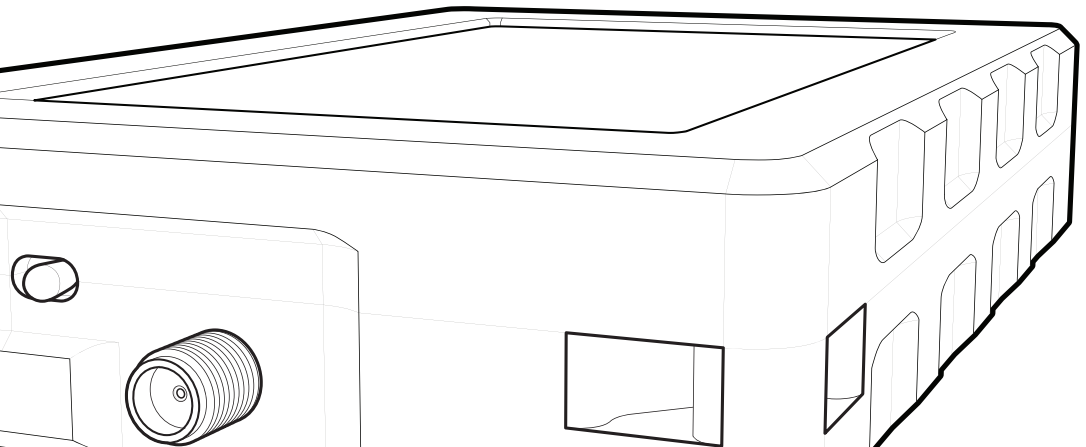




Spectrum Compact 2-40 GHz

STEP-BY-STEP GUIDE



What is Spectrum Compact?

The Spectrum Compact is an ultra-light and easy to use measurement solution. It operates in the 2 – 40 GHz frequency range. Designed specifically for comfortable outdoor use, this battery-powered device is a must-have tool for any microwave radio engineer performing link installations or gathering data for site planning purposes. The built-in LCD touchscreen ensures smooth and intuitive use of the spectrum analyzer, which can be connected directly to any standard flange antenna via an SMA connector. The industry leading sensitivity of Spectrum Compact makes it possible to detect existing interference paths and available radio channels with extra high precision, which also helps avoiding alignment of the antenna on a side lobe. Data logging is used for enhanced data processing and analysis via SAF designed PC software.

Spectrum Compact kit includes:

- Spectrum Compact 2–8 GHz
- Spectrum Compact 5.925–12 GHz
- Spectrum Compact 10–18 GHz
- Spectrum Compact 17–24.3 GHz
- Spectrum Compact 24–40 GHz
- Rugged RF cable,
- 2.92mm–2.92mm, 0.3 m
- AC/DC USB charger with USB cable
- Leather bag for Spectrum Compact
- Watertight, shock and dust proof case for Spectrum Compact
- Waveguide adapters UBR to SMA
 - UBR84 to SMA, 6.6–10 GHz, WR112
 - UBR100 to SMA, 8.2–12 GHz, WR90
 - UBR140 to SMA, 12–17 GHz, WR62
 - UBR220 to SMA, 17–24.3 GHz, WR42
 - UBR260 to 2.92, 22–33 GHz, WR34
 - UBR320 to 2.92, 26–40 GHz, WR28
- Lanyard

Additional accessories:

- Rifle scope, tripod and case for sniffer antennas
- Attenuator kit, 20–60dB
- Handheld horn antennas:
 - 6.0-10.0 GHz
Gain: 14.5-18.0dBi
SMA connector
 - 10.7-15.35 GHz
Gain: 19.5-20.5dBi
UBR120 flange
 - 17.0-24.5 GHz
Gain: 21.0-21.5dBi
UBR220 flange
 - 26.5-40.5 GHz
Gain: 20.5-21.5dBi
SMA connector

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SHORT GUIDE
TO USING
SPECTRUM
COMPACT

To turn on the Spectrum Compact, slide the power switch at the top of the device towards the red dot (•). Operation time with a fully charged battery is up to 3 hours for the 24-40 GHz model, and up to 4 hours for all other models.

The screen is divided into two sections – the graph and the control buttons. The graph is mapped on a grid with 10 horizontal divisions and 4 ½ vertical divisions. The horizontal axis represents a linear frequency scale that increases from left to right. The vertical axis represents a logarithmic power scale that increases from bottom to top. The spectrum curve is displayed in this graph. The touchscreen has the following configuration buttons:

SWEEP CONT – start or stop the sweeping of spectrum (the button is green when spectrum is being swept continuously and grey if the sweeping is stopped)

SAVE – save the current spectrum curve for later review

FREQUENCY – select the centre, start, and stop frequencies

SPAN – change the displayed frequency range (difference between the start and stop frequencies)

MARKER – set a marker at a selected frequency

HIGH CONTRAST – change the colour scheme of the interface to improve visibility in direct sunlight

TRACE MODE – change the trace mode

NORMAL – default trace mode showing currently detected power levels

MAXHOLD – displays a blue trace in addition to the NORMAL trace showing the highest detected power levels

CUMULATIVE – displays all the detected frequency points since the sweeping started

AVERAGE 2/4/8/16 – smoothens noise effects

FILL – paints the area below the spectrum curve

TOOLS – gives access to the following options:

SETTINGS – Spectrum Compact settings

MASK MODE – set a previously saved spectrum curve as a mask overlay on the graph

PROFILES – save the current or restore a previously saved configuration of the Spectrum Compact

LEVEL – select the minimum and maximum displayed power levels or select an offset (useful when an attenuator is used)

PRESET – reset the device to factory settings (use this if you don't know how to turn off / change a setting)

FILES – save the current spectrum curve and access previously saved spectrum curves

RECORD - this function continuously records every scan performed for later analysis

ABOUT – access information about Spectrum Compact (supported frequency range, serial number, firmware version etc.)

POWER IN BAND – set up an input power measurement for a selected bandwidth

SIGNAL ID – turn on or off the filter that reduces harmonic (false) signals

AUTO ROTATE – enable or disable the rotation of the screen when Spectrum Compact is turned

DEMO – turn on a simulated signal pattern

TIME – set device time

COLOR – select different colours for the graph (the background, grid, and spectrum curve)

BRIGHT – set the background brightness of the screen

For more in-depth information see the Spectrum Compact user manual.

