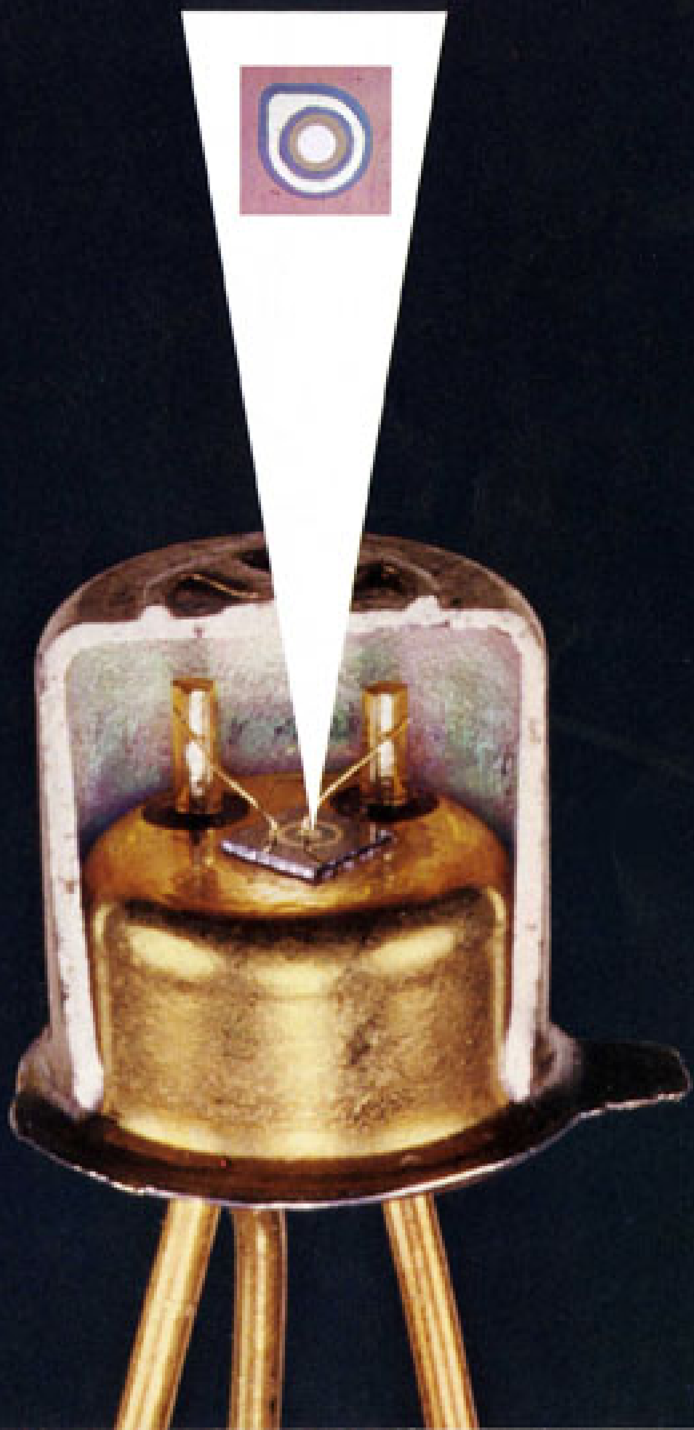
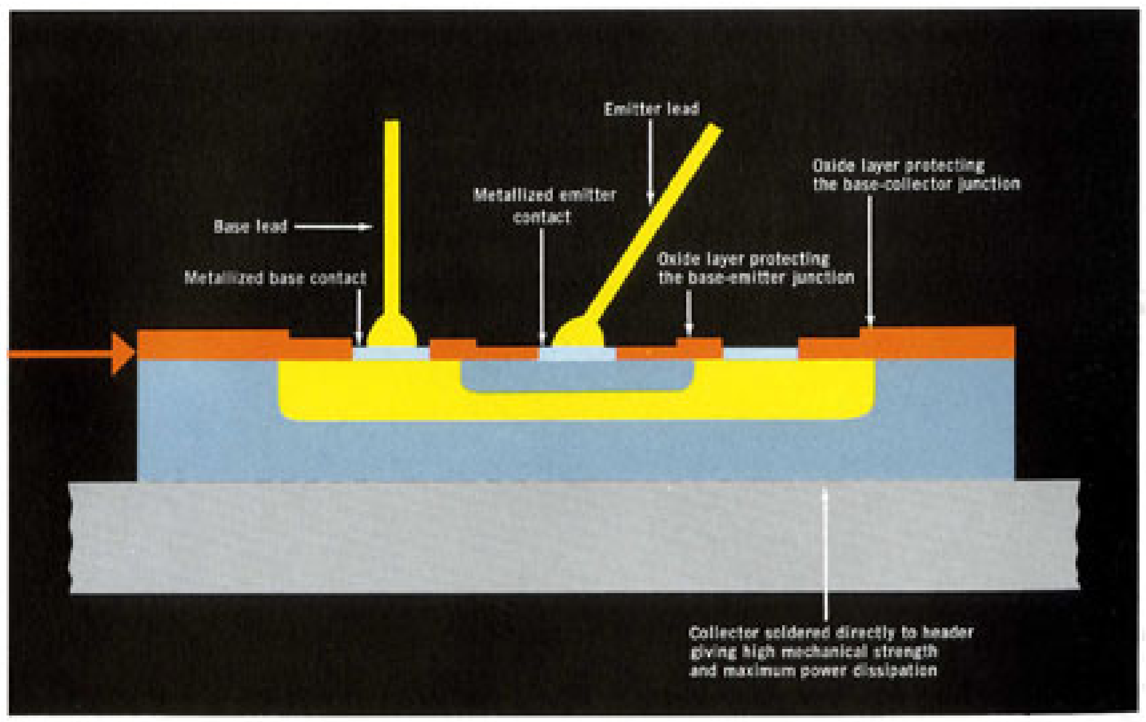
THE MOST SIGNIFICANT SEMICONDUCTOR DEVELOPMENT SINCE THE DIFFUSED SILICON MESA

