

# Decapsulating Integrated Circuits

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Computer chips (integrated circuits) have fascinated microscopists for many years. We have seen many images of them, but, for the most part the secrets of these chips have been denied to us. At one point years ago, we were advised we could simply pry them open. But as the technology advanced, the packages of integrated circuits became inaccessible. Some analytic labs had developed techniques to reveal the secrets of integrated circuits to analyze their design and in some cases connect to them to explore their performance and perhaps to reverse engineer them.

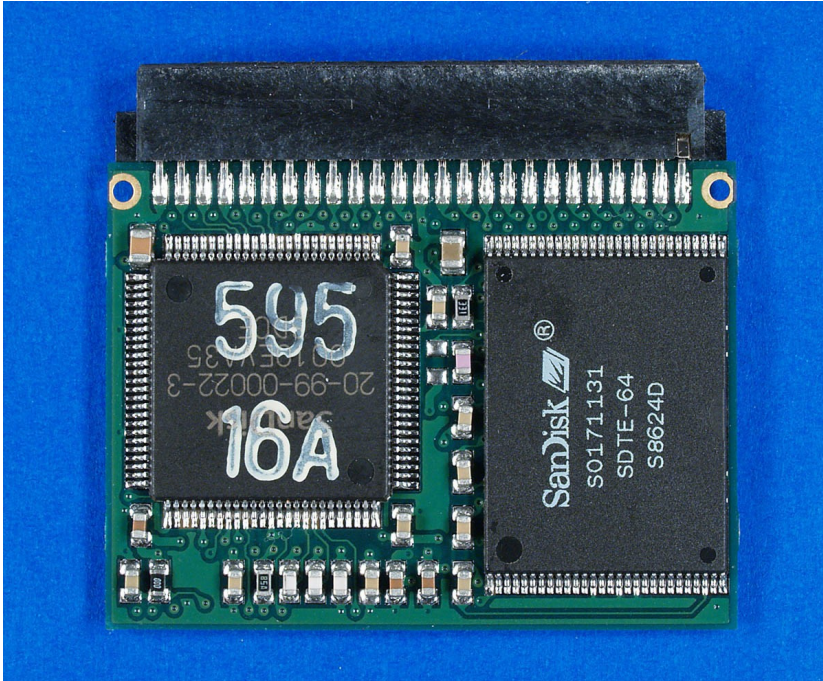
My interest in integrated circuits is purely pictorial, and in my many years as a former aerial mapping photographer, I have been fascinated by the similarity of integrated circuits to the resemblance of city grids to microcircuits.

My curiosity went on for a number of years and found a few references on YouTube about how to access the microchips inside the packages of integrated circuits.

First, integrated circuits (ICs) are a part of our everyday lives. My source is any form of consumer electronics. So, when I find a dead or cheap electronic device at a tag sale, I buy it up for the ultimate purpose of disassembling it to get at its circuit boards. For this article, I will use the very basic example of a Compact Flash Card.

Like Compact Flash Cards, Memory Sticks and SD Cards, the integrated circuits in the cards can simply be accessed by cutting through the edges with a Dremel Motor Tool.

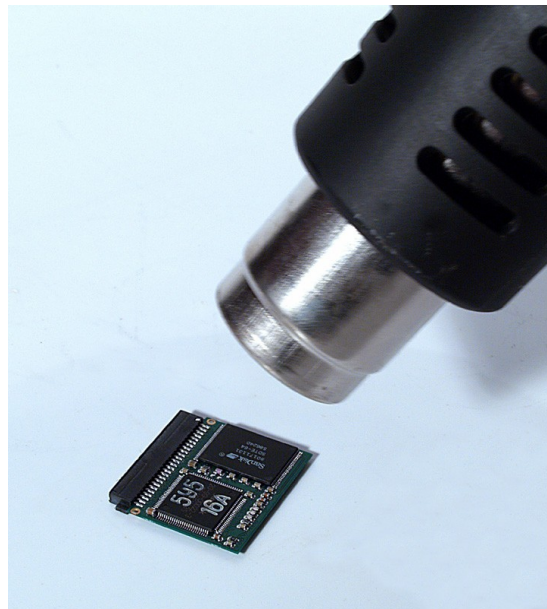
In the case of a Compact Flash Card, this reveals two cards on the front side of the memory card and one on the reverse side.



