

Interconnection of components

TECHNICAL FIELD:

The present invention relates to an arrangement for interconnection of components or elements according to the first part of claim 1.

Within for example radio communication at interconnecting of or connection between different elements or components of which at least one is selective and reflex generating problems arises due to reflection interaction between components if there is no wideband isolation between them, which for different reasons often is the case. Examples of elements or components may e.g. be antennas, pre-selector filters and a number of others.

In e.g. VHF-communications systems (30-90 MHz) transmitter and receiver respectively may be arranged very close to each other. This means that e.g. the transmitter must have a high selectivity, i.e. damp the power on other frequencies which are not used which is problematical although frequency planning is applied. With this high selectivity which is required by a transmitter as well as a receiver follows a high current consumption which in many cases is negative e.g. if the transmitter/receiver is portable. It is furthermore desirable, to the largest extent possible, to be able to use the same components. In this case may e.g. extra filters be used preceding the receiver frontend as well as preceding the transmitter. The transmitter output comprises the output of an active component which is impedance-matched over the whole frequency range, therefore no problems arise. When arranging a filter before the receiver frontend a problem

arises since the receiver frontend comprises a filter with bandpass-selectivity wherethrough the impedance is not the same across the whole band which is a requirement on an external passive filter to function as a bandpass filter with to the receiver added selectivity. What has been described in the foregoing is however merely an example which is intended to illustrate one of the areas which can be of interest.

STATE OF THE ART:

A known interconnected system is a so called "front-end"-radio receiver, usually a bandpass pre-selector filter preceded by antenna. Since this antenna is adapted for wideband signals this means that variations in impedance are very large. If it is a so called "short whip"-antenna of 30-88 MHz the standing wave ratio, VSWR, may reach 1:6 whereas when it is question about an antenna which is mounted on a vehicle the VSWR may be up to 1:4. The phase of the VSWR fluctuates depending on cable length and tuned frequency which strongly affects and degrades the selectivity of the system.

In another known system it has been tried to increase the selectivity of a system by arranging an external "reflective" filter between the antenna and the receiver pre-selector. The intention is then to add the selectivity of each bandpass filter respectively. This may however instead lead to a total selectivity which is smaller than the selectivity of the individual bandpass filters. One of the explanations thereto is that the bandpass range merely constitutes a small part of the whole frequency range over which it is desired to control the bandpass filters. The degradation of the total system selectivity upon interconnection of two elements resides in the uncontrolled phase of the reflection coefficients of the input and output signals respectively. With selective elements it is the object to obtain reflection of power in the stopband

and matching in the passband. Depending on the VSWR of the both elements at the point of interconnection and their phase a non desired matching in the stopband may result which degrades and in the worst case even destroys the selectivity. A known solution to this problem is to overdimension the external filter, or that margins are introduced in relation to prevailing system requirements so that the degraded selectivity therethrough is compensated so that the system requirements in spite of all may be met. This method is however generally current consuming and furthermore requires expensive, passive components.

According to an alternative embodiment buffers are interconnected between the receiver frontend and the external filter. These buffers may e.g. comprise amplifiers or isolators to obtain a good isolation. The intention is to keep the nominal impedance of the frequency range which at least corresponds to the nominal frequency range (e.g. 30-90 MHz). If however an amplifier is connected to the receiver frontend for isolation of the impedance variation of the antenna, this requires a high current consumption which also involves costs. This also influences the frequency of faults occurrence of the system in a negative way. The connection of passive isolators is hard to carry out among others depending on size at lower nominal system frequencies whereas passive isolators as well as amplifiers also require transmitter/receiver re-coupling in order to maintain the performance of the system. Consequently, also this solution based on arranging buffers consume current and furthermore will among others maintenance requirements on a further component or an element be introduced. For e.g. a narrowband radio the cablelength between an external filter and the receiver can be specified. With e.g. a wideband radio a controllable cable length is required, i.e. a phase shifter. In US-A-4 799 066 and US-A-4 965 607 arrangements are described for minimizing the loss between the welldefined, as far as the impedance is concerned in- and output respectively at a received/transmitted frequency

and a less well defined antenna. Therethrough is however not maximum selectivity obtained but the optimization is carried out for minimum passband loss. In e.g. EP-A-0 403 176 and US-A-4 232 399 examples of phase shifters are shown.

