Early Philco Transistors: Philco was one of several large mid-century electronics firms that moved quickly into the newly evolving world of germanium transistor technology - other successful companies of similar market presence included GE, Raytheon, RCA, and Sylvania. In the 1950s, Philco was highly diversified across multiple product lines, including appliances, consumer electronics such as TVs and radios, vacuum tubes, military systems, transistors and computers. Philco's entry into the transistor market began in the early 1950s with PNP germanium alloy audio devices. Examples included the miniature 2N47, shown second from left in the bottom row above, and the later micro-miniature M1 style, shown at far left. These devices were intended for use in hearing aids and other small consumer products. Philco's major and most successful transistor product line began with the SBT (Surface Barrier Transistor) which used a unique precision etch manufacturing process to produce very high frequency switching and RF devices. These first SBTs were developed by Philco in the mid-1950s under a U.S. Army Signal Corps contract. Examples of early Philco SBTs are shown at lower left, beginning with the brown painted "3851" Signal Corps prototype SBT, followed by the gold plated 2N240 and the silver SB100, dated 1955. A unique aspect of these Philco early SBTs was the use of a proprietary "bullet-shaped" metal case, later defined as JEDEC TO-24, which was a successful Philco implementation of a hermetically sealed case. Continued improvements to the precision etch process by Philco supported the rapid development of new higher performance types, including the MAT (Micro Alloy Transistor) and the MADT (Micro Alloy Diffused-base Transistor). These high speed devices were ideally suited for military and commercial applications, including computers, satellites and RF equipment, and were sold in the millions throughout the 1950s. In addition to improvements in transistor technology, Philco also developed a broad range of unique case shapes and styles, many of which are shown above. The transistor types, including SBT, MAT, MADT, and alloy junction were combined with the many different case styles to produce an extensive list of successful transistor model numbers available from Philco (many shown in the photo above). Philco was very successful with the high speed transistor types produced by the precision etch process, but was not a major presence with germanium power transistors (examples shown at top right), or silicon transistors.
Early Philco SBT Transistors: As shown by the March 1956 Teletech ad above, Philco was eager to advertise the commercial availability of its new SBT high frequency transistor technology. Performance up to 50 MC positioned the SBT as the industry leader in high speed operation, and Philco was able to provide these transistors in quantity to the military and to computer manufacturers for evaluation and commercialization purposes. These first SBTs were marketed by Philco as model SB100, and examples of early historically important transistorized computers using the SB100 were the ORDVAC, TRADIC and LARC. With the introduction of the SB100, Philco became the leader in high speed transistor technology, and maintained this lead for almost a decade with the follow on MAT and MADT types.
PHILCO SURFACE BARRIER TRANSISTOR

GERMANIUM TYPE SB-100

FEATURES
- Most Efficient High Frequency Transistor Available
- Lowest Power Consumption
- Hermetically Sealed Resistance Welded Metal Case with Leads Sealed in Glass
- Long Life and Reliability of Operation
- Uniform Characteristics Insured by Controlled Processing and Complete Testing
- Extremely Low Collector Cut Off Current for Stable Operation
- Clearly Marked Lead Orientation
- Designed to Meet Typical Military Environmental Conditions

APPLICATIONS
The Philco type SB-100 is a hermetically sealed surface barrier transistor designed for use as a general purpose IF and RF oscillator or amplifier at frequencies up to 30mc, as a wide band video amplifier, and as a switching transistor at switching frequencies as high as 1.5mc. The polarities of the emitter and collector voltages are similar to those of PNP junction transistors. The tinned flexible leads may be soldered or welded directly into the circuit or they may be clipped and used with standard plug-in sockets.

