RRS Newsletter

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*MICROELECTRONIC INTEGRATED CIRCUITS

by H. K. Bourne

A panel meeting held during the I.E.E.E. International Convention in New York, on March 23-26, 1964, discussed the present position and future growth of microelectronic integrated circuits. A summary of the remarks by members of the panel is given below:

1. Present State of Integrated Circuits

The various methods of making integrated circuits and the forms in which they appear were described, and the effect of extrapolating present techniques into the future was considered. The effect of possible break-throughs which could alter the whole aspect was ignored. The two main approaches for micro-circuits use thin films or monolithic silicon blocks (or molecular electronics). In the thin film method, the developments by I.B.M. using ceramic substrates already come close to practical reality. The development of silicon monolithic blocks is also progressing rapidly. A recent notable advance has been the elimination of parasitic capacity by placing insulation between the layers and the substrate, and between the elements. Silicon devices without parasitic capacity should soon be in general production. This capacity had previously limited the speed of operation of such devices.

Monolithic silicon is cheaper to make than the thin film approach in quantity production, but for special circuits needed in small numbers, then the thin film method is preferable. In particular, the monolithic silicon provides the lowest cost for elements used in digital circuits. It costs about $10 per wafer, so with wafers carrying 400 circuits each 50 mils square, the cost per circuit is 2.5 cents. A circuit containing 33 transistors, two

/diodes

*With the increasing use of very small circuit techniques the following article, to be published in two parts, will, we feel, be of interest to readers.

diodes and 27 resistors will cost under 10 cents. By 1966, elementary circuits will be only 30 mils square and later they may be even smaller. At high volumes, the total cost of production including overheads can be expected to be less than 2 cents per circuit. This cost refers to that of the circuit alone without leads attached and without packaging.

The yield of transistors in production is not particularly good due to the many different characteristics which should meet the specification. Complete integrated circuits should give a yield as good as that of transistors alone, as they will be selected on the basis of their correct functioning rather than on the characteristics of individual components. For example, several thousand 120 Mcs. R.F. amplifiers of monolithic silicon have been produced to meet a required specification with a yield of 90%. As monolithic silicon integrated circuits will have a relatively large tolerance in their characteristics of 20% or more, they will not suit all applications, so that for critical circuits thin film techniques will generally be preferable.

Thin film capacitors cost 30 times as much to make as monolithic silicon capacitors, but the latter have only a small capacitance, so that it will be usual to build large capacitors with thin film techniques. Passive components, such as resistors, which need an area which is small compared with that of the substrate, can be obtained virtually free in the monolithic silicon construction. If their dimension exceeds $\frac{1}{4}$ in., it is generally cheaper to build them using thin film techniques. Typical components in the silicon block are limited to 75,000 ohms resistance and 200 pF capacity. Larger components are generally made separately and connected externally. Much work is being carried out in the field of packaging and in interconnections, and in methods of combining monolithic silicon with thin film circuits.

2. Integrated Circuits in Military and Government Electronics

Integrated microcircuits have made a great impact on military and government electronics, the military having been largely responsible for their rapid development. This development would have occurred in any case, although at a slower pace, due to the higher reliability and lower production cost of integrated circuits. The government subsidy for technical developments in microcircuits has resulted in much competition in industry. For example, $2 million expended by the government causes $100 million expenditure in industry on integrated circuits. The government provides a ready market and is most willing to use integrated circuits. By 1970, the value of these will be more than half of that of all electronic circuits used. The main reasons for their interest is in the improvement in and the maintenance of reliability, rather than in the saving in size and weight which has been popularised by the press. This latter is not generally considered to be the main attribute and is subordinate to reliability.

Typical examples of reliability performance are a data processing unit having one failure in 4.2 million hours and two failures in 19 million hours, and a computer with two failures in 15.25 million hours. Failure rates of complete integrated circuits have been found to be of the same order as those

/of single

of single transistors and limitations to their use are also similar, such as over-heating and damage by nuclear radiation. Their performance in this respect can probably be improved 10 to 100 times in the future, possibly by using completely new devices rather than by normal transistors.

