CONIR

Universal system for control of IR FPA sensors

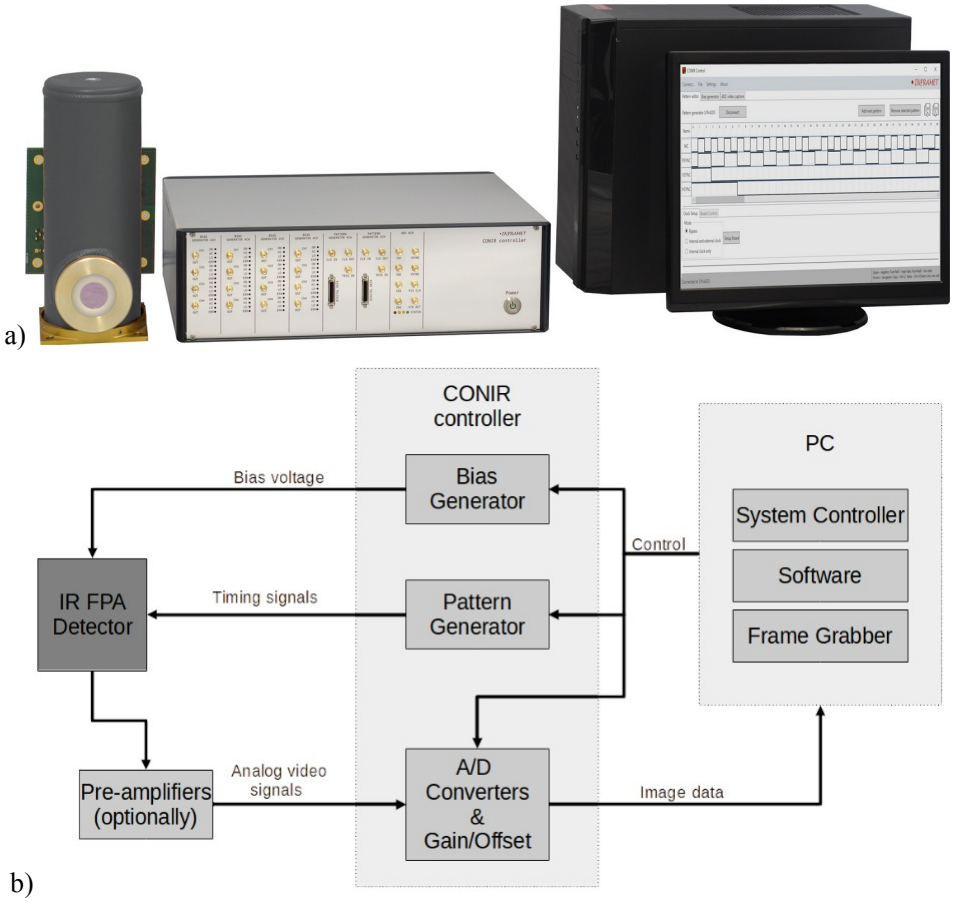


Fig. 1. CONIR universal system for control of IRFPA sensors: a)photo, b)block diagram

1 Introduction

The term IR FPA sensors (focal plane array) means array of detectors sensitive to IR light that can potentially generate electronic two dimensional image when located at focal plane of an IR objective. In detail, IR FPA sensors offered on the market are built by combining array of IR detectors (raw IR FPA sensor) with an read out electronic system (ROIC).

IR FPA sensors cannot generate output image in one of electronic standards of video image like PAL, LVDS, CL, HDMI, GigE etc. Special electronic system capable to amplify analog signals, provide clocks and biases to the sensor, perform A/D conversion and to do image processing is needed.

IR FPA imaging sensors are the most important block of thermal imagers. The latter systems can be built using two main ways: 1)to purchase IR FPA sensor integrated with a miniaturized control/image processing electronics (called thermal camera core) and later to combine this new block with optical objective, optional cooler, and mechanical case to create complete thermal imager; 2) to purchase IR FPA sensor, to develop suitable miniaturized control/image processing electronics, and later to combine such thermal camera core with an optical objective, optional cooler, and mechanical case.

