Polovodičová revolúcia

Tranzistory a mikročipová revolúcia

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Obsah

- Polovodiče (a ich využitie)
- Tranzistor, integrovaný obvod
- Využitie
- Polovodičový priemysel
- Čo sa v tomto smere robilo na Slovensku

Polovodiče, tranzistor

- História polovodičov začína pri skúmaní elektrických vlastností materiálov na zač. 19 st.
- Seebeck 1821, Faraday 1833, Becquerell 1839
- Jednosmerná vodivosť 1874 K.F.Braun NC 1909
- Fotovoltaický efekt selén, 1876
- Elektrón 1897 J.J. Thomson NC 1906
- Názov polovodič, 1910 PhD práca Josef Weiss
- Teoretické fyzikálne vysvetlenie Bloch 1928,
- Empirické používanie, neskôr vysvetlenie na základe kvantovej mechaniky ("homeopatické" vplyvy nečistôt)

Tranzistor

 V r. 1925 navrhol princíp FET (fieldeffect transistor)
 Edgar Lilienfeld (1882-1963)



Tranzistor

- Prvé predvedenie tranzistora bolo v r. 1947, Bell Laboratories (AT&T)
- Bardeen, J.;
 Brattain, W.;
 Shockley, W.
 (NC 1956)



Tranzistor

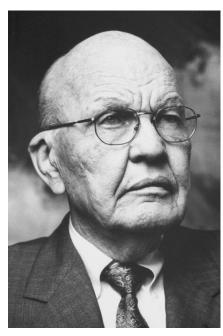


Bardeen, Shockley, Brattain Bell Laboratories (AT&T)

Tranzistor, integrovaný obvod výroba

1959 -

- Planárny proces výroby tranzistorov
 - Hoerni, J. Fairchild
- Integrovaný obvod (IO)
 TI hybridný, Kilby. J. NC 2000.
- Planárny spôsob aplikovaný na výrobu IO
 - Fairchild kremíkový, Noyce, B.



Jack Kilby 1923-2005

Výroba IO

Videá

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<u>Výroba IO</u> a) (6. min.)<u>Výroba IO</u> b) (10 min.) Phillips<u>Výroba IO</u> c) (13 min.) Intel
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Tranzistor -využitie

- Spracovanie signálu (zosilňovač,...)
- Realizácia logických obvodov (AND, OR, NOT, NAND, XOR, ...)
- Pamäť

Najmä posledné dve prispeli k tomu, že rozvoj výpočtovej techniky kopíruje vývoj polovodičovej techniky

Tranzistory - využitie

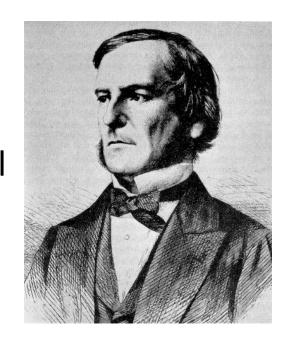
Logické obvody

ALU, CPU,...

Boole, G. (1815-1864)

napr. zjednodušiť.

spojil logiku a algebru. Výroky zapísal formulami, ktoré sa algebraickými úpravami mohli upravovať,



- Realizácia AND, OR, NAND, NOR
- Realizácia 2 bitovej sčítačky s prenosom

História polovodičového priemyslu

- Na začiatku bol tranzistor, ktorý sme už spomenuli. Nasledoval dlhý rad rôzne veľkých vylepšení technologického procesu výroby ale všetky mali spoločné, zmenšovanie, zlacňovanie, zrýchľovanie, zvyšovanie zložitosti vyrobených obvodov - súčiastok
- Shockley, W. (1910-1989) v r. 1956 opustil Bell Labs a presťahoval sa do Palo Alto a založil v Mountain View Shockley Semiconductor Laboratory pod fy. Beckman Instruments. Asi 1. firma, ktorá vznikla na vývoj polovodičových súčiastok. Kvôli Shocklyeho metódam sa 8 mladých výskumníkov z jeho skupiny rozhodlo 1957 od neho odísť. Shockley Lab zanikli 1968.

"Tratorious eight"



Zľava: Gordon Moore, C. Sheldon Roberts, Eugene Kleiner, Robert Noyce, Victor Grinich, Julius Blank, Jean Hoerni a Jay Last (1960)

Cramming more components onto integrated circuits

With unit coat falling as the number of components per circultrises, by 1975 economics may dictate squeezing as many as 65,000 components on a single silicon chip

By Gordon E. Moore

Director, No search and Development Laboratories, Patrolif d. Seeks and other division of Patrolif d'Caronna and Instrument Corp.

computer—or of earl seminals connected to a central com-puter—attenutic controls for automobiles, and personal.

Declarational

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Electronics, Volume 38, Number 8, April 19, 1965

heter than those which are "conventional" electronics. is the time which the "conventions" electronic.

Increments of various costs, especially to explify inonly a most of the present cost.

creating numbers employing digital techniques, are starting to one integration because it cats come of both manufacture

National Systems (1) in the contract of the co

languard decreases will make decrease techniques Imagened electronic will make destruct a scheigen man generally as idial strangelout of a code; performing many function that presently we done in dequately by other behaviour or man time scale. The principals do unaque within lower costs and greatly simple field only—perform from a maly supply of low-cost functional periodge.

