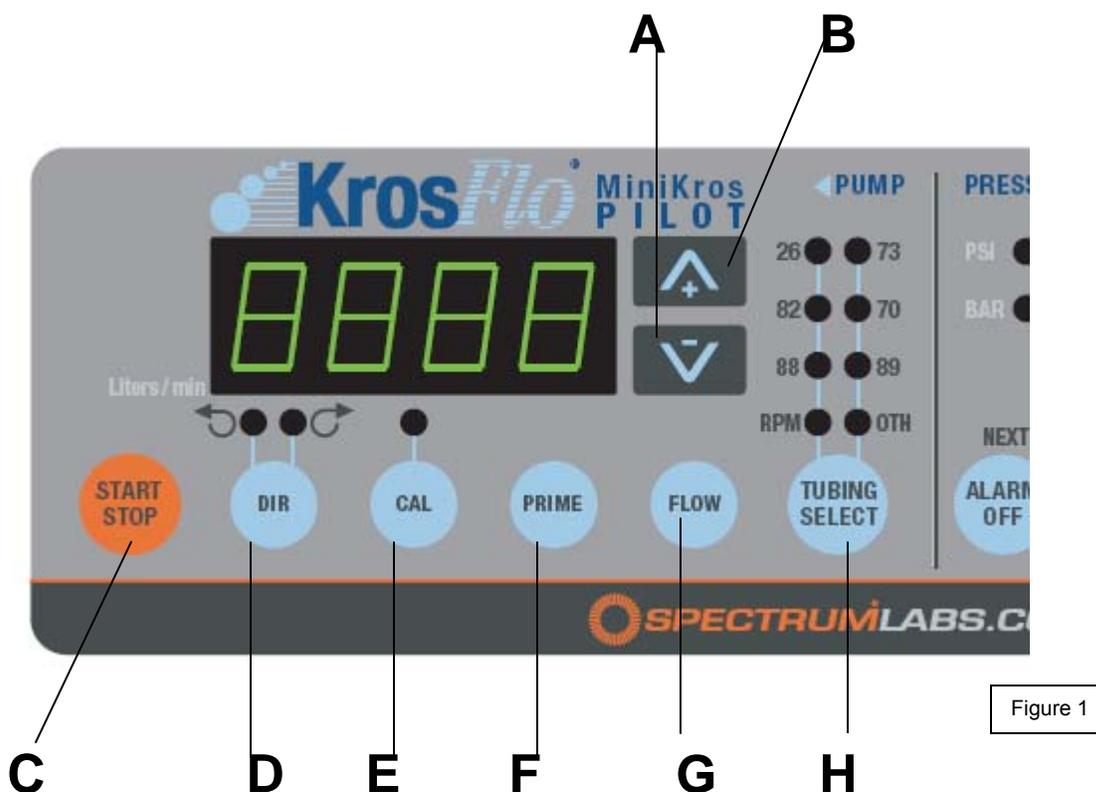


Figure 1

- A. DOWN ARROW (DECREMENT): Decrease value of a flashing display.
- B. UP ARROW (INCREMENT): Increase value of a flashing display.
- C. START/STOP: Start or stop motor.
- D. DIRECTION: Change motor direction; toggles between clockwise (CW) & counter-clockwise (CCW).
- E. CALIBRATION CONTROL: Refine built-in calibration, using a measured volume.
- F. PRIME: Run pump at full speed to fill or clear lines.
- G. FLOW CONTROL: Set flow rate for selected tubing size. To change flow rate, press ▲, ▼ arrow keys. (If pump is running, its speed will change with new settings.)
- H. TUBING SELECT: Select tubing size.

5. Setup and Drive Operation

1. Mount KrosFlo® MiniKros Pilot Pump Head (if not attached), and load tubing (refer to Section I.B. Pump Head operating instructions).
2. Connect power cord to controller and grounded power line outlet.
3. Turn pump on and select tubing SIZE.

NOTE: If CAL LED is lit, that tubing size has been previously field calibrated. If LED is not lit, the drive is operating with the built-in factory calibration. To clear a field calibration, press and hold the CAL switch until the CAL light goes out. This will take about 3 seconds. To recalibrate for better accuracy, refer to following Calibration section.

4. Select motor DIRection (CW or CCW).
5. PRIME and CALibrate the pump (if required).
6. Press FLOW key and watch display to set the flow rate with UP/DOWN (▲, ▼) arrow keys.
7. Press START/STOP key to begin pumping.

NOTE: Normally, pump will not restart automatically after a brownout or powerout condition.

AUTOMATIC START ENABLE/DISABLE

Press and hold START/STOP on power-up. After five (5) seconds, display will change to all dashes. Then, while holding START/STOP, press PRIME five (5) times. Display will flash "ON" or "OFF". Use UP/DOWN (▲, ▼) arrow keys to set automatic start option. Press any other key to exit. When "ON" is selected, pump will start automatically at power-up if it was "ON" when powered down.

6. Calibration

6.1 Standard Tubing

1. Select correct tubing size and flow rate.
2. Press CAL, calibration volume appears.
3. Press START/STOP, the pump will use its stored memory to dispense the specified calibration sample quantity. The pump will stop automatically.
4. Weigh/measure the sample.
5. Use UP/DOWN (▲, ▼) arrow keys to correct the volume on the flashing display.

NOTE: If the adjusted calibration is too great, "Err" will appear in the display. If this occurs, press the CAL control and repeat the calibration procedure. The microprocessor will retain one special calibration value per tubing size, even when power is turned off. The next calibration will replace the existing value.

6. Press TUBING SELECT to exit the calibration cycle.

6.2 Maximum Flow Rate for Other Tubing

1. Press TUBING SELECT to select OTH.
2. To set the maximum flow rate for non-standard pump heads or tubing sizes, press CAL, then FLOW. The maximum flow rate will then flash on the display.
3. Use UP/DOWN (▲, ▼) arrow keys to set desired flow rate.
4. Press TUBING SELECT to exit.

7. Keypad Lock Enable/Disable

Press and hold FLOW. After five (5) seconds, display will change to all dashes. Then, while holding FLOW, press PRIME five (5) times to enable or disable the keypad lock.

8. Troubleshooting & Maintenance

8.1 Fuse Replacement

1. Place the power switch in the off position.
2. Disconnect the AC power input line cord from the receptacle.
3. Remove and check the fuse and replace if defective.
4. Reconnect the AC power input line cord to the receptacle.

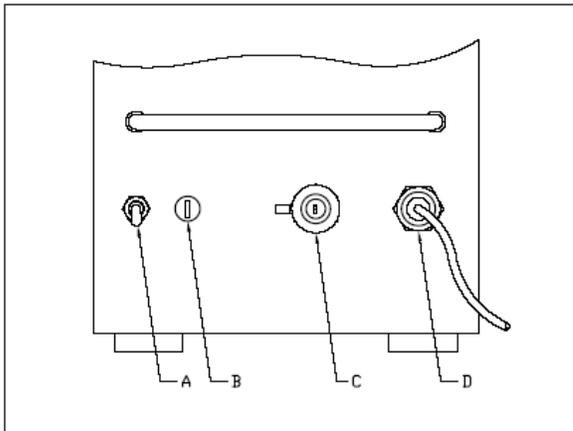


Figure 2: REAR PANEL

- A. Power Switch – All settings are retained in memory
- B. T6.3A Fuse
- C. 18 Pin Connector for Octopus Cable
- D. IEC 320 Power Cord

8.2 Troubleshooting

For problems arising during pump drive operation, refer to the following list for possible corrective actions you can take. If these do not correct the problem, contact your dealer.