Spectrum Manager

Spectrum Manager is a spectrum analysis PC software for SAF Tehnika's Spectrum Compact. In addition to managing firmware updates, Spectrum Manager can be used in both real-time (together with a Spectrum Compact device) and offline modes, and provides you with a variety of functions, such as: PiB (Power in Band), overlay and min/max hold.

To download Spectrum Manager follow these steps:

1. Log in in saftehnika.com
2. In Products menu select "Spectrum Compact" or "V-band and E-band Spectrum Compact"
3. In Downloads section choose "Spectrum Manager PC software"
4. Download .zip file
5. Open .zip file and start setup wizard from Spectrum_Manager.msi

EQUIPMENT
& GENERAL
INSTRUCTIONS



Spectrum Compact

Signal Generator





Coaxial cable

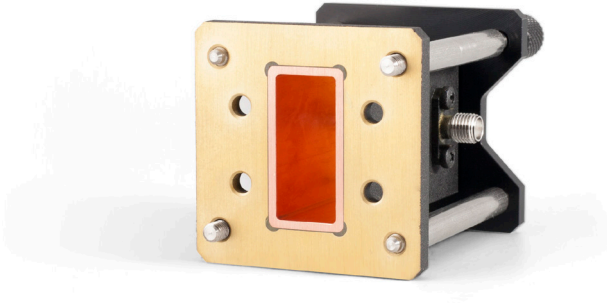


Waveguide adapter

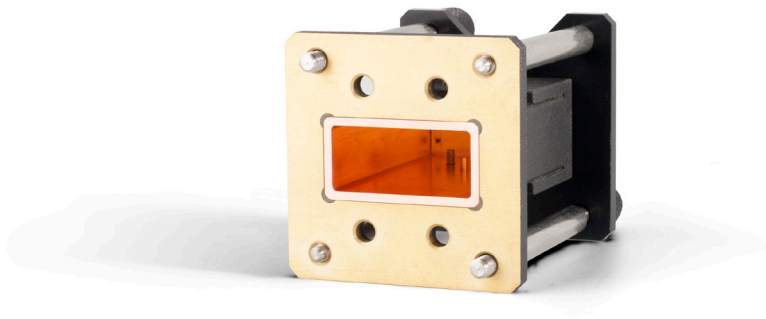


Attenuators





In this position, the waveguide adapter
detects horizontal polarization



In this position, the waveguide adapter
detects vertical polarization

SPECTRUM
COMPACT
APPLICATIONS:
SITE SURVEY

Line of Sight (LoS) verification with SG Compact

Equipment: SC, SG, 2x antennas, 2x 2.92mm cables, 2x compasses, 2x spirit level tools, 2x waveguide adapters (optional)

1. Using a professional radio link design and planning tool, determine the azimuth for both sites and the target received signal level.

At the first site:

2. A reasonable distance away from the tower, use a compass to find the right azimuth angle and look for something in the environment in the direction of the second site to be used as a reference point for when you are up in the tower.
3. Climb the tower.
4. Install the antenna at the chosen height and polarization.
5. Set the horizontal direction of the antenna according to your previously chosen reference point.
6. Adjust the vertical angle of antenna to be 90° relative to the ground, preferably using a spirit level tool.
7. Connect Signal Generator to the antenna.
8. Turn on the Signal Generator.
9. Set the chosen frequency and power.

At the second site:

Do the steps 2. - 6. at the second site.

Make sure that both antennas are installed in the same polarization!

10. Connect Spectrum Compact to the antenna. Use appropriate attenuation! (see: General instructions)

11. Turn on the Spectrum Compact.
12. Tap SPAN, then FULL SPAN. Tap HOME.
13. Check for OVERLOAD:
 - a) If there is an indication above the graph, remove Spectrum Compact from the antenna and add attenuators.
 - b) If there is no indication above the graph, proceed with the next steps.
14. Tap LEVEL, then OFFSET and using the keypad enter the attenuation value used. Tap ENTER, then HOME.
15. Tap FREQUENCY, then CENTRE and using the keypad enter the frequency that was set on the Signal Generator (in MHz). Tap ENTER, then HOME.
16. Tap SPAN, then MIN SPAN to set the span to minimum. Tap HOME. Note: for wider bands (80 MHz and up), tap SPAN and, using the keypad, select a wider span.
17. Tap TRACE MODE, then select either AVERAGE 2 or AVERAGE 4. Tap HOME.

If the calculated target received signal strength is below -80 dBm, zoom in on the power axis for better visualization: tap TOOLS, tap LEVEL, then MAX and using the keypad select the appropriate value, e.g. -70. Tap ENTER, then HOME

18. Tap SWEEP CONT (only if the button is grey).
19. If the initial rough antenna alignment was done correctly and the LoS between the two sites is clear, signal trace should appear at the centre of the graph.
20. Proceed with fine-tuning the antenna alignment.

Spectrum investigation for possible free channels

Equipment: SC, handheld horn antenna, 2.92mm cable, compass, spirit level tool, waveguide adapter

1. A reasonable distance away from the tower, use a compass to find the right azimuth angle and look for something in the environment in the direction of the second site to be used as a reference point for when you are up in the tower.
2. Climb the tower.
3. Connect Spectrum Compact to the handheld antenna or waveguide adapter.
4. Turn on the Spectrum Compact.
5. Point the antenna/waveguide adapter in the chosen direction.
6. Tap SPAN, then FULL SPAN. Tap HOME.
7. Tap SWEEP CONT (only if the button is grey).
8. Check for OVERLOAD:
 - a) If there is an indication above the graph, remove SC from the antenna and add attenuators.
 - b) If there is no indication above the graph, proceed with the next steps
9. Tap FREQUENCY, then START and, using the keypad, enter the frequency which is the lower limit of the frequency range of interest (in MHz). Tap ENTER. Tap STOP and, using the keypad, enter the frequency which is the upper limit of the frequency range of interest. Tap ENTER, then HOME.
10. Tap SWEEP CONT (only if the button is grey).
11. Tap SAVE.

