Spectrum Compact

Designed with field engineers in mind

SAF Tehnika JSC

A **designer, producer and distributor** of digital microwave data transmission equipment for digital voice and data communication.

- **Founded in 1999 with 15+ years of experience in microwave field,**
- **Full-Cycle R&D and Production,**
- **Listed on NASDAQ OMX Riga since 2004,**
- **HQ & Manufacturing -** Riga, Latvia (Europe),
- **Quality assurance –** ISO 2001, CE,
- **Delivered over 100K radios.**

R&D

Production

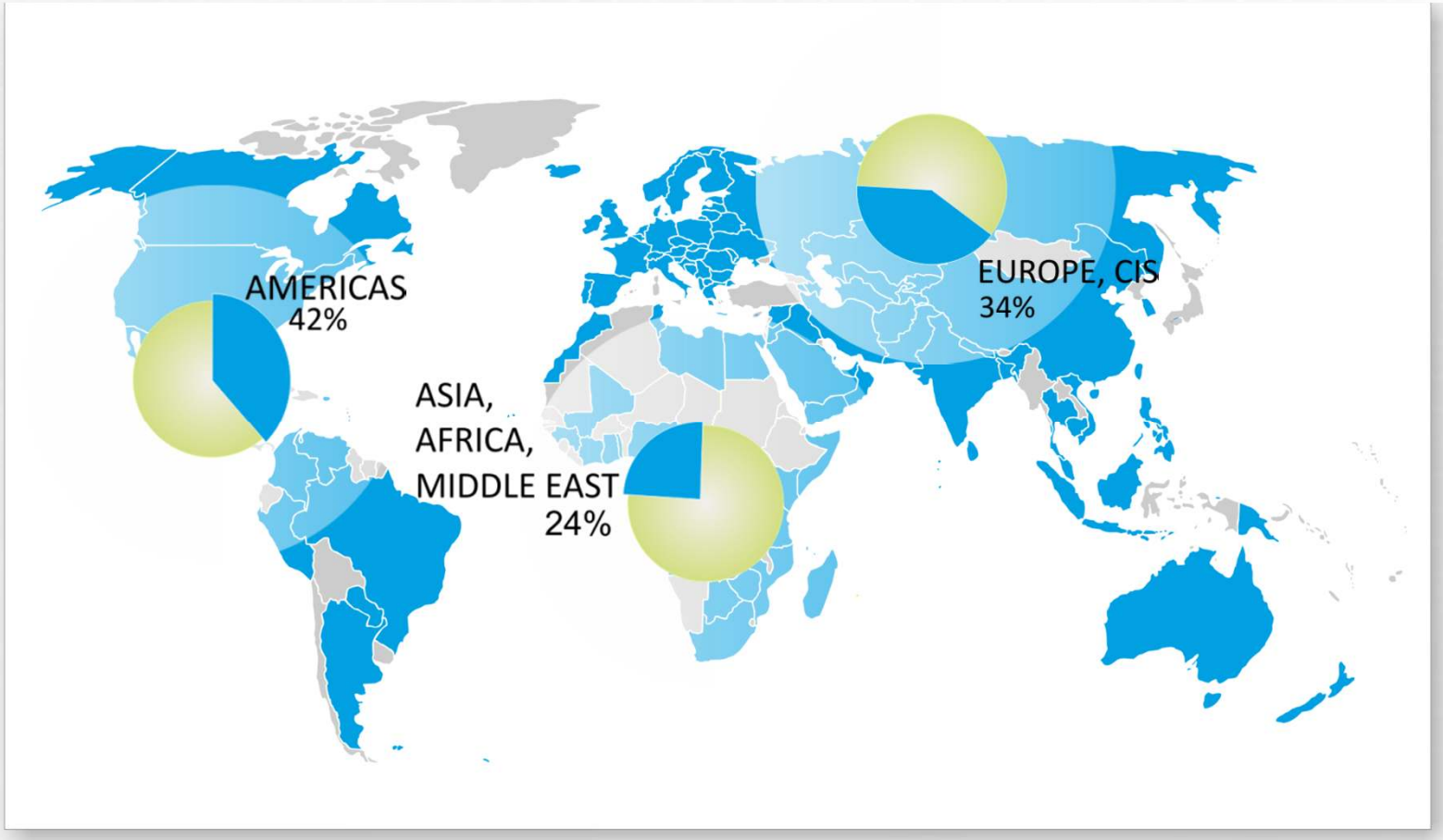
Quality Control

Follow us on

SAF worldwide presence

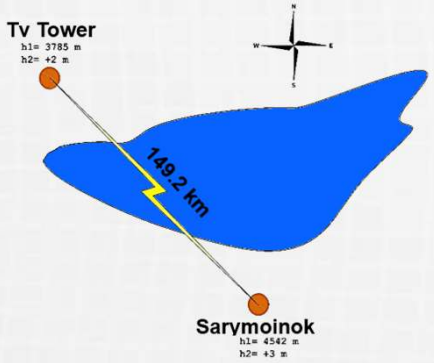
- Local offices

Regional sales FY 12/13

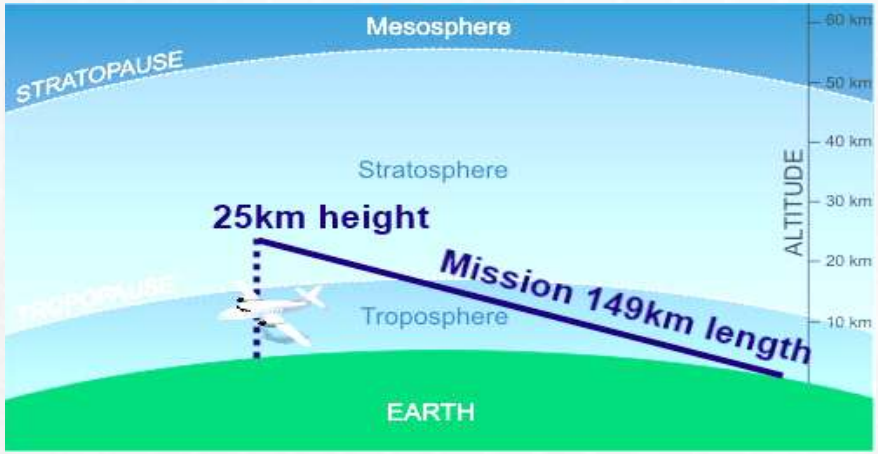


Remarkable achievements

149.2 km link over water providing 8E1 throughput with 99,99% annual availability

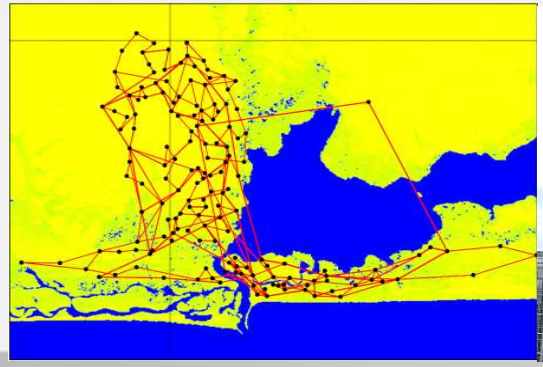


Radio link transmitting data from 25km height in Stratosphere to 149km ground station

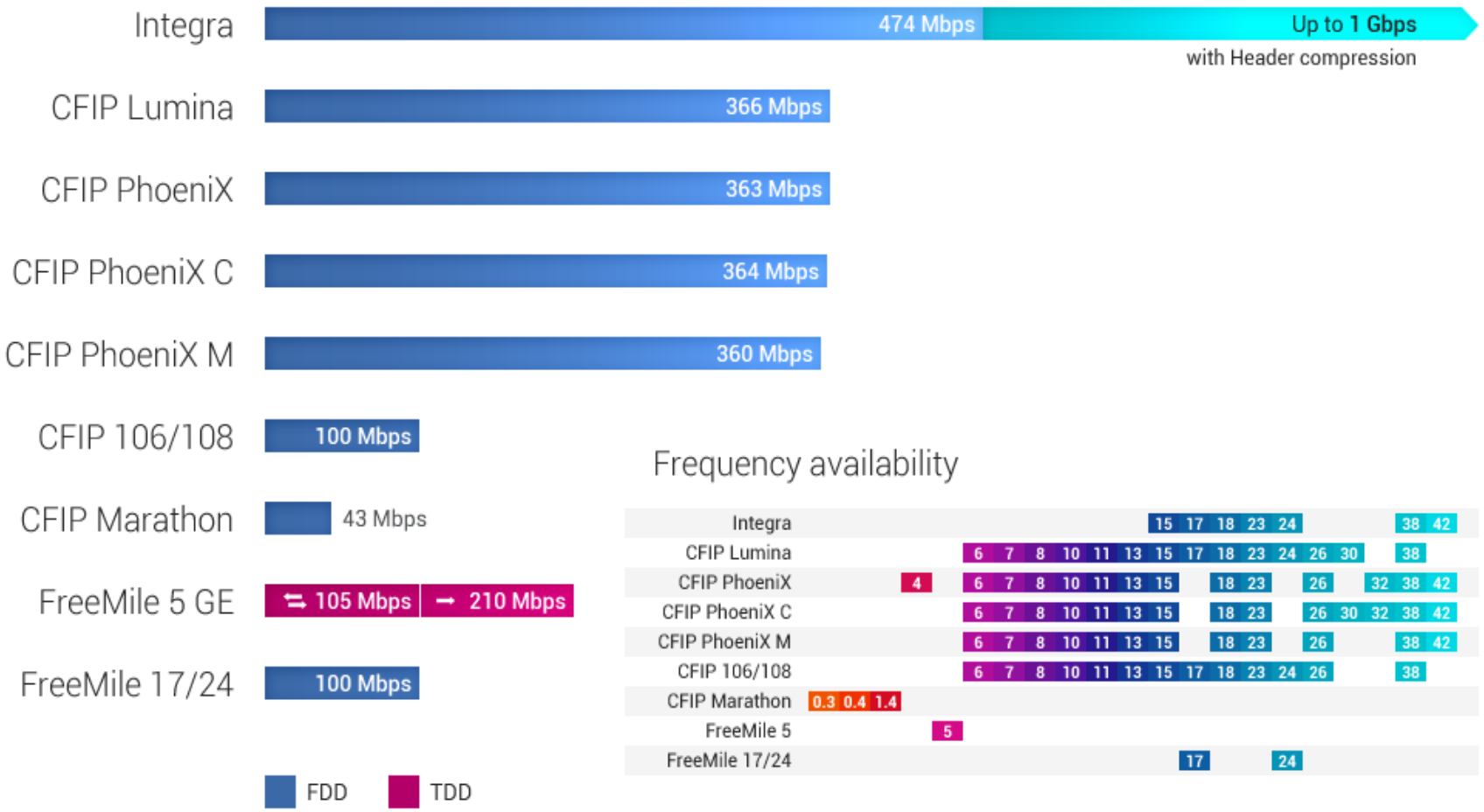


Largest MW network in Lagos, Nigeria.