SPECIFICATIONS

**ELECTRICAL**

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collector Voltage (Common Emitter)</td>
<td>-4.5 volts</td>
</tr>
<tr>
<td>Collector Current</td>
<td>-0.5ma</td>
</tr>
<tr>
<td>Collector Dissipation (at 40°C)</td>
<td>10mv</td>
</tr>
<tr>
<td>Typical Characteristics</td>
<td>35°C</td>
</tr>
<tr>
<td>Collector Voltage</td>
<td>-3.0 volts</td>
</tr>
<tr>
<td>Collector Current</td>
<td>-0.5ma</td>
</tr>
<tr>
<td>Common Emitter Current Amperage</td>
<td>20</td>
</tr>
<tr>
<td>Common Base Output Capacitance</td>
<td>400,000 ohms</td>
</tr>
<tr>
<td>Common Base Input Capacitance</td>
<td>70</td>
</tr>
<tr>
<td>Extrinsic Base Resistance-Collector Capacitance</td>
<td>3.5pF/fj</td>
</tr>
<tr>
<td>Product</td>
<td>800 µs sec. (1500 µs sec. max.)</td>
</tr>
<tr>
<td>Collector Cutoff Current</td>
<td>0.5 microamperes</td>
</tr>
<tr>
<td>Maximum Frequency of Oscillation (f max.)</td>
<td>45mc (30mc min.)</td>
</tr>
</tbody>
</table>

**NOTE:** Accidental application of large voltage surges to transistors may alter their characteristics. Such surges may be derived from soldering irons and test equipment operating from 110VAC lines. As a precaution against this, all equipment should be carefully grounded and pin type soldering irons are recommended. The use of isolation transformers is also a satisfactory safeguard.

**MECHANICAL**

- Base: 0.616" tinned flexible leads. Emitter lead length 1.45" min.
- Collector and base lead length 1.50" min. on a 0.070" dia. circle.

Printed in U.S.A.

Philco reserves the right to modify the design for reasons of improved performance.

PHILCO CORPORATION
LANSDALE, PENNSYLVANIA

Landsdale Tube Company Division

1956 Philco SB100 Transistor Data Sheet: This April 1956 SB100 data sheet documents very early performance data for commercial SBT technology. Note the claimed 45 MC maximum (30 MC minimum) frequency specification here, compared with the 50 MC specification from the TeleTech ad shown on the previous page. As Philco engineers gained more experience with the precision etch process, it’s likely that better performance and greater consistency was achieved for these unique devices.

The Philco Precision Etch Transistor Patent: The scan above is a stylized composite of the drawings associated with Philco patent 2,885,571, filed by Richard Williams and John Tiley in 1954. The unique construction of SBT transistors are documented in this patent. For example, Figure 1 is a cross sectional view of an SBT transistor - the yellow highlighted area is an N Type germanium die (base connection), and the red and blue areas are respectively the emitter and collector areas of the transistor. Figure 3 illustrates the chemical electrolyte etching equipment designed to precision etch the emitter and collector "wells" into the germanium die, thereby creating a very thin base layer, and resulting high frequency performance. This patent also provides is an excellent discussion of the differences between the SBT and the other existing transistor types of the time - point contact and junction.
SB100: The SB100 model number was used by Philco to designate its first general purpose Surface Barrier Transistor (SBT) for fast switching and high frequency use. This historic device was manufactured using the unique Philco precision etch process, and was especially well suited for applications such as computers. Produced first in 1955, the SB100 was the highest frequency transistor commercially available and was supplied to the military and the computer industry for circuit evaluation and product design. The SB100 transistors shown above and included in this kit are very early production units (1955 week 45) supplied to the U.S. Navy by Philco. These first units are somewhat crudely made (note the uneven plating process on the case and leads for these units) and reflect the startup nature of the Philco SBT production facilities. SB100 transistors were expensive and sold for $6 each in 1957.

L5129: In addition to the industry standard “2N” numbering sequence, Philco also used a variety of in-house and preproduction numbering systems for 1950s device identification. Often these non-standard devices were made available to industry for evaluation or production purposes prior to JEDEC approval of the corresponding “2N” type. The L5129 transistors shown above and included in your kit are dated 1957 and are a preproduction type corresponding to the 2N240 SBT. These particular transistors are from a batch provided by Philco to Burroughs for use in the Atlas guidance computer. Burroughs also used this transistor type in the Model D 204 Submarine Computer. Note the improved plating process and general appearance of these 1957 transistors, compared with the 1955 SB100s shown above.
Historic Germanium Computer Transistors Research and Collecting Kit

