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Analysis of Blood Flow Data

The MP100 has the capability to do extensive online and offline analysis of raw blood flow data. The subject is typically an animal. By interfacing the MP100 with existing Flowmeters, one can take an array of calculations and measurements, such as Pulsatile max, Pulsatile Min, Mean Flow, Cardiac Output, Stroke Volume, and Resistance. This application note will explain in detail the set up procedures for recording and analyzing blood flow data.

The first thing needed to successfully record and do either online or offline analysis of a blood flow signal is to interface your existing Flowmeter with the MP100. Typically, most end users use Transonic Flowmeters, which can directly interface with the Universal Interface Module (UIM100A) via a CBL102 connector cable. If you are not using a Transonic Flowmeter, you will need to identify that your Flowmeter has a +/- 10-volt analog output signal to interface with the UIM100A module. Once this has been established, you are then prepared to setup the software and start your acquisition.

You will need to start by setting up 1 analog channel as your primary source for blood flow. To do this, select Setup channels from the MP100 menu, select Analog 1 and label it accordingly. You will then need to calibrate your Flowmeter by selecting the Scaling function and choosing between two known values such as 0-100. Also be sure to label the units accordingly. (ml/min or liters/min)
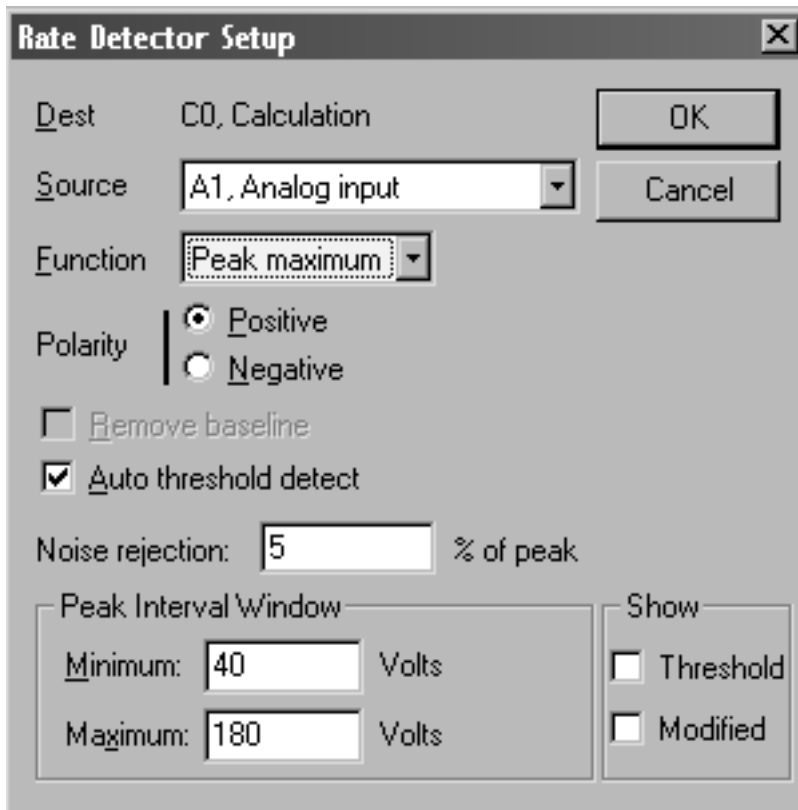
Input Channels ☒