More than 200 SAF links deployed in area of approx. 25x32km



Product Overview



Frequency availability

Integra	15 17 18 23 24 38 42
CFIP Lumina	6 7 8 10 11 13 15 17 18 23 24 26 30 38
CFIP PhoeniX	4 6 7 8 10 11 13 15 18 23 26 32 38 42
CFIP PhoeniX C	6 7 8 10 11 13 15 18 23 26 30 32 38 42
CFIP PhoeniX M	6 7 8 10 11 13 15 18 23 26 38 42
CFIP 106/108	6 7 8 10 11 13 15 17 18 23 24 26 38
CFIP Marathon	0.3 0.4 1.4
FreeMile 5	5
FreeMile 17/24	17 24

All mentioned capacities are in 1+0 configuration full-duplex
The capacity is multiplied by number of radios (in 2+0 / 3+0 / 4+0 configurations)

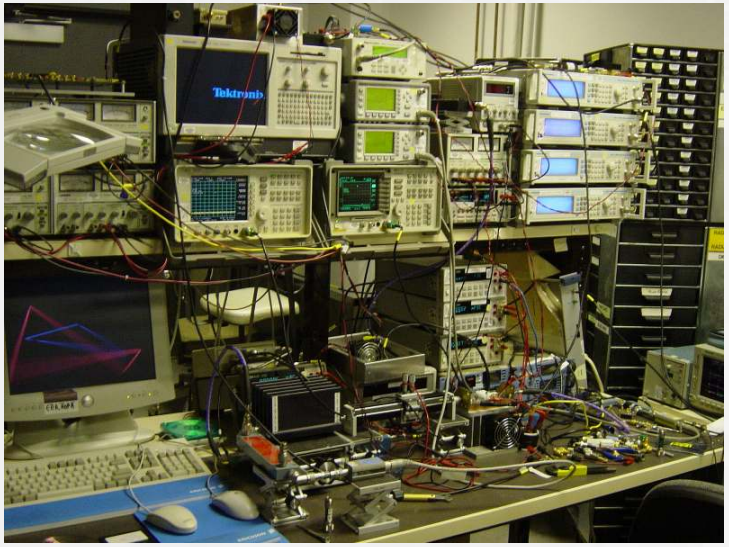
Spectrum Compact

Market of Spectrum Analyzers above 6 GHz

- Spectrum analyzers in higher than 6.x GHz frequencies are produced by few companies.

- Products are mostly of 2 categories:

For Laboratory use
(30k – 100K USD)



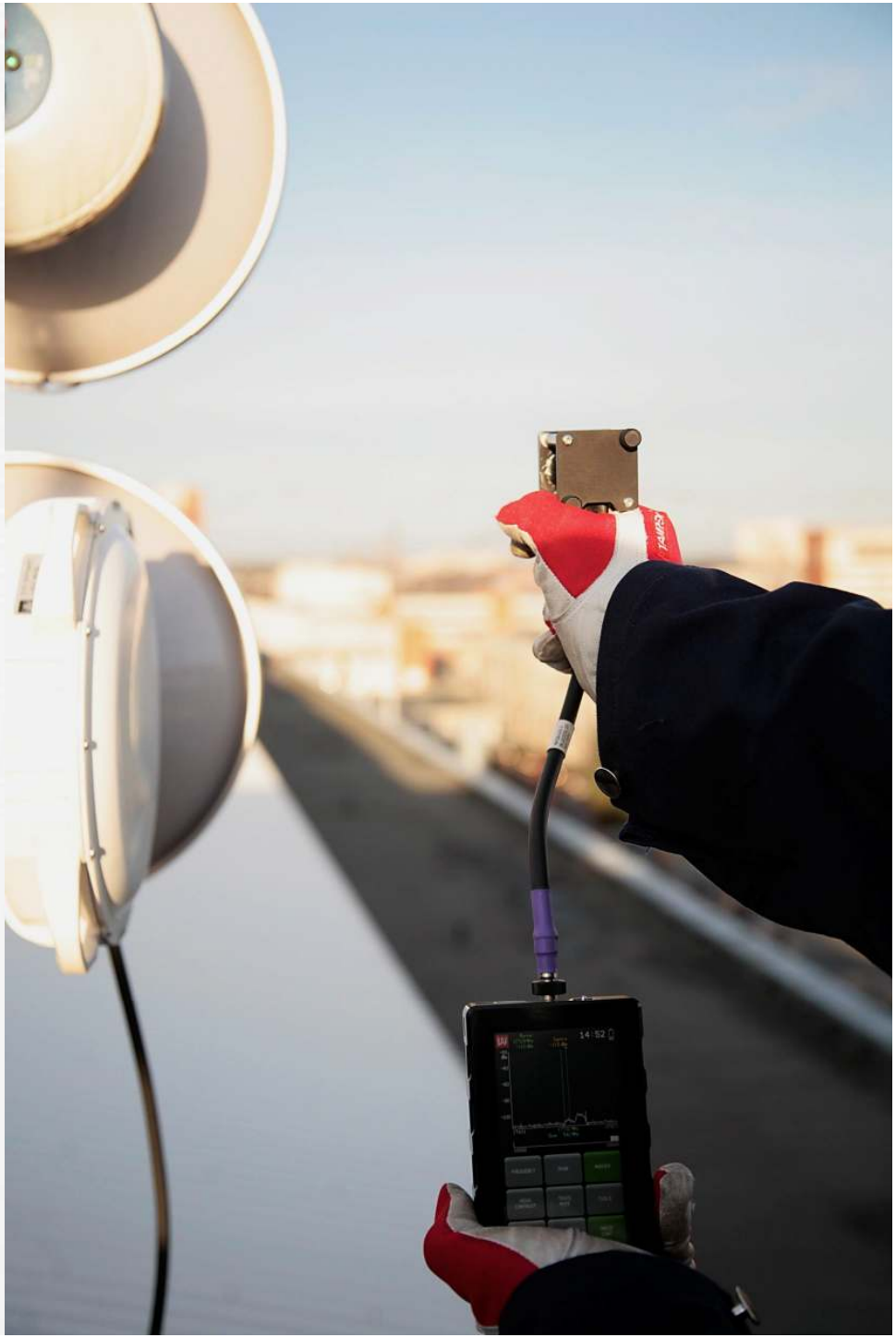
Portable; typically 5cm thick; 3-5kg
(20k – 30K USD)

Roots of the Spectrum Compact

- SAF is a MW Radio manufacturer with 15+ years experience, thus having deep technical knowledge in both – MW transmitter and receiver;
- Spectrum Compact was initially designed for interference detection in markets with limited MW Regulatory supervision;
- From our extensive experience in MW field, we knew what functionality engineers needed in the field to install, maintain and troubleshoot MW radio links;

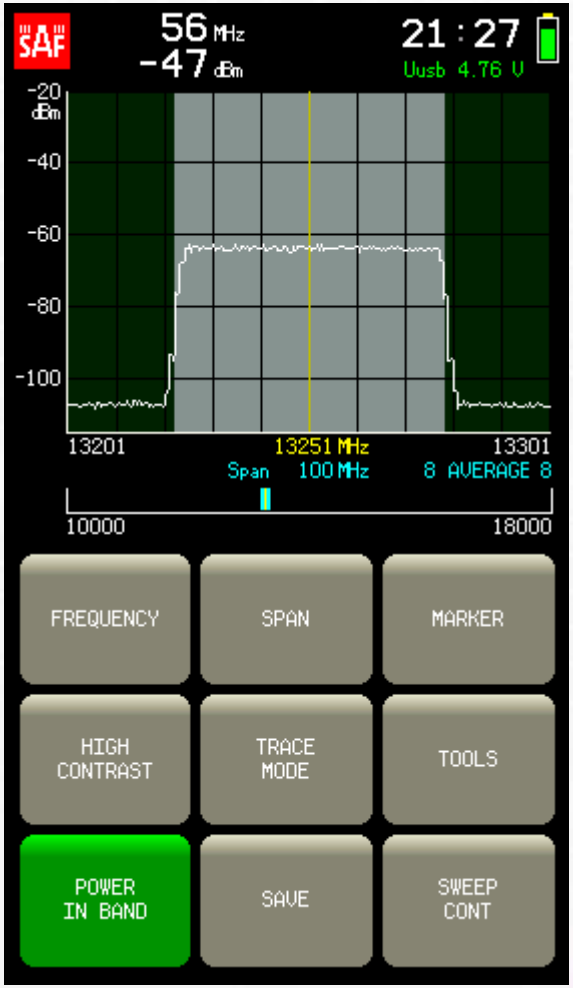
SAF designed a product, containing only the most essential and the most frequently required functionality in the field.

We provide the simplicity and ease of use!



Functionality

- Continuous/single sweep;
- Frequency selection – start, stop and center frequencies;
- Max hold function;
- Power in band function for signal power measurements;
- Span selection;
- High sensitivity;
- Marker with peak and center to marker;
- Changeable offset and power level scale;
- Trace function:
  - Peak hold,
  - Overwrite,
  - Average (2, 4, 8, 16 readings).
- Save and review of spectrum curves;
- Draw function for notes taking.
- High contrast mode
- PC software for analysis



Features & Benefits

Ultra-compact form factor

Not much larger than a modern smartphone, it is designed specifically for comfortable outdoor use in a variety of challenging environments.

Leading Sensitivity

Industry leading -105 dBm receiver sensitivity in all frequency range allows you to discover even weakest signals.

Stand-alone functionality

No laptop or other equipment is required for on-site use.

Resistive LCD Touchscreen

Resistive LCD touchscreen allows to leave your gloves on while operating the unit. Intuitive UI makes easy to control the unit.

Compatible with different antenna systems

Can be used with any manufacturers antenna and radio system.

Free PC software

Upload, save, compare, analyze and print your saved spectrum scans using free PC software.

Spectrum Compact main features

- Set of 4 units, designed for ease of handling on the tower:
  - 5.925 – 12.000 GHz
  - 10.000 – 18.000 GHz
  - 17.000 – 24.300 GHz
  - 24.000 – 40.000 GHz

Pay for what you use!

