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(54) Emi filtering of multi-wire cables

(57) A multiple-wire cable such as a cable connecting a PABX which generates unwanted EMI signals to other equipment acts to radiate EMI and to conduct EMI signals to other equipment.

It is known to apply individual line filters to each line to prevent the EMI signals from being distributed over the cable. According to the invention EMI signals, both radiated and conducted are attenuated by a distributed filter in the form of a screen applied to the cable. To effectively attenuate the conducted signals, the length of the screened cable must be greater than a minimum length determined for the frequency of the EMI and the dimensions of the cable.

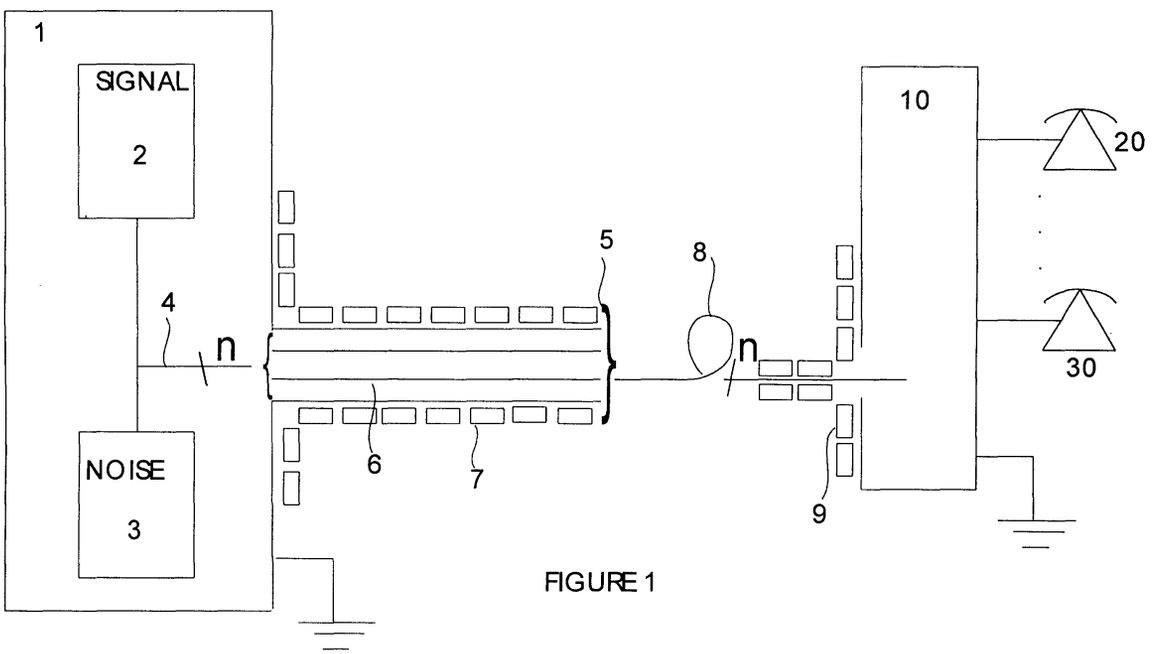

FIGURE 1

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Description

Technical Field

[0001] This invention relates to an arrangement for ameliorating the effects of electromagnetic interference (EMI), such as that generated by noisy equipment. The invention is particularly applicable to multi-wire cables emerging from otherwise EMI sealed equipment housings. In such instances, EMI can escape from the housing and radiate from the cables or be fed into other equipment via the cables.

Background Art

[0002] A known solution to this problem is to use a plurality of filters, one for each line, to prevent the EMI emerging form the housing.

[0003] For example, where the EMI components of concern are of a higher frequency than the signals on the line, low pass filters may be used.

[0004] Because an individual filter must be used for each line, this arrangement is costly and requires additional work to install.

[0005] It is also known to use a ferrite sheath on main cables over the length of the cable to attenuate noise inductively.

Disclosure of the Invention

[0006] With the increase in the use of radio signals for telecommunications and other applications, strict EMI emission standards have been introduced particularly for higher frequencies.

[0007] It is desirable to provide an inexpensive means of meeting these standards.

[0008] This specification therefore discloses a method of reducing above band noise signals on a multi-wire cable, the method including applying a distributed EMI coupling means over at least part of the length of the cable, the length of the coupling means being sufficient to attenuate the noise signals below a pre-determined threshold.

[0009] In another embodiment there is described a method of making noisy equipment EMI compliant without the use of individual EMI line filters, where the equipment is connected to a multi-line cable, the method including:

- applying shielding to at least part of the length of the cable from the point where the cable emerges from the aperture, the shielding extending for a sufficient length to attenuate the noise to a level below a pre-determined threshold value; and

- electrically connecting the shielding to the housing surrounding the aperture to seal the aperture to EMI.