More Transistors from Philco in 1956: The above scan from a 1956 Philco advertising brochure illustrates the expanding range of transistor types developed since the initial SB100 SBT was released. In addition to a variety of alloy junction types (top row), Philco also developed several new and improved SBTs (2N128, 2N129 and 2N240), and the first Philco silicon transistors (T1025, T1159). These latter types were all manufactured using the precision etch process.
Philco Transistors and the U.S. Army Signal Corps: A FY-1954 Sig C Production Engineering Measure contract, awarded by the Signal Corps to assure availability of specific military items, included a contract with Philco for initial production of high frequency surface barrier transistors, with the result that the 2N128, 2N299 and 2N300 SBTs were developed. The December 1956 Teletech ad shown above documents the availability of reliable and high performance SBTs from Philco specifically designed to meet rigid military requirements developed by the Signal Corps. The 2N128 was widely used for many years in computer and RF applications. Initial units were quite expensive, and listed for $9 each in 1957.
Early Philco Silicon Transistors: Texas Instruments was the first company to commercialize silicon transistors, with the introduction of the 900 series product line in late 1954. Philco was also developing silicon transistors during this timeframe, and announced the availability of pilot production units in late 1956. The above ad appeared in the December 1956 Teletech magazine, and highlights the limited availability of the first Philco silicon transistors, the T-1025, registered with JEDEC in 1957 as the 2N354 and the T-1159, registered with JEDEC as the 2N355. Unlike the TI silicon transistors, which were NPN grown junction devices, the Philco silicon transistors used the precision etch process and were designated as SAT, or Surface Alloy Transistors. Due to the high demand by the military for silicon transistors and the manufacturing difficulties encountered by industry with this new technology, the early units were very expensive, with the T-1025 selling for a whopping $46.50 in 1957. Note that Philco often used in-house model numbers, such as T-1025, for transistor types not registered as a "2N" type. Philco continued to develop silicon precision etch transistors, and in 1957 released the 2N495 and 2N496 types, which met Sig C requirements. Industry-wide silicon transistor technology continued to improve over the next decade, with mesa and planar types, which obsoleted the earlier junction and precision etch devices.
Philco Transistor Center, USA: Based on the success of the precision etch process and an industry leadership position in high frequency SBTs, MATs and MADTs, Philco was prepared to invest heavily in the facilities and equipment required for volume production of transistors. Shown at top is a 1956 Philco advertising photo highlighting the opening of the new Transistor Center U.S.A. facility in Spring City, PA. The accompanying text states: "For the first time, the dream of the electronics industry comes true... made possible by many years of Philco pioneering, research and production of semiconductors. Philco's great new transistor plant at Spring City, Pa. is designed for and dedicated to the mass production of reliable transistors. It's the greatest development in transistor history. A complete plant, housing the most advanced transistor manufacturing equipment and utilizing entirely new production methods, is now in mass production at Spring City, Pa. We call it Philco Transistor Center, U.S.A. - and, that's exactly what it is. From this plant come the world's finest transistors - unmatched in quality and reliability." This new facility was constructed in an old hosiery mill located at 501 South Main St in Spring City (see reference 6 at the end of this chapter) and was designed for the very high volume production of Philco transistors, up to 25 million total by the early 1960s. Philco frequently referred to its Transistor Center U.S.A. in ads and catalogues of the time and in promotional material, such as the paperweight shown above.
Philco MAT Transistors: Following the original SBT, one of the first improved transistor types developed by Philco using the precision etch process was the Micro Alloy Transistor (MAT). As noted in the March 1957 ad shown above, the MAT transistor added an alloyed indium emitter electrode to the basic SBT technology, with a resulting device that achieved high gain and high currents at high frequencies. This technology is described in Philco patent 3,032,484 filed in 1959 by Donald Sanders. The most famous and widely used MAT transistor was the 2N393 (development type T-1166), which was sold in very large quantities and was used in such historic computers as the Sylvania MOBIDIC and ATACC, and the GE 312.
By late 1958, as noted above, Philco was heavily marketing its transistor product line to the computer industry. With an extensive range of performance characteristics, and a broad listing of types, Philco was well positioned to address the device requirements of digital computers under development at that time. With high volume production capability at the Transistor Center U.S.A. factory and new higher frequency transistor types based on the precision etch process, Philco was the dominant supplier of germanium computer transistors in the late 1950s.
2N600/601: Philco's precision etch transistors achieved very high switching speeds and were very useful for digital computer and RF applications. The power handling capabilities of these transistors was adequate for low current and voltage circuits, but these devices were not capable of medium or high power switching. In the late 1950s, Philco added a number of transistors to their commercial lineup, including several alloy junction types that were designed to operate in higher power circuits. The 2N600/2N601 series of transistors (above left) were intended for high current pulse and digital circuitry, such as memory core drivers. These transistors used a unique "stud-mounted" metal case, designated TO-31, that allowed heatsyncing for great power handling capabilities. The 2N601 offered switching speeds up to 12 MC, while the 5MC 2N600 was available to meet Navy and Sig C military specifications.

