WxS882C-4030Z1

LoRaWAN AI Restroom Intelligent Sensor

Model Code：

WxS882C-4030Z1：LoRaWAN Edge Computing Terminal（Fully compatible with Polysense WxS8800 hardware platform, enclosure, power supply, LoRaWAN stack and cloud system）
Core Positioning：Edge AI Multi-Spectral Fusion Sensing Terminal for Smart Public Restroom
Core Technology：AI powered Dual-spectrum passive thermal imaging + high-precision millimeter wave 4D point cloud joint edge computing

Product Overview & Core Value Proposition

AI Restroom Intelligent Sensor (WxS882C-4030Z1 LoRaWAN wireless version) is a ceiling-mounted edge AI all-in-one perception terminal built on Polysense WxS8800 software-defined IoT hardware platform.
The product adopts self-developed **dual-spectrum edge AI fusion algorithm**, integrating passive long-wave thermal spectrum perception and high-resolution 4D millimeter wave point cloud radar perception, all target recognition, behavior analysis, multi-dimensional cross-verification computing completed locally on the terminal edge chip, no cloud real-time computing reliance, ultra-low delay, ultra-low false alarm rate.
Break the industry pain point of traditional restroom sensors with single detection dimension, scattered equipment, high misjudgment rate and fragmented data. Single terminal integrates safety early warning, property operation digitalization, space energy-saving automatic control three major business systems, covering all core perception demands of commercial restrooms.
Zero image camera design, only spectrum temperature field and radar point cloud data output, completely avoid face collection and privacy leakage risks, fully meet public space privacy supervision standards.
Compatible with Polysense full series gateways, PolySuite iView cloud platform, unified enclosure structure, power supply module, MPI multi-purpose interface, remote OTA upgrade system, seamless access to existing Polysense IoT deployment projects.

Core Product Highlights (Edge AI Fusion Exclusive Advantages)

- Self-Developed Dual-Spectrum Edge AI Fusion Core Technology
  Dual independent perception channels of thermal temperature field & 4D millimeter wave point cloud, edge real-time coordinate mapping, space-time synchronous cross-verification algorithm. All behavior analysis runs on local MCU, offline normal operation, false alarm rate reduced over 90% compared with single-dimensional sensing equipment.
- Six-in-One Native Edge AI Perception Capability, One Terminal Replaces Multiple Traditional Sensors

Integrate ground water seepage early warning, human fall emergency rescue, regional human presence linkage, bidirectional passenger flow statistical analysis, real-time space occupancy counting, cleaning behavior intelligent identification six core capabilities, eliminate repeated equipment deployment, reduce construction and maintenance costs.

- Software-Defined Edge Computing Platform, Full Remote Intelligent Tuning
  Based on iEdge4.0 embedded edge operating system, all AI algorithm thresholds, detection zoning, statistical rules, upload strategies support remote OTA configuration; full machine differential FOTA firmware iteration, edge perception algorithm can be upgraded remotely without on-site disassembly.
- Ultra-Low Power Native Edge Computing Chip Architecture
  Adopt industrial-grade ultra-low power Sub-GHz edge main control chip, independent timing wake-up computing scheduling architecture, deep STOP2 sleep mode static current less than 1.5μA, lithium battery power supply can achieve 5~10 years long-term stable operation.
- Full Hardware Security Encryption System (Consistent with WxS8800 Platform Standard)
  Built-in hardware cryptographic engine HCE, support AES-128/192/256 full link data encryption, ECC public key accelerator, Flash read protection mechanism, LoRaWAN communication keys stored in encrypted secure area to prevent data tampering and leakage.
- Multi-Channel Intelligent Output Linkage Control
  Dual-channel open-drain event trigger output + 3.3V auxiliary power interface, edge AI identification events can directly linkage exhaust fans, lighting, sound-light alarms, relays, realize autonomous space control without gateway intervention.
- Zero Privacy Risk Passive Sensing Scheme
  No visible light image acquisition, only non-contact temperature field spectrum and invisible millimeter wave point cloud data, no human face, portrait information storage, fully compliant with public place privacy management laws and regulations.
- 100% Compatible with Polysense WxS8800 Ecosystem
  Unified IP67 industrial enclosure, full series PSB power supply modules, MPI multi-purpose universal interface, LoRaWAN 1.0.4 protocol stack, PC configuration tool, online payload decoder, seamlessly dock existing Polysense IoT projects without secondary development adaptation.

