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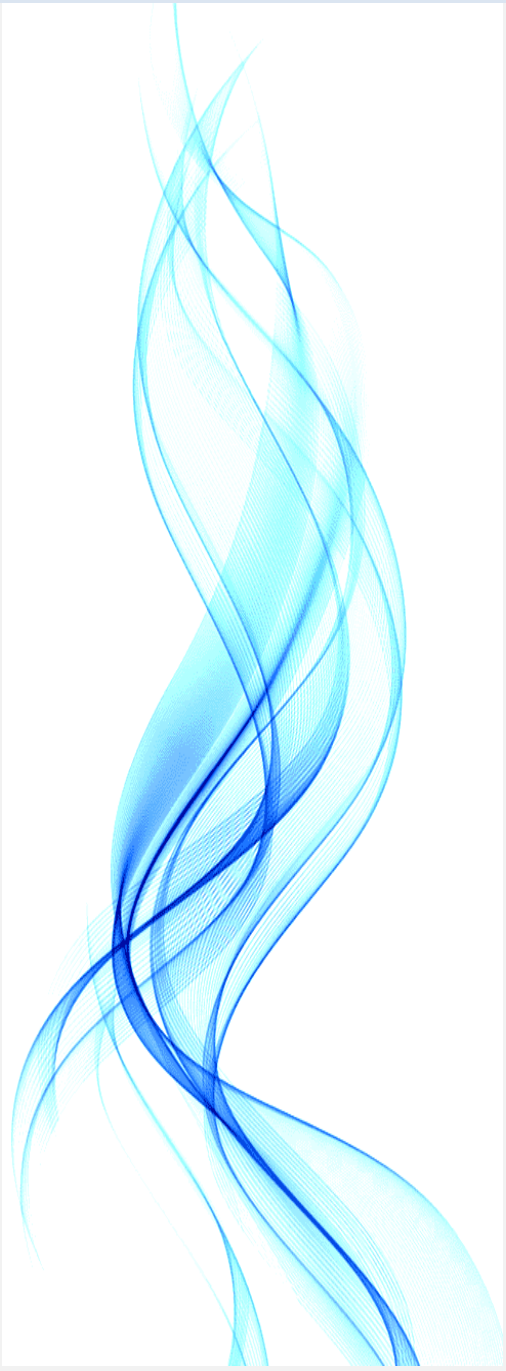

Violation of Layout Design of Semiconductor Integrated Circuits and defence of Reverse Engineering.

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Introduction:-

Reverse engineering is the process of extracting know-how or knowledge from a human made artefact by disassembling and analysing it to discern of what and how it was made. Reverse engineering is lawful process so long as it is used to acquire the trade secret of a known product and to produce an original product by way of forward engineering. It involves making prototypes, experimenting with them, retooling manufacturing facilities, and reiteration of the design and development process until it yields a satisfactory product.

In Integrated Circuit (IC) industry, several practices are considered "fair play" and it is important to differentiate legitimate and illegitimate practices. There can be different practices like copying, study or second sourcing. Copying is prohibited as one simply makes copy of competitor's IC without analysis of the workings of the IC. Legally, one can study competitor's IC for the purpose of teaching, or analyzing the IC (i.e. "study") or makes a chip from the study of a competitor's IC which will perform the same function (i.e. "Second Sourcing"). Second sourcing is currently accepted by the IC industry. The second sourcer creates a paper trail behind him which may be a good evidence of his additional work beyond the copying stage.

Semiconductor technology:-

Semiconductors are commonly known as “chips” or “micro-chips” and needed for data processing (in PCs, laptops, servers etc.), communication devices, electronics goods and other digital devices. Semiconductor materials, like silicon, can change their electrical status and conduct electricity only under certain conditions. They are placed between insulators and conductors. They are good media for the control of electrical current and allow semiconductor devices to switch, amplify and convert electrical current.

Semiconductor technology involves design of integrated circuits, manufacturing and its copying. The ICs are constructed from circuit elements such as resistors, transistors and capacitors. Each of these elements is formed from layers of different semiconductor materials. The resulting elements are interconnected in accordance with the design by the holes and channels in each layer of the IC. It is the combination of layers that makes every design unique and their shape determine circuit's Characteristics. As the designer completes baking a layer, he places it on top of the last layer, takes out the electronic equivalent of a hammer and chisel, and digs channels and holes through the newest layer at carefully selected locations. This procedure is performed on each successive layer until the desired circuit is formed. The electrical interplay of the semiconductor materials along the channels and holes causes the circuit to function. The characteristics of the circuit can be changed by altering either the "flavor" of the semiconductor material used in a given layer, or by altering the shape and number of channels cut into a given layer. The IC begins with

a base layer usually made of silicon. Upon this substrate layer, the designer deposits the primary layer. A mask which contains the designer's layout for holes and channels in the first deposited layer is placed over the substrate layer. The designer then etches the first layer so that it contains a pattern of holes and channels corresponding to the pattern on the mask. Next, he deposits a second layer, uses another mask to etch another pattern, and deposits a third layer. This process continues until the designer has constructed all the layers of each element. As a result of this process, the pattern contained on each mask is the key to the design of the IC. Once the patterns are designed, the IC is very inexpensive to produce. The first step is to acquire the chip and takes a picture of the surface layer. Next step is to remove the surface layer and takes a picture of the next layer. This process continues until the copyist has a photograph of each layer. Those photographs allow him to make the necessary masks to copy the IC.