SYMPTOM	CAUSE	REMEDY
Motor does not rotate. Display does not light.	No power	<ol style="list-style-type: none"> 1. Check fuse and replace if defective. 2. Check that unit is plugged into a live power supply. 3. Check connection of power cord. 4. Check the line cord for continuity and replace if defective. 5. Return for servicing.

8.3 Error Messages

If an error message is displayed, refer to the following list for possible corrective actions you can take. If these do not correct the problem, contact your dealer.

ERROR MESSAGE	CAUSE	REMEDY
"Err 2"	Motor over-speed	<ol style="list-style-type: none"> 1. Clear by pressing any key. 2. Check for proper tube loading and pump operation. 3. Return unit for repair if the error persists.
"Err 3" "Err 5" "Err 12"	Overload	<ol style="list-style-type: none"> 1. Clear by pressing any key. 2. Check for proper tube loading and pump operation. 3. Return unit for repair if the error persists.

“Err 7”	Bad data. Operator parameters set to default values.	<ol style="list-style-type: none"> 1. Clear by pressing any key. 2. Reprogram operating parameters. 3. Return unit for repair if the error persists.
“Err 10” “Err 11”	Voltage out of range	<ol style="list-style-type: none"> 1. Clear by pressing any key. 2. Check that AC line voltage is within specified voltage ranges. 3. Return unit for repair if AC line voltage is correct & error persists.
“Err 13” “Err 14”	Over temperature	<ol style="list-style-type: none"> 1. Check for heat sources or obstructions to cooling. 2. Check for proper tube loading and pump operation. 3. Allow unit to cool. Clear by pressing any key. 4. Return unit for repair if no cause for overheating is found and the error persists.
All other errors	Internal error or failure	<ol style="list-style-type: none"> 1. Clear (if possible) by turning power off and on. 2. Return unit for repair if the error persists.

8.4 Cleaning

Keep the drive enclosure clean with mild detergents. Do not immerse.

Section I.B - MiniKros Pilot Pump Head

1. Introduction and General Description

The MiniKros Pilot Pump Head when combined with the MiniKros Pilot Pump Drive is designed to provide a simple easy-to-use peristaltic pump system. The Pump Head accepts 3 different tubing sizes for a wide range of flow rates. The unique over-center cam design and automatic tubing retention allows quick tubing changes and greatly reduced maintenance time. Each pump comes with one mounting hardware package. A flat-bladed screwdriver is required to complete installation.

2. Specifications

Typical Flow, Pressure and Vacuum Data—3 roller pumps

MasterFlex I/P Tubing	Flow rate*		Discharge Pressure*		Vacuum*	Suction Lift*
	@ 20 rpm L/Rev	@ 650 rpm L/min	Continuous psig (bar)	Intermittent psig (bar)	@ 650 rpm in (mm) Hg	@ 650 rpm ft (m) H ₂ O
I/P ® 26	0.12	4	25 (1.7)	40 (2.7)	26 (660)	29 (8.8)
I/P ® 73	0.2	8	25 (1.7)	40 (2.7)	26 (660)	29 (8.8)
I/P ® 82	0.4	13	10 (0.7)	20 (1.4)	24 (610)	27 (8.2)

Number of rollers:	3
Occlusion:	Adjustable (with Knob on top of Pump Head)
Maximum pump speed (rpm):	650
Nominal torque load—Starting:	Up to 180 oz-in (13 kg-cm)
Nominal torque load—Running:	Up to 120 oz-in (9 kg-cm)
Housing materials:	Polysulfone (PS)
Roller / Rotor materials:	Stainless steel (SS)
Temperature, Operating ‡:	32°F to 104°F (0°C to 40°C)

*For NORPRENE®, PHARMED®, and TYGON® tubing. Values will be less with silicone and C-FLEX®. Flow rate and discharge pressure will vary based on tubing size, formulation, and operating temperature. The chart above is only a guide.

‡ Use in this temperature range for continuous duty operation with no decrease in performance or product life. Pump heads will work outside this range with some possible reduction in performance or product life.

3. Drive Setup

Mount the pump head (if detached) using the 5 screws provided.

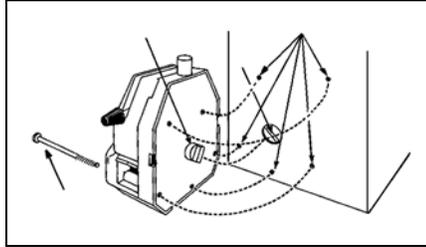


Figure 3

NOTE: Raise occlusion bed to expose mounting holes for top 2 short screws

4. Tube Loading

1. Be sure the pump drive is turned off.
2. Move the lever to the left to open the pump.
3. Load the correct tubing. (Figure 4)
4. Move the lever to the right to close. (Figure 5)



Figure 4

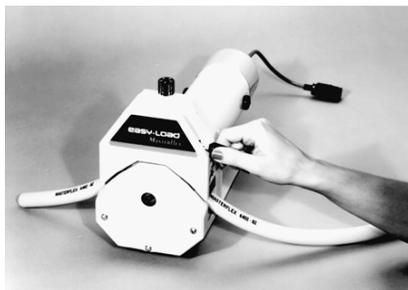


Figure 5



WARNING: Stop the drive when changing the tubing or its position in the rotor mechanism (the rotor is partially exposed when the **LOADING LEVER** is in the open position).

NOTE: For optimum tubing life, keep tubing straight when entering and exiting pump.

5. Occlusion Adjustment

Adjust occlusion setting on top of pump head.



Figure 6

“3” for nominal performance

“4” or “5” for increased pressure/vacuum with reduced tubing life

“1” or “2” for longer life with less pressure and vacuum.

NOTE: For optimum performance turn knob to “1” after loading. Start drive and adjust knob until pump primes and fluid begins to flow.

NOTE: Occlusion usually does not need to be readjusted when changing tubing.

NOTE: After operation for some time, the retainer teeth may scratch or mark the surface of the tubing. This is normal and will not cause leaks or otherwise reduce the tubing life.

6. Multi-Channel Mounting

MiniKros Pilot Pump Heads can be mounted in tandem. Special mounting hardware is required for the add-on head. This hardware is included when a second pump head is purchased (See Figure 7).

See SECTION IV for replacement parts and accessories.

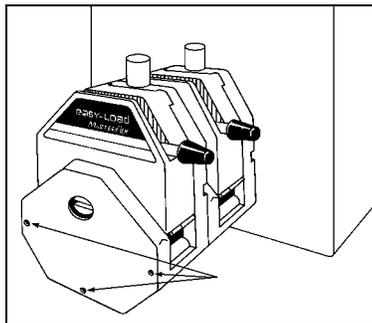


Figure 7



CAUTION: DO NOT OVERTIGHTEN SCREWS OR WING NUTS.

NOTE: The tubing on the inside pump head can be changed without removing the outside pump head.

7. Maintenance and Cleaning

No lubrication is required for the MiniKros Pilot Pump Head. Use a mild detergent solution to clean the pump head.

