Chapter 5. Antenna Alignment

This chapter includes:

Preparation

Before aligning antennas ensure:

- The ODUs are powered up at both ends of the link.
- Transmit and receive frequencies are correctly set.
- Transmit powers are correctly set and transmit mute is turned off.

CAUTION

If frequency and/or power settings are not correct for the application, interference may be caused to other links in the same geographical area. If in doubt, check RAC configuration as a priority on initial power-on, and reconfigure as necessary.

Signal Measurement

Two receive signal measurement methods are available to assist antenna alignment, the RSL graph in Portal, or the RSSI voltage provided at the BNC connector on the ODU. Refer to:

- Alignment via the RSL Graph in Portal
- Alignment using the RSSI Voltage at the ODU
- RSL Measurement Guidelines

Alignment via the RSL Graph in Portal

For details on Portal login and the use of Portal for installation and commissioning, refer to the volume IV Portal.

As Portal is accessed via connection to the INU or IDU, a separate means of communication such as two-way radio or cell phone is required between the Portal operator and the person at the antenna.

The alignment process includes the following steps:

1. Monitor RSL within the Portal Performance screen.
2. Adjust the antenna alignment for maximum RSL.
3. Repeat for the far end of the link.
4. Compare actual RSLs with the expected RSLs from the link installation datapack. Measurement accuracy is nominally ± 2 dB.

Alignment using the RSSI Voltage at the ODU

A voltmeter, such as a multimeter, is used to measure the RSSI voltage available at the BNC connector on the ODU. A suitable BNC to banana-plug connecting cable is available as an optional ODU accessory.

To align using the RSSI voltage at the ODU:

1. Connect the voltmeter to the BNC connector. Center pin is positive. Use a low voltage range for best resolution, nominally 2.5 Vdc FSD.
2. Adjust antenna alignment until the voltmeter reading is at *minimum* value.
3. Repeat for the far end of the link.
4. Check and record the peak voltage at each end. The RSSI voltage provides a direct relationship with RSL. An RSSI of 0.25 Vdc ≡ -10 dBm RSL, and each additional 0.25 Vdc RSSI *increase* thereafter corresponds to a 10 dBm *decrease* in RSL, as follows:

Units	Measurement									
BNC (Vdc)	0.25	0.5	0.75	1.0	1.25	1.5	1.75	2.0	2.25	2.5
RSL (dBm)	-10	-20	-30	-40	-50	-60	-70	-80	-90	-100

5. Compare actual RSLs to the expected RSLs from the link installation datapack. Refer to RSL Measurement Guidelines.
6. Replace the BNC weatherproofing cap.

CAUTION

Failure to replace the RSSI BNC weatherproof cap may result in damage to the ODU.

RSL Measurement Guidelines

The RSL measured should be within ± 4 dB of the predicted value (± 2 dB for transmit, ±2 dB for receive). For any greater discrepancy, it is recommended that the antennas are realigned and if necessary, the path calculations checked or the path resurveyed.

Typically, the RSL is within ±2 dB. Ensure the measurement is made under normal path conditions.

A discrepancy of 20 dB or greater between the measured and calculated RSLs indicates that an antenna is aligned on a side lobe, or there is a polarization mismatch.

Aligning the Antenna

Antenna alignment involves adjusting the direction of each antenna until the received signal strength reaches its maximum level at each end of the link.

Fine adjustment for azimuth (horizontal angle) and elevation (vertical angle) is built into each antenna mount. Adjustment procedures will be provided with each antenna.

If the horizontal adjuster does not provide sufficient range to locate the main beam, the antenna mounting brackets will need to be loosened and the antenna swivelled on its pole mount to locate the beam. Before doing this ensure the horizontal adjuster is set for mid-travel. Some mounts for larger antennas have a separately clamped swivel base to allow the loosened antenna to swivel on it without fear of slippage down the pole. Where such a mount is not provided a temporary swivel clamp can often be provided using a pair of pipe brackets bolted together immediately below the antenna mount.

Refer to:

- Standard Alignment Procedure
- Additional Procedures for a Protected Link

Ensure the antennas are aligned on the main beam, and not a side lobe. For guidance, refer to the sections Locating the Main Beam on page 5-7 and Tracking Path Error on page 5-8.

Standard Alignment Procedure

To align an antenna:

1. Loosen the azimuth adjuster on the antenna mount (horizontal angle) and adjust azimuth position for maximum RSSI/RSL.
2. Tighten the azimuth securing mechanism, ensuring the indication does not drop as it is tightened.
3. Loosen the elevation adjuster (vertical angle) and adjust for maximum RSSI/RSL.
4. Tighten the elevation securing mechanism, ensuring indication does not drop as it is tightened.