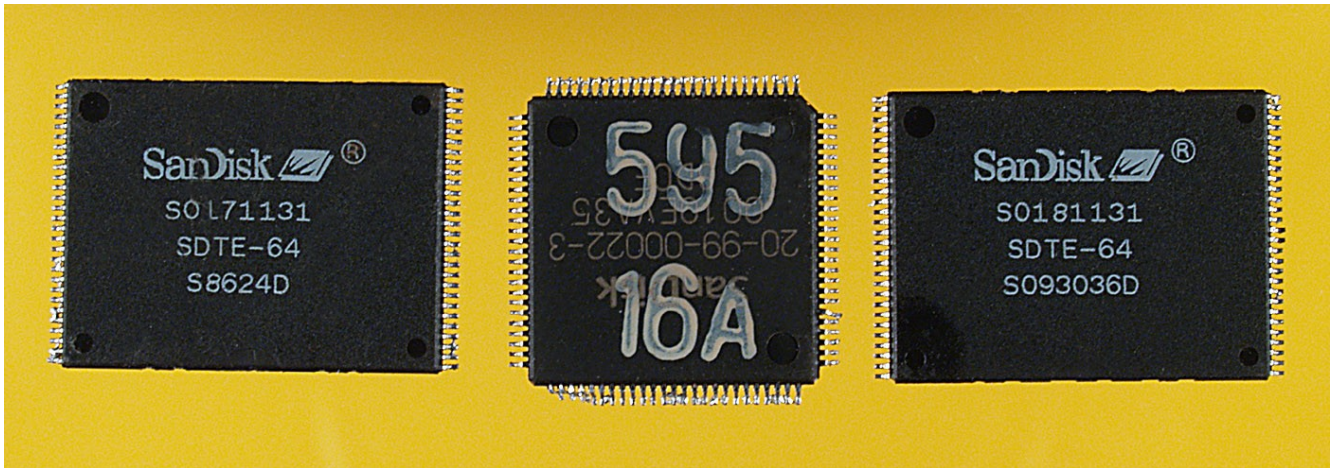
This CF card only represents other printed circuit boards, since the CF card is essentially a printed circuit board. In the case of the CF card, there is also another chip on the other side.

The chip can be "liberated" from any circuit board

with the use of a heat gun, which unsolders the chip from the circuit board. Simply heat the chip for 30 to 60 seconds, and the chip can be flipped away from the circuit board with a box knife.



In the case of the CF card, the chips released are shown below.



The packages shown are not in proportion to the eventual extracted integrated circuits. The two outside packages are NAND memory chips. The center chip is the Controller



For the most part, the packages encasing the ICs are an epoxy compound. I have found that some of the older integrated circuits may be bound in Bakelite, which I have found to be impervious to any solvents I have tried.

I have found that Nitric Acid is very effective.

From what I have read, Fuming Nitric Acid in 90% or higher concentrations is very effective, but trying to get it as a private user is near to impossible in the United States. Apparently, you have to be licensed with the supplier. What has been explained to me is an issue of liability. Therefore, I have settled on 70% Nitric Acid for my decapsulating.



To decapsulate the ICs, I have arrived at the setup shown at the right. I started with coffee cup warmers and the glass dome, but the condensate from the dome dissolved the metal in the coffee cup warmer. Then I moved to the gravy warmer shown, with a dish under the dome. The idea of the warmers was to accelerate the activity of the 70% Nitric Acid.

**Nitric Acid must always be respected.**

Therefore, I wear a face hood and rubber gloves. In addition, since I don't have a fume hood at my disposal, I run my operation in a 16X20 inch plastic darkroom tray in my garage. A fan is positioned next to the

setup to dispel any acid fumes when the dome is lifted. I usually take a deep breath before lifting the dome, and step away until the air has cleared.

I have a container of water to rinse off my tools, and a dish to inspect the progress of the decapsulation. Occasionally, I pull out the chips and place them in the dish of water and brush off any of the packaging material with a non-animal hair brush before returning the chips to the acid bath. At some point, the acid bath will become too dirty, so some of the acid is poured off to another beaker and the ICs are returned to fresher acid.

