Geolocation Justification Report

According to the requirements of 47 CFR 15.407(k)(9), the GPS Module - Teseo-LIV3F (Figure 1) will be the integrated geolocation solution of Extreme AP5050 (Figure 2).

Figure 1 Teseo-LIV3F

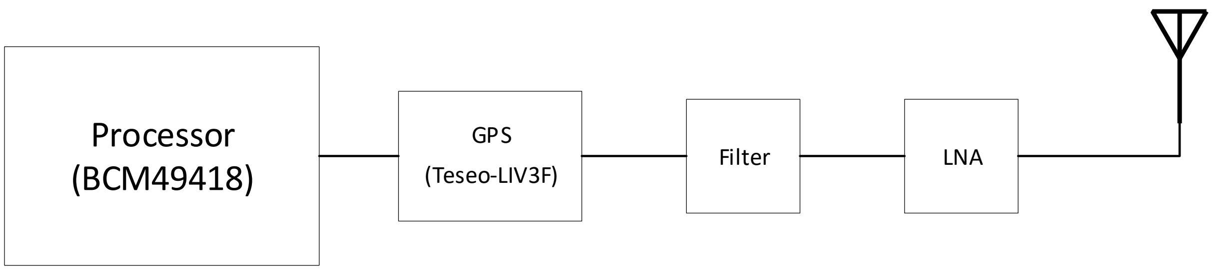


Figure 2 The Block Diagram of The Geolocation System

Teseo-LIV3F is a Global Navigation Satellite System (GNSS) standalone module which is utilized to determine geographic coordinates. Teseo-LIV3F is the only model that will be used for Extreme AP5050.
The manufacturer of Teseo-LIV3F is STMicroelectronics.
The detail specification can be found in the link:
https://www.st.com/resource/en/datasheet/teseo-liv3f.pdf

The GPS antenna (Figure 3) is an integral PIFA antenna which is designed by Wistron NeWeb Corporation (WNC).

Figure 3 Integral PIFA GPS Antenna

The features of GPS antenna are listed as follows:

- **Maximum VSWR**
  - 2.0:1 on 1GHz
- **Minimum Isolation**
  - 27.8dB on 1GHz
- **Average Efficiency**
  - ~74% on 1GHz
- **Peak Gain**
  - 3.6dBi on 1GHz

Extreme Networks standard power AP goes through a power-up sequence, obtains geolocation information, and sends the AFC requests.

To fulfill the requirements of 47 CFR 15.407(k)(8)(ii), the geolocation system generally provides the essential related parameters when the standard power AP registers to an AFC system. Since Extreme Wi-Fi standard power AP requires professional installation, the install height and vertical uncertainty will be entered by the qualified installation personnels. The related parameters of height can be configured in the GUI of IQC controller (Domain Proxy).
Please note the unit of the install height and vertical uncertainty is meter(s), and the height type is above ground level (AGL).
To set the height parameters, the professional installation personnel must enter the OS of IQC controller first, then login the GUI through a certain IP address. After logging into the GUI, the “Professional Install” button can be found above the AP status from. Click the button, the “Professional Install” window will pop up (Figure 4). The related parameters can be entered in this window.

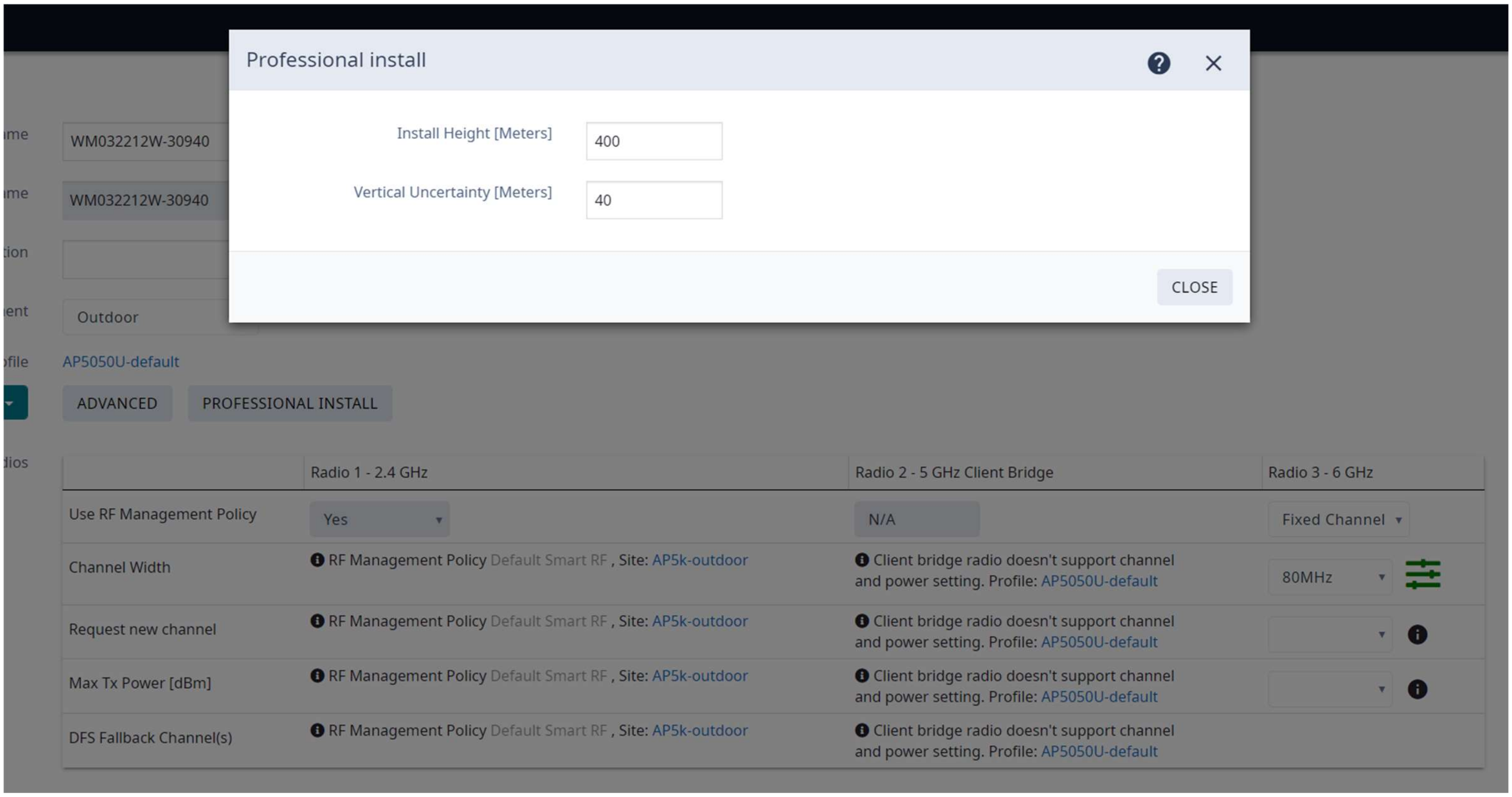


Figure 4 Set the Height in the GUI of IQC Controller

Extreme Networks standard power APs have a certain mechanism to prevent end users from intentionally or unintentionally bypassing the AFC protocol.
Please see the description as follows:

i. After the standard power AP power-up, the GPS module will be activated to obtain geolocation information.

ii. Once the GPS module is locked on valid signal and provided the firmware valid coordinates, the AFC-server registration will start via the proxy IQC controller, and an AFC request will be sent to the AFC-server. The 6GHz radio of the standard power AP doesn't transmit any signals until AP is authorized by AFC. Before the standard power AP gets authorized, the status of 6GHz radio is "AFC-PENDING" (Figure 5), and transmitter doesn't emit any signals.

iii. Once a valid spectrum was received from the AFC system, the IQC controller will bring up the standard power radio within the limits imposed by the AFC server.

iv. The standard power AP will re-register with the AFC server at least every 24 hours to ensure that the standard power radio operates over the approved spectrum. The professional installation personnels will set the "AFC Update Time" through the GUI of IQC controller (Figure 6).

