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.
SAF worldwide presence

- Local offices

- EUROPE HQ
- DENVER, USA
- BOGOTA, COLOMBIA
- BRASIL
- LAGOS, NIGERIA
- RIYADH, SAUDI ARABIA
- GURGAON, INDIA
- KUALA LUMPUR, MALAYSIA
- JAKARTA, INDONESIA
- BRISBANE AUSTRALIA
Regional sales FY 12/13

- AMERICAS: 42%
- EUROPE, CIS: 34%
- ASIA, AFRICA, MIDDLE EAST: 24%
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

Integra: 474 Mbps (Up to 1 Gbps with Header compression)
CFIP Lumina: 366 Mbps
CFIP PhoeniX: 363 Mbps
CFIP PhoeniX C: 354 Mbps
CFIP PhoeniX M: 360 Mbps
CFIP 106/108: 100 Mbps
CFIP Marathon: 43 Mbps
FreeMile 5 GE: 105 Mbps → 210 Mbps
FreeMile 17/24: 100 Mbps

Frequency availability:

<table>
<thead>
<tr>
<th></th>
<th>15</th>
<th>17</th>
<th>18</th>
<th>23</th>
<th>24</th>
<th>26</th>
<th>30</th>
<th>38</th>
<th>42</th>
</tr>
</thead>
<tbody>
<tr>
<td>Integra</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CFIP Lumina</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>10</td>
<td>11</td>
<td>12</td>
<td>15</td>
<td>17</td>
<td>18</td>
</tr>
<tr>
<td>CFIP PhoeniX</td>
<td>4</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>10</td>
<td>11</td>
<td>13</td>
<td>15</td>
<td>18</td>
</tr>
<tr>
<td>CFIP PhoeniX C</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>10</td>
<td>11</td>
<td>13</td>
<td>15</td>
<td>18</td>
<td>23</td>
</tr>
<tr>
<td>CFIP PhoeniX M</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>10</td>
<td>11</td>
<td>13</td>
<td>15</td>
<td>18</td>
<td>23</td>
</tr>
<tr>
<td>CFIP 106/108</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>10</td>
<td>11</td>
<td>13</td>
<td>15</td>
<td>18</td>
<td>24</td>
</tr>
<tr>
<td>CFIP Marathon</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>10</td>
<td>11</td>
<td>13</td>
<td>15</td>
<td>18</td>
<td>23</td>
</tr>
<tr>
<td>FreeMile 5</td>
<td>6.3</td>
<td>0.4</td>
<td>1.4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FreeMile 17/24</td>
<td>5</td>
<td></td>
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<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

All mentioned capacities are in 1x0 configuration full-duplex.
The capacity is multiplied by number of radios (in 2x0 / 3x0 / 4x0 configurations).
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

• 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.

Pay for what you use!

Units can be shared by several teams.
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 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
<table>
<thead>
<tr>
<th><strong>Spectrum Compact</strong></th>
<th><strong>Multi-meter</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Visual representation of the signal</td>
<td>Lack of signal visual representation</td>
</tr>
<tr>
<td>Results displayed with actual Rx Level in dBm</td>
<td>Voltage to Rx level Conversion table required. Rx Level is represented as Voltage reading</td>
</tr>
<tr>
<td>Considerable antenna system alignment time reduction</td>
<td>Significantly longer antenna system alignment</td>
</tr>
<tr>
<td>Higher sensitivity compared to radios</td>
<td>Minimum received signal is limited by radio sensitivity</td>
</tr>
<tr>
<td>Unwanted emission does not affect measurements</td>
<td>Unwanted emission may affect readings</td>
</tr>
</tbody>
</table>
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