[0010] The specification also discloses an arrangement for filtering above-band noise signals from a multi-wire cable, the arrangement including an earthed distributed EM coupling means distributed over at least a part of the length of the cable, the length of the coupling means being such that the coupling of the above-band noise signals to the distributed coupling is sufficient to attenuate the noise signals to below a predetermined threshold over the length of the distributed impedance.

Brief Description of the Drawings

[0011] Figure 1 shows first and second equipment housings interconnected by a cable, according to an embodiment of the invention.

[0012] Figure 2 is a graph representing noise attenuation against cable length.

Best mode of carrying out the Invention

[0013] The invention will be described with reference to the example shown in Figure 1, which represents a multiplexer 1, connected to a PABX 10 via a length of multi-pair cable containing over 100 pairs.

[0014] The multiplexer generates noise at frequencies above 30MHz.

[0015] The multiplexer is co-located with the PABX and the length of the cable would ordinarily be of the order of 5 to 10 meters.

[0016] In figure 1, the multiplexer 1 is shown schematically as containing signal processing equipment 2, and the noise generating source 3 which impose signals and EMI respectively on a multi pair cable 4. In reality the EMI is generated incidentally to the signal processing, e.g. in sampling the signals.

[0017] The housing of the multiplexer 1 is sealed against EMI, but the cable 4 exits via an aperture in the housing enabling EMI to escape from the housing 1 on the cable lines 6.

[0018] However the cable is shielded by shielding 7 which forms an EMI seal with the housing of multiplexer 1. The shielding 7 prevents the EMI on the lines 6 from radiating.

[0019] However the EMI can still travel along the lines 6 and enter the associated equipment, in this case PABX 10.

[0020] As can be seen in Figure 1, the PABX 10 feeds a plurality of telephone subsets, 20.... 30, which are connected to the PABX by unshielded telephone lines. Thus, if noise is present on the cable feeding into PABX 10 and there is no other noise suppression applied to the connections between the cable and the telephone lines, the noise will be radiated by the telephone lines.

[0021] We have found that by providing shielding around the cable the high frequency noise signals are strongly attenuated, while the signal frequencies which are significantly lower than the noise frequencies, are attenuated to a much lesser extent. This is particularly

effective for reducing noise above 30MHz.

[0022] By providing a sufficient length of such shielded cable, the noise signal can be attenuated to a predetermined level, e.g. to a level set by standards for permissible noise at the frequency of interest.

[0023] Figure 2 illustrates the reduction in noise signal in relation to the length of shielded cable. As shown, a particular noise threshold can be achieved by providing a sufficient length of shielding.

[0024] Our invention takes advantage of this characteristic by providing an additional length of cable, shown schematically as loop 8, to ensure the EMI is sufficiently attenuated.

[0025] In this case the housing of the multiplexer 1 and the shielding 7 effectively form a Faraday cage which prevents the escape of the target EMI frequencies.

[0026] Preferably the remote and of shielding 7 is grounded to the same potential as the housing 1.

[0027] We have found that a length of 20m of 100 pair shielded reduces EMI above 30 MHz generated by a Remote Integrated Multiplexer to a level which satisfies EMI standards. The frequency characteristics of different shielded cables can be determined empirically.

[0028] The shielding acts as a distributed capacitance to which the EMI is coupled and attenuates the EMI.

[0029] The invention has the advantage that otherwise non-EMI compliant equipment can be made EMI compliant. This eases the design requirements for the internal circuits which do not need to implement specific EMI techniques. Equipment design is therefore more flexible because the hardware design criteria is less stringent.

[0030] In existing installations which do not comply with new EMI standards, a sufficient length of conductive braid or metal tape may be applied to shield unshielded cables to a length sufficient to attenuate the EMI, and, where necessary, an EMI sealed housing applied around the equipment if the existing housing is not EMI sealed. The newly applied shielding is connected electrically to the EMI sealed housing to form a Faraday cage.

Claims

1. A method of reducing above band noise signals on a multi-wire cable, the method including applying a distributed EMI coupling means over at least part of the length of the cable, the length of the coupling means being sufficient to attenuate the noise signals below a pre-determined threshold.

2. A method as claimed in claim 1 wherein the coupling means is in the form of conductive shielding surrounding said at least part of the length of the cable.

3. A method as claimed in claim 1 or claim 2,

   - wherein the lines of the cable are connected to circuitry which produces the noise signals,

   - the method including enclosing the circuitry in an EMI sealed housing and electrically connecting the distributed coupling to the housing.

4. A method as claimed in claim 3 wherein the housing and the coupling means form a Faraday cage to effectively contain the noise signals.