8. Dual Pump Head

A separate pump head can be purchased separately (Cat.No. ACM3-H3S-01N) and mounted to the first pump head. The ACM3-H3S-01N comes with the proper mounting screws and hardware for attaching the dual pump heads.

Section I.C - MiniKros[®] Pilot Filter Stand

1. Materials of Construction

Component	Material
Base	316 SS
Rod	316 SS
Cap	316 SS
Module Supports	Delrin

2. Setup and Use

Please refer to the included assembly instructions.

Two module supports for holding KrosFlo size modules and two module supports for holding MiniKros size modules are included. Use only one set at a time. Insert the middle section of the filter into the supports and move the supports toward the end of the filters until they stop against the end caps for a secure fit.

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II. MiniKros Pilot Pressure / Flow Monitor

1. Introduction

During tangential flow filtration, the MiniKros® Pilot Pressure/Flow Monitor, built into the pump drive, performs several important functions that greatly enhance process control, facilitate scale-up and optimize product recovery. These functions include High and Low Pressure Alarms, High Pressure Stop (pump shut-off) and direct output of pressures and flow rates into Microsoft® Excel®. The user defined pressure alarm and shut-off points are safety features that help ensure maximum sample recovery and help protect membrane integrity. The MiniKros® Pilot Pressure Monitor also comes with KF Comm, a software program that allows the user to collect real time data from the pump and pressure monitor into Microsoft® Excel® spreadsheet format. The Inlet, Retentate, Permeate and Transmembrane pressures (TMP) along with feed and permeate flow rates are recorded at user defined time intervals eliminating the need for manual recording most parameters. In doing so, this monitor enables quick analysis using Excel® graphs and facilitates optimization, scale-up and process documentation. This section explains the functions and setup of the Pressure and Flow Monitor.

2. Panel Controls and Features

Pressure / Flow Monitor

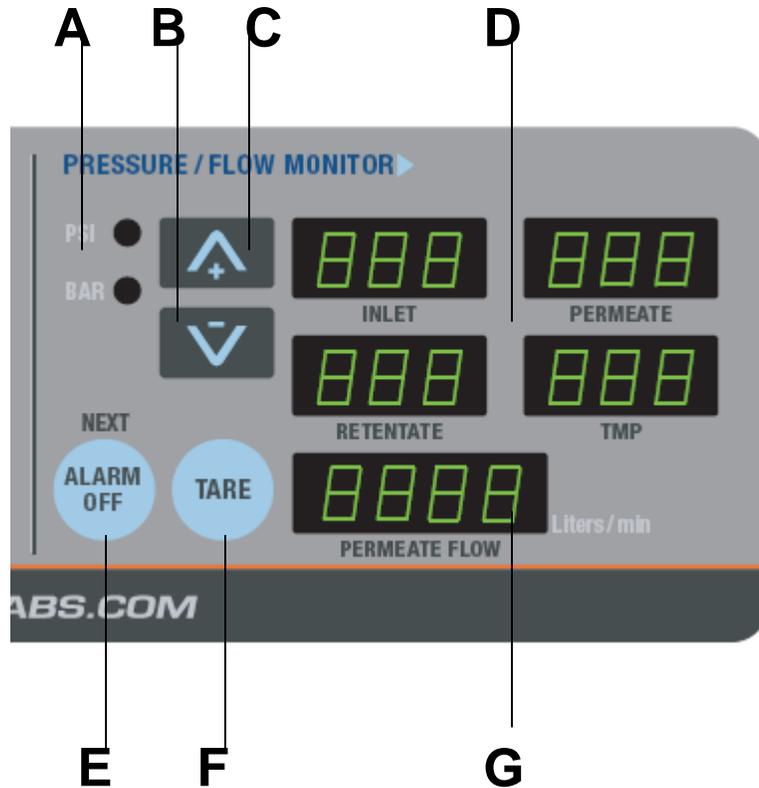


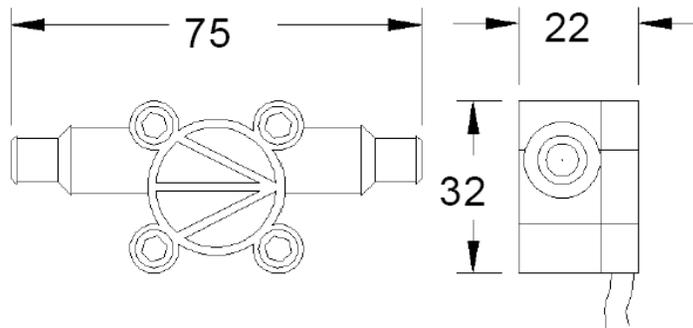
Figure 1 Front panel – Pressure / Flow Monitor

- A. **PRESSURE UNIT INDICATORS:** One of the two indicators will be lit to indicate the units of pressure, “PSI” or “BAR” for the displayed measurements. The pressure units may be changed during the Pressure Monitor Setup (see Section II.4).
- B. **DOWN ARROW (DECREMENT):** Decrease value of a flashing display.
- C. **UP ARROW (INCREMENT):** Increase value of a flashing display.
- D. **PRESSURE DISPLAYS:** Inlet, Retentate, and Permeate readings from pressure transducers with calculated Transmembrane (TMP) pressure.
- E. **ALARM OFF / NEXT:** The monitor is equipped with both high and low inlet pressure and low permeate pressure alarms. The trigger points for the alarms can be set from 0 to 50 PSI. The trigger points are set during the monitor setup (see Section II.4). When an alarm is triggered by either a high or low pressure, an audible alarm will sound. You can silence the alarm by momentarily pressing the ALARM OFF button. Once an alarm is triggered, it will continue to sound until the ALARM OFF button is pressed or the monitor is turned off or unplugged. During the setup mode this button (NEXT) is used to move through the different options.
- F. **TARE:** The monitor can be manually tared by pressing the TARE button down. It is recommended to tare (or zero) the monitor occasionally to ensure that the transducers have a good zero point. There is an option that can be set during the monitor setup (see Section II.4) to force the monitor to tare every time it is turned on.

Caution: The user should only tare the unit when all of the pressure transducers are either disconnected from the liquid line or are not exposed to any pressure. Taring the unit while non-zero pressure conditions exist will give the monitor a false zero and result in inaccurate pressure displays. To correct this condition, disconnect all the transducers from the liquid lines and then press the TARE button.

- G. PERMEATE FLOW DISPLAY: The flowrate in Liters/min of the permeate line as measured by the turbine flow meter.

Permeate Flowmeters



The MiniKros® Pilot TFF System comes with a low flow and high flow Permeate Flowmeter which both use the same precision turbine design. The turbine rotates freely on robust sapphire bearings while sensors detect the revolutions.

Specifications:

Model #	Flow Range	Linearity %FSD	Approx. K Factor	Reorder #
803	0.05 – 0.5 LPM	2.0	17000	ACM3-FML-01N
845	0.2 – 4.5 LPM	1.5	3500	ACM3-FMH-01N

- Accuracy: $\pm 1.5 - 2\%$ FSD
- Repeatability: $\pm 0.1\%$ reading over top 90% of range
- Pressure ratings: 145 psi (10 bar)
- Max. Temperature: 257 °F (125 °C)
- 8 mm / 12 mm OD Hose Barb Connections
- Materials of Construction (Fluid Contact)
 - Body – PVDF
 - 'O' Ring Seal – Silicone

NOTE: Each flow meter comes with the Factory Calibration Setting (K factor) printed on the meter. This value can be entered into the MiniKros Pilot System while the Pressure / Flow Monitor is in the setup mode ensuring that each flow meter is reading accurate flow rates. Please refer to Section II.4.9 for instructions on how to enter the K factor.

