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HVAC IoT Sensor Reference Guide

Key Sensor Types, Typical Installation Locations, Alert Triggers, and Maintenance Implications for FM Teams

How to Use This Guide

This reference is designed for facility managers and building engineers evaluating, overseeing, or working alongside IoT-based HVAC monitoring programs. Use it to understand what each sensor type measures, where it is installed on commercial HVAC equipment, what alert conditions it generates, and what those alerts mean for maintenance decisions. This is not a technical installation manual - it is a working reference that helps facility management teams ask better questions, interpret monitoring alerts more confidently, and engage more effectively with service providers about sensor-based findings.

PART 1: SENSOR TYPE PROFILES

SENSOR TYPE 1: TEMPERATURE SENSORS

Field	Details
What It Measures	Air temperature at specific points in the HVAC system - supply air, return air, refrigerant line temperatures at suction and discharge, ambient outdoor temperature, and equipment surface temperatures where relevant
Sensor Technology	Thermistors, RTDs (resistance temperature detectors), or thermocouple sensors depending on application and temperature range required
Data Output	Continuous temperature readings in °F or °C - typically updated every 30 seconds to 5 minutes depending on platform configuration

Typical Installation Locations on Commercial HVAC Equipment

Location	What It Monitors
Supply air duct - downstream of cooling coil	Temperature of conditioned air leaving the unit and entering the distribution system
Return air duct - upstream of cooling coil	Temperature of air being drawn back from the occupied space
Discharge refrigerant line - leaving compressor	Compressor discharge temperature - indicator of compressor health and head pressure conditions
Suction refrigerant line - entering compressor	Suction line temperature - used with suction pressure to calculate superheat and assess refrigerant charge
Outdoor ambient - near condenser	Ambient temperature context for interpreting all other equipment readings
Condenser coil surface	Heat rejection surface temperature - indicator of condenser fouling or airflow restriction

Alert Triggers and What They Mean

Alert Condition	Likely Cause	Maintenance Implication
Supply air temperature trending warmer over time - same ambient conditions	Dirty evaporator coil · Low refrigerant charge · Airflow restriction	Schedule inspection - efficiency declining before comfort complaint surfaces
Delta-T (supply minus return) narrowing over weeks	Reduced heat transfer efficiency - coil fouling or refrigerant issue	Service visit required - unit losing cooling capacity
Discharge temperature above baseline for current ambient	Compressor working harder than normal - head pressure elevated · Condenser fouling	Condenser inspection and cleaning - assess compressor condition
Suction line temperature higher than expected	Low refrigerant charge · Expansion valve issue	Refrigerant charge verification - check for active leak

Supply air temperature not reaching setpoint despite continuous operation	System undersized for current load · Refrigerant or coil issue · Compressor degradation	Diagnostic service visit - multiple possible causes requiring technician assessment

FM Action Reference

☐ Temperature alert received - note which sensor location generated the alert before calling service provider
☐ Confirm whether alert is a single high reading or a sustained trend - trends are more actionable than momentary spikes
☐ Check whether alert correlates with a known condition - recent high ambient temperatures, increased occupancy, recent maintenance work
☐ Provide trend data to service technician before visit - narrows diagnosis and reduces time to resolution

SENSOR TYPE 2: VIBRATION SENSORS

Field	Details
What It Measures	Mechanical vibration - acceleration, velocity, or displacement - at rotating equipment components. Identifies changes in vibration signature that indicate developing mechanical wear or imbalance
Sensor Technology	Accelerometers - typically MEMS (microelectromechanical systems) or piezoelectric sensors mounted on equipment housing
Data Output	Vibration amplitude across multiple frequency ranges - platform compares current readings against established baseline and flags deviations

Typical Installation Locations on Commercial HVAC Equipment

Location	What It Monitors
Compressor housing	Compressor mechanical condition - bearing wear, valve degradation, internal component wear
Supply fan motor bearing housing	Fan motor bearing wear - one of the most common mechanical failure points in commercial HVAC
Condenser fan motor bearing housing	Condenser fan bearing wear - critical for heat rejection capability
Blower wheel shaft bearing	Blower bearing condition - affects airflow delivery to occupied spaces
Pump bearing housing (hydronic systems)	Pump bearing wear - failure stops hydronic flow to all zones served

Alert Triggers and What They Mean

Alert Condition	Likely Cause	Maintenance Implication
Vibration amplitude increasing gradually at fan motor	Bearing wear developing - early stage	Schedule bearing inspection within 2–4 weeks - early intervention prevents motor failure
Vibration spike at compressor housing	Mechanical event - possible liquid slugging, internal wear, or compressor valve issue	Immediate service assessment - compressor failure risk elevated
Vibration with specific frequency pattern matching bearing geometry	Bearing race damage - identifiable by frequency analysis	Replace bearing before failure - frequency pattern indicates specific failure mode
Sudden vibration increase at condenser fan	Fan blade imbalance from debris or damage · Loose mounting hardware	Inspect condenser fan - clear debris, check blade condition and mounting
Vibration alert at pump bearing	Bearing wear · Cavitation · Seal degradation	Schedule pump inspection - hydronic system flow at risk if pump fails

