



**Recommendation ITU-R S.1527**  
(06/2001)

**Procedure for the identification of  
non-geostationary-satellite orbit  
satellites causing interference into  
an operating geostationary-satellite  
orbit earth station**

**S Series**  
**Fixed-satellite service**

## Foreword

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| <b>SNG</b> | Satellite news gathering   |
| <b>TF</b>  | Time signals and frequency standards emissions                                       |
| <b>V</b>   | Vocabulary and related subjects  |

*Note: This ITU-R Recommendation was approved in English under the procedure detailed in Resolution ITU-R 1.*

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## RECOMMENDATION ITU-R S.1527\*

**Procedure for the identification of non-geostationary-satellite orbit satellites causing interference into an operating geostationary-satellite orbit earth station**

(Question ITU-R 231/4)

(2001)

**Scope**

This Recommendation contains a methodology to calculate the time that a non-GSO satellite would be close to or within the main beam of a GSO FSS earth station antenna and thus with the aid of the ephemeris data, to identify the non-GSO constellation causing interference.

The ITU Radiocommunication Assembly,

*considering*

- a) that the World Radiocommunication Conference (Istanbul, 2000) (WRC-2000) adopted a combination of single-entry validation, single-entry operational and, for certain antenna sizes single-entry additional operational downlink equivalent power-flux density (epfd<sub>↓</sub>) limits contained in Article 22 of the Radio Regulations (RR), along with the aggregate limits in Resolution 76 (WRC-2000), which apply to non-geostationary-satellite orbit (non-GSO) fixed-satellite service (FSS) systems to protect GSO networks in parts of the frequency range 10.7-30 GHz;
- b) that a procedure is needed to identify a non-GSO FSS satellite close to or within the main beam of an operational GSO earth station where it may generate interference,

*noting*

- a) that up-to-date ephemeris data for non-GSO constellations are required to conduct an accurate identification procedure;
- b) that ephemeris data may be usually publicly available;
- c) that a separate Recommendation is under development to enable the measurement of peak epfd<sub>↓</sub> levels generated by the non-GSO satellite identified into the operational GSO earth station,

*recommends*

**1** that the methodology given in Annex 1 could be used to calculate the time that a non-GSO satellite would be close to or within the main beam of a GSO FSS earth station antenna and thus with the aid of the ephemeris data, to identify the non-GSO constellation causing interference;

**2** that the non-GSO satellite system operator should provide assistance to the GSO FSS network operator to obtain the most current ephemeris data, if necessary to identify the source of interference.

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\* Radiocommunication Study Group 4 made editorial amendments to this Recommendation in September 2011 in accordance with Resolution ITU-R 1.

## Annex 1

### 1 Introduction

This Annex provides a procedure which could be followed by a GSO earth station operator, to identify non-GSO systems causing sync-loss or severe degradation in operating GSO downlinks.

This Annex is divided into three parts. The first part intends to show that through a simple observation of a signal interfering with a GSO earth station, it is possible to establish a list of the possible existing non-GSO constellations that may be responsible for interference. The second part provides a description of the test bench that can be used to identify a non-GSO constellation. Finally, the last part provides an example of use of this procedure for identification of the HIBLEO-4FL constellation.

This procedure defines an essential step towards the measurement of the power flux-density (pfd) levels generated by a non-GSO constellation into a GSO earth station in operation.

### 2 Pre-measurement analysis

This part intends to show that through a simple observation of a signal interfering with a GSO earth station, it is possible to establish a list of the possible existing non-GSO constellations that may be responsible for interference.

#### 2.1 Observation of the interference

When receiving interference, a GSO FSS network operator first has to identify the source of interference and, most of all, has to determine whether the interference it receives is internal to its network or external.

A non-GSO interfering system can be identified using some or all of the following set of elements:

- any repeatability of the interference and its associated period;
- the time duration of the interference;
- the frequency of the interference;
- a knowledge of the interference level (which causes synchronization loss, or a severe degradation of the GSO signal reception);
- the date and accurate time of appearance of the performance degradation;
- the characteristics of the interfering signal transmitted;
- spectrum analyser plots of the nominal and interference conditions, if any.

Knowing these characteristics of the interfering signal, it is possible to draw up a list of the non-GSO systems filed at ITU, whose signatures may possibly correspond to the one observed.

#### 2.2 Hypothesis on the possible interfering system

In order to identify the non-GSO systems candidate to be responsible for the interference received by the GSO earth station, it is first necessary to draw up a complete list of the existing non-GSO systems operating in the band of concern for the GSO operator.

Such a list can be set up using the radio-frequency data on file at ITU, which provides information on the non-GSO constellations of interest in the identification of the non-GSO system, such as:

- period of the non-GSO constellation;
- the frequency range used by the constellation;



- the emission designators of the constellation (i.e. the bandwidth and frequency designators);
- the power levels expected on the ground, etc.

Given this information and the limited number of in orbit non-GSO systems that will eventually coexist, the list of candidate interferers will be relatively short.

