

Agenda

- ◉ Day 1 - Basics of Satellite Communications
- ◉ Day 2 - Policy and Regulatory Guidelines for Satellite Services (Analog TV to DTT)*
- ◉ Day 3 - Network Planning (Satellite trends, Link budget)*
- ◉ Day 4 - Vsat Installation and Maintenance
- ◉ Day 5 - Vsat Equipment and Bandwidth Procurement

* - Eldo Kurian from Intelsat



Day 4

Instal and Mantain



Instalação & manutenção Vsat

◎ Vsat installation

- *Site survey*
- AZ / EL
-

◎ Vsat maintenance

- Preventive
- Corrective
-



Vsat installation

Standard installation procedures

1. Site survey
2. Calculating, measuring and working with CLOS AZEL
3. Equipment assembly and configuration parameters
4. Grounding and lightening protection
5. Using a spectrum analyser
6. Align the antenna to satellite
7. Commissioning the service with SP
8. User acceptance tests

Vsat installation site survey - step 1

1. Geografical Local coordinates
2. Clear LOS and visibility arc (satellite look angles)
3. Flat level surface, no underground obstruction, no interference (radar. wimax, microwave towers, celular towers links)
4. IDU, ODU and IFL, optimal or best, location
5. Client's responsibility installation (civil works, grounding, ducts)
6. Site Installation photos (as is)

Vsat installation site survey standard form - step 1

Pedido de Site Survey			
Data: ____/____/____		Direção: _____	
Instalador: _____		Utilizador: _____	
Data objectivo para realização do serviço: ____/____/____		Fax: _____	
Rede: _____ NIF: _____ Morada: _____			
Serviço: _____			
Cliente: _____			
Pessoa para contacto: _____		Telefone: _____	
Nome e Longitude do Satélite: _____			
Unidade Exterior: _____		Unidade Interior: _____	
Relatório			
Localização da Remota LAT / LONG: _____ N / _____ W			
Energia:	Tem UPS ? <input type="checkbox"/> Sim <input type="checkbox"/> Não	Outro: _____	
	Tem Terra ? <input type="checkbox"/> Sim <input type="checkbox"/> Não	Tem para-raios ? <input type="checkbox"/> Sim <input type="checkbox"/> Não	
Comprimento de Cabos: _____ (m)		Tipo de cabo: <input type="checkbox"/> Tipo I <input type="checkbox"/> Tipo III RG: _____	
Localização da Antena: <input type="checkbox"/> Terraço <input type="checkbox"/> Jardim <input type="checkbox"/> Telhado <input type="checkbox"/> Parede <input type="checkbox"/> Torre			
<input type="checkbox"/> Outro: _____			
Altura da Antena ao Solo: _____ (m)			
Tipo de Suporte da Antena: <input type="checkbox"/> NPM <input type="checkbox"/> Universal <input type="checkbox"/> Pedestal <input type="checkbox"/> Parede			
<input type="checkbox"/> Mastro de parede <input type="checkbox"/> Pi torre <input type="checkbox"/> Especial: _____			
Necessidade de Anti-gelo: <input type="checkbox"/> Sim <input type="checkbox"/> Não			
Localização das Unidades Interiores: <input type="checkbox"/> Rack <input type="checkbox"/> Secretária <input type="checkbox"/> Outro: _____			
Sala Climatizada ? <input type="checkbox"/> Sim <input type="checkbox"/> Não			
Cabo em conduta do cliente ? <input type="checkbox"/> Sim <input type="checkbox"/> Não			
Trabalhos Adicionais: <input type="checkbox"/> Autorização de condomínio <input type="checkbox"/> Construção de muros			
<input type="checkbox"/> Outros: _____			
Contacto para autorização de acesso a antena (Nome e forma de acesso): _____			
Assinatura do Cliente: _____			
Data: ____/____/____			

Vsat installation tools and equipments - step 1



1.
Inclinometer



2.
Compass



3.
Laptop or desktop computer
with Windows 98 and above,
WinZip/WinRar and com port connection



4.
Voltmeter



5.
Basic Tools:
Flat, Cross and Heli Screwdrivers
Wrench
Wire cutter



6.
Extra Cables:
RG6 cable
Straight and Cross Ethernet Cables
RS232 serial cable

**Optional but highly recommended
additional and spare equipment
to have on site:**

1. Spectrum Analyzer
2. BUC
3. LNB
4. Satellite Router

Vsat installation

general preparation - step 1

- Support assembly(npm, soil, post mount)
- Dish assembly
- Calculating pointing parameters
- Pointing dish
- Coaxing cable and cable runs
- Connectors, cabling and waterproof sealing

Vsat installation

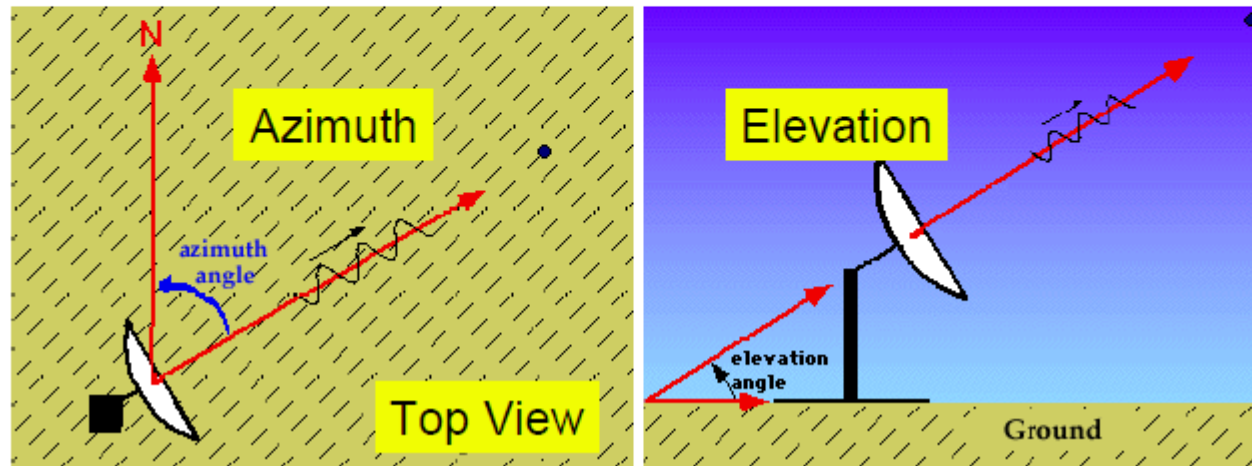
general preparation (cont) - step 1

- Grounding and lightening
- RF equipment installation
- Energy
- IDU installation
- HW / SW testing
- Satellite peacking up
- Commissionning tests

Vsat installation

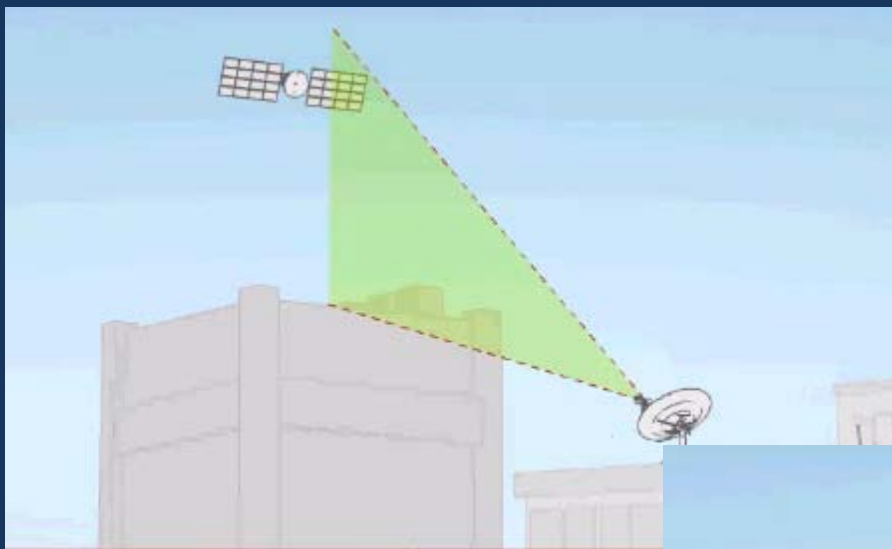
AZ-EL visual - step 2

- Azimuth is the axis of angular rotation
- Elevation is the Angle with respect to the horizon -