2N670: Another power alloy junction transistor, the 2N670 shown above right, was registered with JEDEC by Philco in March 1959. This transistor provided medium power handling capabilities with a high voltage range, and was intended for low-speed, high-voltage pulse amplifiers and switching circuits where peak currents may be very high. The 2N670 used a unique tall version of the standard TO-9 case style. As noted earlier, Philco developed a broad range of proprietary and unusual transistor case styles, and the types illustrated by the 2N600/2N610 and the 2N670 devices are some of the most unusual examples.
Philco MADT Transistors: Another improved transistor type developed by Philco using the precision etch process was the Micro Alloy Diffused-base Transistor (MADT). Using the semiconductor diffusion techniques originally developed at Bell Labs, Philco MADT transistors were able to perform at extremely high frequencies, and were well suited for switching and VHF applications. The above 1958 ad announced the availability of several new MADT transistors and provided some detail regarding the MADT process. This technology is described in Philco patent 3,096,259 filed in 1959 by Richard Williams. Philco MADT transistors were the dominant "high speed" transistors until the early 1960s, when diffused base mesa transistors from Motorola, Texas Instruments and Fairchild became available. Philco MADT types were widely used in 1950s and 1960s computer, military and industrial switching and high frequency applications.
PHILCO MADT TRANISTORS
CONTROLLED IN
DESIGN AND
MANUFACTURE . . .
to meet your exact
circuit requirements
... NOT SELECTED!

New VHF-UHF Transistors available in unlimited
quantities— at realistic prices!

**Philco MADT Transistors in Unlimited Quantities:** By 1959, the Philco Transistor Center was able to produce large quantities (1 - 99 available "off-the-shelf" according to the ad above) of the high performing MADT transistor types. Note the partial view above of the etching machine, with hoses, valves and jets used to electrochemically process each MADT transistor. The exclusive electrochemical precision etching process allowed Philco to manufacture transistors with highly controlled performance characteristics. Philco was "on a roll" in the late 1950s with many new MADT types added to the computer product lines.
PHILCO

2N588: In May 1959, Philco registered a series of its new MADT transistors types with JEDEC with the following "2N' types documented: 2N499, 2N500, 2N501, 2N501A, 2N502A, and the 2N588. These high frequency transistors were intended for the rapidly expanding computer and VHF/UHF market, and the individual types listed provided a broad range of performance characteristics and case styles. The tentative data sheet provided by Philco with the JEDEC registration identified the 2N588 as "The 2N588 is a hermetically, germanium MADT field flow transistor for use in amplifiers and oscillators at frequencies up to 50 MC." As shown above left, the 2N588 used the classic "silver bullet" TO-30 case style. Listed at $6 in 1959, the 2N588 was one of least expensive MADTs available. The 2N588 units included in this kit are dated from the early 1960s and should perform well as a general purpose medium speed amplifier.

