



RPMA Access Point Deployment Guide

System Release 3.0

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Revision History

Revision	Release Date	Change Description
A	November 2016	Initial release.
B	January 2017	IP 66 RJ-45 external plug, Added details on Diplexer deployment, consolidated POE voltage from 72 to 58VDC, added grounding lug for RPMAAP10x models
C	February 2017	Added Taiwan Clarifications.
D	February 2017	Added FCC clarification

1 Introduction

This document provides network planning, installation, configuration and preventive maintenance information for the Access Point as a part of an RPMA network. There are multiple configurations for the Access Point (AP) depending upon the country in which it will be used. This document also serves as a reference for AP models ULPAP110, ULPAPE110 and RPMAAP10, RPMAAP10E. For specific AP details, refer to:

- ULPAP110: *Access Point Product Specification (014-0030-00)*.
- RPMAAP10: *RPMA Access Point Product Specification (014-0088-00)*



Figure 1. RPMA Access Points (ULPAP110 Left, RPMAAP10 Right)

Both the ULPAPx110 and the RPMAAP10x are functionally equivalent. The major distinguishing characteristic that can help identify the correct model number is the location of the RJ-45 POE (Power over Ethernet) connector:

Models ULPAPx110:

- ULPAPx110, the POE connector is on the right side of the enclosure above GPS antenna connector
- The ULPAP110 model is equipped with a Cavity Filter and is certified for FCC/IC markets
- The ULPAPE110 model has no Cavity filter and is nominally intended for non-FCC regulatory domains such as ETSI.
- The ULPAPx110 is not 802.3AF or 802.3AT compliant and requires a passive injector.

Models RPMAAP10x:

- RPMAAP10x, the POE connector is **centered** and offset between antenna connectors
- The RPMAAP10x models also only include one LED light to the left of the RJ-45 POE port as well.
- The RPMAAP10 model is equipped with a Cavity Filter and is certified for FCC/IC markets
- The RPMAAP10E model has no Cavity filter and is nominally intended for non-FCC regulatory domains such as ETSI.

- The RPMAAP10x is 802.3AF or 802.3AT compliant and can be powered by a compatible switch or a passive PoE injector

For deployment/operation in a specific Country or Regulatory domain, please contact your Ingenu Support person for the appropriate model of AccessPoint.

This document is compatible with the software version CS3.o.x

1.1 Overview

The AP is the core component of an RPMA network and RPMA base station solutions. It provides the functionality of an RF transceiver, a data processor, and a data router. The RF transceiver operates in the unlicensed 2.4 GHz ISM band on one of thirty eight 1 MHz channels (and up to forty one channels in some regulatory domains). The AP utilizes Time Division Duplexing and Direct Sequence Spread Spectrum with Ingenu's proprietary Random Phase Multiple Access (RPMA) modulation technique. The maximum transmit power of the AP's transceiver (at the antenna connector) is +30 dBm (1 Watt). The maximum permissible transmit power is determined by the regulatory requirements of the country where the AP will be installed.

GPS is used for timing and synchronization.

All endpoint devices designed with RPMA technology communicate directly with RPMA base stations installed on existing communication towers, rooftops, streetlights, substations, and other elevated sites to collect data or control the endpoint devices. Base station networks are designed and deployed to meet coverage, capacity, and redundancy objectives.

APs are weatherproof with an IP 66 rating and can be installed indoors or outdoors. Ingenu offers various base station configurations to support a wide variety of installations. Section 5.3 defines these pre-configured base station packages. This document focuses on the installation, configuration, and maintenance of the Access Point. For base station-specific information, see the installation manuals for each of the base stations.

