CHEMICAL HERITAGE FOUNDATION

GORDON E. MOORE AND JAY T. LAST

Transcript of an Interview
Conducted by

David C. Brock and Christophe Lécuyer

at

Woodside, California

on

20 January 2006
(With Subsequent Corrections and Additions)

ACKNOWLEDGMENT

This oral history is part of a series supported by grants from the Gordon and Betty Moore Foundation. This series is an important resource for the history of semiconductor electronics, documenting the life and career of Gordon E. Moore, including his experiences and those of others in Shockley Semiconductor, Fairchild Semiconductor, Intel, as well as contexts beyond the semiconductor industry.

This oral history is made possible through the generosity of
the Gordon and Betty Moore Foundation.

CHEMICAL HERITAGE FOUNDATION
Oral History Program
FINAL RELEASE FORM

This document contains my understanding and agreement with Chemical Heritage Foundation with respect to my participation in the audio-recorded interview conducted by David C. Brock and Christophe Lécuyer on 20 January 2006.
I have read the transcript supplied by Chemical Heritage Foundation.

1. The audio recording, corrected transcript, photographs, and memorabilia (collectively called the "Work") will be maintained by Chemical Heritage Foundation and made available in accordance with general policies for research and other scholarly purposes.

2. I hereby grant, assign, and transfer to Chemical Heritage Foundation all right, title, and interest in the Work, including the literary rights and the copyright, except that I shall retain the right to copy, use, and publish the Work in part or in full until my death.

3. The manuscript may be read and the audio recording(s) heard by scholars approved by Chemical Heritage Foundation subject to the restrictions listed below. The scholar pledges not to quote from, cite, or reproduce by any means this material except with the written permission of Chemical Heritage Foundation.

4. I wish to place the conditions that I have checked below upon the use of this interview. I understand that Chemical Heritage Foundation will enforce my wishes until the time of my death, when any restrictions will be removed.

Please check one:

a. ✓ **No restrictions for access.**
NOTE: Users citing this interview for purposes of publication are obliged under the terms of the Chemical Heritage Foundation Oral History Program to obtain permission from Chemical Heritage Foundation, Philadelphia, Pennsylvania.

b. _____ **Semi-restricted access.** (May view the Work. My permission required to quote, cite, or reproduce.)

c. _____ **Restricted access.** (My permission required to view the Work, quote, cite, or reproduce.)

This constitutes my entire and complete understanding.

(Signature) _____
Gordon E. Moore

(Date) 9/14/07

Jay T. Last
Jay T. Last

2/4/07

Revised 10/11/05

Chemical Heritage Foundation
Oral History Program
315 Chestnut Street
Philadelphia, Pennsylvania 19106

The Chemical Heritage Foundation (CHF) serves the community of the chemical and molecular sciences, and the wider public, by treasuring the past, educating the present, and inspiring the future. CHF maintains a world-class collection of materials that document the history and heritage of the chemical and molecular sciences, technologies, and industries; encourages research in CHF collections; and carries out a program of outreach and interpretation in order to advance an understanding of the role of the chemical and molecular sciences, technologies, and industries in shaping society.

GORDON E. MOORE

1929	Born in San Francisco, California, on 3 January

Education

1950	B.S., chemistry, University of California, Berkeley
1954	Ph.D., physical chemistry and physics, California Institute of Technology

Professional Experience

	Johns Hopkins Applied Physics Laboratory
1953-1956	Research Chemist, Physical Chemistry
	Shockley Semiconductor Laboratory
1956-1957	Member, Technical Staff
	Fairchild Semiconductor
1957	Founder
1957-1959	Director of Engineering
1959-1968	Director of Research and Development
	Intel Corporation
1968-1975	Co-founder and Executive Vice-President
1975-1979	President and Chief Executive Officer
1979-1987	Chairman and Chief Executive Officer
1987-1997	Chairman
1997-present	Chairman Emeritus

Selected Honors

1975	Distinguished Alumni Award, California Institute of Technology
1978	Harry Goode Award, American Federation of Information Processing Society
1979	Frederik Philips Award, Institute of Electrical and Electronics Engineers
1980	Computer Society Pioneer Award, Institute of Electrical and Electronics Engineers
1988	Founders Award, National Academy of Engineering
1990	National Medal of Technology

1993	Medal of Achievement, American Electronics Association
1993	John Fritz Medal, American Association of Engineering Societies
1996	Excellence in Achievement, California Alumni Association
1996	Elected to Horatio Alger Association of Distinguished Americans
1997	Founders Medal, Institute of Electrical and Electronics Engineers
1997	Alumnus of the Year, California Alumni Association
1998	Fellow Award, Computer History Museum
2000	D.L. (honorary), Princeton University
2000	D.Sc. (honorary), University of Illinois at Urbana-Champaign
2000	Lester Center Lifetime Achievement in Entrepreneurship and Innovation Award
2000	PricewaterhouseCoopers Leadership Award for Lifetime Achievement, The Smithsonian Institution
2001	Othmer Gold Medal, Chemical Heritage Foundation
2001	Vollum Leadership Award, Oregon Graduate Institute School of Science and Engineering
2001	World Technology Awards: IT-Hardware
2001	Millikan Medal, California Institute of Technology
2002	Presidential Medal of Freedom
2002	Order of the Golden Ark, The Netherlands
2002	25th Anniversary Lifetime Achievement Award, Semiconductor Industry Association
2002	Bower Award for Business Leadership, Franklin Institute
2003	Elected Foreign Member of the Royal Society of Engineering (UK)
2003	L.H.D. (honorary), Johns Hopkins University
2004	Perkin Medal, Society of Chemical Industry
2005	Lifetime Achievement Award, Marconi Foundation at Columbia University

JAY T. LAST

1929 Born in Butler, Pennsylvania on 18 October

Education

1951 B.S., optics, University of Rochester
1956 Ph.D., physics, Massachusetts Institute of Technology

Professional Experience

Shockley Semiconductor Laboratory, Mountain View, California
1956-1957 Senior Technical Staff

Fairchild Semiconductor, Palo Alto, California
1957-1959 Senior Technical Staff; Co-Founder
1959-1961 Head of Integrated Circuit Development

Amelco Corporation, Gardenia, California
1961-1966 Director, Research and Development; Co-Founder

Teledyne Technologies, Inc., Gardenia, California
1966-1974 Vice President, Research and Development

Archeological Conservancy, Albuquerque, New Mexico
1980-present President

Sierra Monitor Corporation, Milpitas, California
1980-present Director

Hillcrest Press, Inc., Santa Ana, California
1982-present President

Think Outside, Inc., San Jose, California
1998-present Member, Board of Directors

Honors

1999 Hutchinson Medal, University of Rochester

ABSTRACT

This oral history with **Gordon T. Moore** and **Jay T. Last** focuses on the years 1956 and 1957, during which time Moore and Last worked at Shockley Semiconductor Laboratory and Fairchild Semiconductor was founded. This transcript is about the life of ideas and the people who brought those ideas to fruition; Moore and Last reflect on their experiences during these years while flipping through an old notebook that documented various aspects of the meetings they had over an eighteen month period. In order to fully understand this oral history, the reader must consult the Supplement to Gordon E. Moore and Jay T. Last Oral History, oral history number 0327S, which is also part of the Chemical Heritage Foundation's collection

INTERVIEWERS

David C. Brock is a senior research fellow with the Center for Contemporary History and Policy of the Chemical Heritage Foundation. As an historian of science and technology, he specializes in oral history, the history of instrumentation, and the history of semiconductor science, technology, and industry. Brock has studied the philosophy, sociology, and history of science at Brown University, the University of Edinburgh, and Princeton University (respectively and chronologically). His most recent publication is *Understanding Moore's Law: Four Decades of Innovation* (Philadelphia: Chemical Heritage Press), 2006, which he edited and to which he contributed.

Christophe Lécuyer is research historian at the Chemical Heritage Foundation. He holds a Ph.D. in history from Stanford University. He has published extensively on manufacturing districts, university-industry relations, and the history of electronics and scientific instrumentation. He was a fellow of the Dibner Institute for the History of Science and Technology and taught at MIT, Stanford University, and the University of Virginia.

npn
pnp
flow polish

flow soldering - careful - tidiness counts

Status 14/6/57.

the lab - 3 weeks from today — power — Rm 1
— rooms — Rm 1
— cable — Rm 1
— not pressing

phones -
— partitions - until next Tues - Thursday
cabinets and for lab
formica

Plumbing contract not out.
→ Power in small rooms -
→ layout office
Run H, O₂, N₂, A ?? flow meters?
→ Distilled H₂O

14/6/57

— personnel requirements —

→ NPN computer — GEM
→ PNP " — JAH
→ PNP NPN — JTC
→ DCTL - direct coupled transistor logic - low saturation voltage (NPN) ↳ D.A.?
→ Power switch - to see the power

Power oscillator - tone depends on photoresist RNN

Materials -

CSL - Canton Trip 11/6/53

Pau: $SiH_4 \rightarrow Si$ to 10"

RCA Summerville NJ (2 days) WEBSTER Alb. Leudolph + KLEIN KUEHNT + Hinds LEDERHANDLER -

Established work ~ 13 ~ Wafers stable (1-2%)

Post setup discussed

Staff meeting 11/11/57. Plant Maint.

hourly vs monthly Steam work

Requisitions - Project heads to $1000
" " + Bob 5000
> 5000 Policy committee

Carbon forks ?

Tool list

Receiving and/or stockroom clerk.

procedures will be written up by Max

write up

- Patent Attorney -

Staff Meeting 11/18/57

		Finished by
→	power transformers here: 2 weeks to go	12/2/57
→	ceiling: started today 2 weeks	12/2/57

(this is only for main power - no hood power)

→ plumbing, sewers etc } laid out
gas, air

→ air handling - blowers, pressure : laid out

→ small rooms: 12/15/57.

→ benches & hoods: finished by Dec 1
cabinets: arrive this Thursday - also 6 hoods.
furnace benches: arrive today

→ phones: no estimate 2-3 weeks DIAL-6695 in 2 weeks
4 trunks

two estimates to J.B today
1 up to 12/31/57
2 up to 3/1/58

Hodgson called:
off Dec 12.66
Desire mgr.

Condex file: CSR

Patent agreement: nothing to find (Minney).

Patent attorney: Flair & Swain - want on this.

÷

When do we want to get into production:

Jan 6 Sawing JB ⇒ how fast to production date shown
Orientation CSR
Lapping (routine) JTC
Crystal evaluation

Mar 3 photo etching RNN
taping diff NPN GEM

Mar 17 evap & alloying GEM

April 1 assembly NPN R.B.

April 15 test & selection VB

May 5 PNP diffusion JAH.

June 2 polish & thickness JTC

June 15 PNIP JTC

Improvements for production - low tech shells in general
∴ we write production specs

Dec 1 Jan 6 Feb ∴ 13 more tech profile by 2/1
after 1 test Sr. Eng. JAH. 2 test Sr. Eng. VB.
month test
Hall
Junior eng. give 1

Engel - write him saying no real interest

Melillo - flow impedance 1AH. 8 hrs at PSI - wants him up.

hire people than agencies at the moment.

Staff meeting - 11/24/57

Beg coming 1050 7mo $12600 Jan 1

in and out baskets -

new P.O. procedure - J.B. signs all P.O.'s

Bendix Transistor requirements #10^6

Power - transformers arrived today
power turned on Dec 7.

Plumbing -

Ceiling - first half - first of next week.

Partitions - start today - 6 days work

Cabinets - here

Formica tops -

Drawers - here

Tops -

Phones

Distilled H_2O - in the lounge.

RF Generator - on its way

Lodgson: Security clearance - see Russell

patent attorney - Contingent fee

Mining bill Lodgson quotes $10,000 total bill 25K

Hodgkins afterward Ben Hobin and Lincoln about 10K

3 types of ~~[illegible]~~ agreement with Bell

1) patents only
2) technical liaison + patents
3) " " " + 25K adv. royalties

Staff meeting 12/3/57

tells: S.C. Technician
electronic technician
project engineer
sr. project engineer

DPK: KEP Inc. UKB
$250,000 Ford

Manager: Friday, N.Y. Times, ad.
Wall St. Journal

John W ECMA
Elect. Ind. Assn → preformal proc. Ind.
→ register transistor types
(to keep out that will steal idea first announced)

Patents: Hoboken will sign a patent agreement.
Buy: — sign std agreement.

Merger question - do we want to make this
transaction
U.S. Instrument
Mastertronics

For:
- product zoom
- available market (on contract)
- point out prod. problems
- test news (long term commitment)

Against
- Now company available
- against the big boys.

Irving 12/2/57

Power - Cut over today or tomorrow

Plumbing - about 75% of awarded

Lights - tomorrow

Ceiling - doing along o.k.

Rooms - rubber moulding outside only #280
Completely finished beginning of next week

Main lab Exhausts: #3500 incl 4 blowers

Phones -

RF Streets: this week

Tops: start to dribble in soon

Wax floor: sometime this week

Poly sinks - BIND -

BLOWERS:

SLICER: this week?

Personnel: → to E.K.

Max after every body is hired

Rate of Placement of tech personnel - [illegible]

to production

EK

Supervisors - some tech skills — chg of tool grind
Design
devices assy

~~Entry~~ group Level girls

employee evaluation by senior personnel -

we will need BS MS engineers

if we want to add people we will train & start soon

15 tech staff — 21 employees

we can work up to 30 people 5-6 technicians now

~ about 5 engineers

Prog testers & inspectors technicians $500-600

Cultivar committee

Potter
Steve
Clifton
Klemsch.

