To upgrade the device software, follow this:

Procedure:

1. Download the software upgrade packages from **https://support.cambiumnetworks.com/files/epmp**
2. Clear the cache of the accessing browser
3. On the device GUI, navigate to **Tools** => **Software Upgrade**
4. Select the **SW Upgrade Option** which represents the location of your software upgrade packages
5. Based on the configuration of **SW Upgrade Option**, enter either the **Software Upgrade Source Info** or click the **Browse** button and locate the software package
6. Click **Upgrade**
7. When the upgrade is completed successfully, click the **Reset** icon

SM Backup / Restore page

Use the **SM Backup / Restore** page to perform the following functions:

- Back up the configuration in either text (.json) format or binary (.bin) format.
- Restore the configuration of using a configuration file that was previously backed up.
- Reset the device to its factory default configuration. For more factory defaulting methods, see:
  - **Using the device external reset button** on page **229**
  - **Resetting the ePMP to factory defaults by power cycling** on page **230**

Figure 55 SM Backup / Restore page

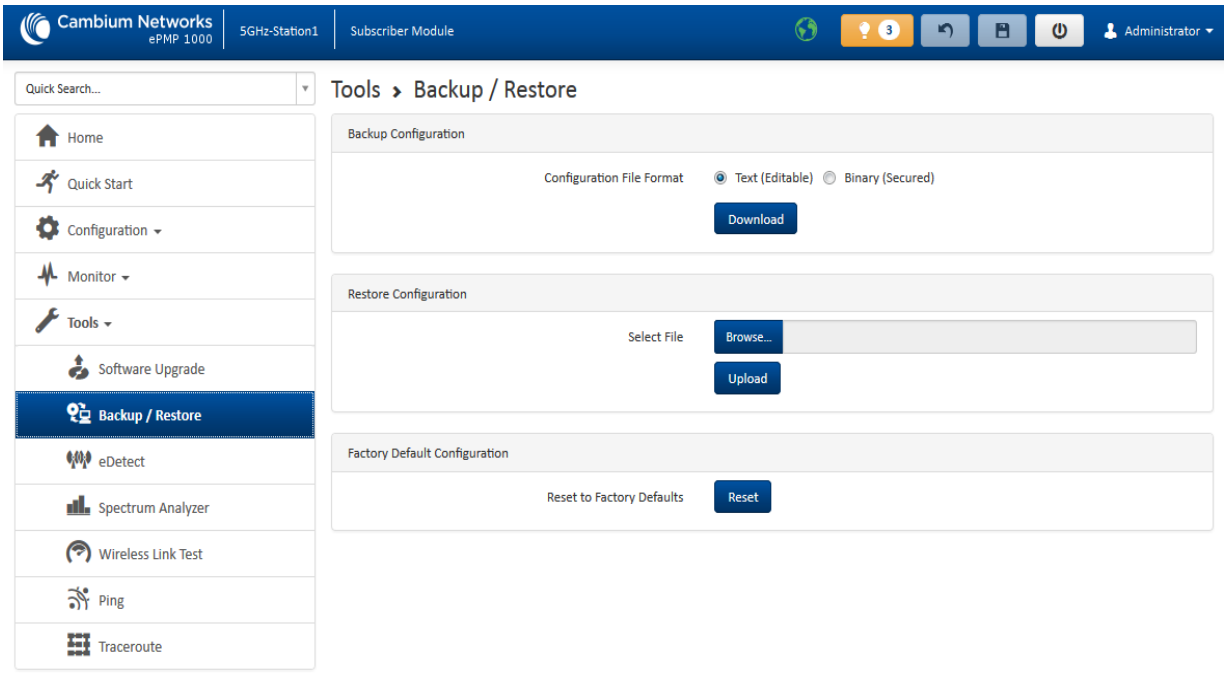


Table 80 SM Backup / Restore attributes

Attribute	Meaning
Backup Configuration	
Configuration File Format	**Text (Editable)**: Choosing this option will download the configuration file in the `.json` format, and can be viewed and/or edited using a standard text editor. **Binary (Secured)**: Choosing this option will download the configuration file in the .bin format, and cannot be viewed and/or edited using an editor. Use this format for a secure backup.
Restore Configuration	
Select File	Click **Browse** to select a local file (located on the device accessing the web management interface) for restoring the device configuration.
Factory Default Configuration	
Reset to Factory Defaults	Use this button to reset the device to its factory default configuration. Caution A reset to factory default configuration resets all device parameters. With the SMs in default configuration it may not be able to register to an AP configured for your network.

SM eDetect page

The **eDetect** tool (not available in ePTP Slave mode) is used to measure the 802.11 interference at the ePMP radio or system when run from the AP, on the current operating channel. When the tool is run, the ePMP device processes all frames received from devices not connected to the ePMP system and collects the interfering frame's information such as MAC Address, RSSI, and MCS. Use the SM eDetect page to collect information about interferers locally at the SM to display on the SM's GUI.

Figure 56 SM eDetect page

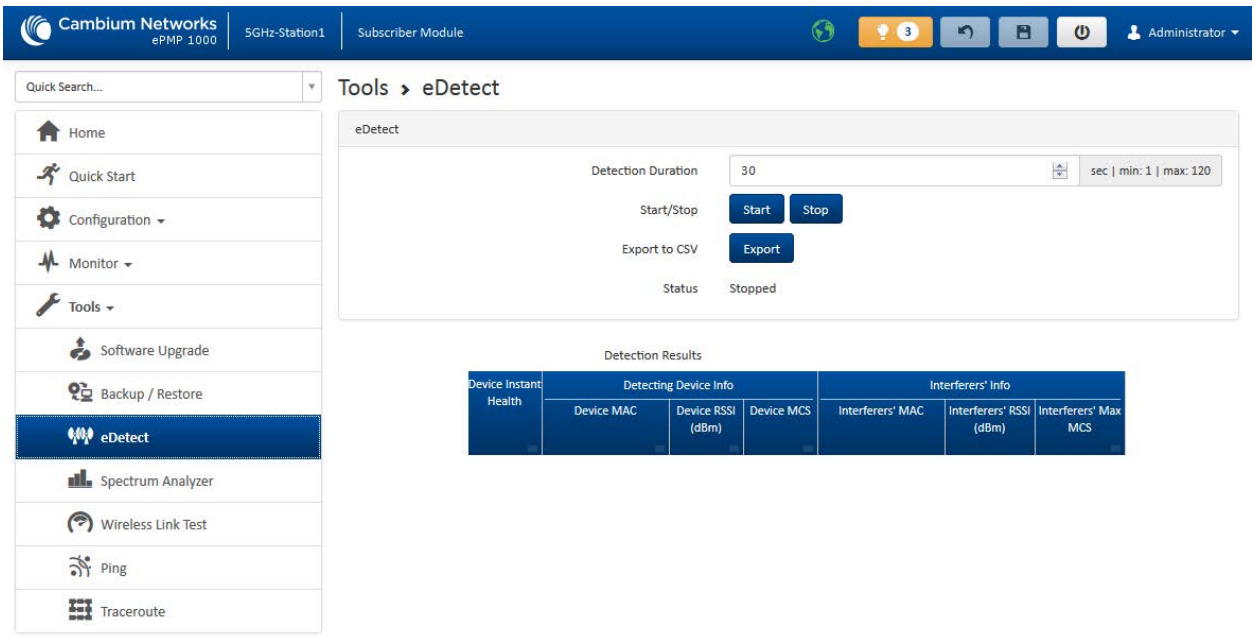


Table 81 SM eDetect attributes

Attribute	Meaning
eDetect	
Detection Duration	Configure the duration for which the SM scans for interferers. Caution During the scanning period, the SM must be connected to the AP and passing user traffic, and there cannot be any outage (unlike running a Spectrum Analyzer). There may be a negligible degradation in the SM's throughput.
Start/Stop	Use to start or stop the interference detection.
Export to CSV	Choose this option to export the detection results to .csv format.
Status	Current status of the Interference Detection tool.
Detection Results	Use the **Detection Results** table to monitor interferers at the SM and their key RF parameters.
Device Instant Health	This is an indicator of the device's health in terms of channel conditions in the presence of interferer(s). **Green**: Indicates that the channel is relatively clean and has good C/I levels (>25dB). The interference level is low. **Yellow**: Indicates that the channel has moderate or intermittent interference (C/I between 10dB and 25dB). **Red**: Indicates that the channel has high interference and poor C/I levels (<10dB).
Device MAC	The MAC address of the SM's wireless interface.
Device RSSI (dBm)	The Received Signal Strength Indicator, which is a measurement of the power level being received by the device's antenna.
Device MCS	Modulation and Coding Scheme – indicates the modulation mode used for a radio's receiver side, based on radio conditions (MCS 1-7, 9-15).
Interferers' MAC	The MAC address of the interferer's wireless interface.
Interferers' RSSI (dBm)	The Received Signal Strength Indicator, which is a measurement of the interferer's power level being received by the device's antenna.
Interferers' MCS	Modulation and Coding Scheme – indicates the modulation mode used by the interferer, based on radio conditions (ex: MCS 1--15).

SM Spectrum Analyzer page

Use the **SM Spectrum Analyzer** page to configure SM spectrum analyzer parameters and to download the spectrum analyzer tool.

To download the spectrum analyzer tool, the AP **Device Mode** must be set to **Spectrum Analyzer**.

Java Runtime Environment is required to run the AP spectrum analyzer.

Caution

Conducting spectrum analysis causes the SM to enter scan mode and the SM drops all RF connections.

Vary the days and times when you analyze the spectrum in an area. The RF environment can change throughout the day or throughout the week.

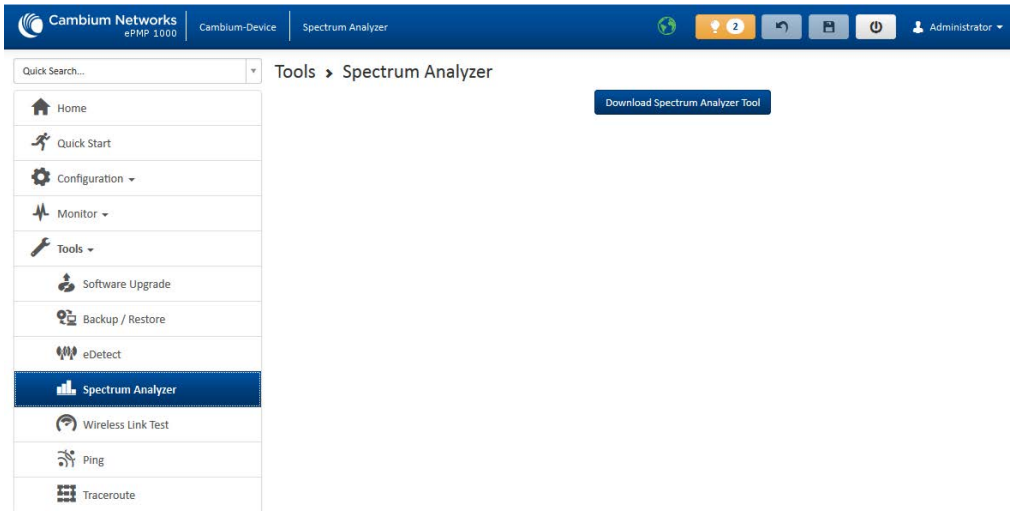
To conduct a spectrum analysis, follow these steps:

Required Software:

- Java Run-time Environment (JRE)

Procedure:

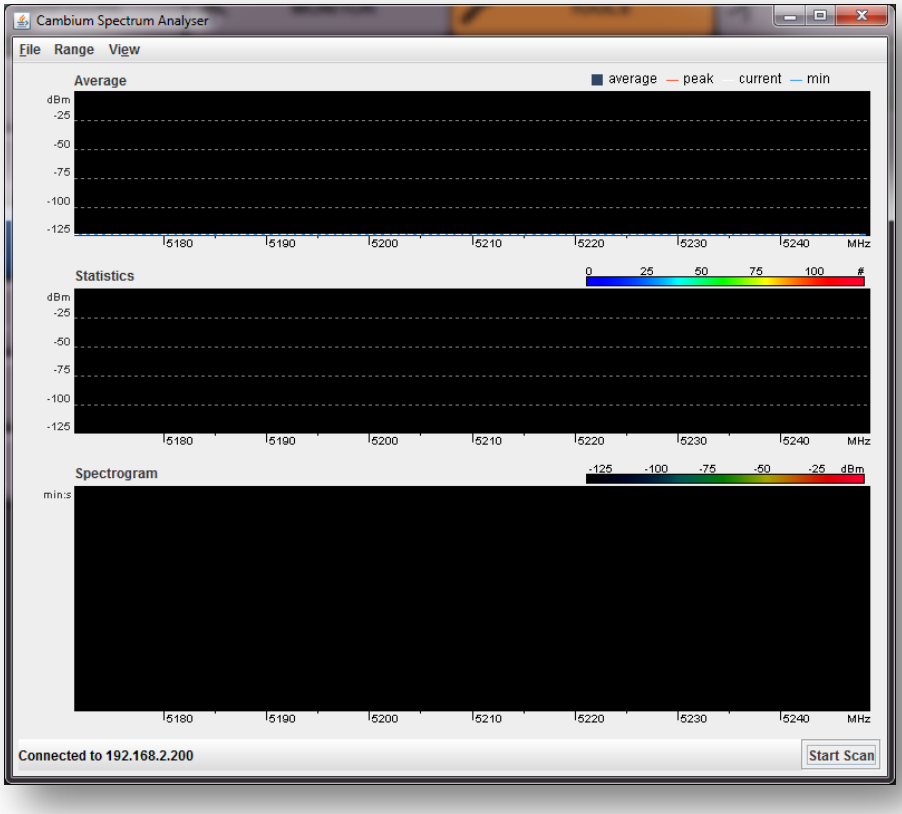
1. On the SM GUI, navigate to **Configure** => **System**
2. Configure **Device** mode to **Spectrum Analyzer**
3. Click the **Save** button
4. Click the **Reset** button
5. Login to the SM and navigate to **Tools** => **Spectrum Analyzer.** Following screen is displayed:



6. Click **Download Spectrum Analyzer Tool**
7. Locate the folder to which the spectrum analyzer tool was saved, and double-click on file `csa.jnlp` to launch the tool
8. If a security warning window is presented, tick the checkbox next to "*I accept the risk and want to run this application*"

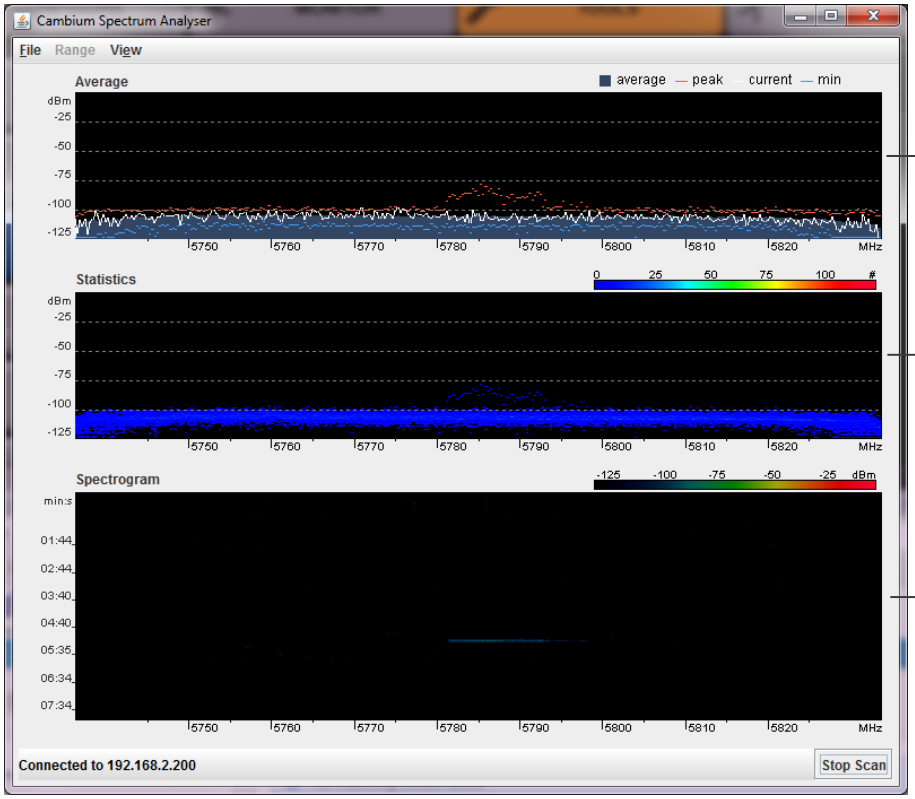
9 In the security warning window, click **Run**

The spectrum analyzer interface is displayed



10 Click **Range** to configure the range of frequencies to scan.

11 Click **Start Scan** to begin scanning



Display of the average, peak, current, and minimum power levels for the configured range

Statistical display of the number of times each frequency in the range was scanned

Spectrogram display of the energy levels detected throughout the configured range, over time

When scanning is complete, follow these steps to return the device to AP operation:

Procedure:

1. In the spectrum analyzer application, click **Stop Scan**
2. Close the spectrum analyzer application by clicking **File** => **Exit**
3. On the SM GUI, navigate to **Configure** => **System**
4. Configure **Device Mode** to **SM**
5. Click the **Save** button
6. Click the **Reset** button

SM eAlign page

Use the eAlign page to aid with link alignment. A valid link to an AP is required for eAlign to provide meaningful measurements.

Figure 57 SM eAlign page

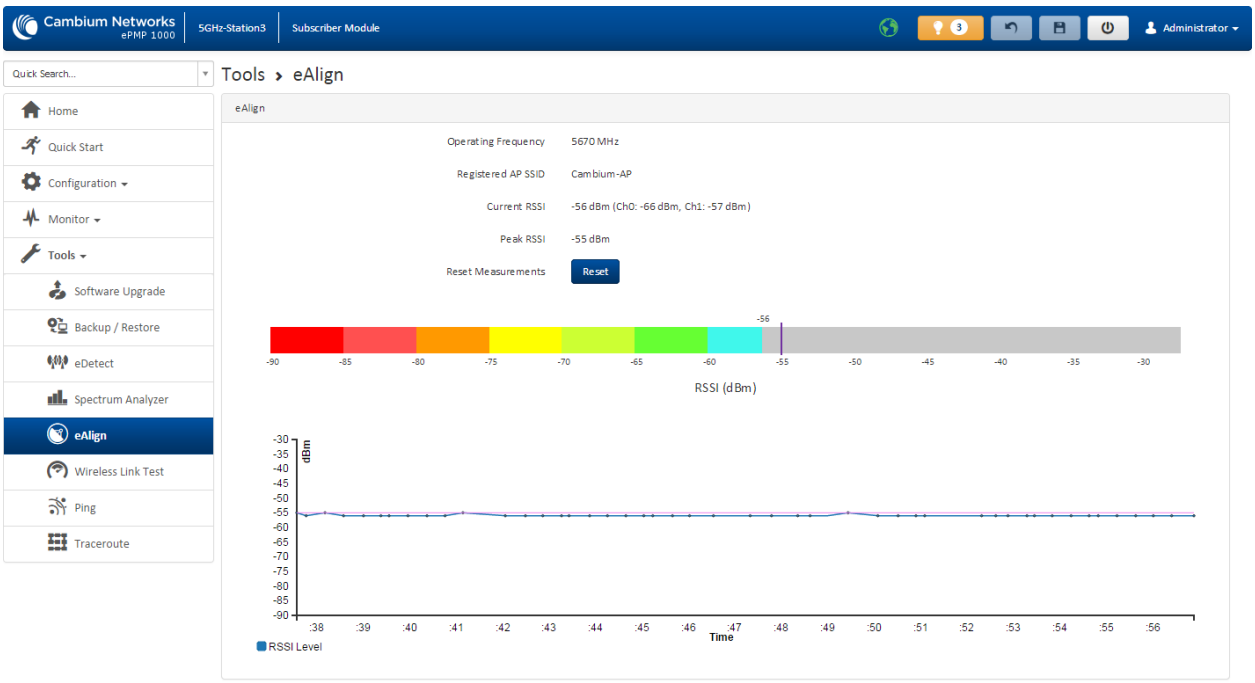


Table 82 SM eAlign attributes

Attribute	Meaning
Operating Frequency	The current frequency at which the SM is operating.
Registered AP SSID	The SSID of the AP to which the SM is registered.
Current RSSI	Current RSSI value measured on the uplink by the SM's receiver.
Peak RSSI	Peak RSSI value measured by the SM's receiver from the time the user navigated to the eAlign page.
Reset Measurements	Click this button to reset all current measurements.

SM Wireless Link Test page

Use the **SM Wireless Link Test** page to conduct a simple test of SM wireless throughput to the AP to which it is registered. This allows you to determine the throughput that can be expected on a particular link without having to use external tools.

Figure 58 SM Wireless Link Test page

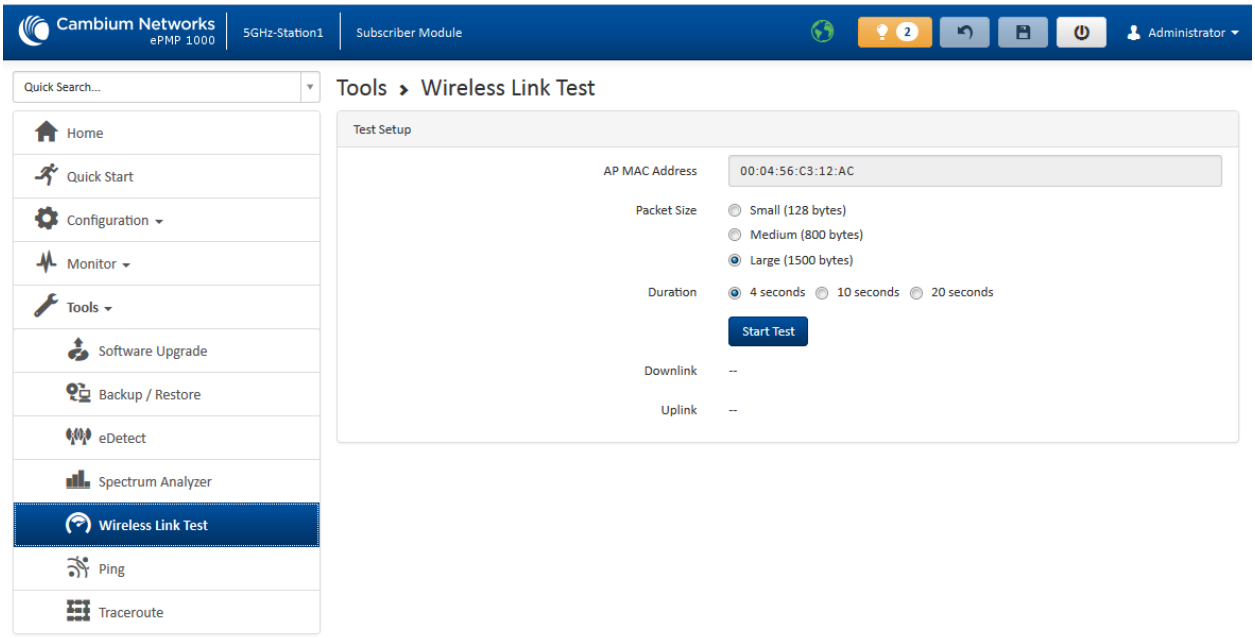


Table 83 SM Wireless Link Test attributes

Attribute	Meaning
Test Setup	
AP MAC Address	This is not an editable field. It is automatically populated with the wireless MAC address of the AP to which the SM is registered.
Packet Size	Choose the Packet Size to use for the throughput test.
Duration	Choose the time duration in seconds to use for the throughput test.
Downlink	This field indicates the result of the throughput test on the downlink, in Mbps.
Uplink	This field indicates the result of the throughput test on the uplink, in Mbps.
Aggregate	This field indicates the result of the aggregate throughput on the link, in Mbps. Displayed only when **Downlink/Uplink Ratio** is set to 75/25, 50/50 or 30/70.

SM Ping page

Use the SM **Ping** page to conduct a simple test of SM IP connectivity to other devices which are reachable from the network. If no ping response is received or if “Destination Host Unreachable” is reported, the target may be down, there may be no route back to the SM, or there may be a failure in the network hardware (i.e. DNS server failure).

Figure 59 SM Ping page

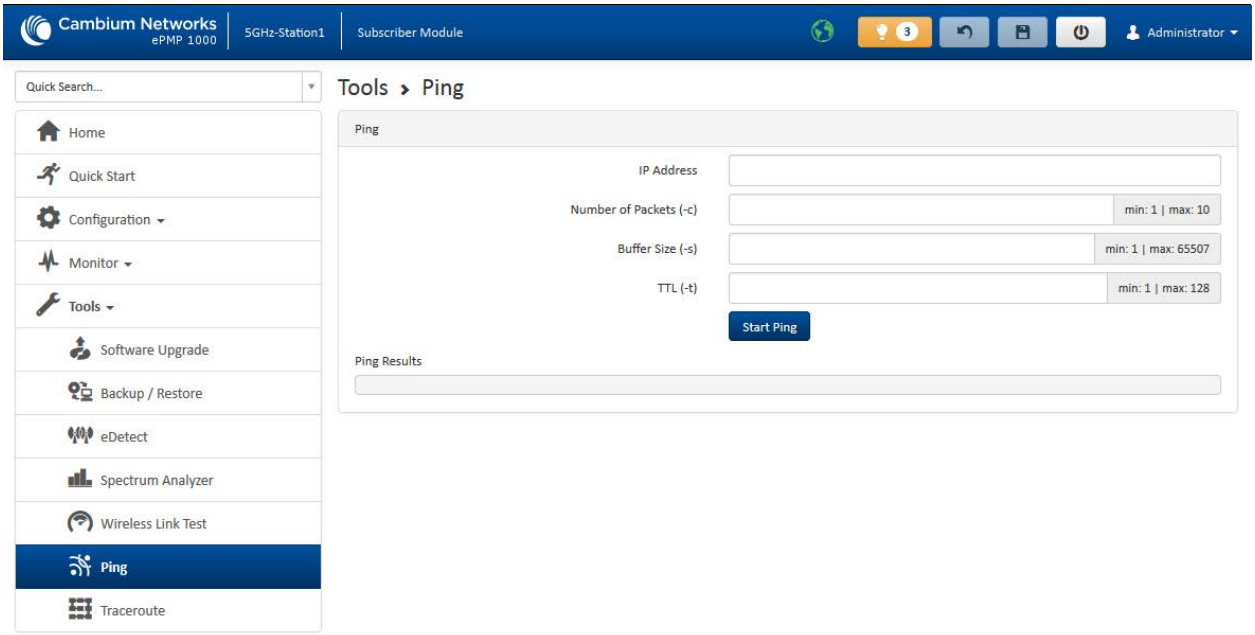


Table 84 SM Ping attributes

Attribute	Meaning
Ping	
IP Address	Enter the IP address of the ping target.
Number of packets (-c)	Enter the total number of ping requests to send to the target.
Buffer size (-s)	Enter the number of data bytes to be sent.
TTL (-t)	Set the IP Time-To-Live (TTL) for multicast packets. This flag applies if the ping target is a multicast address.
Ping Results	Displays the ping test results.

SM Traceroute page

Use the **SM Traceroute** page to display the route (path) and associated diagnostics for IP connectivity between the SM and the destination specified.