NOTE: The flow meter also has an arrow that shows the direction of flow through the body. When assembling the meter in the permeate line make sure the arrow is pointing in the direction of the flow (away from the filter).

Pressure Transducers

The MiniKros Pilot TFF System uses Spectrum's Disposable Pressure Transducers (Cat.No. ACPM-499-03N) to measure the Inlet, Retentate and Permeate pressures. The transducers come sterile (ETO), 3 per pack. The transducers have luer connections and can be attached to special connectors in custom designed KrosFlo MBTs (Module, Bag and Tubing sets)—please contact Spectrum Laboratories for custom disposable filtration systems.

Specifications:

- Suggested Operating Pressure Range: -465 to 1293 mmHg
- Sensitivity: $5\mu\text{V/V/mmHg}$, $\pm 2\%$ (typically $\pm 1\%$)
- Non-linearity and Hysteresis: $\pm 2\%$ of reading or $\pm 1\text{mmHg}$, whichever is greater
- Zero Thermal Effect: $\pm 0.3\text{ mmHg/degree C}$

3. Pressure / Flow Monitor Connections (Octopus Cable)

The MiniKros Pilot System uses a multi-legged cable (Octopus Cable) with an 18-pin connector to communicate with the sensors and the computer. There are three RJ11 female connectors for receiving the pressure sensors, one 8 pin mini-DIN connector for the permeate flow sensor and an RS232 connector for connecting to a computer.

While the pump is turned off attach the 18-pin connector on the Octopus Cable to the back of the MiniKros Pilot console.

Pressure Transducer Connectors: The Octopus Cable has 3 jacks for connecting pressure transducers to the monitor. The jacks are labeled "Inlet Pressure", "Permeate Pressure", and "Retentate Pressure". Connect the three transducers (Spectrum Part Number: ACPM-499-03N). This system should only be used with Spectrum ACPM-499-03N transducers.

Connect the serial cable leg to a PC via the provided RS232 Cable. Refer to the KF COMM manual (Section III) for setup of data collection and graphing.

Attach the Permeate Flow Meter to the cable labeled "Permeate Flow".

4. Pressure Monitor / Flow Meter Setup

The pressure monitor has both high and low pressure alarms, can display pressures in either PSI or BAR, and can display the permeate flow from either a low or high flow permeate meter. The monitor ships from the factory with all of the alarms disabled, pressure units displayed in PSI and set to automatically tare when powered on. The following procedure can be used to change any of these default settings.

Setup Mode

To enter the setup mode while the unit is on hold the ALARM OFF button down and press the up/down (▲, ▼) arrow keys at the same time.

Setting Pressure Units

While in setup mode the display should read "Pressure Units". To change between PSI and BAR press either the (▲) or (▼) keys. When you are satisfied with your selection, press the NEXT key to move to the next step.

Setting High Pressure Stop

1. After selecting the appropriate pressure units, you will be able to either enable or disable the High Pressure Stop alarm. Press either the (▲) or (▼) button to change between On and Off. The High Pressure Stop is intended to stop the pump and sound an alarm if the inlet pressure becomes high enough to potentially damage the filter or adversely affect the process. When the High Pressure Stop is enabled and the inlet pressure exceeds its set point, the pump will stop and the alarm will sound continuously until the ALARM OFF button is pressed or the monitor is turned off. When you are satisfied with your choice, press the NEXT button to move to the next step.
2. If the High Pressure Stop is On, you can now set the pressure Stop Point. Press the (▲) or (▼) button to increase or decrease the Stop Point. A typical value might be 12 psi (0.827 bar). Once the desired value is displayed, press the NEXT button to save the value and move to the next step.

Setting High Pressure Alarm

1. After the High Pressure Stop is set, you can either enable or disable the High Pressure Alarm. You can press either the (▲) or (▼) button to change between On and Off. The High Pressure Alarm is intended to warn the operator that the inlet pressure is approaching the High Pressure Stop. When the High Pressure Alarm is enabled and the inlet pressure exceeds its set point, an intermittent alarm will sound until the ALARM OFF button is pressed or the monitor is turned off. The pump, however, will be allowed to continue running. When you are satisfied with your choice, press the NEXT button to move to the next step.
2. If the High Pressure Alarm is On, you can now set the pressure High Alarm Point. Press the (▲) or (▼) button to increase or decrease the High Alarm Point. A typical value might be 10 psi (0.689 bar). Once the desired value is displayed, press the NEXT button to save the value and move to the next step.

Setting Low Pressure Alarm

1. After the High Pressure Alarm is set, you can either enable or disable the Low Pressure Alarm. Press either the (▲) or (▼) button to change between On and Off. The Low Pressure Alarm is intended to warn the operator that the inlet pressure is falling below what might be expected during the process run. This could be caused by a vacuum, a leak or a restricted feed line to the pump. When the Low Pressure Alarm is enabled and the inlet pressure falls below its set point, the pump will stop and the alarm will sound continuously until the ALARM OFF button is pressed or the monitor is turned off. When you are satisfied with your choice, press the NEXT button to move to the next step.
2. If the Low Pressure Alarm is On, you can now set the pressure Low Alarm Point. Press the (▲) or (▼) button to increase or decrease the Low Alarm Point. A typical value might be 1 psi (0.069 bar). Once the desired value is displayed, press the NEXT button to save the value and move to the next step.

Setting Low Permeate Stop

1. After selecting the low inlet pressure alarm, you will be able to either enable or disable the Low Permeate Pressure Stop. Press either the (▲) or (▼) button to change between On and Off. This control is intended to stop the pump and sound an alarm if the permeate pressure becomes too low and pulls a vacuum on the fibers. This happens when a vacuum pump is placed on the permeate line to increase the TMP. When the Low Permeate Stop is enabled and the permeate pressure goes below the set point, the pump will stop and the alarm will sound continuously until the ALARM OFF button is pressed or the monitor is turned off. When you are satisfied with your choice, press the NEXT button to move to the next step.
2. If the Low Permeate Stop is On, you can now set the pressure Stop Point. Press the (▲) or (▼) button to increase or decrease the Stop Point. A typical value might be -3 psi (-0.206 bar). Once the desired value is displayed, press the NEXT button to save the value and move to the next step.

Setting Low Permeate Alarm

1. After the Low Permeate Stop is set, you can either enable or disable the Low Permeate Alarm. You can press either the (▲) or (▼) button to change between On and Off. The Low Permeate Alarm is intended to warn the operator that the inlet pressure is approaching the Low Permeate Stop. When the Low Permeate Alarm is enabled and the inlet pressure exceeds its set point, an intermittent alarm will sound until the ALARM OFF button is pressed or the monitor is turned off. The pump, however, will be allowed to continue running. When you are satisfied with your choice, press the NEXT button to move to the next step.
2. If the Low Permeate Alarm is On, you can now set the pressure Low Permeate Alarm Point. Press the (▲) or (▼) button to increase or decrease the Low Permeate Alarm Point. A typical value might be -1 psi (-0.069 bar). Once the desired value is displayed, press the NEXT button to save the value and move to the next step.