THE FAIRCHILD PLANAR STORY

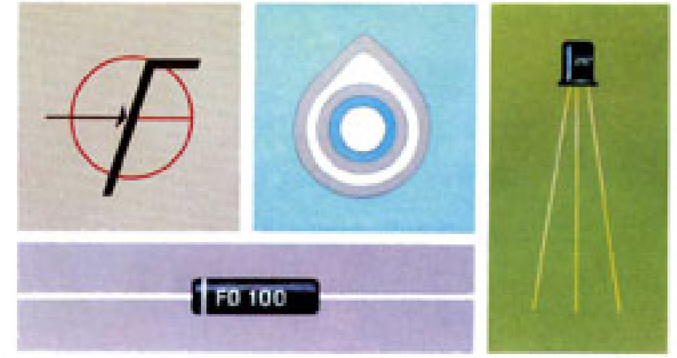


FAIRCHILD
SILICON PLANAR
TRANSISTORS
AND DIODES

Offering stability to a degree never before attainable



THE PASSIVATED SURFACE an integral silicon oxide coating completely protecting the junctions against contamination during manufacture and against change with time.



achieved by 100% oxide protection of junctions

By a unique process revealed in this brochure, Fairchild has passed a milestone in semiconductor technology. The transistors and diodes now in large-scale production by this method offer unprecedented stability—performance unchanged by time, use, environment, or even exposure to foreign matter. This protection and the resulting stability actually reduce the cost of manufacture. And the versatility of the process permits the specifying of planar replacements for almost every transistor and diode in present use.

THE 4 REASONS WHY PLANAR TRANSISTORS AND DIODES ARE DESTINED TO SUPPLANT THE MAJORITY OF OTHER TYPES

RELIABILITY
Reliability statistics already accumulated on Fairchild's planar types excell those obtainable with any prior types. The reasons derive logically from Fairchild's processing steps and the 100% surface protection of the finished devices.

PERFORMANCE
Broadened operating range and extremely low leakage are combined with the speed and power capabilities of the conventional type mesa transistors and diodes. As well as permitting exciting new applications, planar types are available as replacements for existing transistors and diodes *with no circuit changes required.*

COST
On a performance-per-dollar basis, planar types are more than competitive even at the present state of manufacturing technology. Very high yields are made possible by "planar self-protective manufacture" and will lead to much lower prices in the future — competitive even with germanium and low-performance silicon.

ADAPTABILITY
Fairchild's planar manufacturing technique — because of its high yields — and because of the inherent versatility of the structure — lends itself ideally to such advances as multiple transistors, multiple diodes and integrated circuitry. It is also the best way to make universal transistors and diodes that serve broad needs with few types.