Acquire
| Plot
| | Values
| | | Channel Label

Scaling...   ⦿ Analog   ○ Digital
             ○ Calc Rate ▼

☑ ☑ ☑ ⦿ A1	Blood Flow
☐ ☐ ☐ ○ A2	Analog input
☐ ☐ ☐ ○ A3	Analog input
☐ ☐ ☐ ○ A4	Analog input
☐ ☐ ☐ ○ A5	Analog input
☐ ☐ ☐ ○ A6	Analog input
☐ ☐ ☐ ○ A7	Analog input
☐ ☐ ☐ ○ A8	Analog input
☐ ☐ ☐ ○ A9	Analog input
☐ ☐ ☐ ○ A10	Analog input
☐ ☐ ☐ ○ A11	Analog input
☐ ☐ ☐ ○ A12	Analog input
☐ ☐ ☐ ○ A13	Analog input
☐ ☐ ☐ ○ A14	Analog input
☐ ☐ ☐ ○ A15	Analog input
☐ ☐ ☐ ○ A16	Analog input
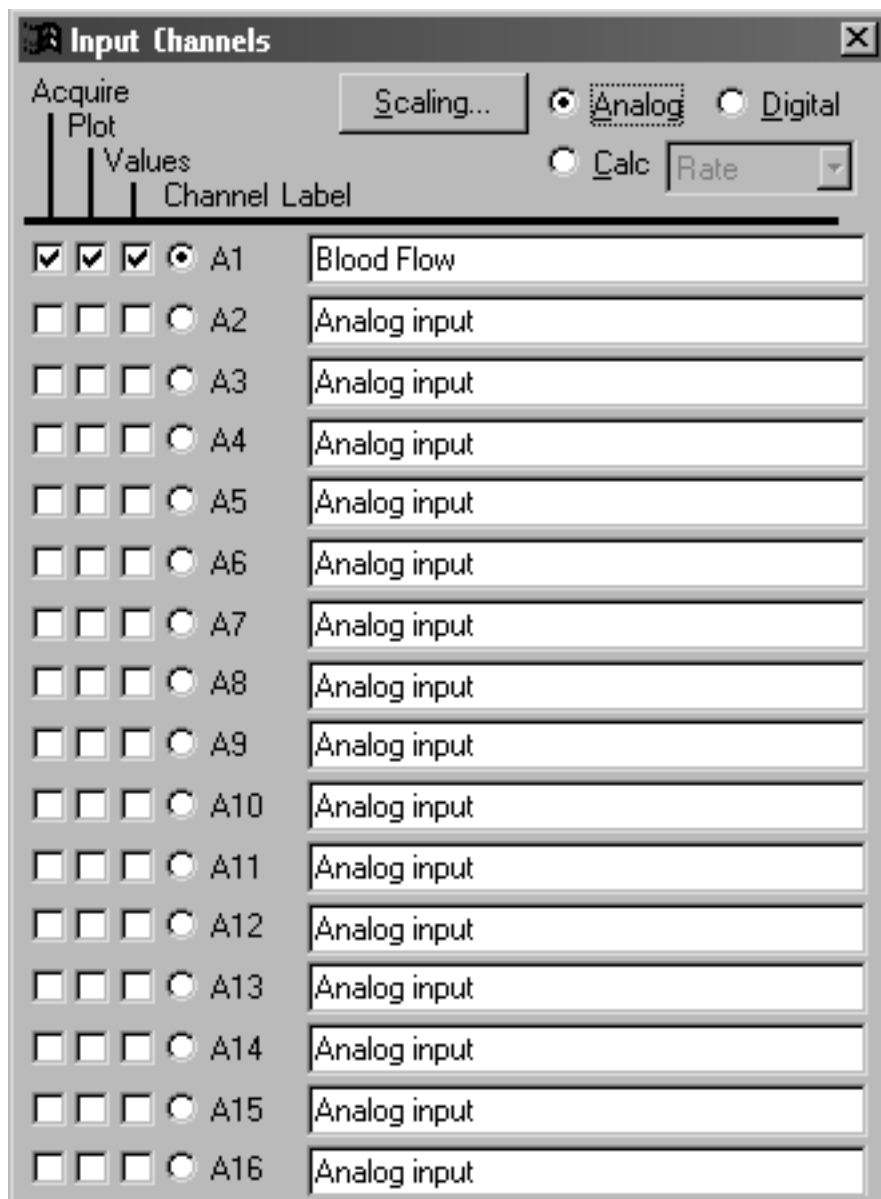
Next you will select Setup channels from the MP100 menu, and set up the Calculation channels accordingly. Following is an example of 6 direct measurements you can get by setting up calculation channels in the AcqKnowledge software.

