

Description

This invention relates to optical transmission systems and especially to multiple-access systems.

Transmitting a large number of channels of information over a given link requires the signals to be separable at the receiving end. This may be achieved by dividing the available band into disjoint slots for each user or by permitting each user to occupy the entire band and rendering the various transmitted signals orthogonal in some way so that the signals will not interfere with one another.

This latter spread spectrum technique has received attention particularly with radio frequency transmission. Proposals for utilising spread spectrum techniques in optical systems have been made, involving the generation of pseudo-random electrical signals which are modulated with information to be transmitted and then applied to an optical source such as a laser. The different channels are then code division multiplexed. Unfortunately both the generation of pseudo-random signals and code multiplexing are complex techniques.

If the coherence time of an optical signal is relatively short then the channels can be multiplexed by imposing a time delay greater than the coherence time. A scheme has been proposed for optical transmission systems in which the signal from a short coherence interval source is split into several components. Each component is then divided in two and one part modulated and one part delayed. These parts are recombined with the other components which have been split and provided with different modulations and delays, and transmitted. At the receiving end the combined signal is redivided, each division split into two and one part delayed, and the parts then recombined so that equally delayed parts of the modulated and unmodulated signal are combined and detected. The disadvantage of this system is that there are high losses at the detection stage, half of the modulated signal and half of the unmodulated signal being lost. The associated direct detection techniques are also high in losses.

An article entitled "Coherence Multiplexing of Fiber-Optic Interferometric Sensors" by Brooks et al in the Journal of Lightwave Technology volume LT-3, number 5, October 1985 discloses a method of transmitting information using a broad spectrum optical carrier signal comprising dividing the carrier signal over at least two paths; modulating the carrier signal in at least one of the paths in accordance with information to be transmitted; recombining the divided signals to provide a recombined signal after imposing relatively different delays on each divided signal to provide a delay multiplexed signal; receiving the information at one of at least

two heterodyne receivers by dividing the recombined signal and coupling one of the divided signals to one of the receivers; and dividing a local oscillator signal having a frequency shifted with respect to the carrier signal, and coupling one of the divided local oscillator signals to said one receiver, the divided local oscillator signal coupled to said one receiver having a relative delay corresponding to the delay of the information to be received.

The present invention provides a method of transmitting information using a broad spectrum optical carrier signal, the method comprising the steps of dividing the carrier signal over at least two paths; modulating the carrier signal in at least one of the paths in accordance with information to be transmitted; recombining the divided signals to provide a recombined signal after imposing a relatively different delay on each divided signal to provide a delay multiplexed signal; receiving the information at one of at least two heterodyne receivers by dividing the recombined signal and coupling one of the divided signals to said one receiver; and dividing a local oscillator signal having a frequency shifted with respect to the carrier signal and coupling one of the divided local oscillator signals to said one receiver, the divided local oscillator signal coupled to the receiver having a relative delay corresponding to the delay of the information to be received; characterised in that the optical carrier signal is divided at a first splitting point, the divided signals are recombined at a recombination point, and the recombined signal is divided at a second splitting point; and the divided local oscillator signals have relative delays imposed upon them by delay means located between the second splitting point and the heterodyne receivers.

The local oscillator signal must have the same spread spectrum characteristics as the optical carrier. The local oscillator signal may be generated from a source other than that used to provide the carrier signal. Alternatively, it may be generated by frequency shifting a signal divided from the carrier signal, in which case it may be transmitted along a separate path or multiplexed onto the same path as the recombined modulated paths. The frequency shift is conveniently imposed prior to transmission in order to keep most of the active components at the transmitter. Preferably, the local oscillator is polarisation multiplexed onto a common transmission path with a recombined delay multiplexed signal.

The paths preferably comprise optical waveguides, such as, for example, optical fibres.

In a preferred embodiment of the invention, a portion of the recombined signal and a portion of the local oscillator signal are mixed to provide a return message carrier signal, and the return mes-

sage carrier signal is divided over at least two paths, one of which is modulated in accordance with a return message and recombined with the other message path with delay multiplexing.

