

Celona Indoor Access Point AP-10

Installation Guide



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Introduction

This document provides the necessary guidance to help the user enable services on the Celona Indoor Access Point AP-10 capable of private LTE connectivity.

About the AP

Celona AP-10 is a 3GPP Release 12 compliant LTE Access Point with internal antenna that supports the 3550 – 3700 MHz Citizens Broadband Radio Service (CBRS) spectrum band. It includes two internal radios that support 2x2 MIMO (multiple-input, multiple-output), 256-QAM modulation, and carrier aggregation (CA). It can be ceiling or wall mounted.

Package Contents

Verify that you have received the items below. If any item is missing or damaged, contact your Celona partner or reseller for instructions.

- The Access Point
- Mounting bracket and screws
- AC power adapter

Ethernet ports

The Celona AP-10 has two 10/100/1000 Ethernet ports. Currently, only one of the ports, marked WAN, is used. Do not connect to the other port.

Power input

In addition to AC power, the Celona AP-10 supports IEEE 802.11at (POE+) connectivity to drive internal circuitry. POE+ can be provided by a POE+ injector or a POE+ capable switch. The drawn power is ≤ 30 W.

Reset port

The Celona AP-10 has a physical port for hard resetting the device. However, the reset port functionality is not enabled at this time.

GPS

A Subminiature Version A (SMA) coaxial RF connector port is available for GPS. If obtaining GPS lock is difficult, connecting a GPS puck to the Celona AP-10 may help achieve lock. The GPS puck is typically placed closer to a window where there is line of sight visibility to the sky and a cable is extended from the GPS puck to the SMA connector port for GPS on the Celona AP-10.

Status LEDs

The Celona AP-10 has 4 LEDs providing the following visual statuses for Power, Backhaul connectivity, Service connectivity, Synchronisation. Among these, the Service connectivity LED is bi-colour. The table below details the statuses.

LED	Identifier	Status
1	Power	Single level LED, green ON = Power on OFF = Power off Blinking / Flashing LED = Rebooting
2	Service connectivity	Bi-level LED, Blue and Red RED = Alarm, Issue with Service BLUE SOLID = Service established BLUE BLINK = Mobile station active
3	Synchronisation	Single level LED, green ON = SYNC established OFF = No SYNC or SYNC Lost
4	Backhaul connectivity	Single level LED, green GREEN SOLID = Backhaul established GREEN BLINK = Backhaul in use OFF = No Backhaul available

Mounting

Installation Overview

The Celona AP-10 can be wall or ceiling mounted and has two omni-directional internal antennas per channel, for a total of 4 antennas. Internal antennas are down-tilt toward the front of the AP.

Before you mount and deploy your access point, we recommend that you perform a wireless design to determine the best location to install your access point.

The AP requires an operational Celona Edge for discovery and network service. Celona recommends installation and deployment of the Celona Edge prior to installation of access points. Have the following information about your wireless network design available:

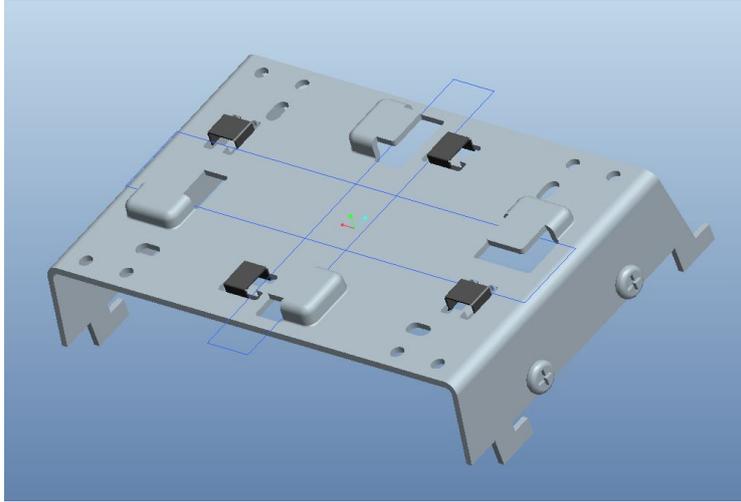
- Locations for access point installation
- Mounting requirements for each location: suspended from a drop-ceiling, surface mount on a hard ceiling, or on a flat horizontal surface

Installing the access point involves the following steps:

1. Mounting and powering the Access Point
2. Access Point Discovery and Provisioning
3. Configuring the Access Point

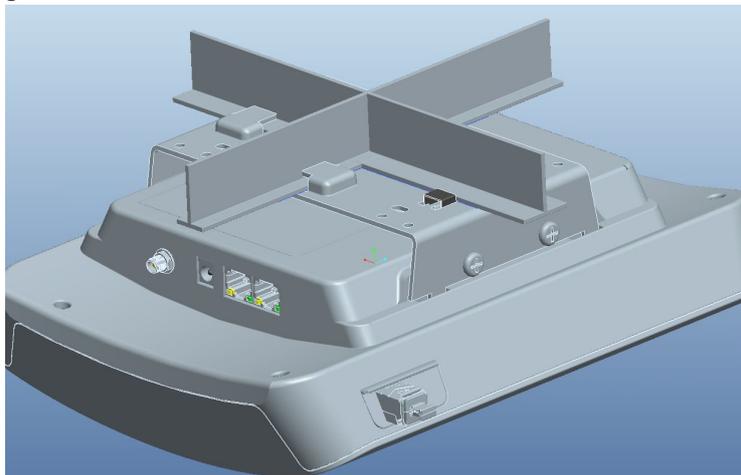
Mounting and Powering the Access Point

The Celona AP-10 supports several mounting methods, including from a suspended drop-ceiling, hard surface ceiling, and on a flat horizontal surface such as a wall. The standard mounting hardware included with the AP supports these mounting methods.



For drop-ceiling mounting, position the rear clips on the mounting bracket to the ceiling grid and twist counter-clockwise until the springs lock into place. Two sets of rear clips on the mounting bracket support both 24mm and 15mm T-grid rails.

Slide the AP onto the bracket arms and secure the AP to the bracket using the screw on the side of the mounting bracket.



For hard-surface mounting, attach the bracket to the hard surface using the included screws with the bracket arms for the AP extending vertically upward. Slide the AP onto the bracket arms and secure the AP to the bracket using the screw(s) on the side of the mounting bracket.

The Celona AP-10 can be powered by IEEE 802.11at (POE+) on the WAN Ethernet port or connected to an AC electrical outlet using the optional AC power adapter.

Access Point Discovery and Provisioning

The AP will connect to the Celona Orchestrator for provisioning and discover the Celona Edge within the network on-premises or in the private/public cloud based on the site assignment. The AP will then connect directly to the Celona Edge and establish control and data plane connections. Once this is completed, the LTE LED on the AP will turn blue, signifying the private LTE network is operational. This will take approximately 2-3 minutes.

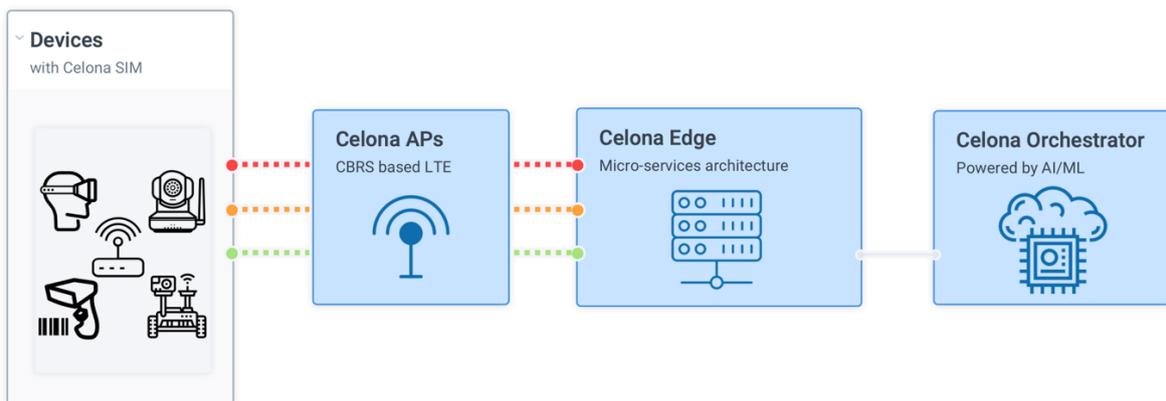
Configuring the Access Point

The Celona AP-10 supports zero-touch provisioning. The AP is preconfigured with details necessary to discover the Celona Orchestrator and the Celona Edge automatically. After the AP discovers the Celona Orchestrator and the Celona Edge, the AP gets provisioned with operational parameters and is authorised to transmit. The Celona Edge alone controls the radio frequency transmission of the Celona AP-10.

Once the AP has gone operational, it is able to provide services to mobile stations. The mobile stations can interact with the enterprise network via the Celona Edge. The user data and control signals are encrypted. The Celona AP-10 performance is periodically monitored by the Celona Edge and operational parameters are continually optimised if necessary. Refer to the Celona Orchestrator configuration guide for detailed instructions on configuring Celona access points.