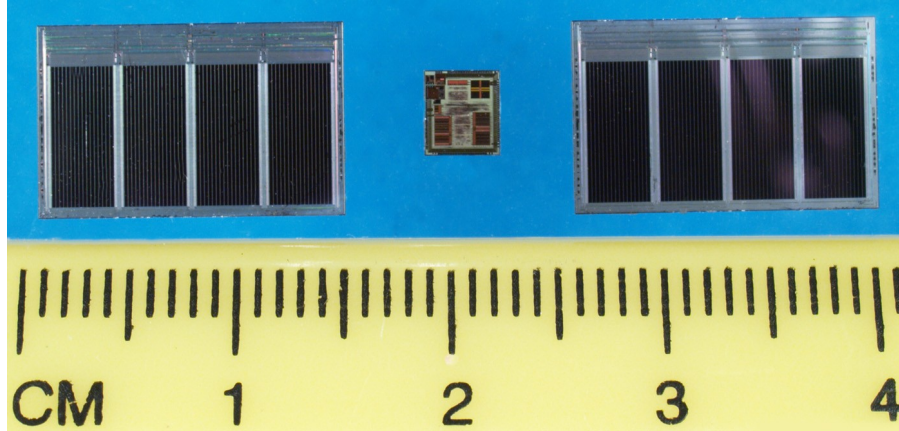
The Nitric Acid is neutralized with Sodium Bicarbonate before being disposed.

After clearing, in the case of the chips from the Compact Flash Card,



these are the resultant integrated circuits:

On the two outsides are the NAND memory chips. In the center is the Controller chip.



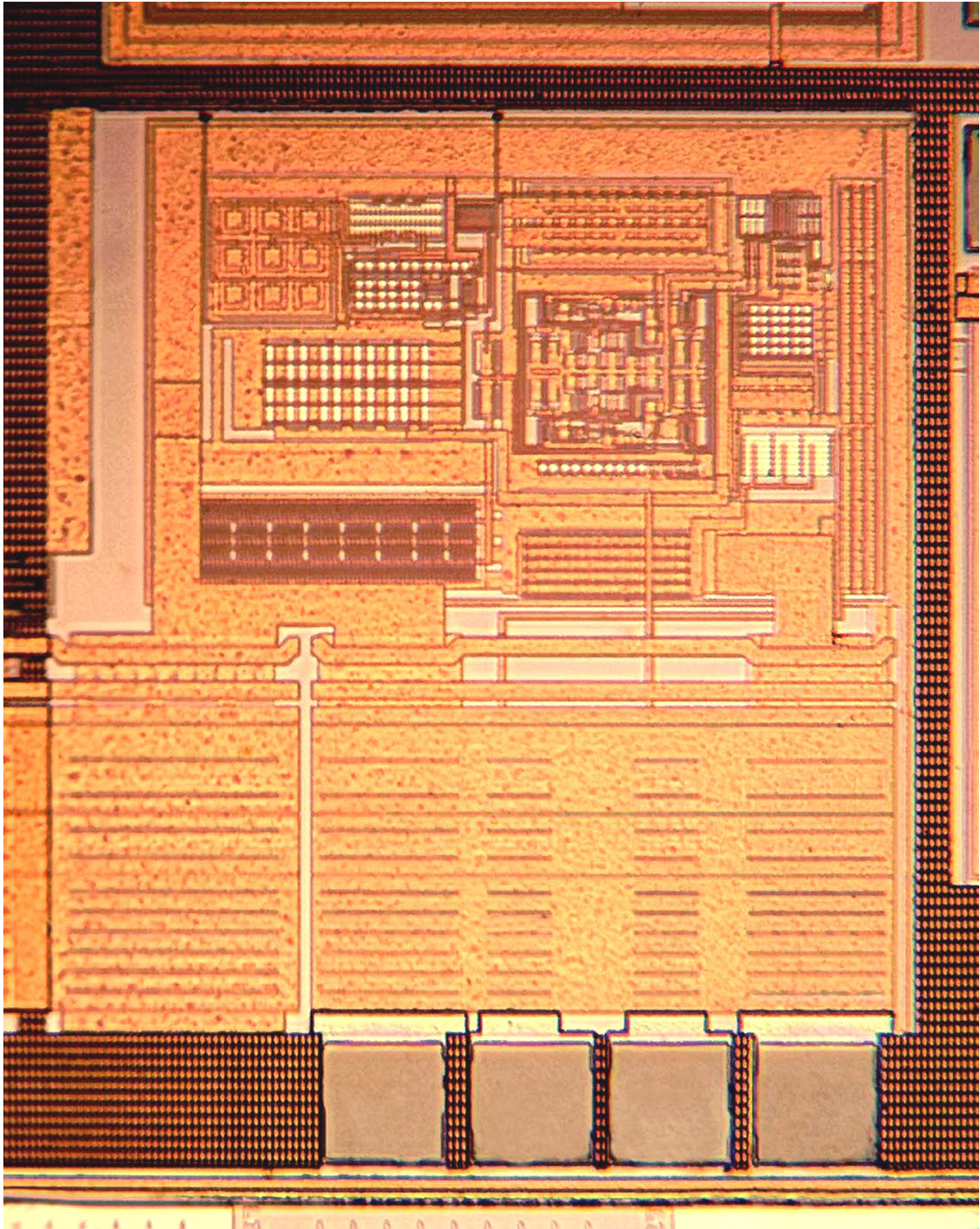
The chips are washed in a Kodak Photo-Flo solution and then blown off with "canned air." Then they are glued to a standard glass slide for photomicrography. The scope I use is an Amscope metallurgical microscope, which I have reviewed previously on this web site.