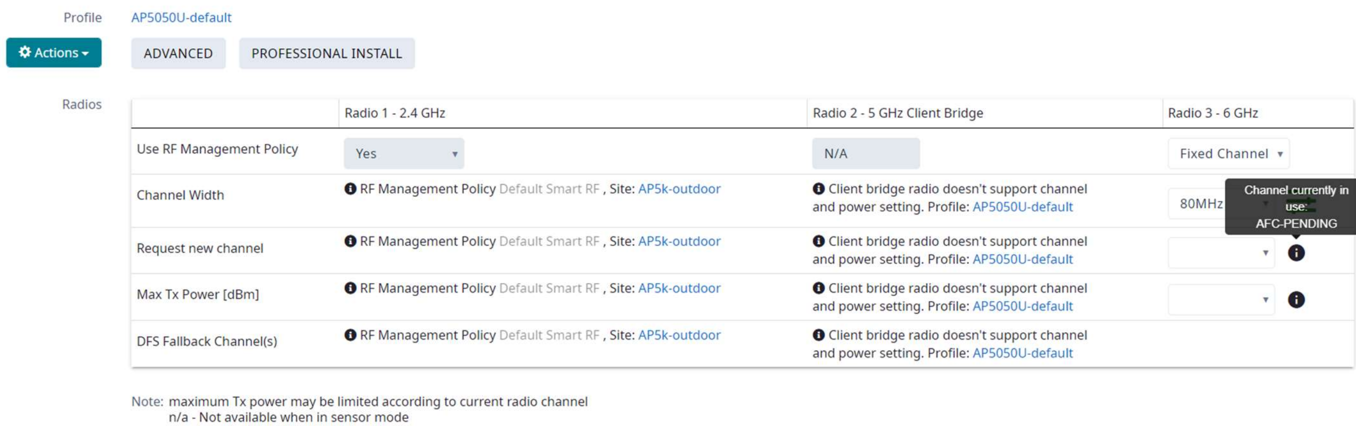


Figure 5 AFC Pending

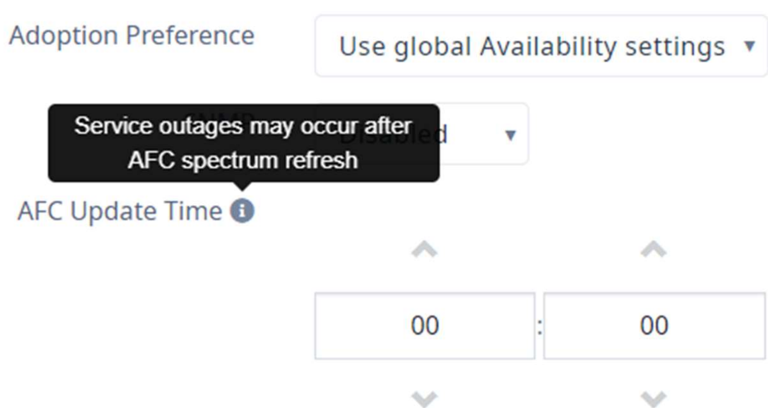


Figure 6 AFC Update Time

According to 47 CFR 15.407(K)(8)(ii), geographic coordinates (latitude and longitude referenced to Noth American Datum 1983 (NAD83)) must be provided when standard power AP registers to the AFC system.

The reference data as follows is the gps_nmea.raw file which loads from Extreme AP5050. It includes all necessary information.

gps_nmea.raw

N,000PGGA,012340.000,2447.87298,N,12059.74833,E,1,08,1.5,067.51,M,15.0,M,,*68
$GPVTG,0.0,T,,M,0.1,N,0.2,K,A*0E
$GPGST,012340.000,49.5,35.8,12.2,89.9,12.3,35.7,18.3*57
$GNGSA,A,3,18,11,15,,,,,,,,,,2.6,1.5,2.1*22
$GNGSA,A,3,87,71,72,86,85,,,,,,,,2.6,1.5,2.1*20
$GPGSV,2,1,07,15,63,331,36,18,38,320,37,11,14,143,33,24,00,000,33*7A

```
$GPGSV,2,2,07,23,00,000,27,13,00,000,25,50,50,133,37,,,,*4A
$GLGSV,2,1,08,86,65,225,36,72,38,308,37,87,37,320,34,71,36,011,45*6D
$GLGSV,2,2,08,85,24,175,35,73,24,087,24,74,19,134,,70,06,053,*62
$GPGLL,2447.87298,N,12059.74833,E,012340.000,A,A*50
$PSTMPRES,8.0,17.9,-0.0,-0.9,2.2,-10.6,3.1,-1.0,8.2,,,,,,,,,,,,,,,,,,,,,,*0C
$PSTMVRES,0.0,-0.0,0.0,0.0,-0.0,0.0,-0.0,-0.0,0.0,,,,,,,,,,,,,,,,,,,,,,*0A
$PSTMCPU,100.00,-1,49*7E
$GPRMC,012341.000,A,2447.87299,N,12059.74839,E,0.1,0.0,261023,,,A*68
$GPGGA,012341.000,2447.87299,N,12059.74839,E,1,08,1.5,066.75,M,15.0,M,,*65
$GPVTG,0.0,T,,M,0.1,N,0.1,K,A*0D
$GPGST,012341.000,43.0,31.6,11.3,90.0,11.4,31.5,16.9*56
$GNGSA,A,3,18,11,15,,,,,,,,,2.6,1.5,2.1*22
$GNGSA,A,3,87,71,72,86,85,,,,,,,2.6,1.5,2.1*20
$GPGSV,2,1,07,15,63,331,36,18,38,320,38,11,14,143,33,24,00,000,33*75
$GPGSV,2,2,07,23,00,000,28,13,00,000,25,50,50,133,37,,,,*45
$GLGSV,2,1,08,86,65,225,36,72,38,308,37,87,37,320,35,71,36,012,45*6F
$GLGSV,2,2,08,85,24,175,36,73,24,087,25,74,19,134,,70,06,053,*60
$GPGLL,2447.87299,N,12059.74839,E,012341.000,A,A*5A
$PSTMPRES,6.5,15.2,-0.7,-0.4,0.5,-8.6,2.1,-3.5,3.3,,,,,,,,,,,,,,,,,,,,,,*34
$PSTMVRES,0.0,0.0,0.0,-0.0,0.0,-0.0,-0.0,-0.0,0.0,,,,,,,,,,,,,,,,,,,,,,*0A
$PSTMCPU,100.00,-1,49*7E
```

*Please note only the GPGGA parameters will be used for AFC registration to obtain geolocation.

To prove the geolocation 95% confidence level, we recorded 5000 pieces of GPGGA values in the national first order benchmark. The calculation of the positioning precision is as follows:

2.1.2.2. Positioning Precision (ellipse)

In order to experiment determination of the positioning precision. A measurement system shown Clause 2.1.3. Through the interface the receiver transmits navigation data in NMEA standard to a PC equipped with appropriate software. The program reads data transmitted from the GPS receiver, decodes out of them the current geographical position, the altitude and the GPS time.