Setting the Auto Tare

1. Set the Auto Tare to On or Off using the (▲) or (▼) button. If this is set to On, the pressure monitor will automatically tare (reset the readings to 0) every time it is turned on. If this is set to Off, it will not automatically tare but will instead use the most recent tare. When you have made your choice, press the NEXT button to move to the next step.
2. If the Auto Tare is set to Off, you can manually tare the monitor when you need to by holding the TARE button. When you are satisfied with your choice press the NEXT button to save the value and move to the next step.

CAUTION: *You should only tare the unit when all of the pressure transducers are either disconnected from the liquid line or not exposed to any pressure. Taring the unit while non-zero pressure conditions exist will give the monitor a false zero and result in inaccurate pressure displays. To correct this condition, simply disconnect all the transducers from the liquid lines and then press the TARE button.*

Setting Permeate Flow Meter K Factor

1. After setting the Auto Tare the display will then show the type of flow meter that is plugged into the octopus cable. There are two types of flow meters with different flow ranges provided with the system:

Model 803 – 0.05 to 0.5 LPM

Model 845 – 0.2 to 4.5 LPM

2. Written on each flow meter is the factory calibration measurement or K factor. Confirm that the correct flow meter type is displayed on the console and then enter the K factor from the flow meter into the system using the (▲) or (▼) buttons.

5. Serial Communications

The MiniKros® Pilot TFF System has two main components—Pump Drive and Pressure/Flow Monitor—each of which has their own internal hardware and software. The Pressure Monitor component is used to communicate with an external computer, the transducers, the flow meter, and the Pump Drive component. The Pump Drive hardware and software control the internal functionality of the drive and do not communicate with the external sensors or a computer. This section explains the process of setting up and using the communication function within the Pressure/Flow Monitor component of the MiniKros® Pilot System.

KF Comm Software

The MiniKros® Pilot TFF System is provided with a software program that collects data from the monitor and displays it in a Microsoft® Excel® workbook. For more information on how to use the software refer to Section III *KF Comm Software*.

Pressure/Flow Monitor - Computer Communications

1. To connect the MiniKros® Pilot System to a computer for data logging (if not using KF Comm software) or control, use the supplied RS232 cable to connect the RS232 connector on the octopus cable to a serial port on your computer. RS232 to USB adaptors are commercially available if no serial port exists.
2. Open the HyperTerminal program (installed under Start/Accessories/Communications on most Windows installations). Pick a name and an icon so that you can save the settings you make below.
3. On the Connect To dialog, go down to the Connect Using item and select the Com port you used for the connection and click OK. On the Port Settings dialog select “19200” for the Bits per second, “8” for the Data bits, “None” for the Parity, “1” for the Stop bits and “None” for the Flow control; then click OK. You can use File/Save to save the settings for easy use later.
4. When you have connected the MiniKros® Pilot System to your computer, you should see it periodically print a line of the current pressure readings on the screen. The periodic output records and displays the inlet pressure, retentate pressure, permeate pressure, transmembrane pressure, pump RPM, high

pressure alarm setting, low pressure alarm setting, and current time and date. If there is no periodic output, make sure that the cable connecting the pressure monitor to the PC is good. It should be a null modem cable. Also check that the correct COM port on the computer is selected. Use File/New Connection on the menu to select a different COM port.

5. The RS232 communication is used as a data output for monitoring a log of the process readings as well as to control and calibrate the pressure monitor function of the MiniKros® Pilot TFF System. In order to better serve the dual purpose, the RS232 port has two different modes or states. When the MiniKros® Pilot System is first turned on the RS232 port is in the locked state. In this locked state, it periodically outputs the current pressure readings and ignores most input. The only way to change from the locked to unlocked state is by pressing the computer's ENTER key, type "Unlock" and press the ENTER key again. The pressure monitor does not echo the keystrokes mixed in with the pressure readings. Make sure to type a capital "U" and lower case "nlock". The periodic output will continue while you are typing.
6. While the monitor is unlocked, it will respond to a small set of commands. When it is ready for another command it will display a prompt of ">" and wait for the next command. In all cases the commands are case sensitive. Each command line is ended by pressing the ENTER key.

?: Typing "?" will provide a list of the available commands.

Lock: Typing "Lock" returns the RS232 port to the locked state. It will then periodically output the current pressure readings.

Ver: Typing "Ver" will cause the pressure monitor to display the version identifier of its software.

Show: Typing "Show" will cause the pressure monitor to display the values of many of the variables that can be set with the RS232 port.

Reset: Typing "Reset" will cause the pressure monitor to reset itself as if it had just been turned on.

Default 171: Typing "Default 171" will reset all of the pressure monitor parameters to those set by the factory. This includes resetting the Baud Rate to 19200 as well as the calibration and zero points of all of the transducers since it does not reset the monitor. Some changes will not take place until the monitor is turned off and then on (or the "Reset" command is given).

Rate #: While the RS232 port is locked it periodically outputs the current pressure readings. The rate is the number of seconds per reading output. Typing the word "Rate" by itself will cause the current rate number to be displayed. Typing the word "Rate" followed by a space and a number will cause the rate to be set to your new value.

Sep C: The Sep command is used to set the character displayed between the pressure readings in the periodic output. Normally this is a space. You may, however, want to set it to a tab or a pipe (|) character. Typing the word "Sep" by itself displays the current separator character. To set a different separator character type the word "Sep" followed by a space and the new character to use. The separator cannot be set to a null, line feed, or return character; any other character can be used.

When displaying the current separator character, characters that might not print visibly are mangled to make them display legibly. For example, a space is shown as "[]" while a tab is shown as "[|]". The mangled form should not

be used to specify the separator, simply type "Sep", a space, and then the character to use.

Cal S ###.##: The Cal command is used to calibrate one or more of the pressure channels. To calibrate the monitor to a transducer, plug the transducer in to the monitor and connect it to a known pressure source. Then type "Cal" followed by a space, the appropriate pressure channel (either "retentate", "permeate" or "inlet") and finally the respective pressure value in the format of **###.##**, e.g. "5.3". When calibrated to a particular transducer, the calibration is only for that transducer on that jack. See the section on Calibration for more information.

Date ####/##/##: Typing the word "Date" by itself displays the current date in the real time clock. To set the date, type the word "Date" followed by a space and the current date in mm/dd/yy format. (mm should be a number from 1 to 12 indicating the current month, dd should be a number from 1 to 31 indicating the current day of the month and yy should be a number from 0 to 99 indicating the last 2 digits of the year.)

Time ##:##:##: Typing the word "Time" by itself displays the current time in the real time clock. To set the time, type the word "Time" followed by a space and the current time in hh:mm:ss format. (hh should be a number from 0 to 23 indicating the current hour, mm should be a number from 0 to 59 indicating the current minute and ss should be a number from 0 to 59 indicating the current second.)

RTC #: The RTC command is used to control whether the date and time are shown. Type "RTC 1" to have the date and time shown, "RTC 0" to prevent the date and time from appearing.

List of Error Messages

That didn't look like a command to me - Returned whenever the monitor cannot parse your input usefully. If you provide a number out of range or negative, this is usually returned. If you format the date or time wrong (when setting the date or time), this is usually returned. The monitor does not understand backspace or rubout. If you try to backspace, you will almost without fail see this message when you press ENTER. If use the wrong case (upper or lower) for a command, you will also see this message when you press ENTER.