2N598: Although best known for its unique precision etch transistor technology, Philco did manufacture the industry standard germanium alloy junction device types as well. Initially targeted for audio applications, such as hearing aids and radios, Philco developed a more complete range of these types that were suitable for low speed computer use. For example, Philco registered the 2N598 (shown above right) with JEDEC in 1959 with the following description: "The 2N598 is a germanium PNP junction transistor designed for use in medium frequency, medium power computer and communications applications. The 6.5 MC minimum cutoff frequency insures good operation in 300 to 400 kc switching circuits. The type features high beta, good beta linearity, and a cold welded case. The 2N598 is made with a rugged internal construction for high reliability and is stabilized by 100 hours of prebaking at 100 C." The 2N598 listed for less than $6 in 1959, and was a good choice for computer designers for low speed switching circuits.
Many Philco MADT Transistors: By the early 1960s, Philco had developed a very broad range of high speed MADT transistors for computer use. Note in the March 1961 ad above that various case styles and performance characteristics were available. Since the mid-1950s, when the first MADTs were developed by Philco, these types of transistors had logged billions of hours of actual field operation, with an impressive claim for reliable operation. The circuit board shown at top in the ad is an illustration of a circuit board from the Philco Transac computer, which used Philco MADT transistors.
Philco 2N1499A Transistor: Building on its industry lead with high speed transistors, Philco introduced an improved version of the 2N1499A MADT in the early 1960s, as noted in the ad above. This device offered impressive performance and was advertised as a “high-speed, low-cost switch”. The 2N1499A was used widely in logic and switching applications in the 1960s, including for example in the Type 24 Serial Drum Storage System which provided auxiliary storage for the DEC PDP-1, PDP-4 and PDP-7 computers. Military versions of the 2N1499A were also available and were used extensively in critical military applications.
Philco 2N1500 Transistor: For the ultimate in switching performance, Philco developed the "ultra high-speed" 2N1500 MADT with exceptional switching speed up to 20 MC. Tentative data sheets were available in 1960 and the ad above appeared in April 1960 issue of Semiconductor Products magazine. This device was used in historically important early transistorized computers, including the 1961 Packard Bell PB250.
2N1499A: In May 1960, Philco registered several new high frequency transistors with JEDEC. This was a very active time for Philco, which was rapidly expanding its lead in commercial switching transistors with new MADT and related types. The registration text for the 2N1499 is based on the associated tentative data sheet which reads in part: "The 2N1499 is a hermetically sealed, germanium Micro Alloy Diffused-base Transistor (MADT) designed for use in saturated switching circuits. The 2N1499 is capable of switching at frequencies in excess of 5 megacycles. It is intended to be used in high-speed commercial computers, data processing and automation equipment. The very thin base width of the 2N1499 makes it exceptionally radiation resistant. The TO-9 package is cold welded for high reliability". Note that Philco was continuing to improve the precision etch manufacturing process and soon offered an improved version of this transistor, designated 2N1499A, which greatly increased the original switching speed, from 5MC to 10 MC. The 2N1499A was marketed as a "high-speed, low-cost switch".

2N1500: When introduced in 1960, the 2N1500 was likely the highest switching speed computer transistor generally available, with advertised performance up to 20 MC. This was an important feature for computer manufacturers and Philco was eager to capture this market. The March 1960 tentative data sheet for the 2N1500 states in part: "The 2N1500 is a hermetically sealed, germanium Micro Alloy Diffused-base Transistor (MADT) specifically designed for very high speed switching applications. Reliable operation of the 2N1500 in switching circuits has been achieved at speeds in excess of 20 megacycles. An important feature of this transistor is the excellent high frequency response at very low collector voltages. This characteristic is made possible by techniques which place the collector in the diffused region of the base". The exceptional high speed performance of the 2N1500 was well received by computer and switching circuit designers and the device found immediate use in computers (the Packard Bell PB250) and in logic design (the Harvard University Cyclotron).
PHILCO

PHILCO Transistors operate
51,614,343
SERVICE HOURS*

in High-Speed Computer Circuits
with only 8 Failures!