Figure 60 SM Traceroute page

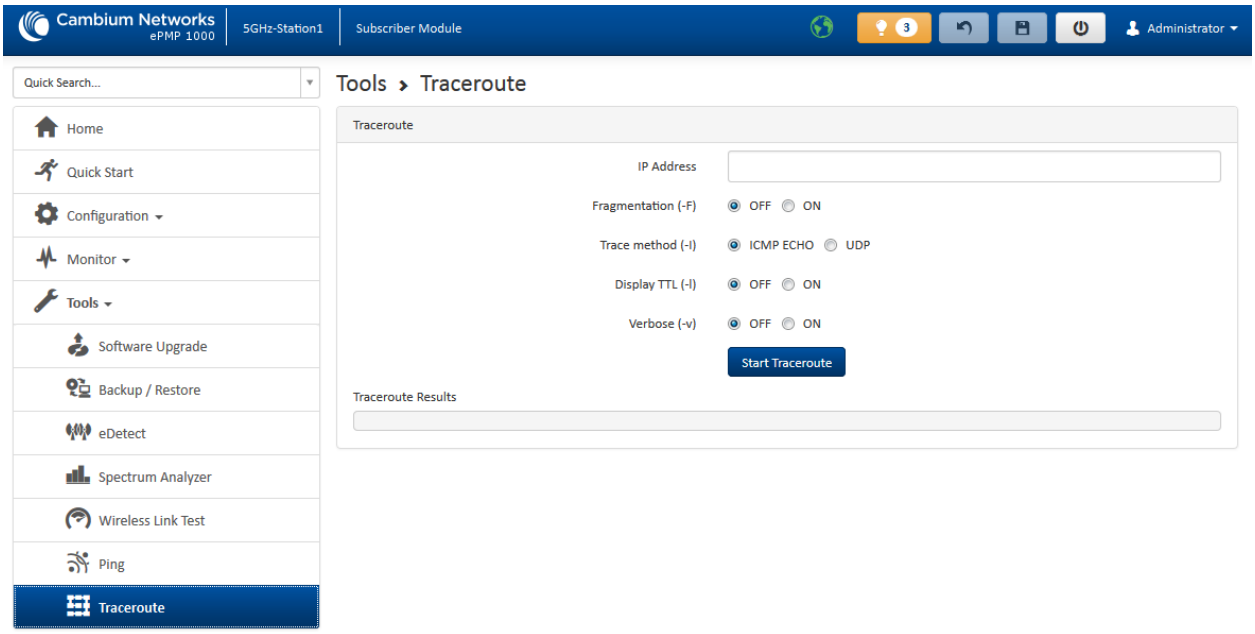


Table 85 SM Traceroute attributes

Attribute	Meaning
Traceroute	
IP Address	Enter the IP address of the target of the traceroute diagnostic.
Fragmentation (-F)	**ON**: Allow source and target to fragment probe packets. **OFF**: Do not fragment probe packets (on source or target).
Trace method (-I)	**ICMP ECHO**: Use ICMP ECHO for traceroute probes. **UDP**: Use UDP for traceroute probes.
Display TTL (-I)	**ON**: Display TTL values for each hop on the route. **OFF**: Suppress display of TTL values for each hop on the route.
Verbose (-v)	**ON**: ICMP packets other than TIME_EXCEEDED and UNREACHABLE are displayed in the output. **OFF**: Suppress display of extraneous ICMP messaging.
Traceroute Results	Displays the results of the traceroute diagnostics.

Radius Server

INSTALLING FREE-RADIUS ON UBUNTU 12.04 LTS

To install the Radius server on Ubuntu 12.04 LTS, follow these instructions:

1. On the free-radius web page http://freeradius.org, download the latest package (currently 3.0.0), either from the main page or the download page.
2. Extract the archive file by using the command line as shown below:
   - To extract a tar.bz2 file, use the command (note the j option)
     tar -jxvf freeradius-server-x.x.x.tar.bz2
   - To extract a tar.gz file, use the command (note the z option)
     tar -zxvf freeradius-server-x.x.x.tar.gz
3. Once the files are extracted to a folder (cd freeradius-server-x.x.x), execute these commands:

```
sudo apt-get install libssl-dev
sudo apt-get install libtalloc-dev
./configure
make
make install
```

CONFIGURING FREE-RADIUS SERVER

To configure Free-Radius server, follow these steps:

Note

IP address or subnet of the client must be configured in the clients.conf file.

Ex. – For the examples listed in the document, the subnet of the external machine is 172.22.121.0 or 192.168.0.0.

1. For testing from external machines, edit /usr/local/etc/raddb/clients.conf and add an entry. For example:

```
client 172.22.121.0/24 {
        ipaddr = 172.22.121.0
        netmask = 24
        secret = cambium
        proto = *
        shortname = epmp1
 }
client 127.0.0.0/24 {
        ipaddr = 172.22.121.0
        netmask = 24
        secret = cambium
        proto = *
        shortname = epmp1
 }

client 192.168.0.0/16 {
        ipaddr = 192.168.0.0
        netmask = 16
        secret = cambium
        proto = *
 }
```

2. To add *EAP-TTLS Username* and *EAP-TTLS Password*, edit *usr/local/etc/raddb/user.*

For example put this string at the end of file:

cambium-SubscriberModule Cleartext-Password := "cambium",

where *cambium-SubscriberModule* - EAP-TTLS Username and "*cambium"* - EAP-TTLS Password.

3. To configure free-radius key and certificate, edit */usr/local/etc/raddb/mods-available/eap* and add your certificates to folder */usr/local/etc/raddb/certs*.

   Locate a string such as *default_eap_type, private_key_file, certificate_file* in *eap* file and change the value to:

```
default_eap_type = ttls
      private_key_password = ***  - according to your certificate
      private_key_file = ${certdir}/***.key
      certificate_file = ${certdir}/***.crt
```

   Under the ttls section, change the following:

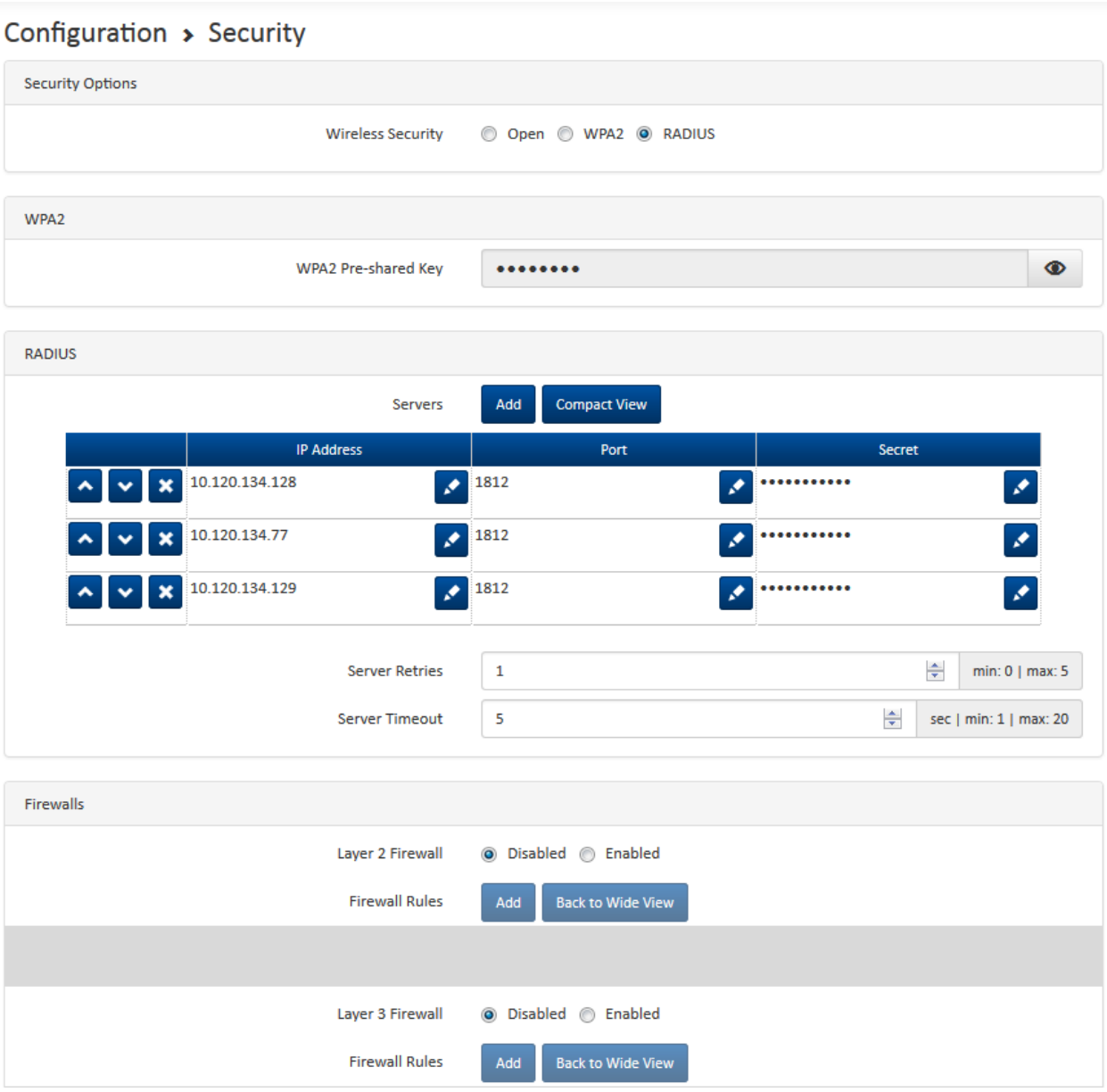
```
      copy_request_to_tunnel=yes
      use_tunnel_reply=yes
```

 Note

Once these steps are performed, free-radius in debug mode can be initiated: *$ radiusd –X*.

CONFIGURING RADIUS PARAMETERS ON AP

Figure 61 AP Radius configuration

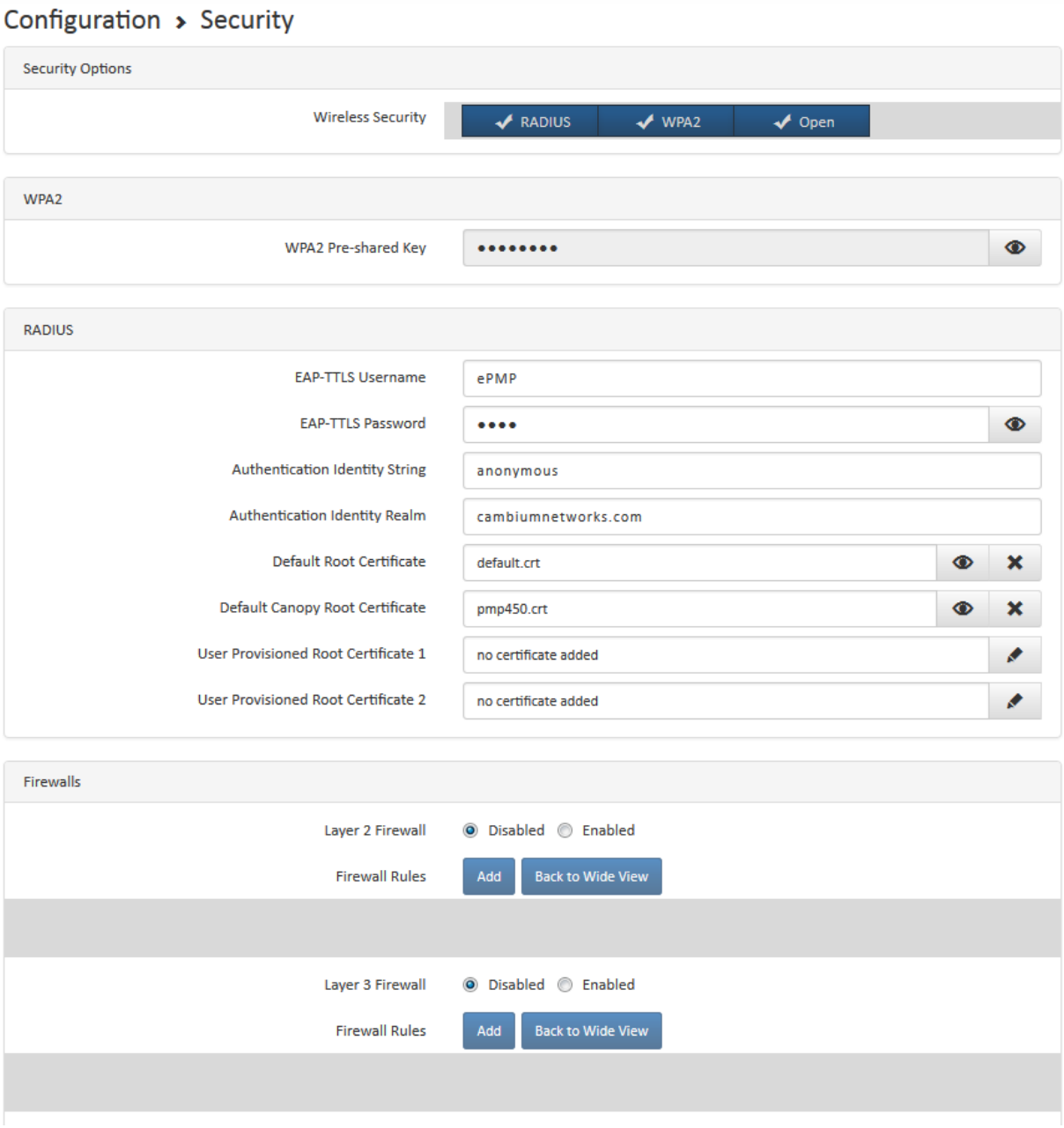


To configure Radius parameters on AP, follow these steps:

1. Open the GUI and login as *admin.*
2. Navigate to ***Configure*** -> ***Security*** -> ***Wireless Security.***
3. Change the value to *RADIUS.*
4. Add IP Address of your RADIUS Server in the *Radius Servers* table.
5. Also configure *Port* (you may use default 1812) and *Secret* which has to be the same as in ***clients.conf*** file.
6. Click ***Save***, to keep the changes.

CONFIGURING RADIUS PARAMETERS ON SM

Figure 62 SM Radius configuration



To configure Radius parameters on SM, follow these steps:

1. Select ***Wireless Security*** as **RADIUS**.
2. Configure *EAP-TTLS Username* and *EAP-TTLS Password,* as configured in file **users**.
3. Choose the *Default Root Certificate*.
4. Click ***Save***, to keep the changes.

CONFIGURING MIR PROFILES

To configure the MIR profiles, follow these steps:

- Create a dictionary file with the MIR Profiles:

  ```
  # touch dictionary.cambium
  ```

- Edit *dictionary.cambium* according to the instructions that you can find under */usr/local/etc/raddb* directory in file ***dictionary***.

  For example:

  ```
  ATTRIBUTE   Cambium-ePMP-ULMB 110   integer    #Max Burst Uplink Rate
  ATTRIBUTE   Cambium-ePMP-DLMB 110 integer    #Max Burst Downlink Rate

  VENDOR                                  Cambium                         17713

  #
  # Cambium vendor-specific attributes.
  #

  BEGIN-VENDOR                        Cambium

  ATTRIBUTE   Cambium-ePMP-ULMB    26integer    #Max Burst Uplink Rate
  ATTRIBUTE   Cambium-ePMP-DLMB    27integer    #Max Burst Downlink Rate
  ```

- Create link on your dictionary:

  ```
  #ln -s dictionary.cambium dictionary.local
  ```

- To configure MIR profiles, edit *usr/local/etc/raddb/users* and add profiles for each client below users configuration :

  ```
  SubscriberModule33 Cleartext-Password := "cambium33"
  Cambium-ePMP-ULMB = 100,
  Cambium-ePMP-DLMB = 100

  SubscriberModule34 Cleartext-Password := "cambium34"
          Cambium-ePMP-ULMB = 110,
          Cambium-ePMP-DLMB = 110

  SubscriberModule35 Cleartext-Password := "cambium35"
          Cambium-ePMP-ULMB = 120,
          Cambium-ePMP-DLMB = 120
  ```

A few example scenarios of MIR and RADIUS configurations are described in **Table 86**.

Table 86 Example scenarios of MIR and RADIUS configurations

Scenario	Description
No MIR control via Radius	In a scenario where Radius is not in use for MIR profiles, the GUI will be the only place to configure MIR profiles and apply them to the corresponding SMs. Configure the MIR profiles in the **Configure** => **Quality of Service** menu option on the AP GUI and apply the corresponding profile # in the SM under the same menu option on SM.
MIR control using only Radius	In the case where only the Radius server is being used for MIR profiles, all settings in the GUI will be overridden for any SM being managed by the Radius Server. In this case, create the MIR profile with Subscriber Module usernames and password on the Radius server. At the time of registration, the AP uses the radius information and applies the corresponding profile to the SM. In the wireless statistics page (=> **Wireless Status**), the MIR profile # from the Radius server along with UL and DL rate information will show up. In this scenario the QOS profiles in the AP GUI are irrelevant. Multiple SMs across multiple APs can then be managed via Radius.
Hybrid control using both Radius and MIR profile on the AP GUI	The system also supports a hybrid mode where Radius and the GUI QOS profiles can be used simultaneously as long as the same SM does not have a profile # associated from the AP & Radius. In case where it is redundant, Radius server setting will override the MIR profile settings from the GUI.

CREATING CERTIFICATE FOR RADIUS SERVER AND SM DEVICE

Create your own certification center

Creating a CA private key

1. Create a root (self-signed) certificate from our private certificate. Go to the directory where the database is stored for our certificates and start generating.
2. Create a private key CA (my own Certificate Authority). RSA key length of 2048 bits encryption algorithm 3DES. File name with a key - `cambium-ca.key`

```
openssl genrsa -des3 -out cambium-ca.key 2048
Generating RSA private key, 2048 bit long modulus
...................... + + +
........... + + +
e is 65537 (0x10001)
Enter pass phrase for cambium.key:
Verifying - Enter pass phrase for cambium-ca.key:
```

3. While creating the private key, you must enter a passphrase, which will be closed by key (and confirm it). Content key, can viewed from the following command:

```
openssl rsa –noout –text -in cambium-ca.key
```

In this case you must enter the private key again.

Creating a CA certificate

Generate a self-signed certificate CA:

```
openssl req –new -x509 -days 3650 -key cambium-ca.key -out cambium-ca.crt
```

Enter pass phrase for cambium.key:
You are asked to enter information that will be incorporated into your certificate request.
What you enter is called a *Distinguished Name* or a *DN*. There are quite a few fields of which you can leave some blank. For some fields there is a default value,

If you enter '.', field is left blank.

Country Name (2 letter country code)
State or Province Name (full name)
Locality Name (Ex. City)
Organization Name (Ex, Cambium Networks)
Organizational Unit Name (Ex. Cambium)
Common Name (Ex. cambium root CA)
Email Address (Ex. admin@cambium.com)

Generating the certificate, you must enter a passphrase, with a closed key CA, and then - to fill in the required fields (company name, email, etc.); the most important of these is the Common Name - the unique name of the certification center.
In this case, as the Common name was chosen "cambium root CA", view the resulting certificate command as shown below:

```
openssl x509 –noout –text -in cambium-ca.crt
```

As a result, we see:
Certificate:
Data:
Version: 3 (0x2)
Serial Number:
ea: 30:7 b: 69 : a2: 13:0 c: 70
Signature Algorithm: md5WithRSAEncryption
Issuer: C = UA, ST = Euro, L = Kiev, O = Cambium Networks, OU = Cambium,
CN = cambium root CA / email address = admin@cambium.com

Issued to (by us, that is self-signed)
Validity
Not Before: Dec 9, 2005 11:34:29 GMT
Not After: Dec 7, 2015 11:34:29 GMT
Validity of the certificate
Subject: C = UA, ST = Euro, L = Kiev, O = Cambium Networks, OU = Cambium,
CN = cambium root CA / email address = admin@cambium.com

Filter (field) certificate
Subject Public Key Info:
Public Key Algorithm: rsaEncryption
RSA Public Key: (2048 bit)
Modulus (2048 bit):
00: c0: ff: 50 : fd: a8: eb: 07:9 b: 17 : d1: a9: e2: a5: dc:
59: a7: 97:28:9 f: bc: a4: 01:16:45:37: f5: 8d: ca: 1e:
12: ca: 25:02:8 a: cf: ee: ae: 35:59: ed: 57:89: c7: 2b:
17:9 f: 8b: de: 60 : db: e5: eb: b3: de: 09:30:3 b: a9: 68:
40: f7: f8: 84 : f4: 6c: b2: 24:3 d: ed: 45 : a3: 8a: 66:99:
40: a9: 53:0 c: 75 : e3: df: f3: ef: 20:0 c: a6: 3f: f2: dd:
e9: 1c: f5: d1: c1: 32:4 c: 44 : fd: c1: a2: d9: e6: e0: dc:
04:0 c: f8: dd: 9e: 31 : aa: 9d: 60 : b0: 84 : d2: e0: b7: a5:
eb: 82:31:4 f: 71 : c4: ee: ab: 5c: 8e: ef: 8c: a1: 1a: 2a:
62: e9: e9: 36 : ff: 12 : b9: c9: ac: 0e: 4d: ac: 08:97:87:
d2: 30:2 f: 41 : a1: 9e: ef: 8b: bf: c6: cf: 66:70:02: ab:
2d: b0: 9c: 56 : b8: 13 : e8: 92:59: f5: d9: 33 : d7: 33:6 a:
7c: cb: 9b: 92 : ee: 4b: 22:32:73:59:70:3 f: b1: f6: 1b:
67:1 d: 28 : eb: bb: 4b: 5e: 61:95:43:78: d5: 3b: db: e1:
37 : f1: ec: 0d: db: 50:65:22: cb: f4: f9: b8: 2a: c6: 1f:
2b: e9: f8: 64:03:4 f: 36 : dc: 72:8 e: be: 3d: 12:8 a: ca:
8b: 95

```
            Exponent: 65537 (0x10001)
        X509v3 extensions:
            X509v3 Subject Key Identifier:
4C: 80 : F5: 82:4 C: A4: 52 : DF: 9E: 0C: 0D: 64:74:68:1 E: 45 : F6: C1: C7: 68
            X509v3 Authority Key Identifier:
                keyid: 4C: 80 : F5: 82:4 C: A4: 52 : DF: 9E: 0C: 0D: 64:74:68:1 E: 45 : F6: C1: C7: 68
                DirName :/ C = UA / ST = Euro / L = Kiev / O = Cambium Networks / OU = Cambium /
                CN = cambium root CA / emailAddress = admin@cambium.com
                serial: EA: 30:7 B: 69 : A2: 13:0 C: 70

            X509v3 Basic Constraints:
                CA: TUAE
Signature Algorithm: md5WithRSAEncryption
57 : db: 0d: 2b: 27 : eb: 0a: 97:7 f: b1: 37 : b3: d1: d7: 14 : a6: 80:66:
        3d: 7c: 00:4 a: 45:1 f: 7c: 2b: 5e: 30 : b2: 72:74:9 f: 6d: 33:82: f7:
        f7: de: 54 : a9: 2b: e7: ea: 1b: 93 : bd: cc: 74:4 f: 11 : ed: 94:0 b: b9:
        b2: 1f: b1: 86:6 e: c6: 48:71:48:9 b: 2b: 0a: 36 : f3: ab: d6: f9: 75 :
        c9: 0d: 1b: e9: 2c: 85:04: fc: 17:9 a: 94 : b9: 14:0 d: 15 : d1: 1e: 8b:
        bb: 9e: 91 : ca: 40:8 c: d8: ef: dd: 4a: 75 : d0: b9: 62 : d4: ee: 1b: e5:
        b5: 7e: fa: f1: 5d: 62 : d1: 78 : b0: 34:04: bb: 60:37:8 a: a8: 74:88:
        f6: 94:3 b: c8: fb: c0: 98 : f4: 94 : e9: d5: 53:8 e: 31 : e6: 25:56: c3:
        84:7 c: 46 : b9: 09:5 f: e3: 43 : a8: 57 : c9: 3a: d9: 3d: a7: b0: 41 : db:
        ea: ca: 60:28:0 b: a3: f0: 0b: e6: d6: c0: 5b: 15:0 c: f8: 19:36:26:
        d3: 2a: 8d: c9: 67 : fe: 04:6 f: e9: bf: f9: 55 : de: 2c: 92:04:81:6 f:
        43 : d5: 94:25: af: 83 : b8: 01:22: c8: 1a: 7e: 2e: a9: 10 : b0: e5: 35 :
        a7: 17 : bf: 65 : a1: 31:55:85: ba: 10:24:71:03:3 b: d6: 71 : a4: ad:
        48:28:46:8 f: 7e: e6: b3: 8c: 37:97:4 f: 36:05:8 c: f6: d1: 40 : a8:
        c4: 58:9 b: 28
```

Now copy the certificate and key of the CA in a public place, for example, in */etc/ssl/cambium*:

```
mkdir /etc /ssl /cambium
cp cambium-ca. * /etc/ssl/cambium/
```

Issuance of certificates

Script certificate generation

Download (from the Cambium support web-site) the script **sign_cert.sh**. It allows you to create server/user.

Edit the following lines in it:

```
ROOTCA = "cambium"
root CA name - Filename of the root certificate (without the suffix '-ca')
O = "Cambium Networks" - Name of the organization
C = "UA" - country
ST = "Euro" - staff
L = "Kiev" - city
OU = "Cambium" - unit
EMAIL = email@cambium.com - email
BITS = 2048 - Size of the generated key in bits
CLIENT_DAYS = 730 - Client certificate validity period in days
SERVER_DAYS = 1461 - Server certificate validity period in days
```

Lines related to the country, city, department, email, etc must be fixed (though not necessarily, this is default values that can be changed in the process of creating the certificate). Variables related to the terms of validity of the certificate can be left without changes.

Creating a server certificate (for RADIUS)

Create a server certificate (option cerver_cert), file name (and certificate) radius.cambium.com.

```
. / sign_cert.sh server_cert radius.cambium.com
create certificate key: radius.cambium.com.key

Generating RSA private key, 2048 bit long modulus
....... + + +
.................................. + + +
e is 65537 (0x10001)
```

First generates key, it is necessary enter the password which will close the key

```
Enter pass phrase for radius.cambium.com.key:
Verifying - Enter pass phrase for radius.cambium.com.key:
decrypt certificate key: radius.cambium.com.crt
Enter pass phrase for radius.cambium.com.key:
writing RSA key
```

Create a certificate request

```
Create certificate request: radius.cambium.com.csr

. / sign_cert.sh radius.cambium.com server_cert
You are about to be asked to enter information that will be incorporated
into your certificate request.
What you are about to enter is what is called a Distinguished Name or a DN.
There are quite a few fields but you can leave some blank
For some fields there will be a default value,
If you enter '.', the field will be left blank.
```

Then you must specify the fields you want, like for the root certificate. Default values have already crammed in square brackets. To use them simply click ENTER.

1. Your Country Name (2 letter country code):
2. State or Province Name (full name):
3. Locality Name (Ex.- city)
4. Organization Name (Ex.- Cambium Networks):
5. Organizational Unit Name (Ex.- Cambium):
6. Common Name (Ex.- radius.cambium.com):
7. Email Address (Ex.- email@cambium.com):

Sign the certificate request

```
sign certificate by CA: radius.cambium.com.crt
sign ca is: cambium-ca
CA signing: radius.cambium.com.csr -> radius.cambium.com.crt:
Using configuration from ca.config
```

Since we sign new created certificate with root certificate, we must enter the password which we used to close root certificate of our center CA

```
Enter pass phrase for. /.. / cambium-ca.key:
Check that the request matches the signature
Signature ok
The Subject's Distinguished Name is as follows
countryName: PRINTABLE: 'UA'
stateOrProvinceName: PRINTABLE: 'Euro'
localityName: PRINTABLE: 'Kiev'
organizationName: PRINTABLE: 'Cambium Networks'
```

```
organizationalUnitName: PRINTABLE: 'Cambium'
commonName: T61STRING: 'radius.cambium.com'
emailAddress: IA5STRING: 'email@cambium.com'
Certificate is to be certified until Dec 25 12:05:18 2013 GMT (730 days)
Everything is OK, completing work
```

Server certificate is created.

