ImageIR® 9400 – The Beast

The Most Universal IR Camera for Every Need

Thermographic cameras sensitive for infrared (IR) radiation are well known and have been used for several decades within Research and Development (R&D) and industrial applications. Development has rushed ahead during this time in terms of sensitivity, speed, and detector sizes, which results in high-efficient systems on one hand and in low-cost solutions on the other. Meanwhile, low-cost solutions can be found in smartphones as well as in small stand-alone systems for rough temperature detection for maintenance.

High-efficient solutions with outstanding sensitivities, high spatial resolution and high-speed data acquisition are needed in R&D in nearly every discipline of science and industry. Within the electronics R&D with continuous increase of high-dense packaging the thermal aspect receives a high priority during the development of smallest structures. This is where thermal imaging is indispensable.

InfraTec is specialised in developing such systems with various featured models to meet these new challenges. The ImageIR® 9400 hp camera offers a system which combines most of the demands on an IR camera in one system.

Demands for High-end Infrared Camera Systems

Which are the main demands? In general, three categories are requested for IR cameras:

- Speed (high frame rate and short integration time)
- Thermal sensitivity (detection of even smallest temperature gradients)
- Spatial resolution (field of view – FOV – combined with preferrable small instantaneous field of view – iFOV).

Usually, only few of these demands can be met by one single camera system since there are contradictory technical conditions existing. For example, a large pixel-size offers higher thermal sensitivity but will reduce the number of pixels with a given limit of Focal plane array (FPA) size (low spatial resolution) – a large number of pixels (high spatial resolution) will reduce the speed (frame rate) due to the limited data stream capability.

With the ImageIR® 9400 hp InfraTec launched a flexible camera system that can partially override these contradictory preconditions.

Fig. 1: The infrared camera ImageIR® 9400 hp

Headquarters
InfraTec GmbH
Infrarotsensorik und Messtechnik
Gostritzer Straße 61 – 63
01217 Dresden / GERMANY

Phone +49 351 82876-610
Fax +49 351 82876-543
E-mail thermo@InfraTec.de
www.InfraTec.eu

USA office
InfraTec infrared LLC
Phone +1 844-226-3722 (toll free)
E-mail thermo@InfraTec-infrared.com
www.InfraTec-infrared.com

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High-resolution Imaging – The Basic ImageIR® 9400 hp

The ImageIR® 9400 hp is based on a (1,280 x 1,024) IR pixels focal-plane array (FPA) with 10 µm pixel pitch. Using the back-illumination technique a fill factor of 100 % is achieved for the medium-wave infrared range (MWIR) wavelength range of (1.5 … 5.5) µm, where the detector is sensitive on. In full frame mode, the camera can reach 180 frames per second (fps); up to 2,600 fps are possible by reducing the frame size (less pixels will be addressed – so called sub-window mode).

The thermal sensitivity of the detector is less than 25 mK, meaning that the smallest temperature difference which can be measured out of the background noise (optical noise & electronics noise) is < 25 mK. With these native parameters, this 1.3 Megapixels camera initially meets the demand for large FOV together with an outstanding iFOV (depending on the lens, of course – see below).

Regarding speed and thermal sensitivity this camera can be classified within the standard range. Normally, another camera (with less but larger pixels) would be needed to reach higher frame rates and higher thermal sensitivity. By using a feature called binning, which is already common in visible light cameras, the ImageIR® 9400 hp can be easily switched to a high-speed camera by the user while increasing thermal sensitivity.

High-Speed Mode – Binning for Speeding Up the ImageIR® 9400 hp

High-speed mode, based on binning, is a hardware combination of several small pixels into one resulting large pixel. With the ImageIR® 9400 four pixels will be merged using the binning method. By employing this method, the effective pixel size (= IR-radiation sensitive area) is increased from one native pixel of 10 µm x 10 µm = 100 µm² to a new pixel of 20 µm x 20 µm = 400 µm².

The signal-to-noise-ratio (SNR) is mainly dependent on the ratio of the receiver(pixel)-area and on the noise level of the read-out-integrated-circuit (ROIC). Whilst increasing the pixel size by a factor of 4 and keeping the ROIC noise close to the initial level, the SNR will be increased significantly! This results into an absolute increase of the thermal sensitivity to finally < 18 mK which can be considered an outstanding value for this class of cameras.

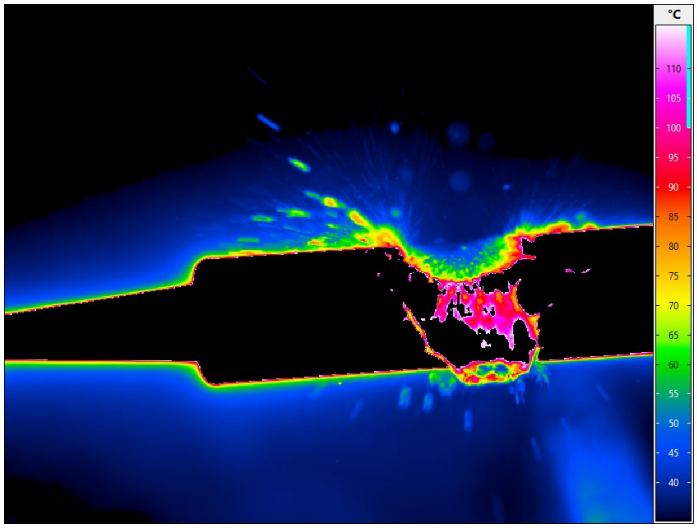

Fig. 2: Binning mode allows increased frame rates to also capture high-speed events

In addition to this SNR gain, the maximum frame rate speed in full frame mode increases to 622 fps. Another side-effect is that the overall FOV does not change when switching from native to high-speed mode.