Input Channels

Acquire	Plot	Values	Calc	Channel	Channel Label
☑	☑	☑	○	C0	Pulsatile Max
☑	☑	☑	○	C1	Pulsatile Min
☑	☑	☑	○	C2	Mean Flow
☑	☑	☑	○	C3	Stroke Volume
☑	☑	☑	○	C4	Resistance
☑	☑	☑	◉	C5	Mean Pressure
☐	☐	☐	○	C6	Calculation
☐	☐	☐	○	C7	Calculation
☐	☐	☐	○	C8	Calculation
☐	☐	☐	○	C9	Calculation
☐	☐	☐	○	C10	Calculation
☐	☐	☐	○	C11	Calculation
☐	☐	☐	○	C12	Calculation
☐	☐	☐	○	C13	Calculation
☐	☐	☐	○	C14	Calculation
☐	☐	☐	○	C15	Calculation

Setup...   ○ Analog   ○ Digital   ◉ Calc [Rate ▼]

- Pulsatile Max
- Pulsatile Min
- Mean Flow
- Stroke Volume
- Resistance
- Mean Pressure
- Rate
- Cardiac Output

Note You will need to adjust the Peak Interval Window dependent on the subject. Typically for a human the parameters 40 Minimum and 180 Maximum are sufficient. For an animal the parameters will be much higher. Please remember to adjust accordingly.

