

ImageIR® – High Dynamic Range (HDR)

How it works and what the benefits are



Why Does InfraTec Introduce HDR Capability?

Thermography systems with cooled detectors offer excellent measurement accuracy. When calibrating these cameras, the integration time and attenuation filters are optimized to provide the best results within a certain temperature range. The span of the temperature range is partly defined by the properties of the thermography system, but even more so by the physical laws underlying the measurement principle.

To measure temperatures spanning more than one calibration range requires the acquisition of multiple thermograms with different calibrations. This can be achieved by using our Multi Integration Time feature (MIT). It combines images of several integration times into one image data set. However, MIT is limited to a temperature range defined by the calibrations with the same filter settings. The HDR feature breaks free of these limitations, changing the filters on a frame-to-frame basis with up to 350 Hz. Thus, calibration ranges spanning more than 1,000 °C can be realized.

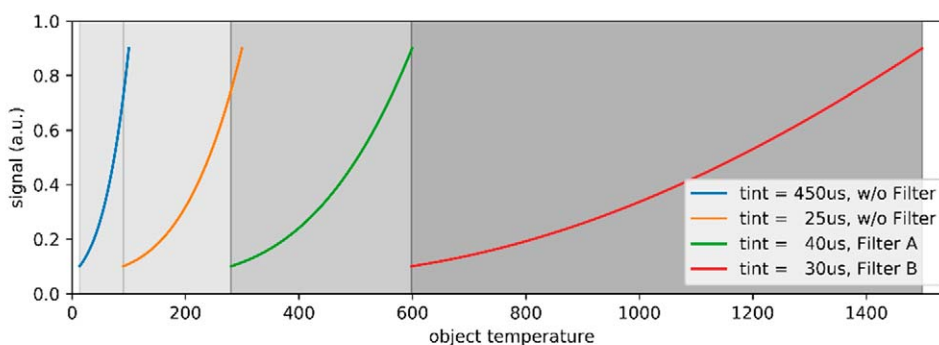


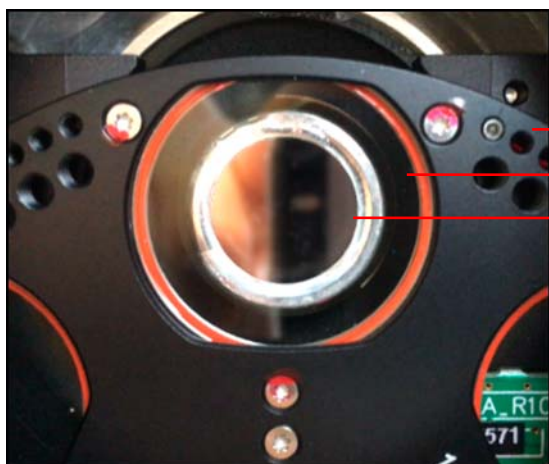
Fig. 1: Example of characteristic calibration curves, indicating the measured signal vs. object temperature. Due to the high radiation flux, filters are required to measure high object temperatures. HDR switches between the individual calibrations, combining the measurements into a single thermogram at up to 350Hz.

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How Does It Work?

The hardware implemented is very similar to the MicroScan feature – a fast filter wheel is equipped with several filters. As the wheel rotates at more than 5,000 rpm, the image integration is precisely synchronized to the filter positions. Up to four individually filtered and calibrated thermograms are thus acquired in rapid succession and can optionally be merged into a single HDR-thermogram.



Filter Wheel
Custom HDR Filter
Detector Entrance Window

Fig.2: A high speed filter wheel inside an ImageIR® 8300 hp

Measuring Range Options and Frame Rates

By using the HDR functionality, an ImageIR® 8300 hp can continuously measure temperatures in a range significantly broader than each single calibration (e.g. 10 °C to 1,500 °C or -10 °C to 800 °C). Fig. 3 and Fig. 4 indicate the benefits of this feature: Fig. 3 shows an illustration of a candle hotter than 700 °C and a finger at room temperature – in the same data set! To visualize both details being at very different temperatures, the IRBIS® temperature loupe feature is used to partially adapt the range for a proper display.