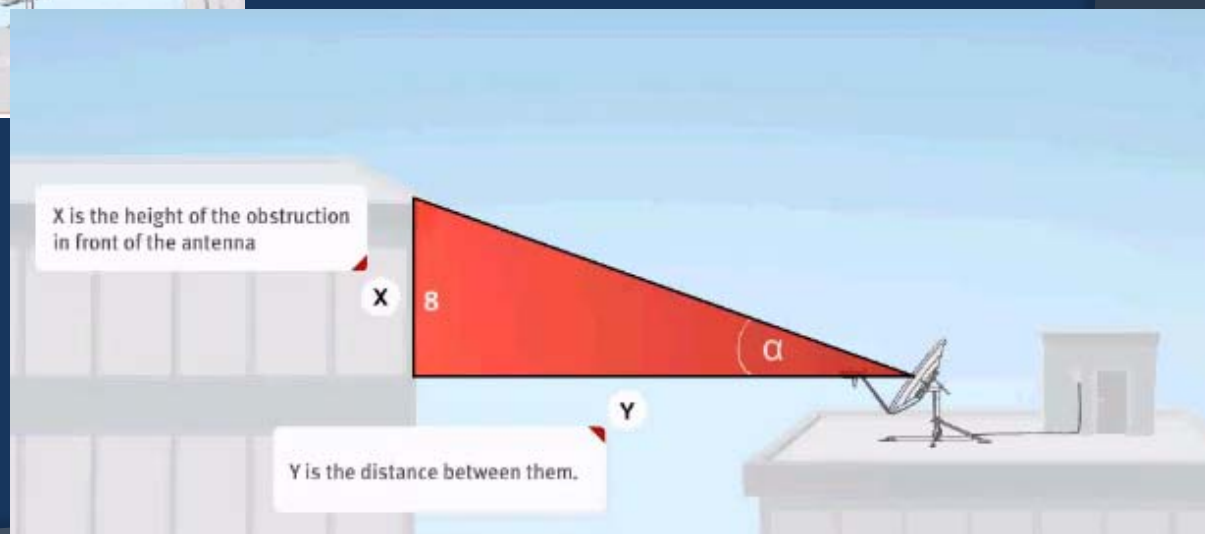
Vsat installation

calculation of LOS AZ-EL - step 2



The antenna needs to have a clear LOS to the satellite

$$\alpha = \arctg \frac{x}{y}$$



Vsat installation equipt assembly & configuration - step 3A

- ⦿ Assemble and anchor the antenna
- ⦿ Make sure your antenna is leveled (using a leveler)
- ⦿ Make sure you have assembled the feed in the correct polarization position
- ⦿ Confirm correct coordinates

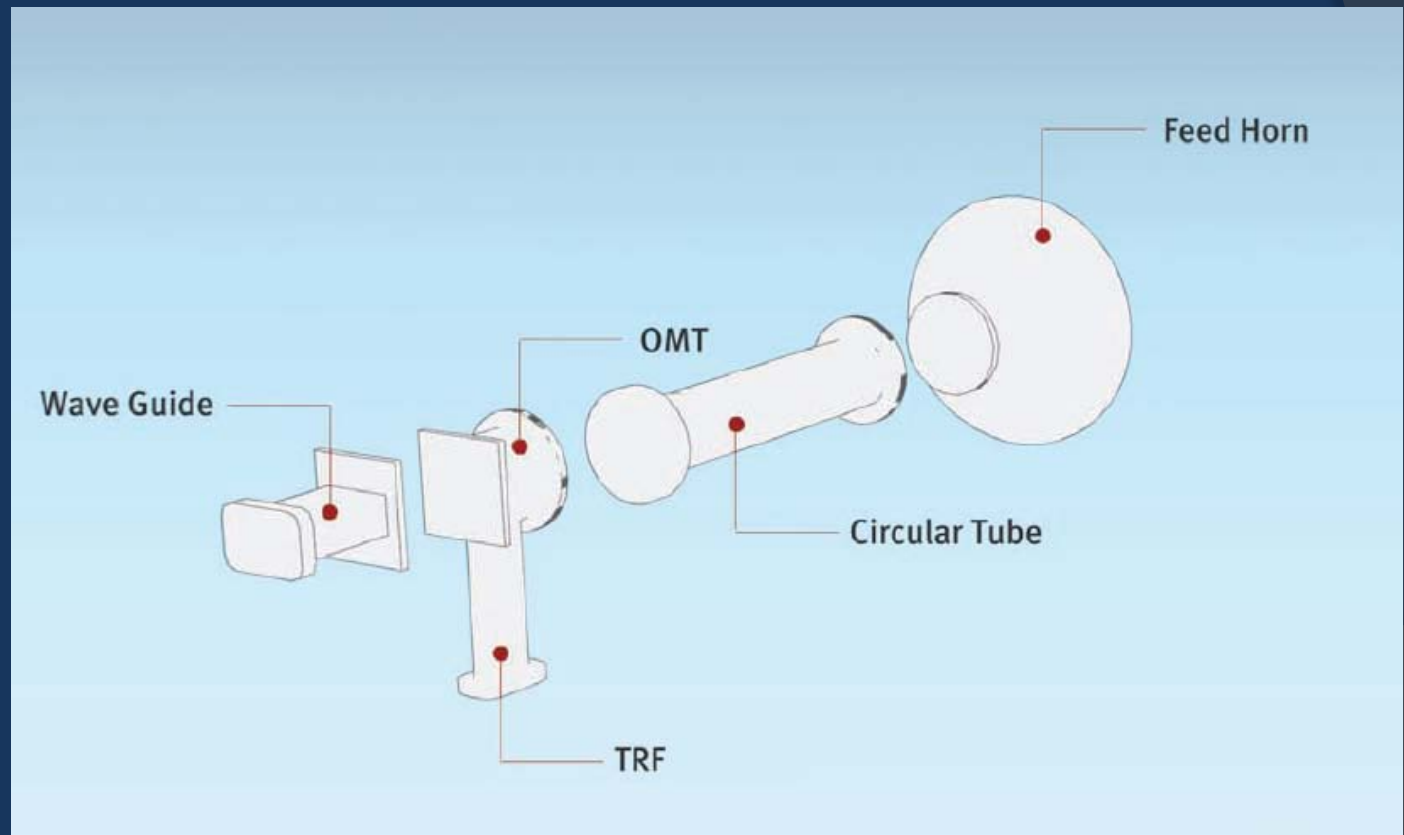
Vsat installation

equipt assembly & configuration - step 3B

- ⦿ Use the compass as reference and adjust the antenna left or right horizontally
- ⦿ Use the inclinometer as reference and adjust the antenna vertically
- ⦿ Grounding and lightening
- ⦿ Install the RF equipment (feed, LNB and BUC)
- ⦿ Find the correct satellite with the spectrum analyser (or alternately with the vendor sw)

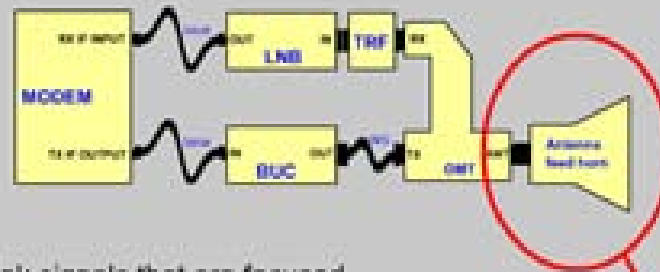
Vsat installation

Rf equipment feed



Vsat installation

feed - step 3C1



FEED HORN

In VSAT antenna, the horn collects the downlink signals that are focused into it by the reflector. It also launches the transmit (uplink) waves in a wide "spray" towards the antenna reflector, which then focuses them into a narrow beam.

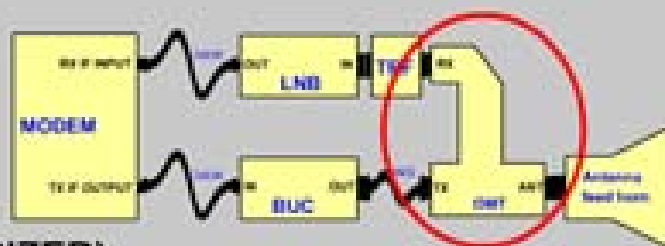
The feed horn and combiner together are called the feed system. The antenna manufacturer usually includes the feed system with the antenna.

In fact, the feed system is designed to match the antenna. ***You should use only the approved feed system components with your antenna;*** otherwise, the antenna may not meet its performance specifications, and is likely to generate interference due to excessive sidelobes or inadequate cross-pol performance.



Vsat installation

OMT feed - step 3C2



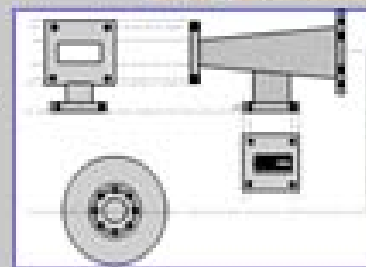
OMT (or COMBINER and/or POLARIZER)

The **combiner** connects to the feed horn and separates the transmit and receive signals going to and from the LNB and BUC, respectively.

In linear cross-pol polarization schemes, an **OMT** (Ortho Mode Transducer) acts as the combiner by separating the waves according to their polarizations.

If a linear co-pol scheme is used (i.e. the VSAT transmits and receives on the same linear polarization), then a **co-pol combiner** is used instead of an OMT. It separates the waves by their frequencies.

For circular polarization, a combination OMT and CP polarizer are used. Together, they are called a **CP combiner**.