Units can be shared by several teams.

- Form factor:
  - dimensions and weight of a unit:

    (128 x 81 x 24 mm / 0,3 kg)
- Ease of use:
  - intuitive GUI; instant ON/Off; built in DC blocker; USB chargeable; resistive touchscreen,
  - Specially designed for MW field engineers.

Spectrum Compact – typical on-site kit

Waveguide adapters to SMA

- Works as low gain antenna,
- Thumb screws for quick attachment to antenna.
- Six different frequency range adapters available.

Rugged RF cable

- SMA-SMA for frequencies from DC to 26,5 GHz or 2,92mm from DC to 50 GHz
- Excellent shielding effectiveness

Spectrum Compact Positioning

Spectrum Compact is a field spectrum analyzer – a unique instrument designed for field engineers.

The Spectrum Compact has the form factor of a multi-meter and comes at only a fraction of a portable Spectrum Analyzer's price.

Form factor of multi-meter, functionality of spectrum analyzer.

Spectrum Compact

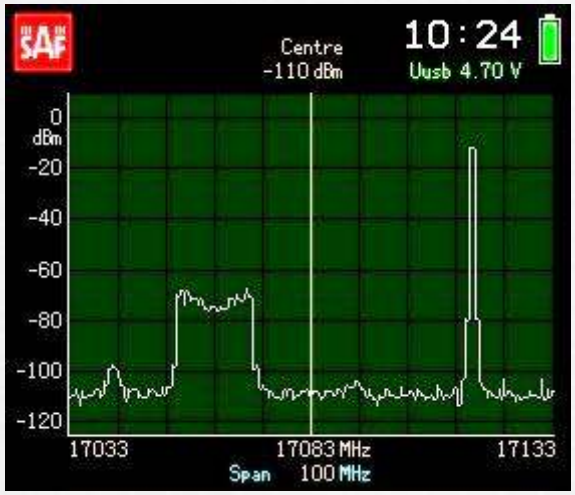
Multi-meter

Hand-held Spectrum Analyzer

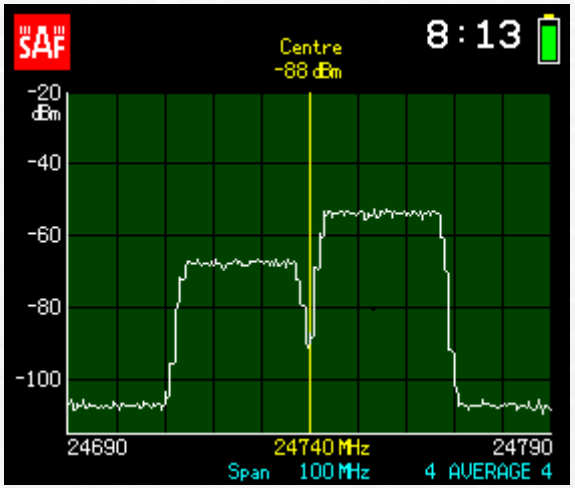
 **Spectrum Compact**		 **Multi-meter**	
+	Visual representation of the signal	—	Lack of signal visual representation
+	Results displayed with actual Rx Level in dBm	—	Voltage to Rx level Conversion table required. Rx Level is represented as Voltage reading
+	Considerable antenna system alignment time reduction	—	Significantly longer antenna system alignment
+	Higher sensitivity compared to radios	—	Minimum received signal is limited by radio sensitivity
+	Unwanted emission does not affect measurements	—	Unwanted emission may affect readings