12. Check both polarizations.
13. Tap SAVE to save current spectrum scan.
14. For work with saved files tap TOOLS, then FILES. Tap VIEW. Use ▲ and ▼ to navigate the file list.
15. Select the file with the spectrum curve in the preferred polarisation and tap VIEW+.
16. Tap POWER IN BAND, then BW and, using the keypad, enter the desired channel bandwidth. Tap ENTER.

The grey band can be placed anywhere within the displayed spectrum by tapping on the screen or by tapping the band and dragging it. Find a free channel in the chosen polarisation by using the grey POWER IN BAND area as a ruler.

17. Tap BACK twice, then select the file with the spectrum curve taken in the opposite polarisation. Check for interference.

Confirmation of dedicated radio channel availability and status

Equipment: SC, handheld horn antenna, 2.92mm cable, compass, waveguide adapter (optional)

1. A reasonable distance away from the tower, use a compass to find the right azimuth angle and look for something in the environment in the direction of the second site to be used as a reference point for when you are up in the tower.
2. Climb the tower.
3. Point the handheld antenna towards the previously chosen reference point.
4. Adjust the vertical angle of antenna to be 90° relative to the ground, preferably using a spirit level tool.

5. Connect Spectrum Compact to the antenna. Use appropriate attenuation! (see: General instructions)
6. Turn on the Spectrum Compact.
7. Tap SPAN, then FULL SPAN. Tap HOME.
8. Tap SWEEP CONT (if the button is grey).
9. Check for OVERLOAD:
 - a) If there is an indication above the graph, remove SC from the antenna and add attenuators.
 - b) If there is no indication above the graph, proceed with the next steps
10. Tap TRACE MODE, then MAXHOLD. Tap HOME.
11. Tap FREQUENCY, then CENTRE and, using the keypad, enter the desired radio frequency (in MHz). Tap ENTER, then HOME.
12. Tap SPAN, using the keypad enter the span = 200 MHz. Tap ENTER, then HOME.
13. Tap POWER IN BAND, then BW and, using the keypad, select the channel bandwidth that was assigned to you. Tap ENTER. Tap SET TO CENTRE. Tap HOME.
14. Tap SWEEP CONT (if the button is grey).
15. Tap SAVE for future reference.
16. Check both polarizations!
17. After checking in the direction of MW link path, it is advisable to check for possible interference sources from behind the antenna. Thus, rotate the antenna by 180° (in the exact opposite direction of the remote site).
18. Tap SAVE to save the spectrum curve for future reference.

19. Check the other polarization.
20. Tap SAVE to save the spectrum curve for future reference.
21. Tap TOOLS, then FILES. Tap VIEW. Use ▲ and ▼ to navigate the file list.
22. Examine the spectrum curves on Spectrum Compact:

All saved spectrum files must be free of any signals within the dedicated frequency channel.

Furthermore, both adjacent (in the same bandwidth in both directions) channels should also be clear. If there are any signals located in adjacent channels, you have to ensure that this will not cause an interference problem.

SPECTRUM
COMPACT
APPLICATIONS:
**RADIO LINK
& PASSIVE
REPEATER
INSTALLATION**

Transmitter verification

1. Connect Spectrum Compact to the radio. Use appropriate attenuation! (see: General instructions)
2. Turn on Spectrum Compact.
3. Tap SPAN, then FULL SPAN. Tap HOME.
4. Check for OVERLOAD:
 - a) if there is an indication above the graph, remove Spectrum Compact from the antenna and add attenuators.
 - b) if there is no indication above the graph, proceed with the next steps.
5. Tap LEVEL, then OFFSET and using the keypad select the attenuation value used. Tap ENTER, then HOME.
6. Tap FREQUENCY, then CENTRE and using the keypad select the frequency equal to the centre frequency set on the radio (in MHz). Tap ENTER, then HOME.
7. Tap SPAN, then MIN SPAN. Tap HOME.

Note: *for wider radio channel bandwidths (80 MHz and up), tap SPAN and using the keypad select a wider span e.g. 120. Tap ENTER. Tap HOME.*

8. If the radio is transmitting in the selected frequency, you should be able to see the signal trace now.
9. Tap TRACE MODE, then AVERAGE 8. Tap HOME.
10. Tap POWER IN BAND, then BW and using the keypad select the bandwidth equal to the channel width set on the radio. Tap ENTER. Tap SET TO CENTRE. Tap HOME.
11. Compare the value shown in the upper left corner of the screen with the

TX power set on the radio. They should match within +/- 1 dB. Also check the shape of the spectrum – the curve should be even with no gaps or spikes.

12. Tap SAVE for future reference.

Antenna alignment

Equipment: SC, transmitter (SG or a radio), 2x antennas, 2x SMA cables, 2x compasses, 2x Spirit level tools, 2x Waveguide adapters (optional)

1. Using a professional radio link design and planning tool determine azimuth for both sites and the target received signal level.

At the first site:

2. Reasonable distance away from the tower, use a compass to find the right azimuth angle and look for something in the environment in that direction to be used as a reference point for when you're up in the tower.
3. Climb the tower.
4. Install the antenna at a chosen height and polarization.
5. Set the horizontal direction of the antenna according to your previously chosen reference point.
6. Adjust the vertical angle of antenna to be 90° relative to the ground, preferably using a spirit level tool.
7. Connect the transmitter to the antenna.
8. Turn on the transmitter (if using Signal Generator - set the chosen frequency and power on Signal Generator).

At the second site:

Do the steps 2. - 6. at the second site.

Make sure that both antennas are installed in the same polarization!

9. Connect Spectrum Compact to the antenna. Use appropriate attenuation!
(see: General instructions)
10. Turn on Spectrum Compact.
11. Tap SPAN, then FULL SPAN. Tap HOME.
12. Check for OVERLOAD:
 - a) If there is an indication above the graph, remove Spectrum Compact from the antenna and add attenuators.
 - b) If there is no indication above the graph, proceed with the next steps.
13. Tap LEVEL, then OFFSET and using the keypad select the attenuation value used. Tap ENTER, then HOME.
14. Tap FREQUENCY, then CENTRE and using the keypad select the frequency equal to the centre frequency set on the transmitter (in MHz). Tap ENTER, then HOME.
15. Tap SPAN, then MIN SPAN. Tap HOME.