Competitive Differentiation vs Traditional Single-Function Restroom Sensors

Comparison Dimension	Traditional Contact Water Leak Sensor	Single PIR Infrared Human Sensor	Single-Dimension Millimeter Wave Radar	This Product Edge AI Dual-Spectrum Fusion Terminal
Detection	Single-point	Single moving	Single radar point	Dual-spectrum thermal + 4D radar

Dimension	contact water sensing only	infrared light perception only	cloud, lack temperature spectrum verification	edge joint calculation, two dimensions cross verify all targets
Water Seepage Warning	Need wiring contact induction, small coverage, human body easy to trigger false alarm	No water temperature field detection ability, cannot identify accumulated water area	Cannot distinguish cold and hot ground, no water leakage early warning logic	Non-contact full ground temperature field scanning, edge algorithm automatically filter human body interference, recognize micro slow seepage without wiring
Fall Recognition	Not supported	Cannot distinguish squat, bend over and fall, static human body lost quickly	Single target tracking only, easy to misjudge mop, trash as fallen person	Multi-target simultaneous tracking + thermal living body feature verification, edge filter non-human low obstacles, fall recognition accuracy ≥90%
Long-Static Human Capture	Not supported	Human body disappears after static for 30s, easy blind spot loss	Only single human body tracked, multi-person occlusion failure	Radar micro-breathing weak motion capture + thermal human contour lock, human body static for half an hour without loss
Passenger Flow Statistics	Not supported	No multi-target counting capability	Cannot distinguish human body and obstacles, unidirectional counting only	Custom virtual boundary edge algorithm, dual-spectrum filter non-human interference, accurate bidirectional in-out cumulative statistics
Cleaning Behavior Identification	Not supported	Not supported	Only rough motion judgment, cannot distinguish mopping	Edge AI extracts low-temperature continuous trajectory features, combined with human body motion constraint, automatic record cleaning time and area
Offline Operation Ability	Wired linkage only, offline no analysis	Local simple switch signal output	Single radar offline rough judgment only	Full AI edge computing logic runs locally, all functions work normally offline without gateway/cloud
Privacy Safety	No image but single function, limited scene	Visible light interference risk, light failure invalid	No image but single dimension misjudgment serious	Zero camera dual passive sensing, no portrait data, fully privacy compliant

Deployment Cost	Need multiple sets of equipment superimposed wiring	Multiple sensors required to cover all functions	Separate water leak sensor matching required	Single terminal covers all six core functions, reduce hardware and construction cost by over 60%

Major Edge AI Native Perception Capabilities (Full Working Mechanism & Output Index)

All perception algorithms run locally on edge MCU, unified timing synchronization dual-spectrum data collection, space-time coordinate matching fusion calculation, independent event judgment logic.

Edge AI Ground Water Seepage & Accumulated Water Early Warning (Core Operation & Maintenance Function ★★★★★)

Edge Computing Working Principle

- Passive long-wave thermal spectrum full ground scanning, real-time output global ground temperature field distribution data, edge AI segmentation algorithm automatically extract continuous low-temperature areas formed by water evaporation;
- Built-in self-adaptive environment background update model, automatically offset temperature drift caused by bathroom heater, day and night temperature change, eliminate long-term environmental interference;
- Multi-frame timing stability filtering logic: only continuous multi-frame stable low-temperature areas are marked as suspected water seepage, filter instantaneous water mist, cold air instantaneous temperature drop single-frame interference;
- 4D millimeter wave point cloud space coordinate matching cross-verification: edge algorithm compares the position of low-temperature area and human body tracking target, if overlapping area exists, automatically judge as human leg cold area interference and shield alarm;
- After dual-spectrum joint confirmation, trigger high-priority water leakage early warning event upload.

Core Output Data

Water leakage alarm event flag, water accumulation area proportion, ground occurrence coordinate, continuous low-temperature duration value

Detection Performance Index

Minimum recognizable micro seepage area: 0.06 ㎡; anti-interference: automatically filter shower water mist, heater hot air instantaneous temperature change

Edge AI Human Fall Emergency Recognition (Core Safety Function ★★★★★)

Edge Computing Working Principle

- 4D high-resolution millimeter wave radar outputs human vertical height, micro-motion amplitude multi-dimensional point cloud data, edge primary judgment: human body height continuously lower than safety threshold + long-term independent micro-motion disappearance, mark suspected fall target;
- Dual-spectrum coordinate mapping synchronization: map the suspected fall ground coordinate to thermal temperature field picture, edge AI contour extraction algorithm identifies 30~37℃ human living body heat source characteristic area;
- Joint verification rule: only suspected fall target exists and corresponding space has complete human thermal contour, confirm real fall event, push high-priority confirmed alarm data;
- Automatically filter static low obstacles such as mop, trash can, low sanitary ware without living body heat source to avoid false emergency alarm.

