Narrow or Wide Bandwidth
5B Series Input Modules:
Which Is the Right Choice?

Two bandwidth versions of the 5B Series input modules are available: 4 Hz (narrow) and 10,000 Hz (wide). The version that is appropriate for your application depends on two factors. First, the frequency content of the input signal must be understood. Second, the sampling rate of the A/D subsystem plays an important role.

The bandwidth of the 5B module is determined by internal low-pass filters. Ideally, they pass information through from input to output without any attenuation for frequency components below the cutoff frequency (either 4 Hz or 10,000 Hz), and they completely block frequency components above the cutoff. Practically, they neither perfectly pass the lower frequencies nor totally reject the higher.

Many signals measured by a data acquisition system are slowly varying with time or "low frequency." Examples are temperatures, flows and liquid levels. Their measurements typically do not move through cycles lasting less than one second. If the signal moved through a cycle with a period of one second, it would have a frequency component of 1 Hz (1 cycle per second). A low bandwidth 5B module with a 4 Hz cutoff would be ideal for this measurement. Because it rejects information above 4 Hz, it will eliminate interference from outside sources. A typical problem in precision measurement systems is 60 Hz noise from ac power lines. 60 Hz noise is reduced by a 4 Hz bandwidth module by a factor of 1000:1.

Some signals measured by a data acquisition system vary rapidly with time. Some examples are:

- Pressure inside a plastic injection molding machine
- Strain on an automobile chassis during a crash test
- Vibrations from a machine bearing shortly before failure
- Force on a machine tool during a milling operation

The measurements from these signals can go through hundreds or thousands of cycles per second. If these signals were conditioned by a narrow bandwidth module, all of the useful information would be filtered out. The wide bandwidth 5B modules will pass through all information with frequencies below 10,000 Hz (cycles per second) and reject frequencies above 10,000 Hz. They are recommended for these applications.

The sample rate of the A/D subsystem must also be taken into consideration when choosing 5B modules. An A/D converter approximates an analog signal by taking samples at discrete points in time. These samples are reconstructed by the software and used to display the data or to control a process. The faithfulness of the reconstruction is enhanced when more samples are taken in a given time period and when the fineness of the measurement is increased (resolution). The sampled data will actually contain errors if a certain minimum sampling rate is not maintained. The minimum rate is determined by the Nyquist Theorem, which states that the minimum rate must be at least two times the highest frequency in the signal. If this rate is not maintained, a type of error known as aliasing will occur. Low-pass filters on the input signals to restrict the frequencies to below one-half the A/D sample rate are known as antialiasing filters. The 5B modules perform this filtering in addition to the other signal conditioning functions.

Practically, because the filters are not perfect, some frequencies above the cutoff get through. To avoid aliasing, many data acquisition engineers program their A/D subsystems to sample at rates of 5 or 10 times the filter cutoff. This would mean sample rates of 20 to 40 for narrow bandwidth and 50,000 to 100,000 for wide bandwidth modules.