**Universal Access Procedures for Fixed Satellite Service Earth Station Transmission**

**Introduction**

The satellite users broadcast community desires that satellite access procedures become more standardized across all types of fixed-satellite uplinks for the following reasons:

a) that the number of fixed-satellite service transmitting earth stations is increasing;
b) that the number of fixed-satellite service earth station transmissions is increasing;
c) that the number of RF interference cases between satellite networks is increasing;
d) that a common minimum standard for fixed-satellite earth station transmission procedures can reduce the opportunity for accidental RF interference;
e) that all earth station operators and satellite operators do not follow the same satellite access procedure; and
f) that satellite accesses will be more efficient and timely if uplinkers and satellite operators followed the same basic standard for satellite transmissions.

Therefore, the Radio Frequency Interference – End Users Initiative (RFI-EUI) recommends the adoption of the following Universal Access Procedures (UAP) for Fixed Satellite Transmissions.

# Universal Access Procedures (UAP) for Fixed Satellite Transmissions

## 1 Scope

This document defines procedures to be followed for transmitting to (accessing) satellites operating in the fixed satellite service. It also contains more specific considerations to be aware of for the following configuration of transmission systems:

- Transportable (SNG, DSNG, Trailers, Fly-aways)
- Fixed VSAT
- Auto Deploy
- Comms On The Move (ships, vehicle-mount systems)

This document, and the procedures contained within, assumes that readers and operators have been trained on basic satellite communication systems. This document is intended to provide some easy-to-follow procedures so that those who transmit to satellites can do so successfully without interfering with others. It is also assumed that a link budget calculation (transmission power requirements) has been performed by a knowledgeable individual or system before a satellite transmission occurs. This document is not intended to provide detailed level instructions for calculating earth station requirements, such as antenna gain, modulation selection, bandwidth, power level, etc.

## 2 Definitions

The following definitions should be known by transmission operators and are provide here only as a reminder.

| | |
|---|---|
| Access | = Transmission to a satellite |
| CW | = Continuous Wave, an un-modulated RF transmission |

| | |
|---|---|
| DSNG | = Digital Satellite News Gathering. |
| FEC | = Forward Error Correction. A method for correcting transmissions errors at the receive site. |
| FM | = Frequency Modulation. |
| FSS Frequency Bands | = For the purpose of this document, the following is a list of the FSS frequency bands:<br>4/6 GHz (widely referred to as C-band)<br>11-12/13/14 GHz (widely referred to as Ku-band)<br>20/30 GHz (widely referred to as Ka-band) |
| GPS | = Global Positioning System. A satellite based system that provides location information. |
| GSM | = Global System for Mobile Communications. Standard for 2G cellular mobile communications. |
| IF | = Intermediate Frequency. Frequency range used at satellite earth stations to route signals between components, e.g., between modulators and upconverters, between downconverters and demodulators. The most common IF frequencies used are 70 MHz ,140 MHz, L-band (from 950 MHz to 2200 MHz), 300 MHz to 2300 MHz. |
| L-band | = A frequency band from 950 MHz to 2200 MHz widely used by earth stations as an IF frequency to connect modulators with upconverters and downconverters to demodulators. |
| RF | = Radio Frequency. The frequency of a radio wave. For the purpose of this document, the RF frequencies of interest are those in the FSS Frequency Bands. |
| SAC | = Satellite Access Center. An organization responsible for the coordinated access to satellite space segment. This organization can be managed by the satellite operator or by another organization |
| SFD | = Saturation Flux Density. The carrier power density required to saturate a transponder. |
| SNG | = Satellite News Gathering. |
| UAP | = Universal Access Procedures |
| UTC | = Coordinated Universal Time. Primary time standard by which the world regulates clocks and time. |
| VSAT | = Very Small Aperture Terminal. Earth stations using small antennas, typically ranging from 0.75 meters to 2.4 meters. |

# 3 Selection of Equipment

It is strongly encouraged that users and operators acquire and use quality transmission equipment (including antenna, and all transmit/receive amplifiers, frequency converters, modulators, encoders with modulators, and installation materials), which comply with the following ITU-R recommendations and/or have been industry type-approved whenever possible (recognizing that not all equipment may have a type-approval process):

S.465 - Reference radiation pattern of earth station antennas in the fixed satellite service for use in coordination and interference assessment in the frequency range from 2 to 31 GHz;

