be aware that if that line is crossed he could become involved in an offence. In such circumstances particular care should be taken to ensure that it is entirely the client's decision to proceed in a particular manner with the client's proposal. It is no part of the adviser's role as such to incite or encourage the client to carry out or implement the proposal in a particualr way or at all.

3. The adviser ought to be conscious of making a full, frank and honest disclosure to the client of all relevant matters including the risks inherent in the client proceeding. That advice can of course encompass the risk involved in departing from the course advised upon by the adviser.

4. As an adviser it is imperative that you do not turn a blind eye to any matters relevant to the advice. The issues raised must be confronted openly, directly and properly. The reason for the line being drawn in the manner I have set out above is the independence of the professional adviser from the participant. That must be maintained.

17. Conclusion

To many of you here this may sound like a plea that the burden of a practising certificate in today's economic and legal climate is too much to bear. That is not so. The issues I have endeavoured to raise are important and cannot be ignored when one has regard to the increasing commercial role of the legal profession in business matters as well as the increasing Government role in regulating business in a manner that raises the kind of problems I have endeavoured to address today. The raising of these issues and problems were inevitable.They clearly throw out a challenge to the profession but that is a challenge that can be firmly and soundly met by the two qualities that the profession has enjoyed and can be proud of, that is its independence and its high and clearly established ethical standards. Finally if the unfortunate day arrives and the adviser becomes the client I can speak both as Counsel and adviser in saying remember a lawyer who has himself as a client has a fool as a client. Thank You.

Protection of Intellectual Property in Integrated Circuit

Lindsey Naylor
(for on behalf of The Intellectual Property Committee of the Business Law Section)

1. Historical Development

1.1 The Printed Circuit

The first electronic equipment was manufactured using discrete components mounted on an insulating material and connected together with solid copper wires (busbars) of roughly square cross section and about 3/32" across each face. The discrete components and the busbar were massive by comparison with modern standards and even a simple wireless receiver was a large and imposing piece of equipment.

Later, towards the middle of the 1920s, to facilitate commercial production, and to reduce interaction between components and to shield the equipment from stray fields, a metal chassis, in the form of a metal, open sided box came into use with larger components mounted on one side, smaller components mounted within the box and all components connected together within the box by flexible, often multi-stranded wire. This is the familiar "wireless chassis". However, even at this time attempts were being made to reduce the manual labour involved in inter-connecting discrete components. As early as the 1920s, in Germany, one manufacturer produced an "integrated circuit" consisting of several valves, with components, in the one evaluated glass envelope, so that this early integrated circuit could be used to minimise the number of discrete components and valves in a wireless receiver of that time. Later, integrated circuits were produced which consisted of all the components required to couple two valves together in, for example, amplifying stages, in one package which required a limited number of connections to other circuitry.

Thus, the development of "integrated circuits" as a package of interconnected components which could be used to replace discrete components has been an objective of the electronic industry for very many years.

The direct ancestor of the modern integrated circuit is the printed circuit board. Manual wiring together of discrete components is a laborious and tedious operation, very prone to errors on the part of those who carry out the operation. If ony a few items of equipment are needed, then they must be wired by persons with the necessary skill and experience to read circuit diagrams and translate a circuit diagram into a logical way of connecting discrete components, taking into account the necessity to physically space certain wires, to twist together other wires and generally to have regard to the function which the complete piece of equipment is to perform. On the other hand, to prepare an item of electronic equipment for manual wiring in mass production by unskilled workers is also a long, tedious time and cost consuming operation, which also involved the employment of skilled technicians to test the completed equipment to the rectify the inevitable wiring faults.

Thus, when a technique was devised for the manufacture of printed circuit boards, this was eagerly adopted by the industry. An example of the design of a printed circuit board is shown in Fig 1.

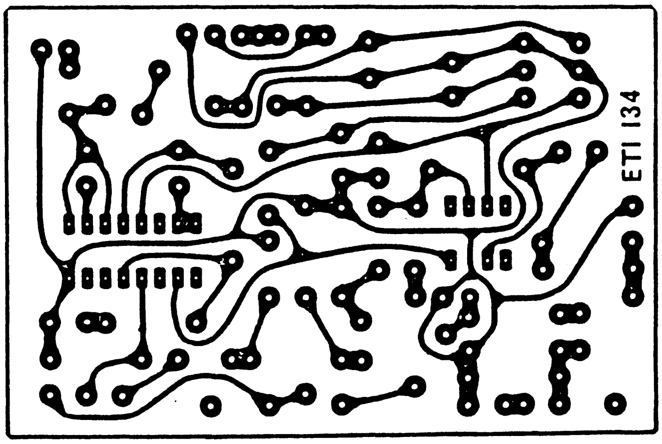


Fig 1 Design for printed circuit

This is a very simple example of a modern printed circuit board intended for use with discrete components, including transistors and integrated circuits although, of course, when printed circuit boards first came into use, they were designed for use with valves and valve sockets which were mounted on the boards. There are several methods of manufacture: If only a few printed circuit boards are required, then the design of the printed circuit board is drawn on or transferred photographically to the surface of a very thin copper sheet, firmly bonded to a sheet of insulating material. The copper is only a few thousandths of an inch in thickness whilst the insulating material can be of any thickness, but is often of the order of 1/16″.

When the pattern has been transferred to the surface of the board, then the board is immersed in a chemical solution which removes the copper in those areas in which it is not protected by the board pattern. Holes are then drilled in the board to receive the discrete components to be mounted on the board and the board is then wired manually. Thus, a printed circuit board made to the design shown in Fig 1 would reproduce this design, the black sections representing the copper remaining after processing.

In commercial production other means are adopted for printing the pattern on the copper sheet and, indeed, often the reverse side of the board is printed with details indentifying the components to be mounted on the board, as in Fig. 2, thus minimising wiring errors.

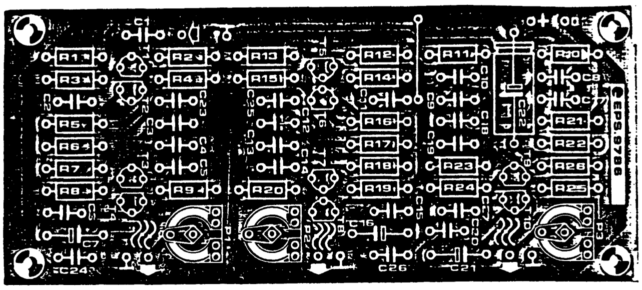


Fig 2 Printed circuit board – component side

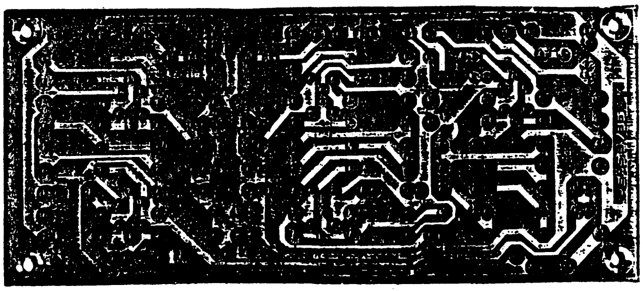


Fig. 2 Printed circuit board — copper side

However, there are now techniques which permit the automatic insertion of components by machines which work quite automatically at a high speed, selecting components, bending wires and inserting components with a high degree of accuracy, under computer control, with the facility of rapid programme change to accommodate different boards.

