Theory, Design and Micron-Scale Implementation of fully-optical logic gates and optical clock circuits

Akbar Rahmani Nejad, Independent Researcher,
P.O.Box 14515-193, Tehran, Iran
Email: arahmaninejad@gmail.com

ABSTRACT

In this paper, it is tried to provide an innovative method to overcome several limitations of state of the art of logical gates and microprocessors, by implementation of micron-scaled optical gates. This technology can overcome such limitations, i.e. processing speed, heat dissipation, electromagnetic radiation and electrical noise immunity. This technology can be fully or partially feasible by substitution of common semiconductor technology with optical logic gates. By implementation of micron-scale optical fiber, optical couplers, fiber optical amplifiers, or fiber lasers, optical attenuators, optical fiber brag grating, femto-second optical lasers, and implementation of fundamental properties of optical coherent light, e.g. superposition, interference, phase delay, etc, it is possible to fabricate micron-scale universal logical gates, i.e. optical NAND gates, optical NOR gates, optical Exclusive-OR, optical exclusive-NOR gates and subsequently fabrication of sequential circuits (optical flip-flops), that all are fundamental blocks of microprocessors. Optical coherent light is produced by femtosecond lasers and is supplied to a network of micron-scaled fiber optics, fiber optical lasers, attenuators, fiber optical couplers, and finally are supplied to opto-couplers that change optical signals to electrical signals to be read by output console or to be written on memory cells. It is also possible to implement a combination of optical and semiconductor gates to decrease above mentioned limitations. The method of fabrication of optical gates is discussed in details and all necessary logical and technical aspects are provided too. The fundamental implemented aspect is superposition of coherent lights in fiber optic couplers. By implementation of femtosecond laser pulses, it is possible to reach to much higher frequencies of about hundreds to thousands of terahertz. Alternative optical method is provided here, e.g. implementation of fiber loops as clock circuit or even as an optical oscillator. By implementation of this technology, there will be one hundred years advance in respect to state of the art technology.

Keywords:, fiber optic coupler, beam splitter, beam combiner, optical NOR gate, universal optical gate, fiber coupler optical gate, exclusive-or optical gate, coherent length, femtosecond laser, fiber optical laser, optical attenuator, phasor logic state, phasor truth table.

1. INTRODUCTION

Light signals are furnished by femtosecond laser diodes and continuous diode lasers, which are adjust to work in a specific optical wave length. The basis of this method is on the implementation of destructive and constructive coupling of light pulses by optical fiber couplers (beam splitters and beam combiners). The phase delay of 180º is achieved by $\lambda/2$ longer input of fiber optical coupler. Presence of optical pulse means high logic and absence of optical pulse means low state logic (amplitude shift keying). By this method, it is shown that optical Exclusive-OR gates, optical "NOT" gates, optical Exclusive-NOR gates, optical "NOR' gates, and finally optical "NAND" gates that are universal gates and is necessary (and enough) condition for fabrication of any logical circuit can be fabricated. Thus, sequential optical circuits and optical registers can be fabricated, and in turn by implementation of above optical gates, it is possible to fabricate optical register and optical memory. Finally, by implementation of optical memories, a complete homogenous system of optical logical circuits will be fabricated. On the other hand it is possible to have a combination of optical logic gates and semiconductor logic gates that the interference between inhomogeneous stages can be accomplished by opt-couplers. It should be emphasized each 2×1 fiber optic coupler (beam combiner) is the fundamental block of optical gates. Fiber optical amplifier (laser), phase delay, beam attenuator and some other optical devices are also should be implemented to reach to desired optical values.

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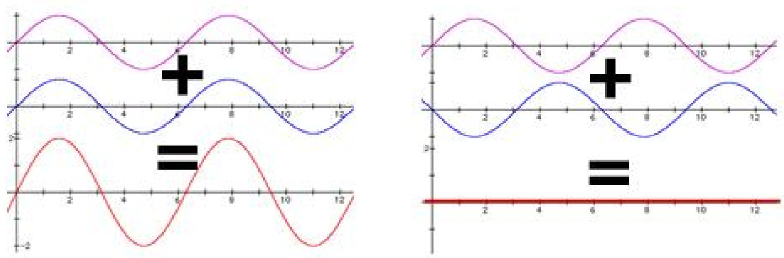
2. OPTICAL GATES IMPLEMENTATION

Implementation of optical logical gates is achieved by micron-scale optical fibers and distance between any successive two gates should be integer multiple of wave length of the furnished optical beam. The main concept of optical is based on amplitude shift keying, i.e. presence of a signal means logic “1” or high logical state and absence of the pulse means logic “0”. Phase of optical signal is important as well, that was discussed in 2.5. (phasor logic truth table).