The invention also provides an optical transmission system using a broad spectrum optical carrier signal, the system comprising means for dividing the carrier signal into at least two paths; means for modulating the carrier signal in at least one of the paths in accordance with information to be transmitted; means for recombining the divided signals to provide a recombined signal after imposing a relatively different delay on each divided signal to provide a delay multiplexed signal; a respective heterodyne receiver associated with each path; and divider means for dividing a local oscillator signal having a frequency shifted with respect to the carrier signal and for coupling one of the divided local oscillator signals to one of the receivers, the divided local oscillator signal coupled to said one receiver having a relative delay corresponding to the delay of the information to be received by that receiver; characterised by a first splitting point at which the optical carrier signal is split, a recombination point at which the divided signals are recombined, a second splitting point at which the recombined signal is divided, and delay means for imposing relative delays on the divided local oscillator signals, the delay means being located between the second splitting point and the receivers.

Aspects of the invention will now be described in detail and by way of example with reference to the accompanying drawings, in which;

Figure 1 illustrates a basic configuration of a transmission system according to the invention; Figures 2 3 and 5 illustrate examples of alternative embodiments; and

Figure 4 illustrates a further embodiment of the invention adapted for two-way transmission.

The principle of operation of the system will be described with reference to Figure 1 which shows a basic configuration. A single laser source 1 is frequency modulated to provide a spread spectrum signal on line 2 to a local node referenced 10. In the node the signal on line 2 is fed to a beam splitter 3 which provides two output signals on lines 4 and 5. On line 4 the signal is further split and shared n ways along n component paths. Each component path is coupled to a different modulator $M_1, M_2, \dots, M_n$ (in the Figure $n=4$), which may conveniently be a lithium niobate phase modulator, and which modulates the respective component signal in accordance with respective input signals $i_1, i_2, \dots, i_n$. The modulators are each connected to a delay line $t_1, t_2, \dots, t_n$, each delay line having a different characteristic delay to all the other delay lines. After the delay lines the n modulated, de-

layed component signals are recombined on transmission line 6. The signal on line 5 passes to a frequency shifter 8 and then continues uncombined to a distribution point referenced 7. The combined modulated signal also passes to the distribution point. At the distribution point the signals on each of the lines 5 and 6 are split n ways and paired, one of each pair being from line 5 and one from line 6. The paired signals then pass to different detectors D_1 to D_n . Each detector has an associated delay $t_1', t_2', \dots, t_n'$ which corresponds to the delay associated with the modulator from which the signal is to be detected, and the signal split from line 5 passes via this delay before being input, along with the signal split from line 6, into a combiner 9 where they are paired for heterodyne detection.

The channel interpreted by the detector will depend upon the delay imposed in its associated delay line. Thus each receiver terminal can be assigned a separate channel by choice of a specific delay corresponding to the transmitter delay, or a terminal may be tunable by having a variable delay.

To provide a suitable spread spectrum source signal to the node 10, a variety of different waveforms may be used to modulate the frequency of the source 1. One particularly suitable source modulation comprises a triangular or saw-tooth waveform. This reduces the number of spurious interfering signals produced in the demodulation process. An alternative modulation comprises a sinusoidal oscillation close to or at the relaxation oscillation frequency of the laser source, thereby maximising the available 'chirp'.

As an alternate to direct FM of a laser, a fixed frequency laser could be used in combination with a separate modulator. The modulator could be driven by a m -sequence generator.

Alternatively a naturally broad linewidth laser source could be used, thereby eliminating the need for imposed frequency modulation although this may then require greater precision in matching the delay lines between transmitter and receiver. Suitable delays can be imposed by short lengths of monomode optical fibre. The delay at the transmission end may of course be applied before rather than after modulation.

The embodiment described with reference to Figure 1 requires two optical fibre paths (5 and 6) from the transmitter to the distribution point 7. It is necessary to control the polarisation of the signals for the heterodyne detection. It is desirable to avoid using polarisation holding fibre for this purpose. Therefore, active polarisation control, polarisation modulation or polarisation diversity reception is generally required. A polarisation feedback control (eg as described with reference to Fig. 3 below)

may be provided by splitting an extra channel from the lines 5 and 6 at the distribution point. Preferably the active parts of such a polarisation control are retained at the node 10 and the control signal is transmitted along one of the fibres 5 or 6 in the return direction.