Bye - Returned after the Lock command is accepted. It lets you know that the console is now locked and you should only see the periodic output.

Bad combination - The Default command must be followed by a space and the number 171 to take affect. If you do not include the 171 you will see this message.

I don't like the separator you've picked, please try again - There are some characters that should not be used as the separator character (see the Sep command). Currently these characters are ENTER and rubout. Trying to use these characters returns the "That didn't look like a command to me message".

I'm sorry I can't update the clock right now - The real time clock is connected to a shared bus. It is possible (although not likely if the monitor is operating properly) that the shared bus could be busy when you try to update the clock. If this occurs you will see this message and the clock will not be updated.

6. Pressure and Permeate Flow Calibration

NOTE: For field calibration follow the instructions in this section or if necessary the system can be returned to Spectrum. You can contact Spectrum by phone at (800) 634-3300, fax at (310) 885-4666, or email at customerservice@spectrumlabs.com to make arrangements for the calibration.

If you experience an error in a pressure or flow measurement, the cause is most likely the transducer or sensor and not the monitor. Please check pressure readings with a new transducer prior to recalibrating the monitor.

Pressure Calibration

To calibrate one or more pressure channels you will need a computer with an available serial port, one or more pressure transducers and a source of known pressure. If you have all of these items available, the following procedure may be used:

1. Disconnect all pressure transducers and flow meters from the unit.
2. Connect power to the unit and turn it on. The digital displays should light up as well as the Pressure Unit indicators.
3. After the power-on sequence has completed and pressure values are being displayed, press the TARE button. After the tare is complete, all displays should show "0" readings.
4. Use the supplied RS232 cable to connect the monitor to a free serial port on a computer and establish communication.
 - i. Open your HyperTerminal program (installed under Accessories/Communications on most Windows installations). Pick a name and an icon so that you can save the settings you make in the following steps.
 - ii. On the Connect To dialog, go down to the Connect Using item and select the Com port you used for the connection and click OK.
 - iii. On the Port Settings dialog select "19200" for the Bits per second, "8" for the Data bits, "None" for the Parity, "1" for the Stop bits and "None" for the Flow control; then click OK. You can use File/Save to save the settings for easy use later.

When you have connected the unit to your computer, you should see it periodically print a line of the current pressure readings on the screen. If you do not see this periodic output, check that you are using a good cable to connect the monitor to the PC. You might also want to check that you've selected the correct COM port on your computer. You will need to use File/New Connection on the menu to select a different COM port.

5. Plug a new pressure transducer (ACPM-499-03N) into each pressure jack on the octopus cable. All pressure readings should change and no longer be "0". The following steps should be performed for each transducer (inlet, retentate and permeate), one at a time.
 - i. With no pressure applied to the transducer, press the TARE button.
 - ii. Using a calibrated pressure gauge and pressure source, apply about 6 psi to the inlet pressure transducer.
 - iii. Unlock the monitor by pressing the ENTER key on the computer, typing "Unlock", and then pressing the ENTER key again. Be sure to type a capital "U" followed by a lower case "nlock".

- iv. Type "Cal inlet" ###.### (where ###.### is the pressure on the transducer) and press ENTER. The inlet pressure reading on the front of the monitor should change to the value you have entered. If the calibration value is a magnitude that indicates a hardware problem then an error message will be displayed and the calibration will not be performed.
- v. Type "Lock" and press ENTER to have the monitor return to periodically sending the current pressure readings.
- vi. Repeat steps i through v to calibrate both the retentate and permeate transducers.

The pressure monitor is now calibrated. You may now disconnect the pressure transducers from the octopus cable.

Permeate Flow Calibration

Follow Section II.6.1.4 for establishing communication with a PC if not already connected.

The permeate flow meters have the factory calibration measurement (K factor) printed on the flow meter. Input this value during the setup as explained in Section II.4.9 to calibrate the flow rate readings.

This K factor was measured from a midrange flow rate on the meter and will ensure a 1.5-2.0% FS error. To obtain an exact calibration at a specific flow a known flow rate will be needed. This can be done with a calibrated flow meter, or using a graduated cylinder or scale with a timer. If these are available the following steps should be performed.

- i. With the system turned off insert a permeate flow meter (ACM3-FML-01N (803) or ACM3-FMH-01N(845)) into the "Permeate Flow" 8-pin jack on the octopus cable.
- ii. Turn on the system. The unit will recognize which flow meter is plugged in.
- iii. Run the desired solution through the flow meter at the desired flow rate. Using a separate calibrated flow meter or graduated cylinder/scale with a timer measure this flow rate.
- iv. Unlock the monitor by pressing the ENTER key on the computer, typing "Unlock", and then pressing the ENTER key again. Be sure to type a capital "U" followed by a lower case "nlock".
- v. Type "Flow Cal #####" (where ##### is the current flow rate in L/min) and press ENTER. The system will then calculate the appropriate K value. The flow rate reading on the front of the console should change to the value you have entered. This will work only within the functioning flow rate of the meter. If the calibration value is a magnitude that indicates a hardware problem then an error message will be displayed and the calibration will not be performed.
- vi. Type "Lock" and press ENTER to have the system return to periodically sending the current readings.

7. Real Time Clock

The pressure monitor includes a real time clock that is accurate to better than 2 minutes per month when the monitor is stored and used between 0 and 40°C.

The real time clock is separate from the timing used to periodically output the pressure and flow readings to the RS232 port. Because the periodic output clock is much less accurate than the real time clock, its frequency error can be as large as 100 ppm (5 minutes per month).

Because these clocks are separate, several times per month one clock will pass the other. If you are recording the pressure and flow readings once per second, you will record up to 420 times per month where either the same second is reported twice or a second seems to be skipped. This is a result of the relative error in these two clocks and not a hardware defect.

Section III. KF Comm Data Acquisition & Graphing Software

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2. Installation

The KrosFlo® MiniKros Pilot System is accompanied with a disc of software that can be used on Windows® PCs. You will need to have Microsoft® Windows 95 or newer and Microsoft Excel XP to use this software.

The supplied software includes an ActiveX control that allows other applications to easily communicate with the MiniKros Pilot System and a spreadsheet template for automatically recording your process separation conditions.

To start the software installation, all that is normally necessary is to put the software disc into a CD drive. If it does not automatically start, you'll need to double-click on the icon for the CD drive and then double click on the Setup.exe item. (The Setup.exe item looks like )

After the installation starts, you'll need to accept the terms of the software license to continue. The license terms are listed in SECTION III.1 of this manual.

If you agree to the terms of the license you can then select the installation location, normally C:\Program Files\Spectrum Chromatography\KFComm. One copy of each spreadsheet will be installed in this location; additionally the KFComm control will be installed in your windows system directory (typically C:\Windows\System) and duplicate copies of each spreadsheet will be installed in your My Documents folder.

If you do not have administrator privileges on the computer, the installation will fail without giving you notice that it has not completed successfully.

3. Instructions for Use

3.1. Opening File

The workbook template that can be used to automatically record your process conditions is named TFF Trial Template. This Excel® workbook contains programming that automatically collects and graphs real-time run data.