The very high rotation speeds of the filter wheel and the exact detector synchronization achieved by InfraTec allow high-speed thermography even with HDR activated. This is demonstrated in Fig. 4, showing the temperature evolution of a fuse being blown. Without interruption, the whole range can be measured (from 1,500 °C down to 10 °C) in about 11 milliseconds with a frame rate of 350 Hz. The high speeds allow capturing the moments leading up to the melting point and beyond with a high temporal, spatial and thermal resolution. Temperatures at the base of the fuse are as accurately measured as right at the breaking point.

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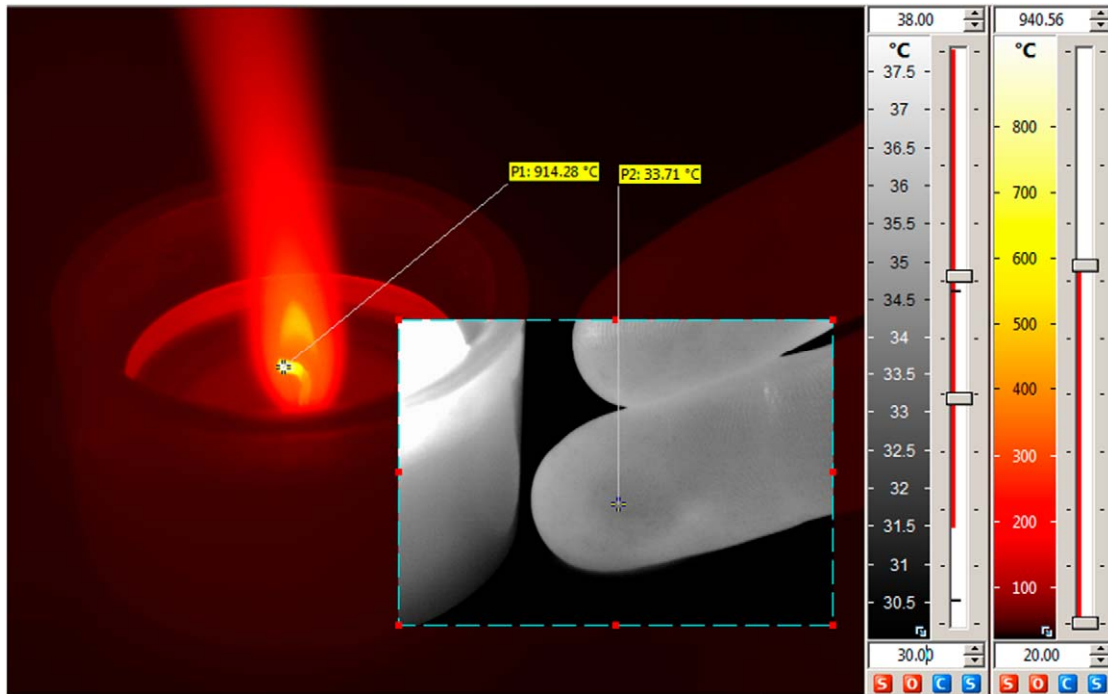
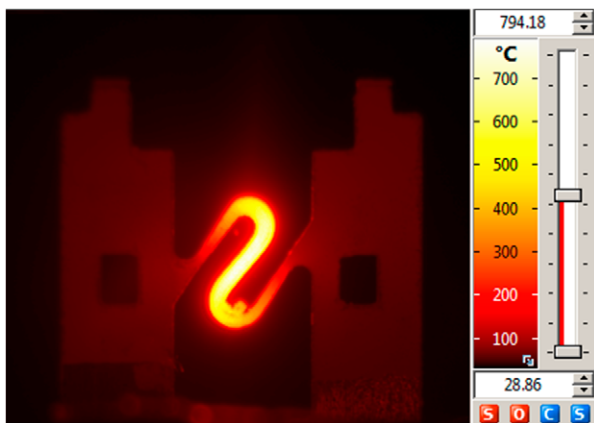
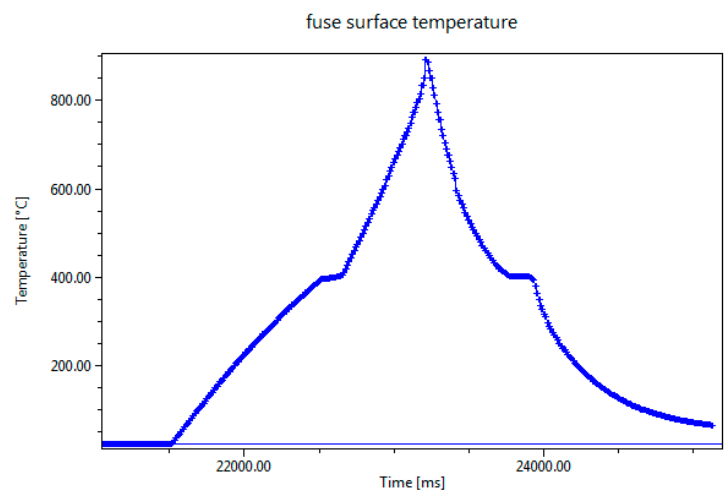