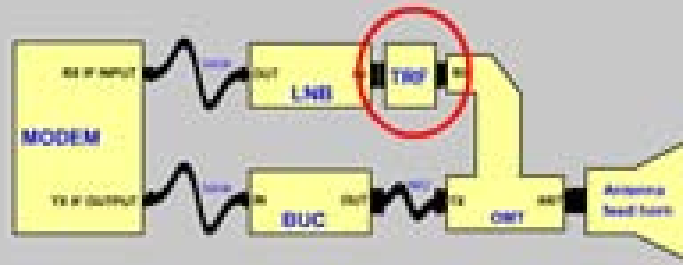
OMT drawing



OMT

Vsat installation

TRF - step 3C3



TRF

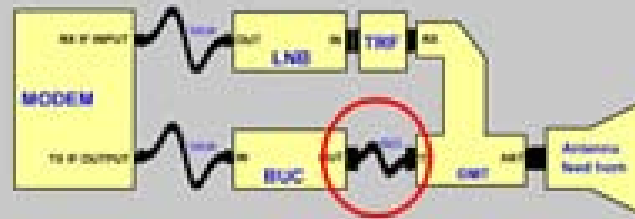
The **TRF** (Transmit Reject Filter) helps stop any remaining transmit signal that leaks out of the OMT from overloading the LNB. It is usually a short piece of waveguide with internal resonator elements.

Sometimes the TRF is integrated into the OMT or feed system, or even into the LNB. **Nevertheless, always be sure to check if a TRF component is required in your system.** Leaving it out can cause severe problems that are very difficult to troubleshoot in the field.



Vsat installation

Waveguide - step 3C4



WAVEGUIDE (WG)

Waveguide is a hollow tube that carries microwave signals. It has much less loss than coaxial cable, but it is expensive and used only for short connections.

Waveguide connectors are called **flanges**. Connections are made by inserting bolts through the holes around the flanges.

Waveguide bends allow signals to go around corners.

Bulky components can be positioned more easily with flexible waveguide.



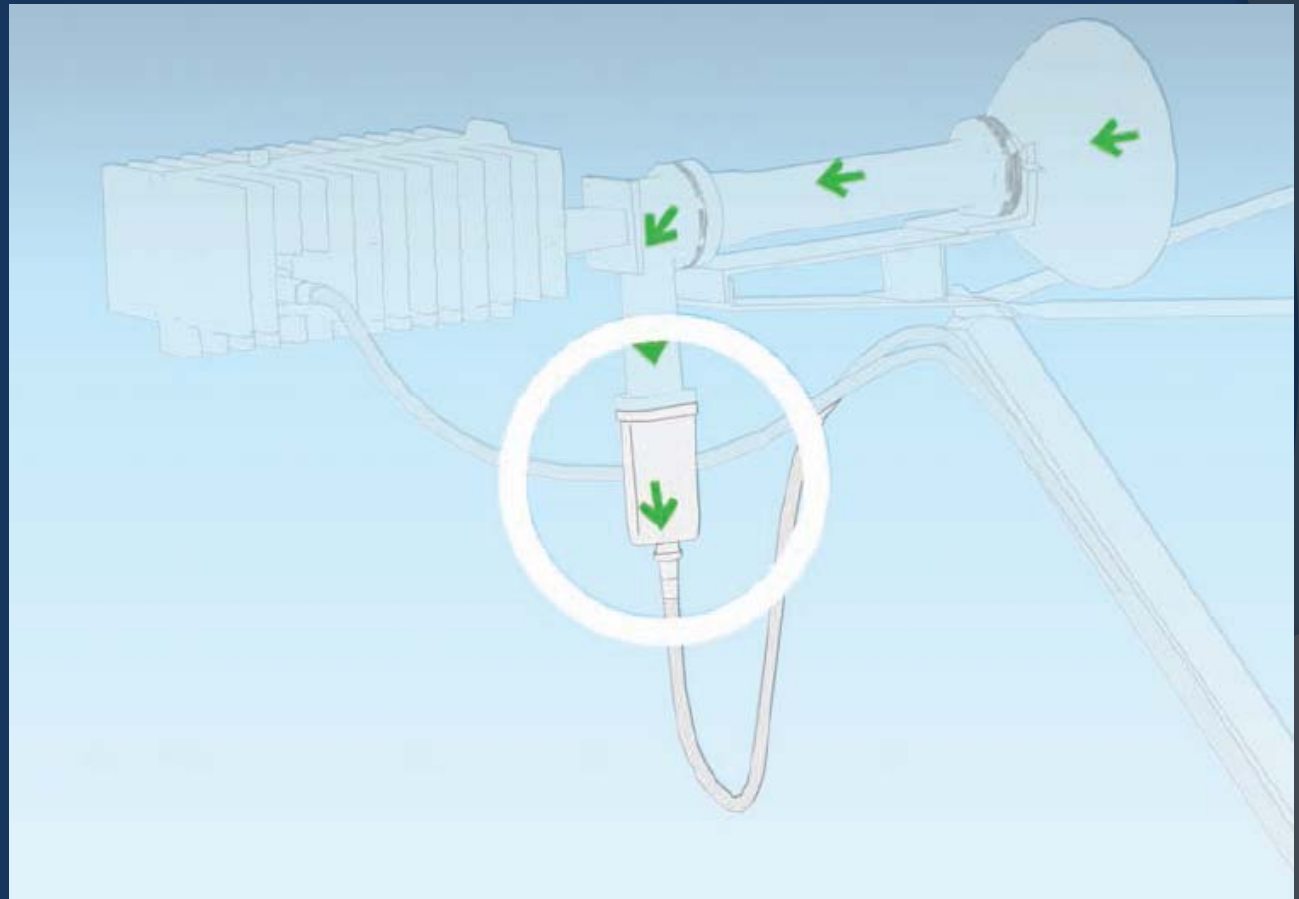
Rigid waveguide Waveguide bend



Flange Flexible waveguide

Vsat installation

LNA,B & Equipment feed - step 3D



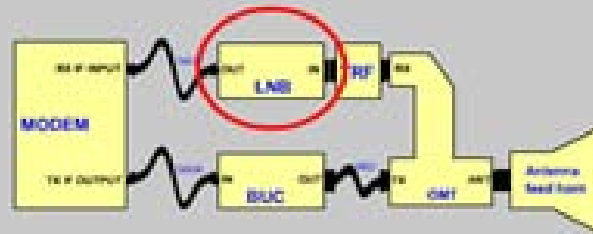
Vsat installation

LNB, LNA - step 3D1

LNB

The **LNB** (**Low Noise Block-downconverter**) accepts the downlink signal from the antenna, amplifies it with a built-in **LNA** (**Low Noise Amplifier**), and translates it down to the receive IF frequency required by the modem.

LNBs are made with different internal features and performance grades. Phase-locked or PLL LNBs are more frequency-accurate and are required by most VSAT terminals. LNBs intended for direct-to-home television should not normally be used for VSATs. If you need to replace an LNB, be sure to use a model authorized by the VSAT system supplier.



Typical VSAT LNBs
(Courtesy Norsat)

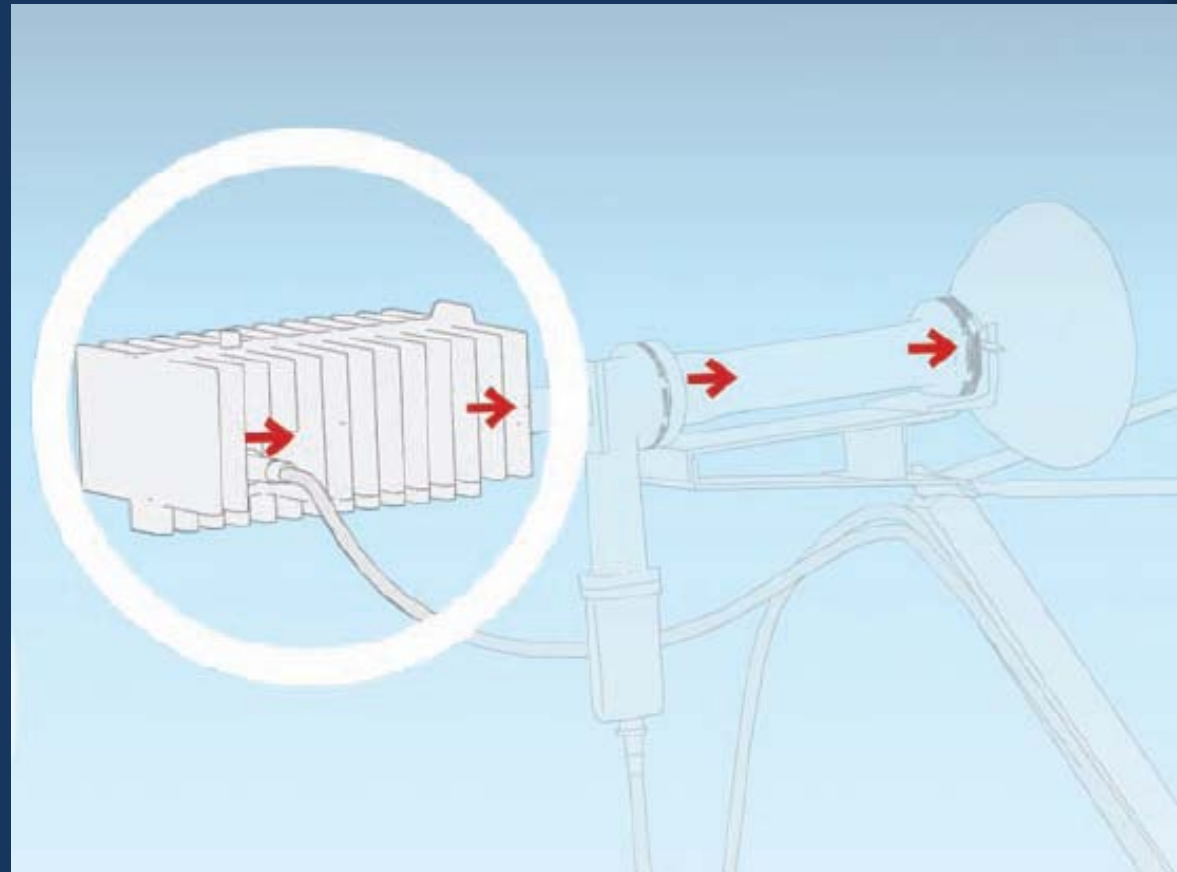


This is an **LBNF** (LNB with built-in feed) used for TV reception. LBNFs are not used in VSATs.