The peak of  $\text{epfd}_{\downarrow}$  generated by a non-GSO system can occur in two configurations:

- when a non-GSO satellite is in-line with a GSO pointing direction if the non-GSO satellite keeps transmitting through its side lobes;
- when a satellite is about to switch off all its transmissions as it gets close to the GSO arc.

In both cases, the peak of  $\text{epfd}_{\downarrow}$  corresponds to clear geometrical configurations.

Therefore, the second element that will help with the identification of a non-GSO system is the time coincidence of an interference event with the particular geometrical situation of the non-GSO satellite with regard to the GSO network.

To determine the location of a non-GSO satellite with respect to a GSO earth station at a particular time, reference ephemeris data along with orbit predicting software are required. Such orbit predicting software packages are widely available on the Internet, and provide information such as:

- the elevation and azimuth of the non-GSO satellites when passing through a GSO earth station main beam;
- whether satellites of a non-GSO constellation are visible from the location of a particular GSO earth station;
- the position of the satellites in the sky of the GSO earth station at the time of an interference problem.

If non-GSO ephemeris data is not available from other sources then the non-GSO satellite system operator should provide assistance to the GSO FSS network operator to obtain the most current ephemeris data.

One difficulty with the identification of a non-GSO satellite in the direction of the GSO satellite orbit is that the non-GSO signal is mixed with GSO satellite signals and therefore may not be readily identifiable.

### 2.3 Tests schedule

The following section explains how to determine the pointing direction towards which the probability of having satellites of the non-GSO systems is high.

If up-to-date ephemeris data and associated orbit prediction software are available, it is possible to determine all satellite passes within  $\pm X^{\circ}$  of an antenna azimuth and elevations, the name of the satellites, and the time and duration of each pass. Such information can be used to determine a (azimuth  $\times$  elevation) window of  $\pm X^{\circ}$  on a side for which the probability of having satellite passes is maximum. This exercise will have to be done for each candidate non-GSO system likely to cause interference.

For the planned period of the test, the GSO operator should establish Table 1 for the selected azimuth:

TABLE 1  
Listing of the timetable for test schedule

| Candidate non-GSO systems | Test antenna pointing direction | Best probability (azimuth × elevation) window | Satellite number pass            | Day of pass (m:d:y) <sup>(1)</sup>  | Theoretical time pass (h:m:s) <sup>(2)</sup>  |
|---------------------------|---------------------------------|---|----------------------------------|---|---|
| 1                         |                                 |   | <i>x</i><br><i>y</i><br><i>z</i> | (m:d:y) <sub><i>x</i></sub><br>(m:d:y) <sub><i>y</i></sub><br>(m:d:y) <sub><i>z</i></sub> | (h:m:s) <sub><i>x</i></sub><br>(h:m:s) <sub><i>y</i></sub><br>(h:m:s) <sub><i>z</i></sub> |
| 2                         |                                 |   |                                  |   |   |
| 3                         |                                 |   |                                  |   |   |

(1) (m:d:y): month, day, year.

(2) (h:m:s): hour, minute, second, thousands of a second.