The location uncertainty with 95% confidence level, which is the ellipse error comprising 95% of the position determining results is following formula:

In our case, the length of the axes are defined by the standard deviations σ_x and σ_y of the data such that the equation of the error ellipse becomes:

$$\left(\frac{x}{\sigma_x}\right)^2 + \left(\frac{y}{\sigma_y}\right)^2 = s$$

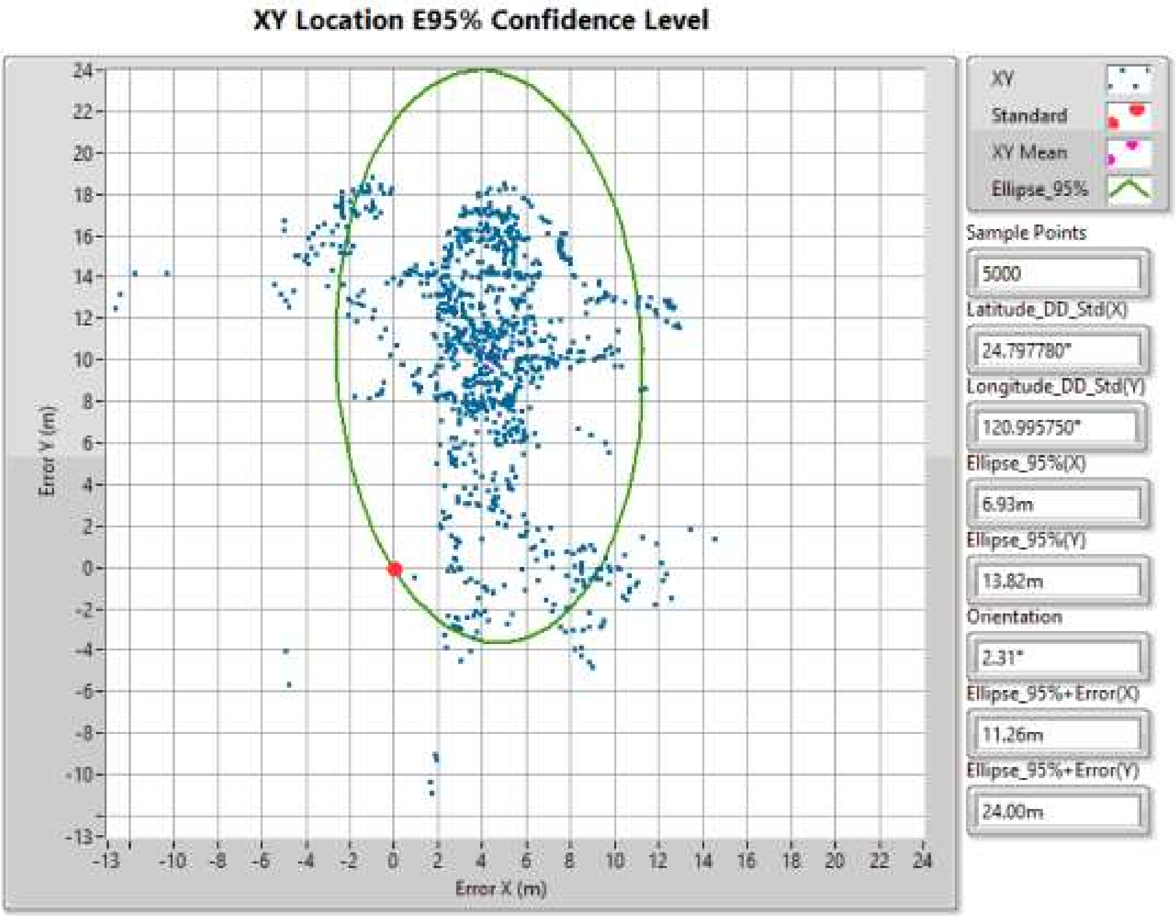
where s defines the scale of the ellipse chi-square distribution number.

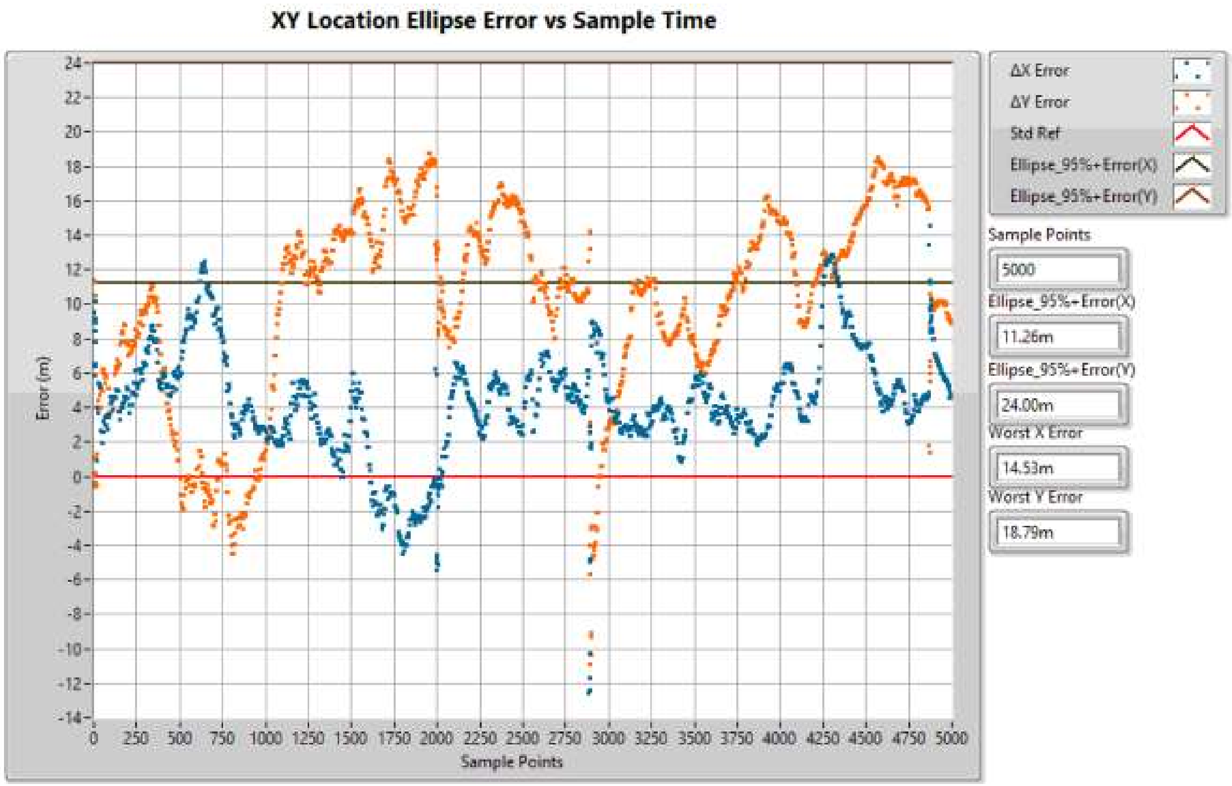
Thus, the 95% confidence ellipse can be defined similarly to the axis-aligned case, with the major axis of length $2\sqrt{s\lambda_1}$ and the minor axis of length $2\sqrt{s\lambda_2}$, where λ_1 and λ_2 represent the eigenvalues of the covariance matrix. To obtain the ellipse orientation:

$$\alpha = \arctan\frac{V1(y)}{V1(x)}$$

where V1 is the eigenvector of the covariance matrix that corresponds to the largest eigenvalue.

The calculation result is as follows:





The test result of the 95% confidence level is listed as below:
Ellipse 95% + error X (m) = 11.26
Ellipse 95% + error Y (m) = 24.00
Ellipse 95% + error Orientation (°) = 2.31

We generate an AFC Request using the API as defined by Wi-Fi alliance® AFC System to AFC Device Interface (SDI) Specification v1.5 as a JSON script and provided in table 10 through 12 and 14 for the area and location, in which the device is located with a confidence level of 95%. And provide the height table 13.
(Please refer to the Annex I for the 95% justification report which issued by the 3rd party lab)

Table 10. Ellipse object

Fields	Presence	Descriptions
NAME: center DATA TYPE: object: Point	R	This field represents the geographic coordinates of the center point of an ellipse within which the AP or Fixed Client Device is located.
NAME: majorAxis DATA TYPE: number	R	This field represents the length of the major semi axis of an ellipse within which the AP or Fixed Client Device is located. The value is a positive integer in meters.
NAME: minorAxis DATA TYPE: number	R	This field represents the length of the minor semi axis of an ellipse within which the AP or Fixed Client Device is located. The value is a positive integer in meters.
NAME: orientation DATA TYPE: number	R	This field represents the orientation of the majorAxis field in decimal degrees, measured clockwise from True North. The allowed range is from 0 to 180.