To configure the software to record Pulsatile Max you will need to select the Rate function, then click on the Setup button and choose Peak maximum as shown below.

```
┌─────────────────────────────────────────────────────┐
│ Rate Detector Setup                            [X]   │
│                                                      │
│  Dest      C0, Calculation         ┌──────────┐     │
│                                    │    OK    │     │
│  Source   [A1, Analog input    ▼]  └──────────┘     │
│                                    ┌──────────┐     │
│  Function [Peak maximum ▼]         │  Cancel  │     │
│                                    └──────────┘     │
│            ◉ Positive                               │
│  Polarity  ○ Negative                              │
│                                                      │
│           □ Remove baseline                         │
│           ☑ Auto threshold detect                   │
│                                                      │
│  Noise rejection:  [5      ]    % of peak           │
│  ┌─Peak Interval Window──────────┐  ┌─Show──────┐   │
│  │  Minimum: [40    ]  Volts     │  │ □ Threshold│  │
│  │  Maximum: [180   ]  Volts     │  │ □ Modified │  │
│  └───────────────────────────────┘  └───────────┘   │
└─────────────────────────────────────────────────────┘
```
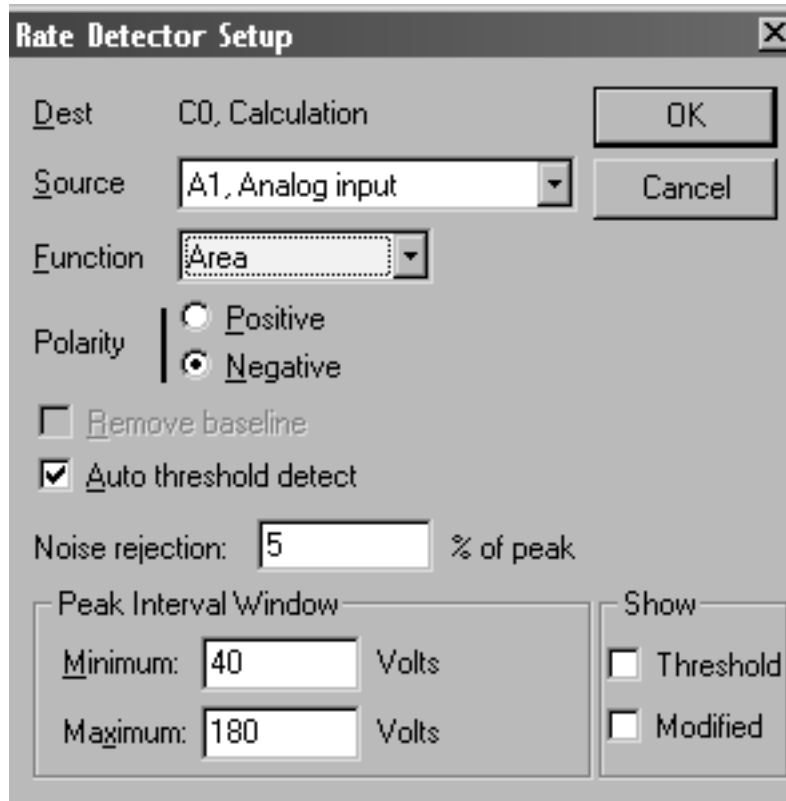
To configure the software to record Pulsatile Min you will need to turn on another Calculation channel, then select the Rate function, click on the Setup button and choose Peak minimum as shown below.
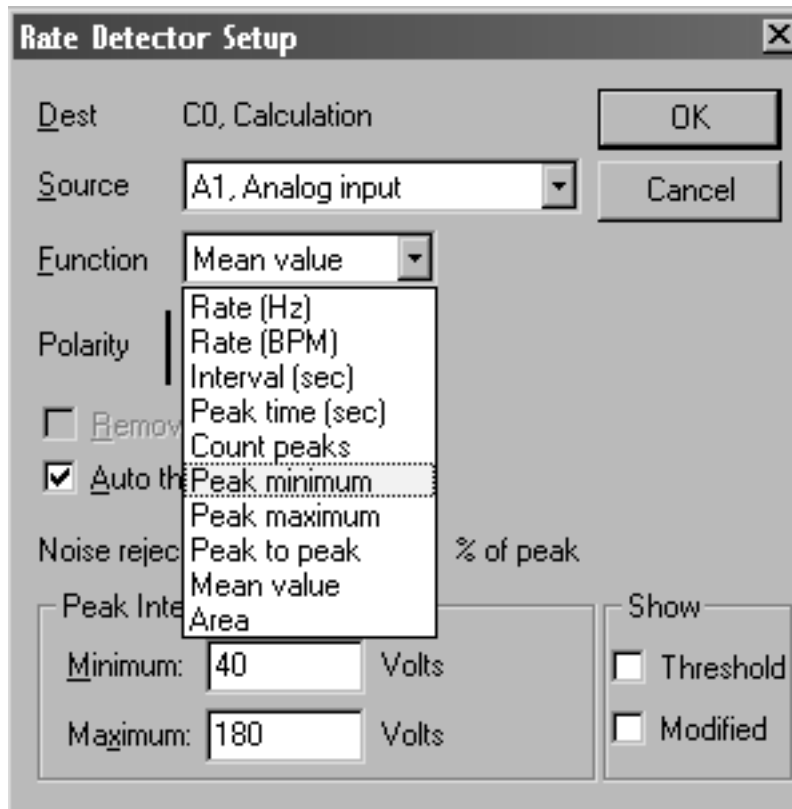
To configure the software to record Mean Flow you will need to turn on another Calculation channel, then select the Rate function, click on the Setup button and choose Mean value as shown below.
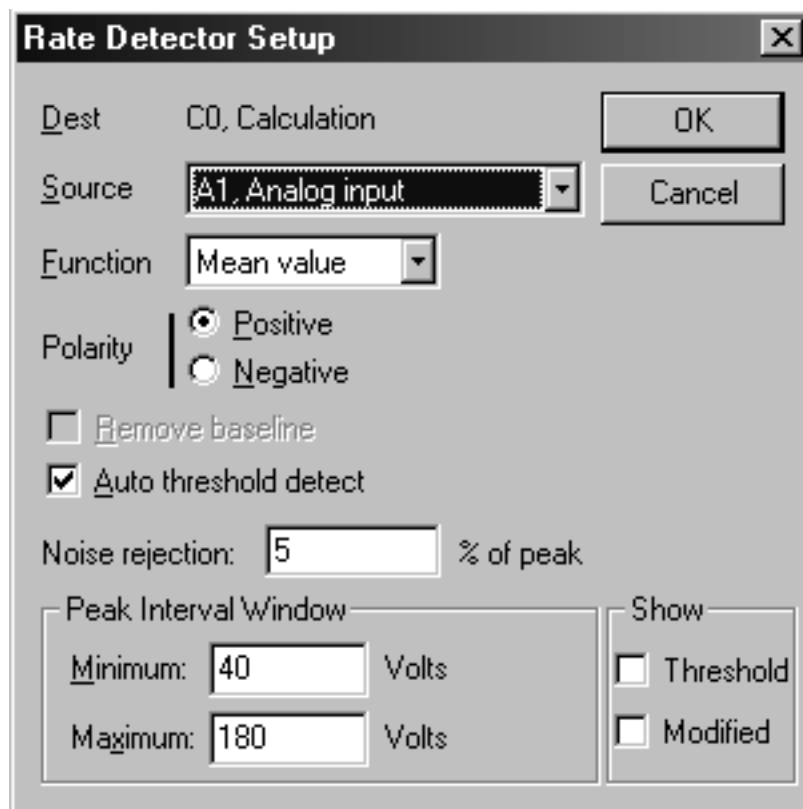
To configure the software to record Stroke Volume you will need to turn on another Calculation channel, then select the Rate function, click on the Setup button and choose Area. Next select Negative (polarity) to obtain a calculation for area under the curve as shown below.
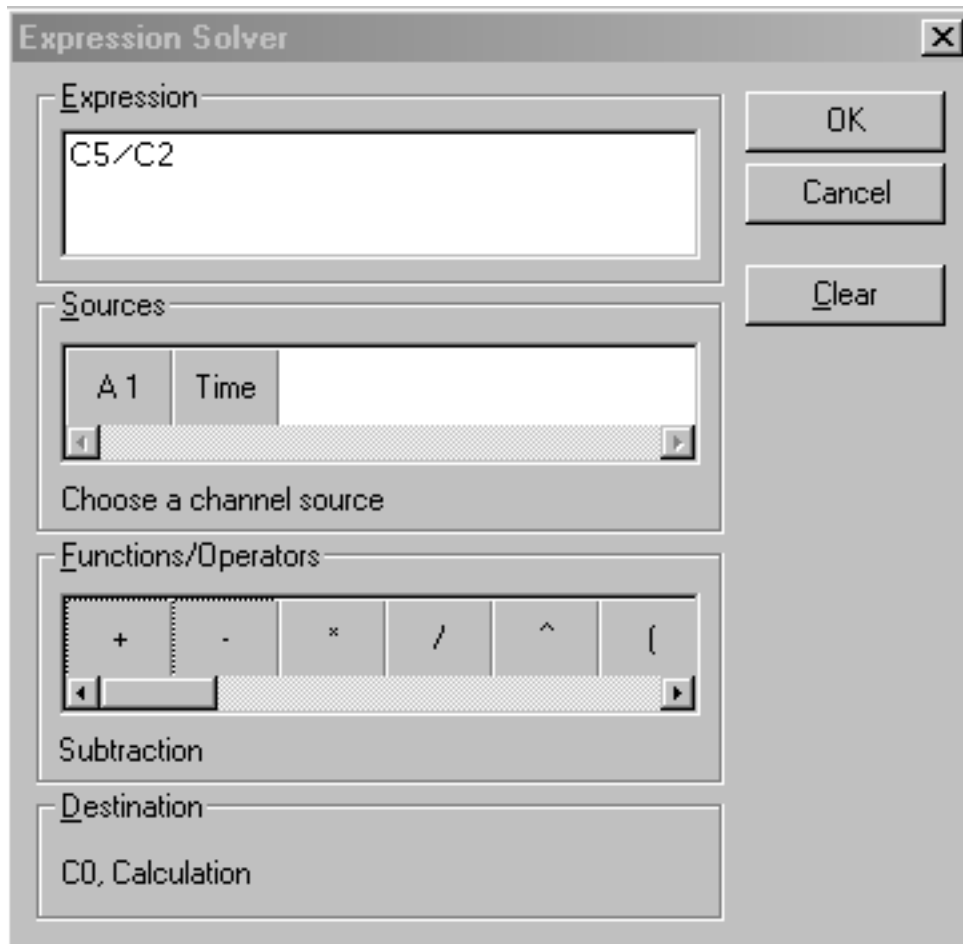