2.1 Principle of constructive and destructive coupling

As it is seen in figure 1, for constructive coupling of two coherent signals, it is enough that they interfere when having zero degree phase difference and for entire destructive interference, it is enough to have 180° phase difference.



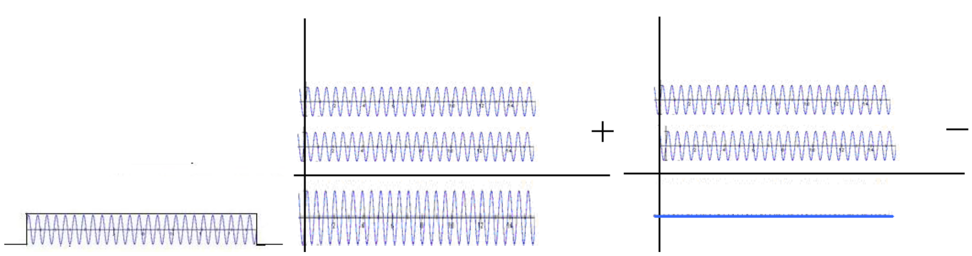
(a) (b)

Fig.1. (a) constructive interference, (b) destructive interference

It is depicted in figure.2, that a femtosecond laser pulse of duration about 50 femtosecond will have 25 cycles of 600nm of coherent light (in the diagram 24 cycles is exhibited for the sake of simplicity). On the other hand an optical beam has restricted to associated coherence length. The optical beam of the laser diode consists typically a total band width approximately to 3-5 nm. Coherence length "l_c" of such a radiation can be estimated as follows:

$$l_c = \lambda^2 / \Delta \lambda \tag{1}$$

By applying a laser beam to fiber optical brag grating, the coherence length of several kilometers is achieved that is enough for our purpose. Then by applying above mentioned pulses to a fiber optical coupler of 2×1 that one of the input legs is $\lambda / 2$ longer than the second leg, we will expect a destructive coupling and if there are two legs having the same length then, it is obvious that we should expect constructive interference.

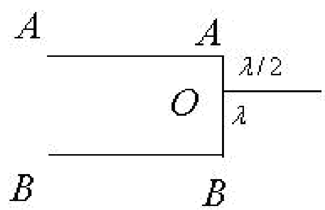


(a) (b) (c)

Fig.2. (a) 50 femtosecond laser pulse, (c) constructive, (c) destructive

2.2 Optical Exclusive-OR Implementation

The core of this gate is a 2×1 fiber optic coupler that the length of one of inputs is $\lambda/2$ longer than the second one. As it is seen in figure.3, optical pulse can be applied to each input of the gate and the length of in put "B" is $\lambda/2$ longer than input "A", then it is obvious when there is a signal only on each of inputs the output will be same as input and when there is no input pulse on both of the inputs then there is no signal at output, finally, if two coherent beam, with no phase difference is applied to two inputs then there will be again no optical signal at output because two beam interfere destructively and there is zero optical output. If we consider the truth table, we will find out that this is the same logic as Exclusive-OR gate that is exhibited in figure.3. In brief, when "A" and "B" are equal to zero then there is no signal in output, when an optical pulse is applied to one of the gates, it will appear as output, and finally, if optical beams are applied to both inputs then the output will be destructive interference of inputs and that results zero. The main draw back of this circuit is that when the output is equal to "1", depending on that, to which input the optical signal is applied, then the output will have different phase lag. This means that, application each of these two high optical state "1" to the next gate will have different result, in other words both "1" states should have the same phase on output. This problem is solved in section 4.

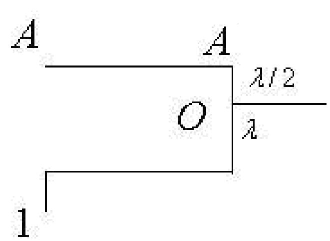


A	B	O
0	0	0
0	1	1
1	0	1
1	1	0

Fig.3. Exclusive-OR optical gate implementation

2.3 Optical "NOT" gate implementation

It is obvious that if it is desired to have a not-gate, it is enough to apply a signal of "1" to one of the gates and the resultant will be not optical logic gate. This optical signal is furnished by continuous laser beam. It is important that signal to be applied to shorter input (λ/2 input), because when there is no input at "A" the output length of signal "1" to have integer multiple of wavelength.