An AP installation requires:

- A 10/100 IP-over-Ethernet connection with 350 Kbps minimum throughput for backhaul to the RPMA gateway
- A Power-over-Ethernet (PoE) injector that combines power and data over the same Ethernet cable.
 - The ULPAPx110 requires a passive PoE injector and cannot be powered directly from most switches. **This AP is not 802.3AF or 802.3AT compliant.**
 - The RPMAAP10x is 802.3AF or 802.3AT compliant and can be powered by a compatible switch or a passive PoE injector.
- An AC or DC power source capable of supplying 48 VDC at a minimum of 25 Watts to the PoE injector. For very long PoE cables, a 56 VDC power supply is recommended.
- A GPS antenna and cable
- An AP antenna and cable

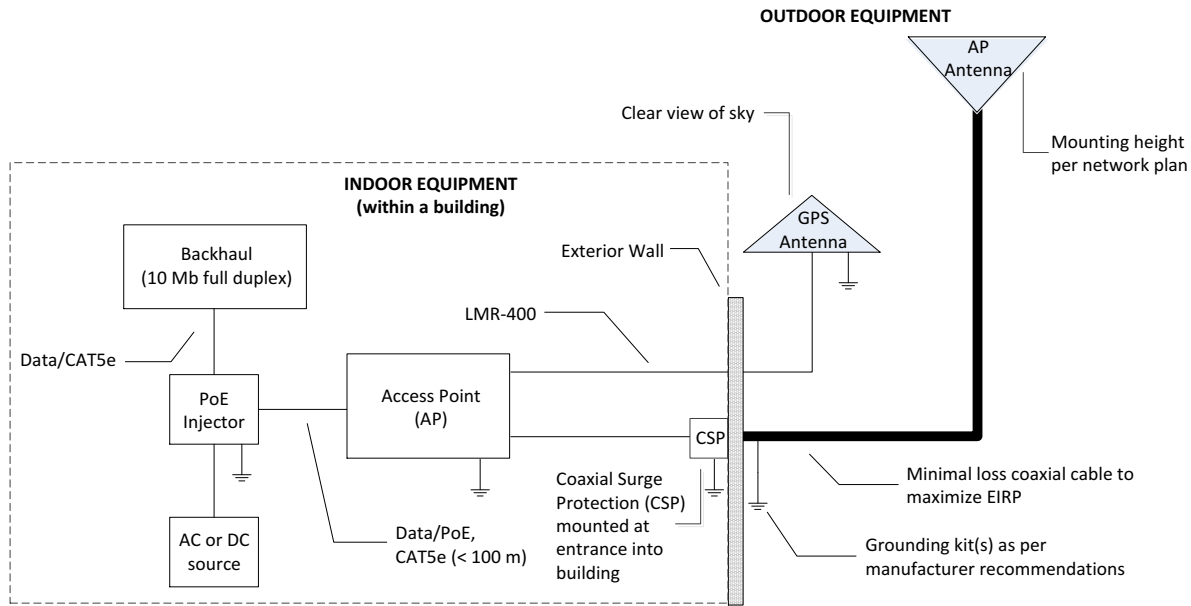


Figure 2. High Level Diagram for Indoor Site Installation of AP and Equipment

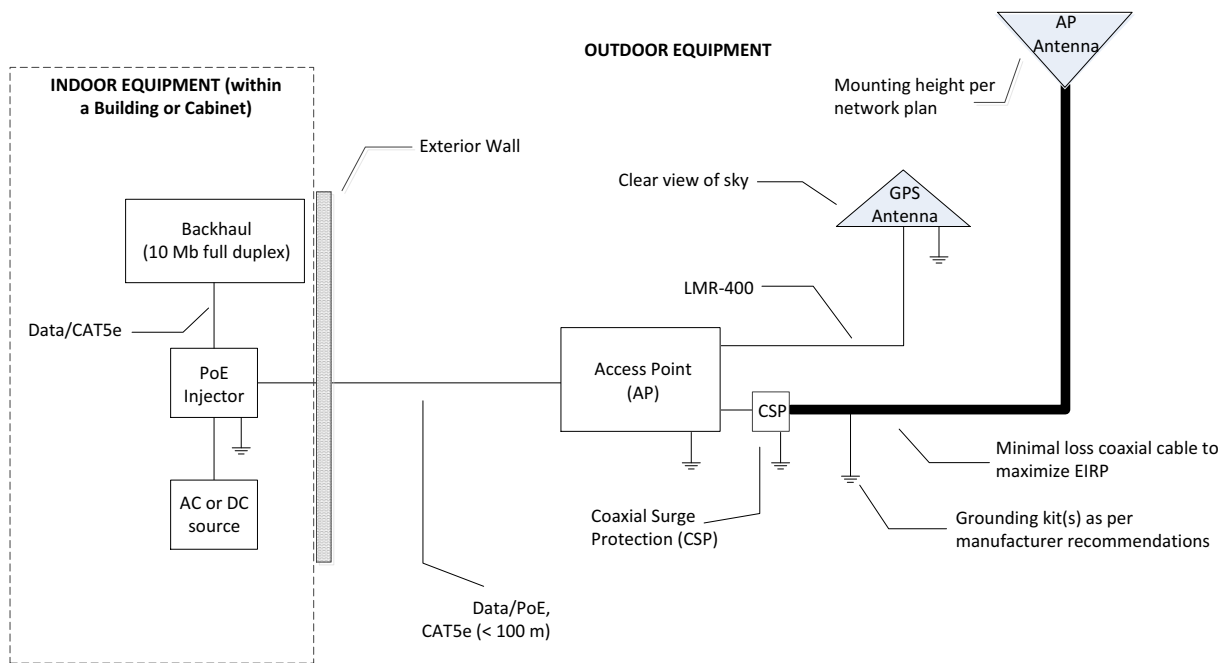


Figure 3. High Level Diagram for Outdoor Site Installation of AP and Equipment

NOTE: The AP does not contain any user-serviceable components. Opening the AP will void the product warranty.

For questions or technical assistance, contact Ingenu at support@ingenu.com.

1.2 Referenced Documents

The following document provides additional details about the AP.

- **Access Point Product Specification (014-0030-00)**
Provides detail about product specifications (ULPAP10 and ULPAP10E), characteristics, and requirements for the AP.
- **RPMA Access Point Product Specification (014-0088-00)**
Provides detail about product specifications (RPMAAP10 and RPMAAP10E), characteristics, and requirements for the AP.
- **EMS Operator Guide (010-0107-00)**
Provides instruction on using the Element Management System (EMS) to manage and monitor the Access Point. This document should be used for Access Point day-to-day operations and monitoring.

2 Network Planning / Configuration Considerations

Prior to the installation of an AP at a new location, a number of network design and configuration decisions must be addressed. This chapter provides an overview of these decisions which should be reflected in the AP Installation Configuration Worksheet provided in [Appendix B](#). Detailed network planning and configuration is outside the scope of this document.

2.1 Network Planning

Network planning is critical to a successful AP installation and the reliable operation of an RPMA network. The following issues must be addressed in the network planning and design process.