FM Action Reference

☐ Vibration alert received - confirm which component and location generated the alert

☐ Ask service provider: is this a new alert or a trend that has been developing - trend duration affects urgency
☐ Do not reset vibration alerts without technician assessment - vibration patterns that recur indicate a real condition
☐ Provide vibration trend history to technician - baseline comparison is essential for accurate diagnosis

SENSOR TYPE 3: REFRIGERANT LEAK DETECTION SENSORS

Field	Details
What It Measures	Two complementary approaches: (1) Refrigerant gas detectors monitor air in the space around equipment for the presence of refrigerant vapor. (2) Pressure transducers monitor refrigerant pressure on the suction and discharge sides of the system to detect charge loss through pressure trends
Sensor Technology	Gas detectors: infrared or electrochemical sensors calibrated to specific refrigerant types (R-410A, R-454B, R-32, etc.) · Pressure transducers: electronic pressure sensors with wireless transmission
Data Output	Gas detectors: refrigerant concentration in ppm with threshold alerts · Pressure transducers: continuous suction and discharge pressure readings with trend analysis

Typical Installation Locations on Commercial HVAC Equipment

Location	What It Monitors
Mechanical room or equipment enclosure - near refrigerant circuit components	Refrigerant vapor presence in the air - confirms active leak
Suction line - low pressure side of refrigerant circuit	Suction pressure trending - declining trend indicates charge loss
Discharge line - high pressure side of refrigerant circuit	Discharge pressure - elevated discharge with low suction suggests refrigerant or compressor issue
Near common leak points - valve stems, flare fittings, brazed joints	Targeted leak detection at highest-probability failure locations

Alert Triggers and What They Mean

Alert Condition	Likely Cause	Maintenance Implication
Refrigerant vapor detected above threshold by gas sensor	Active refrigerant leak - charge loss in progress	Schedule leak search and repair promptly - EPA AIM Act HFC Management Rule compliance implications for covered systems
Suction pressure trending lower over weeks - same ambient conditions	Slow refrigerant charge loss · Expansion valve restriction	Refrigerant charge verification - leak search if charge is confirmed low
Suction pressure low combined with suction temperature high	Low refrigerant charge - both metrics corroborate	High-confidence charge loss indication - schedule leak repair and recharge
Discharge pressure elevated combined with suction pressure low	Low charge · Condenser issue · Compressor valve problem	Diagnostic service visit - multiple possible causes
Rapid suction pressure drop	Sudden large refrigerant loss · Major component failure	Immediate service response - system may be shutting down on low pressure safety

EPA AIM Act Compliance Note

Systems with 15 or more pounds of HFC refrigerant with GWP greater than 53 are subject to the EPA HFC Management Rule. Every time refrigerant is added to a covered system, a leak rate calculation is required. Continuous pressure monitoring provides the trend data that supports leak rate documentation and demonstrates proactive management. Confirm with your service provider that refrigerant addition events are being documented with leak rate calculations as required.

FM Action Reference

☐ Refrigerant alert received - confirm whether it is a gas detection alert (active vapor) or a pressure trend alert (charge loss developing)
☐ Gas detection alert - treat as urgent, schedule service promptly, confirm system is still operating safely
☐ Pressure trend alert - schedule refrigerant charge verification at next available service visit
☐ Confirm with service provider that any refrigerant addition is accompanied by leak rate documentation per EPA HFC Management Rule requirements

SENSOR TYPE 4: OCCUPANCY SENSORS

Field	Details
What It Measures	Presence or absence of people in a space - and in CO2-based systems, occupancy density and ventilation adequacy
Sensor Technology	Passive infrared (PIR): detects body heat and motion · CO2 sensors: measure carbon dioxide concentration as proxy for occupancy density · Ultrasonic or microwave: detect movement including stationary occupants
Data Output	PIR: binary occupied/unoccupied signal · CO2: continuous ppm reading · Combined systems: occupancy count or density estimate with timestamp

Typical Installation Locations in Commercial Buildings

Location	What It Monitors
Ceiling-mounted in open office, retail floor, waiting area	General space occupancy - triggers HVAC conditioning based on presence
Conference room - wall or ceiling mounted	Meeting room occupancy - enables demand-controlled ventilation based on actual meeting attendance
Return air duct - CO2 sensor	Average CO2 concentration of return air from served zones - proxy for overall occupancy and ventilation adequacy
Building entrance or zone transition points	Occupancy flow - building-level occupancy trends for portfolio-level energy management