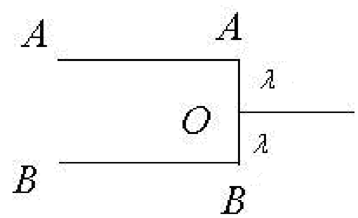
A	1	O
0	1	1
1	1	0

Fig.4. "NOT" gate implementation

The half wavelength phase shift is equal to 180° phase shift, and it is compulsory to devise above mentioned method to correct output to have the same phase as input "A". Logical input "1" is exactly in phase of signal "A". When signal "A" is applied, output will be destructive interference of two signals that is "0" state. It is important that signal "A" to be applied to shorter input, because to have multiple integer of length distance to successive gate, i.e. no phase reversal should be accomplished.

2.4 Universal Optical NOR gate implementation

"NOR" gate implementation is rather complicated in compare with previous gates, because when two signals interfere constructively, then they produce a signal having an amplitude of twice of previous amplitude, As it is seen in figure.5, both inputs have the same length of fiber optic, when both inputs are "0" then the output is "0" and for the rest rows of the truth table the output signal will have logical high state and this is exactly a common "OR" gate but for last state of truth table, when two inputs are equal to "1" the output has an output amplitude twice the previous amplitude of "1" state. Now suppose if a high state from second row or third row and to be applied to the successive logic gate, this signal is high logical state and it has the amplitude of high logical state but a high state from last the row has twice amplitude of other high state logic .By applying the high state from last row of the truth table to the successive gate, it is impossible to have the state "0" in the case of destructive interference, in the other word the output is undetermined and will have amplitude of equal or twice of state "1" that is not acceptable.



A	B	O
0	0	0
0	1	1
1	0	1
1	1	1 (2)

Fig.5. Optical "OR" gate

A solution is illustrated in figure.6. As it is seen, each inputs called "A", "B" are divided by 1×2, 50/50 splitter. The length of each micron optical fiber between "A" and " A_1 " is multiple integer of wavelength, i.e. the phase of input is not changed, and this assumption is recognized for distance between "B" and " B_1 ". The " O_1 " optical coupler adds inputs constructively and the " O_2 " adds destructively.

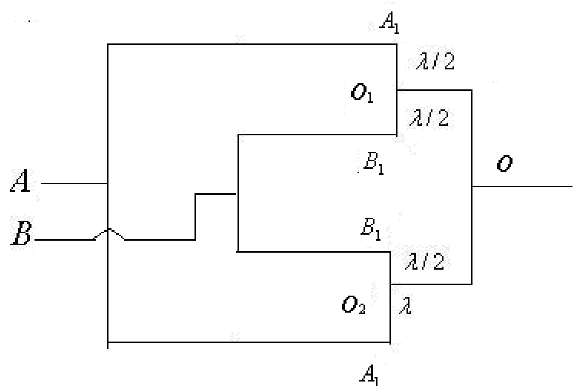


Fig.6. Pseudo "NOR" gate implementation

As it is seen in figure.6, the upper gate " O_1 " is a "NOR" gate and the lower gate " O_2 " is an Exclusive-OR Gate. It is seen that outputs from both gates interfere constructively in fiber optical coupler " O ". The logical truth table for each gate is demonstrated in figure.7. On the other hand the distances between " O_1 " to O and " O_2 " to " O "is designed to be integer multiple of wavelength of optical beam, hence when inputs "A" and "B" are zero then " O_1 " and " O_2 " are equal to zero and by constructive coupling (interference) of these signal to fiber optic coupler "O ", the result will be zero amplitude and zero logical state. If the first input is equal to zero and second input equal to "1" then "O_1" and "O_2" having equal logical state of "1" but the amplitude of signal in "O" is doubled and by assumption that each input is halved by 1×2, 50% splitter at first stage, then the output "O " will have logical state "1" and amplitude is still the same as the first input (before applying to the splitter). For the case that first input is "1" logical state and second input is "0" the argument is exactly the same. Finally, for the last case that input "A" and "B" are both equal to"1" then "O_1" is equal to logical state "1" but the amplitude is twice as "A_1" or "B_1" (that each have half of the amplitude of "A" or "B"). hence in this case output of logical state"O_1" will be still "1" and the amplitude will be equal to the amplitude of "A" or "B" that results output of "2" (two times in respect to amplitudes at "A_1"or "B_1"), in other word the beams are splitted at first then this is equal to the amplitude of "A" or "B".

A	B	O_2
0	0	0
0	1	1
1	0	1
1	1	0

A	B	O_1
0	0	0
0	1	1
1	0	1
1	1	1 (2)

Σ

O_1	O_2	O
0	0	0
1	1	1 (2)
1	1	1 (2)
0	1 (2)	1 (2)

Fig.7. logical states and amplitudes of optical OR gate, number "2" in parenthesis indicate that amplitude is doubled

The final logical state is depicted in figure.8, that is the truth table of an OR gate, that by applying the output to a NOT gate (that is discussed in 2.3) universal optical NOR gate is implemented. It is obvious that the length of fibers between successive optical logic gates should be an integer multiple of the wavelength of applied optical beam that this amount in this paper is 0.6 microns.

