I KNOW YOU!

Intelligent Low Power Object Detection

With today's popularity of Artificial Intelligence (AI), AI technology is now finding its way into smaller IoT devices, even from the sensor perspective. Performing AI calculation on the sensor delivers great benefits including bandwidth saving, computation-cost saving, power saving, faster response rate, and data security reinforcement. PIXART's Low-Power Intelligent Object Detection (LIOD) technology specially designed for applications that require detection capabilities with the least power consumption.

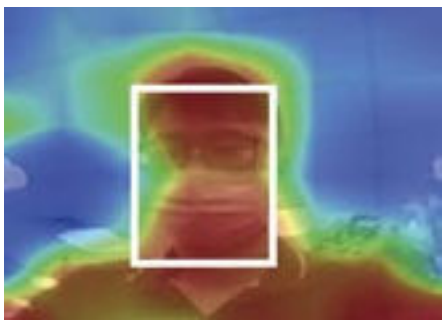
PIXART's LIOD product consists of an ultra-low-power CMOS image sensor and an ultra-low-power image-processing chip. The sensor is able to detect both objects and motions, and therefore can be applied to a variety of applications, including the detection of human faces and bodies, as well as report their positions.

Below are the key advantages of the LIOD sensors

- Provide motion detection functionalities with a power consumption rate of less than 100µW, making them applicable on always-on devices.
- Integrated with a Hard-Wired Deep Learning Engine that helps to save a large amount of computing cost on the host side.
- Instead of outputting bulky image data that occupies data bandwidth, the sensor can directly deliver readily usable information (e.g. object position, size, etc) in real-time.

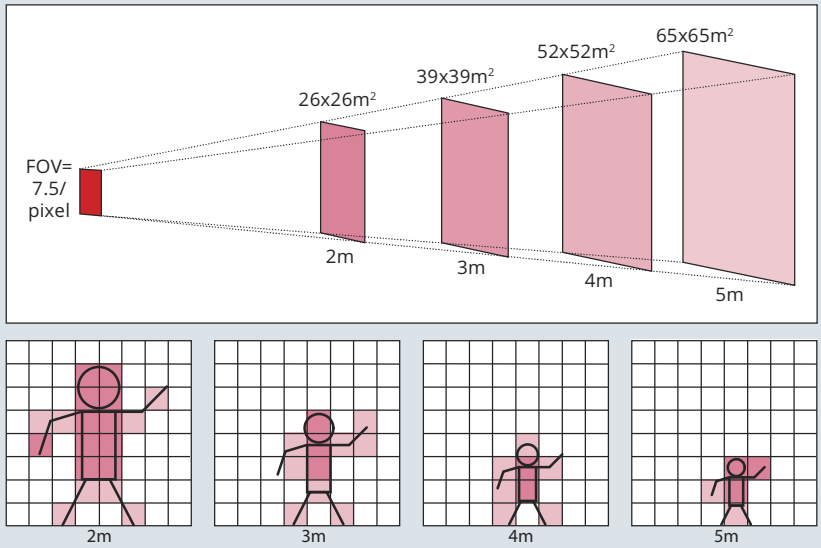
23.65	23.07	24.06	24.19	24.97	25.03	24.54	23.59
23.52	24.24	24.32	24.58	25.18	24.64	25.06	23.81
24.47	24.62	24.75	28.32	30.37	26.69	25.15	24.69
23.45	23.53	24.65	29.27	29.48	26.38	24.95	26.67
23.8	22.9	24.1	28.23	28.04	24.5	21.77	23.49
24.83	25.28	25.76	29.95	30.28	25.52	23.16	23.37
24.58	28.28	28.27	28.45	30.05	28.3	28.37	23.52
30.96	30.56	28.43	29.04	27.45	27.51	27.95	30.64

Thermal information (°C) detected from PAF9701C1



A low-resolution thermal image obtainable by combining the output of PAF9701C1 with PixArt imaging sensors

PAF9701C1



Detection Distance of PAF9701C1

An example of data output by the 3-in-1 device

PIXART's FIR (Far Infrared) sensing technology mainly detects far-infrared heat radiation with a wavelength in the range of 5~15μm. By converting energy into temperature through its algorithm, the FIR sensor is able to contactless measure the temperature of objects, making it suitable to apply in a wide variety of day-to-day temperature sensing applications.

The sensor **PAF9701C1** has a resolution of 64 pixels and can directly output calibrated and readable temperature values. Owing to its built-in algorithm, FIR sensor array is designed to identify the distribution of a thermal object in the detected space/area and outputs its thermal information.

PAG7920LT: Image Sensor is a QVGA Global Shutter Image Sensor in a Ultra-low power design that support smart motion detection, Auto-exposure and auto-gain control functionality and ROI (Region of Interest) functionality.