Carefully documented reports now reveal that Philco electro-chemical transistors have amassed more than fifty-million hours of operation in six computers under actual field conditions. Here is proof of the outstanding performance and reliability that electronics engineers and designers have come to expect from Transistor Center, U.S.A. Of course, these transistors are still operating in their original high speed computer switching circuits . . . extending service life data on these transistors beyond the limits of any previously published information.

When you think of transistors, think first of Philco. Make Philco your prime source for all transistor information.

<table>
<thead>
<tr>
<th>Total Transistor Service Hours</th>
<th>Total Transistors</th>
<th>Total Failures</th>
<th>Report</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,608,111</td>
<td>99</td>
<td>0</td>
<td>ELECTRONICS, Oct. 1, 1957, pg. 357</td>
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<tr>
<td>5,400,000</td>
<td>600</td>
<td>1</td>
<td>ELECTRONICS, Oct. 1, 1957, pg. 357</td>
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<tr>
<td>1,250,000</td>
<td>125</td>
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<td>10,000,000</td>
<td>10,182</td>
<td>2</td>
<td>WSCC REPORT, Feb. 1957</td>
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<td>8,640,000</td>
<td>8,800</td>
<td>2</td>
<td>PHILCO REPORT, Feb. 12, 1959</td>
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<tr>
<td>10,196,332</td>
<td>18,601</td>
<td>3</td>
<td>PHILCO REPORT, Nov. 19, 1958</td>
</tr>
</tbody>
</table>

*Documented service hours in these six computers only. Total transistors hours in similar circuits are many times this amount.

†Failures due to all causes including human error.

Reliable Philco Computer Transistors: This 1959 ad documented an important milestone in the reliable use of Philco germanium precision etch for commercial computers. In the published reports that presented the actual failure rate data, Philco assessed the performance of its transistors in six computers actually used in the field. The results were impressive, with over 51,000,000 service hours logged for the six computers during 1957 and 1958, with only eight documented Philco transistor failures. This level of transistor reliability was more than acceptable for commercial computers. As was also common for computers developed in the 1950s and 1960s, transistor logic was implemented with “pluggable” circuit boards so that any component failures could be quickly repaired with an easily replaced board.
Philco Transistors and Philco Computers: Although not directly stated in this 1960 ad, and based largely on the success of its transistors, Philco made a major financial investment in developing its own line of commercial digital computers, beginning in the late 1950s with the historic Transac. Note the hand holding a Philco transistor with transistorized circuit cards in the background. As stated in the text, some of these large scale computers used tens of thousands of individual transistors, and Philco was very successful in supplying these transistors for its own computers and to other computer manufacturers.
Philco Develops the Transac: Introduced in late 1957, the Transac S-2000 was Philco’s first entry into the rapidly expanding market for large scale commercial computer systems. As suggested by the ads above, the Transac system was quite expansive, with multiple bays of equipment, and was positioned by Philco as the "world's first all-transistor management brain". Depending on the specific hardware configuration, each Transac computer system required up to 50,000 individual transistors, and Philco’s Transistor Center U.S.A. was fully capable of producing such quantities of high speed precision etch devices. Note that several other 1950s transistor companies, including GE, RCA, and Sylvania, also entered the computer market with systems that used large numbers of transistors produced by each company.
Real Time Process Control with MADT Transistors: The very high speed performance characteristics of Philco’s MADT transistors were the basis for the development of small scale commercial computers intended for use as automated process control systems for such industries as electric power, metals, chemicals, petrochemicals and ceramics. As noted in the 1960 ad above, Philco partnered with Leeds and Northrup to design and manufacture the LN 3000 process control computer. Containing only 1200 MADT transistors, this unique real-time computer was an ideal application for the fast Philco transistors.
PHILCO

1960s Transistorized Computer Circuit Boards: At upper left is a photo of one of the circuit board types used in historic 1960s DEC PDP computers. This particular module is a type 4215 Four Bit Counter DEC System Building Block, consisting of four flip-flop circuits, and used in the PDP-4 and PDP-5 computers. Note that eight Philco 2N1754 MADT transistors were used in the module (enlarged view above). Also shown above, at upper right, is a circuit board from the Philco Transac 2000 computer. This module uses a Raytheon silicon power transistor, dated 1963. Although Philco had developed a comprehensive line of 1950s/1960s high speed germanium computer transistors, based on the precision etch process, and used throughout the computer industry, Philco was not an active presence in silicon transistor development. As a result, the Transac computers contained tens of thousands of Philco germanium transistors, as well as smaller numbers of silicon transistors manufactured by other companies.
**PHILCO**