To use printed circuits is, of course, only to use a diffferent technique for connecting discrete components together. The printed circuit board itself seldom plays an active role in the operation of the equipment, merely serving as a mounting surface for components, the copper patterns replacing the wires which were formerly used. Sometimes, however, the active properties of the copper sheet on the board can be utilised, particularly if double sided boards are used in which copper sheets are bonded to both sides of the insulating material and, hence, a capacitor can be formed between the two sheets if necessary, the insulating material forming the dielectric.

1.2 Intellectual Property Rights in the Printed Circuit

Because the printed circuit is an important milestone in the development of the modern integrated circuit, it is relevant to consider the protection of intellectual property rights in a device constructed using a printed circuit board.

The most obvious intellectual property right would be patents which are obtained with respect to the circuitry employed in the device itself. Patents concerning circuitry are, of course, independent of the manner in which the circuit is constructed, so that if a patentable invention is made concerning a new and novel circuit to achieve some useful result it does not matter whether the actual circuit is constructed using discrete components wired together with busbars or by some other means, or mounted on a printed circuit board or embedded in an integrated circuit. Thus, the question of patent rights as to the circuitry itself is independent of the practical embodiment of the circuit. It follows that unless a printed circuit board is manufactured by some patentable process (which could, of course, cover some patented method of inserting components or electrically connecting components to the copper pattern when inserted or mounted) then the only intellectual property rights in the printed circuit board itself would lie in the field of copyright or design. If it is assumed that the author is a qualified person and the works are "original works" then copyright would subsist in the drawings and transparencies prepared to enable the printed circuit board to be manufactured and, in the actual pattern of the board, which would reproduce, and could be seen to reproduce, these patterns as artistic works. Although the design is one which is dictated entirely by function, it is nevertheless registerable under the Designs Act 1906 and accordingly, if the design were to be applied industrially, without registration under the Designs Act 1906, then the copyright would be lost, and any third party would then be able to manufacture duplicate printed circuit boards.

It also follows that unless the actual circuitry was covered by a patent, no intellectual property right would be infringed by a person who made up the circuit using discrete components and wired these together or by a person who designed a new printed circuit board which did not reproduce the pattern on the old circuit board. Very little "reverse engineering" would be needed, of course, as the boards are of sufficient size to enable the circuit to be easily followed.

2. Analogue Integrated Circuits

2.1 Composition of Integrated Circuits

It is always essential when considering integrated circuits to keep in mind that integrated circuits consist of the normal circuit components; passive components such as resistors, capacitors and inductors and active components such as transistors of various types and diodes of various types. Thus, an integrated circuit is merely a means of constructing and linking together components which have characteristics similar to those of their discrete counterparts in some form which lends itself to miniaturisation and to some convenient manufacturing method.

Further, it must be remembered that there is no specific form of an "integrated circuit". Some common forms of construction are the monolithic circuit, in which the circuit is constructed on one side of a silicon chip (although it must not be assumed that silicon will be the only material used); thin film integrated circuits which are constructed on a flat insulating surface upon which layers of materials are deposited by vacuum spluttering or some other means so as to produce insulating, conducting or resistive films which can then be worked upon to produce passive circuit elements and interconnections as well as connecting points for active elements; hybrid circuits, which combine elements of thin film circuits and monolithic type circuits and thick film hybrids.

With the direction of development tending towards VLSI, techniques (Very Large Scale Integration) which may contain from one to ten million active devices, it is plain that any attempted specific description of "an" integrated circuit will be of limited temporal validity.

2.2 Development

Analogue Integrated Circuits are closely related to printed circuit boards and can be characterised in very general terms as integrated circuits which do not store or retain information, but in most of which an input signal is processed in some way to give an output signal which is proportional in amplitude or frequency to the input signal or is controlled by some other means. This is not a very good definition, as it is not universal and a better but less useful definition would be to define an analogue circuit as any integrated circuit which is not a digital integrated circuit. A typical example of an Analogue Integrated Circuit is an audio amplifier.

Fig 3 shows the internal circuit diagram of a typical Integrated Circuit, audio power amplifier and Fig 4 shows the manner in which such an amplifier would be connected to form part of, say, a wireless receiver. There are two important facts which require emphasis here. There is no technical reason why the circuitry shown in Fig 3 should not be duplicated using discrete components, mounted on a printed circuit board or even discrete components, wired up in accordance with the circuit diagram and there is no reason why, if the circuitry was of a new or novel form and is otherwise patentable, it should not form the subject of a patent, which would cover not only its embodiment in the Integrated Circuit, but also its embodiment in equipment manfactured using discrete components. Further, is should be noted that not all the components required for practical use of the integrated circuit in this particular case are embodied in the integrated circuit — external components need to be added so that it would be common for this integrated circuit to be mounted on a printed circuit board.

As a practical matter, economic considerations would make it extremely unlikely that any commercial manufacturer would attempt to duplicate or copy an integrated circuit using discrete components (except, of course, for experimental purposes).

One of the great advantages of integrated circuits is that active components, such as transistors, can be formed as part of the integrated circuit at minimal cost, so that integraged circuits employ active devices in a manner which could be prohibitively expensive for a designer of circuitry using discrete components. Conversely, passive components such as resistors and capacitors are more expensive to form in integrated circuits, but cheaper than transistors as discrete components, so that a designer of discrete circuits would tend to favour a design which incorporated passive rather than active devices, whenever possible. Most manufacturers of analogue integrated circuits publish the details of the internal circuitry of their integrated circuits as often this is of importance to potential users.

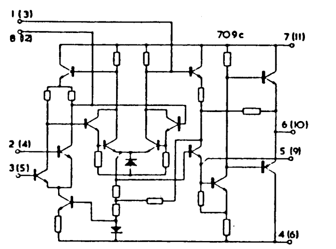


Fig 3 Typical circuit diagrams

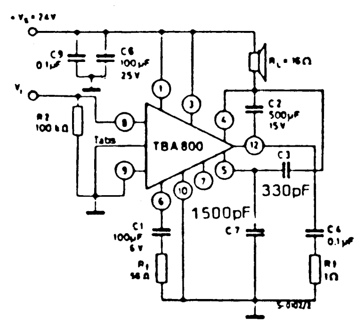


Fig 4 Compared with the other circuits, this configuration entails a smaller number of external components and can be used at low supply voltages.

2.3 Manufacture

Because of their nature, analogue integrated circuits can and often are first made up using discrete components and prototype printed circuit boards. It is only after these prototypes have been developed to the stage at which they exhibit the desired characteristics that such circuitry, or such part as is appropriate, is translated into the form of an Integrated Circuit.

The basis of monolithic integrated circuits is a thin wafer of silicon, the so-called "silicon chip". To form silicon transistors it is necessary for the pure silicon to be contaminated (doped) with other substances in order to suitably modify its electrical characteristics and some part of the technology of manufacturing integrated circuits consists of selective "doping" of specific areas of the silicon chip in order to bring this about.