S.524 “Maximum permissible levels of off-axis e.i.r.p. density from earth stations in geostationary-satellite orbit networks operating in the fixed satellite service transmitting in the 6 GHz, 13 GHz, 14 GHz and 30 GHz frequency bands”

S.725 - Technical characteristics for very small aperture terminals (VSATs);

S.726 - Maximum permissible level of spurious emissions from very small aperture terminals (VSATs);

S.731 - Reference earth-station cross-polarized radiation pattern for use in frequency coordination and interference assessment in the frequency range from 2 to about 30 GHz;

S.1844 - Cross-polarization reference gain pattern for linearly polarized very small aperture terminals (VSAT) for frequencies in the range 2 to 31 GHz.

All systems should be installed and tested by trained/certified earth station technicians/service companies.

The use of poor quality or non-approved equipment may result in the SAC not accepting the operation of the customer transmissions.

It is particularly important that antenna systems have the correct performance and size, in accordance with the calculated link budgets, to minimize the potential for interference to/from adjacent satellites.

Whenever possible, a spectrum analyzer that is monitoring the downlink signal should be available at the uplink so that the uplink operator will be able to see the downlink from the space segment and the results of any adjustments that are made.

# 4 Procedures

Any satellite access requires four primary parameters to be correct: **Antenna Alignment, including transmitting polarizer settings, if applicable; Frequency and Bandwidth Settings; Time of Transmission;** and **Power Density Level.** If any one of these basic parameters is not correct, then interference with another transmission is likely and/or no services will be able to be carried out.

## 4.1 Universal Access Procedure

The following procedure is to be used as a minimum sequence of actions that are to be taken before any satellite access occurs.

### 4.1.1 Know the transmission plan

- Have all of the following information readily available before proceeding – it will be needed when contacting the SAC.
- Name of the Uplink Operator, Phone Number, Company, Earth Station Registration Code, Technical Contact, Satellite, Frequency/Transponder/Polarization, Assigned Transmission Time, Expected Power Level.
- Link budget tools are available online or through the satellite operators. There is also a chart in Appendix A that can be used to estimate the appropriate power level based on bandwidth and antenna size.

### 4.1.2 Ensure equipment and cabling is functioning

- Verify that the equipment is functioning as designed – the antenna is not dented, soiled, or covered with ice or snow; cable terminations are clean and secure; RF inputs have terminators installed; waveguide is not cracked and does not contain water; waveguide pressurizer/dehydrator is working properly and is not indicating abnormally high leakage.

- All transmitting equipment is operating normally, but with the final stage either muted or connected to a non-radiating RF termination (i.e. dummy load).
- Modulator is set to CW mode.
- Equipment is switched on and warmed up for at least fifteen (15) minutes before the start of testing.

#### 4.1.3 Setup for transmission

- Ensure an un-obstructed line-of-site to the satellite – no buildings, trees, power lines, etc. between the earth station and the line of sight to the satellite(s) to be used. While equipment configuration or operational conditions may in some instances limit in part the applicability of the procedure, careful diligence to the applicable portions should significantly reduce the possibility of unacceptable interference to other satellite users.
- Ensure the antenna is secure and stable.
- Peak the transmitting antenna on a satellite beacon or known traffic carrier found on the downlink signal from the correct satellite (see antenna peaking and cross-pol below).
- Set polarity or cross-pol, if linear polarity (see antenna peaking and cross-pol below)
- Set center frequency, modulation, and bandwidth settings.
- Be ready at the correct time of day, as scheduled with the SAC. This means: Be ready up to 10 minutes prior to booked time slot, in case the space segment is available and the operator authorizes early access.
- Prepare by setting the appropriate power level per section 5.4.3 Power Levels.

#### 4.1.4 Transmit with Permission Only

- In systems that do not have central control of transmission (non-closed systems), call the SAC – if the SAC cannot be contacted DO NOT PROCEED with any transmissions.
- Verbally state the uplink polarity, frequency, and bandwidth will be used before transmitting – the SAC will verify that the parameters are correct.
- Set the frequency and bandwidth for the test transmission. This may be at the normal service frequency or at a special test frequency assigned by the SAC.
- Enable the transmission to the satellite only when authorized by the SAC.
- Set power levels only as authorized by the SAC starting with the modulator – distortion will occur if inter-device power levels are set too high.
- Adjust transmit antenna peak and polarization only as authorized and instructed by the SAC.
- Change modulator from CW to Modulate only as authorized by the SAC.
- Contact the SAC to end transmission on time or when instructed by the SAC – if more time is needed, contact the SAC as soon as possible.
- The SAC will provide detailed peaking instructions to ensure proper alignment of the antenna and its polarizer, if it has one. In general the polarizer for the transmit station is adjusted so as to reduce the interference onto transponders operating with the opposite polarization on the satellite. That may not be the same as the polarization setting used to obtain the lowest received cross pol signal from a beacon or another carrier on the same satellite using the same transmit antenna.
- Any instructions issued from the Satellite Access Center must be adhered to immediately and without question.