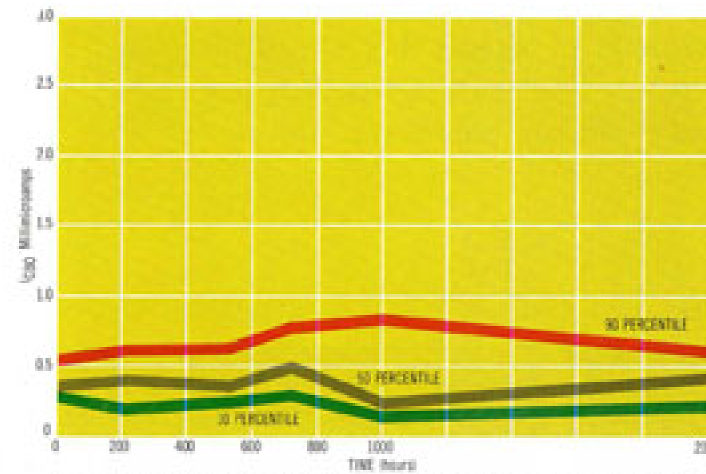
The 

PLANAR PROCESS

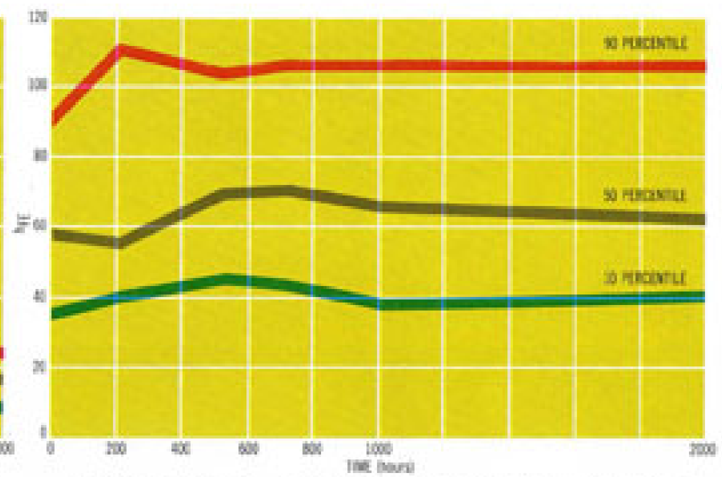
and how it builds in an unprecedented degree of reliability

The way it is made tells why a planar transistor or diode will be far more stable and reliable than any other type. Use and statistical studies confirm this.

STABILITY — THE MOST IMPORTANT KIND OF RELIABILITY Planar transistors and diodes because of their protected junctions give the circuit designer the most important assurance he can ask — that performance parameters will stay put — so that this circuit will continue to function as intended — for an indefinite length of time, and through all the environmental extremes considered in its design.



SUSTAINED LOW LEAKAGE — The life test shown above was conducted at 200° C storage to increase any effects of time. Note that the leakage values are in fractions of millimicroamperes, hence the apparent small changes are fractions of extremely small values.

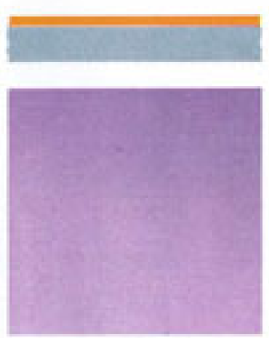


NO LOSS IN BETA (h_{FE}) — A random thousand 2N1613 (Planar 2N697) units subjected to 2000-hour life test at 200°C. Graph shows that beta distribution actually has a slight upward shift with time, stabilizing after 1000 hours and affording a large design safety factor.

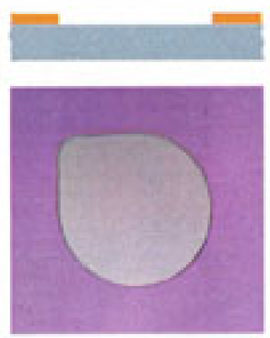
PROTECTION FROM START TO FINISH

One planar transistor on a silicon wafer is followed through the various steps in which the junctions, surface and contacts are formed. Photographs are magnified 128 times.

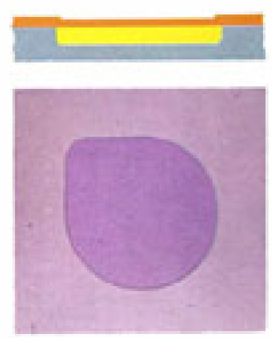
All photographs unretouched — colors are interference colors.



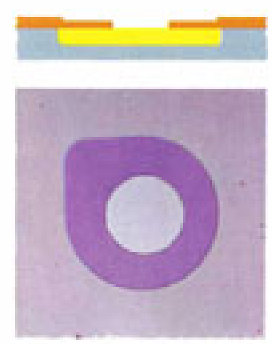
The entire silicon wafer surface receives protective oxidation before any of the diffusion steps that will form the base and emitter junctions.