Core Output Data

Fall emergency alarm flag, fallen human body ground coordinate, continuous static duration of target

Recognition Performance Index

Dual-spectrum fusion recognition accuracy ≥90%, false alarm rate lower than 5% under complex bathroom environment

Edge AI Zonal Human Presence Intelligent Linkage (Energy Saving Core Function ★★★★★)

Edge Computing Working Principle

- Millimeter wave weak motion edge algorithm capture human thoracic breathing micro-vibration signal, solve the problem of static human body loss of single infrared sensor;
- Thermal spectrum picture pre-divided shower area, toilet dry area, entrance three independent perception partitions, edge AI automatically lock human body belonging area;

- Dual-spectrum or logic human presence judgment: either radar captures human micro-motion or thermal extracts human heat source, judge space occupied;
- Double-spectrum continuous no-human 5 cycle lock judgment, trigger 3-minute delay timing, edge local drive OD control output automatically turn off partition lighting and exhaust fan, realize autonomous energy-saving control without cloud instruction.

Core Output Data

Global space human presence flag, independent partition occupancy state signal, event trigger linkage switch control signal

Edge AI Bidirectional Passenger Flow Statistical Analysis (Operation Management Function ★★★★)

Edge Computing Working Principle

- User-definable virtual detection boundary set via remote OTA, edge real-time track human body cross-boundary motion vector, distinguish entering / leaving two directions and cumulative count separately;
- Built-in human body wandering filtering algorithm, automatically avoid repeated counting caused by human pacing back and forth near the door;
- Thermal spectrum feature secondary filtering: edge AI judge whether the cross-boundary target has human heat source contour, eliminate false counting triggered by mop, cart, metal cabinet reflection interference;
- RTC timing trigger hourly cumulative passenger flow statistics data regular upload, support daily total flow data summary output.

Core Output Data

Hourly inbound / outbound passenger flow, daily total passenger flow cumulative value

Application Limitation Note

Cannot penetrate solid compartment wall, only realize public activity area passenger flow statistics

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Edge AI Real-Time Space Occupancy Counting (Space Scheduling Function ★★★★)

Edge Computing Working Principle

- Millimeter wave multi-target edge tracking algorithm output real-time effective human target number within coverage space;
- Thermal spectrum contour statistical calibration: edge AI extract independent human heat source quantity, adopt self-weight fusion algorithm to correct target overlapping, occlusion counting error;
- Real-time output weighted fusion space occupancy number, when the maximum stable tracking target upper limit is exceeded, automatically mark space crowded state flag.

Core Output Data

Real-time space occupancy number (0~8), space crowded state flag

Application Limitation Note

Cannot penetrate compartment wall, statistical data only for public activity area

Edge AI Cleaning Mopping Behavior Intelligent Identification (Property Digital Function ★★★★)

Edge Computing Working Principle

- Thermal spectrum edge feature extraction: identify long strip continuous low-temperature trajectory formed by cold mop moving on ground, lock motion speed threshold range unique to mopping behavior;
- Millimeter wave human body constraint judgment: only single human target exists in space, and human motion trajectory is highly overlapped with low-temperature strip area;
- Edge time-series continuous judgment: distinguish fixed static cold water area (judged as water seepage) and moving low-temperature trajectory (judged as cleaning work);
- Automatically record cleaning start timestamp, end timestamp, working partition, output cleaning operation record data for property attendance assessment.

Core Output Data

Cleaning start / end event flag, single cleaning duration, cleaning working partition ID

Hardware Architecture & Edge Computing Platform

Edge Computing Platform Core Advantages

- iEdge4.0 dedicated edge operating system, independent algorithm scheduling core, separate perception data processing and communication task scheduling;
- All AI fusion algorithms solidified local firmware, offline full-function operation without gateway/cloud real-time interaction;
- Unified 500ms fixed computing cycle, low-power timing wake-up architecture, stop2 deep sleep between computing cycles;
- Support multi-dimensional algorithm parameter remote OTA dynamic modification, no firmware re-flashing required for scene adaptation.

Specifications

Parameters	Value
Smart Terminal	
Interfaces	MPI Interfaces-Any Mixture of Following: Analog input: (AIN(0-20mA) , PT100 , VIN(0-10V/0-3.3V) Digital: Switch input Series: Unibus, I2C， SPI*1, UART(3.3V TTL), RS485