Below are a few images taken of the Controller of the CF card.



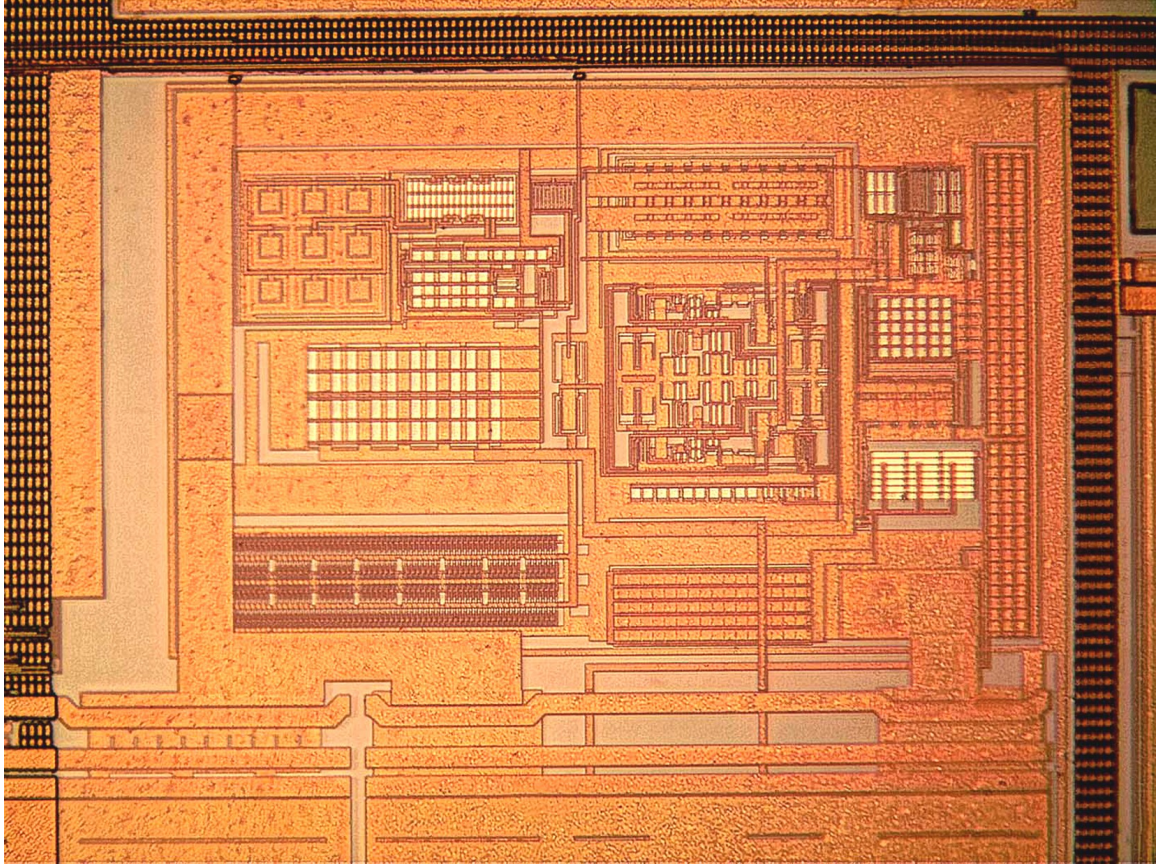
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