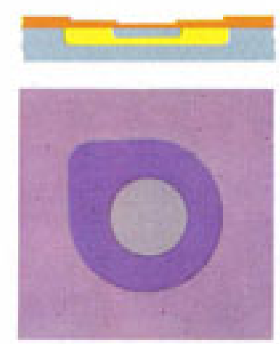
A window is etched through the oxide to prepare for base diffusion. Surrounding oxide has been masked against etching by a photo lithographic technique.



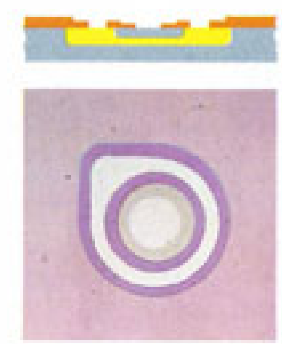
Base impurity enters through the exposed area. The base collector junction is formed by diffusion under the original oxide at a protected location. New oxide forms over exposed base area.



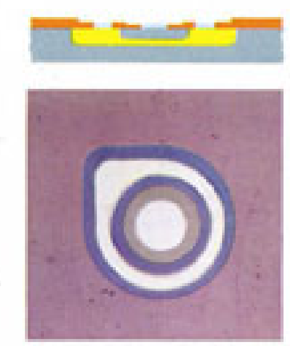
A smaller window is etched through the second oxide coating to prepare for emitter diffusion. Precision masking at various stages maintains exact relative positioning of areas.



Emitter impurity diffuses through the exposed area. Again, due to the concurrent lateral diffusion, the emitter-base junction is placed under the second oxide at a protected location.



Base and emitter contact areas are etched through the oxide coatings. Precision masking keeps etching well away from junctions. Protective oxide over junctions remains undisturbed.



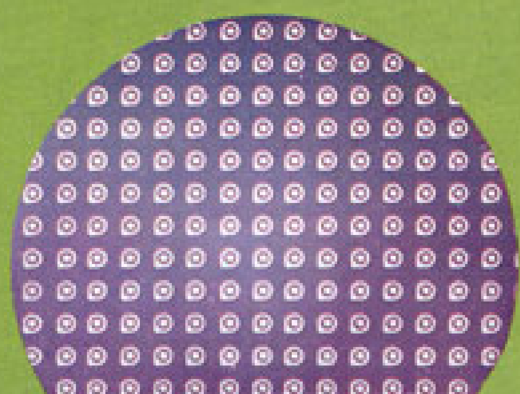
Metallizing of base and emitter contacts completes the processing of the wafer prior to separation into individual dice. At no step have the junctions been exposed to contamination.

PLANAR YIELD

the key both to lower cost and to new, advanced devices

Fairchild's planar process characteristically yields in excess of 90% finished units meeting very high specifications. (50% yield has been good by other methods.) The economic advantage is huge—first to provide high-performance, high-reliability units at reasonable cost—ultimately to supplant even the low-performance types as these lose their price advantage. Increased volume can only snowball the effect.

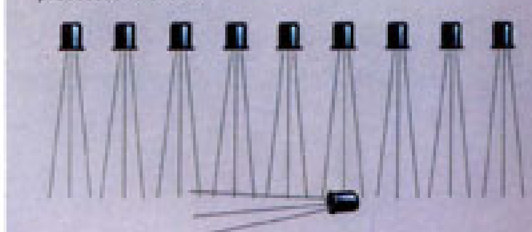
THE EXTRAS IN THIS WAFER ARE THE SECRETS TO LOW-COST TRANSISTORS



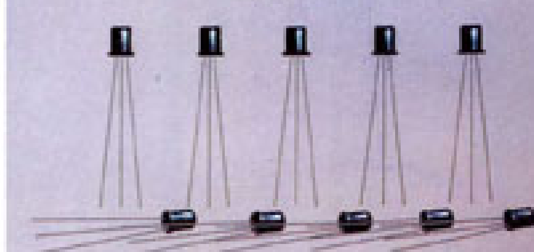
It took extra steps and extra precision to manufacture this planar wafer — an apparent extra cost. But because of the passive oxide that protects the sensitive regions of the transistors on this wafer, more of these structures will survive to meet rigid specifications.

A COMPARISON OF REJECT BURDENS

The transistors or diodes that pass specifications obviously must carry the cost burden of those that fail. A comparison of planar yield with "good" yields by other processes is shown.