Note: *for wider radio channel bandwidths (80 MHz and up), tap SPAN and using the keypad select a wider span e.g. 120. Tap ENTER. Tap HOME.*

16. Tap TRACE MODE, then either AVERAGE 2 or AVERAGE 4. Tap HOME.

If the calculated target received signal strength is below -80 dBm, zoom in on the power axis for better visualization: tap TOOLS, tap LEVEL, then MAX and using the keypad select e.g. -70. Tap ENTER, then HOME.

17. Tap SWEEP CONT (if the button is grey).
18. If the initial rough antenna alignment was done correctly and the LoS between the two sites is clear, signal trace should appear at the centre of

the graph now.

19. Proceed with fine-tuning the antenna alignment (see next page).

Antenna alignment fine-tuning

1. On Spectrum Compact tap TRACE MODE, then MAXHOLD. Tap HOME.

! Only adjust one side of the link at a time.

2. Start with the horizontal adjustments.
3. Begin on Spectrum Compact site.
4. Loosen up the antenna to do the adjustments.
5. By slowly turning the antenna, sweep all the way through.

In addition to a prominent main lobe, antenna radiation patterns also have smaller side lobes. The most common mistake during alignment is aligning to a side lobe. Thus, it is important to sweep all the way through before fixing the antenna position.

6. Now sweep the range once more, while simultaneously comparing the two traces shown on the screen of Spectrum Compact.
7. Fix the position on the Spectrum Compact site when the NORMAL trace more or less matches the blue MAXHOLD trace i.e. when the currently received signal level is the highest possible.
8. Contact the transmitter site.

Do the steps 4. - 7. on the transmitter site.

When the horizontal fine alignment is completed, align the antennas vertically in the same manner.

9. Tap TRACE MODE, then either AVERAGE 2 or AVERAGE 4. Tap HOME.

10. Tap POWER IN BAND, then BW and using the keypad select the bandwidth equal to:
 - a) 4 MHz, if using a signal generator as the transmitter;
 - b) The width of the channel set on the radio, if using a radio as the transmitter. Tap ENTER. Tap SET TO CENTRE. Tap HOME.
11. Compare the value shown in the upper left corner of the screen with calculations. If the measured value is +/- 1dB from the calculated value, there are no significant signal losses across the path and you have aligned the antenna precisely.
12. Tap HOME and SPAN
13. In SPAN menu tap SPAN window and using keypad select 3 times wider SPAN than your dedicated channel. It will show you the situation in adjacent channels.
14. Tap SAVE for future reference.

Antenna polarization adjustment

1. Connect Spectrum Compact to the antenna. Use appropriate attenuation! (see: General instructions)
2. Turn on Spectrum Compact.
3. Tap SPAN, then FULL SPAN. Tap HOME.
4. Check for OVERLOAD:
 - a) If there is an indication above the graph, remove Spectrum Compact from the antenna and add attenuators.
 - b) If there is no indication above the graph, proceed with the next steps.
5. Tap LEVEL, then OFFSET and using the keypad select the attenuation

value used. Tap ENTER, then HOME.

6. Tap FREQUENCY, then CENTRE and using the keypad select the frequency equal to the centre frequency set on the transmitter (in MHz). Tap ENTER, then HOME.
7. Tap SPAN, then MIN SPAN. Tap HOME.

Note: *for wider radio channel bandwidths (80 MHz and up), tap SPAN and using the keypad select a wider span e.g. 120. Tap ENTER. Tap HOME.*

8. On Spectrum Compact tap TRACE MODE, then MAXHOLD. Tap HOME.

If the calculated target received signal strength is below -80 dBm, zoom in on the power axis for better visualization: tap TOOLS, tap LEVEL, then MAX and using the keypad select e.g. -70. Tap ENTER, then HOME.

9. Tap SWEEP CONT (if the button is grey).
10. Before making any adjustments, mark the current position of the feeder.
11. Loosen the screws enough to allow movement of the feeder.
12. Adjust the feeder clockwise or anti-clockwise, while simultaneously comparing the two traces shown on the screen of Spectrum Compact.
13. Carefully tighten and fix the feeder or OMT in position when the NORMAL trace matches the blue MAXHOLD trace i.e. when the currently received signal level is the highest possible.

Note: *This adjustment is necessary to make only at the one end of the link.*

Replacement of an already installed antenna decreasing the network downtime

1. Install the replacement antenna at the desired new position and direct it towards the remote site.
2. Check whether the antenna is in the correct polarization.
3. Connect Spectrum Compact to the antenna. Use appropriate attenuation! (see: General instructions)
4. Turn on Spectrum Compact.
5. Tap SPAN, then FULL SPAN
6. Check for OVERLOAD:
 - a) If there is an indication above the graph, remove Spectrum Compact from the antenna and add attenuators.
 - b) If there is no indication above the graph, proceed with the next steps.
7. Tap LEVEL, then OFFSET and using the keypad select the attenuation value used. Tap ENTER, then HOME.
8. Tap FREQUENCY, then CENTRE and using the keypad select the frequency equal to the centre frequency set on the transmitter (in MHz). Tap ENTER, then HOME.
9. Tap SPAN, then MIN SPAN. Tap HOME.

Note: for wider radio channel bandwidths (80 MHz and up), tap SPAN and using the keypad select a wider span e.g. 120. Tap ENTER. Tap HOME.

10. On Spectrum Compact tap TRACE MODE, then MAXHOLD. Tap HOME.

If the calculated target received signal strength is below -80 dBm, zoom in on the power axis for better visualization: tap TOOLS, tap LEVEL, then MAX and using the keypad select e.g. -70. Tap ENTER, then HOME.

11. Tap SWEEP CONT (if the button is grey).
12. If the initial rough antenna alignment was done correctly and the LoS between the two antennas is clear, signal trace should appear at the centre of the graph now.
13. Start with the horizontal adjustments.
14. Loosen the antenna to do the adjustments.
15. By slowly turning the antenna, sweep all the way through.

