UNIVERSITY OF ILLINOIS
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OPERATIONAL RESULTS USING C73621 CATHODE RAY TUBES AS STORAGE TUBES IN THE ILLIAC

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SUMMARY

A set of 40 cathode ray tubes especially manufactured for Williams storage use was installed in the Illiac on December 3, 1953. The tubes, manufactured by RCA, have the developmental type number C73621.

Section II describes the tests made on the tubes at the University before they were installed in the Illiac and section III describes the tests and their results in the Illiac. On the basis of these tests a "read-around-ratio" of 250 is guaranteed to machine users. This may be compared with a guaranteed "read-around-ratio" of 60 with the selected 3KP1 tubes which were in use until December 3, 1953. The results here are based on the first two weeks of operation with the new tubes.

I INTRODUCTION

The University of Illinois has received 60 RCA developmental type C73621 cathode ray tubes. These are special tubes developed by RCA for use with Williams type electrostatic memories under contract with the Bureau of Ships. Of these tubes, 59 were received intact. One tube was cracked when received.

The 59 remaining tubes were tested external to the Illiac in order to screen out tubes with possible faults which were detrimental to storage. After these tests 40 tubes were placed in the Illiac memory. No selection seemed necessary or was made of the tested tubes in order to select which of the tubes were to be used. Within the Illiac, standard read around ratio tests were made on the tubes.

In order that the results of these tests may be more meaningful, the following operating conditions of the Illiac memory should be noted. All of the tests were conducted using standard Illiac memory circuits. The tubes are operated at 2000 volts accelerating potential with the post ultor and ultor tied together and returned to an astigmatism control potentiometer. The tubes are pulsed on with 50 volt positive pulses with rise times of about 0.4 microseconds and with both upper and lower excursions carefully fixed. The tubes are operated with individual astigmatism, focus and intensity controls for each tube. The regeneration amplifier has a gain of about 60,000 and is a straightforward RC coupled amplifier, without any "peaking". The input resistor to the amplifier is 15K. For the normal output signal, the input signal developed across the 15K resistor is 0.8 volt.

The system of operation is a modified Williams system in which amplitude discrimination of the output is made at a time corresponding to the time the beam has been moved to the "twitch" position. Writing is done by returning the beam to the first position. All tests were run with the normal 1024 storage locations on each cathode ray tube.

II EXTERNAL TESTS

The tests external to the Illiac were made on a special test device normally used to test tubes and repair memory regeneration chassis. This unit has a circuit-sequenced automatic read around ratio test which tests all 1024 memory positions. The unit performs a test which clears the entire raster to 1's, bombards the test address n times with 0's, regenerations being prevented in the neighborhood of the bombardment address, and automatically checks for 1 to 0 failures. (It should be mentioned that with the Illiac system, the beam is on longer for 0's and failures can occur both from 0's to 1's and 1's to 0's.) A somewhat incomplete test which tests for 0 to 1 failures is also run at all addresses which does not automatically check for failures but which is visually checked. The read around ratio for a tube is considered to be the maximum value of n at which no failures occur at any of the 1024 addresses. The maximum value at which the test may be run is at a read around ratio of 1008. All of the 59 tubes were capable of operating without failure at this value at all addresses testing for failures in both directions. As this test is not the most severe one available, these values are instructive only in that from previous experience, these figures would indicate a worst Illiac read around ratio of at least 250.

A check for the presence of flaws on the storage surface was made by moving the raster about in a discrete television type scan of one address. At each point the beam intensity is reduced slowly until the information begins to be lost. The presence of flaws is indicated by such spots being lost first. So long as a reasonably large number begin to lose information under the same minimum conditions, no exceptional flaws are assumed present and the tube is considered flaw-free for all practical purposes. This test has been used previously with 3KP1 tubes and found to be a good measure of the presence of flaws. None of the 59 test C73621 tubes showed any evidence of flaws using this test.

A further spot check was made on a few tubes to check the deflection plate to pickup screen shielding. No appreciable signal was found to be coupled through.

III ILLIAC PERFORMANCE

At the time of this writing forty C73621 type tubes have been installed in the Illiac memory for about two weeks. In that time, reasonably extensive read around ratio tests have been run but, of course, no long term information is available yet. The read around test is performed at all points in the following way. All tests are performed with a large area of 0's surrounding the test neighborhood. Zeros correspond to the longest beam on time with the Illiac system. The selected address has the immediately surrounding addresses filled first with 0's and then the test address is bombarded by reading a 0 from it n times. The surrounding addresses are checked for 0 to 1 failures and any present are recorded

in the routine at a point far removed from the test address. Then the test is repeated, bombarding the address with 0's with the immediately surrounding addresses being 1's. Each test is run twice in rapid succession to prevent random regenerations from interfering. All addresses are so tested. The read around ratio is here defined as the maximum number of bombardments at which no failures occur at any address on any tube in either direction. Using selected 3KP1 type tubes, this figure reached a value which varied from 60 to 80. With no selection, this figure varied from 250 to 300 with the type C73621 tubes. Tests were run beyond this number after replacing the two worst tubes. With two complete tests at each value, the following total number of failures on the 40,960 storage addresses was noted at the nominal values given:

TEST READ AROUND RATIO	TEST FAILURES IN TWO RUNS
300	3
350	8
400	11
500	15

As there is a possibility of random regenerations spoiling the test to a certain extent in the very large test values, a single run with a test value of 990 was run. This test insures a true value of at least 495 and may be as high as 512. This test gave a total of 51 failures on the 40,960 addresses.

IV MISCELLANEOUS COMMENTS

Three tubes have been changed since the first forty were installed. One of these three was changed because the output signals were smaller than those of the other tubes. The other two tubes were removed because they had a larger number of read around errors than the other tubes under similar test conditions. This has tended to raise the guaranteed minimum read around ratio. These changes were made before the tests which produced the results in the table on page 4.

It is the opinion of the writer, based upon these results during the last two weeks, that these tubes are a significant advance in the construction of electrostatic storage tubes. They have improved the read around performance from 60 (with selected 3KP1's) to 250 and they are free from flaws which would produce errors at this time.

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