[Title of invention] PROGRAMMABLE BI-DIRECTIONAL LOGIC CIRCUIT

[Inventor] Shinji Karasawa, Natori City, Japan

[Abstract]

A logic circuit is formed by means of two kinds of junctions. One connects from many input lines to one output line. The other junction connects from one input line to many output lines. Since the input possesses some electric power and the output is passive, the junction operates transference from many to one or from one to many. That is, we can get a logically bi-directional reaction through the passive junction by exchanging the inputs and the output.

A pair of bi-directional junctions is able to exchange a pattern of digital signal by connecting both terminals of one line side. This bi-directional logic circuit is designed by a paradigm of activity. That is, transferring of activity is presented by transferring of some amount of electric charge. The transference of electric charge is carried out in a dynamic MOS device. The intermittent current is able to transmit electric charge from drain side to source side. Since the drain and the source in a floating gate MOSFET is exchangeable symmetry, it functions as a controllable passive junction. So, a floating gate MOSFET is able to operate as a programmable and controllable bi-directional connection. The presenting invention is the configuration of bi-directional logic circuit and the applications. In traditional Programmable Logic Device (PLD), a digital signal is transferred from the gate to the drain and the signal does not transfer from drain to the gate.

7 Claims, 7 Drawing Sheets, 1 Table

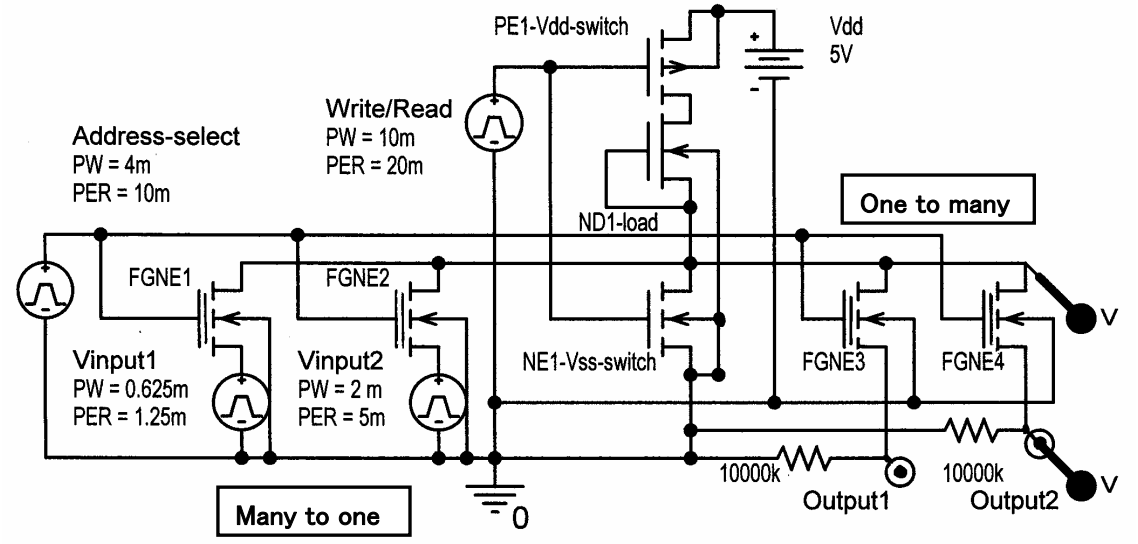

Fig.1 The representative of drawing that explains a programmable bi-directional logic circuit.

1. BACKGROUND OF THE INVENTION

[Field of the Invention]

Today's computer is lacking the function that abstracts information from real world. There is a world of information in a human society where human being originated communication by words and many of the information are the symbol that the human being defined. Such function that he human being recognizes the information is acquired through learning. The learnable function is necessary for an intelligent machine.

The medium of programmable nonvolatile memory is achieved by means of Floating Gate Metal Oxide Semiconductor Field Effect Transistor FG-MOSDFET. The FG-MOSFET is used not only as flash memory, but it is also used in the field of programmable logic device i.e. PLD, PAL, FPGA.

