IMPEDANCE MATCHING MULTIPLEXER FOR COMMUNICATION SYSTEM USING CABLE NETWORK CONSTRUCTED IN BUILDINGS AND IN-BUILDING SYSTEM USING THE SAME

BACKGROUND OF THE INVENTION

Field of the invention

The present invention relates generally to a mobile communication/broadcasting repeater, and more particularly, to an apparatus for constructing an in-building optical distribution system or an in-building radio frequency (RF) distribution system proposed as a method for eliminating shadow areas inside of buildings using a pre-installed cable network for television viewing.

Description of the Prior Art

Due to high advancement of mobile communication technology and the resultant various services, the degree of dependence on the mobile communication of modern society is increasing rapidly. Thus, mobile communication operators make investments of great capital in plant and equipment in order to eliminate shadow areas. In general, the quality of speech (QoS) outside of buildings is for the most part acceptable, but deterioration of the QoS caused by either mutual interference between buildings or shadow areas inside of buildings in built-up areas or multistory condominium complexes is emerging as a big problem.

This problem is called an in-building problem in the mobile communication. As a

rule, any signal for mobile communication is attenuated by about 10 to 15 dB when it penetrates each wall in the process of passing through the building. In particular, because a large building has several walls which the signal has to penetrate, the signal is subjected to attenuation of 30 to 50 dB, thereby causing service to be disrupted.

Further, the signals for Wideband Code Division Multiple Access (WCDMA), Global System for Mobile Communications (GSM) 1800, Wireless Broadband (Wibro) etc., all of which use a relatively high frequency, generate greater in-building signal attenuation to reach a serious level.

In order to solve this in-building problem, the repeater system of an in-building optical distribution mode or an in-building radio frequency (RF) distribution mode is usually used.

However, an in-building optical distribution method or an in-building RF distribution method requires tremendous expenses due to construction expenses for separate premise communication lines, and does not avoid damaging the building due to installation of communication cables. Further, the aesthetics of buildings are spoiled by exposed cables and line equipment.

SUMMARY OF THE INVENTION

Accordingly, the present invention has been made to solve these various problems occurring in the prior art, and an objective of the present invention is to provide an apparatus capable of constructing a wired/wireless broadcasting/communication integrated in-building system to solve the mobile communication/broadcasting in-building problem by using either TV community premise transfer line equipment of 75Ω characteristic impedance, which is typically completed within a construction time of the building or security CCTV transfer

line equipment without using expensive line equipment, such as optical distribution equipment and RF distribution equipment, of the in-building system.

According to an aspect of the present invention, there is provided an impedance matching multiplexer for a communication system using a cable network constructed in a building. The impedance matching multiplexer has a Ziplexer-W including: a case (10) having a predetermined size and formed with a space therein; a plurality of 75Ω connectors (20) exposed outside the case; a 50Ω connector (30) exposed outside the case; a dual impedance matching diplexer (40) located in the case, having a low pass filter (LPH) passing only closed circuit television (CCTV) signals and community antenna television (CATV) signals, and a high pass filter (HPF) passing only mobile communication/broadcasting signals, and connected with the plurality of 75Ω connectors; and a multistage 1/4 wavelength matching transfer line (50) connecting the 50Ω connector and the dual impedance matching diplexer.

Further, the impedance matching multiplexer may further include a Ziplexer-M in order to cope with a plurality of mobile communication/broadcasting operator systems. The Ziplexer-M may include: a case (10-1) having a predetermined size and formed with a space therein; a plurality of 75Ω connectors (20-1) exposed outside the case; a plurality of 50Ω connectors (30-1) exposed outside the case; a dual impedance matching diplexer (40-1) located in the case, having a low pass filter (LPH) passing only closed circuit television (CCTV) signals and community antenna television (CATV) signals, and a high pass filter (HPF) passing only mobile communication/broadcasting signals, and connected with the plurality of 75Ω connectors; an intermediate impedance matching multiplexer (60) located in the case, connected with dual impedance matching diplexer, and splitting a frequency band of the signals; and a single stage 1/4 wavelength matching transfer line (70) connecting the 50Ω connector and the dual impedance matching diplexer.

According to another aspect of the present invention, there is provided an in-building system using an impedance matching multiplexer for a communication system using a cable network constructed in buildings in order to eliminate shadow areas inside of buildings, which the impedance matching multiplexer includes a Ziplexer-W, or the Ziplexer-W and a Ziplexer-M, the in-building system comprising the Ziplexer-W.