Table 14. Point object

Fields	Presence	Descriptions
NAME: longitude DATA TYPE: number	R	This field represents longitude of the AP or Fixed Client Device location in decimal degrees. The AFC System shall assume values in this field to have 6 decimal places of precision and shall treat the Point object as a mathematical point with no dimensional attributes. The precision to which this value is specified shall not be interpreted as an indication of location uncertainty. The allowed range is from -180 to +180. Positive values represent longitudes east of the prime meridian; negative values west of the prime meridian. The value shall be relative to the WGS 84 datum [2].
NAME: latitude DATA TYPE: number	R	This field represents latitude of the AP or Fixed Client Device location in decimal degrees. The AFC System shall assume values in this field to have 6 decimal places of precision and shall treat the Point object as a mathematical point with no dimensional attributes. The precision to which this value is specified shall not be interpreted as an indication of location uncertainty. The allowed range is from -90 to +90. Positive values represent latitudes north of the equator; negative values south of the equator. The value shall be relative to the WGS 84 datum [2].

"ellipse": {
"majorAxis": 24,
"minorAxis": 12,
"orientation": 2.31,
"center": {
"latitude": 24.70778,
"longitude": 120.99575
}

Table 11. LinearPolygon object

Fields	Presence	Descriptions
NAME: outerBoundary DATA TYPE: array of object: Point	R	This field represents the vertices of a polygon within which the AP or Fixed Client Device is located. At least three and no more than 15 unique vertices may be used to define the polygon. Connecting lines between successive vertices may not cross any other connecting lines between successive vertices. The distance between successive vertices should not exceed 130 km.

N/A

Table 12. RadialPolygon object

Fields	Presence	Descriptions
NAME: center DATA TYPE: object: Point	R	This field represents the geographic coordinates of the center point of a polygon within which the AP or Fixed Client Device is located.
NAME: outerBoundary DATA TYPE: array of object: Vector	R	This field represents the vertices of a polygon within which the AP or Fixed Client Device is located. At least three and no more than 15 unique vertices may be used to define the polygon. Connecting lines between successive vertices may not cross any other connecting lines between successive vertices. The distance between successive vertices should not exceed 130 km.

N/A

Table 13. Elevation object

Fields	Presence	Descriptions
NAME: height DATA TYPE: number	R	This field represents the height of the AP or Fixed Client Device antenna in meters. When the value of heightType field is "AGL", the value of this field shall be given relative to local ground level. When the value of heightType field is "AMSL", the value of this field shall be given with respect to WGS84 ellipsoidal datum.
NAME: heightType DATA TYPE: string	R	This field represents the reference level for the value of the height field. The allowed values are as follows: "AGL": Above Ground Level. Antenna height as measured relative to the local ground level. "AMSL": Above Mean Sea Level. Antenna height as measured with respect to WGS84 ellipsoidal datum.
NAME: verticalUncertainty DATA TYPE: number	R	This field indicates the vertical distance above and below the value of the height field within which the AP or Fixed Client Device is located. This value is a positive integer in meters.


```
"location": {
        "indoorDeployment": 2,
        "elevation": {
          "height": 52.52,
          "heightType": "AMSL",
          "verticalUncertainty": 38
        },
```


(Please refer to the Annex II for the complete JSON script)

Annex I

Geolocation Justification Report

FCC ID	**:**	**QXO-AP5050**
Equipment	**:**	**Access Point**
Brand Name	**:**	**Extreme Networks**
Model Name	**:**	**AP5050U, AP5050D**
Applicant	**:**	**Extreme Networks, Inc.** **2121 RDU Center Drive Morrisville North Carolina United States 27560**
Manufacturer	**:**	**Extreme Networks, Inc.** **2121 RDU Center Drive Morrisville North Carolina United States 27560**
Sample Received	**:**	**Oct. 06, 2023**
Start Test Date	**:**	**Oct. 26, 2023**
Final Test Date	**:**	**Oct. 30, 2023**
Standard	**:**	**FCC KDB 987594 D01v02**

Table of Contents

History of this test report

Report No.	Version	Description	Issued Date
F2251735-15	01	Initial issue of report	Nov. 02, 2023

Summary of Test Result

Conformance Test Specifications				
Report Clause	**Description**	**Radius 95%+ Uncertainty+ Error (m)**	**Ellipse 95%+Error X (m) / Y (m) / Orientation(˚)**	**Probability 95%+ Uncertainty+ Error Z (m)**
2.1.3	Field Trial Test Result	21.91	11.26 / 24.00 / 2.31	37.47
Note: If there are additional cables between the GPS antenna and the product, GPS cable length is not taken into account in the test results and should be evaluated by the manufacturer.				

1 General Description

1.1 Information

1.1.1 General Information

General Description	
GPS Type:	
☒	Build-in GPS is part of the device certification
	GPS Chip Manufacturers: STMicroelectronics N.V.
☐	Independent GPS is not part of the device certification
	GPS Provider: ☐ Single Provider; ☐ Multi Provider
	GPS Manufacturers:
	GPS chip manufacturers:
	GPS Models:
	Types of GPS devices: USB Dongle / handsets / tablets
Installation Environment:	
☐	Indoor
☒	Outdoor
Altitude Definition:	
☒	The altitude is determined and entered by the professional installer.
☒	The altitude is determined by GPS Altitude.

1.1.2 GPS Antenna Information

Antenna Category	
☒	Integral antenna (antenna permanently attached)
☐	External antenna (dedicated antennas)

Ant.	Brand	Model Name	Antenna Type	Connector	Gain (dBi)	EUT
1	WNC	95XEAJ15.G89	Metal PIFA	I-PEX	3.3	1
2	WNC	95XEAJ15.G75	PCB	I-PEX	3	2

Note: The above information was declared by manufacturer.

1.1.3 Table for Multiple Listing

Model Name	EUT No.	Antenna
AP5050U	1	Internal Antenna
AP5050D	2	Narrow beam/ Wide beam