30

12/9/57

Staff meeting:

Hale visit: accurate forecast on budgets
sales

Fairchild organization

Fairchild Controls } Components
Electronics

↓

wholly owned subsidiary of Fairchild Camera

applied for security clearance for facility on Fairchild subcontracts

Mostert → Harlan Fowler ← 220 →
Beauclair → Phil Peeters ← 375 Review contracted tools - monitor shop work

Technicon Paul Hinchliffe Surveying 1/2/58 400 400 Bus Ad Criminology

Beyond of March:

Gayle Technical
Phil
Max
Haley

23 now

Rigging Tomboy 3 technicians Janitor } by Jan 1

Mechanical drawing
Silicon
autotesting

Jr Engineer → Jan
technician - Robert Jan 20
technician - Richard Feb
Sr Engineer - Ernest
technician - Jim - Feb
technician - Ernest Feb
3 technicians - need for people
going to production

total 38.

Ernest to get receipt for April budget

⇒ Make out a project budget: equipment, supplies, materials

(get predicted schedule from Bob)

written purchasing procedure PO cards vs #10-25

no charge accounts PA Hardware, etc.

Bill Chelsey - prospective Mgr.

Ad - Tim or Wood for a Mgr.

~~Power~~

Facilities

Power ON.

Secondary power: Owens doing now

Plumbing - almost done - back in gas line

Sewer - some more CM tuffing to go -

Ceilings: almost done.

Partitions: being painted now.

Racks: start - on Wednesday

Wax floor the Tues perhaps

Phone: all done

Poly sinks: big bind still 3 weeks to go

32. Staff Meeting: Monday Dec 16.

Chief of Air Force security Wed A.M.

Baldwin - Head of Product Engineering

Facilities:

Power: primary OK

secondary: all will be done by Owens to bench some plugs and bricks.
all in the week.

Plumbing: - waiting for sinks & bench tops

Gas handling: waiting for valves

Poly sinks - 3 weeks to go; stainless steel will come - with sinks

Lab bathroom doors -

Hoods:

Tops: many in today:

Exhaust system - recirculating system.

Electrical 14K —
Ceilings —
Partitions
Plumbing - 5K
Phone
Cabinets —
Tops
Misc. tooling
Compressor etc.
Pads etc
Floors —

Leasehold 40K
Off equipment etc 20K

Purchase Orders: want a written procedure

Welder, Rod of Jon
cold welding press - ??? 5K - 7B soon -

monthly payroll: about 25K by March - 30 people

Employee Relation Committee:

not a grievance committee - just to set policies
purchase of material from company - Yes
Lab tools overnight & authority - Lack of tool holders.
Coffee - catered 1/25 gallon. 10 AM.
3 PM.

34

Meeting 12/23/57

Missed -

Meeting 12/30/57

- Distilled & D.I water -
- Fume hoods -
- Blowers -
- Power - another week
- wire up micro-mach - Hall to do some soldering

two technicians needed - CSR
the Hybrid

two technicians
two comp. engineers

Welder - hot water order - due Jan 30 -
no cold welder ordered yet

$75,000 spent in Dec.

a detailed Budget is needed month by month -

inventory system needed

1/2/58 Report on IBM meeting R.N.N.
Dec 20

3 general categories

low power 150 m W at Room temp
→ core drivers 1W
Servo Drivers ½-1 amp 10W out at 100°C (Available from GE, TI)
↓
saturation resistance pow

What they want for computers €

		would like	can get (npn, selected)	
collector saturation	R_{cs}	10 Ω	100 Ω	
input resistance	h_{ib}	39 Ω	50 Ω.	1 ma
	h_{fe}	70	80	20 ma.
gain bandwidth	f_{ab}	20	30	
	C_{ob}	1.6 μμf.		20V.
collector breakdown	V_{cb}	40V	> 25.	used in a 28V system
Power dissipation	P	125 mW	1 mW/°C.	

they need good matched pnp's to go along with these.
(Low loss can only be done with double diffusion + no mat'l lock techniques usable)

Reliability - GE has baked at 200°C.
Power rather than glass seals.

Want to cut out all random catastrophic failures
put in a detergent filled bomb at 50 psi -
bleed tests

Texas Co.

Samples by end of first quarter - 20-50 or so.

Quantity requirements in a year. 20-60,000

36 they will go to Ge + air-conditioning if they can't get Si

clamped RC coupled logic

haven't thought in terms of large signal parameters yet.

symmetric transistors to simplify the logic

Core Driver

DC β 150ma 60-100

f_α >2 mc.

h_{ib} 30Ω

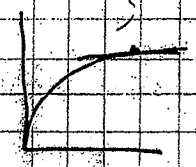
1W @ 100°C. (not radiation ~250ma)

V_{ce} 60V (this is high)

R_{cs} 2Ω (can get 100Ω)

V_{eb} 2V

rise time .25 μsec.



should be specified:

I_c = 150 ma

V_b <

I_b <

drift transistors may come close to this.

They will use 2900-3000 of these now (contracts out now).

10 computers at 100-200 each. will pay $100 each for first 500

- this will be used as a high freq power switch -

main thing - get the saturation resistance down. Inside diffusion

this is a point area in transistors at the moment -

TI 903
Ge
Transitron
Hughes
Motorola
Raytheon
} all getting into 5 mc area.

Edlpo - Pioneer - using to drive servo amplifiers
low freq (DC).
get bet 100°C (also gain at -50°C — need
good lifetime for this)

Diffusion advantages:

make pnp
high α
inside mesh - interdigitate
put in intrinsic layers.
uniform large area.
leads have resistance
easy to collector heat sink
(avoid encapsulation)
handle a large no. of elements at once

Disadvantages

lifetime (low β)
hard to make contacts.
(high saturation resistance)

∴ push any pnp.
interdigitation

smallest island 5 x 5 mils at the moment.
completely surround the emitter.

Should we head for the core driver now?

get top side structure on npn
try to lock β up.
back side diffusion as soon as lapping is in good shape
Bob Noyce a missing
[redacted] & cutoff no problem now -

Jan 6 - 1958 Policy meeting

Poly sinks - one - last Friday

Marigolds

1 hood by Friday

Evaporator working

→ check all Beauty queen cabinets ←

→ clean up as soon as possible ←

~~Interest~~ on loan will be about $50K a year

Budget summary

Oct 1 - Dec 31 Total salaries 45 K.
op expenses 80K
Capital exp 91 K
$216

1958 - whole year - budget
Salaries 334
op expenses 360
cap expenses 216
910

1959 - first quarter 2)

Total 1,388,000
thru March 1959

R&D Technician in Feb. (Uc)
Sr eng March
Sr eng April (Uc)

Σ = 19 = 150K for pp

Administrative

supporting 44 K

Production 23 people EK + technicians 958

Feb - two 3 technicians } Houghs
Mar 1
April 2
May 2

£ = £48,540

Do we want engineering people full time + production?
Who does what has to be defined - detail as for a
transfer things to production.
At what stage is this necessary - as soon as line is running smoothly
we can get on bidders list

Jan 20 - member of Finished Board coming - Coldbrook -

Managers - get Baldwin up again to see Hodgson next week

Ben Fisher - out here this week - on 8th or 9th
experience - plant management - Ex Procon
→ Std Coil now

Jordan Boyer -

Houghs - Comelo - Paulkin

Wardrobe - talked to - Dysart 57 salmon type
don't get along well scientific staff
→ out this month

90 1/13/88

Diffusion – no hoods, DI water
Ga Co OK
Sb – just getting started – oxide masking not working
P – " " "

B diffusion OK. – can't see oxide marked (24 hours) 10
Rad B OK – wafer $\approx 5 \times 10^{20}$
doping to Sb – 6 gal thick oxide – wafer $\approx 3 \times 10^{20}$

make an appointment with Sb & Ga (Dave)

Masking – ~~photoresist~~ worked one.

Mounting – jigs not built yet

Encapsulation – not well set up for the ridge furnace

Glovebox – Al or Cu ??

Stds – new sputter system has the moving control system developed
Stds freeze out – new oven + oil box being built

tomorrow – another try

1/13/57 Policy meeting

1/13/58

4

Educational summary

1. Blue Sky - large group
   short-term courses - 4 people
2. Technician outside education
   inside education
3. Formal education

Proposed that we have an orientation program - minimum 80% of expenses. Pass the course

Present:

Voting Power

Carlson
Hodgson
Hill
Nance
Weiss

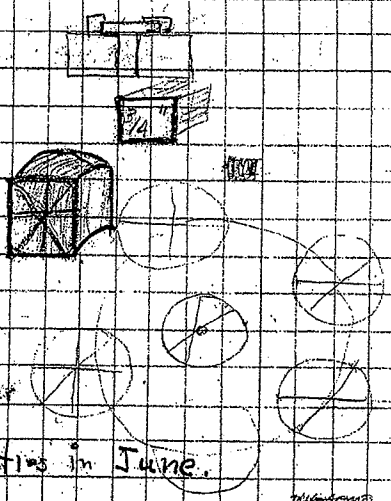
Minority bill:
Employee information

1/20/58 Policy meeting.

50-200 mc.

low power npn
pnp.

Trans Emp coast:



→ 50-100 mc low power npn } OR ?
switching transistors pnp } core driver

core driver - small Eng. quantities in June.
to 100°C.

→ no spec. sheets to anybody for a couple of months. ←

25,000

250,000

When head motors
compressed air
pressurizing
clean up the lab.

CSR more concerned about timing than $
we don't want to get out on a limb

Chas Colvin - ~~director~~ director FCI. visiting Colvin Labs.

Hodgson Wed.

Clean up this weekend FRIDAY

1/27/58 Policy meeting

Purchasing: hold ~ 2 copies - 1 to purchasing
1 to project leader

$5000 committee approval
2-5 Manager + 1
over $2000 - 2 people
up to 1K project leader
up to $50 Brown etc.

- Progress Reports - due monthly -

Conversation with I.B.M.

new specs. 80 fortran
40-2 rb
30 (20 min) β

100 in 6 mos
10,000 next year

- 62 committees -

2/3/58 Policy meeting.

IBM ready to order 100 core drivers @ $150-200 ea. 6 mo delivery
replaced s/pn

Bay visited
Harold Jacobs - Signal Corps SCEL. want to see what we have done

Diffusion	Structure & Encapsulation
JAH	Belm
DA	Murray
Pauls	Brown
	Noyce
	Parker

Project 109
110
new lapping #

to make decision on pnp - npn ... Ed Baldwin

9 AM Thursday Technical Meeting -
(...) - Noyce -
general information & coordination session
bottleneck session

we want

1 ohm cm N
P

20 ohm cm N } for back side diffusion
60 ohm cm P }

no twins coming thru from now on. boat turning
111 stockpile
grow 100

Tom Ray, Emp 2/7/58

Jordan Scientific Corp Richard Chaney
Ted Park Sec'd to the Physics

Company - recent R&D possibilities PSI Evaporated thin film Impedance
Temple Diffusion oxide masks

Submit contract proposals -

B. Reich -

Sperry - Contamination system per pc 10⁵/month complex
pnp core drivers & npn, pnp Logic just like IBM

Arma - Processing 5 per - 500 hr life Reliability
guidance system for Titan

Hycon Eastern - nothing of interest

Epsco - Boston shift registers
Digital voltmeters
core switch

IBM Omega rise time in switching pulse
20 nsec minimum only bandwidth point
-20 to +100°C - $200 - $50 prefer pnp
We should weed out the bad ones

WADC pnpn in basic load → only possible R&D money
$10 mc Reliability Working Inverter Warning on Op
20 amps unit

Summary
get cost samples to get point contacts

Tech Meeting 2/7/58

our problems now

what about β

what about a single metal for contact resistance

no wafers soldered on headers

no metallized contacts yet

No high-freq. measurements

flow sheets to follow process to close circle

Staff meeting 2/10/58 2/10/58

Baldwin here

Personnel requirements
Publicity blurb -

IBM Owego quote i 2/8/58

open for npn → pnp 6 max. - $150 for 100

current gain question low temp β min 20 at -20

IBM will prob. use 2000-3000

Baldwin: Romo, Hughes, etc } sold our rejects β min down in spec.

Litton

Sperry??

Sketch

Baldwin numbers

BV_{CEO}	40V	P_C	100°C 1W
BV_{EBO}	2V	T_J	175°C
$I_{C\,max}$	500 ma	I_{CO}(100°C) = 200μa max @ V_{CO} = 30V	
h_{fe}		I_C 150ma V_C 10V	20
$r_{bb'}$		I_C 50ma V_C 10V	40Ω
f_{hfe}		I_C 150ma V_C 10V	80 Mc
R_{CS}		I_b = 10ma I_C 150ma	10Ω
C_{ob}		I_C 10ma V_C = 10V	30pf

EB ⇒ electronic test gear for production needs emphasis

Bernie Elmiger → electronic circuits automation, test instrumentation 3-4 technicians $13.5 + 10% bonus

2/10/58 cont'd

keep any stock out of production

what does employee think they should be doing

how much will production slow if 3 guys quit cost $70-90,000

spent 100,000 in January $80,000 standard improvement

evaluation report on 3 bad pipes

process & product manuals. (Dolphins)

2/13/58

Tech meeting

Problem areas:

Diffusion ops
what about lifetime
polishing, cleaning?

Mounting - Ouvrahm: Silver solder needs a flux
heaters only go to 400°F - two part time.
Photoresist + Ag + Sn ?
Header meeting in order
Evap. cleanup - good in temp & outgassing
→ Wafer won't hold up at the moment
Silk screening - printronics
Contamination due to photoresist - better clean-up procedures necessary??
Lettering - B 2→20 how much did mask change?
I_{B_0} 10μa at 60 V on pnp.
Nat Situation improving

50 Staff meeting 2/17/58

Radburn: Necess. functions:

R+D | Eng | Ems. | Mfg | Q.C. | Sales

R&D: Prod

Devia Desp
Gen.

Mfg Process
CSR

Devia Gen.
Mfg

Tech Consltt

Eng. Services | JB

Eng

Plant Eng
Purchasing

Tooling

Maintenance

Pre-Product
Pur
Produce only
meet schedules

Elect. Section
Design & Substitute
Tool Gen

Design

Fabrication

Mfg E.K

Prod. Control

Lines

Mfg Engineering
Cost reduction
Emp & motion
Line flow

Inspection

Pro mell

Quality Control

Quality Assur.