   The terminal is now aligned and ready to carry operational traffic.
5. Record RSL and/or RSSI voltage in the commissioning log.

Additional Procedures for a Protected Link

- For a hot standby link, one RAC/ODU is transmitting, and at the receive end both are receiving. The ODUs at each end are coupled to a common antenna using an equal or unequal loss coupler.
- For a space diversity link, one RAC/ODU is transmitting, and at the receive end both are receiving. Each ODU has its own antenna. Normally the top antenna is assigned as primary, and the lower as secondary.
- With frequency diversity, the two links operate independently from a radio-path perspective, and the ODUs at each end are normally coupled to a common antenna using an equal loss coupler.
- With ring protection, *each link* in the ring operates as 1+0.

Hot Standby

This procedure details the additional steps required to ensure that no Tx protection switching occurs during the alignment procedure, which may confuse results. It assumes a common antenna at each end of the link.

1. At each end check the type of coupler installed; equal or unequal split. If unequal, check which RAC/ODU is connected to the low insertion loss side, as this is the RAC/ODU which should be locked as Tx *and* Rx online to assist signal acquisition.
    - Default Portal assignments have the primary RAC/ODU online Tx and the secondary RAC/ODU online for Rx bus-driving and Rx protection-switch management. To maximize signal levels when an unequal coupler is installed, both Tx and Rx must be locked to the low-loss side of the coupler, meaning that *primary* Tx and *primary* Rx should be locked online *at both ends*.
    - If an equal loss coupler is installed, then it does not matter which RAC/ODU is locked online at each end.
2. Within the Portal > Diagnostics > System/Controls screen check which RAC is Tx online, and which is Rx online. The default situation has the primary RAC as Tx online, and the secondary RAC as Rx online.
3. If an unequal coupler is installed, use the Protected Link controls to lock the low-loss RAC as Tx online and Rx online at both ends of the link. If an equal loss coupler is installed, lock to the default Tx online and Rx online at both ends of the link[1].
4. Use the Standard Alignment Procedure above to align each antenna.
5. Return the Protected Link controls to Auto/Lock Off on completion.

Space Diversity

[1] For an equal loss coupler, selection of primary or secondary at each end is unimportant; what is important is that whatever combination is selected it is locked online.

This procedure details the additional steps required to ensure that all four antennas are in correct alignment and that during the alignment process no unwanted Tx switching occurs.

1. Within the Portal > Diagnostics > System/Controls screen check which RAC is Tx online, and which is Rx online. The default situation has the primary RAC as Tx online, and the secondary RAC as Rx online.
2. Use the Protected Link controls to lock the primary RAC as Tx online at both ends of the link. Rx online can be left as Auto/Lock Off[2].
3. Use the Standard Alignment Procedure above to align each antenna. If *RSL* is to be used for alignment purposes, proceed to the Diagnostics > Performance screen, select the Link from the Plug-in menu, and toggle between each RAC to view its RSL by clicking on the Link Plug-in and selecting a RAC. The selected RAC is indicated by an Arrowhead.
4. Return the Protected Link controls to Auto/Lock Off on completion.

Frequency Diversity

This procedure assumes a common antenna at each end of the link and an equal loss coupler.

1. Select one (any) RAC/ODU for RSSI/RSL measurement and use the Standard Alignment Procedure above to align each antenna. Providing each link is operating normally there is no need to use the System/Controls > Protected Link locks to lock a RAC to Tx or Rx online[3].

Ring

Follow the Standard Alignment Procedure above.

[2] Rx online defines which receiver is passing traffic to the Backplane bus; from an RSSI/RSL viewpoint, both receivers remain online.

[3] Although the Diagnostics > System/Controls screen provides locks for Tx and Rx online, they define only the traffic connections through to the Node backplane bus; they do not affect over-air status as each link operates as a distinct entity on separate frequency pairings.

Main Beams and Side Lobes

This section describes how to locate the main beam, and typical tracking path errors. Refer to:

- Locating the Main Beam
- Tracking Path Error

Locating the Main Beam

Ensure the antennas are aligned on the main beam, and not a side lobe.

Once a measurable signal is observed, very small alignment adjustments are required to locate the main beam. For instance, a 1.2m antenna at 23 GHz typically has 0.9° of adjustment from center of main beam to the first null (0.4° to the -3 dB point). Antenna movement across the main beam will result in a rapid rise and fall of signal level. As a guide, 1 degree of beam width is equivalent to moving approximately 1.0 mm around a standard 114 mm (4.5 in.) diameter O/D pipe.