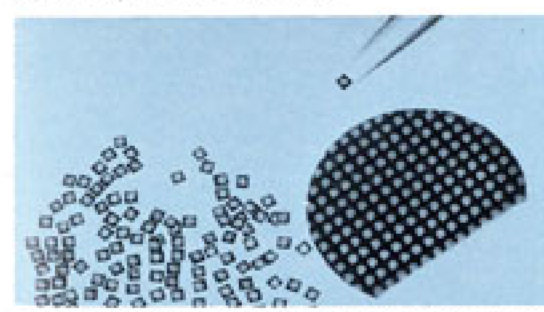
PLANAR
(9 to 1)



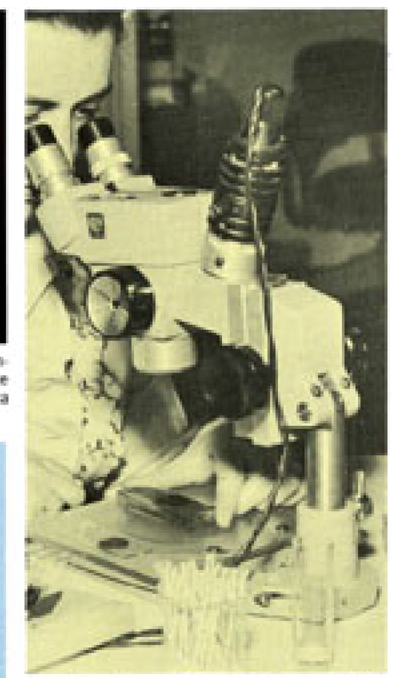
TYPICAL OTHER
(5 to 5)

A REVEALING DIVISION OF COST IN FAIRCHILD'S PLANAR MANUFACTURE

In the wafers thousands of potential transistors or diodes are handled together. They receive the extra steps necessary for surface passivation. Simultaneous processing makes these valuable extra steps a small part of total transistor cost.



Once the dice are cut apart, the manufacturing steps become more costly because of individual handling. Protection against some of the normal production hazards is built in, making subsequent steps easier.



Assembly steps are the costly ones. But the costs are similar whether the transistors are low performance types or high. Three things count. The first two are the scale of production and degree of automation. The other is yield — the final acceptance rate.

HIGH YIELDS NOW MAKE MULTIPLES FEASIBLE

Advantages

- Closely matched twins, triplets or quads can be tied together in one package.
- Functional multiples with a common electrical connection can be packaged together reducing external soldered connections.
- Higher packaging density is made possible.

The Arithmetic of Practicality

Using a four-transistor quad as an example, simple arithmetic shows the vital part played by planar high-yield manufacture in making such devices feasible.

By planar (90% yield of single transistors)
.90 x .90 x .90 x .90 = 65% yield of quad assemblies

By other processes (50% yield of single transistors)
.50 x .50 x .50 x .50 = 6% yield of quad assemblies

The photo shows a Fairchild two-transistor chopper in one TO-5 package, the first of a family of Fairchild multiple transistors and multiple diodes to come. The same planar advantages are essential to future development of integrated circuits.

"HARDWARE" *to the tightest specifications and for the broadest requirements*

Fairchild silicon planar transistors and diodes embodying all the claimed advantages of performance and reliability are available now. The selection is broad and will increase further.

SILICON PLANAR TRANSISTORS

The most significant combination of performance parameters ever offered is available now in Fairchild planar transistors. They can fulfill the most demanding requirements — also simpler needs, of course.

PERFORMANCE PROFILE OF PLANAR TYPES

(These figures do not represent ultimates; they are performance available or imminent as of November 1960. Full data is available on all types.)

2N 708

SPEED — 400 megacycles gain-bandwidth product . . .
in a planar transistor that also has power dissipation of *1 watt* at 25°C case temperature

2N 699B

POWER — 5 watts dissipation in TO-5 package . . .
in a planar transistor that also has gain-bandwidth of 120 mc. *(Planar power transistors also planned)*

2N 1613

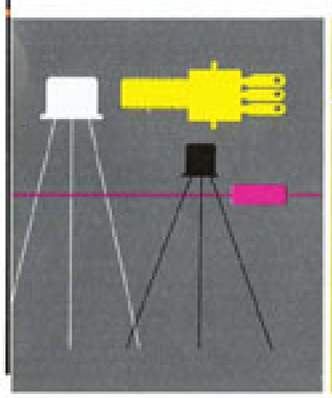
LOW LEAKAGE — 0.0008 μA typical at 25°C . . .
and 10 μA maximum at 150°C in a general purpose planar at $V_{CB} = 60V$

2N 1613 2N 708

TIGHT SPREAD OF "ON" BASE VOLTAGE . . .
This permits close matching of transistors for differential usage and simplifies dc logic chain designs

2N 1613

BROAD CURRENT RANGE — I_C from 100 μA to 500 mA . . .
5000-to-1 range all in one planar transistor with guaranteed h_{FE} greater than 15 at both extremes



A planar/mesa performance comparison (2N 1613 versus 2N 697)
The following apply to a planar "immediate superior" and the specific mesa type it replaces.