Although PLD implements logic circuits, traditional PLD is used in a digital computing system. The digital computing system possesses a segmentation of operation and each object of recognition possesses a segmentation of its. In some cases, the segmentation of the object is not easy to find. So, every possible combination of segmentation must be referred in a cognitive process. Since the segmentation of serial operation is removed in a parallel and distributed system, a network of circuits is able to achieve the difficulty.

An action of decision-making is ignited by means of a decoder where many input lines are connected to one output line and the command line for execution line is connected to many output lines where the meaning of activity depends on each circuit of the system. Since a passive junction is able to function as a logically bi-directional reaction, the passive junction of many input lines to one output line functions as the junction of one input line to many output lines. Now, we can use FG-MOSFET as a controllable passive junction, because the drain and the source in a FG-MOSFET are exchangeable symmetry. By changing the circuit for input side and the circuit for output side, we can get bi-directional logic circuit through the passive junctions.

[Related Art Statement]

An implementation of circuit is carried out by an activity. Technologies of dynamic MOS network and technologies of PLD are utilized for the activity transfer system. The activity transfer circuit can be termed as the electric charge transfer circuit where existence of the functioning is represented by the existence of electric charge A circuit manipulates not only static states, but also it manipulates the activity that is a change of the state. The translation is represented by means of a logic circuit or a logical statement such as a sum-of-product expressed in Boolean algebra.

The design technology of "state machine" in VLSI is available for the activity transfer circuit. An activity is expressed by an if-then-rule, i.e. if preconditions are satisfied, then it operates the function. Here, the change of a digital state is expressed as an impulse. Since each impulse is transferred intermittently, it is able to connect individually in a dynamic MOS circuit. Although the impulse driven VLSI system is able to realize by using existing technologies, there are differences between digital circuit and impulse circuit. The impulse driven system is dynamic and it does not deal with

stored data. We can term the system that transfers discrete activities as “impulse driven device” in order to distinguish from traditional digital circuits.

The bi-directional logic circuit is designed by means of the paradigm of impulse activity. The intermittent activities make possible to manipulate the time–shared operations. The trace of transmission of activities is memorized as connecting points of junctions. The fundamental junction that connects from many input lines to one output line or from one input line to many output lines is realized by using FG-MOSFET. The programmable and controllable passive connection of a FG-MOSFET between the drain and the source are exchangeable symmetry.

Transmission gates are able to exchange the signal source of input and the load of output. A combination of the circuit that transfers from many input lines to one output line and the circuit that transfers from one input line to many outputs lines are able to organize activities and the network of these circuits memorizes those activities. The bi-directional logic circuit is available not only for circuits in an interpreter but also for most of intelligent circuits.

2. SUMMARY OF THE INVENTION

The invention of bi-directional logic circuit is concerned with the operation of dynamic MOS IC. That is, a decoder transfers some amount of electric charge from many to one, and an encoder transfers some amount of electric charge from one to many. The connecting points of the junction are the same but the flow of electric charge is opposite direction.

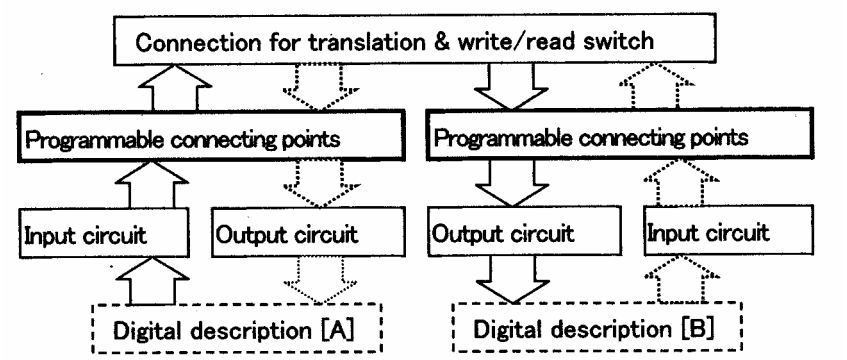

Fig. 2 A block diagram of a programmable bi-directional logic circuit

Fig.1 shows a MOS circuit diagram of a programmable bi-directional logic circuit. A floating gate MOSFET (FG-MOSFET) operates as a programmable and controllable connection. There are programmable connections for a decoder in left side and those for an encoder in right side. By preparing the entrance and exit for both sides as shown in Fig.2, the direction of flow on the signal can be changed by switches made of transfer gate, because the function of these programmable connecting points is passive.