Examples of the signal visual representation

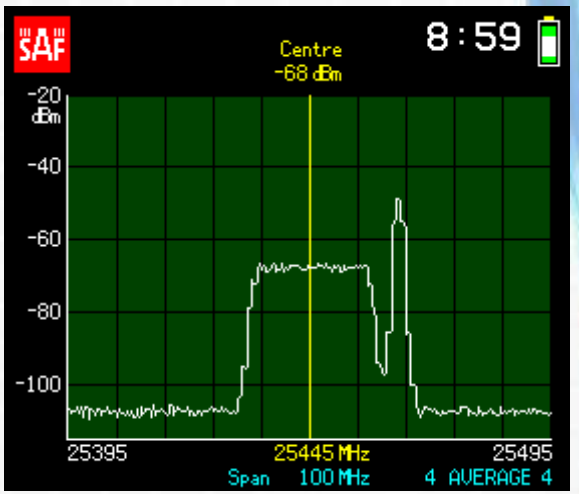
Spectrum scan



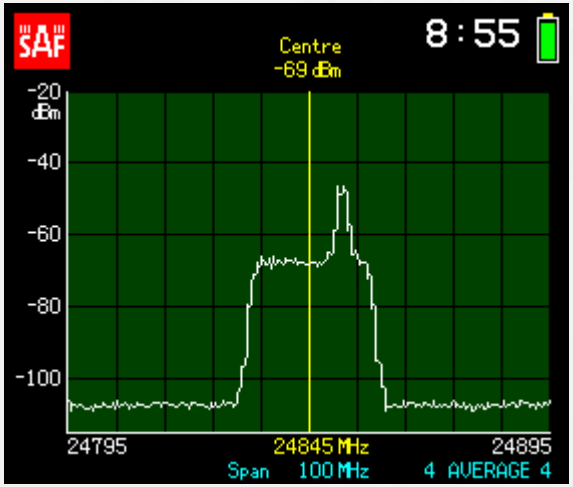
Adjacent channel interference



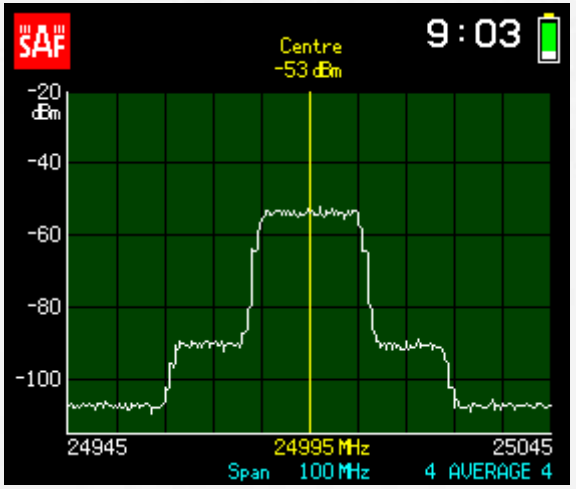
Out-of-band interference



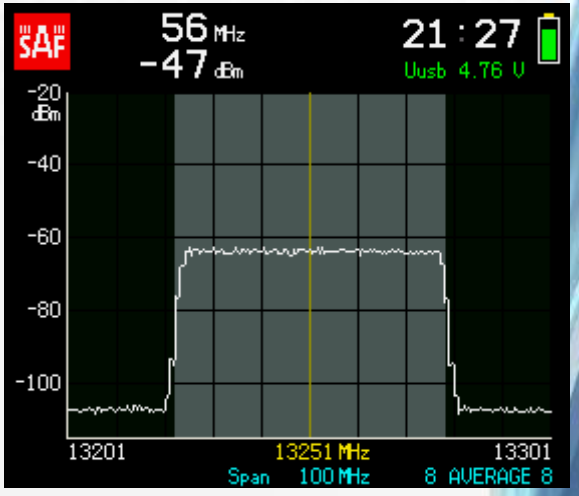
In-band interference



Co-channel interference

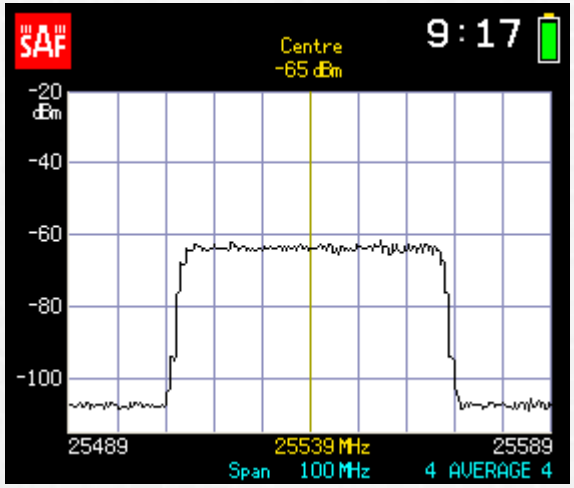


Power in Band

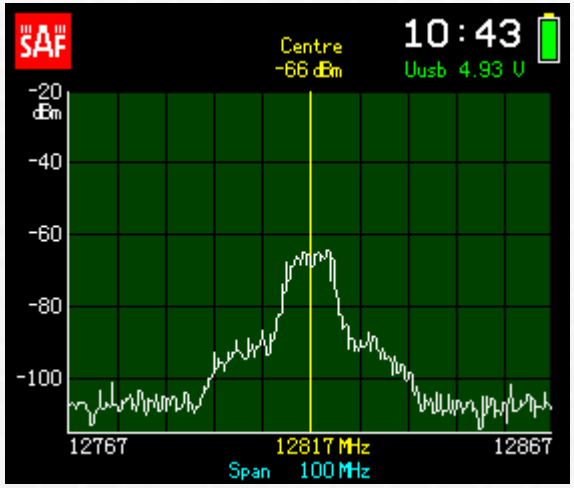


Examples of the signal visual representation

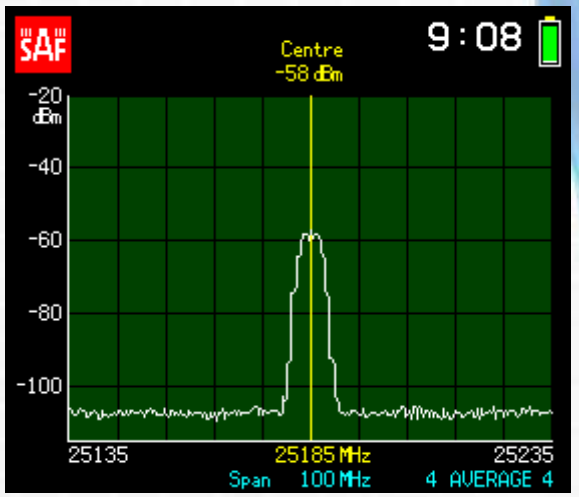
High contrast mode



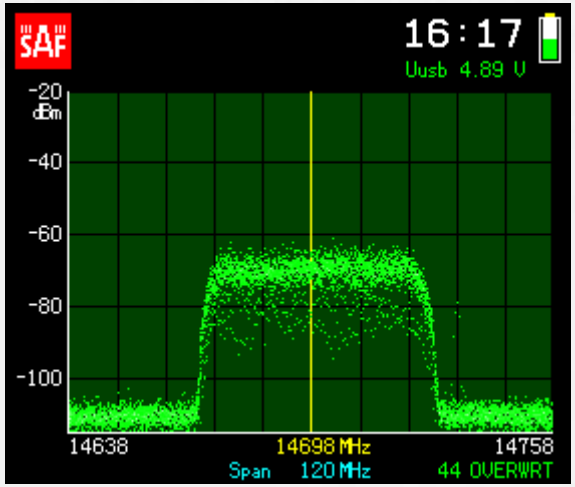
Damaged transmitter



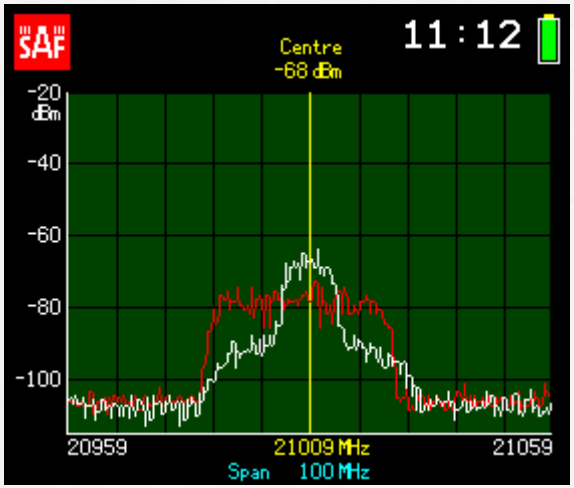
7 MHz channel



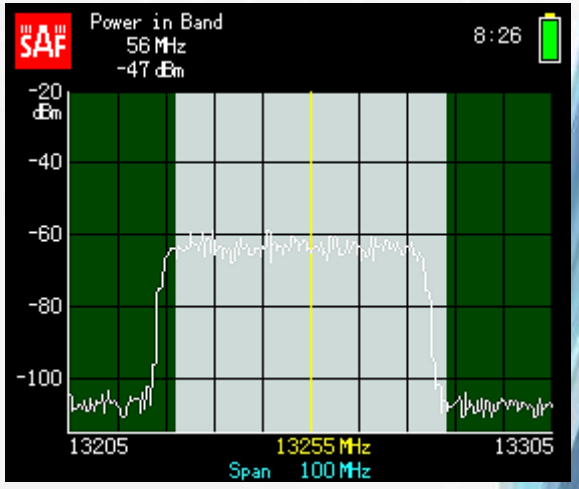
Multipath



Reference Mask



Misconfigured Radio

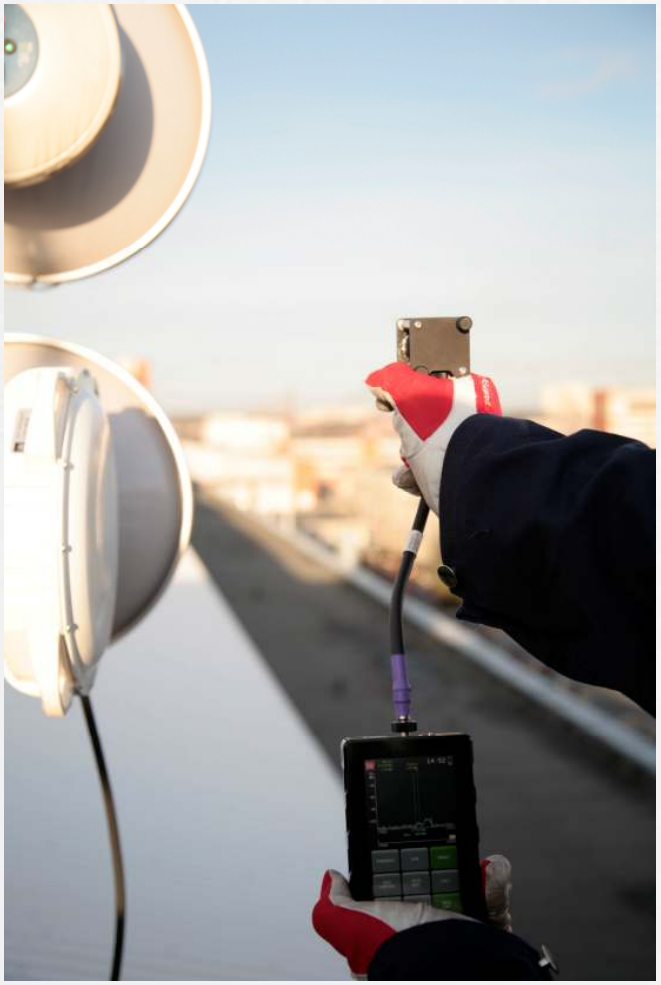


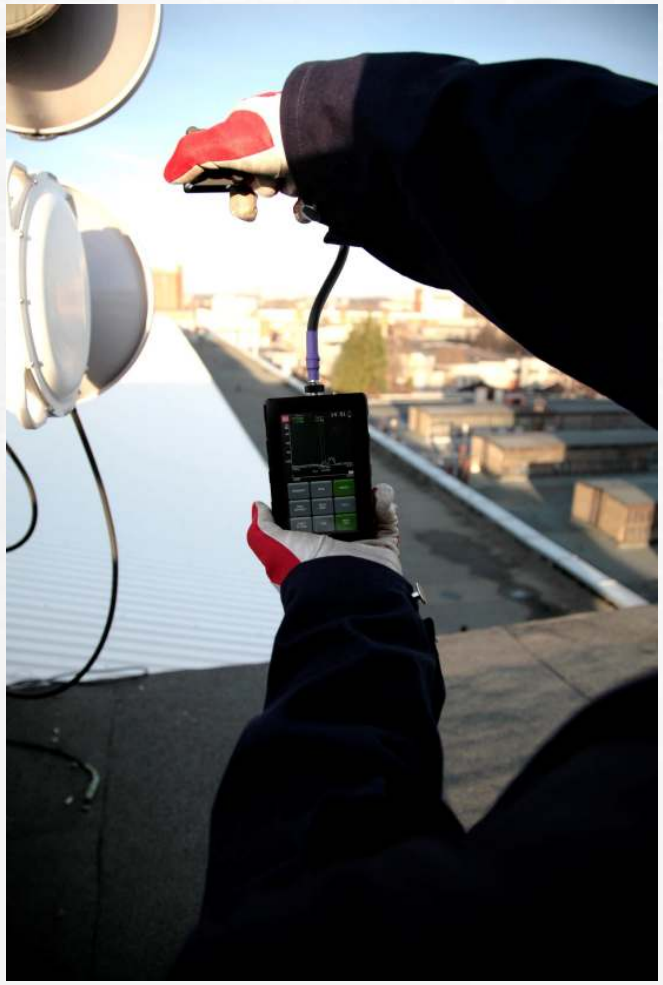
Spectrum Compact vs Portable Spectrum Analyzers

Manufacturer	Model	Frequency Range	Weight (kg)	Dimensions (mm)
SAF Tehnika	Spectrum Compact	5.9GHz – 40.0 GHz	0,3 x 4	128 x 81 x 24
Anritsu	Site Master S820D	2 MHz - 20 GHz	2,3	254 x 178 x 61
Anritsu	Spectrum Master	9 kHz – 43 GHz	3,8	315 x 211 x 77
Rhode & Schwarz	HSF 20	9 kHz - 20 GHz	3,0	194 x 300 x 69
Tektronix	SA2500	10 kHz - 6.2 GHz	5,5	230 x 330 x 120
Agilent	Field Fox	5 kHz - 26.5 GHz	3,0	292 x 188 x 72
BK Precision	2658A	50 kHz - 8.5 GHz	1,8	162 x 70 x 260
Pendulum	Path Align-R	1.8 GHz – 23.5GHz	3,2	89 x 213 x 333
Aaronia (Spectran)	HF-60100	1 MHz – 9.4 GHz	0,430	250 x 86 x 27

In the field

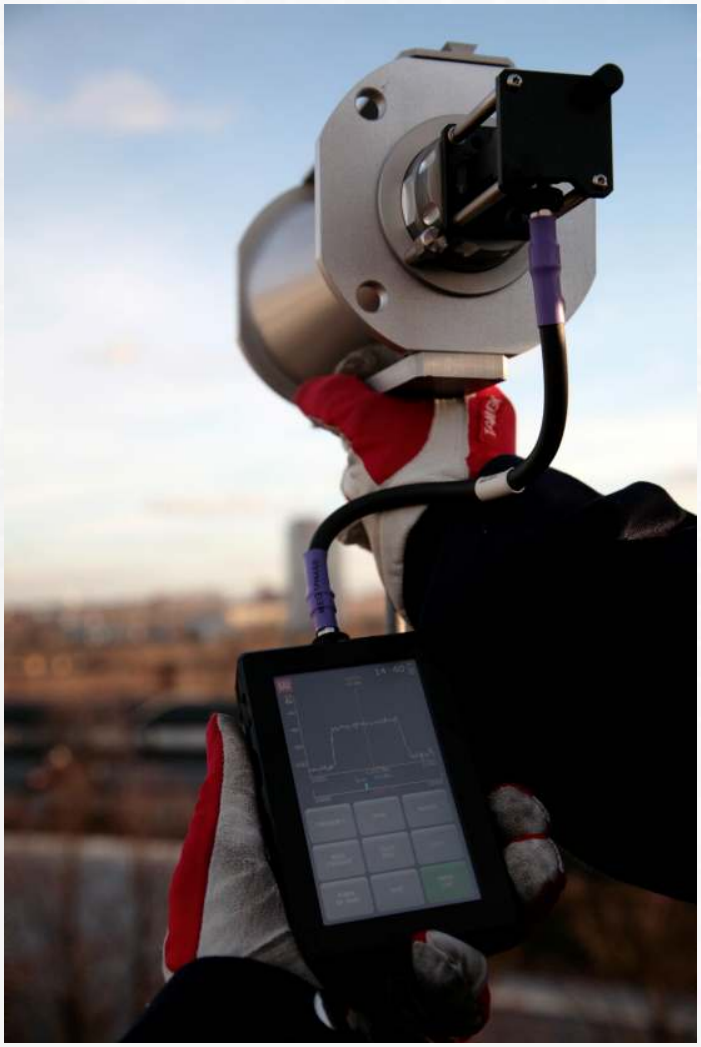
Changing polarization is easy!