In addition to a prominent main lobe, antenna radiation patterns also have smaller side lobes. The most common mistake during alignment is aligning to a side lobe. Thus, it is important to sweep all the way through before fixing the antenna position.

16. Now sweep the range once more, while simultaneously comparing the two traces shown on the screen of Spectrum Compact.
17. Fix the position when the NORMAL trace matches the blue MAXHOLD trace i.e. when the currently received signal level is the highest possible.

When the horizontal fine alignment is completed, align the antenna vertically in the same manner (steps 14-17).

18. Tap TRACE MODE, then either AVERAGE 2 or AVERAGE 4. Tap HOME.
19. Tap POWER IN BAND, then BW and using the keypad select the bandwidth equal to the channel width set on the radio. Tap ENTER. Tap SET TO CENTRE. Tap HOME.
20. Tap SWEEP CONT (if the button is grey).
21. If the transmitter is working and the LoS between the two sites is clear, signal trace should appear at the centre of the graph now.
22. Compare the value shown in the upper left corner of the screen with

calculations. If the measured value is +/- 1dB from the calculated value, the antenna alignment is correct. If the measured value is lower, mark the current antenna position and proceed with antenna alignment fine-tuning. Adjust the antennas on both sites.

23. Remove the Spectrum Compact and hot swap the radio to the new antenna.

SPECTRUM
COMPACT
APPLICATIONS:
**COMMISSIONING
FROM GROUND
LEVEL**

Status verification of an installed microwave radio from ground level

Equipment: SC, SMA cable, hand-held antenna

1. Connect Spectrum Compact to the waveguide adapter via SMA cable.
2. Move away from the tower to approximately a distance equal to the antenna height AGL (Above Ground Level).

Note: *To perform measurements from the ground level you must be able to see the antenna of interest and be in front of it.*

3. Turn on Spectrum Compact
4. Tap FREQUENCY, then CENTRE and using the keypad select the frequency equal to the centre frequency of the radio (in MHz). Tap ENTER, then HOME.
5. Tap SPAN, then MIN SPAN. Tap HOME.

Note: *for wider radio channel bandwidths (80 MHz and up), tap SPAN and using the keypad select a wider span e.g. 120. Tap ENTER. Tap HOME.*

6. Tap SWEEP CONT (if the button is grey).
7. Direct the handheld antenna towards the antenna of interest at about 45-degree angle.

Note: *Antennas have prominent side lobes from 30-60 degrees. The further you go out from the antenna, the greater probability of success.*

8. The spectrum curve should appear on the screen of Spectrum Compact indicating that the radio is operational.
9. Tap SAVE.
10. Tap POWER IN BAND, then BW and using the keypad select the bandwidth equal to the channel width set on the radio. Tap ENTER. Tap SET TO CENTRE. Tap HOME.

11. Compare the marked grey area with the measured signal. If the signal doesn't match the marked grey area, it means that the actual radio channel is different than in configuration description.

Please note: *if the signal was not detected from ground level it may not necessarily mean that the transmitter is not working. You may have to get alongside the antenna at the remote site to see the signal. See: Verifying the radio configuration.*

Polarization verification of an installed microwave antenna from ground level

Equipment: SC, SMA cable, handheld antenna

1. Connect Spectrum Compact to the waveguide adapter via SMA cable.
2. Move away from the tower to approximately a distance equal to the antenna height AGL (Above Ground Level).
3. Turn on Spectrum Compact
4. Tap FREQUENCY, then CENTRE and using the keypad select the frequency equal to the centre frequency of the radio (in MHz). Tap ENTER, then HOME.
5. Tap SPAN, then MIN SPAN. Tap HOME.

Note: *for wider radio channel bandwidths (80 MHz and up), tap SPAN and using the keypad select a wider span e.g. 120. Tap ENTER. Tap HOME.*

6. Tap SWEEP CONT (if the button is grey).
7. Direct the hand-held antenna towards the antenna of interest at about 45-degree angle and turn hand-held antenna to a horizontal position (to check the vertical polarization).
8. Tap SAVE.

9. Tap TOOLS, then MASK MODE. Tap SELECT FILE, then SET AS MASK. Tap BACK twice, then HOME.
10. Tap SWEEP CONT.
11. Direct the waveguide adapter towards the antenna at about 45-degree angle and turn the flange to a vertical position (to check the horizontal polarization).
12. Tap SAVE.
13. Compare the measurement for the vertical polarization (the yellow mask curve) and the horizontal polarization (the white trace). The highest signal corresponds to the polarization of the antenna.

Please note: *if the signal was not detected from ground level it may not necessarily mean that the transmitter is not working. It may be necessary to get alongside the antenna at the remote site to see the signal. See: Verifying the radio configuration.*

SPECTRUM
COMPACT
APPLICATIONS:
**BASIC TROUBLE-
SHOOTING**

This is a simplified troubleshooting guide that describes how to use Spectrum Compact to diagnose & possibly solve few of the most common microwave link problems.

Problem: too low RX level or no signal at all.

Possible causes: misconfigured radio(s), misaligned antennas, mismatching polarizations, damaged or inoperable transmitter, damaged receiver**, no Line of Sight.

See: "Commissioning from ground level", "Transmitter verification", "Verifying the radio configuration", "Verification of antenna alignment and LoS", "Transmitter verification".

Problem: RX level fluctuations*,

Possible causes: multipath, damaged transmitter, damaged receiver**, Line of Sight problems.

See: "Commissioning from ground level", "Verifying the radio configuration", "Verification of antenna alignment and LoS", "Interference and multipath detection", "Transmitter verification".

Problem: good RX level but bad signal-to-noise ratio (MSE)/ bad constellation diagram.

Possible causes: misconfigured radio(s), interference, damaged transmitter, damaged receiver**

See: "Commissioning from ground level", "Verifying the radio configuration", "Verification of antenna alignment and LoS", "Interference and multipath detection", "Transmitter verification".

** it is advised to determine the time when the fluctuations happen and investigate at that time of the day, week etc.*

*** suppose this only if all other fails, since this is not a direct Spectrum Analyzer measurement, but a conclusion made as a result of indirect measurements.*

Problem: scanned spectrum curve is with notches.