<table>
<thead>
<tr>
<th>COMPUTER NAME AND MANUFACTURER</th>
<th>COMMENTS AND HISTORICAL IMPORTANCE</th>
<th>TYPES &amp; QUANTITIES OF PHILCO TRANSISTORS USED</th>
</tr>
</thead>
<tbody>
<tr>
<td>SYSTEM BUILDING BLOCKS DEC</td>
<td>One of the first commercial products from Digital Equipment Corp (DEC). These modules were a coordinated set of transistorized circuit boards used for building and testing computer systems. Typical modules were the Flip-Flop, Logic Gate, Clock and Pulse Amplifier. The early 1960s DEC PDP minicomputers were constructed using these digital modules.</td>
<td>Each digital module circuit board was approximately 4.5&quot; by 7&quot; and used germanium transistor circuitry. Most modules used fewer than 20 transistors, including MAT (2N393) and MADT (2N1754).</td>
</tr>
<tr>
<td>LARC Remington-Rand Univac</td>
<td>The Univac LARC (Livermore Advanced Research Computer) was designed in the late 1950s to provide exceptional performance for scientific calculations at the Lawrence Livermore lab. The computer used all solid state design and magnetic core memory to achieve very high speed operation.</td>
<td>62,000 total transistor count including 57,000 SBT (SB100), with fewer MADT (2N501) and alloy junction (2N597). Small numbers of transistors from other companies were also used.</td>
</tr>
<tr>
<td>MOBIDIC Sylvania</td>
<td>MOBIDIC (Mobile Digital Computer) was developed by Sylvania under contract from the U.S. Army Signal Corps. The 1959 MOBIDIC A was the first large scale fully transistorized general purpose computer delivered to the Army. A military truck/trailer was required to house and move the operational computer.</td>
<td>The MOBIDIC series of Army computers included several models (A, B, C, D and 7A). All used Eccles-Jordan flip-flop circuits, with up to 30,000 MAT transistors (2N393) for the system.</td>
</tr>
<tr>
<td>TRANSAC Philco</td>
<td>Philco entered the large scale commercial computer market with the Transac S-2000 in late 1957. Additional versions of the Transac line were built, including the models 210, 211 and 212, until Philco withdrew from the general purpose computer field in 1965.</td>
<td>The first Transac, Model S-2000, was a very large scale computer system, using over 40,000 SBTs. Later models were upgraded to use the faster MADT types.</td>
</tr>
</tbody>
</table>