A	B	O
0	0	0
0	1	1
1	0	1
1	1	1

Fig.8. the output is exactly as logical output of an OR gate, digit (2) indicates that the amplitude is twice of input at each gate, i.e. "A'" or "B'" that each of them have half of the amplitude of "A" or "B"

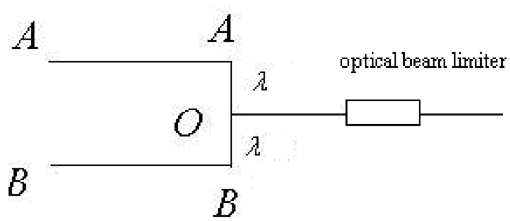
2.5 Phasor truth table and phasor logical state for "OR" & "AND" implementations

If we do not consider the phase of optical pulses, truth table depicted in figure.8, seems plausible. Further investigation exhibits that there are three factors that should be recognized, logical state, amplitude of optical pulse and phase of the beam. It is assumed that any signal has an amplitude of "1" and phase of zero should be the logical state "1" (i.e. $1<0^{\circ}$) and any signal having amplitude "0" will have the logical state zero. But, when a signal is delayed for half of wavelength, then it takes a value of "$1<\pi$", that is undetermined. Then the truth table of figure.7 is written as followings:

A	B	O_1	O_2	O
0<0	0<0	0	0	0
0<0	1<0	1/2< π	1/2< π	1< π
1<0	0<0	1/2 < π	1/2 <0	0
1<0	1<0	1< π	0	1< π

Fig.9. phasor truth table of pseudo optical NOR gate illustrated in

It is obvious that above mentioned gate is not useful implementation, because useful gates should exhibit only one state distinguished out of four possible states, in other word, gates that have two inputs then four states should have one state having distinguished state in compare with other states. When all factors are recognized, i.e. phase, amplitude and logical state and according to phasor logical state postulate that was mentioned Then there are a wide range of solutions to above mentioned problem that is out of capacity of a paper but as an example it is possible to use a beam limiter (fixed beam attenuator) after optical "OR" gate of figure.5, that limits or dumps the output beam to intensity of amplitude “1” and applying the output of this gate to a NOT gate yields an optical NOR gate.



A	B	O
0	0	0
0	1	1
1	0	1
1	1	1

Fig.10. Optical "OR" gate implementation by optical fiber and beam dump

It is desirable to fabricate logical adders and counters by exclusive-or and exclusive-nor gates, but all kind of sequential gates can be fabricated by optical NOR gates that is a universal gate. "Universal NOR optical gates" in turn is fabricated by micron-scaled optical fiber, fiber optical couplers, and fiber optical splitters. It is obvious the length of optical fibers in the scale of nanometer is useless because optical beams have a range in some fraction of microns that should be maintained to yield enough phase shifts for destructive coupling but for constructive coupling it is only necessary to have inputs of equal length, even in nanometer-scale domain. As another example for phasor truth table, it is possible to exhibit the phasor truth table of Exclusive-OR gate and eventually, it is seen that the truth table of exclusive-OR without recognizing the concept of phase shift, will lead to evident errors. This problem is solved in section 4. it is possible to use optical gate in figure 10, to implement "AND" optical gate. For this purpose it is necessary to set the beam limiter to such the value that dumps three first row of truth table to value zero but because the fourth row has an amplitude of two times of the second and third rows, to be attenuated to half of amplitude that is equal to high logical state. A close review of this case reveals that this is the "AND" optical implementation. This method can solve the problem of residual pulses that was discussed in section 3. Mathematical notation for the case "OR" and "AND" implementations are written as following:

"OR" implementation: $\quad E\,(1 \rightarrow 1;\, 2 \rightarrow 1)$ (2)

"AND" implementation: $\quad E\,(1 \rightarrow 0;\, 2 \rightarrow 1)$ (3)

Amplitude "1" denotes amplitude of high logic state and amplitude "2" denotes the result of constructive interference of two high logic having amplitudes of "1". "E" denotes dumping energy and " $1 \rightarrow 1$" denotes amplitude "1" is remained at

1, " $2 \rightarrow 1$" denotes doubled amplitude is halved to its original value and " $1 \rightarrow 0$" denotes attenuation (truncation) of amplitude "1" to zero. The attenuation factor of the attenuator can be set to desired value depending on the application.