The potential cost is very low indeed and for digital applications, integrated circuits are already cheaper to use than conventional components. Transistors cost $1.5 to $2.00 each in large numbers. The corresponding price for an integrated circuit containing transistors would be from $1.00 to $1.75 per transistor and the resistors are free. The cost of materials for integrated circuits is small, the major cost being the overhead cost of the support organization.

Low usage circuits are still more expensive to make in integrated circuit form than are separate circuits and tuned circuits are not at present feasible in integrated circuits. Integrated circuits are attractive to research workers, as new circuits to perform required functions can be developed and built very rapidly. However, difficulties are sometimes experienced in meeting delivery dates due to orders having been accepted which have an unrealistic schedule. As more and more standard circuits become available this difficulty should disappear.

Practically all modern military digital systems are now being designed with integrated circuits. Microelectronic equipment can be expected to expand in the future at a rate faster than that of electronic equipment as a whole. The introduction of integrated circuits is making new missions possible which could not be accomplished before.

(To be continued)

LETTER TO THE OUTSTATIONS

Dear Colleagues,

At last we can settle down to our normal work again - the dreaded Open Days, which were not so dreadful after all, are now in the past. Unfortunately we are not able to tell you anything about them in this issue, but we hope to summarise the events next month. Proceedings were conducted, if not in an odour of sanctity, at least in a fertile atmosphere which, from time to time emanated from Barker's farm nearby.

A total of some 347 guests visited the Station during three days, and, on Saturday, families and friends were able to see how we spend our working hours, and to view the well polished and neatly arranged fruits of our labours.