When Integrated Circuits were first manufactured in commercial quantities, the manufacturing technique used was relatively simple compared to those now in use. Pure silicon was formed into a bar about 1″ in diameter and several feet in length by a drawing process from the molten material. This bar was then cut into wafers about 10 mils thick and these wafers were highly polished to remove any surface imperfections. The next process was to form a single crystal structure on the surface of the wafer which is "doped" with an impurity to give the required electrical activity and then passed through a furnace with an appropriate atmosphere to form a thin film of inert silicon oxide on the surface. The "doped" crystal structure forms the basis of the integrated circuit and the actual integrated circuit is then formed by inducing a series of photographic and chemical reactions in this structure, each time protecting the work done by forming an additional layer of silicon oxide.

First, the desired circuitry is transferred to a series of masks similar to photographic negatives, each mask being appropriate for a particular layer of the completed Integrated Circuit. These marks are about 400 times the size of the Integrated Circuit, and made with a high degree of accuracy, within 2-10,000ths of an inch.

By photographic duplication, a single pattern may be reproduced a thousand times or more on a wafer.

The next step is to coat the surface of silicon oxide of the prepared wafer with a light sensitive material. The surface is then exposed to ultra violet light through the first mask. The oxide layer is then etched away in the areas not exposed to light, so that the active layer underneath can be worked upon chemically, by diffusing some other impurity through the areas from which the silicon oxide protective coating has been removed, so as to alter the electrical characteristics of the exposed parts of this layer. The wafer is then coated again with silicon oxide, again coated with a light sensitive material, exposed again to light through the next mask and the process repeated, each step building up more of the Integrated Circuit, its interconnections, and its active and passive devices. Finally, the wafer is separated into the individual Integrated Circuits.

There are numerous variations. For example, because of the difficulty of forming capacitors and resistors in the silicon, these components can be formed by a metal film which is deposited on top of the active elements, and then worked upon. Further, more than one Integrated Circuit may be enclosed in a common container, which appears externally to be a single Integrated Circuit. Also, in the case of audio power amplifiers and other devices which generate heat, precautions have to be taken to ensure that this heat is dissipated.

The description given is that of earlier technology. There are now a number of different technologies which are employed. One which has been recently described (David Webber-Memorandum 25-2-86) is based on the n-channel metal oxide semiconductor (NMOS) and uses three layers of conducting material on the chip, separated by layers of silicon dioxide as an insulator. The upper layer is the "metal" layer, the next layer the "polysilicon" layer and the lower layer "the diffusion" layer. Active devices are manufactured in these layers by making connections through the layers and by spatially arranging the layers in a certain fashion, in accordance with mask diagrams, which define the pattern for each layer of the chip.

In this respect, it should be noted that connections need not be made to create a transistor and the layers are not restricted to any particular height above the substrate.

3. Digital Integrated Circuits

3.1 Definition

Digital is not a word which is limited to Integrated Circuits but in common meaning is taken to be a description of equipment which operates by means of electrical pulses, the presence or absence of which conveys information. Perhaps the earliest embodiment of digital electronics is morse code, in which pulses generated by opening and closing a switch (morse key) are used to convey intelligence. The most sophisticated development of digital circuitry and techniques lies in the general field of digital computers.

3.2 Whilst computers did exist before integrated circuits were developed, it is the development of Integrated Circuits which permit the packing of large numbers of active circuit elements in a very small space which has facilitated the development of computer technology and other technology which involves digital techniques, such, for example as digital sound recording in which the analogue output of a microphone is translated into a series of pulses for recording and processing, these pulses being translated back into an analogue form in order to reproduce the original sound.

Digital Integrated Circuits are manufactured using much the same techniques as analogue circuits, but whereas analogue circuits usually employ circuitry which is "continuous", in that a signal is processed sequentially by a series of amplifiers, frequency changes, detectors and the like, requiring a number of different circuit functions to be incorporated in the one integrated circuit, generally speaking digital circuitry is repetitious consisting of the assembly together of a number of more or less standard building blocks to give the desired result. Further, in the computing field (and in other fields as well) digital circuitry is concerned with the storage and retrieval of information, as indicated by the presence or absence of pulses, in a permanent, semi-permanent or transitory form, as well as the processing of data as, for example, by switching pulses, dividing pulses, dividing pulses, adding pulses and the like.

Whereas manufacturers publish circuit drawings of analogue Integrated Circuits, in the case of digital Integrated Circuits, the internal diagrams usually only show the circuit blocks which are included in the particular Integrated Circuit, as shown in Figs 5 and 6.

This practice is adopted in order to keep the layout diagram simplified, as the internal circuitry is invariably complex.

It is sometimes useful to differentiate between Integrated Circuits which retain or store data and the data which they retain or store. For present purposes, Memory I.C.'s can be considered as falling into two broad classes, those into which data can be written for permanent or semi-permanent storage and those which store data for a relatively short period. Those which store data for long periods, ROM or PROMs (read only memories or permanent read only memories) store data in such a way there is no physical change which can be discerned by visual observation, but the information can only be retrieved by interrogating the memory by feeding a series of digital pulses into the Integraed Circuit and by observing the manner in which these pulses are modified in the memory, by a display of some kind. However, it may be important to realise that memory IC's usually consist of a matrix of interconnected divices, each device of an identical type and each capable of existing in two states, an "on" state and an "off" state. For convenience the devices are arranged in a roughly square array so that a ROM with, say, 1024 cells would be organised in an array of 32 devices x 32 devices. It follows that in ordinary circumstances, the opportunities for ingenuity in devising memory IC's are limited.

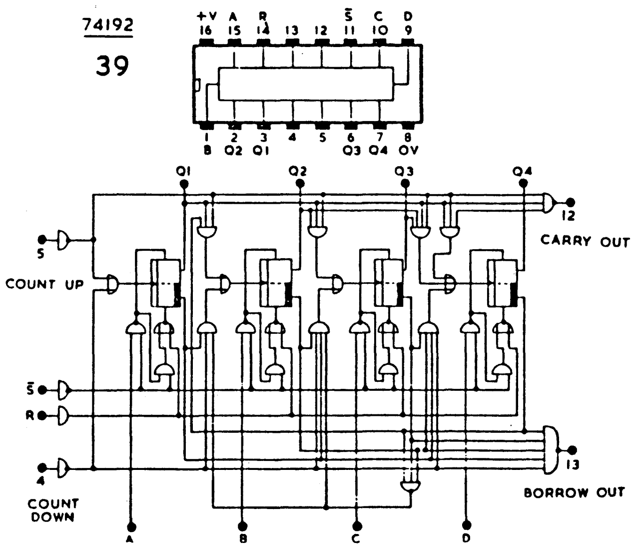


Fig 5

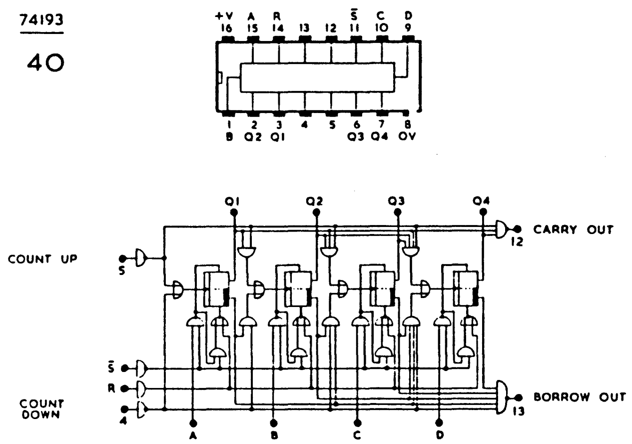


Fig 6

4. Mechanical Constructions

A silicon chip upon which an integrated circuit is formed requires to be protected agains physical damage and it also needs to be connected to a source of power and other circuitry. Fig 7 shows a pattern which illustrates the kind of pattern to be discerned on the top surface of some silicon chips upon which an integrated circuit is formed and attention is directed to the five squares at the left hand side of the illustration. Parts of similar squares can also be discerned on the right hand side and, in many cases, a series of squares will be found along each side of the silicon chip. These squares are for the purpose of making connections to the Integrated Circuit.