A	B	O
0	0	0
0	$1 < 0^{\circ}$	$1 < 0$
$1 < 0^{\circ}$	0	$1 < \pi$
$1 < 0^{\circ}$	$1 < 0^{\circ}$	0

Fig.12. Phasor truth table of optical Exclusive-OR

2.6 Optical gates symbolization

It is enough to use logical gate symbols for optical gates but a sign of flash can be added to distinguish between optical implementation and semi-conductor logical gates. This is depicted in figure.11. Implementation of other logical gates will be easy, by applying output of “OR” optical logic gate to a “NOT” optical logic gate, a “NOR” optical gate is fabricated. By applying the output of a “NOT” optical gate to another “NOT” optical gate a buffer having delay of period of 0.6 micron optical beam, i.e. 0.6 divided to light speed equal to two femtosecond is achieved. By a series of optical buffers this delay can be extended but pulse width will decrease, this phenomenon was discussed in successive sections. a piece of optical fiber having specific length can delay the pulse for desired value of time, e.g. three meter length can make a delay of 0.1 nanosecond. Finally, It is possible to fabricate “AND” logical gates by applying De Morgan principle.

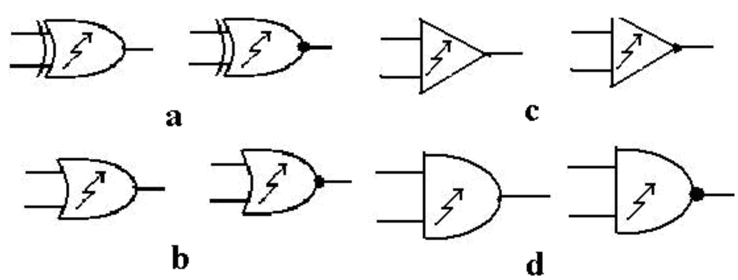
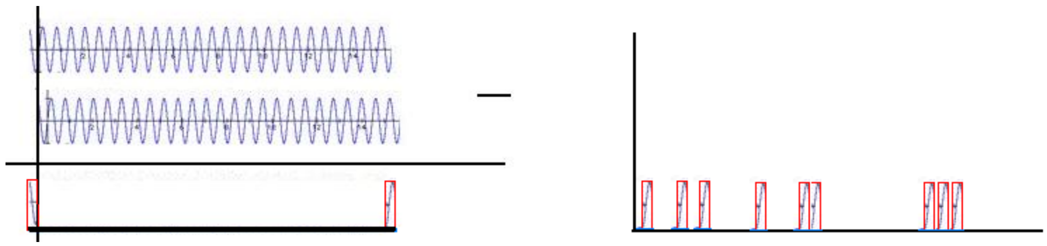


Fig.11. symbols for optical logic gates (a) exclusive-or and exclusive-nor optical gates , (b) buffer and not optical gates, (c) OR an Nor optical logic gates, (d) “AND” and ‘NAND” optical logic gates

3. “PULSE RESIDUALS” PROBLEM

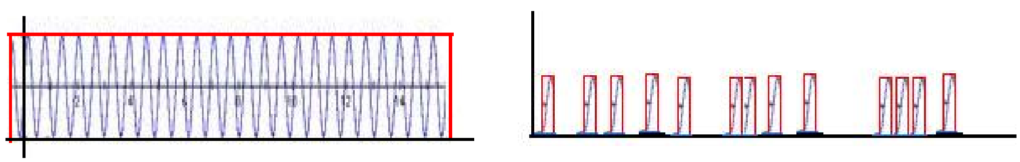
As it would be predicted by reader, when two optical pulses interfere destructively, because of half of wavelength delay of one optical pulse in respect to the second, there will be remained an un-interfered tail for lagged optical pulse equal to half period of optical period, e.g. for a 600 nm optical beam the half wave length will be equal to 300nm and the equivalent period will be 300nm divided to light speed that is one femtosecond, that is small value but if billions of gates in an optical processor each produce such small pulse that may randomly set next to each other then the result may be very close to a pulse of logic “1”, and this can be regarded as optical logic error.



(a) (b)

Fig.13. (a) two half wavelength width truncated pulses, (b) a probable pattern of half wavelength that may approaches to state "1" optical signal after several stages of destructive interference of optical beams in optical gates

An efficient method can be implementation of an attenuator and an optical fiber laser just after the gate. As it is predicted easily the amplitude of truncated (residual) optical beam is half of optical beam having logic “1”, because this signal is due to of truncation of lagged signal but the second is due to doubling of amplitude because of constructively interference of two optical beams. Hence after implementation of an attenuator to be fixed at a specific value such that halves the amplitude of signal “1” and then by doubling it by fiber optic laser, the signal “1” still remains the same, but for residual pulse, because it has the half of amplitude of signal “1” , it will completely dumped by attenuator and there is no beam to be gained by fiber optic laser hence this residual pulse can be eliminated completely.