Vsat installation

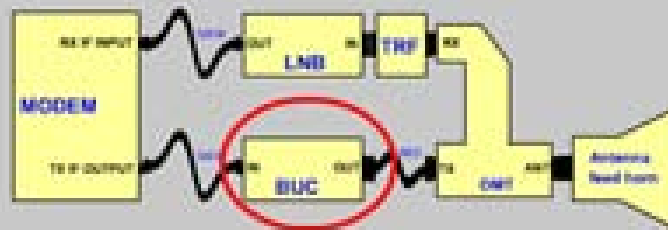


assembly. and config. Feed / BUC - step 3E



Vsat installation

assembly. config. Feed / BUC - step 3E 1



BUC

The BUC (**B**lock **U**p**C**onverter) accepts the transmit IF signal from the modem, translates it to the uplink frequency (e.g., Ku-band), and amplifies it with an **SSPA** (**s**olid **s**tate **p**ower **a**mplifier).

In most VSATs, the SSPA has a capacity of 5 Watts or less, and it is built in to the BUC. In larger VSATs, a separate booster SSPA is used to amplify signals to as much as 100 Watts.



A low-power BUC integrated in an ODU
(Courtesy Invacom)



A stand-alone BUC with 80W booster SSPA
(Courtesy Paradise Datacom)

Vsat installation

grounding, lightening, ESD/EMI protection - step 4

- ⦿ The grounding shall be assured through the connection of dish (where all the other components are connected) to the earth potential, whatever would be with copper plates or rods
- ⦿ Mainly for top building or roof installations (but not only) the lightning protection shall be used. For this cases a lightening arrestor shall be installed.
- ⦿ Special care shall be taken on the ESD when manipulating electronics (BUC, LNB, Modems) and EMI when in proximity of interference sources

Vsat installation

Spectrum analyser - step 5A



- ◎ The standard method for observing electric signals is to use an oscilloscope. The horizontal axis of a CRT oscilloscope increases by a unit of time. Oscilloscopes are sometimes referred to as time-domain instruments. Observation in time domain is useful to obtain signal timings and phases.

Vsat installation

Spectrum analyser - step 5B



- ◉ But the performance of certain elements such as amplifiers, oscillators, mixers, modulators, filters, and others require the analysis of other characteristics (frequency response, harmonic distortion, intrinsic noise) and meaningful information is not attained until their frequency responses are obtained.
- ◉ Instruments that display levels of an electric signal as a function of the respective frequencies are called frequency domain instruments, called spectrum analyzer

Vsat installation

Spectrum analyser - step 5C

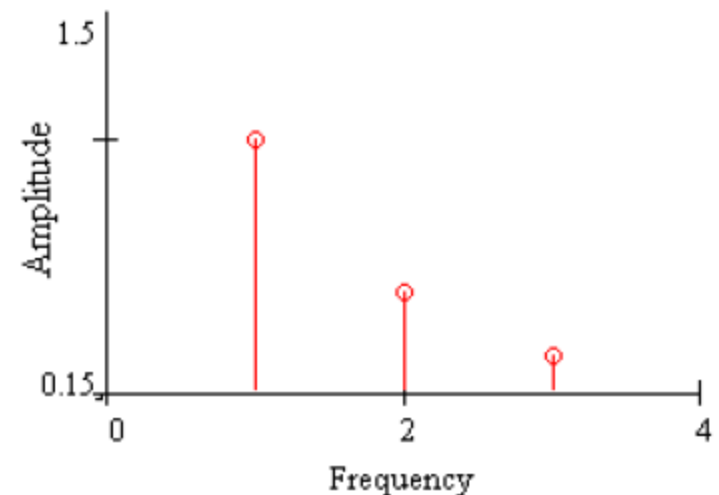
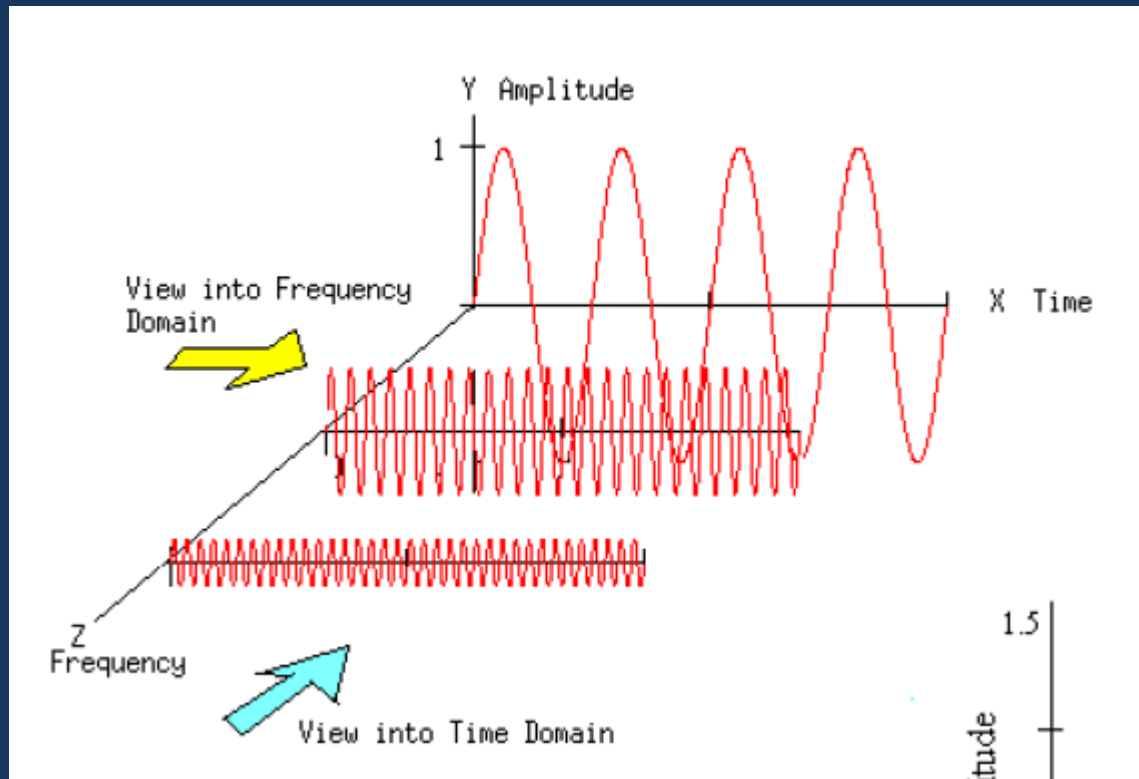


- Being basically one receiver with scanning capacity, they integrate one filter of variable tuning (mixer) to convert the input signal into several IF's depending on the components within the original signal, and showing them according to resolution band filters used, in a way that makes it possible to visualize them.
- According to the RF band we wish to check, we shall use specific types of spectrum analyser e.g. DC-8GHz, 10Hz-6,2GHz or 9GHz-20GHz