Furthermore, the high-speed mode can of course be switched to sub-window mode, maintaining the excellent thermal sensitivity and achieving a frame rate of up to 3,300 fps.

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Phone +49 351 82876-610
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MicroScan – Detailed Imaging of ImageIR® 9400 hp

Even though the native FPA size of the ImageIR® 9400 hp offers already 1.3 Megapixels, it can be extended by a cost-effective option called MicroScan. With this additional opto-mechanical device, the image projected by the lens onto the FPA is periodically shifted in 4 directions at defined positions relative to the FPA. The shift is exactly ¼ of the pixel size (in this case 2.5 µm) in four directions. For each shift position an image will be captured and after completing all 4 images it will be recalculated to a new high-resolution image with a 4 times higher (sub-) pixel amount of (2,560 x 2,048) IR pixels (> 5.2 Megapixels). Not only the pixel amount will be increased by four times, but also the iFOV will be improved by a factor of two. Equal using the high-speed mode, the FOV is not changed when applying the micro scanning option. This feature allows the use for very large specimen with outstanding iFOV. Using this optional MicroScan function, the universal 2in1 camera is expanded to a 3in1 camera.

Calibration – Radiometric High-precision Measurements

InfraTec pays highest attention to performance and reliability of the radiometric measurement results with the ImageIR® series. Most important is the precise and stable temperature calibration of especially the ImageIR® 9400 hp as a 3in1 multi-talent. Based on certified temperature reference sources (Black Bodies), InfraTec can provide calibrations within the range of (-20 … 3,000) °C with an accuracy of +/- 1 K for (0 … 100) °C or +/- 1 % else. The accuracy is defined as the reproducible deviation of the absolute temperature measurement at environmental operation condition of (-20 … 50) °C of the camera. Well-developed algorithms and multiple calibration parameters allow the influence of the camera's ambient temperature to be perfectly compensated.

Extended configurations of the camera such as high-speed mode, the use of optical filters, special lenses, MicroScan mode including customised modifications are of course also individually calibrated on temperature by InfraTec to achieve the best performance for each single application case. Even microscopic lenses can be calibrated up to 500 °C to cover for example the growing markets of micro-electronics, micro-mechanics and additive manufacturing processes.

All InfraTec ImageIR® cameras are equipped with a special designed optical module which is thermally completely decoupled from the camera's electronics to avoid heating-up of any IR-optical elements within the optical measurement path.

Lenses – Big Variety of FOV/iFOV for the ImageIR® 9400 hp

The spatial resolution in terms of FOV and iFOV can be quantified with the camera in combination with the lenses used. InfraTec offers a variety of lenses for the ImageIR® 9400 hp with focal lengths from 25 mm to 200 mm to cover most of the applications. For temperature measurements of small structures InfraTec offers additional close-up lenses to reach an iFOV of down to 35 µm. For even smaller structures InfraTec's various microscopic lenses are perfect solutions. For example, the M=8x magnification lens offers an iFOV of outstanding 1.25 µm at a FOV of (1.6 x 1.28) mm². For all lenses offered, InfraTec provides a high-precision calibration to ensure perfect measurements for all object sizes and scenes.

Connectivity – Interface Between ImageIR® 9400 hp and the World

Given all the possibilities in terms of speed, spatial resolution, and thermal precision the ImageIR® 9400 hp needs of course to communicate with other devices for synchronisation, signal exchange and real-time data stream. Real-time 100 % acquisition and recording are guaranteed with the 10 Gig-E data interface. The transfer by optical fibre cable allows up to several hundred metres distances and a complete protection against any electromagnetic disturbances. Synchronisation and trigger signals in both directions – in and out – are standard with an outstanding precision of only 20 ns jitter.

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Summary

The ImageIR® 9400 hp from InfraTec is the ultimate solution for industrial, university and commercial laboratories offering all advantages within one camera where usually multiple camera set-ups are needed.

Based on the detector's native spatial resolution of (1,280 x 1,024) infrared-sensitive pixels, it can be expanded up to (2,560 x 2,048) IR pixels with an opto-mechanical MicroScan option. Furthermore, due to the binning option, it can be switched to a spatial resolution of (640 x 512) pixels in order to increase speed and thermal sensitivity - all with a constant field of view and in one camera.

Spatial resolution up to 1.25 µm/pixel can be served with specially developed lenses for microscopic applications. In terms of speed, the above-mentioned binning option also offers frame rates in full-frame mode up to 622 fps and in sub-window mode up to > 3,300 fps. Thermal sensitivity is also strongly influenced by the binning-mode as the effective pixel size is changed from 100 µm² to 400 µm², which initially means a significant improvement of the signal-to-noise-ratio which is necessary for high-speed thermal imaging with low integration times respectively high speed.

Being proficient in all of these different sensitivities the ImageIR® 9400 hp turns out into the perfect workhorse for any laboratory where heat and temperatures need to be monitored.

Feel free to contact InfraTec to arrange a test of the flexible ImageIR® 9400 hp on YOUR application!

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