Commonly the silicon chip will be found in a bakelite moulding (or a moulding of some similar material, which will also contain the leads and connecting pins, again usually adaped so as to enable the chip to be plugged into a socket or connected to a printed circuit board by some other means. Thus, not only is the silicon chip which carries the integrated circuit invisible, in order to obtain access to the chip it is necessary to remove the casing, by breaking it open or by some machining operations which will then expose the chip.

Further, as part of the manufacturing process and in order to protect the surface of the chip it is common to coat the surface with a layer of silicon oxide.

Reference has been made to successive operations which work on different layers in the chip. As a result, the actual chip consists of a number of substances which are arranged in a three dimensional space, being materials with differing electrical properties and chemical composition, interconnected together. Thus, an inspection of the surface of the chip will not indicate or will not fully indicate the manner in which the different substances which make up the chip are disposed beneath the surface — always accepting that the surface is visible through the layer of silicon oxide.

It is possible, in many cases, to gain some insight concerning the spatial disposition of the various substances which make up an integrated circuit by shining a beam of collimated light at the chip containing the integrated circuit if this beam is at the correct angle, then a skilled person viewing the chip under a microscope is able to determine the patterns which are created by the diffraction of the light beam. This technique was used to take a coloured photograph which has been reproduced in black and white as Fig. 7. Accordingly, Fig. 7 shows more detail than would be apparent from a visual inspection of the surface of the integrated circuit. Fig. 8 is a plan of the layout, originally in colour to indicate different layers within the chip.

In order to defeat the efforts of persons anxious to investigate chips in this manner, other substances can be used as a protective layer on top of the integrated circuit — for example, glass which will disturb the diffraction pattern and make investigation of the interior of the chip in this manner difficult if not impossible.

Thus, in the end result, a monolithic integrated circuit, (which is the sense in which this word is commonly used) means an integrated circuit formed on the silicon chip, protected by being moulded as an integral part of a case of bakelite or some other material which also includes the connecting means to the integrated circuit and the external pins for plugging into a socket, or, in some cases, connecting wires.

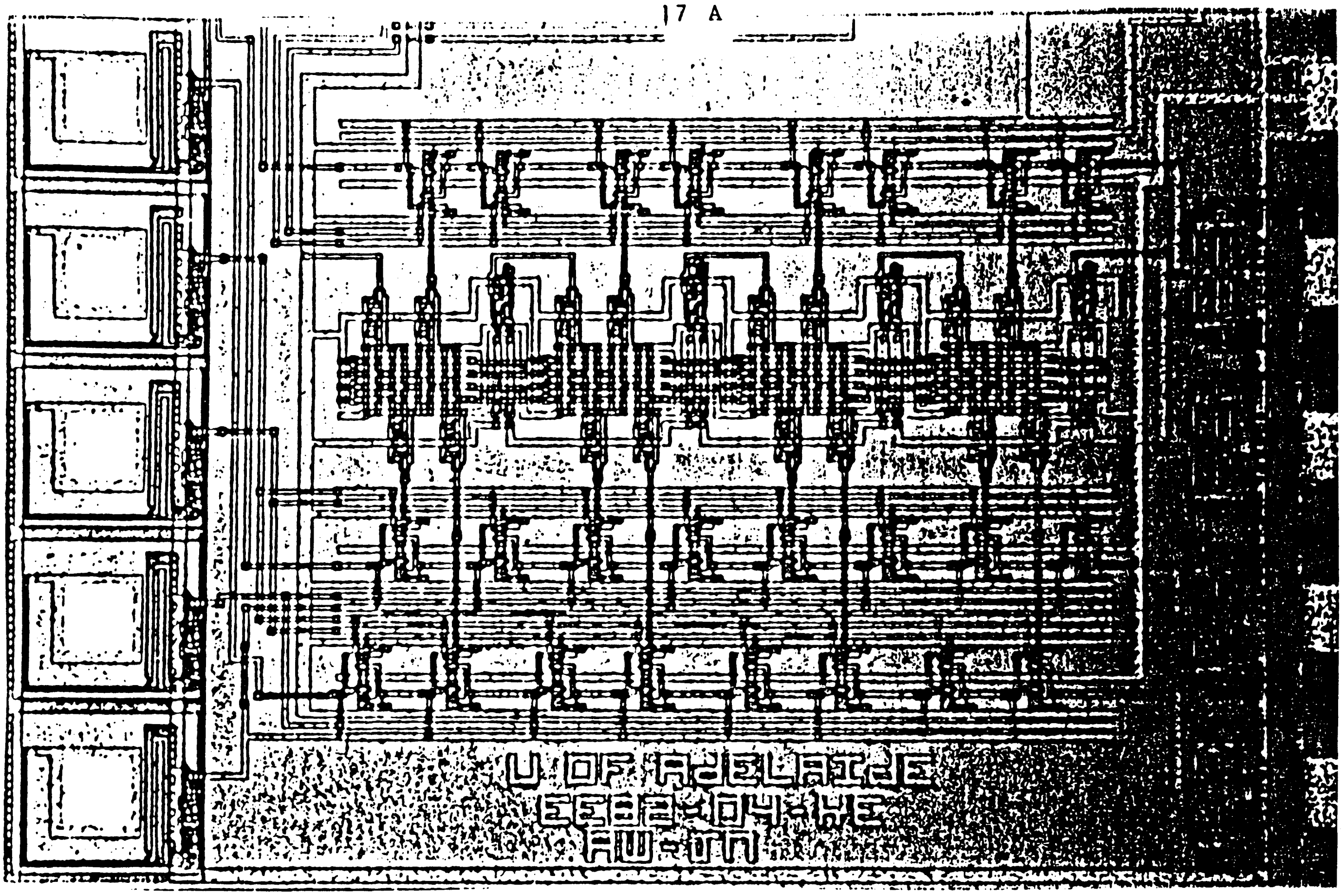


Fig. 7

5. Intellectual Property Rights

Bearing in mind that an "integrated circuit" consists of standard circuit elements, that is, resistors, capacitors, inductors and active components such as transistors and diodes connected together, there is no reason why some new or novel circuit arrangement which would be capable of patent protection if constructed with discrete components should not be protected if constructed in the form of an integrated circuit. Indeed, there is no reason why a patent which relates to a particular type of circuit would not cover such a circuit regardless of whether it is constructed from discrete components wired together mounted on a printed circuit board or manufactured as an integrated circuit.