Solution Architecture

The high level architecture that enables the Celona AP-10 is shown below.



The system consists of the essential functions detailed in Figure 1: System Architecture. The Celona Orchestrator performs AP authentication, validates the AP's serial number, determines the network the AP needs to connect to and finally directs the Celona AP-10 to the serving Celona Edge.

Each Celona AP-10 obtains service via its serving Celona Edge. The Celona Edge registers the Celona AP-10, arbitrates spectrum with a FCC approved Spectrum Access Service (SAS) system in the United States and algorithmically determines the most optimal radio parameters for the AP.

The Celona Edge becomes automatically aware of the Celona AP-10's location and its existing surrounding radio environment. Once the AP is admitted by the Celona Edge, the AP is able to commence radio transmissions and service the mobile stations.

Celona AP-10 capabilities

The following sections give the reader the capabilities of the Celona Indoor Access Point (AP), which is based on the Qualcomm platform. The AP hosts functions to provide the following services:

- Resource management with admission and flow control
- Encryption of user data and control streams
- Registering mobile stations with Celona Edge for connectivity services
- Paging the mobile stations that are in power save mode
- Fairness in allocation of resources across multiple stations in uplink & downlink directions
- Measurement configurations and handling of mobility of mobile stations

Operations and Maintenance

The Celona AP-10 is operationally maintained by the Celona Orchestrator and Celona Edge using the Broadband Forum standard TR-069. For the AP, the radio parameter provisioning, performance monitoring and fault monitoring occur over the TR-069 interface. The AP supports the following technical reports from the Broadband Forum.

AP Management data model	Technical Report (TR) identifiers
Configuration management	TR-196 Issue 2 TR-181 Issue 2 Amendment 5
Performance management	TR-262
Fault management	TR-157 Amendment 5

Celona AP-10's performance is monitored between every 5 minutes and 15 minutes based on the periodicity determined by the Celona Edge. If a fault surfaces on the AP, the fault is automatically propagated by the AP to the Celona Edge and the Celona Orchestrator.

Security

The certificates that are required to establish HTTPS connections with the Celona Orchestrator and the IPSEC channel with the Celona Edge are installed to the AP-10 at the factory. If the certificates need to be updated or replaced, the process is automatically triggered and managed by the Celona Edge. The certificates conform to the industry compliant X.509 standard. The IPSEC gateway is provisioned at the Celona AP-10 through the Celona Orchestrator. IKEv2 is used to establish the IPSEC tunnel between the Celona AP-10 and the Celona Edge.

Phase and time synchronisation

Celona AP-10 supports Time Division Duplex (TDD) which has strict requirements for maintaining time and phase synchronisation so that it does not interfere with neighbouring APs. The Celona AP-10s have a built in, high fidelity GPS chip that can establish location as well as maintaining clock synchronisation.

The AP's carrier frequency accuracy, time and phase drifts are disciplined by the onboard GPS clock. If the AP cannot obtain a GPS lock for any reason, Celona AP-10 synchronises with a Precision Time Protocol (PTP) server to maintain time, phase and frequency synchronisation.

Data and voice connectivity

Mobile stations can access data, video and voice applications over the enterprise IP network via the Celona Edge after the Celona AP-10 has its radio enabled. Note that the Celona AP-10 can provide voice, video and data sessions simultaneously to mobile stations. Celona AP-10 automatically determines the capability of mobile stations before determining whether requested services can be accommodated.

Celona AP-10 and Celona Edge perform admission control for mobile stations and Celona Edge enforces authentication of the mobile station before accepting service requests, and keep all control signals and user data encrypted.

Celona AP-10 employs sophisticated adaptive modulation and code rate control for adapting mobile station link according to the dynamic channel conditions seen on the air interface. It also employs effective power control to keep transmit powers from the mobile stations as low as practicable.

Power save mode

Celona AP-10 enables and controls power save options on the mobile stations. When a mobile station has encountered a long lull in data volume, Celona AP-10 monitors traffic volume on each flow enabled at the mobile station.

When the traffic volume is zero for a duration of time, duration determined by the Celona AP-10 based on mobile capability as well as current loading in the system, Celona AP-10 enables Power Save mode on the mobile station. While in power save mode, the mobile station is able to turn off its receiver and transmitter functions for the most part except for essential functions. This increases the battery standby time on the mobile stations.

When the mobile station is in power save mode and if there is user data destined towards the mobile station, Celona Edge pages the mobile station indicating data arrival via the Celona AP-10 in order to awaken the station.

Radio access technology

Celona AP-10 implements an extensive set of 3GPP world-wide standards to provide advanced, 4th generation packet radio service to mobile stations.