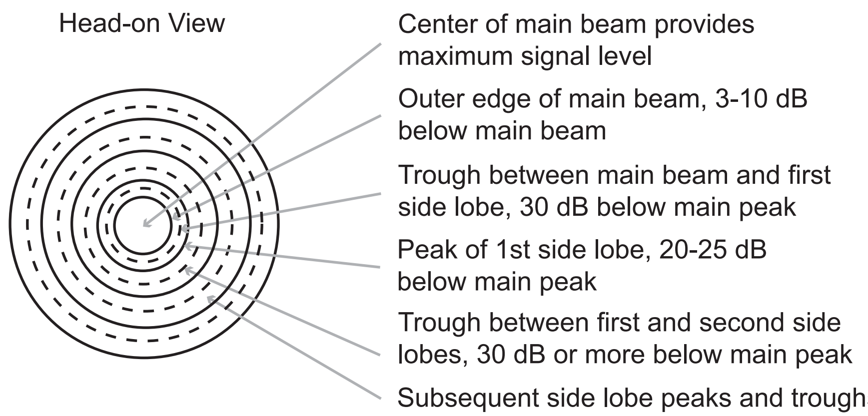
Antennas can be verified as being on main beam (as opposed to a side lobe) by comparing measured receive signal level with the calculated level.

Signal strength readings are usually measurable when at least a main beam at one end and first side lobes at the other are aligned.

The strongest signal occurs at the center of the main beam. The highest first lobe signal is typically 20–25 dB less than the main beam signal. When both antennas are aligned for maximum main beam signal strength, the receive signal level should be within 2 dB of the calculated level for the path. This calculated level should be included in the installation datapack for the link.

Figure 5-1 on page 5-8 is an example of a head-on, conceptual view of the beam signal strength, with concentric rings of side lobe peaks and troughs radiating outward from the main beam.

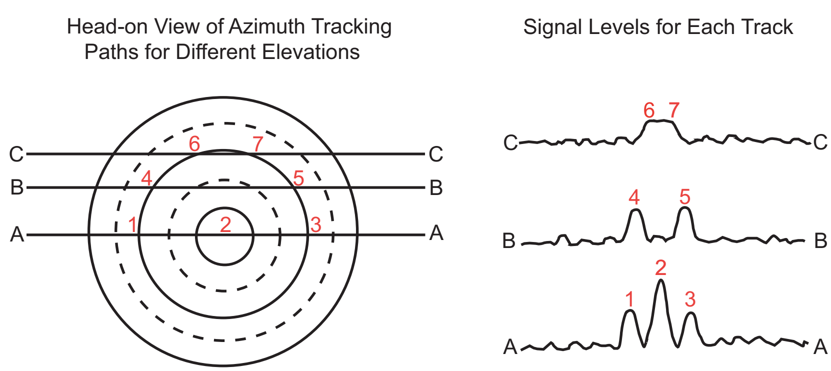
Figure 5-1. Indicative head-on signal pattern for a parabolic antenna



Tracking Path Error

Side lobe signal readings can be confused with main beam readings. This is particularly true for the first side lobe as the signal level at its center is greater than the signal level at the edges of the main beam, and if tracking on an incorrect elevation (or azimuth) a false impression of main beam reception can be obtained. Figure 5-2 shows an example of this with a simplified head-on view of an antenna radiation pattern, and tracking paths for three elevation settings.

Figure 5-2. Example Tracking Path Signals



Line AA represents the azimuth tracking path of a properly aligned antenna. The main beam is at point 2, and the first side lobes at points 1 and 3.

Line BB represents the azimuth tracking path with the antenna tilted down slightly. Signal strength readings show only the first side lobe peaks, 4 and 5. In some instances the side lobe peaks are unequal due to antenna characteristics, which can lead to the larger peak being mistaken for the main beam. The correct method for locating the main beam in this case is to set the azimuth position midway between the first side lobe peaks, and then adjust the elevation for maximum signal.

Line CC represents an azimuth tracking path with the antenna tilted down further still. The first side lobe signal peaks (6 and 7) appear as one peak, leading to a mistaken interpretation of a main beam. The correct method for locating the main beam is to set the azimuth at mid peak, between 6 and 7, and then adjust elevation for maximum signal.

This first side lobe peaking is probably the most frequent cause of misalignment in both azimuth and elevation, especially so if one side lobe peaks higher than the other, as shown in Figure 5-3. A common error is to move the antenna left to right along line DD, or top to bottom along line EE, always ending up with the maximum signal at position 1.

Figure 5-3. Example Tracking Path Signals Centered on the First Side Lobe