Ship Test

Life Test

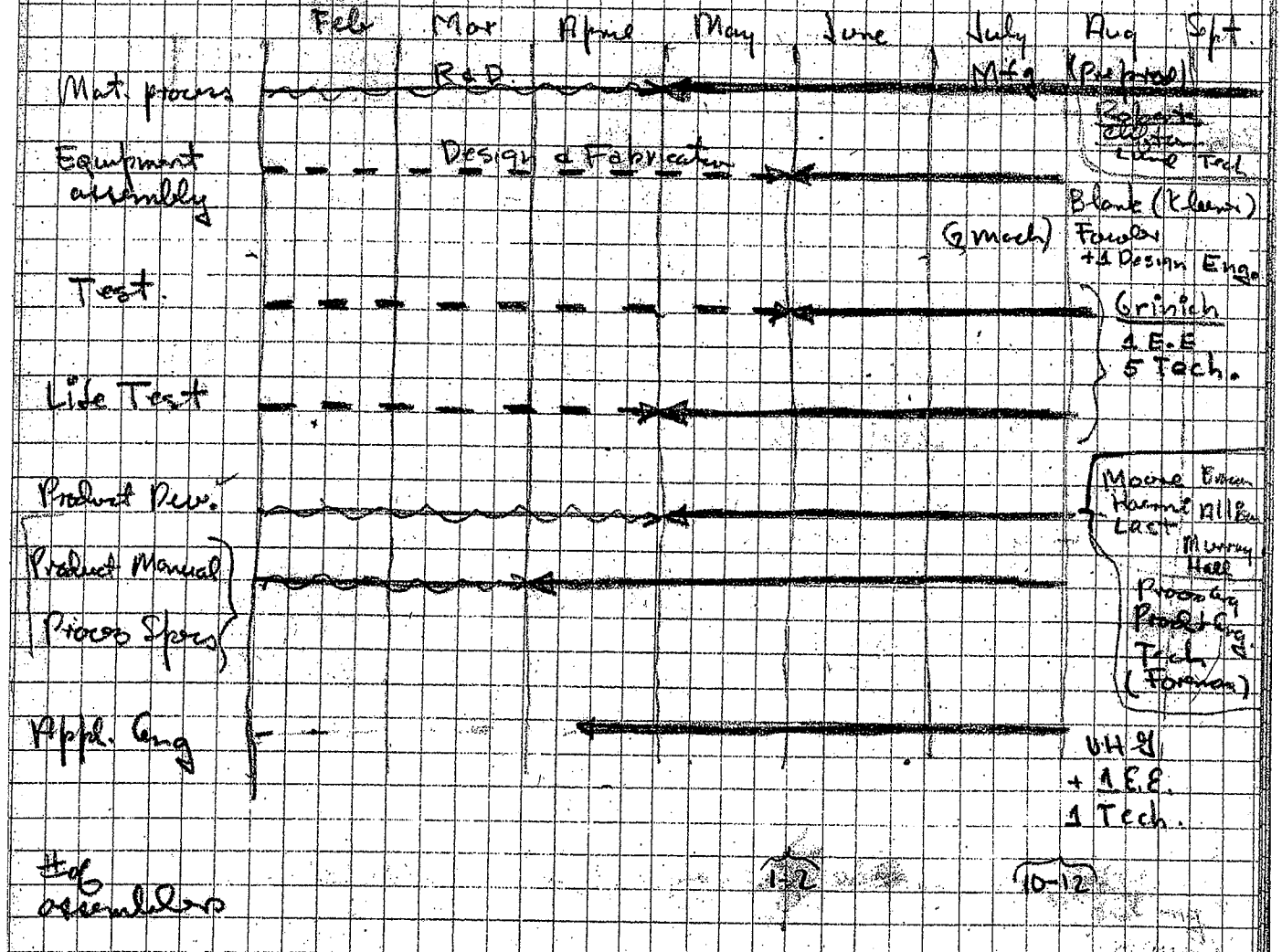
Sales T.B.

Sales Eng

Liaison

the above will take place ~ 6 months ~ 150 days after first product

IBM 1000 units by Aug 1 - 58
We should have production rate of 1000 - 2000 units/wk.
by this time 1000 hour life test
almost two months before August.



— Additional investment for the most part.

pre production equipment budget figure by $100,000

5c RNN

Assume we have IBM Switch - what do we add?

(Same thing + smaller geometry - logic transistor
low power high speed)

add identical Kirk NPN instead of PNP (or v. versa

Follow this line } back side diffusion - accurate doping

No Major Capacitance Change

PNIP

Power Oscillator

PNP low R_{cs}
(NPN)

IAmp PNPN

High Power heat sinks tens of watts

PNP } power switch
NPN }
PNPN 10^T amp

simple geometry
then interdigitation

spend time & effort on { interdigitation / small geometry } 10W 100 mc.

Staff meeting 2/24/58

LRL trip : RNN

Ramo - computer people
Hughes - cellular city
Hughes - ground systems
Fairchild - pat. div.
Plant controls
Lytton -

Ramo - OK on downgraded specs.
have transistorized almost everything (using GE mainly)
down on TI because of reliability (Philco good)

Hughes Cellular city - radar
computers → 2000-3000 transistors/machine
¼ Si because of low leakage
¼ mc clock. (mod freq)
direct coupled 0.3 μsec storage
on current to mcs
want high DC. β line.
all Ge units

using GE
Raytheon
General Transistor

would like a pnpn thyratron as an output
(using a flip-flop now)

{ airborne systems people need Si now
{ ground control people not so hushed

Ex 2/14 Cont'd

Hughes ground systems - Bob Anderson

Hirsley - they went to TI silicon & got strong on reliability & availability

so they are stuck on Si now.

Fairchild Part div. - they have shake table 60g thru audio

96 hour test -

welding & metallizing

Lytton pushing epi base back up

using 900A + 2n Transistor

↳ change from TI design to produce

½ mc clock circuits

higher V_{EB}

V_{CB} - 10V-12V at ~1μA

base-emitter voltage ~ on - .7-.9 V.

10-20 ma collector

3 ns

higher β (~30)

applications: reading & writing magnetic storage

core drivers 8720

pnpn thyristor to replace relays 100ma - 1 amp

CB: ready market for any device with some slight increase in specs.

we must get strong in reliability

free development samples in May. 2/24 Conf

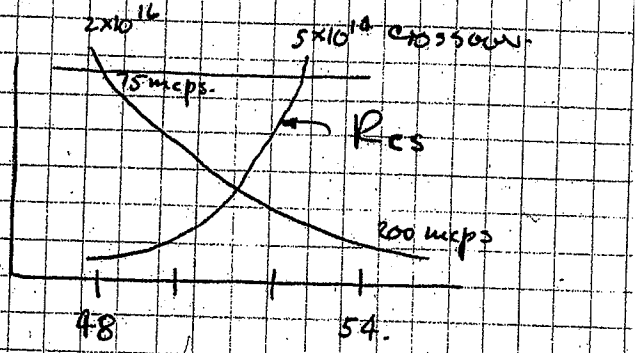
pre-production samples in July (at a price)

large scale production - end of the year.

Forecast of capital equipment requirements:

Now interest in saturating circuits → lower on resistance DCTL

10^{20} in from back side C 30
10^{18} in from front



Spr: 50 ± 2 μ.

C_o ± %2.
back side

~~Rhodesian~~ pnip

we can sell the whole spectrum.

argument: wants better but variable

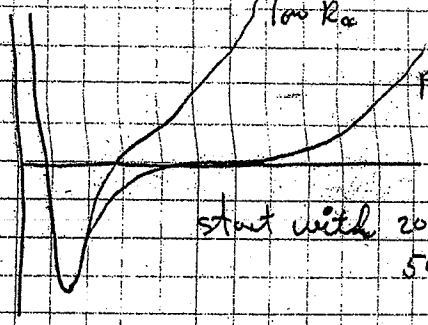
problem contamination

make our downgraded spec transistor now.

put some effort on this - if this is in good shape by May 1 put this one in production

first device should be npn (reliability)
get up.

work then the pnp with back side diffusion



increase thickness 50 ± 2
100 ± 4

EB: Conclusions:

Target NPN IBM Omega with downgraded specs

	FEB	MAR	APRIL	MAY	JUNE	JULY	AUG
mech equip (new)	3000	13,100	3600 36,000	10,600	5600	4600	9200
mech equip (misc)	—	4000	3,000	—	—	—	—
elec equipment	5800	6100	5300	27,300	27,300	27,300	2,300
new estimate	Σ 8800	23,100	11,900	37,900			
				Σ=80,000			

mech equip (new) (no leasehold no furniture labor) } 72,650 asap
8,000

lifetest equipment } ~ 10,000.
new lifetest

Σ = 92,000

Pre-product (few samples)

Eng Samples 2000/week.

Diff between old & new estimate = 12K.

start production buildup here to get to 20,000/week

$200-300 K

Twelve evaporation slide Tel apparat. already here

racks vibration shaker

Income projections (go-this year)

July 1000/week @ 25% yield

½ (go after tax)

∴ 100 salable/week @ ₦50-150 ea

avg = ₦50

∴ Income ₦5000/week July $ = 20,000

end of year 10,000/week at current rate.

if prices down by 2x

yield up by 2x.

Aug 15K/week

increase 10K/month

5	July
15	Aug
25	Sept
35	Oct
45	Nov
55	Dec

≈ 200K

then up exponentially

± a few months

2.5 - 3 million sales next year in this area

if they are reliable

2/27/58 Tech meeting

- sputtering etc

heaters 1000 W 4 types

3 Composition Body
Kovar - glass — more reliable

→ Kovar leads probably - hi temp solder to 1100 F

Make our own disks

Ag Sn 220°

La Rogue Signal Corps - Chief Solid State Group.

→ metallic etching

Photo resist in ill repute

omitter efficiency ??

to improve β cleanup

→ go back to 1 Ω-cm material
(or even higher)
Must base ε to 10^{17}

Background believe emitter efficiency & lifetime degradation
β-3 at present.

3/2/68 Palm

membership on JETEC
EIA RETMA

JETEC 14 W –

Tom Bay JETEC member

Alternate Vic Grinich
Julie Blank

IBM Order here 100 @ 150

1 W output at 70 mc 900 good units

La Rogue $ max 250 mc 25°C 35% efficiency
$500 K back side diffusion
small geometry

La Rogue here tomorrow

Yield: Final seal yield will be the number used.

10 AM Wed. Contact meeting

Budget - AFU.

R&D pre-med budgets have to be split up.

Tech meeting March 6

Brand – 30% off – 70mc

pnp > 80mc only way to hit specs. $\frac{r_b}{f_\alpha}$ $r_{es} = 10\,\Omega$.

Impurity profile within 5%

r_b 735Ω

$\frac{\mu_e}{\mu_h} = 4$

$\therefore$ r_b now 100Ω npn

3.3μ base needed to get 80mc f_t

pnp 20Ω npn 120 same geometry.

				mobility transit time
pnp	β: base width 2μ	β = 15-25		
npn	3μ	β = 3-4	10^{19}	
		β = 8-10	10^{18}	
		β = 12	5×10^{18}	

N. floating

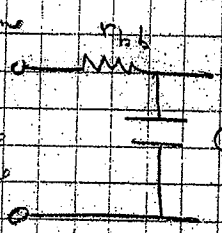
we need 3μ only f_t

	npn	pnp
$\therefore$	f_α = 150	80
	r_b = 100	40

P-doped Ta2 short thins on 3μ layer.

62 We need measurements

rise time



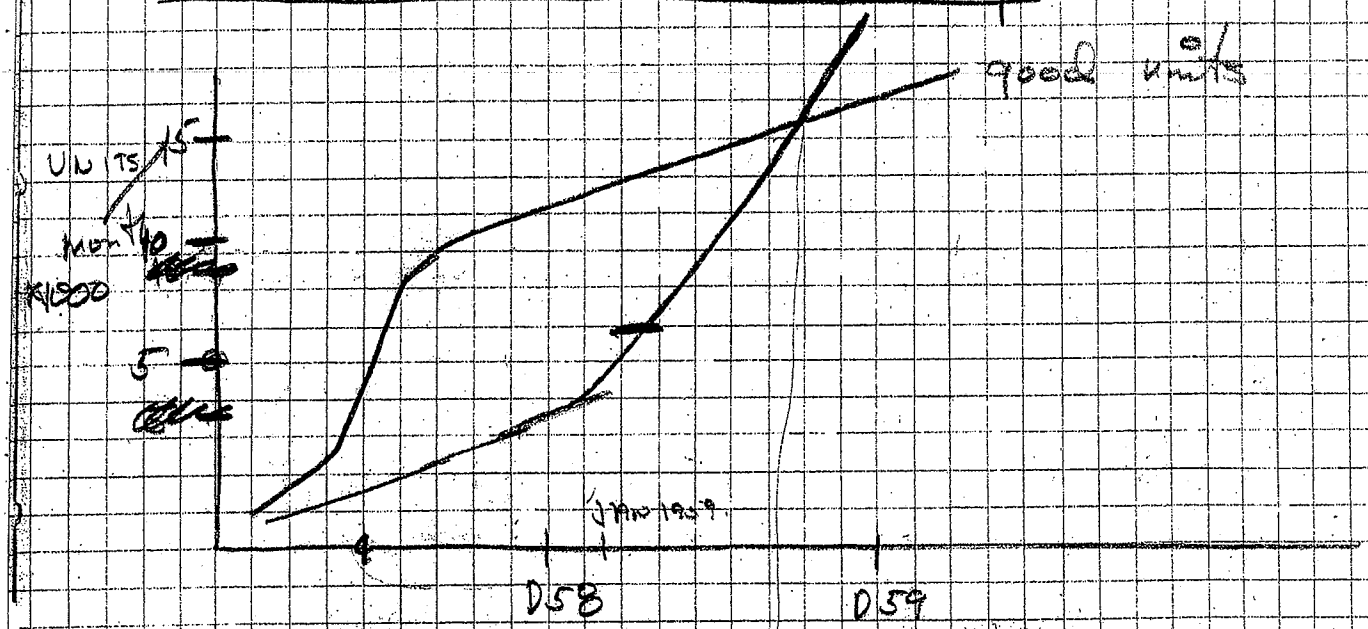
$t_r = r_b C_Q$ a $\frac{r_b}{f_\alpha}$ the important quantity.