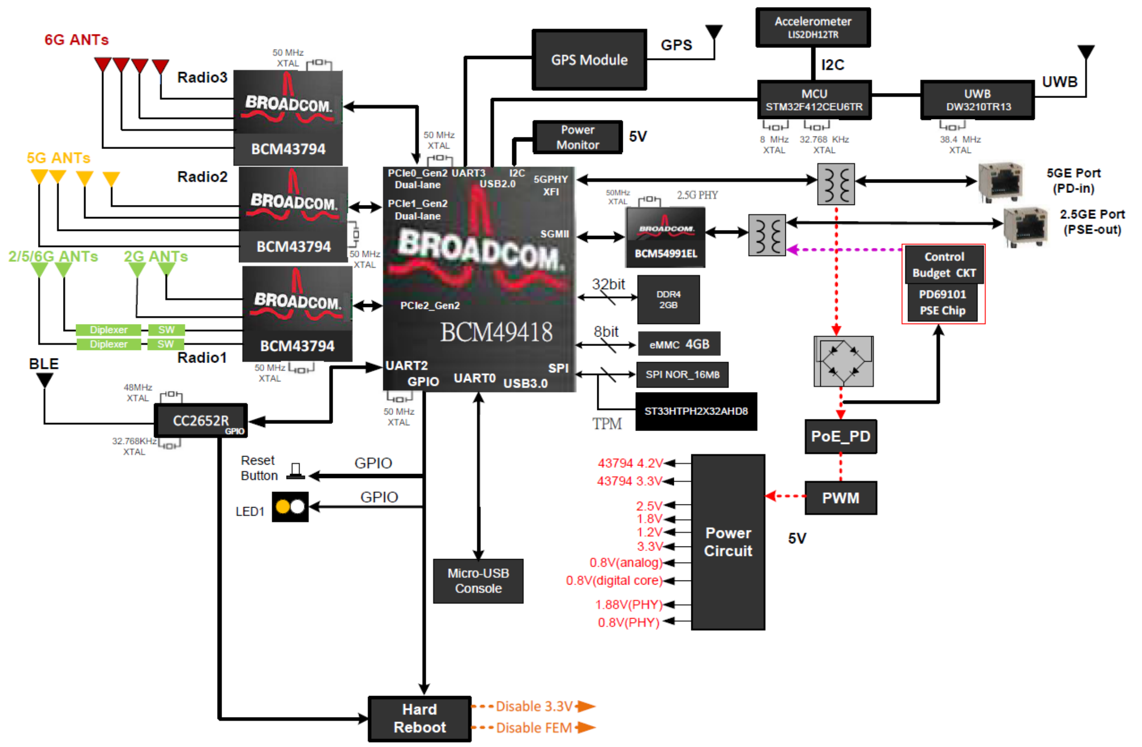
Note1: The above information was declared by manufacturer.

Note2: From the above models, model: AP5050D was selected as the representative model for the test due to the lowest antenna gain and its data was recorded in this report.