SUMMARY OF THE INVENTION:

An object with the present invention is to provide an arrangement for interconnection of components e.g. in radio communication which are selective and reflective to obtain a high system selectivity without having to over-dimension its component/components to comply with given system requirements or to obtain an acceptable selectivity. It is further an object with the present invention to provide an arrangement wherein the phase can be controlled, where no buffers, e.g. in the form of amplifiers or passive isolators between the components as well as also no transmitters/receiver selectors are required. It is thus an object with the invention to enable the interconnection of components without this leading to any loss in system selectivity. It is furthermore an object of the invention to be able to interconnect selective components without the total selectivity being lower than the selectivities of each component respectively or particularly that the total selectivity even exceeds the sum of the individual selectivities. An object of the invention is to reduce or eliminate the loss in passband selectivity when interconnecting selective and (narrowband) reflective components.

An arrangement through which these as well as other objects are achieved is given by the characteristics of the characterizing part of claim 1. A method through which the above mentioned objects are achieved as given by claim 22. Preferred embodiments are given by the characteristics of the subclaims.

BRIEF DESCRIPTION OF THE DRAWINGS:

The invention will in the following be further described under reference to the appended drawings in an explanatory and by no means limiting way wherein

- Fig. 1 illustrates interconnection of two "reflective" elements, antenna and pre-selector filter respectively,
- Fig. 2 illustrates interconnection of antenna-external filter-pre-selector filter,
- Fig. 3 schematically illustrates an example of interconnection of a wideband antenna with a VSWR-ratio of 3,5:1 and a pre-selector with 5° phase resolution,
- Fig. 4 statistically illustrates the embodiment of Fig. 3,
- Fig. 5 schematically illustrates interconnection of antenna-external filter-pre-selector with no isolation and with 5° phase resolution,
- Fig. 6 is a statistic illustration of the embodiment of Fig. 5 in comparison to a perfect isolation.

DETAILED DESCRIPTION OF THE INVENTION:

Interconnection of two elements of the reflective kind, an antenna and a pre-selector filter or a bandpass filter is illustrated in Fig. 1. Between the two reflective elements 1, 3 a phasor 2 is arranged. The phasor 2 is tunable between 0 and 180° which corresponds to a full turn in a Smith-chart™, wherefrom a Smith-chart phase and amplitude for different reflection parameters can be plotted and read and wherefrom further the corresponding complex conjugated impedance is obtained. With a correct tuning of the phasor 2 no degradation in selectivity occurs when interconnecting the two elements or components 1, 3. A correct tuning may instead give rise to an increase or improvement of the total selectivity of the system which may be 6 dB. The pre-

selector filter is connected to a receiver 6 which corresponds to an extra pole in the filter.

In Fig. 2 an embodiment is illustrated wherein a pre-selector filter or a bandpass filter 3 of a radio input is preceded by an outer or an external bandpass filter 5. For interconnection of the different elements a phasor (phase tuner) 4 is interconnected between the pre-selector filter 3 and the external bandpass, BP, filter 5. It is then also possible to arrange a first phasor 2' before the external bandpass filter 5, i.e. between the external filter 5 and the antenna 1. It is now significant how the phasor 2; 2', 4 is tuned or controlled, i.e. which phase positions it shall take for different, in this particular case, receiving frequencies.

According to one embodiment the phasor 2; 2', 4 may be controlled or tuned with application of the so called dead-count-method. With this method initially a number of values of the reflection parameters of the elements or components to be measured and the phase values of the tuned frequencies are to be calculated and stored in a look-up table. Then one phase value is valid for one frequency for a given cable length. Consequently a value for the phasor for the tuned frequency can be found in the table. This method is simple to apply but it does not take into account the aging of components e t c. It is furthermore necessary, as stated above, that a cable of a well defined length is arranged between the external filter and the radio.

