

# T400-Series Technical Note

## Frequency Response for Research Flowmeters

The frequency response and phase delay of Transonic's Flowmeters are a function of the sampling frequency, signal frequency and filter cutoff frequency.

The sampling rate of Transonic® Flowprobes ranges from 3.6 KHz (3600 samples/second) in the smallest Probes to 225 Hz (225 samples/second) of the largest Probe sizes. These sample rates allow Transonic® Flowmeters to fully resolve pulsatile flow.

The voltage signal output of Transonic® Flowmeters is filtered to exclude high frequency noise in the measurement that may be generated from the circuitry and is not flow related. As a general rule, the harmonic content of a pulsatile signal such as heart flow is well described by the first 10 harmonics of the signal. Therefore, a 10 Hz filter should be used for or a 1 Hz heart beat (60 beats/min) to characterize the components of the pulsatile flow signal. For the highest quality measurement, the filter band width chosen should correspond to the frequency cycle of the measurement. The 400-Series Flowmeters have a 160 Hz filter to fully resolve flow at higher frequencies as required in conscious mouse studies where heart rates can reach 750 beats per minute.

FILTER SETTING	APPLICATION
0.1 Hz	Average
10 Hz	Heart rate to 60 BPM
30 Hz	Heart rate to 180 BPM
40 Hz	Heart rate to 240 BPM
100 Hz	Heart rate to 600 BPM
160 Hz	Heart rate to 960 BPM

The impedance of a blood vessel is calculated by measuring pressure and flow volume and dividing the pressure by the flow volume. This calculation implies that the measurements are performed simultaneously. Yet different instruments may have different delays on the output signal which can add error to the measurement.

The largest component of the time delay in Transonic® research Flowmeters is the result of the low-pass 3rd order Butterworth output filter. The table below gives the delay in the output signal for the various research Flowmeters at each filter setting.

FLOWMETER MODEL	FILTER FREQUENCY (MSEC)				
	10HZ	30HZ	40HZ	100HZ	160HZ
T106/T206	26	9		4	
T110/R	25.2	7.7		2.3	
T420/T410	23.9		6.8		2.75

Frequency response and phase delay graphs are available for the various filters.