Alert Triggers and What They Mean

Alert Condition	Likely Cause	Maintenance Implication
CO2 consistently above 1,000 ppm during occupied hours	Inadequate ventilation for actual occupancy · Outdoor air damper not opening correctly · High occupancy density	HVAC controls inspection - confirm outdoor air damper operation and ventilation rate
CO2 not declining during unoccupied periods	Outdoor air damper stuck open · Controls issue · Actual occupancy present outside scheduled hours	Controls inspection - confirm damper operation and scheduling
Space conditioning continuing at full output during confirmed unoccupied periods	Occupancy-based controls not functioning · Scheduling error	Controls review - energy waste occurring during unoccupied periods
Occupancy detected but HVAC not responding with appropriate conditioning	Controls integration issue · Sensor communication fault	Controls diagnostic - confirm sensor-to-HVAC communication is functioning

FM Action Reference

☐ CO2 alert above 1,000 ppm - confirm space was occupied when alert generated before scheduling service
☐ Persistent CO2 elevation - ask service provider to confirm outdoor air damper operation and ventilation rate setting
☐ Review occupancy data monthly - identify locations where HVAC is conditioning unoccupied spaces at full output
☐ Use occupancy data to validate HVAC scheduling - confirm programmed schedules reflect actual building use patterns

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SENSOR TYPE 5: AIR QUALITY SENSORS

Field	Details
What It Measures	Composition of air in occupied spaces and HVAC air streams - CO2, humidity, particulate matter (PM2.5 and PM10), volatile organic compounds (VOCs), and in some applications specific contaminants
Sensor Technology	CO2: non-dispersive infrared (NDIR) sensors · Humidity: capacitive or resistive sensors · Particulate: optical particle counters · VOC: electrochemical or photoionization detectors
Data Output	Continuous readings for each parameter - typically compared against ASHRAE 62.1 ventilation standards and OSHA/EPA indoor air quality guidelines

Typical Installation Locations in Commercial Buildings

Location	What It Monitors
Occupied zones - wall-mounted at breathing height	Space-level air quality - what occupants are actually experiencing
Supply air duct - downstream of filter	Particulate level in supply air - indicator of filter condition and bypass
Return air duct	Average air quality of return air from occupied zones
Mechanical room or equipment room	Temperature and humidity conditions affecting equipment operation
High-occupancy or regulated spaces - conference rooms, healthcare areas, food service	Compliance-critical air quality monitoring

Alert Triggers and What They Mean

Alert Condition	Likely Cause	Maintenance Implication
Particulate reading elevated in supply air	Filter loading - allowing particles to bypass · Filter media failure · Unseated filter frame	Inspect and replace filter - confirm filter frame seating
Particulate rising in occupied zone despite clean supply air	Internal source - renovation dust, occupant activity, malfunctioning equipment	Investigate source - may not be HVAC equipment issue
Humidity above 60% in occupied space	Inadequate dehumidification · Outdoor air damper issue · Cooling coil problem	HVAC inspection - elevated humidity accelerates mold growth risk
Humidity below 30% in occupied space	Over-drying · Humidification system issue · Outdoor air conditions	Review humidification controls - occupant comfort and static discharge risk
VOC spike in occupied zone	Off-gassing from new materials · Cleaning products · Adjacent space contamination	Investigate source - increase ventilation rate if safe to do so

FM Action Reference

☐ Particulate alert in supply air - check filter status before scheduling service call - may be FM-addressable
☐ Humidity alert - confirm whether alert is a trend or a momentary condition before scheduling service
☐ Use air quality data to support filter replacement decisions - replace based on particulate readings, not calendar alone
☐ Retain air quality monitoring records - relevant for OSHA compliance documentation and lease compliance in regulated occupancies

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PART 2: SENSOR ALERT PRIORITY REFERENCE

Use this to calibrate urgency when multiple alerts are active simultaneously.

Alert Type	Urgency Level	Typical Response Window	Who Responds
Refrigerant gas detection - active vapor	Immediate	Same day	Licensed HVAC technician
Compressor vibration spike	Immediate	Same day	Licensed HVAC technician
Discharge temperature - sudden significant rise	Immediate	Same day	Licensed HVAC technician
Suction pressure - rapid drop	Immediate	Same day	Licensed HVAC technician
Fan motor vibration - trend alert	Urgent	Within 1 week	Licensed HVAC technician
Suction pressure - gradual declining trend	Urgent	Within 1 week	Licensed HVAC technician
Delta-T narrowing trend	Urgent	Within 2 weeks	Licensed HVAC technician
Supply air temperature - gradual upward trend	Scheduled	Next planned visit	Licensed HVAC technician
CO2 above 1,000 ppm - persistent	Scheduled	Within 2 weeks	FM check first - then technician if controls issue confirmed
Particulate elevated in supply air	Scheduled	Within 1 week	FM - check and replace filter
Humidity out of range - gradual	Scheduled	Within 2 weeks	Licensed HVAC technician
Occupancy-based conditioning not responding	Scheduled	Within 2 weeks	Controls technician