An alternate way for tuning or controlling of the phasor is to find the phase value which gives the best performance for the system adaptively, via tuned frequencies with the use of SNR (Signal to Noise Ratio) or BER (Bit Error Rate). With the assistance of these methods, the solution will also be independent of the length of the cable which thus may take different sizes. With adaptive matching the bit errors are detected in the receiver whereafter the

phasor is matched for minimum bit error. The tuning of the phase shifter merely insignificantly affects the passband damping and therethrough the desired signal.

It is also possible to in a number of other ways arrange the phasor either in a continuous or discrete mode with low through losses, preferably less than 1 dB. Following what has been said in the foregoing it is not possible to avoid passband mismatch. This is however possible through an adaptive equivalent transformer ratio for adaption of the passband VSWR. This is however of minor importance in comparison to the loss of selectivity in the stopband.

In Fig. 3 are illustrated the effects of non phase matching with a pre-selector filter or a bandpass filter which is preceded by an antenna with a VSWR-ratio of 3,5:1. The figure shall also illustrate (not all shown) 36 curves corresponding to an antenna impedance with a phase resolution of 5° , i.e. one curve corresponds to each setting of the phasor. It is of course possible to use another phase resolution which will be given by the application and chosen in an appropriate manner. I.e. the phase resolution is system-related and will be so chosen that the best system performance is achieved. It may, as stated above be continuous, e.g. be voltage controlled or have discrete steps, wherein 5° merely is given as an example. It can be coarser as well as finer. In the embodiment is illustrated a frequency of between 47,5 MHz to 52,5 MHz and region I corresponds to the passband region whereas the regions denoted II illustrate stopband regions. The 36 curves, $36,5^\circ \times 5 = 180^\circ$ corresponds to a full turn in the Smith-chartTM. The curve illustrated • corresponds to the passband filter at a nominal load and source impedance and in the figure is illustrated the loss which an incorrect phase shifter tuning would give rise to in decibel, corresponding to b, whereas the gain selectivity by using the phasor is denoted a. The antenna is in this case a wideband antenna. From the figure it is clear that

the different phases have a little effect on the passband loss compared to the variations in selectivity.

Fig. 4 statistically illustrates the result of Fig. 3 wherein curve c (denoted • in Fig. 3) corresponds to nominal filter for nominal load, curve d corresponds to minimum selectivity, curve e to average selectivity for all phase positions and finally curve f (dashed) corresponds to maximum received selectivity which is obtained through a correct tuning of the phasor.

In Fig. 5 (relative frequency deviation) is illustrated an interconnection essentially corresponding to Fig. 2 above with an external bandpass filter preceding a pre-selector filter or a bandpass filter. Between them phase shifters with a 5° resolution are arranged. The curve denoted • corresponds to the external bandpass filter whereas the curve illustrated by rings (0) corresponds to the pre-selector filter. The group of curves corresponds to phase shifter interconnection with a resolution of 5° . In the embodiment shown herein the components (external bandpass filter and pre-selector filter) are interconnected without any isolation arranged between them.

In Fig. 6 is compared the statistics of the embodiment illustrated in Fig. 5 with no isolation between the components and an embodiment with isolation, particularly perfect isolation, between the components, i.e. pre-selector filter and external bandpass filter. In the embodiment shown herein curve g corresponds to minimum selectivity, a full line corresponds to average selectivity, curve i illustrates the embodiment with a perfect isolator arranged between the components whereas curve j corresponds to a maximum resulting selectivity corresponding to perfect phasor tuning wherein A corresponds to selectivity gain through the use of a phasor which is perfectly tuned in relation to a perfect isolator arranged between the components. Depending on the frequency

band being used, or within a frequency band, the filters may be active as well as passive, this having no effect. This also applies to the phasors, i.e. they may within a frequency band be either active or passive.

