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Letters

High-Pressure Tests of Silicon Transistors and Miscellaneous Components

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The design of larger and more refined electronic instrumentation packages for operation in the deep ocean is greatly complicated if the system components have to be protected from the extreme hydrostatic pressure encountered. If system components can be found that are capable of operating at the ambient pressures, the package design is reduced to one of surrounding the instrumentation package with a waterproof jacket that is fluid-filled and pressure-equalized to the sea. Mechanical and electrical penetrations through the package wall present no serious sealing problems because very little or no pressure differential exists across the seal. The only requirements imposed on the fluid used on the inside of the package are that it be noncorrosive and possess good electrical insulating properties.

This letter describes a series of tests conducted at the Marine Physical Laboratory to determine the effects of prolonged exposure to high hydrostatic pressure on a new transistor package and a number of standard off-the-shelf electronic components.

Test 1. Silicon planar transistors. In this test a set of ten transistors was immersed in castor oil and subjected to pressures from 0 to 0.6895 kb in 0.06895-kb increments. At each of the eleven pressure levels both h_{FE} and I_{CBO} were measured on each transistor.

The transistors were a new type of epoxy-encapsulated, passivated silicon planar devices, samples of which were furnished by the General Electric Company. These devices were of particular interest because of their small size and low cost.

Five each of two types were tested, a low-gain device GE type 16A1 (2N2711) and a high-gain device GE type 16A2 (2N2712).

The measured I_{CBO} of the ten devices was considerably less than the maximum 1 μa specified by the manufacturer at all pressure levels. The value I_{CBO} was not measurable on the Tektronix curve tracer, and it appeared to be less than a minimum detectable 1 μa.

No significant changes in h_{FE} were noted throughout the range of test pressures.

Test 2. The same set of ten specimen transistors used in test 1 was placed in the pressure test chamber and subjected to a prolonged immersion at 0.6895 kb for a period of 43 days.

In this test two of the transistors, one of each type, were operated continuously in a multivibrator circuit made up of conventional components including a pair of germanium diodes, two ceramic disk capacitors, and nine compression-molded composition carbon resistors. The remaining eight transistors were simply suspended in the castor oil at the elevated pressure for the full period of the test. No electrical tests were made on these devices during the 43-day immersion except that the amplitude and frequency of the output of the multivibrator were monitored. An increase in the frequency of the multivibrator output of approximately 15 per cent was noted as the pressure was elevated to 0.6895 kb. No further change in frequency or amplitude was noted during the 43-day period. The multivibrator frequency returned to the original zero pressure value upon return to zero pressure.

The other eight transistors were checked for

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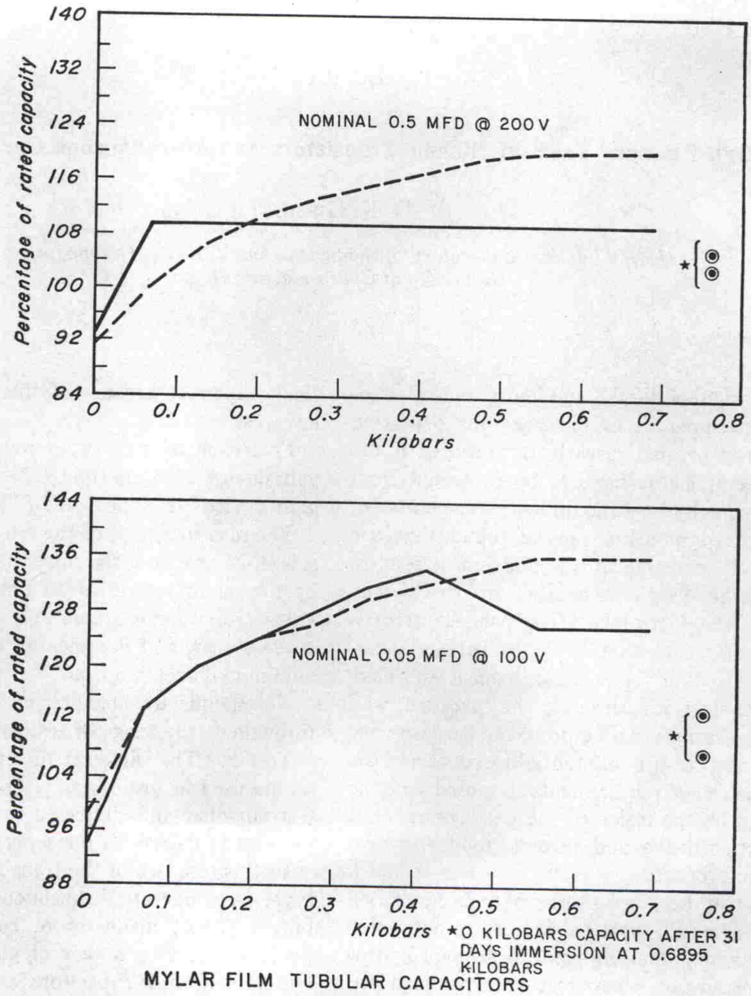

Fig. 1. Effect of hydrostatic pressure on Mylar film tubular capacitors.

h_{FE} and I_{CBO} upon removal from the test chamber, and no significant changes were noted from the original values measured before testing.

Test 3. Samples of off-the-shelf components were immersed in castor oil and subjected to pressures from 0 to 0.6895 kb followed by a 30-day immersion at 0.6895 kb. The following units were tested:

2 each—0.1 μf at 50 v, Centralab CK ceramic disk capacitors.

2 each—0.01 μf at 50 v, Sprague TG-S series ceramic disk capacitors.

4 each—Corning type CYFM fused monolithic construction glass capacitors in 1000 and 6800 pf.

4 each—Cornell Dubilier Mylar film tubular capacitors of the WMF series which have high density thermosetting plastic end seals (two sizes were tested, 0.5 μf at 200 v and 0.05 μf at 100 v).

2 each—Texas Instrument Company's SCM series tantalum electrolytic capacitors which are contained in an aluminum can with glass end seal; the units tested were 3.3 μf at 15 v.

6 each—Ohmite ¼ w, 10 per cent tolerance,