Method of reverse engineering:-

Reverse engineering of semi-conductor based products can broadly take several forms like Product teardowns, System level analysis, Circuit extraction or Process analysis. In product teardowns, unit is dissembled, the board and sub-assemblies are photographed and the components are inventoried to identify internal boards and components. System analysis can be done by way of either reverse engineering or functional analysis to analyse operations, signal paths and interconnections of Electronic system. In Process analysis, the structure and materials are examined to see how it is manufactured and what it is made of.

Circuit extraction:

Circuit extraction of semiconductor chips has become more difficult as the computing power has grown exponentially and the size of chips is gradually falling down. In earlier days, IC may have had one layer of metal and used 1-2 um technology. The complexity of devices has followed moore's[1] law and nowadays devices have up to 12 layers of metal and use an esoteric combination of materials to create both the conductors and dielectrics. There may have hundreds of millions of logic gates, plus huge analog, RF, memory and other macrocell areas. MEMs, inductors and other devices are also being integrated on chip and circuits are to be extracted from 65 –nm chips. The circuit extraction process involves Package removal ("Device Depot"), Delayering, Imaging, Annotation, Schematic read back and Analysis.

[1] ***Moore's law***: In 1965, Moore, had predicted that the number of transistors on a single chip would double every 12 months – which he later revised to every 24 months – quickly became a reality, and is known to this day as Moore's law.

Legal position of Reverse engineering:-

Under Law, the protection is given to the layout-design itself or to the final product in which it is finally assembled. Article 2(ii) of the IPIC Treaty & Section 6 Article 35 of TRIPS Agreement has defined 'layout design' as "three-dimensional disposition, however expressed, of the elements, at least one of which is an active element, and of some or all of the interconnections of an integrated circuit, or such a three-dimensional disposition prepared for an integrated circuit intended for manufacture." This definition has also been adopted by India by inserting an explanation to Section 17 of the Semiconductor Integrated Circuits Layout-Design Act, 2000. which states that right conferred by registration of a layout-design shall be available to the registered proprietor irrespective of the fact whether the layout-design is incorporated in an article or not. On the contrary in USA, a mask work is not eligible for protection unless and until it is fixed in a semiconductor chip product. A mask work is 'fixed' according to section 901(a)(3) of the SCPA, in a semiconductor chip product "when its embodiment in the product is sufficiently permanent or stable to permit the mask work to be perceived or reproduced from the product for a period more than transitory duration."

The registered-proprietor has the exclusive right to reproduce by any means the registered layout-design or any substantial portion of it. Any person who unauthorizedly makes, imports, or distributes in violation of the exclusive rights of the mask work owner is guilty of infringement. However, there is one exception to this exclusive right that any person may reproduce the layout-design for the purposes of scientific evaluation, analysis, research or teaching. A two-prong test determines whether the reverse engineering exception applies: (1) the work must not be substantially similar to the original chip, and (2) the competing work must be accompanied by a record of investment and toil by the reverse engineer.

The issues of "***substantial similarity***" and "***paper trail***" are dealt with in judgment of Federal Circuit "***Brooktree Corporation v. Advanced Micro Devices, Inc 977 F.2d 1555.***". In this case, it was held that there is no hard and fast rule or percentage that governs what constitutes "substantial similarity." It was further held that Substantial similarity may exist where an important part of the mask work is copied, even though the percentage of the entire chip which is copied may be relatively small. Mask work owners are protected not only from wholesale copying but also against piecemeal copying of substantial or material portions of one or more mask works.

There is always a gray area to determine whether a chip layout was born of legitimate reverse engineering or of copying and this require resolution on case-by-case basis. Evidence of the presence or absence of such a paper trail would significantly reduce the gray area between legitimate and illegitimate behaviour. Reverse engineering generally produces a "paper trail" recording the engineer's efforts to understand the original chip and to design a different version after reverse engineering. There is

always a possibility of overlapping of legitimate and illegitimate behaviour which can be withered away with the help of paper trail work. Whether there is a true case of reverse engineering or simply a job of copying; the same may be proved with the help of paper trail work of the second firm. The paper trail work may help to understand that the second firm have prepared a great deal of paper--logic and circuit diagrams, trial layouts and computer simulations of the chip. On the reverse engineering defense, great weight is generally placed on the paper trail. In "***Brooktree Corporation v. Advanced Micro Devices, Inc.***", it was held that the paper trail is evidence of independent effort, but it is not conclusive or incontrovertible proof of either originality or the absence of copying.

The reverse engineering defense of "copying groupings of transistors and interconnection lines" was dealt with in judgment of Court for the Nineth Circuit in "***Altera Corporation* vs. *Clear Logic, Incorporated 424 F.3d 1079***" on the ground that the placement of the groupings is a system or an idea and is not entitled to protection under the SCPA. This was rejected and it was held that the boundaries and organization of these groupings are more than conceptual and physically a part of the mask work. The mask work is structured according to the groupings. These groupings physically dictate where certain functions will occur on a chip and describe the interaction of parts of the chip.

Conclusion:-

The reverse engineering exception is useful to IC industry since it attempts to protect from outright piracy and helps in creating a genuinely improved product which promotes competition and innovation. However, there is always a gray area between the legitimate and illegitimate efforts as reverse engineering exception also creates a potential for fraudulent/ lengthy documentation ("paper trail work") to validate the illegal copying of the original product.

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