A FG-MOSFET disconnects between source and drain by means of injection of channel hot electron. The tunneling of electrons from the drain to the floating gate takes place by the channel hot electron mechanism owing to the electric field in the transistor channel between source and drain. The electron energy distribution presents a tail in the higher energy side that can be modulated by the longitudinal electric field of top gate. This operation needs some amount of current. On the other hand, the electron in a floating gate is ejected by Fowler-Neordheim tunneling effect through the oxide from floating gate to silicon surface. A strong electric field induces a quantum-mechanical phenomenon of tunneling without destroying its dielectric properties. The current of ejection is very little compared with injection.

In order to construct the decoder automatically, a floating gate transistor is used as pull-down transistors. If one of pull-down transistor connects the output to low level (L) directly without internal resistance, the output becomes the low level (L). This NOR operation is achieved by the internal resistance of high level (H) of electric source. In a NOR type of decoder, every line with a low level of gate voltage at writing remains as a connectable state and this connectable transistor cuts the current between source and drain at the low level of gate voltage.

A bi-directional logic circuit is formed as a NOR type of decoder. The connections of NOR type of decoder are formed by the flows from each signal source. If the terminals of signal sources are switched from many to one, the circuit operates OR function. So, the encoder that translates from one line into many lines can be formed as a NOR type of decoder.

Fig.3 and Fig.4 show responses on a programmed MOS decoder possessed of encoder shown in Fig.2. These data are obtained by using a simulator PSpice. Fig.3 shows existence of a delay time and a spike at the end of switching. Those are caused by a storage effect of capacitance. The problem is achieved by using impulsive signal and decrease of the capacitance.

One of the methods to remove the spike is control of the timing of operation. Fig.4 is a characteristic diagram showing the response (B) those operating conditions are shown in Fig.2.

The practical design of a dynamic MOS IC needs data on device manufactured, for those data are depends on the process of manufacture. Since the bi-directional logic circuit consists of traditional elements made of semiconductor, there are many techniques in the field of dynamic MOS IC. Any technologies in the field of VLSI are available for the bi-directional logic circuit.