### 3 Test bench presentation

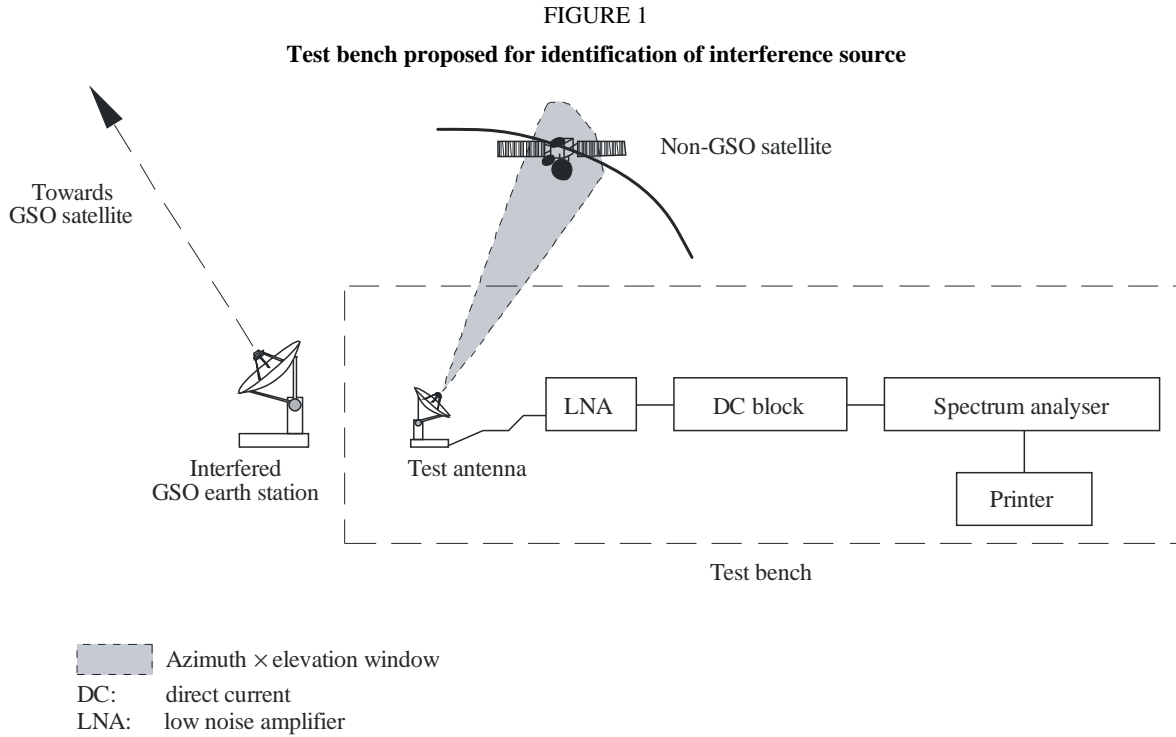
#### 3.1 Test bench set up

The proposed test bench will observe the pfd level received from non-GSO systems into the GSO earth station in the pointing direction with the greatest probability of appearance of their satellites with regard to the GSO earth station location (see § 2.3).

The test antenna that is used is separated from the GSO earth station antenna and may be of small diameter: 1.2 m or 3 m. Indeed, the aim of the analysis is not to measure the interference level generated into the GSO earth station in operation, but rather to detect and observe signals coming from a particular non-GSO satellite, at the frequency at which interference has been detected in a GSO earth station. The test antenna is located close to the GSO earth station.

The signal can also be observed in the telemetry bands. Indeed, most non-GSO FSS systems are not planning to serve all the areas in visibility of the satellite which means that the observed satellite may not be transmitting towards the measurement site. In order to make the first observation of the signal it is therefore necessary to validate the constellation parameters observing the telemetry bands.

The test bench proposed for identification of the non-GSO interference source is the following:



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The required information on the test bench elements are given in Table 2.

TABLE 2

| Description           | Required characteristics                                 | Note  |
|-----------------------|--|---|
| Test antenna and feed | Size<br>Frequency range<br>Antenna gain pattern          | Provided by the manufacturer                  |
| LNA                   | Frequency range<br>Gain and noise temperature            | Measured by the manufacturer                  |
| Coaxial cables        | Low loss cables<br>Loss as a function of the frequency   | Measured during calibration tests (see § 3.2) |
| DC block              | Loss   | Measured                                      |
| Power supply          | Compatible with the LNA voltage                          |   |
| Spectrum analyser     | Low noise floor<br>Frequency range compatible with tests |   |
| Printer               | Compatible with spectrum analyser                        |   |

In order to have accurate results it is necessary to calibrate the test reception chain as described in § 3.2.

### 3.2 Test bench calibration

The test bench calibration consists of measuring the gain and loss of the whole reception chain as well as accurately pointing the test antenna towards the predicted azimuth and elevation of the non-GSO satellite. Indeed, it is important when calibrating the reception chain, that the carrier-to-noise ratio ( $C/N$ ) expected for the non-GSO characteristic signal, be high enough to be detected with the test set-up used. Too much loss in the reception chain may make it impossible for such a test to be successful.

### 4 Example: Identification procedure applied to HIBLEO-4FL

To prove the feasibility of the technique, a practical test has been undertaken to detect non-GSO system signals from two separate locations: one near Washington DC, in the United States of America, and another at Goonhilly earth station in the United Kingdom.

The HIBLEO-4FL (Globalstar) system has been selected because:

- its orbital parameters for a 48-satellite constellation inclined at  $52^\circ$  at an altitude of 1 414 km are representative of proposed non-GSO systems;
- it radiates to the ground a constant power telemetry (7 kHz bandwidth) that is function of the elevation;
- the transmissions are near 7 GHz using circular polarized single beam antenna, that are fully detectable with a linear polarized antenna;
- HIBLEO-4FL is the only user of the 7 GHz downlink band, thus, there would be no confusion from signals from other satellite systems;
- the test equipment was commercially available for 7 GHz.

These tests prove that it is possible:

- to determine a non-GSO constellation signature without implementing specific standardized signature signals;
- to detect satellites from a non-GSO system operating in low orbit with code division multiple access modulation; and
- to predict with a very good accuracy, the location of non-GSO satellites with regard to a GSO earth station location.

It is important to note that the HIBLEO-4FL system is very close to a system like F-SAT MULTI 1B in terms of orbital parameters and pfd on the ground. Table 3 provides the most important figures of both constellation orbital parameters and pfd levels.

