Precision Timing Solutions

Robust Solutions for A2L-Based HVAC/R

Precision Timing in A2L-Based HVAC/R

HVAC/R applications represents harsh environment with wide temperature swings and electrical transients. When compared to quartz crystal oscillators, MEMS-based oscillators are more resistant to shock and vibration, highly immune to electromagnetic energy and power supply noise. Moreover, in applications concerned with gas permeability, SiTime offers hermetic solutions.

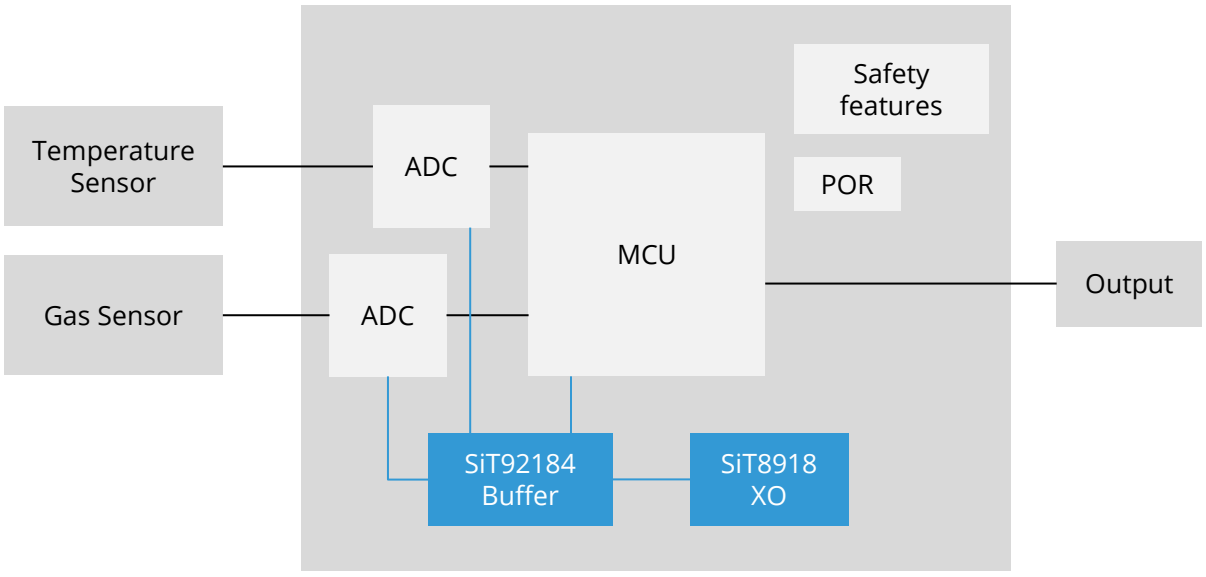
Key Considerations

- Wide temperature range
- Vibration tolerance
- Immunity to transients
- Hermeticity

Driven by environmental as well as regulatory concerns, the HVAC industry is undergoing a transition to a new class of refrigerants, known collectively as A2L — an ASHRAE classification, where A represents low toxicity and 2L slow burning, low flammability. While there are no specific regulations in either the US or the EU mandating the use of A2L, these regions do require refrigerants with a GWP below a specific threshold (typically, 700 for stationary residential and light commercial air conditioning and heat pumps).

Given that A2L carries a flammability risk (albeit, low), the detection and mitigation of any refrigerant leak is essential. This requirement is driving designers to look for robust timing solutions that can withstand the harsh environments in which HVAC/R systems operate.

A2L Leak Detection Sensor Block Diagram



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A2L Refrigerant

While A2L has a lower global warming potential (GWP) and offers similar or better energy efficiency over A1 refrigerants, it does come with a few downsides:

- Higher flammability than A1 refrigerants, requiring additional safety measures.
- A2L refrigerants and equipment are currently more expensive than traditional options.
- Technicians require additional training and certification to work with A2L refrigerants due to their different properties and safety considerations.

Regulation and Standards are Driving the Change

In the US, several states have introduced measures curtailing the use of older refrigerants. For example, the California Air Resources Board (CARB) set a GWP limit of 750 for refrigerants, effective Jan. 1, 2023 for HVAC/R products and Jan. 1, 2024 for chillers. More importantly, the EPA issued a final rule in October 2023 to restrict the use of higher GWP refrigerant in several refrigerant applications. For residential and light commercial HVAC systems, the installation compliance date is generally January 1, 2025, with some applications allowed a later phase over date. This rule impacts the installation of new systems but does allow for the maintenance of legacy systems within a broad set of restrictions.

From an equipment safety perspective, Underwriters Laboratory has issued the new HVAC/R Safety Standard, UL/CSA 60335-2-40. The recently issued fourth edition defines refrigerant detection systems requirements to help mitigate fire hazards and evaluate system reliability. This new set of safety standards goes into effect Jan 1, 2025, further driving the industry to update equipment designs.

Leak Detection is Key

The first area that must be addressed by system designers is leak. In contrast to most residential applications, commercial application rely on chillers rather than the traditional compressor/condenser/evaporator arrangement with refrigerant shipped to an indoor unit (think mini splits). With a chiller, a packaged heat pump is used to heat or cool (chill) a water and glycol mixture, and it is this heated/cooled mixture that is sent to interior fan/coil units (FCUs) to blow chilled or heated air into the interior.

This difference in architecture helps manufactures of commercial chiller systems to handle potential refrigerant leaks as simple mitigation techniques such as venting, which can be used to reduce fire risk. However, while gas leak mitigation may be simple, leaks must be detected quickly by a sensor and the system (and operator) alerted to a potentially dangerous situation as per as UL requirements (UL/IEC 60335-2-40). Moreover, any leak detector needs to have a long operating life (roughly 15 years in commercial applications), as well as not require any calibration or maintenance. These sensors need to detect a range of A2L refrigerants, not just a single gas.

The combined impact of both the EPA final rule regarding the phasedown of HFCs and UL HVAC/R safety standard, both going into effect January 1, 2025, means that even residential heat pumps and air conditioners will also require the ability to detect and mitigate leaks, at least in the external system.

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Featured Products – please refer to the Selector Guide for more options

Type	Product	Frequency	Key Features	Key Values
High-Temperature XO	SiT8918	1 to 110 MHz	• -40°C to 125°C operating temperature • 2.0 x 1.6 mm package	• Small size • High reliability • Resilient to shock, vibration and electromagnetic interference, ideal for harsh and high-current environments
Clock Buffer	SiT92184	0 Hz to 200 MHz	• -40°C to 125°C operating temperature • Low additive phase jitter 50 fs RMS • 1.8 V to 3.3 V • 4 LVCMOS output	• Low jitter • Synchronous glitch-free output enable (OE) function eliminates intermediate incorrect output clock cycles when enabling or disabling outputs

SiTime Timing Solutions

More robust in harsh environments
- 4x better vibration resistance — 0.1 ppb/*g* typical
- 20x better shock survivability

Better stability over a wide temperature range
- Up to -55 to +125°C operation
- Airflow and thermal shock resistant — 1 ppb/°C

Programmability for flexible design
- Any frequency, any stability, any voltage within a wide range
- Qualify once for multiple parts

Higher quality and reliability
- Up to 50x better reliability — 2.2 billion-hour MTBF
- Lifetime warranty

Unique features
- EMI reduction — Up to 30 dB lower
- Low power for longer battery life
- Smaller size — Down to 1.2 mm x 1.1 mm packages

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