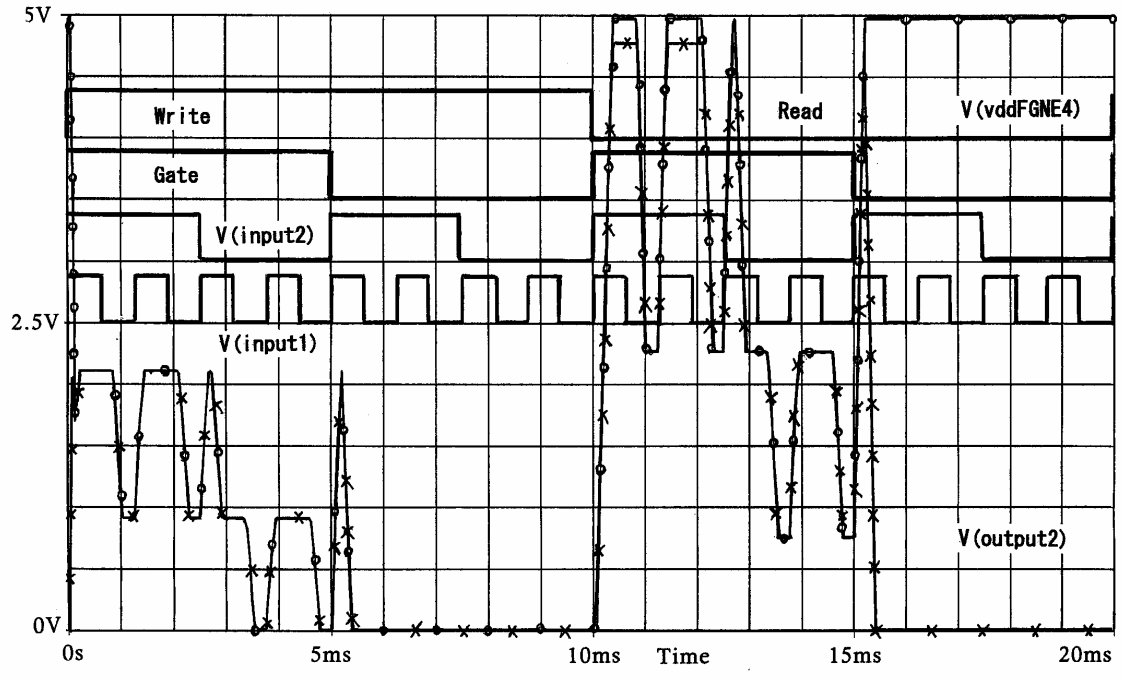

Fig. 3 Responses (A) on a programmed decoder possessed of encoder shown in Fig. 2

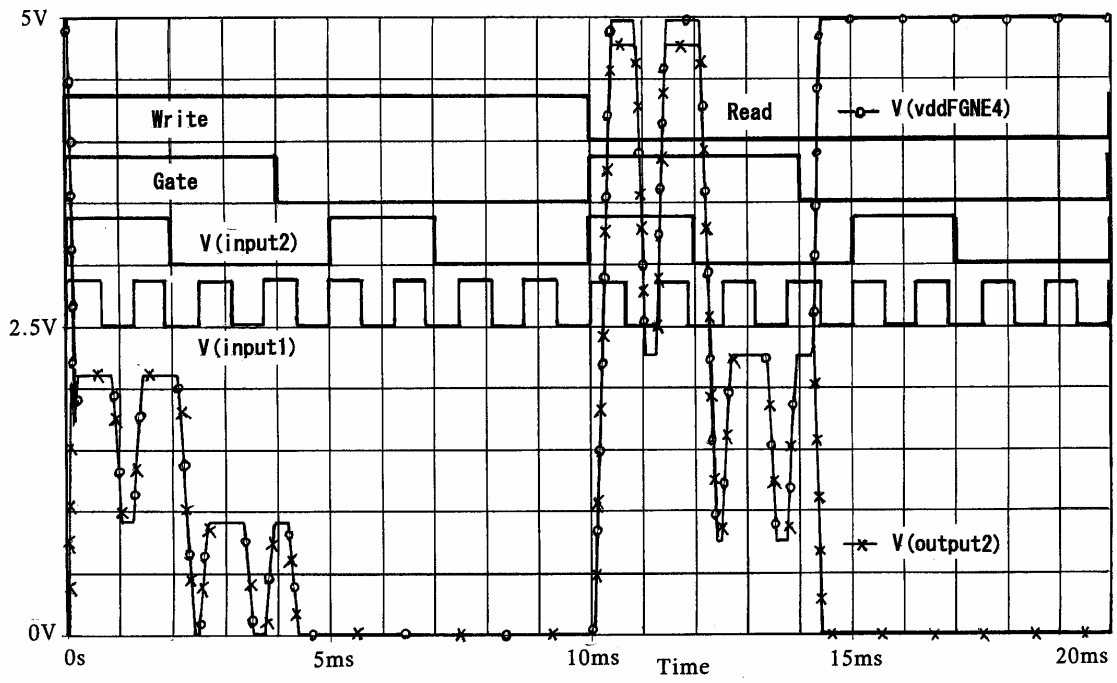

Fig. 4 Responses (B) on a programmed decoder possessed of encoder shown in Fig. 2.

