Multi PAS

Refrigerant leakage detection enabled by Photoacoustic Spectroscopy (PAS) technology

Infineon leveraged its knowledge in MEMS technologies and first introduced a new generation of state-of-the-art carbon dioxide (CO2) sensors based on the Photoacoustic Spectroscopy (PAS) principle. Since then, Infineon started its journey to become a leader in PAS enabled market segment. The next bold move is to further expand its environmental sensing portfolio by developing a gas sensor concept for refrigerant leakage detection. In addition to the XENSIV™ PAS CO2 sensor, today Infineon plans to offer refrigerant leakage sensor solutions tailored for the detection of methane, propane, R-32 and R454B gases (additional gases possible).

The transition towards more sustainable refrigerants

As part of the global effort to mitigate climate change, commercial refrigeration industries are called to make conscious choices. The introduction of the Montreal Protocol in 1987 established a worldwide phase-out schedule for production and consumption of multiple Ozone Depleting Substances (ODS), including ChloroFluoroCarbons (CFCs) and HydroChloroFluoroCarbons (HCFCs). In response to the discontinuation of CFCs and HCFCs and the increasing demand for refrigeration and air-conditioning equipment, the deployment of HydroFluoroCarbons (HFC) has been growing worldwide. Since HFCs are not considered harmful for the ozone layer, they have been intentionally developed as replacements for Ozone-Depleting Substances (ODS) in the refrigeration sectors. However, HFCs are very strong greenhouse gases contributing significantly to global warming. In this regard, several regulations have been introduced to address and limit the use of HFCs. Two examples are the American Innovation and Manufacturing (AIM) Act enacted in 2020 and the F-gas Regulation as well as the MAC Directive declared by the European Commission in 2022. The rising number of regulations which ban or heavily restrict the use of HFCs to protect our ecosystem are facilitating the adoption of more climate-friendly technologies and the transition towards low Global Warming Potential (GWP) alternatives, such as A2L and A3 gases.

How are refrigerants classified?

Standards like ASHRAE 34-2019 and ISO 817 “Refrigerants — Designation and safety classification” provide a safety classification based on the evaluation of toxicity and flammability of refrigerants.

The toxicity of refrigerants is defined considering the potential health issues caused by the exposure to the substance, while flammability is evaluated by looking at the ability of the refrigerant to burn or ignite, causing fire or combustion.

According to the International Standard ISO 817:2014, the safety classification is defined by letters and numbers. The capital letters designate a toxicity class based on allowable exposure, while the numbers indicate the degree of flammability. More specifically, class A denotes refrigerants of lower toxicity, while class B refers to refrigerants of higher toxicity. With regard to flammability, refrigerants follow under one of the following categories:
Class 1 (No flame propagation), Class 2L (Mildly flammable with lower burning velocity), Class 2 (Flammable) and Class 3 (Higher flammability).

Increasing flammability ↑	Lower toxicity	Higher toxicity
Higher flammability	A3	B3
Flammable	A2	B2
Lower flammability	A2L	B2L
No flame propagation	A1	B1

Increasing toxicity →

Figure 1 Classification of refrigerants

What is the Global Warming Potential (GWP)?

Toxicity and flammability are two important criteria used to evaluate and select the appropriate refrigerant. However, the environmental impact is also a key factor to be considered when making the right choice. Generally, the environmental impact of greenhouse gases is defined by the Global Warming Potential (GWP). The GWP is a measure of the potential impact of greenhouse gases on the atmosphere expressed as a factor relative to CO2, which is the reference gas. The GWP factor is used to reflect the impact of refrigerant gases on global warming over a specified time, which is usually 100 years.

Refrigerants such as A2L and A3 gases certainly have a smaller impact on climate change compared to HFCs. However, the challenge in deploying lower GWP alternatives instead of using traditional HVAC/R refrigerants is the level of flammability. On the one hand, an increasing number of regulations require HVAC appliance manufacturers to reduce their products' greenhouse emissions by using more environmentally friendly refrigerants. On the other hand, safety measures with regards to flammability are becoming a central part of the HVAC/R equipment benchmarking and assessment. To prevent the risk of explosion caused by flammable refrigerants, an increasing number of safety standards require the deployment of refrigerant leakage detection systems.

What are the safety standards that require a leakage detection device?

There are several standards that specify safety requirements to ensure a responsible use of refrigerants by integrating a leakage detector into refrigeration systems.