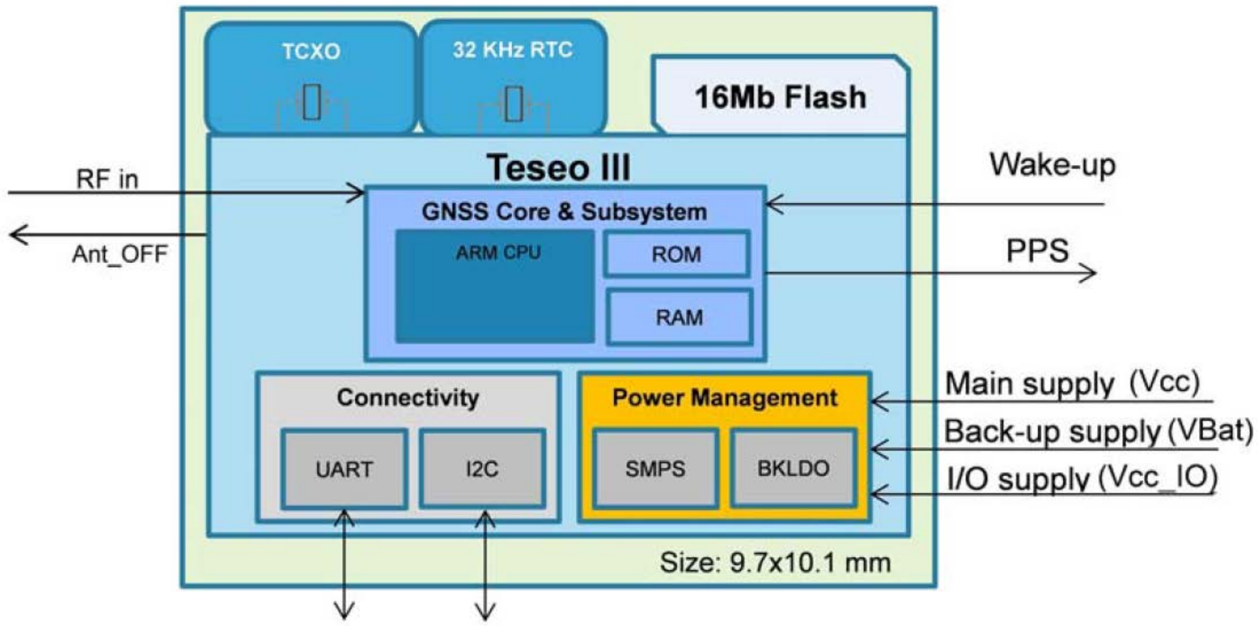
1.1.4 Geolocation System Block Diagram

EUT 1

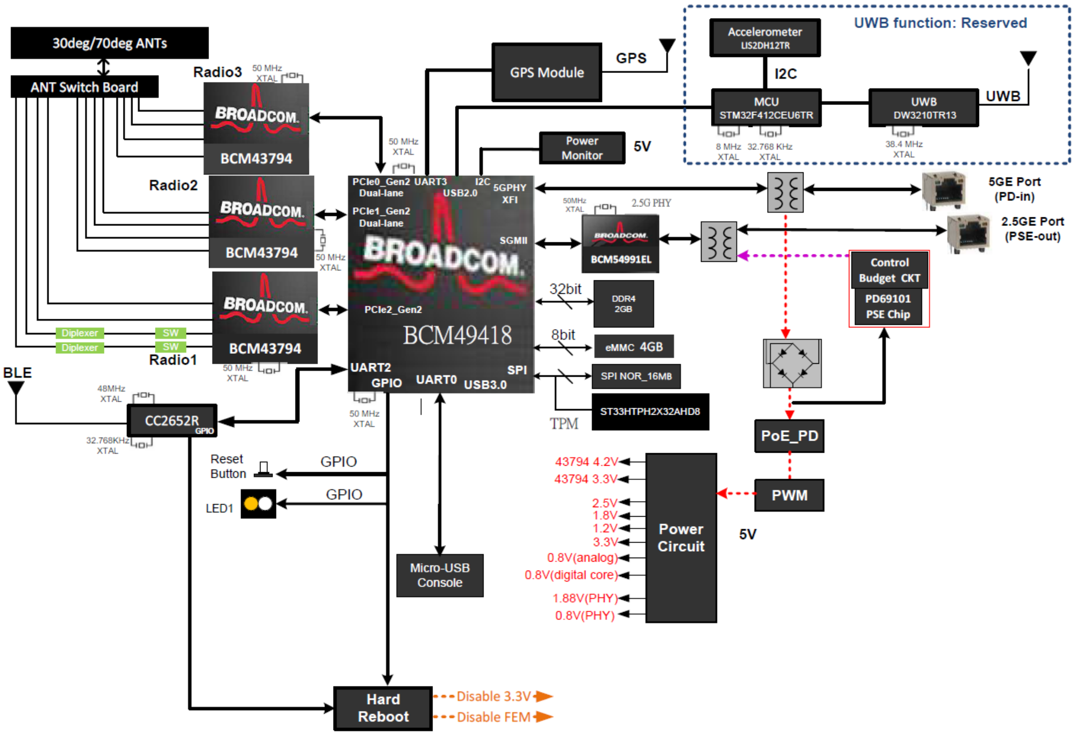
System Block



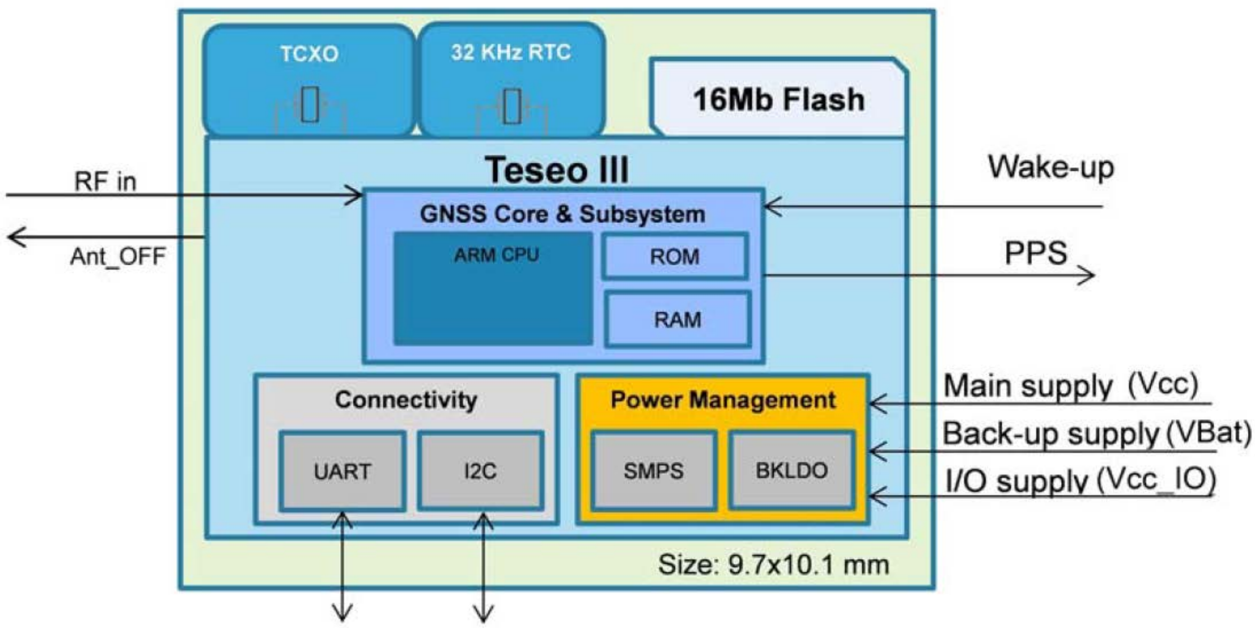
GPS Block



EUT 2
System Block



GPS Block



1.1.5 Security Features

Security Description	
☒	When end users want to bypass the AFC protocol, the EUT can automatically authenticate the GPS module by the software license.

1.1.6 After the EUT Power Cycle to Update the Geolocation

Update the Geolocation	
☒	A power cycle occurs when a device is moved, or a temporary power failure. Device can automatically determine their location and re-authenticate with the AFC to reestablish operations.

1.2 Testing Location Information

Testing Location Information	
Test Lab.：Sporton International Inc. Hsinchu Laboratory	
Hsinchu	ADD: No.8, Ln. 724, Bo’ai St., Zhubei City, Hsinchu County 302010, Taiwan (R.O.C.) TEL: 886-3-656-9065 FAX: 886-3-656-9085

Test Condition	Test Site No.	Test Engineer	Test Environment (°C / %)	Test Date
Radiated (Field Trial Test)	-	Jeff Wu	20.2~21.3 / 66~68	Oct. 26, 2023~ Oct. 30, 2023

1.3 Support Equipment

Support Equipment				
No.	Equipment	Brand Name	Model Name	FCC ID
A	Notebook	DELL	E4300	N/A
B	POE	Mircosemi	PD-9001GR/AT/AC	N/A

2 Test Result

2.1 Geolocation 95% Confidence Level

2.1.1 Field Trial Test Condition

Test Mode	
Mode	Outdoor installation environment
1	The class 1 grade 1 level reference point

2.1.2 Positioning Precision

2.1.2.1. Positioning Precision (circular)

In order to experiment determination of the positioning precision. A measurement system shown Clause 2.1.3. Through the interface the receiver transmits navigation data in NMEA standard to a PC equipped with appropriate software. The program reads data transmitted from the GPS receiver, decodes out of them the current geographical position, the altitude and the GPS time.

The standard errors (σ) from the known position in the directions of the coordinate axis are required. In practice, DRMS errors σx, σy describe one-dimensional errors in the latitude and longitude direction directions. The position determining results and is calculated with the formula:
Distance Root Mean Squared:

$$\sqrt{\sigma_x{}^2 + \sigma_y{}^2}$$

The location uncertainty with 95% confidence level, which is the radius of the circle comprising 95% of the position determining results is following formula:

95% confidence level =2.08×(0.56σx+0.62σy)

2.1.2.2. Positioning Precision (ellipse)

In order to experiment determination of the positioning precision. A measurement system shown Clause 2.1.3. Through the interface the receiver transmits navigation data in NMEA standard to a PC equipped with appropriate software. The program reads data transmitted from the GPS receiver, decodes out of them the current geographical position, the altitude and the GPS time.

The location uncertainty with 95% confidence level, which is the ellipse error comprising 95% of the position determining results is following formula:

In our case, the length of the axes are defined by the standard deviations σ_x and σ_y of the data such that the equation of the error ellipse becomes:

$$\left(\frac{x}{\sigma_x}\right)^2 + \left(\frac{y}{\sigma_y}\right)^2 = s$$

where s defines the scale of the ellipse chi-square distribution number.

Thus, the 95% confidence ellipse can be defined similarly to the axis-aligned case, with the major axis of length $2\sqrt{s\lambda_1}$ and the minor axis of length $2\sqrt{s\lambda_2}$, where λ_1 and λ_2 represent the eigenvalues of the covariance matrix. To obtain the ellipse orientation:

$$\alpha = \arctan\frac{V1(y)}{V1(x)}$$

where V1 is the eigenvector of the covariance matrix that corresponds to the largest eigenvalue.

2.1.2.3. Positioning Precision (altitude)

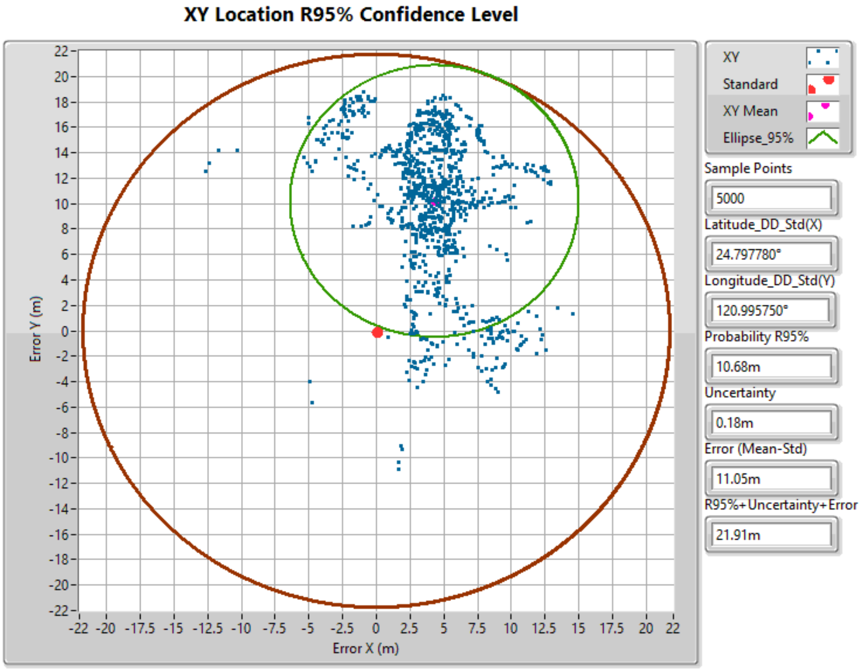
In order to experiment determination of the positioning precision. A measurement system shown Clause 2.1.3.
Through the interface the receiver transmits navigation data in NMEA standard to a PC equipped with appropriate software. The program reads data transmitted from the GPS receiver, decodes out of them the current geographical position, the altitude and the GPS time.