- Determine the maximum permissible Effective Radiated Power, ERP, based on regulatory requirements for the country where the AP will be installed (e.g., ETSI, FCC, China). Some countries may also have specific antenna requirements. ERP is determined by the AP's transmit power output, antenna gain and antenna cable loss.
NOTE: The maximum ERP authorized by the FCC in the United States is +36 dBi.
- Determine network coverage requirements
- Establish network reliability requirements
- Select and approve site and antenna locations
- Select the appropriate AP antennas
- Predict RPMA Network coverage with a propagation model
- Select the AP antenna cable type, determined by cable length, to minimize loss
- Assign AP channel (frequency) and Reuse Code
- Determine antenna cable attenuation
- Determine AP transmit power setting

2.2 Network Configuration

The following AP network configuration settings must be determined by your network planning and network operations teams and provided for AP configuration. These settings can be set via the AP web interface (shown in chapter 7) or in EMS (refer to the *EMS Operator Guide, 010-0107-00*), except as noted below:

- Site Name **NOTE:** The site name is for reference only and is not set in the AP or in EMS.
- AP ID
- System ID
- Client or Server Mode operation

- Static or DHCP IP address assignment
- AP IP address, if static
- Netmask setting
- Default router
- DNS servers
- NTP servers
- Server port number
- Gateway Hostname or IP Address
- Gateway port number
- Channel assignment
- Reuse Code (Allows AP coexistence on the same channel)
- AP antenna cable attenuation in dB
- Transmit output power setting, most frequently automatically set by inserting antenna cable loss in dB when using the standard antenna for the country of operation. In the United States the standard antenna's gain is 6dBi or 9dBi. As an example, the FCC would permit:
 - **36dBm EIRP (Max):** +30dBm - 0dB cable loss + 6dBi Antenna Gain = 36dBm EIRP
 - AP Transmit (+30dBm)
 - 0dB cable loss to antenna
 - 6dBi Omni-Antenna (Model: L-Com HGV-2406U)
 - **36dBm EIRP (Max):** +30dBm - 3dB cable loss + 9dBi Antenna Gain = 36dBm EIRP
 - AP Transmit (+30dBm)
 - ≥3dB cable loss to antenna
 - 9dBi Omni-Antenna (Model: L-Com HG-2409U-PRO)