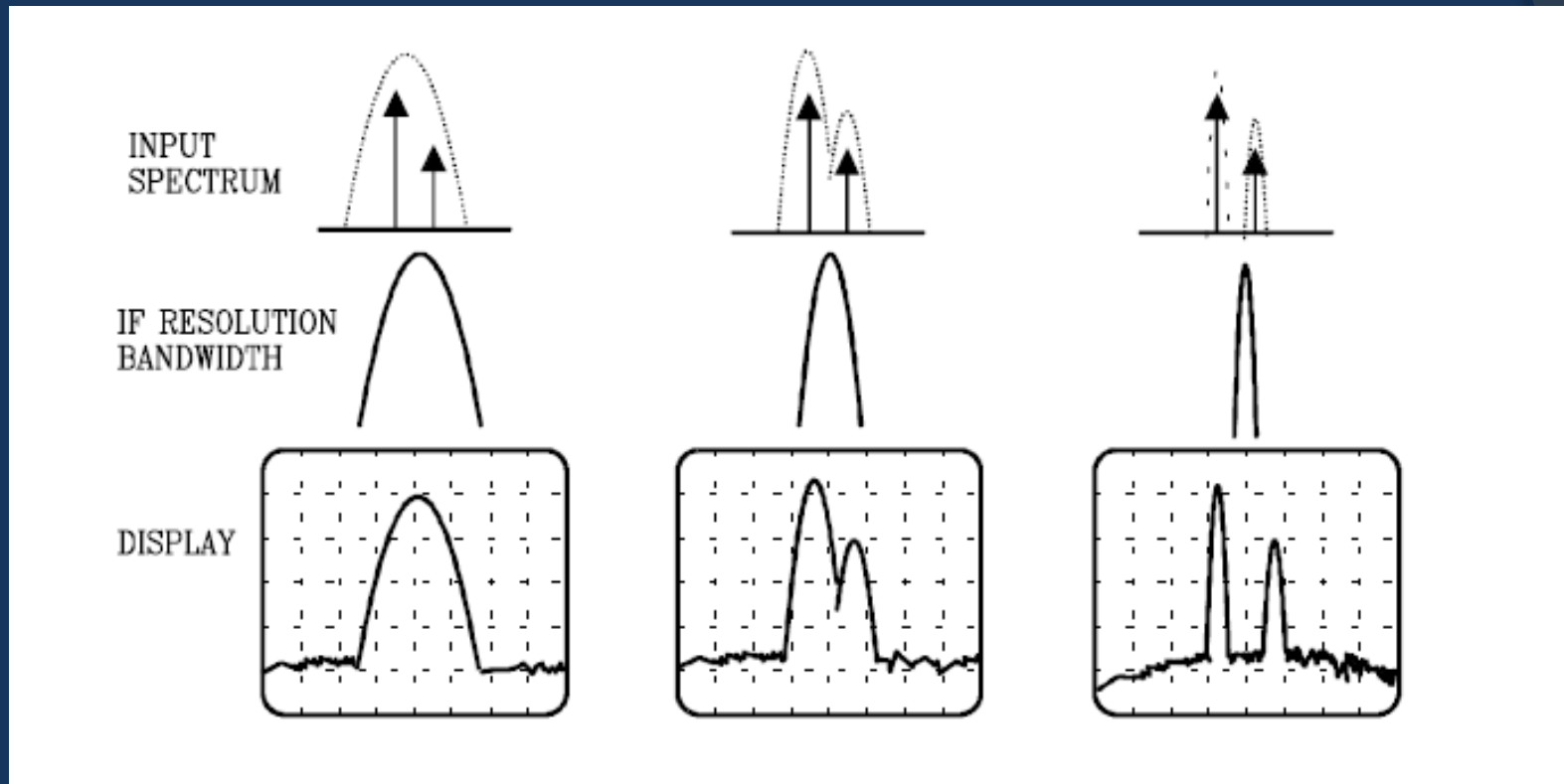
Vsat installation

Spectrum analyser - step 5D



Vsat installation

Spectrum analyser - step 5E



Vsat installation

Align antenna using a s.analyser - step 0A



1. Pre-set the polarization, through the axial rotation of feed-horn
2. Set the elevation angle got from the “pathfinder” with as much accuracy as possible
3. Find the downlink carrier details (the pre-recorded satellite spectrum view will be very helpful)
4. The downlink frequency carrier in hertz will be located next to the RX_freq. This value needs to be converted to an L-Band range.
5. Next to the RX_bitrate you will find a value in bits that you can convert to the span required on the spectrum analyzer.

Vsat installation



Align antenna using a s.analyser - step 6B

6. Connect the LNB to the splitter input using a 75 ohm RG6 coaxial cable.
7. Connect the splitter DC pass-through out to the satellite modem, and the DC blocking out to the spectrum analyzer.
8. Adjust the spectrum analyzer to the beacon frequency of the satellite - or to a pre-recorded downlink carrier - where the Center frequency will be the calculated RX_Freq and the span will be the calculated RX_bitrate just in units of Mhz instead of Mbps.

Vsat installation



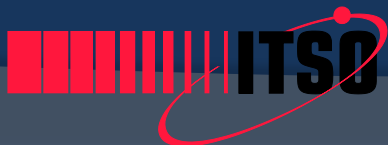
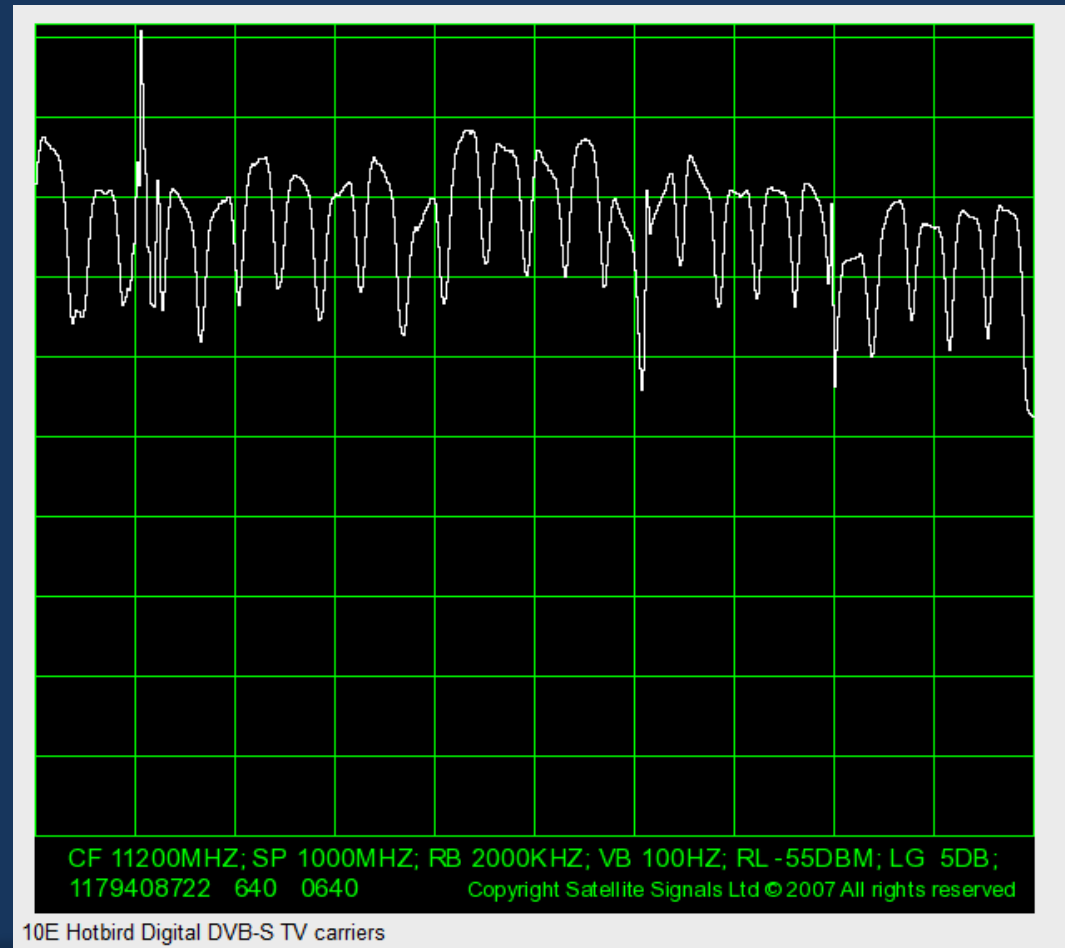
Align antenna using a s.analyser - step 6C

9. Adjust the elevation to the correct value, according to the site location and antenna offset.
10. Sweep the sky in the expected azimuth area until you acquire the satellite signal. If the signal is not acquired, decrease or increase the elevation angle by slightly adjusting the regulation strut, and repeat the azimuth sweep until the signal is acquired.
11. Adjust the feed horn slightly and monitor the size of the carrier on the spectrum to complete the maximization of the gain. To determine the best pol. setting, rotate the feed element until you acquire the strongest signal level.