In our case, the altitude of the axes is defined by the standard deviations σ z of the data. Z95 error is calculated with following formula:
Z95 error = 1.96 * σ z

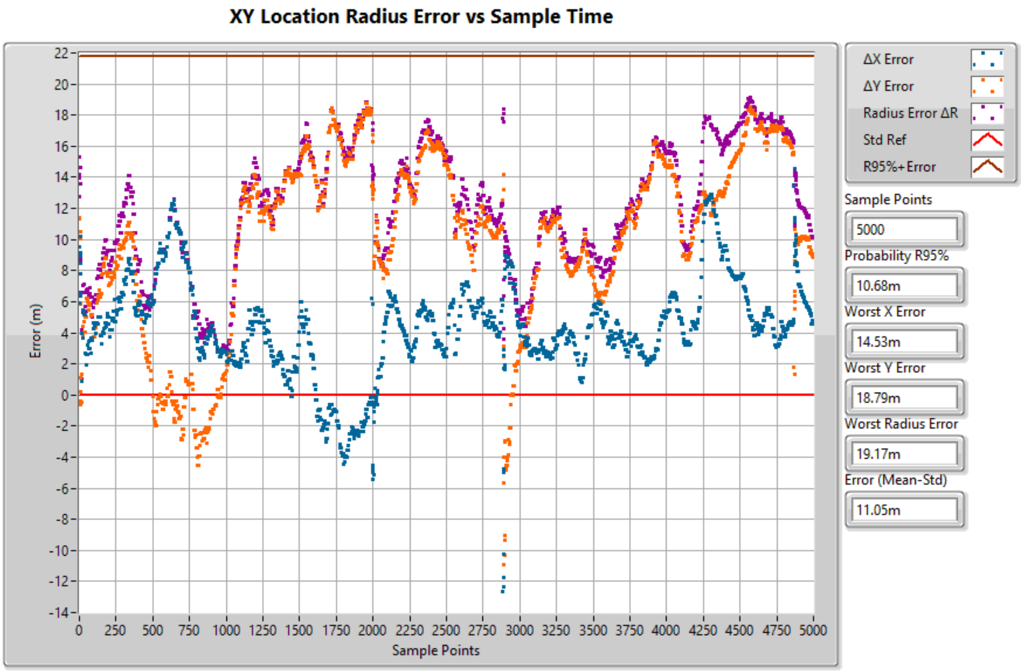
95% confidence level= Z95 Error + Mean Error
Mean Error=Mean point– Standard point