Formostoppi in tous, seni conductor in agrae del scale will predoming a. Semiconductor devices we the only rewill present the Nomine details of the safe we have been also re-sumble an addition presently in existing of or the active al-ment of languard details. Purely considerable are elements look attractive too, because of their percental for low costs and high reliability, but they can be used only depreciation to add high reliability, but they can be used only depreciation to Silicon in lighty to remain the busic material, although

other will be of use in specific application. For example, gallium arounds will be important intergrand microse se function. But all conveil preferations natural lower frequencies. because of the technology which has already excited around it and its crisis, and because it is as abundant and which obinspenie state provid

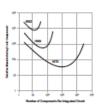
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The article location of the control Most companied in the command of company field these.

Most companied in the command of company field these in the long ways, a placed case magnet from the machiner in being not in only production employing intermediate formation. These machiners can be an application per component might be expected in death of the description of the component per circuit (providing much chairs) bear due then which have "conventional" elements. In facilities we have been produced in molecular quantities; in 1991, the contraction of the produced in molecular quantities; in 1991, the contraction of the produced in molecular quantities; in 1991, the contraction of the produced in molecular quantities; in 1991, the contraction of the contraction

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Electronics, Volume 38, Number 8, April 19, 1965

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the components control leading probability than open symbol for instrumential primes. This is realists, the effects of chained for individual controllator dealers. The con-ciliance level of completely describe presently available party and the individual controllator dealers. If other condi-

hormalogith yield the interest of beautiful and interest of the province of th dire territor line ad a patrace concluded with the years. As long as a function is confined to a small area or a water, the amount of capacitance which must be defeated distinctly limited. In fact, shelping dissentions consistent gand encurember (possible) grows the truture of higher speed for the same power per unit a ma.

> Day of reacting. On will be able to build such component crossed appears. Yet, we air under what decentation is we should be. The tool car of minings particular system function must be minimized. For the cap we could amortize the regimenting over several identical linear, or endow for-His techniques for the engineering of large function to that to disproportion to expense used to home by a particular array. Pushapa merby divide design actions in spread and of transfer from logic diagram to technological surface.

tion without myspecial engineering.

It may prove to become expensed to build large

systems out of another functions, which we requested years of a function of good of these conserved. The security of they distriction, another of with functional design and construction, should mean.

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a digital system. All, a considerable degrees in a gration all additions with a substitute of large when

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adoption will not change linear options and adoption will not c

will be allowed with the more interest. The last of large whose propriets and individual to the growth and individual to the property and individual to the growth and individual to the growth and individual to the growth and the property of the property Even in the microscope area, structures included in the

Článok Gordon Moore z r. 1965 Kde sa prvý raz objavil tzv. Mooreov zákon strany a oplatí sa

(naozaj má len 4 prečítať)

Fairchild

- Pre úplnosť. Neboli prvý dodávatelia tranzistorov. Od 1954 tranzistory komerčne dodával TI
- V 60. rokoch patrili s TI a Motorolou k špičke vo výrobe polovodičových súčiastok
- Boli aj neúspechy. Westinghouse im vyfúkol kontrakt v programe Apollo
- Neochota vedenia ísť aj do IC, plus výmena riadenia, plus ďalšie dôvody...
- Odchody zakladateľov
 - 1961 Hoerni, Last, Roberts -> Amelco, neskôr Intersil, Eurosil
 - 1968 Noyce a Moore > Intel
 - 1968 Kleiner -> Investičný fond
 - 1968 Grinich UC Berkeley
 - 1969 Blank

Intel 1968

Založili Robert Noyce (1927-1990) a Gordon Moore (1929)



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Intel

- 2020 príjmy 77,87 miliárd \$
- Cestu k úspechu ovplyvnilo mnoho faktorov
- Zamestnanci č. 3 a 4. boli Andy Grove (CEO 1987-1998) a Les Vadász
- 1. podukt bola 64bitová pamäť v r. 1969
- Neskôr 256bitová statická a 1024 bitová dynamická pamäť, pamäť EPROM
- 1971 1. mikroprocesor 4004

- 1982-3 Prešiel na komplikovanejší technologický proces CMOS, ktorý umožňoval menej energeticky náročné komponenty
- Od 1985 vyrába len mikroprocesory
- Katapultovali ju IBM PC, ktoré mali Intel mikroprocesory
- Jedna z mála firiem, ktorá si obvody stále aj sama vyrába

AMD 1969

- Založil Jerry Sanders + 7 ďalších z Fairchildu
- Podobne ako Intel sa venovali najprv výrobe pamätí, riešili rôzne technologické otázky
- V 80 rokoch kríza
- Neskôr sa im podarilo uchytiť na trhu z mikroprocesormi a dnes sú vážna konkurencia Intelu.
- už si sami nevyrábajú súčiastky

Ďalší...

- Vzniklo mnoho ďalších menej úspešných firiem, ale aj množstvo úspešných, ktoré sme nespomenuli.
- Rozvinul sa sektor výroby špeciálnych zariadení pre výrobu polovodičových súčiastok
- Do nedávna bol trend výrobu outsourcovať, čo sa v súčasnosti javí ako rizikový faktor.

Českosloslovensko

- Tesla Piešťany 1961
- Diódy, tranzistory
- Licencia dynamická pamäť 16kb na prelome 70. 80. rokov
- V 70. rokoch výroba IC
- 1984 CCD snímač 2x72 vert. 104 horiz. Bodov, 1985 2x288x384 bodov
- Tesla Rožnov pod Radhoštěm, výroba IO, elektrónky

Zdroje

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