Further, it might be expected there would be a number of circuit patents to cover circuit designs which are particularly suited to integrated circuits. As has been explained, it is relatively easy to produce active devices in monolithic circuits but, in this type of circuit, resistances are more difficult to produce and inductances are difficult indeed. In ordinary large scale design, resistors and capacitors are usually cheaper than active devices and inductances provide no real problems. Thus, the circuit techniques required in the interests of economy and efficiency are different in the case of integrated circuits and, in particular, monolithic integrated circuits from those used over the years in conventional designs.

Further, it should be mentioned that patents could exist concerning new and novel methods of construction, of making connections, of electrical circuit protection, of mechanical protection, of new methods of making active and passive circuit elements suited to the method of construction, and the like. Thus, there appears to be considerable scope for patent protection of those elements of integrated circuit design or construction which require the necessary "inventive step".

The protection of information stored in an integrated circuit which stores information is to be considered as a quite separate issue to the protection of the integrated circuit itself — just as the protection of any intellectual property rights concerning the paper on which this dissertation is written is a quite separate issue to the protection of any literary copyright in the work.

In the end result, there appear to be two possible methods of protecting the intellectual property rights in an integrated circuit, which does not utilise patented circuitry and which is made by some

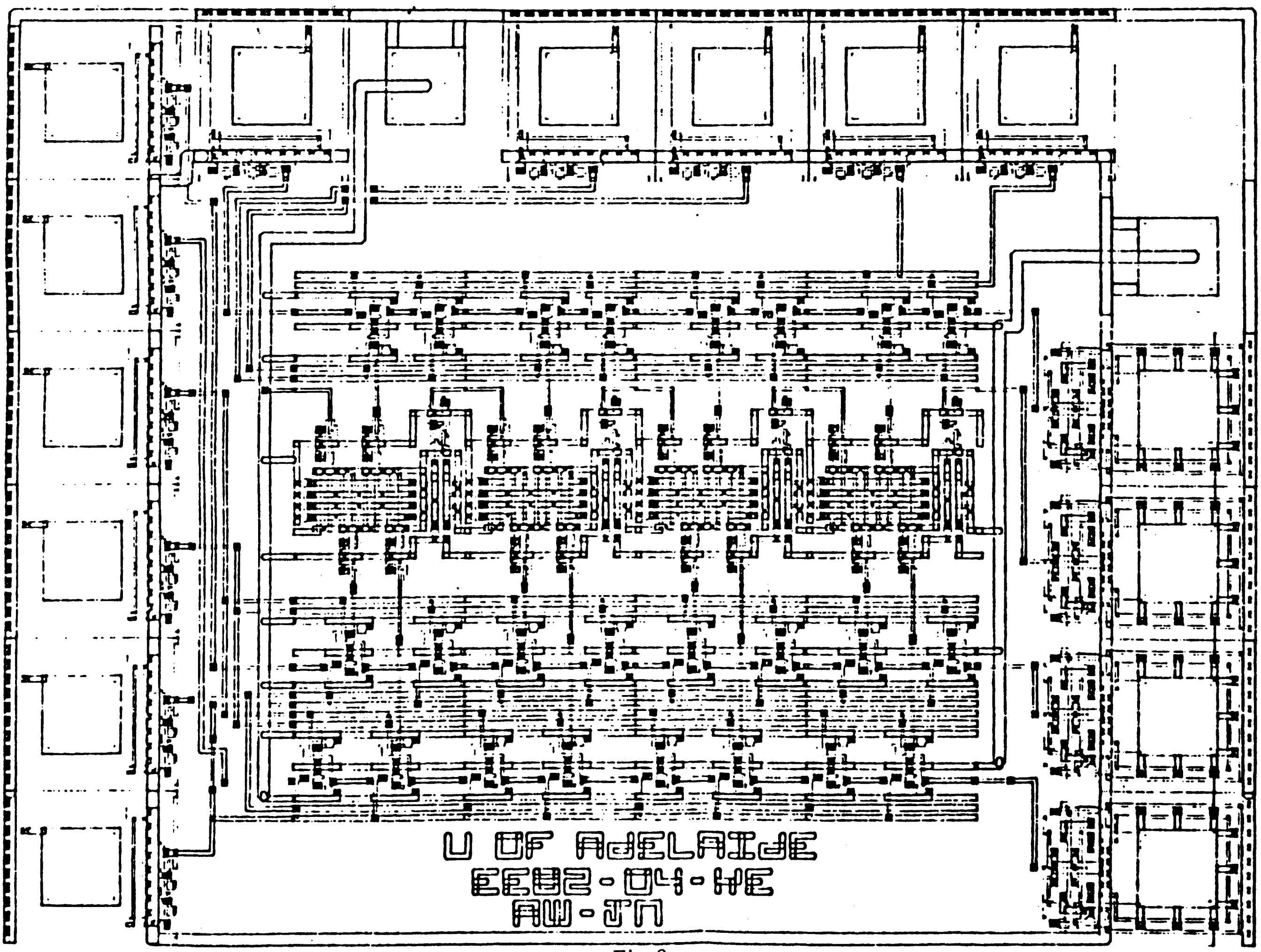


Fig. 8

patented process — or which does not otherwise embody some patented invention.

6. Registered Designs

Under the Designs Act 1906 a design must be registered in respect of an "Article". "Article" is defined in Section 4(1) to mean "any article of manufacture and includes a part if such an article is made separately". There is no doubt that the commercial form of an integrated circuit is an Article, but this is not, of course, the integrated circuit itself. As previously mentioned, before an integrated circuit can be of any practical use it is necessary to attach leads to it, to supply it with power, to feed signals into it, to take signals out of it and to make connections to various parts of the circuit. Accordingly, in its most common form it is presented as a moulding of bakelite or some similar material, about 1/8″ in thickness, often 1/2″ wide and of varying length, depending on the number of connections to be made.

There is thus a difficulty. If the integrated circuit is only "made" when it can be used, that it, when the leads are attached to it and it can be inserted into a socket or otherwise connected to a circuit, it is not an "article" until such time as it is completed, with the bakelite moulding, or otherwise embedded in some material which will firmly hold the integrated circuit and its connecting leads. If the question of operation is not material, then perhaps the integrated circuit is an Article within the definition at the time it is completed as an integrated circuit, even although it cannot be "used" at this time.

No direct assistance can be obtained from cases which consider this question in relation to the Registered Designs Act 1949 (U.K.) as in that Act a part of an Article is defined as meaning "any article of manufacture and includes any part of an article if that part is made and sold separately". No doubt there is some reason for the simplification of the definition is in the Australian Act, but the consequence is that unless some such limitation is implied, there is no way of determining the meaning to be given to the words "made separately". To give an example, is the lead in a lead pencil "an Article" separate from the pencil, if it is "made separately".

In "The Law of Intellectual Property" (S. Ricketson, Law Book Co. 1984) at para. 17.11 there is a comment to the effect that in the view of the Design Law Revision Committee, in a report of 1973, the effect of the requirement of separate manufacture "would be to prevent registration of a design for a part of an article which had no separate existence and which was really an integral portion of the article, for example, a shape of a portion of a chair leg which was really an integral part of the chair leg . . ." If this was the intention, then perhaps it would have been appropriate to express it with some slight degree of clarity. However, on this reasoning, the silicon chip upon which the integrated circuit is "constructed" is an integral part of the Integrated Circuit as a whole, that is, the silicon chip with its leads and outer casing.