TABLE 3

|   | F-SAT MULTI 1B              | HIBLEO-4FL                                 |
|---|-----------------------------|--|
| Altitude (km)                                   | 1 469                       | 1 414                                      |
| Orbital type                                    | Circular                    | Circular                                   |
| Inclination (degrees)                           | 53                          | 52   |
| Frequency (GHz)                                 | 10.7-12.75 for the downlink | Near 6.8 for telemetry                     |
| pfd levels<br>(dB(W/(m <sup>2</sup> · 40 kHz))) | Around -145                 | $pfd_{min} = -148$<br>$pfd_{max} = -135.8$ |



The tests carried out in the United States of America and in the United Kingdom, for which a detailed description of the former is given in Appendix 1, prove that HIBLEO-4FL is detectable, identifiable and that the time of pass of a satellite into the main beam of the GSO earth station antenna, whichever pointing direction, can be predicted with about 3 s accuracy.

## **5 Conclusion**

It has been demonstrated in this Annex, that the identification of a non-GSO constellation can be achieved, and at low cost. It is possible to predict the time pass of a non-GSO satellite close to or within the main beam of a GSO earth station, with an accuracy of about 3 s. A procedure as simple as the one presented here provides information that is essential for GSO operators seeking to identify the non-GSO system responsible for the interference observed.

## **Appendix 1**

### **to Annex 1**

The test example provided in this Appendix is the one that has been performed in the United States of America.

## **1 Preparation of the tests**

### **1.1 Information search on HIBLEO-4FL**

The preparation of the tests requires the gathering of as much information as possible on the HIBLEO-4FL constellation from the ITU filing (referred to as RES46/C/182). The following information on the non-GSO system is available from the filing:

#### *Constellation configuration*

HIBLEO-4FL is a non-GSO constellation of 48 satellites combined into eight planes of six satellites with a circular orbit at an altitude of 1414 km and an inclination of 52°. All 48 satellites were in orbit at the time of the tests.

#### *Frequency plan*

The frequencies of the telemetry carriers are between 6876 MHz and 6877.1 MHz, ignoring Doppler shifts. There are eight blocks of 13 feeder carriers each for the satellite to gateway downlinks. Each carrier bandwidth is 1.23 MHz. Each block occupies 15.99 MHz ( $\pm$  the Doppler shifts on the uplink/downlink bent pipe links) and carries two cross polarized signals.

NOTE 1 – The Doppler shift is  $\pm 135$  kHz for the telemetry carriers and for the feeder carriers (only the downlink Doppler has been taken into account).

This information will help in matching the observed spectrum to the HIBLEO-4FL frequency plan.

#### *Power levels*

Document RES46/C/142 also provides the gain and e.i.r.p. used by the HIBLEO-4FL satellites as a function of the elevation angle on the ground.

From Table 4, it is possible to calculate the pfd level declared at the ITU by the HIBLEO-4FL system as a function of the elevation angle (dB(W/(m<sup>2</sup> · 40 kHz))) (see Fig. 2).

TABLE 4

| Elevation (degrees) | Distance <sup>(1)</sup> (km) | Loss <sup>(2)</sup> (dBm <sup>2</sup> ) | Gain <sup>(3)</sup> (dBi) | e.i.r.p. (dB(W/7 kHz)) | pfd <sup>(4)</sup> (dB(W/(m <sup>2</sup> · 7 kHz))) |
|---------------------|------------------------------|---|---------------------------|------------------------|---|
| 0                   | 4 476.5                      | 144                                     | 36.3                      | -11.6                  | -155.6  |
| 10                  | 3 504.4                      | 141.9                                   | 36.3                      | -11.6                  | -153.5  |
| 20                  | 2 798.4                      | 139.9                                   | 36.3                      | -10.6                  | -150.5  |
| 30                  | 2 307.3                      | 138.3                                   | 36.3                      | -8.6                   | -146.9  |
| 40                  | 1 970.5                      | 136.9                                   | 36.3                      | -7.6                   | -144.5  |
| 50                  | 1 740.7                      | 135.8                                   | 36.3                      | -7.6                   | -143.4  |
| 60                  | 1 586.3                      | 135                                     | 36.3                      | -8.6                   | -143.6  |
| 70                  | 1 487.3                      | 134.4                                   | 36.3                      | -10.6                  | -145  |
| 80                  | 1 432                        | 134.1                                   | 36.3                      | -12.6                  | -146.7  |
| 90                  | 1 414 <sup>5)</sup>          | 134                                     | 36.3                      | -14.6                  | -148.6  |

- (1) The formula of calculation of the distance between the GSO earth station and the non-GSO satellite is provided by HIBLEO-4FL filing by the following equation:

$$D(m) = 7\,792\,000 \left( \frac{\cos(\theta) + \arcsin(0.8185 \cos(\theta))}{\cos(\theta)} \right)$$

where  $\theta$  is the elevation angle of the non-GSO satellite at the receiving antenna. See also Note 5.

- (2) Calculation of the spreading loss (dBm<sup>2</sup>):

$$L_{\text{spreading loss}} \text{ (dB)} = 10 \log(4 \pi D^2)$$

where  $D$  is the distance between the non-GSO satellite and the GSO earth station (m).