μballs

photoresist contaminant —

Policy meeting 3/10/58

I.B. Estimated Sales Buildup



Aug-Sept 1958 Announce product(s) WESCON

selling as many as we can make.

Then in a conservative sales growth

(probably will do better)

Unit price: Avg price ~ $10

Most sales growth exponentially

(price drops) Sales volume doubles/year.

Est sales volume '58 $200K

'59 $900K

Break-even on P&L middle of '59

1958 produce 23,600 good units

3600 use keep for test

2000 give away

18000 available for sale

have 3-4 months inventory on hand.

(to get increased equipment to allow for increased sales)

EB - we should be able to double this sale picture

MARKET: SRI lots '56 predicted 1957 sales $3,000,000 Si transist

1958 $8,000,000

1959 $19,000,000

TI reported $15,000,000 semiconductors 1957. out of total sale $65M

// ~ 1,000,000 units

- Transitron - coming up -

[redacted] 2-3% of [redacted] business in conservative estimate

[redacted]

Hull Budget

MS

thru 1957 245,000

~~about~~ 1958 957,000 +150,000 (new estimate)

~~∴ out of money in 1958~~

total thru Feb '58 357,000

rest of 1958 1,000,000

∴ out of money – end of 1958

no room for second product till middle of 1959 on original budget.

Second facility? [redacted] 60-100,000 ft2 = $25/

firm decision on php – mpn April [redacted] 15

66 Tech Staff meeting 3/13/58

design - $V_{B_{b-c}}$ are low by a factor of 4 800 → 75

what will npn - pnp - have

npn

2.2 μ base β = 40-80 $\left\{\begin{matrix}650\,\Omega/\square \\ 4\text{-}80\end{matrix}\right.$ instead of expected 300 Ω

Co-op diffusion Plus offset Ga diffusion

Xtal 59P pushed in 8 μ.

Chicago meeting

electrochemical potential; means.

pnp

Junction 2.2 μ. β = 20+ R_s = 700 Ω

Plan for npn - pnp decision

Set week beginning March 31 for production runs

Basis for judging - moms -

rewafers/batch - 5 batches in a week.

- 7 batches of which 5 are chosen - how thick?

250 wafers

we need vac bake-out furnace & atmosphere around welder

Mar 17
Mar 24

40/day =

- by Aug 1 handle 100/day -

Material situation

- Sb not available —

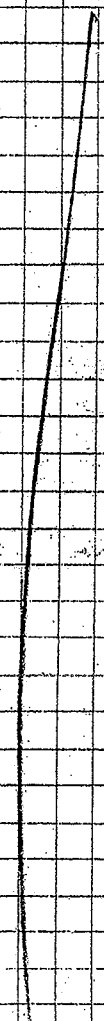
Phos
- 51P shorts 100
- 58P good 111
- 59P.

As now available for slicing

We need a resistivity spec for resistivity

2-1

2-0.5



March 30. Policy Meeting

GP Board meeting - 90 along with us this year -
another board meeting - a couple of months re new facility
Complete 1959 forecasts - in a couple of months.
grant contracts?
record products?
Costs for one product - O'Donnell for two

RNN Electronic Industries Assn Meeting -
Office of Sc. Res. ARDC. - Yost
90% of work - big name at universities - fundamental work
mechanism of diffusion

O.N.R - some stamp - academic work - big name
all on basis of unsolicited proposals
no interest in hardware at all

DOFC. - Fathop

Signal Corps - Belmar - Cleary
no money now for anything but
contract continuation
If they have money:
Ultrasonic phenomena & solids
Photosensitivity
Low temperature - low noise
Binary & ternary compounds
Si & Ge
Solid energy converters
new Si technique
Paramedic amplifiers
Si perfection

it will take about 9 mos to get money out under contract

(new techniques - Si early ~ 1959 perhaps)

IBM — Coming out here in 2-3 weeks
- Browning -

may or equip circuit parameters hard.
talk over more reasonable acceptance specs.

send us out test circuitry.

Sweden people - good complementary symmetry work

Philco } saturating circuitry
Sperry }

saturating vs non-saturating currently battle
Lowitzer

Philco getting rid of non-essential resistances

Si alloy - emitter efficiency problem - ?

IE - 3 dec ppm 200V/— 4 hrs no data sheet yet

non testers

Sonnenstein - fluidics solder - work under contract on ultrasonic techniques

Overtime problems -

Equipment door request -

Tech Staff Meeting 4/3/18

1) npn used - good content next pulse spec
but not PC spec always - high Ic

2) exp - Ky, c sheet

↓

rbs, Cd

3) Timex 10ns (better in the 30s)

npn used - bad - high input impedance

20V - 5 ns

10V - 8 ns

7.0V - 12 ns

SIP - 2 leads

58P - good - high resistive material - highly doped

59P - no shorts

64P - weighted shorts

71P - no high shorts.

Alborg
Vose contact tlf kontakt per sked
Bor Ballog

Policy meeting 4/7/58.

merit increase - 2% / 6 mos. normally 4-7% / year

adjustment of inequities or first go-around.

hiring requirement salary 1% of total payroll. → after 2 months

one ½% for "merit" increase total 2½%

Dept heads decide how the pot is split up.

Review annually in one day - April 30
Sept 30

Review annually at once.

Advantage for counting part of time
Need to get comparisons at one time

Don't mention cut of living

Time sheets by April 15th

New rate #10

$25
$25

Tech Meeting 4/10/58

Allergy problems.

9AM Monday - allergy

2:00 Monday - PNP. NIMH decision

Tech Meeting 4/17/58.

Wed 10:15 new meeting date.

Product Manuals.

Hole, insulation - CSR.

* Saw + Lap JTL

Basic Design UHG DA JAH.

Discussion JAH DA

Photographing Mailing RJM JTL

Cover, Ribbing, Back, Base, Mounting, Wedges } GEM. R.B.

Test Program Characteristics UHG

FINISHED BY FIRST OF MAY

WEDNESDAY AM - PRODUCT MANUAL. ROUGH DRAFT

bid/jam

6

Policy Meeting: 4/21/58

Product planning 1958 - 1959 PNN

1 core Driver — pre production now in the field
2 complement " " "

what next?

PNPN 3 terminal power Switch
can make right except for packaging, up where up of specs.

- small logic transistor
- intrinsic barrier devices
- high power transistor interdigitated
  - 5A - 60 mil

identical assembly to our Core Drivers

Facilities — continuing research e.g. drugs & point bare
high power packaging
application of pnpn

study effort on various other devices —

15K for device 3 capital equipment

[redacted]

		expendable
50 000	R&D cap equipment	
95 000	Engineering	+ 15
5 000	engineering	3000
1 000	sales	2000

[redacted]

→ 42,000 paid

- 15,000 Rad
- 10, Furniture
- 13,000 Heating contingency

5000/month expendable equipment

Now running about 8000/month

Max will work out forecast 8 month budget.

Personell hiring - personell request forms coming out,

- Internal contact people - get resumes here first

[redacted]

Admin department

Policy Meeting 5/5/58

New Numbering System

109-111 - Still used for research.

100 → 200 in Eng phase,

→ 300 heavy production

304 Materials Processing

New Jobs

New materials

Improved processing techniques (Labor) 105

Controlled certified (prpn)

Basic work on contracts (Charge to prpn)

prpn trade

169 - Non allocated Direct Labor

Sick Leave

Manual - 6 Days. (Non E

No Med for personal abuse

prof - 12 Days (Non

Cond. Sick Leave + personal leave

5/7/58

Report on Electrochemical Society Meeting, Cleveland

Hughes Surface treatment:

1) monitor clean

2) immerse into Organo-silane

3) cure by heat & age

50% dimethyldichlorosilane
50% methyltrichlorosilane

boiled 100°C for ½ hour

~80°C no effect on clean chips

stand up under boiling trichloro, etc

Radio - Bell

Surface stabilization by Oxidation

1000°C high purity O_2 10 min - second hour

Amorphous film -

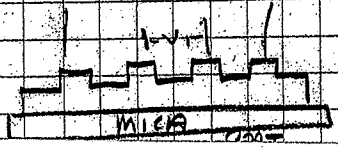
surface impervious to

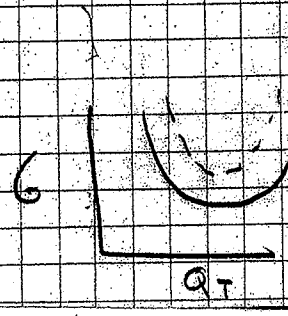
H_2

O_2

NH_3

O_3





Tech Staff Meeting — 5/9/58

wafer yield
starting
avg slices on hand

CSR

Boron ρ vs Length of {initial resistivity} {K=9 / K=8}

{ρ / ρs} " (1.8, 1.6, 1.4, 1.3) K=8 K=9.5

got 67 wafers ρ with none at 1.4. 1.4-1.0 Spec
71 wafers ρs

So we will get 50-70 wafers at these specs.
our wafers now cost us ~ $5 ea ch.
try to keep 5-10 shrinkage wafers ahead.

PFA

9-10 wafers ± 2 runs flat bath determ
5 on single flat boat.
No is the diff as for as shortage.
Sh + Qa shortage JAH put to check shorting
to try to check locate cause of shorts ~ more detail -

Engineering changes on the npn

possible changes.

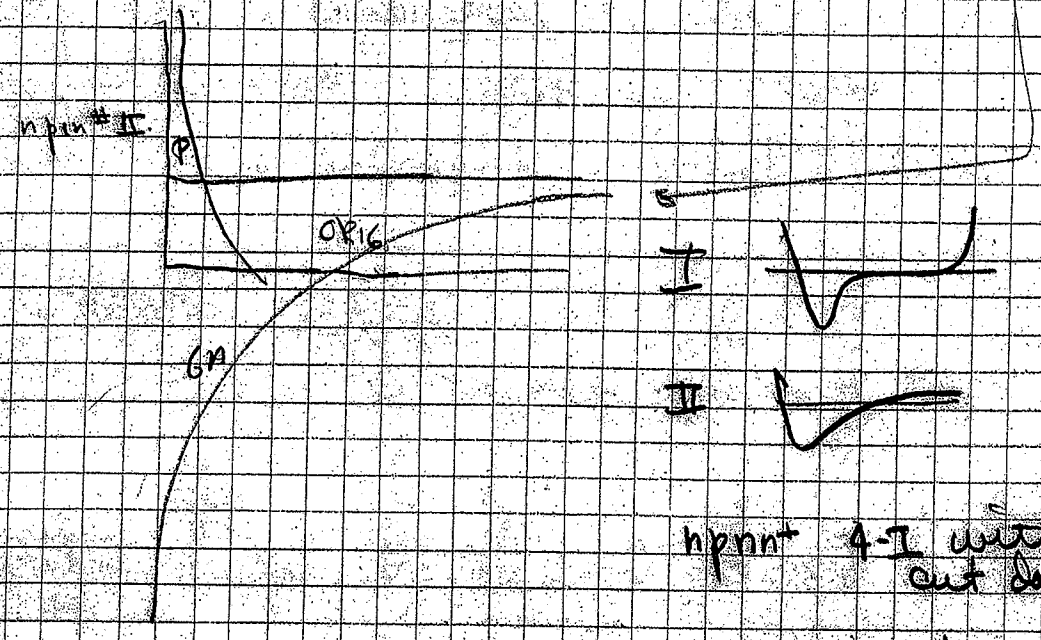
1) p n p

2) p n p n — lamp

3) p n π n — to get higher standoff & higher power

4) n p i n — I, II — backside diffusion; more difficult - compensation

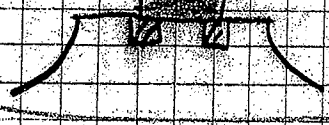
5) n p n n+ — Low V saturation



npnn+ 4-T with I-gen cut down

6) vpn tetrode - triode — Wafer & Emitter shorted to base at the center.

7) npn - diff



Advantages

complementary pairs
not many pn's crossed.

new area
ready to go (identical contemporary)
high voltage

new applications
including
HF oscillator

I low r_c'

II easier control of W-Spiral charge

5) higher current capabilities
paired with npin ≠ 1

higher F_{max}

easy - Flexibility

Difficulties

contacts.

slowly developing market
non-dead design getting
f_T of npn low - thin epi
charge npn to get high voltage

not applicable to computer
poor HF amp with (have to go
to smaller geometry

- recover confined doping
long diffusion times
- high r_c'

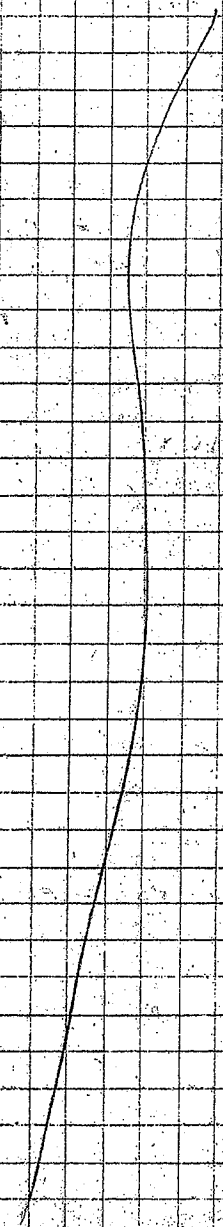
aqueous lap
long $\sqrt{nt}$

- one of two low
high r_b

lower P at low i

Tech meeting:

JT celebration meeting:



Task meeting 5/21/58

(8)

Status reports

Item - Transistor yield Deltronatg

F.S. Yield - 20%

Losses: Surface.