(a) (b)

Fig.14.(a) an optical logic high state "1". (b) after several stages of logical implementation, number of residual pulses increase and may approach to pulse width of optical high logic (but half amplitude in respect to it) and can be confused with high state by optical processor

This phenomenon is exhibited in figure 14. It is obvious that any train of optical residual half wavelength of optical pulses can be formed after unpredictable successive stages of optical logic manipulation.

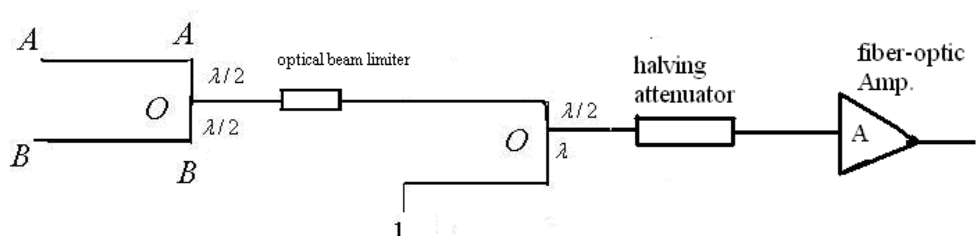


Fig.15. Detailed implantation of Universal NOR optical gate with pulse residual compensation and recovery circuit

It is very important to mention that optical attenuator after first gate is set to have "AND" gate and halving attenuator is for diminishing any optical ripples due to any phase difference that is close to zero phase difference and may make optical pulses (ripples) having very small amplitude and optical amplifier is due to reconstruction the amplitude of high logical state to its initial value. It is possible to show above mentioned circuit in a simpler method that is more familiar and even it is possible to have one schematic diagram for all above circuit as an universal optical NOR gate. By application of De Morgan law, it is possible to fabricate "NOR" and any other gates from "NAND" optical gate.

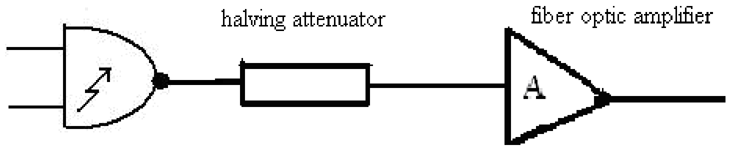


Fig.16. Schematic diagram of an optical "NOR" gate that sends its output signal to a optical attenuator and then to a fiber-optical laser

As it is seen in figure 16, that for example, if the attenuator is set to completely diminish an optical signal of 1mW, then if the signal is fed to this attenuator, then there is no optical signal to be gained by fiber-optic laser and the output will have an amplitude of zero. But when there is a logic “1” the amplitude is due constructive addition of two signals then, it has an amplitude of 2mW and after passing through the attenuator, there will be a signal of 1mW that to be amplified to 2mW that is exactly the same as high state signal. In fact, it is obvious that the attenuation and amplification gain should be somehow more than this value to reach to very practical result.

4. EXCLUSIVE-OR SOLUTION

Exclusive-OR implementation an optical implementation with no amplitude problem, i.e. there is no constructive interference to double the output to two times of input and is fairly easier to be fabricated. If we intend to implement "AND" optical gate of two inputs of "A" and "B", and if $\bar{A}$ = X, hence:

$$(B \oplus X) \oplus X = A.B \qquad (4)$$

As it is seen, the phase difference between applied signals "A" and "B" and signal appears on output is multiple integer of wavelength and the phase difference that is mentioned for Exclusive-OR gates is solved. Half wavelength phase shift

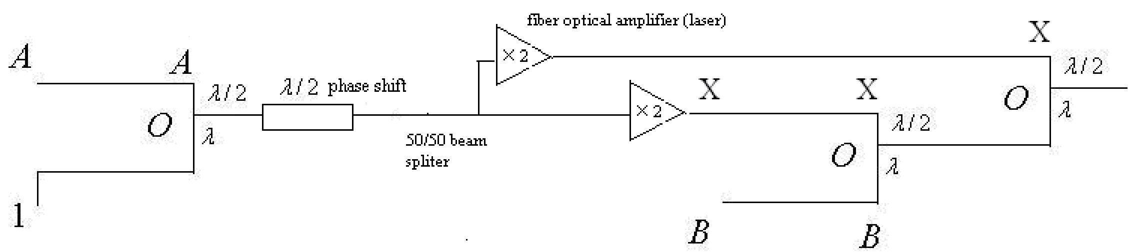


Fig.17. Exclusive-OR implementation of "AND" optical gate

after “NOT” gate is for satisfaction of phasor truth table that the total phase shift should be integer multiple of wavelength , i.e. the high logical state should be “1<0” should not changed to “1<π”. Universal "NAND" optical gates can be used to fabricate exclusive-OR gates.