Operation and Troubleshooting

This chapter provides instructions for operators of ePMP networks. The following topics are described:

General Planning for Troubleshooting

Effective troubleshooting depends in part on measures that you take before you experience trouble in your network. Cambium recommends the following measures for each site:

Procedure:

1. Identify troubleshooting tools that are available at your site (such as a protocol analyzer).
2. Identify commands and other sources that can capture baseline data for the site. These may include:
   - Ping
   - tracert or traceroute
   - Throughput Test results
   - Throughput data
   - Configure GUI page captures
   - Monitor GUI page captures
   - Session logs
3. Start a log for the site, including:
   - Operating procedures
   - Site-specific configuration records
   - Network topology
   - Software releases
   - Types of hardware deployed
   - Site-specific troubleshooting process
   - Escalation procedures
   - GPS latitude/longitude of each network element

GENERAL FAULT ISOLATION PROCESS

Effective troubleshooting also requires an effective fault isolation methodology that includes

- Attempting to isolate the problem to the level of a system, subsystem, or link, such as
  - AP to SM
  - AP to CMM
  - AP to GPS
  - CMM to GPS
  - power
- Researching System Logs of the involved equipment.
- Answering the questions listed in the following section.
- Reversing the last previous corrective attempt before proceeding to the next.
- Performing only one corrective attempt at a time.

QUESTIONS TO HELP ISOLATE THE PROBLEM

When a problem occurs, attempt to answer the following questions:

1 What is the history of the problem?

- Have we changed something recently?
- Have we seen other symptoms before this?

2 How wide-spread is the symptom?

- Is the problem on only a single SM? (If so, focus on that SM.)
- Is the problem on multiple SMs? If so:
    - o is the problem on one AP in the cluster? (If so, focus on that AP)
    - o is the problem on multiple, but not all, APs in the cluster? (If so, focus on those APs)
    - o is the problem on all APs in the cluster? (If so, focus on the CMM and the GPS signal.)

3 Based on data in the System Log

- Is intermittent connectivity indicated? (If so, verify your configuration, power level, CINR, cables and connections, and the speed duplex of both ends of the link).
- Does the problem correlate to loss-of-sync events?

4 Are connections made via *shielded* cables?

5 Does the GPS antenna have an *unobstructed* view of the entire horizon?

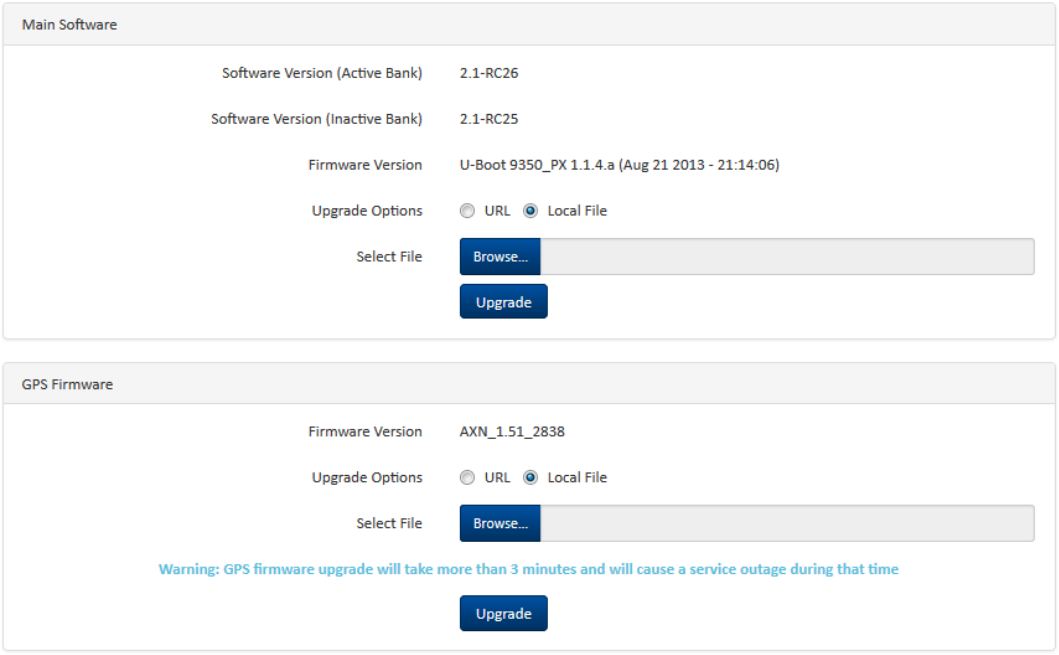
Upgrading device software

To take advantage of new features and software improvements for the ePMP system, monitor the Cambium Networks PMP Software website: **https://support.cambiumnetworks.com/files/epmp**

To upgrade the device software (AP or SM), follow this:

Procedure:

1. When upgrading multiple v1.0.3 integrated devices, ensure that the browser cache is cleared at the beginning of the upgrade process.
2. Log in to the device GUI via the management IP
3. Navigate to page **Tools**, **Software Upgrade**



4. Under the **Main Software** section, set the **Upgrade Option** to **URL** to pull the software file from a network software server or select **Local File** to upload a file from the accessing device.
   If **URL** is selected, enter the server IP address, Server Port, and File path.
5. If **Local File** is selected, click **Browse** to launch the file selection dialogue
6. Click **Upgrade**

Caution

Do not power off the unit in the middle of an upgrade process.

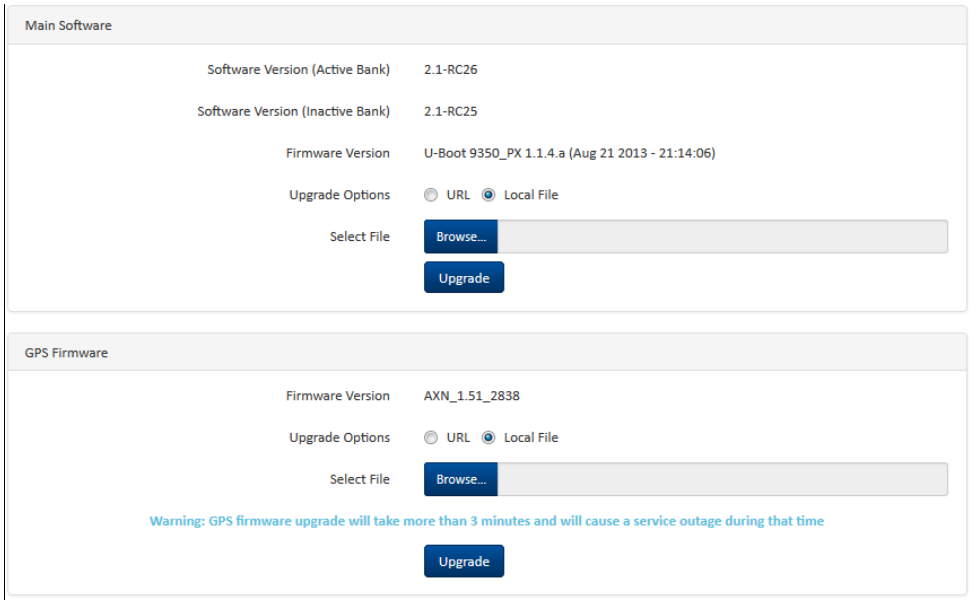
7. Once the software upgrade is complete, click the **Reset** icon.

Upgrading on-board GPS chip firmware

To upgrade the GPS Synchronized ePMP radio's on-board GPS chip, follow this:

Procedure:

1. When upgrading multiple v1.0.3 (or later) integrated devices, ensure that the browser cache is cleared at the beginning of the upgrade process.
2. Log in to the device GUI via the management IP
3. Navigate to page **Tools**, **Software Upgrade**



4. Under the section **GPS Firmware**, set the **Upgrade Options** to **URL** to pull the software file from a network software server or select **Local File** to upload a file from the accessing device.

Note

Use the same package that is used to upgrade the device's software. The new GPS firmware is part of the software upgrade packages.

5. If **Local File** is selected, click **Browse** to launch the file selection dialogue and click **Upgrade.**

Caution

Do not power off the unit in the middle of an upgrade process.

7. Once the software upgrade is complete, click the **Reset** icon.

Caution

In case of a locked GPS device the upgrade typically has a "GPS Firmware Version" as "Not Available"(although not always). The user must attempt the upgrade anyway. It is however likely to fail with a "GPS general communication error" displayed in the notification icon. If this occurs the user must power-cycle (not just reboot) the radio and attempt the upgrade again.

Testing hardware

This section describes how to test the hardware when it fails on startup or during operation.

Before testing hardware, confirm that all outdoor cables, that is those that connect the AP or SM to equipment inside the building, are of the supported type, as defined in **Ethernet cabling** on page **55**

CHECKING THE POWER SUPPLY LED

When the power supply is connected to the main power supply, the expected LED behavior is:

- The Power (green) LED illuminates steadily.

If the expected LED operation does not occur, or if a fault is suspected in the hardware, check the LED states and choose the correct test procedure:

- **Power LED is off** on page **225**
- **Ethernet LED is off** on page **225**

POWER LED IS OFF

Meaning: Either the power supply is not receiving power from the AC/DC outlet, or there is a wiring fault in the unit.

Action: Remove the AP/SM cable from the PSU and observe the effect on the Power LED. If the Power LED does not illuminate, confirm that the mains power supply is working, for example, check the plug. If the power supply is working, report a suspected power supply fault to Cambium Networks.

ETHERNET LED IS OFF

Meaning: There is no Ethernet traffic between the AP/SM and power supply.

Action: The fault may be in the LAN or AP/SM cable:

- Remove the LAN cable from the power supply, examine it and confirm it is not faulty.
- If the PC connection is working, remove the AP/SM cable from the power supply, examine it, and check that the wiring to pins 1&2 and 3&6 is correct and not crossed.

Test Ethernet packet errors reported by AP/SM

Log into the AP or SM and click **Monitor**, **Performance**. Click **Reset System Counters** at the bottom of the page and wait until **LAN RX – Total Packet Counter** has reached 1 million. If the counter does not increment or increments too slowly, because for example the ePMP system is newly installed and there is no offered Ethernet traffic, then abandon this procedure and consider using the procedure **Test ping packet loss** on page **226**.

Check the **LAN RX – Error Packet Counter** statistic. The test has passed if this is less than 10.

Test Ethernet packet errors reported by managed switch or router

If the AP/SM is connected to a managed Ethernet switch or router, it may be possible to monitor the error rate of Ethernet packets. Please refer to the user guide of the managed network equipment. The test has passed if the rate of packet errors reported by the managed Ethernet switch or router is less than 10 in 1 million packets.

Test ping packet loss

Using a computer, it is possible to generate and monitor packets lost between the power supply and the AP/SM. This can be achieved by executing the Command Prompt application which is supplied as standard with Windows and Mac operating systems.

Caution

This procedure disrupts network traffic carried by the AP or SM under test.

Procedure:

1. Ensure that the IP address of the computer is configured appropriately for connection to the AP or SM under test, and does not conflict with other devices connected to the network.
2. If the power supply is connected to an Ethernet switch or router then connect the computer to a spare port, if available.
3. If it is not possible to connect the computer to a spare port of an Ethernet switch or router, then the power supply must be disconnected from the network in order to execute this test:
   - Disconnect the power supply from the network.
   - Connect the computer directly to the LAN port of the power supply.
4. On the computer, open the Command Prompt application.
5. Send 1000 ping packets of length 1500 bytes. The process will take 1000 seconds, which is approximately 17 minutes.

   If the computer is running a Windows operating system, this is achieved by typing (for an IPv6 address, use the ping6 command):

   ping –n 1000 –l 1500 <ipaddress>

   where <ipaddress> is the IP address of the AP or SM under test.

   If the computer is running a MAC operating system, this is achieved by typing:

   ping –c 1000 –s 1492 <ipaddress>

   where <ipaddress> is the IP address of the AP/SM under test.
6. Record how many Ping packets are lost. This is reported by Command Prompt on completion of the test.

   The test has passed if the number of lost packets is less than 2.

Troubleshooting the radio link

This section describes how to test the link when there is no radio communication, when it is unreliable, or when the data throughput rate is too low. It may be necessary to test both the AP and the SM.

MODULE HAS LOST OR DOES NOT ESTABLISH RADIO CONNECTIVITY

If there is no wireless activity, follow this:

Procedure:

1. Check that the AP and SMs are configured with the same **Frequency Carrier**. Also, if operating in a region where DFS is required, ensure that the SM's **Frequency Carrier List** contains the frequencies configured in the AP's **DFS Alternate Frequency Carrier 1** and **DFS Alternate Frequency Carrier 2** fields.
2. Check that the **Channel Bandwidth** is configured the same at the AP and at the SM
3. On the AP, verify that the **Max Range** setting is configured to a distance slightly greater than the distance between the AP and the furthest SM that must register to the AP.
4. Check that the AP's **Synchronization Source** is configured properly based on the network configuration.
5. Verify the authentication settings on the AP and SM. if **Authentication Type** is set to **WPA2**, verify that the **Pre-shared Key** matches between the AP and the SM **Preferred AP List**
6. Check that the software at each end of the link is the same version.
7. Check that the desired AP's SSID is configured in the SM **Preferred AP List**.
8. On the SM, check the **DL RSSI** and **DL CINR** values. Verify that for the SM installed distance, that the values are consistent with **Table 87 5 GHz threshold, power and link loss** on page **306** and **Table 88 2.4 GHz threshold, power and link loss** on page **307**.
9. Check Tx Power on the AP and SM
10. Check that the link is not obstructed or the AP/SM misaligned.
11. Check the DFS status page (**Monitor**, **System Status**) at each end of the link and establish that there is a quiet wireless channel to use.
12. If there are no faults found in the configuration and there is absolutely no wireless signal, retry the installation procedure.
13. If this does not work then report a suspected AP/SM fault to Cambium Networks.

LINK IS UNRELIABLE OR DOES NOT ACHIEVE DATA RATES REQUIRED

If there is some activity but the link is unreliable or does not achieve the data rates required, proceed as follows:

Procedure:

1. Check that the interference has not increased by monitoring the uplink and downlink CINR values reported in the AP page **Monitor**, **Wireless Status**
2. Check that the RSSI values reported at the AP an SM are proper based on the distance of the link – see **Table 87 5 GHz threshold, power and link loss** on page **306** and

   Table 88 2.4 GHz threshold, power and link loss on page **307.**
3. Check that the path loss is low enough for the communication rates required.
4. Check that the AP or SM has not become misaligned.
5. Review your Quality of Service configuration and ensure that traffic is properly classified and prioritized.

MODULE HAS LOST OR DOES NOT GAIN GPS SYNCHRONIZATION

To troubleshoot a loss of sync, perform the following steps.

Procedure:

1. If the AP is receiving synchronization via CMM, verify that the CMM is properly receiving sync via its attached GPS antenna (see *PMP Synchronization Solutions User Guide*). Verify that the cables from the CMM to the network switch are at most 30 Ft (shielded) or 10 Ft (unshielded) and that the network switch is not PoE (802.3af) capable.
2. If the CMM is receiving GPS synchronization pulses, verify that the AP's **Synchronization Source** is set to **CMM** and that the AP's GPS status bar icon is lit green.
3. If the AP is receiving synchronization via its internal GPS module and an external GPS antenna, verify the cabling from the AP to the GPS antenna, and verify that the AP's **Synchronization Source** is set to **GPS**.

Using the device external reset button

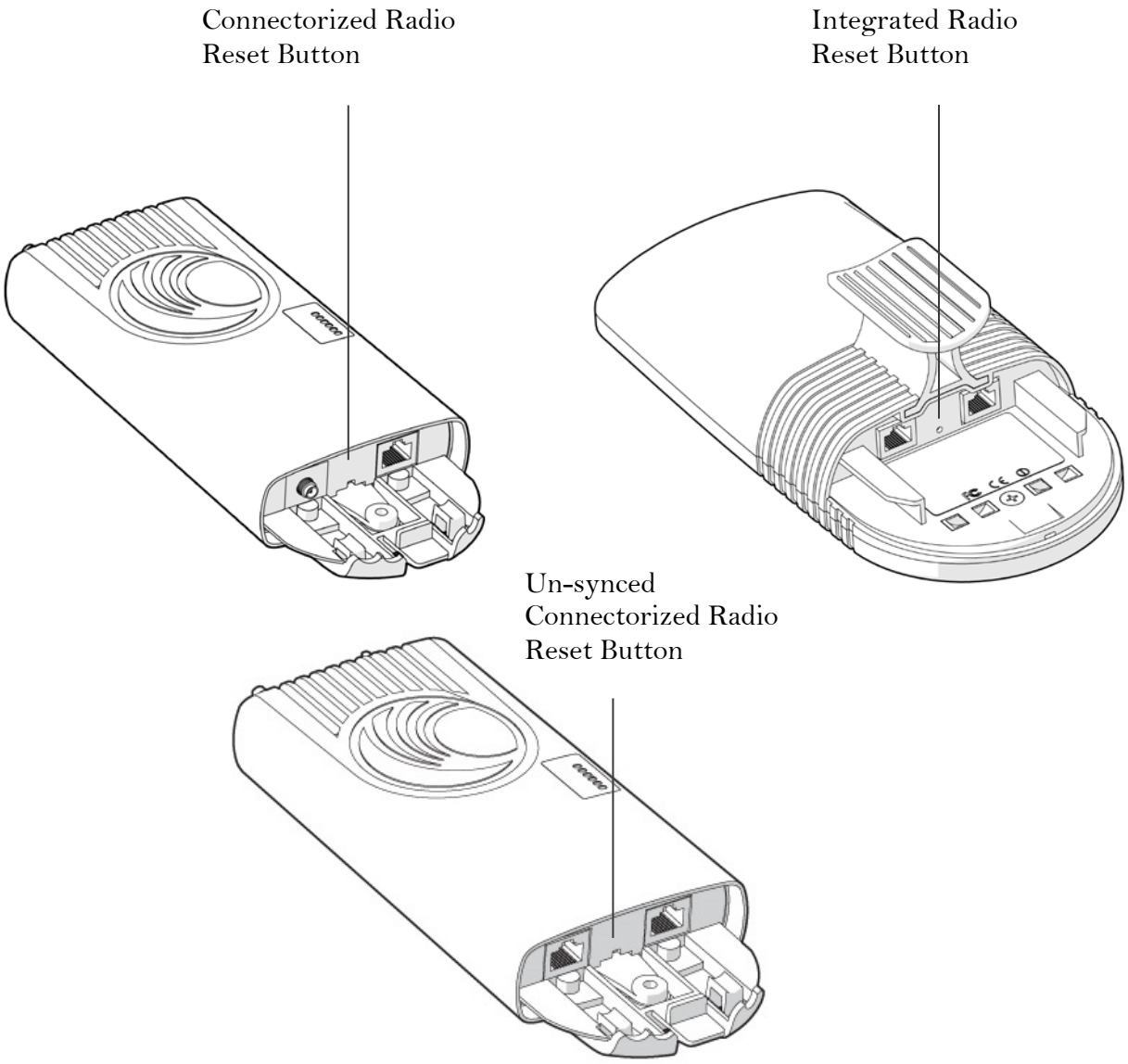
ePMP APs and SMs feature an external button which serves two purposes:

- To reset the device (briefly depress the button for more than two seconds but less than ten seconds then release)

  Caution

  If the reset button is pressed for more than ten seconds while powered on, the device will reset back to its factory default configuration

- To reset the device to its factory default configuration (depress the button for more than ten seconds then release)



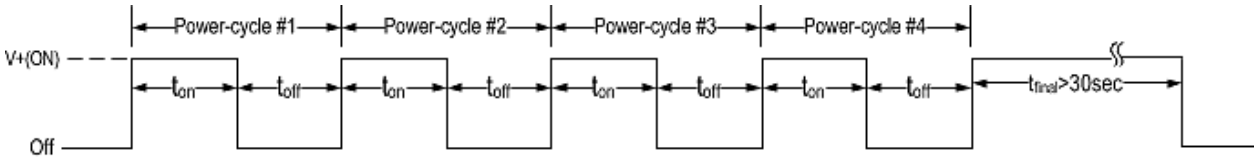
Resetting the ePMP to factory defaults by power cycling

Operators may reset an ePMP radio to default factory configuration by a sequence of power cycling (removing and re-applying power to the device). This procedure allows operators to perform a factory default reset without a tower climb or additional tools. The procedure is depicted in Figure 63.

Procedure:

1. Remove the Ethernet cable from PoE jack of the power supply for at least 10 seconds.
2. Reconnect the Ethernet cable to re-supply power to the ePMP device for **3-5 seconds** and disconnect cable to power off the ePMP device for **3-5 seconds**. (1st power cycle)
3. Reconnect the Ethernet cable to re-supply power to the ePMP device for **3-5 seconds** and disconnect cable to power off the ePMP device for **3-5 seconds**. (2nd power cycle)
4. Reconnect the Ethernet cable to re-supply power to the ePMP device for **3-5 seconds** and disconnect cable to power off the ePMP device for **3-5 seconds**. (3rd power cycle)
5. Reconnect the Ethernet cable to re-supply power to the ePMP device for **3-5 seconds** and disconnect cable to power off the ePMP device for **3-5 seconds**. (4th power cycle)
6. Reconnect the Ethernet cable to re-supply power to the ePMP device for at least **30 seconds** and allow it to go through the boot up procedure (Note: Device will go through an additional reset automatically). This will reset the current configuration files to factory default configuration (e.g. IP addresses, Device mode, RF configuration etc.). The device can be pinged from a PC to check if boot up is complete (Successful ping replies indicates boot up is complete).
7. Access the ePMP device using the default IP address of 192.168.0.1 (AP) or 192.168.0.2 (SM).

Figure 63 Power cycle timings



Where:	Is:
V+(ON)	Power through PoE has been applied to the device
Off	Power through PoE has been removed from the device
t_{on}	Time duration for which the device has been powered on. This should be 3-5 seconds.
t_{off}	Time duration for which the device has been powered off. This should be 3-5 seconds.

Legal and reference information

This chapter provides legal notices including software license agreements.

 Caution

Intentional or unintentional changes or modifications to the equipment must not be made unless under the express consent of the party responsible for compliance. Any such modifications could void the user's authority to operate the equipment and will void the manufacturer's warranty.

The following topics are described in this chapter:

- **Cambium Networks end user license agreement** on page **232**
- **Hardware warranty** on page **304**
- **Limit of liability** on page **305**
- **Compliance with safety standards** on page **308** lists the safety specifications against which the ePMP has been tested and certified. It also describes how to keep RF exposure within safe limits.
- **Compliance with radio regulations** on page **320** describes how the ePMP complies with the radio regulations that are enforced in various countries.
- **Notifications** on page **338** contain notes made to regulatory bodies for the ePMP.
- **Data throughput tables** on page **349** contain tables and graphs to support calculation of the data rate capacity that can be provided by ePMP configurations.

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	* the Free Software Foundation; either version 2 of the License, or * (at your option) any later version. */ GPLv2 See full license text on page **246**.
libnfnetlink	/* iftable - table of network interfaces * * (C) 2004 by Astaro AG, written by Harald Welte <hwelte@astaro.com> * (C) 2008 by Pablo Neira Ayuso <pablo@netfilter.org> * * This software is Free Software and licensed under GNU GPLv2+. */ /* libnfnetlink.c: generic library for communication with netfilter * * (C) 2002-2006 by Harald Welte <laforge@gnumonks.org> * (C) 2006-2011 by Pablo Neira Ayuso <pablo@netfilter.org> * * Based on some original ideas from Jay Schulist <jschlst@samba.org> * * Development of this code funded by Astaro AG (http://www.astaro.com)

```
*
* This program is free software; you can redistribute it and/or modify it
* under the terms of the GNU General Public License version 2 as published
* by the Free Software Foundation.
*
* 2005-09-14 Pablo Neira Ayuso <pablo@netfilter.org>:
*  Define structure nfnlhdr
*  Added __be64_to_cpu function
* Use NFA_TYPE macro to get the attribute type
*
* 2006-01-14 Harald Welte <laforge@netfilter.org>:
*  introduce nfnl_subsys_handle
*
* 2006-01-15 Pablo Neira Ayuso <pablo@netfilter.org>:
*  set missing subsys_id in nfnl_subsys_open
*  set missing nfnlh->local.nl_pid in nfnl_open
*
* 2006-01-26 Harald Welte <laforge@netfilter.org>:
*  remove bogus nfnlh->local.nl_pid from nfnl_open ;)
*  add 16bit attribute functions
*
* 2006-07-03 Pablo Neira Ayuso <pablo@netfilter.org>:
*  add iterator API
*  add replacements for nfnl_listen and nfnl_talk
*  fix error handling
*  add assertions
*  add documentation
*  minor cleanups
```

	/ / rtnl - rtnetlink utility functions * * (C) 2004 by Astaro AG, written by Harald Welte <hwelte@astaro.com> * * Adapted to nfnetlink by Eric Leblond <eric@inl.fr> * * This software is free software and licensed under GNU GPLv2+. * */ GPLv2 See full license text on page **246**.
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System threshold, output power and link loss

The following table specifies the system threshold (dBm), output power (dBm) and maximum link loss (dB) per channel bandwidth and modulation mode:

- 5 GHz – **Table 87**
- 2.4 GHz – **Table 88**

Table 87 5 GHz threshold, power and link loss

Modulation mode	System threshold (dBm) per channel bandwidth				Output power (dBm)	Maximum link loss (dB) per channel bandwidth			
	5 MHz	10 MHz	20 MHz	40 MHz	All bands	5 MHz	10 MHz	20 MHz	40 MHz
MCS15	-74	-71	-68	-65	23	121	118	115	112
MCS14	-76	-73	-70	-67	23	123	120	117	114
MCS13	-79	-76	-73	-70	23	126	123	120	117
MCS12	-83	-80	-77	-74	23	130	127	124	121
MCS11	-87	-84	-81	-79	23	134	131	128	126
MCS10	-89	-86	-83	-80	23	136	133	130	127
MCS9	-92	-89	-86	-84	23	139	136	133	131
MCS7	-77	-74	-71	-68	23	124	121	118	115
MCS6	-79	-76	-73	-70	23	126	123	120	117
MCS5	-82	-79	-76	-73	23	129	126	123	120
MCS4	-86	-83	-80	-77	23	133	130	127	124
MCS3	-90	-87	-84	-82	23	137	134	131	129
MCS2	-92	-89	-86	-83	23	139	136	133	130
MCS1	-95	-92	-89	-87	23	142	139	136	134

Table 88 2.4 GHz threshold, power and link loss

Modulation mode	System threshold (dBm) per channel bandwidth				Output power (dBm)	Maximum link loss (dB) per channel bandwidth			
	5 MHz	10 MHz	20 MHz	40 MHz	All bands	5 MHz	10 MHz	20 MHz	40 MHz
MCS15	-74	-71	-68	-65	23	121	118	115	112
MCS14	-76	-73	-70	-67	23	123	120	117	114
MCS13	-79	-76	-73	-70	23	126	123	120	117
MCS12	-83	-80	-77	-74	23	130	127	124	121
MCS11	-87	-84	-81	-79	23	134	131	128	126
MCS10	-89	-86	-83	-80	23	136	133	130	127
MCS9	-92	-89	-86	-84	23	139	136	133	131
MCS7	-77	-74	-71	-68	23	124	121	118	115
MCS6	-79	-76	-73	-70	23	126	123	120	117
MCS5	-82	-79	-76	-73	23	129	126	123	120
MCS4	-86	-83	-80	-77	23	133	130	127	124
MCS3	-90	-87	-84	-82	23	137	134	131	129
MCS2	-92	-89	-86	-83	23	139	136	133	130
MCS1	-95	-92	-89	-87	23	142	139	136	134

Compliance with safety standards

This section lists the safety specifications against which the ePMP has been tested and certified. It also describes how to keep RF exposure within safe limits.