- (3) Gain provided by the manufacturer.

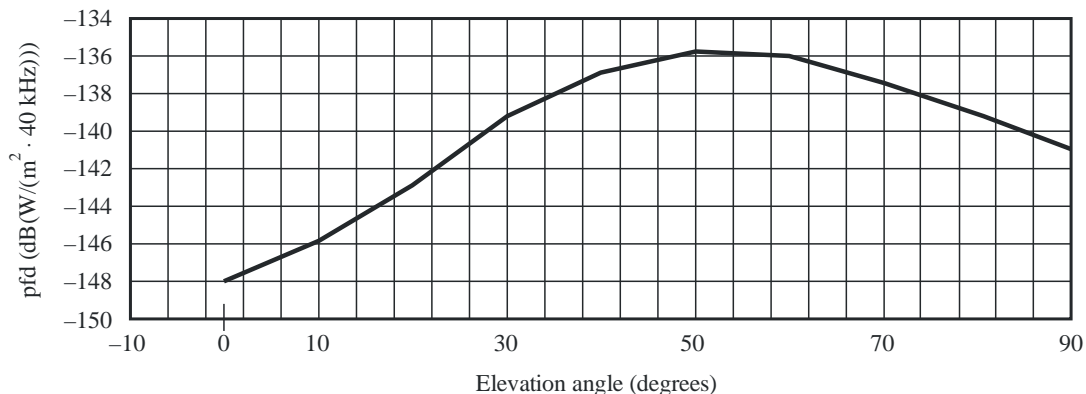
- (4) Calculation of pfd at the antenna input is the following:

$$\text{pfd (dB(W/(m}^2 \cdot 7 \text{ kHz)))} = \text{e.i.r.p. (dB(W/7 kHz))} - \text{spreading loss (dBm}^2)$$

- (5) It is noted that when the elevation angle is 90 degrees, the distance between the GSO earth station and the non-GSO satellite is the altitude of the non-GSO satellite.

FIGURE 2  
HIBLEO-4FL pfd on the ground

(6.8 GHz for telemetry, altitude of 1 414 km, bandwidth = 7 kHz)



*Polarization emission*

HIBLEO-4FL radiates both left-band circular polarization and right-hand circular polarization for the telemetry links. As there is no way of predicting which polarization might be active on the pass, the choice made was to use a linear polarization antenna in order to be able to get all transmissions. Therefore a 3 dB loss will have to be added to the receive link budget.

**1.2 Preparation of the test set up**

The test bench used for the identification of HIBLEO-4FL is identical to the one proposed in § 3.1 with the features given in Table 5.

TABLE 5

| Description         | Key specifications                                   | Source     | Part number                  | Notes                     |
|---------------------|--|------------|------------------------------|---------------------------|
| Antenna and feed    | 1.2 m<br>6.9 GHz<br>36.3 dBi<br>Antenna gain pattern | Andrew     | PL-65D                       |                           |
| LNA                 | 6.9 GHz<br>53.3 dB<br>T = 58 K                       | Vertex     | LFX-7060-02                  |                           |
| Coaxial cables      | 50 $\Omega$ , low loss                               | Pasterneck | PE-B3199 with<br>Nconnectors | Similar to<br>Belden 9913 |
| Coaxial to spectrum | 50 $\Omega$ , Heliac,<br>50 m                        | Andrew     | LDF4-50A with<br>Nconnectors |                           |
| DC block            | 15 V, low loss<br>at 6.9 GHz                         | Avcom      | DGP-1                        | dB loss<br>at 6.9 GHz     |
| Power supply        | 12 to 14 V DC<br>300 mA max                          | BK         |                              | Set at 15 V               |
| Spectrum analyser   | 6.9 GHz  | HP         | E4408B                       |                           |
| Printer             | Compatible with<br>spectrum analyser                 | HP         | Any                          |                           |

The choice of the size of the test antenna has been determined by two criteria. The first one was the convenience of having a small antenna to conduct tests and the second one, was to have an antenna large enough to detect signals. An antenna of 1.2 m was available by the time of the test and has been capable of detecting HIBLEO-4FL telemetry signal so that all the tests campaign has been done using a 1.2 m antenna dish.