Figure 2 shows an alternative embodiment in which a single fibre is used for the transmission of the local oscillator signal and the delay multiplexed modulated signals. In this embodiment polarisation holding fibre is used up to a final combiner 20, after which it can be presumed that the polarisations of the various signals will vary in a similar manner. The local oscillator signal arrives at the distribution point delay multiplexed from the other signals (and also frequency shifted). In order to detect the different information signals the signal on line 6 is split N ways, each subdivision then being split again, one part delayed and the parts recombined. However this latter method of detection suffers from additional losses as half of the signal and half of the local oscillator signal is lost.

A third embodiment of the invention is shown in Figure 3 in which the local oscillator signal and the combined delay multiplexed modulated signals are combined for transmission on a single fibre. To maintain a strong local oscillator signal to enable separation at the distribution point, the local oscillator signal is polarisation multiplexed on to the common transmission fibre. Non-polarisation holding fibre is employed and a polarisation control is present in one signal arm prior to the polarisation multiplex to ensure exact orthogonal polarity.

Referring now in more detail to Figure 3, the local node 10 comprises a beam splitter 3, modulators and delays and local oscillator frequency shifter 8 as in Figure 1. The local oscillator path 5 also contains a polarisation controller 11, from which the local oscillator signal is input to a polarisation splitter/combiner 12 where it is multiplexed onto the transmission fibre 6 by orthogonal polarisation. At the distribution point 7 a polarisation splitter 13 demultiplexes the local oscillator signal which is then split $n + 1$ ways. The combined modulated signal is similarly split. Of the split local oscillator signals, n are subjected to respective delays and combined in heterodyne detection with n of the split modulated signals as described for the embodiment of Figure 1. The $n + 1$ th split modulated signal is recombined, without further delays, with the $n + 1$ th signal split from the local oscillator. This composite signal is fed back to the polarisation controller 11 along the reverse of the outward path 6'. In Figure 3, the paths 6 and 6' are shown separately for convenience. However, in practice both paths may be provided by a single optical fibre carrying both the outgoing delay multiplexed signals and the returning polarisation control signal.

A two-way transmission system can be achieved by utilising a second output from the combiner 9 (which may be a conventional X-coupler, for example) at each receiver as the carrier for the return message. Figure 4 illustrates such a scheme.

In this embodiment the second output passes to a return modulation station 16 comprising a beam splitter 14, one of the output signals from the splitter 14 being modulated at modulator 15 in response to an input signal (labelled R_n) and the other delayed. The signals originally split are then recombined and combined with the signals from the other return modulation stations 16 for transmission along line 17. At the reception end for the return message the combined return signal is split n ways. Each split signal is then split again and one part is appropriately delayed. The split signals are then recombined and input to a direct detector 18. It does not matter on which portion of the split signal the delay t_n is imposed in for the return. It may be in the same path as the modulator 15. The return transmission path is less sensitive than the forward path because there is no heterodyne gain.

It should be noted that various methods could be used to generate the spread spectrum signal. The source may be naturally broad linewidth with a random wavelength output, or a laser source may be swept or modulated. A laser source of fixed wavelength may be modulated by a pseudo-random signal generator. If the laser output and modulation are reproducible the local oscillator signal may be locally produced at the receiver rather than transmitted: the use of fixed frequency lasers and a maximal-sequence generator would readily adopt to local generation.

A system of this form is illustrated in Figure 5. In this case, the signal from the source 1 is modulated in a modulator 21 under the control of an m-sequence generator 22 before passing to the node 10. In this embodiment the frequency shifter is omitted from the node 10. At the remote distribution point, local oscillator signals are provided from a second source 23, frequency shifted with respect to the primary source 1, via a further modulator 24 controlled by a second m-sequence generator 25 which is locked in phase with the primary generator 22.

Some projected network parameters will now be discussed with reference to the distribution network of the form shown in Figure 1.

A launch power of +3dB from the common source is assumed. For 140Mbit/s operation the best measured PSK heterodyne receiver sensitivity is -59dBm for a local oscillator power of -23dBm (the theoretical figure for unlimited local oscillator power is -63dBm). The launch power is split between the signal path and the local oscillator path.

The signal path is split N ways with an excess loss of, say, 2dB for N of 1 to 20. Each signal is modulated by a phase modulator with total fibre to fibre loss of, say, 3dB. All the outputs from the modulators are recombined with a loss of $10\log N + 2\text{dB}$. The transmission loss of the network may be assumed to be 5dB. The loss at the distributor may be taken as $10\log N + 2\text{dB}$. A 3dB loss is assumed for recombining signal and local oscillator fields prior to photodetection. In the local oscillator path the budgeted losses include 3dB through the acoustic optic frequency shifter and a further 3dB through a polarisation controller (when used). The remaining transmission and distribution losses for the local oscillator path will be similar to the signal path.

