AU9212160

(12) PATENT ABRIDGMENT (11) Document No. AU-B-12160/92
(19) AUSTRALIAN PATENT OFFICE (10) Acceptance No. 643370

(54) Title
SYSTEM FOR MONITORING SIGNAL QUALITY IN AN OPTICAL NETWORK

International Patent Classification(s)
(51)[5] H04B 010/08

(21) Application No. : 12160/92 (22) Application Date : 09.03.92

(30) Priority Data

(31) Number (32) Date (33) Country
4109683 23.03.91 DE GERMANY

(43) Publication Date : 24.09.92

(44) Publication Date of Accepted Application : 11.11.93

(71) Applicant(s)
ALCATEL N.V.

(72) Inventor(s)
DR. ROLF HEIDEMANN

(74) Attorney or Agent
ALCATEL AUSTRALIA LIMITED , BOX 525 G.P.O., SYDNEY N.S.W. 2001

(56) Prior Art Documents
AU 22041/92 H04B 10/08
AU 52199/90 H04B 10/08
AU 16877/88 H04B 10/08

(57) Claim

1. A system for optically transmitting a useful signal from a transmitter over an optical waveguide or a fibre-optic network to a receiver, wherein in addition to a useful signal, the transmitter transmits an auxiliary signal, the useful signal and the auxiliary signal being transmitted over the same optical waveguide or the same fibre-optic network toward the receiver at different wavelengths, and wherein at a desired point in the transmission link, means are provided for extracting and analysing the auxiliary signal and for transmitting the results of the analysis, if necessary together with other information, as a response signal over the same optical waveguide or the same fibre-optic network to the transmitter, the transmitter including means for controlling the further transmission of the useful signal and the auxiliary signal in accordance with the response signal.

P/00/011 28/5/91

Regulation 3.2

643370

AUSTRALIA

Patents Act 1990

ORIGINAL
COMPLETE SPECIFICATION
STANDARD PATENT

Invention Title:
"SYSTEM FOR MONITORING SIGNAL QUALITY IN AN OPTICAL NETWORK"

The following statement is a full description of this invention, including the best method of performing it known to us:-

This invention relates to a system for optically transmitting a useful signal from a transmitter over an optical waveguide or a fibre-optic network to a receiver.

The need for transmission systems in which the signals are transmitted to the terminal (TV receiver, home computer, etc.) optically is obvious today. One of the reasons is that in optical transmission systems, the signal bandwidth can be considerably wider than in electric transmission systems. Such an optical transmission system is described schematically in the journal "Funkschau", No. 22, 1990, page 56.

In this prior art system, no provision is made for monitoring the transmitted signal. However, network providers assume responsibility for the quality of the signal up to a given point in the transmission link. They therefore require the network manufacturer to provide a facility which makes it possible to monitor a signal at this point (henceforth called "monitoring point").

It is an object of the present invention to provide a system which permits such signal monitoring. According to the invention there is provided a system of the aforementioned type, wherein in addition to a useful signal, the transmitter transmits an auxiliary signal, the useful signal and the auxiliary signal being transmitted over the same optical waveguide or the same fibre-optic network toward the receiver at different wavelengths, wherein at a desired point in the transmission link, means are provided for extracting and analysing the auxiliary signal and for transmitting the results of the analysis, if necessary together with other information, as a response signal over the same optical waveguide or the same fibre-optic network to the transmitter, the transmitter including means for controlling the further transmission of the useful signal and the auxiliary signal in accordance with the response signal.

In conventional attempts to attain this object, it is necessary to convert the optical signal to an electric one. Such a proposal is described in Gunter Domann, J. of Lightwave Technology, Vol. 6, 1988, pages 1720-1727.

The invention eliminates the need to convert the optical useful signal to an electric signal. In addition, the means according to the invention are suited to setting up a so-called service channel, ie., they open up the possibility of interactive communication between monitoring point and transmitter.

The principle consists in the fact that the transmitter, besides transmitting the useful signal, sends out an auxiliary signal at another wavelength. Because of the different wavelengths, the auxiliary signal can be extracted from the optical waveguide at the monitoring point and then be used to indirectly monitor the quality of the useful signal.