Vsat installation

Align antenna using a s.analyser - step 6D

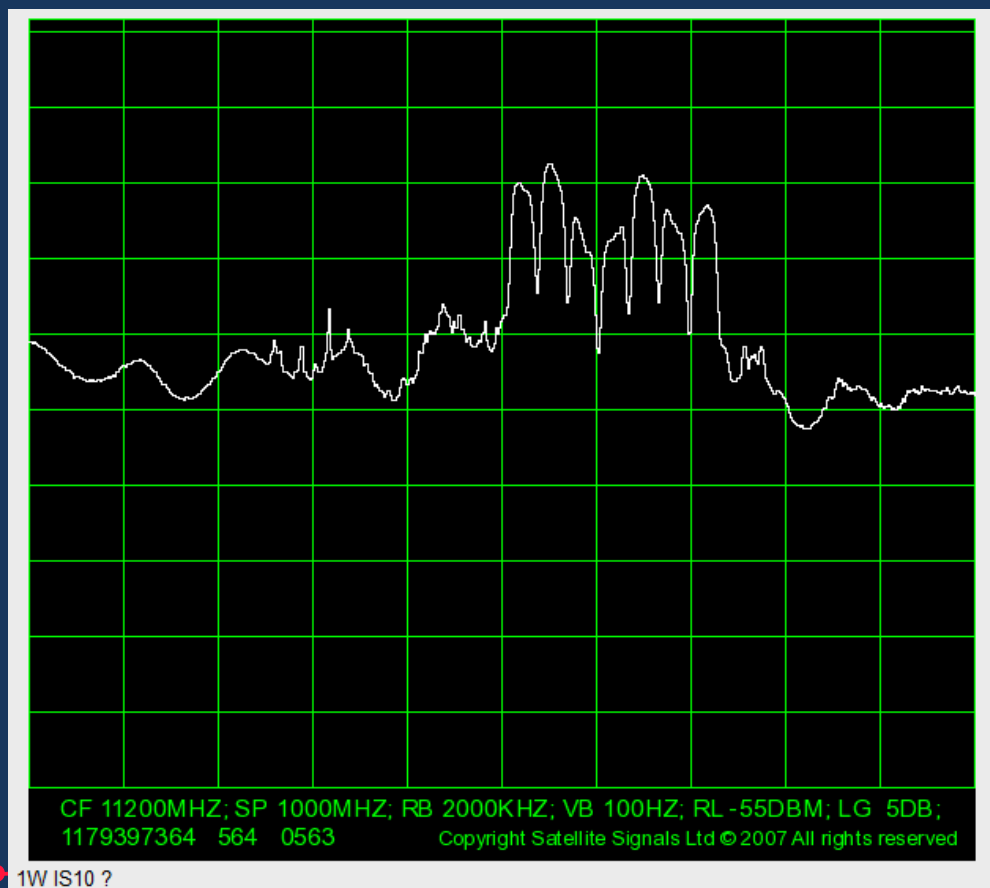


10E Hotbird Digital DVB-S TV carriers

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911570741)

Vsat installation

Align antenna using a s.analyser - step 0E



1W IS10 ?



Vsat installation

Align antenna using a s.analyser - step 6 of 6

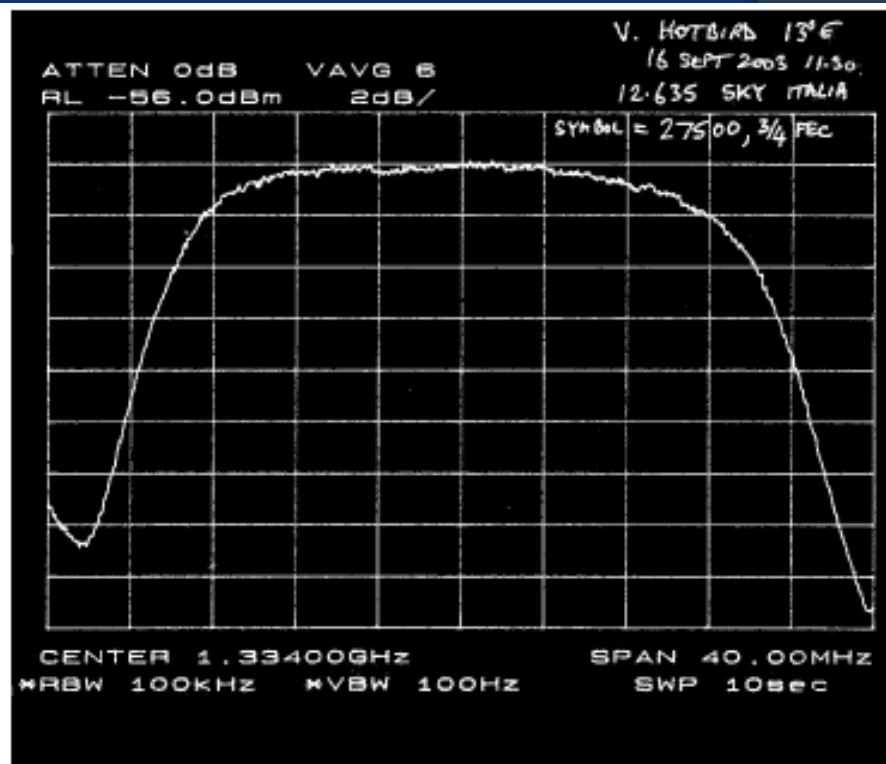


Spectrum plot of a DVB-S carrier

Symbol Rate= 27500 ksym/s

Bandwidth

- 3 dB 26.4 MHz,
- 3.8 dB 27.5 MHz,
- 4 dB 27.93 MHz,
- 6 dB 30.27 MHz,
- 12 dB 34.53 MHz.



Ref data: South East UK, 1.8m west, az=12.8cm, Skyrelay RF head,
LO=11.3 GHz, Hotbird 13E, SKY ITALIA, 12.635 GHz



Vsat installation

commissioning service with hub - step 7



- ⦿ Previously the customer acceptance tests should be conducted tests of recognition of the vsat network.
- ⦿ Regardless of the services that have been awarded by the client (data, voice, voice and data) we test the calls recognition functionality of the remote terminal on the Hub, allowing even optimize notes, and provide a channel of "orders" to the possibility of centralized support is essential.
- ⦿ There are systems in which once made the appointment, have automated procedures.
- ⦿ The following are the fundamental tests

Vsat installation

commissioning service with hub - step 7B



Antenna alignment

- Maximize pointing using the inbound from remote making adjustments to maximize it in the Hub (you can also use the outbound but since the lobe is narrower than in inbound, operation is more difficult)
- Check the crosspol measuring 2 inrout in the hub, at 2 crosspol.
- Do the 1 dB compression adjustment, if possible in EIRP (Gilat and HNS for example doesn't allow).

Vsat installation

commissioning service with hub - step 7C



- ◎ Power off / power on test
- ◎ Modem reset test (inbound direction)
- ◎ Indoor equipment setting & statistics
 - Equipment details
 - Modem parameters
 - Ethernet statistics (through ping and trace)
 - Satcom statistics (through ping and trace)

Vsat installation

user acceptance tests - step 8A

- ⊙ Commonly designated as “user acceptance and quality check” tests
- ⊙ Aim to verify if applications are running according to specifications, and verify the compliance of the basic contract conditions to be verified for the provisional (or final acceptance) tests and the release of down payments.