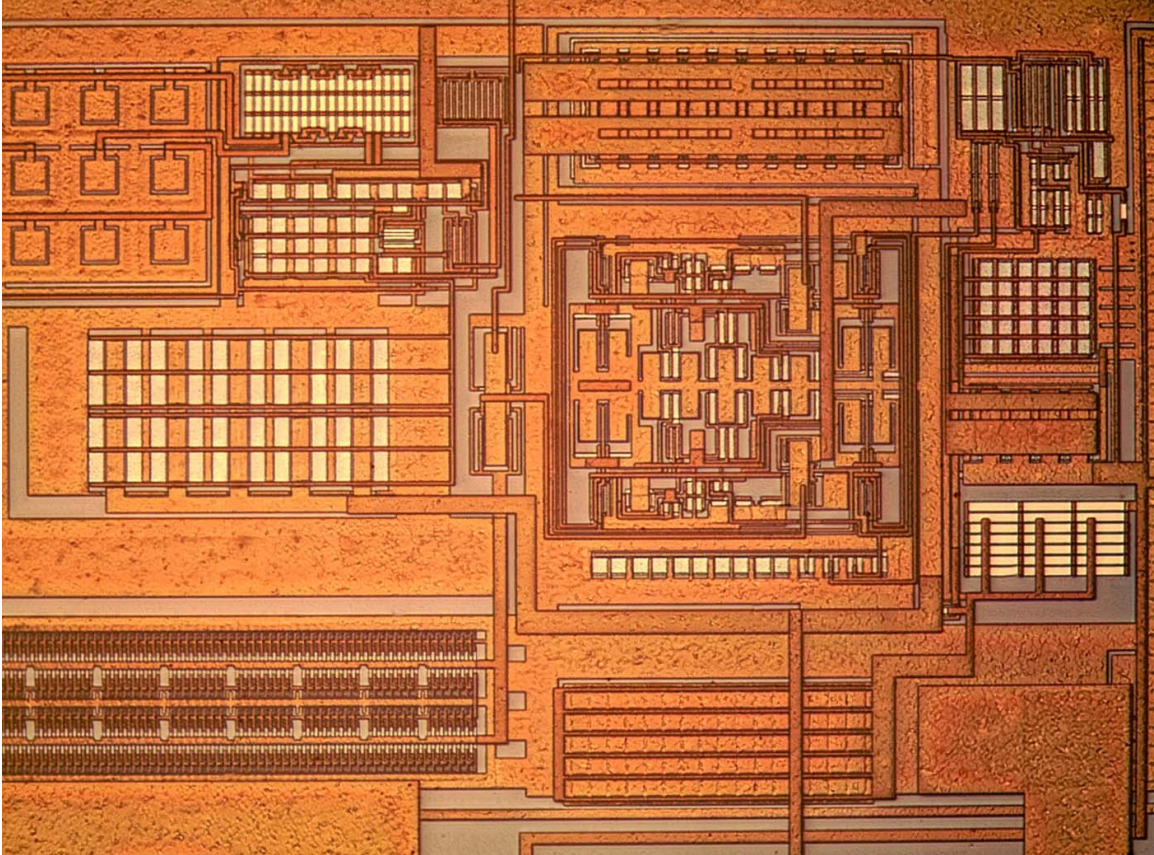


20X





40X



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