A good time was had by all, not least

Yours sincerely,

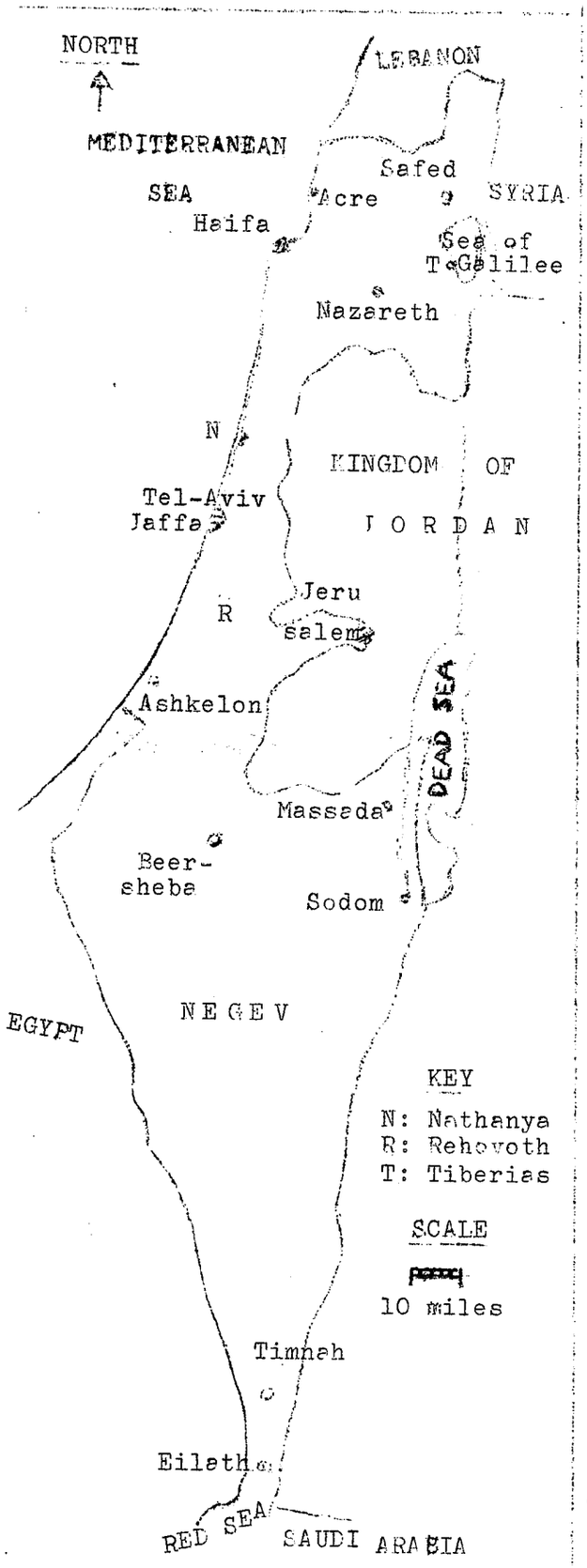
The Editor

JOURNEY TOWARDS THE QUIET SUN

REPORT ON A VISIT TO ISRAEL

Part 2

Four weeks to 'do' (as tourists are wont to) a country a little larger than Wales and half of which is still desert may seem ample, but we found it a full-time job, exhausting and yet exhilarating. The map below apart from showing some of the places mentioned in my report, may also make you realize the difficulties, both natural and man-made, Israel continues to face after 16 years of independence. On three sides confronted by hostile neighbours, its back to the sea, the country is in places only 10 miles wide. Half the water resources, vital in a region without rainfall for over seven months of the year, are concentrated on 4% of the total land area at the northern end of Israel, but are wanted in the south. Over half of the $2\frac{1}{2}$ million inhabitants are immigrants from perhaps a hundred countries with enormous differences in the standard of living and the cultural background, so that integration becomes a major problem. The official language is Hebrew, as 'dead' as Latin for many centuries, but now alive again and growing rapidly to cope with the needs of the 20th century. Israel is the only country where you may find illiterates in over 70 languages. Born there they have learned to read and write Hebrew at school but have also picked up the native speech of their immigrant relatives and friends. In any case, no tourist is likely to find himself in language difficulties. Some books are bilingual: if you want to read one in English you start from the front, as any sensible person would; if you read Hebrew you turn the same book over and begin from the 'end' - whichever way you go you are bound to reach the end in the middle. (Problem for librarians: which is the front cover?).



Haifa was our point of arrival and departure - perhaps the most beautiful city in the Middle East, with its white stone houses covering the steep slopes of Mount Carmel. From the roads that snake up 1000 feet to the crest an unforgettable panorama can be enjoyed across the bay to Acre, the crusader port, and the mountains of Lebanon beyond. At night the town becomes a brilliant sea of light with added pools of reflection from the illuminated ships in the harbour. Half-way up the hill in an extensive Persian-style garden rich in ornaments such as vases, eagles and peacocks among the flowers, framed by tall cypresses, a golden-domed edifice overlooks the town. This is the shrine of the Baha'i faith, a world religion founded in Persia in the last century. The 12000 gold-leaf tiles covering the dome cost £1 each and, like the building, were donated by members of the faith.

Haifa, Israel's major port and industrial centre with nearly a quarter of a million inhabitants, was an unimportant town of under 10,000 at the turn of the century. Later it became the terminus of a major oil pipeline with large refineries. The line has long been cut, and the oil arrives by tanker ; some has been found in the Negev desert. Haifa is also the home of the Technion, the Israel Institute of Technology, opened in 1924 and a very important factor in the rapid growth of the country. On an outlying spur of the Carmel range just beyond the reach of the tentacles of residential development lies Technion City, the new campus of the Institute, in a setting of unique beauty. Thanks to the kind introduction by Dr. Altman, at present at R.R.S. and a keen computer user, we were privileged in enjoying a conducted tour of the Einstein Institute of Physics where he normally lectures. The facilities provided for undergraduates and research students are very impressive and could hardly be more modern. A lot of useful work goes on, from Néel-point investigations in the basement to solar physics on the roof-top. Other faculties of the Technion cover the main branches of engineering, nuclear science, mathematics chemistry, aeronautics, agriculture, architecture and town planning. Two thousand five hundred undergraduate and 800 graduate students with an academic staff of 600 work there and in the original building in town. Research and development sponsored by the government, industry and international institutions are being carried out. At the centre of the 300 acre site stands the impressive Winston Churchill Auditorium, largely financed by donations from Britain, with a portrait of Sir Winston in the lobby. Cleverly designed residential blocks nearby have rooms arranged at two levels so that sleeping may go on undisturbed simultaneously with studying (not by the same person, of course).