After being separated from the useful signal, the auxiliary signal is converted to an electric signal and analysed. The results of the analysis are sent in the form of a response signal to the transmitter. The latter controls the further transmission of the useful and auxiliary signals in accordance with the information contained in the response signal.

The auxiliary signal need not be transmitted continuously but may also be sent from time to time. It may be an analog or digital signal, a test signal with variable or invariable message content, a voice signal from the operators, and the like. The same applies to the response signal.

It is apparent that the system according to the invention can also be used for interactive communication between units or persons at the monitoring point and units or persons at the transmitter. This use corresponds to that of a service channel.

The invention will now be described in greater detail with reference to the accompanying drawing, in which:

Figure 1 is a block diagram of the system according to claim 1;

Figure 2 is a block diagram of the system according to claim 2; and

Figure 3 shows an alternative version of the system of Figure 2.

Figure 1 shows a transmitter 1, a receiver 2, an optical waveguide 3 interconnecting the transmitter and receiver, a monitoring point with a first coupler 4a and a second coupler 4b, a photodiode 5, a monitoring device 6, a light source 7, a useful signal S_1, an auxiliary signal S_2, and a response signal S_3. The first coupler 4a extracts the auxiliary signal S_2 from the optical waveguide 3, so that it can be passed to the photodiode 5. The latter converts the optical auxiliary signal S_2 to an electric signal. The monitoring device 6 analyses the electric signal and, together with the light source 7, generates the optical response signal S_3. This response signal is coupled by the coupler 4b into the optical waveguide 3 in a direction opposite to that of the useful signal, thus conveying to the transmitter 1 information that can be used for the further transmission of the useful signal S_1 and the auxiliary signal S_2.

The transmitter may, for example, be part of the centre ("head end") of an optical cable-television network, the receiver a TV set, and the monitoring point a subscriber entrance unit or a so-called network termination point. The invention can be used in connection with any application where a transmitter is connected via an optical waveguide to a receiver or via a fibre-optic network to many receivers and where signal monitoring is to take place somewhere between the transmitter and the receiver(s).

In a preferred embodiment of the invention, the signal monitoring is combined with signal amplification. If use is made of a fibre-optic amplifier with a light-amplifying (eg., erbium-doped) length of fibre, the pump source of this amplifier can also be used to generate the response signal. To this end, the pump light is coupled into the light-amplifying length of fibre in a direction opposite to that of the useful signal. Thus, a portion of the pump light (namely that which was absorbed neither in the light-amplifying length of fibre nor in the optical waveguide) will reach the transmitter. The monitoring device produces an electric response signal and modulates the pump source therewith. The pump light thus conveys a message from the monitoring point to the transmitter. The use of the pump light as an information carrier for arbitrary signals is the subject matter of a New Zealand Patent application 240524).

The modulation of the pump light is an intensity modulation. The modulation frequency must be high enough to ensure that the gain of the light-amplifying length of fibre is not modulated. On the other hand, the bandwidth of the response signal must be so small that the signal can still be interpreted after travelling the path to the transmitter, ie., despite the attenuation introduced on this path. However, this does not impose any limit that could invalidate the principle.

An embodiment of a system combining signal monitoring and signal amplification in accordance with the invention is shown in Figure 2. There, all elements correspond to those of Figure 1 except that a light-amplifying length of fibre 8 has been added, that the wavelength of the signal S_3 is the pump wavelength, and that the internal construction of the monitoring device 6 is different if necessary.

If suitable values are chosen for the wavelengths of the light source and the auxiliary signal (eg., λ_3 = 980 nm and λ_2 = 1300 nm), the light source will be transparent to the auxiliary signal. In that case, the auxiliary signal can be passed through the light source without interfering with and being altered by the latter.

This permits a simplification of the systems of Figures 1 and 2. The simplified version of the system of Figure 2 is shown in Figure 3. In addition to a laser 120, the light source 7 of Figure 3 includes a photodiode 11 as is commonly used to monitor the laser. In the arrangement of Figure 3, this photodiode 11 receives not only the backface emission of the laser as usual, but also the auxiliary signal. Since the backface emission of the laser contains mainly low-frequency components while the auxiliary signal contains mainly high-frequency components, the two signals can be readily separated in the monitoring device and processed separately.

The analysis of the backface emission gives information on the condition of the laser. The backface emission can also be used as usual to regulate the average pump power of the laser.

As indicated in Figure 3, the light source 7, namely its photodiode 11, is connected to the monitoring device 8 by a line over which the received auxiliary signal and the electric signal formed from the backface emission of the laser are transferred to the monitoring device 6. A second line between the monitoring device 6 and the light source 7, namely the laser 10 of the source, serves to supply an electric response signal to the laser, which converts this signal to an optical response signal.

There are many possibilities of analysis which can be incorporated into the electric circuit. For instance, it is possible to determine the signal strength, the signal-to-noise ratio, the condition of the laser, etc.

As it is not the useful signal proper which is analysed, but only the auxiliary signal, the transmission quality of the useful signal can be inferred from the transmission quality of the auxiliary signal. For optical waveguides now in use, the ratio of the attenuation of two signals of different wavelength on a link of a given length is known, so that the attenuation of the useful signal can be inferred from the attenuation of the auxiliary signal. In the worst case, of course, a failure of the auxiliary signal to appear indicates a break in the fibre-optic link.

As mentioned previously, S_2 and S_3 can also be used to set up a so-called service channel.

Finally it should be noted that the useful signal and the auxiliary signal may, of course, be composed of two or more signals, and that it is also within the scope of the invention to use two or more auxiliary signals on two or more wavelengths for the purpose of monitoring the useful signal(s) at different points of the transmission link or for service-channel purposes.

The claims defining the invention are as follows:

1. A system for optically transmitting a useful signal from a transmitter over an optical waveguide or a fibre-optic network to a receiver, wherein in addition to a useful signal, the transmitter transmits an auxiliary signal, the useful signal and the auxiliary signal being transmitted over the same optical waveguide or the same fibre-optic network toward the receiver at different wavelengths, and wherein at a desired point in the transmission link, means are provided for extracting and analysing the auxiliary signal and for transmitting the results of the analysis, if necessary together with other information, as a response signal over the same optical waveguide or the same fibre-optic network to the transmitter, the transmitter including means for controlling the further transmission of the useful signal and the auxiliary signal in accordance with the response signal.

2. A system as claimed in claim 1, wherein before said desired point, the useful signal and the auxiliary signal pass through a fibre-optic amplifier comprising a pump source, and the pump source also serving to transmit the response signal.

3. A system as claimed in claim 2, wherein the wavelength at which the auxiliary signal is transmitted and the laser of the pump source are so chosen that the auxiliary signal can be passed through the laser without being changed and without interfering with the operation of the laser.

4. A system as claimed in claim 1 or 3, wherein the means for transmitting the response signal include a light source with a laser and a photodiode for receiving both the backface emission of the laser and the auxiliary signal.

5. A system substantially as herein described with reference to Figures 1 - 3 of the accompanying drawings.

DATED THIS SECOND DAY OF MARCH 1992

ALCATEL N.V.

ABSTRACT

This invention provides an arrangement for monitoring signal quality at certain points in a fibre-optic network, such as a cable TV network.

According to the invention, a useful signal (S_1) and an auxiliary signal (S_2) are transmitted over the same optical waveguide (3). Only the auxiliary signal is analysed at a monitoring point. From analysis values, inferences are drawn regarding the quality of the useful signal (S_1). The results are transmitted as a message signal (S3) from the monitoring point.

Figure 1.

12160/92

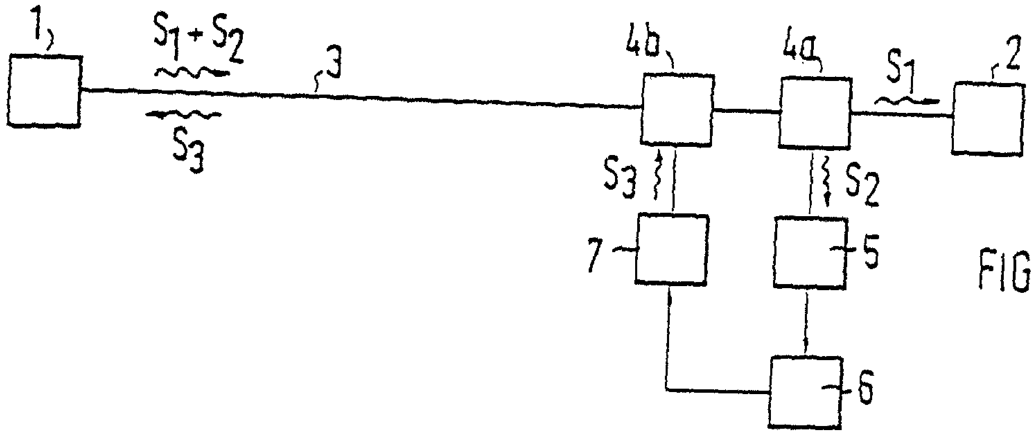

FIG.1

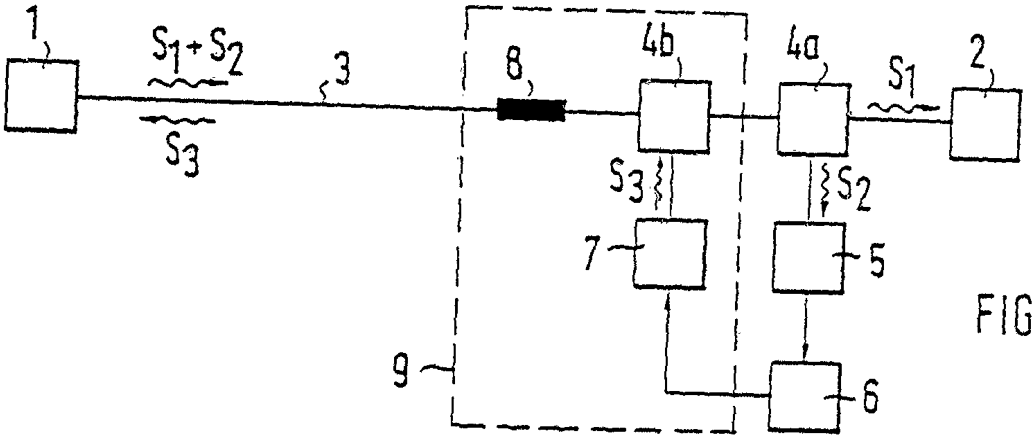

FIG.2

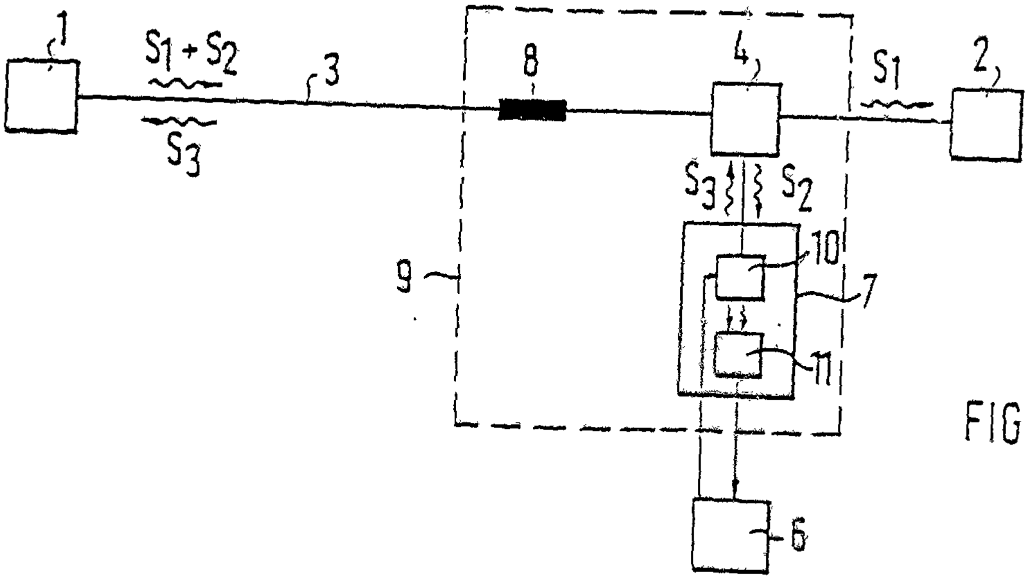

FIG.3