To configure the software to record Resistance, you will need to turn on another Calculation channel, then select the Expression function, click on Setup button and divide Mean Pressure by Mean Flow as shown below. In order to use this function properly you will need to have a transducer that is collecting Blood pressure as well as Blood flow.

To configure the software to record Mean pressure, you will need to turn on another Calculation channel, then select the Rate function, click on the Setup button and choose Mean value as shown below.

Rate Detector Setup
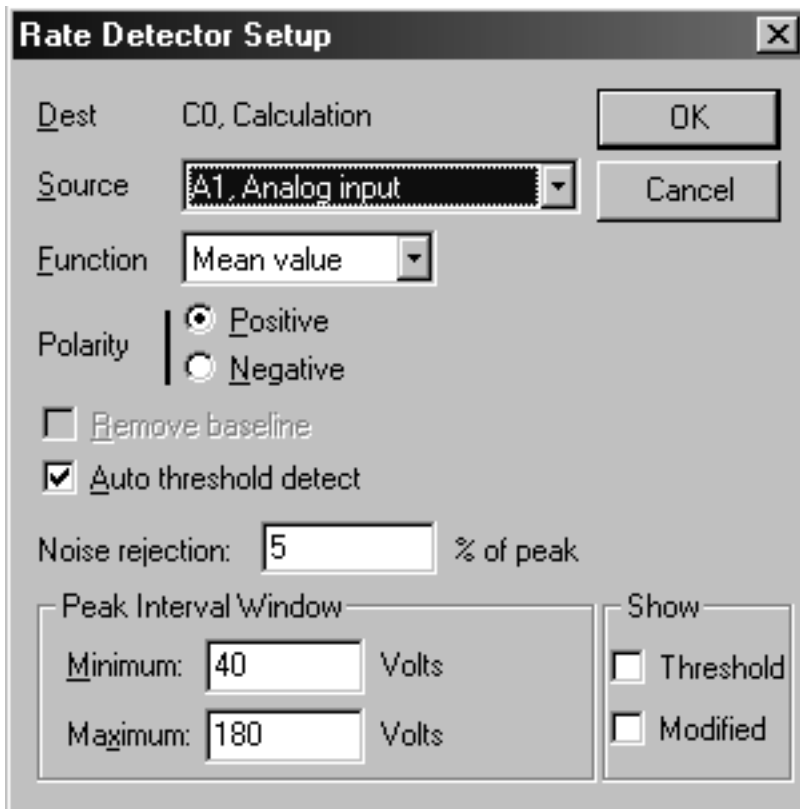
Dest	C0, Calculation
Source	A1, Analog input ▼
Function	Mean value ▼
Polarity	⦿ Positive ○ Negative

☐ Remove baseline

☑ Auto threshold detect

Noise rejection: 5   % of peak

Peak Interval Window

Minimum: 40   Volts

Maximum: 180   Volts

Show

☐ Threshold

☐ Modified

[OK]   [Cancel]

To configure the software to record Rate, you will need to turn on another Calculation channel, then select the Rate function, click on the Setup button and choose Rate (BPM) or Rate (Hz) whichever you are interested in calculating. This is shown below.

Rate Detector Setup

Dest	C0, Calculation
Source	A1, Analog input
Function	Rate (BPM)
Polarity	⦿ Positive ◯ Negative

☐ Remove baseline
☑ Auto threshold detect

Noise rejection: 5 % of peak

Peak Interval Window

Minimum: 39.99 BPM
Maximum: 180 BPM

Show

☐ Threshold
☐ Modified

OK   Cancel

To configure the software to record Cardiac output, you will need to turn on another Calculation channel, then select the Math function, click on the Setup button and multiply Stroke Volume by Heart Rate. This will then provide you with a value for Cardiac output.