Possible causes: passive components act as a filter, damaged transmitter, reflections from surroundings

See: "Commissioning from ground level", "Verifying the radio configuration", "Verification of antenna alignment and LoS", "Interference and multipath detection", "Transmitter verification".

Problem: scanned spectrum curve is with spikes.

Possible causes: external interference, damaged transmitter.

See: "Commissioning from ground level", "Verifying the radio configuration", "Verification of antenna alignment and LoS", "Interference and multipath detection", "Transmitter verification".

This guide does not provide insight beyond the previously mentioned problems and if none of the actions described here help, more advanced troubleshooting might be needed - please contact techsupport.

Verification of far end radio configuration

1. Connect Spectrum Compact to the waveguide adapter via SMA cable.
2. Get alongside the antenna.
3. Turn on Spectrum Compact
4. Tap FREQUENCY, then CENTRE and using the keypad select the frequency equal to the centre frequency of the remote radio (in MHz). Tap ENTER, then HOME.
5. Tap SPAN, then MIN SPAN. Tap HOME.

Note: *for wider radio channel bandwidths (80 MHz and up), tap SPAN and using the keypad select a wider span e.g. 120. Tap ENTER. Tap HOME.*

6. Tap TRACE MODE, then AVERAGE 4 to reduce noise effects. Tap HOME.
7. Tap SWEEP CONT (if the button is grey).
8. Place the waveguide adapter next to the antenna.
9. The spectrum curve should appear on the screen of Spectrum Compact indicating that the radio is transmitting.
10. Turn the flange to a horizontal position and aim at the remote site to check the vertical polarization.
11. Tap SAVE.
12. Tap TOOLS, then MASK MODE. Tap SELECT FILE, then SET AS MASK. Tap BACK twice, then HOME.
13. Tap SWEEP CONT.
14. Turn the flange to a vertical position and aim at the remote site to check the horizontal polarization.

15. Tap SAVE.
16. Compare the measurement for the vertical polarization (the yellow mask curve) and the horizontal polarization (the white trace). The highest signal corresponds to the polarization of the antenna.
17. Tap POWER IN BAND, then BW and using the keypad select the bandwidth equal to the channel width set on the radio. Tap ENTER. Tap SET TO CENTRE. Tap HOME.
18. Compare the marked grey area with the measured signal. If the signal doesn't exactly match the marked grey area, it means that the actual radio channel (frequency and/or bandwidth) doesn't correspond with the license.
19. Tap SAVE for further analysis and future reference.

Verification of antenna alignment and LoS

(With link interruption)

1. Climb the tower.
2. Remove the radio from the antenna.
3. Check whether the antenna and the radio is installed in the correct polarization.
4. Connect Spectrum Compact to the antenna. Use appropriate attenuation! (see: General instructions)
5. Turn on Spectrum Compact.
6. Tap SPAN, then FULL SPAN
7. Check for OVERLOAD:
 - a) If there is an indication above the graph, remove Spectrum Compact

from the antenna and add attenuators.

b) If there is no indication above the graph, proceed with the next steps.

8. Tap LEVEL, then OFFSET and using the keypad select the attenuation value used. Tap ENTER, then HOME.
9. Tap FREQUENCY, then CENTRE and using the keypad select the frequency equal to the centre frequency set on the transmitter (in MHz). Tap ENTER, then HOME.
10. Tap SPAN, then MIN SPAN. Tap HOME.

Note: *for wider radio channel bandwidths (80 MHz and up), tap SPAN and using the keypad select a wider span e.g. 120. Tap ENTER. Tap HOME.*

11. Tap TRACE MODE, then either AVERAGE 2 or AVERAGE 4. Tap HOME.
12. Tap POWER IN BAND, then BW and using the keypad select the bandwidth equal to the channel width set on the radio. Tap ENTER. Tap SET TO CENTRE. Tap HOME.
13. Tap SWEEP CONT (if the button is grey).
14. If the transmitter is working and the LoS between the two sites is clear, signal trace should appear at the centre of the graph now.

If the calculated target received signal strength is below -80 dBm, zoom in on the power axis for better visualization: tap TOOLS, tap LEVEL, then MAX and using the keypad select e.g. -70. Tap ENTER, then HOME.

15. Compare the value shown in the upper left corner of the screen with calculations. If the measured value is +/- 1dB from the calculated value, the antenna alignment is correct. If the measured value is lower than calculated, mark the current antenna position and proceed with antenna alignment and fine-tuning.

Typical cases:

- a) Received signal level up to 10dB lower than calculated can relate to near line of sight situation.
- b) Received signal level from 10 – 20dB lower can relate to wrong antenna alignment on the side lobes.
- c) Received signal level above 25dB lower than calculated can relate to complete antenna misalignment or polarization mismatch of installed antennas.

Verification of antenna alignment using reference antenna

(Without link interruption)

1. Climb the tower.
2. Install reference antenna close as possible to the antenna under the question.
3. Connect Spectrum Compact to the reference antenna. Use appropriate attenuation! (see: General instructions)
4. Turn on Spectrum Compact.
5. Tap SPAN, then FULL SPAN
6. Check for OVERLOAD:
 - a) If there is an indication above the graph, remove Spectrum Compact from the antenna and add attenuators.
 - b) If there is no indication above the graph, proceed with the next steps.
7. Tap LEVEL, then OFFSET and using the keypad select the attenuation value used. Tap ENTER, then HOME.
8. Tap FREQUENCY, then CENTRE and using the keypad select the frequency

equal to the centre frequency set on the transmitter (in MHz). Tap ENTER, then HOME.

9. Tap SPAN, then MIN SPAN. Tap HOME.

Note: for wider radio channel bandwidths (80 MHz and up), tap SPAN and using the keypad select a wider span e.g. 120. Tap ENTER. Tap HOME.

10. Tap TRACE MODE, then MAX HOLD. Tap HOME.

11. Start with the horizontal adjustments.

12. Loosen up the antenna to do the adjustments.

13. By slowly turning the antenna, sweep all the way through.

In addition to a prominent main lobe, antenna radiation patterns also have smaller side lobes. The most common mistake during alignment is aligning to a side lobe. Thus, it is important to sweep all the way through before fixing the antenna position.