2.3 Backhaul

Backhaul is the interconnection of the APs in a network to the back office systems including the RPMA gateway and the element management system. The backhaul method to be used must be determined for each AP prior to installation. Common backhaul methods include the following:

- Cellular 3G/4G data modems
- Wireless IP service providers
- Existing Ethernet infrastructure
- DSL links
- Point-to-Point radio links
- Microwave links

NOTE: A 10/100 Mb IP-over-Ethernet connection with 350 Kbps minimum throughput is required but a minimum throughput of 512 Kbps is recommended.

3 Installation Prerequisites and Considerations

Before starting the actual physical installation of an AP, it is very important to complete the prerequisite tasks outlined in this chapter as well as take into account the installation considerations indicated. Information gathering templates are provided in the appendices of this document.

3.1 Installation Prerequisites

3.1.1 Site Survey

A site survey should be conducted prior to installation for all AP sites. The site survey provides detailed, site-specific, information required to plan an AP installation and should be documented. See [Appendix A](#) for a Site Survey Worksheet template. A copy of this completed worksheet should be provided to the Network Planning team and used to prepare required site drawings and a Scope of Work document if required.

A site survey provides:

- Site name
- AP ID
- Site street address or other location
- Site access information
- Landlord contact information
- Specific landlord requirements
- Latitude
- Longitude
- Site type (building, tower, pole, or other)
- Height of existing structure
- AP and equipment mounting locations
- AP antenna mounting location and height
- Antenna line length required
- GPS antenna mounting location
- GPS antenna cable length
- AP power type, commercial power, 48 VDC, solar solution or other
- Distance to available power
- Photos of site including antennal location, AP location, and the overall site
- Other site-specific information
- Available Backhaul

3.1.2 AP Configuration

The AP configuration should be documented and provided to the Network Operations Team prior to the start of the installation. See [Appendix B](#) for an AP Installation Configuration Worksheet template. This worksheet provides the information required to configure the AP and includes the following information:

- Site name
- AP ID
- Deployment Region ID
- Backhaul type
- AP antenna gain
- AP antenna azimuth
- AP IP Address type, Static or Dynamic
- AP IP Address assignment, if static
- Default router
- Network mask
- DNS servers
- NTP servers

- AP antenna cable type
- AP antenna cable length
- AP antenna cable loss
- Channel assignment
- Reuse code
- Client or server mode of operation
- Gateway hostname or IP address
- Gateway port number
- Server port

3.2 Installation Considerations

When planning a new AP installation, the following items must be considered.

3.2.1 Grounding

The RPMAAP10x units have a grounding stud designed for grounding the chassis. See Figure 4 RPMAAP10x Grounding .

The Lug to attach to the stud is a crimp-style connector, Burndy PN YA4C (or equivalent). This crimp connector is electroplated tin. The crimp connector sizing would be selected based on ground wire gauge. Nominally this is #6 stranded wire for establishing a solid earth ground to guard and protect against lightning.



Figure 4 RPMAAP10x Grounding Stud

3.2.2 AP Antenna

The AP antenna should be mounted at a location that minimizes physical obstructions between the antenna and the endpoints with which it will be communicating. Rooftop installations create

the largest concern in this area. Antenna placement and height are very important to maximize network performance. The AP antenna should be securely mounted in a vertical position. Top mounting the antenna to a tower or mast is preferred. When the antenna is being side mounted to a tower or mast a 36" (1 m) or greater standoff bracket is required. The AP antenna cable is connected to a type-N female connector on the AP.

There are a variety of antenna options available to address the regulatory requirements of different countries. See the *Access Point Product Specification (014-0030-00 or 014-0088-00)* for additional details.