	Control interface: OD & PWR
Data Report Mode	Cross-threshold report, plus periodic report (the threshold and the periodic report cycle are both user-configurable)
Data Sampling	Support intensive data sampling and averaging to improve data accuracy
Wireless	
LoRaWan Global Bandes	LoRaWan Alliance Certified Stack V1.0.4 (Class A/C) AS923 (AS923-1, AS923-2, AS923-3, AS923-4), AU915, CN470, CN779, EU433, EU868, IN865, KR920, RU864, US915
LoRa Chip	Integrated SX1262x RF LoRa/(G)FSK/(G)MSK/BPSK
Maximum Link Budget	168 dB
Rx Sensitivity	-148dBm (SF12/125kHz/~293bps)
Distance	Up to 5km (NLOS); 18km (LOS)
Antenna	Integrated or external SMA (½ wavelength whip)
Security	
Data Encryption	HCE enabled AES-128/192/256
Mechanical	
Dimension	WxS8800 4.0 Enclosure (ϕ140x82x40mm, IP68)
IP rating	IP67 & IP30 (gas enclosure)
Operating Temperature	-40℃ to +85℃
Total Weight	150~250 g
Electrical	
Power Supply	5VDC
Power Type	
Current Consumption Index	
Average Edge Computing Operating Current	150mA
LoRa Transmit Peak Current	Max 300mA
STOP2 Deep Sleep Static Current	<2μA
Compliance/Certification	
LoRa Alliance	LoRaWAN 1.0.4 Class A/C
Regultory	FCC(America): 2AO7W-WXS8000, IC(Canada): 23701-WXS8000 CE(European Union)： B1810246 ROHS(European Union): R2BJ180927F0664E

Data Upload Strategy & Standard LoRaWAN Payload Definition

Three Classified Upload Mechanisms Controlled by Edge OS

- Periodic Cyclic Upload (Fixed 500ms Edge Computing Cycle)
  Upload real-time space occupancy number, global and zonal human presence state data;

- Event Trigger Instant High-Priority Upload
  Water seepage early warning, human fall emergency alarm, cleaning start/end record, push data immediately once edge AI confirms event;
- RTC Timing Regular Upload
  Hourly bidirectional passenger flow cumulative statistical data, daily total flow summary data uploaded at whole hour.

Fixed 16-Byte Standard Binary Uplink Payload (Unified Polysense Decoding Standard)

Byte Offset	Field Name	Data Type Description
Byte 0	Upload Type Identification Code	uint8_t:0=Periodic Data /1=Water Leak Alarm /2=Fall Emergency Alarm /3=Cleaning Record /4=Hourly Passenger Flow Statistic
Byte 1	Real-Time Space Occupancy Count	uint8_t (0~8)
Byte 2	Water Accumulation Alarm Flag	uint8_t:0=None /1=Water Seepage Confirmed
Byte 3	Fall Emergency Alarm Flag	uint8_t:0=None /1=Fall Event Triggered
Byte 4~5	Daily Cumulative Inbound Passenger Flow	uint16_t Big-Endian
Byte 6~7	Daily Cumulative Outbound Passenger Flow	uint16_t Big-Endian
Byte 8 ~ 15	Reserved Extended Field	Store cleaning duration, partition ID, equipment fault diagnosis code and other extended data

Official Payload Decoding Resources

- ConfigurationTool Download:
  - https://OTA.polysense.online/wincc/ConfigurationTool.rar
  - https://Github.com/Polysense/ConfigurationTool
- Payload Online Decoder:
  - https://www.polysense.online/decode/index.html
- Payload Online Documentations：
  - https://github.com/Polysense/SensorDecoders

Remote OTA Intelligent Management & Edge Algorithm Iteration

- OTA Downlink Remote Configuration Function
  Support remote modification of all edge AI core parameters: perception sensitivity, virtual detection boundary coordinate, temperature threshold, upload cycle, LoRaWAN communication parameters, zoning division rules; no on-site disassembly required.
- FOTA Full Machine Differential Firmware Upgrade
  Incremental firmware upgrade package transmission, breakpoint resume transmission, original configuration parameters automatically retained after upgrade, support edge AI fusion algorithm remote iteration update.
- Local PC Offline Configuration Tool
  Download Address: https://OTA.polysense.online/wincc/ConfigurationTool.rar
  Realize local equipment parameter calibration, firmware burning, algorithm debugging.

Installation Specification & Target Application Scenarios

Standard Installation Requirements

- Mount Height Range: 2.4m ~ 2.8m ceiling central position of restroom;
- Obstacle Avoidance Requirement: Keep away from large metal beams, heater air outlets to prevent signal shielding interference;
- Virtual Detection Boundary Adaptation: Default boundary parameters adapted to standard restroom door width, adjustable remotely via OTA for special-size doors.

Applicable Scenarios

Recommended Deployment: Hospital ward bathrooms, pension institution toilets, office building public restrooms, government office washrooms, scenic area public toilets, industrial park staff restrooms

Product Image

- Dimension: (ϕ140x82x40mm, IP68)
- The device can be installed on any flat, solid surface:
- Self-tapping screws (size: M4x25mm)