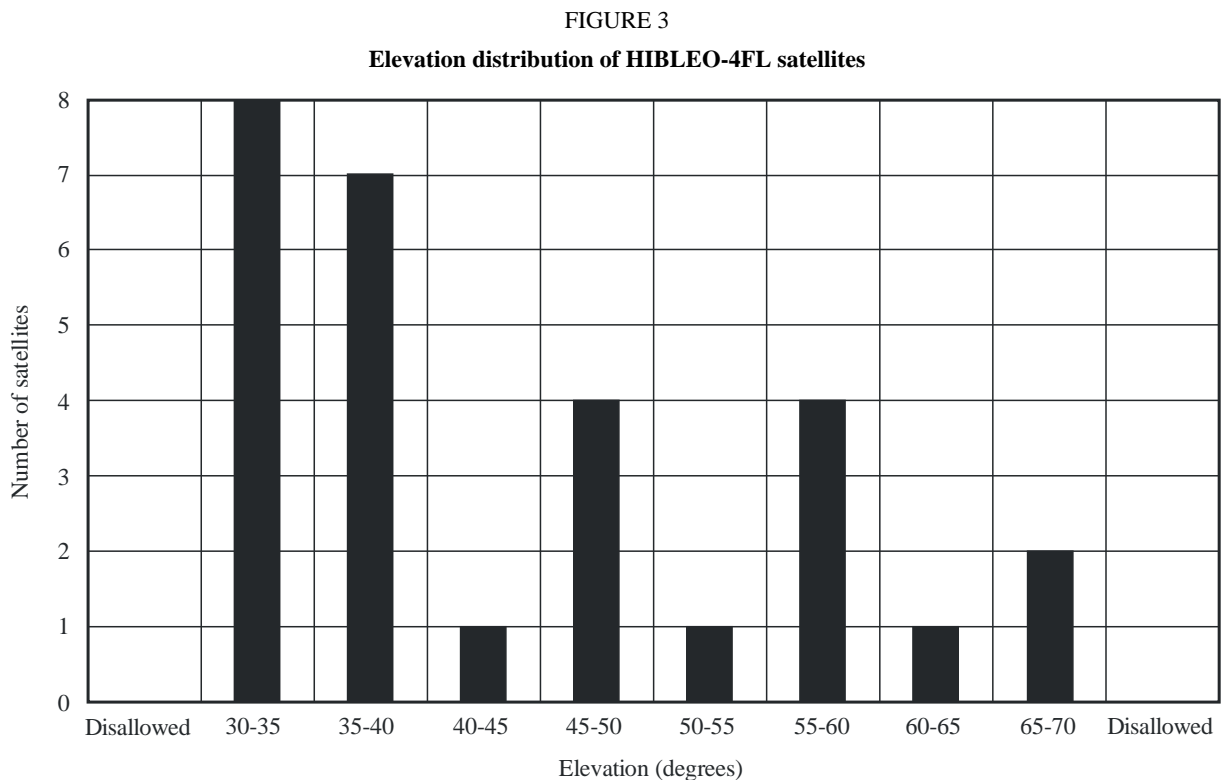
### 1.2.1 Schedule table for the test and antenna pointing direction

Knowing the location of the test antenna to be  $39.3^\circ$  N of latitude and  $77.3^\circ$  W of longitude, and using commercial orbital tools, it has been possible to determine the best probability window for having HIBLEO-4FL satellites, as explained in § 2.3.

The selected azimuth should not be along the GSO arc. It is chosen to point the test antenna towards the closest North direction possible, considering the natural shield of the environment.

Before determining the elevation of the test antenna pointing direction, a  $360^\circ$  sweep in azimuth is done around the test antenna location to make sure that no terrestrial services are detected. There are none. There may be some mobile services but with an antenna elevation in the  $30^\circ$  to  $43^\circ$  range, a mobile transmitter would need to be nearby which is not possible considering the tests location.

Figure 3 provides the distribution of the HIBLEO-4FL satellites for 22 November 1999, for a test antenna located at a latitude of  $39.3^\circ$  N and a longitude of  $77.3^\circ$  W, and an azimuth of  $319.3^\circ$ .



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For the above reasons, the test antenna pointing direction has been chosen towards elevations varying between  $30^\circ$  and  $40^\circ$  of elevation and towards  $319.3^\circ$  azimuth.

Table 8 provides the schedule that has been chosen for the day of the tests.

### 1.3 Calibration of the test bench and spectrum analyser set up

The calibration of the test bench has been cautiously done.

After performing the manufacturer's calibration procedure, the spectrum analyser is set to the features given in Table 6.

TABLE 6  
Set up of the spectrum analyser

|  |                                    |
|--|------------------------------------|
| <i>Frequency:</i>                                    |                                    |
| Centre frequency                                     | 6 877 MHz                          |
| Frequency offset                                     | 0 Hz                               |
| <i>Span</i>  | 1.1 MHz                            |
| <i>Amplitudes:</i>                                   |                                    |
| Reference level (adapted to the expected pfd values) | -70 dBm                            |
| Attenuation  | 0 dBm                              |
| Scale  | 2-log per division                 |
| <i>Control:</i>                                      |                                    |
| Resolution bandwidth                                 | 1 kHz                              |
| Video bandwidth                                      | 1 kHz                              |
| Sweep time   | 500 ms <sup>(1)</sup>              |
| Trigger  | Continuous                         |
| Trace  | Clear write A, then maximum hold A |

(1) To be set smaller if the spectrum analyser allows it.

## 2 Measures and analyses of the results

### 2.1 Validation of the non-GSO system frequency plan

The first step of the measures consists in validating the frequency plan of HIBLEO-4FL.

