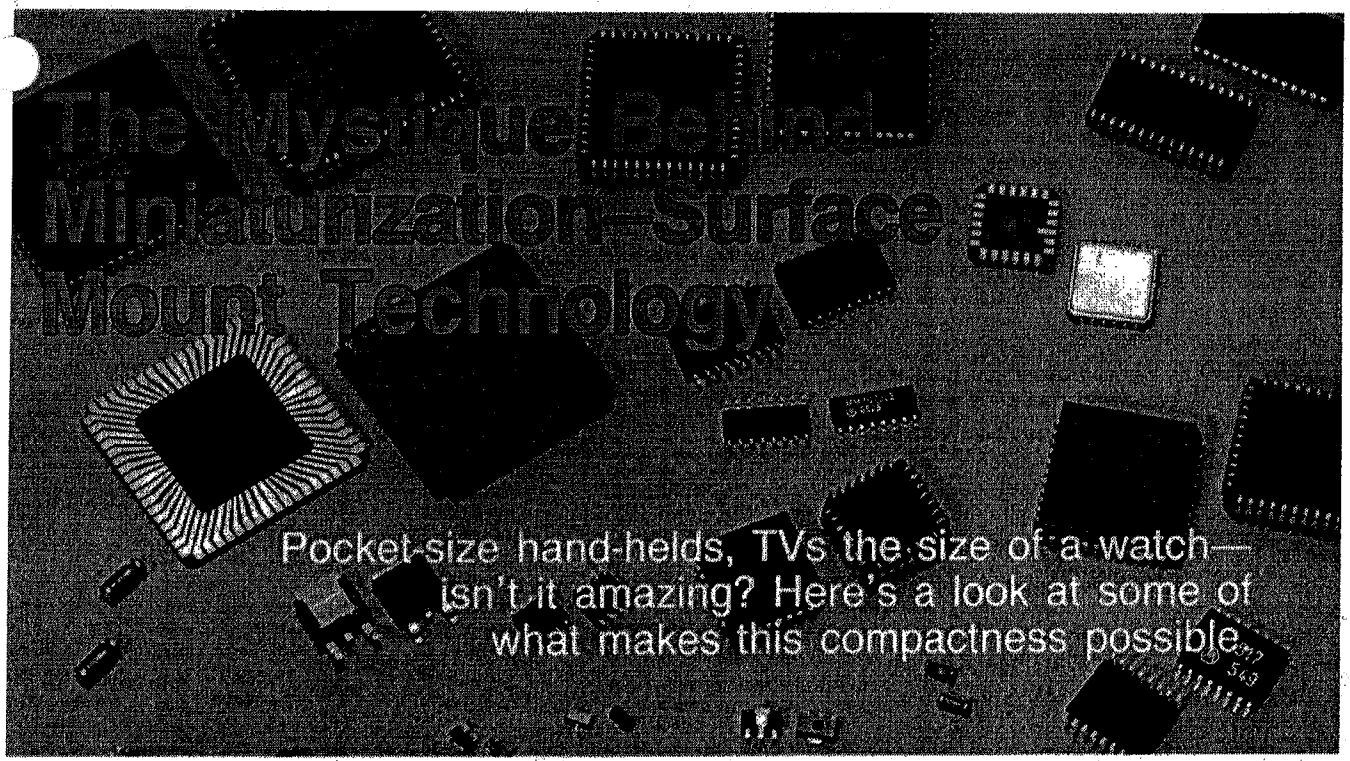
CMPE 174
SURFACE MOUNT TUTORIAL



The Mystique Behind Miniaturization—Surface Mount Technology

Pocket-size hand-helds, TVs the size of a watch—isn't it amazing? Here's a look at some of what makes this compactness possible.

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The electronic packaging revolution is upon us. Electronic equipment is getting smaller and smaller, with miniaturization being the name of the game. We now have hand-held transceivers that fit into a shirt pocket. Station transceivers that would have occupied an entire desktop 20 years ago, now are essentially portable radios. How has this all come about?

One of the major contributors to miniaturization is the use of surface-mount technology (SMT). Several years ago, electronics manufacturers began to mount miniaturized components directly on the surface of PC boards—an automated technique that evolved from thick-film hybrids. (Here, "hybrid" means an assembly built on a substrate using chip capacitors, resistors and so forth.) Today, surface mounting can meet the electronics industries' insatiable demand for boards that are smaller, cheaper and more reliable.

Surface mounting is changing most aspects of the electronic industry. For example, the electronic component industry must now create whole new families of tiny active, passive and electromechanical devices to meet the demand for surface-mountable components. Some of these devices are shown in the title photo. New kinds of automatic assembly and soldering machines currently used in production lines place and attach components to boards at fantastic rates. This automated equipment is constantly being improved.