Although PSK is more demanding on laser linewidth than ASK for conventional heterodyne detection this should not be as significant in embodiments of the invention when both the modulation signal and local oscillator are derived from a common source and reasonable care is taken to match the delays between the two paths before recombination.

For the above parameters a network size of $20 \times 140\text{Mbit/s}$ to 20 terminals would represent an upper limit from power budget considerations.

Another constraint that could limit network size is the maximum FM deviation of the source laser. Taking a instantaneous channel spacing of about 5 x IF bandwidth and by assuming an IF bandwidth of 2 x bitrate a total optical frequency sweep of about 28GHz is required for the 20 channel scheme. This degree of current controlled frequency chirp has been reported by several groups working with DFB lasers.

The frequency of modulation used will determine the length of the fibre delays needed. For a modulation rate of 1MHz the maximum fibre delays will be about 100 metres. This length may be considered a little unwieldy. To considerably reduce the delay paths necessary it is proposed that GHz sweep frequencies could be used. This may be achieved by driving the source laser at its relaxation frequency, say 1 to 2 GHz. Although this would result not only in wide deviation frequency modulation but also in some unwanted amplitude modulation, the AM signal should be outband of the receivers' IF.

Analogue transmission could also be used.

The network can be extended by the inclusion of broadband travelling wave laser amplifiers at strategic points in both the signal and local oscillator paths. It may also be possible to share a single swept laser source between an unlimited number of primary distribution fibres by the use of high power laser amplifiers. The network can further be extended by combining many coherent spread

spectrum systems with conventional wavelength multiplexing techniques. The ultimate capacity of such a distribution network may only be limited by the intrinsic fibre transmission bandwidth.

The present invention provides a new local distribution network scheme and transmission system which offers the performance of coherent transmission using a heterodyne spread spectrum concept. The demands on component resources of this new network are particularly lean; a single DFB laser source could be shared by up to 20 channels; no laser frequency locking schemes are required; and no narrowband optical filters are needed to realise the basic network. Channel selection is achieved using only matched optical delays (the need for accurate matching of the phase delays is eliminated by using heterodyne detection rather than homodyne detection) and for moderate data rates (140Mbit/s) the terminal receiver can be of the standard PINFET type. The system can be readily extended by the application of conventional WDM techniques and also by the use of laser amplifiers. Although primarily considered as a wideband signal distribution network, the system can be reconfigured to provide a lower capacity return channel without the need for an individual light source at each terminal.

Claims

1. A method of transmitting information using a broad spectrum optical carrier signal, the method comprising the steps of dividing the carrier signal over at least two paths; modulating the carrier signal in at least one of the paths in accordance with information to be transmitted; recombining the divided signals to provide a recombined signal after imposing a relatively different delay on each divided signal to provide a delay multiplexed signal; receiving the information at one of at least two heterodyne receivers (D_i) by dividing the recombined signal and coupling one of the divided signals to said one receiver (D_i); and dividing a local oscillator signal having a frequency shifted with respect to the carrier signal and coupling one of the divided local oscillator signals to said one receiver, the divided local oscillator signal coupled to the receiver having a relative delay corresponding to the delay of the information to be received; characterised in that the optical carrier signal is divided at a first splitting point, the divided signals are recombined at a recombination point, and the recombined signal is divided at a second splitting point; and the divided local oscillator signals have relative delays imposed upon them by delay means (t_r) located between the second splitting point

The signal path is split N ways with an excess loss of, say, 2dB for N of 1 to 20. Each signal is modulated by a phase modulator with total fibre to fibre loss of, say, 3dB. All the outputs from the modulators are recombined with a loss of $10\log N + 2\text{dB}$. The transmission loss of the network may be assumed to be 5dB. The loss at the distributor may be taken as $10\log N + 2\text{dB}$. A 3dB loss is assumed for recombining signal and local oscillator fields prior to photodetection. In the local oscillator path the budgeted losses include 3dB through the acoustic optic frequency shifter and a further 3dB through a polarisation controller (when used). The remaining transmission and distribution losses for the local oscillator path will be similar to the signal path.