Further, the in-building system using the impedance matching multiplexer includes the Ziplexer-W, or the Ziplexer-W and the Ziplexer-M may further comprise the Ziplexer-W and the Ziplexer-M in order to cope with a plurality of mobile communication/broadcasting operator systems.

BRIEF DESCRIPTION OF THE DRAWINGS

The above and other objects, features and advantages of the present invention will be more apparent from the following detailed description taken in conjunction with the accompanying drawings, in which:

FIG. 1 conceptually illustrates a construction (Ziplexer-W) of an impedance matching multiplexer for a communication system using a cable network constructed in buildings according to the present invention;

FIG. 2 conceptually illustrates a construction (a Ziplexer-M) of another impedance matching multiplexer for a communication system using a cable network constructed in buildings according to the present invention;

FIG. 3 shows graphs plotting characteristics of a coupling port;

FIG. 4 is a simulation graph of 70Ω-50Ω conversion 4-stage 1/4 wavelength matching transfer line;

FIG. 5 shows simulation graphs of band pass filters having different impedance

characteristics of an intermediate impedance matching multiplexer according to the present invention;

FIG. 6 is a simulation graph of a single stage 1/4 wavelength matching transfer line;

FIG. 7 illustrates a construction of an integrated in-building system using a construction (Ziplexer-W) of an impedance matching multiplexer for a communication system using a cable network constructed in buildings according to the present invention; and

FIG. 8 illustrates a construction of an integrated in-building system in a large building using a construction (Ziplexer-W and Ziplexer-M) of an impedance matching multiplexer for a communication system using a cable network constructed in buildings according to the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Hereinafter, an impedance matching multiplexer for a communication system using a cable network constructed in a building and an in-building system using the same according to the present invention will be described with reference to the accompanying drawings. In the following description and drawings, the same reference numerals are used to designate the same or similar components, and so repetition of the description on the same or similar components will be omitted.

FIG. 1 conceptually illustrates a construction (Ziplexer-W) of an impedance matching multiplexer for a communication system using a cable network constructed in a building according to the present invention. As illustrated in FIG. 1, the Ziplexer-W is comprised of a case 10, a plurality of 75Ω connectors 20, a 50Ω connector 30, a dual impedance matching diplexer 40, and a multistage 1/4 wavelength matching transfer line 50.

The case 10 is formed with an inner space, and is closed against the outside by means of assembly. The case 10 serves to protect components installed therein. The case 10 is an ordinary case that typically protects components, and thus is not limited to any specific case.

The 75Ω connectors 20 and the 50Ω connector 30 are installed outside the case 10, and are connected with the components in the case 10. The 75Ω connectors 20 and the 50Ω connector 30 act to connect the components with cables, have the same structure as connectors used as means for connecting with an ordinary cable, and thus are not limited to any specific connector.

The dual impedance matching diplexer 40 consists of a low pass filter (LPF), passing only closed circuit television (CCTV) signals that do not make use of a carrier frequency and community antenna television (CATV) signals that make use of 5 to 650 MHz, and a high pass filter (HPF), passing only mobile communication/broadcasting signals of 800 to 2,500 MHz. The dual impedance matching diplexer 40 is characterized in that the characteristic impedance of a coupling port has 75 Ω, that the characteristic impedance of an LPF port has 75 Ω, and that the characteristic impedance of an HPF port has 50 Ω.

As illustrated in simulation graphs of FIG. 3 showing a characteristic of the coupling port, even the signals having different impedance characteristics give rise to no difference in attenuation characteristic, but a considerable difference in return loss characteristic.

Thus, the present invention employs a method for gradually matching impedance, in which the characteristic impedances of the coupling port and the HPF port having a characteristic shown in FIG. 3(b) are matched with 75 Ω and 70 Ω, respectively. At this time, a method of FIG. 3(c) has an effect of performing conversion into the characteristic of

50Ω at a time, but is remarkably deteriorated in the return loss characteristic. Hence, the present invention excludes the method of FIG. 3(c).

The multistage 1/4 wavelength matching transfer line 50 includes a 4-stage 1/4 wavelength matching micro strip line, and serves to perform optimized matching using a circuit connecting the 50Ω connector 30 and the dual impedance matching diplexer 40.