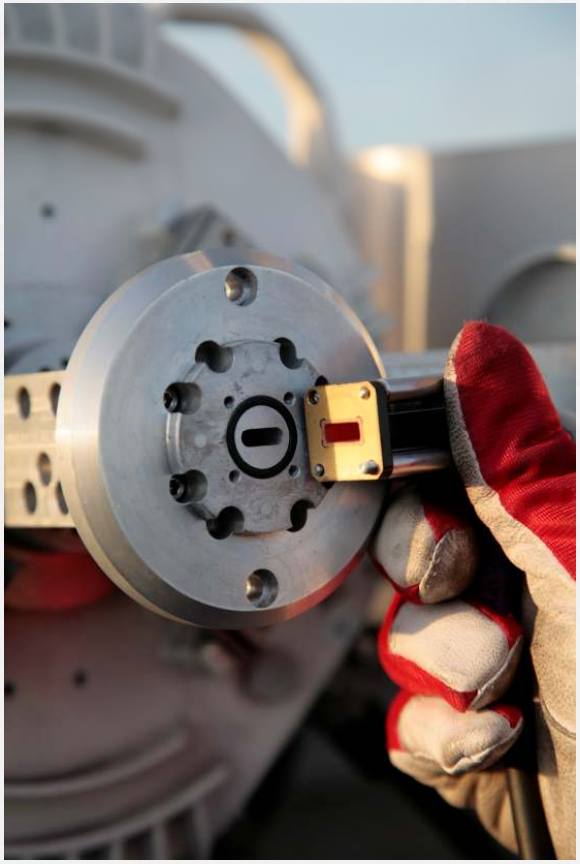
In the field

Using hand-held Horn antennas

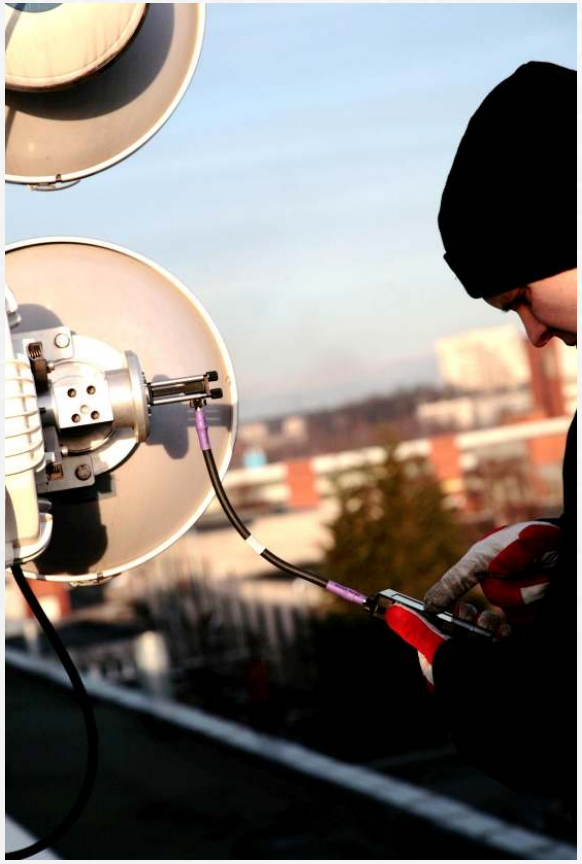


In the field

Attaching the flange



Setting the parameters



Adjusting antenna

Technical data

Technical Specifications

Spectrum Compact

P/N	J0SSAP11	J0SSAP12	J0SSAP13	J0SSAP14
Frequency bands	6/7/8/10/11 GHz	10/11/13/15/17 GHz	17/18/23/24 GHz	24/26/30/32/38
Frequency range	5.925 - 12.000 GHz	10.000 - 18.000 GHz	17.000 - 24.300 GHz	24.000-40.000 GHz
Input power range	-105 dBm to -40 dBm			-100 dBm to -40 dBm
Max input power	0 dBm			0 dBm
RBW (Resolution bandwidth)	1 MHz			1 MHz
Span	100 MHz to full bandwidth			100 MHz to full bandwidth
Sweep speed	0.5s @ 100 MHz Span			0.5s @ 100 MHz Span
Guaranteed accuracy	+/- 3 dB			+/- 3 dB
Input	50 ohm SMA (f)			50 ohm 2.92 mm (f)
Interface	mini USB 2.0 (1.1)			mini USB 2.0 (1.1)
LED indication	when charging			when charging
Battery	2380 mAh Polymer Lithium-ion			2 x 2380 mAh Polymer Lithium-ion
Battery life	up to 4h			up to 3h
Operating temperature	-5°C to +40°C / 23°F to 104°F			-5°C to +40°C / 23°F to 104°F
Dimensions	128 x 81 x 24 mm / 5.04 x 3.2 x 0.94 in			130x81 x 28 mm/ 5.11 x 3.2 x 1.1 in
Weight	0.3 kg / 10.6 oz			0.4 kg/ 14.11 oz

- coaxial cable or frequency specific SAF adapter kit will be required

Using Spectrum Compact readings

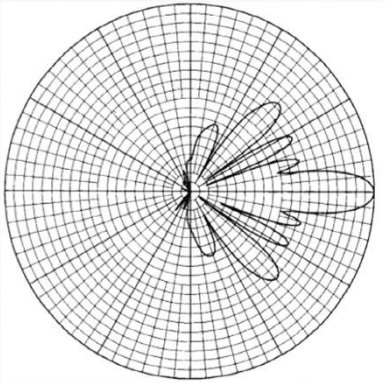
- **In all stages of link life-cycle**
  Site survey,
  Radio link installation,
  Site acceptance,
  Troubleshooting.

- **Applications**
  Seeking for free channels,
  Interference detection,
  Verification of the radio configuration,
  Antenna adjustment,
  Cross-polarization adjustment,
  Received signal power comparative measurements,
  Investigation of the radio operation,
  Investigation of the radio connection to the antenna,
  Replacement of already installed antennas,
  Saving the spectrum curves.

Signal propagation (1):
Antennas

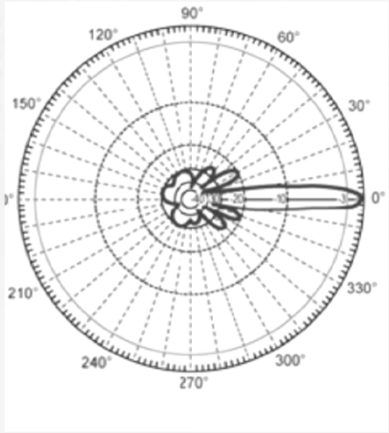
Small size antennas

- Antennas sized up to 1.2m have wider main beam and more evident side lobes.
- Typical error – antenna is aligned on side lobes.



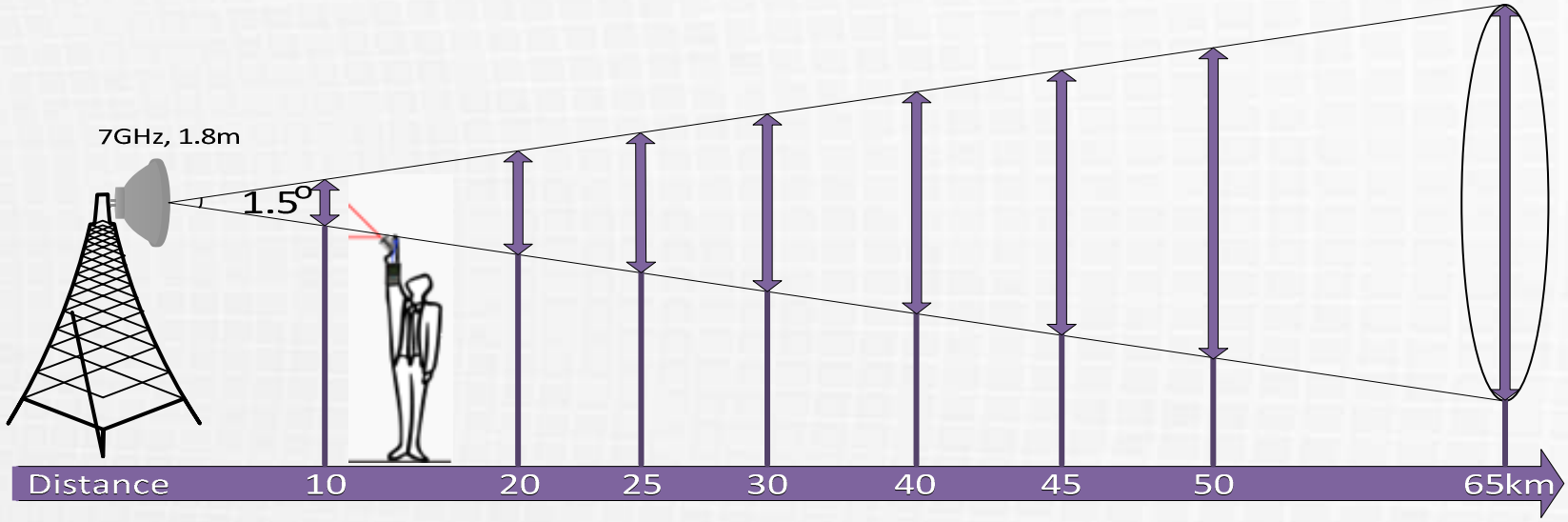
Large size antennas

- Bigger antennas with higher gain have a narrow main beam and less relevant side lobes.
- Typical problem for installators – finding the first signal from the far side site.