Maximum dissipation	Planar 50% higher	Gain-bandwidth	same
Maximum V_{CBO}	Planar 25% higher	Switching speeds	same
Maximum V_{EBO}	Planar 40% higher	V_{CER}	25% higher
Low current h_{FE}*	Planar very superior	V_{BE} SAT	same
I_{CBO}	Planar 100 times lower	V_{CE} SAT	same
C_{ob}	Planar 30% lower	h_{FE} (@ 150 mA)*	same
I_{EBO}	Planar 10,000 times lower		

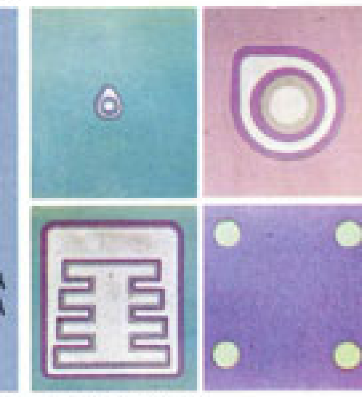
In addition, the noise figure is considerably improved.
*h_{FE} is useful and specified over a broader current range on the planar types.

PLANAR TYPES REPLACE MANY TRANSISTORS DIRECTLY

One or two planar transistor types replace many mesa, grown diffused, grown and alloy transistor types. Use planar transistor types which provide higher power dissipation and higher f_T and/or f_{max}[1] as replacement types[2] for the following transistors:

2N 117	2N 335	2N 472	2N 560	2N 756	2N 1077	2N 1212	2N 1386	2N 1586
2N 118	2N 335A	2N 473	2N 696	2N 757	2N 1149	2N 1247	2N 1387	2N 1587
2N 118A	2N 335B	2N 474	2N 697	2N 758	2N 1150	2N 1248	2N 1388	2N 1588
2N 119	2N 336	2N 474A	2N 698	2N 759	2N 1152	2N 1249	2N 1389	2N 1589
2N 120	2N 336A	2N 475	2N 699	2N 760	2N 1153	2N 1267	2N 1390	2N 1590
2N 160	2N 337	2N 476	2N 699A	2N 761	2N 1154	2N 1268	2N 1417	2N 1591
2N 160A	2N 338	2N 477	2N 702	2N 762	2N 1156	2N 1269	2N 1418	2N 1592
2N 161A	2N 347	2N 478	2N 730	2N 770	2N 1157	2N 1270	2N 1479	2N 1593
2N 162A	2N 348	2N 479	2N 731	2N 772	2N 1196	2N 1271	2N 1482	2N 1594
2N 332	2N 349	2N 479A	2N 745	2N 1060	2N 1199	2N 1276	2N 1528	2N 1631A
2N 333	2N 470	2N 541	2N 746	2N 1074	2N 1205	2N 1277	2N 1564	2N 1644A
2N 333A	2N 471	2N 542	2N 754	2N 1075	2N 1206	2N 1278	2N 1565	2N 2503
2N 334	2N 471A	2N 543	2N 755	2N 1076	2N 1207	2N 1279	2N 1566	

[1] Compiled from "Derivation and Tabulation Associates Inc." [2] Specific applications determine the degree of electrical and/or mechanical interchangeability.



PLANAR CONFIGURATIONS
Top left – High-speed switching transistor (2N708)
Top right – General purpose transistor (2N1613)
Bottom left – Power transistor
Bottom right – Diode (FD 200)

SILICON PLANAR DIODES

The more advanced silicon planar diodes offer desirable combinations of performance parameters difficult or impossible to attain by other manufacturing techniques. On standard specification, the passivated surface offers a bonus in extra reliability.

THREE TYPES WITH ADVANCED PERFORMANCE

This represents state-of-the-art performance available as of November 1960.