5. A method of reducing EMI emanating from a multi-wire cable connected to equipment which generates above band noise signals, the method including:

   - applying a conductive shield to at least part of the length of the cable, the length of the shielding being sufficient to attenuate the noise signals below the predetermined threshold;

   - enclosing the equipment in an EMI sealed housing; and electrically connecting the shielding to the housing to form an effective Faraday cage at the noise frequencies.

6. A method of making noisy equipment EMI compliant without the use of individual EMI line filters, where the equipment is connected to a multi-line cable, the method including:

   - applying shielding to at least part of the length of the cable from the point where the cable emerges from the aperture, the shielding extending for a sufficient length to attenuate the noise to a level below a pre-determined threshold value; and
   - electrically connecting the shielding to the housing surrounding the aperture to seal the aperture to EMI.

7. A method as claimed in any one of claims 1 to 6 including the step of electrically connecting the remote end of the shielding to the same potential as the housing.

8. An arrangement for filtering above-band noise signals from a multi-wire cable, the arrangement including an earthed distributed EMI coupling means distributed over at least a part of the length of the cable, the length of the coupling means being such that the coupling of the above-band noise signals to the distributed coupling is sufficient to attenuate the noise signals to below a predetermined threshold over the length of the distributed impedance.

9. An arrangement as claimed in claim 8 wherein the distributed coupling means is in the form of a conductive jacket surrounding as least a part of the length of the cable.

10. An arrangement as claimed in claim 8 or claim 9 wherein the cable is connected to equipment which generates unwanted noise signals and the distributed coupling means is earthed to the equipment housing and forms a Faraday cage therewith.

11. A method of reducing above band noise signals substantially as herein described with reference to the accompanying drawings.

12. An arrangement for reducing as claimed in 9, wherein the distributed coupling means is in the form of a conductive jacket surrounding as least a part of the length of the cable.