Negative on voltage > 1.5V.

Base.

Cc

Problems: Soldering leaves with Ag-Sn + flux insulation

(Au solder leaves voids to

go rusty creeks)

not on final headers.

Life test 20 going -

none failed in 4500 hrs.

Crucible Baker - Sm

POLICY MEETING - 5/27/58

Input on visits of Hodgson Carter, Fairchild.

we have to get big mfg. facility in operation at end of 1959 beginning of 1960.

We have to get upto 100,000 units a week by end of 1959.

Three product building

Units / week.

npn 4000-6000 - week
pnp ~2000 / week
pnpn - pilot line

New plant ready for occupancy April 1 in order to meet 4th quarter rate.

End of 1959 - 80

npn 30,000/week
pnp 30,000
pnpn. 30,000

total ~100,000

There are manufacturing measures -

Yields will go from 20% → 70% by end of year npn
25% → 65% by end of year pnp
25%

this will give us 60,000 devices salable/week by end of 1959

Cumulative number of unit produced.

end of 1959	500,000	npn	good units
	350,000	pnp	
	200,000	pnpn.	

Use rule of thumb - 3-4 months inventory on hand.

∴ Sales lag by this time interval

Cumulative sales in $

Assumptions npn avg price $20 this year 1958

$10-12 first half of 1959

$5-7.50 second " of 1959

$5 1960

pnp Some prices

pnpn

$20 first half of 1959

$10-12 second " " "

$5-6 1960.

If these prices hold, we should have accumulated

high figures	low figures
2.8 million dollars.	2.1
1.4	.9
.8	.5
5.0	3.5 million
4.9 million	by end of 1959.

#6/ Based on 200 printers/assembler/week on a balanced line
Min of 80 ft²/assembler

Assembler buildup 40 end of 1958
450 end of 1959 (2 shifts max 250 at one time)

∴ we need 250 × 80 = 20,000 ft² for assembly and test.

for supporting facilities we need ~ 30,000 ft².

Pre-prod.
PE
E,T
SE } Systems engineering
Engg Services
Sales
Admin

Engg 12 - 15,000 ft²
Comp Sv 10-12 ft²
Sales 2,000
Admin 3,000 ft²
Misc Storage 5,000 ft² Sales admin stores, etc.

Cafeteria, Lounge 5,000

Total: 55-57,000 square feet likely needed.

Assembler $290/month 180% overhead

monthly costs	130,000	end of 1959.
	130,000	overhead
	200,000	annual payroll.
	450,000	total operating expenses
	1,250,000	Monthly sales

Operating break even late 1959

total square break even spring of 1960

Franklin's total investment 3½ at max point

$3,300,000 Exclusive of buying building

this would add $1,250,000

this does not include any sales money

this does not include material costs

How many professional people

application engineers	7-10	administration	7-8
instrumentation	4-5	technicians	
Sustaining eng.	7-8	design	6-8
pre-production	10	shop	8-10
Sales	10 in field		
quality control	4-5		
manufacturing	7-8		

90

: 100-150 professional people

this gives a total of 600-650 people by end of 1959.

50 R+D people half professional

Location - Carter - go where cheapest - Arizona

max of 100,000 ft² per bldg union problems.

stay away from over of aircraft industries

Fairchild likes small towns

Julie: Sites available

Redwood city north - nothing available

10 acres to get 100,000 ft²

East Bay - Oakland out for downtown

Bohannon - $1/ft² lease only they have big

Stanford $25,000 acre. get financing

Ravens Street $30,000 acre lease only

near Bayshore 5 feet of fill - $50,000 acre total.

South Mt. View cheap but noisy

Sunnyvale - Kifer road $9-13,000 acre.

San Jose - too far away

Los Gatos - no utilities but cheap.

Saratoga

R N Wayne

Switching time

for going to

Drive current vs time

$$t = \frac{Q}{I}$$

$$\Delta Q_T = Q_E + Q_B + Q_C$$

$$\Delta V_C = V_{BE(on)} + V_B I_B + V_{BE(off)}$$

$$\Delta V_{CB} = 2V_{B'E\,on} + V_{BE\,off} + r_B I_B + r_C I_C$$

$$\Delta V_{BE} = V_{B'E\,on} + V_{BE\,off}$$ off on abs.

$$Q_{VE} = Q_{BD} + t(V_{BE\,off})$$

$$I_C \tau_{transit} = Q_B$$

$$10^{-9}$$

all charge comes thru base - ground

$$t = \frac{Q_I}{I_B}$$

q2

$$Q_c = f(I, V_c, V_{BE}, \theta_b)$$

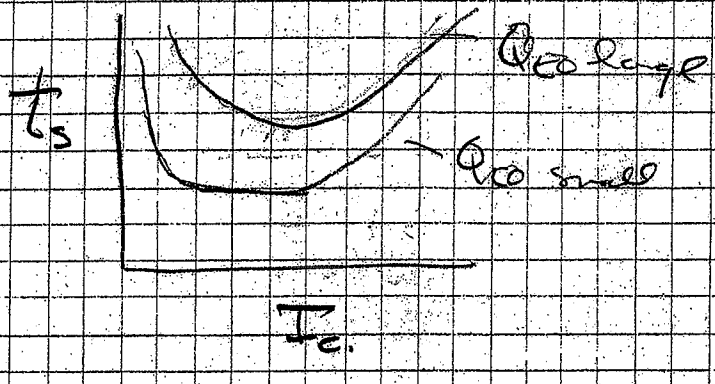
$$Q_B = f(I_c)$$

$$Q_E = C + f(V_{BE}, \theta_b)$$

$$I_B = I_c / N$$

$$t_s = N\left[\frac{Q_{EO} + f V_c I_c}{I_c}\right]$$

$$t_s = N\left[\frac{Q_{CO} + A\left[\frac{I_c}{P^{1/3}}\right]^{q/3}}{I_c}\right]$$



Data

P_c on limited to 1 W $N = 5$

I	T_c	T meas.
50	43	46
100	35	32
150	20	30
200	17	30
250	16	39

Recs at high freq much higher than expected

Policy meeting 6/9/58

forecast - equipment needs - up to 15,000 rpm engineering orders.
15,000+ Mfg orders
to 30,000

same for other two products.

equipment & material.

R&D - R&D
Mfg - G
CSR (FK - methods

Provided improvements - 53,000 ft²

Operating break-even point - Sept 1959.

Wages R&D	22	January 1959	Now we have 10-12.
	26	July 1959	
	28	Dec 1959	

Total personnel.

total	184	Jan 1959.	Mfg. 63 50
	398	July	199
	638	Dec 1959	476

a4

IBM requirements

300 Beg the year — #150 each.

1500 By end of the year — #75

3540 Beg of 1st Quarter 1959

20,000 End of 1959.

Keep 3-4 months inventory

breakdown voltage
on voltage.

Rel #20,000 / mo — matured & paying — Mfg #39,000

#29,500 — " " — #117,000

#27,000 / 3 — " " — #328,000

6/30/58

Report of Board Meeting:

Forecast to end of 1959 accepted

Spend $209,000 over forecast

New facility - agreed - principle, but date not decided.

Rent more space 1000-1000 (at the yea
(to possible by the end of the year)

Committed to sales of 15,000 - 20000 dozen
this year.

at avg price of $40-50

Income expected $500,000 - $700,000 this year.

Will this pressure make us look bad in 1959?

Start carrying inventory August 1.

This could lead to a net operating profit - December!!

O'Donnell

We can get architects plans for $5000.

Phelps Dodge in trouble.

contract from Ouse 2000 on min of 40
Power
to be delivered this year

Zero Neutrons have dropped pp in a
long - Wire
letter talking 50,000

RCA at top of list 100 mc
will hit the market at the end of the year
sell for $10 or so

Western 2039 → commercial
IBM has a contract with TI to build

Western 2039. —

our Source at $6-8 could compete with for
the market (Zero Neutrons)

FAIRCHILD SEMICONDUCTOR CORPORATION

To: Management Group Date: August 4, 1958

From: D. Miller

Subject: Organization Chart

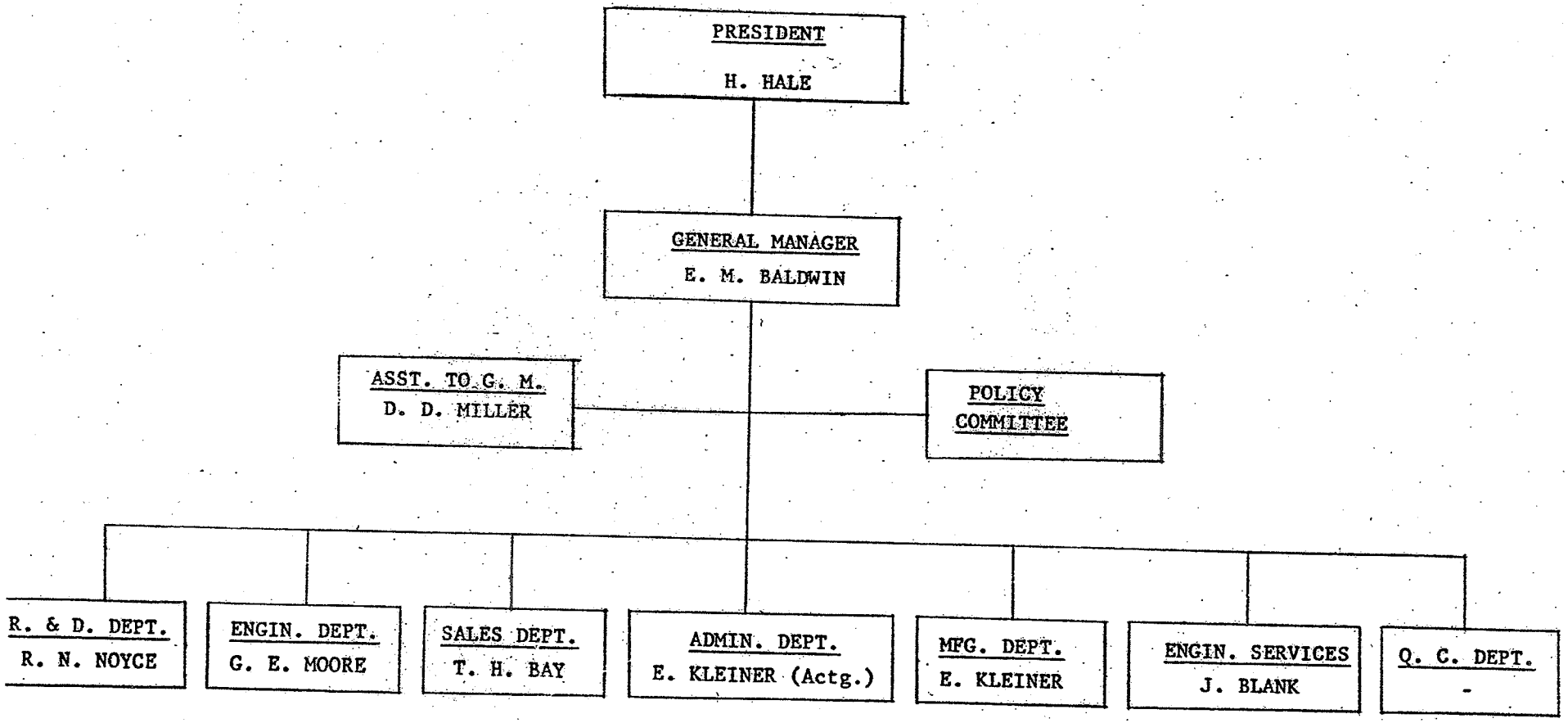
Copies: All Supervision, M/F

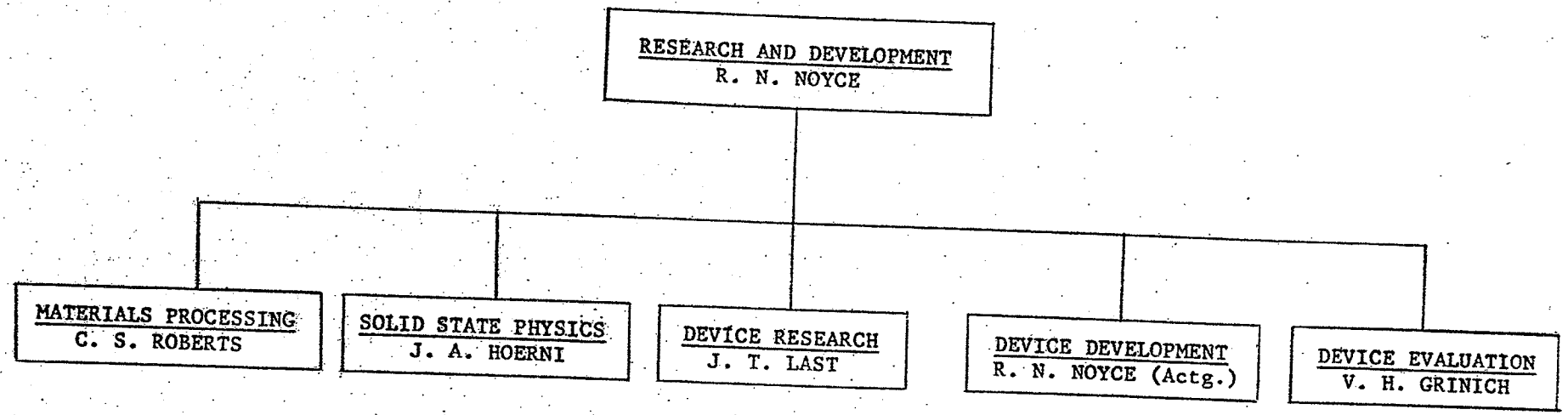
Enclosed are organizational charts for each department. It should be noted that these charts are tailored to our current organization, arrived at by discussions with each department manager, and the general manager, and do not include a sectional breakdown for those areas which will be staffed at a later date.

The organizational charts will be revised at periodic intervals, and will incorporate any additions or changes to each department chart.