This 4-stage 1/4 wavelength matching micro strip line 50 is adapted to provide services of downstream/upstream links for mobile communication/broadcasting by connecting with one mobile communication/broadcasting port and installing a subscriber direction broadband service antenna, and has a stable return loss characteristic at a frequency range between 800 and 2,500 MHz, as shown on the simulation graph of a 70Ω-50Ω conversion 4-stage 1/4 wavelength matching micro strip line of FIG. 4.

The Ziplexer-W as the impedance matching multiplexer for a communication system using a cable network constructed in buildings as illustrated in FIG. 1 can be coupled to a repeater for the mobile communication/broadcasting and CATV/CCTV transfer line equipment when constructing the in-building system.

Meanwhile, in the case of a single-band single-operator system, this coupling has no problem. However, in the case of a multi-band multi-operator system, the coupling requires a separate multiplexer or a divider/combiner, has a complicated construction process, and generates great signal loss. Hence, a Ziplexer-M as illustrated in FIG. 2 is preferably used for the coupling of the repeater/line repeater and the CATV/CCTV transfer line.

FIG. 2 conceptually illustrates a construction (Ziplexer-M) of another impedance matching multiplexer for a communication system using a cable network constructed in a building according to the present invention. As illustrated in FIG. 2, the Ziplexer-M is comprised of a case 10-1, a plurality of 75Ω connectors 20-1, a plurality of 50Ω connectors 30-1, a dual impedance matching diplexer 40-1, an intermediate impedance matching

multiplexer 60 and a single stage 1/4 wavelength matching transfer line 70.

The intermediate impedance matching multiplexer 60 splits a frequency band of the signals in order to cope with multiple mobile communication/broadcasting operator systems using various frequencies, i.e. a multi-band multi-operator system. The intermediate impedance matching multiplexer 60 is also connected by the plurality of 50Ω connectors 30-1 and the single stage 1/4 wavelength matching transfer line 70, as described with reference to FIG. 2.

As illustrated in simulation graphs of band-pass filters (BPF) of having different impedance characteristics in the intermediate impedance matching multiplexer 60 of FIG. 5, even the signals having different impedance characteristics give rise to no difference in attenuation characteristic, but a considerable difference in return loss characteristic as in the dual impedance matching diplexer 40 of the Ziplexer-W of FIG. 1.

Thus, the present invention employs the BPF that has input of 70 Ω and output of 65 Ω, and the characteristic as illustrated in FIG. 5(b) in order to secure a gradual impedance matching characteristic and a stable return loss characteristic.

The intermediate impedance matching multiplexer 60 constructed by combining several BPFs has effects of removing crosstalk noise of other signals and inhibiting a second harmonic caused by a line repeater.

The single stage 1/4 wavelength matching transfer line 70 is a circuit connecting the intermediate impedance matching multiplexer 60 and each 50Ω connector, and serves to perform optimized matching.

The single stage 1/4 wavelength matching transfer line 70 converts characteristic impedance of 50 Ω into characteristic impedance of 75 Ω as illustrated in the simulation graphs of the single stage 1/4 wavelength matching transfer line of FIG. 6. However, as illustrated in the simulation graph of FIG. 6(a), a section showing the return loss of 25 dB or

more has about 1/3-octave bands, and thus is unstable. As illustrated in the simulation graph of FIG. 6(b), when the characteristic impedance of 50 Ω is converted into intermediate characteristic impedance of 65 Ω using the single stage 1/4 wavelength matching transfer line, the section showing the return loss of 25 dB or more has about 2/3-octave bands, and thereby it is possible to obtain a stable return loss characteristic.

Hence, the present invention employs a method of FIG. 6(b) having the stable return loss characteristic by means of the gradual impedance matching.

Further, the dual impedance matching diplexer 40 of FIG. 1, and the intermediate impedance matching multiplexer 60 of FIG. 2 should secure cross band rejection of 42 dB or more. In order to secure this cross band rejection, a cavity type has excellent performance, but it is expensive and bulky. For this reason, the present invention employs a method of integrating an inductor & capacitor (L-C) lumped element. Thereby, the impedance matching multiplexer (the Ziplexer-W and the Ziplexer-M) according to the present invention removes the cross-talk noise from the CATV/CCTV signals, as well as harmful high-frequency noise. In order words, the impedance matching multiplexer improves the signal & noise (S/N) ratio to provide a good image quality, and removes harmful low-frequency noise from the mobile communication/broadcasting signals to improve signal quality, Ec/Io (a ratio of chip energy to interference).