ELECTRICAL SAFETY COMPLIANCE

The ePMP hardware has been tested for compliance to the electrical safety specifications listed in **Table 89**.

Table 89 ePMP safety compliance specifications

Region	Standard
USA	UL 60950-1, 2nd Edition
Canada	CSA C22.2 No.60950 2nd Edition
International	International CB certified and certified to IEC 60950-1:2005 (modified) plus EN60950-1:2006 + A1:2010

ELECTROMAGNETIC COMPATIBILITY (EMC) COMPLIANCE

The ePMP complies with European EMC Specification EN301 489-1 with testing carried out to the detailed requirements of EN301 489-4.

The EMC specification type approvals that have been granted for ePMP are listed under **Table 90**.

Table 90 EMC emissions compliance

Region	Specification (Type Approvals)
USA	FCC CFR 47 Part 15 class B
Canada	RSS210, Issue 8
Europe	ETSI EN301 489-4

HUMAN EXPOSURE TO RADIO FREQUENCY ENERGY

Standards

Relevant standards (USA and EC) applicable when working with RF equipment are:

- ANSI IEEE C95.1-1991, IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz.
- Council recommendation of 12 July 1999 on the limitation of exposure of the general public to electromagnetic fields (0 Hz to 300 GHz) (1999/519/EC) and respective national regulations.
- *Directive 2004/40/EC of the European Parliament and of the Council of 29 April 2004* on the minimum health and safety requirements regarding the exposure of workers to the risks arising from physical agents (electromagnetic fields) (18th individual Directive within the meaning of Article 16(1) of Directive 89/391/EEC).
- US FCC limits for the general population. See the FCC web site http://www.fcc.gov and the policies, guidelines, and requirements in Part 1 of Title 47 of the Code of Federal Regulations, as well as the guidelines and suggestions for evaluating compliance in FCC OET Bulletin 65.
- Health Canada limits for the general population. See the Health Canada web site http://www.hc-sc.gc.ca/ewh-semt/pubs/radiation/99ehd-dhm237/limits-limites_e.html and Safety Code 6.
- EN 50383:2002 Basic standard for the calculation and measurement of electromagnetic field strength and SAR related to human exposure from radio base Subscriber Modules and fixed terminal Subscriber Modules for wireless telecommunication systems (110 MHz - 40 GHz).
- BS EN 50385:2002 Product standard to demonstrate the compliances of radio base Subscriber Modules and fixed terminal Subscriber Modules for wireless telecommunication systems with the basic restrictions or the reference levels related to human exposure to radio frequency electromagnetic fields (110 MHz – 40 GHz) – general public.
- ICNIRP (International Commission on Non-Ionizing Radiation Protection) guidelines for the general public. See the ICNIRP web site http://www.icnirp.de/ and Guidelines for Limiting Exposure to Time-Varying Electric, Magnetic, and Electromagnetic Fields.

Power density exposure limit

Install the radios for the ePMP family of PMP wireless solutions so as to provide and maintain the minimum separation distances from all persons.

The applicable power density exposure limit from the standards (see **Human exposure to radio frequency energy** on page **309**) is:

- **10 W/m^2** for RF energy in the 5 GHz and 2.4 GHz frequency bands.

Calculation of power density

Peak power density in the far field of a radio frequency point source is calculated as follows:

Note

The following calculation is based on the ANSI IEEE C95.1-1991 method, as that provides a worst case analysis. Details of the assessment to EN50383:2002 can be provided, if required.

$$S = \frac{P.G}{4\pi d^2}$$

Where:	Is:
S	power density in W/m^2
P	maximum average transmit power capability of the radio, in W
G	total Tx gain as a factor, converted from dB
d	distance from point source, in m

Rearranging terms to solve for distance yields:

$$d = \sqrt{\frac{P.G}{4\pi.S}}$$

Calculated distances and power compliance margins

The calculated minimum separation distances, recommended distances and resulting margins for each frequency band and antenna combination is shown in **Table 91** through

Channel Bandwidth	Antenna	P (W)	G	S (W/m^2)	d (m)	R (m)	C
40 MHz	Modular Array, 17 dBi	0.834	50.1	12	0.58	1.2	43.3
40 MHz	Modular Dish, 24 dBi	0.834	251.2	13	1.29	2.5	37.5
40 MHz	Module Dipole, 2 dBi	0.834	1.6	14	0.10	0.2	38.0
5 MHz	Modular Array, 17 dBi	0.869	50.1	12	0.59	1.2	41.5
5 MHz	Modular Dish, 24 dBi	0.869	251.2	13	1.32	2.6	38.9
5 MHz	Module Dipole, 2 dBi	0.869	1.6	14	0.10	0.2	36.5

Table 106**.** These are conservative distances that include compliance margins. At these and greater separation distances, the power density from the RF field is below generally accepted limits for the general population.

Explanation of terms used in **Table 91** through

Table 106:

Channel Bandwidth	Antenna	P (W)	G	S (W/m^2)	d (m)	R (m)	C
40 MHz	Modular Array, 17 dBi	0.834	50.1	12	0.58	1.2	43.3
40 MHz	Modular Dish, 24 dBi	0.834	251.2	13	1.29	2.5	37.5
40 MHz	Module Dipole, 2 dBi	0.834	1.6	14	0.10	0.2	38.0
5 MHz	Modular Array, 17 dBi	0.869	50.1	12	0.59	1.2	41.5
5 MHz	Modular Dish, 24 dBi	0.869	251.2	13	1.32	2.6	38.9
5 MHz	Module Dipole, 2 dBi	0.869	1.6	14	0.10	0.2	36.5

Tx burst – maximum average transmit power in burst (Watt)

P – maximum average transmit power capability of the radio (Watt)

G – total transmit gain as a factor, converted from dB

S – power density (W/m^2)

d – minimum distance from point source (meters)

R – recommended distances (meters)

C – compliance factor

Table 91 and Table 92 below are the power compliance margins for the following devices:

Model Number	Part Number	FCC ID	Industry Canada
C058900P112A	C058900C112A	Z8H89FT0006	109W-0006

Table 91 Power compliance margins, 5.1 GHz, AP

Conn Type	Channel Bandwidth	Antenna	P (W)	G	S (W/m^2)	d (m)	R (m)	C
PMP	5/10 MHz	Connectorized Omni, 3 dBi	0.063	2.0	10	0.03	0.1	99.8
PMP	5/10 MHz	Connectorized Sector Array, 16 dBi	0.032	39.8	10	0.10	0.3	89.8
PTP	5/10 MHz	Connectorized Patch Panel Array, 23 dBi	0.010	199.5	10	0.13	0.3	56.7
PTP	5/10 MHz	Connectorized Dish, 30 dBi	0.002	1000.0	10	0.13	0.3	56.7
PMP	20/40 MHz	Connectorized Omni, 3 dBi	0.063	2.0	10	0.03	0.1	99.8
PMP	20/40 MHz	Connectorized Sector Array, 16 dBi	0.100	39.8	10	0.18	0.4	50.5
PTP	20/40 MHz	Connectorized Patch Panel Array, 23 dBi	0.008	199.5	10	0.11	0.3	71.3
PTP	20/40 MHz	Connectorized Dish, 30 dBi	0.001	1000.0	10	0.10	0.2	39.9

Table 92 Power compliance margins, 5.2/5.4/5.8 GHz, AP

Antenna	P (W)	G	S (W/m^2)	d (m)	R (m)	C
Connectorized Sector, 15 dBi	0.199	31.6	10	0.22	.4	33.1

Table 93 through Table 96 below are the power compliance margins for the following devices:

Model Number	Part Number	FCC ID	Industry Canada
C058900P122A	C058900C122A	Z8H89FT0005	109W-0005

Table 93 Power compliance margins, 5.1 GHz, SM

Conn Type	Channel Bandwidth	Antenna	P (W)	G	S (W/m^2)	d (m)	R (m)	C
PMP	5/10 MHz	Connectorized Omni, 3 dBi	0.063	2.0	10	0.03	0.1	99.8
PMP	5/10 MHz	Integrated Patch Array, 16 dBi	0.100	39.8	10	0.18	0.4	50.5
PMP	5/10 MHz	Connectorized Sector Array, 16 dBi	0.100	39.8	10	0.18	0.4	50.5
PTP	5/10 MHz	Integrated Patch Array, 16 dBi	0.100	39.8	10	0.18	0.4	50.5
PTP	5/10 MHz	Connectorized Patch Panel Array, 23 dBi	0.013	199.5	10	0.14	0.3	45.0
PTP	5/10 MHz	Connectorized Dish, 30 dBi	0.001	1000.0	10	0.09	0.2	50.2
PMP	20/40 MHz	Connectorized Omni, 3 dBi	0.063	2.0	10	0.03	0.1	99.8
PMP	20/40 MHz	Integrated Patch Array, 16 dBi	0.032	39.8	10	0.10	0.2	39.9
PMP	20/40 MHz	Connectorized Sector Array, 16 dBi	0.032	39.8	10	0.10	0.3	89.8
PTP	20/40 MHz	Integrated Patch Array, 16 dBi	0.032	39.8	10	0.10	0.2	39.9
PTP	20/40 MHz	Connectorized Patch Panel Array, 23 dBi	0.005	199.5	10	0.09	0.2	50.2
PTP	20/40 MHz	Connectorized Dish, 30 dBi	0.001	1000.0	10	0.09	0.2	50.2

Caution

For countries that follow FCC regulations, the combined conducted power must be reduced according to Table 94, for the lower edge of the 5.1 GHz band in order, to meet restricted band requirements.

Table 94 FCC conducted power (combined) for lower edge of 5.2 GHz

Channel Bandwidth	Antenna	Conducted Power (combined)
5/10 MHz	Connectorized Omni, 3 dBi	18 dBm
5/10 MHz	Integrated Patch Array, 16 dBi	7 dBm
5/10 MHz	Connectorized Sector Array, 16 dBi	7 dBm
5/10 MHz	Connectorized Patch Panel Array, 23 dBi	0 dBm
5/10 MHz	Connectorized Dish, 30 dBi	-7 dBm
20/40 MHz	Connectorized Omni, 3 dBi	15 dBm
20/40 MHz	Integrated Patch Array, 16 dBi	7 dBm
20/40 MHz	Connectorized Sector Array, 16 dBi	7 dBm
20/40 MHz	Connectorized Patch Panel Array, 23 dBi	2 dBm
20/40 MHz	Connectorized Dish, 30 dBi	-5 dBm

Table 95 Power compliance margins, 5.4 GHz, SM

Antenna	P (W)	G	S (W/m^2)	d (m)	R (m)	C
Integrated Patch Array, 13 dBi	0.020	20	10	0.06	0.2	126.2
Integrated Patch Array, 13 dBi with Reflector Dish, 6 dBi	0.020	79.4	10	0.11	0.3	71.3
Connectorized Patch Panel Array, 23 dBi	0.020	199.5	10	0.18	0.4	50.5
Connectorized Dish, 30 dBi	0.020	1000	10	0.40	1	62.9

Table 96 Power compliance margins, 5.8/5.9 GHz, SM

Antenna	P (W)	G	S (W/m^2)	d (m)	R (m)	C
Integrated Patch Array, 13 dBi	0.199	20	10	0.18	0.4	50.5
Integrated Patch Array, 13 dBi with Reflector Dish, 6 dBi	0.199	79.4	10	0.36	0.8	50.7
Connectorized Patch Panel Array, 23 dBi	0.199	199.5	10	0.56	1.2	45.4
Connectorized Dish, 30 dBi	0.199	1000	10	1.26	2	25.2

Table 97 Power compliance margins, 2.4 GHz, AP (FCC ID: Z8H89FT0012)

Conn	Channel	Antenna	P	G	S	d	R	C

Type	Bandwidth		(W)		(W/m^2)	(m)	(m)	
PMP	20 MHz	Connectorized, 8 dBi Omni	0.631	6.3	10	0.18	0.4	50.5
PMP	40 MHz	Connectorized, 8 dBi Omni	0.631	6.3	10	0.18	0.4	50.5
PMP	20 MHz	Connectorized, 17 dBi Sector	0.079	50.1	10	0.18	0.4	50.5
PMP	40 MHz	Connectorized, 17 dBi Sector	0.032	50.1	10	0.11	0.3	71.3
PTP	20 MHz	Connectorized, 25 dBi Dish	0.003	316.2	10	0.08	0.2	63.2
PTP	40 MHz	Connectorized, 25 dBi Dish	0.003	316.2	10	0.08	0.2	63.2

Table 98 Power compliance margins, 2.4 GHz, SM (FCC ID: Z8H89FT0011)

Conn Type	Channel Bandwidth	Antenna	P (W)	G	S (W/m^2)	d (m)	R (m)	C
PMP	20 MHz	Connectorized, 8 dBi Omni	0.631	6.3	10	0.18	0.4	50.5
PMP	20 MHz	Integrated, 12 dBi Patch	0.251	15.8	10	0.18	0.4	50.5
PMP	20 MHz	Integrated 12 dBi Patch with 8 dBi Reflector Dish	0.398	100.0	10	0.56	1.0	50.0
PMP	20 MHz	Connectorized, 17 dBi Sector	0.079	50.1	10	0.18	0.4	50.5
PMP	20 MHz	Connectorized, 19 dBi Panel	0.050	79.4	10	0.18	0.4	50.5
PMP	20 MHz	Connectorized, 25 dBi Dish	0.010	316.2	10	0.16	0.4	63.5
PMP	40 MHz	Connectorized, 8 dBi Omni	0.100	6.3	10	0.07	0.2	79.6
PMP	40 MHz	Integrated, 12 dBi Patch	0.050	15.8	10	0.08	0.2	63.2
PMP	40 MHz	Integrated 12 dBi Patch with 8 dBi Reflector Dish	0.050	100.0	10	0.20	0.4	40.1
PMP	40 MHz	Connectorized, 17 dBi Sector	0.025	50.1	10	0.10	0.2	39.9
PMP	40 MHz	Connectorized, 19 dBi Panel	0.020	79.4	10	0.11	0.3	71.3
PMP	40 MHz	Connectorized, 25 dBi Dish	0.006	316.2	10	0.13	0.3	56.7
PTP	20 MHz	Integrated, 12 dBi Patch	0.398	15.8	10	0.22	0.4	31.9
PTP	20 MHz	Integrated 12 dBi Patch with 8 dBi Reflector Dish	0.398	100.0	10	0.56	1.2	45.4
PTP	20 MHz	Connectorized, 17 dBi Sector	0.158	50.1	10	0.25	0.5	39.5
PTP	20 MHz	Connectorized, 19 dBi Panel	0.050	79.4	10	0.18	0.4	50.5

PTP	20 MHz	Connectorized, 25 dBi Dish	0.010	316.2	10	0.16	0.4	63.5
PTP	40 MHz	Integrated, 12 dBi Patch	0.050	15.8	10	0.08	0.2	63.2
PTP	40 MHz	Integrated 12 dBi Patch with 8 dBi Reflector Dish	0.050	100.0	10	0.20	0.4	40.1
PTP	40 MHz	Connectorized, 17 dBi Sector	0.025	50.1	10	0.10	0.2	39.9
PTP	40 MHz	Connectorized, 19 dBi Panel	0.020	79.4	10	0.11	0.3	71.3
PTP	40 MHz	Connectorized, 25 dBi Dish	0.006	316.2	10	0.13	0.3	56.7

 Note

Gain of antenna in dBi = 10*log (G).

The regulations require that the power used for the calculations is the maximum power in the transmit burst subject to allowance for source-based time-averaging.

At 2.4 GHz, 5.4 GHz and EU 5.8 GHz the products are generally limited to a fixed EIRP which can be achieved with the Integrated Antenna. The calculations above assume that the maximum EIRP allowed by the regulations is being transmitted.

 Note

If there are no EIRP limits in the country of deployment, use the distance calculations for FCC 5.8 GHz for all frequency bands.

Table 99 through

Table 106 below are the power compliance margins for the following devices:

Channel Bandwidth	Antenna	P (W)	G	S (W/m^2)	d (m)	R (m)	C
40 MHz	Modular Array, 17 dBi	0.834	50.1	12	0.58	1.2	43.3
40 MHz	Modular Dish, 24 dBi	0.834	251.2	13	1.29	2.5	37.5
40 MHz	Module Dipole, 2 dBi	0.834	1.6	14	0.10	0.2	38.0
5 MHz	Modular Array, 17 dBi	0.869	50.1	12	0.59	1.2	41.5
5 MHz	Modular Dish, 24 dBi	0.869	251.2	13	1.32	2.6	38.9
5 MHz	Module Dipole, 2 dBi	0.869	1.6	14	0.10	0.2	36.5

Model Number	Part Number	FCC ID	Industry Canada
C058900P072A	C058900C072A	Z8H89FT0015	109W-0015
C058900P062A	C058900C062A	Z8H89FT0015	109W-0015

Table 99 Power compliance margins, 5.1 GHz, AP

Connection Type	Antenna	P (W)	G	S (W/m^2)	d (m)	R (m)	C
PMP	Modular Array, 17 dBi	0.079	50.1	10	0.18	0.4	50.5
PMP	Modular Dish, 24 dBi	0.016	251.2	10	0.18	0.4	50.5
PMP	Module Dipole, 2 dBi	0.398	1.6	11	0.07	0.2	79.6
PTP	Modular Array, 17 dBi	0.398	50.1	12	0.40	1	62.9
PTP	Modular Dish, 24 dBi	0.398	251.2	13	0.89	2	50.2
PTP	Module Dipole, 2 dBi	0.398	1.6	14	0.07	0.2	79.6

Table 100 Power compliance margins, 5.2 GHz, AP

Connection Type	Antenna	P (W)	G	S (W/m^2)	d (m)	R (m)	C
PMP	Modular Array, 17 dBi	0.020	50.1	10	0.09	0.2	50.2
PMP	Modular Dish, 24 dBi	0.004	251.2	10	0.09	0.2	50.2
PMP	Module Dipole, 2 dBi	0.200	1.6	11	0.05	0.1	39.7

PTP	Modular Array, 17 dBi	0.020	50.1	12	0.09	0.2	50.2
PTP	Modular Dish, 24 dBi	0.004	251.2	13	0.09	0.2	50.2
PTP	Module Dipole, 2 dBi	0.200	1.6	14	0.05	0.1	39.7

Table 101 Power compliance margins, 5.4 GHz, AP

Connection Type	Antenna	P (W)	G	S (W/m^2)	d (m)	R (m)	C
PMP	Modular Array, 17 dBi	0.020	50.1	10	0.09	0.2	50.2
PMP	Modular Dish, 24 dBi	0.004	251.2	10	0.09	0.2	50.2
PMP	Module Dipole, 2 dBi	0.200	1.6	11	0.05	0.1	39.7
PTP	Modular Array, 17 dBi	0.020	50.1	12	0.09	0.2	50.2
PTP	Modular Dish, 24 dBi	0.004	251.2	13	0.09	0.2	50.2
PTP	Module Dipole, 2 dBi	0.200	1.6	14	0.05	0.1	39.7

Table 102 Power compliance margins, 5.8 GHz, AP

Connection Type	Channel Bandwidth	Antenna	P (W)	G	S (W/m^2)	d (m)	R (m)	C
PMP	40 MHz	Modular Array, 17 dBi	0.052	50.1	10	0.14	0.4	77.1
PMP	40 MHz	Modular Dish, 24 dBi	0.011	251.2	10	0.15	0.4	69.8
PMP	40 MHz	Module Dipole, 2 dBi	0.398	1.6	11	0.07	0.2	79.6
PTP	40 MHz	Modular Array, 17 dBi	0.834	50.1	12	0.58	1.2	43.3
PTP	40 MHz	Modular Dish, 24 dBi	0.834	251.2	13	1.29	2.5	37.5
PTP	40 MHz	Module Dipole, 2 dBi	0.834	1.6	14	0.10	0.2	38.0
PMP	5 MHz	Modular Array, 17 dBi	0.064	50.1	10	0.16	0.4	62.4
PMP	5 MHz	Modular Dish, 24 dBi	0.013	251.2	10	0.16	0.4	62.9
PMP	5 MHz	Module Dipole, 2 dBi	0.398	1.6	11	0.07	0.2	79.6
PTP	5 MHz	Modular Array, 17 dBi	0.869	50.1	12	0.59	1.2	41.5
PTP	5 MHz	Modular Dish, 24 dBi	0.869	251.2	13	1.32	2.6	38.9
PTP	5 MHz	Module Dipole, 2 dBi	0.869	1.6	14	0.10	0.2	36.5

Table 103 Power compliance margins, 5.1 GHz, SM

Antenna	P (W)	G	S (W/m^2)	d (m)	R (m)	C
Modular Array, 17 dBi	0.398	50.1	12	0.40	1	62.9
Modular Dish, 24 dBi	0.398	251.2	13	0.89	2	50.2
Module Dipole, 2 dBi	0.398	1.6	14	0.07	0.2	79.6

Table 104 Power compliance margins, 5.2 GHz, SM

Antenna	P (W)	G	S (W/m^2)	d (m)	R (m)	C
Modular Array, 17 dBi	0.020	50.1	12	0.09	0.2	50.2
Modular Dish, 24 dBi	0.004	251.2	13	0.09	0.2	50.2
Module Dipole, 2 dBi	0.200	1.6	14	0.05	0.1	39.7

Table 105 Power compliance margins, 5.4 GHz, SM

Antenna	P (W)	G	S (W/m^2)	d (m)	R (m)	C
Modular Array, 17 dBi	0.020	50.1	12	0.09	0.2	50.2
Modular Dish, 24 dBi	0.004	251.2	13	0.09	0.2	50.2
Module Dipole, 2 dBi	0.200	1.6	14	0.05	0.1	39.7

Table 106 Power compliance margins, 5.8 GHz, SM

Channel Bandwidth	Antenna	P (W)	G	S (W/m^2)	d (m)	R (m)	C
40 MHz	Modular Array, 17 dBi	0.834	50.1	12	0.58	1.2	43.3
40 MHz	Modular Dish, 24 dBi	0.834	251.2	13	1.29	2.5	37.5
40 MHz	Module Dipole, 2 dBi	0.834	1.6	14	0.10	0.2	38.0
5 MHz	Modular Array, 17 dBi	0.869	50.1	12	0.59	1.2	41.5
5 MHz	Modular Dish, 24 dBi	0.869	251.2	13	1.32	2.6	38.9
5 MHz	Module Dipole, 2 dBi	0.869	1.6	14	0.10	0.2	36.5

Compliance with radio regulations

This section describes how the ePMP complies with the radio regulations that are enforced in various countries.

Caution

Changes or modifications not expressly approved by Cambium Networks could void the user's authority to operate the system.

TYPE APPROVALS

This system has achieved Type Approval in various countries around the world. This means that the system has been tested against various local technical regulations and found to comply. The frequency bands in which the system operates may be unlicensed and, in these bands, the system can be used provided it does not cause interference. The system is not guaranteed protection against interference from other products and installations.

The radio specification type approvals that have been granted for ePMP frequency variants are listed under **Table 90**.

Table 107 Radio certifications

Frequency band	Region	Regulatory approvals
2.4 GHz, 5 GHz	USA	FCC Part 15 Class B
	Canada	IC RSS-210 Issue 8, Annex 8 (or latest)
	Europe	ETSI EN302 502 v1.2.1 ETSI EN301 893 v1.7.1

FCC AND ETSI COMPLIANCE TESTING

The system has been tested for compliance to both US (FCC) and European (ETSI) specifications. It has been shown to comply with the limits for emitted spurious radiation for a Class B digital device, pursuant to Part 15 of the FCC Rules in the USA and appropriate European ENs. These limits have been designed to provide reasonable protection against harmful interference. However the equipment can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to other radio communications. There is no guarantee that interference will not occur in a particular installation. To comply with FCC RF exposure limits for general population or uncontrolled exposure, the antenna(s) used for the ePMP transmitter must be installed to ensure a separation distance specified in **Table 91** through

Channel Bandwidth	Antenna	P (W)	G	S (W/m^2)	d (m)	R (m)	C
40 MHz	Modular Array, 17 dBi	0.834	50.1	12	0.58	1.2	43.3
40 MHz	Modular Dish, 24 dBi	0.834	251.2	13	1.29	2.5	37.5

40 MHz	Module Dipole, 2 dBi	0.834	1.6	14	0.10	0.2	38.0
5 MHz	Modular Array, 17 dBi	0.869	50.1	12	0.59	1.2	41.5
5 MHz	Modular Dish, 24 dBi	0.869	251.2	13	1.32	2.6	38.9
5 MHz	Module Dipole, 2 dBi	0.869	1.6	14	0.10	0.2	36.5

Table 106 from all persons and must not be co-located or operating in conjunction with any other antenna or transmitter.

OEM Responsibilities to comply with FCC and Industry Canada Regulations

The ePMP Module is certified for integration into products only by OEM integrators under the following conditions:

1. The antennas(s) must be installed such that a minimum separation distance specified in **Table 91** through

Channel Bandwidth	Antenna	P (W)	G	S (W/m^2)	d (m)	R (m)	C
40 MHz	Modular Array, 17 dBi	0.834	50.1	12	0.58	1.2	43.3
40 MHz	Modular Dish, 24 dBi	0.834	251.2	13	1.29	2.5	37.5
40 MHz	Module Dipole, 2 dBi	0.834	1.6	14	0.10	0.2	38.0
5 MHz	Modular Array, 17 dBi	0.869	50.1	12	0.59	1.2	41.5
5 MHz	Modular Dish, 24 dBi	0.869	251.2	13	1.32	2.6	38.9
5 MHz	Module Dipole, 2 dBi	0.869	1.6	14	0.10	0.2	36.5

2. Table 106 is maintained between the radiator (antenna) and all persons at all times.

3. The transmitter module must not be co-located or operate in conjunction with any other antenna or transmitter. As long as the two conditions above are met, further transmitter testing is not required. However, the OEM integrator is still responsible for testing their end-product for any additional compliance requirements required with this module installed (for example, digital device emissions, PC peripheral requirements, etc.).

 Note

In the event that these conditions cannot be met (for certain configurations or co-location with another transmitter), then the FCC and Industry Canada authorizations are no longer considered valid and the FCC ID cannot be used.

 Note

A Class B Digital Device is a device that is marketed for use in a residential environment, notwithstanding use in commercial, business and industrial environments.

Notwithstanding that Cambium Networks has designed (and qualified) the ePMP products to generally meet the Class B requirement to minimize the potential for interference, the ePMP product range is not marketed for use in a residential environment.