D. Miller

DM:gb


PRESIDENT
H. HALE
GENERAL MANAGER
E. M. BALDWIN
ASST. TO G. M.
D. D. MILLER
POLICY COMMITTEE
R. & D. DEPT.
R. N. NOYCE
ENGIN. DEPT.
G. E. MOORE
SALES DEPT.
T. H. BAY
ADMIN. DEPT.
E. KLEINER (Actg.)
MFG. DEPT.
E. KLEINER
ENGIN. SERVICES
J. BLANK
Q. C. DEPT.
-



PROFESSIONAL

1. J. Clifton

TECHNICIAN

1. G. Barber
2. T. Bright *
3. L. Lunn *
4. B. Person *

PROFESSIONAL

1. P. Flint
2. T. Sanders

TECHNICIAN

1. P. Hinchcliffe

PROFESSIONAL

1. D. Allison
2. R. Craig

TECHNICIAN

1. C. Gunter
2. P. King

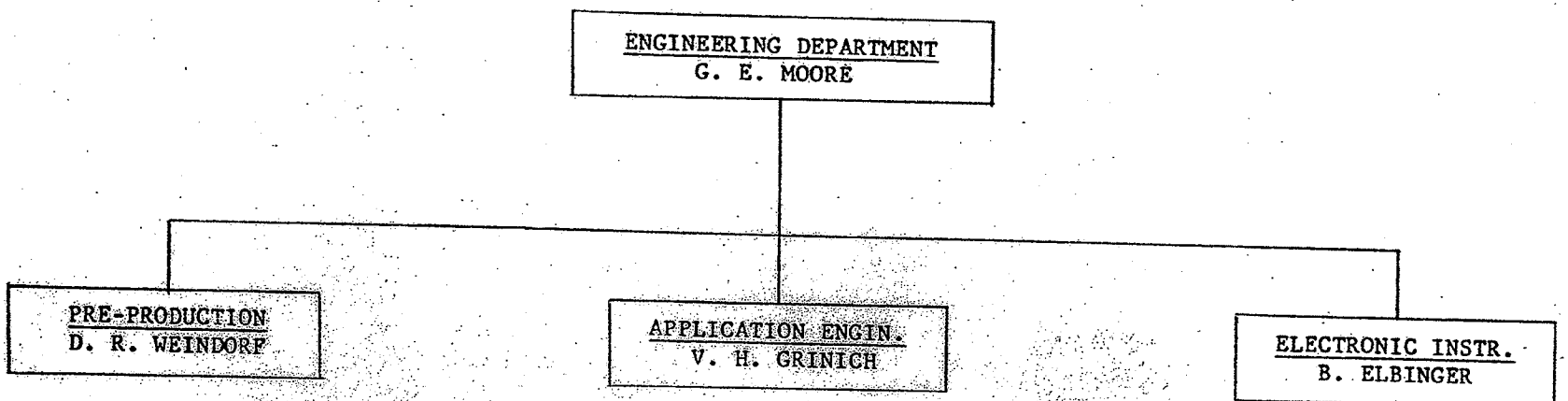
PROFESSIONAL

1. I. Haas
2. G. Reddi

TECHNICIAN

1. M. Siegel

* Currently performing material processing operation.



PROFESSIONAL

1. R. Brown
2. L. Carlson
3. J. Nebozuk
4. C. Plough

FOREMAN AND TECHNICIAN

1. W. Allen
2. J. Carnahan
3. R. Hall
4. P. King
5. R. Parker
6. R. Robson
7. R. Vander Veen

ASSEMBLER *

1. P. Burch
2. M. Campbell
3. M. Crowder
4. A. Ferguson
5. A. Holt
6. M. Patkus
7. V. Smithee
8. J. Sopko
9. P. Sarantopoulos

* Currently in department

PROFESSIONAL

1. R. Beeson
2. B. Black
3. M. Desai
4. R. Kikoshima

TECHNICIAN

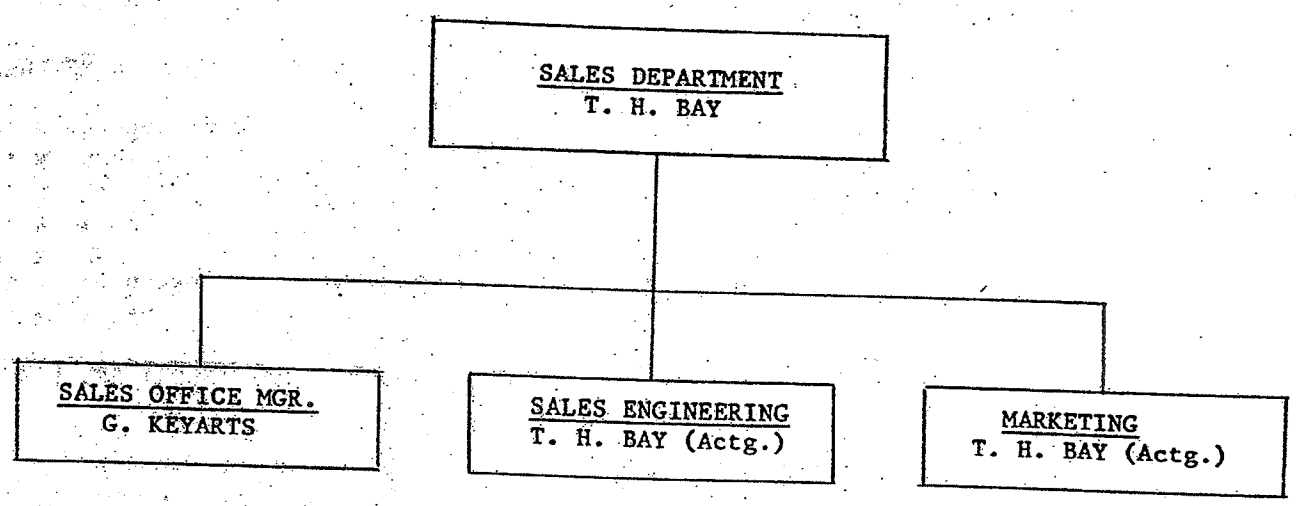
1. G. Allen
2. D. Ferris
3. E. Held

FOREMAN

1. E. Beauchamp

TECHNICIAN

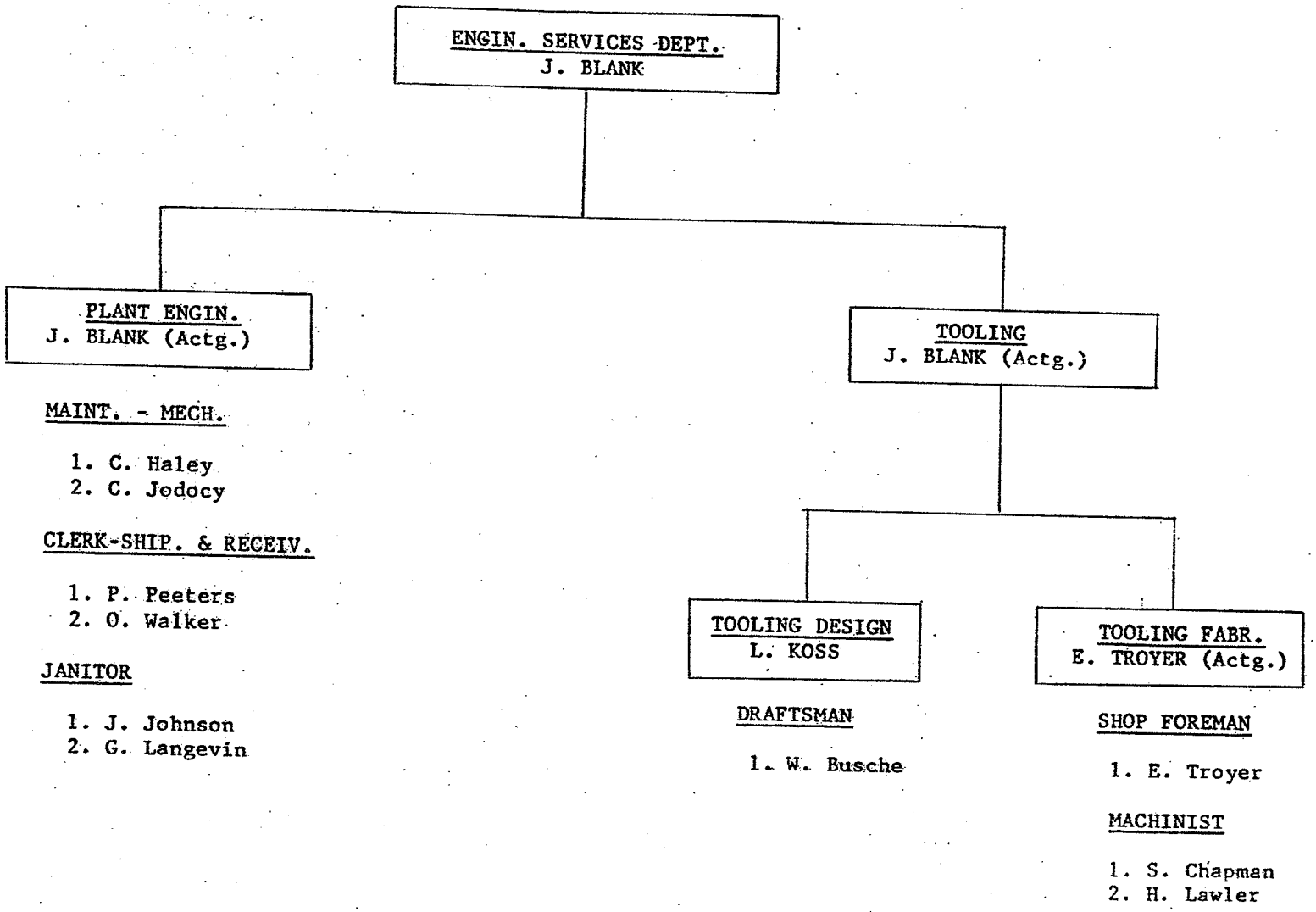
1. N. Kanawyer
2. M. Peterhans

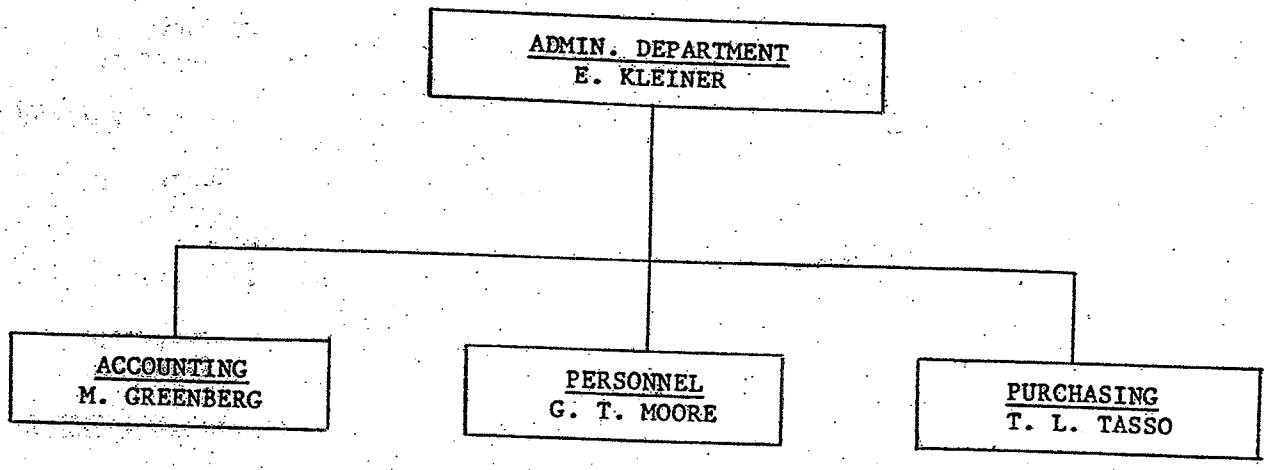


EASTERN SALES

1. H. Bobb

DM 7/30/58


ENGIN. SERVICES DEPT.
J. BLANK
PLANT ENGIN.
J. BLANK (Actg.)
MAINT. - MECH.
1. C. Haley
2. C. Jodocy
CLERK-SHIP. & RECEIV.
1. P. Peeters
2. O. Walker
JANITOR
1. J. Johnson
2. G. Langevin
TOOLING
J. BLANK (Actg.)
TOOLING DESIGN
L. KOSS
DRAFTSMAN
1. W. Busche
TOOLING FABR.
E. TROYER (Actg.)
SHOP FOREMAN
1. E. Troyer
MACHINIST
1. S. Chapman
2. H. Lawler



BOOKKEEPER

1. L. Tibbs

INTERVIEWER

1. C. Heineman * (Actg.)

CLERK-TYPIST

1. M. Hrynczak

SECRETARIAL

1. G. Baker
2. C. Heineman *
3. M. Weis

R & D Meeting 8/5/58

Actual

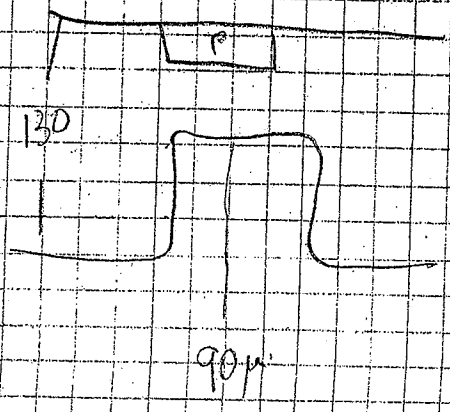
1. Resistance Growth
2. Intermetallics
3. NPN 50% DA all Ech
4. PNP
5. PNPN
6. Backside { Diffusion / Alloying / Etching }

Ultrasonic
T.P. Transmission
Pump Gate

Start:

1. Mesa diode Pit alloy (100)
2. Small Geometry ← pull away

Antimony furnace being set up for high doping



N_2OH etch

10^{23} gradient

1 μμf.

area 10^{-6} 10^{-4} cm^2

Ransom - Acta Mat.
selective etch

98

Pat Gilbey
straight meta.
Uhlir method.