The applications of bi-directional logic circuits are as follows. Fig.5 shows a block

diagram of a network of layered bi-directional logic circuits for linguistic activities

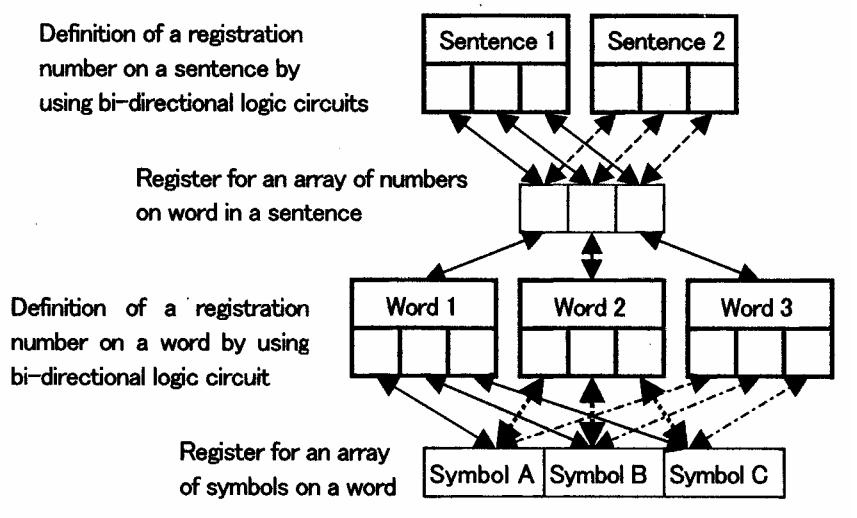

Fig. 5 A network of layered bi-directional logic circuits for linguistic activities

Fig.6 is a bi-directional translator between different languages. A translation of between different languages is carried out by expressions by the different languages on the same affair.

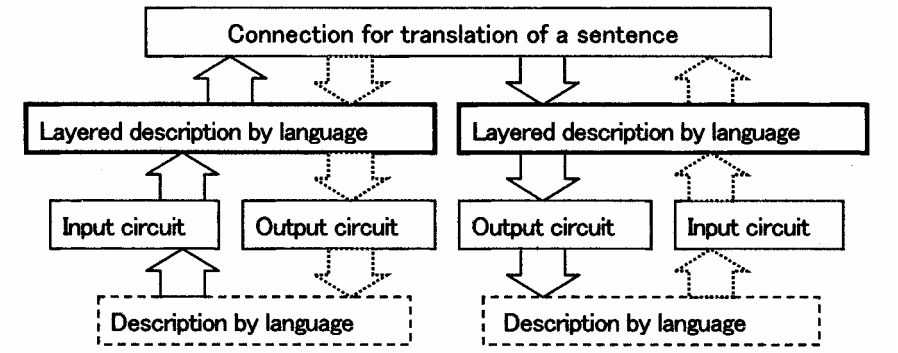

Fig. 6 A block diagram of a programmable bi-directional translator

As shown in F1g.7, programmable bi-directional circuit possessed of normalization on each visual pattern is available for a bi-directional translator between visual pattern and linguistic expression.

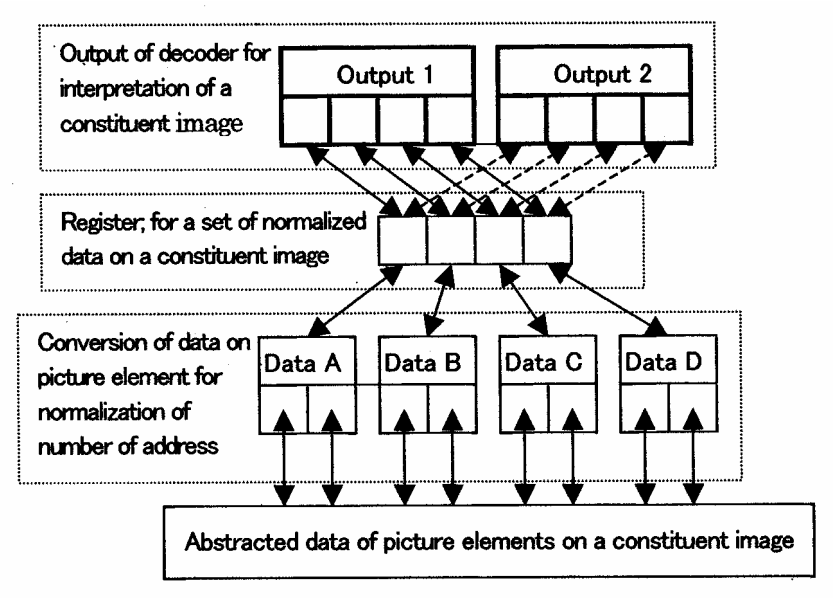

Fig.7 A block diagram of pattern recognition by means of programmable bi-directional circuits

3. BRIEF DESCRIPTION OF THE DRAWINGS

For a better understanding of the invention, the summary of invention includes 7 drawings.