There would not be any such ambiguity under the Registered Designs Act 1949, as a silicon chip upon which an integrated circuit was formed would not be of any practical use until manufacture had been completed and it formed part of the "Integrated Circuit" of commerce. In this respect, it may be approrpriate to say that the size of the silicon chip is commonly less than 1/8″ square and the attachment of leads would be a matter of great difficulty without the specialised equipment needed for this purpose.

The question was addressed by Brinsden J. in *S.W. Hart & Co. Pty. Ltd. v Edwards Hot Water Systems* (1982) APIC 90-017 with reference to the Designs Act 1906 prior to the 1982 amendments. At the relevant time, the Act defined an "Article" as "any article or substance". Brinsden J. considered that an Article, to which a registered design applies must be one "likely to be delivered for sale and therefore must be marked with the prescribed mark to denote the design is registered . . ." On this line of reasoning, as the silicon chip carrying the integrated circuit is not intended for sale separately and as any marking could only be discerned if it were to be examined through a microscope, registration would not be possible. Further, although, of course, obiter Brinsden J. did briefly comment to the effect that the Designs Act, as amended, gave a strong indication that "parts of an article" must be parts intended for separate sale.

If the observation made by Brinsden J. is correct then bearing in mind the size and nature of the silicon chip upon which the integrated circuit is formed, it seems very doubtful, to say the least, that it falls within the definition of an "Article" under the Designs Act 1906, as amended.

If, contrary to the views which have been expressed an integrated circuit formed on a silicon chip is itself an "Article", then the next factor to be considered is whether the surface pattern constitutes a "design".

Section 4(1) of the Act defines a "design" as meaning "features of shape, configuraton, pattern or ornamentation applicable to an article, being features that, in the finished article, can be judged by the eye, but does not include a method or principle of construction".

Whilst it may not be possible to directly apply the case law which has accumulated concerning the interpretation of the corresponding provision in the Registered Designs Act 1949 as, in that Act, there is a reference to "features which in the finished article appeal to and are judged solely by the eye," there is a strong suggestion in the cases that the omission of these words in the Australian Act has not affected the meaning of the provision. It would be difficult to find something less likely to appeal to the eye than the surface of an integrated circuit (except, perhaps, in the case of an integrated circuit engineer).

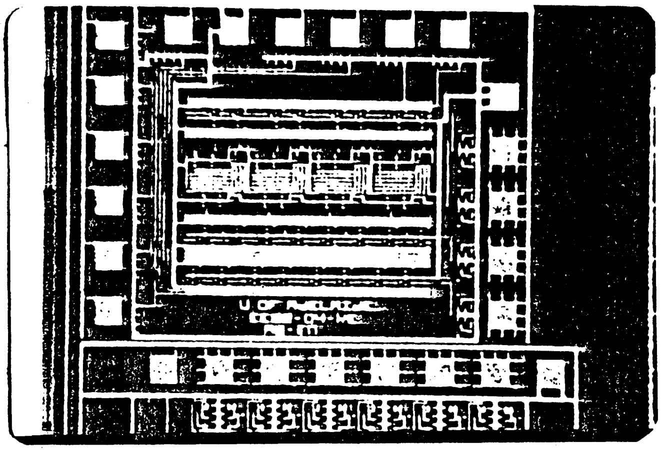
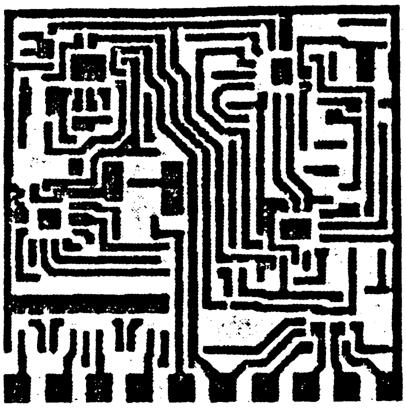


Fig. 9

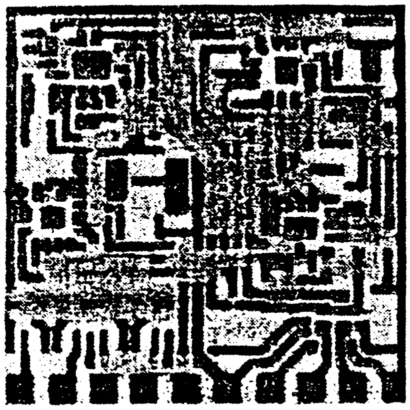
Fig. 9 shows the surface of the integrated circuit shown in Figs. 7 and 8 when illuminated by normal incident light and Fig. 10 shows the features of construction of a "hybrid chip".

The first question here must be whether the eye must be an unaided eye, or whether it is possible for the eye to view the design through a micropscope. In order to make an assessment of the design, in most cases substantial magnification of the order of at least 50 times would be needed. If this is permissible, then there are other problems. The first is that in most cases, the actual integrated circuit is coated with a layer of silicon dioxide in order to protect it, thus partially obscuring the surface pattern. The second problem is that although, in ordinary light and with the aid of a microscope a pattern can be seen on the surface of the silicon chip, in order to bring out a pattern which has some resemblance to that of a mask, it is necessary to shine a beam of light from a collimated light source into the integrated circuit at

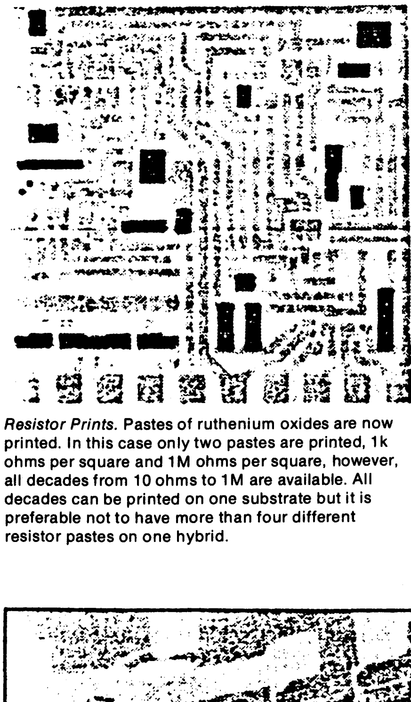
The substrate is 96% alumina. Philips uses two sizes: 2" x 2" and 60 mm x 60 mm either 0.025 or 0.635 mm on 1.0 mm thick which can be prescribed to the desired size. This particular substrate has a 1" x 1" circuit on a 2" x 2" x 0.025" substrate.