March 1

---good logic unit - small geometry

CSR - InSb - Zong

(GaAs) "

① Not decent InSb crystals

② Use work on GaAs simply steps for horizontal growing - a graph to start
closed system controlled
partial pressure - a separate
reaction between Cu + As

→ Phillips Res Reports

8/25/58 Polaris - info meeting —
(Cable group + Walt Engelis)

RNB - Weapon Show -
big interest at booth - from competitors as well
we scooped the industry - nobody ready to show
something like our model 2N560 Bell closed +
competition - No prospect of anybody getting ahead of us
in the immediate future.

transistor

EK - Personnel situation
Hughes - PSI in bad shape morale-wise
Metz coming up from PSI
Instrumentation still a problem
O'Keefe coming - Philco complex
Ashmead - Application engineer
best response from NY Times - Electronic News.

Boyle Sales picture
Response extremely gratifying at show.
Electronic Equipment Add — 467 responses.
ad went out 8/10 + 30 letters + telegrams
within first 10 days.
Requests for quotes for sample quote
order for 500 IBM - Poughkeepsie
Boeing - 200-500 Sperry order this week
200-500 Sperry
700 GE-Utica $ = 1000-2000
(") Burroughs

Item Poroduction

up above 1000 final seals/week for the first time

furnaces in operation 70 wafers/day.

10 final seals/wafer = 700/day.

∴ several hundred a day. ∴ 1500 this week.

big fund will occur on testing

yields jumped to 87%

Bay (cont'd)

total # of inquiries ~ 1000 all told.

Basin - IBM Owego - will order at least 2000-3000 today

open orders now - 550

shipped ~ 250-275

expected order 5000-6000

"we can sell the 15000 units we expect to make this year without any trouble"

unit price will probably hold up to 90-50 up through December

Booked-to date 262 $36,000

On order 590 $28,000

Duke Blvd - cost estimate on new bldg - $15/ft² with
primary distribution + air conditioning

Timing scale on bldg - 9 months from initiation
Shaved a month or so.

15
10
15,000

3
$2,000
10
$75,000

102

9/5/58

pnp status meeting: [NAH RVN VH6 Gem NTL]

wafer-wire 0.6-0.7Ω material (grown to thickness of 0.6-1.1)

(npn creeping up to 2Ω - still getting 1V sat. ms.)

Base diffusion in poor shape - (Sb ~~in Ge~~).
impredictable
↓ V/I = 10-20 6μ junction
~~most convenient~~ thing ~~to do~~ should be kept for
add wafers + run. $R_b C_c$ product.

the problem is probably alloying as far as R_b & C_c goes

As long time ~~to~~ as ~~of~~ this wafer
for alloying - As will stay in segment better than Sb
(CSR)

Emitter diffusion not giving any trouble (Boron)

V/I = 0.5 - 0.6

3.5 |-|
2.8 O →

2.5 gives pits
3.1 gives lower curve.

run Oxygen, nitrogen - ~~+ then~~

Nickel – electroless plate which is buffered acid –
a – dip of base layer and then three dilute –
evaporate nickel

Front side – evaporate Alum-phos. (optimal alloying – more than 5 minutes base voltage increases worse.
as low as 1.2 V has been obtained
best thin 3 mm – no alloying at 5800C)

– time held voltage drop during sintering ratio from 1.6/1V. –
to some probing

Germ – points on opposite side of base my 3 Ω
gold back 1 Ω

(photoresist would help up to alloying temp RIH)

work with Au-Sb for this

Back side

1) dip of base (t 80 μ thick)
wash aluminum
alloy while front side is alloyed (resists alloying time t 3 mm at 580)
solder with Au-Ga 10% made by C.S.R.
(short system ordered from Ralphs) Rsat 1-1.8V

some switching between 900 – 500 mils

outside layer ~15μ

164

2) evap a heavy layer of Au on backside
dice
solder directly
switches at about as 1)

3) evap Al-Au
use Zn as solder (melts at 690°K)
gives 1V sat voltage.
very easy to solder.

4) keep boron layer
solder with Au-Ga gives best sat voltage

~~Sample~~ wafer - keep before

1 ~~neutron~~
2 1+F

Gallium
acid used Hcl

5) 5% Sn 95% Pb.

6) to keep evap Al - Au a thicker
pressure weld at 230°C

9/6/00

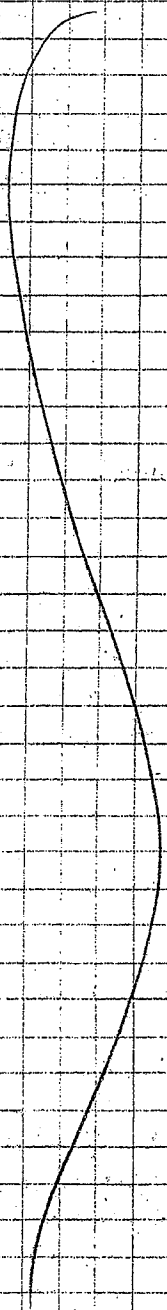
try flip - proposal

What are Target characteristics?

5 pins

All DC parameters should be in same as 4 pin

Base voltage (same to 4 pin ... (include curve)



106 9/15/58 R&D Meeting

Patents
Description of invention - what is new, what advantages
Description of applications

Patentable Ideas:

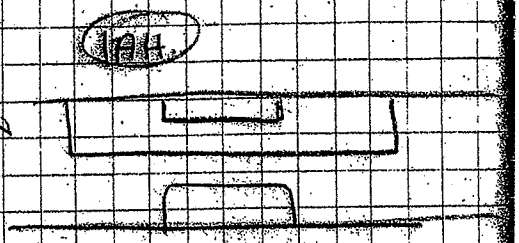
Single metal contact (?) BTL using — we used this at Purdue for factory claim on on the patent.

automatic indexing [Selective plating, Kellaway techniques etc. CSP

[John Rolls - Lippincott & Smith - proposed patent attorney]

[A method of making by use of a gaseous etch
Bean pits

[Diode with oxide over b.p.
collector adjunder emitter



[Think have PNPN voltage drop to switch by conductivity modulation.

[Shorted base - emitter PNPN - non-surface sensitive
2 Terminal

[Turn off pnpn with a pulse

No plating for n-type diffusion, leading Ga diodes

watch on future diodes - Sb as soon as possible

Status reports

JAH - $10\,\Omega$ cm - no injecting contact
Various soldering techniques
lead directly to Si wafer

VHJ pnpn - evaluate switching times
pnp - switching time comp. to npn, lower storage time
smaller gain npn
RbCl 1000 - 1500

CSR [pulsed, investigations
multi-metal - miscible liquids
preferentable plating (chemiplating)
Silver and Rhenium

crystals - can grow 1/2 to 2 lbs
resistivity control - good shape
get out good InSb -
then GaAs - (L.D.)

JC - Resistance grown - no reproducibility, yet
lifetime - good shape

PTCut - dopants in collector junction
select elements in solder junction
phys. characteristics - switching, plating, soldering
how continuous is wetting of surface under dc.

10d

DA - dep function problem - p type thick for diffusion problems
if box width is reduced may not get enough
plus diffusion 1100 → 1200 to get a parallel
the cuts go fortunately as well.

Sophia coming in again recently.

1 hour of oxidation - thick enough oxide layer

1 µ box shorted (9 fingers)
this will be continued -

Write progress reports on the first -
have this meeting on 10th - 15th.

~~get a line former - set up services~~

POLICY MEETING 9/12/58

NEW BUILDING - SAN JOSE

put as much possible into ~~[illegible]~~ leasehold improvements in 5 year program

Price limit. $750,000 plant
250,000 leasehold improvements

62,000 ft² (90 ± 100,000 buy rd of 1960)

110

Sept 49

Policy Meeting

Bldg Location - Mat. Trees

Oct 6

~~Philco~~

RCA MA 1863

P_c - 2W @ 25°C case $I_{c\,max}$ = 50 ma. n/pn.

	Min.	Typ	Max.		
R_{cs}		8	12	20 Ω	
h_{fe}		.8	1.5	f = 100 mc. V_c = 20V	I_c = 5 ma.
$r_{bb'} C_c$			35	130 μμs.	
70 Mc P_g		13	17 db	V_c = 30V	I_E = optimum
C_{ob}	-	0.4	0.8	16 μμf	V_c = 20V
t_r + t_s		I_c = 20 ma		3 to 5 m/s.	

test conditions

price now 460∞
June 1959 8∞

5 x 10 mil melt. Probably.

VRly - How is we count in Trig to local this count - limitations from this point of view Current

TI 2N 338
Philco 49b - outgrowth Limited - Eng.

112 10/9/58

Report on Ottawa Electronics Meeting CSR DFA

Westinghouse spending $2,000,000/year on thermoelectrics
GE 1,000,000/
Emphasis on power generation.
Ref. of paper of most studies too low.

For power generation: $M = \frac{\mp \alpha^2}{4 K \rho}$

$\alpha = 200 \mu V/^\circ C$
$k < 10^{-2}$ watt units
$\sigma \sim 200$ mho/cm.

Mooser – short range order the important thing for semiconductivity – long range order for specific crystal structure.

10/16/58

R&D meeting

Nelson, Finch, Harris | Roberts, Worley, Haas | Clifton, Reddi, Dwyer | VTL, Young

WB – 5 wideband units

Swan 100 → 250

Drive gain 10 → 30 db.

two B units suitable – time fairly tight

own filter made 6–9 db.

high Q – lifetime – loss controlled

keep high Q stable – [illegible]

impedance eff – over flanks of WB

$f_c \sim \frac{1}{W_B^2}$

WB

14

Policy meeting

Mercie - Europa

Siemens

Mullard (sub. of Philips)

diodes selling for 25¢ [produced here for 35-40¢ sell for 50]

assembly done very well - big + strong result

diode sales

nothing much of interest for us to sell

few diodes perhaps.

adv. sales

no pressure to go to Sc. - Policy under

instructions not market.

post of selling value for money

Mullard. Pa Ld.

Thus - Pa Research.

Hodgetts HQ. Simmonds test work.

Pa Diodes being made.

Sample of OA 170 - 1mA max cutoff. Ge

Gilbert & Linfield - Hanes

Printhead on supplying up until 100,000
200,000 units
for design
cost to us £3

net cost Sir 20%

power stations 25-30 $/
22½ $

heavy oil [7½
[3

Swords 15

Stalbridge 10c

Yeovil 19c

Southampton —

packages are non-std packages.
could be put in our packing

Result - interested actively in a marketing arrangement.
coming here - April

16 Small Geometry Meeting

VHG DFH RH RNN
VHH 6EM JTL

	Motorola Ge	UE Ge	Motorola
	2N695 Switch	2N559	2N700 UHF
BV_{CEO}	12		30
BV_{CBO}	15	25 (10μa)	30
BV_{EBO}	3 (100μa)	6 (100μa)	0.5
Phase shift			
R_{cs}	25 (10/1)	22 (10/.4)	
C_{ob}	4 (6)		0.8
r_b'			50 (700mc / 7.6)
t_{d+r}	10	.15	
t_s	10	2.5	
t_f	10	0.5	
	25 μsec pulse width	Voltage Source	
f_{max}			600mc (2
A_p			12db (200mc / 7
C_{te}			

Phil. 2N501

θ_{JA}

12 ← BUces

15

2

4.5 (2, .5, 20mc)

20 (10/1) max

5 (1/3) max

typ max [25ma/2.5 1.05v66]

9 18

9 12

7 10

FSC Present ...

X1040c

30

60

5

10 [5ma, 10V / 20mc]

20 [10/1]

40 [20/2]

.1 [10V]

8 td

18 tr

300-700

300lb @ 100mc

calc

7 pf @ 0.5V

look at 2N501 for switch to get lower R_{CS}

Computer want to drive at 10 ma

0.2 Ω-cm 30 V BV_{CEO} min

1.4-2.0 Ω used more common

what gold content is poss.

V_{CES}

switch must satisfy

$BV_{CBO} > 40V$ — $BV_{CES} > 20V$ out to 20 mils

breakdown pt. 150°

T_{max} rounds 150°

this may be the output voltage of the 10V

Storage time used for t_s in

t_s 10

how much gold?

in T_{max}

good switch

in between

1/8/59

Small Geometry Objective Specs etc.

UHG
GEM
DFA
JTL

specs - measuring program

→ BV_{CBO} 30 V MIN. Design 60V 0.5 Ω-cm (50)

lower in sensitivity - low surface breakdown limits to the use of surface

100μA 30V

50% range of testing resistivity

→ BV_{EBO} ~~3 V~~ 5V Design

100μA

B

→ LV_{CER} = ? f(BV_{CBO}, β) ~ 20V

limiting voltage uses base lateral resistance

(asymptotic voltage) 10 Ω = R (50 Ω)

I = 25 ma

→ h_{FE} (10ma, 0.6 V) ≥ 20

→ h_{FE} (50ma, 0.6 V) ≥ ?

→ $V_{BE\,sat}$ (10ma, 1ma) ≤ 0.9V ?

→ $V_{CE\,sat}$ (10 mw 1ma) ≤ 0.5V

12.

→ I_{CBO} (15V) ≤ 0.1 μa

→ h_{fe} (20mc, 10ma, 10V) ≥ 10 Avg now = 15

→ C_{OB} (10V) ≤ 5 pf

Switching times Current 2N501 Philco Re Sudbury

I_C = 10 ma I_{B_1} = 0.6 ma turn on I_{B_2} = 0.04 ma turn off

Design centers t_D 50 μsec

t_R 150 μsec

t_S 150 μsec

t_F 65 μsec

Philco Application note 350

Circuit $\beta = \frac{I_C}{I_{B_2}}$

data on present units !!

f_{max} — don't specify (400 mc)

power gain — take what comes.

Bob Beeson - measurements.

