ORTHOGONAL DETECTION OF RADAR TARGETS IN RAIN AT KU-BAND
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THE BOEING COMPANY
AIRPLANE DIVISION
RENTON, WASHINGTON

D6-16136
ORTHOGONAL DETECTION OF RADAR TARGETS IN
RAIN AT K U -BAND

The performance of conventional, linearly polarized air-
borne radars, using the higher frequencies (X-band and
above), can be severely degraded by even moderate rain-
fall. However, the difference in the polarization prop-
erties between precipitation and desired targets can be
used as a basis for discrimination. Because raindrops
are nearly spherical, the backscattered energy from a
linearly polarized incident wave is not depolarized. The
backscattered energy from man-made and natural
objects, on the other hand, are depolarized significantly.
These polarization differences form the basis for the
most practical discrimination schemes. Normal radar
practice in the past has been to use circularly polarized
transmission as a basis for discrimination. However, a
linearly polarized radar capable of receiving and display-
ing the orthogonal component of the backscattered energy
as well as the co-polarized component should be able to
discriminate targets from precipitation. Other potential
advantages inherent in dual polarization are being inves-
tigated.

The Boeing K U -band radar system was modified to permit
either horizontally- or vertically-polarized linear trans-
mission, and simultaneous reception of both the co-polar-
ized and cross-polarized signal return.

The parameters of the K U -band radar are as follows:

- Frequency = 16.1 kmc
- Pulse length = 0.33 μ sec
- PRF = 2100 per sec
- Radiated power = 72KW, peak
- Antenna beam width = 2.0 degrees (pencil)
- Antenna gain = 40 dB
- Antenna scan angle = ± 40 degrees
- Isolation between channels: at least 30 dB

The test site is on the south shore of Lake Washington.

The test data obtained is shown in a series of photographs
on the following pages. The basic information in the
photographs is a comparison of the co-polarized and
cross-polarized radar return from terrain and various
waterborne and airborne targets under the rain conditions
noted. The rainfall rates noted are subjective because
no adequate means of measuring the rainfall, in the area
being scanned by the radar, were available. From the
photographs it is clear that clutter due to weather is
greatly reduced in the cross-polarized channel, and the
detection of targets in that channel is greatly enhanced.
Measurements made indicate clutter return in the cross-
channel is down approximately 20 db from that in the co-
channel. Changing the transmitted polarization from
horizontal to vertical makes no apparent difference in
the effect.

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CLEAR WEATHER

- TRANSMISSION POLARIZATION: HORIZONTAL
- RANGE MARKS: 1.7 MILES
HEAVY RAIN

CO-POLARIZED RETURN

CROSS-POLARIZED RETURN

- TRANSMISSION POLARIZATION: HORIZONTAL
- RANGE MARKS: 1.7 MILES

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HEAVY RAIN

"A" SCOPE DISPLAY SHOWING RAIN AND LAND RETURNS IN THE TWO CHANNELS.

TOP TRACE: CO-POLARIZED RETURN
BOTTOM TRACE: CROSS-POLARIZED RETURN
SWEEP SPEED: 10 μSEC/CM
SWEEP LENGTH: 10 MILES

TOP TRACE: CO-POLARIZED RETURN
BOTTOM TRACE: CROSS-POLARIZED RETURN
SWEEP SPEED: 5 μSEC/CM
SWEEP LENGTH: 5 MILES

* TRANSMISSION POLARIZATION: HORIZONTAL
MEDIUM RAIN

BARGE ON LAKE WASHINGTON AT APPROXIMATELY ONE MILE IN RANGE

CO-POLARIZED RETURN

CROSS-POLARIZED RETURN

- TRANSMISSION POLARIZATION: HORIZONTAL
- RANGE MARKS: 1.7 MILES
MEDIUM RAIN

BARGE ON LAKE WASHINGTON AT APPROXIMATELY 1.5 MILES
FISHING BOAT ON LAKE AT APPROXIMATELY 2.5 MILES

CO-POLARIZED RETURN

FISHING BOAT

BARGE

CROSS-POLARIZED RETURN

- TRANSMISSION POLARIZATION: HORIZONTAL
- RANGE MARKS: 1.7 MILES
LIGHT RAIN

"A" SCOPE DISPLAY SHOWING AIRBORNE TARGET IN RAIN

TOP TRACE: CO-POLARIZED RETURN
BOTTOM TRACE: CROSS-POLARIZED RETURN
TARGET: 727 AIRCRAFT AT 5 MILES

TOP TRACE: CO-POLARIZED RETURN
BOTTOM TRACE: CROSS-POLARIZED RETURN
TARGET: SMALL AIRCRAFT AT 1.5 miles


- TRANSMISSION POLARIZATION: HORIZONTAL
- SWEEP SPEED: 10 μS/CM

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MEDIUM RAIN

BARGE ON LAKE WASHINGTON AT APPROXIMATELY 1.5 MILES

CROSS-POLARIZED RETURN

BARGE

CO-POLARIZED RETURN

- TRANSMISSION POLARIZATION: VERTICAL
- RANGE MARKS: 1.7 MILES
MEDIUM RAIN

BARGE ON LAKE WASHINGTON AT APPROXIMATELY ONE MILE

CO-POLARIZED RETURN

CROSS-POLARIZED RETURN

- TRANSMISSION POLARIZATION: VERTICAL
- RANGE MARKS: 1.7 MILES