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Claims

1. A method of transmitting information using a broad spectrum optical carrier signal, the method comprising the steps of dividing the carrier signal over at least two paths; modulating the carrier signal in at least one of the paths in accordance with information to be transmitted; recombining the divided signals to provide a recombined signal after imposing a relatively different delay on each divided signal to provide a delay multiplexed signal; receiving the information at one of at least two heterodyne receivers (D_i) by dividing the recombined signal and coupling one of the divided signals to said one receiver (D_i); and dividing a local oscillator signal having a frequency shifted with respect to the carrier signal and coupling one of the divided local oscillator signals to said one receiver, the divided local oscillator signal coupled to the receiver having a relative delay corresponding to the delay of the information to be received; characterised in that the optical carrier signal is divided at a first splitting point, the divided signals are recombined at a recombination point, and the recombined signal is divided at a second splitting point; and the divided local oscillator signals have relative delays imposed upon them by delay means (t_r) located between the second splitting point



and the heterodyne receivers (D_i).

2. A method according to claim 1, further comprising the step of generating the local oscillator signal from a source (25) other than that used to provide the carrier signal. 5
3. A method according to claim 1, further comprising the step of generating the local oscillator signal by frequency shifting a signal divided from the carrier signal. 10
4. A method according to claim 3, wherein the local oscillator signal is polarisation multiplexed onto a common transmission path (6) with a recombined delay multiplexed signal. 15
5. A method according to any preceding claim, in which a portion of the recombined signal and a portion of the local oscillator signal are mixed to provide a return message carrier signal, and the return message carrier signal is divided over at least two paths, one of which is modulated in accordance with a return message and recombined with the other message path with delay multiplexing. 20
6. A method according to any preceding claim, in which the local oscillator signal is combined with the recombined signal for transmission. 25
7. A method according to claim 6, in which the local oscillator signal is polarisation multiplexed with respect to the recombined signal. 30
8. A method according to any preceding claim, in which the broad spectrum optical carrier is generated by modulating a source. 35
9. A method according to claim 8, in which the carrier is modulated by a triangular waveform. 40
10. A method of transmitting information as claimed in any preceding claim, further comprising the step of tuning the delay of the local oscillator signal by means (t_i') associated with said one receiver (D_i) to provide a means for selecting a desired channel at that receiver. 45
11. An optical transmission system using a broad spectrum optical carrier signal, the system comprising means for dividing the carrier signal into at least two paths; means (M_i) for modulating the carrier signal in at least one of the paths in accordance with information to be transmitted; means for recombining the divided signals to provide a recombined signal after imposing a relatively different delay on each 50

divided signal to provide a delay multiplexed signal; a respective heterodyne receiver (D_i) associated with each path; and divider means (3,7,8) for dividing a local oscillator signal having a frequency shifted with respect to the carrier signal and for coupling one of the divided local oscillator signals to one of the receivers; the divided local oscillator signal coupled to said one receiver having a relative delay corresponding to the delay of the information to be received by that receiver; characterised by a first splitting point at which the optical carrier signal is split, a recombination point at which the divided signals are recombined, a second splitting point at which the recombined signal is divided, and delay means (t_i') for imposing relative delays on the divided local oscillator signals, the delay means being located between the second splitting point and the receivers.

12. An optical transmission system according to claim 11, wherein the broad spectrum optical carrier signal is provided by an optical source (1) and means for modulating the optical source. 25
13. An optical transmission system according to claim 12, wherein the means for modulating the optical source (1) impose a triangular modulation for providing the broad spectrum optical carrier signal. 30
14. An optical transmission system according to claim 13, further comprising means (8) for imposing a frequency shift on a portion of the broad spectrum optical carrier signal to provide the local oscillator signal. 35
15. An optical transmission system according to claim 14, wherein the local oscillator signal is polarisation multiplexed and transmitted with a delay multiplex carrier signal. 40
16. An optical transmission system according to any of claims 11 to 15, further comprising means for sending a return message, wherein a portion of the multi-channel delay multiplex signal and a portion of the local oscillator signal are mixed to provide a return message carrier signal, and the return message carrier signal is divided over two paths one of which is modulated in accordance with the return message and recombined with the other return message path with delay multiplexing. 45