5. SEQUANTIAL OPTICAL LOGIC IMPLEMENTATION

By implementation of universal gates, it is possible to fabricate any logic circuit, sequential or combinational, and in fact the main difference between optical logic gates and semiconductor logical gate is that the carriers in the first case are photons and in second type are electrons, then above mentioned rule is completely applicable to optical gates.

Implementation of attenuator/amplifier can eliminate the residual optical noises efficiently (figure.16). Due to very small lag of optical gates, there is almost no time delay between output of optical flip flops and input.

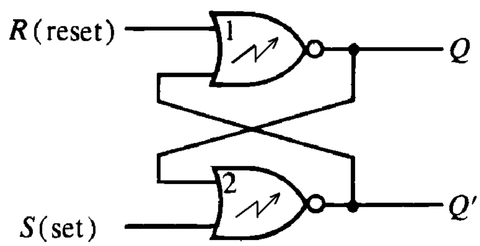


Fig.18. R-S flip-flop implementation by optical Nor gates

On the other hand it is easily predictable that the sole time delay is due to length of fiber optic from output "Q" to the input of gate "1" and also the length of optical fiber between Q' and input of gate "2". The above mentioned lengths that is really small values in compare with femtosecond period of optical pulses. On the other hand it is possible to implement unique characteristics of optical signals to fabricate memory cells, e.g. D-latch.

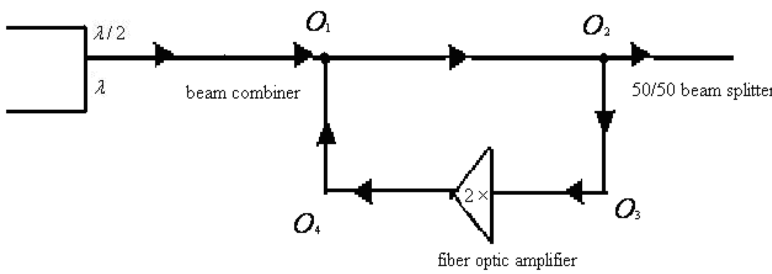


Fig.19. Optical D-latch

As it is seen in Figure.19, the input beam is splitted in two branches by 50/50 fiber optical splitter at "O_2"then is amplified to two times of amplitude by amplifier that is a fiber optical laser and finally, combined at O_1. When a light pulse is applied, it is splitted at "O_2"then is amplified to two times by amplifier then is applied again in the circuit and this loop is sustained. But by applying a signal "$1<\pi$", i.e. a signal having the opposite phase, a destructive interference is occurred at "O_1" and there is no output signal to be amplified again after splitting. It is obvious that "$1<\pi$" is forbidden but by applying a 1<0 signal to a half wavelength delay circuit, the desired situation is occurred. It is not very difficult to devise other types of such memory cells, by implementation of optical devices. An optical switch in the input of this circuit will depends on that if a state of "1<0" to be applied to have a latch of this state as high logical state or a state of"$1<\pi$" to be applied to "O_1" to have a destructive interference and output will be "0<0".

6. CLOCK CIRCUITS

As it is seen in figure.19, there are two main branches of the loop, first the main branch that is "O_1 O_2" and the second is the feedback branch that is "O_2 O_3 O_4 O_1" loop. By proper setting of the length of these two branches it is possible to reach to pulse oscillator or clock circuits. Suppose a light signal beam of 100 hundreds of femtosecond is injected to input "O_1". Associated length of this pulse can be calculated as followings:

$$l = cT = 3\times 10^{8} \times 100 \times 10^{-15} = 30\ \mu\text{m} \tag{5}$$

There are two distinct conditions: when the length of feedback circuit is equal or longer than length of the main branch, e.g. the main branch can be equal to 30 micron and the feedback branch has the length of 30 micron. Then by applying this pulse to "O_1" it is reached to "O_2" then it is halved by beam splitter and it is amplified to the previous amplitude and is fed in to "O_1" and the scenario is started again exactly as previous loop. The result will be optical pulses having duration of 30 microns and duty cycle will be 0.5 (pulse duration of 100 femtosecond, with 100 femtosecond spacing). For the case that the length of feedback branch is longer than main branch, the output signal will have less duty cycle but the length of optical pulse is still 30microns, e.g. if the length of feedback branch is 60 micron, then spacing between each successive signal is 200 femtosecond. The second case will happen when the feedback branch is slightly shorter than the main branch and the phase of applied optical signal is equal to the phase of the main signal. That if the 100 femtosecond pulse is comprised of 600nm then the length of feedback branch should be an integer multiple of this value, then there will happen an stunning criteria and this criterion is Barkhausen criterion for oscillation that for the case of optical feedback oscillators, it should have three conditions: the first and second conditions are the same as previous, i.e. the total loop gain equal to unity, it should be considered that 50/50 splitter changes the product of two gains to be 2 instead of unity, and total phase shift of zero degree but there are two other conditions that is stated as following:

following:

$$AB=2 \tag{6-1-a}$$

$$AB=1 \qquad \text{(for buffered optical oscillators)} \tag{6-1-b}$$

$$l_{feedback} = \mathrm{K}\lambda \tag{6-2}$$

$$l_{main-branch} \le \frac{1}{2} l_{feedback} \tag{6-3}$$

$$l_{main-branch} \le l_{optical} \tag{6-4}$$

The third condition is necessary to have a build up of constructive interfered optical signals to reach to the saturation of the amplifier of main loop that yields a sinusoid wave form and the fourth condition is necessary to have no delay time between successive pulses. This case is out of scope of this paper and is subject of another complete paper. It is also possible to set beam splitter on 99%-1% (1×2) then $AB \approx 1$ and Barkhausen criterion is satisfied in semiconductor technology oscillators, (.i.e. The product of amplification and attenuation coefficients to be set to be slightly larger than unity; $AB \ge 1$ (i.e. $AB \cong 1.01$) to increase the 99% to 100% original intensity of input light.)

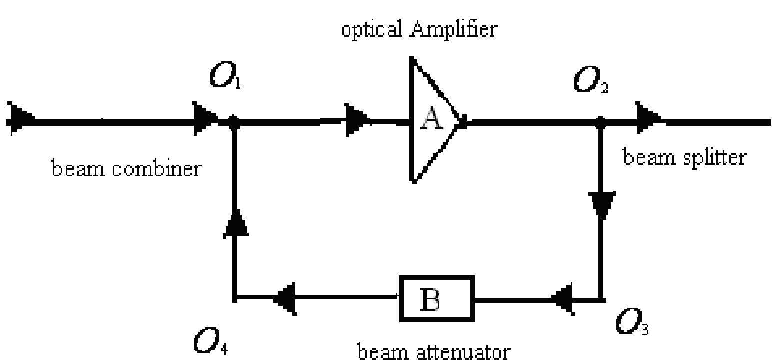


Fig.20. optical micron scaled oscillator and clock system

In other words this can be equivalent to buffering of oscillator condition of semi-conductor oscillators that can be stated as optical buffering. It is obvious that setting parameters on such precise values for beam splitter and beam attenuator is practically difficult. It is also possible to implement a beam splitter instead of beam attenuator such that only the desired amount of optical signal to be fed to the loop and the rest can be dumped in another branch. This devise solves any coherence problem i.e. the output light beam from optical splitter (B) will have the desired phase. Finally it is possible to set beam splitter to any ratio except 50%-50% and compensates it such that the product of A to B recovers the original injected value of light in to the loop. It is obvious that if AB> 1, then there will be saturation and if AB<1 the out put will fade to reach to zero after several oscillations.

7. CONCLUSION

In this paper, it is tried to step in a new fertile area of science that may lead to a drastic change in microprocessors technology, i.e. it is tried to show the future of microprocessor technology by implementation of photons instead of electrons, photons are much more efficient and faster than electrons, they are at our service but just we should find the method of implementation of these particle of spin 1 (in compare with electrons that have spin ½). Photons are incomparably faster than electrons; they do not have considerable loss of energy as heating of environment. You do not deal with gate delay time, rising time, falling time of semiconductor gates. They can interact with each other constructively or destructively and leave each other without any change. If we can employ photons, then it is not necessary to then superconductivity will have less importance in this area. Cascading microprocessors will not be important any more and a personal computer may have the processing power of a supercomputer. It is obvious that we can not avoid semiconductor devices in final and initial stages, but billions of logical manipulations can be accomplished by optical gates that as a consequence, the speed of processors may increase to hundreds of times easily. Of course, if it is intended to use optical devices, in final stage, it is possible to use fiber optical laser as final stage and write data on optical memories. A processor composed of threads of optical fibers is very close to natural processors, human brain is composed of threads that are called neuron. in this paper concept of coherence bears more than its usual meaning, it means coherence and synchronization of phase difference of zero degree. It means that by precise fabrication of optical fibers having length of multiple integers of the wavelength and applying signal "1<0" at the starting point of fiber optic, and by implementation of precise optical lasers and brag grating, it is possible to reach to above mentioned concept.

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