Vsat installation

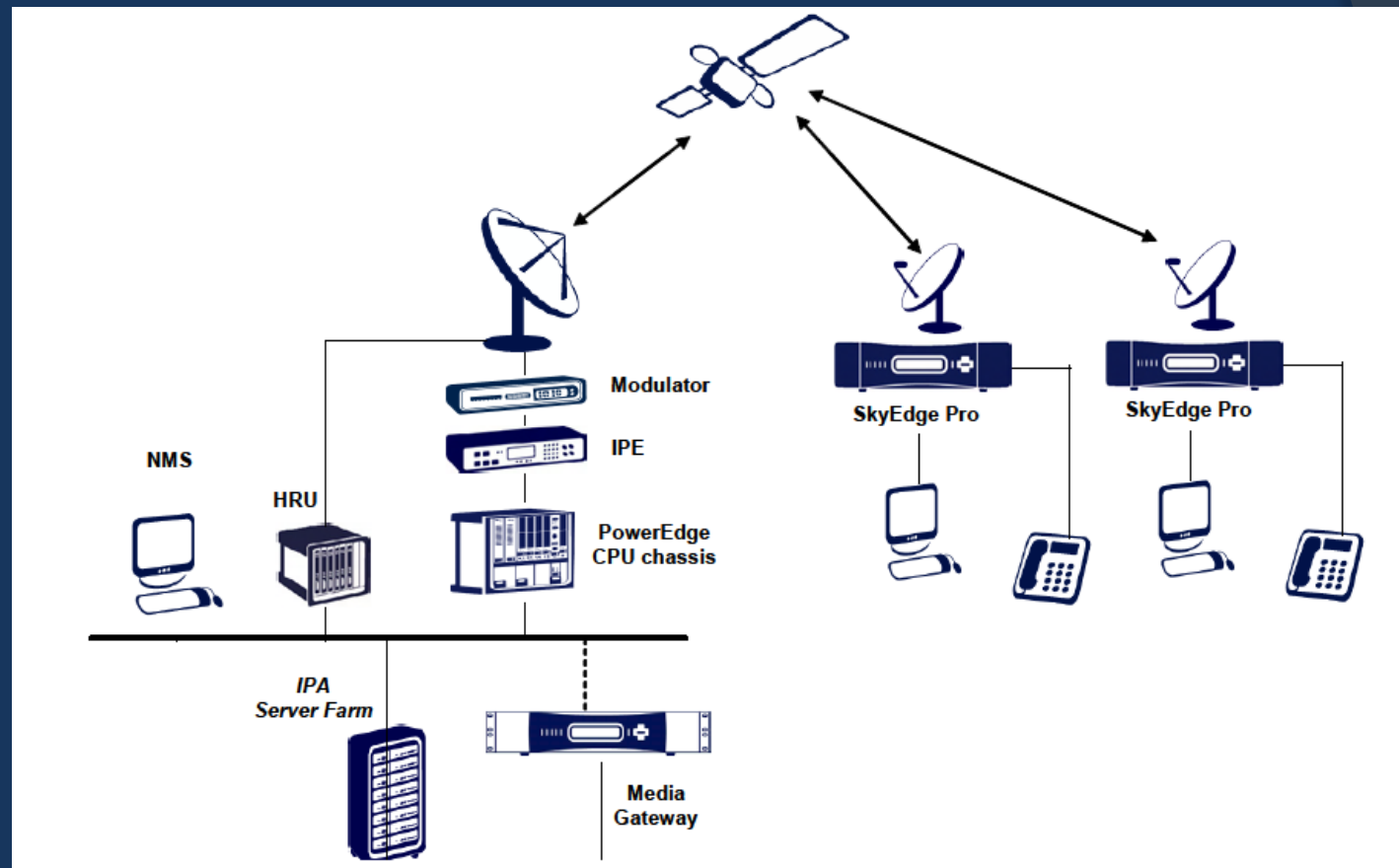
user acceptance tests - step 8B



- ⊙ Used also in the framework of the “warranty period” where the timegap (contractually agreed) from provisional acceptance to the final acceptance, is used to recheck all the system.
- ⊙ These tests are witnessed by the customer , and the results will be summarized in a “punch” list, being signed both by the customer and tester.

Vsat installation

example of user acceptance tests - step 8C



Vsat installation



example of user acceptance tests - step 8D

Hub verification of remote power failure and recovery

Hub to vsat and vsat to hub, communications test

- ping test

- ftp test

- http acceleration

- bypass card functionality

Telephony

- general

- vsat to vsat call

- vsat to hub call

- hub to vsat call

NMS configuration backup and restore



Vsat maintenance

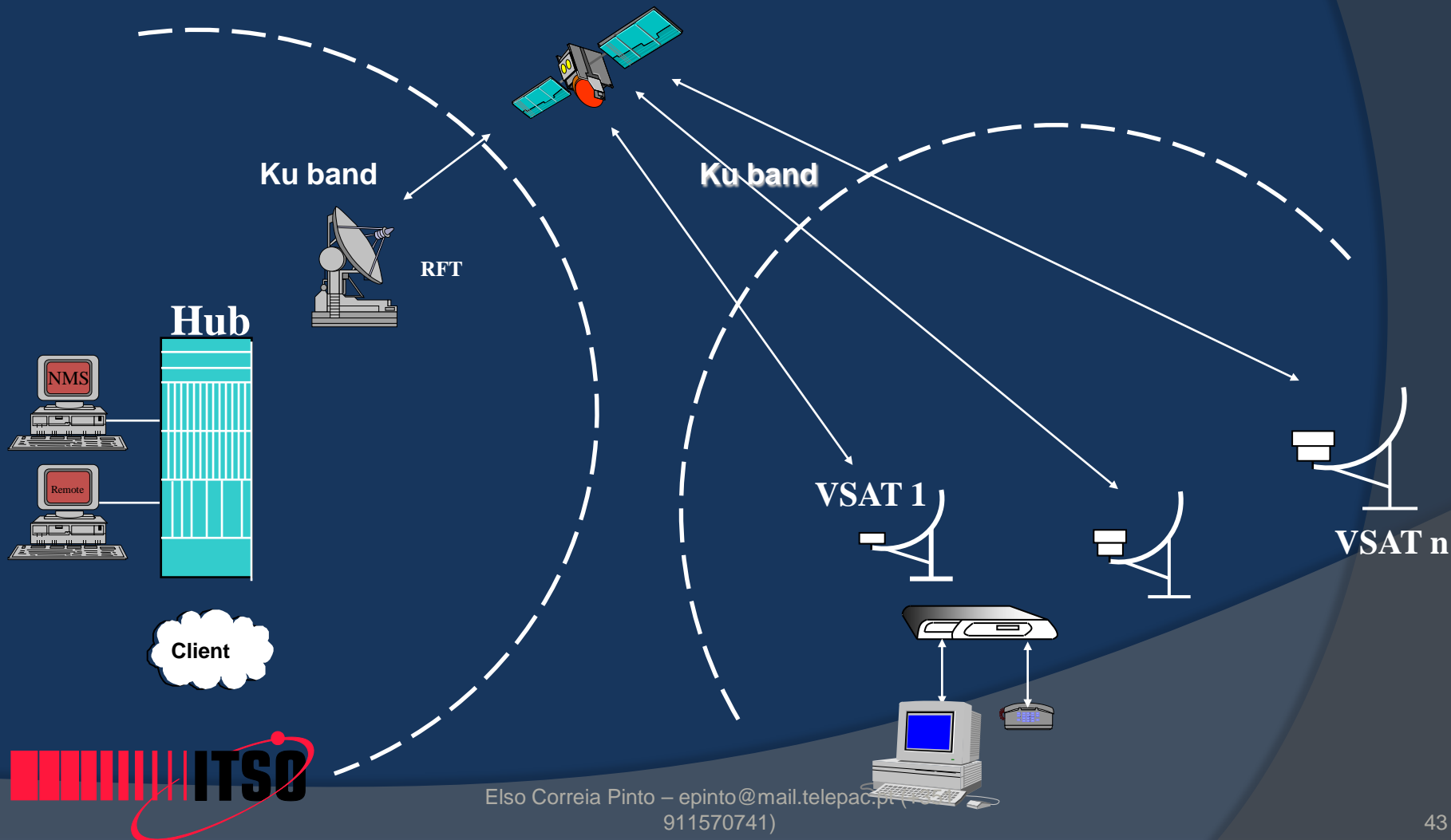
preventive maintenance



- ◎ The documents list, delivered with the installation of a Vsat system, does includes, besides, installation manuals, system manuals, wiring diagrams and so on, in summary the named “**maintenance plans and procedures**” referring both to the preventive and to the corrective actions (incident resolution).
- ◎ According to a predetermined plan and taking into account the extension of useful life of equipment, the verification of operating conditions, continuously, leads to the named “controlled maintenance” which gives the best cost effective solution for maintenance.