Run at 0.5 Ω-cm

4 finger base 80%

shallowness - to front point

8 finger emitter (Ducrot 3)

4 finger base

12

Au diffused 2N696 ≡ X4100

X4100 Au diffused .030 mil collector
.015 mil emitter

F ₹ 9000 diffusion recipe

ρ = 0.5 Ω cm ?

set of compatible specs needed - compare with 2N560

aim to hit low current switching specs.

try to meet Buships 2N360 spec change ≠ 5

I_C = 10 ma I_{B1} = .05 ma I_{B2} = -.05 ma

$t_s + t_f$ = 250 m/μs max.

but we make ARMA equiv spec ?

$t_d + t_r$ = 0.65 μsec. I_C = 3 ma
I_{B1} = 0.2 ma

we have to worry about J, K, L,
high level unit

Arma NTC-M320-R18

BV_{CES} = 40 V design calls 80 ~ collector base breakdown design 80 ?

$t_d + t_r$

h_{FE} 20 @ 10 ma design calls for 10 at 50 ma.

(1)

K $t_d + t_r = 400$ m/μs

$I_C = 40$ ma
$V_{CC} = 12$ V
$I_{B1} = 2$ ma

L $t_s + t_f = 1,8$ μs

$I_{C1} = 3$ ma
$V_{CC} = 12$ V
$I_{B1} = 10$ ma
$I_{B2} = -0,6$ ma.

we must meet our switching time specs. 100% so we don't have t_r or t_{ST}

we want to make:

K: 300 m/μs

L 400 m/μsec.

use Tektronix as std test for us

Measurements?

Alma Xista meeting Thurs 1/20

JAH $\rho = 0.60 \pm .15$ Ω Cm.

no change to emitter predep.

No Nickel plating

Somewhat shorter emitter diffusion

Remove oxide on both side of wafer.

Evaporate Au [is this critical?]

~~Au diffused~~ ~ 3" of 0.015" wire

Au diffused in O_2 - 920° for 20 minutes. (6 minute)

Standard from this point on.

Die sort - Know breakdown voltage. [20 - 10 μA max]

New final test specs

we want 10 good devices from each test run.

Omit everything after final seal.

Optimize: Initial ~~diffusion~~ resistivity

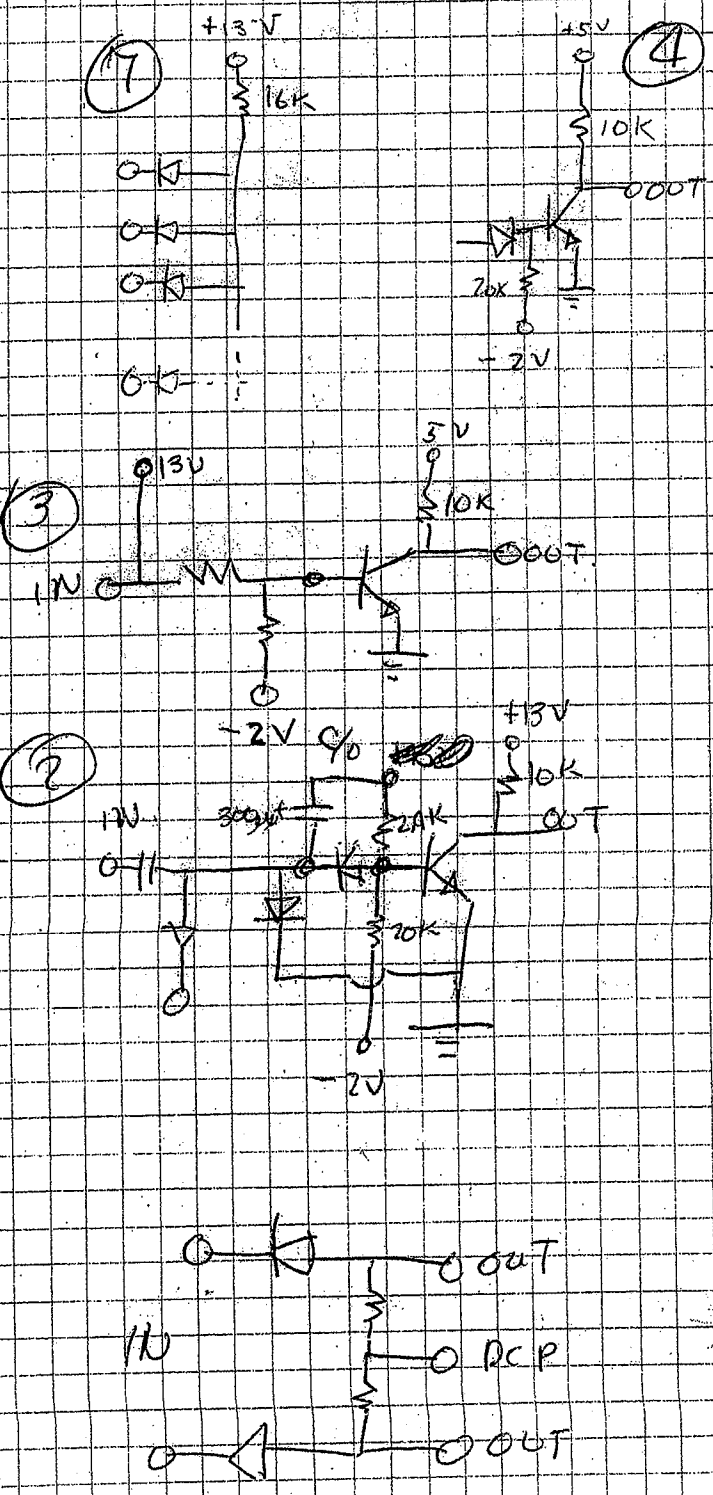
No diffusion

Emitter diffusion

Arman - KANJIAN -

Micromini circuits.

Full adder
Airborne Dig computer



Atomic people decide how many elements / wafer

"Volumetric efficiency" stink

# of external connections necessary for sterling increases

Decreases reliability

4-5 wafers seem to be optimum.

Altogether 9 Resistors

37 Diodes

send us plates with Resistors, capacitors on the plate - we put on Resistors + surface wiring

hole diam 0.1"

Diodes: Capacitance 300pf ± 25%

Diodes back to back.

Diodes now used. ~~PEK~~ 1N658 Radio Receptor
1N663 PSI
or.

Resistors ±1%

Diode specs

100 KΩ in 0.3 sec from 5 ma to -40V
this can be reduced

diode ~~f~~ common

Circuit clock freq 130 Kc

QUANTITY: 20 sets of wafers to make
20 adders
2 or 4 ~~sets~~ sets to us

Quote ASAP

Cost

Transistron
Semiconductor
Supply a ~~resist~~ semiconductors
37 diodes
9 resistors / adder

Cost / adder

Also surface protection ideas
Price with/without protection

Xistor min β 15 – 20

$V_B > 20V$

I_{C_0}

$I_C = 1ma$ $I_{B_1} = 7.5ma$

off < 1 μsec.

$I_{B_2} = .2ma$

Eng Change Board

Meeting Time – Thurs 10:30

Quorum: Mfg
Eng –
Sustaining Engineering

Emergency Conditions

120

Trma

2/4/59

diffuse

new list of specs (to be issued)

150 ma s/sec. BV_{CEO} 10ma 25 V

90V

LV_{CER} 25V.

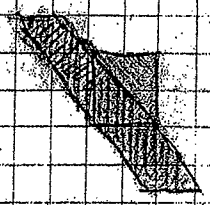
1.8V max.

1.8V

3.5

C_c 30 pf. Max 50 pf.

I_{CBO} .01



$t_s + t_f$ 150 mμsec max

t_s 100 mμsec $t_s = 50$

Bell Lab 3/4 amp core driver 2081

total switch 250 mμsec

reported at Wash meeting

what is turnoff?

V_{sat} 0.4V 6A

C_c < 30 pf 6V

BV_{CES} 75V

turnon 50-100 mμsec.

Resistivity 0.6 – 0.8 Ω ?

we have met the objective specs already –

[K+L] specs

low current Arma specs → higher ρ
high current specs → lower ρ

ρ 1.5 — Au 975° — 1050°
1.8
1.7

we are better by a factor of 2.

V_CE sat ok

0.5 Ω cm meets 54100 dly specs

$t_s + t_f$ = 100 nsec

(45+55)

spread
118
88
ns/step

q & h (low current spec)

1.65 μsec. spec

spread
2.0 mV
1.23 mV

K+L normal base

$t_s + t_f$

1650 nsec.

K+L ok!

132

1.7 Ω

150 mil spec — Comparator Results Ours / Fairchild

$t_s + t_f$ Req { 240, 200, 150 }

gain — Ours good — 122 min, 147 max

$t_d + t_r$ acceptable

.49 - .96

Fairchild measurement

K+L — K .32 - .39

$t_s + t_f$ .94 — .63 — factor of 3 safety

$V_{CE\,sat}$ { 1.3, 1.6, 2.05 } [should be 0.8 or so]

K+L, J+L

this meets all specs with greater margin

[can't get 100 ma low $V_{CE\,sat}$ complete with present breakdown voltage] greater speeds

Optimum 0.8 Ω

Report on Eastern Trip Mayer, Hench, et al

S.S. Circuits Conf. Feb 15 -

Core current limit [illegible]

Small memory [illegible]

2N 05 M2

Hughes Se 7K RMC

1000 bit shift register - temperature.

White diode - Ambient sensitive as

Gain. Q is Covered

at 100 ma sec.

New 2N560

1060 ? V_{CE} 25 v

16 pf.

Johnson - why not use field effect devices

See Westinghouse

134

Western 2N1072

$f_\alpha = 70$ mc

8 W

BV_{CBO} 75V

$h_{FE} \leq 13$ 1 amp

dual ⌈ V_{CE} sat [0.6 a] = 2-3 V 25°C

4-6 V 150°C

V_{BE} sat ——→ 2-4 V

t_{off} $I_C = 1.5$ a .1-.3 μsec

$I_{B_1} - I_{B_2} = 0.03$

1W696 See Equivalent types Section VI 1

2N1060

2/20/59

New product meeting

136

2/23/59

Wendell Hughes

4100 meeting

run large batches now —
20 wafers 0.4-0.6 μm annular
diffused - ordered from production
100% storage time meas $t_c + t_s$

run thru 10⁴ final seals by end of April.

2/23/59

R&D meeting

- hi freq amplifier
  - pn pn
- high power unit — FM 8000

μ miniturization —

Wendell Lefsky — back side alloying Au.
Al alloying

U. wash.

Discussion of Au vs Ag as
Bias Mount —

JAH
VAG
WW.
JT — μ mini
JClifton

184

ECCB Meeting

2/27/59

Eng waiver 2-4 days.
Temp Eng Chge Notice 1 month.

Note.

5300 Highly desirable to make high voltage - Bi-directional - only communication - to in to make standard devices.

1190 make 200 good/week by Oct 1
(of 1090) - ?

1140 won't replace 338 because it uses 4 stage off voltage
3 pf max at 200.

3/18/59

R&D planning meeting

PRE PROD

MARS

1140

4500

pmpn 5500

1040 - (338 replacement)

6000

PRODUCTION

(OCT 1)

JULY 1 (NEW BLDG)

JULY 1 (NEW BLDG)

SEPT - OCT

OCT 15 (when 1140 goes out)

410 at IA

Commitments

5500 - 1000 in Sept. (Aeroneutronics) low voltage
500 by Dec. (Sperry)

140

3/12/59

New diagrams:

SURFACES

OUTMODE THE MESA — OXIDE MASKING —

HIGH VOLTAGE

LEADS

Selen

- thin base layer
- allowing the long diffusion into emitter - impurity interactions
Gaps.

Ben

Boron - high & low doping
oxide masking -
problem of curing shorts
metals as getters & lifetime controllers
new phenomena devices & Read diode.

Wafer

surface protection & stabilization (low melting point glass)
get leads out -
surface problems in general - effect of ions
surface cleanliness - production & maintaining
high temp contacts -
long range - oxide & sulphide glasses - very conductive

3/18/89

Jay

power device
1090-338
1090-
small room pwp
micro-min program
parameter amplifier diode - various forms

KGM

large areas - light power

time schedule - personnel schedule
objectives

147

4/5/59

low storage - low V_{cc} sat - high β

Storage ≤ 100
fall ~ 200

Several 1000 with no 4 u

meas f_{max} vs I_{bc} I_{co}

- small geometry - Size considerations scale up by 1.5 ×

meas k_s factor on small geom. 5 ma collector

4010	inverse β	$\frac{1}{\beta_n}$		highest voltage	.03
4000	"	"	.02	middle	.13 -.18

5/14/59 143

R&D Meeting

Item time for report ½ hour · 1-2 speakers
+ statements of future work.

Purpose of R&D
supply a flow of ideas to rest of company
To see that company keeps abreast of new fields
sustaining function
maintain technical reputation of the company

Program Reports - Section head accumulate program reports.
= no set time scale -
final reports written up to now - set up tel report numbering systems.

W.W - Electrochem Society Meeting - Philco

Red Boron - high temp semiconductor
SiC - little real interest shown.
evap of Bi from Sr Hopkins - Sperry Rand.
Rectifier - GaAs Diodes Zn diffusion 2,8 Kmc
10 Volts.

plasma-arc plating - Linde - for depositing refractory materials

Phosphorus up to 5000 Ω-cm

Boron carbide - 2 parts / billion

new lifetime measurement technique

1111 Å pt probe

1 Å - interrupted light illumination

useful for lifetimes 50 - 350 μsec

hard for low lifetimes

END

Balance sheet - end of first year

Current assets	102,759
Fixed Assets	230,304
org. exp.	12,175
	345,299

current liabilities	93,722
owe Founders	985,000
	1,078,220

Net worth

cap. stock	1025
surplus	4100
net loss	738,100.91

Net worth = 732,975.91

Overhead: Cost sales 218,494
R&D 274,903
493,328

R&A overhead 73,375

R&D expenses: Material 33 097
Labor 108 854
Overhead 274 903
411,856