3.2.3 Diplexer

The Access Point has been FCC certified to allow use of a Diplexer Filter as a means of combining two disparate Access Points onto a single antenna. The two Models and methods used in this configuration are:

- ULPAP310.
- RPMAAP10E

Figure 5 Diplexer Deployment onto a Single Antenna shows the block diagram of how 2 Access Points are deployed using a Diplexer. Table 5 describes the Sub-Bands (SBANDS) of available diplexers and the appropriate Ingenu Part Numbers for the 3 filter types. Since the Diplexer is basically a dual Cavity filter, the general cavity filter enabled Access Points are not required. This Diplexer method of deployment is uncommon and requires installation by a trained Professional. Please contact Ingenu for further details as to applicability of this installation type to your network.

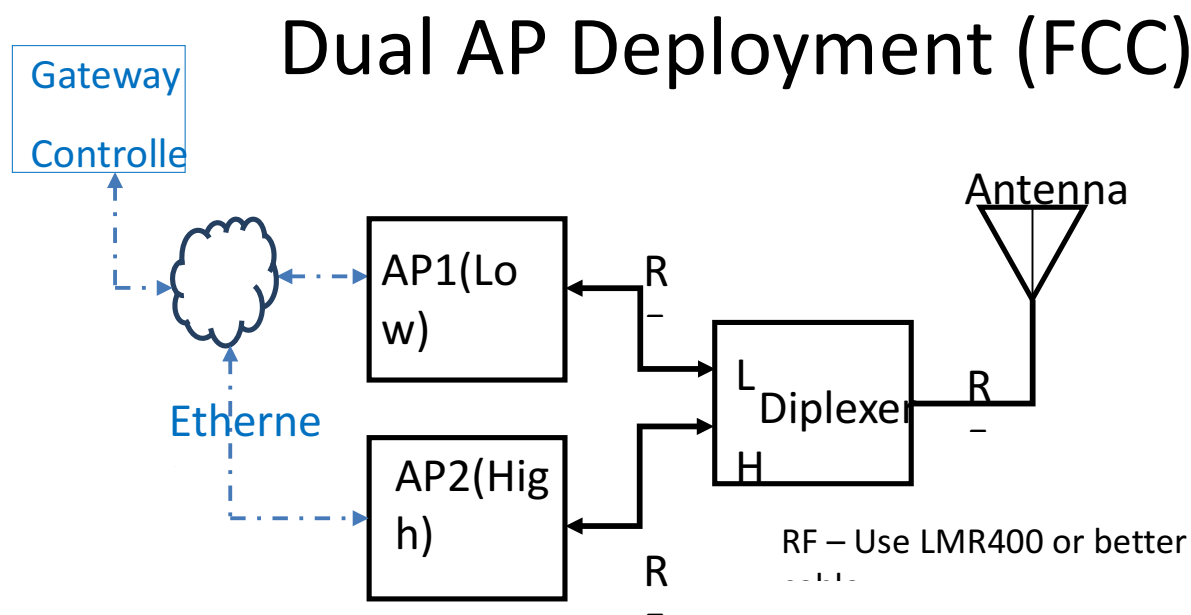


Figure 5 Diplexer Deployment onto a Single Antenna

3.2.4 AP Antenna Cable

A 50 ohm low loss coaxial cable is used to connect the antenna to the AP. The type of cable is selected based on the length of the cable run and network design requirements. For short cables, under 55' (17 m) LMR-400 cable is acceptable. ½ inch cable such as Andrew LDF4-50A is recommended for cables up to 100' (32 m). For longer runs, a 7/8 inch cable or 1½ inch cable may be used to reduce the cable attenuation.

The antenna cable should always be attached to the tower or other structure with clamps at the spacing recommended by the manufacturer. It is also very important to maintain the minimum bending radius recommended by the manufacturer to avoid kinking the cable during installation. When using an antenna cable larger than ½ inch, ½ inch LDF4-50A jumpers with type-N male connectors, typically 3 feet (1 m) to 6 feet (2 m) long, should be installed between the antenna cable and both the antenna and the AP to minimize the chance of damage to their connectors. The AP and the AP antenna both have type "N" female connectors.