Patentansprüche



1. Verfahren zur Informationsübertragung unter Benutzung eines optischen Breitbandträgersignals, das folgende Schritte aufweist: Aufteilen des Trägersignals auf mindestens zwei Pfade; Modulieren des Trägersignals in mindesten einem der Pfade entsprechend der zu übertragenden Information; Rekombinieren der aufgeteilten Signale zur Lieferung eines rekombinierten Signals nach Erteilen einer relativ unterschiedlichen Verzögerung an jedes abgeteilte Signal, um ein verzögerungsmultiplexiertes Signal zu liefern; Empfangen der Information in einem von mindestens zwei Heterodyne-Empfängern (D_1) durch Teilen des rekombinierten Signals und Ankoppeln eines der abgeteilten Signale an einen der Empfänger (D_1); und Teilen eines Empfangsoszillatorsignals mit einer in Bezug auf das Trägersignal verschobenen Frequenz und Ankoppeln eines der abgeteilten Empfangsoszillatorsignale an den einen Empfänger, wobei das an den Empfänger angekoppelte abgeteilte Empfangsoszillatorsignal eine relative Verzögerung aufweist, die der Verzögerung der zu empfangenden Information entspricht; dadurch gekennzeichnet, daß das optische Trägersignal an einem ersten Teilungspunkt unterteilt wird, die unterteilten Signale an einem Rekombinationspunkt rekombiniert werden, und das rekombinierte Signal an einem zweiten Teilungspunkt unterteilt wird; und daß den abgeteilten Empfangsoszillatorsignalen relative Verzögerungen durch Verzögerungseinrichtungen (t_1') erteilt werden, die zwischen dem zweiten Teilungspunkt und den Überlagerungsempfängern (D_1) angeordnet sind. 5
2. Verfahren nach Anspruch 1, das weiter den Schritt der Erzeugung des Empfangsoszillatorsignals durch eine andere Quelle (25) als die zur Lieferung des Trägersignals benutzten Quelle umfaßt. 10
3. Verfahren nach Anspruch 1, das weiter den Schritt der Erzeugung des Empfangsoszillatorsignals durch Frequenzverschiebung bei einem vom Trägersignal abgeteilten Signal umfaßt. 15
4. Verfahren nach Anspruch 3, bei dem das Empfangsoszillatorsignal auf einen gemeinsamen Übertragungspfad (6) mit einem verzögerungsmultiplexierten Rekombinationssignal polarisationsmultiplexiert wird. 20
5. Verfahren nach einem beliebigen vorhergehenden Anspruch, bei dem ein Teil des rekombinierten Signals und ein Teil des Empfangsoszillatorsignals zur Lieferung eines Rückmelde-trägersignals gemischt werden und das Rück-meldeträgersignal auf mindestens zwei Pfade abgeteilt wird, von denen einer entsprechend der Rückmeldung moduliert und mit dem anderen Meldungspfad durch Verzögerungsmultiplexieren rekombiniert wird. 25
6. Verfahren nach einem beliebigen vorhergehenden Anspruch, bei dem das Empfangsoszillatorsignal, zur Übermittlung, mit dem rekombinierten Signal kombiniert wird. 30
7. Verfahren nach Anspruch 6, bei dem das Empfangsoszillatorsignal in Bezug auf das rekombinierte Signal polarisationsmultiplexiert wird. 35
8. Verfahren nach einem beliebigen vorhergehenden Anspruch, bei dem der optische Breitbandträger durch Modulieren einer Quelle erzeugt wird. 40
9. Verfahren nach Anspruch 8, bei dem der Träger mit einer dreieckigen Wellenform moduliert wird. 45
10. Verfahren zur Informationsübertragung nach einem beliebigen vorhergehenden Anspruch, das weiter den Schritt der Abstimmung der Verzögerung des Empfangsoszillatorsignals durch Einrichtungen (t_1') umfaßt, die mit dem genannten einen Empfänger (D_1) assoziiert sind, um ein Mittel zur Wahl eines gewünschten Kanals bei diesem Empfänger zu schaffen. 50
11. Optisches Übertragungssystem, das ein optisches Breitbandträgersignal benutzt, und folgende Mittel aufweist: Einrichtungen zum Aufteilen des Trägersignals auf mindestens zwei Pfade; Einrichtungen (M_1) zum Modulieren des Trägersignals in mindestens einem der Pfade entsprechend der zu übertragenden Information; Einrichtungen zum Rekombinieren der abgeteilten Signale zur Lieferung eines rekombinierten Signals nach der Erteilung einer relativ unterschiedlichen Verzögerung an jedes abgeteilte Signal, um ein verzögerungsmultiplexiertes Signal zu liefern; einen jedem Pfad zugeordneter, entsprechender Heterodyne-Empfänger (D_1); und Teilereinrichtungen (3, 7, 8) zum Teilen des Empfangsoszillatorsignals mit relativ zum Trägersignal verschobener Frequenz und zum Ankoppeln eines der abgeteilten Empfangsoszillatorsignale an einen der Empfänger; wobei das an den einen Empfänger angekoppelte, abgeteilte Empfangsoszillatorsignal eine relative Verzögerung entsprechend der Verzögerung der vom Empfänger zu empfangenden Information aufweist; gekennzeichnet durch einen ersten Teilungspunkt, an wel-