Signal propagation (2):

1.8 m antenna beam height VS distance @ 7GHz



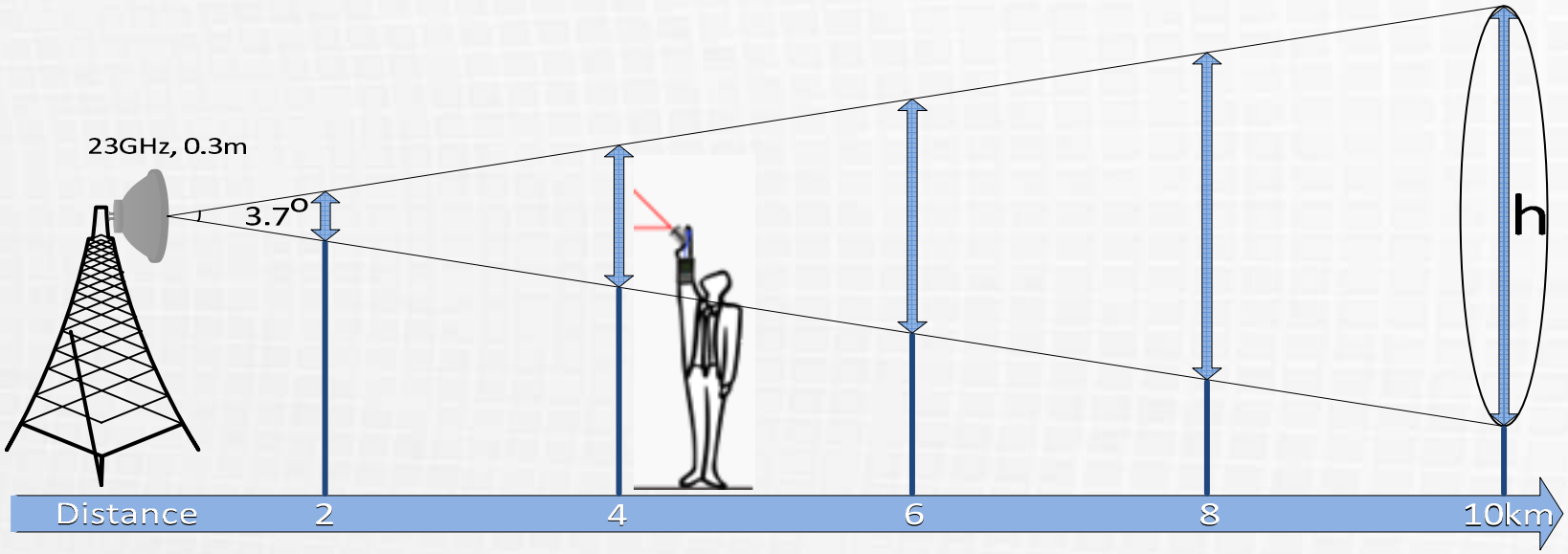
Distance	10km	20km	25km	30km	40km	45km	50km	65km
Height of the beam	261m	523m	654m	785m	1047m	1178m	1309m	1650 m

In this example – if antenna is located on tower 130m high, you should be able to catch the main beam from the ground level already 10 km from the tower.

261 / 2 = 130,5 (m)

Signal propagation (3):

0.3 m antenna beam height VS distance @ 23Ghz



Distance	2 km	4 km	6 km	8 km	10 km
Height of the beam	129 m	258 m	387 m	516 m	645 m

In this example – if antenna is located on tower 130m high, you should be able to catch the main beam from the ground level approximately 4 km from the tower.

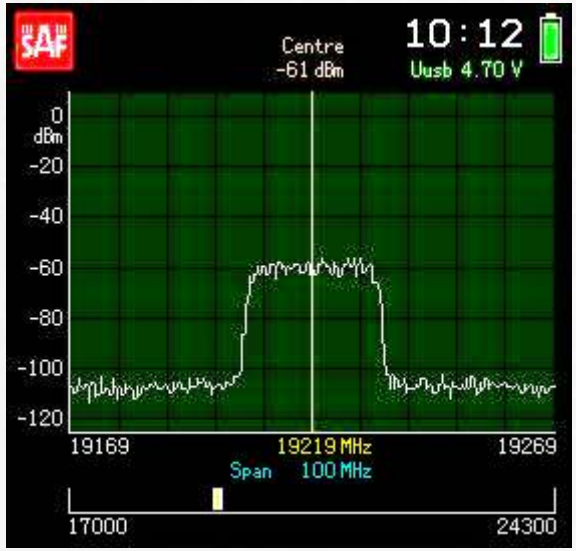
258 / 2 = 129 (m)

Applications (1)

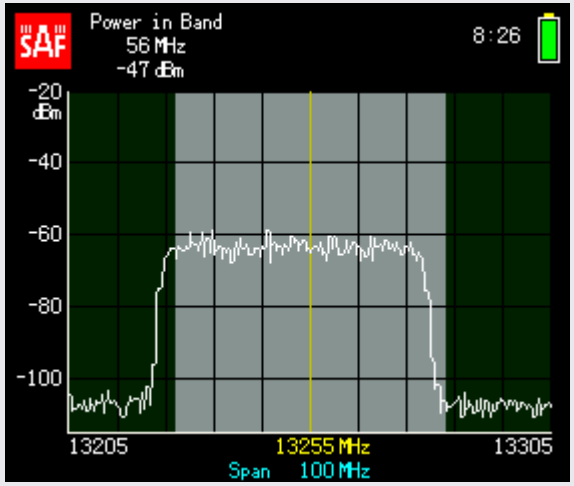
Verifying radio configuration and performing diagnostics of the radio:

- Checking the frequency
- Checking bandwidth
- Checking Tx Power

Tx frequency	19219000 kHz
Rx frequency	18209000 kHz
Modem configuration	
Configuration file	embedded->28_X_FP_EGEv4b.bin
Bandwidth	28000 kHz ETSI
Modulation	256QAM WeakFEC with ACM
Total capacity / rate	174.700 Mbps with max ACM / Unlimited
Ethernet capacity / rate	174.700 Mbps with max ACM / Unlimited



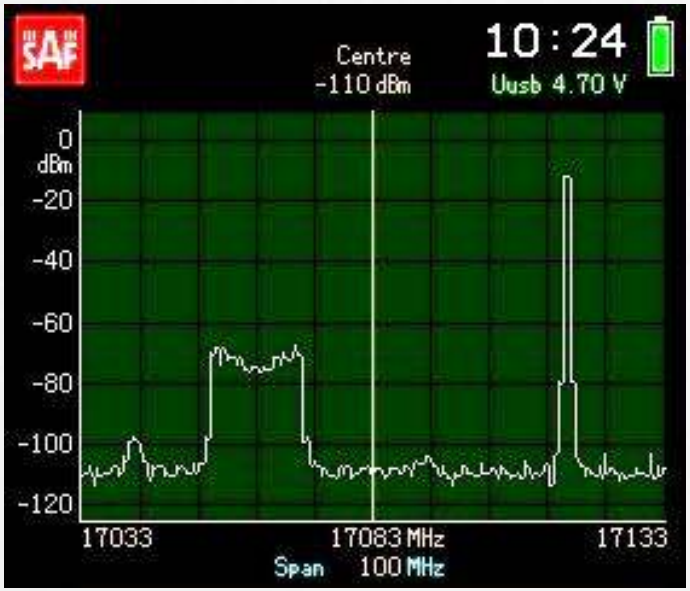
Case study (1)
Frequency readings from ground level

Phase: Troubleshooting	Location: From the ground level
Problem:	
The link did synchronize, but never worked in highest modulation. The Rx level was according to calculations.	
Description:	
Installation was done by third party installers and client did not have direct access to the site.	
Solution:	
Client did the frequency readings with the Spectrum Compact, using **Power In Band** function. The received signal did not perfectly match in the marked area, thus client found that installers misconfigured one of the radios by setting 5MHz off the center of the channel.	

Applications (2)

Seeking for free channels

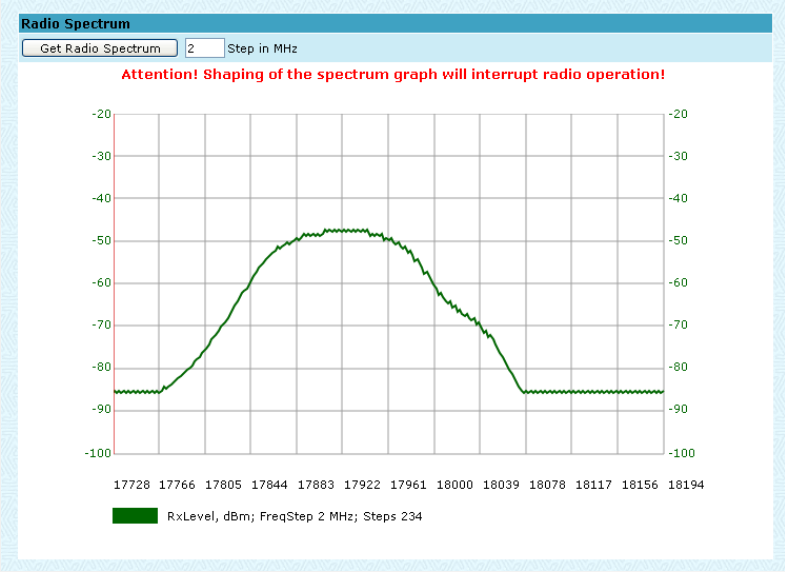
- Useful in license-free bands e.g. 17GHz and 24Ghz radios
- Useful functionality in countries with weak or no spectrum Regulatory supervision.

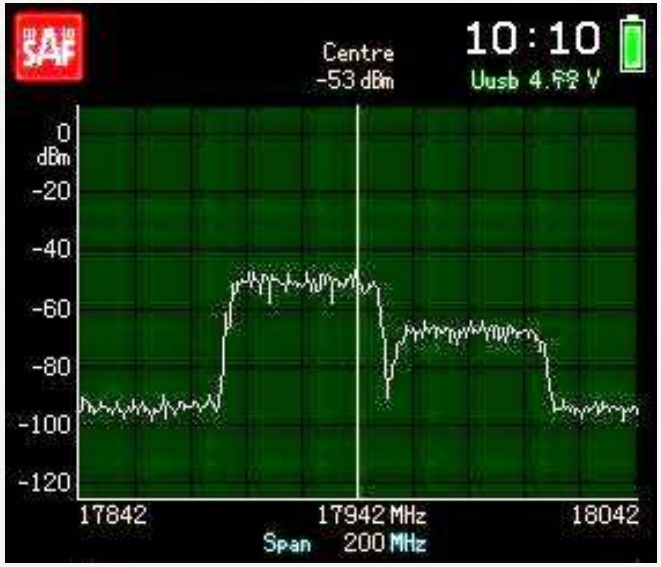


Applications (3)

Finding interference

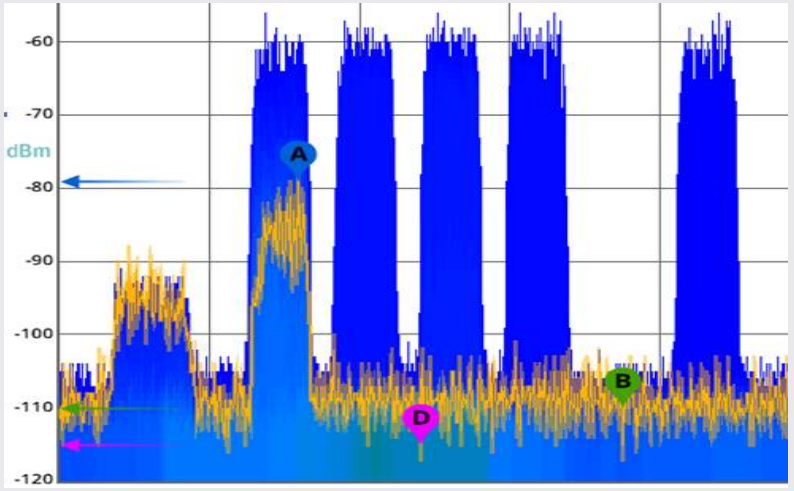
- Way better sensitivity and bandwidth resolution than built-in spectrum analyzers in a radio.
- Market leading seinsitivity -105 dB





The same spectrum shown in radio (left picture) and Spectrum Compact (right picture).