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Model</th>
<th>Frequency Range</th>
<th>Weight (kg)</th>
<th>Dimensions (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SAF Tehnika</td>
<td>Spectrum Compact</td>
<td>5.9GHz – 40.0 GHz</td>
<td>0.3 x 4</td>
<td>128 x 81 x 24</td>
</tr>
<tr>
<td>Anritsu</td>
<td>Site Master S820D</td>
<td>2 MHz - 20 GHz</td>
<td>2.3</td>
<td>254 x 178 x 61</td>
</tr>
<tr>
<td>Anritsu</td>
<td>Spectrum Master</td>
<td>9 kHz – 43 GHz</td>
<td>3.8</td>
<td>315 x 211 x 77</td>
</tr>
<tr>
<td>Rhode &amp; Schwarz</td>
<td>HSF 20</td>
<td>9 kHz - 20 GHz</td>
<td>3.0</td>
<td>194 x 300 x 69</td>
</tr>
<tr>
<td>Tektronix</td>
<td>SA2500</td>
<td>10 kHz - 6.2 GHz</td>
<td>5.5</td>
<td>230 x 330 x 120</td>
</tr>
<tr>
<td>Agilent</td>
<td>Field Fox</td>
<td>5 kHz - 26.5 GHz</td>
<td>3.0</td>
<td>292 x 188 x 72</td>
</tr>
<tr>
<td>BK Precision</td>
<td>2658A</td>
<td>50 kHz - 8.5 GHz</td>
<td>1.8</td>
<td>162 x 70 x 260</td>
</tr>
<tr>
<td>Pendulum</td>
<td>Path Align-R</td>
<td>1.8 GHz – 23.5GHz</td>
<td>3.2</td>
<td>89 x 213 x 333</td>
</tr>
<tr>
<td>Aaronia (Spectran)</td>
<td>HF-60100</td>
<td>1 MHz – 9.4 GHz</td>
<td>0.430</td>
<td>250 x 86 x 27</td>
</tr>
</tbody>
</table>
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**

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

* 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

<table>
<thead>
<tr>
<th>Distance</th>
<th>10km</th>
<th>20km</th>
<th>25km</th>
<th>30km</th>
<th>40km</th>
<th>45km</th>
<th>50km</th>
<th>65km</th>
</tr>
</thead>
<tbody>
<tr>
<td>Height of the beam</td>
<td>261m</td>
<td>523m</td>
<td>654m</td>
<td>785m</td>
<td>1047m</td>
<td>1178m</td>
<td>1309m</td>
<td>1650m</td>
</tr>
</tbody>
</table>

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.

\[ \frac{261}{2} = 130.5 \text{ (m)} \]
Signal propagation (3):
0.3 m antenna beam height VS distance @ 23Ghz

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.

\[ \frac{258}{2} = 129 \text{ (m)} \]
Applications (1)

Verifying radio configuration and performing diagnostics of the radio:

- Checking the frequency
- Checking bandwidth
- Checking Tx Power

<table>
<thead>
<tr>
<th>Tx frequency</th>
<th>19219000 kHz</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rx frequency</td>
<td>18209000 kHz</td>
</tr>
<tr>
<td><strong>Modem configuration</strong></td>
<td></td>
</tr>
<tr>
<td>Configuration file</td>
<td>embedded-&gt;28_X_FP_EGEv4b.bin</td>
</tr>
<tr>
<td>Bandwidth</td>
<td>28000 kHz ETSI</td>
</tr>
<tr>
<td>Modulation</td>
<td>256QAM WeakFEC with ACM</td>
</tr>
<tr>
<td>Total capacity / rate</td>
<td>174.700 Mbps with max ACM / Unlimited</td>
</tr>
<tr>
<td>Ethernet capacity / rate</td>
<td>174.700 Mbps with max ACM / Unlimited</td>
</tr>
</tbody>
</table>
**Case study (1)**  
**Frequency readings from ground level**

<table>
<thead>
<tr>
<th><strong>Phase:</strong> Troubleshooting</th>
<th><strong>Location:</strong> From the ground level</th>
</tr>
</thead>
</table>

**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 sensitivity -105 dB

The same spectrum shown in radio (left picture) and Spectrum Compact (right picture).
Interference detection and free channel location

<table>
<thead>
<tr>
<th>Phase: Troubleshooting</th>
<th>Location: On the tower</th>
</tr>
</thead>
</table>

**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)**

<table>
<thead>
<tr>
<th>Phase: Installation</th>
<th>Location: On the tower</th>
</tr>
</thead>
</table>

**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)

<table>
<thead>
<tr>
<th>Phase: Troubleshooting</th>
<th>Location: From the ground and On the tower</th>
</tr>
</thead>
</table>

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 useful.
- 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**

<table>
<thead>
<tr>
<th>Phase: Installation</th>
<th>Location: On the tower</th>
</tr>
</thead>
</table>

**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

<table>
<thead>
<tr>
<th>Vertical Polarization</th>
<th>Horizontal Polarization</th>
</tr>
</thead>
</table>

[Images of vertical and horizontal polarization]
### Case study (6)
**Antenna and radio interconnection issue**

<table>
<thead>
<tr>
<th>Phase: Site acceptance</th>
<th>Location: From the ground level</th>
</tr>
</thead>
</table>

#### 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

<table>
<thead>
<tr>
<th>Phase: Maintenance</th>
<th>Location: On the tower</th>
</tr>
</thead>
</table>

**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

- 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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