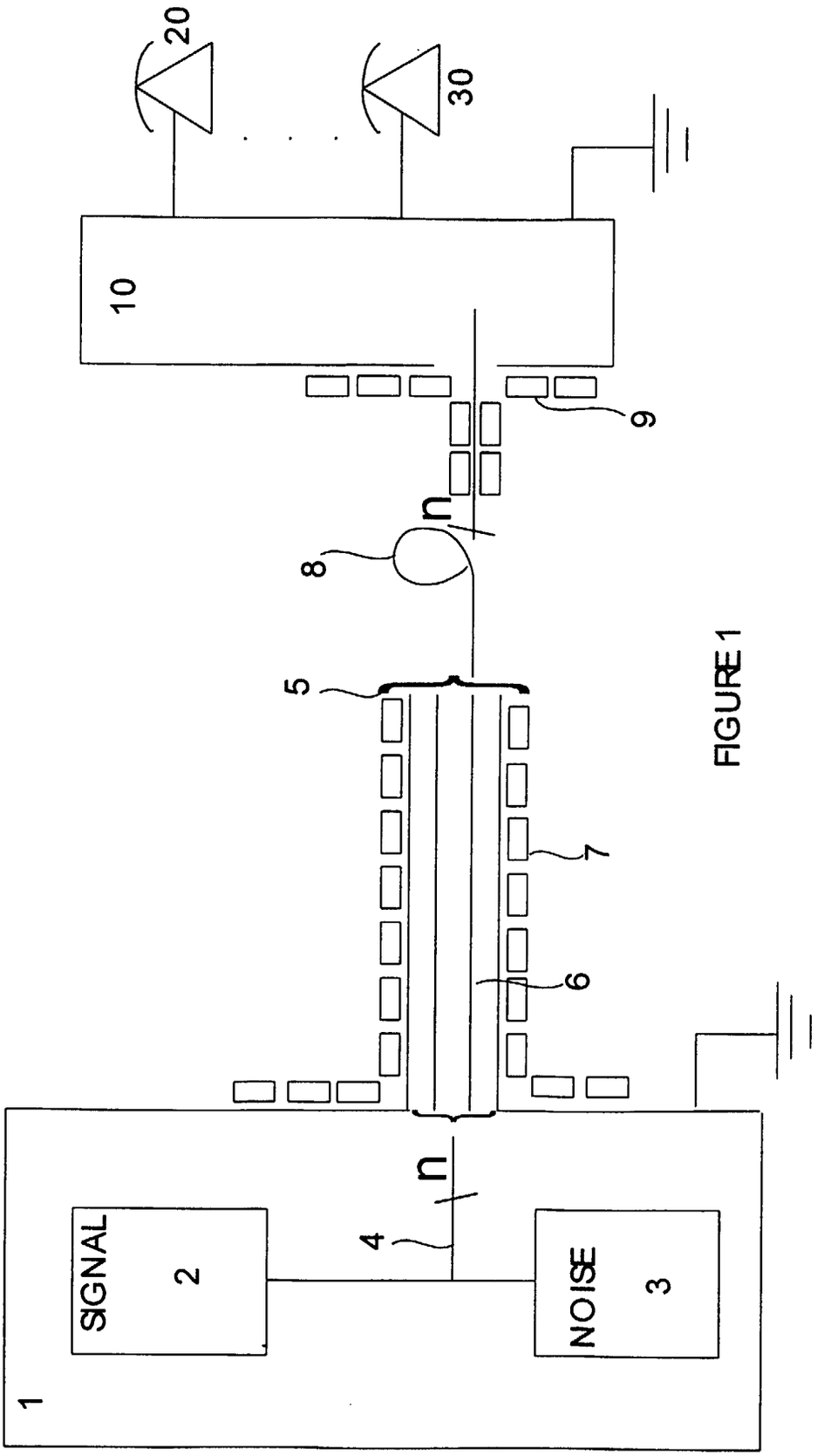

FIGURE 1

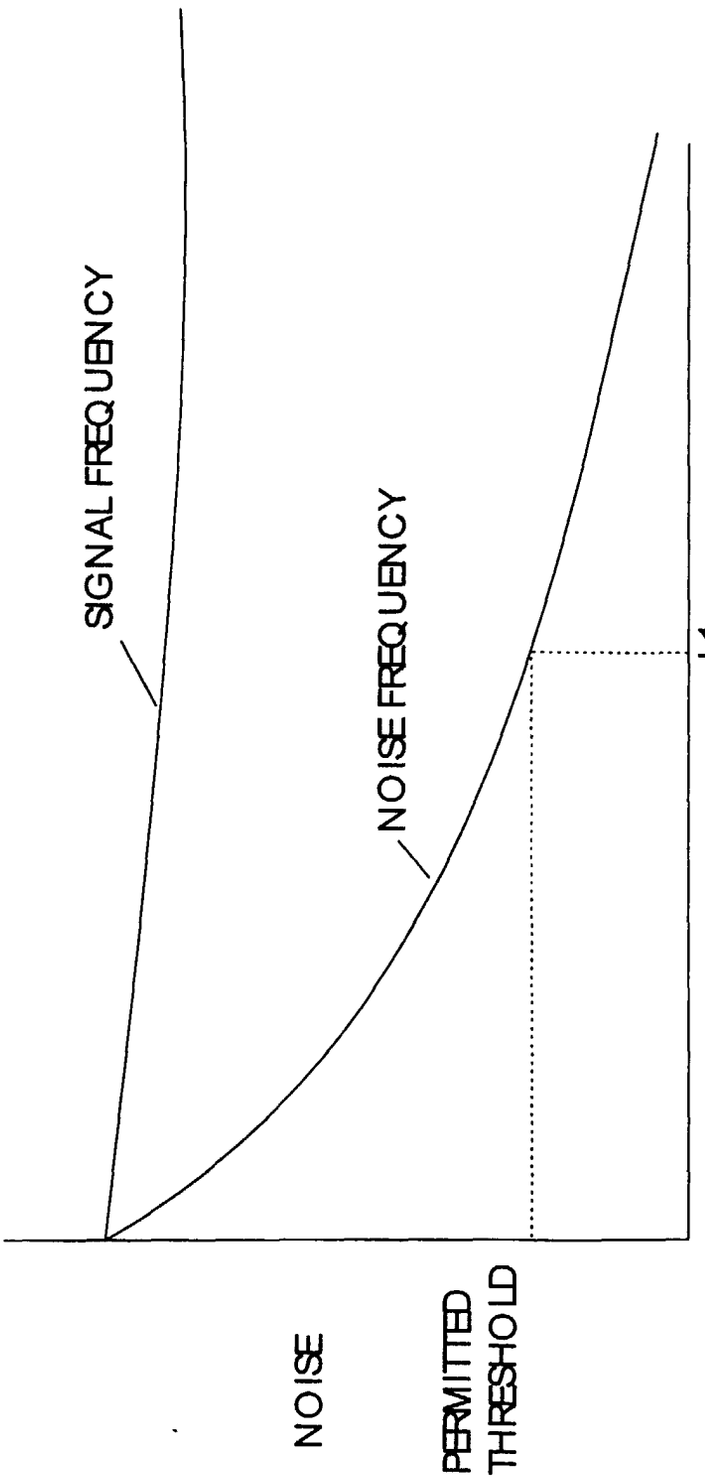
SIGNAL FREQUENCY
NOISE FREQUENCY
L1
LENGTH
NOISE
PERMITTED
THRESHOLD

FIGURE 2