In this article, I'll introduce you to some surface-mount components available from Motorola, and acquaint you with the terminology and manufacturing processes of the surface-mount world. Then, you'll have a better understanding of just how all that electronics power at your disposal is contained in such a small package.

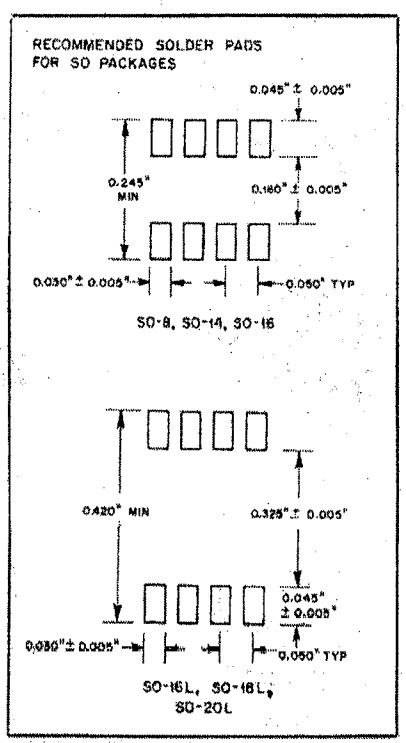

Fig 1—Typical surface-mount component footprints.

What is Surface Mounting?

Surface mounting involves soldering a component directly to a series of solder pads called a *footprint*, rather than inserting the component leads into holes on a PC board. The footprint is a series of pads that conform to the lead layout of the surface-mount device (SMD) or component (SMC); see Fig 1. Both old and new mounting techniques are shown in Fig 2.

Surface mounting has several advantages over the insertion method it is replacing. For example, the use of smaller components and the elimination of PC-board through holes can *triple* board density. The use of a smaller board with fewer layers cuts costs immediately. Additionally, circuit performance is improved. With the smaller boards, traces between components are shorter, lowering parasitic inductance and capacitance. Table 1 shows the benefits achieved by redesigning a board to use SMT. The table illustrates only the savings obtained by redesigning a *single* board. Approximately 65% of a unit's costs are related to component size. Some of the cost parameters related to component size include the number of PC boards, cabinet size, connectors and cabling, and cooling requirements.

Surface mounting allows components to be placed on *both* sides of a PC board—a major advantage. The use of chip capacitors, resistors and semiconductors can, in theory, give these boards densities equal to those of hybrids.

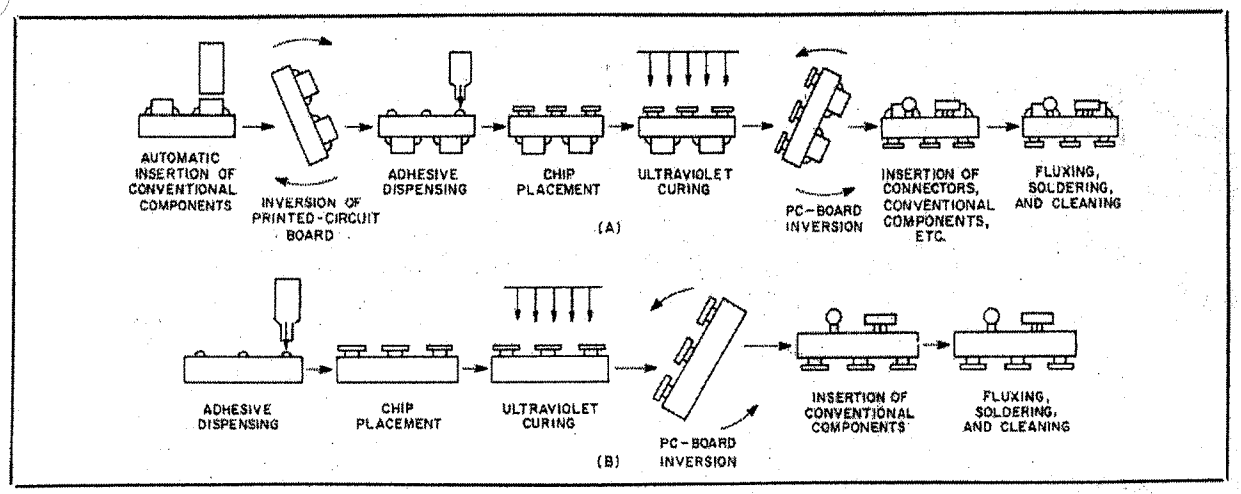

Fig 4—Surface-mount PC-board assemblies can be produced automatically (A) or semiautomatically (B). On semiautomatic assembly lines, the through hole leaded components are inserted manually.