**Philco Transistors in Historic 1950s/1960s Computers:** Philco high speed germanium transistors from the late 1950s/early 1960s were used in many of the pioneering and historic computers developed at that time. This was because the Philco SBT, MAT and MADT transistors were among the fastest switching devices available and a major design goal for these transistorized computers was computing speed. The table above highlights the importance of these Philco transistors in several early historically significant solid state computers.
The 1960 Annual Report well summarizes the broad range of products available from Philco, including radio/TV/phonographs, refrigerators/freezers/air conditioners, ranges, laundry equipment, radar, missiles, transistors, computers and microwave/communications equipment. Shown above are examples of some of these Philco products. The October 1961 edition of Philco News (upper left) highlighted the impressive milestone of 25,000,000 Philco transistors produced. Although overall sales were substantial (over $400,000,000 in 1960), Philco’s financial results were in decline at this time and the company registered a significant loss of $1,605,000 in the first quarter of 1961. The Philco board of directors agreed to a buy-out by Ford Motor Company to be completed by November of 1961, at which time Philco became a wholly owned subsidiary of Ford. The Philco transistor manufacturing organization (Lansdale Division) did not fare well with the Ford takeover, and Philco exited this business in 1963.
In the 1950s, Philco had licensed four other companies to manufacture its unique line of precision etch transistors - these second source companies included Sprague, CBS, Motorola and General Transistor. Sprague was by far the highest volume second source manufacturer of Philco licensed transistors. When Philco exited the transistor manufacturing business in 1963, Sprague continued to expand its production capabilities for these devices. Because of the millions of high performance Philco transistors sold to industry and the military, Sprague found a ready market for its Philco style transistors well into the 1970s. The February 1964 ad above from the IEEE Spectrum magazine highlights Sprague's commitment to continued volume availability of the original Philco SBT, MAT and MADT transistors, as well as newer silicon types using precision etch.
Philco Microelectronics: Ford's acquisition of Philco in 1961 coincided with substantial changes in the semiconductor industry. Silicon technology was rapidly replacing germanium, and industry advances were dominated by new semiconductor technology leaders on the West Coast, including Fairchild. Philco Ford established the general offices for its new Microelectronics Division in Santa Clara, Ca – right in the heart of what would be known as Silicon Valley. Through licensing of Fairchild IC technology, as noted in the mid-1960s ad above, Philco Microelectronics moved quickly into this new technology and marketed a comprehensive line of integrated circuits. By 1968, the company expanded its product line to include MOS and bipolar ICs, MOS Fets and epoxy encapsulated silicon transistors. Gone were the earlier germanium SBTs, MATs and MADTs which had established Philco as the premier 1950s high speed transistor company.
**Additional References for Philco Transistor History**

1) The Computer History Museum, online at computerhistory.org and located at 1401 N Shoreline Blvd. Mountain View, CA 94043, has been established to preserve and present for posterity the artifacts and stories of the Information Age. There at many webpages at the CHM site that offer substantial historic information about Philco transistors and computers. Examples include:

- **DEC SYSTEM BUILDING BLOCKS**
- **LARC COMPUTER**
- **MOBIDIC COMPUTER**
- **TRANSAC COMPUTER**

2) Ed Thelen’s large collection of webpages is one of the most useful internet resources available on computer history. We have used these information extensively in developing the Transistor Museum research documentation on computer transistors. Use this link as a good entry point into Ed’s amazing site: [Ed Thelen Site – 1961 BRL Third Survey of Domestic Electronic Digital Computing Systems](https://www.edthelen.com/1961-BRL-Third-Survey/)

3) Patent **2,885,571** filed by Richard Williams and John Tiley in 1954 is the first Philco SBT patent.

4) Patent **3,032,484** filed by Donald Sanders in 1959 is the first Philco MAT patent.

5) Patent **3,096,259** filed by Richard Williams in 1960 is the first Philco MADT patent.

6) The [Spring-Ford Historical Society Facebook](https://www.facebook.com/groups/Philoctcenter/) page has unique photos and commentary about the Philco Transistor Center Building which opened in 1956 at 501 S. Main Street in Spring City, Pa.

7) The original and most informative industry publication describing the emerging Philco SBT technology is the five part series of articles published in the December 1953 Proceedings of the IRE. The article titles and authors, all Philco engineers and scientists, are shown here:

- **Part I - Principles of the Surface-Barrier Transistor**
  by W. E. Bradley.
- **Part II - Electrochemical Techniques for Fabrication of Surface-Barrier Transistors**
  by J. W. Tiley and R. A. Williams.
- **Part III - Circuit Applications of Surface-Barrier Transistors**
  by J. B. Angell and F. P. Keiper.
- **Part IV - On the High-Frequency Performance of Transistors**
  by R. Kansas.
- **Part V - The Properties of Metal to Semiconductor Contacts**
  by R. F. Schwarz and J. F. Walsh.

This Philco section of the Historic Germanium Computer Transistors Research and Collecting kit has included a number of observations, statements and conclusions regarding the early history of Philco transistor development. This Transistor Museum material has been based on a review of multiple highly informative publications and websites devoted to this topic. Because of the historical importance of Philco transistors to the early development of solid state computers, the amount of research information available is substantial. For those interested in further research into early Philco transistors, the references shown above are an excellent starting point.