NOTE 1: The total RF cable loss from AP Antenna connector to the antenna must be calculated or measured with antenna system test equipment during installation as detailed in section [6.3 Antenna System Sweep Testing](#). This value in dB is used when configuring the AP in the EMS.

NOTE 2: All outdoor antenna cable connections must be weather sealed in an appropriate manner.

The table below shows the attenuation for common types of antenna lines.

Table 1. Attenuation at 2.4 GHz for Common Types of Antenna Cables

Model	Size	dB/25 ft	dB/50 ft	dB/100 ft	dB/ 100 m
LMR-400	.40 inch	1.7	3.4	6.8	22.2
LDF4-50A	½ inch	.9	1.9	3.7	12.1
AVA5-50FX	7/8 inch	.5	1.0	2.0	6.6
AVA7-50	1½ inch	.3	.6	1.2	3.8

3.2.5 GPS Antenna

The GPS antenna provides timing signals to the AP. It should be mounted so that it has a clear view of the sky. A mounting location should be chosen that minimizes shadowing from trees or structures. The AP should normally see a minimum of nine satellites as shown on the AP's home web page.

NOTE: The GPS antenna should be mounted at least one meter, horizontally, away from the AP antenna or other transmitting antennas to minimize the chance of interference.

In normal operation, the AP requires GPS synchronization for precision timing of all nodes on the network. To provide a reliable GPS signal, the AP has a built-in GPS receiver which requires an externally connected GPS antenna. The GPS antenna cable is connected to a type-N female connector on the AP.

Many different GPS antennas are available but Ingenu recommends using the PCTEL GPS antenna model GPSL1-TMG-SPI-4oNCB for the following reasons:

1. The PCTEL GPS antenna has a low noise, high gain amplifier which is well-suited to address cable attenuation when the GPS antenna mounting location requires a long length of cable. Up to a 20 dB cable loss is acceptable when using this high gain antenna.
2. The PCTEL GPS antenna provides integrated, onboard, lightning protection that minimizes the need for a downstream, inline surge suppressor. The GPS antenna must be properly grounded. See figure 4. If using an external surge suppressor, it must be a "DC pass-through" type.

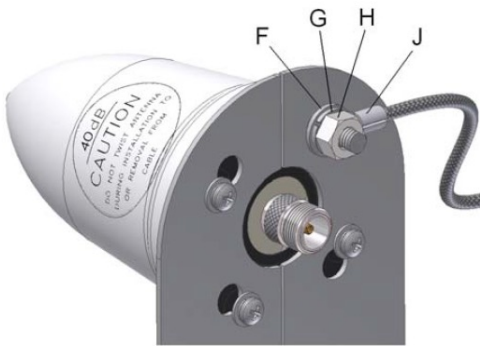


Figure 6 PCTEL GPS Model GPSL1-TMG-SPI-4oNCB

The PCTEL GPSL1-TMG-SPI-4oNCB GPS antenna has a type-N female connector.

NOTE: Most GPS antennas have a Low Noise Amplifier (LNA) that requires power from the AP. The AP supplies 3.3 V at up to 50 ma. If this current is exceeded, the AP detects the excess current and shuts down its GPS power supply. When this occurs, the AP sends a GPS antenna fault message back to the EMS. The AP must be power cycled to restore power to the GPS antenna.

3.2.6 Antenna Cable Lightning Suppression and Grounding

A coaxial RF surge suppressor must be installed at the location shown in the table below and must be connected with a #6 gauge or larger stranded wire to an appropriate ground for lightning protection. In most tower installations the outer shield of the AP antenna cable must be grounded with one or more grounding kits provided by the antenna cable manufacturer. The grounding kits must be connected to appropriate building or tower grounds using a #2 gauge wire. The mounting pipe for the antenna should be grounded to the same point if it is not attached to a grounded structure.

Table 2. RF Surge Protector Installation Locations

AP Location	Surge Protector Location
Indoors	Near cable entrance inside the first exterior wall
Outdoors	Antenna connector of the Access Point
Outdoors Inside Enclosure	Entrance to the enclosure

3.2.7 AP DC Power Requirement

Both the ULPAPx110 and the RPMAAP10x AP maybe powered over the Ethernet port using a passive PoE injector. The RPMAAP10x AP may also be powered from active 802.3af/at Power Sourcing Equipment (PSE).