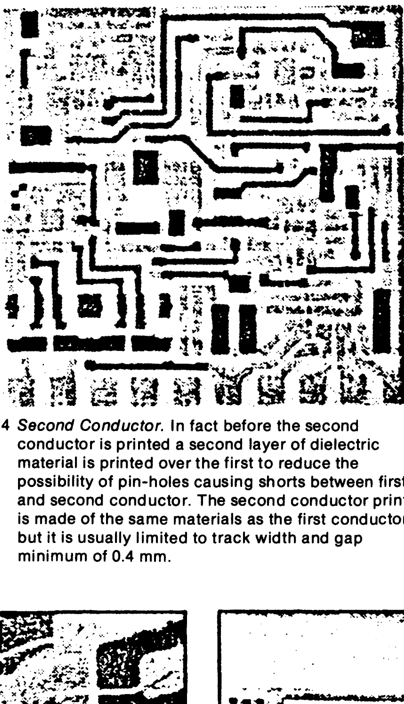
1 *Main Conductor Print.* Usually silver-paladium but may be gold or a combination of both. Track width and separation is usually 0.4 mm but 0.25 mm is not uncommon.



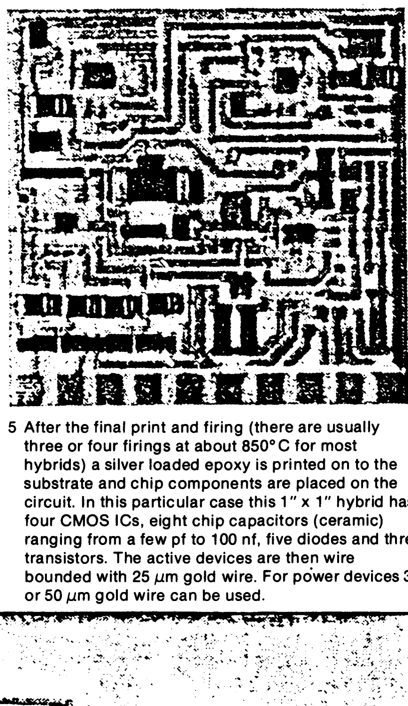
2 *Dielectric Print.* This is an insulating glass print which allows tracks to be printed over the first conductor print.



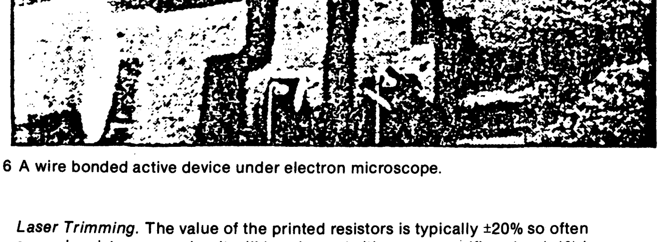
3 *Resistor Prints.* Pastes of ruthenium oxides are now printed. In this case only two pastes are printed, 1k ohms per square and 1M ohms per square, however, all decades from 10 ohms to 1M are available. All decades can be printed on one substrate but it is preferable not to have more than four different resistor pastes on one hybrid.



4 *Second Conductor.* In fact before the second conductor is printed a second layer of dielectric material is printed over the first to reduce the possibility of pin-holes causing shorts between first and second conductor. The second conductor print is made of the same materials as the first conductor but it is usually limited to track width and gap minimum of 0.4 mm.

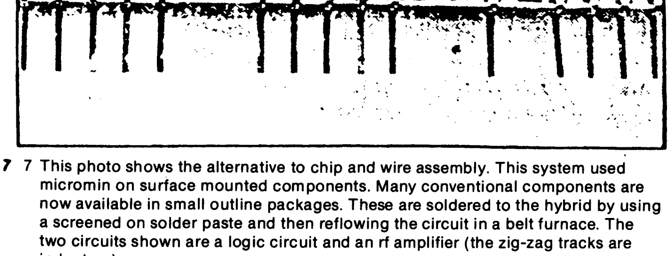


5 After the final print and firing (there are usually three or four firings at about 850°C for most hybrids) a silver loaded epoxy is printed on to the substrate and chip components are placed on the circuit. In this particular case this 1" x 1" hybrid has four CMOS ICs, eight chip capacitors (ceramic) ranging from a few pf to 100 nf, five diodes and three transistors. The active devices are then wire bounded with 25 μm gold wire. For power devices 38 or 50 μm gold wire can be used.



6 A wire bonded active device under electron microscope.

Laser Trimming. The value of the printed resistors is typically ±20% so often several resistors on a circuit will be trimmed either to a specific value (±1% is common) or some parameter of the completed circuit will be trimmed, eg, the frequency of an oscillator or the voltage of a regulator.



7 7 This photo shows the alternative to chip and wire assembly. This system used micromin on surface mounted components. Many conventional components are now available in small outline packages. These are soldered to the hybrid by using a screened on solder paste and then reflowing the circuit in a belt furnace. The two circuits shown are a logic circuit and an rf amplifier (the zig-zag tracks are inductors).

After the circuits have been assembled the chips (if any) will be protected with an epoxy chip coating, pinned, cleaned, coated in an epoxy encapsulant and then tested before delivery to the customer.

Figure 2. Hybrid construction. (Courtesy of Philips.)

Fig. 10 Hybrid thick film integrated circuit the correct angle. If this is done, light diffraction in the silicon chip will produce a coloured pattern which bears some resemblance to the pattern shown in Fig. 8.

In this area, it may be important to realise that an engineer purchasing an Integrated Circuit, in its completed commercial form, would be neither interested nor concerned with the physical appearance of the integrated circuit itself, but only its electrical characteristics.

As Lord Pearson commented in *Amp v Utilux Pty. Ltd.* (1972) R.P.C. 103, when speaking of the terminal in that case:

"If it had eye appeal, that would be wasted, but I do not think it has any. An experienced electrical engineer, if he examined it carefully before it was incorporated in a machine, might be able to envisage it in operation and form some provisional opinion as to its probable efficiency when tested in operation. But he would be judging it by the mind for efficiency, not the eye for appearance."

The shape of the terminal considered in that case was relevant to the function so that an electrical engineer, would be likely to consider from observation whether the terminal would be suitable for its intended purpose. In the present case, an electronic engineer experienced in the design of intergrated circuits, adequately equipped with a microscope, a source of suitable light and photographic equipment, if he examined the integrated circuit at all would be examining it to determine the manner in which the various materials were spatially disposed within the three dimensional space of the silicon chip. Any consideration as to its use would require knowledge of its electrical characteristics which would not be apparent from an optical examination.

Further, there is the comment by Brinsden J. in *S.W. Hart & Co. Pty. Ltd. v Edwards Hot Water Systems* concerning the words in the definition of a design, to the effect that a design "does not include a method or principle of construction".

Brinsden J. cited with approval the explanation by Luxmore J. in *Keston Ltd. v Kempat Ltd.* (1935) 53 R.P.C. 139 to the effect that "a mode or principle of construction is a process or operation by which a shape is produced as opposed to the shape itself. Brinsden J. then continued: "The evidence I think clearly demonstrates that the absorber plates and the tank take their shape by reason of the mode or principle of construction and not because the plaintiff desired to construct them in that shape."

Applying this reasoning to the surface pattern of an integrated circuit on a silicon chip, it could be said that the surface pattern is an artifact generated by the principle of construction of the integrated circuit formed in the surface layers of the silicon chip, not because the manufacturer of the integrated circuit wished to see this pattern on the surface. There is a close parity of reasoning.

In the result, it is arguable that the silicon chip which carries the integrated circuit is not as "Article" within the definition in the Act and it is also arguable that the pattern on the surface is not a "Design" within the definition in the Act. The result must be that it would not be possible to register the surface pattern which is discernable under a microscope as a "Design".

