

## **Real Time Monitoring of Public Safety Passive DAS Infrastructure Through SMART Passives**



### **Abstract**

What are you missing by not monitoring your passive distributed antenna system (DAS)? With Microlab's patent-pending System Monitor Alarm Report Technology or SMART passives, authorities having jurisdiction (AHJ), building owners, and system integrators are now able to monitor the coaxial cabling and antennas within an Emergency Responder Radio Communications System's passive DAS in real-time for catastrophic failures. Unlike cellular radiotelephone networks, ERRCS has rigid RF coverage and audio quality requirements to meet the needs of first responders. Critical areas of a building require 99% coverage with negligible noise and distortion. When the integrity of the DAS cabling and antennas is compromised, there will be a negative impact on radio coverage. SMART Gateway and SMART Coupler are innovative solutions combining an embedded Internet of Things (IoT) diagnostics circuit board with a specialized broadband tapper or coupler. With an Internet browser connected to the SMART Gateway, a GUI is used to observe the VSWR and DAS integrity deep into a building. Other applications include mines, rail, and vehicular tunnels. SMART passives will ensure the reliability of your public safety DAS.

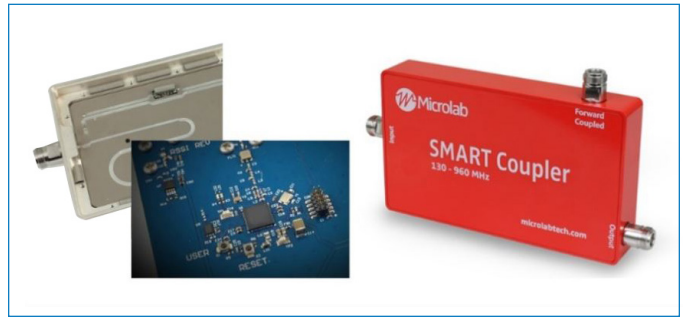
## SMART Gateway and SMART Coupler

Microlab's SMART Gateway and SMART Coupler uses a specially developed broadband passive coupler for 130 – 960 MHz that is embedded with an innovative Microlab, Industrial Internet of Things (I-IoT) active circuit board for diagnostics and communications. A building's distributed antenna system or DAS network is installed with SMART Coupler nodes that are complemented by a SMART Gateway at the head-end's main RF source. SMART passives are public safety band and technology agnostic.

The SMART Coupler was designed to readily replace the required and common passive DAS tappers or couplers. SMART Coupler may be ordered with 6, 10, 15, and 20 dB coupled port values.

The head-end's main RF source for a Public Safety DAS may be a building's dedicated repeater, e.g. FDNY's ARCS or a bi-directional amplifier (BDA) boosting off air, wide area public safety coverage throughout a building via the DAS. Conventional two-way, analog, push-to-talk, digital, or trunked radio systems are connected through the SMART Gateway while maintaining the integrity of the original radio transmission. There is no active signal processing. Just diagnostics and monitoring combined with the radio traffic for distribution over the DAS.

Emergency communications radio traffic remains intact if power to the SMART Gateway fails, however, there will only be a loss of system monitoring until power is restored. If a SMART Coupler were to fail, radio traffic will continue to pass through the DAS.



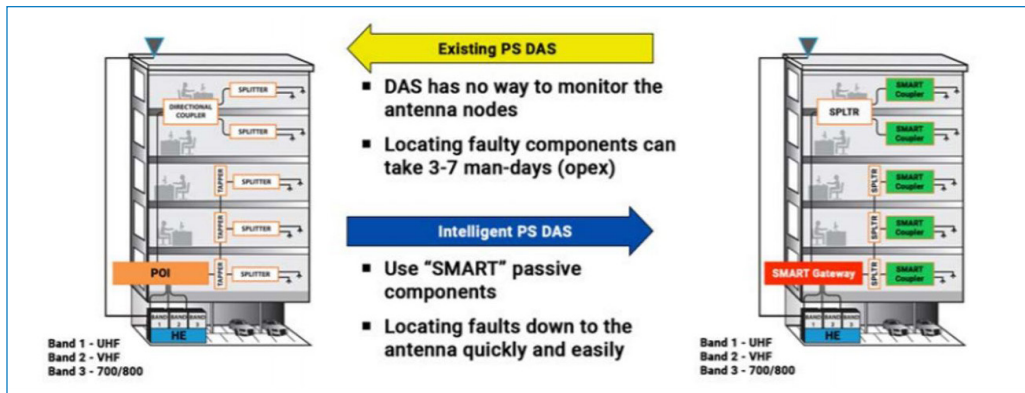
The Gateway injects DC power into the passive DAS coaxial RF transmission lines to power the active portion of SMART Coupler. All diagnostics and communications between the Couplers and Gateway take place over the coaxial cabling. SMART Couplers do not require local network or power connections, i.e. Power over Ethernet PoE, within a building's ceiling, plenum, risers, or distribution paths.