### 4.2 Pre-Transmission Antenna peaking and cross-pol

DO NOT MANUALLY MOVE an antenna while transmitting.

- If possible, peaking of the earth station antenna should occur while the satellite is in the center of its station-keeping box if the transmit antenna used will be operated with fixed pointing (i.e. small antennas such as 3.4m and smaller at Ku Band), otherwise peaking can be done at any time and tracking enabled to make sure that the antenna stays peaked on the satellite at all times.

- Use online calculators provided by the satellite operators to determine the satellite center-of-box timing information as well as look angles for the particular uplink site that will be used.
- If the antenna has an active and functioning satellite tracking system ensure it is disabled before peaking the antenna.
- Antenna Peaking - use a spectrum analyzer that is monitoring the downlink signal to ensure the antenna is properly peaked. Peaking on the satellite beacon is typically preferred, however, any received downlink carrier can be used for peaking purposes. Always ensure peaking is performed on the antenna's main lobe (not a side lobe). There should be three RF peaks when adjusting the antenna pointing on a single axis. The main lobe can be found between the upper and lower side lobes and will be of higher amplitude relative to the side lobes. Peak the transmit antenna by maximizing the received signal level of the main lobe of the received carrier. Once done peaking one axis, perform the same on the other axis and then repeat on the first axis.
- Ensure that the antenna is pointed at the correct satellite by comparing the satellite's spectral signature for the transponder to be accessed and/or others near it, to that which is provided by the satellite operator or by making sure that the beacon frequencies and their polarizations observed on the spectrum analyzer match the information provided by the satellite operator, or by decoding known signals.
- If the antenna has an active and functioning satellite tracking system, peaked settings should be saved and recorded before re-enabling tracking.

The polarity, if linear, should initially be adjusted to maximize a received signal at a specific frequency and minimize the noise floor in between transponders. The center frequency of a transponder on one polarity often, but not always, falls around the guard band between two other transponders on the other polarity. In that case, during cross-pol adjustments the signal level should be maximized on one polarity and minimized on the other at a particular center frequency. If in doubt, confirmation of the correct frequency to be used should be obtained from the SAC.

During satellite access, the antenna peaking and cross-pol alignment of the transmit signal will be checked by the SAC, and fine tuning adjustment may be required.

### 4.2.1 Inclined Satellites

Because inclined satellites are not stationary, getting and staying peaked on an inclined satellite requires additional skill and the proper equipment. An antenna controller that has the ability to track satellites using the 11 ephemeris parameter set, the 2 line NORAD element set, and/or a beacon receiver should be used whenever possible. It is important to be sure that the input to the beacon receiver does not saturate the RF receiver, so that any drop in signal level is detectable. Finally, an operator should be properly trained before transmitting to an inclined satellite.

There are occasions when transmitting to an inclined satellite without the use of a tracking-enabled antenna controller can be successfully accomplished. Those occasions occur when the angular motion of the satellite through the earth station main lobe is sufficiently slow as not to require re-pointing during a short transmission. For this to occur, the antenna must be peaked immediately before the transmission is to take place. The width of the antenna main lobe and the inclination angle of the satellite will determine the time required before the antenna must be manually repositioned.

### 4.3 Avoiding Retransmission of Nearby RF Signals

Retransmission of local terrestrial signals (such as FM, GSM, Wi-Fi, Wimax, Wireless devices) can occur if terrestrial signals are coupled into the satellite uplink equipment due to insufficient shielding or inadequate care during installation. The frequency ranges and equipment interconnect points that are most commonly susceptible to retransmissions are those in the lower-frequency IF or L-band range and the interconnections between the modulator and the upconverter. It is important that good electrical grounding, properly shielded cable, proper connectors, proper terminations on unused equipment inputs, and frequency band blocks or filters as required, are used on all transmission systems. Wireless devices, including cell and cordless phones, wireless computer networks should not be used inside the transmit station RF equipment room. Visit www.gvf.org/training for installation training and guidelines.