The invention shall of course not be limited to the shown embodiments but may be freely varied within the scope of the claims. The invention relates to interconnection of all elements as well as components which are selective and reflective. Furthermore, a number of components may be interconnected wherein phasor may be arranged between one or more of the components. Tuning or controlling of the phasor may further be carried out in a number of different ways of which merely a limited number are mentioned here, wherein those may be selected depending on the application. A particular embodiment wherein the invention may be applied relates to wideband high selective receivers which are connected to "bad" antennas, i.e. they have bad voltage standing wave ratios (VSWR) over the frequency range, e.g. due to lack of space. Furthermore, a number of different embodiments are of course possible wherein the present invention can be applied.

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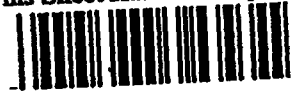


CLAIMS:

1. Arrangement for interconnection of at least two components (1, 3; 1, 5; 3; 5) preferably intended for radio communication, the components or elements to be interconnected being selective and reflective, characterized in that between the at least two components (1, 3; 1, 5; 3; 5) is arranged a tunable phasor (2; 2'; 4) which is tunable between 0-180°, corresponding to a full turn in a Smith-chart™.
2. Arrangement according to claim 1, characterized in that the tuning is adaptive or automatic.
3. Arrangement according to claim 1, characterized in that the phasor (2; 2'; 4) is tuned for a given cable length between the components using the so called dead-count-method.
4. Arrangement according to claim 1, characterized in that the phasor (2; 2'; 4) is tuned with use of the so called SNR-(Signal to Noise Ratio)-method.
5. Arrangement according to claim 1, characterized in that the phasor (2; 2'; 4) is tuned with use of the so called BER (Bit Error Rate)-method.
6. Arrangement according to claim 1, characterized in that at least one of the elements or components which are to be interconnected comprises a wideband designed antenna.



* C L N S *



7. Arrangement according to claim 1, characterized in that at least one of the components comprises a filter (3; 3', 5).

8. Arrangement according to claim 7, characterized in that the filter comprises a pre-selector filter (3, 3').

9. Arrangement according to claim 7, characterized in that two components (3', 5) comprise filters.

10. Arrangement according to claim 9, characterized in that the filters comprise a bandpass filter (5) and a pre-selector filter (3) wherein the bandpass filter (5) preferably precedes the pre-selector filter (3).

11. Arrangement according to claim 1, characterized in that at least two of the components which are to be interconnected comprise a filter and a transmitter.

12. Arrangement according to claim 1, characterized in that for interconnection of three components, preferably an antenna (1), a bandpass filter (5) and a pre-selector filter (3'), it comprises a first (2') and a second (4) phasor.

13. Arrangement according to any one of claims 1-12, characterized in that at least one phasor is passive.

14. Arrangement according to any one of claims 1-12, characterized in that at least one phasor is active.





15. Arrangement according to any one of claims 1-12, characterized in that at least one filter is passive.

16. Arrangement according to any one of claims 1-12, characterized in that at least one filter is active.

17. Arrangement according to any one of claims 1-12, characterized in that the phase resolution of the phasor is adapted to and depending on the system.

18. Arrangement according to any one of claims 1-12, characterized in that the phase tuning is discrete.

19. Arrangement according to any one of claims 1-12, characterized in that the phasor has a phase resolution of 5° .

20. Arrangement according to any one of claims 1-12, characterized in that the phase tuning is continuous.

21. Arrangement according to any one of claims 1-12, characterized in that at least one phasor is active or passive, at least one filter is active or passive, and in that the phase tuning is discrete or continuous.

22. Method for interconnecting elements or components which are selective and reflective wherein a tunable phasor is arranged between the components which are to be interconnected, said phasor being tunable between $0-180^\circ$, corresponding to a full turn in a Smith-chartTM.