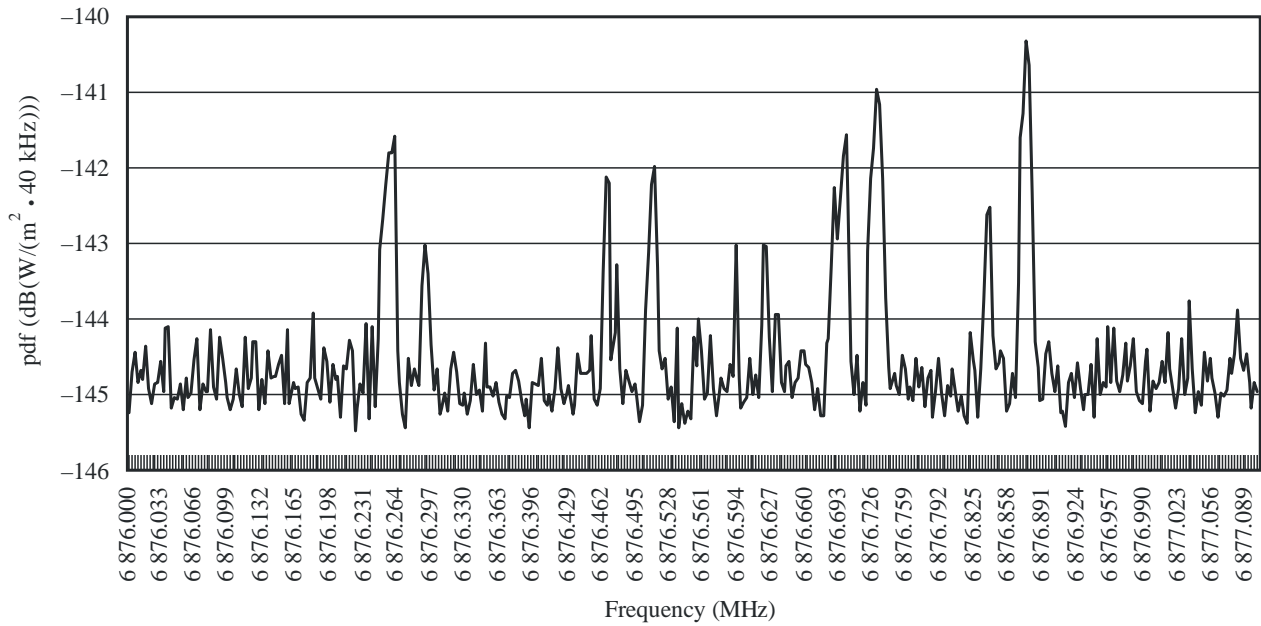
Within a minimum of satellite passes into the test antenna main beam, it is possible to observe the different telemetry frequencies used by the non-GSO satellites.

Figure 4 provides the telemetry recorded over a period of 24 h.

As can be seen from Fig. 4 ten peaks are significantly above the noise floor. All ten correspond to a telemetry frequency used by the HIBLEO-4FL within a Doppler shift of  $\pm 135$  kHz.

FIGURE 4

## HIBLEO-4FL telemetry frequencies over a period of 24 h



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Had the recording time been longer, the five missing telemetry frequencies would probably have been observed (if used). Table 7 guarantees that the system observed is indeed HIBLEO-4FL.

TABLE 7

| Telemetry number | Frequency planned provided in filing (MHz) | Frequency measured (MHz) | Doppler shift (kHz) |
|------------------|--|--------------------------|---------------------|
| 1                | 6876.2                                     | 6876.1525                | -47.5               |
| 2                | 6876.2                                     | 6876.19375               | -6.25               |
| 3                | 6876.4                                     | 6876.43375               | 33.75               |
| 4                | 6876.5                                     | 6876.4975                | -2.5                |
| 5                | 6876.6                                     | 6876.60625               | 6.25                |
| 6                | 6876.6                                     | 6876.64375               | 43.75               |
| 7                | 6876.8                                     | 6876.7525                | -47.5               |
| 8                | 6876.8                                     | 6876.79375               | -6.5                |
| 9                | 6876.9                                     | 6876.94375               | 43.75               |
| 10               | 6877                                       | 6876.9925                | -7.5                |