End Product Labelling

The ePMP Module is labelled with its own FCC ID and IC Certification Number. If the FCC ID and IC Certification Number are not visible when the module is installed inside another device, then the outside of the device into which the module is installed must also display a label referring to the enclosed module. In that case, the final end product must be labelled in a visible area with the following:

Table 108 Product labelling

Radio Type	Label
Access Point (AP)	“Contains Transmitter Module FCC ID: Z8H89FT0006” or “Contains FCC ID: Z8H89FT0006”
Subscriber Module (SM)	“Contains Transmitter Module FCC ID: Z8H89FT0005” or “Contains FCC ID: Z8H89FT0005”
Access Point (AP) / Subscriber Module (SM)	“Contains Transmitter Module FCC ID: Z8H89FT0015” or “Contains FCC ID: Z8H89FT0015”

EXAMPLES OF REGULATORY LIMITS

Examples of the regulatory limits that apply in typical regions of operation are in the following tables:

- 5.1 GHz – **Table 109**
- 5.2 GHz –**Table 110**
- 5.3 GHz – **Table 111**
- 5.4 GHz – **Table 112**
- 5.8 GHz/5.9 GHz – **Table 113**
- 2.4 GHz – **Table 114**

Table 109 Regulatory Limits - 5.1 GHz

Country	Frequency range	Valid Center Frequency for 20 MHz Band	Valid Center Frequency for 40 MHz Band	Valid Center Frequency for 5/10 MHz Band	Conducted Power	EIRP Power
Armenia	5150-5250	5160-5240 every 5 MHz	5170-5230 every 5 MHz	5155-5250 every 5 MHz	20	
Argentina	5150-5250	5160-5240 every 5 MHz	5170-5230 every 5 MHz	5155-5250 every 5 MHz	20	
Azerbaijan	5150-5250	5160-5240 every 5 MHz	5170-5230 every 5 MHz	5155-5250 every 5 MHz	20	
Belarus	5150-5250	5160-5240 every 5 MHz	5170-5230 every 5 MHz	5155-5250 every 5 MHz	20	
Ecuador	5150-5250	5160-5240 every 5 MHz	5170-5230 every 5 MHz	5155-5250 every 5 MHz	20	
Georgia	5150-5250	5160-5240 every 5 MHz	5170-5230 every 5 MHz	5155-5250 every 5 MHz	20	
Guam	5150-5250	5180-5240 every 5 MHz	5190-5230 every 5 MHz	5160-5245 every 5 MHz	20	36 for non PTP AP. 53 for other modes.
Kyrgyzstan	5150-5250	5160-5240 every 5 MHz	5170-5230 every 5 MHz	5155-5250 every 5 MHz	20	
Kazakhstan	5150-5250	5160-5240 every 5 MHz	5170-5230 every 5 MHz	5155-5250 every 5 MHz	20	
Moldova	5150-5250	5160-5240 every 5 MHz	5170-5230 every 5 MHz	5155-5250 every 5 MHz	20	
Malaysia	5150-5250	5160-5240 every 5 MHz	5170-5230 every 5 MHz	5155-5250 every 5 MHz	20	
Other	5150-5250	5160-5250 every 5 MHz	5170-5250 every 5 MHz	5155-5250 every 5 MHz	27	
Peru	5150-5250	5160-5240 every 5 MHz	5170-5230 every 5 MHz	5155-5250 every 5 MHz	20	
Philippines	5150-5250	5160-5240 every 5 MHz	5170-5230 every 5 MHz	5155-5250 every 5 MHz	20	
Puerto Rico	5150-5250	5180-5240 every 5 MHz	5190-5230 every 5 MHz	5160-5245 every 5 MHz	20	36 for non PTP AP. 53 for other modes.
Russia	5150-5250	5160-5240 every 5 MHz	5170-5230 every 5 MHz	5155-5250 every 5 MHz	20	
Tajikistan	5150-5250	5160-5240 every 5 MHz	5170-5230 every 5 MHz	5155-5250 every 5 MHz	20	
Turkmenistan	5150-5250	5160-5240 every 5 MHz	5170-5230 every 5 MHz	5155-5250 every 5 MHz	20	
Ukraine	5150-5250	5160-5240 every 5 MHz	5170-5230 every 5 MHz	5155-5250 every 5 MHz	18	
Uganda	5150-5250	5160-5240 every 5 MHz	5170-5230 every 5 MHz	5155-5250 every 5 MHz	27	30
United States	5150-5250	5180-5240 every 5 MHz	5190-5230 every 5 MHz	5160-5245 every 5 MHz	20	36 for non PTP AP. 53 for other modes.
Uzbekistan	5150-5250	5160-5240 every 5 MHz	5170-5230 every 5 MHz	5155-5250 every 5 MHz	20	

Country	Frequency range	Valid Center Frequency for 20 MHz Band	Valid Center Frequency for 40 MHz Band	Valid Center Frequency for 5/10 MHz Band	Conducted Power	EIRP Power
Venezuela	5150-5250	5160-5240 every 5 MHz	5170-5230 every 5 MHz	5155-5250 every 5 MHz	20	
U.S. Virgin Islands	5150-5250	5180-5240 every 5 MHz	5190-5230 every 5 MHz	5160-5245 every 5 MHz	20	36 for non PTP AP. 53 for other modes.

Caution

For countries that follow FCC regulations, the combined conducted power must be reduced according to Table 110 for the lower edge of the 5.1 GHz band in order to meet restricted band requirements.

Table 110 Regulatory limits - 5.2 GHz

Country	Frequency range	Valid Center Frequency for 20 MHz Band	Valid Center Frequency for 40 MHz Band	Valid Center Frequency for 5/10 MHz Band[1]	Conducted Power	EIRP Power	DFS
Armenia	5250-5350	5270 to 5330 every 5MHz	5280 to 5320 every 5MHz	5255 to 5345 every 5MHz	18		No
Argentina	5250-5350	5260 to 5340 every 5MHz	5270 to 5330 every 5MHz	5255 to 5345 every 5MHz	18		Yes
Azerbaijan	5250-5350	5260 to 5340 every 5MHz	5270 to 5330 every 5MHz	5255 to 5345 every 5MHz	18		No
Belarus	5250-5350	5260 to 5340 every 5MHz	5270 to 5330 every 5MHz	5255 to 5345 every 5MHz	18		No
Canada	5250-5350	5280 to 5320 every 5MHz	5290 to 5310 every 5MHz	5280 to 5320 every 5MHz	12 for 20 MHz, 13 for 40 MHz	30 for 20 MHz and 40 MHz, 27 for 10 MHz, 24 for 5 MHz	Yes
Chile	5250-5350	5270 to 5330 every 5MHz	5280 to 5320 every 5MHz	5255 to 5345 every 5MHz	18		Yes
Colombia	5250-5350	5270 to 5330 every 5MHz	5280 to 5320 every 5MHz	5255 to 5345 every 5MHz	18		Yes
Ecuador	5250-5350	5260 to 5340 every 5MHz	5270 to 5330 every 5MHz	5255 to 5345 every 5MHz	18		No
Georgia	5250-5350	5260 to 5340 every 5MHz	5270 to 5330 every 5MHz	5255 to 5345 every 5MHz	18		No
Ghana	5250-5350	5270 to 5330 every 5MHz	5280 to 5320 every 5MHz	5255 to 5345 every 5MHz	18		Yes
Guam	5250-5350	5245 to 5320 every 5MHz	5235 to 5310 every 5MHz	5250 to 5320 every 5MHz	13	30 for 20 MHz and 40 MHz, 27 for 10 MHz, 24 for 5 MHz	Yes
Hong Kong	5250-5350	5270 to 5330 every 5MHz	5280 to 5320 every 5MHz	5255 to 5345 every 5MHz	18		Yes
Kazakhstan	5250-5350	5260 to 5340 every 5MHz	5270 to 5330 every 5MHz	5255 to 5345 every 5MHz	18		No
Kenya	5250-5350	5270 to 5330 every 5MHz	5280 to 5320 every 5MHz	5255 to 5345 every 5MHz	18		Yes
Kyrgyzstan	5250-5350	5260 to 5340 every 5MHz	5270 to 5330 every 5MHz	5255 to 5345 every 5MHz	18		No
Malaysia	5250-5350	5270 to 5330 every 5MHz	5280 to 5320 every 5MHz	5255 to 5345 every 5MHz	18		Yes
Moldova	5250-5350	5255 to 5350 every 5MHz	5255 to 5350 every 5MHz	5255 to 5350 every 5MHz	27		No
Other	5250-5350	5270 to 5330 every 5MHz	5280 to 5320 every 5MHz	5255 to 5345 every 5MHz	18		No
Peru	5250-5350	5245 to 5320 every 5MHz	5235 to 5310 every 5MHz	5250 to 5320 every 5MHz	13	30 for 20 MHz and 40 MHz, 27 for 10 MHz, 24 for 5 MHz	Yes
Philippines	5250-5350	5260 to 5340 every 5MHz	5270 to 5330 every 5MHz	5255 to 5345 every 5MHz	18		Yes
Puerto Rico	5250-5350	5280 to 5320 every 5MHz	5290 to 5310 every 5MHz	5255 to 5345 every 5MHz	13		Yes
Russia	5250-5350	5260 to 5340 every 5MHz	5270 to 5330 every 5MHz	5255 to 5345 every 5MHz	18		No

[1] 5 MHz Channel bandwidth not available for DFS regions/bands.

Country	Frequency range	Valid Center Frequency for 20 MHz Band	Valid Center Frequency for 40 MHz Band	Valid Center Frequency for 5/10 MHz Band[1]	Conducted Power	EIRP Power	DFS
Taiwan	5250-5350	5270 to 5330 every 5MHz	5280 to 5320 every 5MHz	5255 to 5345 every 5MHz	13	23	Yes
Tajikistan	5250-5350	5260 to 5340 every 5MHz	5270 to 5330 every 5MHz	5255 to 5345 every 5MHz	18		No
Thailand	5250-5350	5245 to 5320 every 5MHz	5235 to 5310 every 5MHz	5250 to 5320 every 5MHz	13	30 for 20 MHz and 40 MHz, 27 for 10 MHz, 24 for 5 MHz	FCC
Turkmenistan	5250-5350	5260 to 5340 every 5MHz	5270 to 5330 every 5MHz	5255 to 5345 every 5MHz	18		No
U.S. Virgin Islands	5250-5350	5260 to 5340 every 5MHz	5270 to 5330 every 5MHz	5255 to 5345 every 5MHz	18		Yes
Uganda	5250-5350	5270 to 5330 every 5MHz	5280 to 5320 every 5MHz	5255 to 5345 every 5MHz	18		Yes
Ukraine	5250-5350	5260 to 5340 every 5MHz	5270 to 5330 every 5MHz	5255 to 5345 every 5MHz	18		No
United States	5250-5350	5260 to 5340 every 5MHz	5270 to 5330 every 5MHz	5255 to 5345 every 5MHz	18		Yes
Uzbekistan	5250-5350	5260 to 5340 every 5MHz	5270 to 5330 every 5MHz	5255 to 5345 every 5MHz	18		No
Venezuela	5250-5350	5280 to 5320 every 5MHz	5290 to 5310 every 5MHz	5280 to 5320 every 5MHz	12 for 20 MHz, 13 for 40 MHz	30 for 20 MHz and 40 MHz, 27 for 10 MHz, 24 for 5 MHz	No

Table 111 Regulatory limits - 5.3 GHz

Country	Frequency range	Valid Center Frequency for 20 MHz Band	Valid Center Frequency for 40 MHz Band	Valid Center Frequency for 5/10 MHz Band	Conducted Power	EIRP Power	DFS
Other	5350-5470	5355 to 5470 every 5MHz	5355 to 5470 every 5MHz	5355 to 5470 every 5MHz	27		No

Table 112 Regulatory limits - 5.4 GHz

Country	Frequency range	Valid Center Frequency for 20 MHz Band	Valid Center Frequency for 40 MHz Band	Valid Center Frequency for 5/10 MHz Band[2]	Conducted Power	EIRP Power	DFS
Argentina	5470-5725	5480 to 5730 every 5MHz	5490 to 5740 every 5MHz	5475 to 5725 every 5MHz	19		None
Armenia	5470-5725	5480 to 5730 every 5MHz	5490 to 5740 every 5MHz	5475 to 5725 every 5MHz	19		None
Australia	5470-5600, 5650-5725	5480 to 5590 every 5MHz, 5660 to 5715 every 5 MHz	5490 to 5580 every 5MHz, 5670 to 5705 every 5 MHz	5475 to 5595 every 5MHz, 5655 to 5720 every 5 MHz	15	30 for 20 MHz and 40 MHz, 27 for 10 MHz, 24 for 5 MHz	ETSI
Austria	5470-5600, 5650-5725	5480 to 5590 every 5MHz, 5660 to 5715 every 5 MHz	5490 to 5580 every 5MHz, 5670 to 5705 every 5 MHz	5475 to 5595 every 5MHz, 5655 to 5720 every 5 MHz	15	30 for 20 MHz and 40MHz, 27 for 10 MHz, 24 for 5 MHz	ETSI
Azerbaijan	5470-5725	5480 to 5730 every 5MHz	5490 to 5740 every 5MHz	5475 to 5725 every 5MHz	19		None
Belarus	5470-5725	5480 to 5730 every 5MHz	5490 to 5740 every 5MHz	5475 to 5725 every 5MHz	19		None
Belgium	5470-5600, 5650-5725	5480 to 5590 every 5MHz, 5660 to 5715 every 5 MHz	5490 to 5580 every 5MHz, 5670 to 5705 every 5 MHz	5475 to 5595 every 5MHz, 5655 to 5720 every 5 MHz	15	30 for 20 MHz and 40MHz, 27 for 10 MHz, 24 for 5 MHz	ETSI
Bosnia and Herzegovina	5470-5600, 5650-5725	5480 to 5590 every 5MHz, 5660 to 5715 every 5 MHz	5490 to 5580 every 5MHz, 5670 to 5705 every 5 MHz	5475 to 5595 every 5MHz, 5655 to 5720 every 5 MHz	15	30 for 20 MHz and 40MHz, 27 for 10 MHz, 24 for 5 MHz	ETSI
Brazil	5470-5725	5480 to 5715 every 5MHz	5490 to 5705 every 5MHz	5475 to 5720 every 5MHz	16	30	FCC
Bulgaria	5470-5600, 5650-5725	5480 to 5590 every 5MHz, 5660 to 5715 every 5 MHz	5490 to 5580 every 5MHz, 5670 to 5705 every 5 MHz	5475 to 5595 every 5MHz, 5655 to 5720 every 5 MHz	15	30 for 20 MHz and 40MHz, 27 for 10 MHz, 24 for 5 MHz	ETSI
Canada	5470-5600, 5650-5725	5495 to 5590 every 5MHz, 5660 to 5705 every 5 MHz	5510 to 5580 every 5MHz, 5670 to 5695 every 5 MHz	5495 to 5595 every 5MHz, 5655 to 5705 every 5 MHz	14	30 for 20 MHz and 40MHz, 27 for 10 MHz, 24 for 5 MHz	FCC
Chile	5470-5725	5480 to 5715 every 5MHz	5490 to 5705 every 5MHz	5475 to 5720 every 5MHz	16	30	FCC
Colombia	5470-5725	5480 to 5715 every 5MHz	5490 to 5705 every 5MHz	5475 to 5720 every 5MHz	16	30	FCC
Croatia	5470-5600, 5650-5725	5480 to 5590 every 5MHz, 5660 to 5715 every 5 MHz	5490 to 5580 every 5MHz, 5670 to 5705 every 5 MHz	5475 to 5595 every 5MHz, 5655 to 5720 every 5 MHz	15	30 for 20 MHz and 40MHz, 27 for 10 MHz, 24 for 5 MHz	ETSI
Cyprus	5470-5600, 5650-5725	5480 to 5590 every 5MHz, 5660 to 5715 every 5 MHz	5490 to 5580 every 5MHz, 5670 to 5705 every 5 MHz	5475 to 5595 every 5MHz, 5655 to 5720 every 5 MHz	15	30 for 20 MHz and 40MHz, 27 for 10 MHz, 24 for 5 MHz	ETSI
Czech Republic	5470-5600,5650-5725	5480 to 5590 every 5MHz, 5660 to 5715 every 5 MHz	5490 to 5580 every 5MHz, 5670 to 5705 every 5 MHz	5475 to 5595 every 5MHz, 5655 to 5720 every 5 MHz	15	30 for 20 MHz and 40MHz, 27 for 10 MHz, 24 for 5 MHz	ETSI
Denmark	5470-5600, 5650-5725	5480 to 5590 every 5MHz, 5660 to 5715 every 5 MHz	5490 to 5580 every 5MHz, 5670 to 5705 every 5 MHz	5475 to 5595 every 5MHz, 5655 to 5720 every 5 MHz	15	30 for 20M and 40M, 27 for 10M, 24 for 5M	ETSI
Ecuador	5470-5725	5480 to 5715 every 5MHz	5490 to 5705 every 5MHz	5475 to 5720 every 5MHz	16	30 for 20 MHz and 40MHz, 27 for 10 MHz, 24 for 5 MHz	None

[2] 5 MHz Channel bandwidth not available for DFS regions/bands.

Country	Frequency range	Valid Center Frequency for 20 MHz Band	Valid Center Frequency for 40 MHz Band	Valid Center Frequency for 5/10 MHz Band[2]	Conducted Power	EIRP Power	DFS
Finland	5470-5600, 5650-5725	5480 to 5590 every 5MHz, 5660 to 5715 every 5 MHz	5490 to 5580 every 5MHz, 5670 to 5705 every 5 MHz	5475 to 5595 every 5MHz, 5655 to 5720 every 5 MHz	15	30 for 20 MHz and 40MHz, 27 for 10 MHz, 24 for 5 MHz	ETSI
France	5470-5600, 5650-5725	5480 to 5590 every 5MHz, 5660 to 5715 every 5 MHz	5490 to 5580 every 5MHz, 5670 to 5705 every 5 MHz	5475 to 5595 every 5MHz, 5655 to 5720 every 5 MHz	15	30 for 20 MHz and 40MHz, 27 for 10 MHz, 24 for 5 MHz	ETSI
Generic ETSI	5470-5600, 5650-5725	5480 to 5590 every 5MHz, 5660 to 5715 every 5 MHz	5490 to 5580 every 5MHz, 5670 to 5705 every 5 MHz	5475 to 5595 every 5MHz, 5655 to 5720 every 5 MHz	15	30 for 20 MHz and 40MHz, 27 for 10 MHz, 24 for 5 MHz	ETSI
Georgia	5470-5725	5480 to 5730 every 5MHz	5490 to 5740 every 5MHz	5475 to 5725 every 5MHz	19		None
Germany	5470-5600, 5650-5725	5480 to 5590 every 5MHz, 5660 to 5715 every 5 MHz	5490 to 5580 every 5MHz, 5670 to 5705 every 5 MHz	5475 to 5595 every 5MHz, 5655 to 5720 every 5 MHz	15	30 for 20 MHz and 40MHz, 27 for 10 MHz, 24 for 5 MHz	ETSI
Ghana	5470-5725	5480 to 5715 every 5MHz	5490 to 5705 every 5MHz	5475 to 5720 every 5MHz	16	30	FCC
Greece	5470-5600, 5650-5725	5480 to 5590 every 5MHz, 5660 to 5715 every 5 MHz	5490 to 5580 every 5MHz, 5670 to 5705 every 5 MHz	5475 to 5595 every 5MHz, 5655 to 5720 every 5 MHz	15	30 for 20 MHz and 40MHz, 27 for 10 MHz, 24 for 5 MHz	ETSI
Guam	5470-5600, 5650-5725	5495 to 5590 every 5MHz, 5660 to 5705 every 5 MHz	5510 to 5580 every 5MHz, 5670 to 5695 every 5 MHz	5495 to 5595 every 5MHz, 5655 to 5705 every 5 MHz	14	30 for 20 MHz and 40MHz, 27 for 10 MHz, 24 for 5 MHz	FCC
Hong Kong	5470-5725	5480 to 5715 every 5MHz	5490 to 5705 every 5MHz	5475 to 5720 every 5MHz	15	30	FCC
Hungary	5470-5600, 5650-5725	5480 to 5590 every 5MHz, 5660 to 5715 every 5 MHz	5490 to 5580 every 5MHz, 5670 to 5705 every 5 MHz	5475 to 5595 every 5MHz, 5655 to 5720 every 5 MHz	15	30 for 20 MHz and 40MHz, 27 for 10 MHz, 24 for 5 MHz	ETSI
Ireland	5470-5600, 5650-5725	5480 to 5590 every 5MHz, 5660 to 5715 every 5 MHz	5490 to 5580 every 5MHz, 5670 to 5705 every 5 MHz	5475 to 5595 every 5MHz, 5655 to 5720 every 5 MHz	15	30 for 20 MHz and 40MHz, 27 for 10 MHz, 24 for 5 MHz	ETSI
Italy	5470-5600, 5650-5725	5480 to 5590 every 5MHz, 5660 to 5715 every 5 MHz	5490 to 5580 every 5MHz, 5670 to 5705 every 5 MHz	5475 to 5595 every 5MHz, 5655 to 5720 every 5 MHz	15	30 for 20 MHz and 40MHz, 27 for 10 MHz, 24 for 5 MHz	ETSI
Kazakhstan	5470-5725	5480 to 5730 every 5MHz	5490 to 5740 every 5MHz	5475 to 5725 every 5MHz	19		
Kenya	5470-5725	5480 to 5715 every 5MHz	5490 to 5705 every 5MHz	5475 to 5720 every 5MHz	16	30 for 20 MHz and 40MHz, 27 for 10 MHz, 24 for 5 MHz	FCC
Kyrgyzstan	5470-5725	5480 to 5730 every 5MHz	5490 to 5740 every 5MHz	5475 to 5725 every 5MHz	19		None
Latvia	5470-5600, 5650-5725	5480 to 5590 every 5MHz, 5660 to 5715 every 5 MHz	5490 to 5580 every 5MHz, 5670 to 5705 every 5 MHz	5475 to 5595 every 5MHz, 5655 to 5720 every 5 MHz	15	30 for 20 MHz and 40MHz, 27 for 10 MHz, 24 for 5 MHz	ETSI
Liechtenstein	5470-5600, 5650-5725	5480 to 5590 every 5MHz, 5660 to 5715 every 5 MHz	5490 to 5580 every 5MHz, 5670 to 5705 every 5 MHz	5475 to 5595 every 5MHz, 5655 to 5720 every 5 MHz	15	30 for 20 MHz and 40MHz, 27 for 10 MHz, 24 for 5 MHz	ETSI
Lithuania	5470-5600, 5650-5725	5480 to 5590 every 5MHz, 5660 to 5715 every 5 MHz	5490 to 5580 every 5MHz, 5670 to 5705 every 5 MHz	5475 to 5595 every 5MHz, 5655 to 5720 every 5 MHz	15	30 for 20 MHz and 40MHz, 27 for 10 MHz, 24 for 5 MHz	ETSI

Country	Frequency range	Valid Center Frequency for 20 MHz Band	Valid Center Frequency for 40 MHz Band	Valid Center Frequency for 5/10 MHz Band[2]	Conducted Power	EIRP Power	DFS
Luxembourg	5470-5600, 5650-5725	5480 to 5590 every 5MHz, 5660 to 5715 every 5 MHz	5490 to 5580 every 5MHz, 5670 to 5705 every 5 MHz	5475 to 5595 every 5MHz, 5655 to 5720 every 5 MHz	15	30 for 20 MHz and 40MHz, 27 for 10 MHz, 24 for 5 MHz	ETSI
Macedonia	5470-5600, 5650-5725	5480 to 5590 every 5MHz, 5660 to 5715 every 5 MHz	5490 to 5580 every 5MHz, 5670 to 5705 every 5 MHz	5475 to 5595 every 5MHz, 5655 to 5720 every 5 MHz	15	30 for 20 MHz and 40MHz, 27 for 10 MHz, 24 for 5 MHz	ETSI
Malaysia	5470-5725	5480 to 5730 every 5MHz	5490 to 5740 every 5MHz	5475 to 5725 every 5MHz	19		None
Malta	5470-5600, 5650-5725	5480 to 5590 every 5MHz, 5660 to 5715 every 5 MHz	5490 to 5580 every 5MHz, 5670 to 5705 every 5 MHz	5475 to 5595 every 5MHz, 5655 to 5720 every 5 MHz	15	30 for 20 MHz and 40MHz, 27 for 10 MHz, 24 for 5 MHz	ETSI
Mauritius	5470-5725	5480 to 5715 every 5MHz	5490 to 5705 every 5MHz	5475 to 5720 every 5MHz	15	30 for 20 MHz and 40MHz, 27 for 10 MHz, 24 for 5 MHz	ETSI
Mexico	5470-5600, 5650-5725	5495 to 5590 every 5MHz, 5660 to 5705 every 5 MHz	5510 to 5580 every 5MHz, 5670 to 5695 every 5 MHz	5475 to 5595 every 5MHz, 5655 to 5720 every 5 MHz	16	30 for 20 MHz and 40MHz, 27 for 10 MHz, 24 for 5 MHz	FCC
Moldova	5470-5725	5480 to 5730 every 5MHz	5490 to 5740 every 5MHz	5475 to 5725 every 5MHz	19		None
Netherlands	5470-5600, 5650-5725	5480 to 5590 every 5MHz, 5660 to 5715 every 5 MHz	5490 to 5580 every 5MHz, 5670 to 5705 every 5 MHz	5475 to 5595 every 5MHz, 5655 to 5720 every 5 MHz	15	30 for 20 MHz and 40MHz, 27 for 10 MHz, 24 for 5 MHz	ETSI
Netherlands Antilles	5470-5600, 5650-5725	5480 to 5590 every 5MHz, 5660 to 5715 every 5 MHz	5490 to 5580 every 5MHz, 5670 to 5705 every 5 MHz	5475 to 5595 every 5MHz, 5655 to 5720 every 5 MHz	15	30 for 20 MHz and 40MHz, 27 for 10 MHz, 24 for 5 MHz	ETSI
Nigeria	5470-5725	5480 to 5715 every 5MHz	5490 to 5705 every 5MHz	5475 to 5720 every 5MHz	15	36	None
Norway	5470-5600, 5650-5725	5480 to 5590 every 5MHz, 5660 to 5715 every 5 MHz	5490 to 5580 every 5MHz, 5670 to 5705 every 5 MHz	5475 to 5595 every 5MHz, 5655 to 5720 every 5 MHz	15	30 for 20 MHz and 40MHz, 27 for 10 MHz, 24 for 5 MHz	ETSI
Oman	5470-5725	5480 to 5715 every 5MHz	5490 to 5705 every 5MHz	5475 to 5720 every 5MHz	15	30 for 20 MHz and 40MHz, 27 for 10 MHz, 24 for 5 MHz	ETSI
Other	5470-5725	5475 to 5730 every 5MHz	5475 to 5740 every 5MHz	5475 to 5725 every 5MHz	30		None
Peru	5470-5725	5480 to 5715 every 5MHz	5490 to 5705 every 5MHz	5475 to 5720 every 5MHz	16	30	ETSI
Philippines	5470-5725	5480 to 5730 every 5MHz	5490 to 5740 every 5MHz	5475 to 5725 every 5MHz	19	26	None
Poland	5470-5600, 5650-5725	5480 to 5590 every 5MHz, 5660 to 5715 every 5 MHz	5490 to 5580 every 5MHz, 5670 to 5705 every 5 MHz	5475 to 5595 every 5MHz, 5655 to 5720 every 5 MHz	15	30 for 20 MHz and 40MHz, 27 for 10 MHz, 24 for 5 MHz	ETSI
Portugal	5470-5600, 5650-5725	5480 to 5590 every 5MHz, 5660 to 5715 every 5 MHz	5490 to 5580 every 5MHz, 5670 to 5705 every 5 MHz	5475 to 5595 every 5MHz, 5655 to 5720 every 5 MHz	15	30 for 20 MHz and 40MHz, 27 for 10 MHz, 24 for 5 MHz	ETSI
Puerto Rico	5470-5600, 5650-5725	5495 to 5590 every 5MHz, 5660 to 5705 every 5 MHz	5510 to 5580 every 5MHz, 5670 to 5695 every 5 MHz	5495 to 5595 every 5MHz, 5655 to 5705 every 5 MHz	14	30 for 20 MHz and 40MHz, 27 for 10 MHz, 24 for 5 MHz	FCC
Romania	5470-5600, 5650-5725	5480 to 5590 every 5MHz, 5660 to 5715	5490 to 5580 every 5MHz, 5670 to 5705	5475 to 5595 every 5MHz, 5655 to 5720	15	30 for 20 MHz and 40MHz, 27 for 10 MHz, 24 for	ETSI