The screenshot below shows an example of what your data may look like if recording Blood flow, Blood pressure, Flow max, and Flow min.
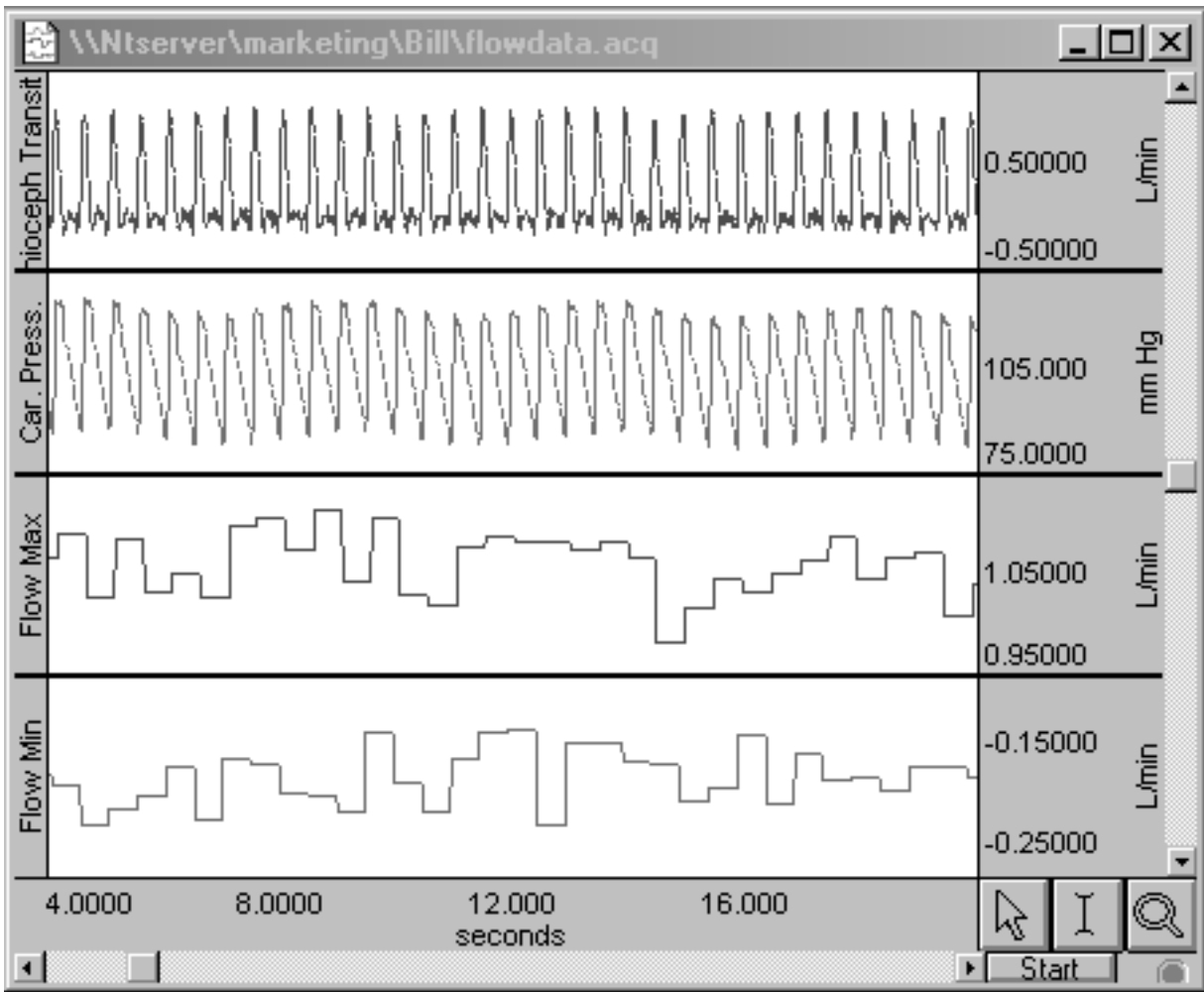