Fig. 3: Candle and fingers within one HDR measuring range. The IRBIS® Temperature Loupe feature is used to visualize both hot and cold regions at the same time.



(a)



(b)

Fig. 4: A Fuse shortly before blowing (a). The temperatures of the fuse can be monitored at high temporal, spatial and thermal resolution (b). The plateaus in the temperature signal at 400 °C are due to a phase transition in the metal, lasting only 50 ms.

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Combination of HDR and MicroScan

The ImageIR® 8300 hp can be even more versatile when using a 6-position filter wheel including both HDR filters and MicroScan filters. The user can decide whether to acquire an image with very wide temperature dynamics using HDR or increased spatial resolution using MicroScan. Add an additional filter wheel and this camera can work with extended temperature ranges – or spectral filters – also in the MicroScan mode.

The example given below demonstrates the versatility of a scientific thermography system utilizing the flexibility possible with an ImageIR® 8300 hp: HDR, MicroScan, high-temperature calibration and on-flame/through-flame spectral filtering.

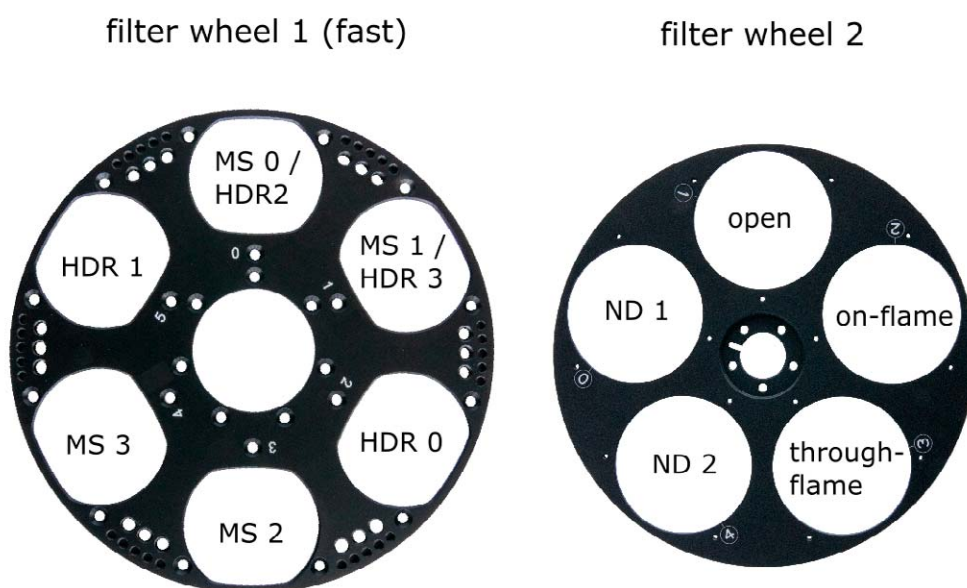


Fig. 5: Maximizing ImageIR® flexibility – The fast filter wheel 1 holds HDR neutral-density filters and MicroScan filters (MS), the filter wheel 2 is equipped with ND and spectral flame filters.

With above sample solution it is possible to achieve:

- 1) A continuous measurement range of (-10 ... 800) °C or (10 ... 1,500) °C using the HDR solution.
- 2) A continuous measurement range with the through-flame filter of (150 ... 2,000) °C using the HDR solution.
- 3) A continuous measurement range with the on-flame filter of (150 ... 2,000) °C using the HDR solution.
- 4) A temperature measurement range from (-20 ... 3,000) °C consisting of individual calibrations. Calibrations up to 1,500 °C can be combined with the MicroScan feature, yielding resolution enhanced images of (1,280 x 1,024) IR-pixels.