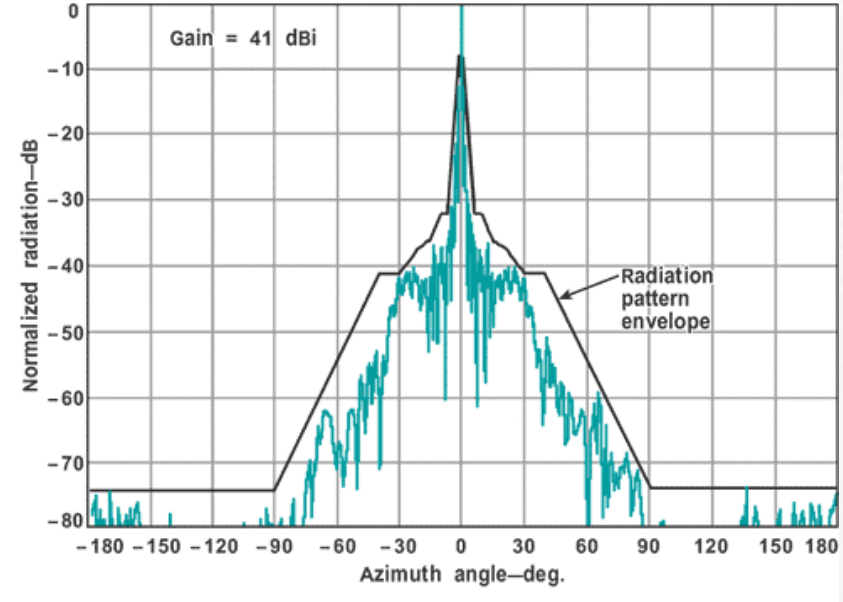
Case study (2)
Interference detection and free channel location

Phase: Troubleshooting	Location: On the tower
Problem:	
Licensed link with synchronization issues and reduced performance.	
Description:	
Client suspected interference. Client did all the troubleshooting steps he could, involving even Regulatory Authorities, but still could not find and resolve the problem.	
Solution:	
Client scanned the incoming spectrum by using Spectrum Compact and waveguide flange and found interference in opposite polarization at adjacent channel. Client scanned the spectrum for free channels and reconfigured radios accordingly.	

Applications (4)

Antenna adjustment

- Precise and fast antenna adjustment due to high resolution bandwidth and fast sweep speed.
- Can be attached to almost any antenna using standard flange waveguide adapters.
- Easily distinguish between main and side lobes using Max Hold function.
- Easier and faster installation without any additional device: e.g. radio, computer, cabling (data & power) and other



Typical radiation pattern of a microwave antenna

Case study (3)
Antenna alignment (1)

Phase: Installation	Location: On the tower
Problem:	
After 2.4m antenna installation, installers tried to align antenna for next 2 days. Having no success, the new route for MW link was considered.	
Description:	
Installers during the alignment process could not find any incoming signal with radio and RSSI readings.	
Solution:	
By attaching the Spectrum Compact to the antenna and sweeping it, client found incoming signal @ -100dBm level. After final alignment client reached the desired signal level.	

Case study (3)
Antenna alignment (2)

Phase: Troubleshooting	Location: From the ground and On the tower

Problem:

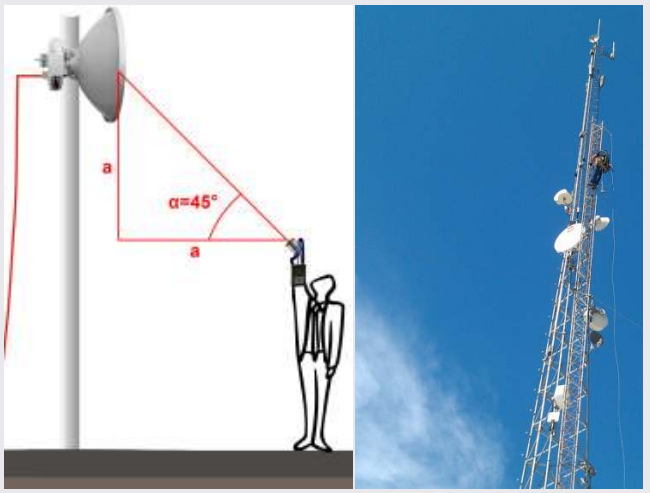
After installation link was 30dBm off the target.

Description:

Installer's crew spent 3 days on the antenna alignment without any success.

Solution:

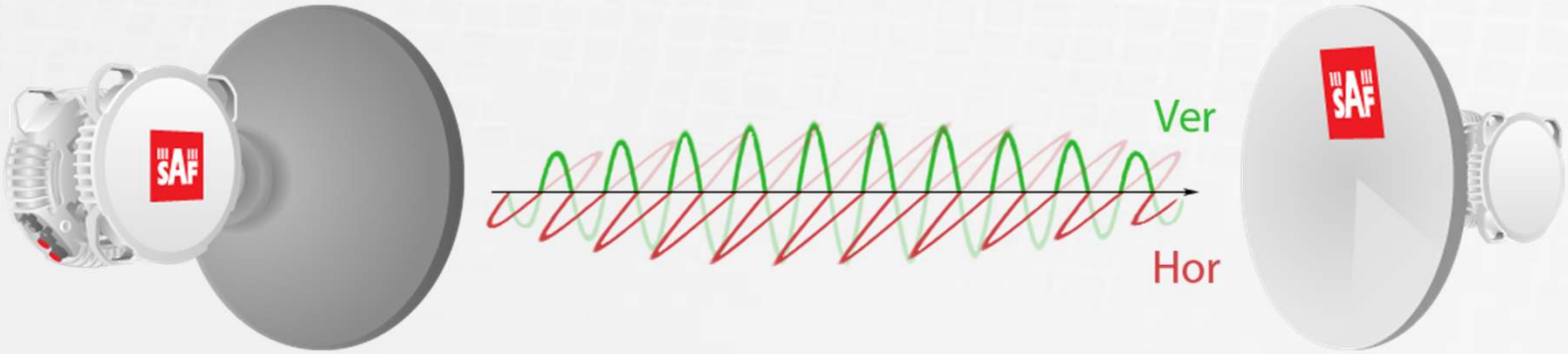
First, the near-end radio Tx signal quality was checked from the ground level. Then on the tower, by pointing waveguide flange to the other side of the link, Spectrum Compact received stronger Rx signal than in receiving radio. That was an indication that antenna is misaligned.
Using the Spectrum Compact, antenna alignment was done in less than 10 minutes.



Applications (5)

Cross-polarization adjustment (Dual polarized Antenna adjustment)

- Dual polarized antenna installation requires precise angling to achieve the best attenuation between vertical and horizontal signals. In this case Spectrum Compact is very usefull.
- For correct XPIC functionality it is very important to align polarization for antennas and ensure the highest cross-polarisation attenuation.



Radiation pattern for two polarizations

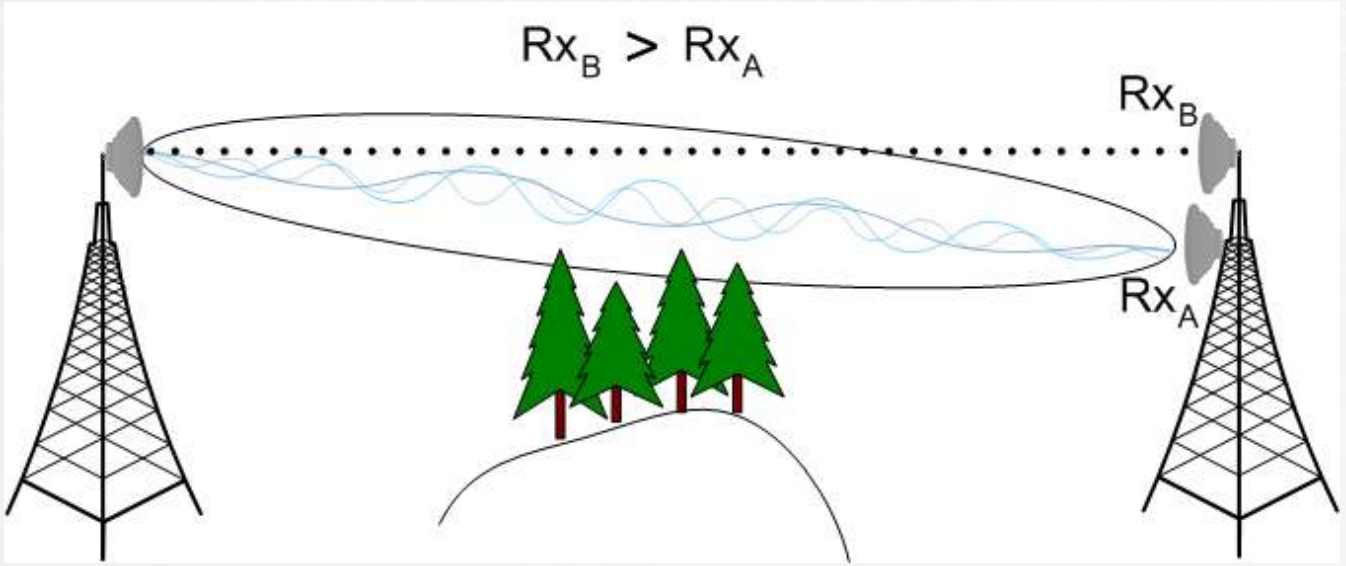
Case study (4)
Cross polarization discrimination

Phase: Installation	Location: On the tower
Problem:	
After the link installation, client needed to ensure that cross polarization discrimination was according to the specification.	
Description:	
Dual polarized systems should be checked and aligned accordingly to achieve best application (such as XPIC) performance.	
Solution:	
Client used the Spectrum Compact for antenna alignment and to ensure that signal polarizations have the best possible discrimination to each other. Client saved the files to prove that link has been installed correctly.	