The impedance matching multiplexer (the Ziplexer-W and the Ziplexer-M) for a communication system using a cable network constructed in buildings according to the present invention has been described. Hereinafter, a construction of the in-building system using the Ziplexer-W or the Ziplexer-M will be described (in FIGS. 7 and 8, the Ziplexer-W is symbolized as "Zx-W", and the Ziplexer-M as "Zx-M").

FIG. 7 illustrates a construction of an integrated in-building system using a construction (Ziplexer-W) of an impedance matching multiplexer for a communication

system using a cable network constructed in a building according to the present invention. As illustrated in FIG. 7, the integrated in-building system using a Ziplexer-W according to the present invention is so constructed that the Ziplexer-W is coupled with a mobile repeater and a CATV line repeater that are connected with a donor antenna, and that the Ziplexer-W is connected with a TV port, which is installed on a wall of a room of the building through a CATV divider unit, and another Ziplexer-W coupled with a mobile switched virtual channel (SVC) antenna.

FIG. 8 illustrates a construction of an integrated in-building system in a large building using a construction (Ziplexer-W and Ziplexer-M) of impedance matching multiplexer for a communication system using a cable network constructed in a building according to the present invention. As illustrated in FIG. 8, the Ziplexer-M is additionally provided to be coupled with a plurality of mobile repeaters connected with a plurality of donor antennas. In this manner, the Ziplexer-M connected with the plurality of mobile repeaters and CATV line repeaters is constructed to be connected with a TV port installed on a wall of the room of the building through a CATV divider unit, and another Ziplexer-W coupled with a mobile SVC antenna.

As can be seen from the foregoing, the present invention makes use of TV community premise transfer line equipment of 75Ω characteristic impedance completed within the construction time of the building or security CCTV transfer line equipment without using expensive line equipment, such as optical distribution equipment and RF distribution equipment, of the in-building system for solving the mobile communication/broadcasting in-building problem, so that it can eliminate the shadow areas at a relative low expense.

Further, the apparatus of the present invention can be used to construct a wired/wireless broadcasting/communication integrated in-building system.

In addition, the impedance matching multiplexer (Ziplexer-W and Ziplexer-M) can remove the cross-talk noise from the CATV/CCTV signals, as well as the harmful high-frequency noise. In order words, the impedance matching multiplexer can improve the S/N ratio to provide a good image quality, and remove the harmful low-frequency noise from the mobile communication/broadcasting signals to improve signal quality, Ec/Io.

Although exemplary embodiments of the present invention has been described for illustrative purposes, those skilled in the art will appreciate that various modifications, additions and substitutions are possible, without departing from the scope and spirit of the invention as disclosed in the accompanying claims.

WHAT IS CLAIMED IS:

1. An impedance matching multiplexer for a communication system using a cable network constructed in buildings, the impedance matching multiplexer including a Ziplexer-W, the Ziplexer-W comprising:

a case having a predetermined size and formed with a space therein;

a plurality of 75Ω connectors exposed outside the case;

a 50Ω connector exposed outside the case;

a dual impedance matching diplexer located in the case, having a low pass filter (LPH) passing only closed circuit television (CCTV) signals and community antenna television (CCTV) signals, and a high pass filter (HPF) passing only mobile communication/broadcasting signals, and connected with the plurality of 75Ω connectors; and

a multistage 1/4 wavelength matching transfer line connecting the 50Ω connector and the dual impedance matching diplexer.

2. The impedance matching multiplexer as claimed in claim 1, further including a Ziplexer-M in addition to the Ziplexer-W, the Ziplexer-M comprising:

a case having a predetermined size and formed with a space therein;

a plurality of 75Ω connectors exposed outside the case;

a plurality of 50Ω connectors exposed outside the case;

a dual impedance matching diplexer located in the case, having a low pass filter (LPH) passing only closed circuit television (CCTV) signals and community antenna television (CATV) signals, and a high pass filter (HPF) passing only mobile communication/broadcasting signals, and connected with the plurality of 75Ω connectors;

an intermediate impedance matching multiplexer located in the case, connected with dual impedance matching diplexer, and splitting a frequency band of the signals; and

a single stage 1/4 wavelength matching transfer line connecting the 50Ω connector and the dual impedance matching diplexer.

3. An in-building system using an impedance matching multiplexer for a communication system using a cable network constructed in buildings in order to eliminate shadow areas inside of buildings, the in-building system comprising a Ziplexer-W.

4. The in-building system as claimed in claim 3, further comprising a Ziplexer-M.