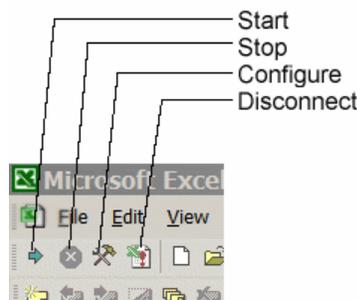
The macros that allow you to record the pressure and flow readings during the course of your experiment have been signed by Spectrum. Depending upon your security settings and the particular version of Excel that you are using, you may be prompted to allow macros to run when you open the template. If your Excel security level is High, then you will need to check the “Always trust macros from this source.” box before you can click the “Enable Macros” button. If you are not an administrator on the computer you are using, you may need to contact an administrator and have them accept the certificate used to sign the macros.

If you do not enable macros then you will not be able to collect new data. If you are opening a workbook that already contains data, you will be able to work with the data whether or not you enable macros.

3.2. Data Collection Tools

The TFF Trial Template has both data collection worksheets and automatic graph worksheets (see Section III.3.4 below). When one of the data collection worksheets is open, and a Pressure Monitor is connected to the computer, the first row of the spreadsheet will always display the most current readings from the Monitor. If the Monitor is connected and turned on and the first line remains blank, then you'll need to use the configure control to use a different serial port.

The first 4 controls on the standard toolbar can be used to control the data collection. The



same items will also appear on the Data menu at the top of the window.

 **Configure Collection.** This is used to set how the data is collected. Clicking on this will bring up a dialog. Use this to set the number of seconds per line collected, the default is 1 second per line. A 3 hour run at 1 line per second would produce about 10,000 data points. To collect fewer points, you would need to set a larger number for the seconds per line parameter. An Excel sheet can only contain about 65,000 rows; this limits collection to about 18 hours at 1 second per line.

You also use this control to indicate to which serial port your Pressure Monitor is connected. If you are unsure to which port number it is connected, click the Find Comm button. The control will cycle through the free serial ports on your computer looking for a Pressure Monitor. If a Pressure Monitor is turned on and connected to the computer, it should be found within 1 cycle of the available ports. The control will continue looking at the available ports for a Pressure Monitor until one is found or until you click the Cancel button. If you are using another program to

communicate with the Pressure Meter, you'll need to close that program before selecting the Configure tool so that the serial port becomes available to the workbook.

 **Start Collection.** This is used to start collecting the pressure data. Once the first row of the KrosFlo® Pressure Data sheet is properly showing the current pressure information, clicking this will begin saving the pressure data in the worksheet. The amount of time per saved point is set using Configure Collection. After clicking on the Start collection button, you will not be able to use Configure Collection until you first click on Stop Collection.

 **Stop Collection.** This is used to temporarily stop collecting the pressure data. After clicking on Start Collection to start saving data, you can click on this to suspend collection. If you select Start, Stop, and then Start again, collection will resume where it left off; it does not begin again at the top of the sheet.

 **End Collection.** This is used to end data collection. Because of the way Excel works, you will have difficulty manipulating the contents of the KrosFlo® Pressure Data sheet. Clicking this will stop the spreadsheet from updating the first line, stop the data collection, and disable the other controls. You will then be able to manipulate the data as you wish.

If you click this once and then save the workbook, the next time you open the workbook, data collection will again be available. If you click this twice and then save the workbook, data collection will no longer be available for this workbook.

3.3. Navigating the Worksheets and Charts

3.3.1. General Info

In the TFF Trial workbook there are three different worksheets for data collection (orange tabs at bottom of Excel® page):



These three worksheets are used for collecting data for different stages of a filtration process:

Module Characteristics – For analyzing initial water flux

Integrity Test – For performing test to ensure membrane integrity

Trial Data – For collecting run data

Note: Data is only collected in the worksheet that is open

These worksheets have a header where the correct filter and tubing size can be selected from a pull down menu. Once the appropriate filter is chosen the table on the right side will display the filter characteristics. Other information regarding the run can be entered and the proper units (PSI or bar) can be selected. The data entered in the 'Module Characteristics' worksheet will also be seen in the 'Integrity Test' and 'Trial Data' worksheets.

Now: 14:34:24	6.22	6.98	3.94	0.000	0.000	App. Fiber Count: 320
Date: 12/12/2005				Location: Spectrum Laboratories Inc.		Fiber ID: 0.5 mm
Module # M80S-100-01N				Application: Particle Conc / Wash		Fiber Length: 20.8 cm
Serial # xxxxxxxx				Objective: 10x Concentration, 5x Diafiltration		Feed Rate @ 4000s ⁻¹ : 0.928 l/min
Surface Area: 1050 sq cm				Attendees:		Feed Rate @ 12000s ⁻¹ : 2.800 l/min
Tubing Size: 26				Notes:		Membrane Type: PS
Pump Calibration: 1				PSI: <input type="radio"/> :bar		Rating: 0.05 µm
Company: Our Valued Customer				Concentration: <input type="radio"/> :Diafiltration		Average Flux: 0.356667 l/min
Starting Amount: 100 liters						
ByWeight: <input type="radio"/> :By Volume						

***Note: Correct tubing size must be selected for proper feed flow rates to be captured in the spreadsheet. If the pump is calibrated (see Section I.A.6) then the correction factor will need to be adjusted to get the correct feed flow rate. ***

The seven remaining worksheets with the green tabs (not all are shown on the above picture) are automatic graphs. Here is a brief overview:

GRAPH	SOURCE
NWP (Normalized Water Permeability)	Graphs data from 'Module Characteristics' worksheet for analyzing initial water flux
Flux Rate vs. Time	Graphs data from 'Trial Data' worksheet to analyze process conditions
Feed Flow Rate vs. Time	
Pressures vs. Time	
Pressures vs. VT (Volumetric Throughput)	
TMP (Transmembrane Pressure) vs. VT	
CF (Concentration Factor) vs. Flux	

3.3.2. Module Characteristics

The 'Module Characteristics' worksheet collects data to measure the NWP of the filter. The header for the data collection in the worksheet looks like this:

Initial NWP													
Time	P _{inlet} (psig)	P _{retentate} (psig)	P _{permeate} (psig)	TMP (psig)	DP (psig)	Q _{inlet} (l/min)	Q _{permeate} (l/min)	Temp (°C)	TCF	Water Flux LMH	Water Flux LMH @ 20°C	WP (LMH/psig)	NWP (LMH/psig)
0:00:10	5.55	2.41	0.00	3.98	3.14	0.580	0.200	23	0.931374	114.29	106.44	28.72	26.74
0:00:20	5.55	2.41	0.00	3.98	3.14	0.580	0.200	23	0.931374	114.29	106.44	28.72	26.74
0:00:30	4.48	2.37	0.20	3.23	2.11	0.580	0.200	23	0.931374	114.29	106.44	35.44	33.01
0:00:40	4.48	1.78	0.20	2.93	2.70	0.580	0.200	23	0.931374	114.29	106.44	39.01	36.33

Here is a breakdown of the abbreviation descriptions:

Column Abbreviation	Description
Time	Time (H:MM:SS)
P _{inlet}	Inlet Pressure
P _{retentate}	Retentate Pressure
P _{permeate}	Permeate Pressure
TMP	Calculated Transmembrane Pressure
DP	Pressure Drop through filter
Q _{inlet}	Feed Flow (calculated from Pump rpm and tubing size)
Q _{permeate}	Permeate Flow (measured and inputted by user at specific times)
Temp	Temperature (measured and inputted by user at specific times)
TCF	Temperature Correction Factor (calculated from Temperature)
Water Flux	Liters of permeate per m ² of surface area per hour (calculated from permeate flow/SA)
Water Flux @20 C	Corrected Water Flux
WP	Water Permeability
NWP	Normalized Water Permeability

Note: For the data collection worksheets there are three different types of columns: collected data (yellow), calculated data (light green) and user inputted data (tan)

When a filter has been properly rinsed and/or wetted according to the instructions on the insert titled 'Hollow Fiber Filter Preparation Guide' then the initial water flux data can be measured. Making sure that the first row is reading the current pressure data click on the 'Start Collection' button. Continue collecting data points at different transmembrane pressures (TMP's) by increasing the resistance on the retentate line. Input the temperature. The 'NWP' worksheet will automatically graph the NWP vs. TMP.