Applications (6)

Received signal power comparative measurements

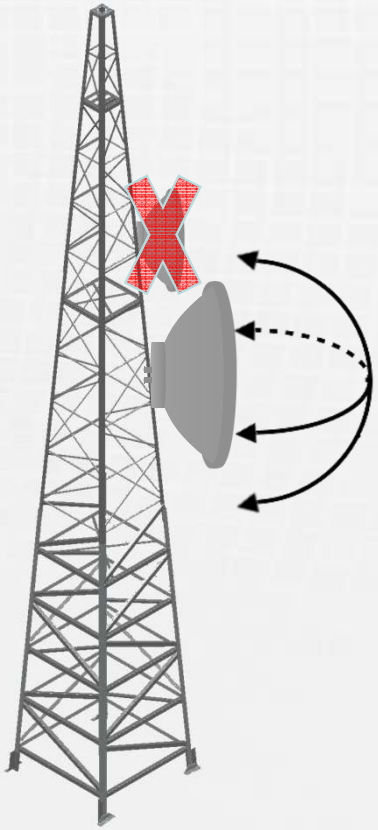
- Usable in Near LOS situations.
- Verify whether usable signal will be received at desired antenna location
- Helps to determine potential installation positions on the tower with the best received signal level



Applications (7)

Replacement of already installed antennas

- Helps to replace old antenna with new one at short notice with little link downtime

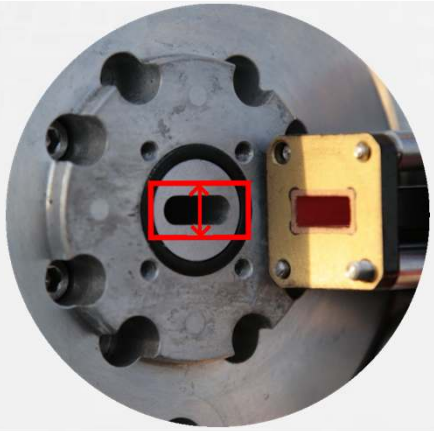
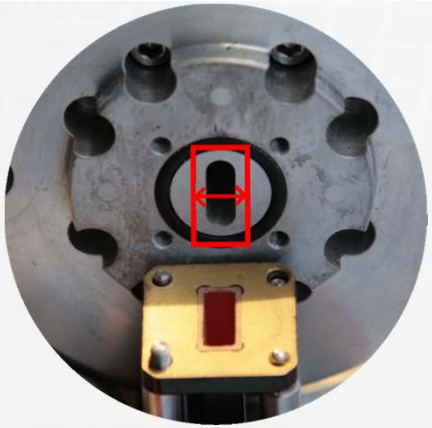


1. Install new antenna
2. Do the alignment with SC unit
3. Hot swap radio to new antenna

Applications (8)

Investigation of the radio operation and radio connection to antenna

- Verify polarization of the signal
- Verify transmitted frequency
- Verify antenna and radio proper inteconnection
- Find out absolute radiated power level from antenna by using values taken from Spectrum Compact and doing additional calculations

Vertical Polarization	Horizontal Polarization
	

Case study (6)
Antenna and radio interconnection issue

Phase: Site acceptance	Location: From the ground level

Problem:

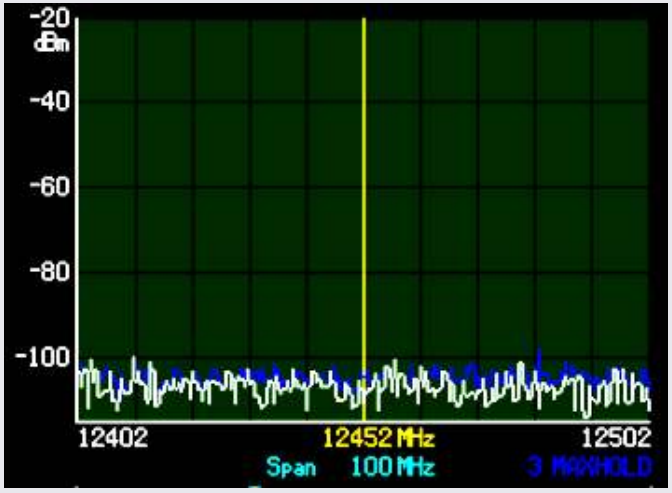
To do the site acceptance and ensure that radio and antenna interconnection polarizations match.

Description:

Client had to do the Site Acceptance for the new link. Antenna installation was done by third party. Radio was powered on.

Solution:

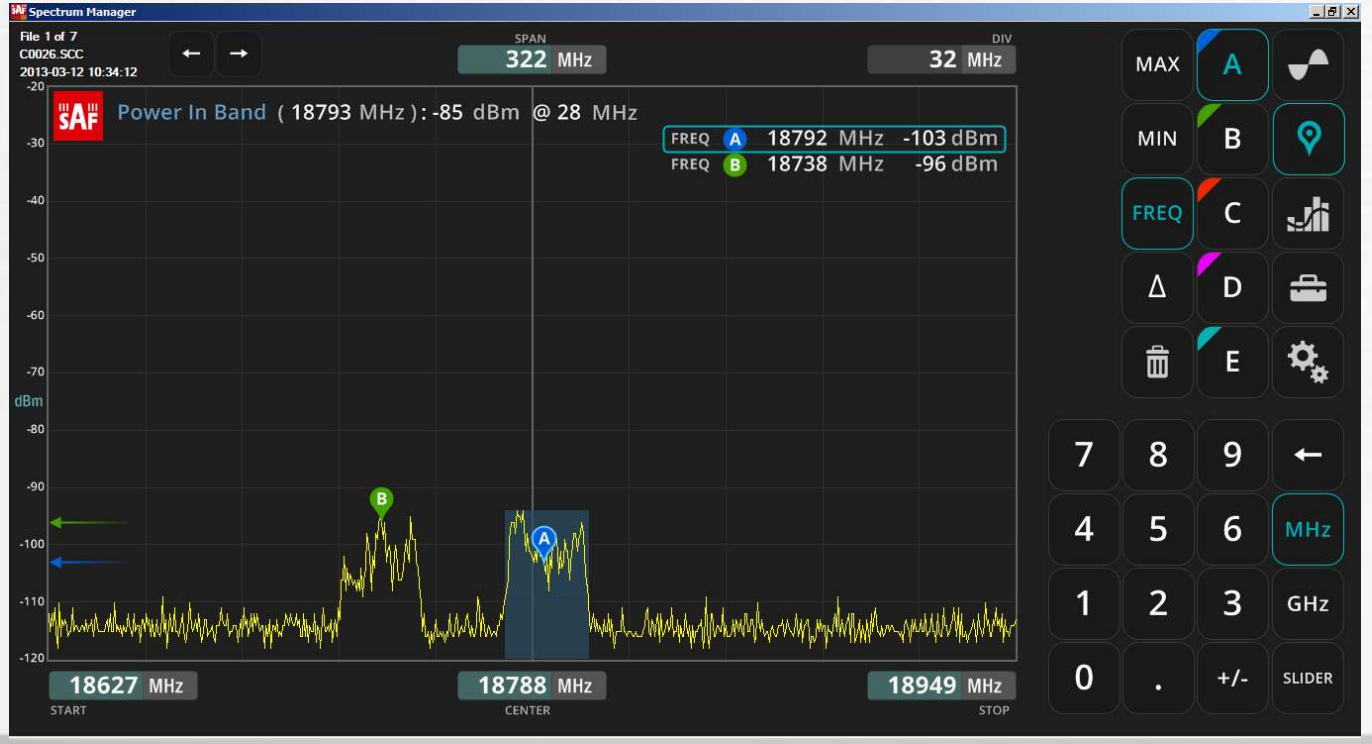
Client did the scanning with waveguide flange from the beneath of the tower. The **Max Hold** function of Spectrum Compact was switched on.
Client did not see any side lobe signal, that was an indication that antenna and radio interconnection didn't match.
Installation crew re-checked the interconnection again and fixed the issue.



Applications (9)

Saving spectrum curves

- Save Spectrum curve for – analysis, installation report, later comparison, troubleshooting.
- PC software – Spectrum Manager for advanced processing of spectrum curves.



Case study (7)
Saving spectrum scans

Phase: Maintenance	Location: On the tower
Problem:	
To do the spectrum scans for operational links, without interrupting them.	
Description:	
Client has contractual obligation to monitor and to do the spectrum rescans every second months, to ensure spectrum cleanness and interference absence.	
Solution:	
Client is using the Spectrum Compact with handheld antenna (and mounting brackets) for spectrum scans. Client compares initial scan with the later ones, to ensure that nothing has changed.	

Troubleshooting

- **Link might be affected or even down due to number of reasons**
- **To find the cause of the problem, it sometimes might be a question of hours, if not – days.**
- **Below are some of the actions typically performed by site engineers:**

- Near and far site transmitter verification
- Detection of improper radio and antenna interconnection
- Investigate reasons of low received signal level:
  Antenna misalignment (side lobes, etc.)
  Wrong polarization
  Damaged antenna
  Damaged transmitter
  Damaged receiver
- Multipath detection
- Interference detection

Check Spectrum Compact on the Web

- Product homepage:
  http://saftehnika.com/en/spectrumanalyzer
- Official video:
  http://www.youtube.com/watch?v=2GoNP974B4k
- In action:
  https://www.youtube.com/channel/UCZu_pMdB7wml7epWPrumPqQ

Accessories

Rugged RF cable, 30 cm

- SAM-SMA cable for frequencies from DC to 26,5 GHz or 2,92 mm cable for frequencies from DC to 50 GHz.
- Excellent shielding effectiveness

Waveguide adapters to SMA

- Specially modified waveguide adapters with thumb screws. No screwdriver is needed.
- Six adapters – each in different frequency range.

Accessories

USB charger

- Universal USB charger fitting different types of AC sockets.
- 1.0 A Output.
- Good quality USB cables.

Lanyard

- Security lanyard for attaching the unit to the hand or to the antenna

Accessories

Belt Bag

- Leather bag, for one Spectrum Compact unit, SMA cable and one waveguide adapter.
- Bag can be attached to the climbers belt.

Packaging

- Standard SAF cardboard packaging with an additional colorful layer on the outside.

Additional accessories

Attenuators

- Coaxial attenuators for readings directly from the radio.

Small antenna

- Small size portable antenna.
- Four frequency ranges:
  06 – 10 GHz
  11 – 15 GHz
  17 – 24 GHz
  26 – 40 GHz

Additional accessories

Protective case

- Watertight and shockproof case with a soft padding inside.

Additional accessories

Antenna on tripod
with riflescope

Additional accessories

Protective antenna case

- Watertight and shockproof case with set of antennas; simple mount; riflescope and tripod.

Thank you!

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