Vsat maintenance

Global network view

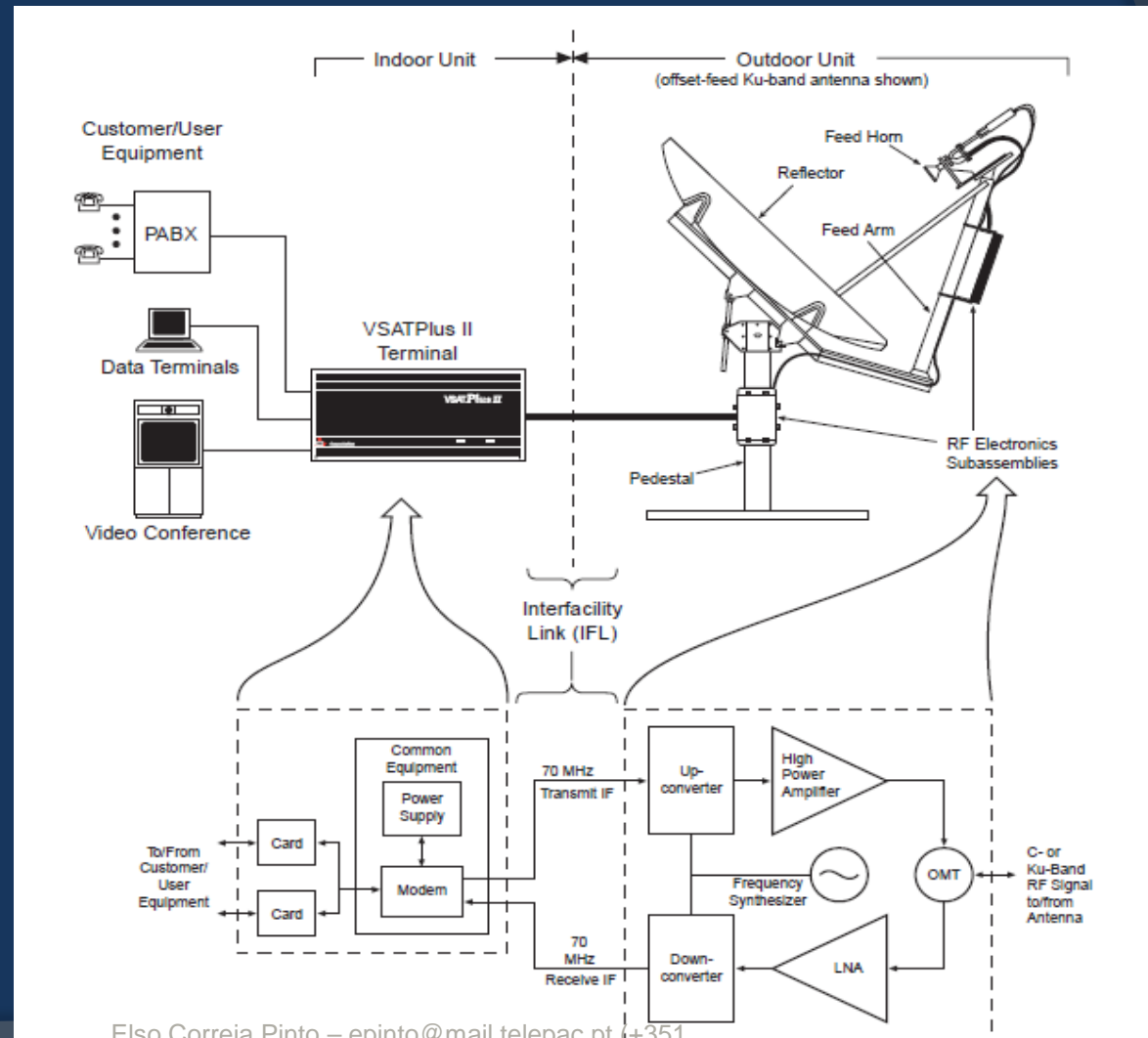


Vsat maintenance hub - maintenance plan



System	Equipment	Model	Periodicity
Antenna	ACU	Electrospace 93C23F	Monthly
	Beacon Receiver	Electrospace	Monthly
Transmission	<i>Modulator (9)</i>	<i>Radyne DMD 4500 4000</i>	Weekly
	<i>Modulator (8)</i>	<i>EFDATA SDM 8000</i>	Weekly
	U/C (4)	ETS 6000	Weekly
	U/C (2)	ETS 6207	Weekly
	TWT (3)	CPI VARIAN VJW2740	Monthly
	KPA (3)	VARIAN KPA 2725G	Monthly
	<i>Switch Modulator</i>	<i>EFDATA SMS – 658 A</i>	Quarterly
	<i>Switch Modulator (2)</i>	<i>RADYNE RCU780</i>	Quarterly
	Switch U/C	ETS 6000	Quarterly
	Switch Branching	MITEC M254	Quarterly
	Switch HPAs	CPI VARIAN	Monthly
Recepcion	LNA (3)	MAXTECH	Weekly
	D/C (4)	ETS 4000	Weekly
	<i>Demodulator (9)</i>	<i>Radyne DMD 4500 4000</i>	Weekly
	<i>Demodulator (4)</i>	<i>EF-Data SDM 8000</i>	Weekly

Vsat maintenance remote units layout



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Vsat maintenance remote units layout

◎ ODU

- Antenna misalignment
- Cable and connectors inspection
- BUC and LNB / LNC assembly (especially the fan and opening for air circulation) , whatever may be the cause for energy failure, overheat conditions (specially in high temperature regions)

◎ IFL

- Connectors and cable, in case of direct exposure to sun (UV) or rodents action (in case of ducts use)

◎ IDU

- Energy problems
- Modems configuration
- Cables and connectors

Vsat maintenance

vsat - maintenance plan



System	Equipment	Manufactor_Model	Periodicity
Antenna	Dish assembly	Gilat and local supplier	monthly
	Offset arm	Gilat	monthly
ODU (Tx/Rx)	BUC	CODAN	monthly
	LNB / LNC	MAXTEC	mensal
	Cable & connector		Each visit
IDU	Modulator	COMTECH	weekly
	Modulator	COMTECH	weekly
	Modulator switch	EFDATA	quarterly
IFL	Cable 6 connector		Each visit

Vsat maintenance troubleshooting & incident resolution



Vsat maintenance troubleshooting & incident resolution



HW swap on site
SW reset / update

Spares list

Power supply
Fan
RF connectors
LAN connectors
BUC / LNB,C
SSPA

Reconfiguration

Factory config
Local config
Remote config

Vsat maintenance

troubleshooting & incident resolution - Rx



1. Check LNB and feed horn
2. Coaxial connection is tight?
3. Check coaxial connector is clean and corrosion free → substitute
4. Check the feed is secure to the LNB
5. Check “O” ring installed between LNB and the feed horn flange
6. Check the outside cover of coax cable is without breaks or sharp bends pinch point or flattened sections of the cable
7. Check the power to feed LNB
8. Check the signal at the end of the cable before the modem with a Spectrum analyser
9. Check the frequency sweeper range under the modem parameters

Vsat maintenance troubleshooting & incident resolution - TX

A graphic of a blue folder or book with the text 'VENDOR HANDBOOK' in white.

VENDOR HANDBOOK

1. Does the BUC matches the antenna and the satellite router being used?
2. Are the input and output freq ranges are correct?
3. Does the DC power level matches the vendors spec at the modem output and at the cable end on antenna?
4. The coaxial connection is tight and connector sealed?
5. The directions of the feed waveguide and OMT are oriented correctly?
6. The BUC is secured to the feed using the screws?
7. The O ring is installed between the BUC and the feed flange?
8. The BUC is properly grounded with protection against lightening and ESD damage , and does the BUC power LED is green ?
9. The outside cover of the coaxial cable is without breaks no sharp bends no pinch point or flattened sections of the cable?
10. Change the BUC (check if the local freq oscillator is same)

Vsat maintenance troubleshooting & incident resolution



Signal Degradation

1. Was there a change of site or antenna?
2. Was there a change or failure of equipment?
3. Are Tx, Rx, and LAN cables are connected to the satellite router?
4. Rx LED on?
5. Tx LED on?
6. NTW LED on?
7. BUC Power LED on?
8. LNB PWR LED on?

Vsat maintenance troubleshooting & incident resolution



Periodic reviews of the action

- . Comparison with other manufacturers
- . On-site practice assessment
- . Which metrics we have used or may use



Upgrading of the existing

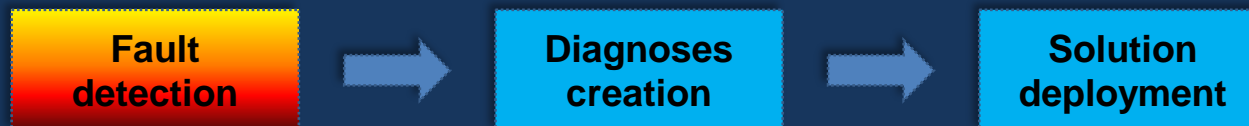
Updating forms

- . Layout
- . Reordering
- . Comments of those involved
- . Training actions

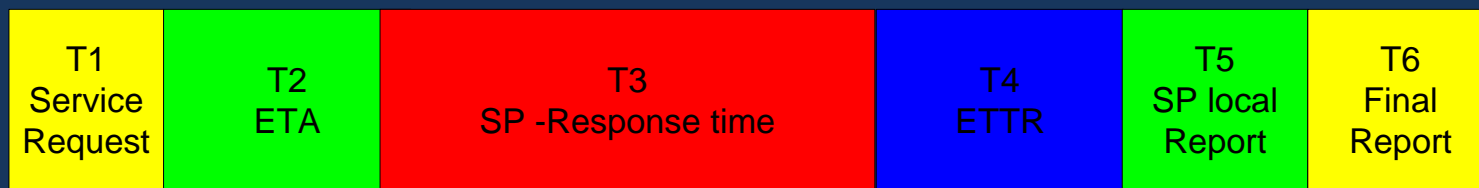
Vsat maintenance troubleshooting & incident resolution



Today the main part of the troubleshooting process is manual, but some projects have been presented and deployed to automate it. As a general overview the following layout is been presented



Vsat maintenance ETA / ETTR control



SP – Global response time

SP – Repair time

Vsat maintenance

slm - service level management

- ◎ What is?
- ◎ Is the position in the company that tries to reduce or minimize (eliminate is impossible) several years of damage caused by badly managed equipment (and or services) whatever responsibility is the vendor's (supplier), services' provider, or the internal management staff.
- ◎ SLA's are the road chart of SLM, or in other words the underpinning process of effective and efficient work

Vsat maintenance plan to implement sla

- ◎ Create a service catalogue
 - The menu the service provides (not a wish list)
 - The catalogue doesn't need to be complex
- ◎ Establish service level requirements
 - Collected during meetings
- ◎ Plan the SLA structure
- ◎ Negotiate and agree SLA
 - SLA must balance between individual people want and what the business actually needs and is willing to pay for.

Vsat maintenance

Service measurements & KPI

- ⦿ Number of breached SLA
- ⦿ Number of escalations
- ⦿ Number of 1st level escalations and xrd escalations
- ⦿ Number of incidents per service
- ⦿ Downtime per incident and global
- ⦿ Number of incidents cleared within SLA
- ⦿ Number of incidents cleared outside SLA and up to x minutes, y minutes

Vsat maintenance sla - guaranteed parameters



SUPPLIER SIDE

- ◉ KPI definitions, limits, steps, toerances
- ◉ Credit algorithm in failure situation
- ◉ SLA parameters definiitons and metrics
- ◉ Ocurrances reporting (type, availability and periodicity)
- ◉ General conditions to SLA application



Vsat maintenance sla - guaranteed parameters



CLIENTS SIDE

- Site downtime is minimized
- Compliance with technical and environmental requirements
- Establishment of schedule operation time (site by site)
- Acceptance of maintenance windows
- Bonus value for better KPI performance
- General conditions to SLA application