Development of a specialized electronic controller optimized for a specific IR FPA sensor is a medium difficulty electronic task. However, the disadvantage of such solution is that when changing the FPA sensor then a new specialized electronic controller must be developed. In addition, the specialized FPA controllers use electronic settings (bias voltages, clocks) exactly as recommended in sensor data sheet valid for typical FPA in situation when sometimes performance improvement can be achieved at slightly different settings. Further on, development of a series of specialized IR FPA controllers are costly and time consuming solution for R/D projects that often deliver series of new IR FPA sensors of not known optimal control settings.

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2 What is CONIR?

CONIR is an universal system for control of IRFPA sensors capable to control great majority of IR FPA sensors offered on the market. The system enables image processing up to 4096 pixels per line and up to 4096 lines, depending on the available memory.

It is a built as a set of two main blocks: 1- CONIR controller, 2-PC set (Fig. 1). The first block is made from four main modules: pattern generator, bias generator, analog digital converter, and optional preamplifiers. PC set is actually typical PC, LVDS frame grabber, and software package. The hardware components of CONIR controller are delivered in the form of a series of cards enclosed in a single 19" x 3U rack housing.

It can be said that CONIR system is a complete set of tools to run virtually any IR FPA sensor offered on market. For example, CONIR system supports control of FPAs and ROICs from such manufacturers as Lynred, Hamamatsu, IRay, Andanta, Mikro-Tasarim and many others.

CONIR system is optimized for use in R/D projects to develop new/improved IR FPA sensors, thermal camera cores or thermal imagers. It can be used as an independent system for control of IR FPA sensors or as a block of bigger FAPA system for testing IR FPA sensors offered by Inframet https://www.inframet.com/ir_fpa.htm.
It should be also noted that in optional version it can be used for semi automatic optimization of bias voltages supplied to tested IR FPA sensor.

3 Maximal resolution of tested IR FPA sensor

Maximal resolution of IR FPA sensor that can be controlled using CONIR controller depends on a number of parameters like digitization dynamic, frame memory, number of analog outputs, pixel clocks, and required minimal number of frames per seconds. As can we see in Table 1 CONIR can be used for control of almost all IR FPAs offered on the market (exceptions: ultra high resolution IR FPAs having number of analog outputs over 4 designed typically for space applications).

Table 1. Approximate maximal resolution of IR FPA sensor that can be achieved using CONIR for a series of different IR FPA sensors

	Resolution	Bits per pixel	Bytes per frame	Nr. of analog outputs	Pixel clock	FPS
1	4096x4096	16bit	32MB	4	10MHz	2
2	4096x4096	16bit	32MB	1	10MHz	0.5
3	2048x2048	16bit	8MB	4	10MHz	8
4	1024x1024	16bit	2MB	4	10MHz	32
5	640x480	16bit	600kB	1	20MHz	60
6	640x480	16bit	600kB	2	20MHz	120
7	320x256	16bit	160kB	1	10MHz	110
8	320x256	16bit	160kB	2	10MHz	200
9	320x256	16bit	160kB	4	10MHz	350
10	1024x768	16bit	1MB	4	10MHz	40
11	1024x768	16bit	1MB	2	10MHz	20
12	1024x768	16bit	1MB	1	10MHz	10

4 CONIR structure

Pattern generator

The clock signal generation card provide the clock signals necessary for the proper operation of the detectors to be tested (example: master clock, video synchronization signals)
Specification of clock signal generator:

- 4 output channels per card, 2 cards for typical version, total 8 channels
- up to 16 channels for optional version,
- up to 8 Mbits of memory per channel,