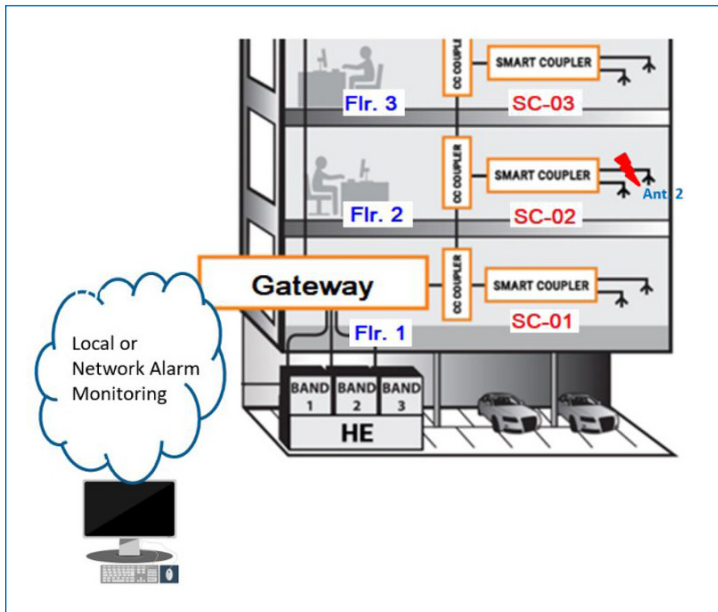
Based on current fire and building codes, passive DAS coverage networks used in a building's Emergency Services Communications System are not monitored for catastrophic failure.

A catastrophic failure would be classified as a cut or damaged coaxial transmission line or disconnected antennas. The result would be an RF transmission line with a short or open circuit condition. An open or short circuit reduces the transfer of radio frequency (RF) energy to the antennas, creating poor to no radio coverage in portions or through the entire building.

## ERRCS DAS With and Without SMART passive Monitoring

The key idea is to equip each DAS with a Microlab SMART passives diagnostic system for monitoring and tracking the incident and reflected power. In other words, the voltage standing wave ratio or VSWR throughout each branch of a DAS. Based on the gateway's supervisory signaling, an abnormal VSWR alarm would be generated in the event of an open or short circuit.





Example: Catastrophic loss of radio coverage, 2nd floor

- DAS cabling malfunction on 2nd floor
- SMART Coupler SC-02 detects a Short or Open circuit feeding Antenna 2
- SMART Coupler SC-02 reports the alarm condition to the SMART Gateway
- SMART Gateway through SNMP via TCP/IP sends specific notifications into the cloud
- SMART Gateway's front panel alarm may connect to the fire alarm panel for notification

With SMART Coupler a building's passive DAS is continuously monitored. An alarm will be reported at the SMART Gateway if a malfunction is detected.

## How does SMART Coupler work?

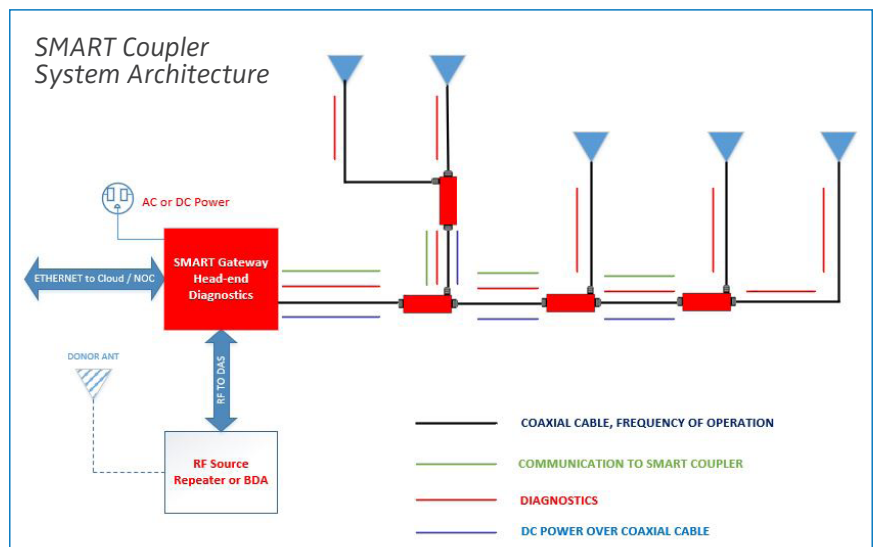
SMART Couplers report VSWR at each port based on a calibrated CW tone generated by the SMART Gateway. The RF test signal or CW tone and communications occur outside of the active public safety spectrum, within the Industrial Scientific Medical (ISM) Band 902-928 MHz.

SMART Couplers may be polled i.e. pinged by the SMART Gateway at set intervals to determine transmission line and antenna integrity and is always on monitoring for catastrophic failure.

If the public safety DAS distributes a trunked radio system such as P25 or Trans European Trunked Radio (TETRA), the CW tone in the SMART Gateway is turned off. The VSWR measurements at each SMART Coupler port are made through the Primary Control Channel's downlink signal.