Country	Frequency range	Valid Center Frequency for 20 MHz Band	Valid Center Frequency for 40 MHz Band	Valid Center Frequency for 5/10 MHz Band[2]	Conducted Power	EIRP Power	DFS
		every 5 MHz	every 5 MHz	every 5 MHz		5 MHz	
Russia	5470-5725	5480 to 5730 every 5MHz	5490 to 5740 every 5MHz	5475 to 5725 every 5MHz	19		None
Serbia	5470-5600, 5650-5725	5480 to 5590 every 5MHz, 5660 to 5715 every 5 MHz	5490 to 5580 every 5MHz, 5670 to 5705 every 5 MHz	5475 to 5595 every 5MHz, 5655 to 5720 every 5 MHz	15	30 for 20 MHz and 40MHz, 27 for 10 MHz, 24 for 5 MHz	ETSI
Slovakia	5470-5600, 5650-5725	5480 to 5590 every 5MHz, 5660 to 5715 every 5 MHz	5490 to 5580 every 5MHz, 5670 to 5705 every 5 MHz	5475 to 5595 every 5MHz, 5655 to 5720 every 5 MHz	15	30 for 20 MHz and 40MHz, 27 for 10 MHz, 24 for 5 MHz	ETSI
Slovenia	5470-5600, 5650-5725	5480 to 5590 every 5MHz, 5660 to 5715 every 5 MHz	5490 to 5580 every 5MHz, 5670 to 5705 every 5 MHz	5475 to 5595 every 5MHz, 5655 to 5720 every 5 MHz	15	30 for 20 MHz and 40MHz, 27 for 10 MHz, 24 for 5 MHz	ETSI
South Africa	5470-5725	5480 to 5715 every 5MHz	5490 to 5705 every 5MHz	5475 to 5720 every 5MHz	15	30	FCC
South Korea	5470-5650	5480 to 5640 every 5MHz	NA	5475 to 5645 every 5MHz	16	30	ETSI
Spain	5470-5600, 5650-5725	5480 to 5590 every 5MHz, 5660 to 5715 every 5 MHz	5490 to 5580 every 5MHz, 5670 to 5705 every 5 MHz	5475 to 5595 every 5MHz, 5655 to 5720 every 5 MHz	15	30 for 20 MHz and 40MHz, 27 for 10 MHz, 24 for 5 MHz	ETSI
Sweden	5470-5600, 5650-5725	5480 to 5590 every 5MHz, 5660 to 5715 every 5 MHz	5490 to 5580 every 5MHz, 5670 to 5705 every 5 MHz	5475 to 5595 every 5MHz, 5655 to 5720 every 5 MHz	15	30 for 20 MHz and 40MHz, 27 for 10 MHz, 24 for 5 MHz	ETSI
Switzerland	5470-5600, 5650-5725	5480 to 5590 every 5MHz, 5660 to 5715 every 5 MHz	5490 to 5580 every 5MHz, 5670 to 5705 every 5 MHz	5475 to 5595 every 5MHz, 5655 to 5720 every 5 MHz	15	30 for 20 MHz and 40MHz, 27 for 10 MHz, 24 for 5 MHz	ETSI
Taiwan	5470-5600, 5650-5725	5495 to 5590 every 5MHz, 5660 to 5705 every 5 MHz	5510 to 5580 every 5MHz, 5670 to 5695 every 5 MHz	5495 to 5590 every 5MHz, 5660 to 5705 every 5 MHz	14	30 for 20 MHz and 40MHz, 27 for 10 MHz, 24 for 5 MHz	FCC
Tajikistan	5470-5725	5480 to 5730 every 5MHz	5490 to 5740 every 5MHz	5475 to 5725 every 5MHz	19		None
Thailand	5470-5725	5480 to 5715 every 5MHz	5490 to 5705 every 5MHz	5475 to 5720 every 5MHz	16	30 for 20 MHz and 40MHz, 27 for 10 MHz, 24 for 5 MHz	FCC
Turkey	5470-5725	5480 to 5715 every 5MHz	5490 to 5705 every 5MHz	5475 to 5720 every 5MHz	15	30 for 20 MHz and 40MHz, 27 for 10 MHz, 24 for 5 MHz	ETSI
Turkmenistan	5470-5725	5480 to 5730 every 5MHz	5490 to 5740 every 5MHz	5475 to 5725 every 5MHz	19		None
U.S. Virgin Islands	5470-5600, 5650-5725	5495 to 5590 every 5MHz, 5660 to 5705 every 5 MHz	5510 to 5580 every 5MHz, 5670 to 5695 every 5 MHz	5495 to 5595 every 5MHz, 5655 to 5705 every 5 MHz	14	30 for 20 MHz and 40MHz, 27 for 10 MHz, 24 for 5 MHz	FCC
Uganda	5470-5725	5480 to 5715 every 5MHz	5490 to 5705 every 5MHz	5475 to 5720 every 5MHz	30	30 for 20 MHz and 40MHz, 27 for 10 MHz, 24 for 5 MHz	FCC
Ukraine	5470-5725	5480 to 5730 every 5MHz	5490 to 5740 every 5MHz	5475 to 5725 every 5MHz	19		
United Kingdom[3]	5470-5600, 5650-5725	5480 to 5590 every 5MHz,	5490 to 5580 every 5MHz,	5475 to 5595 every 5MHz,	15	30 for 20 MHz and 40MHz, 27	ETSI

[3] The band 5600 MHz to 5650 MHz is reserved for the use of weather radars.

Country	Frequency range	Valid Center Frequency for 20 MHz Band	Valid Center Frequency for 40 MHz Band	Valid Center Frequency for 5/10 MHz Band[2]	Conducted Power	EIRP Power	DFS
		5660 to 5715 every 5 MHz	5670 to 5705 every 5 MHz	5655 to 5720 every 5 MHz		for 10 MHz, 24 for 5 MHz	
United States	5470-5600, 5650-5725	5495 to 5590 every 5MHz, 5660 to 5705 every 5 MHz	5510 to 5580 every 5MHz, 5670 to 5695 every 5 MHz	5495 to 5595 every 5MHz, 5655 to 5705 every 5 MHz	14	30 for 20 MHz and 40MHz, 27 for 10 MHz, 24 for 5 MHz	FCC
Uzbekistan	5470-5725	5480 to 5730 every 5MHz	5490 to 5740 every 5MHz	5475 to 5725 every 5MHz	19		None
Venezuela	5470-5725	5480 to 5730 every 5MHz	5490 to 5740 every 5MHz	5475 to 5725 every 5MHz	19	30	None

Table 113 Regulatory limits - 5.8/5.9 GHz

Country	Frequency ranges	Valid Center Frequency for 20 MHz Band	Valid Center Frequency for 40 MHz Band	Valid Center Frequency for 10 MHz Band	Valid Center Frequency for 5 MHz Band[4]	Conducted Power	EIRP Power	DFS
Argentina	5725-5850	5735 to 5840 every 5 MHz	5745 to 5830 every 5 MHz	5730 to 5845 every 5 MHz	5730 to 5845 every 5 MHz	23		None
Armenia	5725-5980	5735 to 5970 every 5 MHz	5745 to 5960 every 5 MHz	5730 to 5975 every 5 MHz	5730 to 5975 every 5 MHz	23		None
Australia	5725-5850	5740 to 5835 every 5 MHz	5750 to 5825 every 5 MHz	5730 to 5845 every 5 MHz	5730 to 5845 every 5 MHz	23	36	None
Azerbaijan	5725-5980	5735 to 5970 every 5 MHz	5745 to 5960 every 5 MHz	5730 to 5975 every 5 MHz	5730 to 5975 every 5 MHz	23		None
Bahrain	5725-5850	5735 to 5840 every 5 MHz	5745 to 5830 every 5 MHz	5730 to 5845 every 5 MHz	5730 to 5845 every 5 MHz	23	33	ETSI
Bangladesh	5725-5825	5735 to 5840 every 5 MHz	5745 to 5830 every 5 MHz	5730 to 5845 every 5 MHz	5730 to 5845 every 5 MHz	30		None
Belarus	5725-5980	5735 to 5970 every 5 MHz	5745 to 5960 every 5 MHz	5730 to 5975 every 5 MHz	5730 to 5975 every 5 MHz	23		None
Botswana	5725-5875	5735 to 5865 every 5 MHz	5745 to 5855 every 5 MHz	5730 to 5870 every 5 MHz	5730 to 5870 every 5 MHz	23	40	No
Brazil	5725-5850	5740 to 5835 every 5 MHz	5750 to 5825 every 5 MHz	5730 to 5845 every 5 MHz	5730 to 5845 every 5 MHz	23	36 for PMP AP. No limit for other modes.	None
Canada	5725-5850	5740 to 5835 every 5 MHz	5750 to 5825 every 5 MHz	5740 to 5835 every 5 MHz	5740 to 5835 every 5 MHz	23 for PMP AP PMP, 30 for PTP and SM mode.	36 for PMP AP. No limit for other modes.	None
Chile	5725-5850	5735 to 5840 every 5 MHz	5745 to 5830 every 5 MHz	5730 to 5845 every 5 MHz	5730 to 5845 every 5 MHz	23	36	None
China	5725-5850	5740 to 5835 every 5 MHz	5750 to 5825 every 5 MHz	5730 to 5845 every 5 MHz	5730 to 5845 every 5 MHz	23	33	None
Colombia	5725-5825	5735 to 5815 every 5 MHz	5745 to 5805 every 5 MHz	5730 to 5820 every 5 MHz	5730 to 5820 every 5 MHz	23	36	None
Denmark	5725-5795, 5815-5875	5735 to 5785 every 5 MHz, 5825 to 5865 every 5 MHz	5745 to 5775 every 5 MHz, 5835 to 5855 every 5 MHz	5730 to 5790 every 5 MHz, 5820 to 5870 every 5 MHz	5730 to 5790 every 5 MHz, 5820 to 5870 every 5 MHz	23	36	ETSI
Ecuador	5725-5850	5735 to 5840 every 5 MHz	5745 to 5830 every 5 MHz	5730 to 5845 every 5 MHz	5730 to 5845 every 5 MHz	23	53	None
Finland	5725-5795, 5815-5850	5735 to 5785 every 5 MHz, 5825 to 5840 every 5 MHz	5745 to 5775 every 5 MHz,	5730 to 5790 every 5 MHz, 5820 to 5845 every 5 MHz	5730 to 5790 every 5 MHz, 5820 to 5845 every 5 MHz	23	36	ETSI
Georgia	5725-5980	5735 to 5970 every 5 MHz	5745 to 5960 every 5 MHz	5730 to 5975 every 5 MHz	5730 to 5975 every 5 MHz	23		None
Germany	5755-5875	5765 to 5865 every 5 MHz	5775 to 5855 every 5 MHz	5730 to 5870 every 5 MHz	5730 to 5870 every 5 MHz	23	36	ETSI
Ghana	5725-5825	5740 to 5810 every 5 MHz	5750 to 5800 every 5 MHz	5730 to 5820 every 5 MHz	5730 to 5820 every 5 MHz	23	36	FCC
Greece	5725-5795	5735 to 5785 every 5 MHz	5745 to 5775 every 5 MHz	5730 to 5790 every 5 MHz	5730 to 5790 every 5 MHz	23	36	ETSI

[4] 5 MHz Channel bandwidth not available for DFS regions/bands.

Country	Frequency ranges	Valid Center Frequency for 20 MHz Band	Valid Center Frequency for 40 MHz Band	Valid Center Frequency for 10 MHz Band	Valid Center Frequency for 5 MHz Band[4]	Conducted Power	EIRP Power	DFS
Guam	5725-5850	5740 to 5835 every 5 MHz	5750 to 5825 every 5 MHz	5740 to 5835 every 5 MHz	5740 to 5835 every 5 MHz	23 for PMP AP PMP, 30 for PTP and SM mode.	36 for PMP AP. No limit for other modes.	None
Hong Kong	5725-5850	5740 to 5835 every 5 MHz	5750 to 5825 every 5 MHz	5730 to 5845 every 5 MHz	5730 to 5845 every 5 MHz	23	36	None
Iceland	5725-5875	5735 to 5865 every 5 MHz	5745 to 5855 every 5 MHz	5730 to 5870 every 5 MHz	5730 to 5870 every 5 MHz	23	36	ETSI
India	5825-5875	5835 to 5865 every 5 MHz	5845 to 5855 every 5 MHz	5830 to 5870 every 5 MHz	5830 to 5870 every 5 MHz	23	36	None
Indonesia	5725-5825	5735 to 5815 every 5 MHz	NA	5730 to 5820 every 5 MHz	5730 to 5820 every 5 MHz	23	36	None
Ireland	5725-5875	5740 to 5860 every 5 MHz	5750 to 5850 every 5 MHz	5730 to 5870 every 5 MHz	5730 to 5870 every 5 MHz	23	33	None
Kazakhstan	5725-5980	5735 to 5970 every 5 MHz	5745 to 5960 every 5 MHz	5730 to 5975 every 5 MHz	5730 to 5975 every 5 MHz	23		None
Kenya	5725-5850	5735 to 5840 every 5 MHz	5745 to 5830 every 5 MHz	5730 to 5845 every 5 MHz	5730 to 5845 every 5 MHz	23	36	None
Kyrgyzstan	5725-5980	5735 to 5970 every 5 MHz	5745 to 5960 every 5 MHz	5730 to 5975 every 5 MHz	5730 to 5975 every 5 MHz	23		None
Liechtenstein	5725-5795, 5815-5875	5735 to 5785 every 5 MHz, 5825 to 5865 every 5 MHz	5745 to 5775 every 5 MHz, 5835 to 5855 every 5 MHz	5730 to 5790 every 5 MHz, 5820 to 5870 every 5 MHz	5730 to 5790 every 5 MHz, 5820 to 5870 every 5 MHz	23	36	ETSI
Malaysia	5725-5875	5740 to 5860 every 5 MHz	5750 to 5850 every 5 MHz	5730 to 5870 every 5 MHz	5730 to 5870 every 5 MHz	23	30	None
Mauritius	5725-5850	5735 to 5840 every 5 MHz	NA	5730 to 5845 every 5 MHz	5730 to 5845 every 5 MHz	23	36	ETSI
Mexico	5725-5850	5740 to 5835 every 5 MHz	5750 to 5825 every 5 MHz	5730 to 5845 every 5 MHz	5730 to 5845 every 5 MHz	23	36	None
Moldova	5725-5980	5735 to 5970 every 5 MHz	5745 to 5960 every 5 MHz	5730 to 5975 every 5 MHz	5730 to 5975 every 5 MHz	23		None
New Zealand	5725-5875 for PMP, 5725-5825 for PTP	5735 to 5865 for PMP, 5735 to 5815 every 5 MHz for PTP	5745 to 5855 for PMP, 5745 to 5805 every 5 MHz for PTP	5730 to 5870 for PMP, 5730 to 5820 every 5 MHz for PTP	5730 to 5870 for PMP, 5730 to 5820 every 5 MHz for PTP	23	36	No
Nigeria	5725-5850	5740 to 5835 every 5 MHz	5750 to 5825 every 5 MHz	5730 to 5845 every 5 MHz	5730 to 5845 every 5 MHz	23		ETSI
Norway	5725-5795, 5815-5850	5735 to 5785 every 5 MHz, 5825 to 5840 every 5 MHz	5745 to 5775 every 5 MHz,	5730 to 5790 every 5 MHz, 5820 to 5845 every 5 MHz	5730 to 5790 every 5 MHz, 5820 to 5845 every 5 MHz	23	36	ETSI
Oman	5725-5850	5735 to 5840 every 5 MHz	5745 to 5830 every 5 MHz	5730 to 5845 every 5 MHz	5730 to 5845 every 5 MHz	23	33	ETSI
Other	5725-5980	5735 to 5970 every 5 MHz	5745 to 5960 every 5 MHz	5730 to 5975 every 5 MHz	5730 to 5975 every 5 MHz	30		None
Peru	5725-5850	5735 to 5840 every 5 MHz	5745 to 5830 every 5 MHz	5730 to 5845 every 5 MHz	5730 to 5845 every 5 MHz	23	36	None
Philippines	5725-5825	5740 to 5810 every 5 MHz	5750 to 5800 every 5 MHz	5730 to 5820 every 5 MHz	5730 to 5820 every 5 MHz	23	30	No
Portugal	5725-5875	5735 to 5865 every 5 MHz	5745 to 5855 every 5 MHz	5730 to 5870 every 5 MHz	5730 to 5870 every 5 MHz	23	36	ETSI

Country	Frequency ranges	Valid Center Frequency for 20 MHz Band	Valid Center Frequency for 40 MHz Band	Valid Center Frequency for 10 MHz Band	Valid Center Frequency for 5 MHz Band[4]	Conducted Power	EIRP Power	DFS
Puerto Rico	5725-5850	5740 to 5835 every 5 MHz	5750 to 5825 every 5 MHz	5740 to 5835 every 5 MHz	5740 to 5835 every 5 MHz	23 for PMP AP PMP, 30 for PTP and SM mode.	36 for PMP AP. No limit for other modes.	None
Russia	5725-5980	5735 to 5970 every 5 MHz	5745 to 5960 every 5 MHz	5730 to 5975 every 5 MHz	5730 to 5975 every 5 MHz	23		None
Serbia	5725-5875	5735 to 5865 every 5 MHz	5745 to 5855 every 5 MHz	5730 to 5870 every 5 MHz	5730 to 5870 every 5 MHz	23	36	ETSI
Seychelles	5725-5850	5740 to 5835 every 5 MHz	5750 to 5825 every 5 MHz	5730 to 5845 every 5 MHz	5730 to 5845 every 5 MHz	23	36	ETSI
Singapore	5725-5850	5740 to 5835 every 5 MHz	5750 to 5825 every 5 MHz	5730 to 5845 every 5 MHz	5730 to 5845 every 5 MHz	23	30	ETSI
South Africa	5725-5850	5735 to 5840 every 5 MHz	5745 to 5830 every 5 MHz	5730 to 5845 every 5 MHz	5730 to 5845 every 5 MHz	30	36	No
South Korea	5725-5825	5740 to 5810 every 5 MHz	5750 to 5800 every 5 MHz	5730 to 5820 every 5 MHz	5730 to 5820 every 5 MHz	23	30	No
Spain	5725-5795, 5815-5855	5735 to 5785 every 5 MHz, 5825 to 5845 every 5 MHz	5745 to 5775 every 5 MHz, 5835 to 5835 every 5 MHz	5730 to 5790 every 5 MHz, 5820 to 5850 every 5 MHz	5730 to 5790 every 5 MHz, 5820 to 5850 every 5 MHz	23	36	ETSI
Switzerland	5725-5795, 5815-5875	5735 to 5785 every 5 MHz, 5825 to 5865 every 5 MHz	5745 to 5775 every 5 MHz, 5835 to 5855 every 5 MHz	5730 to 5790 every 5 MHz, 5820 to 5870 every 5 MHz	5730 to 5790 every 5 MHz, 5820 to 5870 every 5 MHz	23	36	ETSI
Taiwan	5725-5850	5740 to 5835 every 5 MHz	5750 to 5825 every 5 MHz	5730 to 5845 every 5 MHz	5730 to 5845 every 5 MHz	23 for PMP AP PMP, 30 for PTP and SM mode.	36 for PMP AP. No limit for other modes.	None
Tajikistan	5725-5980	5735 to 5970 every 5 MHz	5745 to 5960 every 5 MHz	5730 to 5975 every 5 MHz	5730 to 5975 every 5 MHz	23		None
Thailand	5725-5850	5740 to 5835 every 5 MHz	5750 to 5825 every 5 MHz	5730 to 5845 every 5 MHz	5730 to 5845 every 5 MHz	23	30	None
Turkmenistan	5725-5980	5735 to 5970 every 5 MHz	5745 to 5960 every 5 MHz	5730 to 5975 every 5 MHz	5730 to 5975 every 5 MHz	23		None
U.S. Virgin Islands	5725-5850	5740 to 5835 every 5 MHz	5750 to 5825 every 5 MHz	5740 to 5835 every 5 MHz	5740 to 5835 every 5 MHz	23 for PMP AP PMP, 30 for PTP and SM mode.	36 for PMP AP. No limit for other modes.	None
Uganda	5725-5825	5735 to 5815 every 5 MHz	5745 to 5805 every 5 MHz	5730 to 5820 every 5 MHz	5730 to 5820 every 5 MHz	30	32 dBm + 2 + (Configured Antenna Gain/3)	No
Ukraine	5725-5980	5735 to 5970 every 5 MHz	5745 to 5960 every 5 MHz	5730 to 5975 every 5 MHz	5730 to 5975 every 5 MHz	23		None
United Kingdom[5]	5725-5795, 5815-5850	5735 to 5785 every 5 MHz, 5825 to 5840 every 5 MHz	5745 to 5775 every 5 MHz	5730 to 5790 every 5 MHz, 5820 to 5845 every 5 MHz	5730 to 5790 every 5 MHz, 5820 to 5845 every 5 MHz	23	36	ETSI
United States[6]	5725-5850	5740 to 5835 every 5 MHz	5750 to 5825 every 5 MHz	5740 to 5835 every 5 MHz	5740 to 5835 every 5 MHz	23 for PMP AP PMP, 30 for PTP and SM mode.	36 for PMP AP. No limit for other modes.	None
United States[7]	5725-5850	5740 to 5835 every 5 MHz	5750 to 5825 every 5 MHz	5740 to 5835 every 5 MHz	5735 to 5840 every 5 MHz	17.5 for PMP AP PMP, 29 for PTP and SM mode.	36 for PMP AP. No limit for other modes.	None
Uzbekistan	5725-5980	5735 to 5970 every 5 MHz	5745 to 5960 every 5 MHz	5730 to 5975 every 5 MHz	5730 to 5975 every 5 MHz	23		None

[5] 5795 MHz to 5815 MHz band is assigned for Road Transport and Traffic Telematics (RTTT).

[6] Devices containing FCC ID(s) Z8H89FT0005, Z8H89FT0006

[7] Devices containing FCC ID(s) Z8H89FT0015

Country	Frequency ranges	Valid Center Frequency for 20 MHz Band	Valid Center Frequency for 40 MHz Band	Valid Center Frequency for 10 MHz Band	Valid Center Frequency for 5 MHz Band[4]	Conducted Power	EIRP Power	DFS
Venezuela	5725-5850	5735 to 5840 every 5 MHz	5745 to 5830 every 5 MHz	5730 to 5845 every 5 MHz	5730 to 5845 every 5 MHz	23	36	None
Vietnam	5725-5850	5735 to 5840 every 5 MHz	5745 to 5830 every 5 MHz	5730 to 5845 every 5 MHz	5730 to 5845 every 5 MHz	23	30	None

Table 114 Regulatory limits - 2.4 GHz

Country	Frequency ranges	Valid Center Frequency for 20 MHz Band	Valid Center Frequency for 40 MHz Band	Valid Center Frequency for 5/10 MHz Band	Conducted Power	EIRP Power
Armenia	2400-2500	2412-2472 every 5MHz	2422-2462 every 5MHz	2407-2477 every 5MHz		
Argentina	2400-2500	2412-2472 every 5MHz	2422-2462 every 5MHz	2407-2477 every 5MHz	27	36
Australia	2400-2500	2412-2462 every 5MHz	2422-2452 every 5MHz	2407-2477 every 5MHz		36
Azerbaijan	2400-2500	2412-2472 every 5MHz	2422-2462 every 5MHz	2407-2477 every 5MHz		
Bahrain	2400-2500	2412-2472 every 5MHz	2422-2462 every 5MHz	2407-2477 every 5MHz		36
Brazil	2400-2500	2412-2472 every 5MHz	2422-2462 every 5MHz	2407-2477 every 5MHz	23	36
Belarus	2400-2500	2412-2472 every 5MHz	2422-2462 every 5MHz	2407-2477 every 5MHz		
Canada	2400-2500	2412-2462 every 5MHz	2427-2452 every 5MHz	2407-2467 every 5MHz		36 for PMP AP. 30 dBm + 6 + ((Configured Antenna Gain - 6)/3) for other modes.
Chile	2400-2500	2412-2472 every 5MHz	2422-2462 every 5MHz	2407-2477 every 5MHz	23	36
China	2400-2500	2412-2472 every 5MHz	2422-2462 every 5MHz	2407-2477 every 5MHz		36
Colombia	2400-2500	2412-2472 every 5MHz	2422-2462 every 5MHz	2407-2477 every 5MHz	23	36
Ecuador	2400-2500	2412-2472 every 5MHz	2422-2462 every 5MHz	2407-2477 every 5MHz		36
Georgia	2400-2500	2412-2472 every 5MHz	2422-2462 every 5MHz	2407-2477 every 5MHz		
Ghana	2400-2500	2412-2472 every 5MHz	2422-2462 every 5MHz	2407-2477 every 5MHz	23	36
Guam	2400-2500	2412-2462 every 5MHz	2427-2452 every 5MHz	2407-2467 every 5MHz		36 for PMP AP. 30 dBm + 6 + ((Configured Antenna Gain - 6)/3) for other modes.
Hong Kong	2400-2500	2412-2472 every 5MHz	2422-2462 every 5MHz	2407-2477 every 5MHz		36
Indonesia	2400-2500	2412-2472 every 5MHz	2422-2462 every 5MHz	2407-2477 every 5MHz	23	36
India	2400-2500	2412-2472 every 5MHz	2422-2462 every 5MHz	2407-2477 every 5MHz		36
Kenya	2400-2500	2412-2472 every 5MHz	2422-2462 every 5MHz	2407-2477 every 5MHz	23	36
Kyrgyzstan	2400-2500	2412-2472 every 5MHz	2422-2462 every 5MHz	2407-2477 every 5MHz	27	
South Korea	2400-2500	2412-2472 every 5MHz	2422-2462 every 5MHz	2407-2477 every 5MHz		36
Kazakhstan	2400-2500	2412-2472 every 5MHz	2422-2462 every 5MHz	2407-2477 every 5MHz		
Moldova	2400-2500	2412-2472 every 5MHz	2422-2462 every 5MHz	2407-2477 every 5MHz		
Mexico	2400-2500	2412-2472 every 5MHz	2422-2462 every 5MHz	2407-2477 every 5MHz		36
Malaysia	2400-2500	2412-2472 every 5MHz	2422-2462 every 5MHz	2407-2477 every 5MHz		36

Country	Frequency ranges	Valid Center Frequency for 20 MHz Band	Valid Center Frequency for 40 MHz Band	Valid Center Frequency for 5/10 MHz Band	Conducted Power	EIRP Power
Nigeria	2400-2500	2412-2472 every 5MHz	2422-2462 every 5MHz	2407-2477 every 5MHz		36
New Zealand	2400-2500	2412-2472 every 5MHz	2422-2462 every 5MHz	2407-2477 every 5MHz		36
Other	2400-2500	2412-2472 every 5MHz	2422-2462 every 5MHz	2407-2477 every 5MHz		
Peru	2400-2500	2412-2472 every 5MHz	2422-2462 every 5MHz	2407-2477 every 5MHz		36
Philippines	2400-2500	2412-2472 every 5MHz	2422-2462 every 5MHz	2407-2477 every 5MHz	23	36
Puerto Rico	2400-2500	2412-2462 every 5MHz	2427-2452 every 5MHz	2407-2467 every 5MHz		36 for PMP AP. 30 dBm + 6 + ((Configured Antenna Gain - 6)/3) for other modes.
Russia	2400-2500	2412-2472 every 5MHz	2422-2462 every 5MHz	2407-2477 every 5MHz		
Singapore	2400-2500	2412-2472 every 5MHz	2422-2462 every 5MHz	2407-2477 every 5MHz	23	36
Thailand	2400-2500	2412-2472 every 5MHz	2422-2462 every 5MHz	2407-2477 every 5MHz		20
Tajikistan	2400-2500	2412-2472 every 5MHz	2422-2462 every 5MHz	2407-2477 every 5MHz	27	
Turkmenistan	2400-2500	2412-2472 every 5MHz	2422-2462 every 5MHz	2407-2477 every 5MHz	27	
Taiwan	2400-2500	2412-2472 every 5MHz	2422-2462 every 5MHz	2407-2477 every 5MHz		36
Ukraine	2400-2500	2412-2472 every 5MHz	2422-2462 every 5MHz	2407-2477 every 5MHz		
Uganda	2400-2500	2412-2472 every 5MHz	2422-2462 every 5MHz	2407-2477 every 5MHz	23	
United States	2400-2500	2412-2462 every 5MHz	2427-2452 every 5MHz	2407-2467 every 5MHz	27	36 for PMP AP. 30 dBm + 6 + ((Configured Antenna Gain - 6)/3) for other modes.
Uzbekistan	2400-2500	2412-2472 every 5MHz	2422-2462 every 5MHz	2407-2477 every 5MHz	27	
Venezuela	2400-2500	2412-2472 every 5MHz	2422-2462 every 5MHz	2407-2477 every 5MHz	23	36
U.S. Virgin Islands	2400-2500	2412-2462 every 5MHz	2427-2452 every 5MHz	2407-2467 every 5MHz		36 for PMP AP. 30 dBm + 6 + ((Configured Antenna Gain - 6)/3) for other modes.
Vietnam	2400-2500	2412-2472 every 5MHz	2422-2462 every 5MHz	2407-2477 every 5MHz	23	36
South Africa	2400-2500	2412-2472 every 5MHz	2422-2462 every 5MHz	2407-2477 every 5MHz		36
CIS Countries	2400-2500	2412-2472 every 5MHz	2422-2462 every 5MHz	2407-2477 every 5MHz	27	36

Notifications

This section contains notifications of compliance with the radio regulations that are enforced in various regions.

