A Low Size, Weight and Power Cryogenically Cooled Mid-Wave Infrared Image Sensor for Small-Satellite Payloads

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INTRODUCTION

There is an established need for a readily available, low-cost, and high performance cryogenically cooled IR imaging sensors to support earth observing missions. The New Space economy is fast developing and requires rapid development of low-cost commercial space payloads. However, there is a dearth of space qualified commercially available high-performance sensors. This presentation shows a novel family of cryo cooled IR sensors used in high-end earth observing payload.

These cooled IR sensors are enabling a low-cost alternative for rapid space missions, while simultaneously offering state of the art performance for the Small-Sat based New Space economy.

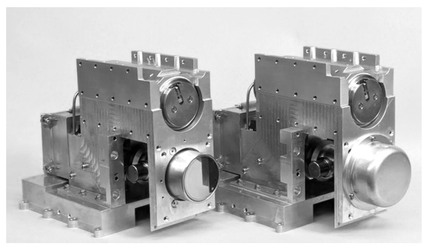

Fig. 1: Commercial cryocooled, space qualified IR sensor platform for wide-band, multispectral and hyperspectral imaging. Platform consists of IR focal-plane array (FPA), dewar, cryocooler, cooler drive electronics, FPA electronics, power module, and packaging.

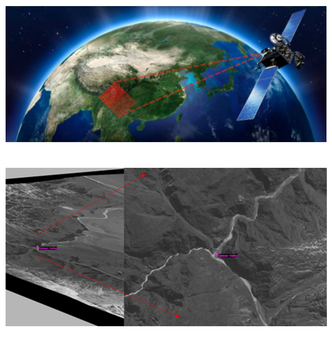

Fig. 2: Commercial high resolution scanner payload available in visible band; this development extends it to the IR band, making fully space qualified payload readily available

Large IR sensors address a variety of wide-band, multi-spectral and hyperspectral earth-observing mission needs through a software programmable architecture. The payload can be configured as a HD format area scan sensor or a single line scan, multi-line scan or a TDI sensor for push broom or whisk broom LEO payload applications.

The system is in a fully space flight qualified package that consists of an advanced IR FPA, a long-life compact dewar, a long-life low-vibration cooler, high throughput focal-plane electronics, efficient cooler drive electronics and custom ASIC chips for a highly power efficient system.

DESIGN ARCHITECTURE

The first-generation FM sensor has been developed with a standard 720p HD format MWIR detector running near 80K temperature and utilizing a legacy ASIC based sensor electronics. A second gen ASIC has been developed to lower the SWAP-C of the sensor and can operate FPAs up to 2k x 2k resolution. EM units have been assembled capable of running in 3-4 mega-pixel formats and are available for FM deliveries.

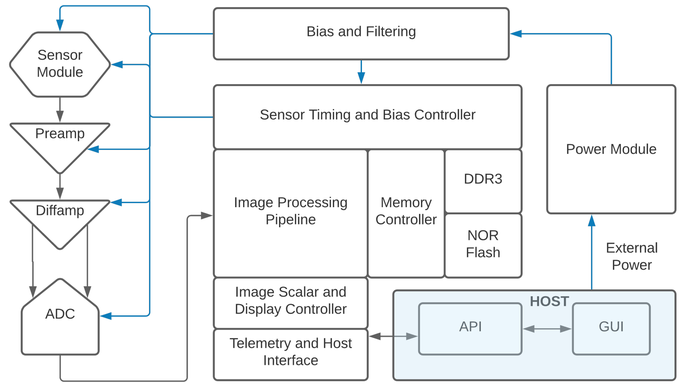

Fig. 3: IR sensor electronics architectures

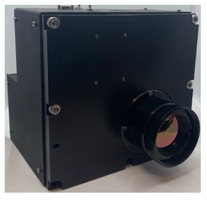

Fig. 4: EM units up to 2k x 2k IR sensor formats

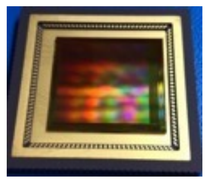

Fig. 5: Platform incorporates several proven IR FPA ICs

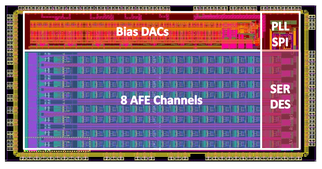

Fig.6: Second-generation ASIC chip reducing SWaP-C

Fig. 7: ASIC based electronics demonstrates very low <0.6ADU noise

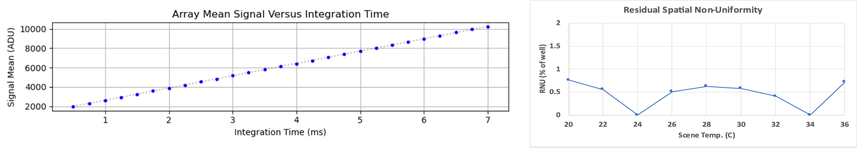

Fig. 8: Highly linear characteristics (<0.8% RNU) demonstrated

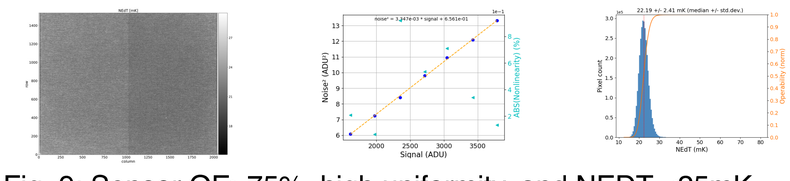

Fig. 9: Sensor QE>75%, high uniformity, and NEDT <25mK

The flexible programmable sensor provides optimal performance for a variety of space applications

RESULTS

A low SWaP-C large format MWIR sensor has been developed addressing industry need for a commercially available high performance cooled MWIR payload for small sats. The sensor platform is optimized for large format, 1280 x 720 to 2k x 2k focal-plane arrays. It meets a benchmark of 70 mW per megapixel per second which is superior to the trend line of contemporary MWIR sensor cores. The sensor is being upgraded with HOT detectors to further reduce the power by a factor of two. The hardware is designed to be modular and scalable to address several space applications.

Qualified IR sensor available for integration in small sats

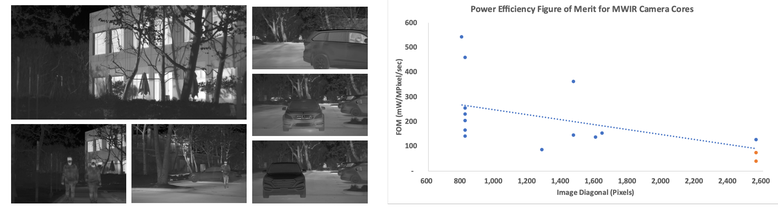

Fig. 10: IR images from HD sensor (left) and power figure of merit comparison (right) is shown for the sensor (orange dots) compared with contemporary solutions (blue dots). Developed sensor power is below the power figure of merit trend line.

CONCLUSIONS

1. **Architecture enables common electronics and package for a variety of line scan, TDI, and area scan HD IR sensor applications.**
2. **Package size and power optimized by utilizing custom ASIC based electronics, space qualifying certain commercial components and utilizing the latest generation small pixel FPA.**
3. **Sensor platform optimized for SWIR, MWIR and LWIR applications requiring line scan or area sensing for broadband imaging, multi-spectral sensing, and hyperspectral sensing.**
4. **The flexible architecture addresses the need for a readily available, low cost, and high-performance IR sensor to support New Space Small-Sat earth observing missions.**

Commercial IR sensor available for rapid deployment, highly configurable for mission needs, and offering optimal performance at a reasonable cost