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CHOPPED RADIATION METHOD FOR A PYROELECTRIC DETECTOR

WHAT IS THE CHOPPED RADIATION METHOD ?

When describing the working principle of infrared radiation pyrometers, the term "chopped radiation" is used to characterize the mechanical or optical modulation of radiation, primarily thermal infrared radiation, intercepted by the infrared detector. In general, this is accomplished by an optical chopper which has mechanical blades driven by a motor which periodically interrupts the incident radiation from the measured target to the detector. During each interruption the detector is exposed to an internal reference source having a defined and measured temperature.

WHY IS THE CHOPPED RADIATION METHOD USED ?

Chopping is a requirement when using a Pyroelectric detector.

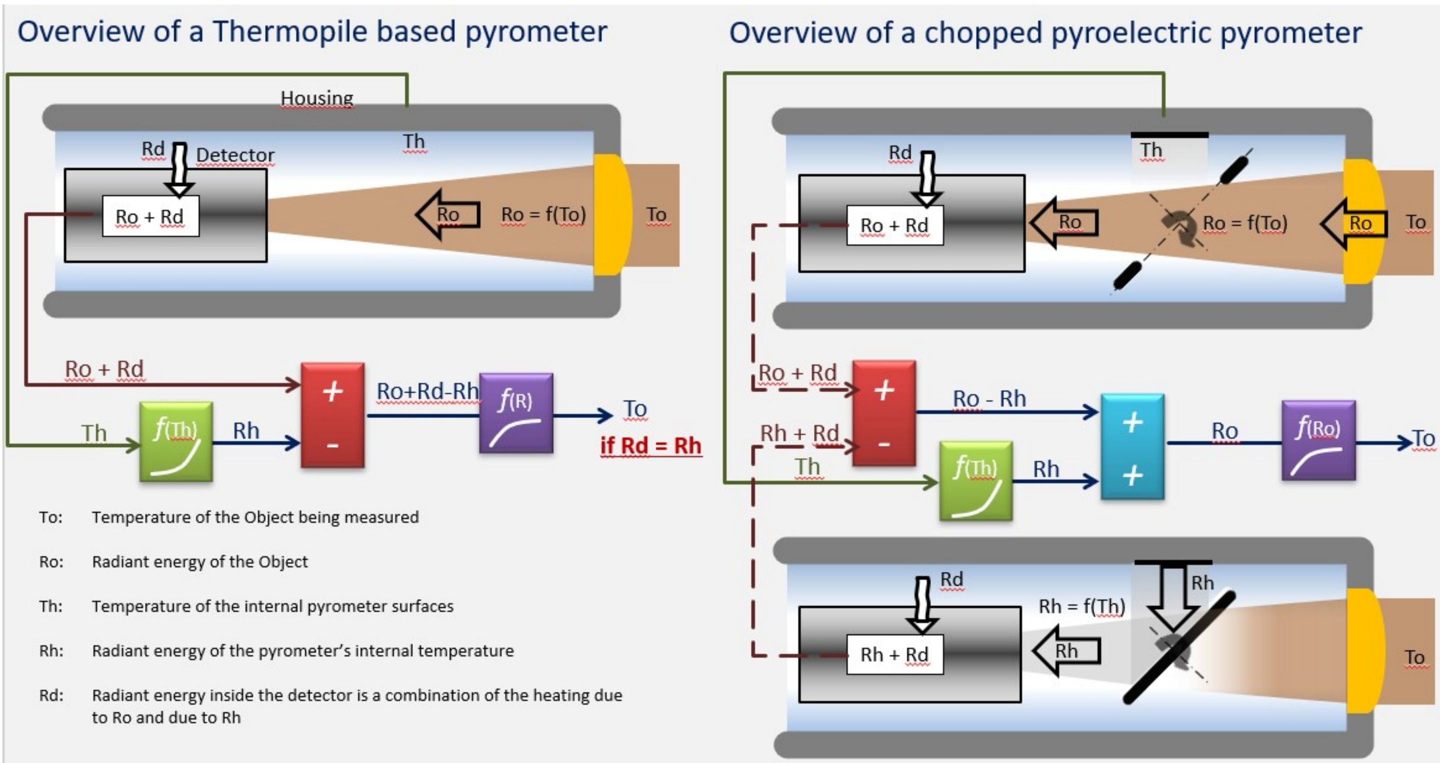
High quality, high performance infrared detectors of the pyroelectric type must be operated in the chopped radiation method, because they respond to radiation differences only, not to absolute radiation intensities. Pyroelectrics are the best uncooled detectors available, in terms of detectivity, fast response, reliability and stability.