Ultra-fast — the FD100

For use in advanced computer logic application

2 mμsec. max. rev. recovery time @ If = 10mA, Vr = 6V
10mA minimum forward conductance @ 1 volt
2.0 μμf maximum capacitance @ VR = 0V, f = 1mc
75V minimum breakdown voltage

Ultra-fast, high conductance — the FD200

"Universal" type for switching and general purpose applications

100mA min. forward conductance @ 1 volt
50mμsec. max. rev. recovery time @ If = 30mA, Ir = 30mA
200V minimum breakdown voltage
5 μμf maximum capacitance @ VR = 0V, f = 1mc

General purpose, high conductance, low leakage — the FD300

"Universal" type for all applications where speed is not critical

Over 200mA forward conductance @ 1 volt
0.005 μA maximum leakage @ —125V, 25°C
Under 6 μμf capacitance @ VR = 0V

OVER 200 STANDARD SPECIFICATIONS FULFILLED BY PLANAR DIODES

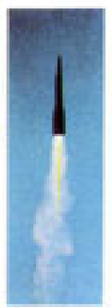
These include the most widely used high performance silicon diodes — and others that prior to Fairchild's planar introduction were difficult to obtain because of production problems encountered in other processes.

Some of the most popular types available with planar reliability are listed below. Switching diodes in the planar line are available with recovery time as low as 2 millimicroseconds.

1N 251 (JAN)	1N 662 (Sig C)	1N 843
1N 457 (JAN)	1N 663 (Sig C)	1N 903
1N 458 (JAN)	1N 837A	1N 904
1N 559 (JAN)	1N 840	1N 905
1N 643 (Sig C)	1N 841	1N 914 (USN)
1N 658	1N 842	1N 916

THREE QUESTIONS ANSWERED



1. AREAS OF APPLICATION

- For direct use in any circuits designed around silicon mesa types.
- In lieu of high-performance germanium types in circuits now being designed for future manufacture (since lower prices are anticipated for planar silicon devices).
- To solve problems of heat, packaging density, circuit simplification, reverse leakage, long term stability or reduction of the number of device types required.
- In circuits requiring much less than planar performance — but which can benefit from reliability and design simplification. A projection of future planar prices versus your own production timetable can save your product from early obsolescence.

2. AVAILABILITY OF TECHNICAL DATA

Detailed specification sheets are available on each planar type now in production and will be issued on new types as they are released.

Circuit application data is available showing effective circuits to take full advantage of the performance characteristics of planar devices for a wide range of needs.

Technical papers are available on various fundamental investigations by Fairchild research and application personnel.

Fairchild's sales engineers or the application engineering department in the Mountain View home office can supply any of the above.

3. CONVENIENT SOURCES OF FAIRCHILD PLANAR TRANSISTORS AND DIODES

Local distributor stocks in the major electronic manufacturing areas enable quick delivery. Up to 999 units of any type can be furnished at factory prices. See back cover for your nearest distributor.

Large production orders for quantities over 999 are processed by Fairchild's field offices in a number of areas of the country.

Government source inspected sales on Fairchild types with MIL approval can be placed through Fairchild field offices.

FAIRCHILD GROWTH

The reflection of product acceptance

Fairchild's main office and transistor manufacturing plant, occupying 68,000 square feet in Mountain View, California. This expanded facility was necessitated by production requirements less than one year after Fairchild's first product announcement. Further expansion of this facility is planned for early 1961.

The research and development center in Palo Alto occupying Fairchild Semiconductor's entire original plant facility of 17,000 square feet plus a 10,000 square foot addition. A completely new 60,000 square foot research and development building will be started in early 1961.

Quarters for Fairchild's Minuteman reliability program, occupying 7,800 square feet in a second Mountain View location.

Fairchild's Instrumentation Department moved from the main plant to 7,700 square foot quarters in Palo Alto, California.

Fairchild's 52,000 square foot diode plant in San Rafael, California, was occupied in November 1960.

FAIRCHILD DISTRIBUTORS

1 to 999 units at factory prices

ALMAC ELECTRONICS CORPORATION
6301 Maynard Ave., Seattle 4, Washington
PArkway 3-7310

ATLAS ELECTRONICS INC.
774 Pfeiffer Blvd., Perth Amboy, New Jersey
Hillcrest 2-8000

CRAMER ELECTRONICS INC.
811 Boylston St., Boston 15, Massachusetts
COpley 7-4700
WUX: FAX Boston, Massachusetts

DENNY-HAMILTON ELECTRONICS
1862½ Bacon St., San Diego 7, California
ACademy 4-3451

HAMILTON ELECTRO SALES
11965 Santa Monica Boulevard
Los Angeles 25, California
EXbrook 3-0441, BRadshaw 2-9154
TWX: W LA 6637

KIERULFF ELECTRONICS INC.
820 West Olympic Boulevard
Los Angeles 15, California
Richmond 8-2444, TWX: LA 46

PHILA ELECTRONICS INC.
1225 Vine St., Philadelphia 7, Pennsylvania
LOcust 8-7444

SCHAD ELECTRONIC SUPPLY, INC.
499 South Market St., San Jose 13, California
CYpress 7-5858

