Uncooled amorphous silicon IRFPA with 25 µm pixel-pitch for large volume applications

By M. Vilain, J.L. Tissot, O. Legras, C. Minassian, B. Fièque, J.M Chiappa

ULIS - BP 21 – 38113 Veurey-Voroize, France

ABSTRACT

This paper reviews the specifications and performances of uncooled infrared focal plane array made from amorphous silicon microbolometers with a pixel-pitch of 25 µm, integrated into a LCC TEC-less package. These detectors have been specifically designed for large volume production, while keeping the main features of high end developments, at detection pixel level, as well as at ROIC level, like detector configuration by serial link in order to minimize the number of electrical inputs, low power, large dynamic range…) The main particular features of this achievement are the miniaturized very low weight package, along with easy TEC-less operation naturally afforded via the readout architecture, which leads to very low consumption levels, making it well adapted to low end hand held cameras. We present in the last part of this paper the main electro-optical characteristics and TEC-less operation, demonstrating wide thermal dynamic range and low power, thanks to the simple single-level amorphous silicon technology, coupled with advanced ROIC design.

1 INTRODUCTION

Uncooled infrared detectors are now available for various applications. Their simple operating conditions are similar to those of digital CMOS Active Pixel Sensor (APS) for visible applications. They have already shown their potentiality to fulfill many commercial (automotive, medical, fire-fighter…) and military (thermal weapon sight, Enhanced Driver Vision…) applications. NETD as low as 30 mK is routinely measured on 25 µm pixel pitch detectors for high end application. However for low end application for which the competition is harder, the price is more important than the sensitivity. Therefore a new detector family has been developed to address these new market needs which are mainly oriented on reduced size and cost.

2 PACKAGE DESIGN FOR HIGH PRODUCTION VOLUME

Due to the reduced pixel pitch, the 160 x 120 and 384 x 288 arrays are integrated under vacuum in a specifically designed ceramic package (figure 1). These packages are sealed under vacuum but free from the traditional pinch-off tube, leading to a more compact package with reduced impact on the proximity electronics design.

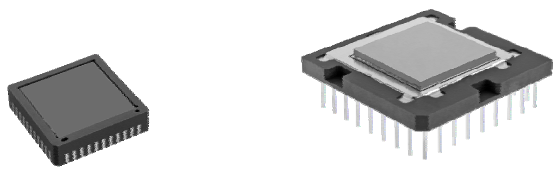

Figure 1: Ceramic package for 160 x 120 / 25 µm and 384 x 288 / 25 µm

The package size is reduced by suppressing the thermo-electric cooler usually used to stabilize the focal plane temperature. As a consequence, the detector has to be operated in TEC-less mode with a feed-back of the focal plane temperature variation on the non-uniformity correction coefficients.
Moreover, these packages are compliant with the RoHs regulation.

3 ARCHITECTURE AND READOUT CIRCUIT DESIGN

A dedicated readout circuit design has been especially developed for the 25µm pitch FPA. It enables the circuit to extract a small signal from a large background common mode current. A serial link has been introduced to drive the readout parameters like gain, reading direction and format. Moreover an analog to digital converter has been integrated on-chip in order to reduce the proximity electronics complexity.

4 PERFORMANCE DATA

The characterization is carried out using the analog and the digital outputs. The following table shows the equivalent results which could be obtained respectively using these two options (see table 1). The FPA power consumption is reduced down to 40 mW when the on-chip analog to digital converter is not used, as some 100 mW are needed for digital mode operation.

Parameter	Analog output	Digital output
Responsivity	7.53mV/K	7.55mV/K
Rms Noise	654µV	693µV
NETD (T_1=293 K , T_2=308 K)	86mK	91mK
Temperature dynamic range	200°C	200°C
FPA Power consumption	40mW	140mW

Table 1: Performance comparison using analog or digital output at 60 Hz frame rate

5 TEC-LESS OPERATION

A new algorithm has been developed specifically for uncooled amorphous silicon IRFPA. It enables to keep the fixed pattern noise less or equal to the temporal noise leading to good image quality on large temperature range. An experiment has been set up with a focal plane temperature ranging from -15°C to 60°C with fast temperature transition. This algorithm requires few additional memories to store DC output voltage in front on calibration blackbodies. Gain and offset corrections are performed in real time during detector operation. The measured characteristics will be described.

6 CONCLUSION

Uncooled IR detector with pixel-pitch of 25 µm offers numerous advantages in the design of uncooled IR imaging systems. The size of the infrared optics can be drastically reduced enabling the possibility to develop miniature systems for low end radiometric camera or for surveillance, fire-fighters or predictive maintenance. A small LCC package and a dedicated read out integrated circuit structure have been designed for these detectors. The possibility to operate readily the detector in a TEC-less mode by the means of simple and robust algorithms opens the way to reduced power consumption systems needed for man-portable applications.