2.4 GHZ, 5.4 GHZ REGULATORY COMPLIANCE

The ePMP complies with the regulations that are enforced in the USA, Canada and Europe. The relevant notifications are specified in this section.

2.4 GHz, 5.1 GHz, 5.4 GHz FCC and IC notification

U.S. Federal Communication Commission (FCC) and Industry Canada (IC) Notification.

This device complies with part 15.407 of the US FCC Rules and Regulations and with RSS-210 Issue 8 of Industry Canada. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) This device must accept any interference received, including interference that may cause undesired operation. In Canada, users must be cautioned to take note that high power radars are allocated as primary users (meaning they have priority) of 5250 – 5350 MHz and 5470 – 5725 MHz and these radars could cause interference and/or damage to license-exempt local area networks (LELAN). To comply with FCC/IC RF exposure limits for general population or uncontrolled exposure, the antenna(s) used for the ePMP transmitter must be installed at a separation distance specified in **Table 109**, **Table 110**, **Table 111**, **Table 112, Table 113** and **Table 114.**

For the connectorized version of the product and in order to reduce potential radio interference to other users, the antenna type and its gain must be so chosen that the equivalent isotropically radiated power (EIRP) is not more than that permitted by the regulations. The transmitted power must be reduced to achieve this requirement.

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the US FCC Rules and with RSS-210 of Industry Canada. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio-frequency energy and, if not installed and used in accordance with these instructions, may cause harmful interference to radio communications. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment on and off, the user is encouraged to correct the interference by one or more of the following measures:

- Increase the separation between the affected equipment and the unit;
- Connect the affected equipment to a power outlet on a different circuit from that which the receiver is connected to;
- Consult the dealer and/or experienced radio/TV technician for help.

FCC IDs and Industry Canada Certification Numbers are reproduced on the product label (**Figure 64** and **Figure 65**).

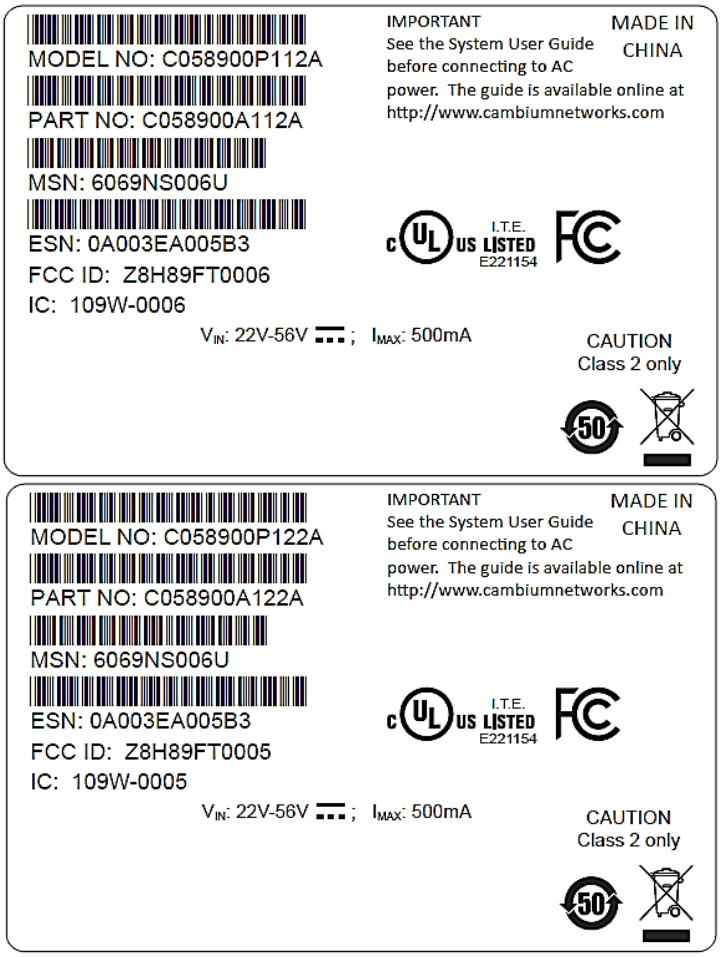
End Product Labelling

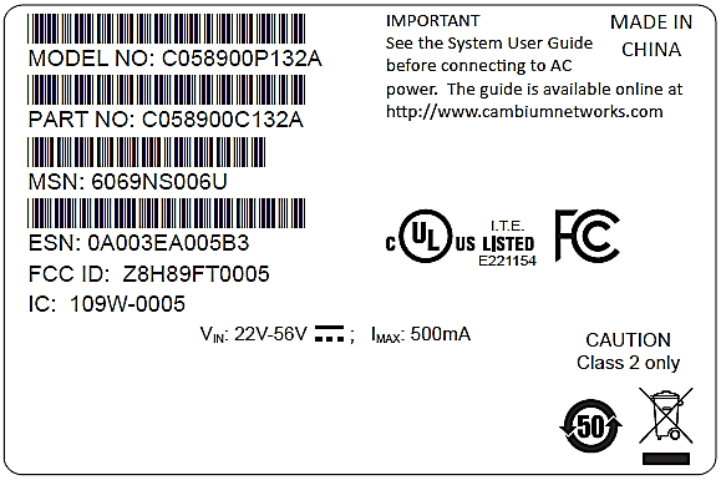
The ePMP Module is labelled with its own FCC ID and IC Certification Number. If the FCC ID and IC Certification Number are not visible when the module is installed inside another device, then the outside of the device into which the module is installed must also display a label referring to the enclosed module. In that case, the final end product must be labelled in a visible area with the following:

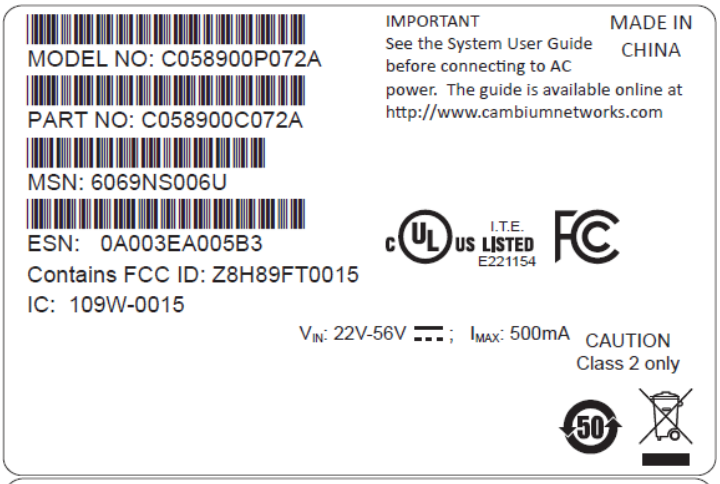
Table 115 Product labelling

Region	Label
Access Point (AP)	“Contains Transmitter Module FCC ID: Z8H89FT0006” or “Contains FCC ID: Z8H89FT0006”
Subscriber Module (SM)	“Contains Transmitter Module FCC ID: Z8H89FT0005” or “Contains FCC ID: Z8H89FT0005”
Access Point (AP) / Subscriber Module (SM)	“Contains Transmitter Module FCC ID: Z8H89FT0015” or “Contains FCC ID: Z8H89FT0015”

Figure 64 FCC and IC certifications on 5 GHz product labels




MODEL NO: C058900P132A
PART NO: C058900C132A
MSN: 6069NS006U
ESN: 0A003EA005B3
FCC ID: Z8H89FT0005
IC: 109W-0005
IMPORTANT
See the System User Guide before connecting to AC power. The guide is available online at http://www.cambiumnetworks.com
MADE IN CHINA
I.T.E.
US LISTED
E221154
VIN: 22V-56V ⎓ ; IMAX: 500mA
CAUTION
Class 2 only


MODEL NO: C058900P072A
PART NO: C058900C072A
MSN: 6069NS006U
ESN: 0A003EA005B3
Contains FCC ID: Z8H89FT0015
IC: 109W-0015
IMPORTANT
See the System User Guide before connecting to AC power. The guide is available online at http://www.cambiumnetworks.com
MADE IN CHINA
I.T.E.
US LISTED
E221154
VIN: 22V-56V ⎓ ; IMAX: 500mA
CAUTION
Class 2 only

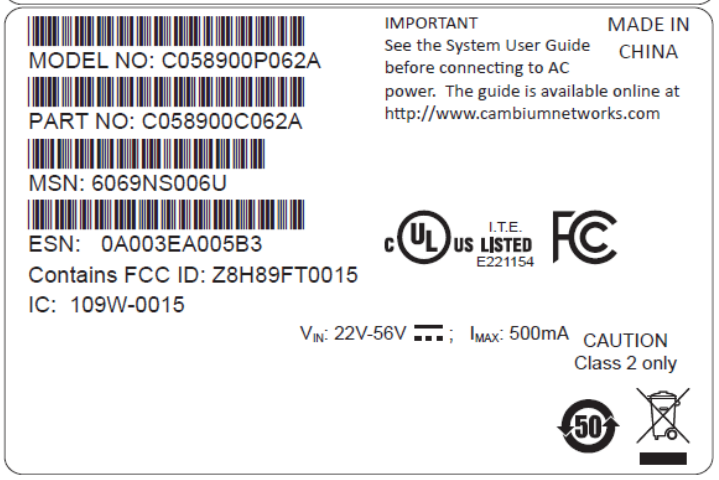
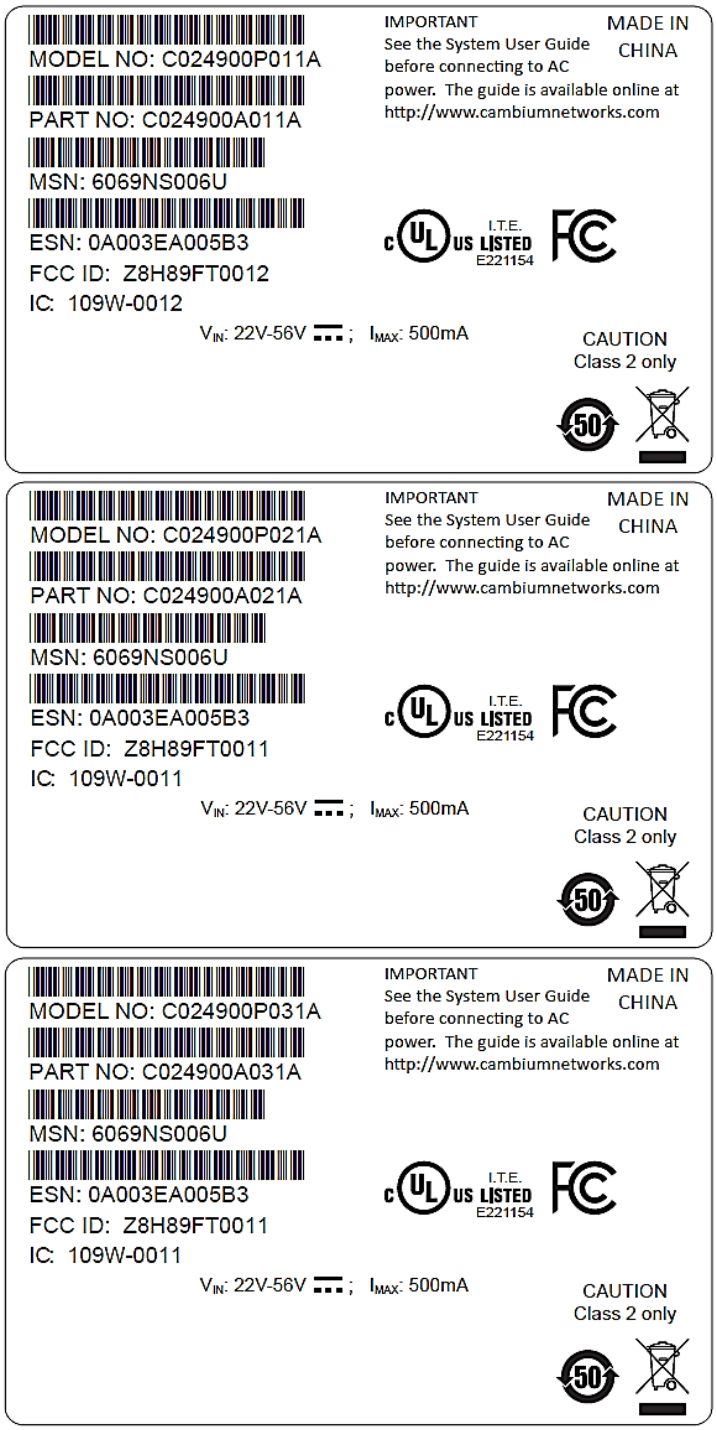

MODEL NO: C058900P062A
PART NO: C058900C062A
MSN: 6069NS006U
ESN: 0A003EA005B3
Contains FCC ID: Z8H89FT0015
IC: 109W-0015
IMPORTANT
See the System User Guide before connecting to AC power. The guide is available online at http://www.cambiumnetworks.com
MADE IN CHINA
I.T.E.
US LISTED
E221154
VIN: 22V-56V ⎓ ; IMAX: 500mA
CAUTION
Class 2 only

Figure 65 FCC and IC certifications on 2.4 GHz product labels



Wherever necessary, the end user is responsible for obtaining any National licenses required to operate this product and these must be obtained before using the product in any particular country. Contact the appropriate national administrations for details on the conditions of use for the bands in question and any exceptions that might apply.

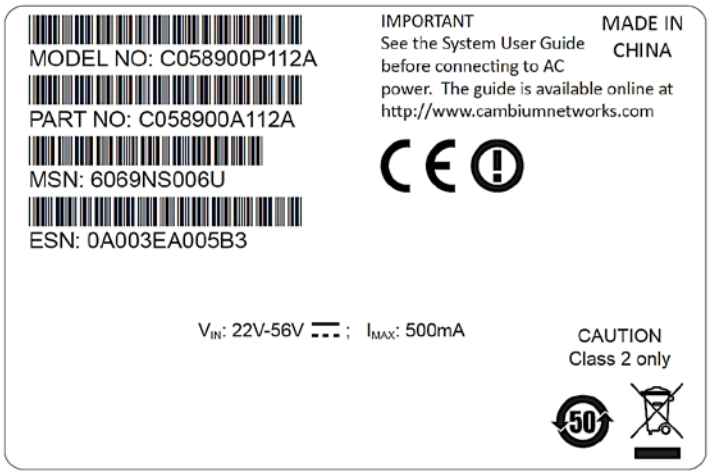
5.4 GHz European Union notification

The ePMP product is a two-way radio transceiver suitable for use in Broadband Wireless Access System (WAS), Radio Local Area Network (RLAN), or Fixed Wireless Access (FWA) systems. It is a Class 1 device and uses operating frequencies that are harmonized throughout the EU member states. The operator is responsible for obtaining any national licenses required to operate this product and these must be obtained before using the product in any particular country.

Hereby, Cambium Networks declares that the ePMP product complies with the essential requirements and other relevant provisions of Directive 1999/5/EC. The declaration of conformity may be consulted at the support website.

The European R&TTE directive 1999/5/EC Certification Number is reproduced on the product label (**Figure 66**).

Figure 66 European Union certification on 5.4 GHz product label



5.8 GHZ REGULATORY COMPLIANCE

This system has achieved Type Approval in various countries around the world. This means that the system has been tested against various local technical regulations and found to comply. The frequency band in which the system operates is “license exempt” and the system is allowed to be used provided it does not cause interference. The licensing authority does not guaranteed protection against interference from other products and installations.

For the connectorized version of the product and in order to reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the Effective Isotropically Radiated Power (EIRP) is not more than that permitted for successful communication.

U.S. Federal Communication Commission (FCC)

This device complies with part 15 of the US FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) This device must accept any interference received, including interference that may cause undesired operation.

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the US FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio-frequency energy and, if not installed and used in accordance with these instructions, may cause harmful interference to radio communications. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment on and off, the user is encouraged to correct the interference by one or more of the following measures:

- Increase the separation between the affected equipment and the unit;
- Connect the affected equipment to a power outlet on a different circuit from that which the receiver is connected to;
- Consult the dealer and/or experienced radio/TV technician for help.

Industry Canada (IC)

This Class B digital apparatus complies with Canadian ICES-003.

Cet appareil numérique de la classe B conforme á la norme NMB-003 du Canada.

RSS-GEN issue 3 (7.1.3) Licence-Exempt Radio Apparatus:

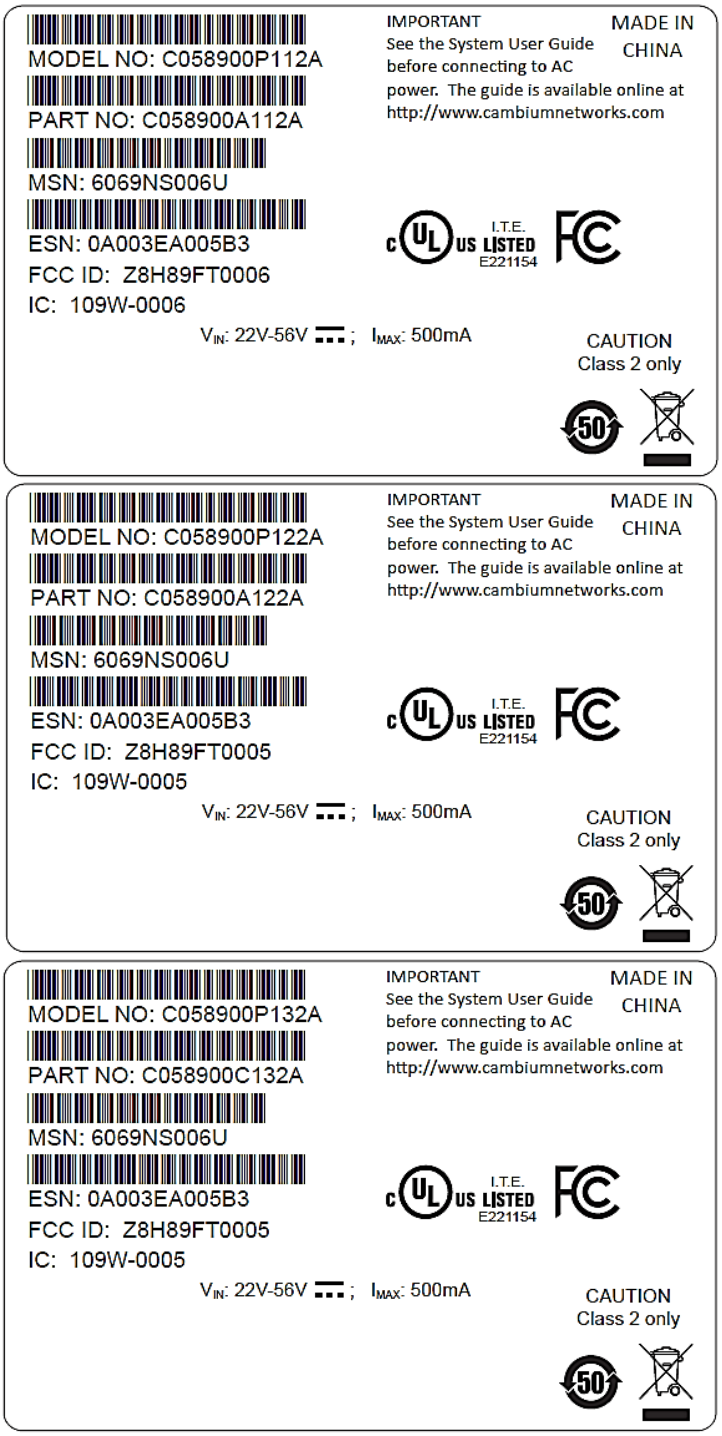
> This device complies with Industry Canada license-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.
>
> *Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes : (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.*

In Canada, high power radars are allocated as primary users (meaning they have priority) of the 5650 – 5850 MHz spectrum. These radars could cause interference or damage to license-exempt local area network (LE-LAN) devices.

Product labels

FCC IDs and Industry Canada Certification Numbers are reproduced on the product label (**Figure 67**).

Figure 67 FCC and IC certifications on 5.8 GHz product label



Wherever necessary, the end user is responsible for obtaining any National licenses required to operate this product and these must be obtained before using the product in any particular country. Contact the appropriate national administrations for details on the conditions of use for the bands in question and any exceptions that might apply.

5.8 GHz European Union notification

The ePMP is a Class 2 device as it operates on frequencies that are not harmonized across the EU. Currently the product may only be operated in the UK, Eire (IRL), Germany, Norway and Denmark. However, the regulatory situation in Europe is changing and the radio spectrum may become available in other countries in future. See www.ero.dk for further information. The operator is responsible for obtaining any national licenses required to operate this product and these must be obtained before using the product in any particular country.

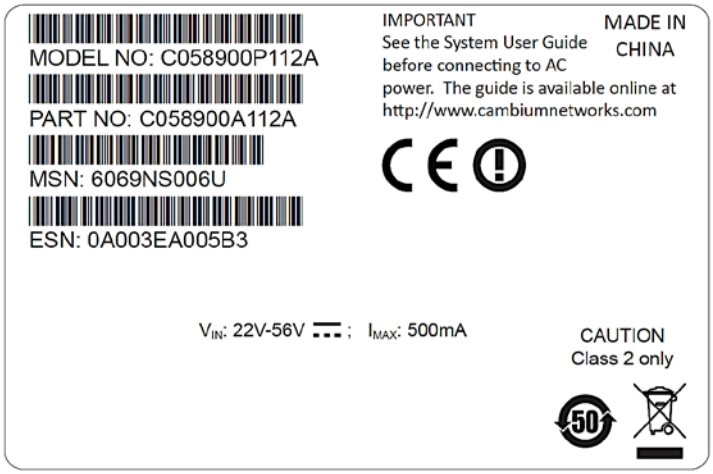
Caution

This equipment operates as a secondary application, so it has no rights against harmful interference, even if generated by similar equipment, and must not cause harmful interference on systems operating as primary applications.

Hereby, Cambium Networks declares that the ePMP product complies with the essential requirements and other relevant provisions of Directive 1999/5/EC. The declaration of conformity may be consulted at the support website.

The European R&TTE directive 1999/5/EC Certification Number is reproduced on the product label (**Figure 68**).

Figure 68 European Union certification on 5.8 GHz product label



5.8 GHz operation in the UK

The ePMP connectorized product has been notified for operation in the UK, and when operated in accordance with instructions for use it is compliant with UK Interface Requirement IR2007. For UK use, installations must conform to the requirements of IR2007 in terms of EIRP spectral density against elevation profile above the local horizon in order to protect Fixed Satellite Services. The frequency range 5795-5815 MHz is assigned to Road Transport & Traffic Telematics (RTTT) in the U.K. and shall not be used by FWA systems in order to protect RTTT devices. UK Interface Requirement IR2007 specifies that radiolocation services shall be protected by a Dynamic Frequency Selection (DFS) mechanism to prevent co-channel operation in the presence of radar signals.

THAILAND NOTIFICATION

เครื่องโทรคมนาคมและอุปกรณ์นี
มีความสอดคล้องตามข้อกำหนดของ กทช.

This telecommunication equipment conforms to the requirements of the National Telecommunications Commission.

Data throughput tables

This section contains tables to support calculation of the data rate capacity that can be provided by ePMP configurations, as follows:

- See **Data throughput capacity** on page **349**

DATA THROUGHPUT CAPACITY

The data throughput rates (Mbps) achieved with an AP/SM pair and the link distance (range) is 0 km as shown in **Table 116**, **Table 117**, **Table 118**, **Table 119**.