### 4.4 Additional Considerations for Fixed Earth Stations

In general, the UAP should be followed. If any sort of antenna movement or maintenance is conducted, then re-peaking the antenna is critical. Antenna alignment should be checked periodically, especially after an earthquake, severe weather, satellite repositioning, significant electrical event, or other major event that could affect the antenna positioning.

#### 4.4.1 Modulation settings

Digital modulators have a number of modulation settings that must be configured. The primary ones are: center frequency, modulation type, bit rate, symbol rate, bandwidth, scrambling, FEC, and roll off. Analog modulators primary settings are: center frequency, deviation, energy dispersal settings, and sub carriers. Regardless of the type of transmission, ensure that the modulator is in CW mode with RF output muted before accessing the satellite. Make sure the modulator bandwidth settings are correct so that the bandwidth occupied when modulation is activated is equal to or less than that which is allocated.

#### 4.4.2 Time of day

Unless the transponder is leased full-time, there is an assigned start and end booking time for a transmission that should be confirmed in GMT/UTC. The transmission should be planned to fall within the time booked. If, for whatever reason, the transmission time is going to change, then the SAC must be notified as soon as possible to minimize disruptions to other users. If possible, cease transmission 30 seconds or more prior to the end of the booked transmission window in the event there is additional traffic that is planned for the following adjacent time slot.

#### 4.4.3 Power levels

The amount of power required to successfully fulfill a transmission requirement should be estimated by means of a link budget. The link budget is calculated based on modulation type, frequency band, bandwidth, amplifier to antenna loss, antenna gain, atmospheric loss, satellite gain, downlink losses, and receiver sensitivity. Power level adjustment can be made at the modulator, the upconverter, and the amplifier. Each device should be adjusted properly by trained/certified personnel so that there are no spurs or spectral regrowth. When properly set, transmit spectral regrowth and intermodulation products are kept to a minimum.. Any power adjustments should be accomplished using only the HPA, unless the HPA has a fixed gain, and under the instruction of the SAC during the initial level setting and at any time later on during normal operation. This includes any planned redundancy changes. In general all redundant devices should be adjusted at the time of the initial service activation so as to ensure that the transmitted signal level between all redundant chains remains within +/- 0.5 dB. The SAC determines the final carrier level.

There is also a chart in Appendix A that can be used to estimate the appropriate power level based on bandwidth and antenna size. Note that it is to be used as a reference only as it applies to a specific use scenario.

### 4.5 Additional Considerations for Transportable Earth Stations

In general, the UAP should be followed, and all considerations for Fixed Earth Stations should also be reviewed. It is critical to ensure that Transportable Earth Stations are as level as possible and physically secured during the entire transmission, which also includes ensuring any pedestrian traffic remains outside of the path of the RF beam. Transmission from long bridges, during high winds, and other phenomenon that might move the earth station should be executed cautiously.

A more detailed procedure is available in the ITU Document ITU-R SNG770-1 that is available on the ITU web site.

### 4.6 Determining location of the earth station and the satellite

The first step involved with antenna peaking is to determine the location of the transportable earth station and the pointing angles needed to find the satellite. GPS systems make the determination of the location much easier. Determining the pointing angles for the antenna depend on physical factors, such as how level the ground is and the direction the vehicle is parked. Magnetic compass readings may need to be adjusted to true north based on the current location's magnetic declination. Some antenna controllers will take these readings into account, but it is important to be aware of possible pointing angle calculation errors. Therefore, peaking the antenna using a spectrum analyzer is extremely important.

### 4.7 Additional Considerations for Fixed VSAT Earth Stations

Although the general concept contained in the UAP applies, the procedure itself does not. The critical components for Fixed VSAT Earth Stations are ensuring that the antenna is properly aligned and secured; the equipment is properly functioning; and the cables and connectors are well built. Please reference installation training sources at the Global VSAT Forum's web site (www.gvf.org) for details concerning these types of earth stations. Fixed VSAT Earth Stations tend to be closed systems and their frequency settings, power levels (on certain systems), and time of transmission are controlled by the system's hub controller.

During installation, setup, and testing of VSAT remote terminals, it is critical that correct antenna peaking and cross-pol alignment is successfully accomplished to avoid interference to adjacent satellites.