3.3.3. Integrity Test

The 'Integrity Test' worksheet measures the inlet pressure at set time intervals and calculates the ΔP over time. If the psi/min change is not > than 0.5psi/min then the filter is integral. A sharp decrease in pressure over time shows either a broken filter or the filter was not properly wetted out. Follow the instructions in the "Hollow Fiber Filter Preparation" insert for proper wetting and integrity testing procedures.

3.3.4. Trial Data

The 'Trial Data' worksheet is used to log and calculate the filtration run data (see sample below).

Now: 14:34:24 6:22 6:98 3:94

Date: 12/12/2005

Module # M80S-100-01N

Serial # XXXXXXX

Surface Area: 1050 sq cm

Tubing Size: 26

Pump Calibration: 1

Company: Our Valued Customer

Starting Amount: 100 liters

By Weight: By Volume

Location: Spectrum Laboratories Inc.

Application: Particle Conc / Wash

Objective: 10x Concentration, 6x Diafiltration

Attendees:

Notes:

PSI: :bar

Concentration: :Diafiltration

App. Fiber Count: 320

Fiber ID: 0.5 mm

Fiber Length: 20.8 cm

Feed Rate @ 4000s⁻¹: 0.928 l/min

Feed Rate @ 12000s⁻¹: 2.800 l/min

Membrane Type: PS

Rating: 0.05 µm

Average Flux: 0.356667 l/min

Time	P _{inlet} psig	P _{retentate} psig	P _{permeate} psig	TMP psig	DP psig	Q _{inlet} l/min	Shear sec ⁻¹	Q _{permeate} l/min	Q _{retentate} l/min	V _{permeate} liters	CFF L/min/m ²	LMH (Filt. Flux)	VT L/m ²	Temp °C	Conc Factor	%Trans	Notes
0:00:00	5.00	4.00	1.00	3.50	1.00	2.200	9350.0	0.400	1.800	0.000	0.00	228.6	0.0000	23	1.00		Start Concentration
0:00:10	5.00	4.00	1.00	3.50	1.00	2.200	9350.0	0.400	1.800	0.067	0.00	228.6	0.0001	23	1.00		
0:00:20	5.00	3.90	1.00	3.45	1.10	2.200	9350.0	0.400	1.800	0.133	0.00	228.6	0.0001	23	1.00		
0:00:30	6.00	4.20	1.10	4.00	1.80	2.200	9350.0	0.390	1.810	0.199	0.00	222.9	0.0002	23	1.00		
0:00:40	6.00	4.20	1.10	4.00	1.80	2.200	9350.0	0.370	1.830	0.262	0.00	211.4	0.0002	23	1.00		
0:00:50	6.20	4.30	1.10	4.15	1.90	2.200	9350.0	0.360	1.840	0.323	0.00	205.7	0.0003	23	1.00		
0:01:00	6.20	4.30	1.10	4.15	1.90	2.200	9350.0	0.350	1.850	0.387	0.00	200.0	0.0004	23	1.00		

The columns are the same as the 'Module Characteristics' with the following additions:

Column Abbreviation	Description
Shear	Shear rate of the liquid flowing through the fibers (with fixed viscosity) in sec ⁻¹
Q _{retentate}	Retentate Flow
V _{permeate}	Total volume of permeate. This can be changed to total weight of permeate when using a scale instead of the permeate flow meter by clicking on the 'By Weight' button on the header.
CFF	CrossFlow Filtration. This is a measure of the feed flow in relation to surface area.
LMH	Filtrate rate in liters per m ² per hour
VT	Volumetric Throughput (a measure of the total permeate per m ² of SA)
Pump	RPM of the pump
Temp	Temperature (user inputted)
Conc. Factor	Concentration Factor – this is calculated from the initial volume (input into the header) and the totalized permeate volume. When running the filtration system in diafiltration mode select the 'Diafiltration' button on the top of the worksheet. This turns off the Conc. Factor calculation. To turn it on again during the run click on the 'Concentration' button.
% Trans.	Percent transmission of particle to pass through with permeate. This data will be entered after the proper assays are performed on the permeate samples.

NOTE: The permeate rates are to automatically measured by the permeate flow meter. It is possible to use a scale (not provided) to measure the weight of the permeate and manually input the total weight at specific times. This spreadsheet will then automatically back calculate and populate the permeate flow rate column.

4. Compliancy

Spectrum offers an additional software program that enables the KF COMM program to comply with 21 CFR Part 11 regulations. Please contact Spectrum at 800-634-3300 for further information.

Section IV. Ordering Information & Accessories

PART NUMBERS	DESCRIPTIONS
SYM3-111-01N	MiniKros® PILOT SYSTEM, 110V Integrated Components: 650 RPM Pump Drive with 13 LPM Pump Head Digital Display Feed Flow Rate Digital Pressure Monitor with 3 Transducers Digital Permeate Flow Monitor with 2 Meters KF Comm Data Collection Software and Cables Stainless Steel Hollow Fiber Filter Stand and Enclosure UL, CE Listed IP66 Enclosure Washdown Rating
SYM3-112-01N	MiniKros® PILOT SYSTEM, 220V Integrated Components: 650 RPM Pump Drive with 13 LPM Pump Head Digital Display Feed Flow Rate Digital Pressure Monitor with 3 Transducers Digital Permeate Flow Monitor with 2 Meters KF Comm Data Collection Software and Cables Stainless Steel Hollow Fiber Filter Stand and Enclosure UL, CE Listed IP66 Enclosure Washdown Rating
SYM3-011-01N	MiniKros® PILOT SYSTEM, 110V without support stand
SYM3-012-01N	MiniKros® PILOT SYSTEM, 220V without support stand
ACM3-H3S-01N	13 LPM Pump Head with 3 Stainless Steel Rollers
ACM3-PHP-01N	17LPM High Performance Pump Head with 3 Stainless Steel Rollers
ACPM-499-03N	Disposable Pressure Transducers, sterile, 3/pack
ACM3-FML-01N	0.05 to 0.5 LPM Permeate Flow Meter
ACM3-FMH-01N	0.2 to 4.5 LPM Permeate Flow Meter
EZST-F20-01N	MBT Flow Path Stand, supports up to 20 Liter KrosFlo® EZ Bags
EZST-M3K-01N	KrosFlo® Module Stand, supports up to 3X KrosFlo® modules

Disposable and Irradiated Filter, Bag and Tubing Assemblies (MBT™) are custom. Please contact us for design and a quotation.



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