By comparing timestamped VSWR measurements at the SMART Gateway from each SMART Coupler, the SMART passives system continuously monitors for catastrophic malfunction. The SMART Gateway then communicates through SNMP a part of TCP/IP alarm notifications. Alarms may be customized and routed to system integrators, building owners, or public safety authorities through e-mail, text, etc. SMART Gateway has a normally closed, dry contact terminal pair to connect the SMART Gateway to the fire alarm panel.

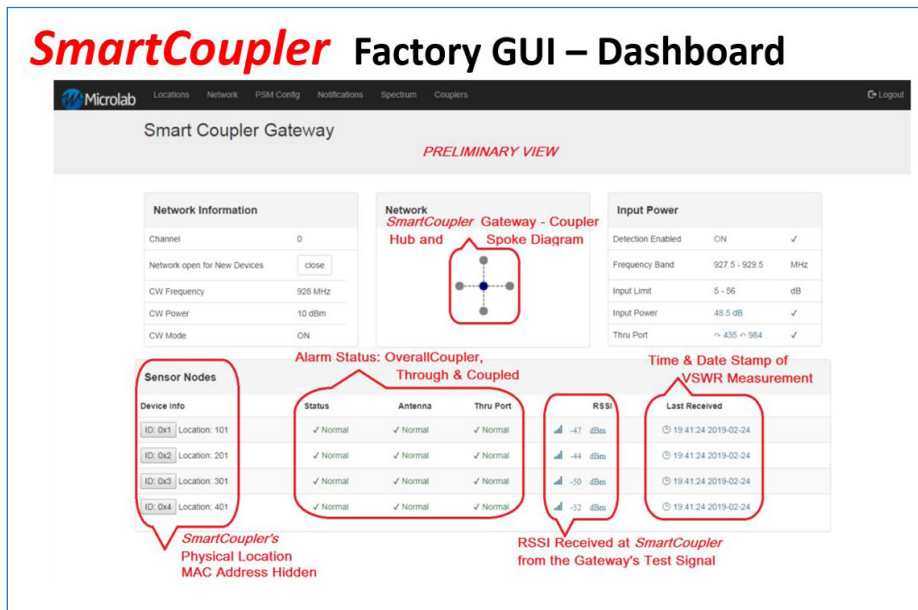
SMART Couplers are powered, communicate, and provide diagnostics with the head-end's SMART Gateway through the DAS RF coaxial cabling. SMART Couplers do not require local AC/DC power or Ethernet connections at each location within a building. SMART Coupler was designed to replace the required tappers and couplers that are typical in passive DAS networks.



The color-coded diagram demonstrates the flow of radio traffic, ISM band diagnostics and communications to and from each coupler, ISM band CW tone, and DC power over the coaxial cabling network.

## Configuring SMART Passives and potential Network Operations Center i.e. NOC

A computer with an up to date browser connects to the SMART Gateway whereby all diagnostics and alarms are readily viewed. In addition to local monitoring, the gateway node enables remote monitoring through SNMP via TCP/IP. The convenient GUI dashboard will be used to generate e-mail, SMS notification if an alarm is triggered. The remote real-time monitoring readily enables public safety system integrators to offer cost-effective service level agreements (SLA) to their customers and Authorities Having Jurisdiction (AHJ). The proactive monitoring provided through SMART Coupler speeds up the troubleshooting and restoration of confirmed outages, alleviating costly truck rolls and technicians searching through an entire building looking for the root cause of the DAS fault.



Factory SMART Gateway GUI

This is a high-level view of the SMART Gateway's Graphical User Interface (GUI). There are multiple layers of detailed diagnostic information through the GUI. The media access control address i.e. MAC Address of each SMART Coupler's location may be recorded on the DAS network's as built drawings for easy trouble shooting and ease of targeting outages. SMART Coupler is monitoring for faults at the coupled and through ports. This will enable field personnel to quickly repair or replace damaged RF coaxial cabling and antennas. Overall outage time is reduced, and public safety radio coverage remains intact. Without SMART passives, DAS failures would not be recognized without first responders noticing poor coverage during an incident or the AHJ's annual ERRCS proof of performance.

## Summary

Unlike commercial wireless cellular systems, conventional two-way, push-to-talk, public safety radio systems do not have constant radio traffic. These critical communications systems are used only during an emergency event. If passive RF cabling and the associated antennas fail, first responder radio coverage will be compromised. Emergency Responder Radio Coverage Systems require robust signal strength (RSSI) and delivered audio quality (DAQ). ERRCS radio coverage is where people are and are not typically located in a building. Microlab's 130 – 960 MHz SMART passives or tappers with embedded IoT technology enable real-time, VSWR based continuous monitoring of the RF coaxial cabling and antennas within a Public Safety DAS for catastrophic failure. SMART Gateway's diagnostics, signaling, and DC power for the SMART Couplers, all pass through the DAS RF coaxial cabling. There is no need for AC or DC power at each coupler or Ethernet connection. A common web browser may be used to log in to the SMART Gateway's GUI or dashboard for real-time alarm monitoring and system configuration. The Gateway's normally closed, dry contact, general alarm terminal may be connected to a fire alarm panel.

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