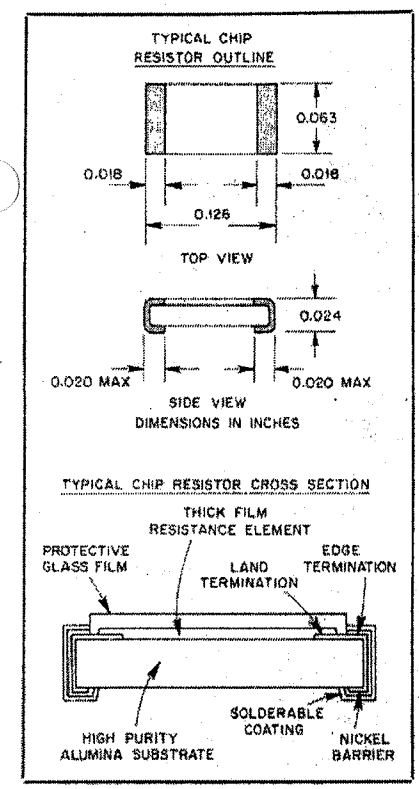

Fig 5—Typical surface-mount chip resistor construction.

can dissipate up to 200 mW in free air, or up to 350 mW when attached to a ceramic substrate. Products available in this package include small-signal transistors (bipolars and FETs), tuning, switching and Zener diodes, and SCRs. The SOT-143 is similar to the SOT-23 with the exception of having four leads. Bipolar RF transistors are available in this package.

For applications where high power dissipation is needed, there's the SOT-89 (Fig 7B). This package (only 0.178 inch across and 0.059 inch high) can dissipate 500 mW in free air and 1 W when mounted on an alumina substrate. Products in this package include bipolar, high-voltage, RF and Darlington transistors.

There are two packages available for use in RF applications: the SOT-143 and an SO-8 modified for RF use known as the SORF. The SORF package has a power dissipation of 1.5 W at 25 °C. Currently, 870-MHz bipolar transistors are being offered in this package. Where the need arises for transistor and diode arrays, Motorola offers low-voltage quad transistor arrays in the SO-16 package and diode arrays in the SO-14 package.

Leadless Diodes

A wide variety of rectifiers and Zener diodes are produced in the small cylindrical glass package referred to as MELF (metallized electrode face), MINI-MELF and MLL (Motorola leadless). Two packages are offered—the MLL34 and MLL41. A full range of ¼, ½ and 1-W Zener diodes are made using the same die as products presently offered as DO-35 and DO-41 Zener diodes. The rectifier category includes 0.5- and 1-A general-purpose and Schottky rectifiers.

Power Devices

Until recently, SMDs have been primarily available in the low-power category. For applications requiring high-power components, there are two options: the DPAK and TO-220 cases.

The DPAK is a power package developed specifically for surface-mount applications; it resembles a miniature TO-220 case. The DPAK has a power dissipation of 1¼ W at 25 °C in free air, and 1¾ W when mounted to a glass-epoxy PC board. DPAK product offerings will include bipolar power transistors, TMOS™ power MOSFETs, thyristors, rectifiers, Zener diodes and transient suppressors.

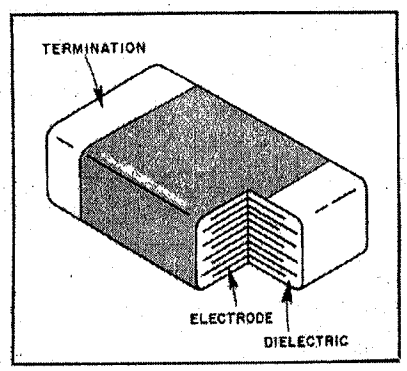

Fig 6—Chip capacitor construction.

For power devices requiring a higher power rating and larger die size than DPAK can accommodate, there's the industry-standard TO-220 package. The TO-220 has a power dissipation rating of 4 W when mounted on a glass-epoxy PC board. Any existing TO-220 product can be lead-formed for surface-mount applications. The current Motorola TO-220 family includes bipolar power transistors, TMOS power MOSFETs, thyristors, rectifiers, Zener diodes, transient suppressors and RF power transistors.

Integrated Circuit Packages

ICs are produced primarily in two packages: the SOIC (standard outline integrated circuit) and the PLCC (plastic leaded chip carriers). The packages have pin counts dependent on the device functions. PLCCs offer the flexibility of higher pin count functions in a smaller package than its