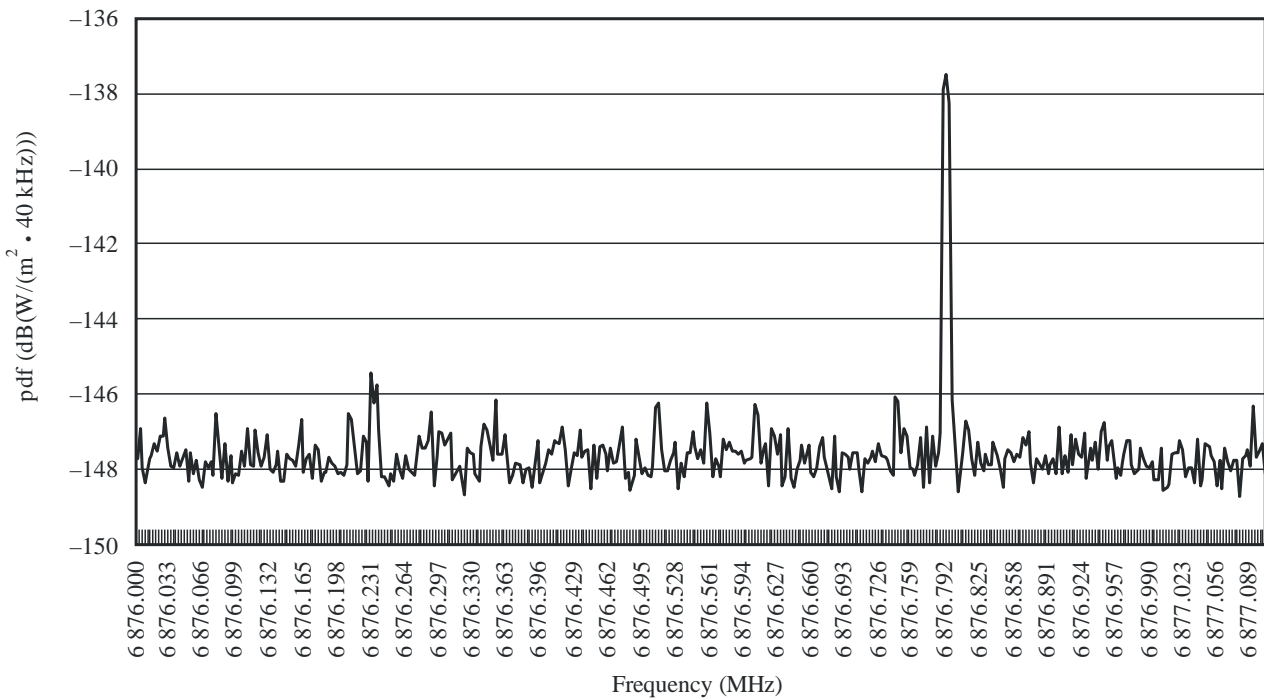


**2.2 Coherence of the pfd levels expected and measured**

The second step of the measurement campaign is to compare the pfd level received at the test antenna for the telemetries and the pfd that were expected from Fig. 2.

The satellite passes are expected as explained in § 2.1. One min before the previous time pass of the satellite until one min after, the signal levels are recorded using the max hold function of the spectrum analyser. One plotting of the telemetry signal levels at the test antenna is presented in Fig. 5 for a satellite passing through the main beam of the test antenna at elevations of 40.2°.

FIGURE 5  
Telemetry signal level measured at elevation angle of 40.2° (Satellite 54)



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**2.3 Accuracy of the constellation parameters**

The last step of the procedure to identify a non-GSO constellation is to measure the accuracy of time prediction of a satellite pass. The timetable that has been used is given in Table 8.

For each satellite pass the test operator has recorded the time at which the maximum pfd level appeared on the screen. For all of them, the time difference between the expected time of the non-GSO satellite pass and the time of worst pfd was within 1.5 s. This negligible delay has to be accounted for the approximate location of the test antenna location and pointing direction.

TABLE 8

| Test antenna pointing direction (degrees) | Accuracy window (azimuth × elevation) (degrees) | Satellite number pass | Day of pass     | Time of pass UTR <sup>(1)</sup>           |
|---|---|-----------------------|-----------------|---|
| Azimuth: 319.3<br>Elevation: 32.7         | $\pm 0.35 \times \pm 0.2$                       | 24<br>23<br>3         | 19 January 2000 | 14:19:51.90<br>17:16:22.06<br>20:13:18.72 |
| Azimuth: 319.3<br>Elevation: 40.2         | $\pm 0.35 \times \pm 0.2$                       | 54                    | 19 January 2000 | 17:57:15.15                               |
| Azimuth: 319.3<br>Elevation: 26.3         | $\pm 0.35 \times \pm 0.2$                       | 55                    | 19 January 2000 | 15:08:22.14                               |

- <sup>(1)</sup> UTR: Universal Time Reference. These times were derived using commercial orbit prediction software which utilizes the two-line element set data used for earth orbiting objects. Such information is usually publicly available on a number of Internet websites.

None the less, this 1.5 s accuracy is precise enough to be used in the correlation of an interference event into a GSO earth station antenna and the actual presence of a non-GSO satellite in the main lobe of the GSO earth station. If a GSO operator notices interference in its antenna, it will have to record the time of appearance of the degradation (to the hundredth second). Then, by using facilities widely available on the Internet, it will be able to determine which satellite of a non-GSO constellation was in its main beam. This preparation step to the measurement of operational limits is necessary for GSO operator seeking protection from the non-GSO systems.

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