Table 116 Throughput for ePMP (Flexible Ratio)

MCS	Spatial Streams	Mod. Type	Coding Rate	5 MHz		10 MHz		20 MHz		40 MHz	
				DL	UL	DL	UL	DL	UL	DL	UL
MCS 15	2	64-QAM	5/6	23	20.4	48.4	48.4	95.6	88	202	135
MCS 14	2	64-QAM	3/4	20.8	20.2	43.6	44.2	88	83.4	182	128
MCS 13	2	64-QAM	2/3	18.6	18.8	38.7	38.7	79.3	76.1	163	116
MCS 12	2	16-QAM	3/4	13.7	13.7	29.1	28.7	59.6	58.1	123	61.7
MCS 11	2	16-QAM	1/2	9.27	9.37	19.3	19.1	39.8	38.7	82.2	61.9
MCS 10	2	QPSK	3/4	7.06	6.9	14.7	14.5	30	29.1	62.1	57.4
MCS 9	2	QPSK	1/2	4.85	4.5	9.64	9.59	20.1	19.4	41.6	41.1
MCS 7	1	64-QAM	5/6	11.5	11.6	24.4	24.3	49.7	48.4	103	61.8
MCS 6	1	64-QAM	3/4	10.7	10.5	22	21.8	44.6	43.6	92.1	61.6
MCS 5	1	64-QAM	2/3	9.3	9.37	19.3	19.3	39.9	38.7	82.1	61.6
MCS 4	1	16-QAM	3/4	7.08	6.69	14.7	14.5	30	29.1	61.9	57.6
MCS 3	1	16-QAM	1/2	4.85	4.56	9.67	9.64	20.1	19.4	41.5	41.2
MCS 2	1	QPSK	3/4	3.54	3.37	7.35	7.18	15	14.4	31	30.8
MCS 1	1	QPSK	1/2	2.56	2.25	5.01	4.75	10.2	9.67	20.8	20.5

Table 117 Throughput for ePMP (75/25 Ratio)

MCS	Spatial Streams	Mod. Type	Coding Rate	5 MHz		10 MHz		20 MHz		40 MHz	
				DL	UL	DL	UL	DL	UL	DL	UL
MCS 15	2	64-QAM	5/6	18.7	3.64	42.2	10.7	87	27	178	56
MCS 14	2	64-QAM	3/4	16.5	3.38	37.7	9.75	78.4	24.1	162	51.6
MCS 13	2	64-QAM	2/3	14.7	3.09	32.8	8.97	69.4	21	143	44.6
MCS 12	2	16-QAM	3/4	10.9	2.21	24.6	6.63	52.1	16.1	108	34
MCS 11	2	16-QAM	1/2	7.04	1.42	16.5	4.3	34.7	10.4	72.9	22.3
MCS 10	2	QPSK	3/4	5.47	1.03	12.3	3.2	25.9	7.8	54.4	16.6
MCS 9	2	QPSK	1/2	3.52	0.619	8.2	2.14	17.2	5.16	36.3	11.1
MCS 7	1	64-QAM	5/6	9.36	1.88	21.1	5.46	43.5	13.7	91.7	28.2
MCS 6	1	64-QAM	3/4	8.2	1.65	18.8	4.88	39.2	11.9	82.3	25.8
MCS 5	1	64-QAM	2/3	7.04	1.55	16.4	4.3	34.7	10.6	72.9	22.3
MCS 4	1	16-QAM	3/4	7.08	6.69	14.7	14.5	30	29.1	61.9	57.6

MCS 3	1	16-QAM	1/2	4.85	4.56	9.67	9.64	20.1	19.4	41.5	41.2
MCS 2	1	QPSK	3/4	3.54	3.37	7.35	7.18	15	14.4	31	30.8
MCS 1	1	QPSK	1/2	2.56	2.25	5.01	4.75	10.2	9.67	20.8	20.5

Table 118 Throughput for ePMP 50/50 Ratio)

MCS	Spatial Streams	Mod. Type	Coding Rate	5 MHz		10 MHz		20 MHz		40 MHz	
				DL	UL	DL	UL	DL	UL	DL	UL
MCS 15	2	64-QAM	5/6	10.5	11.4	25.9	26.9	56.5	58.4	115	114
MCS 14	2	64-QAM	3/4	9.35	10.3	23.4	24.2	50.6	51.8	104	105
MCS 13	2	64-QAM	2/3	8.19	9.17	21.1	21.5	44.6	46.7	94.2	95.7
MCS 12	2	16-QAM	3/4	6.23	6.9	15.6	16	33.6	34.8	70.4	72.3
MCS 11	2	16-QAM	1/2	4.09	4.56	10.5	10.6	22.4	23.1	46.9	47.8
MCS 10	2	QPSK	3/4	3.12	3.38	7.84	8.01	16.4	17.1	35.2	35.9
MCS 9	2	QPSK	1/2	1.95	2.24	5.08	5.27	11.1	11.3	23.4	23.5
MCS 7	1	64-QAM	5/6	5.26	5.85	12.9	13.7	28.2	28.7	58.9	60.8
MCS 6	1	64-QAM	3/4	4.68	5.33	11.7	12.2	25.8	25.9	54.1	53.7
MCS 5	1	64-QAM	2/3	4.21	4.69	10.5	10.7	22.3	23.1	47.1	48
MCS 4	1	16-QAM	3/4	3.12	3.45	7.82	8.01	16.8	17.1	35.2	36
MCS 3	1	16-QAM	1/2	2	2.26	5.16	5.3	11.1	11.3	23.4	23.8
MCS 2	1	QPSK	3/4	1.55	1.66	3.75	3.91	8.22	8.47	17.6	17.9
MCS 1	1	QPSK	1/2	0.938	1.07	2.35	2.35	5.49	5.63	11.8	11.8

Table 119 Throughput for ePMP (30/70 Ratio)

MCS	Spatial Streams	Mod. Type	Coding Rate	5 MHz		10 MHz		20 MHz		40 MHz	
				DL	UL	DL	UL	DL	UL	DL	UL
MCS 15	2	64-QAM	5/6	4.2	18	12.9	39.6	31.7	82	68.2	134
MCS 14	2	64-QAM	3/4	3.73	15.8	11.7	36	28.1	74.2	61.2	132
MCS 13	2	64-QAM	2/3	3.26	14.3	10.3	32.4	25.8	65.5	54.1	131
MCS 12	2	16-QAM	3/4	2.33	10.8	7.8	23.9	18.8	49.2	39.9	101
MCS 11	2	16-QAM	1/2	1.56	7.04	5.15	16	12.5	32.8	26.6	68
MCS 10	2	QPSK	3/4	1.17	5.34	3.9	11.7	9.36	24.4	20	51.2
MCS 9	2	QPSK	1/2	0.778	3.51	2.35	7.82	6.24	16.2	12.9	34
MCS 7	1	64-QAM	5/6	2.32	9.11	6.47	19.8	15.7	41	32.9	86.6
MCS 6	1	64-QAM	3/4	1.95	8.13	5.86	17.9	14.1	37.3	30.6	77
MCS 5	1	64-QAM	2/3	1.56	7.04	5.15	16	12.5	32.7	26.7	68
MCS 4	1	16-QAM	3/4	1.17	5.34	3.9	11.7	9.37	24.6	20	51.2
MCS 3	1	16-QAM	1/2	0.778	3.52	2.35	7.82	6.25	16.3	13.3	34.1
MCS 2	1	QPSK	3/4	0.469	2.62	1.88	5.86	4.67	12.1	9.85	25.5
MCS 1	1	QPSK	1/2	0.312	1.75	1.17	3.9	3.02	8.08	6.48	17

Radio Specifications

CONNECTORIZED RADIO SPECIFICATIONS

Table 120 Connectorized Radio specifications, 5 GHz

Product	
PART NUMBERS	C058900A112A (US/FCC), C050900A013A (EU), C050900A011A (ROW)
MODEL NUMBERS	C058900P112A (US/FCC), C050900P013A (EU), C050900P011A (ROW)
Spectrum	
CHANNEL SPACING	Configurable on 5 MHz increments
FREQUENCY RANGE	5150 - 5875 MHz
CHANNEL WIDTH	5 MHz, 10 MHz, 20 MHz or 40 MHz
Interface	
MAC (MEDIA ACCESS CONTROL) LAYER	Cambium Proprietary
PHYSICAL LAYER	2x2 MIMO/OFDM
ETHERNET INTERFACE	100/1000BaseT, rate auto negotiated (802.3af compliant)
POWERING METHODS SUPPORTED	30V PoE Supply (included), CMM3 & CMM4, 802.3af PoE Supply
PROTOCOLS USED	IPv4, UDP, TCP, IP, ICMP, SSH, SNMPv2c, HTTP, HTTPs, FTP
NETWORK MANAGEMENT	HTTP, HTTPs, SSH, FTP, SNMPv2c
VLAN	802.1Q with 802.1p priority
Performance	
SUBSCRIBERS PER SECTOR	Up to 120
ARQ	Yes
NOMINAL RECEIVE SENSITIVITY (W/ FEC) @ 20MHZ CHANNEL	MCS1 = -89 dBm to MCS15 = -68 dBm (per branch)
NOMINAL RECEIVE SENSITIVITY (W/ FEC) @ 40MHZ CHANNEL	MCS1 = -87 dBm to MCS15 = -65 dBm (per branch)
MAXIMUM DEPLOYMENT RANGE @ 20 MHz CHANNEL	Up to 13 miles
MAXIMUM DEPLOYMENT RANGE @ 40 MHz CHANNEL	Up to 9 miles

MODULATION LEVELS (ADAPTIVE)	MCS1 (QPSK 1/2) to MCS15 (64QAM 5/6)
LATENCY (nominal, roundtrip)	17 ms
GPS SYNCHRONIZATION	Yes, via Internal GPS, CMM3, or CMM4
QUALITY OF SERVICE	Three level priority (Voice, High, Low) with packet classification by DSCP, COS, VLAN ID, IP & MAC Addr,
Link Budget	
ANTENNA Options	Antennas for 90° or 120° sectors are available
TRANSMIT POWER RANGE	-20 to +30 dBm (combined, to regional EIRP limit) (1 dB interval)
ANTENNA GAIN	15 dBi (90° sector)
MAXIMUM TRANSMIT POWER	30 dBm combined (5.8 GHz Band)
Physical	
ANTENNA CONNECTION	50 Ω, RP (Reverse Polarity) SMA, female
SURGE SUPPRESSION	1 Joule Integrated
ENVIRONMENTAL	IP55
TEMPERATURE	-30°C to +55°C (-22°F to +131°F)
WEIGHT	4.5 kg (10 lbs) with antenna 0.52 kg (1.1 lbs) without antenna
WIND SURVIVAL	190 km/hour (118 mi/hour) with antenna
DIMENSIONS (H x W x D)	Radio: 26.9 x 11 x 7.7 cm (10.6 x 4.3 x 3.0 in) Antenna (excl brackets): 80.4 x 16 x 6.3 cm (31.7 x 6.3 x 2.5 in)
Security	
ENCRYPTION	128-bit AES (CCMP mode)
Certifications	
FCCID	Z8H89FT0006
INDUSTRY CANADA CERT	109W-0006
CE	EN 302 502 v1.2.1 EN 301 893 v1.7.1

Table 121 Connectorized Radio specifications, 2.4 GHz

Product	
PART NUMBER	C024900A011A
MODEL NUMBER	C024900P011A
Spectrum	
CHANNEL SPACING	Configurable on 5 MHz increments
FREQUENCY RANGE	2402 - 2472 MHz (20 MHz) 2407 - 2472 MHz (40 MHz)
CHANNEL WIDTH	5 MHz, 10 Mhz, 20 MHz or 40 MHz
Interface	
MAC (MEDIA ACCESS CONTROL) LAYER	Cambium Proprietary
PHYSICAL LAYER	2x2 MIMO/OFDM
ETHERNET INTERFACE	100/1000BaseT, rate auto negotiated (802.3af compliant)
POWERING METHODS SUPPORTED	30V PoE Supply (included), CMM3 & CMM4, 802.3af PoE Supply
PROTOCOLS USED	IPv4, UDP, TCP, IP, ICMP, SSH, SNMPv2c, HTTP, HTTPs, FTP
NETWORK MANAGEMENT	HTTP, HTTPs, SSH, FTP, SNMPv2c
VLAN	802.1Q with 802.1p priority
Performance	
SUBSCRIBERS PER SECTOR	Up to 120
ARQ	Yes
NOMINAL RECEIVE SENSITIVITY (W/ FEC) @ 20MHZ CHANNEL	MCS1 = -89 dBm to MCS15 = -68 dBm (per branch)
NOMINAL RECEIVE SENSITIVITY (W/ FEC) @ 40MHZ CHANNEL	MCS1 = -87 dBm to MCS15 = -65 dBm (per branch)
MAXIMUM DEPLOYMENT RANGE @ 20 MHz CHANNEL	Up to 13 miles
MAXIMUM DEPLOYMENT RANGE @ 40 MHz CHANNEL	Up to 9 miles
MODULATION LEVELS (ADAPTIVE)	MCS1 (QPSK 1/2) to MCS15 (64QAM 5/6)
LATENCY (nominal, roundtrip)	17 ms
GPS SYNCHRONIZATION	Yes, via Internal GPS, CMM3, or CMM4

QUALITY OF SERVICE	Three level priority (Voice, High, Low) with packet classification by DSCP, COS, VLAN ID, IP and MAC Address.
Link Budget	
ANTENNA Options	Antennas for 90° or 120° sectors are available
TRANSMIT POWER RANGE	-20 to +30 dBm (combined, to regional EIRP limit) (1 dB interval)
ANTENNA GAIN	15 dBi (90° / 120° sector)
MAXIMUM TRANSMIT POWER	30 dBm combined
Physical	
ANTENNA CONNECTION	50 Ω, RP (Reverse Polarity) SMA, female
SURGE SUPPRESSION	1 Joule Integrated
ENVIRONMENTAL	IP55
TEMPERATURE	-30°C to +55°C (-22°F to +131°F)
WEIGHT	4.5 kg (10 lbs) with antenna 0.52 kg (1.1 lbs) without antenna
WIND SURVIVAL	190 km/hour (118 mi/hour) with antenna
DIMENSIONS (H x W x D)	Radio: 26.9 x 11 x 7.7 cm (10.6 x 4.3 x 3.0 in) Antenna (excl brackets): 80.4 x 16 x 6.3 cm (31.7 x 6.3 x 2.5 in)
Security	
ENCRYPTION	128-bit AES (CCMP mode)
Certifications	
FCCID	Z8H89FT0006
INDUSTRY CANADA CERT	109W-0006
CE	EN 302 502 v1.2.1 EN 301 893 v1.7.1

INTEGRATED RADIO SPECIFICATIONS

Table 122 Integrated Radio specifications, 5 GHz

Product	
PART NUMBERS	C058900C132A (US/FCC), C050900C033A (EU), C050900C031A (ROW)
MODEL NUMBERS	C058900P132A (US/FCC), C050900P033A (EU), C050900P031A (ROW)
Spectrum	
CHANNEL SPACING	Configurable on 5 MHz increments
FREQUENCY RANGE	5150 - 5875 MHz
CHANNEL WIDTH	5 MHz, 10 Mhz, 20 MHz or 40 MHz
Interface	
MAC (MEDIA ACCESS CONTROL) LAYER	Cambium Proprietary
PHYSICAL LAYER	2x2 MIMO/OFDM
ETHERNET INTERFACE	100BaseT, Cambium PoE (V+ = pins 7 & 8, Return = pins 4 & 5)
PROTOCOLS USED	IPv4, UDP, TCP, IP, ICMP, SSH, SNMPv2c, HTTPs, FTP
NETWORK MANAGEMENT	HTTPs, SSH, FTP, SNMPv2c
VLAN	802.1Q with 802.1p priority
Performance	
ARQ	Yes
NOMINAL RECEIVE SENSITIVITY (W/ FEC) @ 20MHZ CHANNEL	MCS1 = -89 dBm to MCS15 = -70 dBm (per branch)
NOMINAL RECEIVE SENSITIVITY (W/ FEC) @ 40MHZ CHANNEL	MCS1 = -87 dBm to MCS15 = -65 dBm (per branch)
MAXIMUM DEPLOYMENT RANGE @ 20 MHz CHANNEL	Up to 13 miles
MODULATION LEVELS (ADAPTIVE)	MCS1 (QPSK 1/2) to MCS15 (64QAM 5/6)
LATENCY (nominal, roundtrip)	17 ms
QUALITY OF SERVICE	Three level priority (Voice, High, Low) with packet classification by DSCP, COS, VLAN ID, IP & MAC Addr, Broadcast, Multicast and Subscriber Module Priority
Link Budget	

ANTENNA BEAM WIDTH	24° azimuth, 12° elevation
TRANSMIT POWER RANGE	-20 to +30 dBm (combined, to regional EIRP limit) (1 dB interval)
ANTENNA GAIN	13 dBi, integrated patch
MAXIMUM TRANSMIT POWER	30 dBm combined (5.8 GHz Band)
Physical	
ANTENNA CONNECTION	Integrated patch antenna
SURGE SUPPRESSION	1 Joule Integrated
ENVIRONMENTAL	IP55
TEMPERATURE	-30°C to +55°C (-22°F to +131°F)
WEIGHT	0.49 kg (1.1 lb.)
WIND SURVIVAL	145 km/hour (90 mi/hour) with antenna
DIMENSIONS (H x W x D)	29.1 x 14.5 x 8.3 cm (11.4 x 5.7 x 3.3 in)
POWER CONSUMPTION	7 W Maximum, 5 W Typical
INPUT VOLTAGE	24 to 30 V
Security	
ENCRYPTION	128-bit AES (CCMP mode)
Certifications	
FCCID	Z8H89FT0006
INDUSTRY CANADA CERT	109W-0006
CE	EN 302 502 v1.2.1 EN 301 893 v1.7.1

Table 123 Integrated Radio specifications, 2.4 GHz

Product	
PART NUMBER	C024900A031A
MODEL NUMBER	C024900P031A
Spectrum	
CHANNEL SPACING	Configurable on 5 MHz increments
FREQUENCY RANGE	2402 - 2472 MHz (20 MHz) 2407 - 2472 MHz (40 MHz)
CHANNEL WIDTH	5 MHz, 10 Mhz, 20 MHz or 40 MHz
Interface	
MAC (MEDIA ACCESS CONTROL) LAYER	Cambium Proprietary
PHYSICAL LAYER	2x2 MIMO/OFDM
ETHERNET INTERFACE	100BaseT, Cambium PoE (V+ = pins 7 & 8, Return = pins 4 & 5)
PROTOCOLS USED	IPv4, UDP, TCP, IP, ICMP, SSH, SNMPv2c, HTTPs, FTP
NETWORK MANAGEMENT	HTTPs, SSH, FTP, SNMPv2c
VLAN	802.1Q with 802.1p priority
Performance	
ARQ	Yes
NOMINAL RECEIVE SENSITIVITY (W/ FEC) @ 20MHZ CHANNEL	MCS1 = -89 dBm to MCS15 = -70 dBm (per branch)
NOMINAL RECEIVE SENSITIVITY (W/ FEC) @ 40MHZ CHANNEL	MCS1 = -87 dBm to MCS15 = -65 dBm (per branch)
MAXIMUM DEPLOYMENT RANGE @ 20 MHz CHANNEL	Up to 13 miles
MODULATION LEVELS (ADAPTIVE)	MCS1 (QPSK 1/2) to MCS15 (64QAM 5/6)
LATENCY (nominal, roundtrip)	17 ms
QUALITY OF SERVICE	Three level priority (Voice, High, Low) with packet classification by DSCP, COS, VLAN ID, IP & MAC Addr, Broadcast, Multicast and Subscriber Module Priority
Link Budget	
ANTENNA BEAM WIDTH	24° azimuth, 12° elevation

TRANSMIT POWER RANGE	-20 to +30 dBm (combined, to regional EIRP limit) (1 dB interval)
ANTENNA GAIN	12 dBi, integrated patch
MAXIMUM TRANSMIT POWER	30 dBm combined
Physical	
ANTENNA CONNECTION	Integrated patch antenna
SURGE SUPPRESSION	1 Joule Integrated
ENVIRONMENTAL	IP55
TEMPERATURE	-30°C to +55°C (-22°F to +131°F)
WEIGHT	0.49 kg (1.1 lb.)
WIND SURVIVAL	145 km/hour (90 mi/hour) with antenna
DIMENSIONS (H x W x D)	29.1 x 14.5 x 8.3 cm (11.4 x 5.7 x 3.3 in)
POWER CONSUMPTION	7 W Maximum, 5 W Typical
INPUT VOLTAGE	24 to 30 V
Security	
ENCRYPTION	128-bit AES (CCMP mode)
Certifications	
FCCID	Z8H89FT0006
INDUSTRY CANADA CERT	109W-0006
CE	EN 302 502 v1.2.1 EN 301 893 v1.7.1

UN-SYNCED CONNECTORIZED RADIO SPECIFICATIONS

Table 124 Un-synced Connectorized Radio specifications, 5 GHz

Product	
PART NUMBERS	C058900A122A (US/FCC), C050900A023A (EU), C050900A021A (ROW)
MODEL NUMBERS	C058900P122A (US/FCC), C050900P023A (EU), C050900P021A (ROW)
Spectrum	
CHANNEL SPACING	Configurable on 5 MHz increments
FREQUENCY RANGE	5150 - 5875 MHz
CHANNEL WIDTH	20 MHz or 40 MHz
Interface	
MAC (MEDIA ACCESS CONTROL) LAYER	Cambium Proprietary
PHYSICAL LAYER	2x2 MIMO/OFDM
ETHERNET INTERFACE	100BaseT, Cambium PoE (V+ = pins 7 & 8, Return = pins 4 & 5)
PROTOCOLS USED	IPv4, UDP, TCP, IP, ICMP, SSH, SNMPv2c, HTTPs, FTP
NETWORK MANAGEMENT	HTTPs, SSH, FTP, SNMPv2c
VLAN	802.1Q with 802.1p priority
Performance	
ARQ	Yes
NOMINAL RECEIVE SENSITIVITY (W/ FEC) @ 20MHZ CHANNEL	MCS1 = -89 dBm to MCS15 = -70 dBm (per branch)
NOMINAL RECEIVE SENSITIVITY (W/ FEC) @ 40MHZ CHANNEL	MCS1 = -87 dBm to MCS15 = -65 dBm (per branch)
MAXIMUM DEPLOYMENT RANGE @ 20 MHz CHANNEL	Up to 13 miles
MAXIMUM DEPLOYMENT RANGE @ 40 MHz CHANNEL	Up to 9 miles
MODULATION LEVELS (ADAPTIVE)	MCS1 (QPSK 1/2) to MCS15 (64QAM 5/6)
LATENCY (nominal, roundtrip)	17 ms

QUALITY OF SERVICE	Three level priority (Voice, High, Low) with packet classification by DSCP, COS, VLAN ID, IP & MAC Addr, Broadcast, Multicast and Subscriber Module Priority
Link Budget	
ANTENNA Options	Antennas for 90° or 120° sectors are available
TRANSMIT POWER RANGE	-20 to +30 dBm (combined, to regional EIRP limit) (1 dB interval)
ANTENNA GAIN	15 dBi (90° sector)
MAXIMUM TRANSMIT POWER	30 dBm combined (5.8 GHz Band)
Physical	
ANTENNA CONNECTION	50 Ω, RP (Reverse Polarity) SMA, female
SURGE SUPPRESSION	1 Joule Integrated
ENVIRONMENTAL	IP55
TEMPERATURE	-30°C to +55°C (-22°F to +131°F)
WEIGHT	4.5 kg (10 lbs) with antenna 0.52 kg (1.1 lbs) without antenna
WIND SURVIVAL	190 km/hour (118 mi/hour) with antenna
DIMENSIONS (H x W x D)	Radio: 26.9 x 11 x 7.7 cm (10.6 x 4.3 x 3.0 in) Antenna (excl brackets): 80.4 x 16 x 6.3 cm (31.7 x 6.3 x 2.5 in)
Security	
ENCRYPTION	128-bit AES (CCMP mode)
Certifications	
FCCID	Z8H89FT0006
INDUSTRY CANADA CERT	109W-0006
CE	EN 302 502 v1.2.1 EN 301 893 v1.7.1

Table 125 Un-synced Connectorized Radio specifications, 2.4 GHz

Product	
PART NUMBERS	C024900A021A
MODEL NUMBERS	C024900P021A
Spectrum	
CHANNEL SPACING	Configurable on 5 MHz increments
FREQUENCY RANGE	2402 - 2472 MHz (20 MHz) 2407 - 2472 MHz (40 MHz)
CHANNEL WIDTH	20 MHz or 40 MHz
Interface	
MAC (MEDIA ACCESS CONTROL) LAYER	Cambium Proprietary
PHYSICAL LAYER	2x2 MIMO/OFDM
ETHERNET INTERFACE	100BaseT, Cambium PoE (V+ = pins 7 & 8, Return = pins 4 & 5)
PROTOCOLS USED	IPv4, UDP, TCP, IP, ICMP, SSH, SNMPv2c, HTTPs, FTP
NETWORK MANAGEMENT	HTTPs, SSH, FTP, SNMPv2c
VLAN	802.1Q with 802.1p priority
Performance	
ARQ	Yes
NOMINAL RECEIVE SENSITIVITY (W/ FEC) @ 20MHZ CHANNEL	MCS1 = -89 dBm to MCS15 = -70 dBm (per branch)
NOMINAL RECEIVE SENSITIVITY (W/ FEC) @ 40MHZ CHANNEL	MCS1 = -87 dBm to MCS15 = -65 dBm (per branch)
MAXIMUM DEPLOYMENT RANGE @ 20 MHz CHANNEL	Up to 13 miles
MAXIMUM DEPLOYMENT RANGE @ 40 MHz CHANNEL	Up to 9 miles
MODULATION LEVELS (ADAPTIVE)	MCS1 (QPSK 1/2) to MCS15 (64QAM 5/6)
LATENCY (nominal, roundtrip)	17 ms
QUALITY OF SERVICE	Three level priority (Voice, High, Low) with packet classification by DSCP, COS, VLAN ID, IP & MAC Addr, Broadcast, Multicast and Subscriber Module Priority
Link Budget	

ANTENNA Options	Antennas for 90° or 120° sectors are available
TRANSMIT POWER RANGE	-20 to +30 dBm (combined, to regional EIRP limit) (1 dB interval)
ANTENNA GAIN	15 dBi (90° / 120° sector)
MAXIMUM TRANSMIT POWER	30 dBm combined
Physical	
ANTENNA CONNECTION	50 Ω, RP (Reverse Polarity) SMA, female
SURGE SUPPRESSION	1 Joule Integrated
ENVIRONMENTAL	IP55
TEMPERATURE	-30°C to +55°C (-22°F to +131°F)
WEIGHT	4.5 kg (10 lbs) with antenna 0.52 kg (1.1 lbs) without antenna
WIND SURVIVAL	190 km/hour (118 mi/hour) with antenna
DIMENSIONS (H x W x D)	Radio: 26.9 x 11 x 7.7 cm (10.6 x 4.3 x 3.0 in) Antenna (excl brackets): 80.4 x 16 x 6.3 cm (31.7 x 6.3 x 2.5 in)
Security	
ENCRYPTION	128-bit AES (CCMP mode)
Certifications	
FCCID	Z8H89FT0006
INDUSTRY CANADA CERT	109W-0006
CE	EN 302 502 v1.2.1 EN 301 893 v1.7.1

Glossary

Table 126 Glossary

Term	Definition
AES	Advanced Encryption Standard
ANSI	American National Standards Institute
AP	Access Point
CINR	Carrier to Interference plus Noise Ratio
CMM	Cluster Management Module
CNSS	Cambium Network Services Server
DFS	Dynamic Frequency Selection
EIRP	Equivalent Isotropically Radiated Power
EMC	Electromagnetic Compatibility
EMD	Electromagnetic Discharge
ETH	Ethernet
ETSI	European Telecommunications Standards Institute
FCC	Federal Communications Commission
FEC	Forward Error Correction
GPS	Global Positioning System
GUI	Graphical User Interface
HTTP	Hypertext Transfer Protocol
IC	Industry Canada
IEEE	Institute of Electrical and Electronics Engineers
IP	Internet Protocol
LAN	Local Area Network
LED	Light Emitting Diode
LOS	Line of Sight
MIMO	Multiple In Multiple Out
MTU	Maximum Transmission Unit
nLOS	Near Line of Sight
NTP	Network Time Protocol
OFDM	Orthogonal Frequency Division Multiplexing
PC	Personal Computer
PMP	Point to Multipoint
QAM	Quadrature Amplitude Modulation
QPSK	Quadrature Phase Shift Keyed
RF	Radio Frequency
RMA	Return Merchandise Authorization
RSSI	Received Signal Strength Indication
RTTT	Road Transport and Traffic Telematics
RX	Receive
SAR	Standard Absorption Rate
SNMP	Simple Network Management Protocol
SM	Subscriber Module
SW	Software
TDD	Time Division Duplex
TDWR	Terminal Doppler Weather Radar
TX	Transmit
UNII	Unlicensed National Information Infrastructure
URL	Uniform Resource Locator