WHAT'S INSIDE

FLIR microbolometer ISC0601B and the i7 thermal imaging camera

FLIR, the world leader in thermal imaging cameras, continues to reduce the price of its low-end camera and microbolometer.

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With new environmental standards placed on the thermal insulation of buildings, the sale of thermal cameras for diagnostics has risen sharply. The increase in production volumes and the development of low-cost solutions has enabled the market arrival of low-end cameras costing less than 1,000€. Compared to a cost of over $10,000 several years ago, thermal cameras are becoming more and more affordable, and the desire to reduce cost for the adoption of thermal cameras in large-volume applications such as security and automotive is at the heart of every manufacturer's strategy.

i7 Camera teardown (Courtesy of System Plus Consulting)

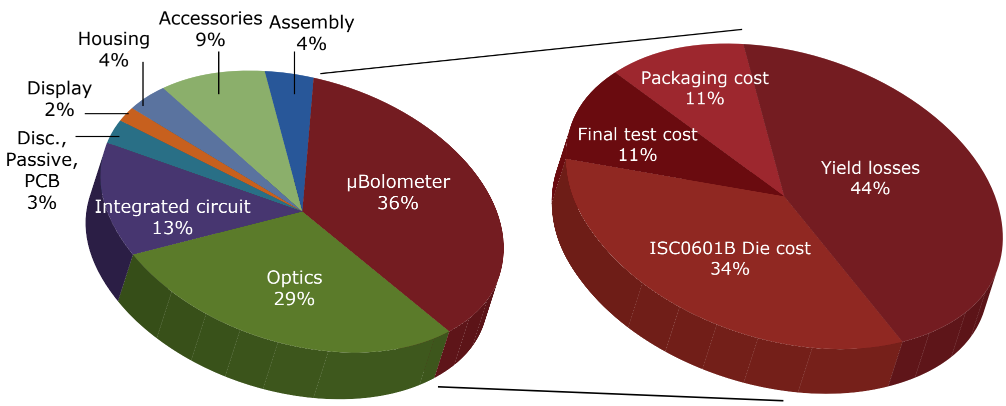
The camera family i3, i5 and i7 from FLIR is emblematic of effective cost reduction. The three cameras are nearly identical, which makes cost reduction easier. Mechanical parts, electronic boards and even the microbolometer sensors are similar; only the optic in GASIR changes. The electronic is designed around a PXA270 processor, an FPGA, and 512Mbit of SDRAM and 256Mbit of flash memory. The presence of an FPGA suggests that there is still room for integration of the electronics. The decision to describe one camera under three different names implies that the cost of a low-end camera is still impacted by technologic choices made for high-end cameras.

The main component of the camera, the microbolometer ISC0601A, has never been used before for this range of camera. The cameras i3, i5 and i7 have, respectively, a definition of 60 x 60 pixels, 80 x 80 pixels and 140 x 140 pixels. But the sensor itself has a definition of 320 x 240 pixels. The sensor used in the i3 has 20 times more pixels than necessary, and four times more pixels than the i7. Incidentally, the same sensor can be used in more expensive cameras. The extremely high cost of developing a microbolometer explains FLIR's decision to develop a limited number of sensors, and use downgraded sensors in low-cost cameras.

As shown in the i7's cost breakdown, the microbolometer is the most expensive element of the camera, representing 36% of the manufacturing cost.

ISC0601A microbolometer

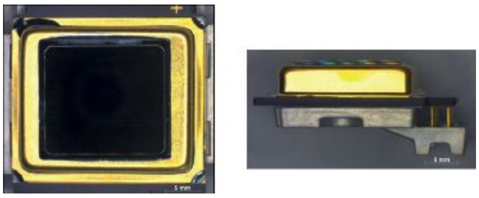
The microbolometer is encapsulated in a hermetic housing consisting of a ceramic substrate HTCC, a metal box and an IR window in silicon. The microbolometers operate under a high vacuum, 10-4mbar, 100 times lower than for a MEMS gyroscope. The final test integrates an expensive four-day leak test to guarantee package tightness.



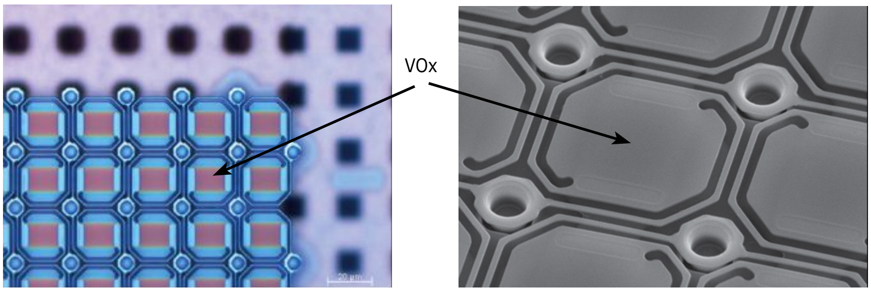
i7 Camera cost breakdown (Courtesy of System Plus Consulting)

Each pixel is composed of a thin resistance in vanadium oxide (VOx) covered with an absorber in silicon oxide which absorbs the infrared ray. The temperature of the SiO2 layer is proportional to the temperature of the IR radiation, and the value of the resistance VOx is proportional to the temperature of the absorber. A measurement of the resistance provides the temperature. For maximum operating frequency, the thermal mass must be minimized. This is achieved by suspending the VOx resistors and the absorber on a micro-bridge. The read-out electronic is manufactured on the silicon substrate before the micro-bridges; therefore, it is under the micro-bridges.

It is the production of these micro-bridges with very thin layers deposited on a sacrificial organic material that makes manufacturing microbolometers extremely complex and expensive. The deposition steps are very slow because of the low temperature used.



Microbolometer ISC0601A package (Courtesy of System Plus Consulting)



Pictures of the micro-bridge with the VOx resistor - Optic and SEM views (Courtesy of System Plus Consulting)

Supply chain and cost structure

Initially manufactured internally on 150mm wafers, FLIR microbolometers have since 2006 been manufactured by ON Semiconductor on 200mm wafers. The transition to 200mm and the outsourcing of production to a large-capacity foundry has reduced manufacturing costs.

Today, the manufacturing cost is still high, due to a low yield and a low production volume: 100,000 units for Thermography in 2011 (source : Yole Développement)..

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