14. Now sweep the range once more, while simultaneously comparing the two traces shown on the screen of Spectrum Compact.

15. Fix the position on the Spectrum Compact site when the NORMAL trace more or less matches the blue MAXHOLD trace i.e. when the currently received signal level is the highest possible.

16. Align the reference antenna vertically in the same manner.

17. Tap POWER IN BAND, then BW and using the keypad select the bandwidth equal to the channel width set on the radio. Tap ENTER. Tap SET TO CENTRE. Tap HOME.

18. Tap SWEEP CONT (if the button is grey).

If the calculated target received signal strength is below -80 dBm, zoom in on the power axis for better visualization: tap TOOLS, tap LEVEL, then MAX and

using the keypad select e.g. -70. Tap ENTER, then HOME.



19. Compare the value shown in the upper left corner of the screen with values from the radio Rx level indication. The measured value should be +/- 1dB from the radio Rx value subtracting the difference between gain of installed and reference antennas. If the measured value is higher than subtracted, the current antenna must be re-aligned. If the values match, then antenna has been installed correctly and problem should be investigated further.

Interference detection

Initial interference detection (without traffic interruption)

1. Connect Spectrum Compact to the waveguide adapter via SMA cable.
2. Get alongside the antenna.
3. Turn on the Spectrum Compact
4. Tap FREQUENCY, then CENTRE and using the keypad select the frequency equal to the centre frequency of the remote radio (in MHz). Tap ENTER, then HOME.
5. Tap SPAN, using the keypad select the span = 200 MHz. Tap ENTER, then HOME.
6. Tap TRACE MODE, then AVERAGE 4. Tap HOME.
7. Tap SWEEP CONT (if the button is grey).
8. Place the waveguide adapter next to the antenna.
9. Turn the flange to a horizontal position and aim at the remote site to check for vertical polarization interference.
10. Tap SAVE to save the spectrum curve for further analysis and future

reference.

11. Tap SWEEP CONT.
12. Turn the flange to a vertical position and aim at the remote site to check for horizontal polarization interference.
13. Tap SAVE to save the spectrum curve for further analysis and future reference.
14. Tap SWEEP CONT.
15. Now turn the flange to a horizontal position and aim exactly in the opposite direction the antenna is facing to check for vertical polarization interference in back of the antenna.
16. Tap SAVE to save the spectrum curve for further analysis and future reference.
17. Tap SWEEP CONT.
18. Turn the flange to a vertical position and aim at directly the opposite direction the antenna is facing to check for horizontal polarization interference in back of the antenna.
19. Tap SAVE to save the spectrum curve for further analysis and future reference.
20. Tap TOOLS, then FILES. Tap VIEW. Use  and  to navigate the file list.
21. Examine the spectrum curves on Spectrum Compact:

The spectrum taken alongside the antenna in the same polarization as the radio link should show the spectrum curve of your radio. Under good conditions the edge of the curve should be even. If it is stepped or has one or several prominent spikes on top of or right next to it – It is a sign of possible interference.

Note: *If there is no visible deformation of the spectrum, but link still suffers*

from SN degradation, it is possible that the interference is hidden by the radio signal. Proceed with "Interference detection".

Interference detection (with link interruption)

1. Turn off the transmitter at the remote site.
2. Connect Spectrum Compact to the antenna. Use appropriate attenuation!
(see: General instructions)
3. Turn on Spectrum Compact.
4. Tap SPAN, then FULL SPAN
5. Check for OVERLOAD:
 - a) If there is an indication above the graph, remove Spectrum Compact from the antenna and add attenuators.
 - b) If there is no indication above the graph, proceed with the next steps.
6. Tap LEVEL, then OFFSET and using the keypad select the attenuation value used. Tap ENTER, then HOME.
7. Tap FREQUENCY, then CENTRE and using the keypad select the frequency equal to the centre frequency set on the transmitter (in MHz). Tap ENTER, then HOME.
8. Tap SPAN, using the keypad select the span = 200 MHz. Tap ENTER, then HOME.
9. Tap TRACE MODE, then AVERAGE 4 to reduce the noise effects. Tap HOME.
10. Tap POWER IN BAND, then BW and using the keypad select the bandwidth equal to the desired channel width. Tap ENTER.
11. Tap SWEEP CONT (if the button is grey).

12. Examine the displayed frequency range - there should be no signals within the grey band.
13. Tap SAVE for further analysis and future reference.

With possible bursty interferer, (5.8GHz; 17GHz; 24GHz bands)

1. Turn off the transmitter at the remote site.
2. Connect Spectrum Compact to the antenna. Use appropriate attenuation! (see: General instructions)
3. Turn on Spectrum Compact.
4. Tap SPAN, then FULL SPAN.
5. Check for OVERLOAD:
 - a) If there is an indication above the graph, remove Spectrum Compact from the antenna and add attenuators.
 - b) If there is no indication above the graph, proceed with the next steps.
6. Tap LEVEL, then OFFSET and using the keypad select the attenuation value used. Tap ENTER, then HOME.
7. Tap FREQUENCY, then CENTRE and using the keypad select the frequency equal to the centre frequency set on the transmitter (in MHz). Tap ENTER, then HOME.
8. Tap SPAN, using the keypad select the span = 200 MHz. Tap ENTER, then HOME.
9. Tap TRACE MODE, then MAXHOLD. Tap HOME.
10. Tap SWEEP CONT (if the button is grey).
11. Leave the configured Spectrum Compact at the antenna for about 30 minutes.

12. Examine the displayed frequency range — there should be no signals within your desired channel width.
13. Tap SAVE for further analysis and future reference.

Note: *It is advised to determine the time when the fluctuations happen and investigate at that time of the day, week etc.*

Multipath detection

1. Investigation should be done at antenna radio port.
2. Remove the radio from the antenna.
3. Connect Spectrum Compact to the antenna. Use appropriate attenuation! (see: General instructions)
4. Turn on Spectrum Compact.
5. Tap SPAN, then FULL SPAN.
6. Check for OVERLOAD:
 - a) If there is an indication above the graph, remove Spectrum Compact from the antenna and add attenuators.
 - b) If there is no indication above the graph, proceed with the next steps.
7. Tap FREQUENCY, then CENTRE and using the keypad select the frequency equal to the centre frequency set on the transmitter (in MHz). Tap ENTER, then HOME.
8. Tap SPAN, then MIN SPAN. Tap HOME.