### 4.8 Additional Considerations for Auto Deploy Earth Stations

Auto Deploy Earth Stations are a subset of Transportable Earth Stations that automatically determine the location of the earth station, find a known satellite, and calibrate themselves so that antenna pointing does not require manual peaking. However, it is still essential to conduct a manual check and ensure the antenna is pointed at the correct satellite before transmitting. Like Transportable Earth Stations, it is critical to ensure that Auto Deploy Earth Stations are level or adjusted for non-level mounting, if the system does not or cannot properly handle non-level mounting, and physically secured during the entire transmission, which also includes ensuring any pedestrian traffic and cars/trucks or any moving or fixed objects remains outside of the path of the RF beam. Transmission from long bridges, during high winds, and other phenomenon that might move the earth station should be executed cautiously. The system should be checked, before transmission begins, to verify that the antenna is pointed in the same direction that the satellite would be – towards the equator.

It is expected that this type of system is software controlled and that the implementation should ensure the UAP is adhered to, safety considerations are paramount and all system checks are automated with user guidance incorporated.

With Auto Deploy systems, it is still necessary to contact the SAC before accessing the satellite, and to follow the UAP, to ensure that the antenna and service are correctly setup.

### 4.9 Additional Considerations for Comms On The Move Earth Stations

Comms on The Move Earth Stations, like Auto Deploy Earth Stations and Fixed VSAT Earth Stations, are designed to be fully automatic.  However, they are also designed to function properly while in motion.  It is critical to ensure that people and objects do not cross the transmission path from the antenna to the satellite.

As for Auto Deploy systems, this type of system is software controlled and the implementation shall ensure the UAP is adhered to, safety considerations are paramount and all system checks are automated with user guidance incorporated.

It is very important that the system shall automatically shut down its transmissions if it loses tracking of the correct satellite, or off-points from the satellite by a fraction of a degree, to avoid harming services on an adjacent satellite.

# APPENDIX A

## Uplink Power Guidelines

Please note that the entries in the following table are only guidelines and not absolutes. Specific power levels depend on transmission path losses (including atmospheric), the gain of the antenna at the user location, the power output of the satellite, the frequency, the modulation, and the bandwidth.

| | **HPA POWER IN WATTS (per carrier)** | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | **13-14 GHz FSS Band (Transponder SFD @ 92 dBW/m$^2$)** | | | | | | **6 GHz FSS Band (Transponder SFD @ 89 dBW/m$^2$)** | |
| **Antenna Diameter** | 1.2 m | 1.8 m | 2.4 m | 3 m | 3.8 m | 4.5 m | 3.8 m | 4.5 m |
| **Carrier Bandwidth** | | | | | | | | |
| 3 MHz | 18.5 | 8.2 | 4.6 | 3.0 | 1.8 | 1.3 | 18.4 | 13.2 |
| 6 MHz | 36.9 | 16.4 | 9.2 | 5.9 | 3.7 | 2.6 | 36.8 | 26.4 |
| 9 MHz | 55.4 | 24.6 | 13.8 | 8.9 | 5.5 | 3.9 | 55.2 | 39.6 |
| 12 MHz | 73.8 | 32.8 | 18.4 | 11.8 | 7.4 | 5.2 | 73.6 | 52.8 |
| 18 MHz | 110.7 | 49.2 | 27.6 | 17.7 | 11.0 | 7.9 | 110.4 | 79.2 |
| 24 MHz | 147.6 | 65.6 | 36.8 | 23.6 | 14.7 | 10.5 | 147.2 | 105.6 |
| 36 MHz | 221.4 | 98.4 | 55.2 | 35.4 | 22.1 | 15.7 | 220.8 | 158.4 |
| 36 MHz (Saturated) | Note 2 | Note 2 | 276.7 | 177.4 | 110.7 | 78.8 | 1106.6 | 793.9 |

Notes:

1. Total transponder bandwidth of 36 MHz with a 3 dB loss from the HPA to the antenna flange.
2. Power output exceeds maximum uplink power density limits.
3. A link budget analysis must be conducted for every transmission.
4. The Saturation Flux Density (SFD) is referenced to the uplink geographical locations.
5. This table is not to be used as a reference to downsize the transmit antenna without seeking the permission from the satellite operator. Severe interference to adjacent satellites may occur if the satellite operator is not contacted and requested to evaluate any transmit antenna downsizing (note the required increase to the flange power so as to keep the signal level constant on the satellite)