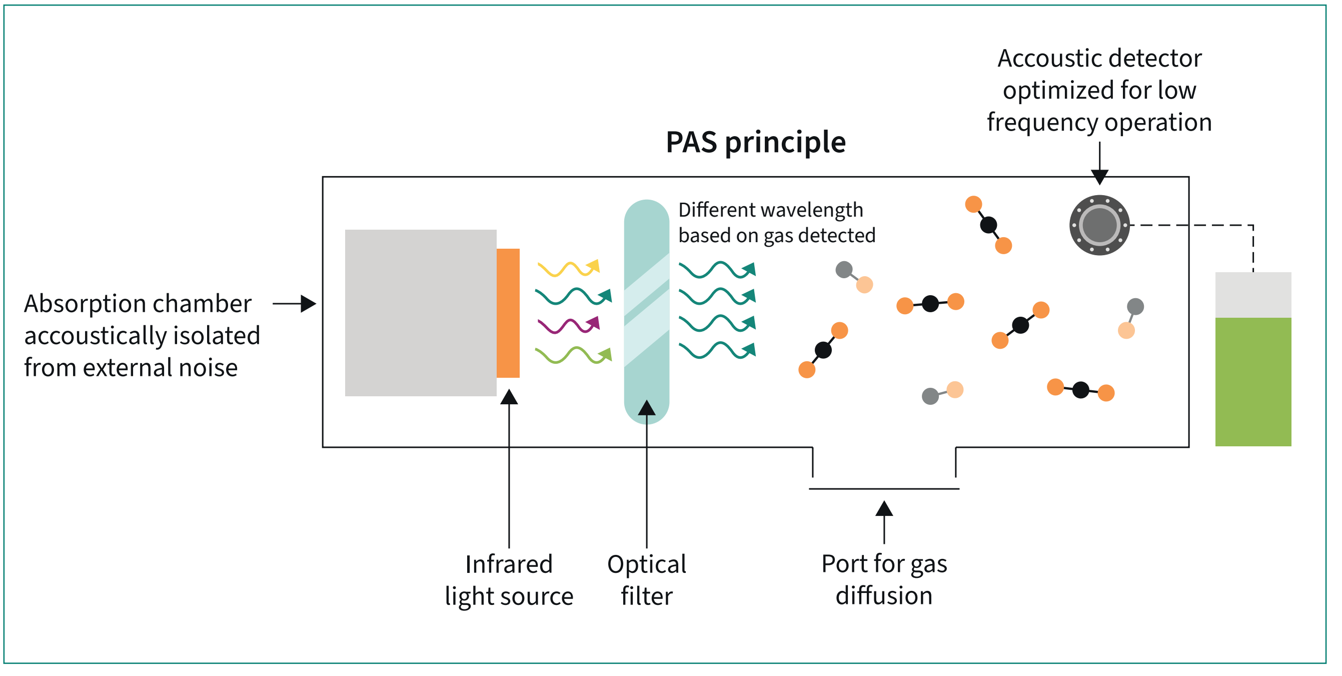
1. ASHRAE Standard 15 – Safety Standard for refrigeration Systems. This standard is widely recognized as industry best practice for personal safety by equipment manufacturers, engineers, and contractors and it is often adopted into local building codes and regulations. ASHRAE Standard 15 defines the rules for the safe application of refrigeration equipment and provides specific guidelines on the installation of refrigerant leakage detectors.
2. UL Standard 60335-2-40 – This standard describes testing methods for determining the safety and reliability of refrigerating appliances. UL Standard 60335-2-40 requires the installment of refrigerant leak detectors for all systems in the occupied space exceeding the refrigerant charge limit.
3. EN 378 – Refrigerating systems and heat pumps – Safety and environmental requirements. This European standard is the regional equivalent to the international standard ISO 5149. EN 378 specifies the requirements for the safety of persons and property, provides guidance for the protection of the environment, and establishes procedures for the installation of refrigerant detection systems in machinery rooms.
4. International Fire Code (IFC) – The IFC is a model code that regulates minimum fire safety requirements for new and existing buildings, facilities, storage and processes. According to section 608.91 of this standard, a detector triggering an audible and visible signal shall be installed in the machinery rooms.

1) 2021 International Fire Code (IFC)

The Photoacoustic Spectroscopy (PAS) Principle

Based on the PAS principle, pulses of light from an infrared source pass through an optical filter tuned to the absorption wavelength of the intended measured gas. At each pulse, the gas molecules inside the measurement chamber shake and produce a pressure wave as a result of the filtered light being absorbed by the molecules. This phenomenon is also called the “photo-acoustic effect”.

The acoustic detector, optimized for low-frequency operation, detects the pressure change generated, and the microcontroller converts the output into the gas concentration reading. In order to deliver precise gas sensing data, the absorption chamber is acoustically insulated from outside noise.



Why is PAS technology ideal to detect refrigerant leaks?

The photoacoustic spectroscopy technology represents an excellent choice for refrigerant leakage detection in various industries and applications. Thanks to its high sensitivity and selectivity, PAS enables to detect even small concentrations of the target gases of interest and differentiate between various refrigerants. This specificity helps in distinguishing refrigerant leaks from other common gases present in the environment. Another advantage of PAS technology is the real-time monitoring as well as the wide detection range. PAS provides continuous gas measurements allowing for immediate detection and response to any leaks. Moreover, its versatility in detecting a wide range of refrigerant gases makes it suitable for different types of refrigeration systems and applications.