- clock rate up to 100 MHz,
- internal or external clock,
- internal or external trigger,
- high level voltage: 1.8V, 2.5V, 3.3V, 5.5V,
- output impedance: 50 Ω,
- output connectors: SMA type
- user friendly graphical software

Bias generator

The bias voltage generation card provide the bias voltages necessary for proper operation of the detectors to be tested.
Specification of bias voltage generator:

- 4 output channels per card, 4 cards for typical version (16 channels)
- up to 24 channels for optional version,
- bias voltage ranges: 0..5V 100mA (0.0763mV step) or 0..15V 50mA (0.2289mV step),
- positive or negative polarization,
- set point accuracy <=0.1%
- set point resolution 16 bit,
- output current limit 0..100mA
- average output noise: 50 nV/√Hz @ 1 kHz, 250 nV/Hz @ 1Hz
- integrated self-test
- channels isolated from the housing
- easy controlled via PC

Analog to digital converter

The A/D converter card allows to convert analog signals from the detector into digital image data.
Specification of analog to digital converter:

- 4 A/D conversion channels per card,
- A/D converters input voltage range: 0-5 V,
- A/D dynamic range: 14-bits
- probe rate up to 40MHz per channel
- integrated analog gain & offset

Digital acquisition card (frame grabber)

A digital data acquisition card is used to capture digital image data for further analysis and processing.
Specification of digital acquisition card:

- parallel LVDS input
- up to 200 megabytes per second
- up to 32 bit LVDS per card
- TTL trigger IN

Pre-amplifier module (option)

The pre-amplifier modules are designed to amplify the weak signals from the tested sensor and adapt them to the input of the A/D converter. This block is optional and needed in rare case of sensors that generate very weak analog signals.
Specification of pre-amplifier modules:

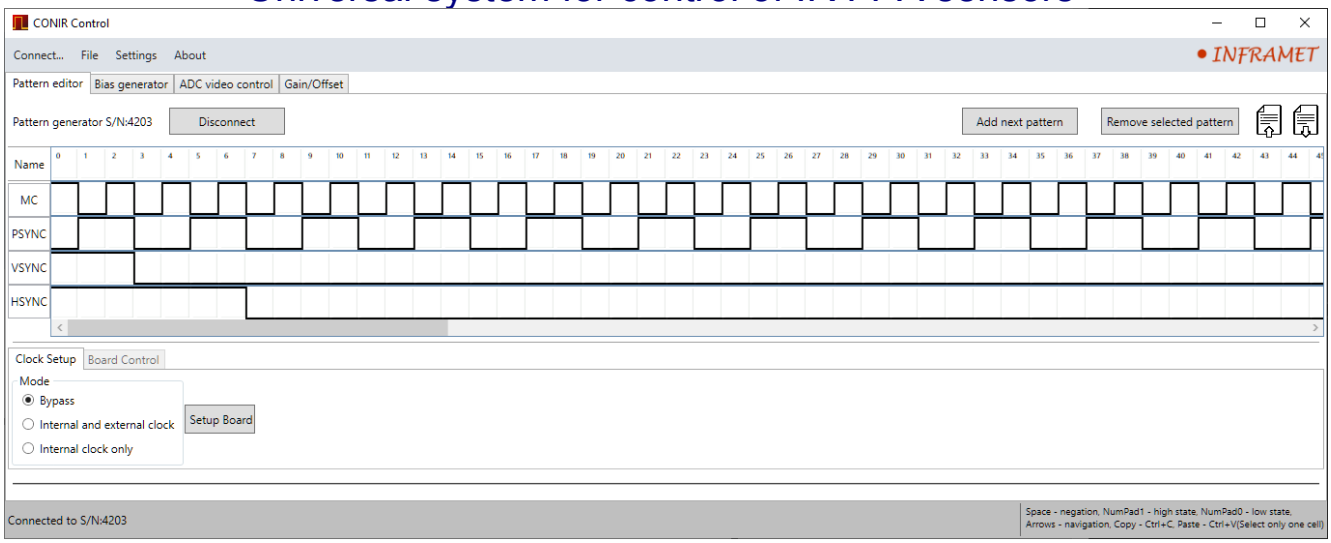
- independent gain control from 1 to 3,
- offset control
- ultra-low noise: 1 nV/√Hz @ 1 kHz.