The screenshot below shows an example of what your data may look like if recording Blood pressure, Pulse rate, Mean flow, and Stroke volume.
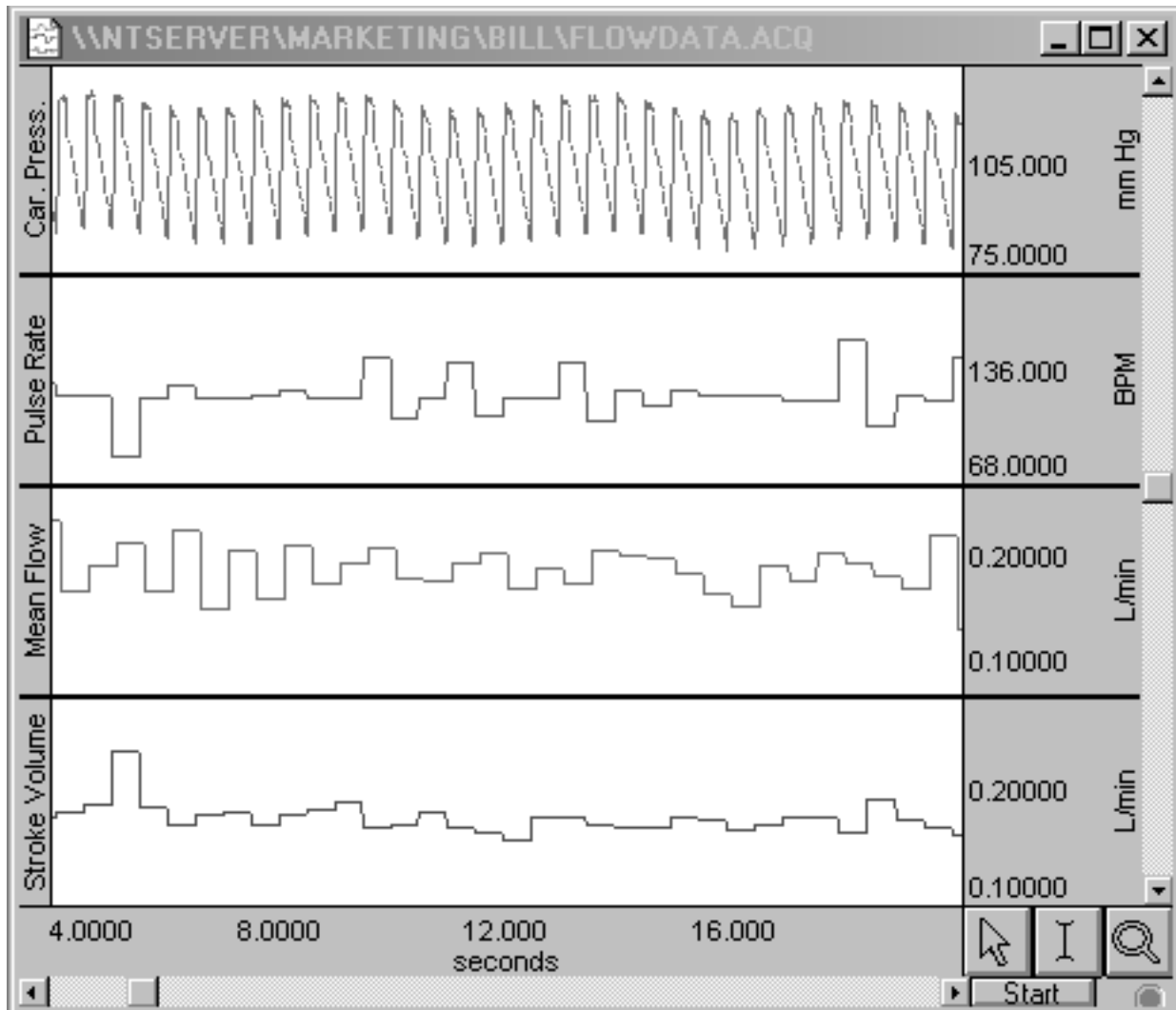
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