Thermal Drift is eliminated when properly chopping the signal of a Pyroelectric detector.
Detectors in all infrared pyrometers simultaneously intercept infrared radiation emitted by the measured target and the radiation emitted by the pyrometer’s forward internal surfaces. For un-chopped pyrometers that use a thermopile, the radiation from the pyrometer's housing temperature and other surfaces within view of the detector’s wide acceptance angle gives rise to a bias on the output signal of the detector and subsequently to thermal drift whenever the housing temperature changes. Although thermopile based pyrometers will employ internal temperature compensation, the result is inferior to a chopped pyroelectric detector based pyrometer.

Also, for un-chopped pyrometers measuring low temperatures at or below the ambient or when focussing on small targets, and/or when the pyrometer has a narrowband spectral range, the bias can significantly exceed the measured signal.

Correct compensation of this bias for a specified pyrometer measurement accuracy of 0.5 °C (0.9 °F) would require a stabilization of the housing temperature to be better than approximately 0.9 °F/100 = 0.01°F, a virtually impossible specification for any affordable industrial/commercial un-chopped pyrometer.

A pyrometer that uses a chopped pyroelectric detector evaluates two subsequent signals in addition to the internal temperature of the pyrometer housing. The 'bias' of the detector is therefore eliminated.



During the short chopping cycles, which are normally in the millisecond range, Th and Rd do not change. The bias is thus eliminated completely and substituted using Rh, which is measured well within a specified reference accuracy of <0.5 °C (0.9 °F) over the permissible ambient temperature range.

Chopping Reduces Signal Noise to yield optimal NETD
(Noise Equivalent Temperature Differential, in other words, measured temperature resolution which is different than a 'displayed resolution' specification)

The chopped radiation method automatically provides a modulated signal with a precisely defined frequency. Such a signal lends itself to narrowband spectral ranges using digital signal processing with unsurpassed noise suppression and signal stability.

DESIGN COMMENTS

It is sometimes argued that the chopped radiation method has its weak link in the chopper, as it tends to make pyrometers more expensive and unreliable. This may be true for obsolete or badly designed pyrometers. Of course, a chopper adds to the manufacturing costs, but it is generally less than 5% compared to the total cost of the pyrometer.

Today, the 11.5 year MTBF of the current HEITRONICS chopper rivals typical electronic chips and other components. Today's chopper has been internally revised/designed since the first version 35 years ago. 11.5 years is the specification for continuous operation under specified environmental operating conditions.

CHOPPED RADIATION METHOD TECHNOLOGY BENEFITS

- Virtually no thermal drift
- Excellent dynamic compensation of thermal shock
- Accuracy spec that includes entire permissible ambient span, not just at lab temperature !
- Unequaled noise filtering
- Superb temperature resolution
- High optical resolution *(high Distance-to-Spot-Size ratio and small target measurement)*
- Fast response times
- Long-term stability

APPLICATION EXAMPLES

- Long wavelength low temperature measurement for Atmospheric and Ocean Sciences
- Transfer Standards for calibration laboratories
- Narrowband spectral ranges such as at 3.9 µm , 4.5 µm , 5 µm, 8 µm and 10.5 µm for viewing through combustion gas, measuring combustion gas, glass/thin glass/ultrathin glass and long distance viewing through the atmosphere.
- Food, sterilization, pharma and medical device manufacturing applications.
- Any application, requiring the highest measurement performance in one of more of the categories listed under the above “Technology Benefits” heading.