The acceptable power source voltage range is 38 – 56 VDC. At the nominal input voltage of 48 VDC the typical input current is 0.3 Amps. The maximum input power dissipation is 13 Watts. When connecting to the distribution panel of a 48 VDC power system, it should be fused with a minimum of a ½ Amp slow-blow fuse. The maximum fuse or circuit breaker size should be 2 Amps.

3.2.8 PoE Injector

A standard passive PoE (Power over Ethernet) injector is typically used to apply power to the AP (Figure 7a). An example of an approved device is the L-com BT-CAT5-P1 Single-Port CAT-5 Midspan/Injector (also known as PoE Passive Splitter). When connected to an outdoor AP the PoE injector must be properly grounded for lightning and surge protection.

The following figure illustrates a typical setup utilizing the PoE injector Figure 7 (a) and a PSE switch (b).

Note: Figure 6 (b) only applies to the RPMAAP10x AP.

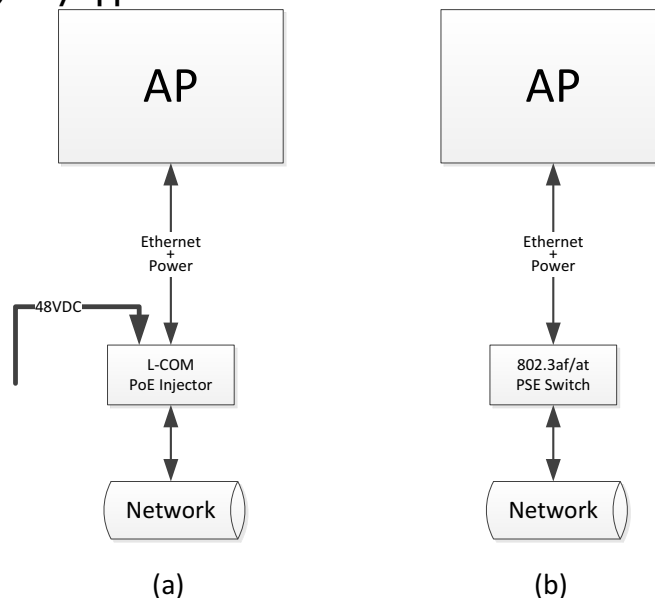


Figure 7. Block Diagram Showing PoE Injector Connections

3.2.9 Ethernet Cable

The Ethernet cable connection to the AP provides both data and DC power. The maximum Ethernet cable length is 328 feet (100 meters). A quality Cat5e or Cat6 cable is required. For most applications, an Unshielded Twisted Pair (UTP) cable with solid conductors is recommended. It is very important that connectors be specified for the cable being used. As an example, if using Cat5e solid conductor cable, the connectors should be specified for Cat5e solid conductor cable. Some connectors are specified for both solid and stranded conductors. Always use an RJ45 crimping tool that is specified for use with the connectors being used.

During the installation of the Ethernet cable, a pulling force of 25 pounds should not be exceeded. The bending radius of the cable should never be less than four times its diameter. Ethernet cable should not be deformed by tightly cinched cable ties.

After the Ethernet cable has been installed and the RJ45 connectors attached the cable must be tested and proper operation verified, with a two piece Ethernet test device, prior to connecting the AP or PoE injector.

Shielded Ethernet cable may be required in cases where the cable is installed in close proximity to equipment or conductors generating strong electromagnetic fields. In this case follow Shielded Twisted Pair (STP) installation guidelines.

3.2.10 Weather Sealing the ULPAPx110 AP's PoE Connector

When installing the ULPAPx110 AP outdoors the provided weather tight cable restraint must be used. Follow the instructions provided with the cable restraint.

3.2.11 Weather Sealing the RPMAAP10x AP's PoE Connector

The Amphenol RJF21B female RJ-45 receptacle on the RPMAAP10x is IP66 rated. To ensure a complete fluid and dust free connection, please use corresponding Amphenol part No. RJF6MB. Amphenol offers two separate versions shown below, with either a plastic (top) or metal gland for your convenience. The RJF21B receptacle has been configured on the AP with the following code A configuration:

