Range and Angle Tracking Performance
(Radar-Dependent Errors)

EXERCISE OBJECTIVE
When you have completed this exercise, you will be familiar with the radar-dependent sources of error which limit range and angle tracking performance.

DISCUSSION
Introduction
Many factors can cause errors to occur in tracking radars, and thus, limit the range and angle tracking performance. The tracking errors are of many types. However, most of these errors can fall in the following three categories: radar-dependent errors, target-caused errors, and errors caused by the propagation media. In the military area, a fourth category adds: errors caused by electronic countermeasures (ECM). This exercise discusses radar-dependent errors. The next exercise deals with target-caused errors and briefly discusses errors due to the propagation media.

Resolution, Precision, and Accuracy
Range and angle tracking performance is often expressed in terms of resolution, accuracy, and precision.

The resolution indicates the ability of a tracking radar to separate two closely spaced targets, either in range or angle.

The precision is a measure of the ability of a tracking radar to sense small changes in the target position. The accuracy refers to the absolute error with respect to earth reference.

In practice, the accuracy is related to the total tracking error. It includes the errors that continually affect the tracking accuracy to a certain level (systematic or bias errors) as well as the errors which affect tracking accuracy more or less on a random basis (noise errors). On the other hand, precision is the tracking error due to noise errors only.

Radar-Dependent Errors
Like any instrument or device, a tracking radar has its own limitations. Almost any part of a tracking radar may be a source of tracking error. The imperfections of a tracking radar may affect range tracking, angle tracking, or even both. All errors that originate from the tracking radar are referred to as radar-dependent errors.
Range and Angle Tracking Performance
(Radar-Dependent Errors)

Table 6-1 lists common sources of radar-dependent errors. The first column provides a brief description of the error source. The second column indicates whether the resulting tracking error is a bias or a noise error. The third column indicates the tracking coordinates that are affected by the error (range, angle, or both range and angle).

<table>
<thead>
<tr>
<th>ERROR SOURCE</th>
<th>RESULTING TRACKING ERROR</th>
<th>AFFECTED TRACKING COORDINATE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zero Range Setting</td>
<td>Bias Error</td>
<td>Range</td>
</tr>
<tr>
<td>Antenna Unbalance</td>
<td>Bias Error</td>
<td>Angle</td>
</tr>
<tr>
<td>North Alignment</td>
<td>Bias Error</td>
<td>Angle</td>
</tr>
<tr>
<td>Antenna Servosystem Unbalance</td>
<td>Bias Error</td>
<td>Range and Angle</td>
</tr>
<tr>
<td>Receiver Thermal Noise</td>
<td>Noise Error</td>
<td>Range and Angle</td>
</tr>
<tr>
<td>Antenna Servosystem Noise</td>
<td>Noise Error</td>
<td>Range and Angle</td>
</tr>
<tr>
<td>Antenna Servosystem Limitations</td>
<td>Bias Error</td>
<td>Angle</td>
</tr>
</tbody>
</table>

Table 6-1. Sources of radar-dependent errors.

In modern tracking radars, some sources of error are so well controlled that they can be virtually neglected. This is particularly true when the accuracy and precision rely on the quality of the electronic circuitry of the tracking radar. However, three of the error sources mentioned above are major contributors to the total tracking error: the receiver thermal noise, the antenna servosystem noise, and the antenna servosystem limitations. The receiver thermal noise is a fundamental limitation of radars that reduces tracking accuracy at long range while the effect of the antenna servosystem noise and limitations can be reduced to minimum with careful design.

The receiver thermal noise is electrical noise present in the radar receiver. It is due to the movement of electrons in components of the radar receiver and has a constant power level unless the operating temperature of the receiver changes. The receiver thermal noise is a limitation to the signal-to-noise (S/N) ratio at the receiver input. Since the received signal level decreases exponentially with range (signal level \( \propto 1/R^4 \)), the S/N ratio at the receiver input decreases with range, and thereby, the tracking error due to the receiver thermal noise increases with range. Receiver thermal noise is the major source of tracking error at long range.

The antenna servosystem noise, which is commonly called servo noise, is the hunting action of the servosystem that controls antenna motion. It is due to backlash and compliance of the mechanical components (gears, shafts, etc.) in the antenna mount. Note that angular tracking error due to the servo noise is independent of range. This is because the servo noise does not depend on the target echo.

The antenna servosystem limitations are the factors which determine the velocity and acceleration capability of the antenna, or in other words, the ability of the tracking radar to track in angle a target moving at a high speed. Examples of antenna servosystem limitations are the electrical characteristics of the servo loop (gain, bandwidth, etc.), the motor torque, the inertia of the radar antenna, etc. The antenna servosystem limitations cause the antenna to be unable to catch up with a target that moves at a high speed. This results in an angular tracking error which is
Range and Angle Tracking Performance
(Radar-Dependent Errors)

referred to as the tracking lag error. This error increases as the angular speed of the tracked target increases. Furthermore, the polarity of the angular error signal is always the same when the antenna lags the target since the antenna is unable to catch up with the target.

Note that the antenna servosystem noise and limitations can be eliminated by using an electronically steered antenna (phased-array antenna).

**Automatic Gain Control (AGC)**

The angle tracking system of a tracking radar is basically a closed-loop system. To maintain a stable closed-loop operation, the amplitude of the angular error signal, which is proportional to the target echo amplitude, must be made independent of the variations in the target echo amplitude that are due to the target range and radar cross section (size). To do so, these variations in the target echo amplitude must be reduced to minimum.

Figure 6-1 shows an example of echo pulses obtained from the same target at short and long range, using a lobe switching tracking radar. For both ranges, the angular error is the same and causes the target echo amplitude obtained with the antenna beam at the left of the antenna axis to be 3 dB higher than that obtained with the antenna beam at the right of the antenna axis. As can be seen, the difference between the amplitudes of the target echo pulses obtained in the two beam positions (angular error signal amplitude) when the target is at short range is 0.3 V. It decreases to 0.03 V when the target is at long range. This illustrates that target range greatly affects the amplitude of the angular error signal obtained for a given angular error.

Automatic gain control (AGC) circuits are used to reduce the variation of the target echo amplitude due to the target range and radar cross section. A sensitivity time control (STC) circuit is often located at the input of the processing unit of any radar. STC increases the gain with range. As a result, this reduces the decrease of the target echo amplitude with range and prevents saturation of the processing unit that may result from large targets at short range.

An AGC circuit is often added at the input of the tracking unit of a tracking radar to further reduce the variation of the target echo amplitude due to the target range and radar cross section. This AGC circuit continually measures the amplitude of the tracked-target echo pulse. It then uses the measured echo amplitude to adjust the gain. The gain is made to decrease as the measured echo amplitude increases and vice versa. The addition of an AGC circuit to the tracking unit of a radar significantly reduces the hunting action of the antenna, especially at short ranges where the target angular rate of change and echo pulse amplitude are high.
Range and Angle Tracking Performance
(Radar-Dependent Errors)

Figure 6-1. Angular error signal amplitude at short and long range for a given angular error.

Procedure Summary

In the first part of the exercise, Equipment Setup, you will set up the Tracking Radar, position the target table with respect to the Tracking Radar, and calibrate the Tracking Radar.

In the second part of the exercise, Range Origin Calibration (Zero Range Setting), you will measure the range of targets at the near and far ends of the target table grid. You will change the range origin calibration and measure the range of the targets once again. You will compare the range measurements to show that an imperfect calibration of the origin affects the accuracy of the tracking radar.

In the third part of the exercise, Antenna Unbalance, you will align the radar antenna as perfectly as possible with the target. You will then successively position the antenna beam to the left and right of the antenna axis by successively applying
Range and Angle Tracking Performance  
(Radar-Dependent Errors)

positive and negative voltages to the microwave switch of the radar antenna. For each beam position, you will measure the target echo amplitude. You will compare the target echo amplitudes obtained for the two beam positions to determine whether or not the antenna is unbalanced.

In the fourth part of the exercise, Receiver Thermal Noise, you will lock the tracking radar onto a fixed metal plate target. You will decrease the S/N ratio at the receiver input by changing the orientation of the metal plate target. This will allow you to observe the effect of the receiver thermal noise on the tracking error.

In the fifth part of the exercise, Automatic Gain Control, you will lock the tracking radar onto a target. You will vary the target range and observe the radar antenna behavior with and without AGC circuit at the Radar Target Tracker input.

In the sixth part of the exercise, Tracking Lag, you will lock the tracking radar onto a target moving perpendicular to the antenna axis direction at short range. You will increase the target speed to observe how this affects the angle tracking error.

PROCEDURE

Equipment Setup

1. Before beginning this exercise, the main elements of the Tracking Radar Training System (i.e., the antenna and its pedestal, the target table, the RTM and its power supply, the training modules, and the host computer) must be set up as shown in Appendix A.

   On the Radar Transmitter, make sure that the RF POWER switch is set to the STANDBY position.

   On the Antenna Controller, make sure that the MANual ANTENNA ROTATION MODE is selected and the SPEED control is set to the 0 position.

   Turn on all modules and make sure the POWER ON LED's are lit.

2. Turn on the host computer, start the LVRTS software, select Tracking Radar, and click OK. This begins a new session with all settings set to their default values and with all faults deactivated. If the software is already running, click Exit in the File menu and then restart the LVRTS software to begin a new session.

3. Connect the modules as shown on the Tracking Radar tab of the LVRTS software. For details of connections to the Reconfigurable Training Module, refer to the RTM Connections tab of the software.

   Note: Make the connections to the Analog/Digital Output Interface (plug-in module 9632) only if you wish to connect a conventional radar PPI display to the system or obtain an O-scope display on a conventional oscilloscope.
Note: The SYNC. TRIGGER INPUT of the Dual-Channel Sampler and the PULSE GENERATOR TRIGGER INPUT of the Radar Transmitter must be connected directly to OUTPUT B of the Radar Synchronizer without passing through BNC T-connectors.

Connect the hand control to a USB port of the host computer.

☐ 4. Make the following settings:

On the Radar Transmitter

RF OSCILLATOR FREQUENCY . . . . . . . CAL.
PULSE GENERATOR PULSE WIDTH . . . 1 ns

On the Radar Synchronizer / Antenna Controller

PRF . . . . . . . . . . . . . . . . . . . . . . . . . . . 288 Hz
PRF MODE . . . . . . . . . . . . . . . . . . . . . . . SINGLE
ANTENNA ROTATION MODE . . . PRF LOCK.
DISPLAY MODE . . . . . . . . . . . . . . . . . . POSITION

On the Dual-Channel Sampler

RANGE SPAN . . . . . . . . . . . . . . . . . . . . . 3.6 m

In the LVRTS software

System Settings:
Log./Lin. Mode . . . . . . . . . . . . . . . . . . . . Lin.
Gain . . . . . . . . . . . . . . . . . . . . . . . . as required
AGC . . . . . . . . . . . . . . . . . . . . . . . . . . . . . Off

Radar Display Settings:
Range . . . . . . . . . . . . . . . . . . . . . . . . . 3.6 m

☐ 5. Connect the cable of the target table to the connector located on the rear panel of the Target Controller. Make sure that the surface of the target table is free of any objects and then set its POWER switch to the I (on) position.

Place the target table so that its grid is located approximately 1.2 m from the Rotating-Antenna Pedestal, as shown in Figure 6-2. Make sure that the metal rail of the target table is correctly aligned with the shaft of the Rotating-Antenna Pedestal.
Range and Angle Tracking Performance (Radar-Dependent Errors)

Figure 6-2. Position of the Rotating-Antenna Pedestal and target table.

☐ 6. Calibrate the Tracking Radar Training System according to the instructions in sections I to V of Appendix B.

Range Origin Calibration (Zero Range Setting)

☐ 7. If necessary, realign the radar antenna axis with the target.

Use a measuring tape to determine the target range (measured from the back of the radar antenna horns). Record the target range in the following blank space.

Actual Target Range = _____ m

On the Dual-Channel Sampler, slightly turn the ORIGIN control knob counterclockwise to modify the range origin calibration (zero range setting).

☐ 8. On the Radar Transmitter, make sure that the RF POWER push button is depressed. The RF POWER ON LED should flash on and off to indicate that RF power is being radiated by the radar antenna. The target echo pulse should be displayed on the O-Scope Display.
Use the hand control to align the range gate marker with the target echo pulse on the O-Scope Display. Press the trigger button on the hand control to lock the Tracking Radar onto the target. The Tracking Radar should beep to confirm that it is locked onto the target.

Record the distance indicated by the Range Gate Distance display (measured target range) in the following blank space.

Measured Target Range = ______ m

On the Radar Transmitter, set the RF POWER switch to the STANDBY position. The RF POWER STANDBY LED should be lit.

9. On the Target Controller, use the Y-axis position control to place the target at the near end of the target table grid.

Use a measuring tape to determine the target range (measured from the back of the radar antenna horns). Record the target range in the following blank space.

Actual Target Range = ______ m

10. On the Radar Transmitter, depress the RF POWER push button. The RF POWER ON LED should start to flash on and off and the target echo pulse should appear on the O-Scope Display.

Use the hand control to align the range gate marker with the target echo pulse on the O-Scope Display. Press the trigger button on the hand control to lock the Tracking Radar onto the target.

Record the distance indicated by the Range Gate Distance display (measured target range) in the following blank space.

Note: The radar antenna position may fluctuate slightly at a regular rate (antenna hunting) once the Tracking Radar is locked on the target. This is due to the antenna servo noise and limitations. If this occurs, stop the antenna hunting while reading the Range Gate Distance display by gently placing your fingertips on the side of the radar antenna frame.

Measured Target Range = ______ m

On the Radar Transmitter, set the RF POWER switch to the STANDBY position. The RF POWER STANDBY LED should be lit.
Range and Angle Tracking Performance
(Radar-Dependent Errors)

How do the actual target ranges and the measured target ranges compare? Briefly explain.

What kind of error (bias or noise error) results from the modification of the range origin calibration?

On the Dual-Channel Sampler, slightly turn the ORIGIN control knob clockwise to readjust the range origin.

Antenna Unbalance

☐ 11. On the Target Controller, use the Y-axis position control to place the target at the far end of the target table grid.

Remove the small metal plate target from the mast of the target table.

Place a large metal plate target on the mast of the target table. Make sure that the target is oriented perpendicular to the metal rail of the target table, and then tighten the screw to secure the target to the mast.

Slightly rotate the radar antenna manually so that its axis is aligned with the middle of the metal plate target as perfectly as possible.

☐ 12. On the Radar Target Tracking Interface (plug-in module, Model 9633), remove the BNC cable which interconnects the LOBE SWITCH CONTROL OUTPUT and LOBE SWITCH CONTROL INPUT of the Radar Target Tracker.

Connect the LOBE SWITCH CONTROL INPUT of the Radar Target Tracker to the +15-V dc output of the Power Supply using the BNC connector/banana plug cable provided with the Tracking Radar. This applies a +15-V dc bias voltage to the microwave switch of the Dual Feed Parabolic Antenna (radar antenna) and positions the antenna beam to the left of the antenna axis.

On the Radar Transmitter, depress the RF POWER push button. The RF POWER ON LED should start to flash on and off and the target echo pulse should appear on the O-Scope Display.

In LVRTS, set the Gain of the MTI Processor so that the amplitude of the target echo pulse on the O-Scope Display is approximately 0.5 V.
Range and Angle Tracking Performance
(Radar-Dependent Errors)

Record the target echo amplitude in the following blank space.

Echo Amplitude = _____ V (beam to the left of antenna axis)

☐ 13. On the Radar Transmitter, set the RF POWER switch to the STANDBY position. The RF POWER STANDBY LED should be lit.

Disconnect the LOBE SWITCH CONTROL INPUT of the Radar Target Tracker from the +15-V dc output of the Power Supply then connect it to the -15-V dc output of the same module. This applies a -15-V dc bias voltage to the microwave switch of the radar antenna and positions the antenna beam to the right of the antenna axis.

☐ 14. On the Radar Transmitter, depress the RF POWER push button. The RF POWER ON LED should start to flash on and off.

Record the target echo amplitude in the following blank space.

Echo Amplitude = _____ V (beam to the right of antenna axis)

On the Radar Transmitter, set the RF POWER switch to the STANDBY position. The RF POWER STANDBY LED should be lit.

Is the antenna unbalanced, i.e., is the target echo amplitude obtained with the antenna beam to the left of the antenna axis different from that obtained with the antenna beam to the right of the antenna axis?

☐ Yes ☐ No


________________________________________________________

________________________________________________________

________________________________________________________

Receiver Thermal Noise

☐ 15. Remove the cable connecting the LOBE SWITCH CONTROL INPUT of the Radar Target Tracker to the -15-V dc output of the Power Supply.

Interconnect the LOBE SWITCH CONTROL OUTPUT and LOBE SWITCH CONTROL INPUT of the Radar Target Tracker with a short BNC cable.

On the Target Controller, select the SPEED MODE then select the POSITION MODE to place the target in the center of the target table grid.
Range and Angle Tracking Performance
(Radar-Dependent Errors)

☐ 16. On the Radar Transmitter, depress the RF POWER push button. The RF POWER ON LED should start to flash on and off and the target echo pulse should appear on the O-Scope Display.

Align the radar antenna with the target so that the target echo amplitude is the same for both positions of the antenna main beam (i.e., so that the trace on the O-Scope Display no longer appears as doubled).

In LVRTS, set the Gain of the MTI Processor so that the amplitude of the target echo pulse on the O-scope display is approximately 0.25 V.

Use the hand control to align the range gate marker with the target echo pulse on the O-Scope Display then press the trigger button on the hand control to lock the Tracking Radar onto the target.

☐ 17. In LVRTS, disconnect the Oscilloscope probes 1 and 2 from TP1 and TP2 of the MTI Processor. Leave Probe E connected to TP8 of the Radar Target Tracker. Connect the Oscilloscope probe 1 to TP26 (angular error signal) of the Radar Target Tracker.

Make the following settings on the Oscilloscope:

Channel 1 . . . . . . . . . . . . . . . . . . . . . . . . 20 mV/div
Channel 2 . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . Off
Time Base . . . . . . . . . . . . . . . . . . . . . . . . 0.1 s/div

Set the Oscilloscope to Continuous Refresh.

The signal displayed on the Oscilloscope screen is the angular error voltage, and the RMS value of this voltage is indicated in the Waveform Data section of the Oscilloscope. This value should be fairly low and may fluctuate. Evaluate the average RMS value of the error voltage indicated by the Oscilloscope and record the result in the following blank space.

\[ \text{Angular Error Voltage: } \quad \text{mV} \quad \text{(high S/N ratio at receiver input)} \]

Note: The radar antenna position may fluctuate slightly at a regular rate (antenna hunting) when the Tracking Radar is locked on the target. This is due to the antenna servo noise and limitations. If this occurs, stop the antenna hunting while evaluating the angular error voltage by gently placing your fingertips on the side of the radar antenna frame.

Observe the radar antenna and the Range Gate Distance display of the O-Scope Display. Are the antenna position and range gate distance stable?

Yes ☐ No ☐
Range and Angle Tracking Performance
(Radar-Dependent Errors)

Press the trigger button on the hand control to unlock the Tracking Radar.

☐ 18. Slowly vary the orientation of the target to gradually decrease the S/N ratio at the receiver input until the target echo pulse on the O-Scope Display is almost completely lost in noise. While doing this, increase the Gain of the MTI Processor to maintain the target echo amplitude to approximately 0.25 V. Also, slightly vary the radar antenna orientation so that the target echo amplitude remains the same for both positions of the antenna main beam.

Note: The target echo pulse on the O-Scope Display may be completely lost in noise after you readjusted the antenna position. If so, slightly readjust the orientation of the target until the target echo pulse reappears on the O-Scope Display.

Use the hand control to align the range gate marker with the target echo pulse on the O-Scope Display then press the trigger button on the hand control to lock the Tracking Radar onto the target.

Observe the RMS value of the angular error voltage displayed in the Waveform Data section of the Oscilloscope. This value should fluctuate. Evaluate the average RMS value of the error voltage indicated by the Oscilloscope and record the result in the following blank space.

Note: The radar antenna position may fluctuate slightly at a regular rate (antenna hunting) when the Tracking Radar is locked on the target. This is due to the antenna servo noise and limitations. If this occurs, stop the antenna hunting while evaluating the angular error voltage by gently placing your fingertips on the side of the radar antenna frame.

Angular Error Voltage: ________ mV (low S/N ratio at receiver input)

Compare the angular error voltage (RMS value) obtained with low and high S/N ratios at the receiver input.

Observe the radar antenna and the Range Gate Distance display of the O-Scope Display. Are the antenna position and range gate distance perfectly stable? Briefly describe what you observe.

Note: The radar antenna position may fluctuate slightly at a regular rate (antenna hunting). If this occurs, stop the antenna hunting while making your observations by gently placing your fingertips on the side of the radar antenna frame.
What kind of error (bias or noise error) results from the receiver thermal noise?

\[ \text{Automatic Gain Control} \]

19. On the Radar Transmitter, set the RF POWER switch to the STANDBY position. The RF POWER STANDBY LED should be lit.

Remove the large metal plate target from the mast of the target table.

Place a semi-cylinder target on the mast of the target table (convex side oriented toward the radar antenna), then tighten the screw to secure the target to the mast.

In LVRTS, set the Gain of the MTI Processor to 2.

20. On the Target Controller, use the Y-axis position control to place the target at the near end of the target table. The target range is now approximately 1.1 m.

On the Radar Transmitter, depress the RF POWER push button. The RF POWER ON LED should start to flash on and off and the target echo pulse should appear on the O-Scope Display.

Align the radar antenna with the target so that the target echo amplitude is the same for both positions of the antenna main beam.

In LVRTS, set the Gain of the MTI Processor so that the amplitude of the target echo pulse on the O-Scope Display is approximately 0.4 V.

Use the hand control to align the range gate marker with the target echo pulse on the O-Scope Display then press the trigger button on the hand control to lock the Tracking Radar onto the target.

Observe the radar antenna. Does it remain aligned with the target without hunting?

\[ \square \text{Yes} \quad \square \text{No} \]
Range and Angle Tracking Performance
(Radar-Dependent Errors)

21. On the Target Controller, use the Y-axis position control to increase the target range until the target is at the far end of the target table. While doing this, observe the target echo pulse on the O-Scope Display and the behavior of the radar antenna. Describe what you observe and briefly explain.

On the Target Controller, use the Y-axis position control to place the target at the near end of the target table. The amplitude of the target echo pulse on the O-Scope Display should be approximately 0.4 V (when antenna hunting is stopped).

In LVRTS, turn on the AGC while observing the target echo pulse on the O-Scope Display and the behavior of the radar antenna. Describe what you observe.

On the Target Controller, use the Y-axis position control to increase the target range until the target is at the far end of the target table. While doing this, observe the target echo pulse on the O-Scope Display and the behavior of the radar antenna. Describe what you observe and briefly explain.

Does AGC have a positive effect on the operation of the angle tracking loop of the Radar Target Tracker? Briefly explain.
Range and Angle Tracking Performance
(Radar-Dependent Errors)

Tracking Lag

22. On the Target Controller, make sure that the X- and Y-axis SPEED controls are in the MINimum position, select the SPEED MODE, then set the X-axis SPEED control so that the target speed is equal to approximately 10 cm/s. The Tracking Radar should still be locked onto the target.

**Note:** There may be antenna hunting as the radar tracks the target in angle. If so, open the Friction Compensation window, reduce both the clockwise and counterclockwise settings by about 15 to 30%, click the OK button to close the window, and relock the tracking radar onto the target.

Make the following settings on the Oscilloscope:

<table>
<thead>
<tr>
<th>Channel 1</th>
<th>0.1 V/div</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time Base</td>
<td>50 ms/div</td>
</tr>
</tbody>
</table>

Observe the angular error voltage on the Oscilloscope. What is the relationship between the target direction and the polarity of the angular error voltage?

- Yes
- No

Observe the angular error voltage on the Oscilloscope. The mean (AVG) value of the angular error voltage is displayed in the Waveform Data section of the Oscilloscope. This value should fluctuate. Evaluate the mean value of the magnitude of the error voltage and record the result in the following blank space.

**Magnitude of the Angular Error Voltage:** _____ V (mean value)

23. On the Target Controller, set the X-axis SPEED control to the MAX. position.

Observe the angular error voltage on the Oscilloscope. Evaluate the mean value of the magnitude of the angular error voltage and record the result in the following blank space.

**Magnitude of the Angular Error Voltage:** _____ V (mean value)
Range and Angle Tracking Performance
(Radar-Dependent Errors)

Compare the magnitude of the angular error voltage obtained in this step with that obtained in the previous step. What happens to the angular tracking error as the target speed increases?

On the Target Controller, select the POSITION MODE to stop the target.

☐ 24. On the Radar Transmitter, set the RF POWER switch to the STANDBY position. The RF POWER STANDBY LED should be lit. Turn off all equipment.

CONCLUSION

In this exercise, you observed that target range measurements are erroneous when the range origin (zero range setting) is not well calibrated. You saw that antenna imbalance causes the target echo amplitude obtained with the antenna beam in one position to slightly differ from that obtained with the antenna beam in the other position, when the antenna axis is perfectly aligned with the target. You also saw that this is a source of angular tracking error. You observed that the receiver thermal noise increases the tracking error when the S/N ratio at the receiver input is low (target at long range). You found that the AGC circuit at the input of the Radar Target Tracker greatly stabilizes the operation of the angular tracking loop by minimizing the amplitude variation of the target echo pulse. You observed that the radar antenna lags the target when the tracking radar is locked onto a target moving almost perpendicular to the antenna axis direction at a high speed. You saw that this causes a tracking lag error that is due to limitations of the speed and acceleration of the antenna.

REVIEW QUESTIONS

1. Name a few sources of radar-dependent errors.

2. Complete the following sentence: In practice, the accuracy of a tracking radar...
Range and Angle Tracking Performance
(Radar-Dependent Errors)

3. Complete the following sentence: In practice, the precision of a tracking radar...

4. Briefly explain how the receiver thermal noise affects the accuracy of a tracking radar.

5. Briefly explain why adding an AGC circuit at the input of the tracking unit can reduce the angular tracking error.