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# APPLICATIONS NOTES

## SELECTION OF FILTERS FOR USE ON SIGNAL/DATA LINES

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# APPLICATIONS NOTES

## SELECTION OF FILTERS FOR USE ON SIGNAL/DATA LINES

The reason for fitting a filter is to remove unwanted signals, so there is often a compromise on data circuits between allowing the wanted signals to pass while getting rid of as many unwanted signals as possible. The normal solution is to use a low pass filter which cuts off as soon as possible above the data signal frequencies. The steepness of the attenuation curve is again normally a compromise between the ideal and the practical. Steeper curves mean more filter elements which entail a larger size , more capacitance, inductances, and dc resistance which can lead to compatibility problems. MPE standard filters are designed using a number of elements practically established to give a good compromise between performance and size.
Filter circuits used by MPE are computer designed using in-house software which optimises the performance for a given application while offering a very flat pass band with minimum ripple and phase distortion.

**1. Analogue data circuits** (including signals for control circuits such as fire alarms, intruder alarms, sensors, etc)

The main criteria for filter selection or design are choosing the impedance of the filter to match the circuit and to select a filter (low pass) with a pass band the same as or greater than the bandwidth of the signal to be passed. The filter should naturally be suitable for operating at the working voltage and current levels of the analogue signal but as these are normally low, there is not usually a problem.
Consideration should also be given to the dc resistance of the filter and its total capacitance and inductance, as interfacing equipment is sometimes limited particularly in the capacitance and resistance which it can tolerate, so compatibility problems can occur.
It should be remembered that if used on relay or indicator lamp circuits, when the circuit is switched off the stored energy in the filter capacitors will cause the relay or lamp to stay on momentarily until discharged. If the relay or lamp is ac driven switched through a filter, then the filter and switch should not be used on the earthy side of the circuit as the filter capacitors to earth will by-pass the switch causing the circuit to remain partially energised.

## 2. Digital signal circuits

Square wave signals are made up from a summation of a series of sinewaves, based on the fundamental frequency (or the data rate) and its harmonics. To create a near perfect square wave, the fundamental frequency and many tens of harmonics are needed, but it is generally recognised that a reasonable square wave can be generated using only up to the 10th harmonic. This will have slightly rounded leading and trailing edges, but will otherwise look like a good square wave.

It can be seen that to transmit a perfect square wave down a line would require a very high bandwidth.
Most practical data systems rely on the fact that a reasonable square wave signal only needs components up to the 10th harmonic so only needs a bandwidth of 10 times the data rate.
This is normally used as the basis for filter designs for digital data, but can only be used as a guide. Some good quality data links can operate at much lower bandwidths over short distances, while some cheap systems need a higher bandwidth to operate at all.

The main criteria for selection of filters for digital data are therefore circuit impedance, and pass band (normally taken as 10 x data rate) e.g. approx 100kHz for 9.6kbit/s.
Many data transmission formats permit data to be transmitted at different speeds. For optimum filtering performance, the filter passband should be selected to pass the maximum speed which it is intended to use on the system.
Voltage and current of the data signals are not usually significant.
The total capacitance, dc resistance, and to a lesser extent inductance can be critical in terms of compatibility with data circuitry. Generally, better quality systems are more tolerant and are more likely to be compatible.

Because of the many different formats, data speeds, and equipment variability, in terms of tolerance to line capacitance and resistance, it is always a good idea to check compatibility with filters by testing a prototype. It is not possible to guarantee that equipment will work with a given filter without testing.

## 3. Use of filters with modems

Modems are often used to modulate and compress digital data signals for transmission down standard telephone circuits which have a bandwidth of 300Hz to 3.4kHz. Good quality modems are available which can pass data of 33.6kbit/s or even higher speeds down standard telephone lines including through high performance filters. However, because of the variable standard of modems, it is always wise to check compatibility by testing.