2.1.3 Field Trial Test Result

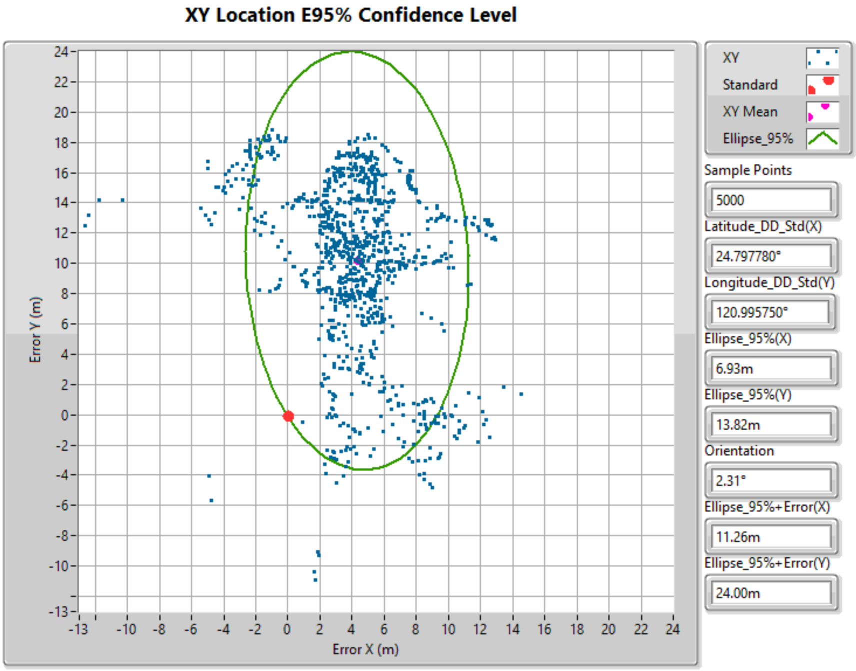
Radius XY 95% Confidence Level



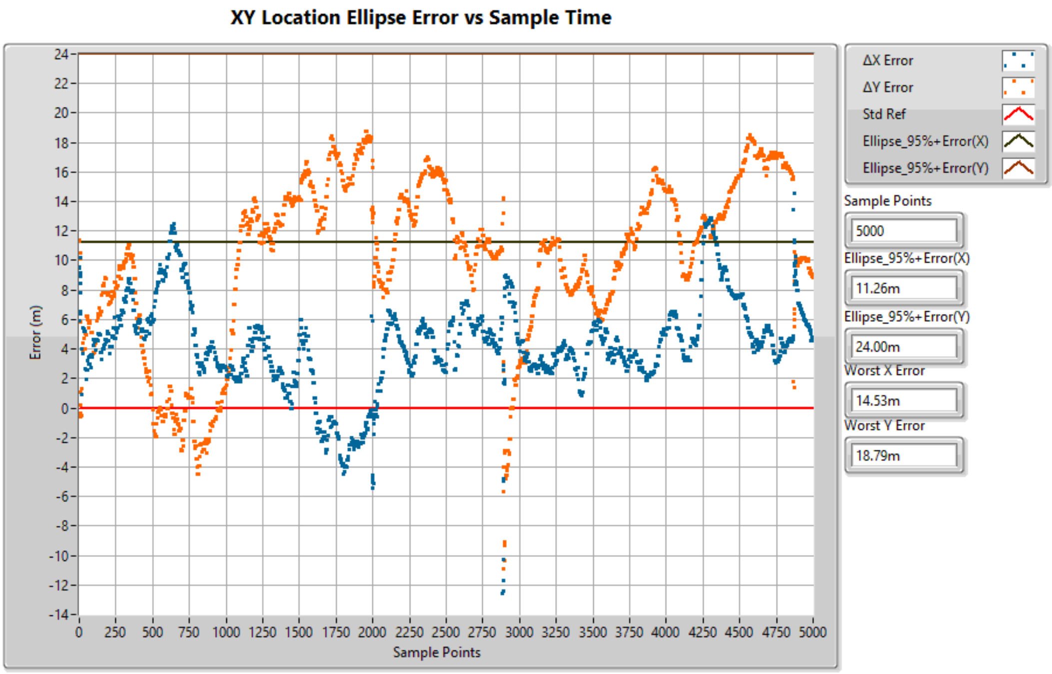
Radius XY Error vs Sample Time



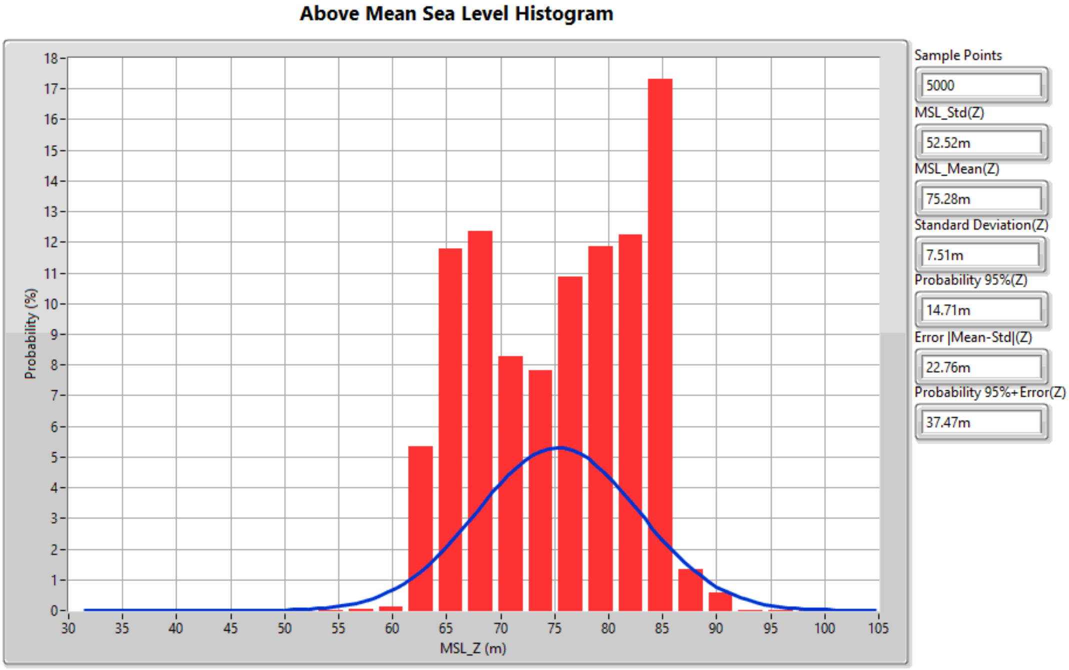
Ellipse XY 95% Confidence Level



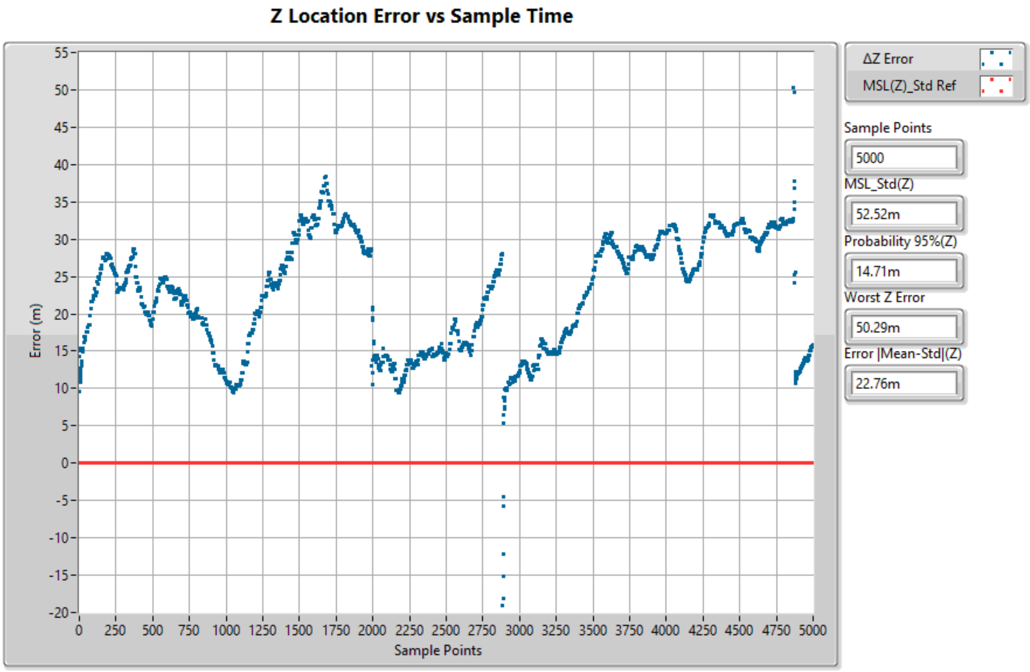
Ellipse XY Error vs Sample Time



Z 95% Confidence Level



Z Error vs Sample Time



3 Test Equipment and Calibration Data

Instrument	Manufacturer	Model No.	Serial No.	Spec.	Calibration Date	Calibration Until	Remark
Test software	SPORTON	SENSE-GPS XYZ	V1.2	N/A	N.C.R.	N.C.R.	Radiation

Note: NCR means Non-Calibration required.

1. Photographs of Field Trial Test Configuration

———THE END———

ANNEX II

############################ 2023-12-05T06:41:27Z ############################
{
  "headers": {
    "Host": "testserver.wfatestorg.org",
    "Accept": "application/json",
    "Content-Type": "application/json",
    "User-Agent": "Apache-HttpClient/4.5.6 (Java/1.8.0_382-internal)",
    "Accept-Encoding": "gzip,deflate",
    "X-Forwarded-For": "192.168.100.169",
    "X-Forwarded-Host": "testserver.wfatestorg.org",
    "X-Forwarded-Server": "testserver.wfatestorg.org",
    "Content-Length": "630",
    "Connection": "Keep-Alive"
  },
  "body": {
    "version": "1.4",
    "availableSpectrumInquiryRequests": [
      {
        "requestId": "WM032212W-31190",
        "deviceDescriptor": {
          "serialNumber": "WM032212W-31190",
          "certificationId": [
            {
              "rulesetId": "US_47_CFR_PART_15_SUBPART_E",
              "id": "QXO-AP5050"
            }
          ]
        },
        "location": {
          "indoorDeployment": 2,
          "elevation": {
            "height": 52.52,
            "heightType": "AMSL",
            "verticalUncertainty": 38
          },
          "ellipse": {
            "majorAxis": 24,
            "minorAxis": 12,
            "orientation": 2.31,
            "center": {
              "latitude": 24.70778,
              "longitude": 120.99575
            }
          }
        },

```
            "inquiredFrequencyRange": [],
            "inquiredChannels": [
              {
                "globalOperatingClass": 131
              },
              {
                "globalOperatingClass": 132
              },
              {
                "globalOperatingClass": 133
              },
              {
                "globalOperatingClass": 134
              }
            ],
            "minDesiredPower": 0.0
          }
        ]
      }
    }
```


############################ 2023-12-05T06:41:27Z ############################


```
{
  "availableSpectrumInquiryResponses": [
    {
      "response": {
        "responseCode": 0,
        "shortDescription": "SUCCESS"
      },
      "availableChannelInfo": [
        {
          "channelCfi": [
            1,
            5,
            9,
            13,
            17,
            21,
            25,
            29,
            33,
            37,
            41,
            45,
            49,
            53,
            57,
```

61,
65,
69,
73,
77,
81,
85,
89,
93
],
"globalOperatingClass": 131,
"maxEirp": [
25.14628918346527,
25.95712779116996,
34.36164408247819,
31.35796733034539,
22.17765496252408,
21.874305831391176,
32.94830382363587,
27.3857590452321,
28.23847679506604,
22.005897124165077,
23.993581894454845,
27.736010516969717,
29.114114297615906,
23.800598491373176,
33.71680230129948,
24.305683240760814,
32.0477020990067,
25.537995288203895,
30.030855641299528,
27.53458859491937,
33.839324908914804,
25.148467154238617,
24.047040781758426,
25.705353610937483
]
},
{
"channelCfi": [
3,
11,
19,
27,
35,
43,
51,

```
      59,
      67,
      75,
      83,
      91
    ],
    "globalOperatingClass": 132,
    "maxEirp": [
      28.156589140105083,
      34.3682672869852,
      24.88460578803099,
      30.39605900187191,
      25.01619708080489,
      27.003881851094658,
      26.81089844801299,
      27.315983197400627,
      28.548295244843708,
      30.544888551559183,
      28.15876711087843,
      27.05734073839824
    ]
  },
  {
    "channelCfi": [
      7,
      23,
      39,
      55,
      71,
      87
    ],
    "globalOperatingClass": 133,
    "maxEirp": [
      31.16688909674489,
      27.8949057446708,
      28.0264970374447,
      29.821198404652797,
      31.55859520148352,
      30.067640695038047
    ]
  },
  {
    "channelCfi": [
      15,
      47,
      79
    ],
```

```
          "globalOperatingClass": 134,
          "maxEirp": [
            30.905205701310614,
            31.036796994084515,
            33.077940651677864
          ]
        }
      ],
      "requestId": "WM032212W-31190",
      "availabilityExpireTime": "2023-12-06T06:41:27Z",
      "rulesetId": "US_47_CFR_PART_15_SUBPART_E"
    }
  ],
  "version": "1.4"
}
```