7. Copyright

It will be assumed for the purpose of considering the question of copyright that the masks and other materials produced in the course of designing and manufacturing an integrated circuit are "original works" and that the "author" is a qualified person although, in practice, neither assumption may be correct.

The first problem is to identify the relevant artistic work within the definition in s.10(1) of the Copyright Act 1968. It is probable that the only relevant artistic works are the mask layout diagrams, as function drawings of the integrated circuit will bear little relationship to the actual appearance of an integrated circuit, just as ordinary circuit drawings bear little resemblance to a piece of equipment which has been made in accordance with these drawings. The next question is whether these drawings are copied when a person makes a duplicate of an integrated circuit.

The procedure which such a person would need to follow has already been outlined. In brief, the protective casing would need to be removed from the silicon chip, by breaking it open or by cutting it through and then a light beam from a source of collimated light would have to be directed at the silicon chip at the correct angle, so as to produce a diffraction pattern which the expert observer could interpret with the aid of a microscope and no doubt coloured photographs. The expert observed, by the use of his own skill, knowledge and experience and with the assistance of data as to the electrical characteristics of the integrated circuit obtained by measurements or from published characteristics would then re-design masks which when used in the manufacturing process intended to be used would reproduce an integrated circuit with similar electrical characteristics. In order to produce the masks the expert observer would need to identify each substance used in the integrated circuit and the location of this substance in the three dimensional space in which the integrated circuit exists and the manner in which this substance is connected to or insulated from other substances so as to enable it to play its part in the operation of the whole circuit.

It is obvious that the only interest of the expert in the surface layer would be as to the disposition of substances in this layer, including, of course, connecting means. Thus, it may be possible to argue that any resemblance between the appearance of the surface of the original chip and that of the duplicate chip arose by way co-incidence in that both parties used identical means to achieve the same disposition of substances in the silicon chip giving rise to identical surface patterns.

It may be appropriate here to observe that it is assumed that the comment by the learned author of "The Law of Intellectual Property", at paragraph 5.34 where he considers the old case of *Hollingrake v Truswell* (1884) 3Ch.420 is directed only to literary copyright. His comment is to the effect that whilst a work does not need to be published separately in a physical sense, "if it is an integral part of the working of an article to which it is attached or applied, it will not constitute a work capable of being protected by copyright". Such is obviously the case here.

Assuming that the design on the surface of the silicon ship is found to be "copied", then it is appropriate to consider whether a defence exists under s.71 of the Act, as recently analysed in some detail by the Australian High Court *S.W. Hart & Co. Pty. Ltd. v Edwards Hot Water Systems* (1985) 5 IPR 13. It is not proposed to embark upon any detailed analysis of this decision, but only to point out that the most apparent features of the surface of a silicon chip containing an integrated circuit are the rectangular plates which are used to enable connections to be made to the integrated circuit itself. There are also the standard building block type devices which are incorporated in integrated circuits and whilst the disposition of these devices may be "original" the appearance of the devices themselves will be in accordance with a standard form. Of course, there may also be devices and circuitry which are themselves original and which may provide some distinctive surface appearance.

However, in considering the surface appearance the hypothetical non expert will need to act in accordance with the test approved by the High Court, putting to one side the numerous criticisms which have been made. This requires the notional non-expert to form a "visual impression" in his mind of the three dimensional object from the drawing and to then compare the three dimensional object with the visual impression. Because the differences between integrated circuits will almost always require detailed examination of detail, it would seem that such a test could lead to only two results. Either it would be considered that every integrated circuit of a similar type infringes the copyright in each mask used for making integrated circuits of that type or else no integrated circuit infringes the copyright in a mask. There will be exception in the case of comparatively simple circuits, but in most cases the complexity of the appearance would require detailed examination. It may be relevant in this context to cite the comment by Mr. Justice Wilson in *Hart v Edwards* at page 27 of the report where he said "Ordinarily, a drawing will convey to the mind of a viewer a picture of what a three dimensional version of that drawing would look like. But some drawings may be so complex or technical in their expression as not to yield any immediate impression of a three dimensional object capable of being compared with the alleged infringement, not withstanding that in truth the article is a reproduction of the drawing." This is a very appropriate comment here as the surface appearance of the integrated circuit is not brought about by one mask, but has elements from a number of masks.

In this discussion, it has been assumed that because the integrated circuit is three dimensional, and because the surface appearance is derived from elements of all three masks, at different levels, this is the correct approach.

It may be arguable that the surface appearance should be treated as a two dimensional copy of the mask which it most nearly resembles, but this has obvious problems.

It is suggested that it would be very difficult, if not impossible, to establish copyright infringement of an artistic work by the production of an integrated circuit, even if the assumptions which have been made are found to be valid.

To complete this brief analysis, it has been suggested that the surface of the silicon chip carrying the integrated circuit could be an engraving or an etching. An engraving is defined so as to include an etching in s.10(1) of the Act, the definition reading "an etching, lithograph, product of photogravure, woodcut, print or similar work, not being a photograph." The possibilities are interesting but for present purposes both an engraving and an etching appear to have the accepted meaning of being an image produced from a plate. This would seem to be a quite inappropriate description of an integrated circuit.

As to the assumptions which have been made, it should be realised that a great deal of the design and layout work involved in the preparation of an integrated circuit is now carried out by computer and that masks are produced by the computer, not by manual methods as was the case when integrated circuits were first produced. How far copyright exists in a work which is produced by a computer, not in response to instructions to produce a specific drawing, but in response to instructions to produce a layout defined by specific parameters may be a question to be answered.

8. The Future

There are some clear pointers to the direction in which the design of integrated circuits is heading. At the present time design is computer aided, of necessity, as some integrated circuits can contain over 450,000 active devices and it has been said that the packing density is increasing by a factor of two each year and has been so doing for some time. It is interesting to speculate as to the length of time it would take the expert intent on copying a device of this nature to determine the layout optically and to make up the necessary masks. In the case of digital circuitry, at least, one might suspect that the time is not far distant when sophisticated software packages will be available which will permit an engineer to design an integrated circuit for some specific purpose merely by specifying the electrical parameters of the integrated circuit required. The computer will then select the standard "building blocks" which are required, design the optimum layout and then generate the necessary masks, if these are then necessary. In this context, will it be the first person to specify the electrical parameters which an integrated circuit should possess to make it suitable for some specific application who will be able to obtain a monopoly? If the computer programme is such that it will always generate the same design and layout when given the same parameters, as would be the case if it were to be programmed to always produce the most cost effective design and layout, one can envisage problems with the providers of software who find the usefulness of their product inhibited in this way. Bearing in mind that the development of such a programme could mean years of work for the programmer and a team of engineers, the financial loss could be considerable.

It seems that there are arguments which may have had some weight in the past at the time when early development of integrated circuits was taking place, but that time has passed and if an integrated circuit does not embody some patentable invention, then the case for protection is weak and is becoming weaker as time passes.

Law Council of Australia
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GPO Box 1989 (Canberra, ACT 2601
Telephone: (062) 47 3788
Cables and Telegrams: LAWCOL Canberra

Produced by Marett Communications Pty. Ltd.
10th Floor, 258 Little Bourke Street, Melbourne
Telephone: (03) 663 1577.