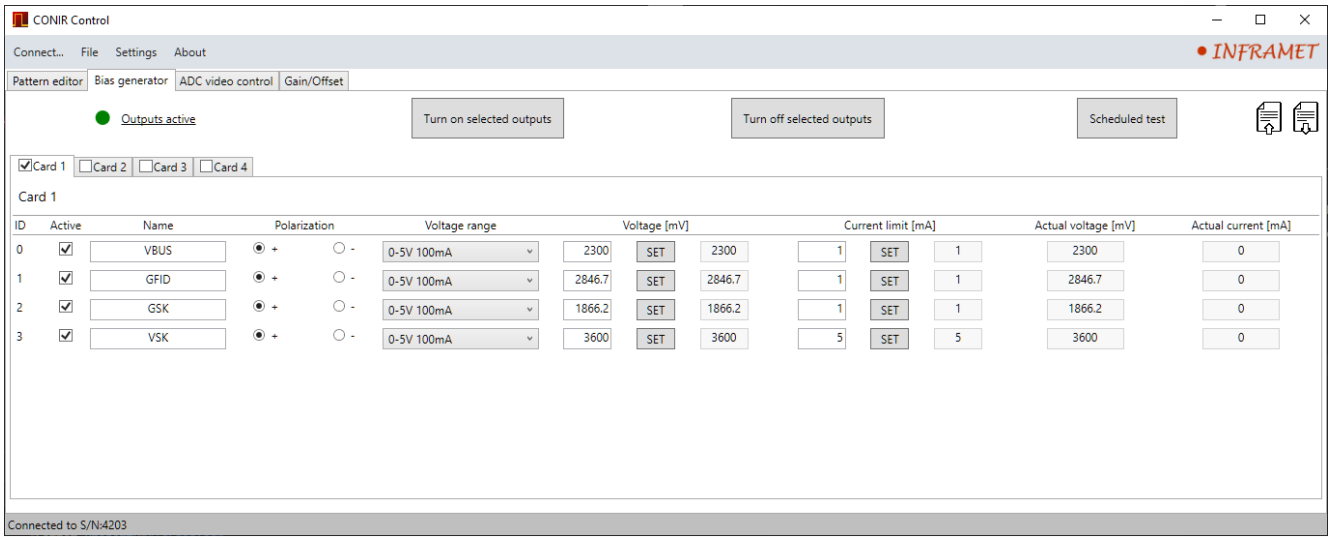
5 Software

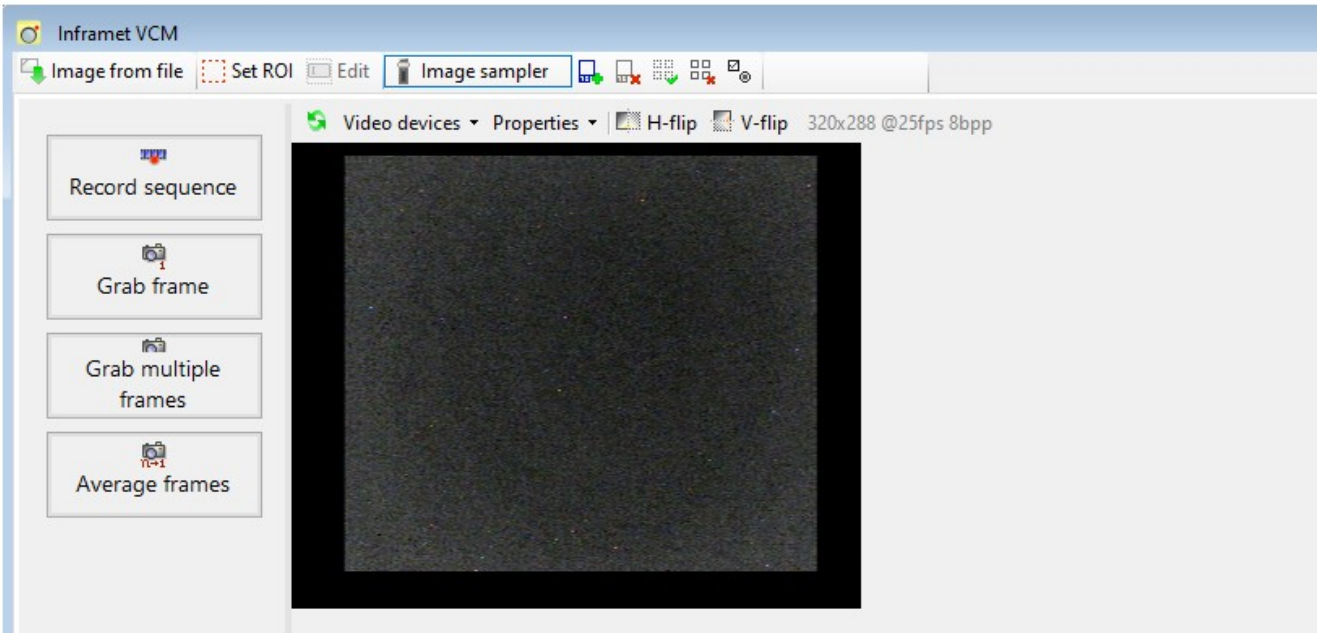
CONIR Control program offers three main functionalities: Pattern editor, Bias generator, Video capture. Views of these functionalities are presented below.

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INFRAMET

6 Market comparison

Inframet is a relative newcomer to a market of universal controllers IR FPA sensors. We have developed first quasi universal controllers for FT system for testing these sensors about 10 year ago when our two main competitors have been active on the market at least two times longer.
Further on, most of FT systems sold worldwide did not have such electronic controller to deliver bias voltages and clocking for the tested IR FPA sensor. Therefore such systems could be used only by customers having their own sensor electronics. New CONIR controller (presented in this data sheet) is offered as independent system or as a block of new FAPA system is a novelty offered since middle of 2022 year.

However, is spite of being a relative market novice the CONIR system posses three main advantages:

1. Compatibility to modern computing systems that typically use Windows/Linux operating systems,
2. Small size, low power consumption,
3. Communication with software written by the customer (Inframet can deliver optional API),
4. Potential use as block of FAPA system that offers ultra expanded test capabilities.

The origin of these advantages is modern design of CONIR controller. Sensor controllers offered by Inframet competitors are basically electronic systems based on technology from 1990s that have been built mostly by combining electronic subsystems (preamplifier, clock signal, bias voltage, A/D) from third parties and by integrating the system if form of a series of 19" x 3U rack housings. This claim of old age is supported by a big size of housing of IR FPA controllers offered by our competitors. Volume of Inframet rack housing is at least 7 times smaller comparing to housing of electronic controller offered by competitors.

Old does not mean automatically worse. The electronic systems offered by the competitors offer similar capabilities to control IR FPA sensors like CONIR system offered by Inframet. Big size of housing makes the total system to look archaic but it is acceptable. High power consumption is also not a big problem. It is also not a big problem that these systems include also tools for control of sensors having ROIC made in CCD technology that are not needed anymore (CCD is replaced by CMOS technology). However, the real problem is compatibility to modern computing systems that typically use Windows/Linux operating systems or communication with modern software written by the customer. Users of any old electronic system that uses software written using very old software tools can easily present a list of potential difficulties to operate such electronic systems.

Finally, a big advantage of CONIR is the fact that it can be used as a block of FAPA system of ultra expanded test capabilities not met by any other system offered on the market.

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