AP radio access technology	Technical specifications
Advanced 4th generation (4G) Long Term Evolution (LTE-Advanced)	All relevant Release 12 specifications from 3GPP 36.331 Release 12 – Radio Resource Control 36.321 Release 12 – Media Access Control 36.322 Release 12 – Radio Link Control 36.323 Release 12 – Packet Data Convergence 36.413 Release 12 – S1 Application interface 36.423 Release 12 – X2 Application interface 29.274 Release 12 – eGTP control plane 29.281 Release 12 – eGTP user plane 36.211 Release 12 – Physical channels and modulation 36.212 Release 12 – Physical channel multiplexing and coding 36.213 Release 12 – Physical layer procedures 36.214 Release 12 – Physical layer measurements

Supported frequency band

Celona AP-10 supports frequency ranges from 3400 MHz to 3800 MHz. The operational frequencies are however limited to a narrower range, from 3550 MHz to 3700 MHz, which is commonly labeled as the CBRS spectrum in the United States or the LTE Band 48. Any Celona AP-10 within a Celona private LTE network is automatically assigned frequency and power levels by Celona’s unique Self Organizing Network (SON) software function, after the Celona Edge retrieves available frequency channels per AP from SAS, given each AP’s geo-location.

Seamless session mobility

If there are multiple Celona AP-10s in the system all connecting to the same Celona Edge, the Celona AP-10s can enable seamless mobility for mobile stations. The source and target Celona

AP-10s handle the transfer of contextual information corresponding to existing flows setup for the mobile station automatically.

Coverage area

The coverage area of each Celona AP-10 depends on a number of factors:

- Transmit power authorized by the Spectrum Manager
- Transmit power set on the Celona AP-10 by Celona Edge
- Number of other APs operating on the same frequency in the geographic area
- Proximity of other APs operating on a different frequency but in the same band
- Building type and material types used within the building
- Expected minimum for data rate at the edge of coverage

As a rule of thumb, at maximum transmit power, the Celona AP-10 should provide coverage between 10,000 and 25,000 square feet.

Transmit power

The Celona AP-10 can transmit at a maximum power of 1 Watt per channel inclusive of internal gain.

Supported system bandwidth

The Celona AP-10 supports two concurrent RF chains. The two RF chains provide two distinct cellular sectors. The following combinations of system bandwidth are possible depending on authorisation provided by the Spectrum Manager.

Sector 1	Sector 2	Aggregated bandwidth (one AP)
20 MHz	20 MHz	40 MHz
10 MHz	10 MHz	20 MHz
5 MHz	5 MHz	10 MHz
20 MHz	-	20 MHz
10 MHz	-	10 MHz
5 MHz	-	5 MHz

Celona AP-10 aggregates two sectors for any mobile station that has ability to support carrier-aggregation. For the mobile stations that have carrier-aggregation enabled, the maximum data rate is double that is possible in a single sector. Note that the mobile station remains connected to only one sector of the Celona AP-10. However, in real-time, Celona AP-10 selectively determines based on data demand whether to enable carrier aggregation and for which mobile stations.

Troubleshooting

Power LED is not green:

- Ensure the AP-10 has a POE+ (802.11 at) connection. POE (802.11 af) is not sufficient.
- Please check for loose connections between the POE+ injector / POE+ switch and the Celona AP-10.

Service connectivity LED is red:

- Ensure backhaul connectivity is active.
- It takes between 5-10 minutes on a first power up and between 3-5 minutes on any subsequent power up to obtain service connectivity.
- If multiple Celona AP-10s are commissioned at the same time, ensure they are all powered up and that they have backhaul connectivity. Celona Edge employs self-organising methods to collectively determine optimum radio parameters for all the Celona AP-10s that are commissioned.

Synchronisation LED is off

- Ensure Celona AP-10 has one of the following options available:
 - o Celona AP-10 has visibility to sky.
 - o Celona AP-10 has an external GPS puck connected to the GPS SMA connector on the Celona AP-10. Ensure GPS puck has visibility to sky.
 - o Ensure the PTP server is on and on the same LAN as the Celona AP-10.

Backhaul connectivity is off

- Ensure Celona AP-10 is connected to the DSL MODEM / Cable MODEM or any other equipment that provides internet connectivity.
- Ensure the AP has a POE+ (802.11 at) connection. POE (802.11 af) is not sufficient.
- Please check for loose connections between the POE+ injector / POE+ switch and the Celona AP-10.
- Ensure the Celona AP-10 has an IP address assigned.

Contacting Support

Celona support is available via support@celona.io.

Warranty

As part of an active Celona Private LTE subscription, Celona indoor APs come with a limited warranty that includes advanced replacement for RMA.