chem das optische Trägersignal geteilt wird; einen Rekombinationspunkt, an dem die abgeteilten Signale rekombiniert werden; einen zweiten Teilungspunkt, an dem das rekombinierte Signal geteilt wird; und Verzögerungseinrichtungen (t_1) zur Erteilung relativer Verzögerungen an die abgeteilten Empfangsoszillatorsignale, wobei die Verzögerungseinrichtungen zwischen dem zweiten Teilungspunkt und den Empfängern angeordnet sind.

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12. Optisches Übertragungssystem nach Anspruch 11, bei dem das optische Breitbandträgersignal von einer optischen Quelle (1) und Einrichtungen zum Modulieren der optischen Quelle geliefert wird.

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13. Optisches Übertragungssystem nach Anspruch 12, bei dem die Einrichtungen zum Modulieren der optischen Quelle (1) eine Dreiecksmodulation zur Lieferung des optischen Breitbandträgersignals erteilen.

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14. Optisches Übertragungssystem nach Anspruch 13, das weiter Einrichtungen (8) zur Erteilung einer Frequenzverschiebung an einen Abschnitt des optischen Breitbandträgersignals umfaßt, um das Empfangs-oszillatorsignal zu liefern.

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15. Optisches Übertragungssystem nach Anspruch 14, bei dem das Empfangsoszillatorsignal polarisationsmultiplexiert und mit einem verzögerungsmultiplexierten Trägersignal übermittelt wird.

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16. Optisches Übertragungssystem nach einem beliebigen Anspruch 11 bis 15, das weiter Einrichtungen zum Senden einer Rückmeldung umfaßt, bei der ein Teil des verzögerungsmultiplexierten Vielfachkanalsignals und ein Teil des Empfangsoszillatorsignals zur Lieferung eines Rückmeldeträgersignals gemischt werden, und bei dem das Rückmeldeträgersignal auf zwei Pfade aufgeteilt wird, von denen einer entsprechend der Rückmeldung moduliert und durch Verzögerungsmultiplexieren mit dem anderen Rückmeldepfad rekombiniert wird.

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Revendications

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1. Un procédé de transmission d'information utilisant un signal de porteuse optique à large bande, le procédé comprenant les étapes consistant à diviser le signal de porteuse en au moins deux trajets; moduler le signal de porteuse dans au moins l'un des trajets selon une information à transmettre; recombinaer les si-

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gnaux divisés pour fournir un signal recombinaé après avoir imposé un retard relativement différent à chaque signal divisé pour fournir un signal multiplexé à retard; recevoir l'information à un premier d'au moins deux récepteurs hétérodynes (D_1) en divisant le signal recombinaé et en couplant l'un des signaux divisés audit premier récepteur (D_1), et diviser un signal d'oscillateur local à fréquence décalée par rapport au signal de porteuse et coupler l'un des signaux divisés d'oscillateur local audit premier récepteur, le signal divisé d'oscillateur local couplé au récepteur présentant un retard relatif correspondant au retard de l'information à recevoir; caractérisé en ce que le signal de porteuse optique est divisé à un premier point de séparation, les signaux divisés sont recombinaés à un point de recombinaison, et le signal recombinaé est divisé à un deuxième point de séparation; et les signaux divisés d'oscillateur local présentent des retards relatifs qui leur sont imposés par un moyen de retard (t_1) situé entre le deuxième point de séparation et les récepteurs hétérodynes (D_1).

2. Un procédé selon la revendication 1, comprenant en outre l'étape consistant à engendrer le signal d'oscillateur local à partir d'une source (25) autre que celle qui est utilisée pour fournir le signal de porteuse.

3. Un procédé selon la revendication 1, comprenant en outre l'étape consistant à engendrer le signal d'oscillateur local par décalage de fréquence d'un signal divisé provenant du signal de porteuse.

4. Un procédé selon la revendication 3, dans lequel le signal d'oscillateur local est multiplexé en polarisation sur un trajet commun de transmission (8) avec un signal recombinaé multiplexé à retard.

5. Un procédé selon une revendication précédente quelconque, dans lequel une partie du signal recombinaé et une partie du signal d'oscillateur local sont mélangées pour fournir un signal de porteuse de message de renvoi, et le signal de porteuse de message de renvoi est divisé en au moins deux trajets, dont l'un est modulé conformément à un message de renvoi et est recombinaé avec l'autre trajet de message avec un multiplexage à retard.

6. Un procédé selon une revendication précédente quelconque, dans lequel le signal d'oscillateur local est combiné avec le signal recombinaé en vue de la transmission.



7. Un procédé selon la revendication 6, dans lequel le signal d'oscillateur local est multiplexé en polarisation par rapport au signal recombéné. 5
8. Un procédé selon une revendication précédente quelconque dans lequel la porteuse optique à large spectre est engendrée par modulation d'une source. 10
9. Un procédé selon la revendication 8, dans lequel la porteuse est modulée selon une forme d'onde triangulaire. 15
10. Un procédé de transmission d'information selon une revendication précédente quelconque, comprenant en outre l'étape consistant à accorder le retard du signal d'oscillateur local par un moyen (t_1') associé audit premier récepteur (D_1) pour réaliser un moyen de choix d'un canal souhaité à ce récepteur. 20
11. Un système de transmission optique utilisant un signal d'onde porteuse optique à large bande, le système comprenant un moyen de division du signal de porteuse en au moins deux trajets; un moyen (M_1) de modulation du signal de porteuse dans au moins l'un des trajets selon une information à transmettre; un moyen de recombinaison des signaux divisés pour fournir un signal recombéné après avoir imposé un retard relativement différent à chaque signal divisé pour fournir un signal multiplexé à retard; un récepteur hétérodyne respectif (D_1) associé à chaque trajet; et un moyen diviseur (3, 7, 8) pour diviser un signal d'oscillateur local à fréquence décalée par rapport au signal de porteuse et pour coupler l'un des signaux divisés d'oscillateur local à un premier des récepteurs; le signal divisé d'oscillateur local couplé audit premier récepteur présentant un retard relatif correspondant au retard de l'information à recevoir par ce récepteur; caractérisé par un premier point de séparation auquel le signal d'onde porteuse optique est séparé, un point de recombinaison auquel les signaux divisés sont recombénés, un deuxième point de séparation auquel le signal recombéné est divisé, et un moyen de retard (t_1') pour imposer des retards relatifs aux signaux divisés d'oscillateur local, le moyen de retard étant situé entre le deuxième point de séparation et les récepteurs. 25
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12. Un système de transmission optique selon la revendication 11, dans lequel le signal d'onde porteuse optique à large spectre est fourni par une source optique (1) et un moyen de modu- 55

lation de la source optique.

13. Un signal de transmission optique selon la revendication 12, dans lequel le moyen de modulation de la source optique (1) impose une modulation triangulaire pour fournir le signal d'onde porteuse optique à large spectre. 5
14. Un système de transmission optique selon la revendication 13, comprenant en outre un moyen (8) d'imposition d'un décalage de fréquence à une partie du signal d'onde porteuse optique à large spectre afin de réaliser le signal d'oscillateur local. 10
15. Un système de transmission optique selon la revendication 14, dans lequel le signal d'oscillateur local est multiplexé en polarisation et transmis avec un signal de porteuse multiplexé à retard. 15
16. Un système de transmission optique selon l'une quelconque des revendications 11 à 15, comprenant en outre un moyen d'envoi d'un message de renvoi, dans lequel une partie du signal de multiplex à retard à canaux multiples et une partie du signal d'oscillateur local sont mélangées pour fournir un signal de porteuse de message de renvoi, et le signal de porteuse de message de renvoi est divisé en deux trajets dont l'un est modulé selon le message de renvoi et recombéné avec l'autre trajet de message de renvoi avec un multiplexage à retard. 20
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