The occasional express train, Diesel driven and crowded, covers the 60 miles from Haifa to Tel-Aviv in just over an hour. The railway system, single-track with a lay-by here and there to give oncoming trains a chance, is being extended (Dr. B**ch*ng please note) and offers a convenient alternative to often overcrowded roads. You may also enjoy some wonderful views from the train provided someone has not drawn the blinds, because Israelis like other sub- and fully tropical people shun the sun. Luckily our window was unobstructed as we at first skirted the sea along sandy beaches (there are over 100 miles of them in Israel), past Athlit with its crusader fort and ex-British camp, and then along the coastal plain. Vineyards succeeded artificial ponds for breeding carp and were followed by acres and acres of citrus plantations. Harvesting of this wonderful crop starts in December but there was still a lot of fruit on the trees. In the port of Haifa we had seen rows of sheds filled to overflowing with crates of oranges and grapefruit, Israel's principal export bringing in over £20 million annually for about twelve million crates. Israel's most valuable export, however, is much less bulky: cut diamonds worth over £30 million. We pass Nathanya the centre of the diamond cutting industry where the African raw material is skilfully transformed by European craftsmen. Meadows thickly carpeted with yellow giant daisies give way to stretches of sand dunes held in check by carefully planted grasses to prevent further encroachment of fertile land: we are approaching Tel-Aviv, the town built on the dunes, and our 'base camp' for the next few weeks.

(To be continued).

W. S. Newman.

STAFF NEWS

Congratulations to:-

Mr. & Mrs. John Tyler on the birth of their daughter on 8th June.

Mr. & Mrs. Tony Stocker (Tony is a former member of R.R.S.) on the birth of their daughter.

Derek Thorpe on his engagement to Miss Mary Herbert of Harrow.

Tony Legg and Sylvia Naylor on their engagement.

Promotions

Dr. L. Thomas	S.S.O. to P.S.O.
Dr. J.E. Hall	S.S.O. to P.S.O.
Mr. B.R. May	S.O. to S.S.O.
Mr. J.E. Pearson	S.O. to S.S.O.
Mr. H.C. Bevan	E.O. to S.E.O.
Mr. R.J. Cathrew	A.E.O. to E.O.
Mr. P.P. Reader	A.E.O. to E.O.
Mr. A.J. Legg	T/A.E.O. to T/E.O.
Mr. J.E. Goodyer	A.E.O. to E.O.
Mr. C.R. Carter	T/A.E.O. to T/E.O.
Mr. J. Juleff	A.E.O. to E.O.

/Welcome to

Welcome to:

New Staff

Miss D.M. Preece	S.A. transferred from Ministry of Defence
Mr. R. Wilkie	T/Laboratory Mechanic
Mrs. F.E.I. Colsell	Part-time Cleaner
Mrs. H.K. Wood	Part-time Duplicator Operator

Resignations

Mrs. S.R. Gawan	T/C.O. Secretary
Miss J.D. West	T/Typist II.
Mr. G.W. Beckett	S.S.A.

SPORTS AND SOCIAL CLUB

Cricket

It is hoped that lunchtime cricket can start soon after 'Open Week'. Until then the groundsman will not find time to cut the grass. The gear normally used during lunch hour last year has since vanished. Any information leading to its recovery would be appreciated.

D. E. Page.

Table Tennis

The average attendance for the first three evening sessions was $3\frac{2}{3}$ persons per evening. At least $\frac{1}{3}$ of a person is needed to rustle up enough steam to play table tennis on Monday evenings. This could be YOU . Watch for the blank space on the Sports Club notice board to be filled with words pertaining to the date and venue of the next session, put the date in your diary, and remember to turn up, when you may see for yourself how worthwhile it all is.

C. D. Lovett.

Bridge Club

R.R.S. gained a resounding victory in the last match in the NPL Inter-Division League to retain their position at the head of the table. The three leading divisions were: first, R.R.S. with 32 points; second, NCL Radio Chemistry with 27 points and third, Basic Physics with 25 points. Our team was

Dr. Dickinson and Mr. Zavody

Mr. & Mrs. Gordon-Smith.

I should like to thank everybody who has played in the League matches and hope we shall be able to join in this again next winter.

Jean Scott.