SCHWEBER ELECTRONICS
60 Herricks Road
Mineola, Long Island, New York
Pioneer 6-6520, TWX: G CY NY 580-U

SCHWEBER ELECTRONICS
Silver Spring Division
8710 Georgia Ave., Silver Spring, Maryland
JUniper 5-7023

SEMICONDUCTOR DISTRIBUTOR SPECIALISTS, INC.
5706 West North Ave., Chicago 39, Illinois
NAtional 2-8860

VALLEY ELECTRONICS INC.
1735 East Joppa Road, Baltimore, Maryland
VAlley 5-7820, TWX: TOWS 564

VALLEY INDUSTRIAL ELECTRONICS, INCORPORATED
1417 Oriskany Street W., Utica, New York
RAndolph 4-5168, WUX: FAX Utica, New York

WARD TERRY AND COMPANY
Electronics Parts Division
P. O. Box 869, Denver 1, Colorado
AMherst 6-3181

FAIRCHILD FIELD SALES OFFICES

For production orders of 1000 units or more

PALO ALTO, CALIFORNIA
378 Cambridge Avenue, Suite M
DAvenport 1-8780

LOS ANGELES, CALIFORNIA
8833 Sunset Boulevard
OLeander 5-6058, TWX: BV 7085

GARDEN CITY, L. I., NEW YORK
600 Old Country Road
Pioneer 1-4770, TWX: G CY NY 5391

OAK PARK, ILLINOIS
6957 West North Avenue
VIllage 8-5985, TWX: OAK PARK 2820

WASHINGTON 6, D. C.
809 Cafritz Bldg., NAtional 8-2590

MARBLEHEAD, MASSACHUSETTS
119 Rockaway Ave., NEptune 1-4436

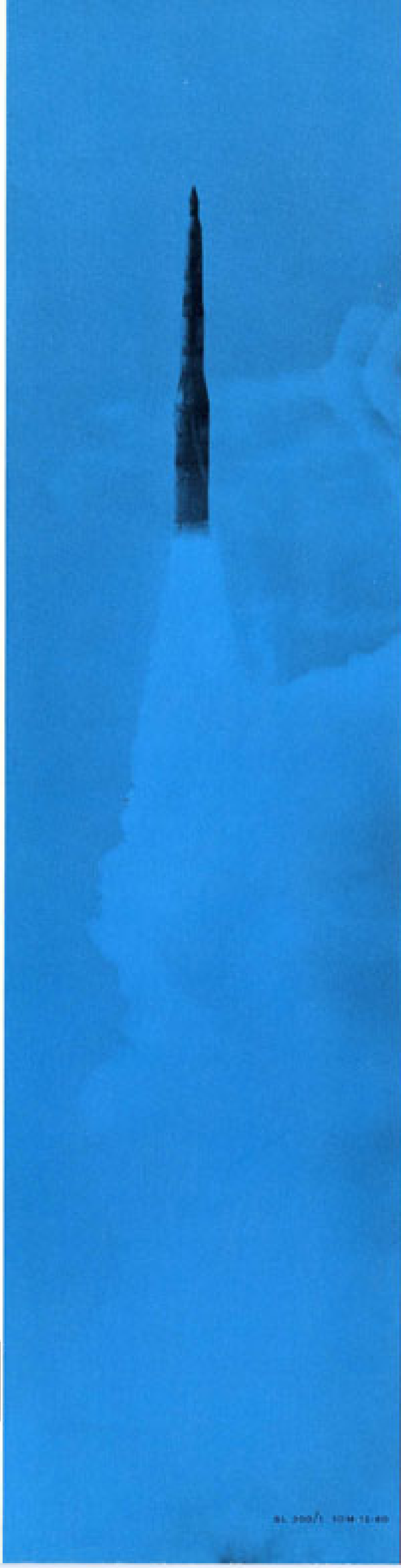
JENKINTOWN, PENNSYLVANIA
100 Old York Road
TUrner 6-6623, TWX: Jenkintown PA 1056

SYRACUSE, NEW YORK
731 James Street, Room 304
GRanite 2-3391, TWX: SS 94

ORLANDO, FLORIDA
618 E. South St., Suite 21, CRestwood 7-5610

FAIRCHILD
SEMICONDUCTOR CORPORATION

Transistors: 545 Whisman Road, Mountain View, Calif. YOrkshire 8-8161, TWX: MN VW CAL 853
Diodes: 4300 Redwood Highway, San Rafael, Calif. GReenfield 9-8000. TWX: SRF 26
A Wholly Owned Subsidiary of
Fairchild Camera and Instrument Corporation



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