PAG7681LS: DSP provides object and motion detection system solution under the lowest power consumption. Supports image input in FHD, HD, VGA and QVGA formats has an Hard-Wired Deep Learning engine integrated. Built-in with PixArt's proprietary Human/Face detection algorithm, Supports color ISP function and JPEG encoding and output.

Due to the COVID-19 pandemic, measuring and record forehead temperature has become an essential part of our daily lives. By combining that 3 sensors

- **PAF9701C1;** FIR sensor with heat sink
- **PAG7920LT;** Image Sensor
- **PAG7681LS;** DSP chip-set

in one single thermal detection device, the device will be able to quickly identify human beings, measure their forehead temperature, and record the temperature to making sure anyone who enters the indoor space will be automatically measured and recorded.

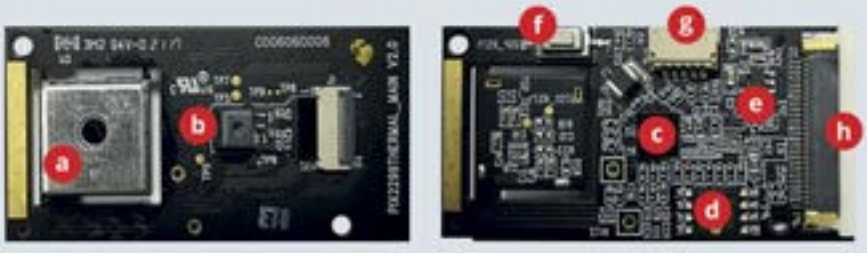
Highly-integrated evaluation boards available

PIXART provides a highly integrated evaluation board for the **PAF9701C1** that is easy to integrate and offers fast verification and system prototype. With 240×240 resolution and consisting of the **PAF9701** (FOV(H,V) = 60 degrees), a **PAG7920LT** image sensor with lens set (FOV(H) = 72.5 degrees), and **PAG7681LS** SoC chip, this 3-in-1 evaluation board (as shown in Figure 1) comes with face detection, temperature result computation, and control setup capabilities to realize a comprehensive smart forehead sensing solution.

The system powered by a 3.3V of power supply and its communication interface is I2C. With its default configuration, the recommended sensing distance of the evaluation board is between 50cm and 100cm.

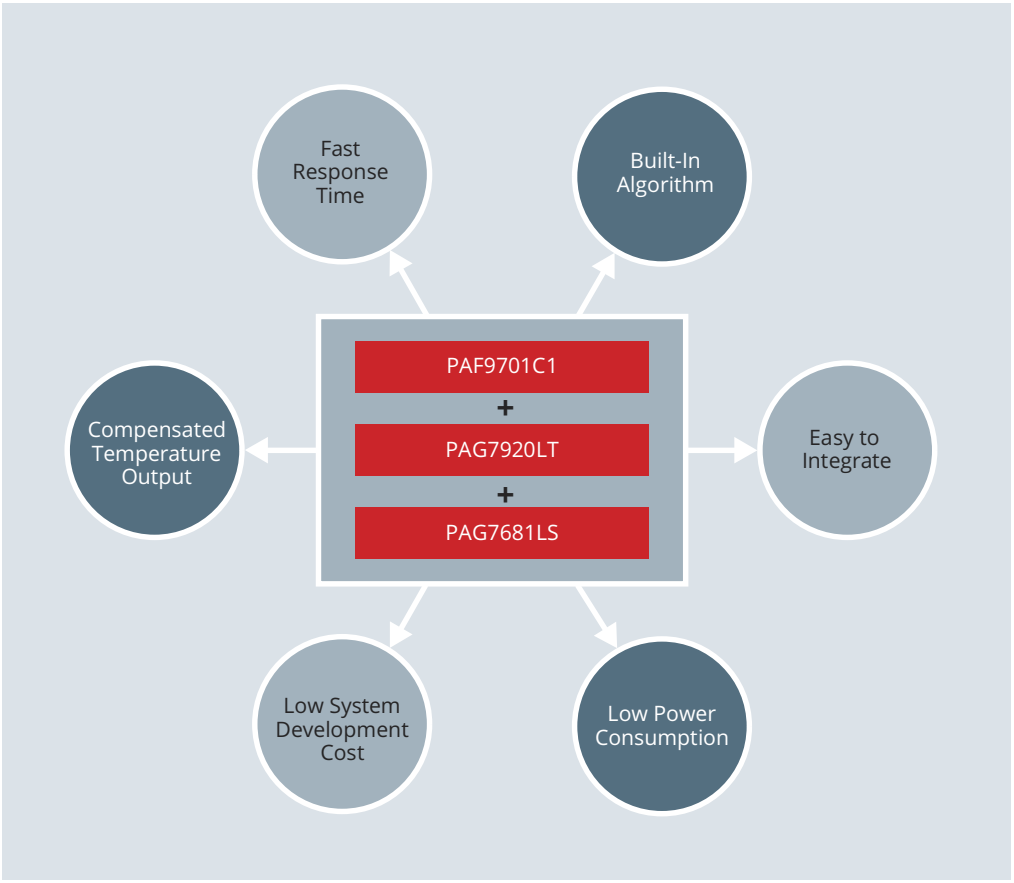
Note: PIXART also provides a complete reference design guide and library for the evaluation board.