References

[1] United States Environmental Protection Agency (EPA) (2023). Protecting Our Climate by Reducing Use of HFCs. Retrieved from: https://www.epa.gov/climate-hfcs-reduction

[2] European Commission (2022). Green Deal: Phasing down fluorinated greenhouse gases and ozone depleting substances. Retrieved from: https://ec.europa.eu/commission/presscorner/detail/en/ip_22_2189

[3] United States Environmental Protection Agency (EPA) (2023). Significant New Alternatives Policy (SNAP). Retrieved from: https://www.epa.gov/snap/refrigerant-safety

[4] American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) (2022). Update on New Refrigerants Designations and Safety Classifications. Retrieved from: https://www.ashrae.org/file library/technical resources/bookstore/factsheet_ashrae_english_november2022.pdf

[5] United States Environmental Protection Agency (EPA) (2023). Transitioning to Low-GWP Alternatives in Residential and Commercial Air Conditioning. https://www.epa.gov/ozone-layer-protection/transitioning-low-gwp-alternatives-residential-and-commercial-air

[6] California Air Resource Board (2023). High-GWP Refrigerants. Retrieved from: https://ww2.arb.ca.gov/resources/documents/high-gwp-refrigerants

[7] United States Environmental Protection Agency (EPA) (2023). Final Rule - Phasedown of Hydrofluorocarbons: Establishing the Allowance Allocation and Trading Program under the AIM Act. Retrieved from: https://www.epa.gov/climate-hfcs-reduction/final-rule-phasedown-hydrofluorocarbons-establishing-allowance-allocation

[8] United States Environmental Protection Agency (EPA) (2023). Understanding Global Warming Potentials. Retrieved from: https://www.epa.gov/ghgemissions/understanding-global-warming-potentials#:~:text=Methane%20(CH4)%20is%20estimated,27%2D30%20over%20100%20years.

[9] American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE). Shaping Tomorrow's Build Environment Today. Retrieved from: https://www.ashrae.org/file library/about/government affairs/advocacy toolkit/virtual packet/15-2013-fact-sheet.pdf

[10] International Organization for standardization (ISO) (2023). ISO 5149-1:2014 – Refrigerating systems and heat pumps — Safety and environmental requirements — Part 1: Definitions, classification and selection criteria. Retrieved from: https://www.iso.org/standard/54979.html

[11] American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) (2018). Safety Standard for Refrigeration Systems. Addendum to Addendum to ANSI/ASHRAE Standard 15-2016. Retrieved from: https://www.ashrae.org/file library/technical resources/standards and guidelines/standards addenda/15_2016_d_20181023.pdf

[12] Underwriters Laboratories (UL) (2019). Understanding UL 60335-2-40 Refrigerant Detector Requirements. Retrieved from: https://www.ul.com/news/understanding-ul-60335-2-40-refrigerant-detector-requirements#:~:text=UL%2060335%2D2%2D40%20also,fire%20due%20to%20a%20leak.&text=Indicating%20type%20detectors%20are%20required,located%20to%20detect%20any%20leaks.

[13] American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) (2022). ANSI/ASHRAE Addendum to ANSI/ASHRAE Standard 15-2019.Shaping. Retrieved from: https://www.ashrae.org/file library/technical resources/standards and guidelines/standards addenda/15_2019_g_20220831.pdf

[14] Underwriters Laboratories (UL) (2023). Testing, Certification and Advisory for Low GWP Refrigerants. Retrieved from: https://www.ul.com/services/flammable-refrigerants-testing-air-conditioning-and-refrigeration

[15] International Code Council (2021). International Fire Code (IFC). Retrieved from: https://codes.iccsafe.org/s/IFC2021P1/chapter-6-building-services-and-systems/IFC2021P1-Pt03-Ch06-Sec608.9

Service Hotline

Infineon offers its toll-free **0800/4001** service hotline as one central number, available 24/7 in English, Mandarin and German.

Germany	0800 951 951 951 (German/English)
China, mainland	4001 200 951 (Mandarin/English)
India	000 800 4402 951 (English)
USA	1-866 951 9519 (English/German)
Other countries	00* 800 951 951 951 (English/German)
Direct access	+49 89 234-0 (interconnection fee, German/English)

*Please note: Some countries may require you to dial a code other than "00" to access this international number, please visit www.infineon.com/service for your country!

Published by
Infineon Technologies AG
Am Campeon 1-15, 85579 Neubiberg
Germany

Public

Date: 08 / 2023

Stay connected!

Scan QR code and explore offering
www.infineon.com