Fig.1 is a block diagram of a programmable bi-directional circuit

Fig.2 is a MOS circuit diagram for a programmable decoder possessed of encoder.

Fig.3 is a characteristic diagram showing the response (A) where storage effect of capacitance exist on the MOS decoder possessed of encoder shown in Fig.2

Fig.4 is a characteristic diagram showing the response (B) where operating conditions are shown in Fig.2

Fig.5 is a block diagram of a network of layered bi-directional logic circuits for linguistic activities

Fig.6 is a block diagram of a programmable bi-directional interpreter

Fig.7 is a block diagram of pattern recognition system by means of programmable bi-directional circuit.

4. DESCRIPTION OF THE PREFERRED ENDOBIMENT

The invention of bi-directional logic circuit is the solution that materializes intelligence in the form of the electron circuit. The bi-directional logic circuit deals with transference of some amount of electric charge as the transference of unit of activity. The transference of electric charge is manipulated by means of dynamic MOS IC. A floating gate MOSFET is used as a programmable and controllable connecting element. The floating gate MOSFET has been used in the field of programmable logic device. The circuit can be embodied by means of computer simulator used in

the field of VLSI. Although the experimental production research is necessary to the mass production, today's technology on semiconductor electronics is possible to manufacture a VLSI composed of bi-directional logic circuit in a practical level. This VLSI possesses the usage such as, media of linguistic expression, language transformation circuit, information compression, and translation device into linguistic expression.

5. EXAMPLE

(A) An example on programmable bi-directional logic circuit for practical linguistic use

A VLSI possessed of bi-directional connecting points is able to use as a medium of linguistic activities. VLSI that translates between the information of letters on a word and a registered number of the word can be used as a medium of words. There are 50～60 kinds of phonetic signs. 64 phonetic signs are possible with 6 bits. If one letter is expressed with 8 bits and a word is expressed with 16 letters tentatively, a word is distinguished by means of 8×16=128 bits data. And 128 bits of data distinguish 8,192 kinds of words. Then, the number of connecting points will be points 128× 8,192 =1,048,576 for the letter data side and 13×8,192=106,496 for registered number side. The VLSI possessed of these connecting points is able to use as the medium of words.

The VLSI that translates between a subset of registered numbers on word and a registered number of the sentence can be used as a medium of the sentence level of linguistic activities. If one sentence is expressed with the data of 13 bits and a sentence is expressed with 19 words tentatively, a sentence is distinguished by means of 13×19=247 bits data. If 247 bits of data distinguish 8,192 kinds of words, the number of connecting points will be points 247×8,192 =2,023,424 for the word data side and 13×8,192=106,496 for registered number side. The 13 bits of registered number on each sentence is implemented as a decoder and those connecting points are used as an encoder. The VLSI possessed of these connecting points is able to use as the medium of sentences.

Here, the standard as a medium of practical language activities is shown in Table 1.

Table 1 An example on programmable bi-directional connections for practical linguistic use

	Inputs	Items	Matrix points on inputs	Outputs	Matrix points on outputs
Word	8bit × 16 letters	8,192	1,048,576	13bit	106,496
Sentence	13bit × 19 words	8,192	2,023,424	13bit	106,496

(B) An example on programmable bi-directional logic circuit for a vision

The pattern of connecting points between a decoder and distributing lines coincides with the

pattern of target. Since the wiring between a register and paralleling decoders is fixed by means of the connections, the data on every target must be adjusted to the data bus. If we assume the number of data bus is 256 lines for a picture of length for 16 segments and side for 16 segments, and 24 of bits is used for the information of each picture element, 256×24=6,144 bits are necessary for each pattern. Here, the value of 24 bits is 8 bits for each 3 primary colors. The total number of connections for 1,000 pieces of templates will be 6,1444,000.