Evaluation Board



a. PAF9701C1 FIR sensor with heat sink
b. FPC module of PAG7920LT Image Sensor
c. DSP chipset of PAG7681LS
d. External FLASH memory of PAG7681LS
e. 3.3V to 1.8V LDO
f. Reset button of PAG7681LS
g. 5pin Reserved Host Control Interface
h. 30pin Reserved Host Control Interface

Figure 1: Schematic Diagram of the Evaluation Board – Dimension: 43×25mm



Connection method of PIXART's 3-in-1 evaluation board explained

By controlling **PAF9701C1** through **PAG7681LS**'s DSP, the architecture adopted by this evaluation board is particularly suitable for outputting thermal values.

As shown in Figure 2, the circuit connection of the evaluation board allows **PAG7681LS** to obtain thermal data from **PAF9701C1** and then directly output the forehead temperature value to the host processor. The process flow shows in Figure 3.

Note that the algorithm for forehead temperature calculation is embedded in **PAG7681LS**'s DSP.

While **PAG7920LT** and **PAG7681LS** are mainly responsible for face and mask recognition, the algorithm will link the face position data with the temperature distribution data detected by PAF9701C1 to compute the compensated temperature values. Under uniform background with the detecting human being 50cm away from the sensor, the evaluation board is able to achieve high accuracy of 37±0.5°C. Note that the accuracy may be affected by factors such as forehead size, hair interference, background situation, and sensing distance. For customers who anticipate their 3-in-1 device to output both the thermal data AND the image data; or simply require more flexibility to tailor for specific applications, feel free to purchase the three sensors **(PAG7920LT, PAG7681LS, PAF9701C1)** from PIXART and establish the connection architecture your own way (for instance, allowing the host processor to directly control the three sensors).

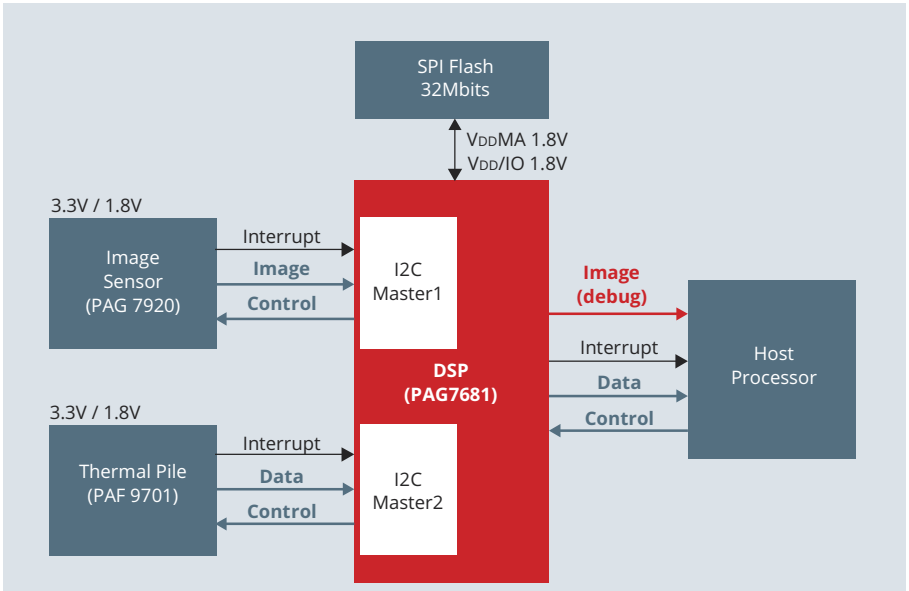


Figure 2: System block architecture of the evaluation board

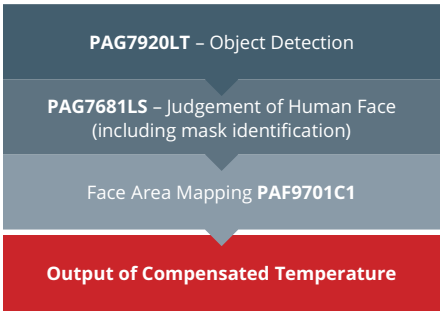


Figure 3: Process flow of the evaluation board

With the correct configuration and suitable connection method, this 3-in-1 solution can support applications such as indoor thermal detection, and living-creature (e.g. human body, pet, etc.) detection. With each purchased sensor, CODICO will provide its porting guide with detailed IC information, so that customers can customize their circuits, computations, and outputs.

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