Note: *for wider radio channel bandwidths (80 MHz and up), tap SPAN and using the keypad select a wider span e.g. 120. Tap ENTER. Tap HOME.*

9. Tap TRACE MODE, then CUMULATIVE. Tap HOME.

10. Tap SWEEP CONT (if the button is grey).
11. Leave the configured Spectrum Compact turned on at the antenna. Investigation should be done in timebeing of problems.
12. Tap SAVE for further analysis and future reference.
13. Examine the spectrum curve. Under good conditions the detected points should make up an even spectrum curve. If the curve is filled of spectrum points in larger amplitude and does not make a clear curve line, then it could point to a multipath issue.

Note: *It is advised to determine the time when the fluctuations happen and investigate at that time of the day, week etc.*

ANNEX

Power ratio and decibel conversion table

power ratio	difference in dB	difference in dB	power ratio
equal	0	0 or 1	about equal
twice	3	2 or 3	about twice
3 times	5	4 or 5	about 3 times
4 times	6	6	4 times
5 times	7	7	5 times
6 or 7 times	8	8	6 times
8 times	9	9	8 times
9 or 10 times	10	10	10 times

A simplified formula for path calculation

Please note: *this formula is an estimation, use a professional radio link design and planning tool to get precise values.*

For distance in km:

$$RX = TX - 32.4 - 20 \times \log_{10}(\text{frequency(MHz)}) - 20 \times \log_{10}(\text{distance(km)}) - \text{distance(km)} \times \text{const. (dB/km)}^* + \text{antenna 1 gain} + \text{antenna 2 gain} - \text{losses}^{**}$$

For distance in miles:

$$RX = TX - 36.6 - 20 \times \log_{10}(\text{frequency(MHz)}) - 20 \times \log_{10}(\text{distance(mi)}) - \text{distance(mi)} \times \text{const. (dB/mi)}^* + \text{antenna 1 gain} + \text{antenna 2 gain} - \text{losses}^{**}$$

* *select the constant from the table on the next page depending on the frequency in question*

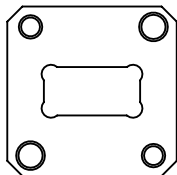
** *waveguide or cable losses*

f, MHz	dB/km	f, MHz	dB/km	f, MHz	dB/km	f, MHz	dB/km
		11000	0.03	21000	0.27	31000	0.18
2000	0.01	12000	0.03	22000	0.33	32000	0.18
3000	0.01	13000	0.04	23000	0.35	33000	0.19
4000	0.01	14000	0.04	24000	0.32	34000	0.19
5000	0.01	15000	0.05	25000	0.28	35000	0.20
6000	0.01	16000	0.07	26000	0.24	36000	0.20
7000	0.01	17000	0.08	27000	0.22	37000	0.21
8000	0.02	18000	0.11	28000	0.20	38000	0.22
9000	0.02	19000	0.15	29000	0.19	39000	0.23
10000	0.02	20000	0.20	30000	0.19	40000	0.24

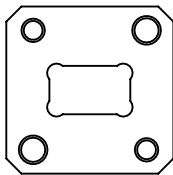
f, MHz	dB/mi	f, MHz	dB/mi	f, MHz	dB/mi	f, MHz	dB/mi
		11000	0.05	21000	0.43	31000	0.29
2000	0.02	12000	0.05	22000	0.53	32000	0.29
3000	0.02	13000	0.06	23000	0.56	33000	0.30
4000	0.02	14000	0.06	24000	0.51	34000	0.30
5000	0.02	15000	0.08	25000	0.45	35000	0.32
6000	0.02	16000	0.11	26000	0.38	36000	0.32
7000	0.02	17000	0.13	27000	0.35	37000	0.34
8000	0.03	18000	0.18	28000	0.32	38000	0.35
9000	0.03	19000	0.24	29000	0.30	39000	0.37
10000	0.03	20000	0.32	30000	0.30	40000	0.38

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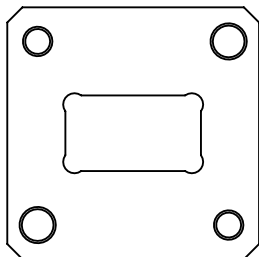
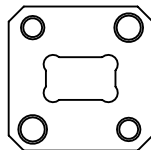
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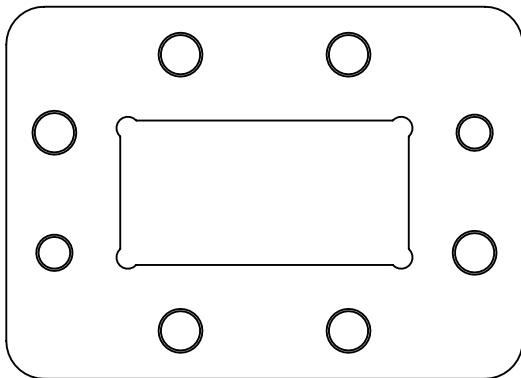
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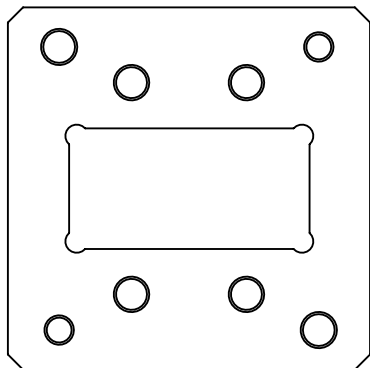
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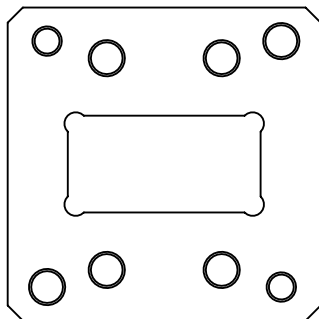
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JOS06WA001



JOS07WA004



JOS10WA003

