RFI/TEMPEST ISOLATION

The need for an isolation device arises from the requirement to remove from a communications signal all other signals, both transverse (across pair) and longitudinal (between the pair and ground) (common-mode), which should not pass between the signal source and its load or pass beyond a specified point in the signal route. This general requirement would be typical of radio frequency interference (RFI) and TEMPEST problems.

Since the unwanted signals and noise may fall within the band-pass of the desired signal, it is not desirable to employ passive filters. The patented technique employed by Versitron, Inc. consists of interposing an isolation device in the signal line to propagate the signal by optical means, thus breaking the electrical conductor path. Almost complete isolation against longitudinal (common-mode) unwanted signal coupling is obtained.

Each isolation unit is housed in two separate modules marked "Input" and "Output". A non-metallic light guide is then placed between the two modules, thus propagating signals without a metallic path. Circuit techniques are employed for digital units in order to suppress transverse noise levels. In addition, time regeneration is available on digital units, while the bandwidth can be restricted as required in analog units. Therefore, with proper installation and choice of model, the isolation device becomes a unidirectional signal repeater covering practically all communications frequencies and isolation requirements.

Common-Mode Isolation:

Common-mode signal isolation, for the purposes of the isolation devices discussed here, is defined as the signal attenuation between the shorted input and the shorted output of an isolation device when the generating source is between the shorted input and a ground reference, and the detecting instrument is between the shorted output and the same ground reference. (See figure 1).

Isolation devices accomplish this common-mode isolation by the use of seperate input and output module chassis. The input module converts the input electrical signal to a modulated light beam and the output module converts the light signal to an output electrical signal. Therefore, no electrical conductor exists by which to conduct the undesired common-mode signal. To complete the isolator installation, a grounded shield most be interposed between the input and output modules in order to eliminate space radiated coupling. This ground plane is normally a chassis wall or shielded room wall. The light beam is passed through the ground plane by means of a waveguide penetration. The dimensions of the waveguide are chosen so that its cut-off frequency is above the highest frequency of interest. This waveguide penetration must be chosen with two factors in mind. First, the wavelength of the highest frequency of interest must be large compared to the diameter of the waveguide. Second, the ratio of the length of the waveguide to the diameter determines the amount of attenuation below the cut-off frequency.

A formula containing these factors but excluding the low frequency "H" wave would take the following form:

$$A = 32\,\frac{L}{d}\left[1 - \frac{f^2}{f_c^2}\right]^{1/2}$$

Where:
- A — Attenuation (dB) of waveguide
- L — Length of waveguide in meters
- d — Diameter of waveguide in meters
- f_c — $\frac{3 \times 10^8}{2d}$ (cut-off frequency)
- f — Any frequency below f_c for which A is computed

The above formula assumes worst-case criteria such as: Diameter = ½ cut-off wavelength: dielectric constant = 1.

For frequencies significantly below cut-off, A = 32 L/D.

In view of the above and the fact that the light guide is a non-conductor, it is obvious that the common-mode isolation is independent of the electronic circuitry of the isolator. This, assumes, of course, that the power sources for the isolator modules are properly isolated or filtered. Photon couplers that do not use the above technique do not provide the highest degree of EMI or TEMPEST protection. They provide only DC and low-frequency isolation.

Transverse-Mode Isolation:

Since the common-mode rejection (balance) of practical circuits and wiring are never perfect and since cross-talk is a danger in multicircuit situations, it is often necessary to provide suppression of unwanted signals and noise in the transverse-mode. This mode is defined as the signal across the input or output terminals of the isolator, minus the desired signal. In the case of digital isolators, the input module light source circuitry is electrically saturated in the ON or OFF state and therefore, does not respond to superimposed undesired signals as long as the total instantaneous value does not exceed the threshold point for the opposite transition. (See figure 2).

Where the undesired signal takes the form of phase or frequency modulation, time regeneration of the desired signal is used.

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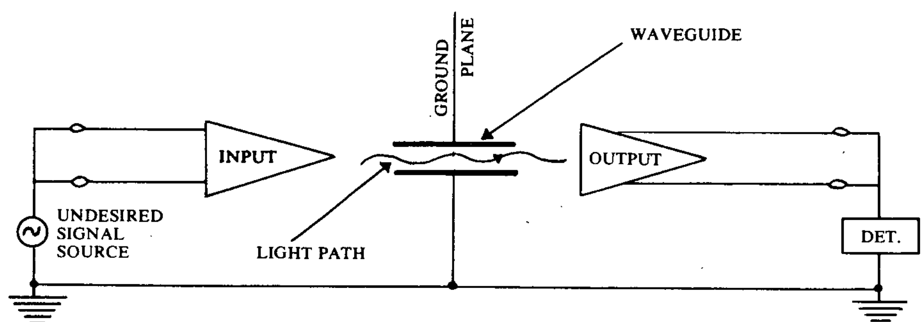
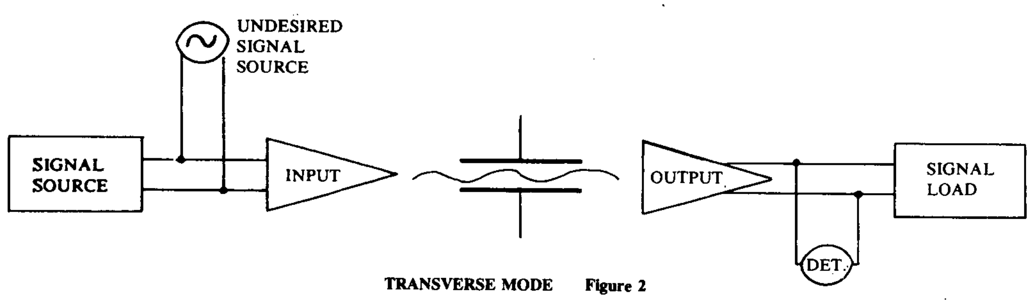


COMMON MODE Figure 1



TRANSVERSE MODE Figure 2