The template matching accompanying with the normalization of the number of data bus accompanied with the translation of data on each picture element. The calculation of the translation uses the address data on a target, such as the center, maximum point, and minimum point. A target of visual recognition is a pattern divided by means of its characteristics such as color. The original visual data on a target are translated automatically from by fixed calculations accompanying with the normalization. The decoder that is mode of programmable bi-directional connecting points is able to produces output instantaneously at the data matching..

6. CLAIMS

[Claim 1](Element of bi-directional logic circuit)

The programmable connection that is made of the floating gate MOSFET of which drain and source are exchangeable symmetry is used for bi-directional logic circuit that transmits some amount of electric charges from drain to source. The programmable and controllable connection is carried out by an ejection of electrons from the floating gate of the MOSFET. By switching from input line to output line and from output line to input line, the electric charges are able to transmit reverse direction. The meaning of transference of electric charge by means of an intermittent current depends on the elements connected to those terminals. A logical relationship is represented by the connections from input to output. A bi-directional logic circuit is designed by using the charge transfer circuits as an element.

[Claim 2](Bi-directional decoder or bi-directional encoder)

By using the same plural connecting points of programmable bi-directional connections, the bi-directional decoder is changed to the encoder by the following switching. The output terminals of encoder are switched to the input terminals of bi-directional decoder and the input terminal of encoder is switched to the output terminal of bi-directional decoder. AND logic function of the bi-directional decoder is conducted by means of internal resistances inserted at the H level of the signal sources, where L level of the signal sources are connected to the ground directly. OR logic function of bi-directional encoder is conducted by means of high impedance of load resistances.

[Claim 3](Bi-directional digital signal translator)

A bi-directional digital signal translator is composed of a pair of bi-directional decoders. That is, one bi-directional decoder is implemented by using inputting digital signal and another bi-directional decoder is implemented by using outputting digital signal on the same item and the connection of these outputs forms a bi-directional digital signal translator.

The bi-directional translator exchanges two kinds of expressions mutually. It is able to translate between an array of characters on a word and a registered number of the word. Also it is able to use to translate between an array of registered number of words of a sentence and registered number of the sentence.

[Claim 4] (Layered structure of bi-directional translator)

A serial activity is able to load to a register according to the occurrences systematically where the timing of shift is given by the signal of segmentation. The register possessed of bi-directional logic circuits is available to manipulate subsets of activities. There are plural layers in linguistic activities, as an example. Those are the layer between an array of characters on a word and a registered number of the word, and the layer between an array of registered number of words of a sentence and registered number of the sentence. The layered registers with bi-directional logic circuits are able to manipulate the subsets of layered structure of activities.

[Claim 5] (Bi-directional translator between different languages)

A translation of between different languages is carried out by expressions by the different languages on the same affair. Since one sentence is expressed by means of a serial series of symbols such as alphabets by using a layer structure of registers possessed of bi-directional logic circuits, linkages of the two kind of layered structure of bi-directional translator is able to construct a translator of language.

[Claim 6] (Bi-directional translator possessed of normalization on each visual pattern)

Flowing normalization helps the visual pattern recognition, because there are a great number of things and affairs in a view field. A target of visual recognition is a pattern divided by means of its characteristics such as color, and it is recognized by means of a bi-directional decoder. The pattern of connecting points between distributing lines and a decoder coincides with the pattern of target. Since the wiring between the register and paralleling decoders is fixed, the data of picture elements on every divided pattern must be adjusted to the data bus for templates matching by using address data on a target, such as the center, maximum point, and minimum point. The original visual data on a target are translated automatically from by fixed calculations accompanying with the normalization.

[Claim 7](Bi-directional translators between visual pattern and linguistic expression)

The translation from visual pattern into linguistic expression is achieved by means of the bi-directional translator where the output of bi-directional decoder on linguistic expression and the output of bi-directional decoders on a visual pattern are connected. In the case that components of the activity are organized, a decoder for vision or a decoder for linguistic expression becomes a layered structure.